APPENDIX A ENGINEERING CONNECTION ASSESSMENT

Engineering Connection Assessment

Wheatland Wind Project Connection

Wheatland Wind Project L.P.
AESO Project Number: P1718

Date: October 30, 2018

Version: V1

Classification: Public

Role	Name	Date	Signature
Prepared	Jorge Villena Myron Jin Li, E.I.T.	November 6, 2018 November 6, 2018	
Reviewed and approved	Maz Mazadi, P. Eng.	Nov 6, 2018	

PROFESSIONAL ENGINEER ALBERTA MAHMOUD (MAZ) MAZADI

Nov 06 2018

APEGA
Permit-to-Practice
P-8200

Alberta Electric System Operator, Calgary Place, 2500, 330 – 5th Avenue SW Calgary, AB T2P 0L4
Phone: 403-539-2450 Fax: 403-539-2949 www.aeso.ca @theaeso

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.

Contents

1 Introduction 1
1.1 Project Overview 1
2 Assessment Scope 2
2.1 Objectives 2
2.2 Existing System 2
2.3 Study Area 2
3 Connection Alternatives 3
3.1 Overview 3
3.2 Connection Alternatives Examined 3
3.3 Connection Alternatives Selected for Further Study 4
3.4 Connection Alternatives Not Selected for Further Study 4
4 Assessment Approach 5
4.1 Standards, Criteria and Assumptions 5
4.2 Studies Performed 5
4.2.1 Power Flow Studies 6
4.2.2 Transient Stability Studies 7
4.2.3 Short-Circuit Current Level Studies 7
4.3 Mitigation Measure Development and Evaluation 7
4.3.1 Post-Mitigation Studies 7
4.3.2 Constraint Effective Factor Studies 7
5 Interpretation of Results 8
5.1 Results Overview 8
5.2 Pre-Project Study Results 15
5.2.1 Category A Conditions 15
5.2.2 Category B Conditions 15
5.3 Post-Project Study Results 15
5.3.1 Category A Conditions 15
5.3.2 Category B Conditions 15
5.4 Post-Project with PENV Study Results 15
5.4.1 Category A Conditions 15
5.4.2 Category B Conditions 15
5.5 Mitigation Measures 16
5.5.1 Pre-Project 16
5.5.2 Post-Project 16
5.5.3 Post-Project with PENV 17
5.5.4 Post-Project Mitigation Study Results 17
6 Project Dependencies 18
7 Conclusions and Recommendations 19

Tables

Table 4-1: Connection Study Scenarios 5
Table 5-1: Summary of Reliability Criteria Violations, Project Impact and Mitigation Measures – Base Scenarios (2019 SP, 2019 SL, and 2019 WP pre-Project and post-Project study scenarios) 9
Table 5-2: Summary of Reliability Criteria Violations, PENV Project Impact and Mitigation Measures- (A comparison of the 2019 SP post-Project and 2019 SP PENV post-Project study scenarios) 12

Attachments

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

Wheatland Wind Project L.P., by its General Partner Wheatland Wind Project Ltd. (Market Participant) has submitted a request for system access service to the Alberta Electric System Operator (AESO) to connect its approved Wheatland Wind Project (Facility) to the AIES. The Facility includes an approved collector station, to be designated the Badlands 981S substation.

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 120 MW and a Rate DTS, *Demand Transmission Service*, contract capacity of 1.0 MW; and a request for transmission development (collectively, the Project).

The scheduled in-service date (ISD) for the Project is December 31, 2019.

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 Sheerness (Area 43), which is part of the South Planning Region. Sheerness (Area 43) is surrounded by the AESO planning areas of Hanna (Area 42), Strathmore/Blackie (Area 45), Brooks (Area 43) and Empress (Area 48).

From a transmission system perspective, Sheerness (Area 43) consists primarily of 240 kV and 144 kV transmission systems. Sheerness (Area 43) is connected to Hanna (Area 42) through the 240 kV transmission lines 9L59 and 9L24, and the 144 kV transmission lines 7L171 and 7L128; Sheerness (Area 43) is connected to Brooks (Area 48) through a 240 kV path made up of 240 kV transmission line 933L, 934L and 950L.

Although Sheerness (Area 43) is part of the South Planning Region, generation in Sheerness (Area 43) has a direct impact on existing constraints in Central East Sub-region[1]. These constraints are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management* (TCM Rule).

2.3 Study Area

The Study Area for the Project consists of the AESO planning areas of Sheerness (Area 43), Hanna (Area 42), Wainwright (Area 32), Alliance / Battle River (Area 36), Provost (Area 37), Lloydminster (Area 13), Vegreville (Area 56) and the tie lines that connect 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).

[1] The Central East Sub-region comprises the following AESO planning areas: Lloydminster (Area 13), Wainwright (Area 32), Alliance/Battle River (Area 36), Provost (Area 37), Hanna (Area 42), and Vegreville (Area 56).

3 Connection Alternatives

3.1 Overview

The AESO, in consultation with the ATCO Electric (ATCO), as the legal owner of transmission facilities (TFO) for the area immediately surrounding the Facility, and the Market Participant, identified five transmission alternatives to meet the Market Participant's request for system access service.

3.2 Connection Alternatives Examined

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

Alternative 1 - In-and-out connection to the 144 kV transmission line 7L85

This alternative includes the following development:

- Add a switching station, to be called Parker 2072S, with three 144 kV circuit breakers;
- Add two 144 circuits, each approximately 200 metres (m) in length, to connect the Parker 2072S substation to the 144 kV transmission line 7L85 (between the Wintering Hills 804S substation and the Bullpound 803S tap point) using an in-and-out configuration;
- Add a 144 kV circuit to connect the Facility to the Parker 2072S substation; and
- Add or modify associated equipment as required for the above transmission developments.

Alternative 2 - T-tap connection to the 144 kV transmission line 7L85

This alternative includes the following development:

- Add a 144 circuit, approximately 200 m in length, to connect the Facility to the 144 kV transmission line 7L85 (between the Wintering Hills 804S substation and the Bullpound 803S tap point) using a T-tap connection; and
- Add or modify associated equipment as required for the above transmission developments.

Alternative 3 - Radial connection to Wintering Hills 804S substation

This alternative includes the following development:

- Add a 144 kV circuit, approximately 9 kilometres (km) in length, to connect the Facility to the existing Wintering Hill 804S substation;
- Modify the Wintering Hill 804S substation by adding a 144 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission development.

Alternative 4 - Radial connection to Coyote Lake 963S substation.

This alternative includes the following development:

- Add a 144 kV circuit, approximately 30 km in length, to connect the Facility to the existing Coyote Lake 963S substation;

- Modify the Coyote Lake 963S substation by adding a 144 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission development.

Alternative 5 - Radial connection to Oakland 946S substation.

This alternative includes the following development:

- Add a 144 kV circuit, approximately 45 km in length, to connect the Facility to the existing Oakland 946S substation;
- Modify the Oakland 946S substation by adding a 144 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission development.

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

Although technically feasible, Alternative 2 was rejected by the Market Participant due to the AESO's criteria for a t-tap configuration that they would be required to implement.

Alternatives 3, 4 and 5 would involve increased transmission development and, hence, overall increased cost compared to Alternative 1. Therefore, Alternatives 3, 4 and 5 were not selected for further study.

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 ISD for the Project is December 31, 2019. Therefore, studies were performed using scenarios for 2019 summer light (SL), summer peak (SP) and winter peak (WP) conditions.

Short-circuit studies were performed using 2019 WP and 2027 WP scenarios.

Table 4-1 lists the study scenarios. Post-project scenarios reflect the Market Participant's requested Rate STS contract capacity of 120 MW at its approved Facility.

The Central Planning Region load and generation forecasts used for the connection studies were based on the *AESO 2017 Long Term Outlook* (2017 LTO).

High wind and economic coal generation dispatches were assumed to represent a credible stressed scenario.

The import/export conditions chosen for each scenario were directly related to the study scenario load condition. Study scenarios with summer light load conditions were coupled with high export conditions; while summer peak and winter peak load conditions were coupled with high import conditions.

Power flow sensitivity studies were performed to assess the ability of the proposed Provost to Edgerton and Nilrem to Vermilion Transmission System Reinforcement (PENV) project[2] to alleviate some of the observed Scenario 5 (2019 SP Post-Project) Reliability Criteria violations.

Table 4-1: Connection Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	Project Load (MW)	Project Generation (MW)
Pre-Project					
1	2019 SL	High Wind, Economic Coal, High Export	2019 SL Pre-Project	0	0

[2]The PENV project was proposed in the Amended Needs Identification Document for the Provost to Edgerton and Nilrem to Vermilion Transmission System Reinforcement in Proceeding 23429 and Application 23429-A001.

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	Project Load (MW)	Project Generation (MW)
2	2019 SP	High Wind, Economic Coal, High Import	2019 SP Pre-Project	0	0
3	2019 WP	High Wind, Economic Coal, High Import[a]	2019 WP Pre-Project	0	0
Post-Project					
4	2019 SL	High Wind, Economic Coal, High Export	2019 SL Post-Project	0	120
5	2019 SP	High Wind, Economic Coal, High Import	2019 SP Post-Project	0	120
6	2019 WP	High Wind, Economic Coal, High Import[a]	2019 WP Post-Project	0	120
7	2027 WP	All generation in the Study Area on	2027 WP Post-Project	0	120
Post-Project Sensitivity with PENV					
8	2019 SP	High Wind, Economic Coal, High Import	2019 SP Post-Project PENV	0	120

[a] All generation in the Study Area must be turned on for the short-circuit studies

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.[3]

Power flow studies were performed for 2019 SL, 2019 SP and 2019 WP pre-Project and post-Project scenarios. Power flow studies were also performed for 2019 SP post-Project PENV, which is the sensitivity study.

[3] 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.

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 selected transmission lines in the Study Area.

Transient stability studies were performed for 2019 SL, 2019 SP and 2019 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 2019 WP pre-Project scenario and for 2019 and 2027 WP post-Project scenarios.

4.3 Mitigation Measure Development and Evaluation

As explained in Section 6 of Attachment A1, mitigation measures are proposed 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 the studied Category B conditions.

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 pre-Project and post-Project connection assessment studies, and the proposed mitigation measures are summarized in Table 5-1. The Reliability Criteria violations observed in the 2019 SP post-Project and the 2019 SP post-Project PENV study scenarios (See Attachment A), and the proposed mitigation measures are summarized in Table 5-2.

- 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 – Base Scenarios (2019 SP, 2019 SL, and 2019 WP pre-Project and post-Project study scenarios)

Scenario Year/Season	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					
2019 SL	None	Thermal - above emergency rating	9L20 (Nevis 766S - Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	New violation	None	Modified RAS 139
	None	Thermal - above emergency rating	7L128 (Michichi Creek 802S - Coyote Lake 963S)	801S901T (Anderson 801S Transformer 901T)	New violation	None	New Anderson 801S RAS
	None	Thermal - above emergency rating	7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S tap point - Anderson 801S)	New violation	None	New Anderson 801S RAS
	None	Thermal - above emergency rating		7L85 (Bullpound 803S tap point - Parker 2072S)	New violation	None	New Anderson 801S RAS
	None	Thermal - above emergency rating		801S901T (Anderson 801S Transformer 901T)	New violation	None	New Anderson 801S RAS
	None	Thermal - above emergency rating	9L29 (Oakland 946S - Coyote Lake 963S)	801S901T (Anderson 801S Transformer 901T)	New violation	None	New Anderson 801S RAS
	None	Thermal - above emergency rating	963S901T (Coyote Lake 963S Transformer 901T)	801S901T (Anderson 801S Transformer 901T)	New violation	None	New Anderson 801S RAS
	None	Thermal - above normal rating	114ST1 (Ghost Pine 114S Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	New 7L171 RAS
	None	Thermal - above emergency rating	801S901T (Anderson 801S Transformer 901T)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	New 7L171 RAS
	None	Thermal - above emergency rating	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	New 7L171 RAS
2019 SP	Thermal - above normal rating	Thermal - above normal rating	7L42 (Hill 751S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally reduced violation	Planned RAS 138	Planned RAS 138
	Thermal - above emergency rating	Thermal - above normal rating	7L749\7L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally reduced violation	Planned RAS 138	Planned RAS 138
	None	Thermal - above normal rating	9L16 (Tinchebray 972S - Cordel 755S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	New 7L171 RAS
	Thermal - above normal rating	Thermal - above emergency rating	9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Planned RAS 134, Planned RAS 138, Planned RAS 139	Modified RAS 134, Planned RAS 138, Modified RAS 139
	Thermal - above emergency rating	Thermal - above emergency rating		701L (North Holden 395S - Strome 223S)	Marginally increased violation	Planned RAS 134, Planned RAS 138, Planned RAS 139	Modified RAS 134, Planned RAS 138, Modified RAS 139
	Thermal - above emergency rating	Thermal - above emergency rating		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally reduced violation	Planned RAS 134, Planned RAS 138, Planned RAS 139	Modified RAS 134, Planned RAS 138, Modified RAS 139
	None	Thermal - above normal rating		7L159 (Ghost Pine 114S tap point - Heatburg 948S)	New violation	None	Modified RAS 134, Planned RAS 138, Modified RAS 139
	Thermal - above normal rating	Thermal - above normal rating		7L701 (Heisler 764S tap point - Battle River 757S)	Marginally increased violation	Planned RAS 134, Planned RAS 138, Planned RAS 139	Modified RAS 134, Planned RAS 138, Modified RAS 139
	Thermal - above emergency rating	Thermal - above emergency rating		766S901T (Nevis 766S Transformer 901T)	Materially increased violation	Planned RAS 134, Planned RAS 138, Planned RAS 139	Modified RAS 134, Planned RAS 138, Modified RAS 139
	None	Thermal - above normal rating		7L16 (Nevis 766S - Heatburg 948S)	New violation	None	Modified RAS 134, Planned RAS 138, Modified RAS 139
	None	Thermal - above normal rating		7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	Modified RAS 134, Planned RAS 138, Modified RAS 139
	Thermal - above normal rating	Thermal - above normal rating	7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally reduced violation	Planned RAS 138	Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating	749L\749AL (Metiskow 648S - Edgerton 899S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally reduced violation	Planned RAS 138, Existing RAS 32	Planned RAS 138, Existing RAS 32
	Thermal - above emergency rating	Thermal - above emergency rating	899ST3A (Edgerton 899S Transformer T3A)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally reduced violation	Planned RAS 138, Existing RAS 32	Planned RAS 138, Existing RAS 32

Scenario Year/Season	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					
	None	Thermal - above normal rating	648ST1 (Metiskow 648S Transformer T1)	7L129 (Buffalo Creek 526S - Bauer 918S tap point)	New violation	None	Planned RAS 138, Real-time operational practices
	Thermal - above emergency rating	Thermal - above emergency rating		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally increased violation	Planned RAS 138, Real-time operational practices	Planned RAS 138, Real-time operational practices
	None	Thermal - above normal rating		7L129 (Bauer 918S tap point - Vermilion 710S)	New violation	None	Planned RAS 138, Real-time operational practices
	Thermal - above emergency rating	Thermal - above emergency rating		7L130 (Vermilion 710S - Kitscoty 705S)	Materially increased violation	Planned RAS 138, Real-time operational practices	Planned RAS 138, Real-time operational practices
	Thermal - above emergency rating	Thermal - above emergency rating		7L14 (Kitscoty 705S - Hill 751S)	Materially increased violation	Planned RAS 138, Real-time operational practices	Planned RAS 138, Real-time operational practices
	Thermal - above emergency rating	Thermal - above emergency rating	912L\9L912 (Red Deer 63S - Nevis 766S)[a]	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Planned RAS 134,Planned RAS 138	Planned RAS 134,Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		701L (North Holden 395S - Strome 223S)	Materially increased violation	Planned RAS 134,Planned RAS 138	Planned RAS 134,Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		701L\7L701 (Strome 223S - Heisler 764S tap point)	Materially increased violation	Planned RAS 134,Planned RAS 138	Modified RAS 134, Planned RAS 138
	None	Thermal - above normal rating		7L129 (Buffalo Creek 526S - Bauer 918S tap point)	New violation	None	Modified RAS 134, Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally increased violation	Planned RAS 134,Planned RAS 138, Existing RAS 32	Modified RAS 134, Planned RAS 138
	None	Thermal - above normal rating		7L129 (Bauer 918S tap point - Vermilion 710S)	New violation	None	Modified RAS 134, Planned RAS 138
	Thermal - above normal rating	Thermal - above emergency rating		7L701 (Heisler 764S tap point - Battle River 757S)	Materially increased violation	Planned RAS 134,Planned RAS 138	Modified RAS 134, Planned RAS 138
	None	Thermal - above emergency rating	7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	New violation	None	New Anderson 801S RAS
	None	Thermal - above emergency rating		7L85 (Bullpound 803S - Parker 2072S)	New violation	None	New Anderson 801S RAS
	None	Thermal - above emergency rating		801S901T (Anderson 801S Transformer 901T)	New violation	None	New Anderson 801S RAS
	None	Thermal - above normal rating	114ST1 (Ghost Pine 114S Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	New 7L171 RAS
	Thermal - above emergency rating	Thermal - above emergency rating	766S901T (Nevis 766S Transformer 901T)[a]	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Planned RAS 134,Planned RAS 138	Modified RAS 134, Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		701L (North Holden 395S - Strome 223S)	Materially increased violation	Planned RAS 134,Planned RAS 138	Modified RAS 134, Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		701L\7L701 (Strome 223S - Heisler 764S tap point)	Materially increased violation	Planned RAS 134,Planned RAS 138	Modified RAS 134, Planned RAS 138
	None	Thermal - above normal rating		7L129 (Buffalo Creek 526S - Bauer 918S tap point)	New violation	None	Modified RAS 134, Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally increased violation	Planned RAS 134,Planned RAS 138, Existing RAS 32	Modified RAS 134, Planned RAS 138
	None	Thermal - above normal rating		7L129 (Bauer 918S tap point - Vermilion 710S)	New violation	None	Modified RAS 134, Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		7L701 (Heisler 764S tap point - Battle River 757S)	Marginally increased violation	Planned RAS 134,Planned RAS 138	Modified RAS 134, Planned RAS 138
	None	Thermal - above emergency rating	801S901T (Anderson 801S Transformer 901T)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	New 7L171 RAS
	None	Thermal - above emergency rating	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	New 7L171 RAS
	Thermal - above normal	Thermal - above normal	701L (North Holden 395S - Strome 223S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally reduced	Planned RAS 138	Planned RAS 138

Scenario Year/Season	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					
	rating	rating			violation		
	Thermal - above normal rating	Thermal - above normal rating	395ST1 (North Holden 395S Transformer T1)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally reduced violation	Planned RAS 138	Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating	EATL (Newell 2075S - Heathfield 2029S)[a]	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Planned RAS 134, Planned RAS 138	Modified RAS 134, Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		701L (North Holden 395S - Strome 223S)	Marginally increased violation	Planned RAS 134, Planned RAS 138	Modified RAS 134, Planned RAS 138
	Thermal - above normal rating	Thermal - above normal rating		701L\7L701 (Strome 223S - Heisler 764S tap point)	Marginally increased violation	Planned RAS 134, Planned RAS 138	Modified RAS 134, Planned RAS 138
	None	Thermal - above normal rating		7L129 (Buffalo Creek 526S - Bauer 918S tap point)	New violation	None	Modified RAS 134, Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally reduced violation	Planned RAS 134,Planned RAS 138, Existing RAS 32	Modified RAS 134, Planned RAS 138
	None	Thermal - above normal rating		7L159 (Ghost Pine 114S tap point - Heatburg 948S)	New violation	None	Modified RAS 134, Planned RAS 138
	Thermal - above normal rating	Thermal - above normal rating		7L701 (Heisler 764S tap point - Battle River 757S)	Marginally increased violation	Planned RAS 134, Planned RAS 138	Modified RAS 134, Planned RAS 138
	Thermal - above emergency rating	Thermal - above emergency rating		912L\9L912 (Red Deer 63S - Nevis 766S)	Materially increased violation	Planned RAS 134, Planned RAS 138	Modified RAS 134, Planned RAS 138
	None	Thermal - above normal rating		9L20 (Nevis 766S - Cordel 755S)	New violation	None	Modified RAS 134, Planned RAS 138
	None	Thermal - above normal rating		7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	Modified RAS 134, Planned RAS 138
2019 WP	None	Thermal - above normal rating	7L129\7LA129 (Buffalo Creek 526S - Vermilion 710S - Bauer 918S)	749L (Edgerton 899S - Killarney Lake 267S tap point)	New violation	None	Real-time operational practices
	Thermal - above normal rating	Thermal - above normal rating	7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	749L (Edgerton 899S - Killarney Lake 267S tap point)	Marginally reduced violation	Real-time operational practices	Real-time operational practices
	Thermal - above normal rating	None		749L\7L749 (Edgerton 899S – Briker 880S tap point)	Removes violation	Real-time operational practices	None
	None	Thermal - above normal rating	9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	New violation	None	Modified RAS 134, Modified RAS 139
	Thermal - above emergency rating	Thermal - above emergency rating		766S901T (Nevis 766S Transformer 901T)	Materially increased violation	Planned RAS 139	Modified RAS 134, Modified RAS 139
	Thermal - above emergency rating	Thermal - above emergency rating	749L\749AL (Metiskow 648S - Edgerton 899S)	7L130 (Vermilion 710S - Kitscoty 705S)	Marginally increased violation	Real-time operational practices	Real-time operational practices
	Thermal - above normal rating	Thermal - above normal rating	648ST1 (Metiskow 648S Transformer T1)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Marginally increased violation	Planned RAS 138, Real-time operational practices	Planned RAS 138, Real-time operational practices
	Thermal - above emergency rating	Thermal - above emergency rating		7L130 (Vermilion 710S - Kitscoty 705S)	Materially increased violation	Planned RAS 138, Real-time operational practices	Planned RAS 138, Real-time operational practices
	Thermal - above emergency rating	Thermal - above emergency rating		7L14 (Kitscoty 705S - Hill 751S)	Materially increased violation	Planned RAS 138, Real-time operational practices	Planned RAS 138, Real-time operational practices
	Thermal - above emergency rating	Thermal - above emergency rating	912L\9L912 (Red Deer 63S - Nevis 766S))	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Planned RAS 134	Modified RAS 134
	Thermal - above normal rating	Thermal - above normal rating		701L (North Holden 395S - Strome 223S)	Materially increased violation	Planned RAS 134	Modified RAS 134
	None	Thermal - above emergency rating		701L\7L701 (Strome 223S - Heisler 764S tap point)	New violation	None	Modified RAS 134
	None	Thermal - above normal rating	7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	New violation	None	New Anderson 801S RAS
	None	Thermal - above emergency rating		7L85 (Bullpound 803S - Parker 2072S)	New violation	None	New Anderson 801S RAS

Scenario Year/Season	Type of Reliability Criteria Violation: Pre-Project	Type of Reliability Criteria Violation: Post-Project	Contingency (System Element Lost)	Details of Violation	Project Impact	Pre-Project Mitigation Measures	Post-Project Mitigation Measures
	None	Thermal - above emergency rating		801S901T (Anderson 801S Transformer 901T)	New violation	None	New Anderson 801S RAS
	Thermal - above emergency rating	Thermal - above emergency rating	766S901T (Nevis 766S Transformer 901T)	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Planned RAS 134	Modified RAS 134
	Thermal - above normal rating	Thermal - above normal rating		701L (North Holden 395S - Strome 223S)	Materially increased violation	Planned RAS 134	Modified RAS 134
	None	Thermal - above emergency rating		701L\7L701 (Strome 223S - Heisler 764S tap point)	New violation	None	Modified RAS 134
	None	Thermal - above emergency rating	801S901T (Anderson 801S Transformer 901T)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	New 7L171 RAS
	None	Thermal - above emergency rating	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	New violation	None	New 7L171 RAS
	Thermal - above normal rating	Thermal - above normal rating	EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Planned RAS 134	Modified RAS 134
	None	Thermal - above normal rating		701L (North Holden 395S - Strome 223S)	New violation	None	Modified RAS 134
	Thermal - above normal rating	Thermal - above normal rating		749L (Edgerton 899S - Killarney Lake 267S tap point)	Marginally increased violation	Planned RAS 134	Modified RAS 134
	Thermal - above normal rating	Thermal - above normal rating	526ST1 OR 526ST2 (526ST1 or 526ST2 (Buffalo Creek 526S Transformer T1 or T2))	749L (Edgerton 899S - Killarney Lake 267S tap point)	Marginally increased violation	Real-time operational practices	Real-time operational practices

[a] Pre-contingency generation curtailment by RAS action under normal condition may be required following these contingencies.

Notes:

- Marginally increased or marginally decreased refers to a percent loading difference (post-Project percent loading minus pre-Project percent loading) below 3%.
- Materially increased or materially decreased refers to a percent loading difference (post-Project percent loading minus pre-Project percent loading) above or equal to 3%.
- RAS 32 is an existing RAS (see Section 1.2.2 of Attachment A1).
- RAS 134 is an existing RAS (see Section 1.2.2 of Attachment A1). Modifications to existing RAS 134 will be part of the approved Sharp Hills Wind Farm Connection.[4] This modified version of RAS 134 is referred to herein as “Planned RAS 134”.
- RAS 138 is an existing RAS (see Section 1.2.2 of Attachment A1). Modifications to existing RAS 138 were proposed for the approved Sharp Hills Wind Farm Connection NIDs. This modified version of RAS 138 is referred to herein as “Planned RAS 138”.
- RAS 139 is an existing RAS (see Section 1.2.2 of Attachment A1). Modifications to existing RAS 139 were proposed for the approved Suncor Hand Hills Wind Energy Project, BluEarth Hand Hills Wind Energy Project and Sharp Hills Wind Farm Connection NID.[5] This modified version of RAS 139 is referred to herein as “Planned RAS 139”.
- In this table, “Modified” refers to adding the Project to the logic of the respective RAS

Table 5-2: Summary of Reliability Criteria Violations, PENV Project Impact and Mitigation Measures- (A comparison of the 2019 SP post-Project and 2019 SP PENV post-Project study scenarios)

Scenario Year/Season	Type of Reliability Criteria Violation: Pre-PENV	Type of Reliability Criteria Violation: Post-PENV	Contingency (System Element Lost)	Details of Violation	Project Impact	Pre-PENV Mitigation Measures	Post-PENV Mitigation Measures
2019 SP	Thermal - above normal rating	None	7L42 (Hill 751S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Planned RAS 138	None
	Thermal - above normal rating	None	7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Planned RAS 138	None
	Thermal - above normal rating	None	9L16 (Tinchebray 972S - Cordel 755S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Removes violation	New 7L171 RAS	None
	Thermal - above emergency rating	Thermal - above emergency rating	9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Modified RAS 134, Planned RAS 138, Modified RAS 139	Modified RAS 134, Modified RAS 139
	Thermal - above emergency rating	Thermal - above normal rating		701L (North Holden 395S - Strome 223S)	Materially reduced violation	Modified RAS 134, Planned RAS 138, Modified RAS 139	Modified RAS 134, Modified RAS 139
	Thermal - above emergency rating	None		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Modified RAS 134, Planned RAS 138, Modified RAS 139	None

[4] The *Sharp Hills Wind Farm Connection NID* was approved on October 4, 2018 in AUC Decision 23066-D01-2018 and Approval 23066-D02-2018.

[5] The *Suncor Hand Hills Wind Energy Connection NID* and the *BluEarth Hand Hills Wind Energy Connection NID*, were originally approved on May 7, 2015 by AUC Decision 2482-D01-2015 and Approval 2482-D03-2015 and Approval 2482-D02-2015, respectively.

Thermal - above normal rating	Thermal - above normal rating		7L159 (Ghost Pine 114S tap point - Heatburg 948S)	Marginally reduced violation	Modified RAS 134, Planned RAS 138, Modified RAS 139	Modified RAS 134, Modified RAS 139
Thermal - above normal rating	Thermal - above normal rating		7L701 (Heisler 764S tap point - Battle River 757S)	Materially reduced violation	Modified RAS 134, Planned RAS 138, Modified RAS 139	Modified RAS 134, Modified RAS 139
Thermal - above emergency rating	Thermal - above emergency rating		766S901T (Nevis 766S Transformer 901T)	Marginally reduced violation	Modified RAS 134, Planned RAS 138, Modified RAS 139	Modified RAS 134, Modified RAS 139
Thermal - above normal rating	Thermal - above normal rating		7L16 (Nevis 766S - Heatburg 948S)	Marginally reduced violation	Modified RAS 134, Planned RAS 138, Modified RAS 139	Modified RAS 134, Modified RAS 139
Thermal - above normal rating	Thermal - above normal rating		7L171 (Michichi Creek 802S - Wintering Hills 804S)	Materially reduced violation	Modified RAS 134, Planned RAS 138, Modified RAS 139	Modified RAS 134, Modified RAS 139
Thermal - above normal rating	None	7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Planned RAS 138	None
Thermal - above emergency rating	None	749L\749AL (Metiskow 648S - Edgerton 899S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Planned RAS 138, Existing RAS 32	None
Thermal - above emergency rating	None	899ST3A (Edgerton 899S Transformer T3A)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Planned RAS 138, Existing RAS 32	None
Thermal - above normal rating	None	648ST1 (Metiskow 648S Transformer T1)	7L129 (Buffalo Creek 526S - Bauer 918S tap point)	Removes violation	Planned RAS 138, Real-time operational practices	None
Thermal - above emergency rating	None		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Planned RAS 138, Real-time operational practices	None
Thermal - above normal rating	None		7L129 (Bauer 918S tap point - Vermilion 710S)	Removes violation	Planned RAS 138, Real-time operational practices	None
Thermal - above emergency rating	None		7L130 (Vermilion 710S - Kitscoty 705S)	Removes violation	Planned RAS 138, Real-time operational practices	None
Thermal - above emergency rating	None		7L14 (Kitscoty 705S - Hill 751S)	Removes violation	Planned RAS 138, Real-time operational practices	None
Thermal - above emergency rating	Thermal - above emergency rating	912L\9L912 (Red Deer 63S - Nevis 766S) [a]	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Planned RAS 134,Planned RAS 138	Modified RAS 134
Thermal - above emergency rating	Thermal - above emergency rating		701L (North Holden 395S - Strome 223S)	Materially reduced violation	Planned RAS 134,Planned RAS 138	Modified RAS 134
Thermal - above emergency rating	Thermal - above emergency rating		701L\7L701 (Strome 223S - Heisler 764S tap point)	Materially reduced violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above normal rating	None		7L129 (Buffalo Creek 526S - Bauer 918S tap point)	Removes violation	Modified RAS 134, Planned RAS 138	None
Thermal - above emergency rating	None		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Modified RAS 134, Planned RAS 138	None
Thermal - above normal rating	None		7L129 (Bauer 918S tap point - Vermilion 710S)	Removes violation	Modified RAS 134, Planned RAS 138	None
Thermal - above emergency rating	Thermal - above normal rating		7L701 (Heisler 764S tap point - Battle River 757S)	Materially reduced violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above emergency rating	Thermal - above emergency rating	7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	Removes violation	New Anderson 801S RAS	New Anderson 801S RAS
Thermal - above emergency rating	Thermal - above emergency rating		7L85 (Bullpound 803S - Parker 2072S)	Removes violation	New Anderson 801S RAS	New Anderson 801S RAS
Thermal - above emergency rating	Thermal - above emergency rating		801S901T (Anderson 801S Transformer 901T)	Marginally reduced violation	New Anderson 801S RAS	New Anderson 801S RAS
Thermal - above normal rating	Thermal - above normal rating	114ST1 (Ghost Pine 114S Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Marginally reduced violation	New 7L171 RAS	New 7L171 RAS
Thermal - above emergency rating	Thermal - above emergency rating	766S901T (Nevis 766S Transformer 901T) [a]	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above emergency rating	Thermal - above emergency rating		701L (North Holden 395S - Strome 223S)	Materially reduced violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above emergency rating	Thermal - above emergency rating		701L\7L701 (Strome 223S - Heisler 764S tap point)	Materially reduced violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above normal rating	None		7L129 (Buffalo Creek 526S - Bauer 918S tap point)	Removes violation	Modified RAS 134, Planned RAS 138	None
Thermal - above emergency rating	None		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Modified RAS 134, Planned RAS 138	None
Thermal - above normal	None		7L129 (Bauer 918S tap point - Vermilion 710S)	Removes violation	Modified RAS 134, Planned RAS 138	None

rating						
Thermal - above emergency rating	Thermal - above normal rating		7L701 (Heisler 764S tap point - Battle River 757S)	Materially reduces violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above emergency rating	Thermal - above emergency rating	801S901T (Anderson 801S Transformer 901T)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Materially reduced violation	New 7L171 RAS	New 7L171 RAS
Thermal - above emergency rating	Thermal - above emergency rating	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Materially reduced violation	New 7L171 RAS	New 7L171 RAS
Thermal - above normal rating	None	701L (North Holden 395S - Strome 223S)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Planned RAS 138	None
Thermal - above normal rating	None	395ST1 (North Holden 395S Transformer T1)	7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Planned RAS 138	None
Thermal - above emergency rating	Thermal - above emergency rating	EATL (Newell 2075S - Heathfield 2029S) [a]	174L (Bardo 197S - North Holden 395S)	Materially increased violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above emergency rating	Thermal - above emergency rating		701L (North Holden 395S - Strome 223S)	Materially reduced violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above normal rating	None		701L\7L701 (Strome 223S - Heisler 764S tap point)	Removes violation	Planned RAS 134, Planned RAS 138	None
Thermal - above normal rating	None		7L129 (Buffalo Creek 526S - Bauer 918S tap point)	Removes violation	Modified RAS 134, Planned RAS 138	None
Thermal - above emergency rating	None		7L50 (Buffalo Creek 526S - Jarrow 252S tap point)	Removes violation	Modified RAS 134, Planned RAS 138	None
Thermal - above normal rating	Thermal - above normal rating		7L159 (Ghost Pine 114S tap point - Heatburg 948S)	Marginally reduced violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above normal rating	Thermal - above normal rating		7L701 (Heisler 764S tap point - Battle River 757S)	Materially reduced violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above emergency rating	Thermal - above emergency rating		912L\9L912 (Red Deer 63S - Nevis 766S)	Materially reduced violation	Modified RAS 134, Planned RAS 138	Modified RAS 134
Thermal - above normal rating	None		9L20 (Nevis 766S - Cordel 755S)	Removes violation	Modified RAS 134, Planned RAS 138	None
Thermal - above normal rating	Thermal - above normal rating		7L171 (Michichi Creek 802S - Wintering Hills 804S)	Materially reduced violation	Modified RAS 134, Planned RAS 138	Modified RAS 134

[a] Pre-contingency generation curtailment by RAS action under normal condition will not be required after the proposed PENV project is in service following these contingencies

Notes:

- Marginally increased or marginally decreased refers to a percent loading difference (post-Project percent loading minus pre-Project percent loading) below 3%.
- Materially increased or materially decreased refers to a percent loading difference (post-Project percent loading minus pre-Project percent loading) above or equal to 3%.
- RAS 32 is an existing RAS (see Section 1.2.2 of Attachment A1).
- RAS 134 is an existing RAS (see Section 1.2.2 of Attachment A1). Modifications to existing RAS 134 will be part of the approved Sharp Hills Wind Farm Connection. This modified version of RAS 134 is referred to herein as “Planned RAS 134”.
- RAS 138 is an existing RAS (see Section 1.2.2 of Attachment A1). Modifications to existing RAS 138 were proposed for the approved Sharp Hills Wind Farm Connection NIDs. This modified version of RAS 138 is referred to herein as “Planned RAS 138”.
- RAS 139 is an existing RAS (see Section 1.2.2 of Attachment A1). Modifications to existing RAS 139 were proposed for the approved Suncor Hand Hills Wind Energy Project, BluEarth Hand Hills Wind Energy Project and Sharp Hills Wind Farm Connection NID. This modified version of RAS 139 is referred to herein as “Planned RAS 139”.
- In this table, “Modified” refers to adding the Project to the logic of the respective RAS

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 current levels were found to be within the typical capabilities of the nearby facilities.

5.2.2 Category B Conditions

The pre-Project power flow studies identified a number of thermal violations under Category B conditions (i.e., loss of a single system element).

In addition, under Category B conditions, no voltage deviations were observed that were beyond the limits listed in Table 3-1 of Attachment A1 at point of delivery (POD) low voltage busses (subsequently referred to as POD bus voltage deviations).

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. Post-Project short-circuit current levels were not significantly higher than pre-Project levels.

The long-term short circuit current 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 a number of system performance issues under Category B conditions, namely: thermal criteria violations, both above the normal rating and the emergency rating.

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

5.4 Post-Project with PENV Study Results

5.4.1 Category A Conditions

No Reliability Criteria violations were observed under the Category A condition for any post-Project PENV scenarios.

5.4.2 Category B Conditions

Post-Project PENV power flow studies identified a number of system performance issues under Category B conditions, namely: thermal criteria violations, both above the normal rating and the emergency rating.

5.5 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.

5.5.1 Pre-Project

Prior to connection of the Project, some of the observed thermal criteria violations can be managed by using real-time operational practices. The remaining thermal criteria violations can be mitigated by the following RAS:

- modifications to the planned RAS 134 (referred to as "planned RAS 134"). This RAS monitors the flow on the 138 kV transmission line 174L;
- modifications to the existing RAS 138 (referred to as "planned RAS 138"). This RAS monitors the flow on the 144 kV transmission line 7L50;
- modifications to the existing RAS 139 (referred to as "planned RAS 139"). This RAS monitors the flow on Nevis 766S transformer 901T; and
- existing RAS 32. This RAS monitors the flow in 7L50.

The modifications to the existing RAS 138 were proposed for the approved Sharp Hills Wind Farm Connection NID. The modifications to existing RAS 139 are included as part of the AESO's planned connection of the approved Suncor Hand Hills Wind Energy Project, BluEarth Hand Hills Wind Energy Project and Sharp Hills Wind Farm Connection NIDs. The modifications to the existing RAS 134 are the result of AESO operational studies performed after the Sharp Hills Wind Farm Connection NID was submitted to the AUC for approval.

In these studies, the above planned RASs sequentially trip generation from Sharp Hills Wind Farm project and Halkirk Wind Farm until the thermal violation is mitigated.

5.5.2 Post-Project

After connection of the Project, some of the thermal criteria violations observed can be mitigated by using real-time operational practices. Some of the remaining thermal criteria violations can be mitigated by:

- modification to planned RAS 134, by including the Project in the RAS logic (referred to as "modified RAS 134");
- modification to planned RAS 139, by including the Project in the RAS logic (referred to as "modified RAS 139");
- planned RAS 138; and
- existing RAS 32.

The thermal criteria violations observed on the 144 kV transmission line 7L171 can be mitigated by a new RAS, referred to as the "new 7L171 RAS". The thermal criteria violations observed on the 240/144 kV transformer at Anderson 801S substation and on the 144 kV transmission line 7L85 can be mitigated by a new RAS, referred to as the "new Anderson 801S RAS".

With the proposed logic, planned RAS 134 and planned RAS 139 have approximately 520 MW of generation tied to them.

For 2019 SP post-Project study scenarios, the studies indicate that, in order to mitigate the thermal violations following the contingencies of 500 kV DC Eastern Alberta Transmission Line (EATL), 240 kV transmission line 912L/9L912 or Nevis 766S transformer 901T, the combined action of modified RAS 134 and planned RAS 138 may result in generation curtailment in excess of the current Most Severe Single Contingency (MSSC) level of 466 MW. Pre-contingency generation curtailment under normal condition may be required using real-time operational practices to prevent generation curtailment by RAS action above the MSSC level (see highlighted cells in Table 5-1).

As indicated in Section 4.2, power flow sensitivity studies were performed with the proposed PENV project in place to assess the ability of the proposed PENV project to address the potential pre-contingency generation curtailment described above.

5.5.3 Post-Project with PENV

With the proposed PENV project in place, all the thermal criteria violations observed can be mitigated by modified RAS 134, modified RAS 139, the new 7L171 RAS, and the new Anderson 801S RAS (see Table 5-2). The thermal overloads that triggered RAS 138, RAS 32, and real-time operational practices were not observed..

In the studies, these RASs involved generation curtailment by RAS action of less than the MSSC level.

5.5.4 Post-Project Mitigation Study Results

As described above, prior to proposed PENV project being in service, the post-Project studies, all thermal criteria violations observed under Category B conditions can be mitigated by the new 7L171 RAS, the new Anderson 801S RAS, the modified RAS 134, the modified RAS 139, the planned RAS 138, the existing RAS 32 and real-time operational practices.

To mitigate the observed thermal criteria violations following the contingencies of 500 kV DC Eastern Alberta Transmission Line (EATL), 240 kV transmission line 912L/9L912 or Nevis 766S transformer 901T under certain system conditions, curtailment above the current MSSC level may be required. This may require pre-contingency generation curtailment under normal condition. Power Flow study with PENV system elements included was performed to ensure that PENV can alleviate this issue.

In the post-Project with PENV studies, all the thermal criteria violations observed can be mitigated by modified RAS 134, modified RAS 139, the new 7L171 RAS, and the new Anderson 801S RAS, involving generation curtailment by RAS action of less than the current MSSC level.

Compared to SP post-Project -prior to PENV-, the post-Project with PENV study showed the following:

- less thermal violations were observed;
- the thermal overloads that triggered RAS 138, RAS 32, and real-time operational practices were not observed; and
- the proposed RASs curtailed generation below the MSSC level.

6 Project Dependencies

The Project does not require the completion of any AESO plans to expand or enhance the transmission system prior to connection. However, prior to the completion of the proposed PENV project, under certain conditions, generation curtailment above the current MSSC level may be needed to remove all thermal criteria violations on the 144 kV transmission line 7L50 (between Jarrow 252S tap point and Buffalo Creek 526S). Real time operational practices, which could include pre-contingency generation curtailment, would be required under such conditions until the PENV project is in service.

In addition, there are a number of thermal violations observed in all studied scenarios, which relate to the transfer out capability from the Central East Sub-region to load centres in the rest of the AIES, including thermal violations on the 138 kV transmission line 174L and Nevis 766S transformer 901T. The AESO plans to address the Central East Sub-region transfer out capability issues through future projects.

7 Conclusions and Recommendations

Based on the study results, Alternative 1 is technically viable. The connection assessment identified a number of pre-Project and post-Project system performance issues. These issues can be mitigated through the use of modified RAS 134, planned RAS 138, modified RAS 139, the new 7L171 RAS, the new Anderson 801S RAS, the existing RAS 32, and real-time operational practices.

The study results for 2019 SP post-Project scenario indicated that, to mitigate the observed thermal criteria violations following several contingencies, generation curtailment by RAS action in excess of the current MSSC level may be required. As a consequence, pre-contingency generation curtailment under normal condition may be required.

In light of these results, a power flow sensitivity study that includes the proposed PENV project was studied. This sensitivity study indicates that, after the energization of PENV, the thermal criteria violations previously observed on the 144 kV transmission line 7L50 (between Jarrow 252S tap point and Buffalo Creek 526S), under certain studied Category B conditions, are alleviated and real-time operational practices will no longer be needed. The remaining thermal violations can be mitigated by the modified RAS 134, the modified RAS 139, the new 7L171 RAS, and the new Anderson 801S RAS. These RASs involve generation curtailment by RAS action of less than the current MSSC level.

The thermal violations identified in the study can be sorted in three categories:

- issues in Hanna (Area 42) and Sheerness (Area 43).These are directly related to the Project and will be addressed by the new RASs proposed;
- issues in the PENV Area.[6] These thermal violations will be addressed by a combination of planned RAS actions. After connection of the Project, the total generation tied to these RASs will exceed the current MSSC level, and when activated, they may trip generation above that level, which may require pre-contingency generation curtailment. This will be addressed by PENV; and
- issues related to the transfer out capability of Central East Sub-region. These thermal violations will be addressed by a combination of modifications to planned RAS actions. After connection of the Project, the total generation tied to these RASs will exceed the current MSSC level. The AESO plans to address the Central East transfer out capability issues through future projects.

It is recommended to proceed with the Project using Alternative 1 as the preferred option to respond to the Market Participant's request for system access service. It is also recommended to modify planned RAS 134 and planned RAS 139; to create two new RASs, including the new 7L171 RAS and the new Anderson 801S RAS; and to use the planned RAS 138, the existing RAS 32, and real-time operational practices to mitigate the identified system performance issues.

Alternative 1 involves adding a transmission line to connect the Facility to a switching station with three 144 kV circuit breakers, to be designated Parker 2072S; adding two 144 kV circuits, approximately 200 m in length, to connect the proposed Parker 2072S substation to the existing 144 kV transmission line 7L85

[6] The PENV area includes the following five AESO Planning Areas: Vegreville (Area 56), Lloydminster (Area 13); Wainwright (Area 32); Provost (Area 37); and Alliance/Battle River (Area 36).

using an in-and-out configuration; and adding a 144 kV circuit to connect the Facility to the Parker 2072S substation.

A minimum rating equal or greater than the rating of the existing 144 kV transmission line 7L85 is recommended for the two new 144 kV circuits that will connect the proposed Parker 2072S substation to the existing 144kV transmission line 7L85.

A minimum rating of 134 MVA is recommended for the new 144 kV circuit that will connect the Facility to the proposed Parker 2072S substation. This will meet the Market Participant's total requested Rate STS contract capacity of 120 MW.

Attachment A:
Engineering Connection Assessment Results

Engineering Connection Assessment: Study Results

P1718 Wheatland WAGF Project

Wheatland Wind Project LP

Date: October 25, 2018

Version: V1D2

Classification: Public

Role	Name	Date	Signature
Prepared	Jaryn Vaile, E.I.T.	October 25, 2018	
Reviewed	Mahmud Rashid, P. Eng.	October 25, 2018	
Approved	Ashraf Haque, P. Eng.	October 25, 2018	

PROFESSIONAL ENGINEER ALBERTA
ASHRAF UL HAQUE

October 25, 2018

Contents

1 Introduction 1
2 Pre-Project Study Results 2
2.1 Power Flow Studies 2
2.1.1 Scenario 1: 2019 Summer Light High Wind Economy Coal Pre-Project 2
2.1.2 Scenario 2: 2019 Summer Peak High Wind Economy Coal Pre-Project 2
2.1.3 Scenario 3: 2019 Winter Peak High Wind Economy Coal Pre-Project 4
3 Post-Project Study Results 5
3.1 Power Flow Studies 5
3.1.1 Scenario 4: 2019 Summer Light High Wind Economy Coal Post-Project 5
3.1.2 Scenario 5: 2019 Summer Peak High Wind Economy Coal Post-Project 6
3.1.3 Scenario 6: 2019 Winter Peak High Wind Economy Coal Post-Project 10
3.1.4 Scenario 8: 2019 Summer Peak High Wind Economy Coal Post-Project Sensitivity with PENV 13
3.2 Transient Stability Studies 16
4 Short Circuit Studies 17
4.1 Pre-Project Results 17
4.2 Post-Project Results 17
4.2.1 Scenario 6: 2019 Winter Peak High Wind Economy Coal Post-Project 17
4.2.2 Scenario 7: 2027 Winter Peak Post-Project 18
5 Mitigation Measure Development and Evaluation 20
5.1 Pre-Project 20
5.2 Post-Project 21
5.3 Evaluation of Mitigation Measures 23
5.3.1 Scenario 4: 2019 Summer Light High Wind Economy Coal Post-Project 23
5.3.2 Scenario 5: 2019 Summer Peak High Wind Economy Coal Post-Project 24
5.3.3 Scenario 6: 2019 Winter Peak High Wind Economy Coal Post-Project 27
5.3.4 Scenario 8: 2019 Summer Peak High Wind Economy Coal Post-Project Sensitivity with PENV 28
5.4 Constraint Effective Factor Studies 30

Tables

Table 2-1: Thermal Criteria Violations under Category B Conditions for Scenario 2 2
Table 2-2: Thermal Criteria Violations under Category B Conditions for Scenario 3 4
Table 3-1: Thermal Criteria Violations under Category B Conditions for Scenario 4 5
Table 3-2: Thermal Criteria Violations under Category B Conditions for Scenario 5 7
Table 3-3: Thermal Criteria Violations under Category B Conditions for Scenario 6 10
Table 3-4: Thermal Criteria Violations under Category B Conditions for Scenario 8 13
Table 3-5: Transient Stability Study Results under Category B Conditions for Scenario 4, Scenario 5, and Scenario 6 16
Table 4-2: Post-Project Short-Circuit Current Levels for Scenario 6 17
Table 4-3: Post-Project Short-Circuit Current Levels for Scenario 7 18
Table 5-1: Pre-Project Mitigation Measures 20
Table 5-2: Post-Project Mitigation Measures 21
Table 5-3: Post-RAS Power Flow Study Results for Scenario 4 23
Table 5-4: Post-RAS Power Flow Study Results for Scenario 5 24
Table 5-5: Post-RAS Power Flow Study Results for Scenario 6 27
Table 5-6: Post-RAS Power Flow Study Results for Scenario 8 28

Attachments

Attachment A1 Engineering Connection Assessment: Study Scope
Attachment A2 Pre-Project Power Flow Diagrams
Attachment A3 Post-Project Power Flow Diagrams
Attachment A4 Post-Project Transient Stability Diagrams
Attachment A5 Dynamic Data and Assumptions
Attachment A6 Post-Mitigation Power Flow Diagrams
Attachment A7 Constraint Effective Factors Table

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.

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: 2019 Summer Light High Wind Economy Coal Pre-Project

Category A Conditions

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

Category B Conditions

No Reliability Criteria violations were observed under Category B conditions.

2.1.2 Scenario 2: 2019 Summer Peak High Wind Economy Coal Pre-Project

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

Thermal criteria violations were observed under certain Category B conditions as shown in Table 2-1.

Table 2-1: Thermal Criteria Violations under Category B Conditions for Scenario 2

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings[a] (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Observed Power Flow (MVA)	% Loading[b]
7L42 (Hill 751S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	114.4	104.7
7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	124.8	114.2
9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	93.3	109.6
	701L (North Holden 395S - Strome 223S)	119.0	131.0	134.2	112.8
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	127.1	116.3
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	154.3	110.3
	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	121.1	121.1
7L701\7LA701\701L (Battle River 757S - Heisler 764S -	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	122.6	112.2

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings[a] (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Observed Power Flow (MVA)	% Loading[b]
Strome 223S)					
749L\749AL (Metiskow 648S - Edgerton 899S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	130.7	119.5
899ST3A (Edgerton 899S 138/25 kV Transformer T3A)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	127.3	116.5
648ST1 (Metiskow 648S 138/25 kV Transformer T1)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	136.8	125.1
	7L130 (Vermilion 710S - Kitscoty 705S)	72.0	72.0	84.2	117.0
	7L14 (Kitscoty 705S - Hill 751S)	72.0	72.0	80.5	111.9
912L\9L912 (Red Deer 63S - Nevis 766S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	109.0	128.1
	701L (North Holden 395S - Strome 223S)	119.0	131.0	151.4	127.2
	7L701 (Strome 223S - 7L701 Tap)	158.0	169.0	169.4	107.2
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	137.0	125.4
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	160.0	114.3
766S901T (Nevis 766S 240/138 kV Transformer T1)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	109.2	128.4
	701L (North Holden 395S - Strome 223S)	119.0	131.0	151.6	127.4
	7L701 (Strome 223S - 7L701 Tap)	158.0	169.0	169.6	107.3
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	137.3	125.6
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	161.0	115.1
701L (North Holden 395S - Strome 223S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	118.6	108.5
395ST1 (North Holden 395S 138/25 kV Transformer T1)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	117.0	107.0
EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	97.8	115.0
	701L (North Holden 395S - Strome 223S)	119.0	131.0	144.5	121.4
	7L701 (Strome 223S - 7L701 Tap)	158.0	169.0	162.6	102.9
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	136.4	124.8
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	156.5	111.8
	912L\9L912 (Red Deer 63S - Nevis 766S)	488.0	557.0	562.6	115.3

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] *Reported as a percentage of the observed power flow (in MVA) 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 voltage deviations beyond the limits listed in Table 3-1 of Attachment A1 (hereafter referred to as point of delivery (POD) bus voltage deviations) were observed.

2.1.3 Scenario 3: 2019 Winter Peak High Wind Economy Coal Pre-Project

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

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

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

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Observed Power Flow (MVA)	% Loading
7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	749L (Edgerton 899S - 749L Tap)	96.0	143.0	103.1	107.4
	7L749 (Edgerton 899S - 7L749 Tap)	96.0	143.0	96.2	100.2
9L20 (Nevis 766S - Cordel 755S)	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	113.9	113.9
749L\749AL (Metiskow 648S - Edgerton 899S)	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	86.3	87.3	101.2
648ST1 (Metiskow 648S 138/25 kV Transformer T1)	7L50 (Buffalo Creek 526S - 7L50 Tap)	139.0	150.5	145.1	104.4
	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	86.3	113.5	131.5
	7L14 (Kitscoty 705S - Hill 751S)	86.3	86.3	108.7	126.0
912L\9L912 (Red Deer 63S - Nevis 766S)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	102.5	113.8
	701L (North Holden 395S - Strome 223S)	146.0	161.0	150.8	103.2
766S901T (Nevis 766S 240/138 kV Transformer T1)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	102.9	114.2
	701L (North Holden 395S - Strome 223S)	146.0	161.0	151.0	103.4
EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	91.5	101.5
	749L (Edgerton 899S - 749L Tap)	96.0	143.0	96.5	100.5
526ST1 OR 526ST2 (Buffalo Creek 526S 138/25 kV Transformer T1 or T2)	749L (Edgerton 899S - 749L Tap)	96.0	143.0	98.4	102.5

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.

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: 2019 Summer Light High Wind Economy Coal Post-Project

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

Thermal criteria violations were observed under certain Category B conditions as shown in Table 3-1.

Table 3-1: Thermal Criteria Violations under Category B Conditions for Scenario 4

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
9L20 (Nevis 766S - Cordel 755S)	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	96.9	96.9	114.0	114.0	17.1
7L128 (Michichi Creek 802S - Coyote Lake 963S)	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	46.0	36.8	127.4	101.9	65.1
7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	139.9	160.0	73.2	52.3	189.7	135.6	83.3
	7L85 (Bullpound 803S - Parker 2072S)	139.9	160.0	-	-	195.9	140.0	-
	801S901T (Anderson 801S	125.0	125.0	70.6	56.5	192.7	154.2	97.7

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
	240/138 kV Transformer T1)							
9L29 (Oakland 946S - Coyote Lake 963S)	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	44.1	35.3	125.6	100.5	65.2
963S901T (Coyote Lake 963S 240/138/25 kV Transformer T1)	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	45.5	36.4	127.0	101.6	65.2
114ST1 (Ghost Pine 114S 138/34.5 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	52.8	48.4	110.9	101.5	53.2
801S901T (Anderson 801S 240/138 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	70.7	64.7	186.5	170.8	106.1
7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	-	-	196.5	179.9	-

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: 2019 Summer Peak High Wind Economy Coal Post-Project

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

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 (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
7L42 (Hill 751S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	114.4	104.7	113.1	103.5	-1.2
7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	124.8	114.2	123.5	113.0	-1.2
9L16 (Tinchebray 972S - Cordel 755S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	53.3	48.8	111.4	102.0	53.2
9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	93.3	109.6	97.1	114.1	4.5
	701L (North Holden 395S - Strome 223S)	119.0	131.0	134.2	112.8	137.5	115.5	2.8
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	127.1	116.3	126.4	115.6	-0.7
	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	105.8	96.8	118.4	108.4	11.6
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	154.3	110.3	157.0	112.2	1.9
	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	121.1	121.1	135.1	135.1	14.0
	7L16 (Nevis 766S - Heatburg 948S)	109.3	123.6	102.3	93.6	114.9	105.2	11.6
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	58.8	53.8	117.0	107.1	53.2
7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	122.6	112.2	121.7	111.4	-0.8
749L\749AL (Metiskow 648S - Edgerton 899S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	130.7	119.5	129.7	118.7	-0.9
899ST3A (Edgerton 899S 138/25 kV Transformer T3A)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	127.3	116.5	126.2	115.4	-1.1
648ST1 (Metiskow 648S 138/25 kV Transformer T1)	7L129 (Buffalo Creek 526S - 7L129 Tap)	120.0	132.0	117.6	98.0	123.1	102.6	4.6

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	136.8	125.1	137.0	125.4	0.2
	7L129 (7L129 Tap - Vermilion 710S)	109.3	123.6	105.5	96.6	111.4	102.0	5.4
	7L130 (Vermilion 710S - Kitscoty 705S)	72.0	72.0	84.2	117.0	87.0	120.9	3.9
	7L14 (Kitscoty 705S - Hill 751S)	72.0	72.0	80.5	111.9	83.1	115.5	3.7
912L\9L912 (Red Deer 63S - Nevis 766S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	109.0	128.1	114.9	135.1	6.9
	701L (North Holden 395S - Strome 223S)	119.0	131.0	151.4	127.2	157.0	131.9	4.7
	7L701 (Strome 223S - 7L701 Tap)	158.0	169.0	169.4	107.2	175.3	110.9	3.7
	7L129 (Buffalo Creek 526S - 7L129 Tap)	120.0	132.0	117.9	98.3	123.8	103.2	5.0
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	137.0	125.4	138.0	126.2	0.9
	7L129 (7L129 Tap - Vermilion 710S)	109.3	123.6	105.9	96.9	112.0	102.5	5.6
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	160.0	114.3	164.7	117.7	3.3
7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	139.9	160.0	70.7	50.5	185.1	132.3	81.8
	7L85 (Bullpound 803S - Parker 2072S)	139.9	160.0	-	-	192.5	137.6	-
	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	65.9	52.7	184.2	147.3	94.6
114ST1 (Ghost Pine 114S 138/34.5 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	57.5	52.7	114.8	105.1	52.4
766S901T (Nevis 766S 240/138 kV Transformer T1)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	109.2	128.4	114.9	135.0	6.7

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
	701L (North Holden 395S - Strome 223S)	119.0	131.0	151.6	127.4	157.0	131.9	4.6
	7L701 (Strome 223S - 7L701 Tap)	158.0	169.0	169.6	107.3	175.3	111.0	3.6
	7L129 (Buffalo Creek 526S - 7L129 Tap)	120.0	132.0	118.2	98.5	123.9	103.2	4.8
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	137.3	125.6	138.0	126.3	0.6
	7L129 (7L129 Tap - Vermilion 710S)	109.3	123.6	106.2	97.2	112.1	102.5	5.4
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	161.0	115.1	164.8	117.8	2.7
801S901T (Anderson 801S 240/138 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	66.8	61.2	179.0	163.9	102.7
701L (North Holden 395S - Strome 223S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	118.6	108.5	117.4	107.4	-1.0
395ST1 (North Holden 395S 138/25 kV Transformer T1)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	117.0	107.0	115.3	105.5	-1.5
EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	97.8	115.0	100.4	118.0	3.0
	701L (North Holden 395S - Strome 223S)	119.0	131.0	144.5	121.4	146.5	123.1	1.7
	7L701 (Strome 223S - 7L701 Tap)	158.0	169.0	162.6	102.9	164.9	104.4	1.4
	7L129 (Buffalo Creek 526S - 7L129 Tap)	120.0	132.0	117.2	97.6	120.7	100.6	2.9
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	136.4	124.8	134.9	123.5	-1.3
	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	99.6	91.2	111.2	101.8	10.6
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	156.5	111.8	158.0	113.0	1.1

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
	912L\9L912 (Red Deer 63S - Nevis 766S)	488.0	557.0	562.6	115.3	580.9	119.0	3.7
	9L20 (Nevis 766S - Cordel 755S)	488.0	498.0	481.7	98.7	489.1	100.2	1.5
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	59.7	54.7	117.5	107.6	52.9
7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	-	-	191.5	175.3	-

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: 2019 Winter Peak High Wind Economy Coal Post-Project

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

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

Table 3-3: Thermal Criteria Violations under Category B Conditions for Scenario 6

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
7L129\7LA129 (Buffalo Creek 526S - Vermilion 710S - Bauer 918S)	749L (Edgerton 899S - 749L Tap)	96.0	143.0	95.4	99.4	96.1	100.1	0.7

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	749L (Edgerton 899S - 749L Tap)	96.0	143.0	103.1	107.4	102.2	106.4	-0.9
9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	87.8	97.4	90.9	100.8	3.4
	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	113.9	113.9	125.4	125.4	11.5
749L\749AL (Metiskow 648S - Edgerton 899S)	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	86.3	87.3	101.2	87.4	101.3	0.1
648ST1 (Metiskow 648S 138/25 kV Transformer T1)	7L50 (Buffalo Creek 526S - 7L50 Tap)	139.0	150.5	145.1	104.4	145.3	104.5	0.1
	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	86.3	113.5	131.5	116.3	134.7	3.2
	7L14 (Kitscoty 705S - Hill 751S)	86.3	86.3	108.7	126.0	111.4	129.1	3.2
912L\9L912 (Red Deer 63S - Nevis 766S)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	102.5	113.8	107.8	119.7	5.9
	701L (North Holden 395S - Strome 223S)	146.0	161.0	150.8	103.2	155.7	106.6	3.4
	7L701 (Strome 223S - 7L701 Tap)	169.0	169.0	167.1	98.9	172.2	101.9	3.0
7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	179.0	190.7	73.3	40.9	188.1	105.1	64.2
	7L85 (Bullpound 803S - Parker 2072S)	179.0	190.7	-	-	193.0	107.8	-
	801S901T (Anderson 801S	125.0	125.0	70.0	56.0	188.8	151.1	95.0

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
	240/138 kV Transformer T1)							
766S901T (Nevis 766S 240/138 kV Transformer T1)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	102.9	114.2	107.9	119.8	5.6
	701L (North Holden 395S - Strome 223S)	146.0	161.0	151.0	103.4	155.8	106.7	3.3
	7L701 (Strome 223S - 7L701 Tap)	169.0	169.0	167.4	99.0	172.3	101.9	2.9
801S901T (Anderson 801S 240/138 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	138.9	150.5	70.3	50.6	183.0	131.8	81.1
EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	91.5	101.5	94.6	105.0	3.4
	701L (North Holden 395S - Strome 223S)	146.0	161.0	143.4	98.2	146.4	100.2	2.1
	749L (Edgerton 899S - 749L Tap)	96.0	143.0	96.5	100.5	97.3	101.4	0.9
526ST1 OR 526ST2 (Buffalo Creek 526S 138/25 kV Transformer T1 or T2)	749L (Edgerton 899S - 749L Tap)	96.0	143.0	98.4	102.5	99.2	103.3	0.8
7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	138.9	150.5	-	-	191.3	137.8	-

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

3.1.4 Scenario 8: 2019 Summer Peak High Wind Economy Coal Post-Project Sensitivity with PENV

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

Thermal criteria violations were observed under certain Category B conditions as shown in Table 3-4.

Table 3-4: Thermal Criteria Violations under Category B Conditions for Scenario 8

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-PENV Post-Project Results		Post PENV Post-Project Results		% Loading Difference (Post PENV-Pre PENV)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	97.1	114.1	100.5	118.1	4.1
	701L (North Holden 395S - Strome 223S)	119.0	131.0	137.5	115.5	129.8	109.1	-6.4
	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	118.4	108.4	118.3	108.3	-0.1
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	157.0	112.2	149.7	107.0	-5.2
	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	135.1	135.1	134.0	134.0	-1.1
	7L16 (Nevis 766S - Heatburg 948S)	109.3	123.6	114.9	105.2	114.7	105.0	-0.2
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	117.0	107.1	113.1	103.5	-3.6
912L\9L912 (Red Deer 63S - Nevis 766S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	114.9	135.1	118.0	138.7	3.6
	701L (North Holden 395S - Strome 223S)	119.0	131.0	157.0	131.9	148.6	124.8	-7.1
	7L701 (Strome 223S - 7L701 Tap)	158.0	158.0	175.3	110.9	166.6	105.4	-5.5

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-PENV Post-Project Results		Post PENV Post-Project Results		% Loading Difference (Post PENV-Pre PENV)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	164.7	117.7	156.9	112.2	-5.5
7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	139.9	160.0	185.1	132.3	180.9	129.3	-3.0
	7L85 (Bullpound 803S - Parker 2072S)	139.9	160.0	192.5	137.6	188.3	134.6	-3.0
	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	184.2	147.3	180.0	144.0	-3.4
114ST1 (Ghost Pine 114S 138/34.5 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	114.8	105.1	111.6	102.1	-2.9
766S901T (Nevis 766S 240/138 kV Transformer T1)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	114.9	135.0	118.0	138.6	3.6
	701L (North Holden 395S - Strome 223S)	119.0	131.0	157.0	131.9	148.6	124.8	-7.1
	7L701 (Strome 223S - 7L701 Tap)	158.0	158.0	175.3	111.0	166.6	105.4	-5.5
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	164.8	117.8	156.9	112.1	-5.7
801S901T (Anderson 801S 240/138 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	179.0	163.9	174.1	159.4	-4.5
EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	100.4	118.0	105.6	124.1	6.1
	701L (North Holden 395S - Strome 223S)	119.0	131.0	146.5	123.1	139.3	117.1	-6.0
	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	111.2	101.8	112.1	102.6	0.9

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-PENV Post-Project Results		Post PENV Post-Project Results		% Loading Difference (Post PENV-Pre PENV)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	158.0	113.0	151.4	108.2	-4.8
	912L\9L912 (Red Deer 63S - Nevis 766S)	488.0	557.0	580.9	119.0	565.9	116.0	-3.1
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	117.5	107.6	113.9	104.3	-3.3
7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	191.5	175.3	186.6	170.8	-4.4

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 (2019 Summer Light High Wind Economy Coal Post-Project), Scenario 5 (2019 Summer Peak High Wind Economy Coal Post-Project), Scenario 6 (2019 Winter Peak High Wind Economy Coal 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 3-5. 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 3-5: Transient Stability Study Results under Category B Conditions for Scenario 4, Scenario 5, and Scenario 6

Studied Contingency	Fault Description and Location	Results
9L24 (Oakland 946S - Lanfine 959S)	3-phase fault at Oakland 946S	Stable
	3-phase fault at Lanfine 959S	Stable
9L29 (Oakland 946S – Coyote Lake 963S)	3-phase fault at Oakland 946S	Stable
	3-phase fault at Coyote Lake 963S	Stable
9L20 (Cordel 755S – Nevis 766S)	3-phase fault at Cordel 755S	Stable
	3-phase fault at Nevis 766S	Stable
9L59 (Anderson 801S - Tinchebray 972S)	3-phase fault at Anderson 801S	Stable
	3-phase fault at Tinchebray 972S	Stable
912L\9L912 (Nevis 766S - Red Deer 63S)	3-phase fault at Nevis 766S	Stable
	3-phase fault at Red Deer 63S	Stable
7L203 (Wintering Hills 804S - Parker 2072S)	3-phase fault at Wintering Hills 804S	Stable
	3-phase fault at Parker 2072S	Stable
7L85 (Parker 2072S - Anderson 801S with T-Tap to Bullpound 803S)	3-phase fault at Parker 2072S	Stable
	3-phase fault at Anderson 801S	Stable
7L171 (Wintering Hills 804S – Michichi Creek 802S)	3-phase fault at Wintering Hills 804S	Stable
	3-phase fault at Michichi Creek 802S	Stable
7L25 (Rowley 768S – Michichi Creek 802S)	3-phase fault at Rowley 768S	Stable
	3-phase fault at Michichi Creek 802S	Stable
7L137 (Rowley 768S – Three Hills 770S)	3-phase fault at Rowley 768S	Stable
	3-phase fault at Three Hills 770S	Stable
7L159 (Three Hills 770S – Ghost Pine 114S – Heatburg 948S)	3-phase fault at Three Hills 770S	Stable
	3-phase fault at Ghost Pine 114S	Stable
	3-phase fault at Heatburg 948S	Stable

4 Short Circuit Studies

4.1 Pre-Project Results

Pre-Project short-circuit current levels are provided in Table 4-1[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)
Anderson 801S	240	257.9	13.6	0.0031 + 0.0206j	15.2	0.0015 + 0.0149j
Anderson 801S	138	149.3	5.0	0.0104 + 0.0992j	5.3	0.0041 + 0.0802j
Bull Pound 803S	138	149.1	3.5	0.0333 + 0.1378j	2.8	0.0545 + 0.2425j
Coyote Lake 963S	138	149.8	6.7	0.0091 + 0.0731j	10.1	0.0006 + 0.0002j
Coyote Lake 963S	240	258.3	6.7	0.0058 + 0.0416j	6.9	0.0047 + 0.0393j
Michichi Creek 802S	138	148.2	4.5	0.0296 + 0.1045j	3.1	0.122 + 0.2292j
Michichi Creek 802S	69	72.4	3.0	0.0643 + 0.3068j	3.1	0.0707 + 0.2757j
Oakland 946S	240	258.0	12.4	0.0034 + 0.0227j	12.4	0.0041 + 0.0227j
Sheerness 807S	240	258.0	13.2	0.0032 + 0.0213j	14.5	0.0017 + 0.0162j
Wintering Hills 804S	138	148.7	3.6	0.0361 + 0.1314j	2.3	0.1266 + 0.3309j
Wheatland 609S	138	148.5	3.3	0.0382 + 0.1428j	2.1	0.1393 + 0.3691j

4.2 Post-Project Results

4.2.1 Scenario 6: 2019 Winter Peak High Wind Economy Coal 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)

[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.

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)
Anderson 801S	240	258.1	14.0	0.003 + 0.02j	15.6	0.0015 + 0.0148j
Anderson 801S	138	148.2	5.4	0.0095 + 0.0899j	5.7	0.0042 + 0.0777j
Bull Pound 803S	138	147.7	4.4	0.022 + 0.1064j	3.8	0.0266 + 0.1567j
Coyote Lake 963S	138	150.2	7.0	0.0088 + 0.0702j	10.5	0.0006 + 0.0003j
Coyote Lake 963S	240	257.9	7.0	0.0055 + 0.0401j	7.1	0.0046 + 0.0388j
Michichi Creek 802S	138	148.3	5.0	0.0261 + 0.092j	3.2	0.1425 + 0.2245j
Michichi Creek 802S	69	71.9	3.1	0.0597 + 0.2966j	3.1	0.0789 + 0.2709j
Oakland 946S	240	258.1	12.8	0.0032 + 0.022j	12.7	0.0041 + 0.0226j
Sheerness 807S	240	258.3	13.6	0.003 + 0.0207j	14.9	0.0017 + 0.0161j
Wintering Hills 804S	138	148.7	4.9	0.0211 + 0.0947j	4.0	0.0381 + 0.1561j
Parker 2072S	138	147.6	5.2	0.0167 + 0.0889j	5.4	0.0081 + 0.0821j
Badlands 961S	138	147.6	5.2	0.0166 + 0.0893j	5.4	0.0071 + 0.0803j
Wheatland 609S	138	149.1	4.4	0.0237 + 0.107j	3.4	0.0503 + 0.1939j

4.2.2 Scenario 7: 2027 Winter Peak 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)
Anderson 801S	240	257.0	14.0	0.0026 + 0.0184j	15.8	0.0014 + 0.0131j
Anderson 801S	138	147.2	5.0	0.0091 + 0.0885j	5.3	0.0041 + 0.0767j
Bull Pound 803S	138	146.3	4.1	0.0218 + 0.1055j	3.6	0.0265 + 0.1563j
Coyote Lake 963S	138	149.0	6.6	0.0084 + 0.0685j	9.9	0.0006 + 0.0002j
Coyote Lake 963S	240	257.6	6.6	0.0052 + 0.0388j	6.7	0.0046 + 0.0382j
Michichi Creek 802S	138	145.8	4.7	0.0256 + 0.0907j	3.1	0.121 + 0.2182j
Michichi Creek 802S	69	72.3	2.9	0.0611 + 0.2992j	3.0	0.0716 + 0.2728j
Oakland 946S	240	257.4	12.6	0.0029 + 0.0203j	13.3	0.0029 + 0.0181j
Sheerness 807S	240	257.0	13.5	0.0027 + 0.019j	15.0	0.0016 + 0.0145j
Wintering Hills 804S	138	146.0	4.6	0.0209 + 0.0937j	3.8	0.0383 + 0.1554j
Parker 2072S	138	145.8	4.9	0.0165 + 0.0881j	5.1	0.0082 + 0.0819j

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)
Badlands 961S	138	145.8	4.9	0.0165 + 0.0884j	5.1	0.0072 + 0.0801j
Wheatland 609S	138	146.0	4.1	0.0235 + 0.1059j	3.2	0.0505 + 0.1932j

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 Pre-Project

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

Table 5-1: Pre-Project Mitigation Measures

Mitigation Measure	Location of Observed Violation
Planned RAS No. 139[a]	174L (Bardo 197S - North Holden 395S
	7L701 (7L701 Tap - Battle River 757S)
	701L (North Holden 395S - Strome 223S)
	766S901T (Nevis 766S 240/138 kV Transformer 901T)
	7L50 (Buffalo Creek 526S - 7L50 Tap)
Planned RAS No. 134[b]	174L (Bardo 197S - North Holden 395S
	701L (North Holden 395S - Strome 223S)
	7L50 (Buffalo Creek 526S - 7L50 Tap)
	7L701 (7L701 Tap - Battle River 757S)
	766S901T (Nevis 766S 240/138 kV Transformer 901T)
	7L701 (Strome 223S - 7L701 Tap)
	912L\9L912 (Red Deer 63S - Nevis 766S)
Planned RAS No. 138[c]	174L (Bardo 197S - North Holden 395S
	701L (North Holden 395S - Strome 223S)
	7L50 (Buffalo Creek 526S - 7L50 Tap)
	7L701 (7L701 Tap - Battle River 757S)
	766S901T (Nevis 766S 240/138 kV Transformer 901T)
	7L701 (Strome 223S - 7L701 Tap)
	912L\9L912 (Red Deer 63S - Nevis 766S)
Existing RAS No. 32	7L50 (Buffalo Creek 526S - 7L50 Tap)
Real time operational practices	749L (Edgerton 899S - 749L Tap)
	7L749 (Edgerton 899S - 7L749 Tap)

Notes:

[a] RAS No. 139 is an existing RAS (see Section 1.2.2.2 of Attachment A1). RAS 139 monitors the loading of Nevis 766S 240/138 kV Transformer 901T. Modifications to RAS No. 139 are proposed for the planned Sharp Hills Wind Project. This modified version of RAS No. 139 is referred to herein as "planned RAS No.139"

[b] RAS No. 134 is an existing RAS (see Section 1.2.2.2 of Attachment A1). RAS 134 monitors the loading of 174L transmission line. Modifications to RAS No. 134 are planned to be in place prior to Wheatland WAGF Project Connection, and exclude tripping of 174L (Bardo 197S - North Holden 395S) in the RAS logic. This modified version of RAS No. 134 is referred to herein as "planned RAS No.134".

[c] RAS No. 138 is an existing RAS (see Section 1.2.2.2 of Attachment A1). RAS 138 monitors the loading of 7L50 transmission line. Modifications to RAS No. 138 are proposed for the planned Sharp Hills Wind Project. Further modifications to RAS No. 138 are planned to be in place prior to Wheatland WAGF Project Connection, and exclude tripping of 704L (Buffalo Creek 526S – Jarrow 252S Tap) in the RAS logic.This modified version of RAS No.138 is referred to herein as "plannedRAS No. 138".

5.2 Post-Project

Post-Project mitigation measures are summarized in Table 5-2.

Table 5-2: Post-Project Mitigation Measures

Mitigation Measure	Location of Observed Violation
Modified RAS No. 134[d]	174L (Bardo 197S - North Holden 395S)
	701L (North Holden 395S - Strome 223S)
	7L50 (Buffalo Creek 526S - 7L50 Tap)
	7L159 (7L159 Tap - Heatburg 948S)
	7L701 (7L701 Tap - Battle River 757S)
	766S901T (Nevis 766S 240/138 kV Transformer T1)
	7L16 (Nevis 766S - Heatburg 948S)
	7L171 (Michichi Creek 802S - Wintering Hills 804S)
	7L701 (Strome 223S - 7L701 Tap)
	7L129 (Buffalo Creek 526S - 7L129 Tap)
	7L129 (7L129 Tap - Vermilion 710S)
	912L\9L912 (Red Deer 63S - Nevis 766S)
	9L20 (Nevis 766S - Cordel 755S)
	749L (Edgerton 899S - 749L Tap)
Modified RAS No. 139[e]	766S901T (Nevis 766S 240/138 kV Transformer T1)
	174L (Bardo 197S - North Holden 395S)
	701L (North Holden 395S - Strome 223S)
	7L50 (Buffalo Creek 526S - 7L50 Tap)
	7L159 (7L159 Tap - Heatburg 948S)
	7L701 (7L701 Tap - Battle River 757S)
	7L16 (Nevis 766S - Heatburg 948S)
	7L171 (Michichi Creek 802S - Wintering Hills 804S)

Mitigation Measure	Location of Observed Violation
Planned RAS No. 138	7L50 (Buffalo Creek 526S - 7L50 Tap)
	174L (Bardo 197S - North Holden 395S)
	701L (North Holden 395S - Strome 223S)
	7L159 (7L159 Tap - Heatburg 948S)
	7L701 (7L701 Tap - Battle River 757S)
	766S901T (Nevis 766S 240/138 kV Transformer T1)
	7L16 (Nevis 766S - Heatburg 948S)
	7L171 (Michichi Creek 802S - Wintering Hills 804S)
	7L701 (Strome 223S - 7L701 Tap)
	7L129 (Buffalo Creek 526S - 7L129 Tap)
	7L129 (7L129 Tap - Vermilion 710S)
	912L\9L912 (Red Deer 63S - Nevis 766S)
	9L20 (Nevis 766S - Cordel 755S)
Existing RAS No. 32	7L50 (Buffalo Creek 526S - 7L50 Tap)
P1718 RAS1[f]	801S901T (Anderson 801S 240/138 kV Transformer 901T)
	7L85 (Bullpound 803S - Anderson 801S)
	7L85 (Bullpound 803S - Parker 2072S)
P1718 RAS2[g]	7L171 (Michichi Creek 802S - Wintering Hills 804S)
Real time operational practices	7L129 (Buffalo Creek 526S - 7L129 Tap)
	7L129 (7L129 Tap - Vermilion 710S)
	749L (Edgerton 899S - 749L Tap)
	7L130 (Vermilion 710S - Kitscoty 705S)
	7L14 (Kitscoty 705S - Hill 751S)

Notes:

[d] RAS 134 monitors the loading of 174L transmission line. RAS Further modifications are proposed to the planned RAS No. 134 for the planned Wheatland WAGF Project to add the Project to the logic of the RAS. This modified version of RAS No. 134 is referred to herein as “modified RAS No. 134”.

[e] RAS 139 monitors the loading of Nevis 766S 240/138 kV Transformer 901T. Further modifications are proposed to the planned RAS No. 139 for the planned Wheatland WAGF Project to add the Project to the logic of the RAS. This modified version of RAS No. 139 is referred to herein as “modified RAS No. 139”.

[f] P1718 RAS1 is a new RAS proposed for the planned Wheatland WAGF Project to mitigate thermal violation on 801S901T (Anderson 801S 240/138 kV Transformer 901T)

[g] P1718 RAS2 is a new RAS proposed for the planned Wheatland WAGF Project to mitigate thermal violation on 7L171 (Michichi Creek 802S - Wintering Hills 804S).

5.3 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 (2019 Summer Light High Wind Economy Coal Post-Project), Scenario 5 (2019 Summer Peak High Wind Economy Coal Post-Project),Scenario 6 (2019 Winter Peak High Wind Economy Coal Post-Project) and Scenario 8 (Scenario 5 (2019 Summer Peak High Wind Economy Coal Post-Project with PENV) using Alternative 1 and the RASs 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.

5.3.1 Scenario 4: 2019 Summer Light High Wind Economy Coal Post-Project

Category B Conditions

Thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by RASs as shown in Table 5-3.

Table 5-3: Post-RAS Power Flow Study Results for Scenario 4

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
9L20 (Nevis 766S - Cordel 755S)	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	114.0	114.0	94.7	94.7
7L128 (Michichi Creek 802S - Coyote Lake 963S)	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	127.4	101.9	51.9	41.5
7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	139.9	160.0	189.7	135.6	78.3	56.0
	7L85 (Bullpound 803S - Parker 2072S)	139.9	160.0	195.9	140.0	84.2	60.2
	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	192.7	154.2	76.8	61.4
9L29 (Oakland 946S - Coyote Lake 963S)	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	125.6	100.5	49.5	39.6
963S901T (Coyote Lake	801S901T (Anderson 801S	125.0	125.0	127.0	101.6	35.1	28.1

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
963S 240/138/25 kV Transformer T1)	240/138 kV Transformer T1)						
114ST1 (Ghost Pine 114S 138/34.5 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	110.9	101.5	53.5	49.0
801S901T (Anderson 801S 240/138 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	186.5	170.8	44.3	40.6
7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.23	123.6	196.51	179.9	85.2	78.0

5.3.2 Scenario 5: 2019 Summer Peak High Wind Economy Coal Post-Project

Category B Conditions

Thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by RASs as shown in Table 5-4.

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

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
7L42 (Hill 751S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	113.1	103.5	107.6	98.4
7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	123.5	113.0	106.0	97.0
9L16 (Tinchebray 972S - Cordel 755S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	111.4	102.0	50.7	46.4
9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	97.1	114.1	63.5	74.6
	701L (North Holden 395S - Strome 223S)	119.0	131.0	137.5	115.5	104.5	87.8
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	126.4	115.6	103.7	94.9

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	118.4	108.4	87.9	80.5
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	157.0	112.2	123.3	88.1
	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	135.1	135.1	89.1	89.1
	7L16 (Nevis 766S - Heatburg 948S)	109.3	123.6	114.9	105.2	84.6	77.4
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	117.0	107.1	53.1	48.6
7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	121.7	111.4	104.6	95.7
749L\749AL (Metiskow 648S - Edgerton 899S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	129.7	118.7	108.4	99.2
899ST3A (Edgerton 899S 138/25 kV Transformer T3A)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	126.2	115.4	106.8	97.7
912L\9L912 (Red Deer 63S - Nevis 766S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	114.9	135.1	65.9	77.5
	701L (North Holden 395S - Strome 223S)	119.0	131.0	157.0	131.9	107.7	90.5
	7L701 (Strome 223S - 7L701 Tap)	158.0	169.0	175.3	110.9	125.5	79.4
	7L129 (Buffalo Creek 526S - 7L129 Tap)	120.0	132.0	123.8	103.2	91.4	76.2
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	138.0	126.2	104.6	95.7
	7L129 (7L129 Tap - Vermilion 710S)	109.3	123.6	112.0	102.5	80.6	73.7
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	164.7	117.7	118.9	85.0
7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	139.9	160.0	185.1	132.3	68.6	49.0
	7L85 (Bullpound 803S - Parker 2072S)	139.9	160.0	192.5	137.6	75.7	54.1
	801S901T	125.0	125.0	184.2	147.3	64.6	51.7

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
	(Anderson 801S 240/138 kV Transformer T1)						
114ST1 (Ghost Pine 114S 138/34.5 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	114.8	105.1	54.8	50.2
766S901T (Nevis 766S 240/138 kV Transformer T1)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	114.9	135.0	65.9	77.4
	701L (North Holden 395S - Strome 223S)	119.0	131.0	157.0	131.9	107.7	90.5
	7L701 (Strome 223S - 7L701 Tap)	158.0	169.0	175.3	111.0	125.5	79.4
	7L129 (Buffalo Creek 526S - 7L129 Tap)	120.0	132.0	123.9	103.2	91.4	76.2
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	138.0	126.3	104.6	95.7
	7L129 (7L129 Tap - Vermilion 710S)	109.3	123.6	112.1	102.5	80.6	73.7
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	164.8	117.8	118.8	84.9
801S901T (Anderson 801S 240/138 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	179.0	163.9	46.1	42.2
701L (North Holden 395S - Strome 223S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	117.4	107.4	107.7	98.5
395ST1 (North Holden 395S 138/25 kV Transformer T1)	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	115.3	105.5	107.1	98.0
EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	100.4	118.0	66.2	77.8
	701L (North Holden 395S - Strome 223S)	119.0	131.0	146.5	123.1	109.9	92.3
	7L701 (Strome 223S - 7L701 Tap)	158.0	169.0	164.9	104.4	127.8	80.9
	7L129 (Buffalo Creek 526S - 7L129 Tap)	120.0	132.0	120.7	100.6	95.0	79.2
	7L50 (Buffalo Creek 526S - 7L50 Tap)	109.3	123.6	134.9	123.5	108.4	99.2
	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	111.2	101.8	89.8	82.2

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	158.0	113.0	123.0	87.9
	912L\9L912 (Red Deer 63S - Nevis 766S)	488.0	557.0	580.9	119.0	398.7	81.7
	9L20 (Nevis 766S - Cordel 755S)	488.0	498.0	489.1	100.2	332.3	68.1
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	117.5	107.6	56.0	51.3
7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	191.5	175.3	76.1	69.7

5.3.3 Scenario 6: 2019 Winter Peak High Wind Economy Coal Post-Project

Category B Conditions

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

Table 5-5: Post-RAS Power Flow Study Results for Scenario 6

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	90.9	100.8	74.4	82.6
	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	125.4	125.4	96.9	96.9
912L\9L912 (Red Deer 63S - Nevis 766S)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	107.8	119.7	87.5	97.1
	701L (North Holden 395S - Strome 223S)	146.0	161.0	155.7	106.6	135.5	92.8
	7L701 (Strome 223S - 7L701 Tap)	169.0	169.0	172.2	101.9	151.9	89.9
7L171 (Michichi Creek 802S - Wintering Hills	7L85 (Bullpound 803S - Anderson 801S)	179.0	190.7	188.1	105.1	68.7	38.4

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
804S)	7L85 (Bullpound 803S - Parker 2072S)	179.0	190.7	193.0	107.8	73.4	41.0
	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	188.8	151.1	66.5	53.2
766S901T (Nevis 766S 240/138 kV Transformer T1)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	107.9	119.8	87.8	97.4
	701L (North Holden 395S - Strome 223S)	146.0	161.0	155.8	106.7	135.8	93.0
	7L701 (Strome 223S - 7L701 Tap)	169.0	169.0	172.3	101.9	152.1	90.0
801S901T (Anderson 801S 240/138 kV Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	138.9	150.5	183.0	131.8	49.9	35.9
EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	90.1	99.0	94.6	105.0	86.0	95.4
	701L (North Holden 395S - Strome 223S)	146.0	161.0	146.4	100.2	138.3	94.7
	749L (Edgerton 899S - 749L Tap)	96.0	143.0	97.3	101.4	92.4	96.2
7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	138.9	142.8	191.3	137.8	73.7	53.1

5.3.4 Scenario 8: 2019 Summer Peak High Wind Economy Coal Post-Project Sensitivity with PENV

Category B Conditions

Thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by RASs as shown in Table 5-6.

Table 5-6: Post-RAS Power Flow Study Results for Scenario 8

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North	85.1	94.0	100.5	118.1	74.1	87.1

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
	Holden 395S)						
	701L (North Holden 395S - Strome 223S)	119.0	131.0	129.8	109.1	105.3	88.5
	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	118.3	108.3	90.7	83.0
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	149.7	107.0	124.8	89.2
	766S901T (Nevis 766S 240/138 kV Transformer T1)	100.0	100.0	134.0	134.0	94.7	94.7
	7L16 (Nevis 766S - Heatburg 948S)	109.3	123.6	114.7	105.0	87.2	79.8
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	113.1	103.5	52.2	47.8
912L\9L912 (Red Deer 63S - Nevis 766S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	118.0	138.7	82.5	97
	701L (North Holden 395S - Strome 223S)	119.0	131.0	148.6	124.8	114.3	96
	7L701 (Strome 223S - 7L701 Tap)	158.0	158.0	166.6	105.4	131.9	83.5
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	156.9	112.2	125.5	89.7
7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	139.9	160.0	180.9	129.3	67.2	48.0
	7L85 (Bullpound 803S - Parker 2072S)	139.9	160.0	188.3	134.6	74.3	53.1
	801S901T (Anderson 801S 240/138 kV Transformer T1)	125.0	125.0	180.0	144.0	63.4	50.7
766S901T (Nevis 766S 240/138 kV Transformer T1)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	118.0	138.6	82.6	97.1
	701L (North Holden 395S - Strome 223S)	119.0	131.0	148.6	124.8	114.4	96.1
	7L701 (Strome 223S - 7L701 Tap)	158.0	158.0	166.6	105.4	131.9	83.5
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	156.9	112.1	125.9	90
801S901T (Anderson 801S	7L171 (Michichi Creek 802S -	109.2	123.6	174.1	159.4	62.2	56.9

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
240/138 kV Transformer T1)	Wintering Hills 804S)						
EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	85.1	94.0	105.6	124.1	79.2	93.1
	701L (North Holden 395S - Strome 223S)	119.0	131.0	139.3	117.1	110.9	93.2
	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	112.1	102.6	89.7	82.1
	7L701 (7L701 Tap - Battle River 757S)	139.9	160.0	151.4	108.2	124.8	89.2
	912L\9L912 (Red Deer 63S - Nevis 766S)	488.0	557.0	565.9	116.0	471.9	96.7
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	113.9	104.3	53.6	49.1
114ST1 (Ghost Pine 114S Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.2	123.6	111.6	102.1	53.7	49.2
7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	109.23	123.6	186.58	170.81	74.5	68.2

5.4 Constraint Effective Factor Studies

Constraint effective factor studies were conducted for Scenario 4 (2019 Summer Light High Wind Economy Coal Post-Project), Scenario 5 (2019 Summer Peak High Wind Economy Coal Post-Project), and Scenario 6 (2019 Winter Peak High Wind Economy Coal Post-Project). 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 7.

Attachment A1
Engineering Connection Assessment: Study Scope

Engineering Connection Assessment: Study Scope

Wheatland Wind Project Connection

Wheatland Wind Project L.P.
AESO Project Number: P1718

Date: October 23, 2018

Version: V2

Classification: Public

Company Name	Name and Credentials	Date	Signature
Teshmont (Studies Consultant)	Dr. Ashraf Ul Haque, P.Eng.	October 24, 2018	Ashraf Ul Haque Digitally signed by Ashraf Ul Haque DN: cn=Ashraf Ul Haque, o, ou, email=ashraf_leaf@yahoo.com, c=CA Date: 2018.10.24 18:47:15 -06'00'
AESO	Jorge Villena, Ph.D. Myron Jin-Li, E.I.T.	October 25, 2018 October 25, 2018	
ATCO Electric (TFO)	Sharon Morganson, P. Eng.	October 25, 2018	Sharon Morganson Digitally signed by Sharon Morganson DN: cn=Sharon Morganson, o=ATCO Electric, ou=Facilities Planning, email=Sharon.Morganson@atcoelectric.com, c=CA Date: 2018.10.25 09:10:49 -06'00'

Contents

1 Introduction 1
1.1 Project Overview 1
1.2 Existing System Overview 2
1.2.1 Study Area 2
1.2.2 Existing Constraints 2
2 Connection Alternative to be Studied 4
2.1 Alternative 1 – In-and-out connection to 144 kV transmission line 7L85 4
3 Criteria, Standards and Requirements 6
3.1 AESO Reliability Criteria 6
3.2 ISO Rules and Information Documents 7
3.3 Wind Aggregated Generation Facility Requirements 7
4 Scenarios and Assumptions 8
4.1 Scenarios 8
4.1.1 Sensitivity Scenarios 8
4.2 Assumptions 9
4.2.1 System Project Assumptions 9
4.2.2 Connection Project Assumptions 9
4.2.3 Load Assumptions 10
4.2.4 Generation Assumptions 10
4.2.5 Intertie Flow Assumptions 13
4.2.6 HVDC Power Order Assumptions 13
4.2.7 Transmission Facility Ratings 14
4.2.8 Protection Fault Clearing Times 20
4.2.9 Project Dynamic Data 21
4.2.10 Voltage Profile Assumption 21
5 Study Methodology 22
5.1 Engineering Studies 22
5.2 Power Flow Studies 22
5.2.1 Contingencies to be Studied 23
5.3 Transient Stability Studies 23
5.3.1 Contingencies to be Studied 23
5.4 Short-Circuit Current Level Studies 23
6 Mitigation Measures 25
6.1 Development 25
6.2 Evaluation 25
6.2.1 Post-Mitigation Studies 25
6.2.2 Constraint Effective Factor Studies 25

Tables

Table 1-1: Project Load and Generation Details 1
Table 3-1: Post-Contingency Voltage Deviation Guidelines for Low Voltage Busses 7
Table 4-1: Connection Study Scenarios 8
Table 4-2: Planned Connection Projects Included in the Studies 9
Table 4-3: Forecast Area Peak Load (2017 LTO at AESO Central Planning Region Peak) 10
Table 4-4: Non-Renewable Generation Dispatch Conditions 10
Table 4-5: Dispatch Conditions for Existing and Under Construction Renewable Generation Facilities for Scenarios 1-6 and 8 11
Table 4-6: Dispatch Conditions for Planned Renewable Generation Projects for Scenarios 1-6 and 8 12
Table 4-7: Intertie Flows by Scenario 13
Table 4-8: HVDC Power Order by Scenario 14
Table 4-9: HVDC to Adjacent AC System MVAr Exchange Limits 14
Table 4-10: Thermal Rating Assumptions for Key Transmission Lines in the Study Area 14
Table 4-11: Summary of Key Transformer Ratings in the Study Area 18
Table 4-12: Summary of Key Shunt Elements in the Study Area 19
Table 4-13: Protection Fault Clearing Times 20
Table 5-1: Summary of Engineering Studies to be performed 22

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 (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

Wheatland Wind Project L.P., by its General Partner Wheatland Wind Project Ltd. (the Market Participant) has submitted a request for system access service to the Alberta Electric System Operator (AESO) to connect its approved Wheatland Wind Project (the Facility) to the AIES. The Facility includes an approved collector station, to be designed the Badlands 981S substation.

The Market Participant's request includes: a request for a new system access service in the Dorothy area, with a Rate STS, *Supply Transmission Service*, contract capacity of 120 MW and a Rate DTS, *Demand Transmission Service*, contract capacity of 1 MW; and a request for transmission development (collectively, the Project).

The scheduled in-service date (ISD) for the Project is December 31, 2019.

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	No existing contract
	Requested Rate DTS	1 MW
	Type	Industrial
	Motors (number and size)	Not Applicable
	Power factor	Not Applicable
	Future load expansion plans	No
Generation	Generation type	Wind
	Existing Rate STS, *Supply Transmission Service,* contract capacity	No existing contract
	Requested Rate STS	120 MW
	Number and size of generating units	36 wind turbines, each rated at 3.4 MW, with a total generating capability of 122.4 MW
	Maximum authorized real power (MARP)	120 MW
	Maximum capability (MC)	120 MW
	Reactive power capability	58.1 MVAr (0.9 pf lagging)

Project Component		Description
		39.4 MVAr (0.95 pf leading)
	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 Sheerness (Area 43).

The Study Area consists of the AESO planning areas of Sheerness (Area 43), Hanna (Area 42), Wainwright (Area 32), Alliance/Battle River (Area 36), Provost (Area 37), Lloydminster (Area 13), Vegreville (Area 56) and tie lines connecting these planning areas to the rest of the AIES.

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

1.2.2 Existing Constraints

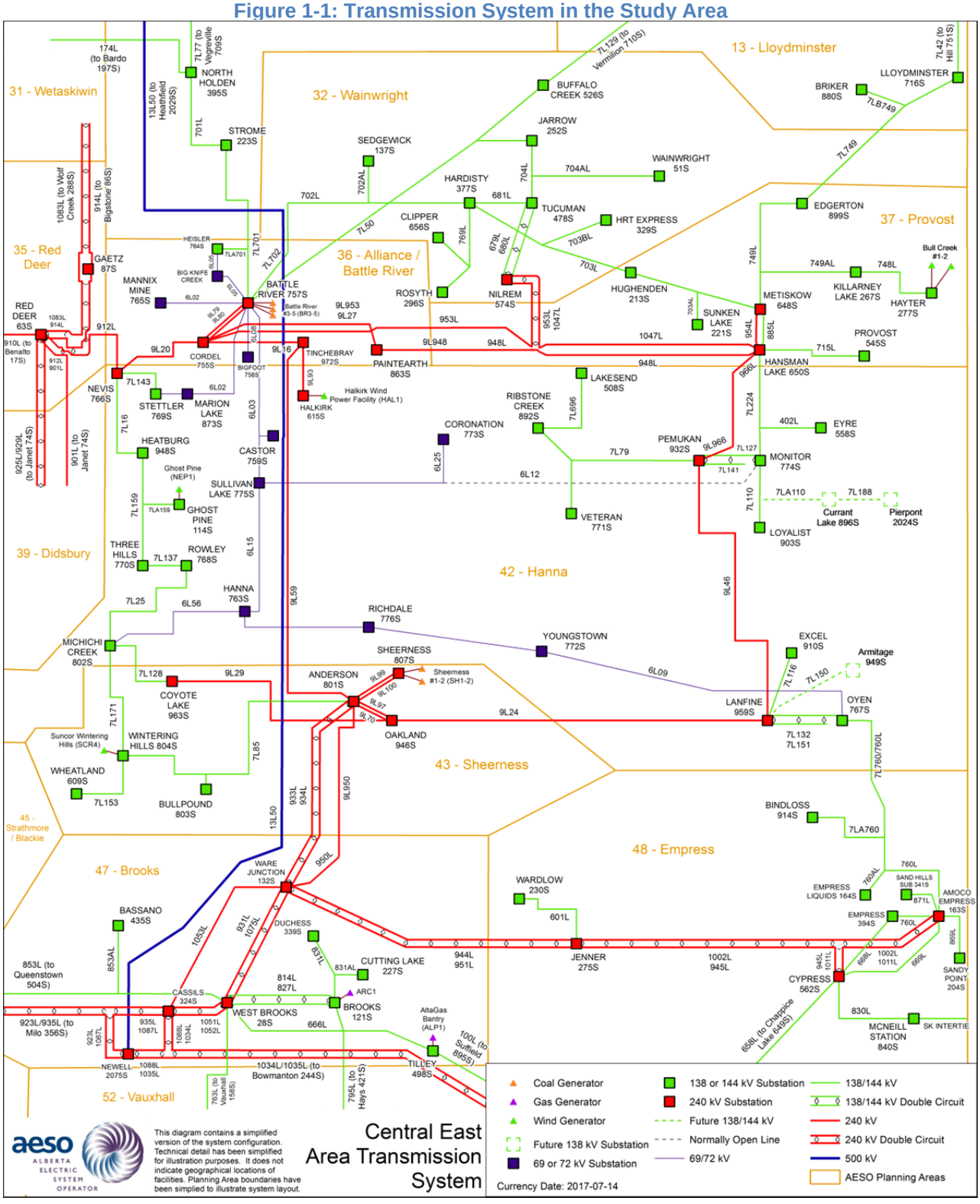
Existing constraints in the Study Area are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management* (TCM Rule).

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

The following existing RASs are used to manage constraints in the area:

- RAS 32: Battle River 757s 7L50 and 7L701 thermal protection scheme
- RAS 134: 174L-395S North Holden overload mitigation scheme
- RAS 138: 7L50-526S Buffalo Creek overload mitigation scheme
- RAS 139: 901T-766S Nevis overload mitigation scheme
- RAS 149: Eastern Alberta Transmission Line (EATL) HVDC

Figure 1-1: Transmission System in the Study Area



2 Connection Alternative to be Studied

The following alternative will be studied:

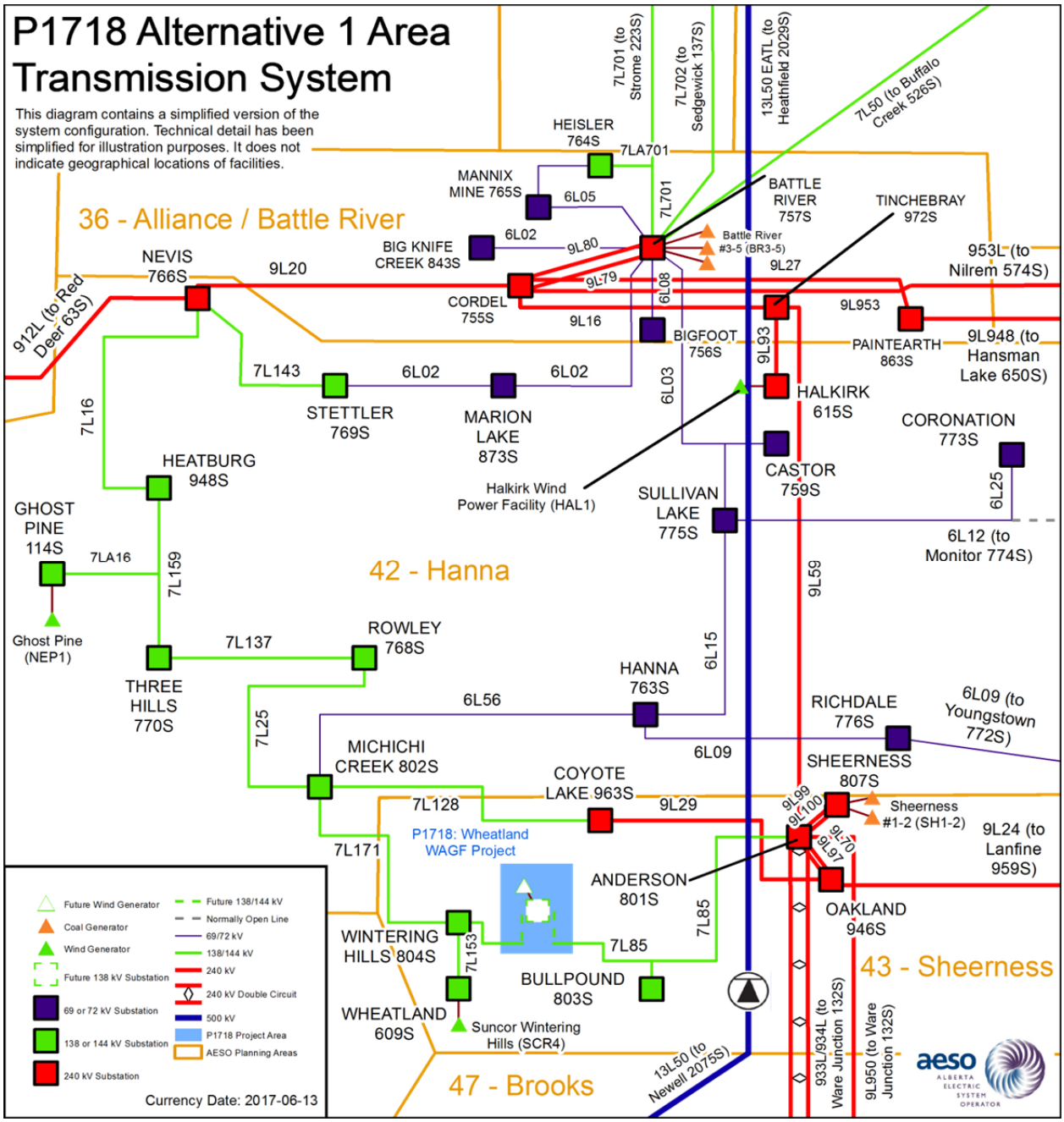
2.1 Alternative 1 – In-and-out connection to 144 kV transmission line 7L85

This alternative included the following developments:

- Add a switching station, to be called Parker 2072S, with three 144 kV circuit breakers.
- Add two 144 kV circuits to connect the proposed Parker 2072S substation to the existing transmission line 7L85 (between the Wintering Hills 804S and Bullpound 803S substations) using an in-and-out configuration.
- Add a 144 kV circuit to connect the Facility to the proposed Parker 2072S substation.
- Add or modify associated equipment as required for the above transmission developments.

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

Figure 2-1: Connection Alternative 1



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, TPL-002-AB1-0 have referenced Applicable Ratings when specifying the required system performance under Category A, 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.*
- 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*, and Sections 502.5 and 502.6 of the ISO rules as they relate to Generating Unit Technical and Operating requirements.

3.3 Wind Aggregated Generation Facility Requirements

The Facility should meet the technical requirements presented in Section 502.1 of the ISO rules, *Aggregated Generating Facilities Technical 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.

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

4.1.1 Sensitivity Scenarios

A sensitivity study that includes the Provost to Edgerton and Nilrem to Vermilion (PENV) Transmission Development project will be studied to assess its impact on the performance of the AIES with the Project connected.

Table 4-1: Connection Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch / Import/Export Conditions	Scenario Name	Project Load (MW)	Project Generation (MW)
Pre-Project					
1	2019 Summer Light (SL)	High Wind, Economic Coal, High Export	2019 SL Pre-Project	0	0
2	2019 Summer Peak (SP)	High Wind, Economic Coal, High Import	2019 SP Pre-Project	0	0
3	2019 Winter Peak (WP)	High Wind, Economic Coal, High Import[a]	2019 WP Pre-Project	0	0
Post-Project					
4	2019 SL	High Wind, Economic Coal, High Export	2019 SL Post-Project	0	120
5	2019 SP	High Wind, Economic Coal, High Import	2019 SP Post-Project	0	120
6	2019 WP	High Wind, Economic Coal, High Import[a]	2019 WP Post-Project	0	120

Scenario No.	Year/Season	System Generation Dispatch / Import/Export Conditions	Scenario Name	Project Load (MW)	Project Generation (MW)
7	2027 WP	All generation in the study area in-service	2027 WP Post-Project	0	120
Post-Project Sensitivity (with PENV)					
8	2019 SP	High Wind, Economic Coal, High Import	2019 SP Post-Project PENV	0	120

[a] All generation in the Study Area must be turned on for the short-circuit studies

4.2 Assumptions

4.2.1 System Project Assumptions

Scenarios 1 through 7 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.

However, as a sensitivity study, the following components of the PENV project shall be assumed to be in service in Scenario 8:

- Drury 2007S substation, connected to the 144 kV transmission line 7L65 in an in-and-out configuration
- One 240 kV circuit (between the existing Nilrem 574S substation and the proposed Drury 2007S substation), operated at a nominal voltage of 138 kV.
- One 240 kV circuit (between the existing Hansman Lake 650S substation and the existing Edgerton 899S substation) operated at a nominal voltage of 138 kV.

4.2.2 Connection Project Assumptions

The connection projects within the Study Area included in the studies are listed in Table 4-2.

Table 4-2: Planned Connection Projects Included in the Studies

AESO Project No.	AESO Project Name	AESO Planning Area No.	Generation (MW)	Load (MW)	Scheduled ISD
635	Suncor Hand Hills Wind Energy Project	42	80.0	0.1	Sep 1, 2019
678	BluEarth Hand Hills Wind Project	42	78.2	0.0	Sep 1, 2020
937	Irma Wind Power	32	90.0	3.0	Jul 1, 2019
1250	E.ON Grizzly Bear Wind	13	120.0	1.5	Dec 15, 2020
1410	ATCO Heartland Pump Station Connection	56	0.0	20.0	Dec 13, 2019

AESO Project No.	AESO Project Name	AESO Planning Area No.	Generation (MW)	Load (MW)	Scheduled ISD
1558	Enbridge New Hardisty Substation	32	0.0	0.0	Dec 1, 2018
1567	EDPR Sharp Hills Wind Farm New Facility Generator Capacity	42	300.0	1.0	Aug 1, 2019

4.2.3 Load Assumptions

The load forecast to be used for the studies is shown in Table 4-3 and is taken from a project specific forecast based on the *AESO 2017 Long-Term Outlook* (2017 LTO)[1] at the AESO Central Planning Region peak. For the studies, when loads for the Alberta Internal Load (AIL) are modified to align with the load forecast in the 2017 LTO, the active power to reactive power ratio in the base case scenarios will be maintained.

Table 4-3: Forecast Area Peak Load (2017 LTO at AESO Central Planning Region Peak)

AESO Planning Area or Region Name	Forecast Peak Load by Year/Season (MW)		
	2019SL	2019SP	2019WP
Central[1]	1,411	1,904	2,181

Note:

[1] The Central Region comprises the following AESO planning areas: Lloydminster (Area 13), Cold Lake (Area 28), Hinton/Edson(Area 29), Drayton Valley (Area 30), Wainwright (Area 32), Abraham Lake (Area 34), Red Dear (Area 35), Alliance/Battle River (Area 36), Provost (Area 37), Caroline (Area 38), Didsbury (Area 39), Hanna (Area 42), and Vegreville (Area 56)

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 2017 LTO. The generation assumptions for the studies will assume high wind and economic coal dispatch conditions. 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 4-4.

Table 4-4: Non-Renewable Generation Dispatch Conditions

Facility Name	Unit	Bus	Pmax	AESO	Unit Net Generation[a] (MW) per Scenario

[1] The 2017 LTO is available on the AESO website.

	No.	No.	(MW)	Planning Area No.	2019 SL	2019 SP	2019 WP
Sheerness	1	1482	400	43	183.2	379.1	391.3
Sheerness	2	1487	390	43	200.3	376.7	369.7
Battle River	3	1495	149	36	60	63	60
Battle River	4	1496	155	36	152.6	134.2	138.7
Battle River	5	1497	385	36	173.4	356.2	378.5

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

Per the 2017 LTO, the total forecast renewable electricity generation in 2019 is 1896 MW. This includes existing, under construction and planned renewable electricity generation facilities.

Using the 2017 LTO's renewable generation forecast of 1896 MW, the generation assumptions will dispatch the renewable electricity generation facilities in order to yield the credible worst-case power flow conditions for the Study Area. Pre-Project dispatch levels for the existing and under-construction renewable electricity generation facilities are shown in Table 4-5.

Table 4-5: Dispatch Conditions for Existing and Under Construction Renewable Generation Facilities for Scenarios 1-6 and 8

Facility Name and Code	AESO Planning Area No.	Bus Number	MC (MW)	Unit Net Generation[s] (MW)
AESO South Planning Region				
Ardenville Wind (ARD1)	53	4735, 4740	68	68
Blue Trail Wind (BTR1)	53	66328, 67328	66	Offline
Castle River #1 (CR1)	53	2234, 3234	39	39
Castle Rock Wind Farm (CRR1)	53	67221	77	77
Cowley Ridge (CRWD)	53	4264	20	20
Enmax Taber (TAB1)	52	15343, 16343	81	81
Kettles Hill (KHW1)	53	2402, 3402	63	Offline
McBride Lake Wind Farm (AKE1)	53	2901, 3901, 4901	73	73
Soderglen Wind (GWW1)	53	12358, 13358	71	71
Summerview 1 (IEW1)	53	2338, 3338	66	66
Summerview 2 (IEW2)	53	4339, 5337	66	66
Suncor Chin Chute (SCR3)	54	2389	30	30
Suncor Magrath (SCR2)	53	11002	30	Offline

Facility Name and Code	AESO Planning Area No.	Bus Number	MC (MW)	Unit Net Generations (MW)
Suncor Wintering Hills (SCR4)	43	60789, 60791, 60793, 60846, 60848, 60850	88	88
Old Man 2 Wind Farm 1 (OWF1)	53	61543	46	46
Blackspring Ridge (BSR1)	49	61736, 61737	300	300
Brooks Solar (BSC1)	47	3256	15	15
AESO South Planning Region Subtotal			**1,199**	**1,040**
AESO Central Planning Region				
Ghost Pine (NEP1)	42	2621 to 2625	82	82
Halkirk (HAL1)	42	66435, 67435	150	150
Fortis Bull Creek 1 and 2 (BUL1 and BUL2)	37	4222	29	29
AESO Central Planning Region Subtotal			**261**	**261**
Total			**1,460**	**1,301**

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

Table 4-6 lists the pre-Project dispatch levels for the planned renewable generation projects in the AESO South and Central planning regions that are included in the study scenarios. Planned renewable generation projects not listed in Table 4-6 are not included in the study and will not be dispatched.

Table 4-6: Dispatch Conditions for Planned Renewable Generation Projects for Scenarios 1-6 and 8

Project Number	AESO Project Name	Project Type	Planned ISD	AESO Planning Area	MC (MW)	Unit Net Generation Dispatch[a] (MW)
462	Enel Alberta Castle Rock Wind Farm phase 2	Wind	31-Dec-19	53	31	31
524	Enel Alberta Riverview Wind Farm	Wind	20-May-19	53	115	115
1800	Capital Power Whitla Wind phase 1	Wind	Jun-19	4	201.6	201.6
1567	Sharp Hills Wind Facility	Wind	01-May-19	42	300	300
Total Planned						**595.6**

Project Number	AESO Project Name	Project Type	Planned ISD	AESO Planning Area	MC (MW)	Unit Net Generation Dispatch[a] (MW)
Total Planned, Existing and Under Construction						**1,896**

The post-Project scenario renewable generation dispatch levels are identical to the pre-Project scenario dispatch levels shown in Table 4-5 and Table 4-6, except that the existing McBride Lake and Old Man River Wind Farms are switched off (i.e., dispatched to 0 MW/MVAr). The Facility is dispatched to 120 MW in all post-Project scenarios. This results in a total renewable dispatch consistent with the 2017 LTO's 2019 renewable generation forecast of 1896 MW.

4.2.5 Intertie Flow Assumptions

The intertie flow assumptions for the Alberta-British Columbia (AB-BC), Alberta-Saskatchewan (AB-SK), and Alberta-Montana (MATL) interties are shown in Table 4-7.

For the 2027 WP Post-Project study scenario (Scenario 7), the intertie flows should be as per the published AESO base cases.

Table 4-7: Intertie Flows by Scenario

Scenario Number	Scenario Name	Import (-) / Export (+) by Intertie		
		AB-BC	AB-SK	MATL
1	2019 SL Pre-Project	700	150	300
2	2019 SP Pre-Project	-800	-150	-300
3	2019 WP Pre-Project	-800	-150	-300
4	2019 SL Post-Project	700	150	300
5	2019 SP Post-Project	-800	-150	-300
6	2019 WP Post-Project	-800	-150	-300
8	2019 SP Post-Project PENV	-800	-150	-300

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. The HVDC power order assumptions for the studies will be set to minimize losses for the pre-Project and post-Project study scenarios.

For the 2027 WP Post-Project study scenario (Scenario 7), the HVDC flows should be as per the published AESO base cases.

Table 4-8: HVDC Power Order by Scenario

Scenario Number	Scenario Name	WATL (MW)	EATL (MW)
1	2019 SL Pre-Project	300 N → S	275 S → N
2	2019 SP Pre-Project	500 S → N	900 S → N
3	2019 WP Pre-Project	425 S → N	875 S → N
4	2019 SL Post-Project	350 N → S	300 S → N
5	2019 SP Post-Project	500 S → N	900 S → N
6	2019 WP Post-Project	400 S → N	900 S → N
8	2019 SP Post-Project PENV	500 S → N	900 S → N

Notes:
N → S: HVDC flow direction is North to South
S → N: HVDC flow direction is South to North

The reactive power limits of the MVAr exchanges between the HVDC terminals (WATL and EATL) and the connected alternating current (AC) transmission systems are shown in Table 4-9. These limits must be maintained when performing the studies.

Table 4-9: HVDC to Adjacent AC System MVAr Exchange Limits

HVDC Facility	North Terminal Reactive Power Limit (MVAr)	South Terminal Reactive Power Limit (MVAr)
EATL	-85 to 75	-35 to 35
WATL	-75 to 75	-35 to 35

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 4-10 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 4-10: Thermal Rating Assumptions for Key Transmission Lines in the Study Area

Line ID	Line Description (Substations)	Voltage Class (kV)	Thermal Rating (MVA)			
			Normal		Emergency	
			Summer	Winter	Summer	Winter
1047L	Nilrem 574S - Hansman Lake 650S	240	499CT [a]	499CT	680	748CT
174L	Bardo 197S - North Holden 395S	138	85	90	94	99
472L	Metiskow 648S - Sunken Lake 221S tap point	138	121	150	133	153

Line ID	Line Description (Substations)	Voltage Class (kV)	Thermal Rating (MVA)			
			Normal		Emergency	
			Summer	Winter	Summer	Winter
472L	Sunken Lake 221S tap point – Hughenden 213S	138	121	150	133	165
679L	Nilrem 574S – Tucuman 478S	138	167	191CT	184	218
680L	Nilrem 574S – Tucuman 478S	138	167	191CT	184	218
681L	Tucuman 478S – Hardisty 377S	138	143	172	172	186
6L02	Battle River 757S - Marion Lake 873S	69	56.5	70.9	64.2	70.9
6L02	Marion Lake 873S – Stettler 769S	69	47CT	47CT	47CT	47CT
6L03	Battle River 757S - Sullivan Lake 775S	69	47CT	47CT	47CT	47CT
6L05	Heisler 764S - Battle River 757S	69	54.6	69	61.3	70.9
6L09	Oyen 767S – Hanna 763S	69	23CT	23CT	23CT	23CT
6L12	Sullivan Lake 775S – Coronation 773S	69	23CT	23CT	23CT	23CT
6L15	Hanna 763S - Sullivan Lake 775S	69	23CT	23CT	23CT	23CT
6L56	Hanna 763S - Michichi Creek 802S	69	35CT	35CT	35CT	35CT
701L/7L701	Heisler 764S tap point - Strome 223S	138	139.9	169	158	169
702L	Sedgewick 137S tap point – Hardisty 377S	138	87	135	96	146
703L	Hughenden 213S - HRT Express 329S tap point	138	121	145	133	160
703L	HRT Express 329S tap point – Hardisty 377S	138	96CT	96CT	133	143CT
704L	Jarrow 252S – Tucuman 478S	138	75	79	83	87
748L	Killarney Lake 267S – Hayter 277S	138	119	146	131	161
749L	Metiskow 648S – Killarney Lake 267S tap point	138	122	150	134	165
749L	Edgerton 899S – Killarney Lake 267S tap point	138	96CT	96CT	134	143CT
749L/7L749	Edgerton 899S – Briker 880S tap point	138	96CT	96CT	124	143CT
769L	Hardisty 377S – Rosyth 296S	138	86	115	95	127
7L110	Monitor 774S – Loyalist 903S	138	109.3	139	123.6	150.5
7L116	Excel 910S –	138	95CT	95CT	95CT	95CT

Line ID	Line Description (Substations)	Voltage Class (kV)	Thermal Rating (MVA)			
			Normal		Emergency	
			Summer	Winter	Summer	Winter
	Lanfine 959S					
7L117	Vermilion 710S - Irish Creek 706S	138	123.6	150.4	9123.6	150.4
7L127	Pemukan 932S – Monitor 774S	138	180.2	217.5	180.2	217.5
7L128	Coyote Lake 963S – Michichi Creek 802S	138	180.2	217.5	180.2	217.5
7L129	Buffalo Creek 526S – Vermilion 710S	138	109.3	139	123.6	142.8
7L130	Vermilion 710S – Kitscoty 705S	138	71.9	86.3	71.9	86.3
7L132	Lanfine 959S – Oyen 767S	138	143CT	143CT	143CT	143CT
7L137	Three Hills 770S – Rowley 768S	138	109.3	139	123.6	142.8
7L139	Whitby Lake 819S – Norberg 936S tap point	138	109.3	139	123.6	150.4
7L139	Norberg 936S tap - St. Paul 707S	138	109.3	139	123.6	150.4
7L14	Kitscoty 705S – Hill 751S	138	71.9	86.3	71.9	86.3
7L143	Nevis 766S – Stettler 769S	138	95CT	95CT	95CT	95CT
7L153	Wintering Hills 804S – Wheatland 609S	138	143CT	143CT	143CT	143CT
7L159	Heatburg 948S - Three Hills 770S	138	109.3	126.5CT	124	126.5CT
7L16	Nevis 766S – Heatburg 948S	138	109.3	126.5CT	123.6	126.5CT
7L171	Michichi Creek 802S - Wintering Hills 804S	138	109.3	139	123.6	150.4
7L224	Hansman Lake 650S – Monitor 774S	138	109.3	139	123.6	142.8
7L25	Michichi Creek 802S – Rowley 768S	138	95CT	95CT	95CT	95CT
7L42	Hill 751S – Lloydminster 716S	138	95CT	95CT	95CT	95CT
7L50	Buffalo Creek 526S – Jarrow 252S tap point	138	109.3	139	123.6	150.5
7L50	Battle River 757S – Jarrow 252S tap point	138	109.3	139	123.6	150.5
7L53	Irish Creek 706S – Lindberg 969S tap point	138	123.6	150.4	123.6	150.4
7L53	Lindberg 969S tap point – Bonnyville 700S	138	123.6	150.4	123.6	150.4
7L65	Vermilion 710S – Vegreville 709S	138	95CT	95CT	95CT	95CT

Line ID	Line Description (Substations)	Voltage Class (kV)	Thermal Rating (MVA)			
			Normal		Emergency	
			Summer	Winter	Summer	Winter
7L70	St. Paul 707S – Bonnyville 700S	138	109.3	139	123.6	150.5
7L701	Battle River 757S – Heisler 764S tap point	138	139.9	179.2	160	193.6
7L702/702L	Battle River 757S – Sedgewick 137S tap point	138	109	118	124	130
7L749	Lloydminster 716S – Briker 880S tap point	138	109.3	139	123.6	150.5
7L760	Oyen 767S – Bindloss 914S tap point	138	109.3	139	123.6	142.8CT
7L79	Pemukan 932S - Ribstone Creek 892S	138	109.3	139	123.6	150.5
7L85	Wintering Hills 804S – Bullpound 803S tap point	138	139.9	179.2	160	190.7CT
7L85	Bull Pound 803S tap point – Anderson 801S	138	139.9	179.2	160	190.7CT
7L92	Vegreville 709S - Whitby Lake 819S (all segments)	138	95CT	95CT	95CT	95CT
7LA159	Ghost Pine 114S - 7L159 tap point	138	109.3	139	123.6	142.8
885L	Metiskow 648S - Hansman Lake 650S	138	287	287CT	344	373
912L/9L912	Nevis 766S - Red Deer 63S	240	507	623	553	623CT
953L	Cordel 755S – Nilrem 574S	240	498CT	498CT	498CT	498CT
954L	Metiskow 648S - Hansman Lake 650S	240	333CT	333CT	499CT	499CT
9L100	Sheerness 807S – Anderson 801S	240	498CT	498CT	498CT	498CT
9L16	Tinchebray 972S – Cordel 755S	240	549	663CT	627	663CT
9L20	Nevis 766S – Cordel 755S	240	488	498CT	498CT	498CT
9L24	Oakland 946S – Lanfine 959S	240	332CT	332CT	432CT	432CT
9L27	Paintearth 863S – Cordel 755S	240	399CT	399CT	399CT	399CT
9L29	Oakland 946S - Coyote Lake 963S	240	332CT	332CT	432CT	432CT
9L46	Lanfine 959S – Pemukan 932S	240	332CT	332CT	432CT	432CT
9L59	Anderson 801S – Tinchebray 972S	240	549	701	627	759
9L70	Anderson 801S – Oakland 946S	240	432CT	432CT	432CT	432CT

Line ID	Line Description (Substations)	Voltage Class (kV)	Thermal Rating (MVA)			
			Normal		Emergency	
			Summer	Winter	Summer	Winter
9L79	Battle River 757S – Cordel 755S	240	498CT	498CT	498CT	498CT
9L80	Battle River 757S – Cordel 755S	240	332CT	332CT	332CT	332CT
9L93	Halkirk 615S – Tinchebray 972S	240	249CT	249CT	249CT	249CT
9L933	Anderson 801S - Ware Junction 132S	240	519	663	592	716
9L934	Anderson 801S - Ware Junction 132S	240	519	663	592	716
9L948	Paintearth 863S - Hansman Lake 650S	240	399CT	399CT	399CT	399CT
9L950	Anderson 801S - Ware Junction 132S	240	519	663	592	716
9L953	Cordel 755S – Nilrem 574S	240	498CT	498CT	498CT	498CT
9L966	Pemukan 932S - Hansman Lake 650S	240	332CT	332CT	432CT	432CT
9L97	Anderson 801S – Oakland 946S	240	432CT	432CT	432CT	432CT
9L99	Sheerness 807S – Anderson 801S	240	498CT	498CT	498CT	498CT

Note:
"CT" indicates that the transmission line is limited by current transformer.

The TFOs provided the details of the substation transformers in the Study Area. The key transformers in the Study Area are shown in Table 4-11.

Table 4-11: Summary of Key Transformer Ratings in the Study Area

Substation (Name and Number)	Transformer ID	Transformer Voltages (kV)	Transformer Rating (MVA)
Anderson 801S	901T	240/144	125
Battle River 757S	912T	240/144	224
	701T	144/72	75
Coyote Lake 963S	901T	240/144	300
Edgerton 899S	T3	240/138	200
Hansman Lake 650S	T1	240/138	200
	T3	240/138	200
Metiskow 648S	T1	138/25	25
	T3	240/138	200
Michichi Creek 802S	701T	144/72	33

Substation (Name and Number)	Transformer ID	Transformer Voltages (kV)	Transformer Rating (MVA)
Nevis 766S	901T	240/144	100
	701T	144/72/25	H-M: 33.3 X-M: 33.3 Y-M: 16.6
Nilrem 574S	T1	240/138	400
	T2	240/138	400

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 4-12.

Table 4-12: Summary of Key Shunt Elements in the Study Area

Substation (Name and Number)	Voltage Class (kV)	Shunt Element (Type)			
		Capacitors		Reactors	
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)	Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)
Buffalo Creek 526S	138	1x 15.00	15.00	-	-
Halkirk 615S	34.5	1x 6.00 + 3x 18.00	60.00	2x -14.00	-28.00
	0.5	2x 12.50	25.00	2x -12.50	-25.00
Hansman Lake 650S	18.0	1x 176.80	176.80	1x -88.20	-88.20
Hardisty 377S	138	1x 27.02 + 1x 44.90	71.92	-	-
Hill 751S	138	1x 18.12 + 1x 22.96	41.08	-	-
Lanfine 959S	240	1x 200.00	200.00	1x -100.00	-100.00
	138	2x 27.55	55.10	-	-
Monitor 774S	138	1x 18.38+1x 27.55	46.00	-	-
Killarney Lake 267S	138	1x 9.10 + 2x 10.90	30.90	-	-
Lloydminster 716S	138	1x 18.12	18.12	-	-
Tucuman 478S	138	1x 27.17	27.17	-	-
Youngstown	25	1x 2.40	2.40	-	-

Substation (Name and Number)	Voltage Class (kV)	Shunt Element (Type)			
		Capacitors		Reactors	
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)	Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)
772S					
Three Hills 770S	138	1x 18.37	18.37	-	-
	25	1x 4.95	4.95	-	-
Michichi Creek 802S	138	1x 9.18	9.18	-	-

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 4-13. Only those contingencies shown in Table 4-13 will be studied for transient stability studies.

Table 4-13: Protection Fault Clearing Times

Contingency (System Element Lost)	Fault Location	Clearing Times (Cycles)	
		Near End	Far End
9L24 (Oakland 946S – Lanfine 959S)	Oakland 946S	5	6
9L24 (Oakland 946S – Lanfine 959S)	Lanfine 959S	5	6
9L29 (Oakland 946S – Coyote Lake 963S)	Oakland 946S	5	6
9L29 (Oakland 946S – Coyote Lake 963S)	Coyote Lake 963S	5	6
9L20 (Cordel 755S – Nevis 766S)	Cordel 755S	5	6
9L20 (Cordel 755S – Nevis 766S)	Nevis 766S	5	6
9L59 (Anderson 801S – Tinchebray 972S)	Anderson 801S	5	6
9L59 (Anderson 801S – Tinchebray 972S)	Tinchebray 972S	5	6
912L/9L912 (Nevis 766S – Red Deer 63S)	Nevis 766S	5.5	6.5
912L/9L912 (Nevis 766S – Red Deer 63S)	Red Deer 63S	5	6
7L203 (Wintering Hills 804S - Parker 2072S)	Wintering Hills 804S	6	24
7L203 (Wintering Hills 804S - Parker 2072S)	Parker 2072S	6	24
7L85 (Parker 2072S – Anderson 946S)	Parker 2072S	6	24
7L85 (Parker 2072S – Anderson 946S)	Anderson 946S	6	24
7L171 (Wintering Hills 804S – Michichi Creek 802S)	Wintering Hills 804S	6	24
7L171 (Wintering Hills 804S – Michichi Creek 802S)	Michichi Creek 802S	6	24
7L25 (Rowley 768S – Michichi Creek 802S)	Rowley 768S	6	24

7L25 (Rowley 768S – Michichi Creek 802S)	Michichi Creek 802S	6	24
7L137 (Rowley 768S – Three Hills 770S)	Rowley 768S	6	24
7L137 (Rowley 768S – Three Hills 770S)	Three Hills 770S	6	24
7L159 (Three Hills 770S – Ghost Pine 114S – Heatburg 948S)	Three Hills 770S	6	8
7L159 (Three Hills 770S – Ghost pine 114S – Heatburg 948S)	Ghost Pine 114S	6	8
7L159 (Three Hills 770S – Ghost pine 114S – Heatburg 948S)	Heatburg 948S	6	8
7L16 (Heatburg 948S – Nevis 766S)	Heatburg 948S	6	24
7L16 (Heatburg 948S – Nevis 766S)	Nevis 766S	6	24
7L128 (Michichi Creek 802S – Coyote Lake 963S)	Michichi Creek 802S	6	8
7L128 (Michichi Creek 802S – Coyote Lake 963S)	Coyote Lake 963S	6	8

4.2.9 Project Dynamic Data

Dynamic data for the Project can be found in Attachment A5.

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

5.1 Engineering Studies

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

Table 5-1: Summary of Engineering Studies to be performed

Scenario No. and Name		Power Flow		Transient Stability		Short Circuit
		Category		Category		Category A
		A	B	A	B	
Pre-Project						
1	2019 SL Pre-Project	X	X			
2	2019 SP Pre-Project	X	X			
3	2019 WP Pre-Project	X	X			X
Post-Project						
4	2019 SL Post-Project	X	X	X	X	
5	2019 SP Post-Project	X	X	X	X	
6	2019 WP Post-Project	X	X	X	X	X
7	2027 WP Post-Project					X
Post-Project Sensitivity						
8	2019 SP Post-Project PENV	X	X			

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).

5.2 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.

5.2.1 Contingencies to be Studied

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

5.3 Transient Stability Studies

Transient stability studies will be performed for the post-Project scenarios.

Keephills #3 in the AESO planning area of 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 key variables including rotor angle, and active and reactive power output for the Sheerness and Battle River generating units. 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.

5.3.1 Contingencies to be Studied

Transient stability studies will be performed for the contingencies shown in Table 4-13

5.4 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:

- Anderson 801S
- Badlands 981S (post-Project scenarios only)
- Bullpound 803S
- Coyote Lake 963S

- Michichi Creek 802S
- Oakland 946S
- Parker 2072S (post-Project scenarios only)
- Sheerness 807S
- Wheatland 609S
- Wintering Hills 804S

Further sensitivity studies, in consultation with the TFOs, 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.

Attachment A: Transmission Planning Criteria – Basis and Assumptions

Transmission Planning Criteria – Basis and Assumptions

Version 1.1

Alberta Electric System Operator, Calgary Place, 2500, 330 – 5th Avenue SW Calgary, AB T2P 0L4
Phone: 403-539-2450 Fax: 403-539-2949 www.aeso.ca @theaeso

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 these standards is given in: AESO. *Alberta Reliability Standards*. Available at: 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
P1718_2019SL_Pre.sav 2019 Summer Light High Wind Economy Coal Pre-Project	N-0 (System Normal Condition)	Figure A2-1
P1718_2019SP_Pre.sav 2019 Summer Peak High Wind Economy Coal Pre-Project	N-0 (System Normal Condition)	Figure A2-2
	7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	Figure A2-3
	7L42 (Hill 751S - Lloydminster 716S)	Figure A2-4
	899ST3A (Edgerton 899S Transformer T3A)	Figure A2-5
	9L20 (Nevis 766S - Cordel 755S)	Figure A2-6
	395ST1 (North Holden 395S Transformer T1)	Figure A2-7
	766S901T (Nevis 766S Transformer 901T)	Figure A2-8
	648ST1 (Metiskow 648S Transformer T1)	Figure A2-9
	701L (North Holden 395S - Strome 223S)	Figure A2-10
	EATL (Newell 2075S - Heathfield 2029S)	Figure A2-11
	7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)	Figure A2-12
	749L\749AL (Metiskow 648S - Edgerton 899S)	Figure A2-13
	912L\9L912 (Red Deer 63S - Nevis 766S)	Figure A2-14
P1718_2019WP_Pre.sav 2019 Winter Peak High Wind Economy Coal Pre-Project	N-0 (System Normal Condition)	Figure A2-15
	7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	Figure A2-16
	766S901T (Nevis 766S Transformer 901T)	Figure A2-17
	749L\749AL (Metiskow 648S - Edgerton 899S)	Figure A2-18
	526ST1 OR 526ST2 (Buffalo Creek 526S Transformer T1 or T2)	Figure A2-19
	648ST1 (Metiskow 648S Transformer T1)	Figure A2-20
	9L20 (Nevis 766S - Cordel 755S)	Figure A2-21
	912L\9L912 (Red Deer 63S - Nevis 766S)	Figure A2-22
	EATL (Newell 2075S - Heathfield 2029S)	Figure A2-23

Figure A2-1: 2019 Summer Light Pre-Project - N-0 (System Normal Condition)

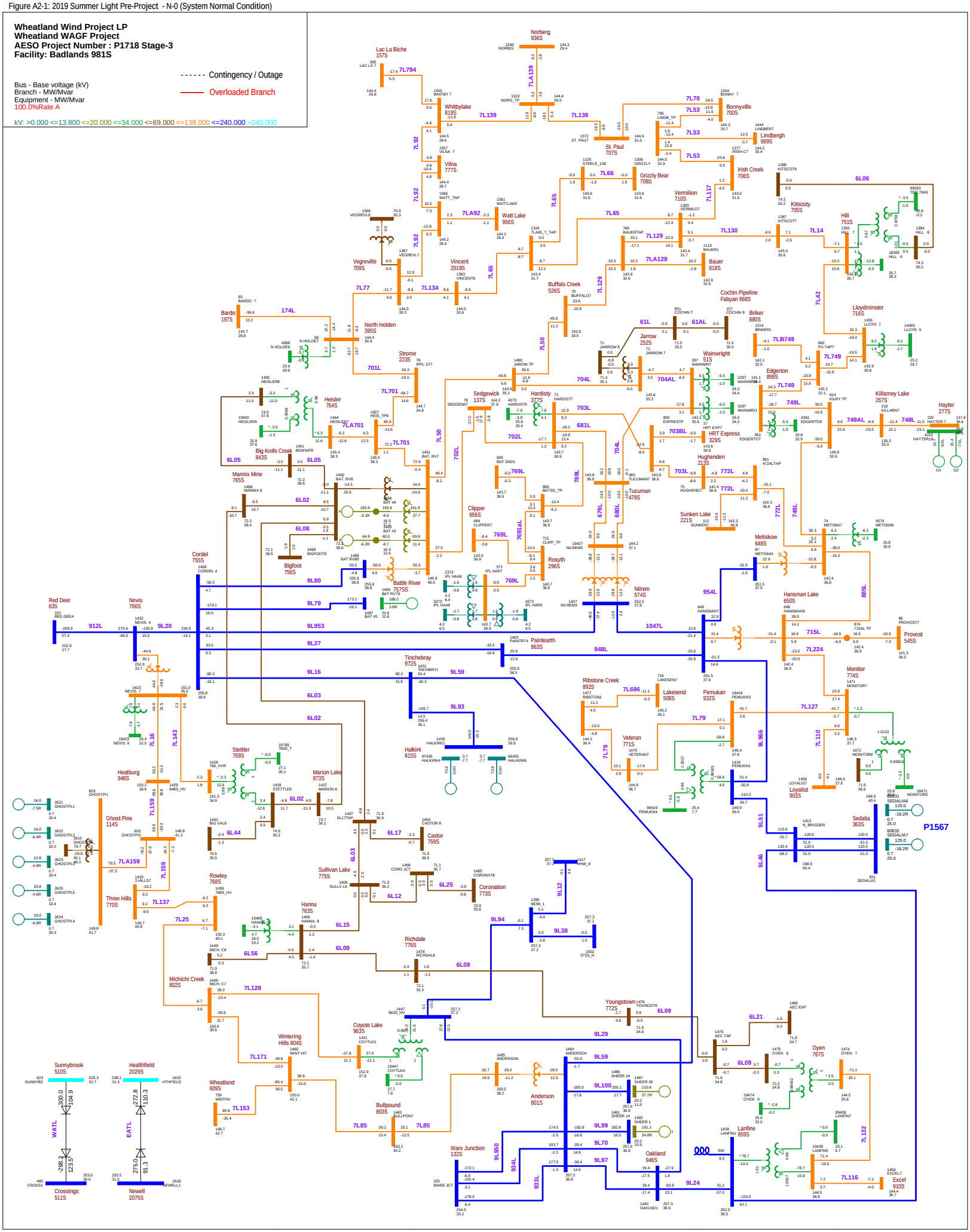


Figure A2-2: 2019 Summer Peak Pre-Project - N-0 (System Normal Condition)

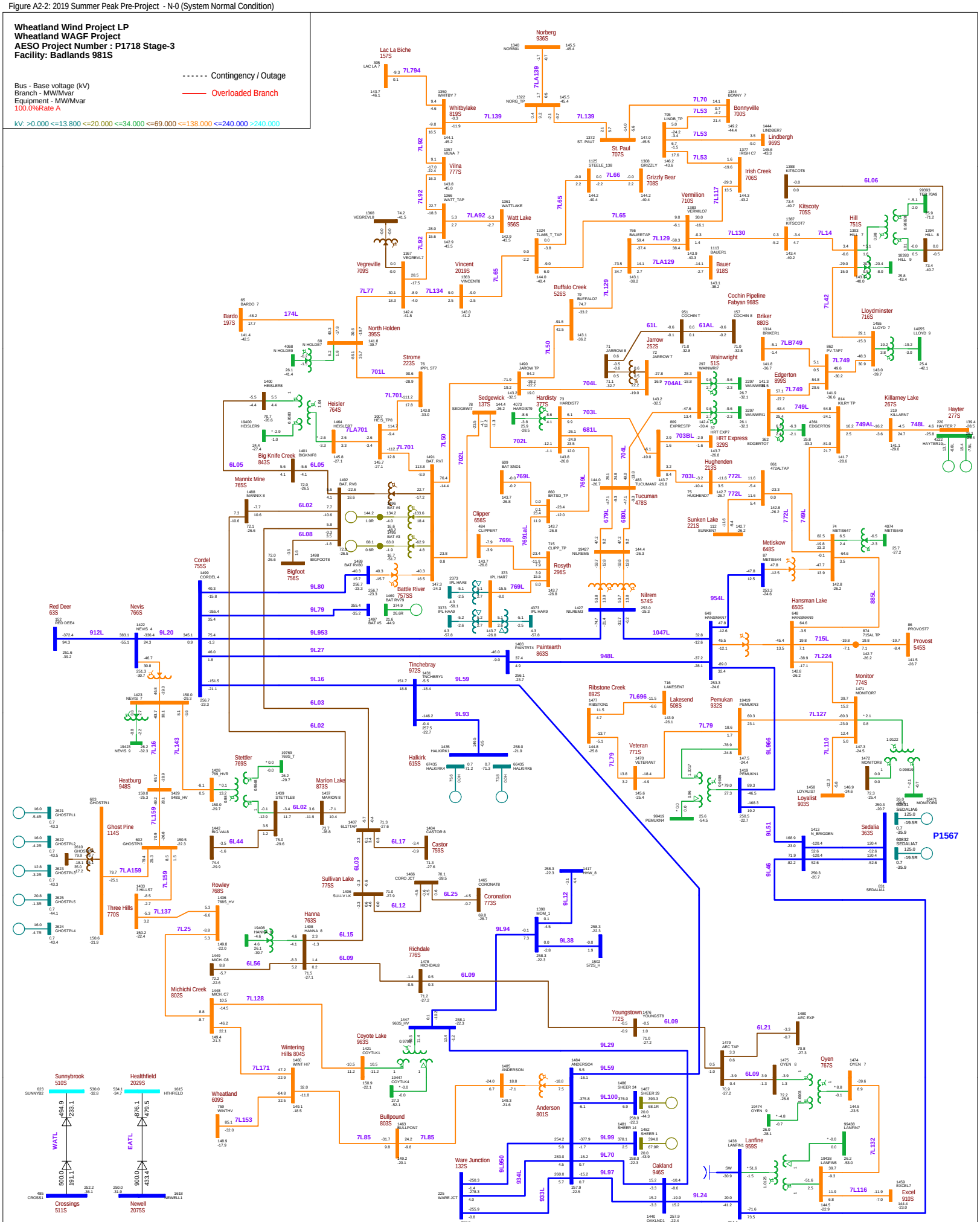


Figure A2-3: 2019 Summer Peak Pre-Project - Contingency of 7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)

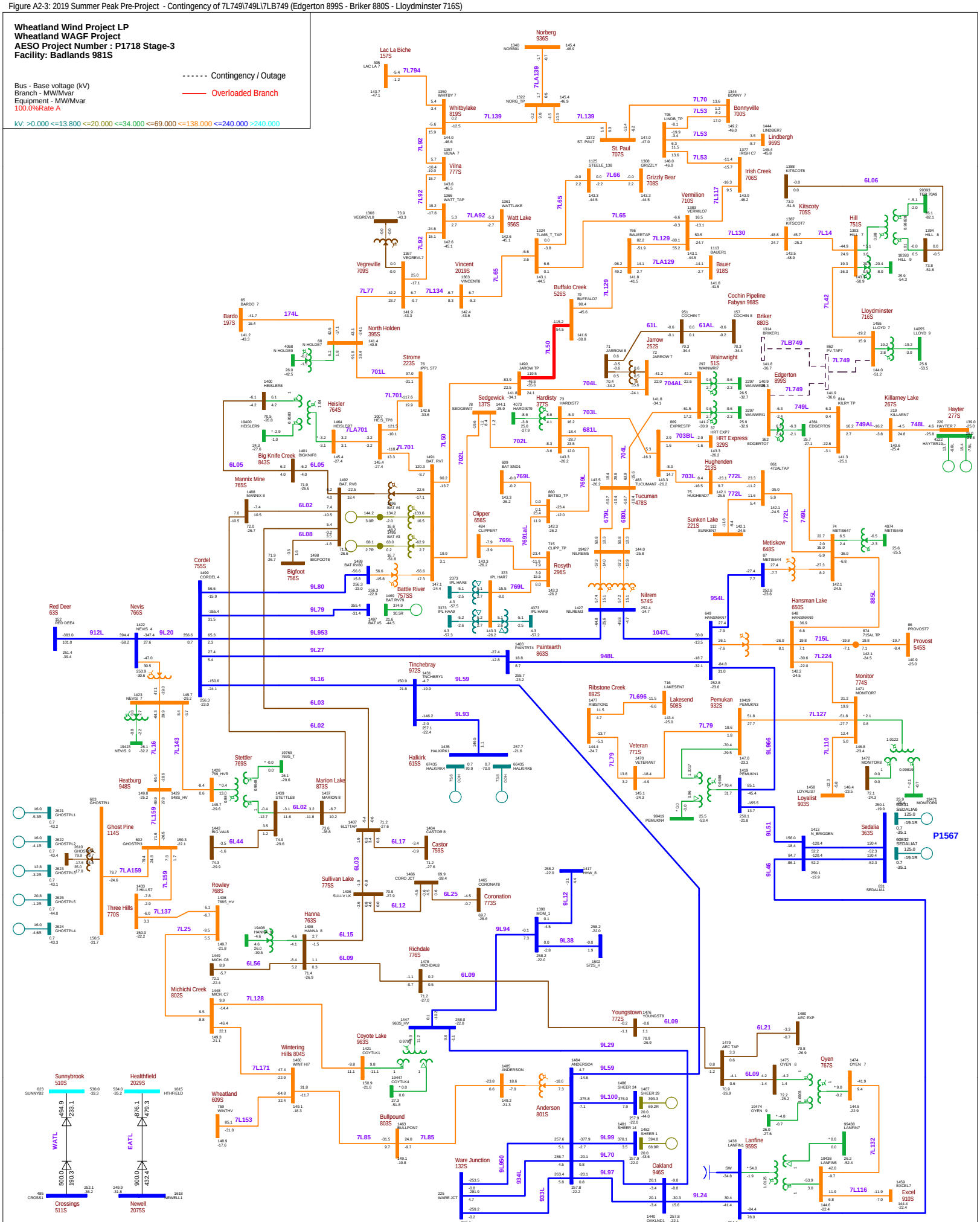


Figure A2-4: 2019 Summer Peak Pre-Project - Contingency of 7L42 (Hill 751S - Lloydminster 716S)

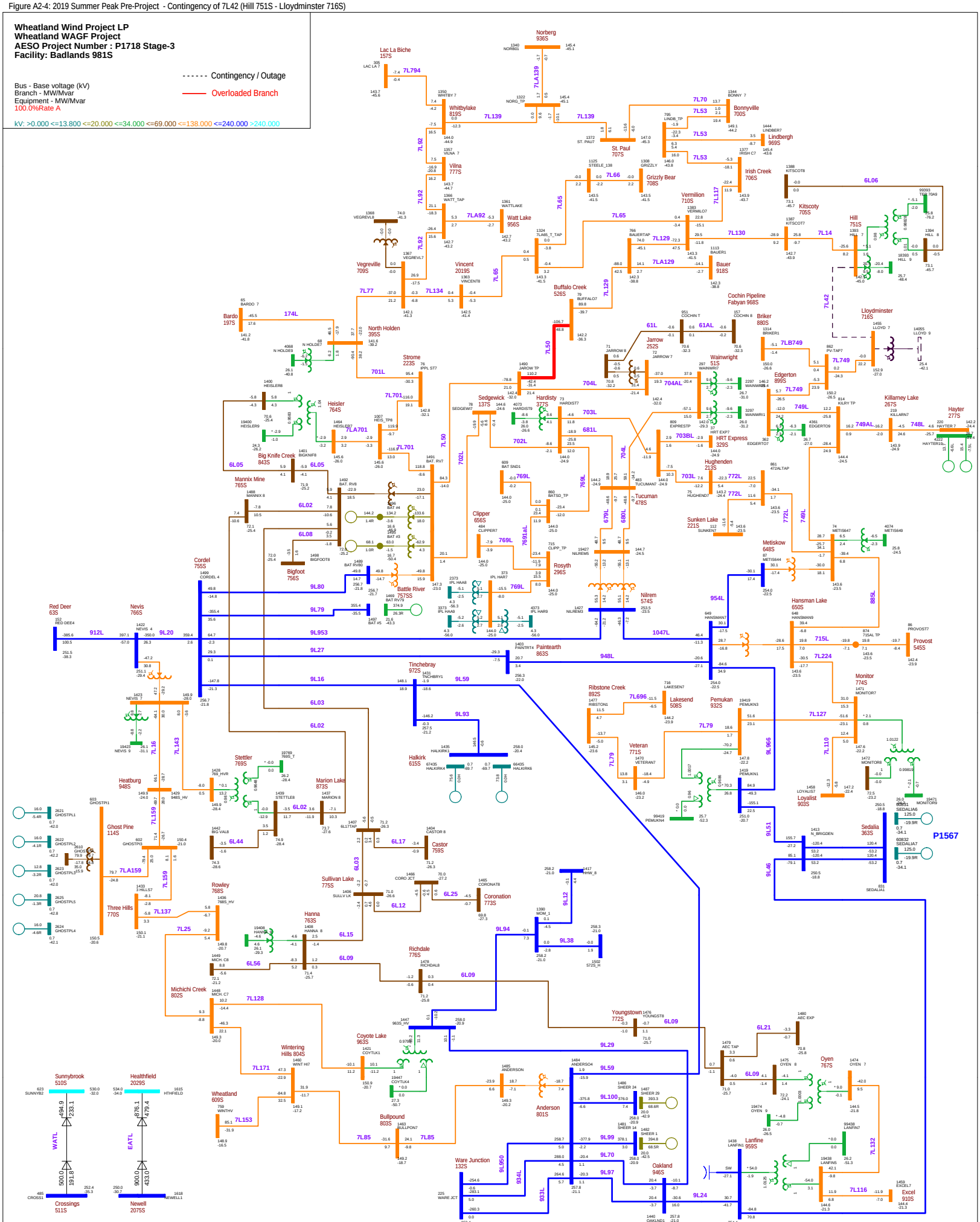


Figure A2-5: 2019 Summer Peak Pre-Project - Contingency of 899ST3A (Edgerton 899S Transformer T3A)

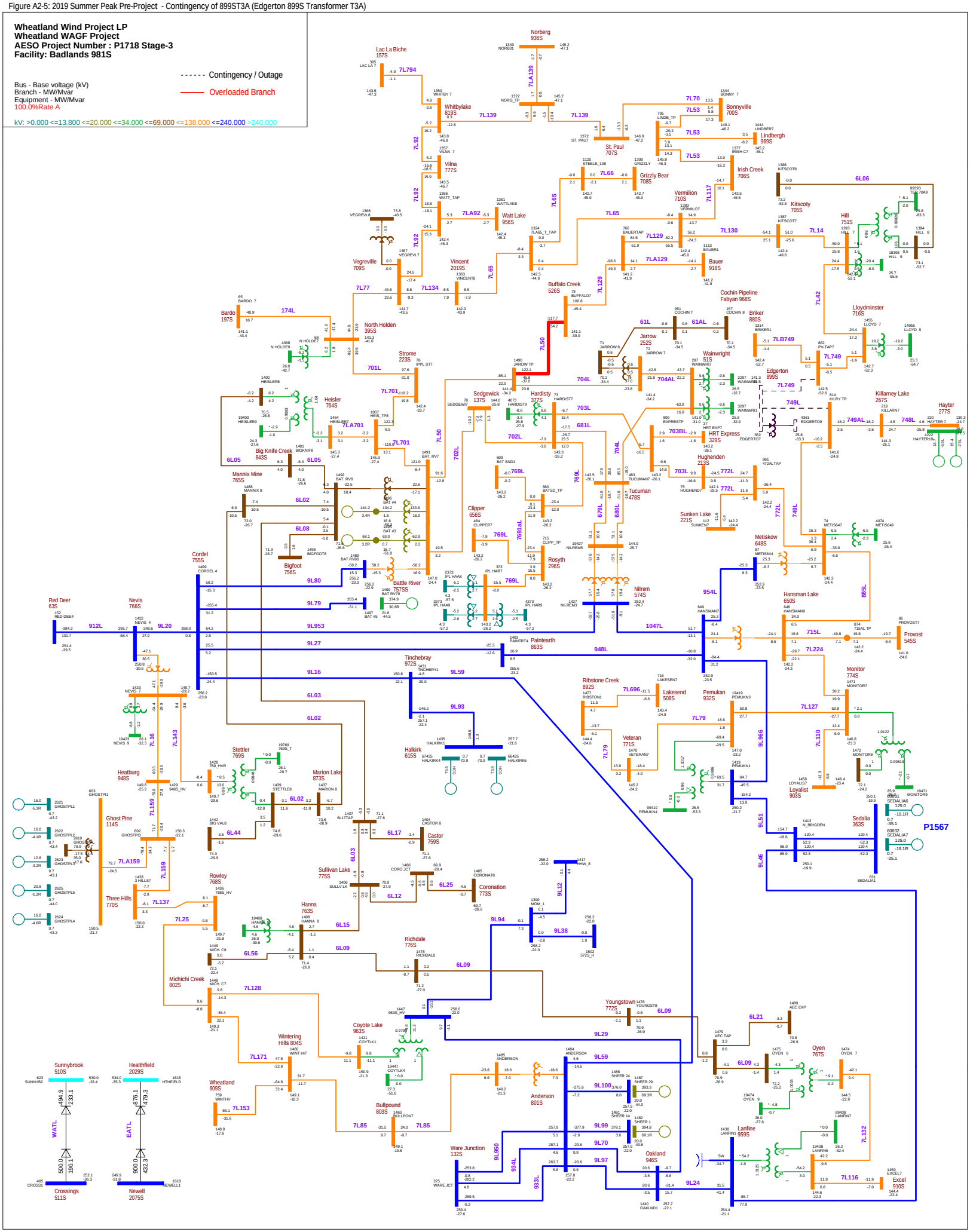


Figure A2-6: 2019 Summer Peak Pre-Project - Contingency of 9L20 (Nevis 766S - Cordel 755S)

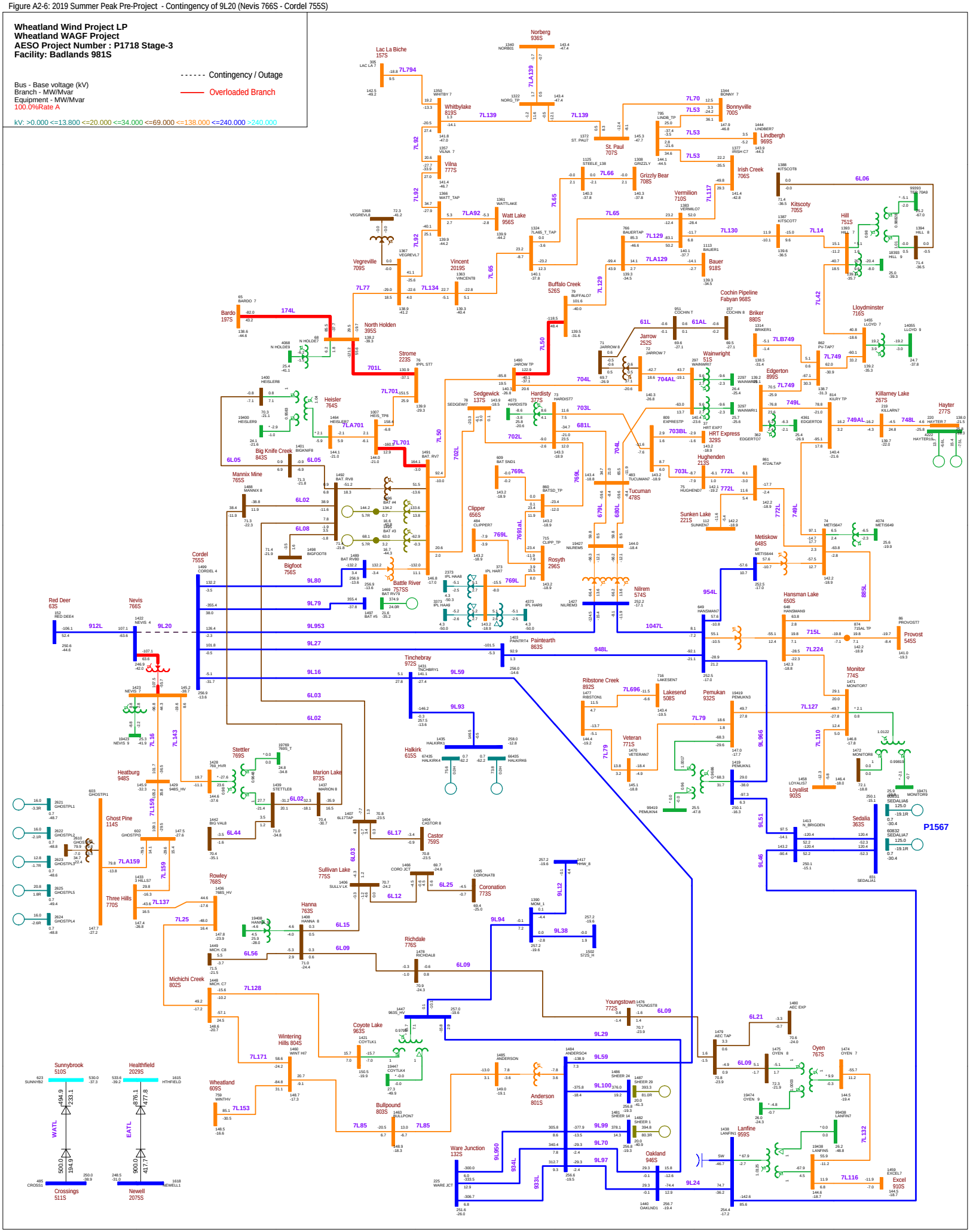


Figure A2-7: 2019 Summer Peak Pre-Project - Contingency of 395ST1 (North Holden 395S Transformer T1)

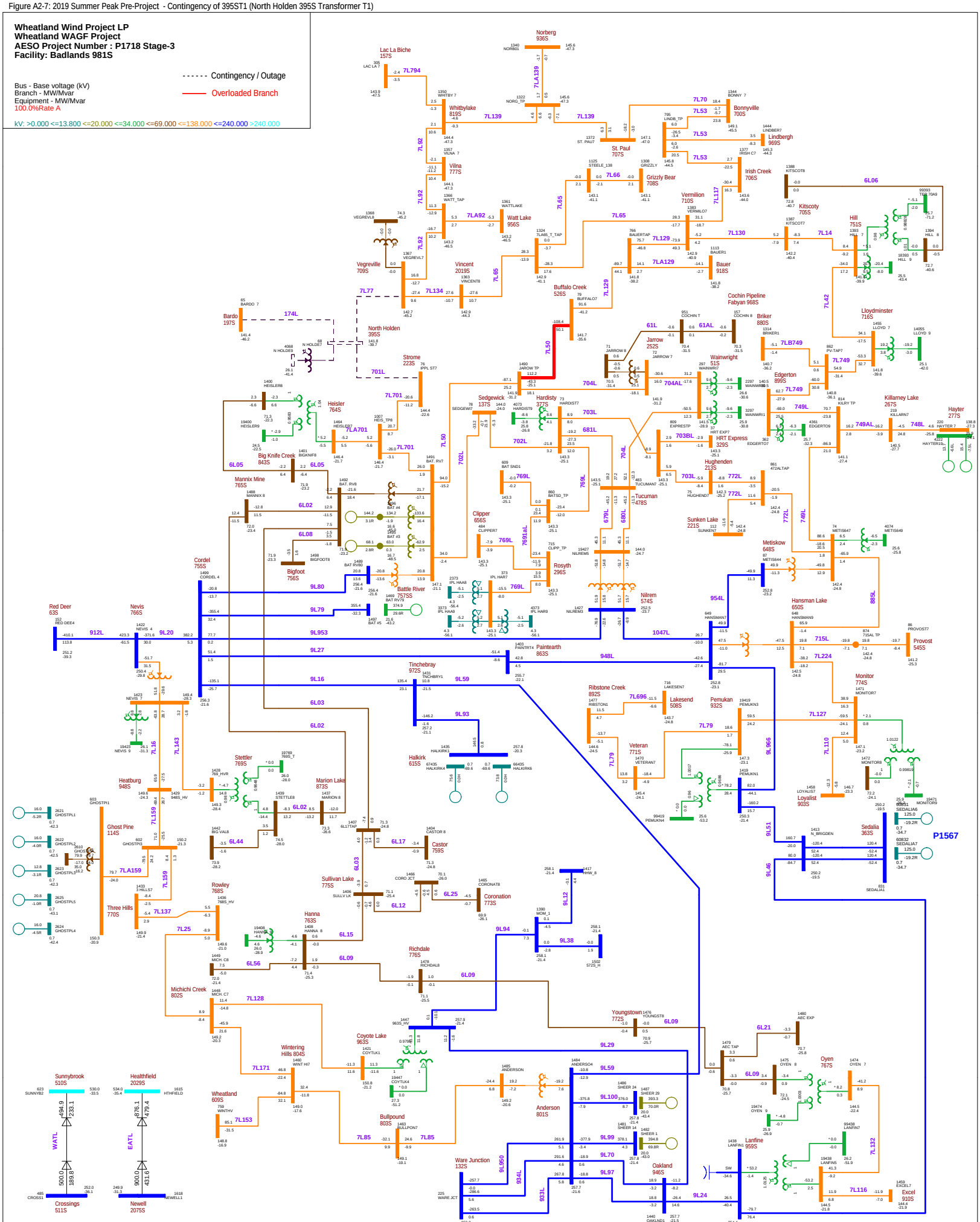

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S
Contingency / Outage
Overloaded Branch
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000
Norberg 936S
Lac La Biche 157S
Whitbylake 819S
Vilna 777S
Watt Lake 956S
Vegreville 709S
Vincent 2019S
Buffalo Creek 526S
Bardo 197S
North Holden 395S
Strome 223S
Heisler 764S
Big Knife Creek 843S
Mannix Mine 765S
Bigfoot 756S
Cordel 755S
Battle River 757SS
Red Deer 63S
Nevis 766S
Heatburg 948S
Ghost Pine 114S
Three Hills 770S
Rowley 768S
Michichi Creek 802S
Wheatland 609S
Sunnybrook 510S
Crossings 511S
Healthfield 2029S
Newell 2075S
Wintering Hills 804S
Coyote Lake 963S
Bullpound 803S
Ware Junction 132S
Anderson 801S
Oakland 946S
Youngstown 772S
Richdale 776S
Sullivan Lake 775S
Hanna 763S
Castor 759S
Coronation 773S
Sedalia 363S
Halkirk 615S
Stettler 769S
Marion Lake 873S
Tinchebray 972S
Paintearth 863S
Clipper 656S
Rosyth 296S
Nilrem 574S
Tucumar 478S
Sedgewick 137S
Hardisty 377S
Jarrow 252S
Wainwright 51S
Vermilion 710S
Lindbergh 969S
Bonnyville 700S
St. Paul 707S
Grizzly Bear 708S
Irish Creek 706S
Kitscoty 705S
Hill 751S
Lloydminster 716S
Edgerton 899S
Killarney Lake 267S
Hayter 277S
Cochin Pipeline Fabyan 968S
Briker 880S
Hughenden 213S
HRT Express 329S
Sunken Lake 221S
Metiskow 648S
Hansman Lake 650S
Provost 545S
Monitor 774S
Lakesend 508S
Pemukan 932S
Ribstone Creek 892S
Veteran 771S
Loyalist 903S
Lanfine 969S
Oyen 767S
Excel 910S
P1567
Vilna 7
Whitby 7
Watt Lake
Vegrevill
Vincent
Buffalo Creek
Bardo 7
Heisler
Big Knife Creek
Mannix Mine
Bigfoot
Cordel 4
Nevis 4
Heatburg
Ghost Pine
Three Hills
Rowley
Michichi Creek
Wheatland
Sunnybrook
Crossings
Healthfield
Newell
Wintering Hills
Coyote Lake
Bullpound
Ware Junction
Anderson
Oakland
Youngstown
Richdale
Sullivan Lake
Hanna
Castor
Coronation
Sedalia
Halkirk
Stettler
Marion Lake
Tinchebray
Paintearth
Clipper
Rosyth
Nilrem
Tucumar
Sedgewick
Hardisty
Jarrow
Wainwright
Vermilion
Lindbergh
Bonnyville
St. Paul
Grizzly Bear
Irish Creek
Kitscoty
Hill
Lloydminster
Edgerton
Killarney Lake
Hayter
Cochin Pipeline
Briker
Hughenden
HRT Express
Sunken Lake
Metiskow
Hansman Lake
Provost
Monitor
Lakesend
Pemukan
Ribstone Creek
Veteran
Loyalist
Lanfine
Oyen
Excel
North Holden
Strome
Tinchebray
Paintearth
Clipper
Rosyth
Nilrem
Tucumar
Sedgewick
Hardisty
Jarrow
Wainwright
Vermilion
Lindbergh
Bonnyville
St. Paul
Grizzly Bear
Irish Creek
Kitscoty
Hill
Lloydminster
Edgerton
Killarney Lake
Hayter
Cochin Pipeline
Briker
Hughenden
HRT Express
Sunken Lake
Metiskow
Hansman Lake
Provost
Monitor
Lakesend
Pemukan
Ribstone Creek
Veteran
Loyalist
Lanfine
Oyen
Excel
7L794
7L139
7L92
7L93
7L65
7L66
7L70
7L53
7L117
7L130
7L14
7L129
7LA129
7LA92
7L77
7L134
7L50
7L42
7L749
7L749A
7L749B
7L748
7L701
7LA701
7L703
7L681
7L704
7L704AL
7L703BL
7L703L
7L702
7L702L
7L769
7L769L
7L691AL
7L772
7L772L
7L749L
7L680L
7L679L
7L6
61L
61AL
7LB749
7L224
7L715
7L127
7L79
7L696
7L110
7L966
7L951
7L946
7L954
885L
948L
1047L
9L953
9L27
9L16
9L59
9L93
9L79
9L80
9L20
912L
6L02
6L03
6L05
6L06
6L08
6L09
6L12
6L15
6L17
6L25
6L44
6L56
6L02
7L16
7L143
7L159
7LA159
7L137
7L25
7L128
7L171
7L153
7L85
9L94
9L38
9L12
9L29
9L59
9L100
9L99
9L70
9L97
9L24
934L
933L
9L950
6L21
6L09
7L132
7L116
7L110
7L127
7L224
7L715
7L749
7L749A
7L749B
7L748
7L14
7L130
7L117
7L65
7L92
7L93
7LA139
7LA701
7LA92
7LA129
7L139
7L129
7L50
7L701
7L702
7L703
7L704
7L681
7L680
7L679
7L772
7L772L
7L769
7L769L
7L691AL
7L703BL
7L704AL
7L704L
7L703L
7L702L
7L701
7L50
7L77
7L134
7L65
7L92
7L93
7LA139
7LA701
7LA92
7LA129
7L139
7L129
7L50
7L42
7L749
7L749A
7L749B
7L748
7L14
7L130
7L117

Figure A2-8: 2019 Summer Peak Pre-Project - Contingency of 766S901T (Nevis 766S Transformer 901T)

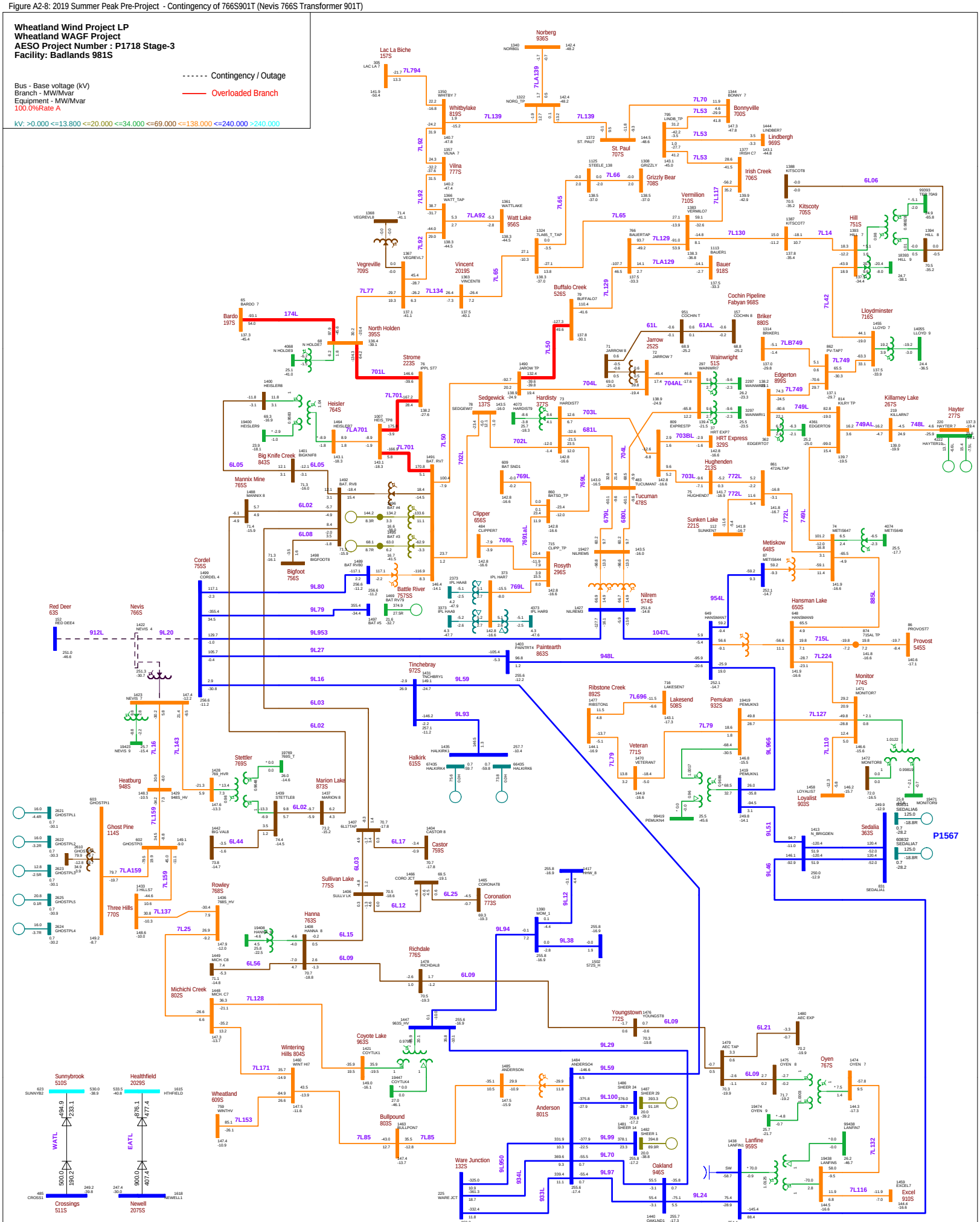


Figure A2-9: 2019 Summer Peak Pre-Project - Contingency of 648ST1 (Metiskow 648S Transformer T1)

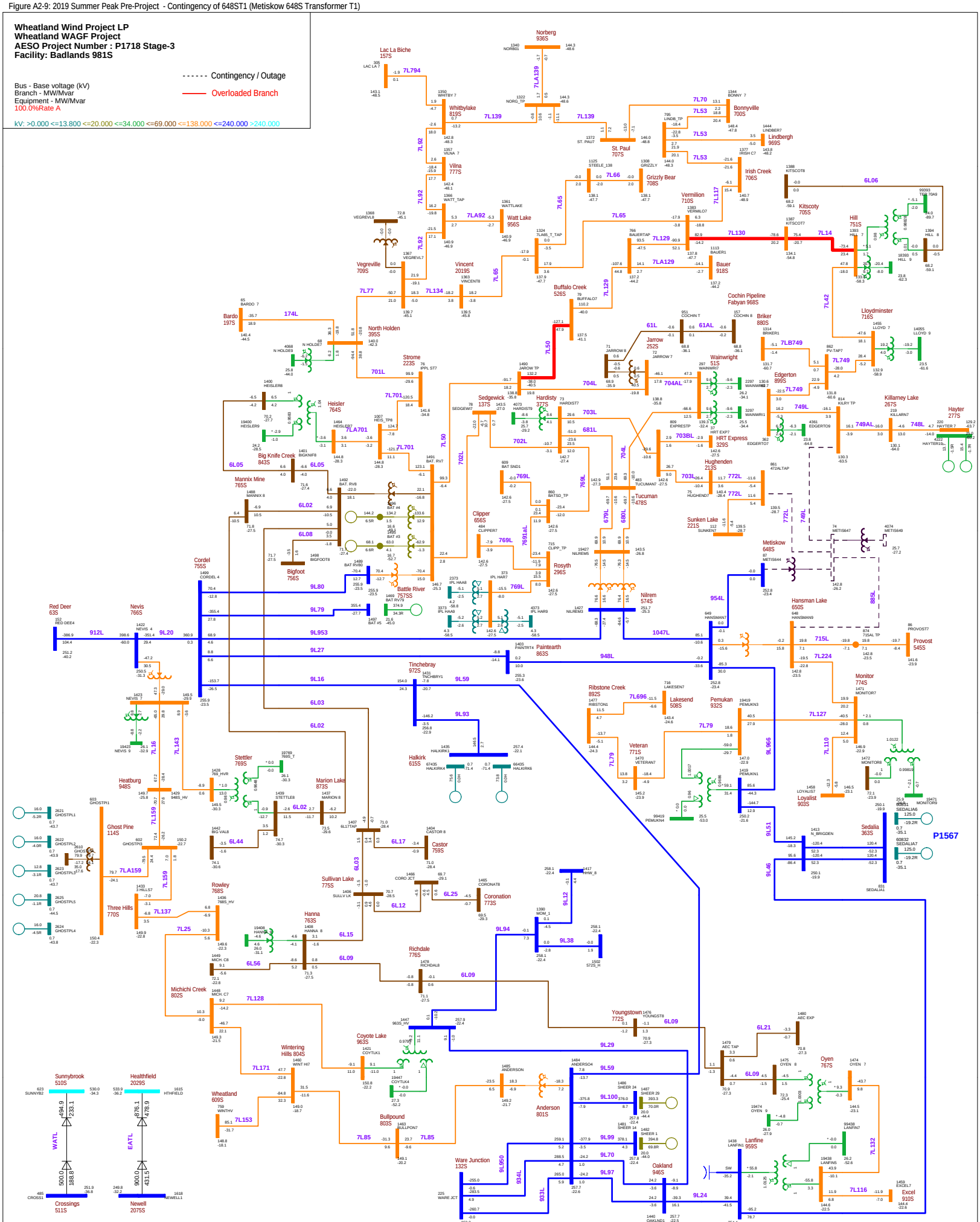


Figure A2-10: 2019 Summer Peak Pre-Project - Contingency of 701L (North Holden 395S - Strome 223S)

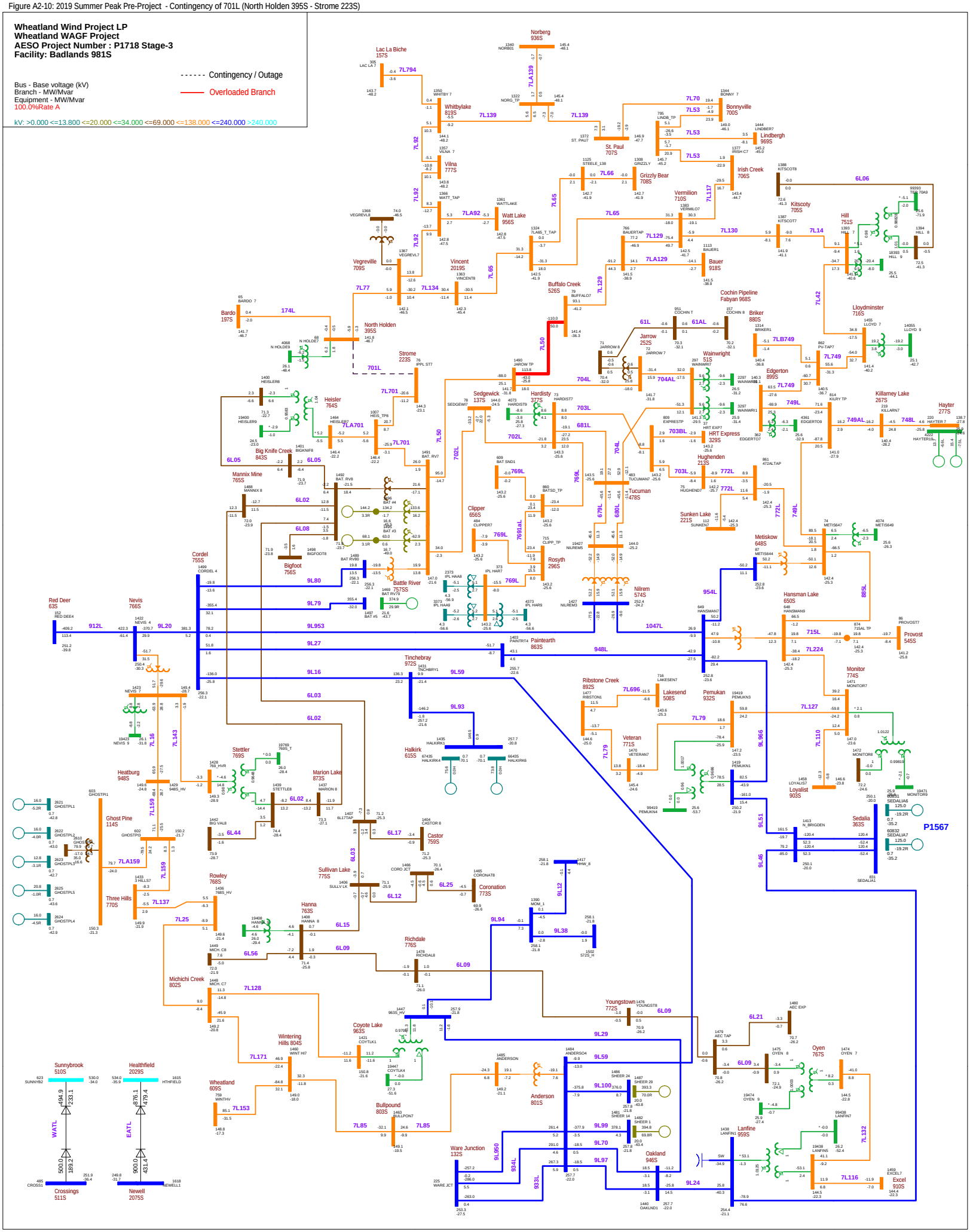


Figure A2-11: 2019 Summer Peak Pre-Project - Contingency of EATL (Newell 2075S - Heathfield 2029S)

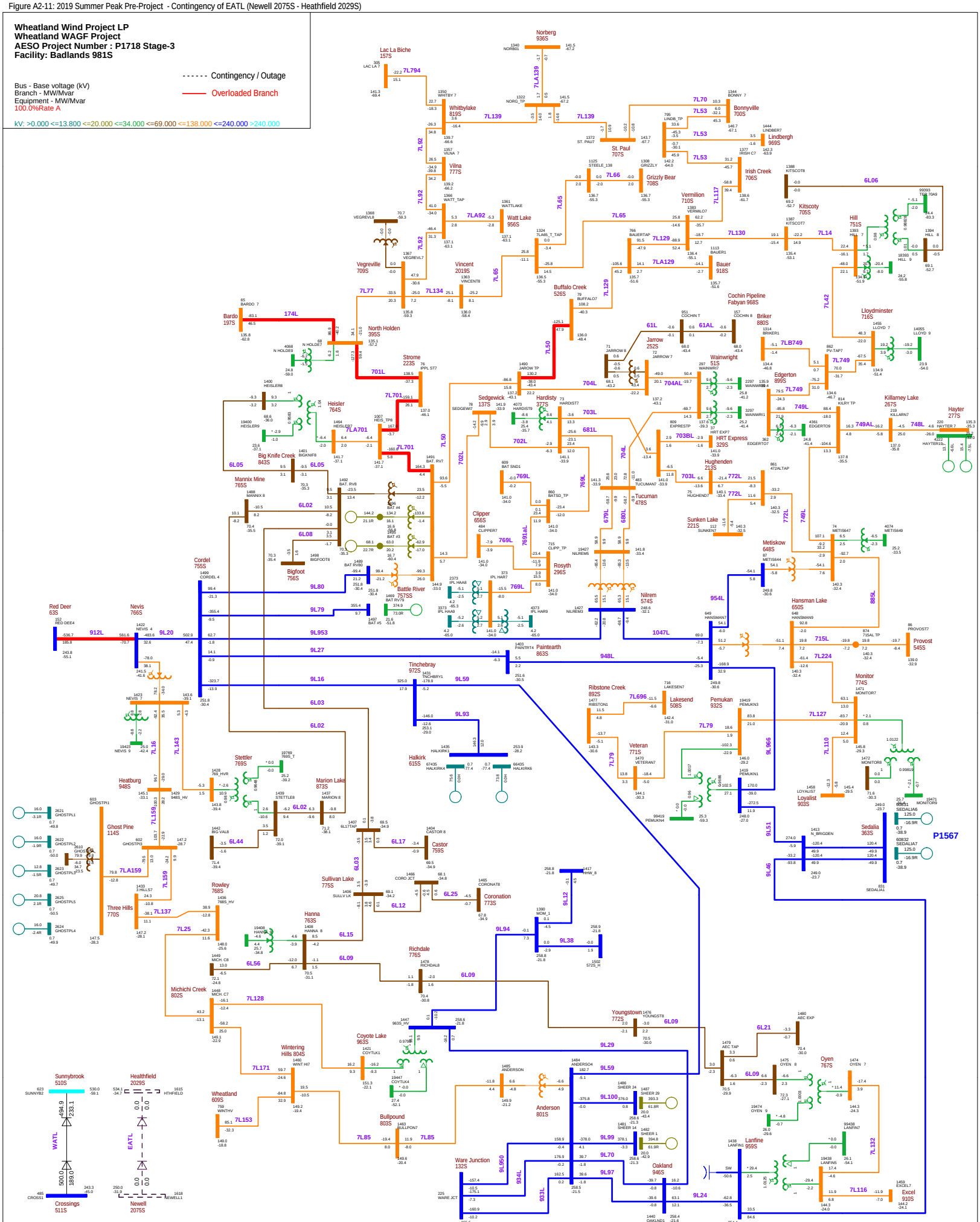


Figure A2-12: 2019 Summer Peak Pre-Project - Contingency of 7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)

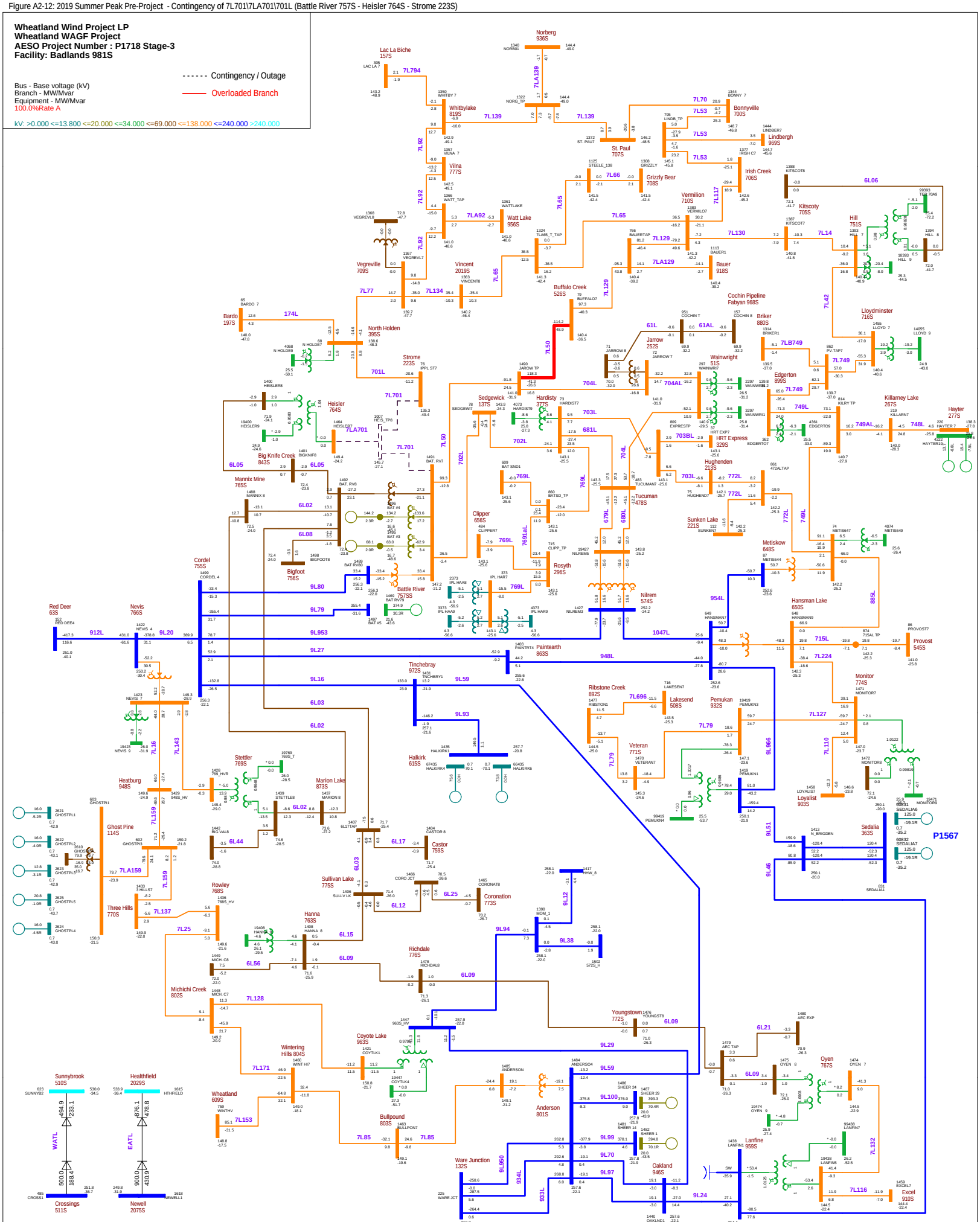


Figure A2-13: 2019 Summer Peak Pre-Project - Contingency of 749L\749AL (Metiskow 648S - Edgerton 899S)

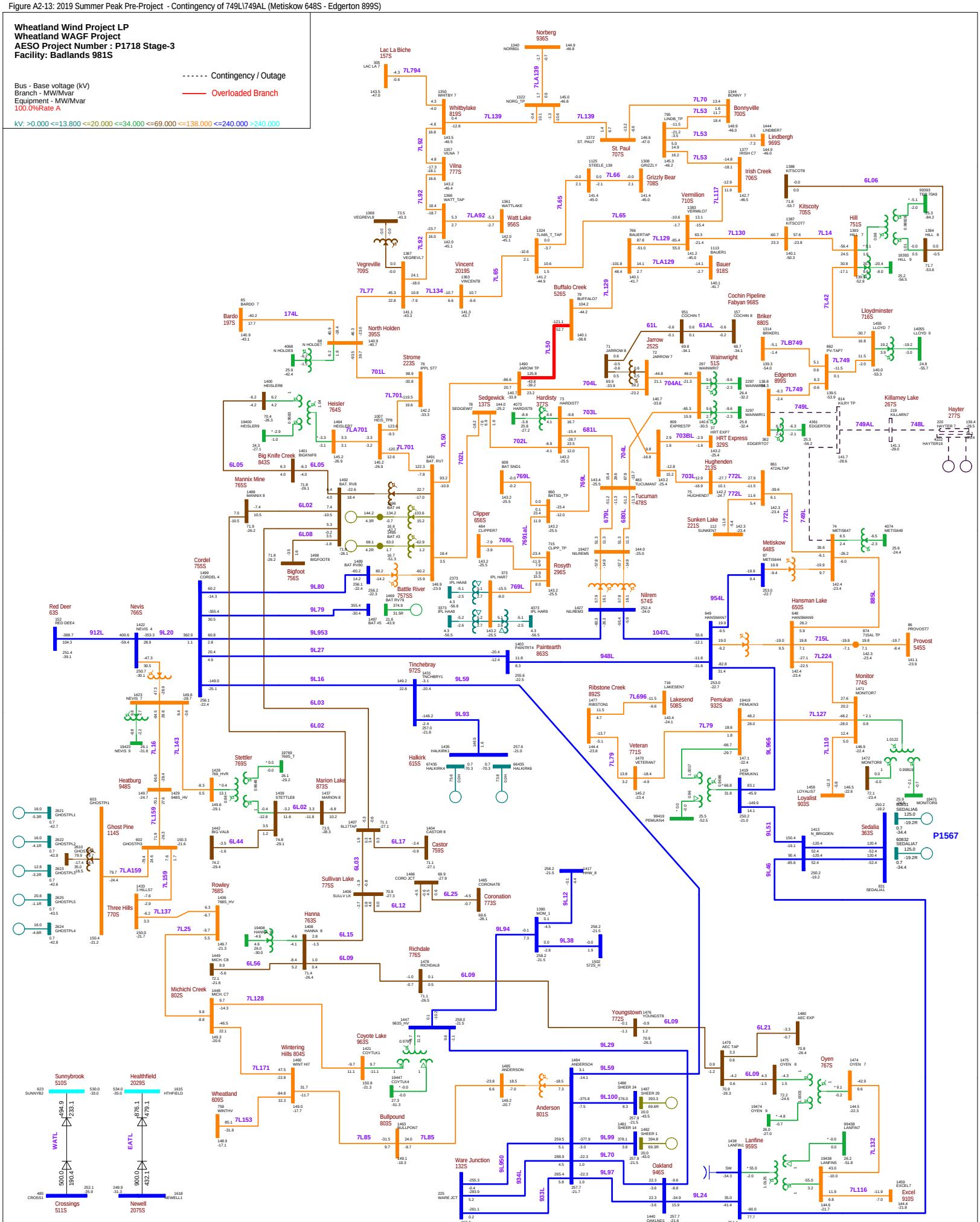


Figure A2-14: 2019 Summer Peak Pre-Project - Contingency of 912L\9L912 (Red Deer 63S - Nevis 766S)

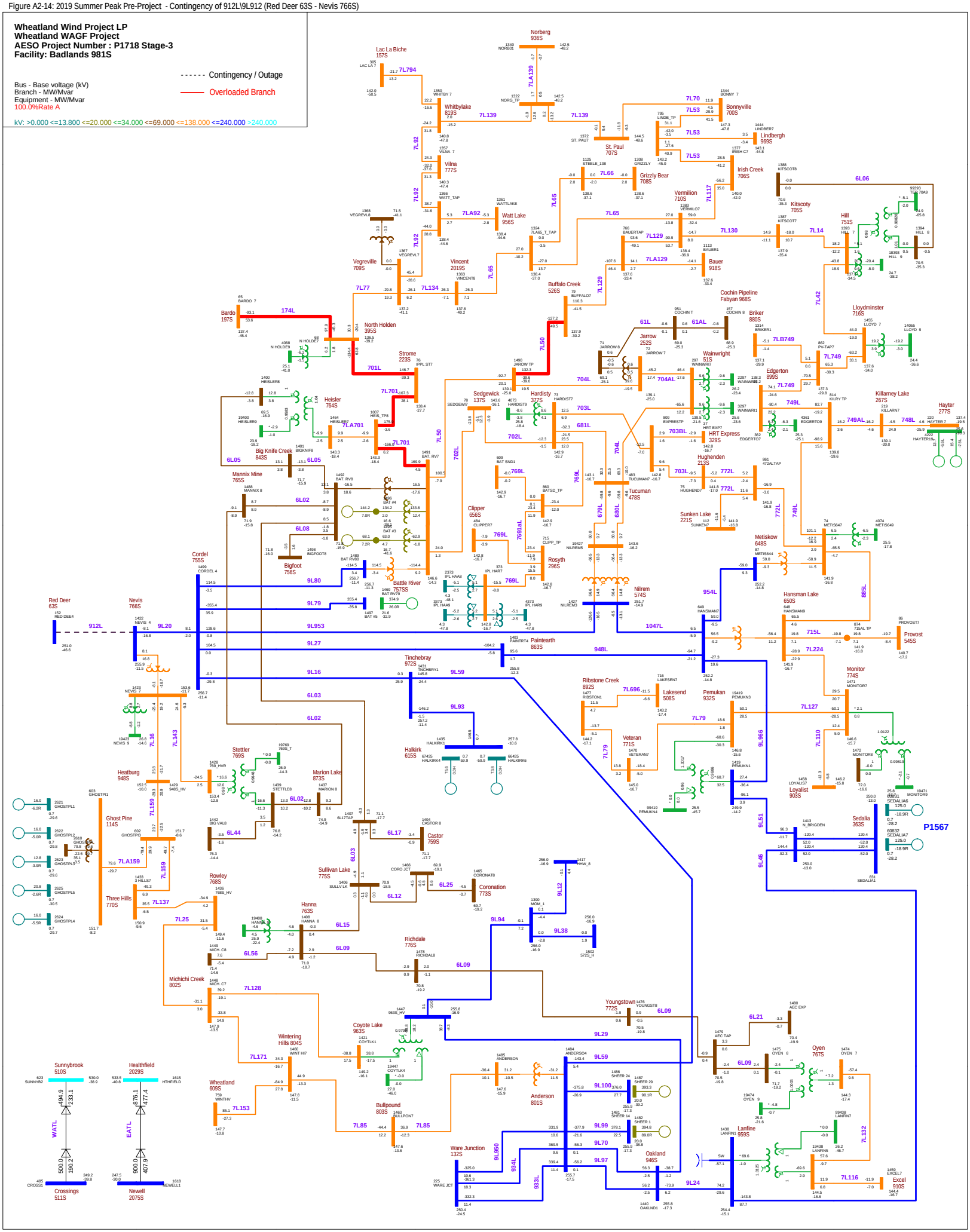


Figure A2-15: 2019 Winter Peak Pre-Project - N-0 (System Normal Condition)

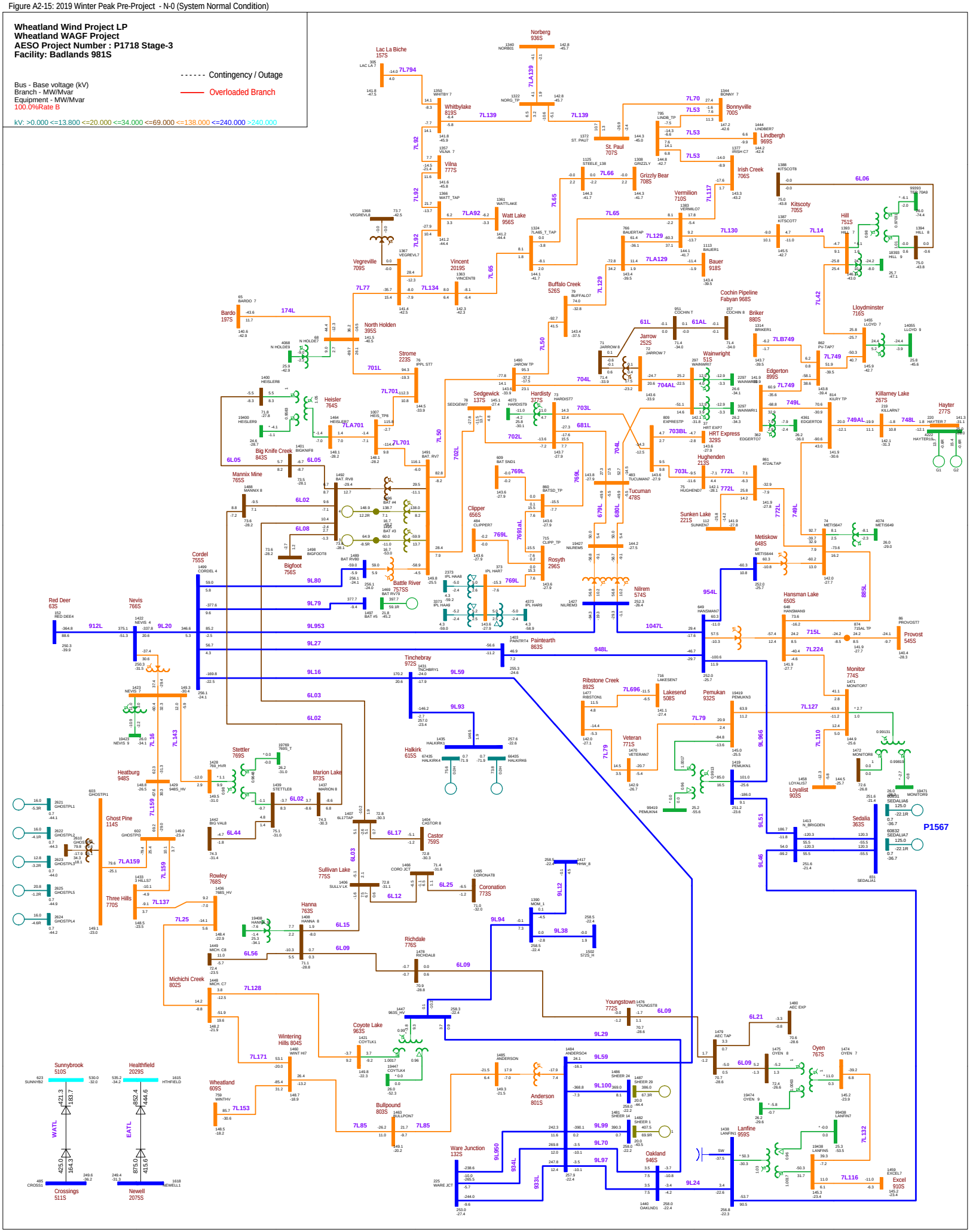

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S
Contingency / Outage
Overloaded Branch
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000
Norberg 936S
Lac La Biche 157S
Whitbylake 819S
Vilna 777S
Watt Lake 956S
Vegreville 709S
Vincent 2019S
Bardo 197S
North Holden 395S
Strome 223S
Heisler 764S
Big Knife Creek 843S
Mannix Mine 765S
Bigfoot 756S
Cordel 755S
Battle River 757SS
Red Deer 63S
Nevis 766S
Heatburg 948S
Ghost Pine 114S
Three Hills 770S
Stettler 769S
Marion Lake 873S
Rowley 768S
Michichi Creek 802S
Sunnybrook 510S
Wheatland 609S
Crossings 511S
Healthfield 2029S
Newell 2075S
Wintering Hills 804S
Coyote Lake 963S
Sullivan Lake 775S
Hanna 763S
Tinchebray 972S
Halkirk 615S
Richdale 776S
Bullpound 803S
Ware Junction 132S
Castor 759S
Coronation 773S
Sedgewick 137S
Hardisty 377S
Buffalo Creek 526S
Jarrow 252S
Wainwright 51S
Vermilion 710S
Lloydminster 716S
Kitscoty 705S
Hill 751S
Bauer 918S
Vermilion 710S
Grizzly Bear 708S
St. Paul 707S
Bonnyville 700S
Lindbergh 969S
Irish Creek 706S
Cochin Pipeline Fabyan 968S
Briker 880S
Edgerton 899S
Killarney Lake 267S
Hayter 277S
Lanfine 959S
Oyen 767S
Excel 910S
Provost 545S
Metiskow 648S
Hansman Lake 650S
Monitor 774S
Loyalist 903S
Sedalia 363S
Pemukan 932S
Ribstone Creek 892S
Veteran 771S
Lakesend 508S
Youngstown 772S
Oakland 946S
Anderson 801S
Clipper 656S
Rosyth 296S
Nilrem 574S
Tucumar 478S
Sunken Lake 221S
Hughenden 213S
HRT Express 329S
Paintearth 863S
Derwent 1S
Hansman 1S
Sedalia 1S
Loyalist 1S
Monitor 1S
Pemukan 1S
Veteran 1S
Lakesend 1S
Ribstone 1S
Youngstown 1S
Oakland 1S
Anderson 1S
Clipper 1S
Rosyth 1S
Nilrem 1S
Tucumar 1S
Sunken Lake 1S
Hughenden 1S
HRT Express 1S
Paintearth 1S
Lanfine 1S
Oyen 1S
Excel 1S
Provost 1S
Metiskow 1S
Hansman Lake 1S
Monitor 1S
Loyalist 1S
Sedalia

Figure A2-16: 2019 Winter Peak Pre-Project - Contingency of 7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)

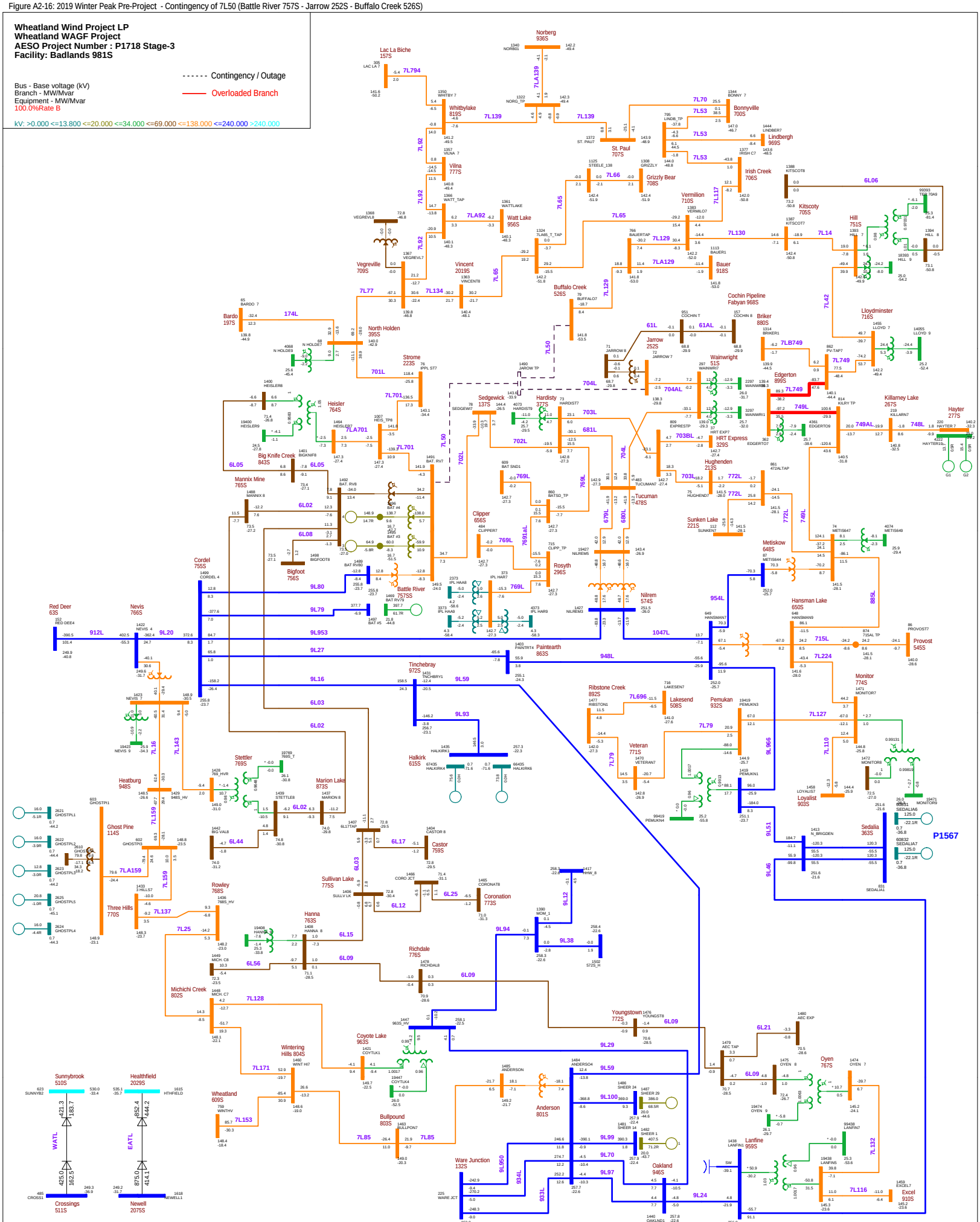


Figure A2-17: 2019 Winter Peak Pre-Project - Contingency of 766S901T (Nevis 766S Transformer 901T)

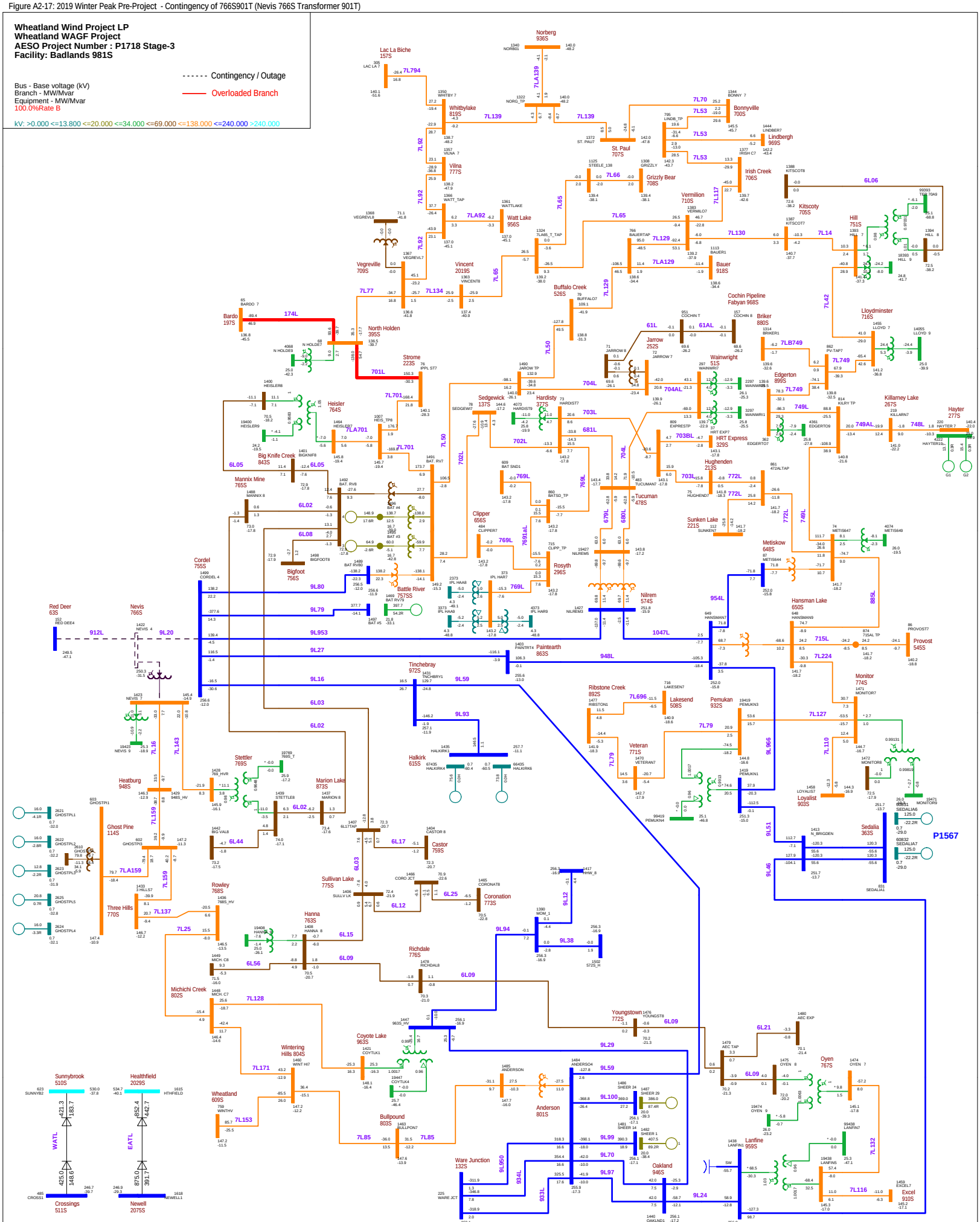


Figure A2-18: 2019 Winter Peak Pre-Project - Contingency of 749L\749AL (Metiskow 648S - Edgerton 899S)

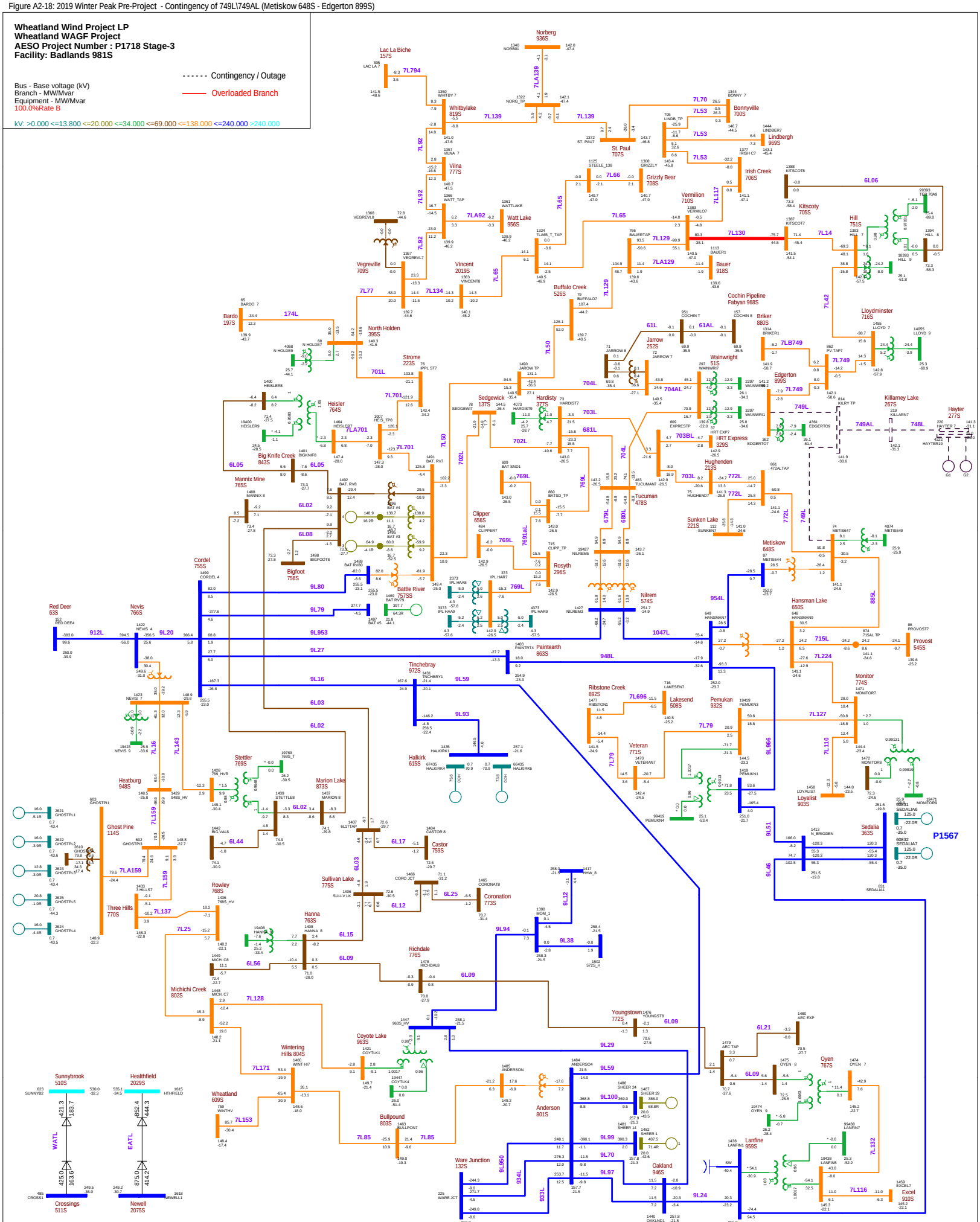


Figure A2-19: 2019 Winter Peak Pre-Project - Contingency of 526ST1 OR 526ST2 (526ST1 or 526ST2 (Buffalo Creek 526S Transformer T1 or T2))

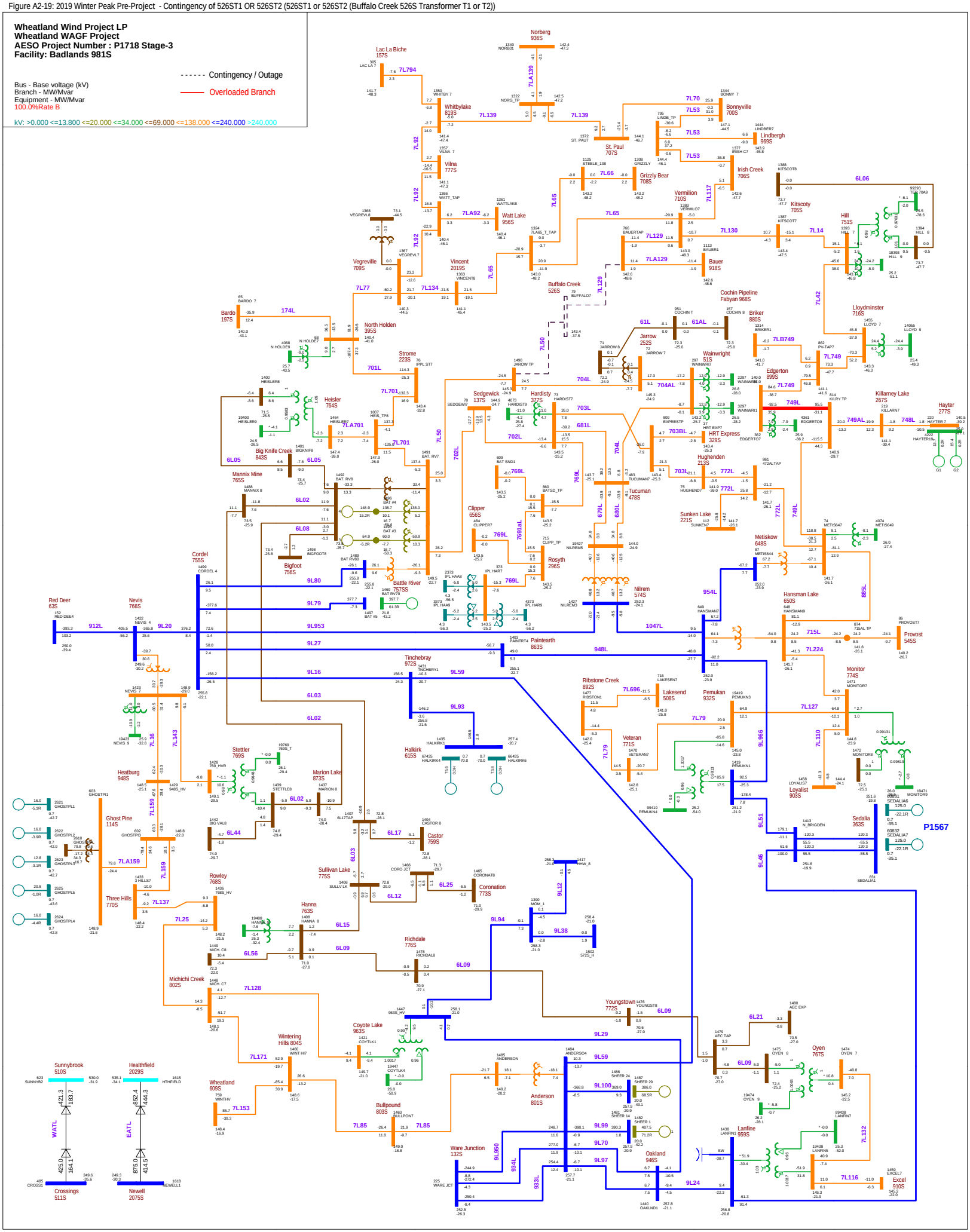


Figure A2-20: 2019 Winter Peak Pre-Project - Contingency of 648ST1 (Metiskow 648S Transformer T1)

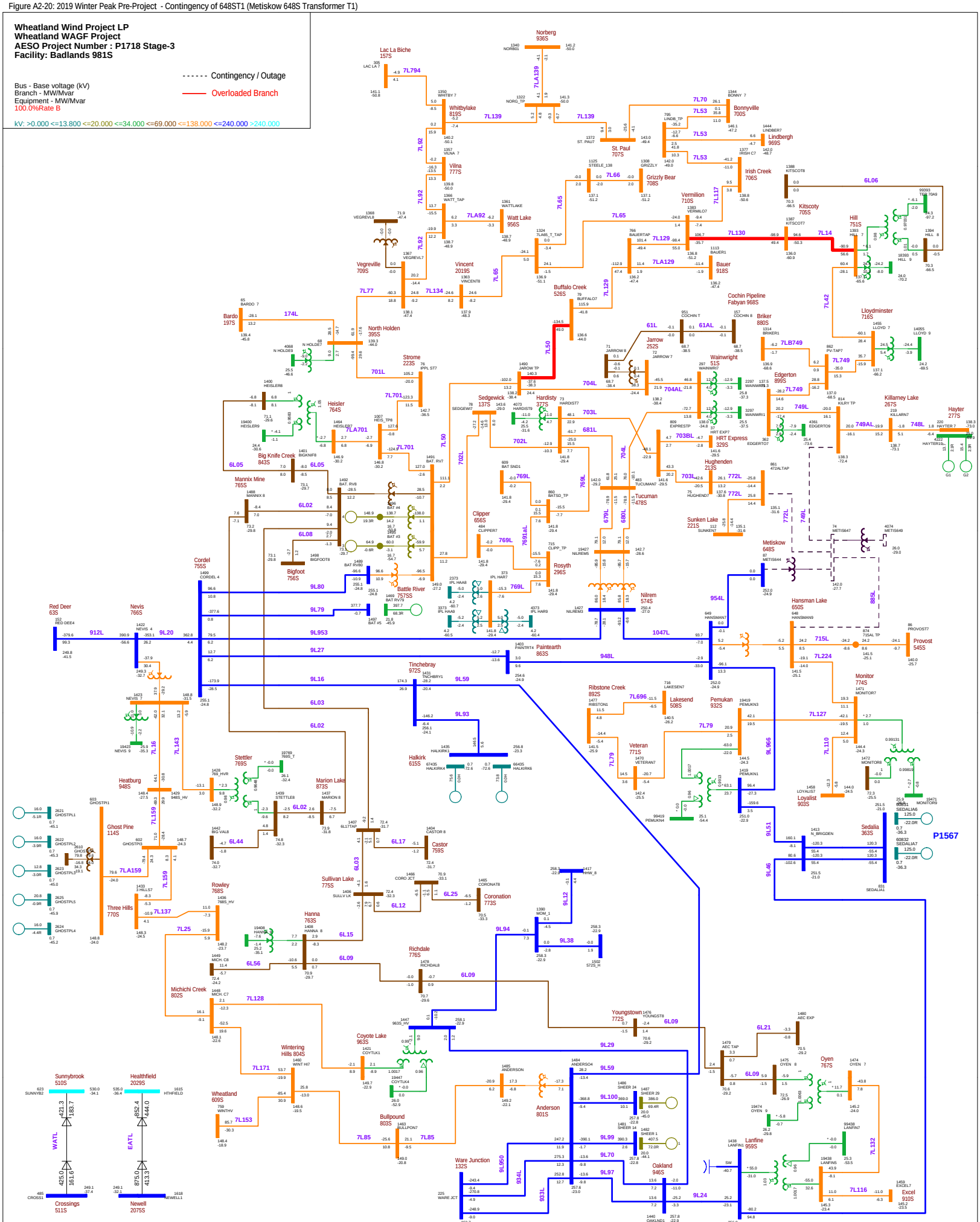


Figure A2-21: 2019 Winter Peak Pre-Project - Contingency of 9L20 (Nevis 766S - Cordel 755S)

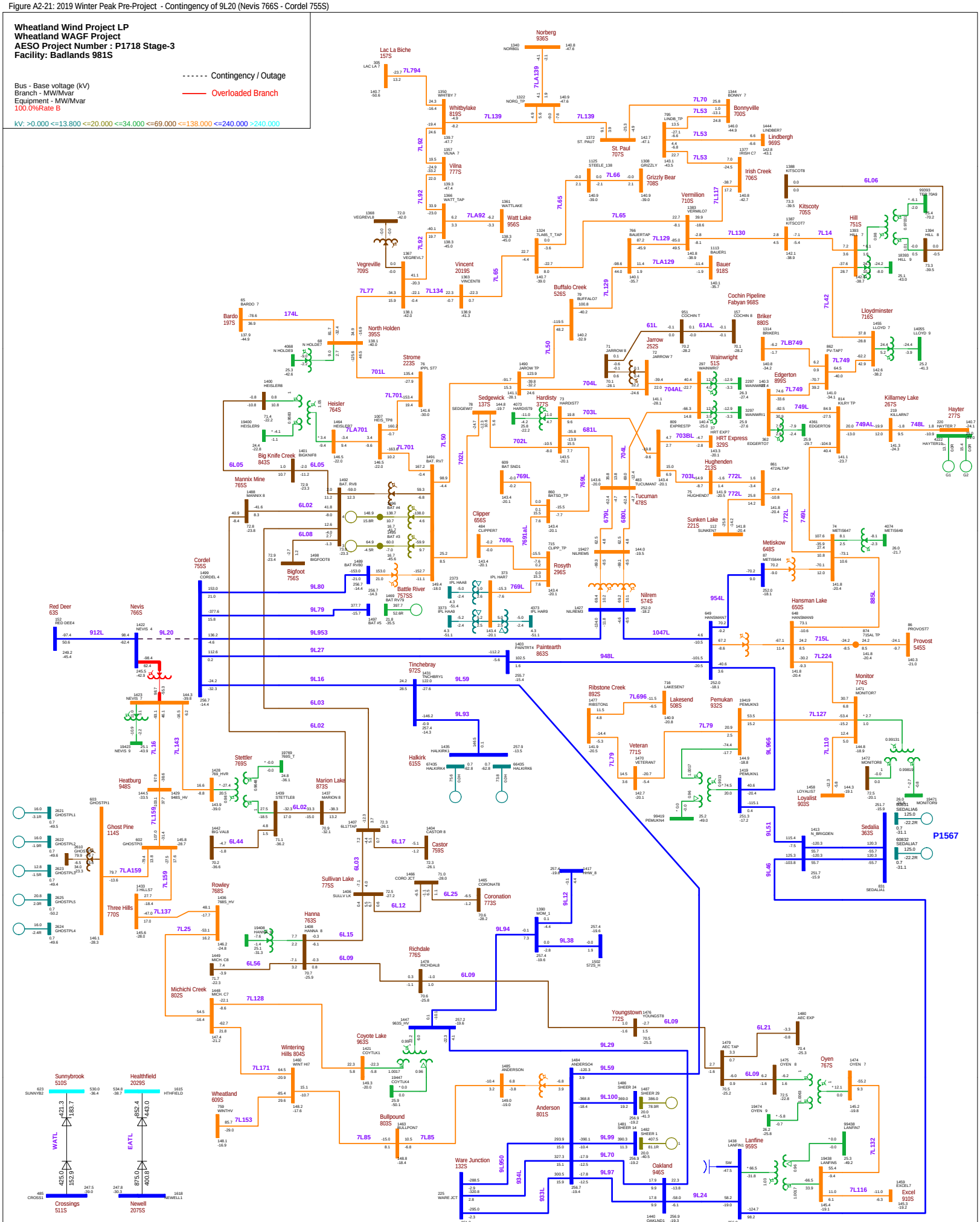


Figure A2-22: 2019 Winter Peak Pre-Project - Contingency of 912L\9L912 (Red Deer 63S - Nevis 766S)

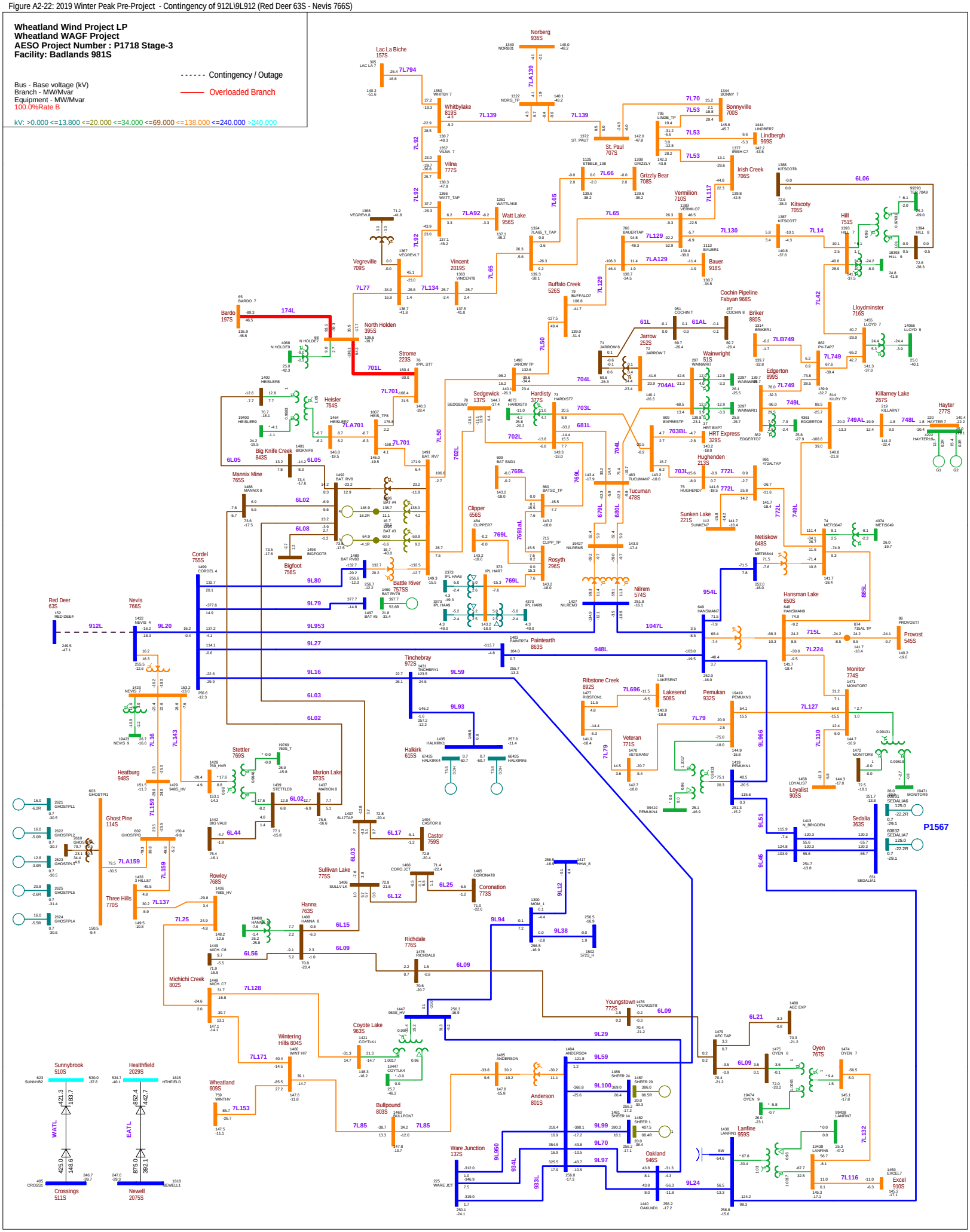
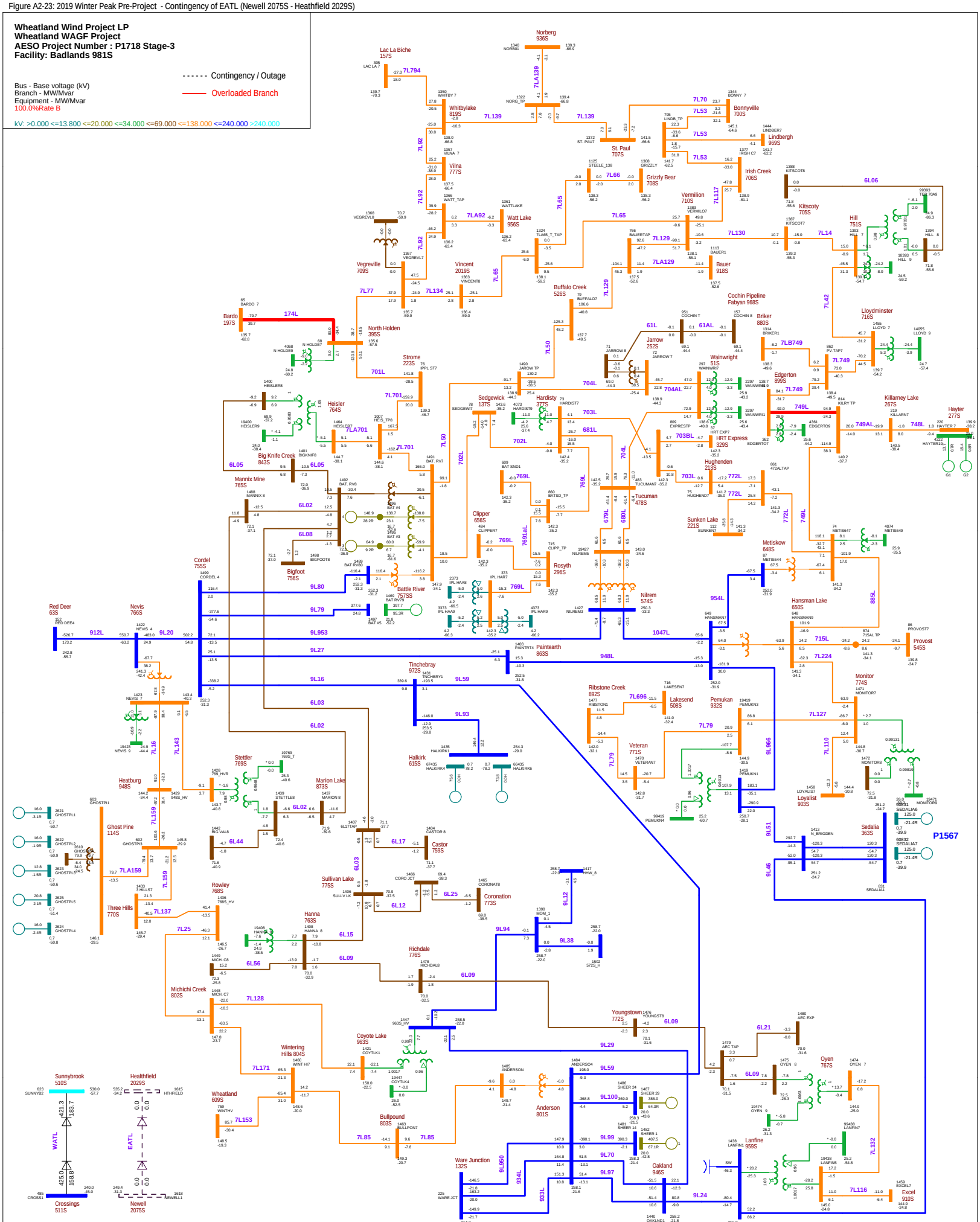


Figure A2-23: 2019 Winter Peak Pre-Project - Contingency of EATL (Newell 2075S - Heathfield 2029S)



Attachment A3

Post-Project Power Flow Diagrams

List of Figures

Scenario and Case Name	Contingency (System Element Lost)	Figure Number
P1718_2019SL_Post.sav 2019 Summer Light High Wind Economy Coal Post-Project	N-0 (System Normal Condition)	Figure A3-1
	114ST1 (Ghost Pine 114S Transformer T1)	Figure A3-2
	801S901T (Anderson 801S Transformer 901T)	Figure A3-3
	9L29 (Oakland 946S - Coyote Lake 963S)	Figure A3-4
	963S901T (Coyote Lake 963S Transformer 901T)	Figure A3-5
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	Figure A3-6
	9L20 (Nevis 766S - Cordel 755S)	Figure A3-7
	7L128 (Michichi Creek 802S - Coyote Lake 963S)	Figure A3-8
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Figure A3-9
P1718_2019SP_Post.sav 2019 Summer Peak High Wind Economy Coal Post-Project	N-0 (System Normal Condition)	Figure A3-10
	EATL (Newell 2075S - Heathfield 2029S)	Figure A3-11
	801S901T (Anderson 801S Transformer 901T)	Figure A3-12
	766S901T (Nevis 766S Transformer 901T)	Figure A3-13
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Figure A3-14
	114ST1 (Ghost Pine 114S Transformer T1)	Figure A3-15
	7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	Figure A3-16
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	Figure A3-17
	899ST3A (Edgerton 899S Transformer T3A)	Figure A3-18
	701L (North Holden 395S - Strome 223S)	Figure A3-19
	912L\9L912 (Red Deer 63S - Nevis 766S)	Figure A3-20
	749L\749AL (Metiskow 648S - Edgerton 899S)	Figure A3-21
	648ST1 (Metiskow 648S Transformer T1)	Figure A3-22
	7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)	Figure A3-23
	395ST1 (North Holden 395S Transformer T1)	Figure A3-24
	9L16 (Tinchebray 972S - Cordel 755S)	Figure A3-25
	9L20 (Nevis 766S - Cordel 755S)	Figure A3-26
	7L42 (Hill 751S - Lloydminster 716S)	Figure A3-27
P1718_2019WP_Post.sav 2019 Winter Peak High Wind Economy Coal Post-Project	N-0 (System Normal Condition)	Figure A3-28
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	Figure A3-29
	7L129\7LA129 (Buffalo Creek 526S - Vermilion 710S - Bauer 918S)	Figure A3-30
	9L20 (Nevis 766S - Cordel 755S)	Figure A3-31
	749L\749AL (Metiskow 648S - Edgerton 899S)	Figure A3-32

Scenario and Case Name	Contingency (System Element Lost)	Figure Number
	648ST1 (Metiskow 648S Transformer T1)	Figure A3-33
	912L\9L912 (Red Deer 63S - Nevis 766S)	Figure A3-34
	7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	Figure A3-35
	801S901T (Anderson 801S Transformer 901T)	Figure A3-36
	EATL (Newell 2075S - Heathfield 2029S)	Figure A3-37
	766S901T (Nevis 766S Transformer 901T)	Figure A3-38
	526ST1 OR 526ST2 (Buffalo Creek 526S Transformer T1 or T2)	Figure A3-39
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Figure A3-40
P1718_2019SP_Post_PENV.sav 2019 Summer Peak High Wind Economy Coal Post-Project Sensitivity with PENV	N-0 (System Normal Condition)	Figure A3-41
	114ST1 (Ghost Pine 114S Transformer T1)	Figure A3-42
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	Figure A3-43
	766S901T (Nevis 766S Transformer 901T)	Figure A3-44
	EATL (Newell 2075S - Heathfield 2029S)	Figure A3-45
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Figure A3-46
	801S901T (Anderson 801S Transformer 901T)	Figure A3-47
	9L20 (Nevis 766S - Cordel 755S)	Figure A3-48

Figure A3-1: 2019 Summer Light Post-Project - N-0 (System Normal Condition)

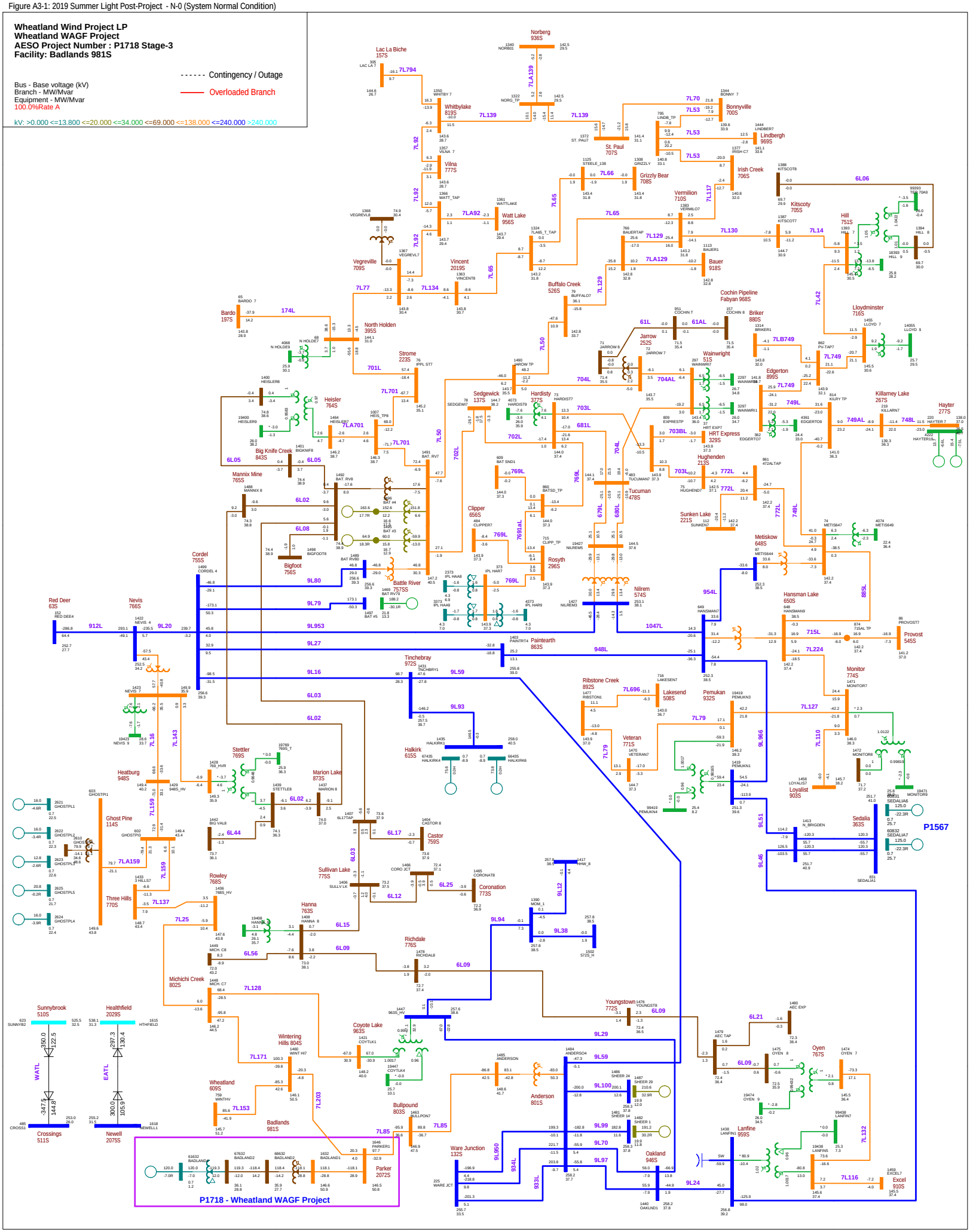


Figure A3-2: 2019 Summer Light Post-Project - Contingency of 114ST1 (Ghost Pine 114S Transformer T1)

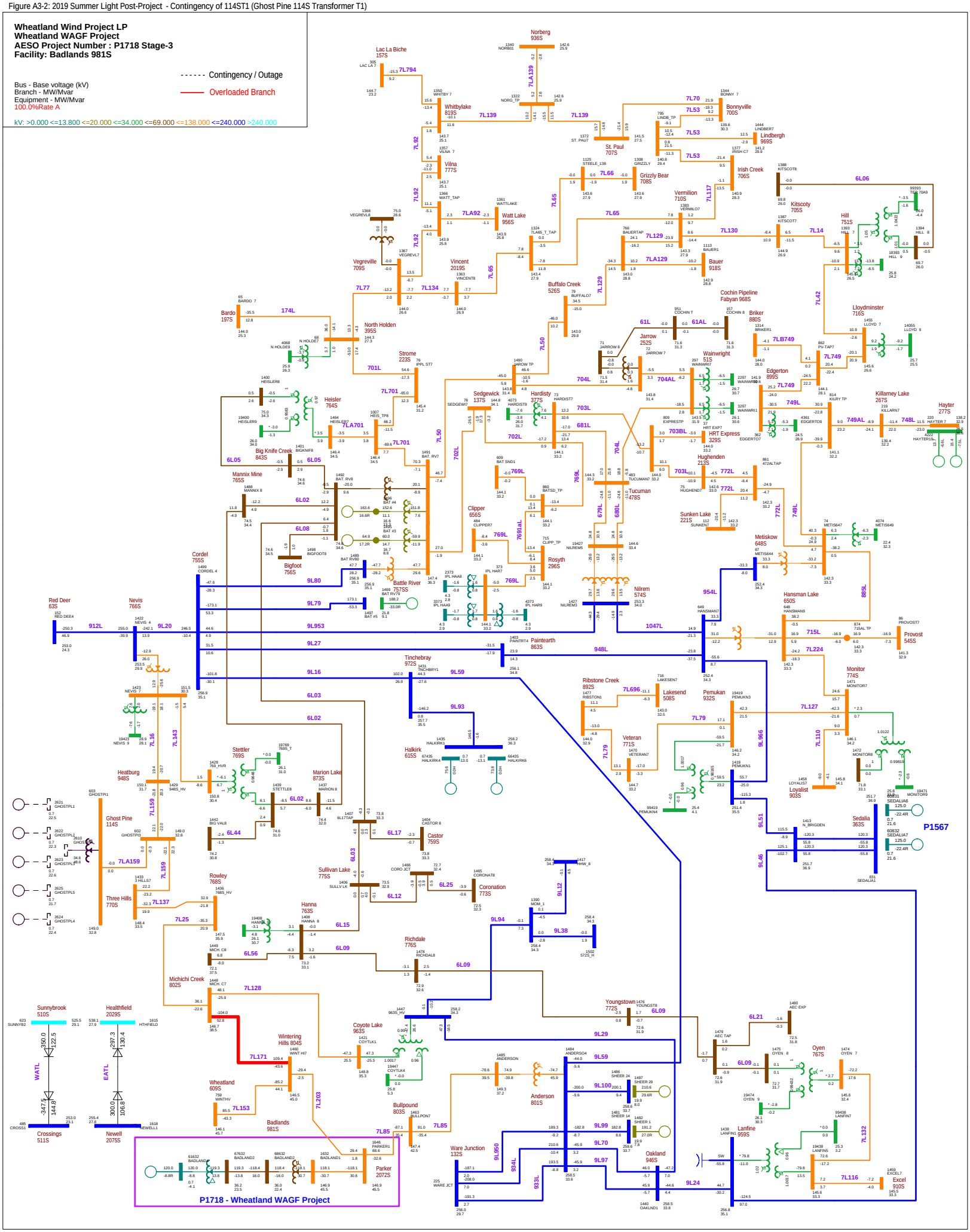


Figure A3-3: 2019 Summer Light Post-Project - Contingency of 801S901T (Anderson 801S Transformer 901T)

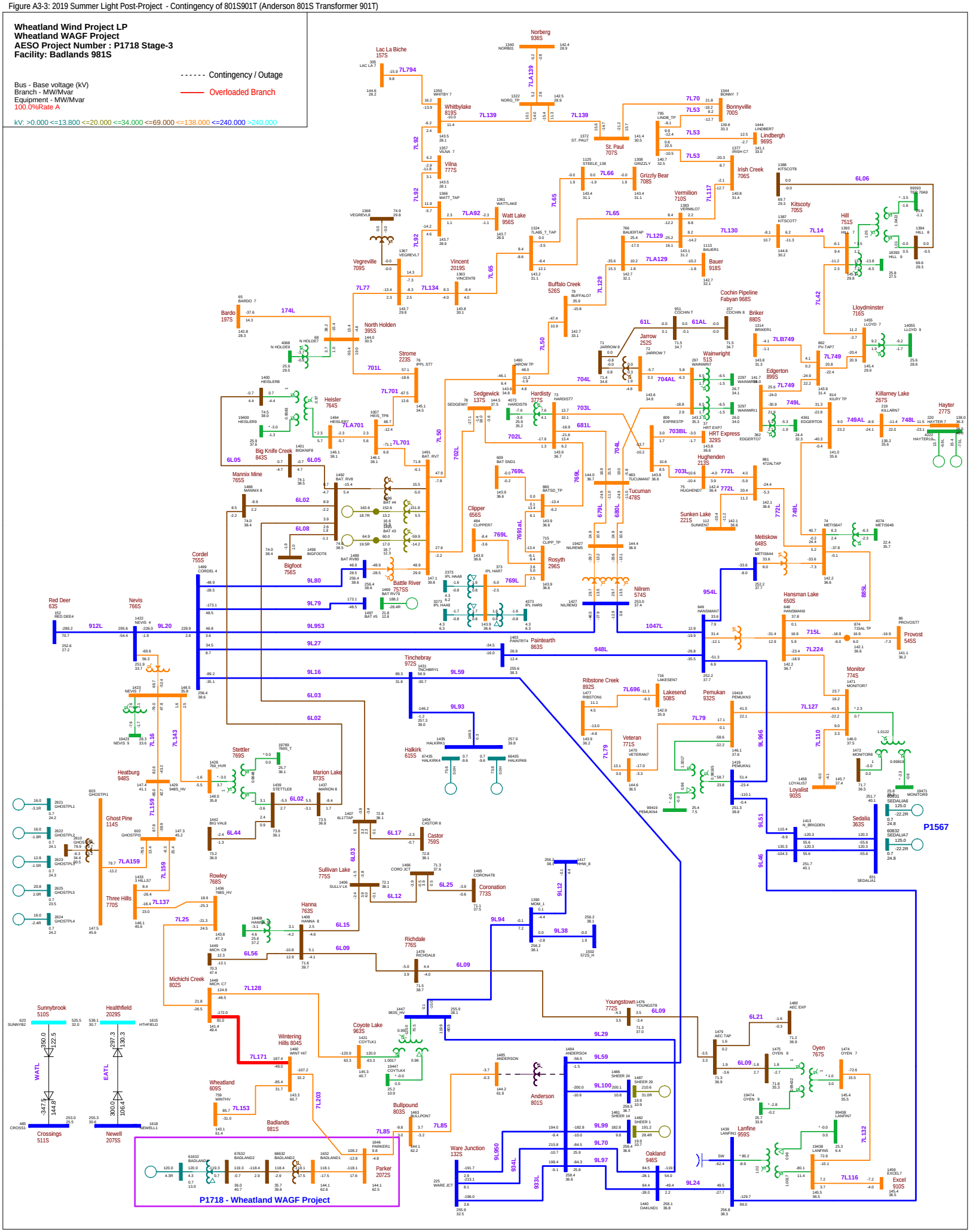


Figure A3-4: 2019 Summer Light Post-Project - Contingency of 9L29 (Oakland 946S - Coyote Lake 963S)

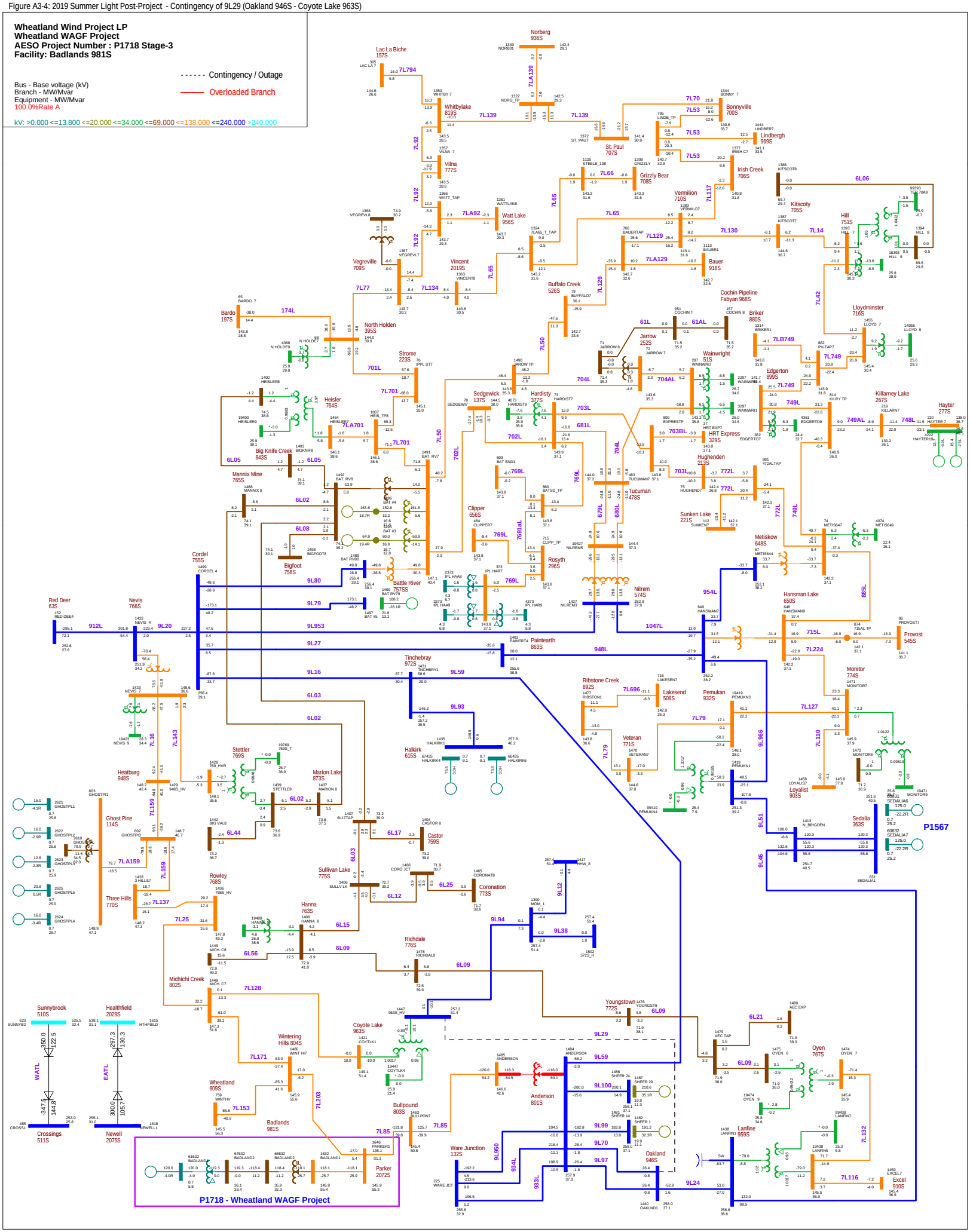


Figure A3-5: 2019 Summer Light Post-Project - Contingency of 963S901T (Coyote Lake 963S Transformer 901T)

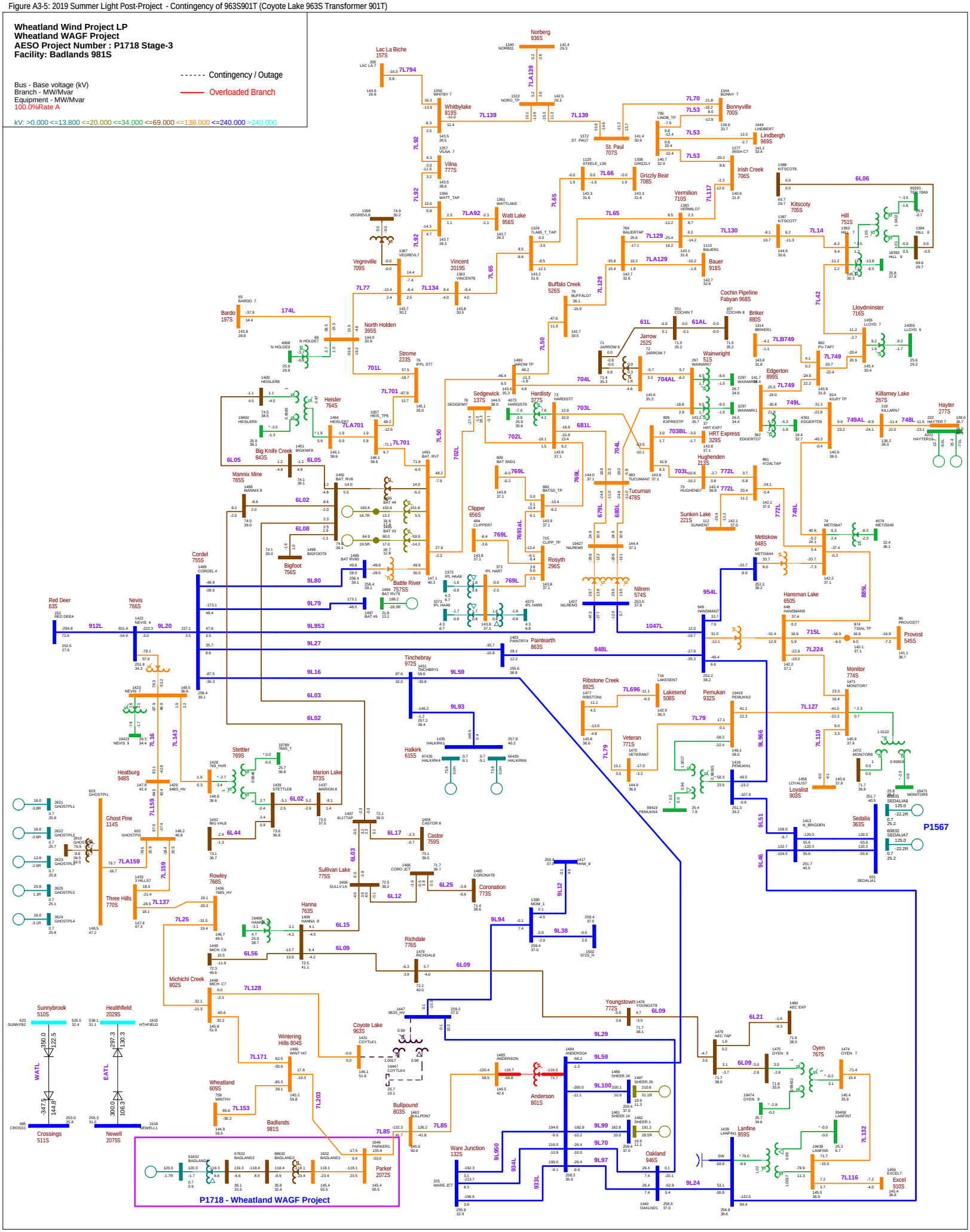


Figure A3-6: 2019 Summer Light Post-Project - Contingency of 7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)

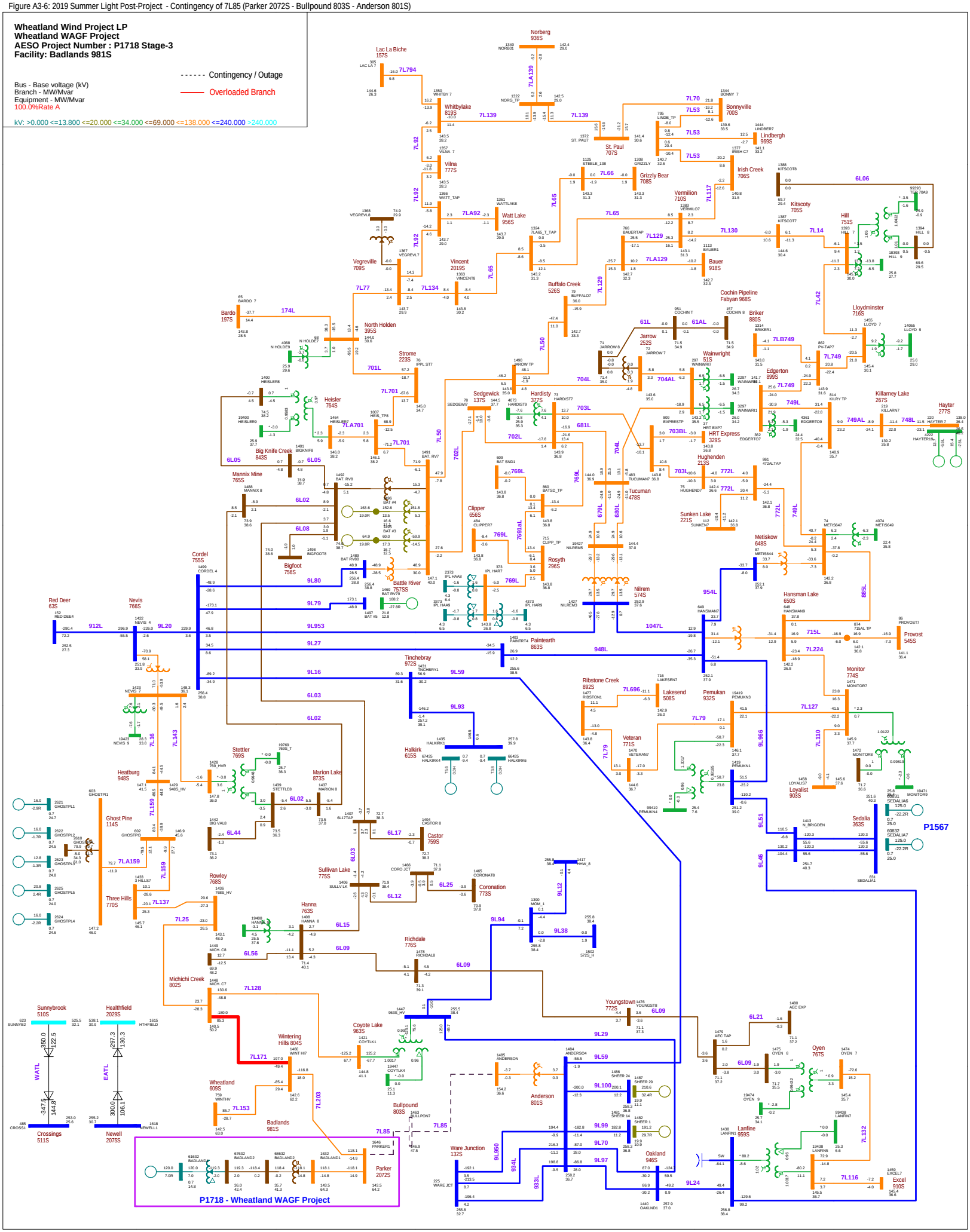


Figure A3-7: 2019 Summer Light Post-Project - Contingency of 9L20 (Nevis 766S - Cordel 755S)

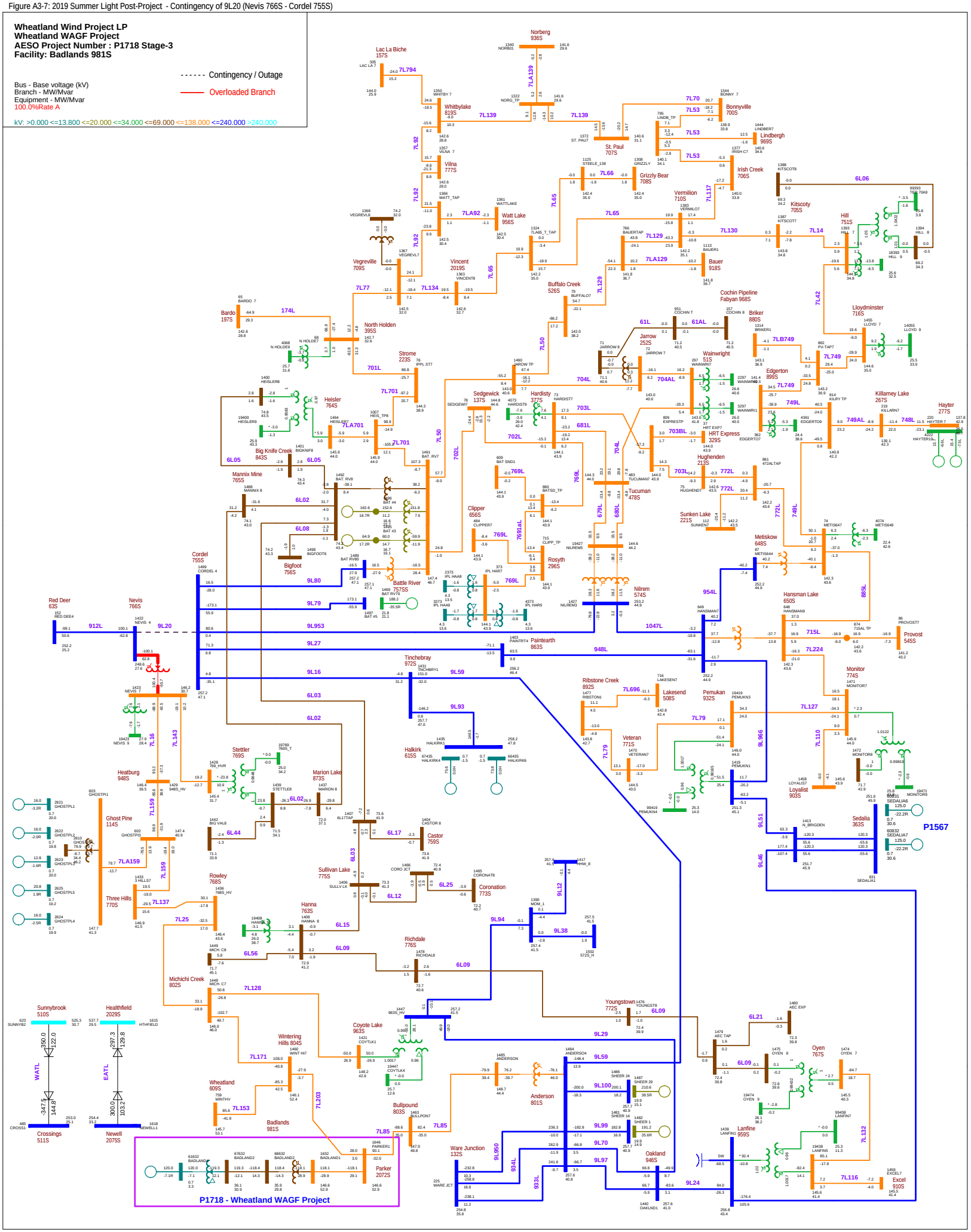


Figure A3-8: 2019 Summer Light Post-Project - Contingency of 7L128 (Michichi Creek 802S - Coyote Lake 963S)

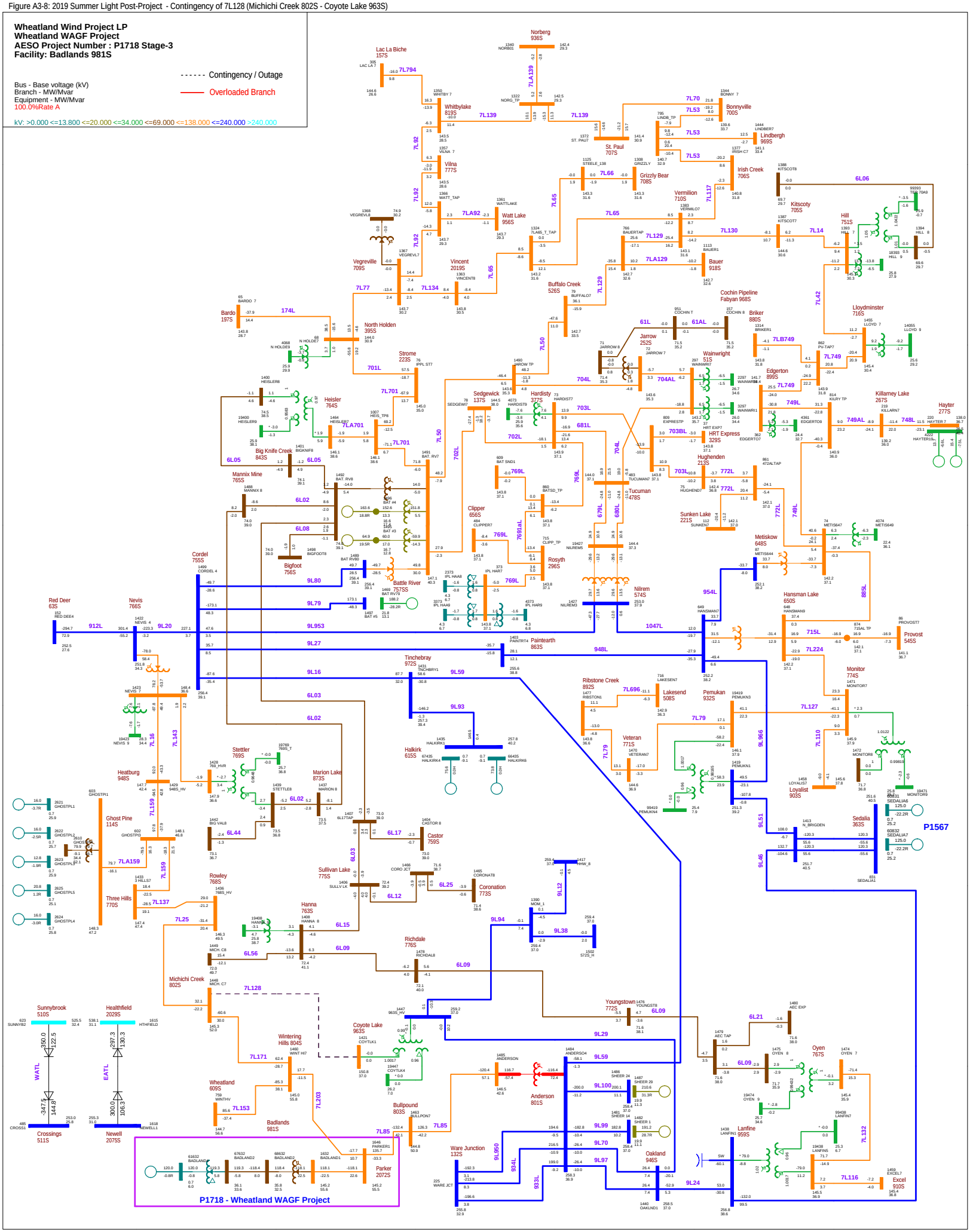


Figure A3-9: 2019 Summer Light Post-Project - Contingency of 7L171 (Michichi Creek 802S - Wintering Hills 804S)

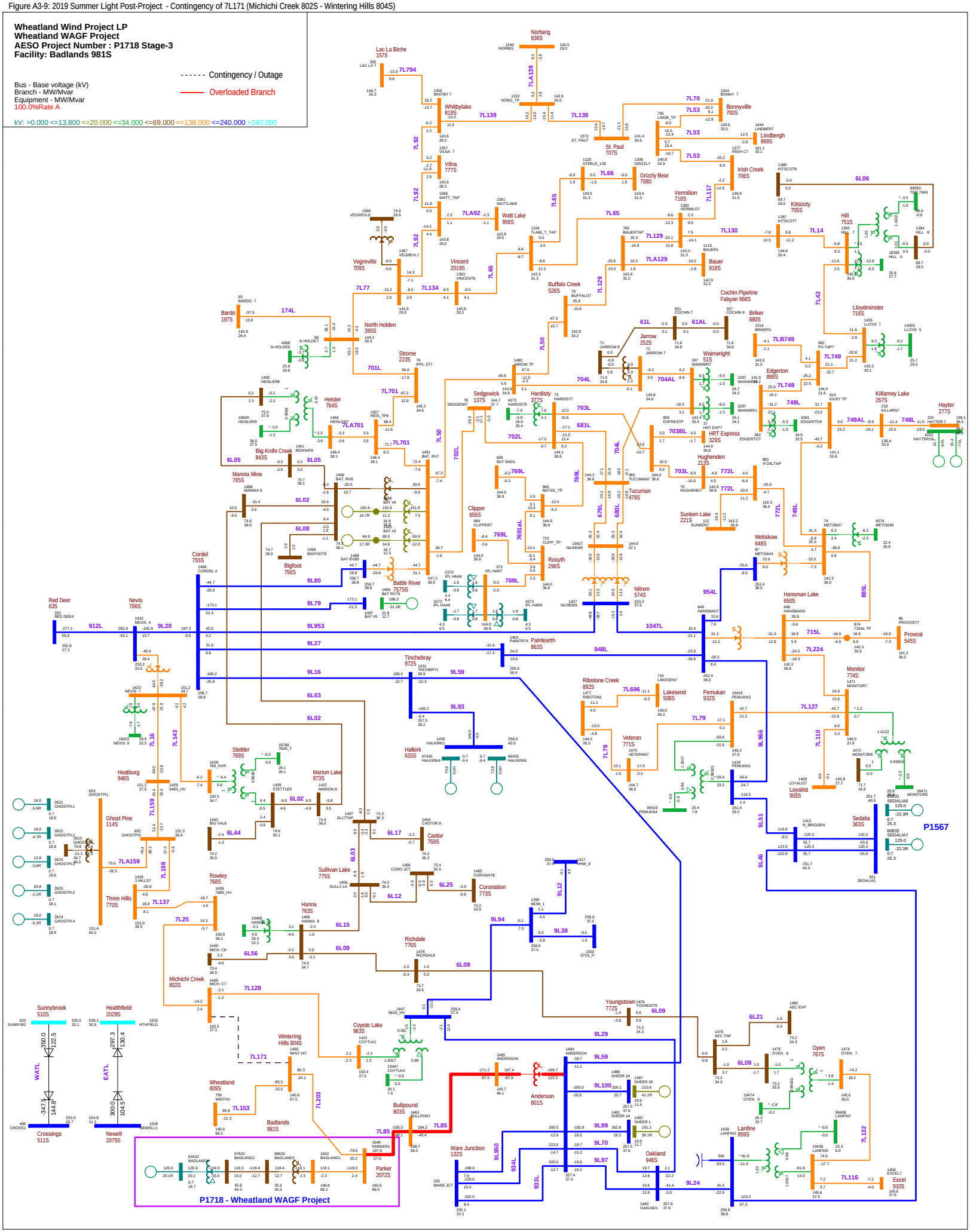


Figure A3-10: 2019 Summer Peak Post-Project - N-0 (System Normal Condition)

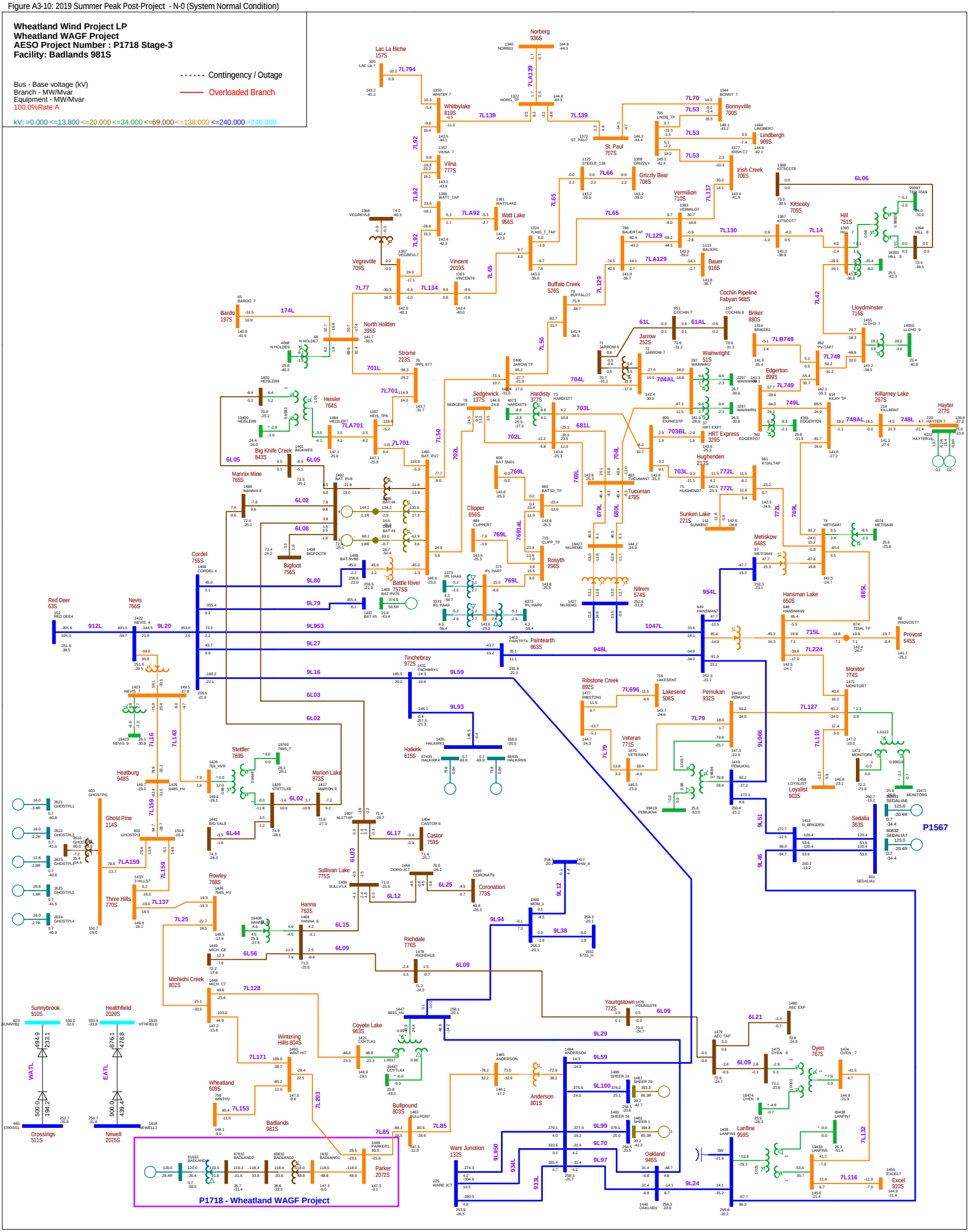


Figure A3-11: 2019 Summer Peak Post-Project - Contingency of EATL (Newell 2075S - Heathfield 2029S)

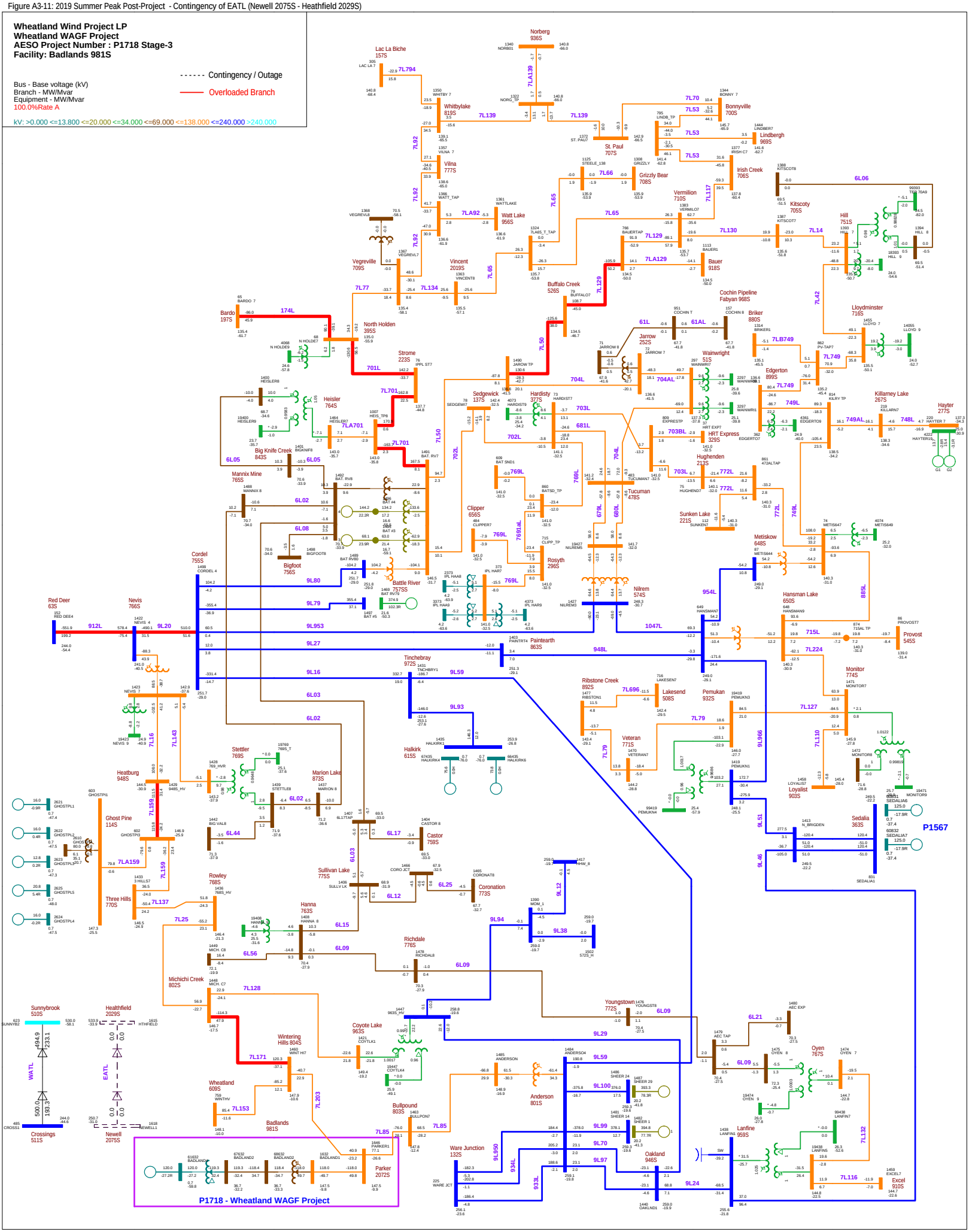


Figure A3-12: 2019 Summer Peak Post-Project - Contingency of 801S901T (Anderson 801S Transformer 901T)

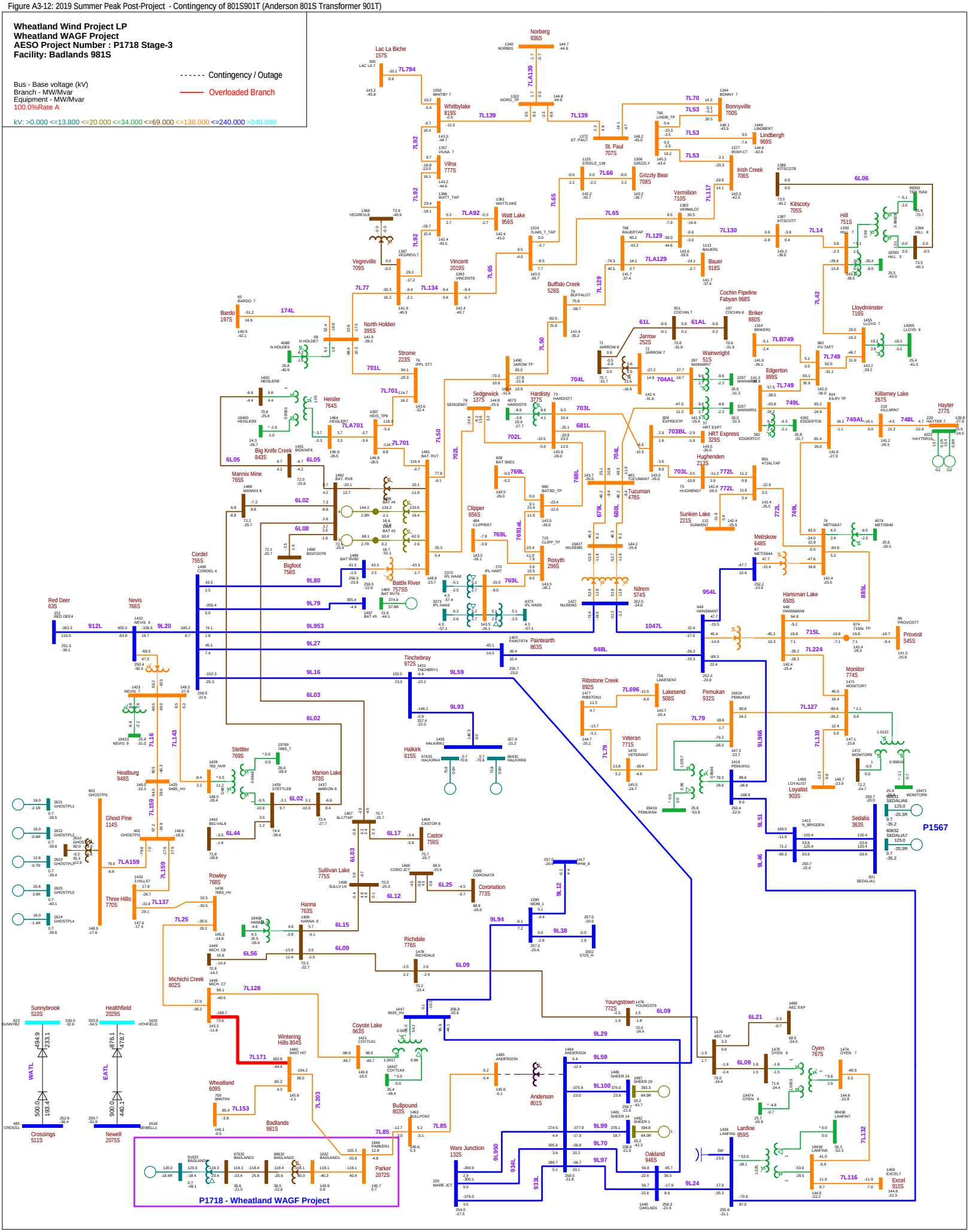

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000
Contingency / Outage
Overloaded Branch
Norberg 936S
Lac La Biche 157S
Whitbylake 819S
Vilna 777S
Watt Lake 956S
Vegreville 709S
Vincent 2019S
Bardo 197S
North Holden 395S
Strome 223S
Heisler 764S
Big Knife Creek 843S
Mannix Mine 765S
Bigfoot 756S
Cordel 755S
Battle River 757SS
Red Deer 63S
Nevis 766S
Heatburg 948S
Ghost Pine 114S
Three Hills 770S
Rowley 768S
Michichi Creek 802S
Sunnybrook 510S
Healthfield 2029S
Crossings 511S
Newell 2075S
Wintering Hills 804S
Wheatland 609S
Badlands 981S
Coyote Lake 963S
Sullivan Lake 775S
Hanna 763S
Stettler 769S
Marion Lake 873S
Halkirk 615S
Tinchebray 972S
Richdale 776S
Bullpound 803S
Ware Junction 132S
Parker 2072S
Anderson 801S
Oakland 946S
Youngstown 772S
Coronation 773S
Castor 759S
Veteran 771S
Lakesend 508S
Pemukan 932S
Loyalist 903S
Sedalia 363S
Ribstone Creek 892S
Hansman Lake 650S
Metiskow 648S
Sunken Lake 221S
Rosyth 296S
Nilrem 574S
Tucuman 478S
Hughenden 213S
HRT Express 329S
Wainwright 51S
Jarrow 252S
Cochin Pipeline Fabyan 968S
Vermilion 710S
Grizzly Bear 708S
St. Paul 707S
Bonnyville 700S
Lindbergh 969S
Irish Creek 706S
Kitscoty 705S
Hill 751S
Lloydminster 716S
Killarney Lake 267S
Hayter 277S
Edgerton 699S
Briker 880S
Lanfine 559S
Excel 910S
Provost 545S
Paintearth 863S
Buffalo Creek 526S
Sedgewick 137S
Hardisty 377S
Clipper 656S
Battle River 757SS
Halkirk
Tinchebray
Ware Junction
Parker
Anderson
Oakland
Youngstown
Coronation
Castor
Veteran
Lakesend
Pemukan
Loyalist
Sedalia
Ribstone Creek
Hansman Lake
Metiskow
Sunken Lake
Rosyth
Nilrem
Tucuman
Hughenden
HRT Express
Wainwright
Jarrow
Cochin Pipeline Fabyan
Vermilion
Grizzly Bear
St. Paul
Bonnyville
Lindbergh
Irish Creek
Kitscoty
Hill
Lloydminster
Killarney Lake
Hayter
Edgerton
Briker
Lanfine
Excel
Provost
Paintearth
Buffalo Creek
Sedgewick
Hardisty
Clipper
Bardo
North Holden
Strome
Heisler
Big Knife Creek
Mannix Mine
Bigfoot
Cordel
Battle River
Red Deer
Nevis
Heatburg
Ghost Pine
Three Hills
Rowley
Michichi Creek
Sunnybrook
Healthfield
Crossings
Newell
Wintering Hills
Wheatland
Badlands
Coyote Lake
Sullivan Lake
Hanna
Stettler
Marion Lake
Halkirk
Tinchebray
Richdale
Bullpound

Figure A3-13: 2019 Summer Peak Post-Project - Contingency of 766S901T (Nevis 766S Transformer 901T)

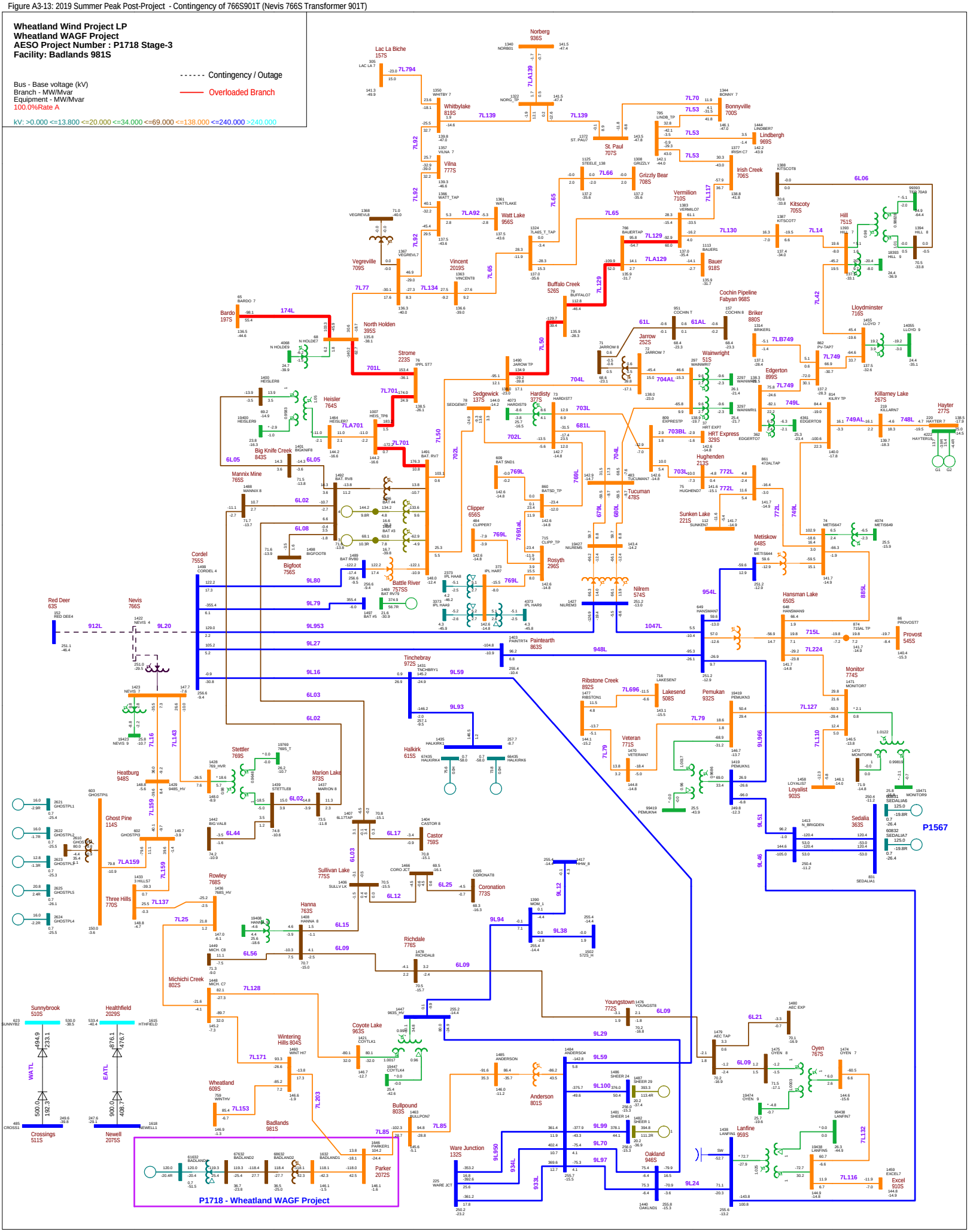


Figure A3-14: 2019 Summer Peak Post-Project - Contingency of 7L171 (Michichi Creek 802S - Wintering Hills 804S)

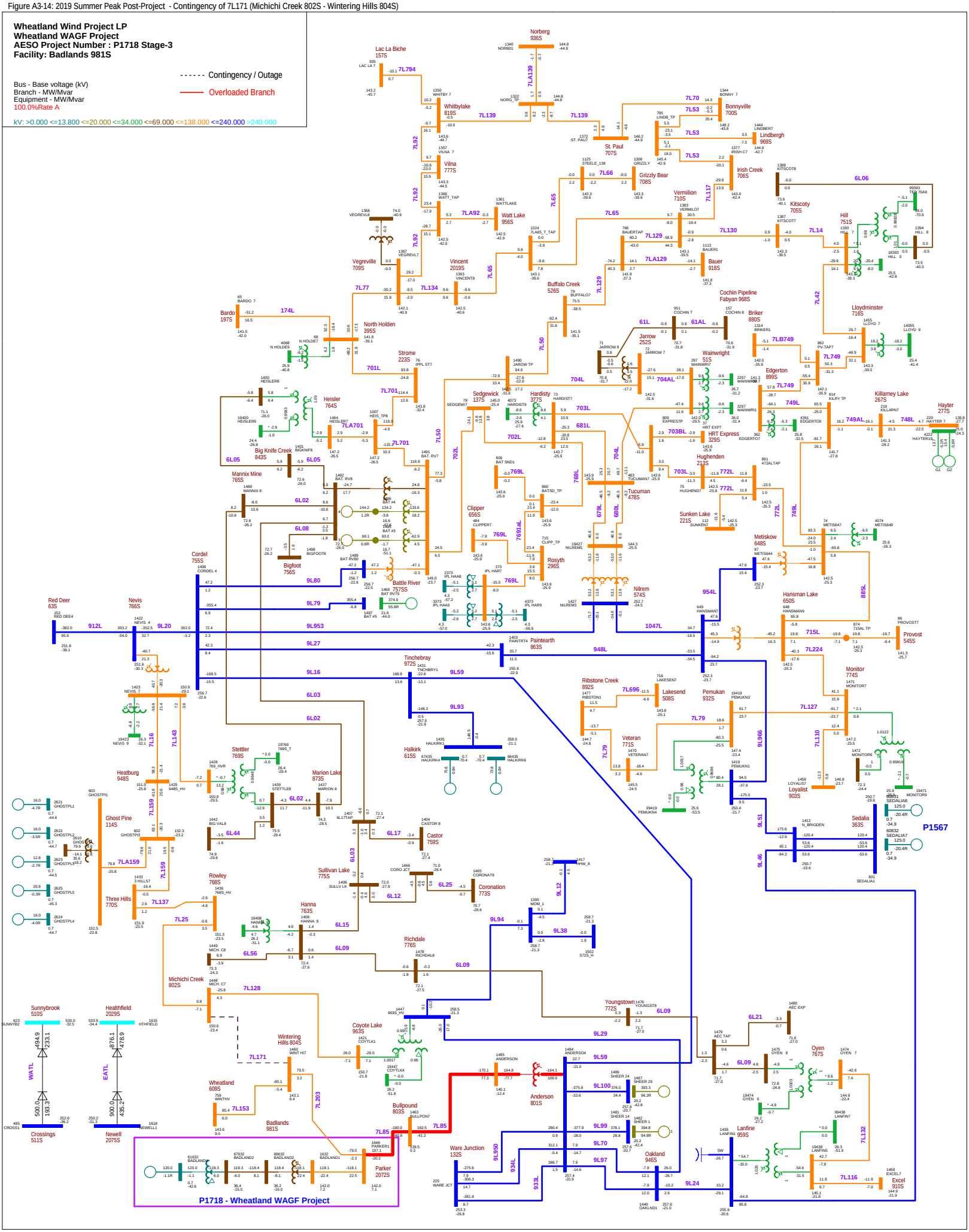


Figure A3-15: 2019 Summer Peak Post-Project - Contingency of 114ST1 (Ghost Pine 114S Transformer T1)

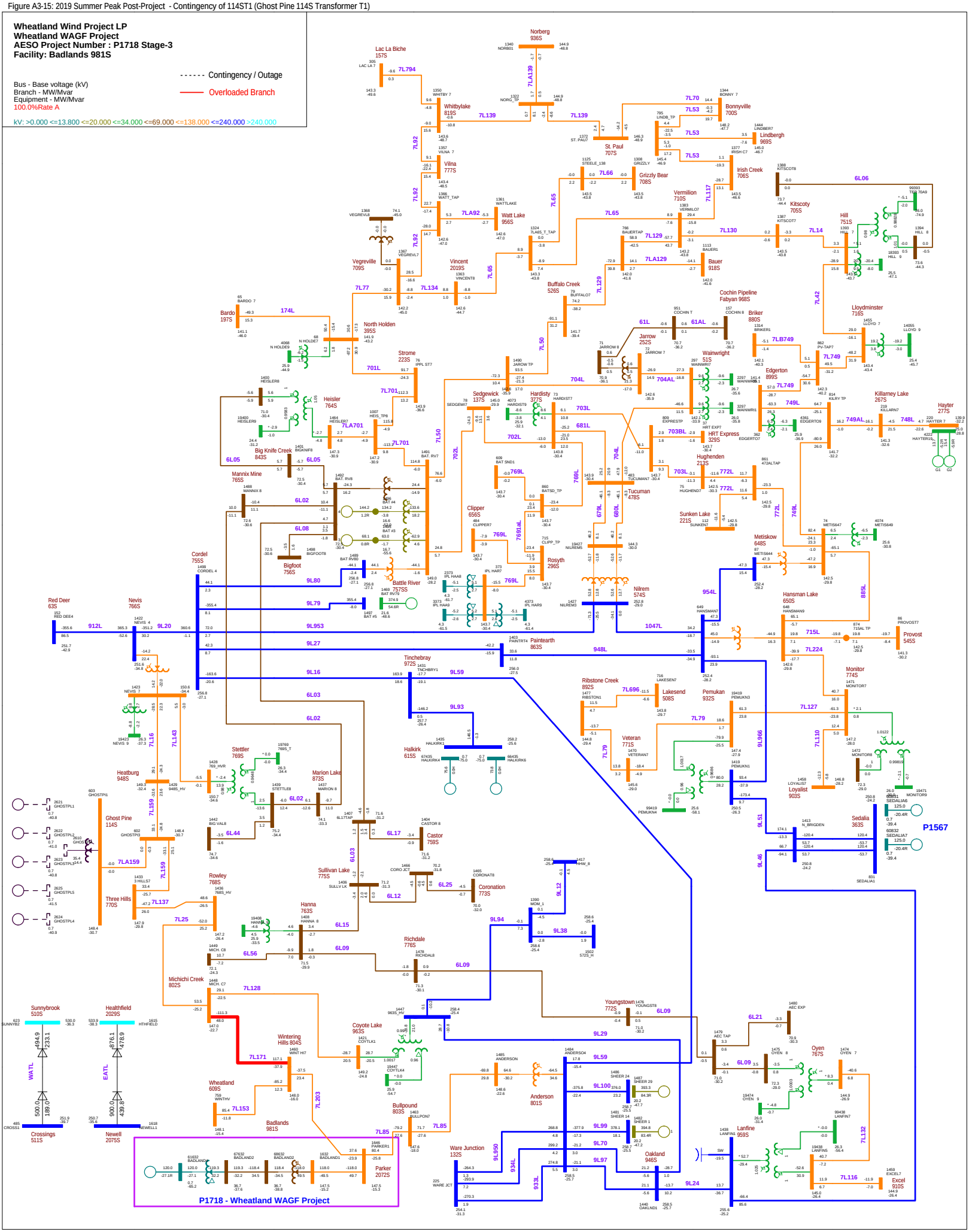


Figure A3-16: 2019 Summer Peak Post-Project - Contingency of 7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)

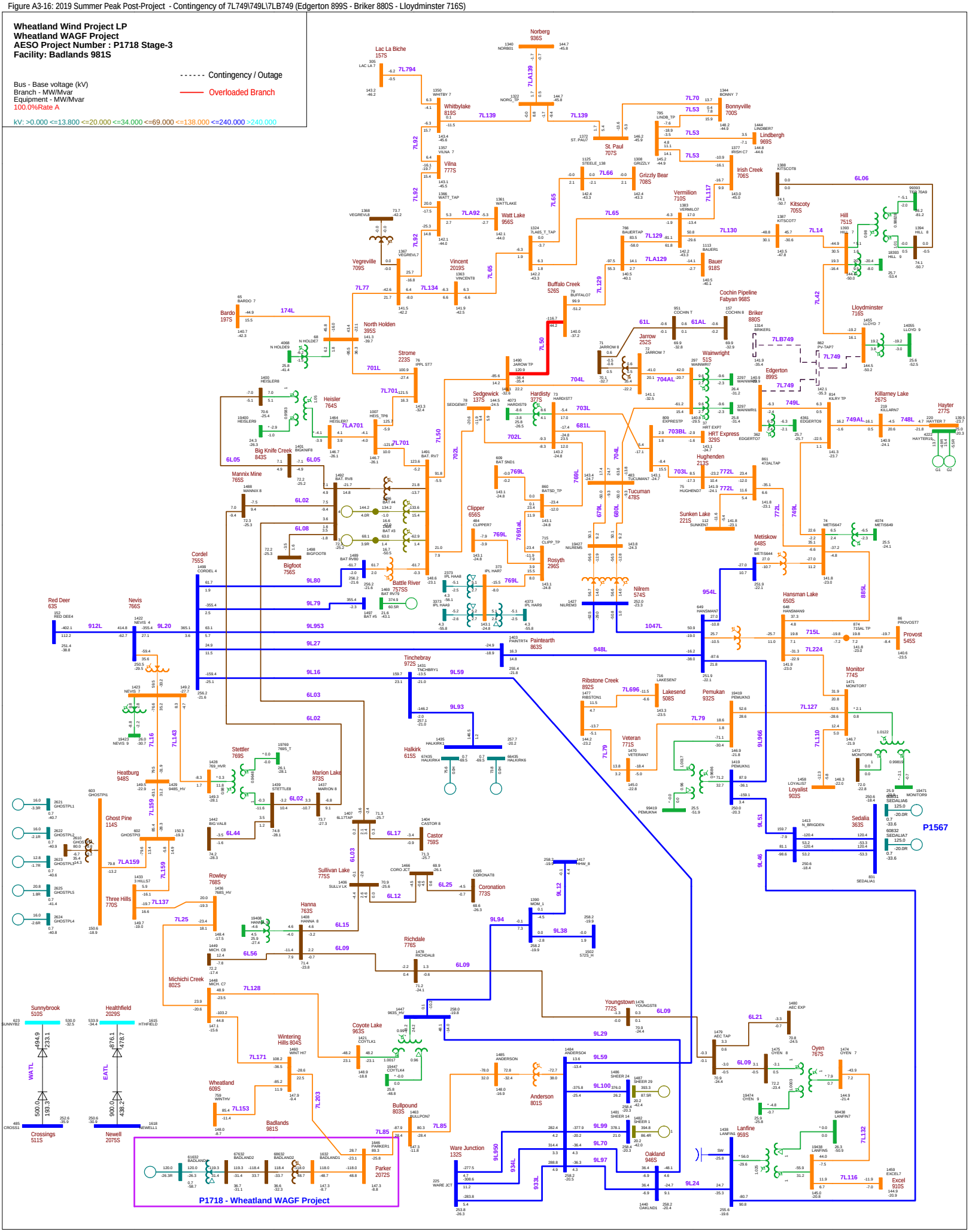


Figure A3-17: 2019 Summer Peak Post-Project - Contingency of 7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)

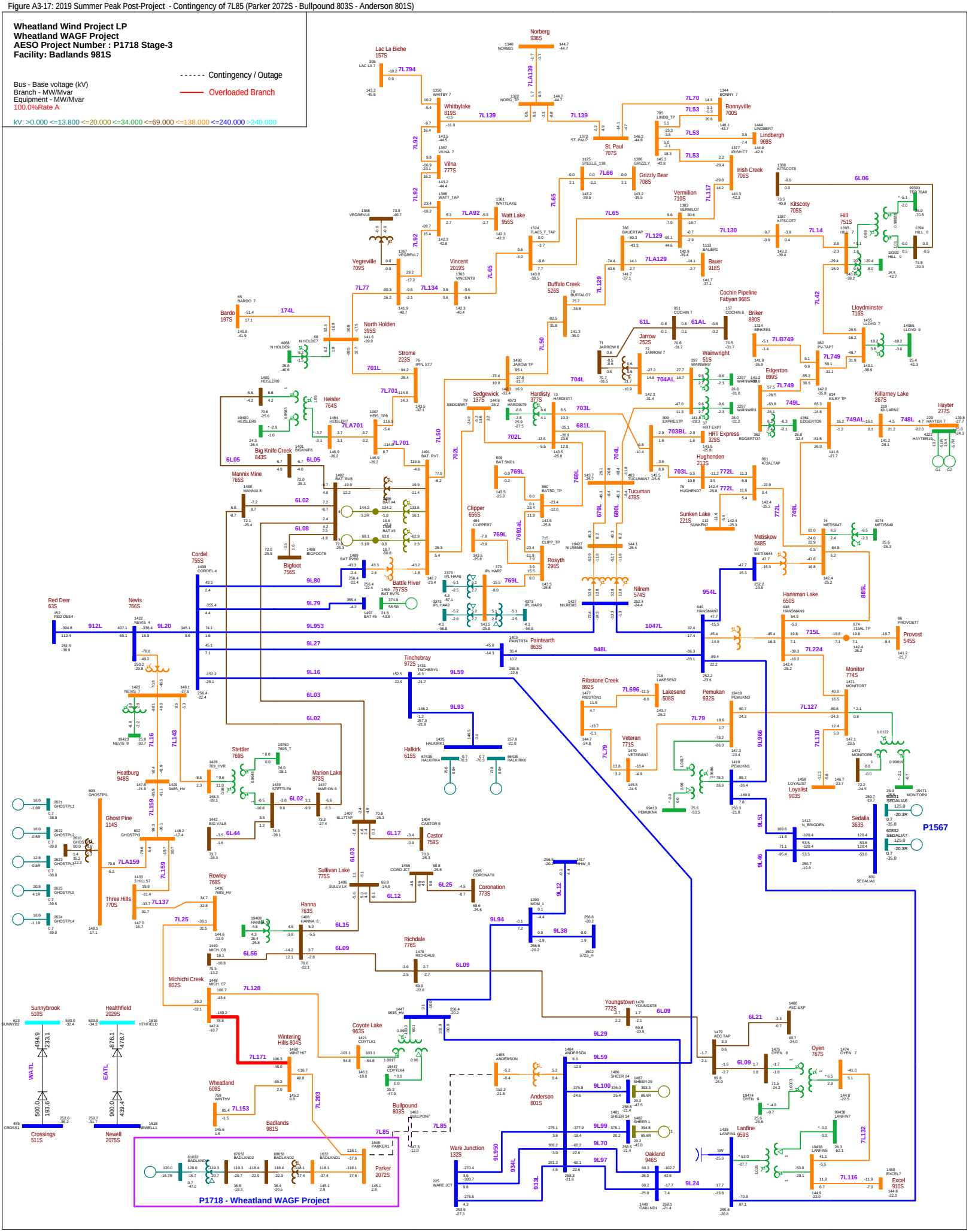

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S
Contingency / Outage
Overloaded Branch
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000
Norberg 936S
Lac La Biche 157S
7L794
7LA139
7L139
Whitbylake 819S
Vilna 777S
7L92
7LA92
Watt Lake 956S
Vegreville 709S
Vincent 2019S
7L65
7L134
7L77
North Holden 395S
Bardo 197S
174L
Strome 223S
701L
7L701
Heisler 764S
7LA701
Big Knife Creek 843S
6L05
Mannix Mine 765S
6L02
6L08
Bigfoot 756S
Cordel 755S
9L80
Battle River 757SS
Red Deer 63S
Nevis 766S
912L
9L20
9L79
9L953
9L27
9L16
6L03
7L16
7L143
Heatburg 948S
7L159
Ghost Pine 114S
7LA159
Three Hills 770S
7L137
7L25
Rowley 768S
Sunnybrook 510S
Healthfield 2029S
WATL
EATL
Crossings 511S
Newell 2075S
Wintering Hills 804S
7L171
Wheatland 609S
7L153
Badlands 981S
7L203
Michichi Creek 802S
7L128
6L56
Stettler 769S
Marion Lake 873S
6L44
Sullivan Lake 775S
6L12
Hanna 763S
6L15
6L09
Coyote Lake 963S
Bullpound 803S
7L85
Parker 2072S
P1718 - Wheatland WAGF Project
Tinchebray 972S
9L59
9L93
Halkirk 615S
Castor 759S
6L17
6L25
Coronation 773S
Richdale 776S
Vermilion 710S
7L117
Grizzly Bear 708S
St. Paul 707S
7L53
7L70
Bonnyville 700S
Lindbergh 969S
Irish Creek 706S
7L66
7L65
7L129
7LA129
Bauer 918S
Buffalo Creek 526S
7L50
Sedgewick 137S
Hardisty 377S
703L
681L
704L
704AL
702L
Jarrow 252S
61L
61AL
Wainwright 51S
Edgerton 699S
7L749
Cochin Pipeline
Fabyan 968S
Briker 880S
7L42
Lloydminster 716S
7LB749
Killarney Lake 267S
749L
749AL
748L
Hayter 277S
Kitscoty 705S
6L06
7L14
Hill 751S
7L130
Tucuman 478S
769L
769AL
Clipper 656S
Rosyth 296S
Nilrem 574S
Sunken Lake 221S
Hughenden 213S
HRT Express 329S
703BL
703L
772L
772AL
680L
678L
704AL
Metiskow 648S
954L
885L
Hansman Lake 650S
715L
7L224
Provost 545S
1047L
948L
Paintearth 863S
Ribstone Creek 892S
7L696
Lakesend 508S
Pemukan 932S
7L79
Veteran 771S
Monitor 774S
7L127
7L110
9L966
Loyalist 903S
Sedalia 363S
P1567
9L51
9L46
Youngstown 772S
6L09
9L29
9L38
9L94
9L12
Oyen 767S
6L21
Lanfine 559S
7L132
7L116
Excel 910S
Oakland 946S
9L24
9L97
9L99
9L100
9L59
Anderson 801S
Ware Junction 132S
9L950
934L
933L
Coronation
Hanna
Oyen
Lanfine
Oakland
Ware Junction
Parker
Bullpound
Anderson
Crossings
Newell
Sunnybrook
Healthfield
Wheatland
Badlands
Wintering Hills
Coyote Lake
Youngstown
Richdale
Michichi Creek
Sullivan Lake
Rowley
Three Hills
Ghost Pine
Heatburg
Stettler
Marion Lake
Halkirk
Castor
Tinchebray
Cordel
Nevis
Red Deer
Mannix Mine
Big Knife Creek
Bigfoot
Heisler
Strome
North Holden
Vegreville
Vincent
Whitbylake
Vilna
Lac La Biche
Norberg
Watt Lake
Vermilion
Grizzly Bear
St. Paul
Bonnyville
Lindbergh
Irish Creek
Kitscoty
Hill
Buffalo Creek
Sedgewick
Hardisty
Jarrow
Wainwright
Edgerton
Cochin Pipeline
Fabyan
Briker
Lloydminster
Killarney Lake
Hayter
Clipper
Rosyth
Nilrem
Tucuman
Sunken Lake
Hughenden
HRT Express
Metiskow
Hansman Lake
Provost
Ribstone Creek
Lakesend
Pemukan
Veteran
Monitor
Loyalist
Sedalia
Youngstown
Oyen
Lanfine
Excel

Figure A3-18: 2019 Summer Peak Post-Project - Contingency of 899ST3A (Edgerton 899S Transformer T3A)

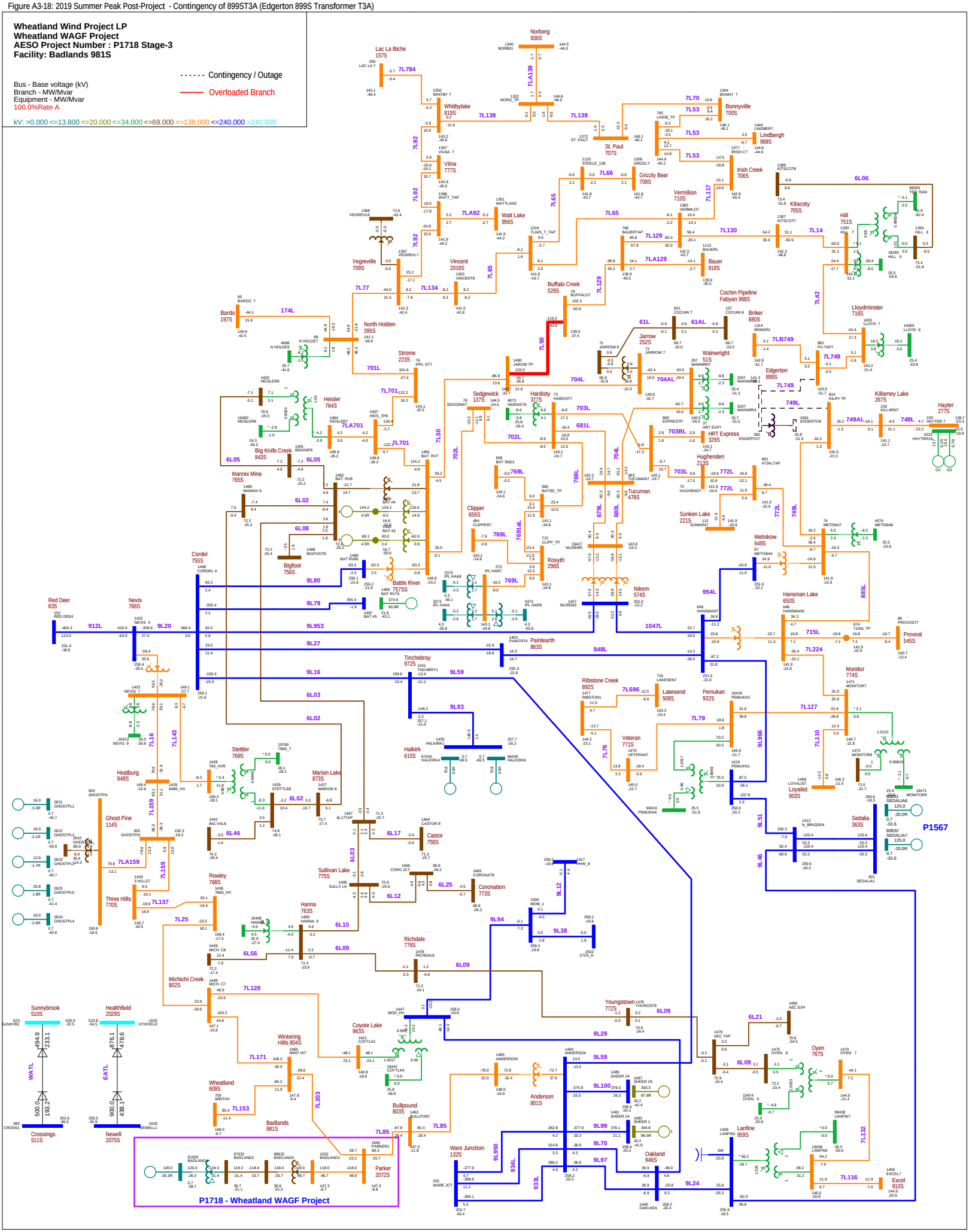

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S
Contingency / Outage
Overloaded Branch
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000
Norberg 936S
Lac La Biche 157S
Whitbylake 819S
Vilna 777S
Watt Lake 956S
Vegreville 709S
Vincent 2019S
Bardo 197S
North Holden 395S
Strome 223S
Heisler 764S
Big Knife Creek 843S
Mannix Mine 765S
Cordel 755S
Bigfoot 756S
Battle River 757SS
Red Deer 63S
Nevis 766S
Heatburg 948S
Ghost Pine 114S
Three Hills 770S
Rowley 768S
Michichi Creek 802S
Sunnybrook 510S
Crossings 511S
Healthfield 2029S
Newell 2075S
Wintering Hills 804S
Wheatland 609S
Badlands 981S
Coyote Lake 963S
Bullpound 803S
Ware Junction 132S
Parker 2072S
Sullivan Lake 775S
Hanna 763S
Richdale 776S
Halkirk 615S
Stettler 769S
Marion Lake 873S
Castor 759S
Tinchebray 972S
Painteart 863S
Clipper 656S
Bigfoot 756S
Rosyth 296S
Nilrem 574S
Tucumcari 478S
Sunken Lake 221S
Hughenden 213S
Hardisty 377S
Sedgewick 137S
Jarrow 252S
Wainwright 51S
Edgerton 899S
Vermilion 710S
Buffalo Creek 526S
Cochin Pipeline
Fabyan 968S
Briker 880S
Lloydminster 716S
Killarney Lake 267S
Hayter 277S
Kitscoty 705S
Hill 751S
Irish Creek 706S
Grizzly Bear 708S
St. Paul 707S
Bonnyville 700S
Lindbergh 969S
Lakesend 508S
Pemukan 932S
Veteran 771S
Ribstone Creek 892S
Loyalist 903S
Sedalia 363S
Lanfine 559S
Oyen 767S
Metiskow 648S
Hansman Lake 650S
Provost 545S
Oakland 946S
Youngstown 772S
Anderson 801S
Whitbylake 819S
Lakesend 508S
Pemukan 932S
Veteran 771S
Loyalist 903S
Sedalia 363S
Lanfine 559S
Oyen 767S
Metiskow 648S
Hansman Lake 650S
Provost 545S
Oakland 946S
Youngstown 772S
Anderson 801S
Monitor 774S
Irish Creek 706S
Kitscoty 705S
Hill 751S
Lloydminster 716S
Killarney Lake 267S
Hayter 277S
Edgerton 899S
Wainwright 51S
Jarrow 252S
Briker 880S
Cochin Pipeline
Fabyan 968S
Buffalo Creek 526S
Vermilion 710S
Bonnyville 700S
Lindbergh 969S
St. Paul 707S
Grizzly Bear 708

Figure A3-19: 2019 Summer Peak Post-Project - Contingency of 701L (North Holden 395S - Strome 223S)

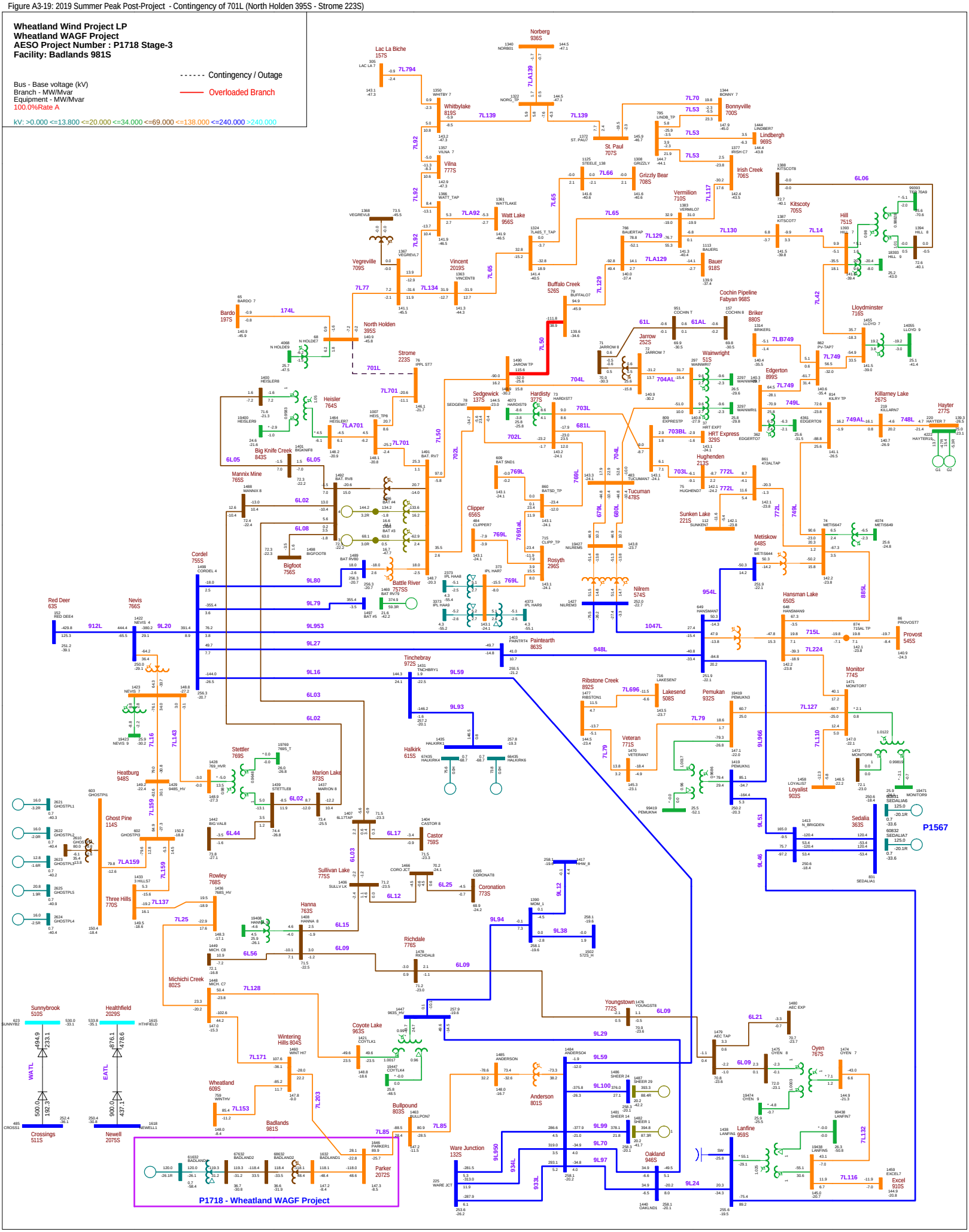


Figure A3-20: 2019 Summer Peak Post-Project - Contingency of 912L\9L912 (Red Deer 63S - Nevis 766S)

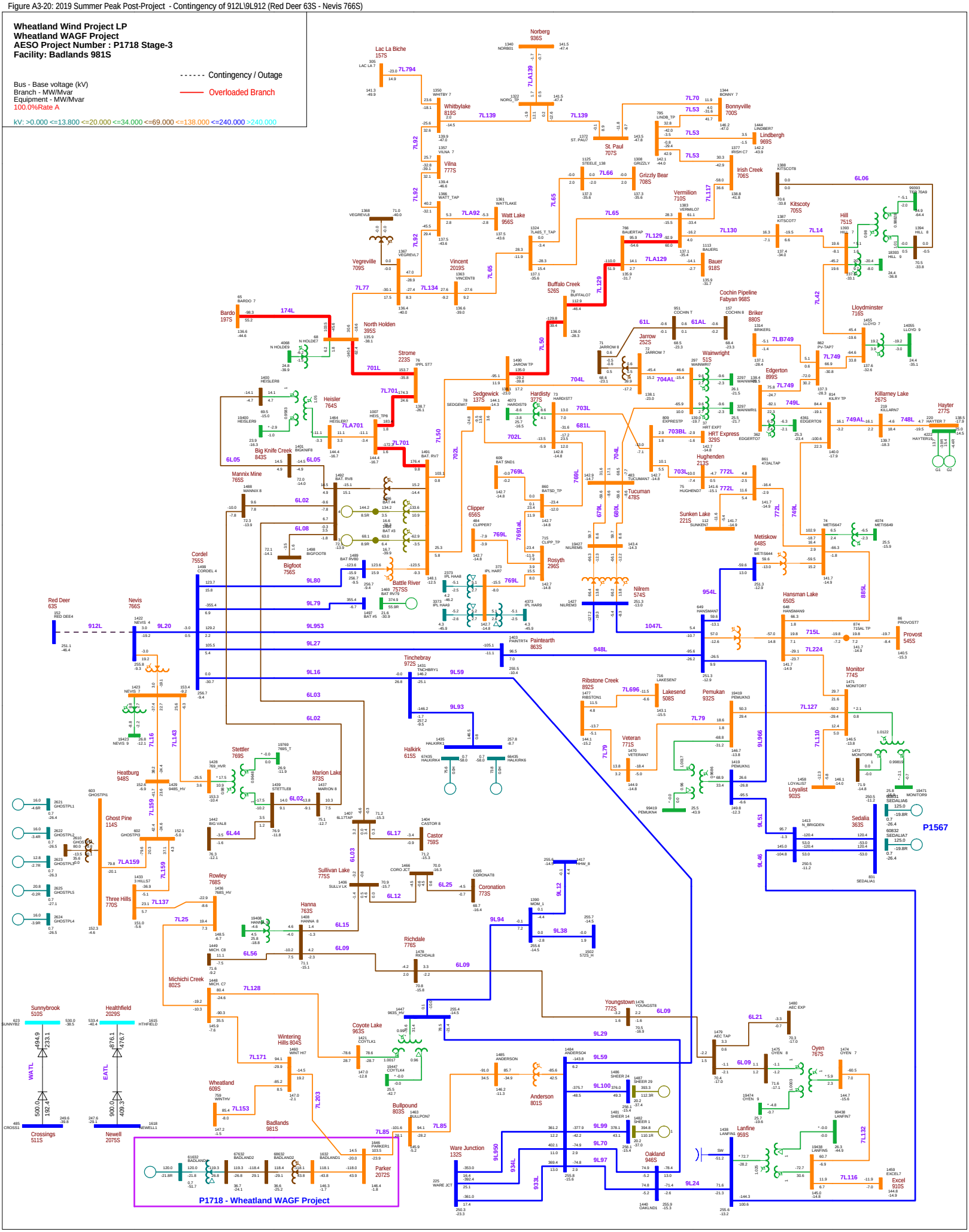


Figure A3-21: 2019 Summer Peak Post-Project - Contingency of 749L\749AL (Metiskow 648S - Edgerton 899S)

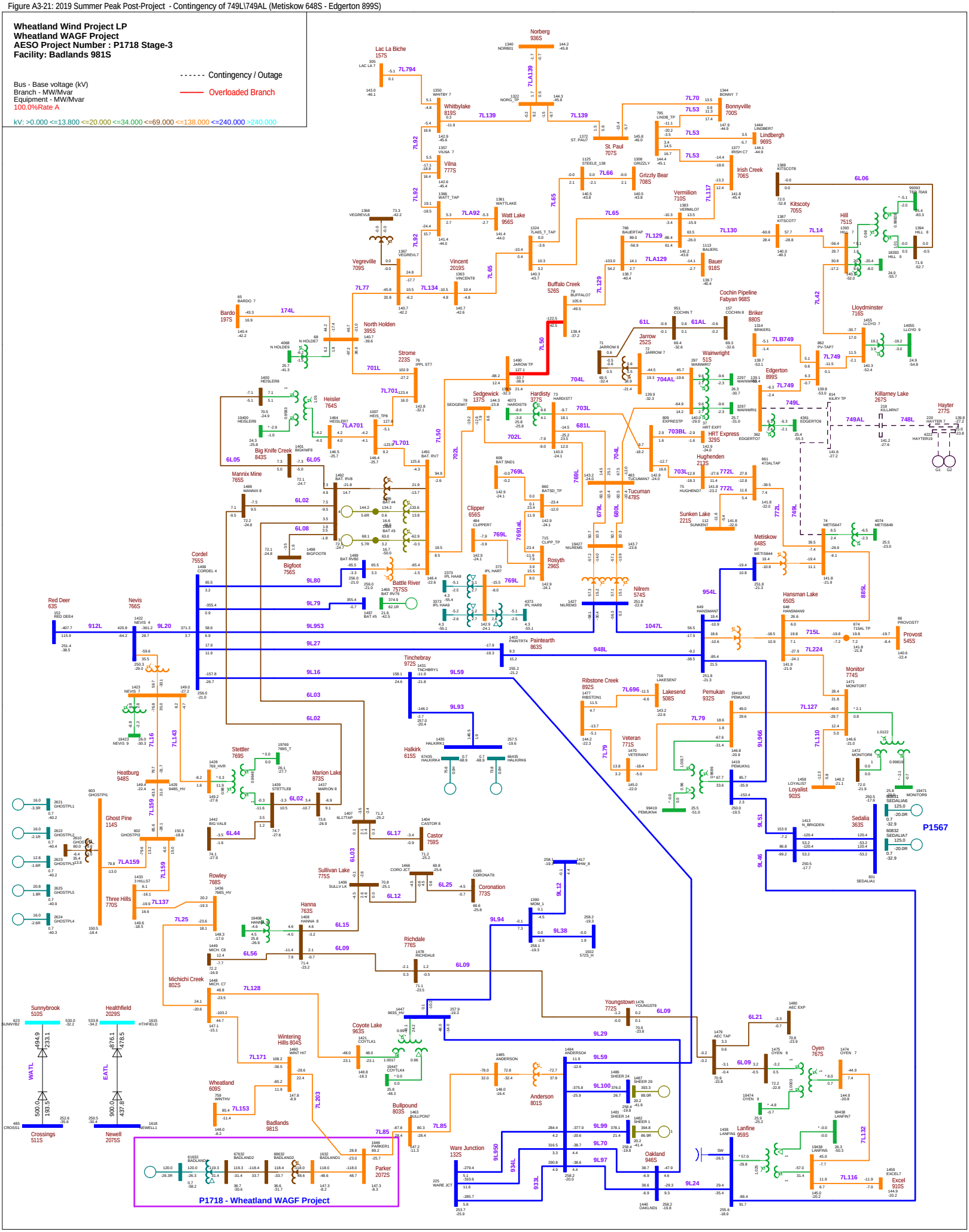


Figure A3-22: 2019 Summer Peak Post-Project - Contingency of 648ST1 (Metiskow 648S Transformer T1)

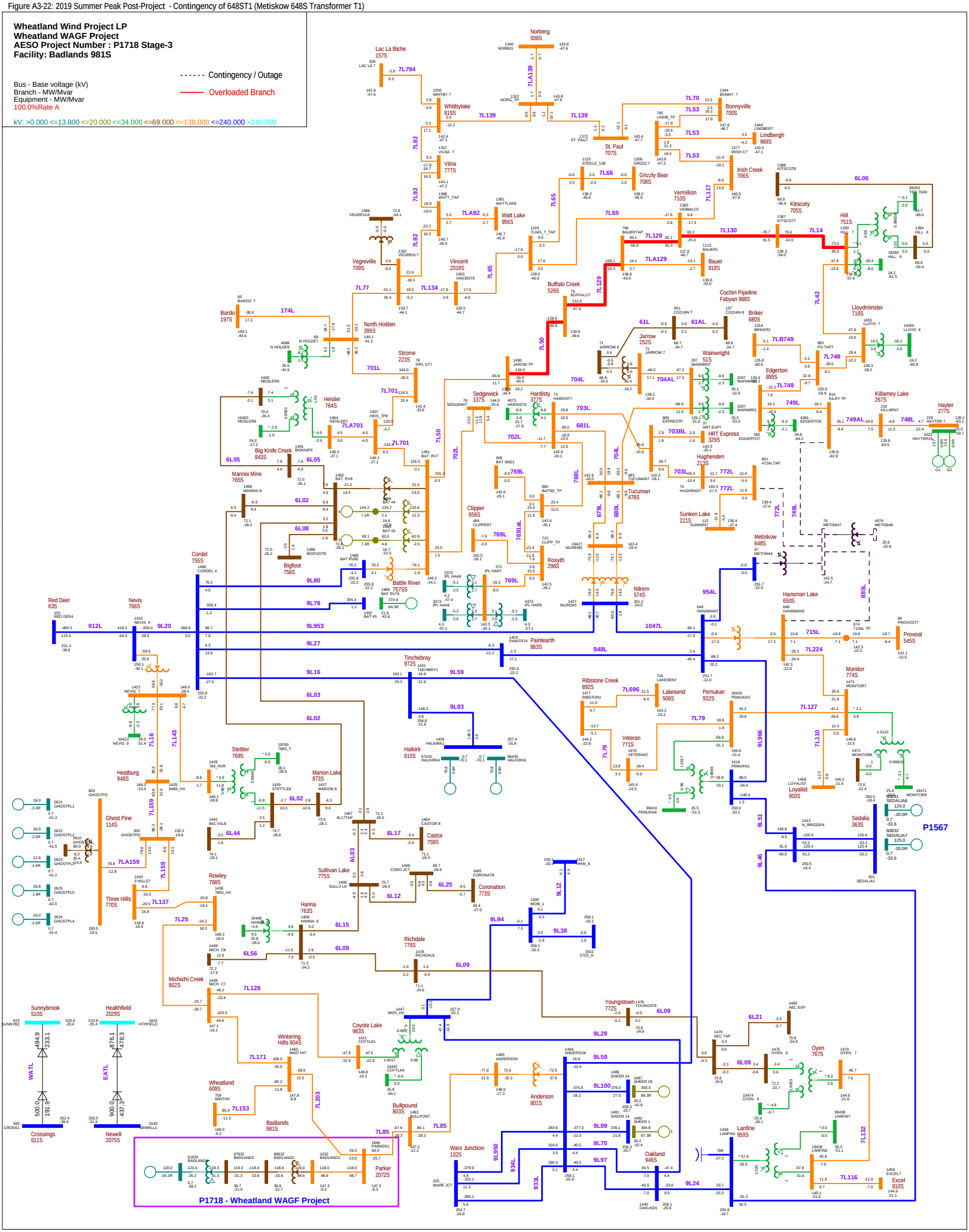


Figure A3-23: 2019 Summer Peak Post-Project - Contingency of 7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)

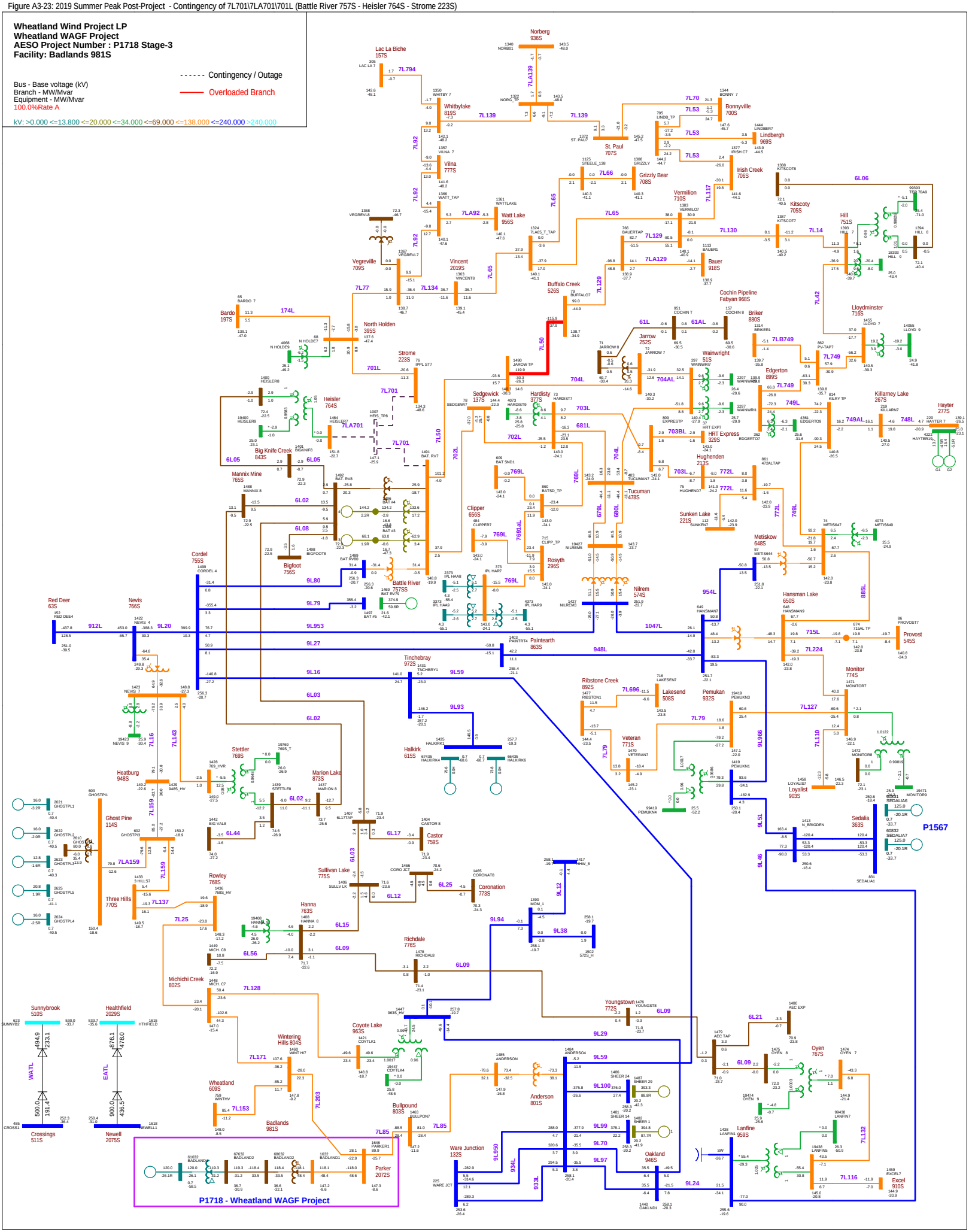


Figure A3-24: 2019 Summer Peak Post-Project - Contingency of 395ST1 (North Holden 395S Transformer T1)

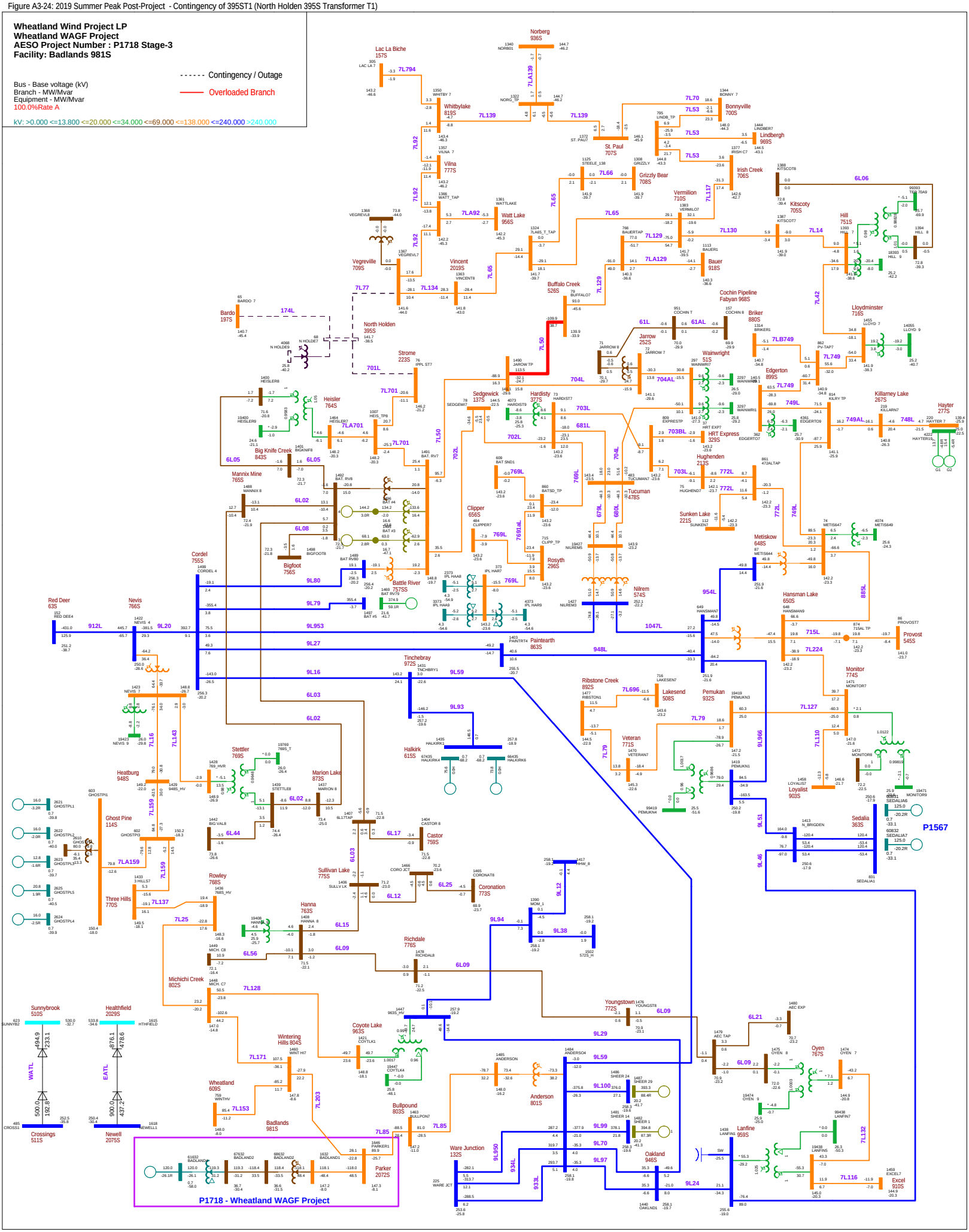


Figure A3-25: 2019 Summer Peak Post-Project - Contingency of 9L16 (Tinchebray 972S - Cordel 755S)

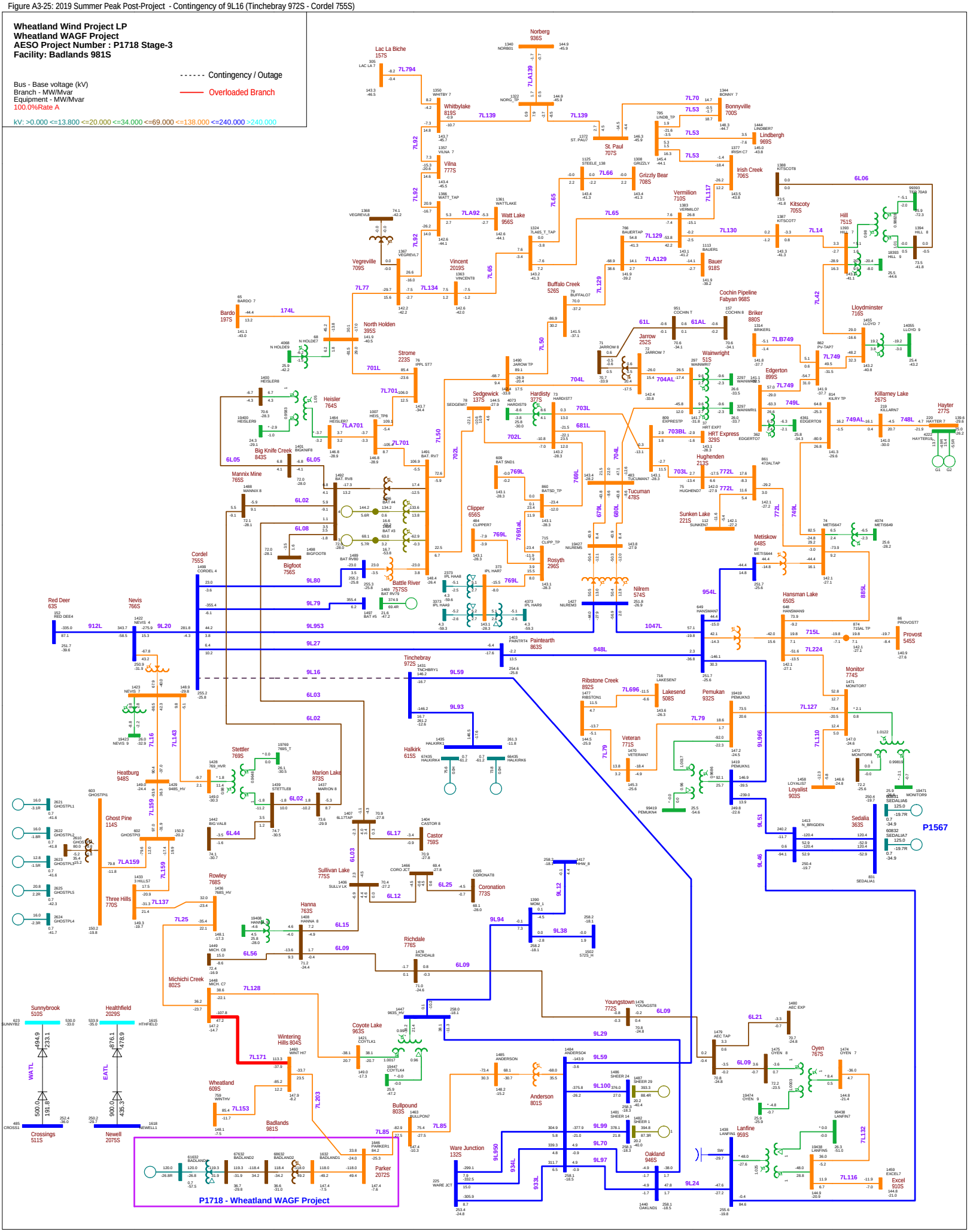


Figure A3-26: 2019 Summer Peak Post-Project - Contingency of 9L20 (Nevis 766S - Cordel 755S)

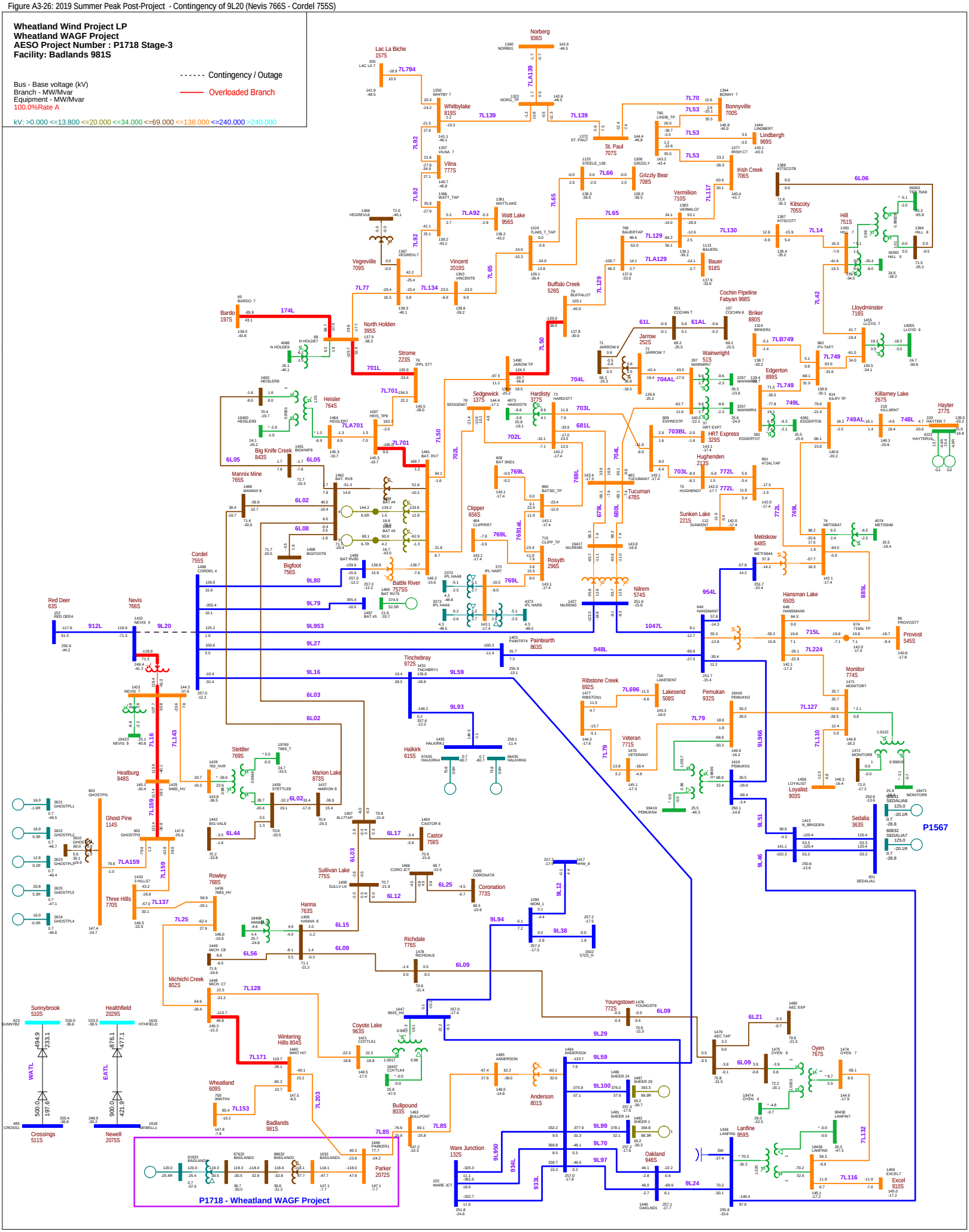

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S
Contingency / Outage
Overloaded Branch
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000
Norberg 936S
Lac La Biche 157S
Whitbylake 819S
Vilna 777S
Watt Lake 956S
Vegreville 709S
Vincent 2019S
Bardo 197S
North Holden 395S
Strome 223S
Heisler 764S
Big Knife Creek 843S
Mannix Mine 765S
Cordel 755S
Bigfoot 756S
Battle River 757SS
Red Deer 63S
Nevis 766S
Heatburg 948S
Ghost Pine 114S
Three Hills 770S
Rowley 768S
Michichi Creek 802S
Sunnybrook 510S
Crossings 511S
Healthfield 2029S
Newell 2075S
Wintering Hills 804S
Wheatland 609S
Badlands 981S
Parker 2072S
Coyote Lake 963S
Sullivan Lake 775S
Hanna 763S
Stettler 769S
Marion Lake 873S
Halkirk 615S
Tinchebray 972S
Richdale 776S
Ware Junction 132S
Anderson 801S
Bullpound 803S
Castor 759S
Coronation 773S
Oakland 946S
Youngstown 772S
Buffalo Creek 526S
Cochin Pipeline
Fabyan 968S
Jarrow 252S
Wainwright 51S
Sedgewick 137S
Hardisty 377S
Clipper 656S
Rosyth 296S
Nilrem 574S
Tucuman 478S
Sunken Lake 221S
Hughenden 213S
HRT Express 329S
Edgerton 699S
Vermilion 710S
Bauer 918S
Grizzly Bear 708S
St. Paul 707S
Irish Creek 706S
Bonnyville 700S
Lindbergh 969S
Kitscoty 705S
Hill 751S
Briker 880S
Lloydminster 716S
Killarney Lake 267S
Hayter 277S
Metiskow 648S
Hansman Lake 650S
Provost 545S
Lakesend 508S
Pemukan 932S
Veteran 771S
Ribstone Creek 892S
Loyalist 903S
Sedalia 363S
Monitor 774S
Oyen 767S
Lanfine 559S
Excel 910S
Paintearth 863S
P1567
7L794
7L92
7L139
7LA139
7L70
7L53
7L65
7L66
7L117
7L130
7L14
7L129
7LA129
7L134
7L77
7L65
7L50
7L42
7L749
7L749L
7L748L
7L749AL
7L704
7L704AL
7L703
7L703L
7L681
7L702
7L702L
7L701
7L701L
7LA701
7L772
7L772L
7L769
7L769L
7L691AL
7L680
7L679
7L696
7L79
7L127
7L110
7L224
7L715
7L954
7L885L
7L966
9L966
9L51
9L46
9L12
9L38
9L94
9L15
9L09
9L56
9L25
7L128
7L171
7L153
7L203
7L85
9L950
9L34L
9L33L
9L24
9L97
9L99
9L100
9L59
9L29
7L132
7L116
6L21
6L09
6L12
6L25
6L17
6L44
6L03
6L02
6L08
6L05
6L06
7LA92
7LA159
7L159
7L143
7L16
7L137
9L20
912L
9L80
9L79
9L953
9L27
9L16
9L59
9L93
1047L
948L
174L
61L
61AL
7LB749
7L749
7L749L
7L749AL
7L748L
7L715
7L224
7L696
7L79
7L127
7L110

Figure A3-27: 2019 Summer Peak Post-Project - Contingency of 7L42 (Hill 751S - Lloydminster 716S)

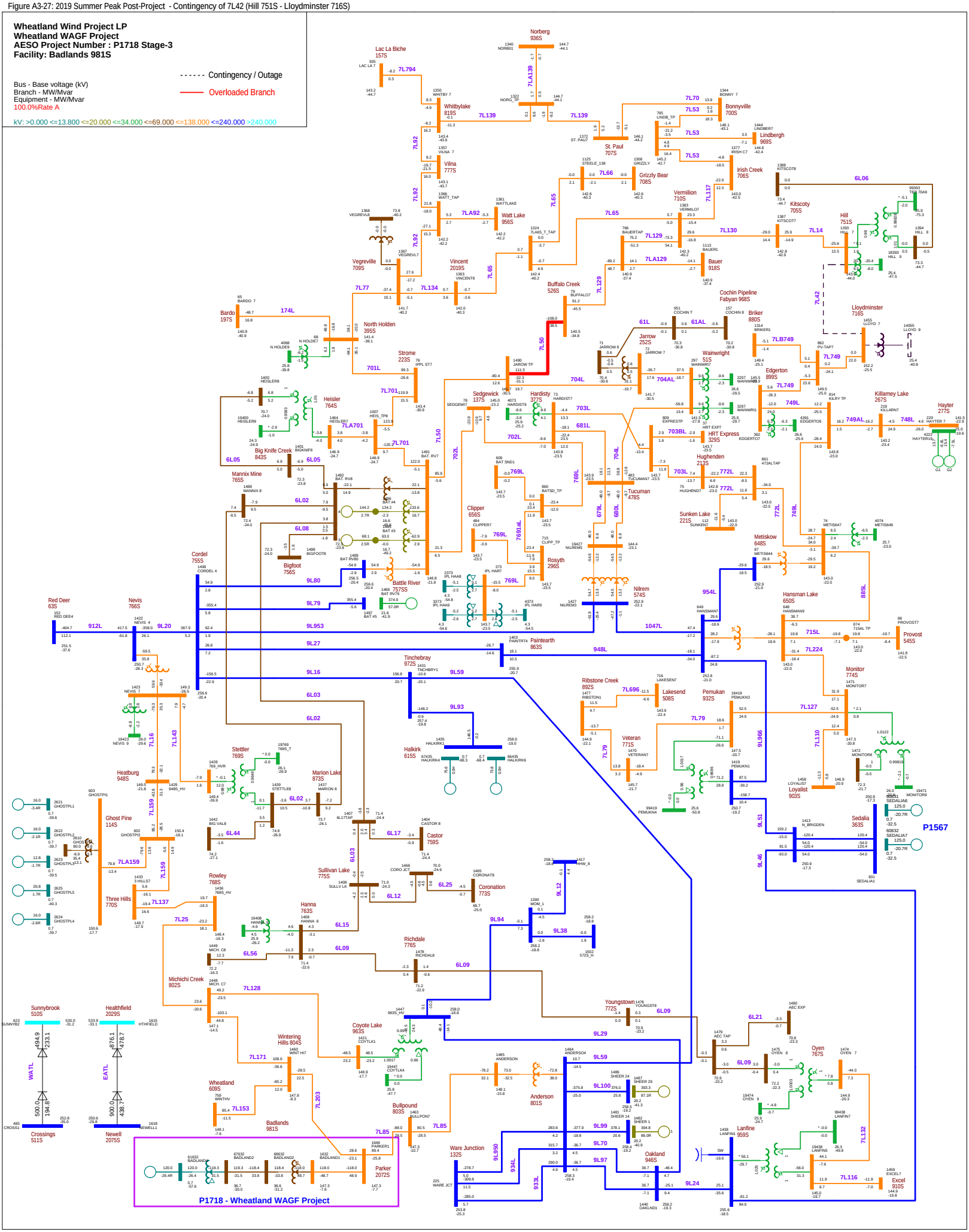


Figure A3-28: 2019 Winter Peak Post-Project - N-0 (System Normal Condition)

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000

Contingency / Outage
Overloaded Branch

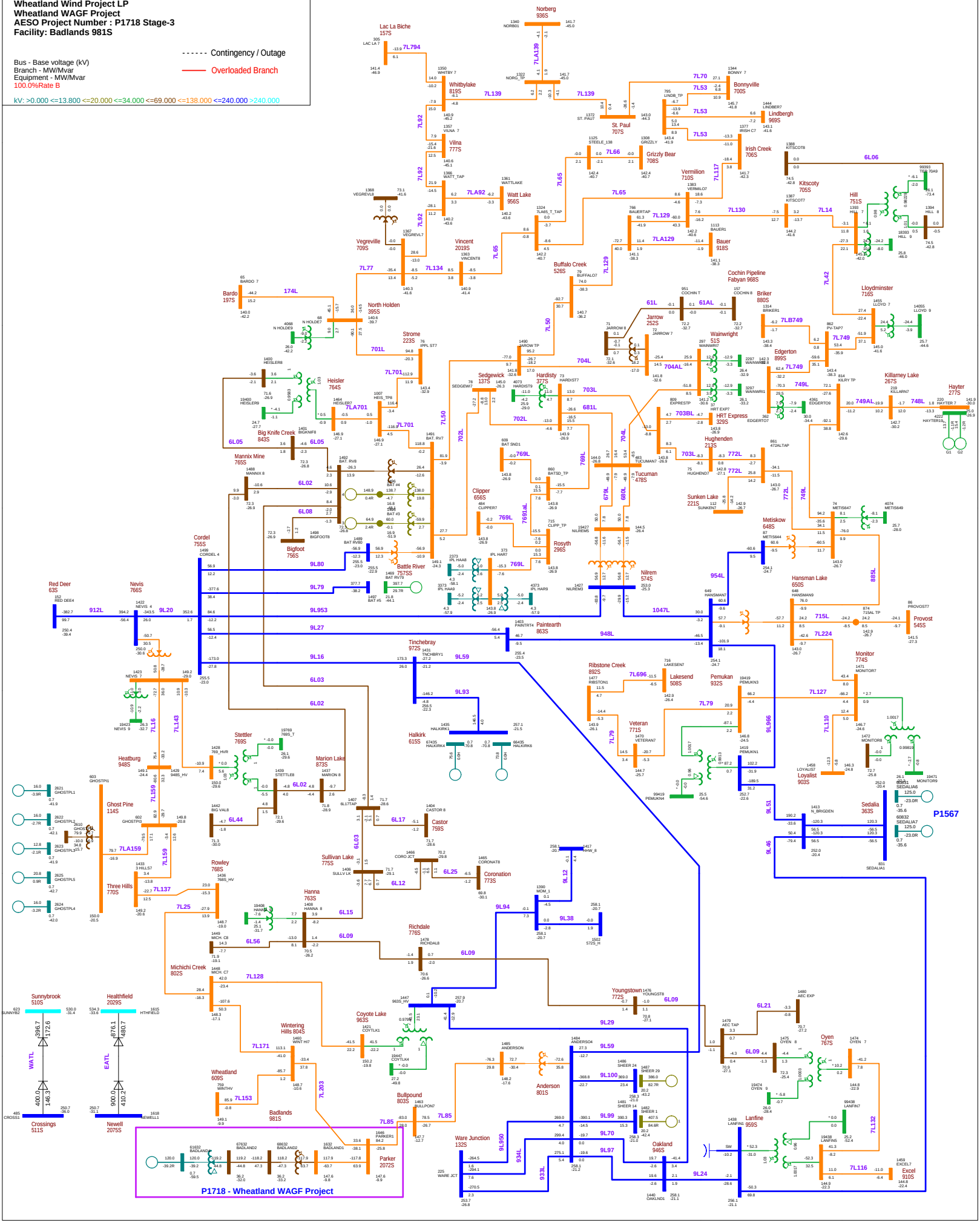


Figure A3-29: 2019 Winter Peak Post-Project - Contingency of 7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)

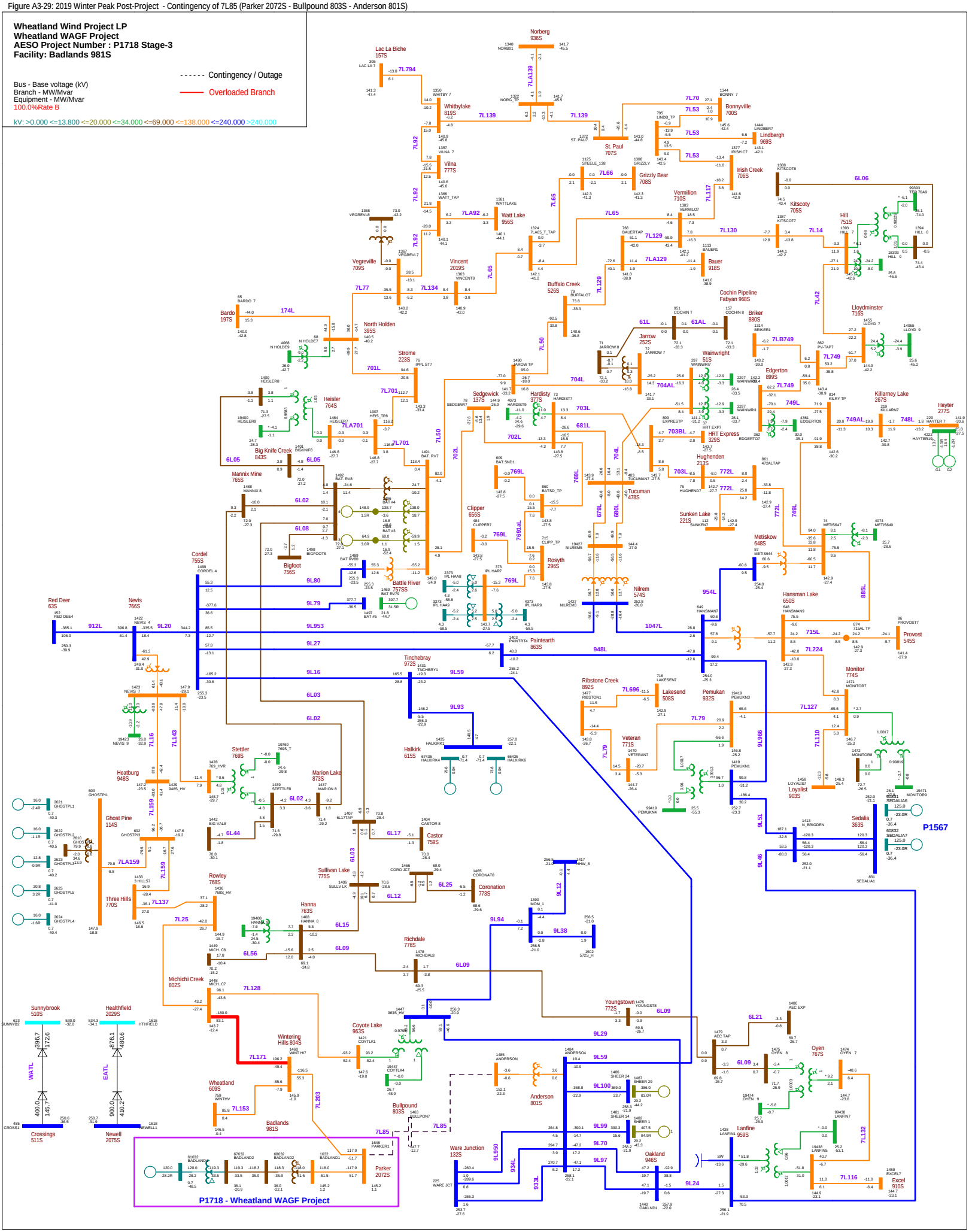


Figure A3-30: 2019 Winter Peak Post-Project - Contingency of 7L129\7LA129 (Buffalo Creek 526S - Vermilion 710S - Bauer 918S)

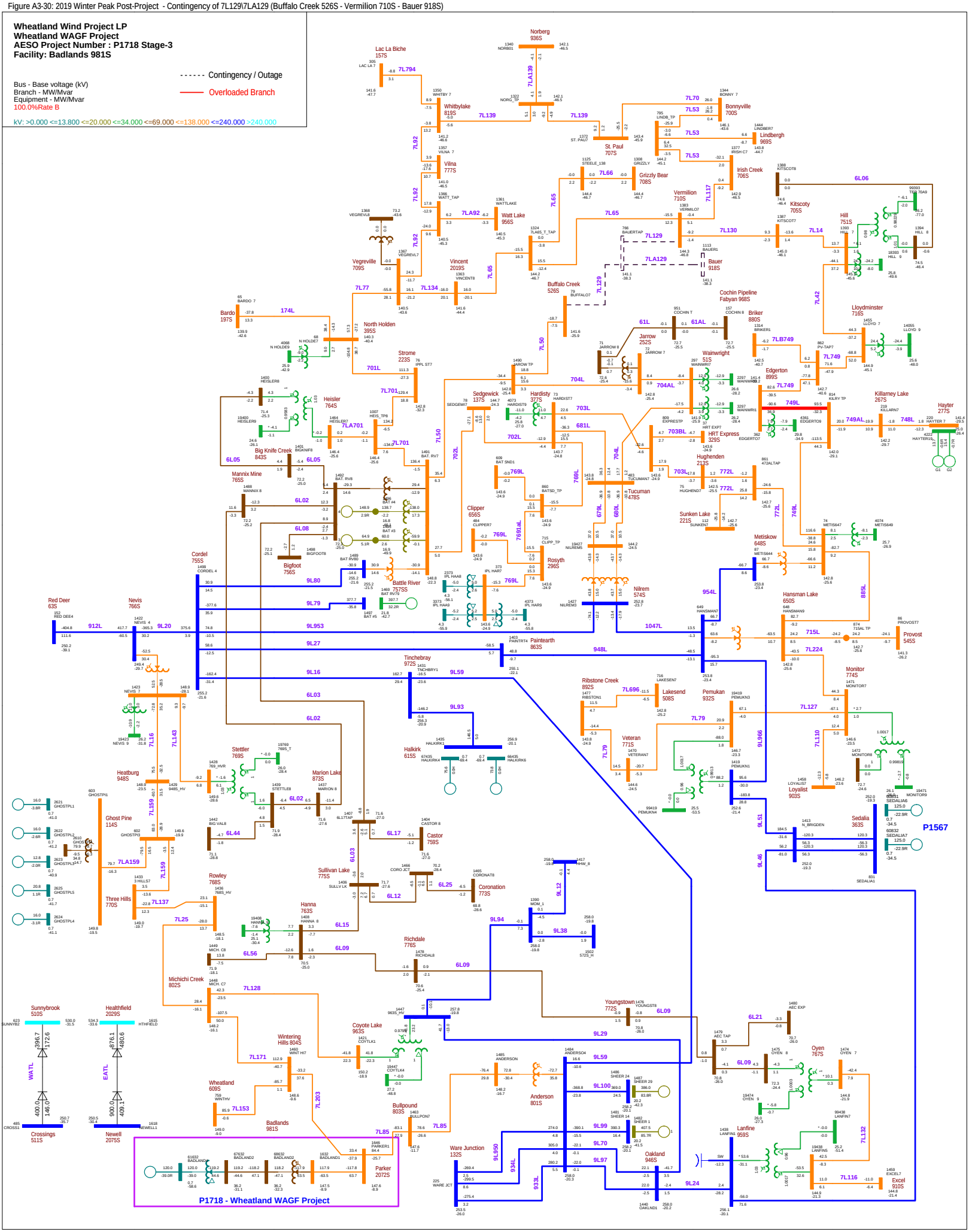


Figure A3-31: 2019 Winter Peak Post-Project - Contingency of 9L20 (Nevis 766S - Cordel 755S)

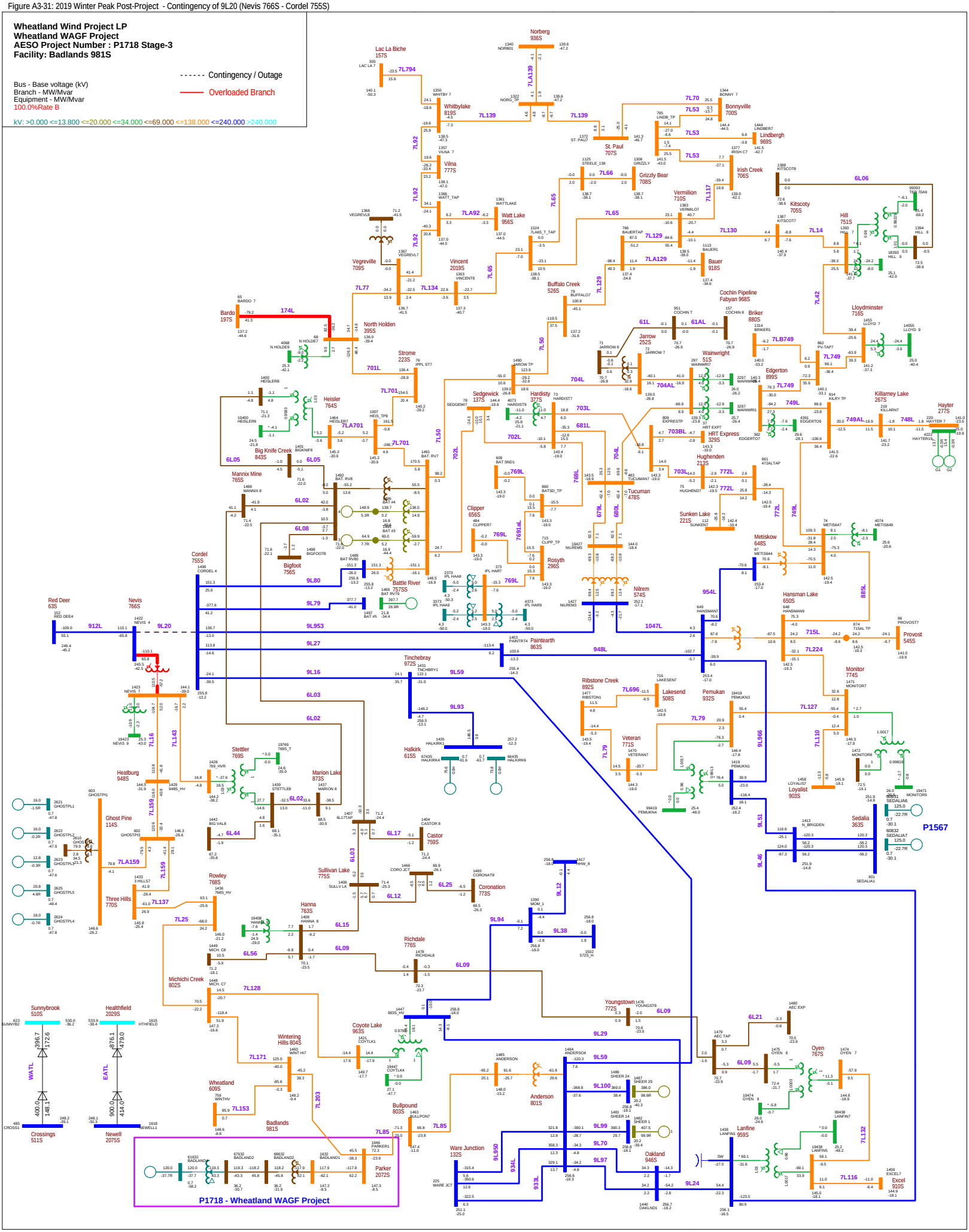


Figure A3-32: 2019 Winter Peak Post-Project - Contingency of 749L\749AL (Metiskow 648S - Edgerton 899S)

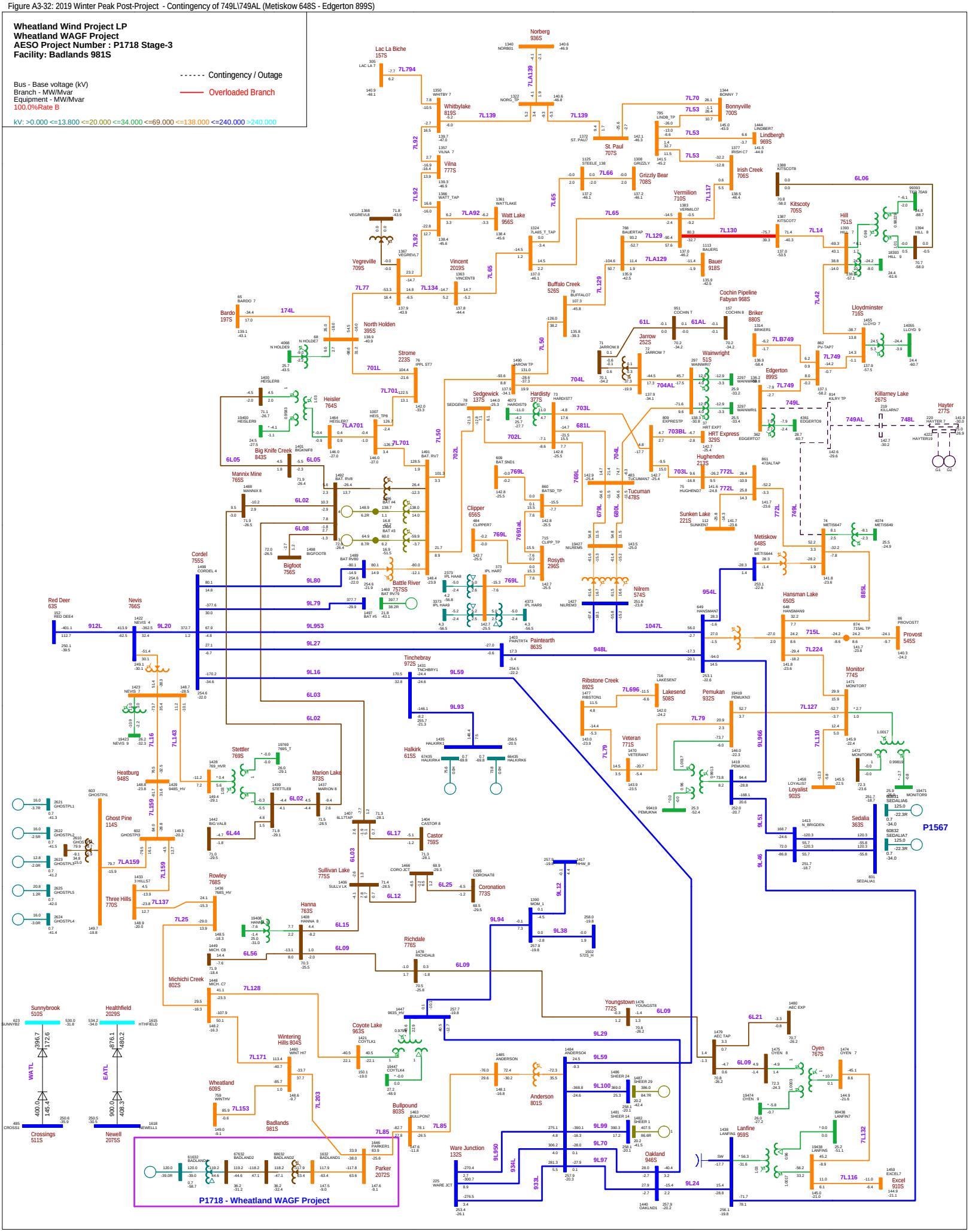


Figure A3-33: 2019 Winter Peak Post-Project - Contingency of 648ST1 (Metiskow 648S Transformer T1)

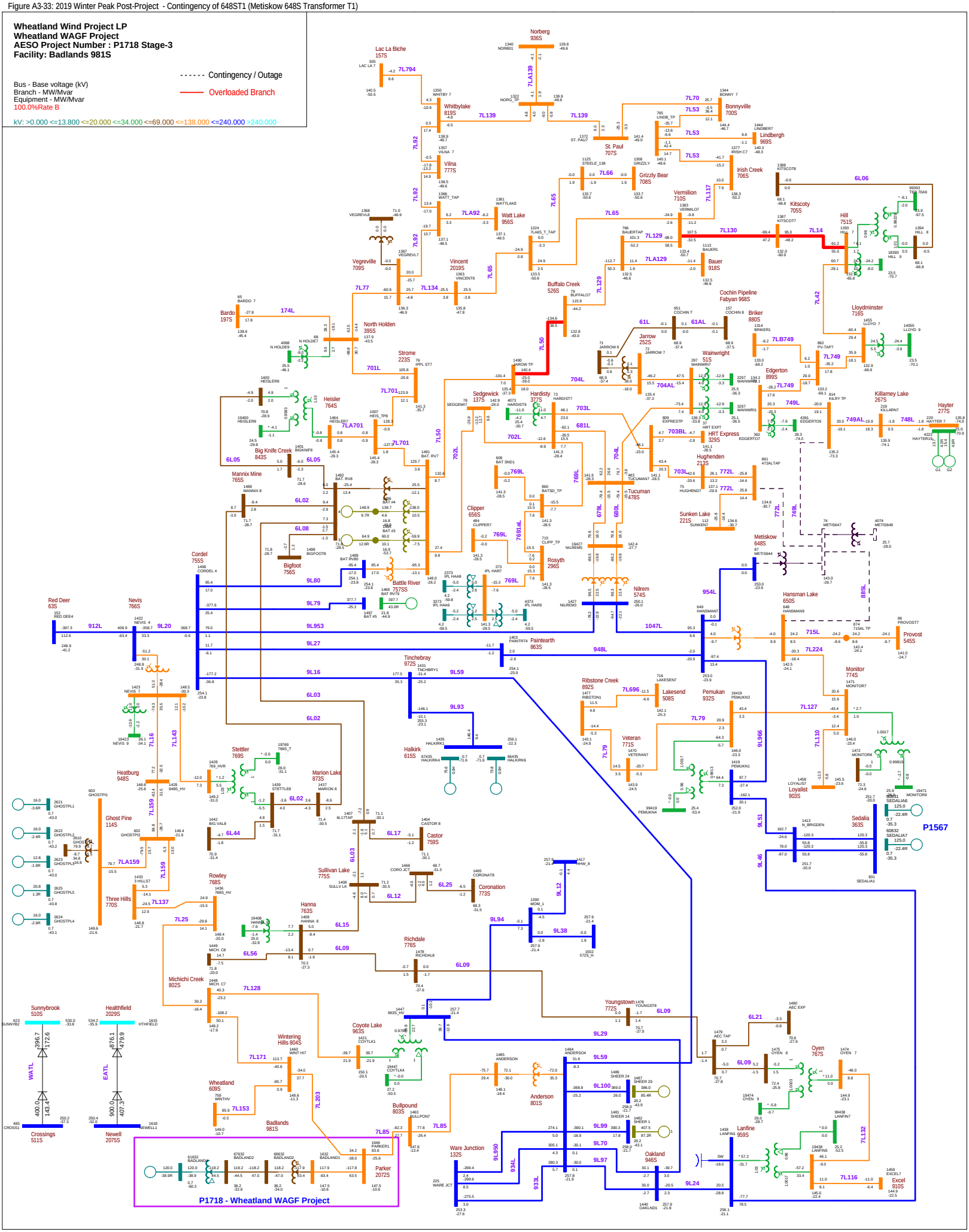


Figure A3-34: 2019 Winter Peak Post-Project - Contingency of 912L\9L912 (Red Deer 63S - Nevis 766S)

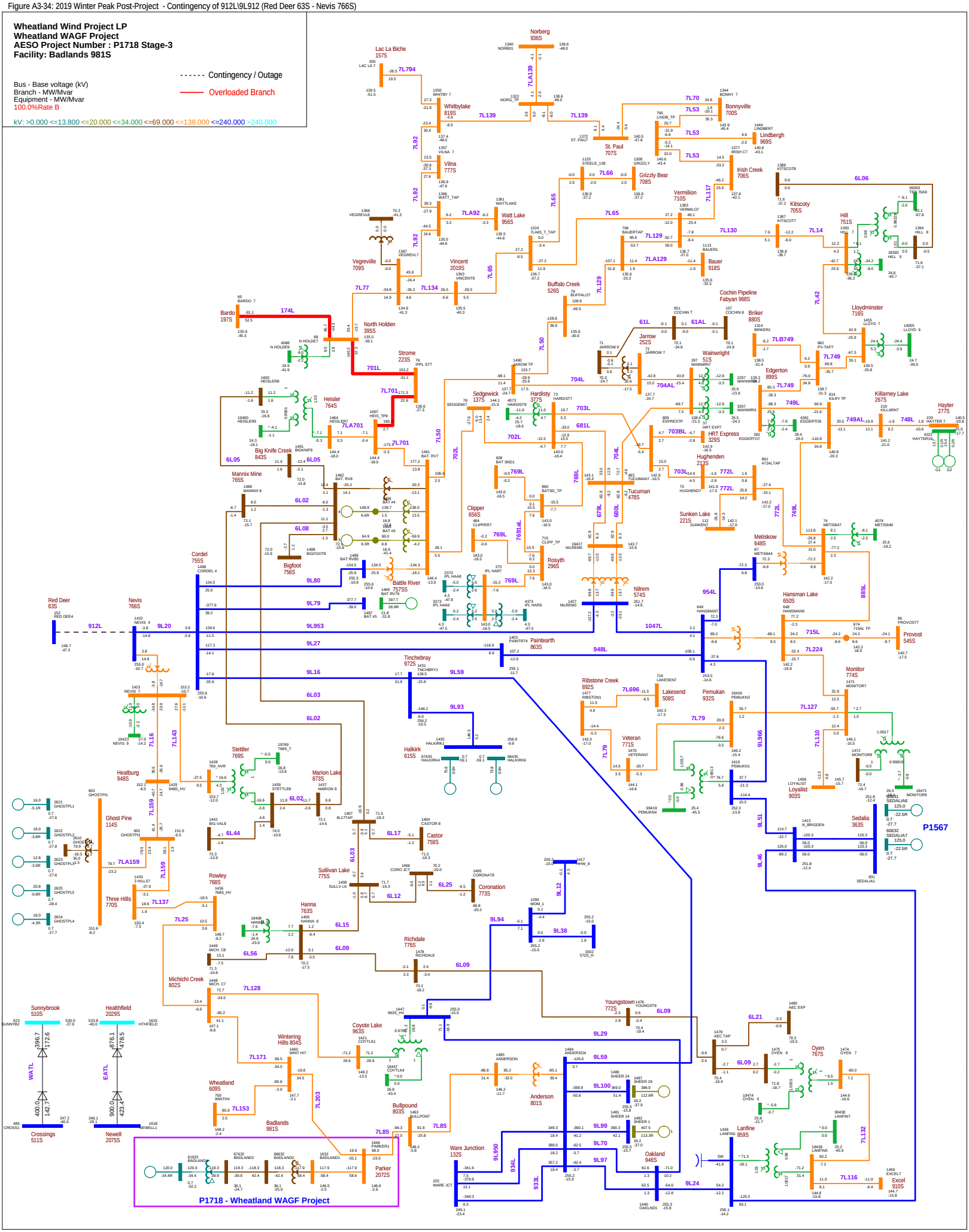


Figure A3-35: 2019 Winter Peak Post-Project - Contingency of 7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)

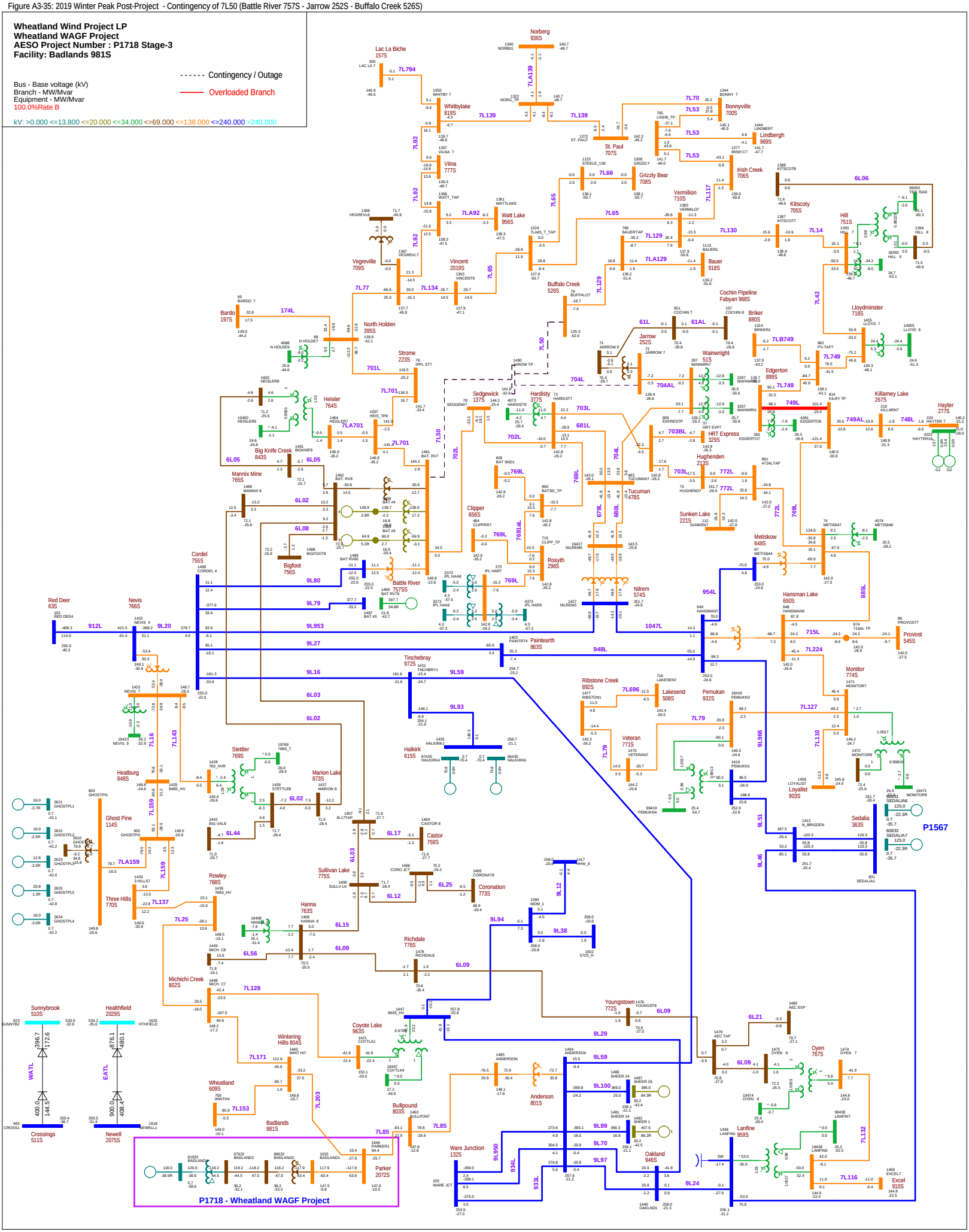


Figure A3-36: 2019 Winter Peak Post-Project - Contingency of 801S901T (Anderson 801S Transformer 901T)

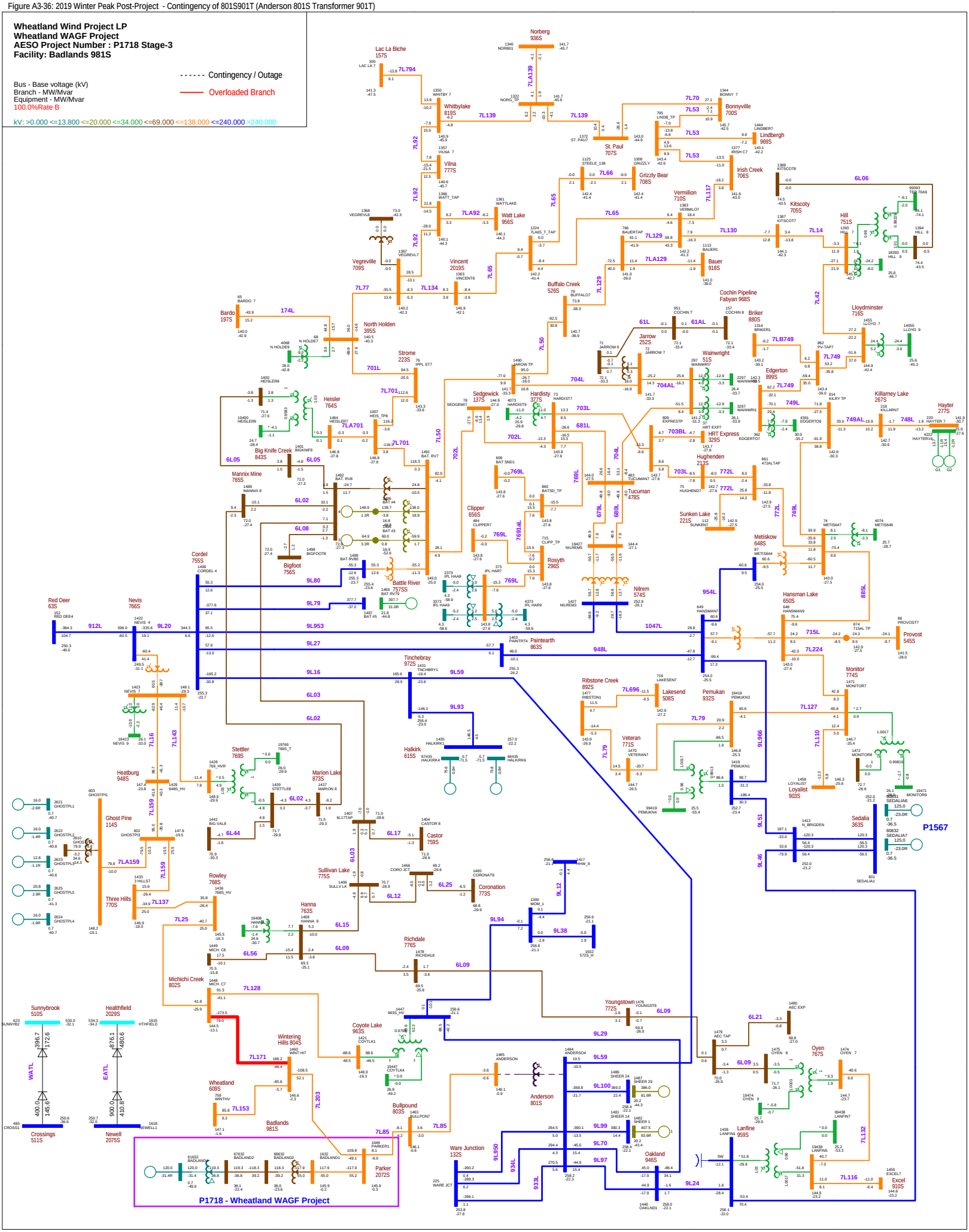


Figure A3-37: 2019 Winter Peak Post-Project - Contingency of EATL (Newell 2075S - Heathfield 2029S)

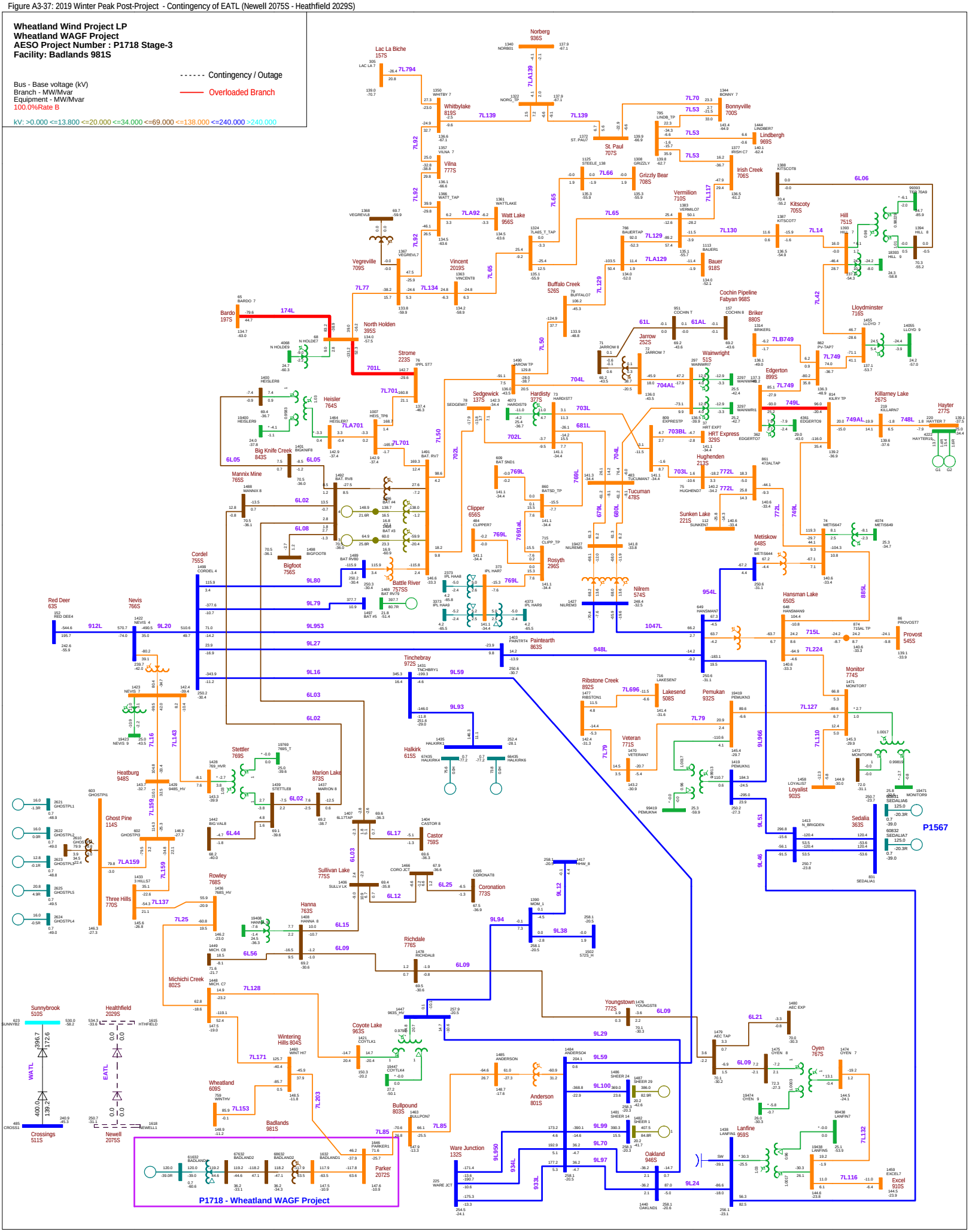


Figure A3-38: 2019 Winter Peak Post-Project - Contingency of 766S901T (Nevis 766S Transformer 901T)

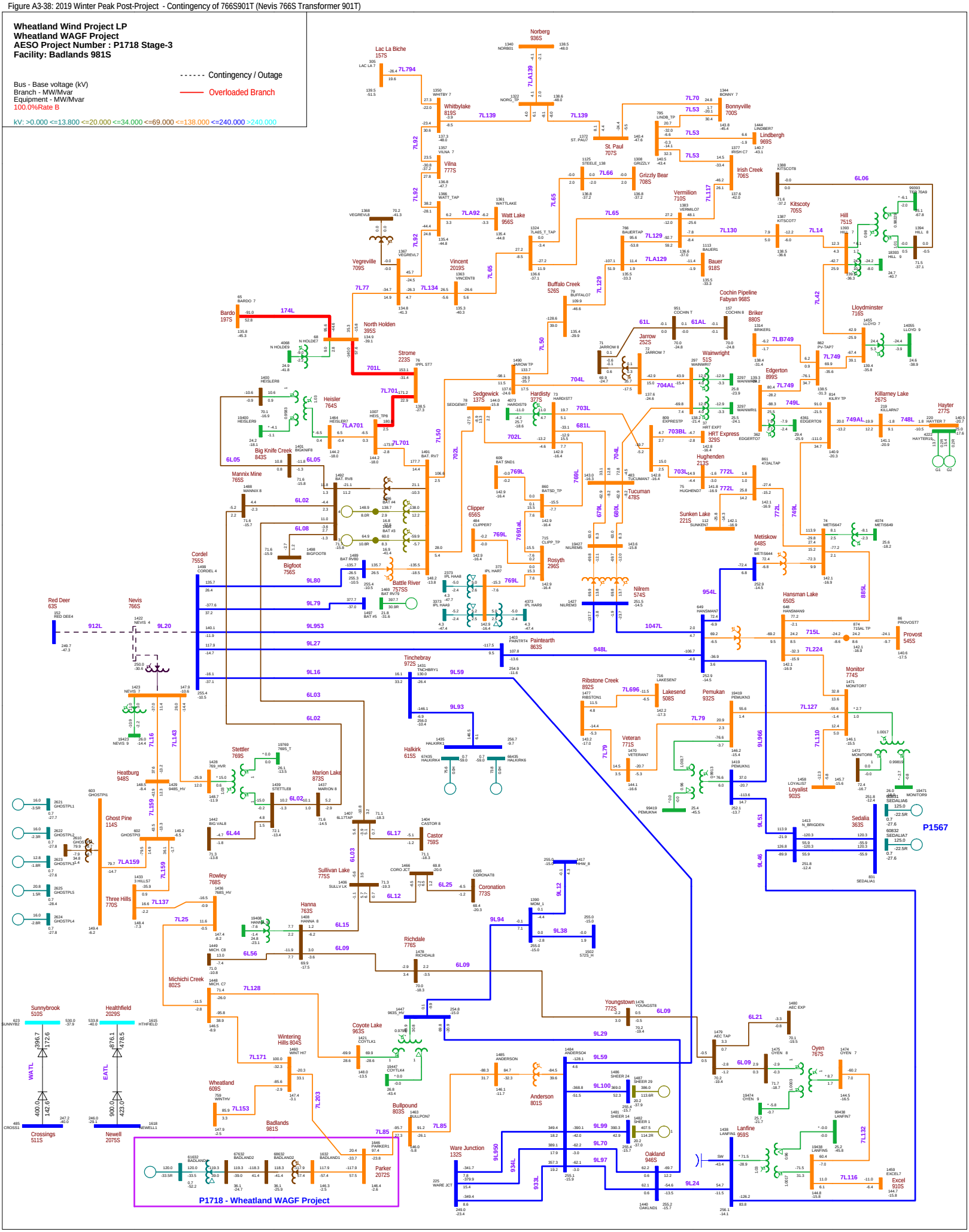


Figure A3-39: 2019 Winter Peak Post-Project - Contingency of 526ST1 OR 526ST2 (Buffalo Creek 526S Transformer T1 or T2)

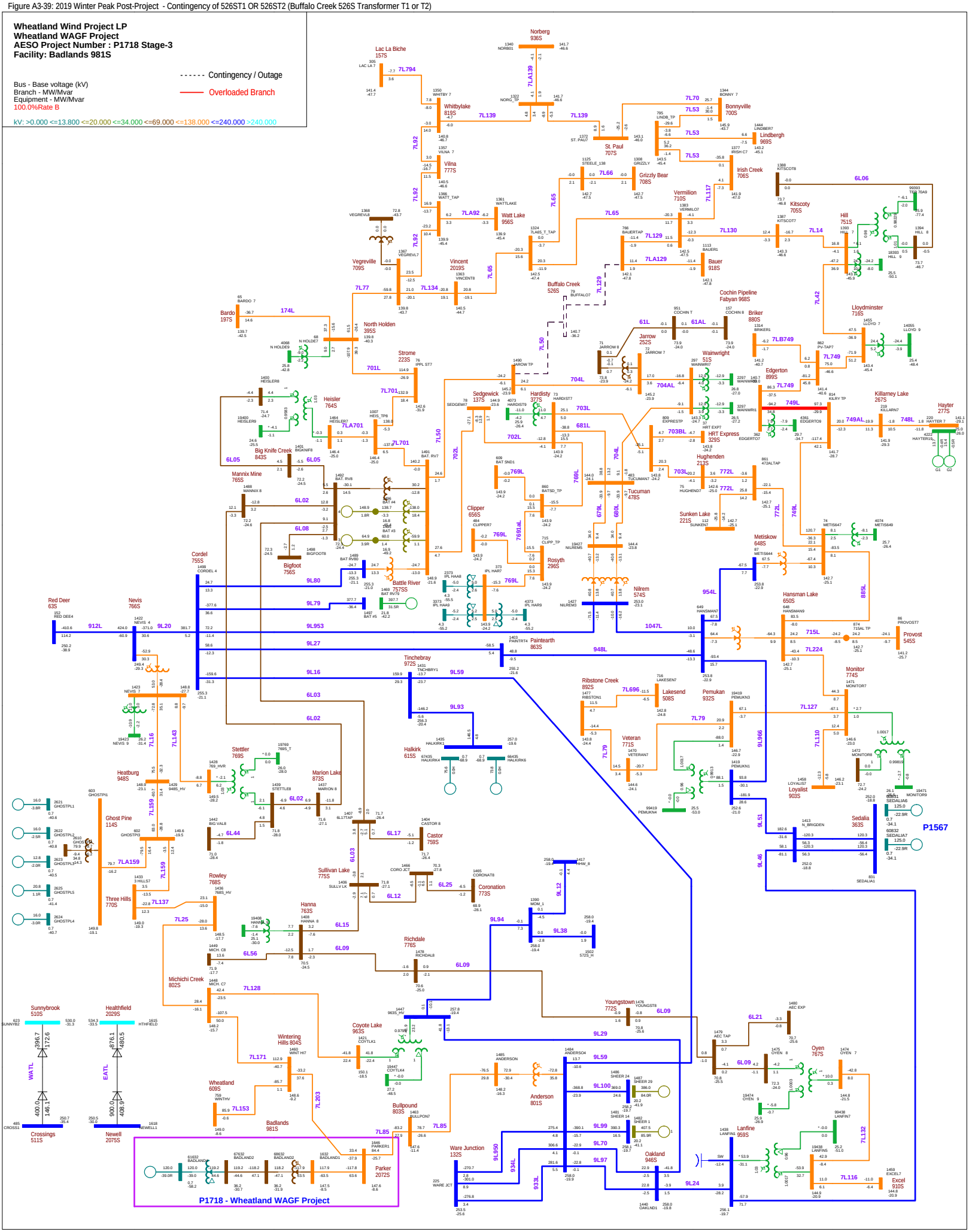


Figure A3-40: 2019 Winter Peak Post-Project - Contingency of 7L171 (Michichi Creek 802S - Wintering Hills 804S)

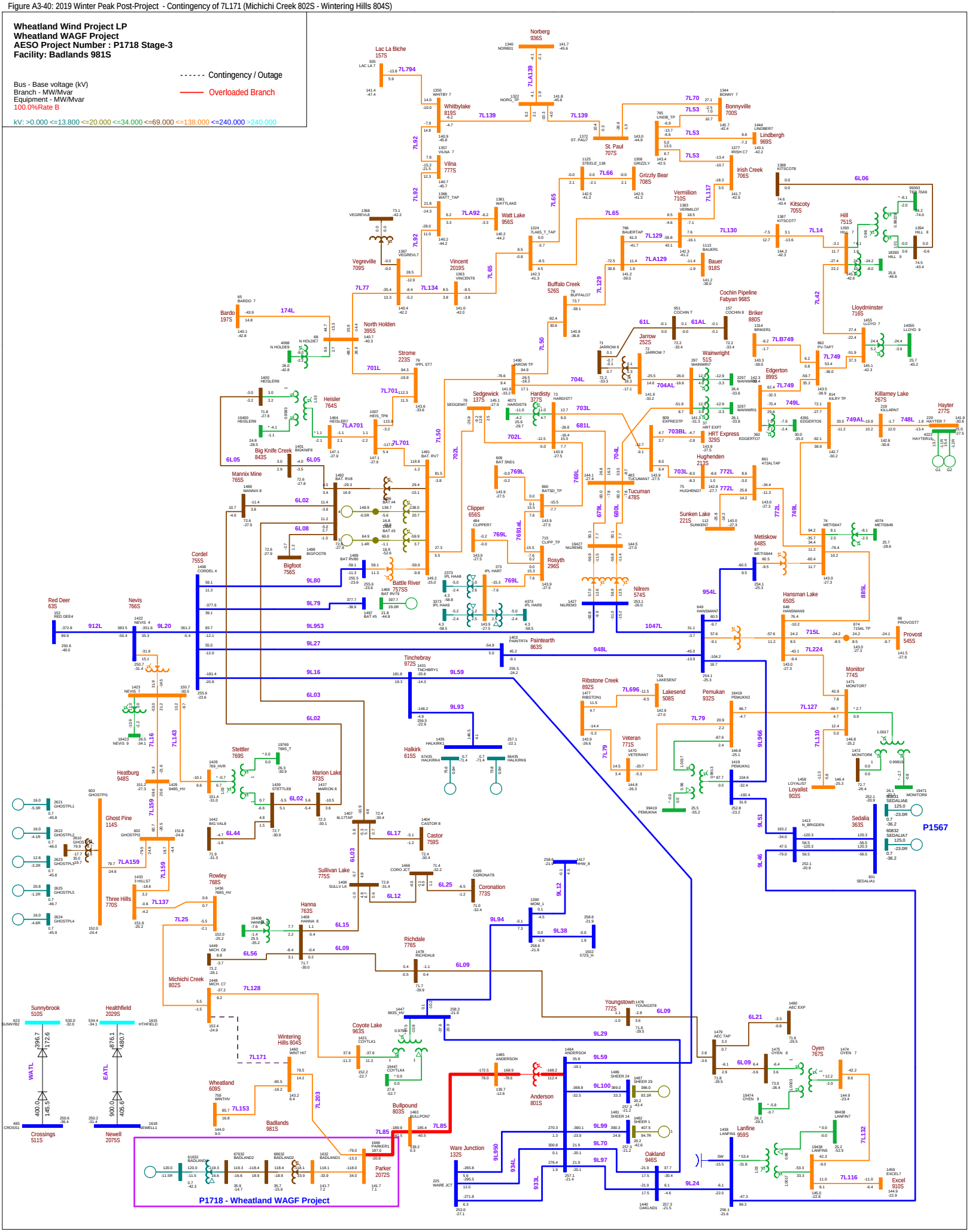


Figure A3-41: 2019 Summer Peak Post-Project PENV - N-0 (System Normal Condition)

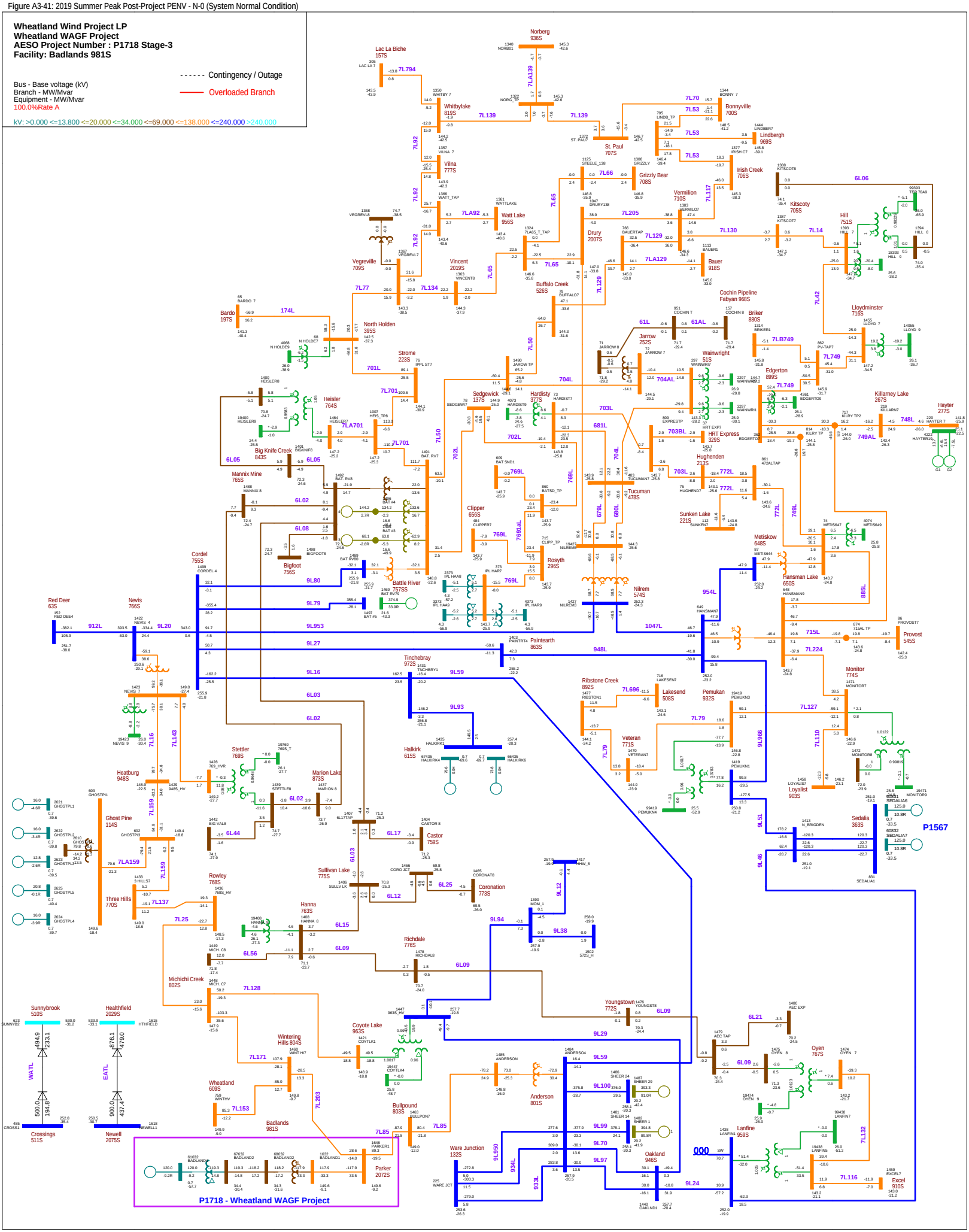


Figure A3-42: 2019 Summer Peak Post-Project PENV - Contingency of 114ST1 (Ghost Pine 114S Transformer T1)

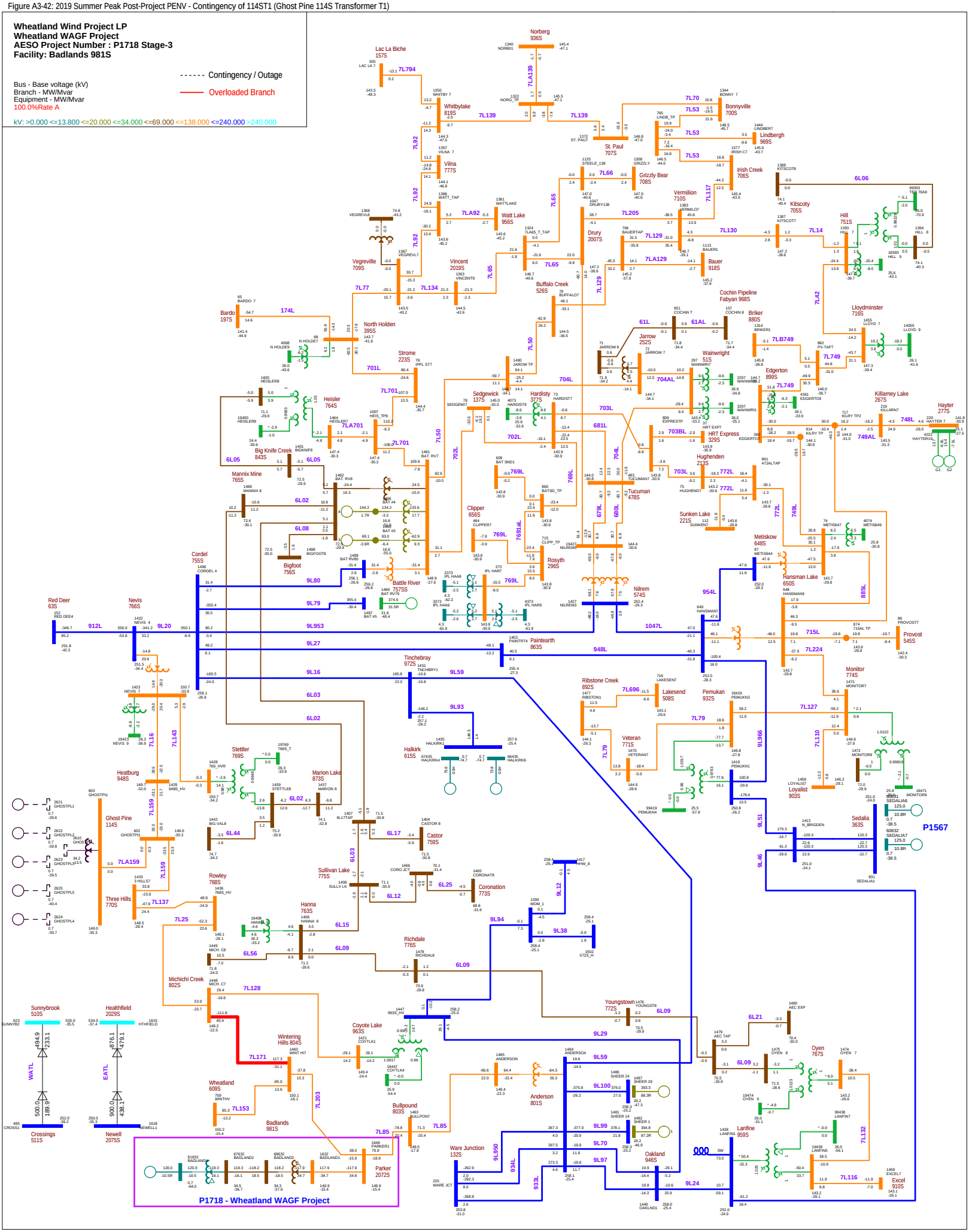


Figure A3-43: 2019 Summer Peak Post-Project PENV - Contingency of 7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)

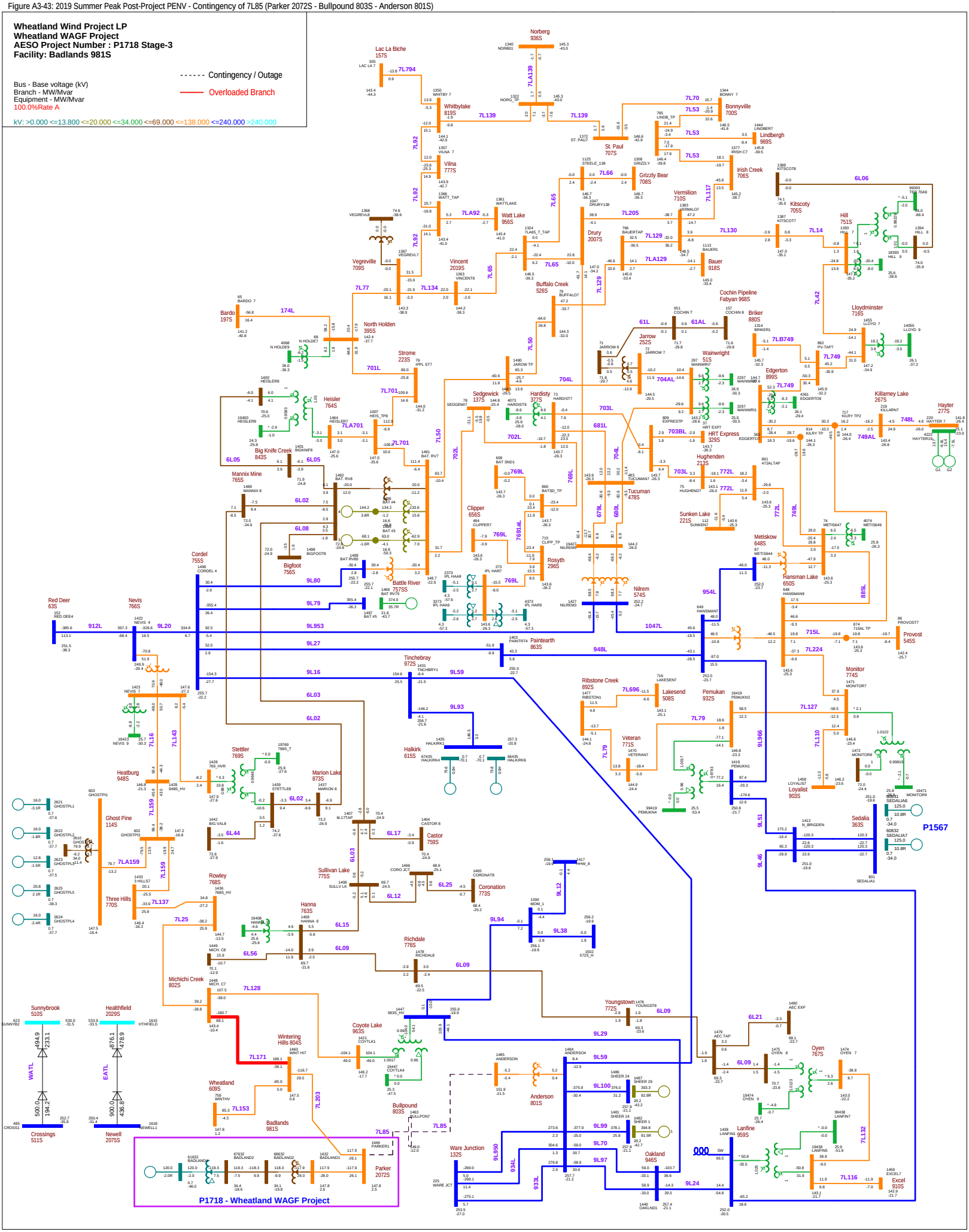


Figure A3-44: 2019 Summer Peak Post-Project PENV - Contingency of 766S901T (Nevis 766S Transformer 901T)

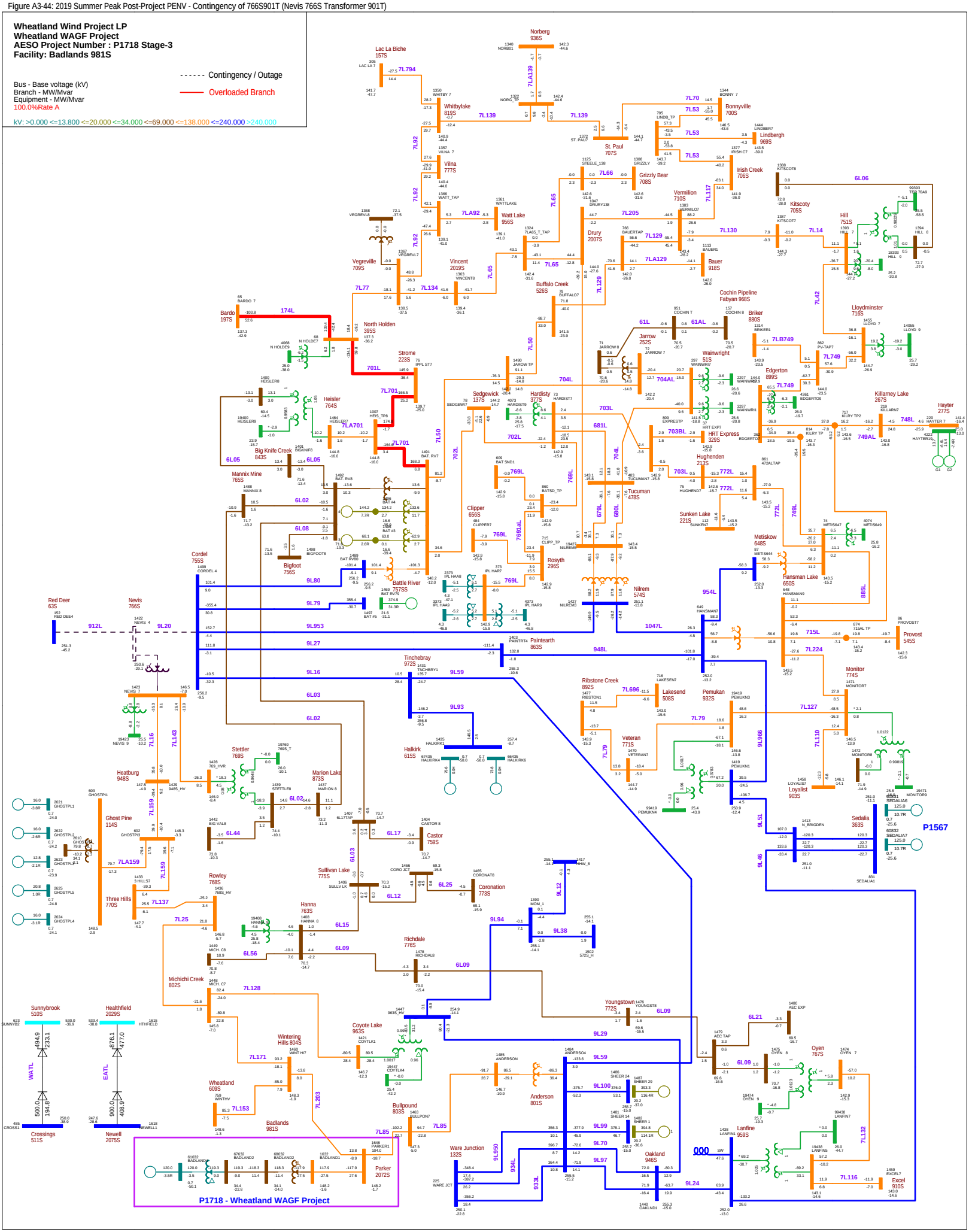


Figure A3-45: 2019 Summer Peak Post-Project PENV - Contingency of EATL (Newell 2075S - Heathfield 2029S)

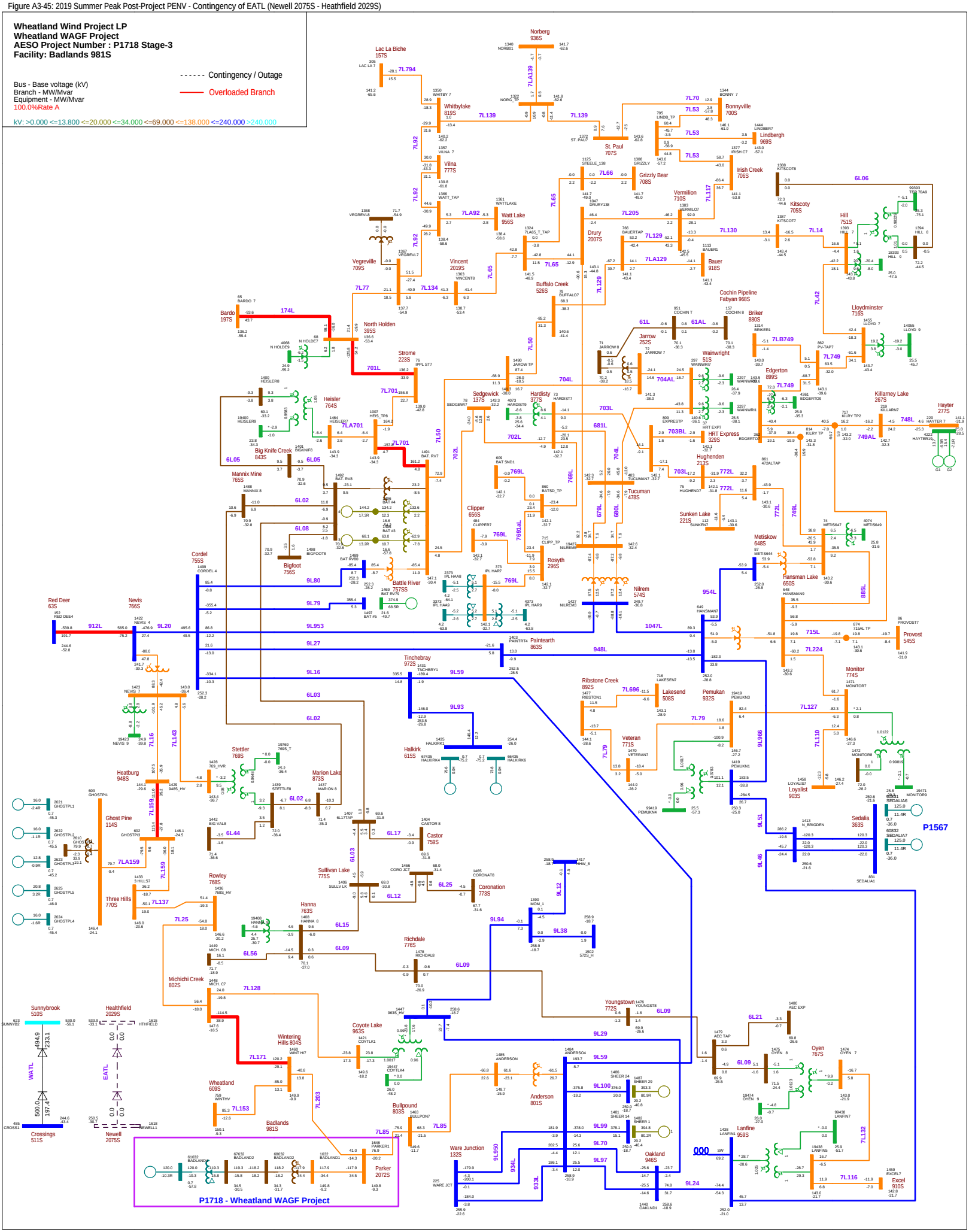


Figure A3-46: 2019 Summer Peak Post-Project PENV - Contingency of 7L171 (Michichi Creek 802S - Wintering Hills 804S)

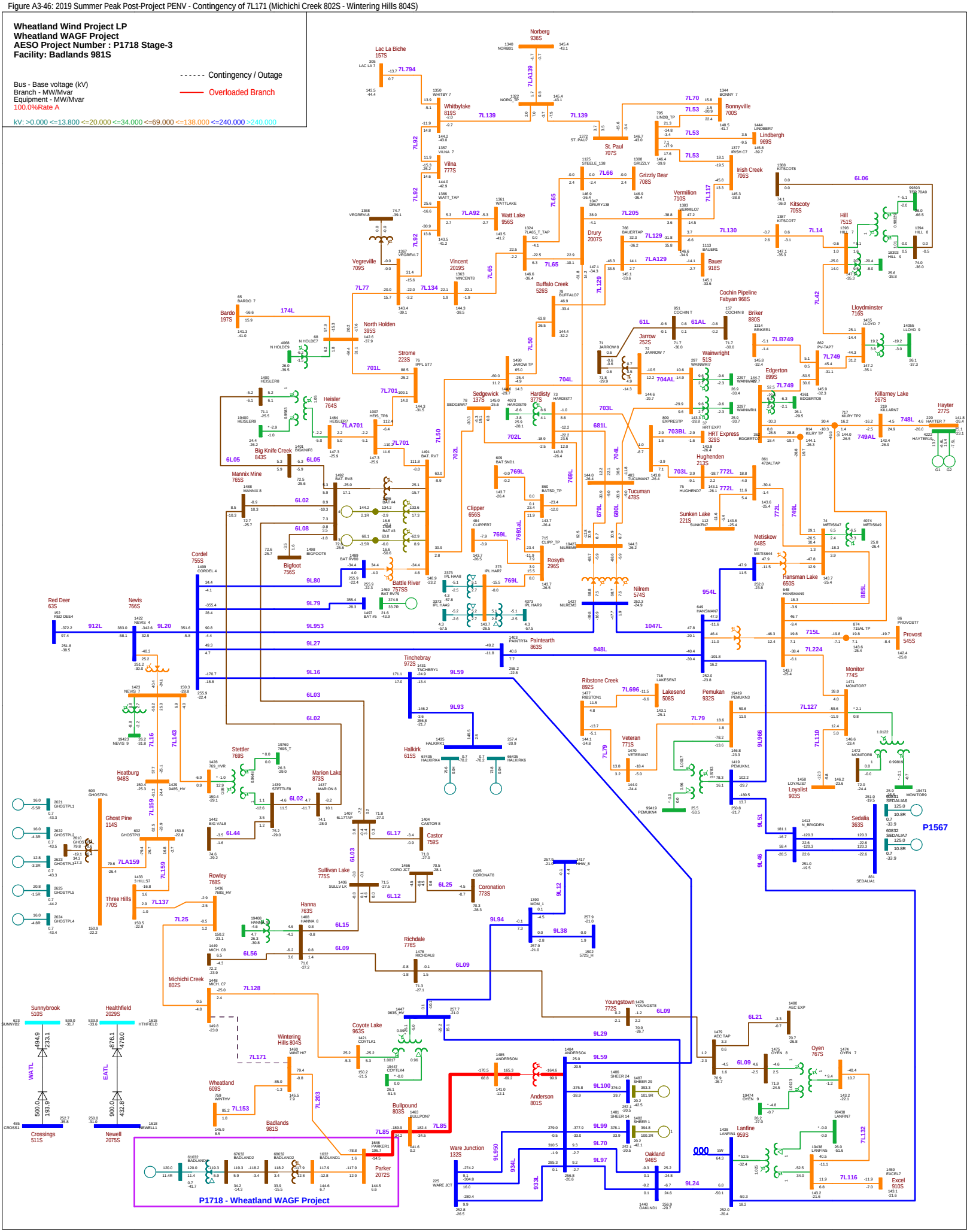


Figure A3-47: 2019 Summer Peak Post-Project PENV - Contingency of 801S901T (Anderson 801S Transformer 901T)

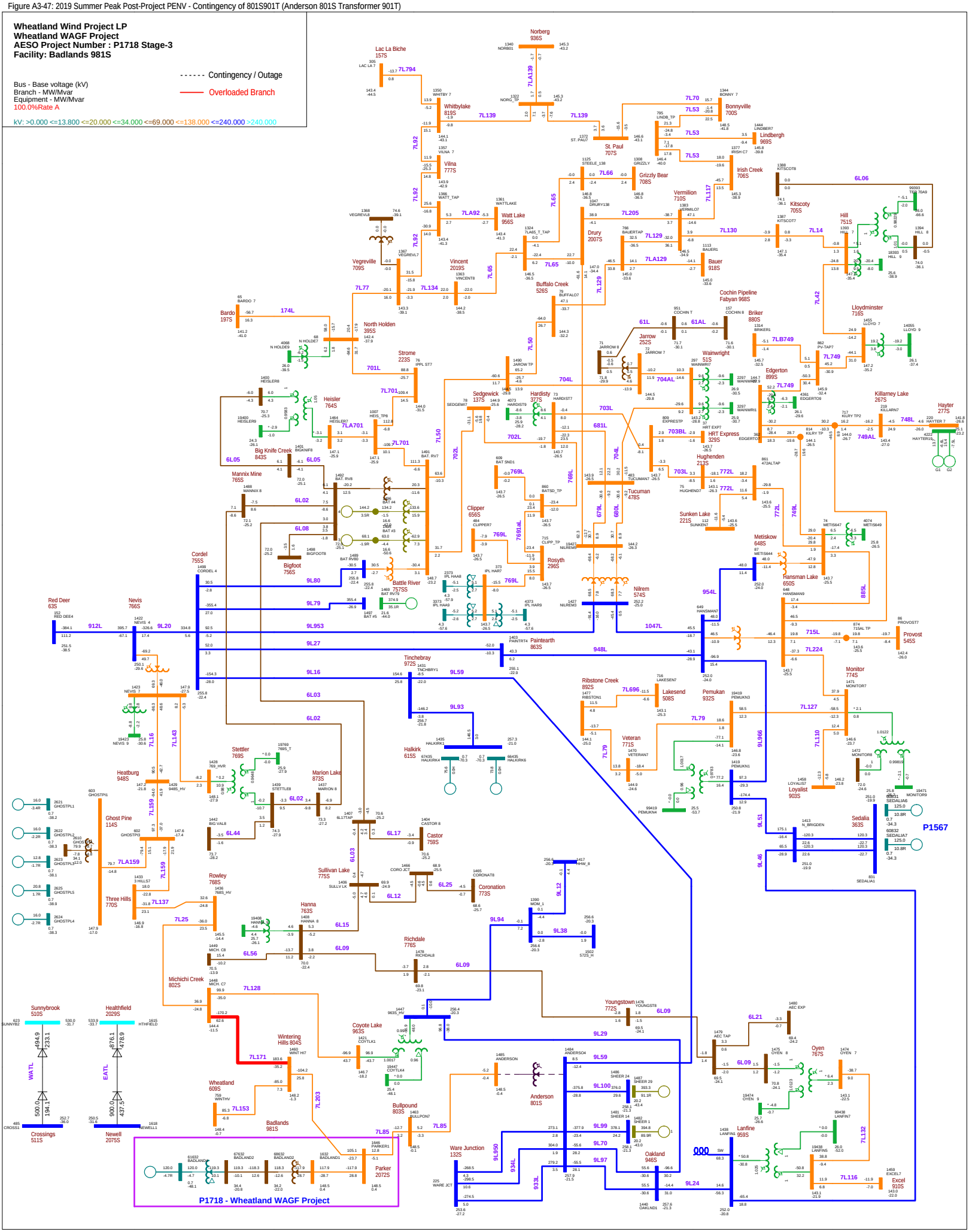


Figure A3-48: 2019 Summer Peak Post-Project PENV - Contingency of 9L20 (Nevis 766S - Cordel 755S)

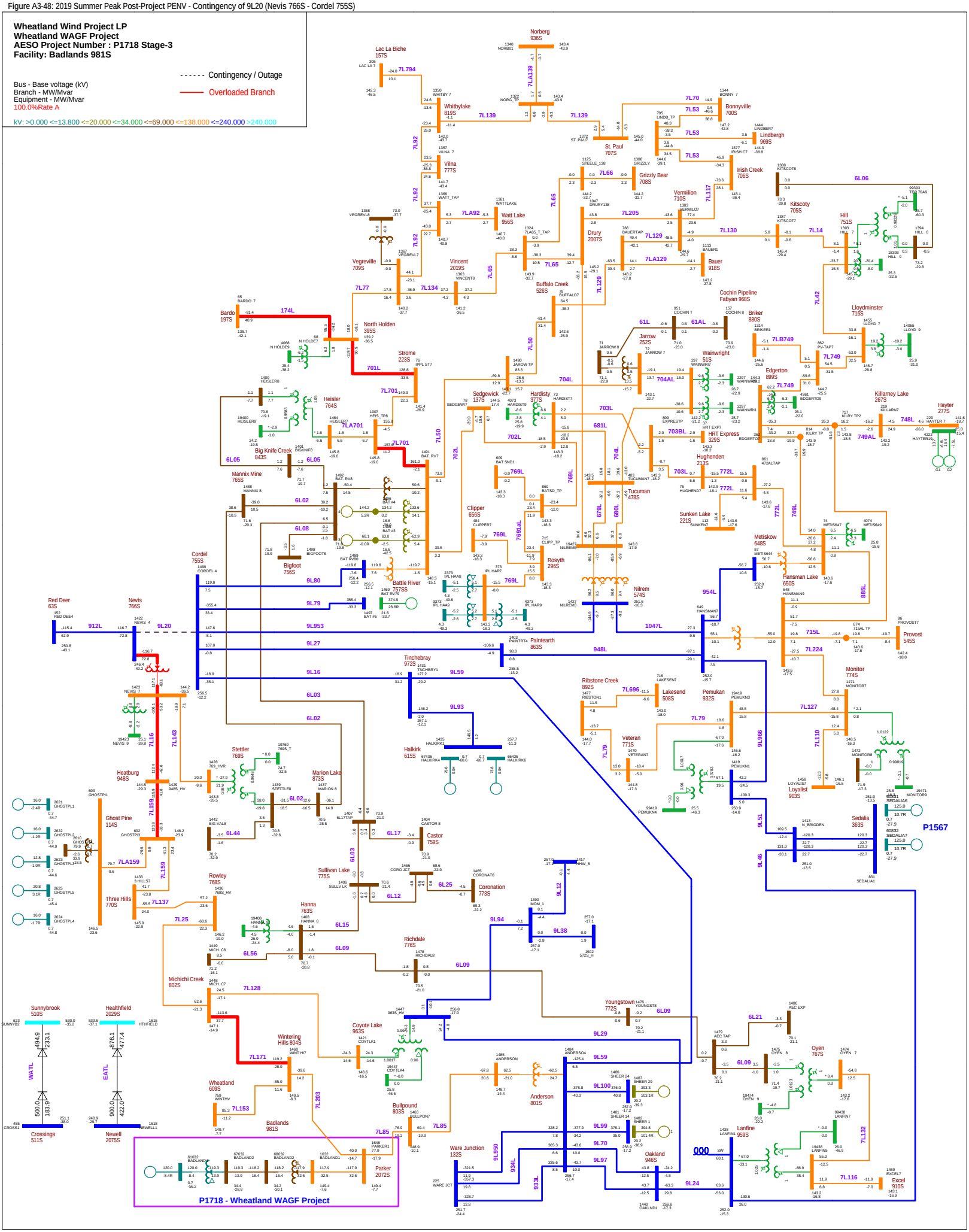
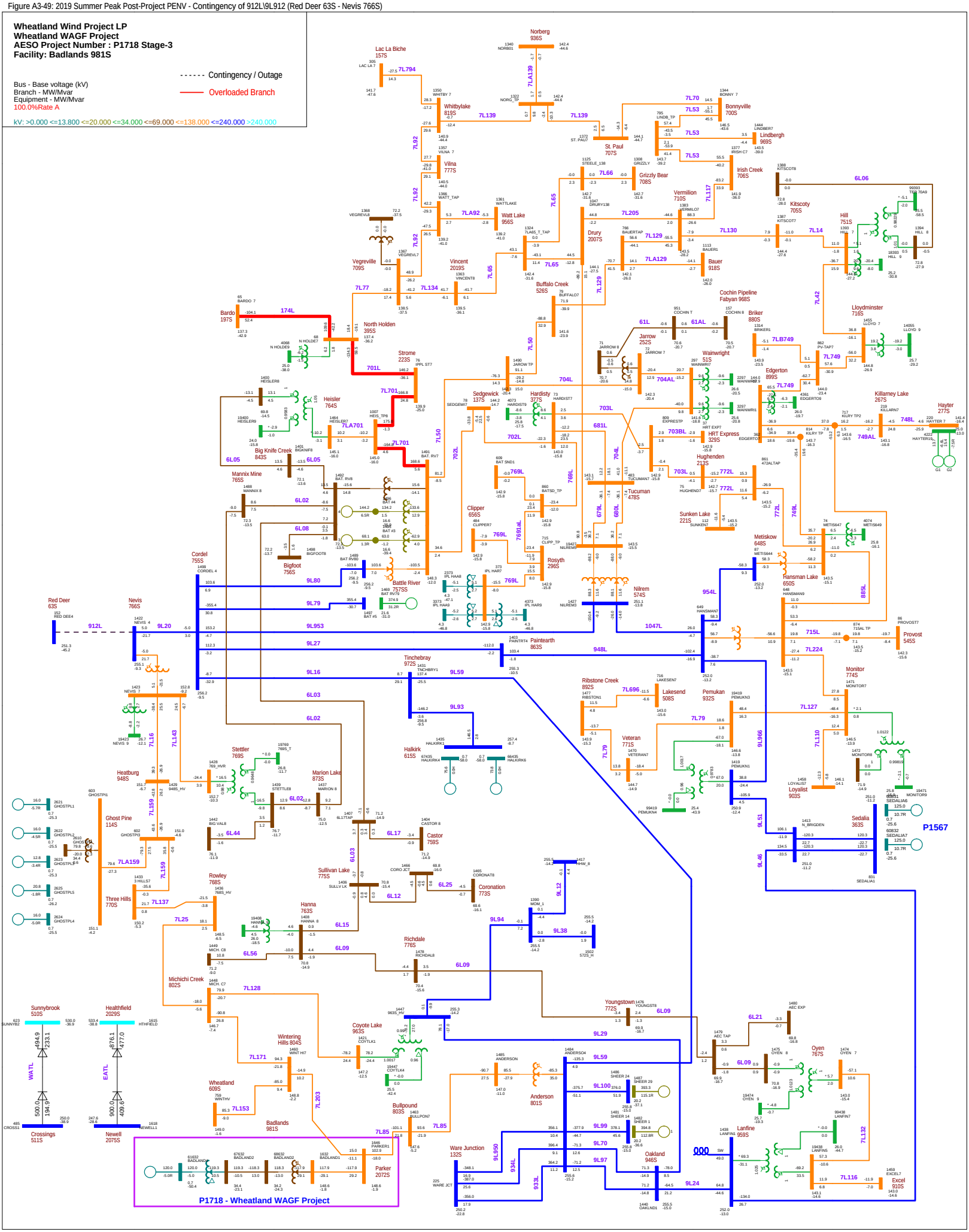


Figure A3-49: 2019 Summer Peak Post-Project PENV - Contingency of 912L\9L912 (Red Deer 63S - Nevis 766S)



Attachment A4

Post-Project Transient Stability Diagrams

Table A4-1: Transient Stability Figures for Contingencies

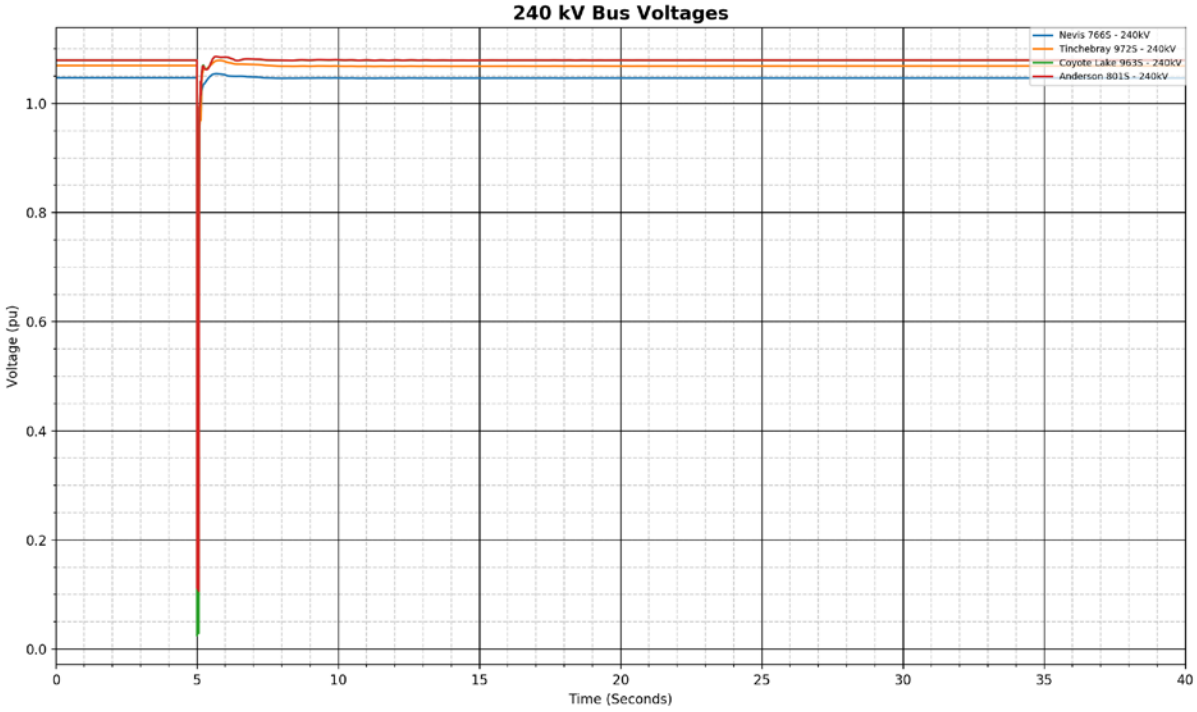
Category	Contingency	Fault Location	Fault Clearing Time		2019 SL	2019 SP	2019 WP
			Near End Cycle	Far End Cycle			
Category B	9L24 (Oakland 946S - Lanfine 959S)	Oakland 946S	5	6	A4-1	A4-28	A4-55
Category B	9L24 (Oakland 946S - Lanfine 959S)	Lanfine 959S	5	6	A4-2	A4-29	A4-56
Category B	9L29 (Oakland 946S - Coyote Lake 963S)	Oakland 946S	5	6	A4-3	A4-30	A4-57
Category B	9L29 (Oakland 946S - Coyote Lake 963S)	Coyote Lake 963S	5	6	A4-4	A4-31	A4-58
Category B	9L20 (Cordel 755S - Nevis 766S)	Cordel 755S	5	6	A4-5	A4-32	A4-59
Category B	9L20 (Cordel 755S - Nevis 766S)	Nevis 766S	5	6	A4-6	A4-33	A4-60
Category B	9L59 (Anderson 801S - Tinchebray 972S)	Anderson 801S	5	6	A4-7	A4-34	A4-61
Category B	9L59 (Anderson 801S - Tinchebray 972S)	Tinchebray 972S	5	6	A4-8	A4-35	A4-62
Category B	912L/9L912 (Nevis 766S - Red Deer 63S)	Nevis 766S	5.5	6.5	A4-9	A4-36	A4-63
Category B	912L/9L912 (Nevis 766S - Red Deer 63S)	Red Deer 63S	5	6	A4-10	A4-37	A4-64
Category B	7L203 (Wintering Hills 804S - Parker 2072S)	Wintering Hills 804S	6	24	A4-11	A4-38	A4-65
Category B	7L203 (Wintering Hills 804S - Parker 2072S)	Parker 2072S	6	24	A4-12	A4-39	A4-66
Category B	7L85 (Parker 2072S - Anderson 801S)	Parker 2072S	6	24	A4-13	A4-40	A4-67
Category B	7L85 (Parker 2072S - Anderson 801S)	Anderson 801S	6	24	A4-14	A4-41	A4-68
Category B	7L171 (Wintering Hills 804S - Michichi Creek 802S)	Wintering Hills 804S	6	24	A4-15	A4-42	A4-69
Category B	7L171 (Wintering Hills 804S - Michichi Creek 802S)	Michichi Creek 802S	6	24	A4-16	A4-43	A4-70
Category B	7L25 Rowley 768S to Michichi Creek 802S	Rowley 768S	6	24	A4-17	A4-44	A4-71
Category B	7L25 (Rowley 768S - Michichi Creek 802S)	Michichi Creek 802S	6	24	A4-18	A4-45	A4-72
Category B	7L137 (Rowley 768S - Three Hills 770S)	Rowley 768S	6	24	A4-19	A4-46	A4-73
Category B	7L137 (Rowley 768S - Three Hills 770S)	Three Hills	6	24	A4-20	A4-47	A4-74
Category B	7L159 (Three Hills 770S - Heatburg 948S with T-Tap to Ghost Pine 114S)	Three Hills 770S	6	8	A4-21	A4-48	A4-75

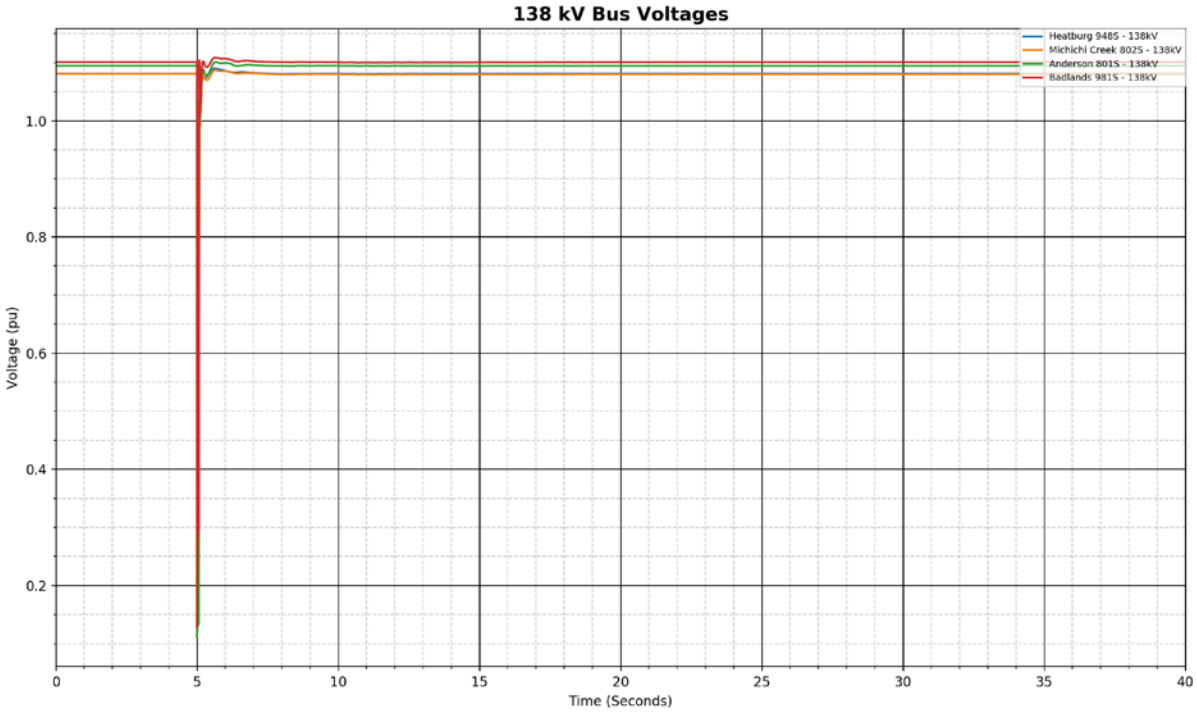
Category	Contingency	Fault Location	Fault Clearing Time		2019 SL	2019 SP	2019 WP
			Near End Cycle	Far End Cycle			
Category B	7L159 (Three Hills 770S - Heatburg 948S with T-Tap to Ghost Pine 114S)	Ghost Pine 114S	6	8	A4-22	A4-49	A4-76
Category B	7L159 (Three Hills 770S - Heatburg 948S with T-Tap to Ghost Pine 114S)	Heatburg 948S	6	8	A4-23	A4-50	A4-77
Category B	7L16 (Heatburg - Nevis 766S)	Heatburg 948S	6	24	A4-24	A4-51	A4-78
Category B	7L16 (Heatburg - Nevis 766S)	Nevis 766S	6	24	A4-25	A4-52	A4-79
Category B	7L128 (Michichi Creek 802S - Coyote Lake 963S)	Michichi Creek 802S	6	8	A4-26	A4-53	A4-80
Category B	7L128 (Michichi Creek 802S - Coyote Lake 963S)	Coyote Lake 963S	6	8	A4-27	A4-54	A4-81

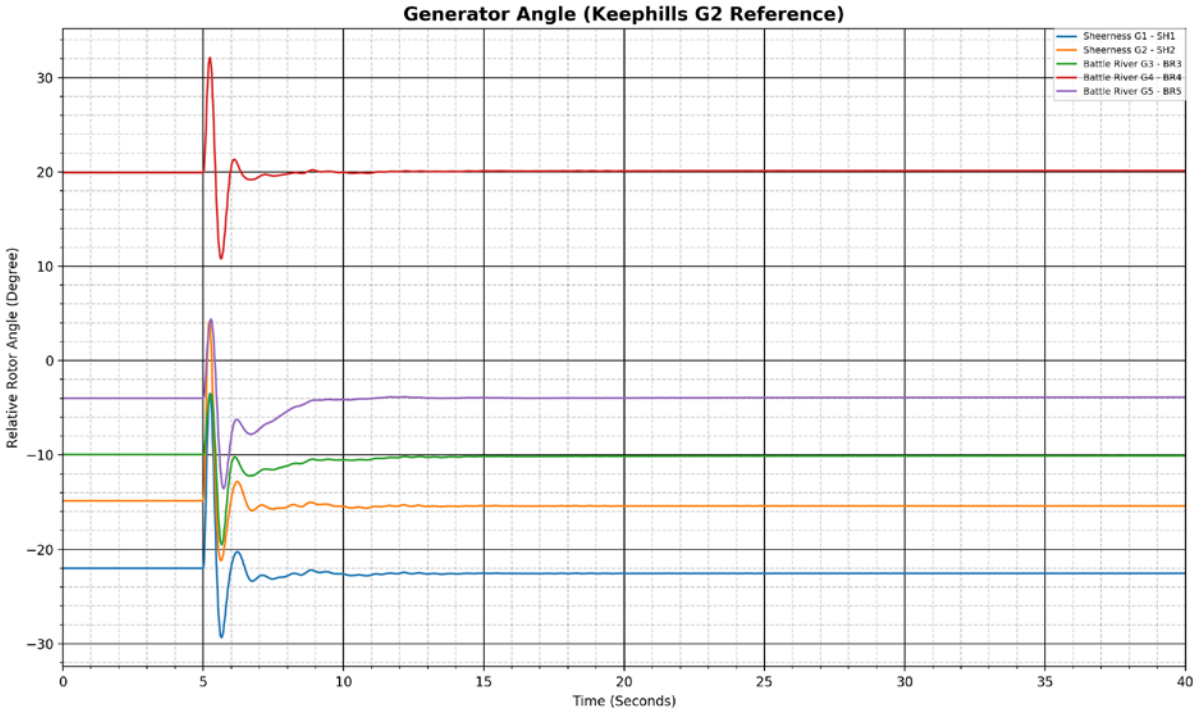
Transient Stability Results

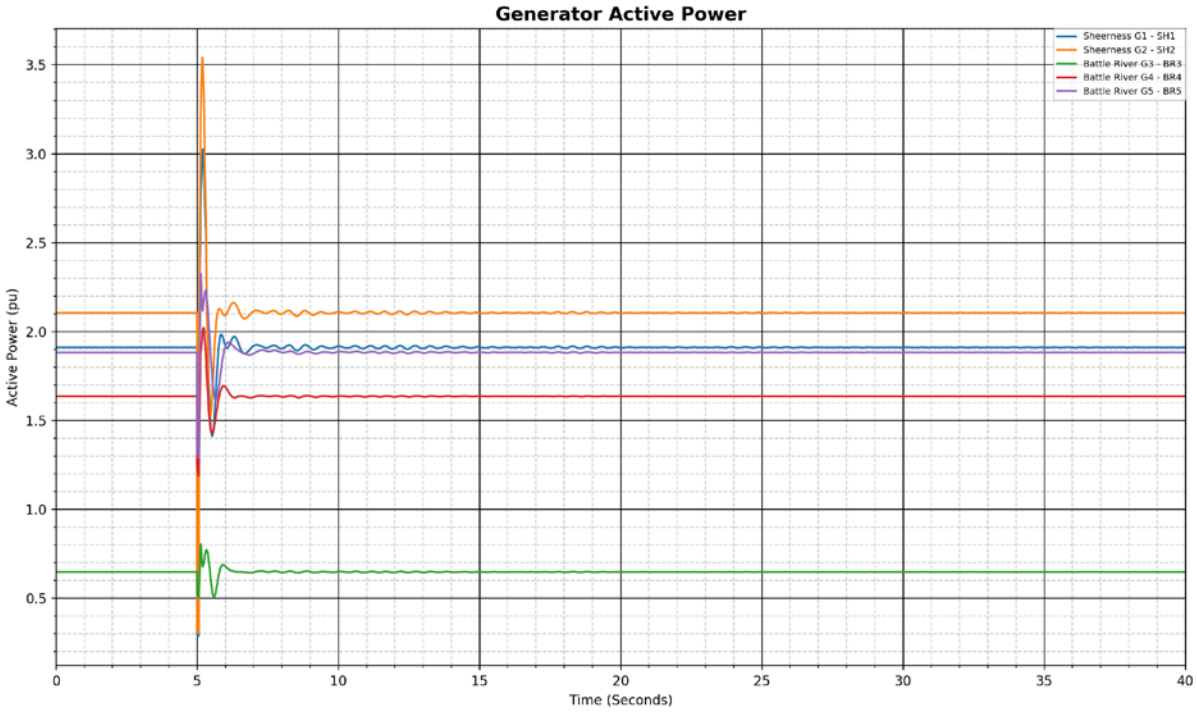
1. Stability Results 2019 Summer Light

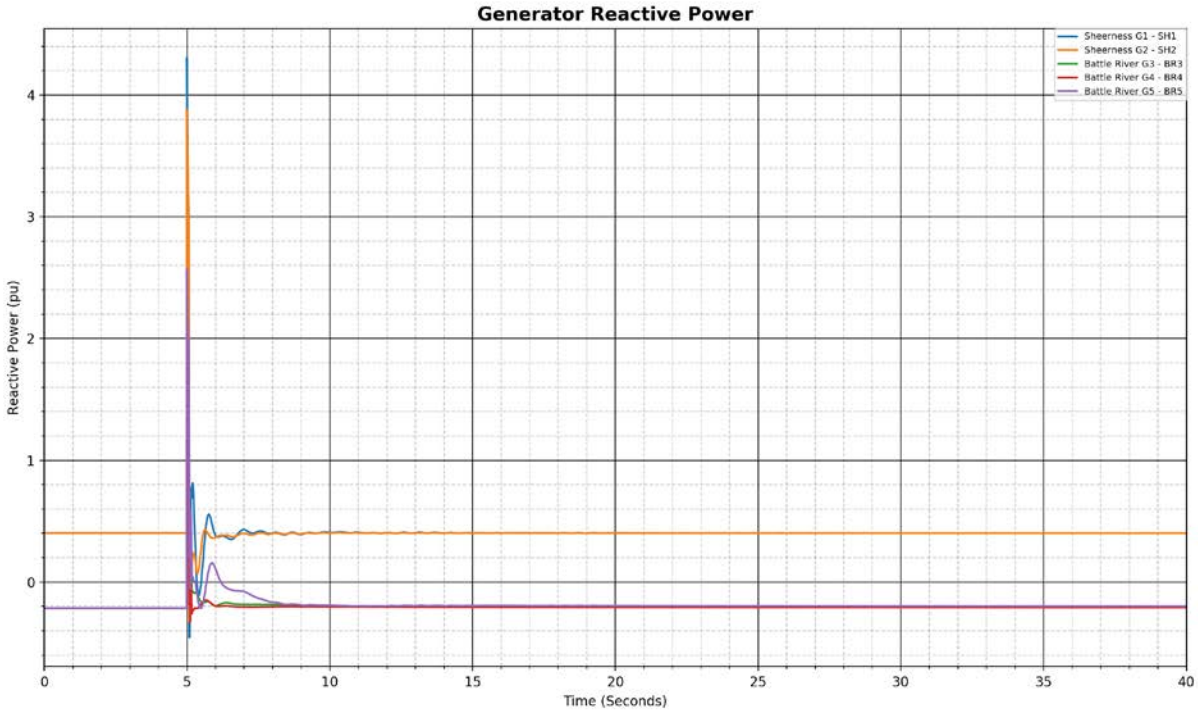
Figure A4-1: 9L24 (Oakland 946S - Lanfine 959S): 3-phase fault at Oakland 946S

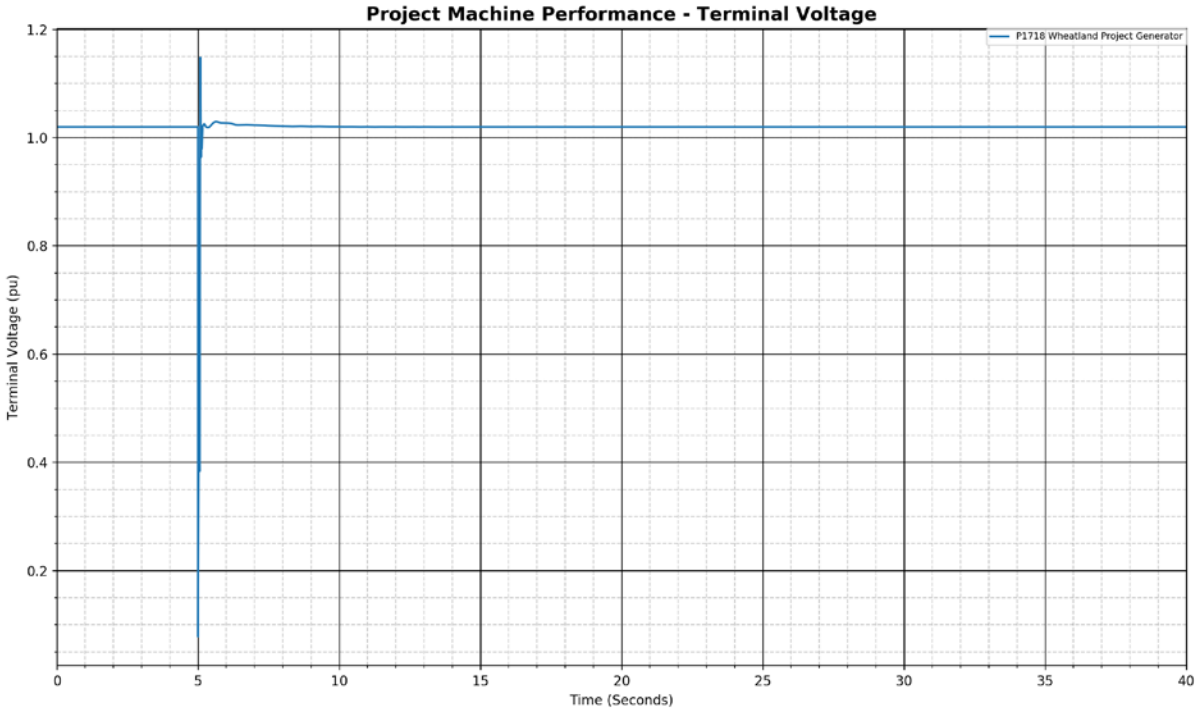


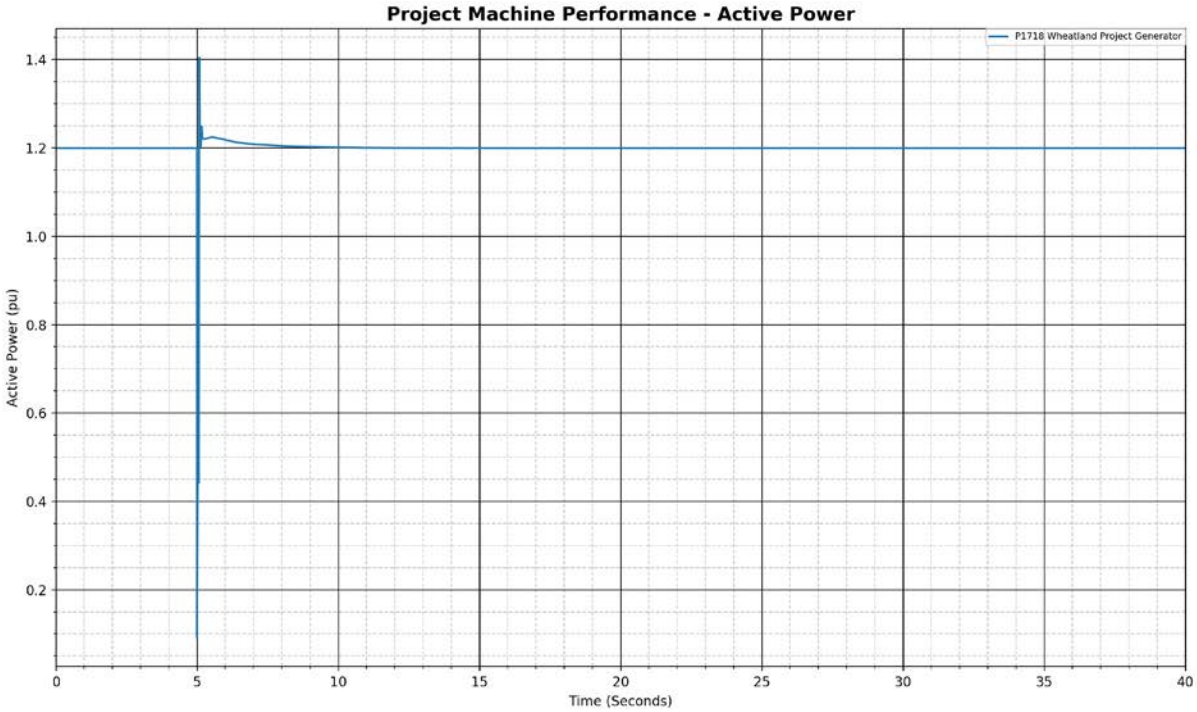


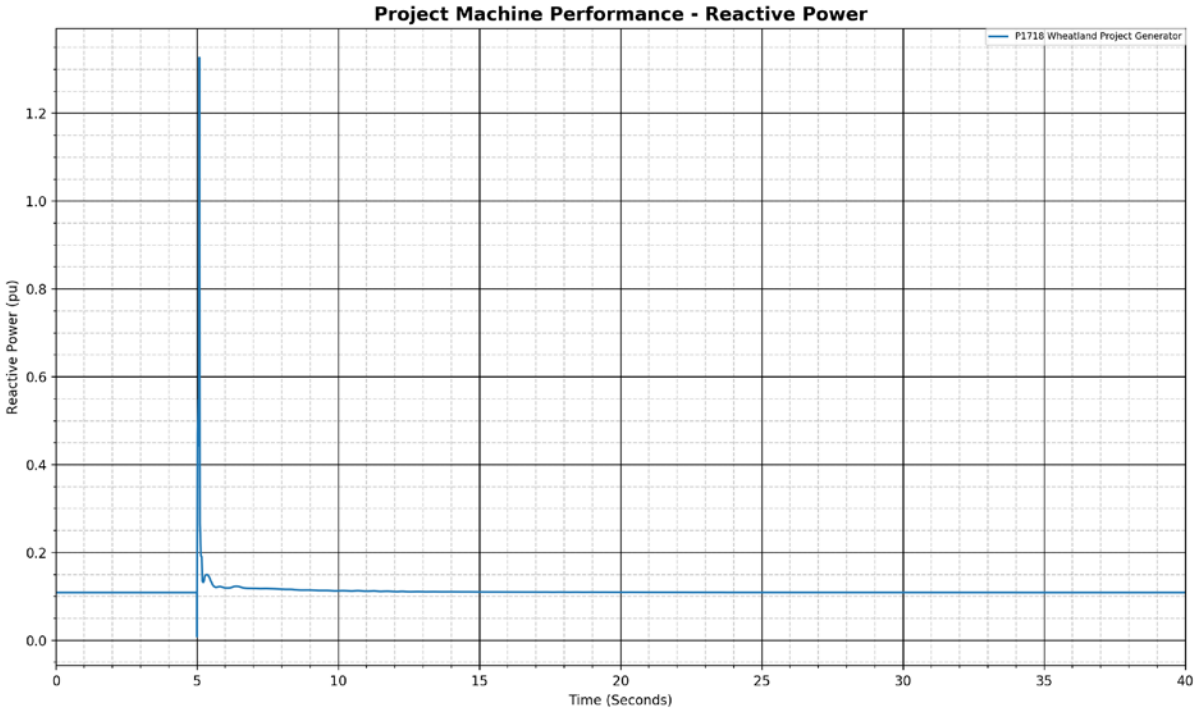

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
30
20
10
0
−10
−20
−30
0
5
10
15
20
25
30
35
40
Time (Seconds)

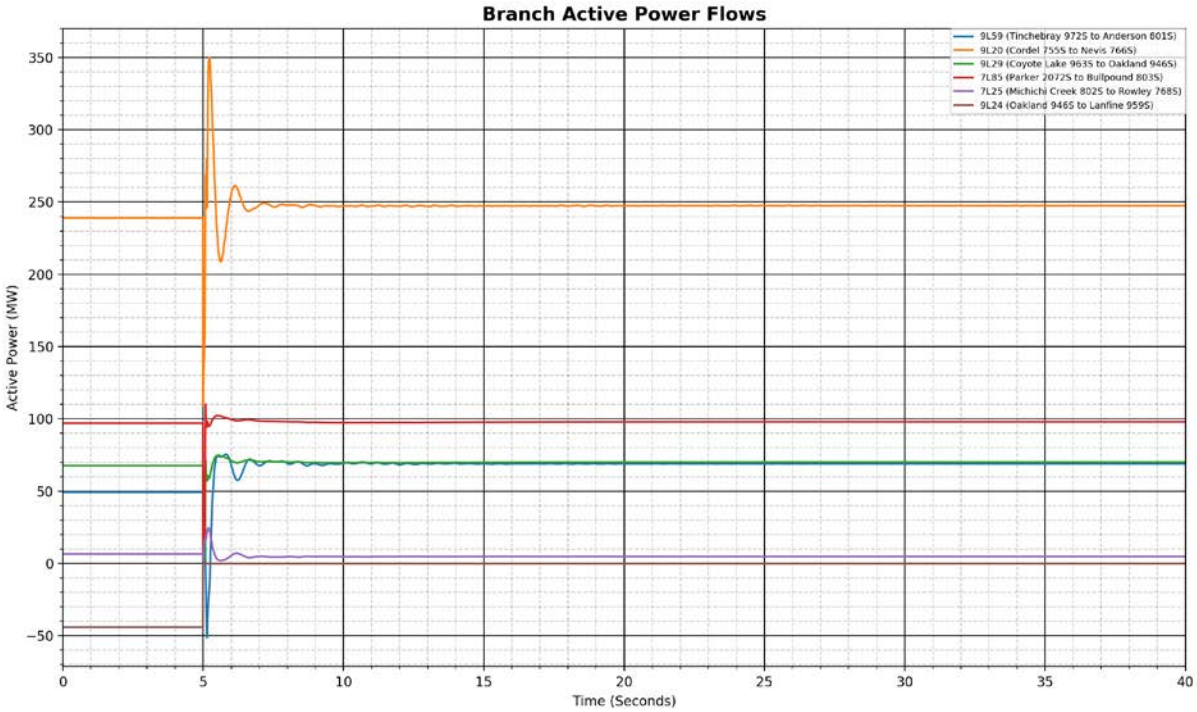

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Active Power (MW)
Time (Seconds)

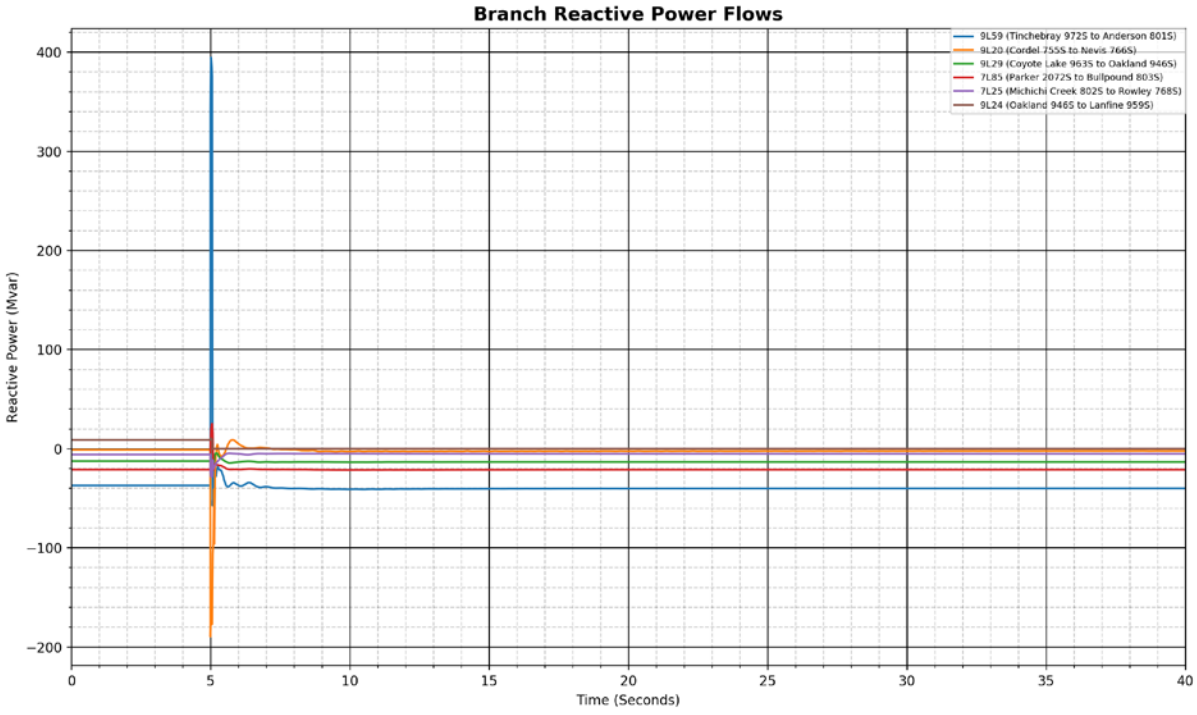
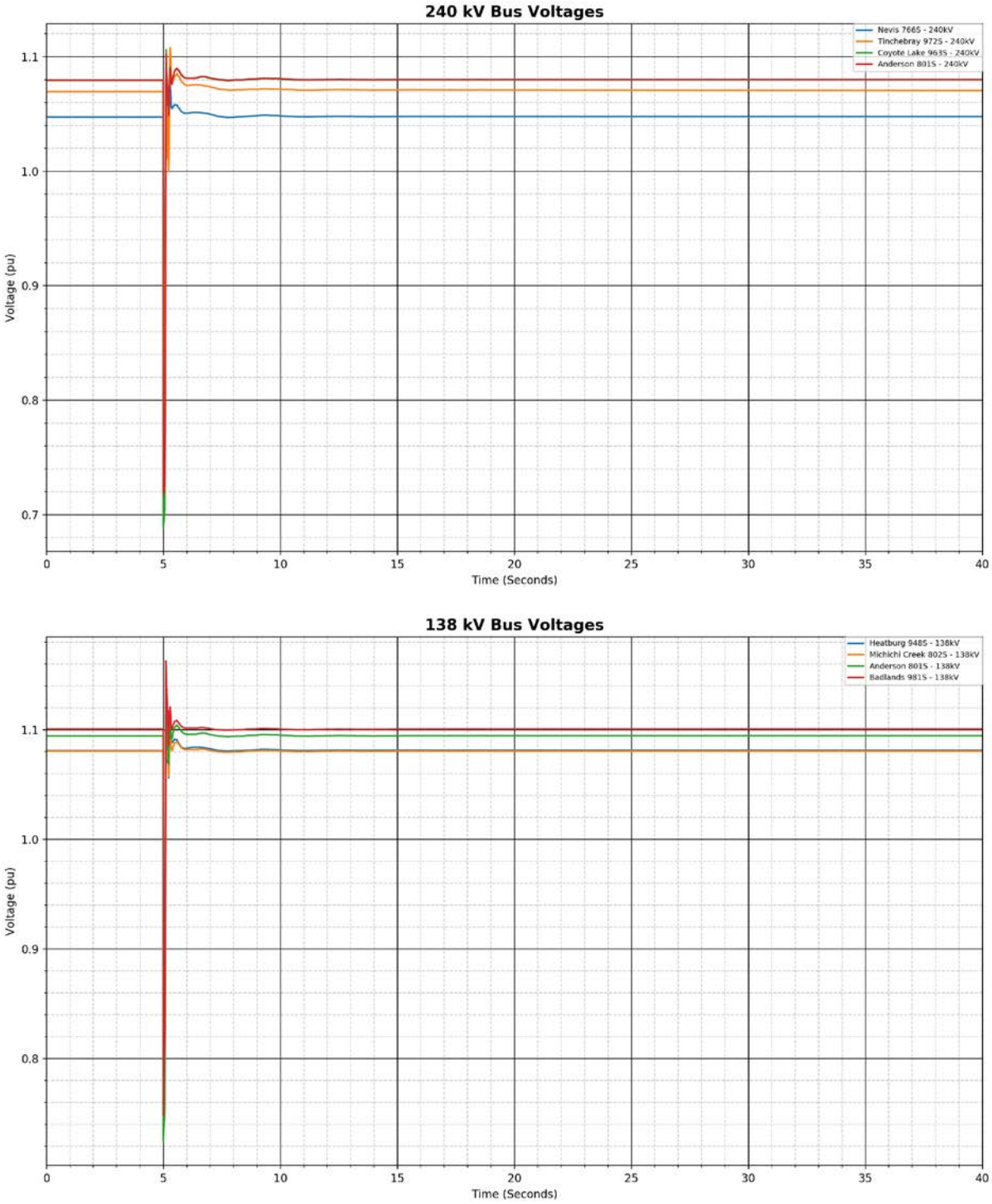
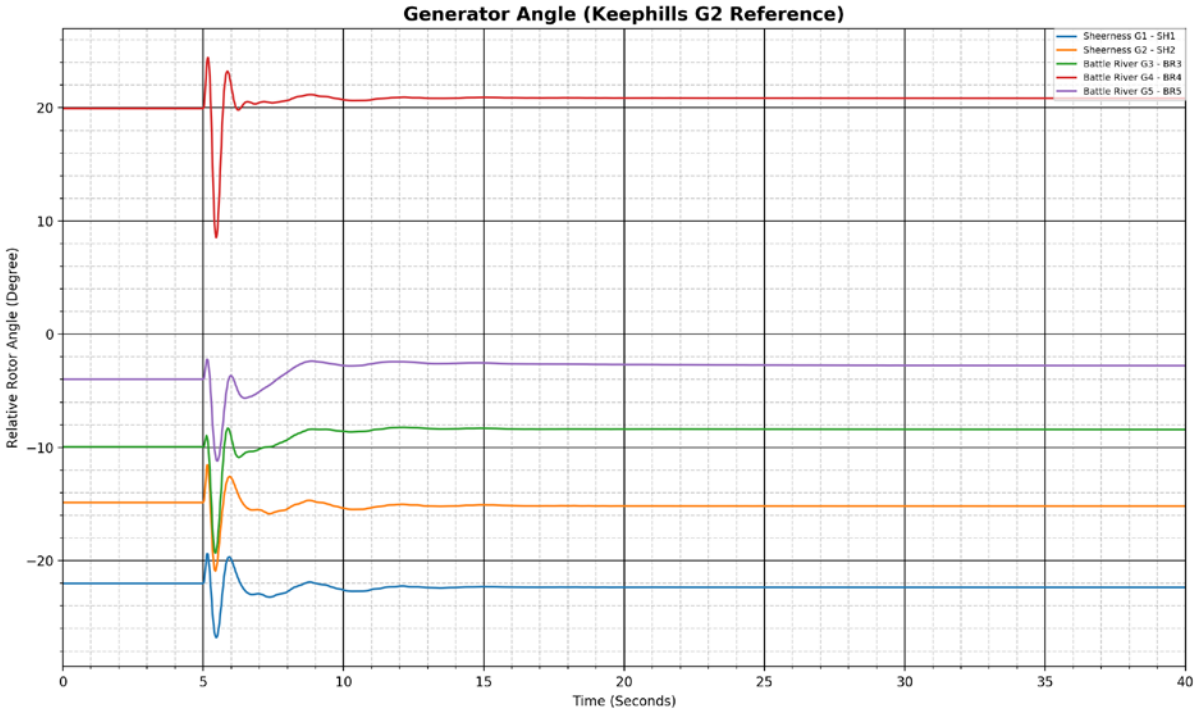
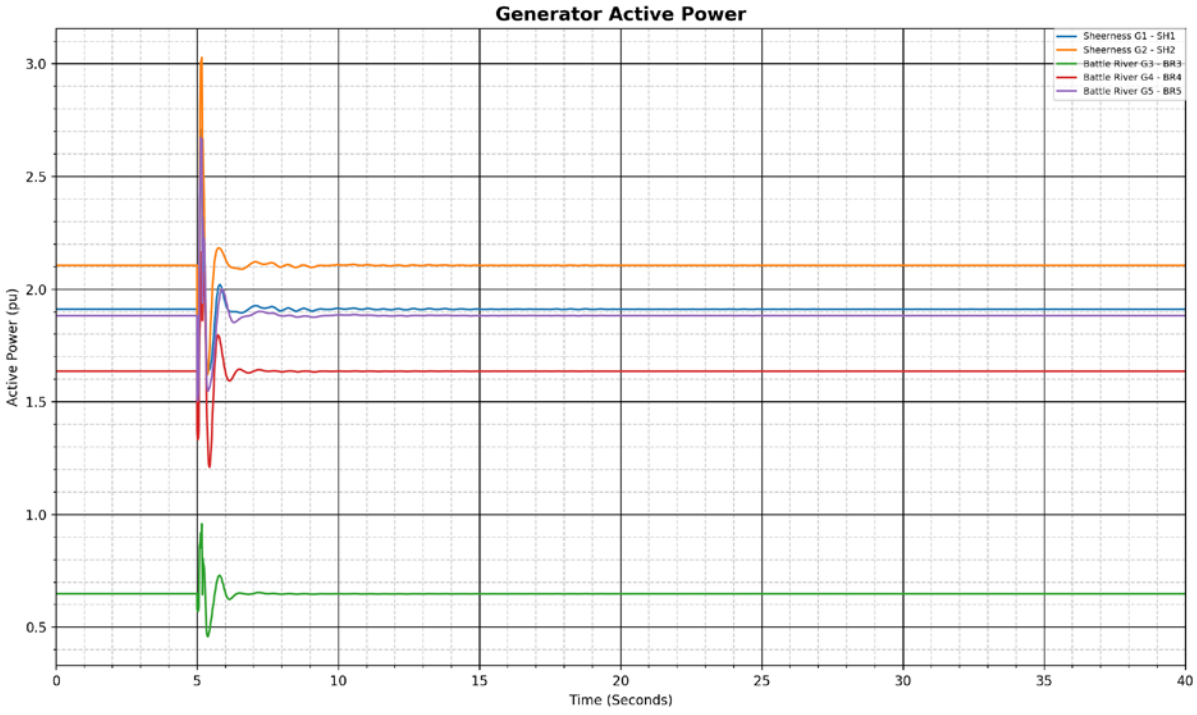
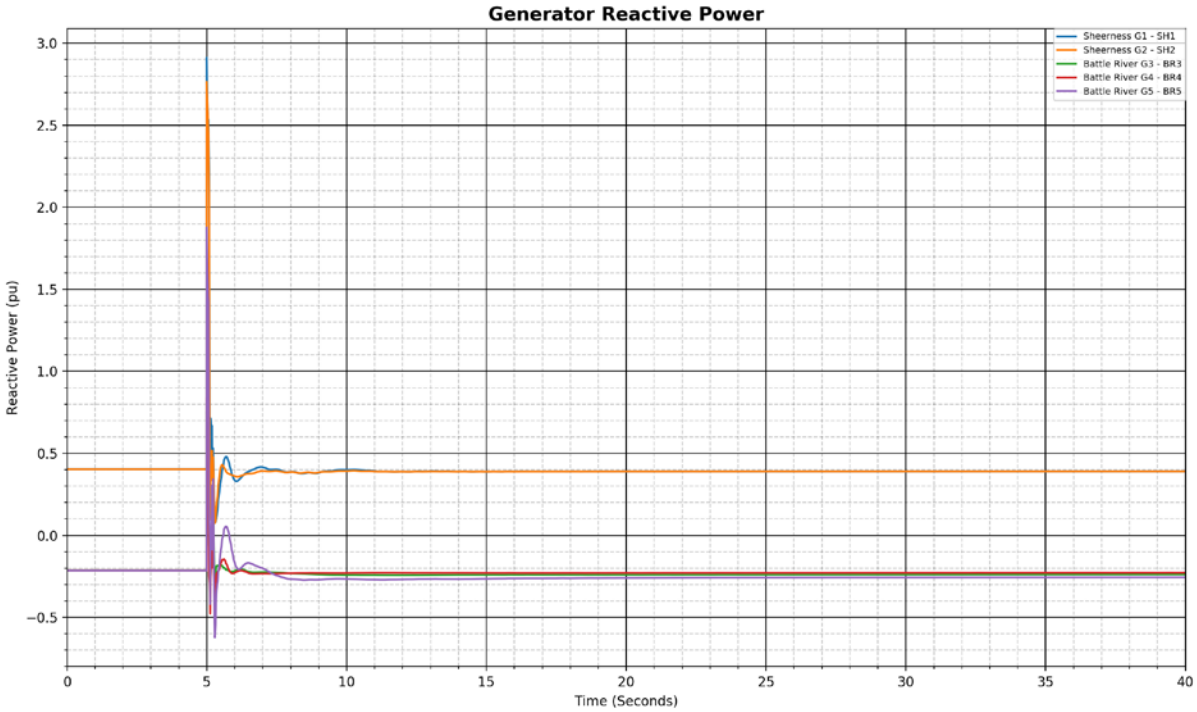

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Reactive Power (Mvar)
Time (Seconds)

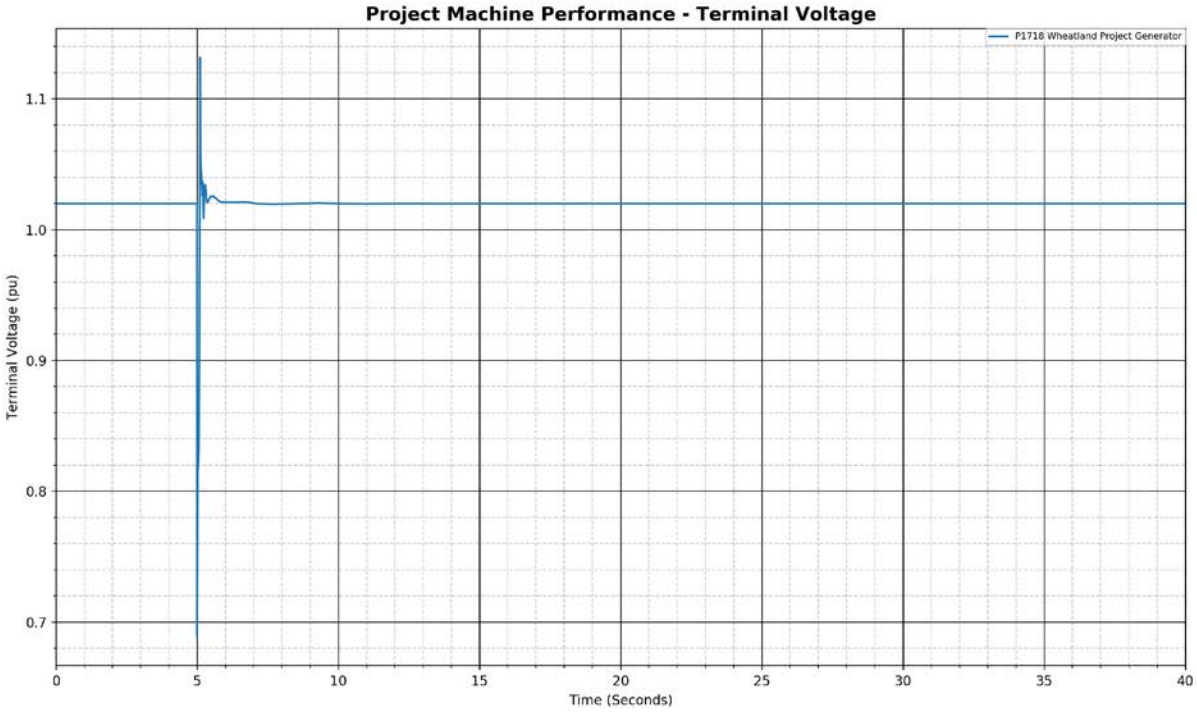
Figure A4-2: 9L24 (Oakland 946S - Lanfine 959S): 3-phase fault at Lanfine 959S

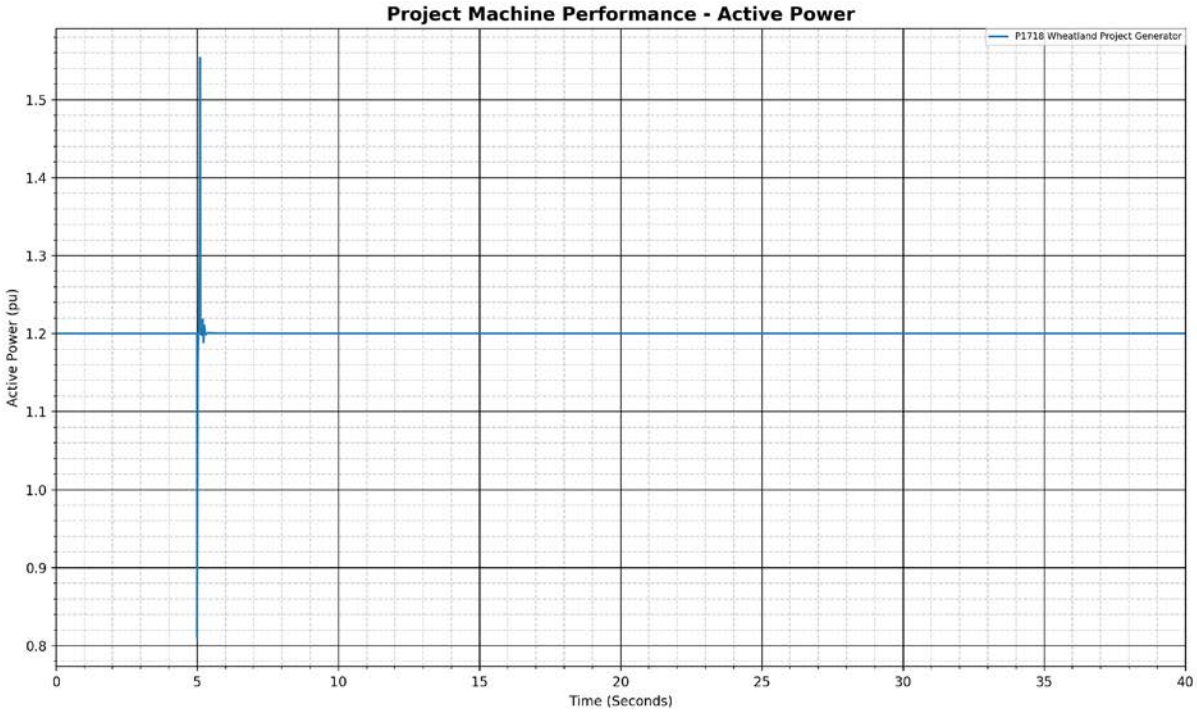


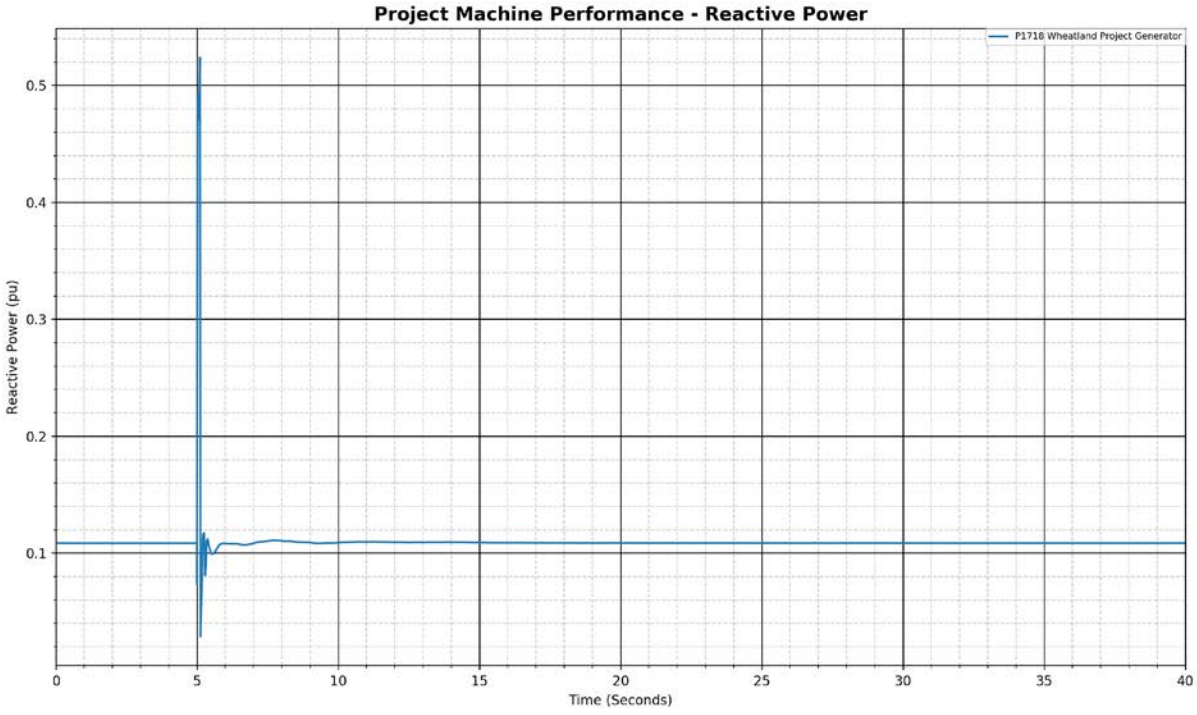

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

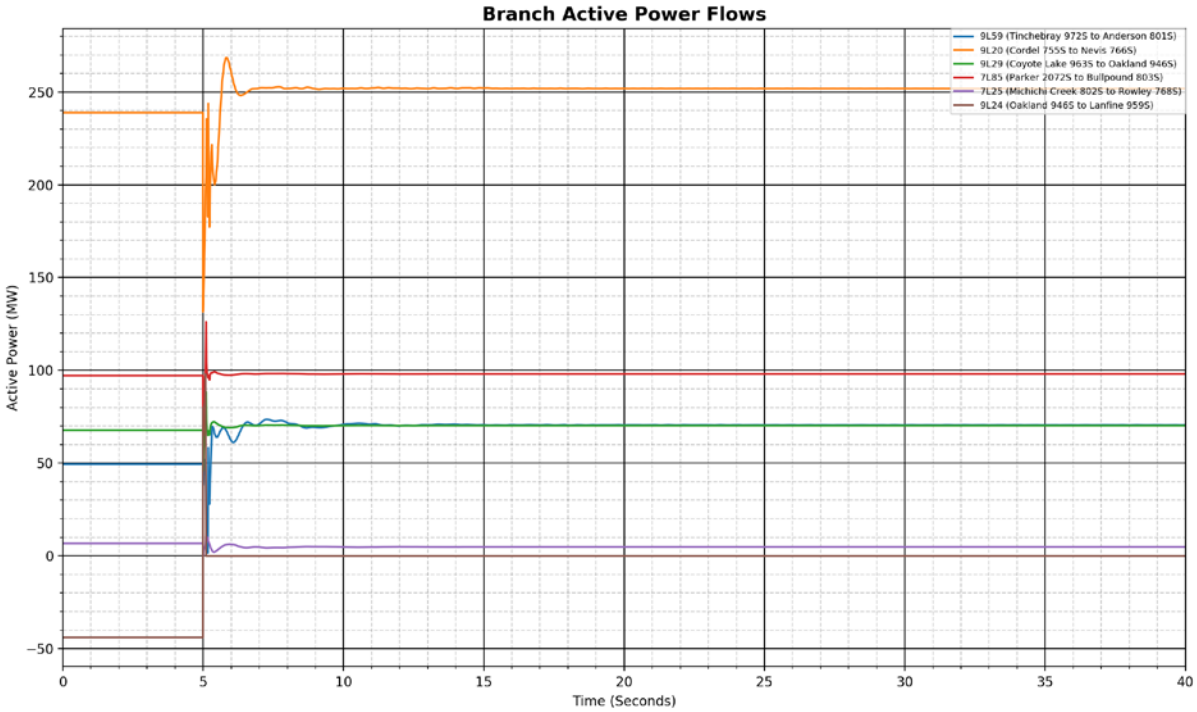

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
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
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Active Power (MW)
Time (Seconds)

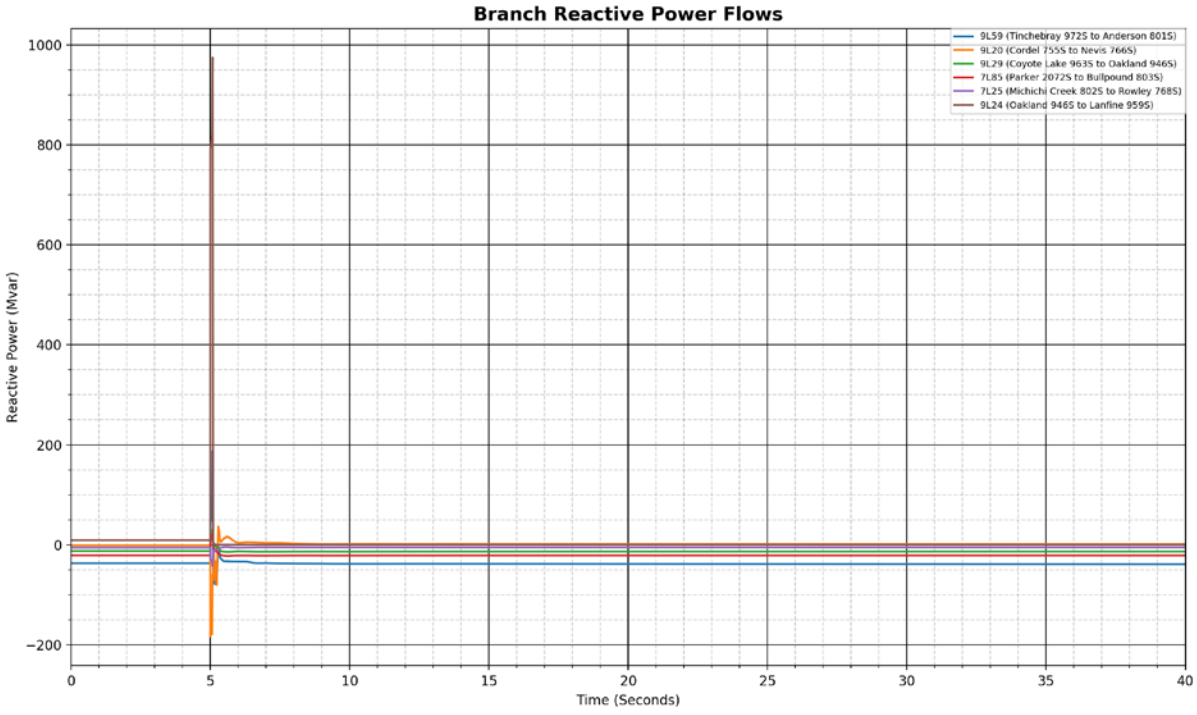
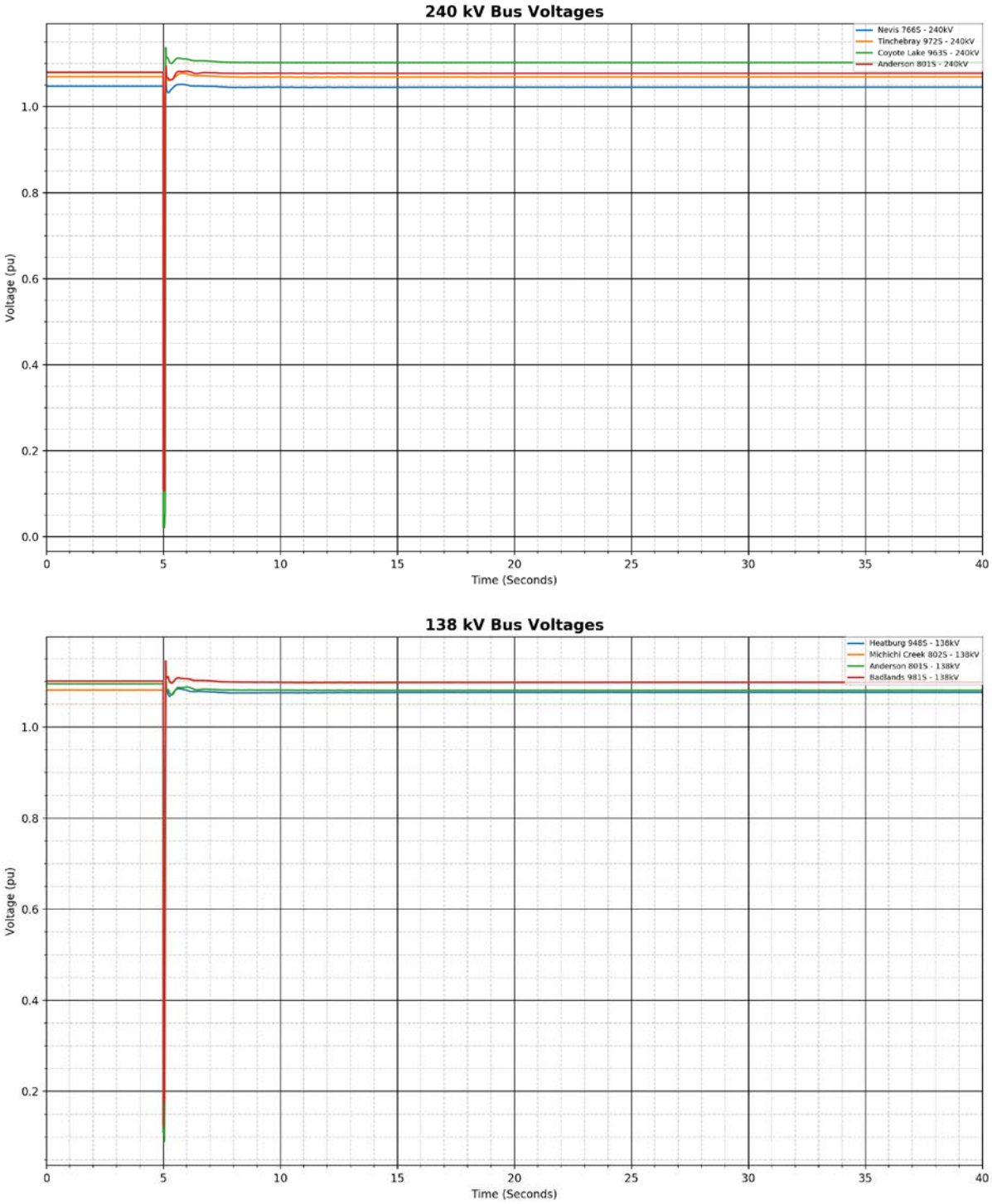
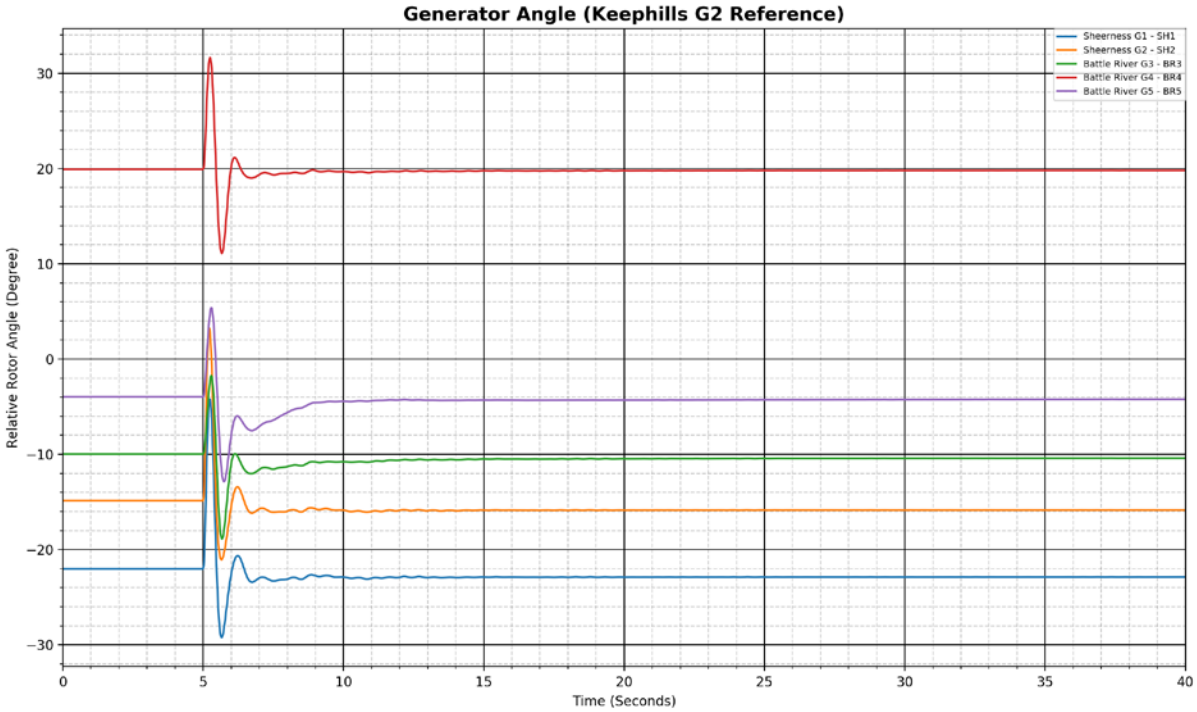
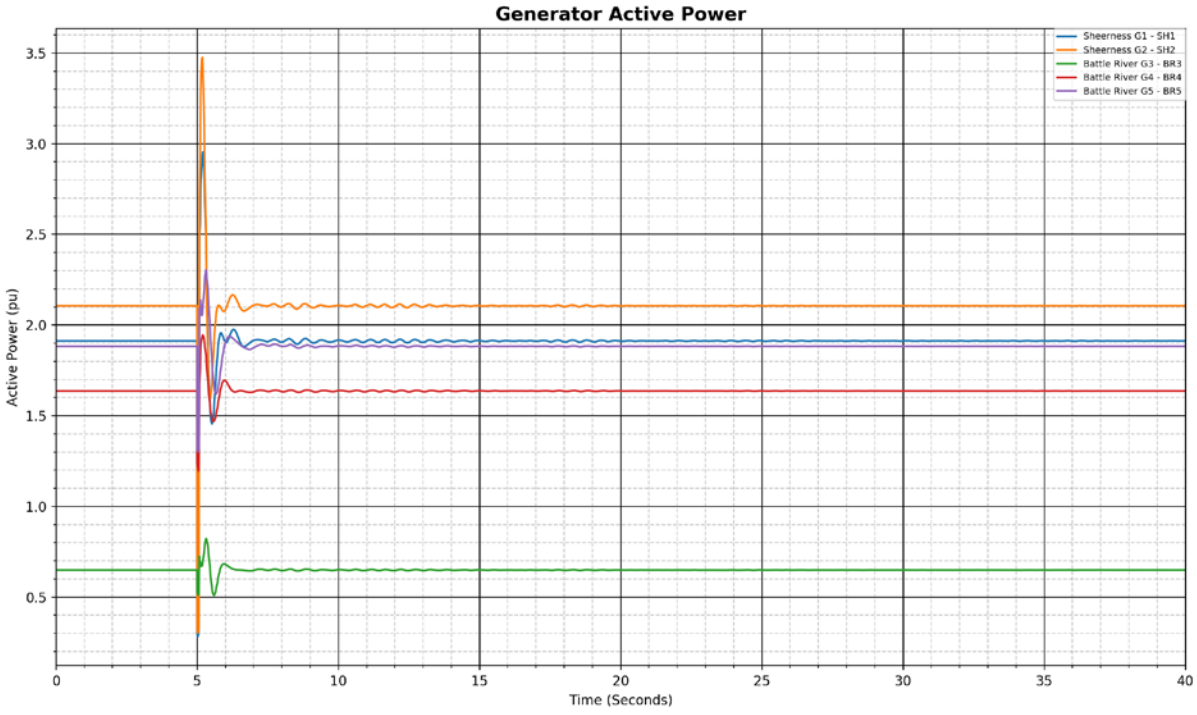
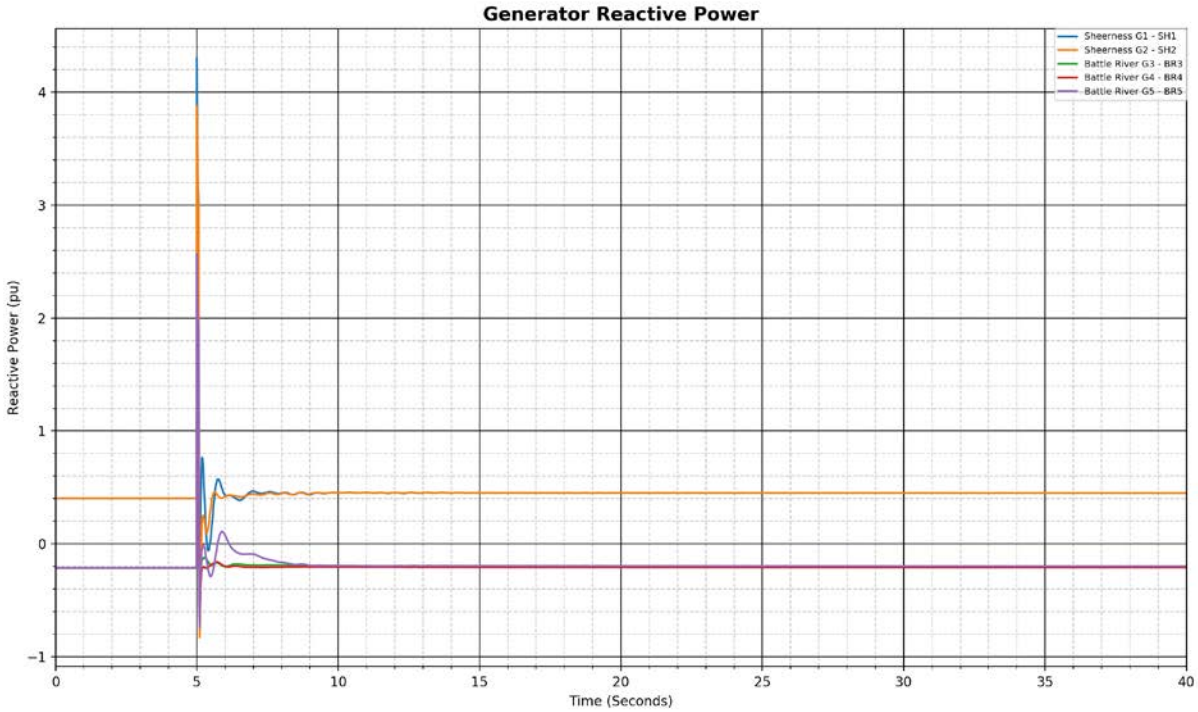

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Reactive Power (Mvar)
Time (Seconds)

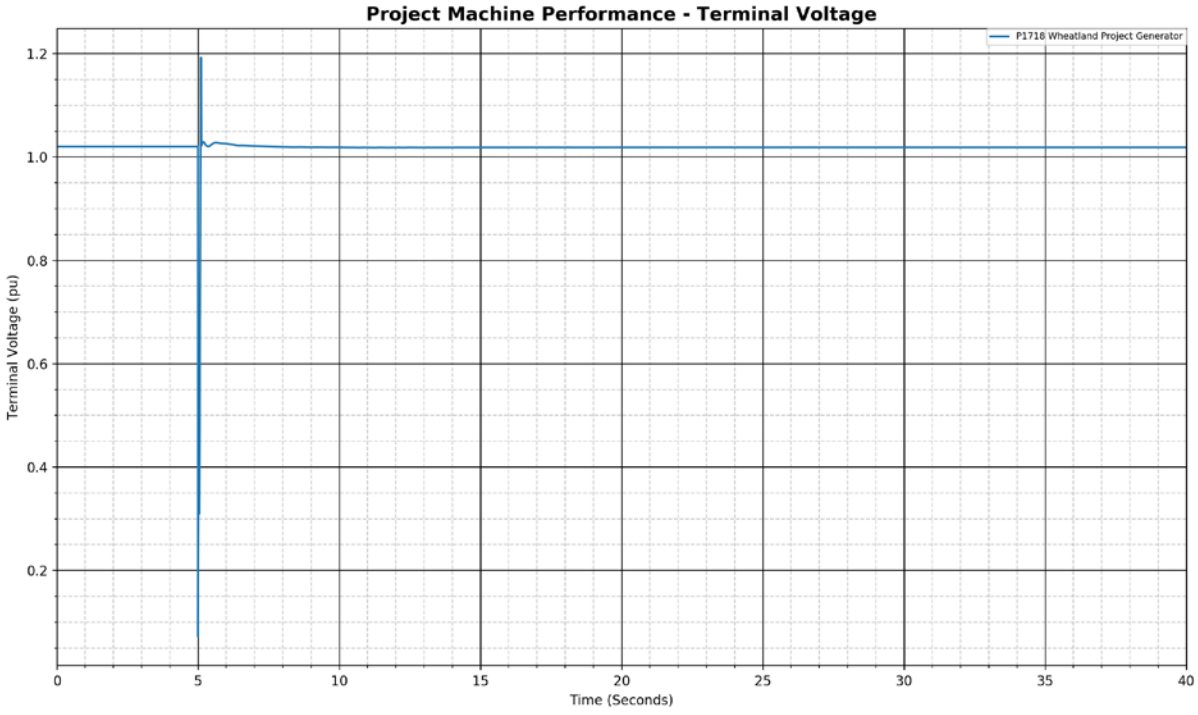
Figure A4-3: 9L29 (Oakland 946S - Coyote Lake 963S): 3-phase fault at Oakland 946S

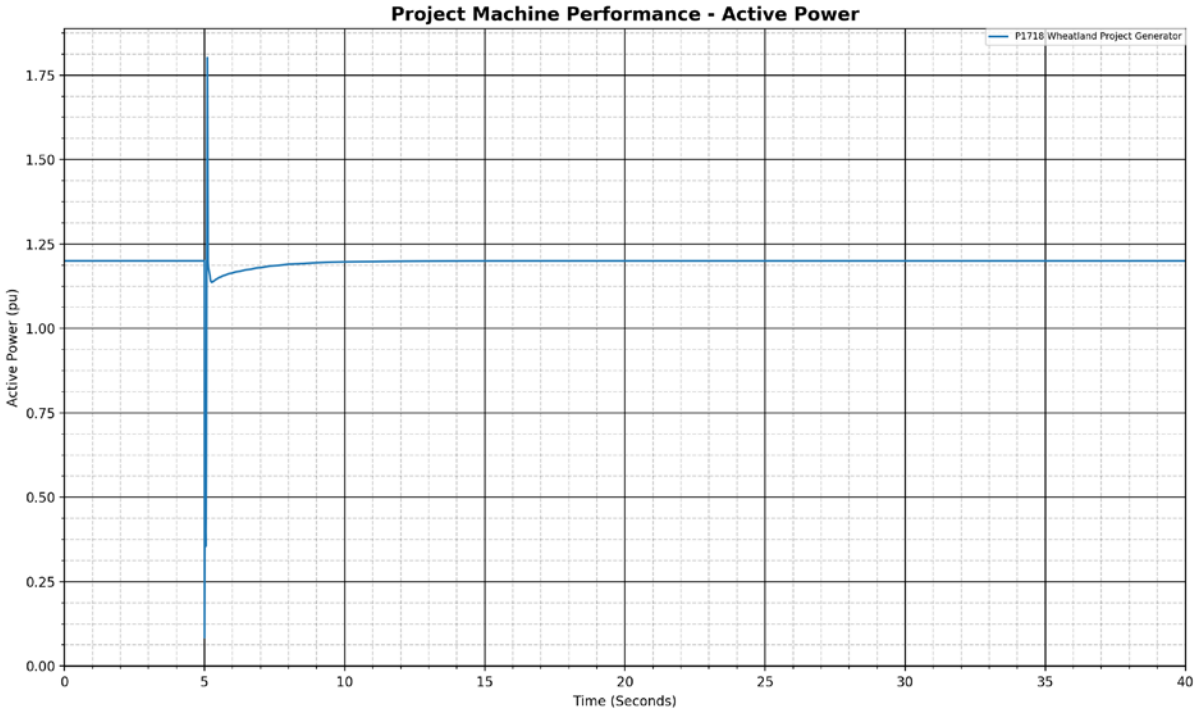


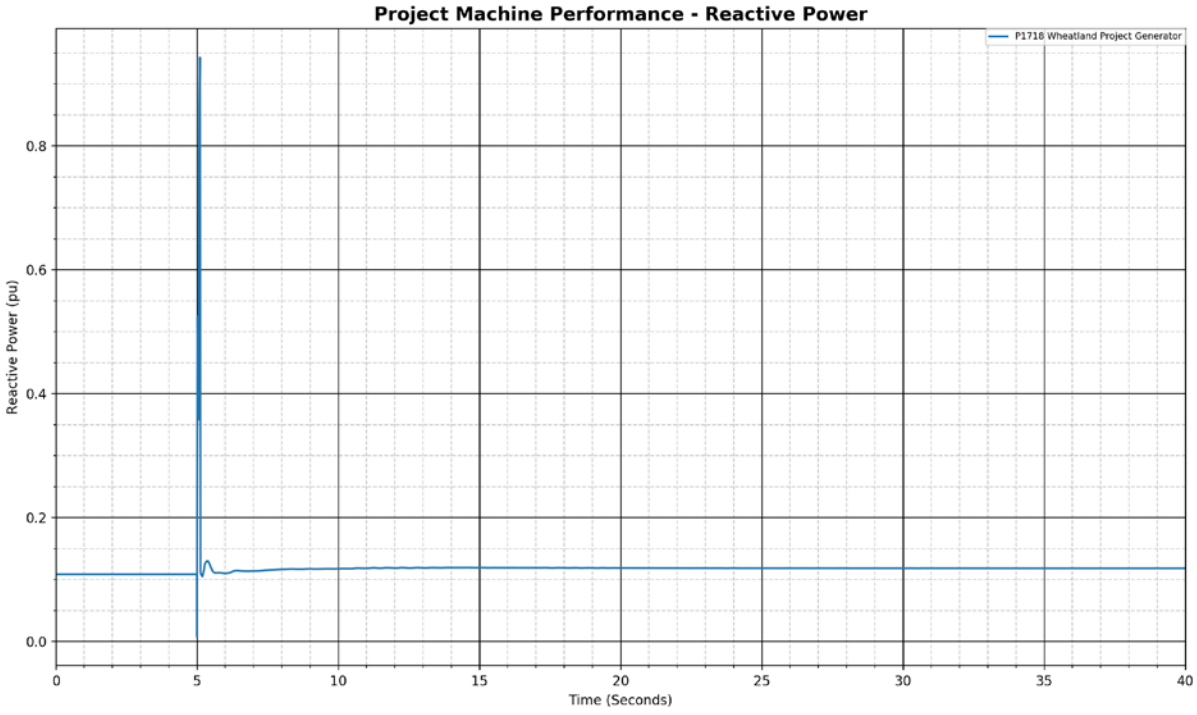

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)


Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.2
0.4
0.6
0.8
0
5
10
15
20
25
30
35
40

Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

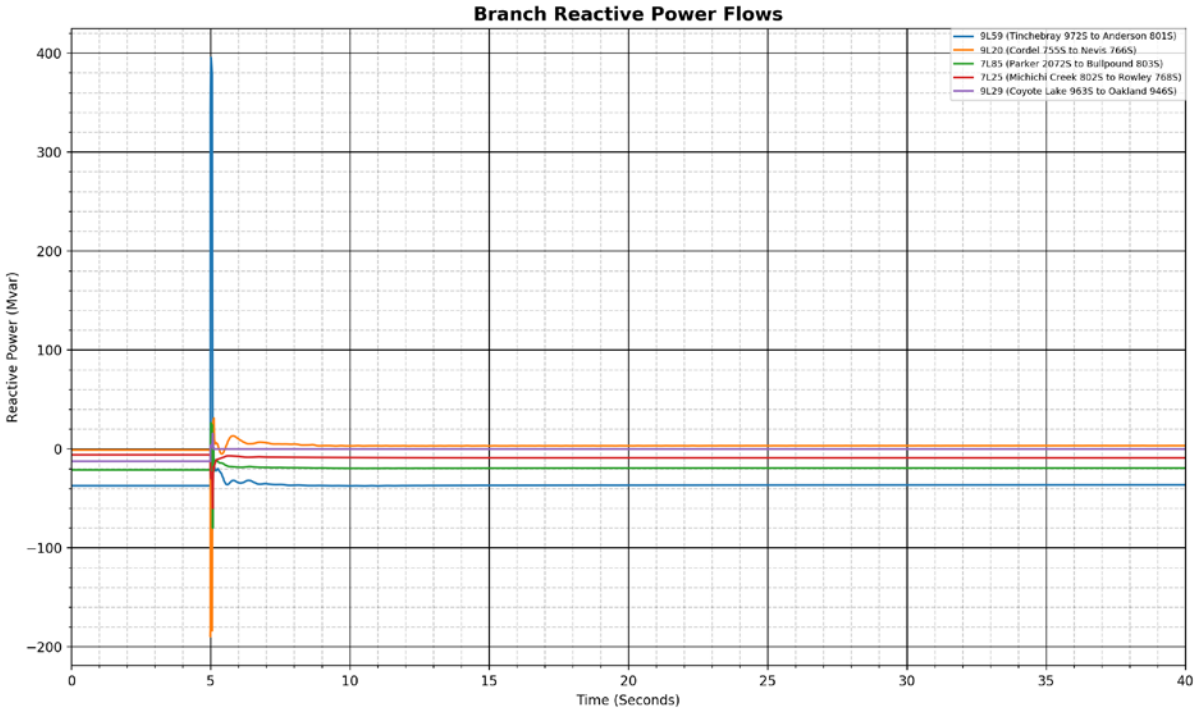
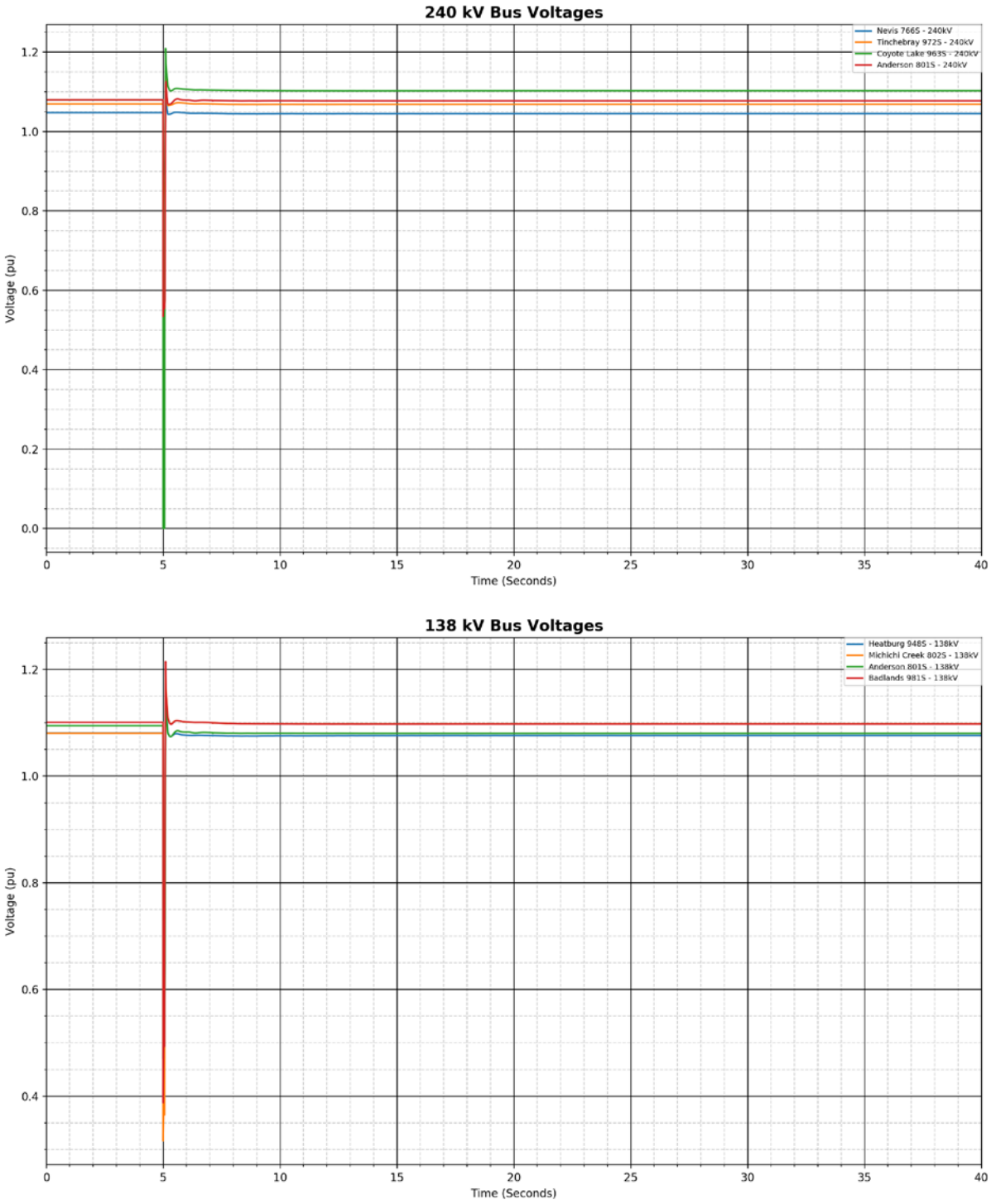
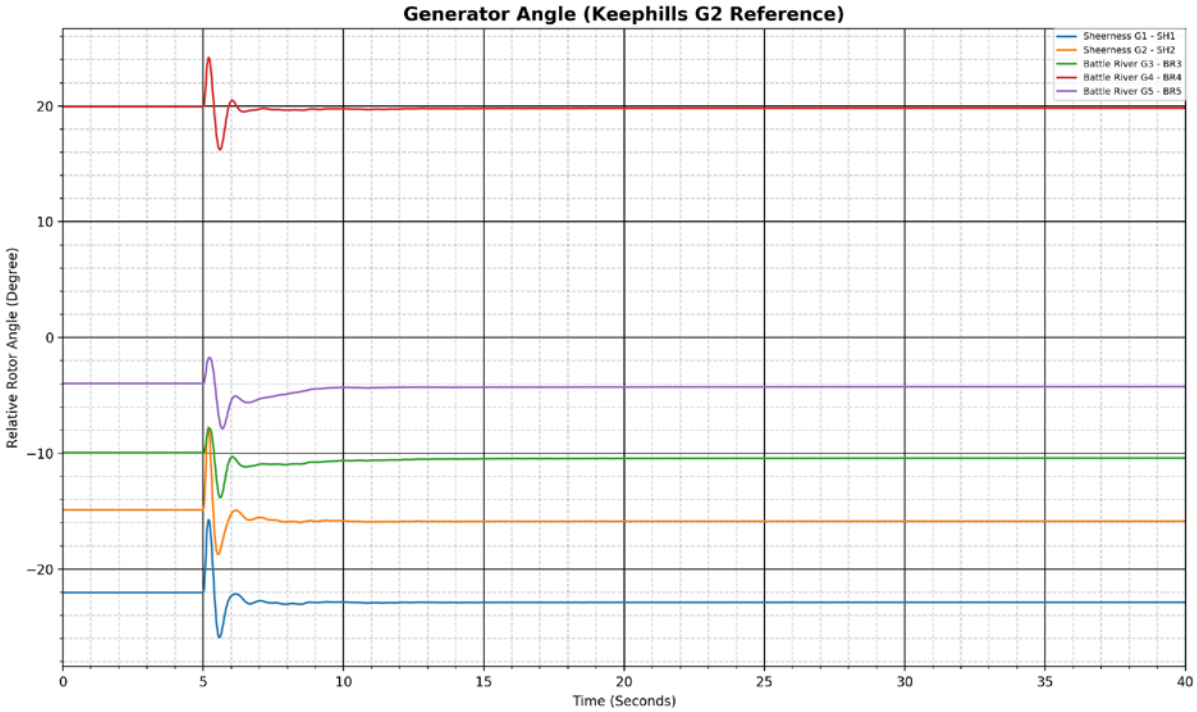
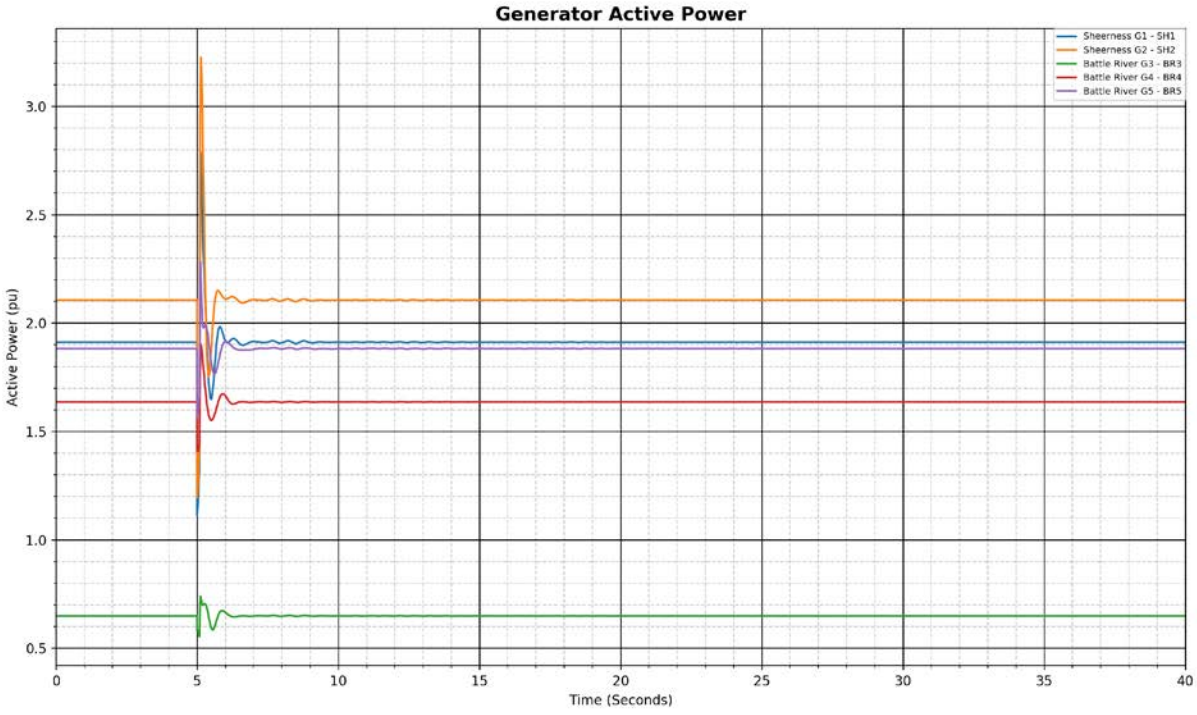
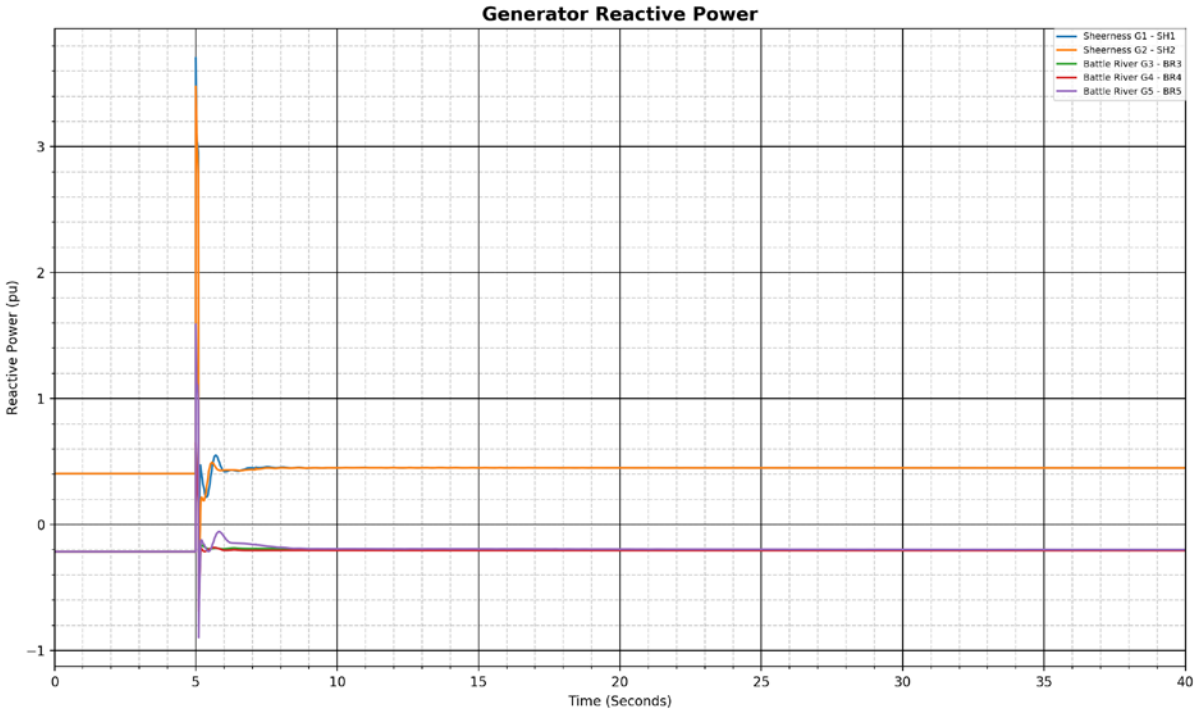

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

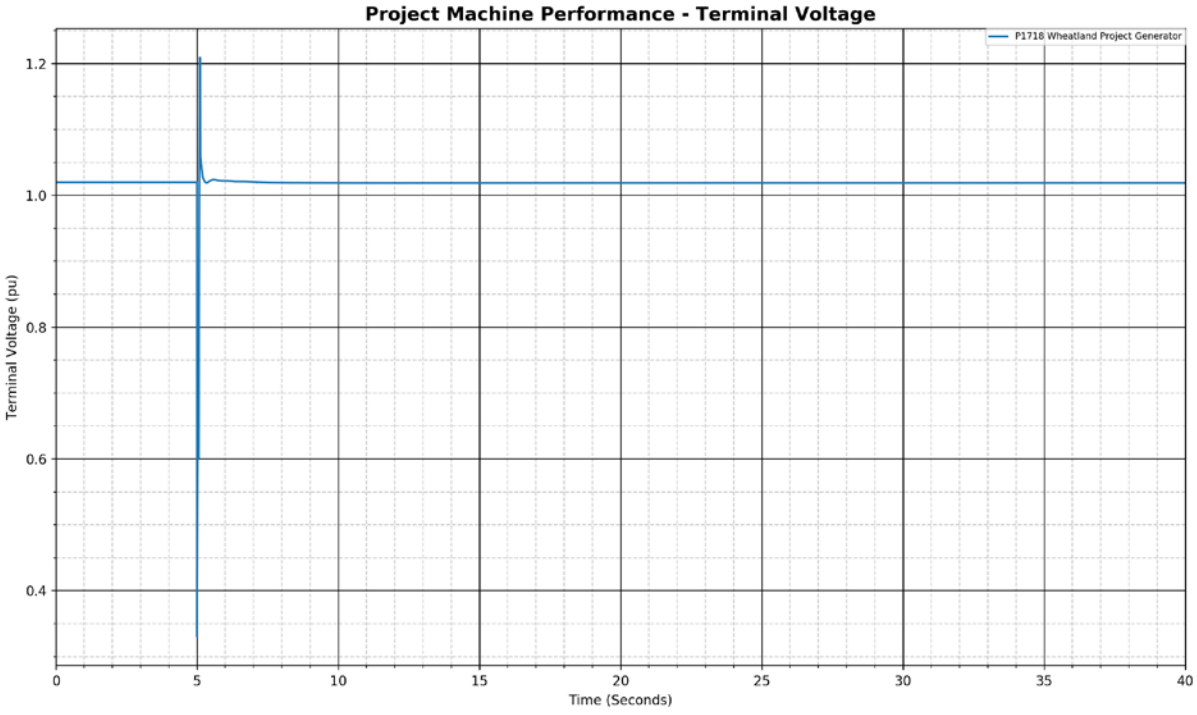
Figure A4-4: 9L29 (Oakland 946S - Coyote Lake 963S): 3-phase fault at Coyote Lake 963S

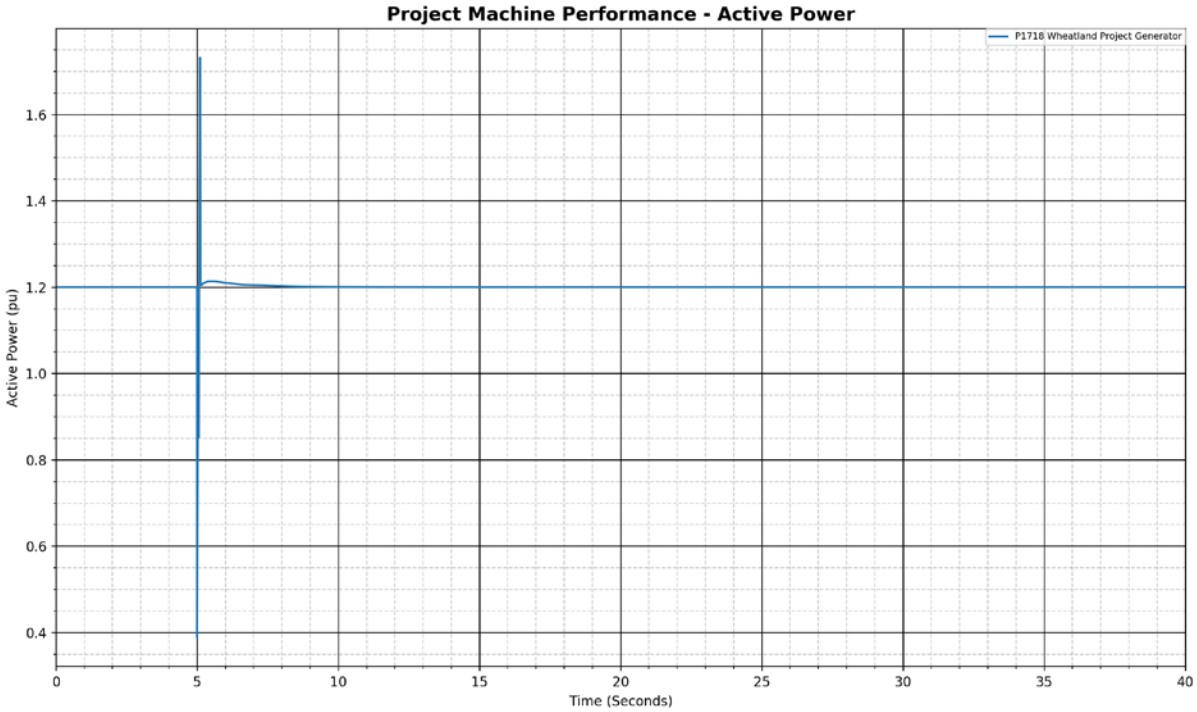


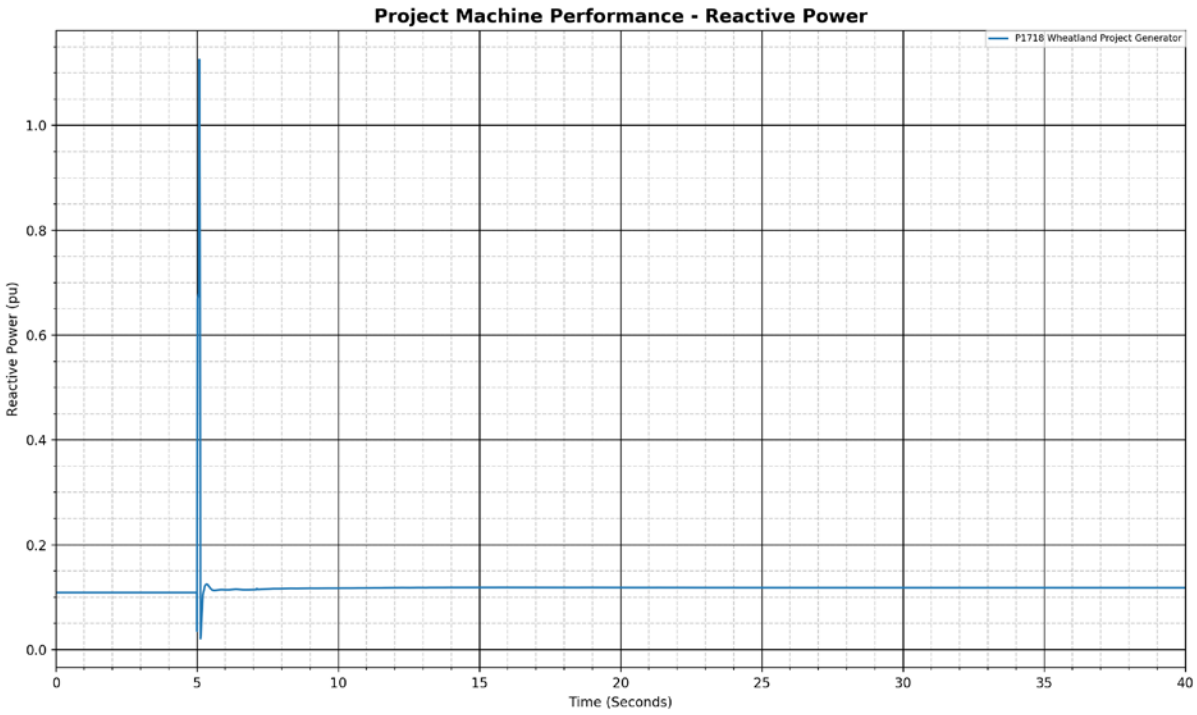

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

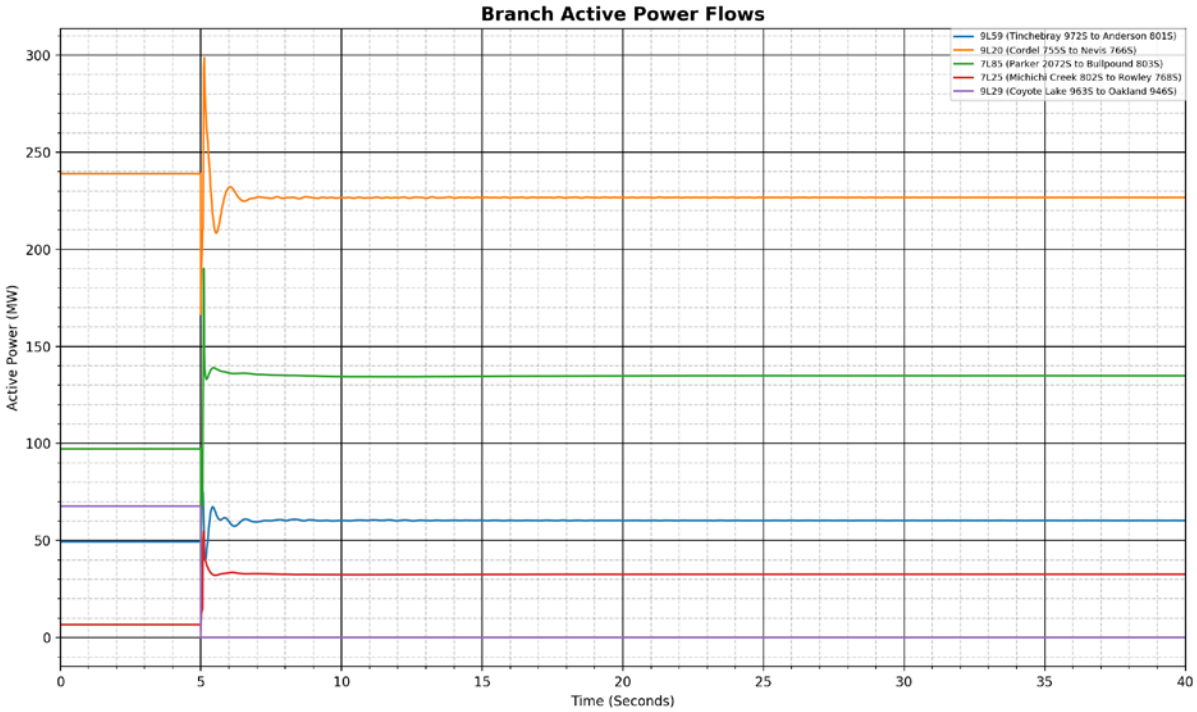

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

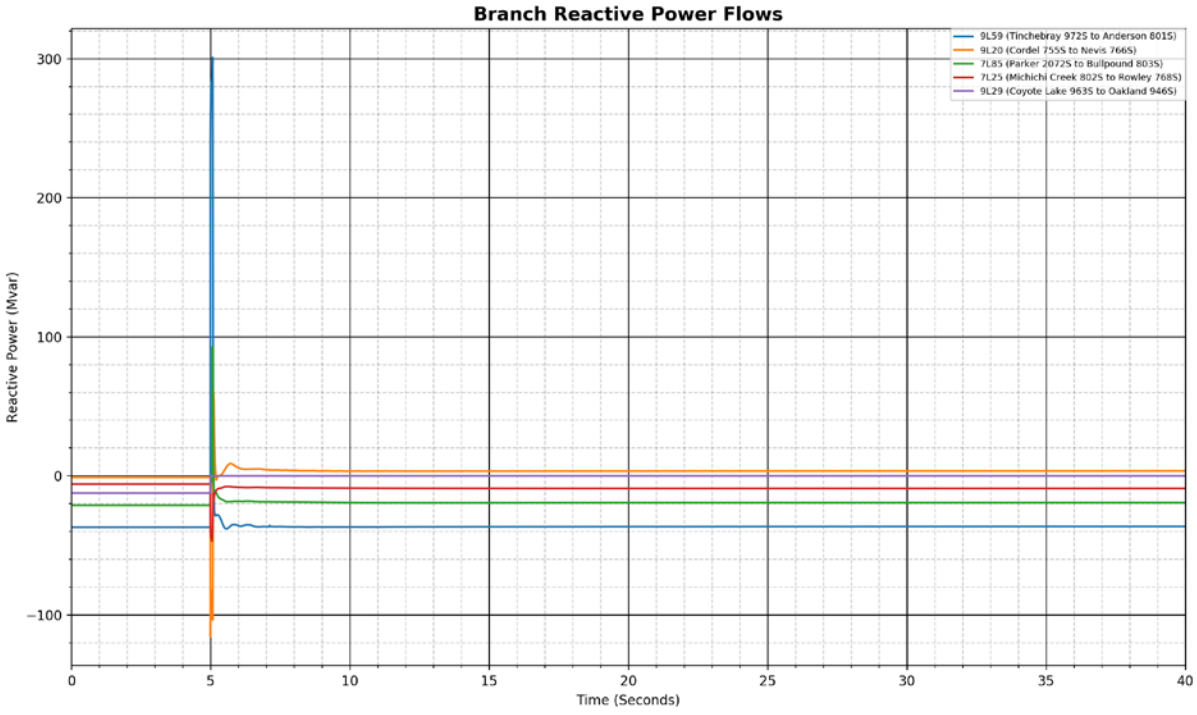
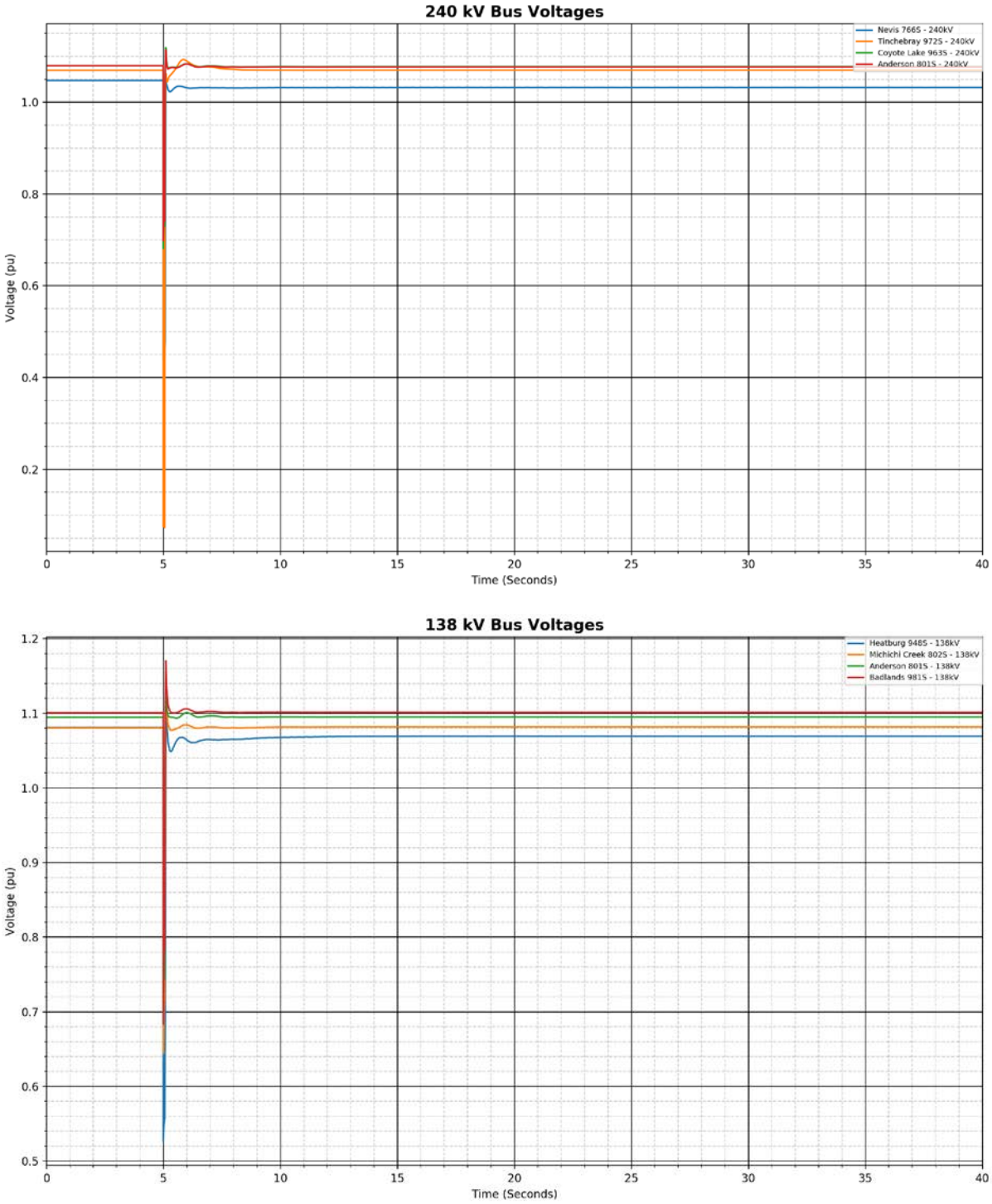
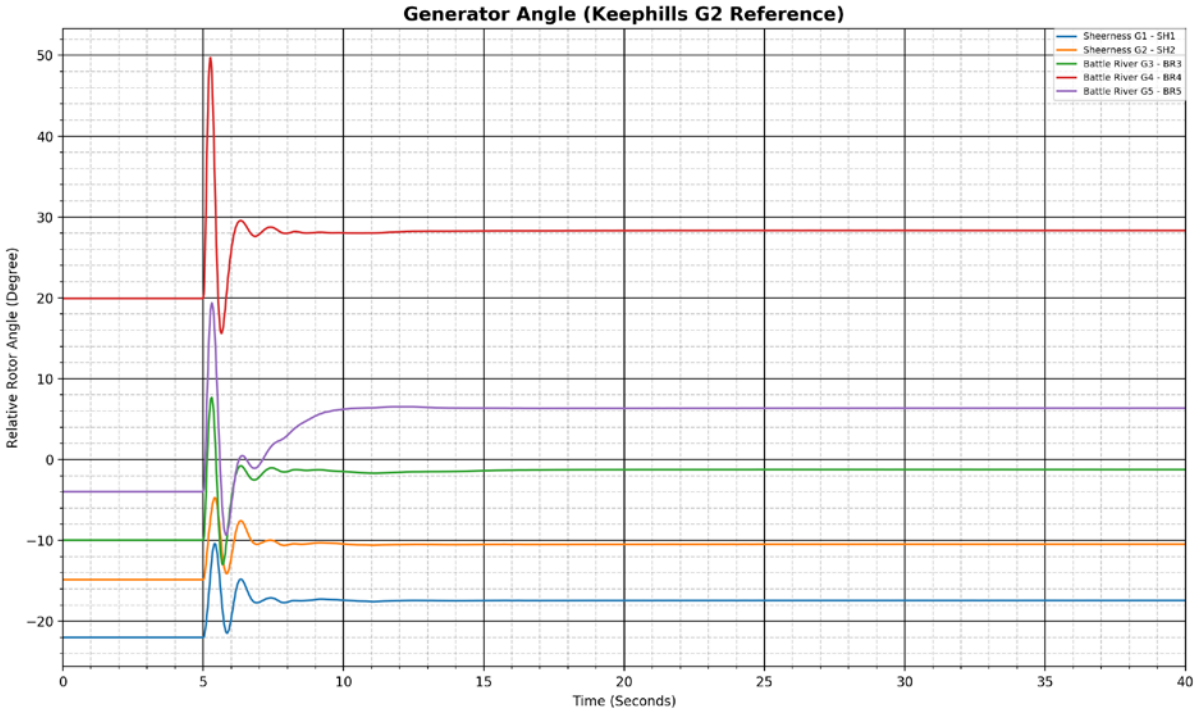
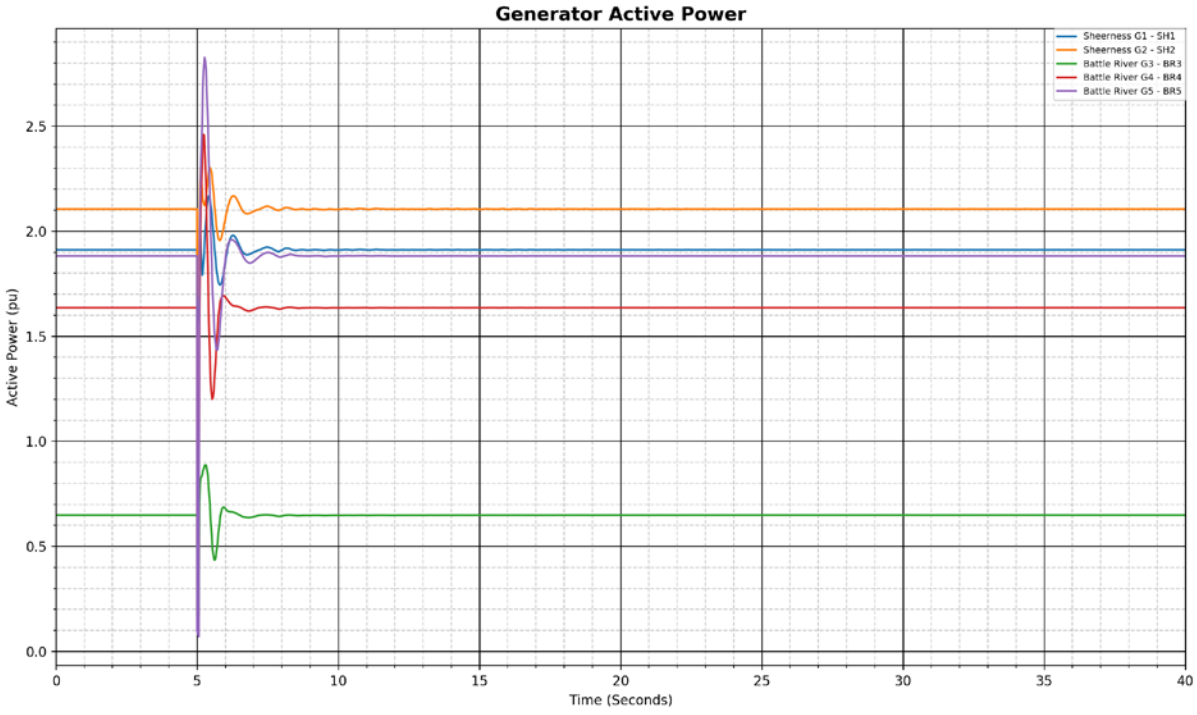
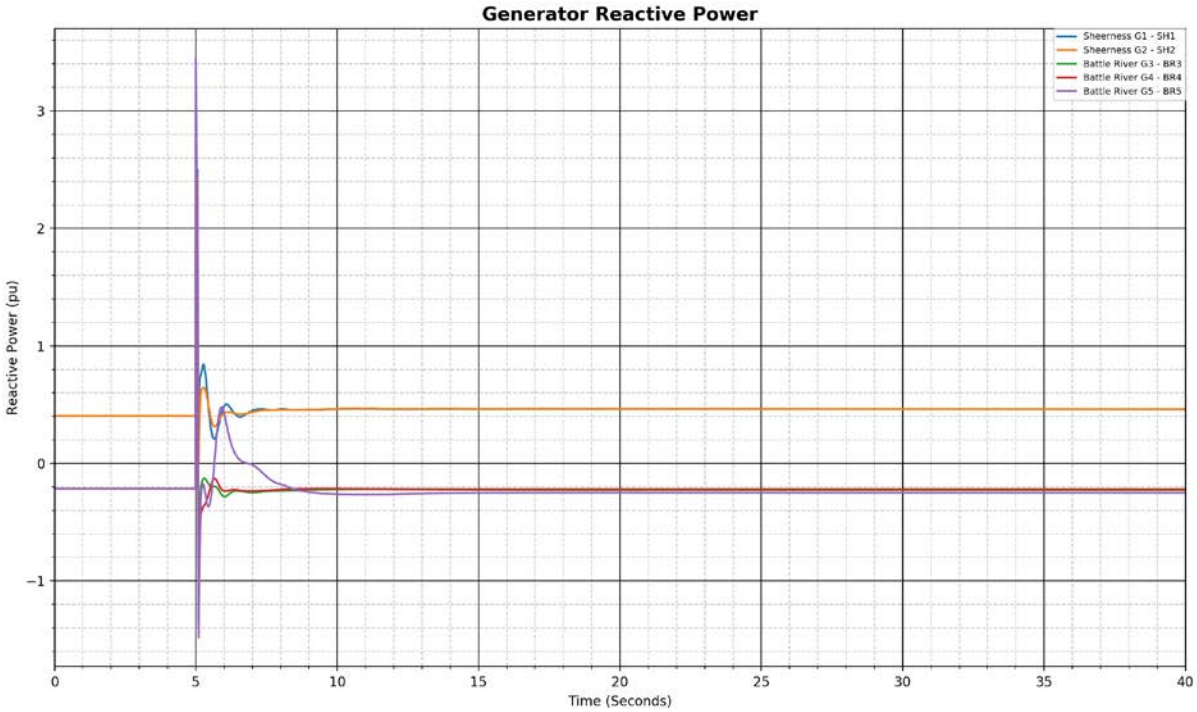

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

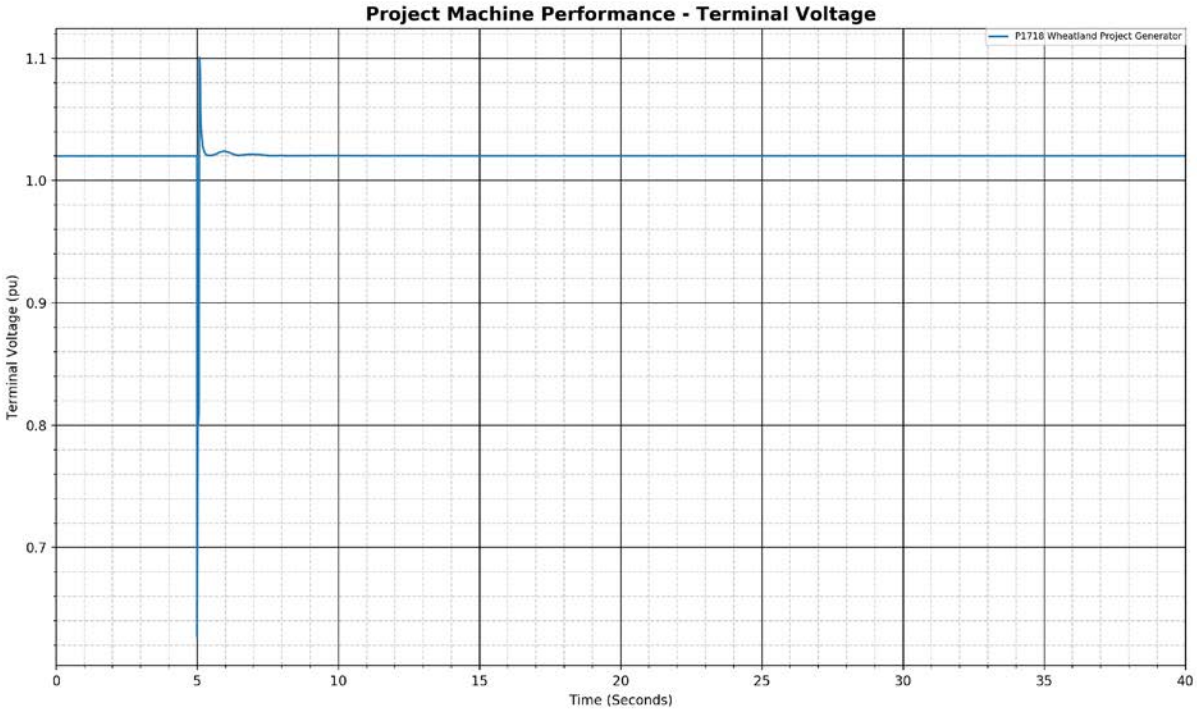
Figure A4-5: 9L20 (Cordel 755S - Nevis 766S): 3-phase fault at Cordel 755S

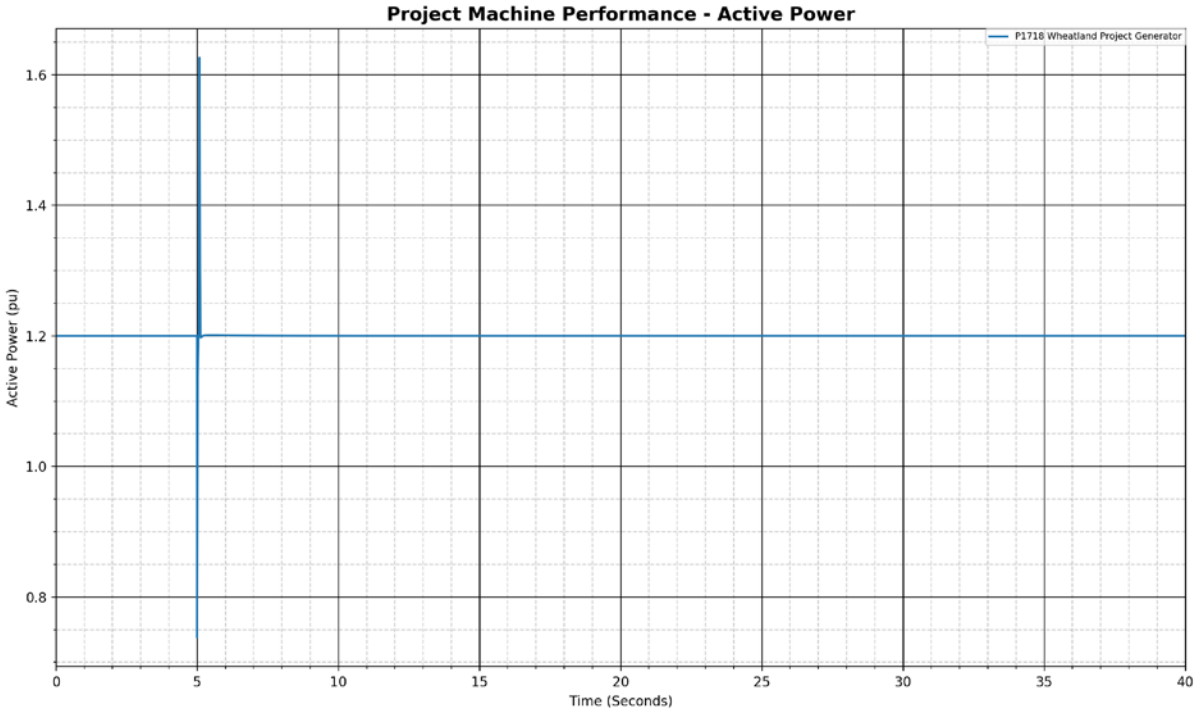


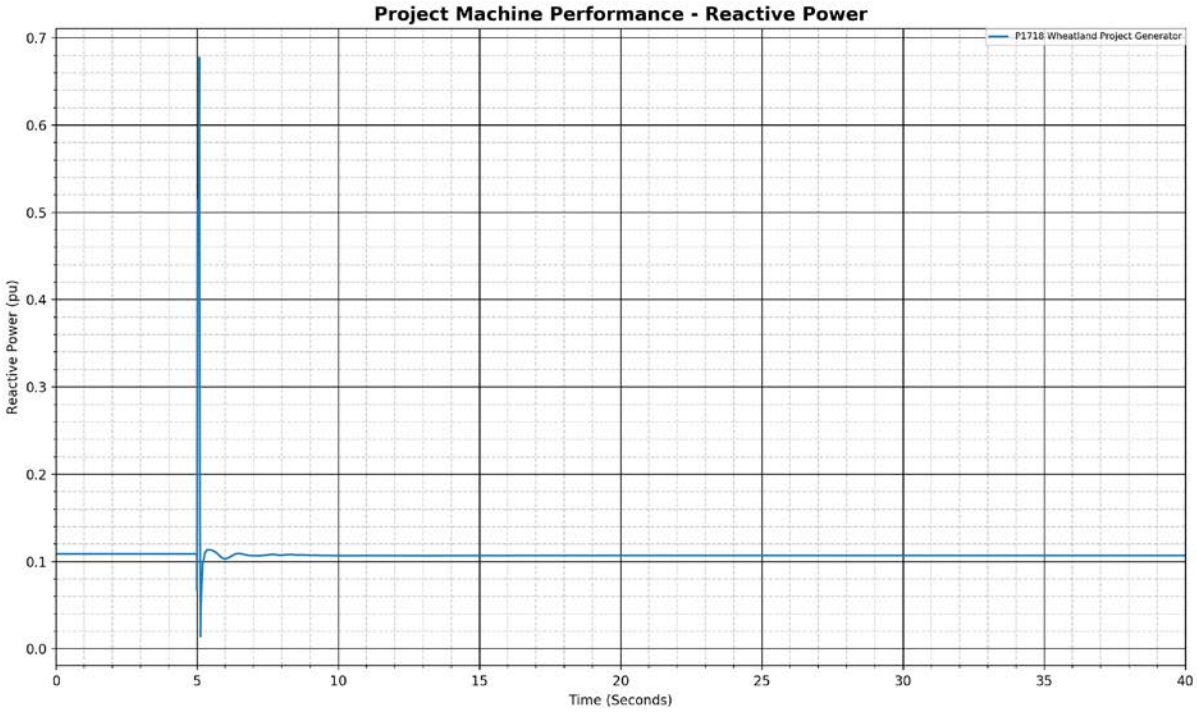

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

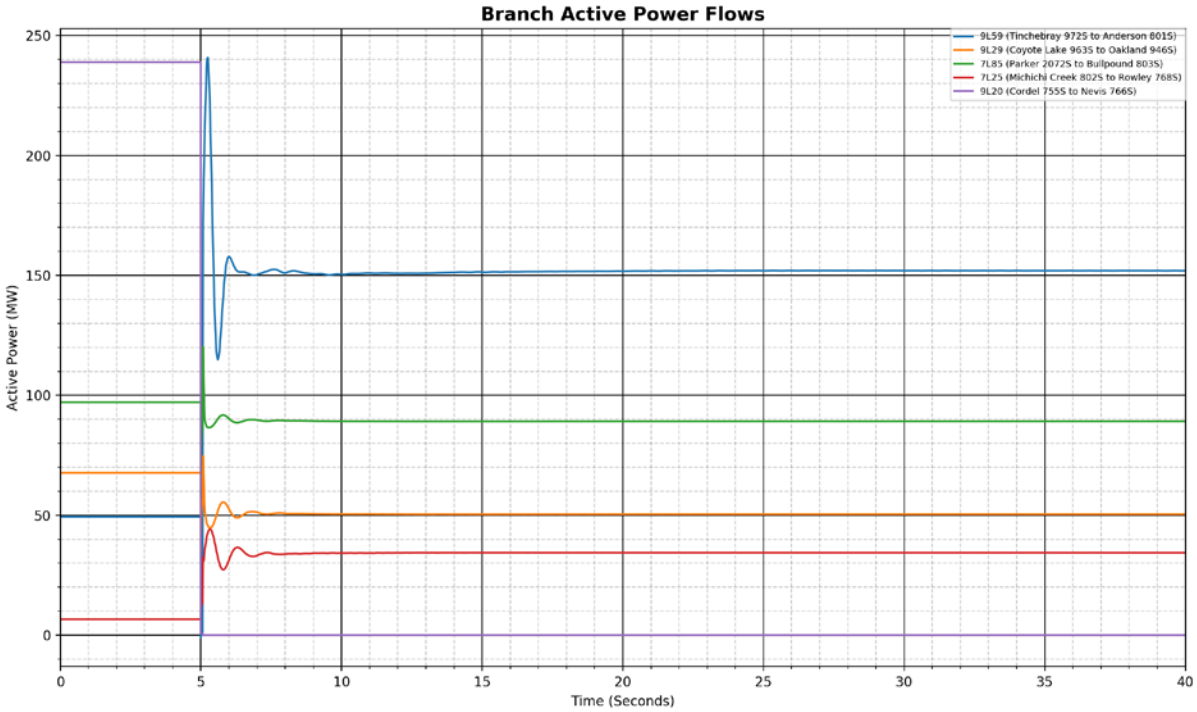

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.6
1.4
1.2
1.0
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Active Power (MW)
Time (Seconds)

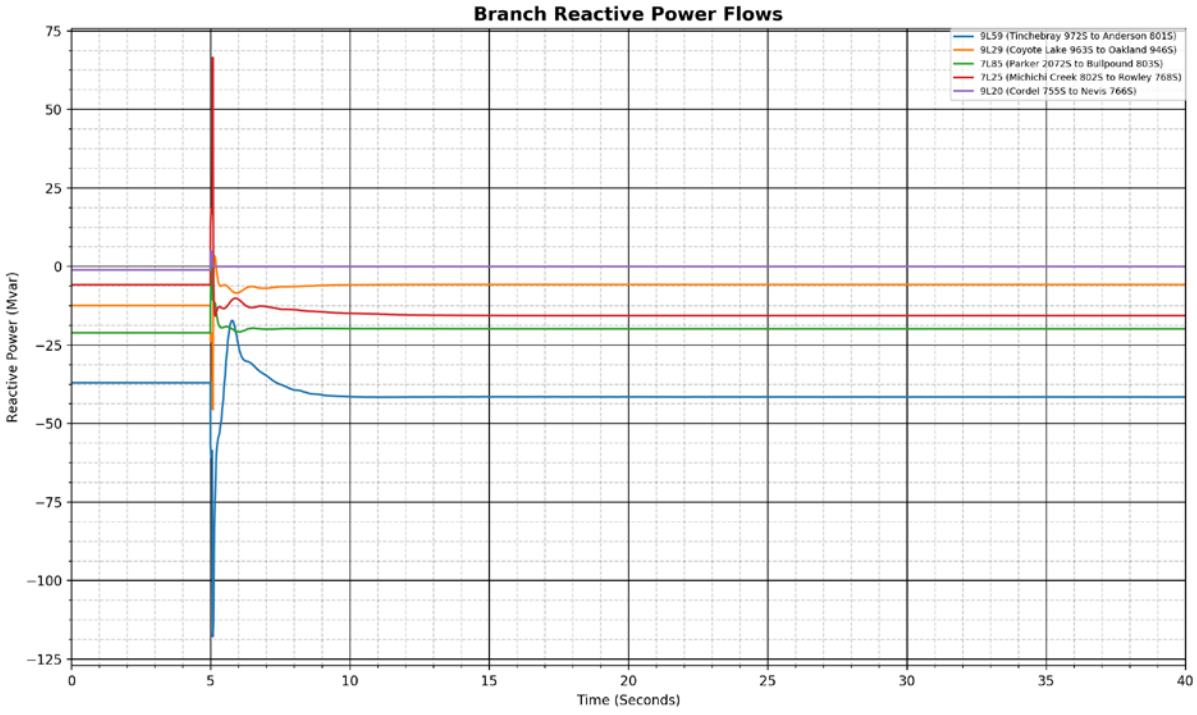
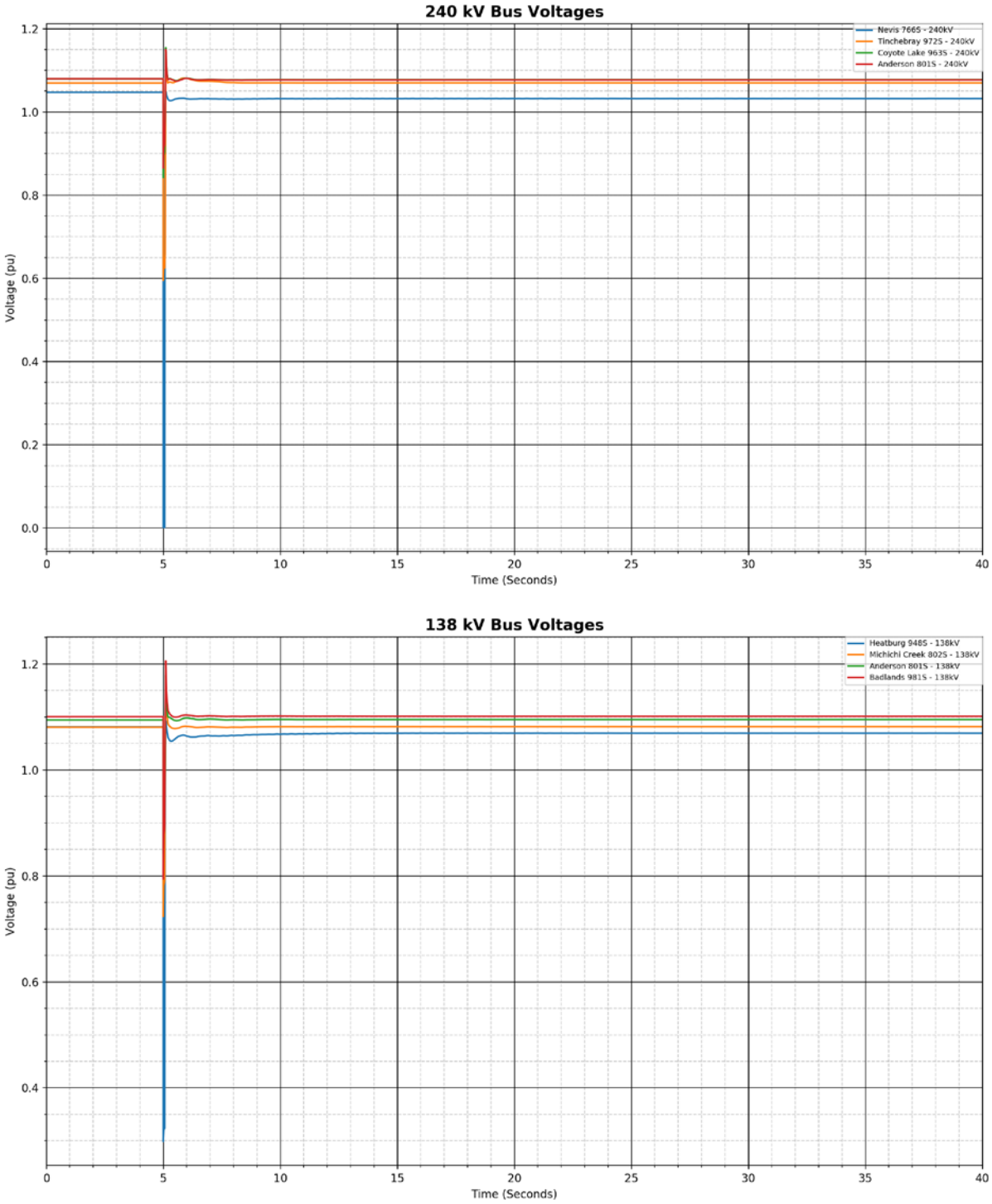
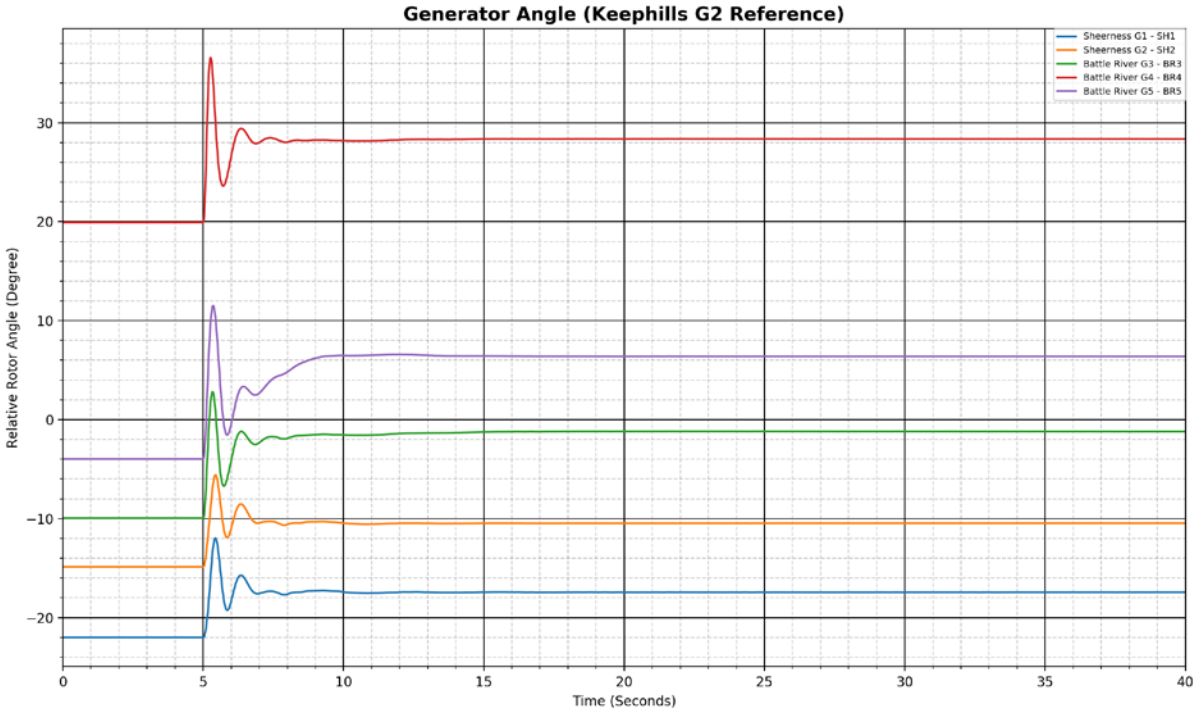
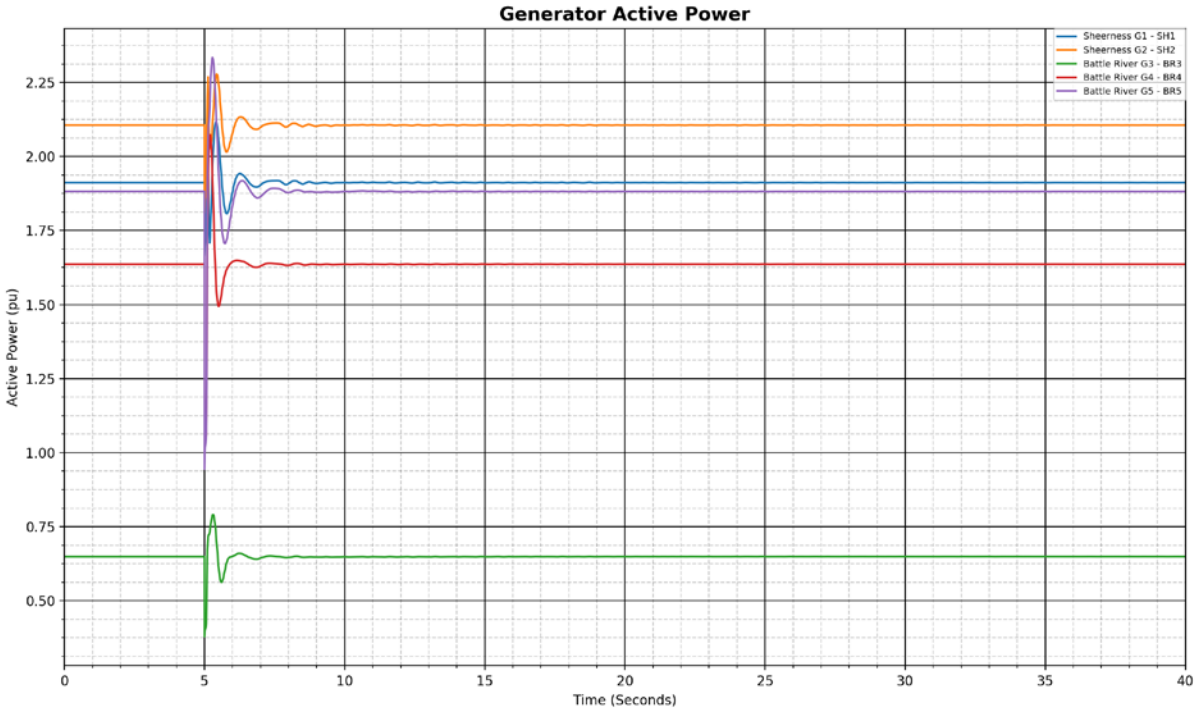
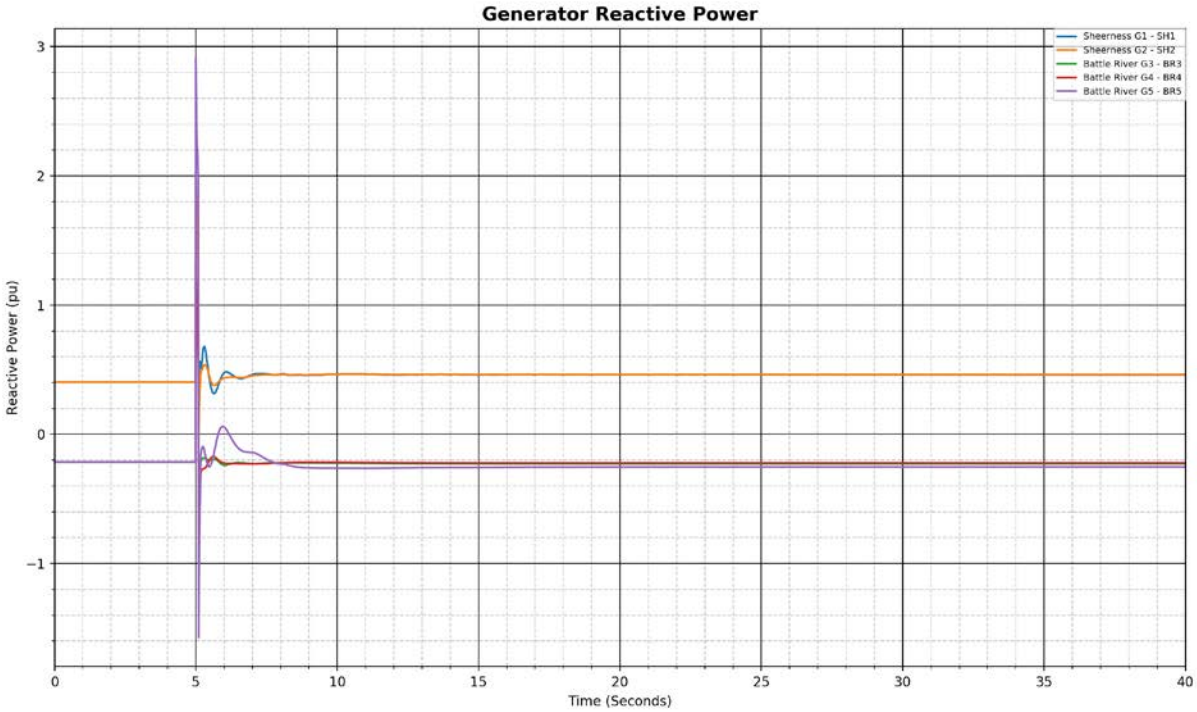

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

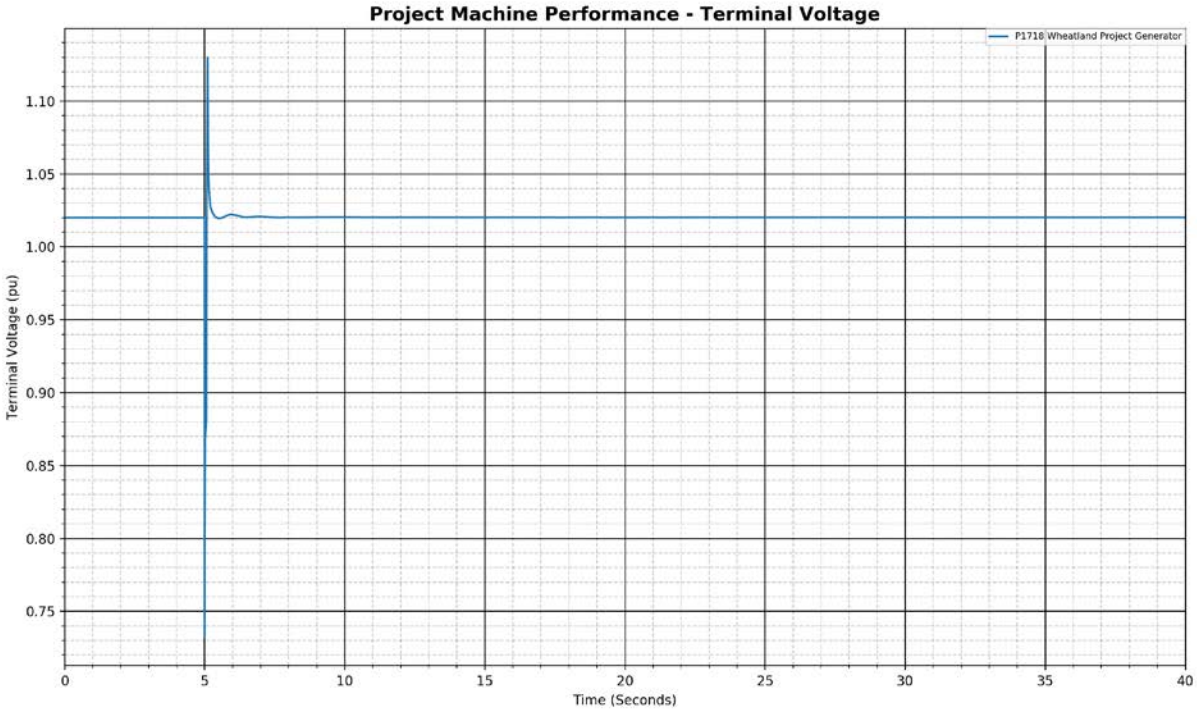
Figure A4-6: 9L20 (Cordel 755S - Nevis 766S): 3-phase fault at Nevis 766S

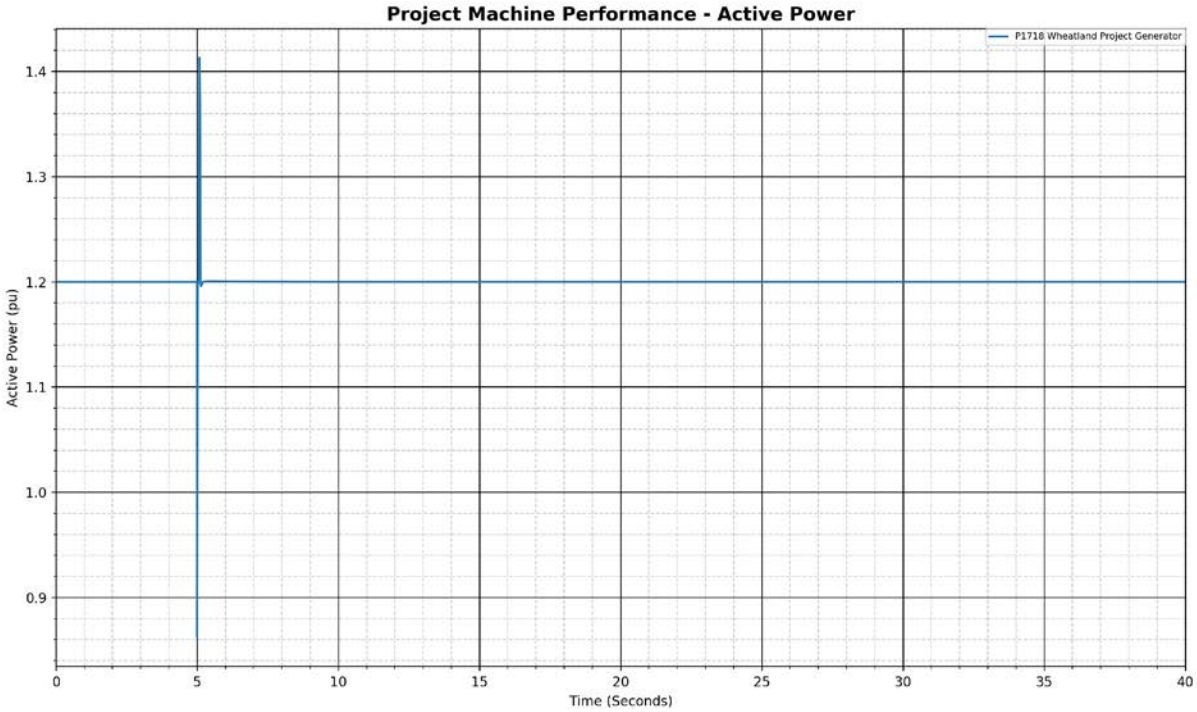


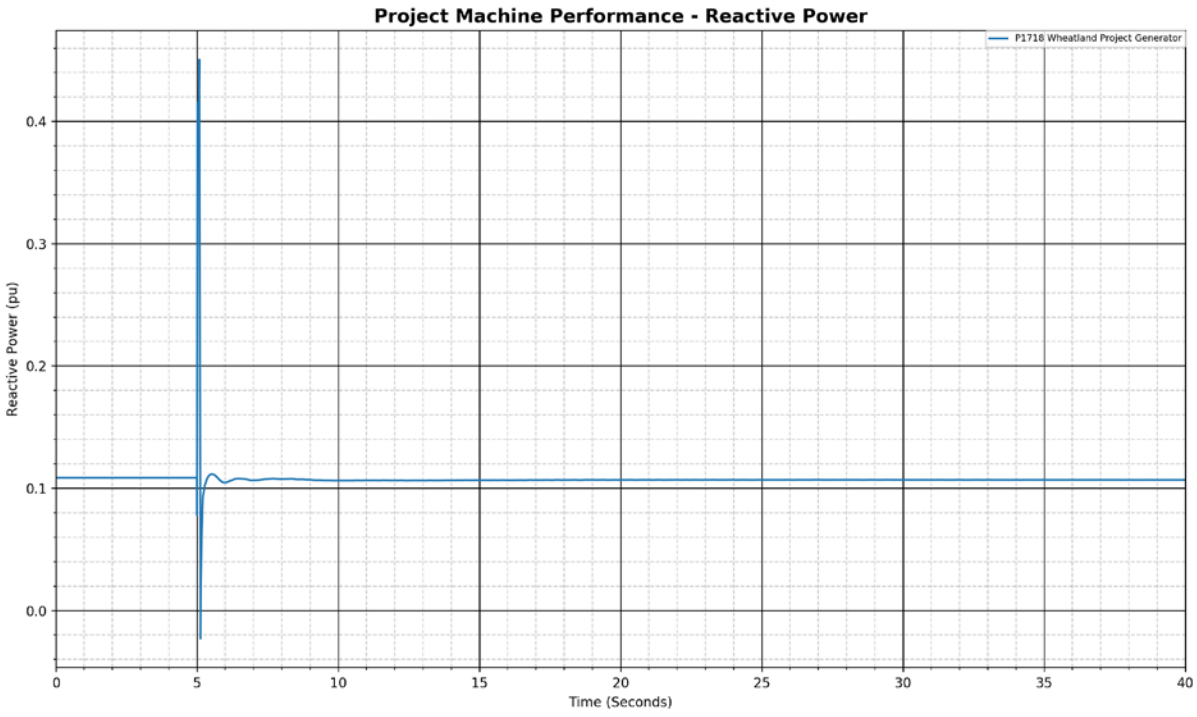

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
30
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

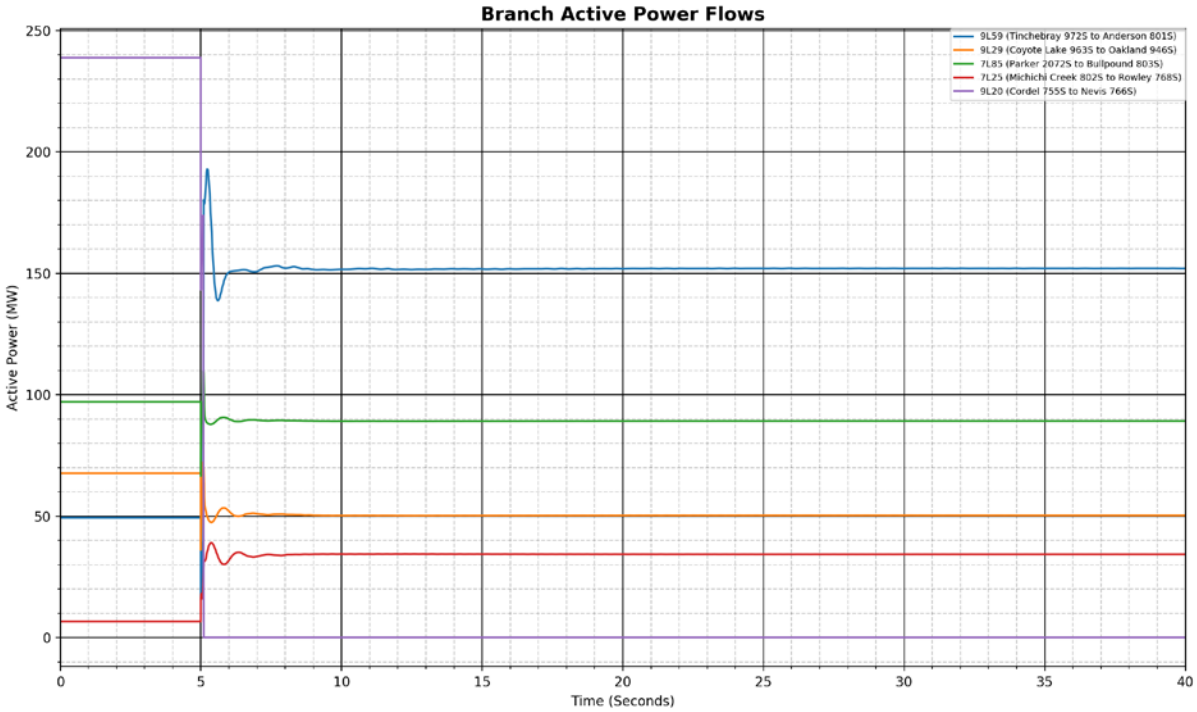

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Active Power (MW)
Time (Seconds)

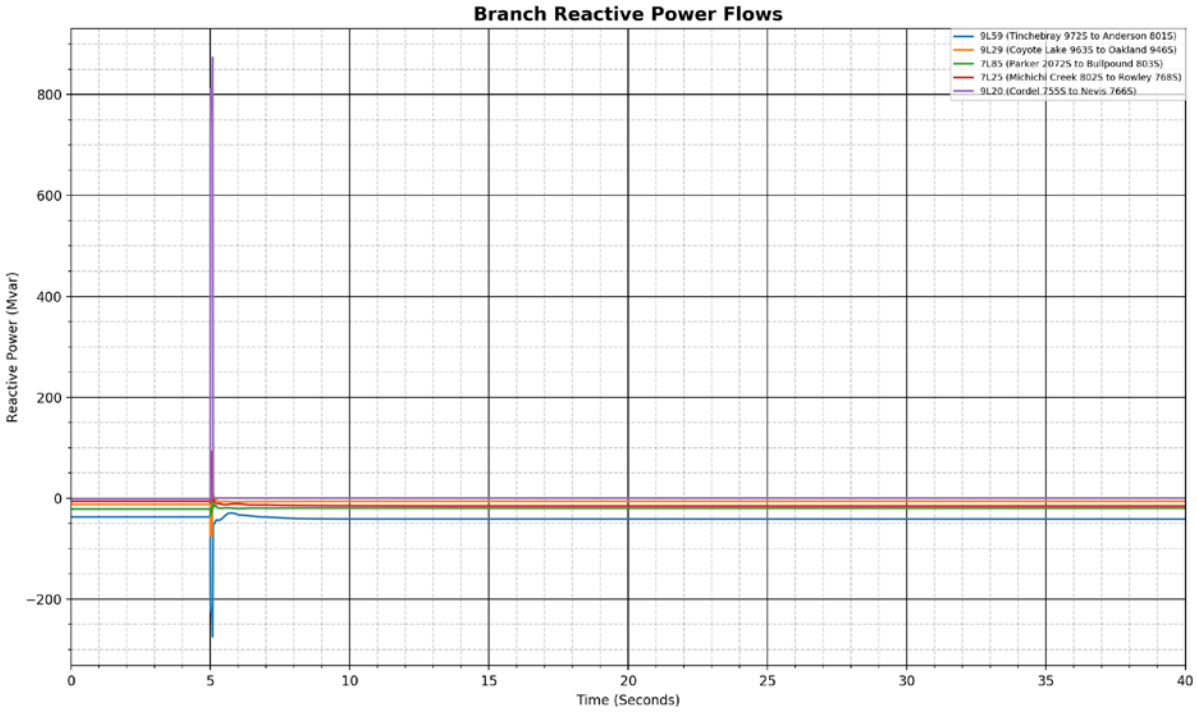
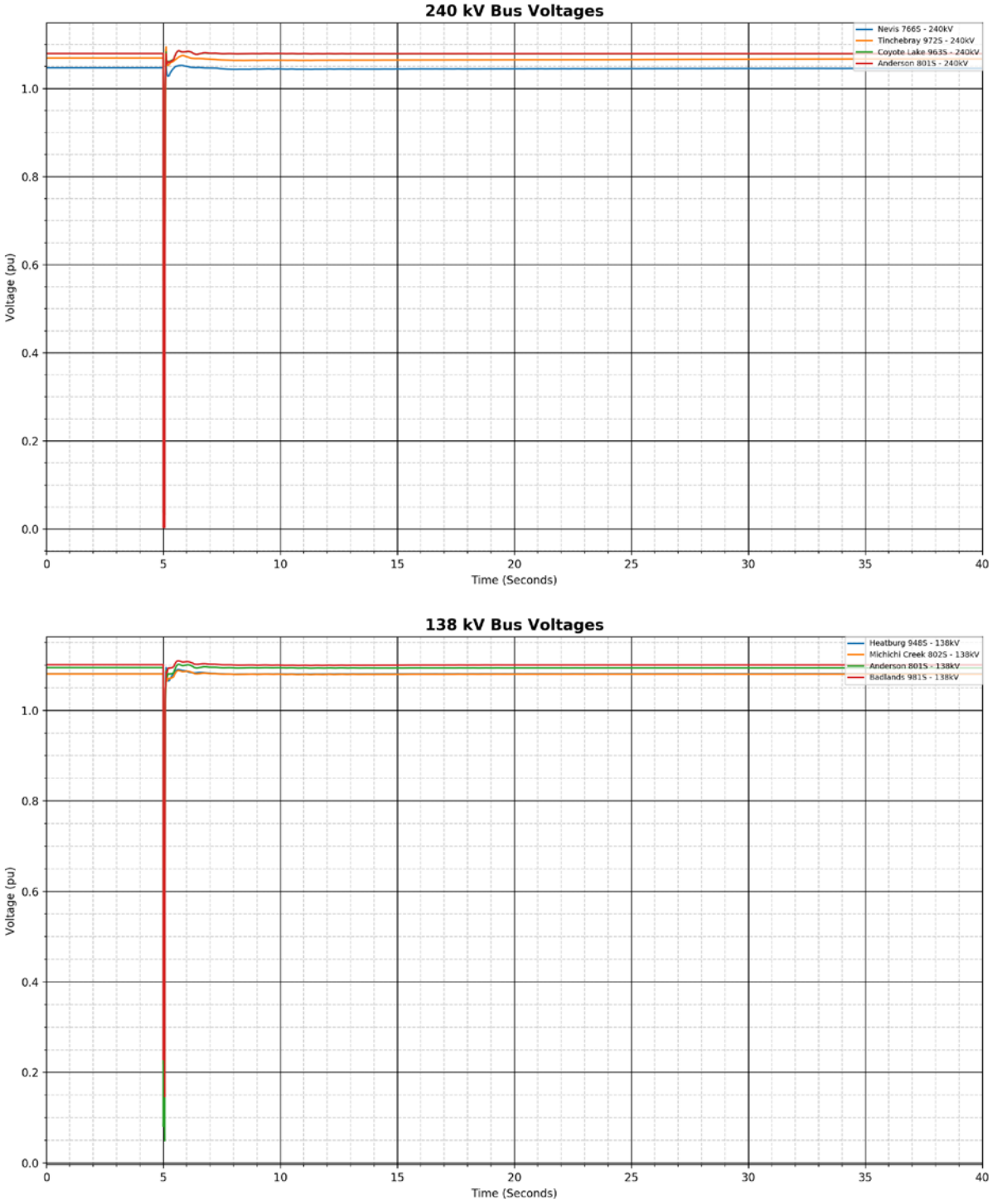
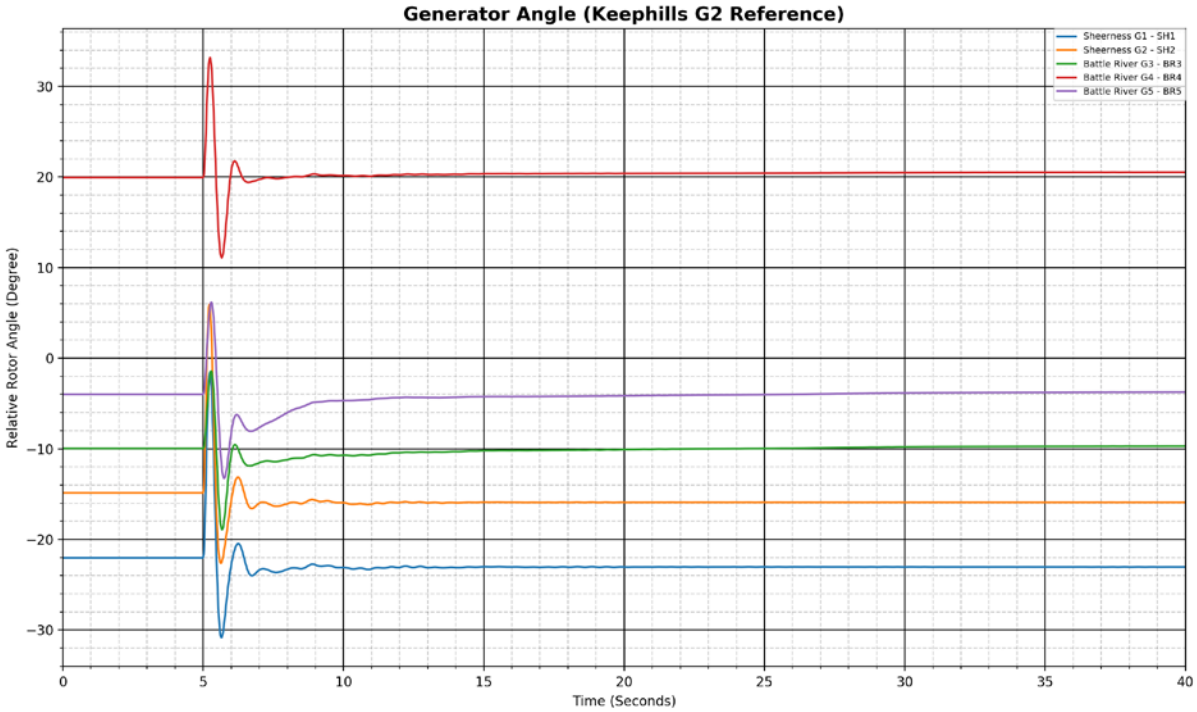
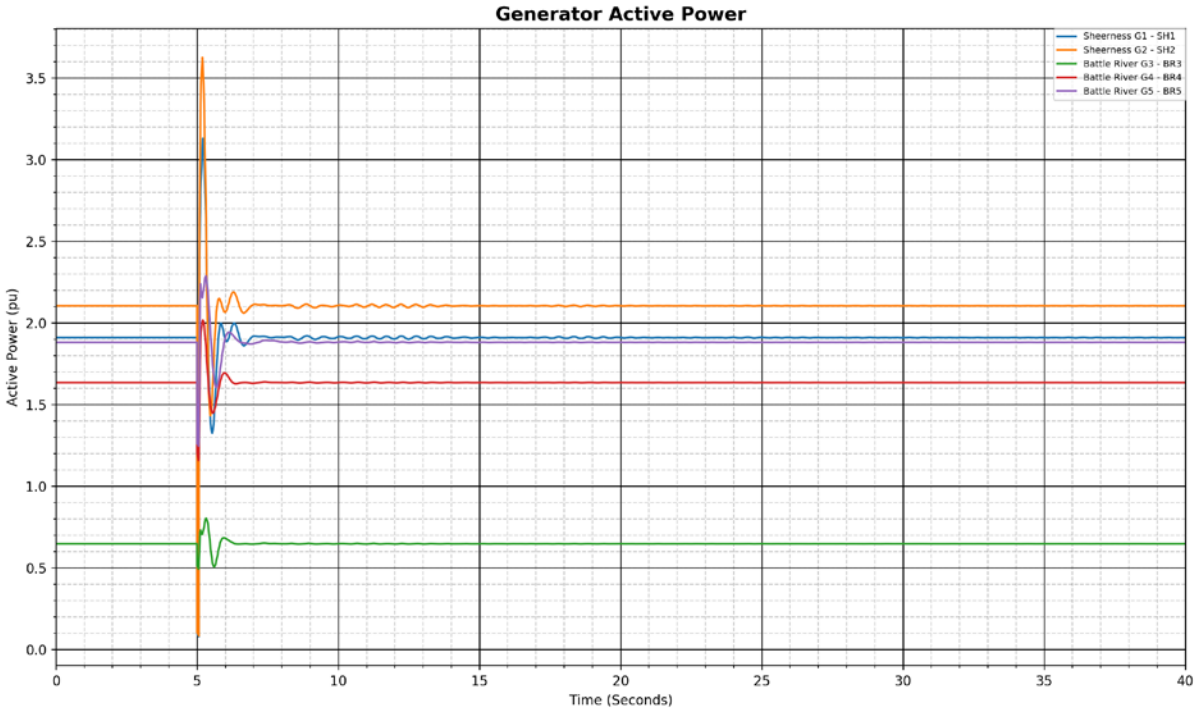
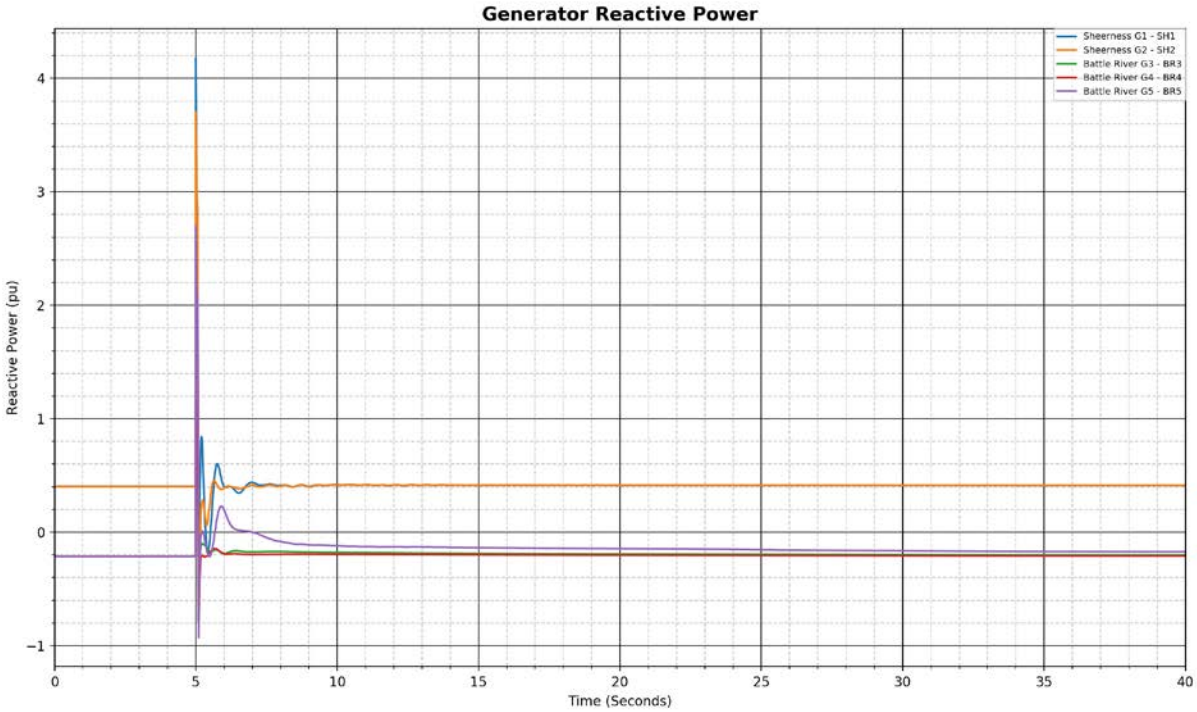

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

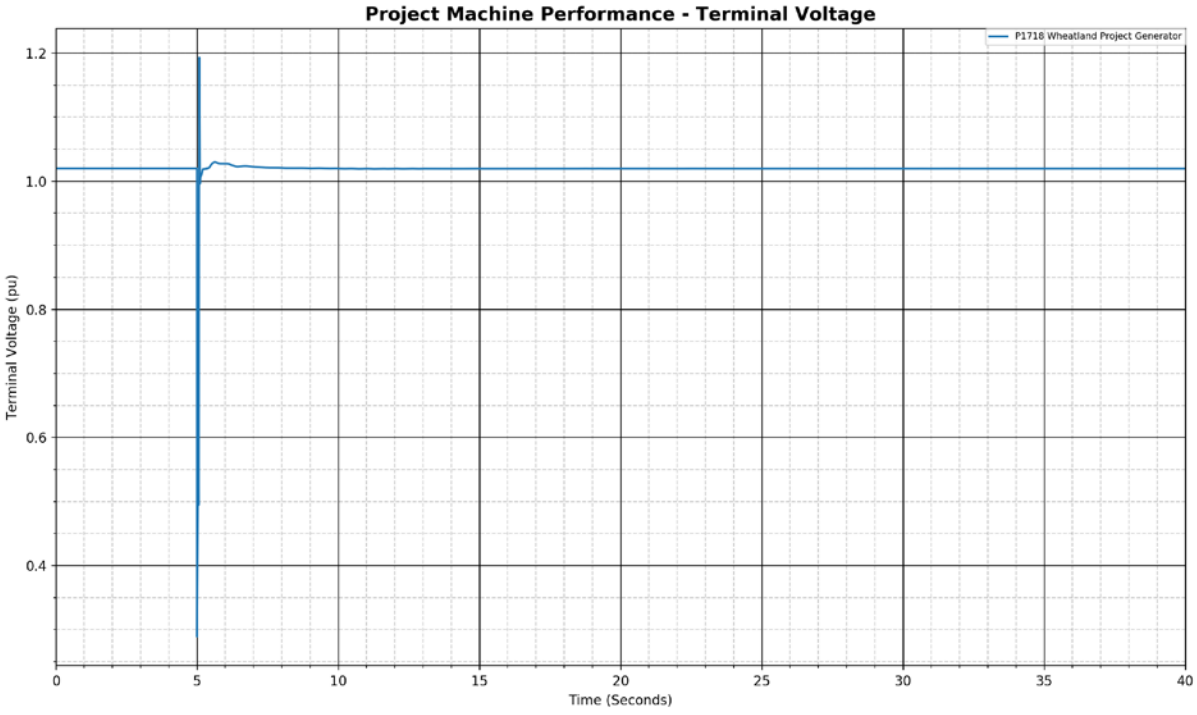
Figure A4-7: 9L59 (Anderson 801S - Tinchebray 972S): 3-phase fault at Anderson 801S

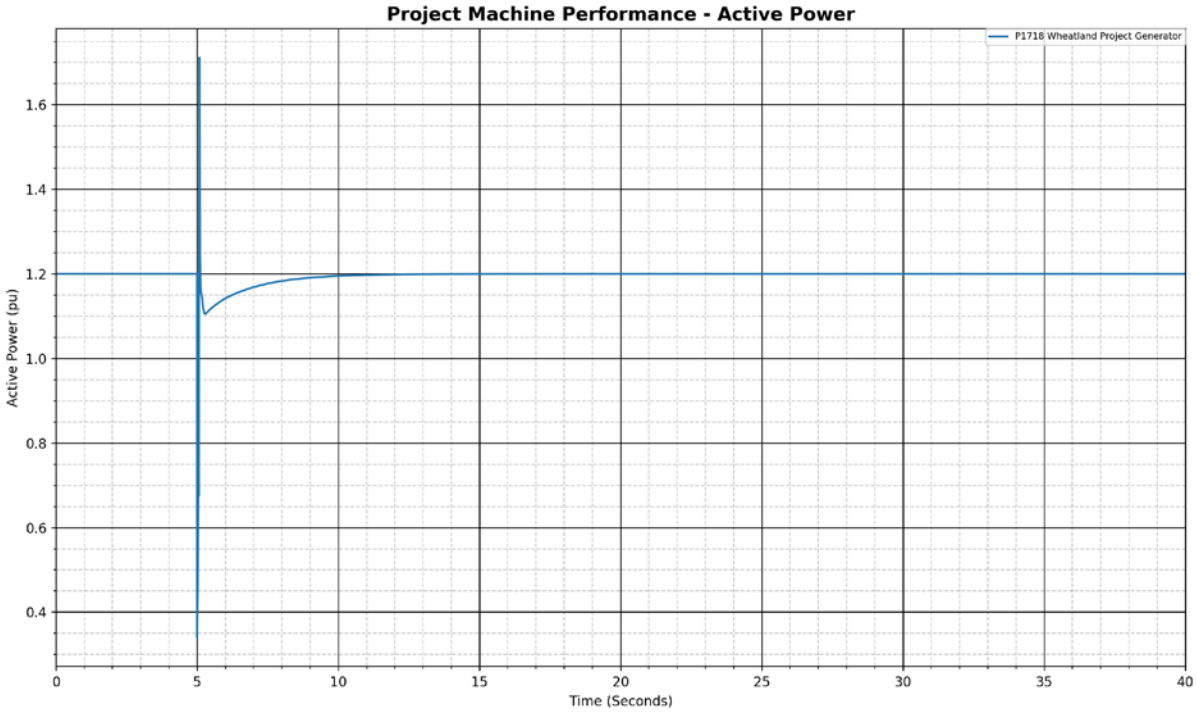


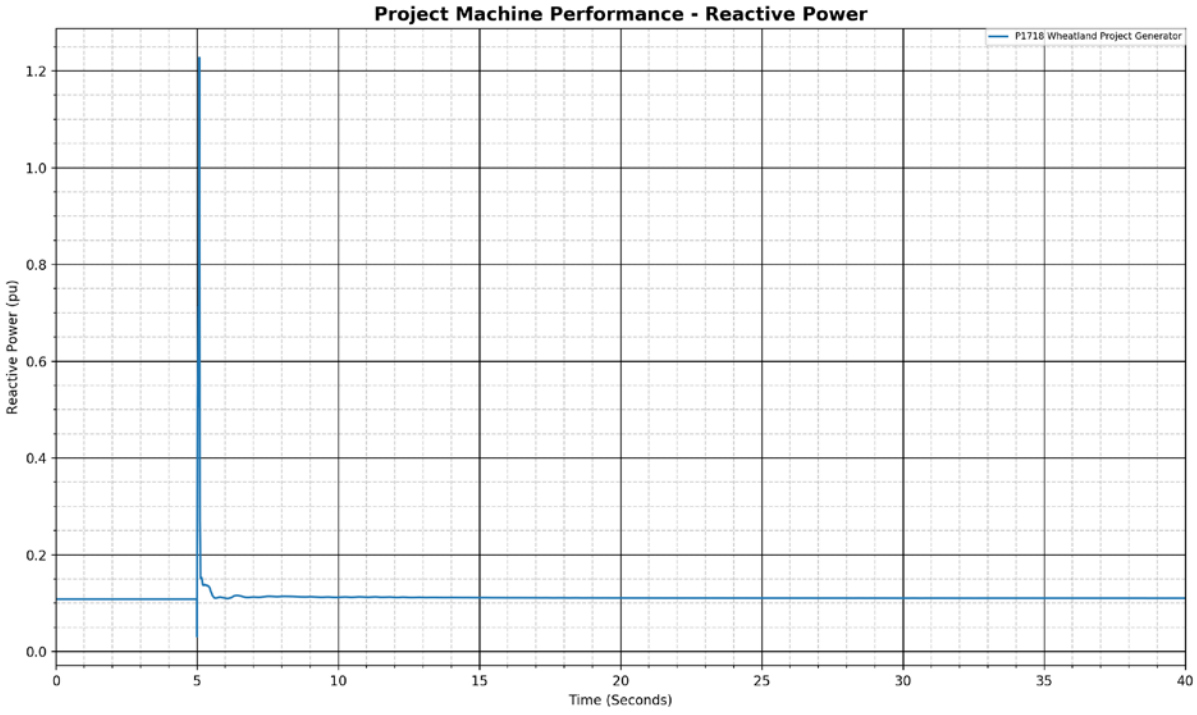

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

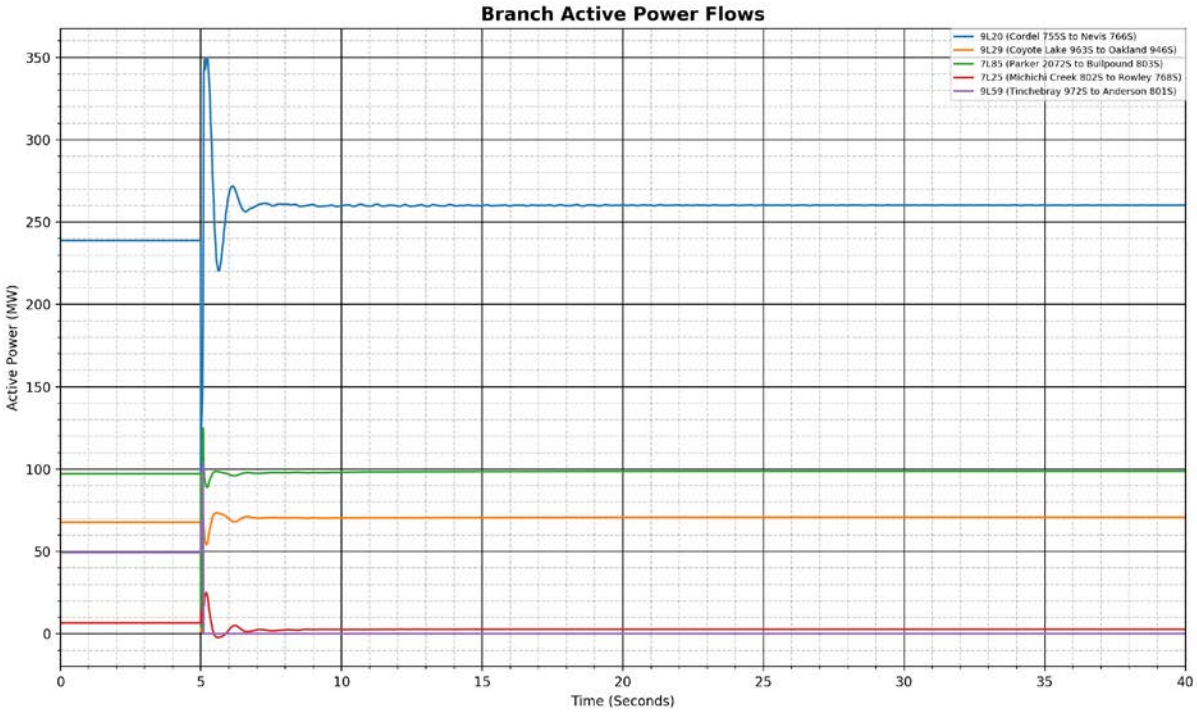

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)


Branch Active Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Active Power (MW)
Time (Seconds)

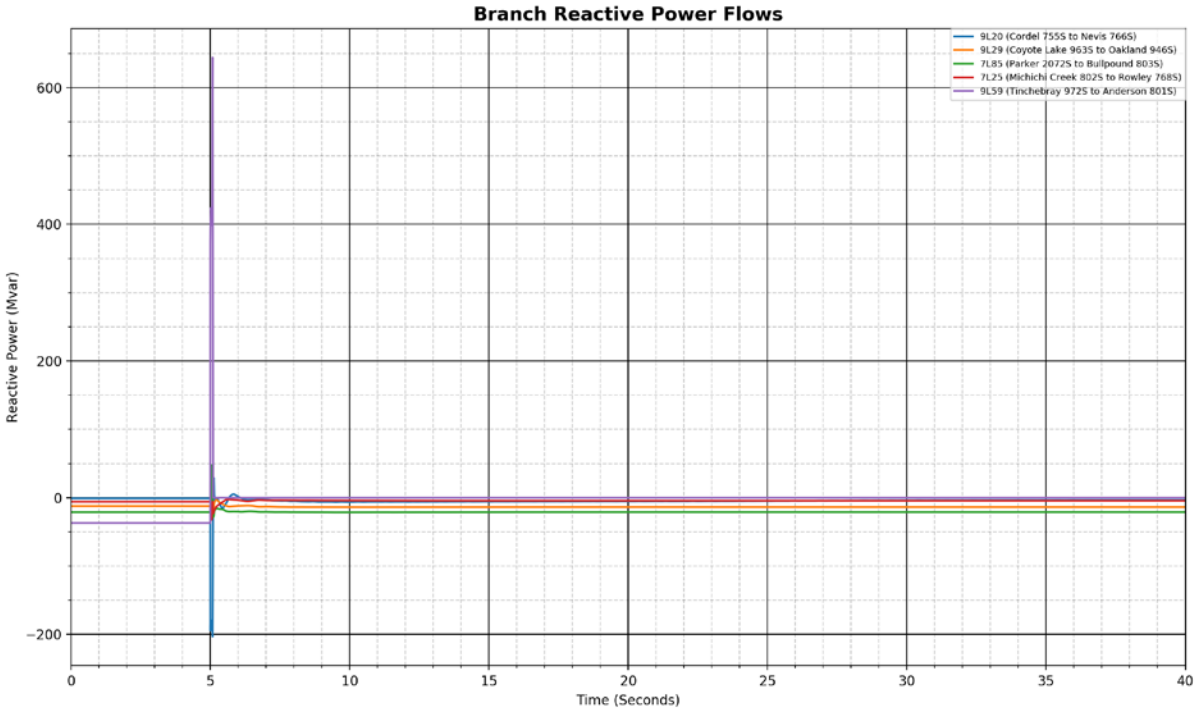
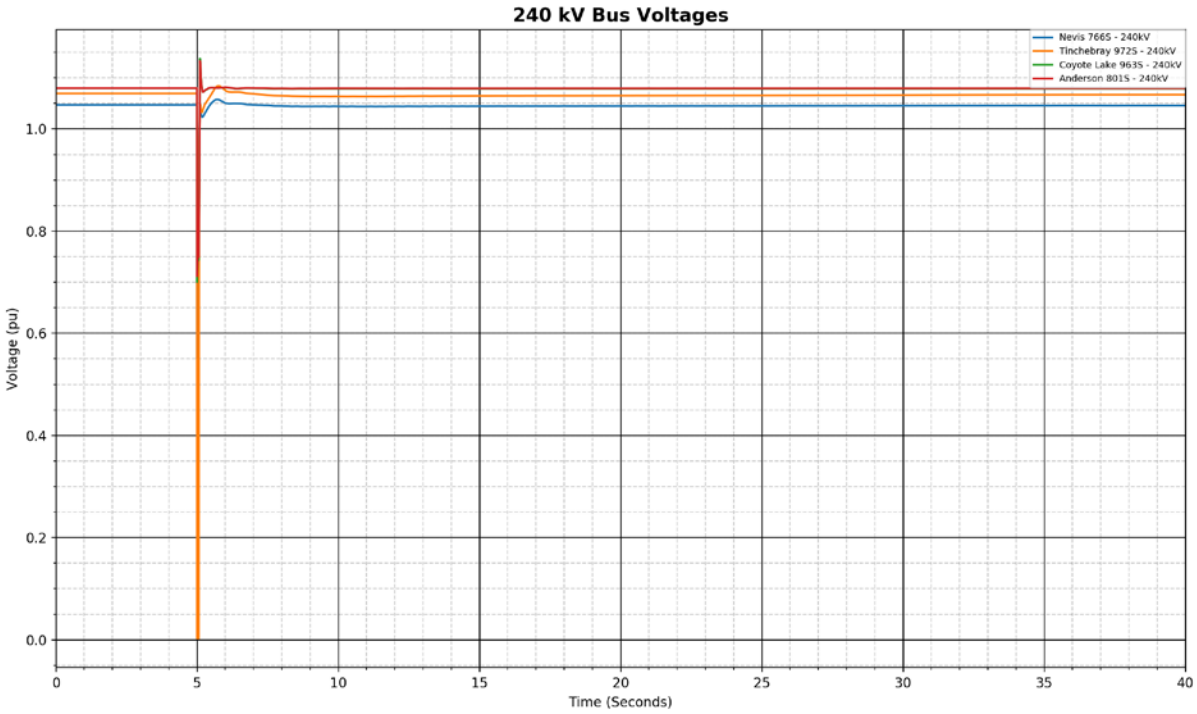
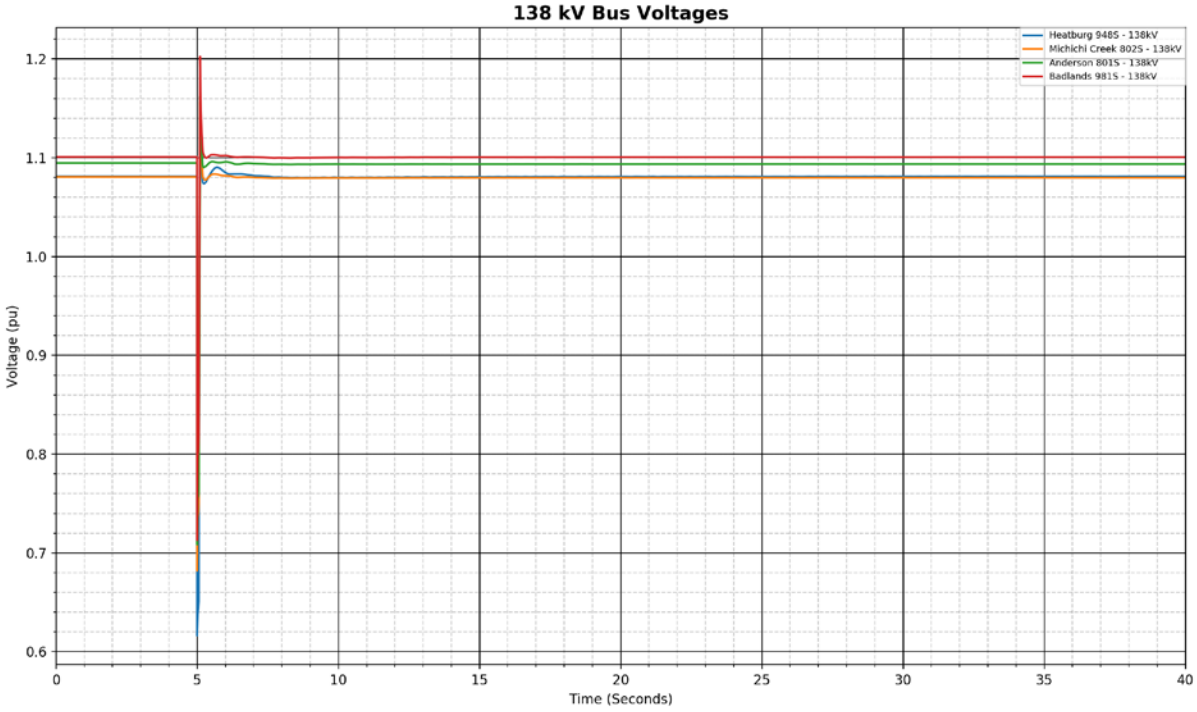
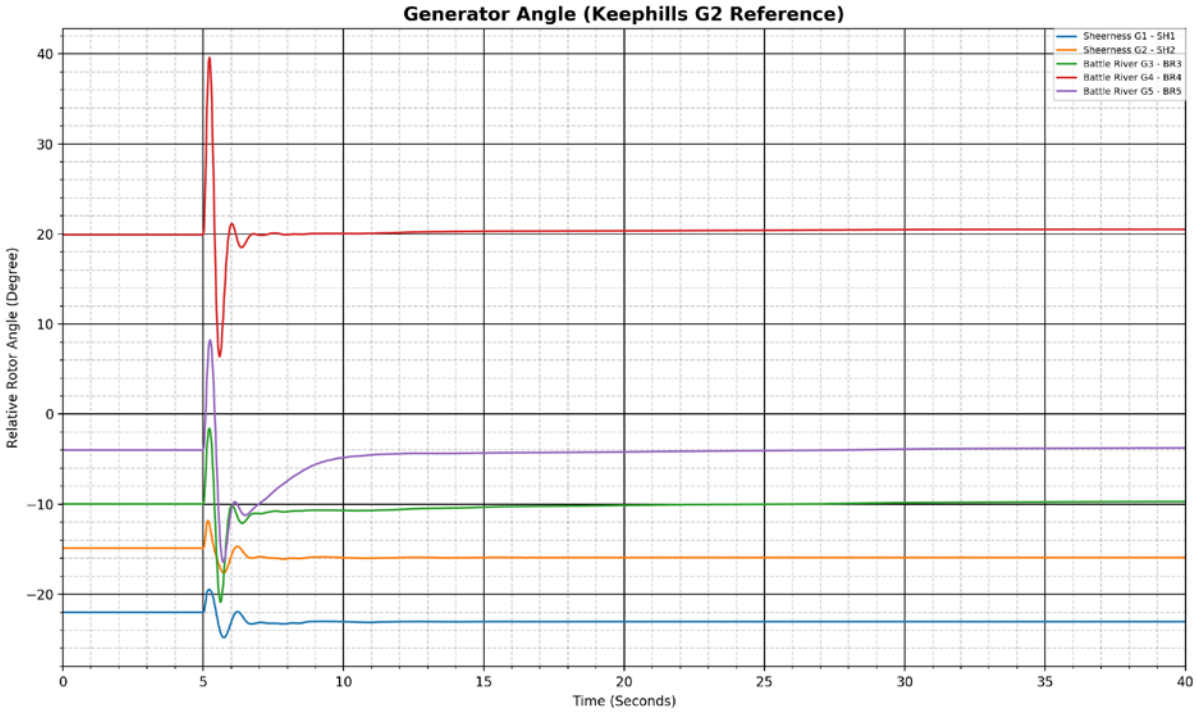
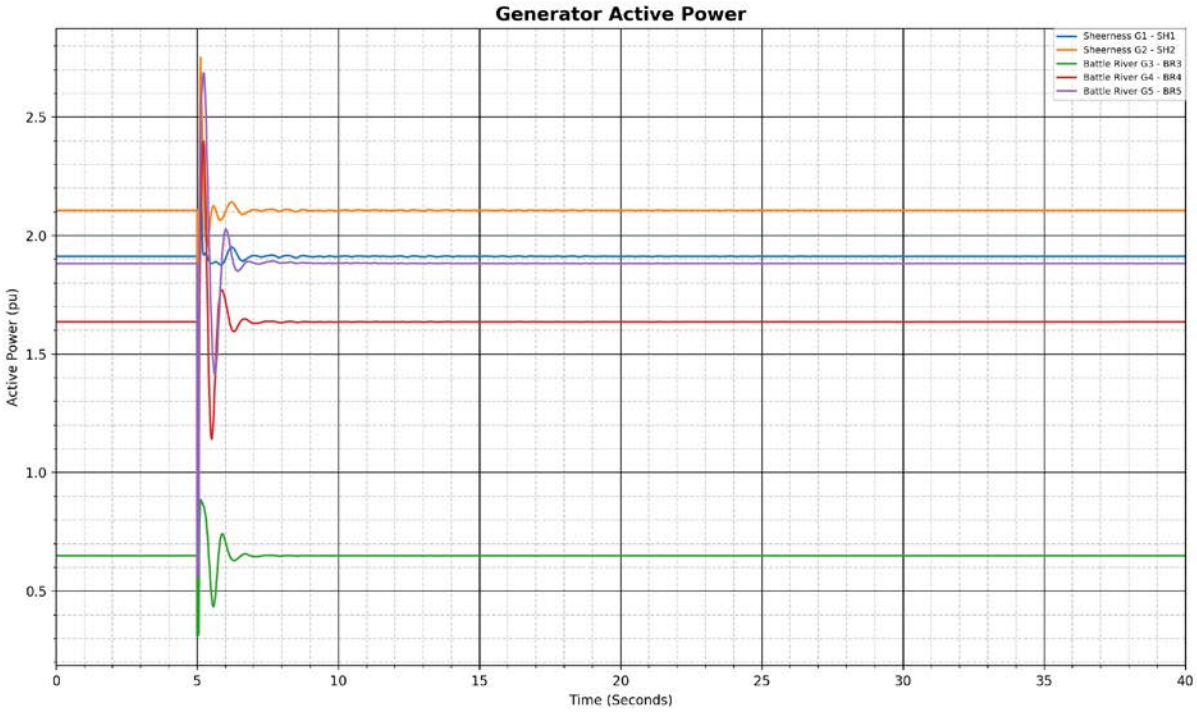

Branch Reactive Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Reactive Power (Mvar)
Time (Seconds)

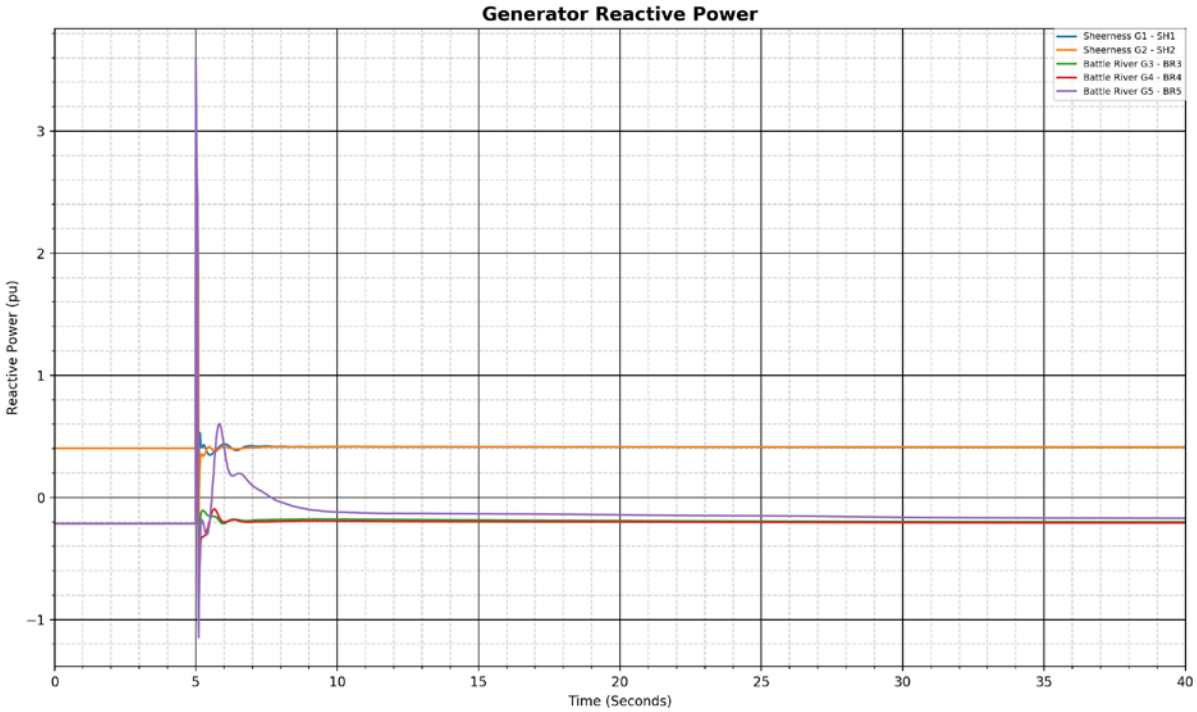
Figure A4-8: 9L59 (Anderson 801S - Tinchebray 972S): 3-phase fault at Tinchebray 972S

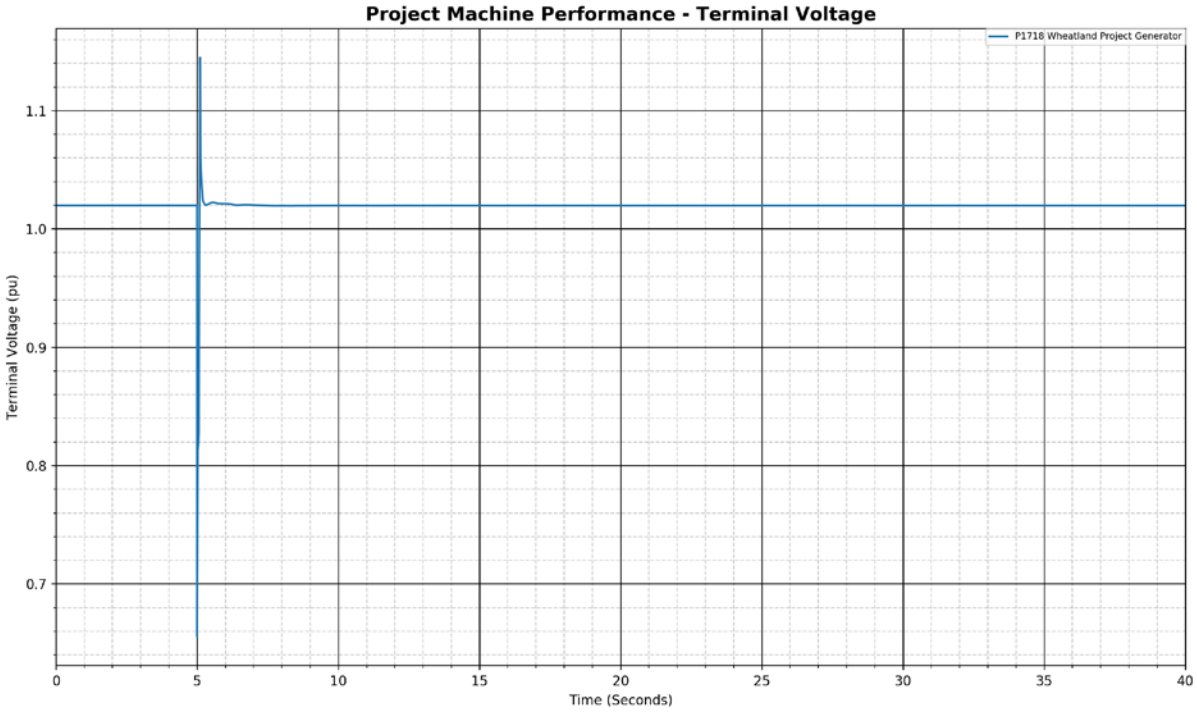


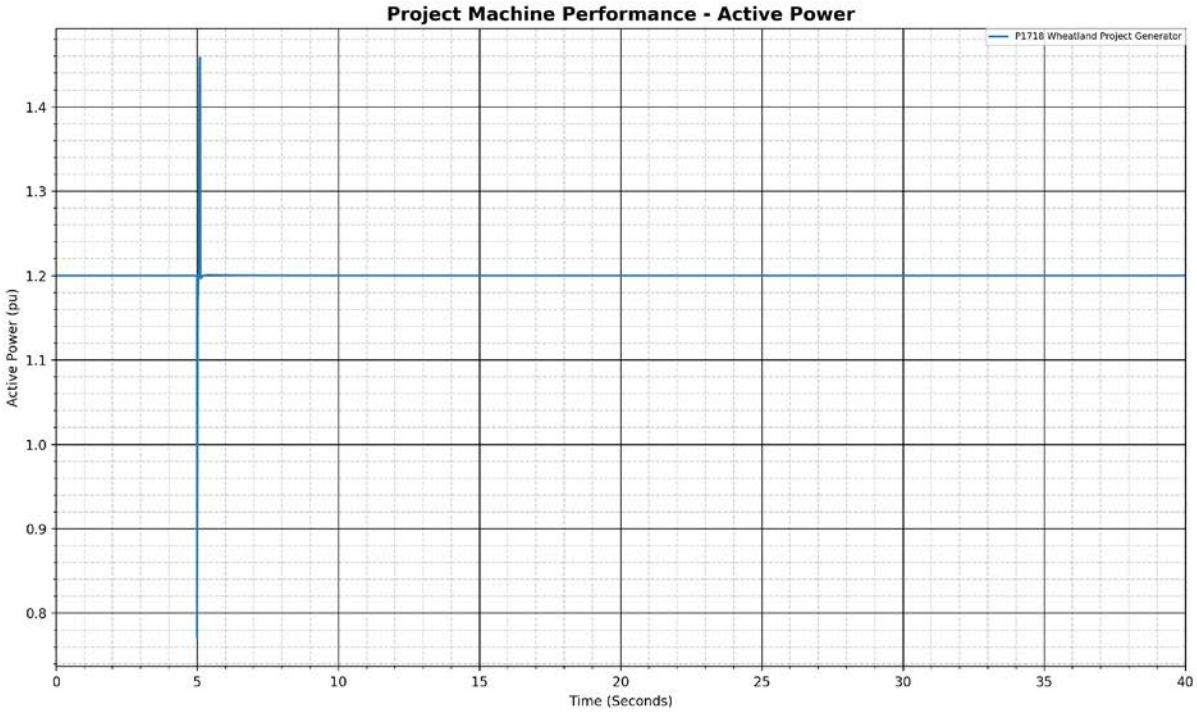


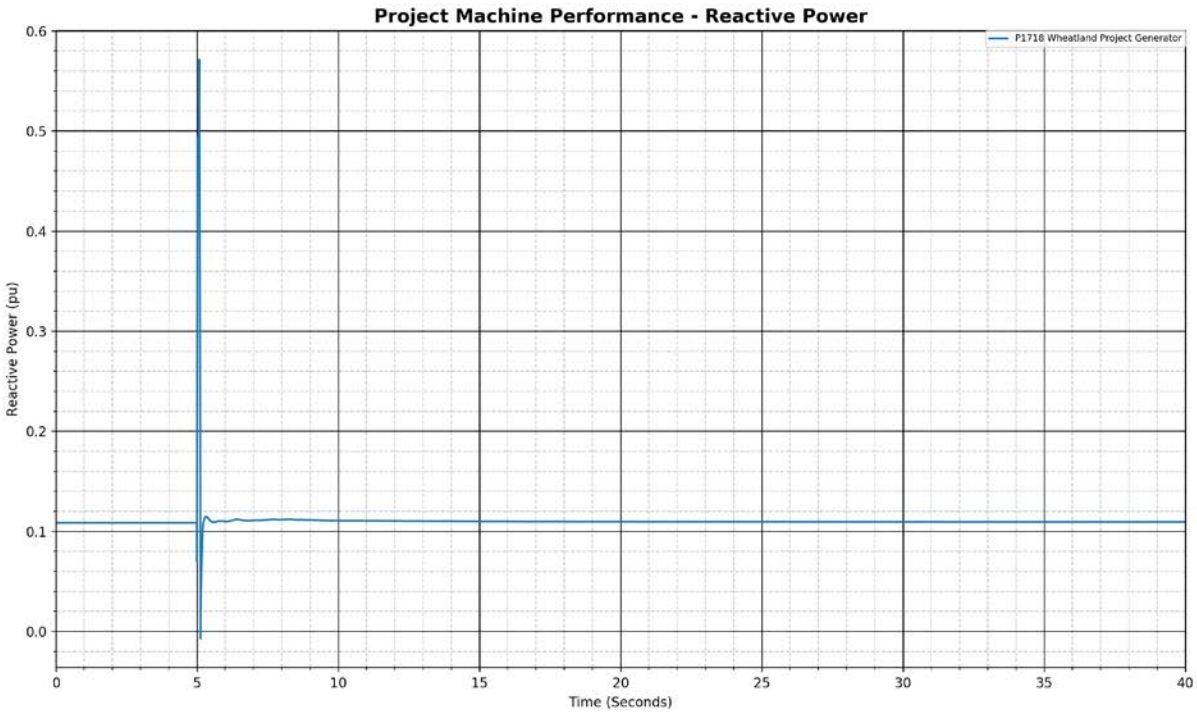

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

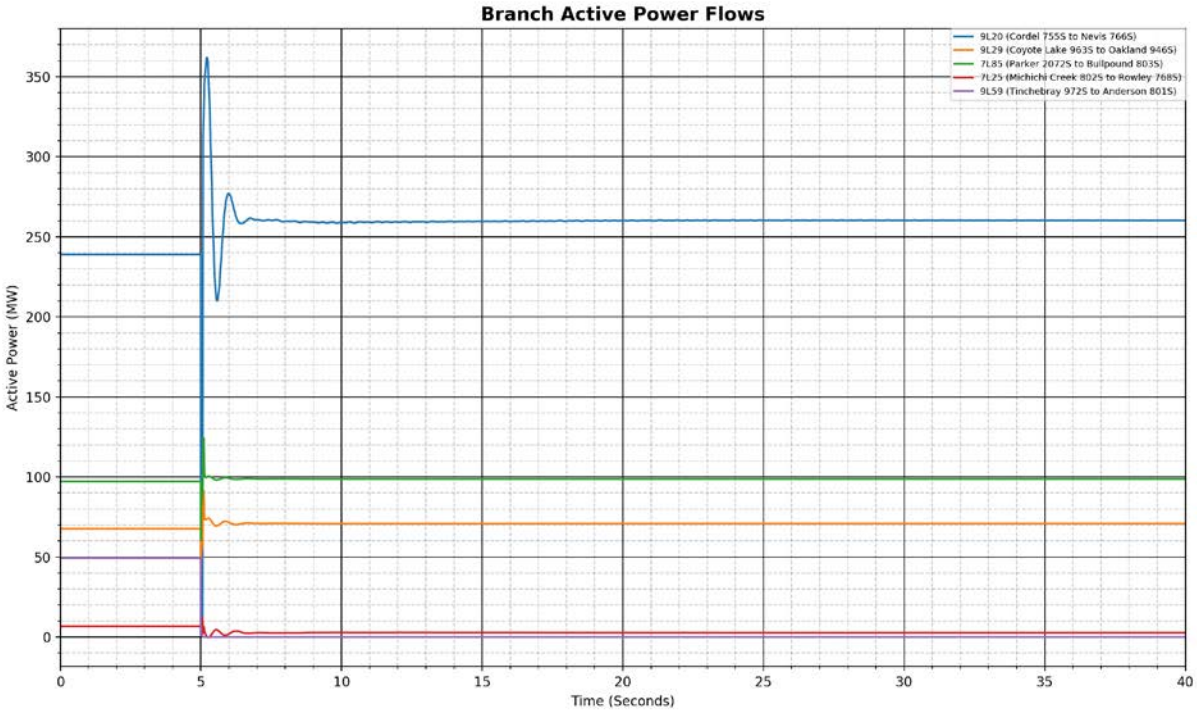

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
3
2
1
0
−1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Active Power (MW)
Time (Seconds)

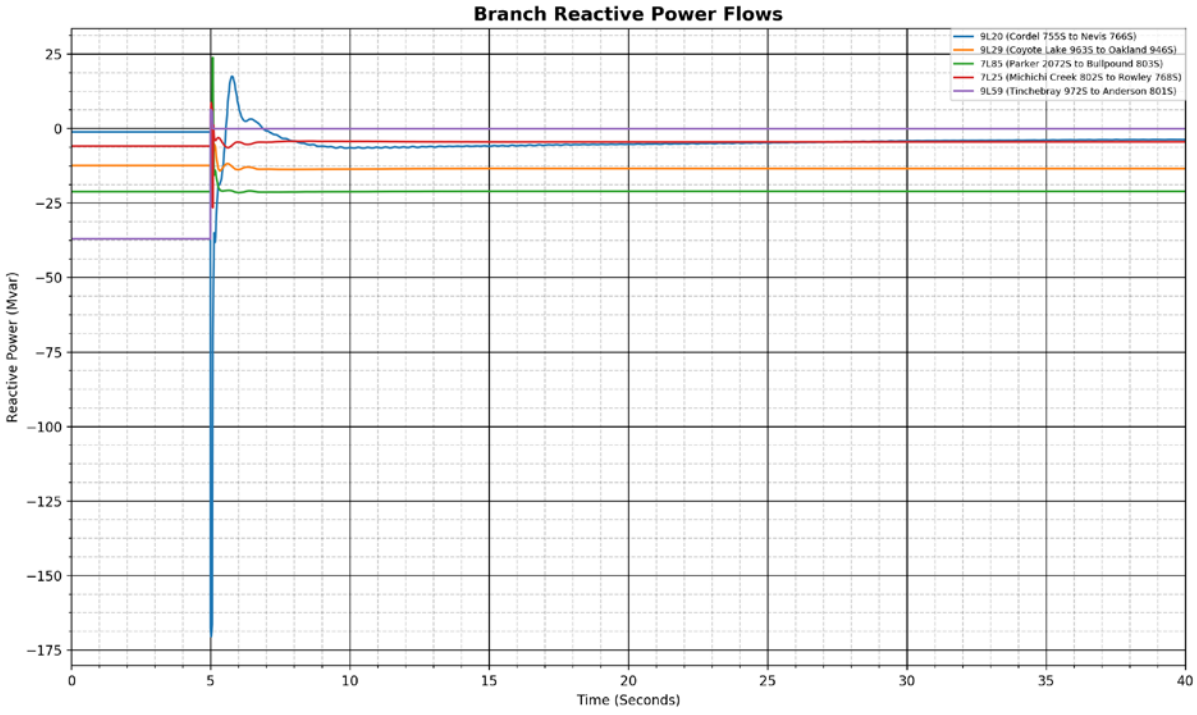
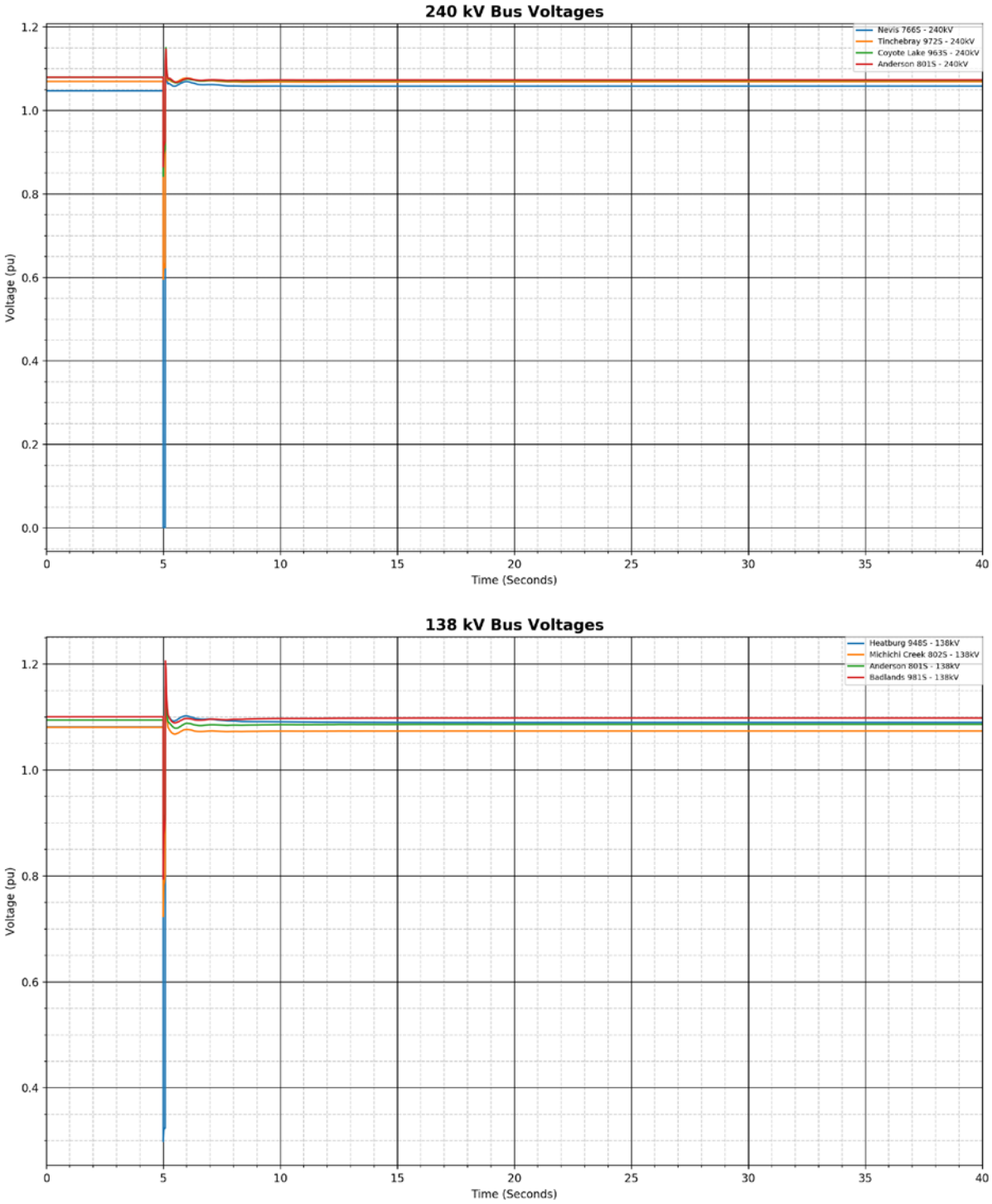
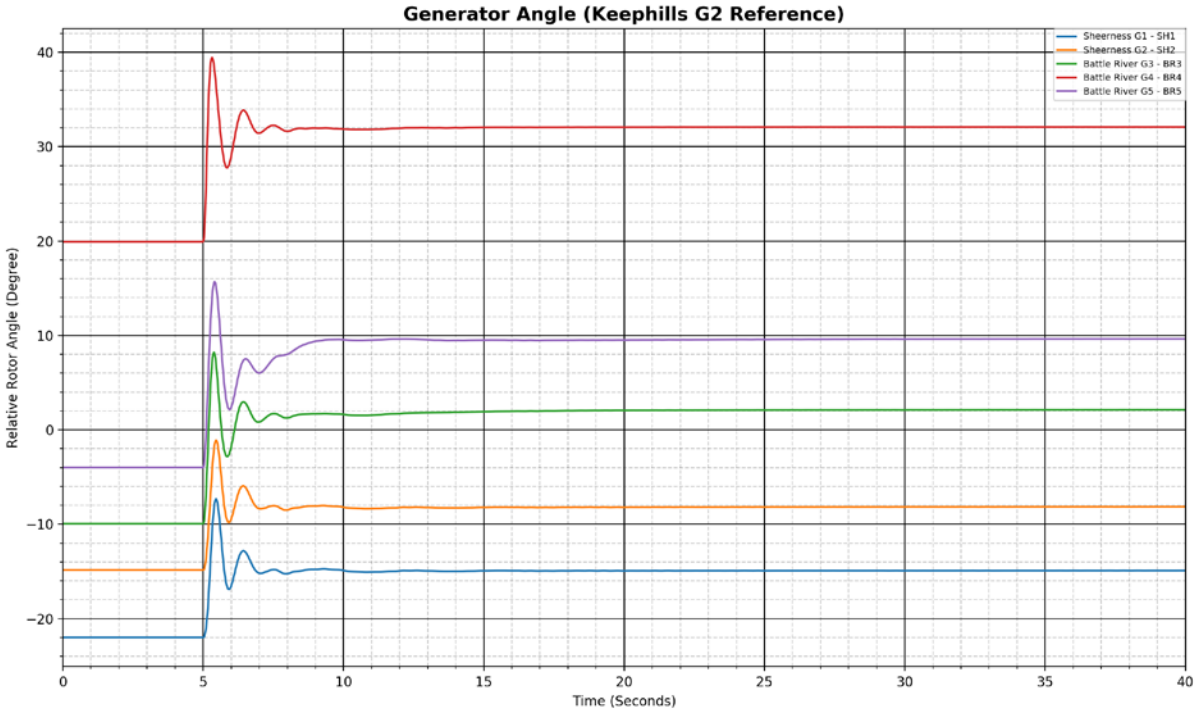
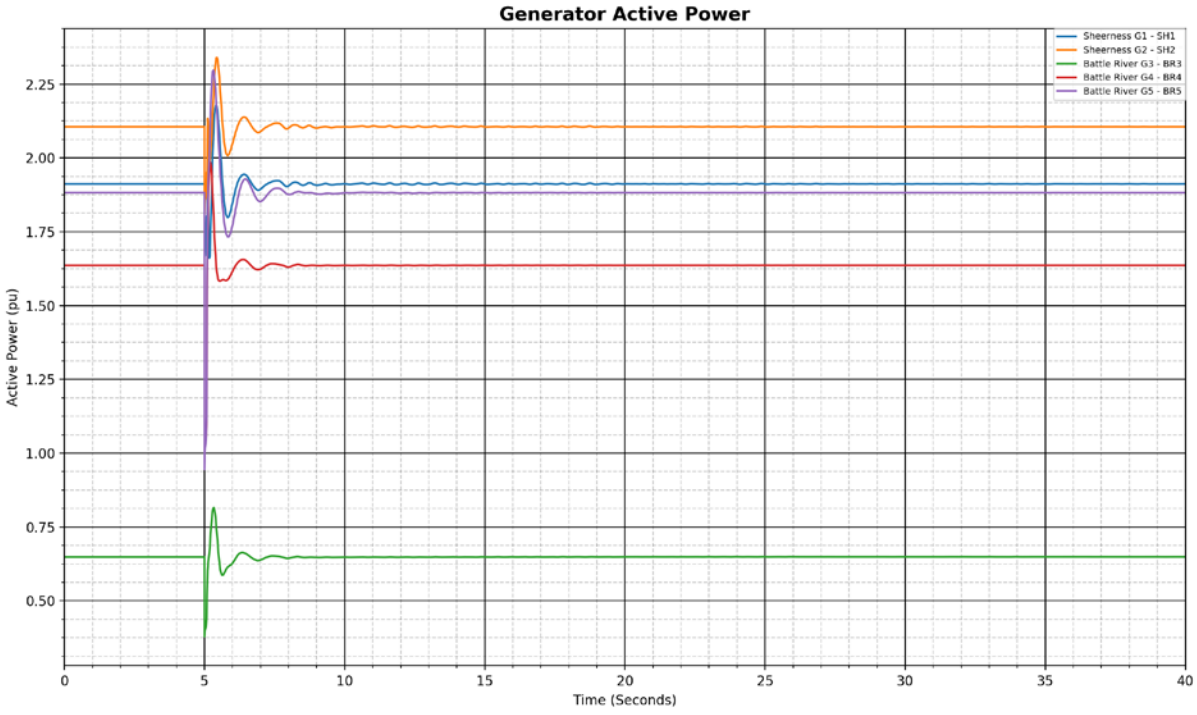
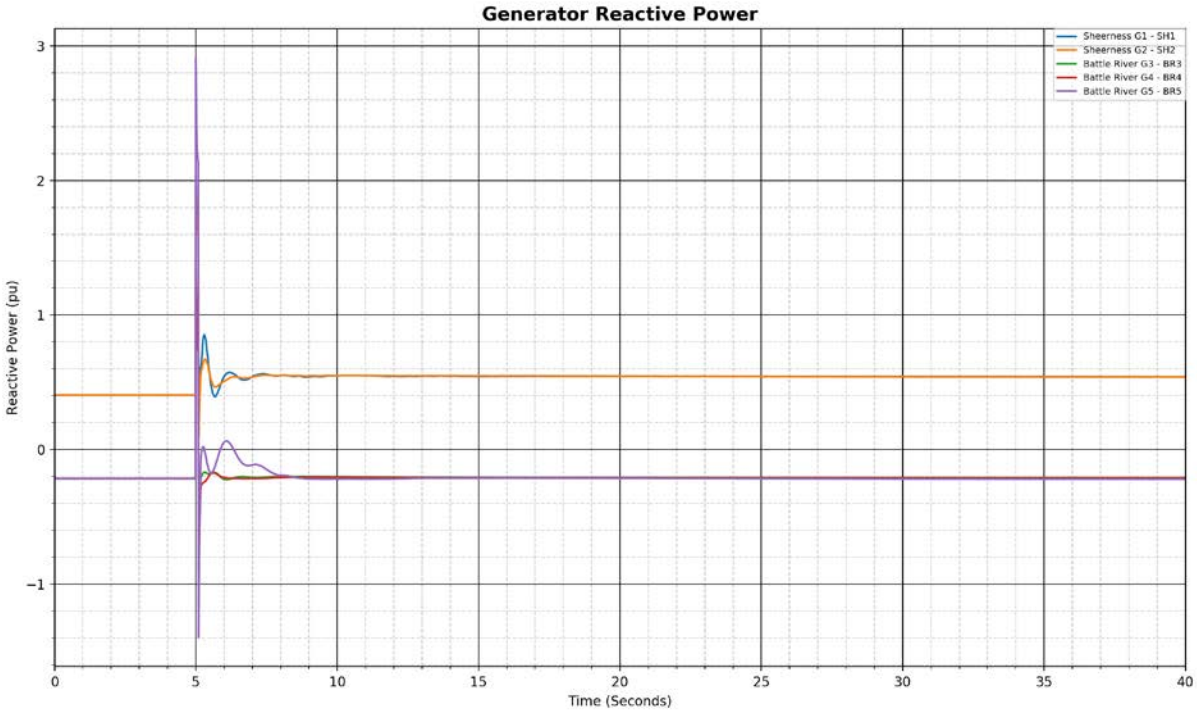

Branch Reactive Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Reactive Power (Mvar)
Time (Seconds)

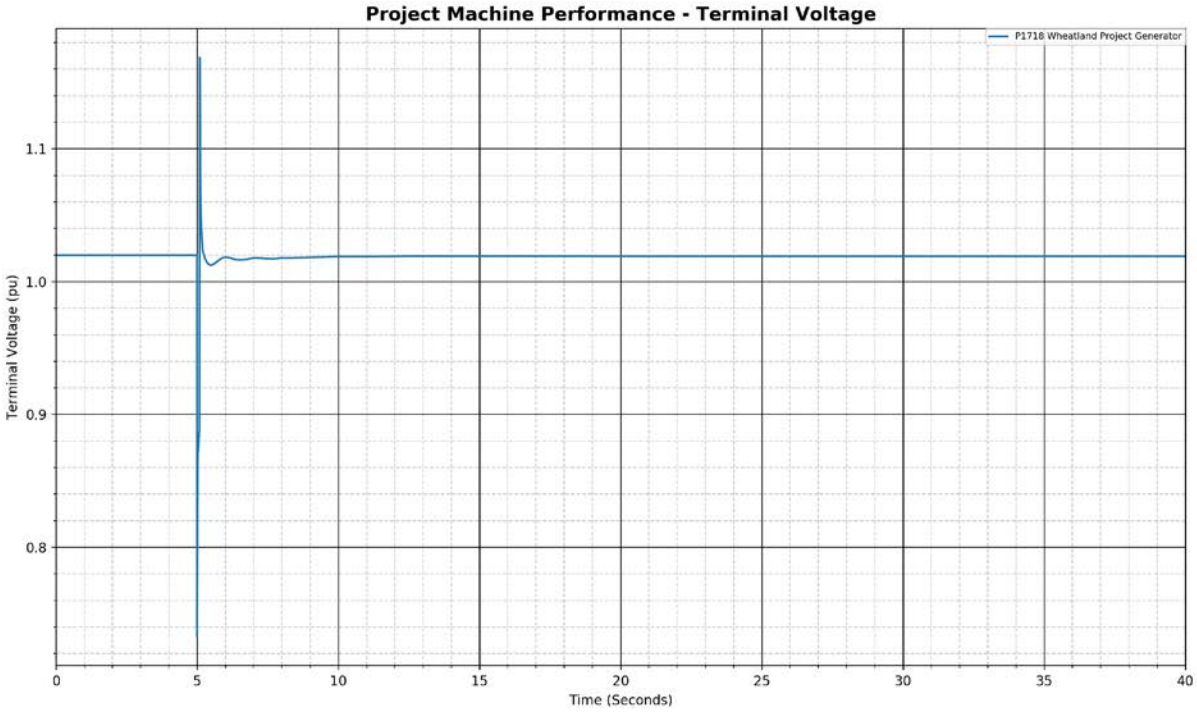
Figure A4-9: 912L/9L912 (Nevis 766S - Red Deer 63S): 3-phase fault at Nevis 766S

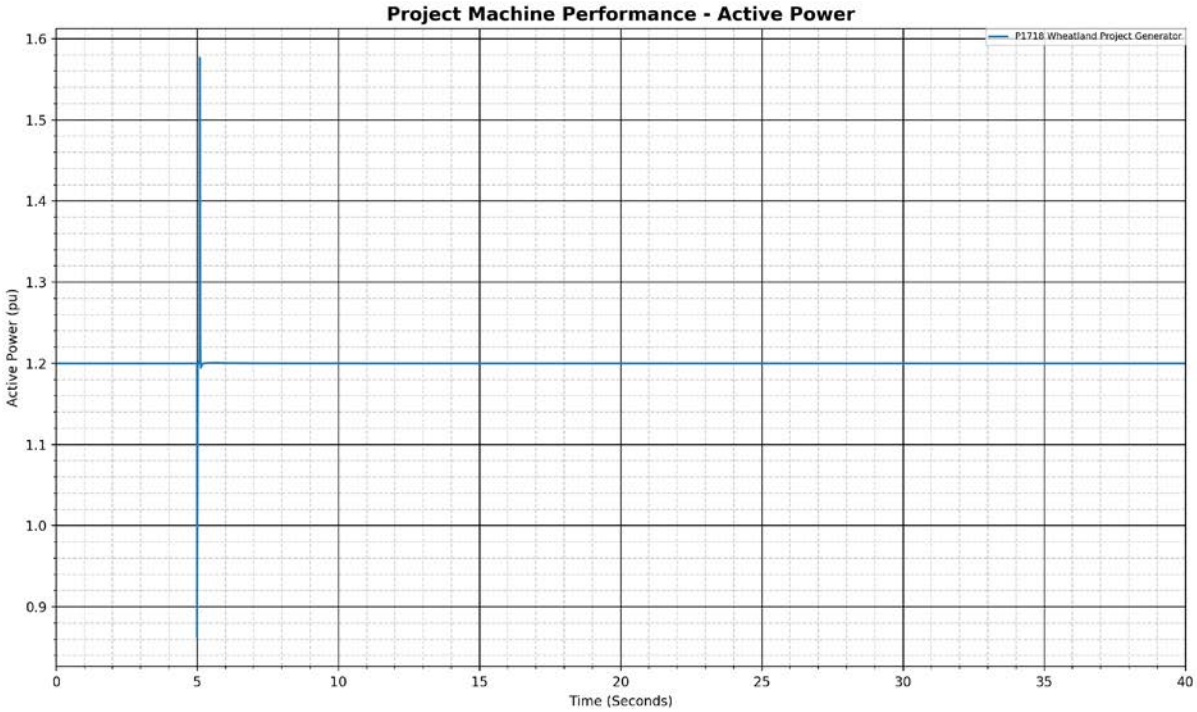


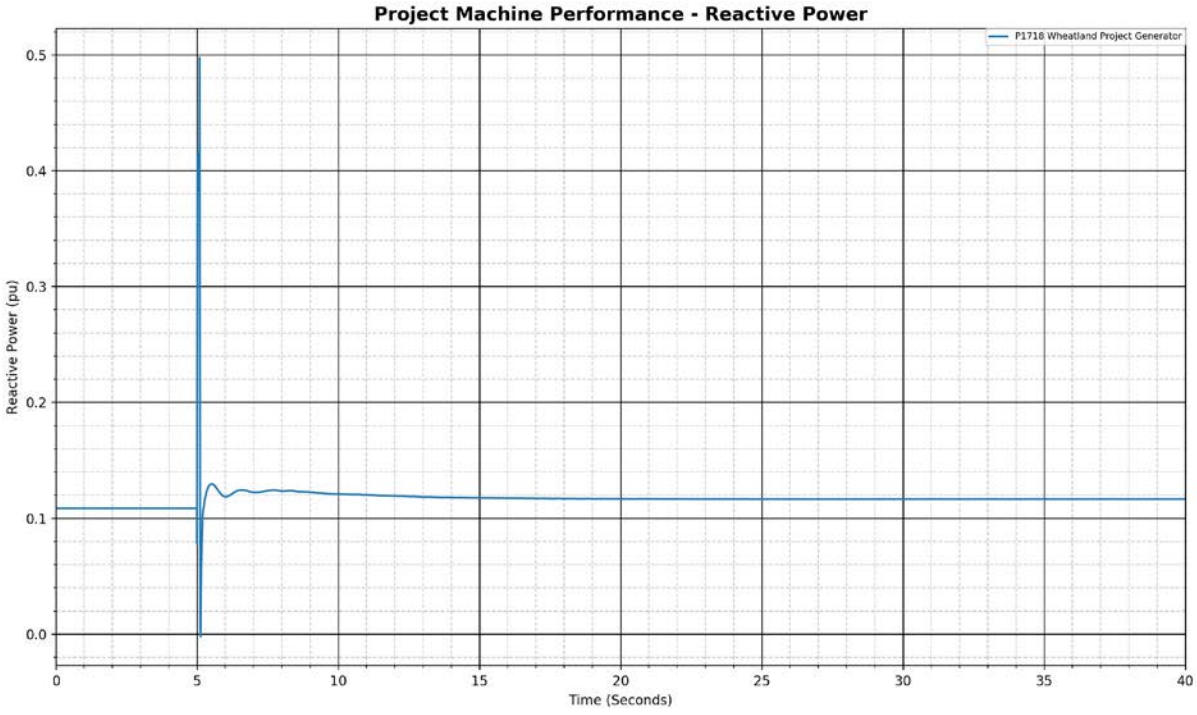

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

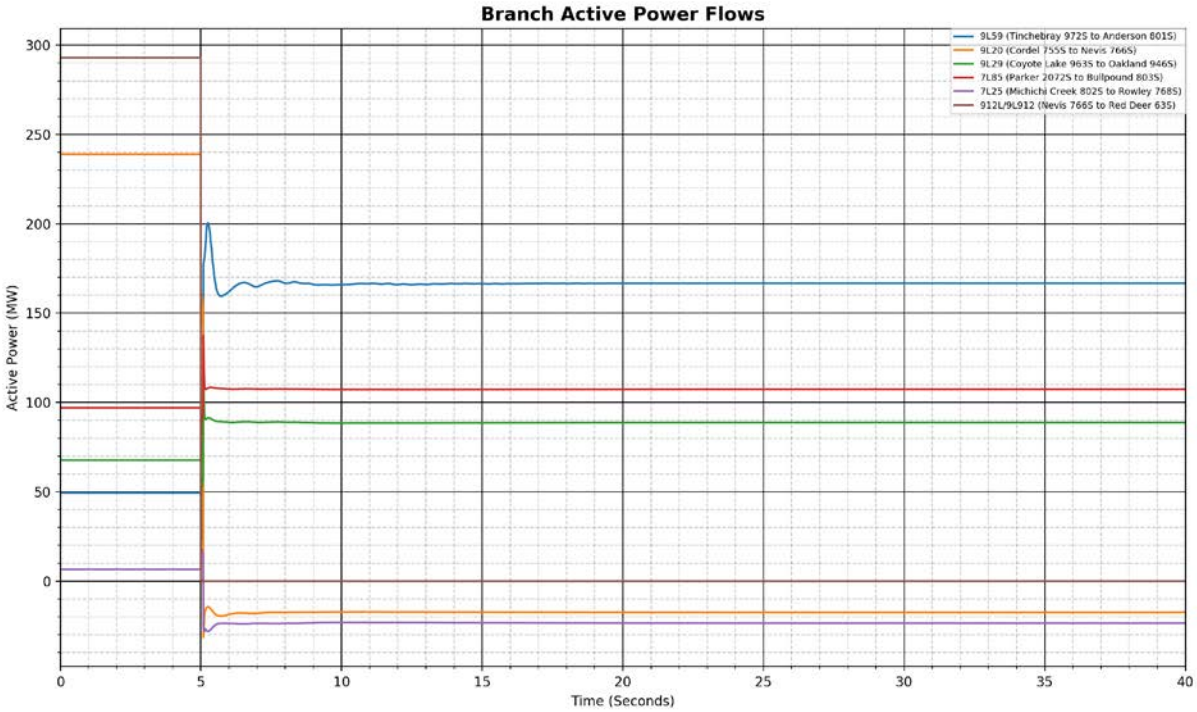

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Active Power (MW)
Time (Seconds)

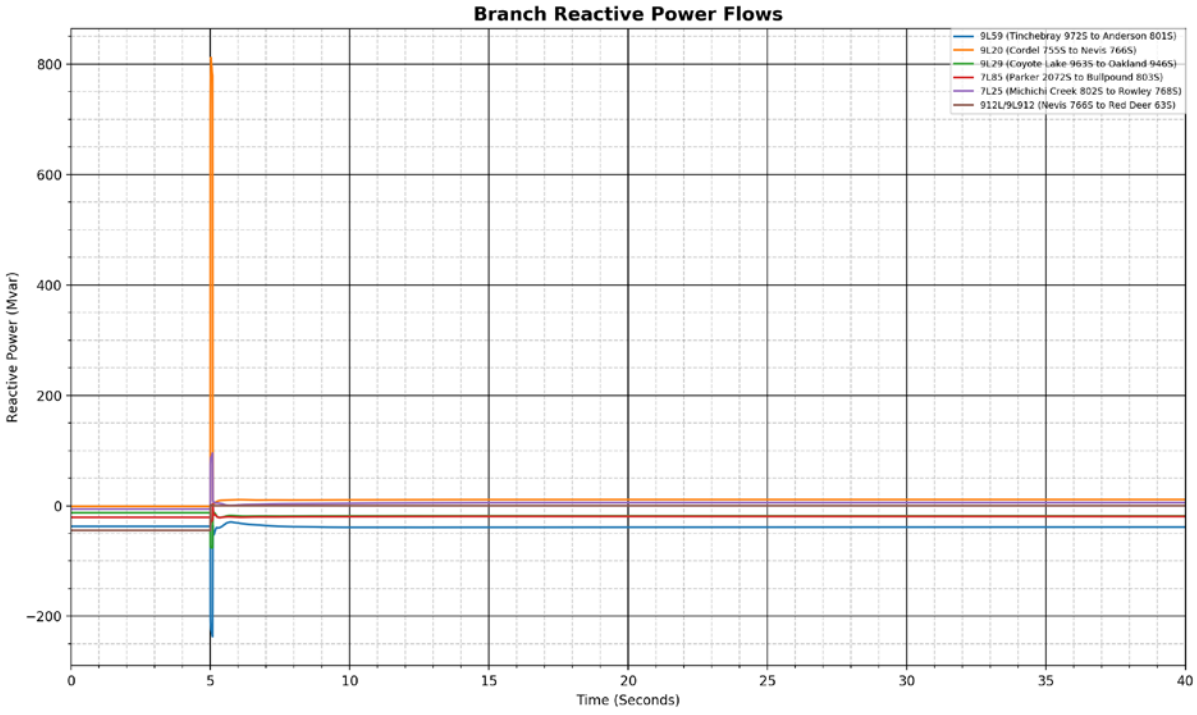
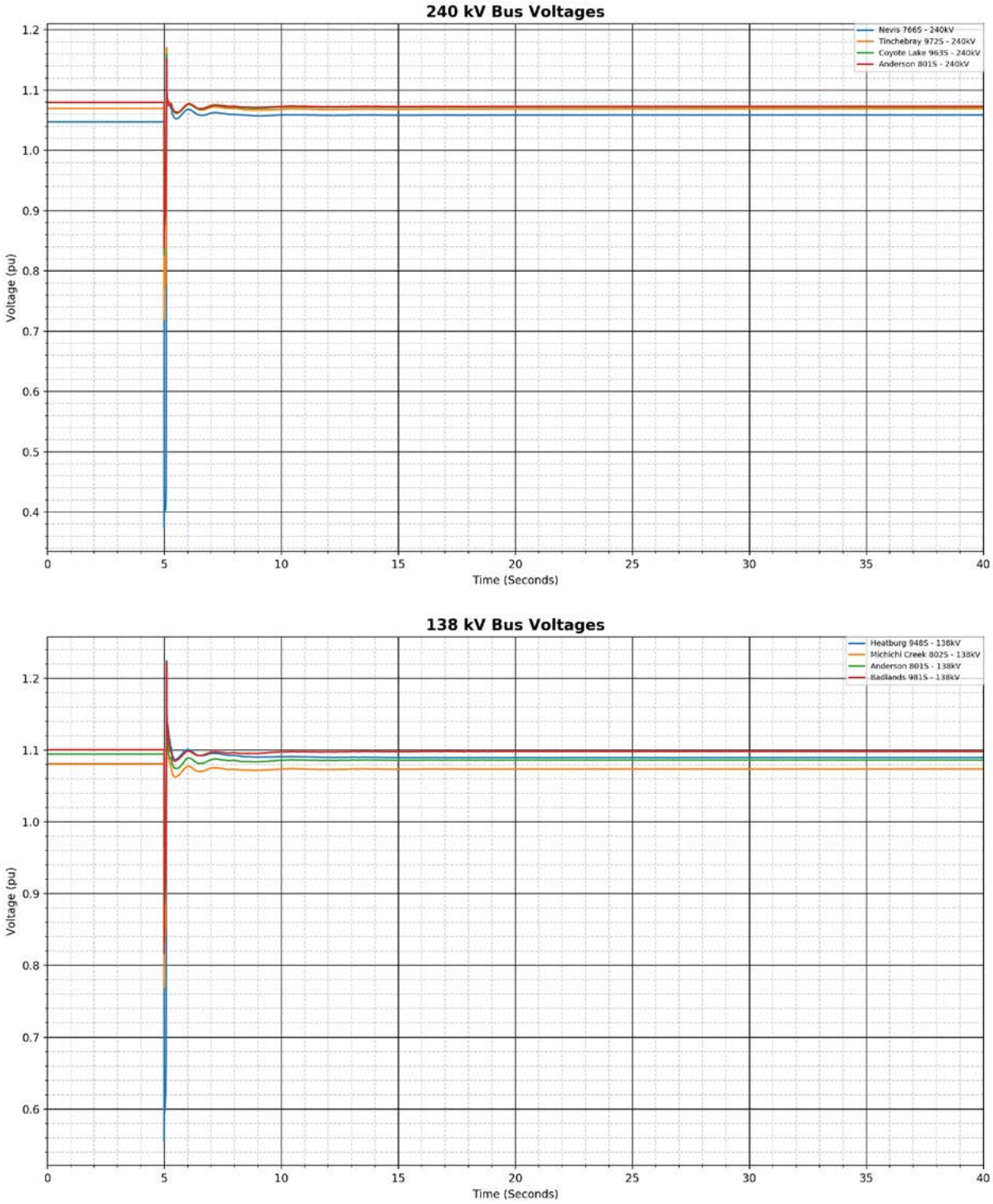
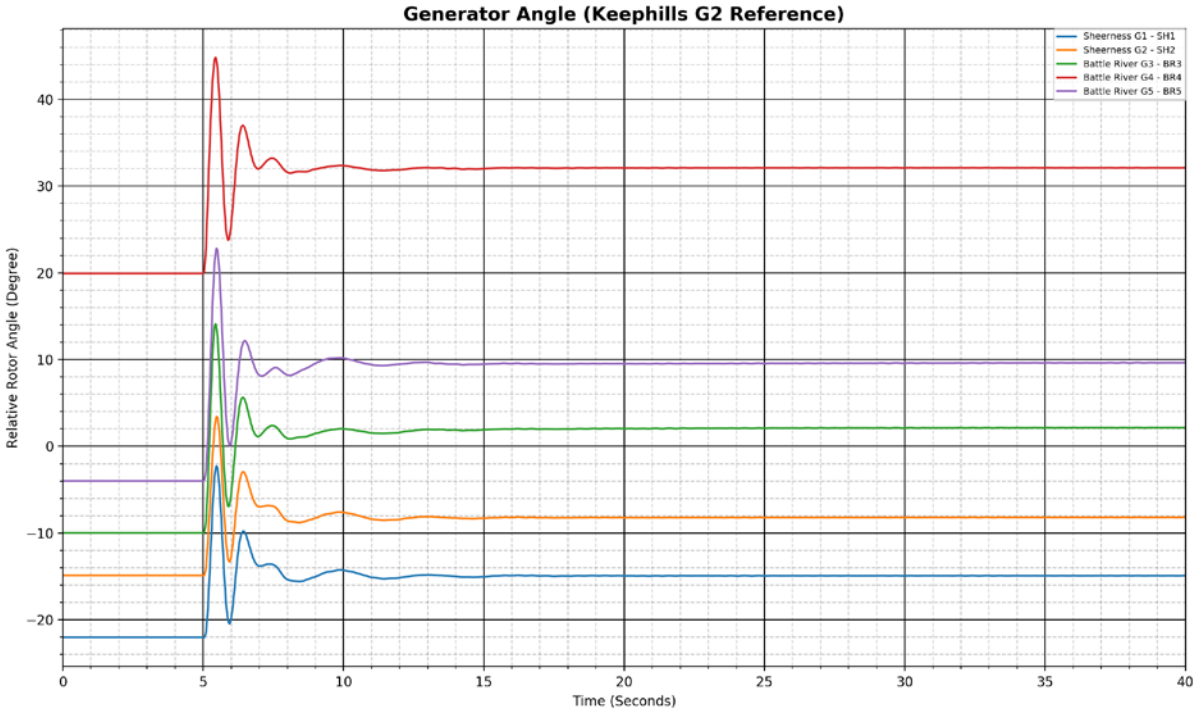
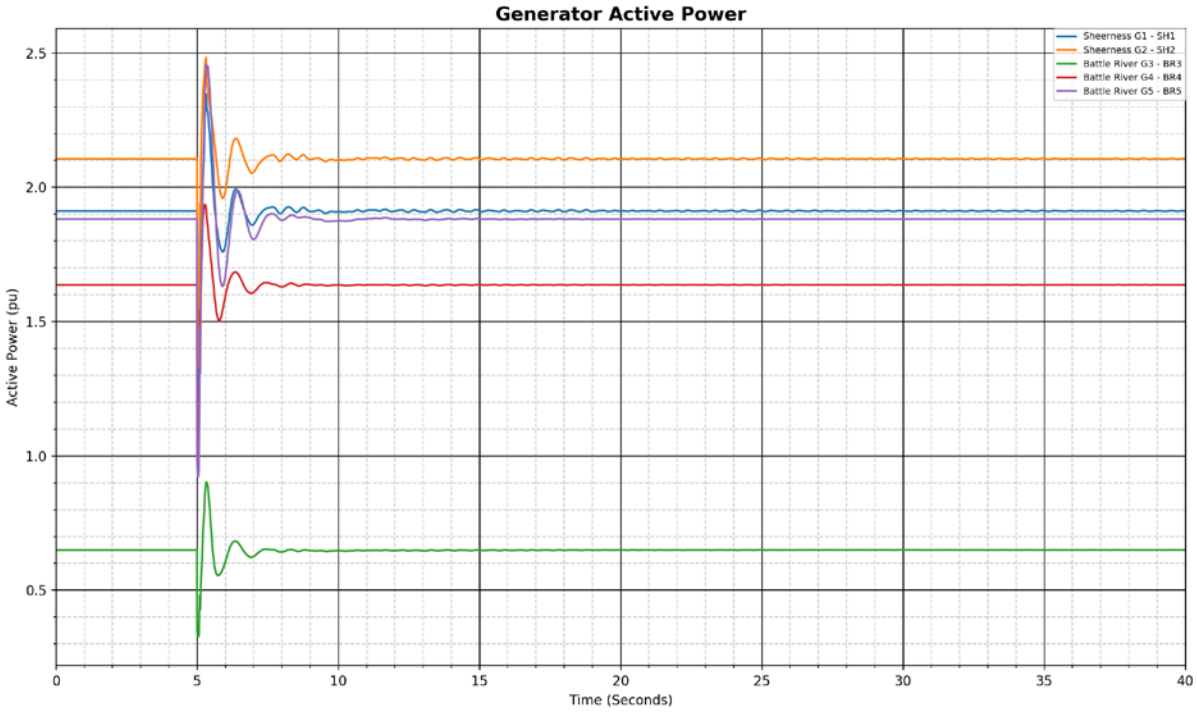
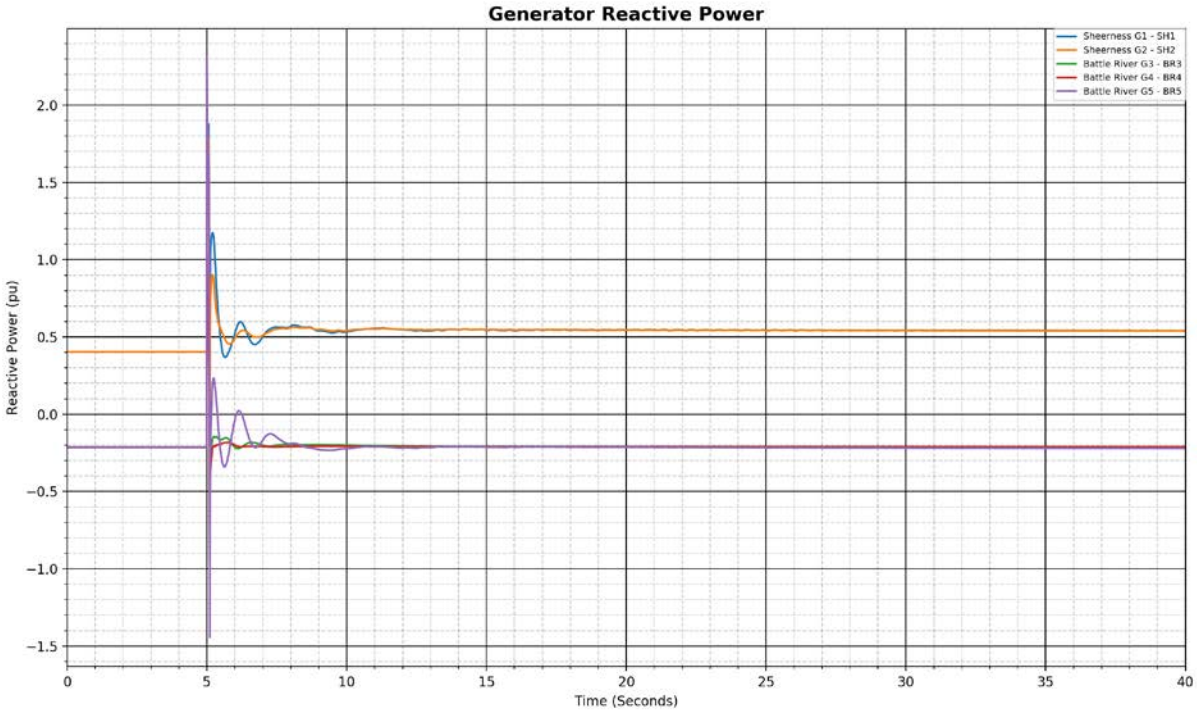

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Reactive Power (Mvar)
Time (Seconds)

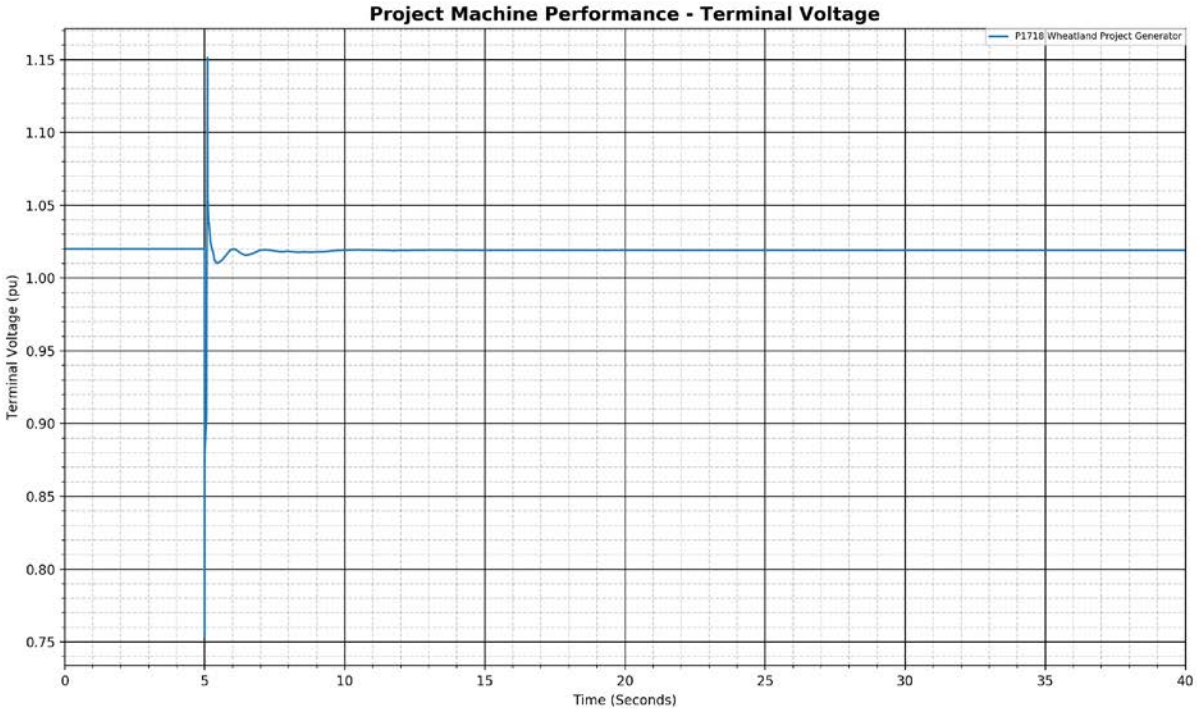
Figure A4-10: 912L/9L912 (Nevis 766S - Red Deer 63S): 3-phase fault at Red Deer 63S

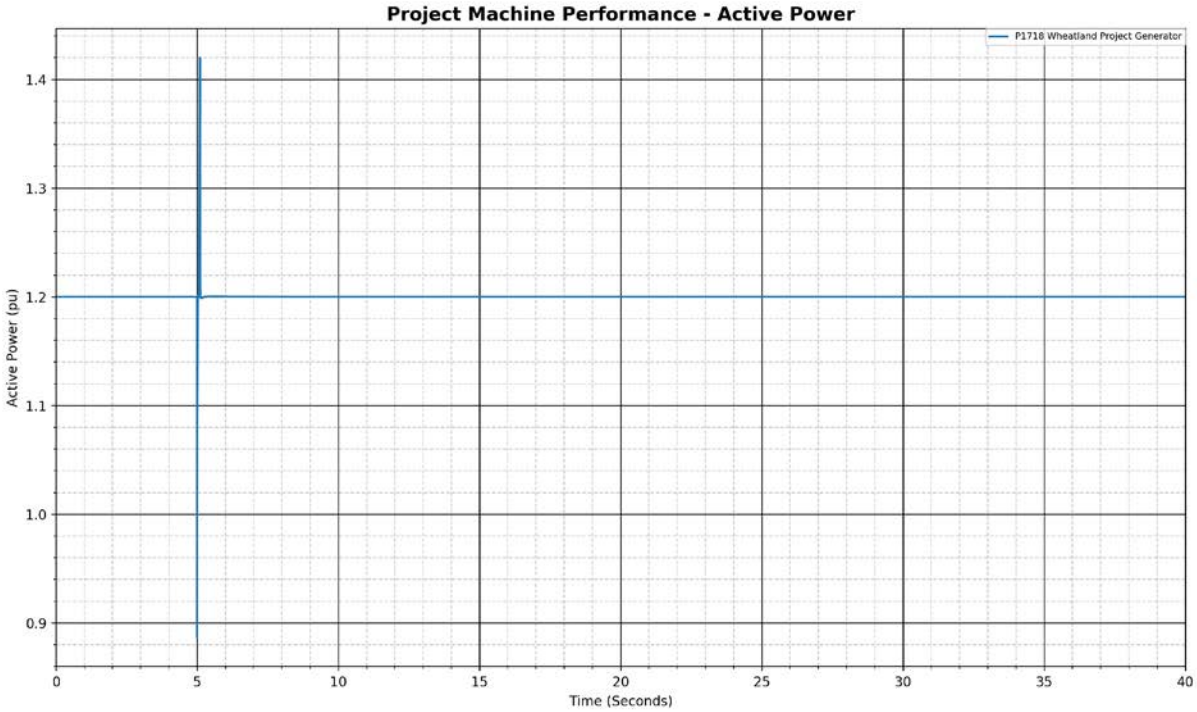


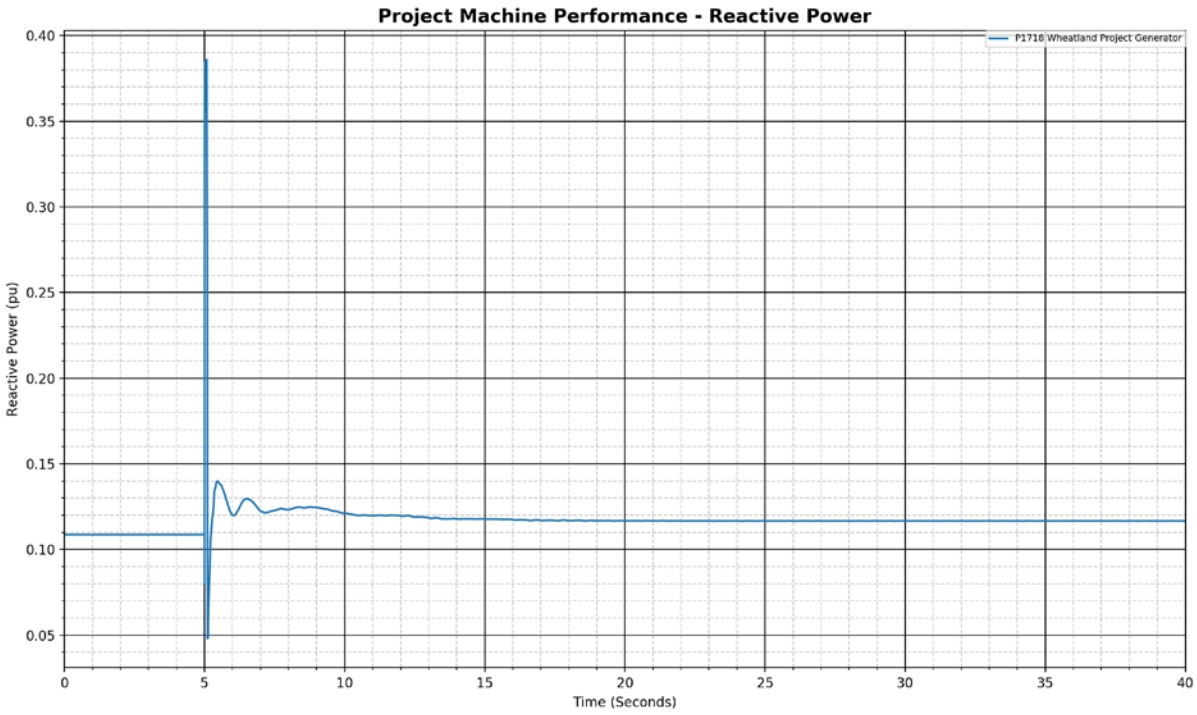

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

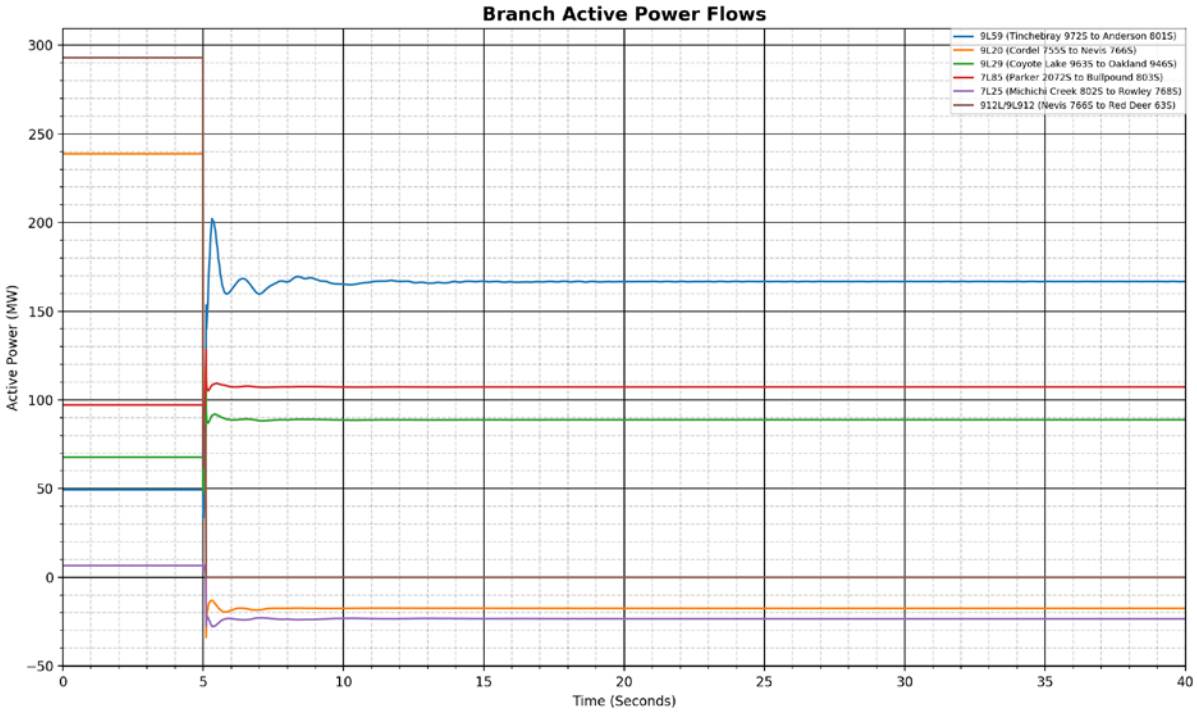

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Active Power (MW)
Time (Seconds)

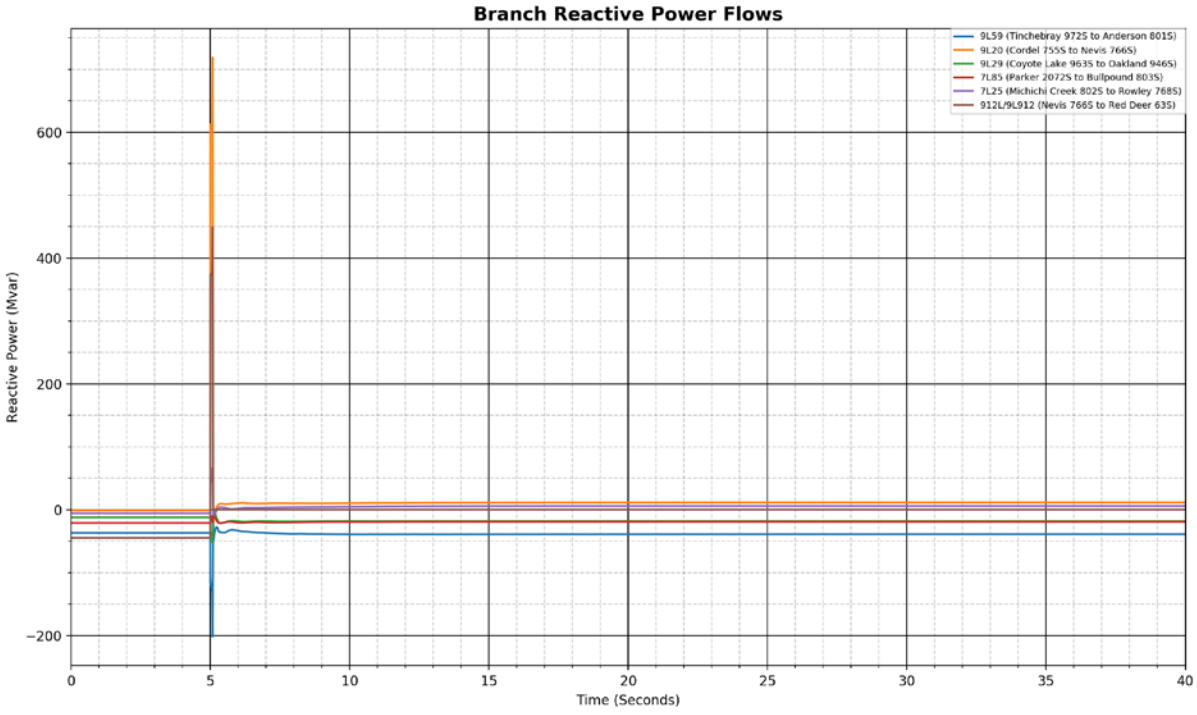
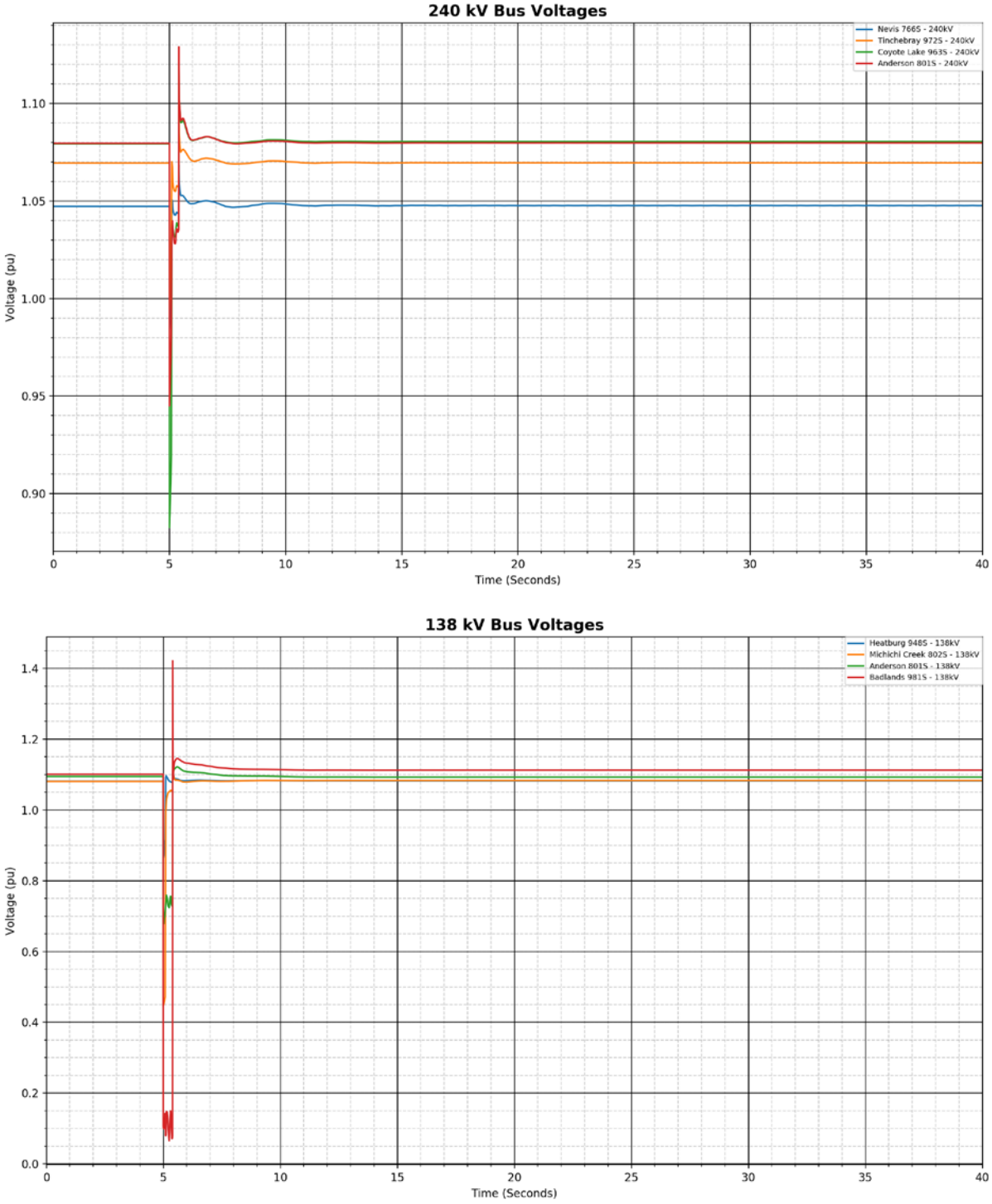
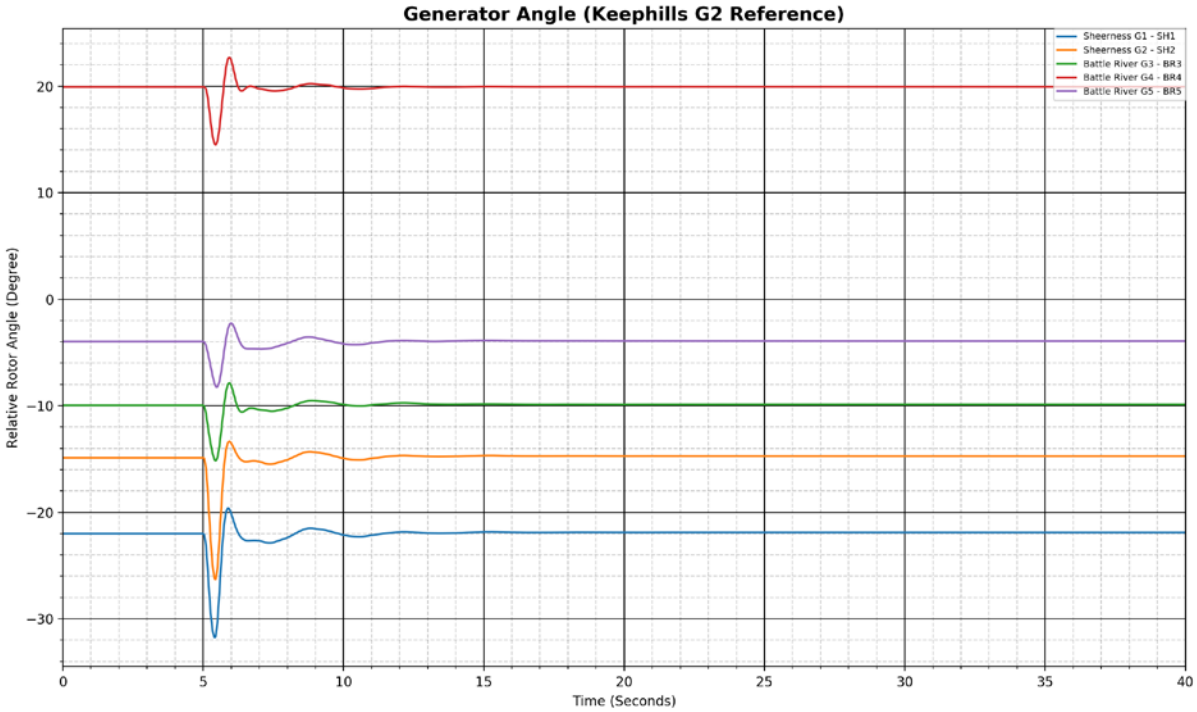
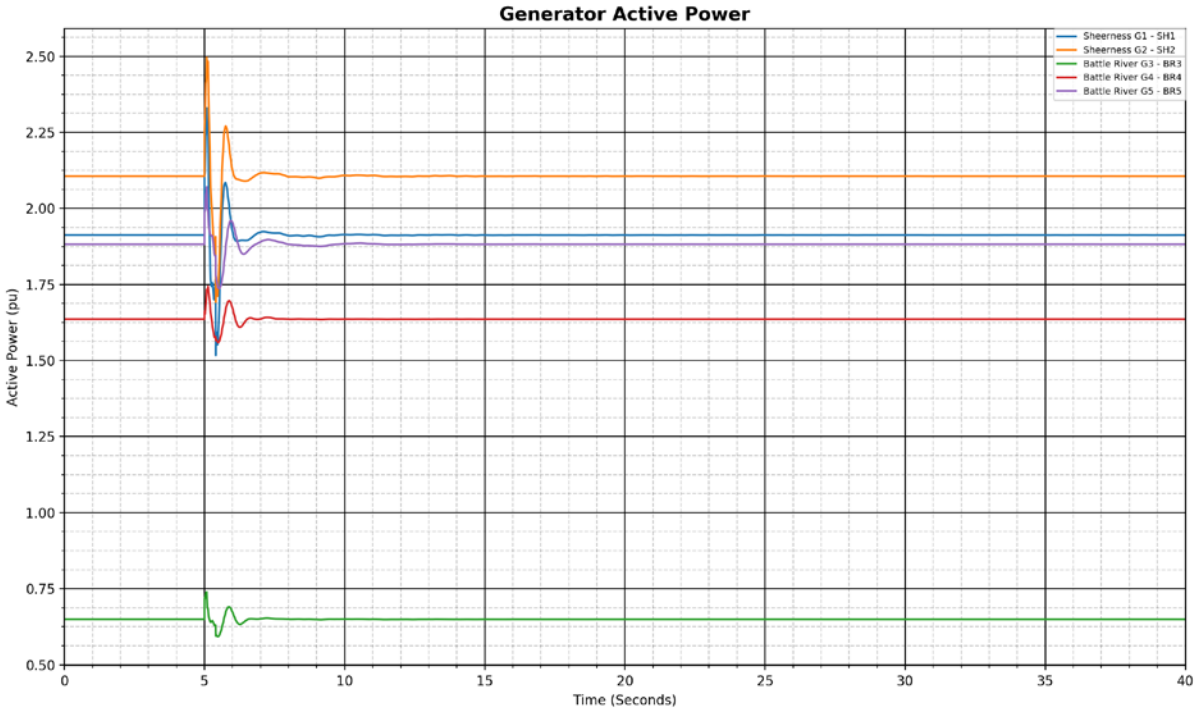
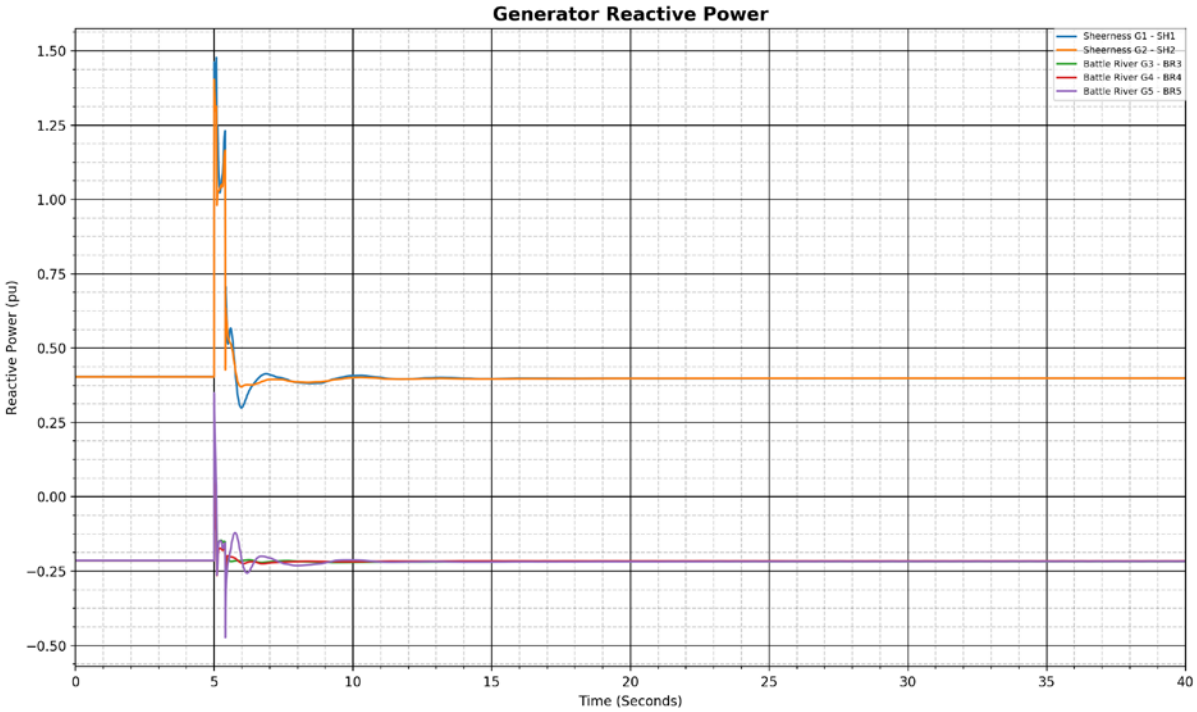

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Reactive Power (Mvar)
Time (Seconds)

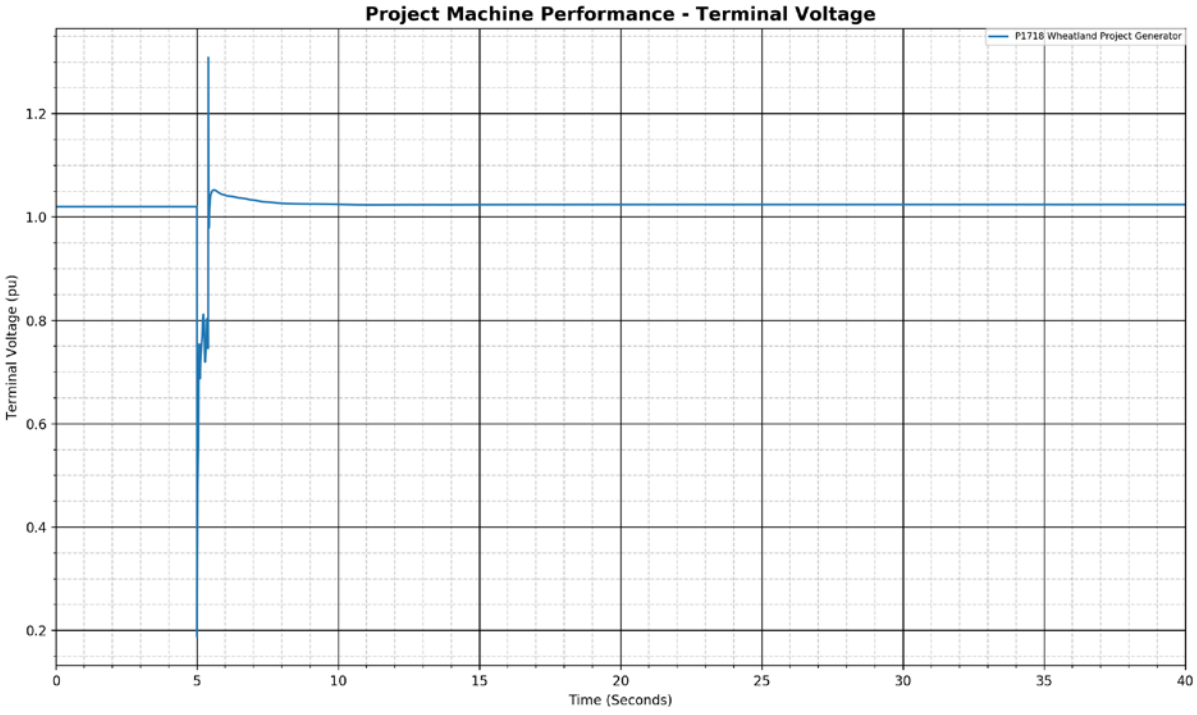
Figure A4-11: 7L203 (Wintering Hills 804S - Parker 2072S): 3-phase fault at Wintering Hills 804S

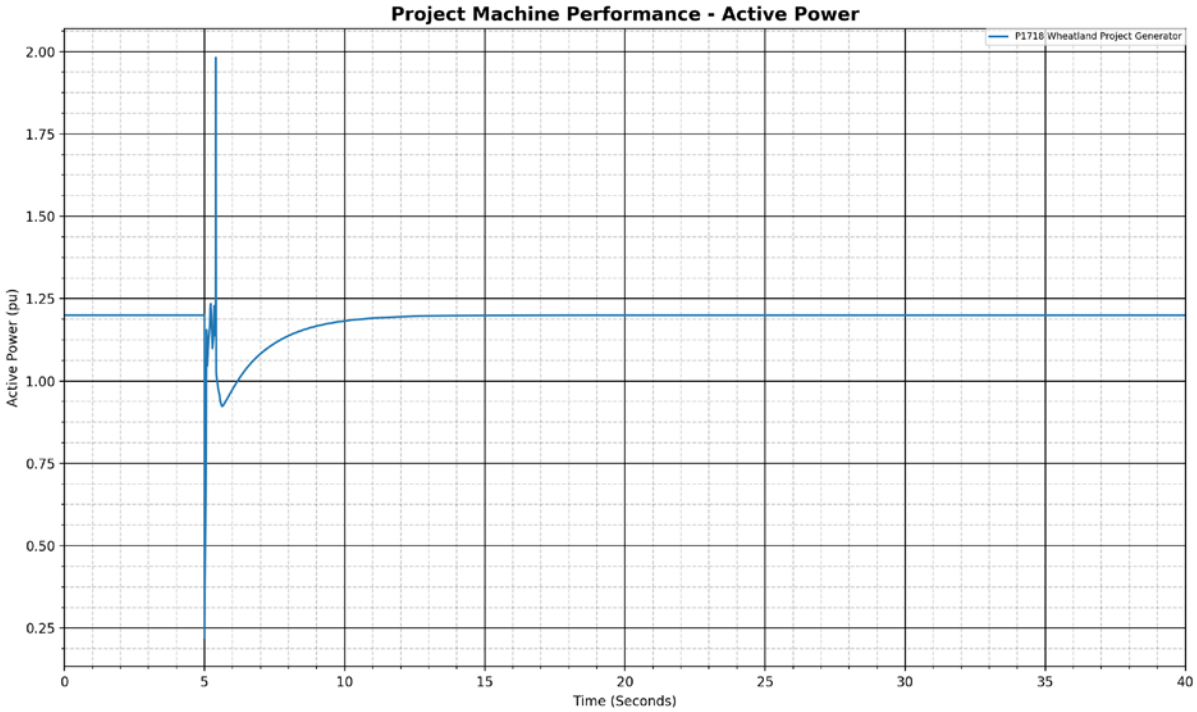


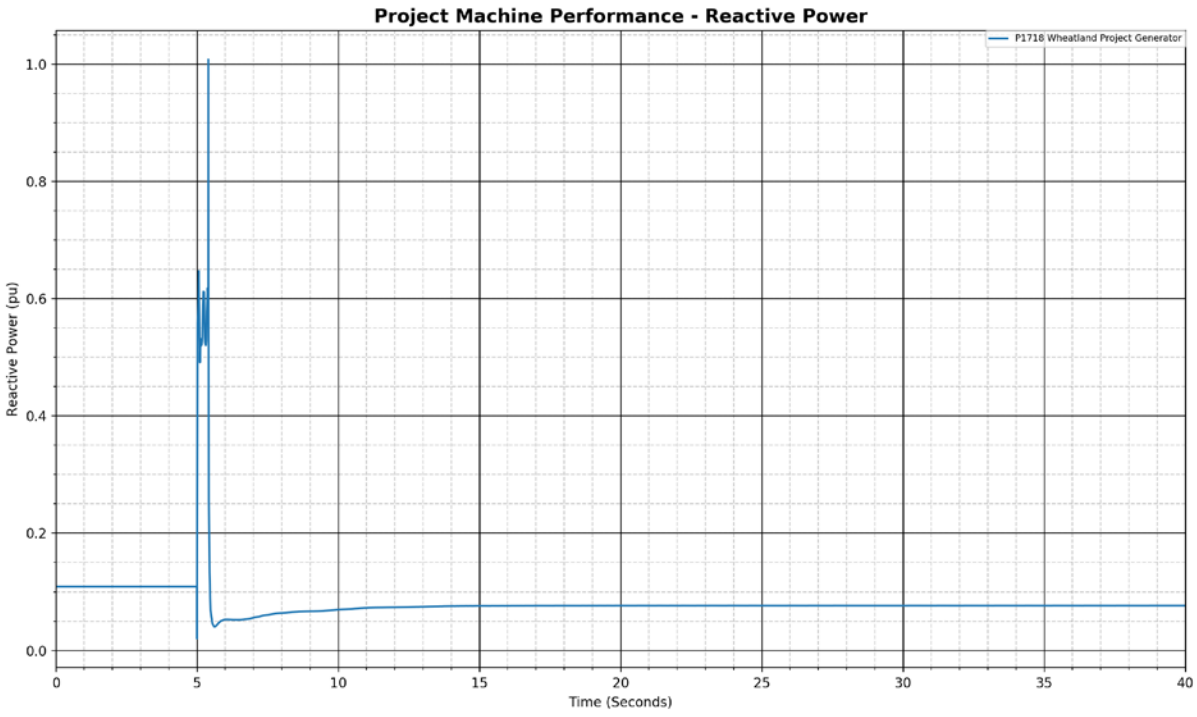

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
−30
0
5
10
15
20
25
30
35
40
Time (Seconds)

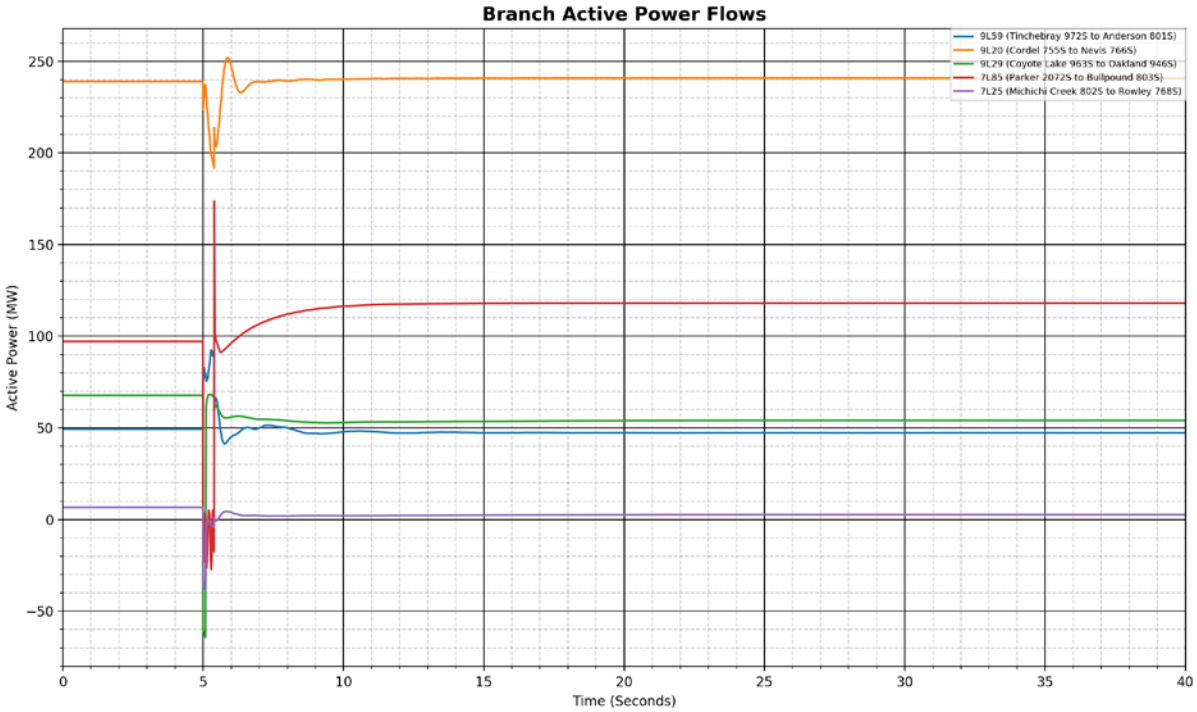

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
Time (Seconds)

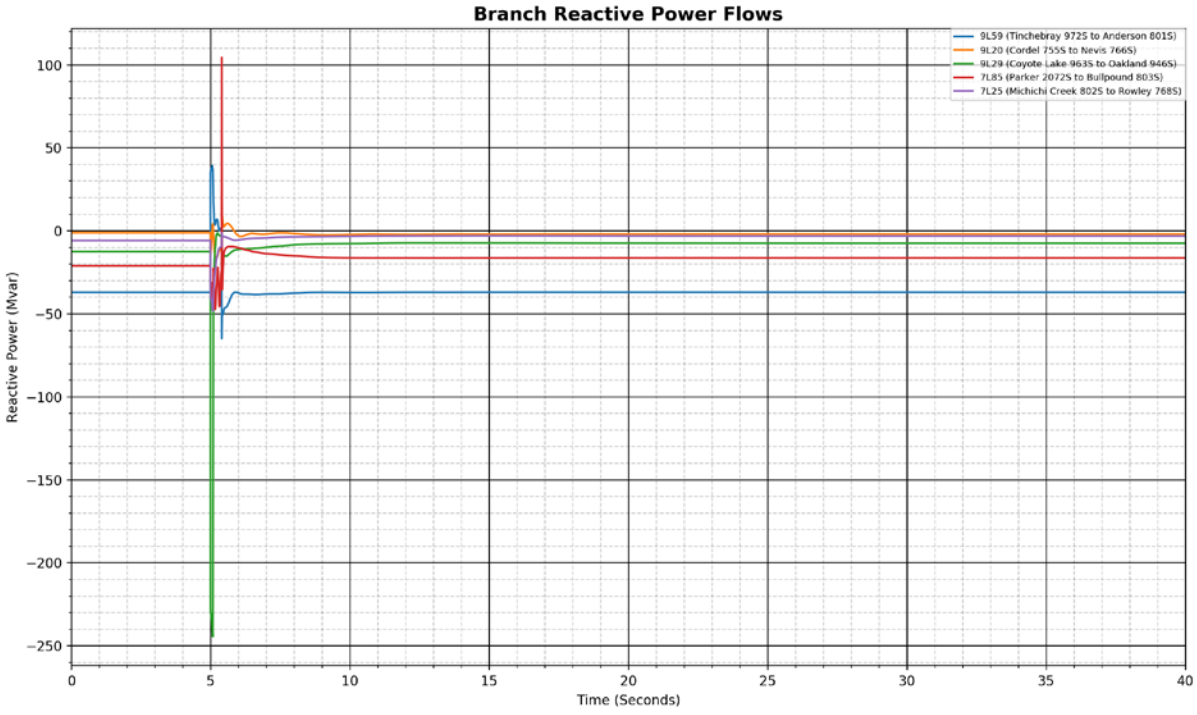
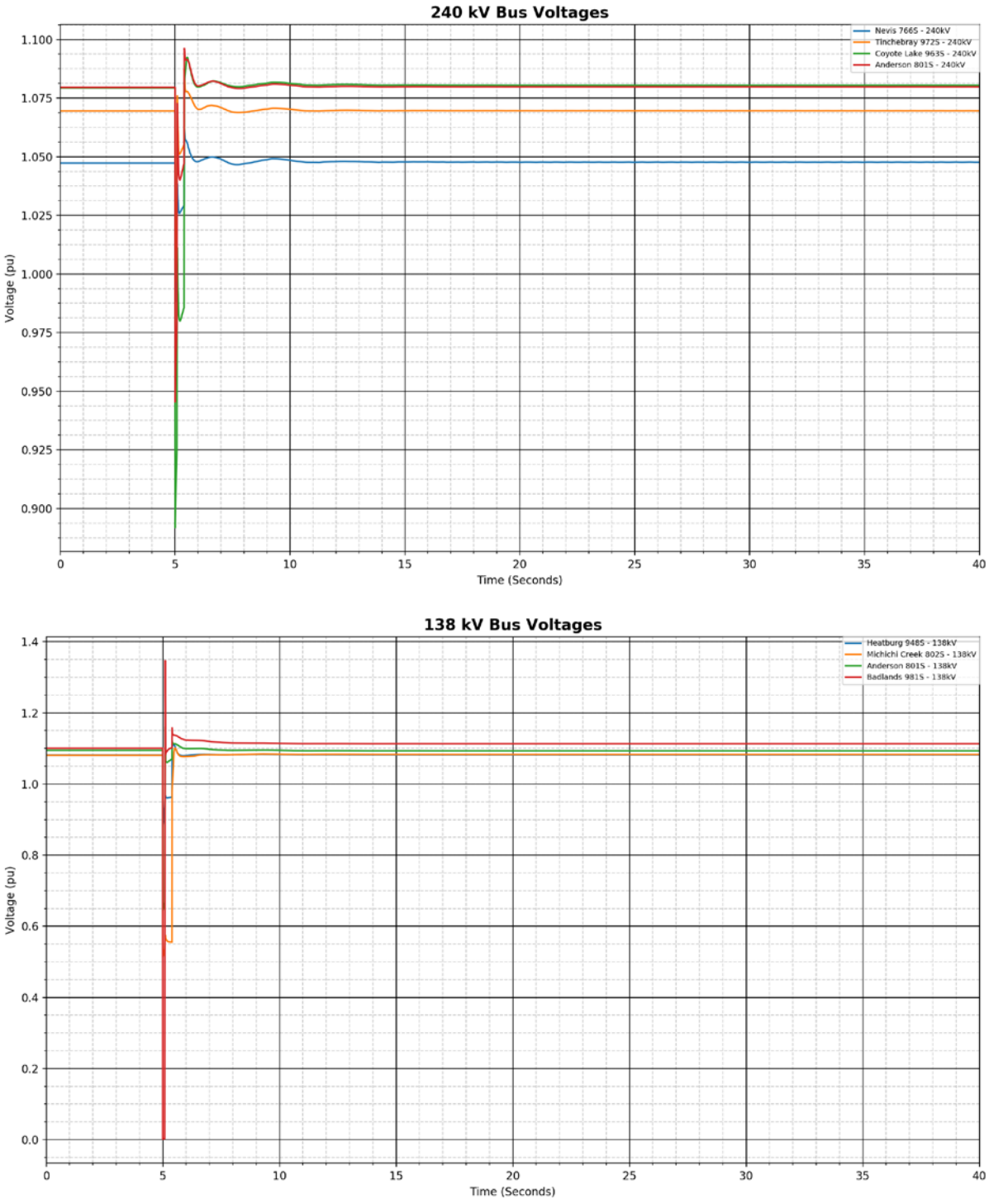
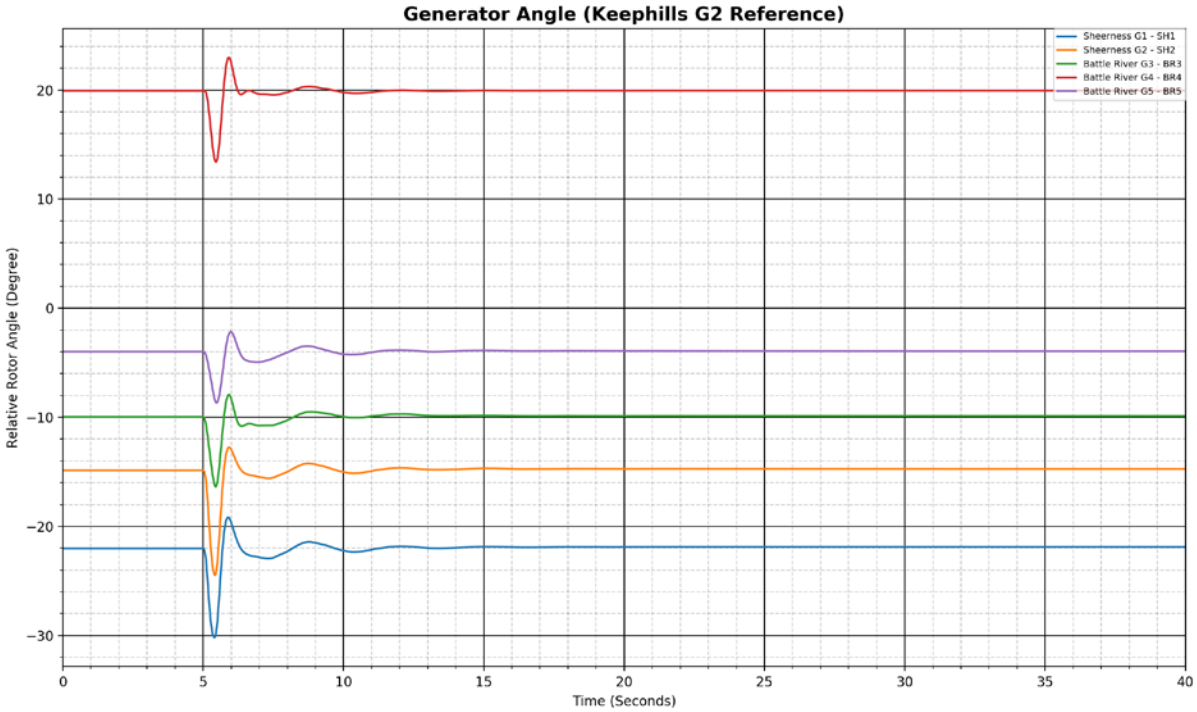
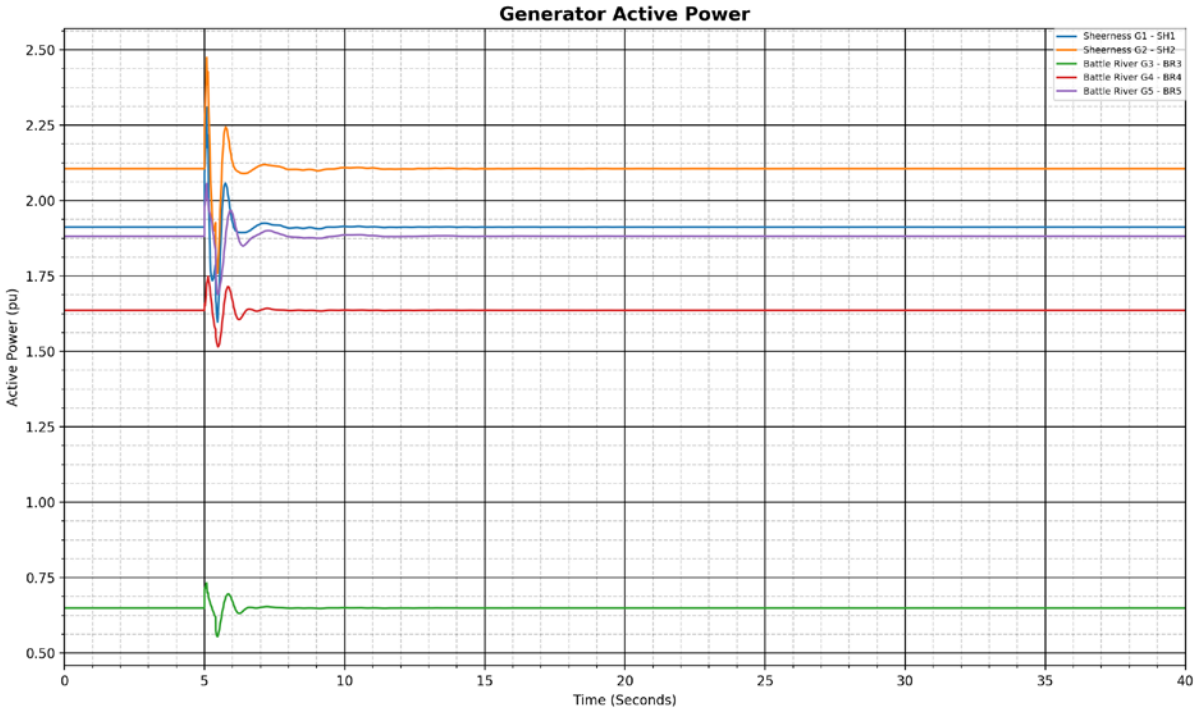
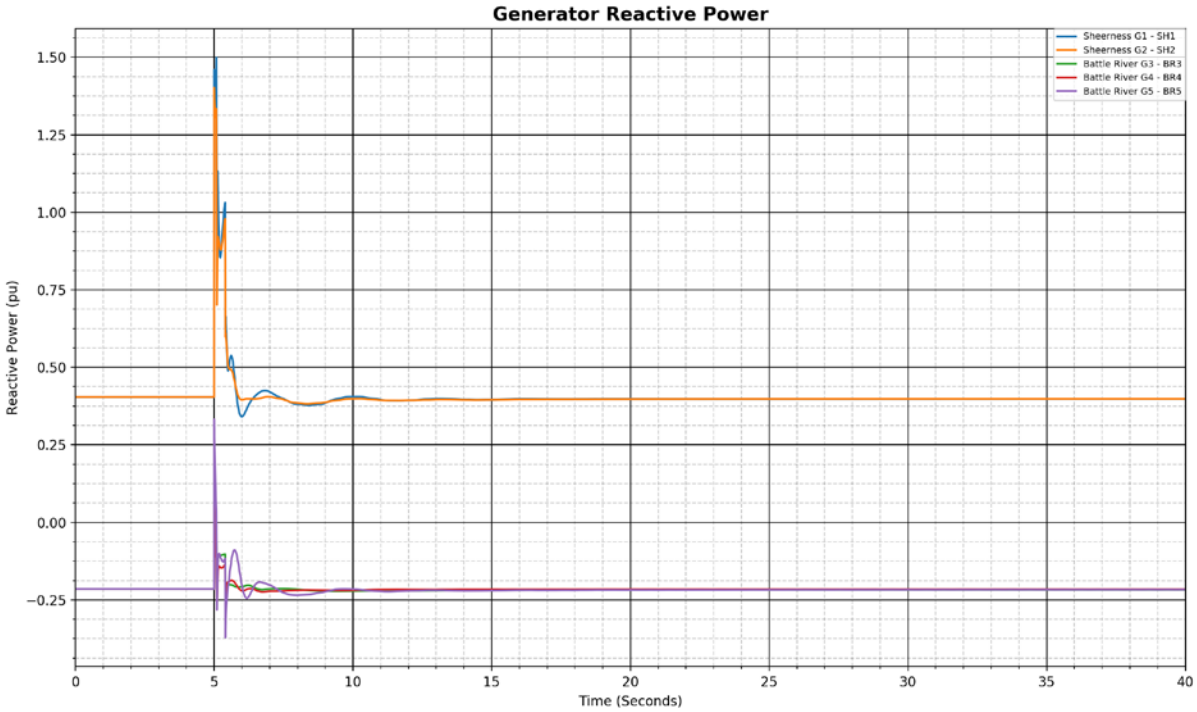

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
Time (Seconds)

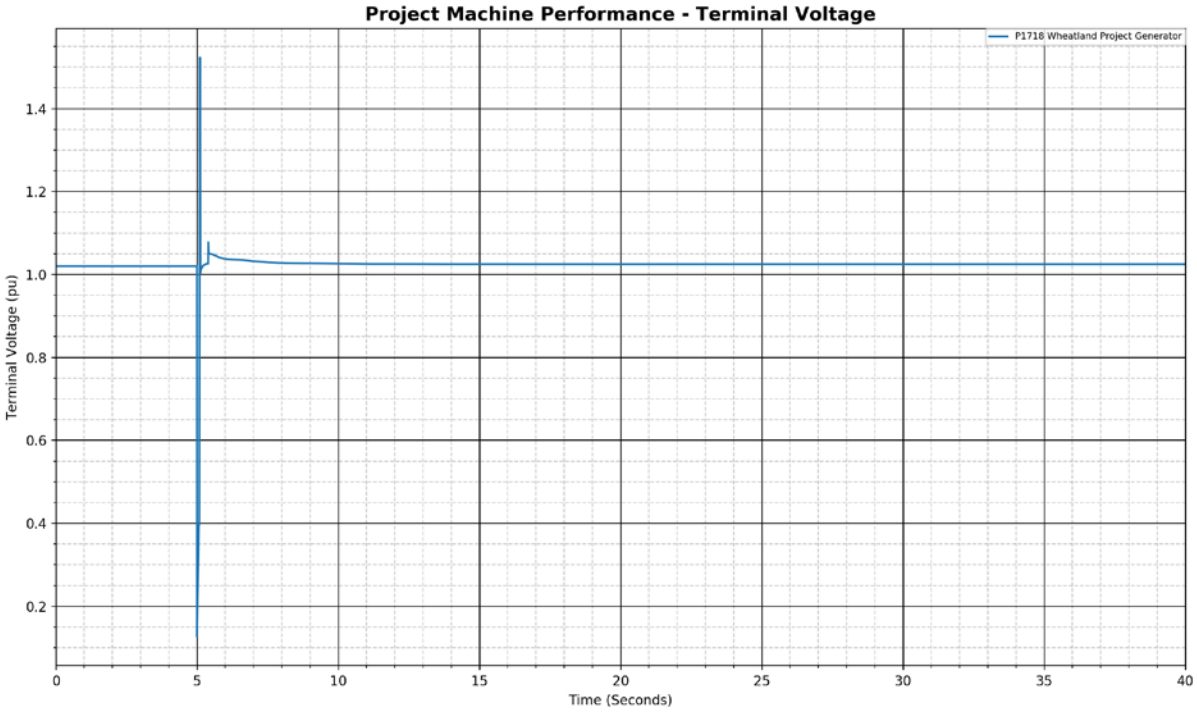
Figure A4-12: 7L203 (Wintering Hills 804S - Parker 2072S): 3-phase fault at Parker 2072S

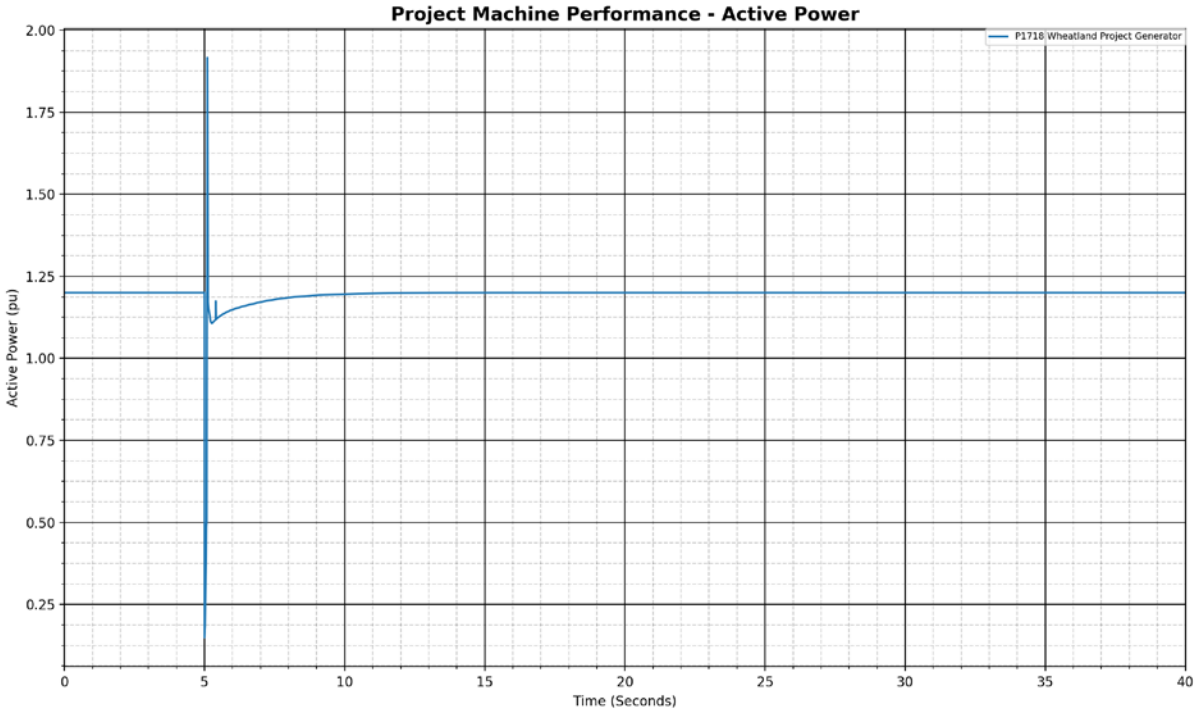


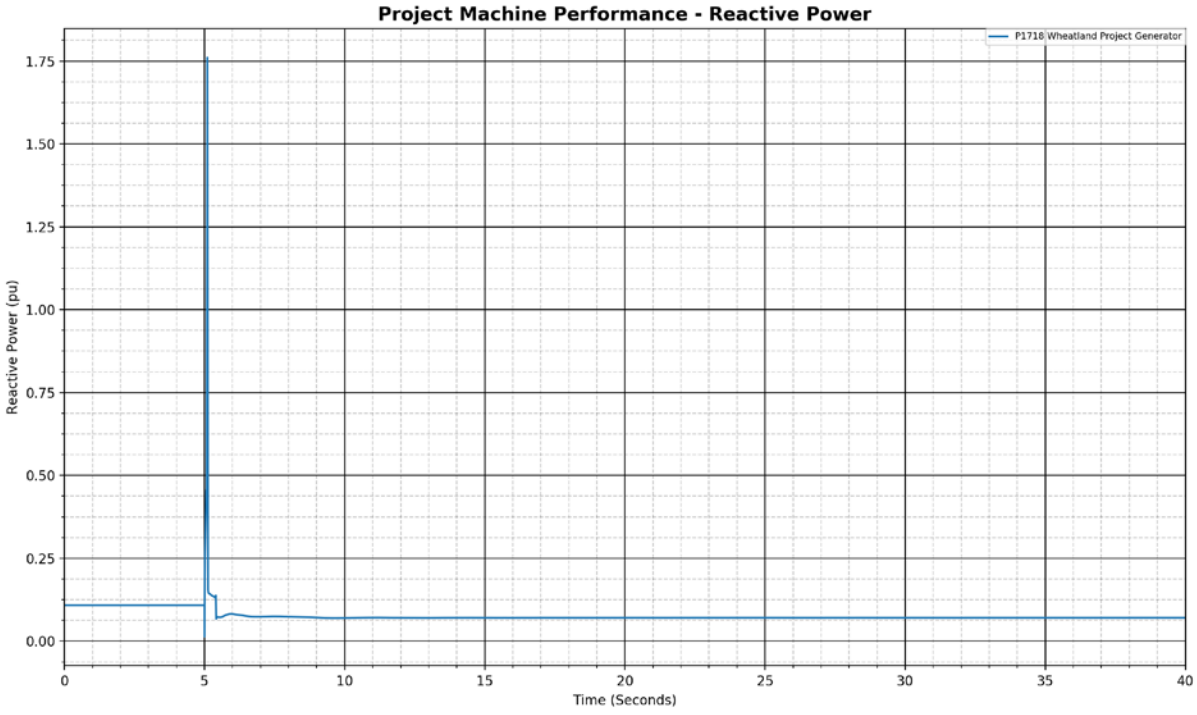

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

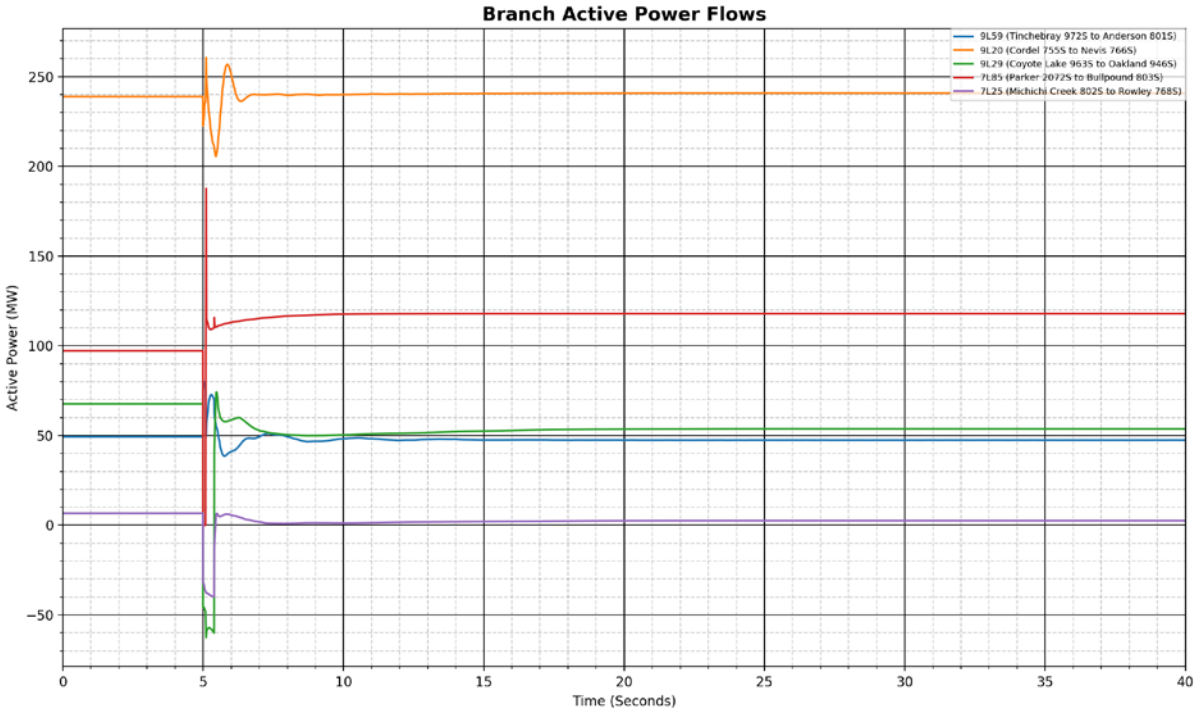

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
Time (Seconds)

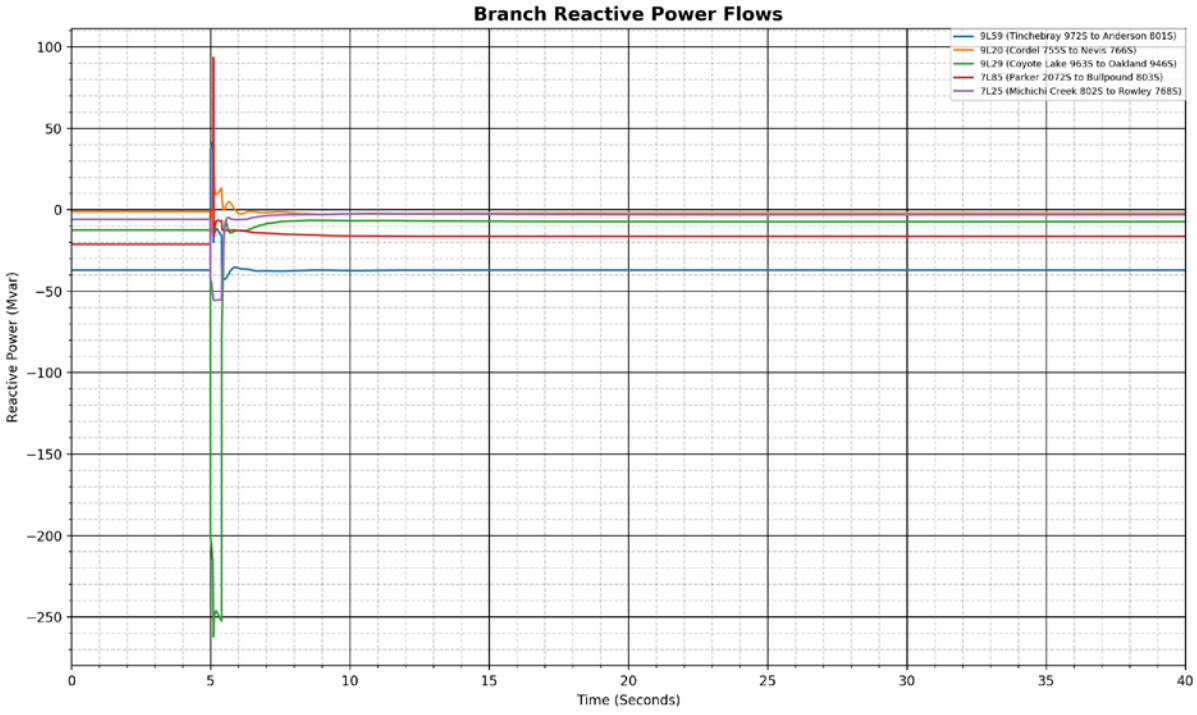
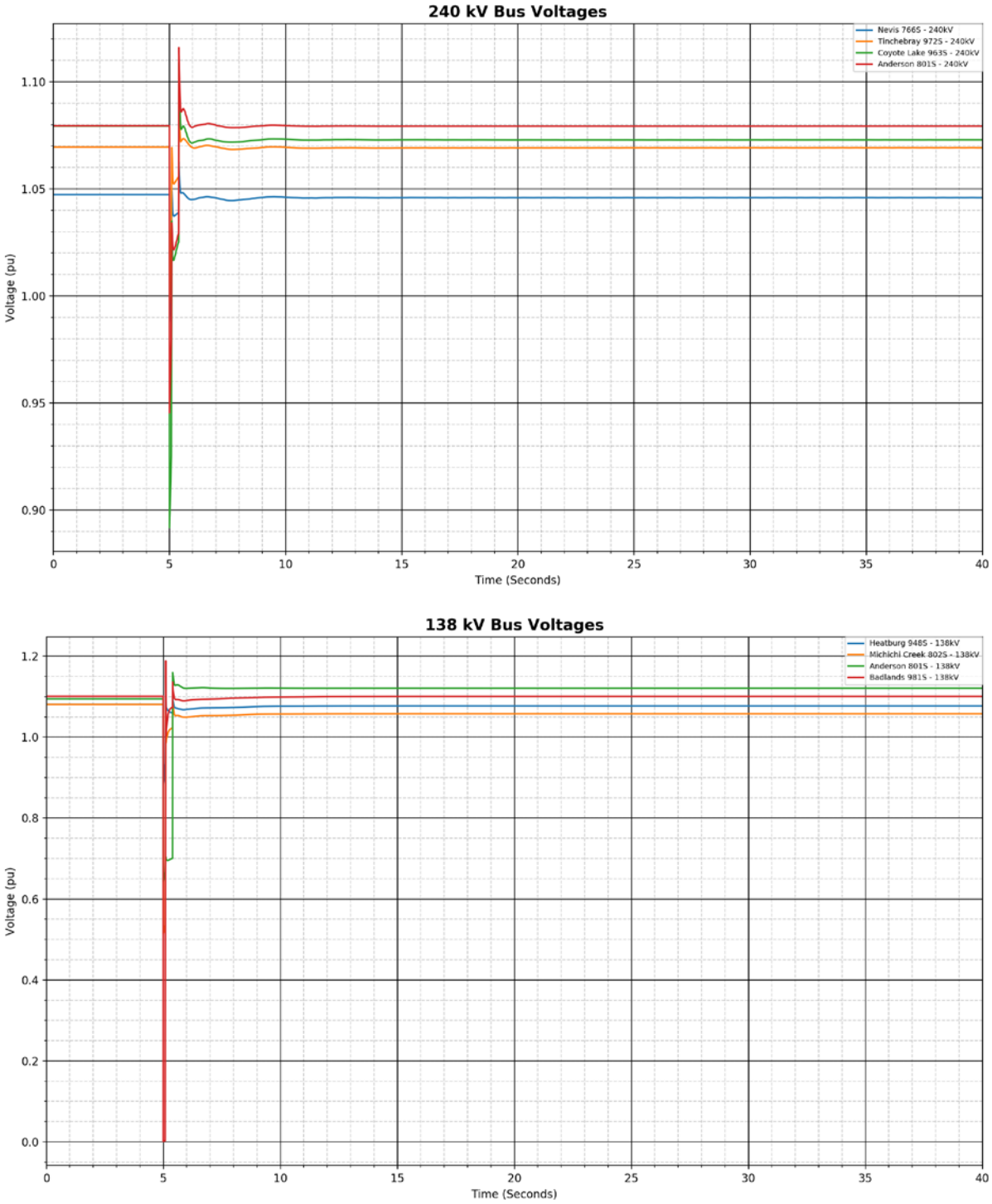
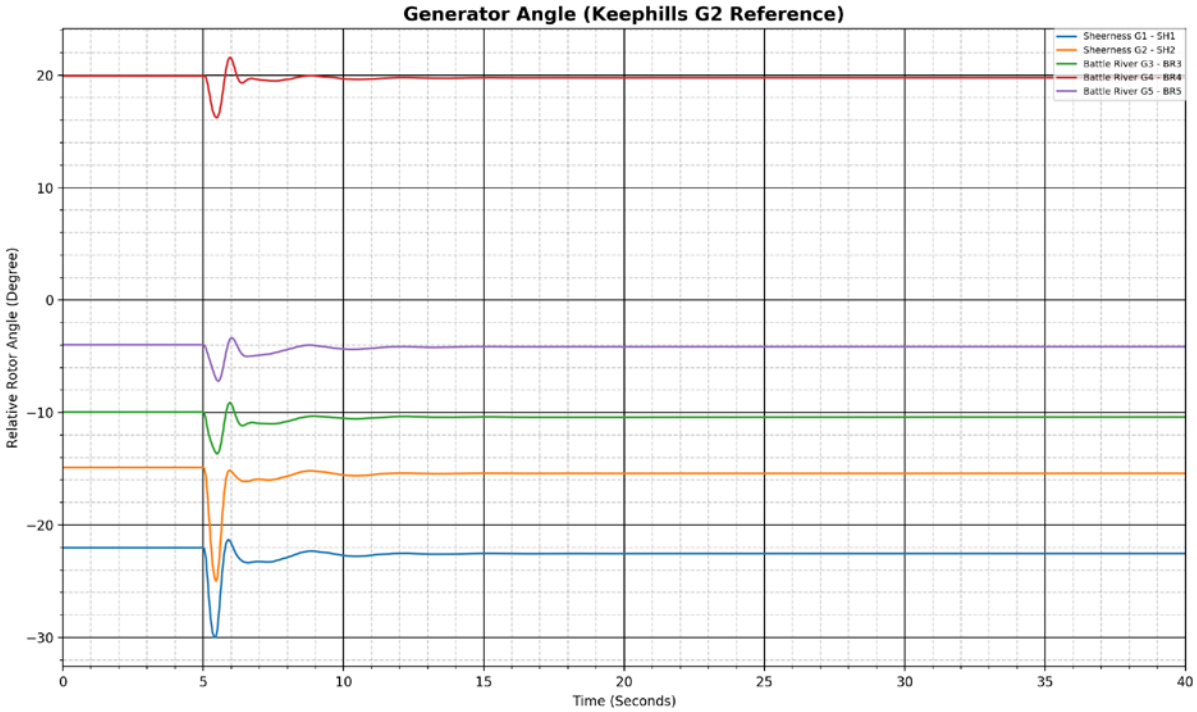
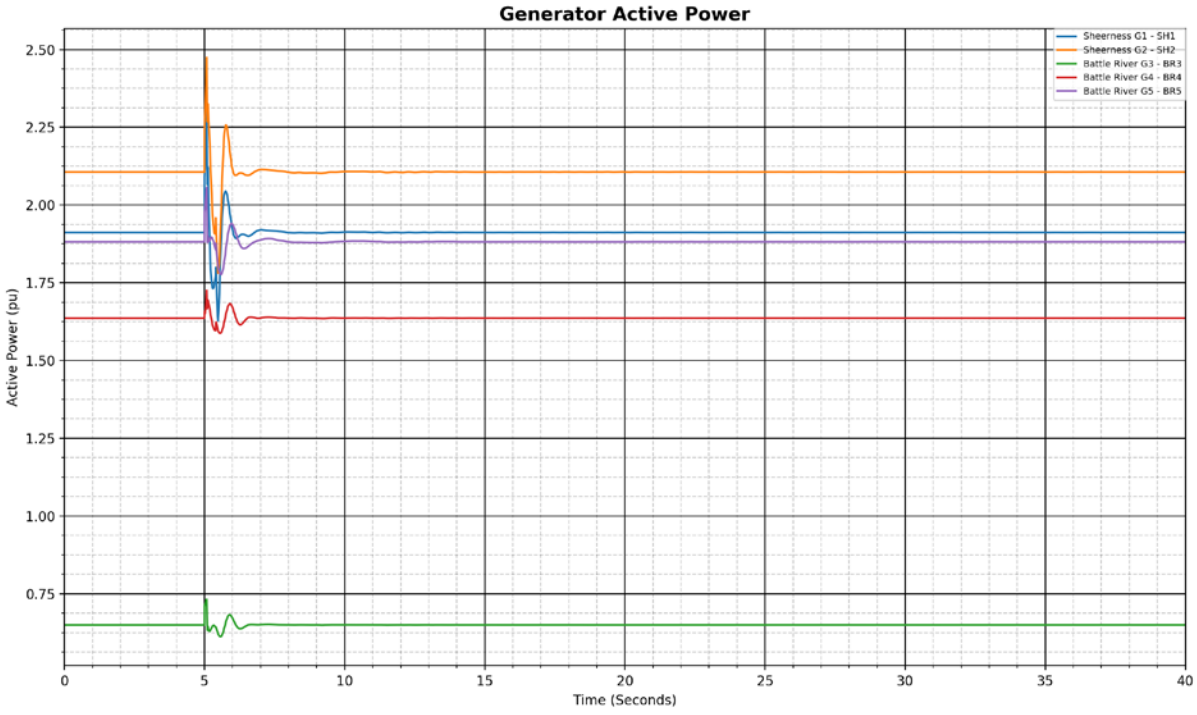
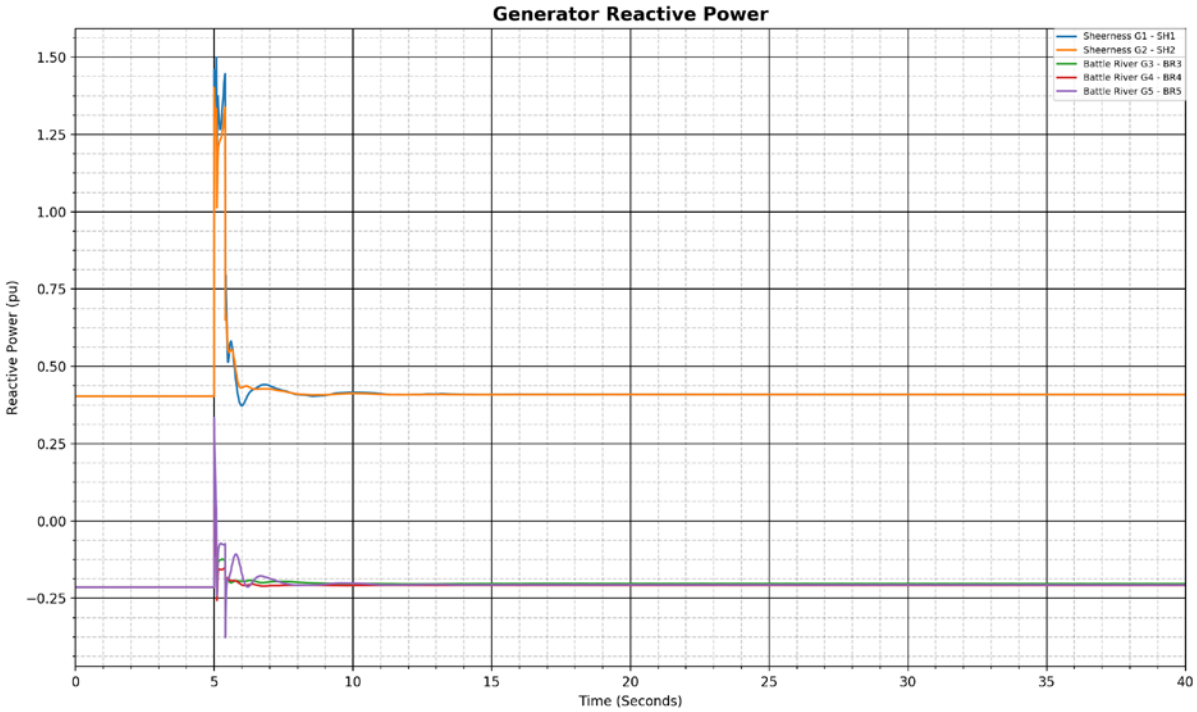

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
Time (Seconds)

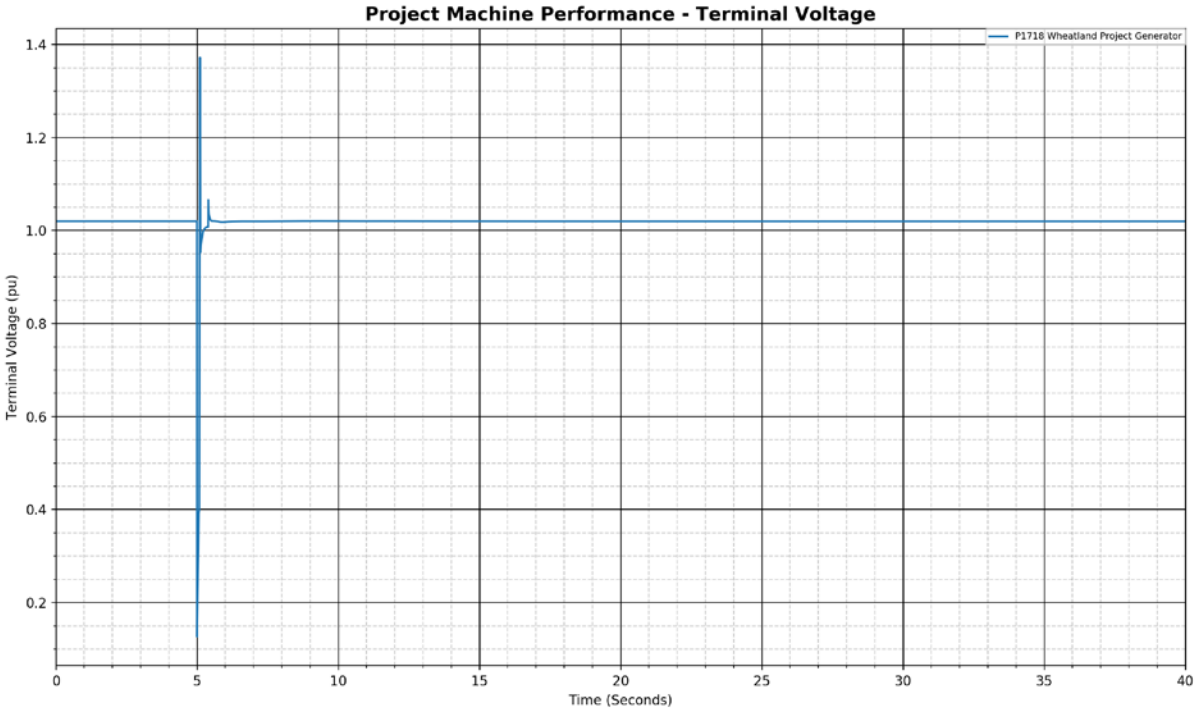
Figure A4-13: 7L85 (Parker 2072S - Anderson 801S): 3-phase fault at Parker 2072S

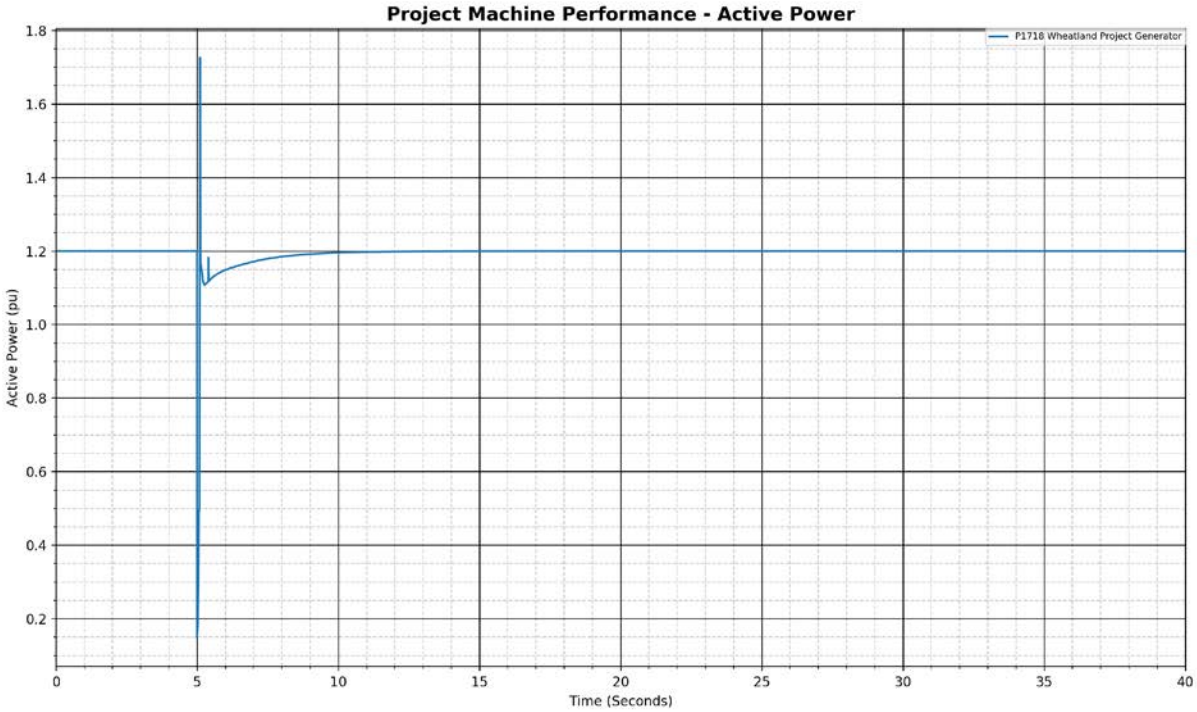


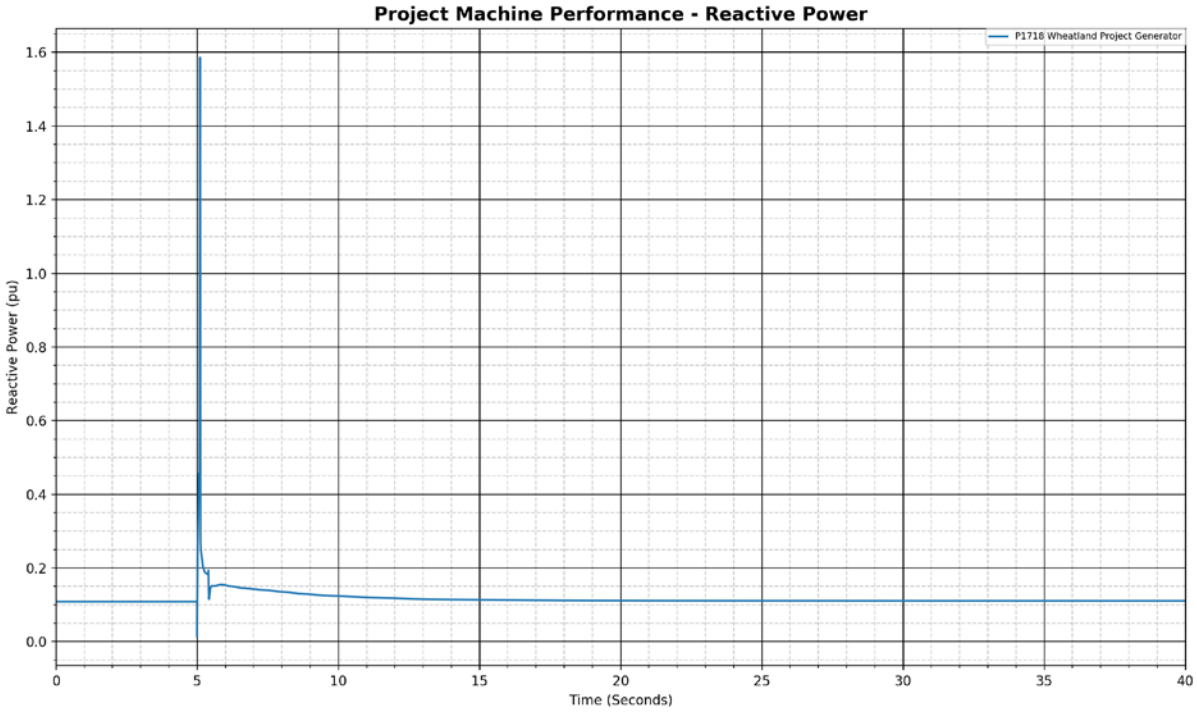

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
−30
0
5
10
15
20
25
30
35
40
Time (Seconds)

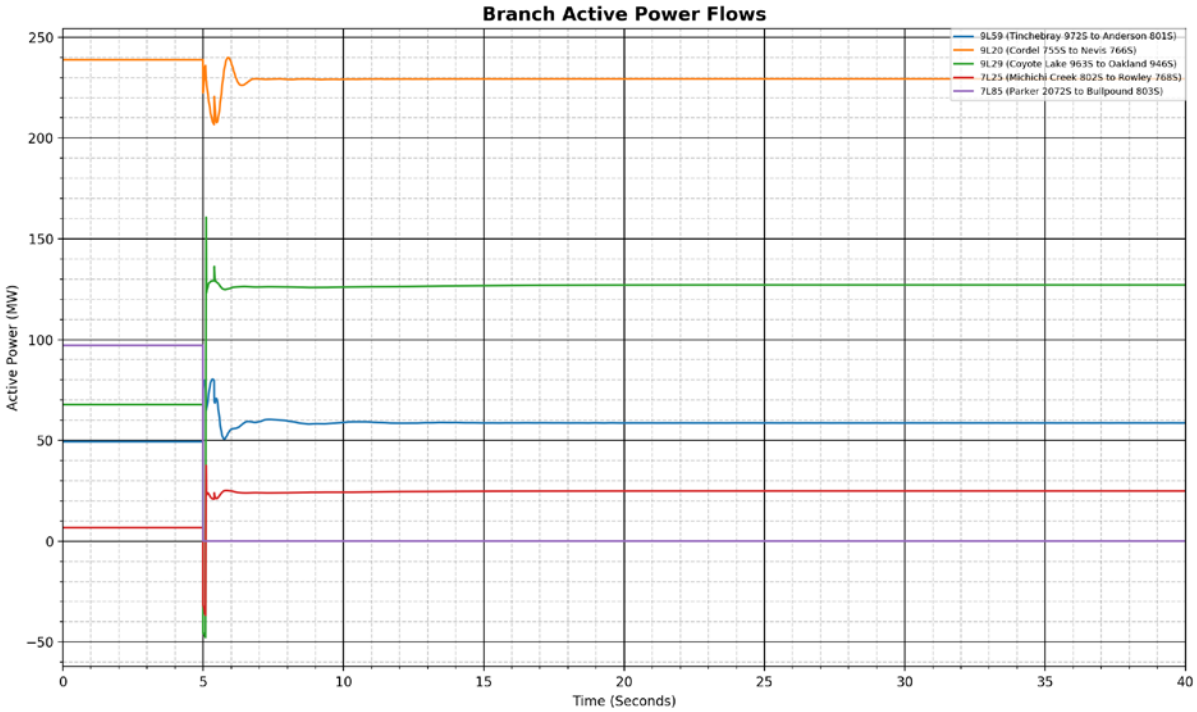

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Active Power (MW)
Time (Seconds)

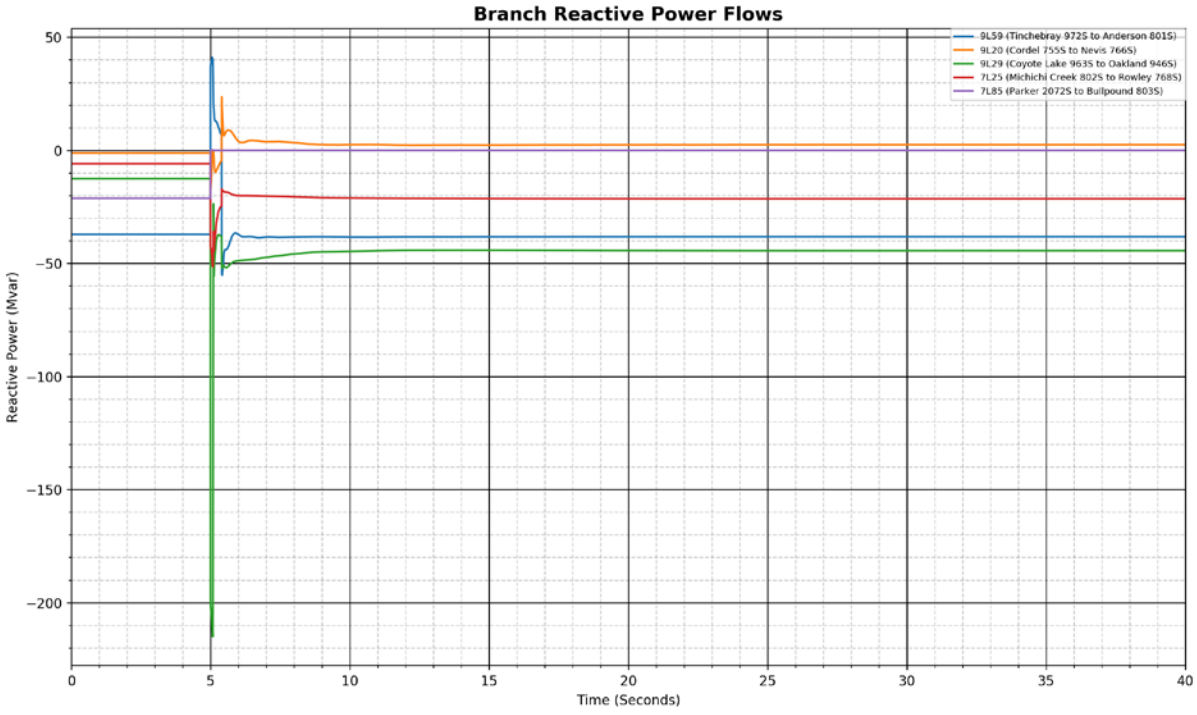
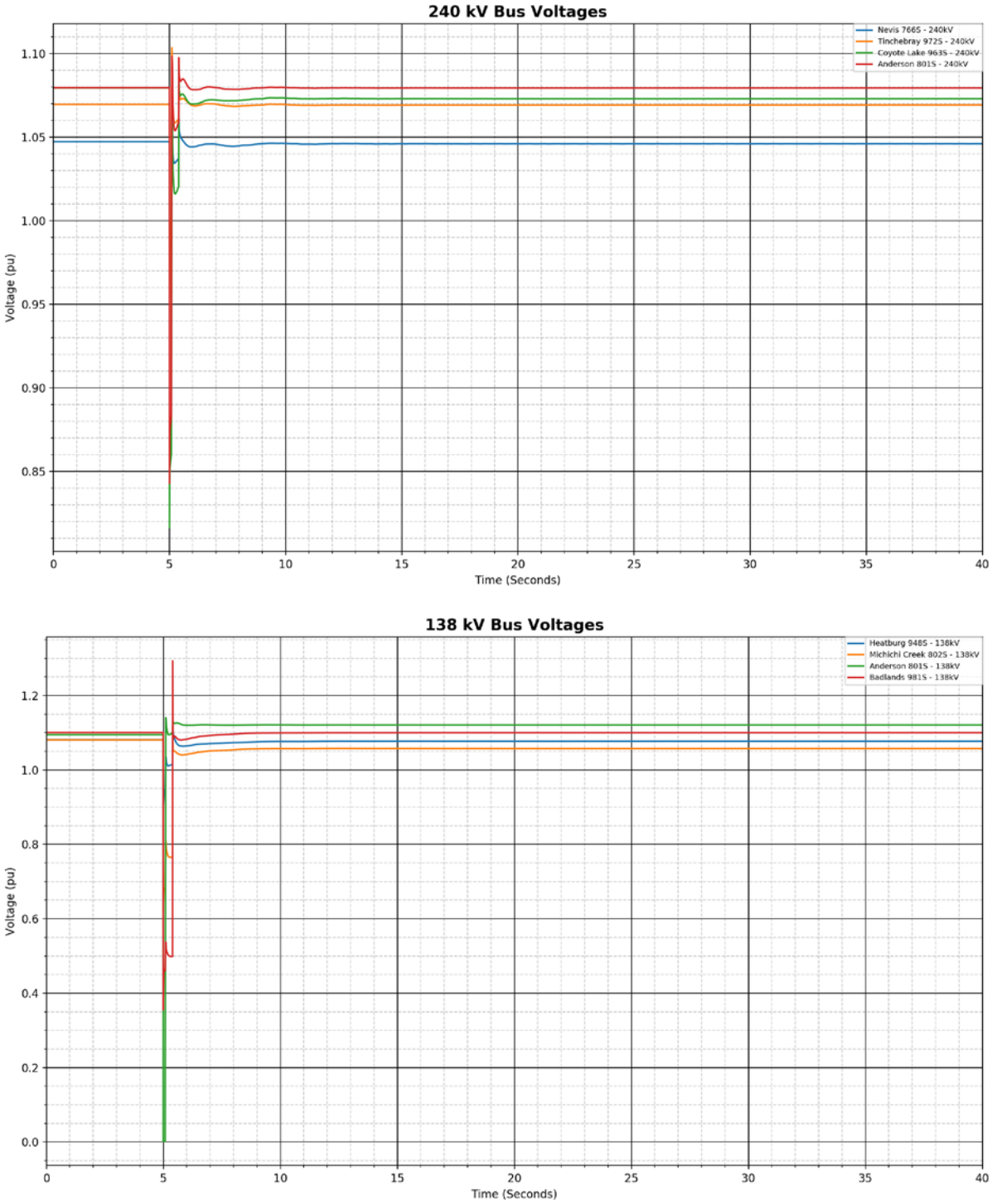
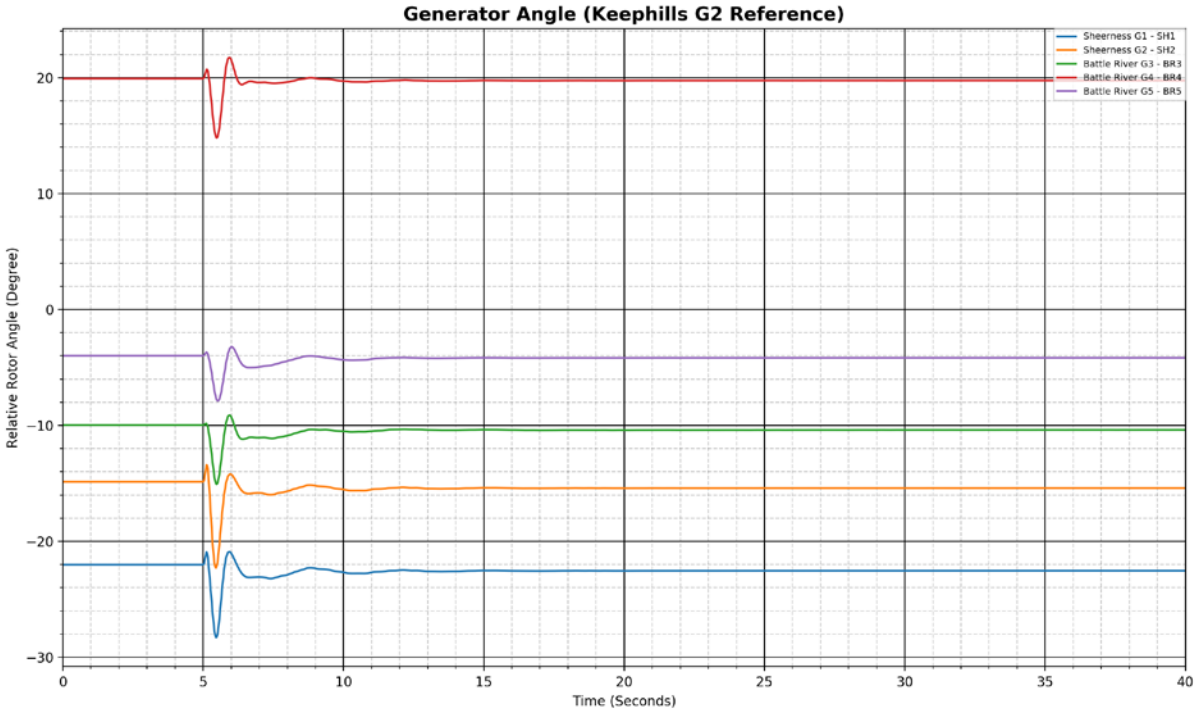
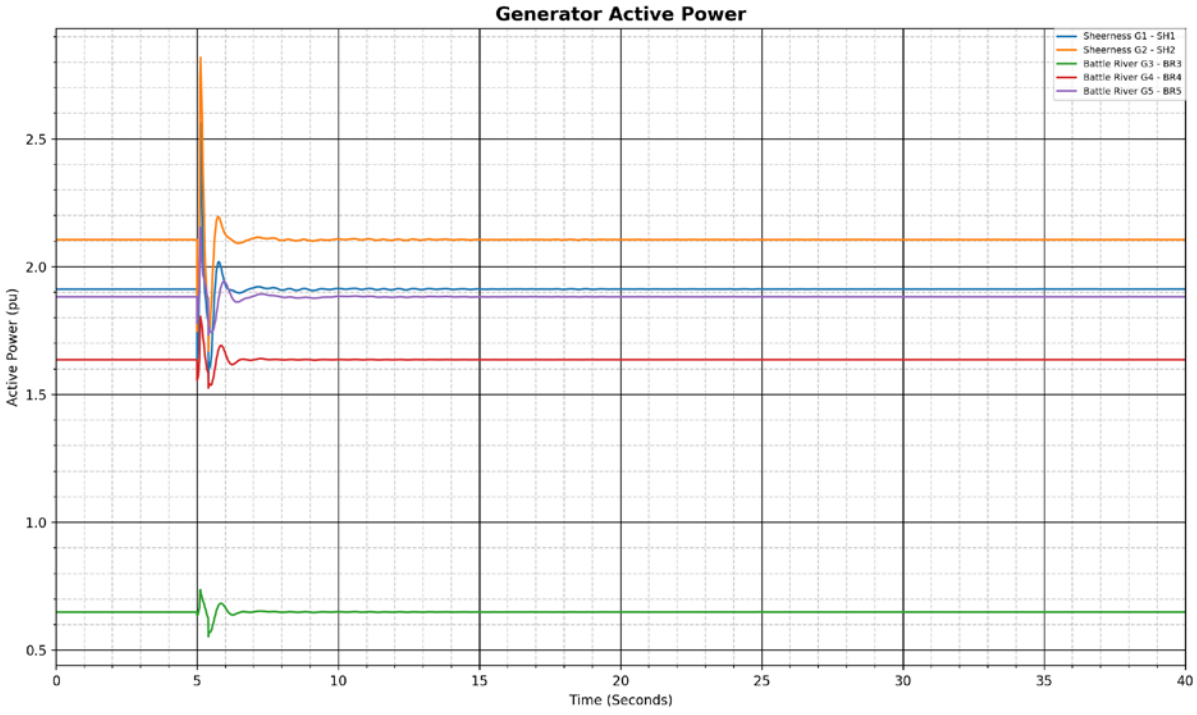
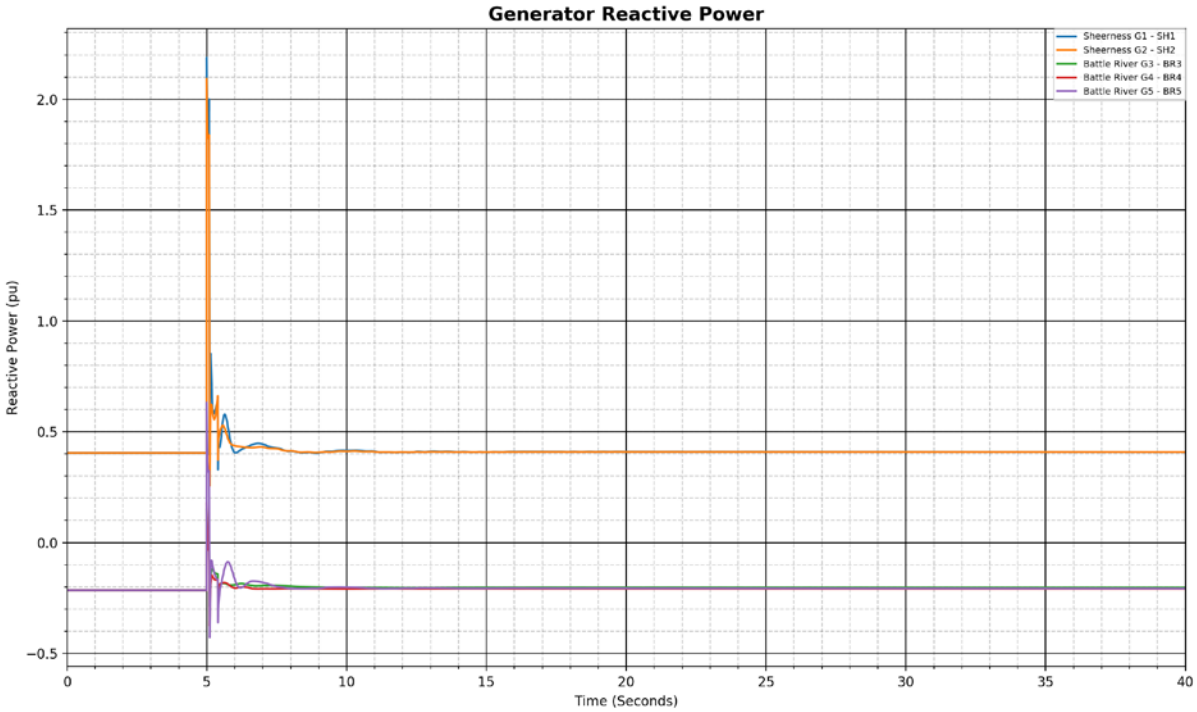

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Reactive Power (Mvar)
Time (Seconds)

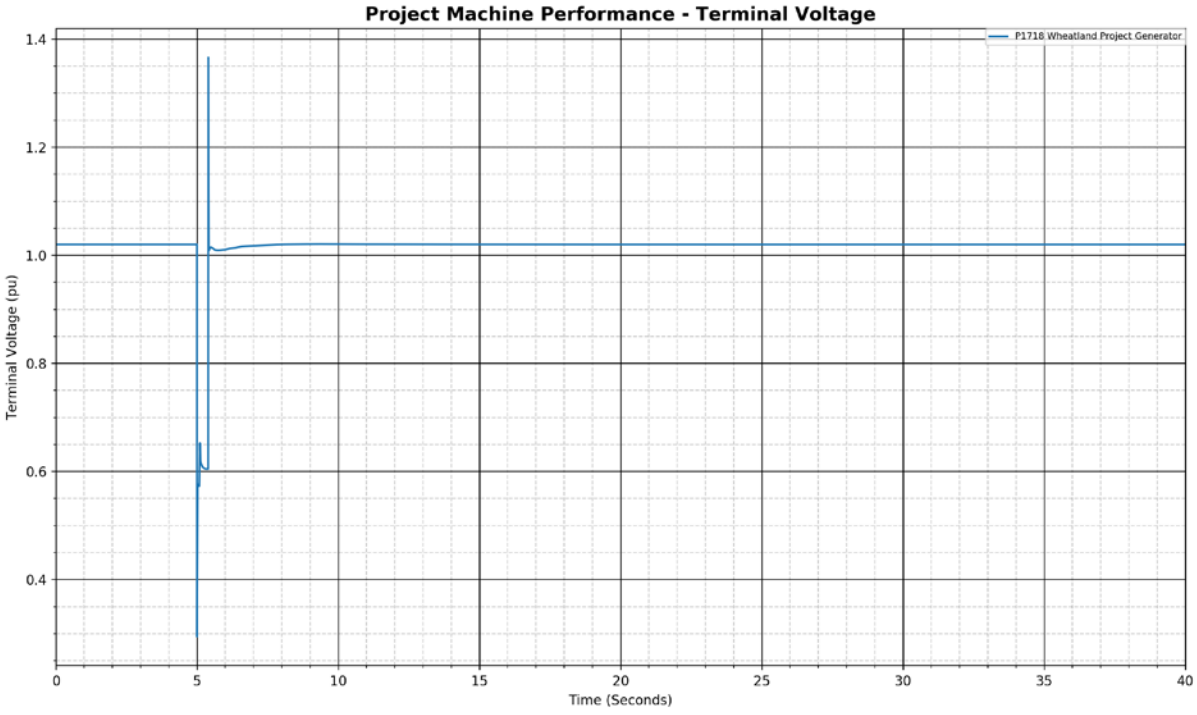
Figure A4-14: 7L85 (Parker 2072S - Anderson 801S): 3-phase fault at Anderson 801S

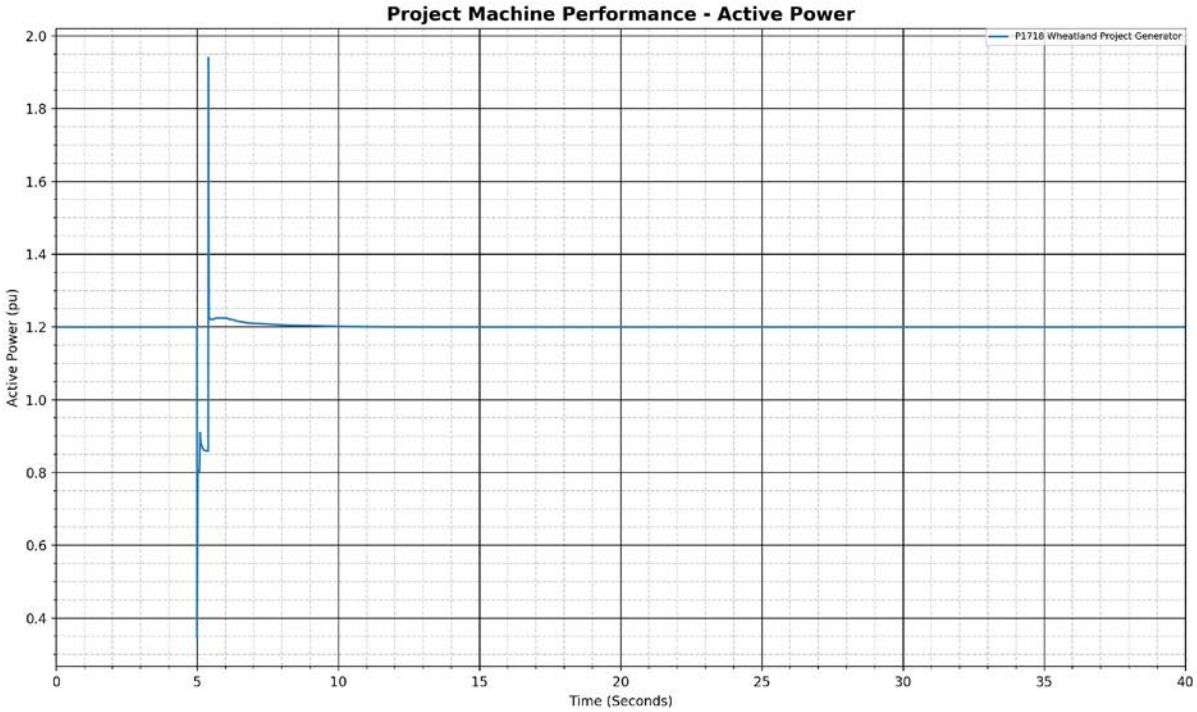


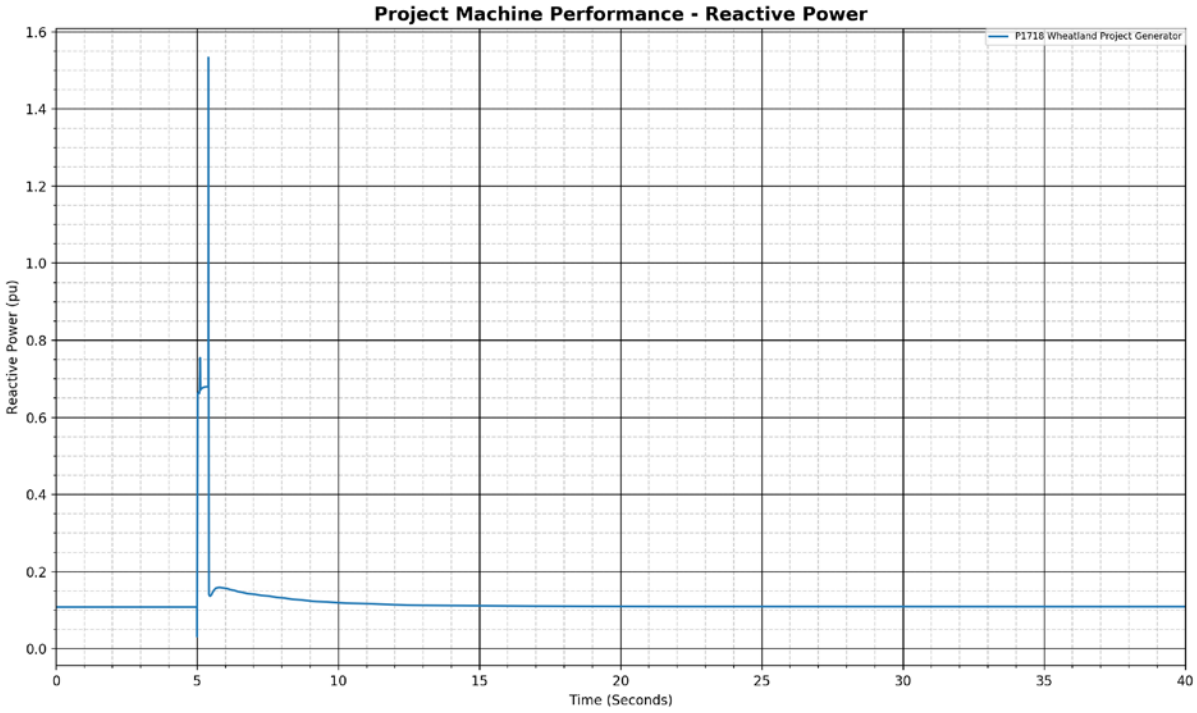

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
−30
0
5
10
15
20
25
30
35
40
Time (Seconds)

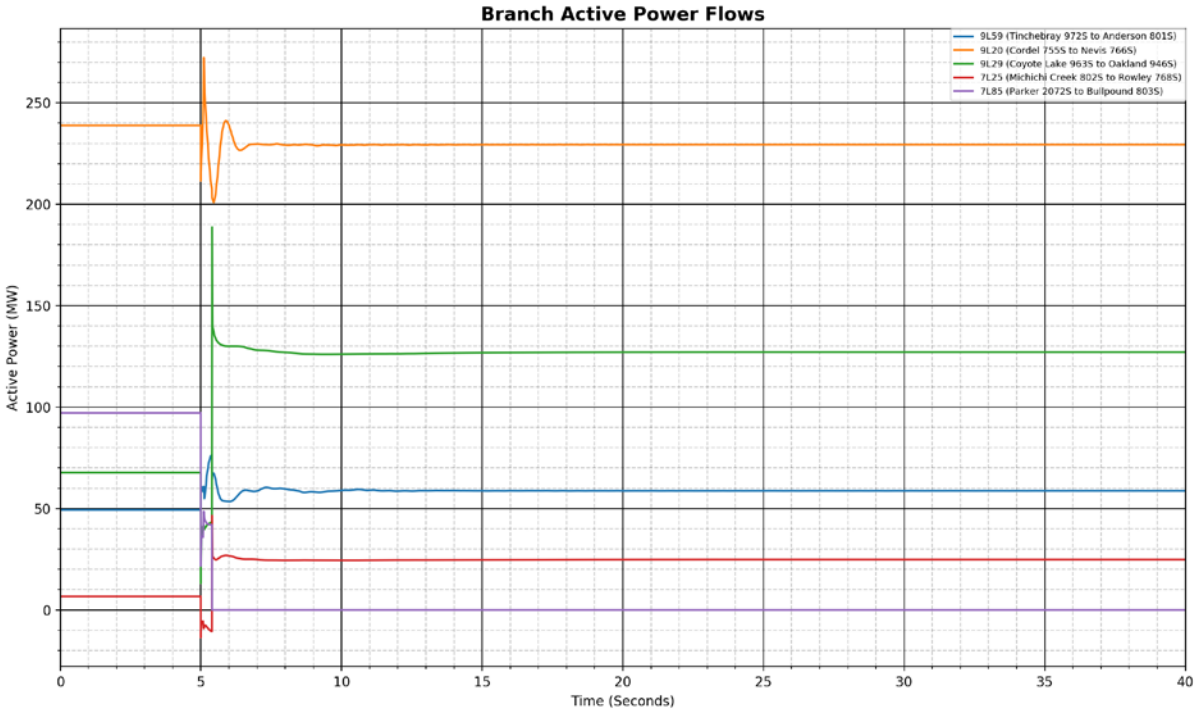

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2.0
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
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
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Active Power (MW)
Time (Seconds)

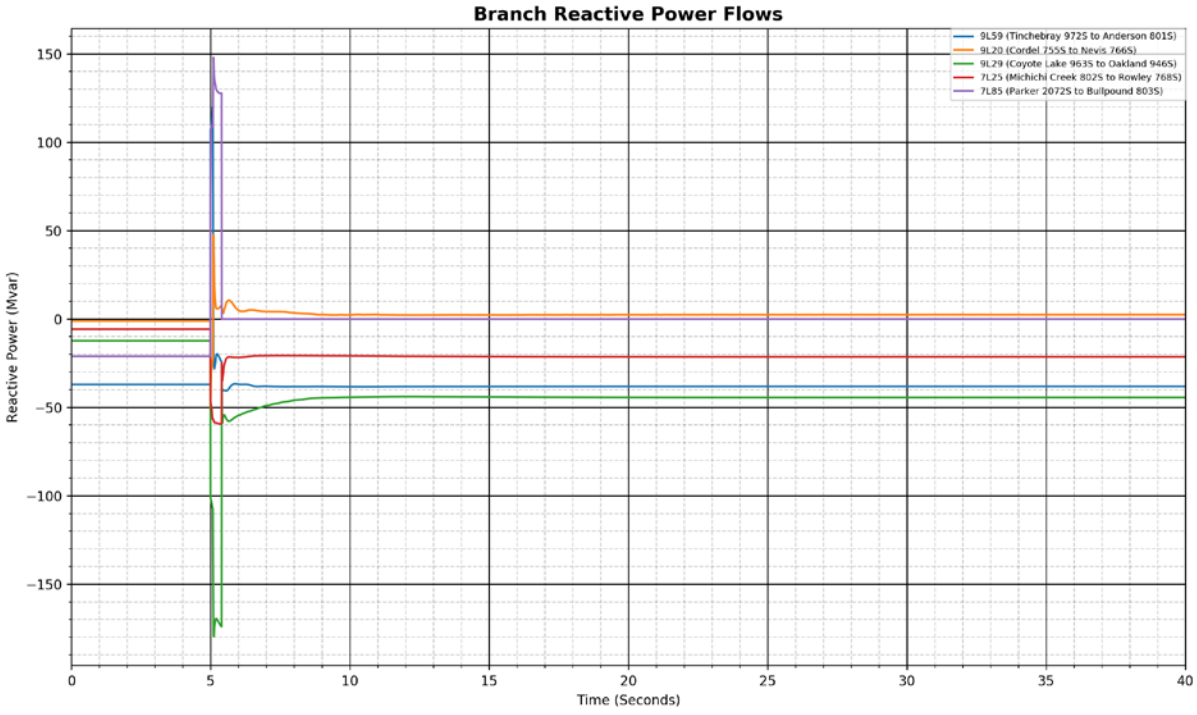
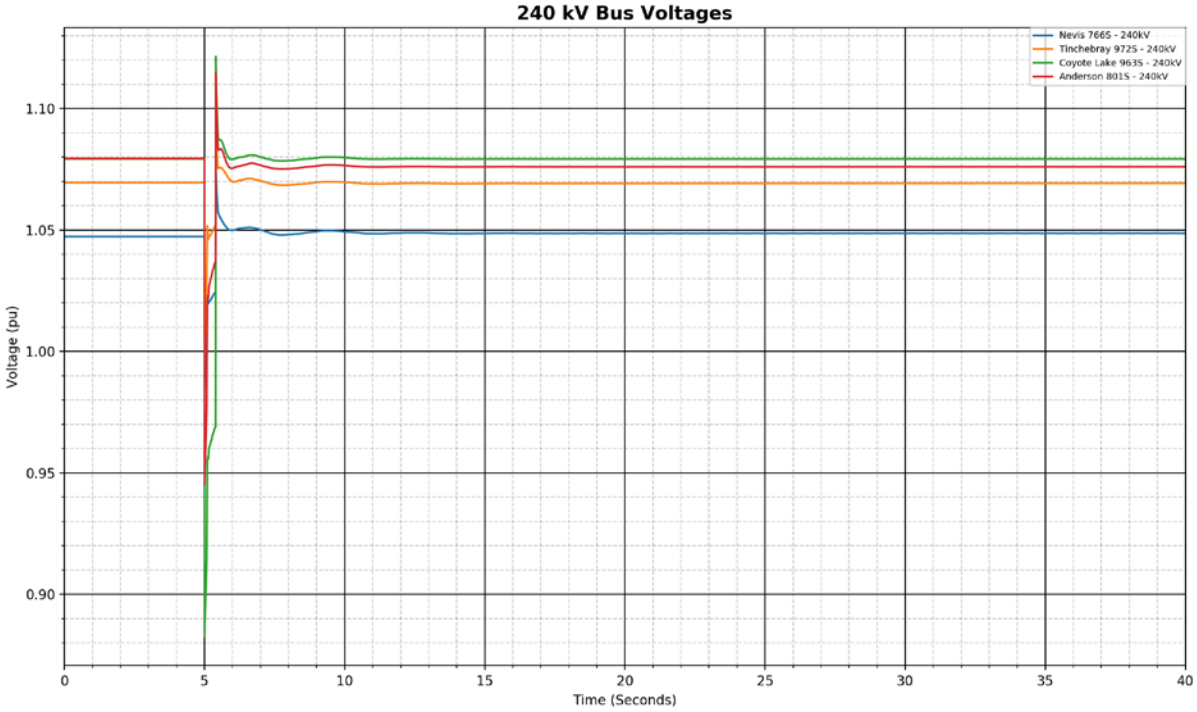
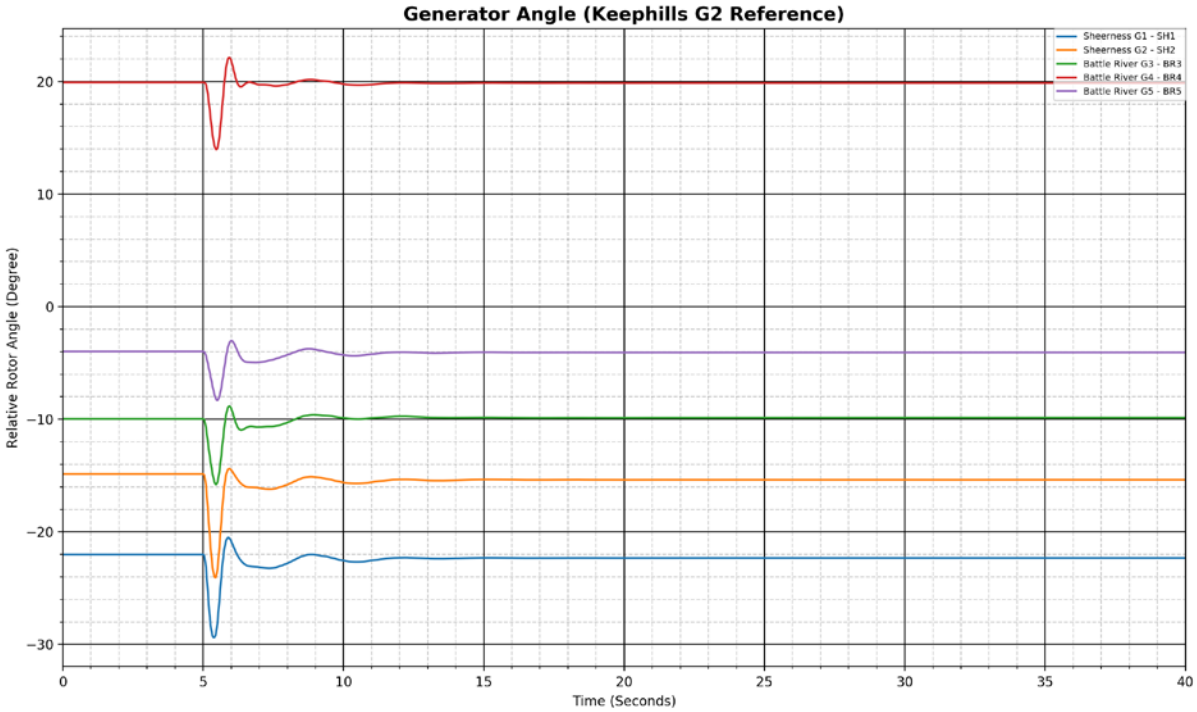
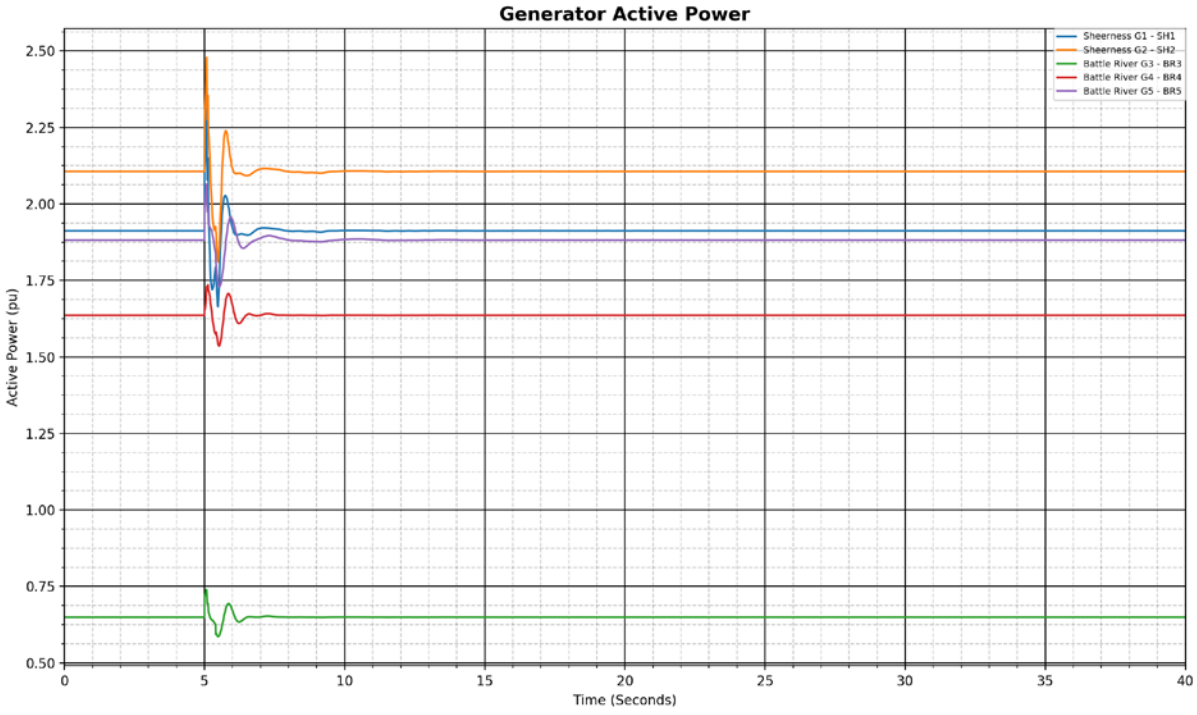
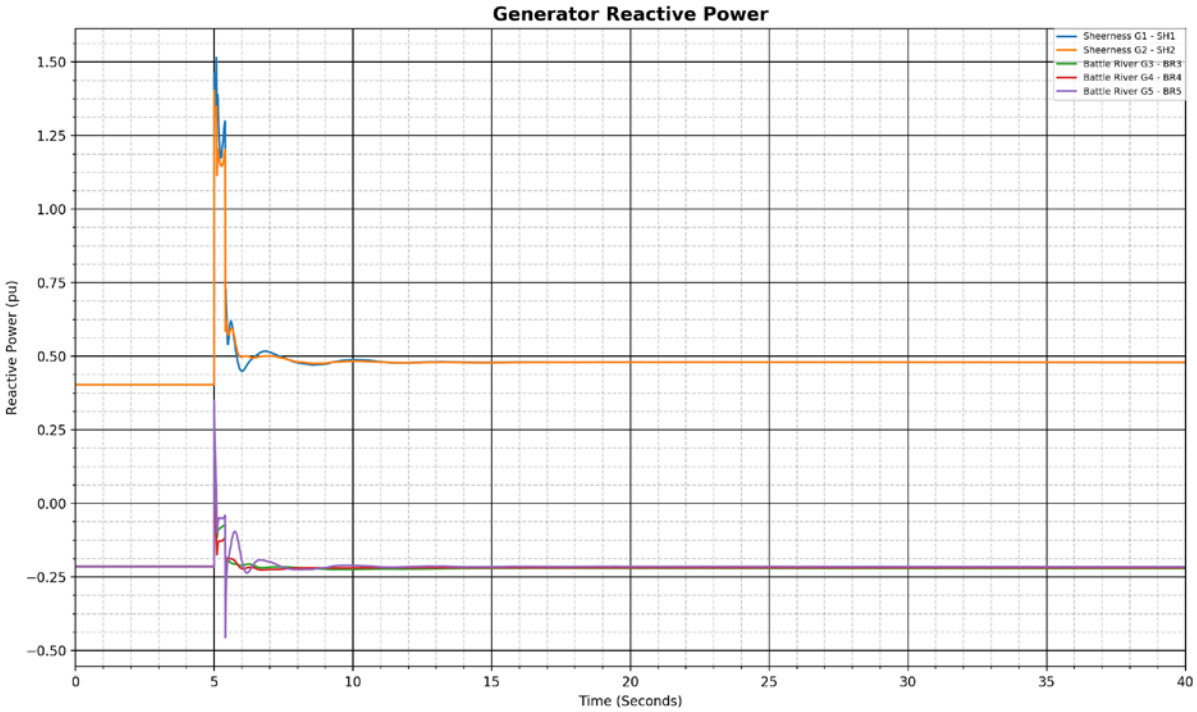

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Reactive Power (Mvar)
Time (Seconds)

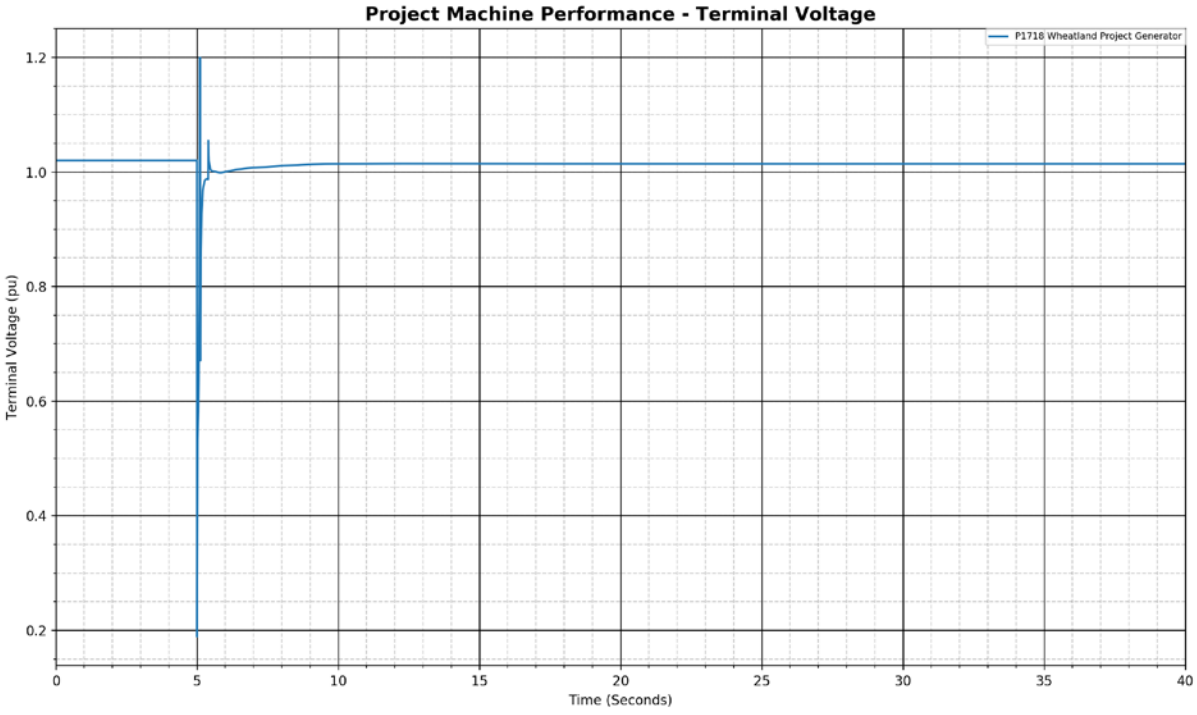
Figure A4-15: 7L171 (Wintering Hills 804S - Michichi Creek 802S): 3-phase fault at Wintering Hills 804S

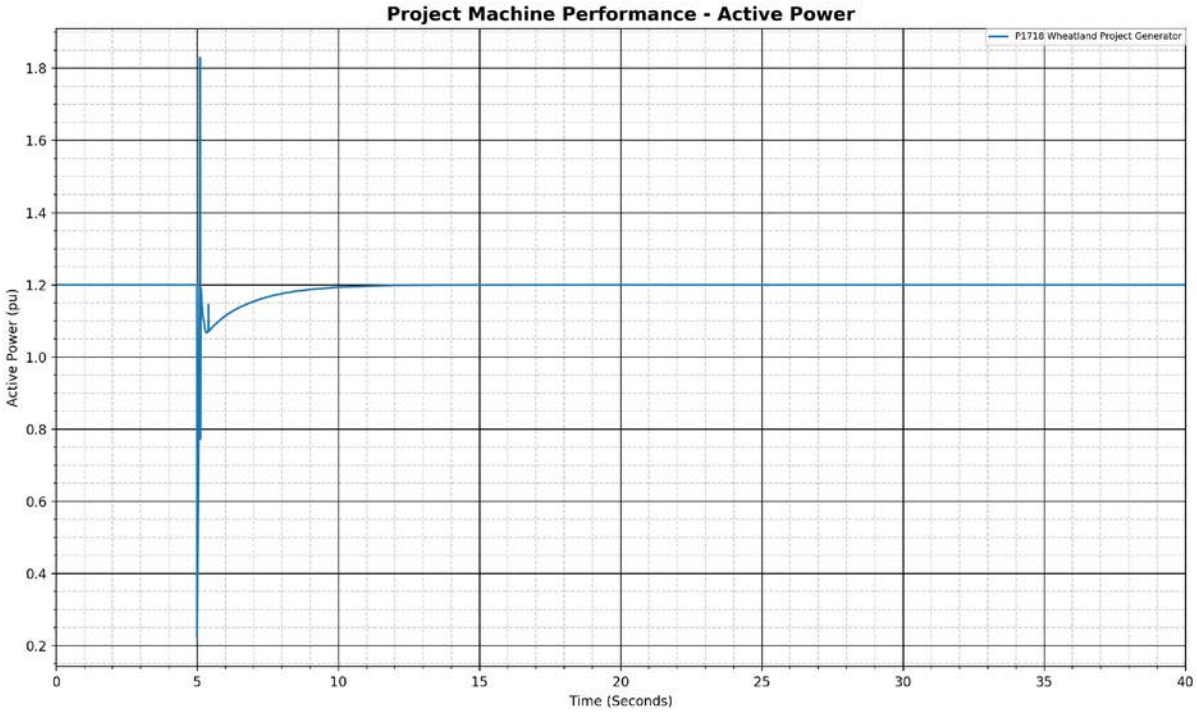


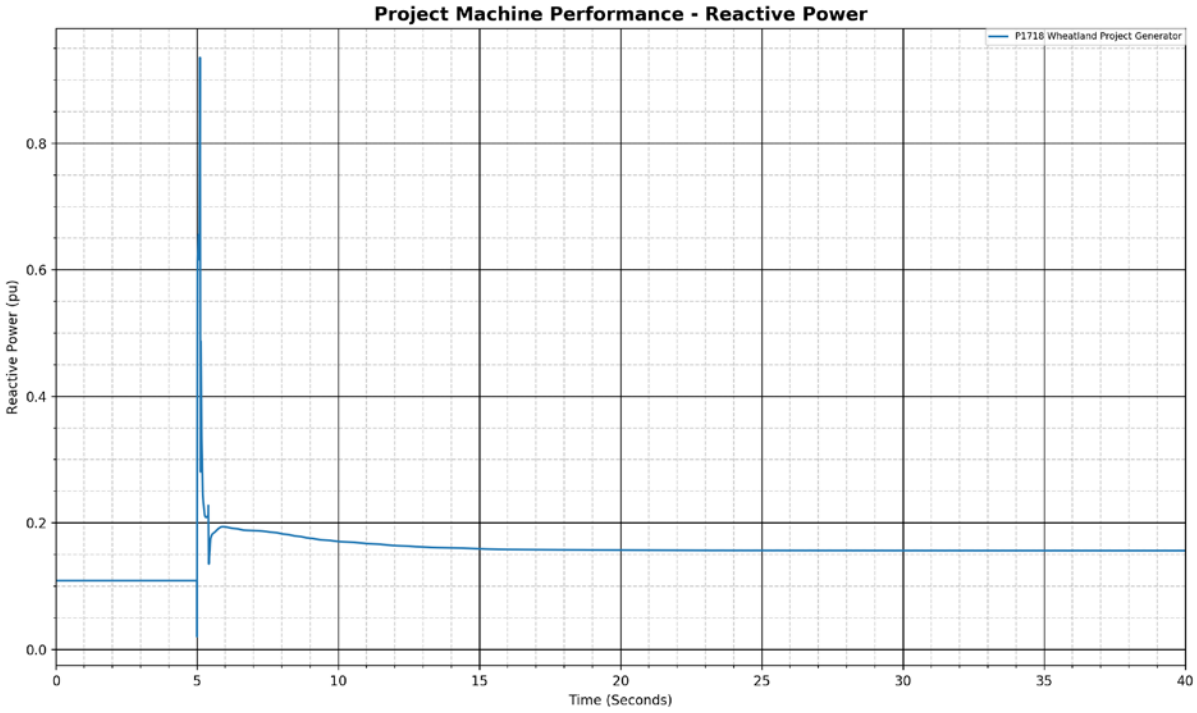

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
−30
0
5
10
15
20
25
30
35
40
Time (Seconds)

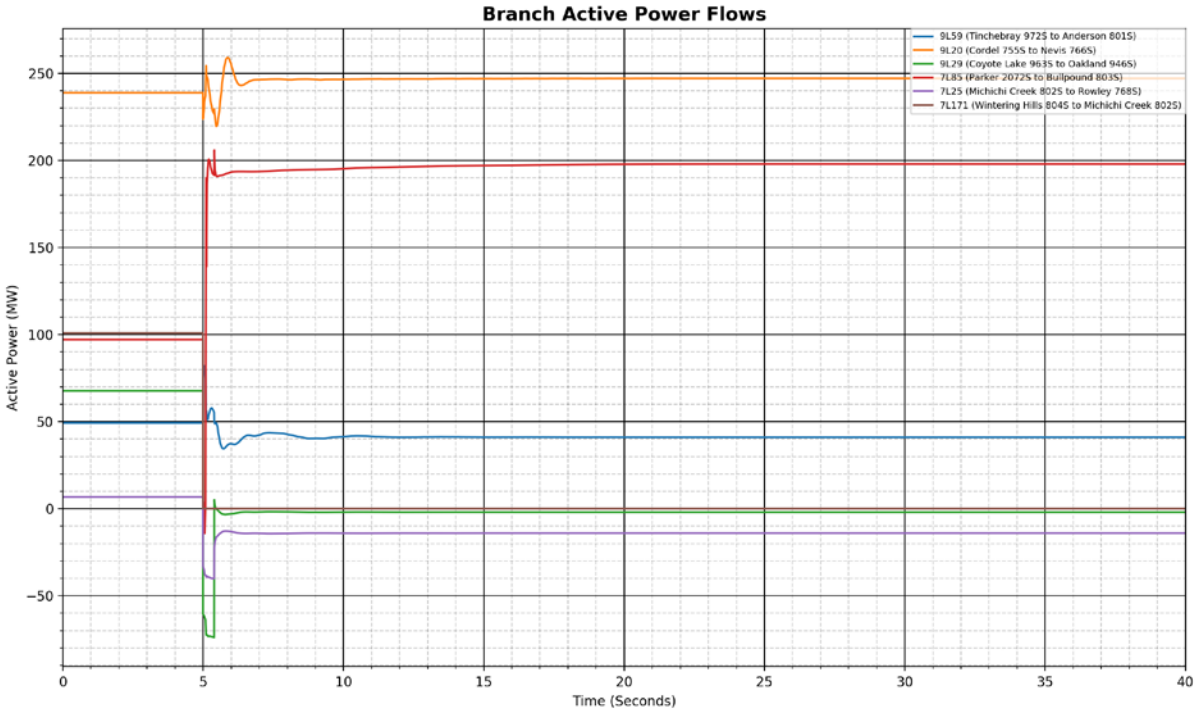

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Active Power (MW)
Time (Seconds)

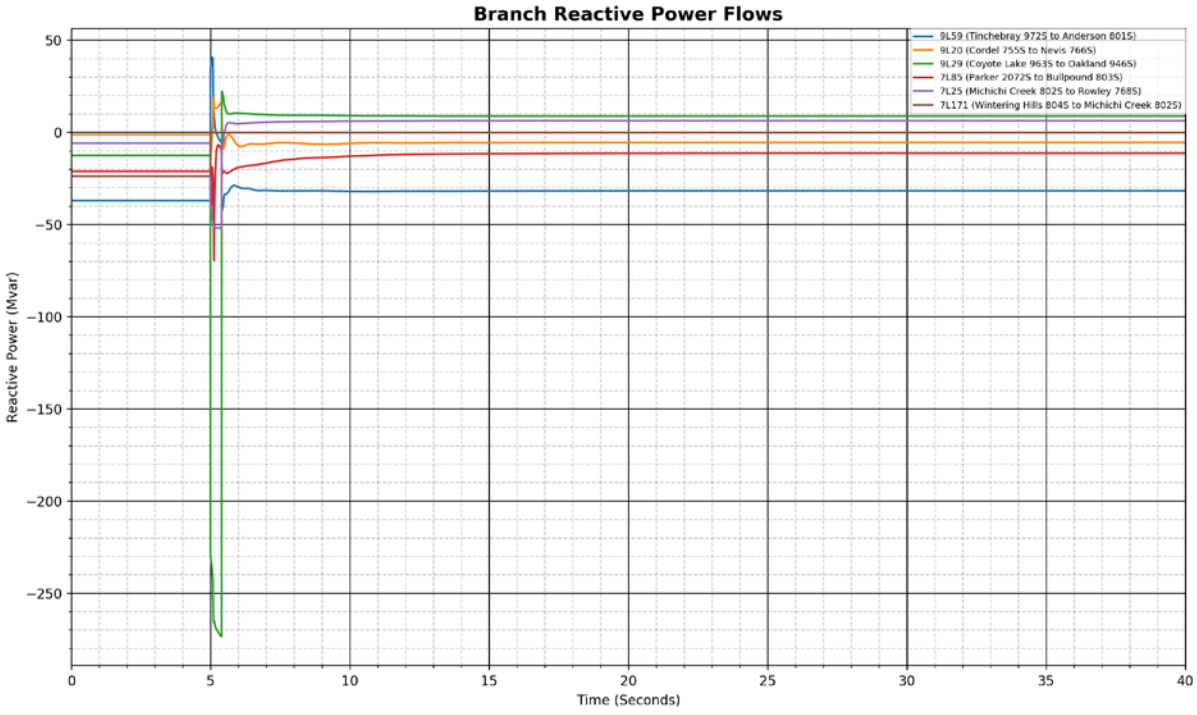
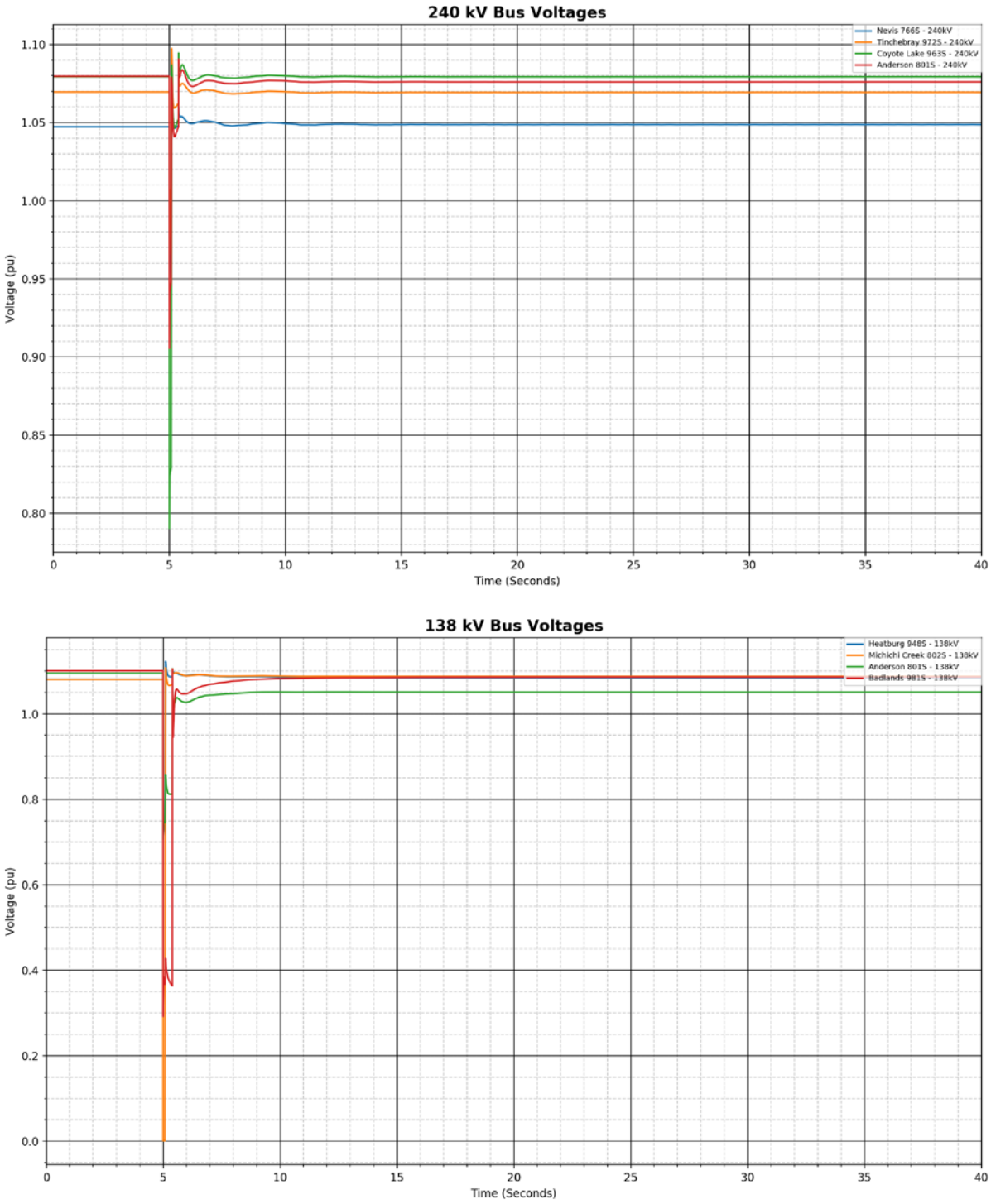
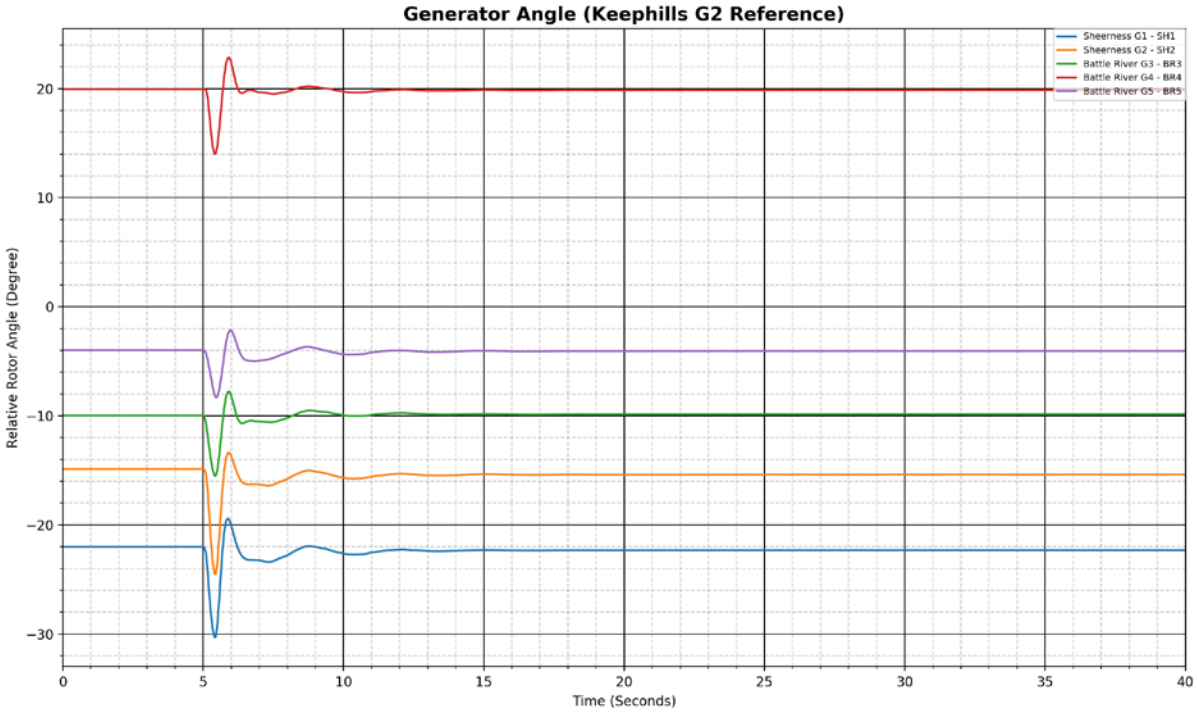
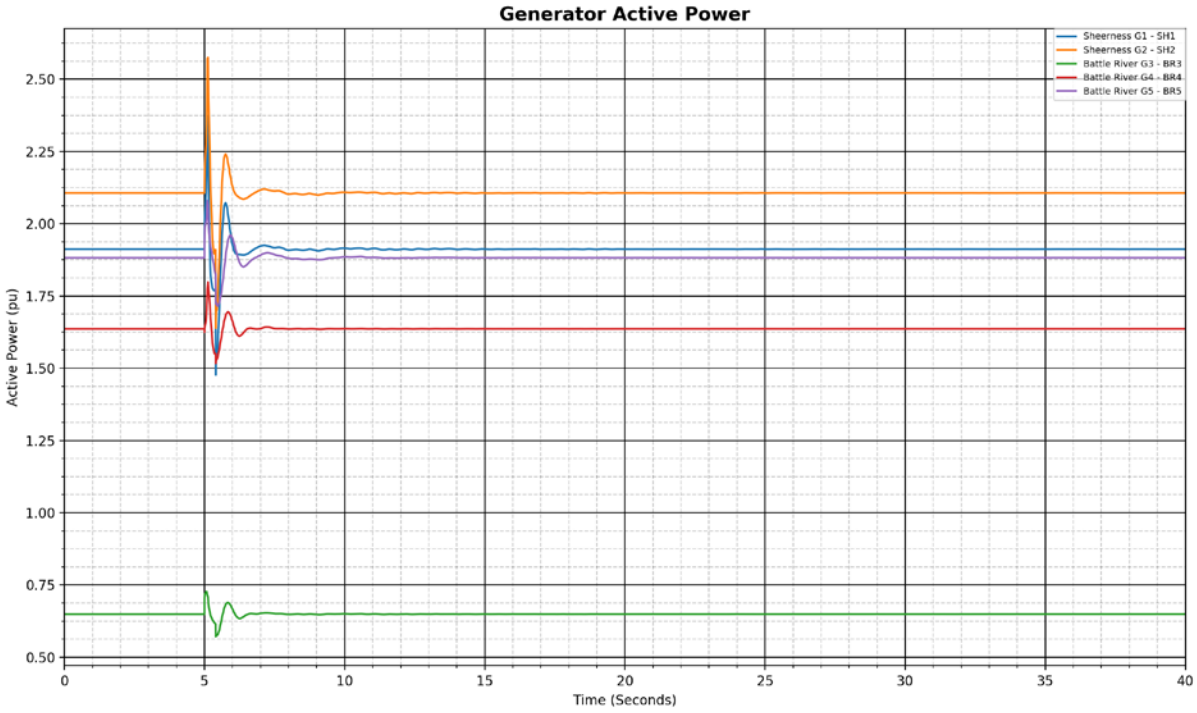
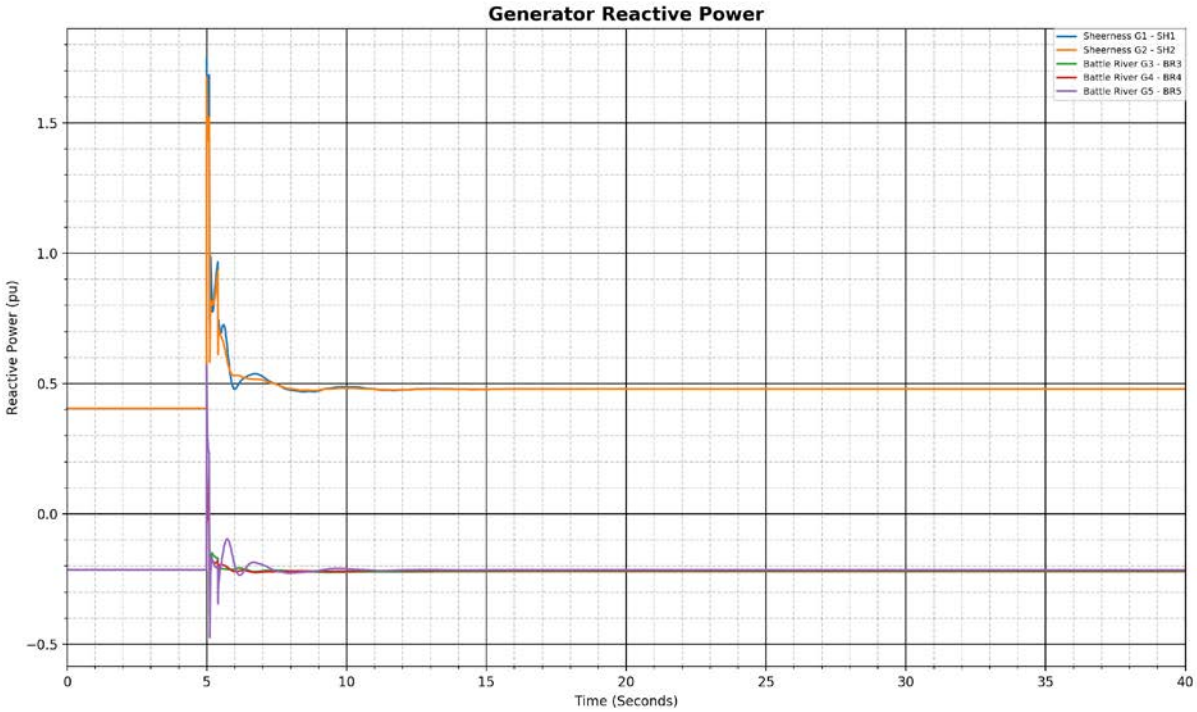

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Reactive Power (Mvar)
Time (Seconds)

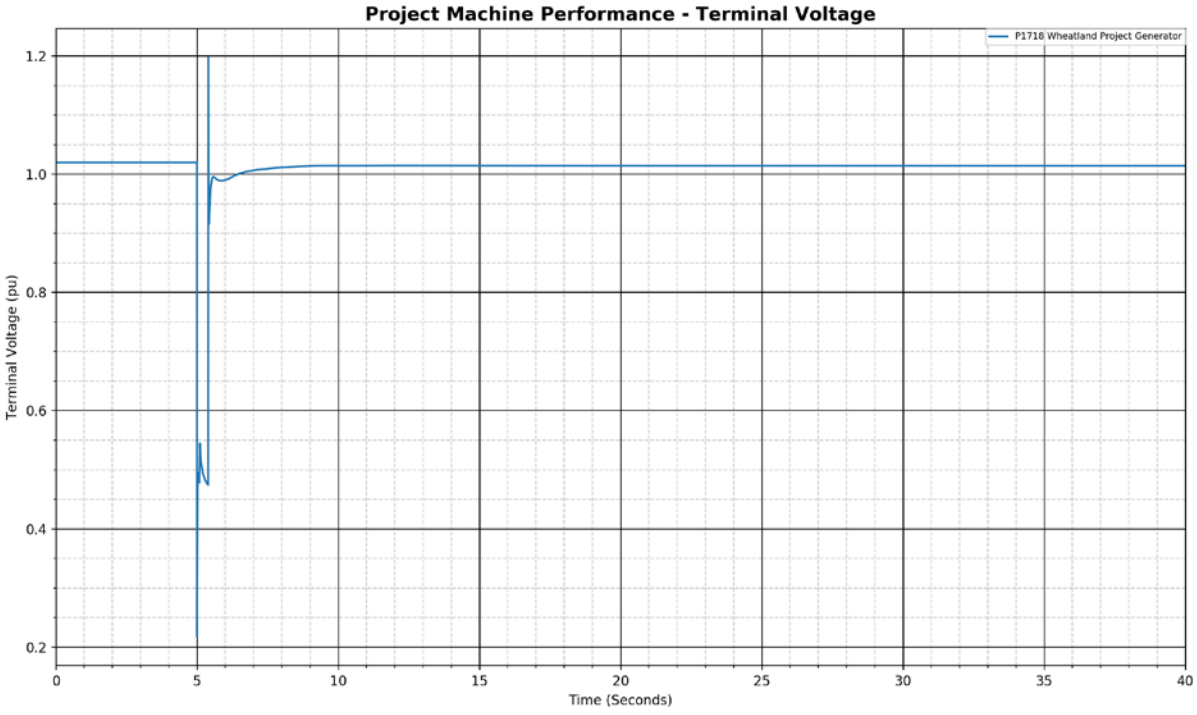
Figure A4-16: 7L171 (Wintering Hills 804S - Michichi Creek 802S): 3-phase fault at Michichi Creek 802S

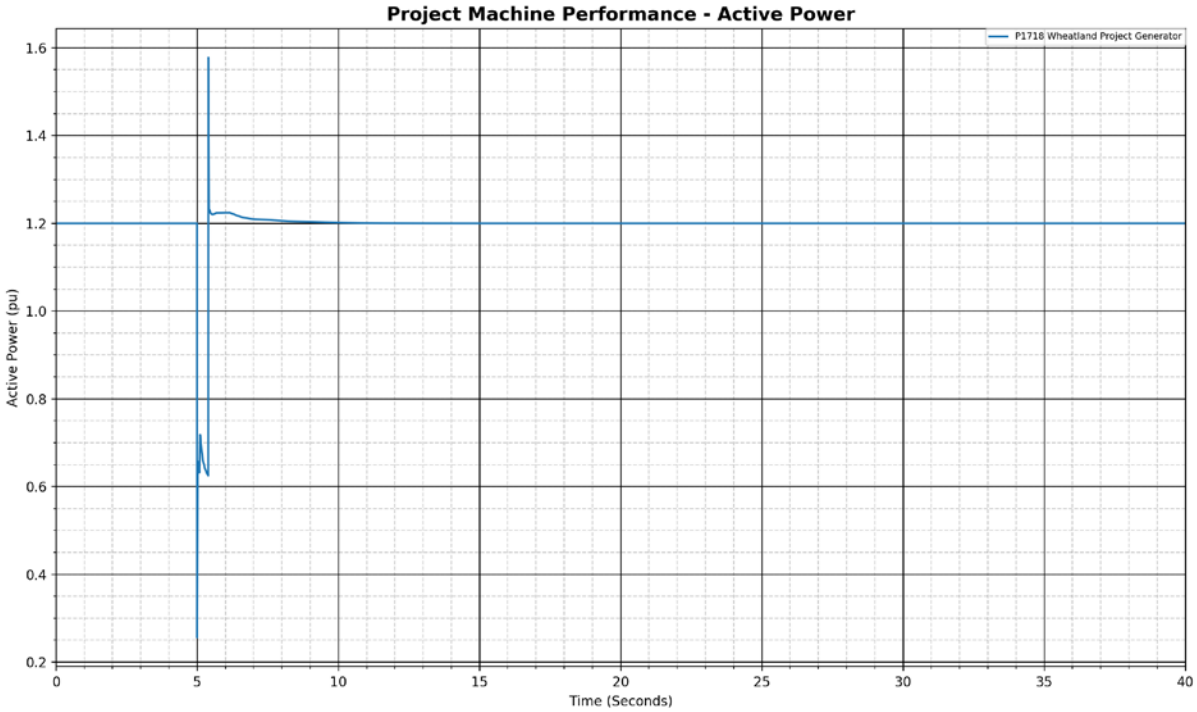


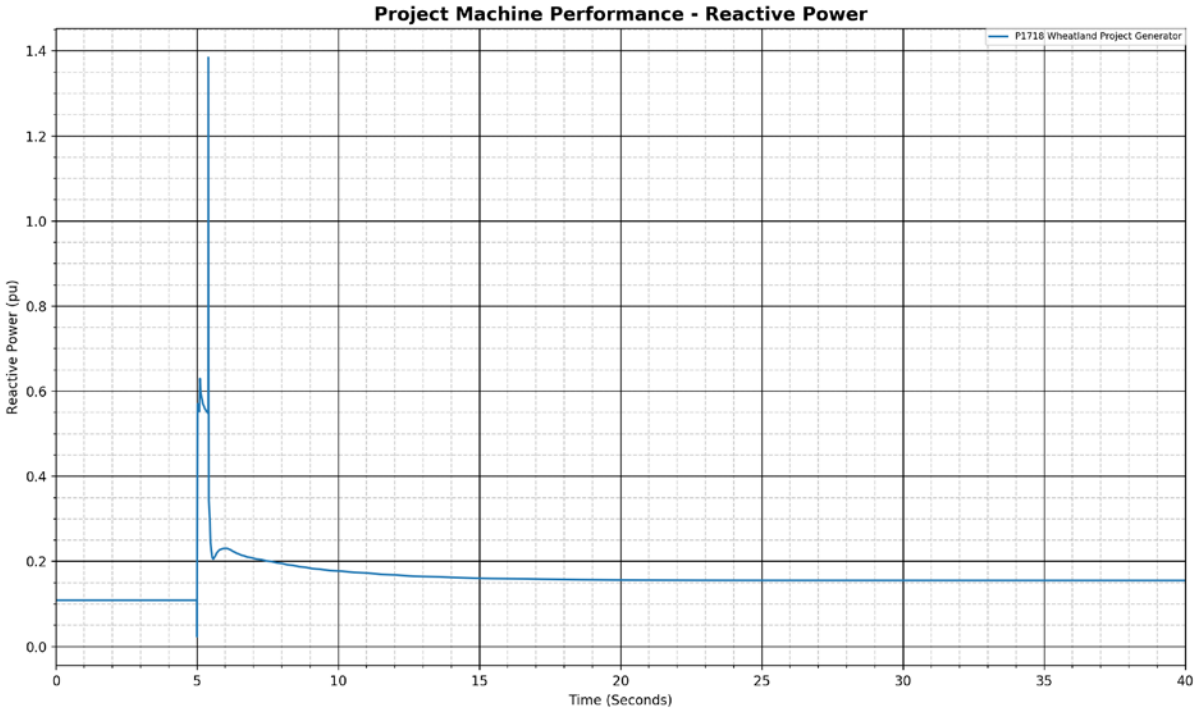

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
−30
0
5
10
15
20
25
30
35
40
Time (Seconds)

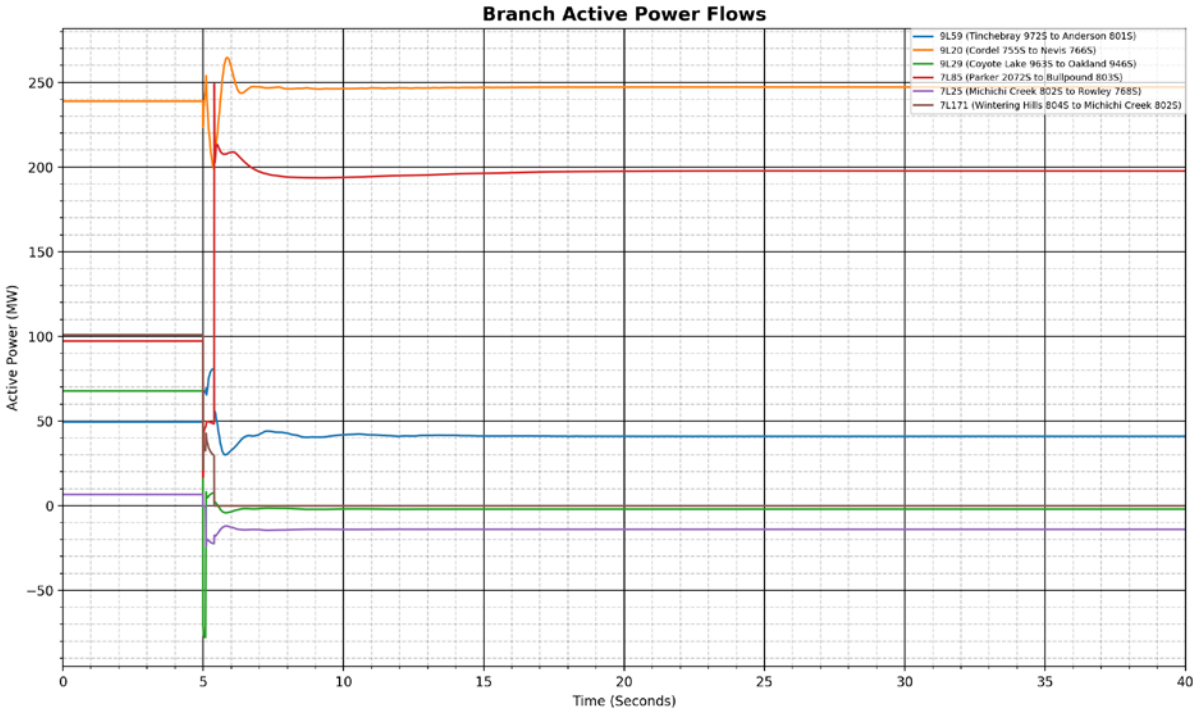

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Active Power (MW)
Time (Seconds)

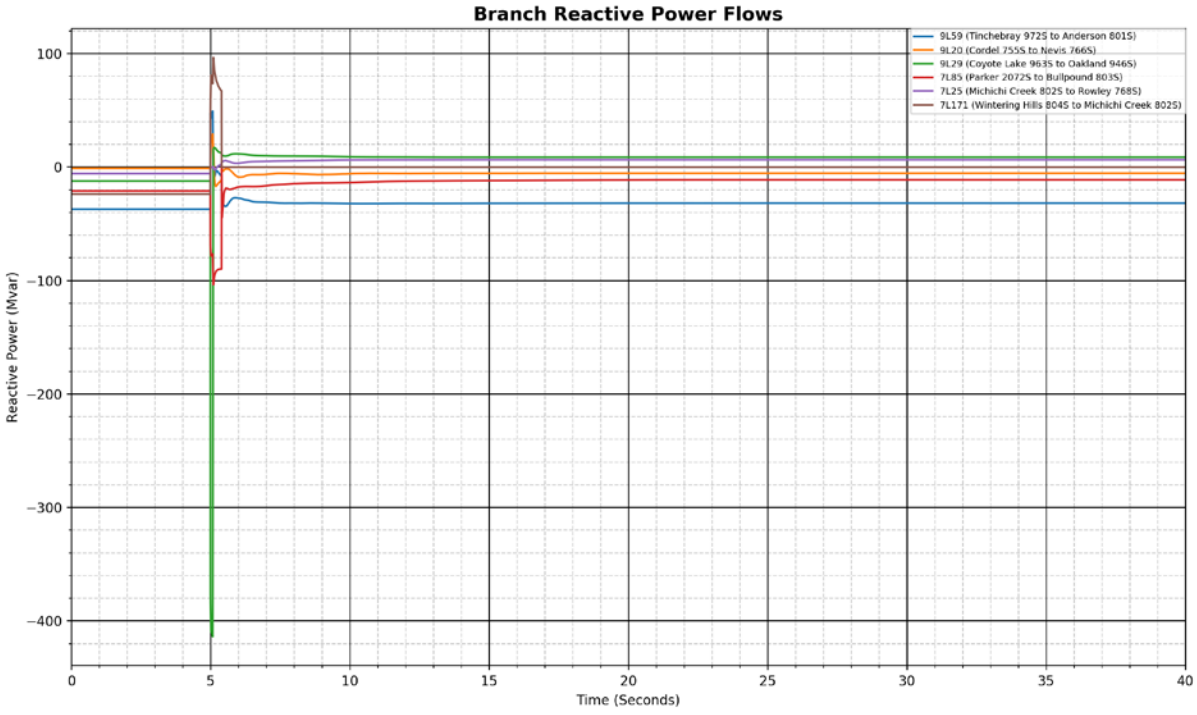
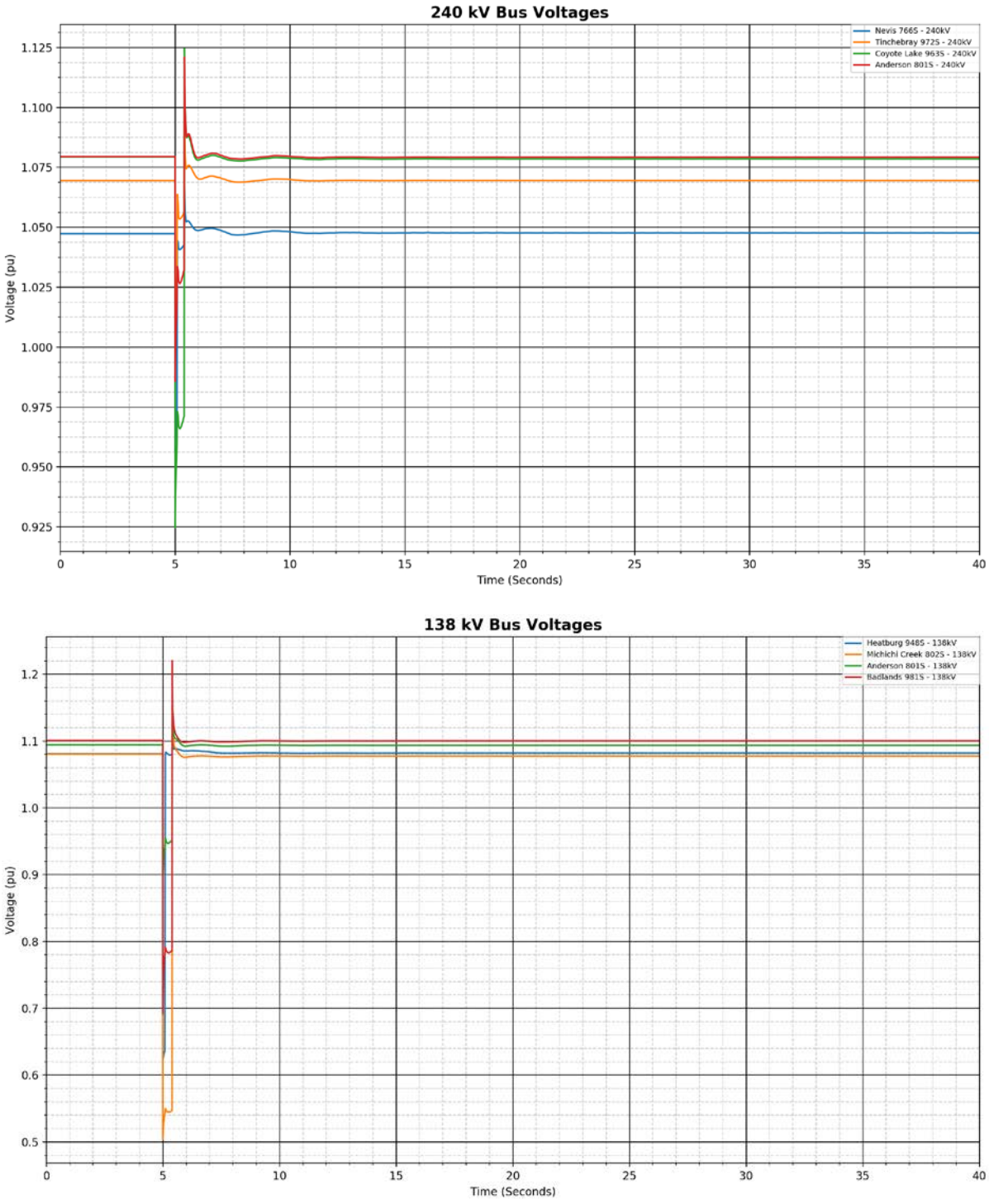
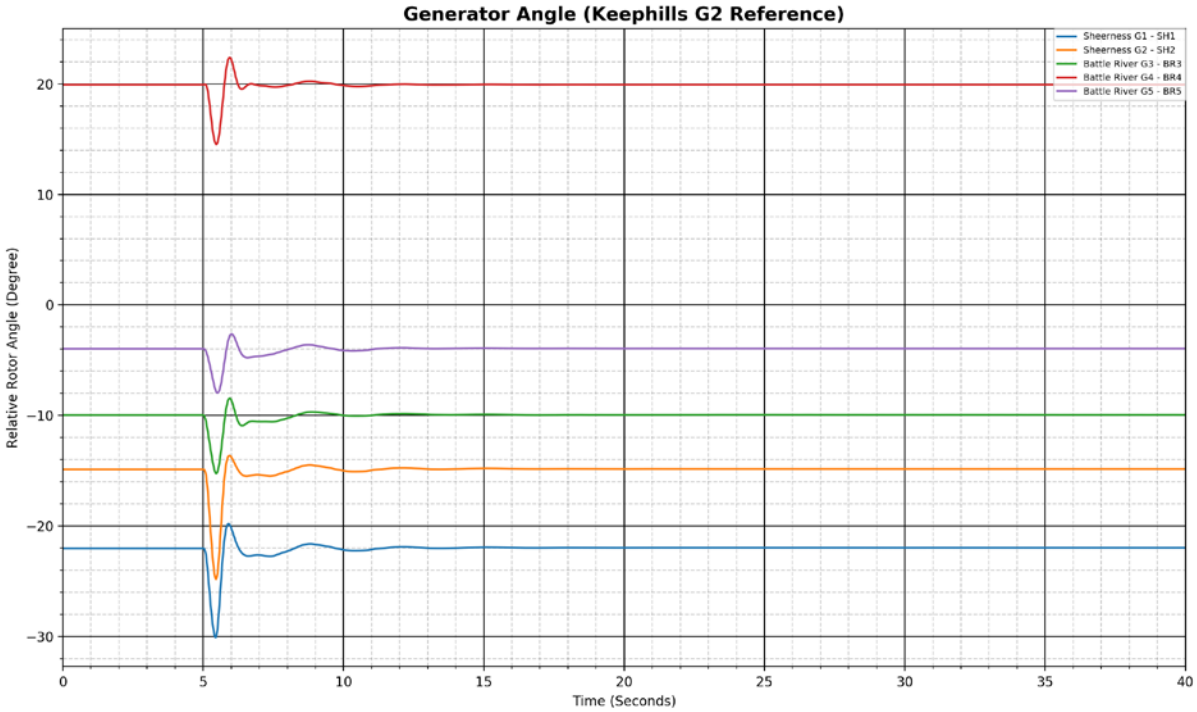
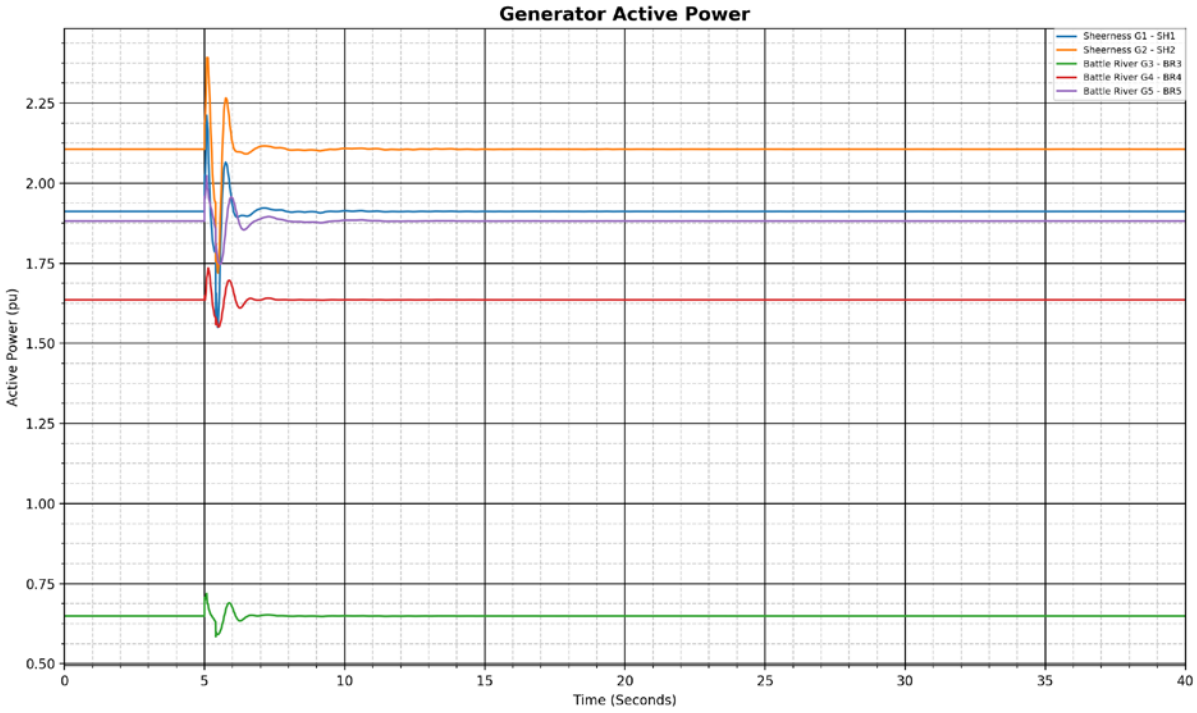
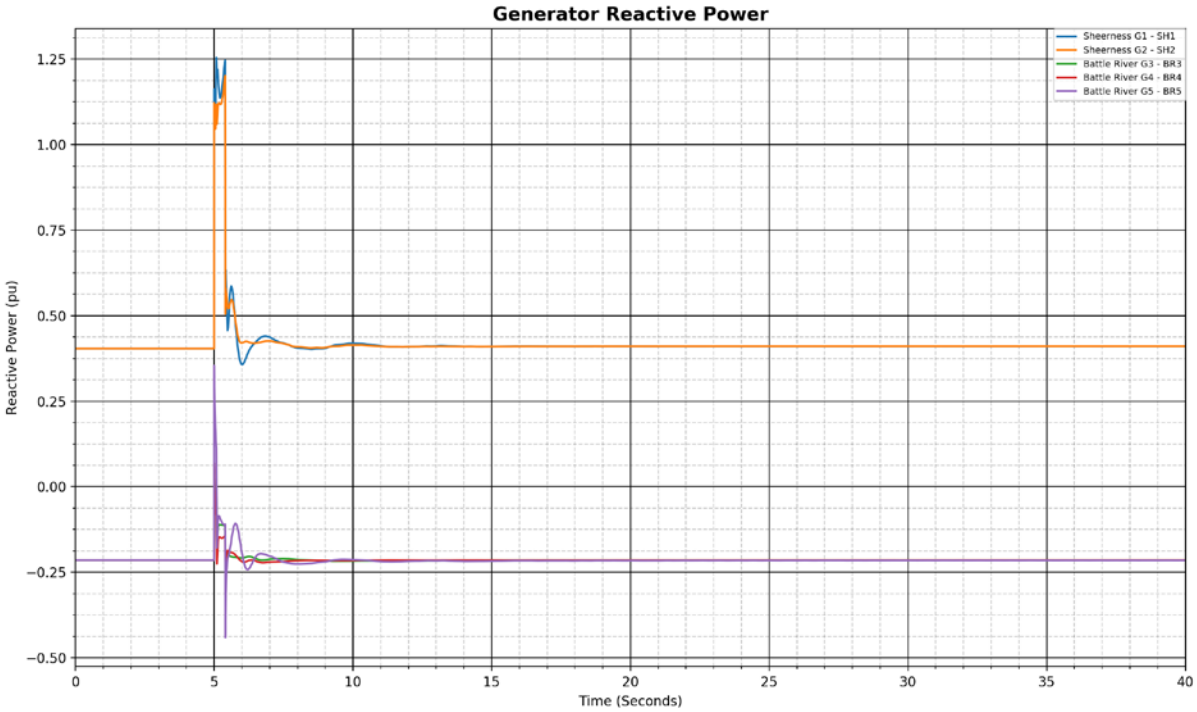

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Reactive Power (Mvar)
Time (Seconds)

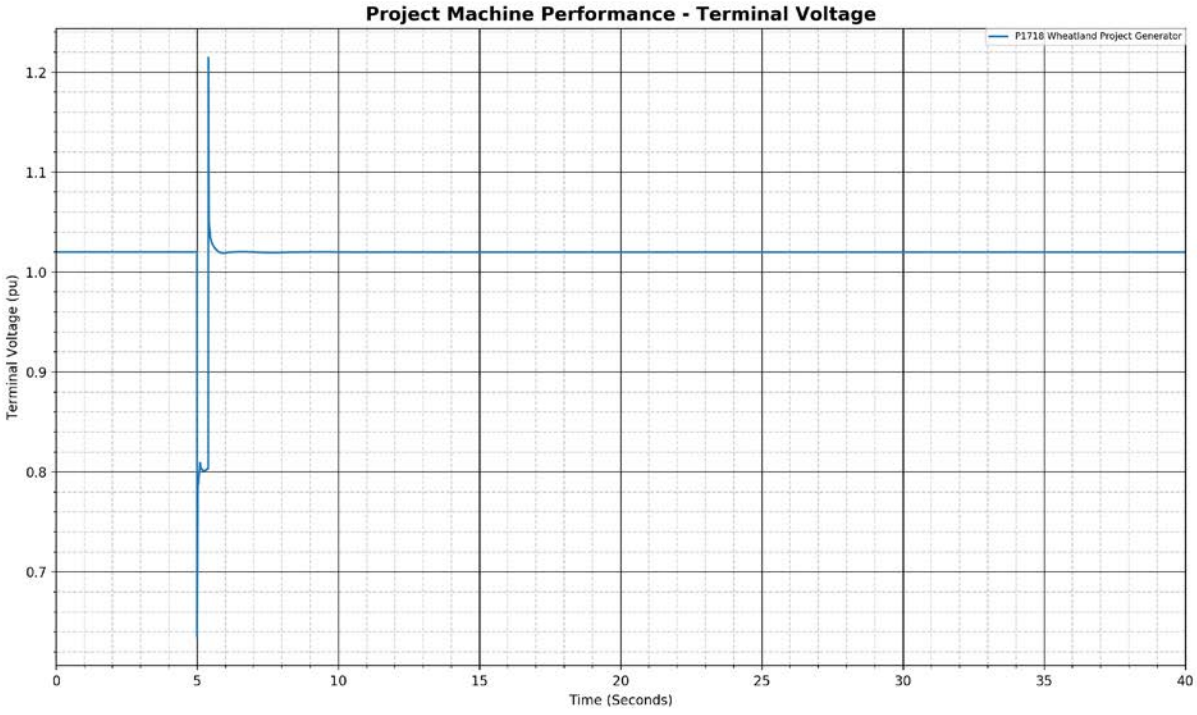
Figure A4-17: 7L25 (Rowley 768S - Michichi Creek 802S): 3-phase fault at Rowley 768S

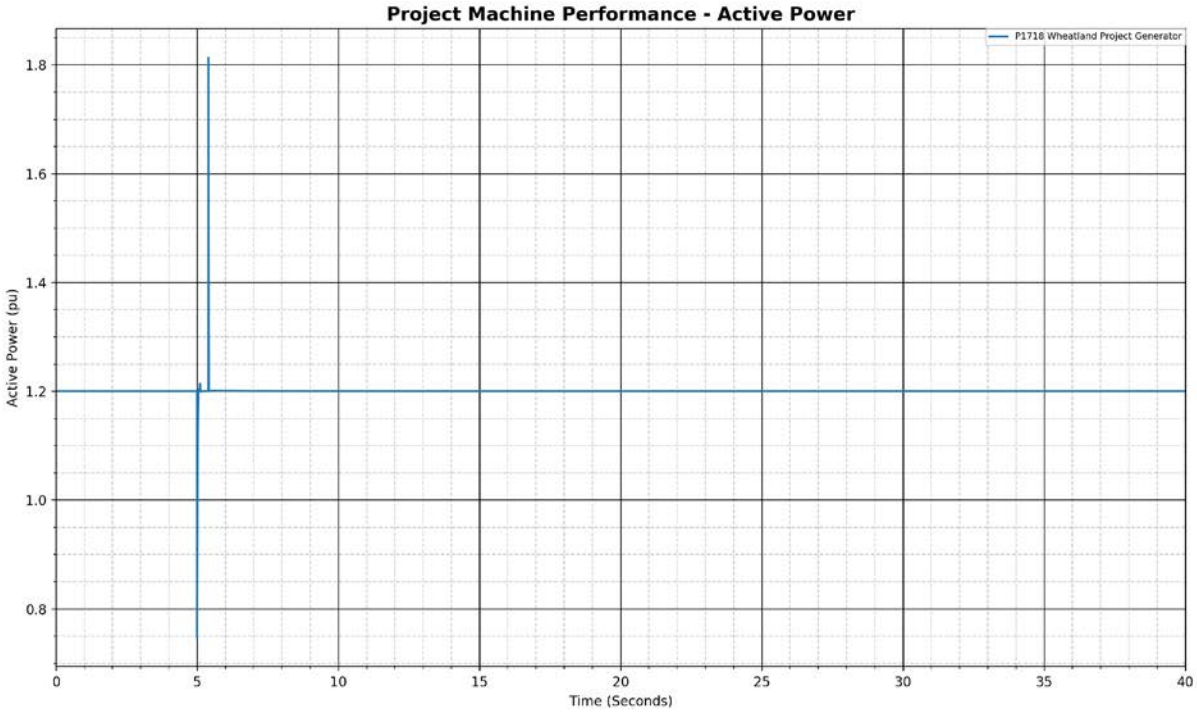


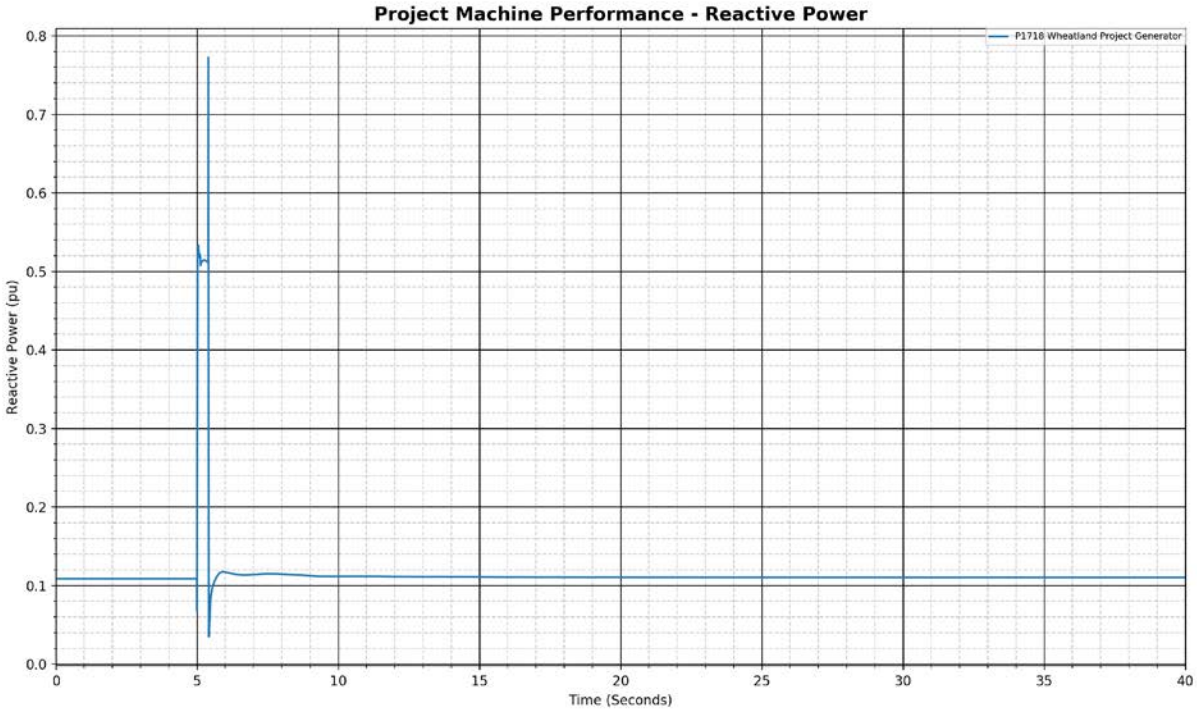

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
−30
0
5
10
15
20
25
30
35
40
Time (Seconds)

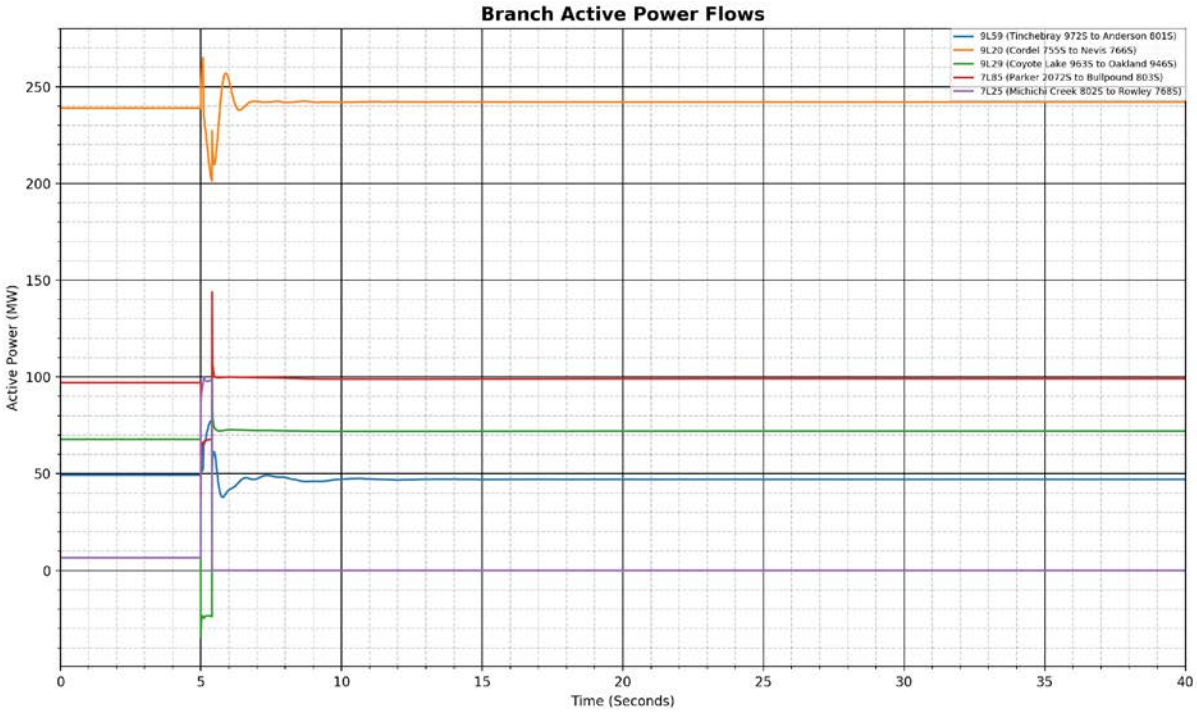

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
Time (Seconds)

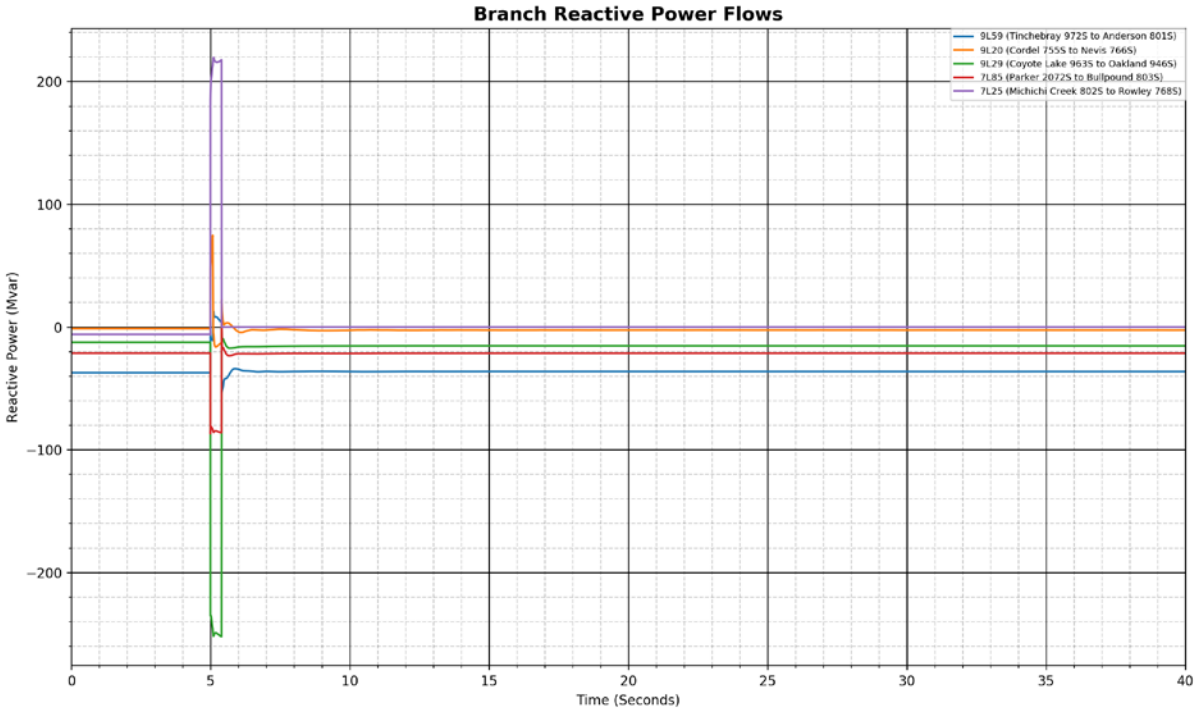
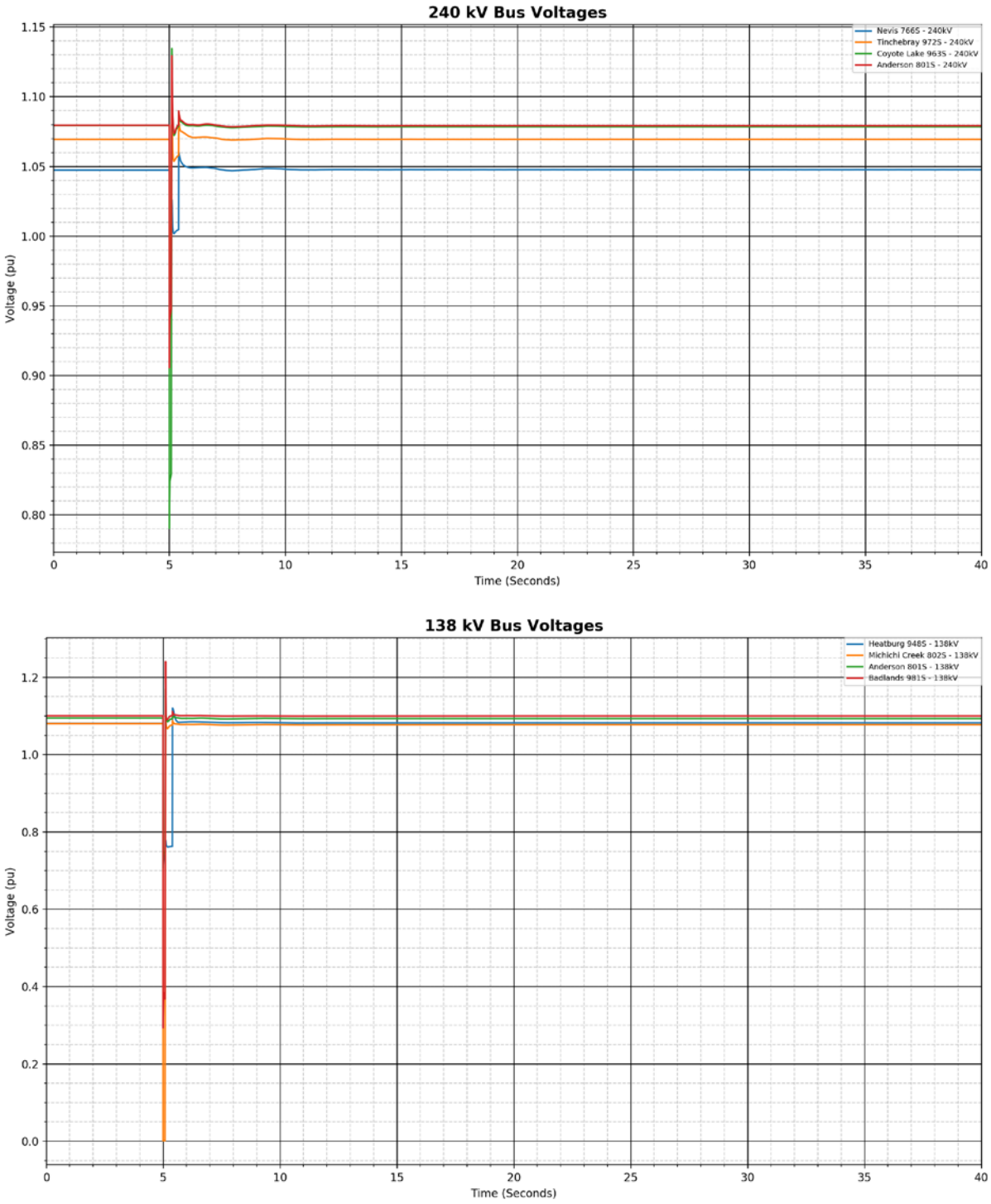
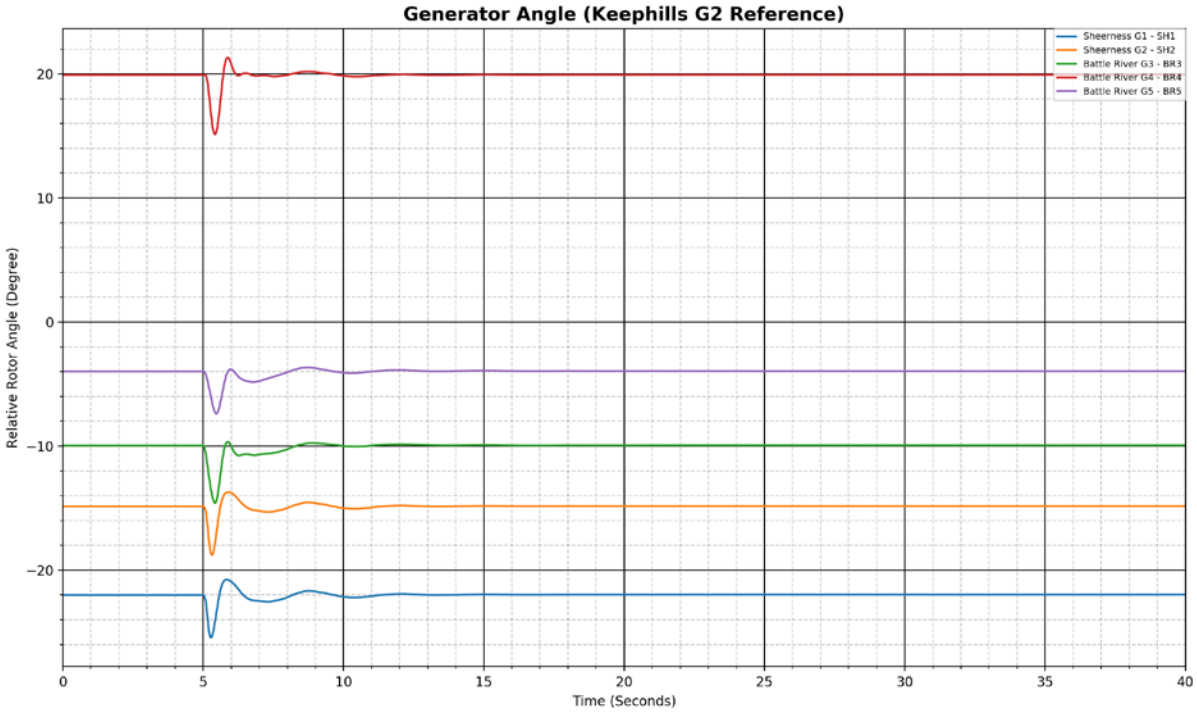
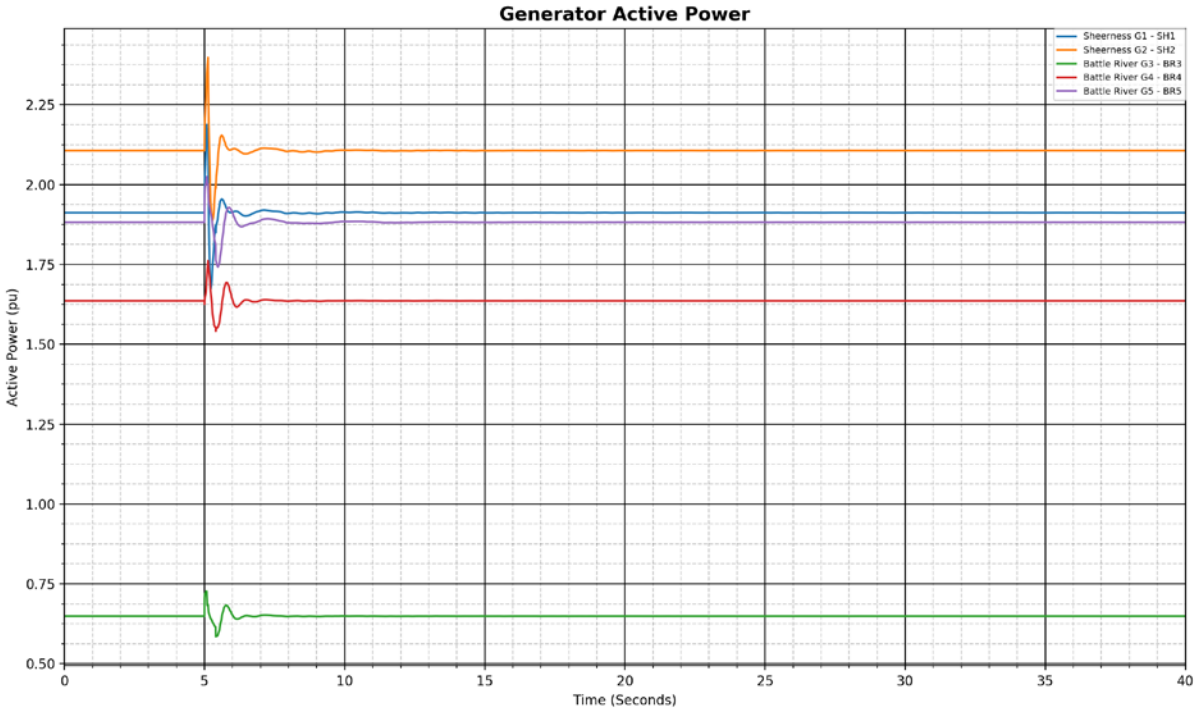
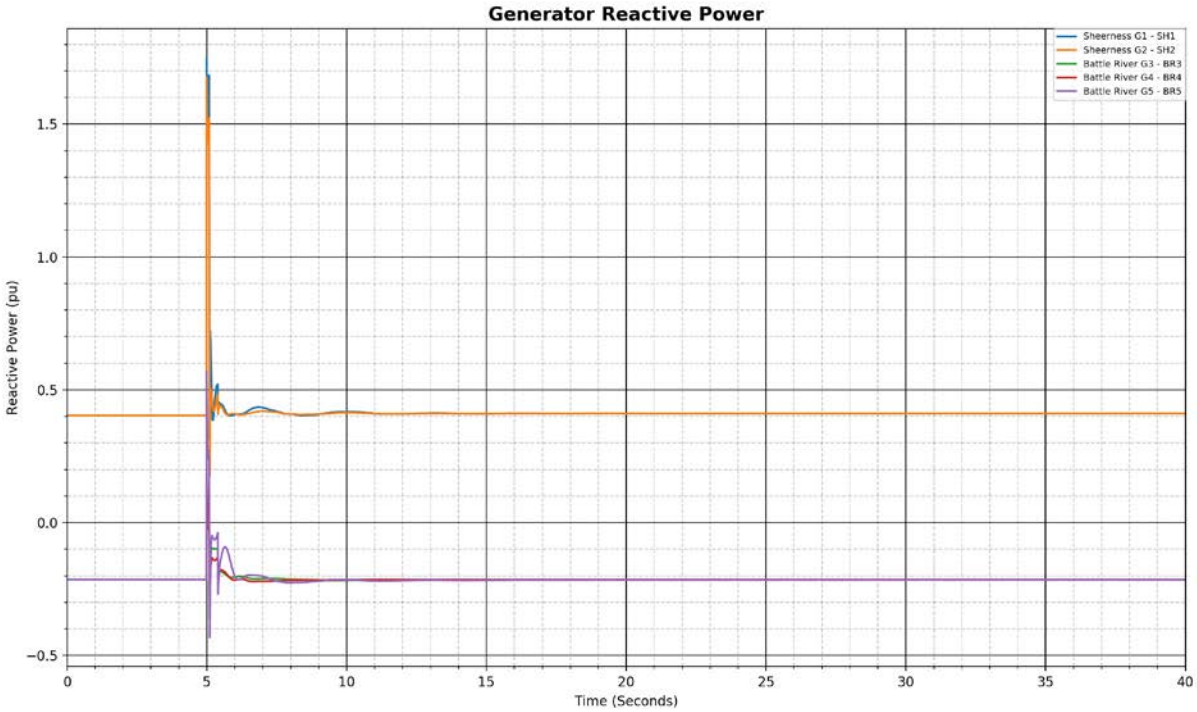

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
Time (Seconds)

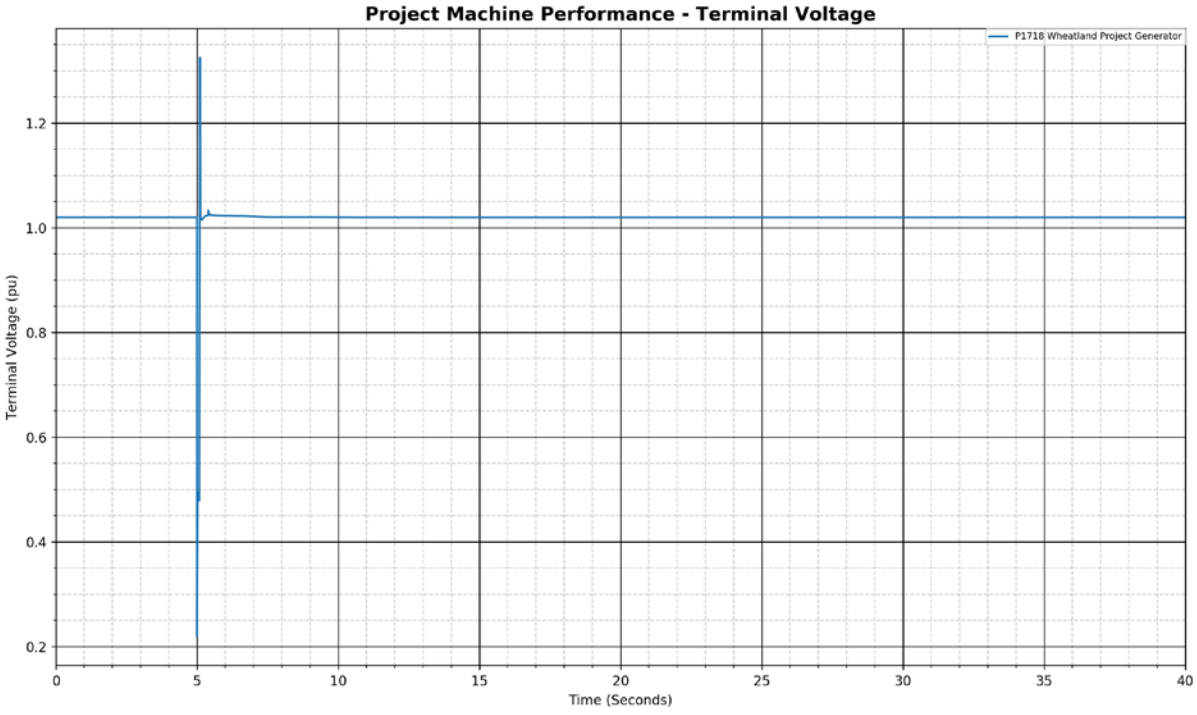
Figure A4-18: 7L25 (Rowley 768S - Michichi Creek 802S): 3-phase fault at Michichi Creek 802S

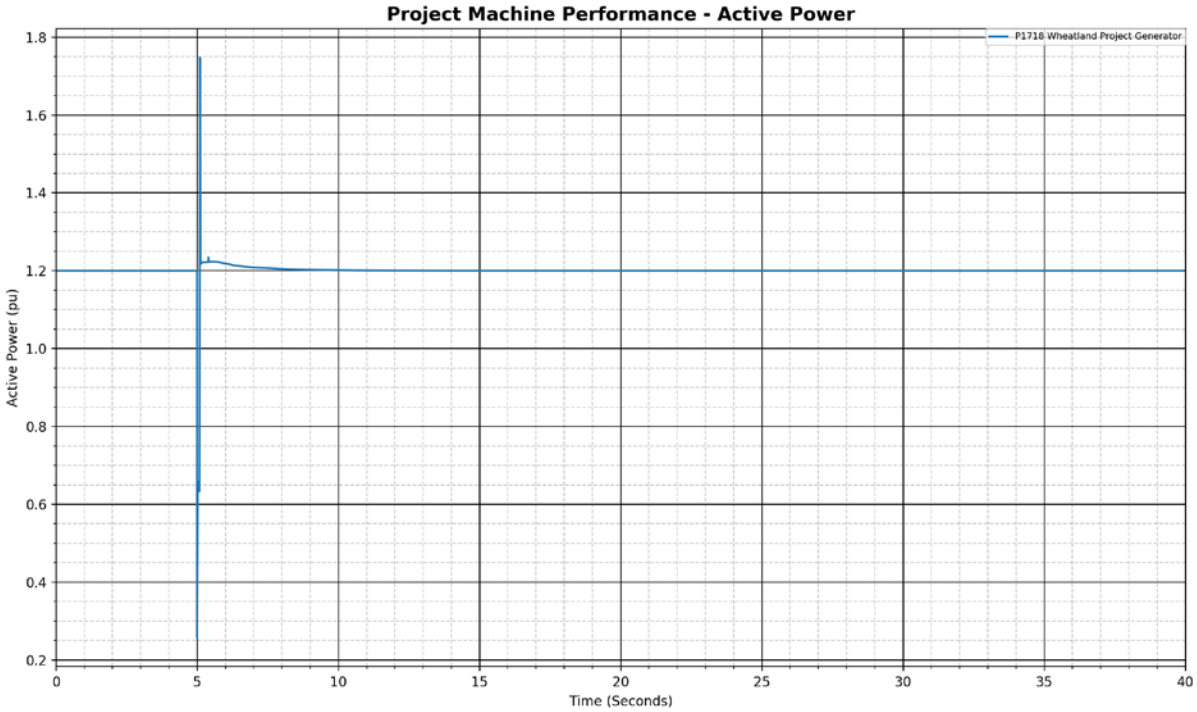


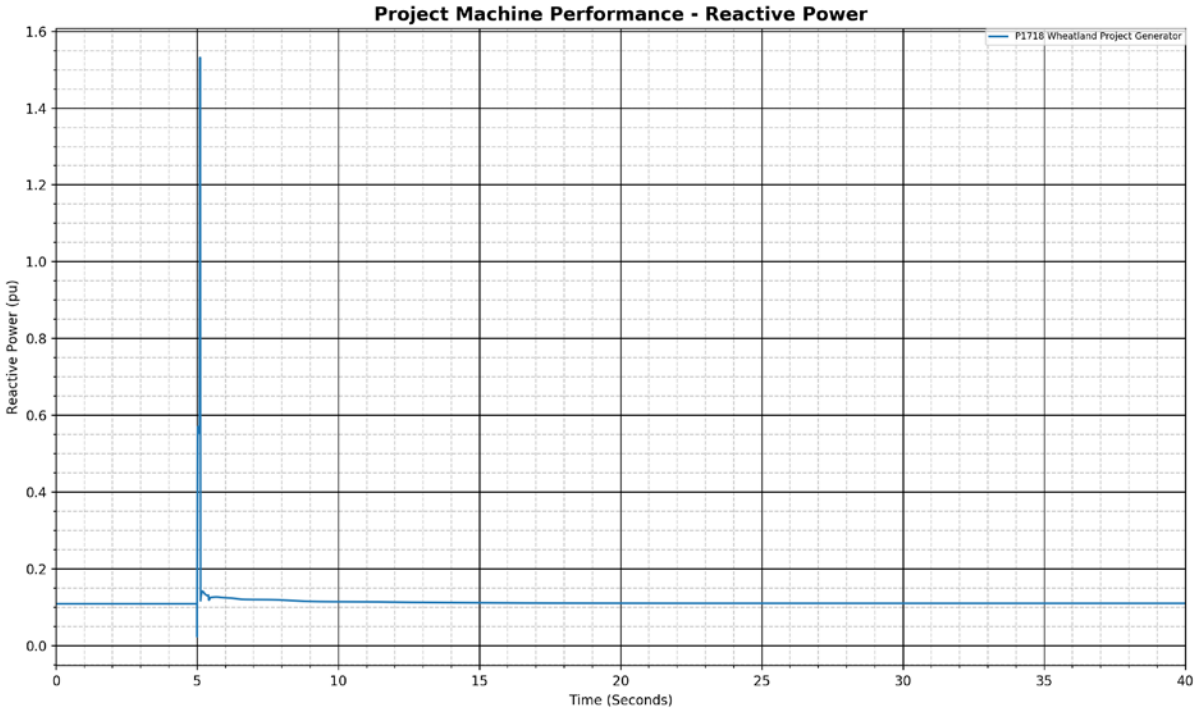

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

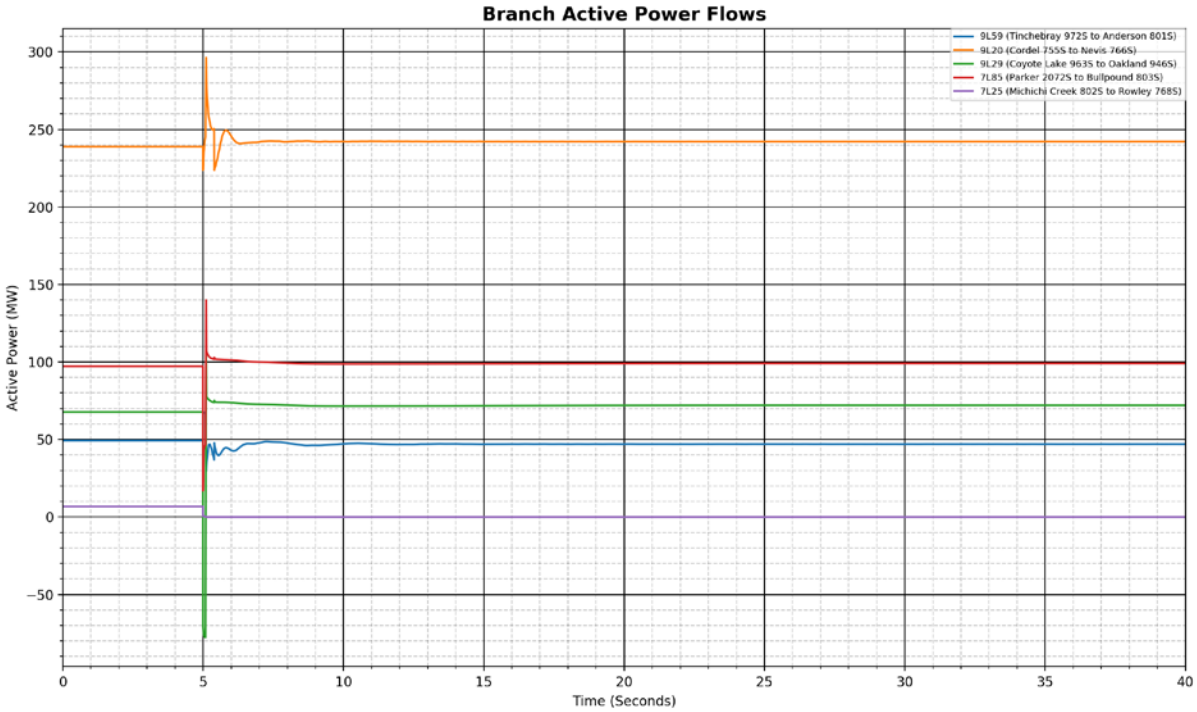

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
Time (Seconds)

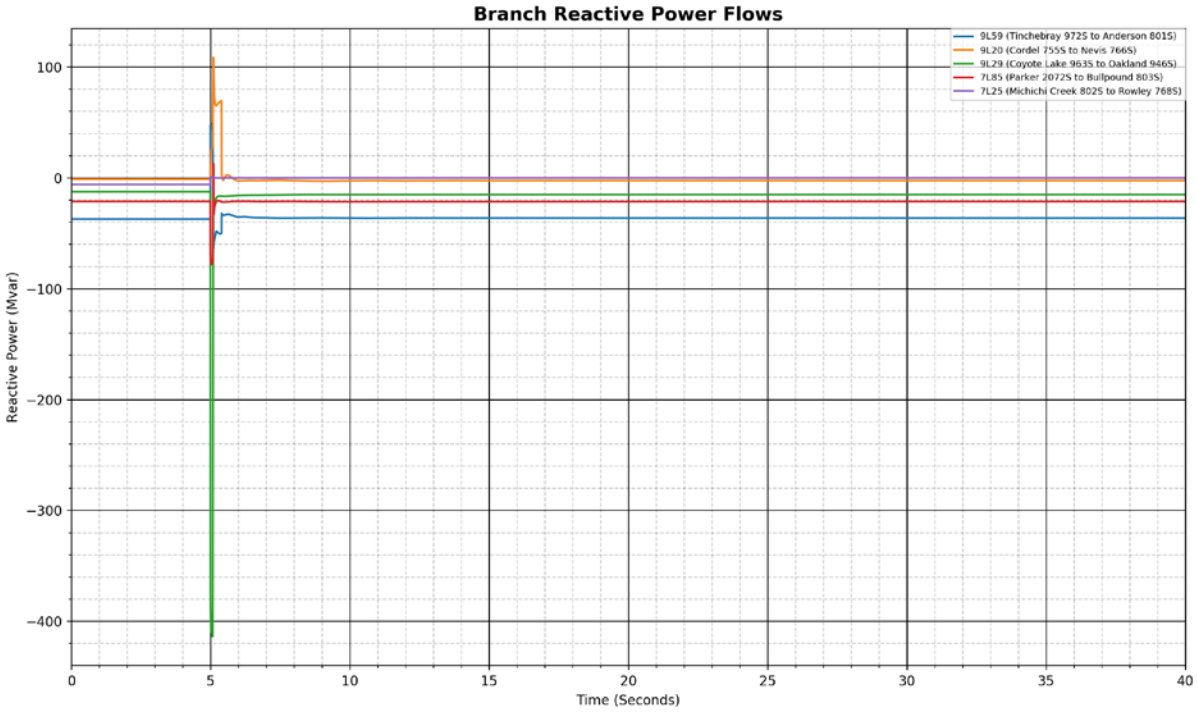
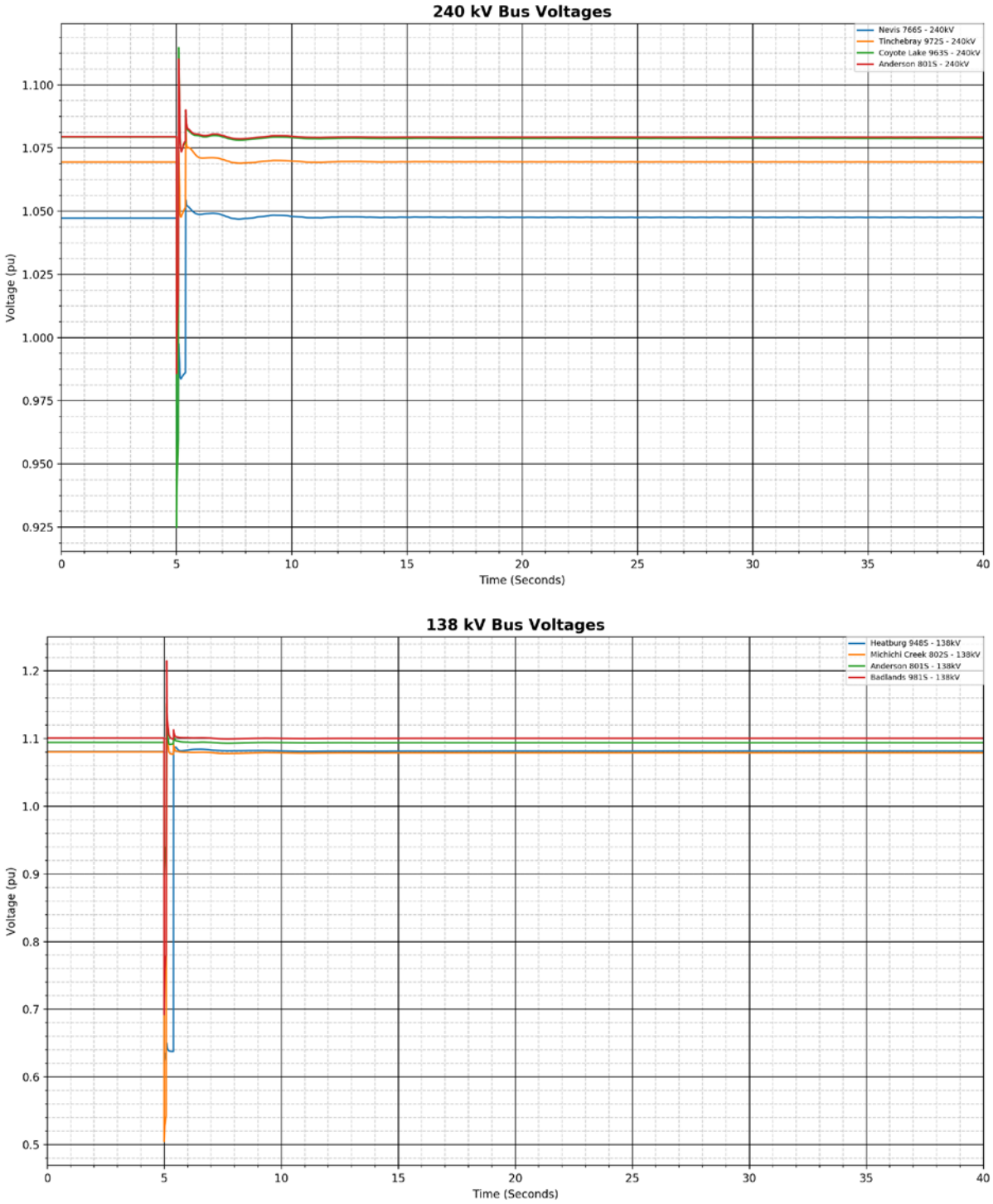
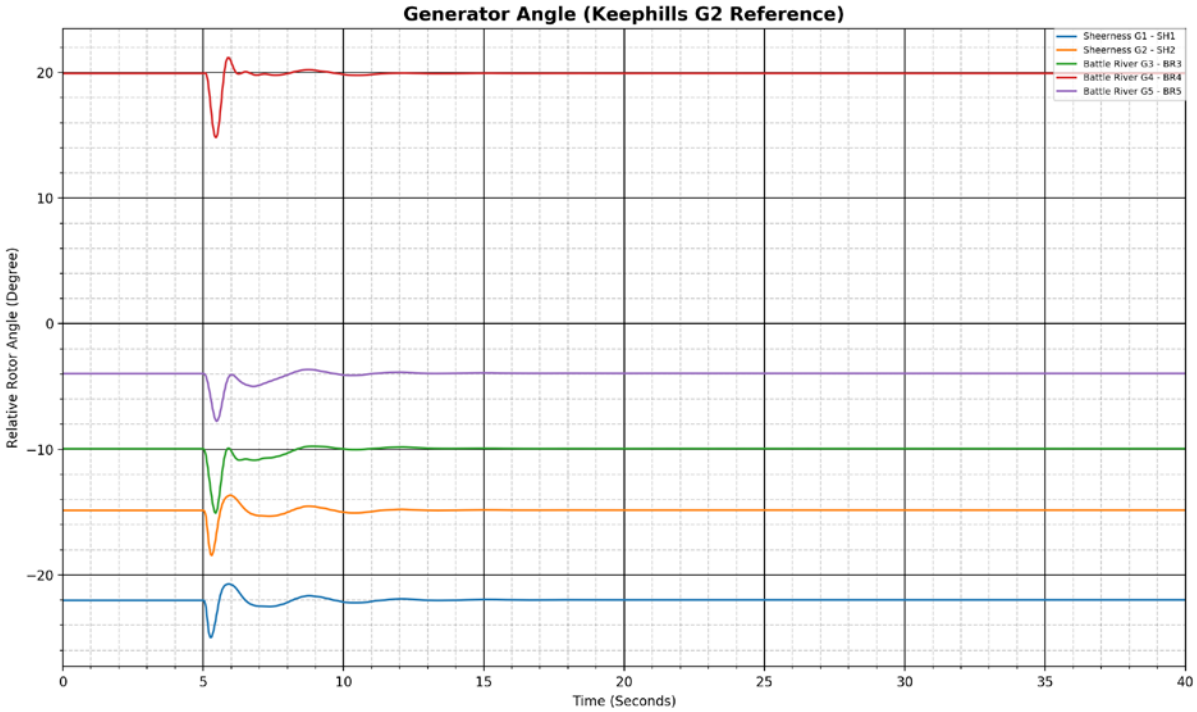
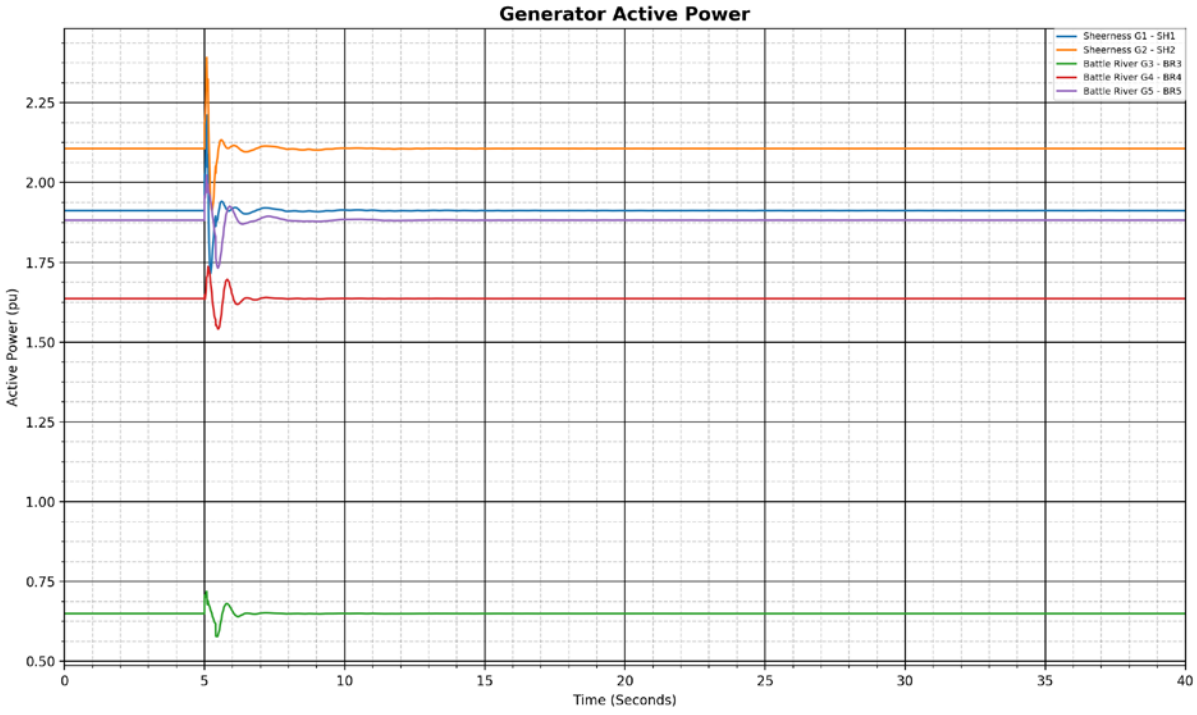
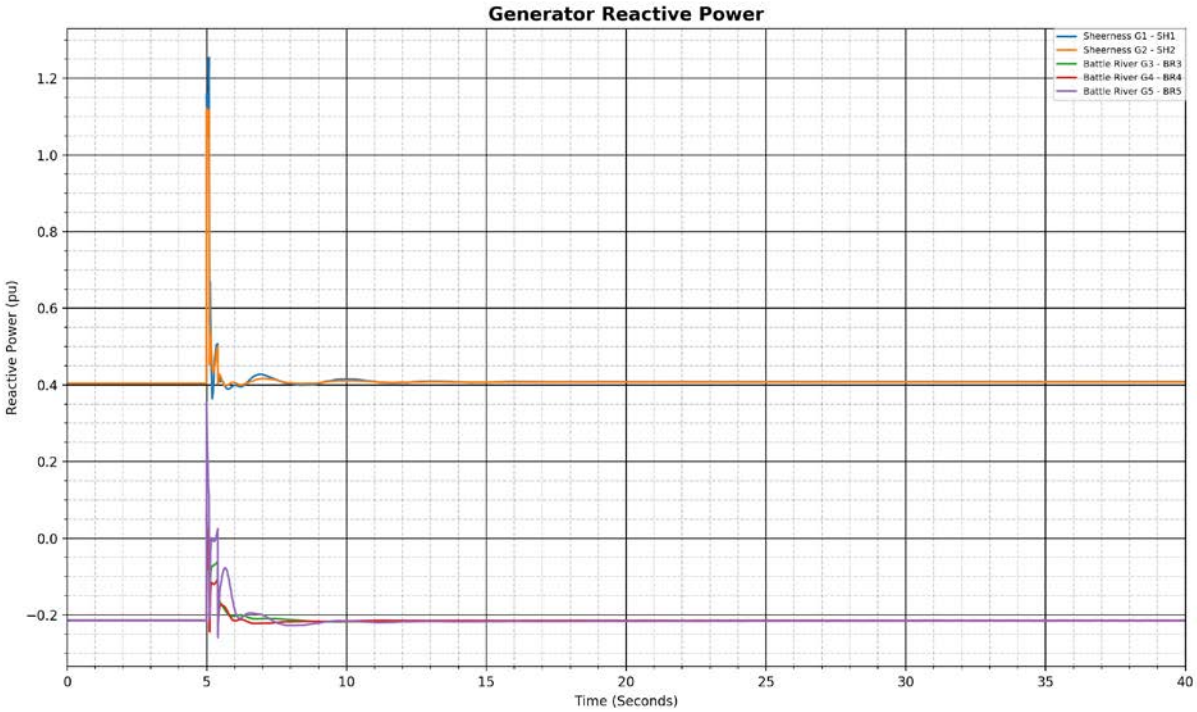

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
Time (Seconds)

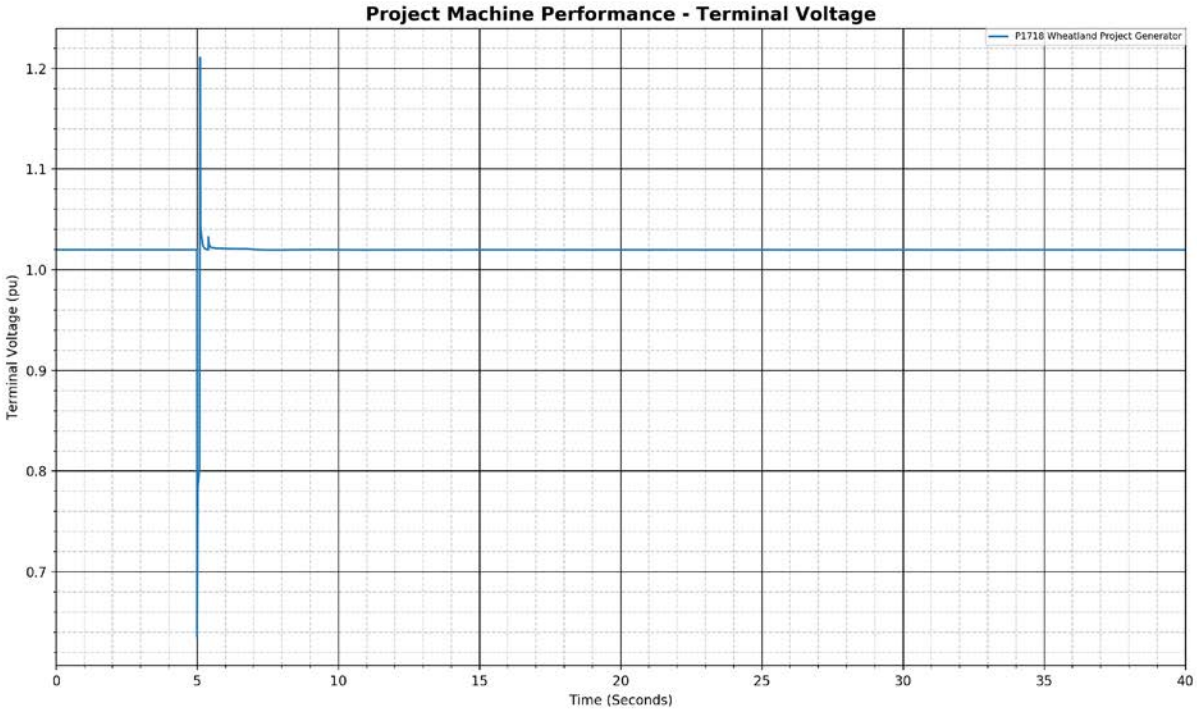
Figure A4-19: 7L137 (Rowley 768S - Three Hills 770S): 3-phase fault at Rowley 768S

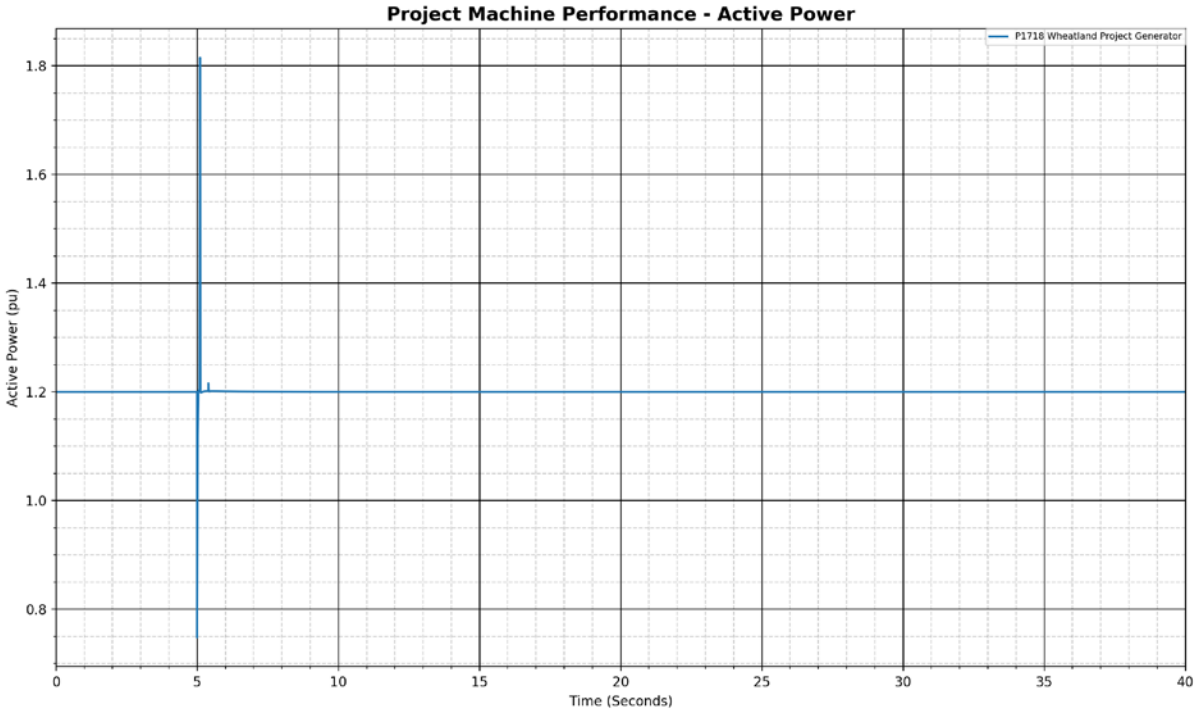


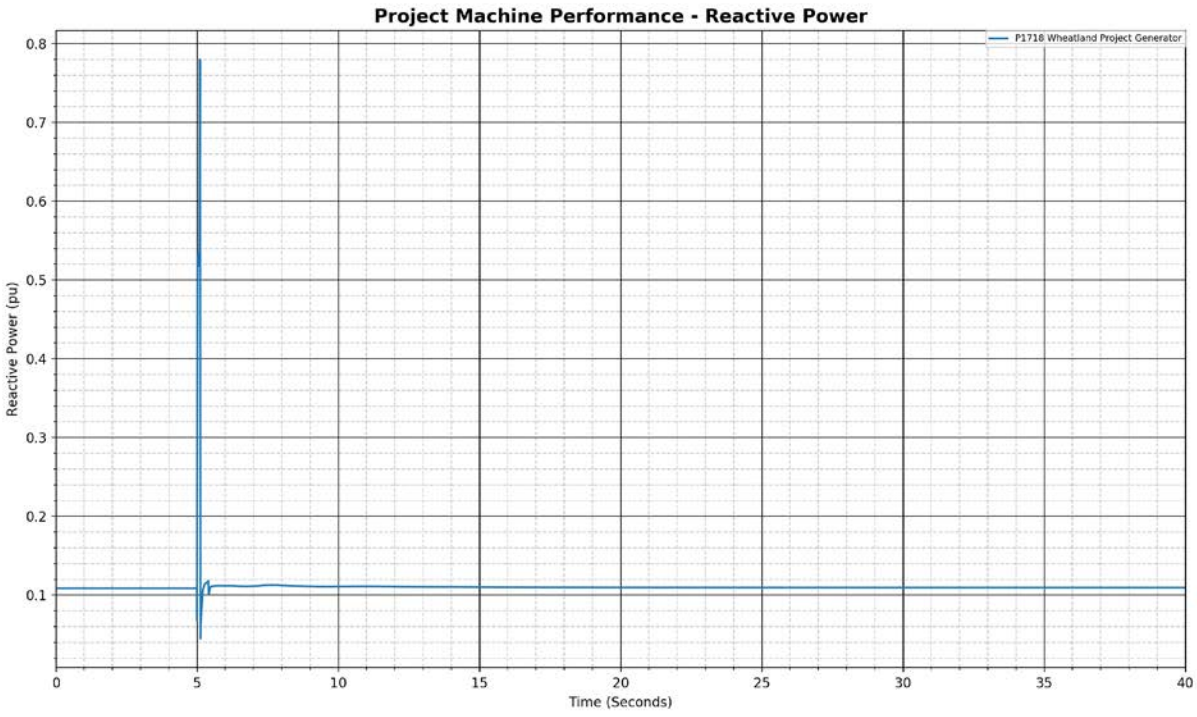

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

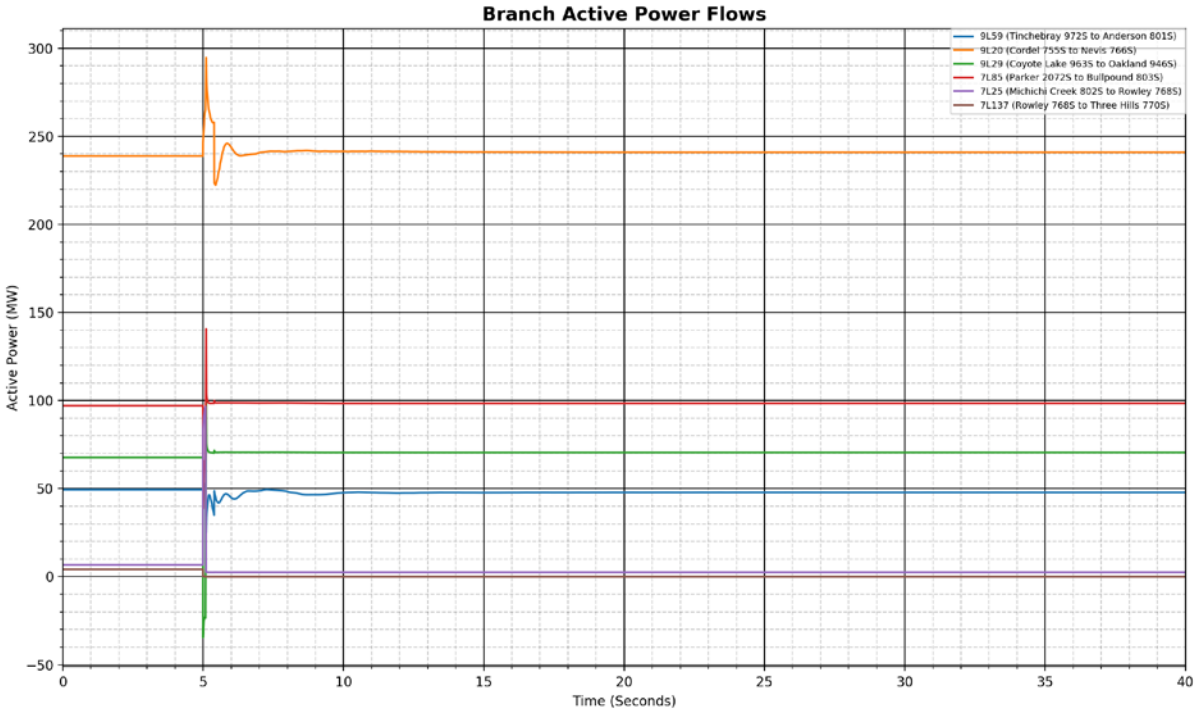

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.8
1.6
1.4
1.2
1.0
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Active Power (MW)
Time (Seconds)

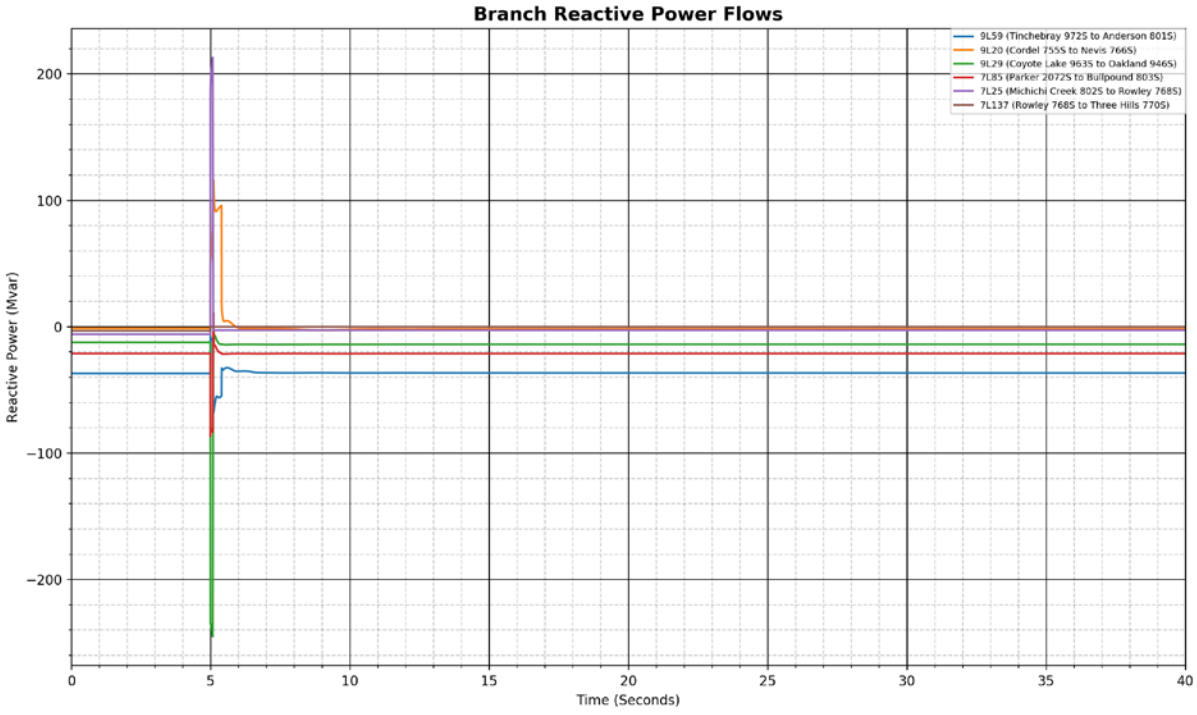
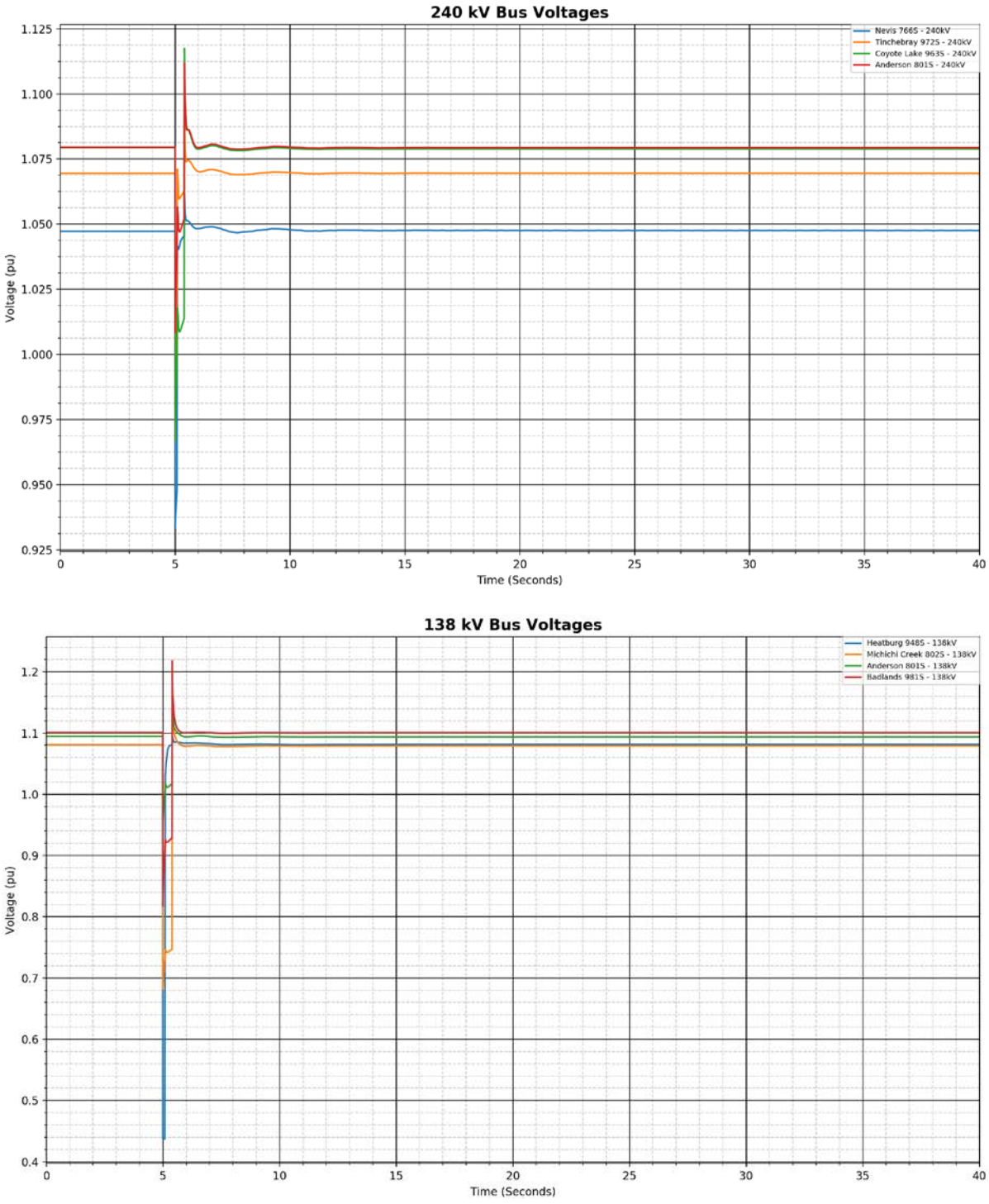
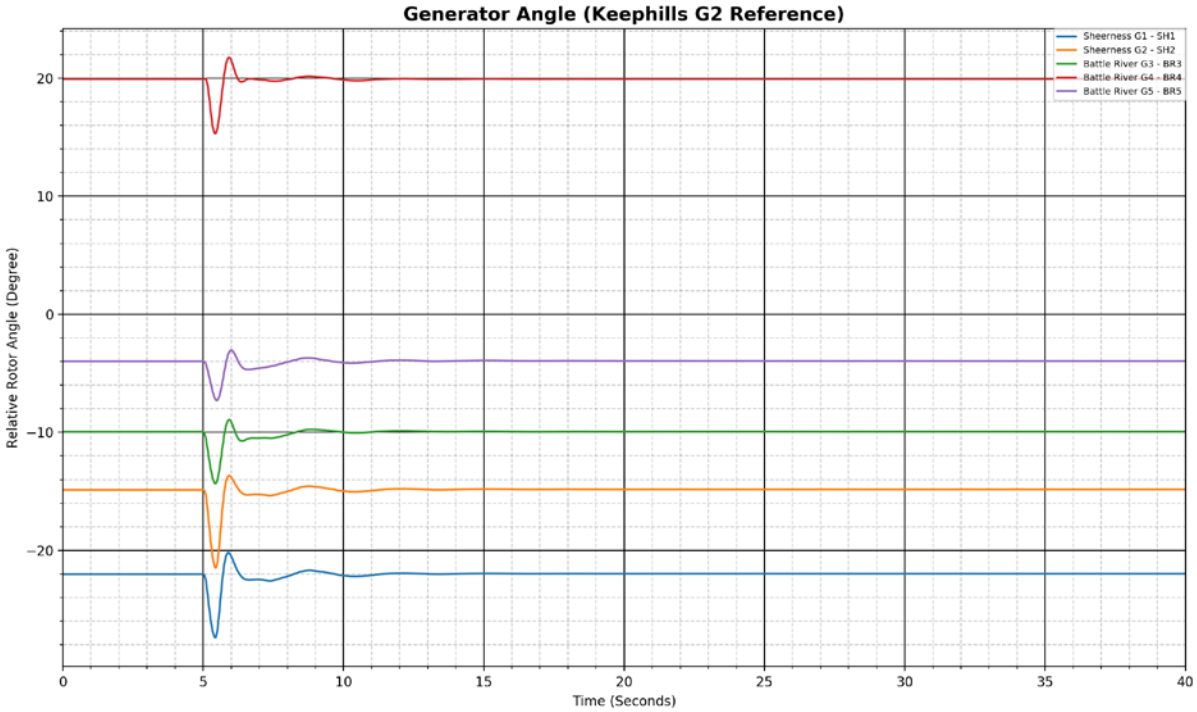
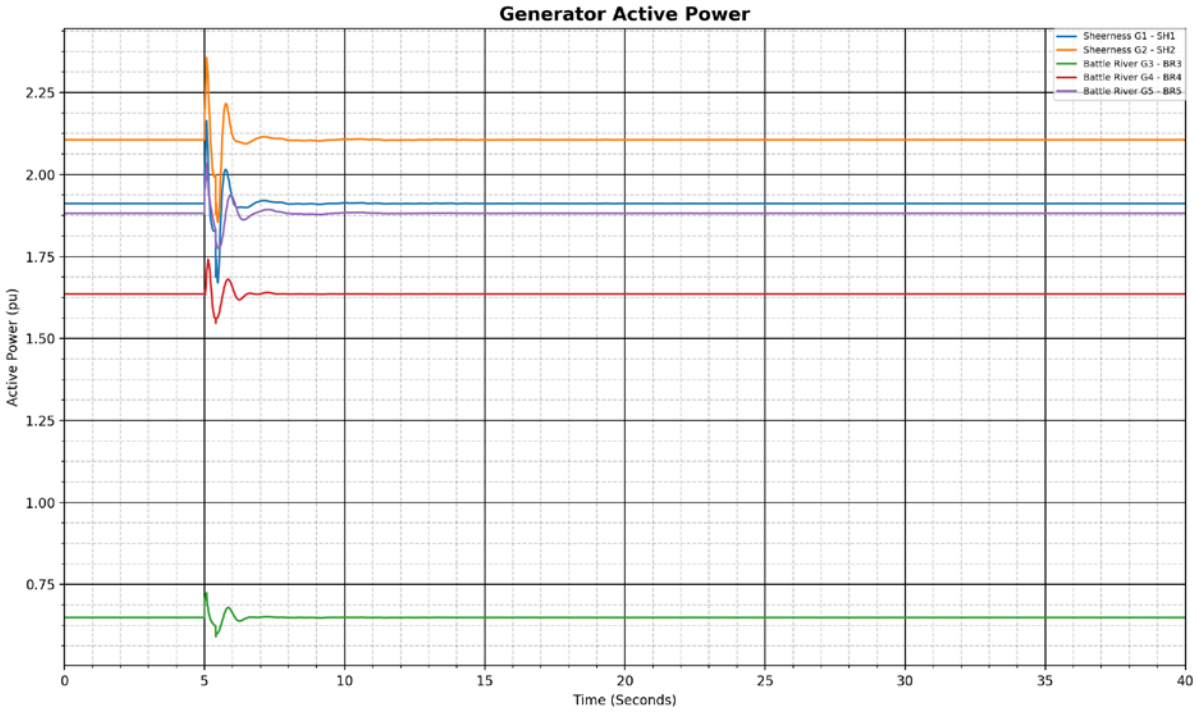
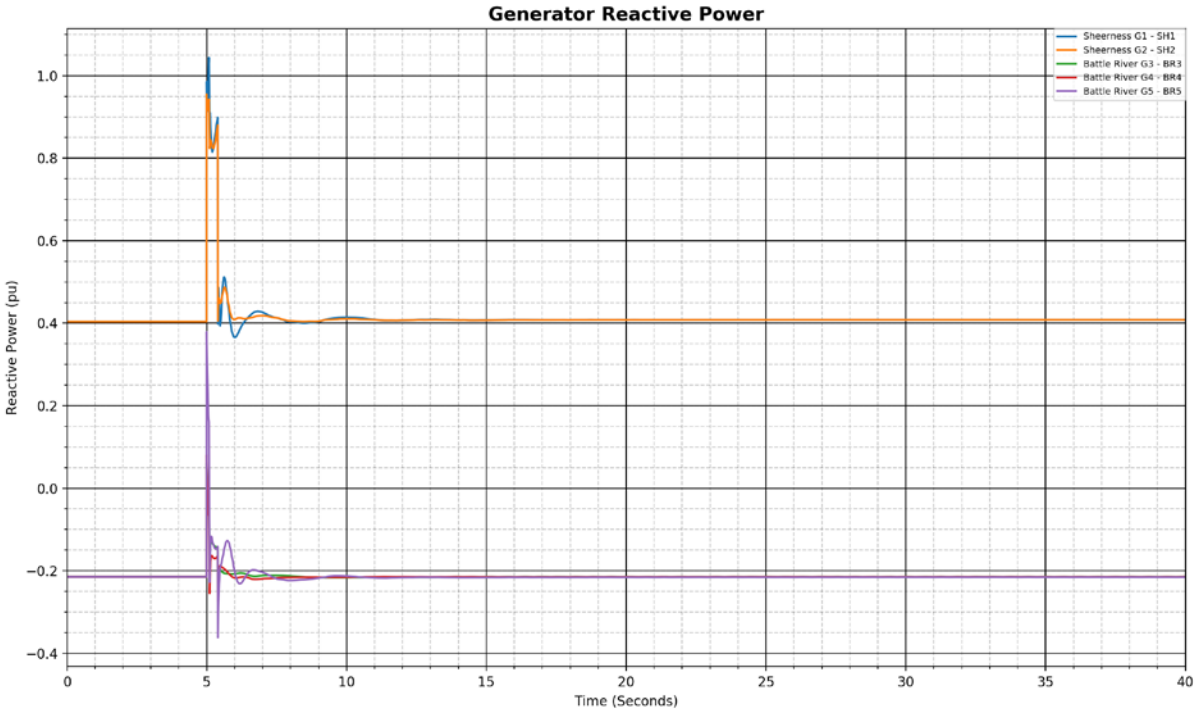

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Reactive Power (Mvar)
Time (Seconds)

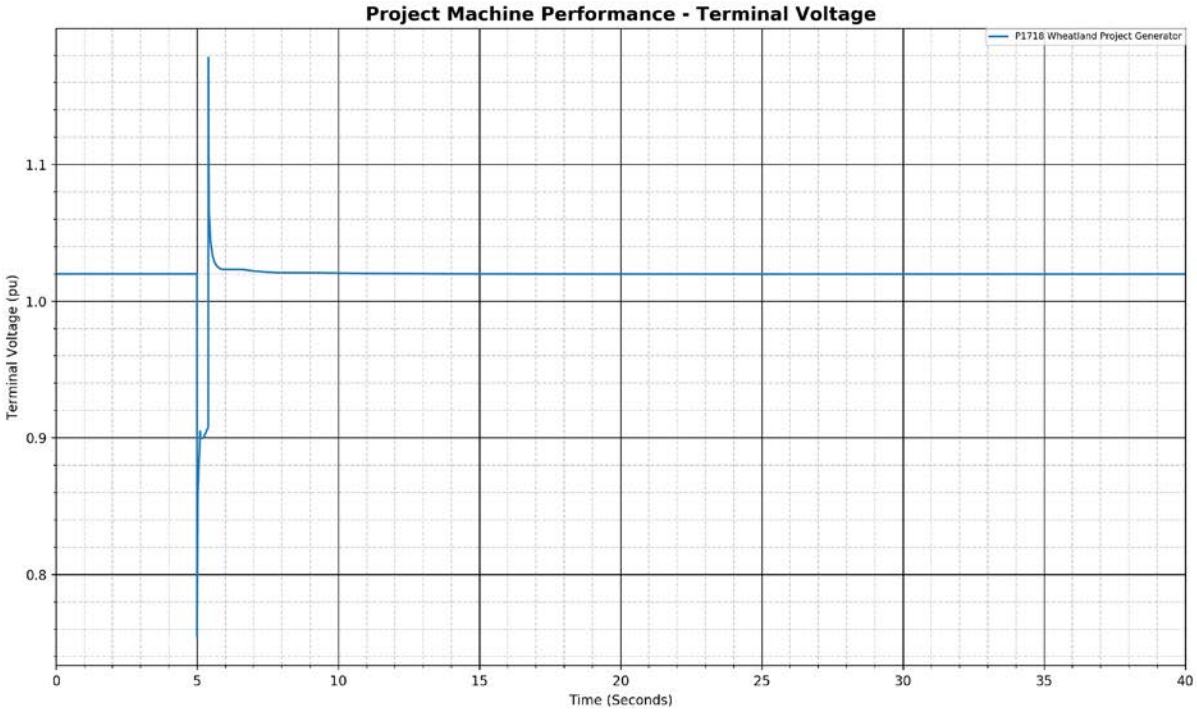
Figure A4-20: 7L137 (Rowley 768S - Three Hills 770S): 3-phase fault at Three Hills 770S

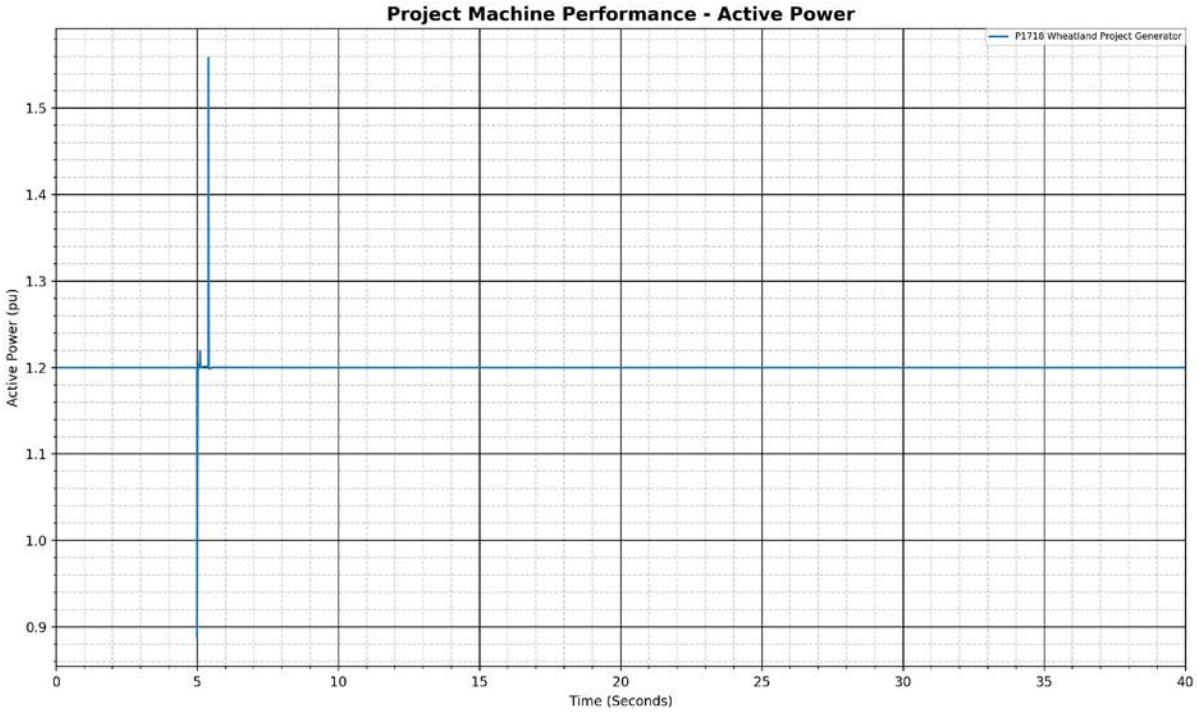


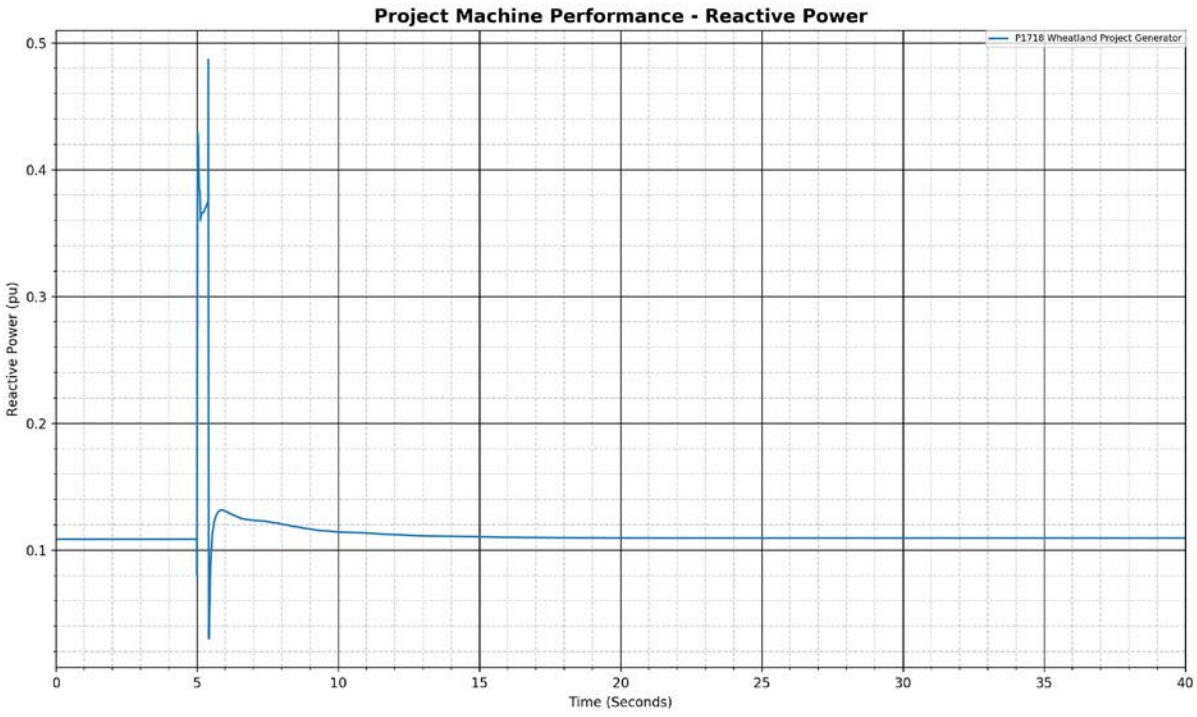

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

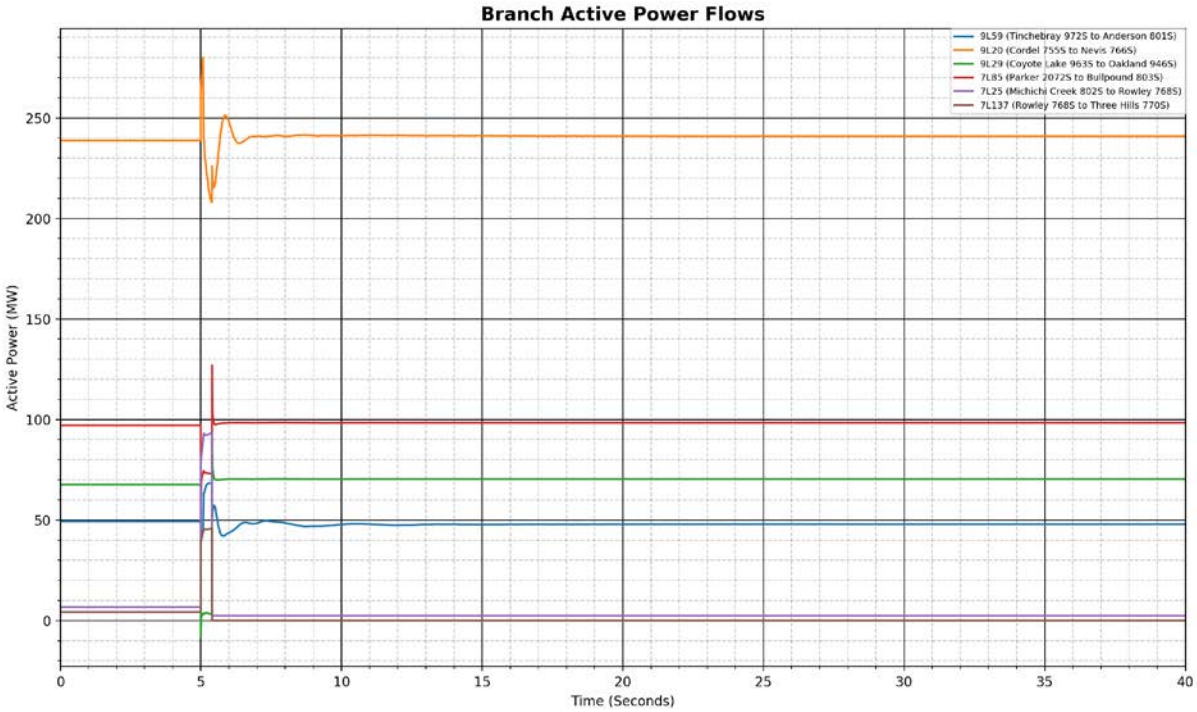

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Active Power (MW)
Time (Seconds)

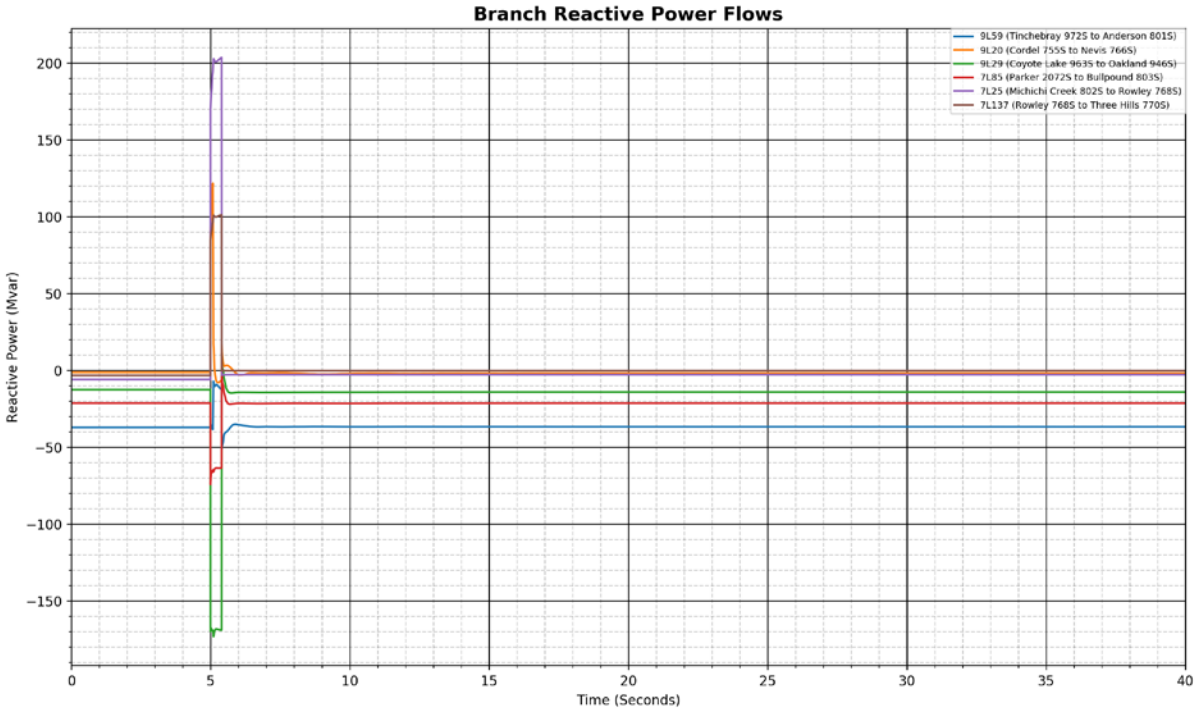
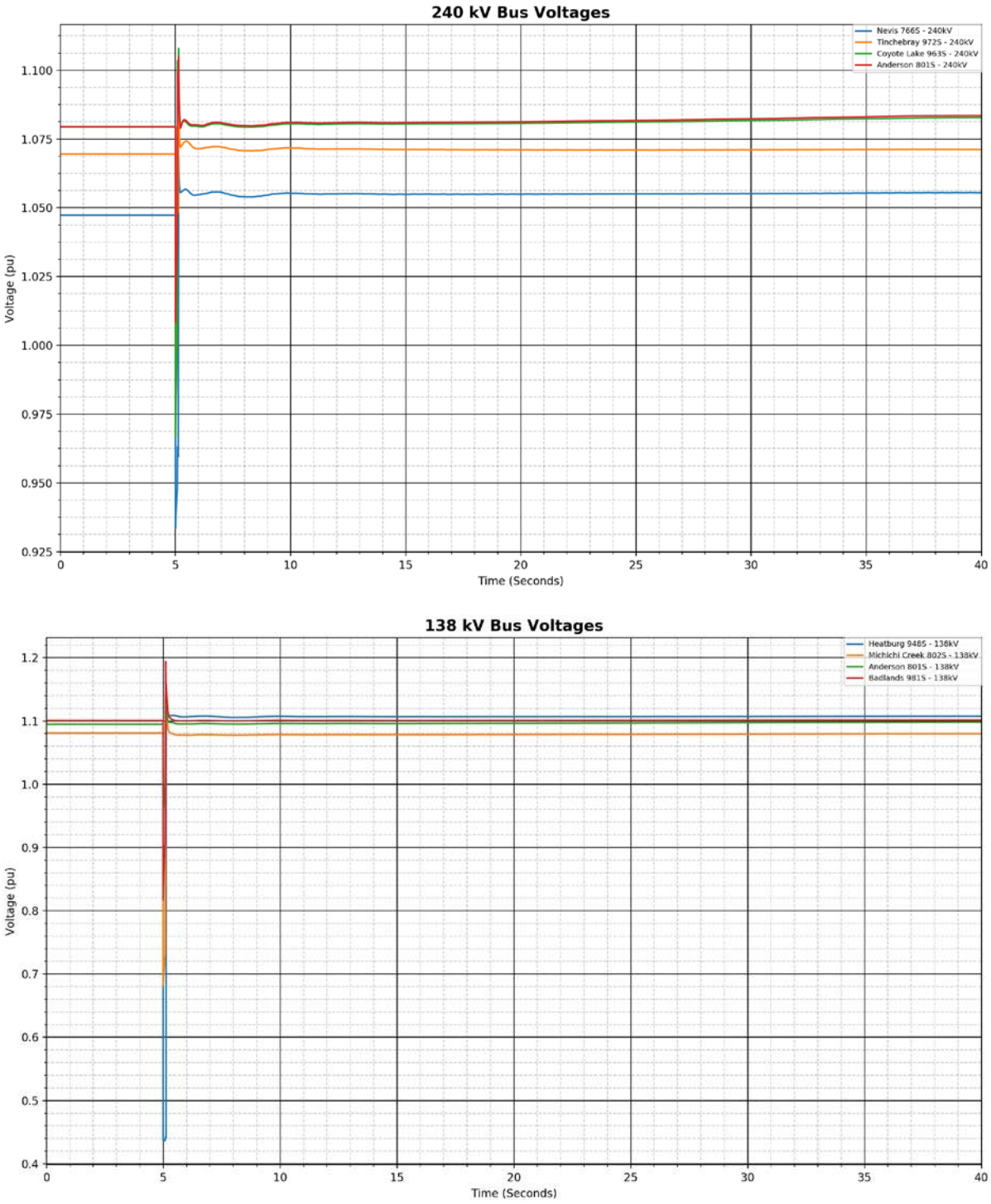
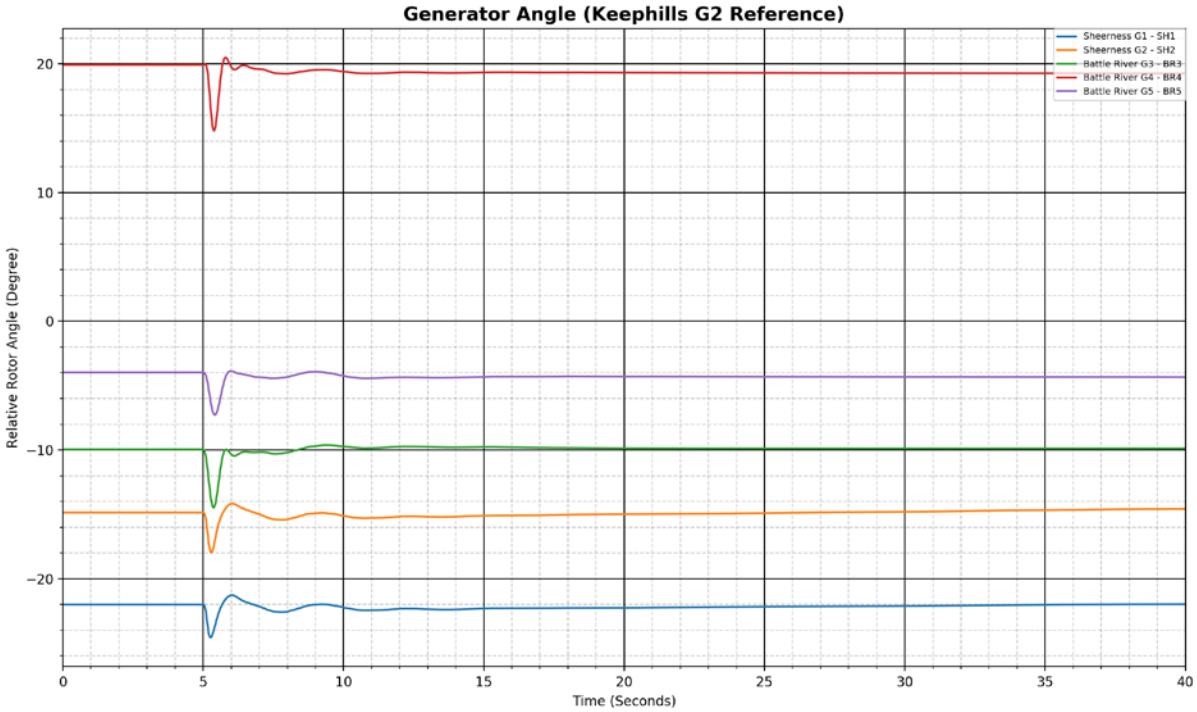
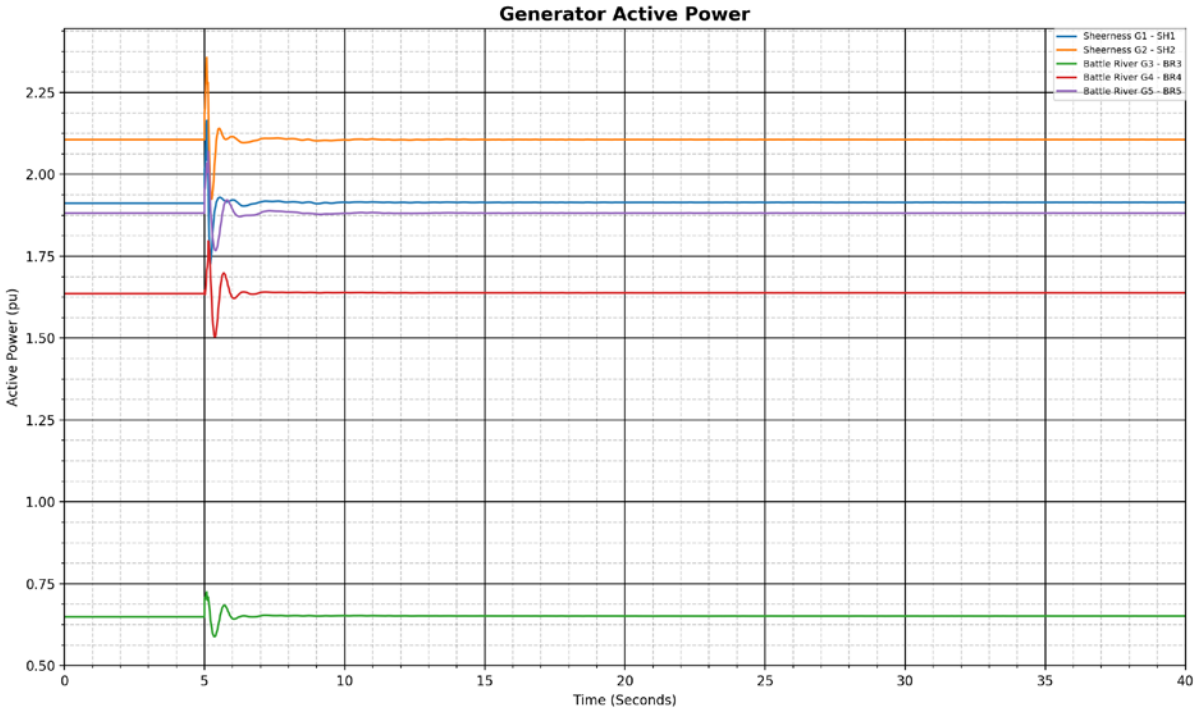
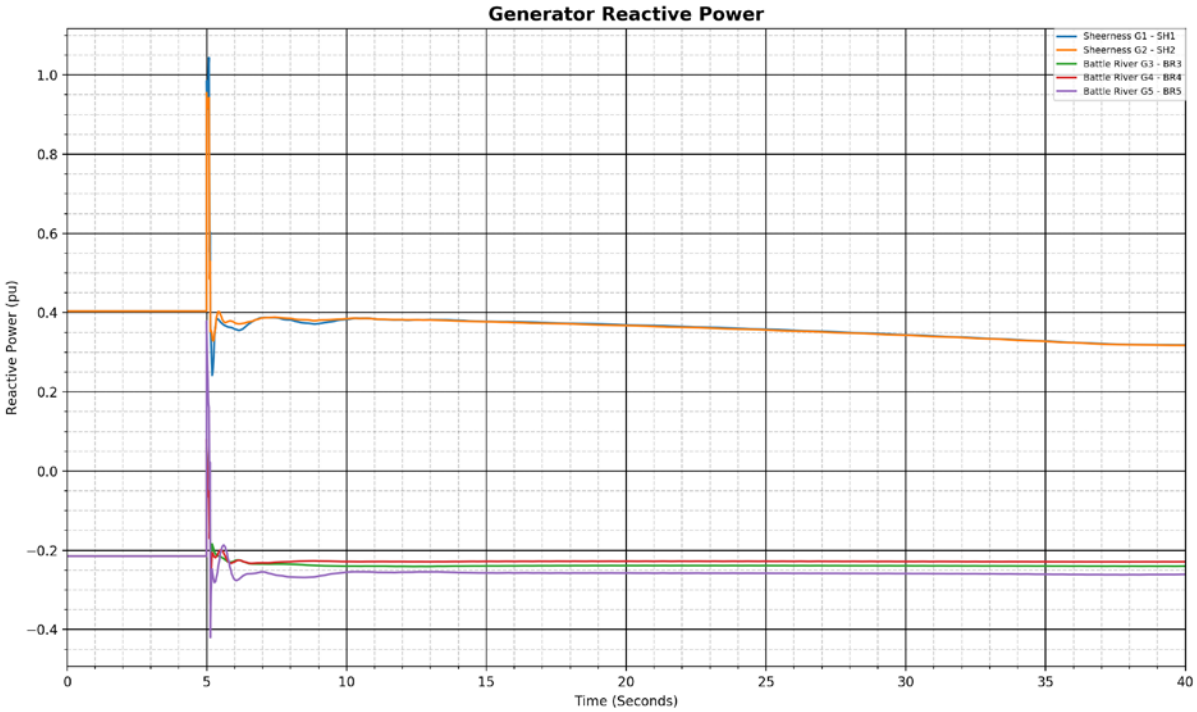

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Reactive Power (Mvar)
Time (Seconds)

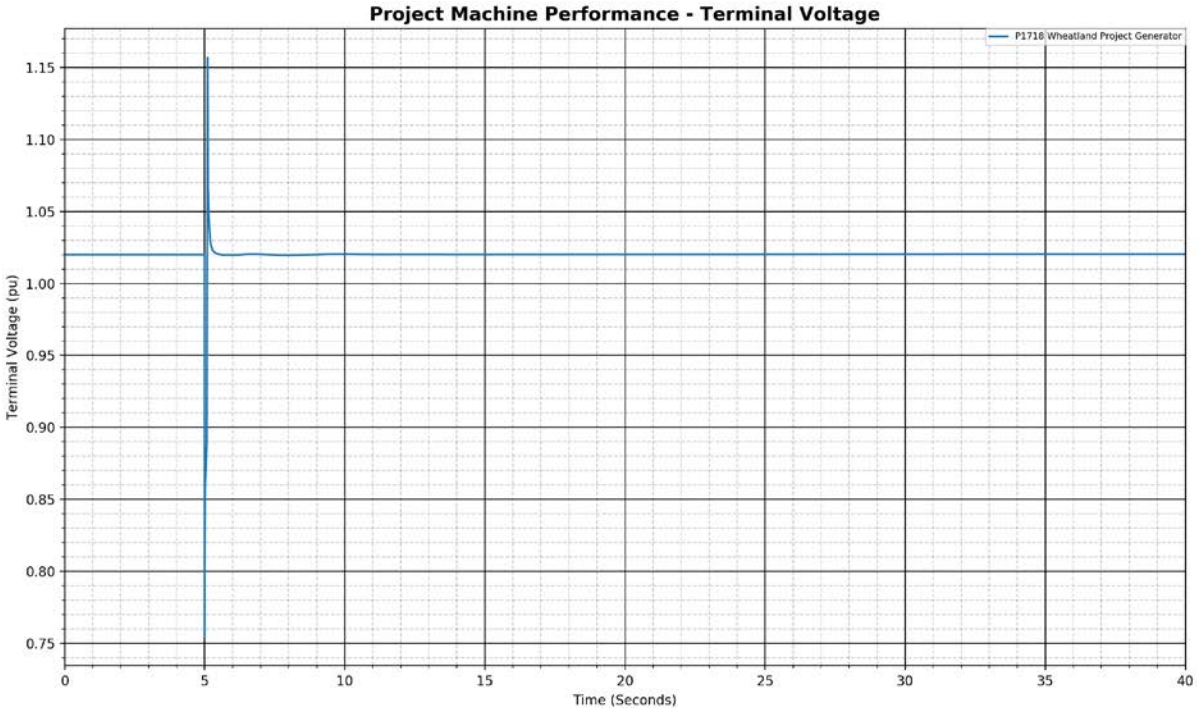
Figure A4-21: 7L159 (Three Hills 770S - Ghost Pine 114S - Heatburg 948S): 3-phase fault at Three Hills 770S

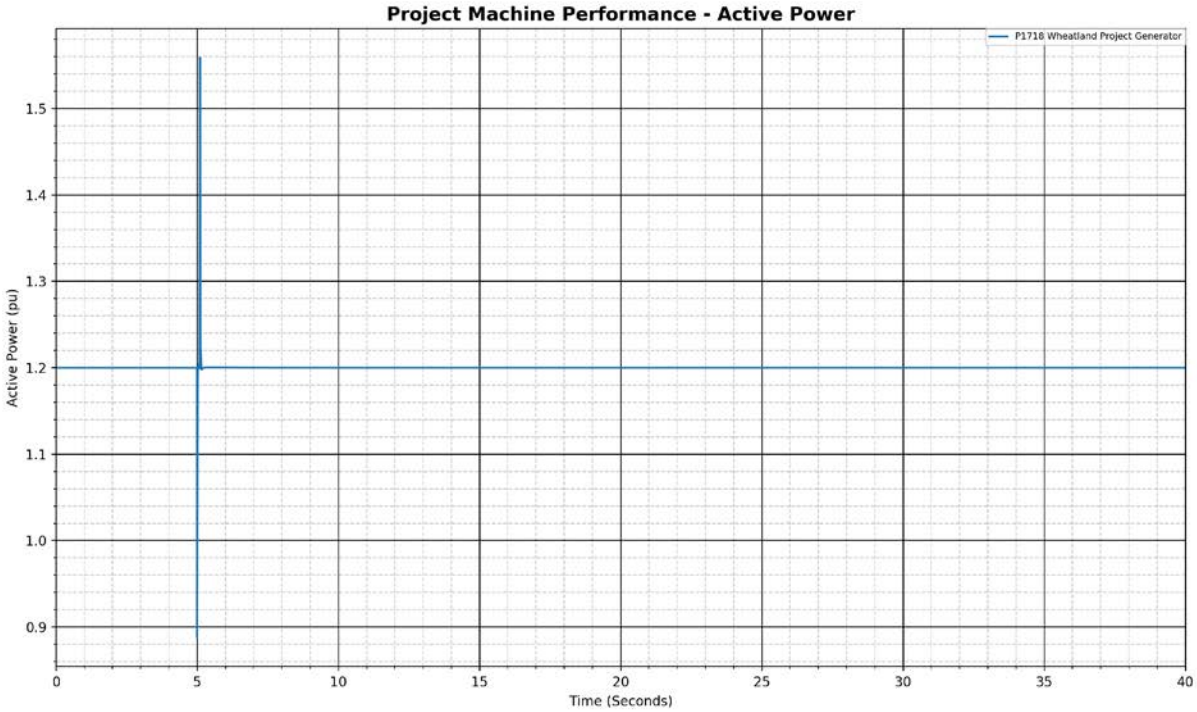


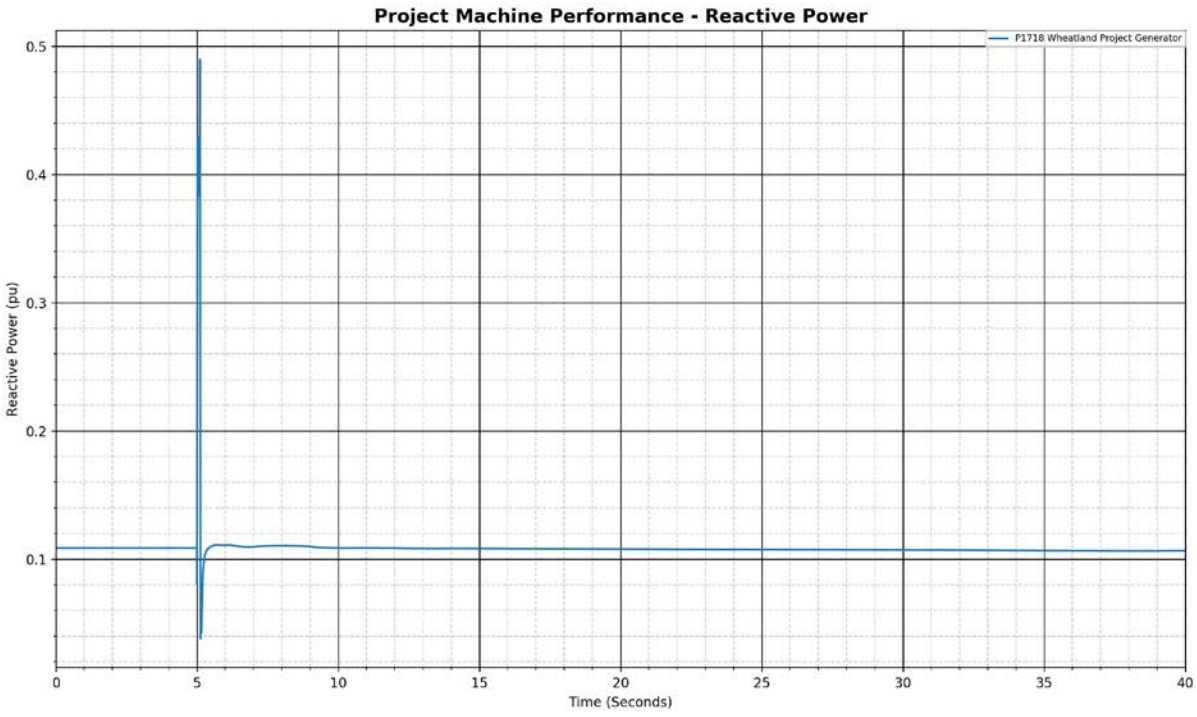

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

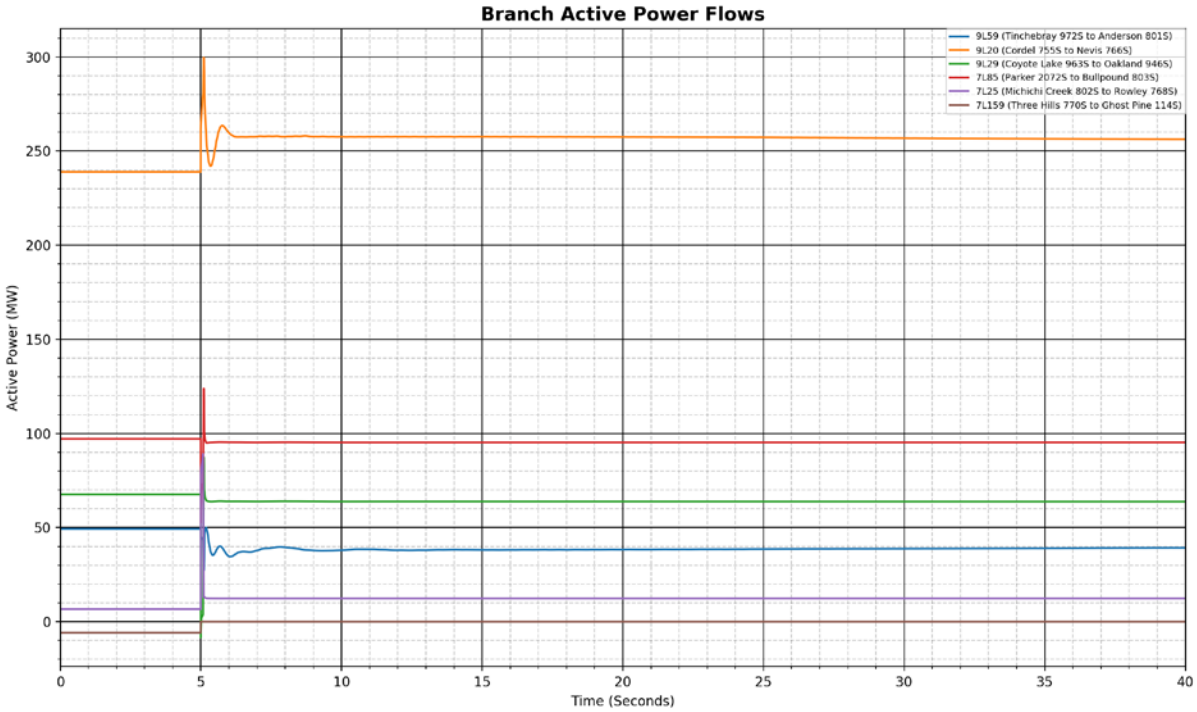

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Active Power (MW)
Time (Seconds)

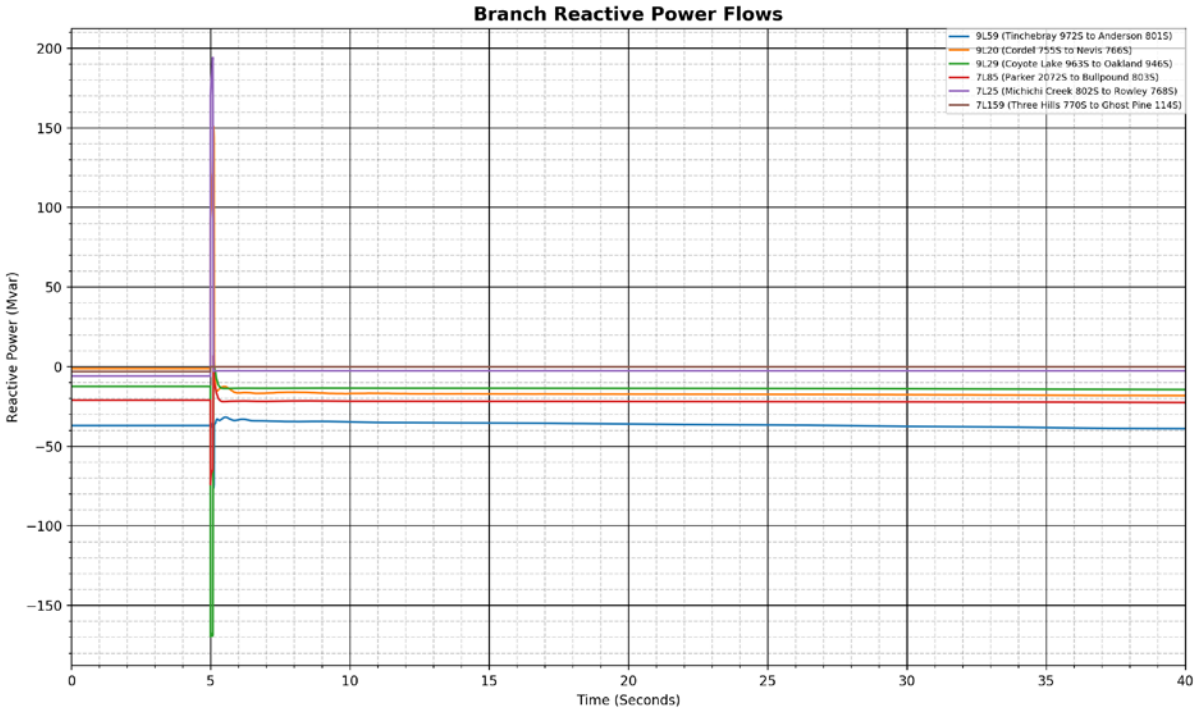
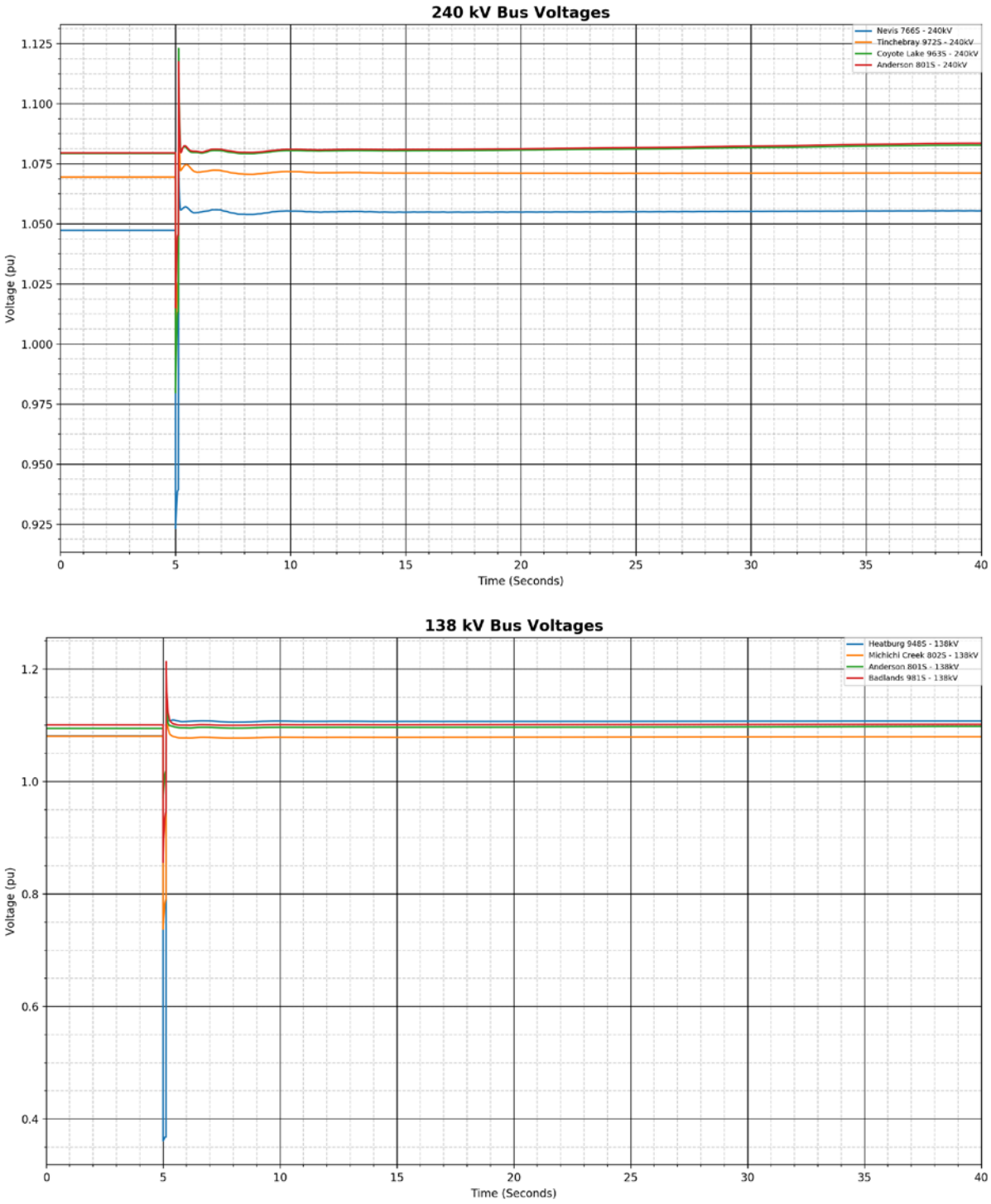
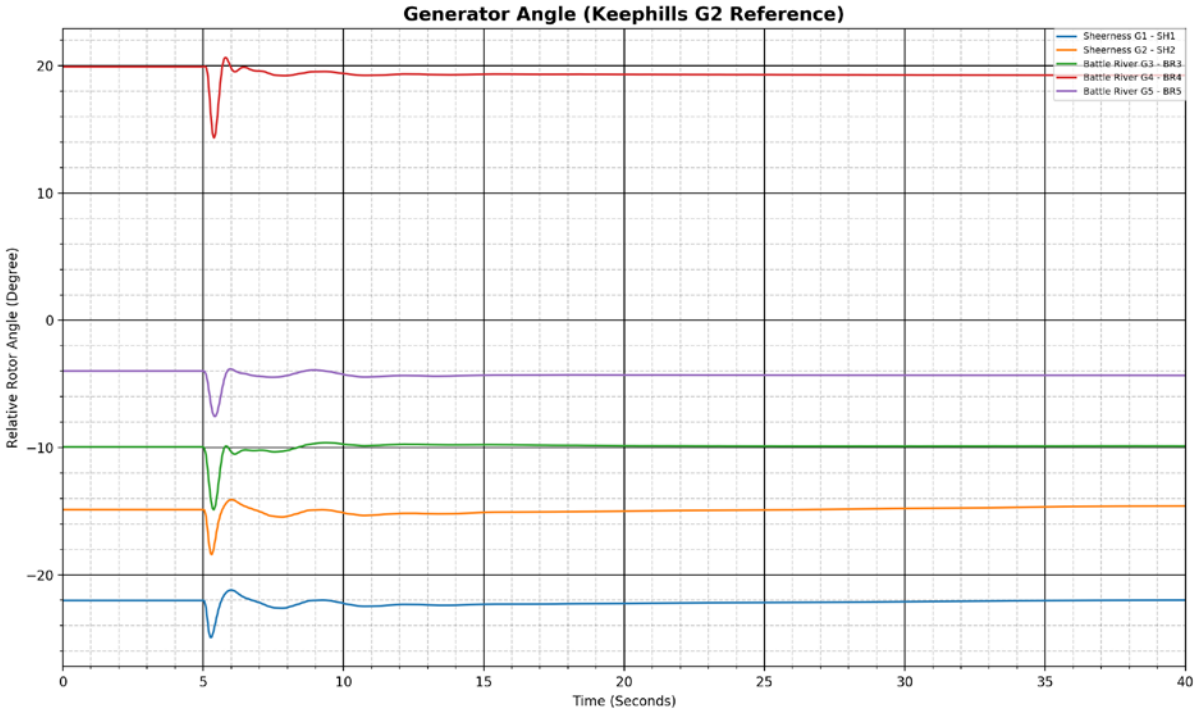
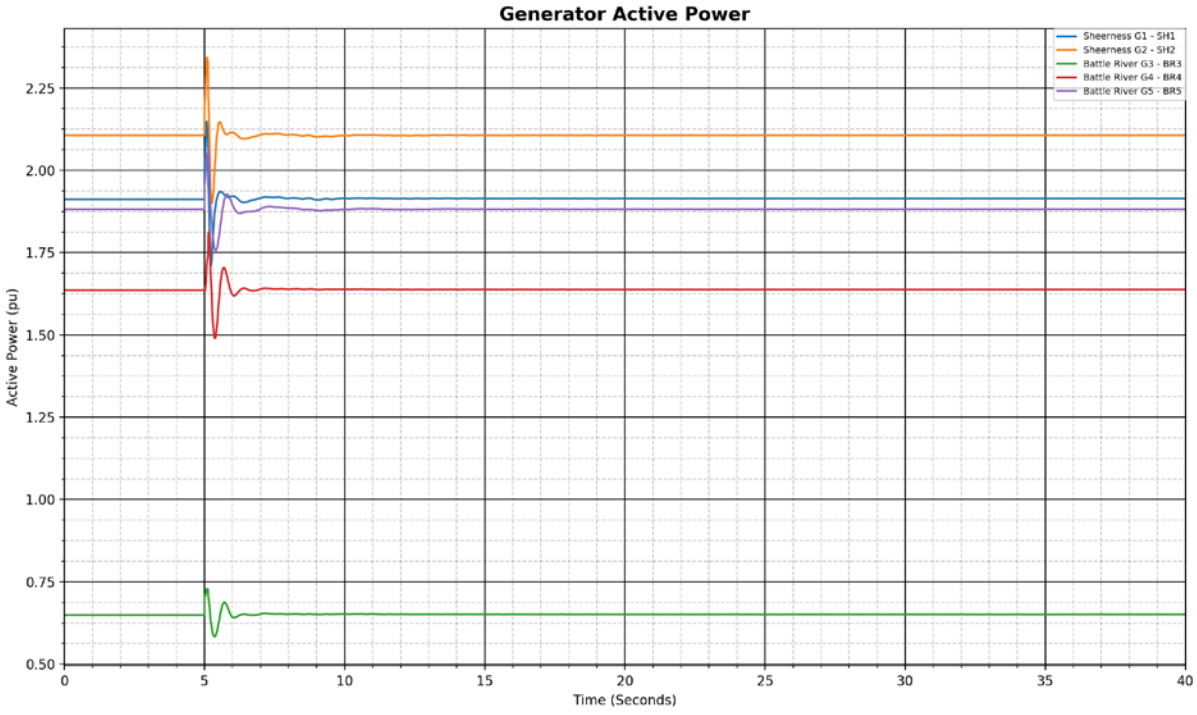
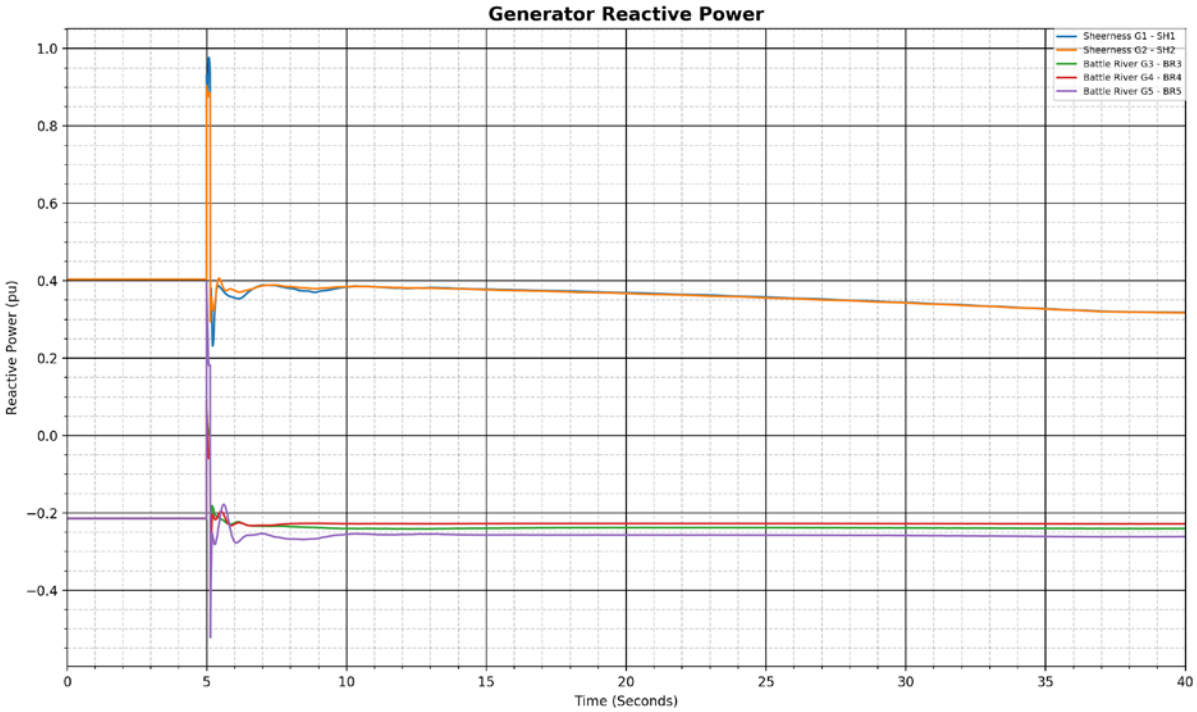

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Reactive Power (Mvar)
Time (Seconds)

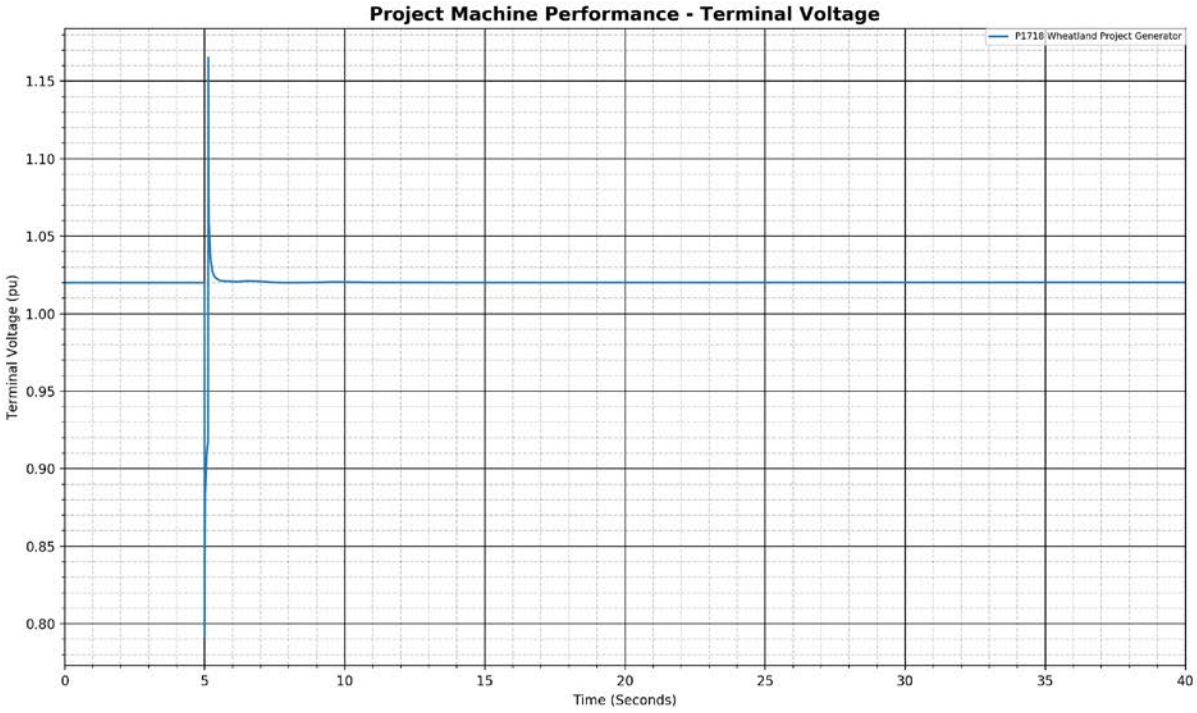
Figure A4-22: 7L159 (Three Hills 770S - Ghost Pine 114S - Heatburg 948S): 3-phase fault at Ghost Pine 114S

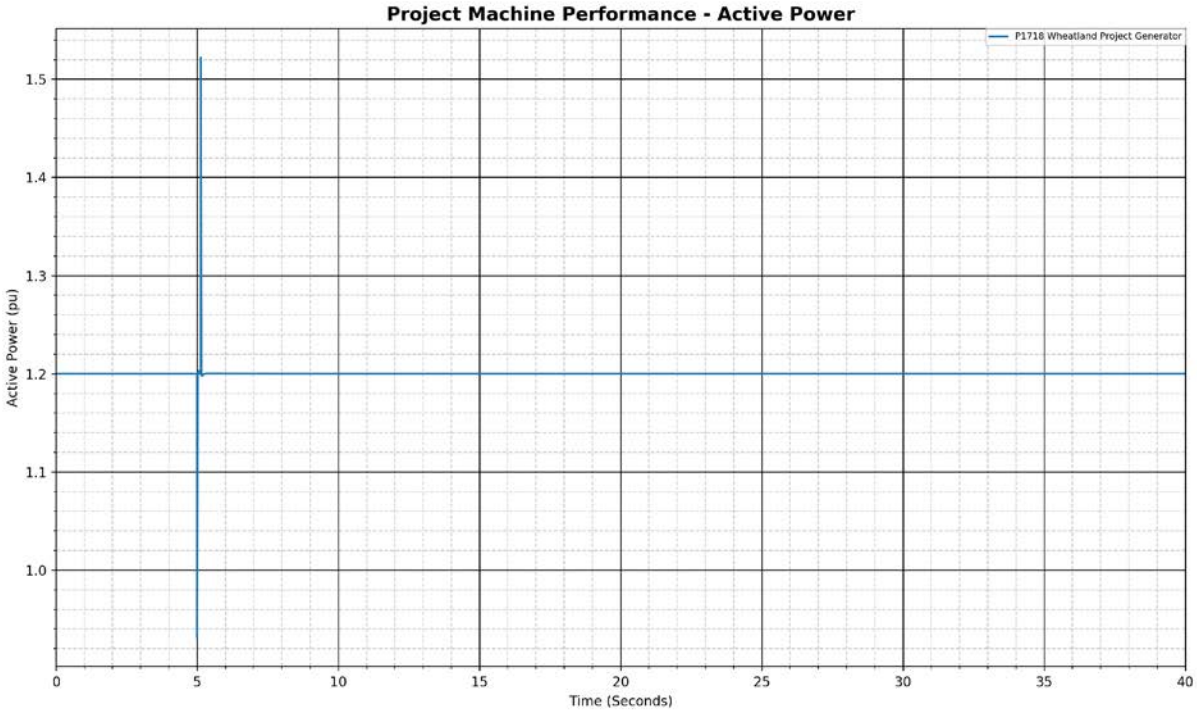


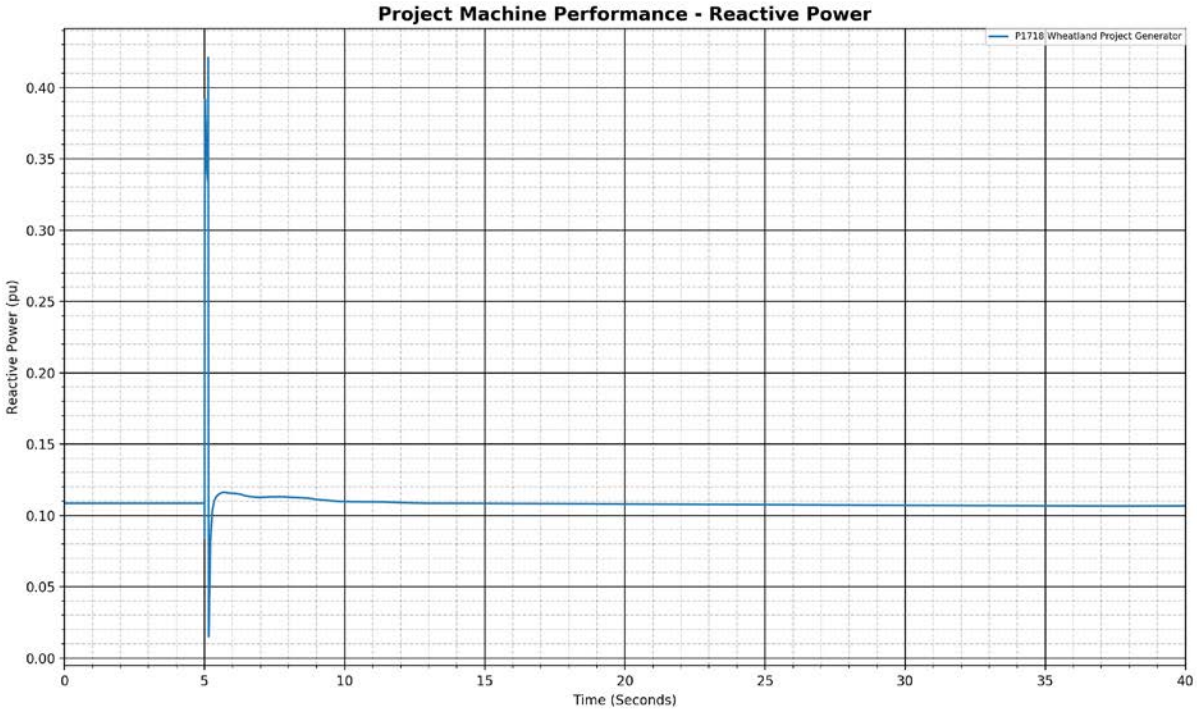

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

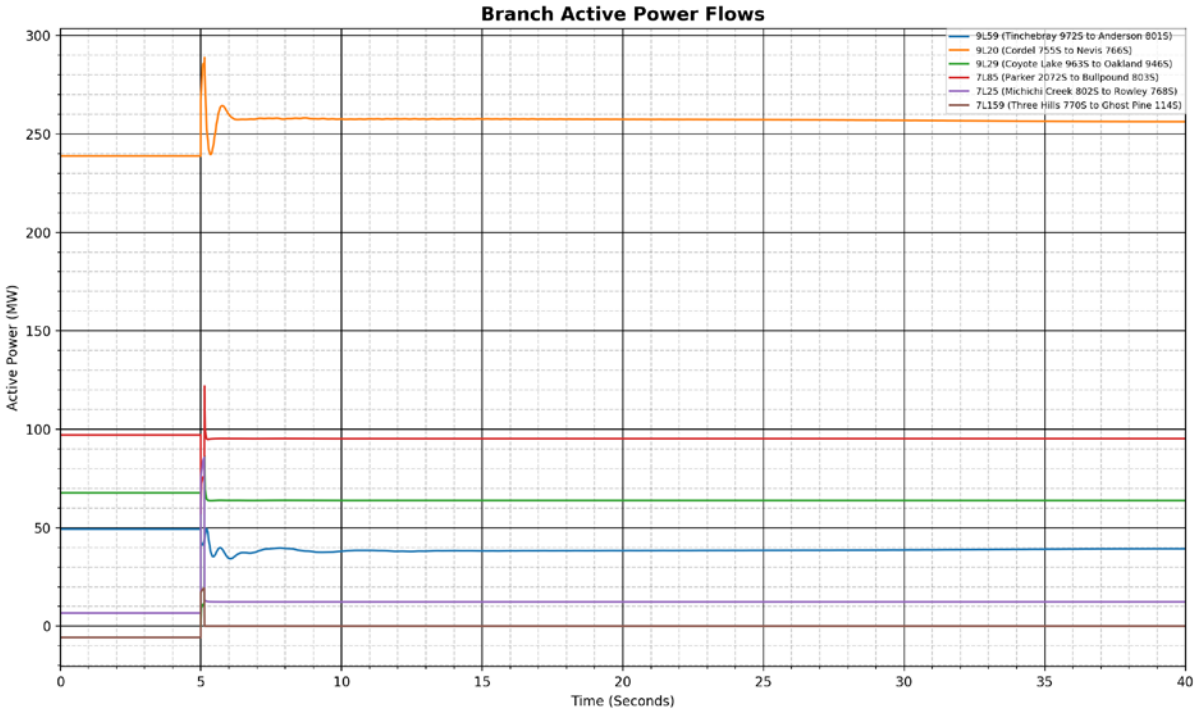

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.5
1.4
1.3
1.2
1.1
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 114S)
Active Power (MW)
Time (Seconds)

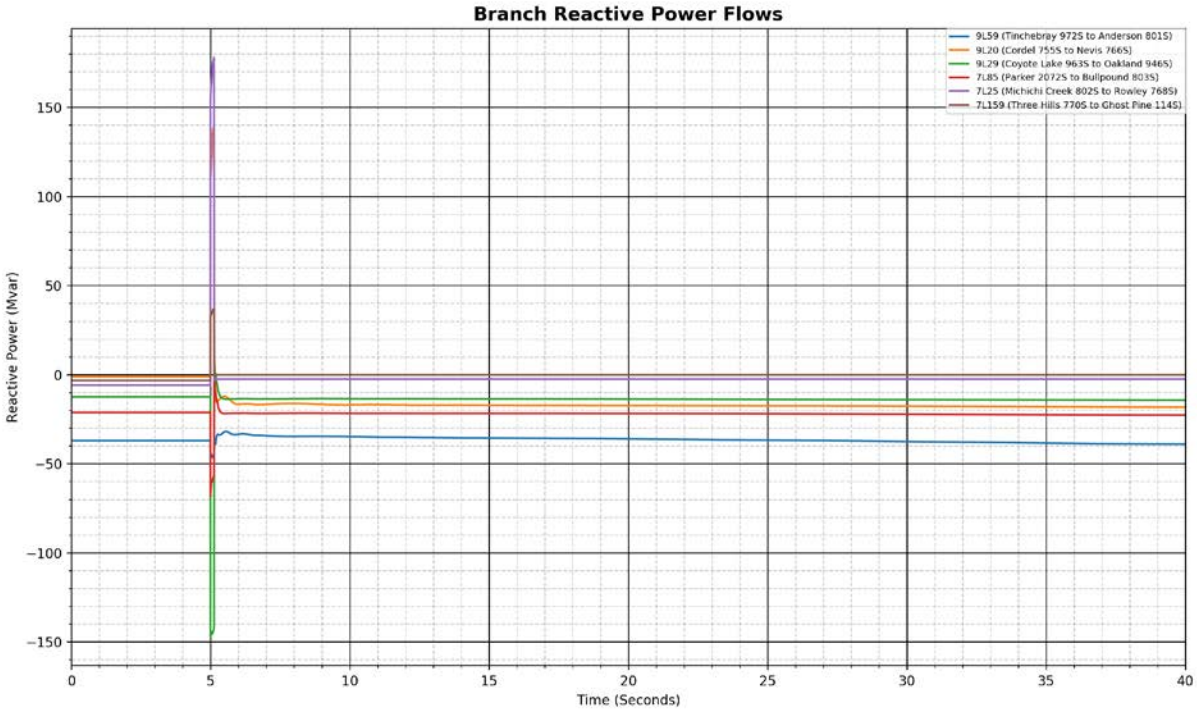
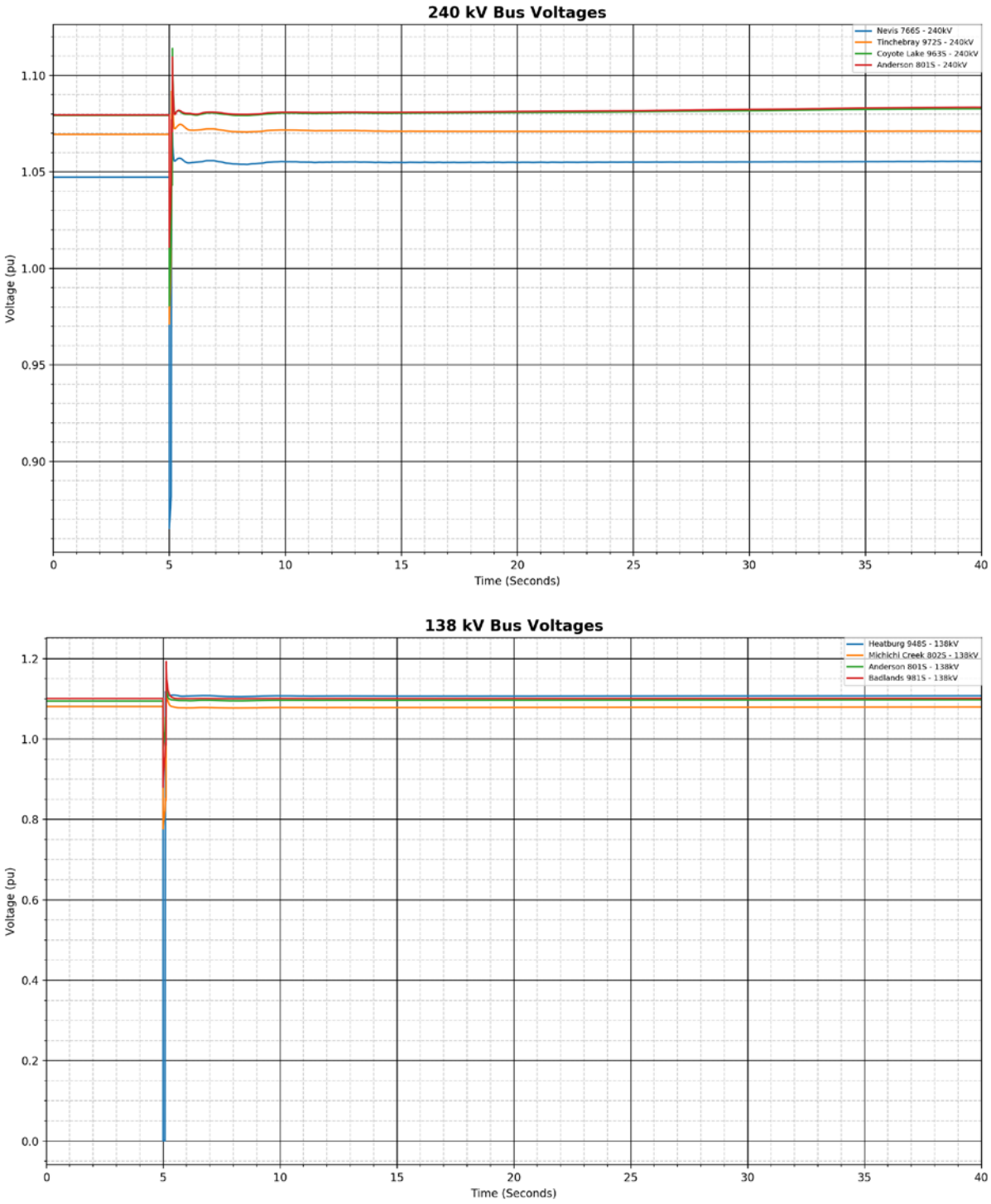
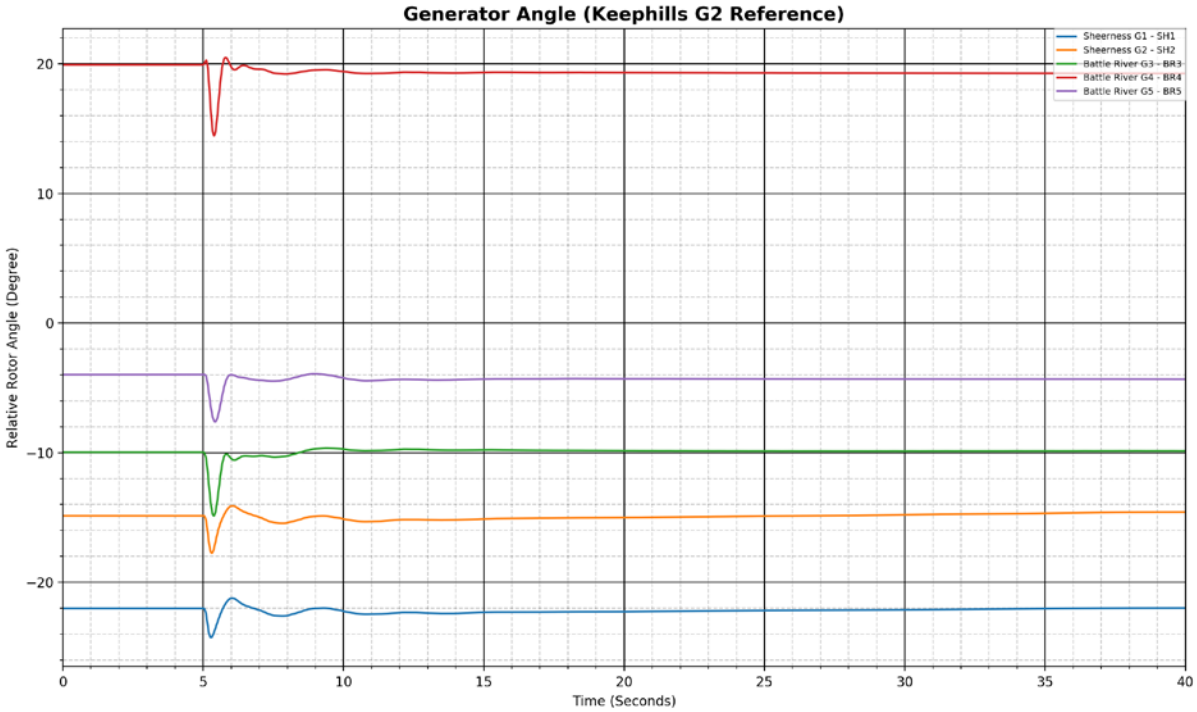
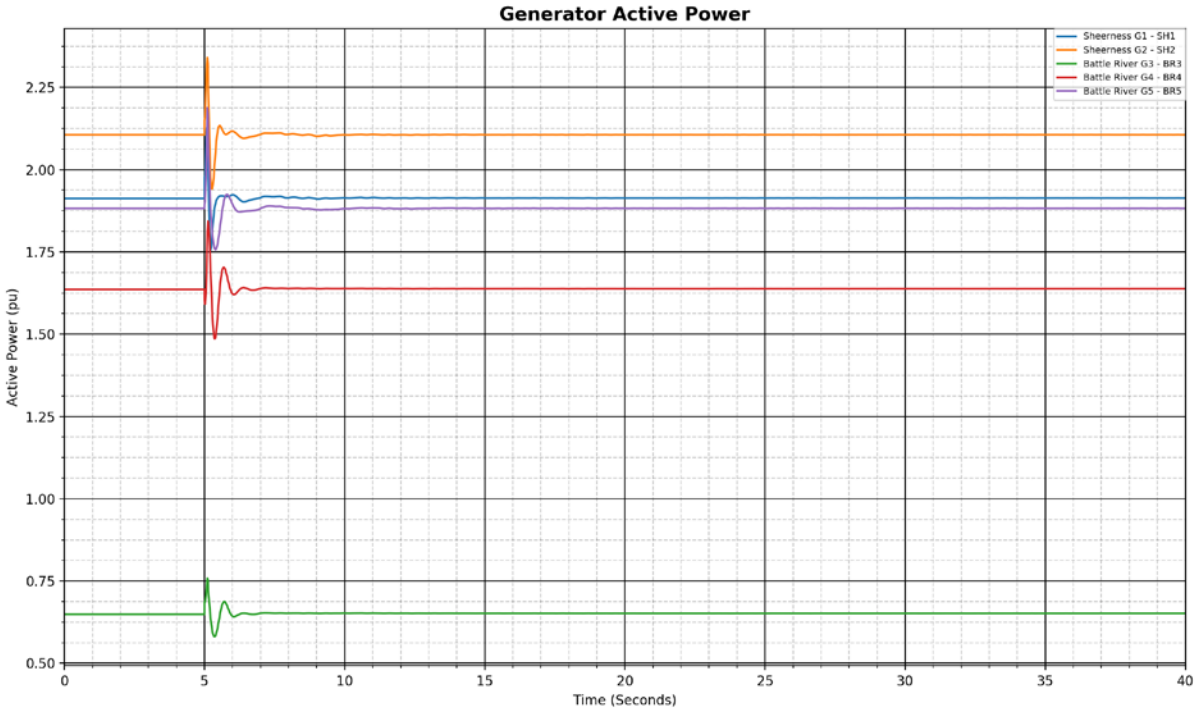
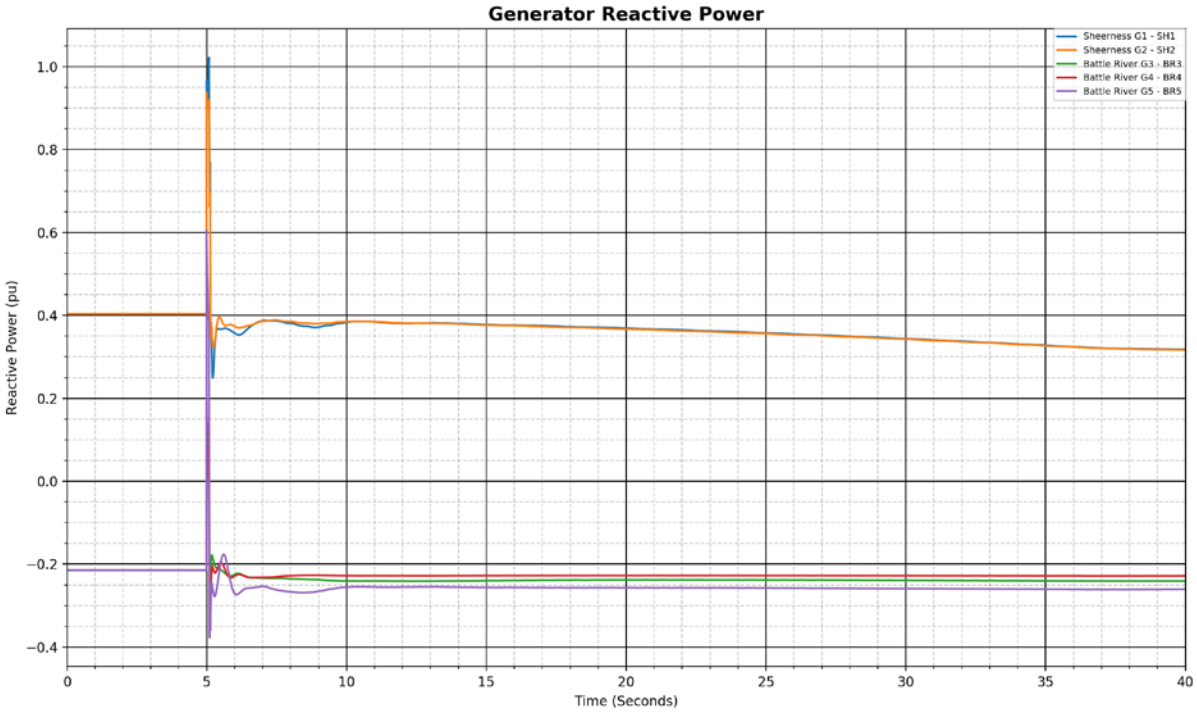

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 114S)
Reactive Power (Mvar)
Time (Seconds)

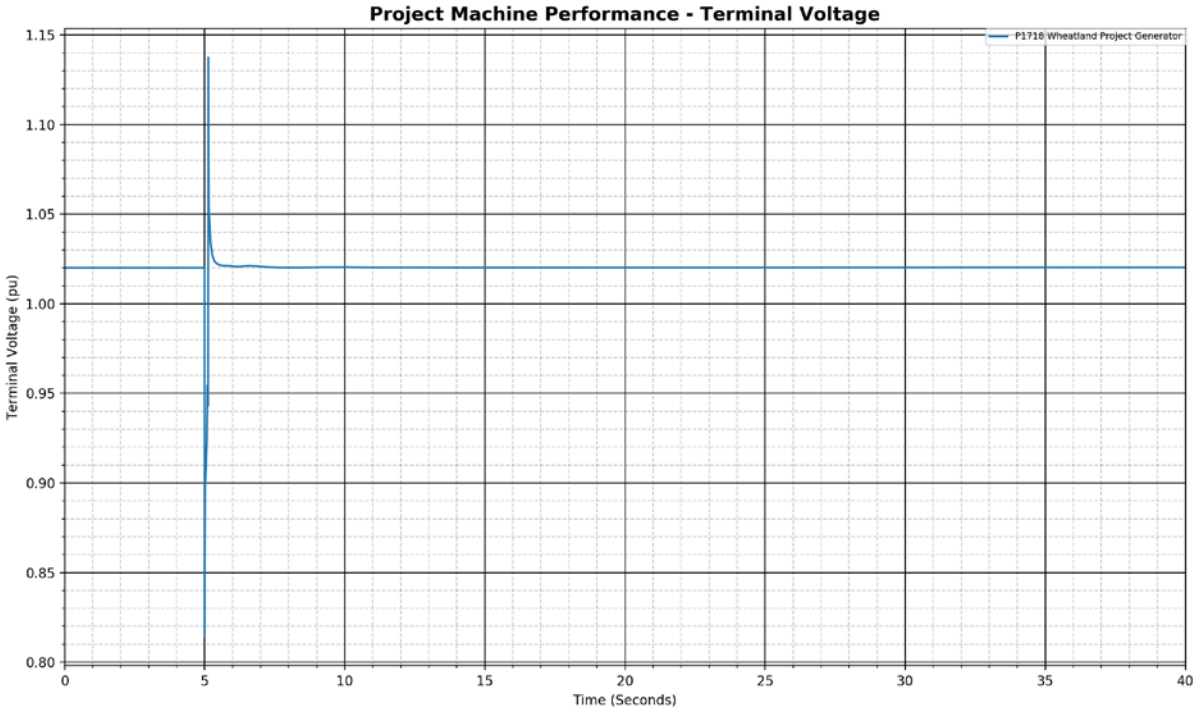
Figure A4-23: 7L159 (Three Hills 770S - Ghost Pine 114S - Heatburg 948S): 3-phase fault at Heatburg 948S

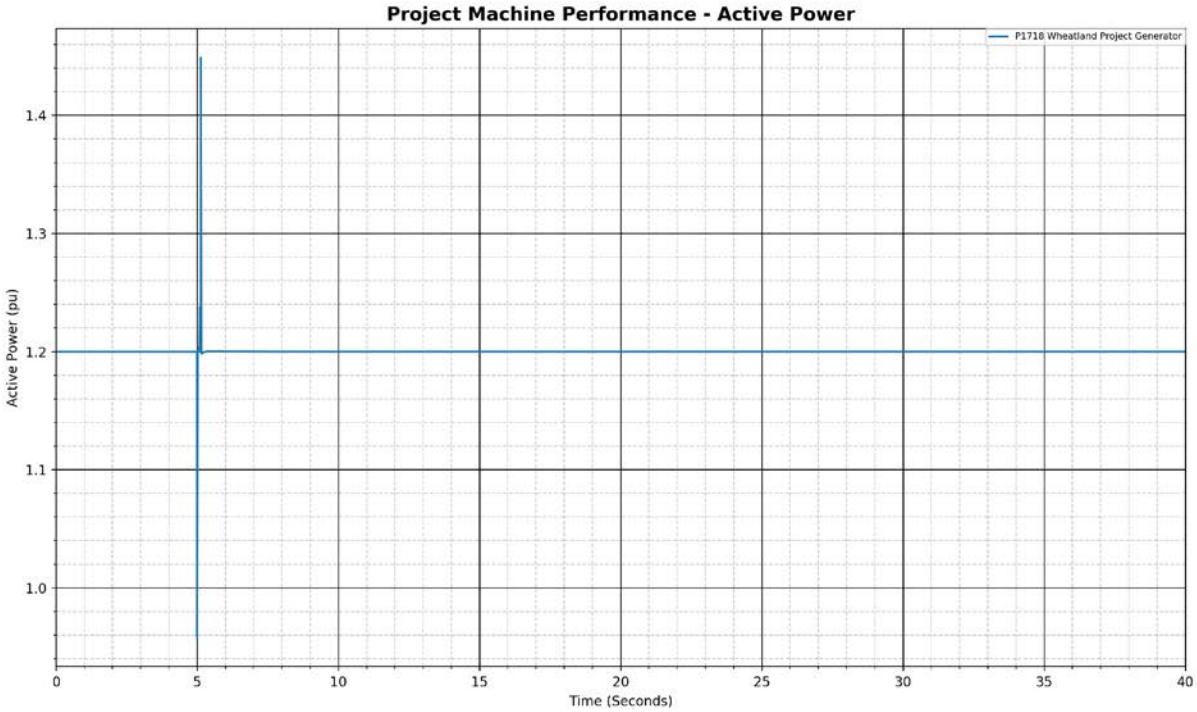


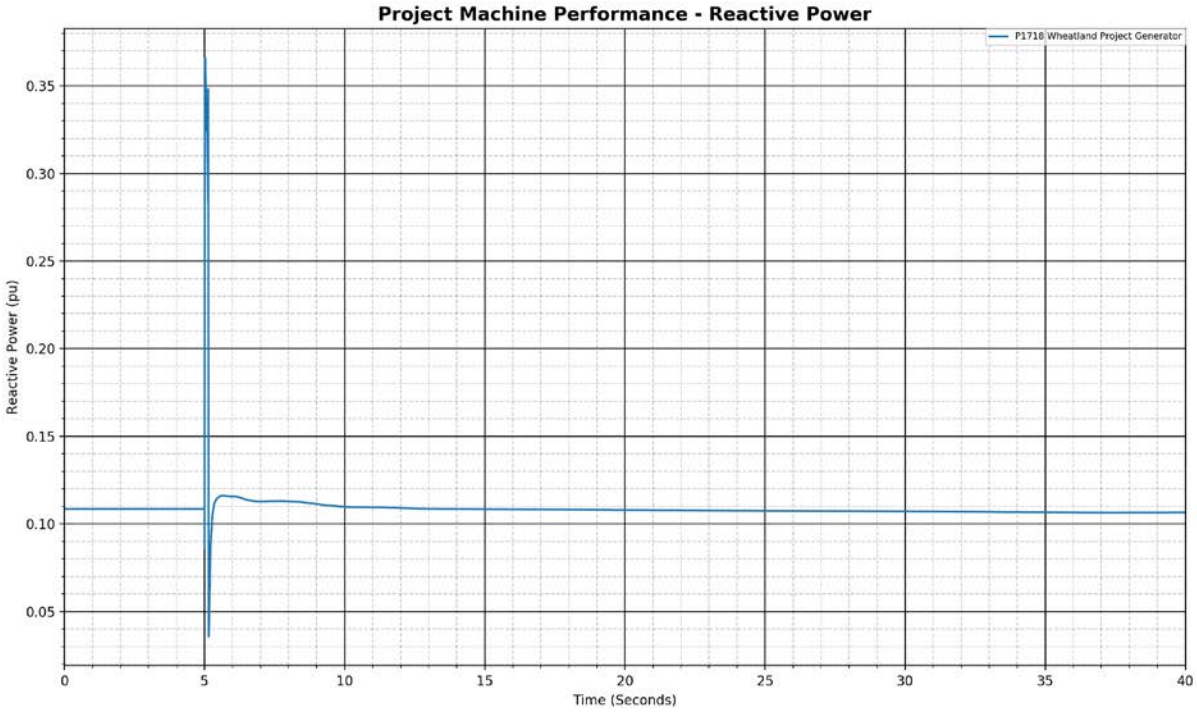

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

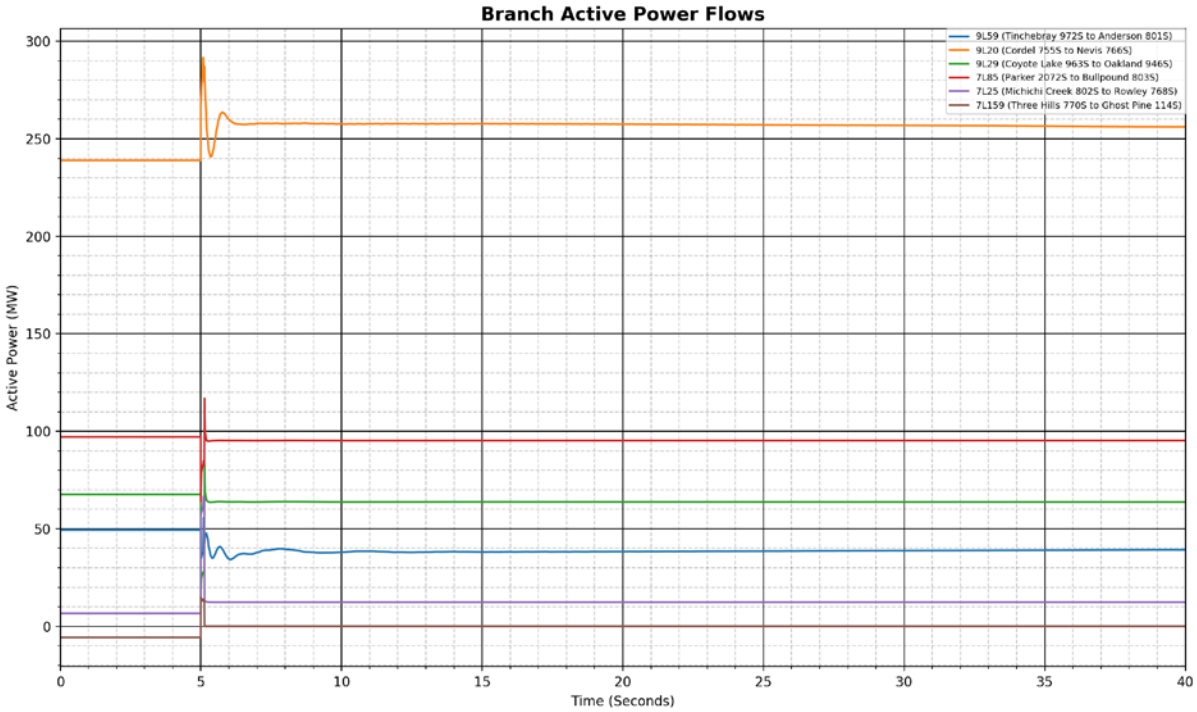

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Active Power (MW)
Time (Seconds)

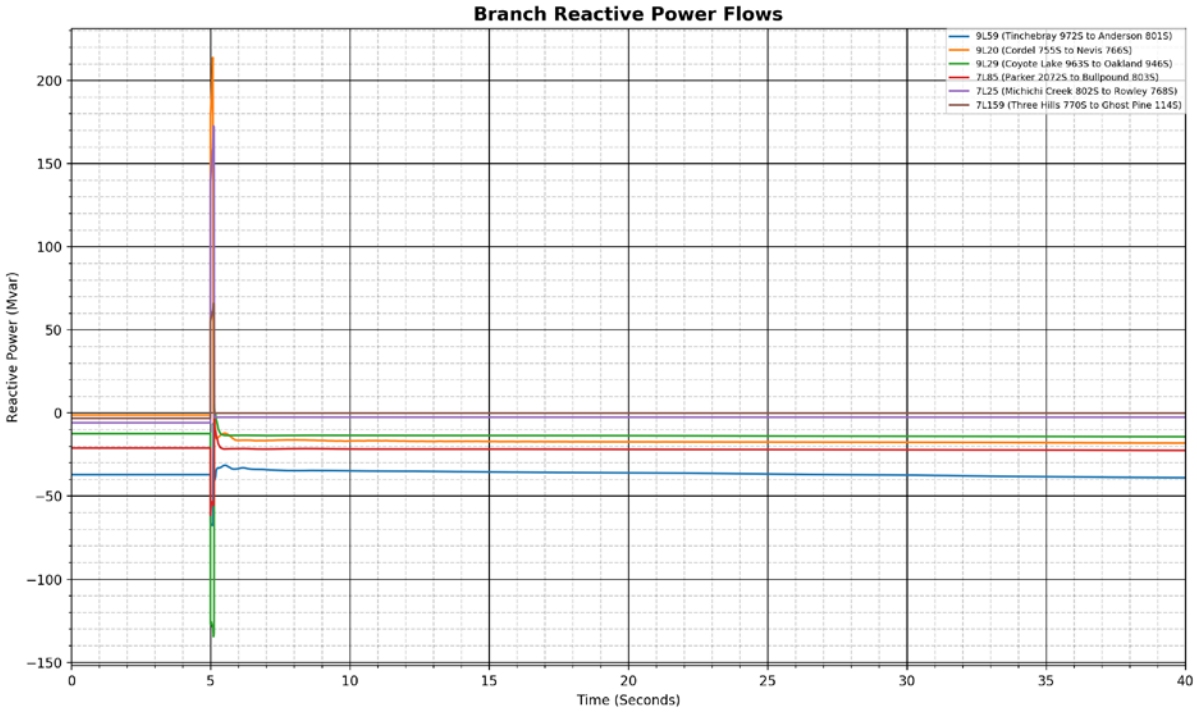
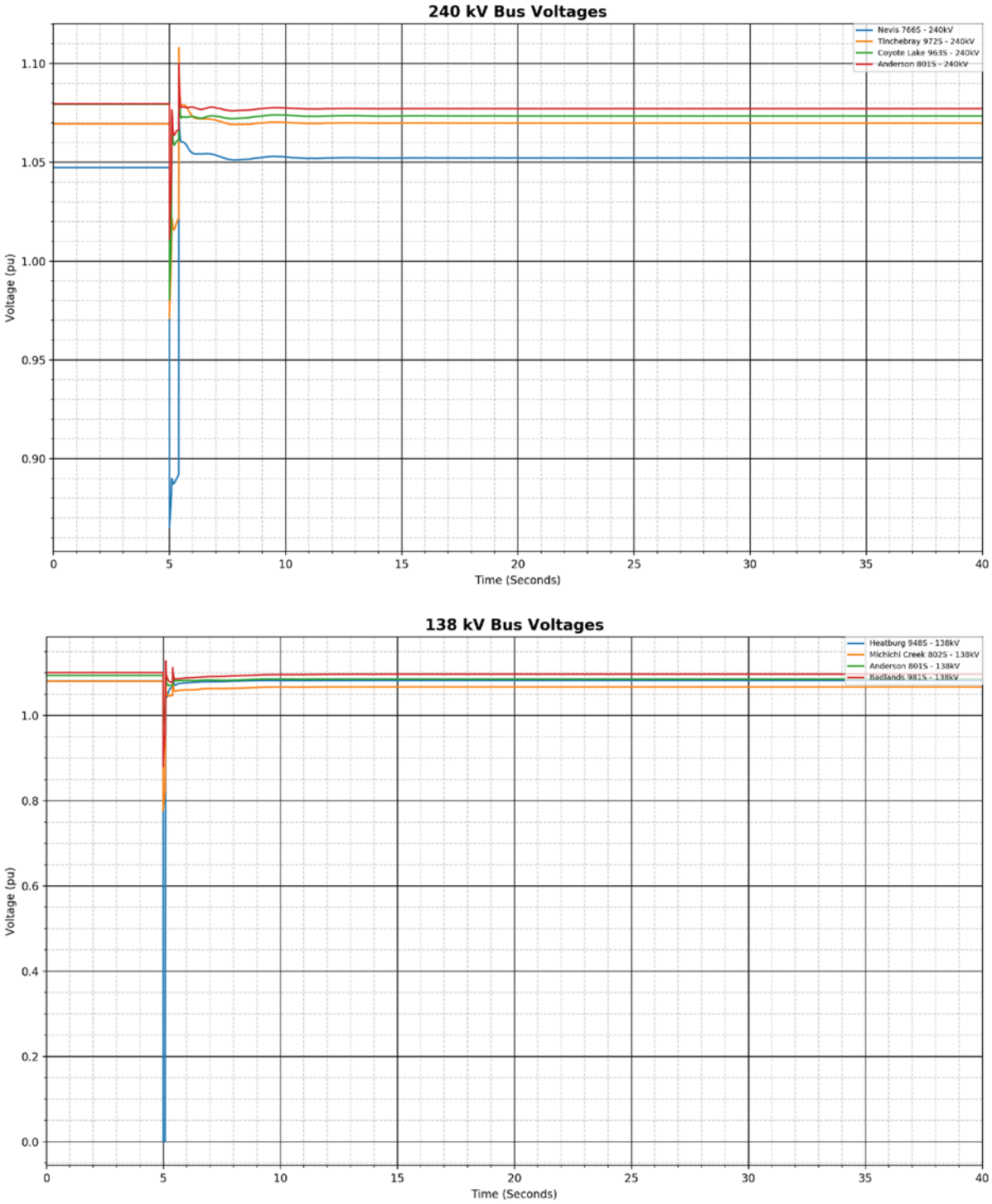
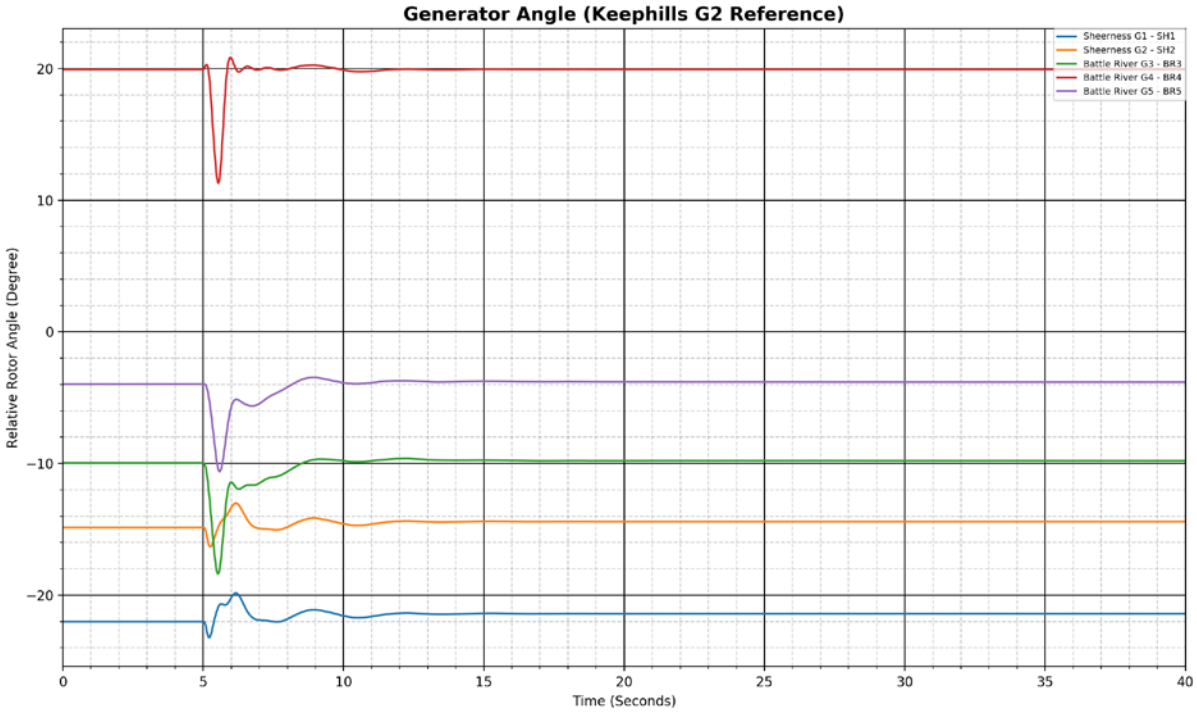
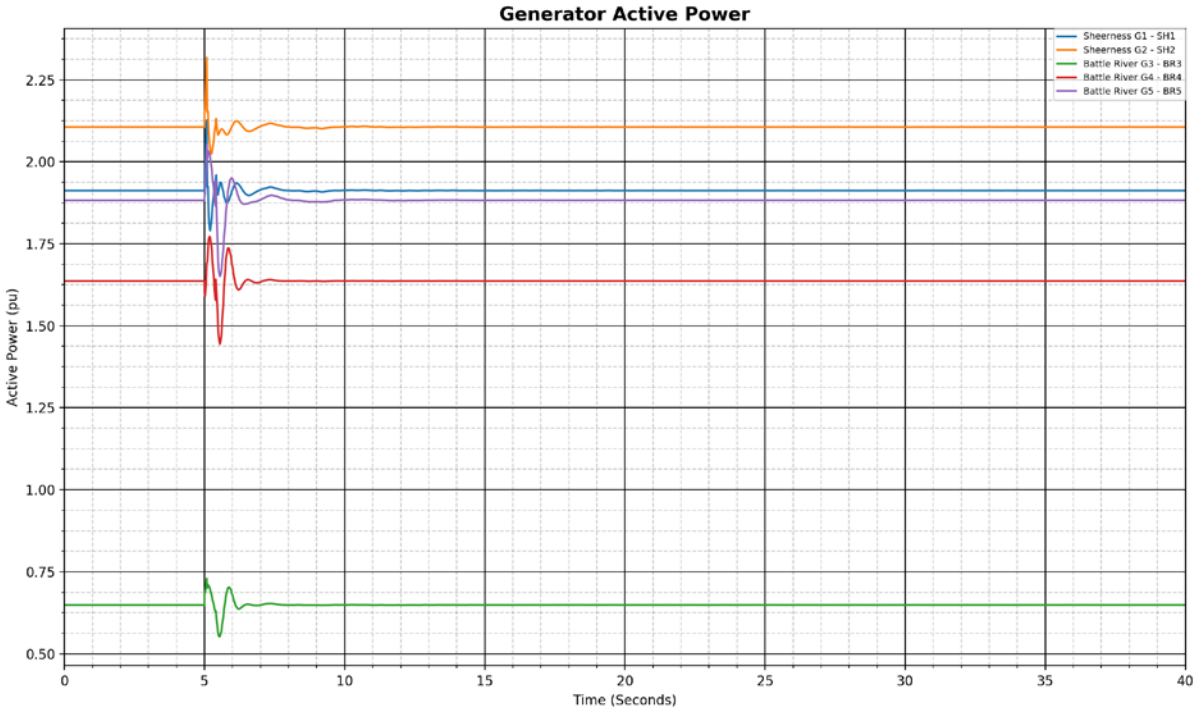
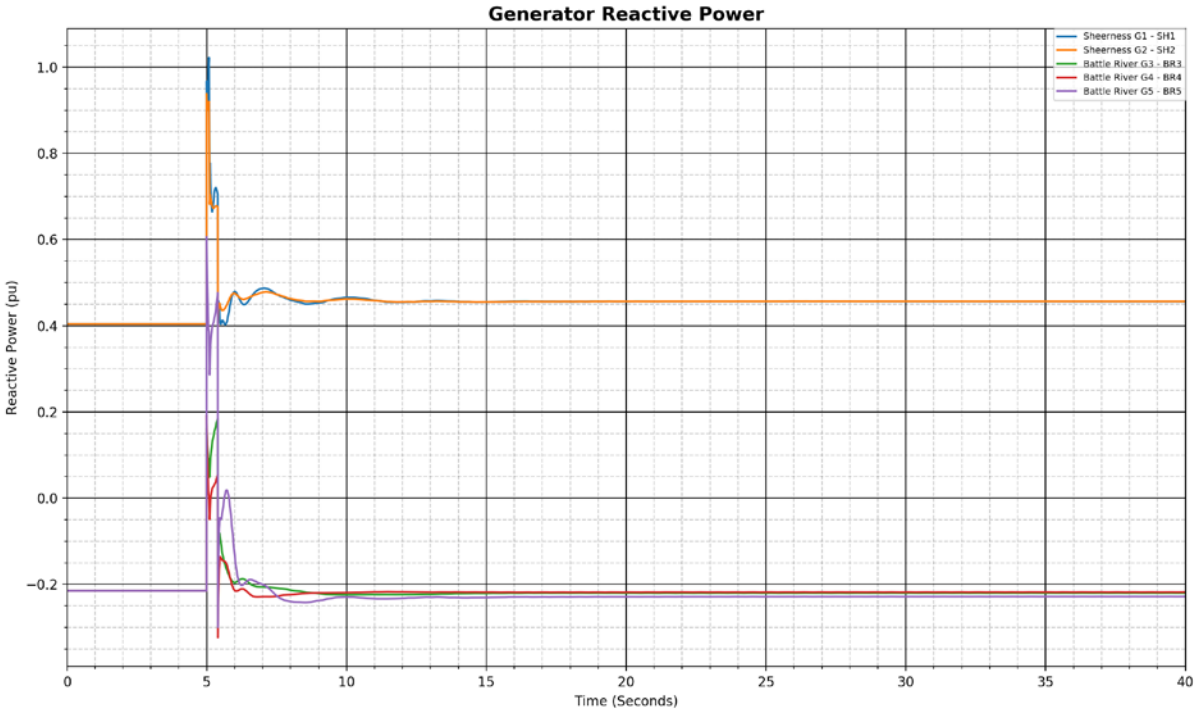

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Reactive Power (Mvar)
Time (Seconds)

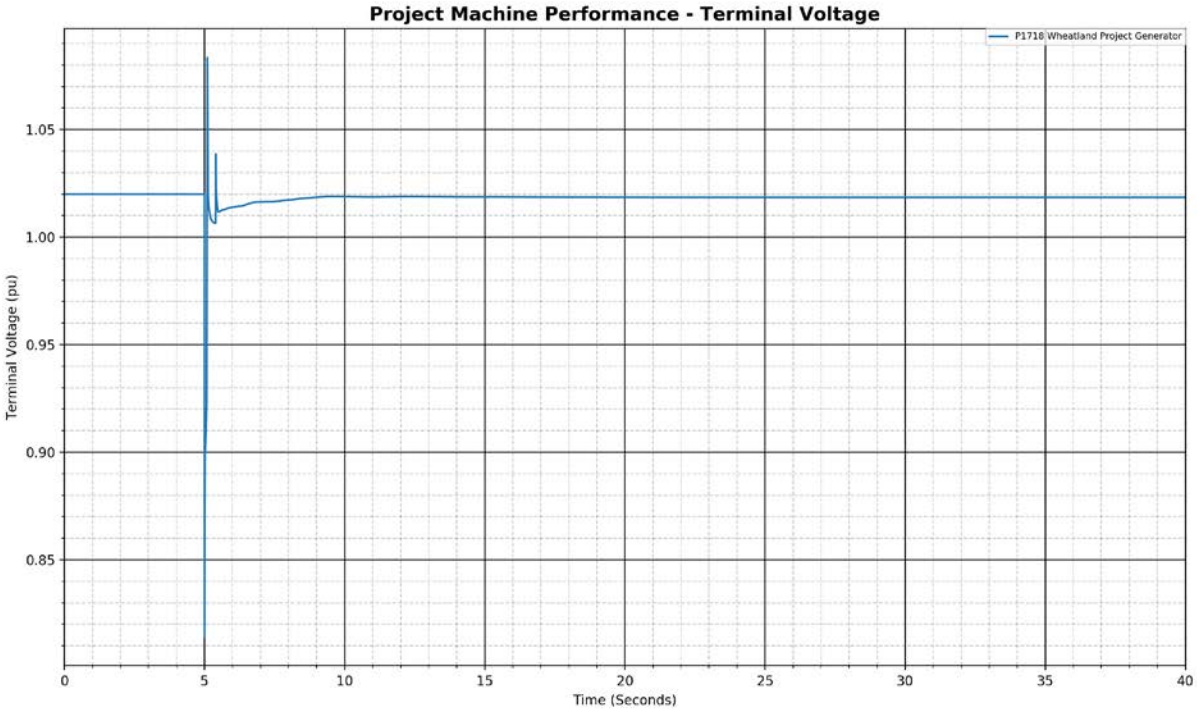
Figure A4-24: 7L16 (Heatburg 948S - Nevis 766S): 3-phase fault at Heatburg 948S

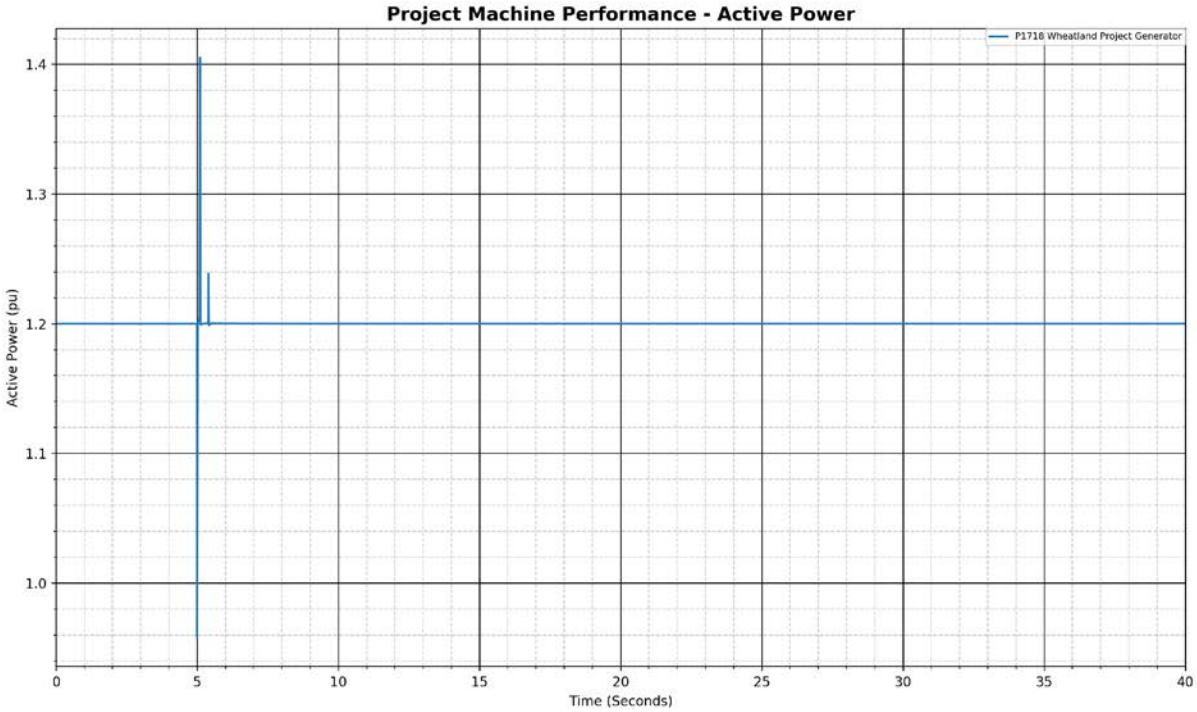


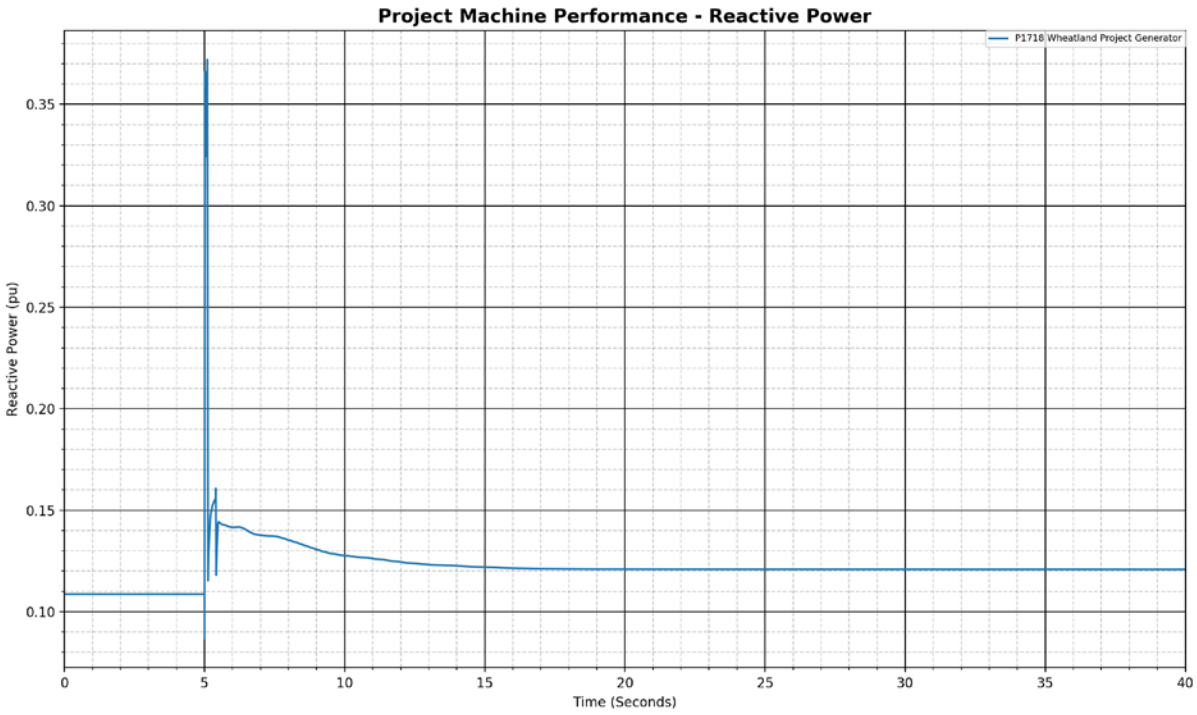

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

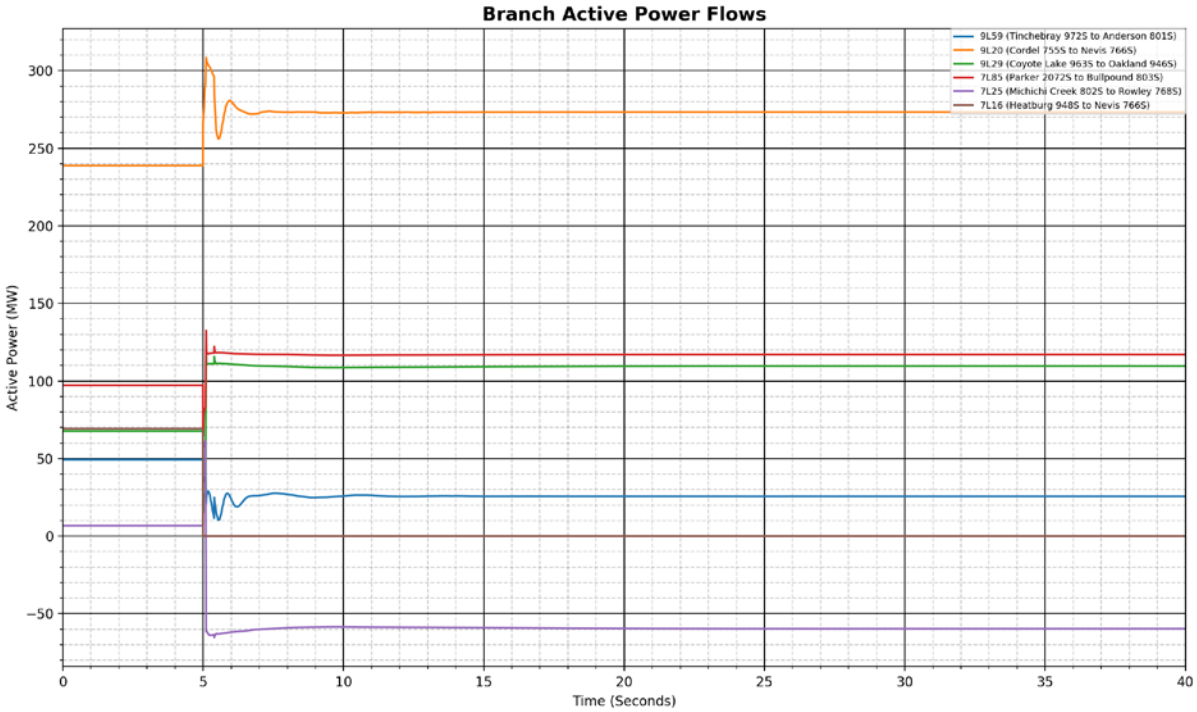

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.35
0.30
0.25
0.20
0.15
0.10
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Active Power (MW)
Time (Seconds)

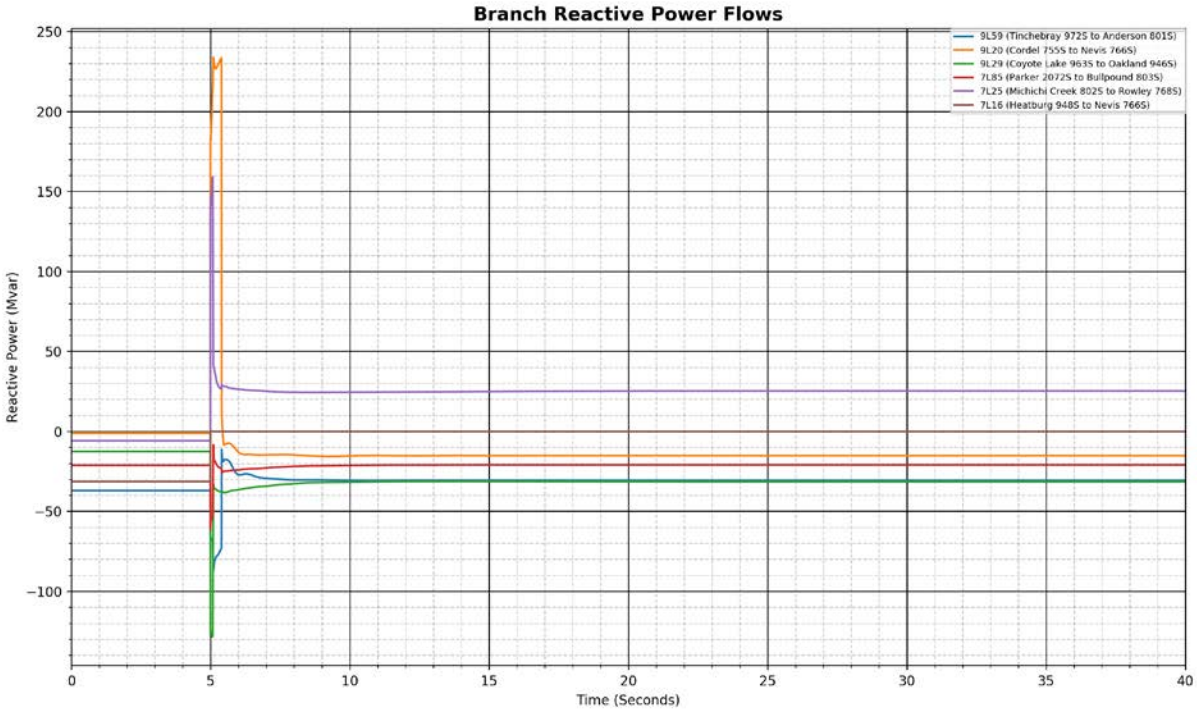
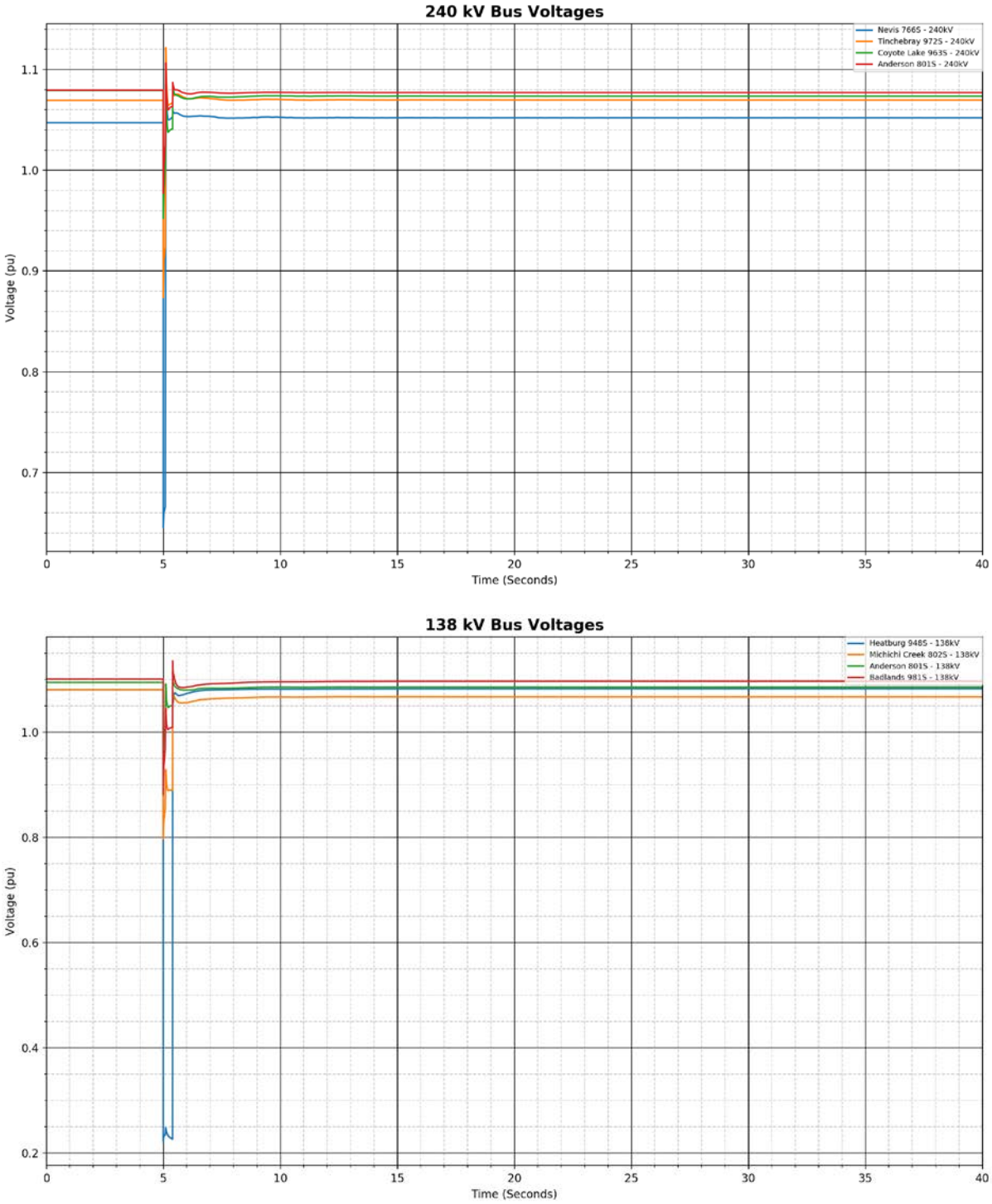
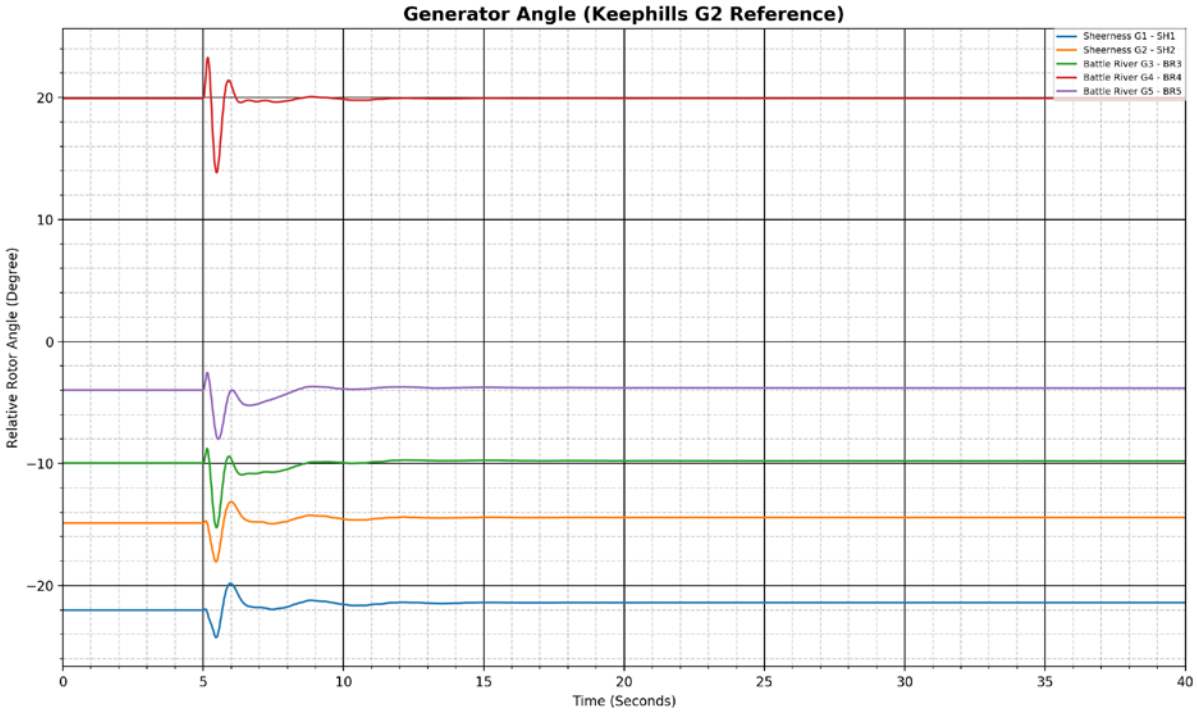
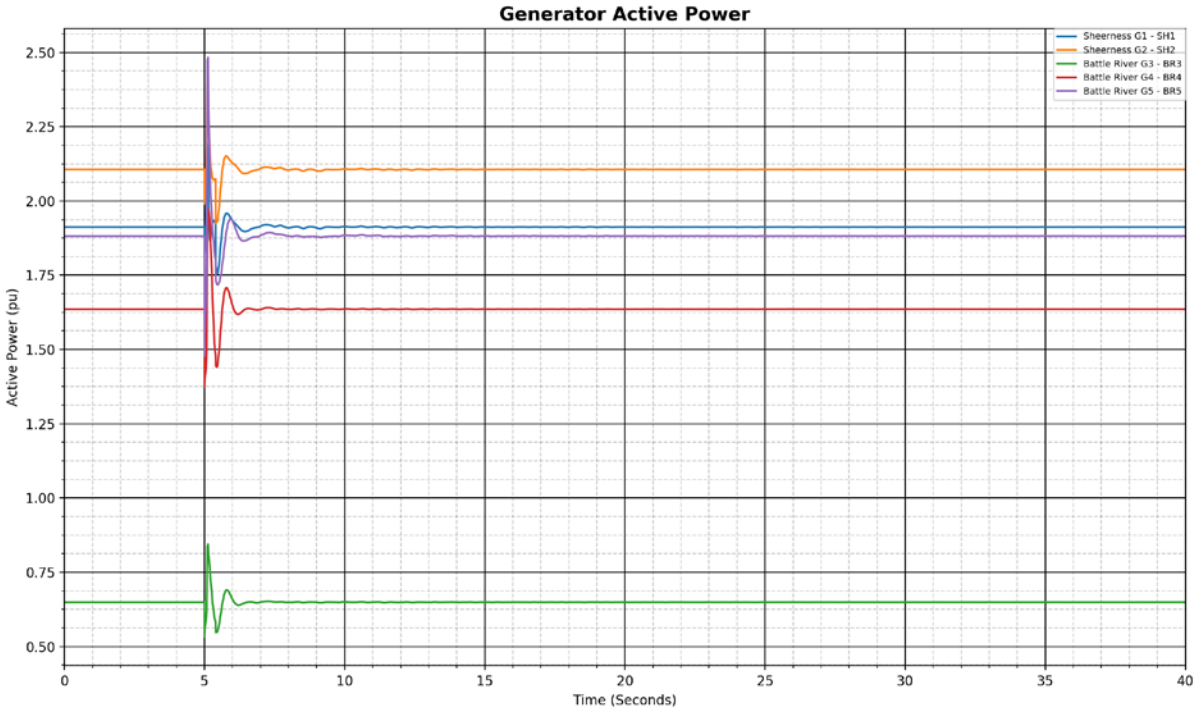
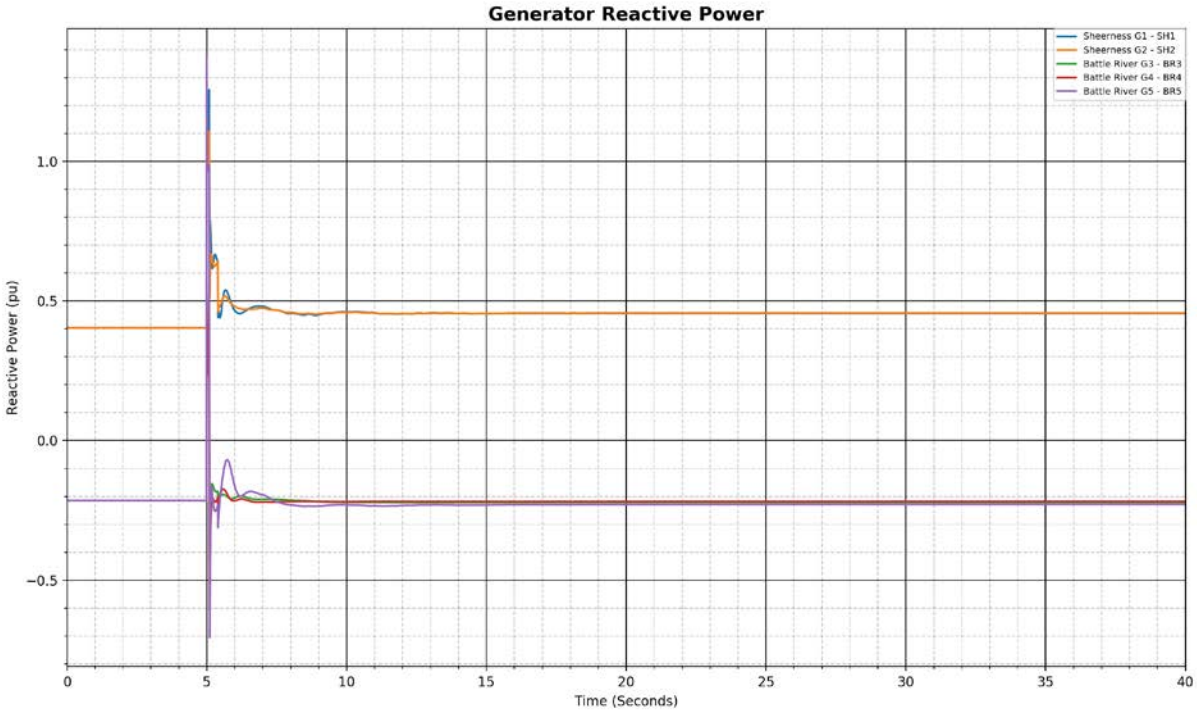

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

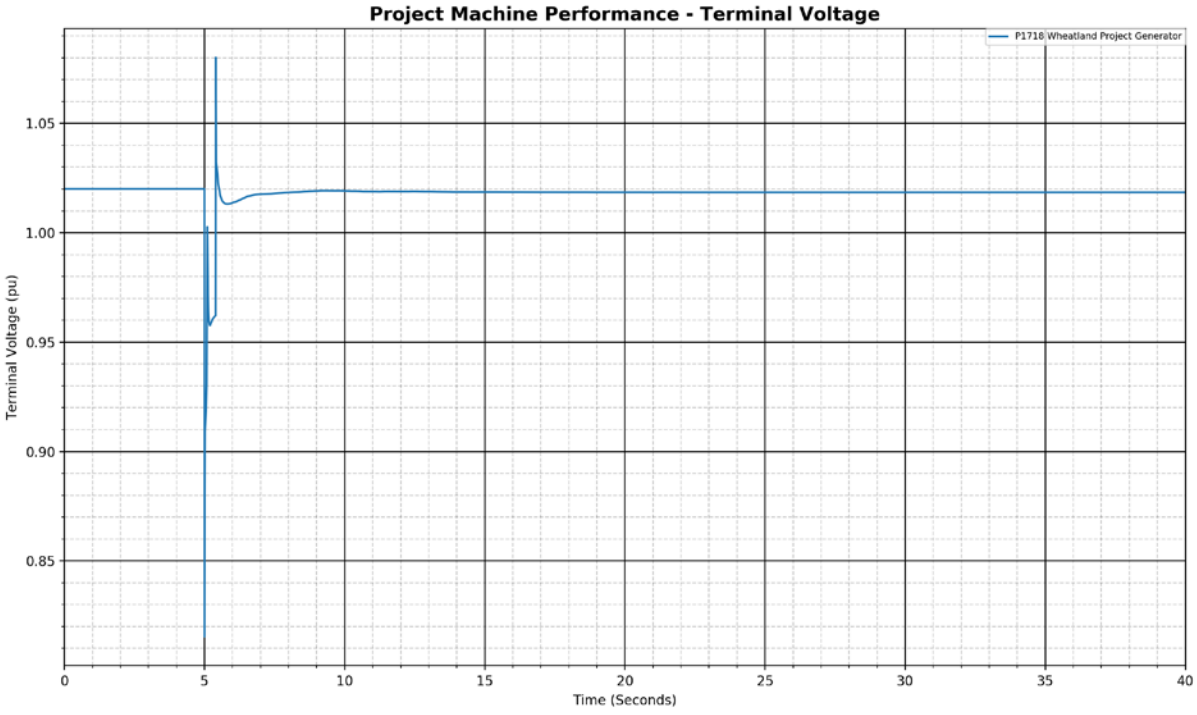
Figure A4-25: 7L16 (Heatburg 948S - Nevis 766S): 3-phase fault at Nevis 766S

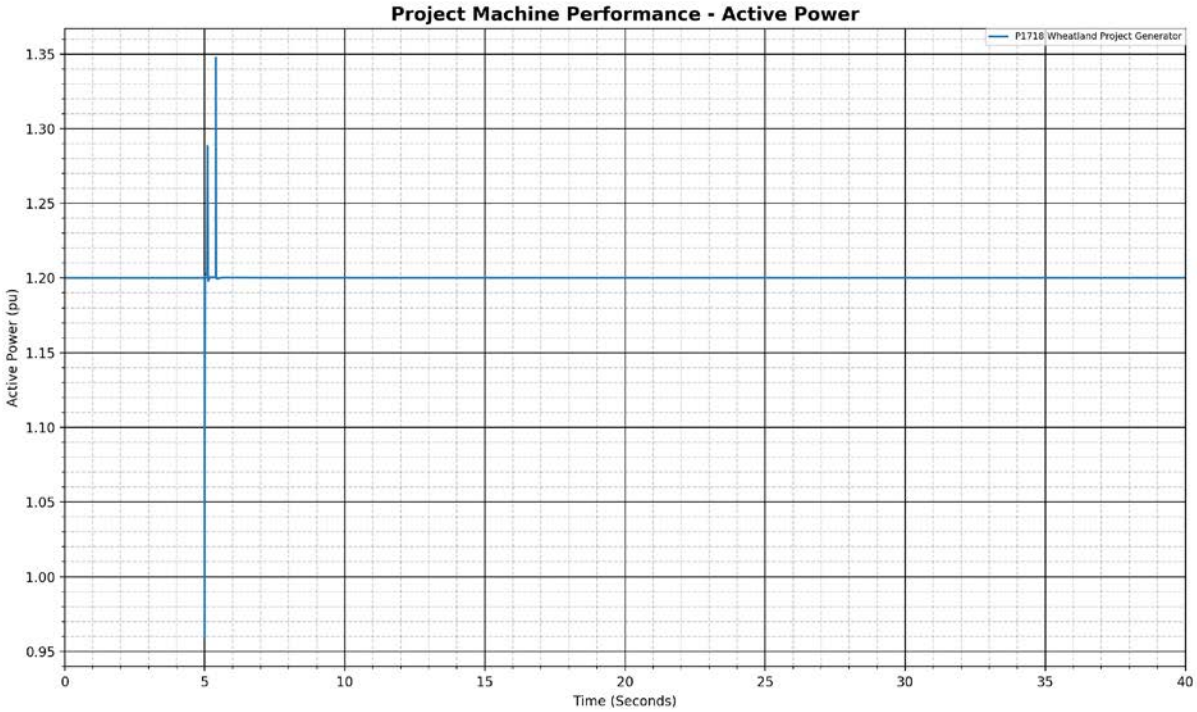


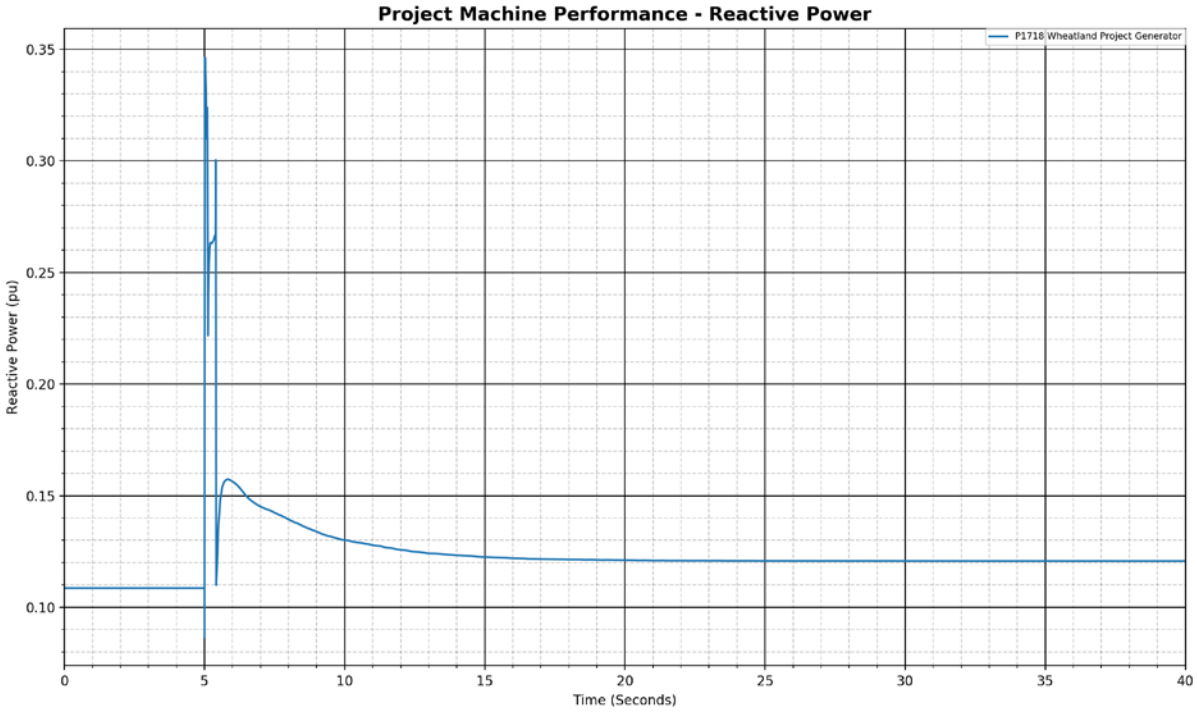

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

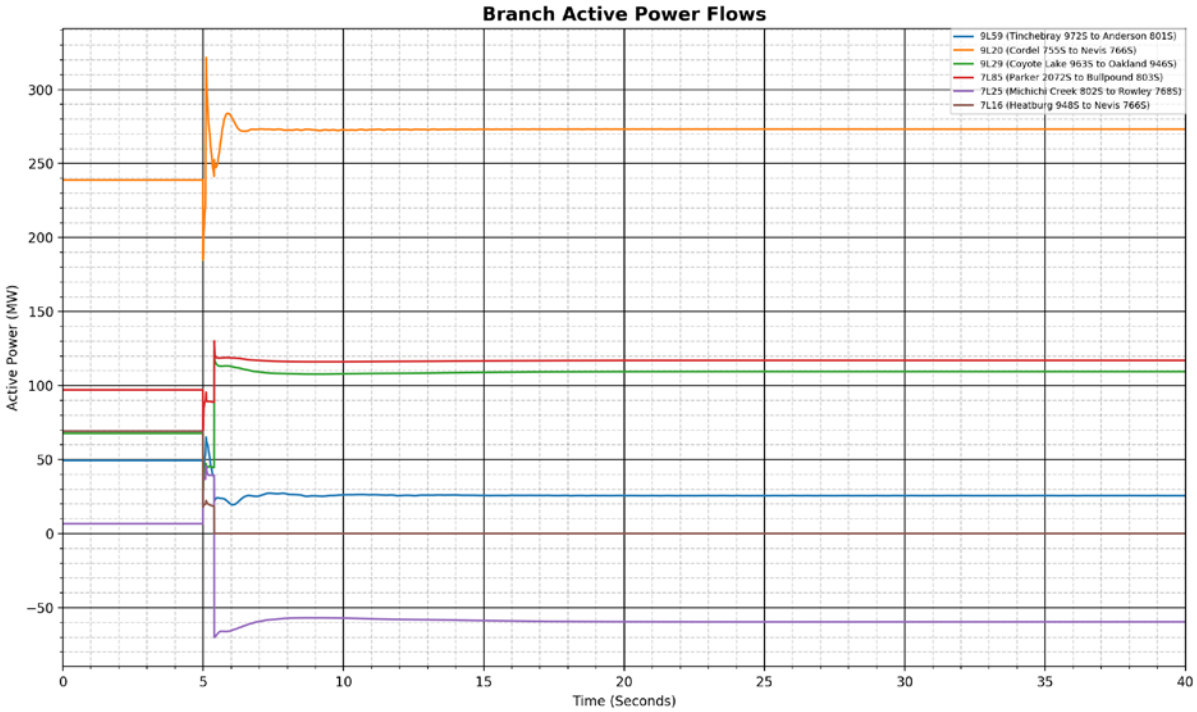

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.35
0.30
0.25
0.20
0.15
0.10
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Active Power (MW)
Time (Seconds)

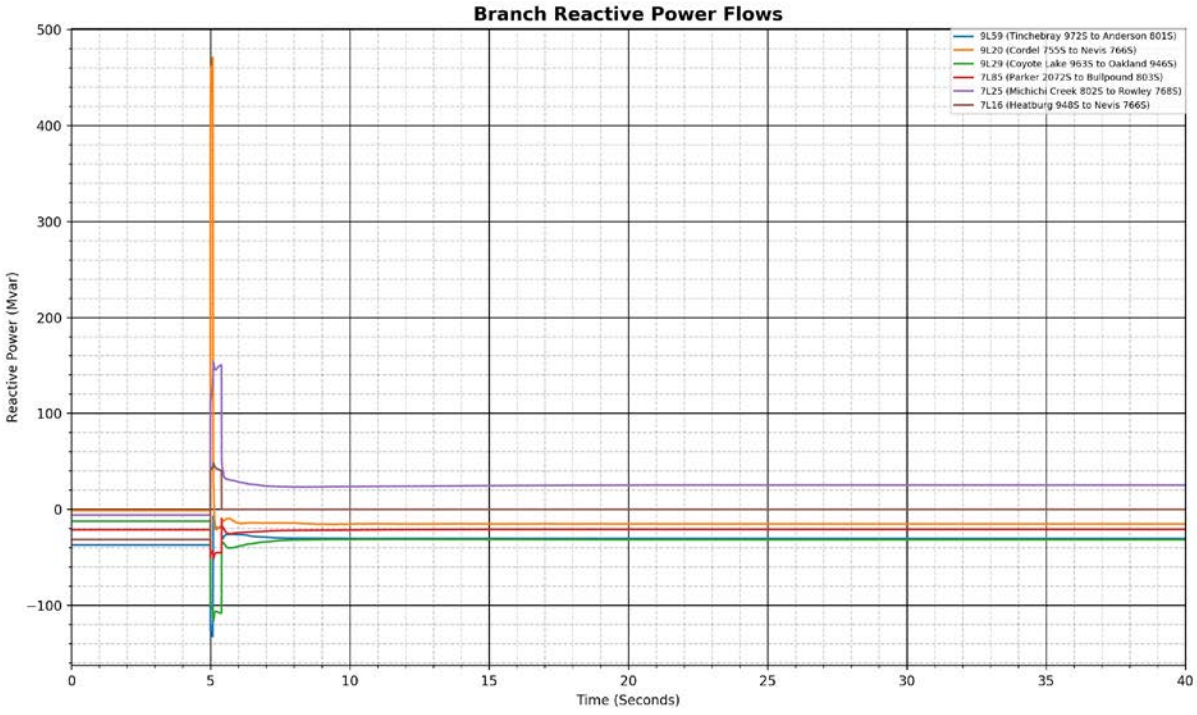
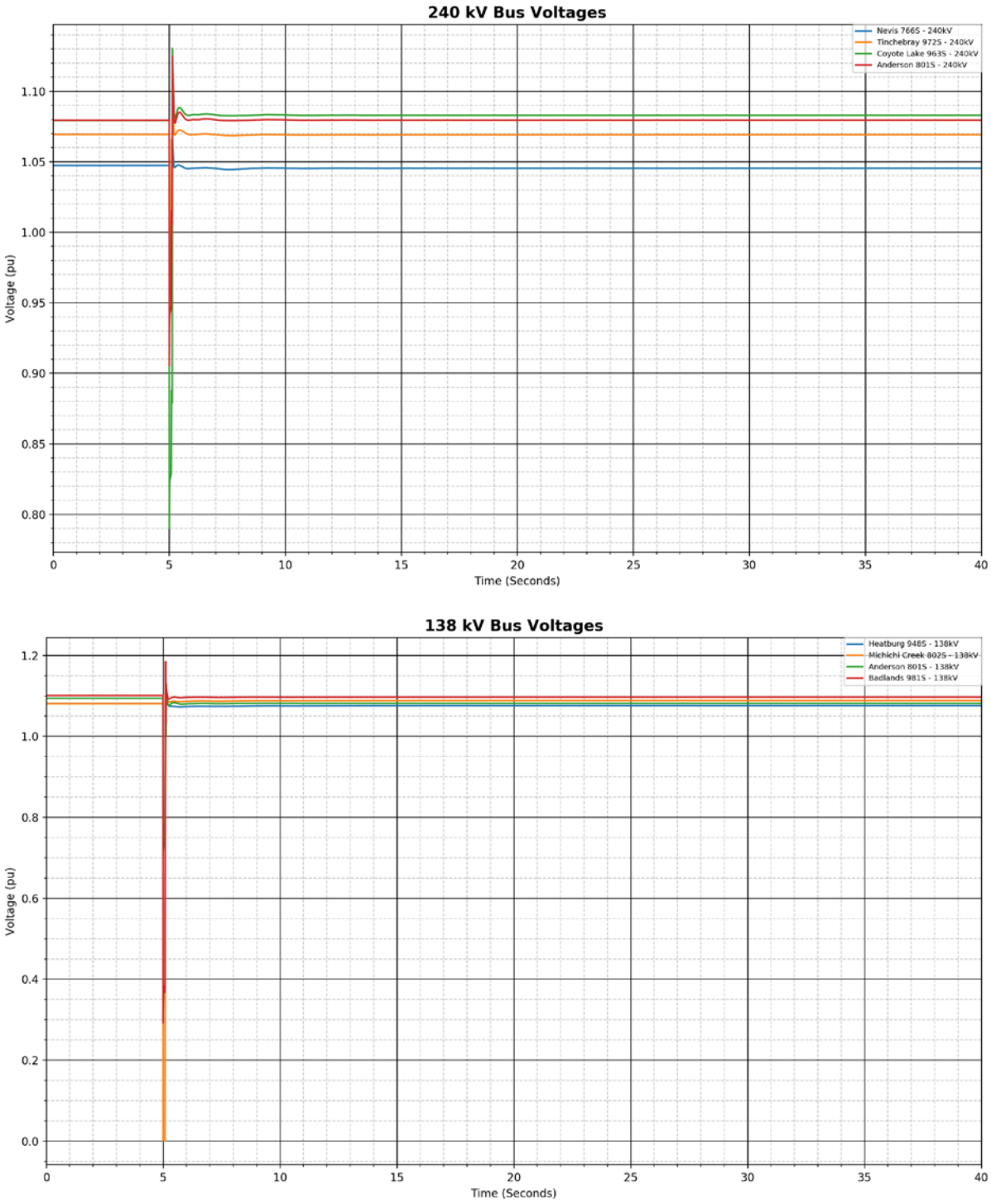
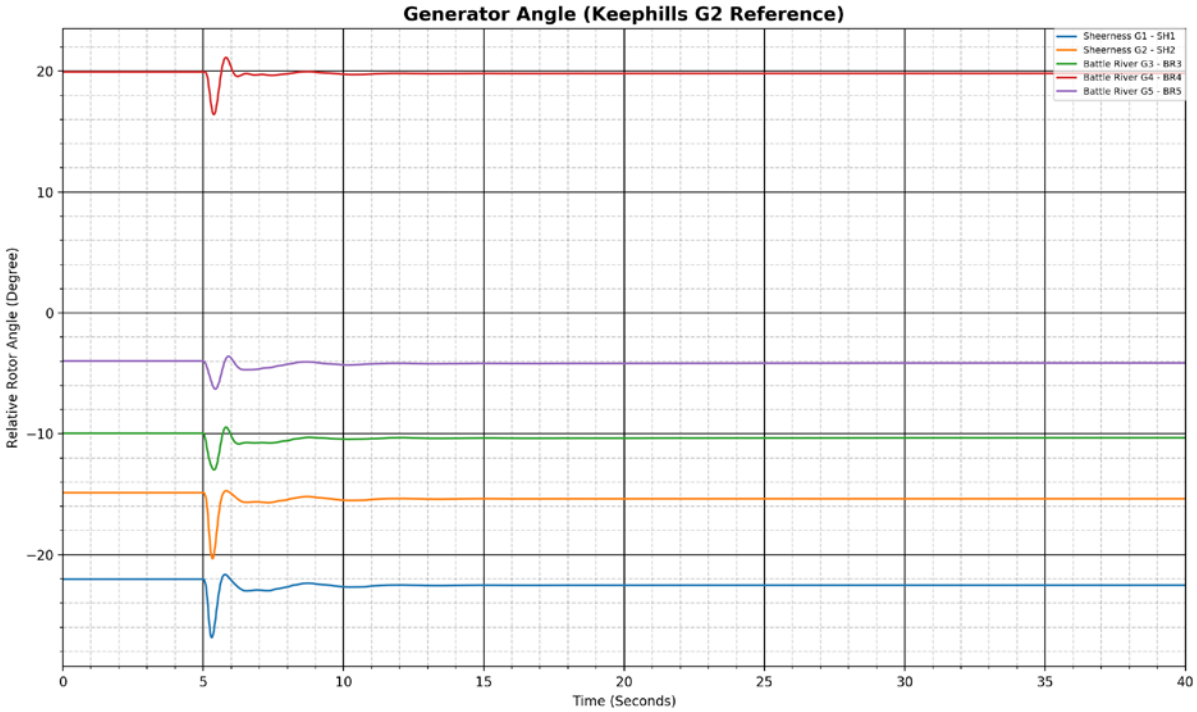
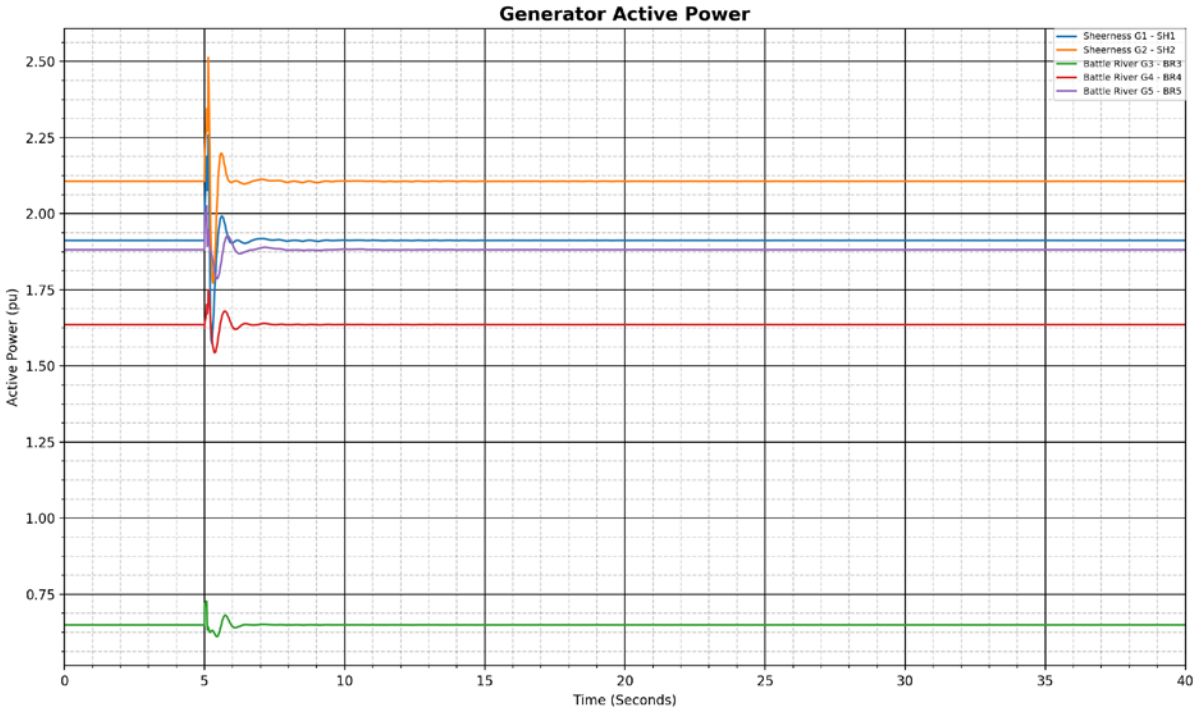
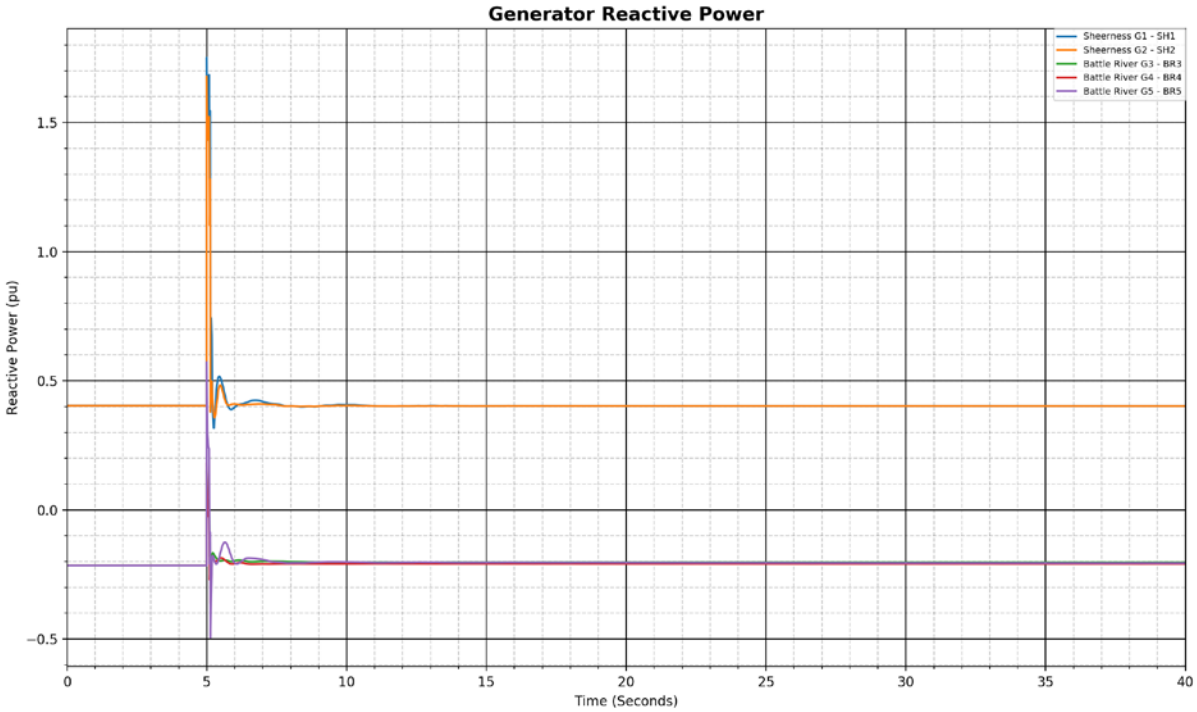

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

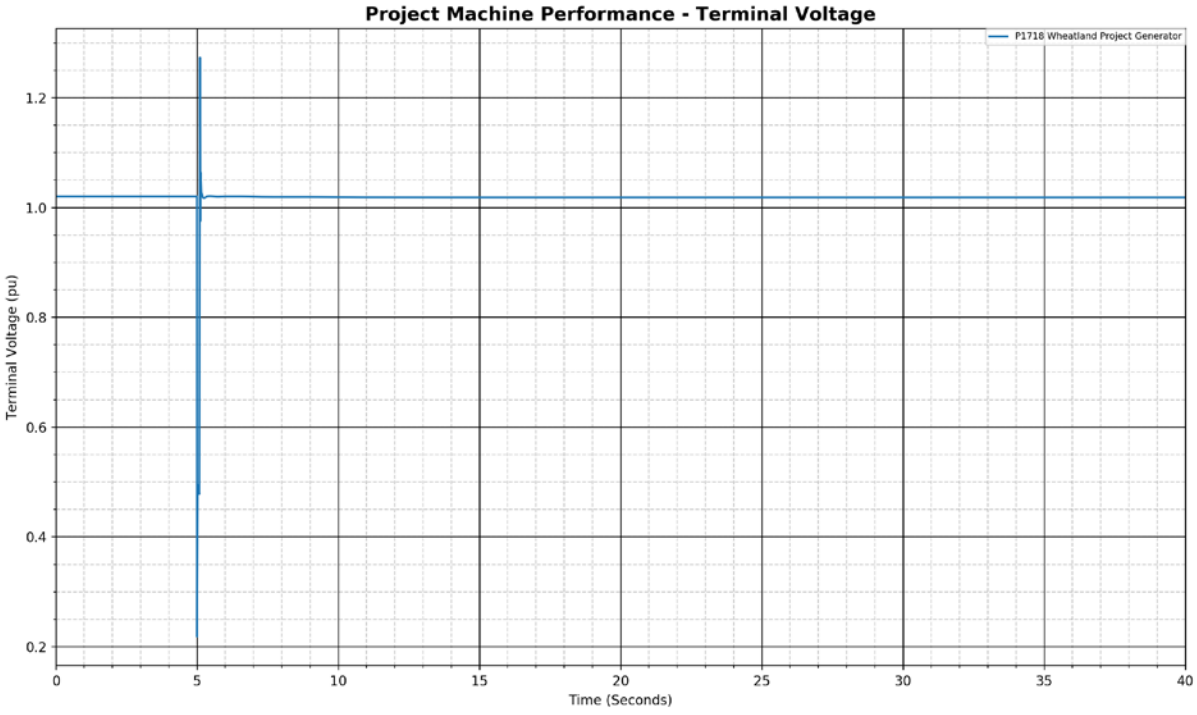
Figure A4-26: 7L128 (Michichi Creek 802S - Coyote Lake 963S): 3-phase fault at Michichi Creek 802S

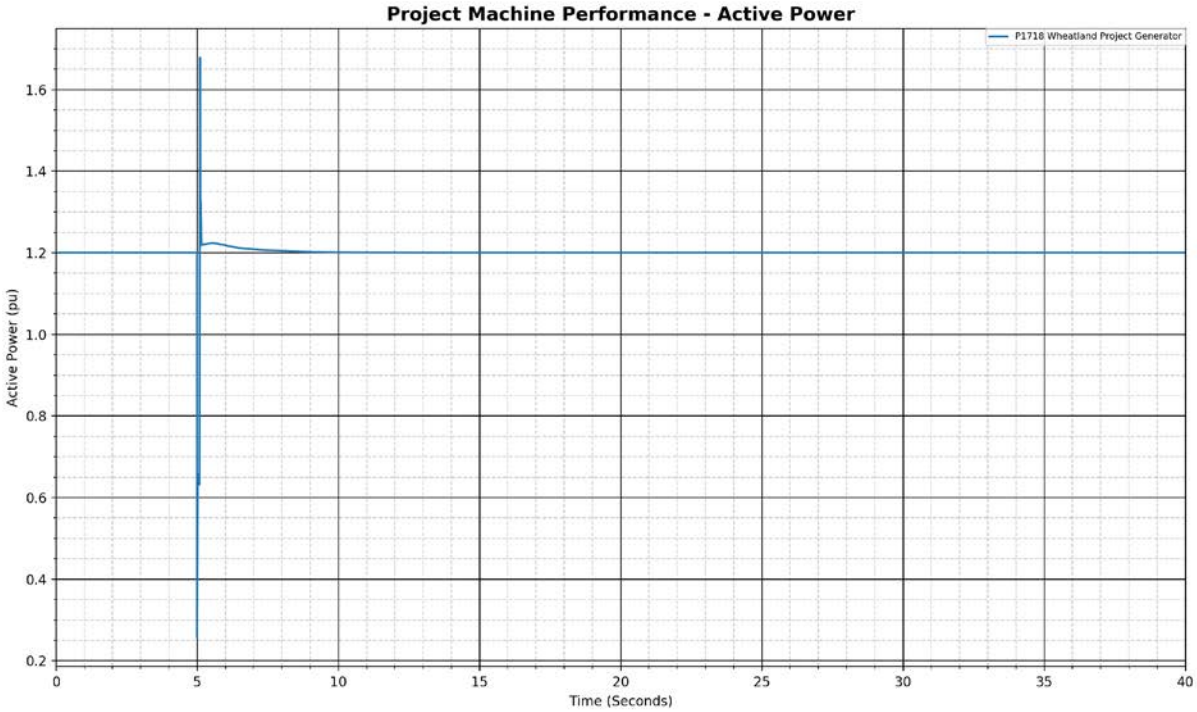


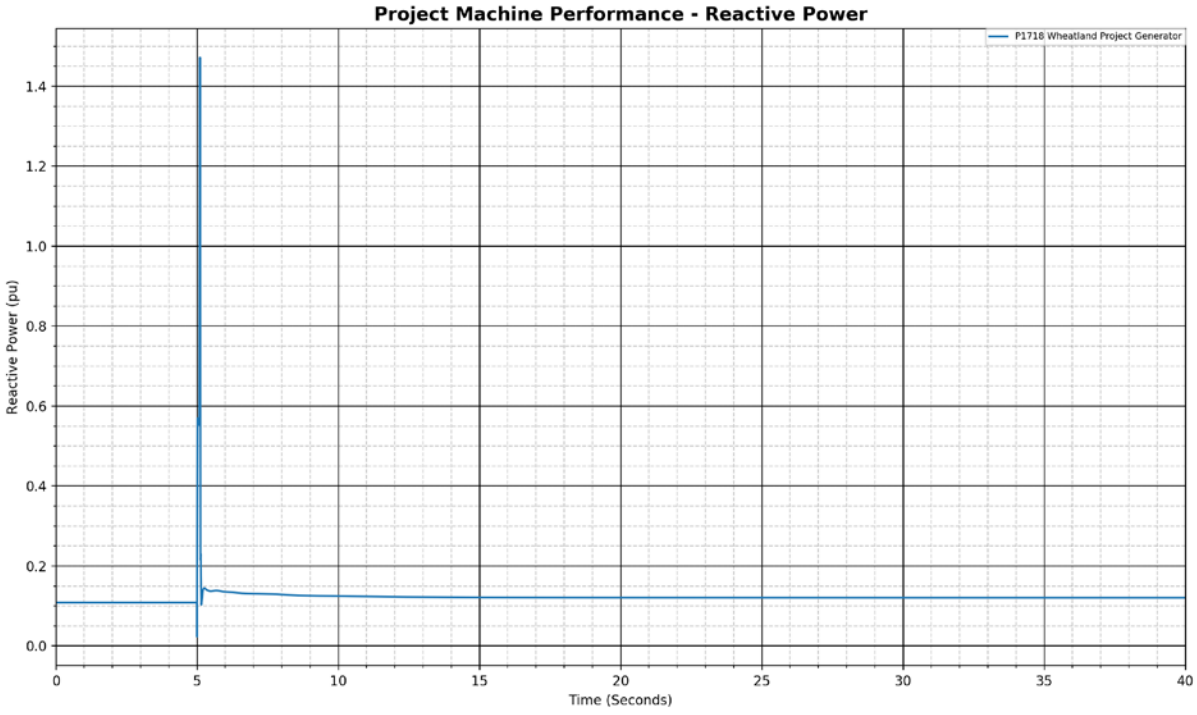

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

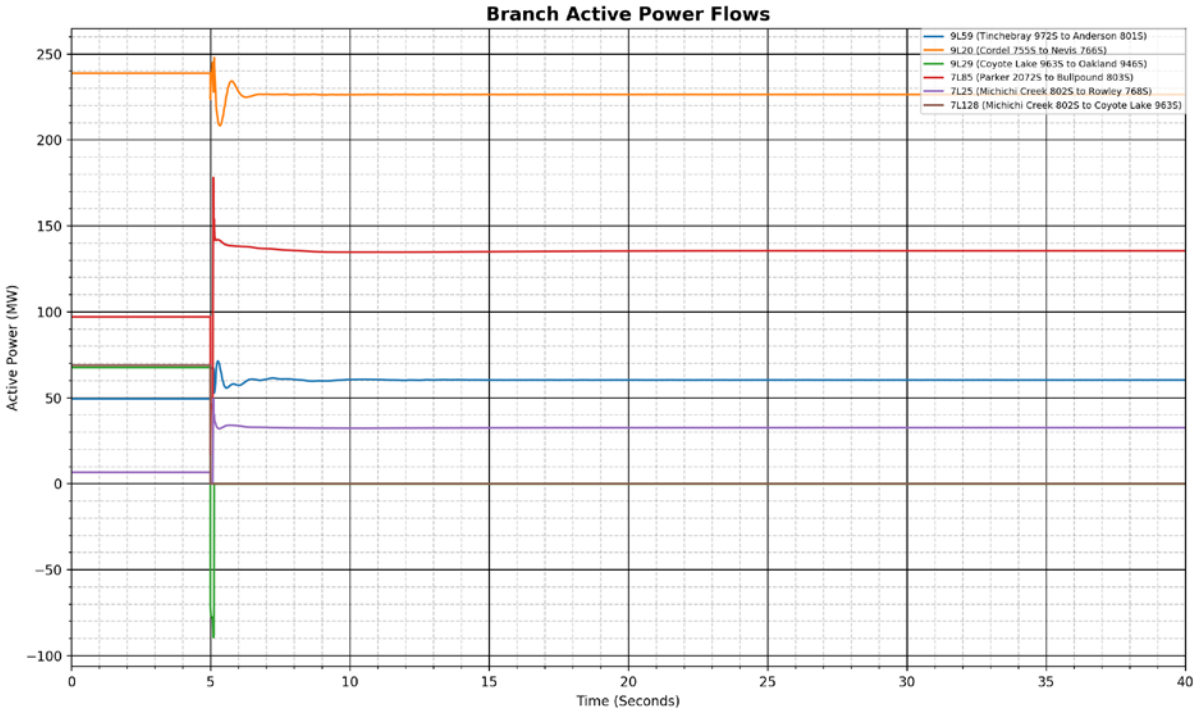

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Active Power (MW)
Time (Seconds)

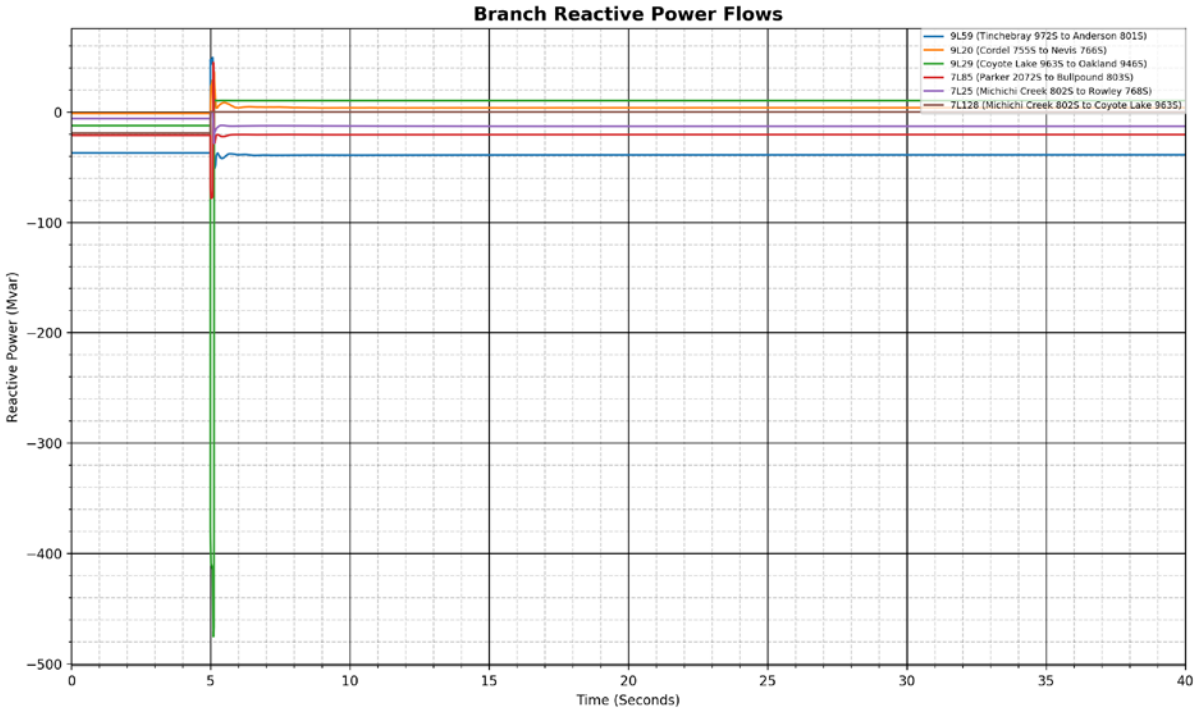
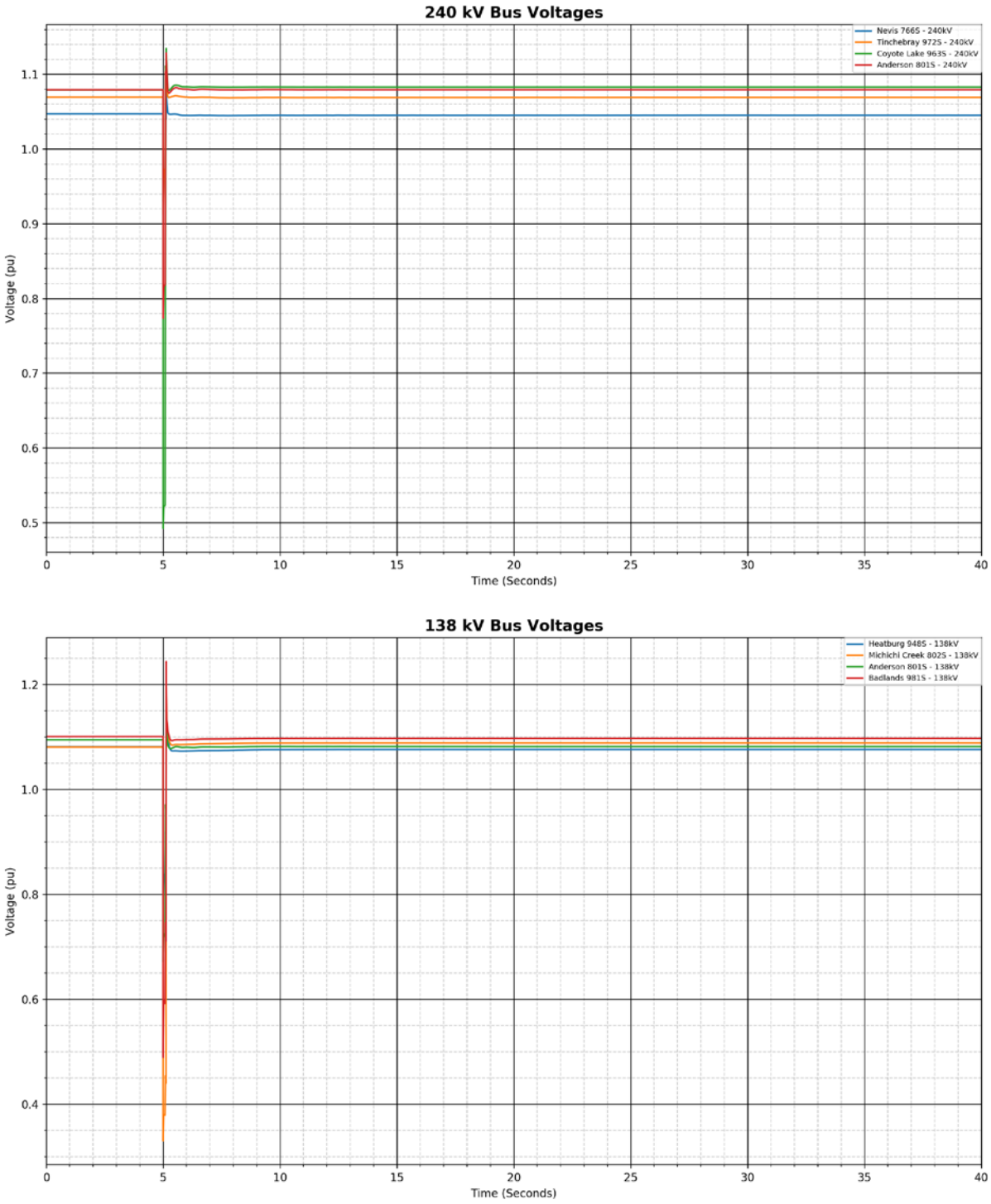
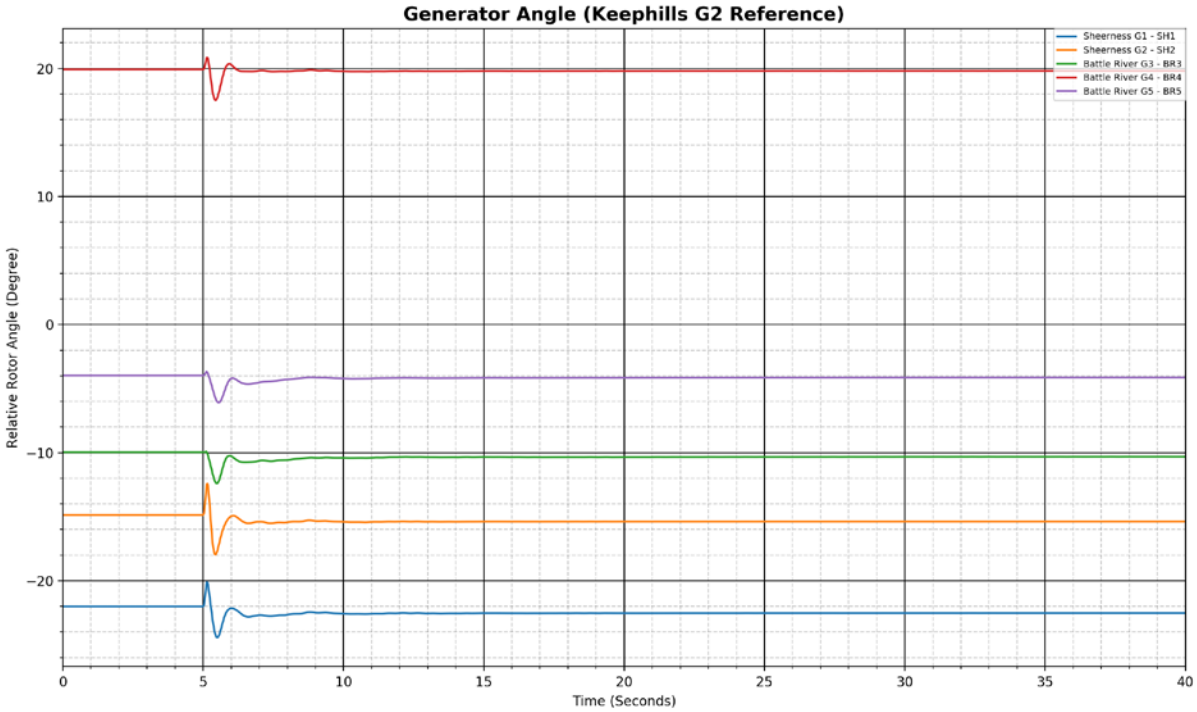
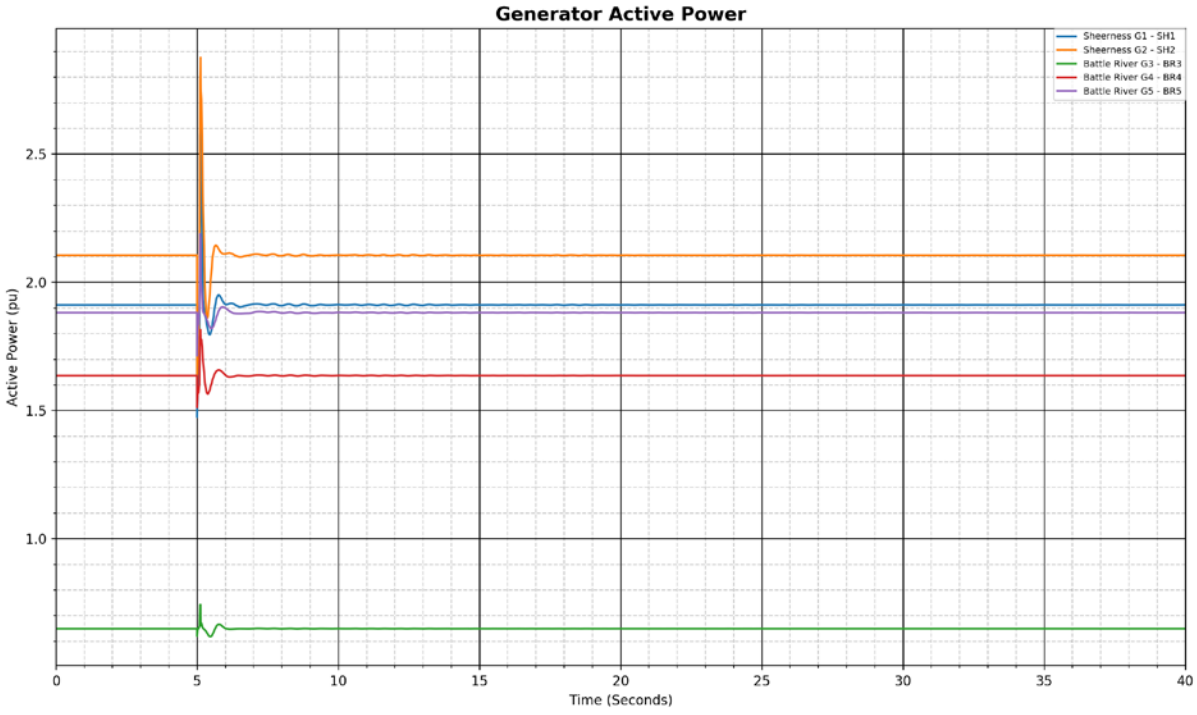
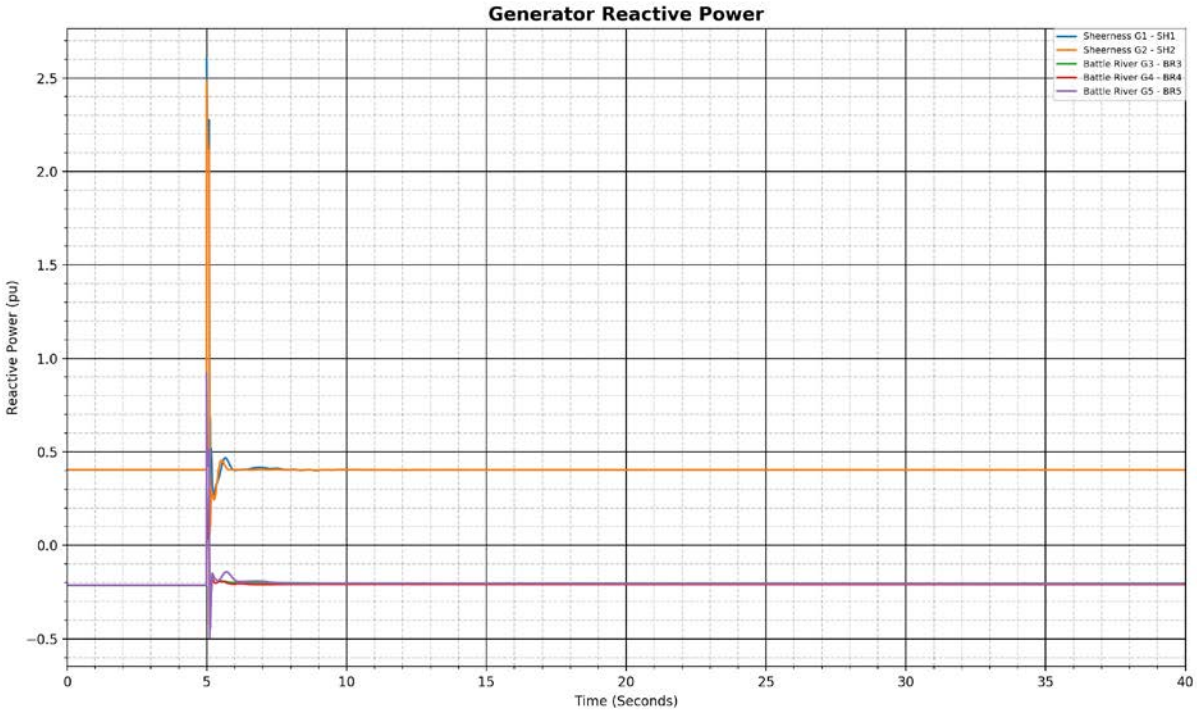

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Reactive Power (Mvar)
Time (Seconds)

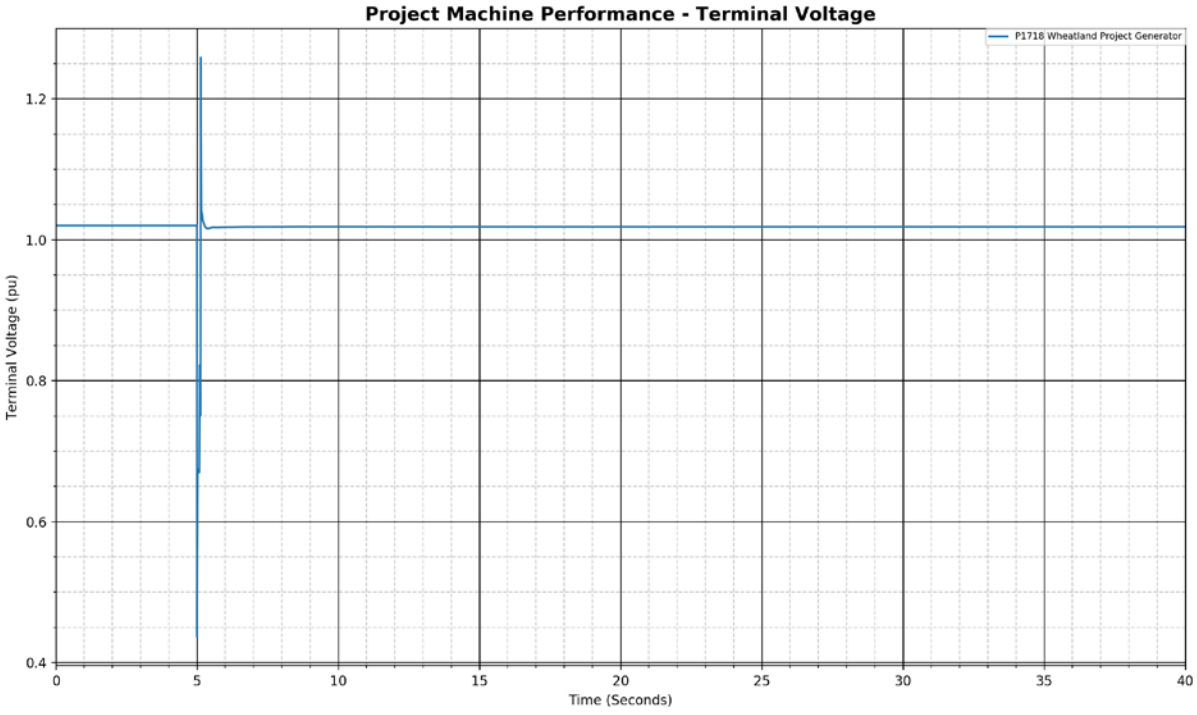
Figure A4-27: 7L128 (Michichi Creek 802S - Coyote Lake 963S): 3-phase fault at Coyote Lake 963S

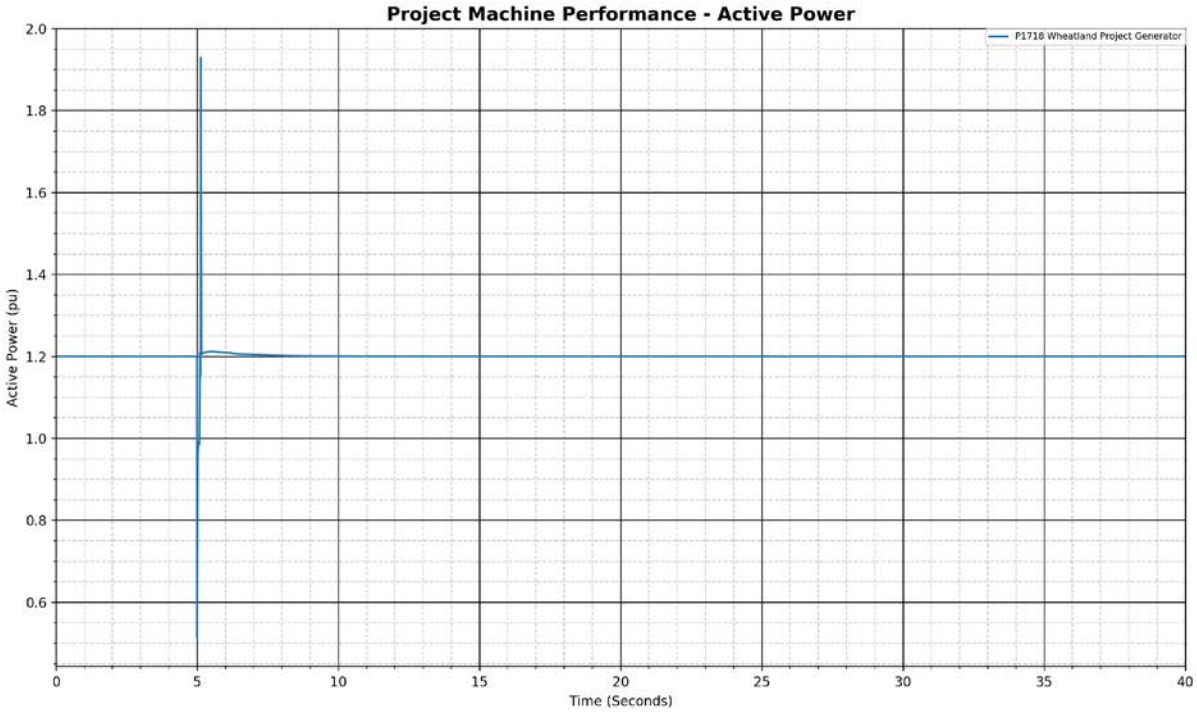


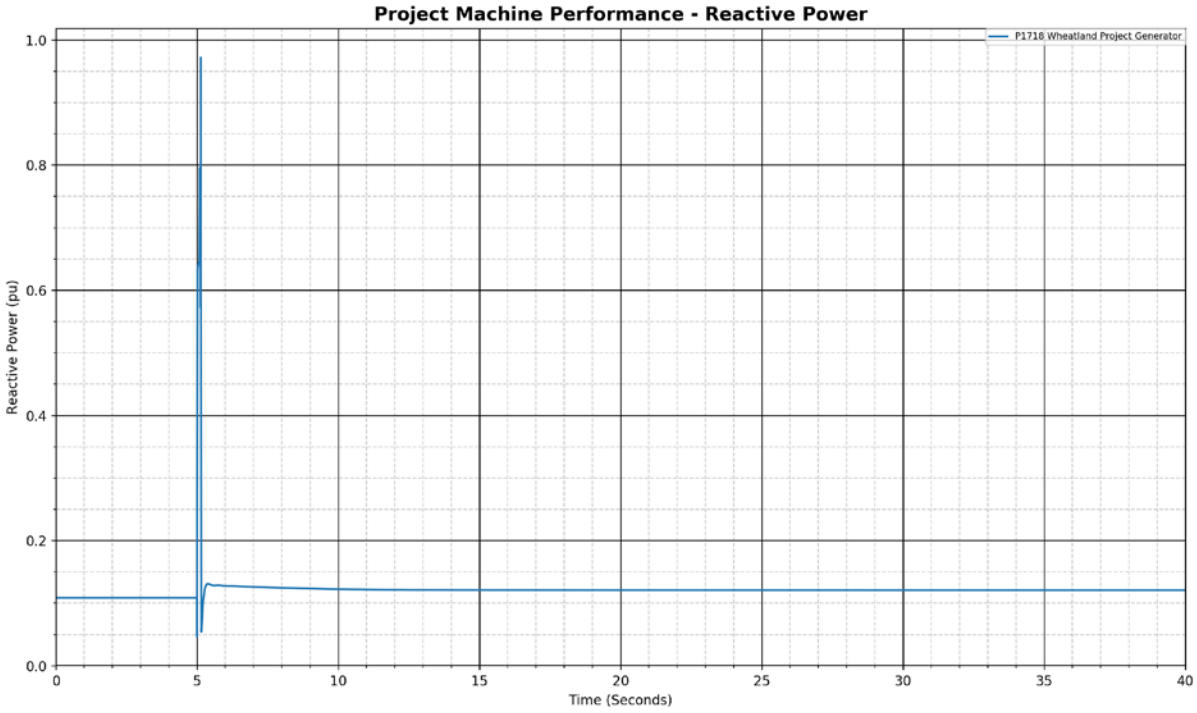

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
20
10
0
−10
−20
0
5
10
15
20
25
30
35
40
Time (Seconds)

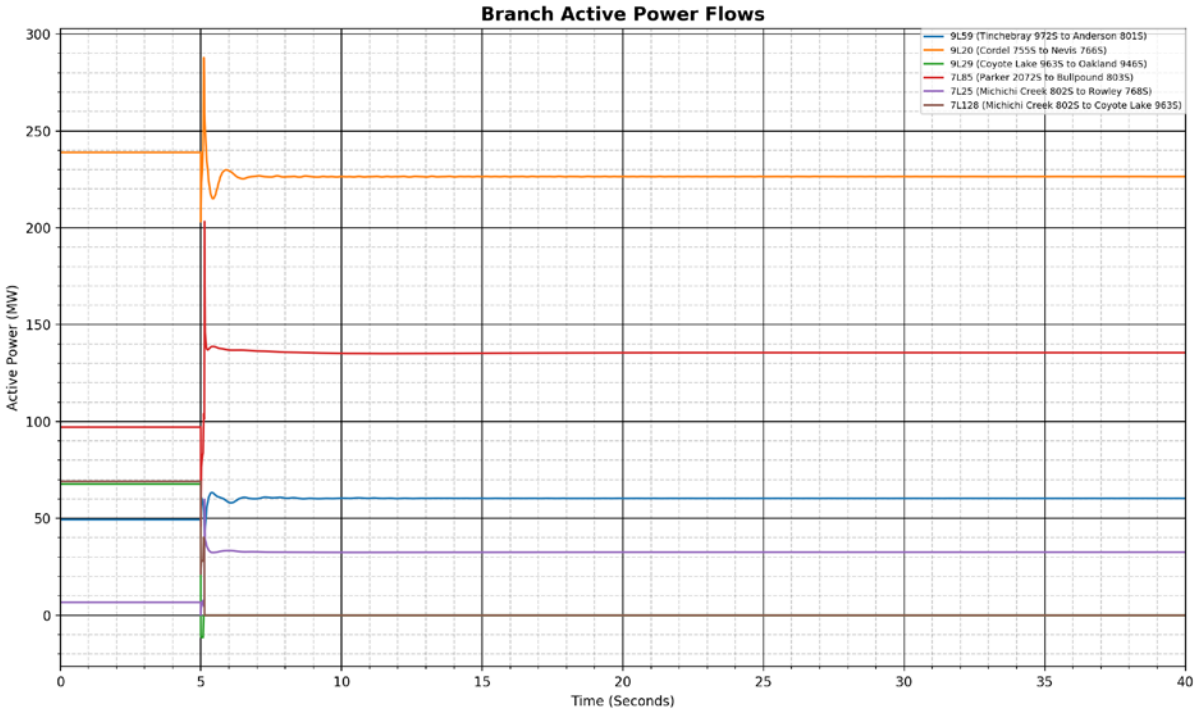

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
2.5
2.0
1.5
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)

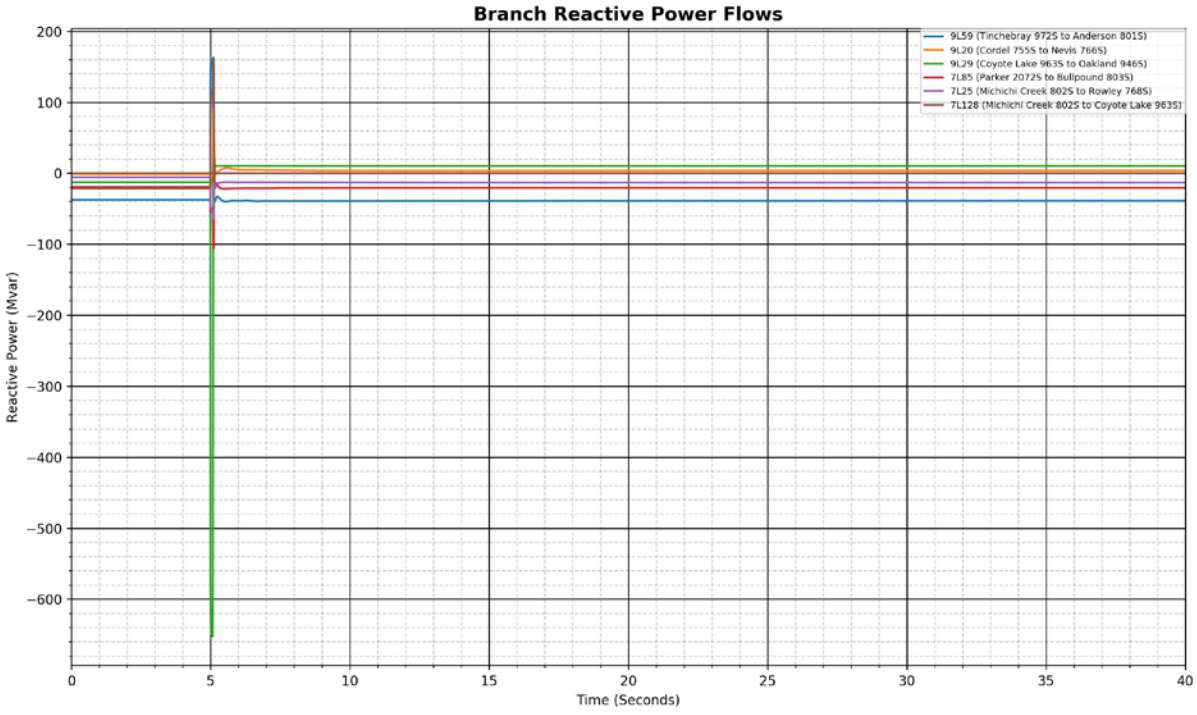

Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0
5
10
15
20
25
30
35
40

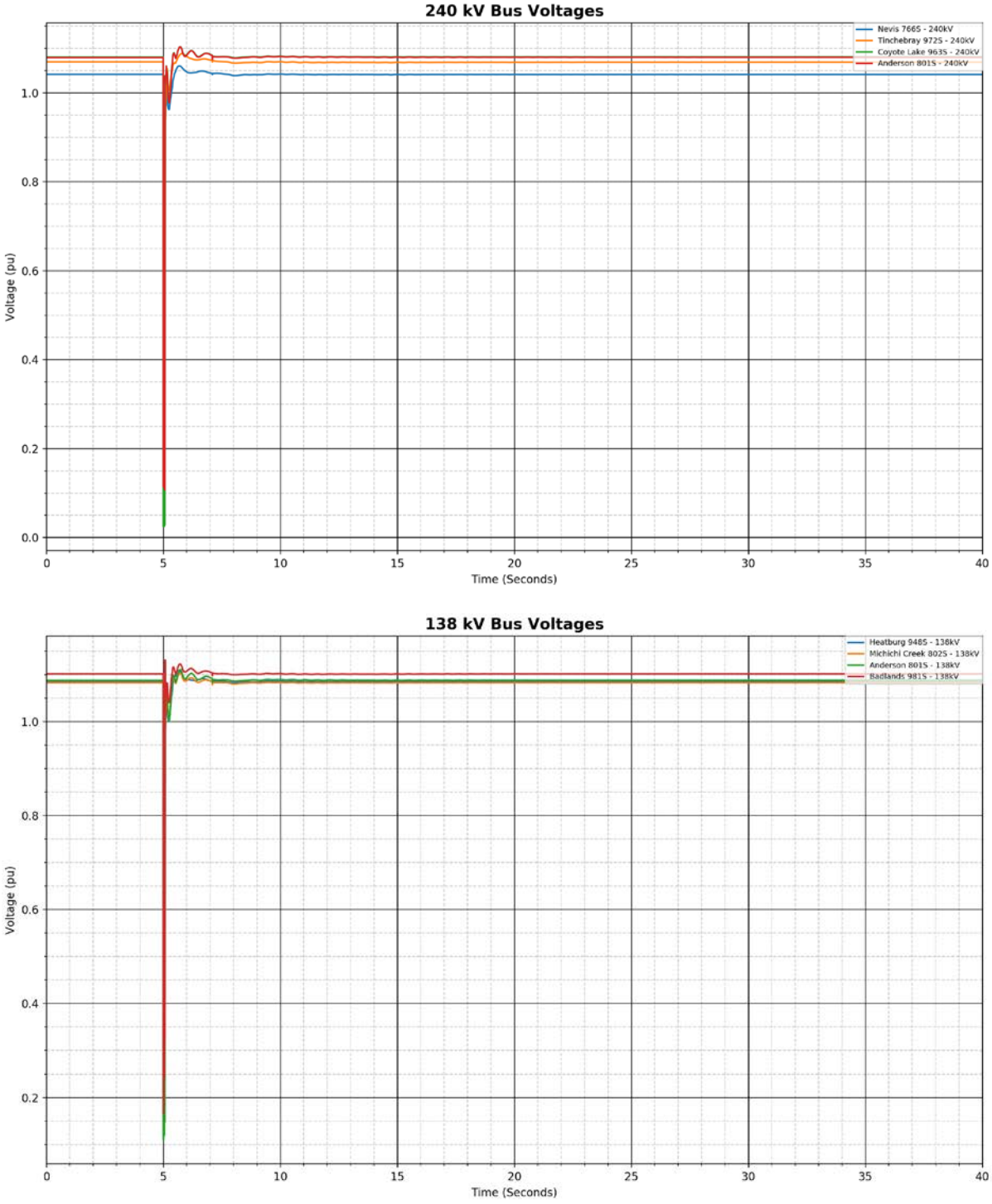

Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40

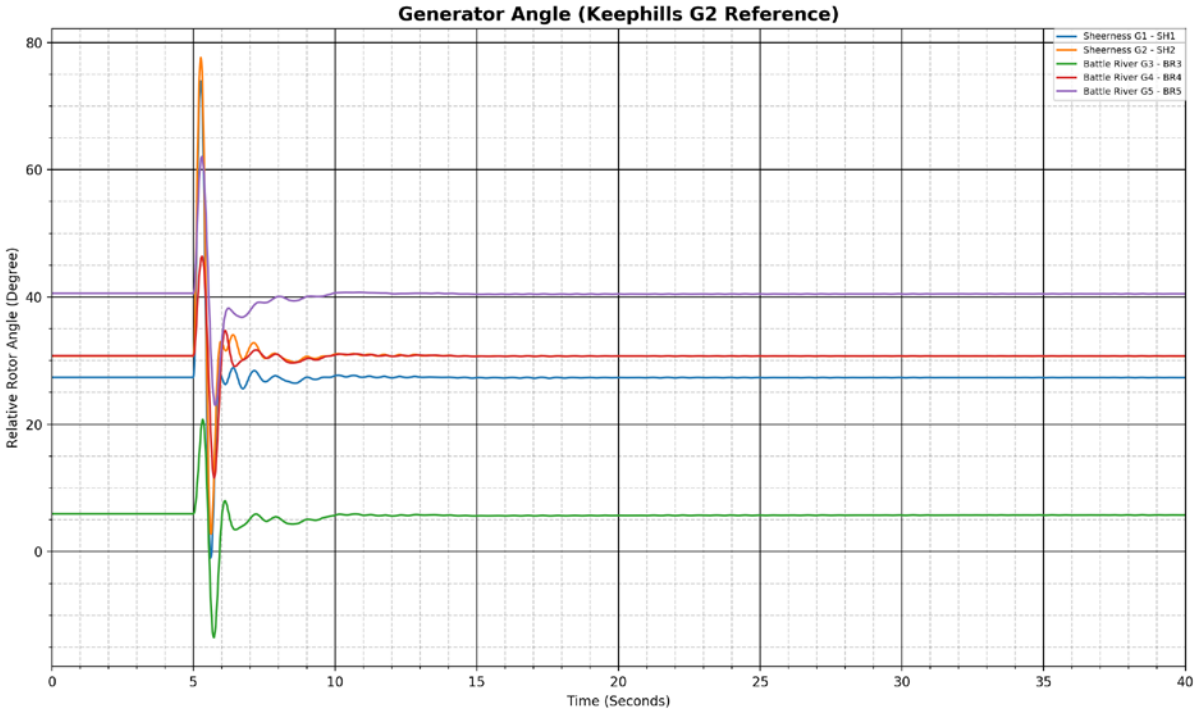

Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Active Power (MW)
Time (Seconds)

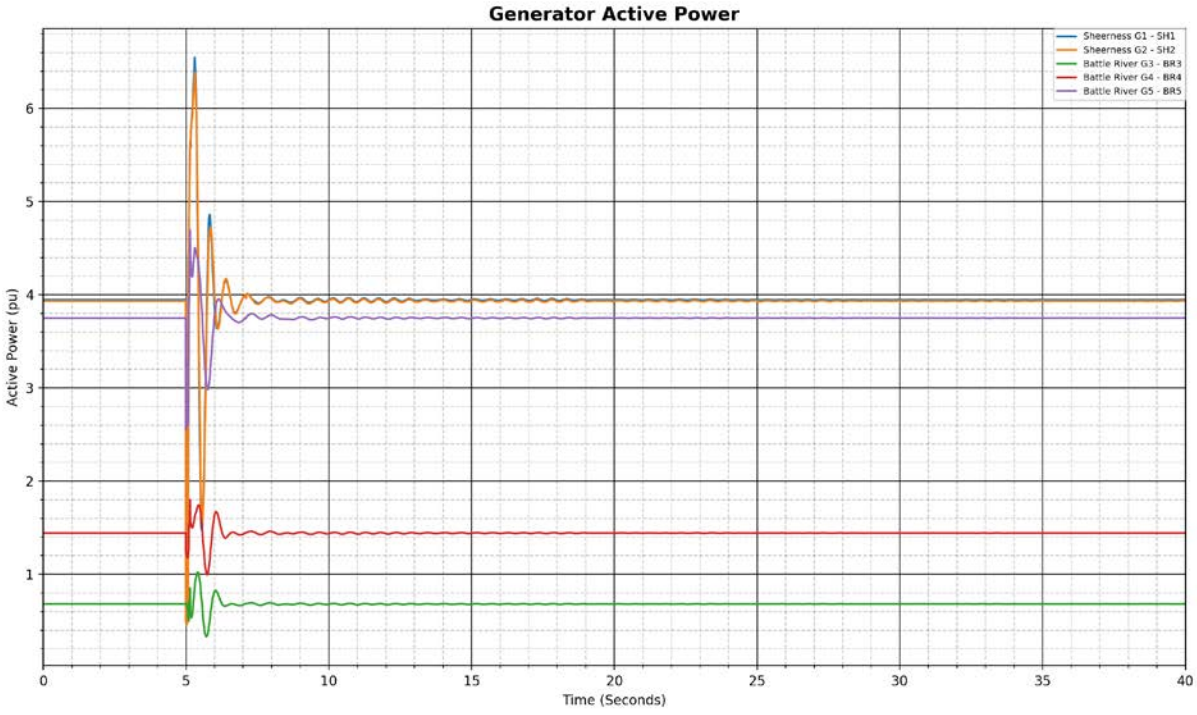

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Reactive Power (Mvar)
Time (Seconds)

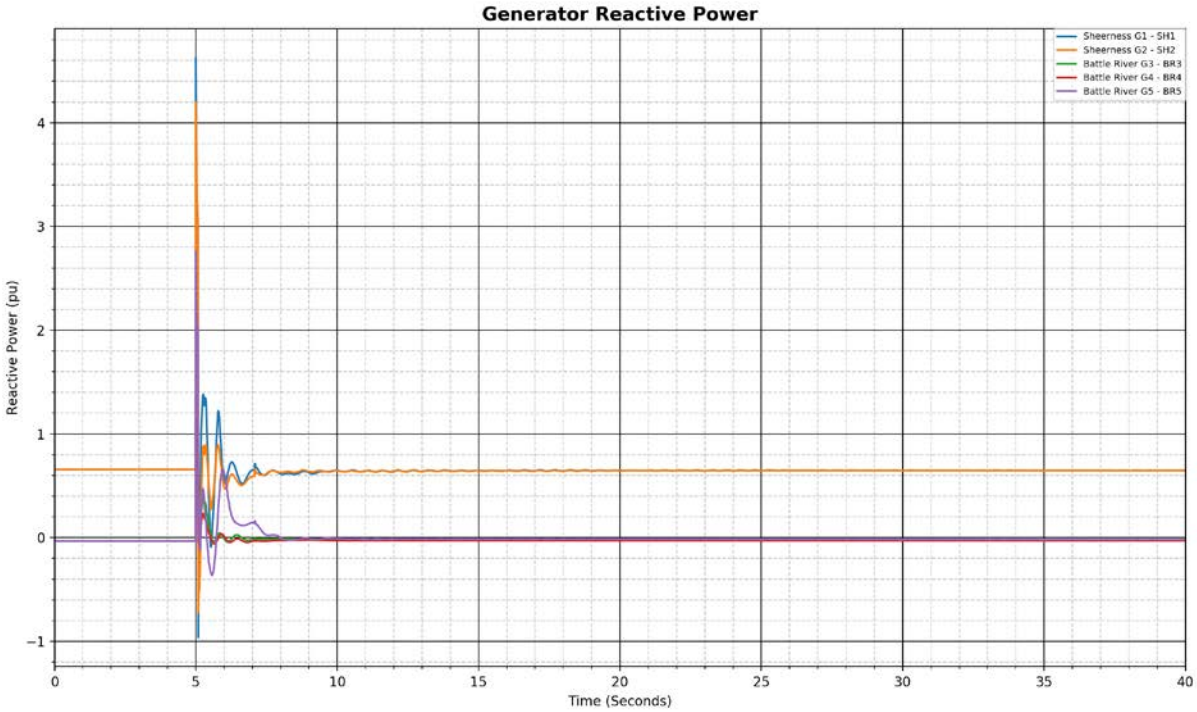
2. Stability Results 2019 Summer Peak

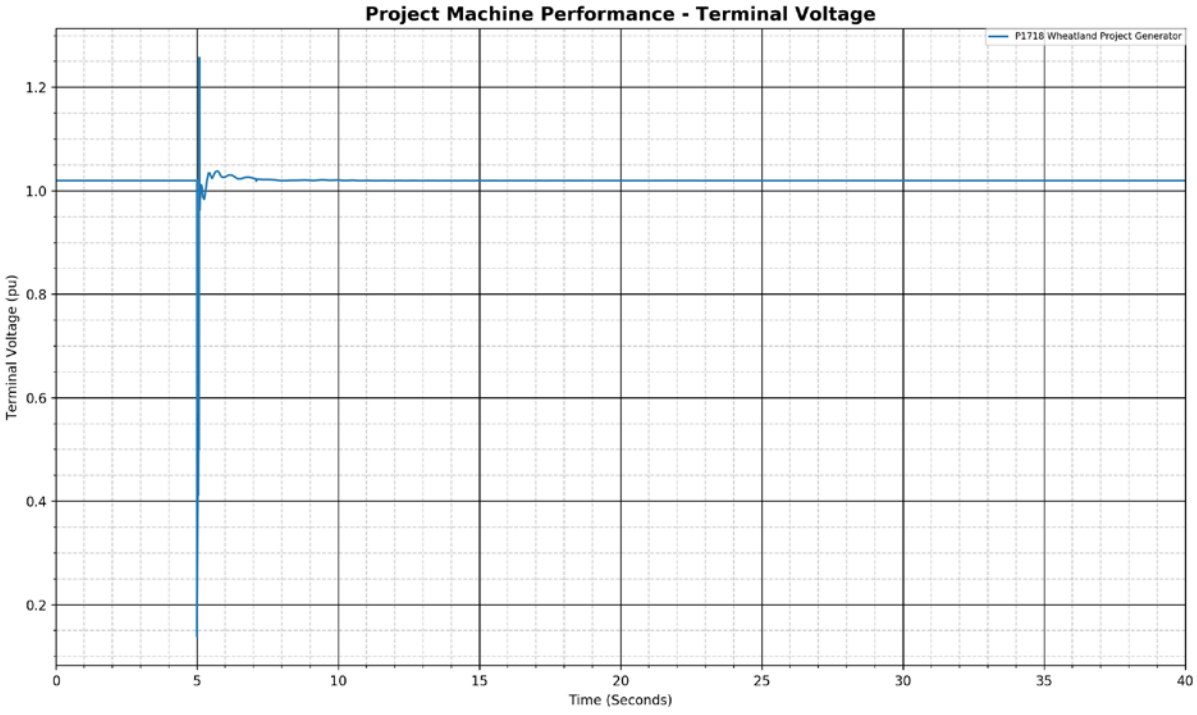
Figure A4-28: 9L24 (Oakland 946S - Lanfine 959S): 3-phase fault at Oakland 946S

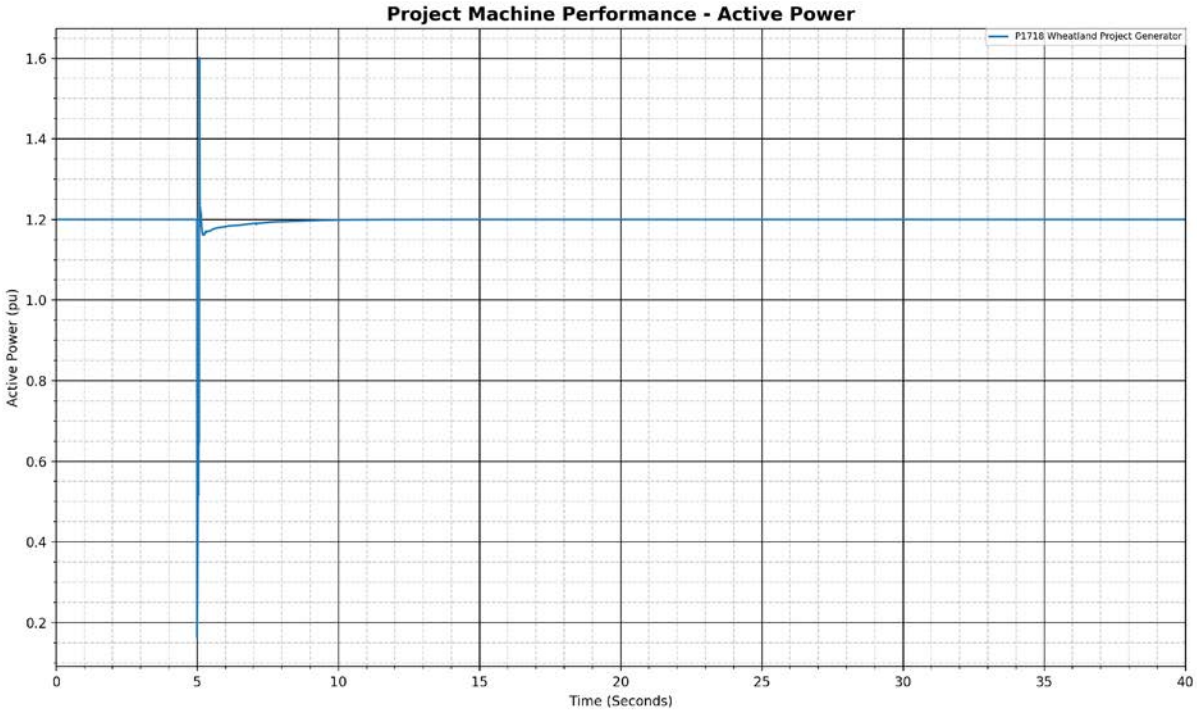


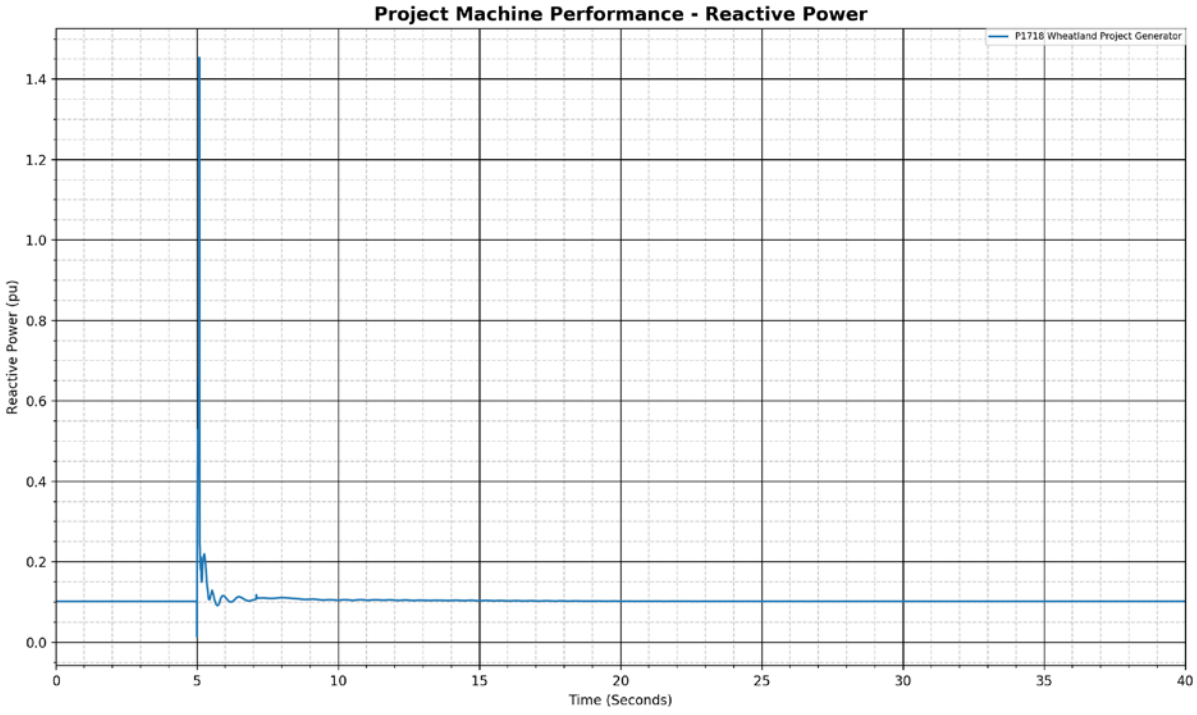

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

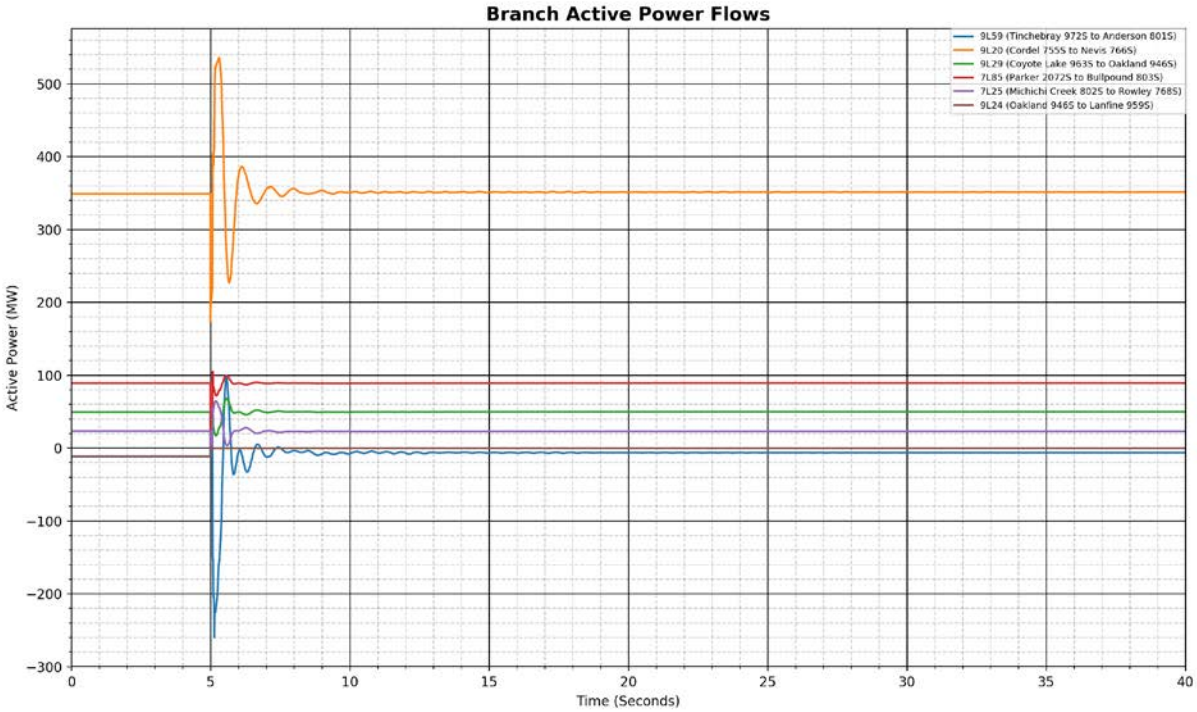

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Active Power (MW)
Time (Seconds)

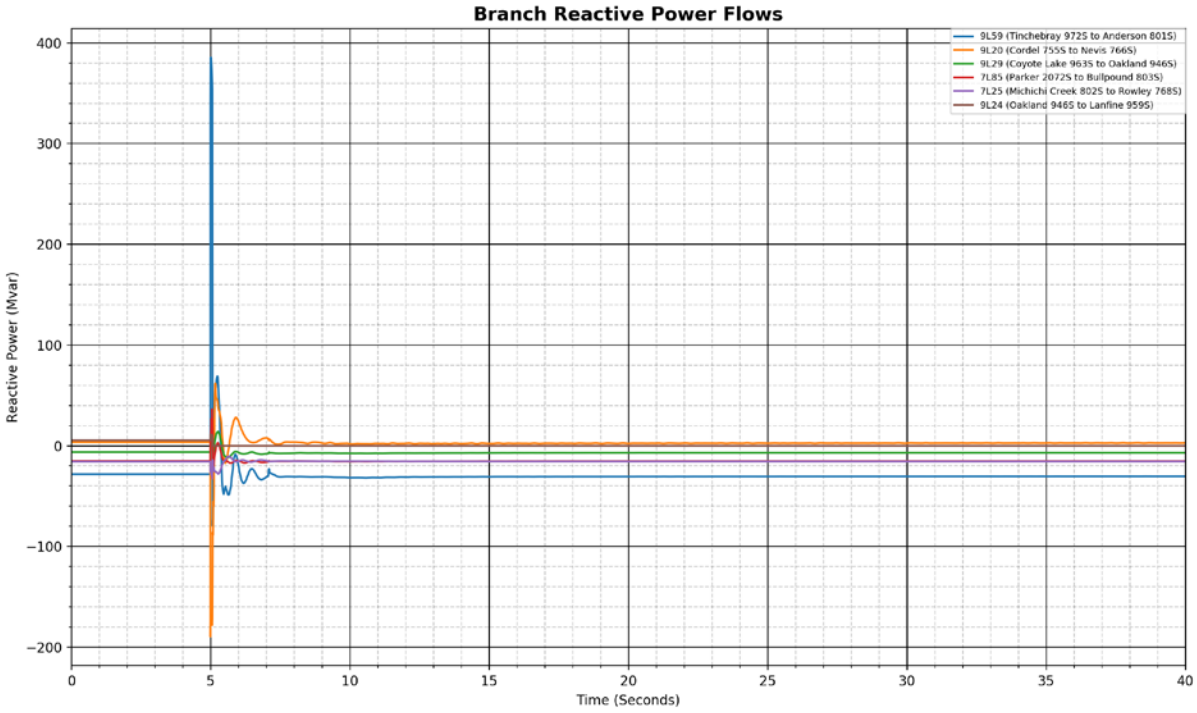
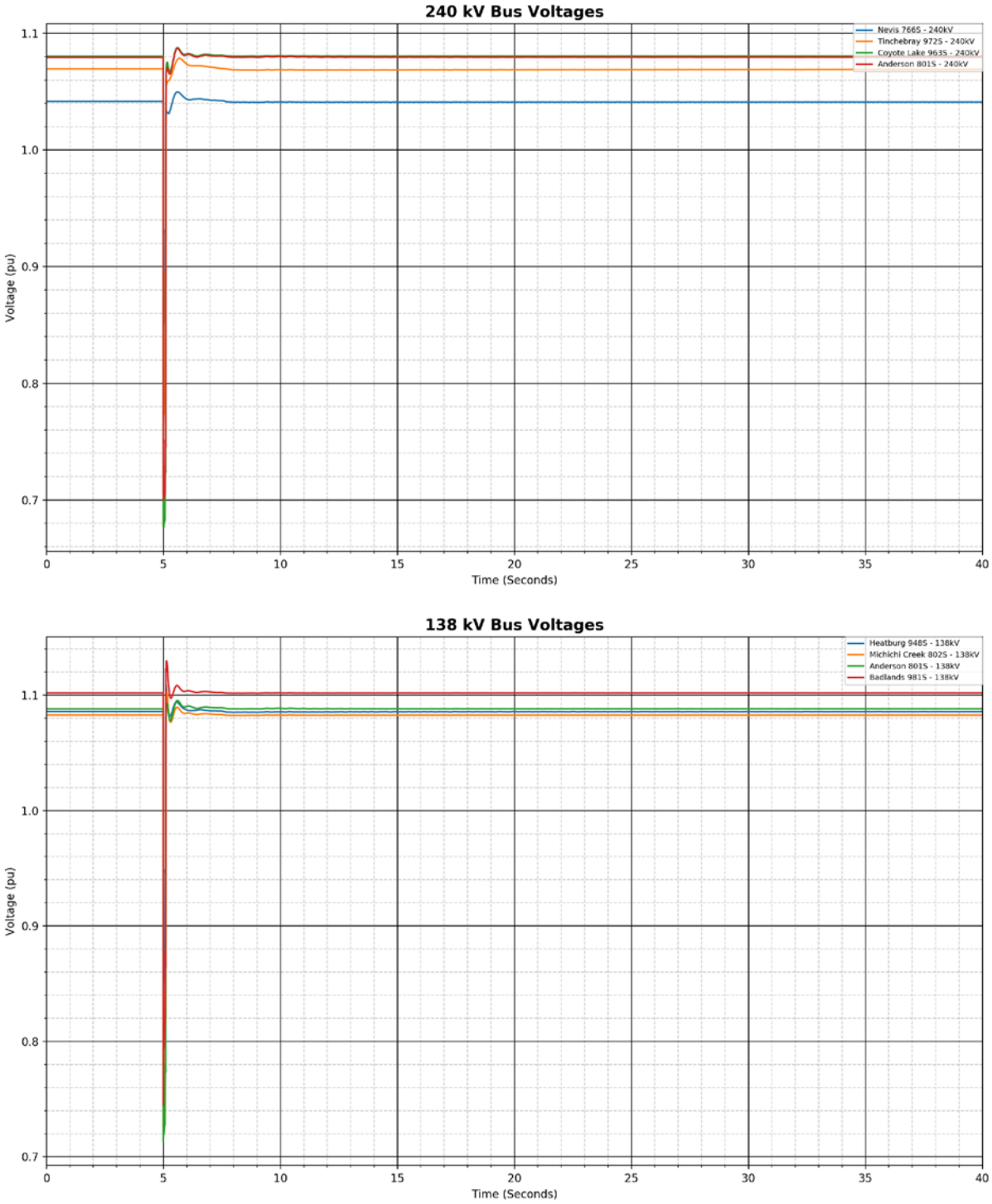
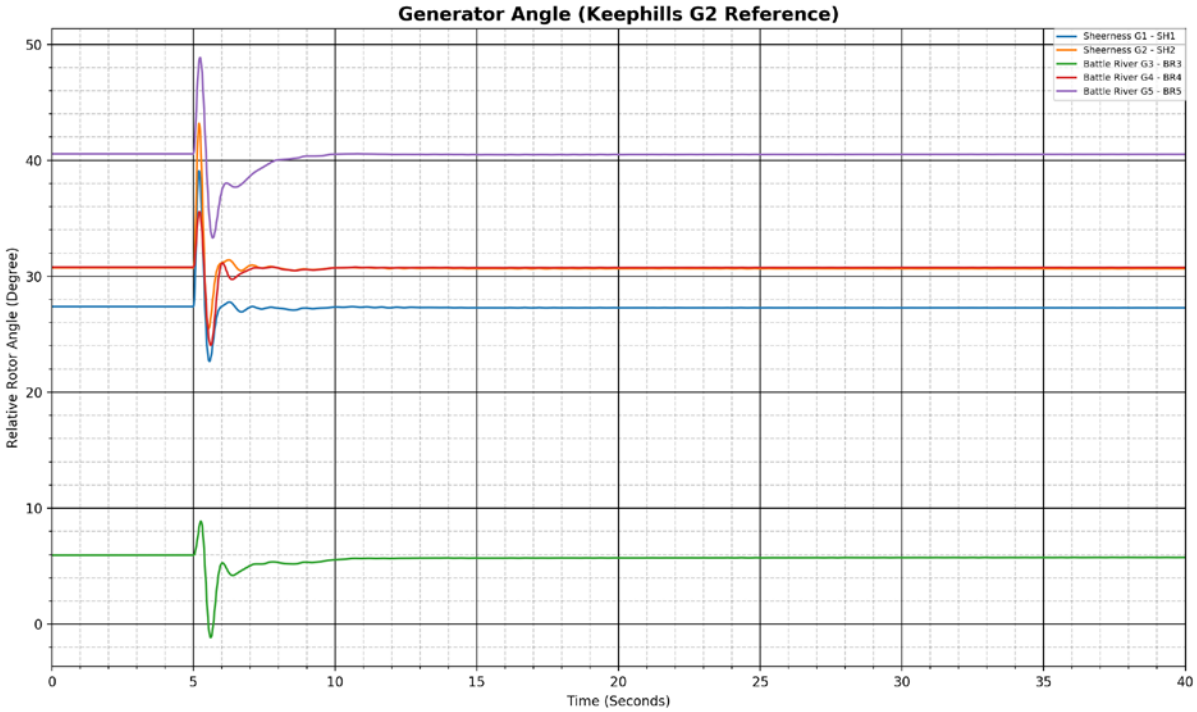
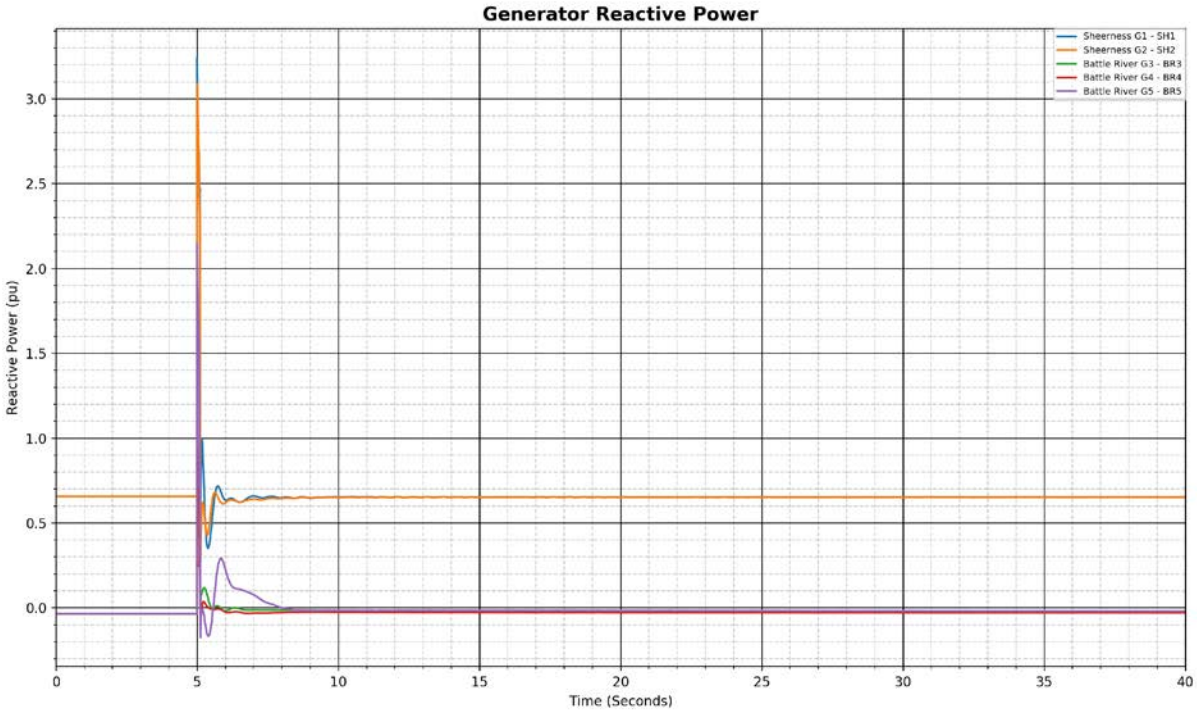

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Reactive Power (Mvar)
Time (Seconds)

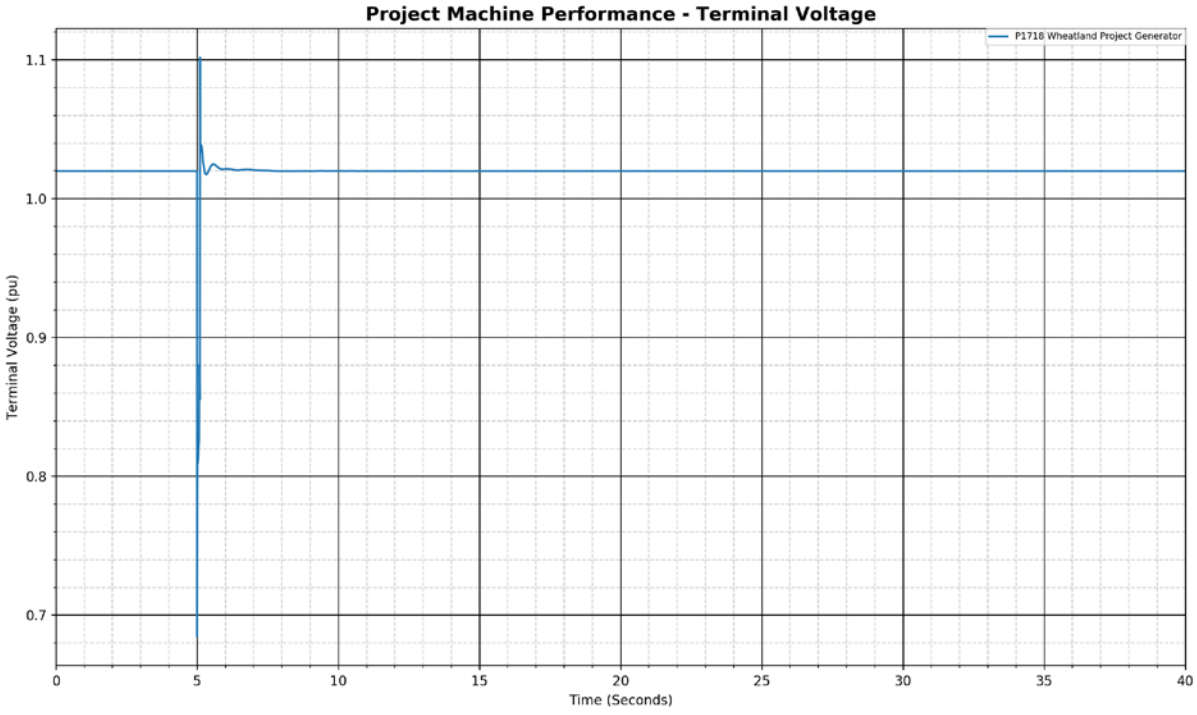
Figure A4-29: 9L24 (Oakland 946S - Lanfine 959S): 3-phase fault at Lanfine 959S

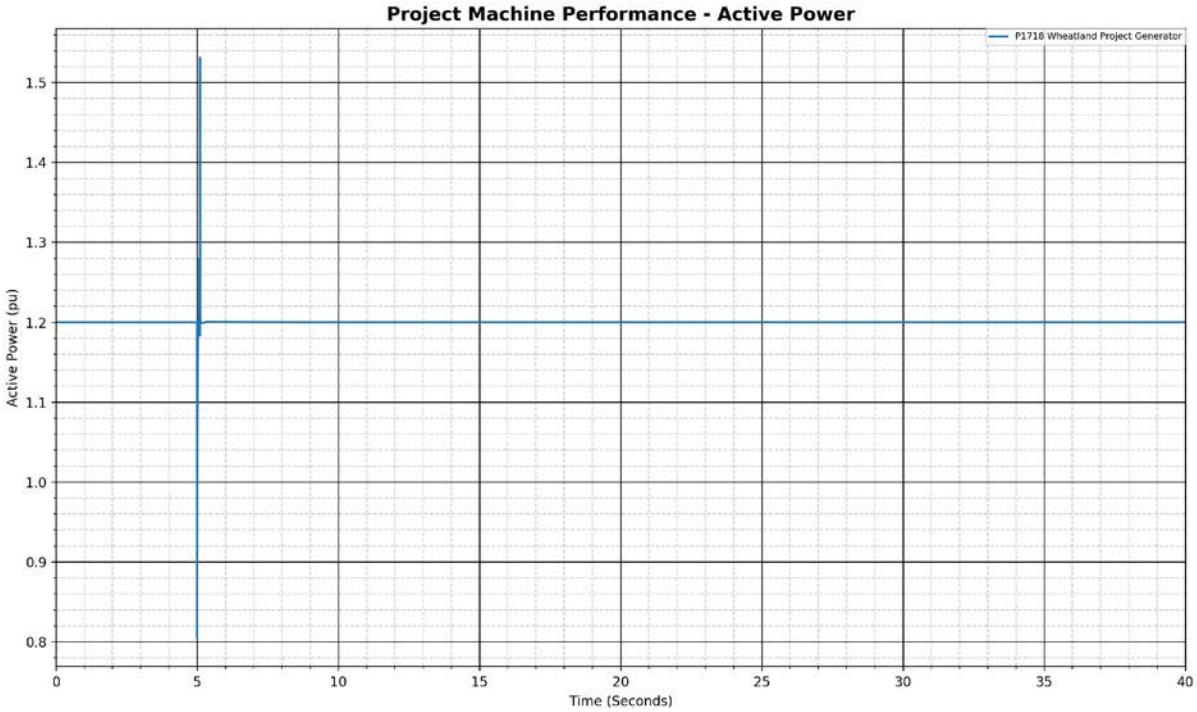


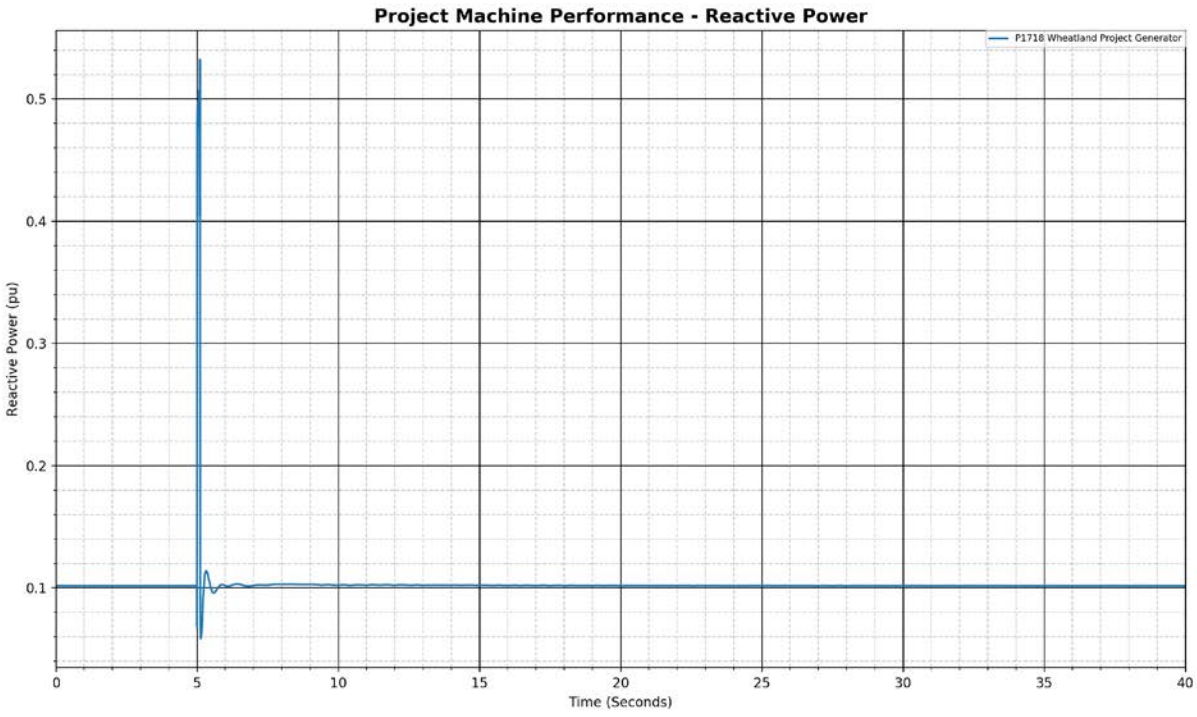

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

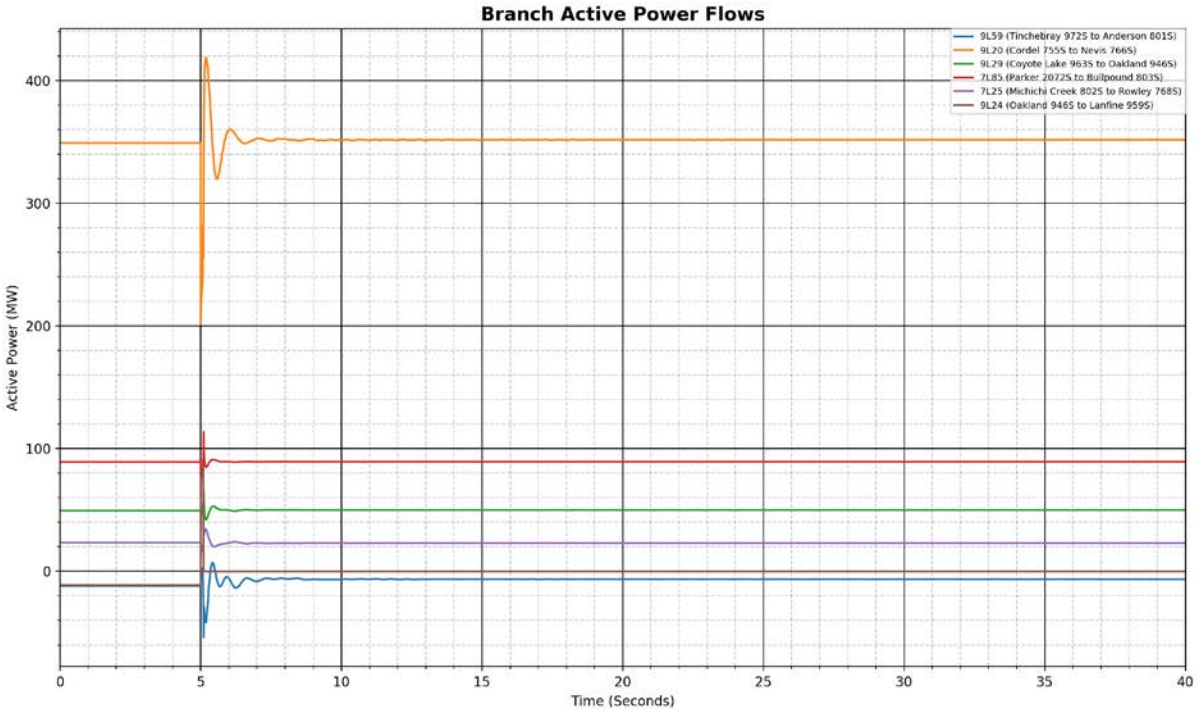
Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Active Power (MW)
Time (Seconds)

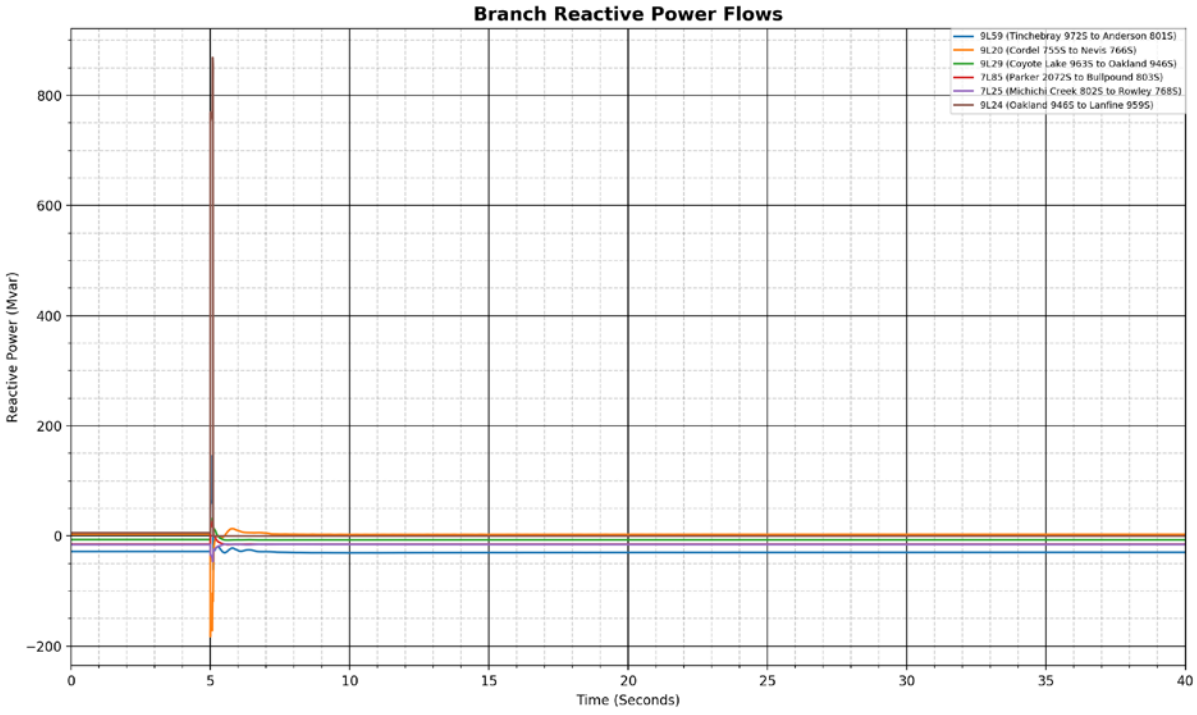
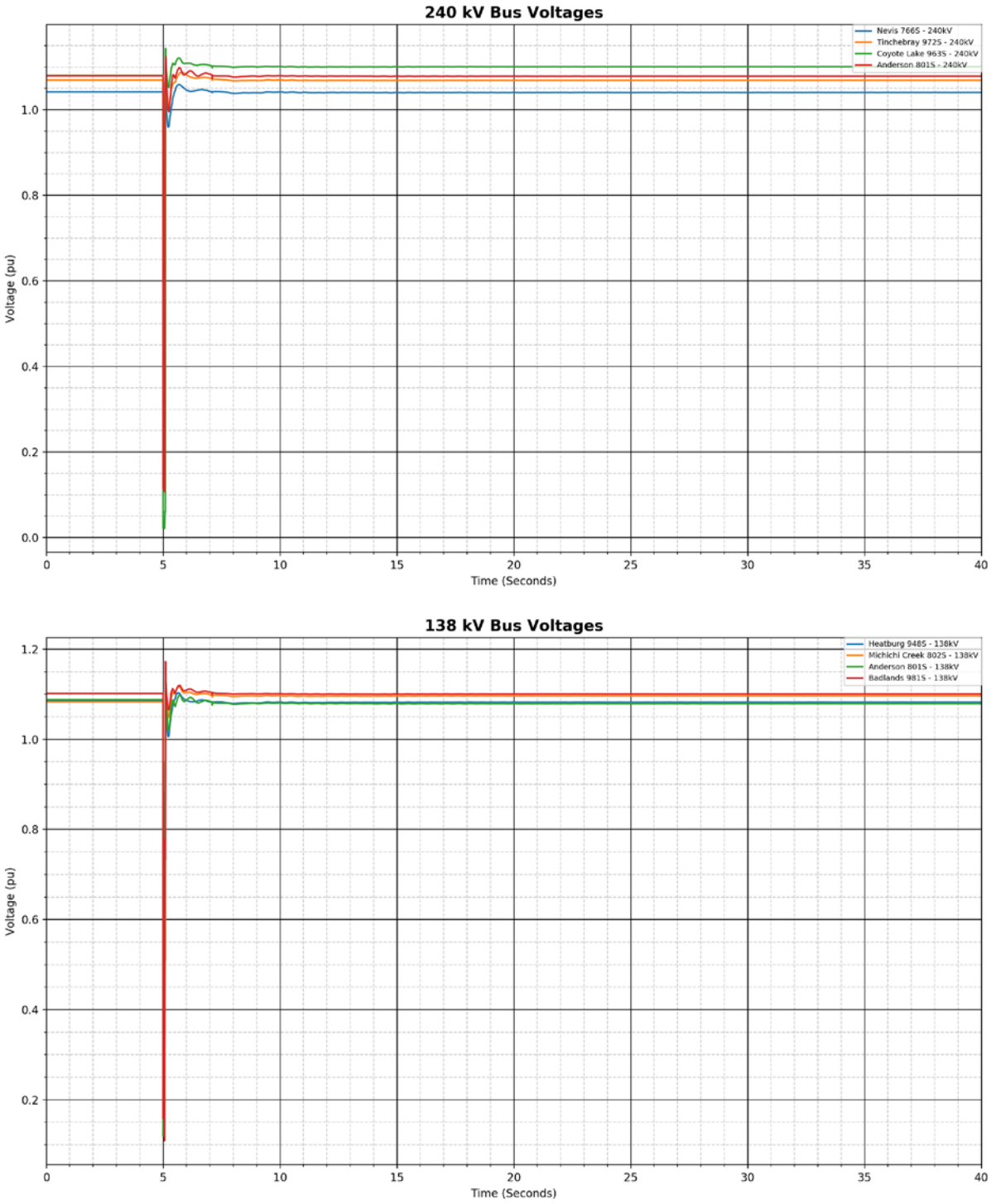
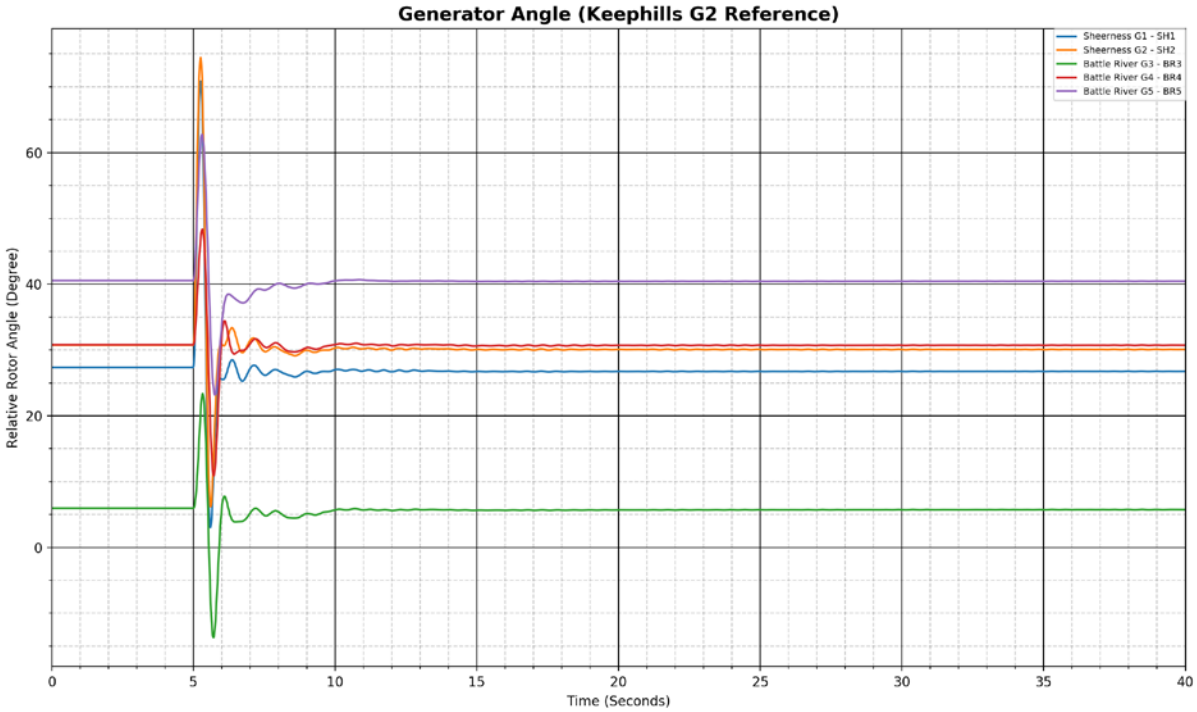
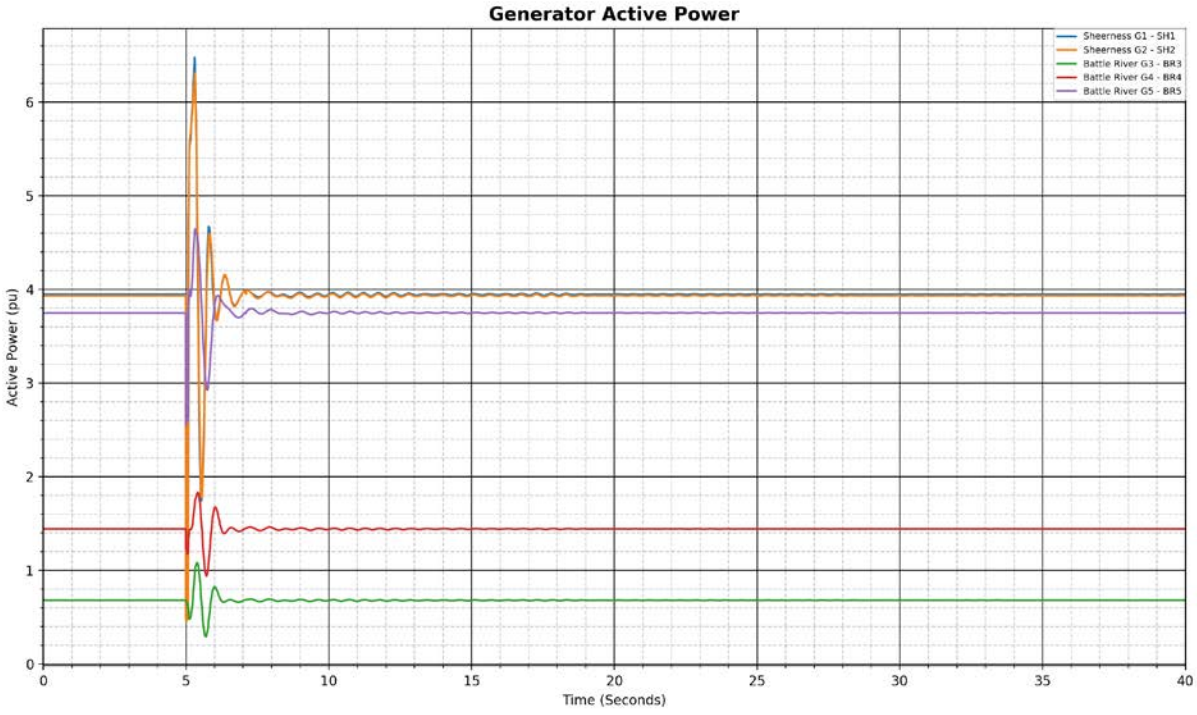
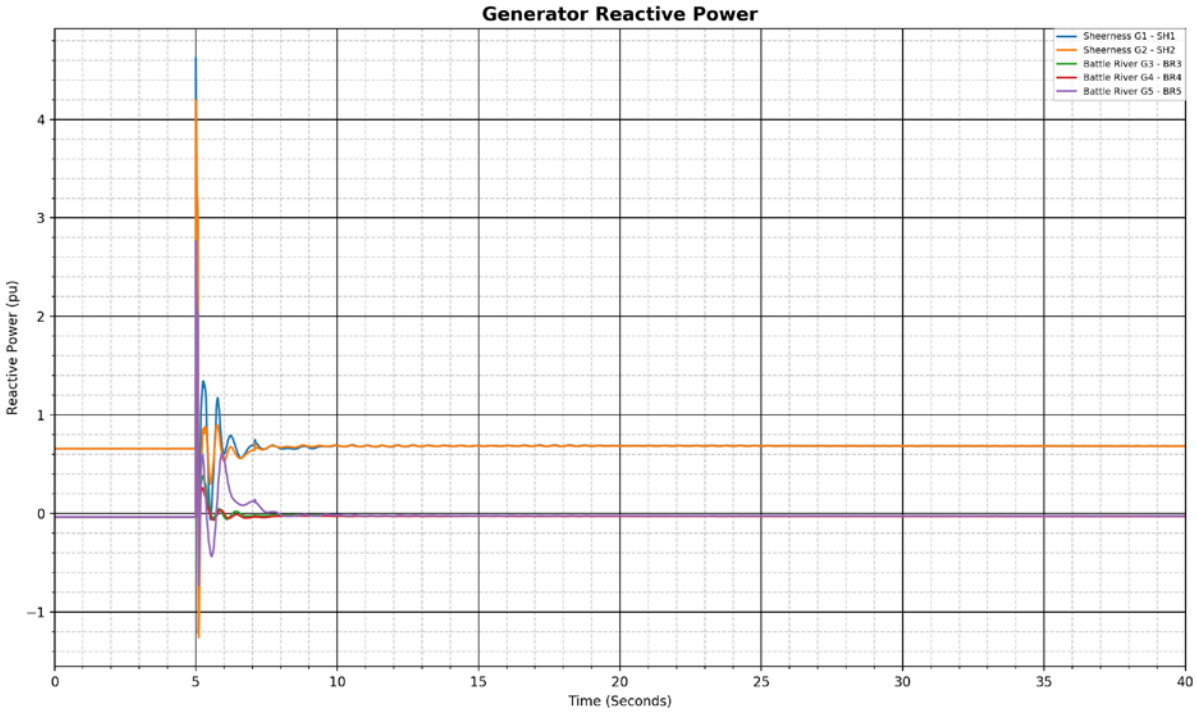

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Reactive Power (Mvar)
Time (Seconds)

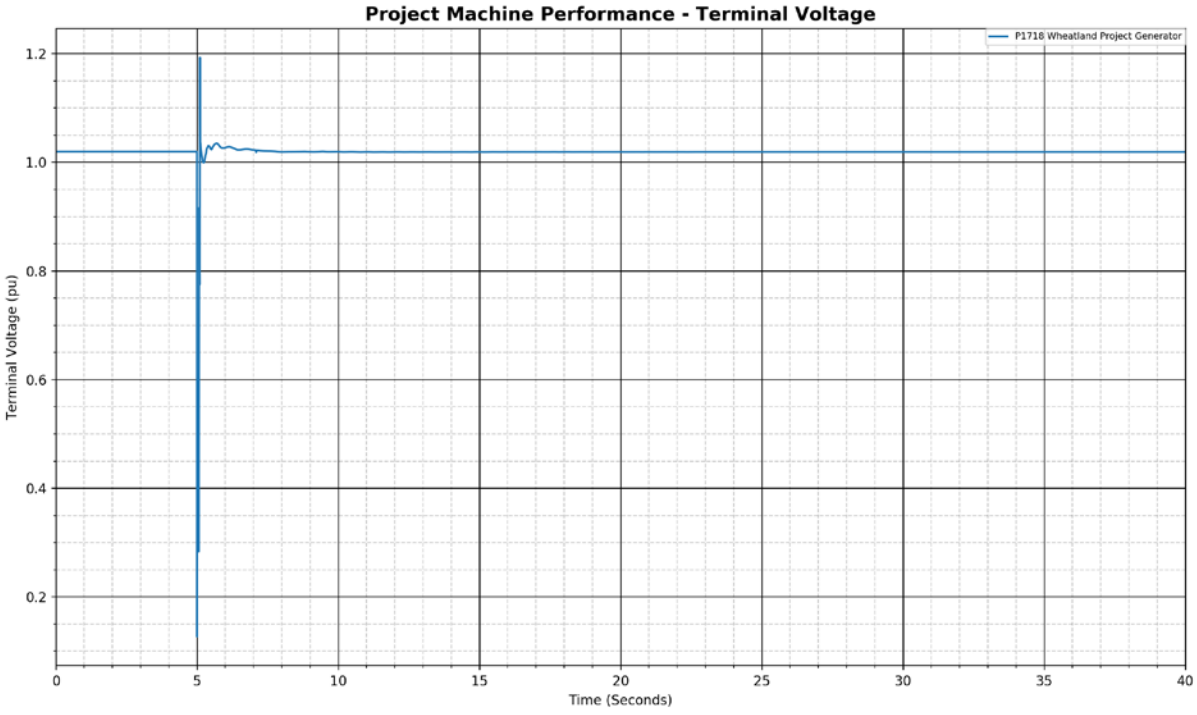
Figure A4-30: 9L29 (Oakland 946S - Coyote Lake 963S): 3-phase fault at Oakland 946S

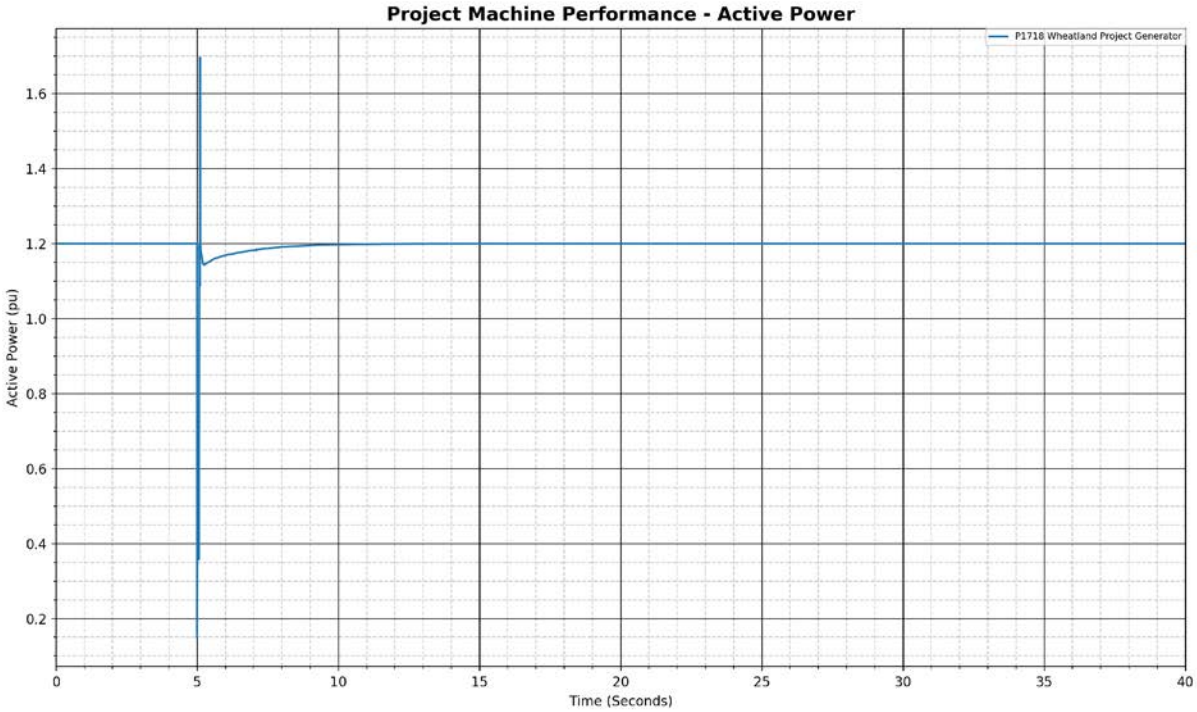


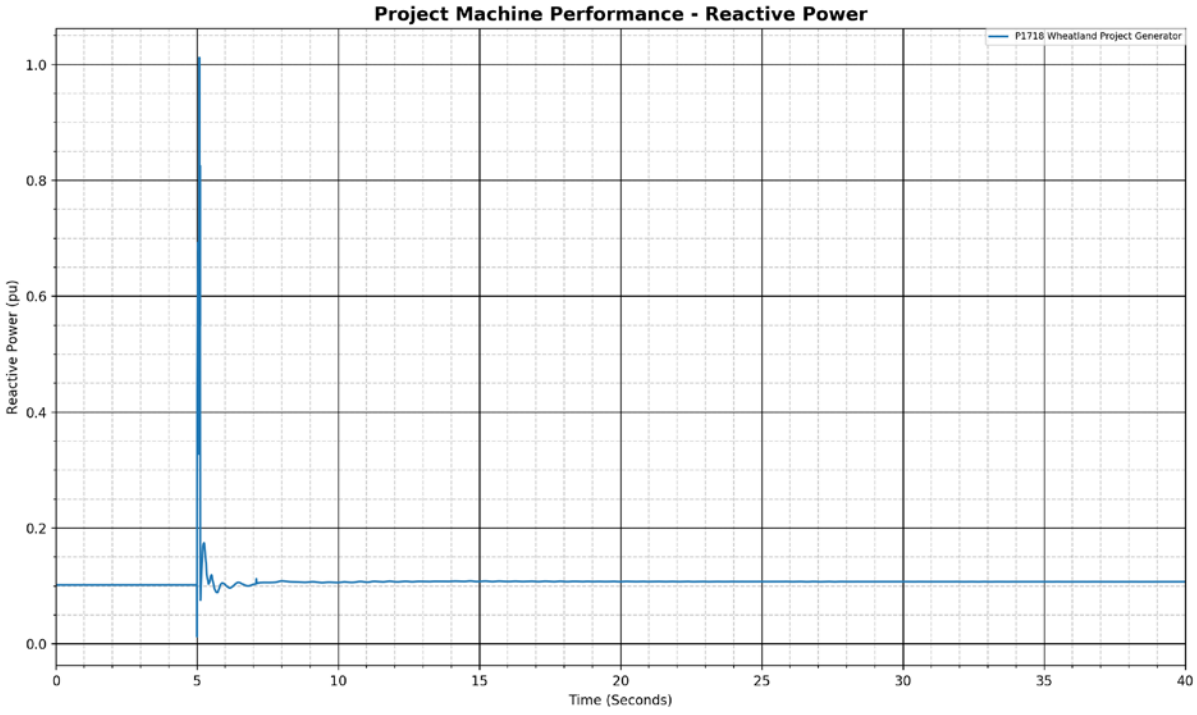

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

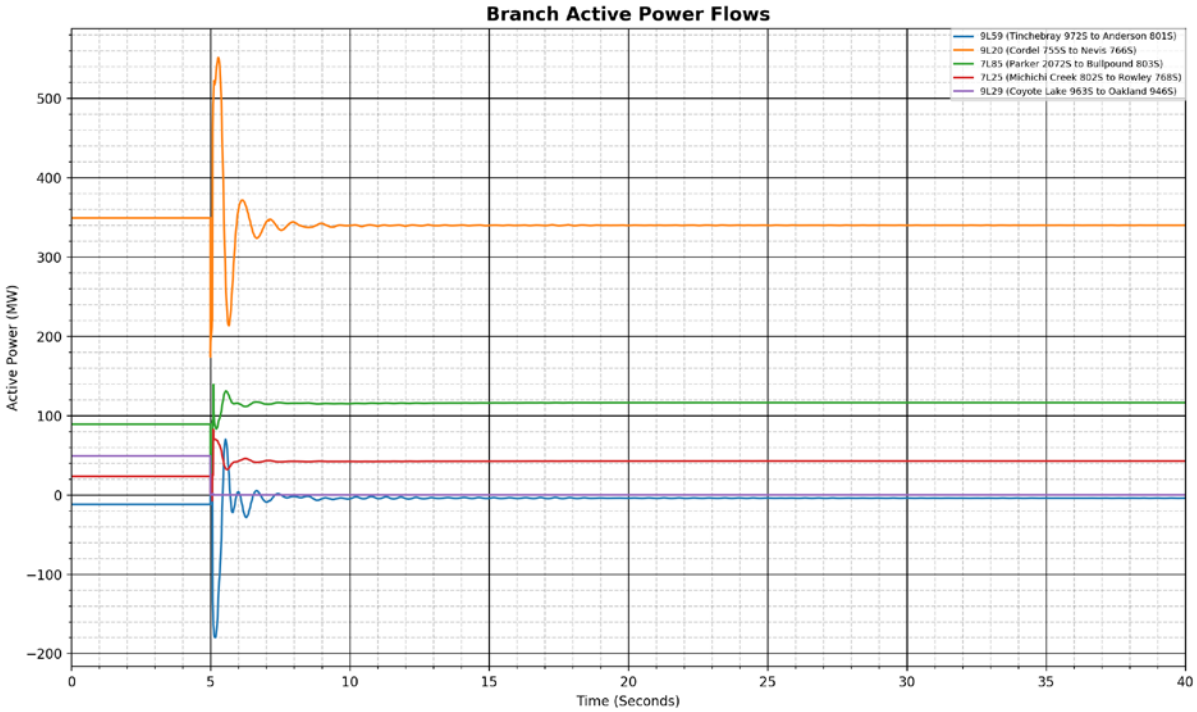

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

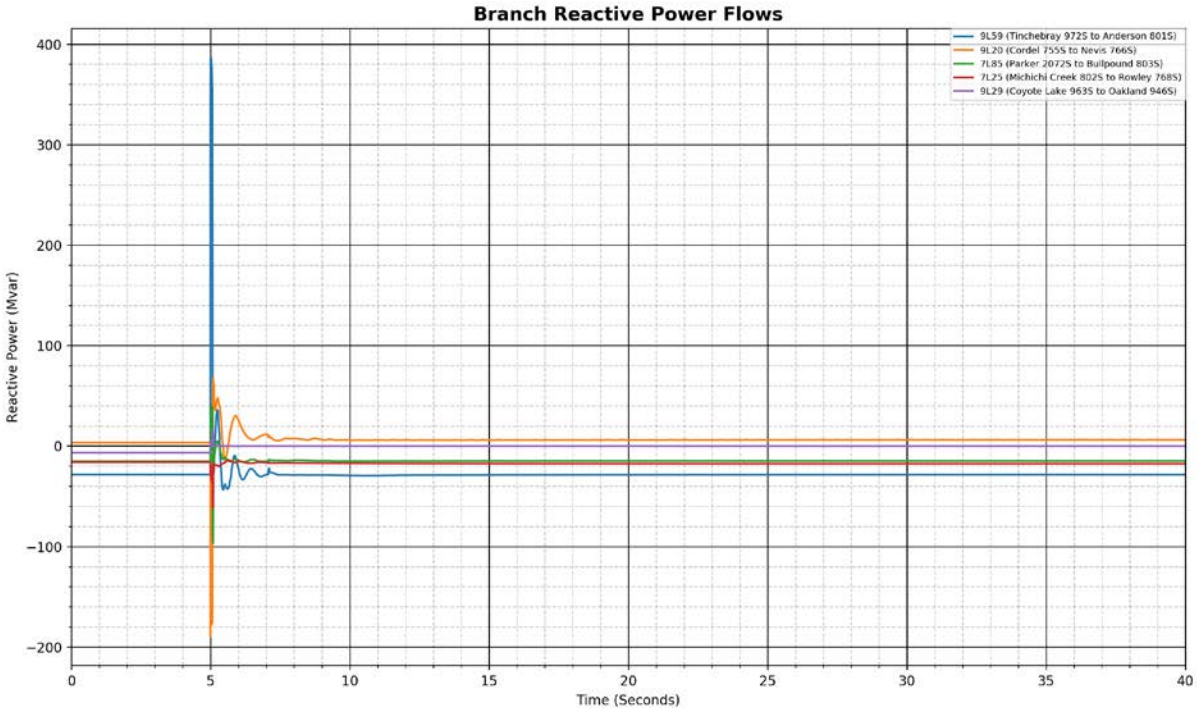
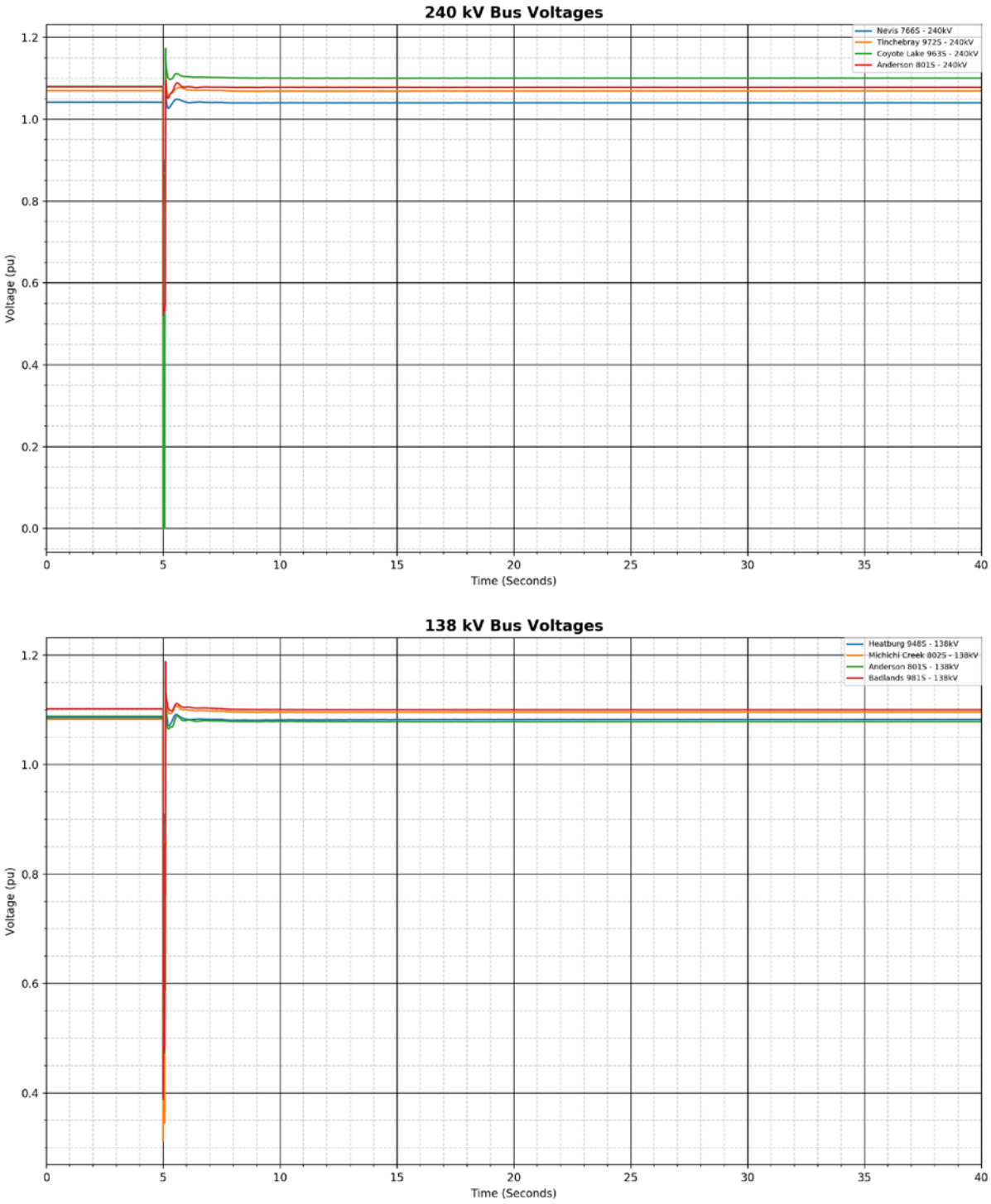
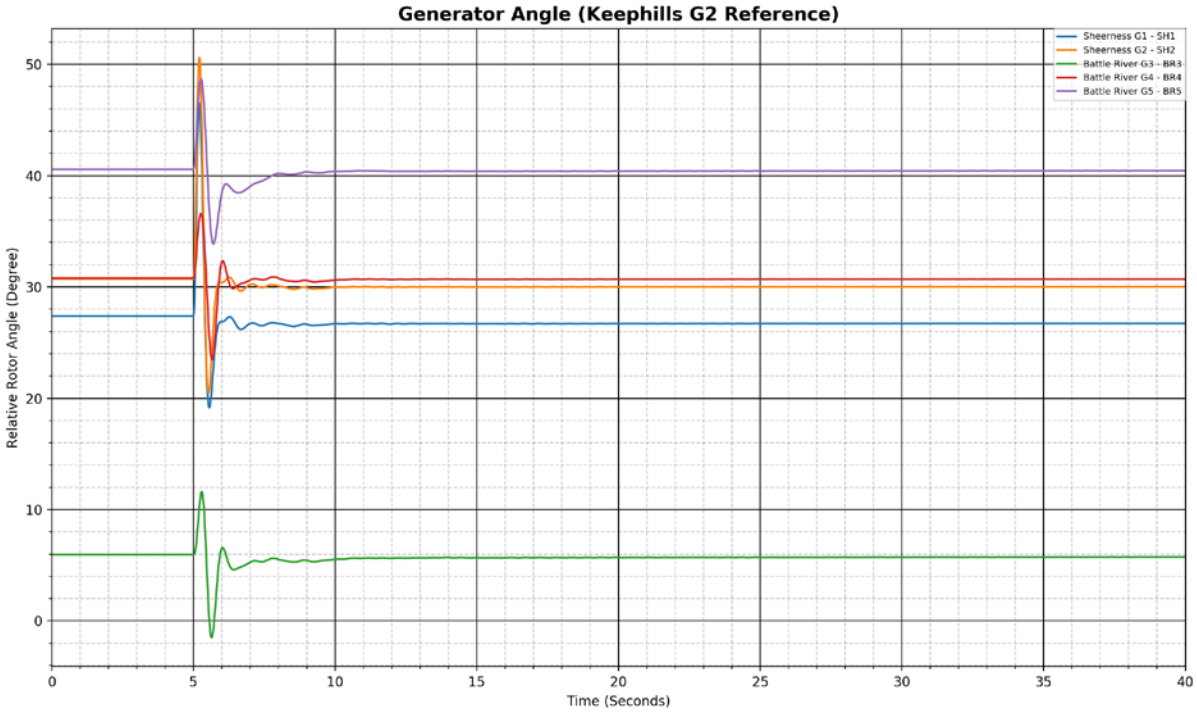
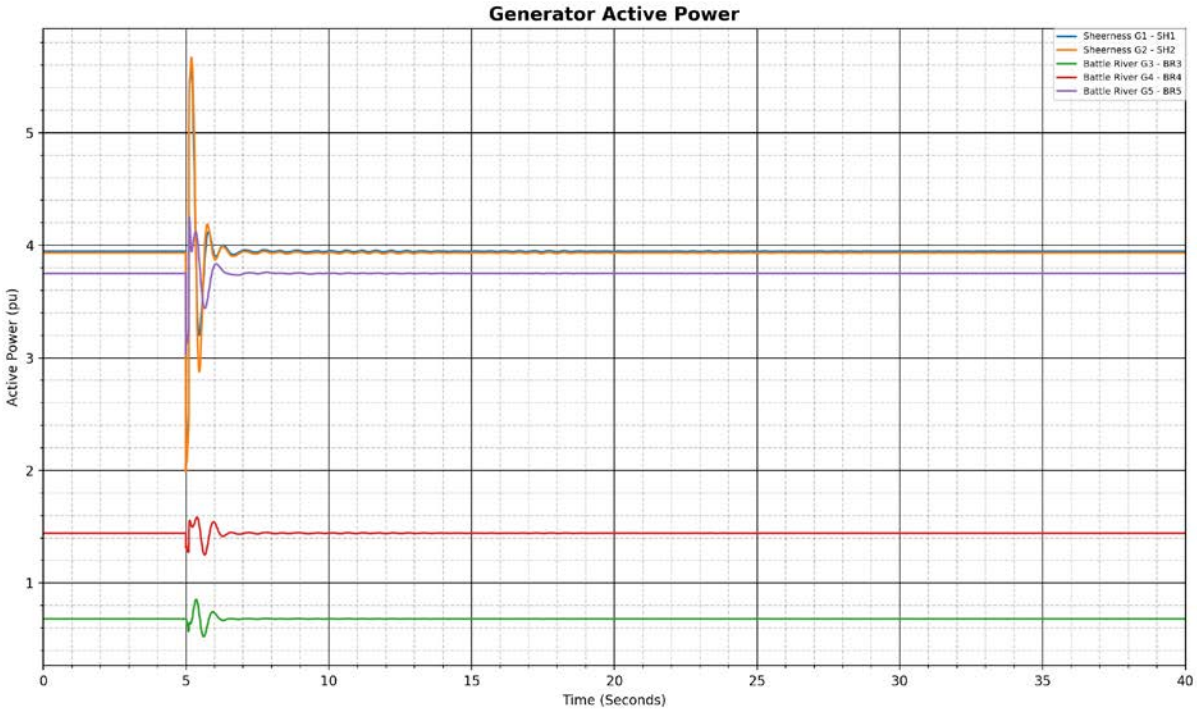
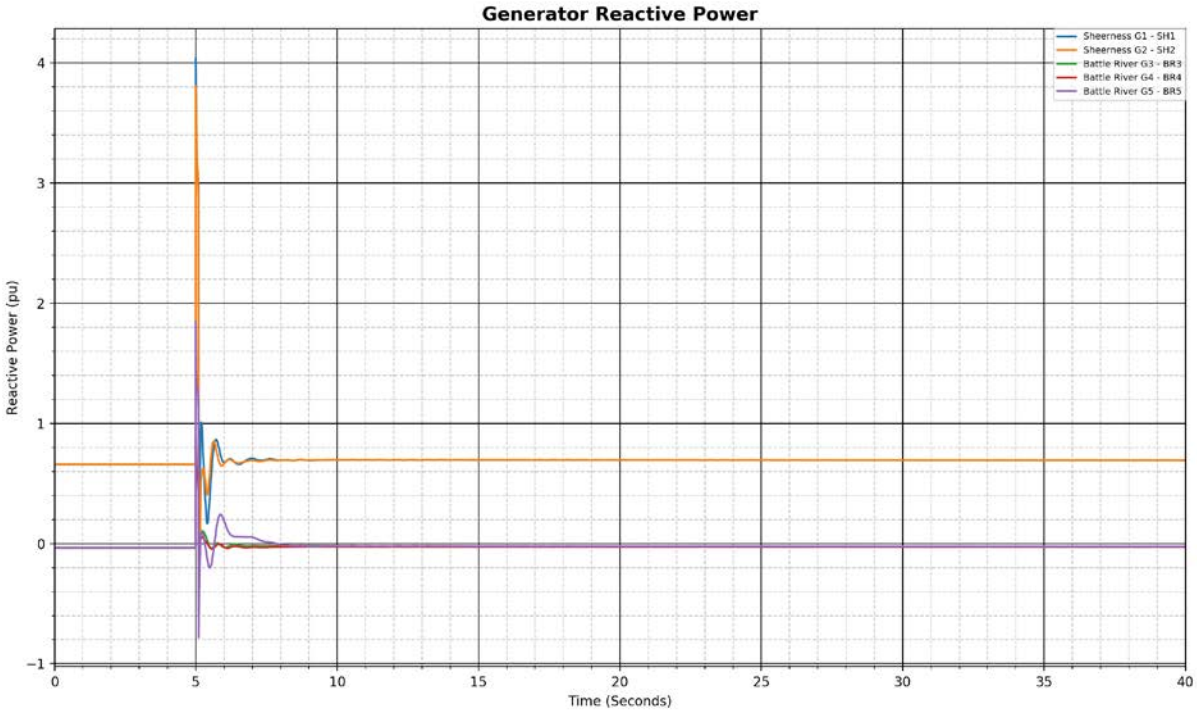

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

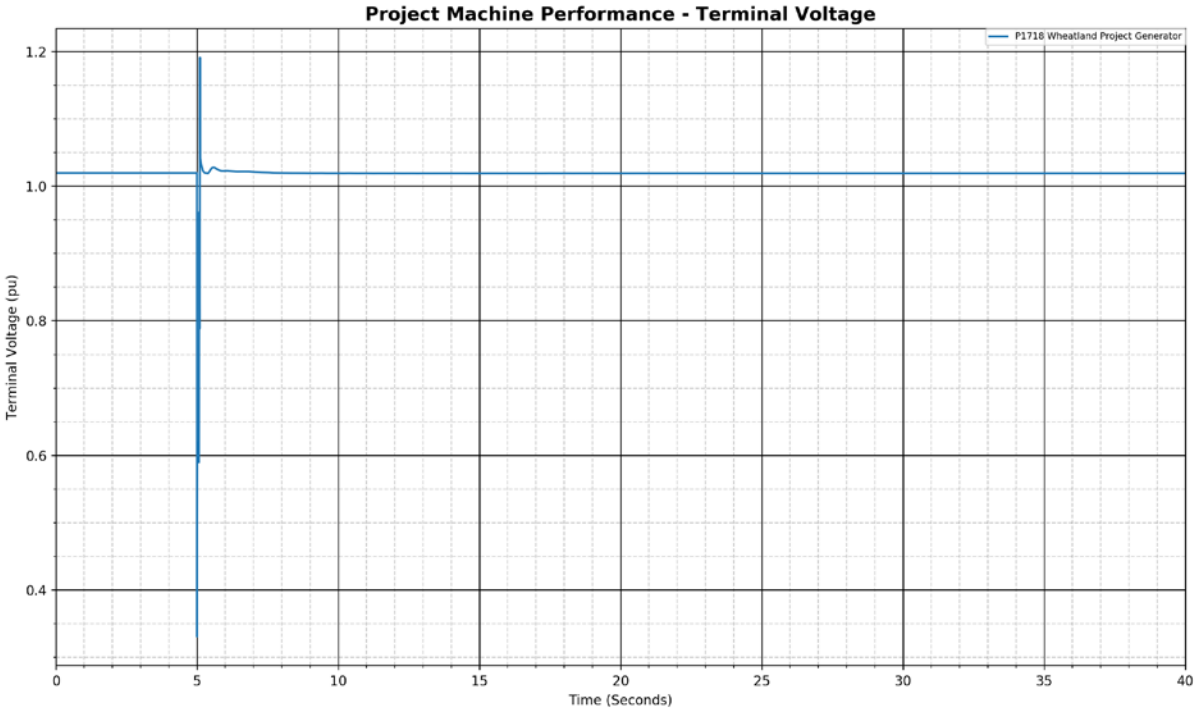
Figure A4-31: 9L29 (Oakland 946S - Coyote Lake 963S): 3-phase fault at Coyote Lake 963S

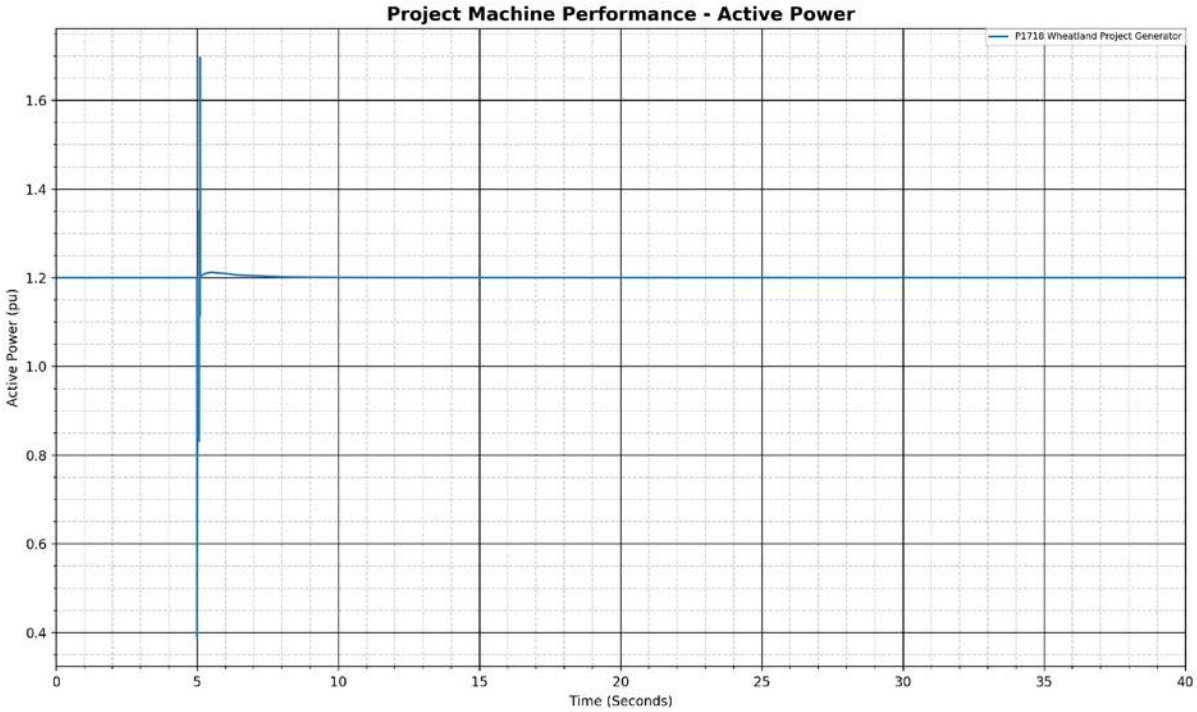


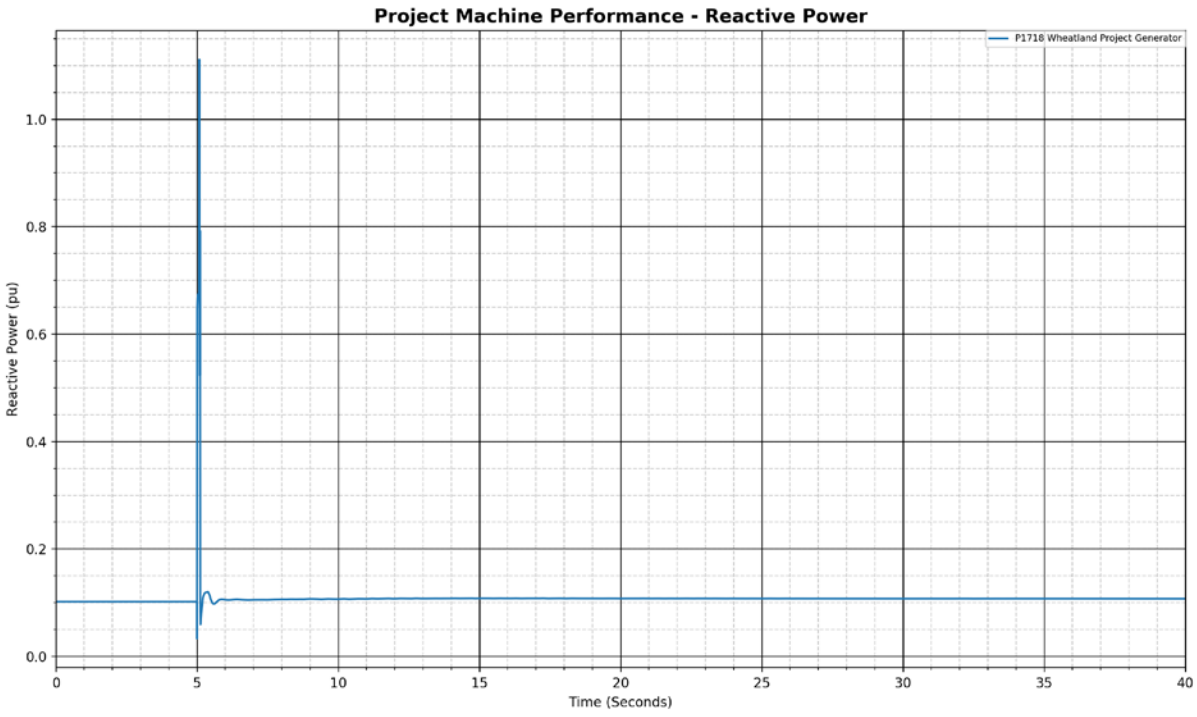

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

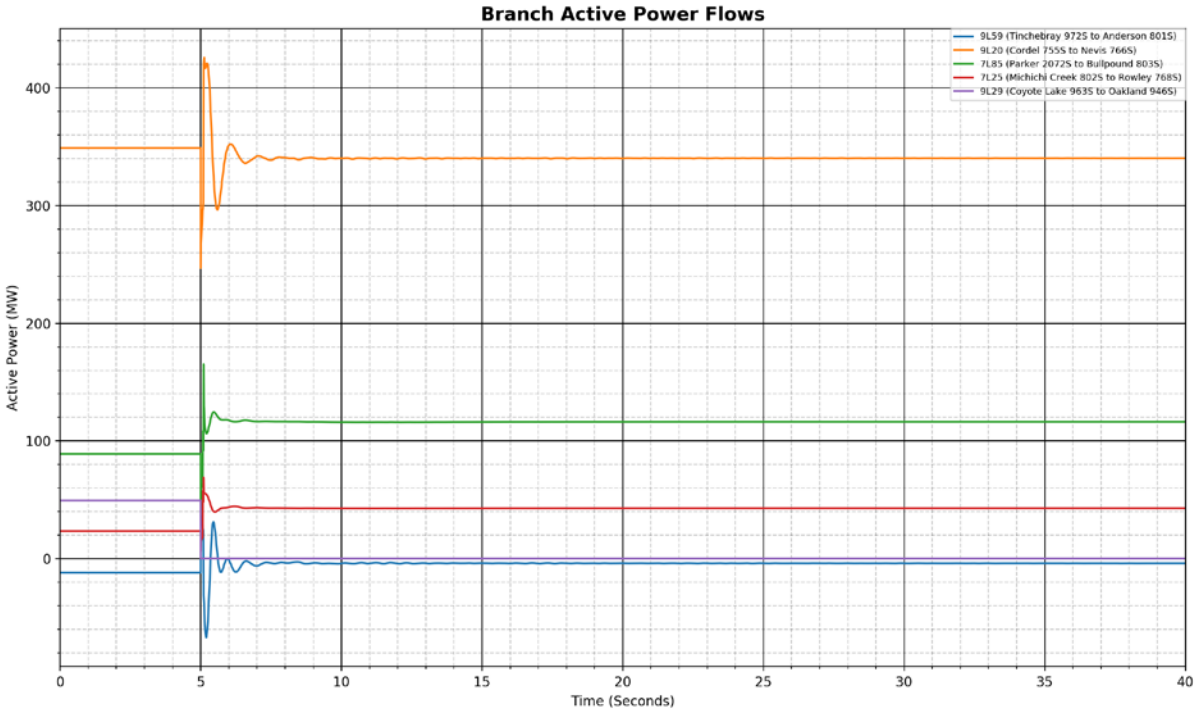

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

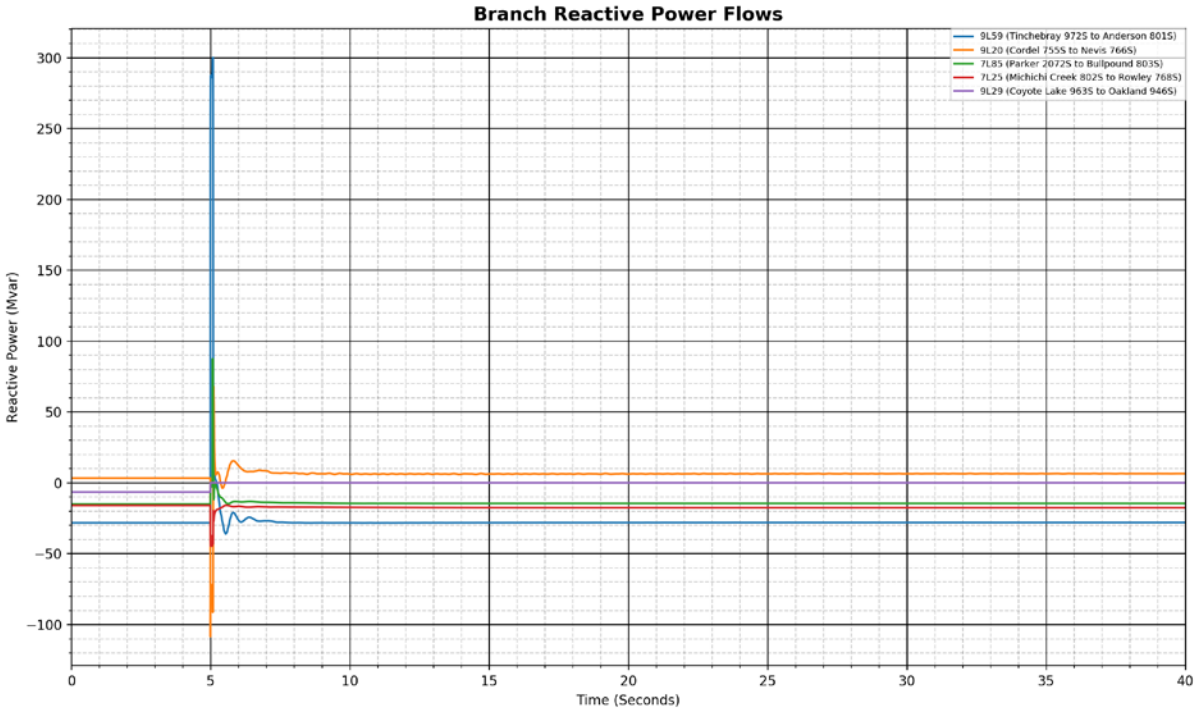
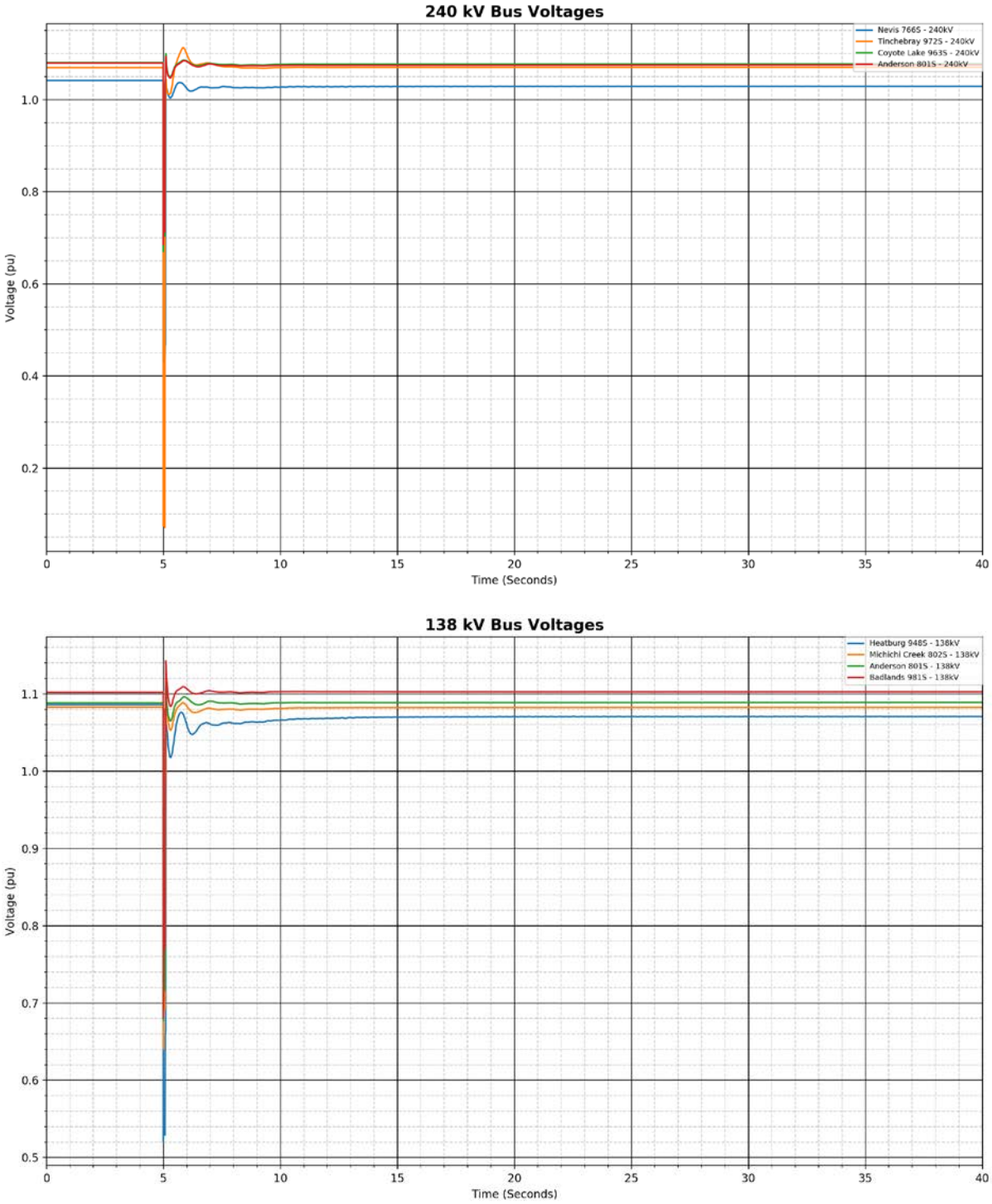
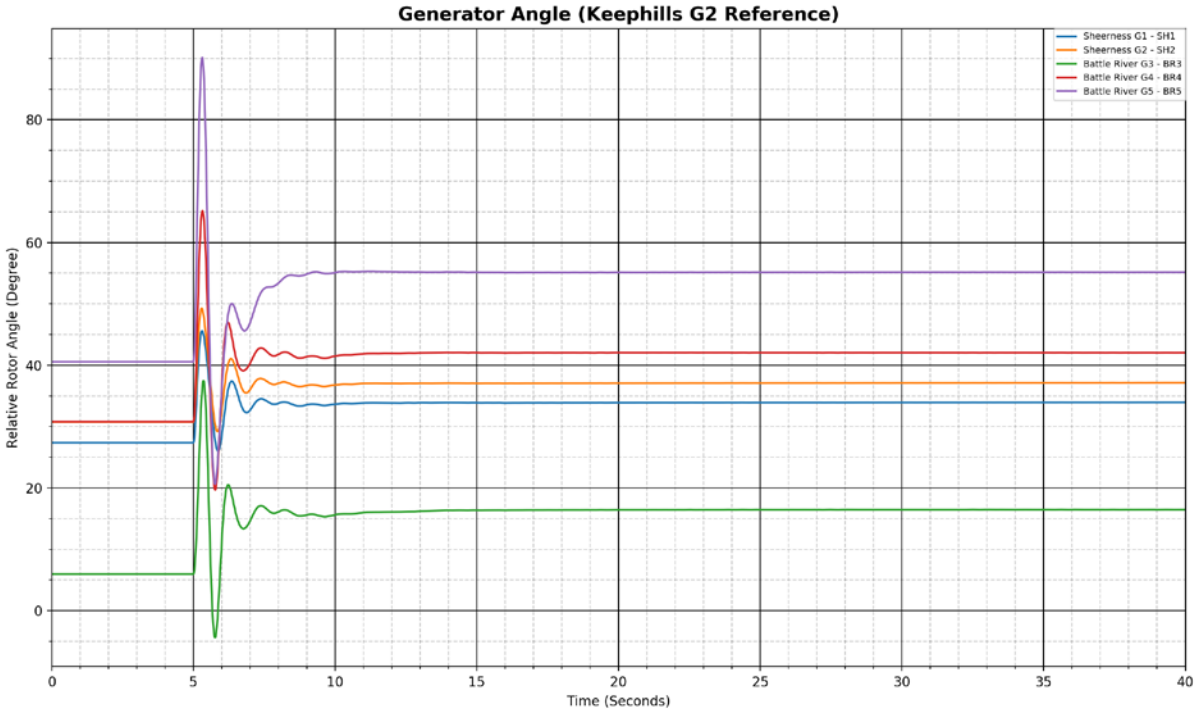
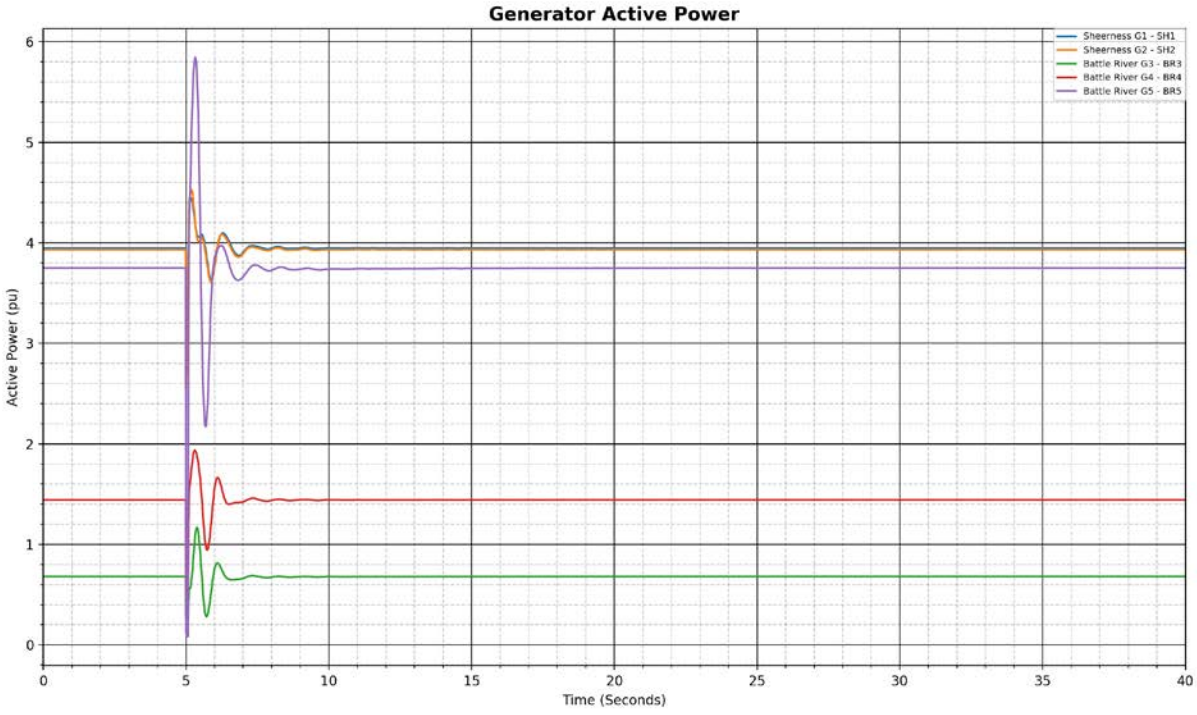
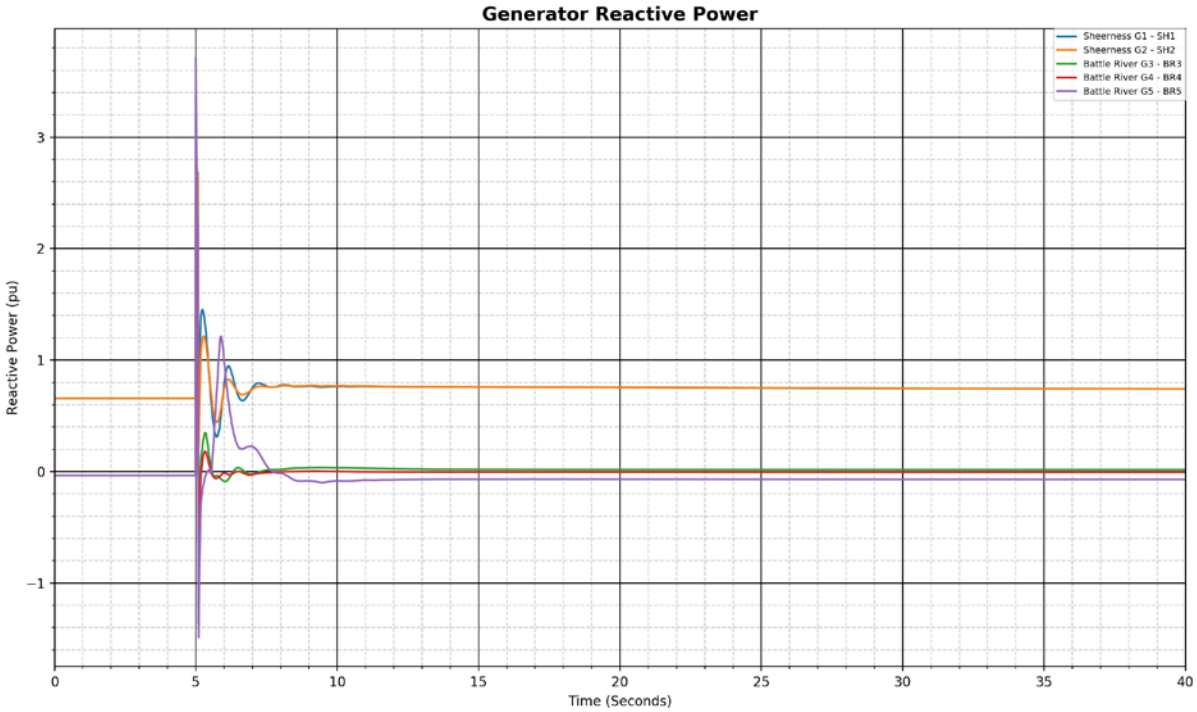

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

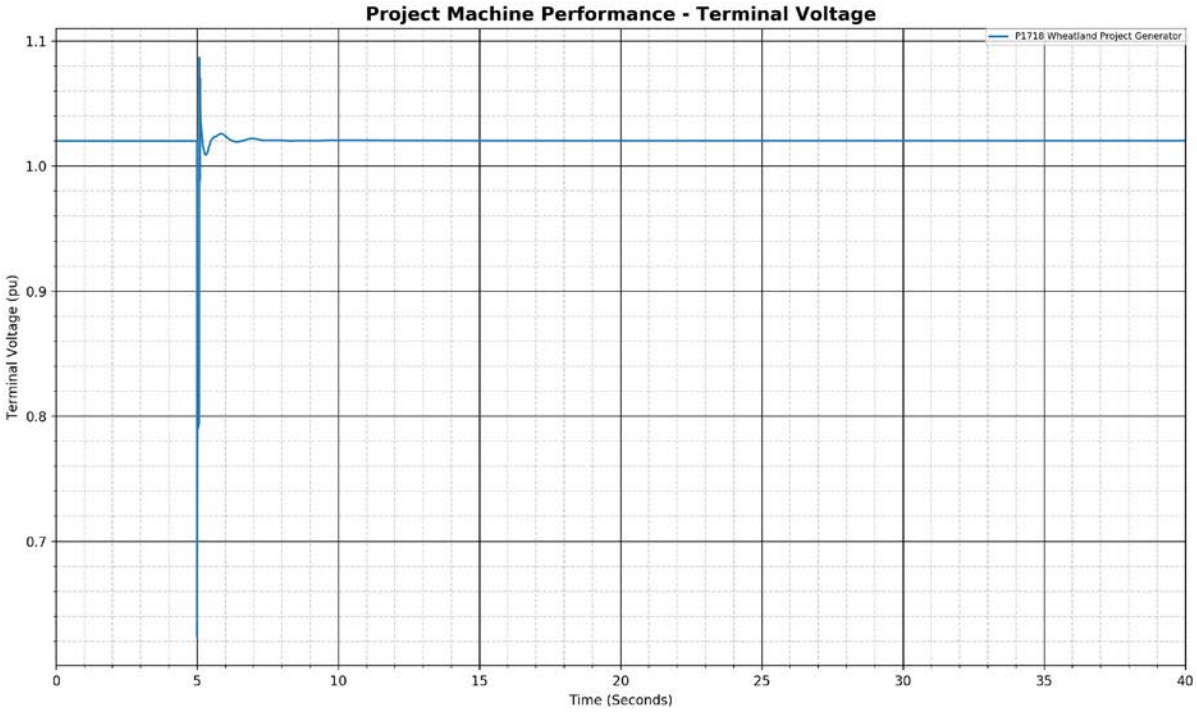
Figure A4-32: 9L20 (Cordel 755S - Nevis 766S): 3-phase fault at Cordel 755S

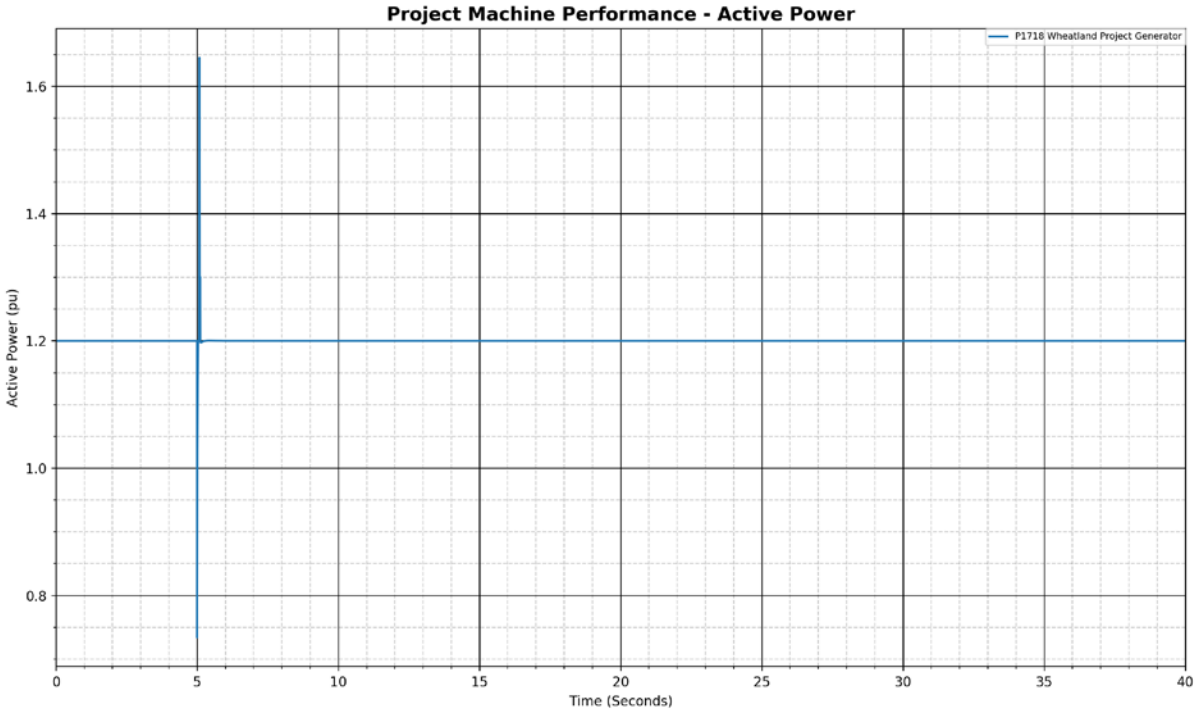


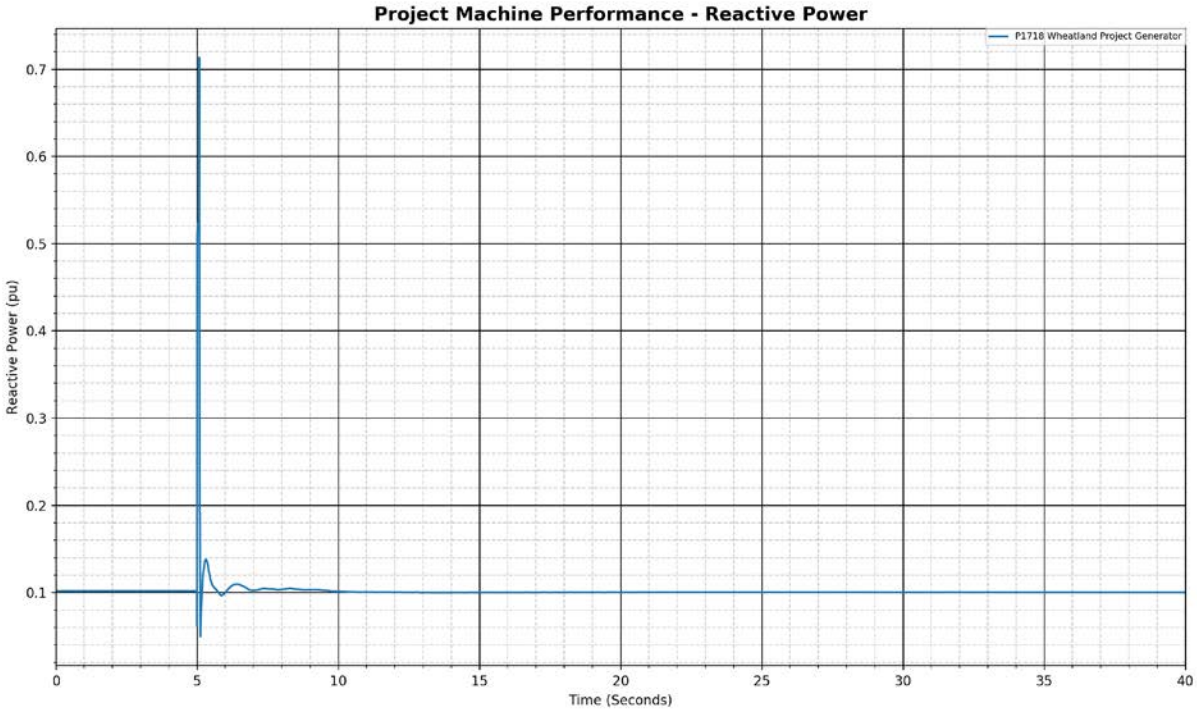

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

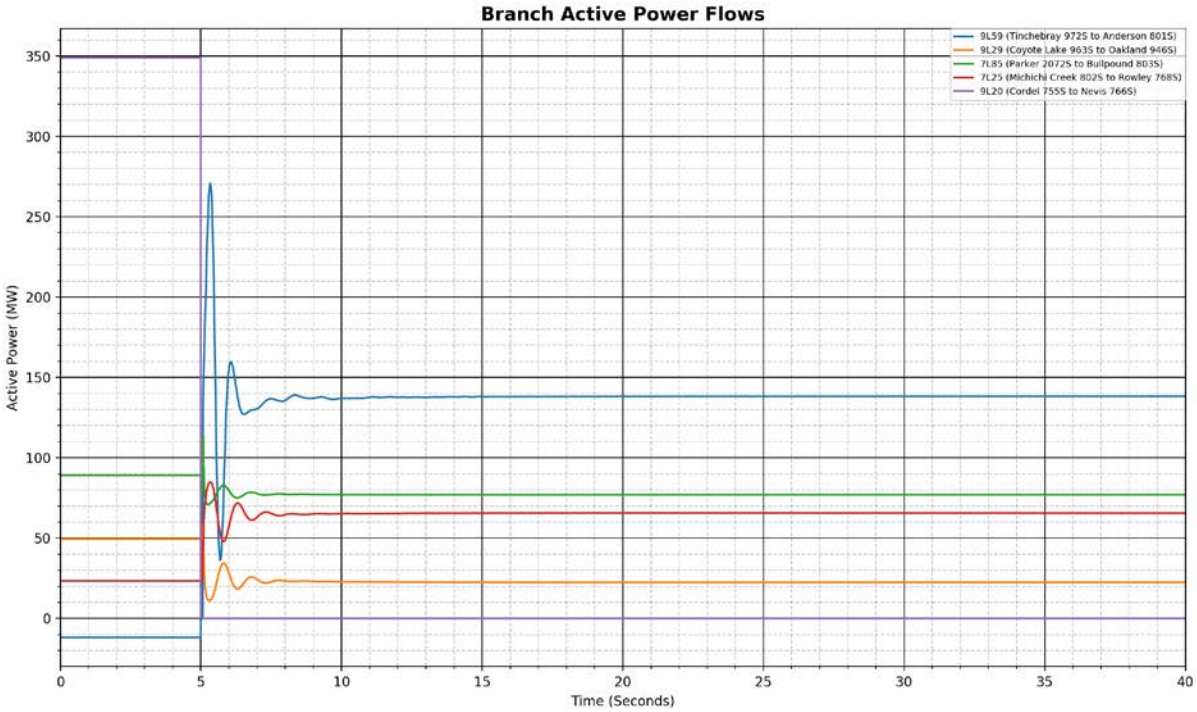

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.6
1.4
1.2
1.0
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Active Power (MW)
Time (Seconds)

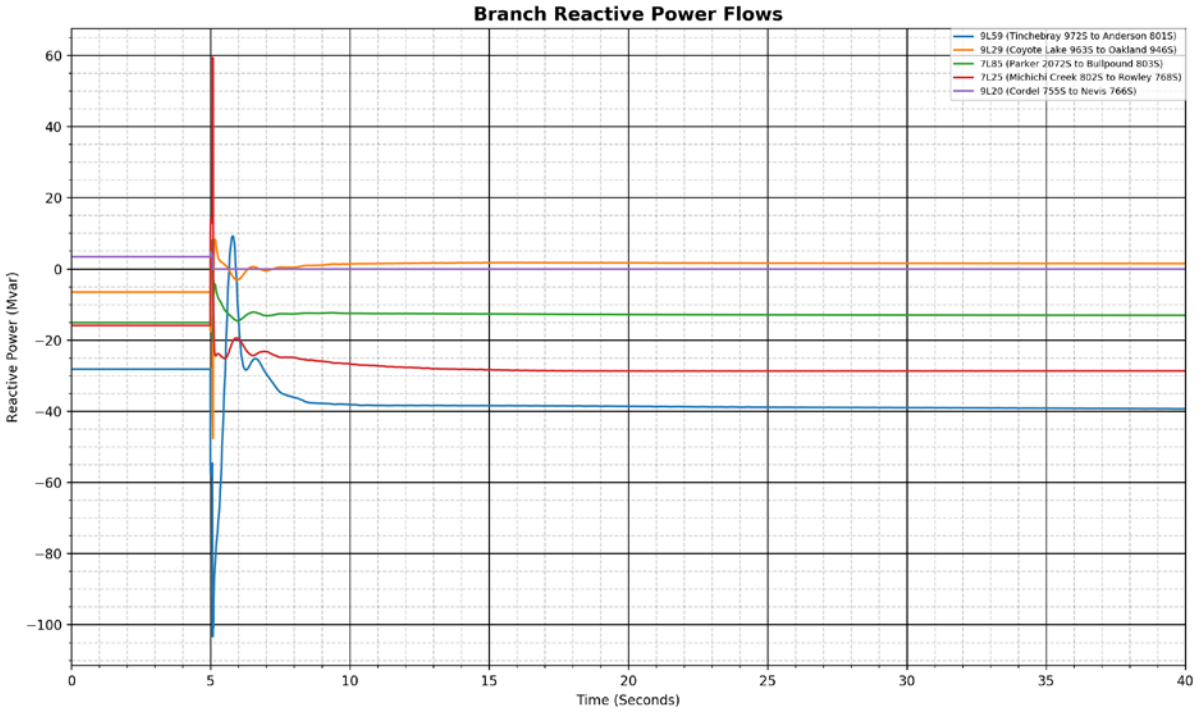
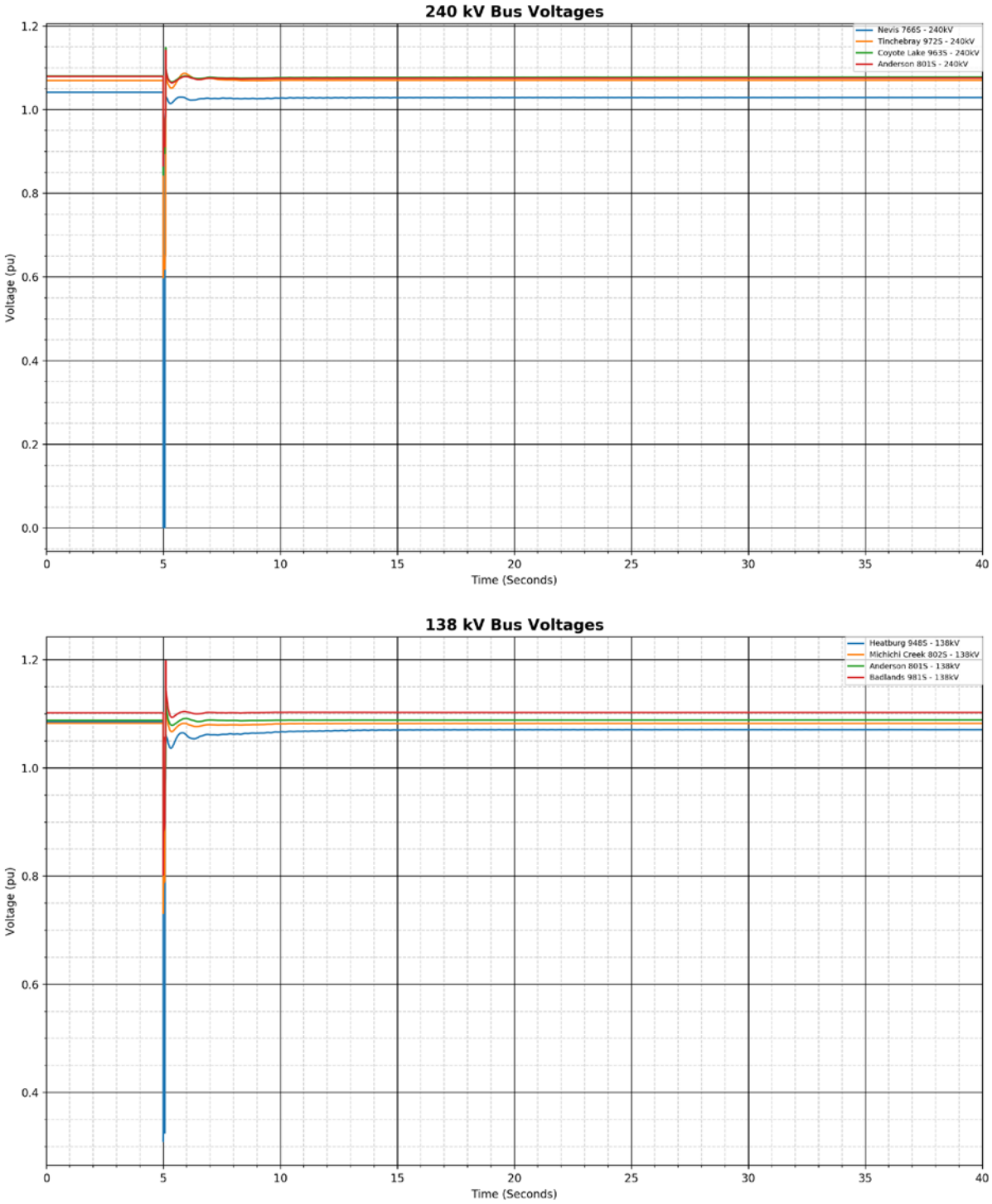
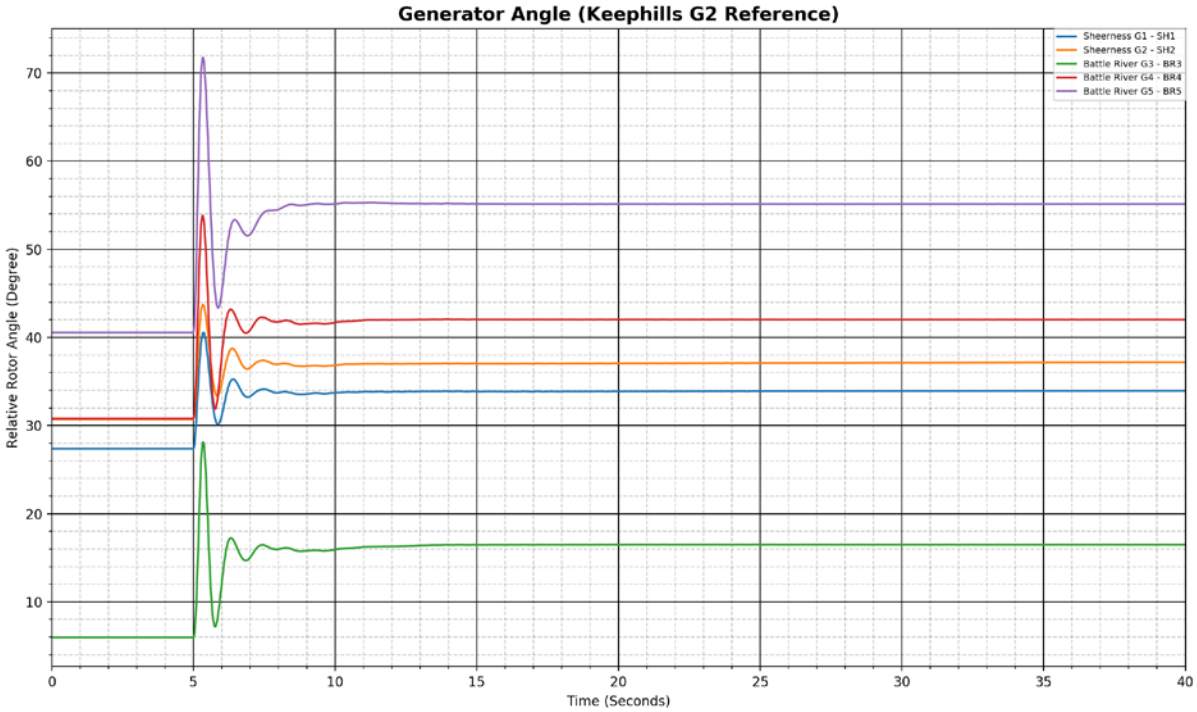
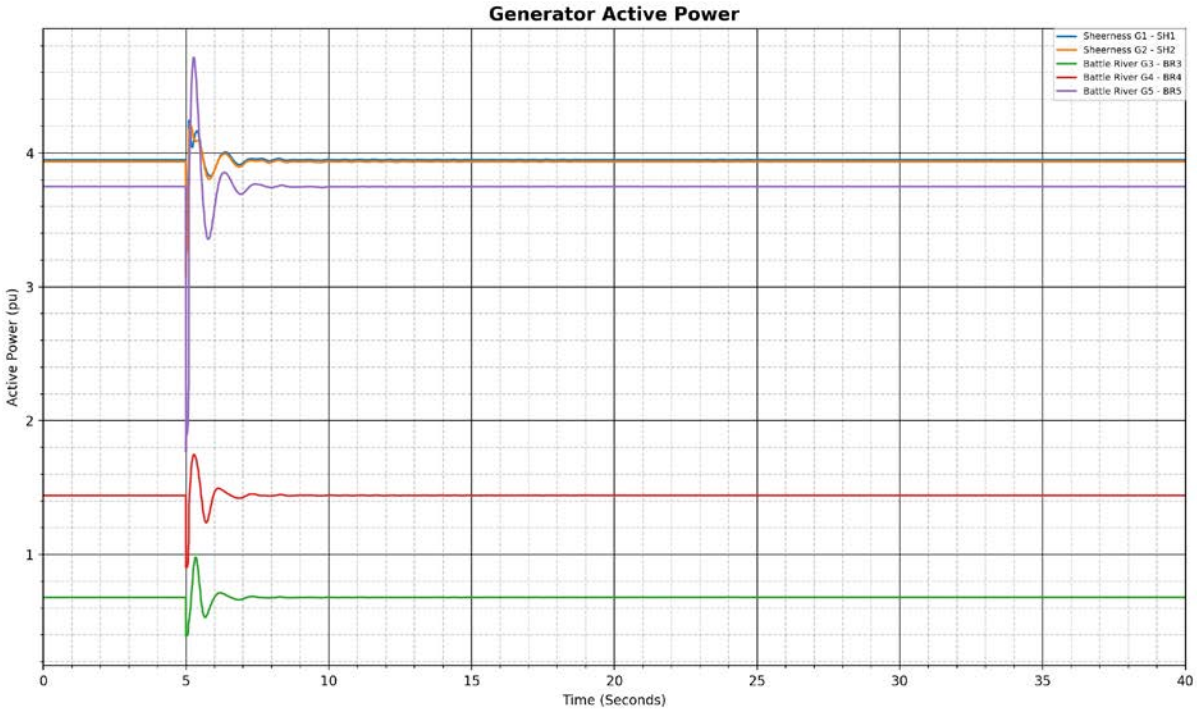
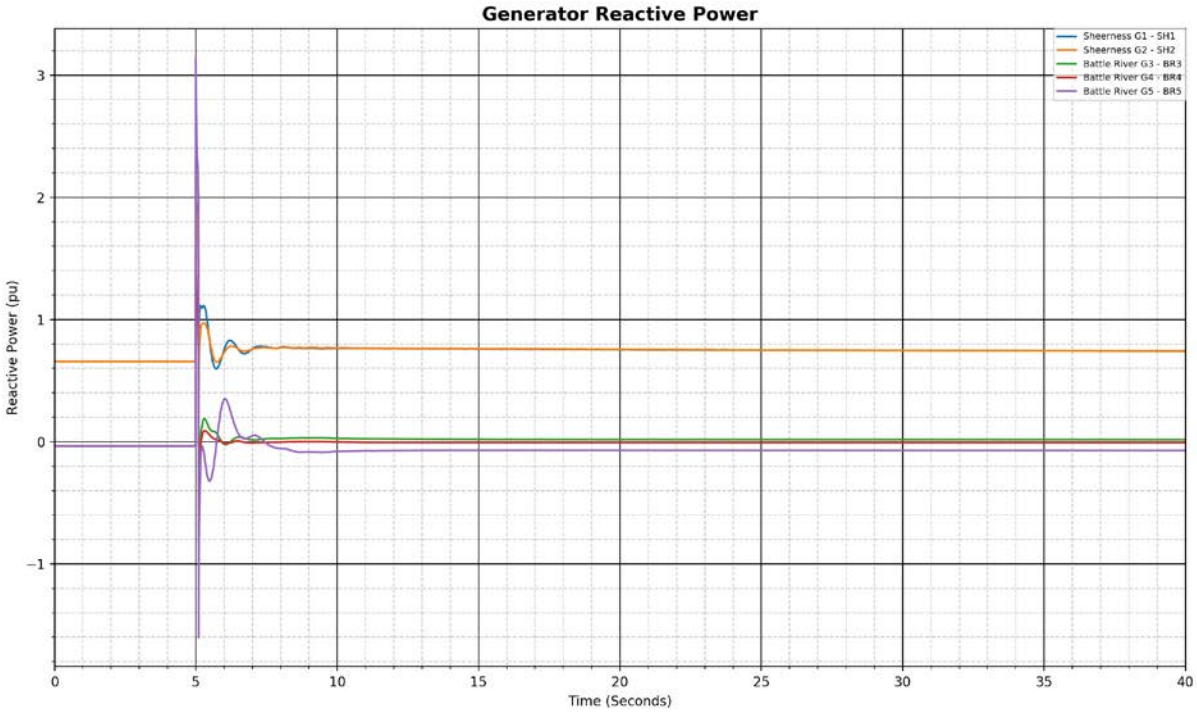

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

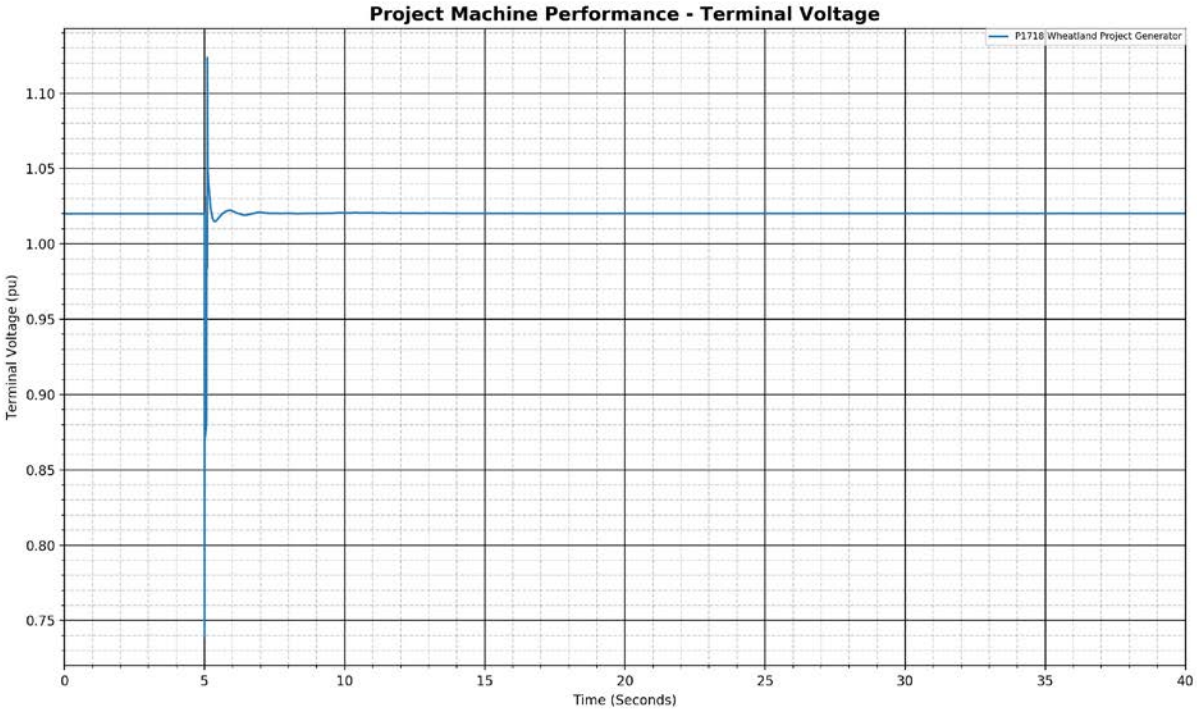
Figure A4-33: 9L20 (Cordel 755S - Nevis 766S): 3-phase fault at Nevis 766S

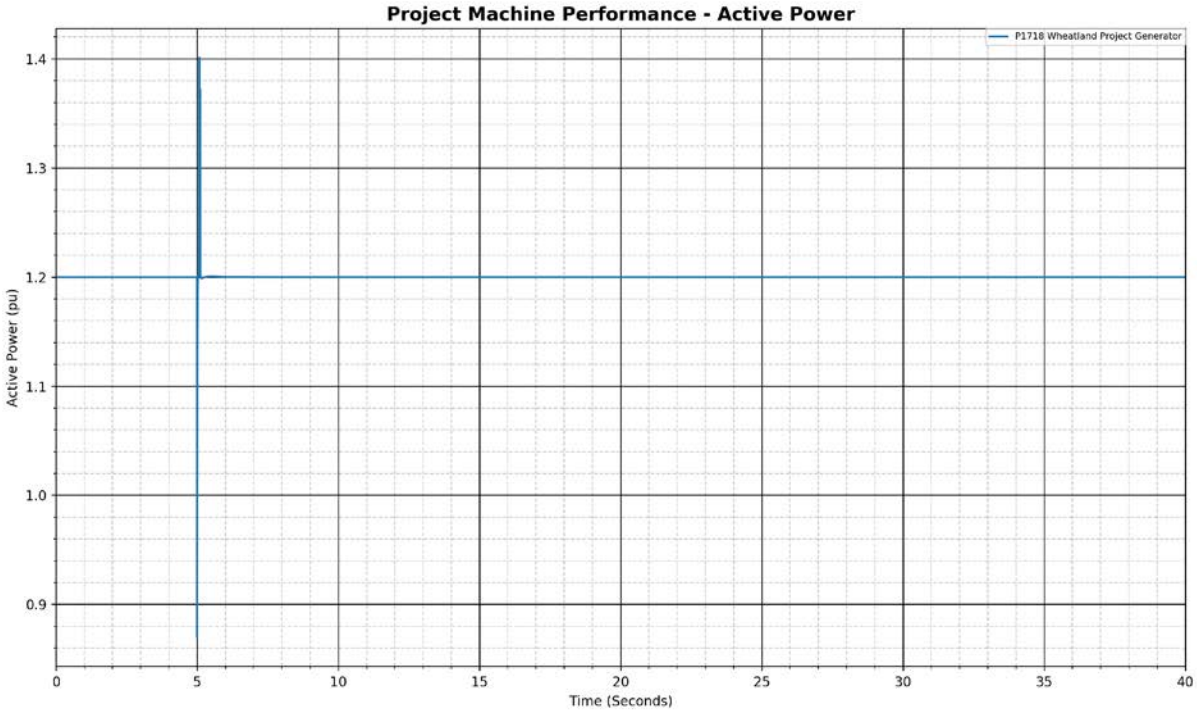


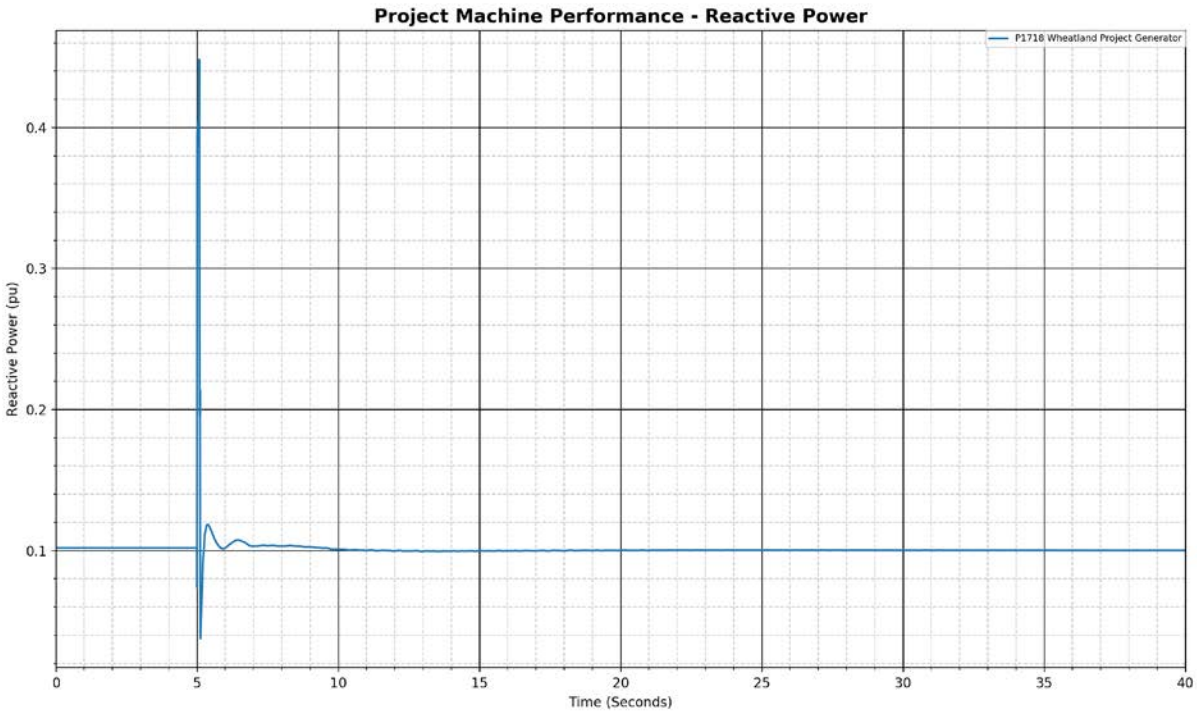

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

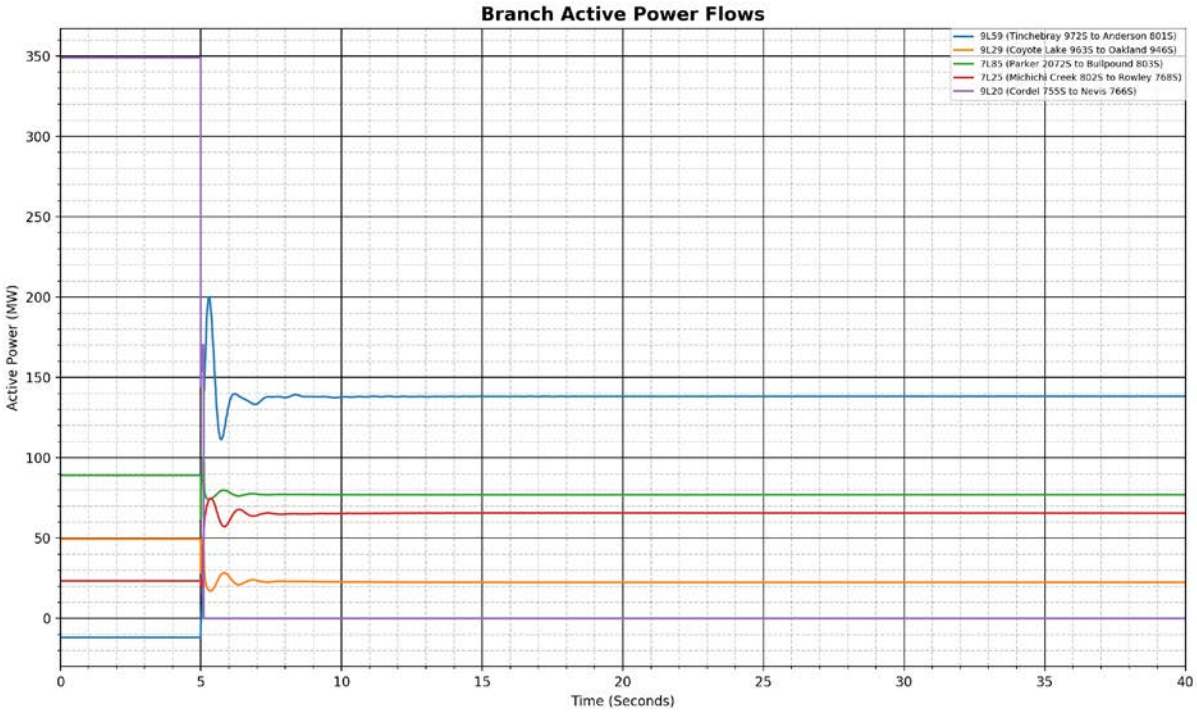

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Active Power (MW)
Time (Seconds)

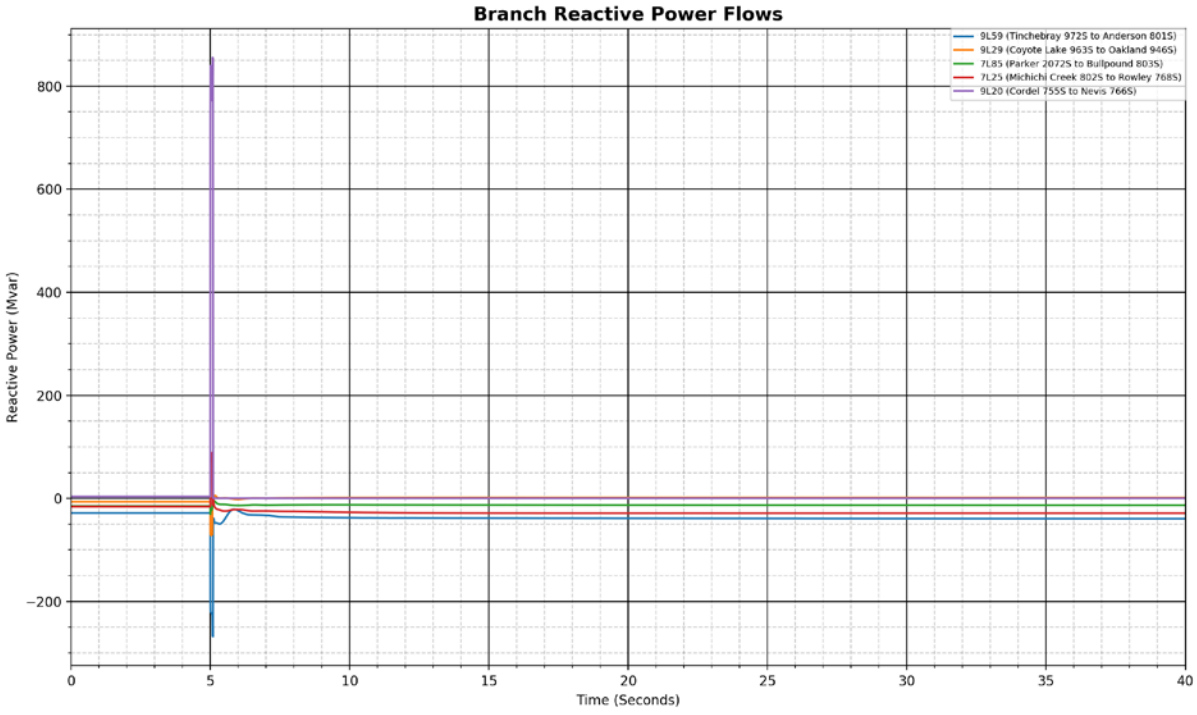
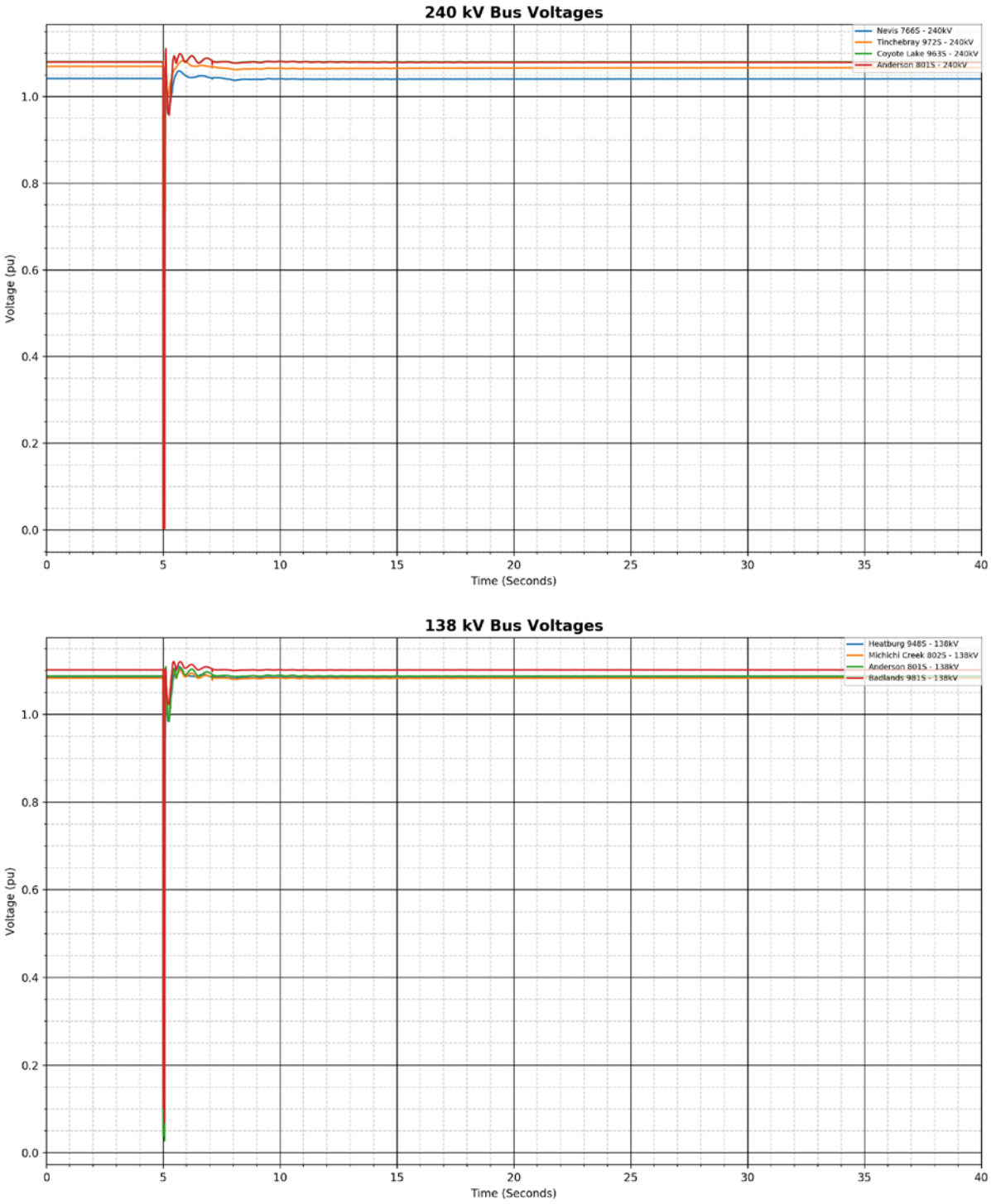
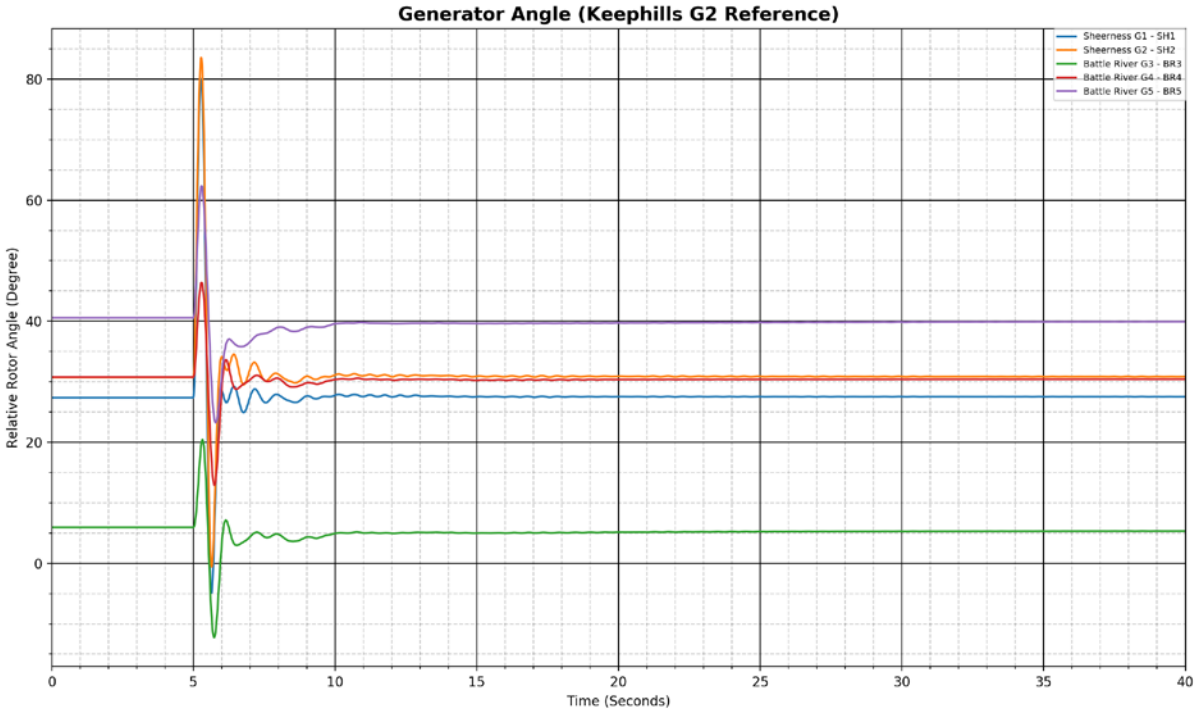
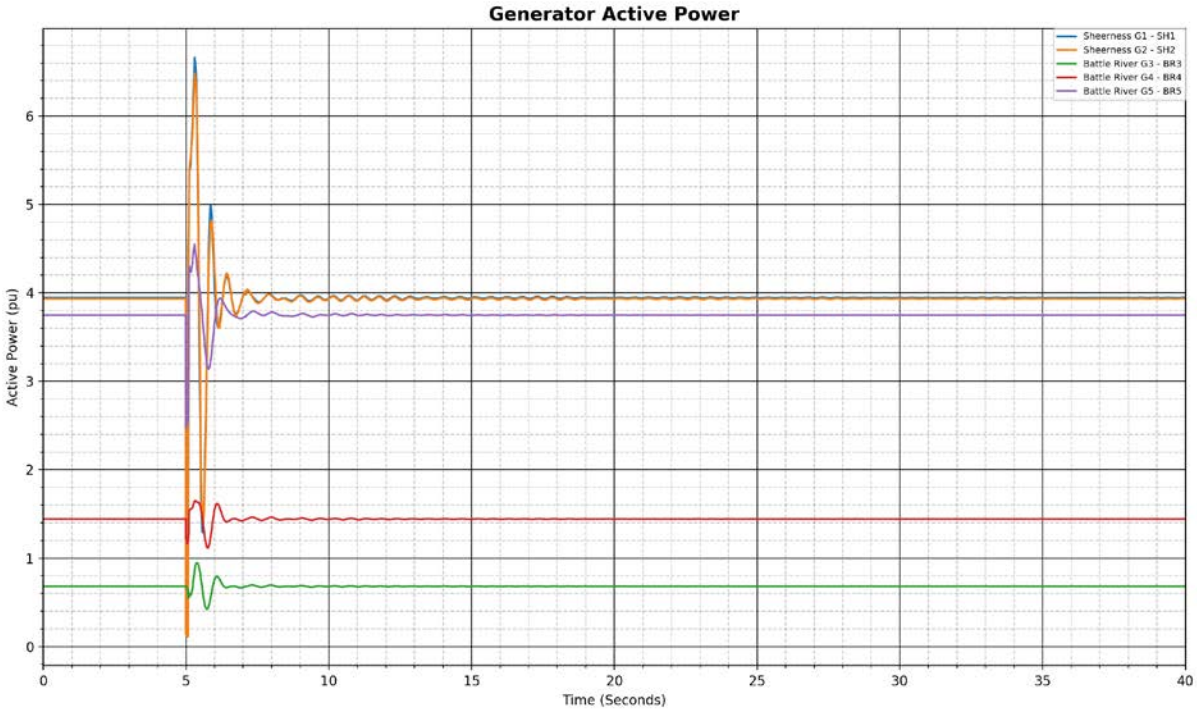
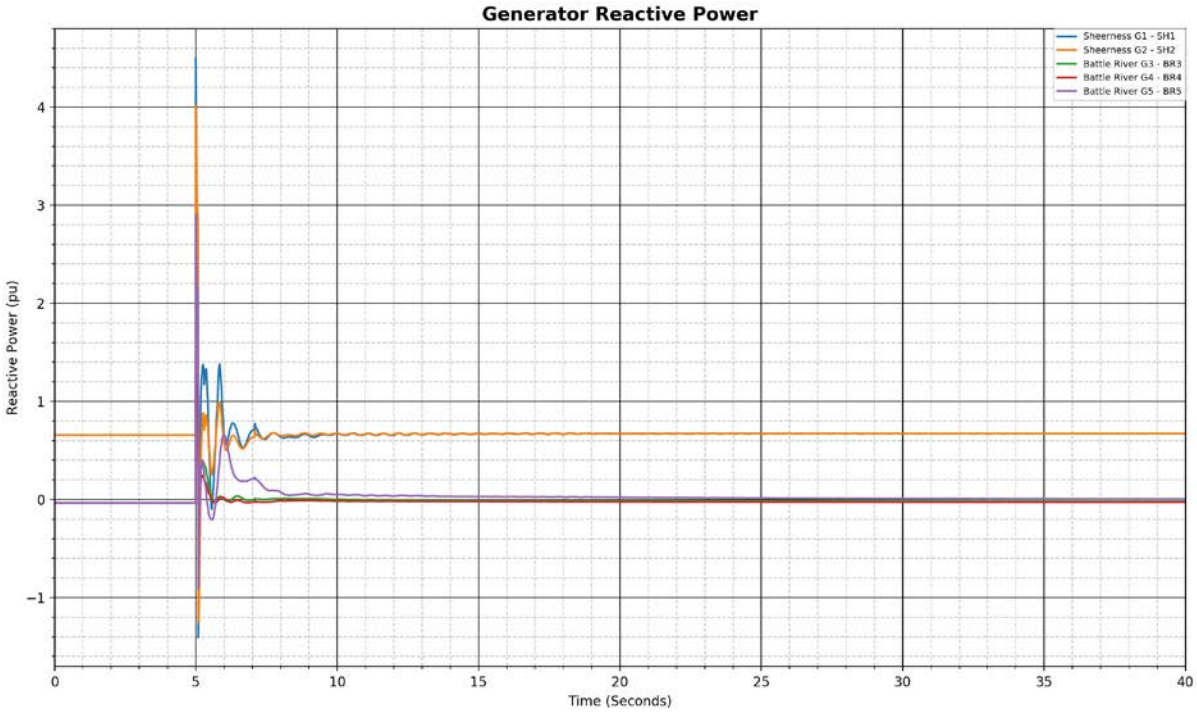

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

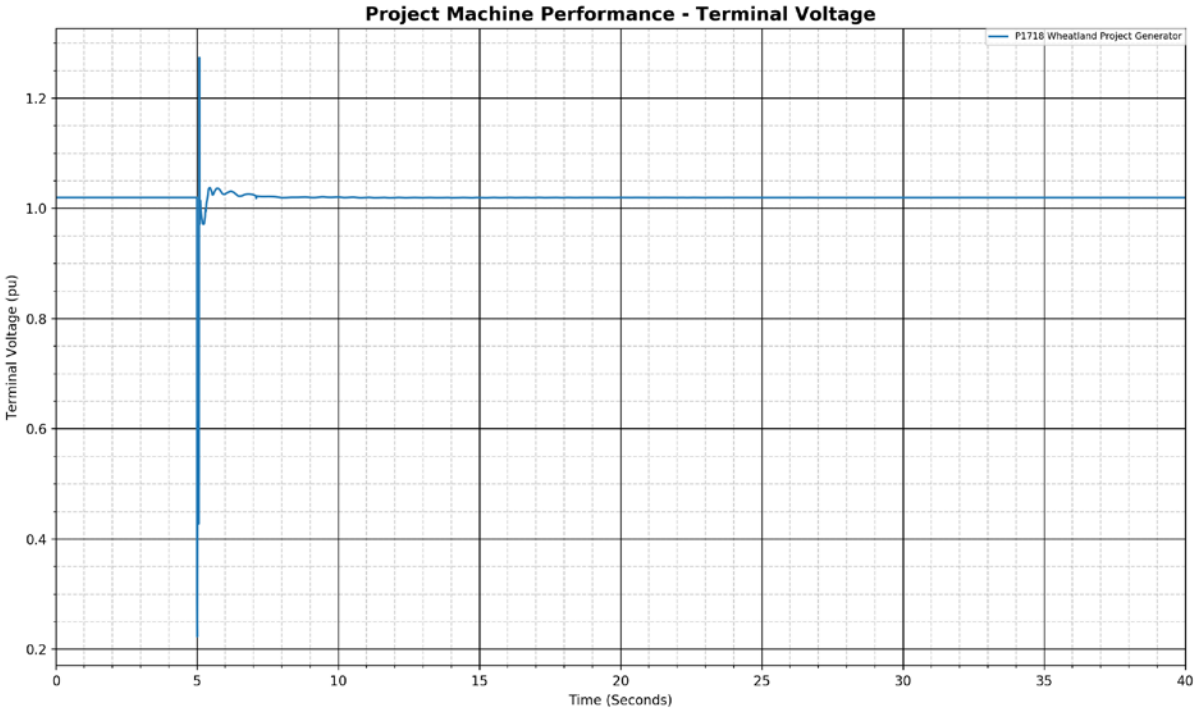
Figure A4-34: 9L59 (Anderson 801S - Tinchebray 972S): 3-phase fault at Anderson 801S

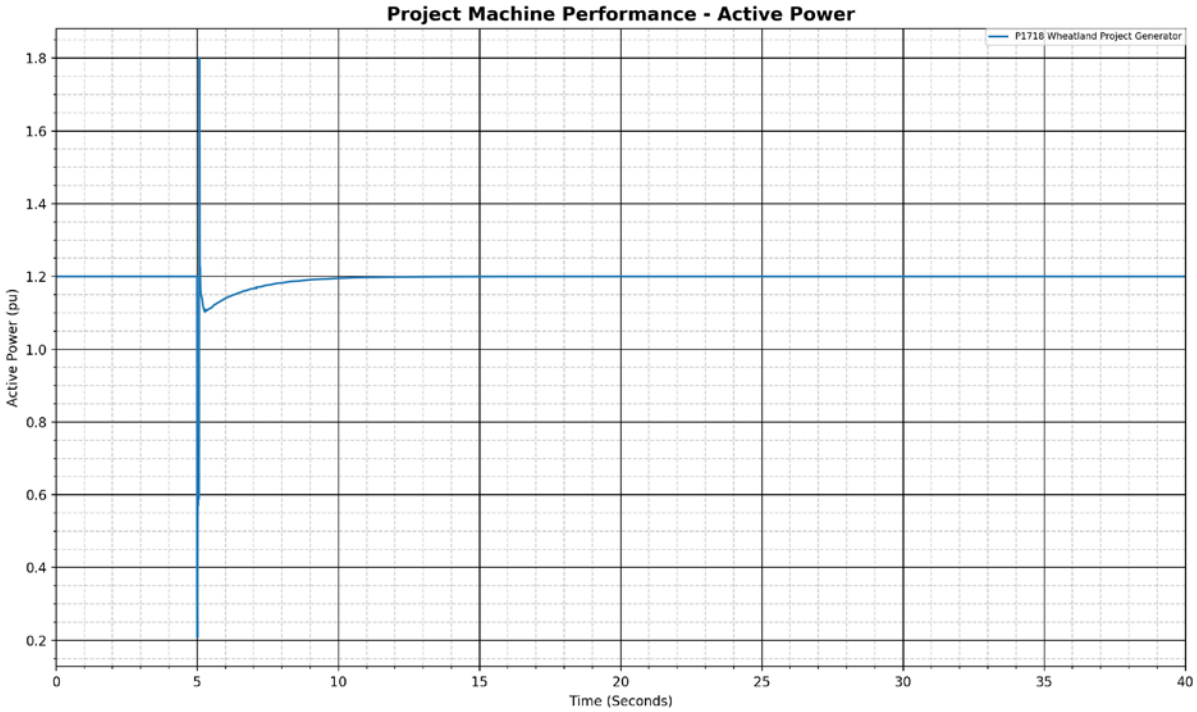


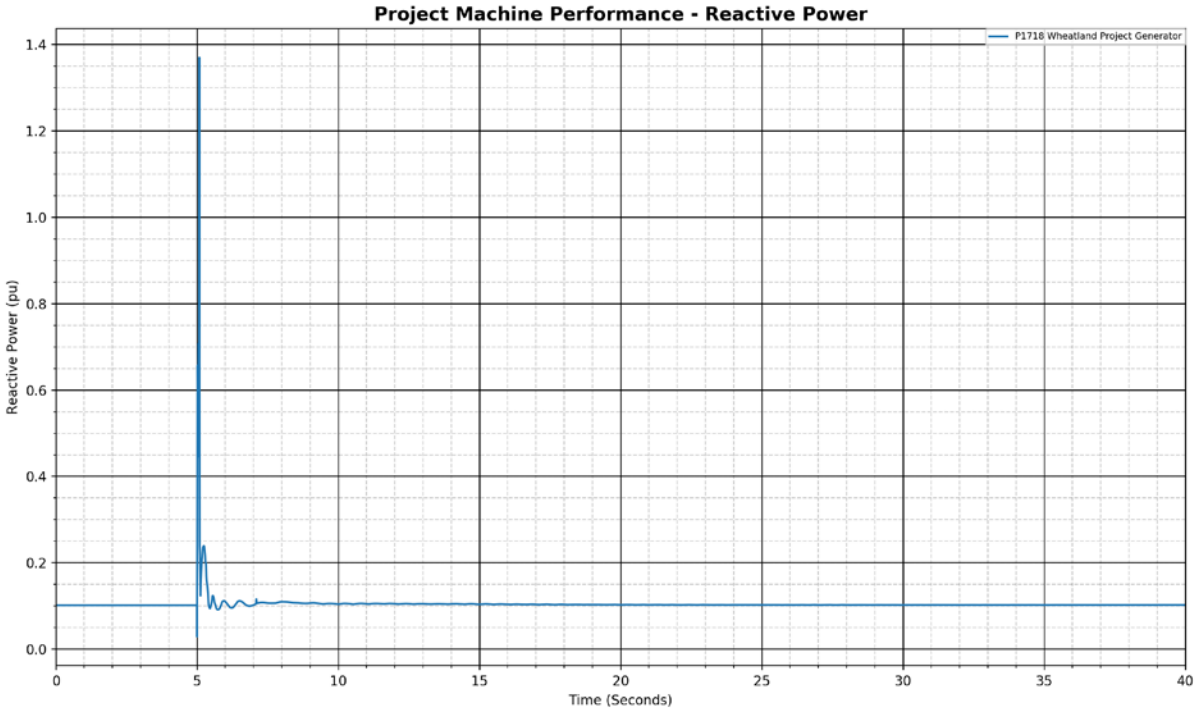

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

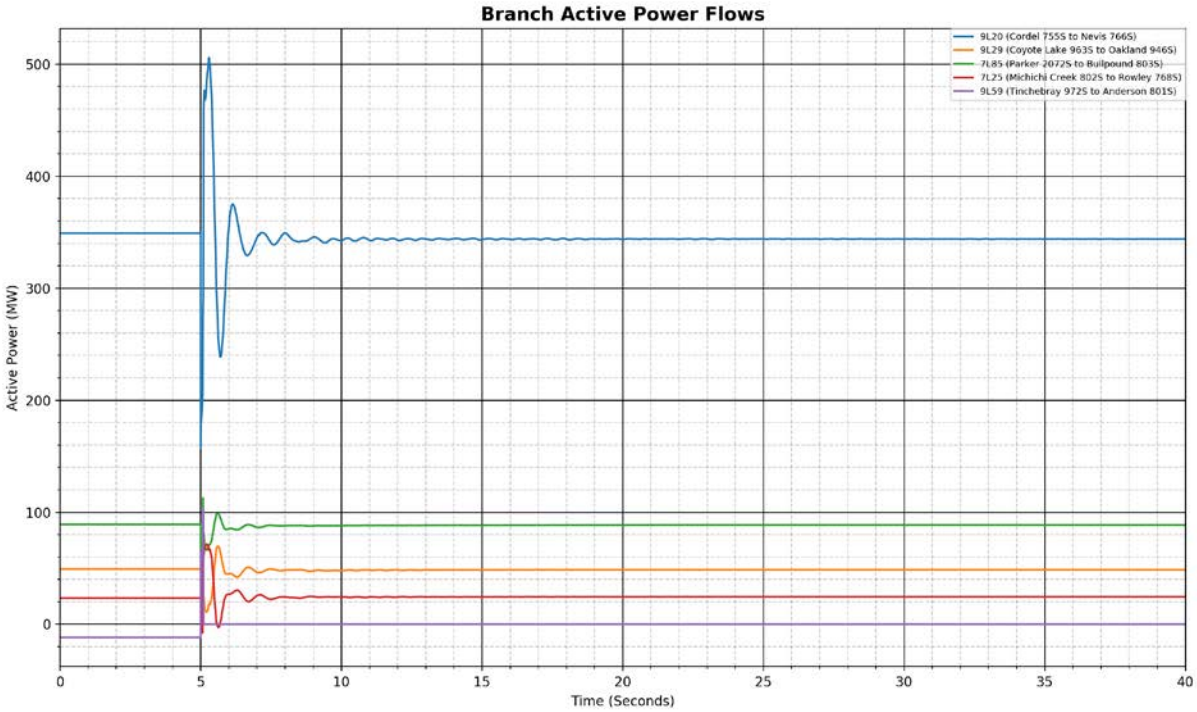

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Active Power (MW)
Time (Seconds)

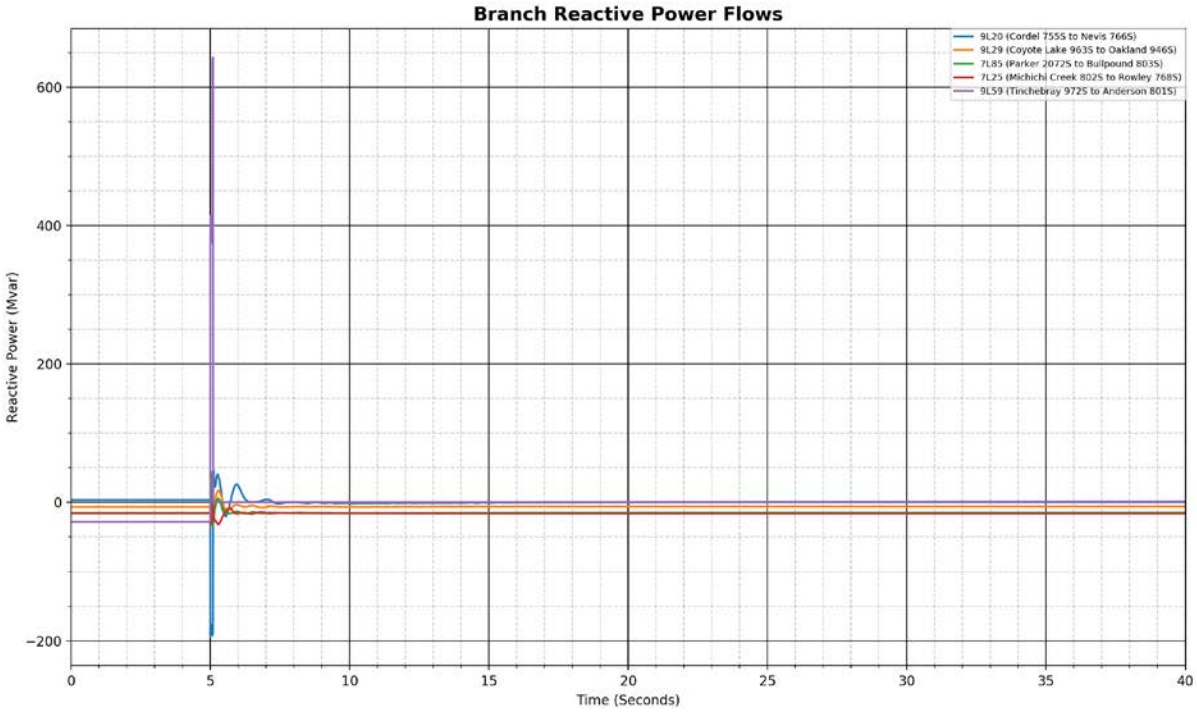
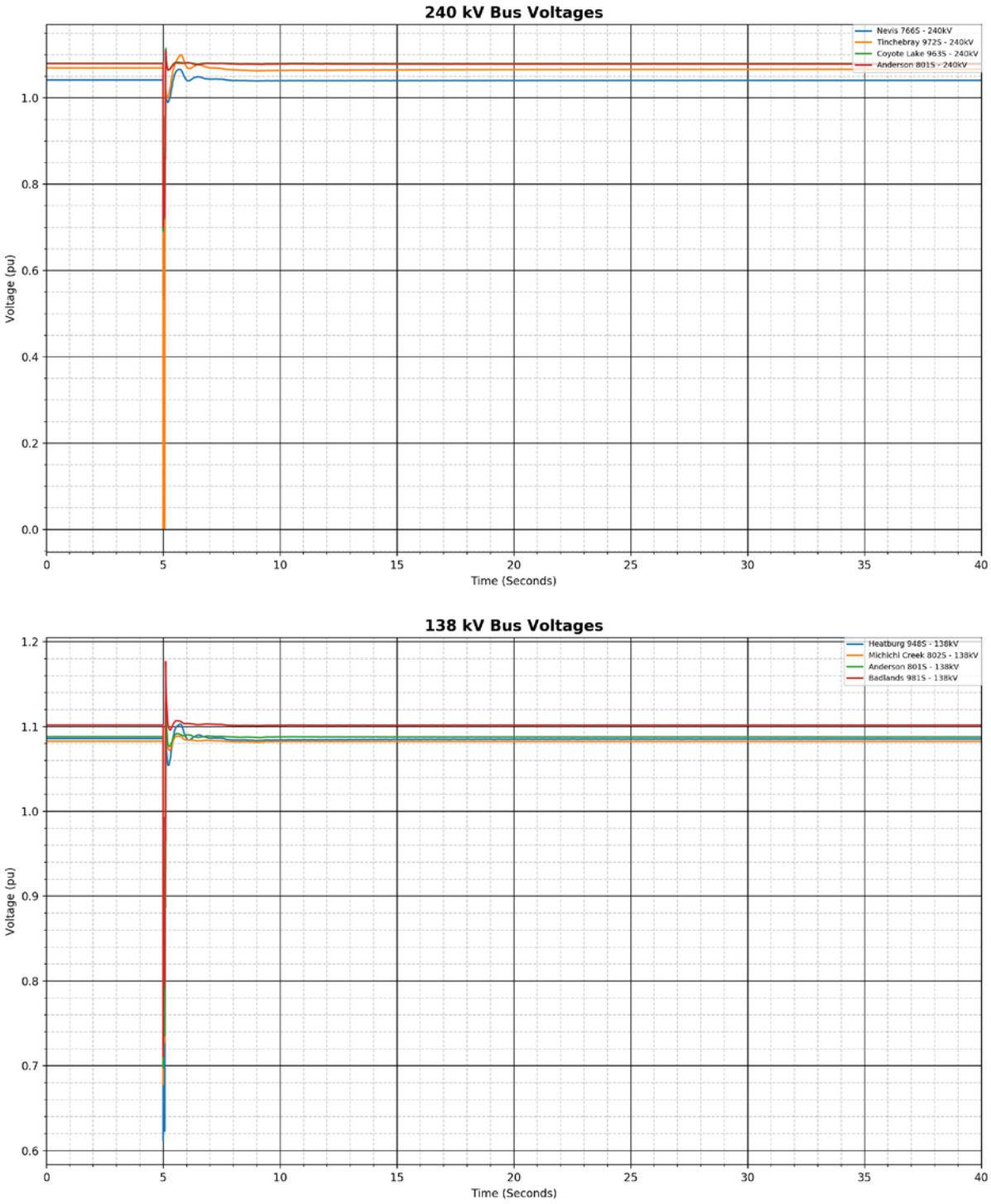
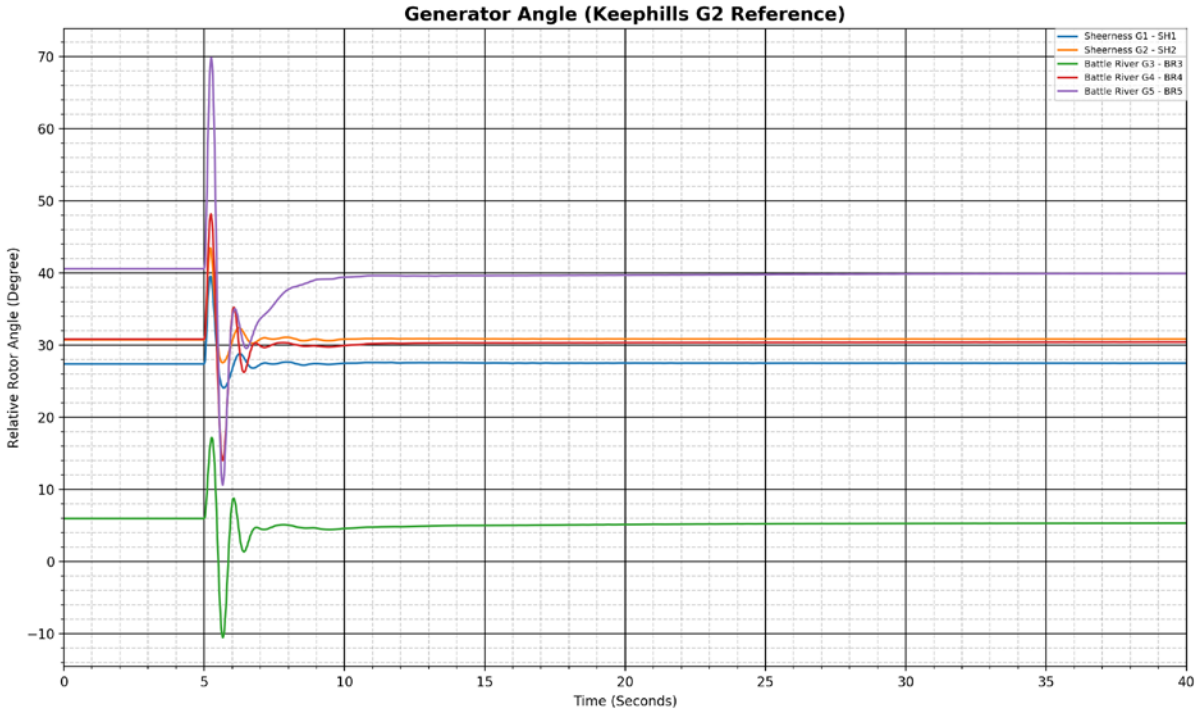
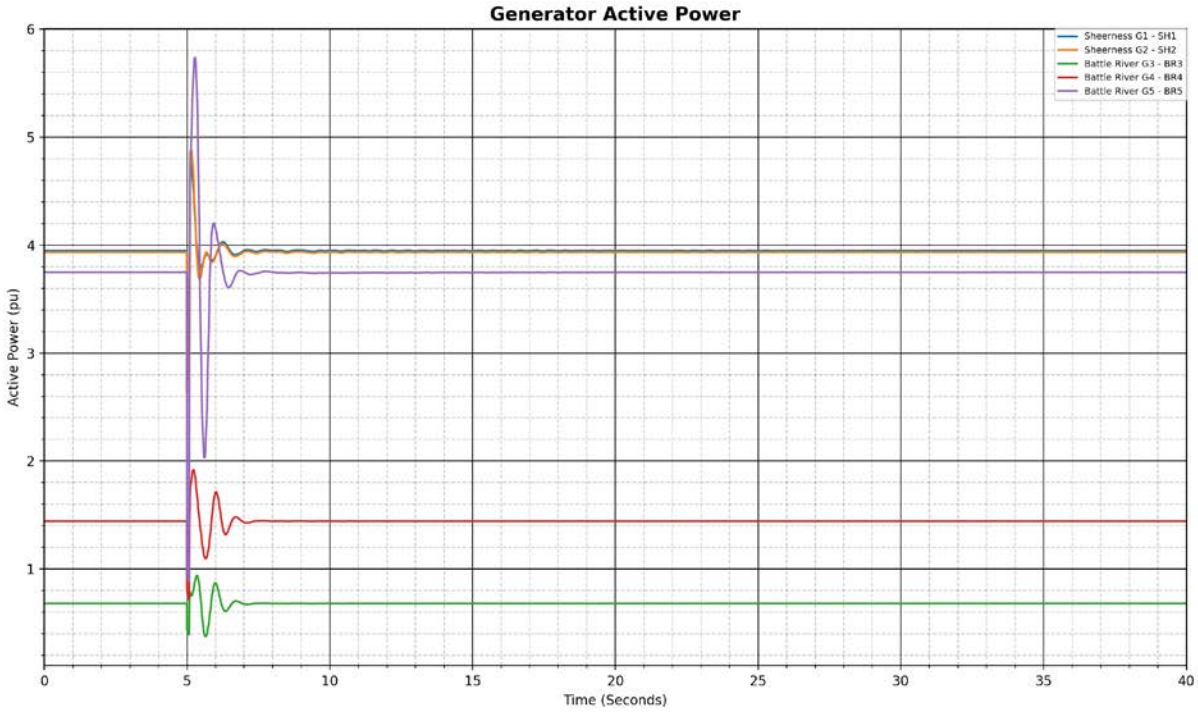
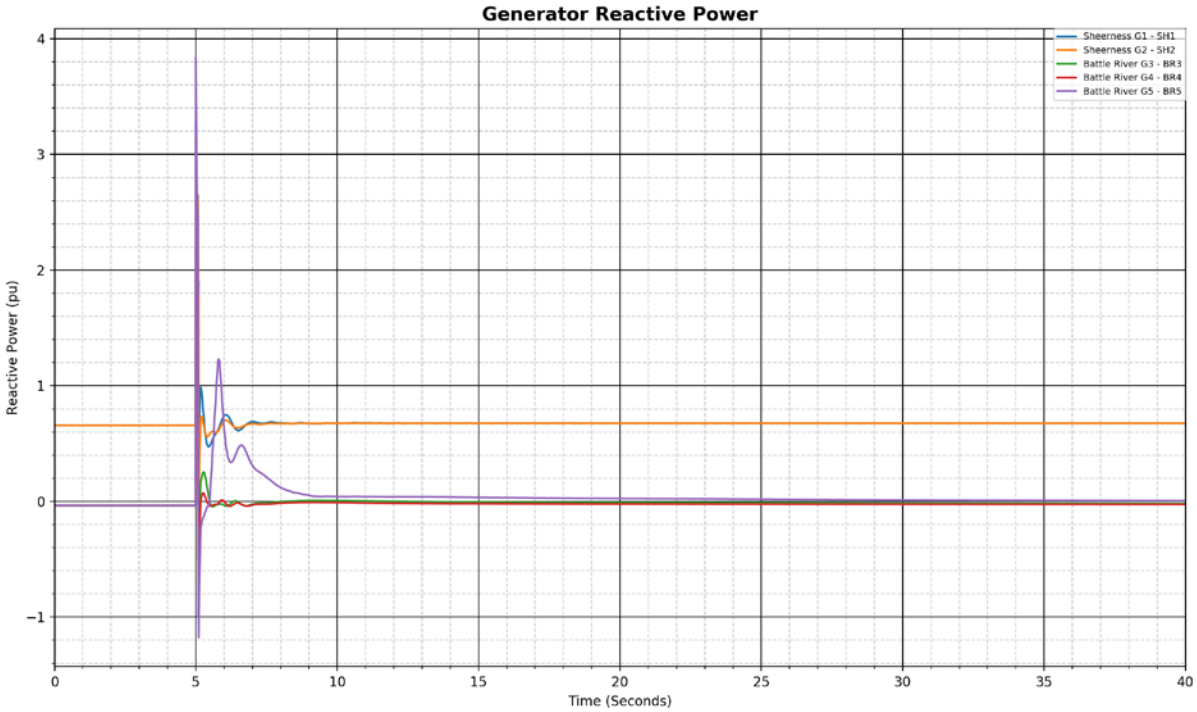

Branch Reactive Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Reactive Power (Mvar)
Time (Seconds)

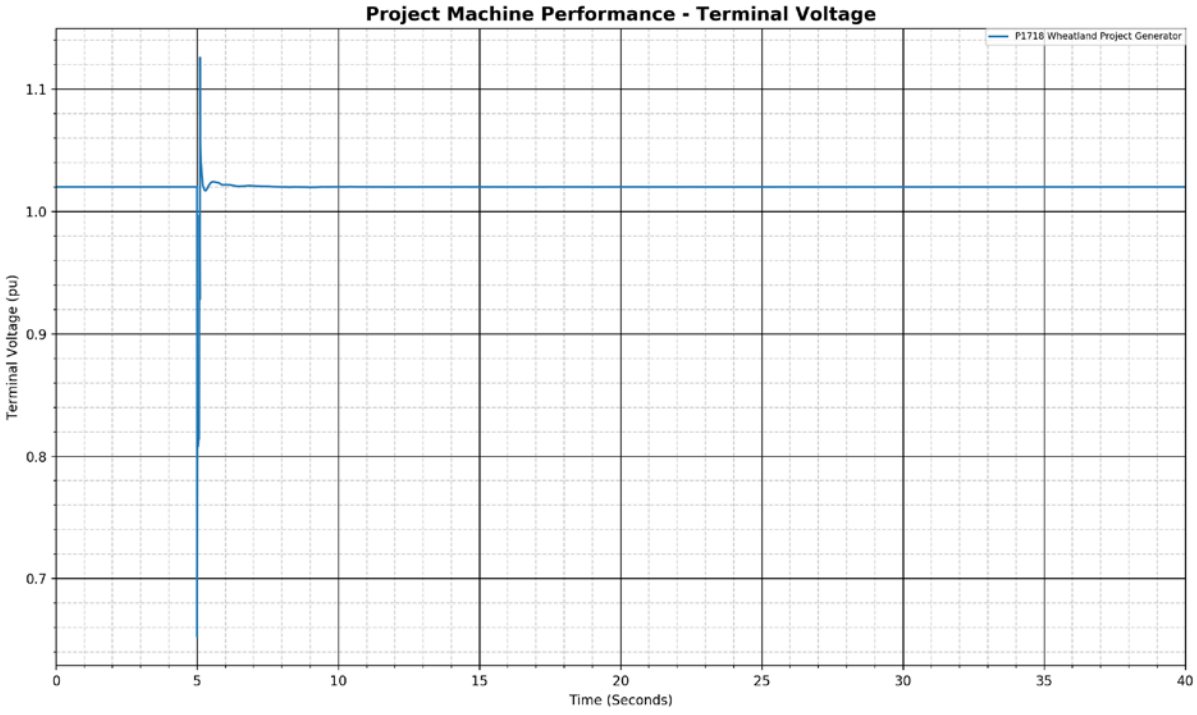
Figure A4-35: 9L59 (Anderson 801S - Tinchebray 972S): 3-phase fault at Tinchebray 972S

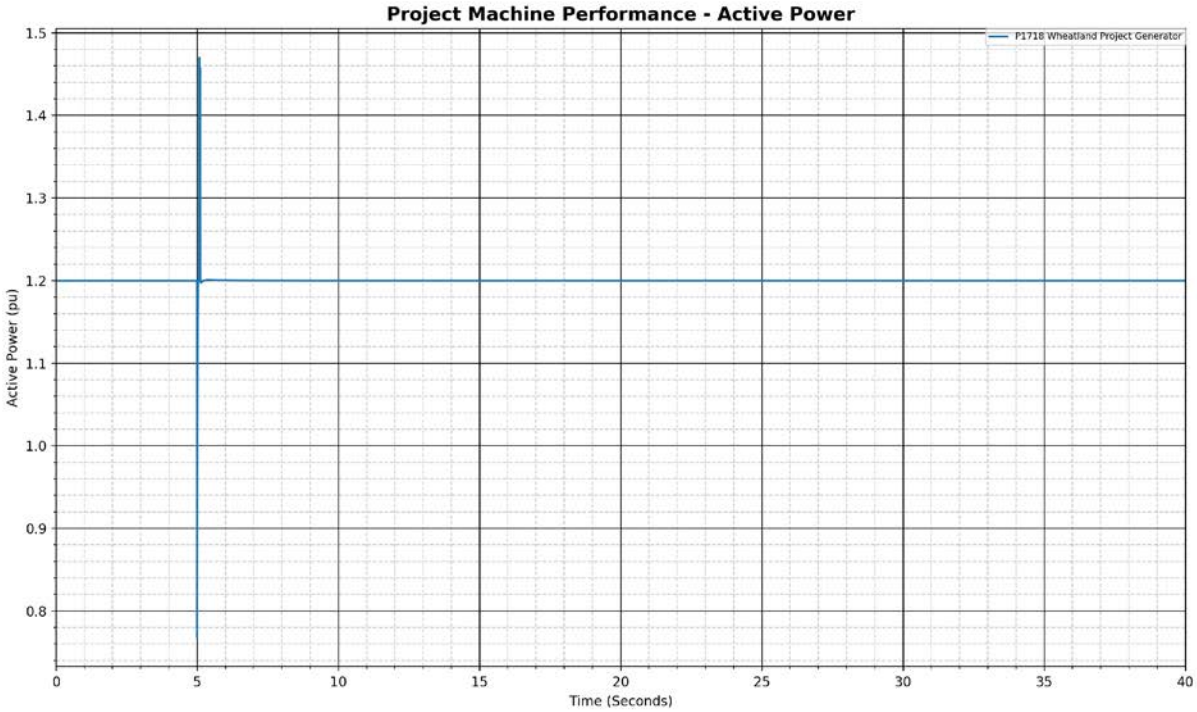


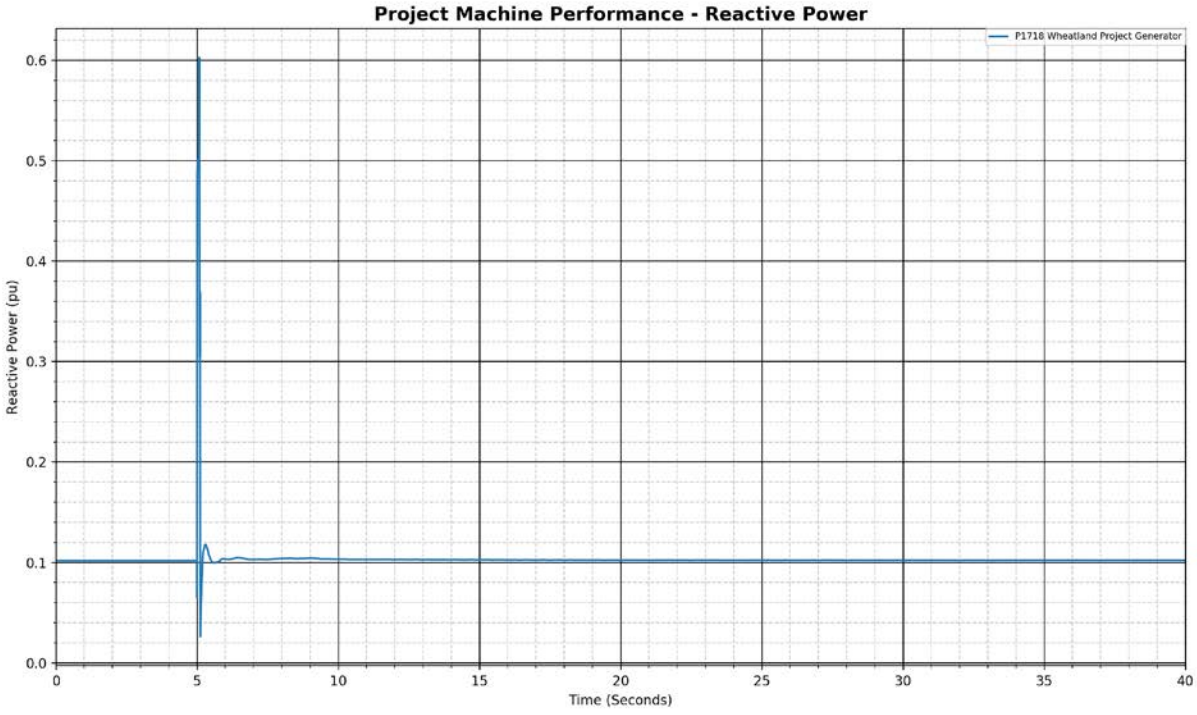

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

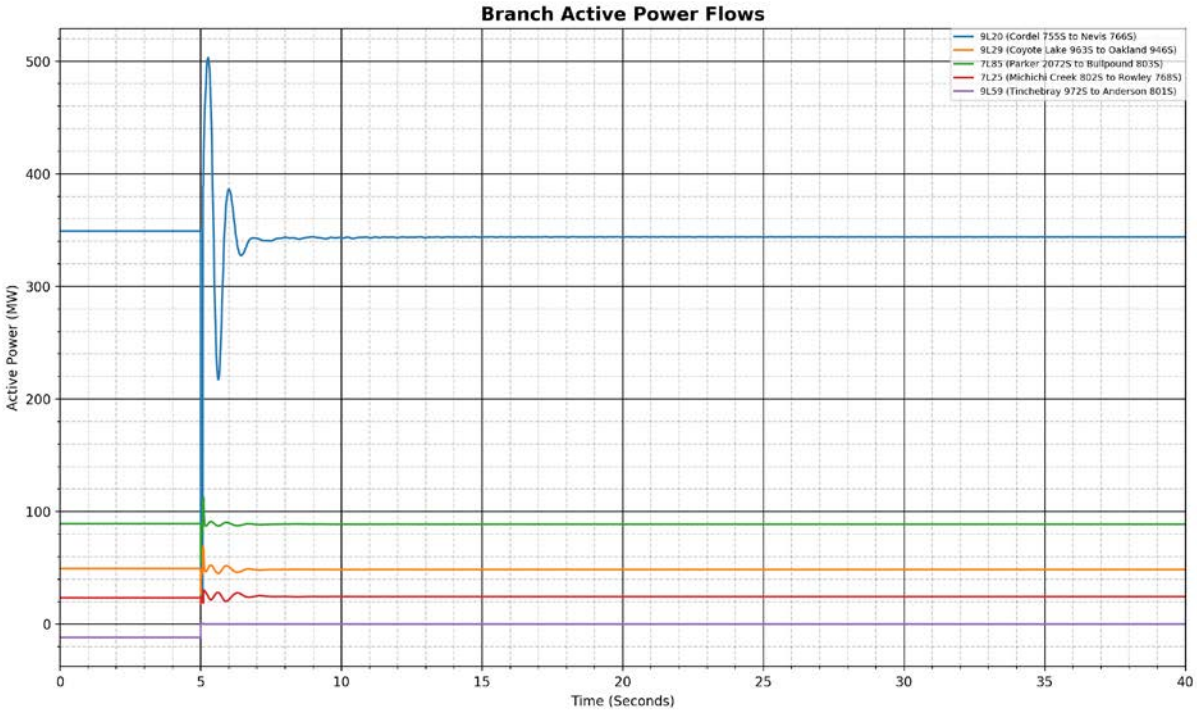

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Active Power (MW)
Time (Seconds)

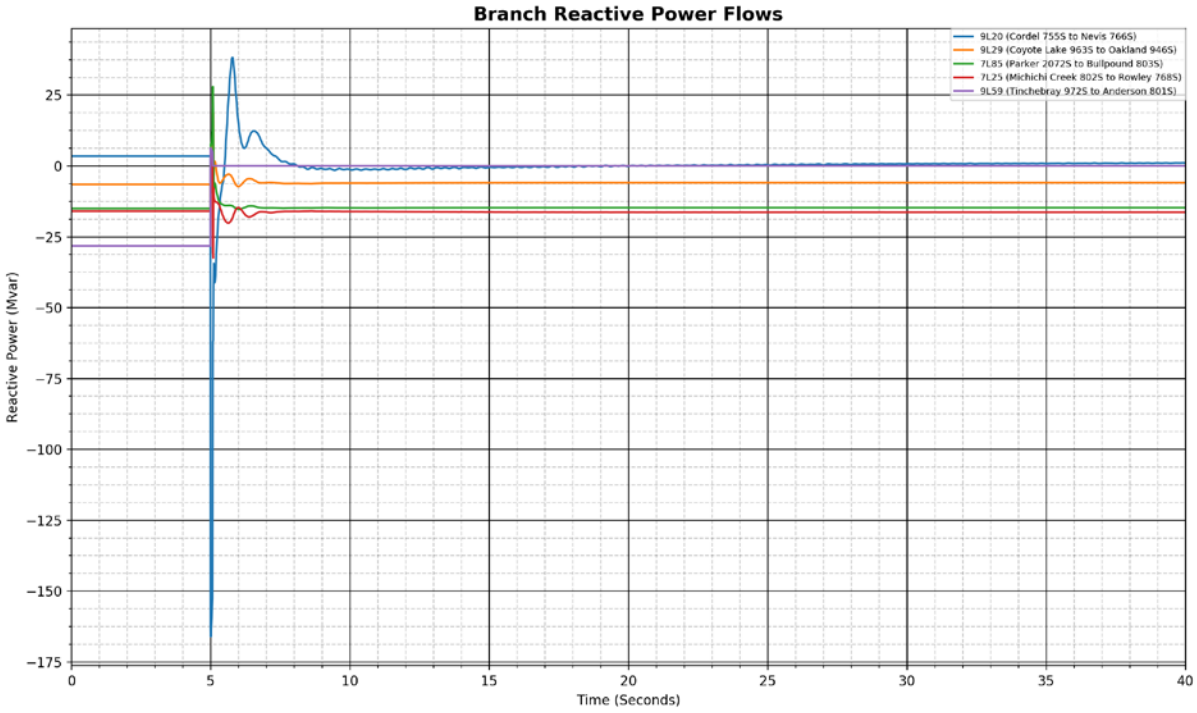
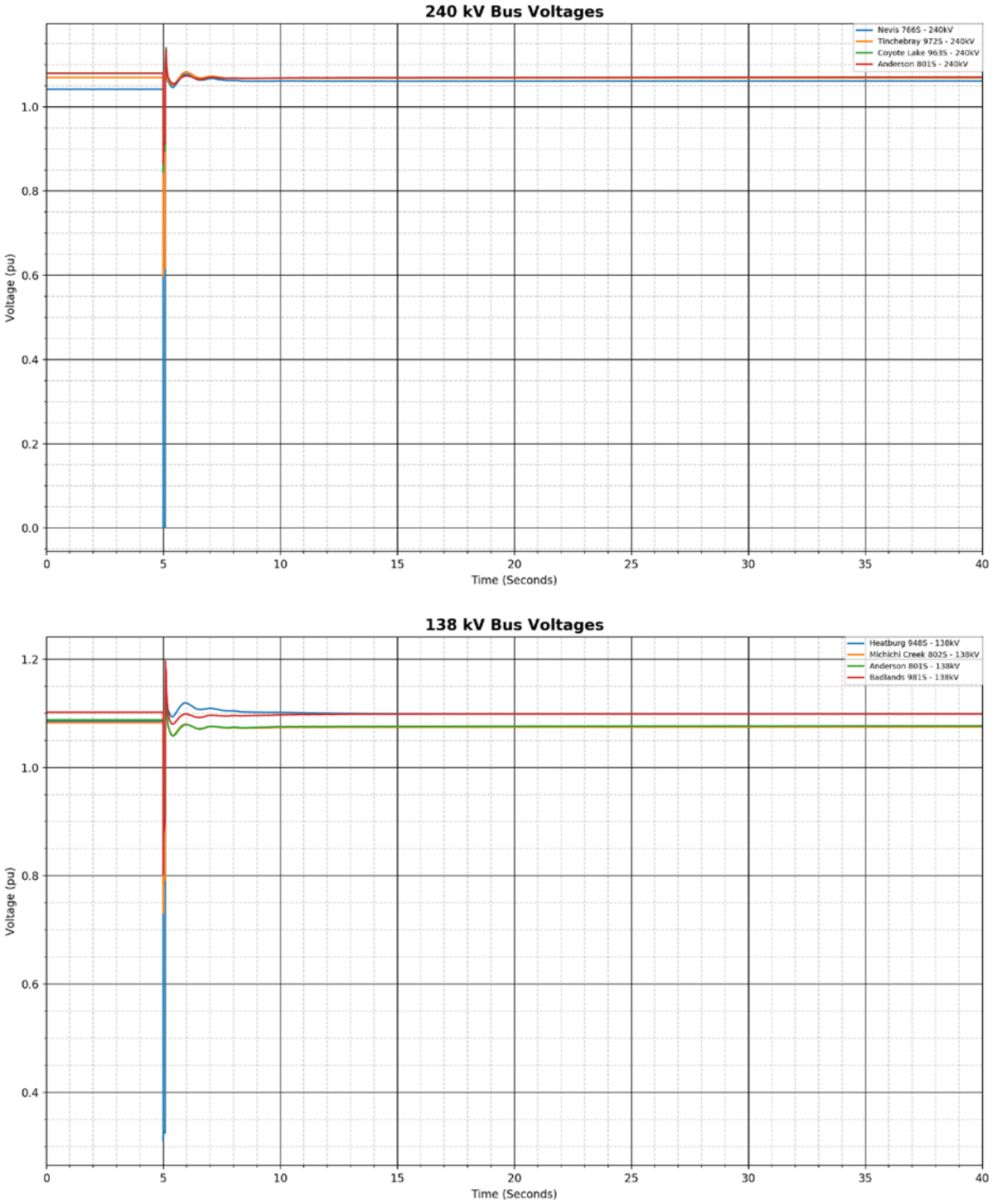
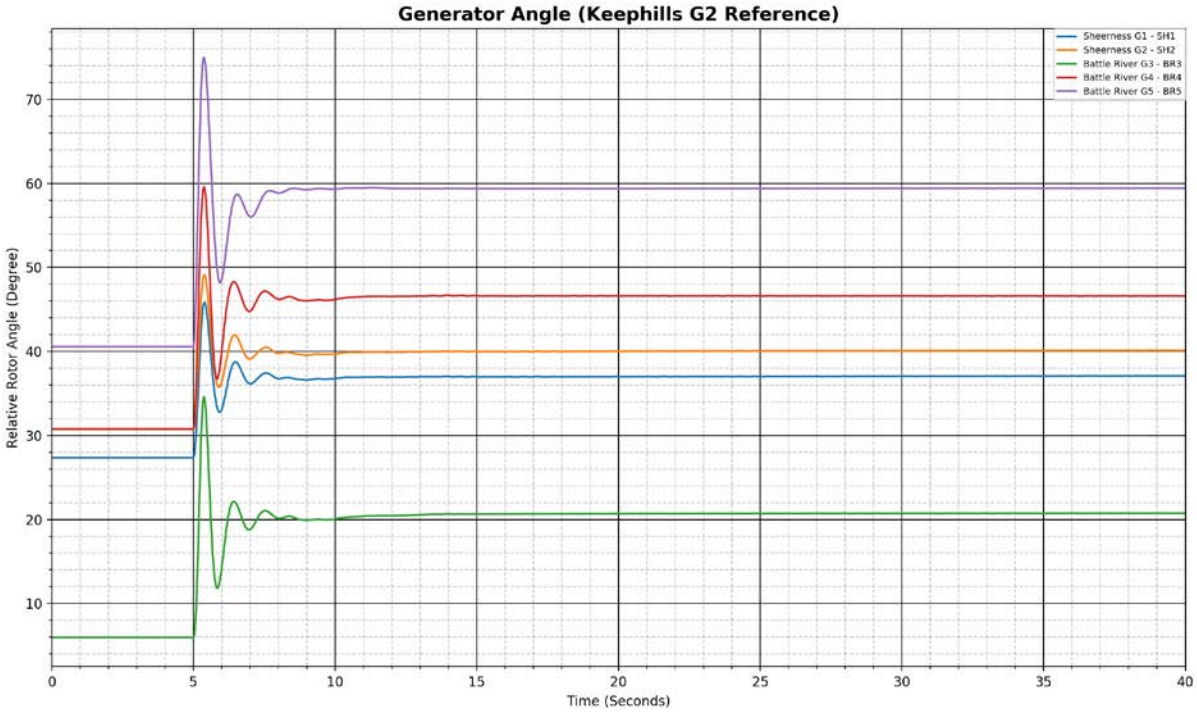
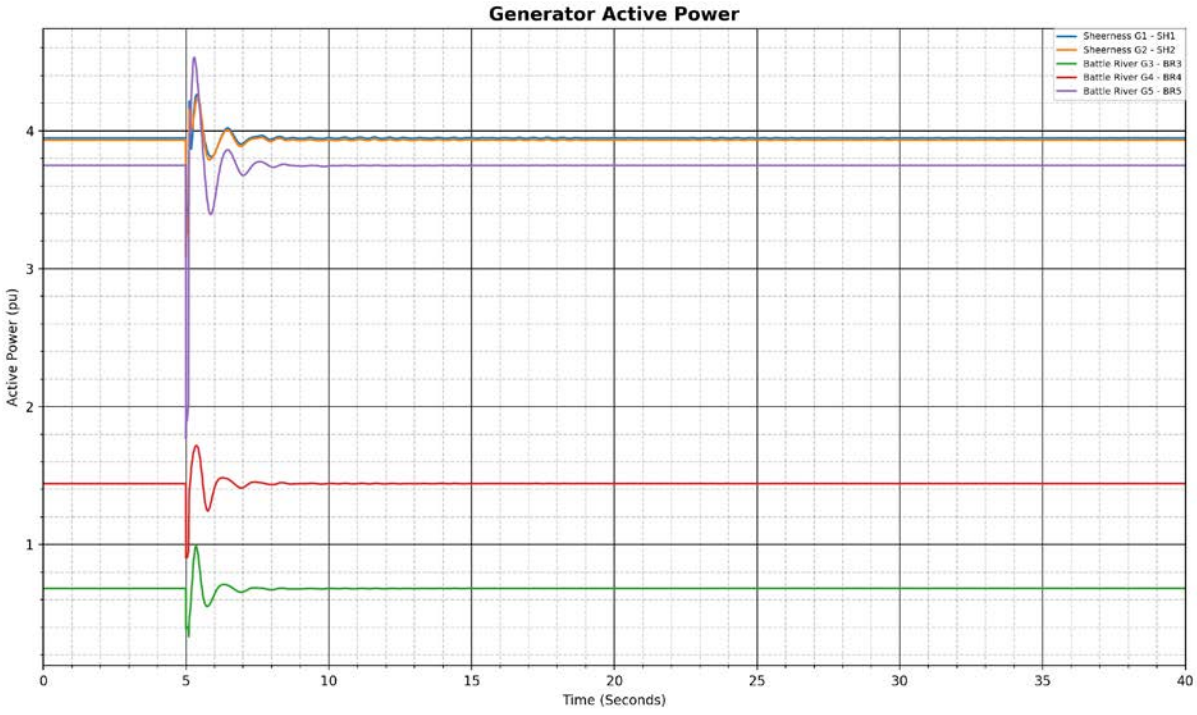
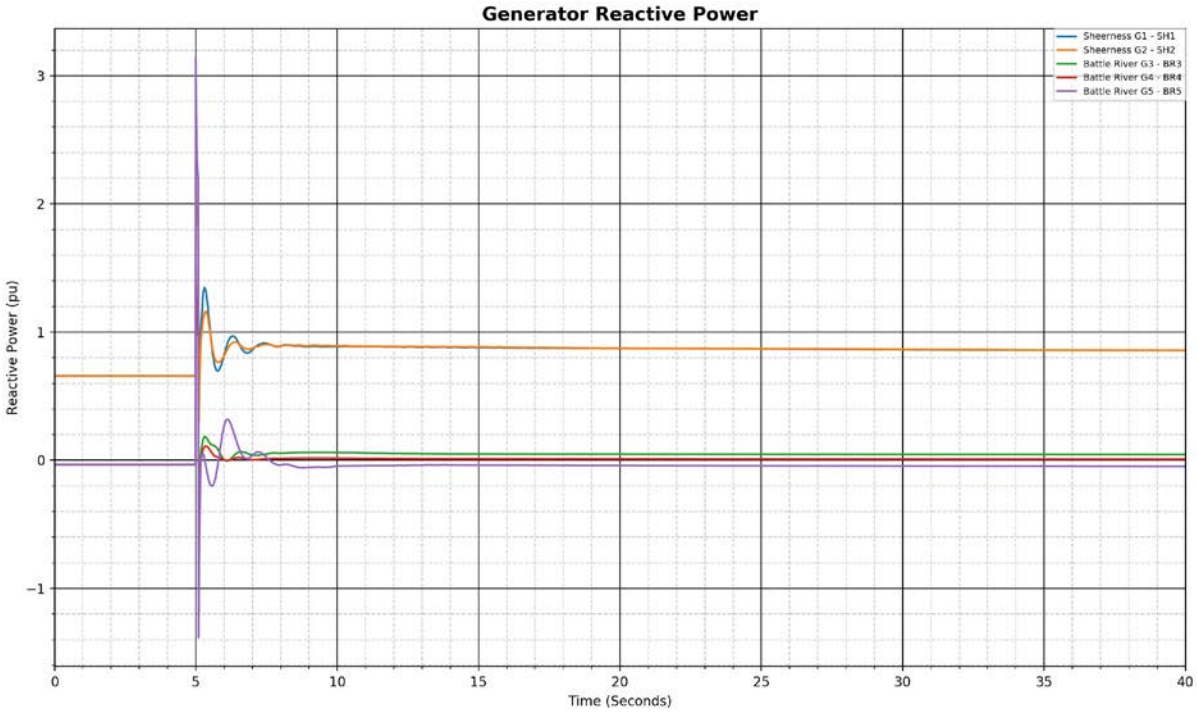

Branch Reactive Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Reactive Power (Mvar)
Time (Seconds)

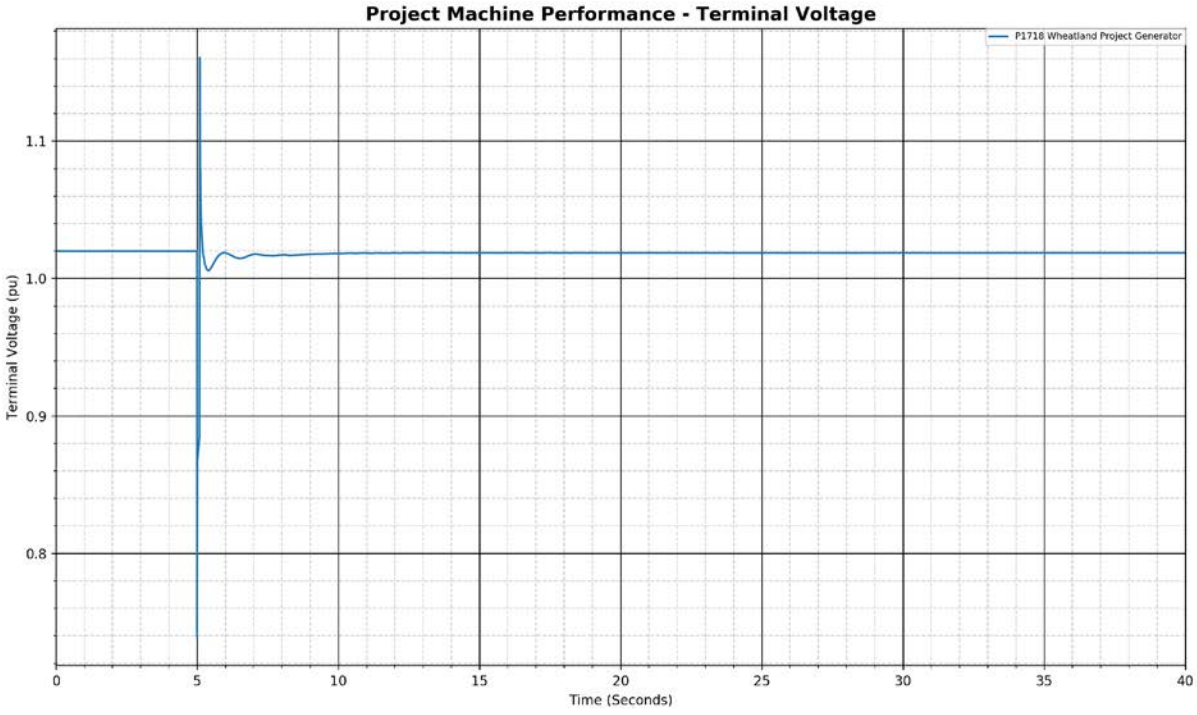
Figure A4-36: 912L/9L912 (Nevis 766S - Red Deer 63S): 3-phase fault at Nevis 766S

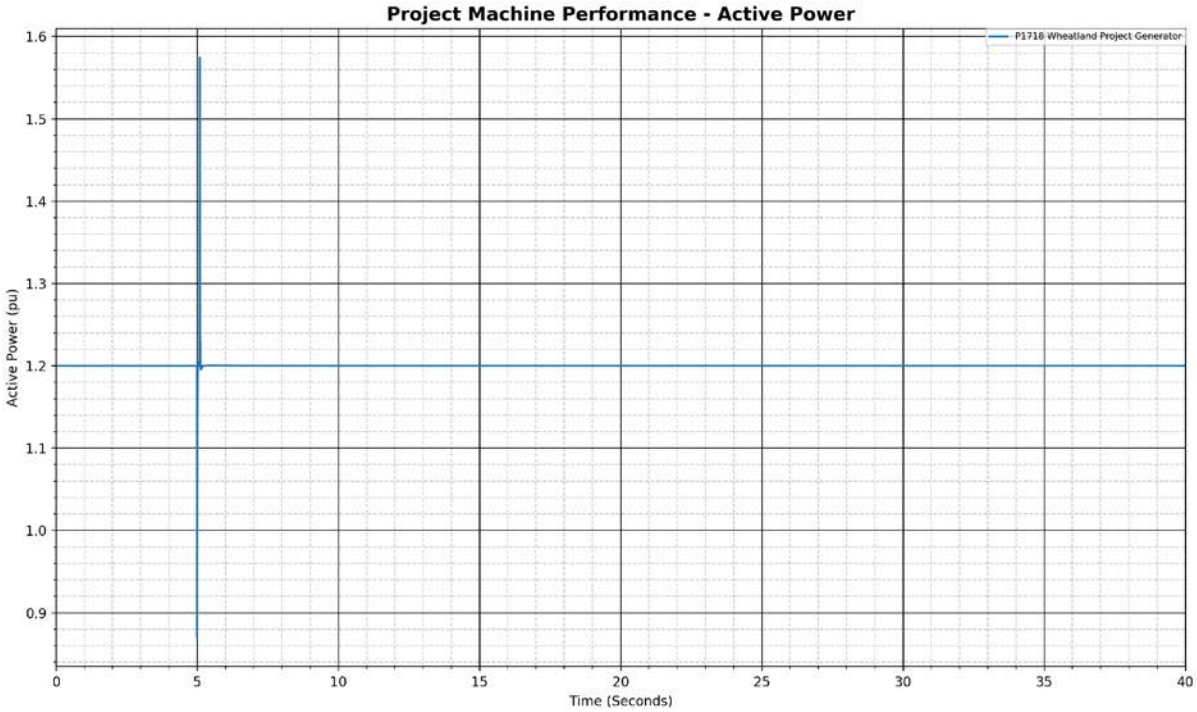


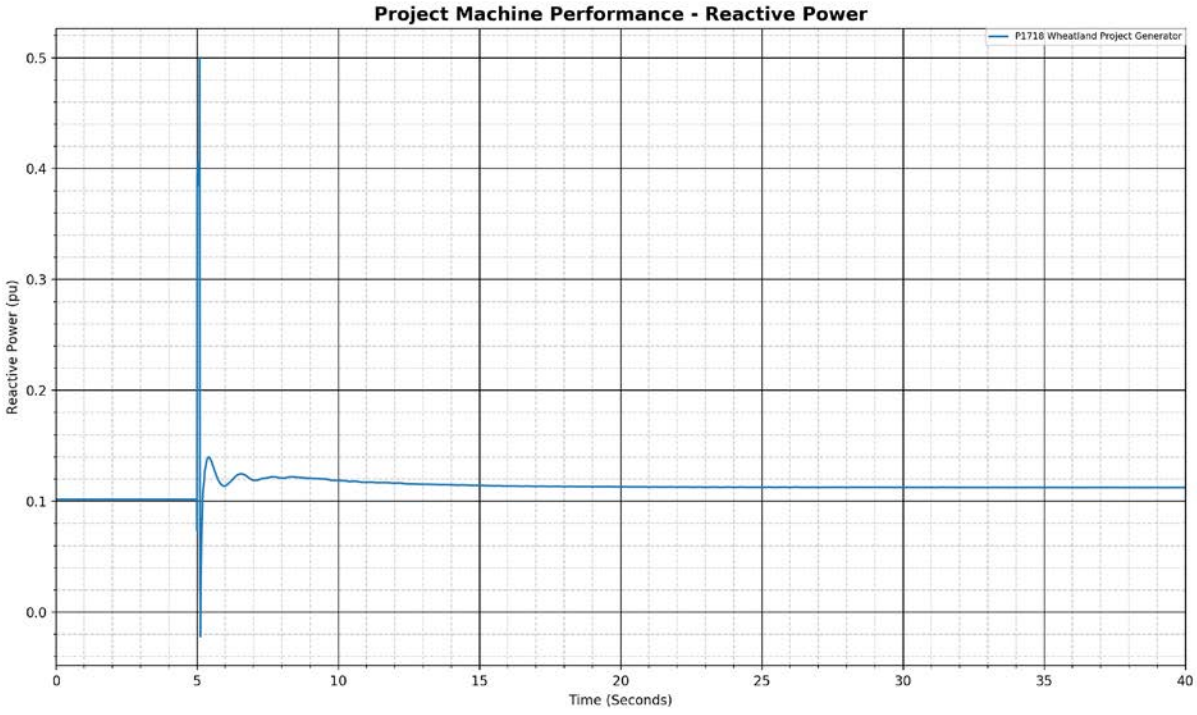

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

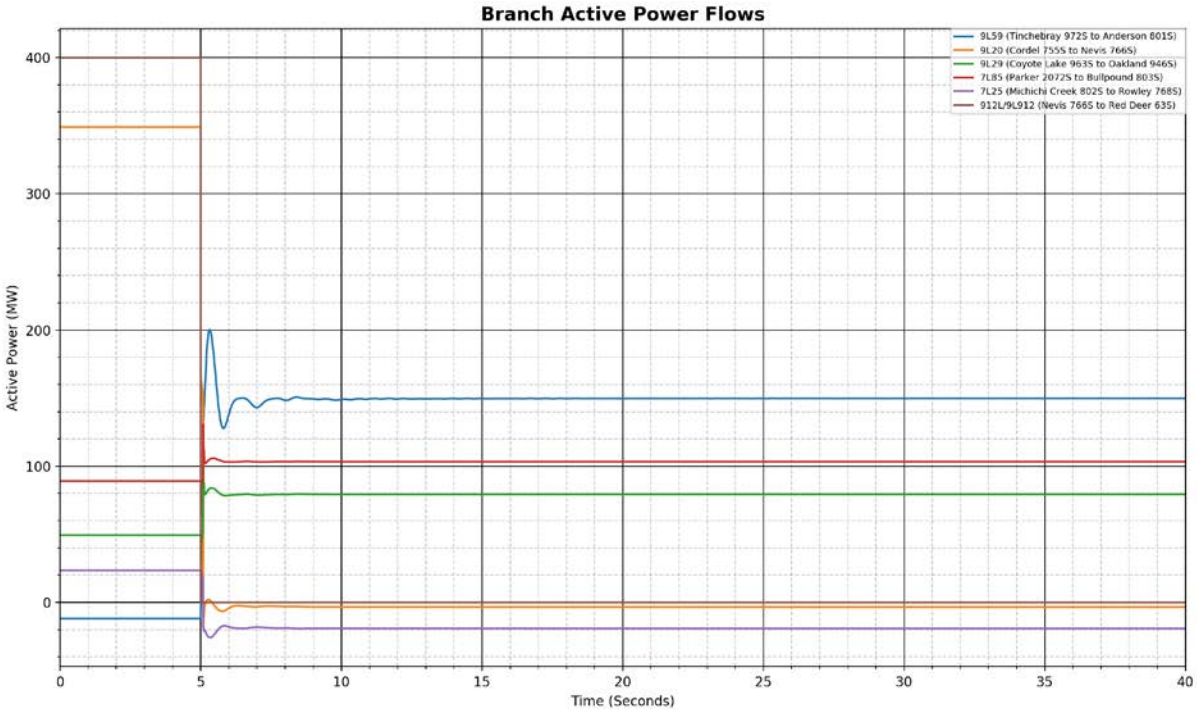

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
3
2
1
0
−1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Active Power (MW)
Time (Seconds)

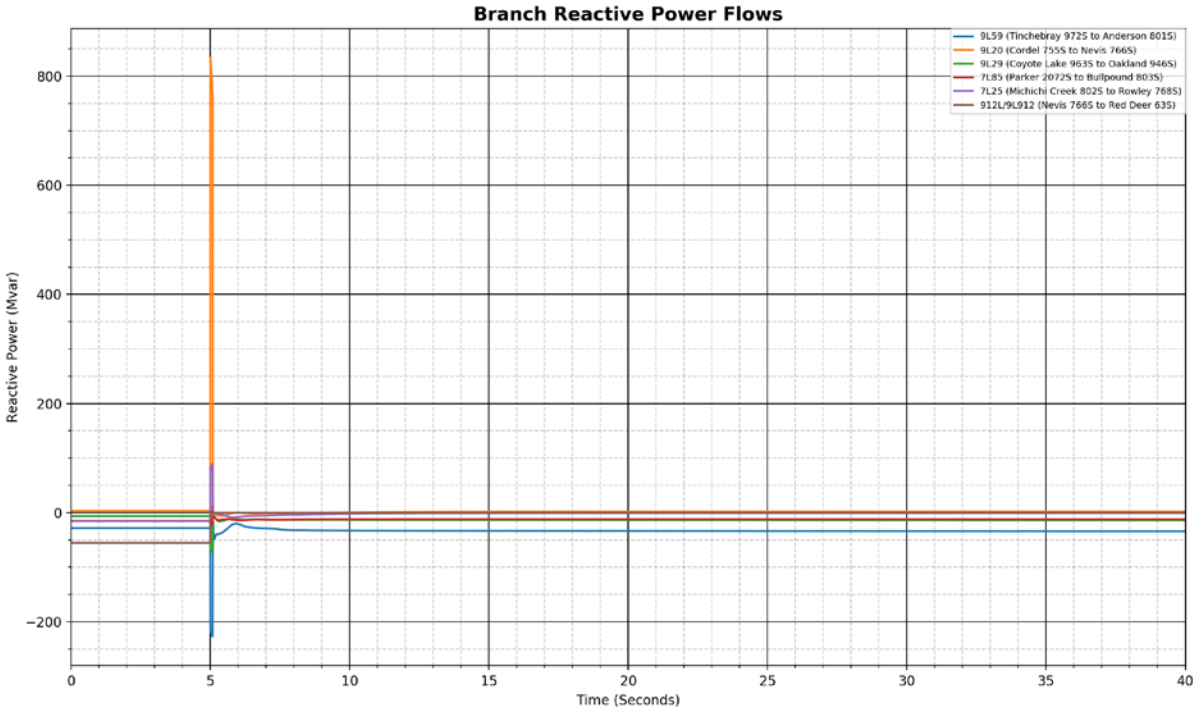
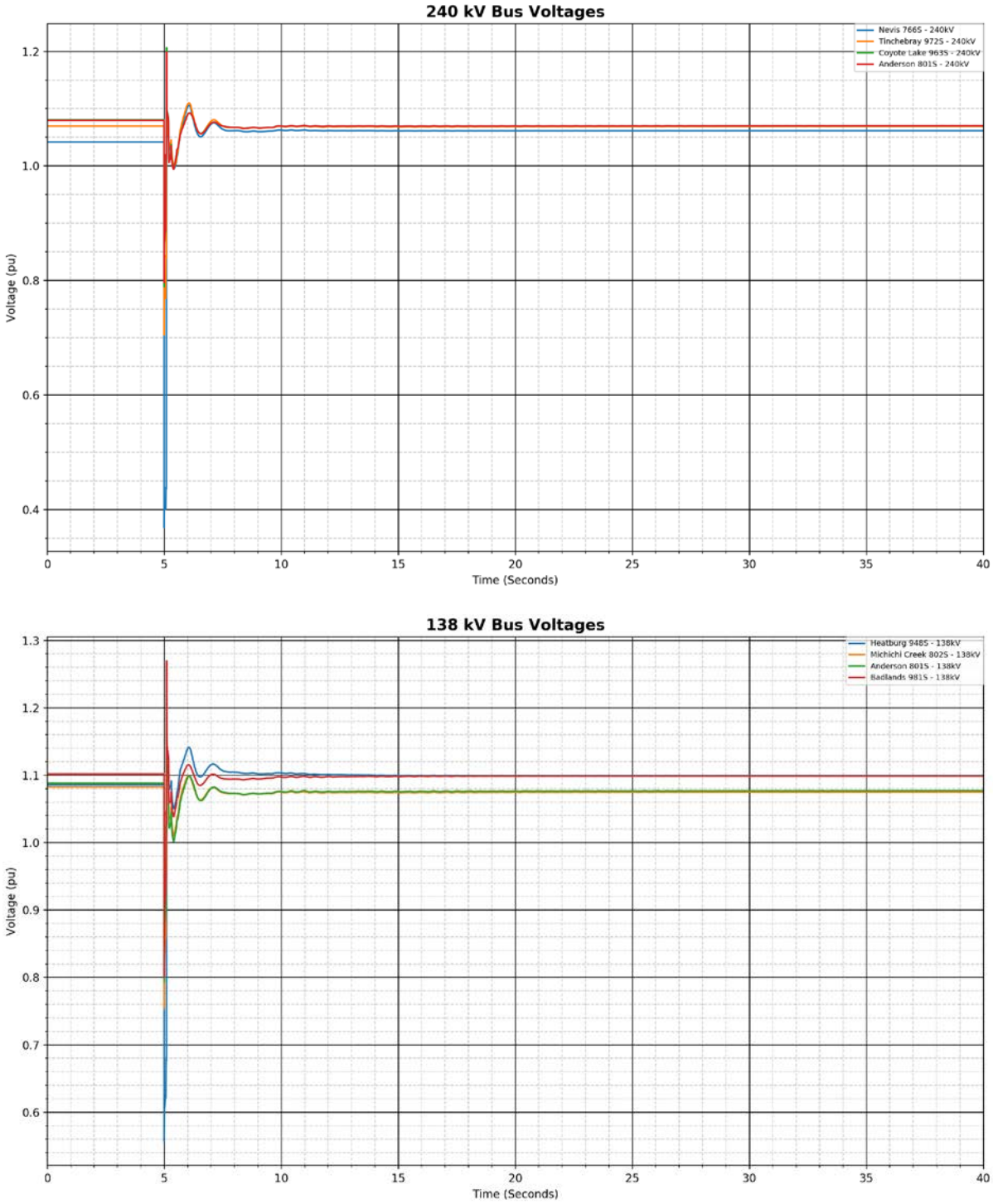
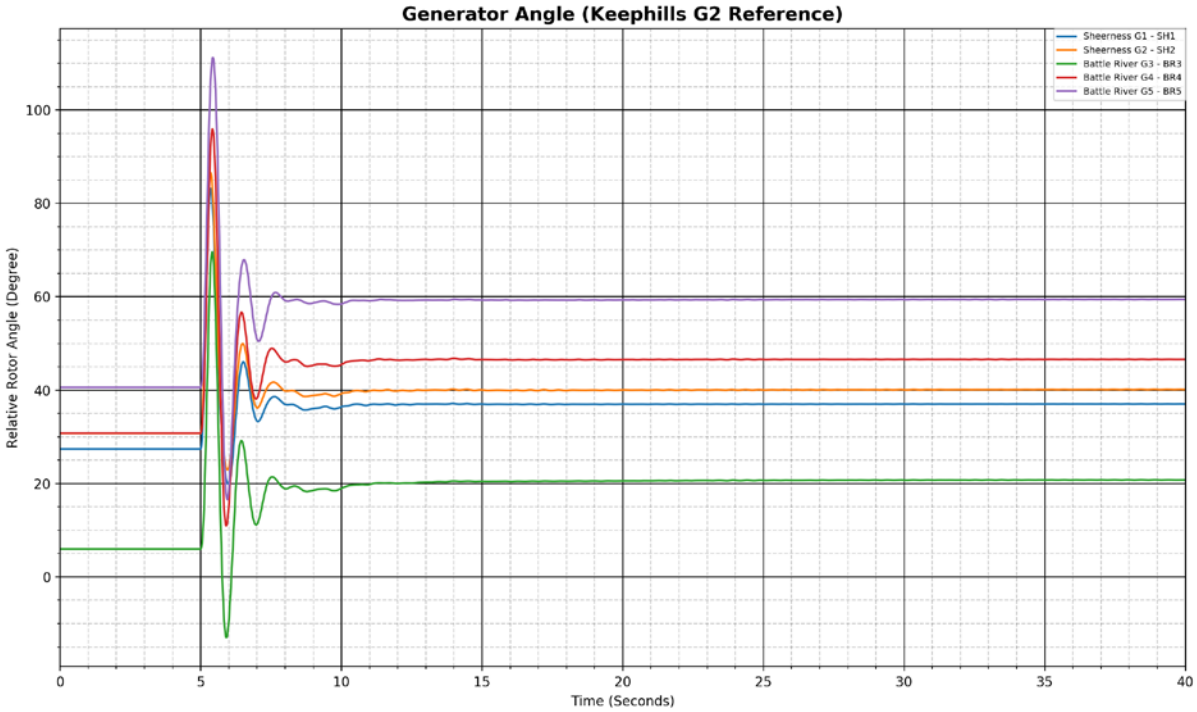
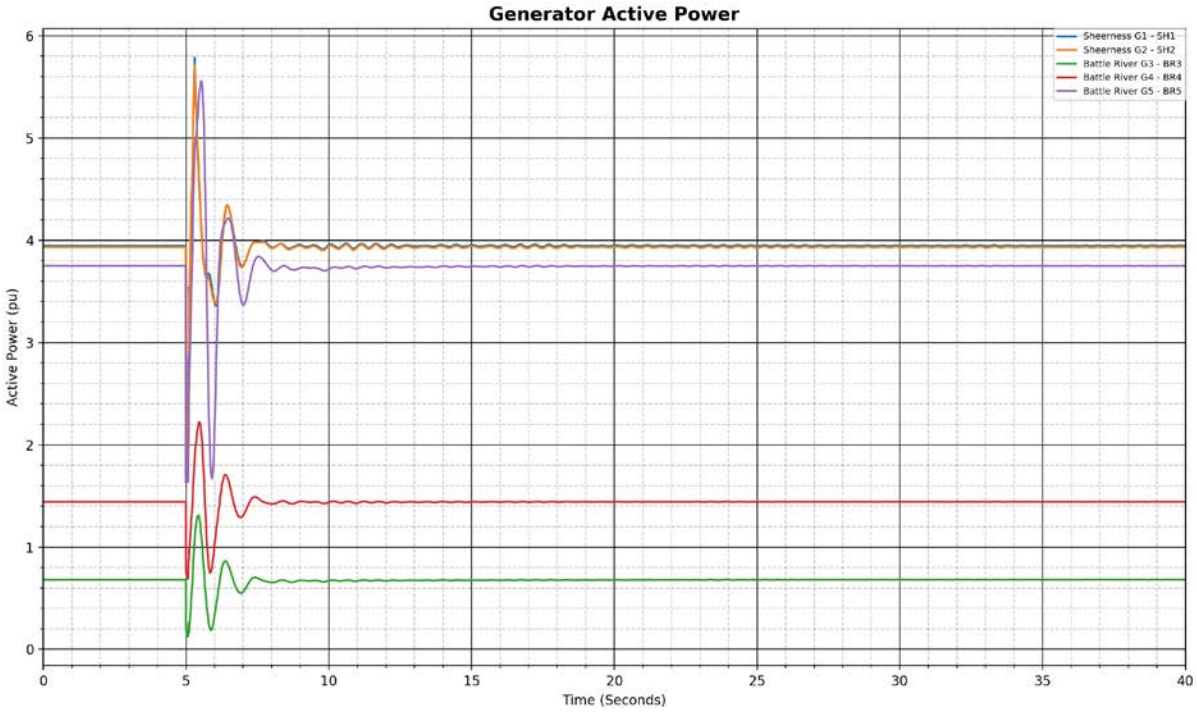
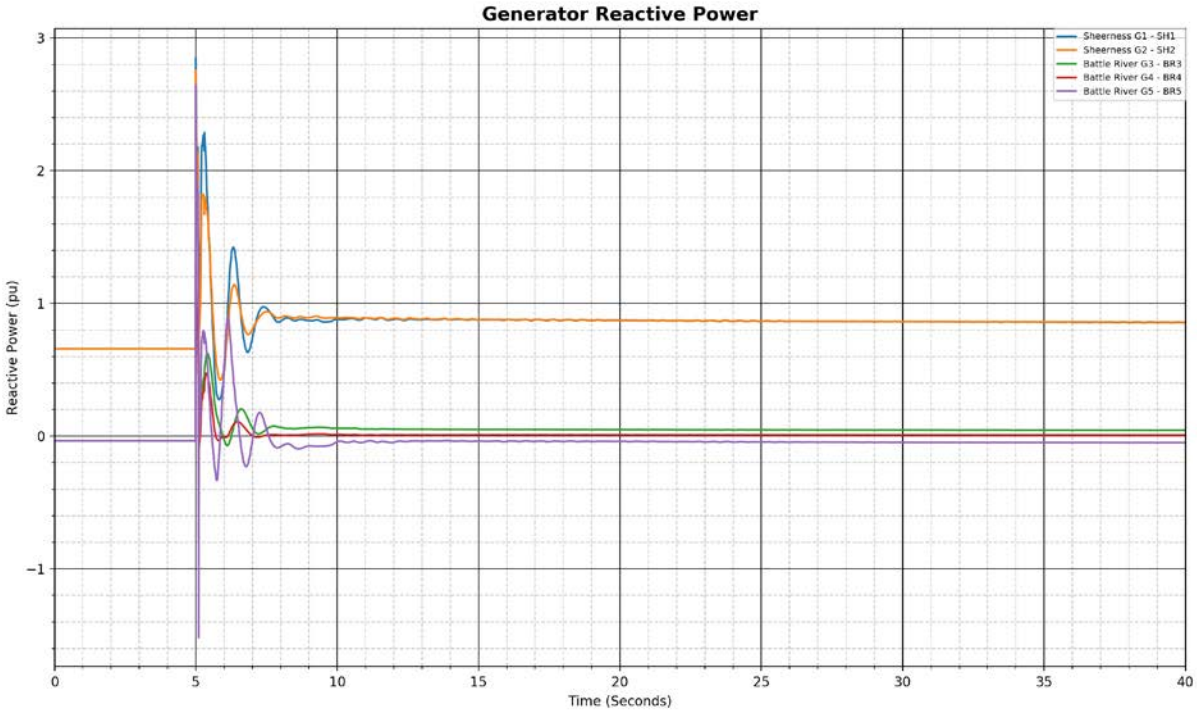

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Reactive Power (Mvar)
Time (Seconds)

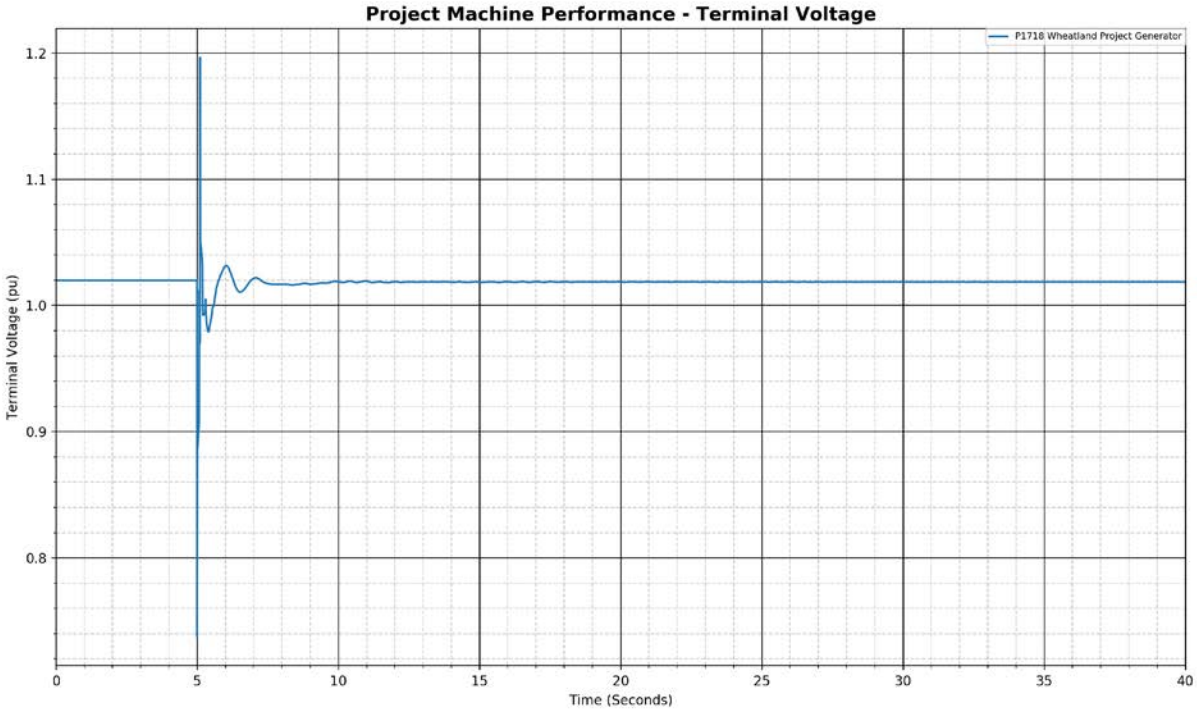
Figure A4-37: 912L/9L912 (Nevis 766S - Red Deer 63S): 3-phase fault at Red Deer 63S

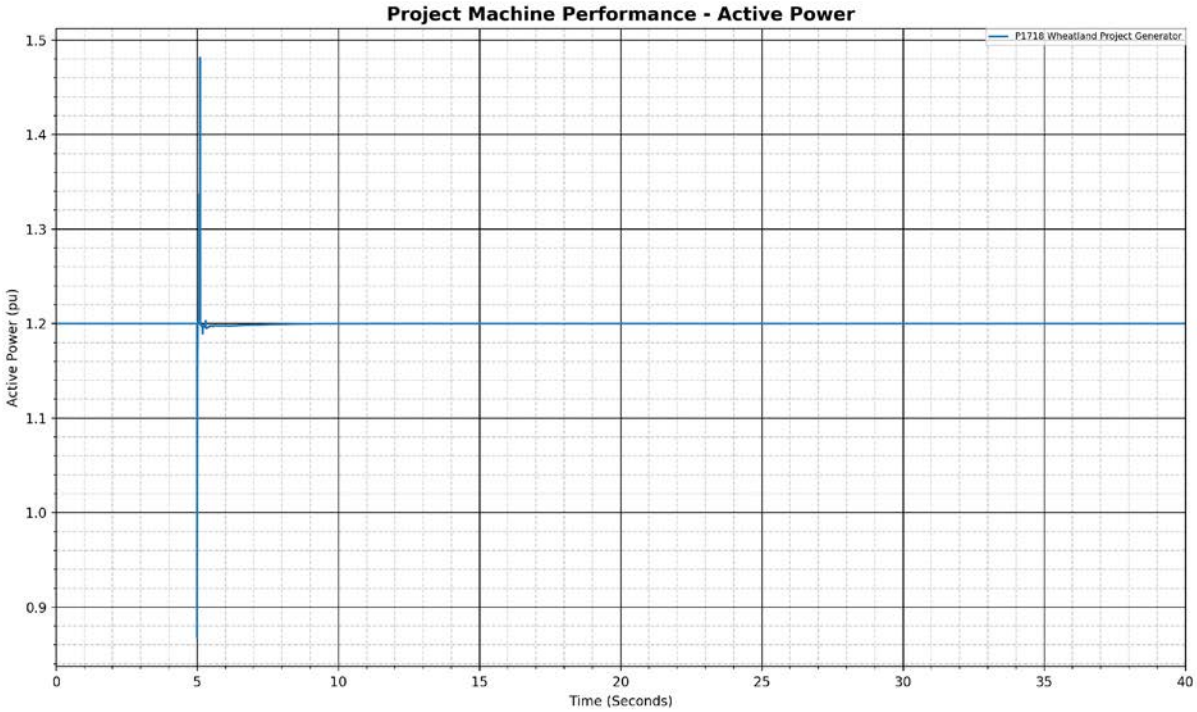


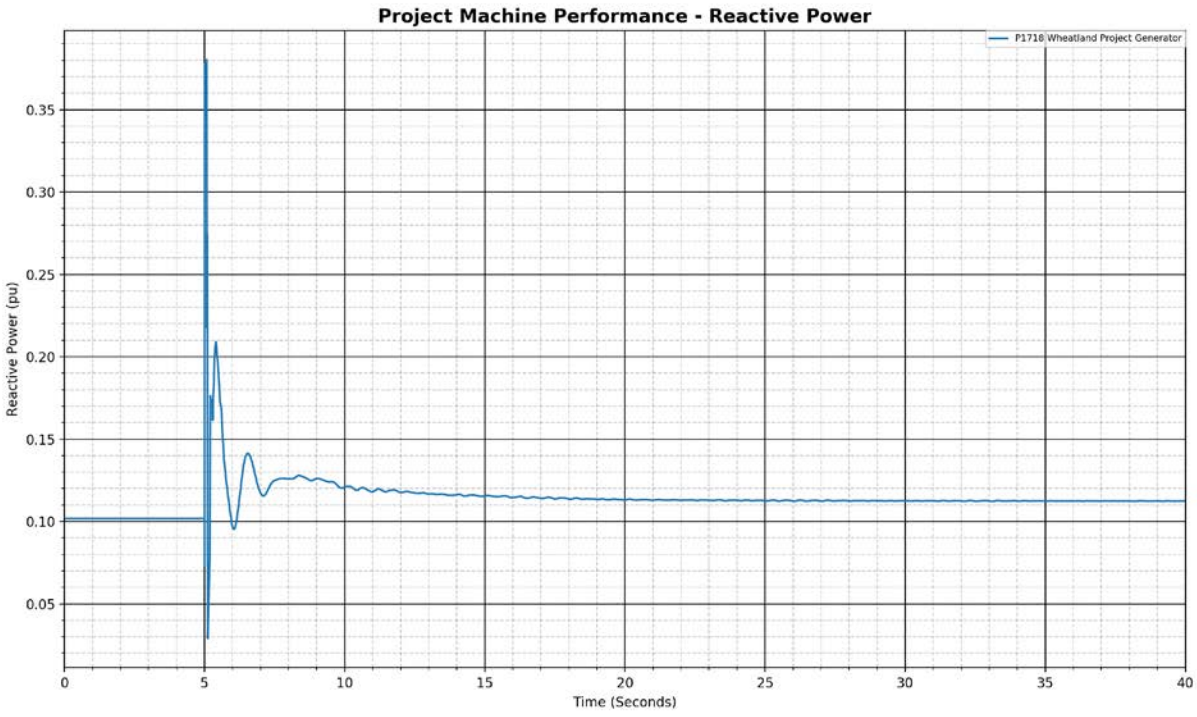

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

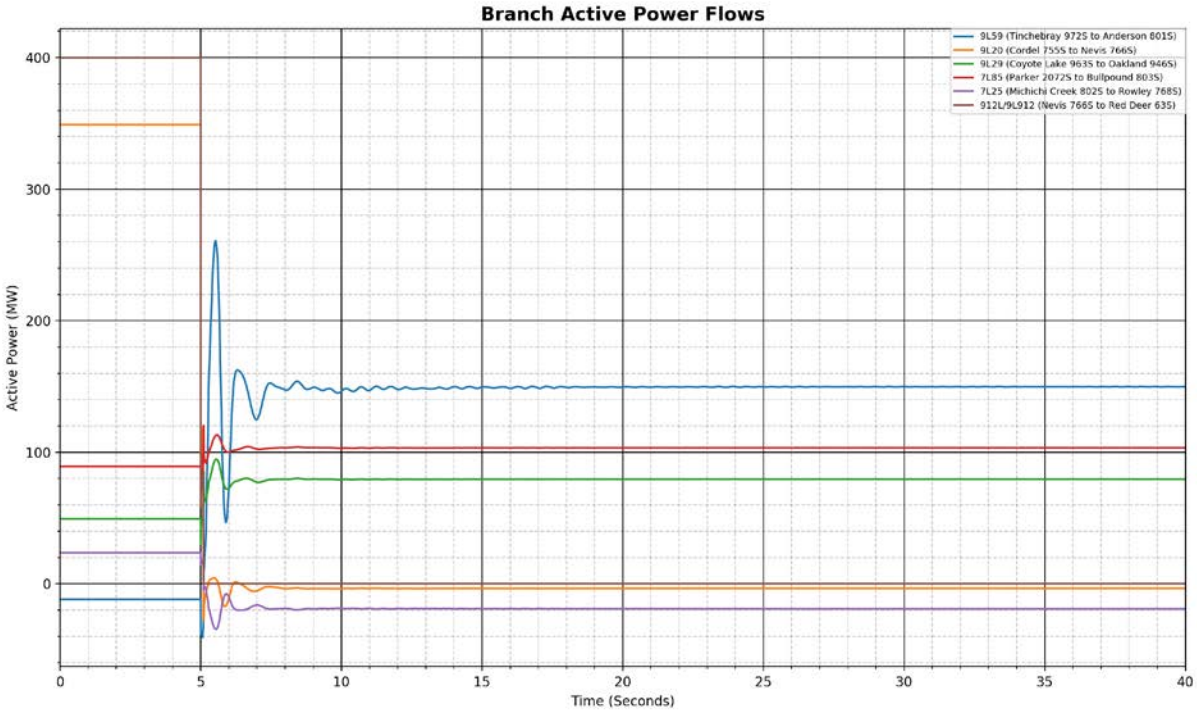

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Active Power (MW)
Time (Seconds)

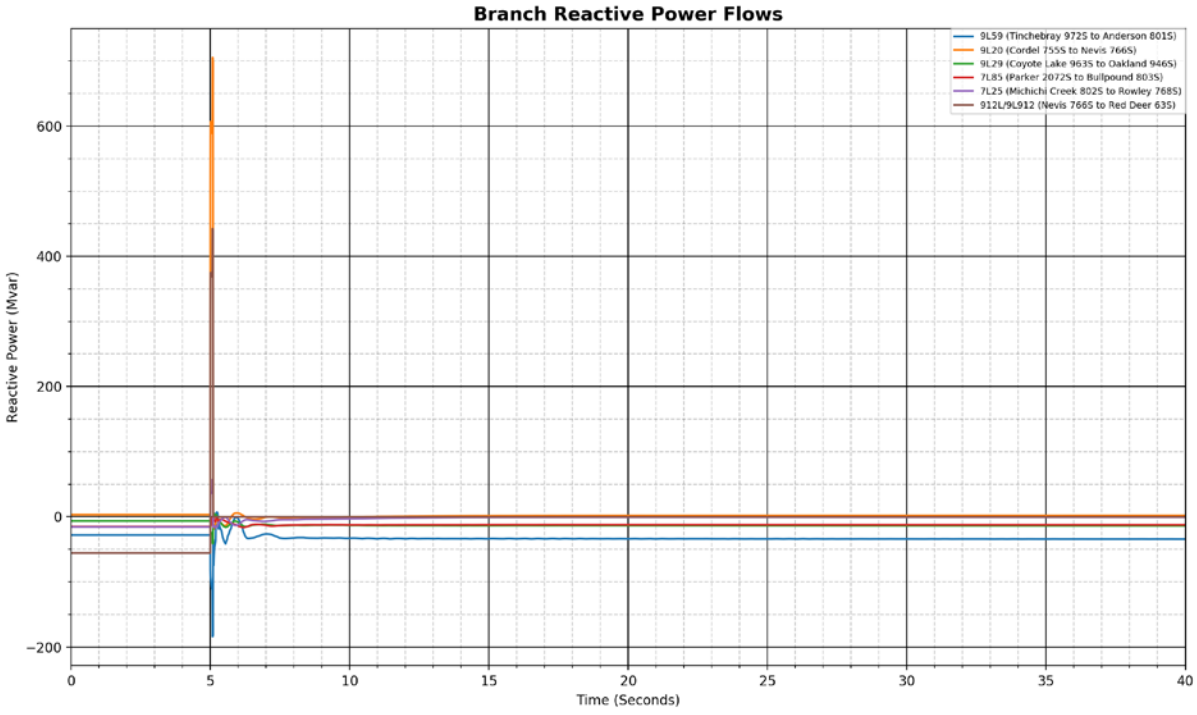
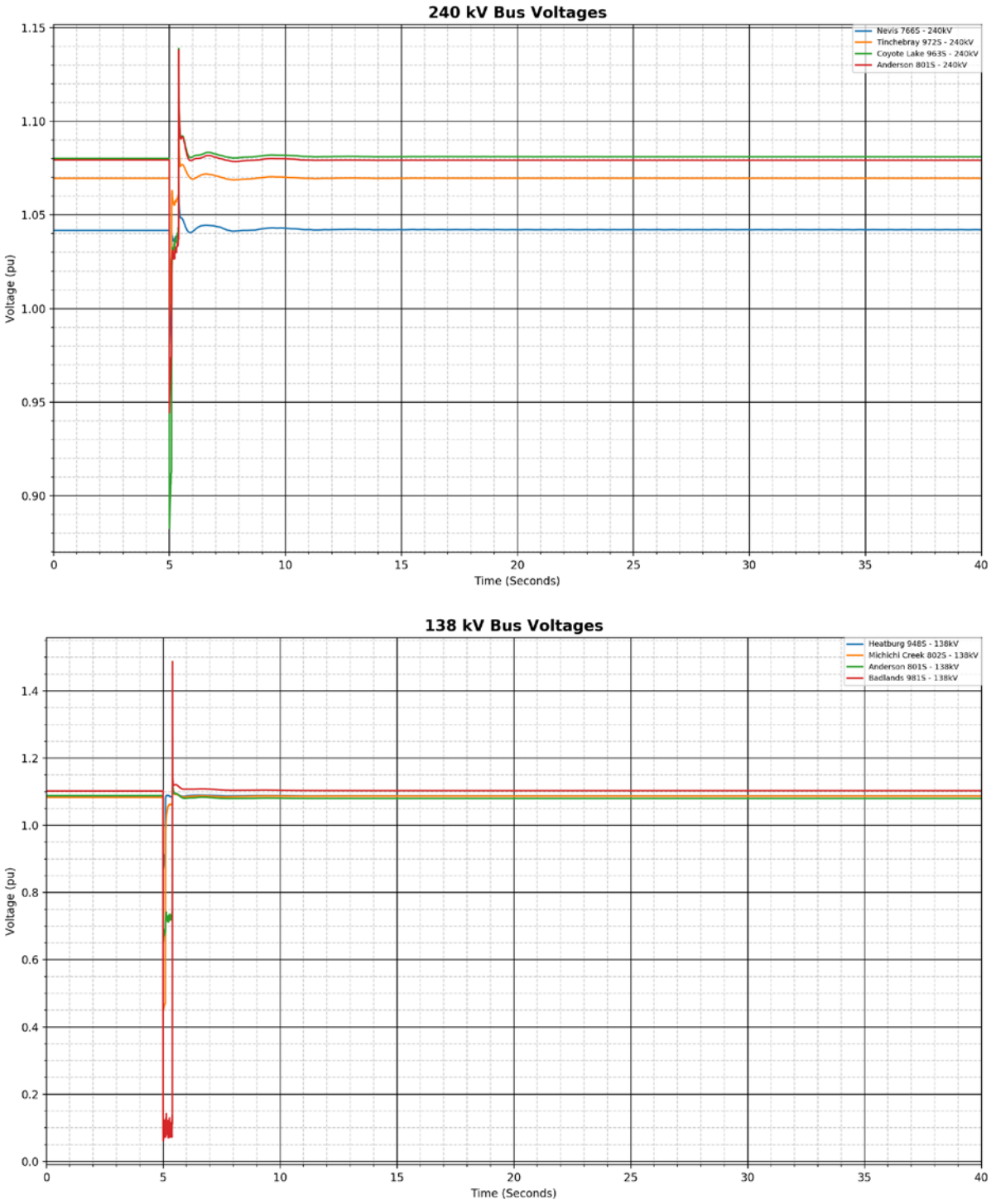
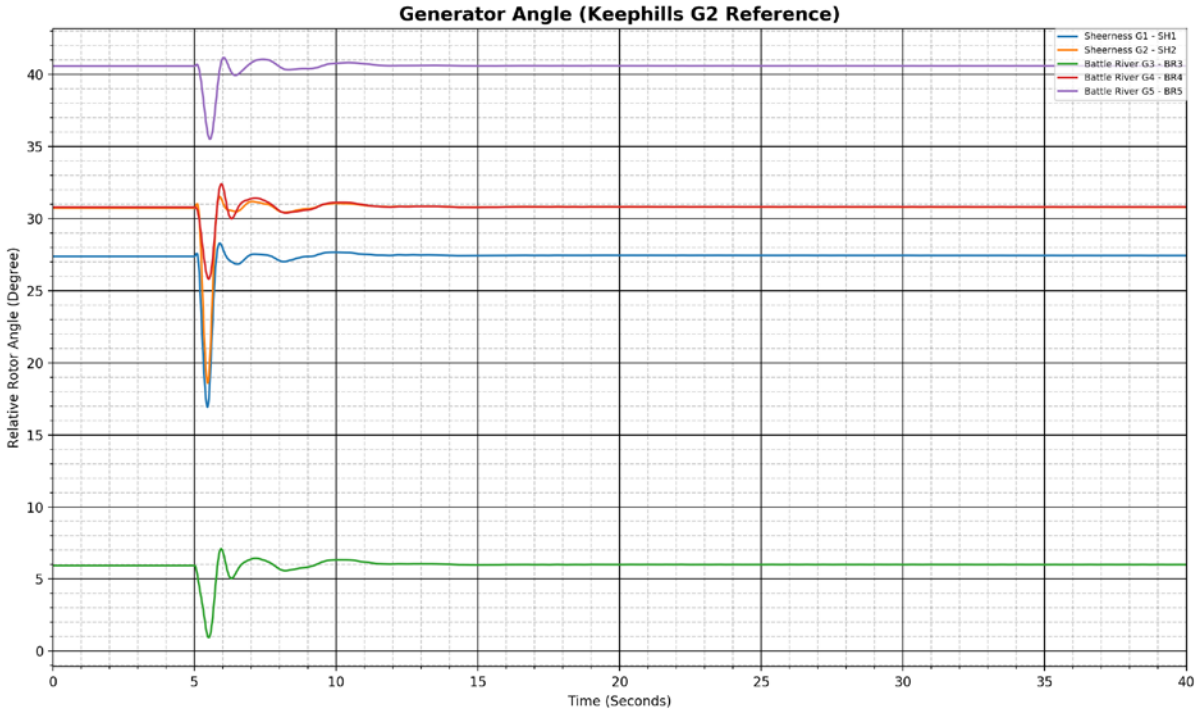
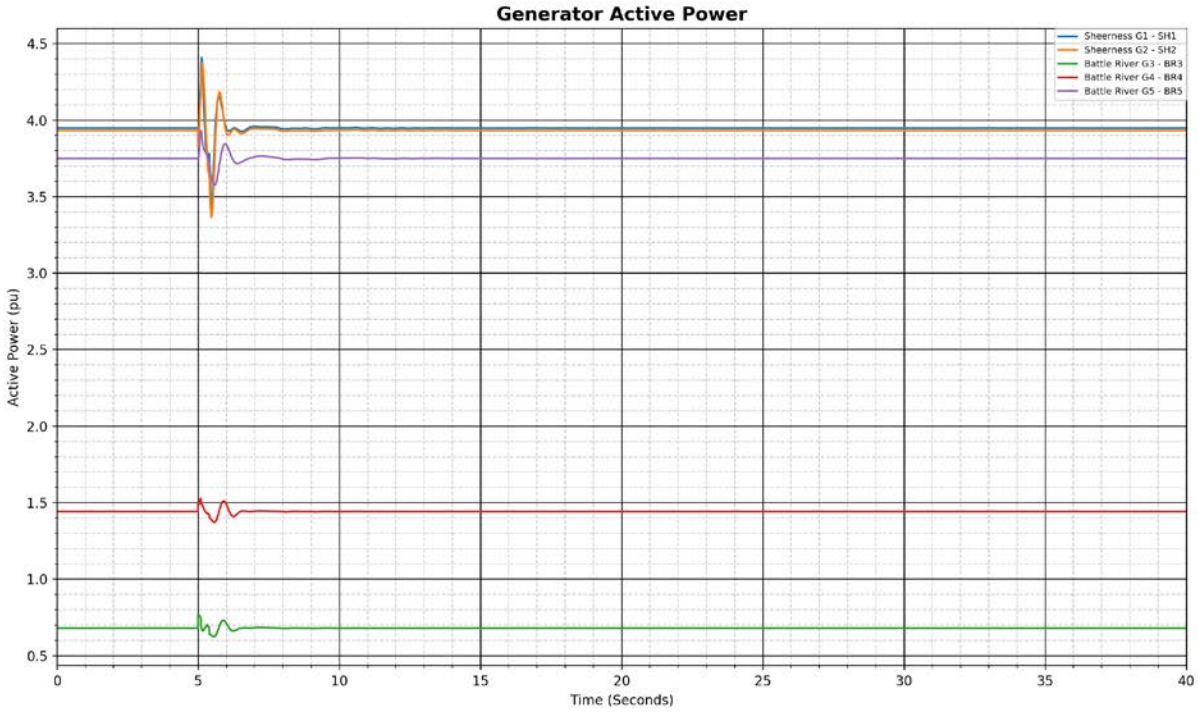
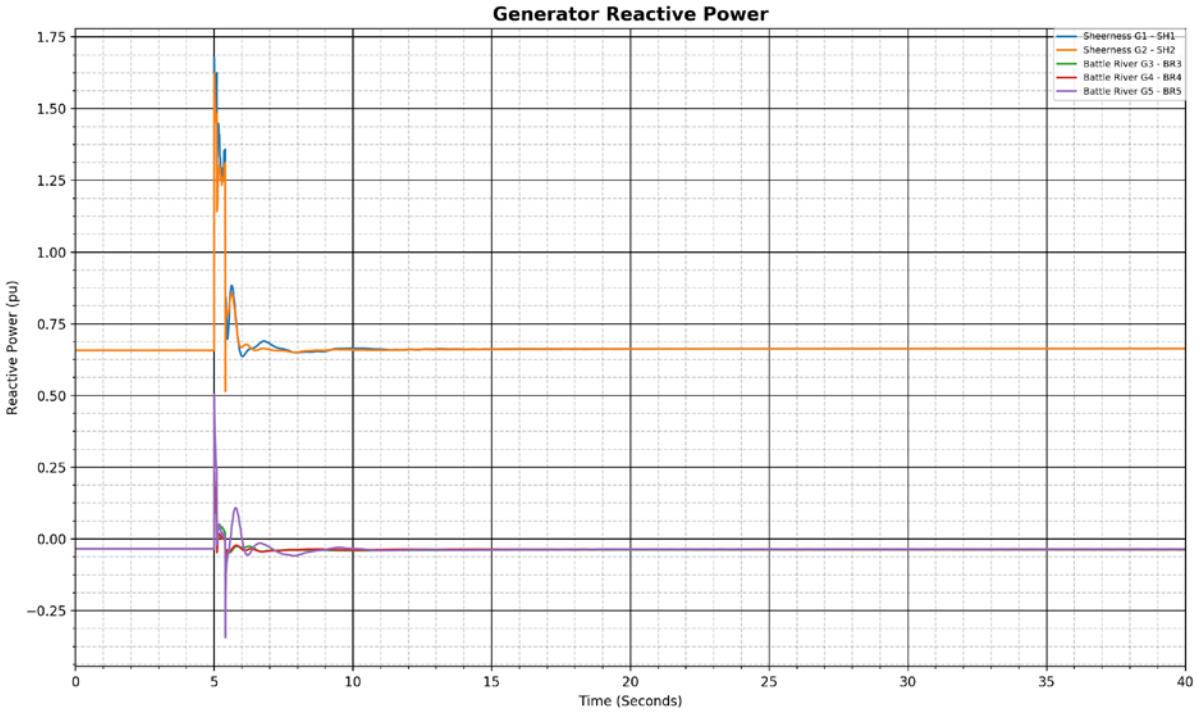

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Reactive Power (Mvar)
Time (Seconds)

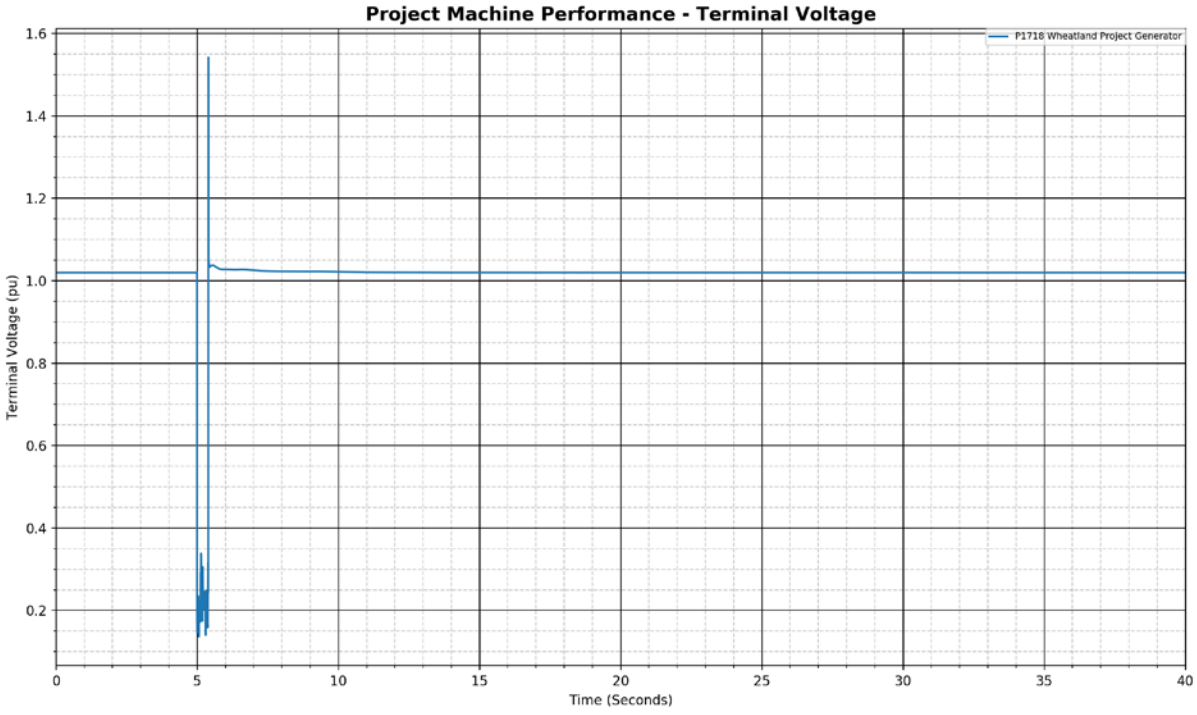
Figure A4-38: 7L203 (Wintering Hills 804S - Parker 2072S): 3-phase fault at Wintering Hills 804S

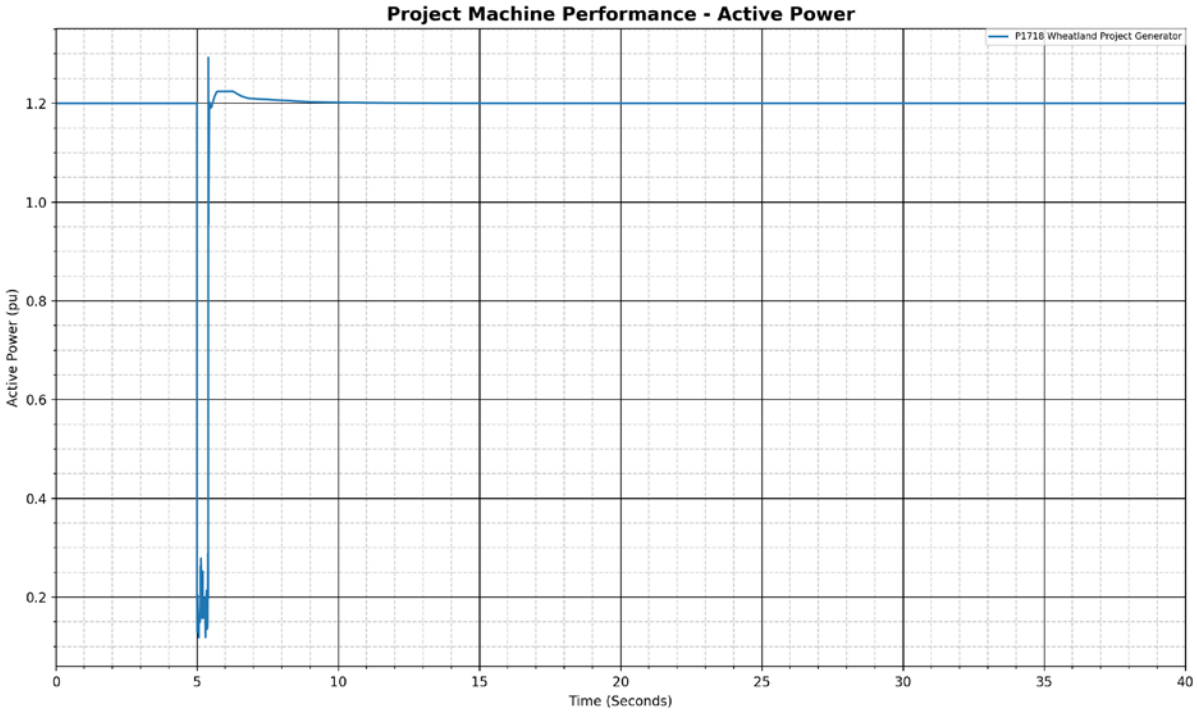


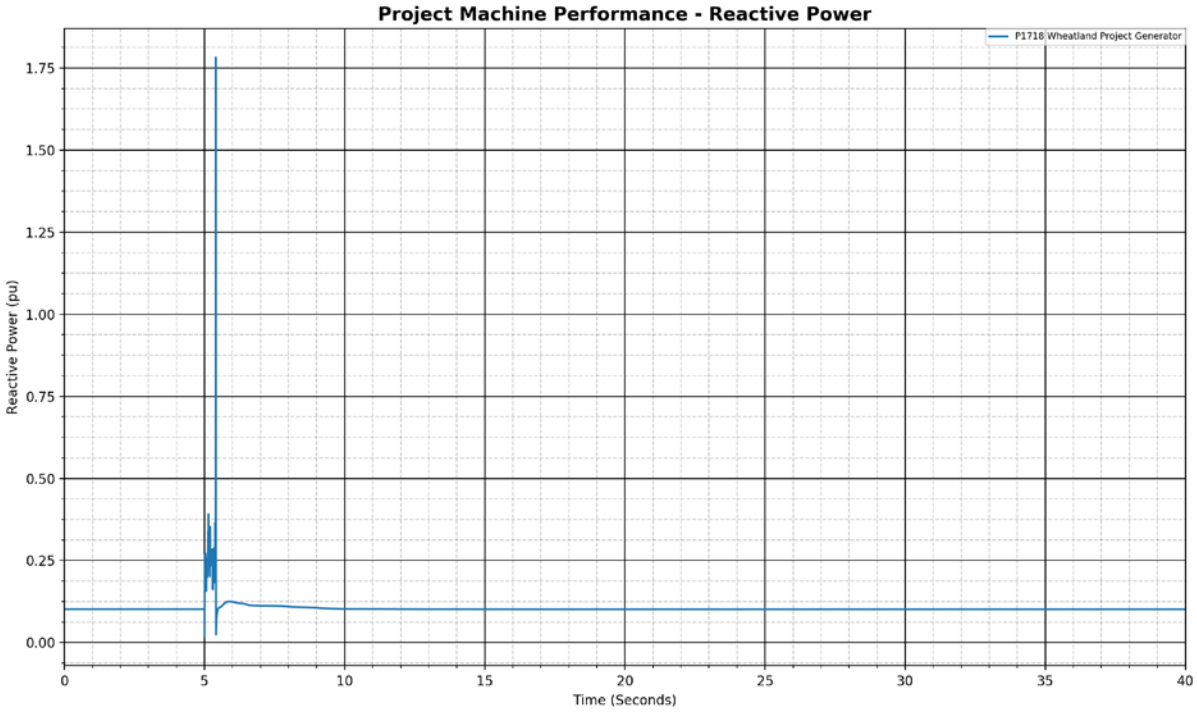

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

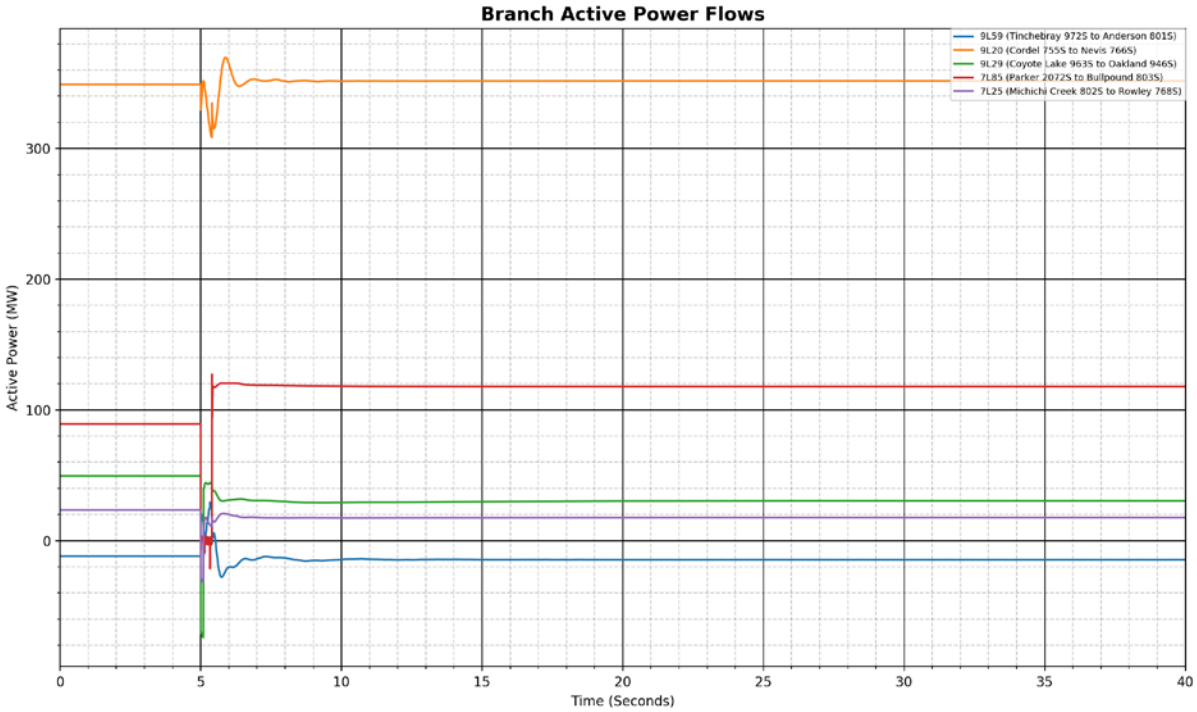

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
300
200
100
0
0
5
10
15
20
25
30
35
40
Time (Seconds)

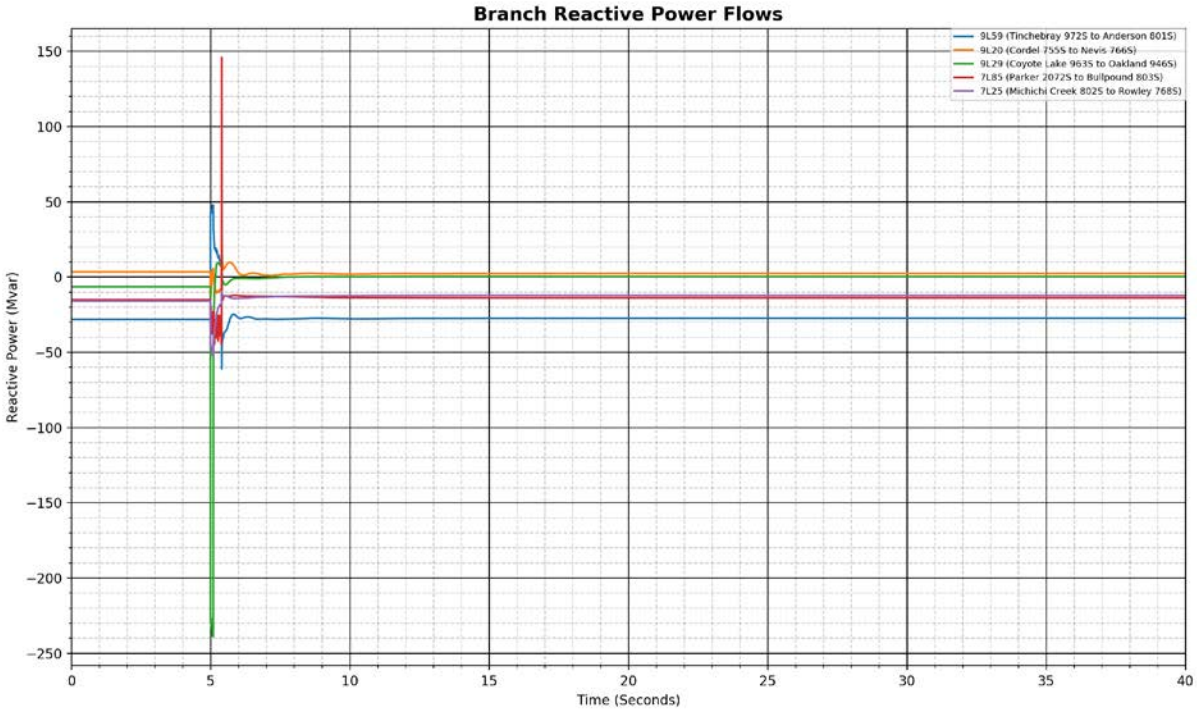
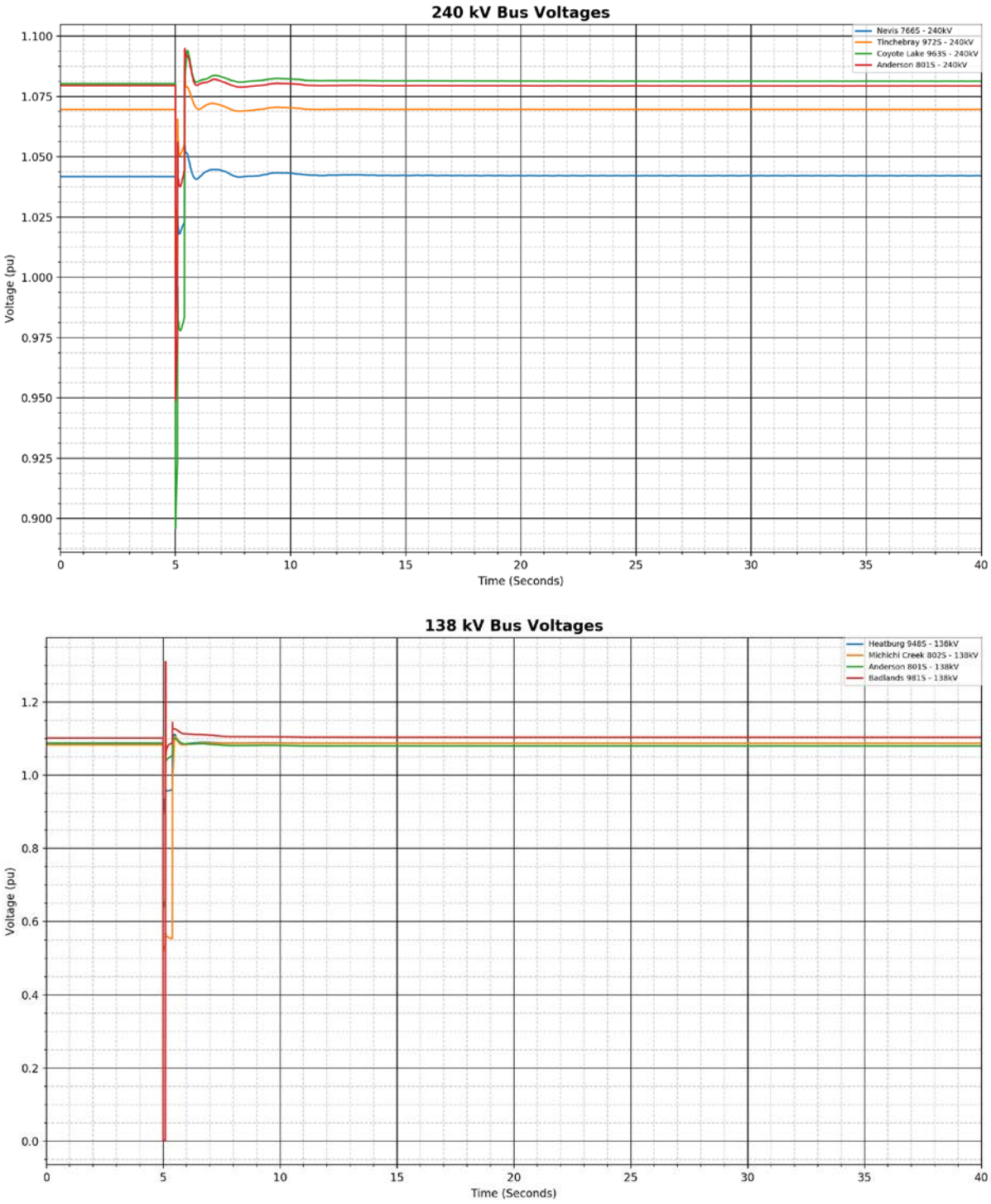
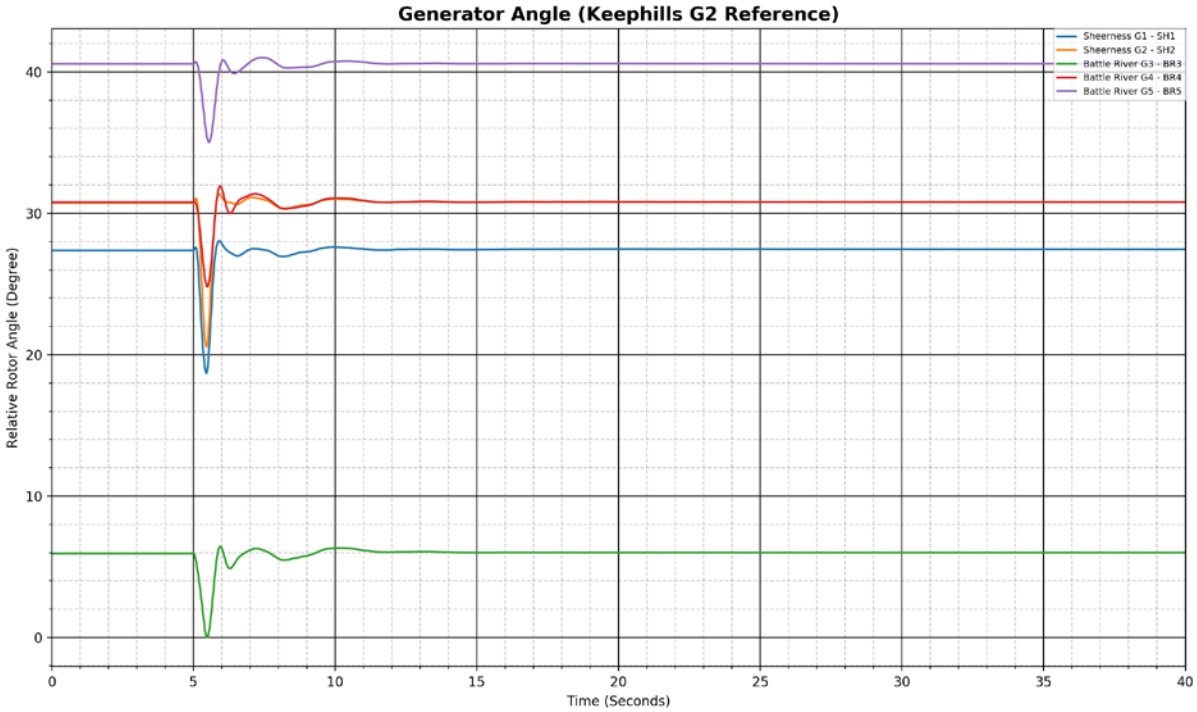
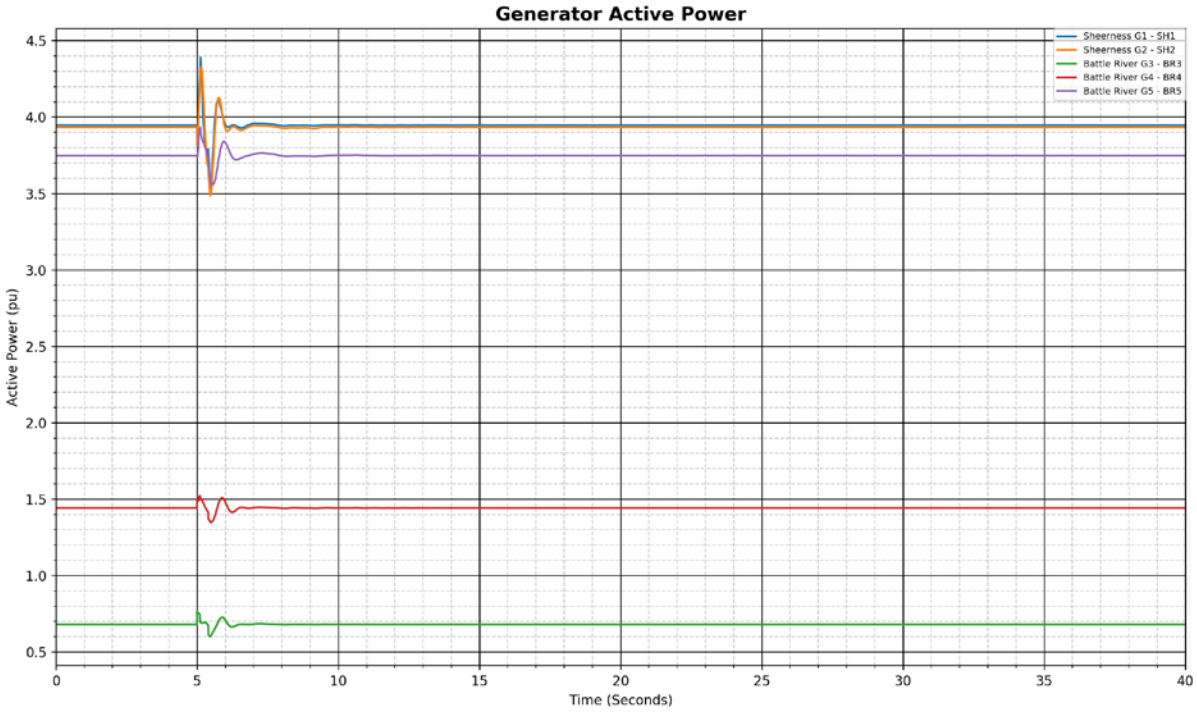
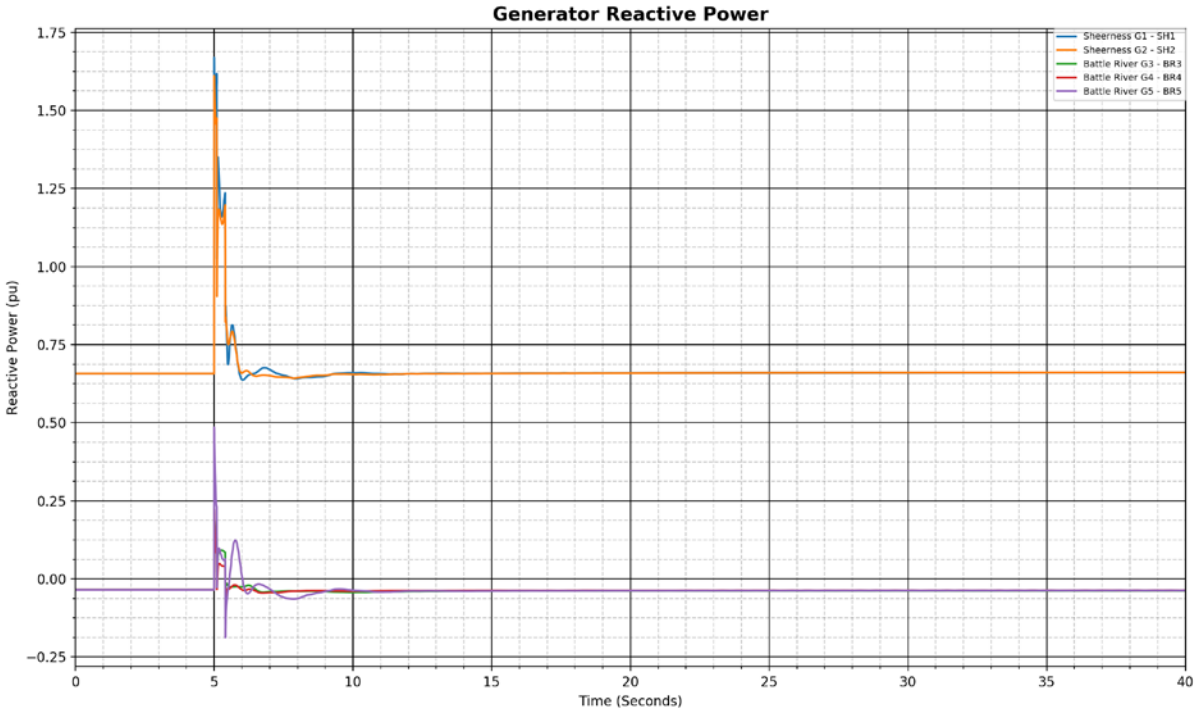

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
150
100
50
0
−50
−100
−150
−200
−250
0
5
10
15
20
25
30
35
40
Time (Seconds)

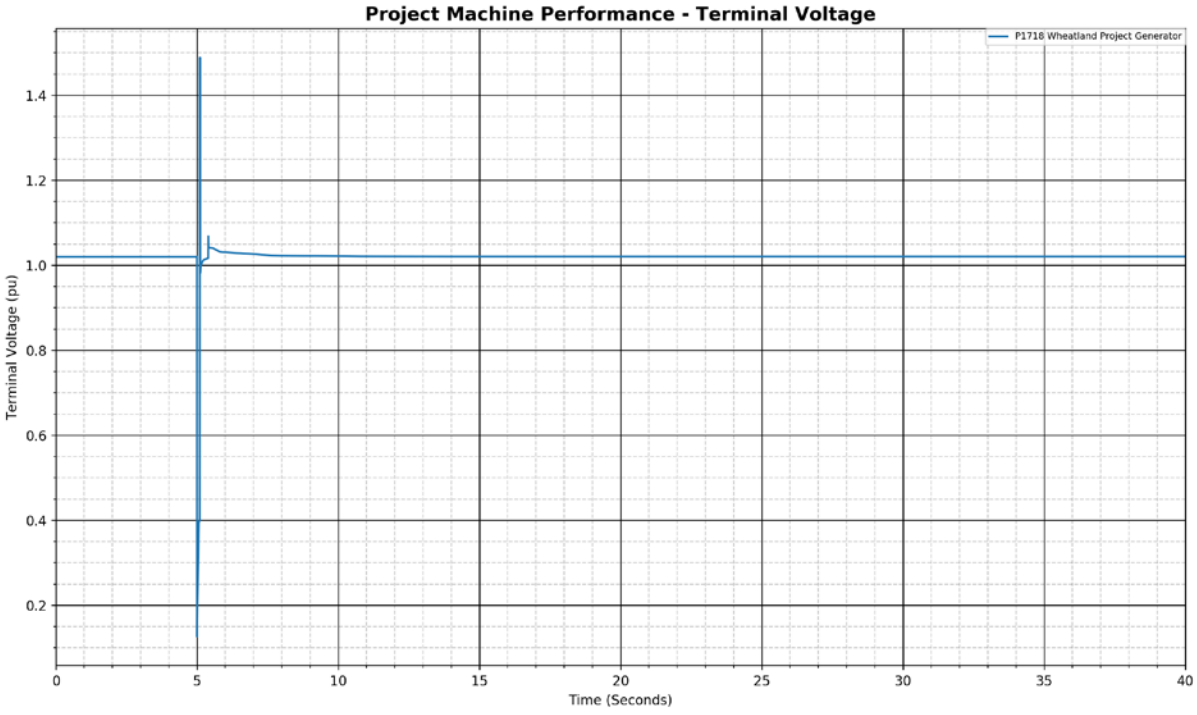
Figure A4-39: 7L203 (Wintering Hills 804S - Parker 2072S): 3-phase fault at Parker 2072S

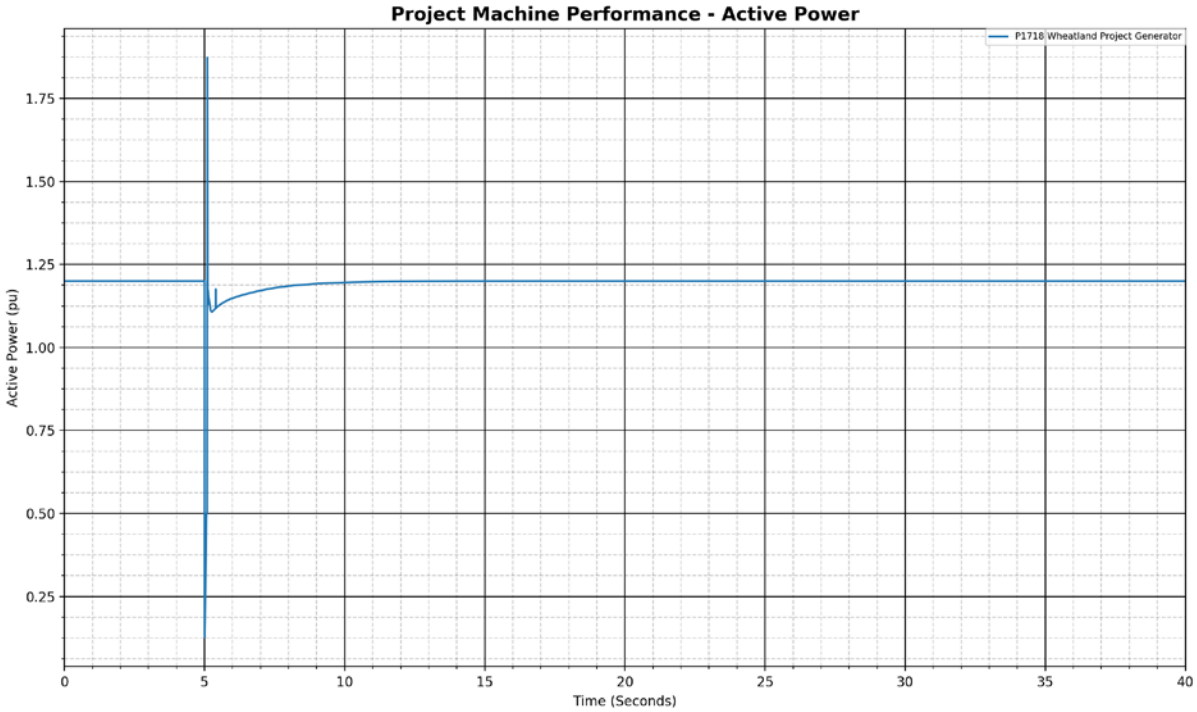


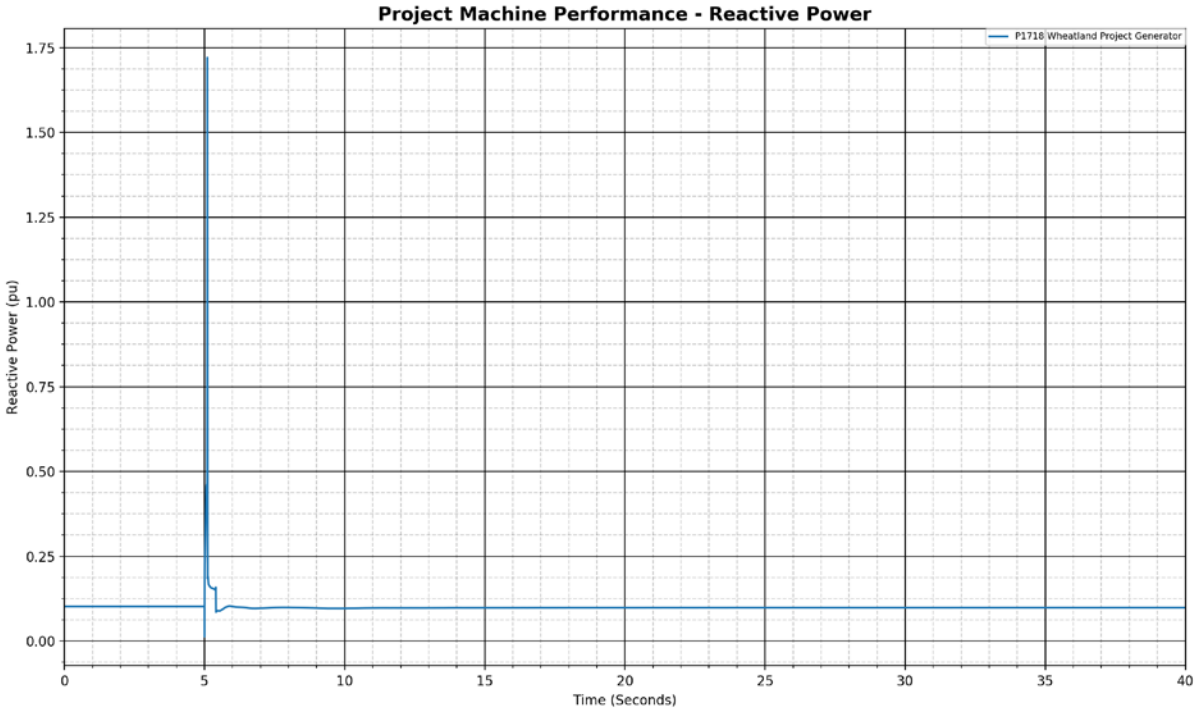

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

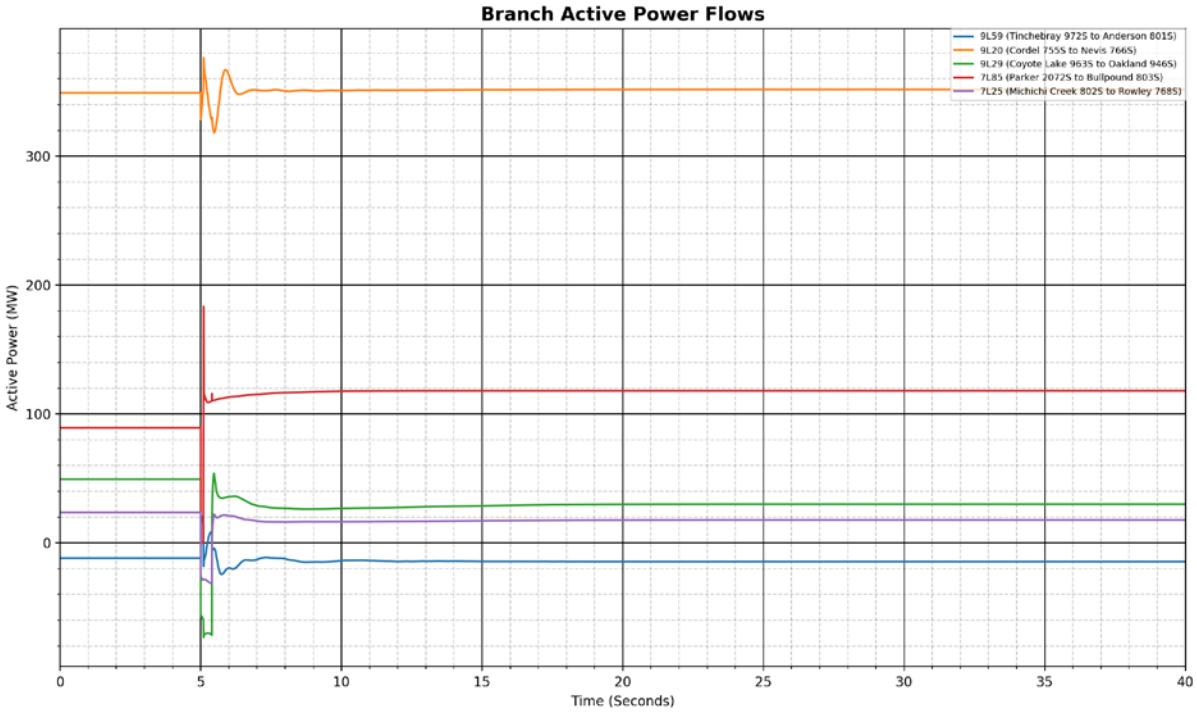

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Reactive Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Project Machine Performance - Terminal Voltage
Terminal Voltage (pu)
Time (Seconds)
P1718 Wheatland Project Generator


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
300
200
100
0
0
5
10
15
20
25
30
35
40
Time (Seconds)

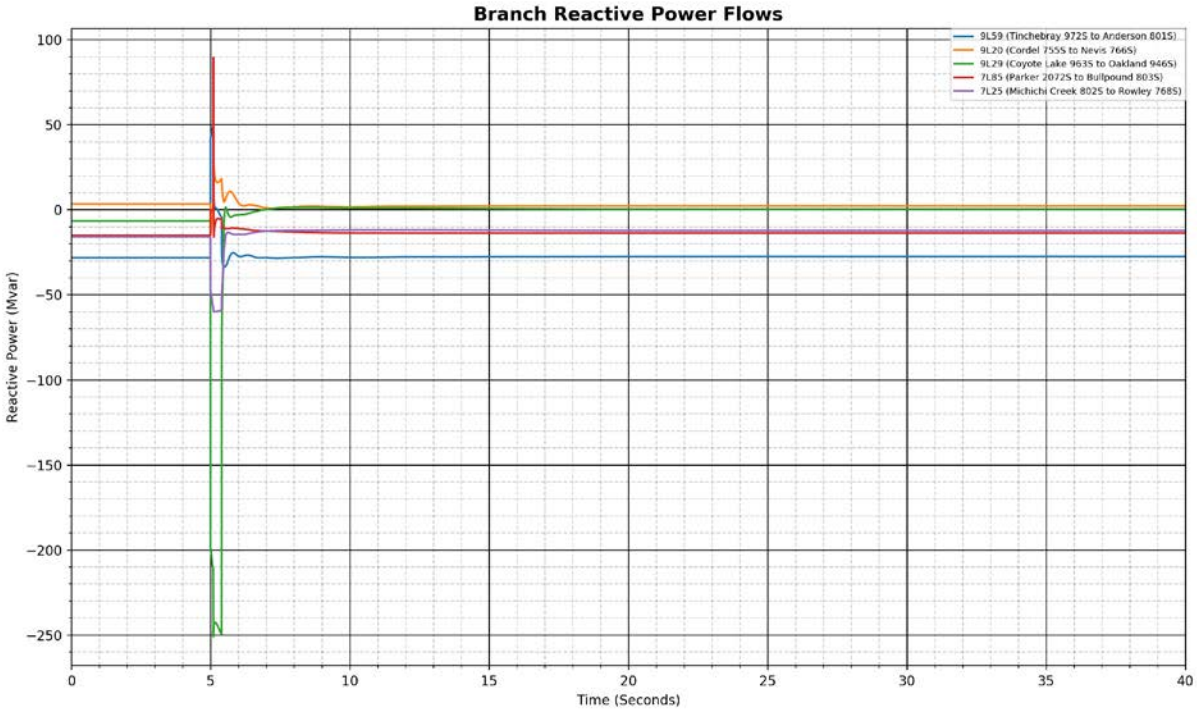
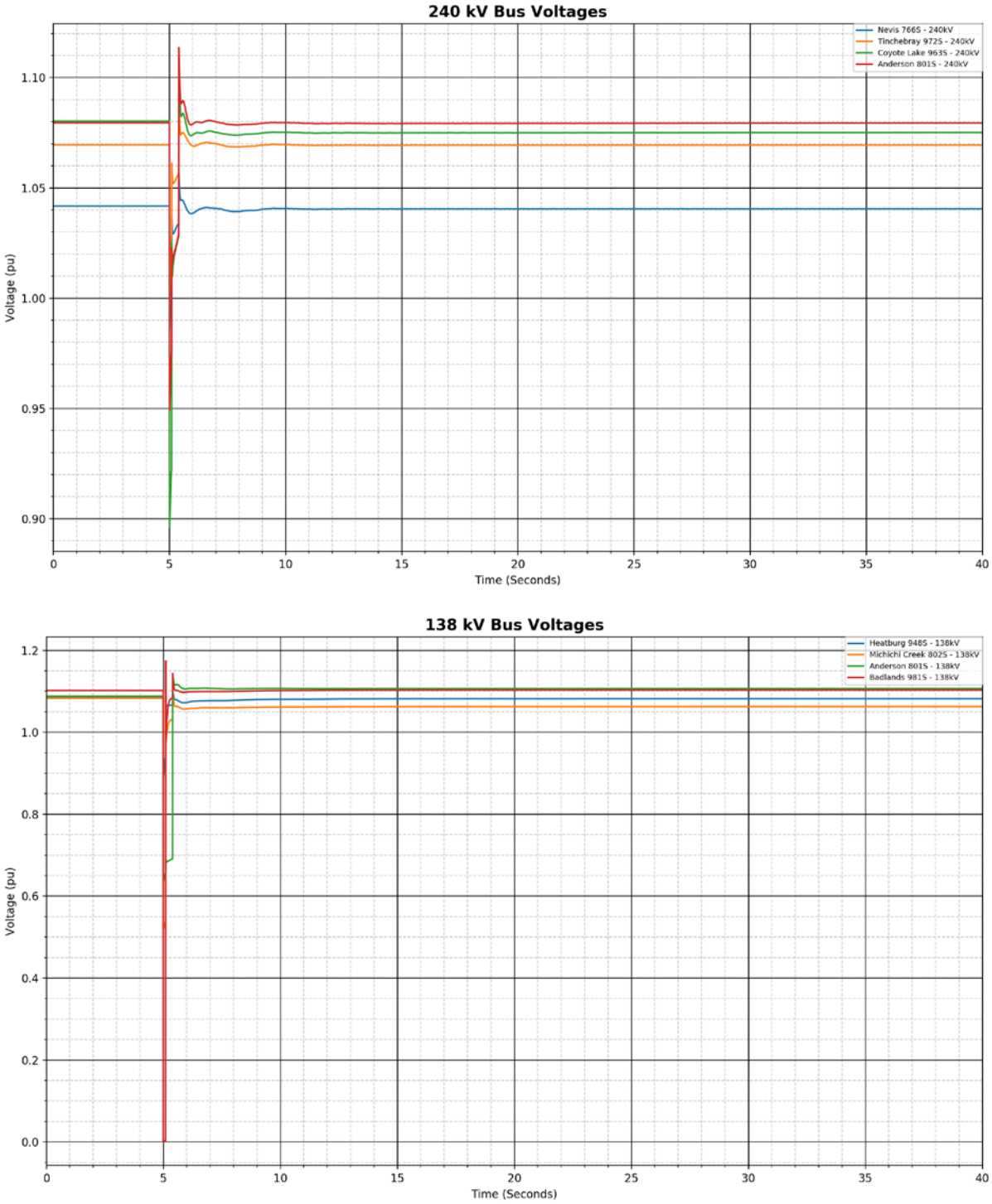
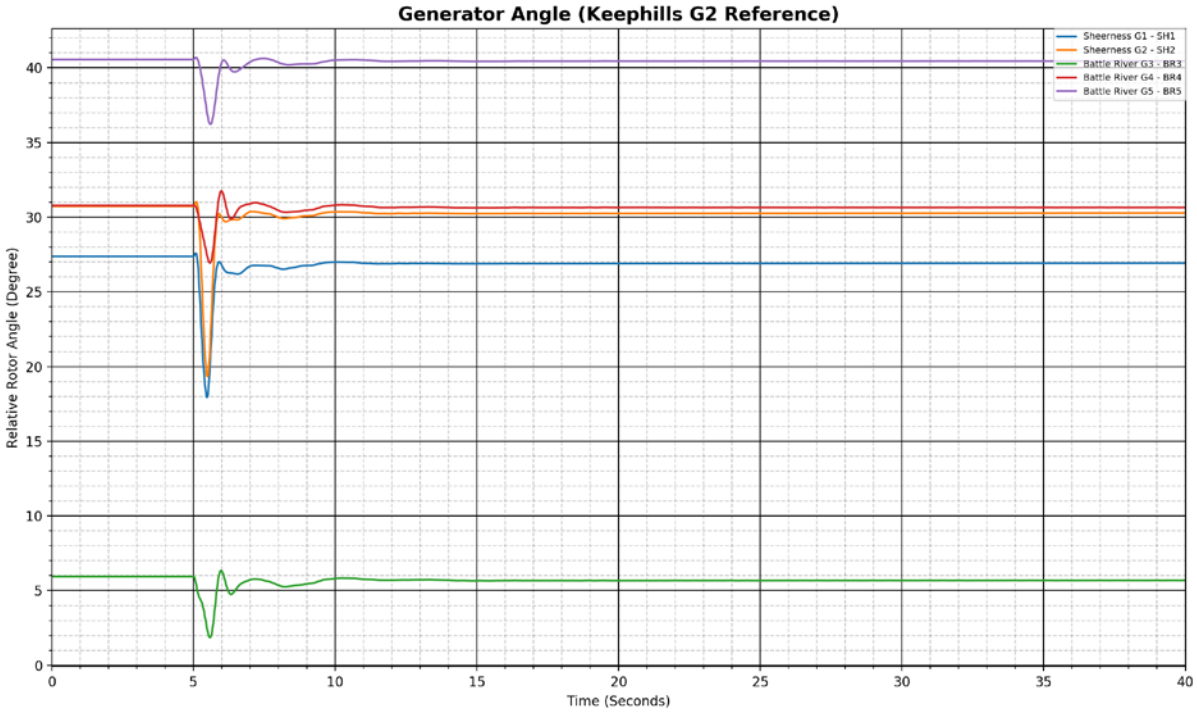
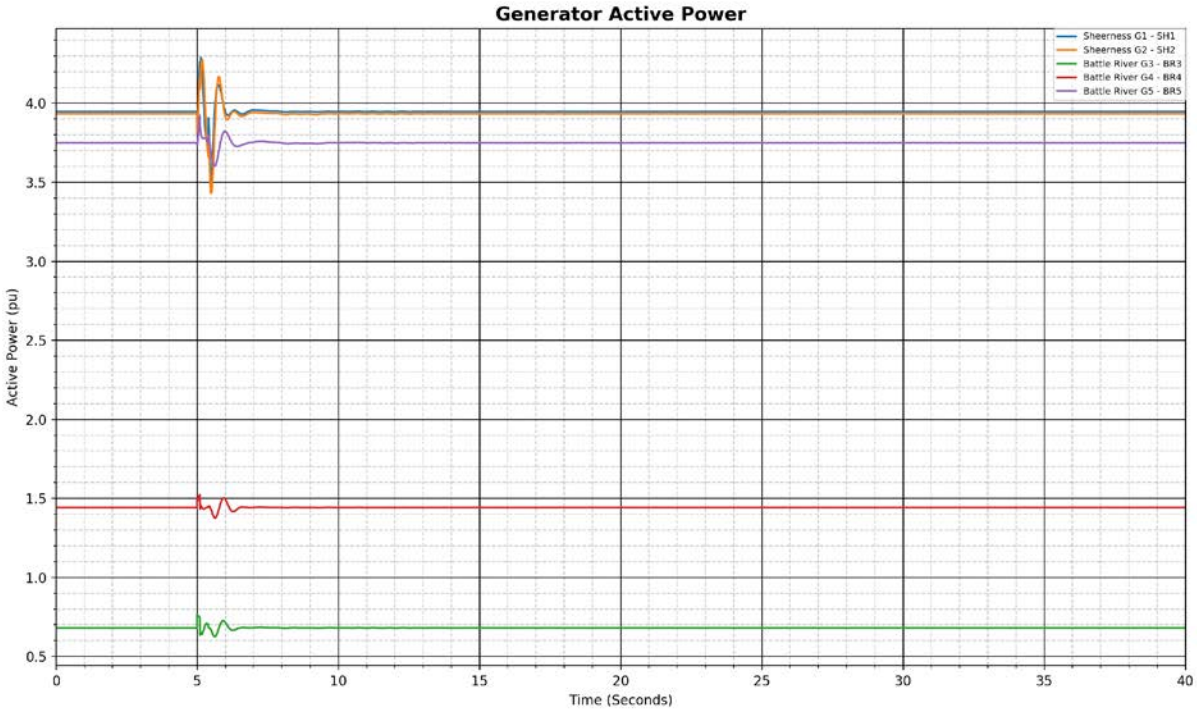
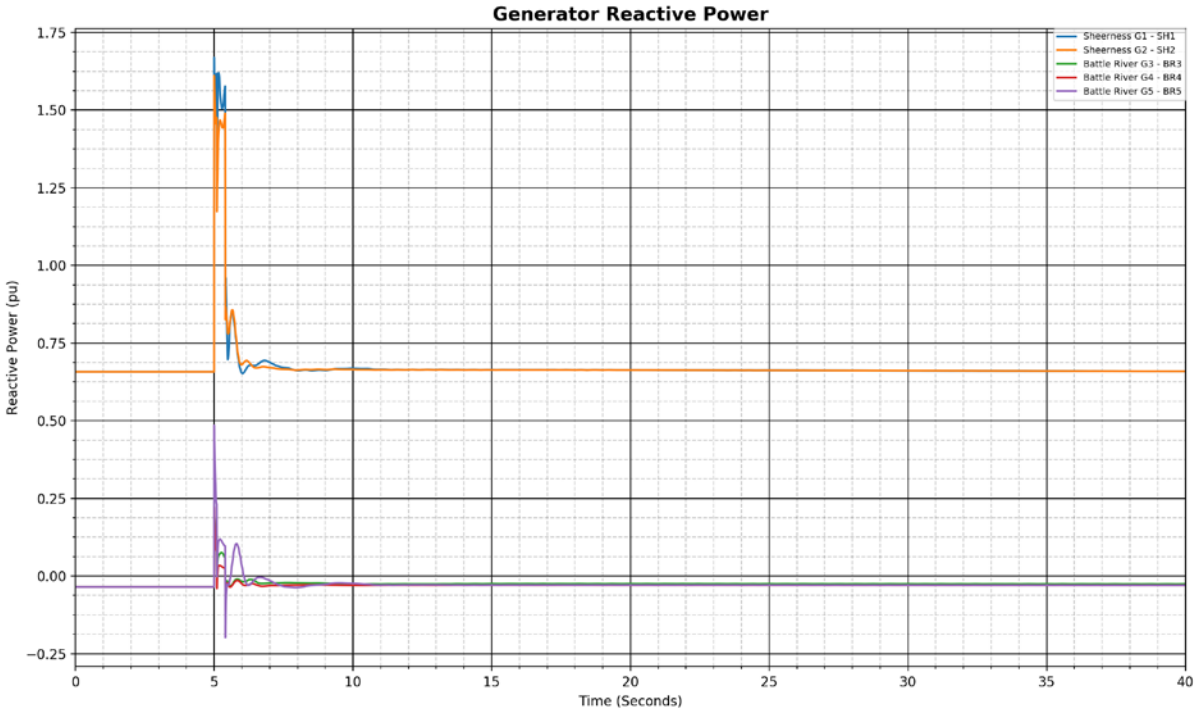

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
100
50
0
−50
−100
−150
−200
−250
0
5
10
15
20
25
30
35
40
Time (Seconds)

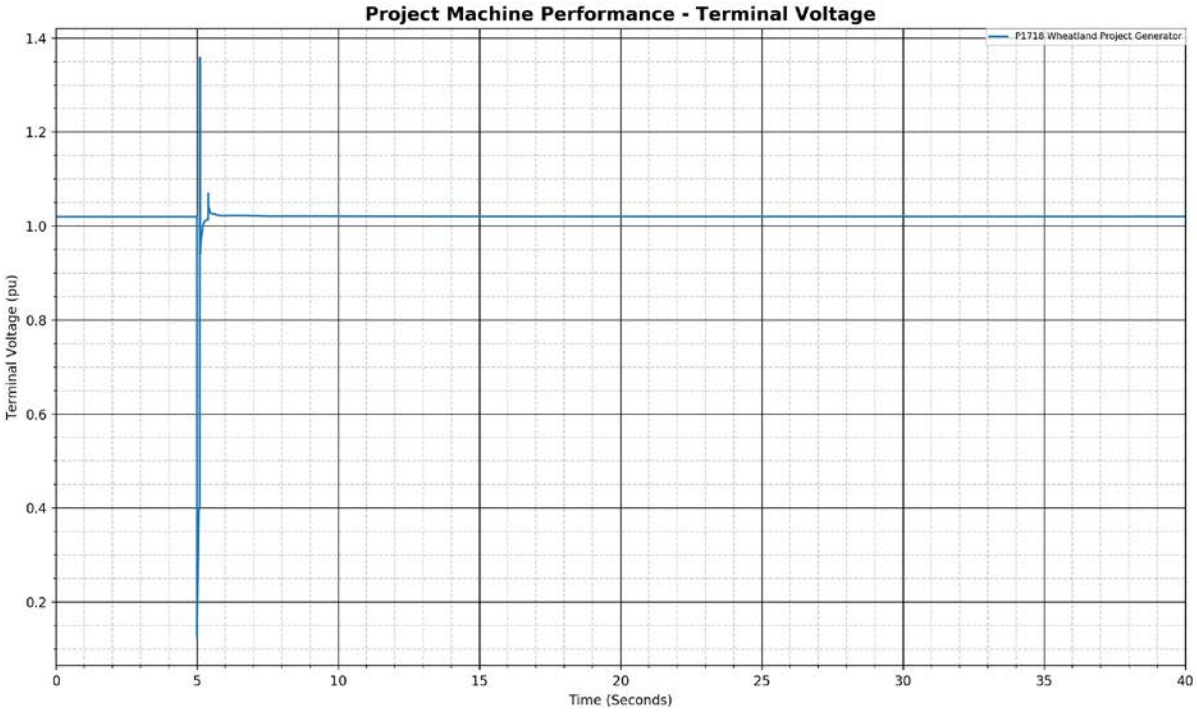
Figure A4-40: 7L85 (Parker 2072S - Anderson 801S): 3-phase fault at Parker 2072S

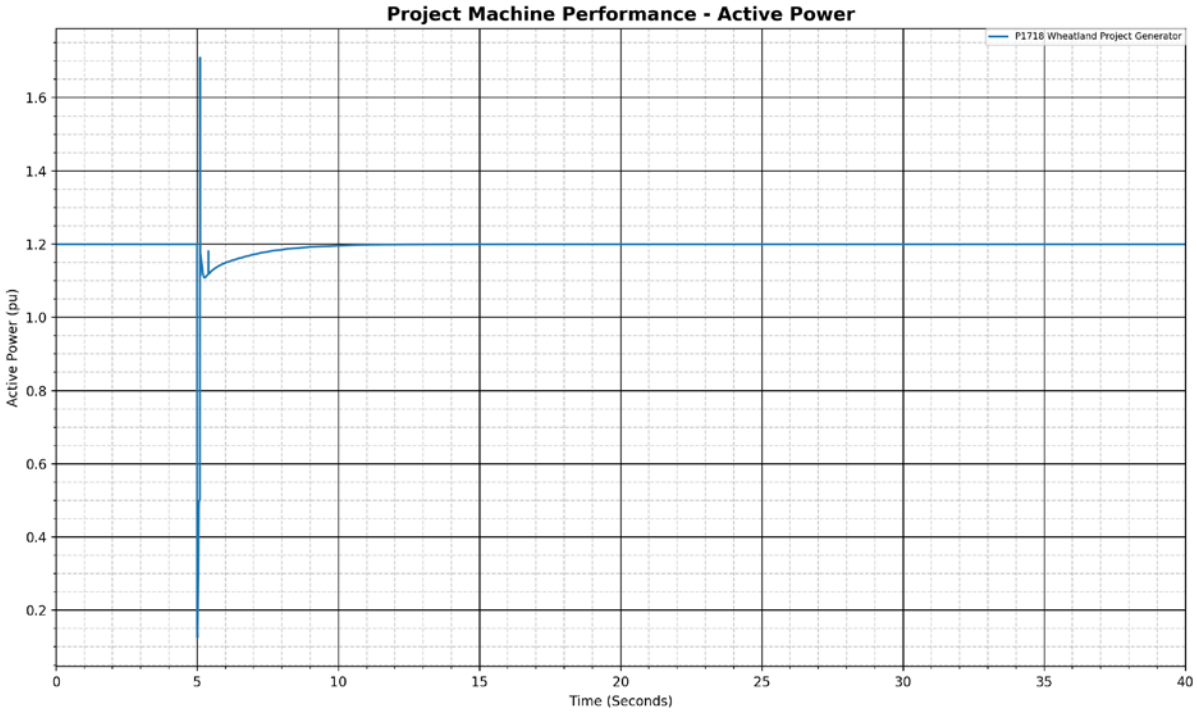


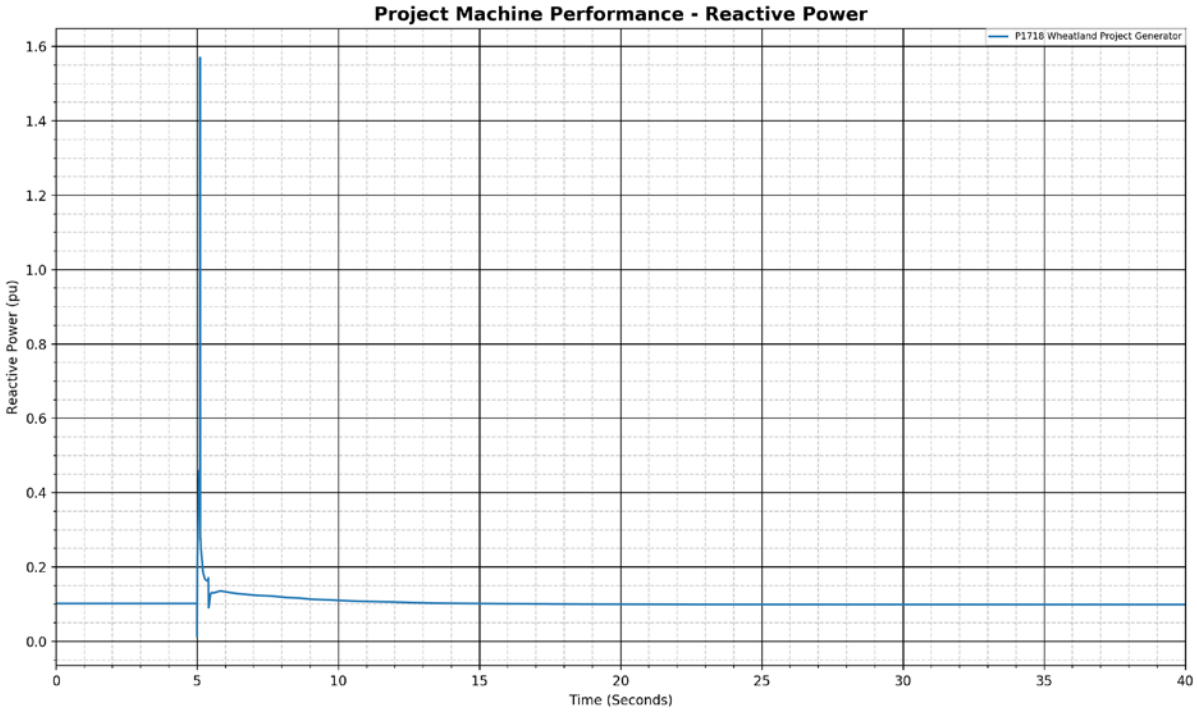

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

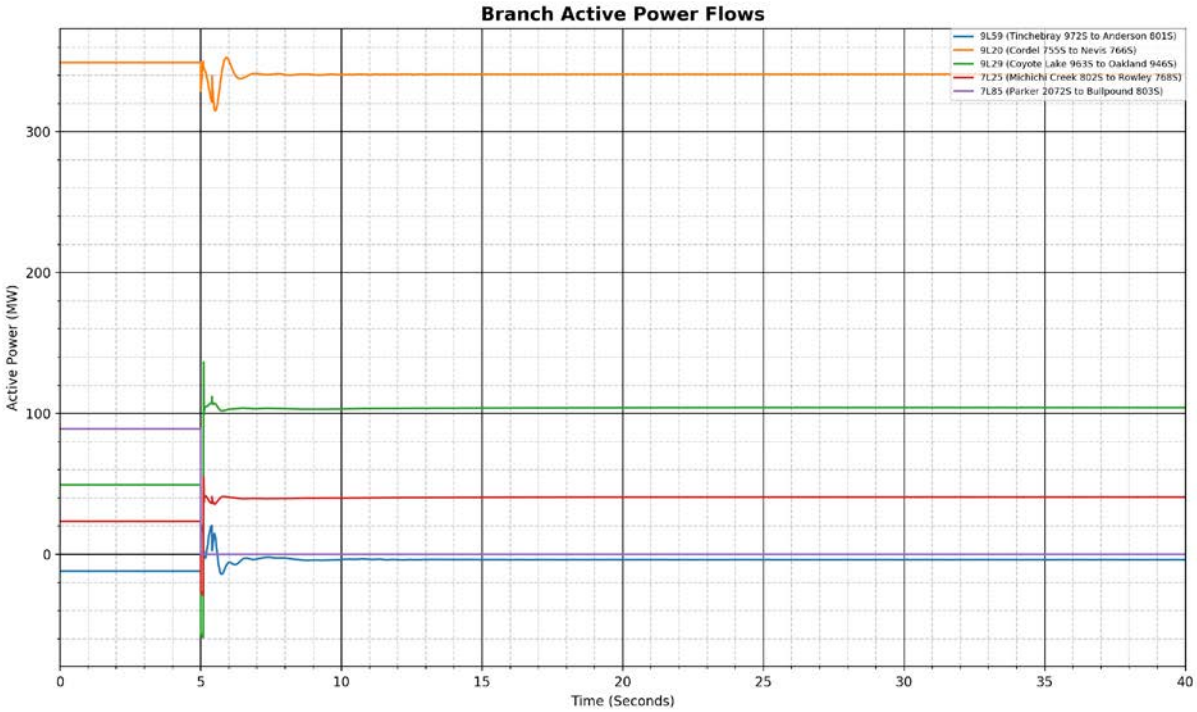

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Active Power (MW)
300
200
100
0
0
5
10
15
20
25
30
35
40
Time (Seconds)

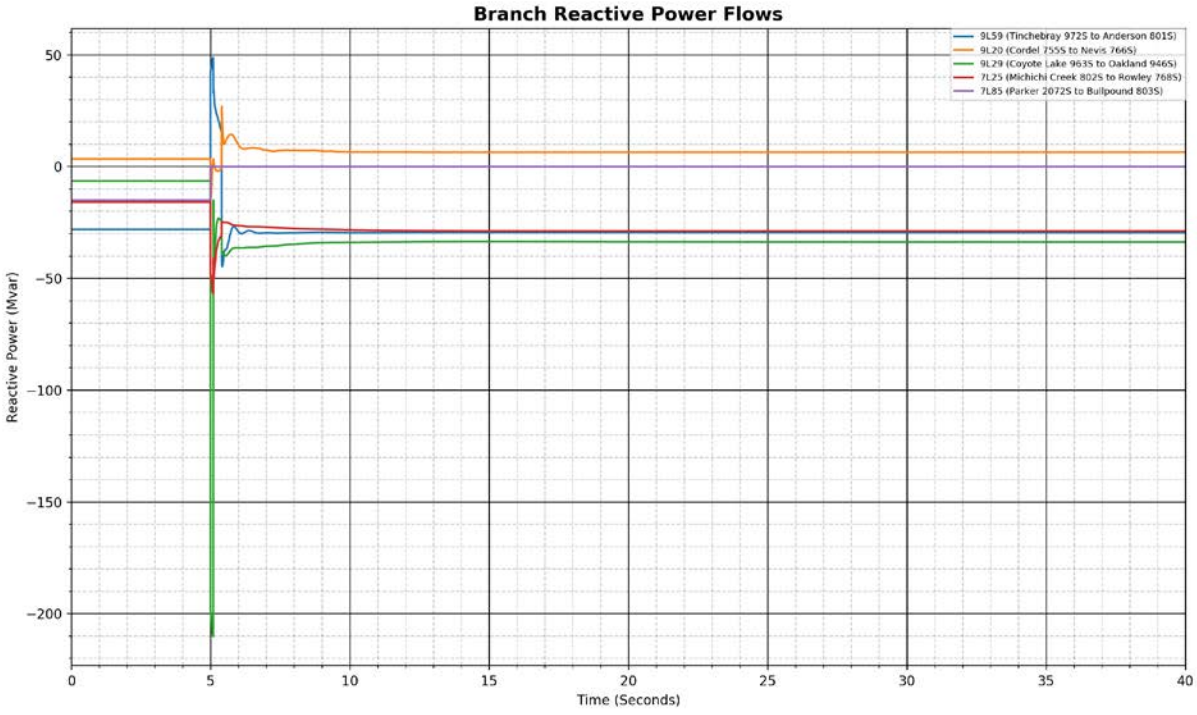
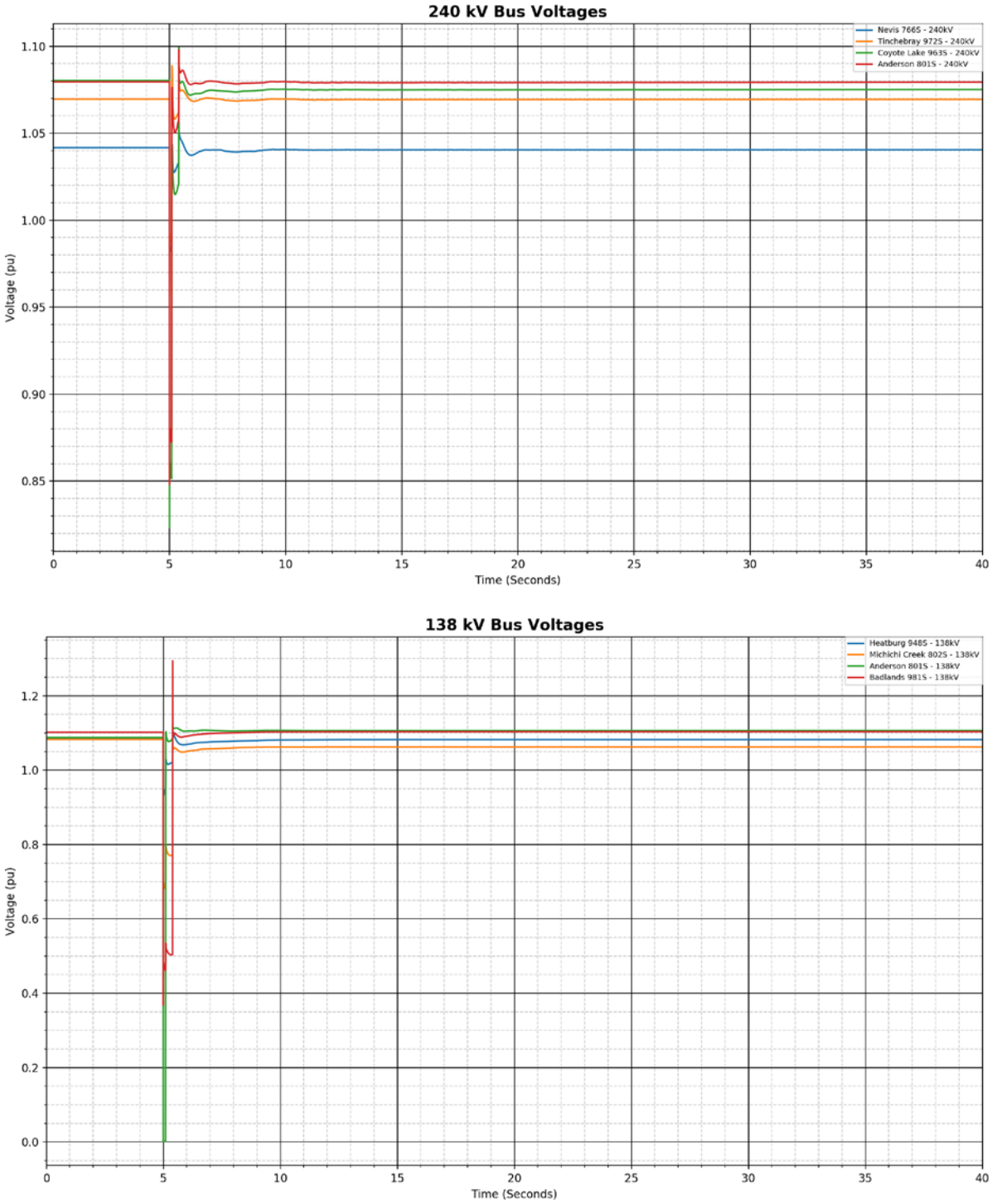
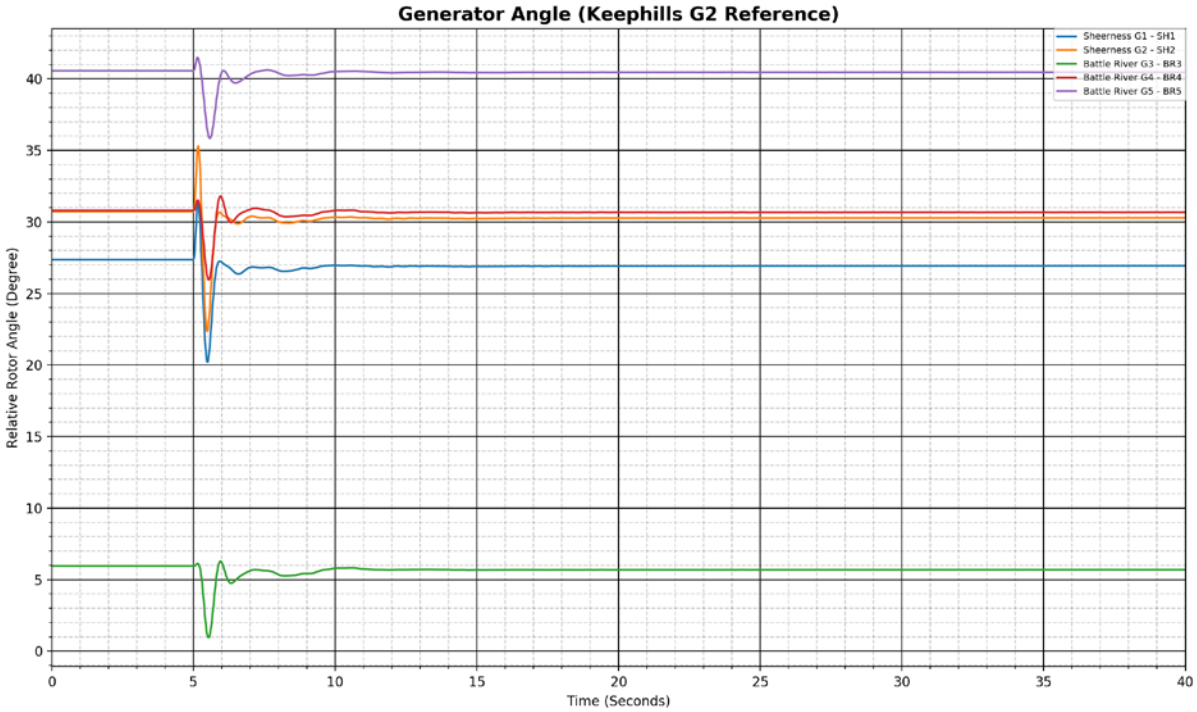
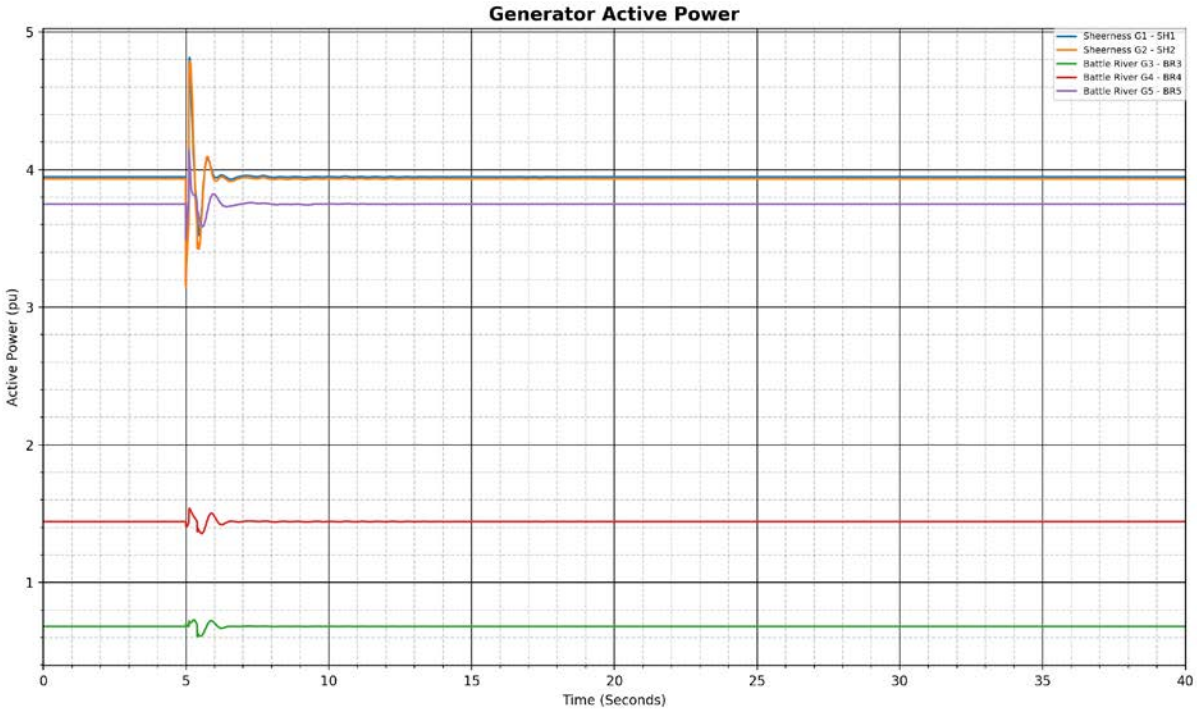
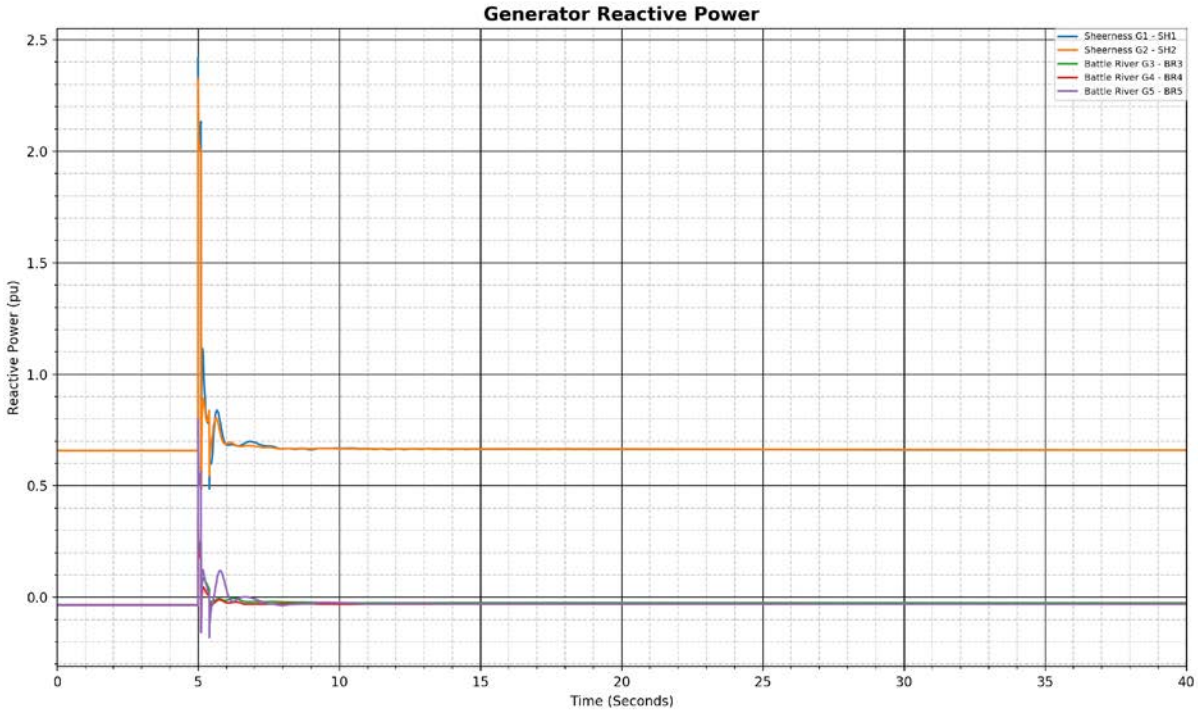

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Reactive Power (Mvar)
50
0
−50
−100
−150
−200
0
5
10
15
20
25
30
35
40
Time (Seconds)

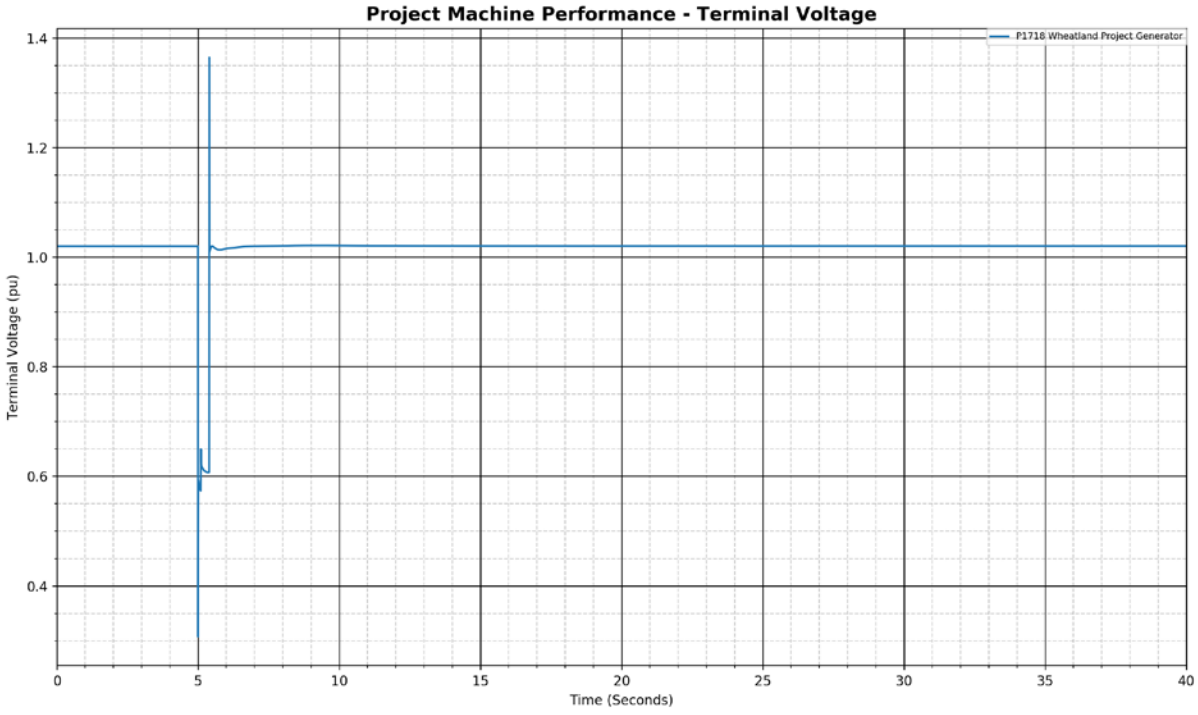
Figure A4-41: 7L85 (Parker 2072S - Anderson 801S): 3-phase fault at Anderson 801S

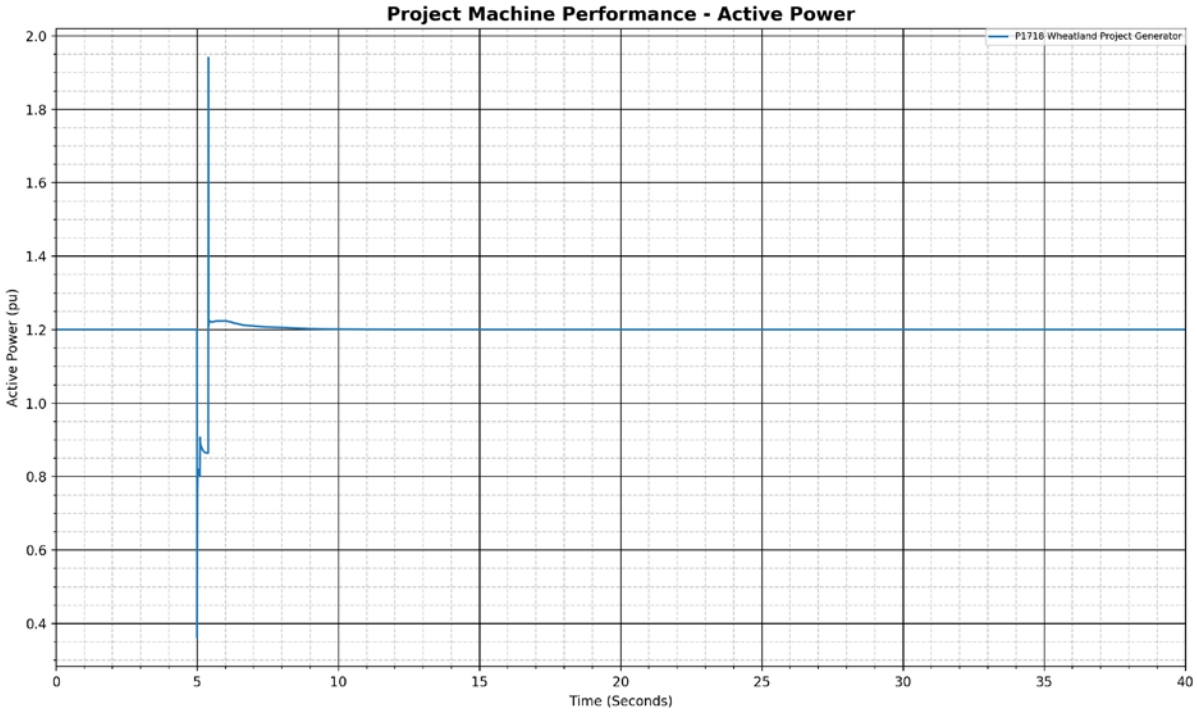


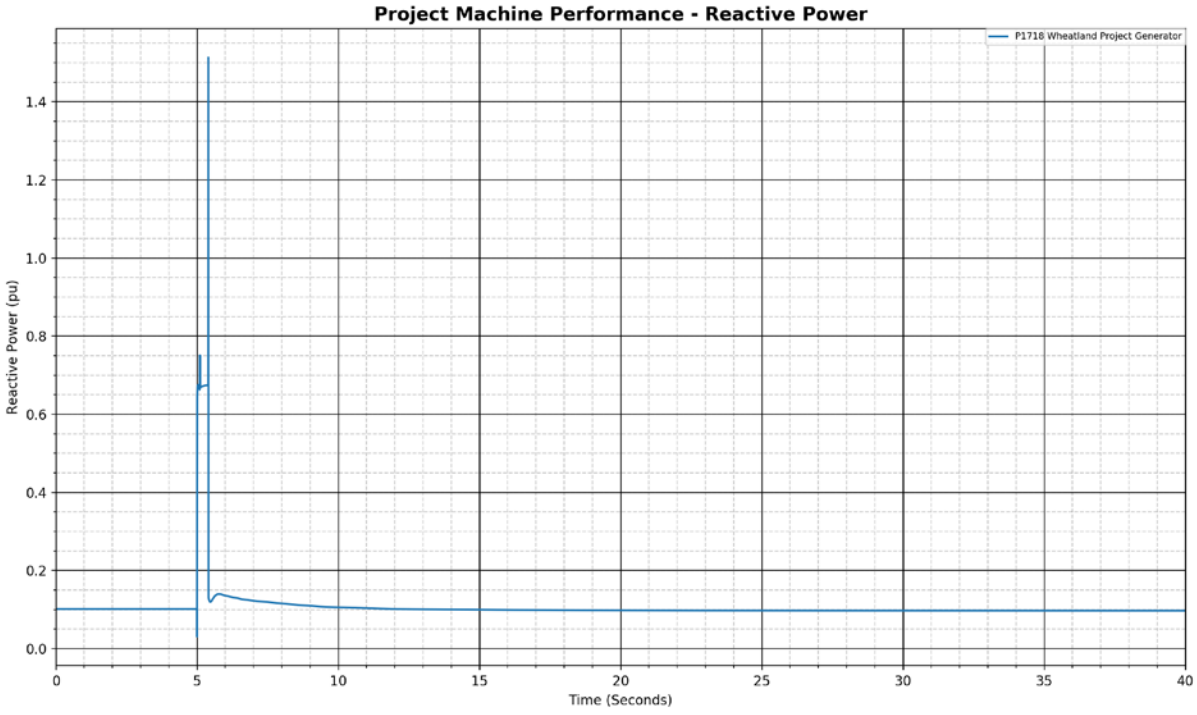

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

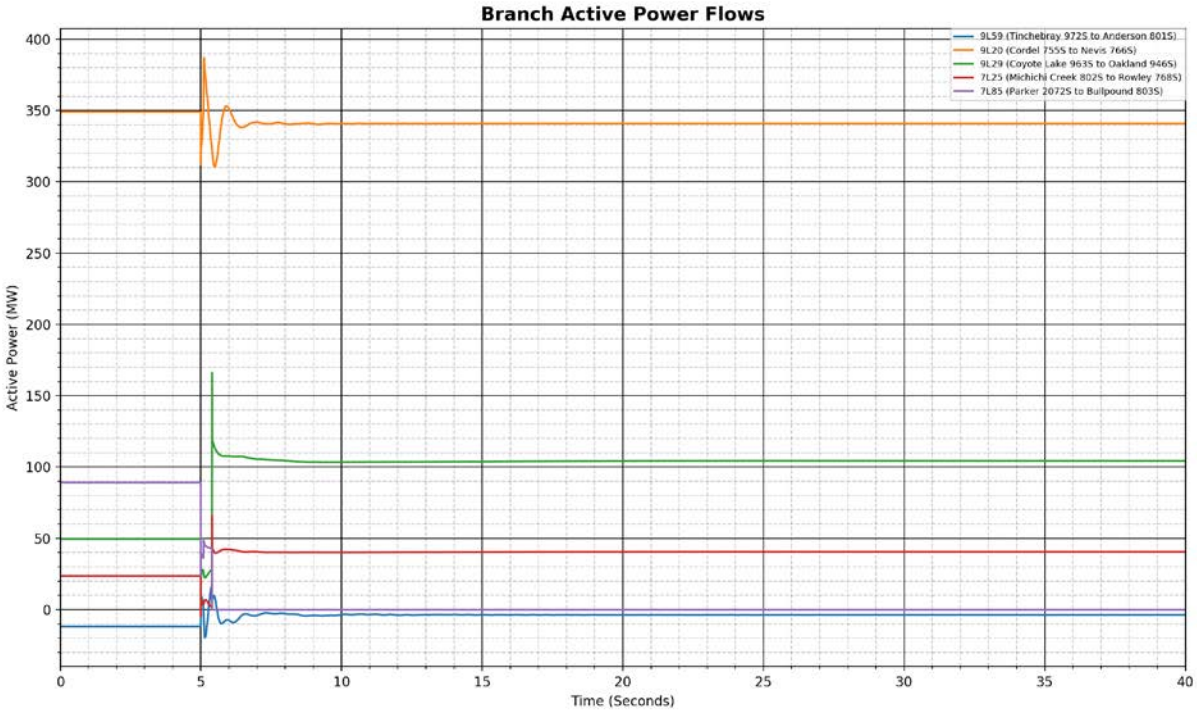

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
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
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Active Power (MW)
Time (Seconds)

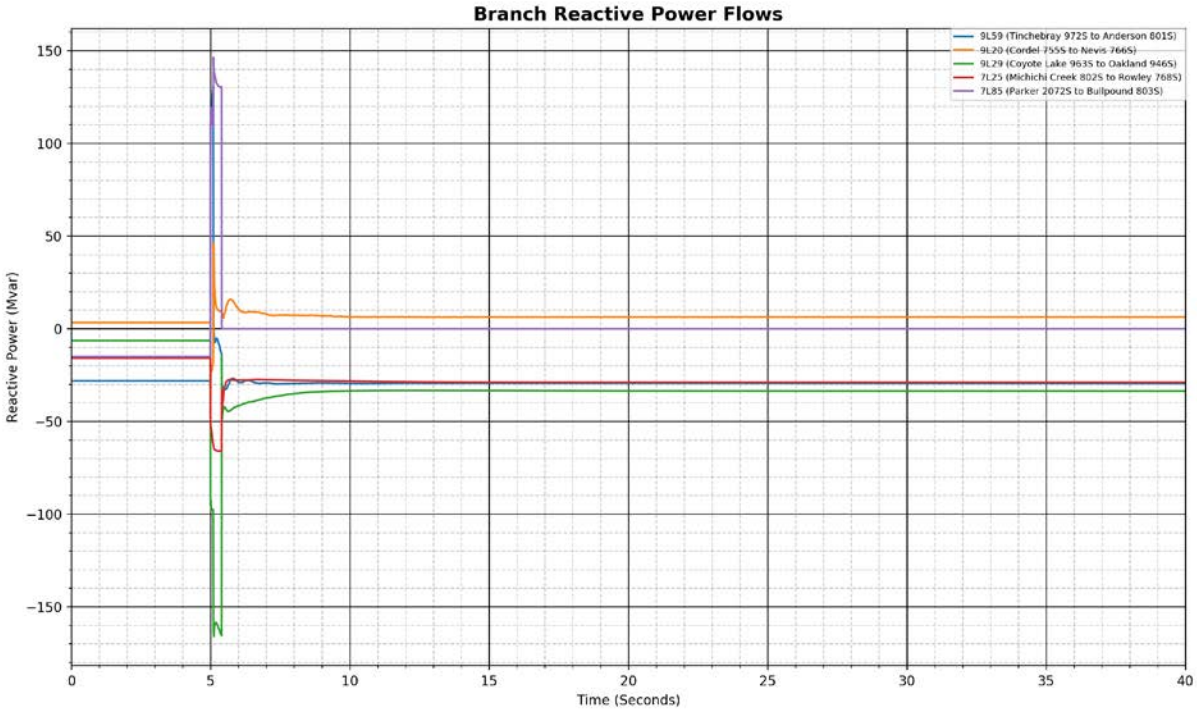
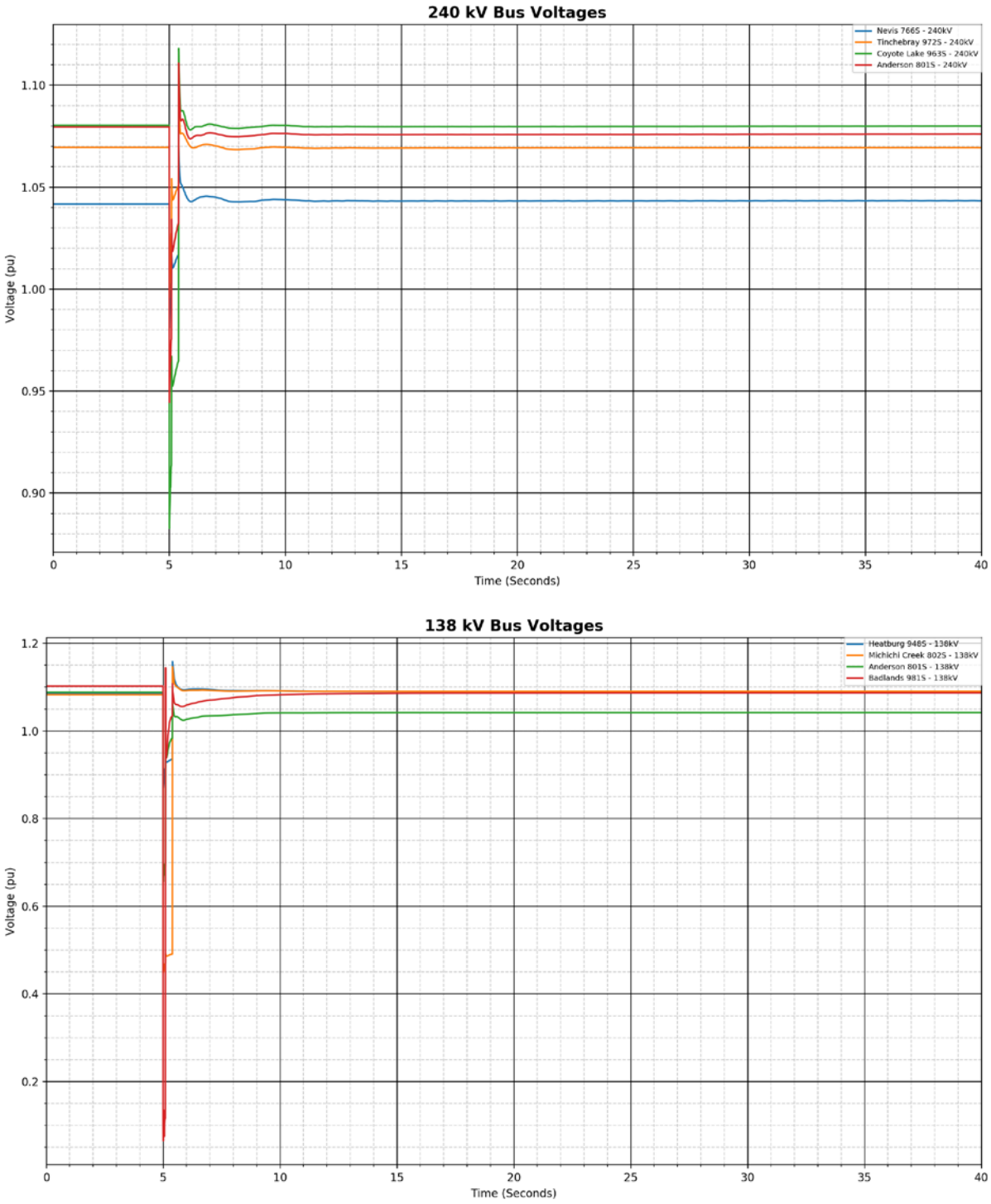
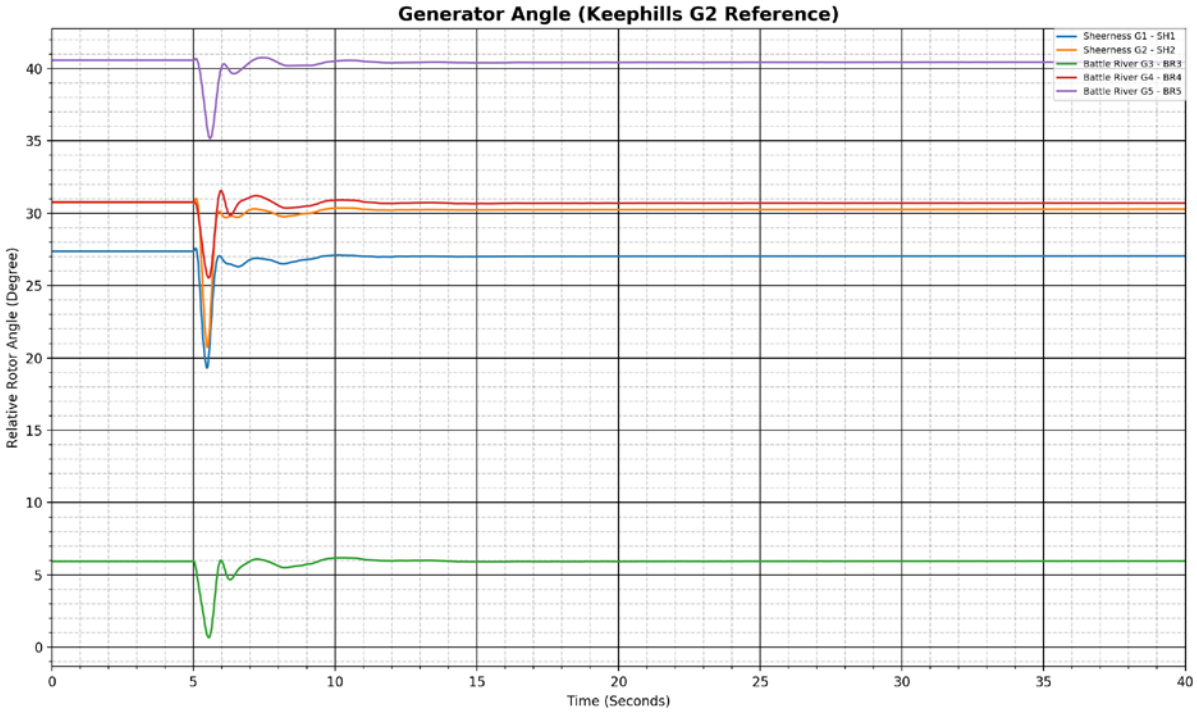
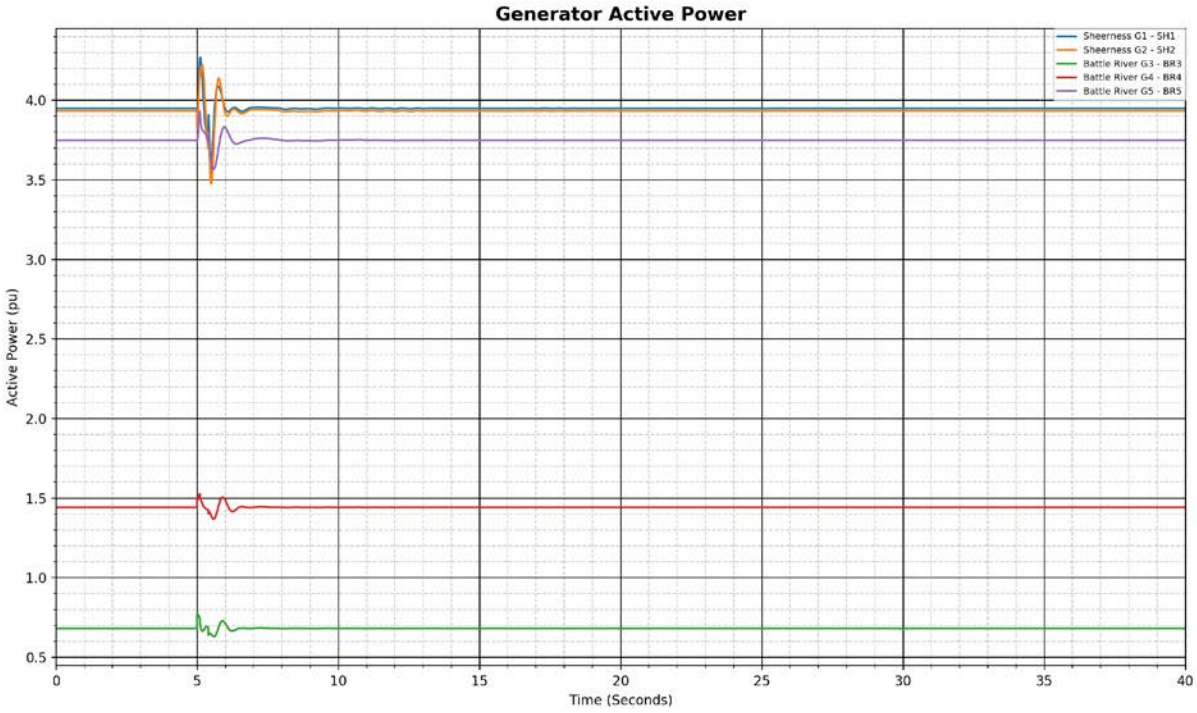
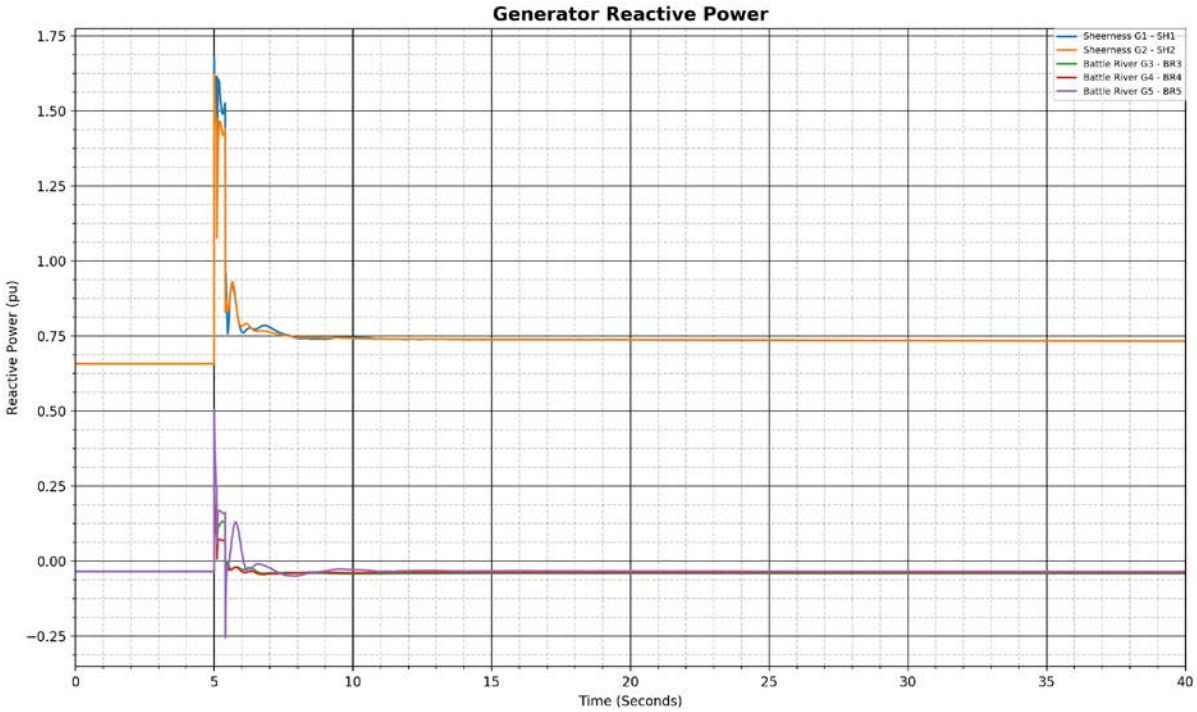

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Reactive Power (Mvar)
Time (Seconds)

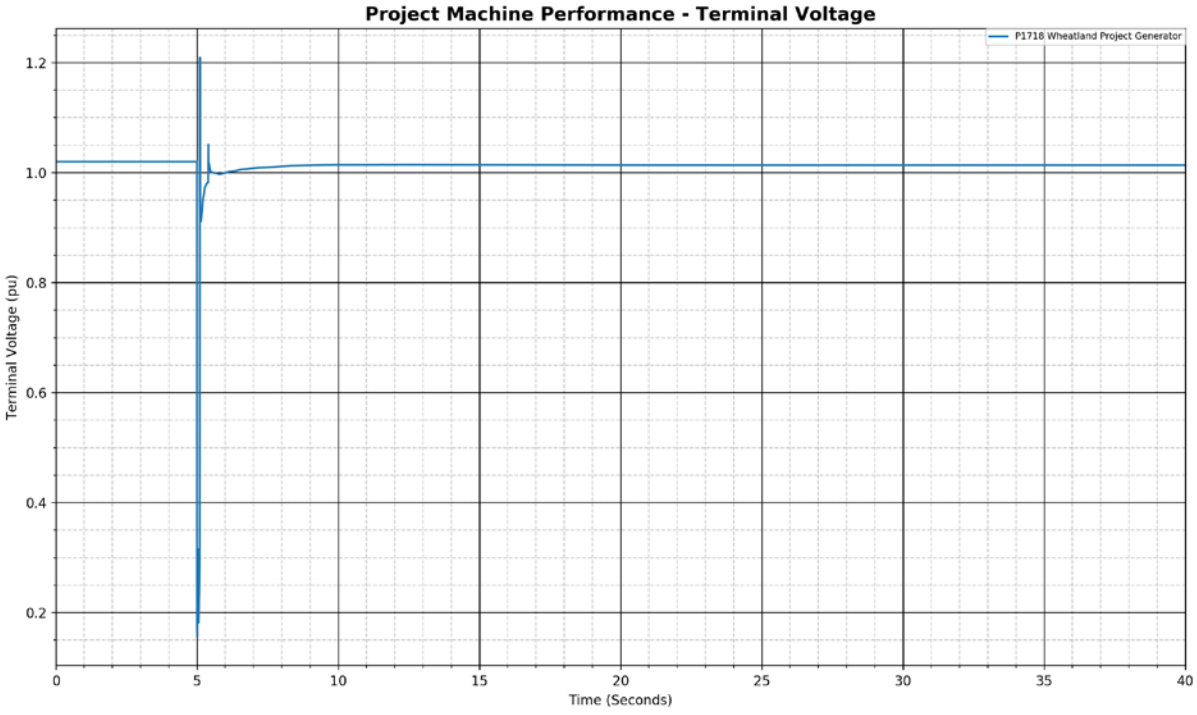
Figure A4-42: 7L171 (Wintering Hills 804S - Michichi Creek 802S): 3-phase fault at Wintering Hills 804S

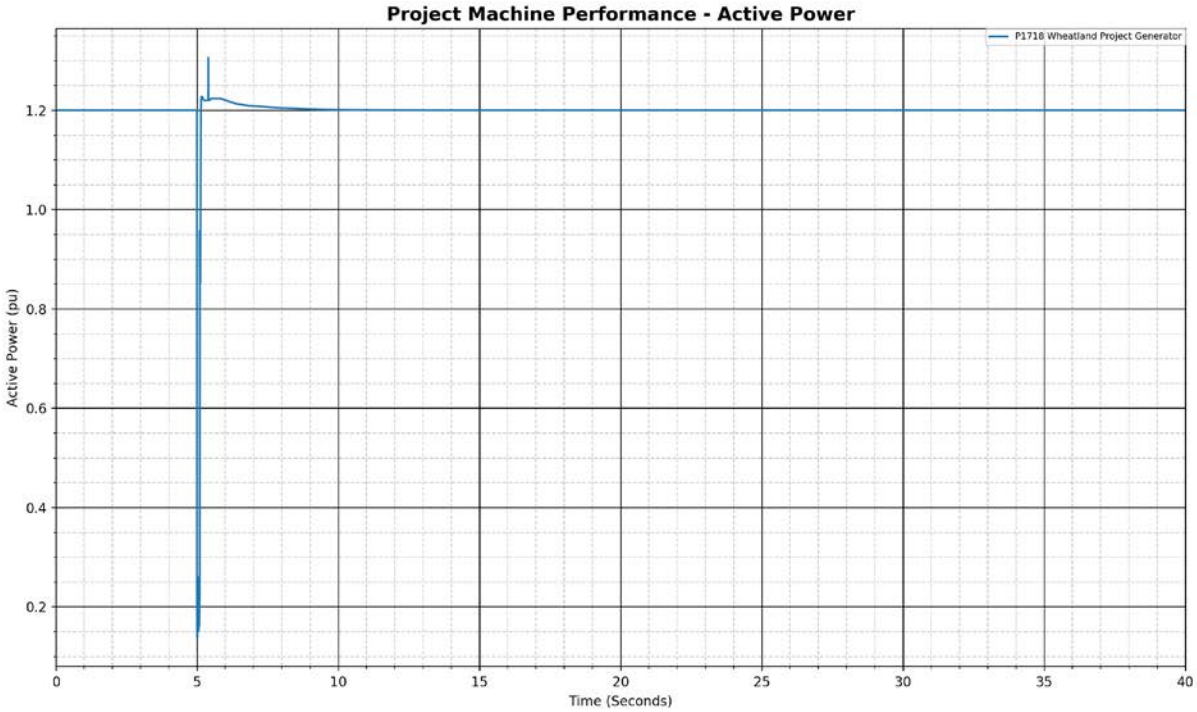


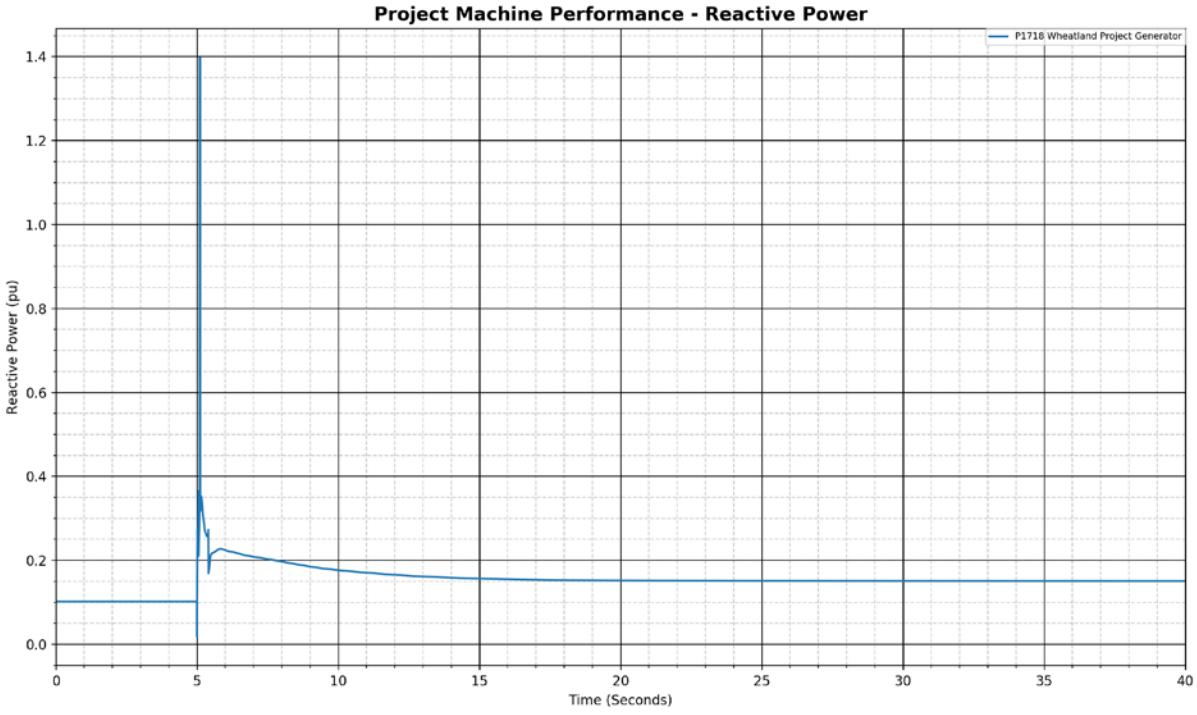

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

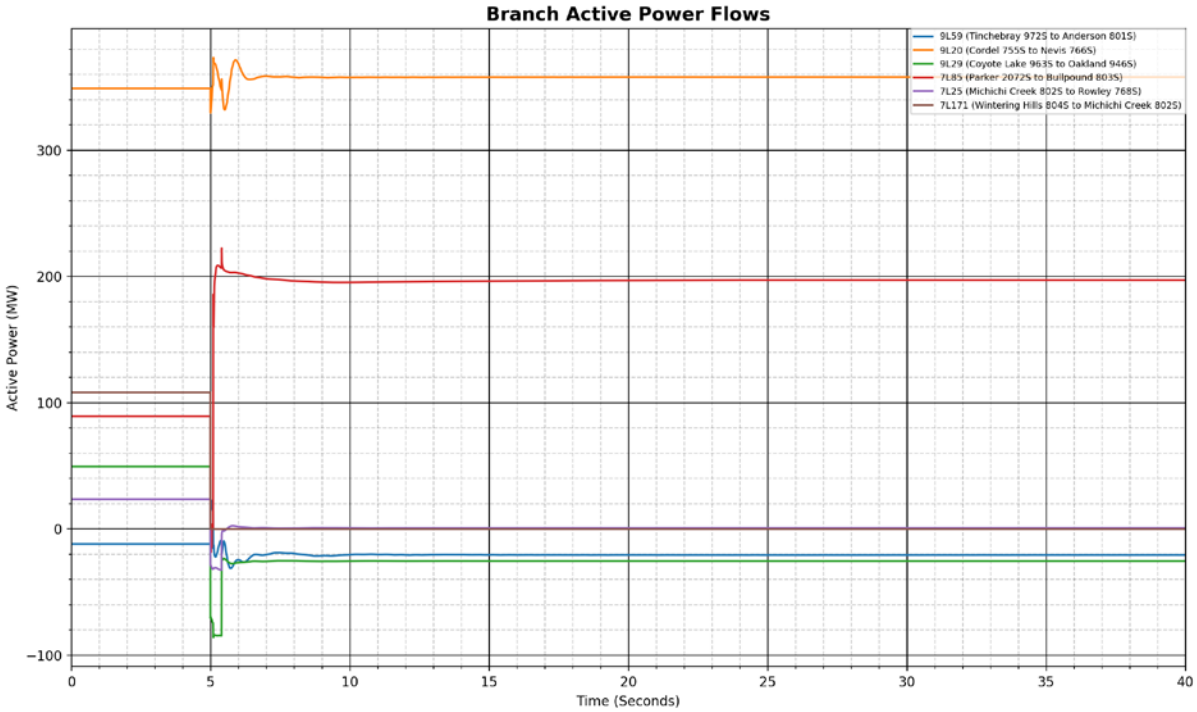

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Active Power (MW)
300
200
100
0
−100
0
5
10
15
20
25
30
35
40
Time (Seconds)

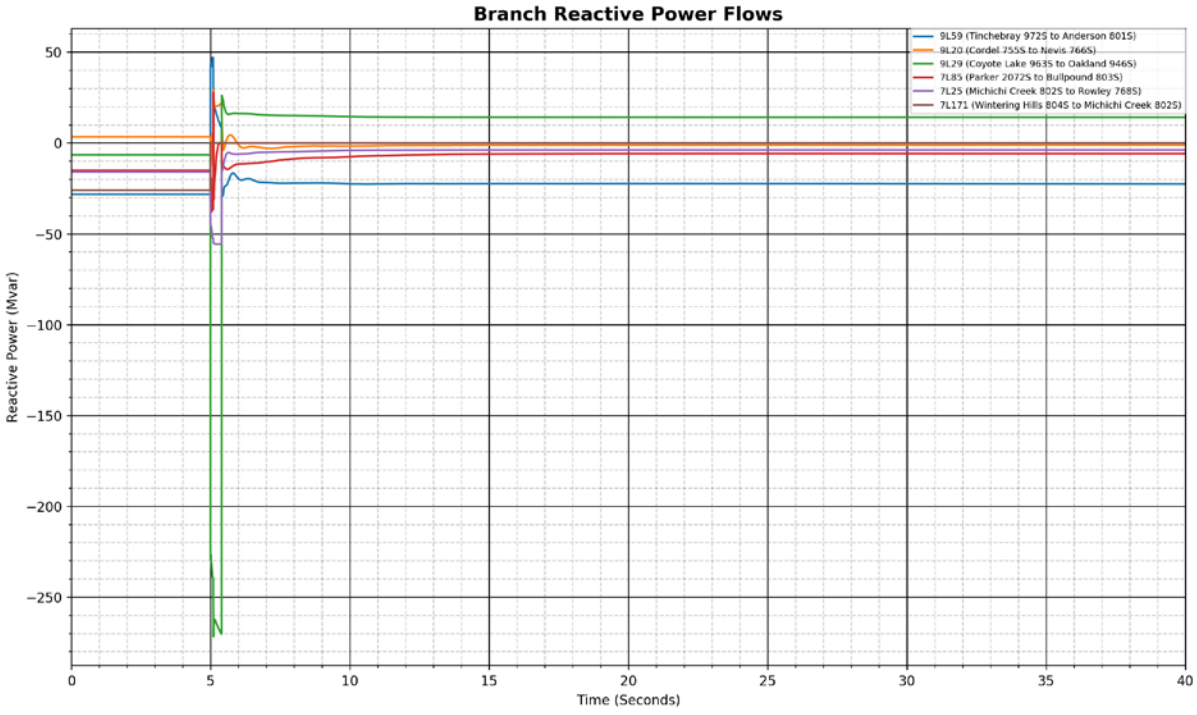
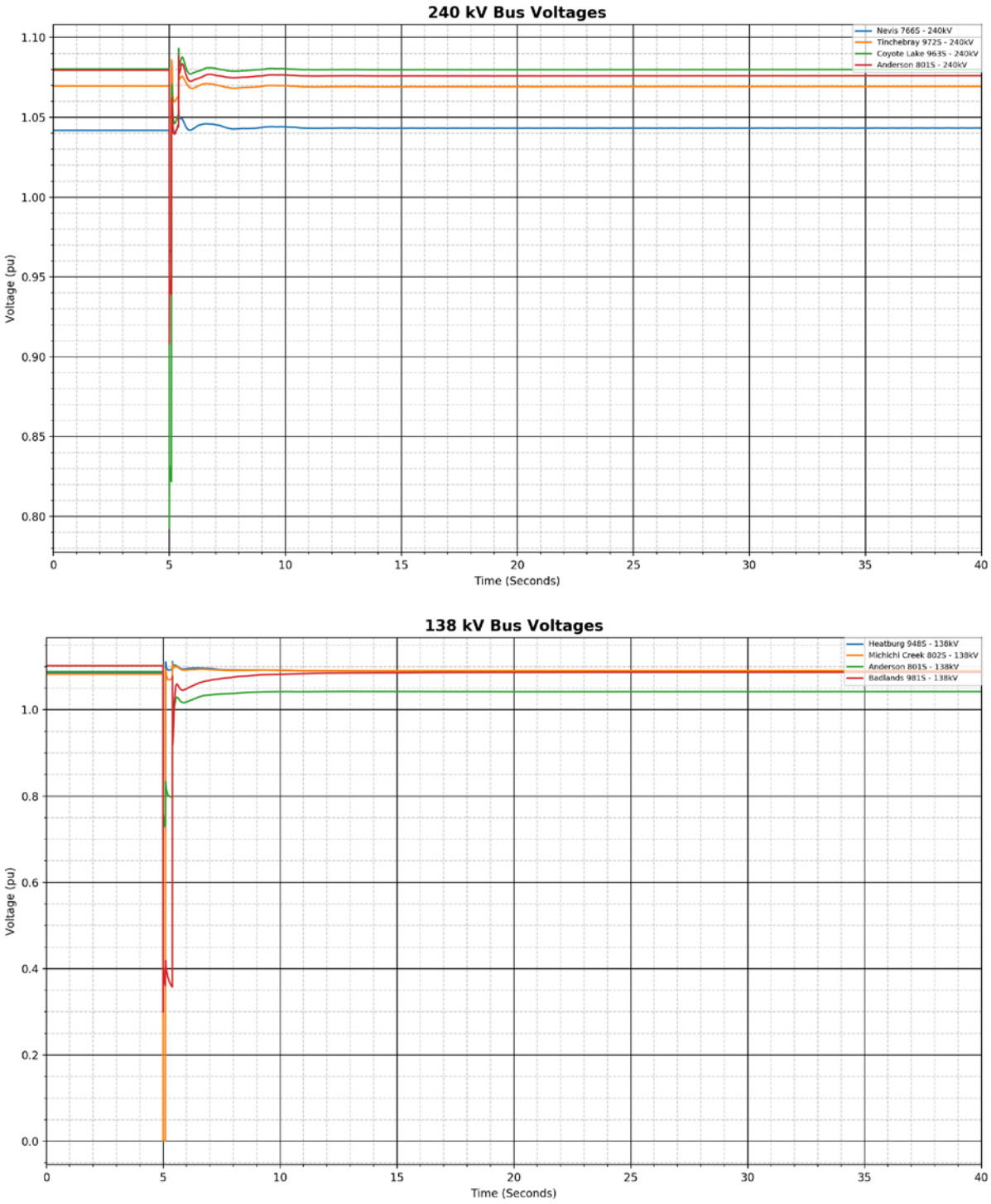
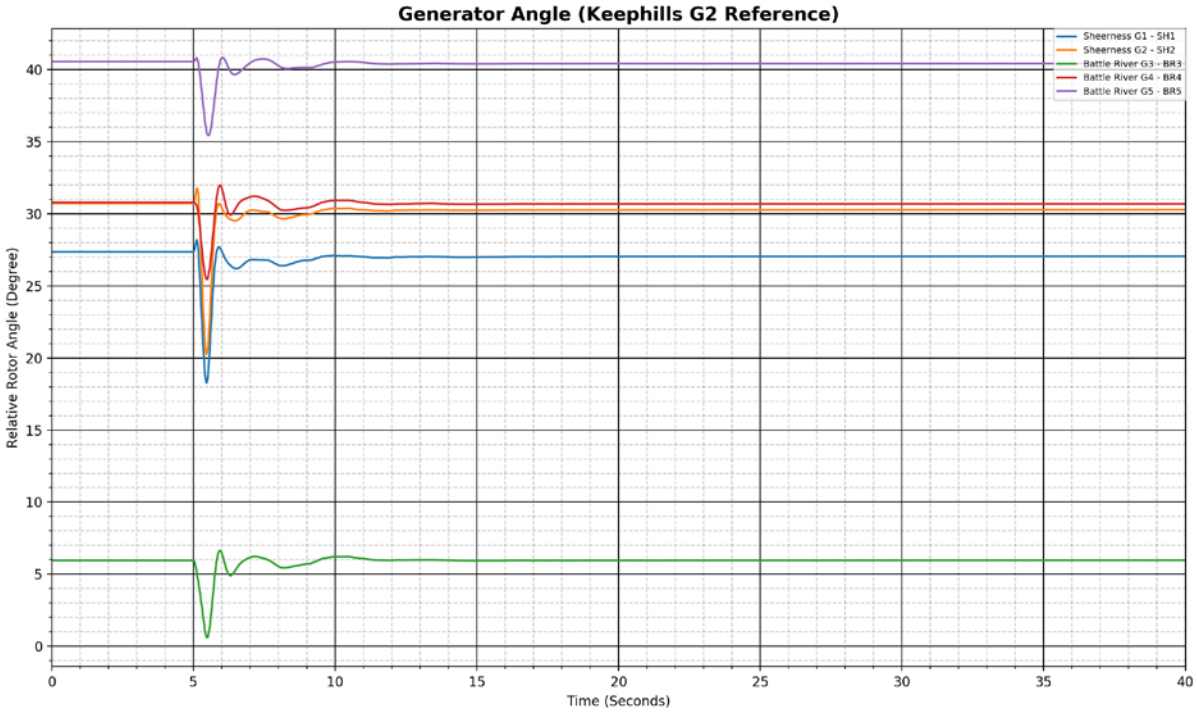
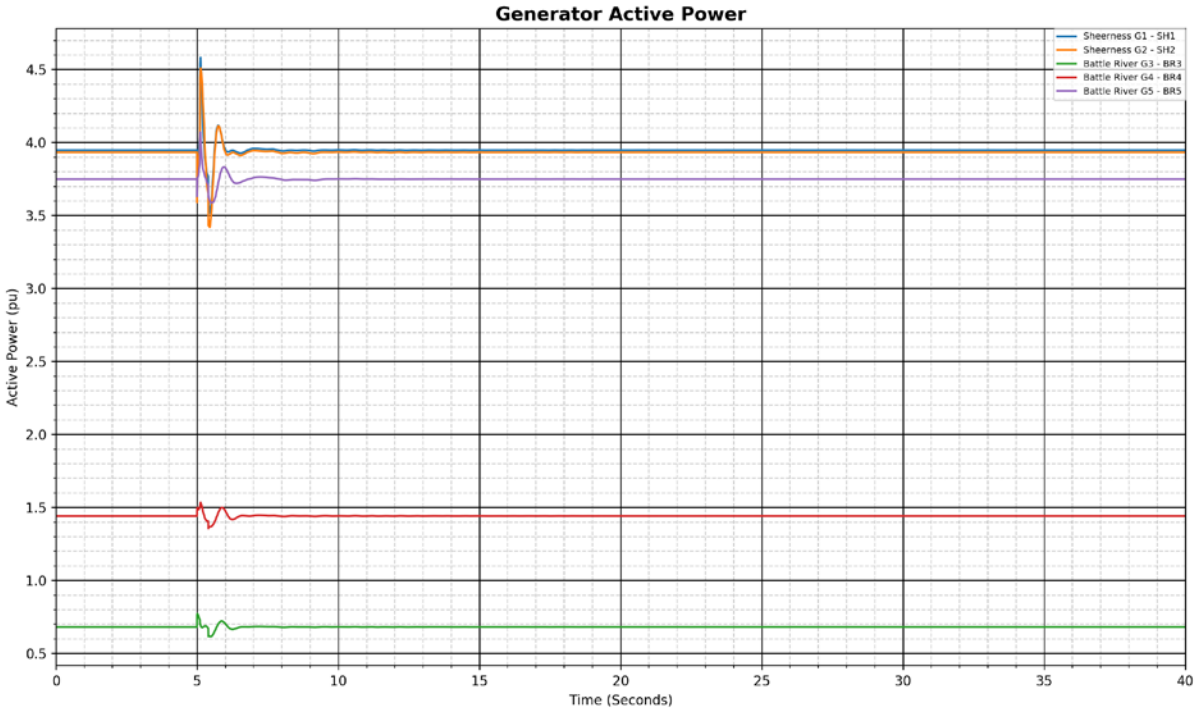
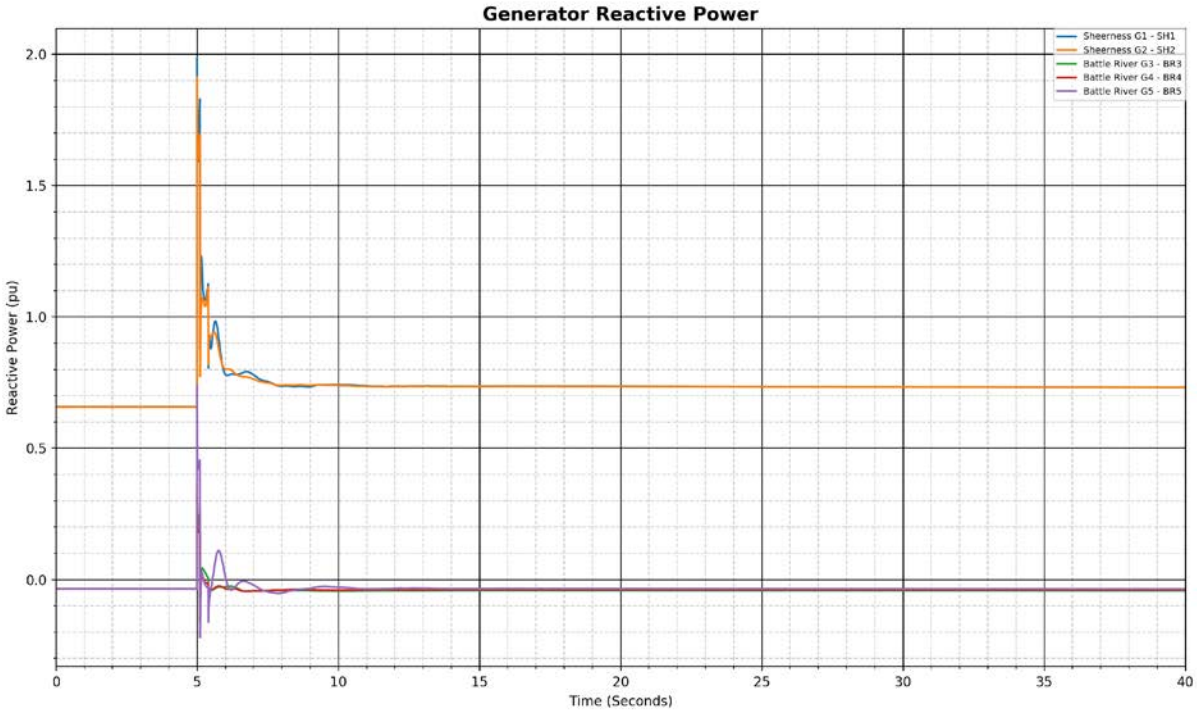

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Reactive Power (Mvar)
50
0
−50
−100
−150
−200
−250
0
5
10
15
20
25
30
35
40
Time (Seconds)

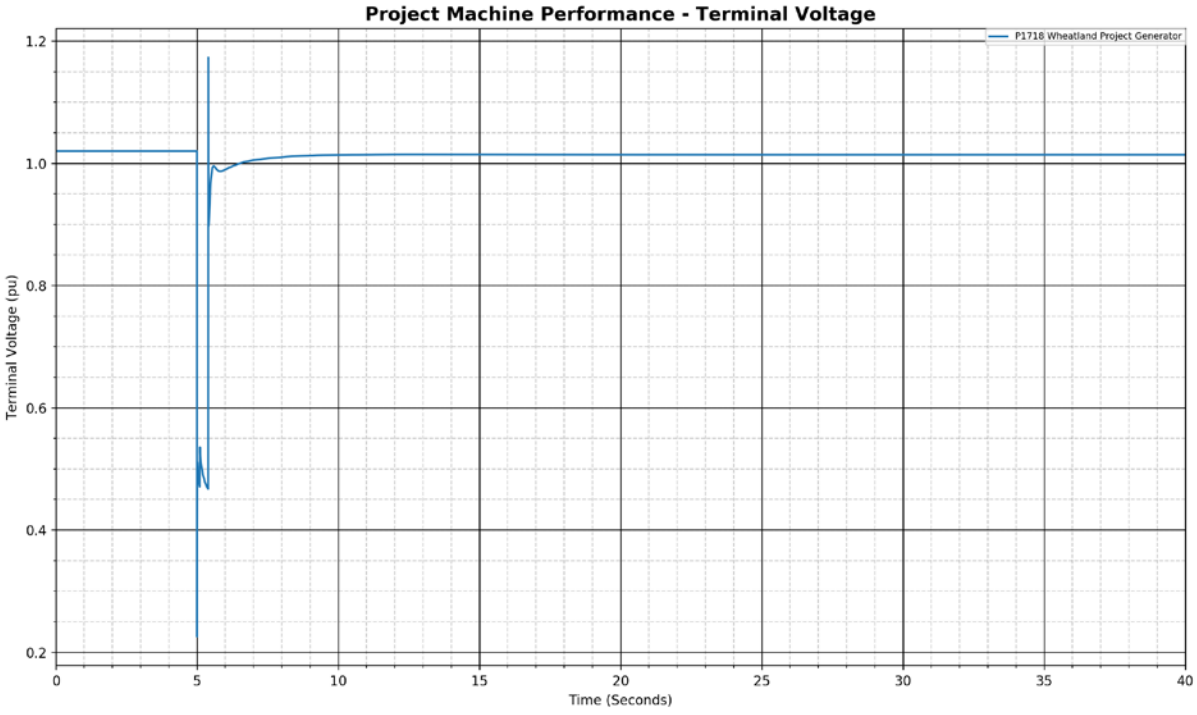
Figure A4-43: 7L171 (Wintering Hills 804S - Michichi Creek 802S): 3-phase fault at Michichi Creek 802S

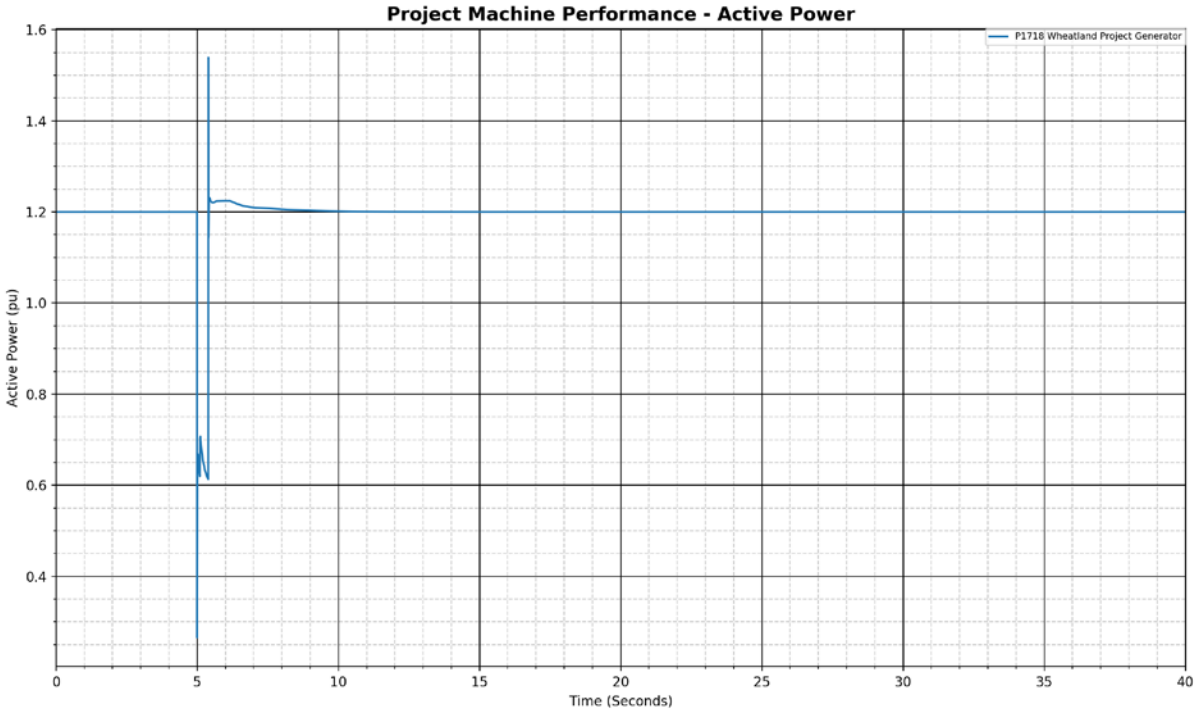


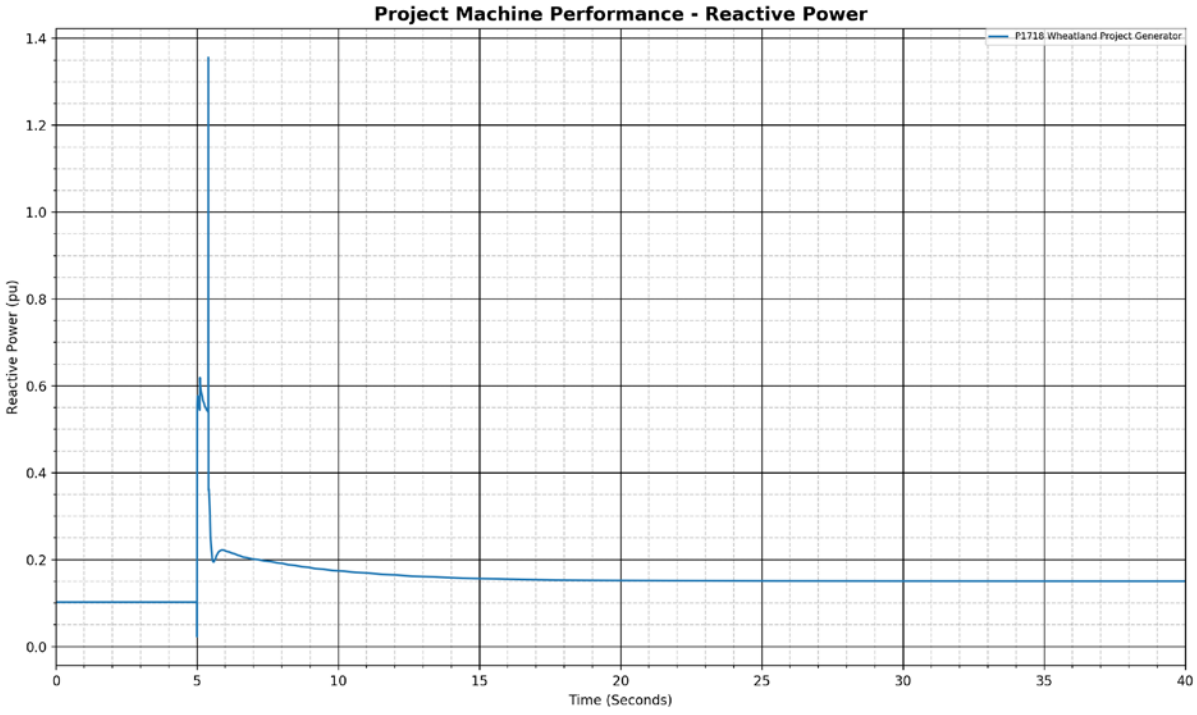

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

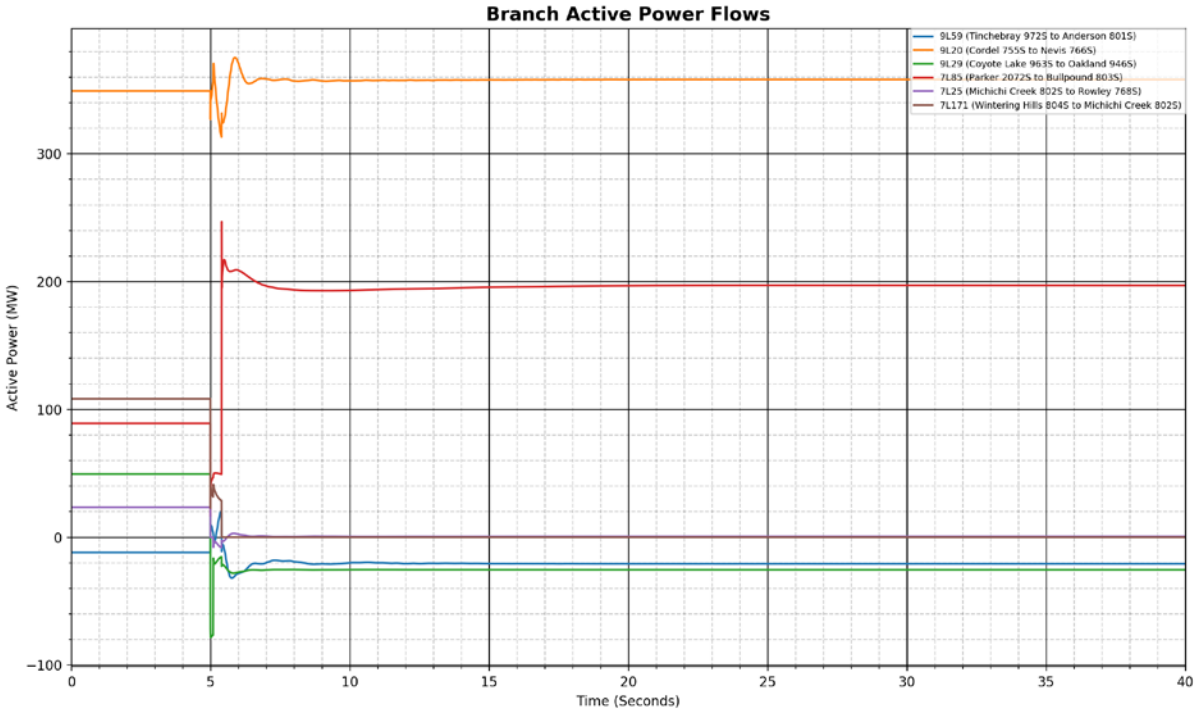

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Active Power (MW)
300
200
100
0
−100
0
5
10
15
20
25
30
35
40
Time (Seconds)

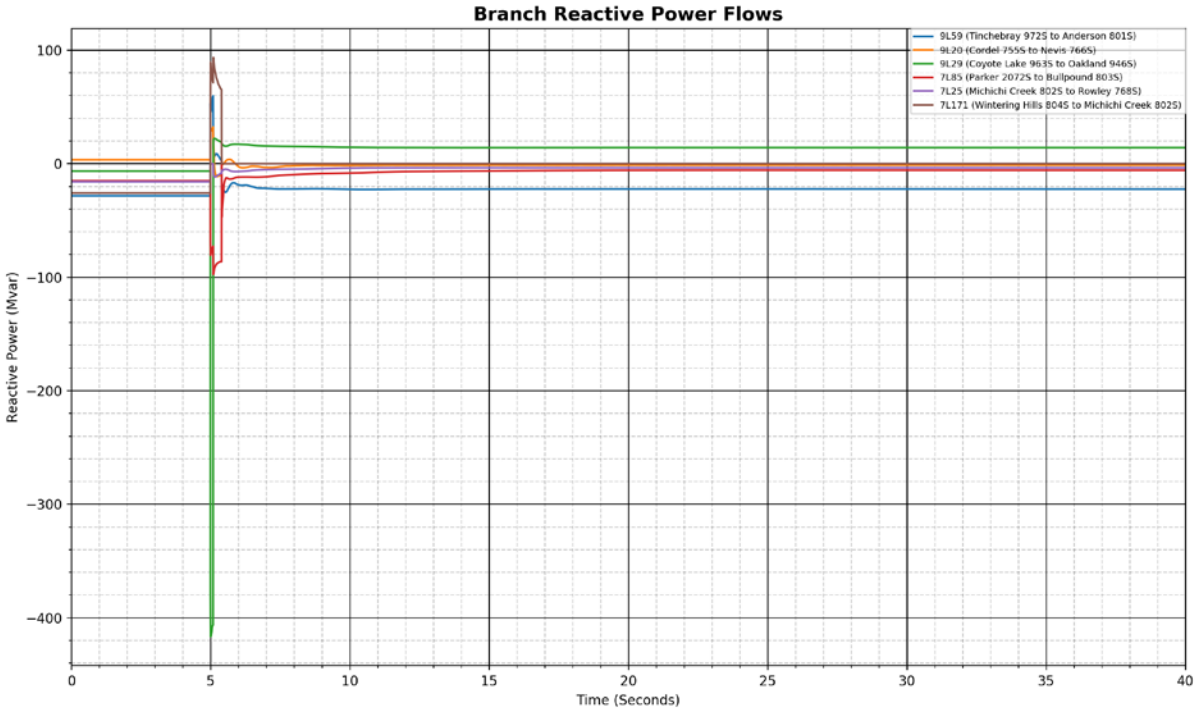
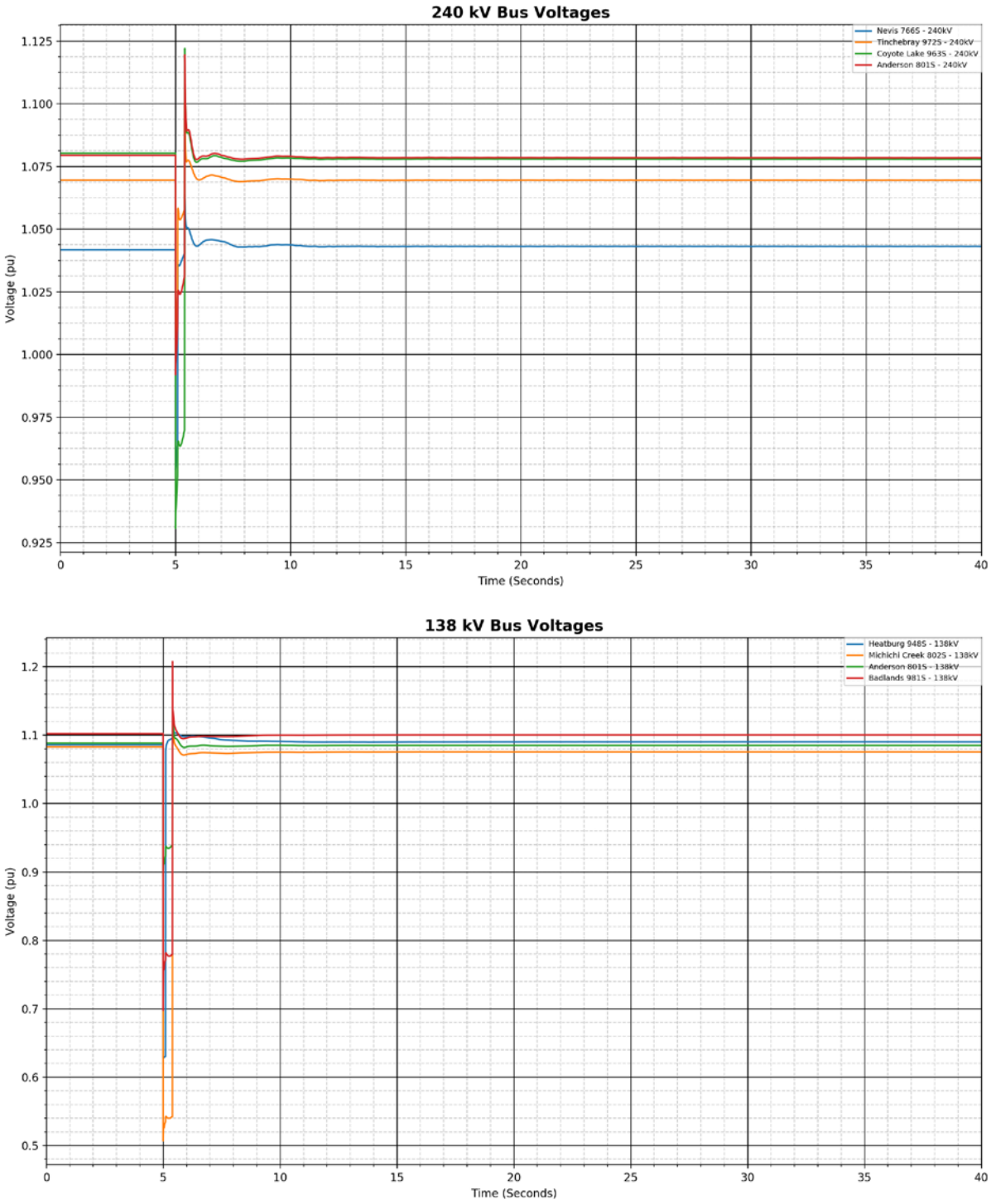
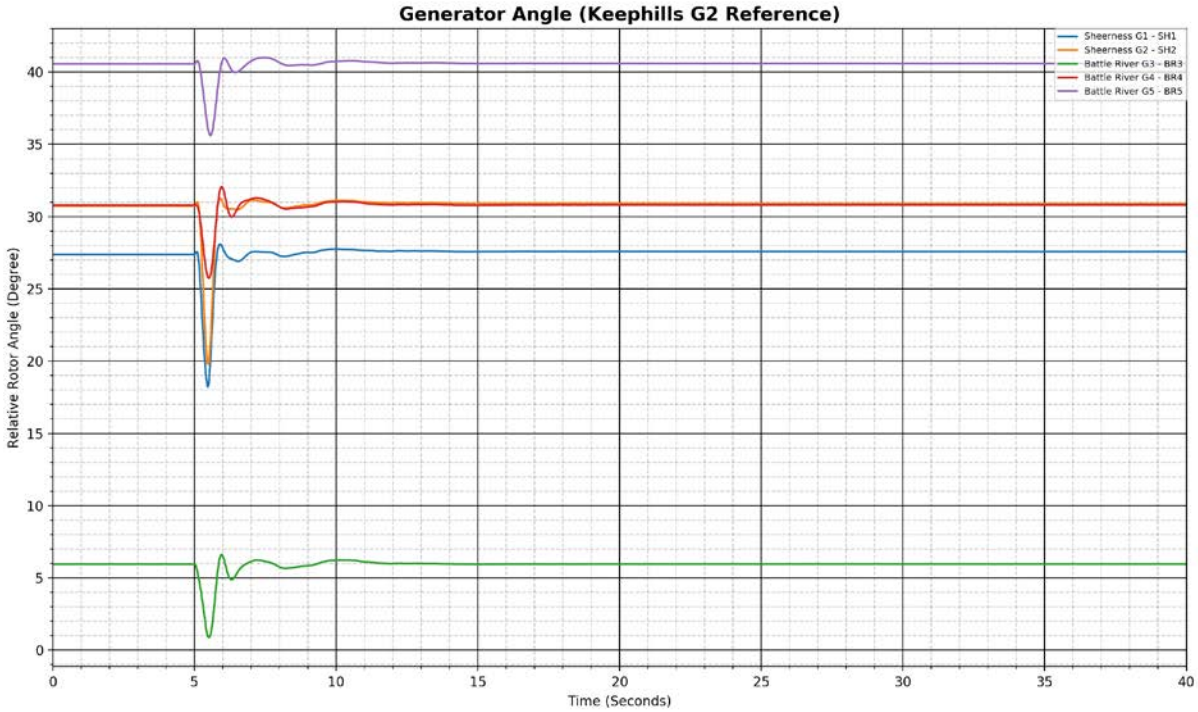
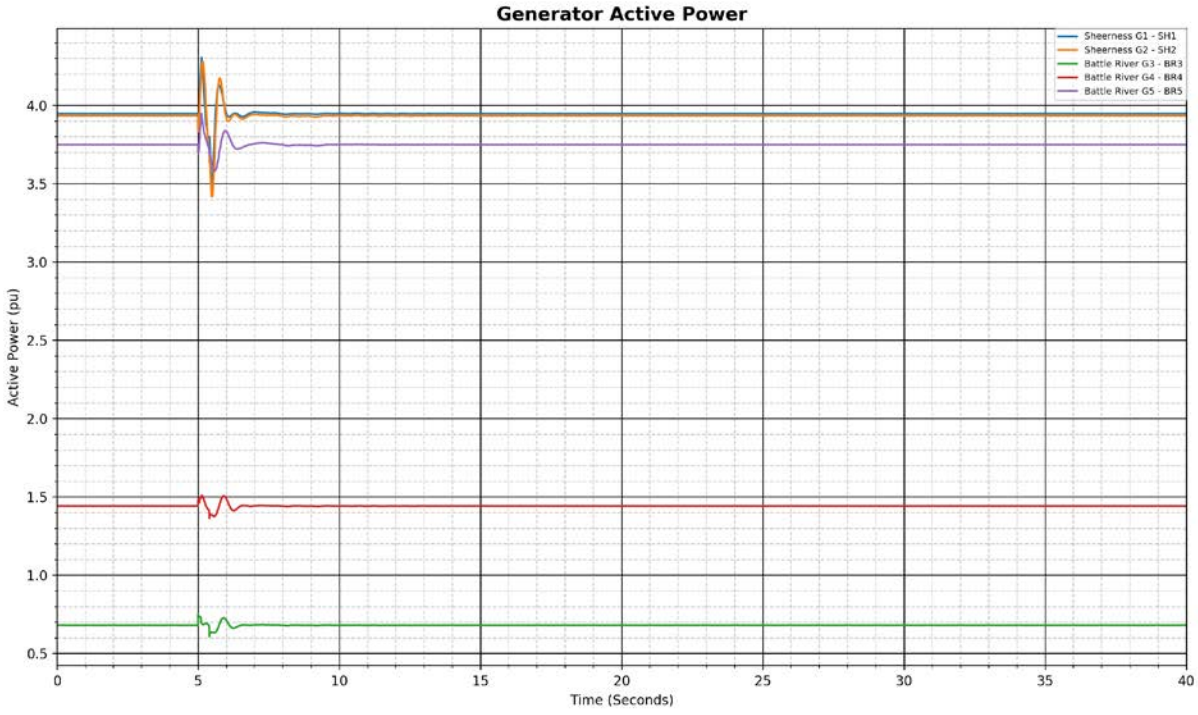
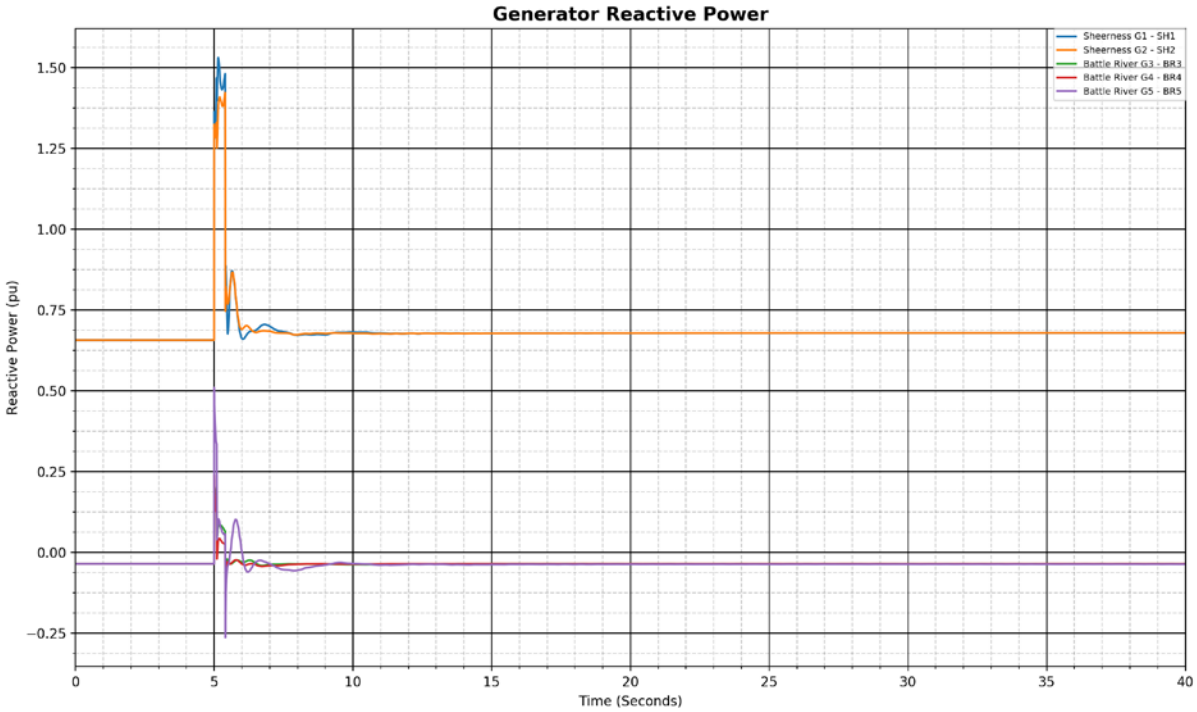

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Reactive Power (Mvar)
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
35
40
Time (Seconds)

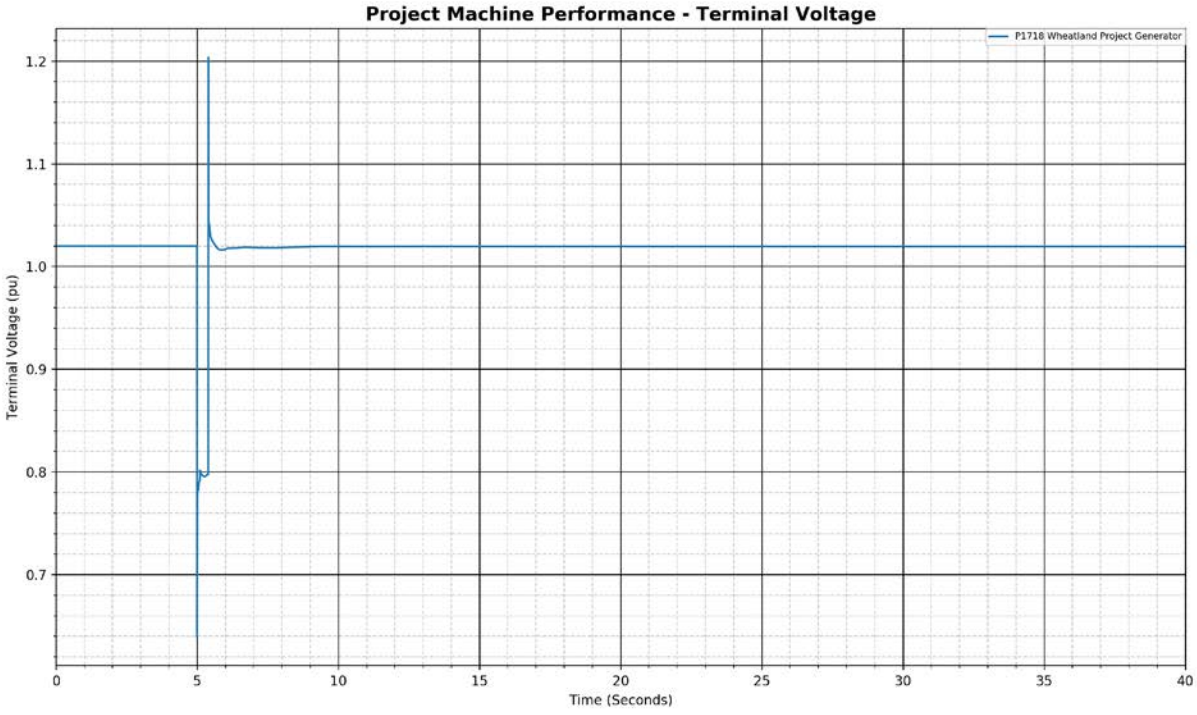
Figure A4-44: 7L25 (Rowley 768S - Michichi Creek 802S): 3-phase fault at Rowley 768S

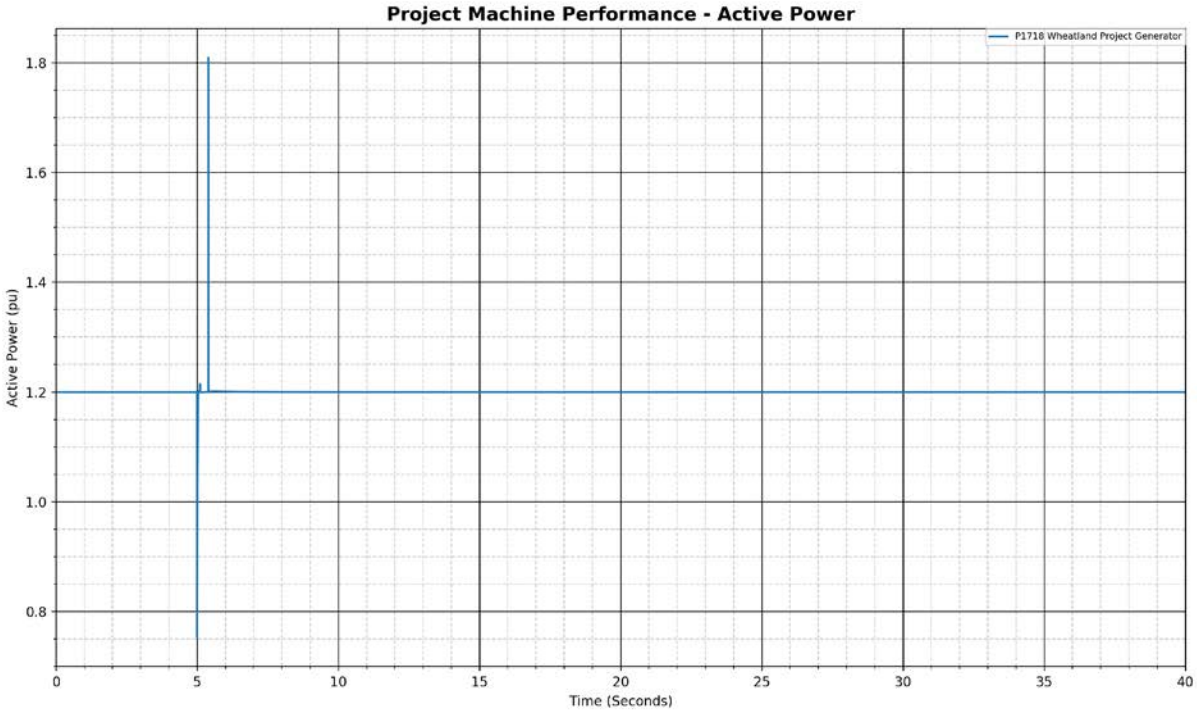


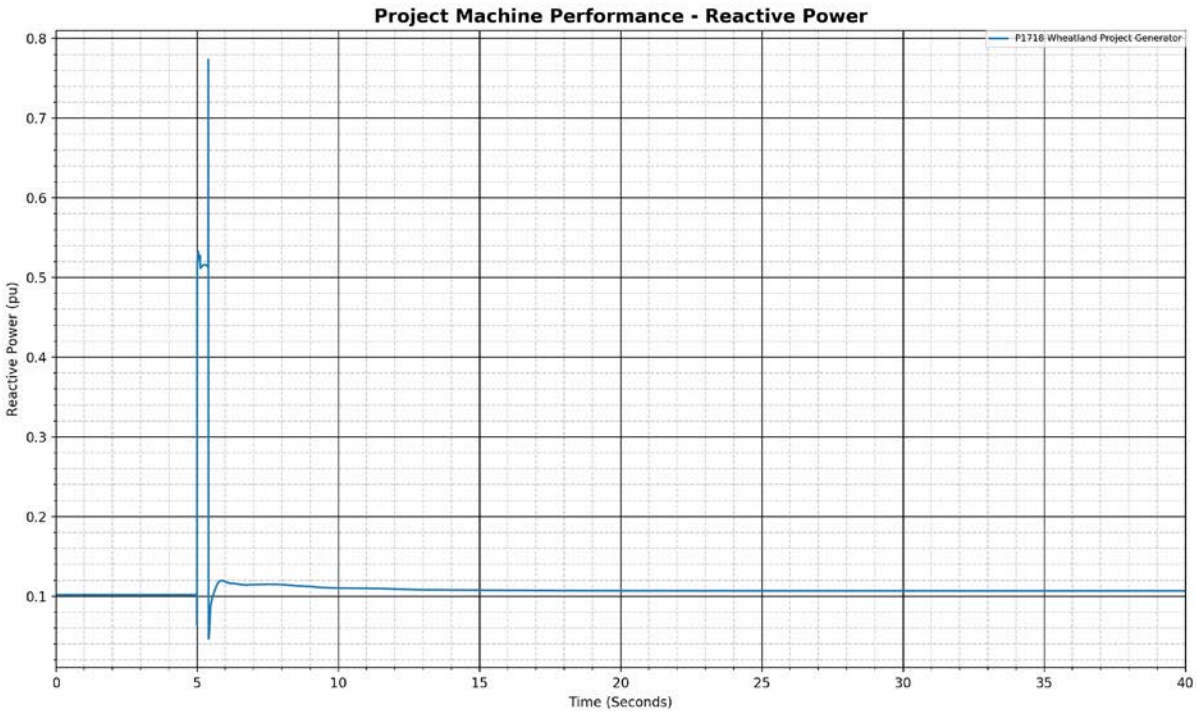

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

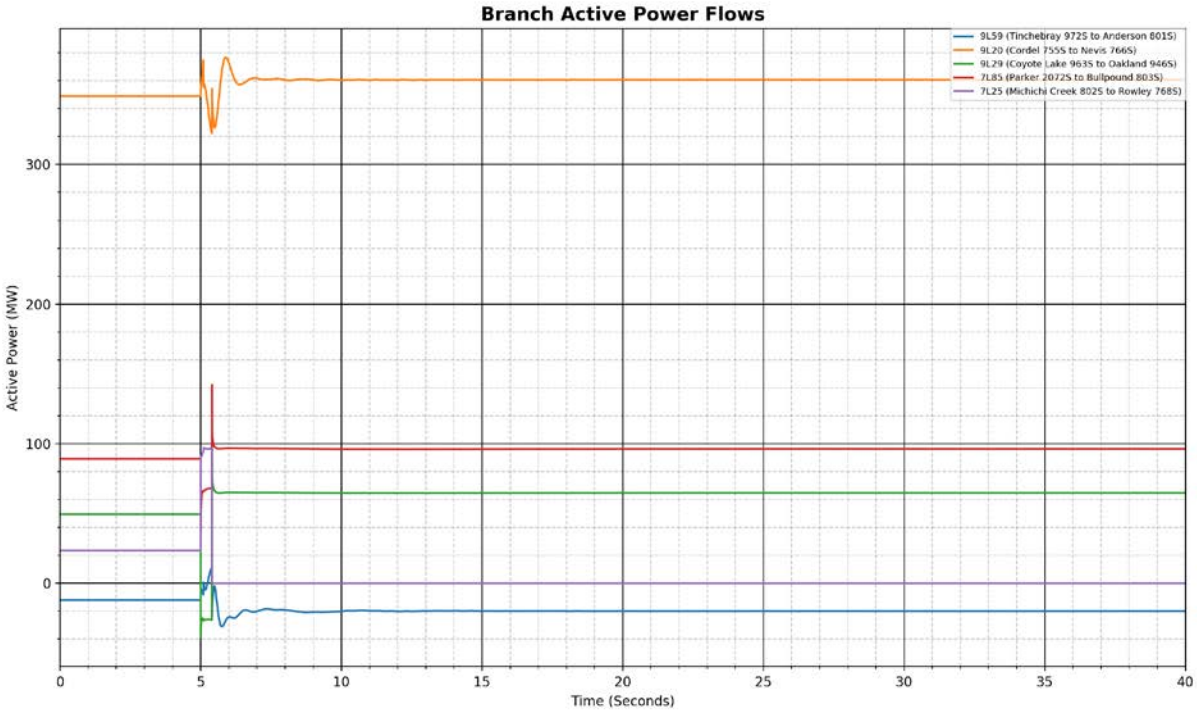

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
300
200
100
0
0
5
10
15
20
25
30
35
40
Time (Seconds)

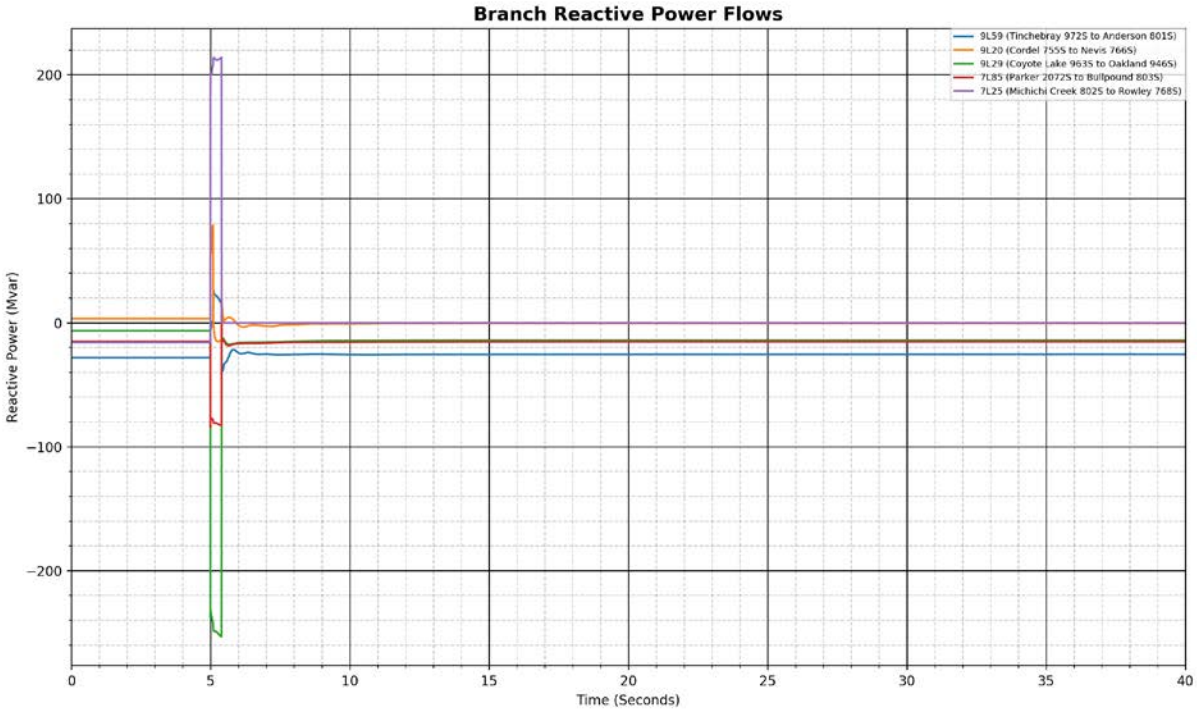
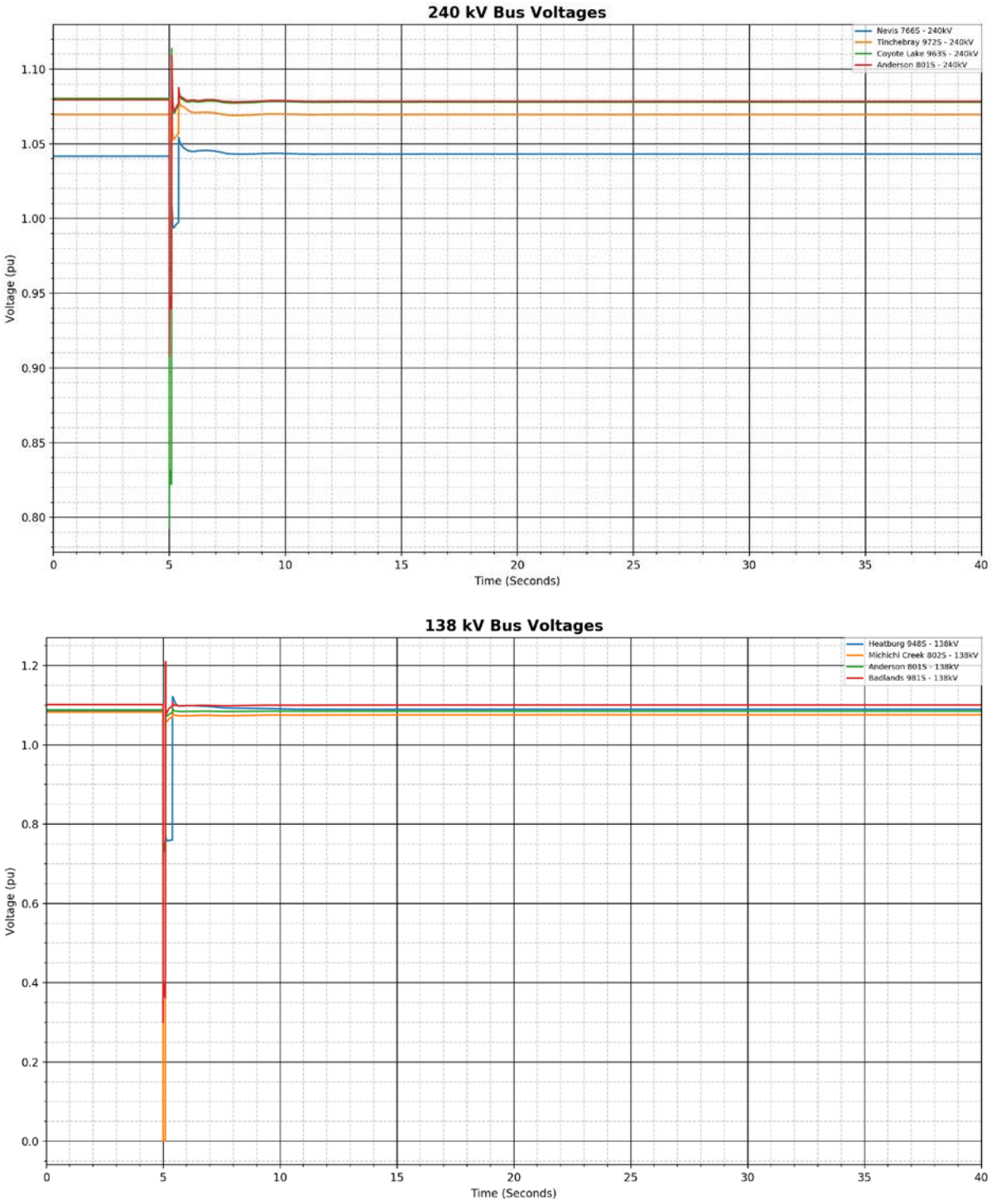
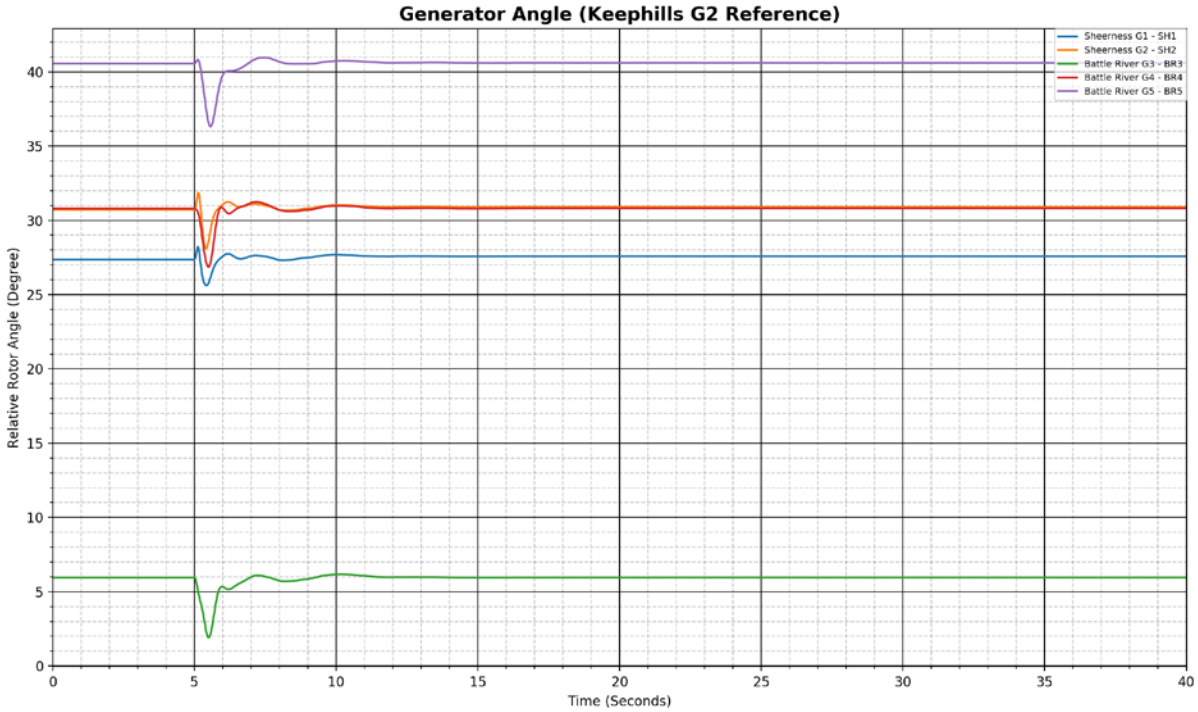
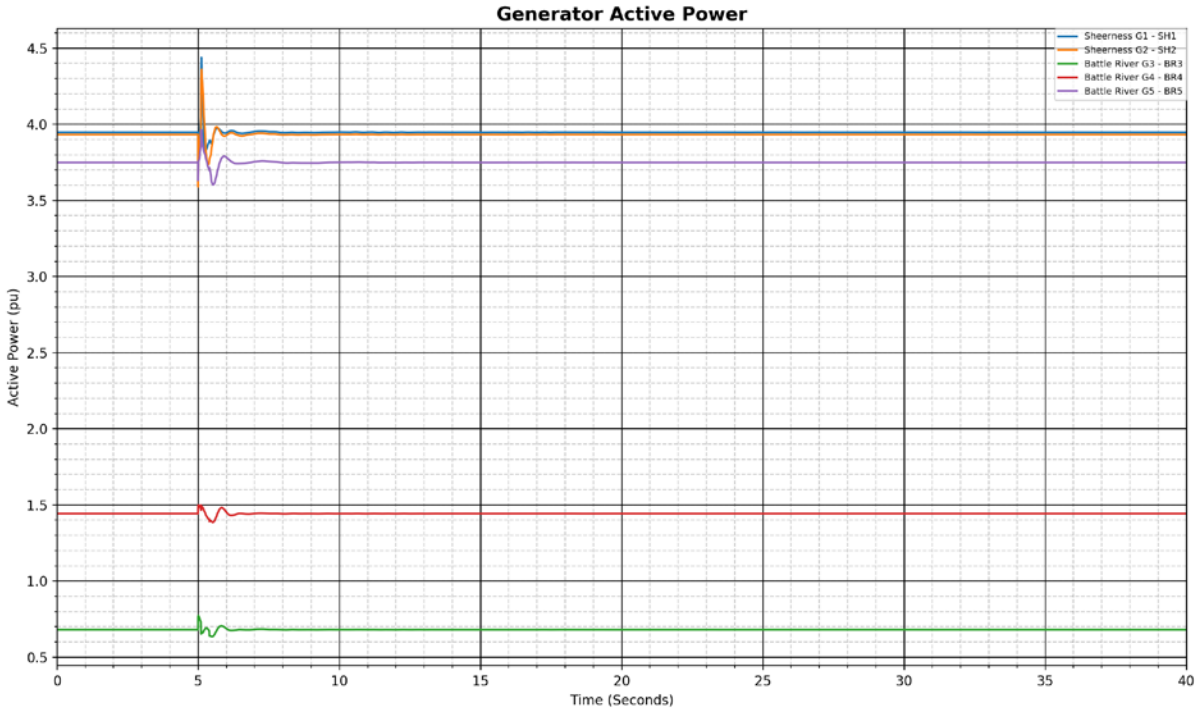
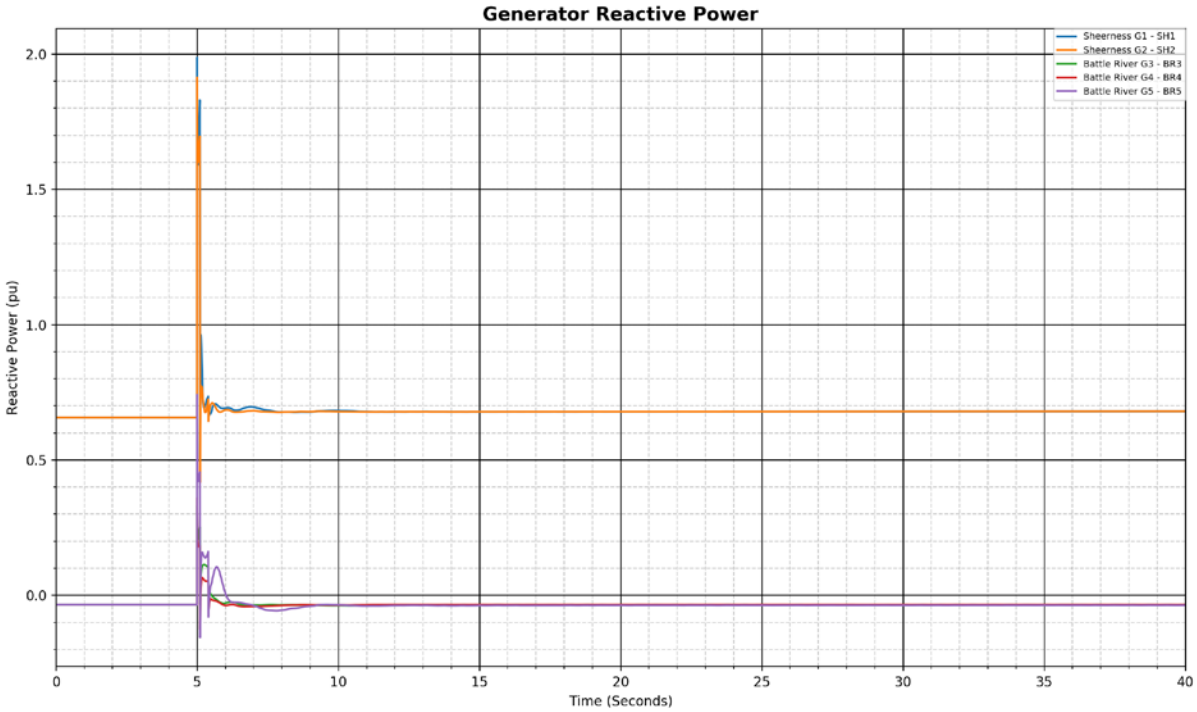

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
200
100
0
−100
−200
0
5
10
15
20
25
30
35
40
Time (Seconds)

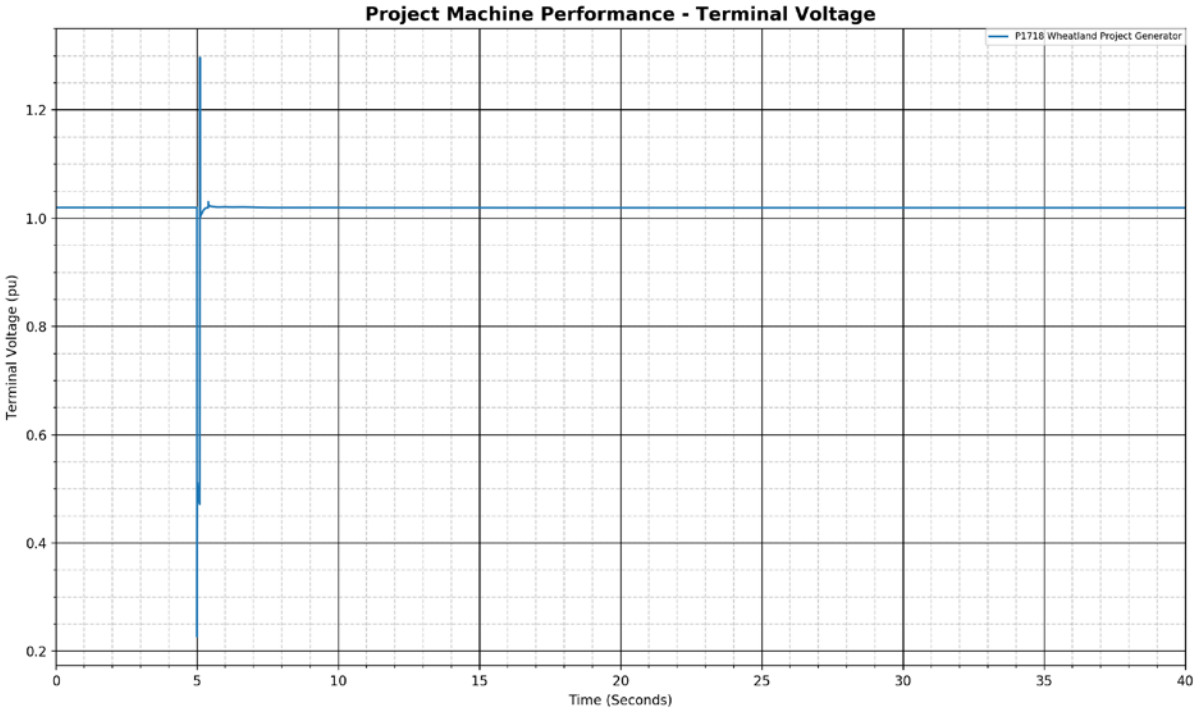
Figure A4-45: 7L25 (Rowley 768S - Michichi Creek 802S): 3-phase fault at Michichi Creek 802S

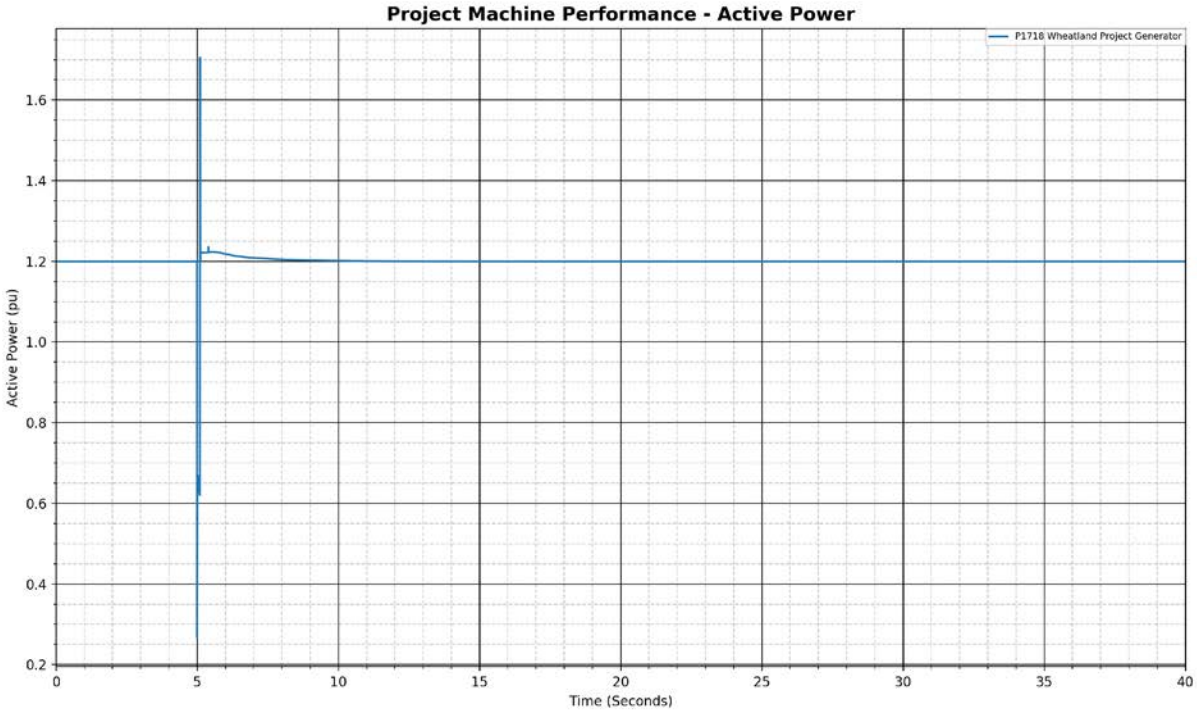


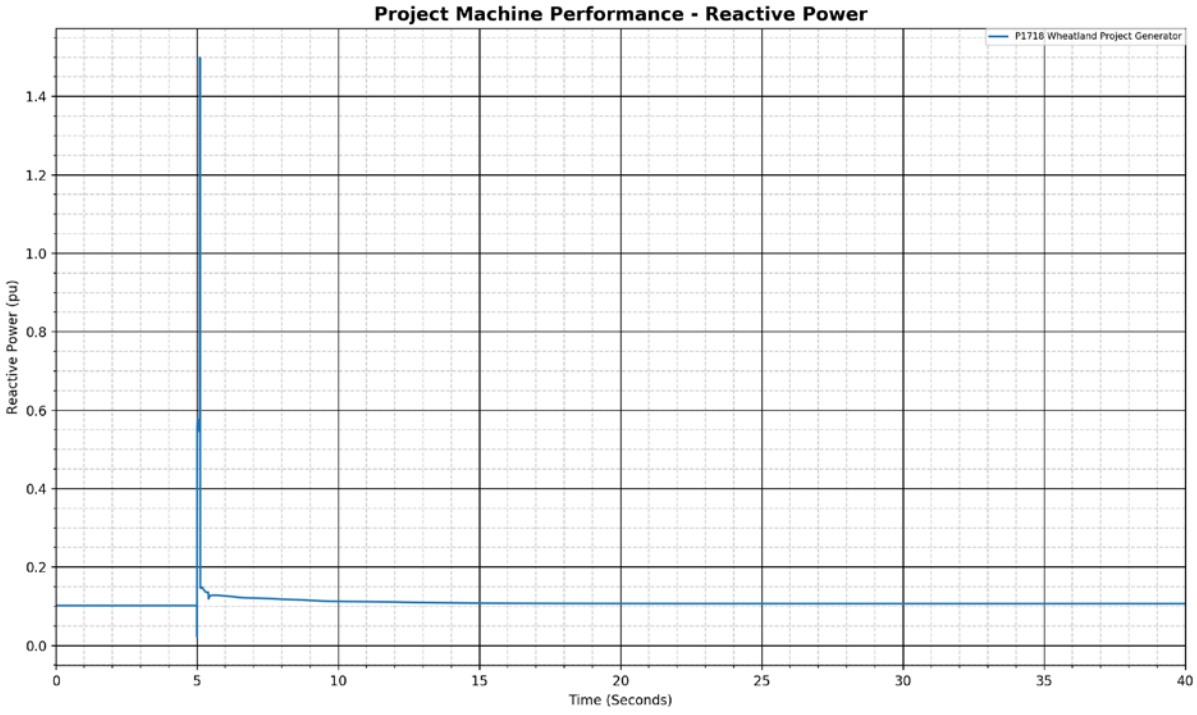

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

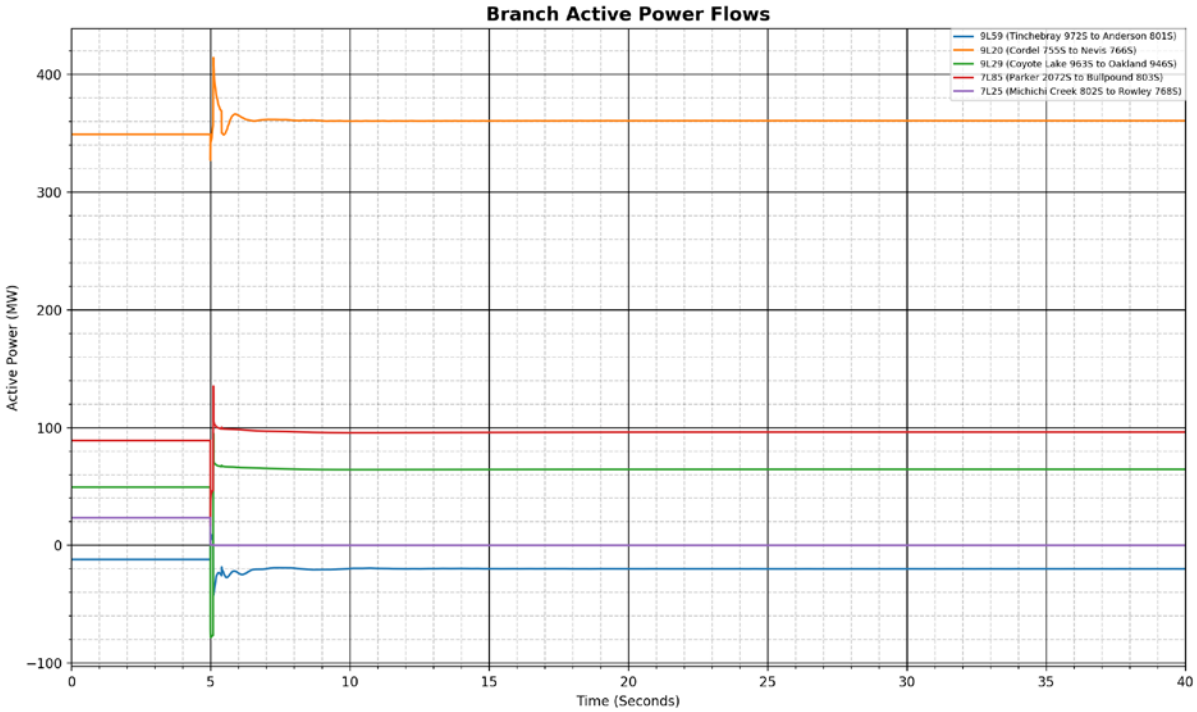

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
Time (Seconds)

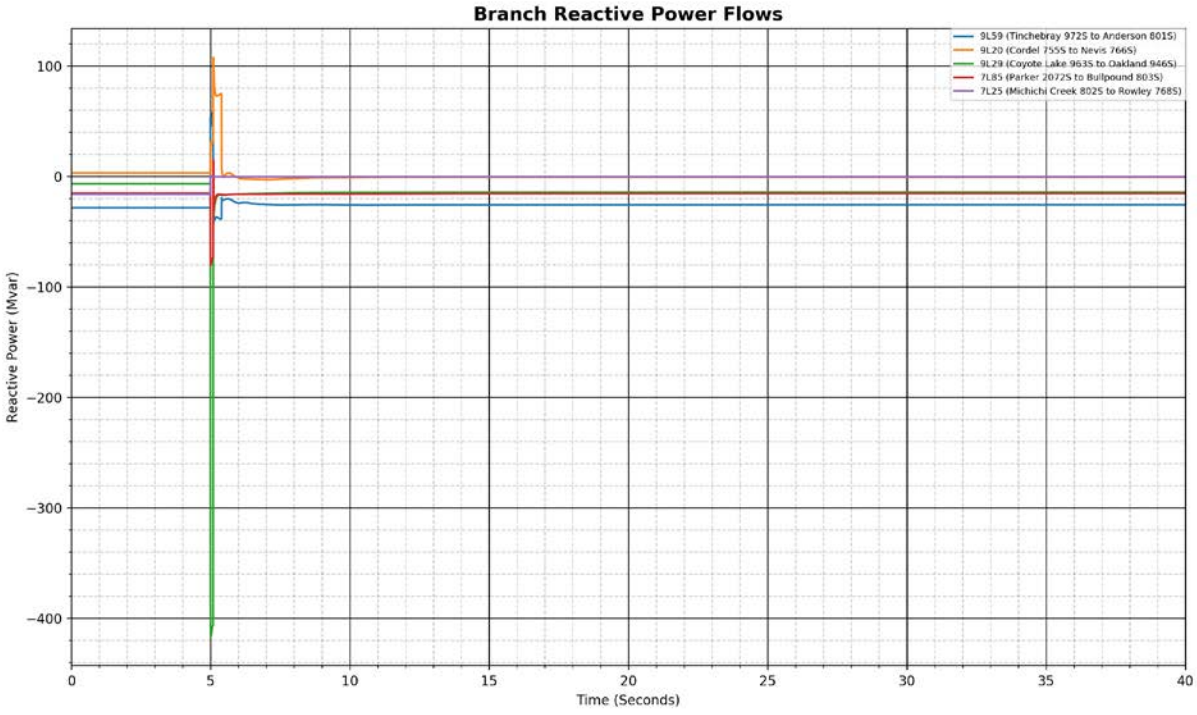
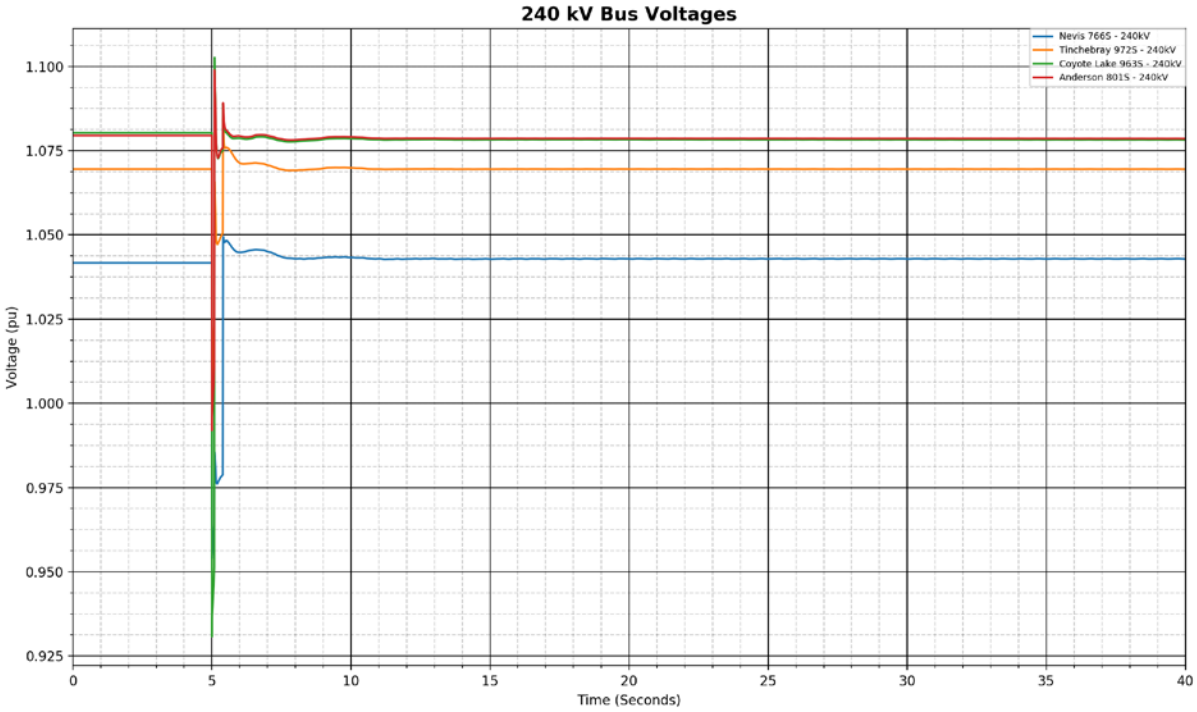
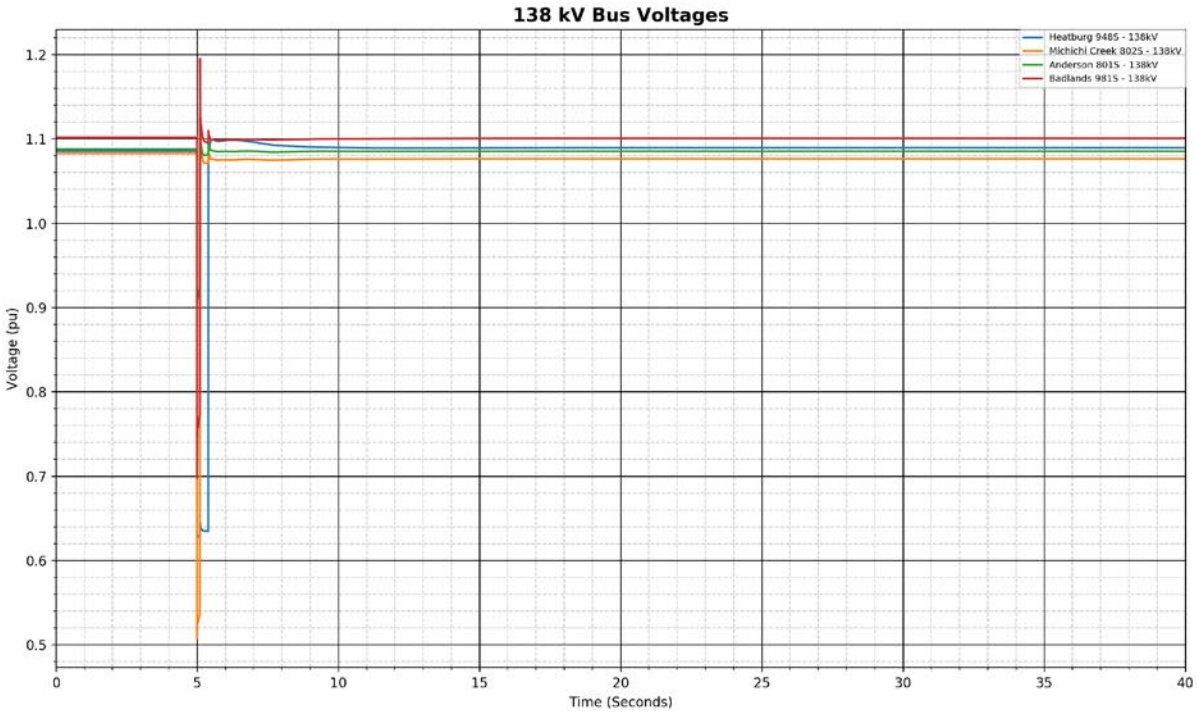
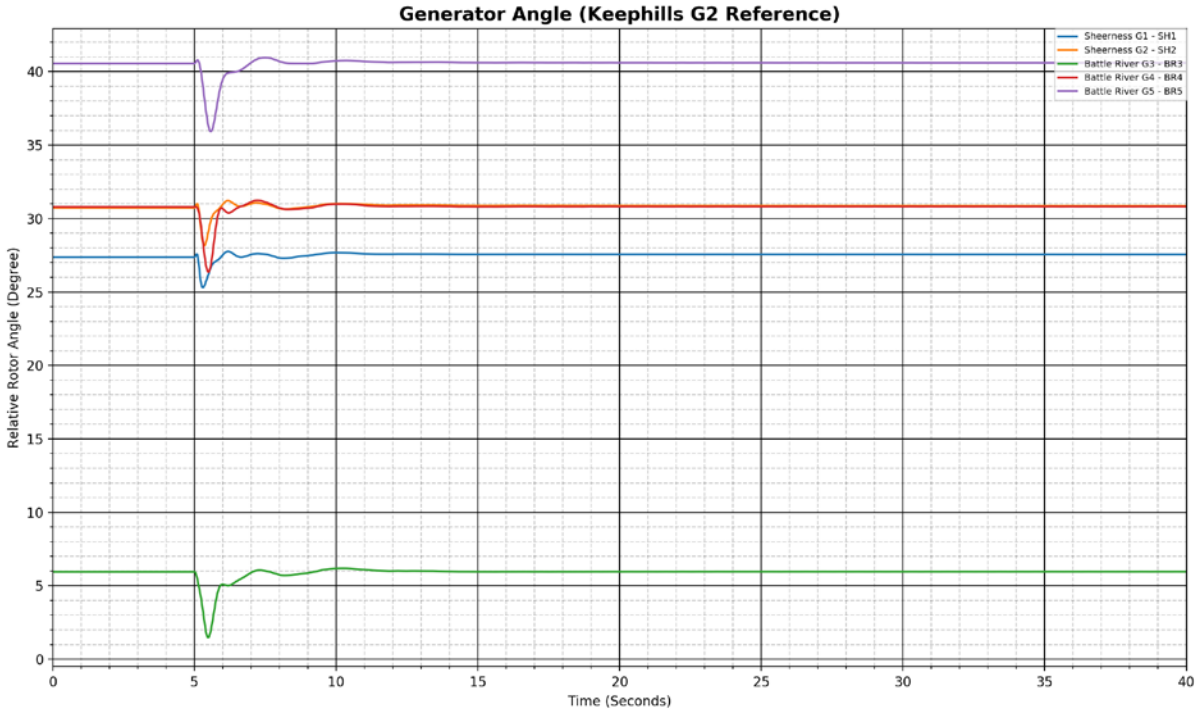
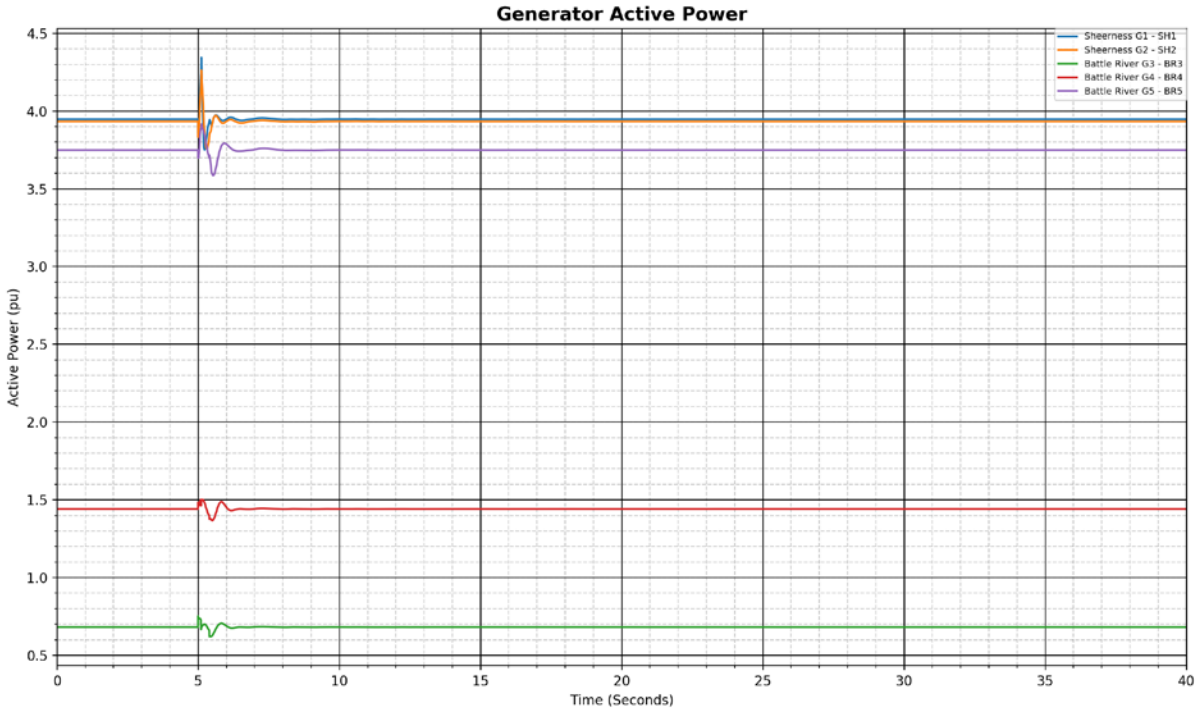

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
Time (Seconds)

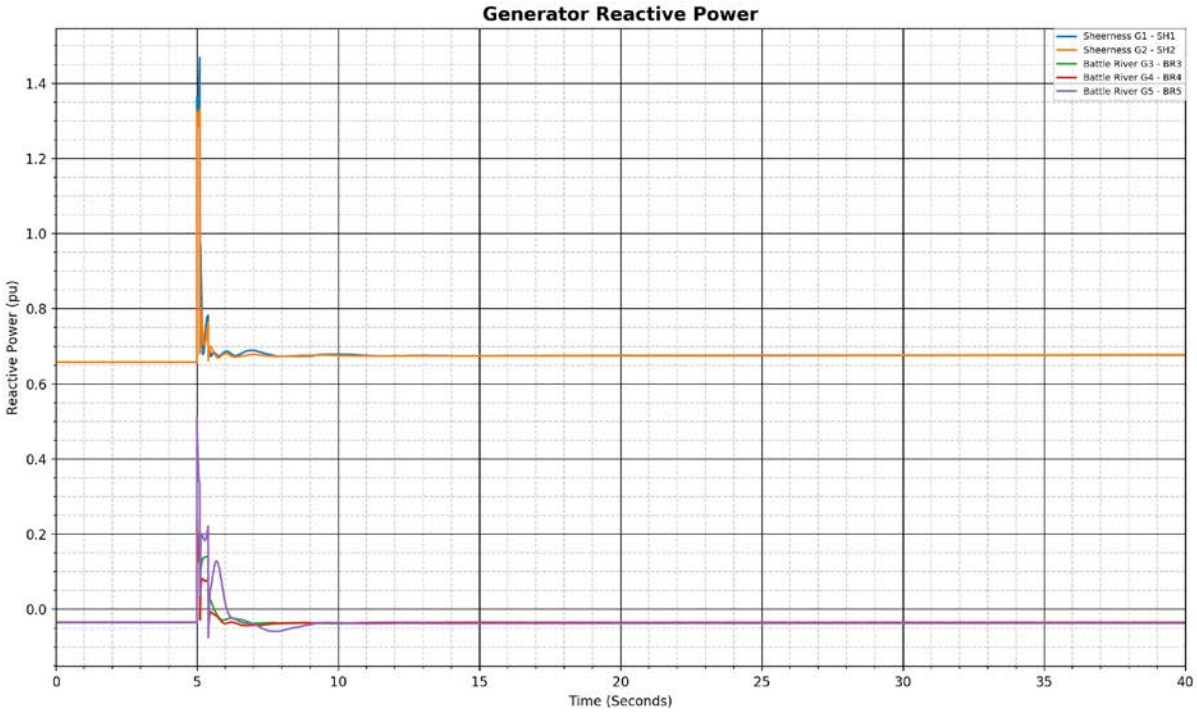
Figure A4-46: 7L137 (Rowley 768S - Three Hills 770S): 3-phase fault at Rowley 768S

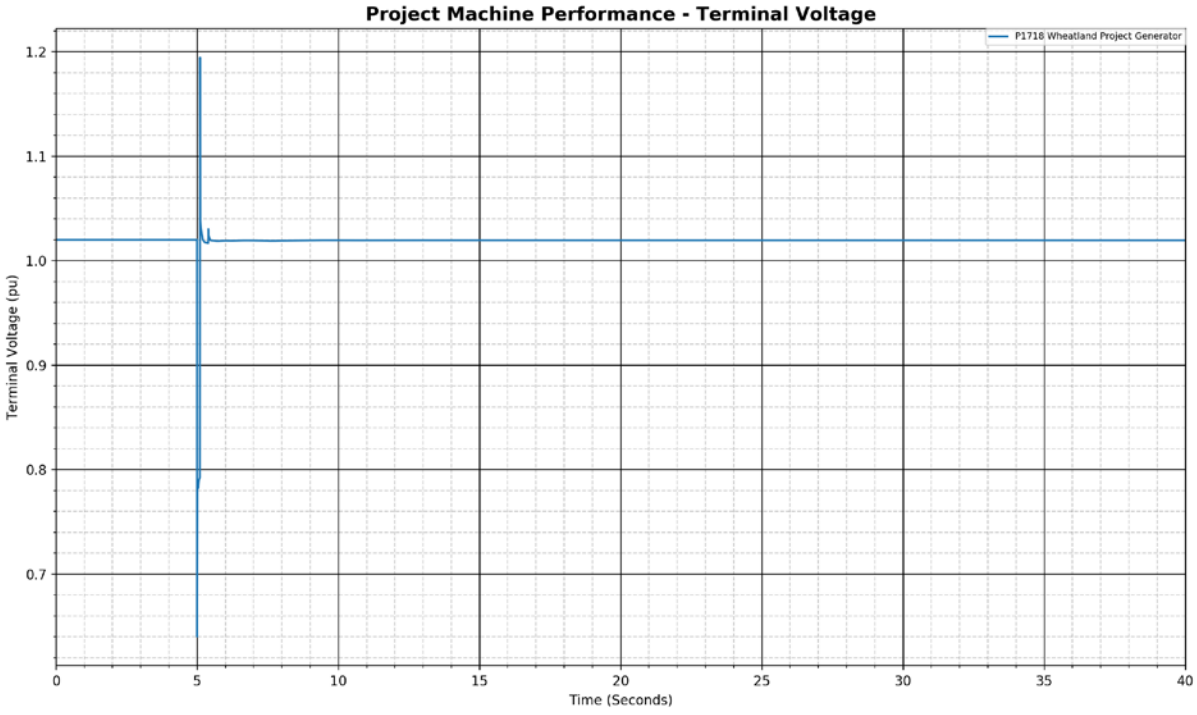


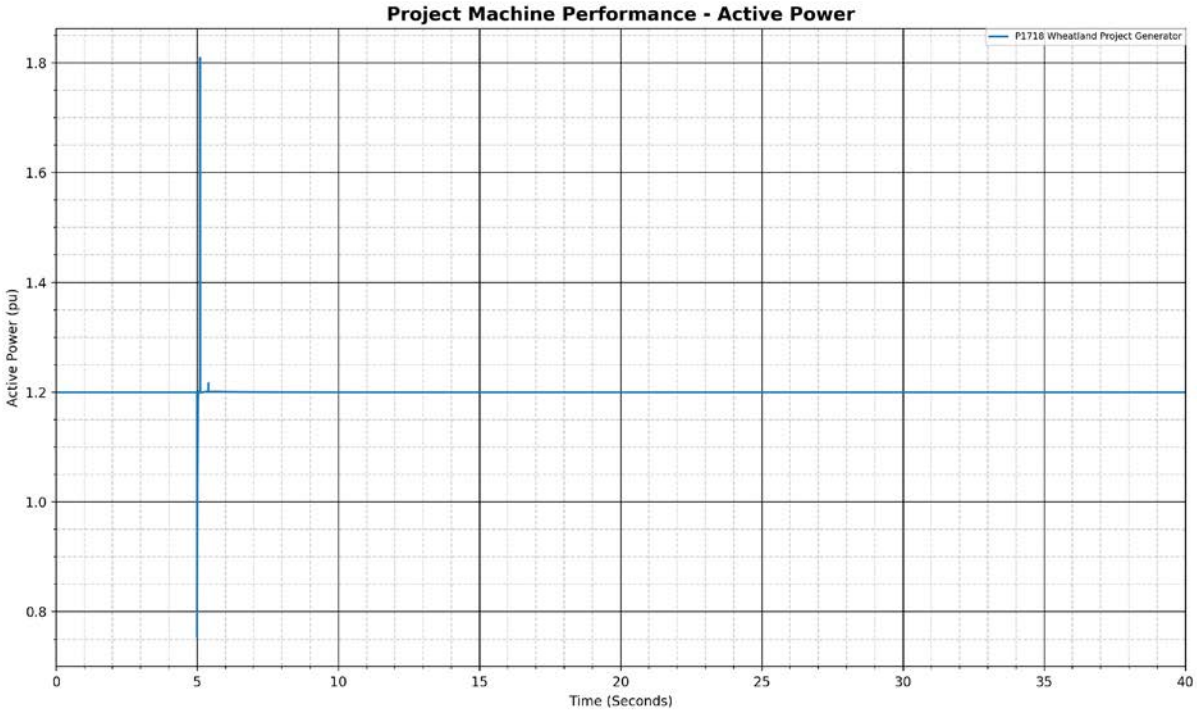


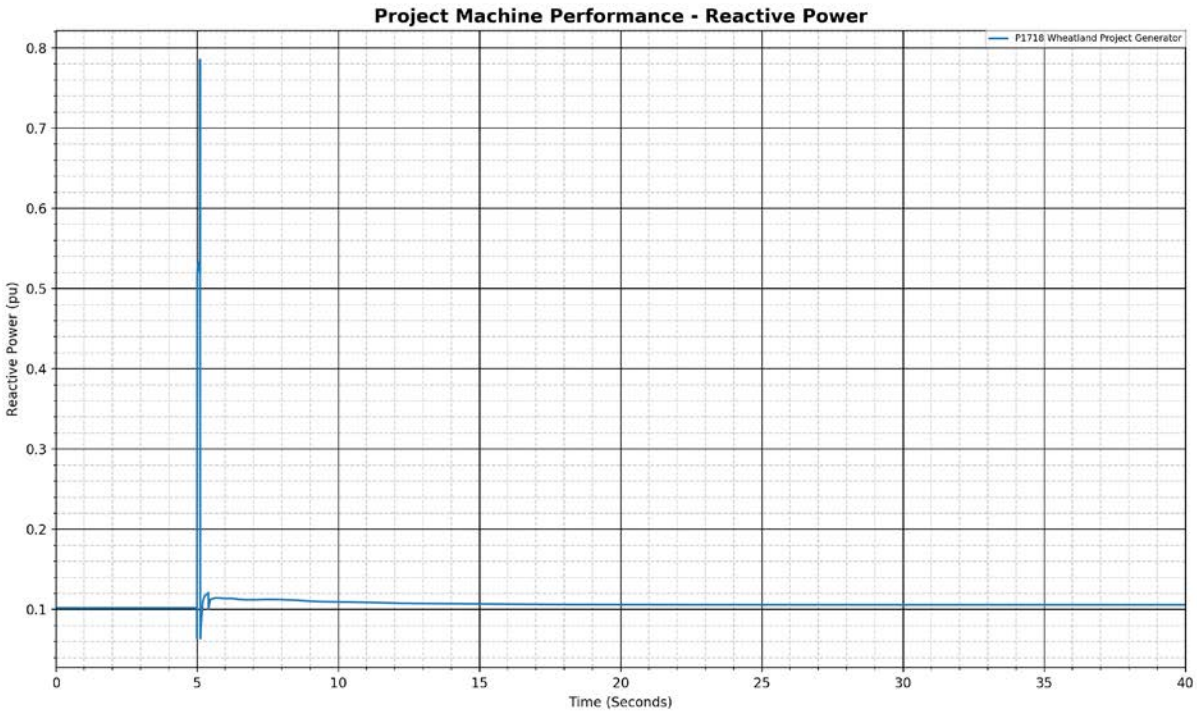

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

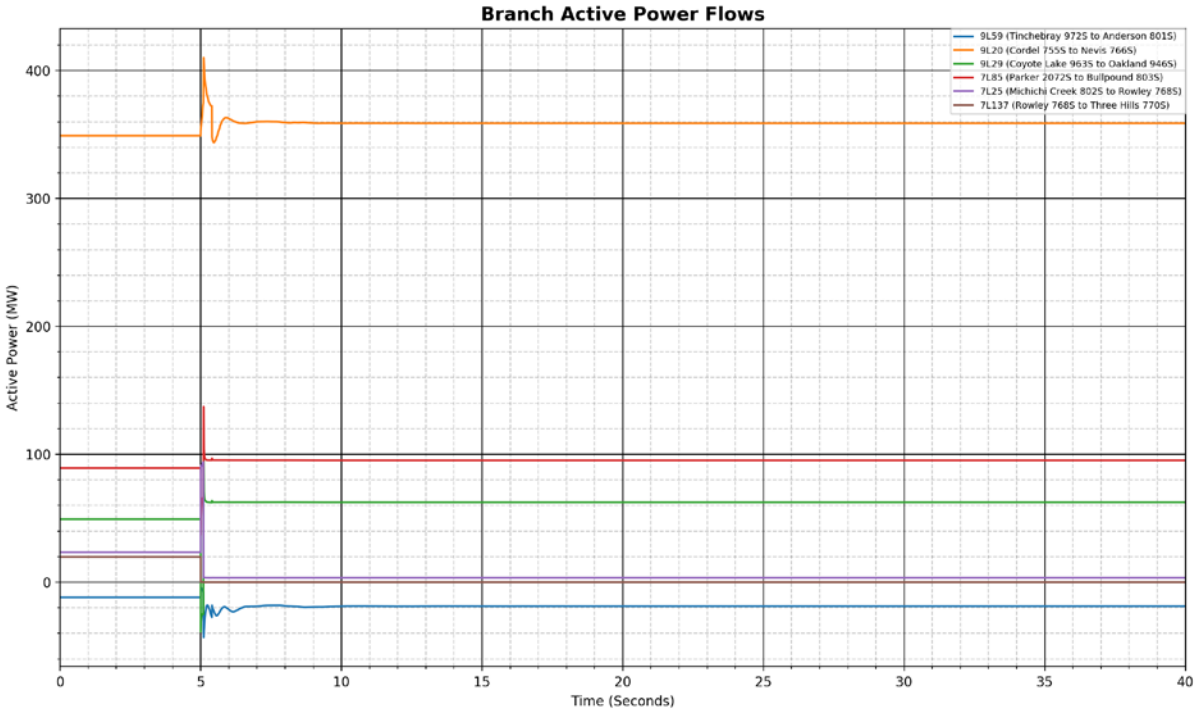

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.8
1.6
1.4
1.2
1.0
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Active Power (MW)
Time (Seconds)

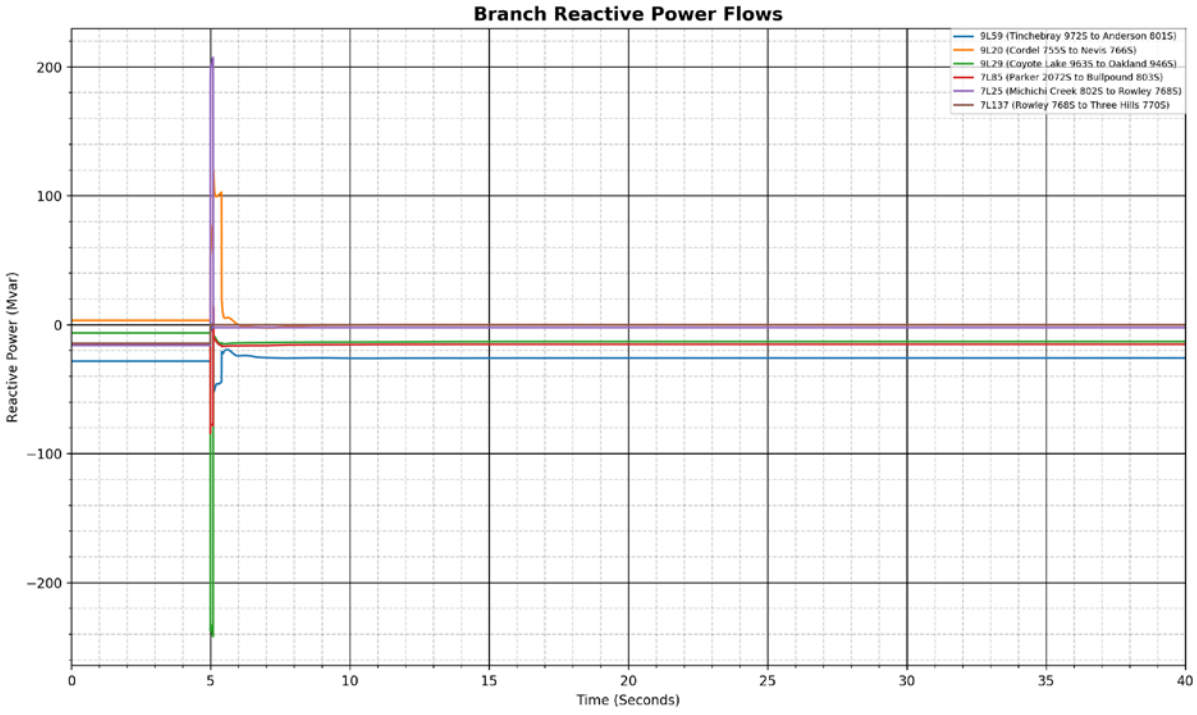
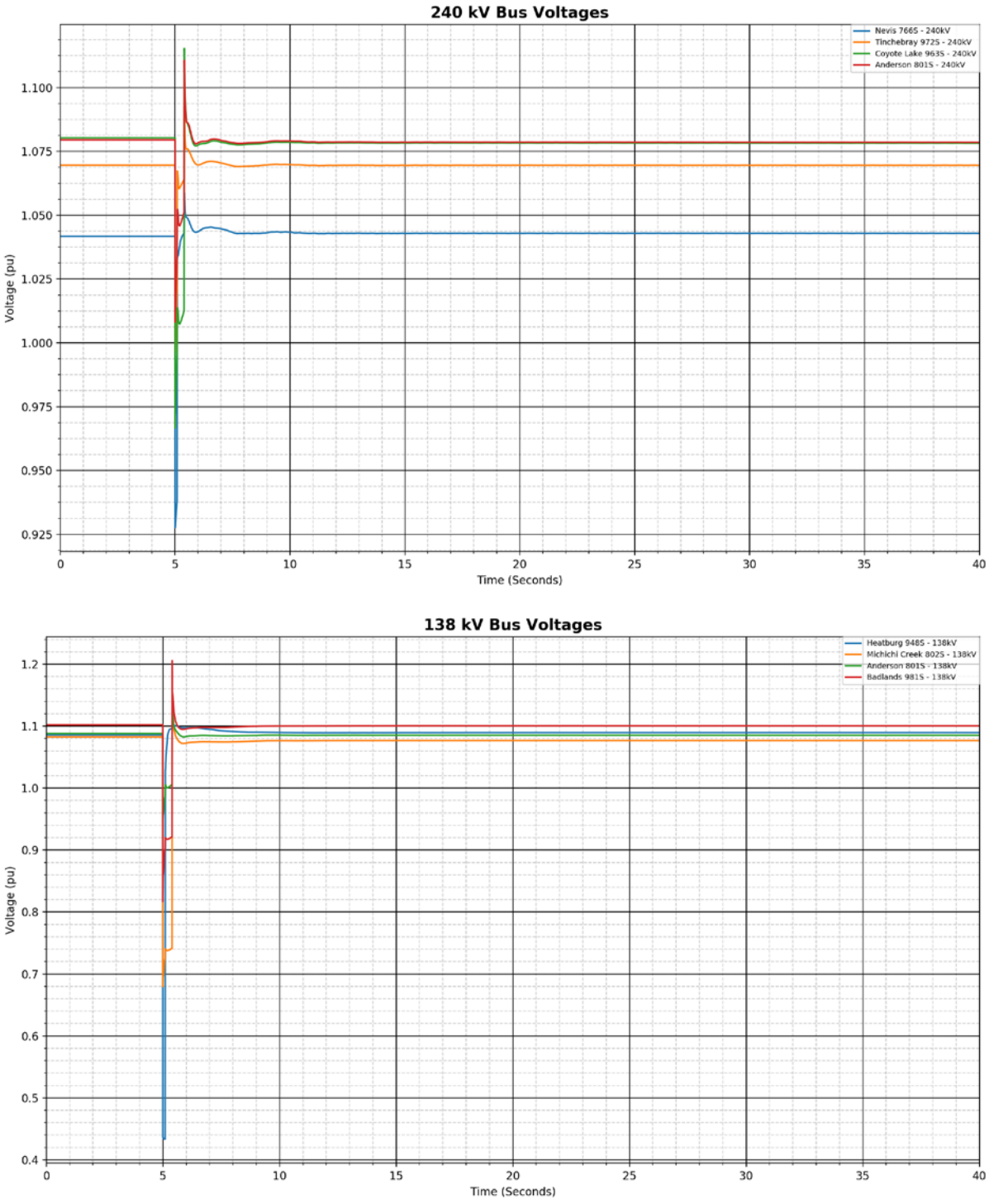
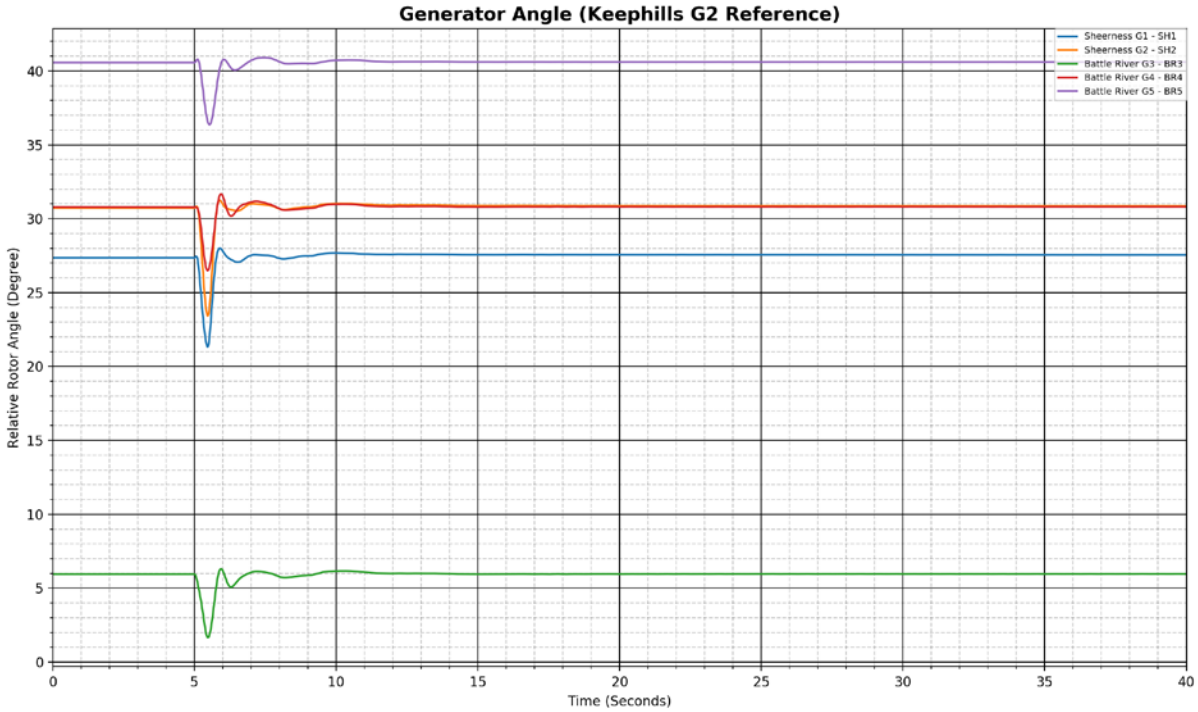
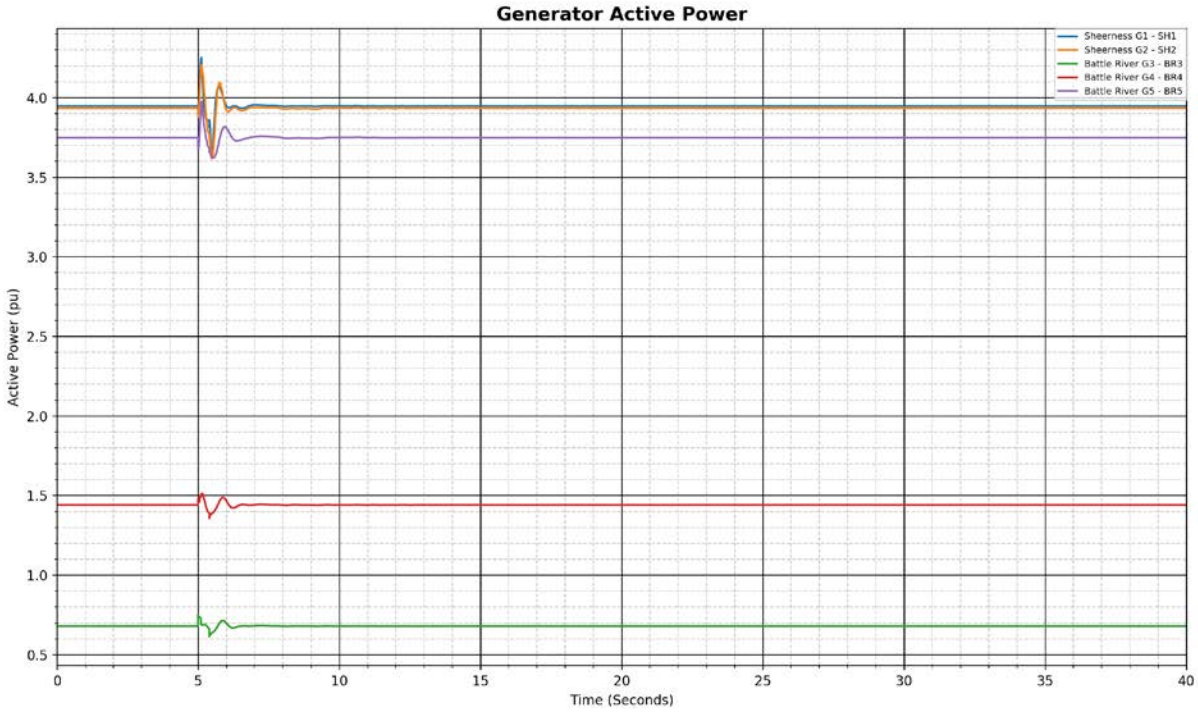
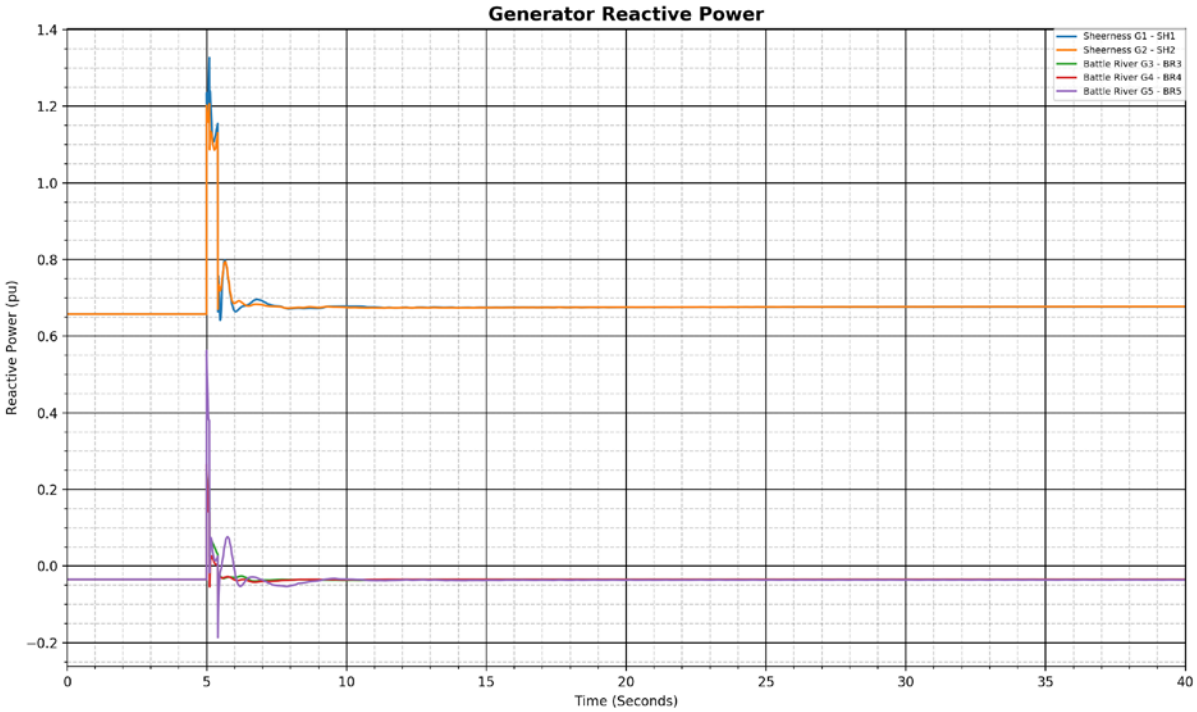

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Reactive Power (Mvar)
Time (Seconds)

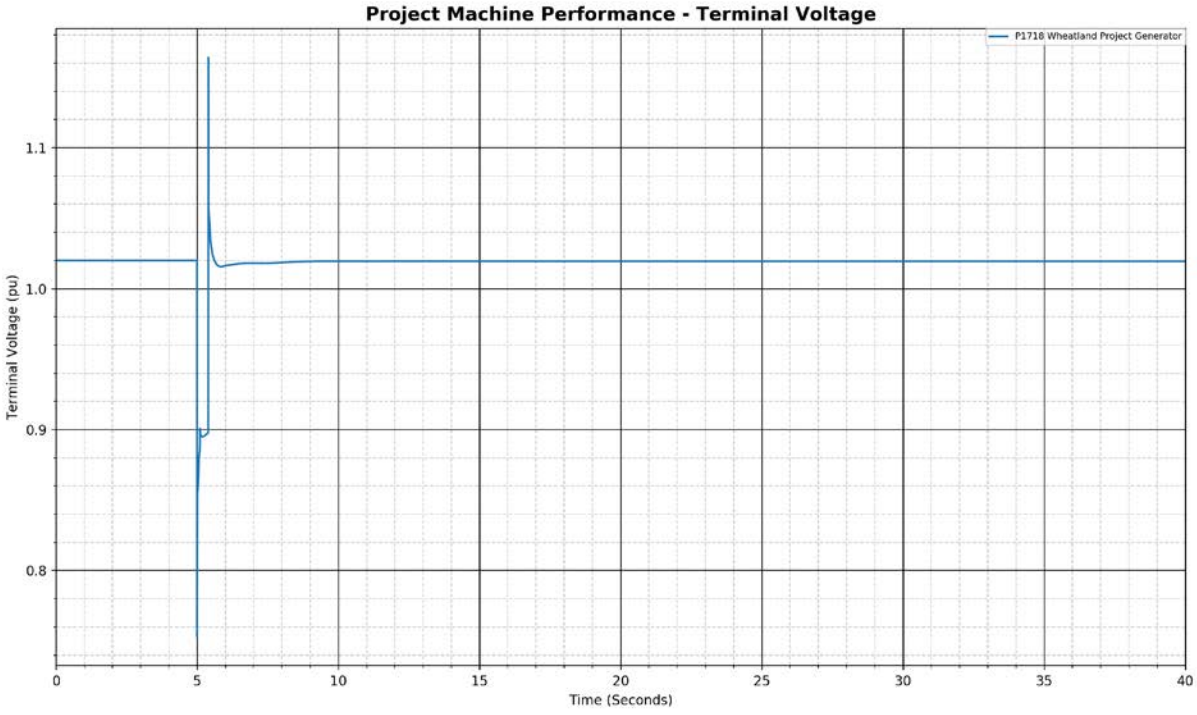
Figure A4-47: 7L137 (Rowley 768S - Three Hills 770S): 3-phase fault at Three Hills 770S

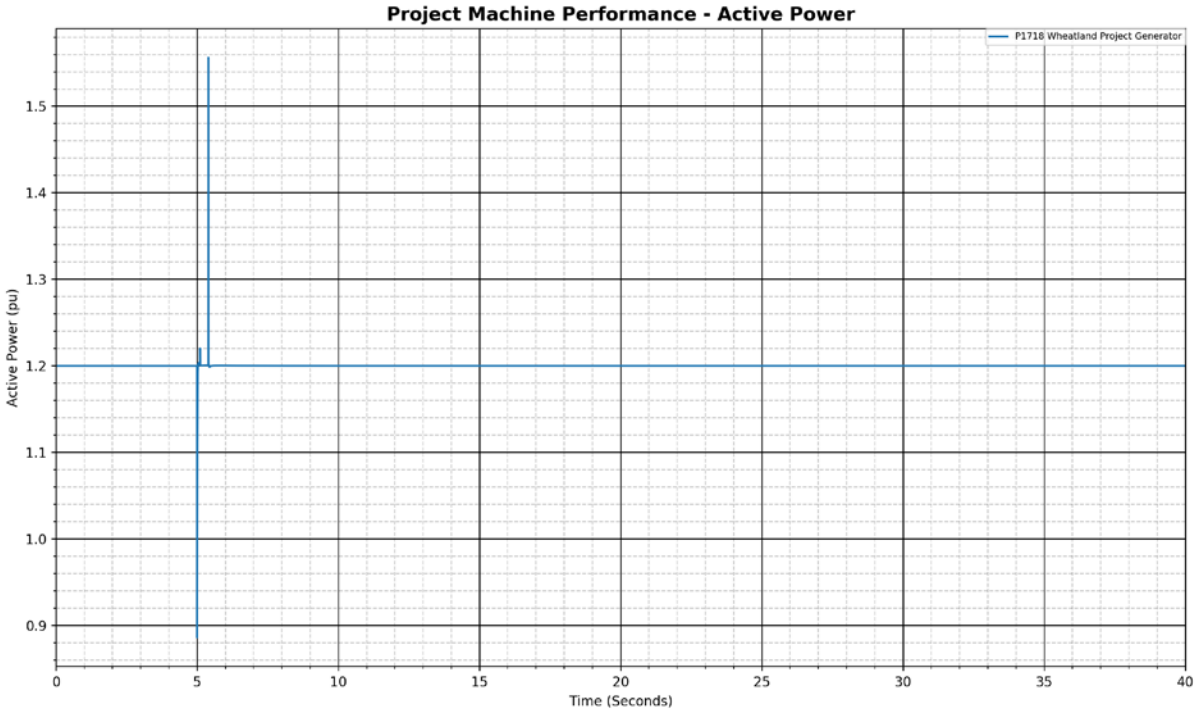


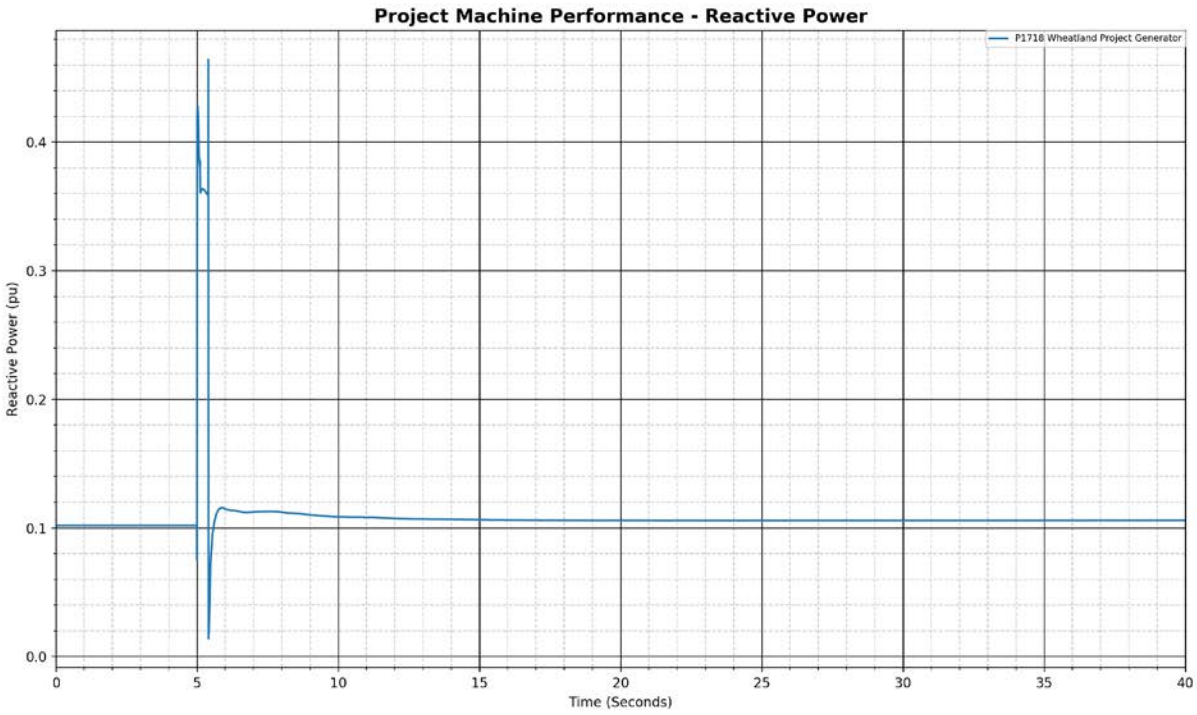

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

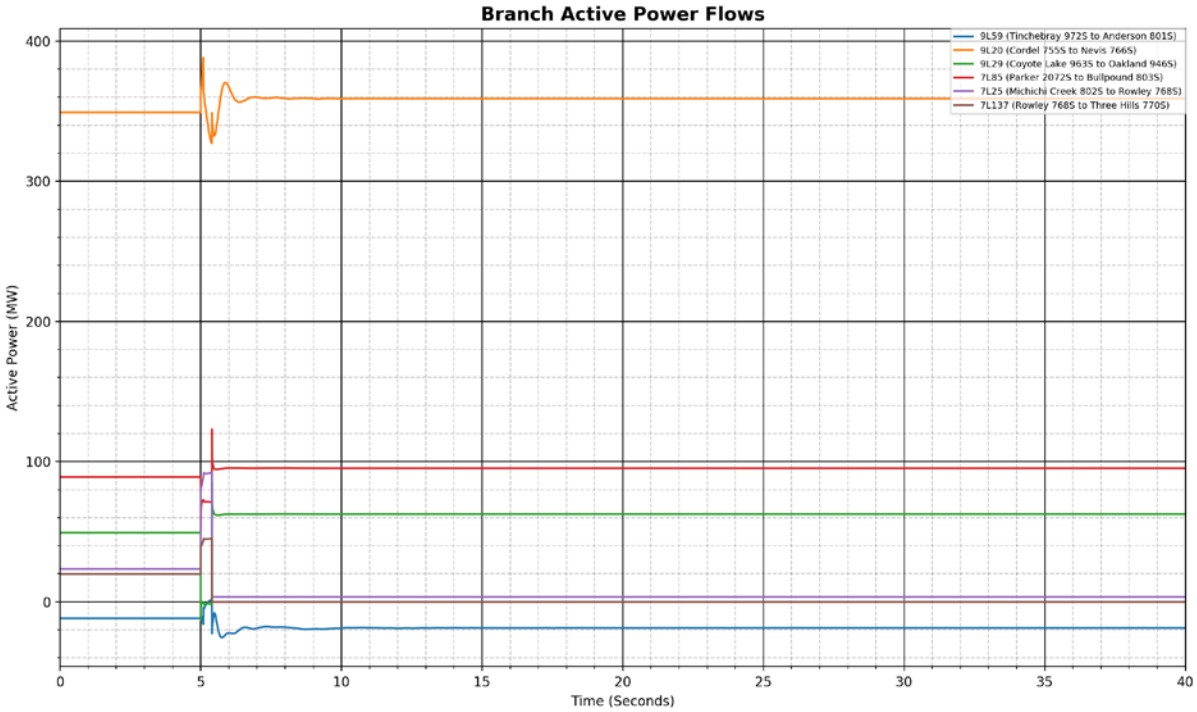

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Active Power (MW)
Time (Seconds)

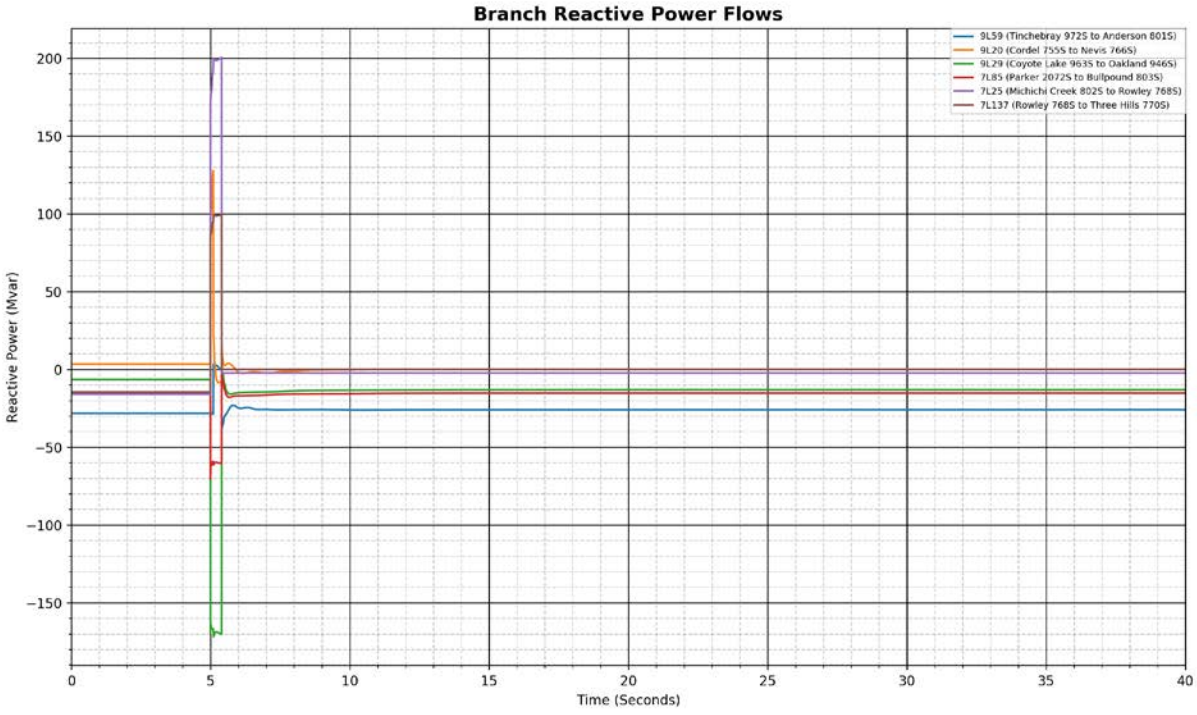
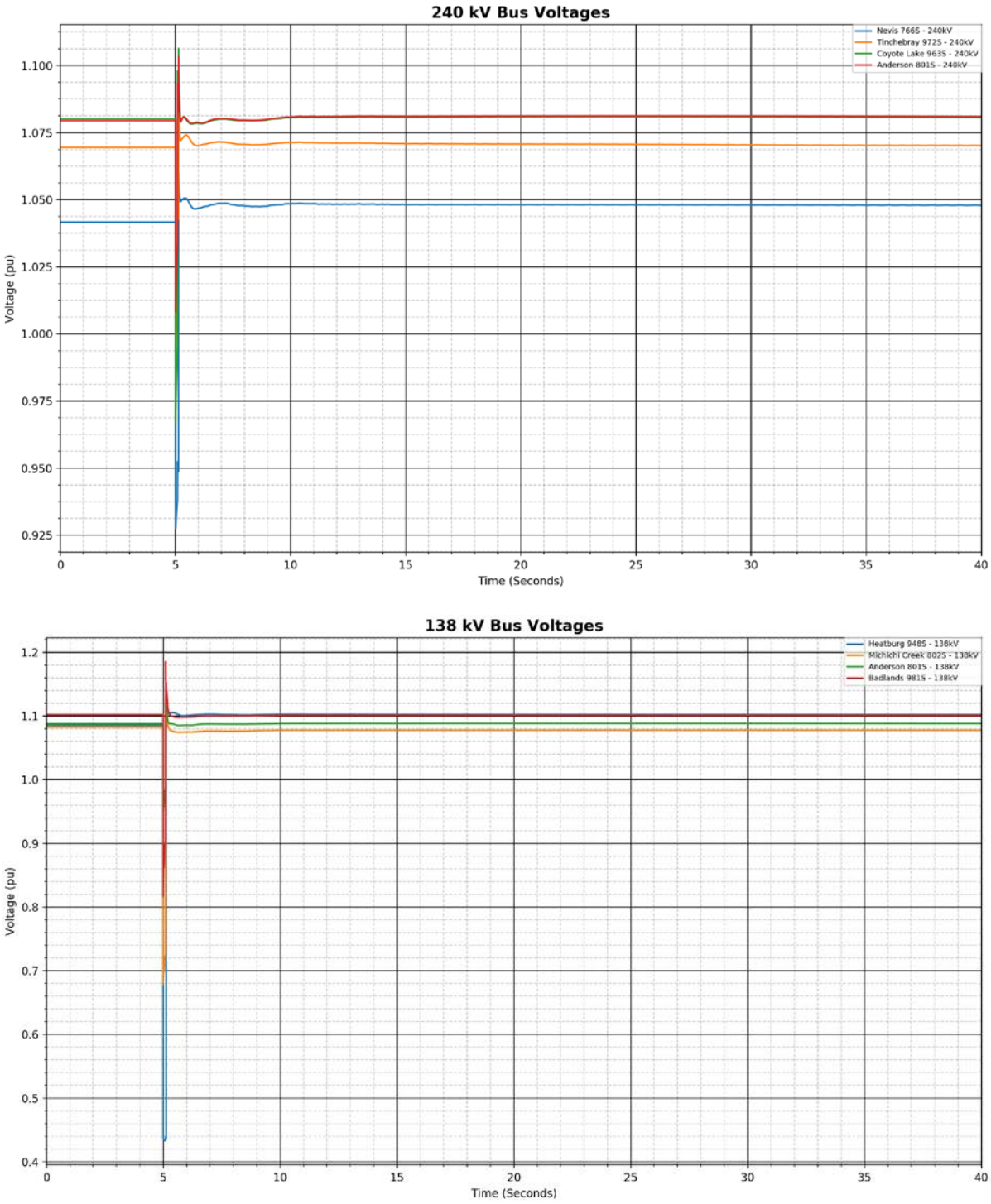
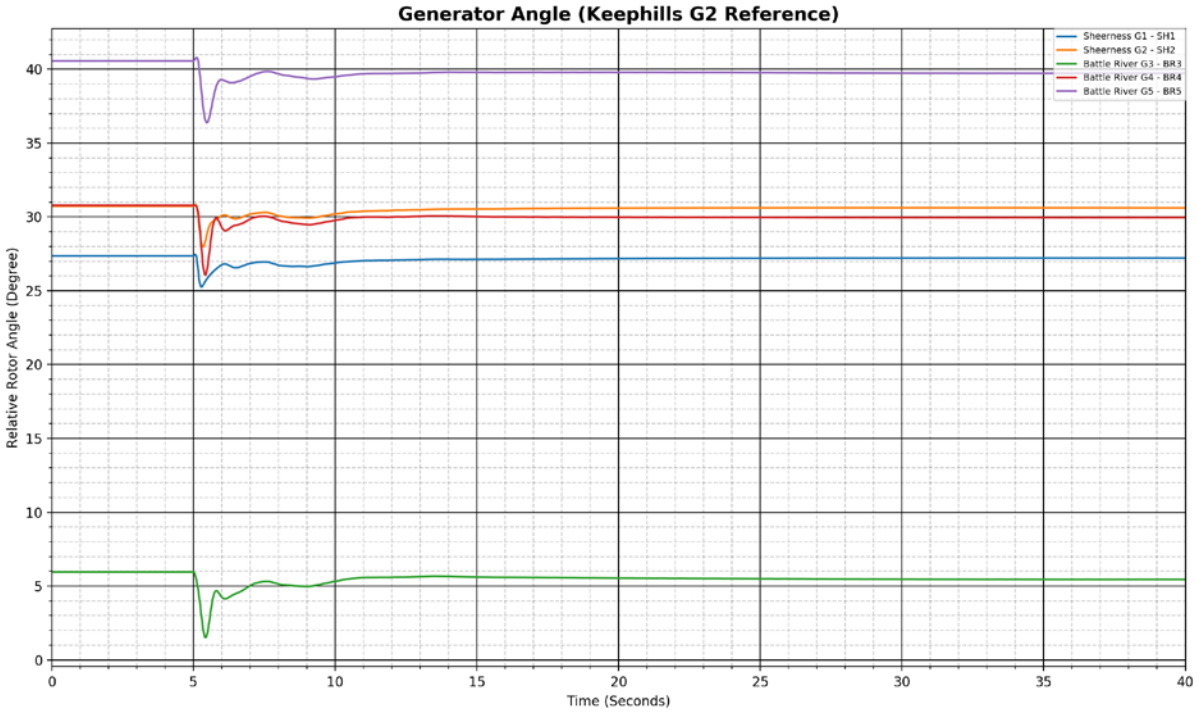
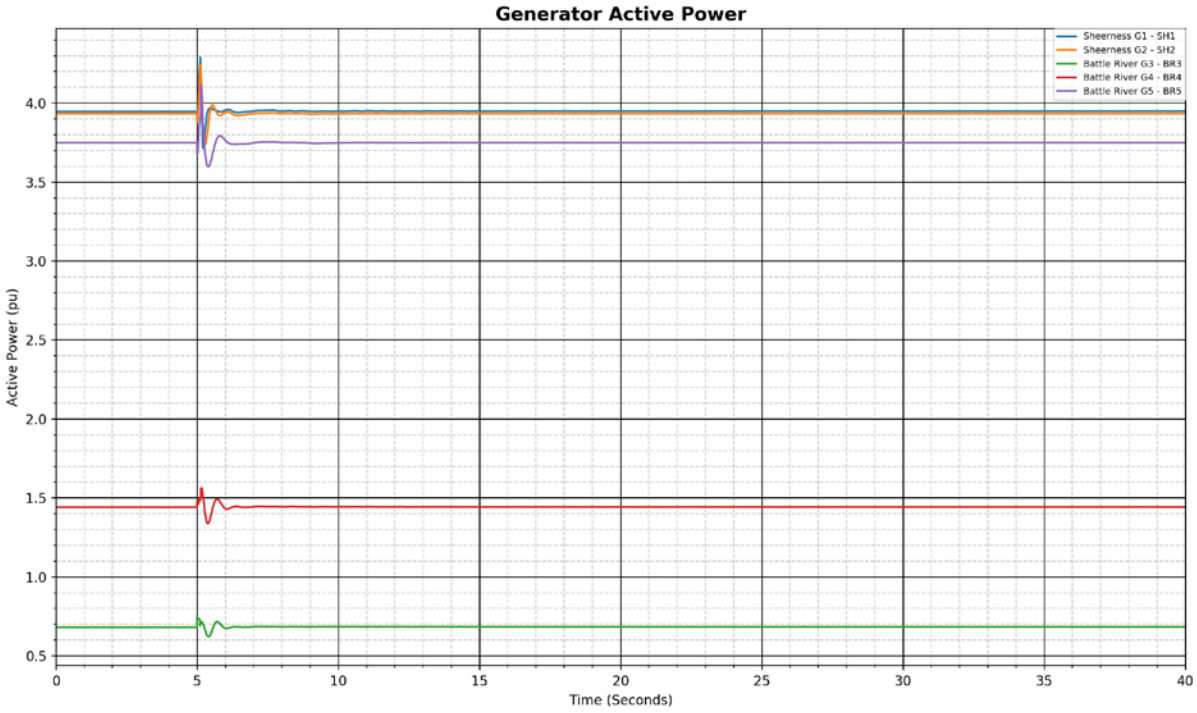
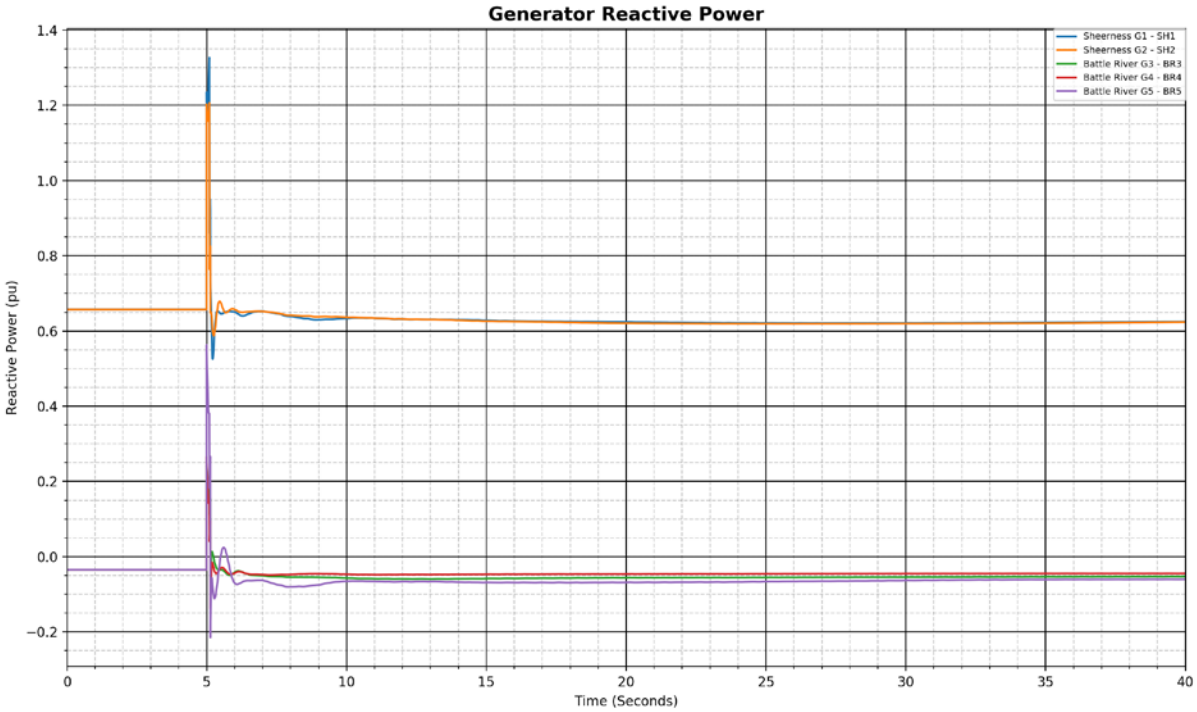

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Reactive Power (Mvar)
Time (Seconds)

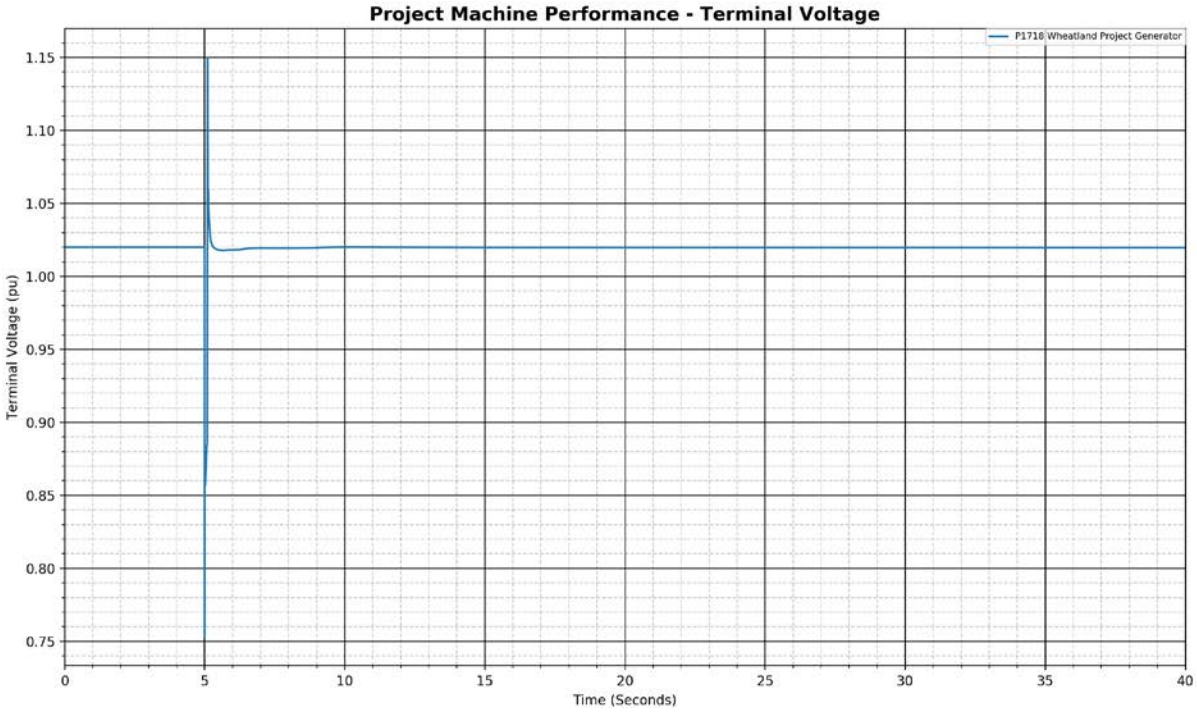
Figure A4-48: 7L159 (Three Hills 770S - Ghost Pine 114S - Heatburg 948S): 3-phase fault at Three Hills 770S

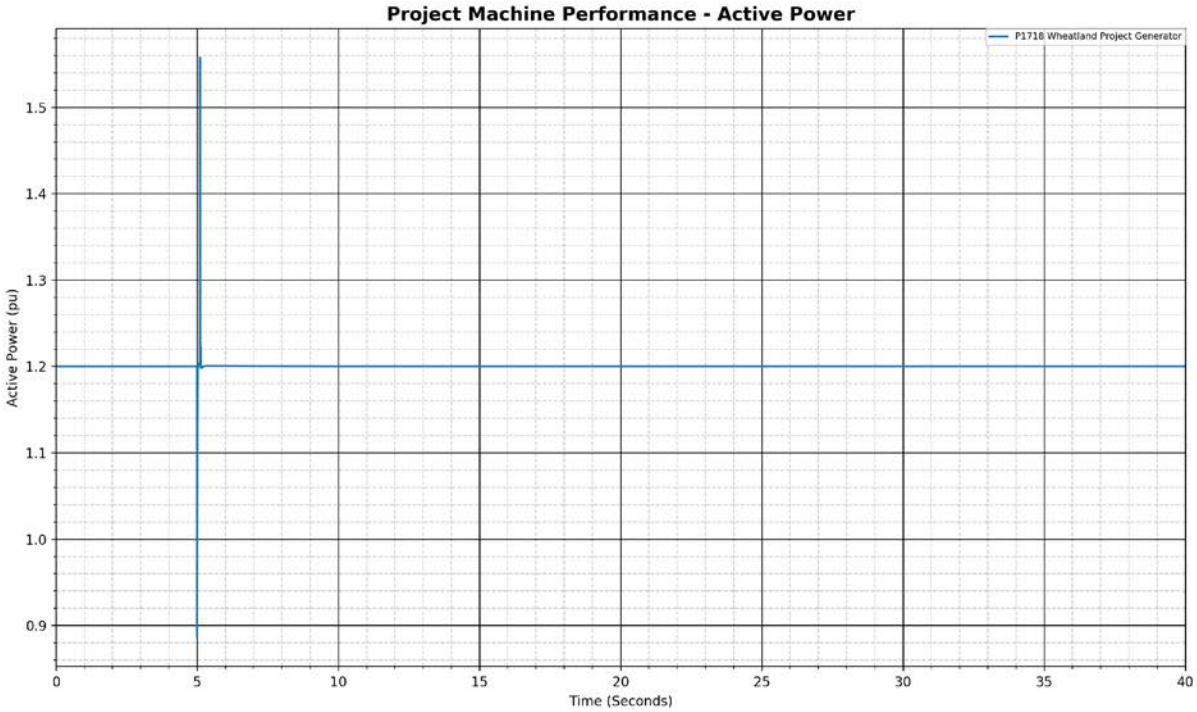


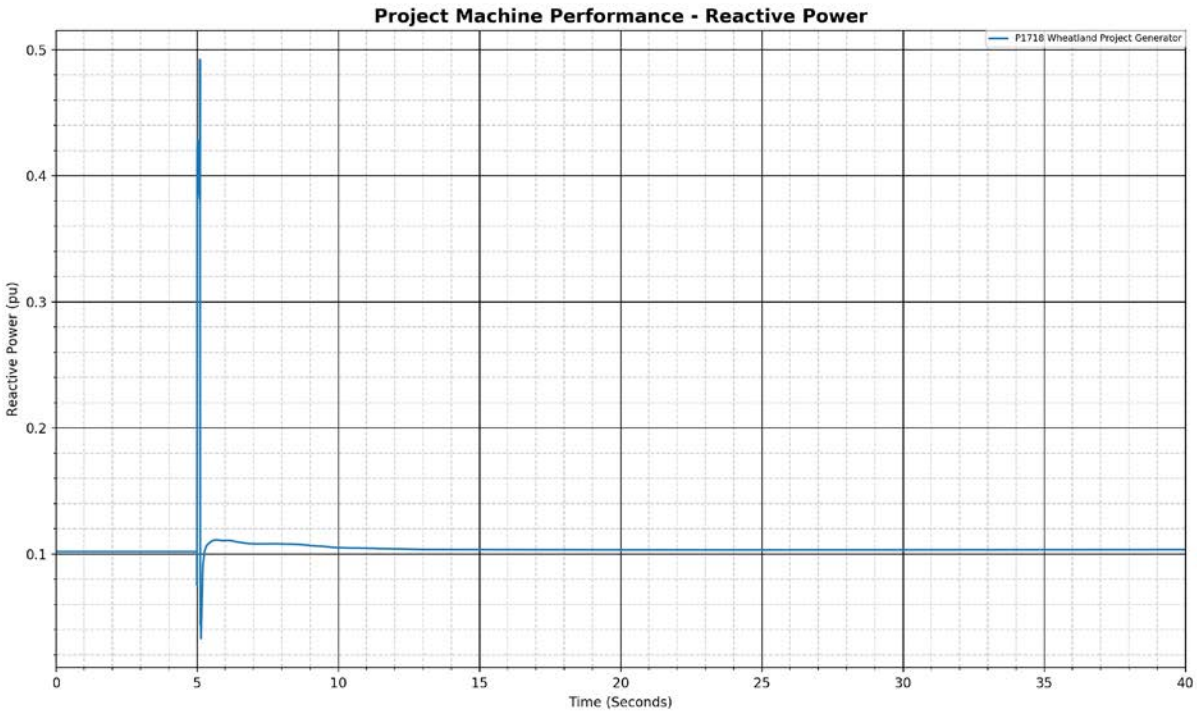

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

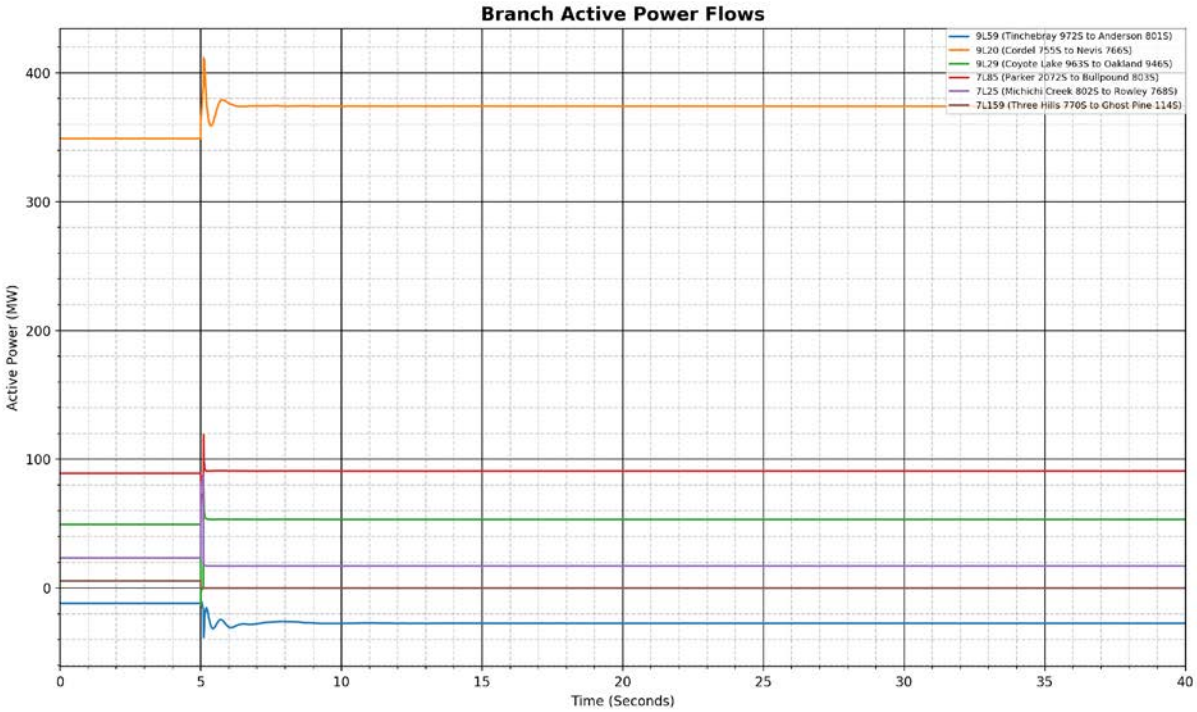

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 114S)
Active Power (MW)
Time (Seconds)

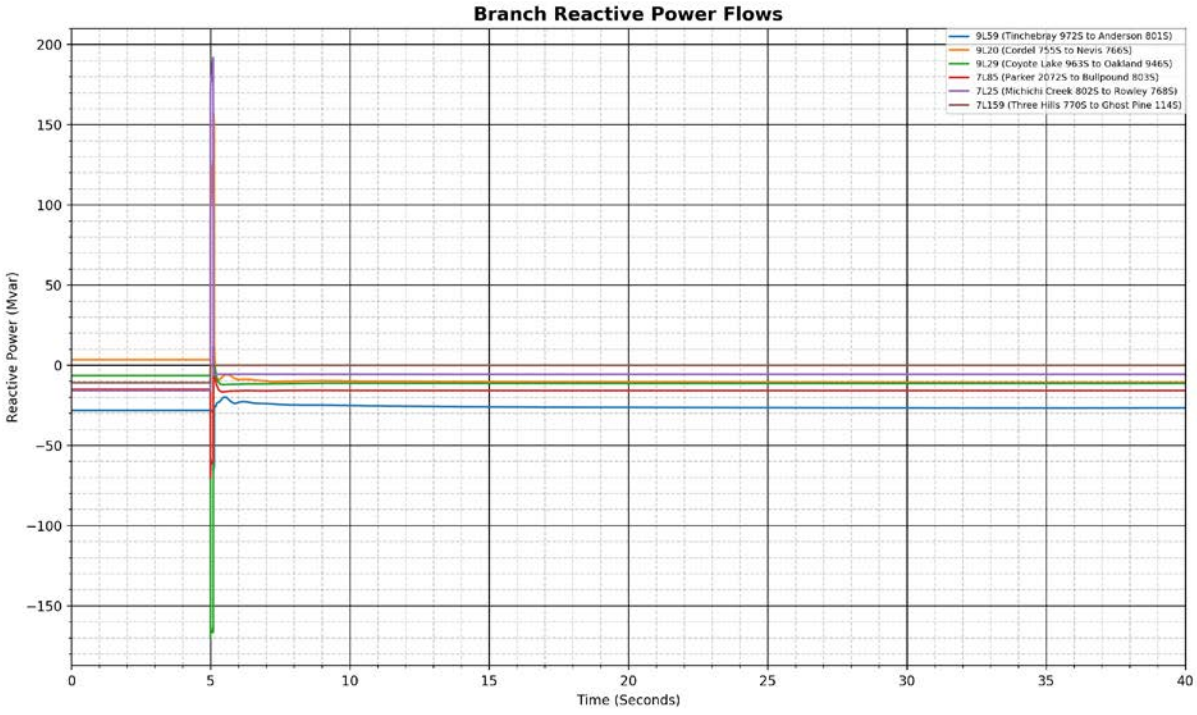
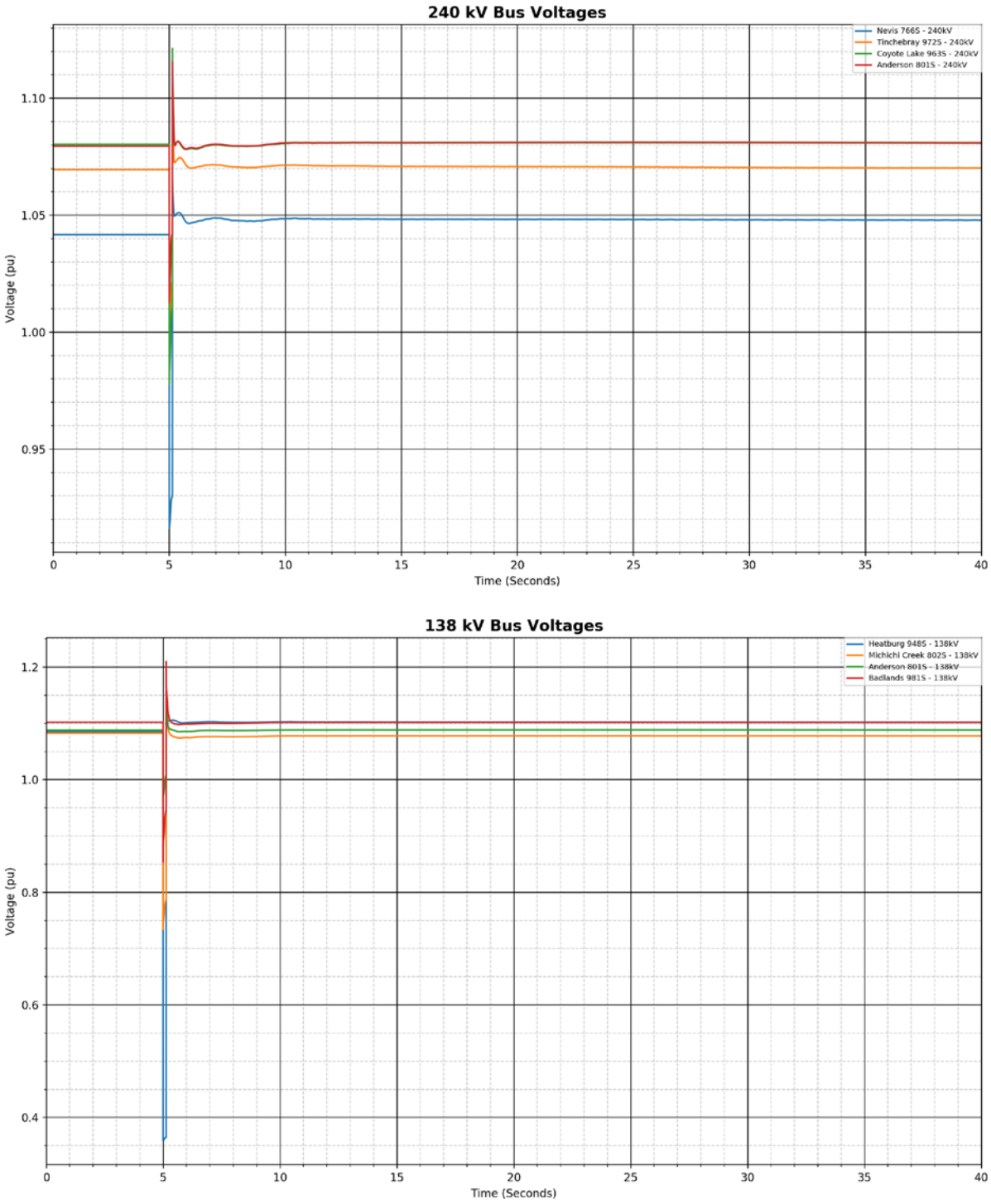
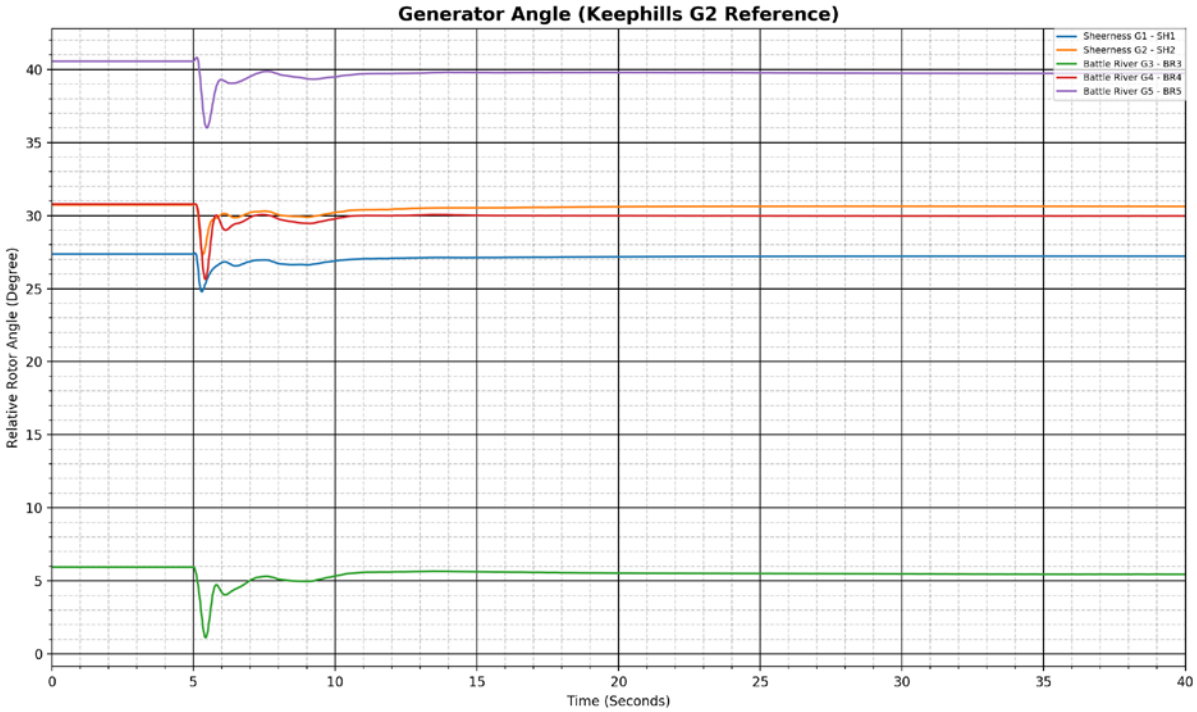
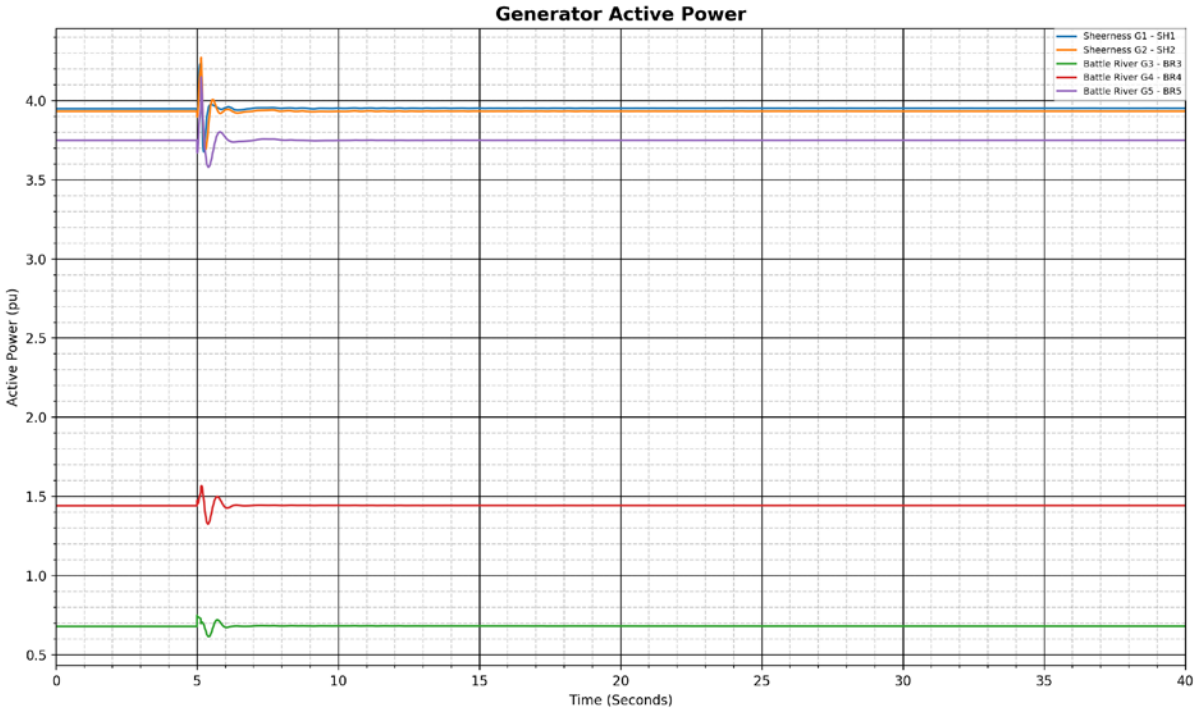
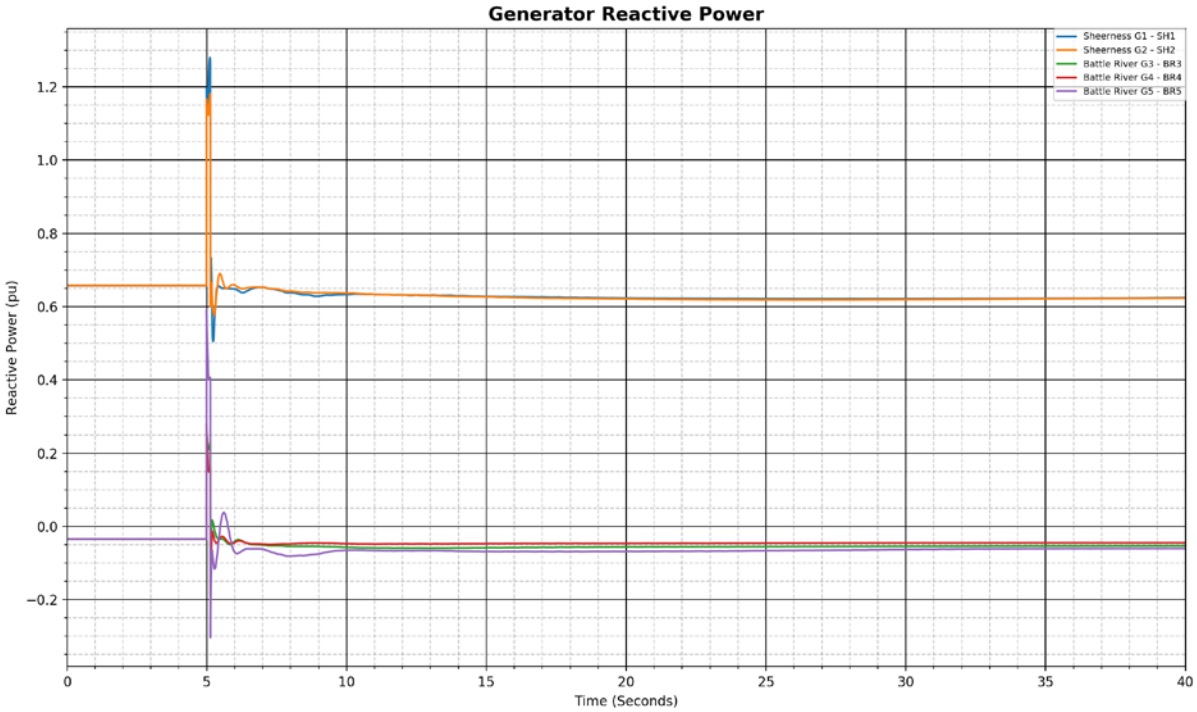

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 114S)
Reactive Power (Mvar)
Time (Seconds)

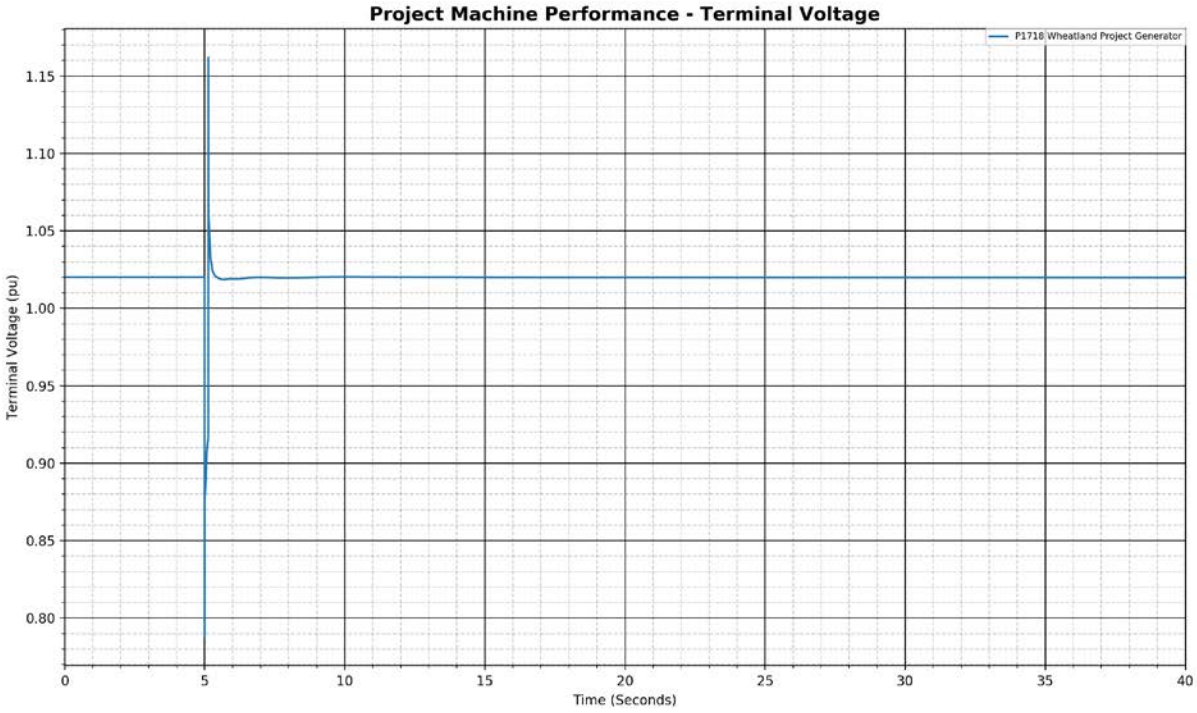
Figure A4-49: 7L159 (Three Hills 770S - Ghost Pine 114S - Heatburg 948S): 3-phase fault at Ghost Pine 114S

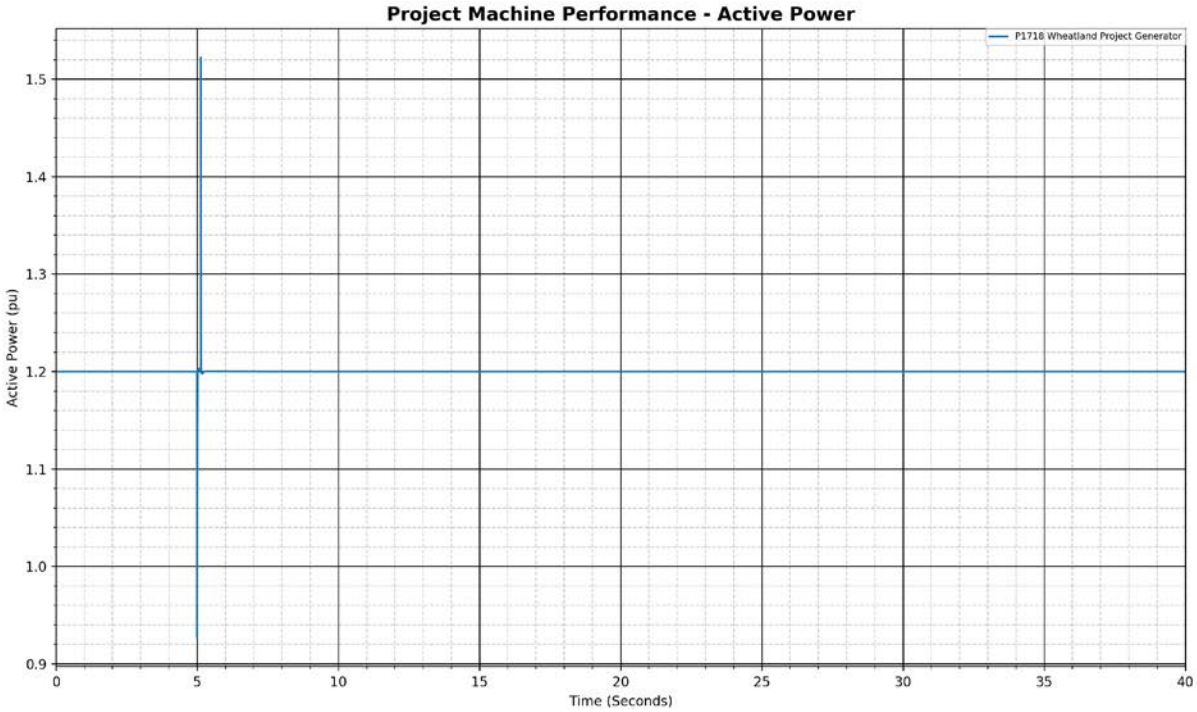


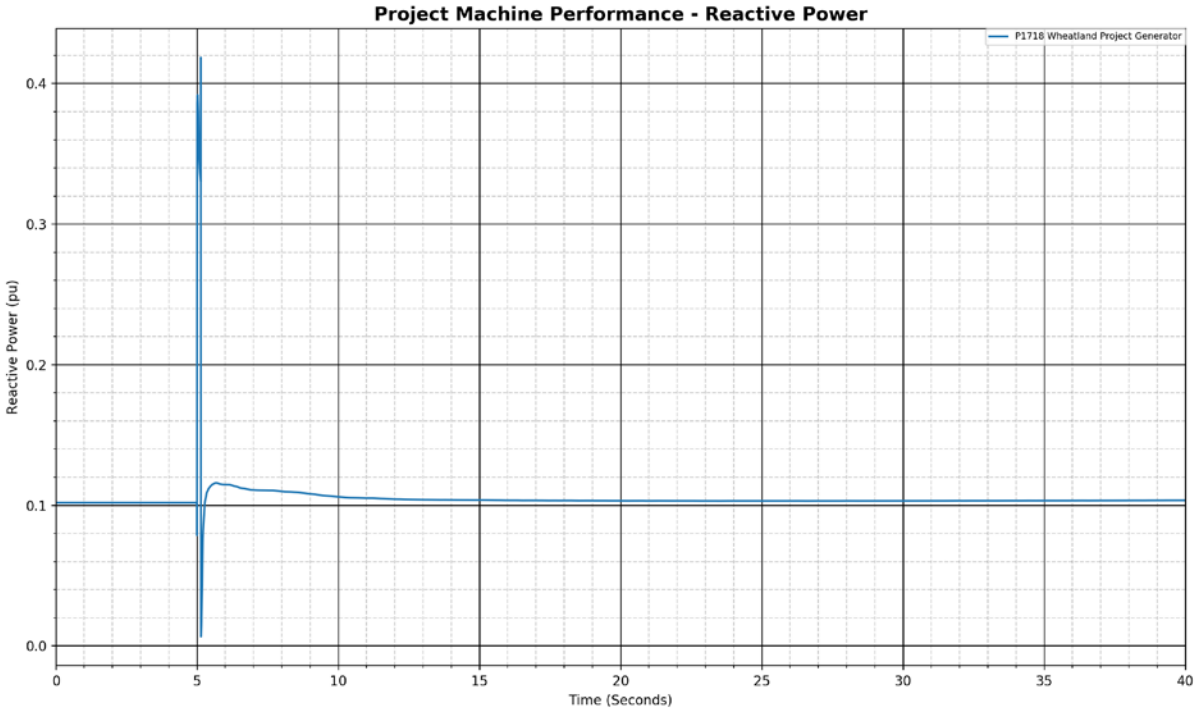

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

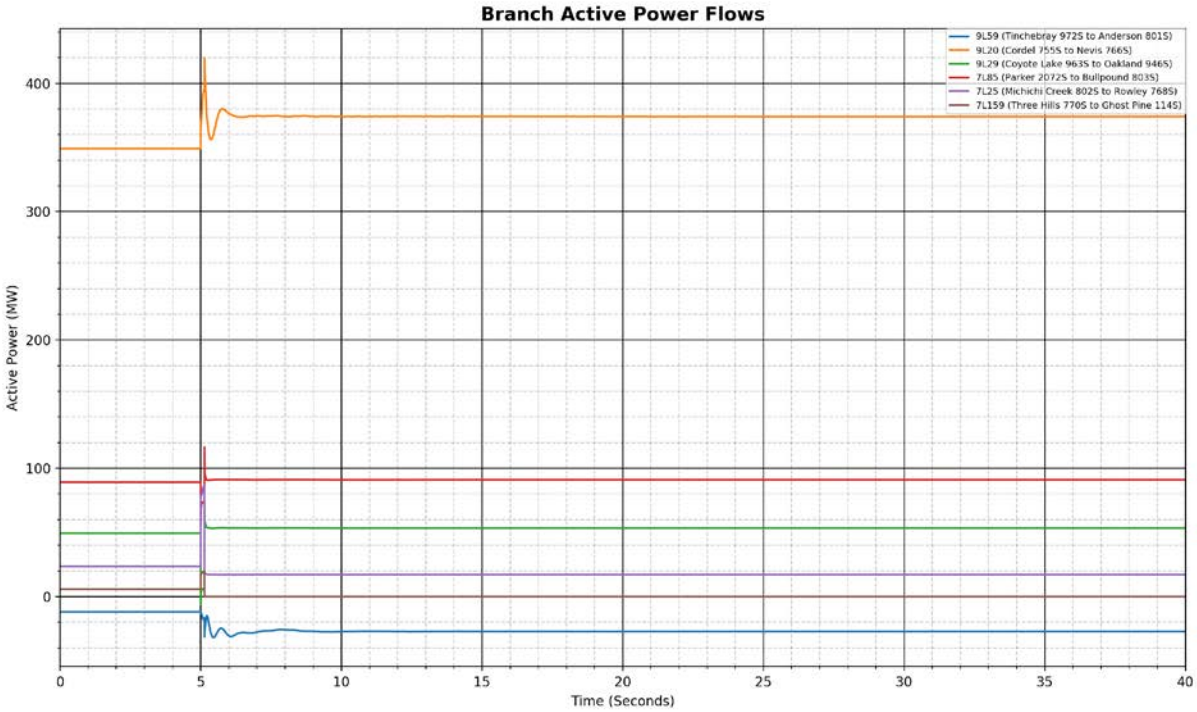

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Active Power (MW)
Time (Seconds)

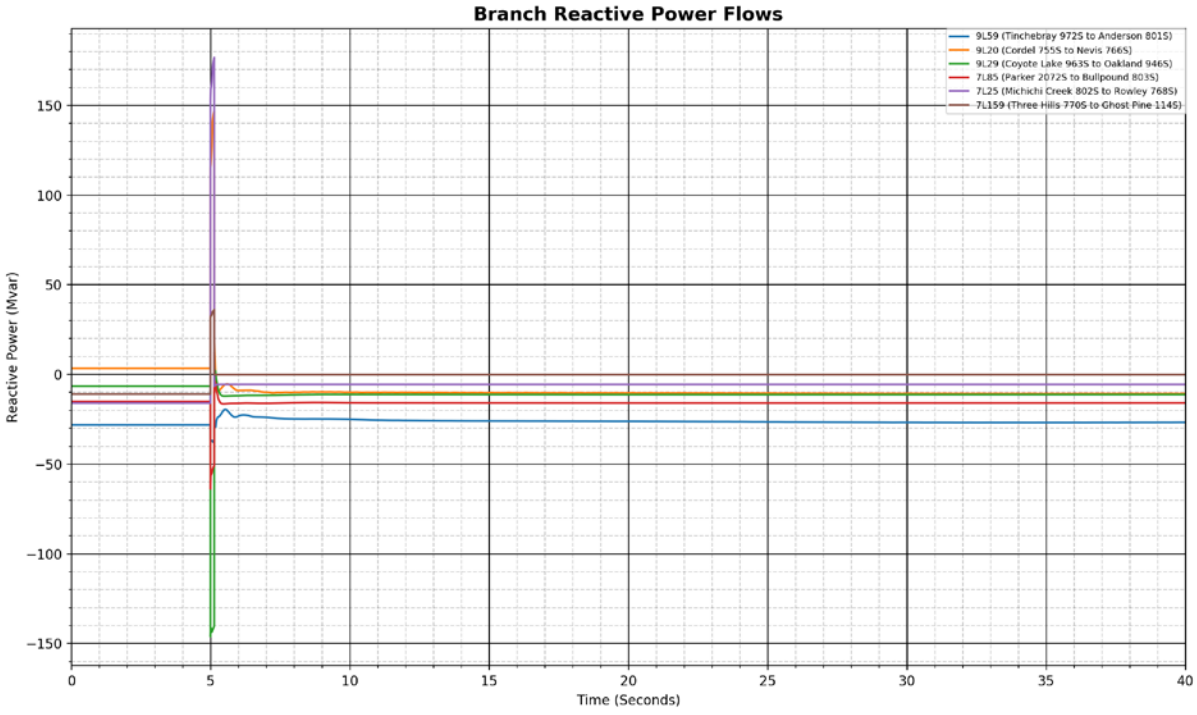
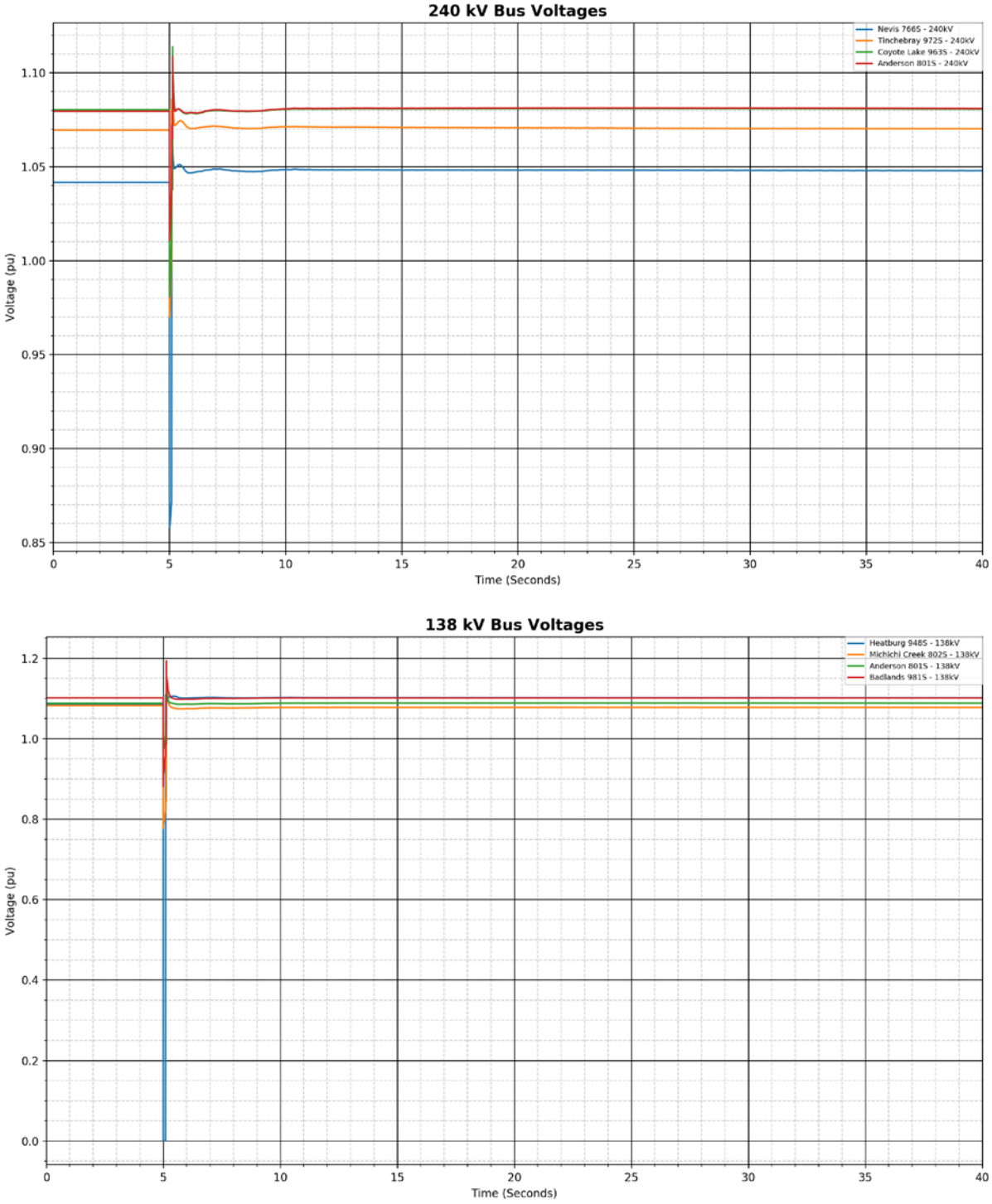
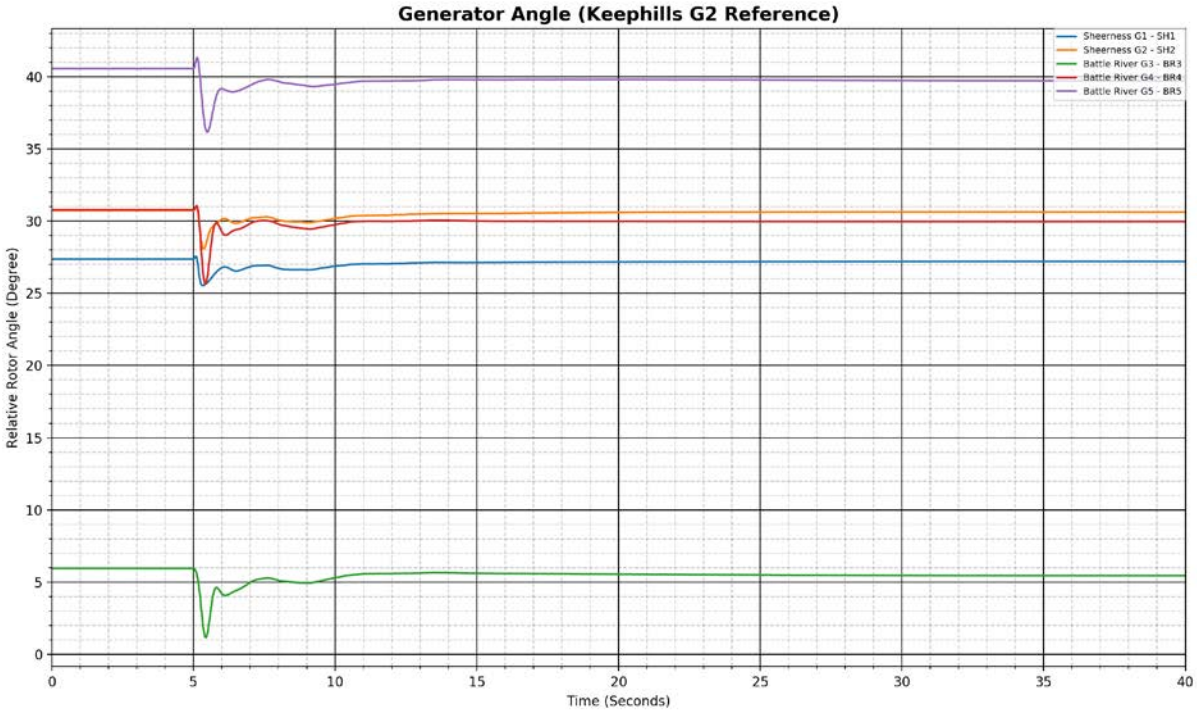
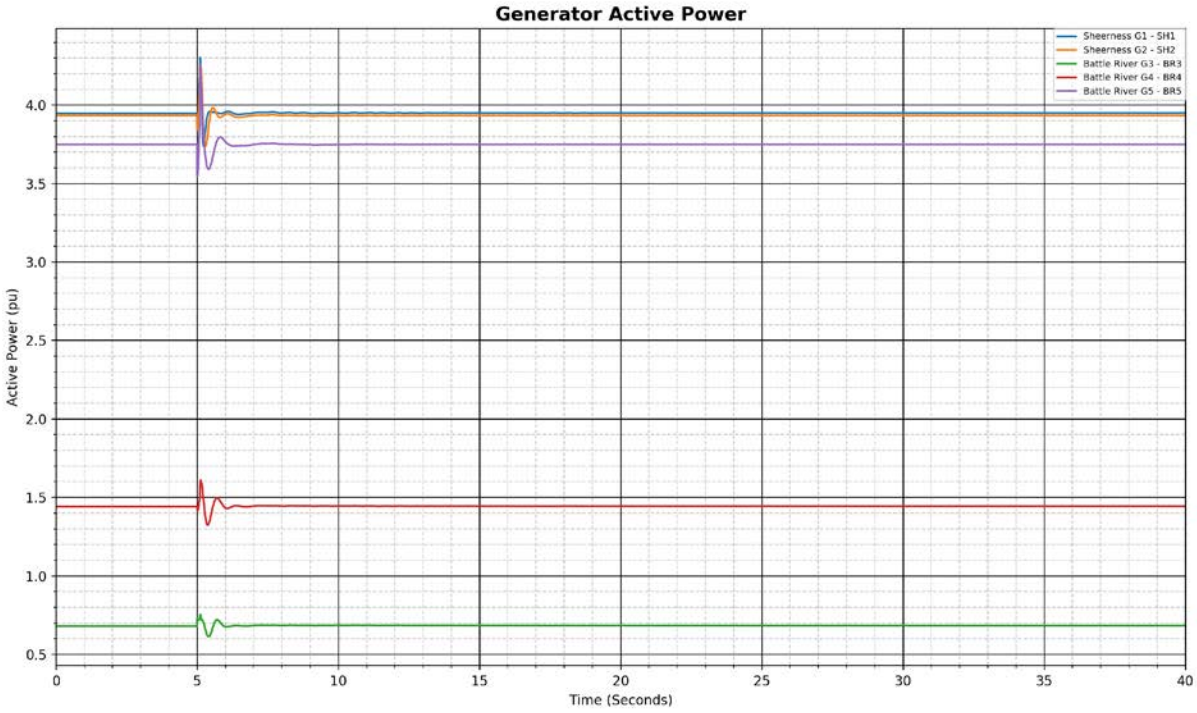
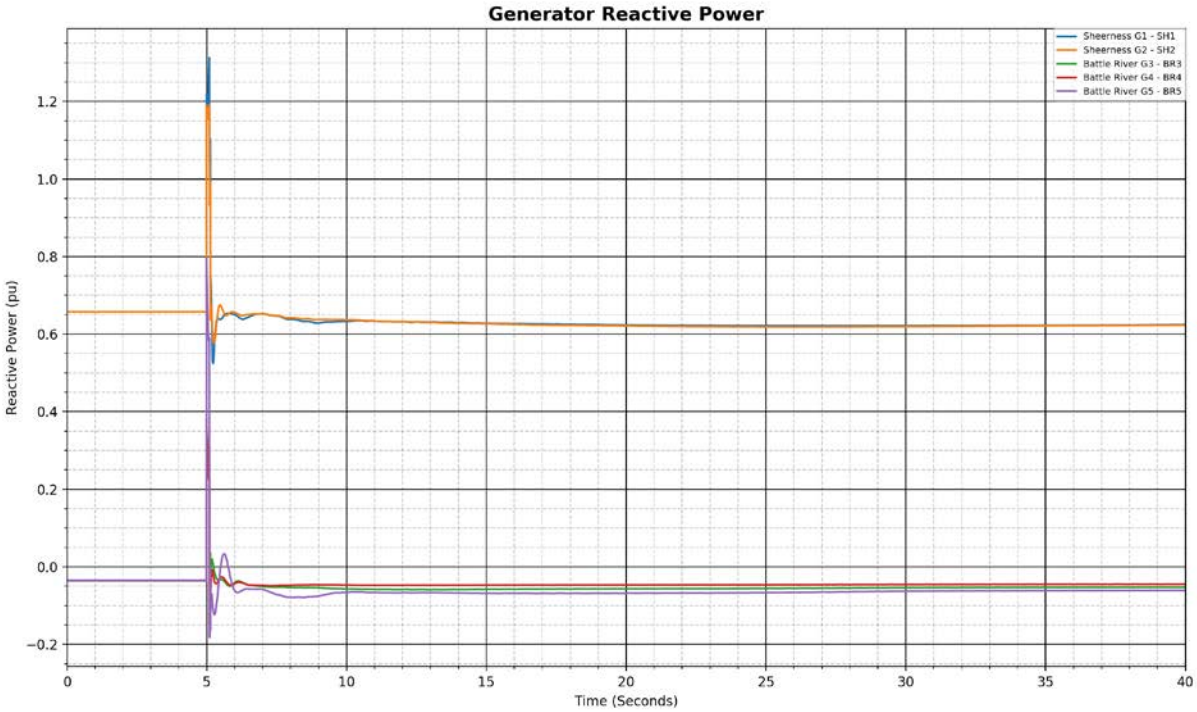

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Reactive Power (Mvar)
Time (Seconds)

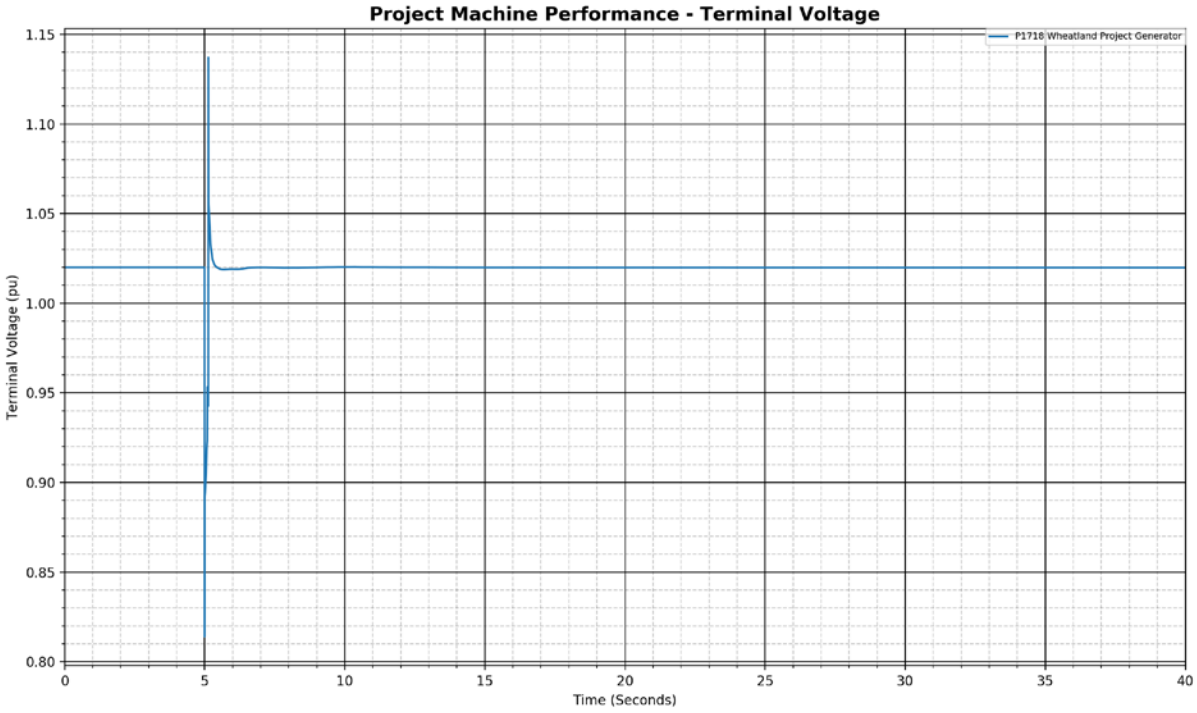
Figure A4-50: 7L159 (Three Hills 770S - Ghost Pine 114S - Heatburg 948S): 3-phase fault at Heatburg 948S

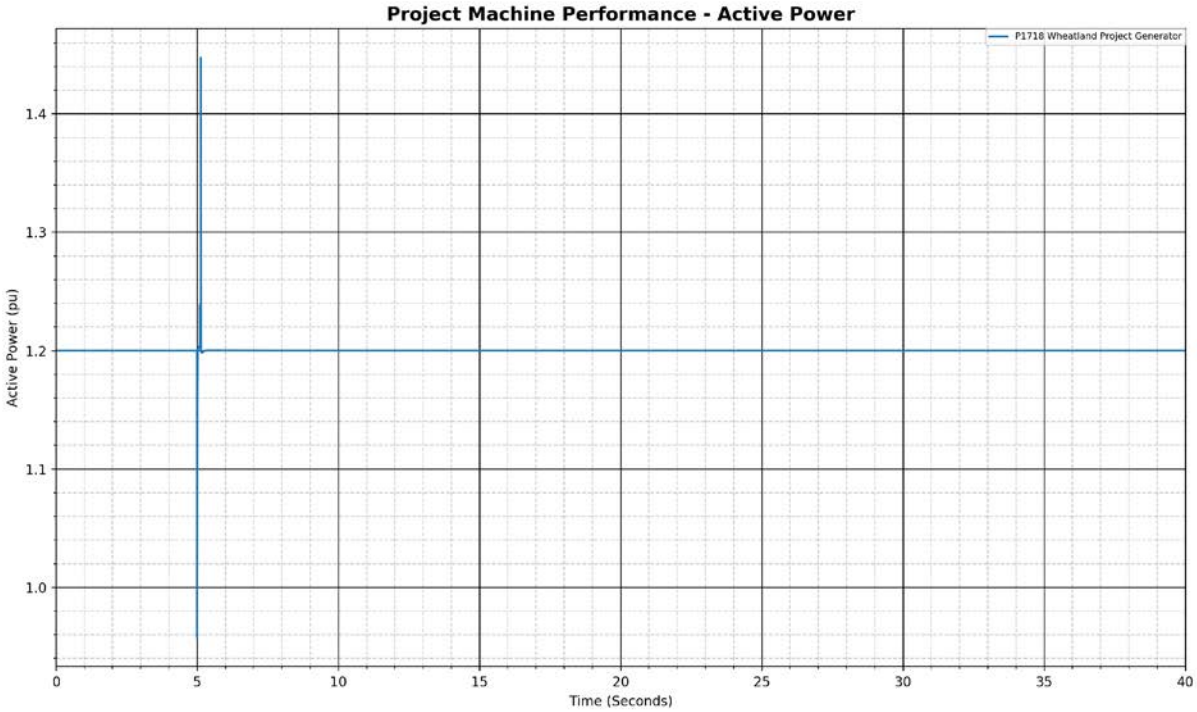


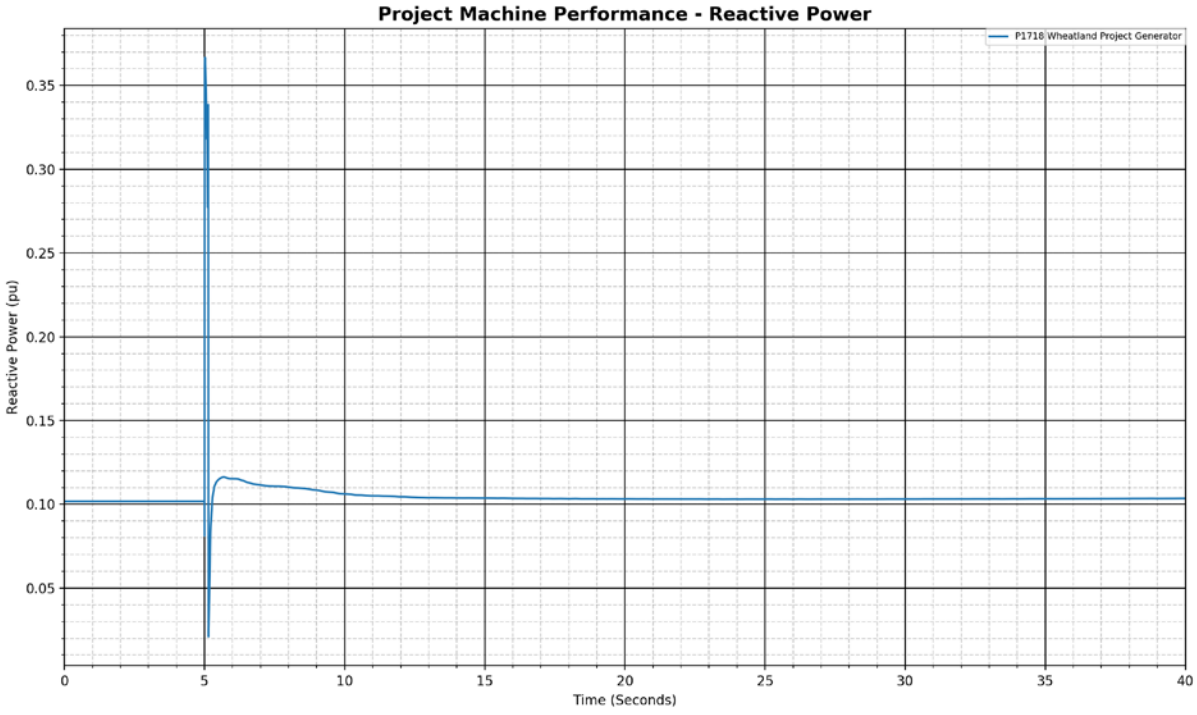

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

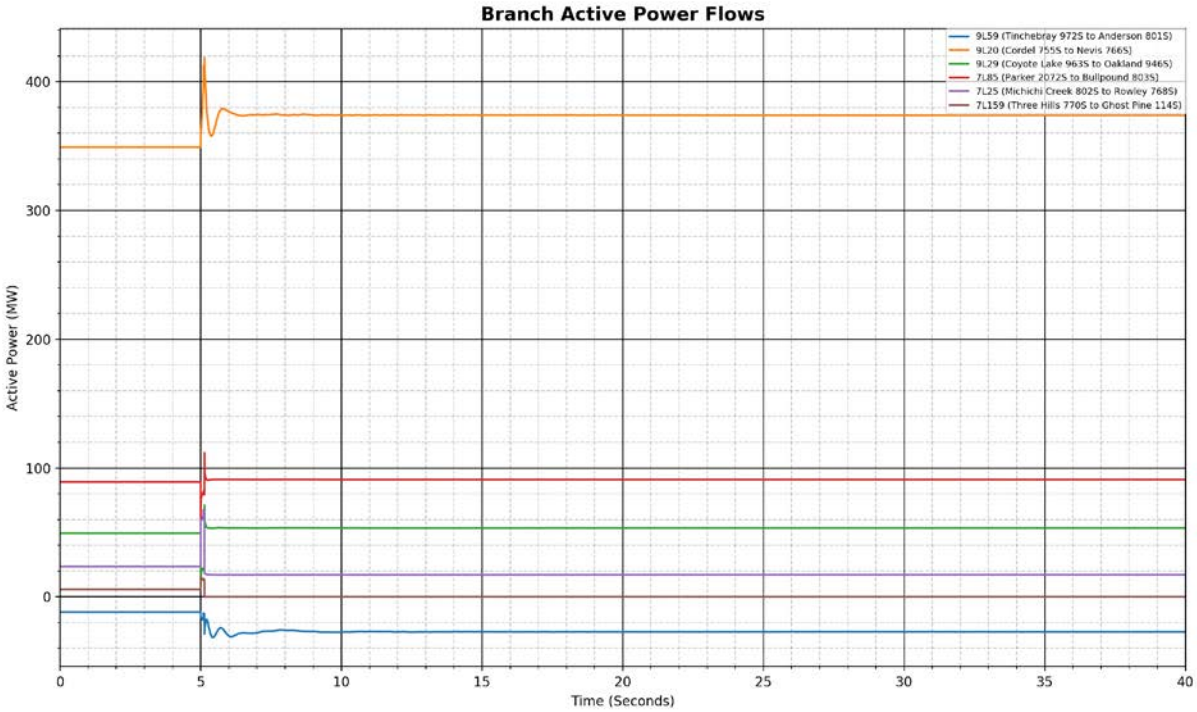

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 114S)
Active Power (MW)
Time (Seconds)

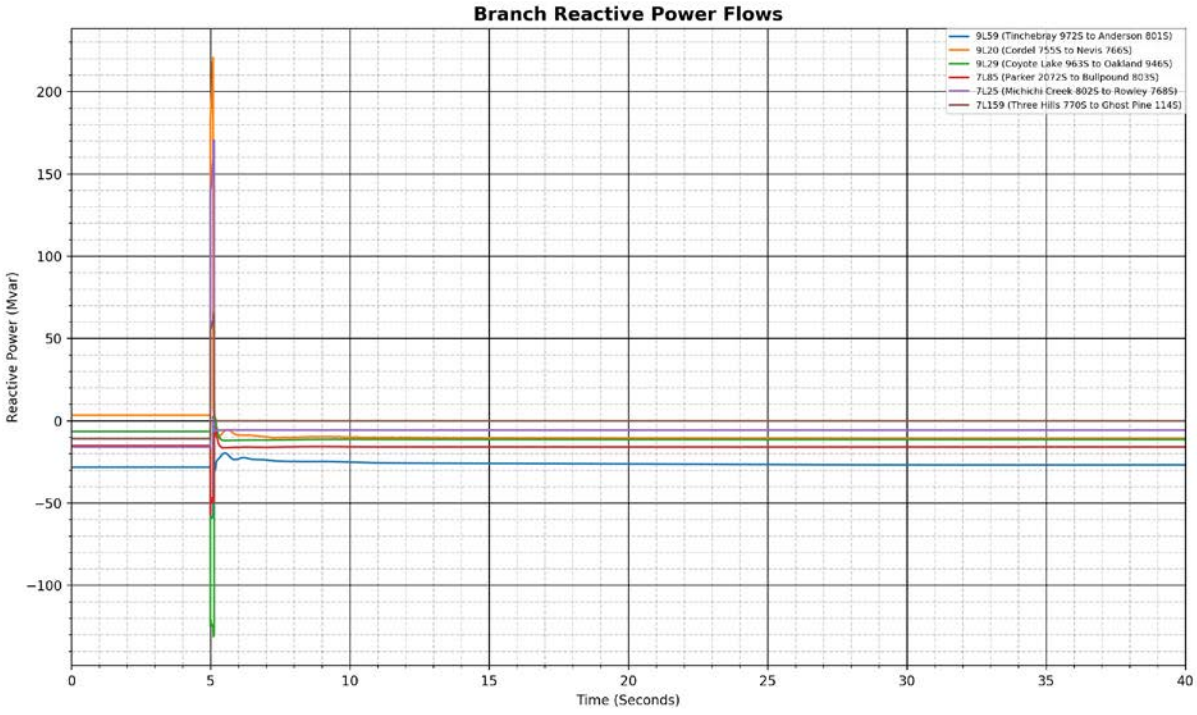
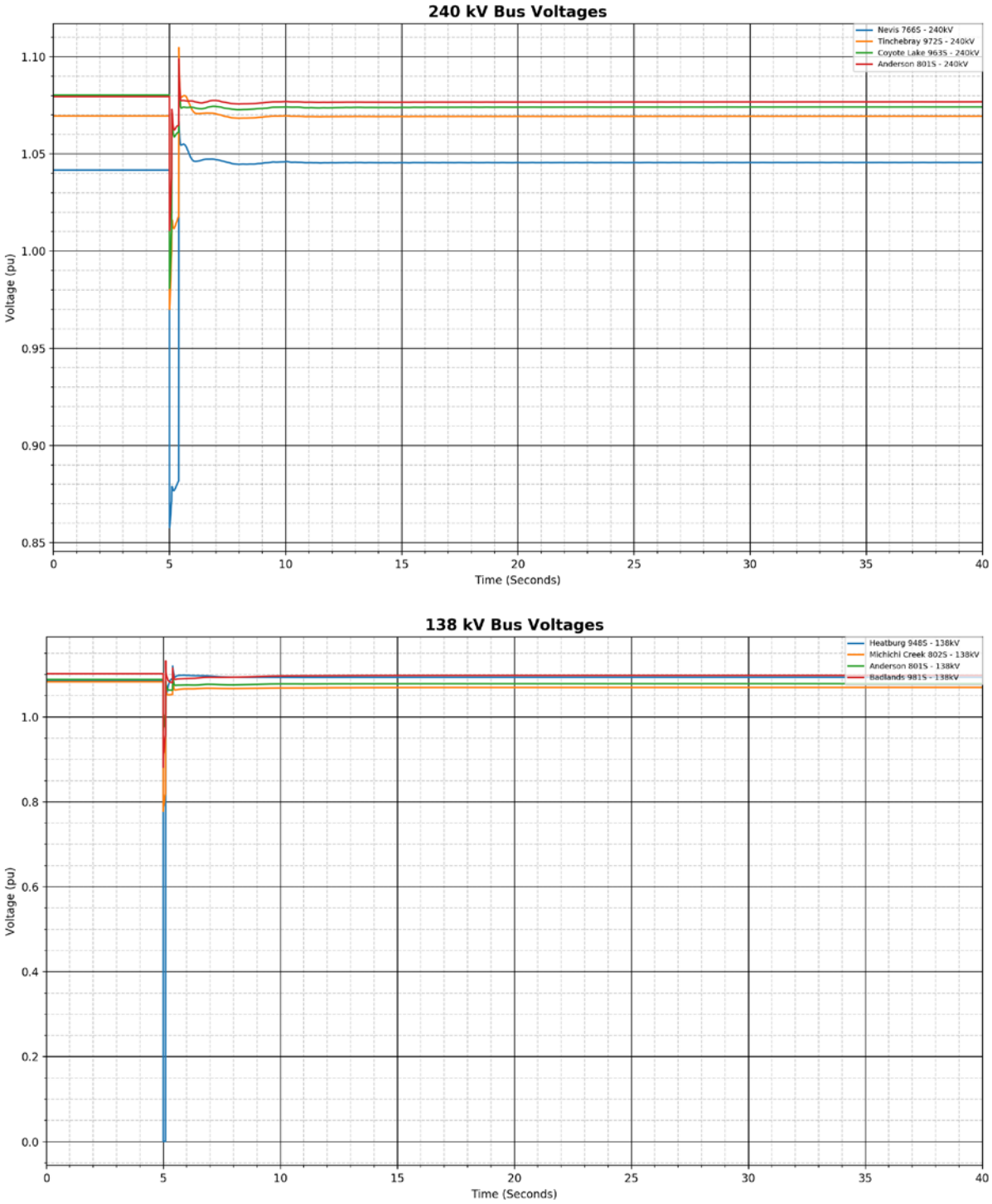
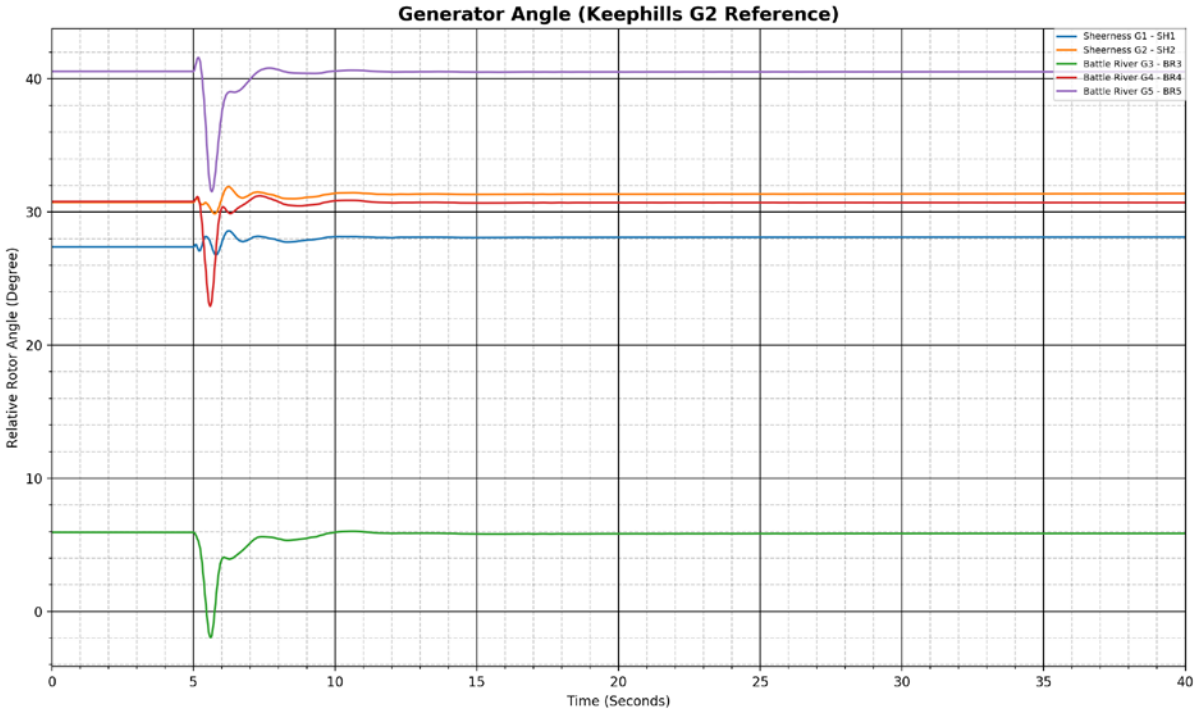
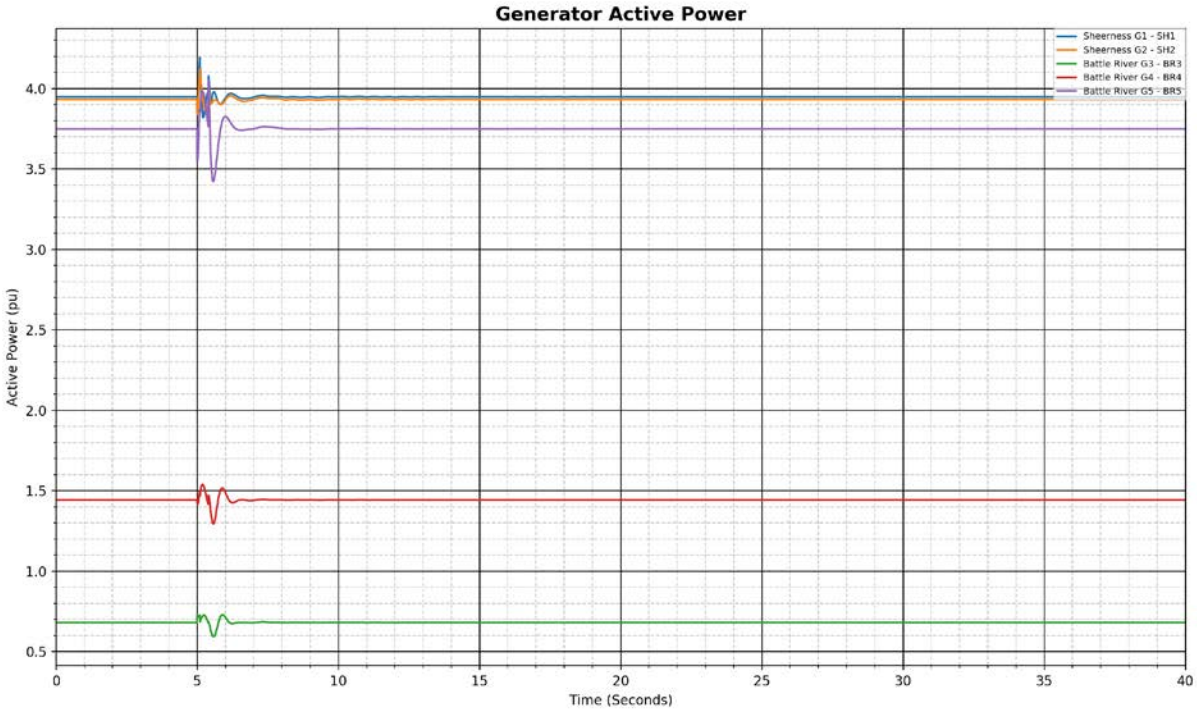
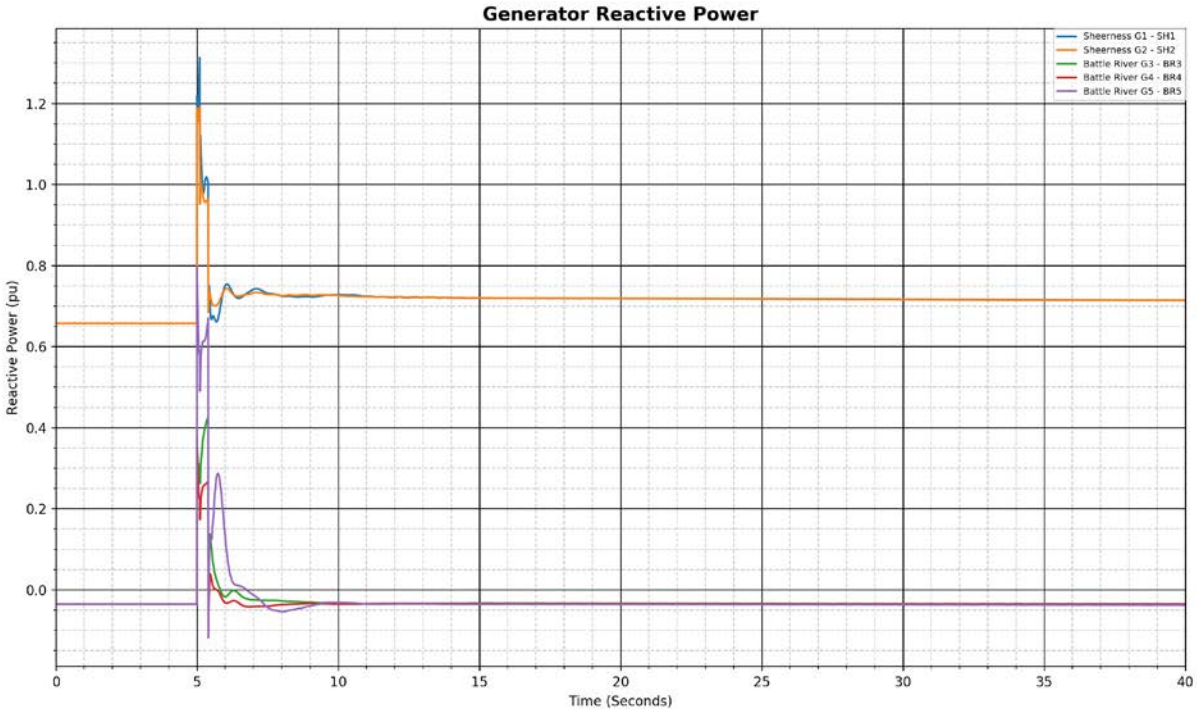

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 114S)
Reactive Power (Mvar)
Time (Seconds)

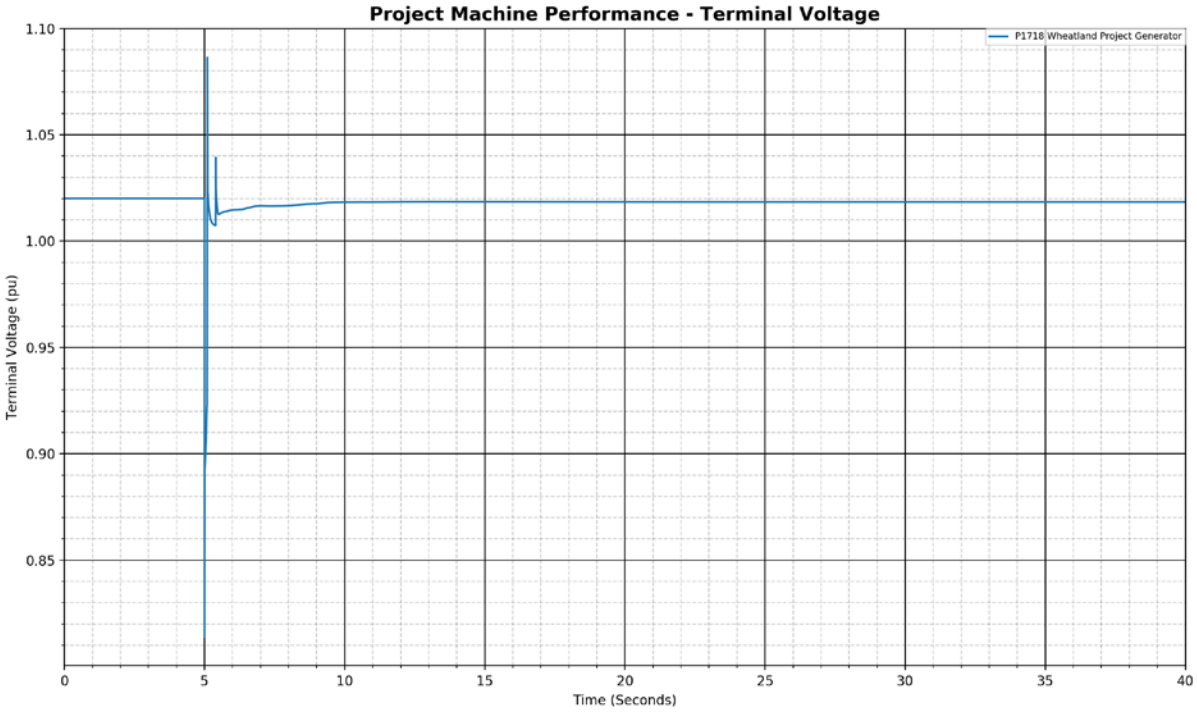
Figure A4-51: 7L16 (Heatburg 948S - Nevis 766S): 3-phase fault at Heatburg 948S

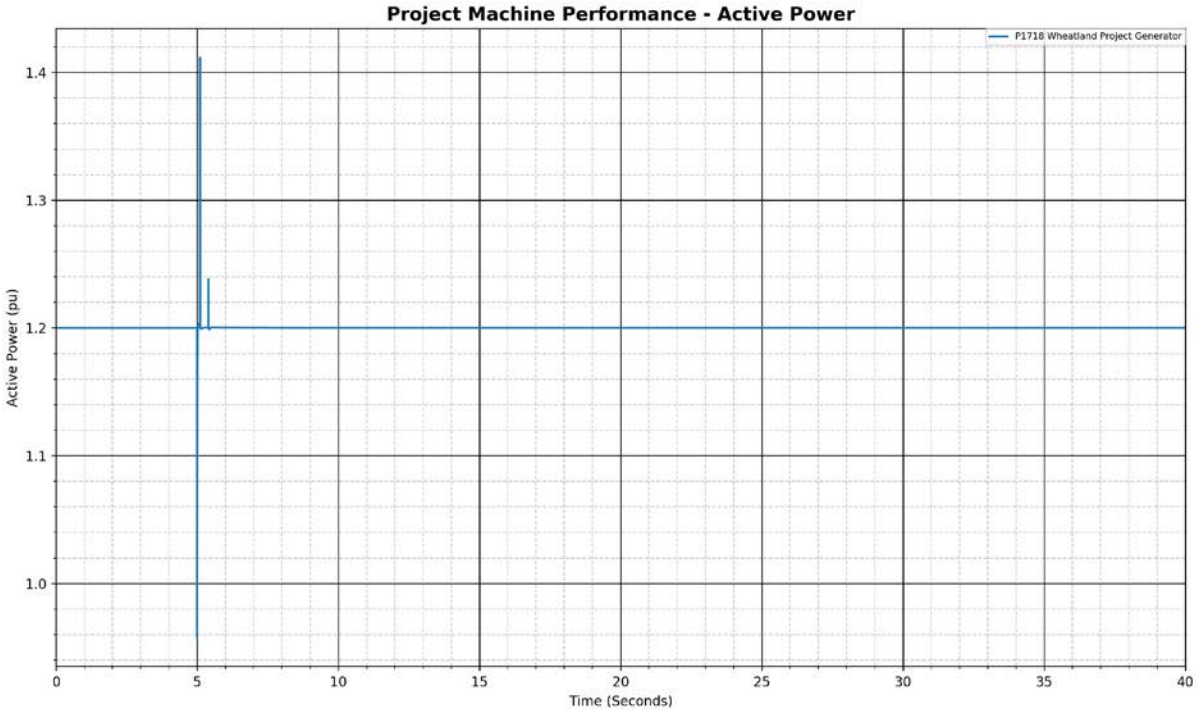


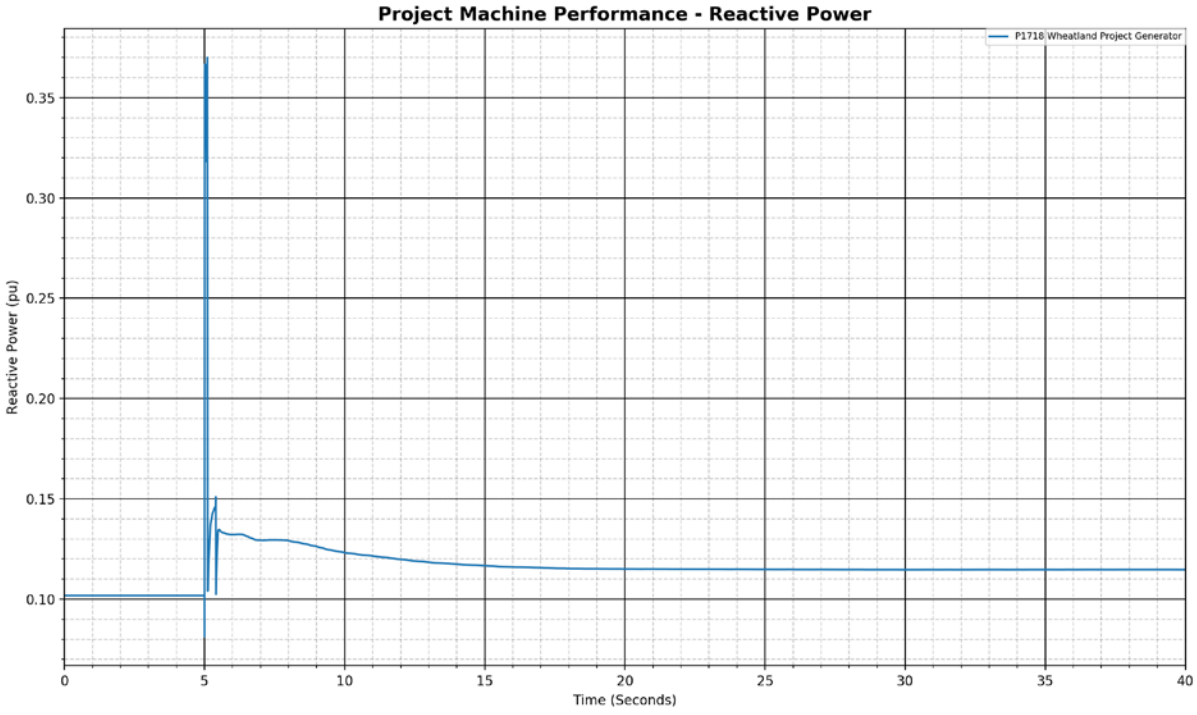

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

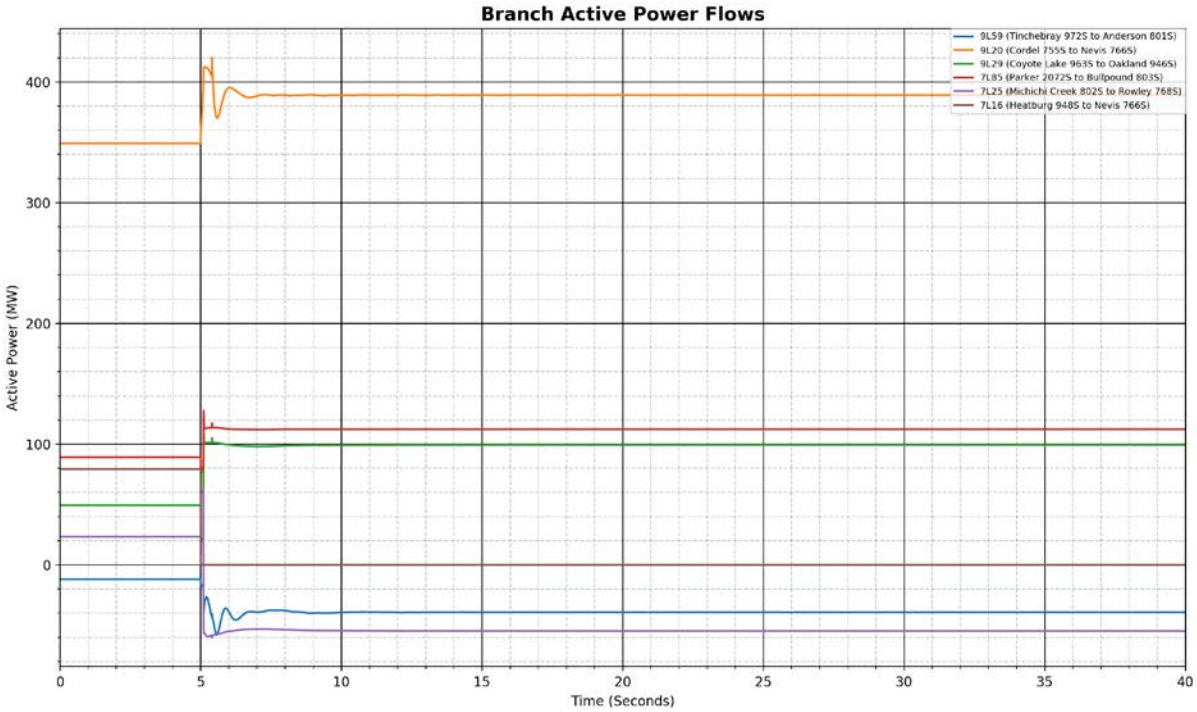

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.35
0.30
0.25
0.20
0.15
0.10
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Active Power (MW)
Time (Seconds)

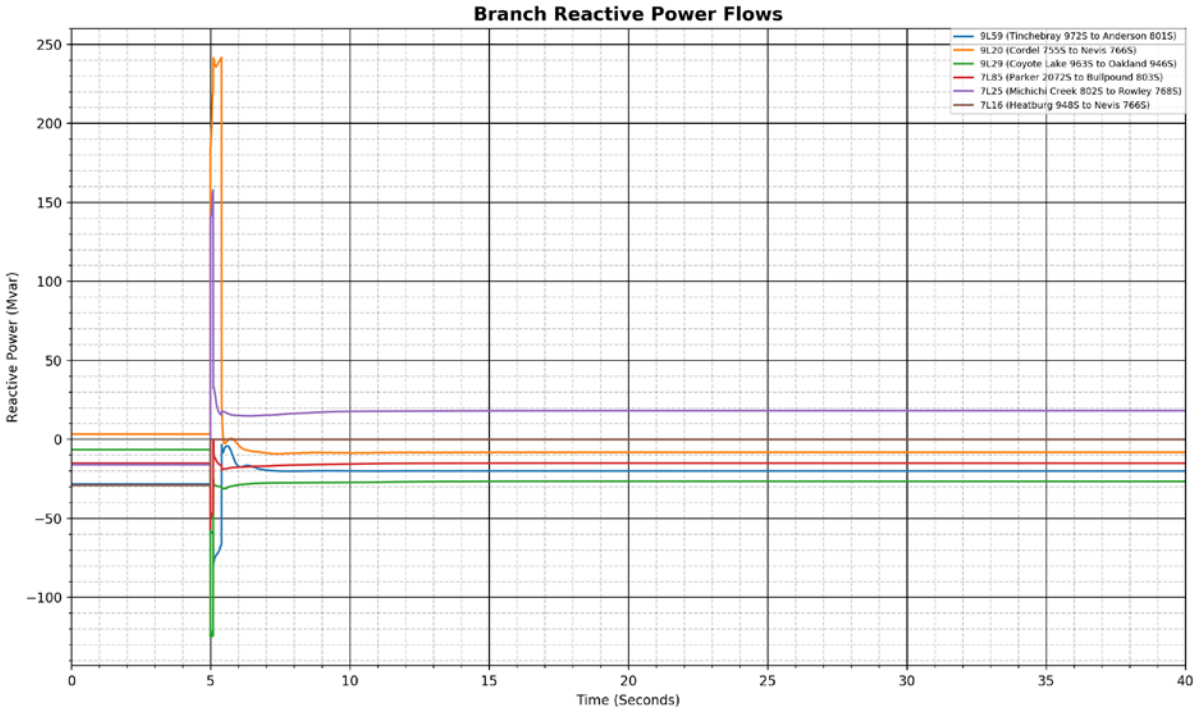
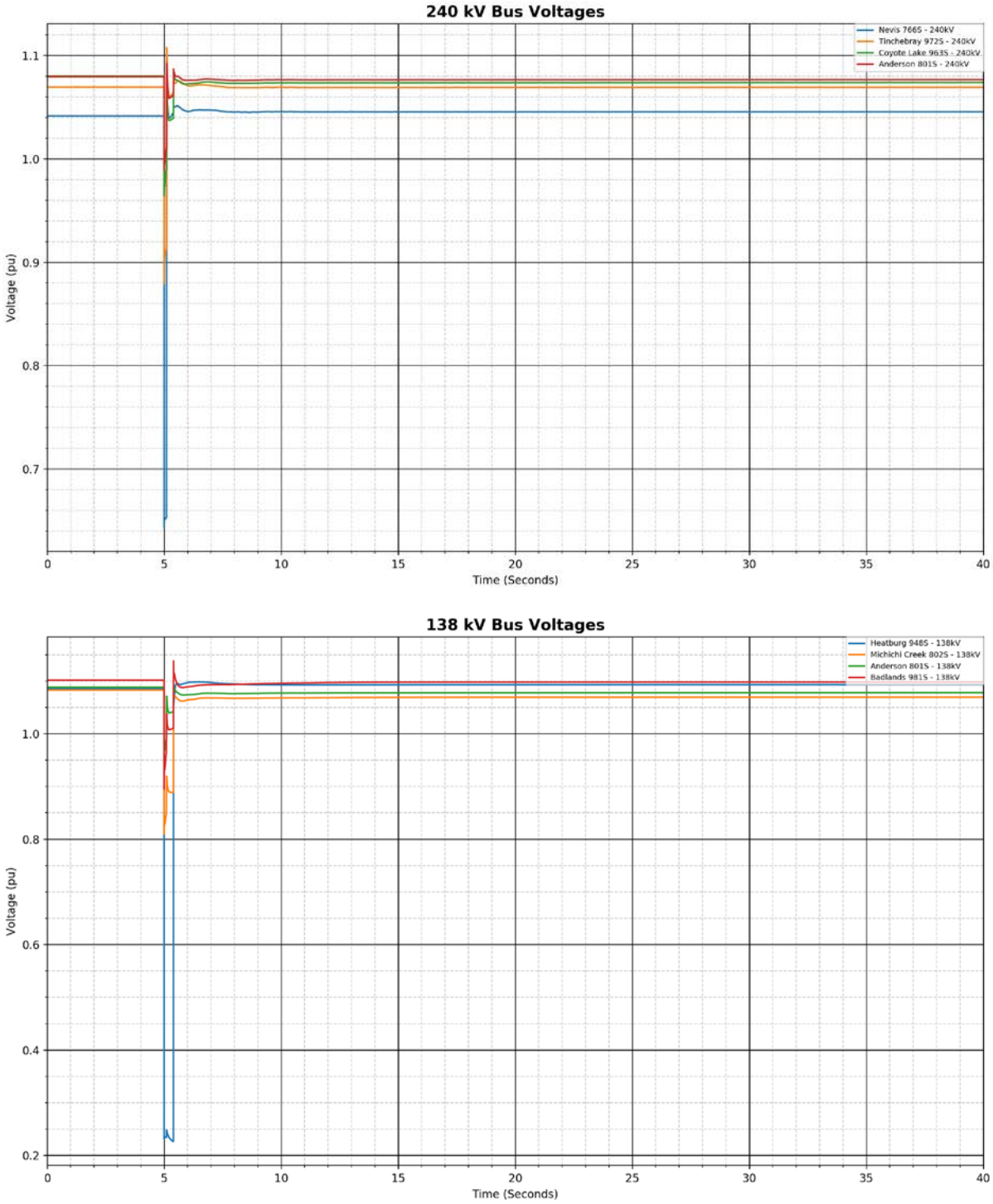
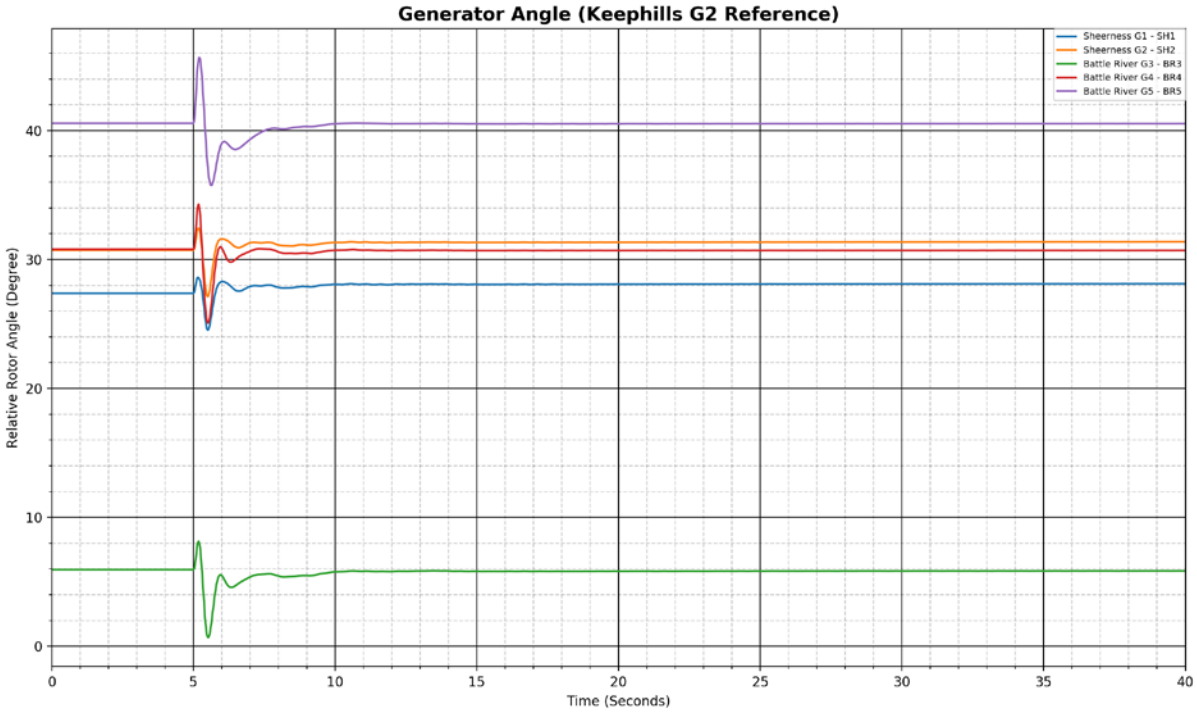
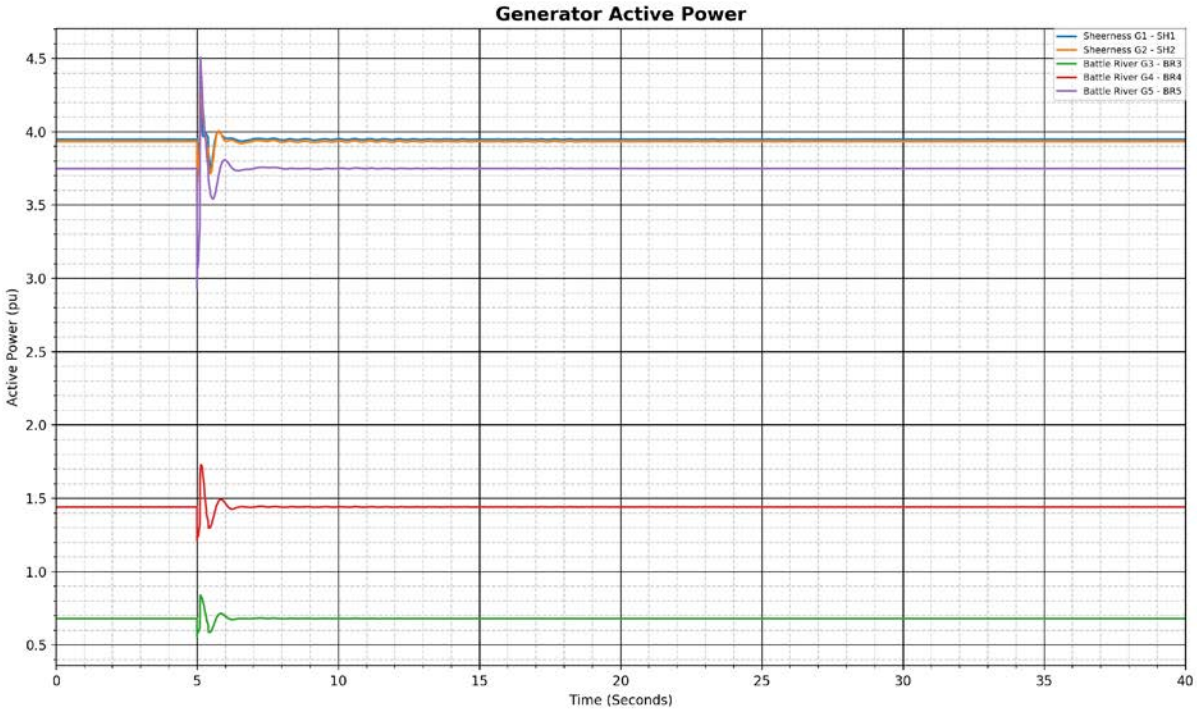
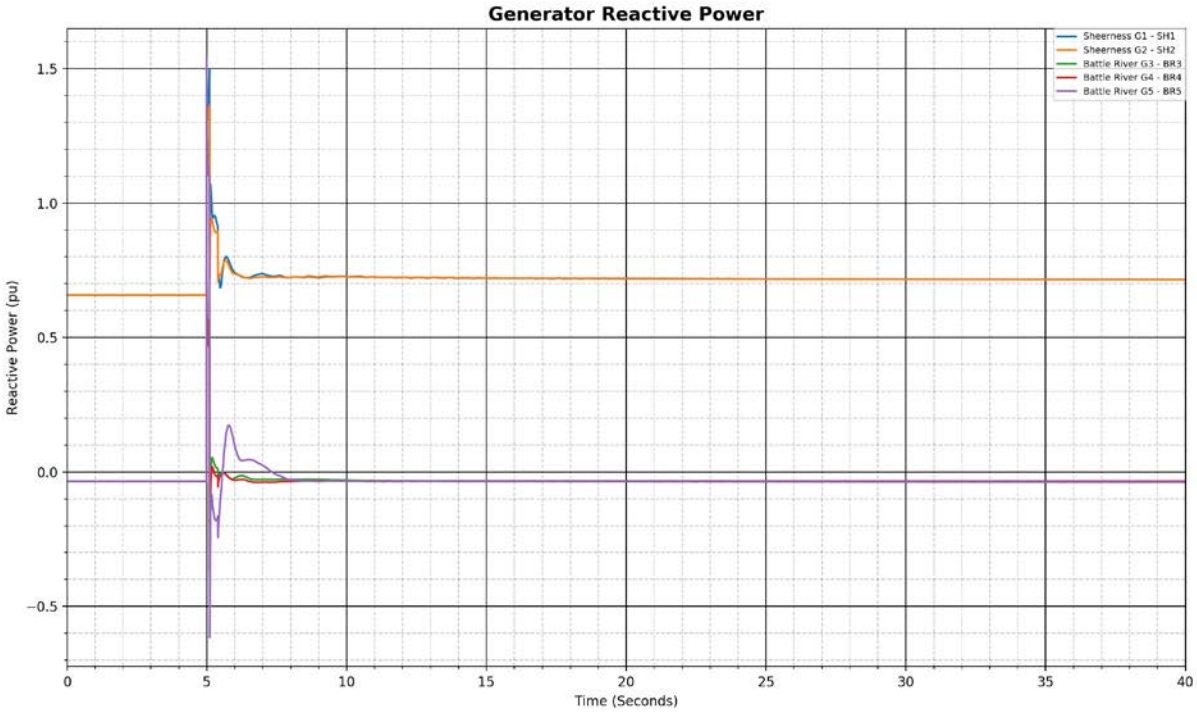

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

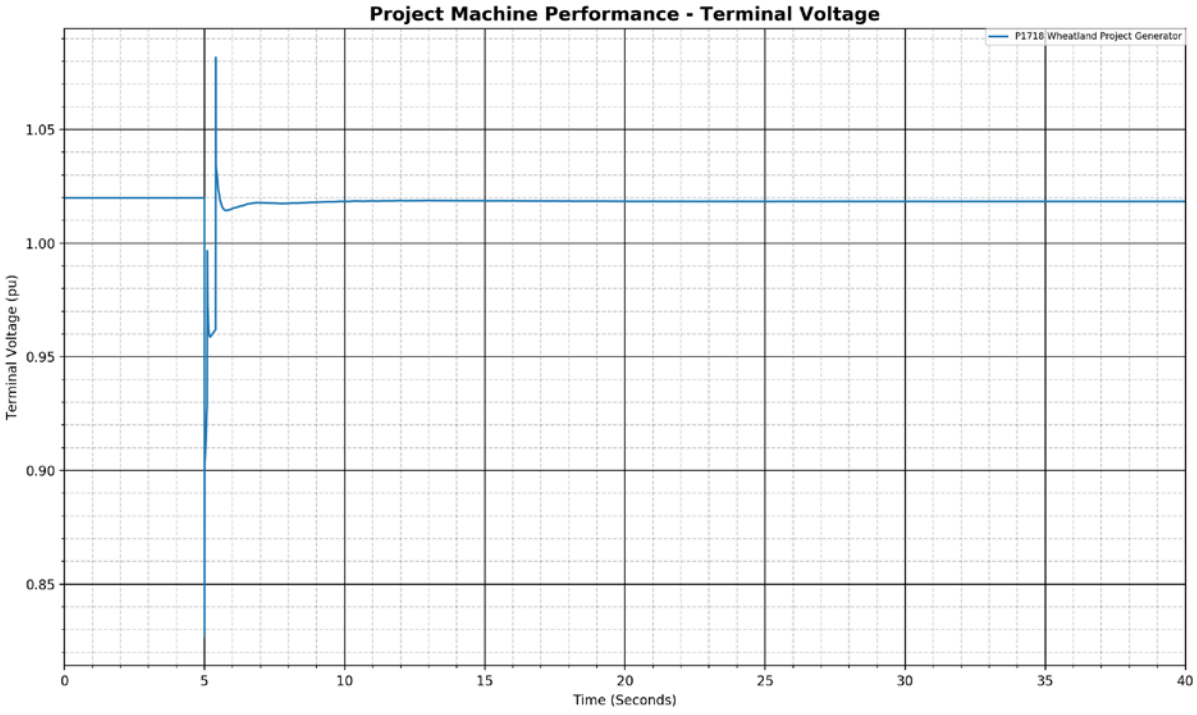
Figure A4-52: 7L16 (Heatburg 948S - Nevis 766S): 3-phase fault at Nevis 766S

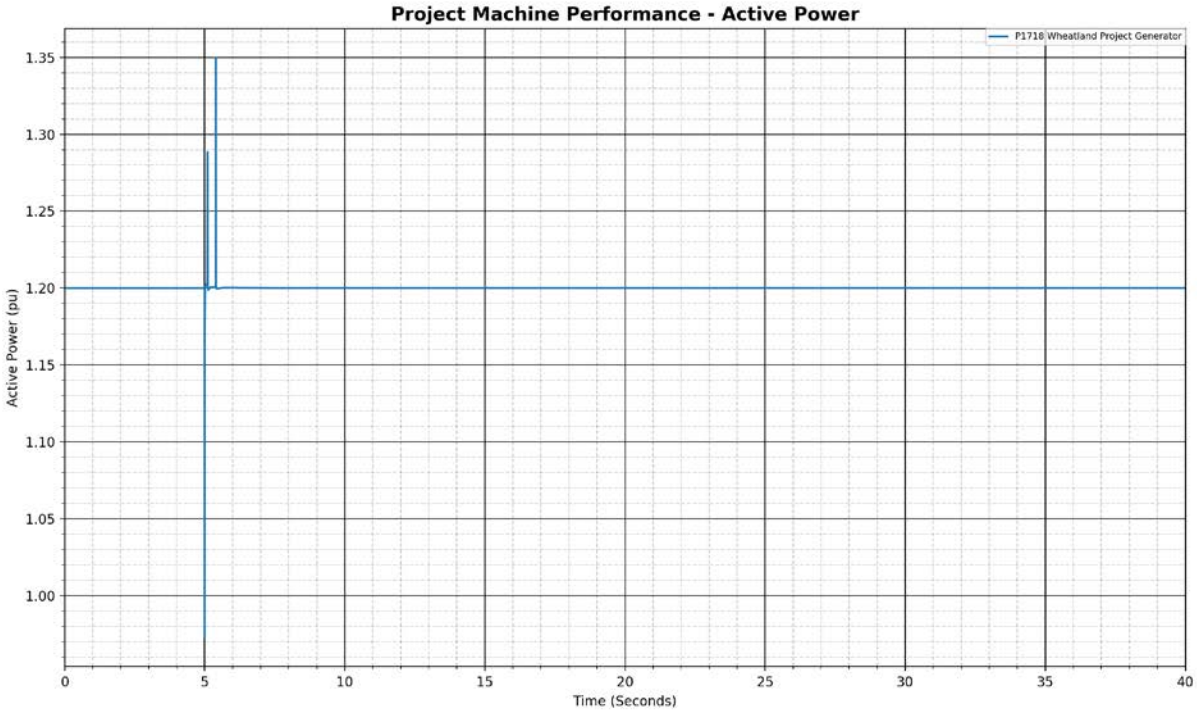


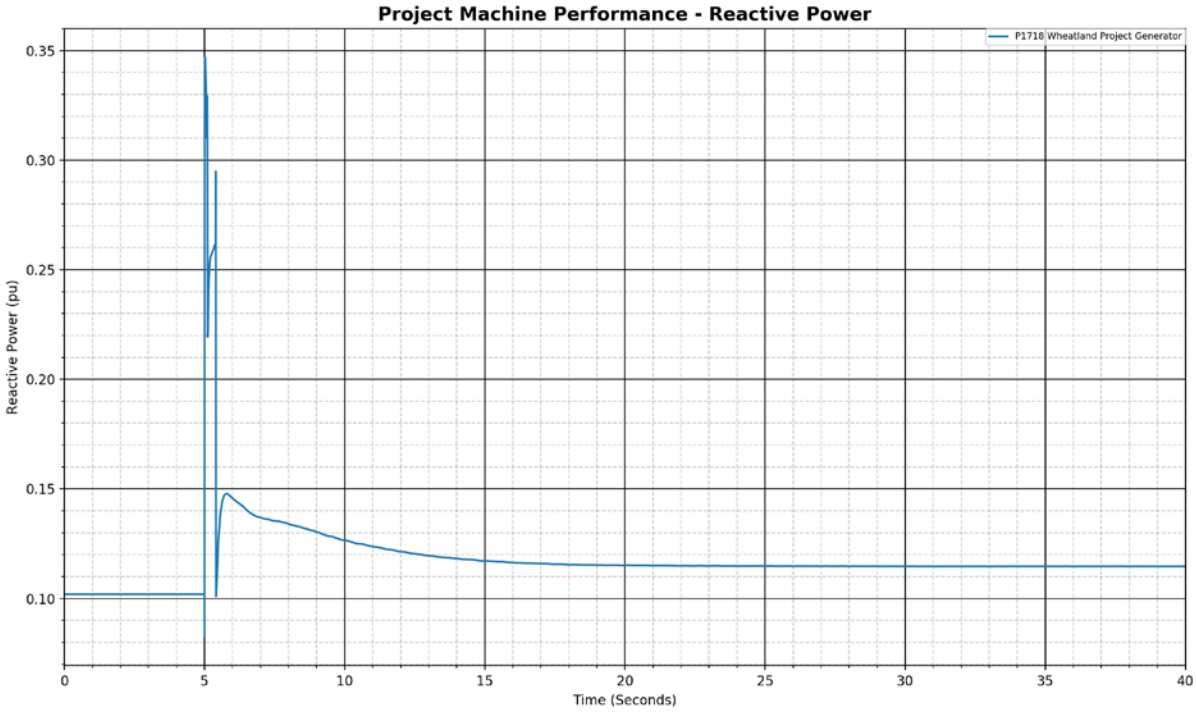

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

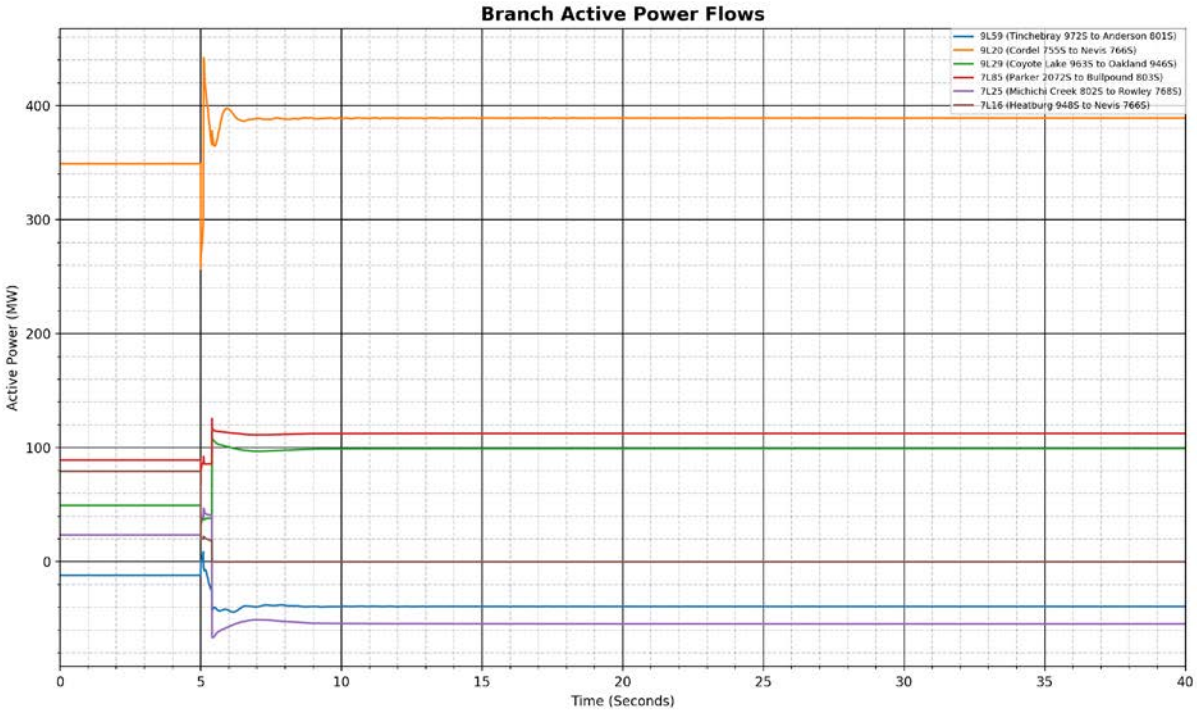

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.35
0.30
0.25
0.20
0.15
0.10
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Active Power (MW)
Time (Seconds)

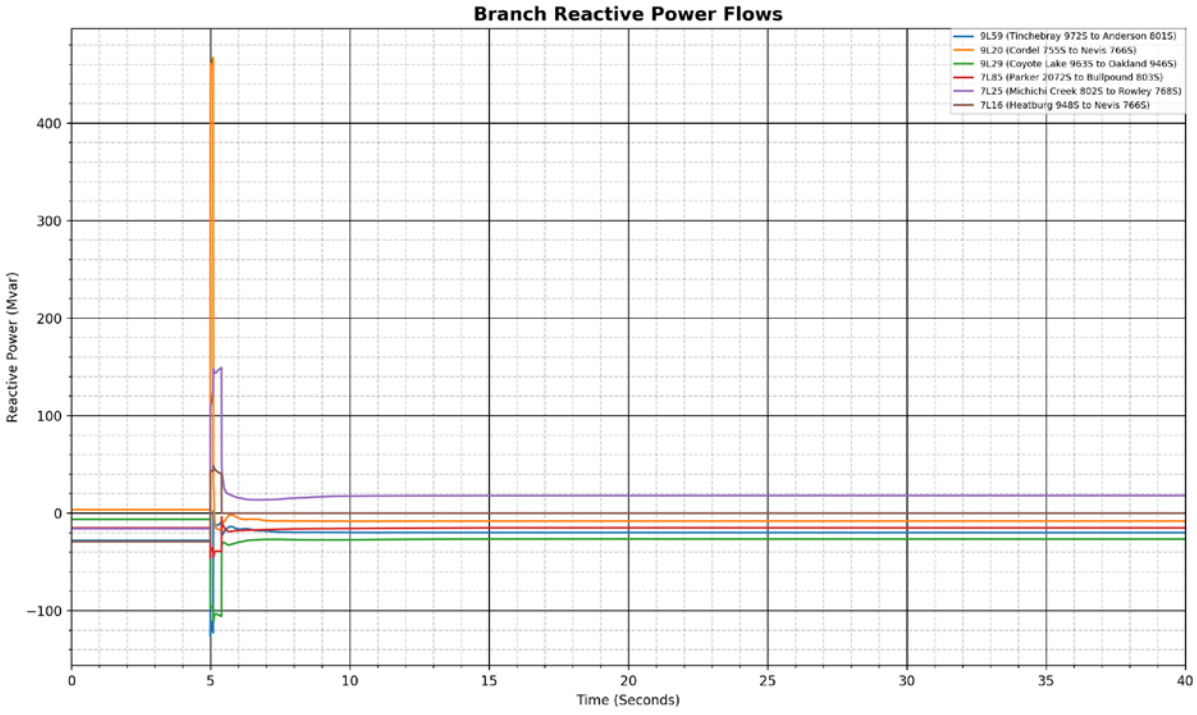
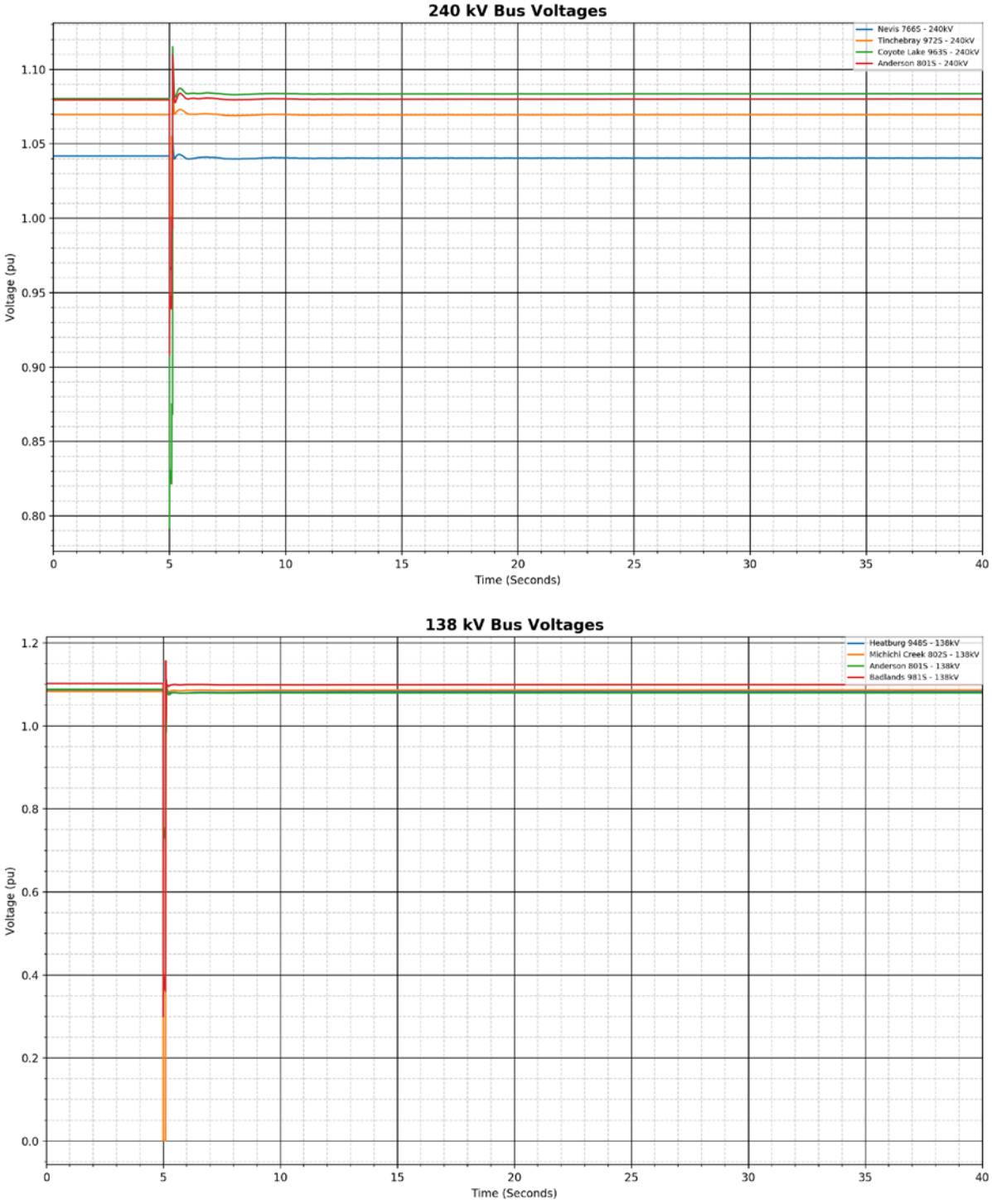
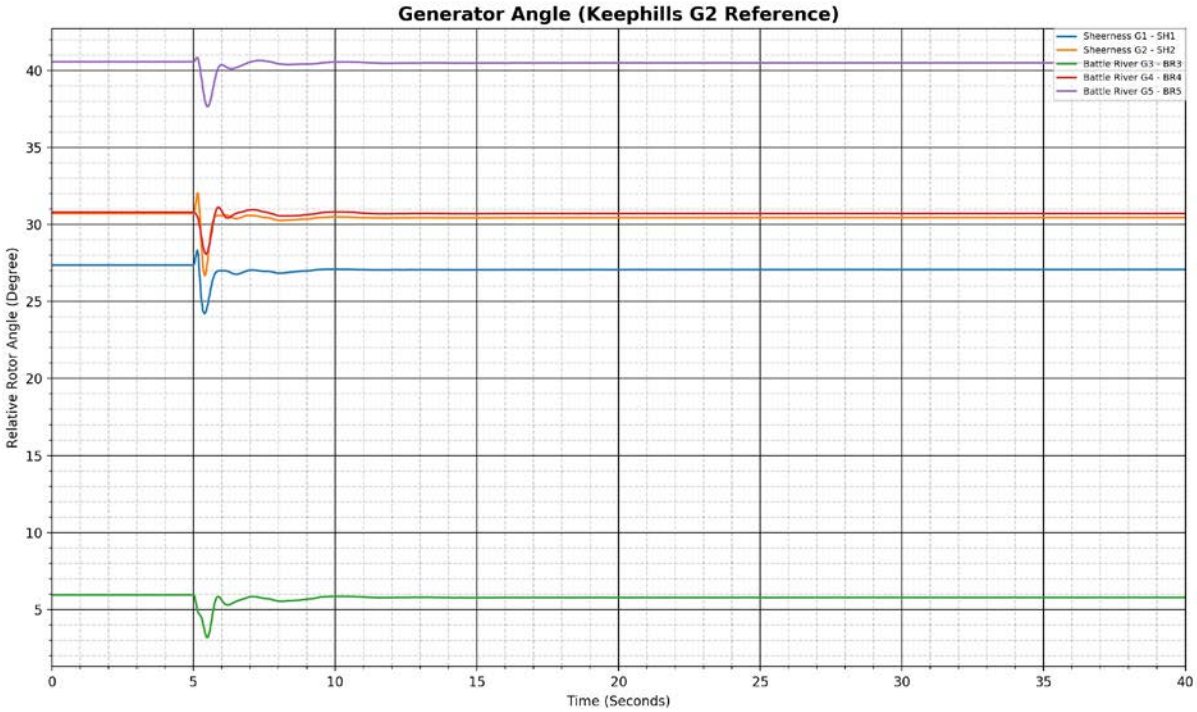
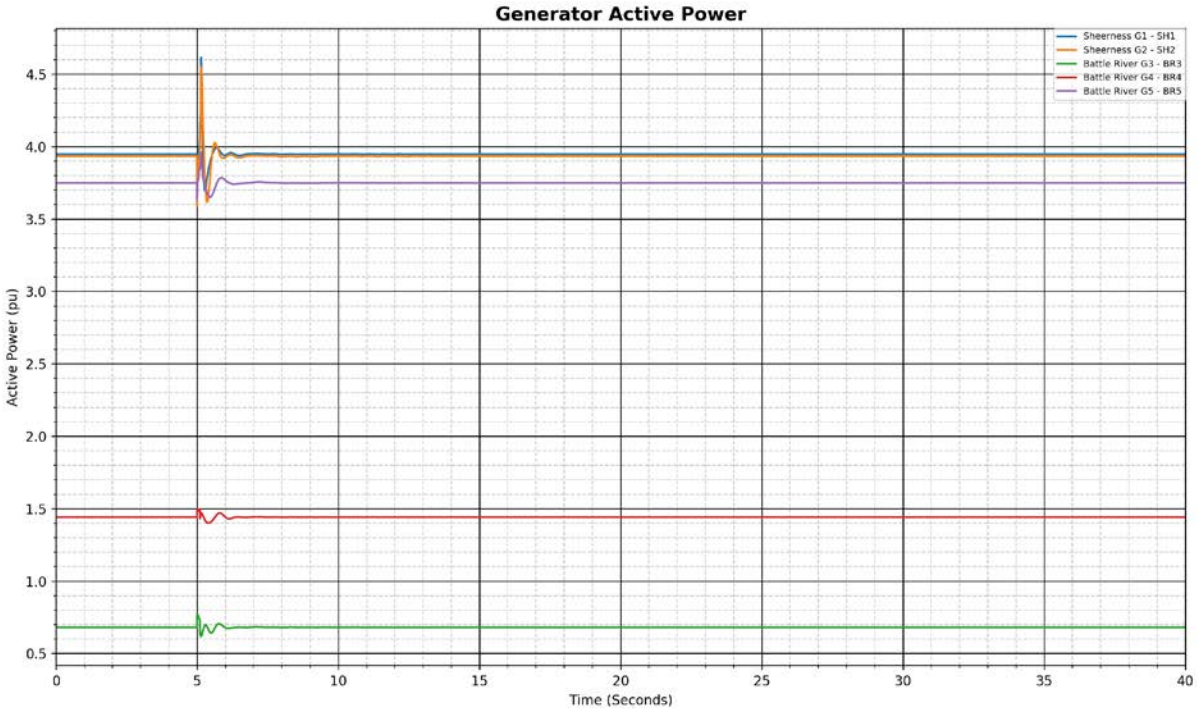
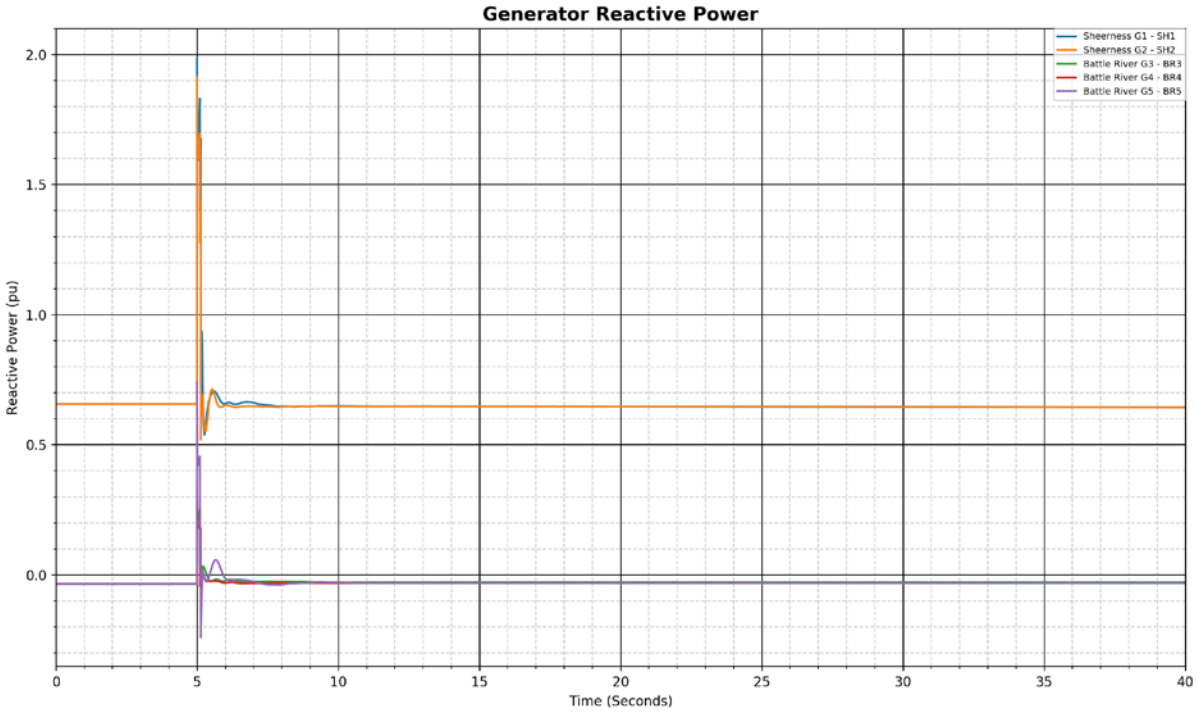

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

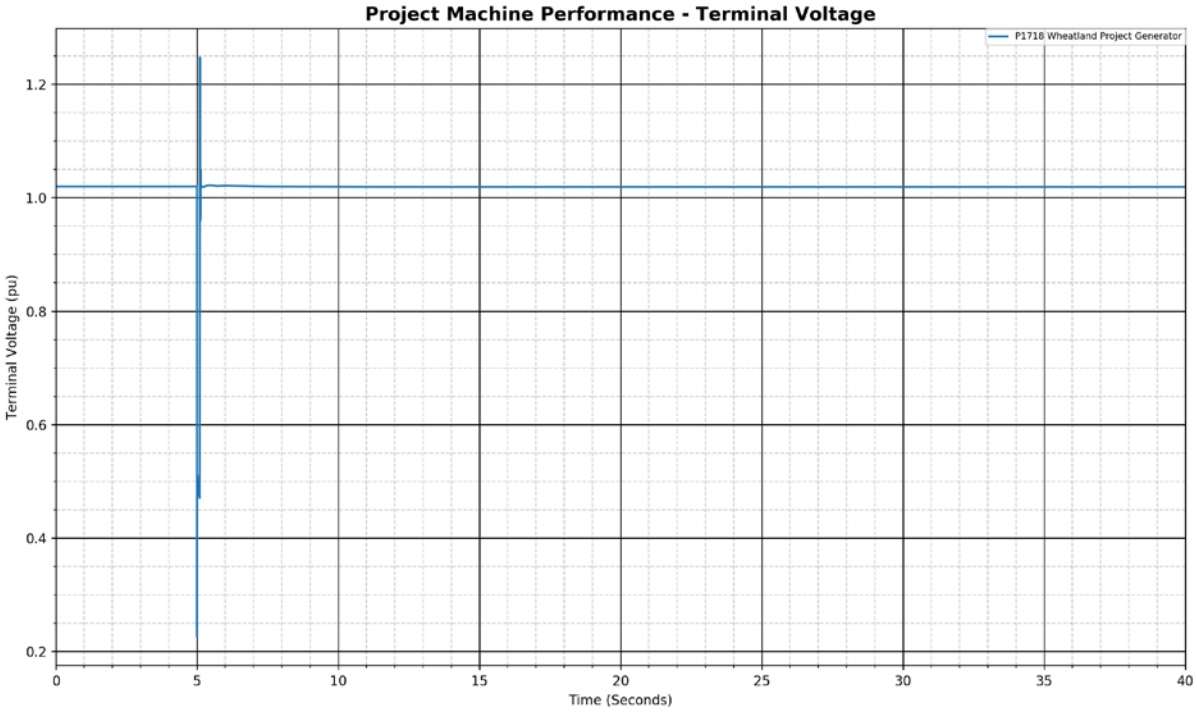
Figure A4-53: 7L128 (Michichi Creek 802S - Coyote Lake 963S): 3-phase fault at Michichi Creek 802S

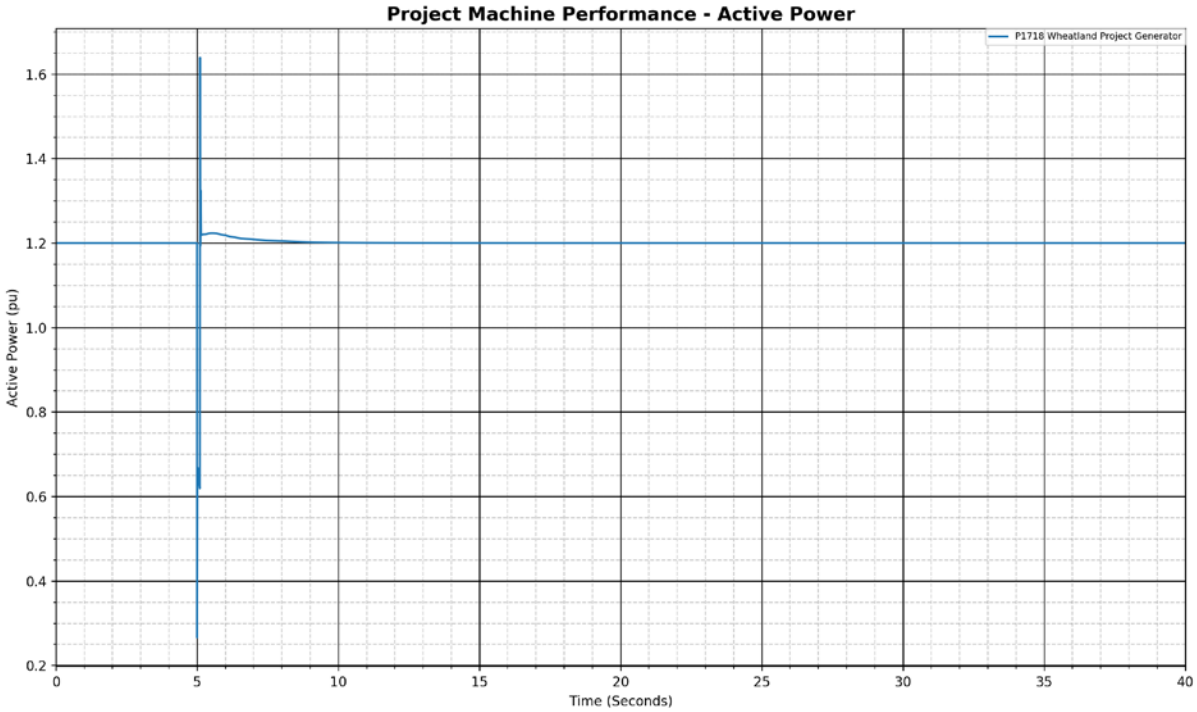


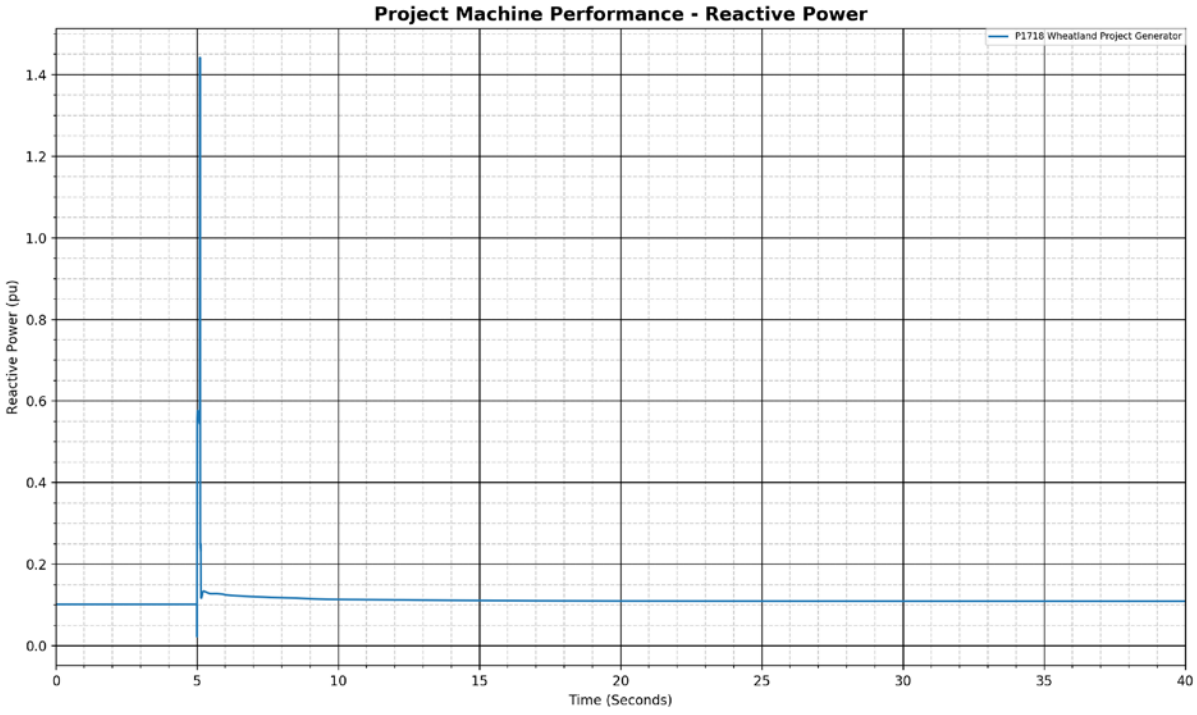

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

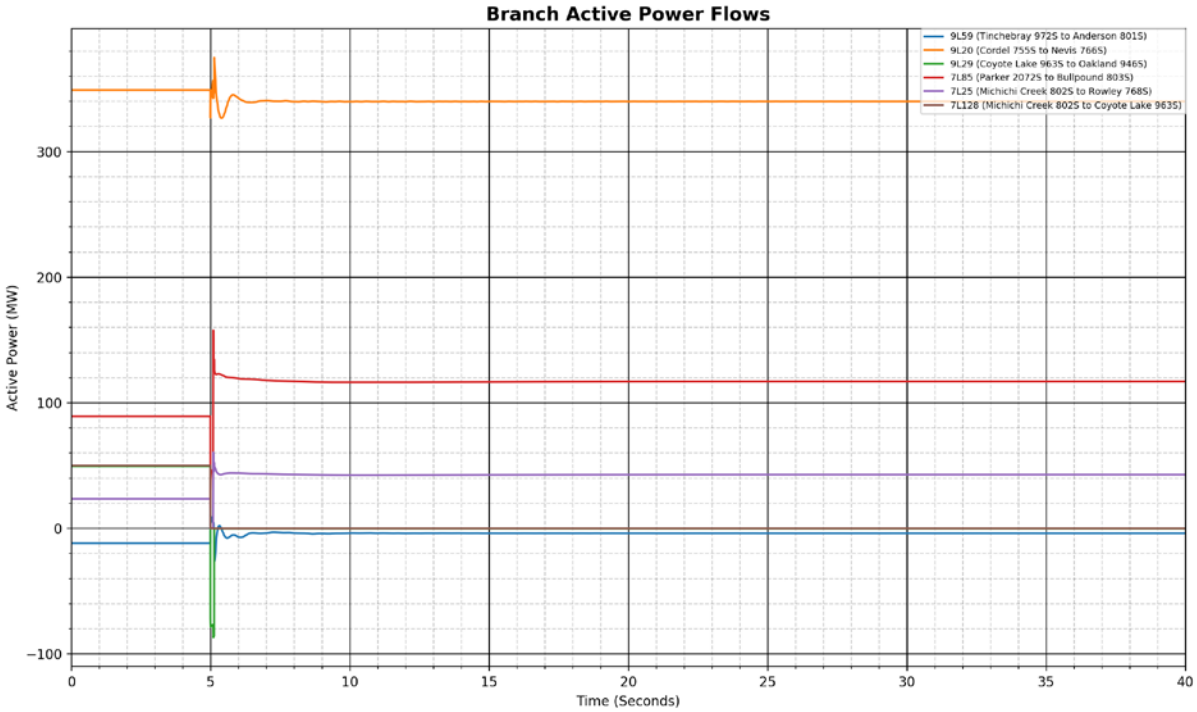

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Active Power (MW)
300
200
100
0
−100
0
5
10
15
20
25
30
35
40
Time (Seconds)

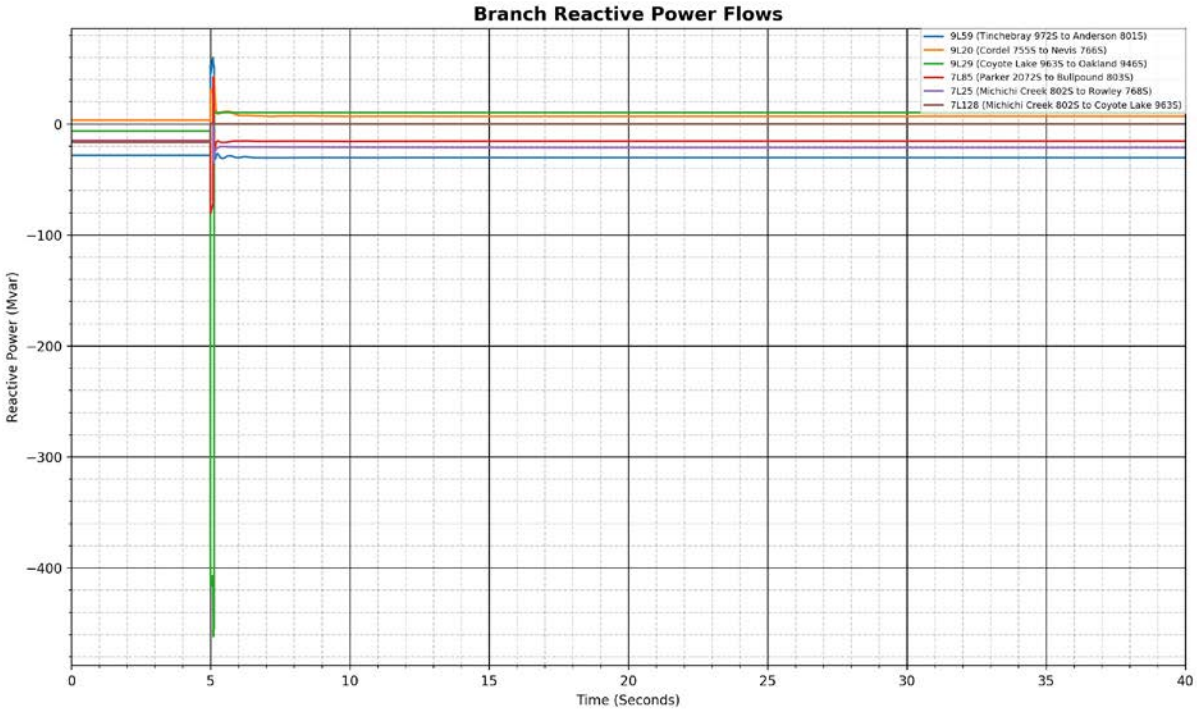
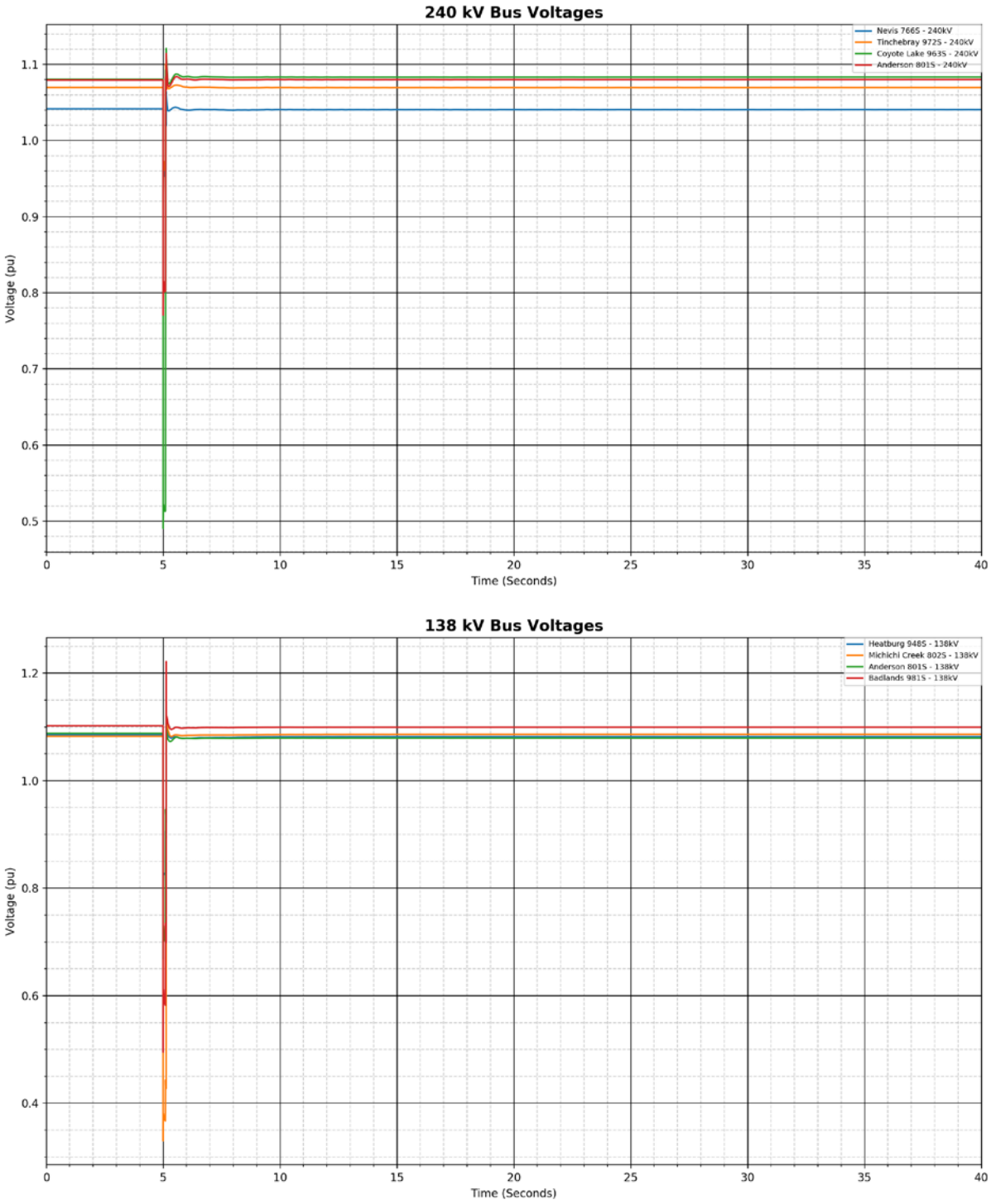
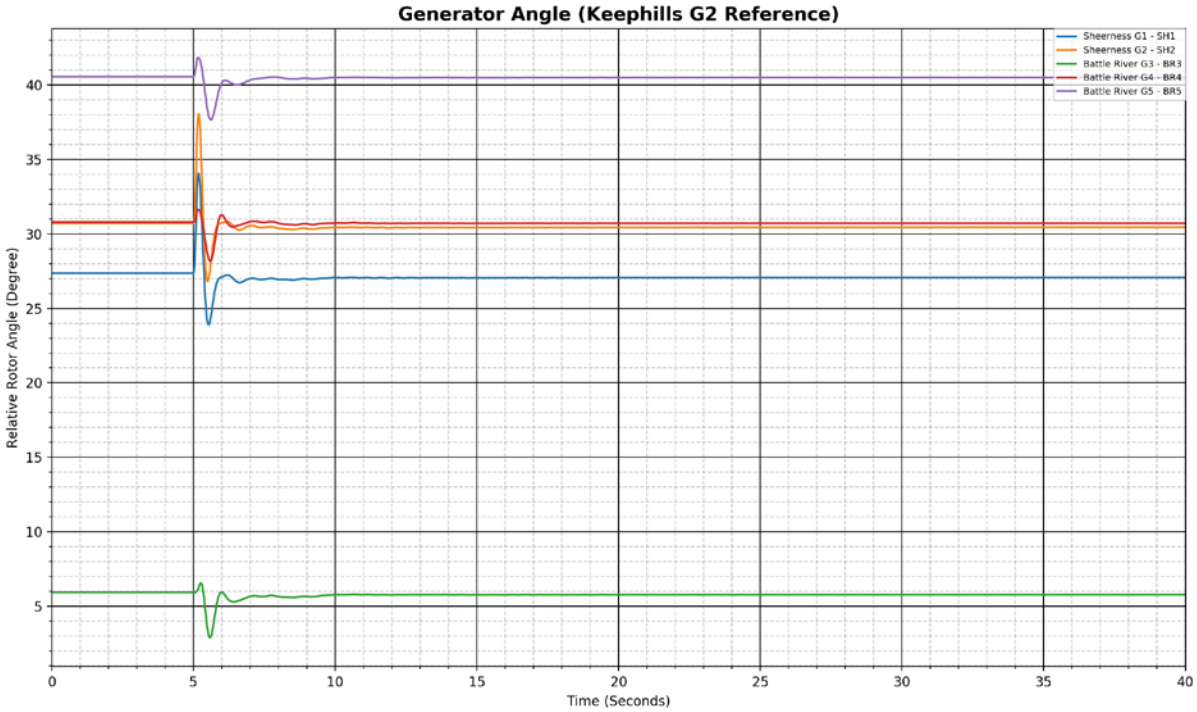
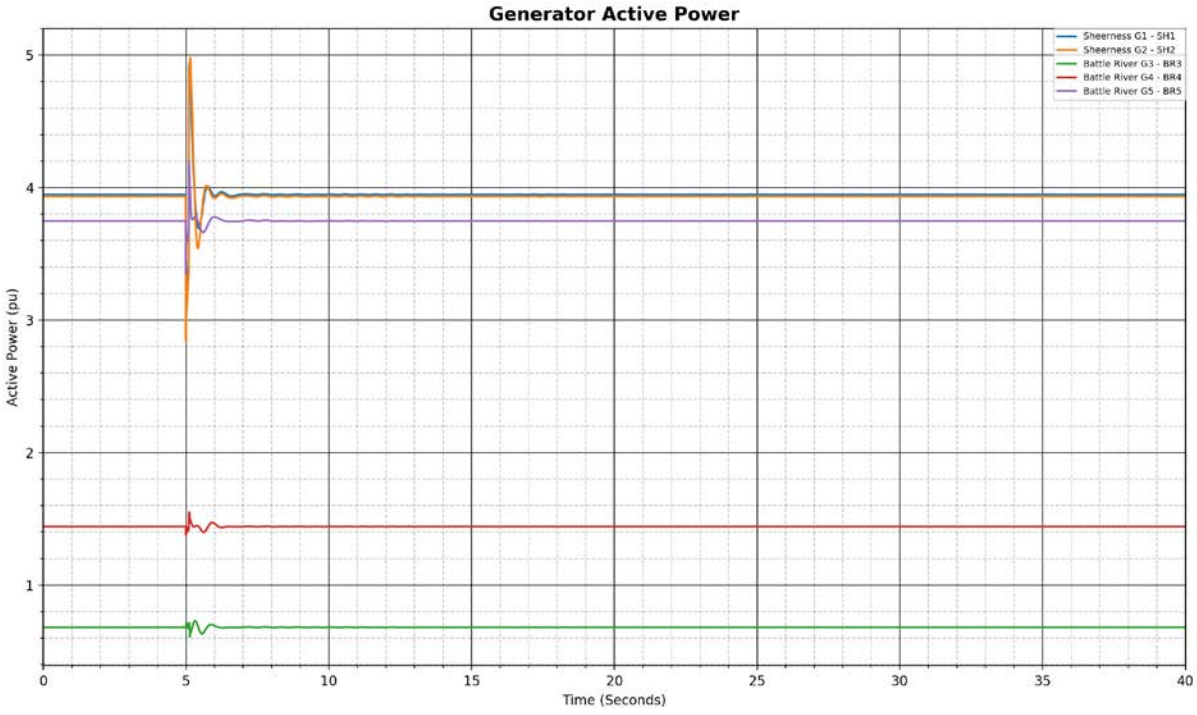
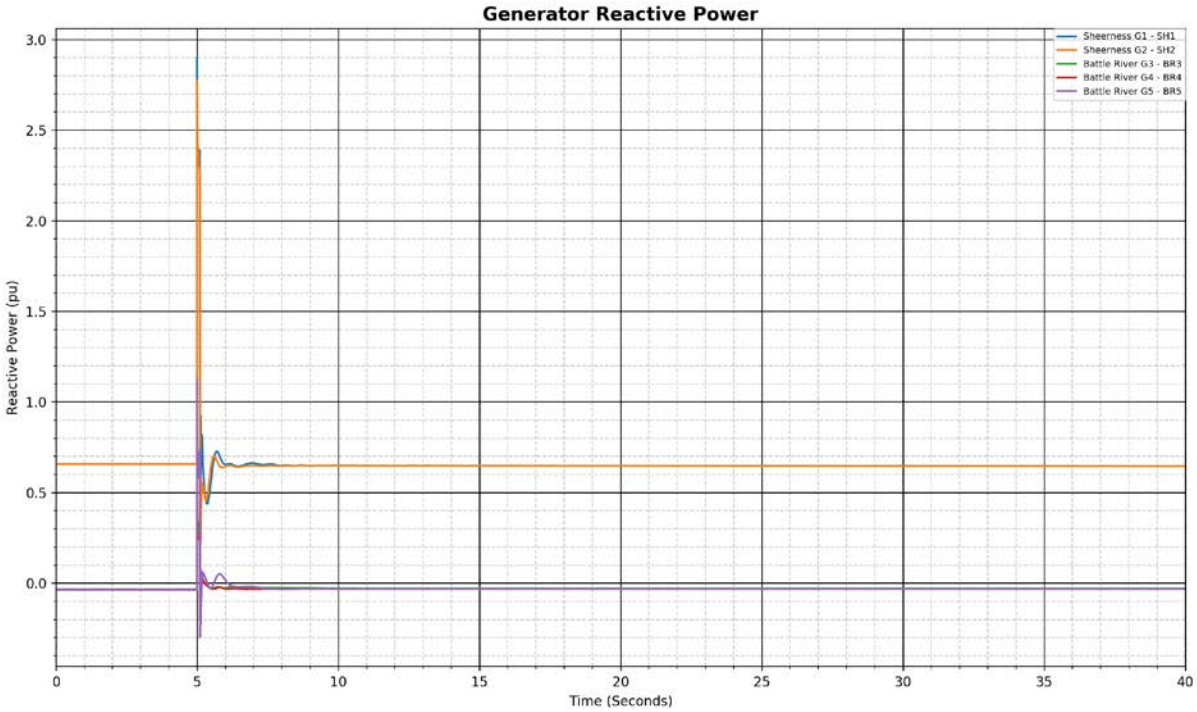

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Reactive Power (Mvar)
0
−100
−200
−300
−400
0
5
10
15
20
25
30
35
40
Time (Seconds)

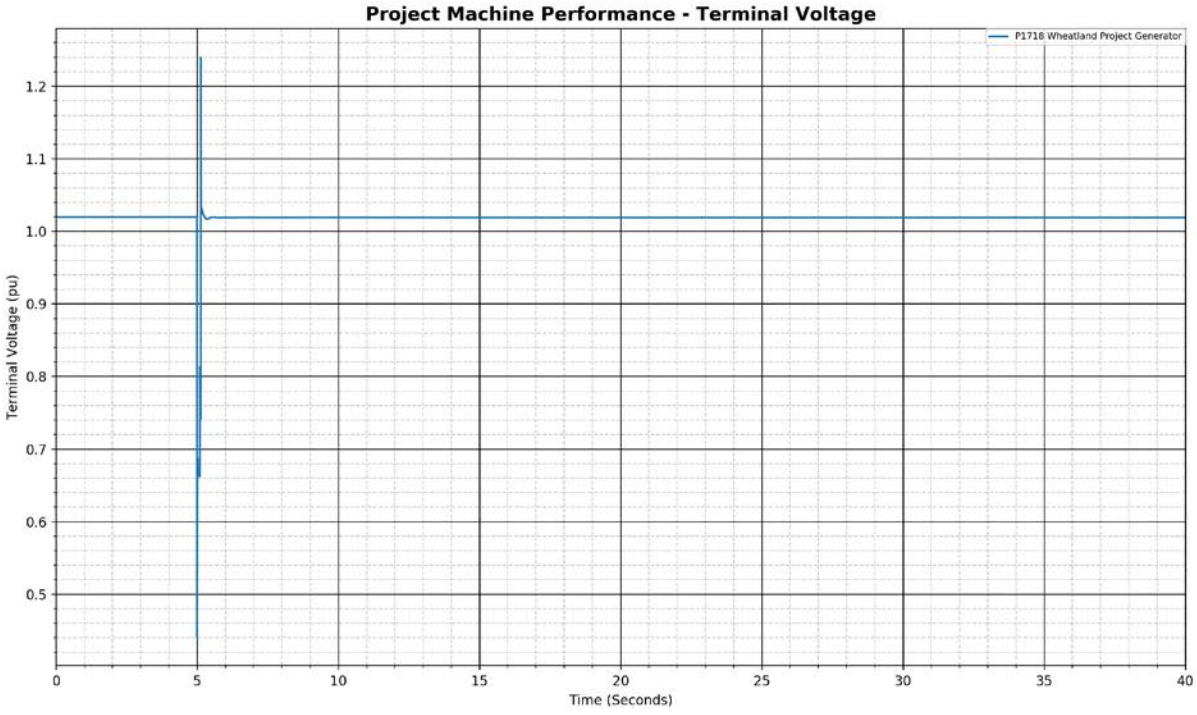
Figure A4-54: 7L128 (Michichi Creek 802S - Coyote Lake 963S): 3-phase fault at Coyote Lake 963S

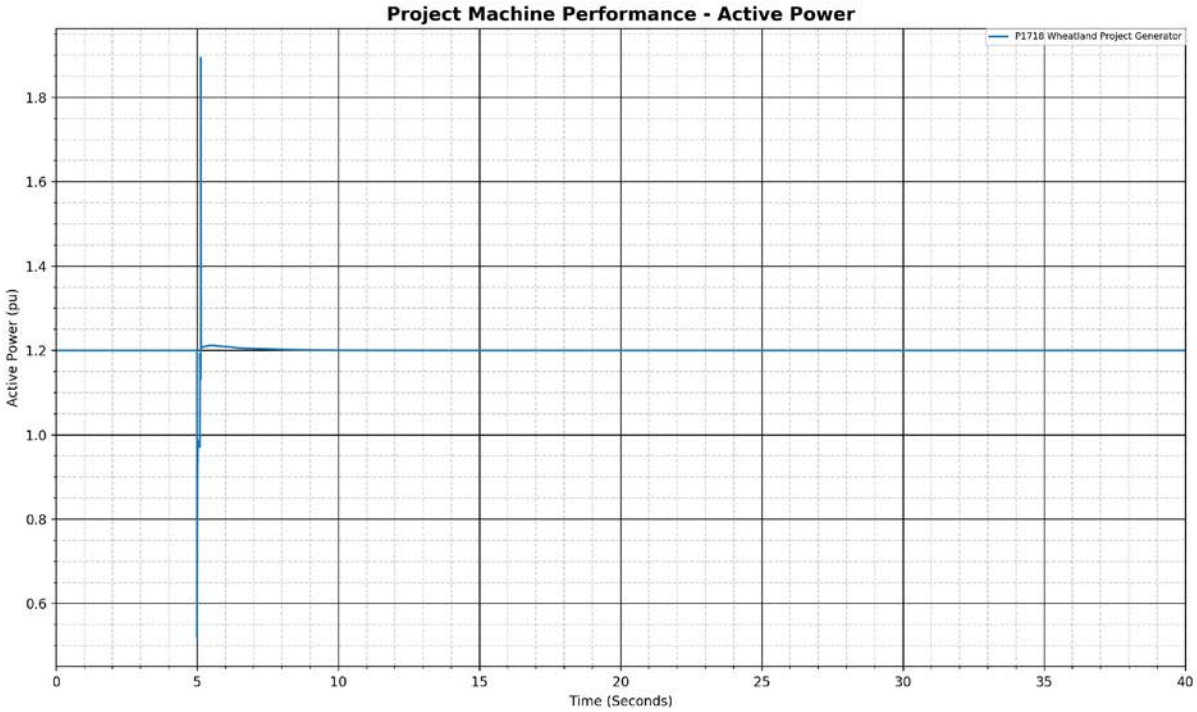


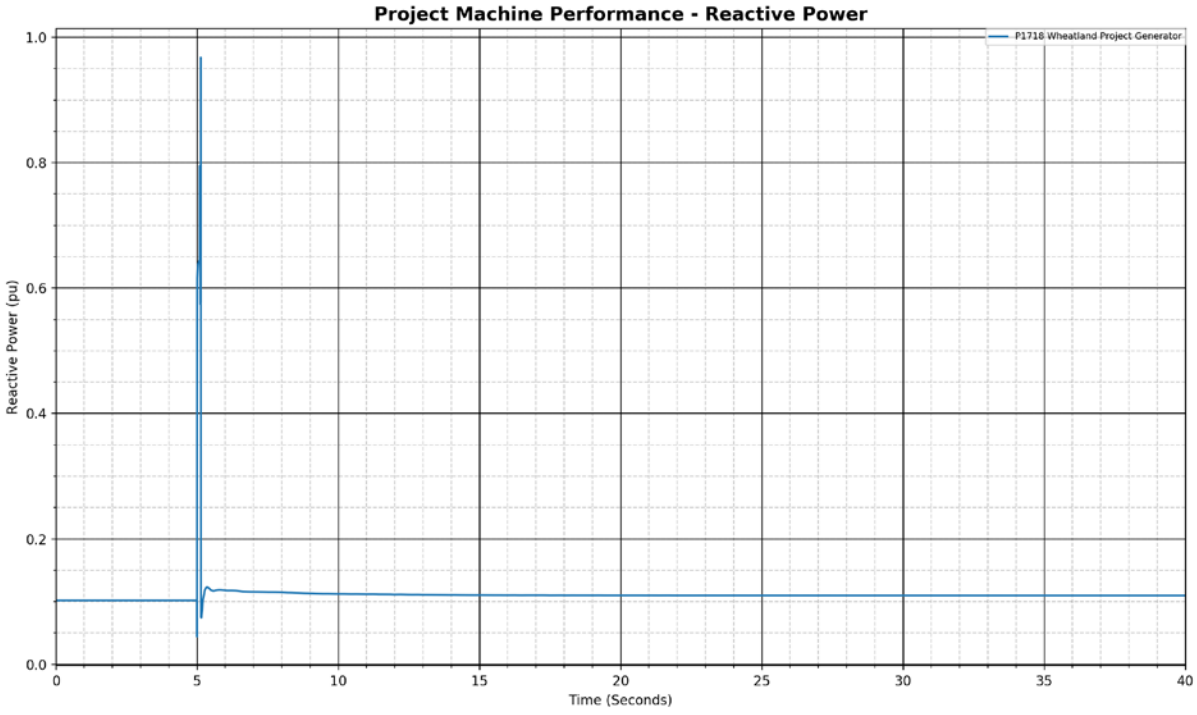

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

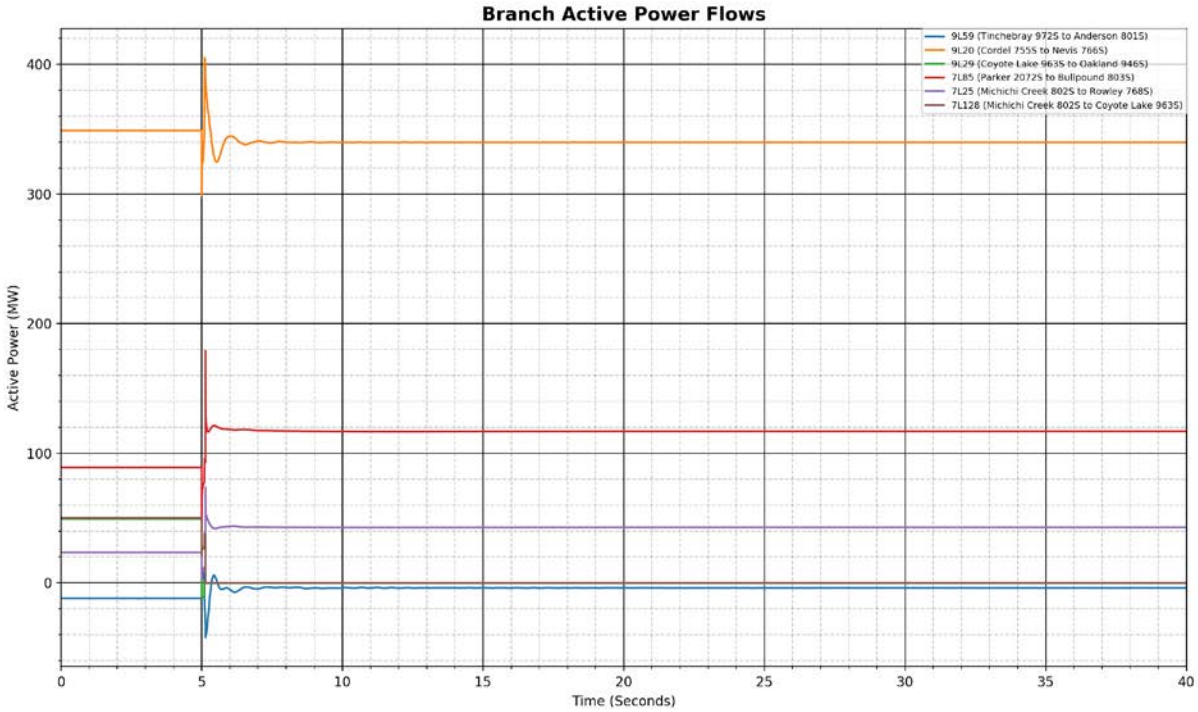

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)

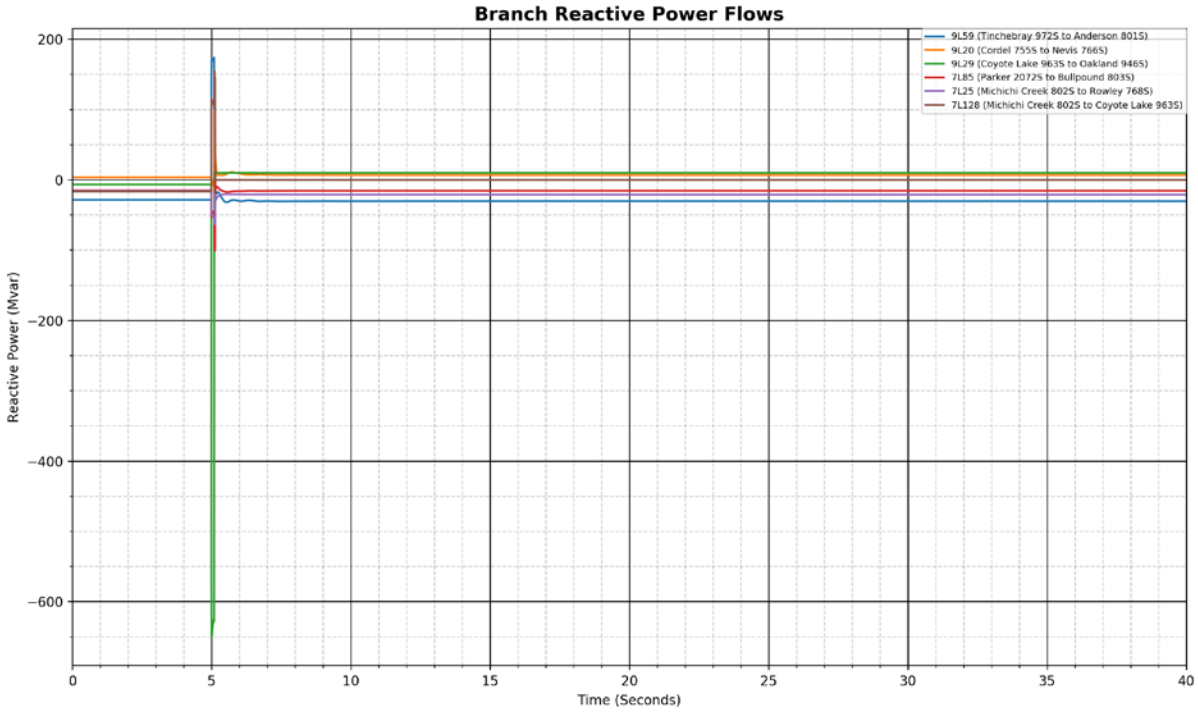

Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0
5
10
15
20
25
30
35
40

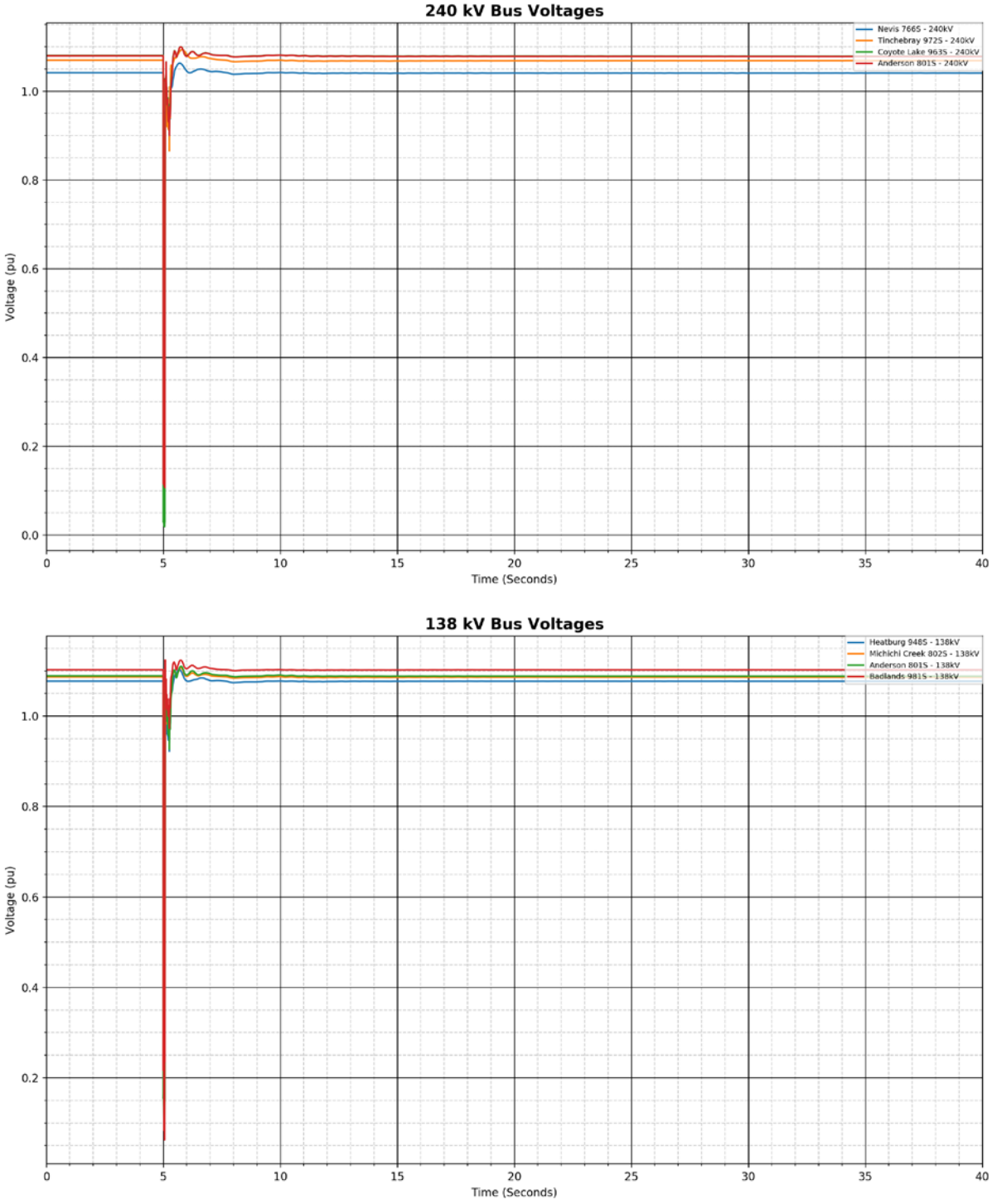

Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40

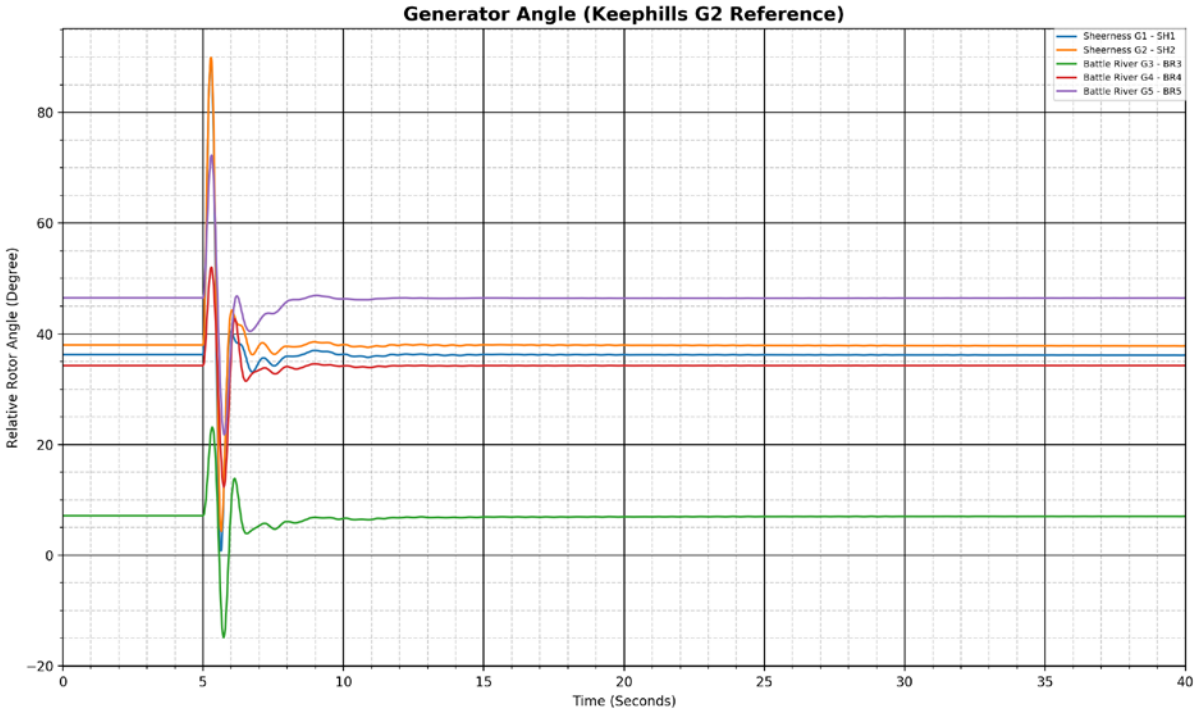

Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Active Power (MW)
Time (Seconds)

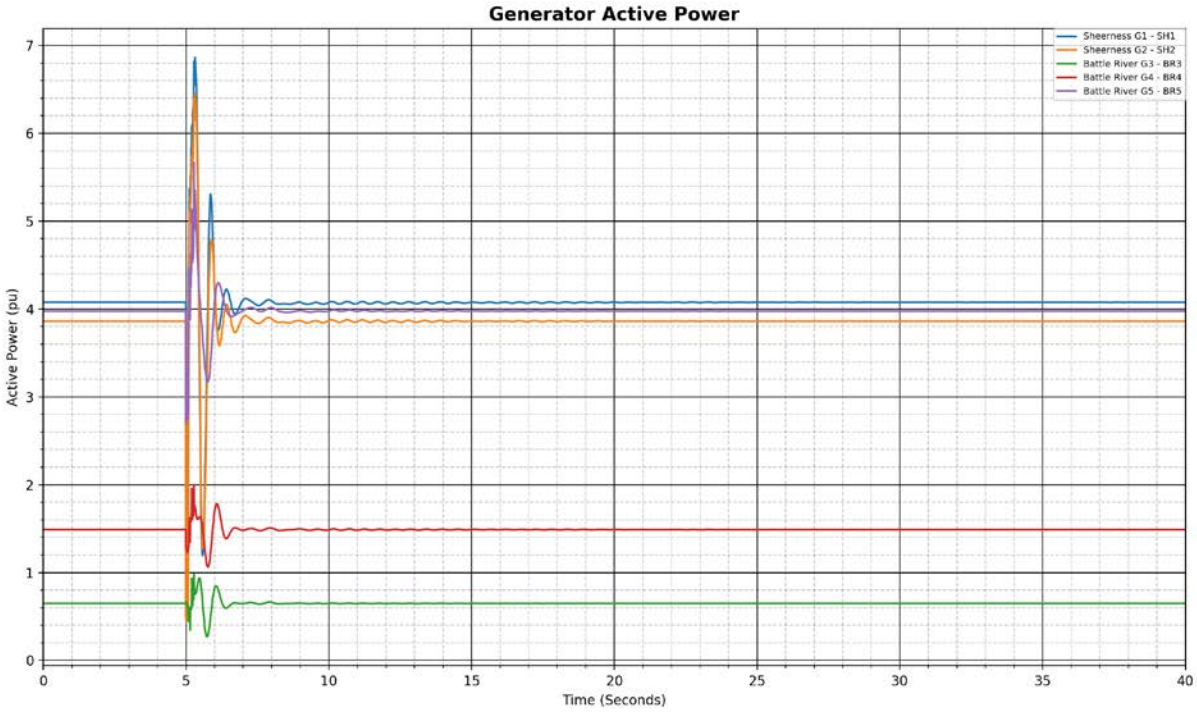

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Reactive Power (Mvar)
Time (Seconds)

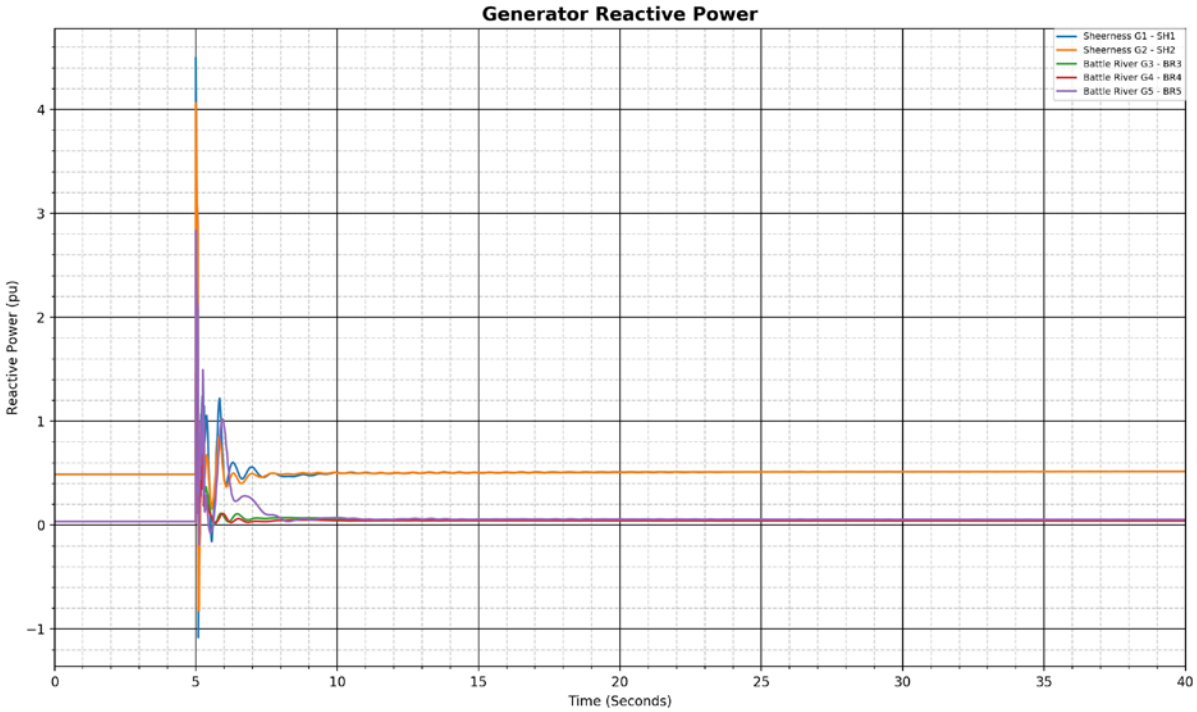
3. Stability Results 2019 Winter Peak

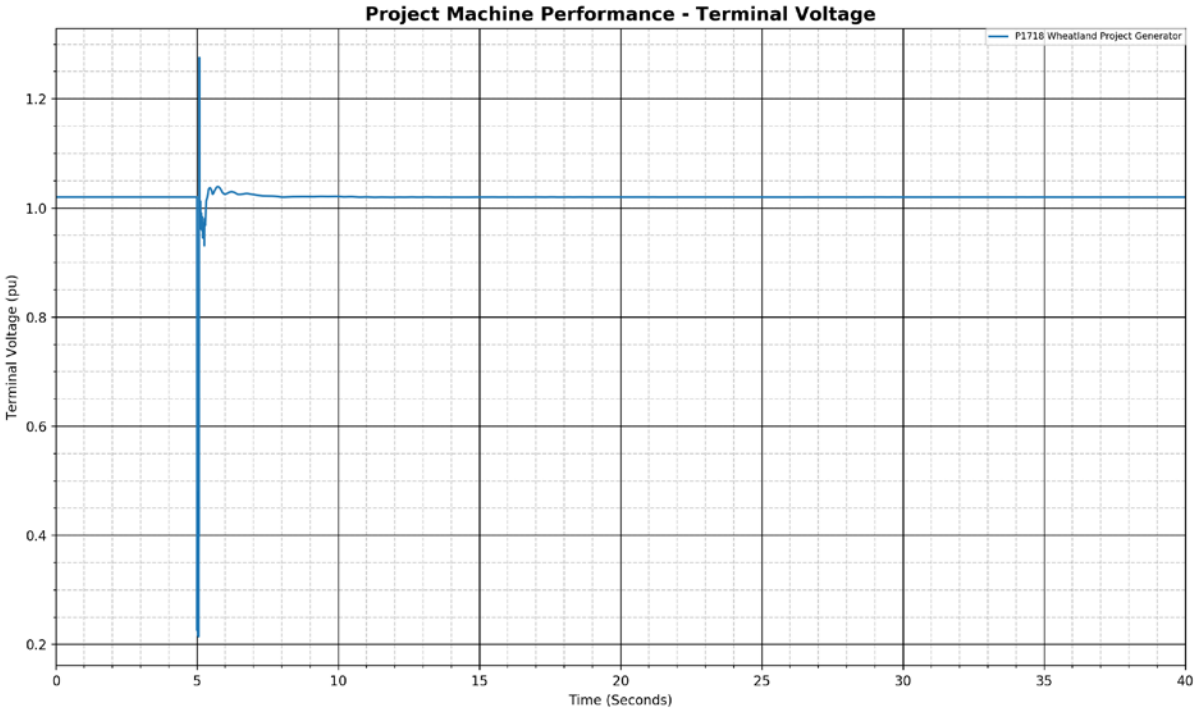
Figure A4-55: 9L24 (Oakland 946S - Lanfine 959S): 3-phase fault at Oakland 946S

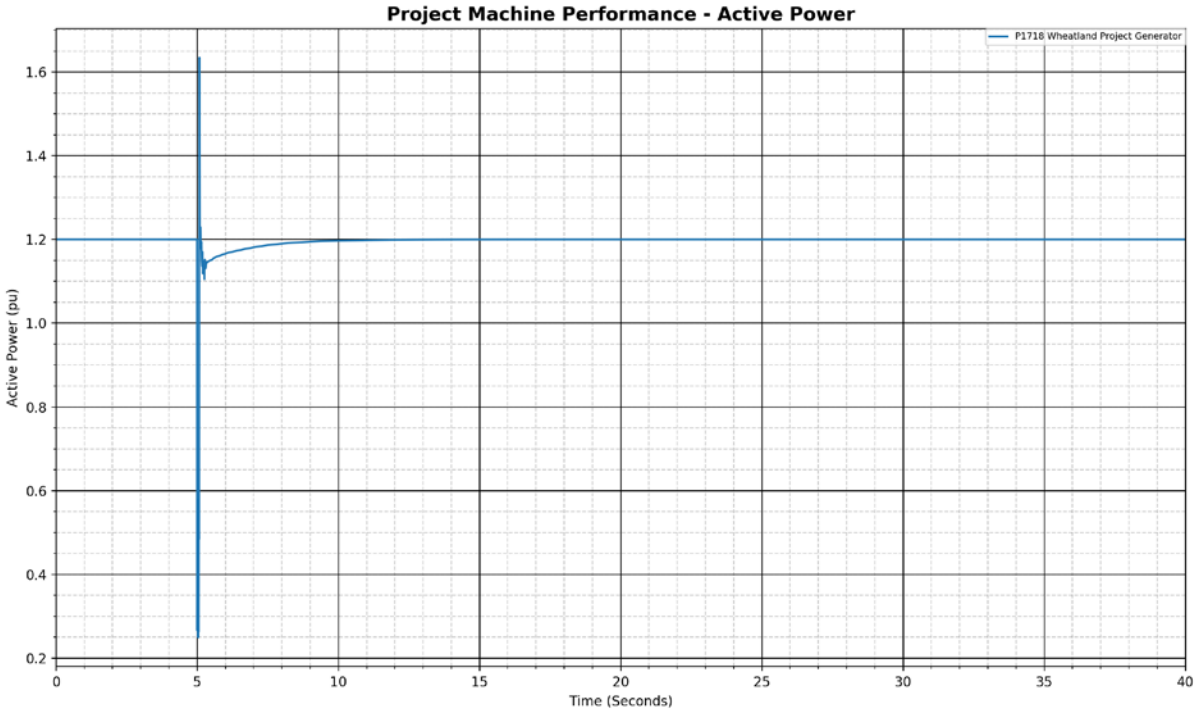


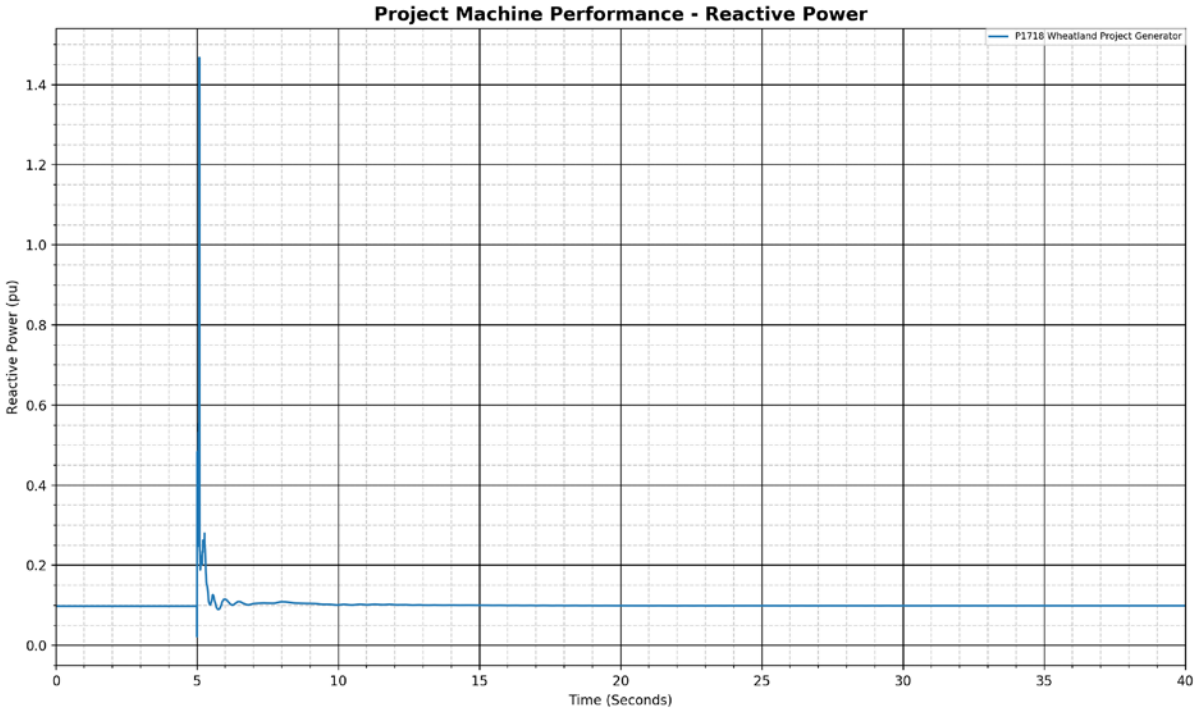

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

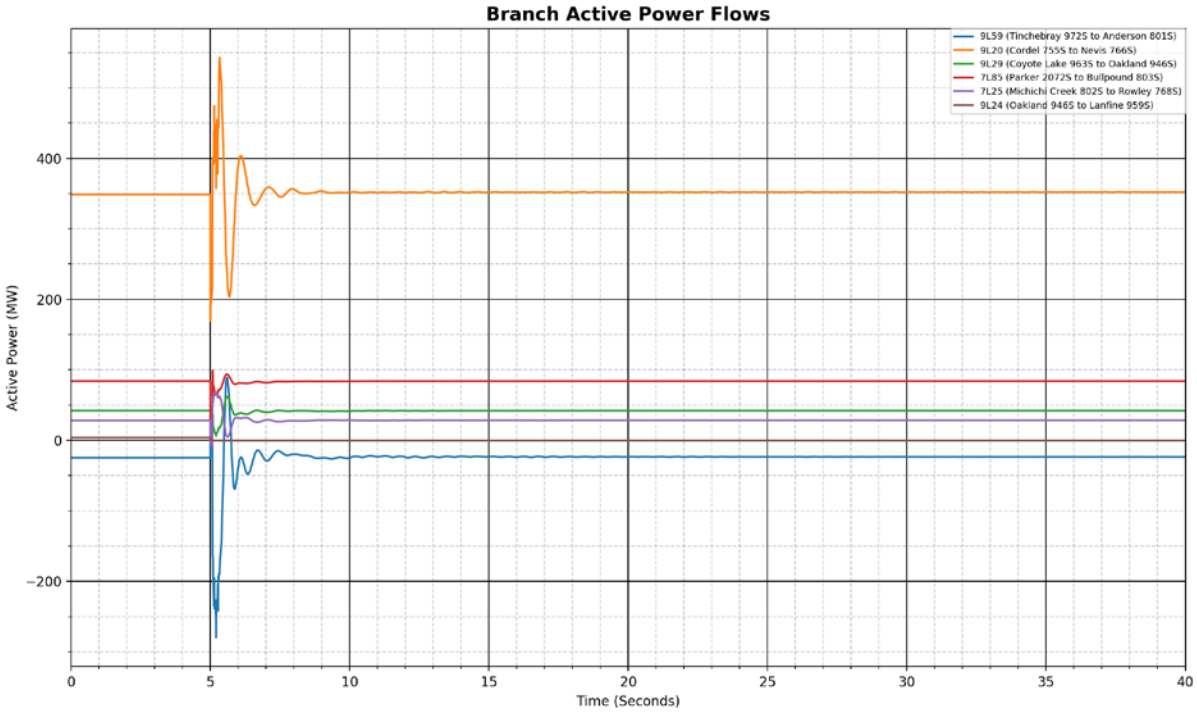

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Active Power (MW)
400
200
0
−200
0
5
10
15
20
25
30
35
40
Time (Seconds)

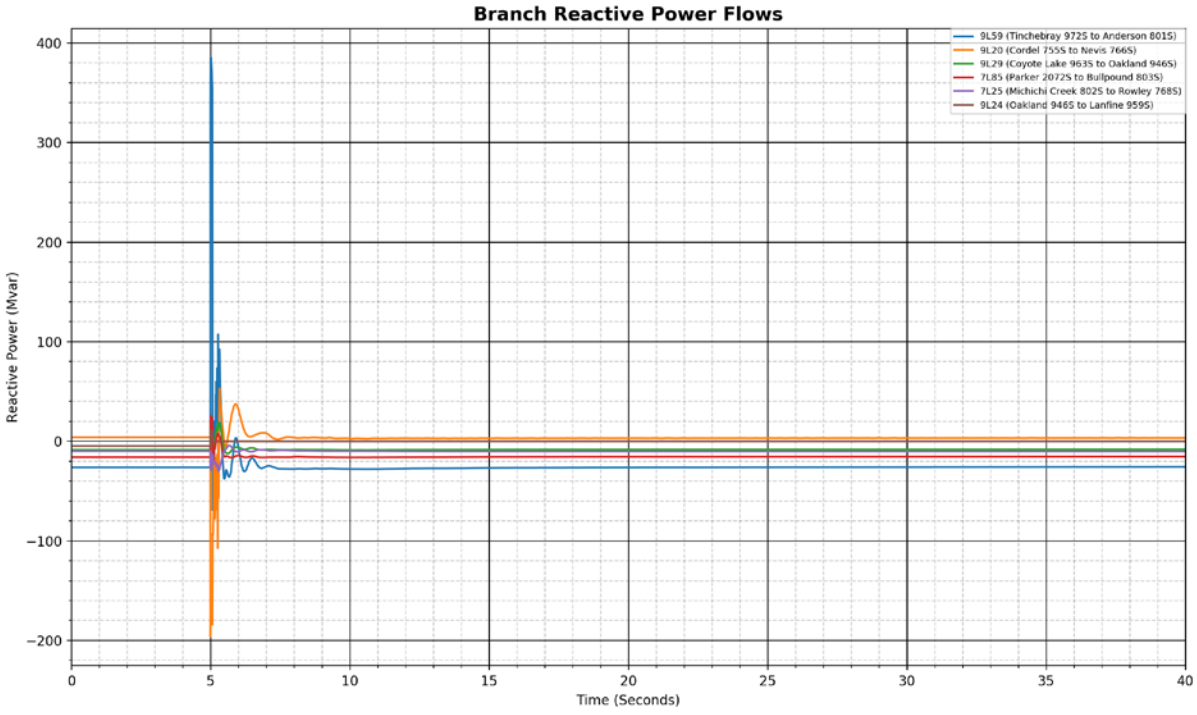
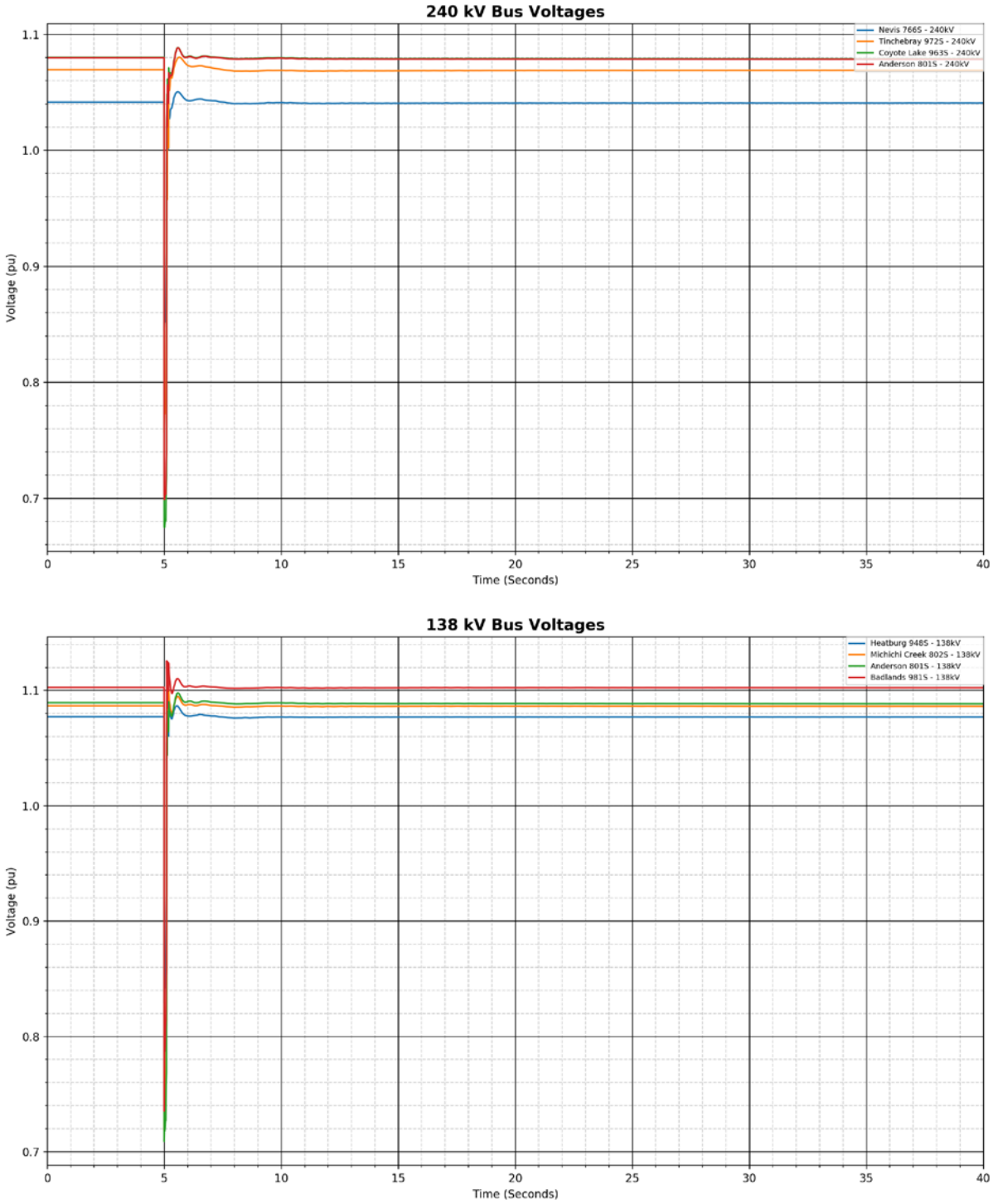
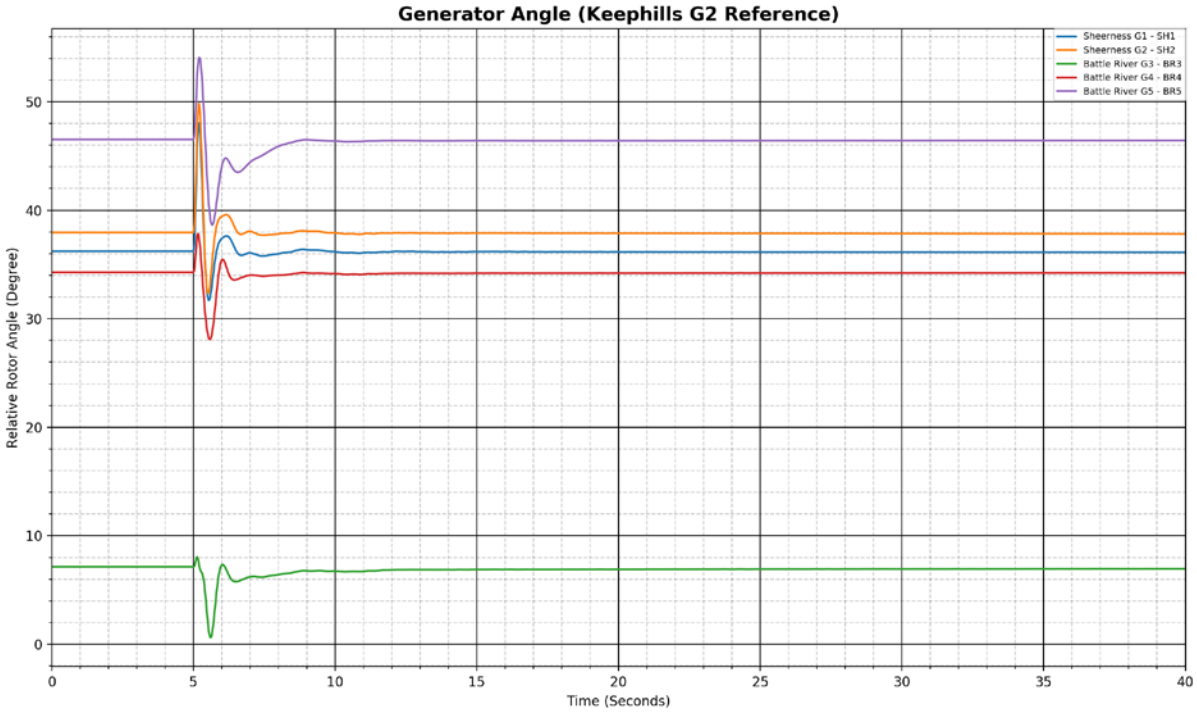
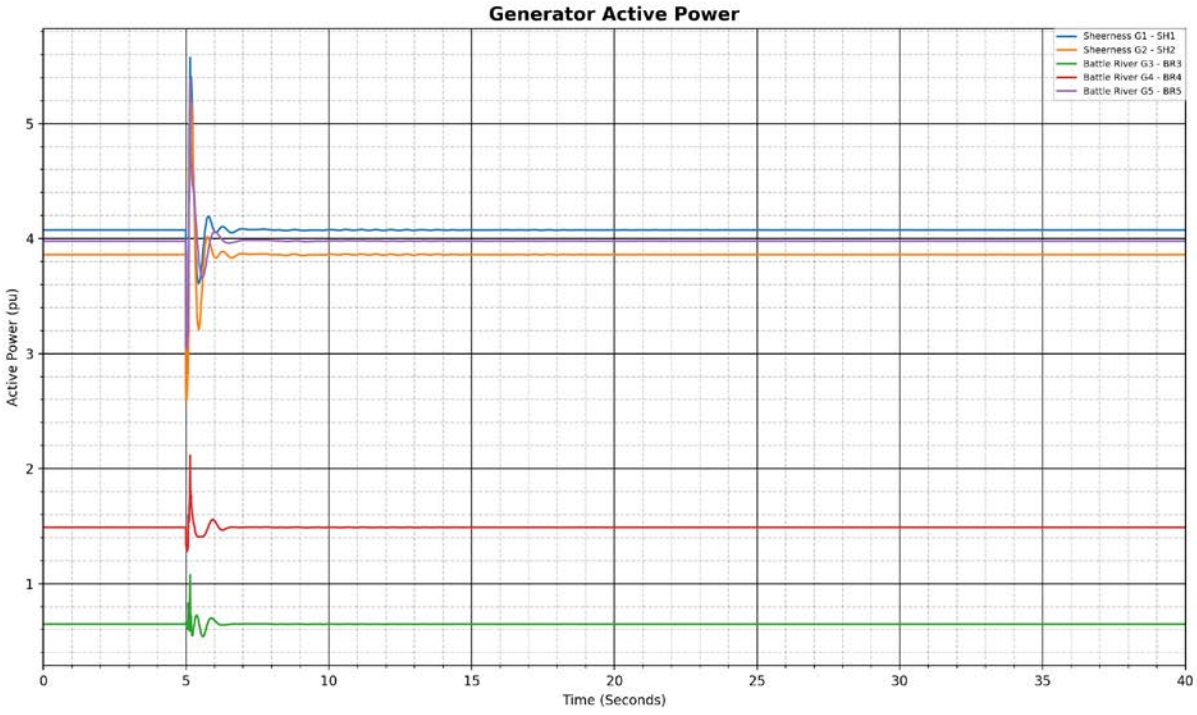
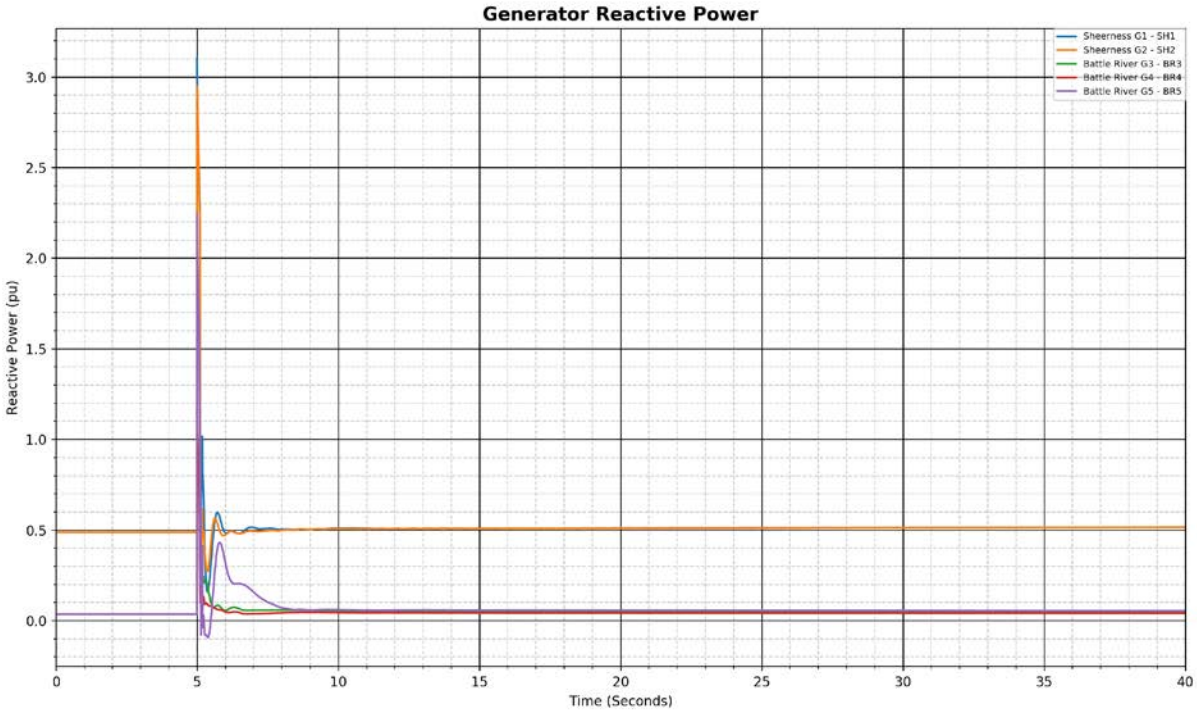

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Reactive Power (Mvar)
400
300
200
100
0
−100
−200
0
5
10
15
20
25
30
35
40
Time (Seconds)

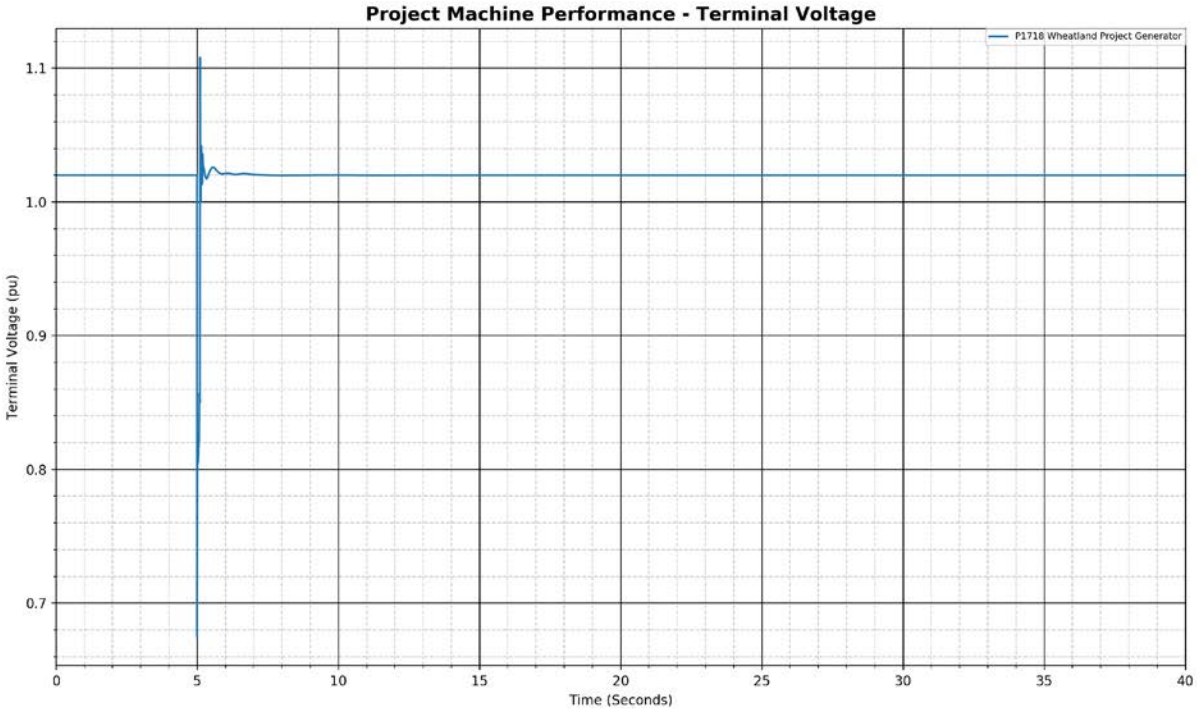
Figure A4-56: 9L24 (Oakland 946S - Lanfine 959S): 3-phase fault at Lanfine 959S

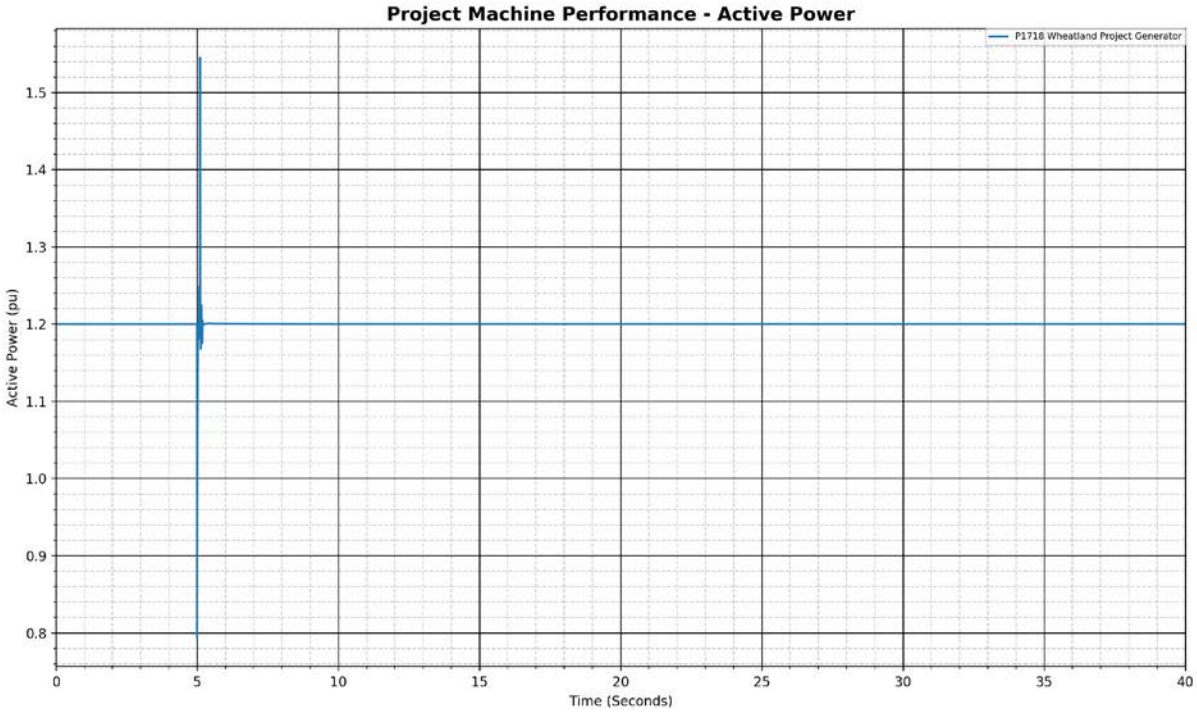


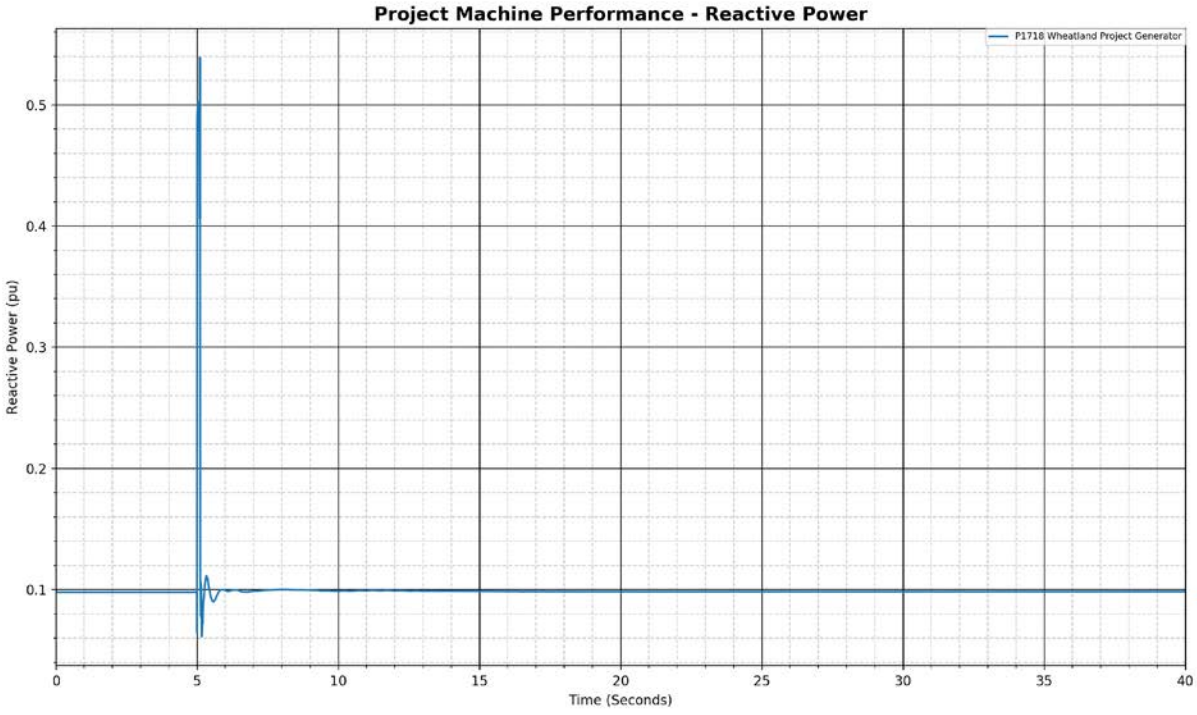

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

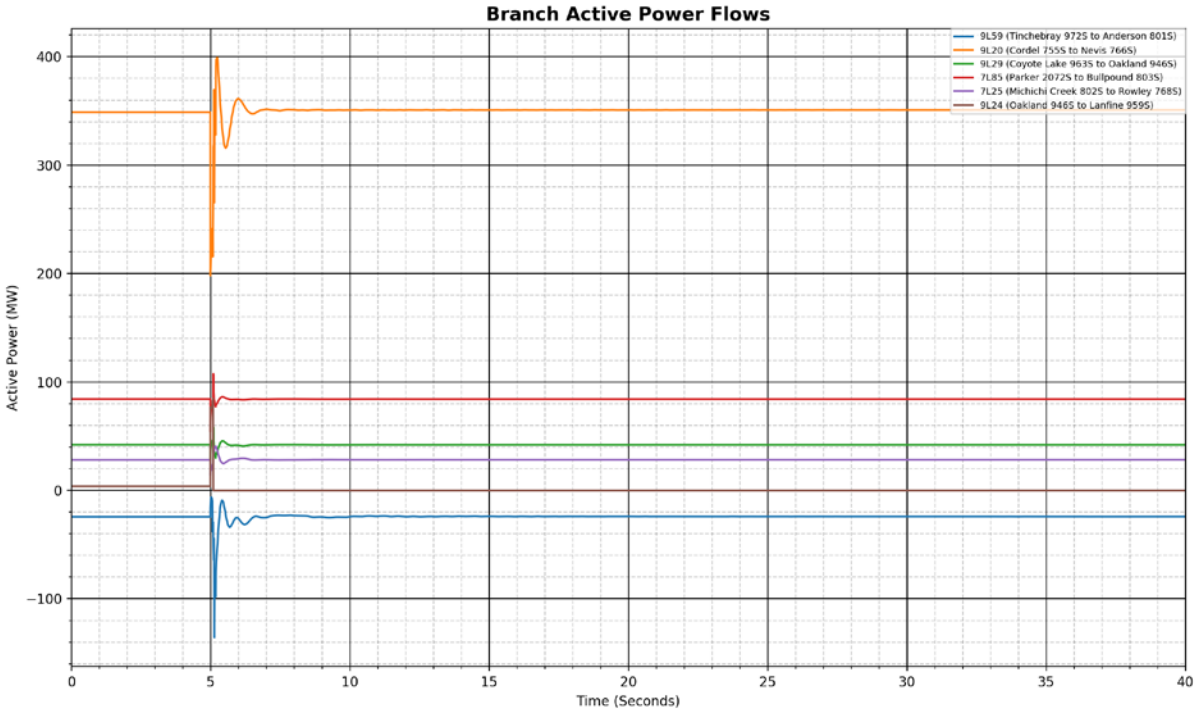

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Active Power (MW)
Time (Seconds)

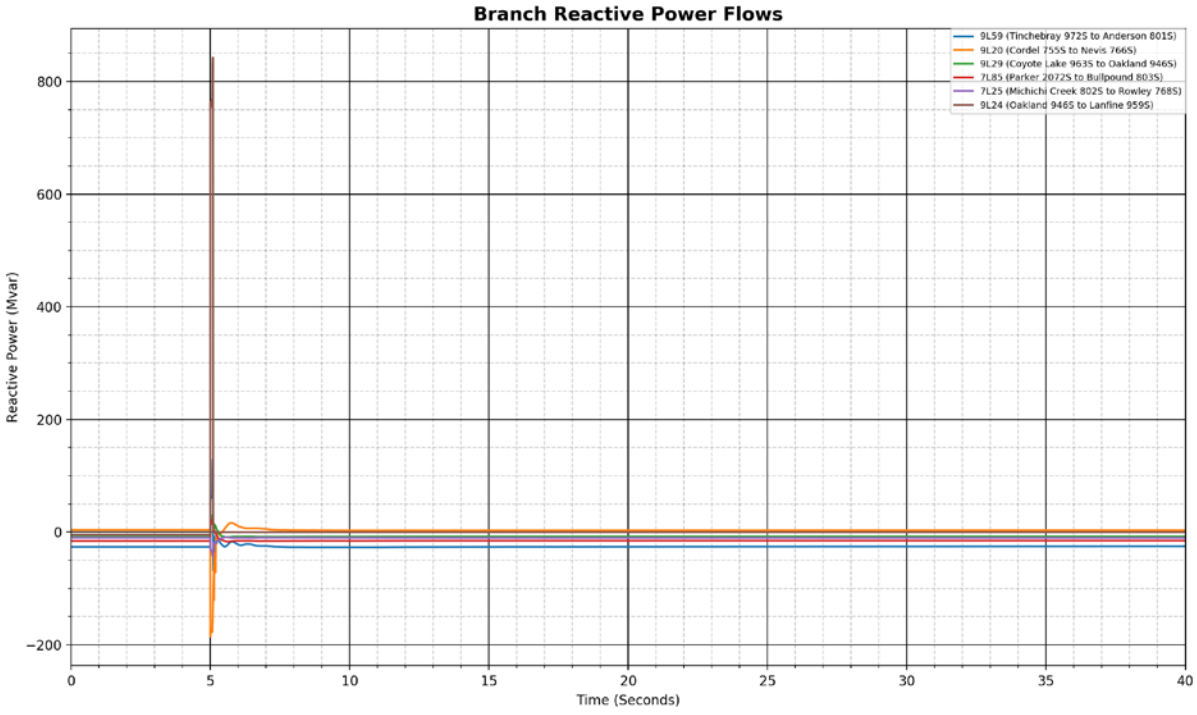
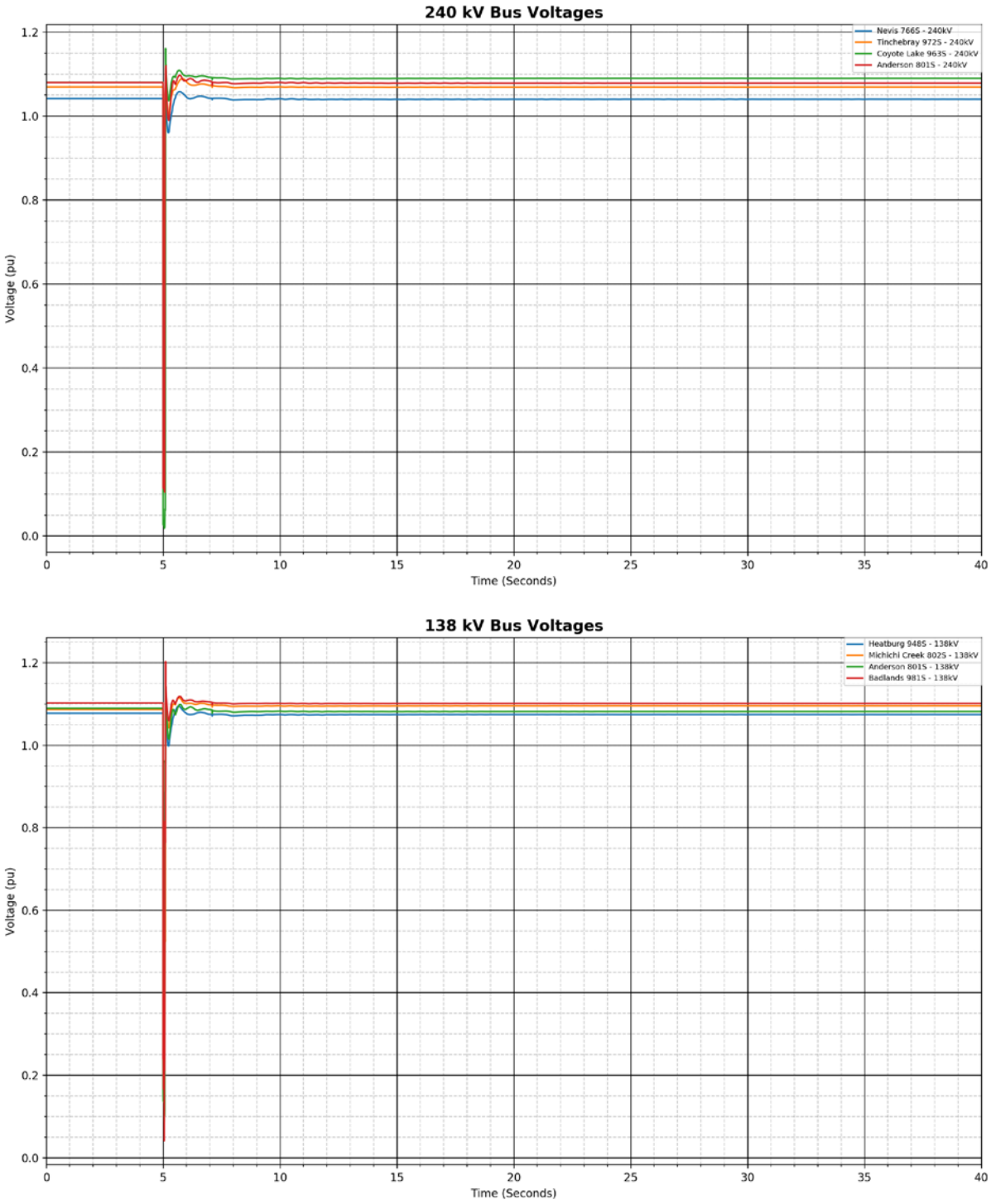
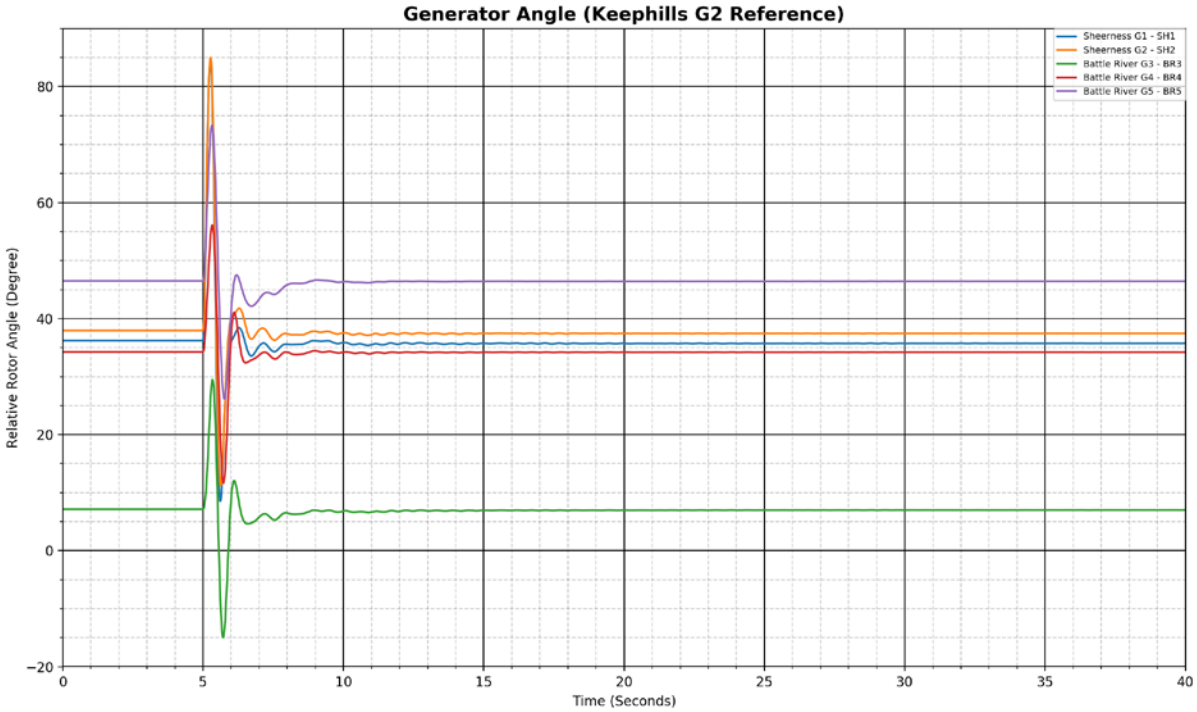
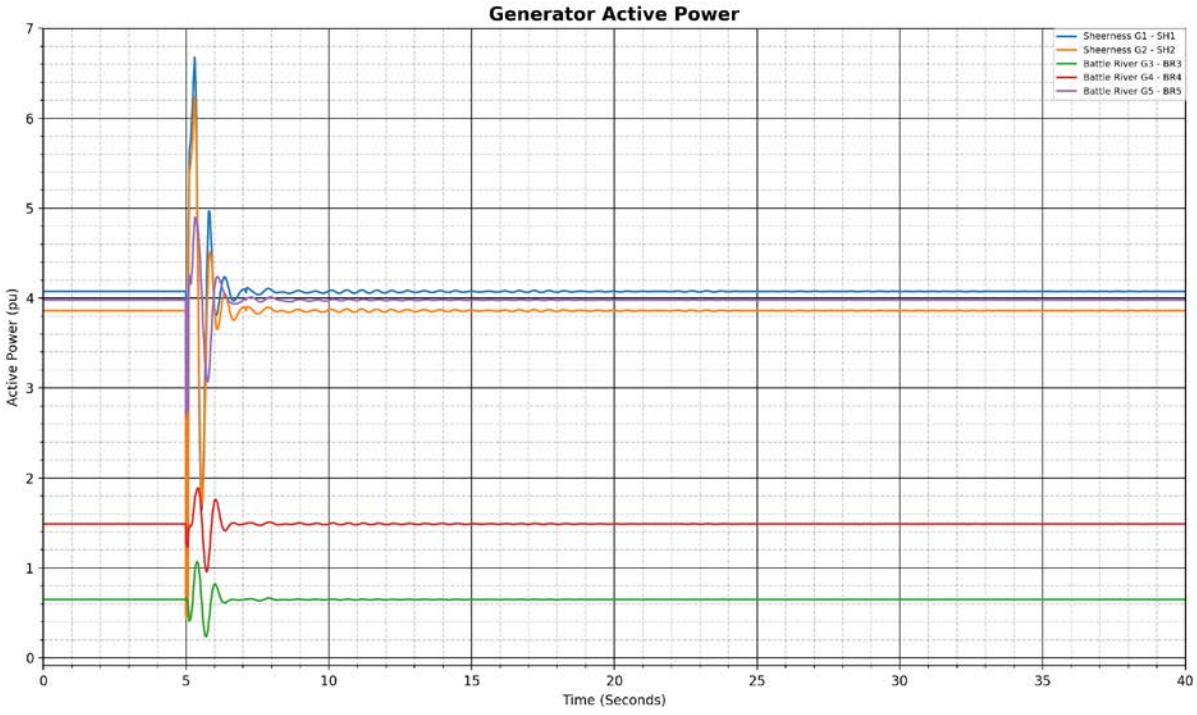
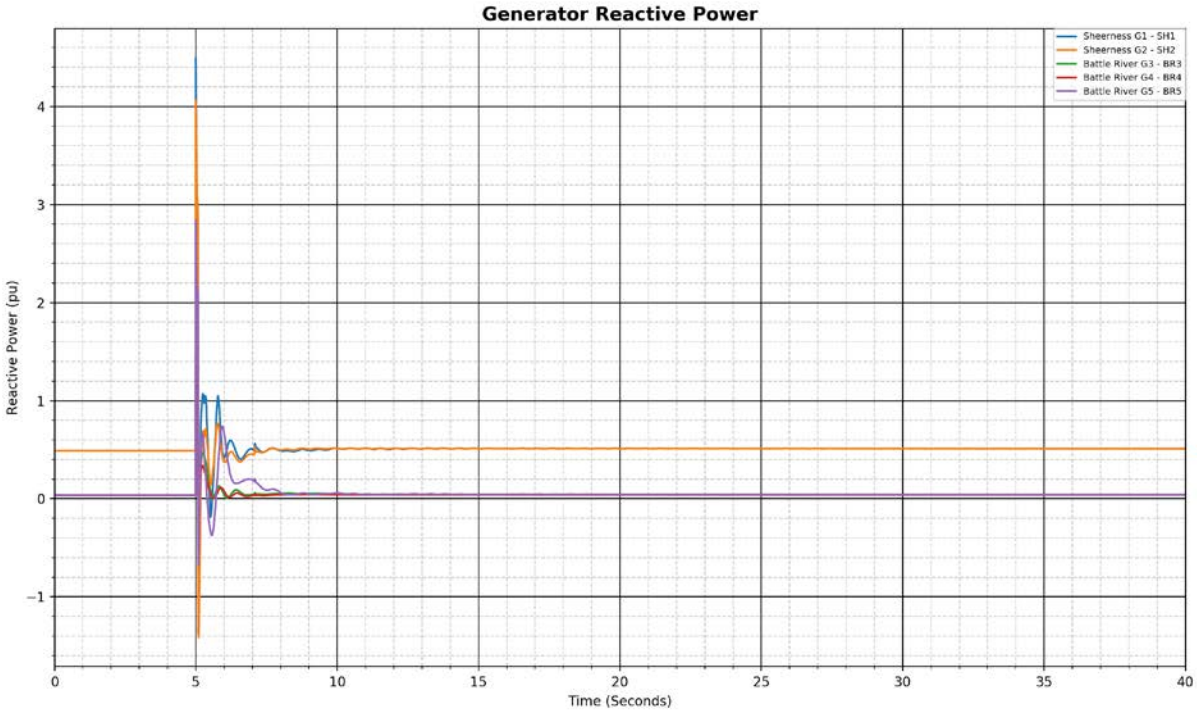

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L24 (Oakland 946S to Lanfine 959S)
Reactive Power (Mvar)
Time (Seconds)

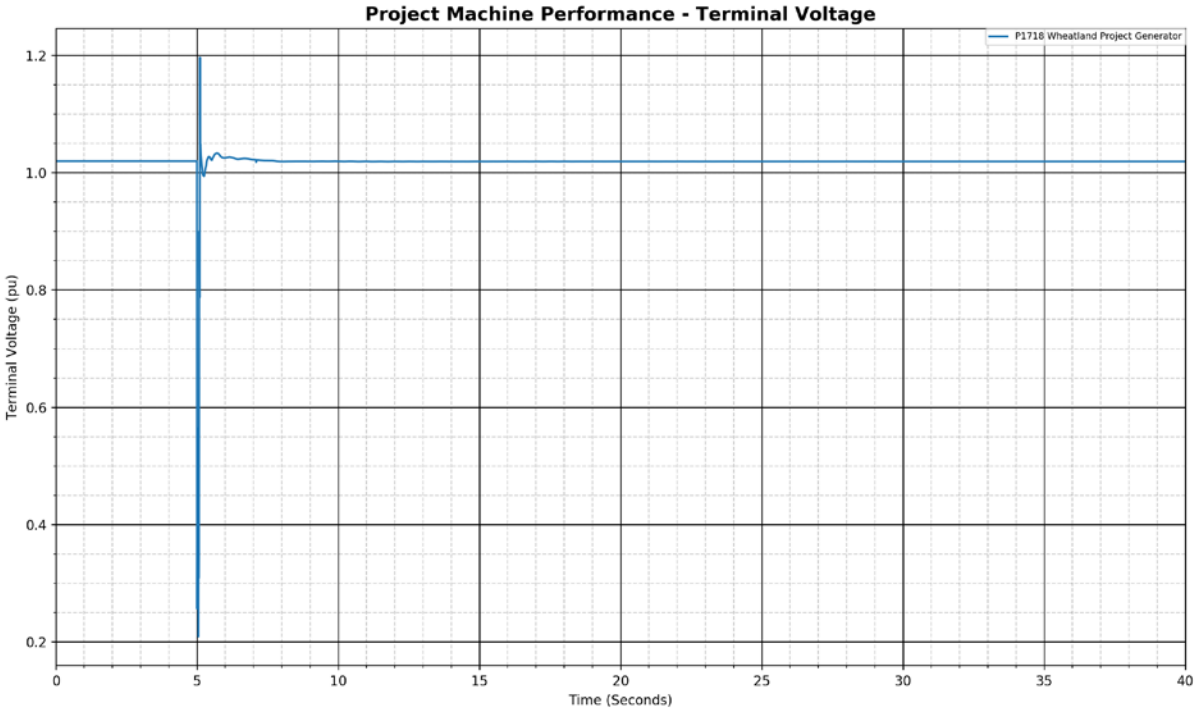
Figure A4-57: 9L29 (Oakland 946S - Coyote Lake 963S): 3-phase fault at Oakland 946S

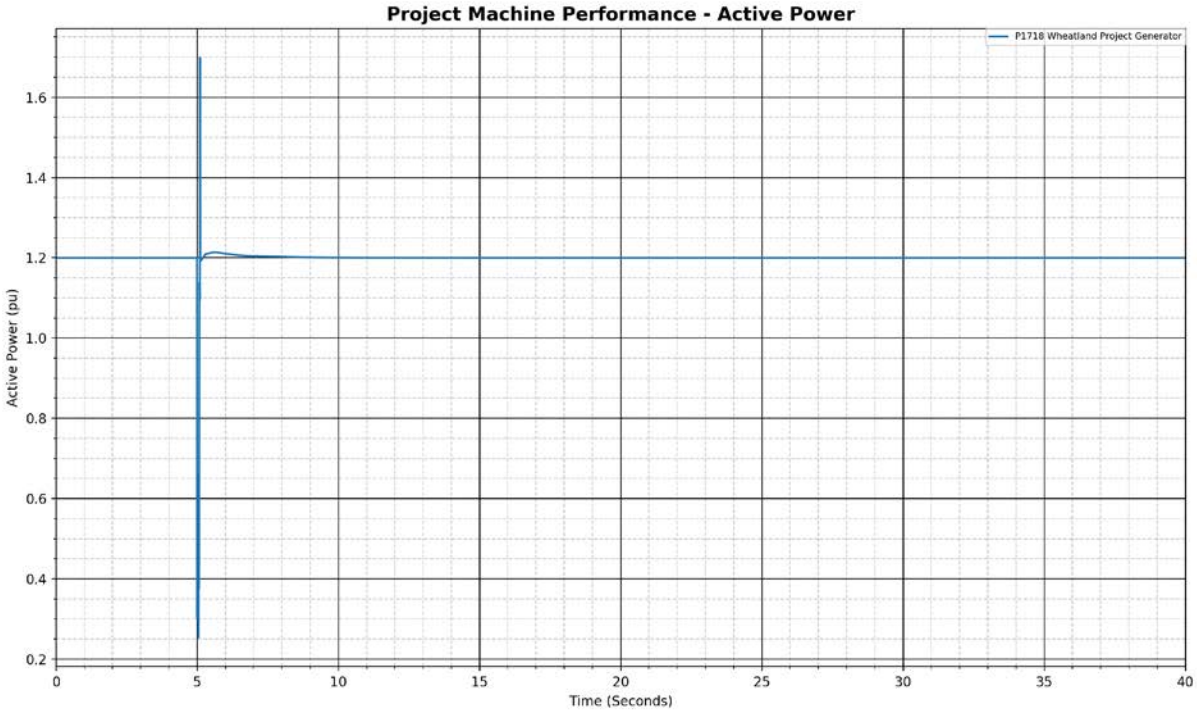


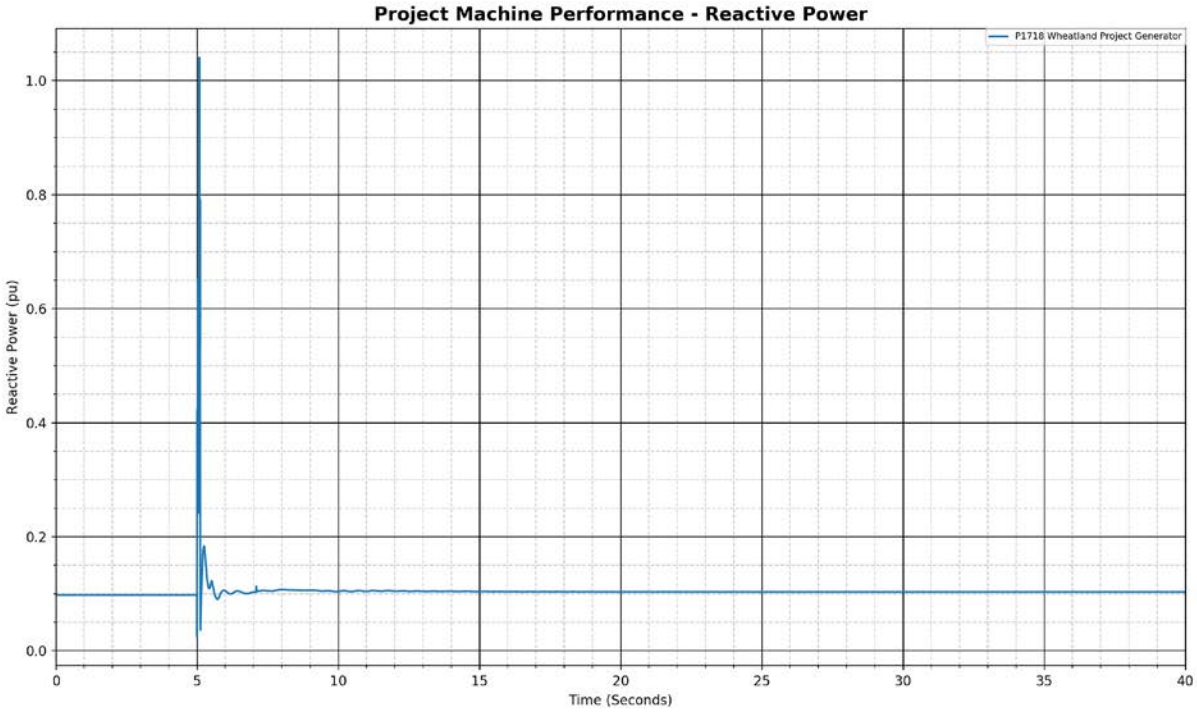

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

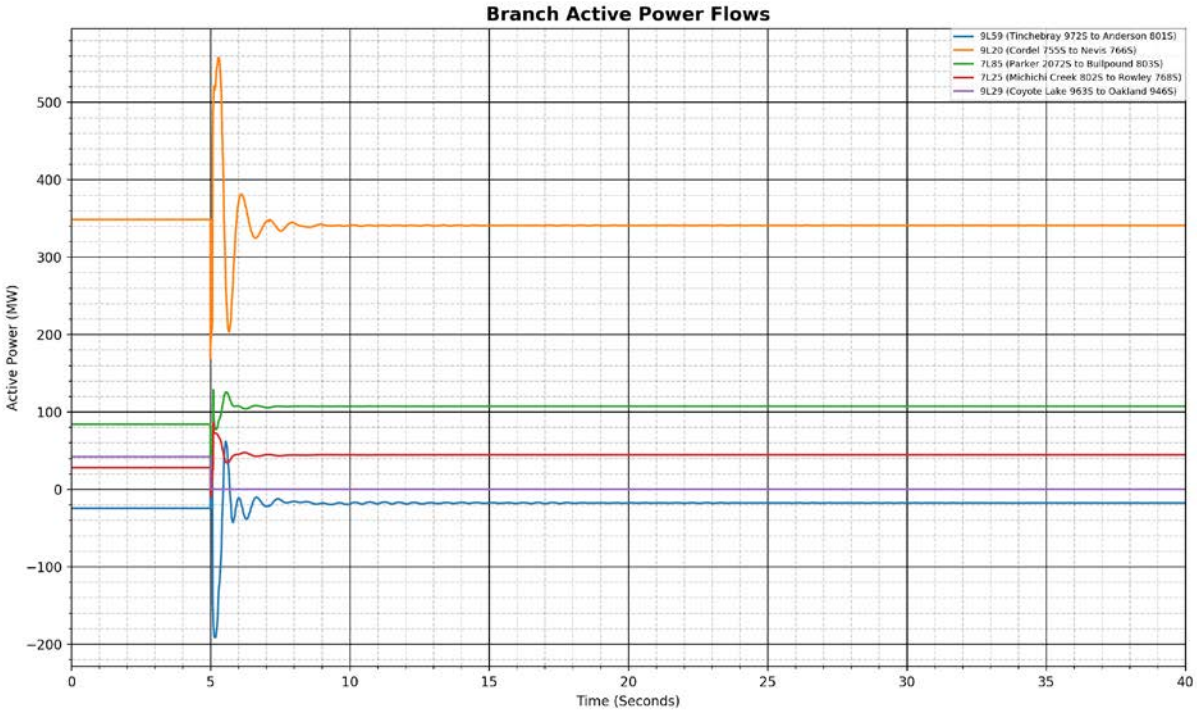

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

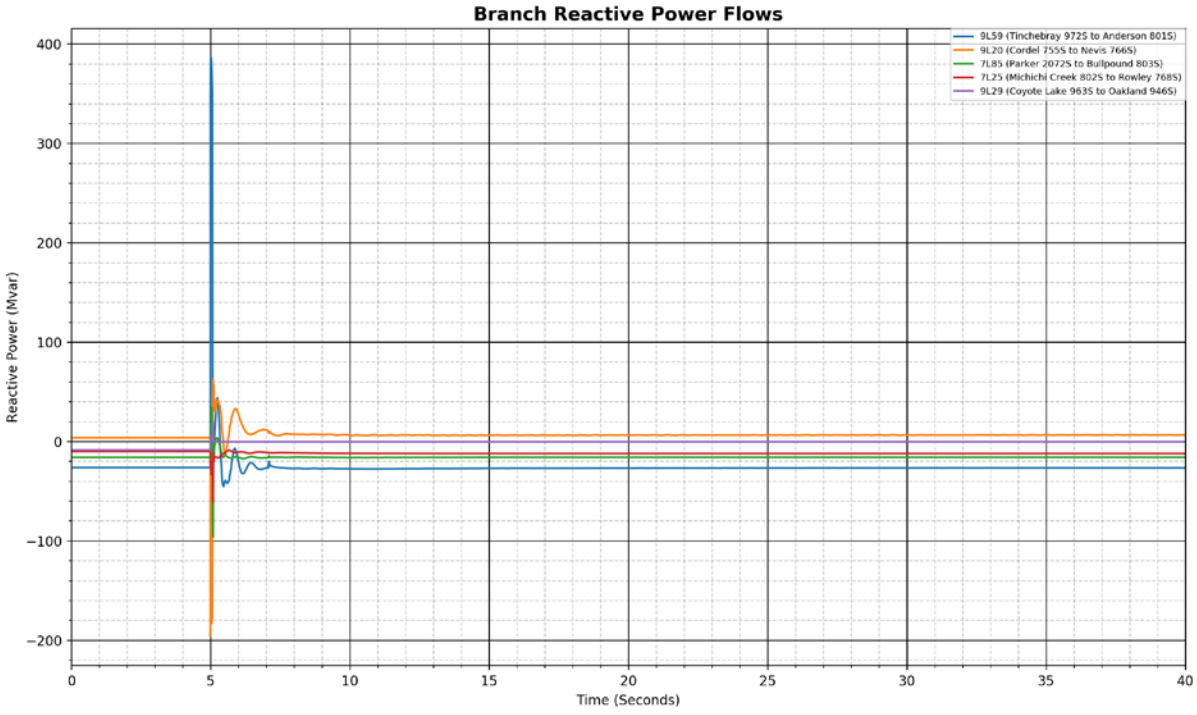
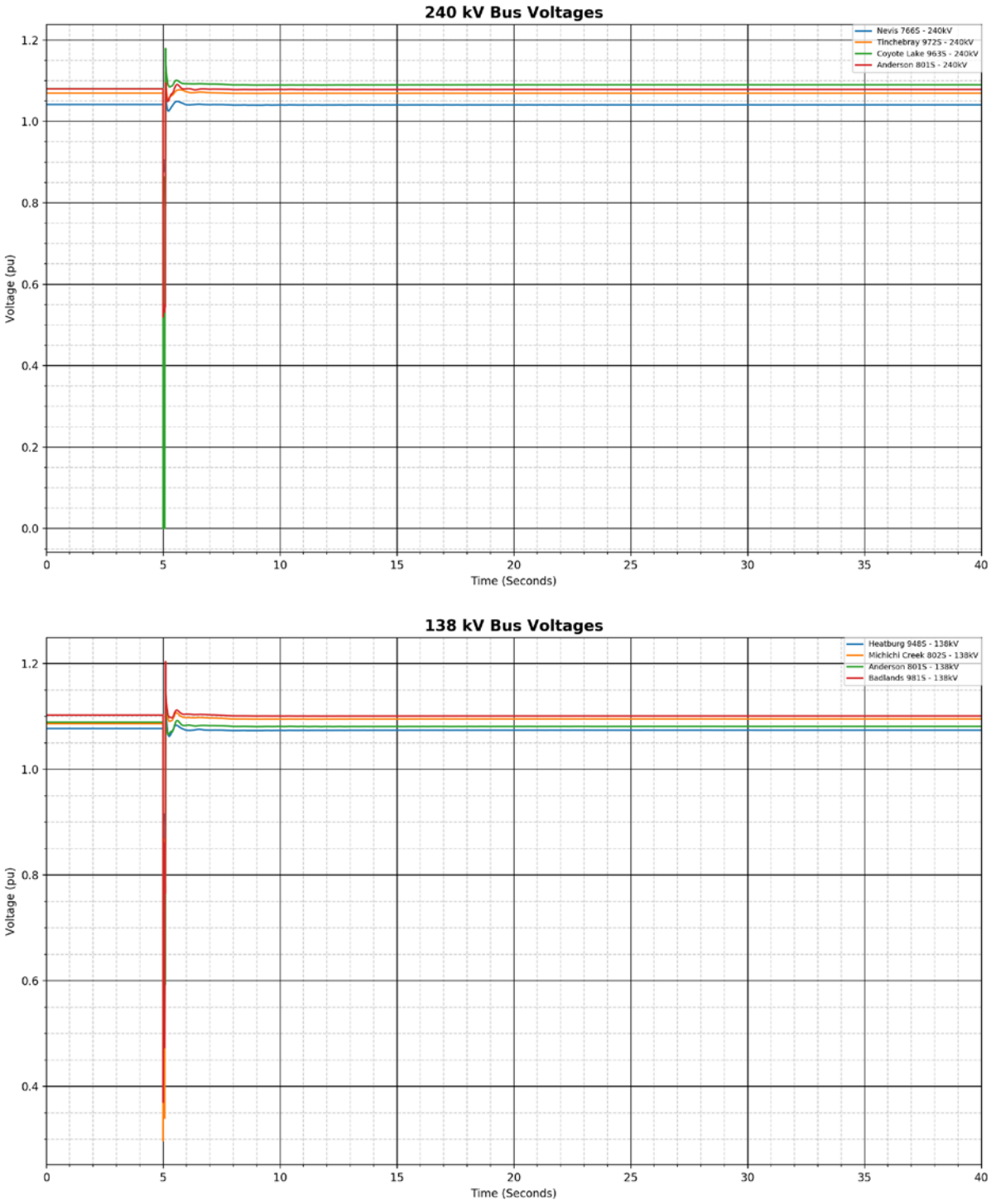
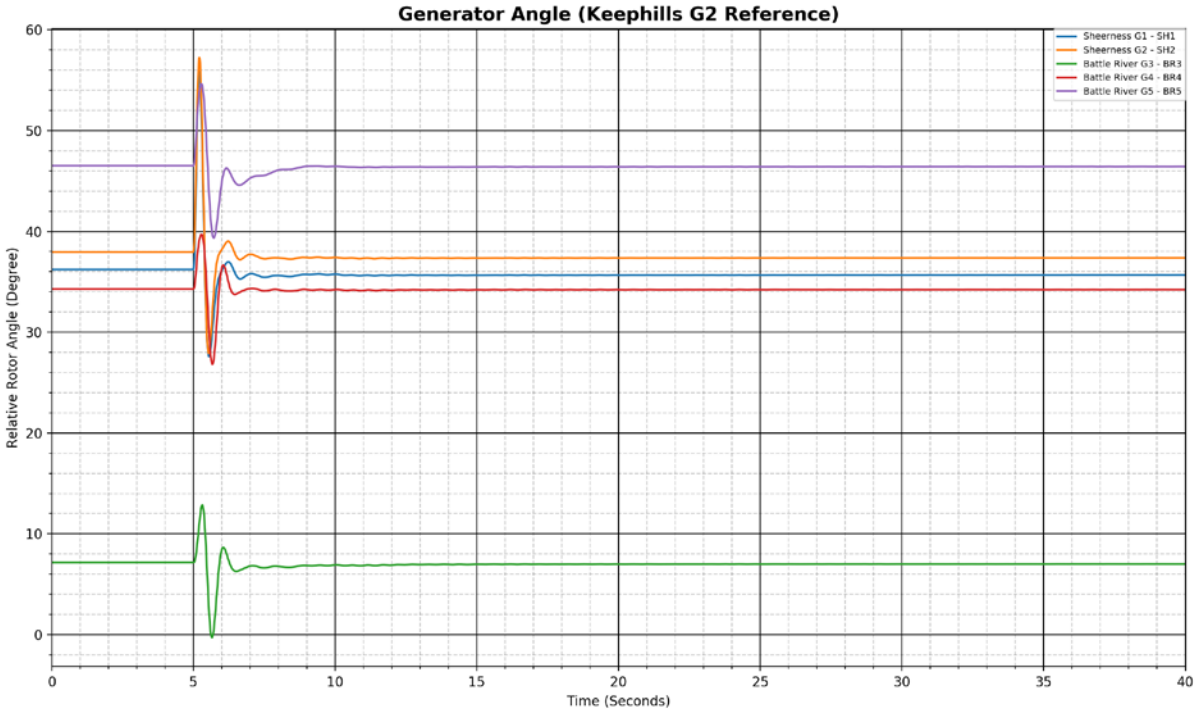
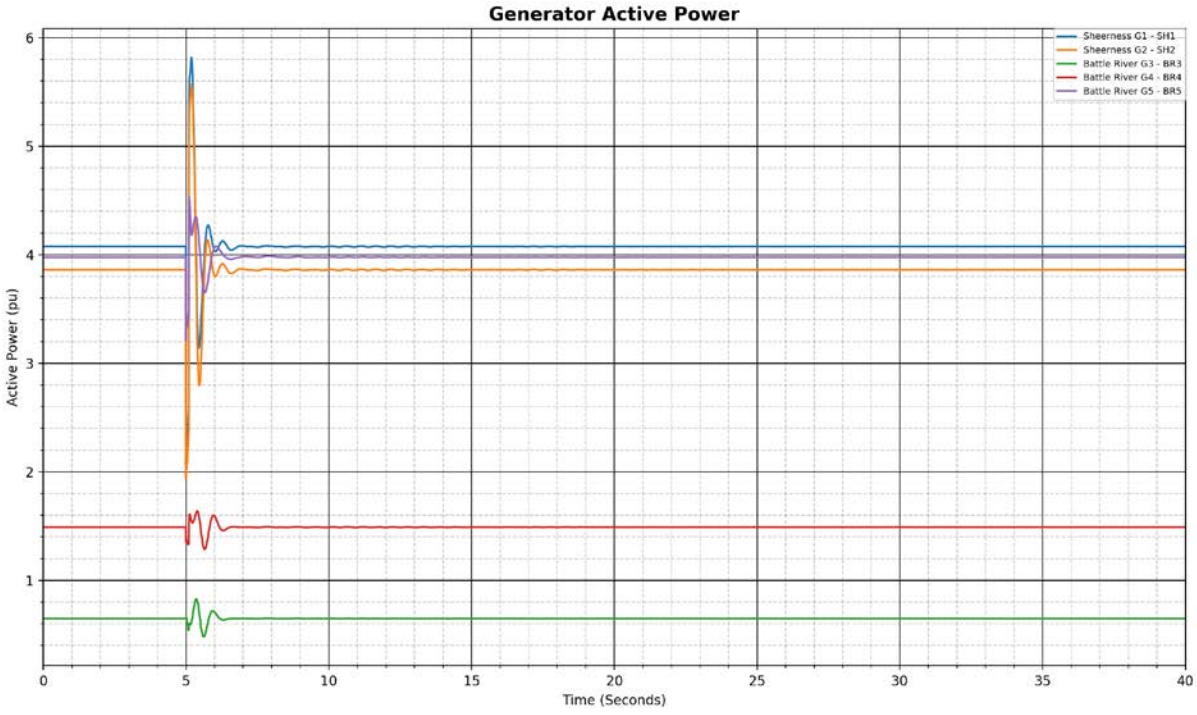
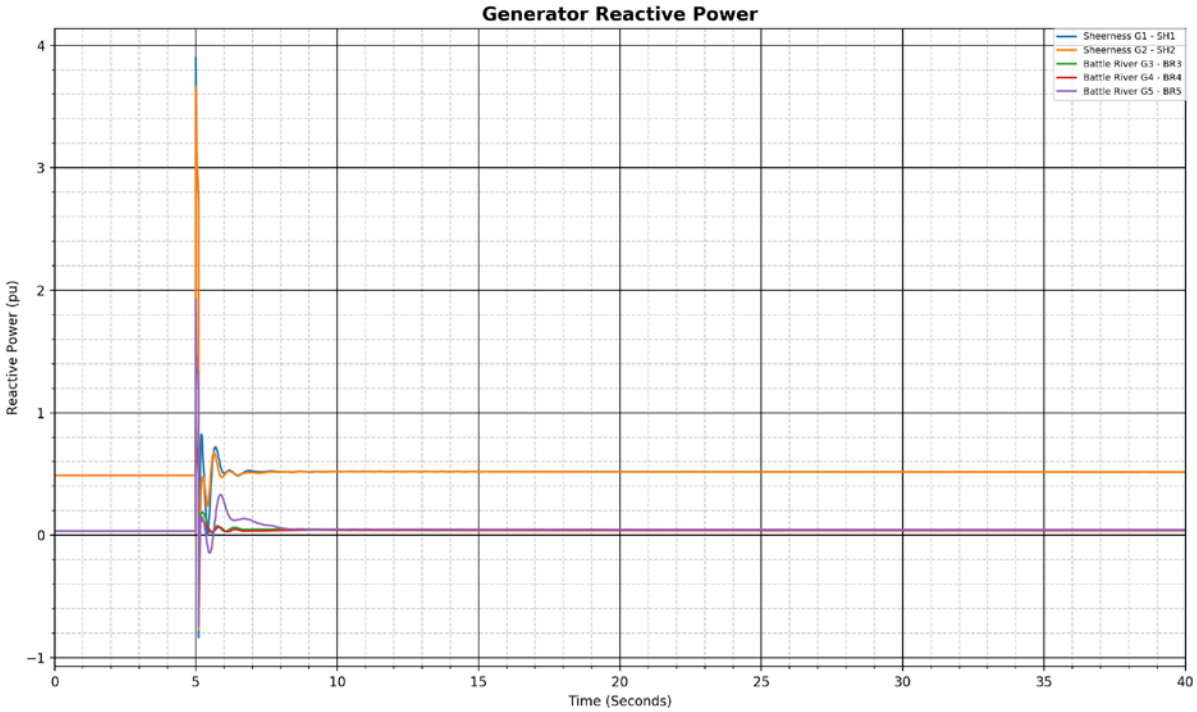

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

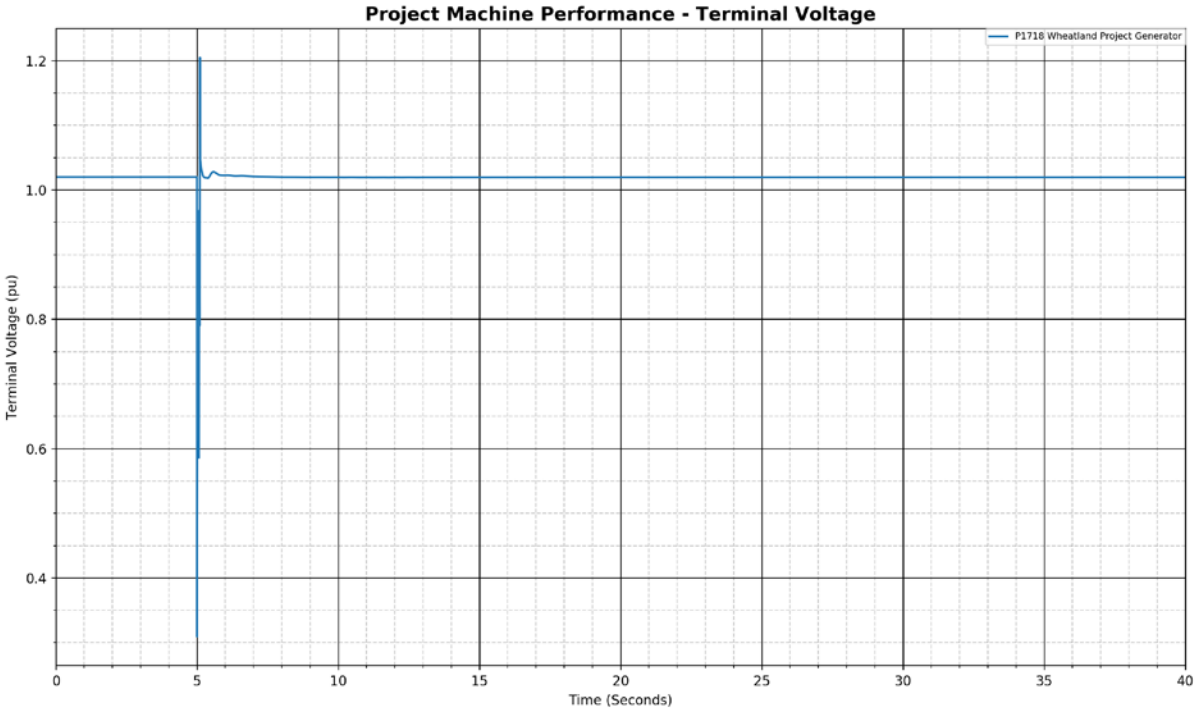
Figure A4-58: 9L29 (Oakland 946S - Coyote Lake 963S): 3-phase fault at Coyote Lake 963S

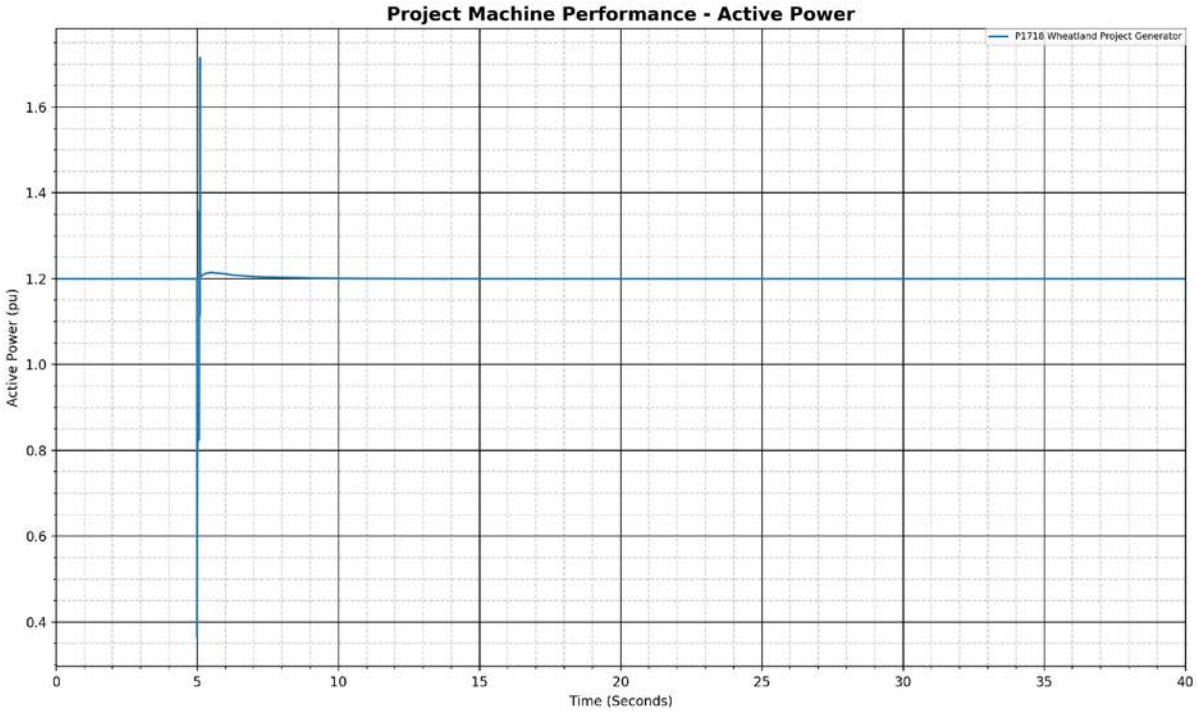


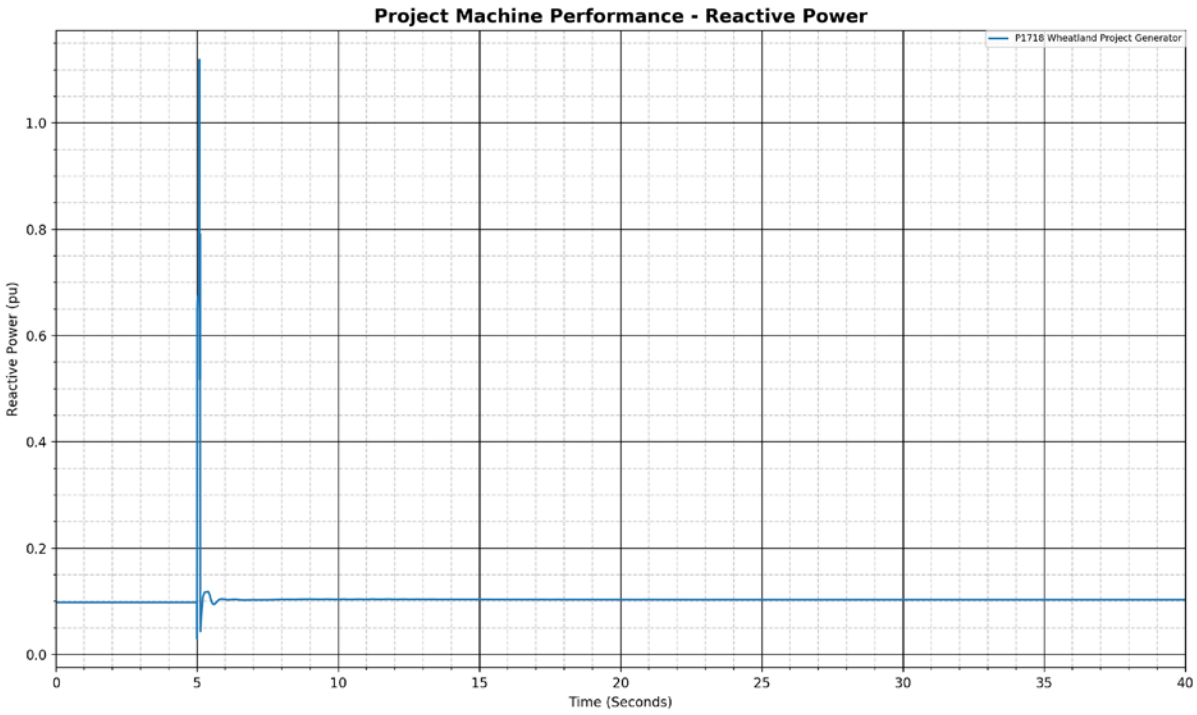

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

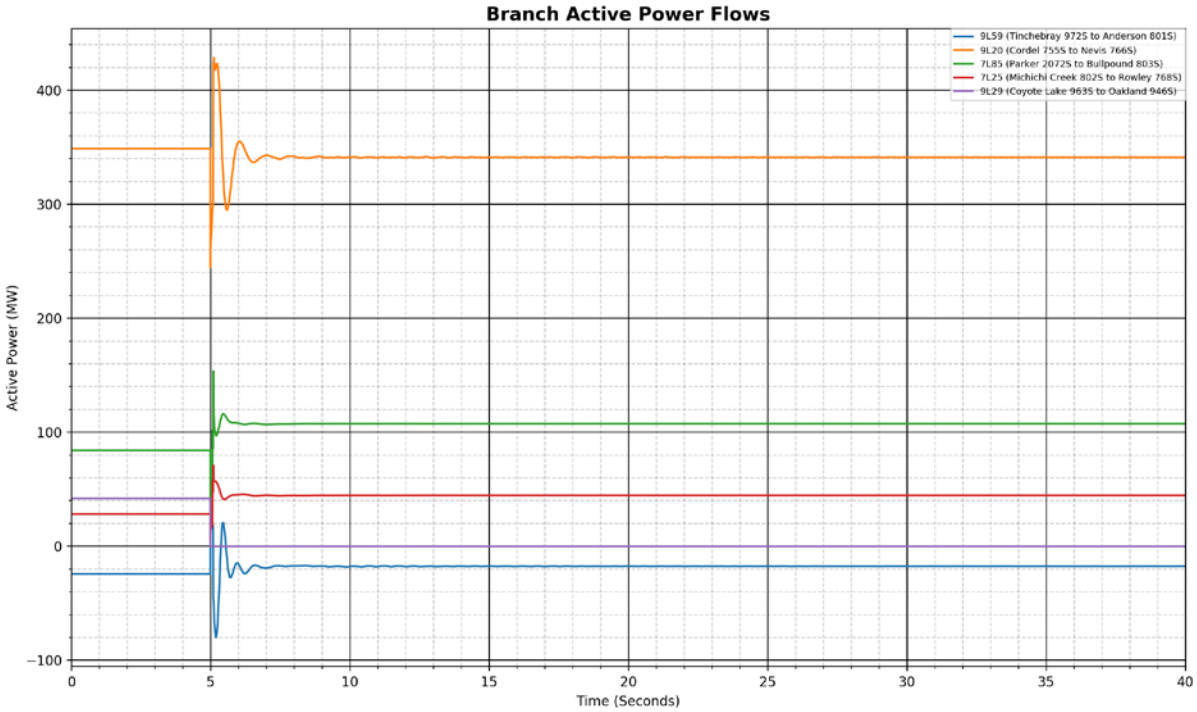

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

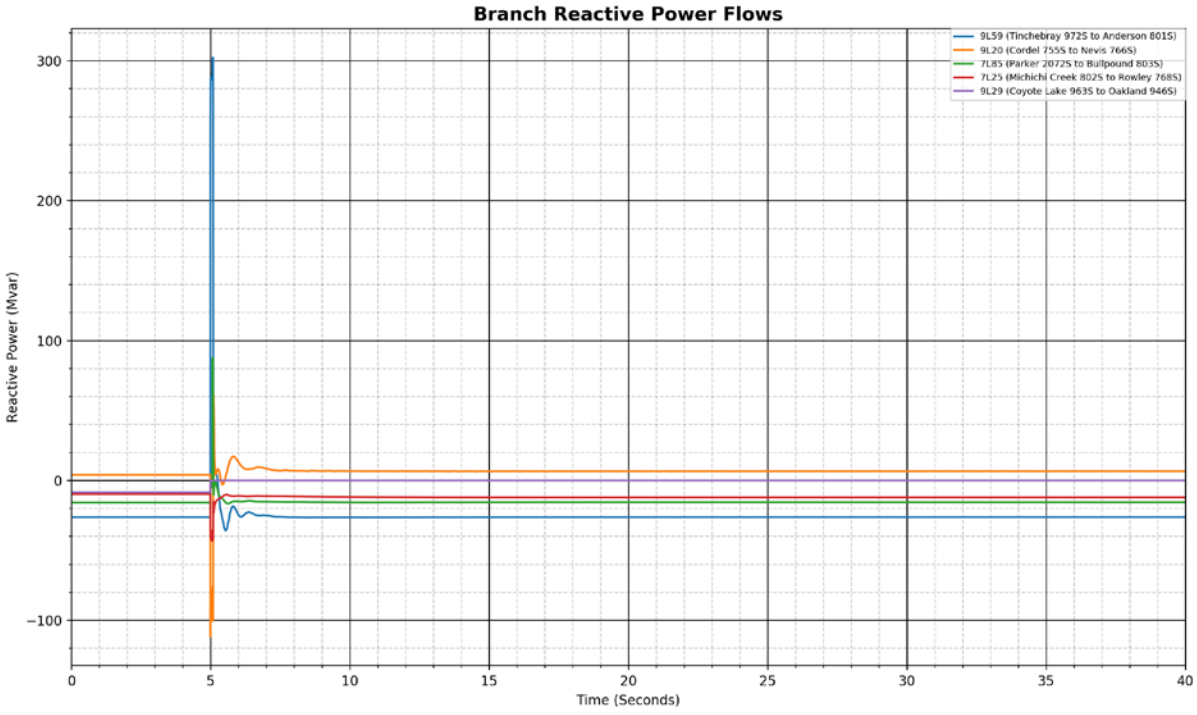
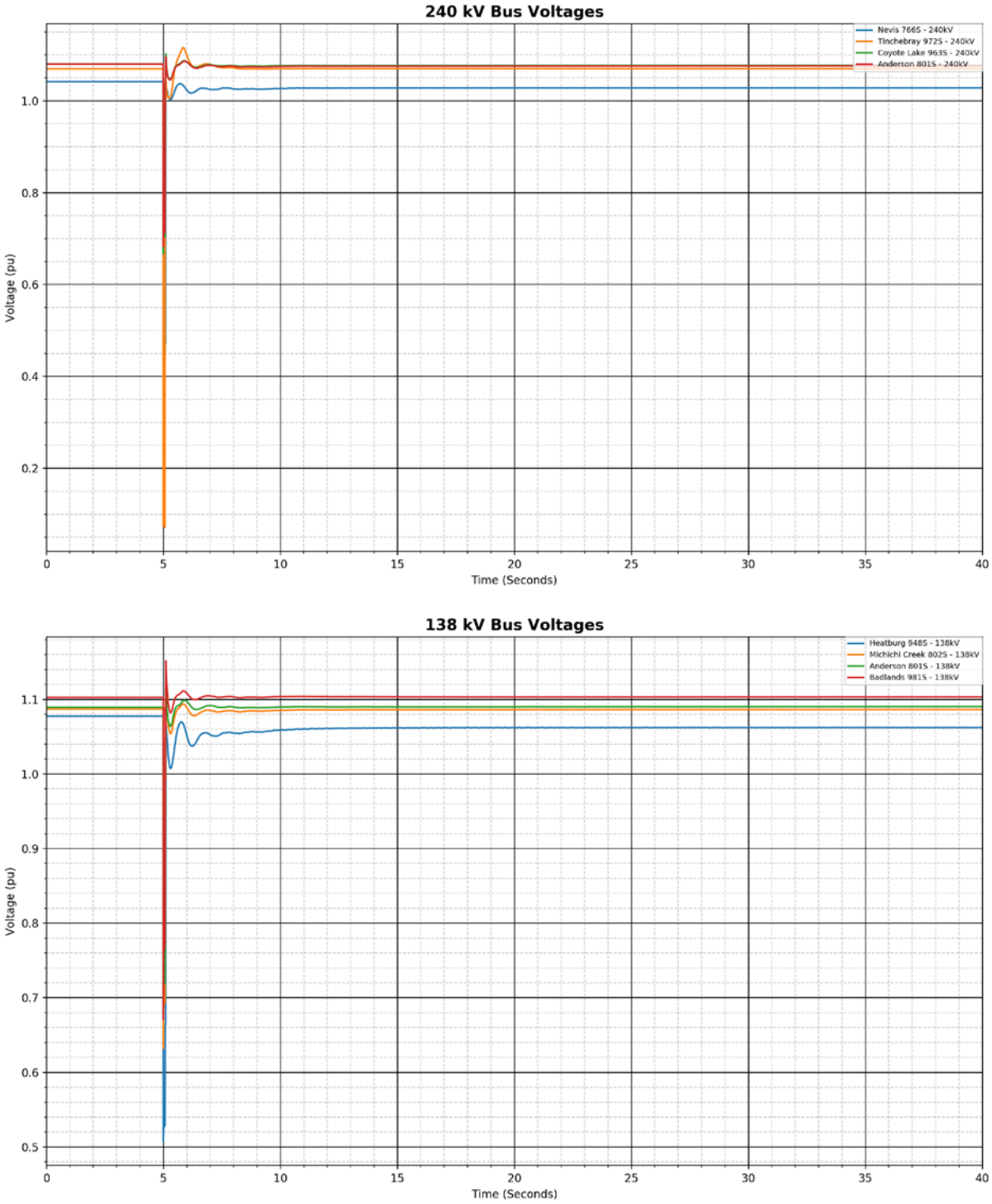
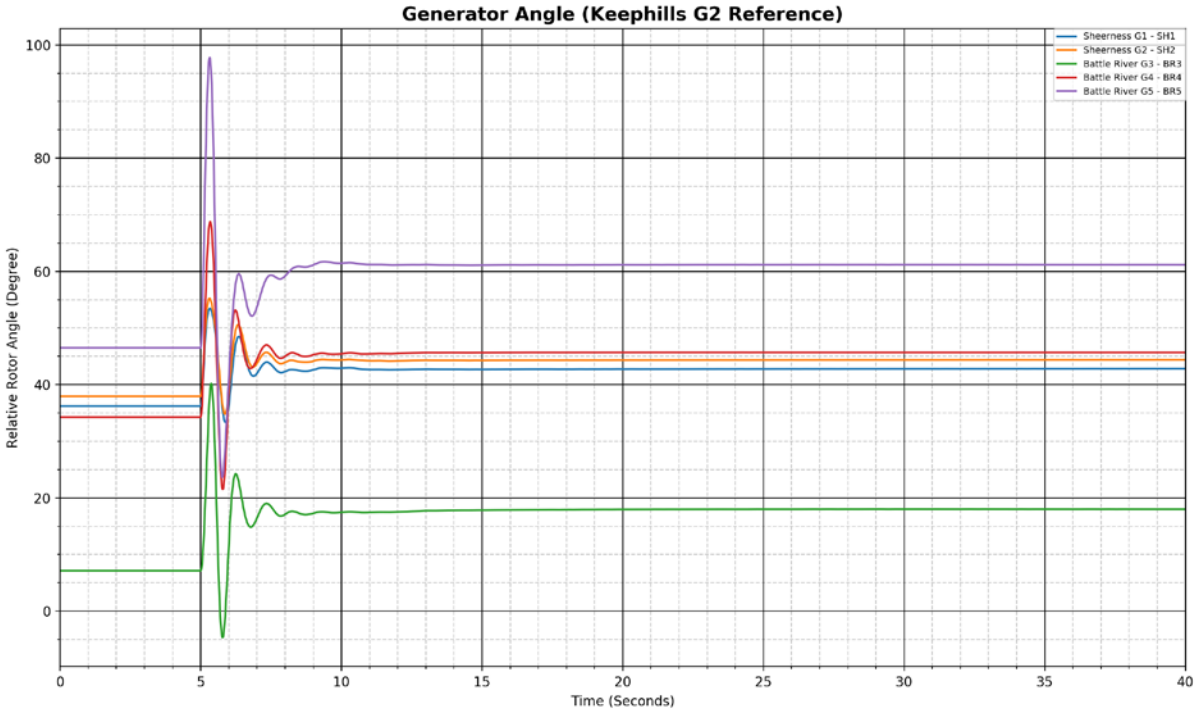
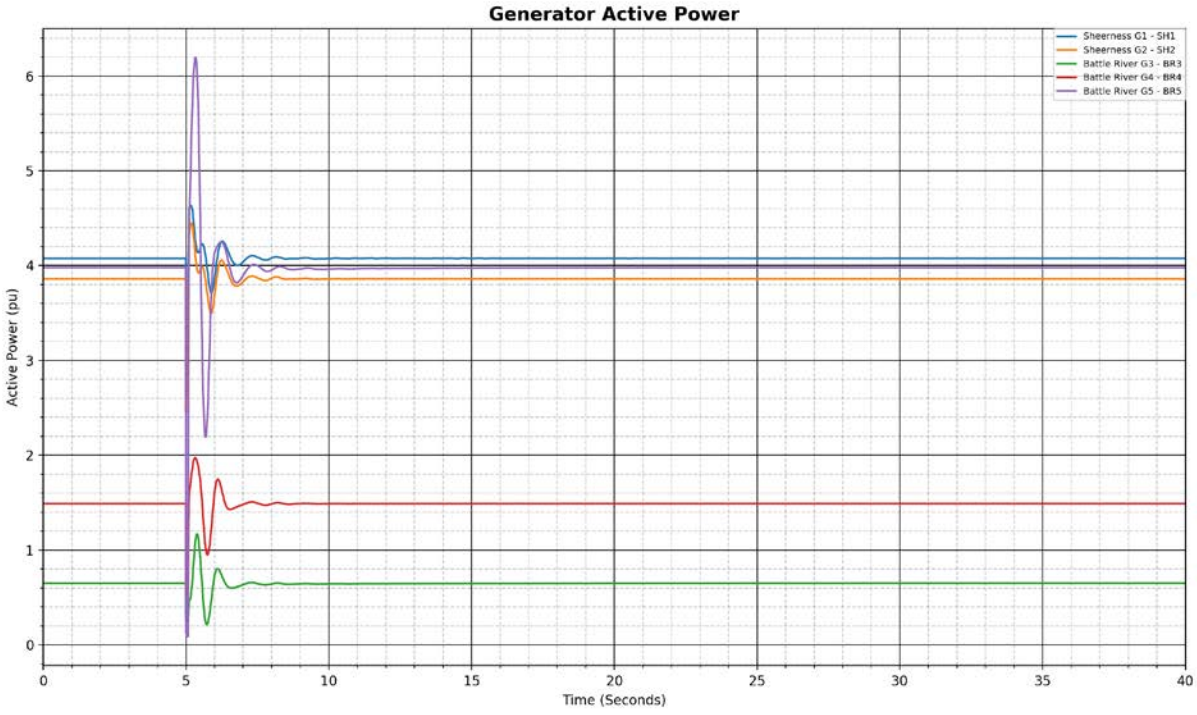
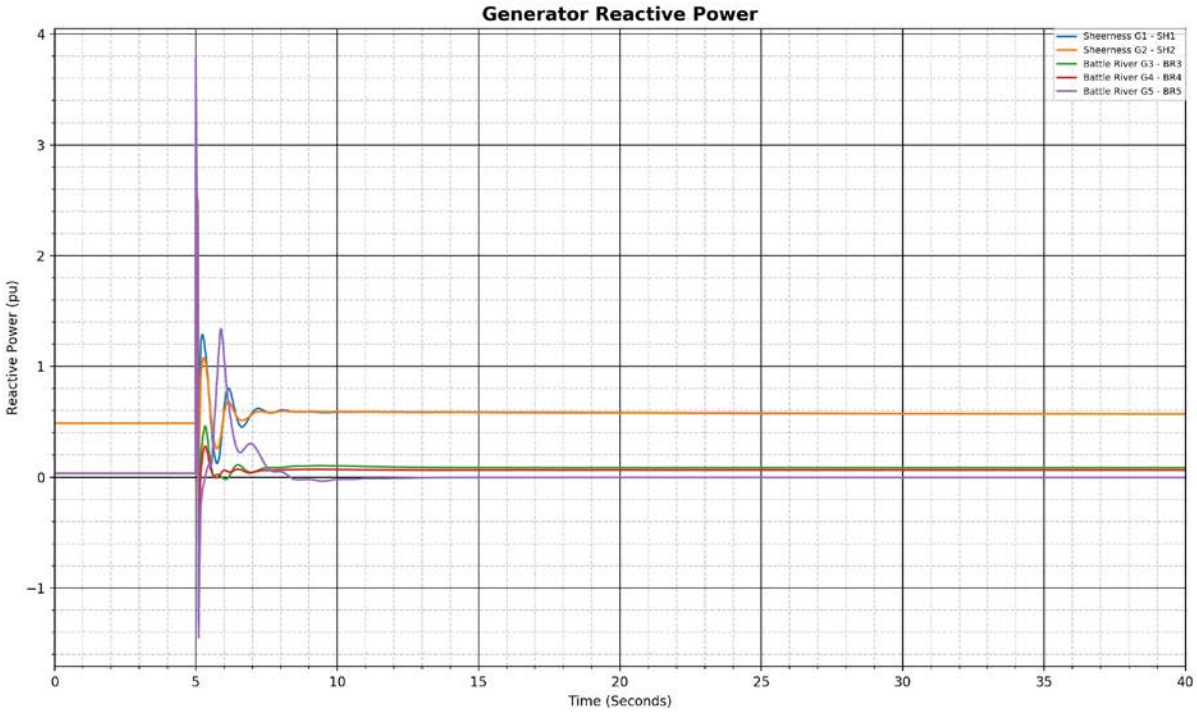

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

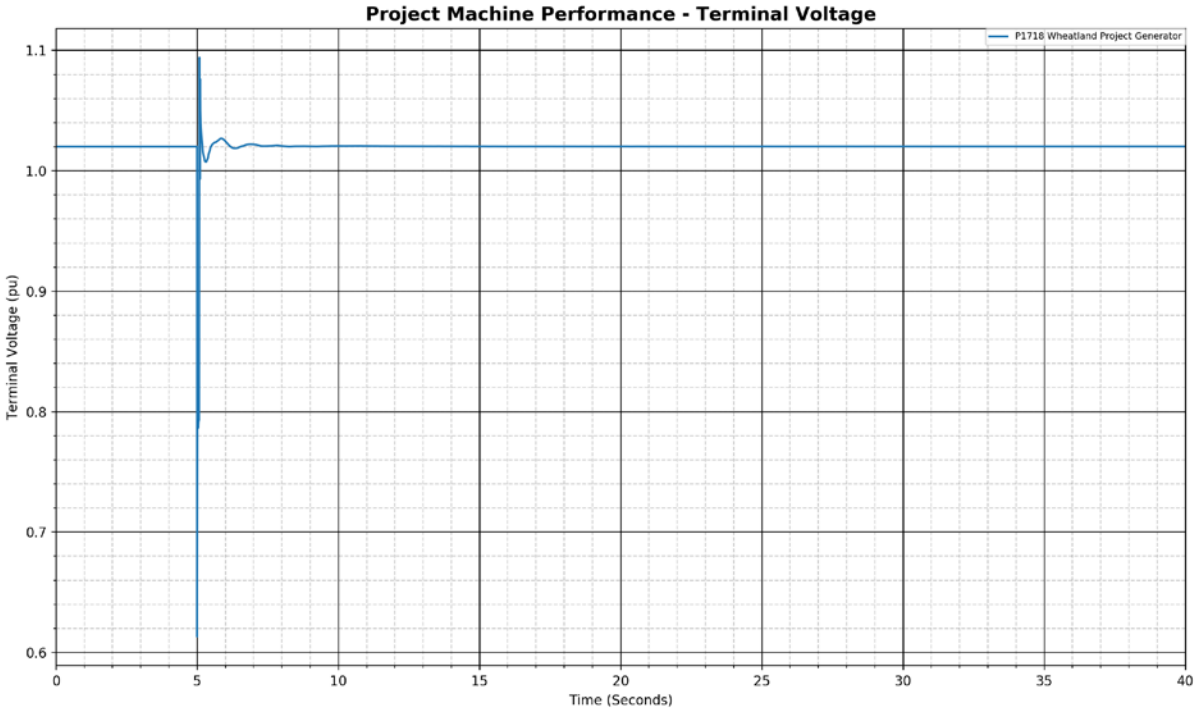
Figure A4-59: 9L20 (Cordel 755S - Nevis 766S): 3-phase fault at Cordel 755S

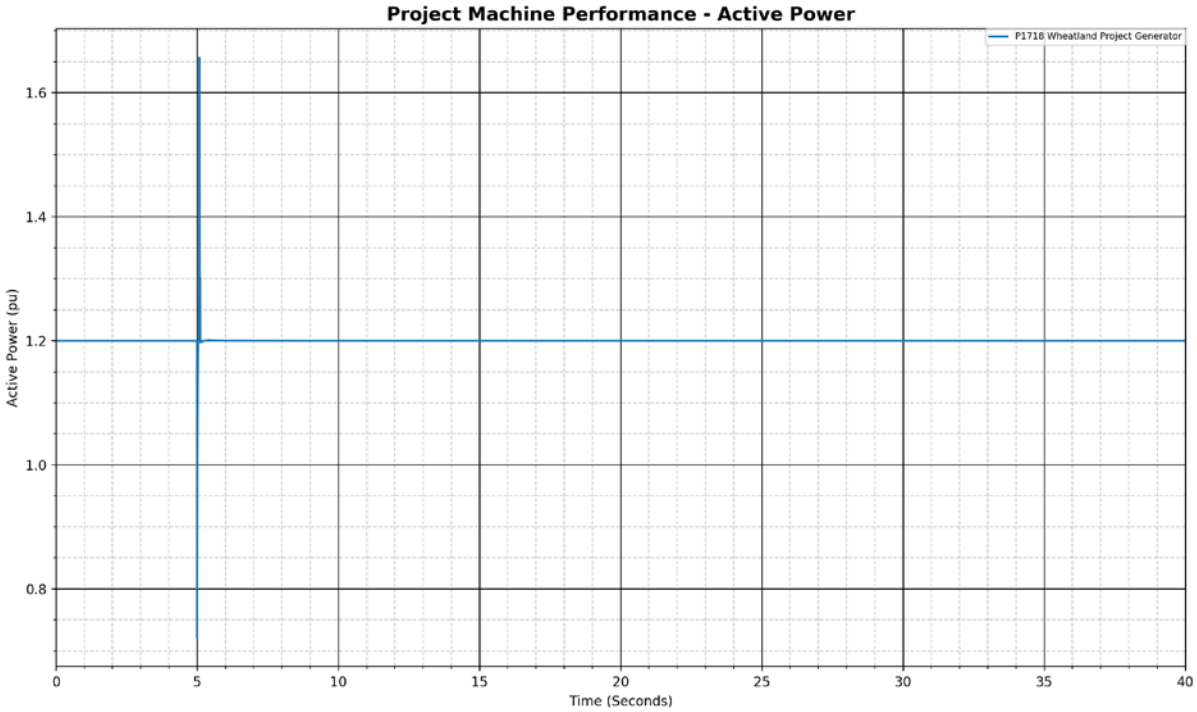


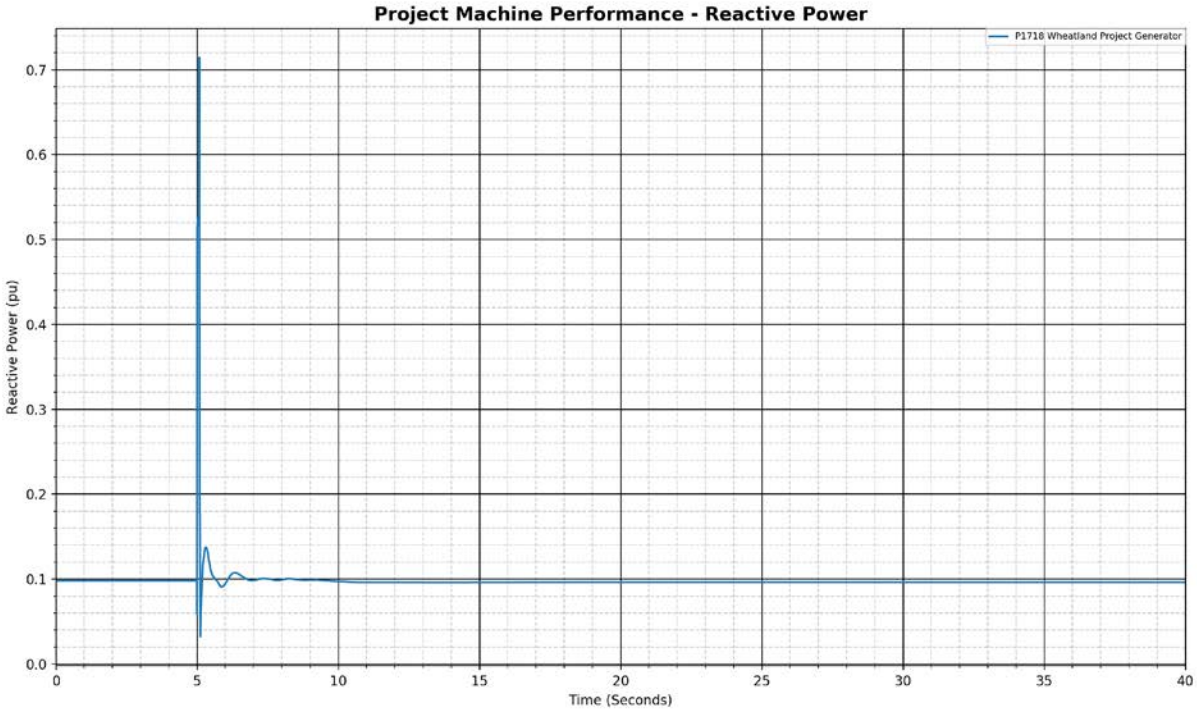

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

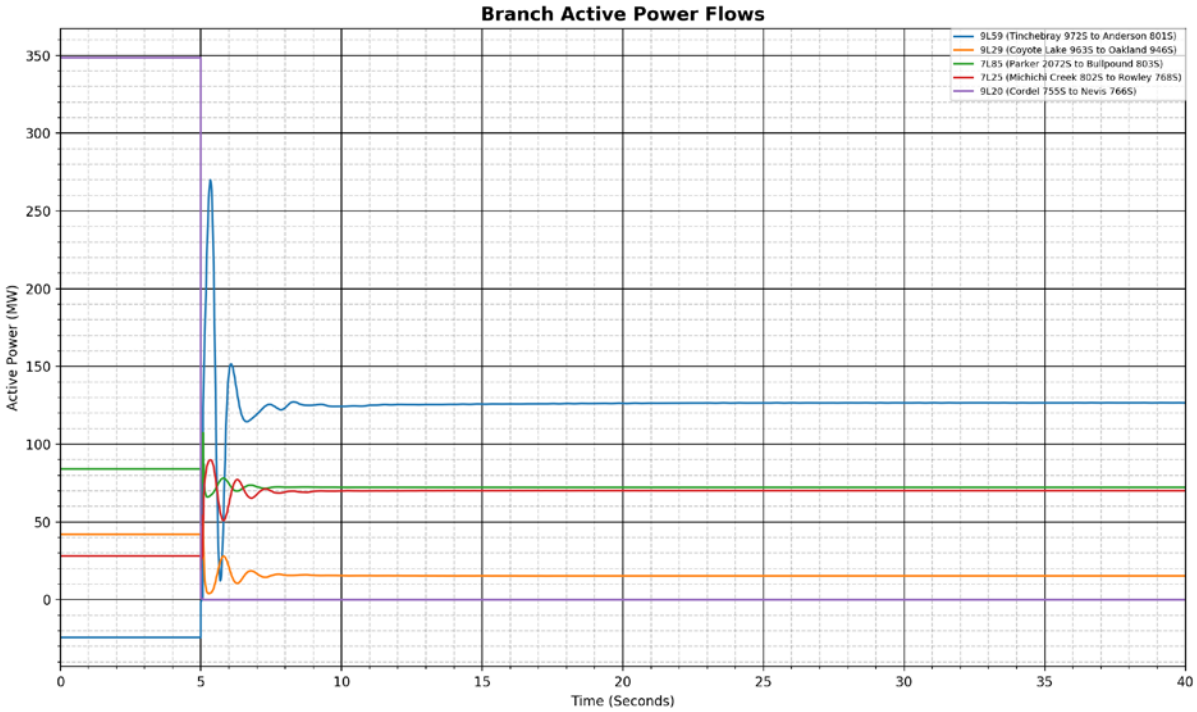

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.6
1.4
1.2
1.0
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Active Power (MW)
Time (Seconds)

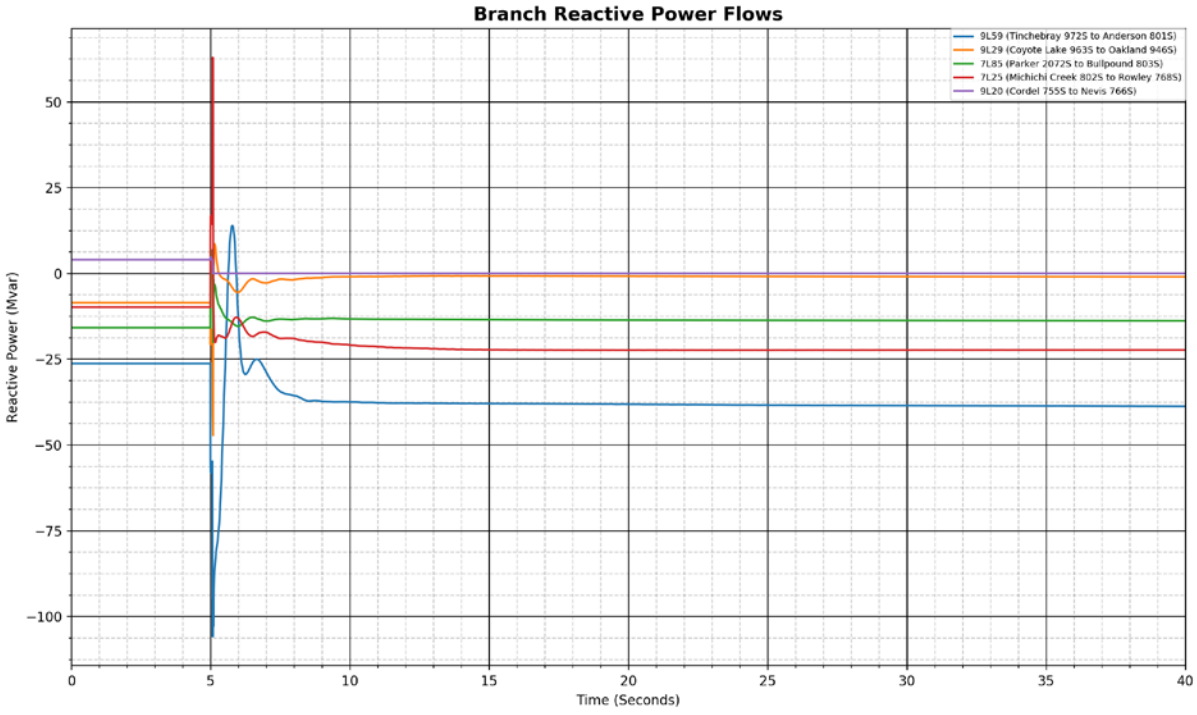
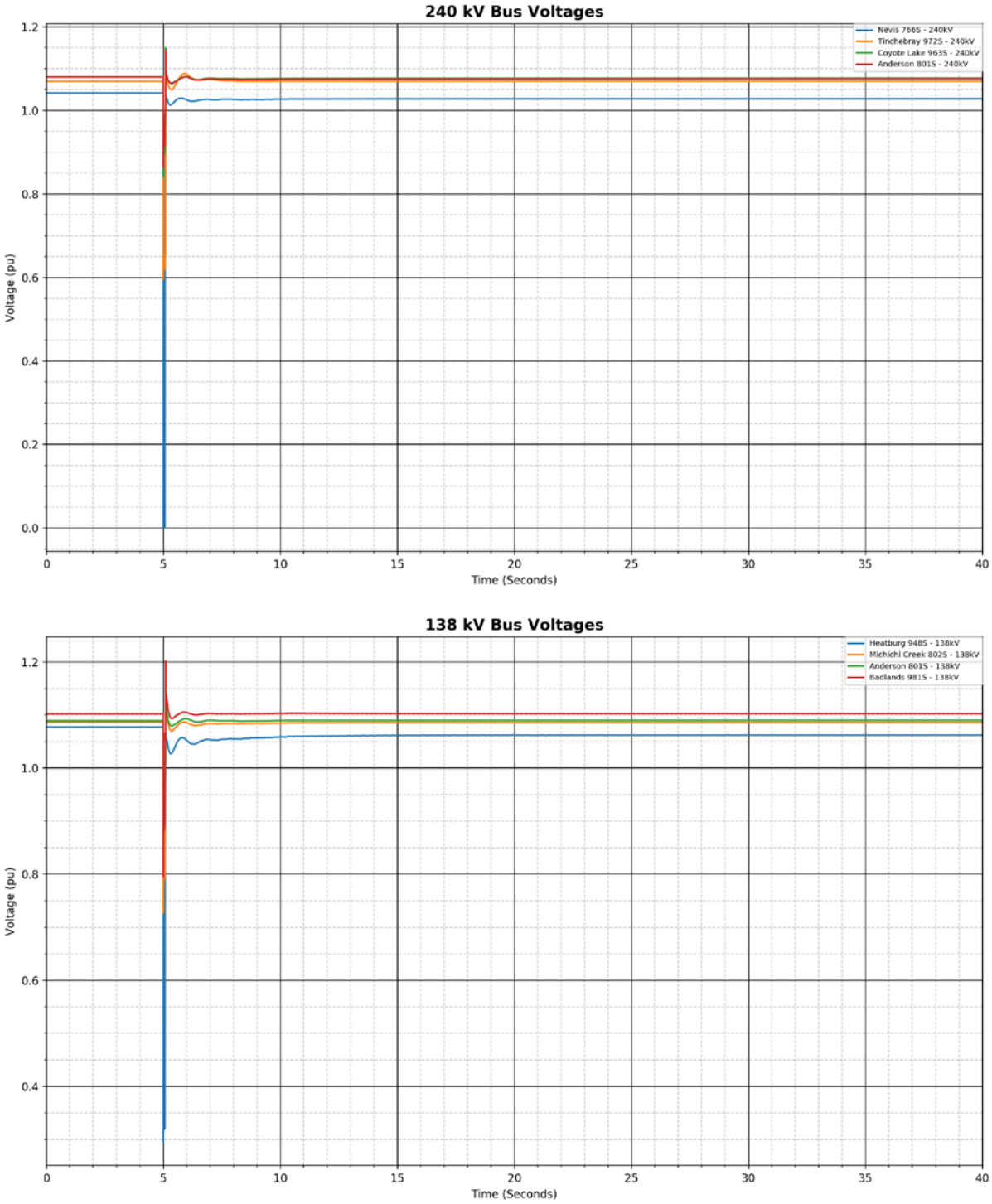
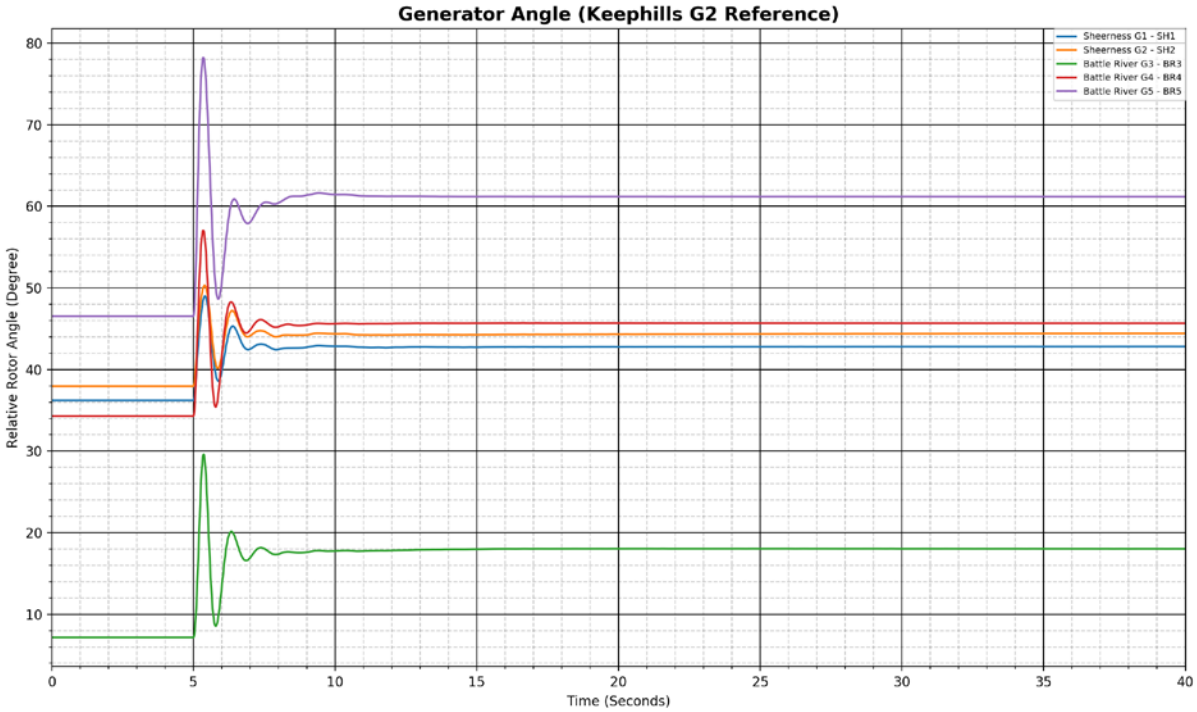
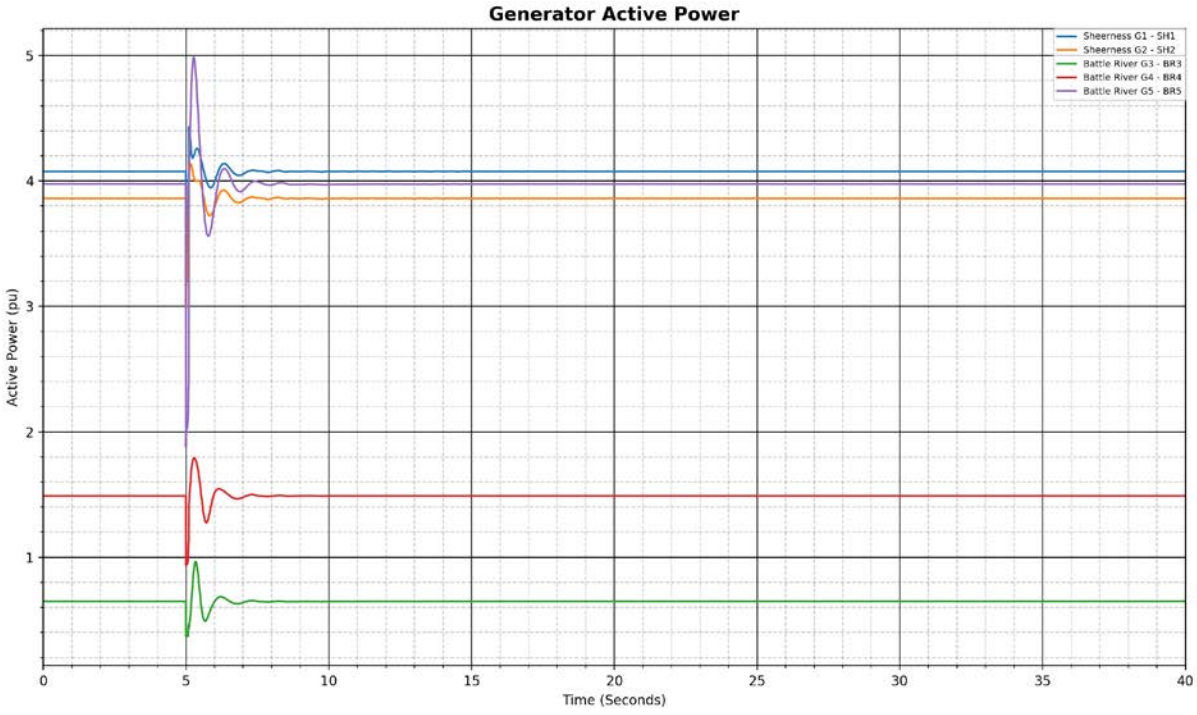
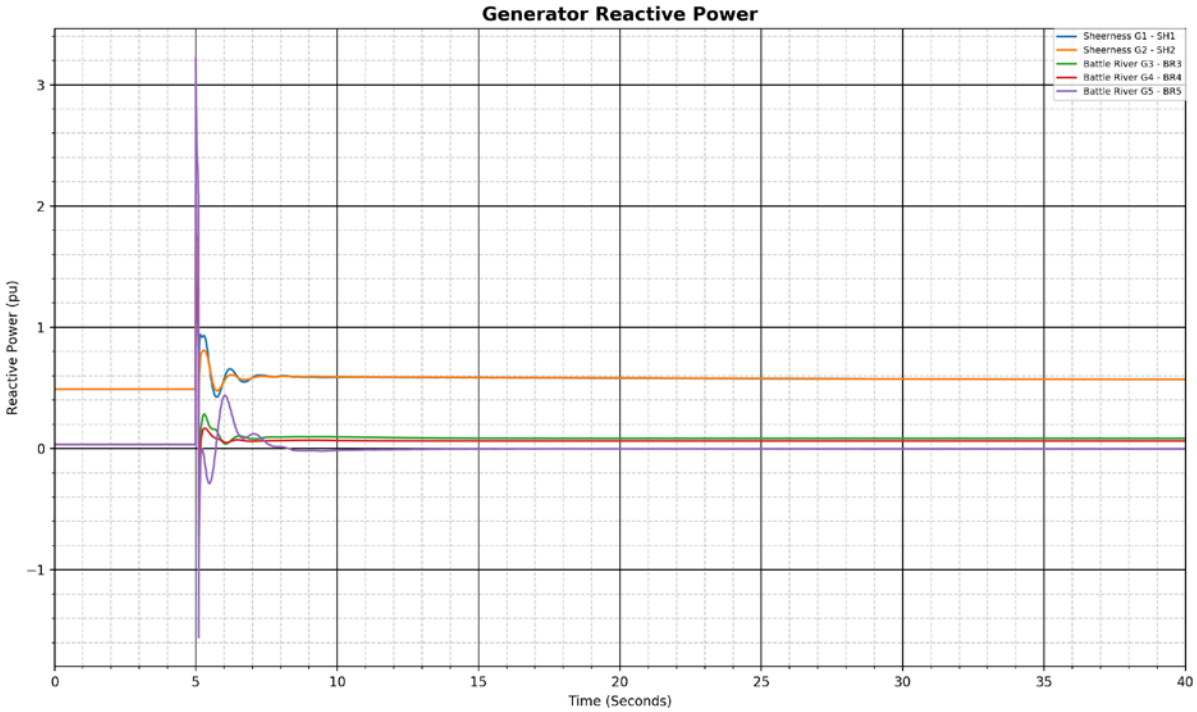

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

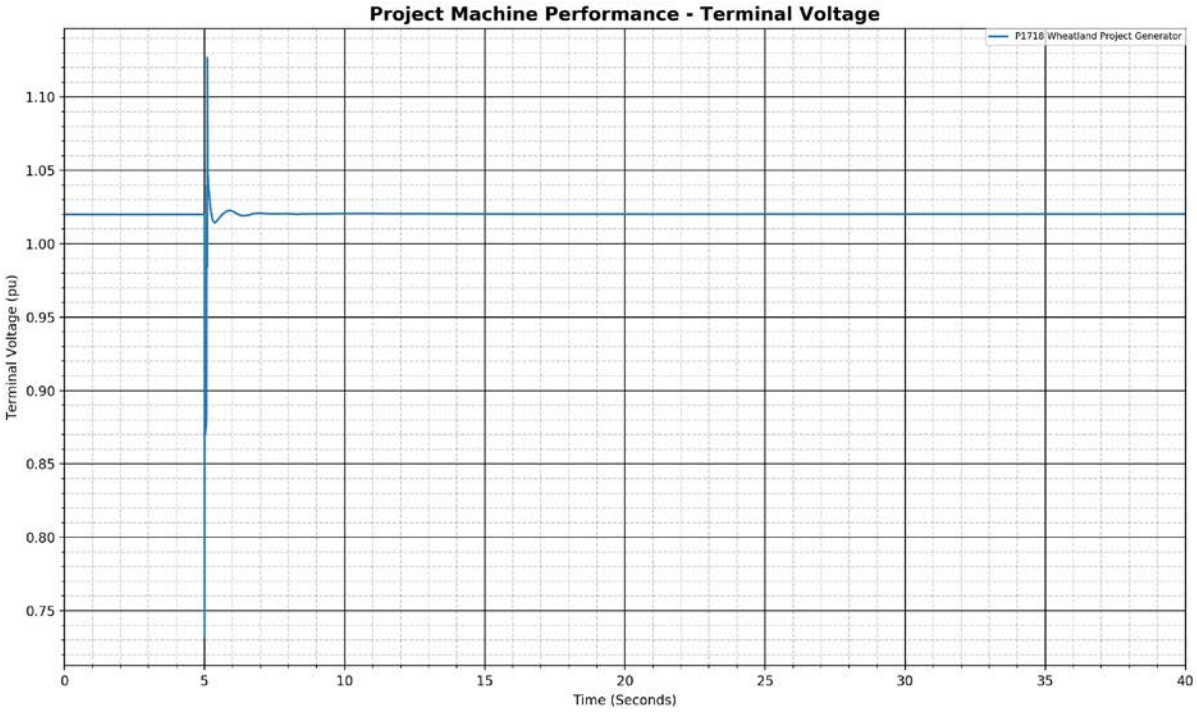
Figure A4-60: 9L20 (Cordel 755S - Nevis 766S): 3-phase fault at Nevis 766S

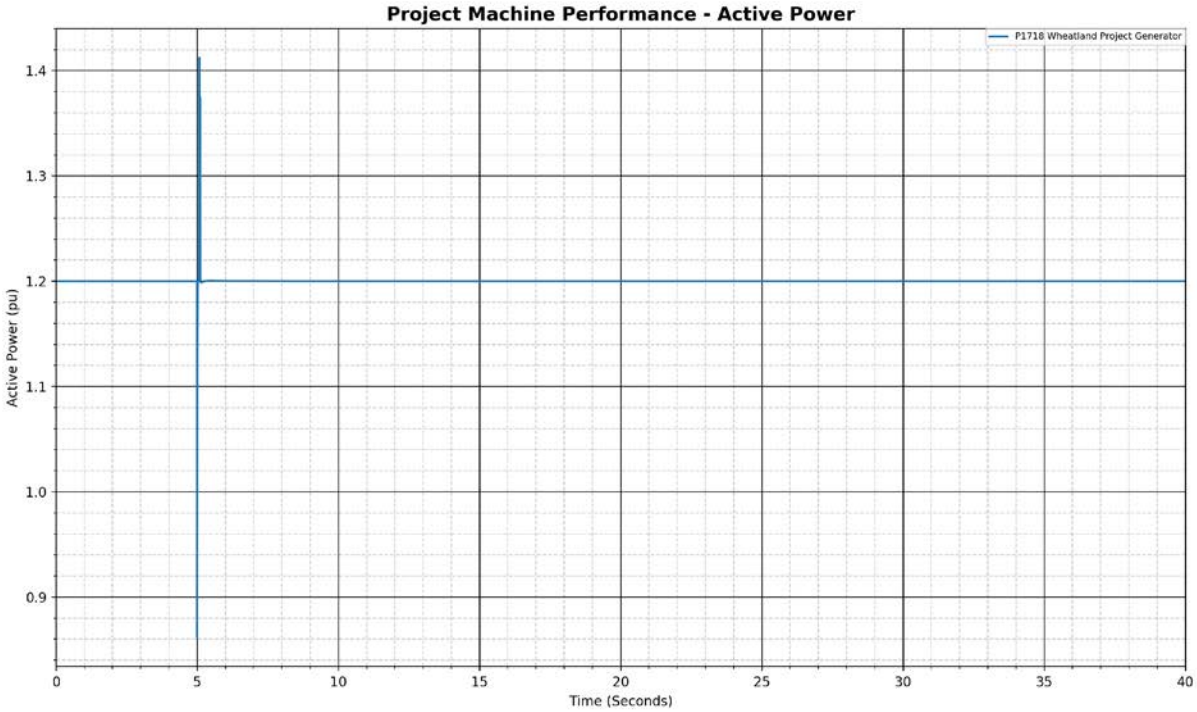


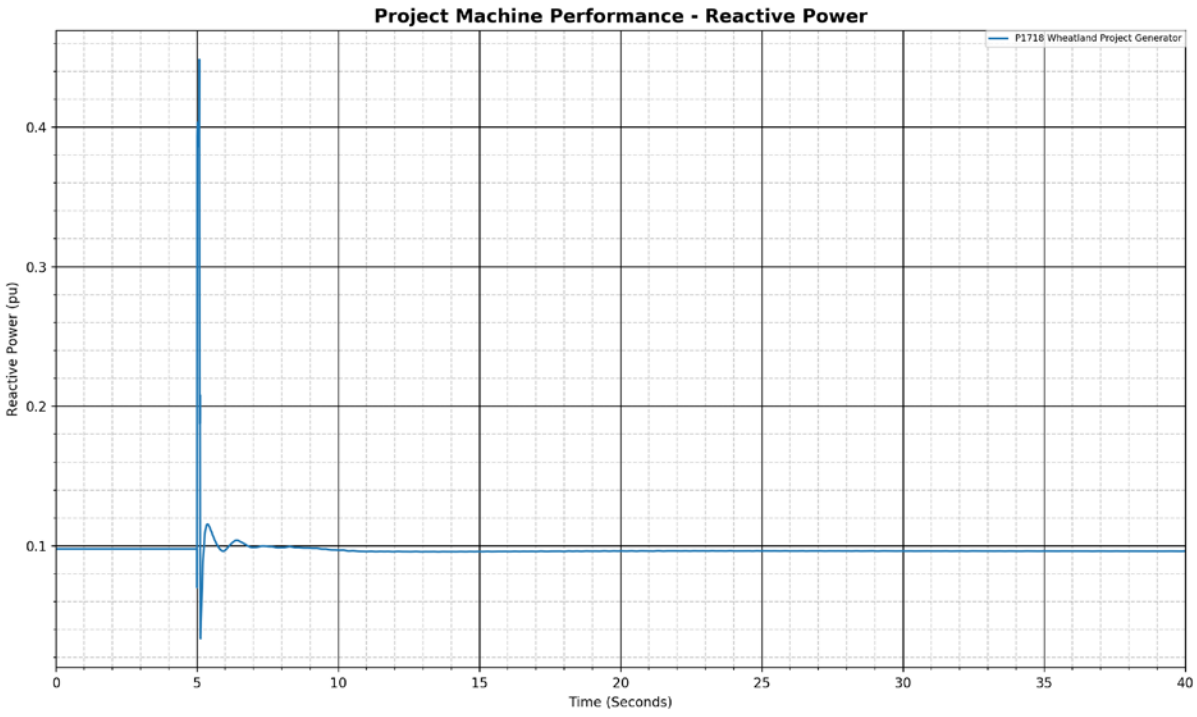

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

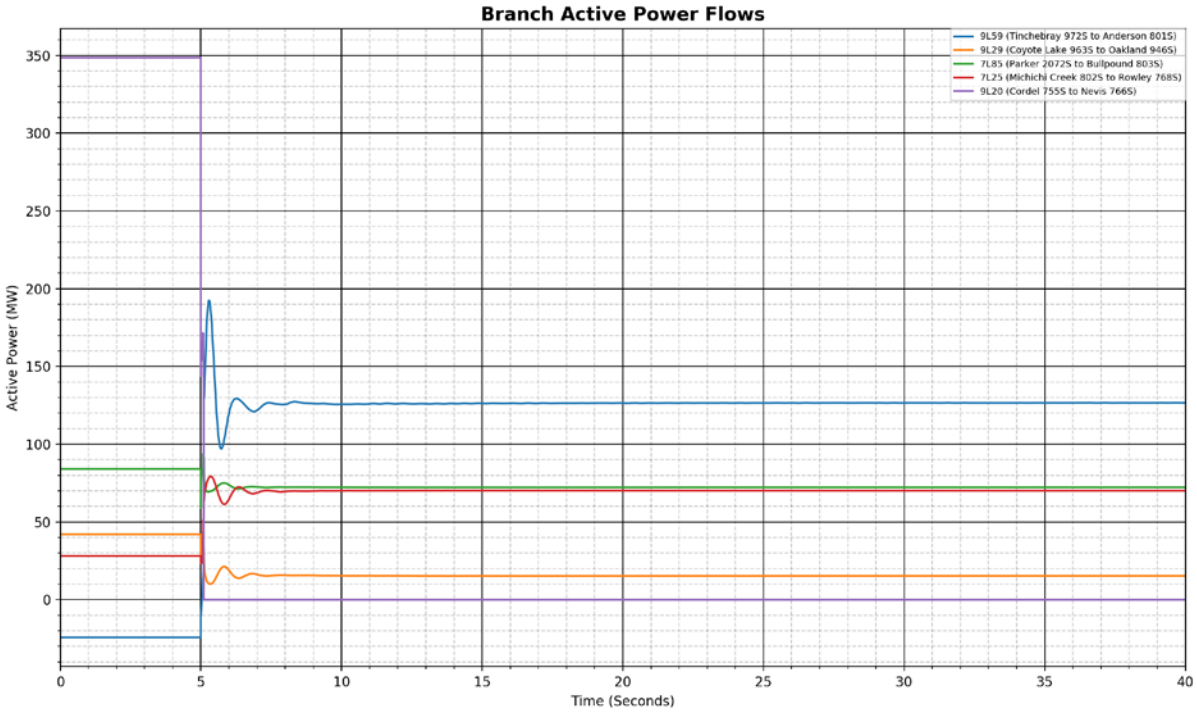

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Active Power (MW)
Time (Seconds)

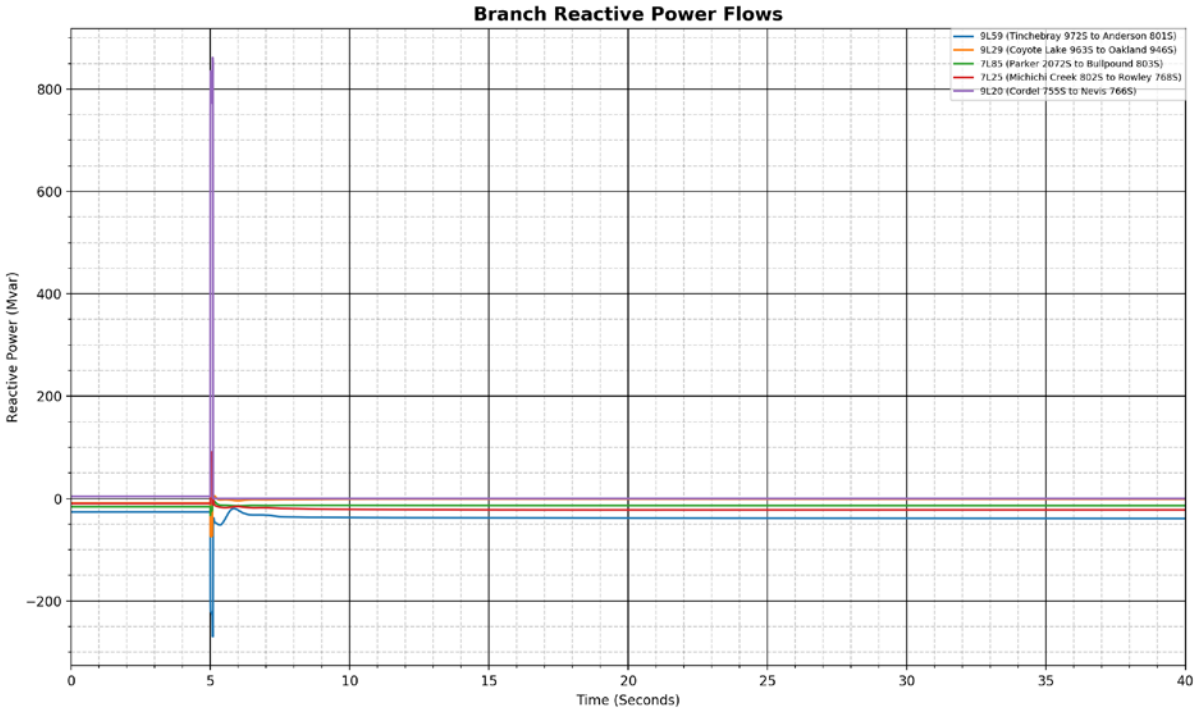
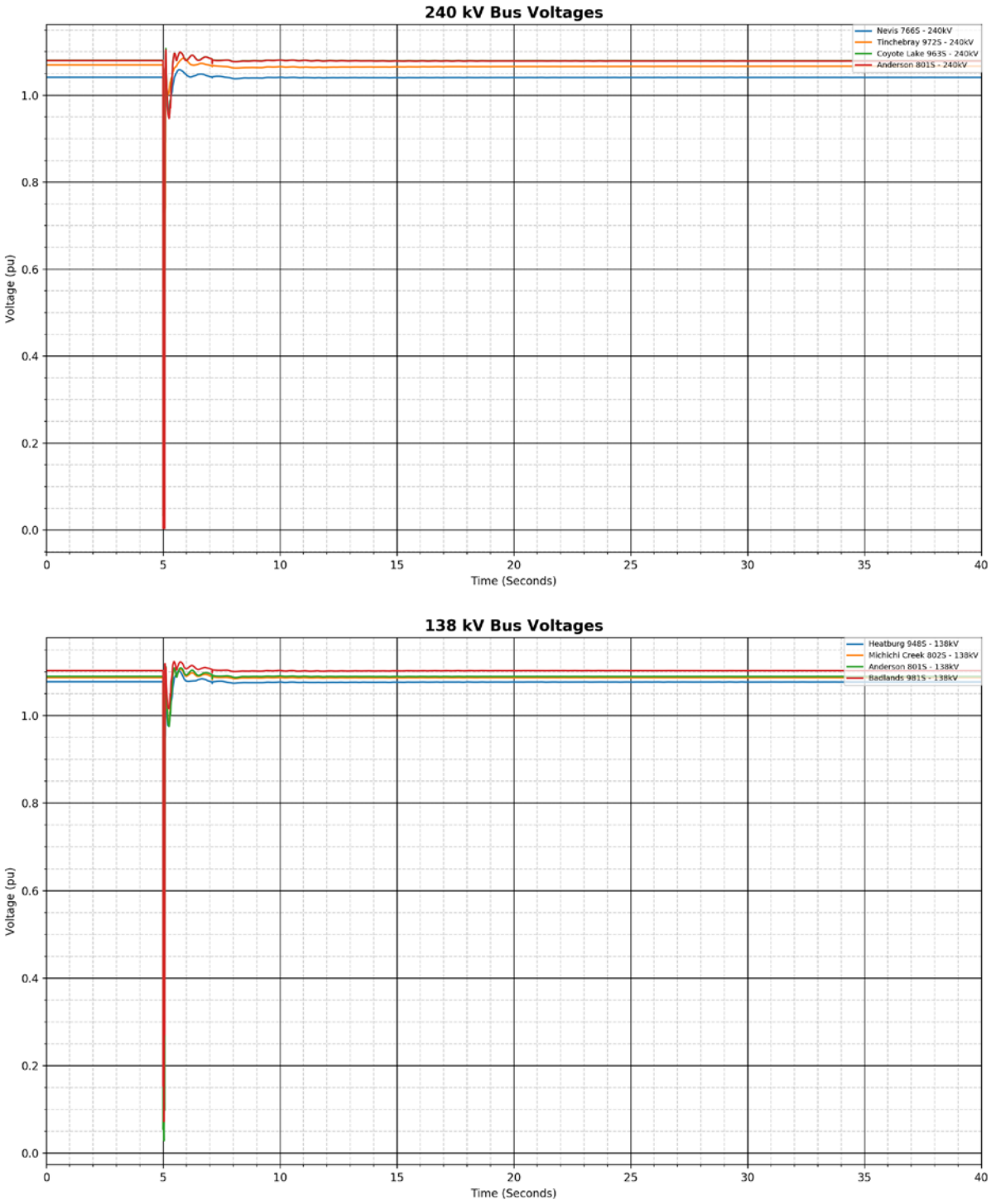
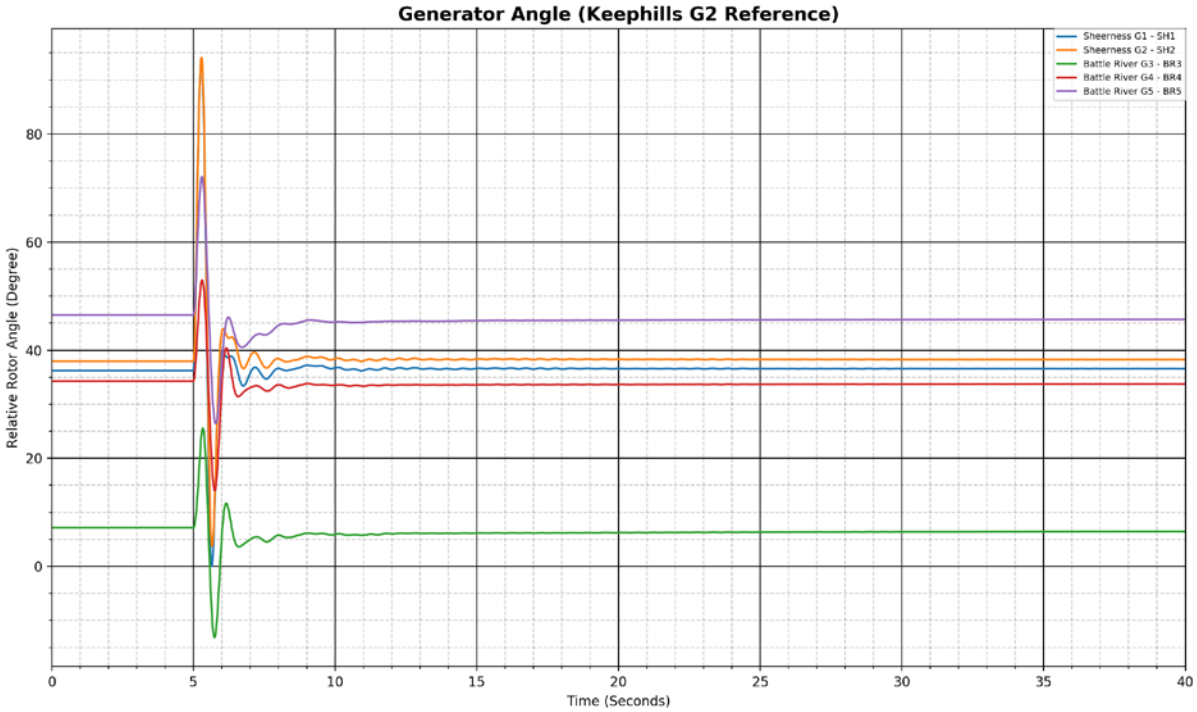
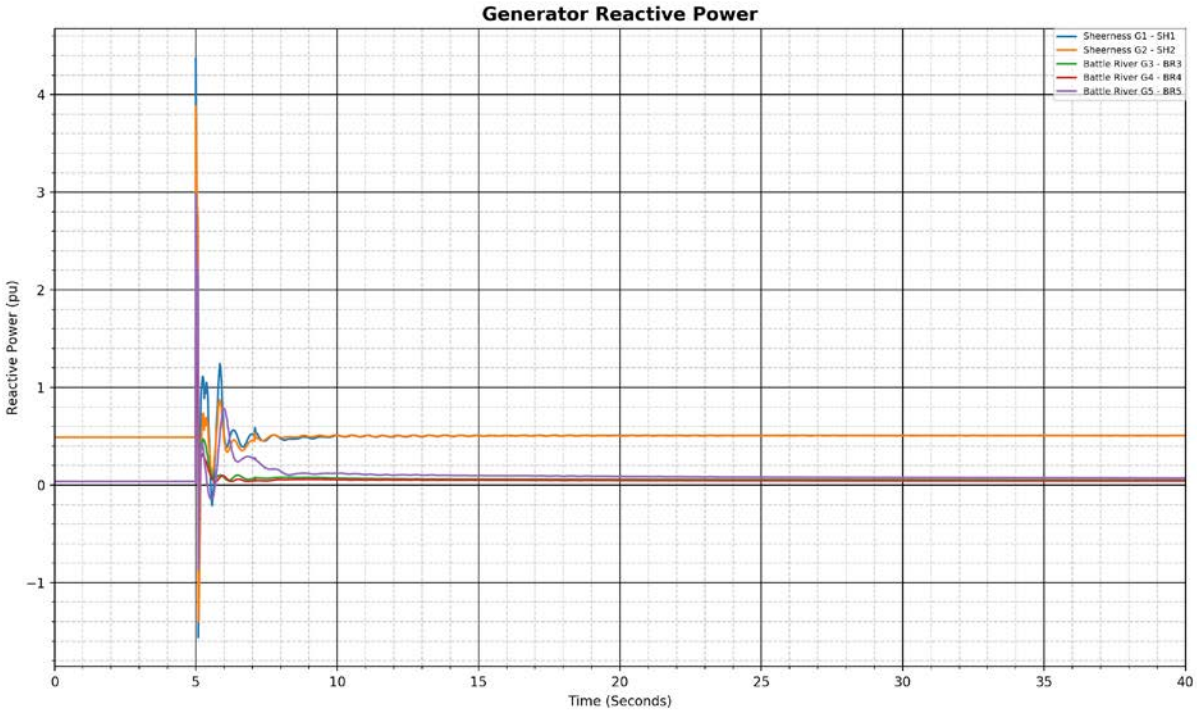

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L20 (Cordel 755S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

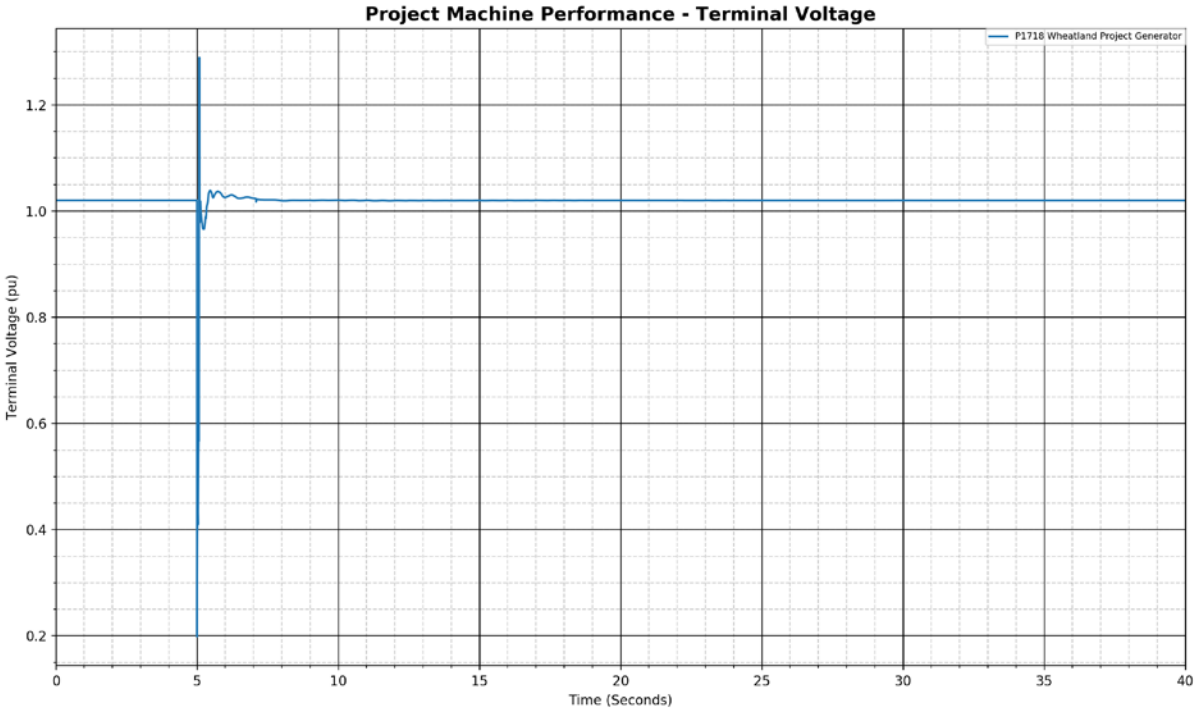
Figure A4-61: 9L59 (Anderson 801S - Tinchebray 972S): 3-phase fault at Anderson 801S

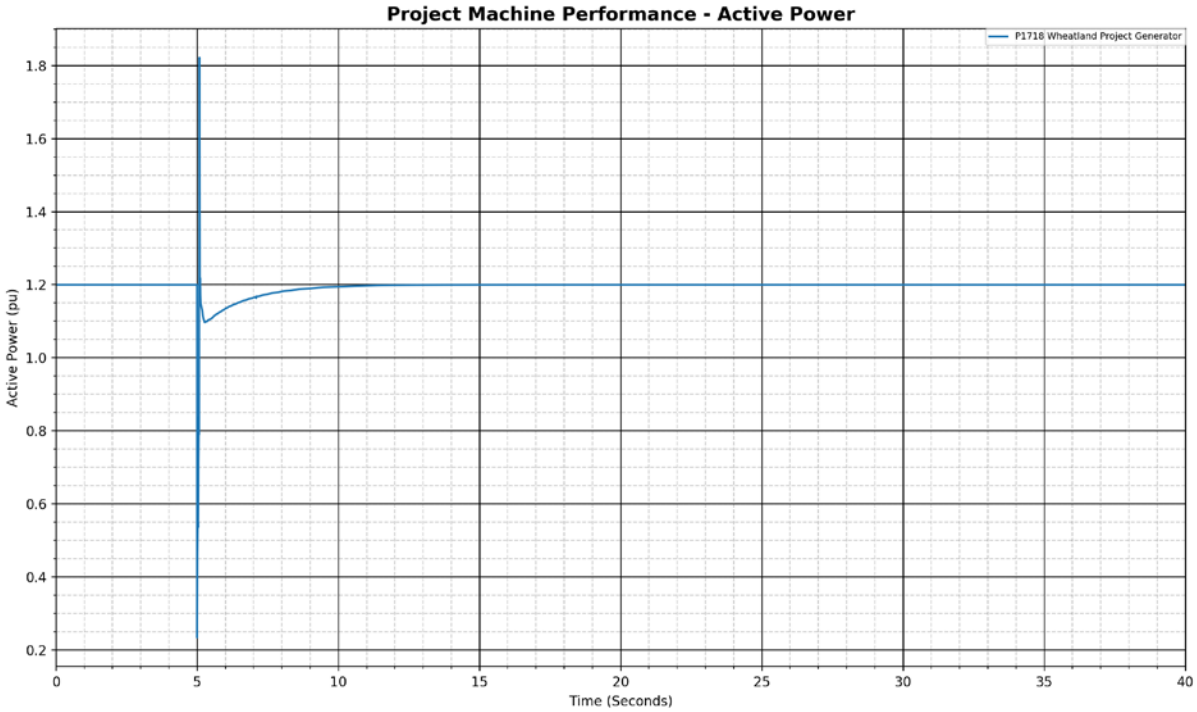


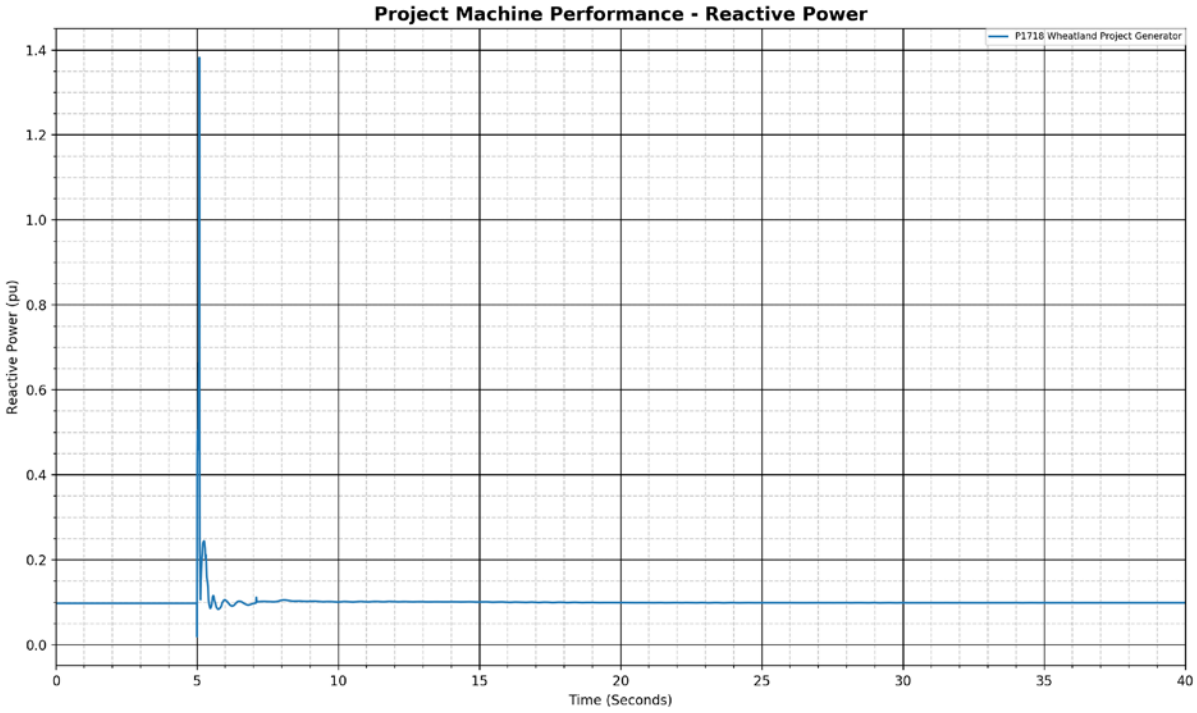

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

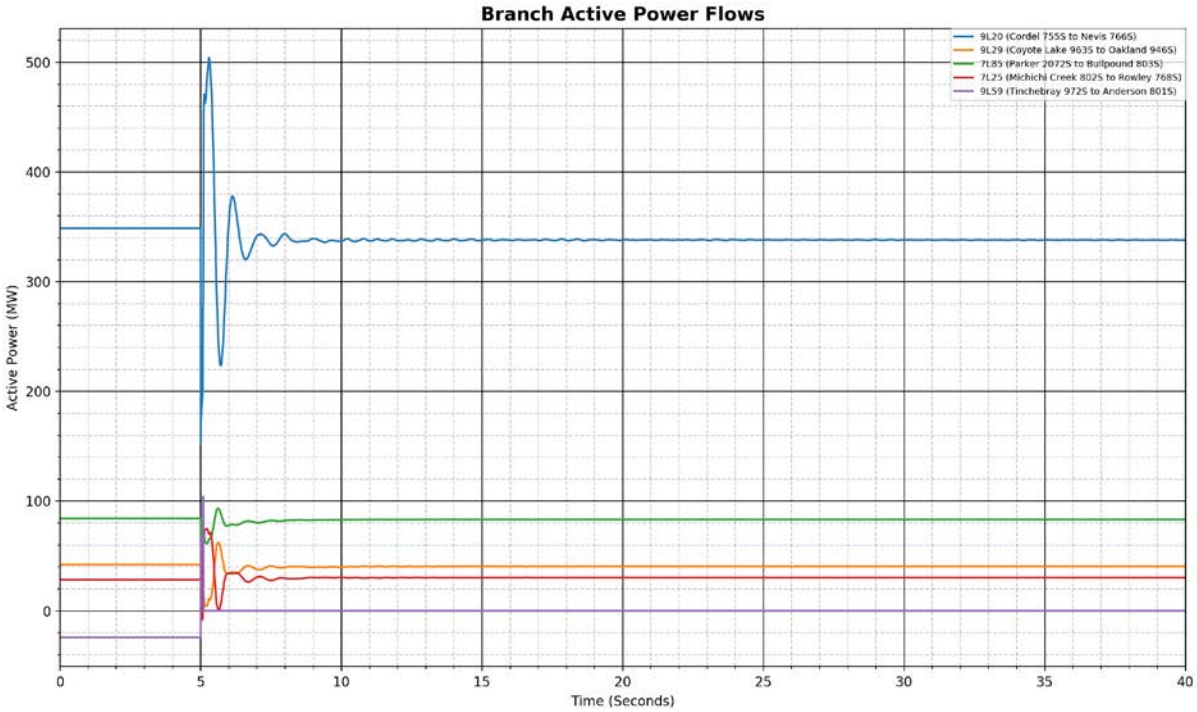
Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Active Power (MW)
Time (Seconds)

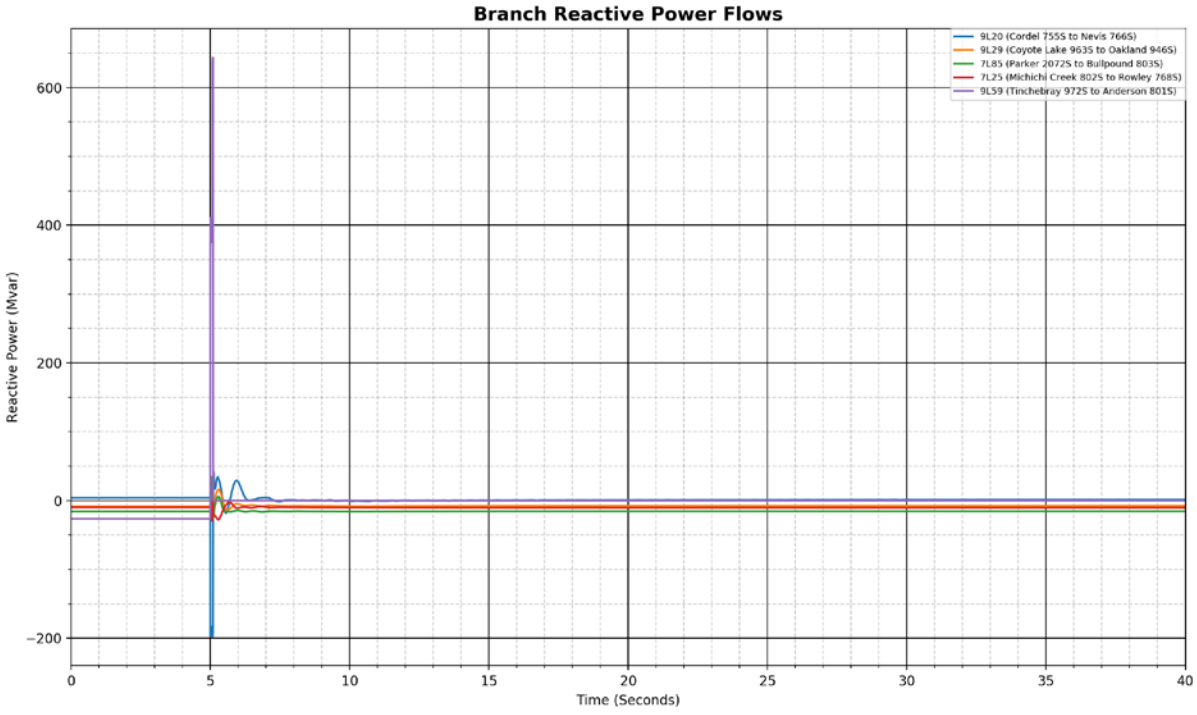
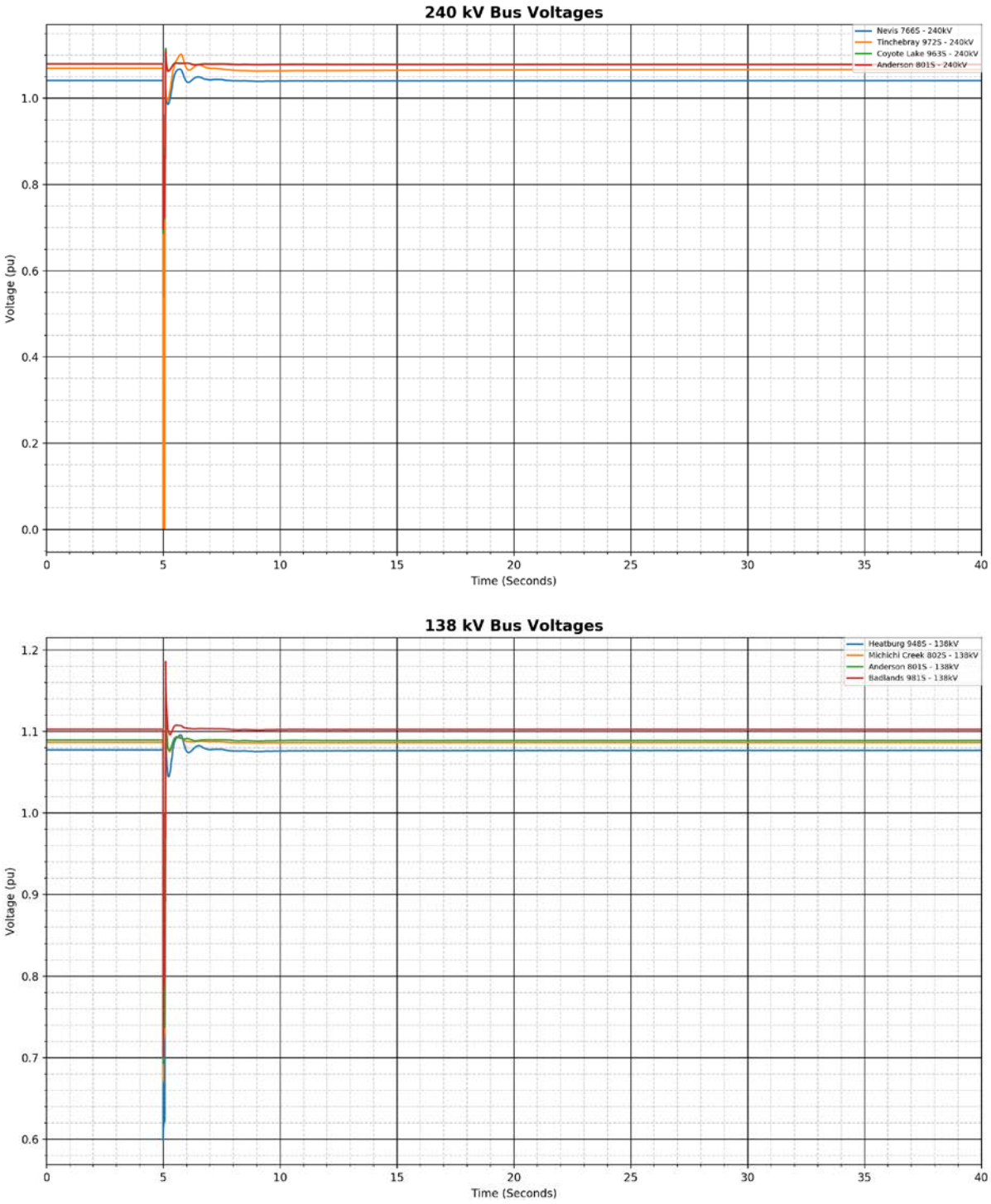
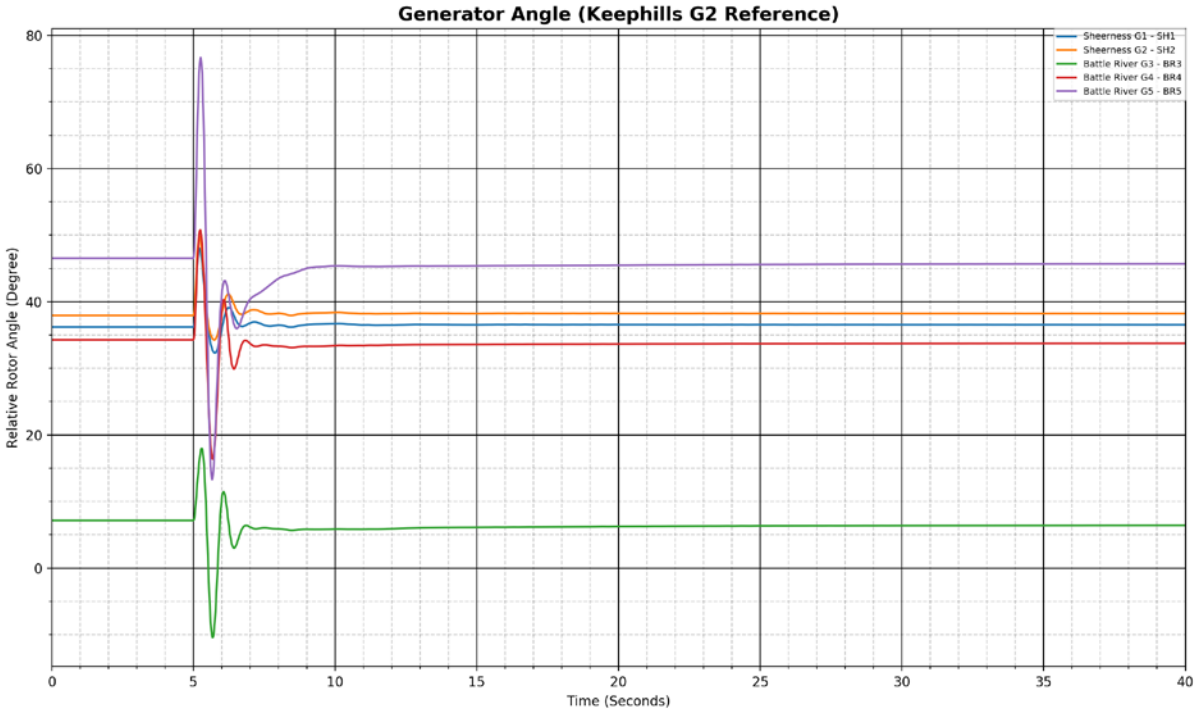
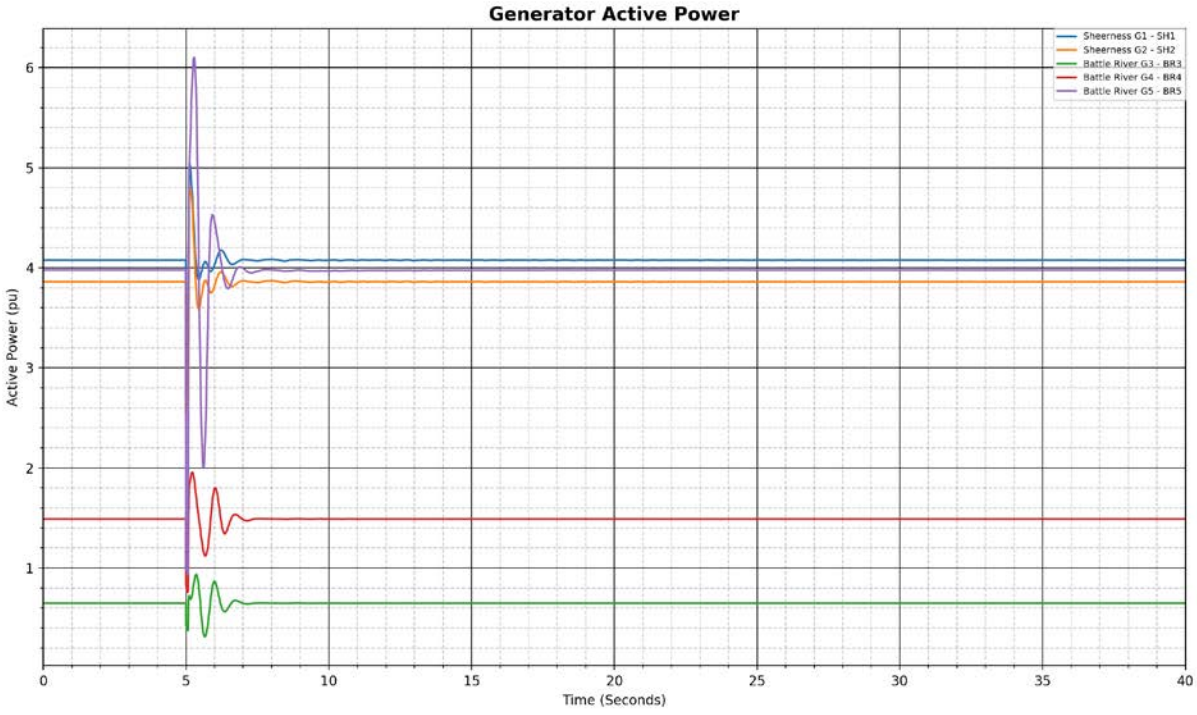
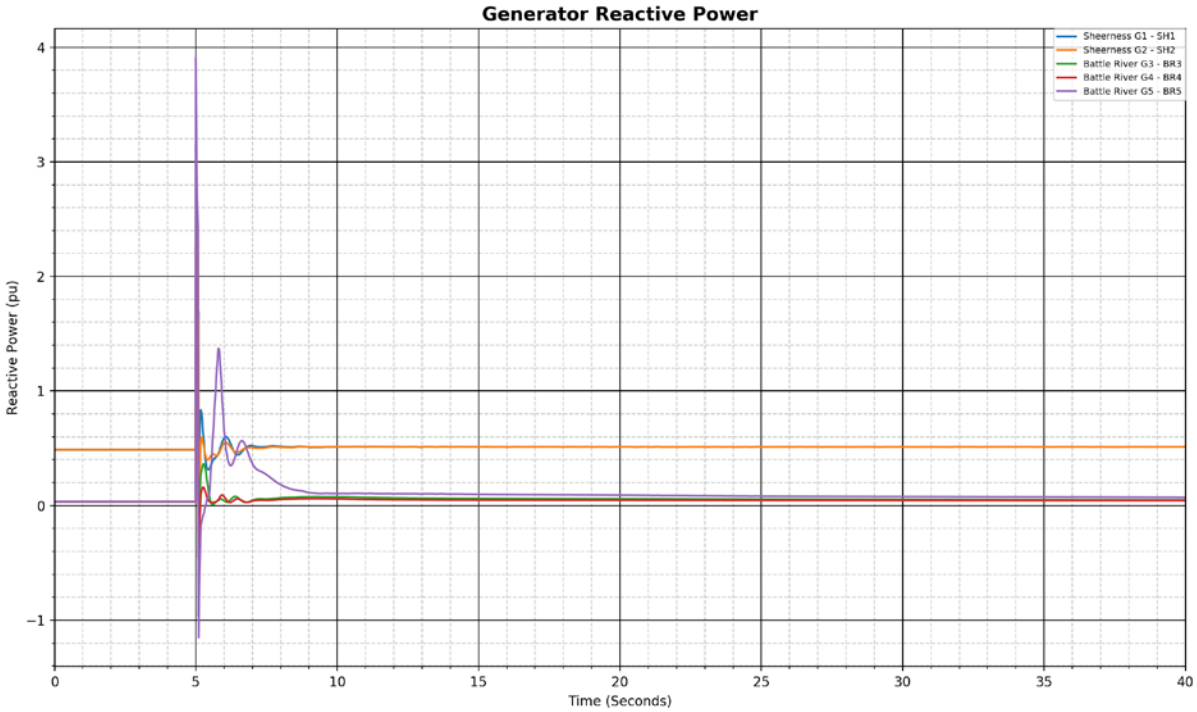

Branch Reactive Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Reactive Power (Mvar)
Time (Seconds)

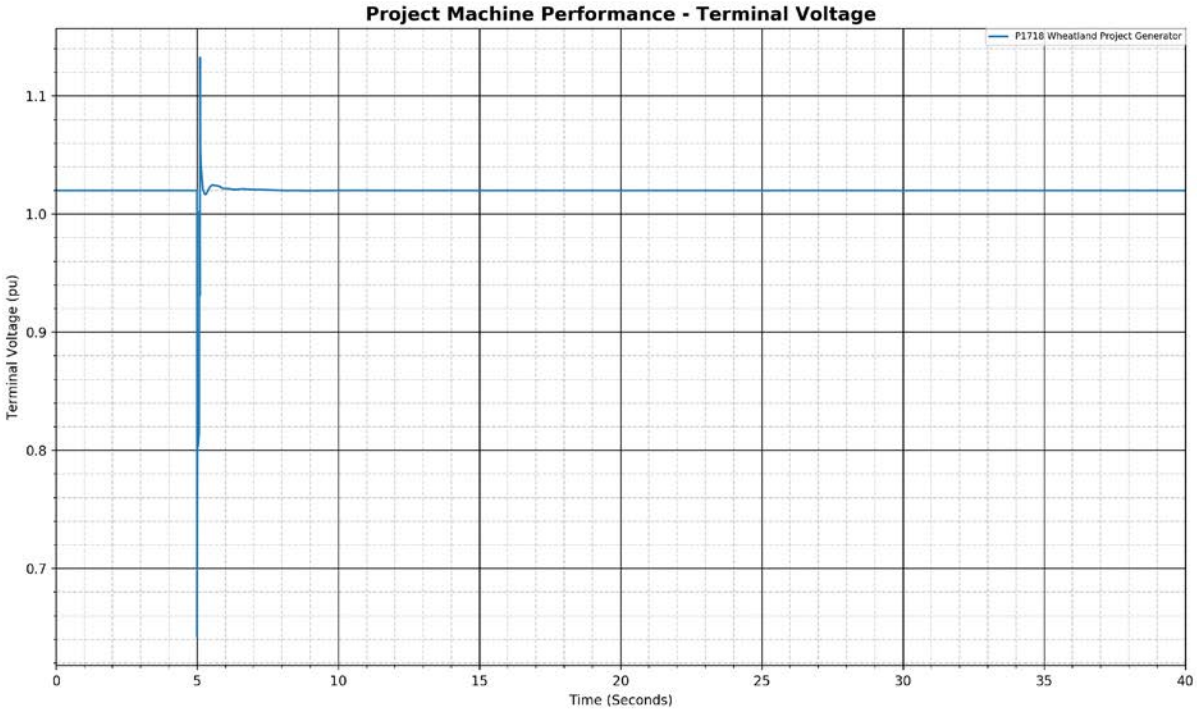
Figure A4-62: 9L59 (Anderson 801S - Tinchebray 972S): 3-phase fault at Tinchebray 972S

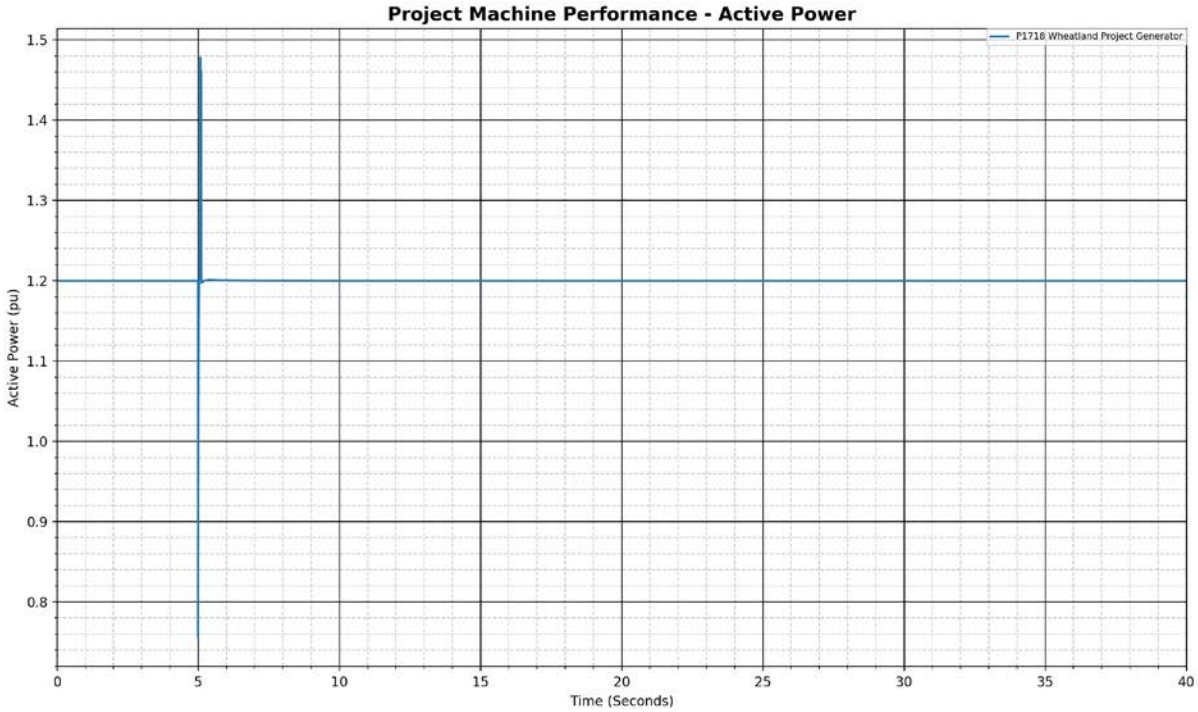


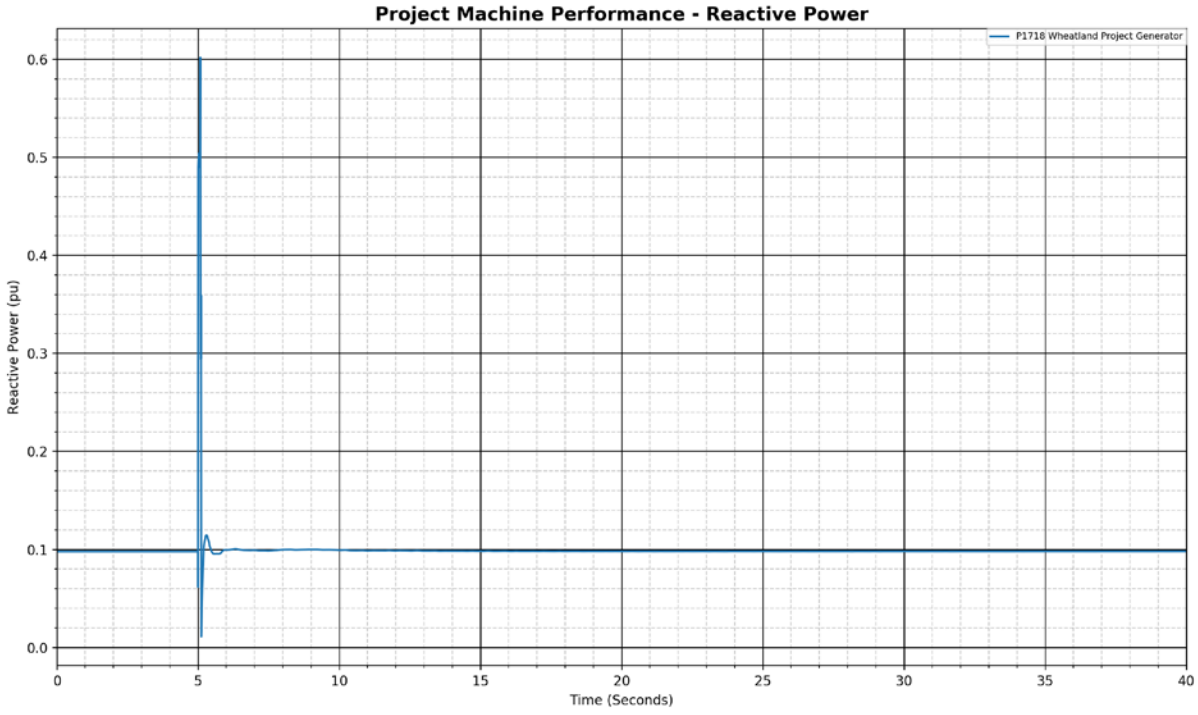

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

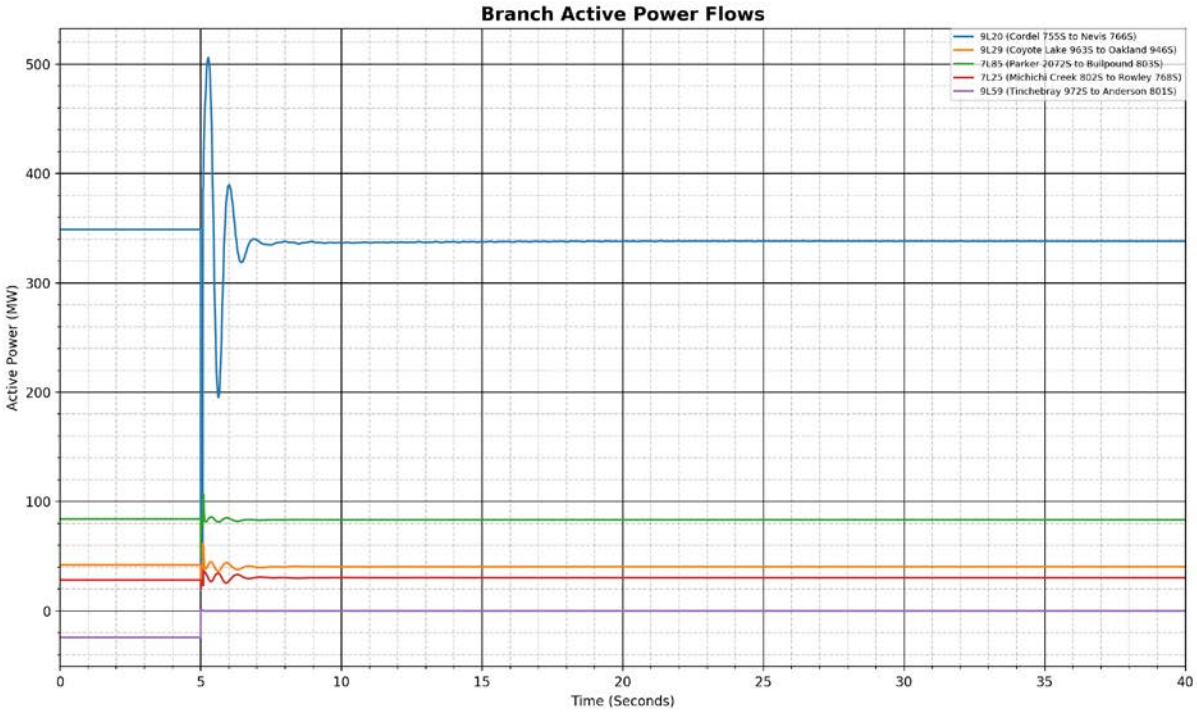

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Active Power (MW)
Time (Seconds)

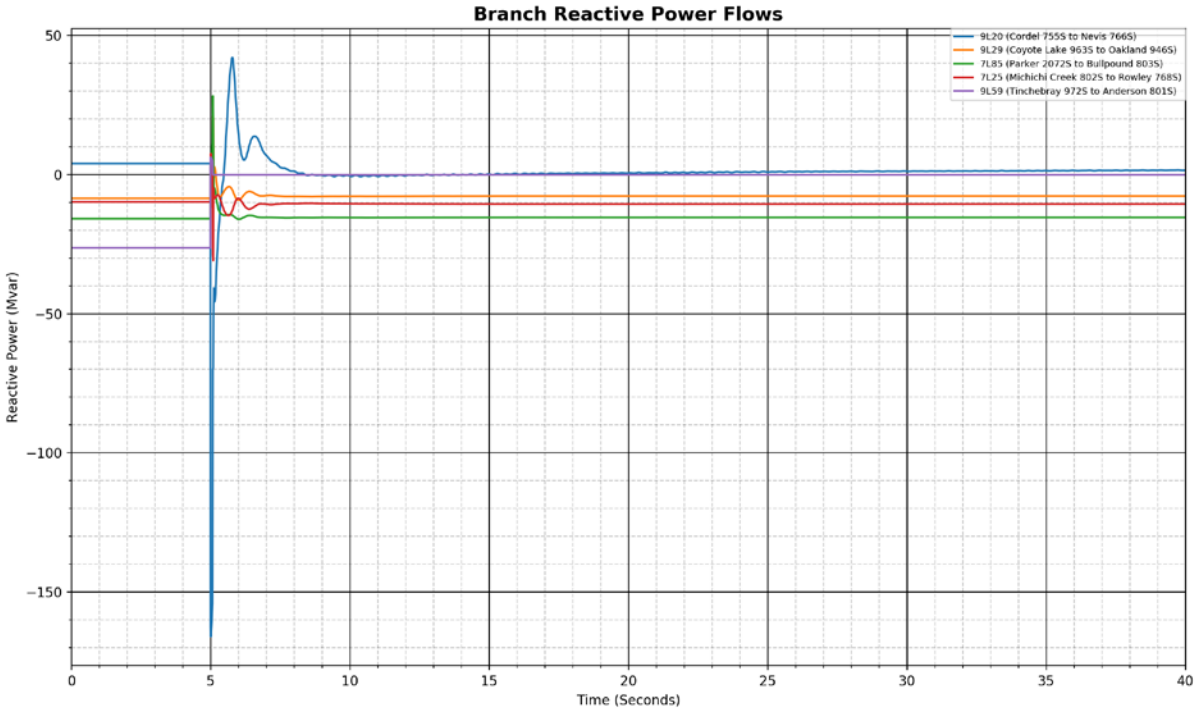
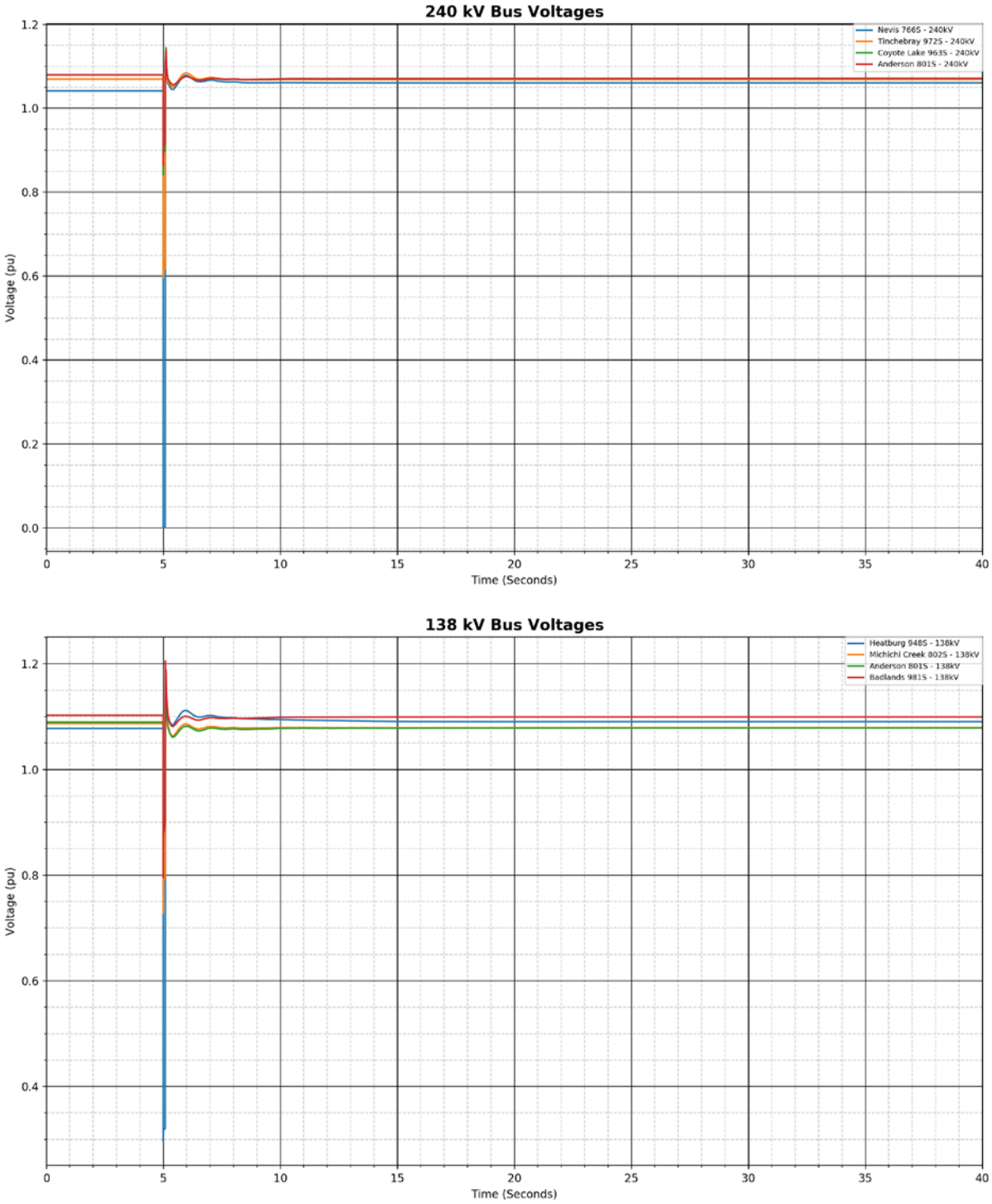
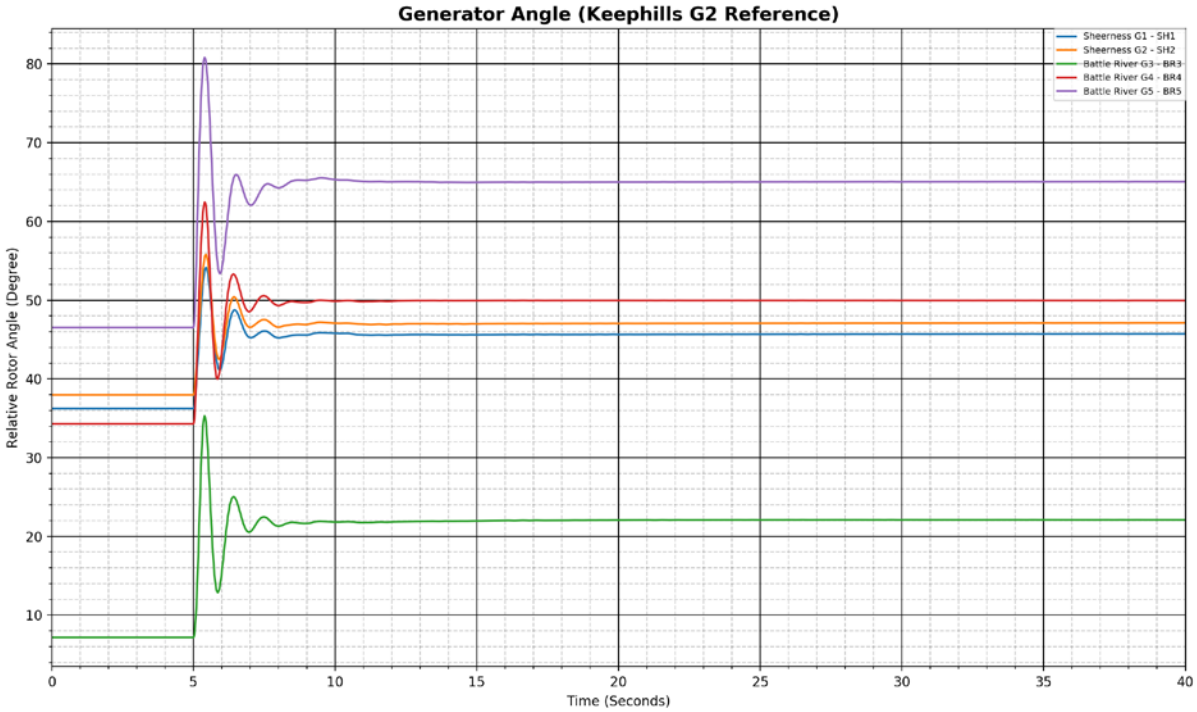
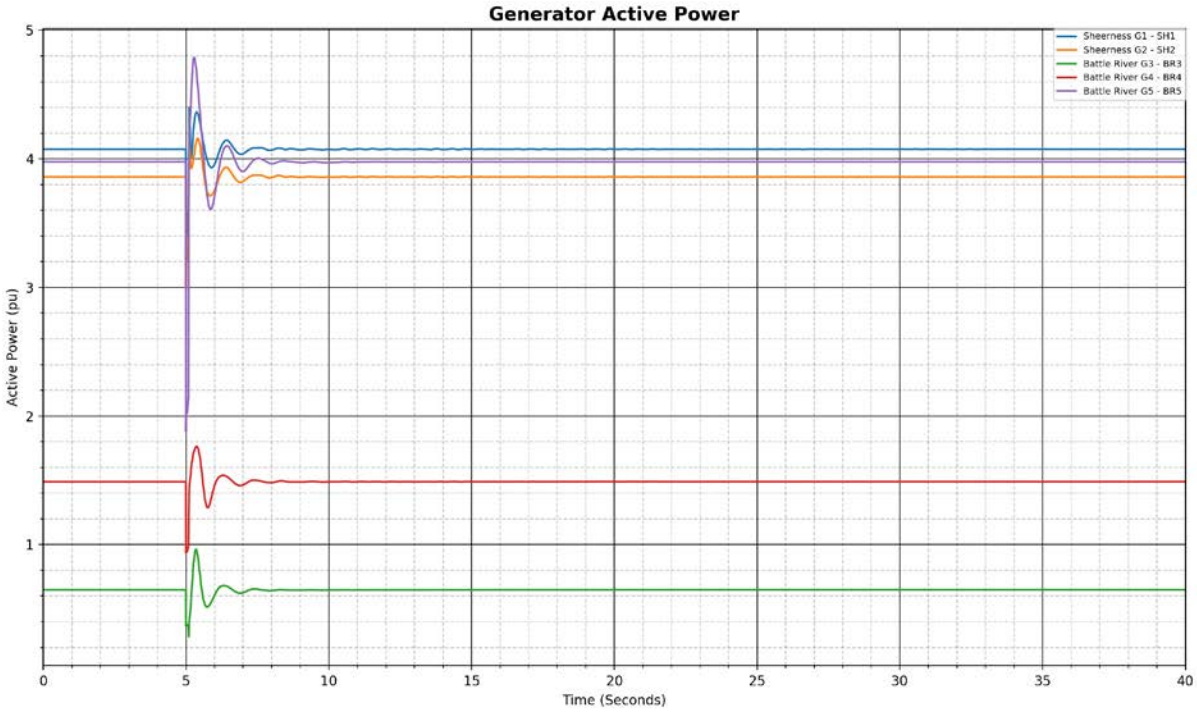
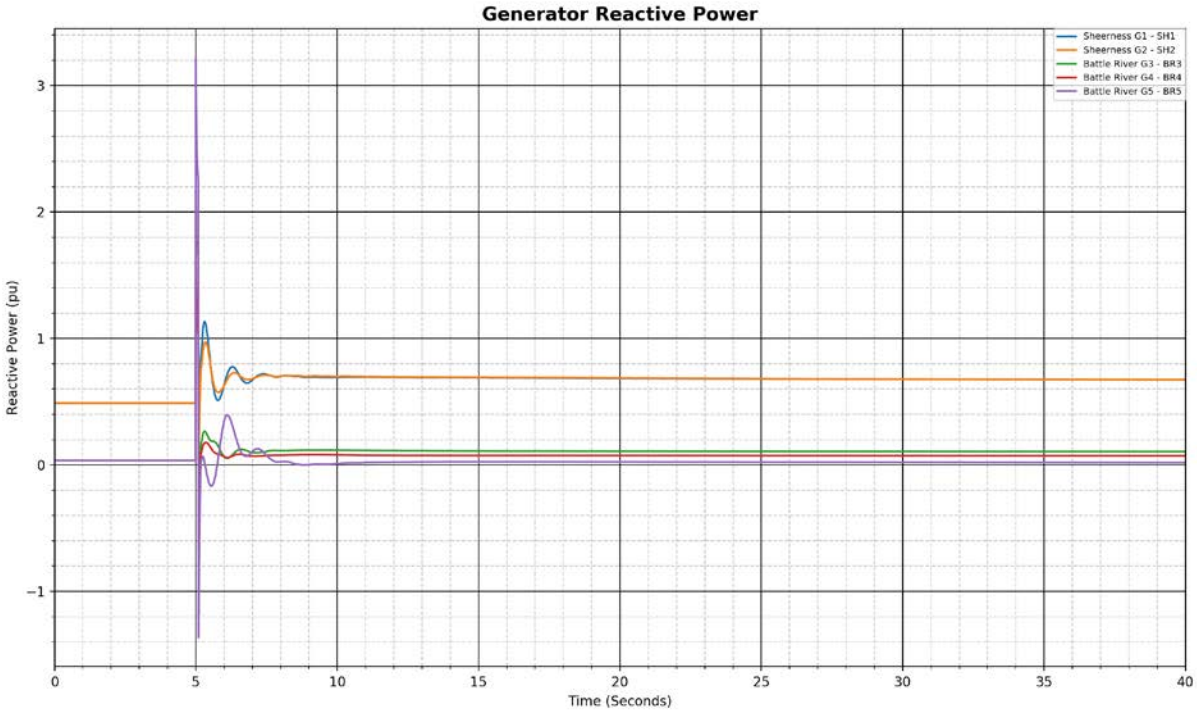

Branch Reactive Power Flows
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
9L59 (Tinchebray 972S to Anderson 801S)
Reactive Power (Mvar)
Time (Seconds)

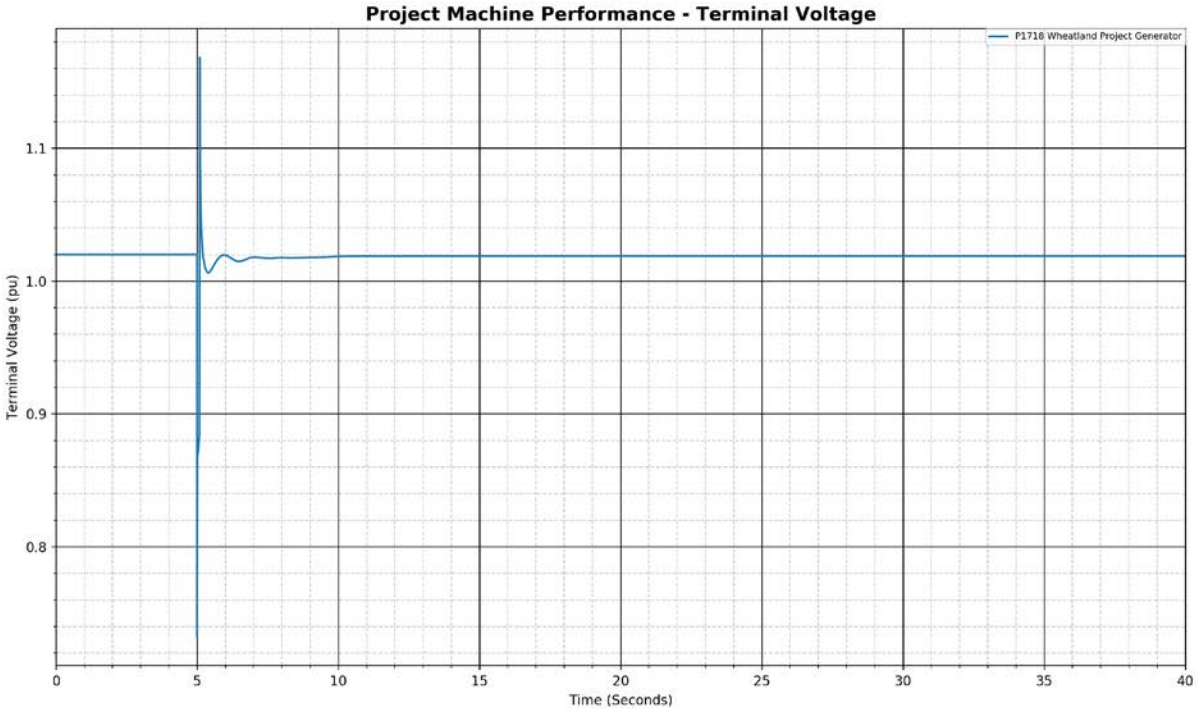
Figure A4-63: 912L/9L912 (Nevis 766S - Red Deer 63S): 3-phase fault at Nevis 766S

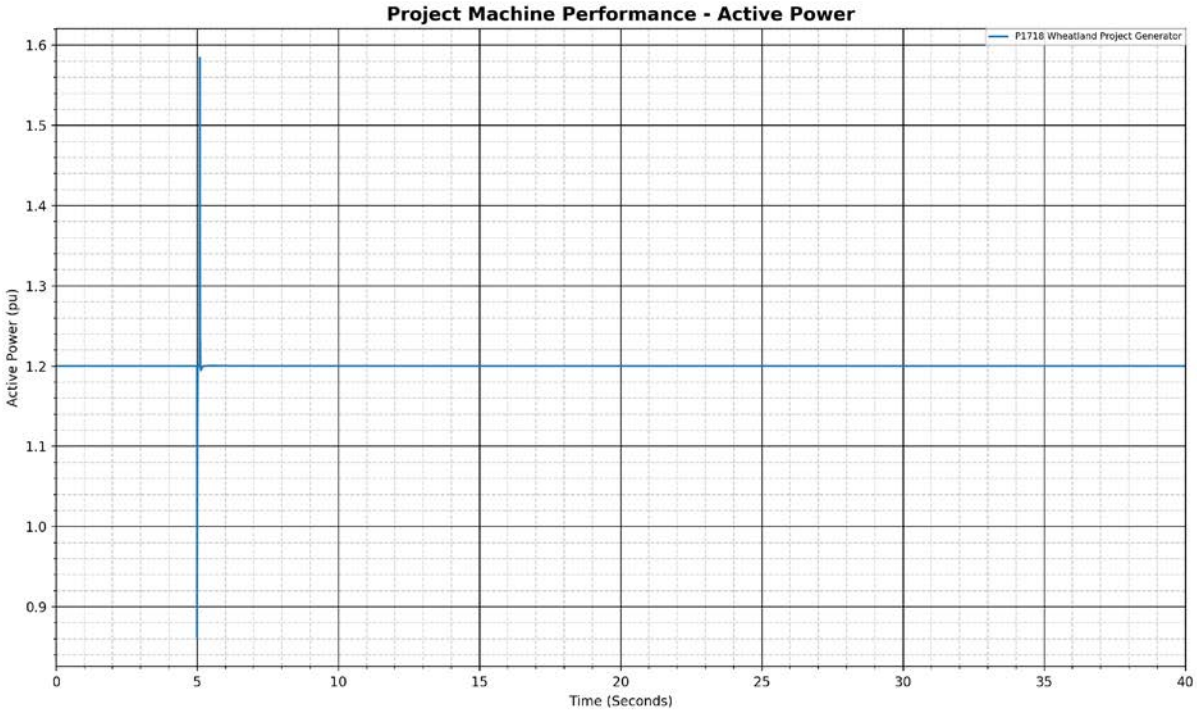


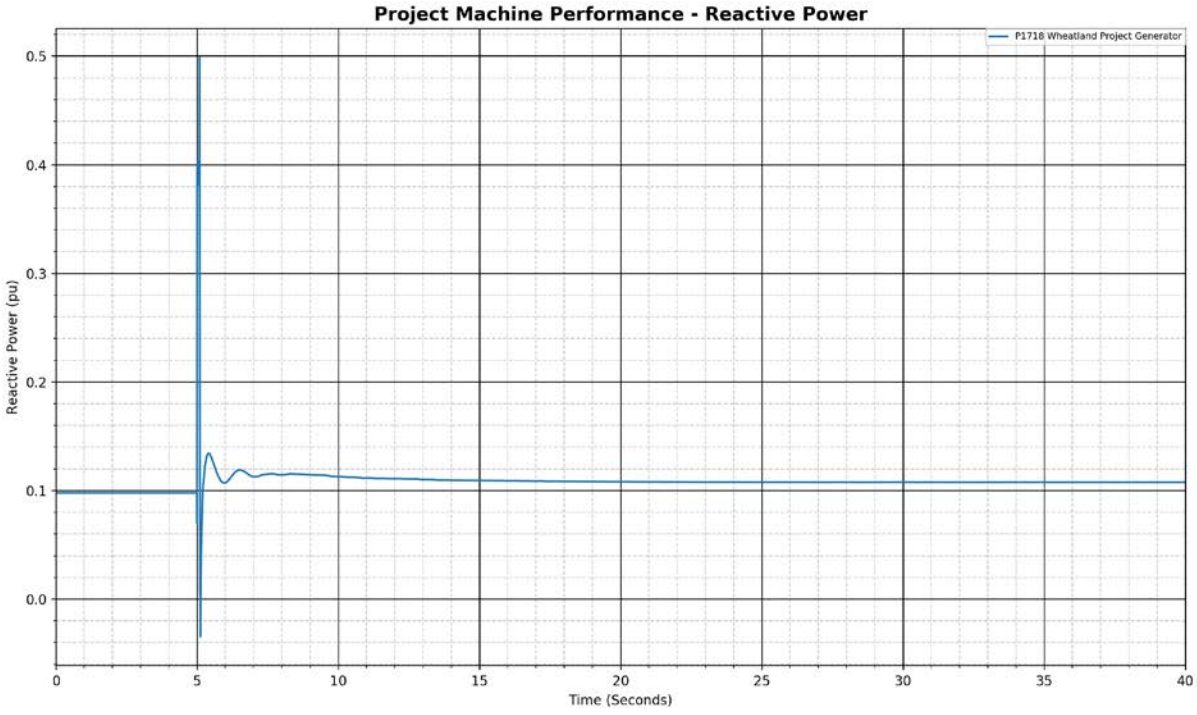

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

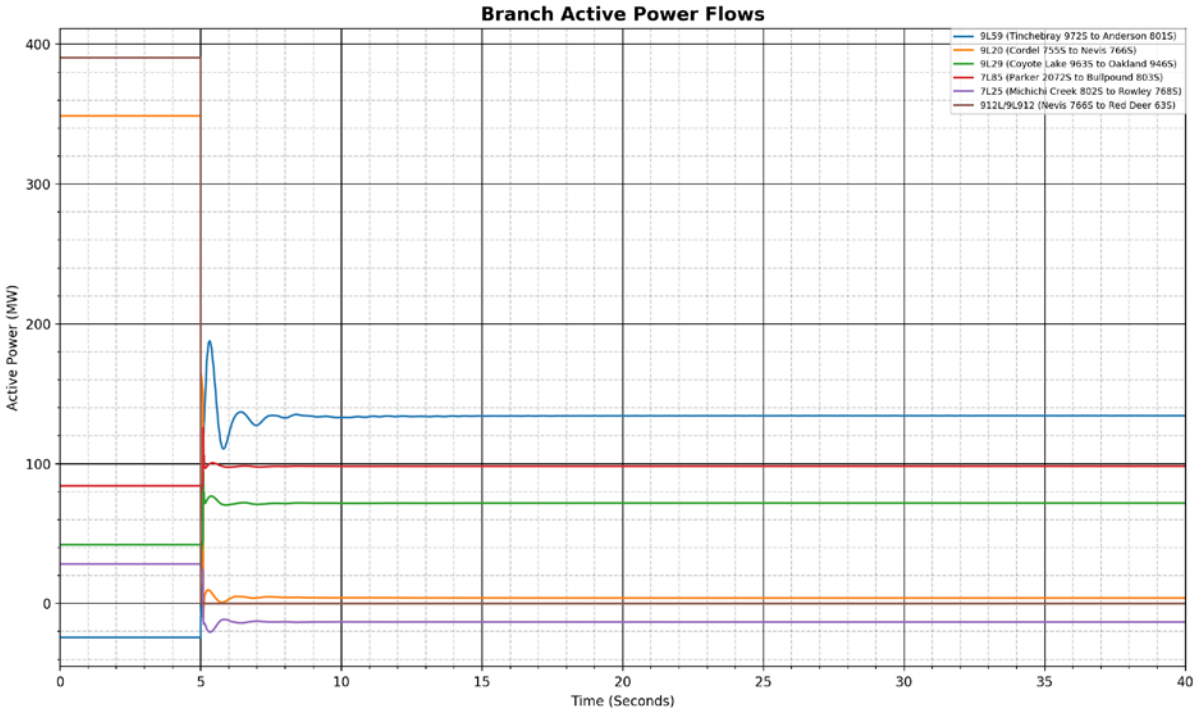

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
3
2
1
0
−1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Active Power (MW)
Time (Seconds)

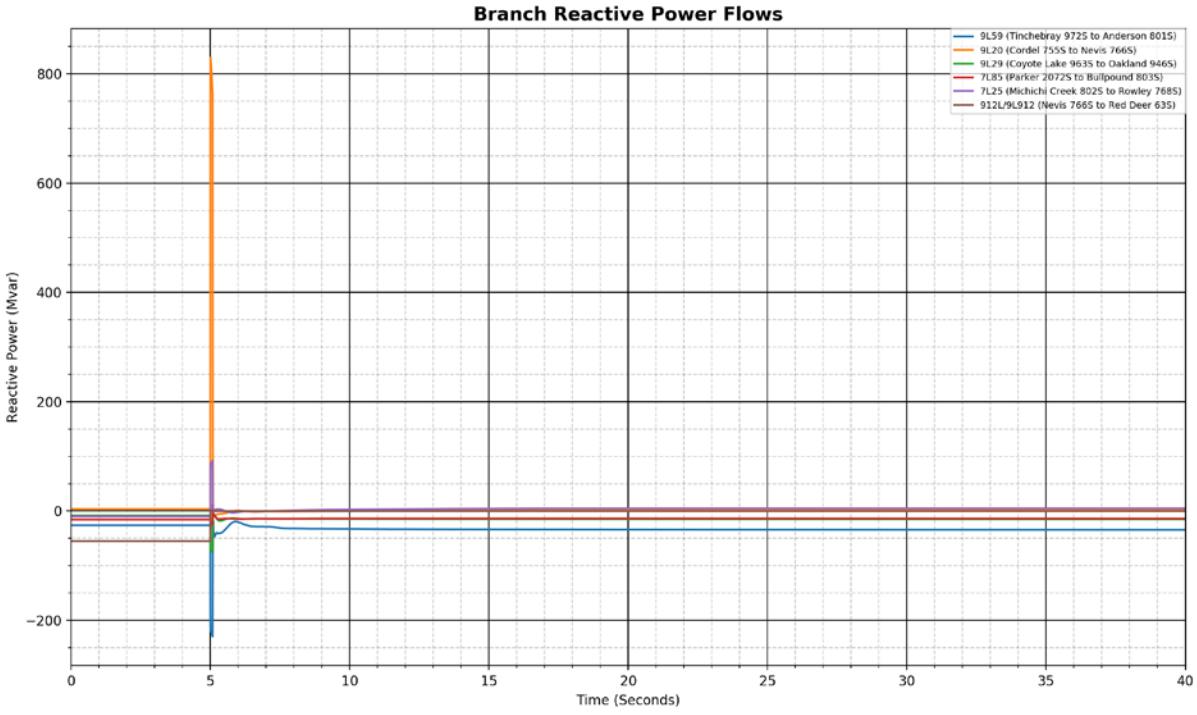
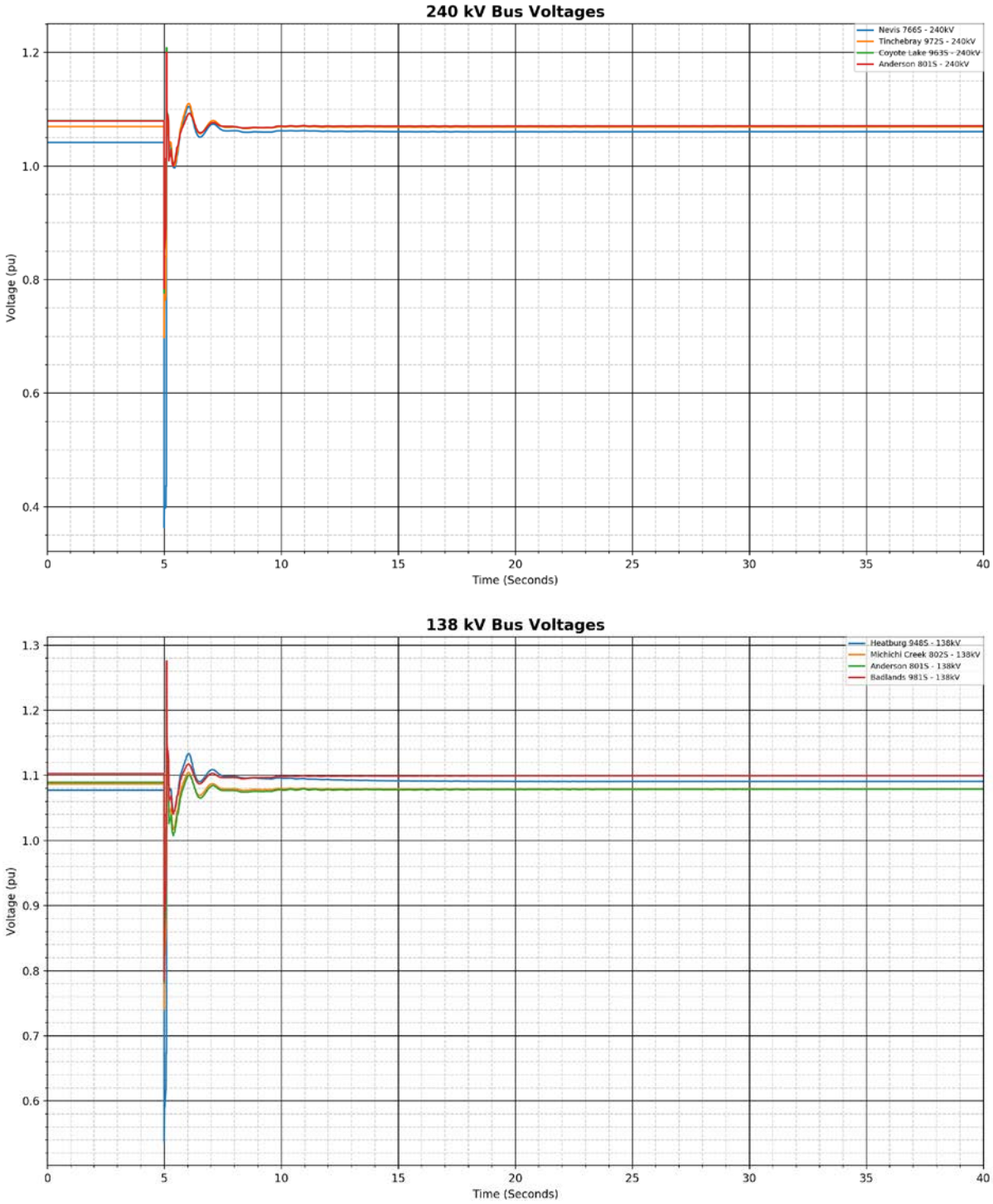
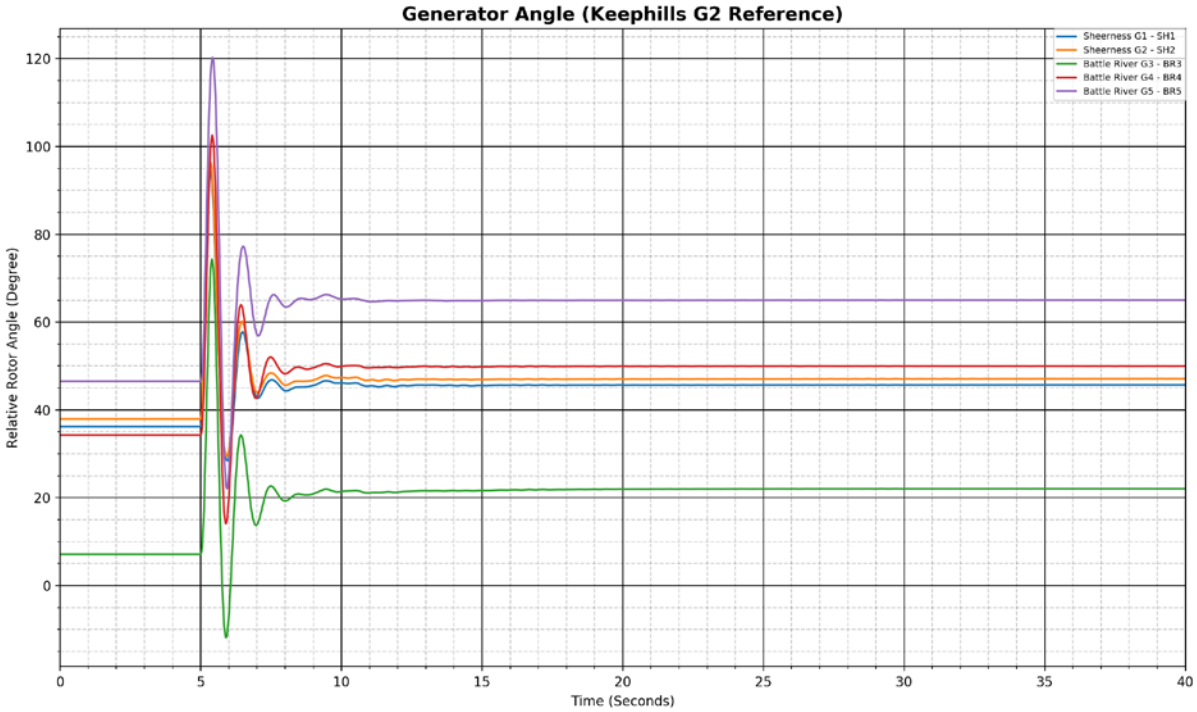
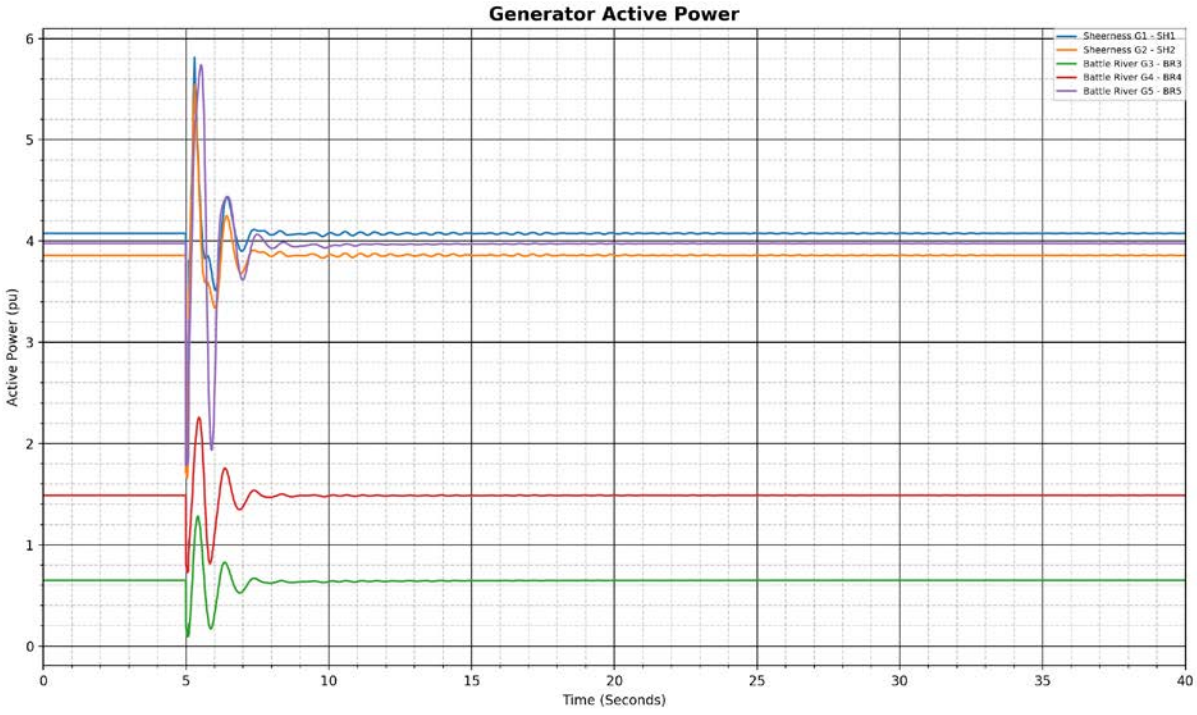
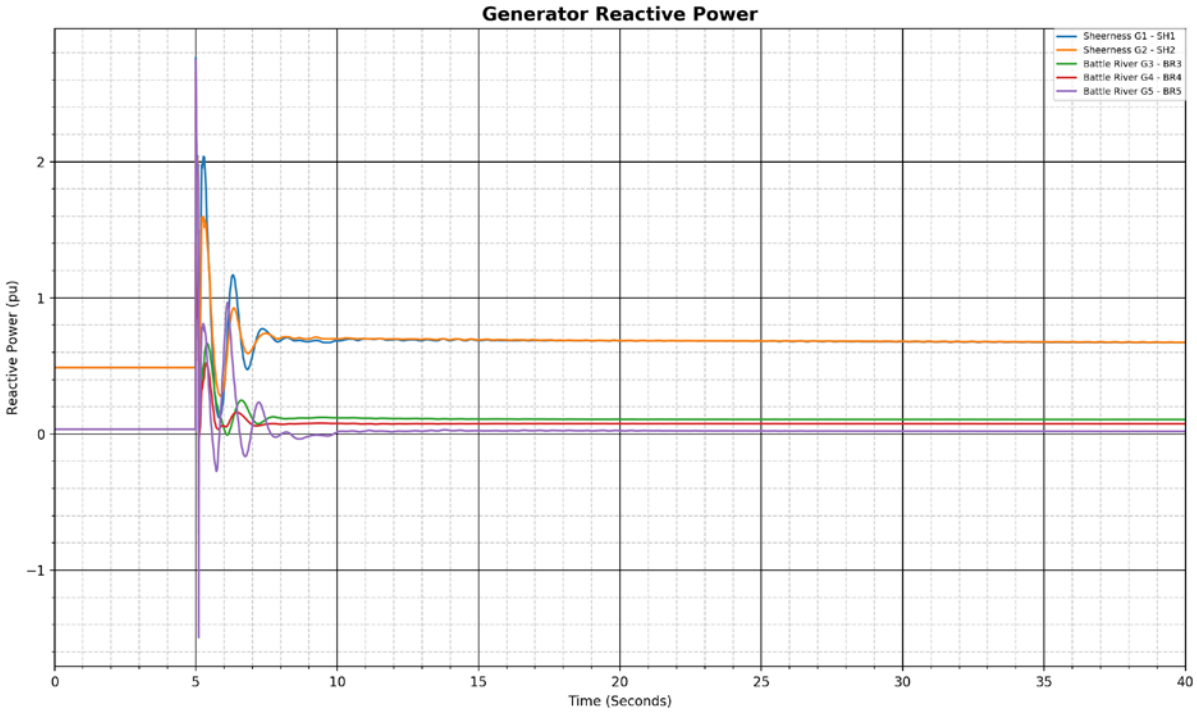

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Reactive Power (Mvar)
Time (Seconds)

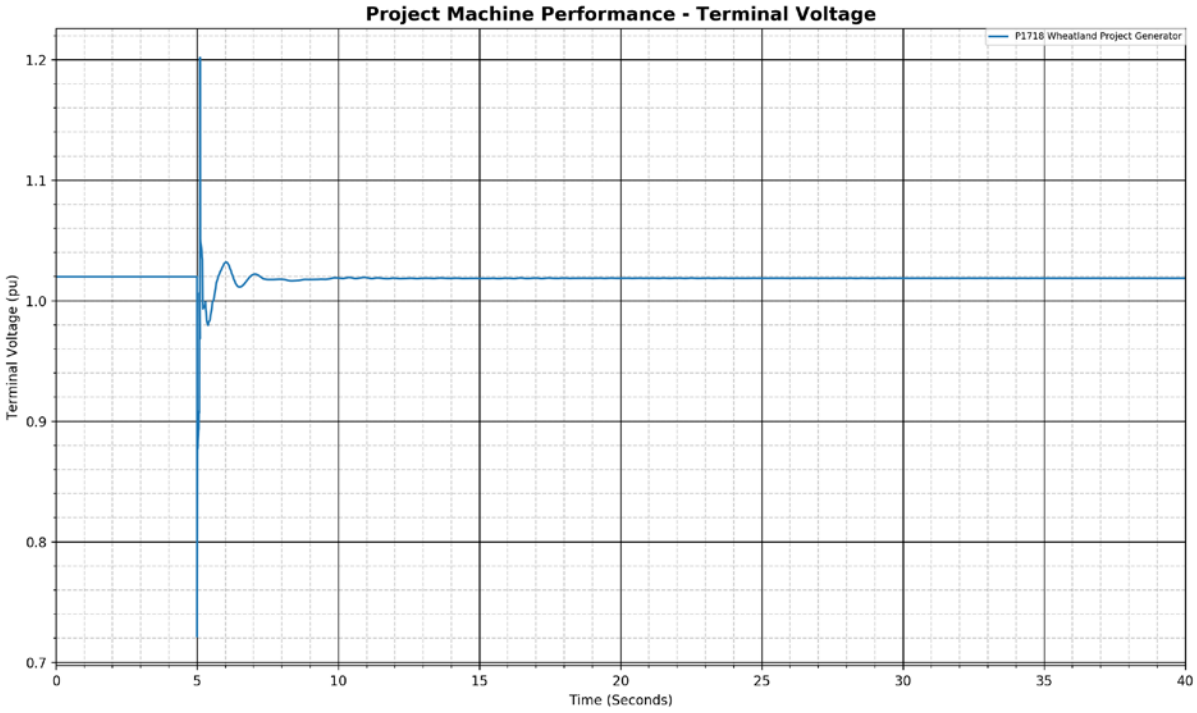
Figure A4-64: 912L/9L912 (Nevis 766S - Red Deer 63S): 3-phase fault at Red Deer 63S

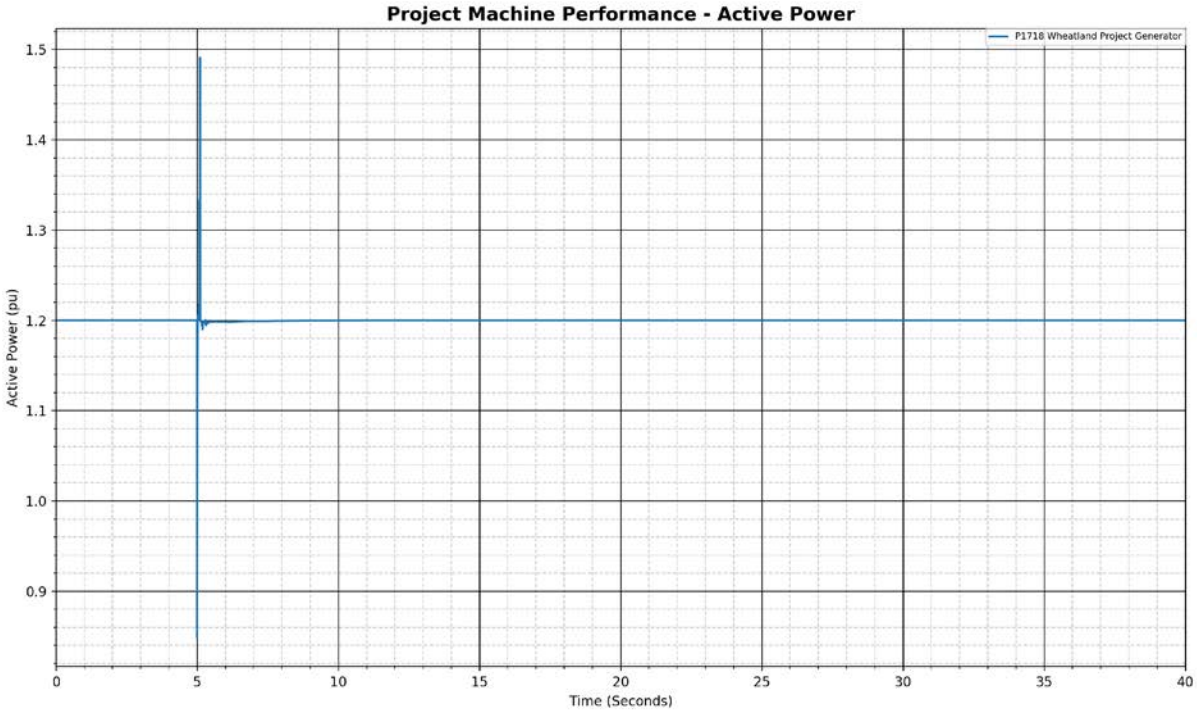


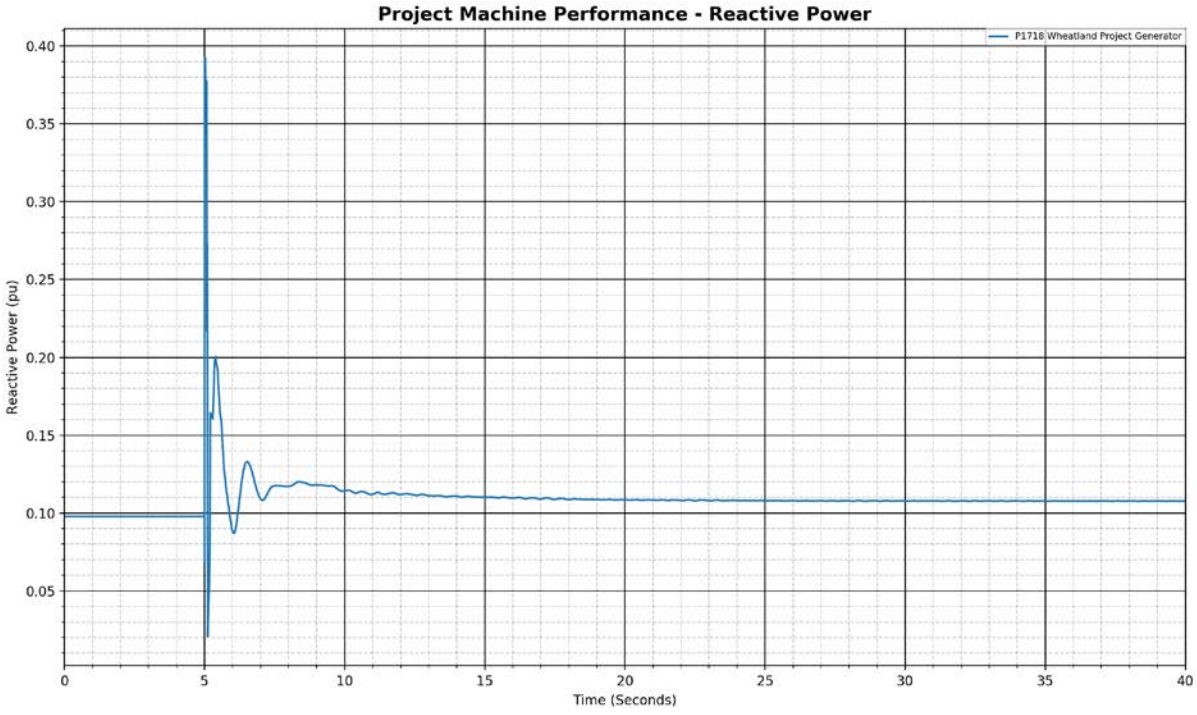

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

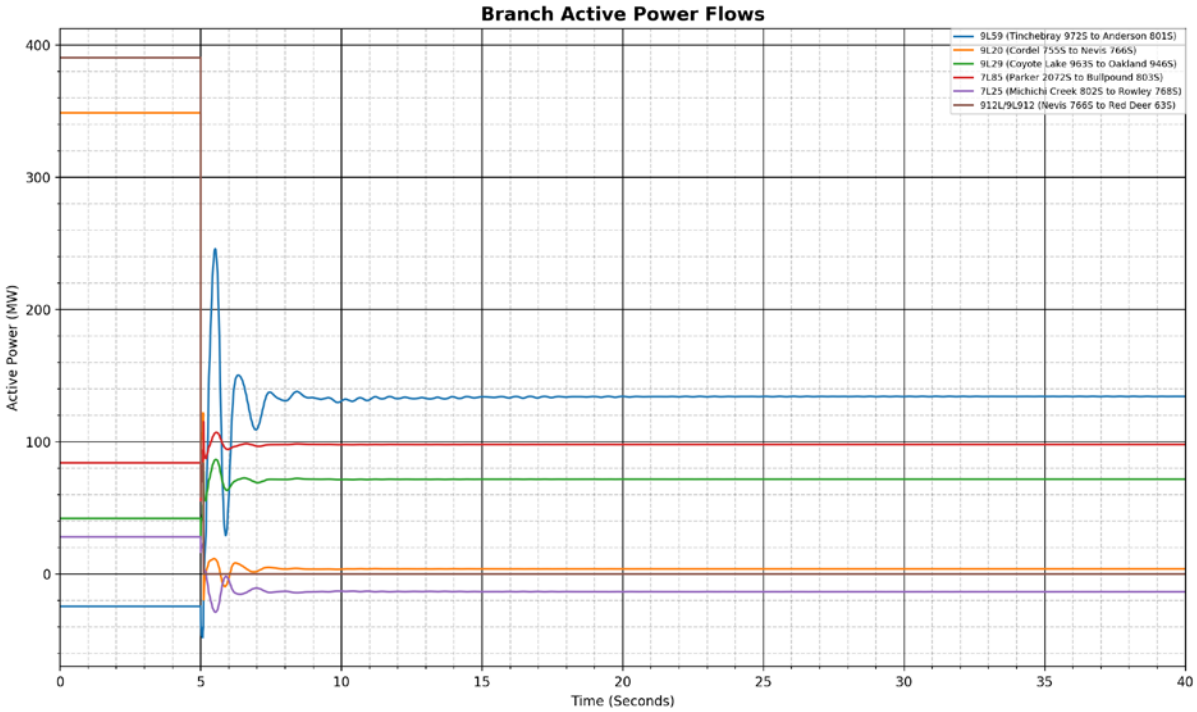

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2
1
0
−1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Active Power (MW)
Time (Seconds)

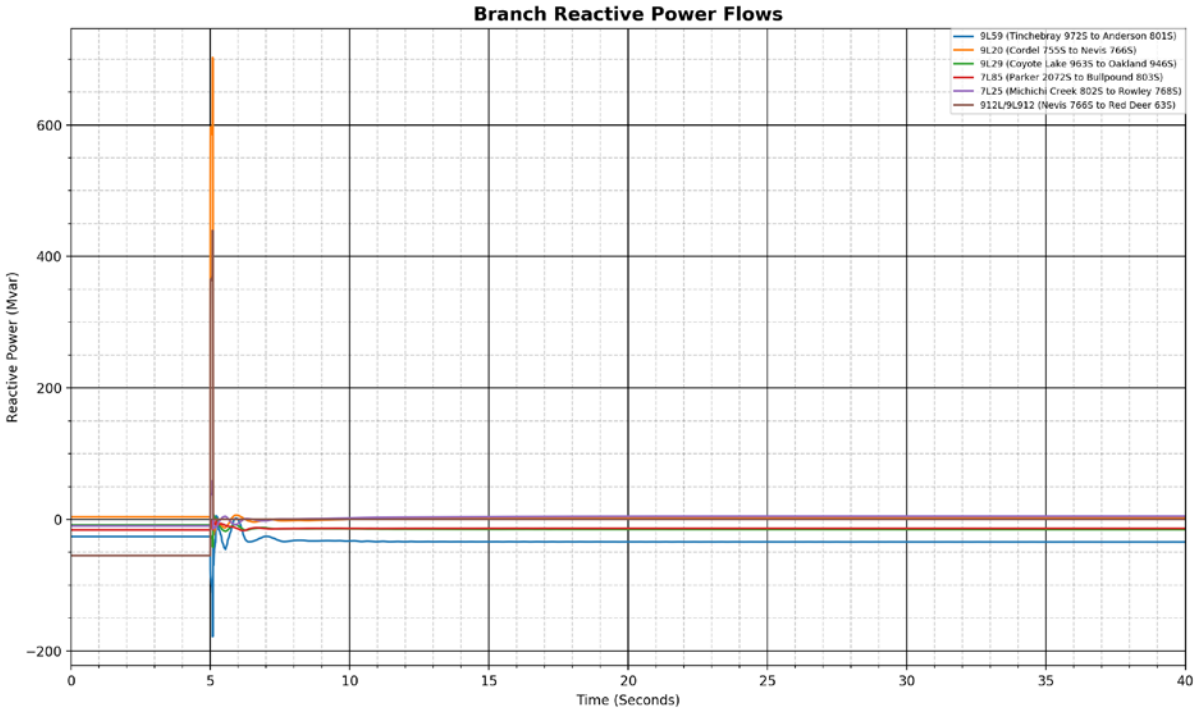
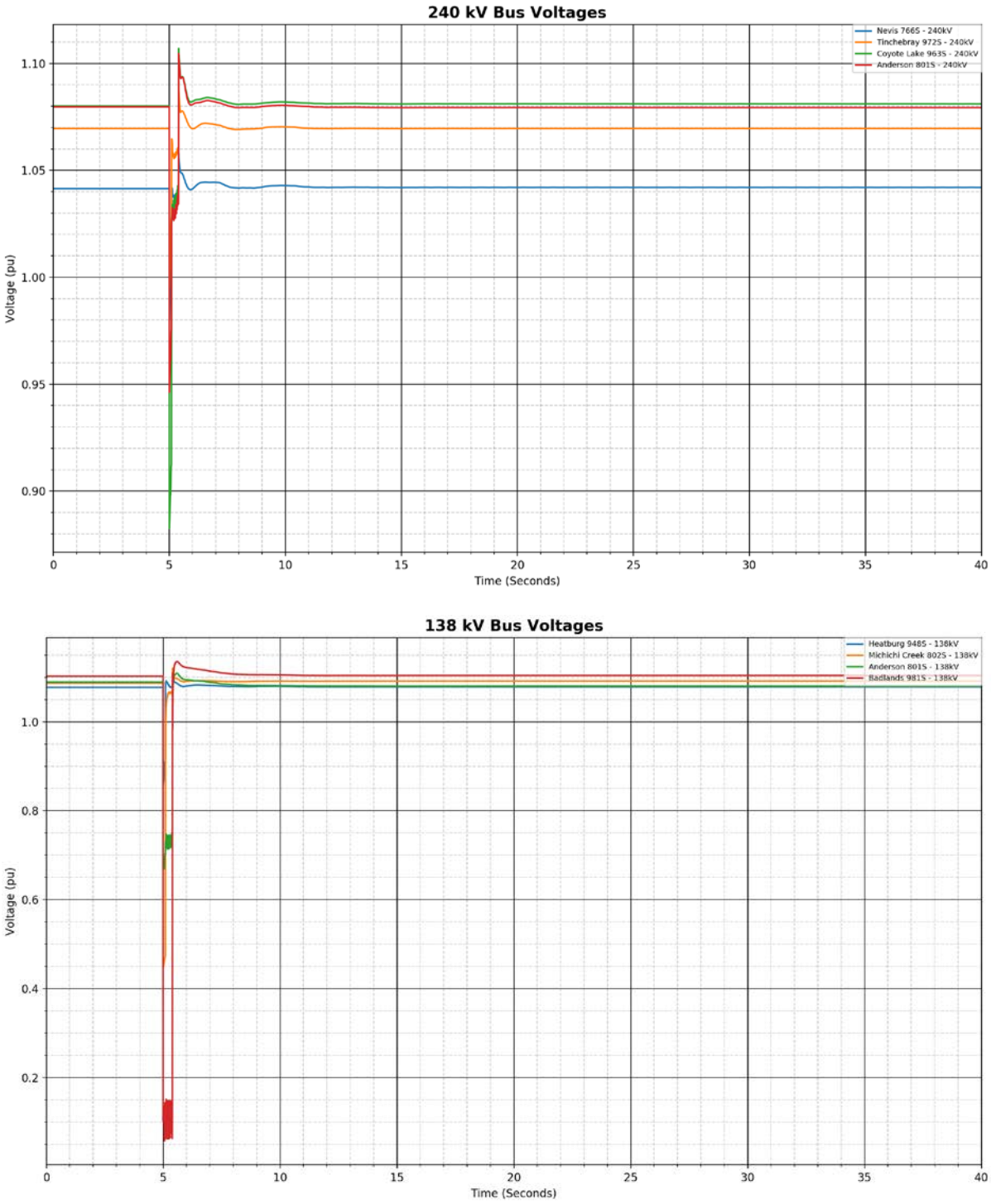
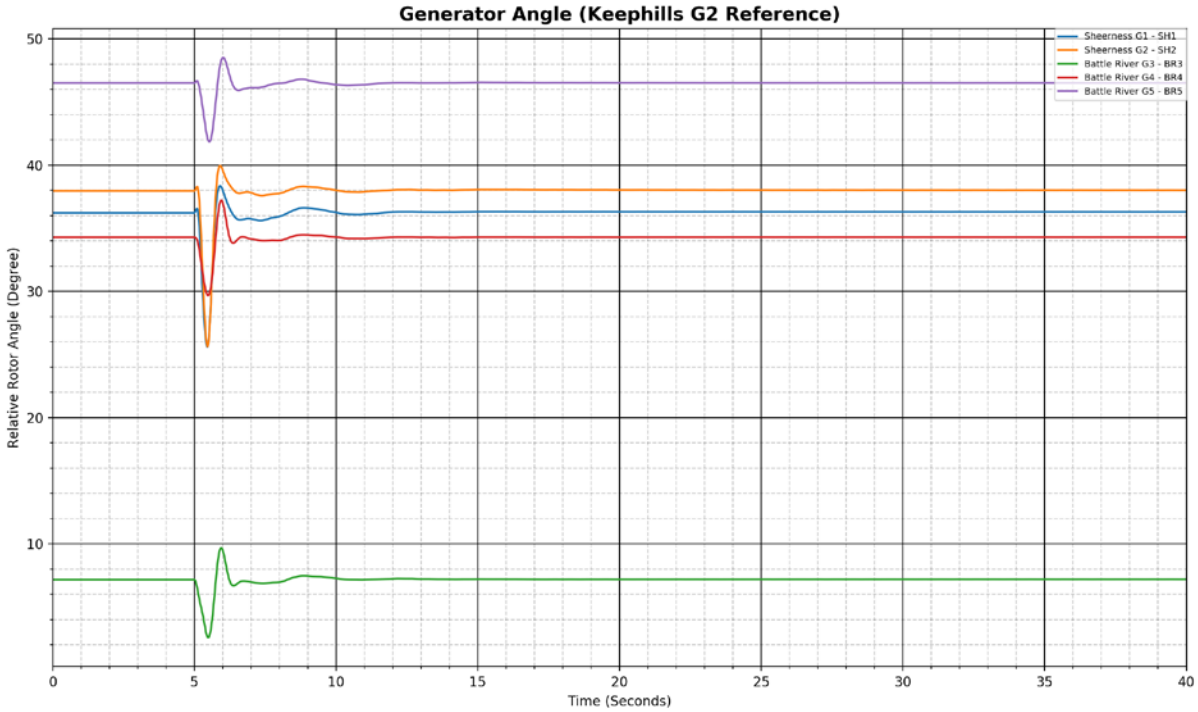
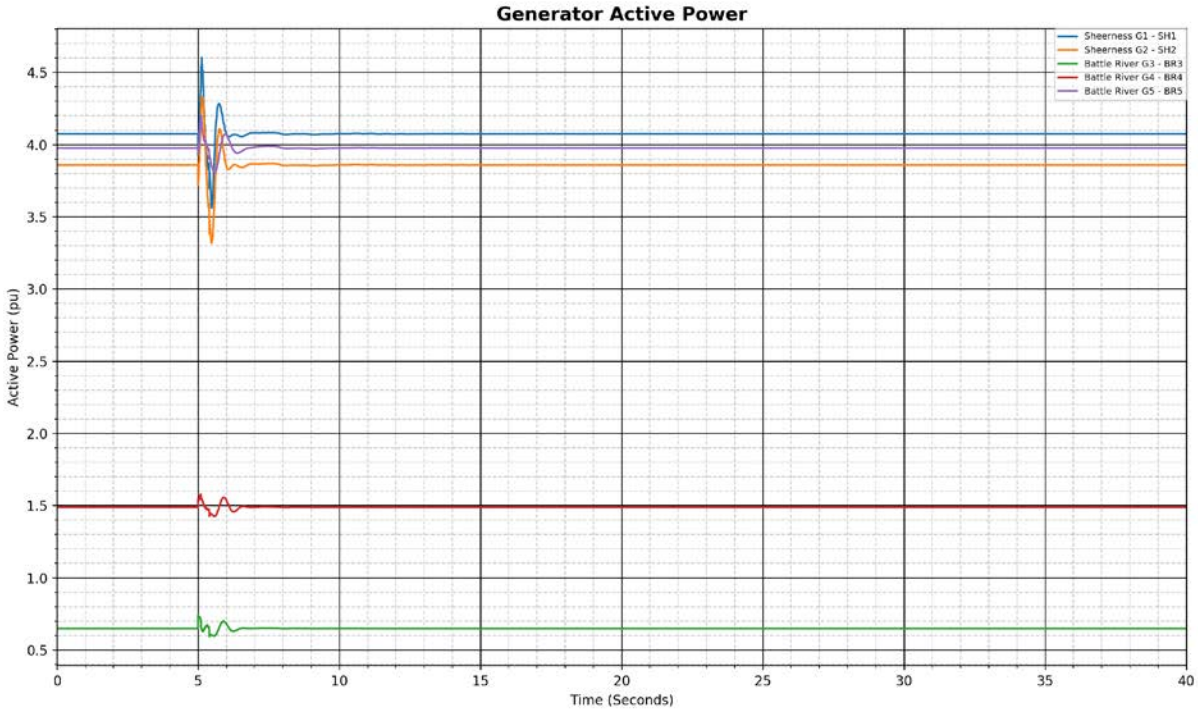
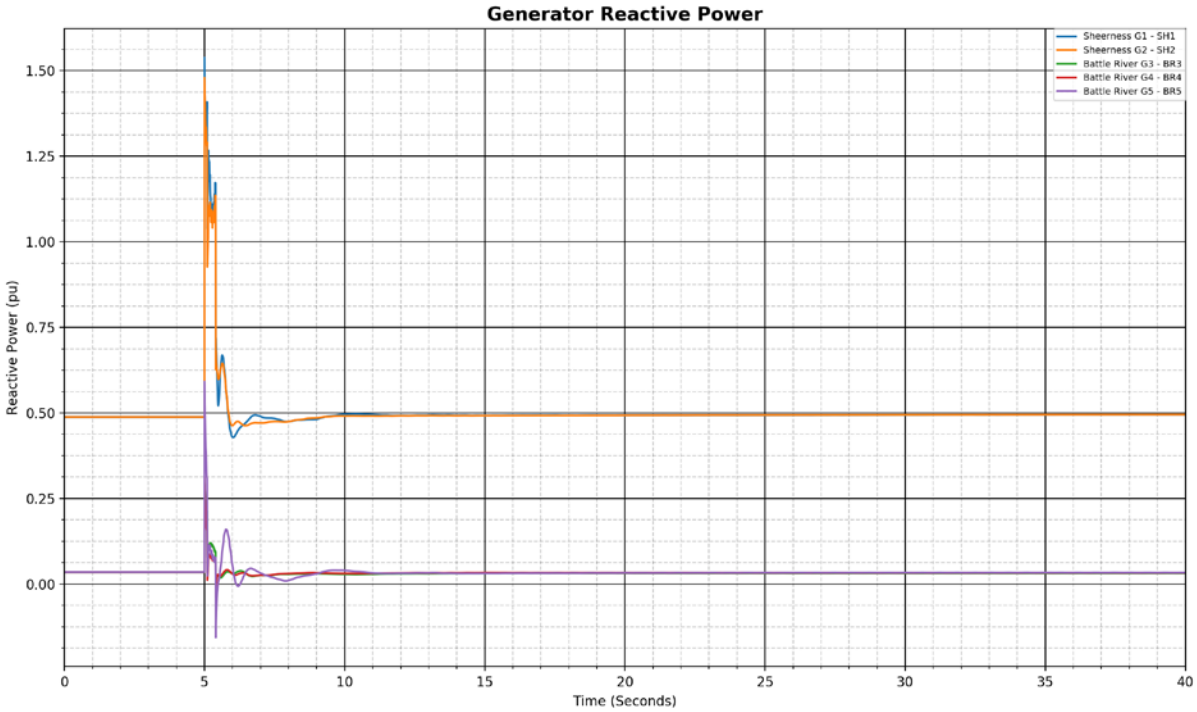

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
912L/9L912 (Nevis 766S to Red Deer 635)
Reactive Power (Mvar)
Time (Seconds)

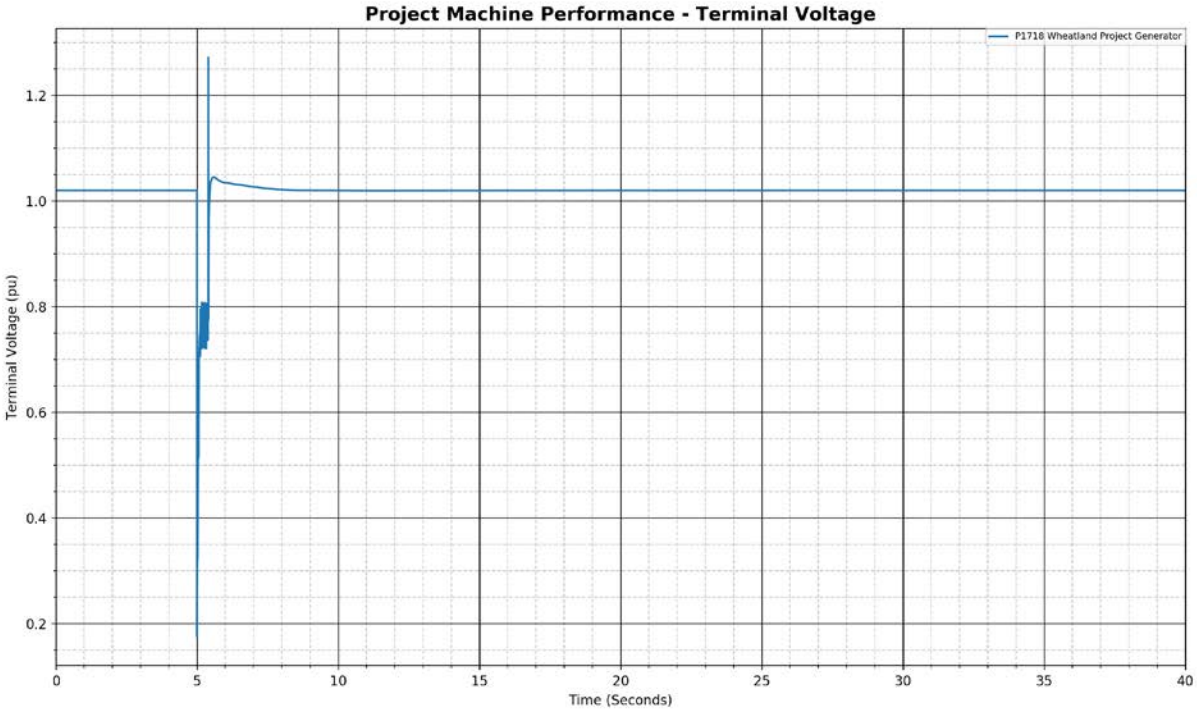
Figure A4-65: 7L203 (Wintering Hills 804S - Parker 2072S): 3-phase fault at Wintering Hills 804S

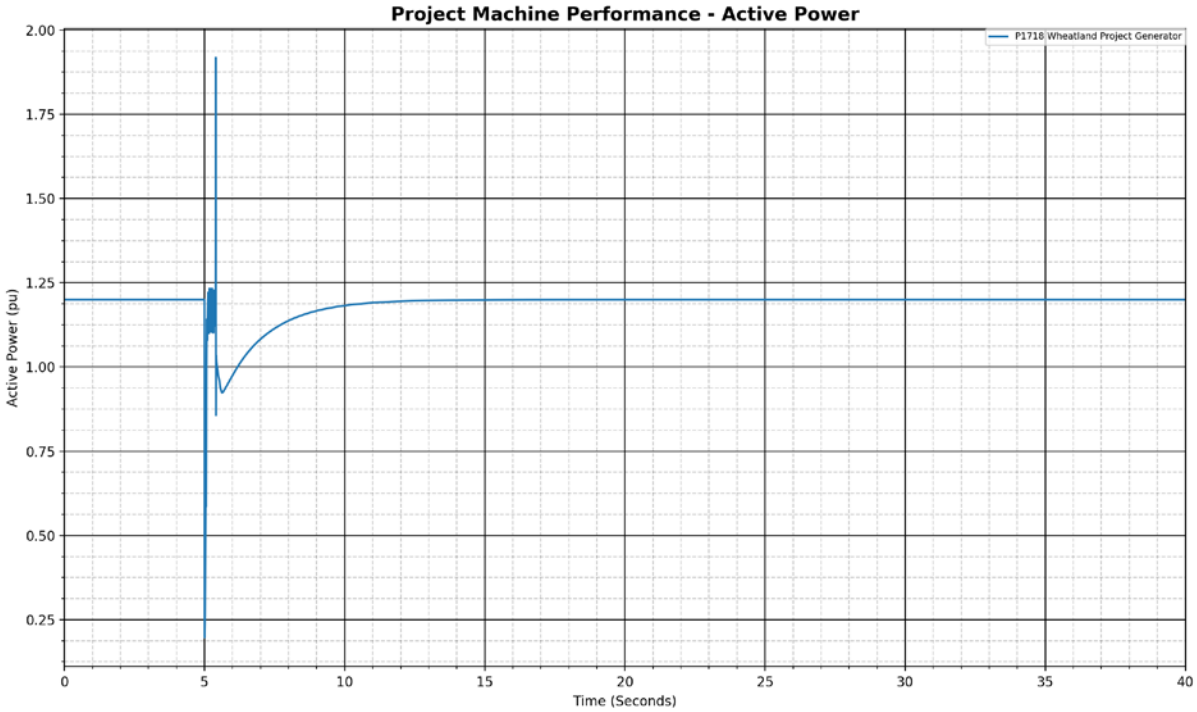


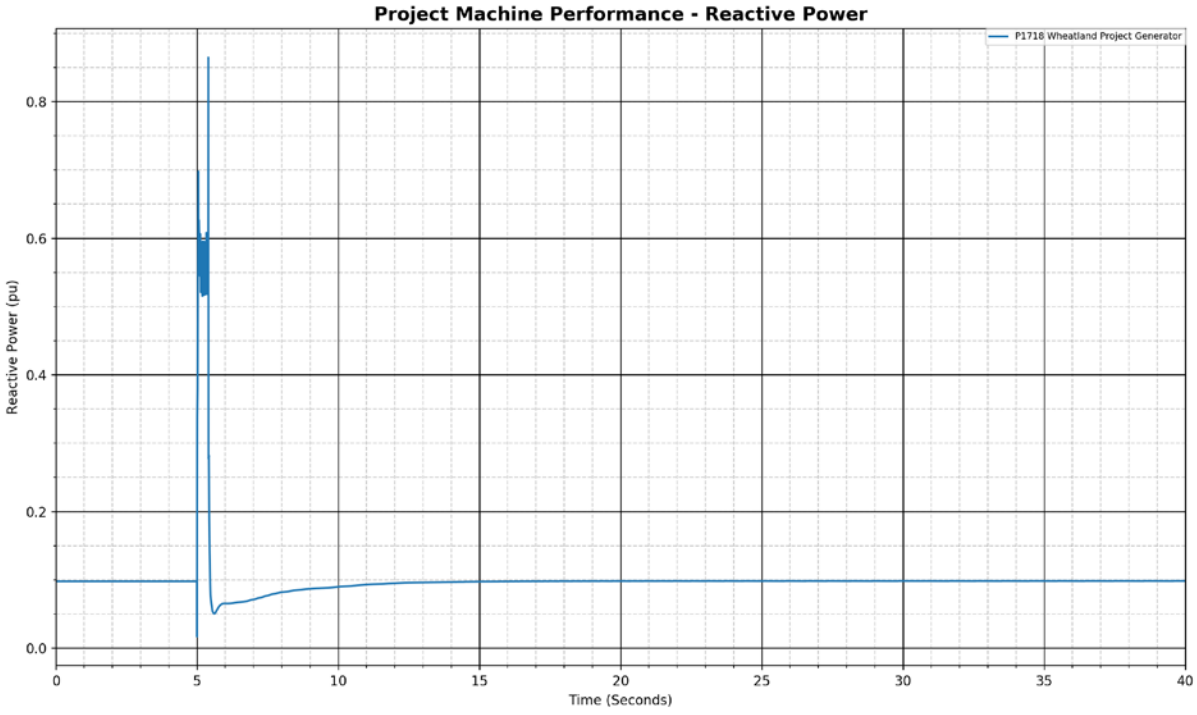

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

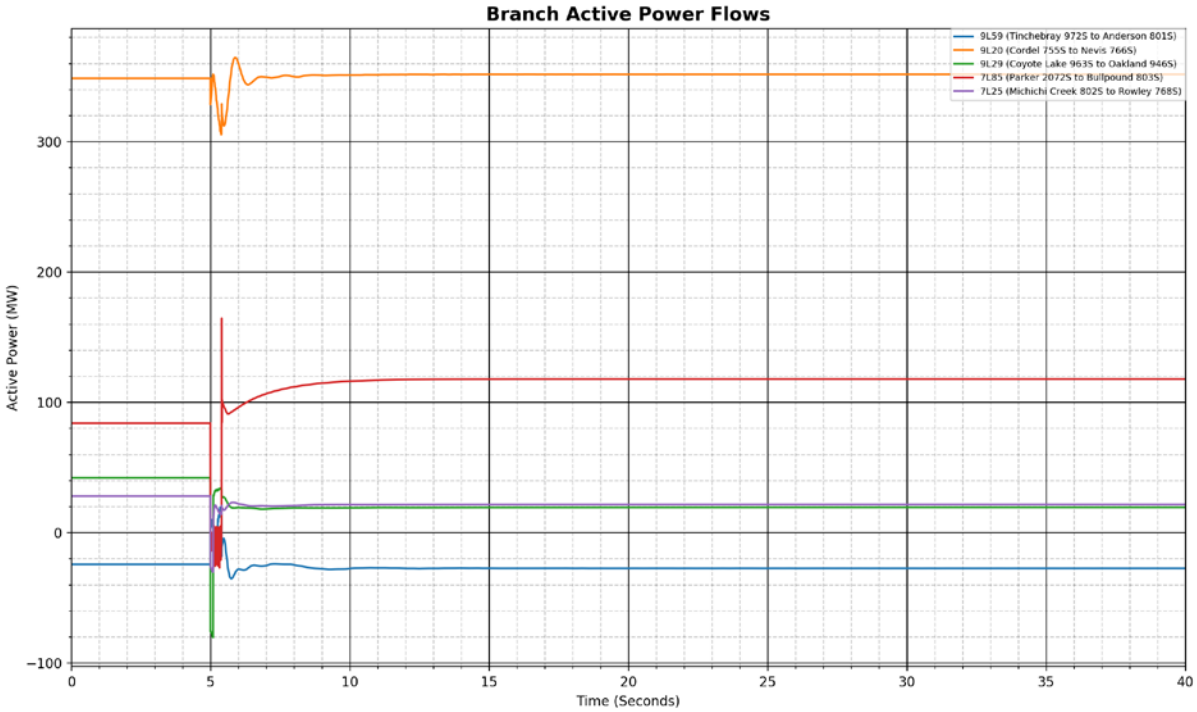

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
Time (Seconds)

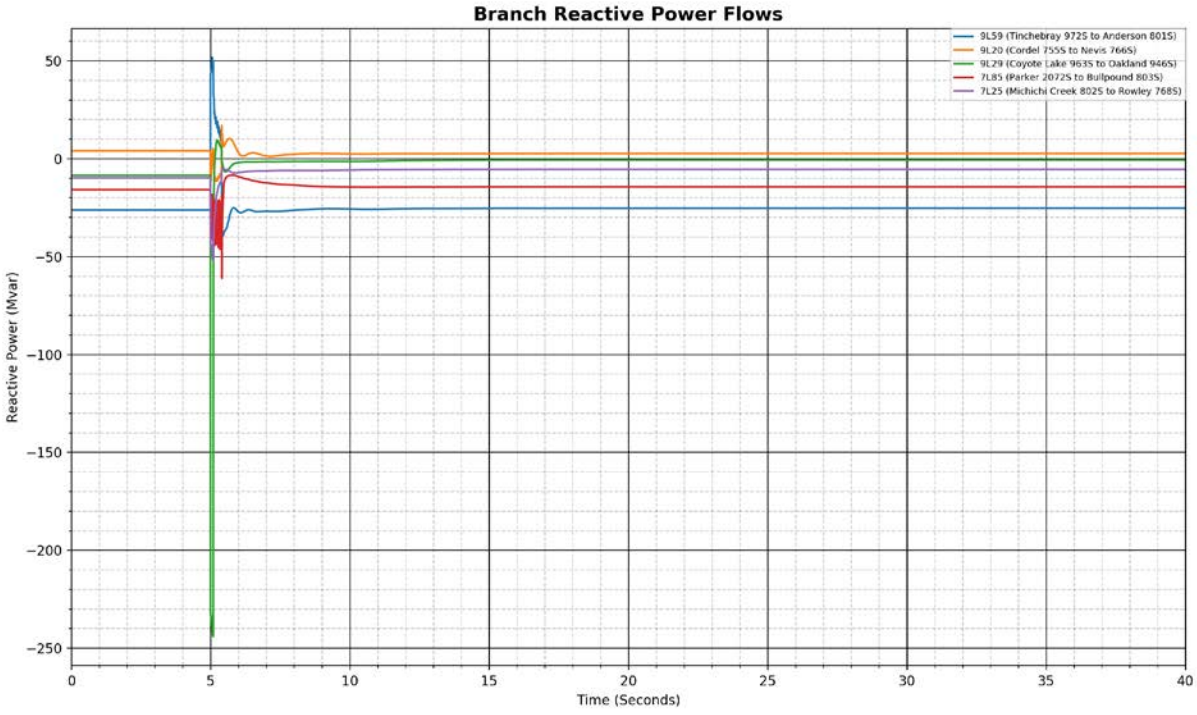
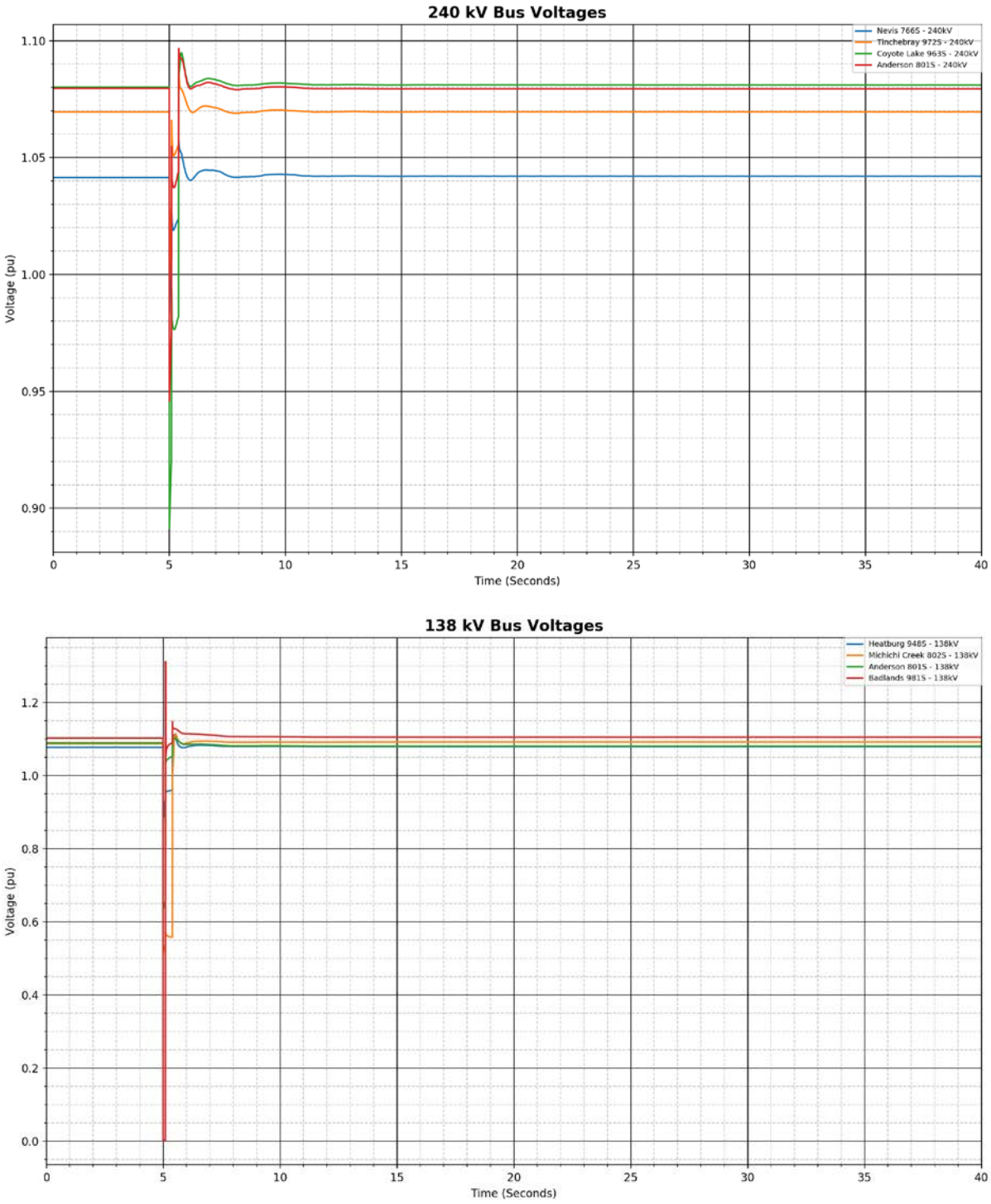
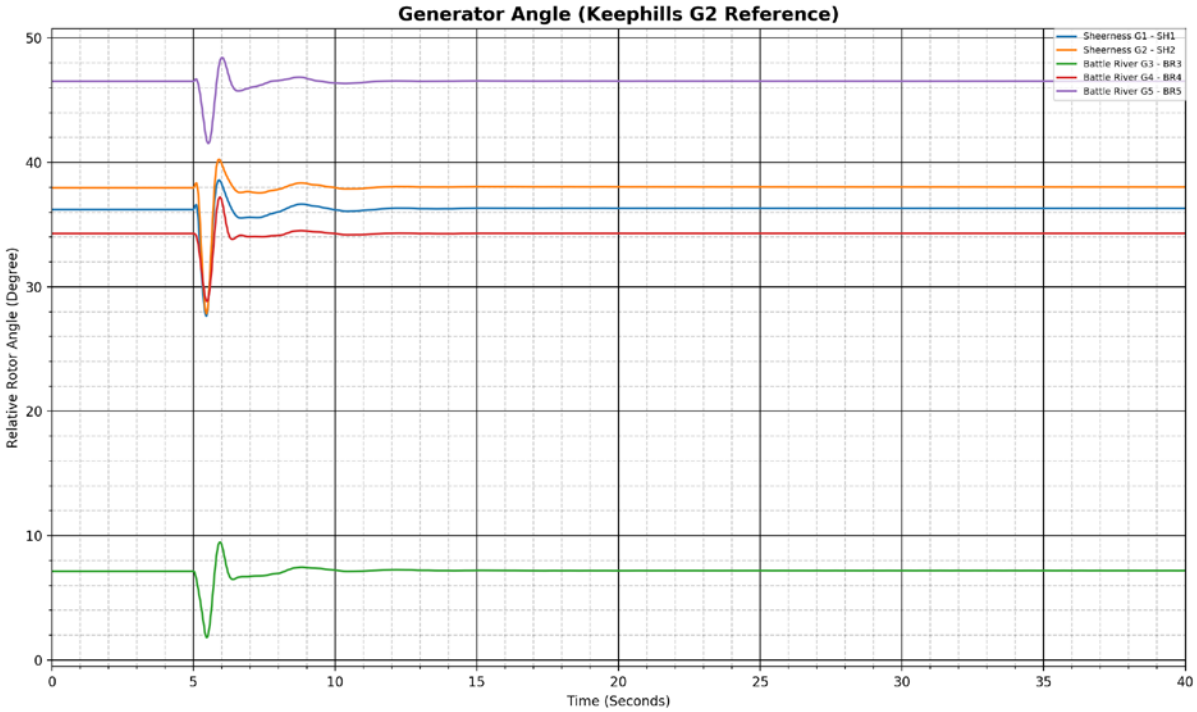
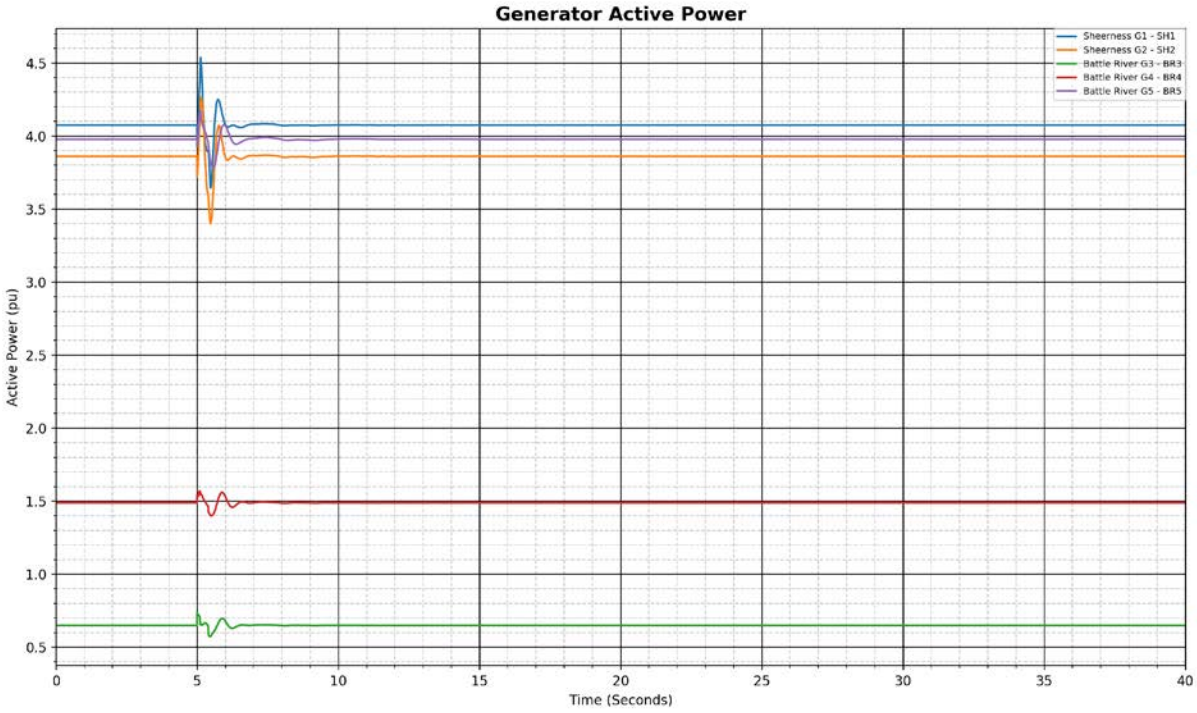
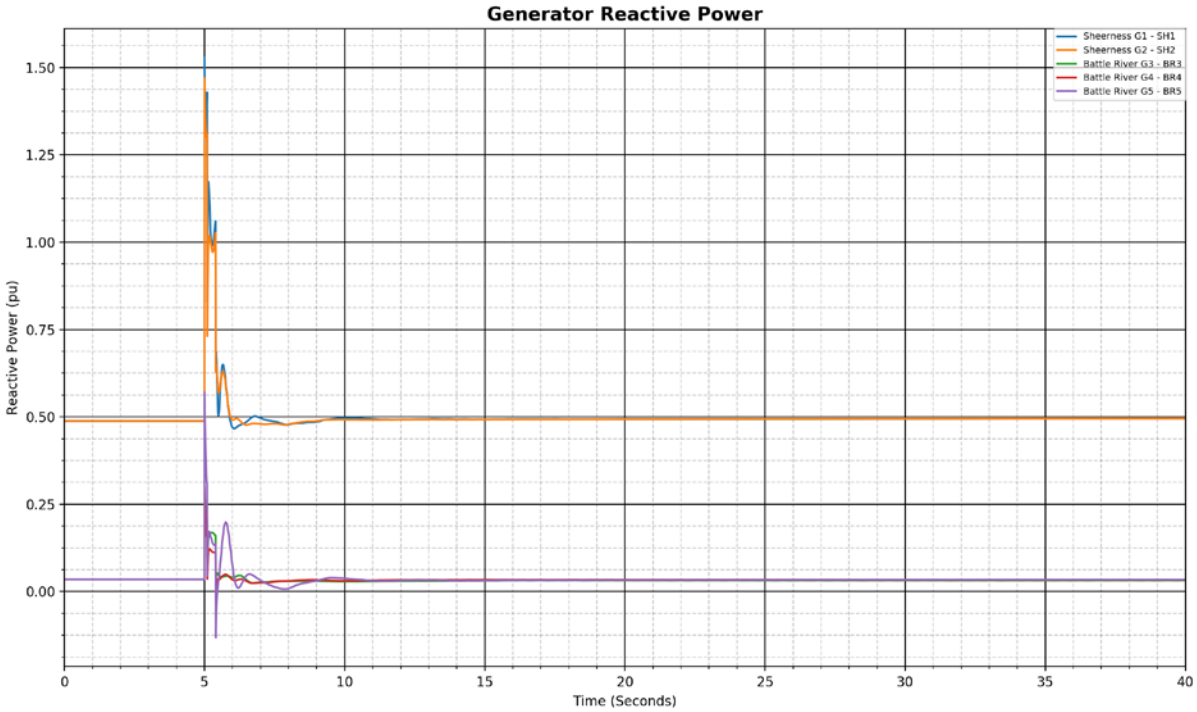

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
Time (Seconds)

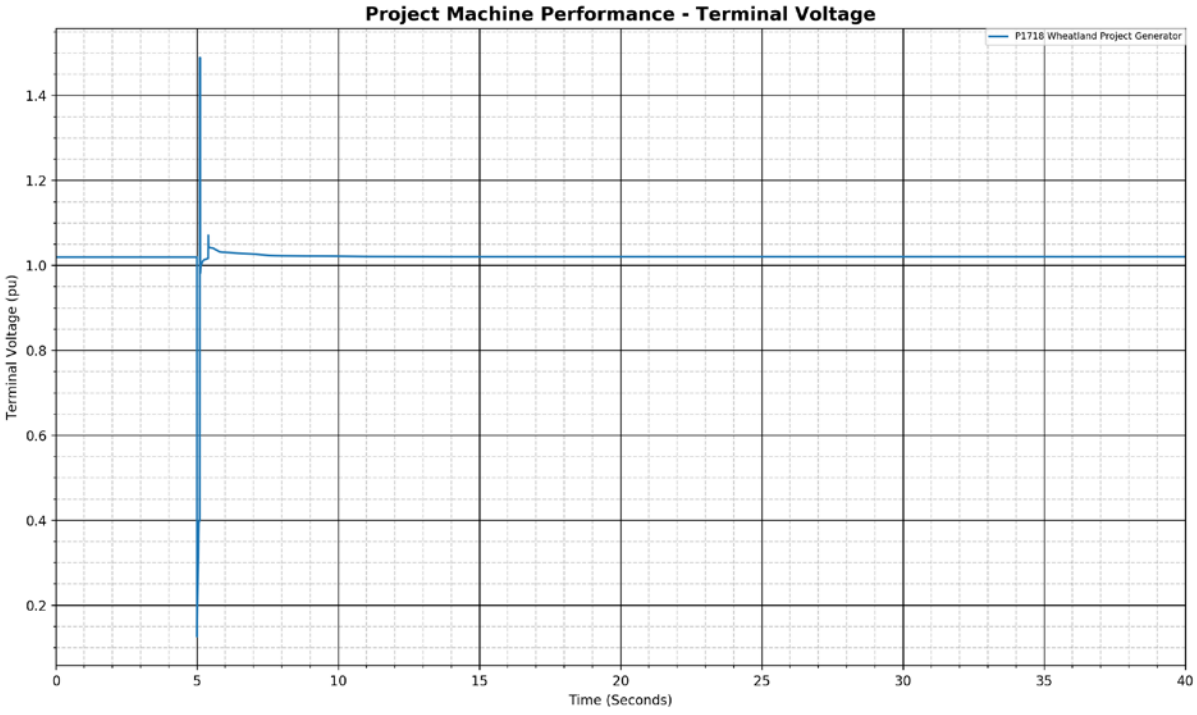
Figure A4-66: 7L203 (Wintering Hills 804S - Parker 2072S): 3-phase fault at Parker 2072S

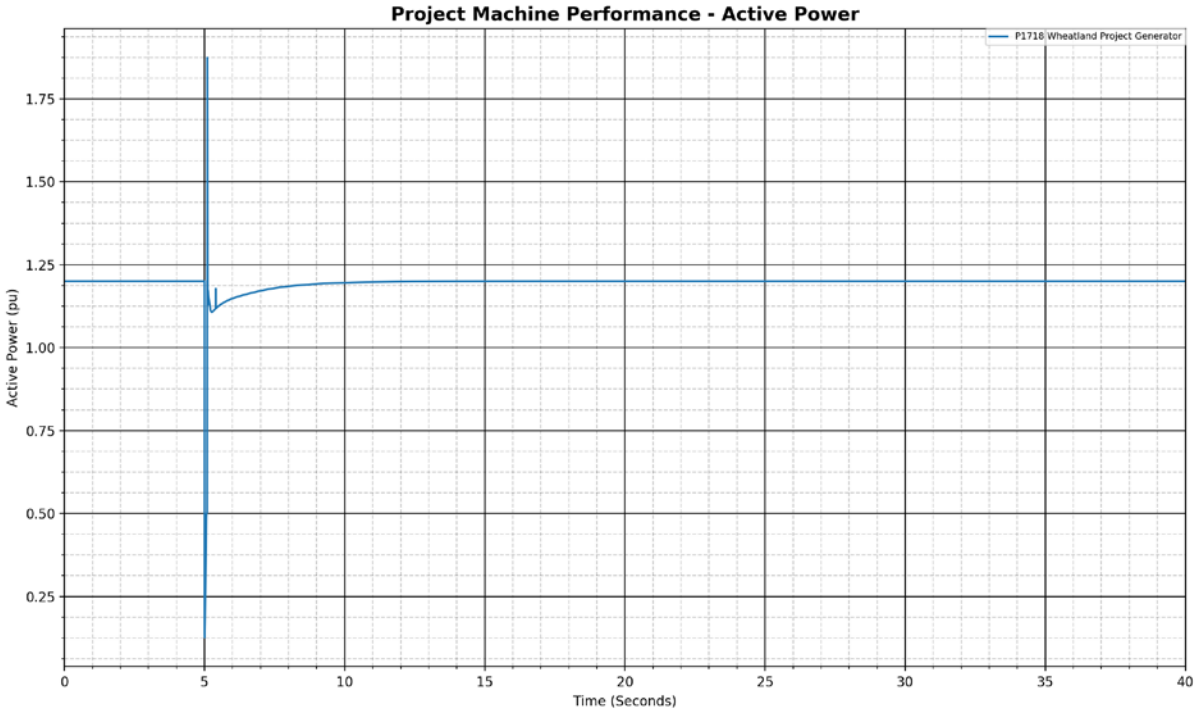


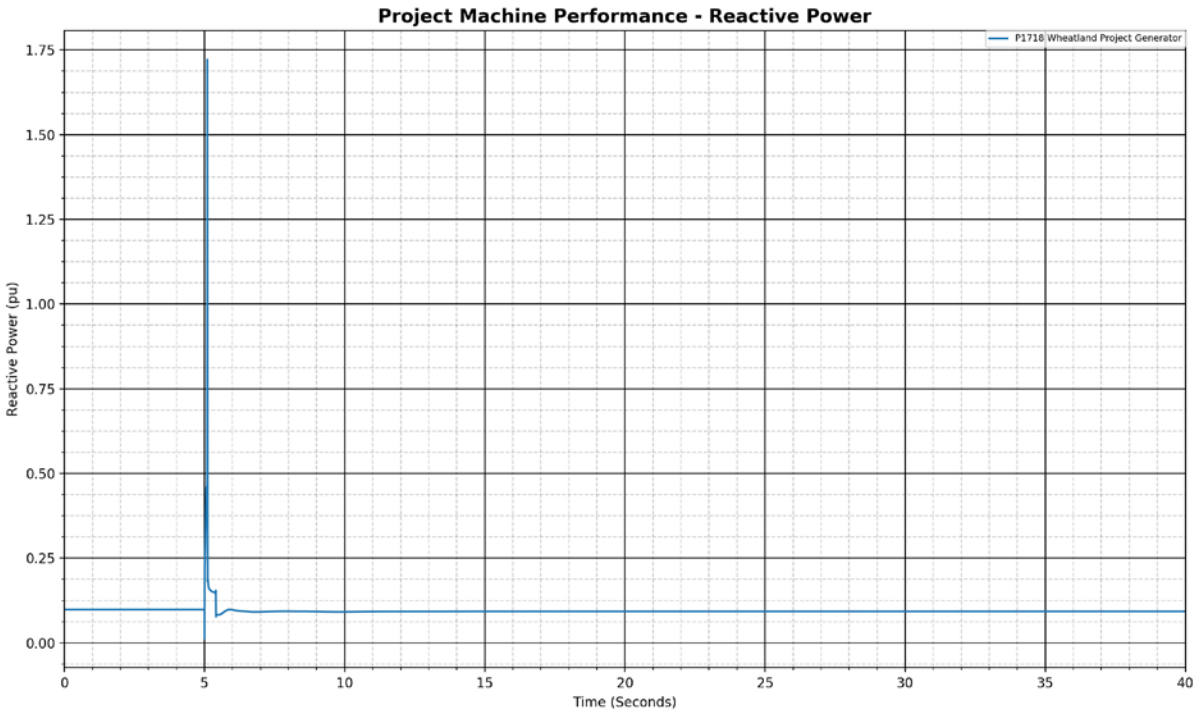

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

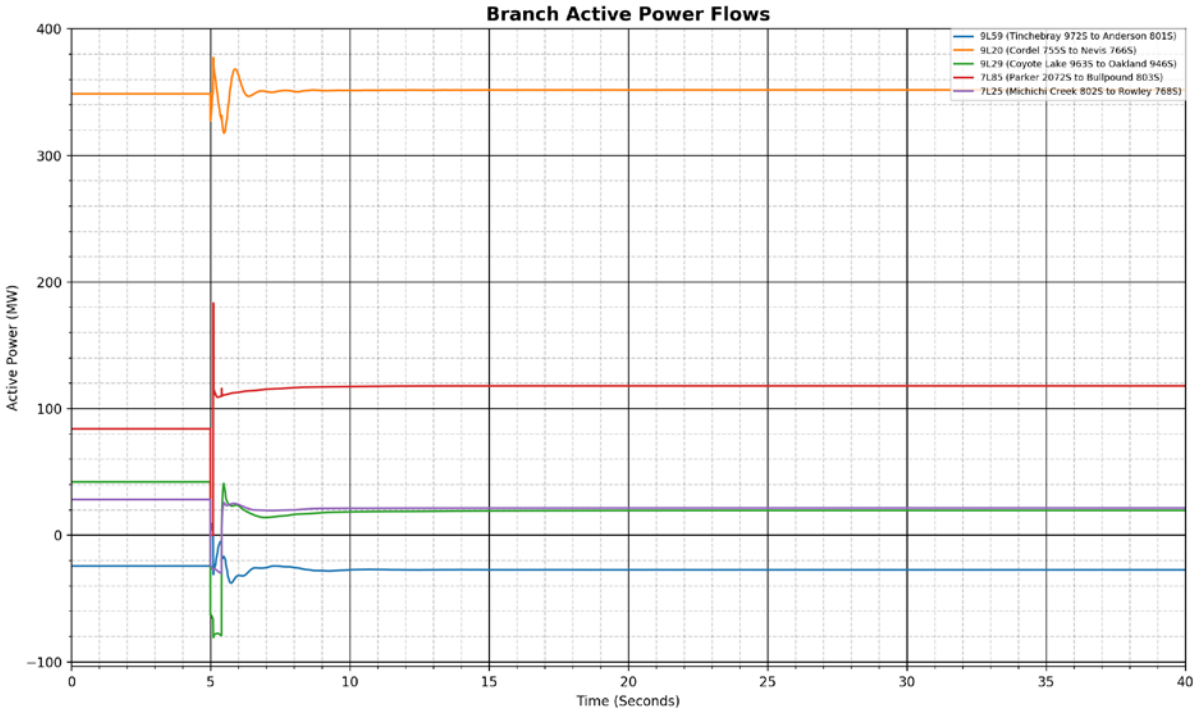

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
Time (Seconds)

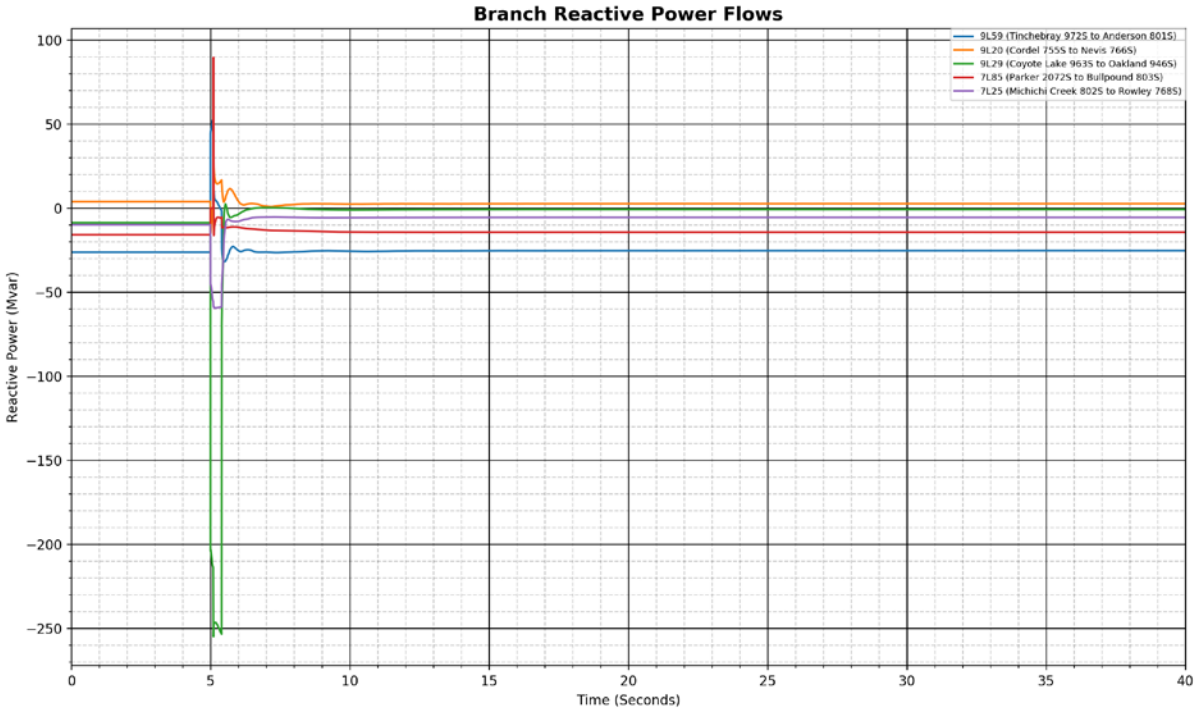
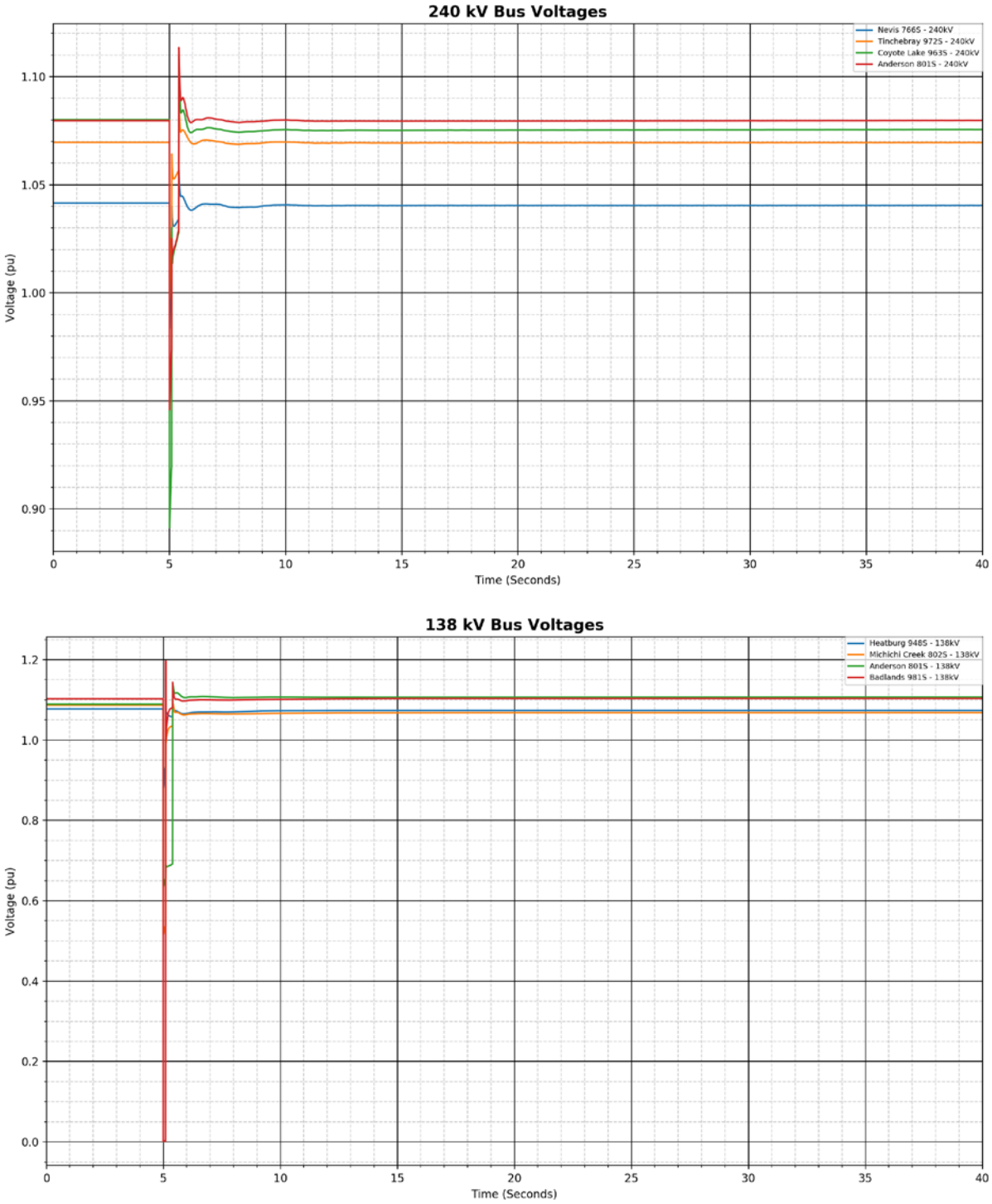
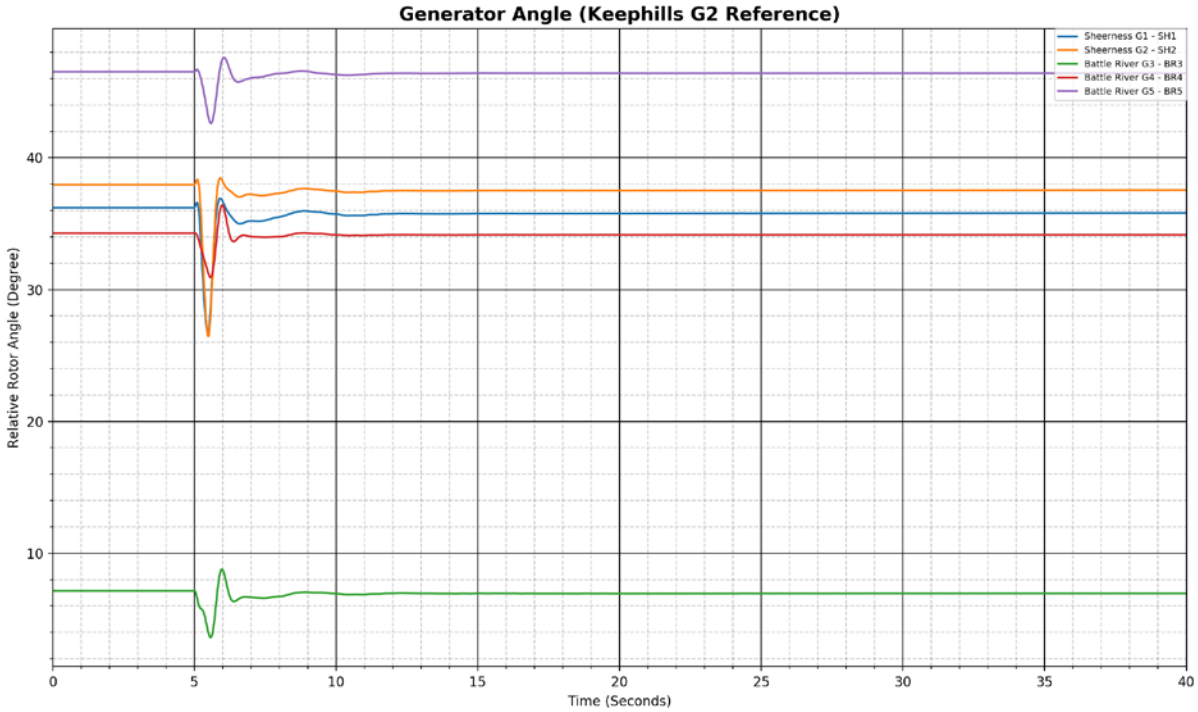
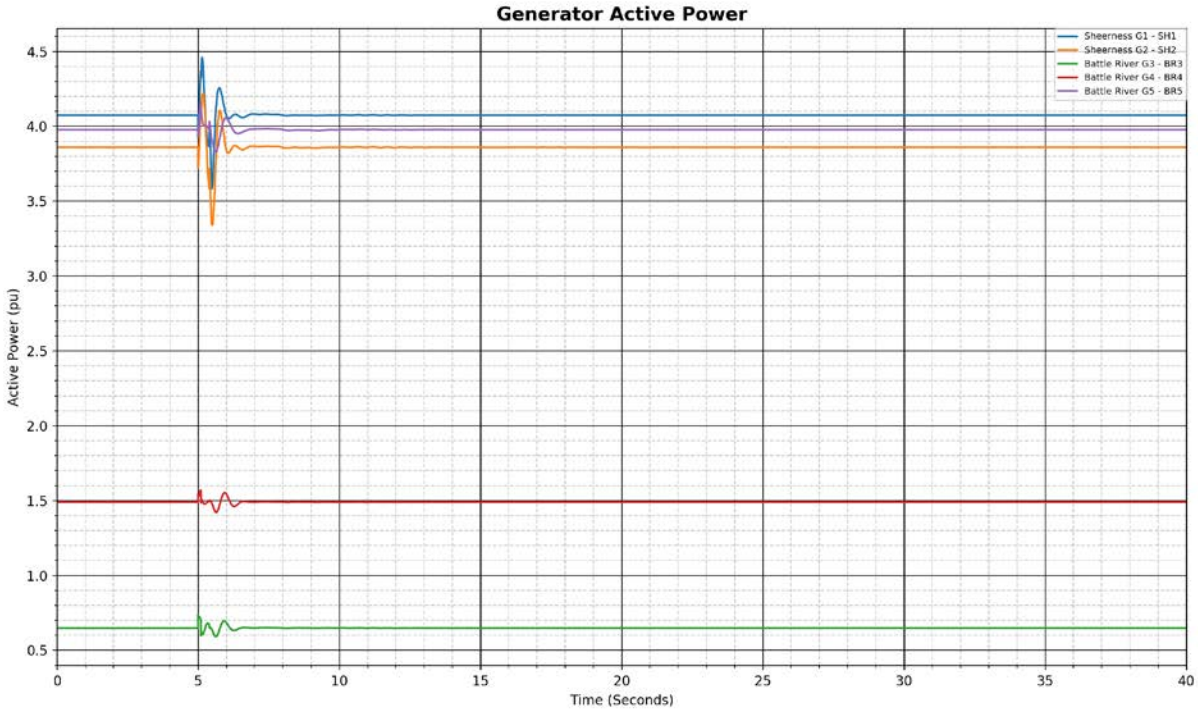
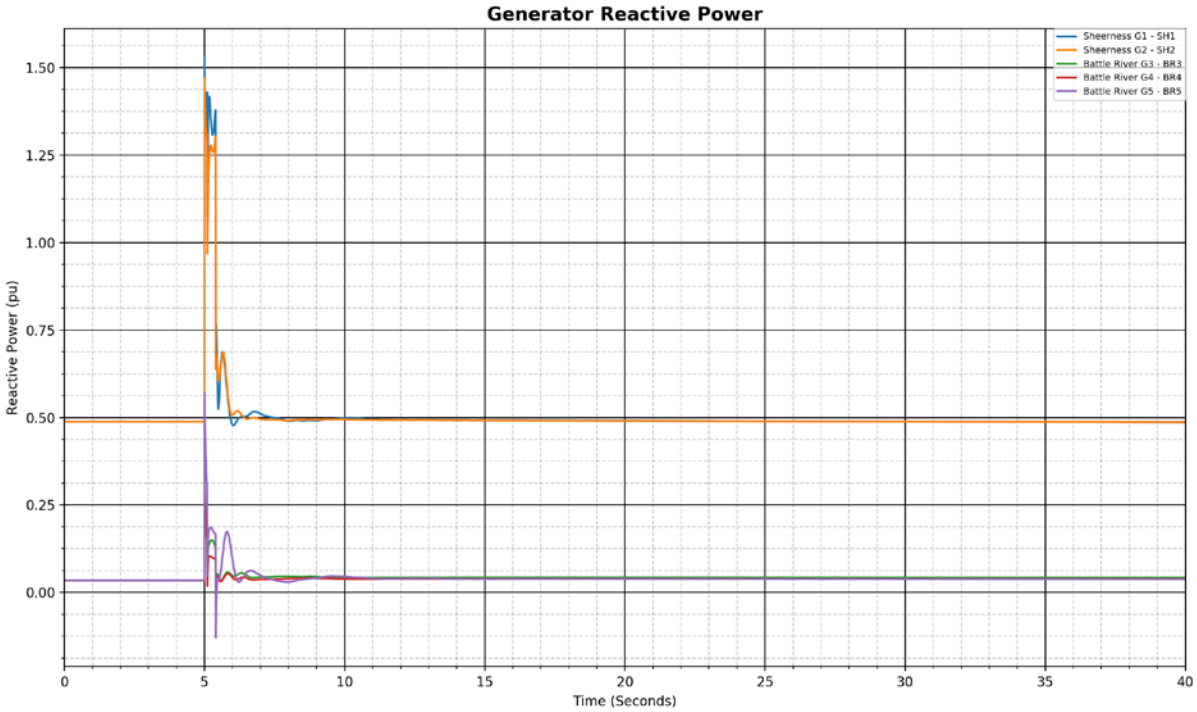

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
Time (Seconds)

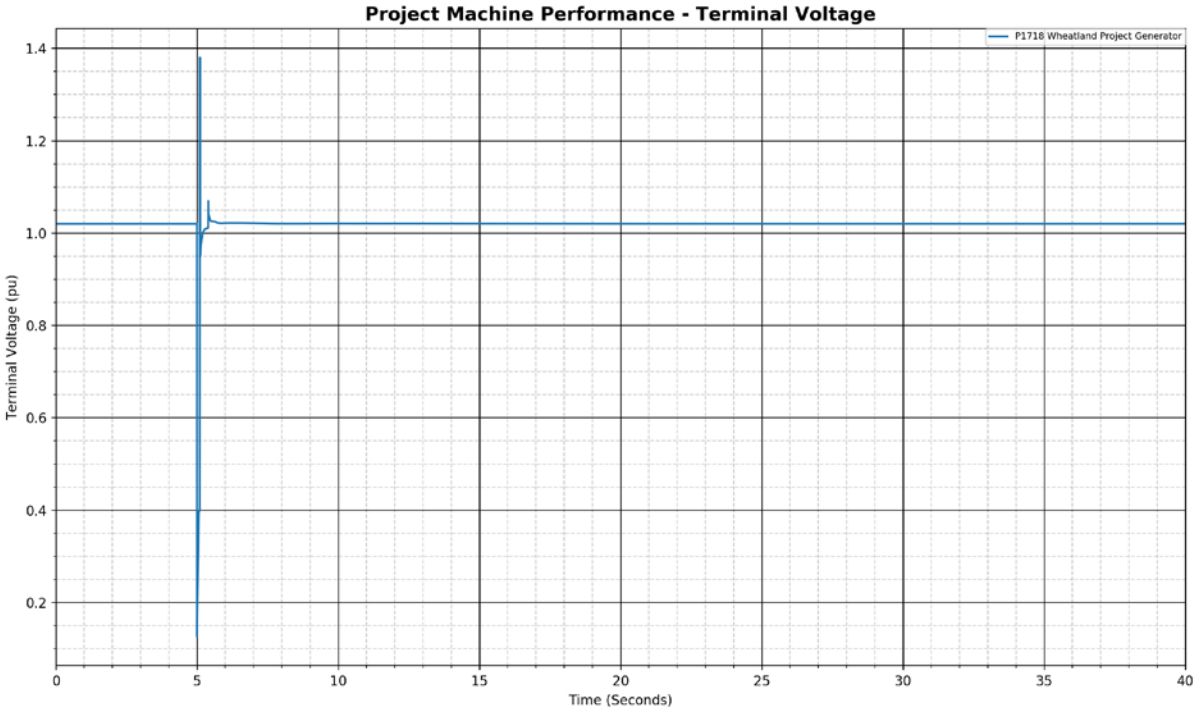
Figure A4-67: 7L85 (Parker 2072S - Anderson 801S): 3-phase fault at Parker 2072S

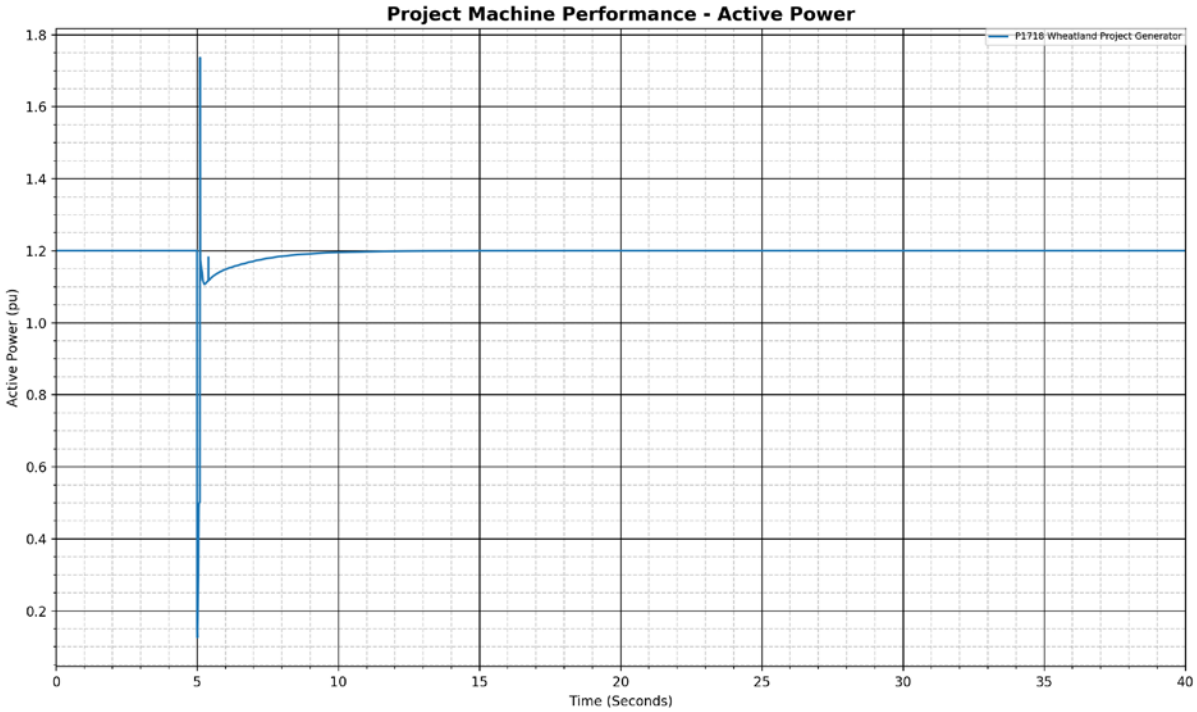


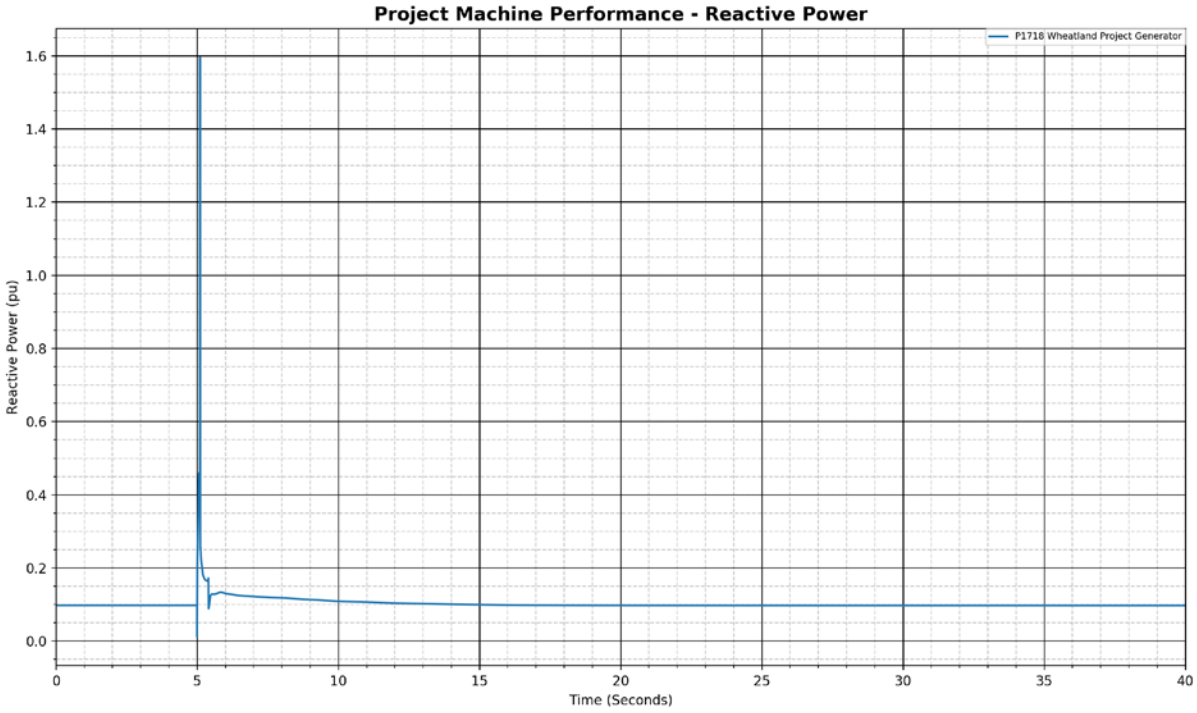

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

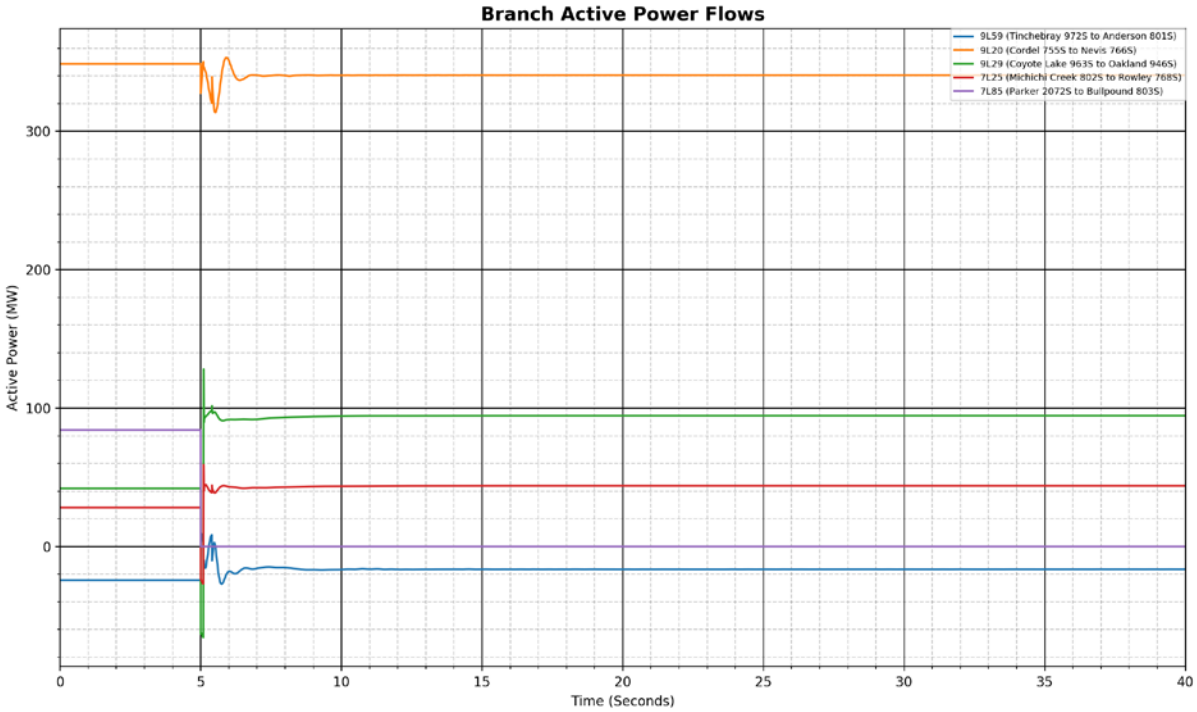

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Active Power (MW)
300
200
100
0
0
5
10
15
20
25
30
35
40
Time (Seconds)

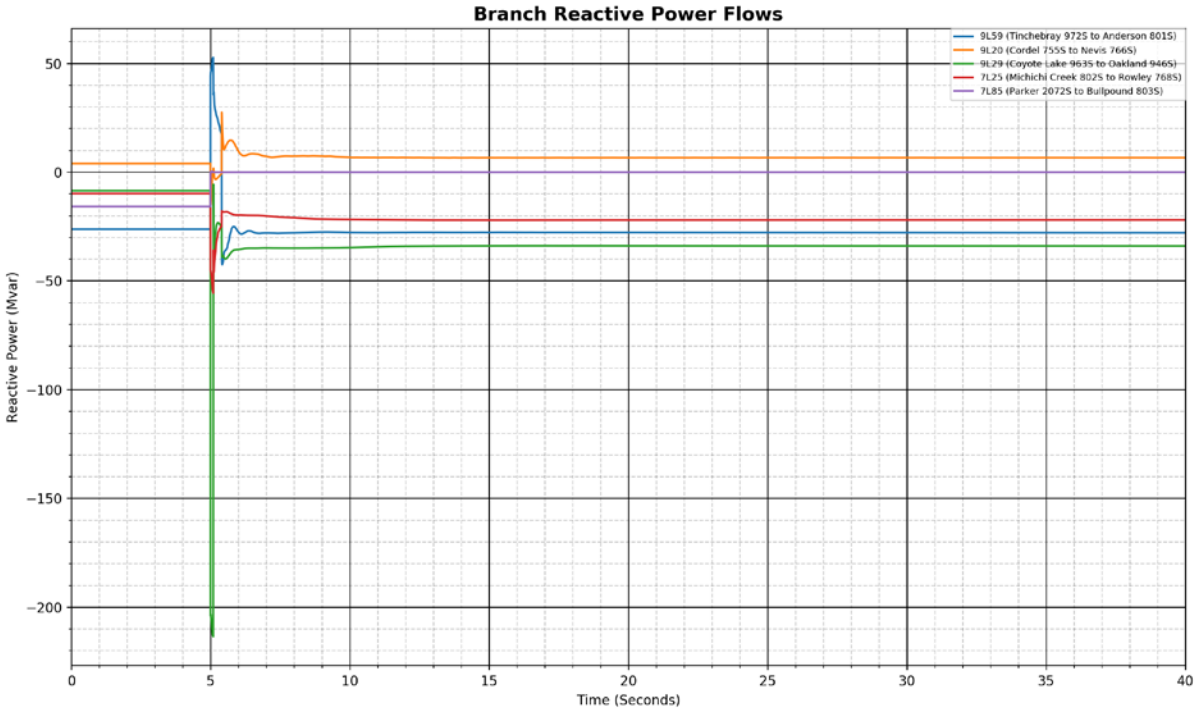
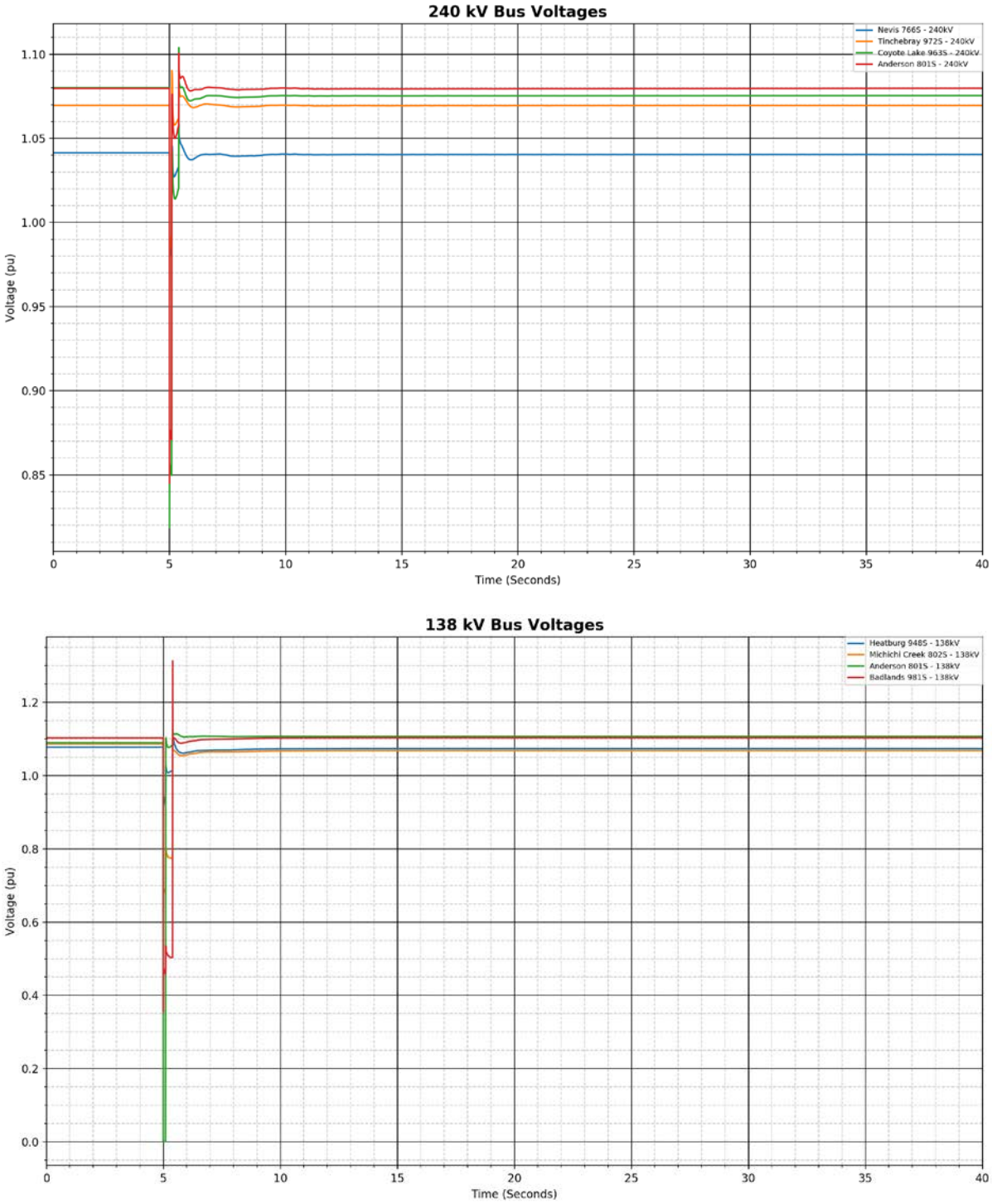
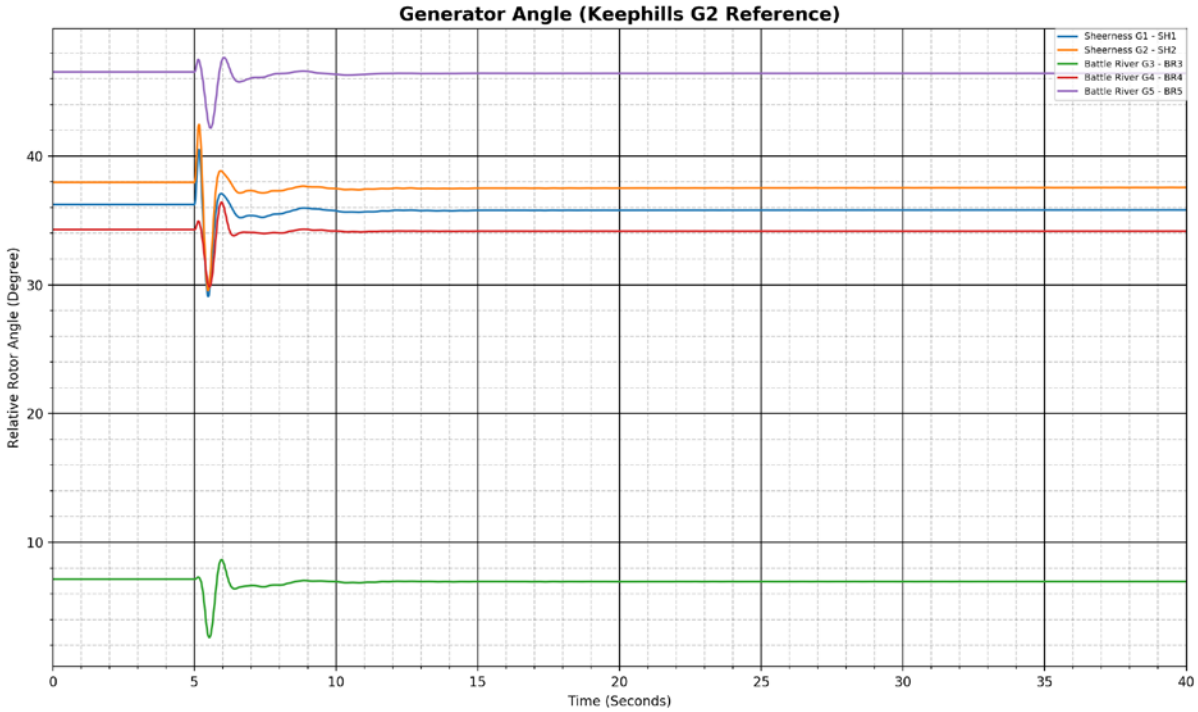
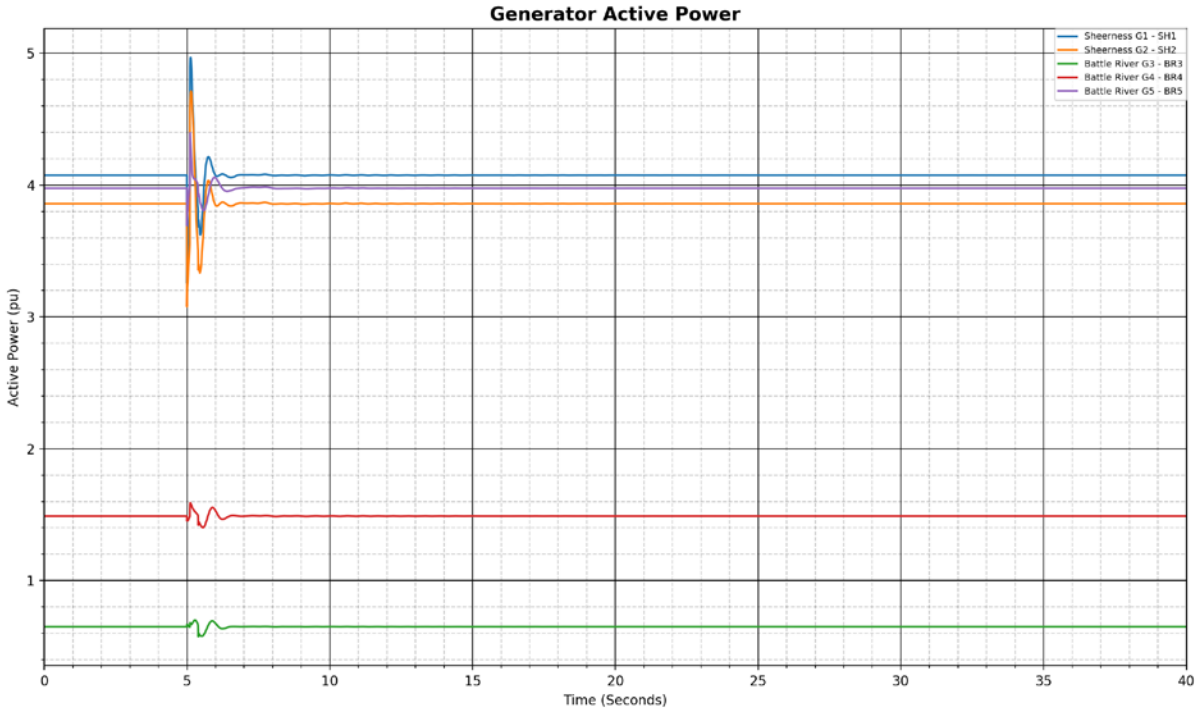
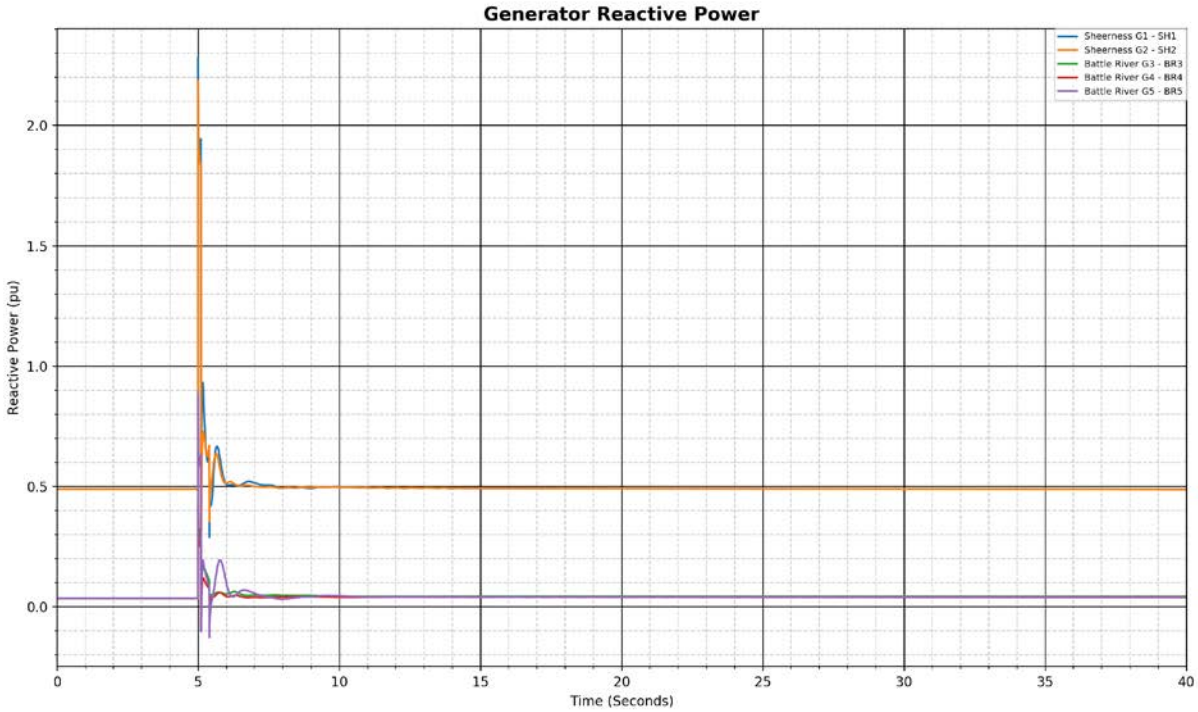

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Reactive Power (Mvar)
50
0
−50
−100
−150
−200
0
5
10
15
20
25
30
35
40
Time (Seconds)

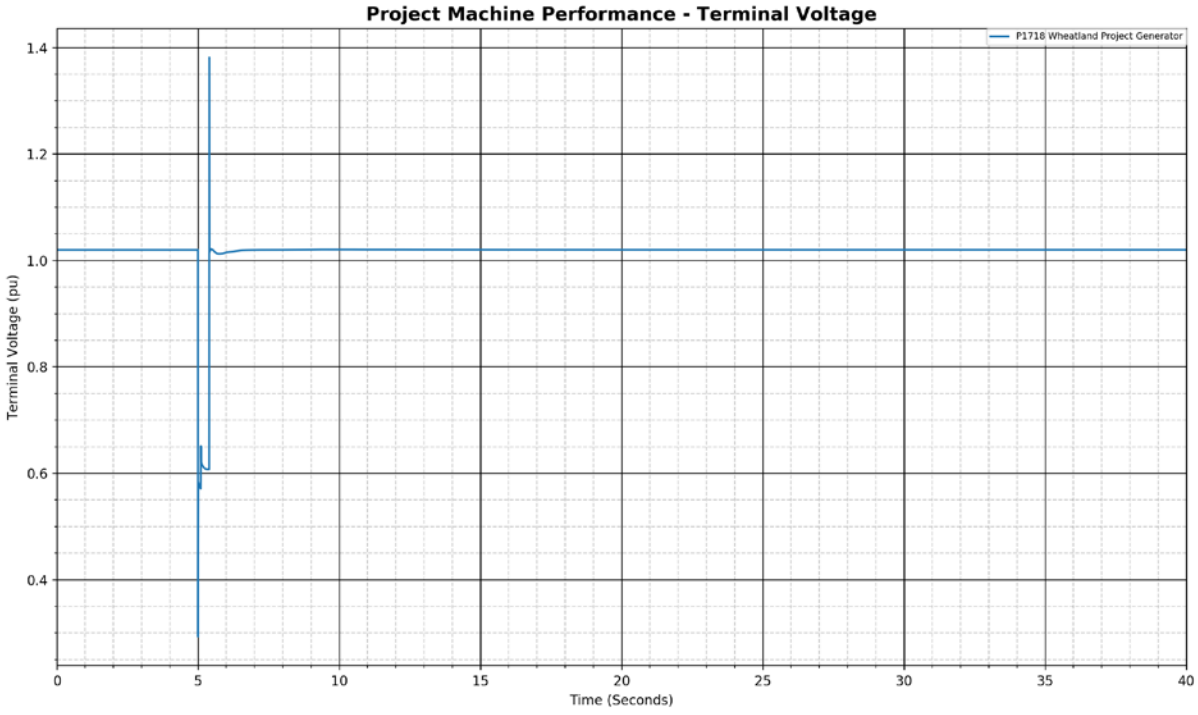
Figure A4-68: 7L85 (Parker 2072S - Anderson 801S): 3-phase fault at Anderson 801S

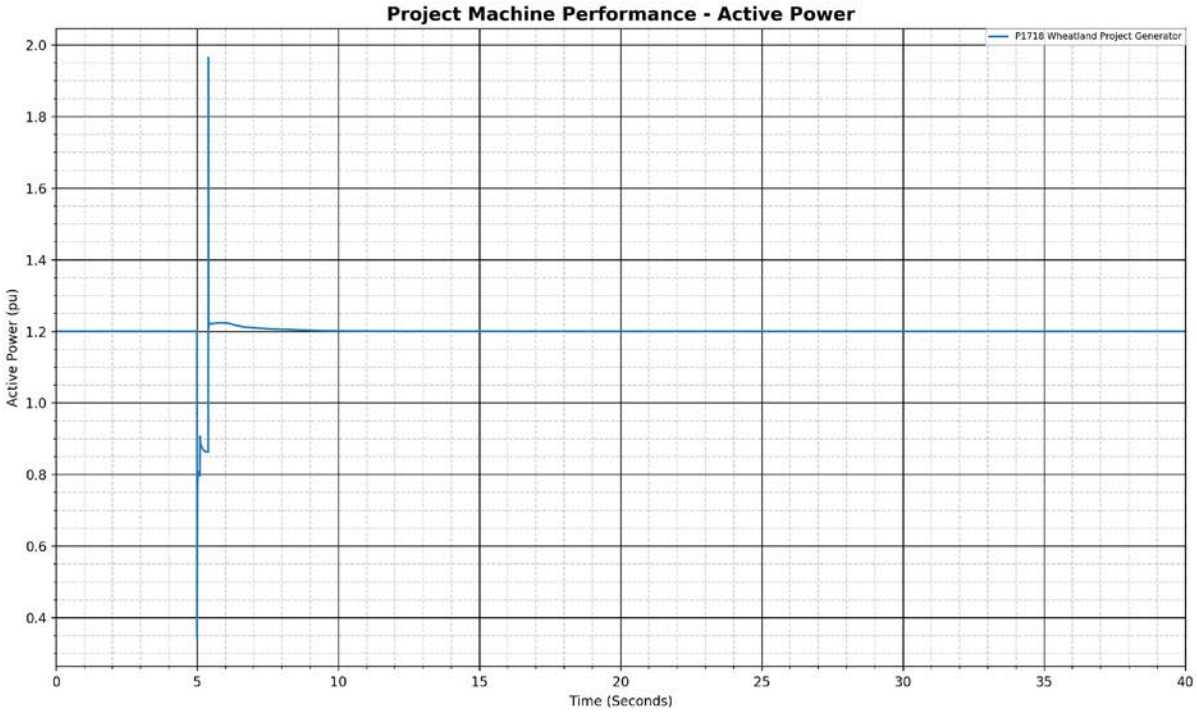


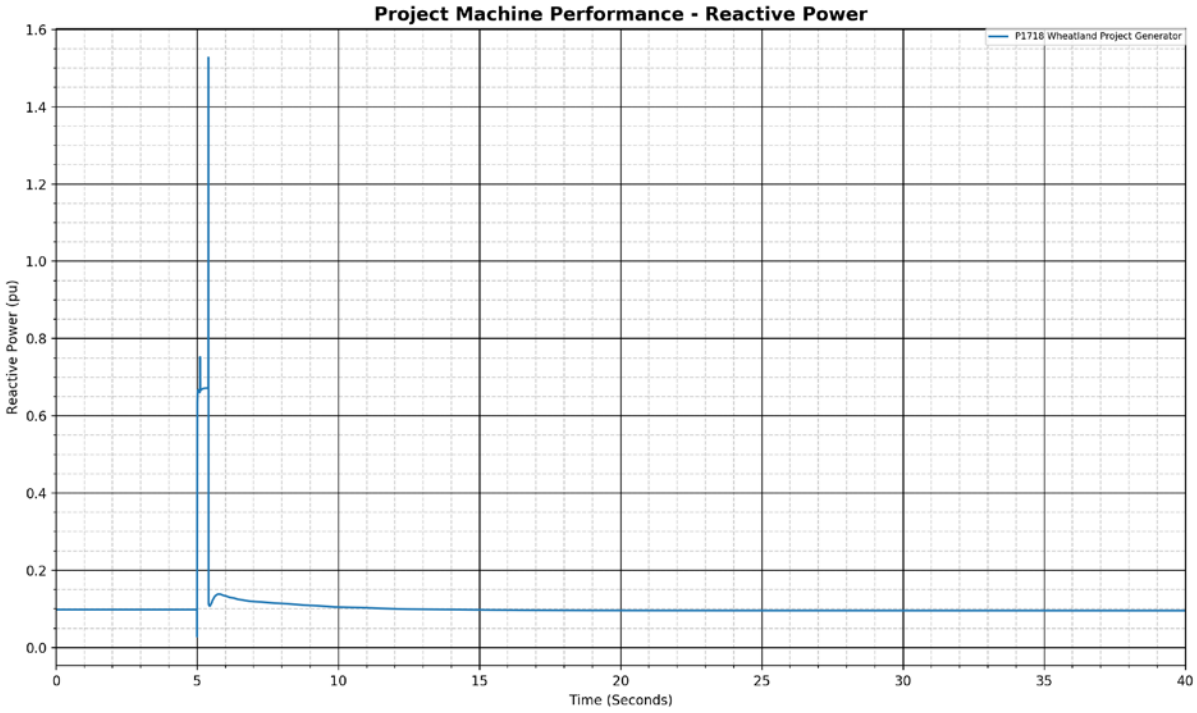

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

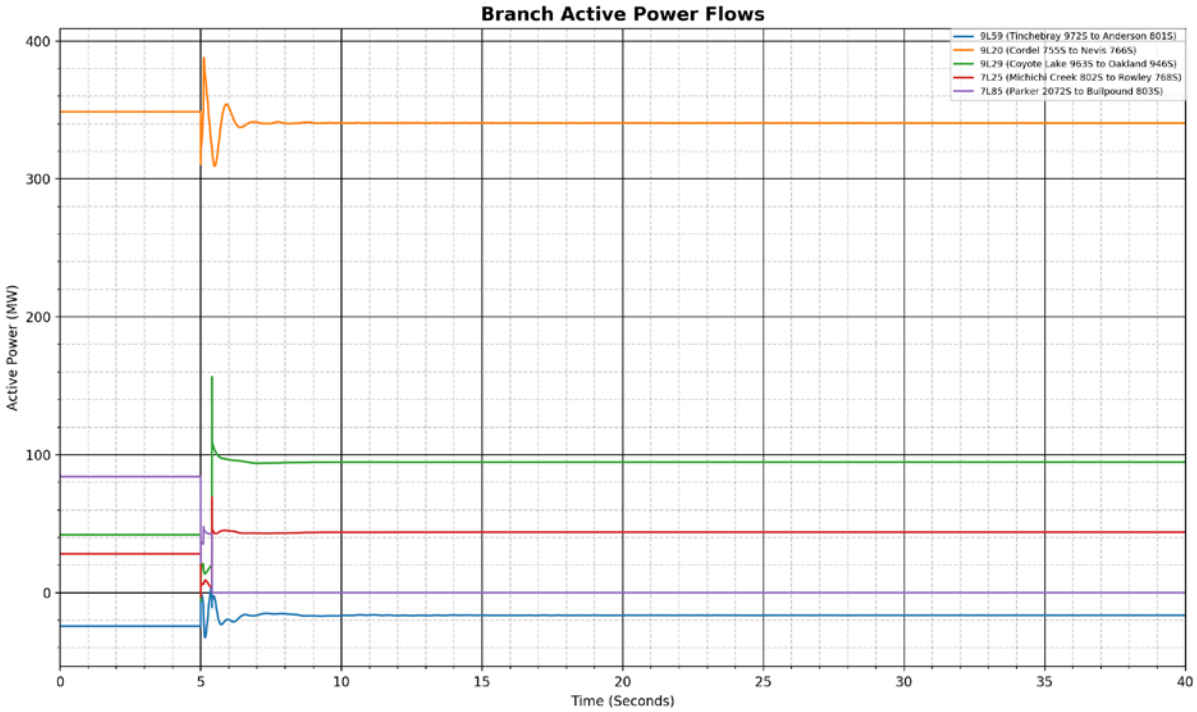

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
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
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Active Power (MW)
Time (Seconds)

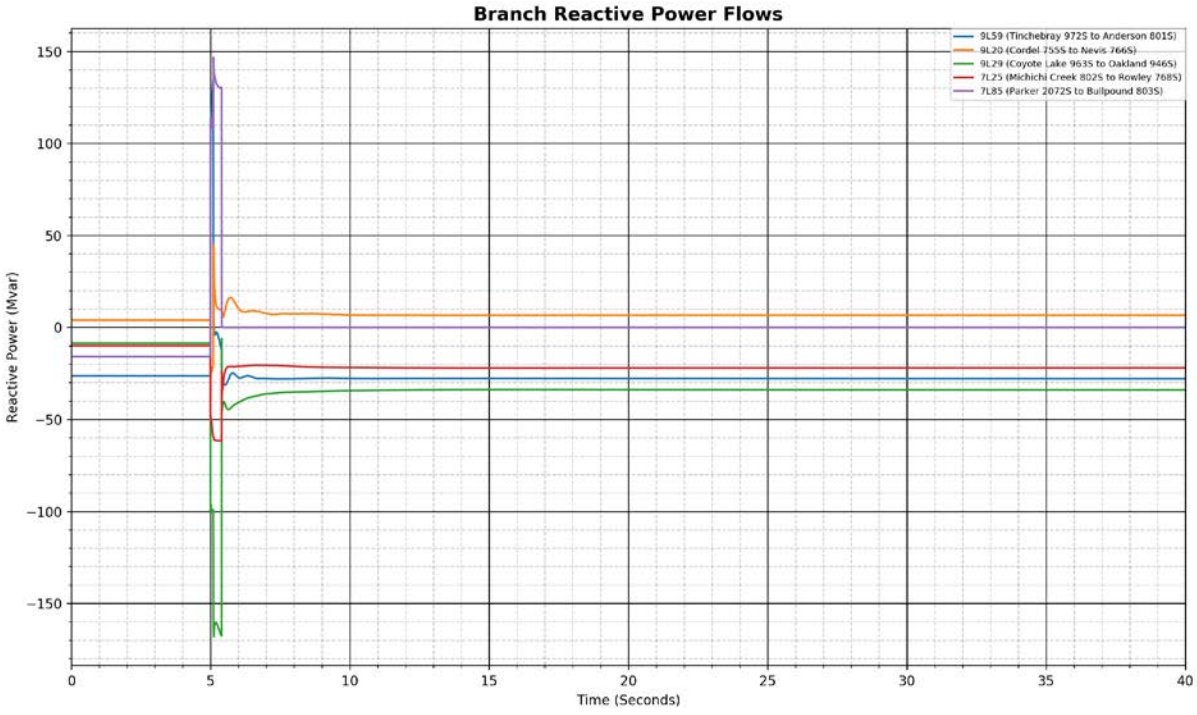
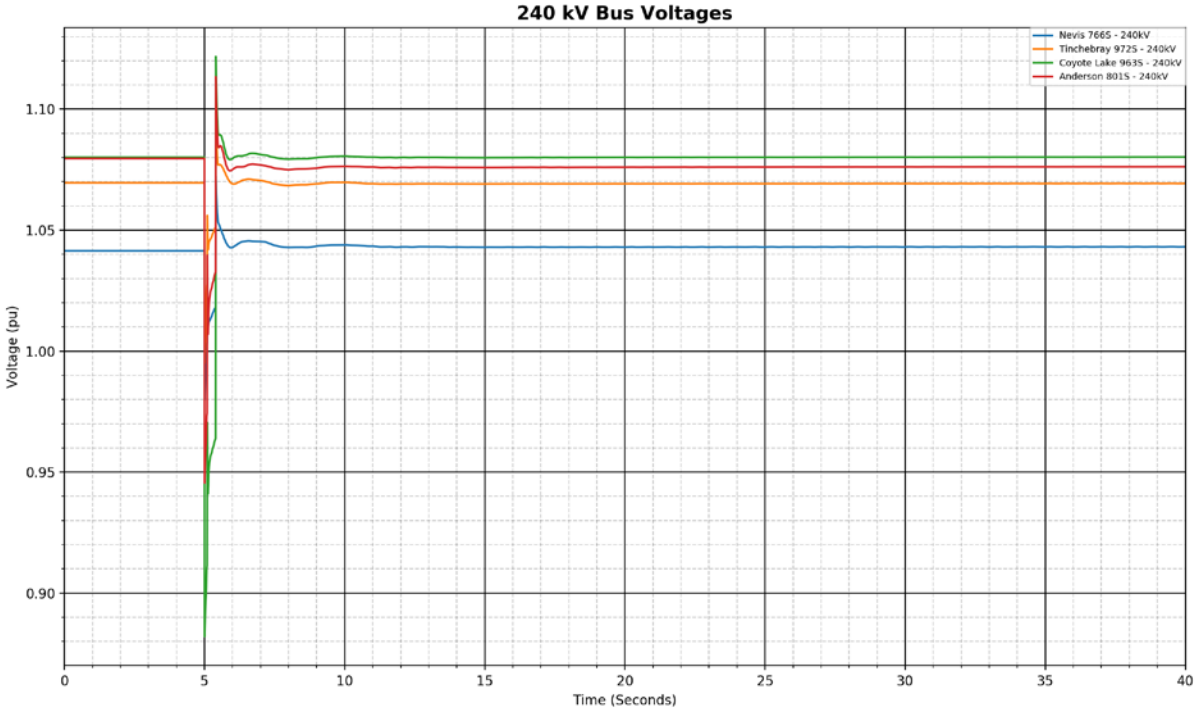
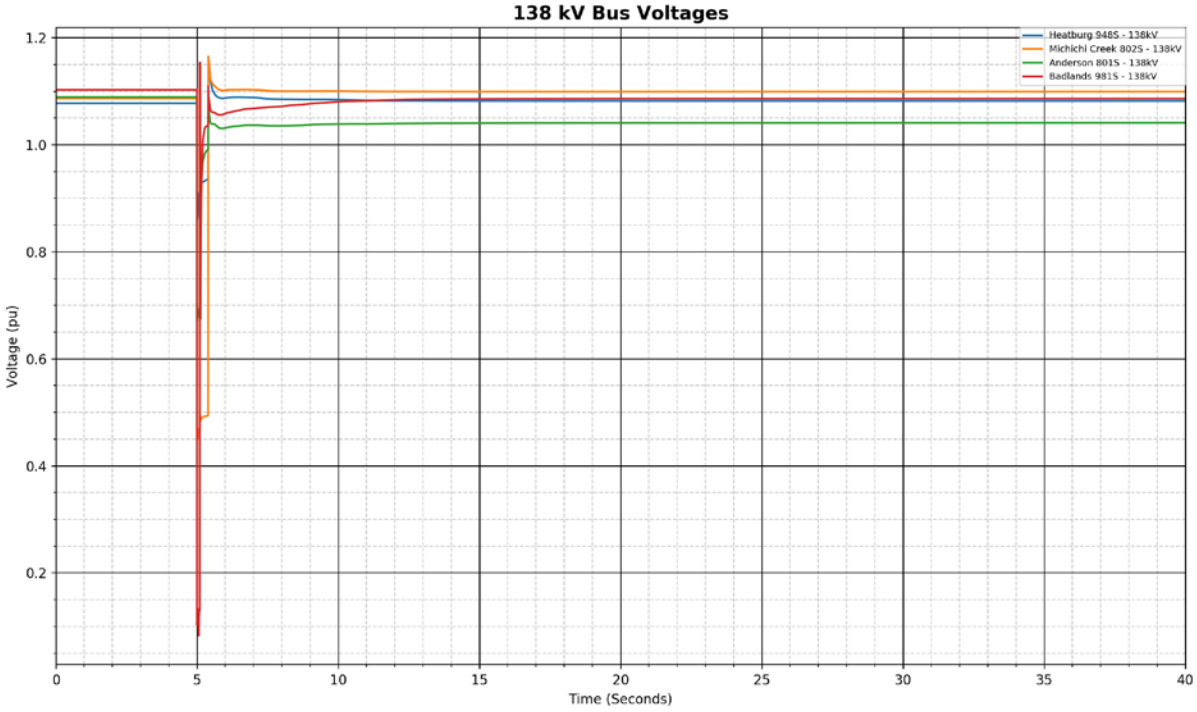
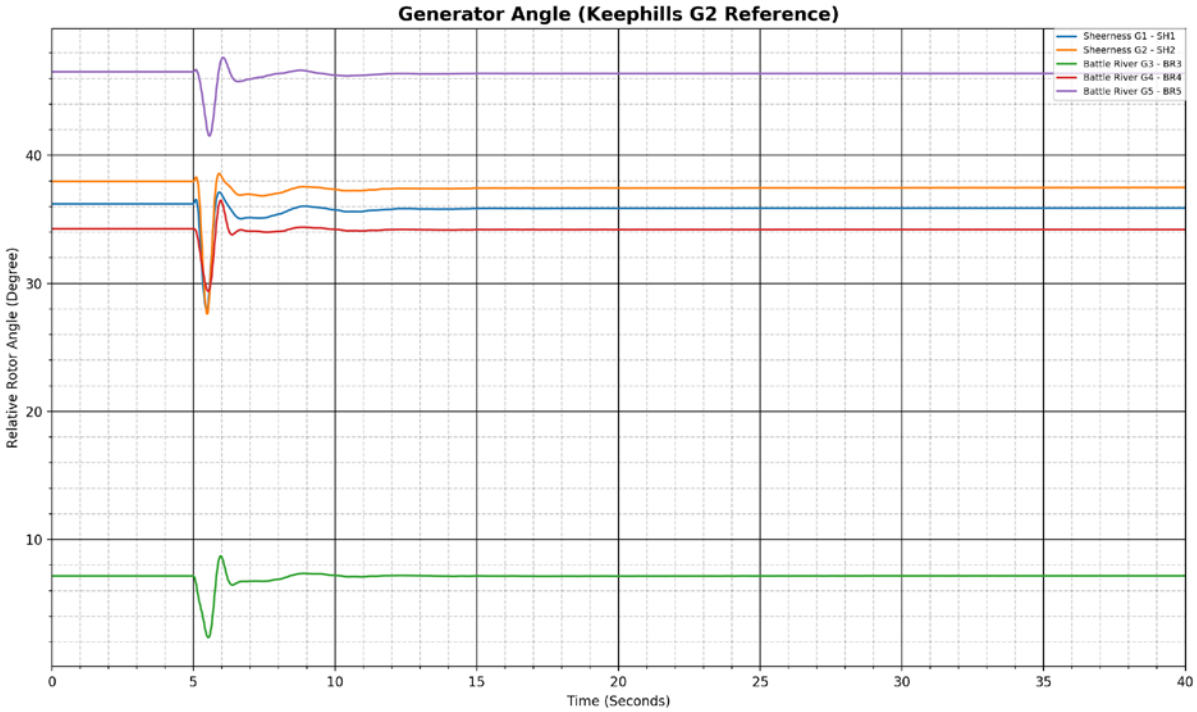
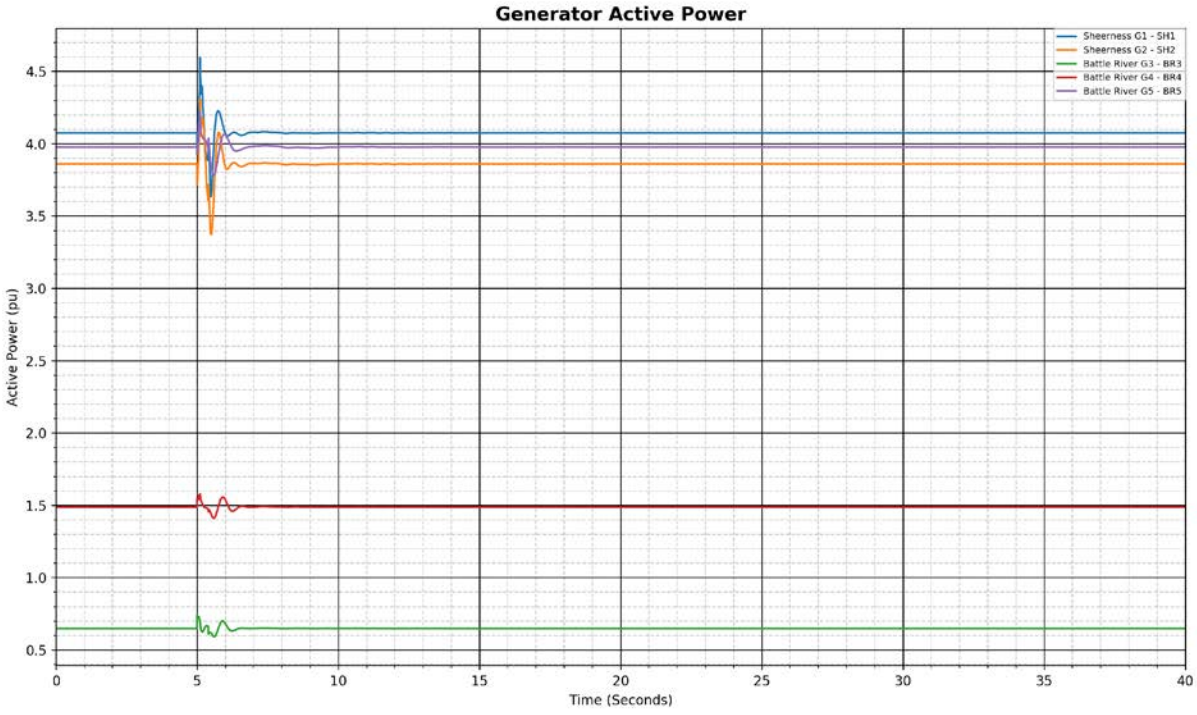

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L85 (Parker 2072S to Bullpound 803S)
Reactive Power (Mvar)
Time (Seconds)

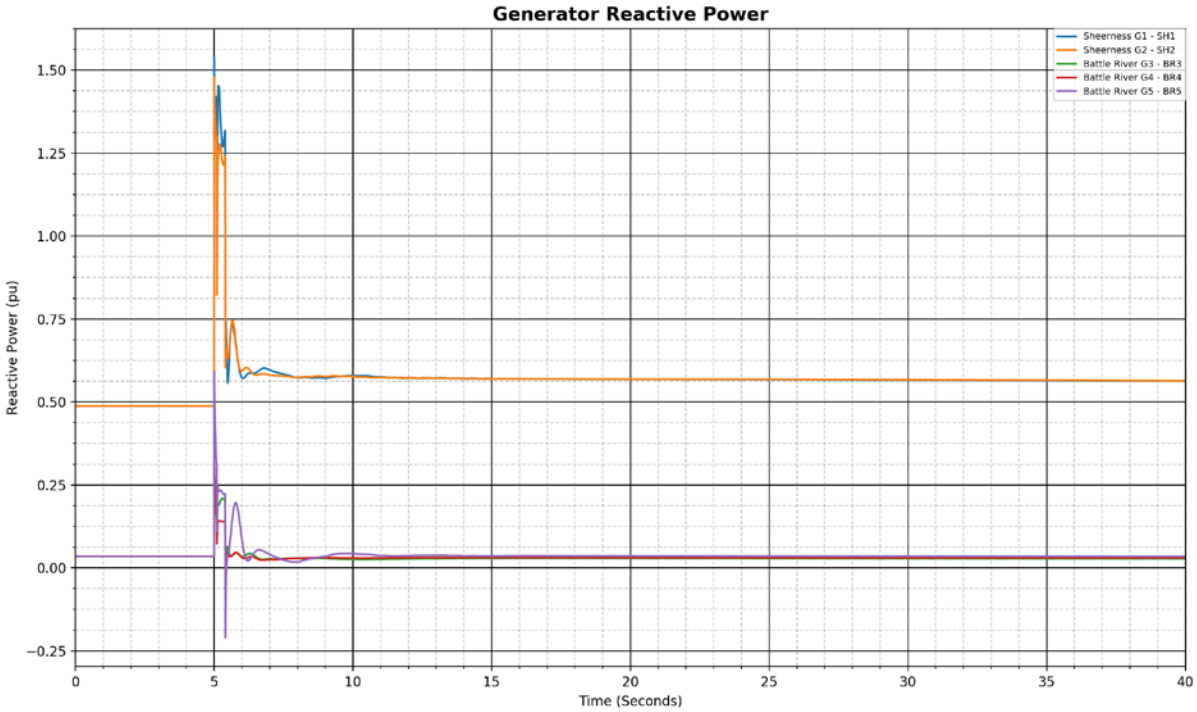
Figure A4-69: 7L171 (Wintering Hills 804S - Michichi Creek 802S): 3-phase fault at Wintering Hills 804S

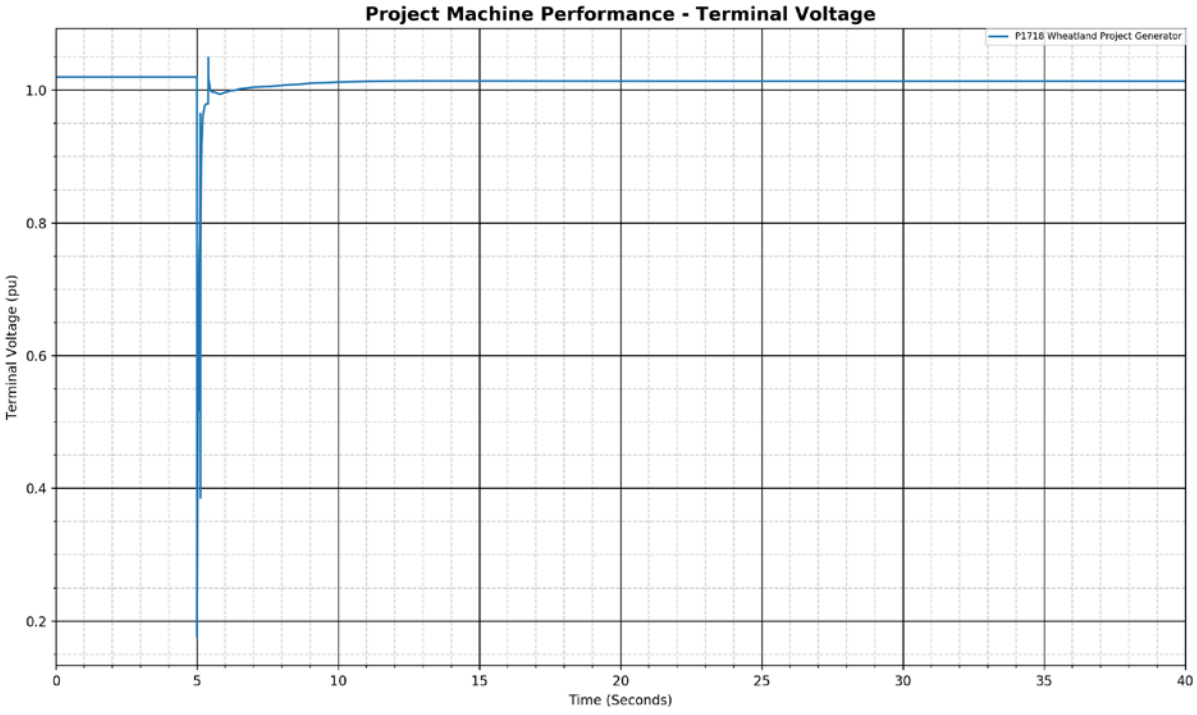


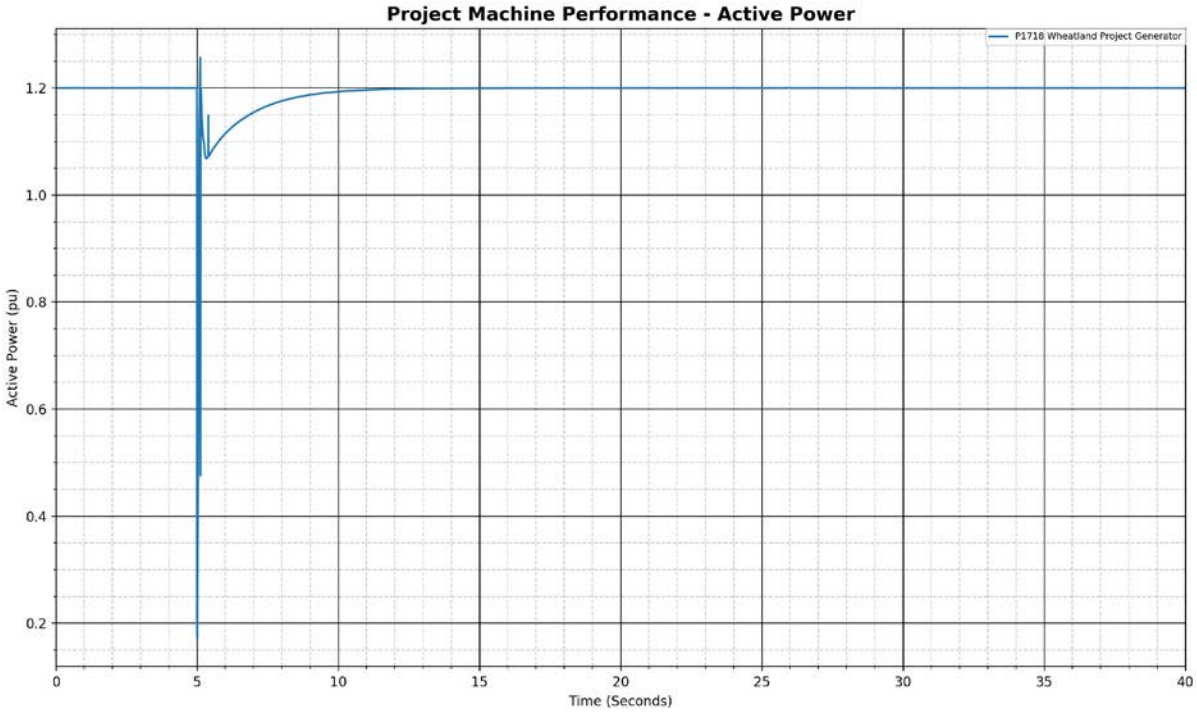


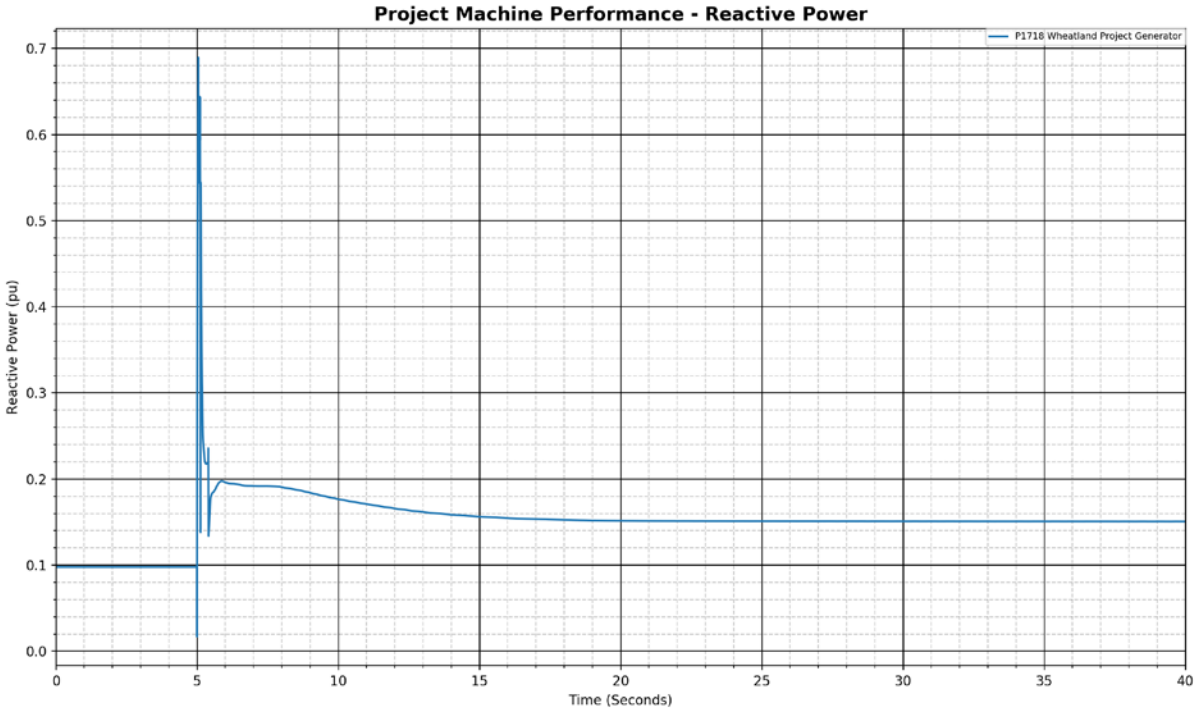

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

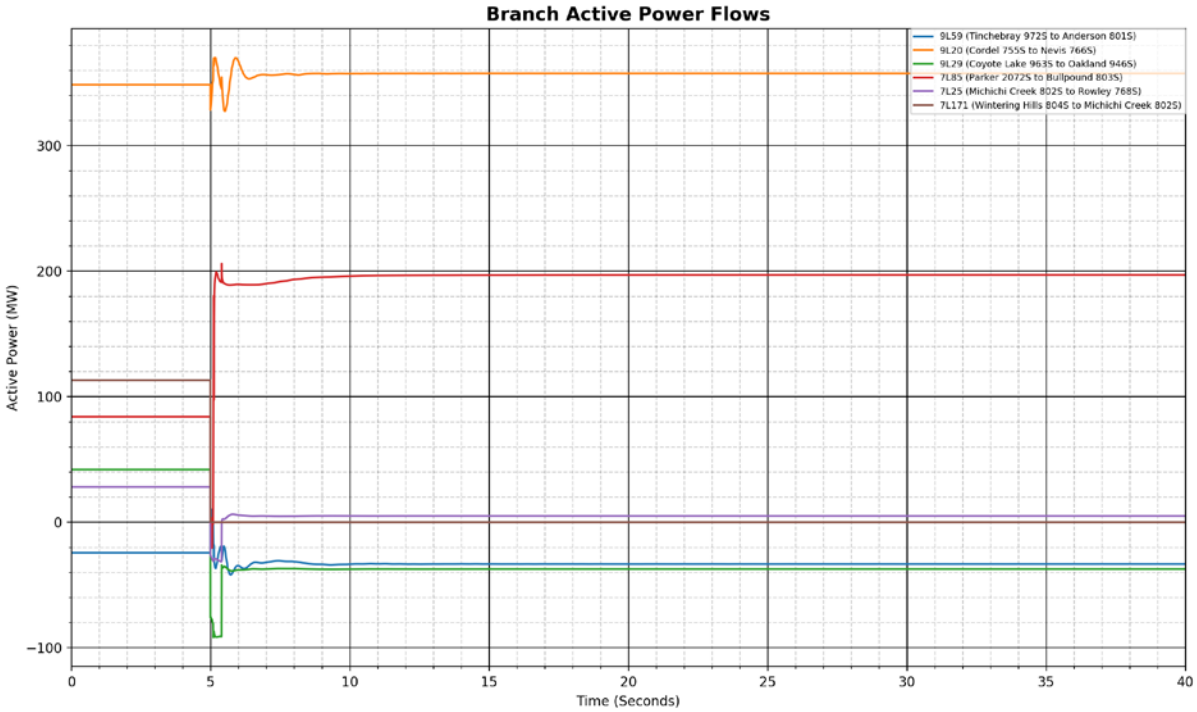

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Active Power (MW)
300
200
100
0
−100
0
5
10
15
20
25
30
35
40
Time (Seconds)

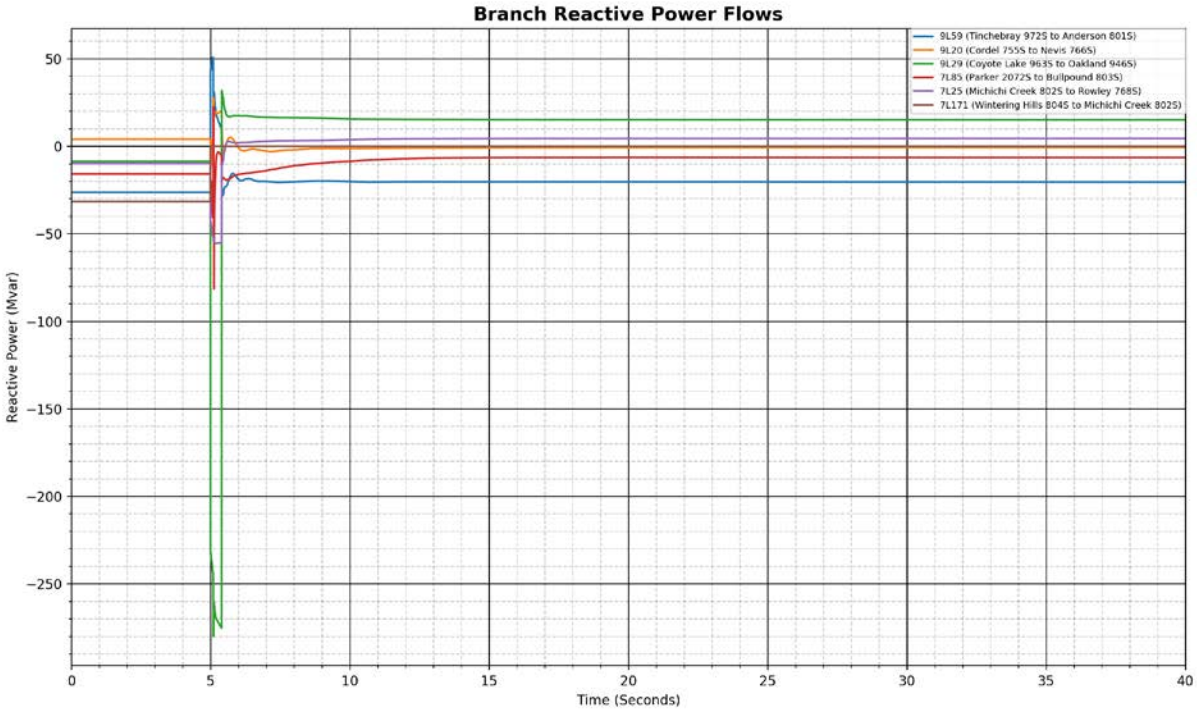
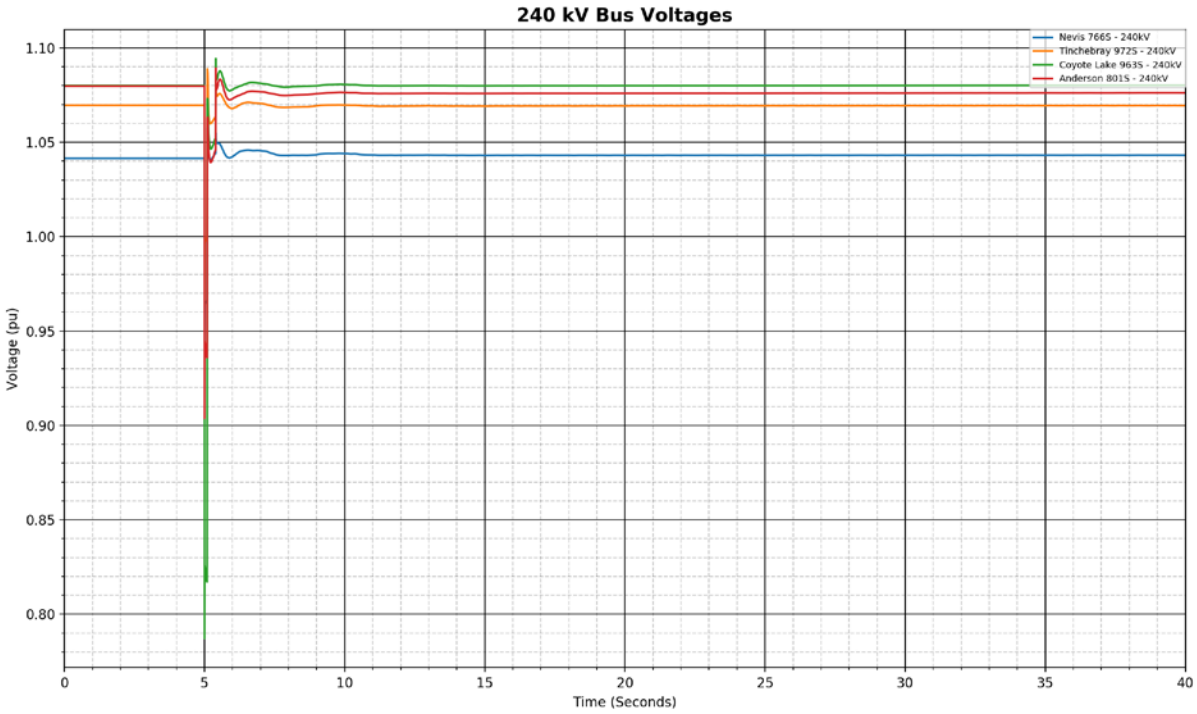
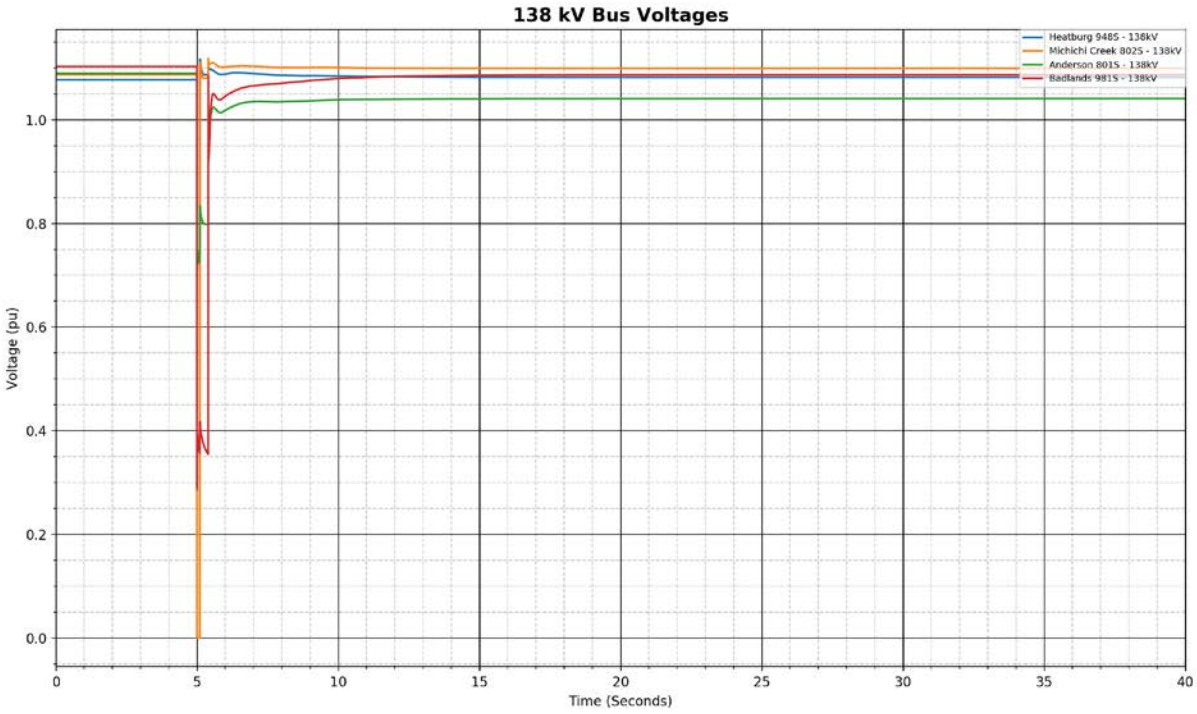
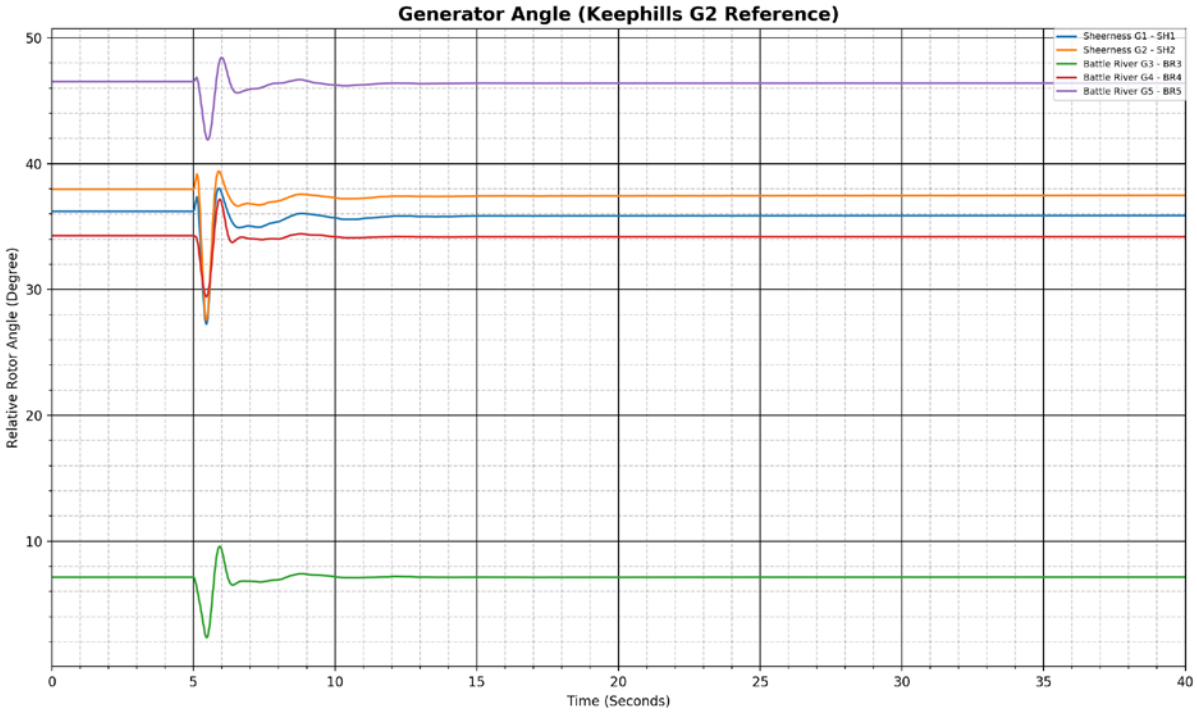
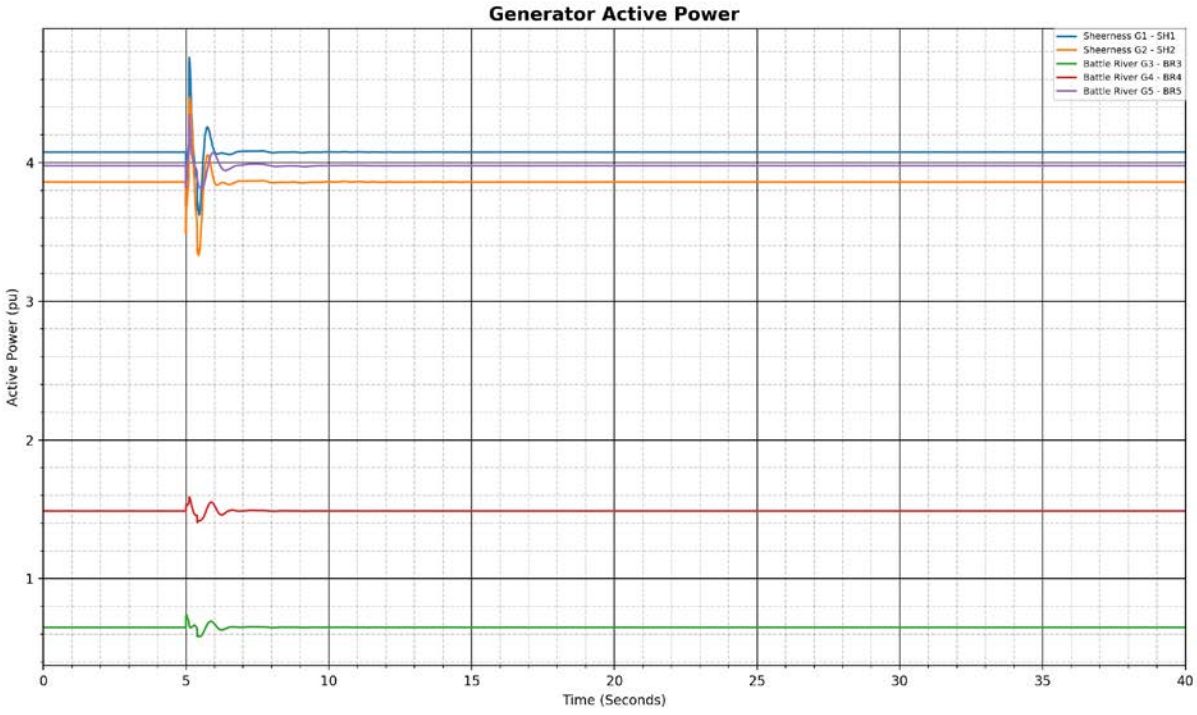

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Reactive Power (Mvar)
50
0
−50
−100
−150
−200
−250
0
5
10
15
20
25
30
35
40
Time (Seconds)

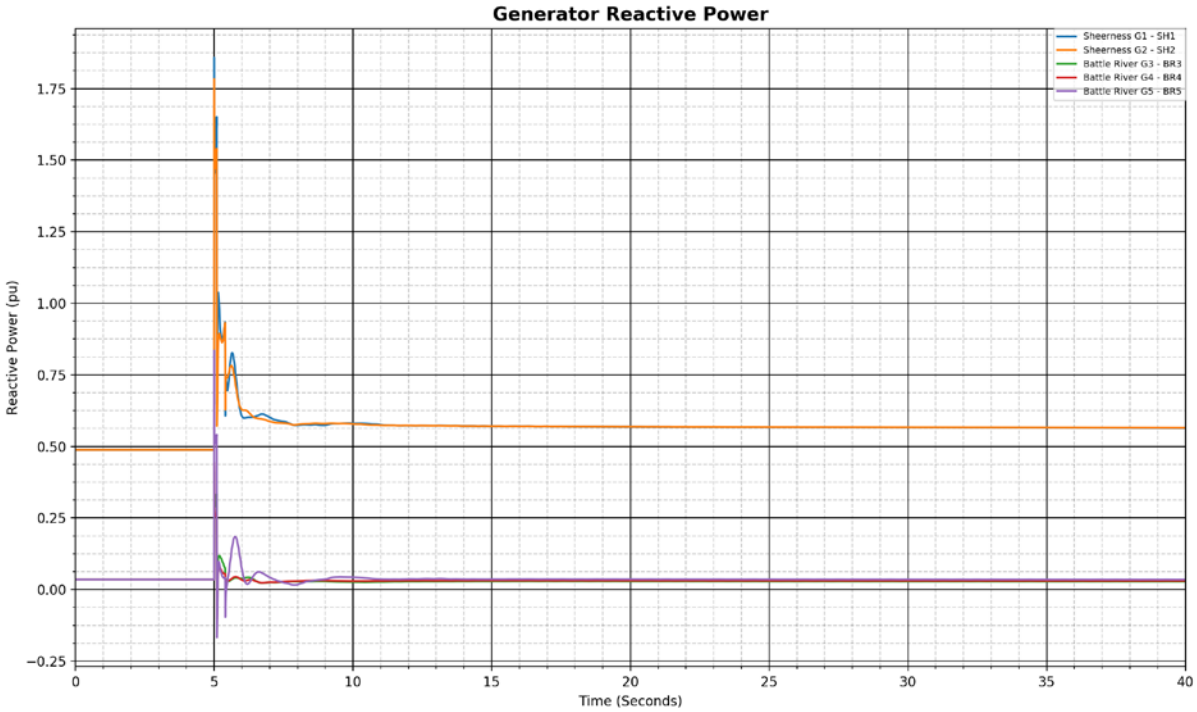
Figure A4-70: 7L171 (Wintering Hills 804S - Michichi Creek 802S): 3-phase fault at Michichi Creek 802S

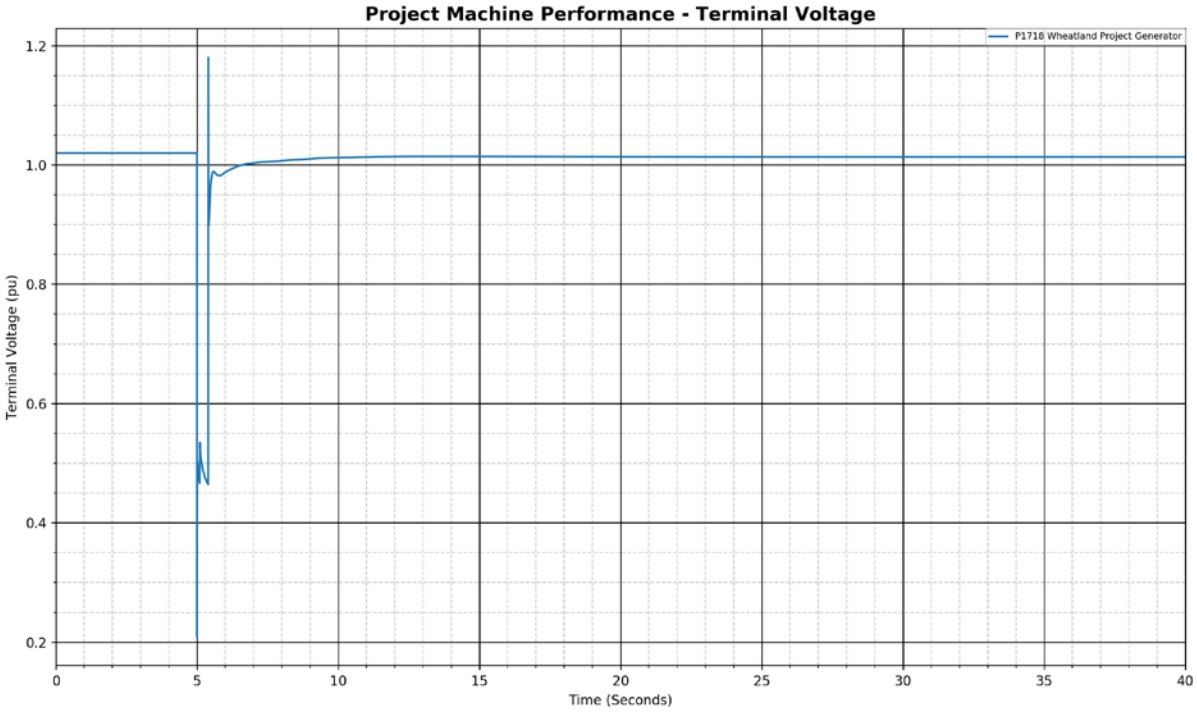


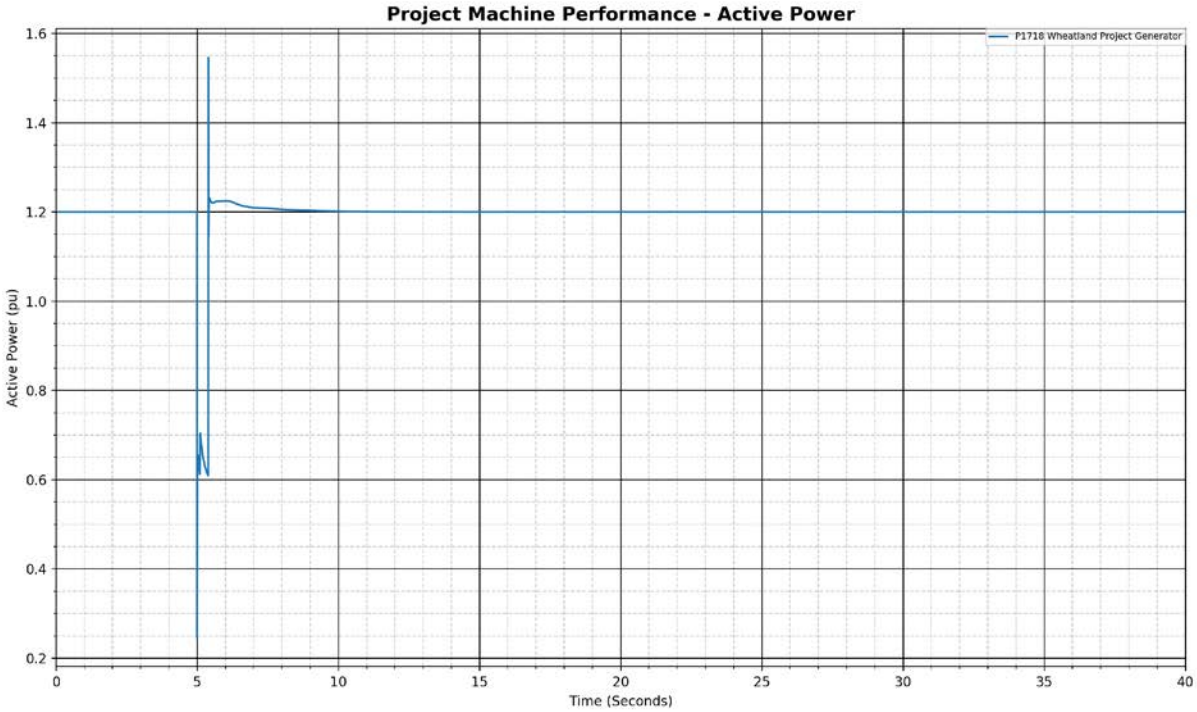


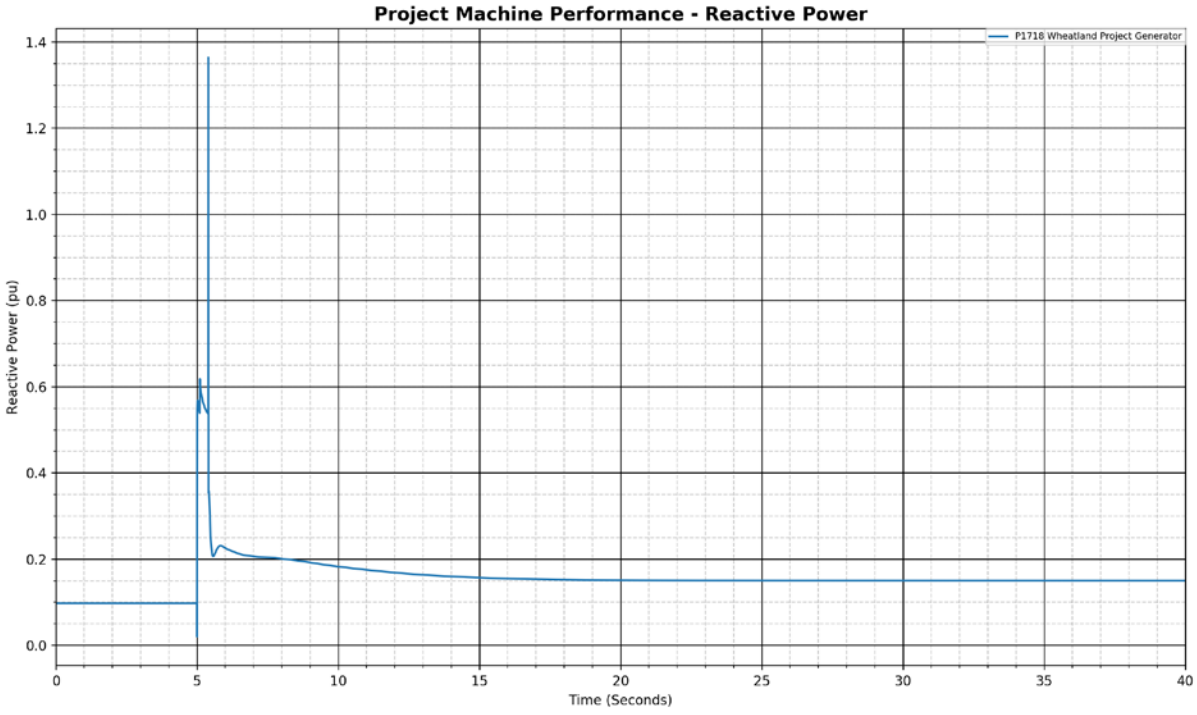

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

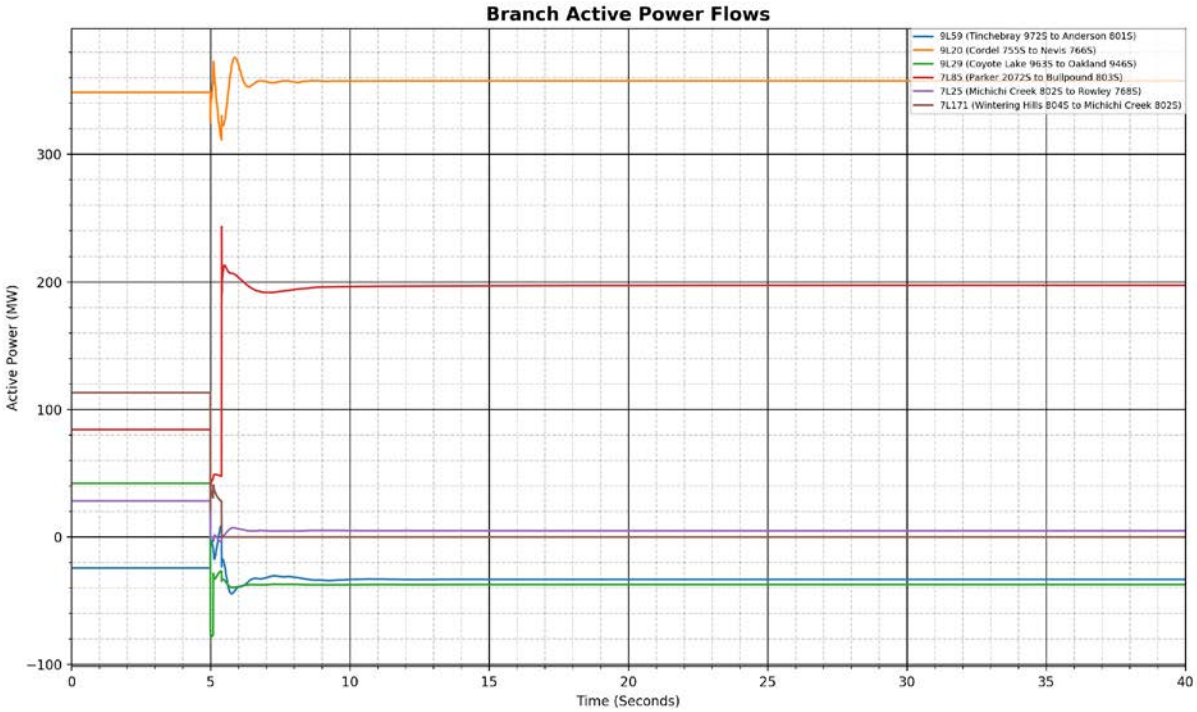

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Active Power (MW)
300
200
100
0
−100
0
5
10
15
20
25
30
35
40
Time (Seconds)

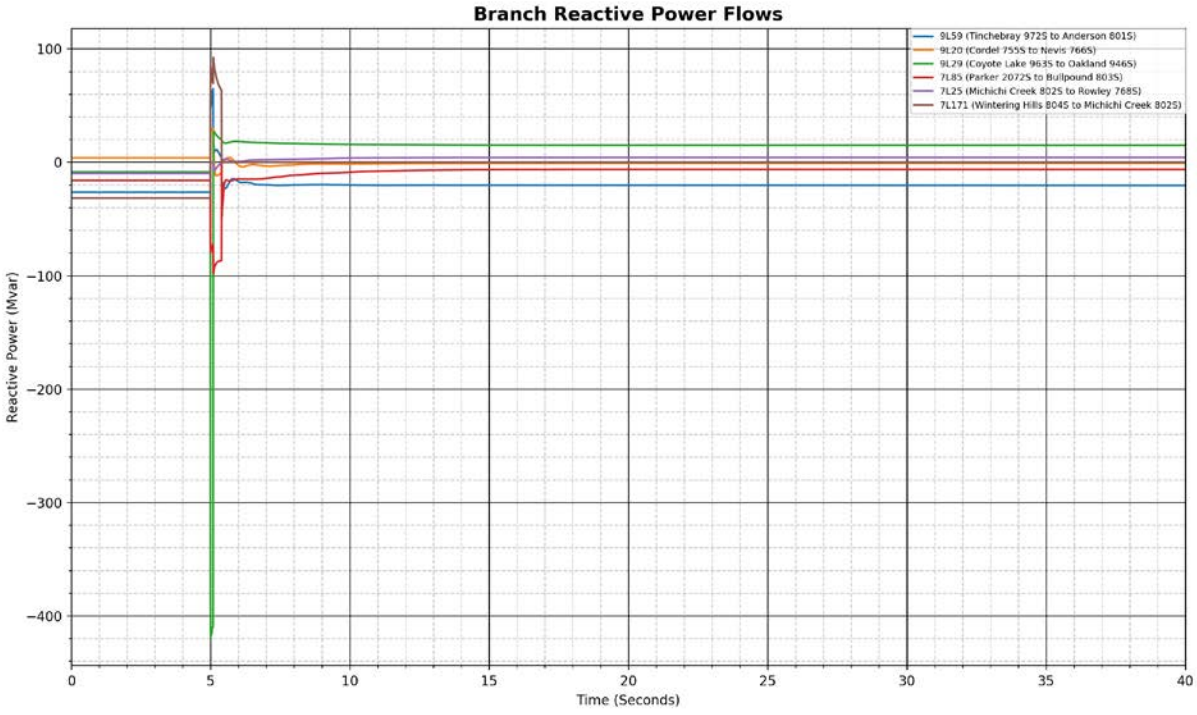
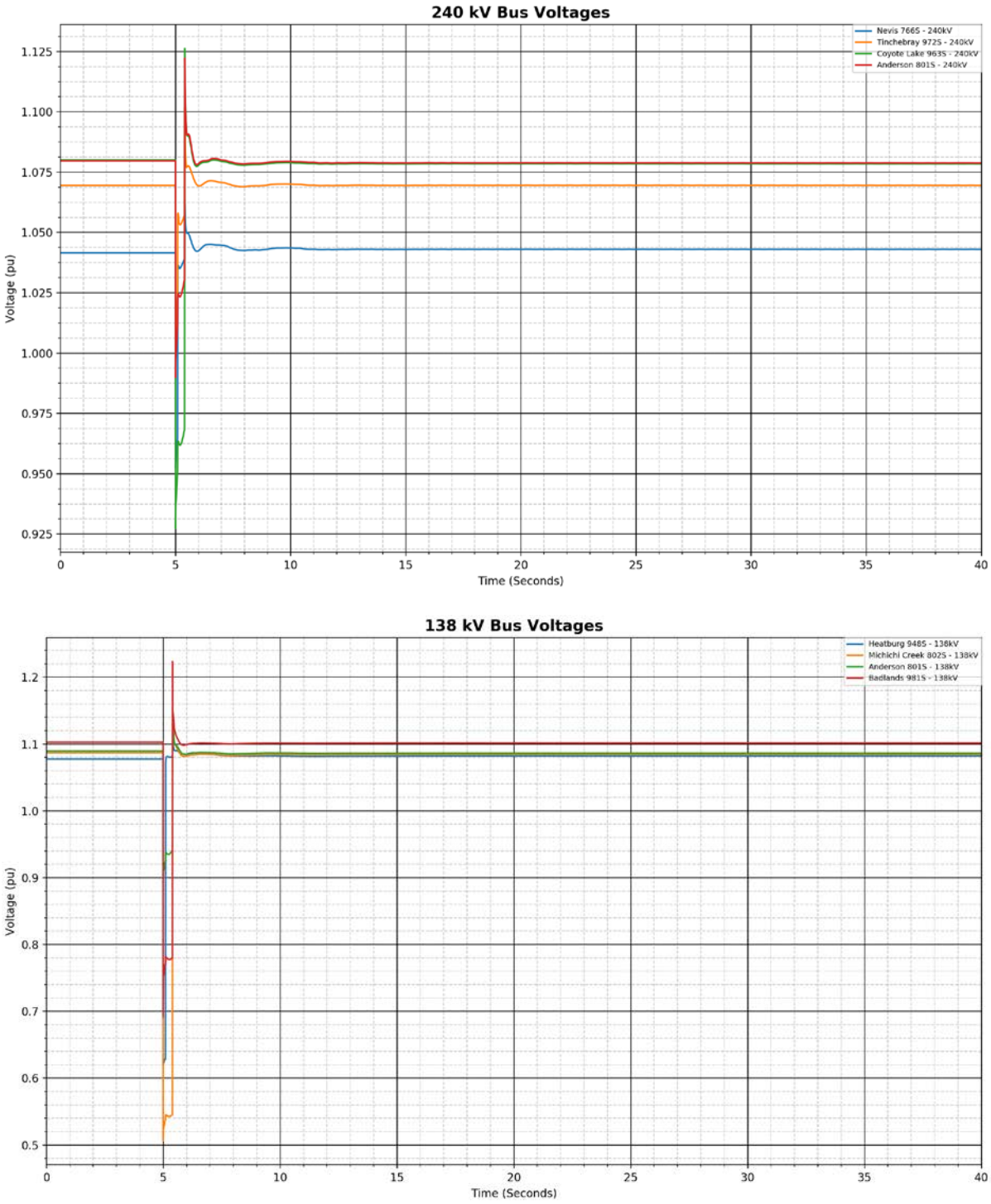
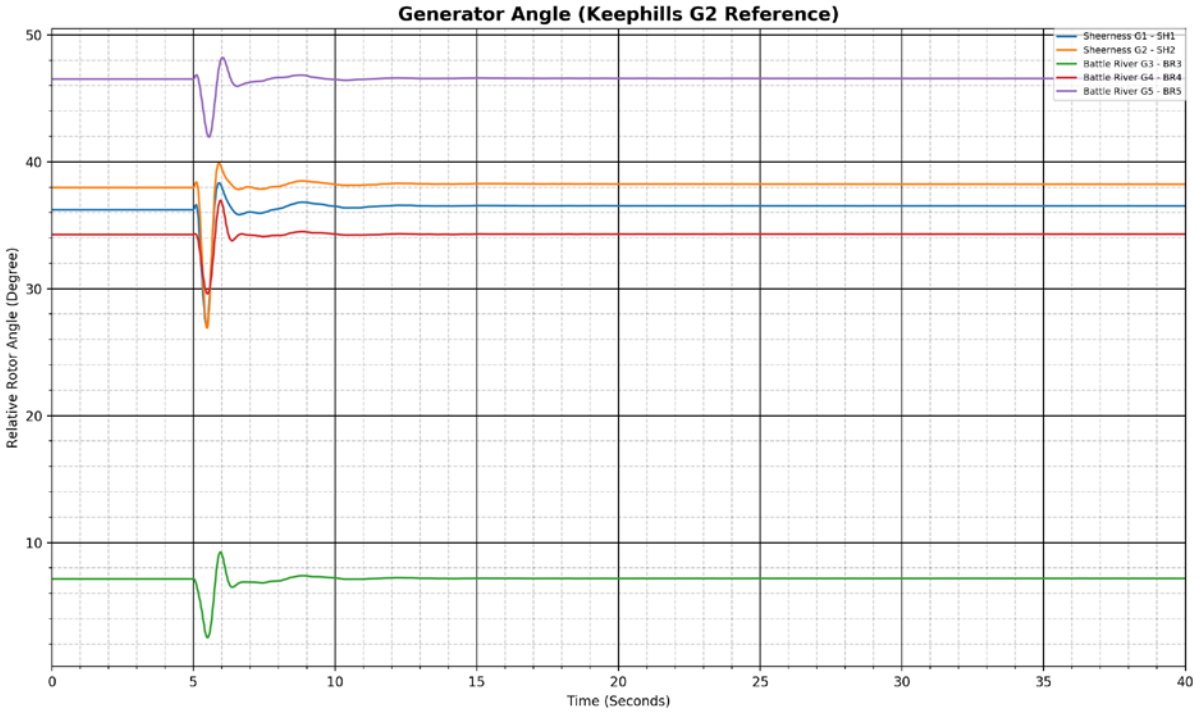
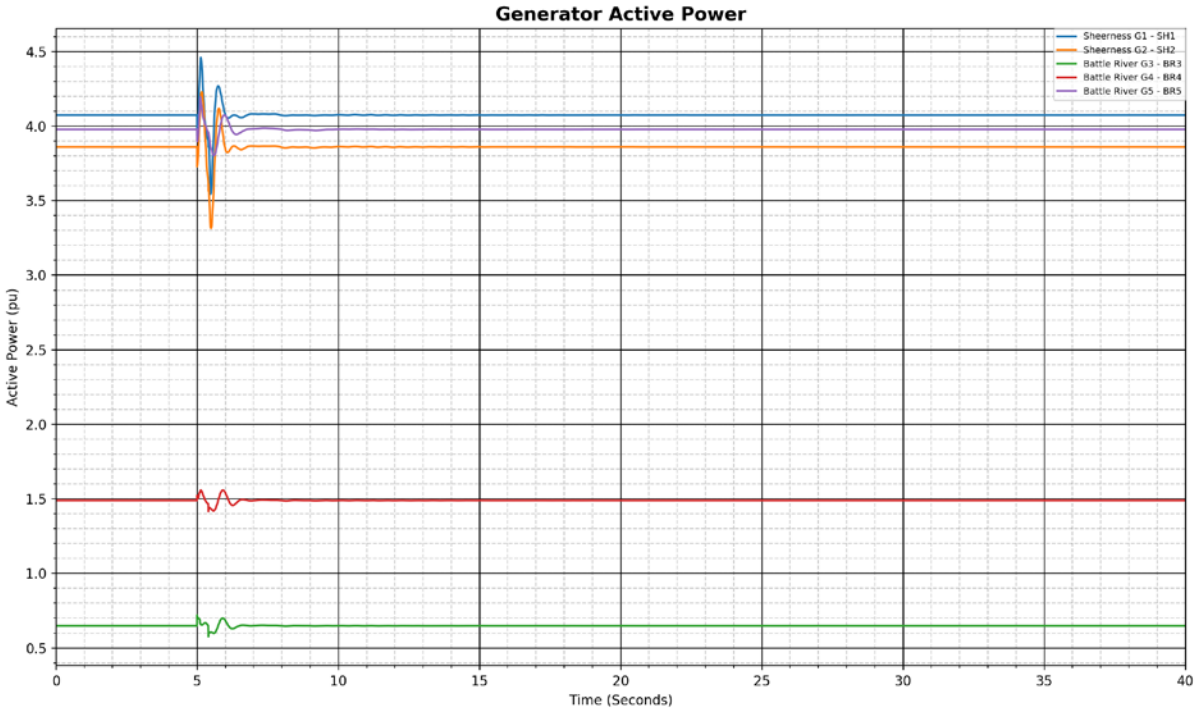
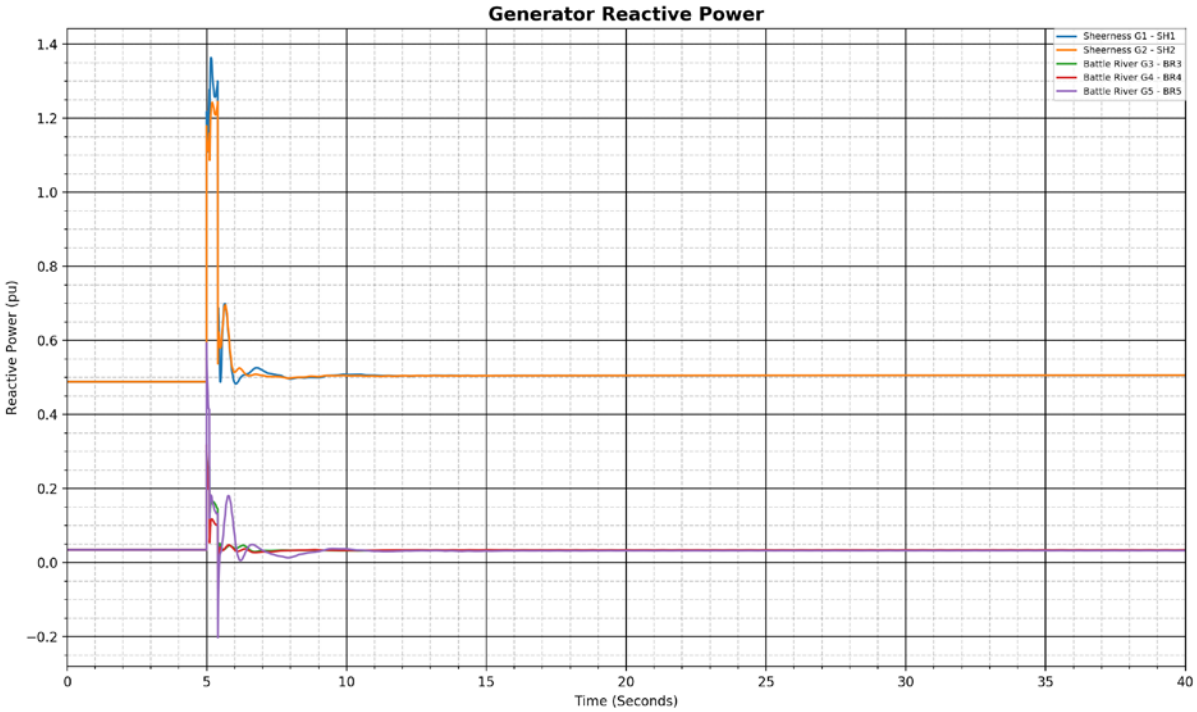

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L171 (Wintering Hills 804S to Michichi Creek 802S)
Reactive Power (Mvar)
100
0
−100
−200
−300
−400
0
5
10
15
20
25
30
35
40
Time (Seconds)

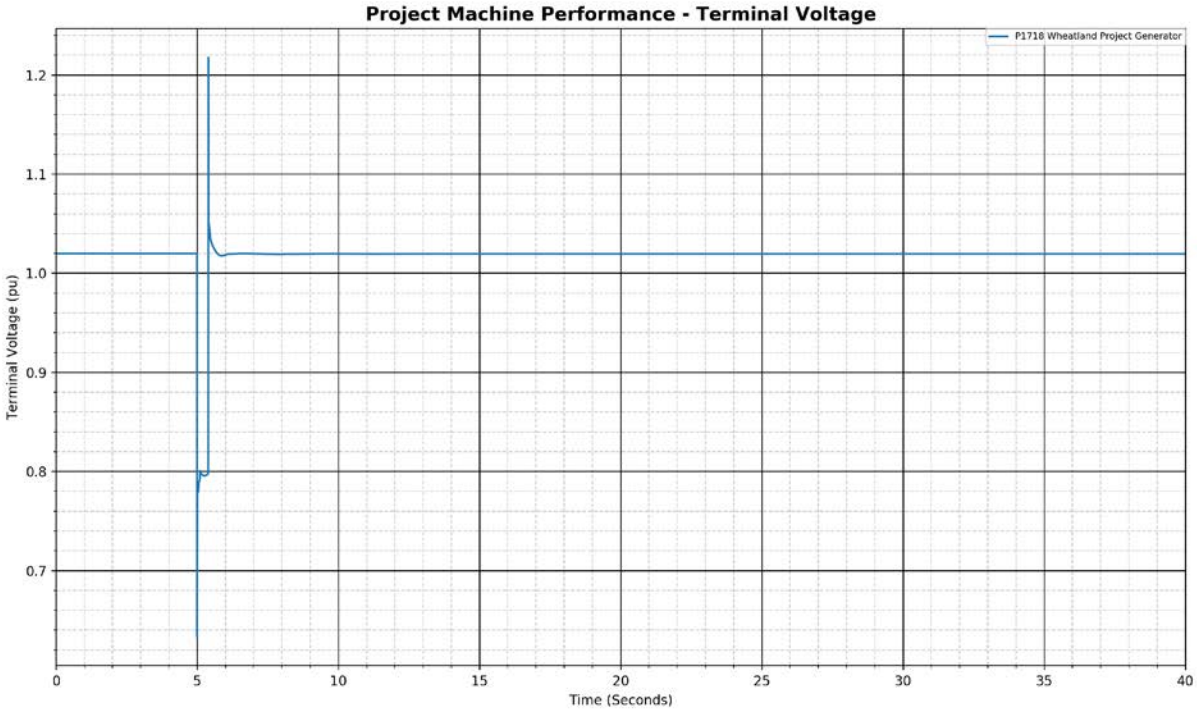
Figure A4-71: 7L25 (Rowley 768S - Michichi Creek 802S): 3-phase fault at Rowley 768S

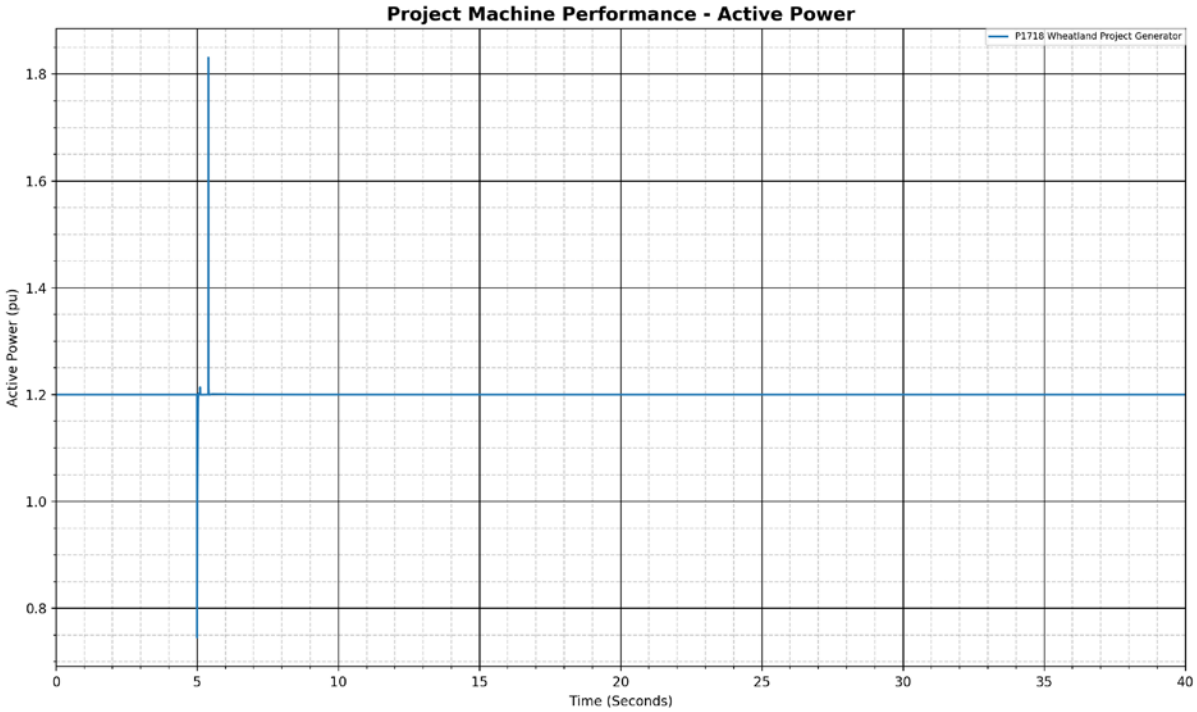


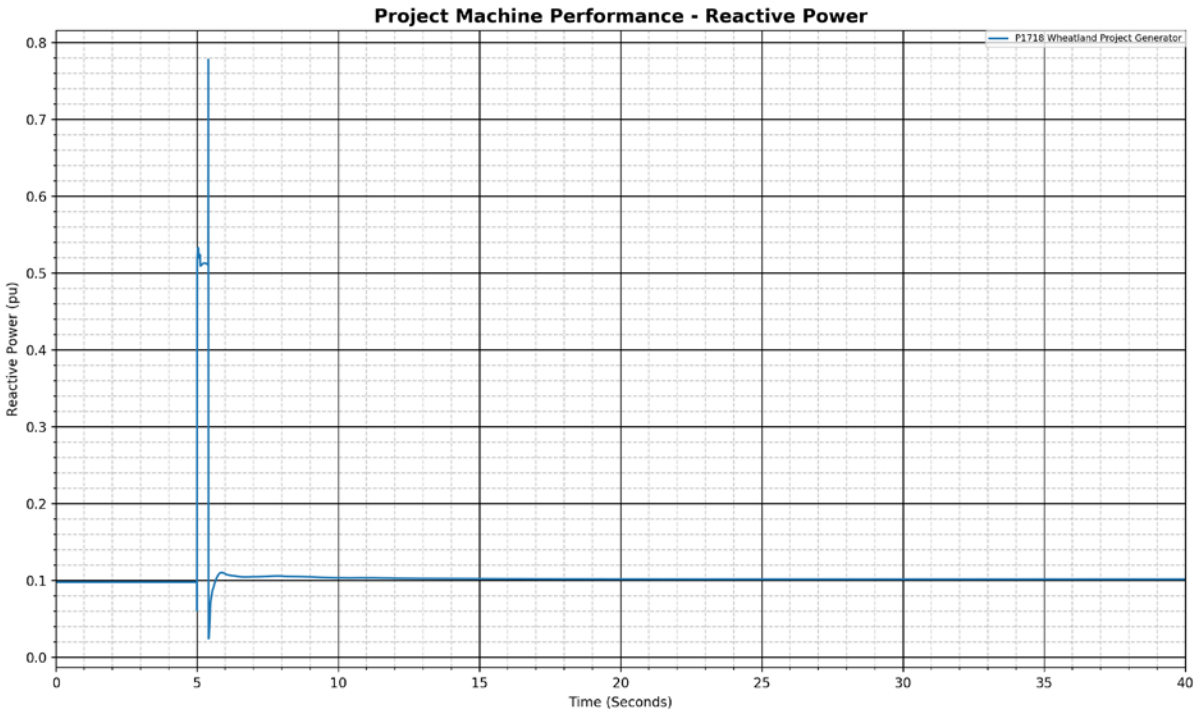

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

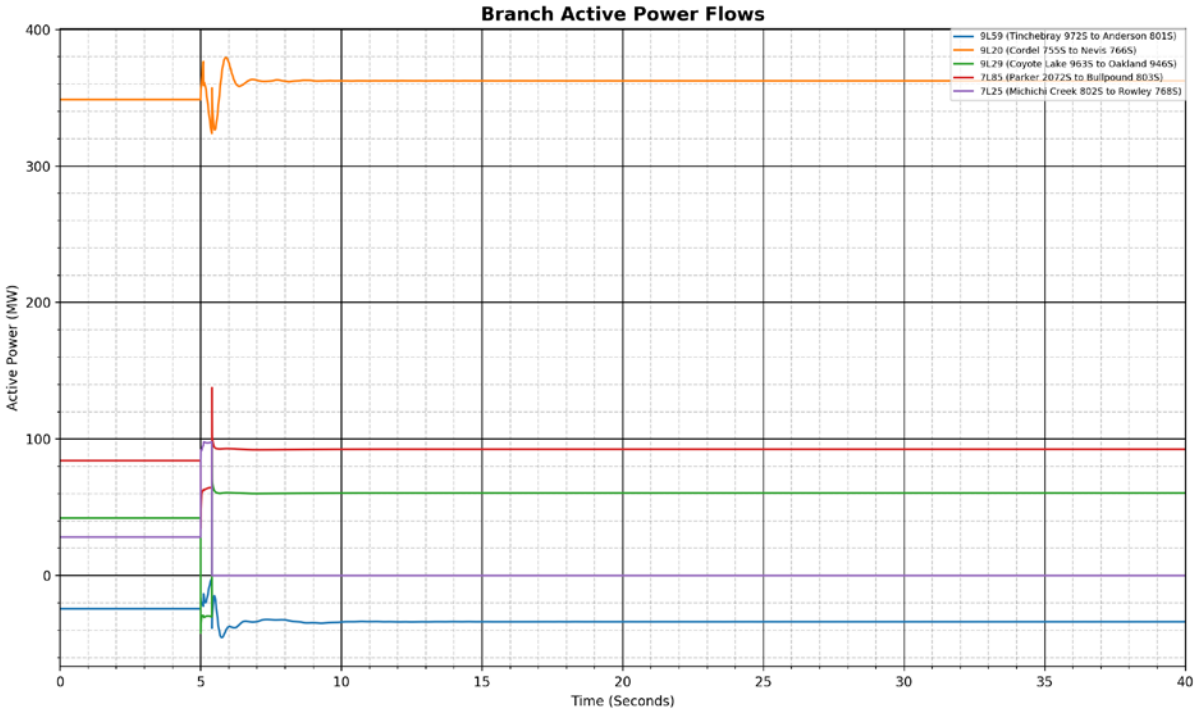

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.1
1.0
0.9
0.8
0.7
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.8
1.6
1.4
1.2
1.0
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
Time (Seconds)

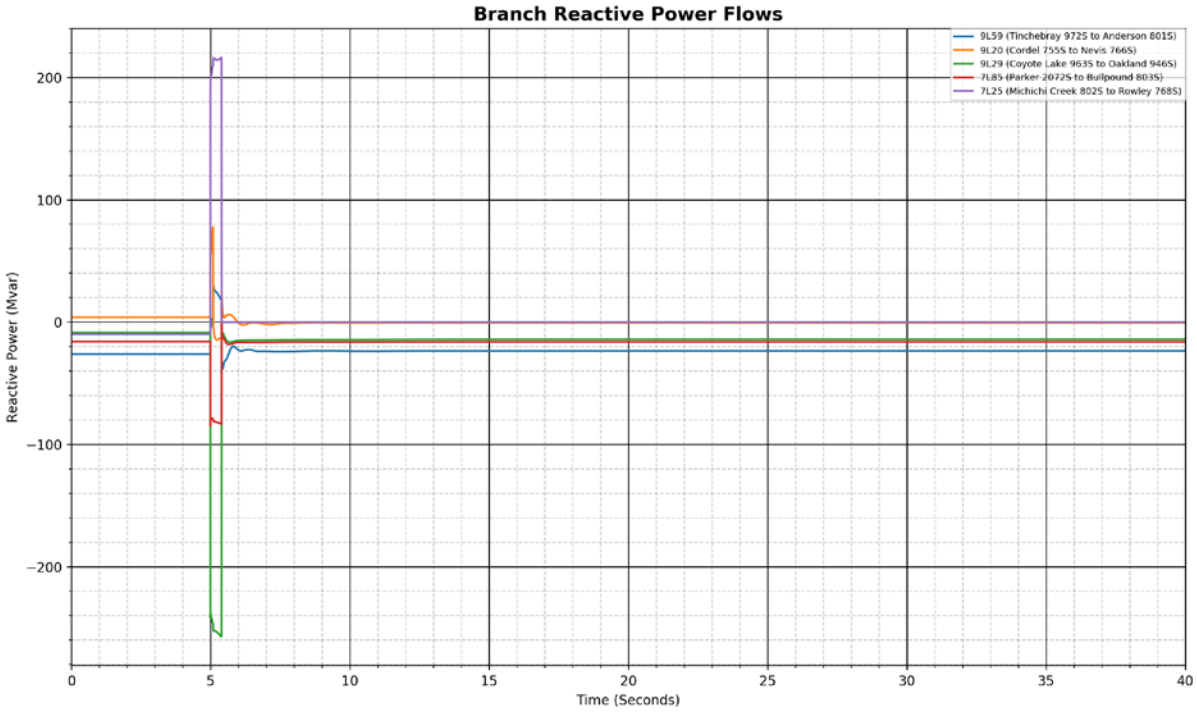
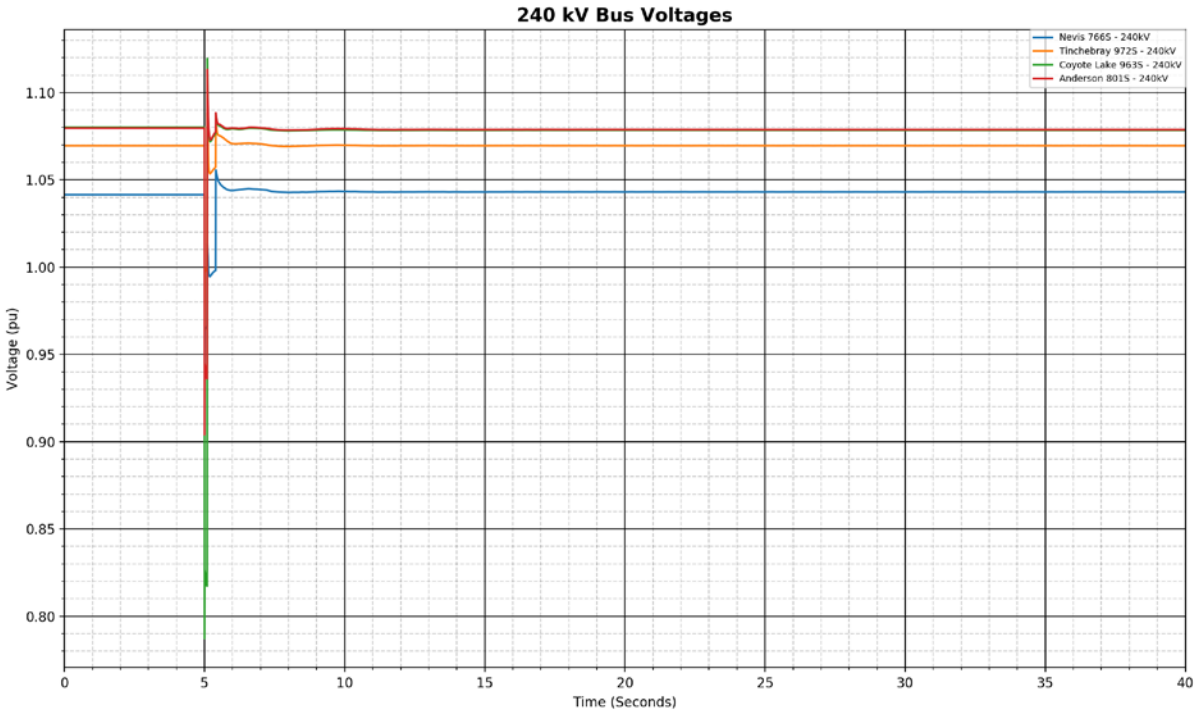
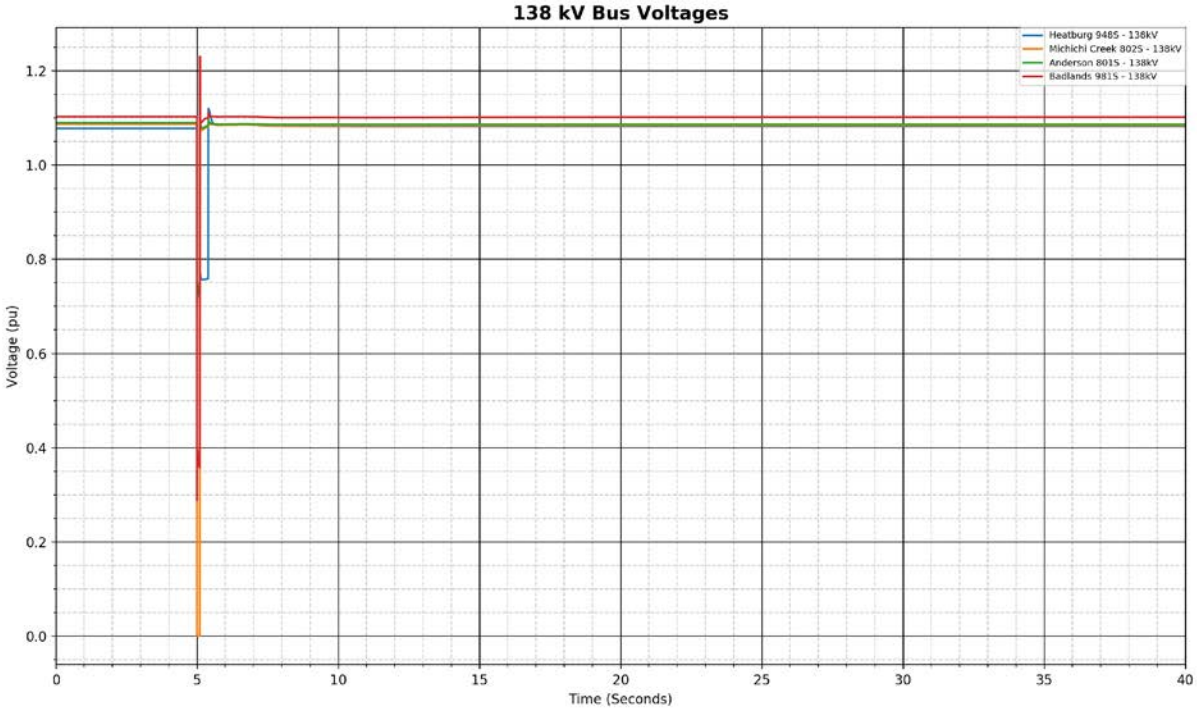
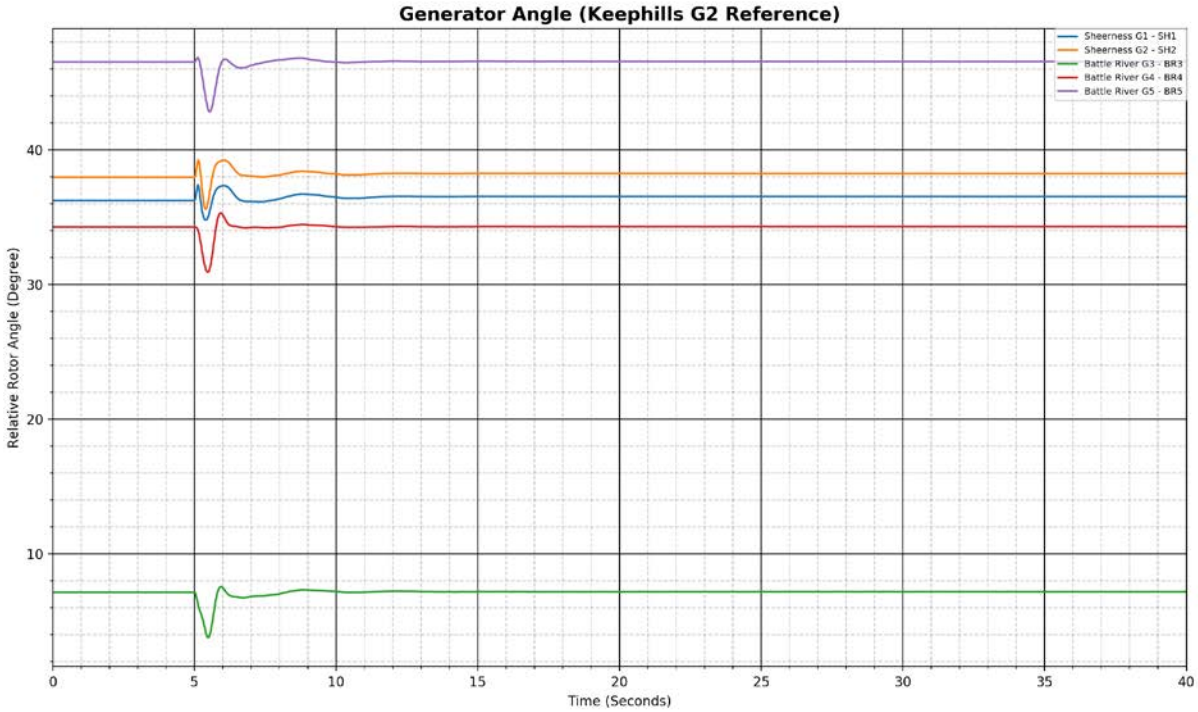
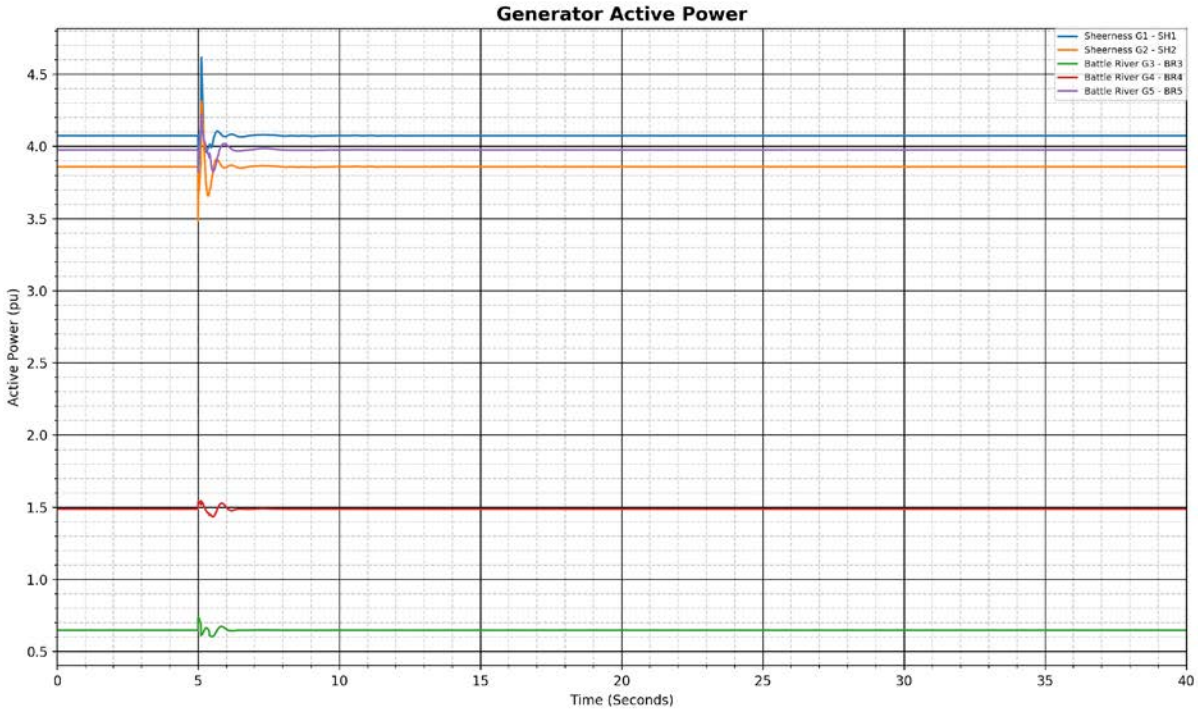

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
Time (Seconds)

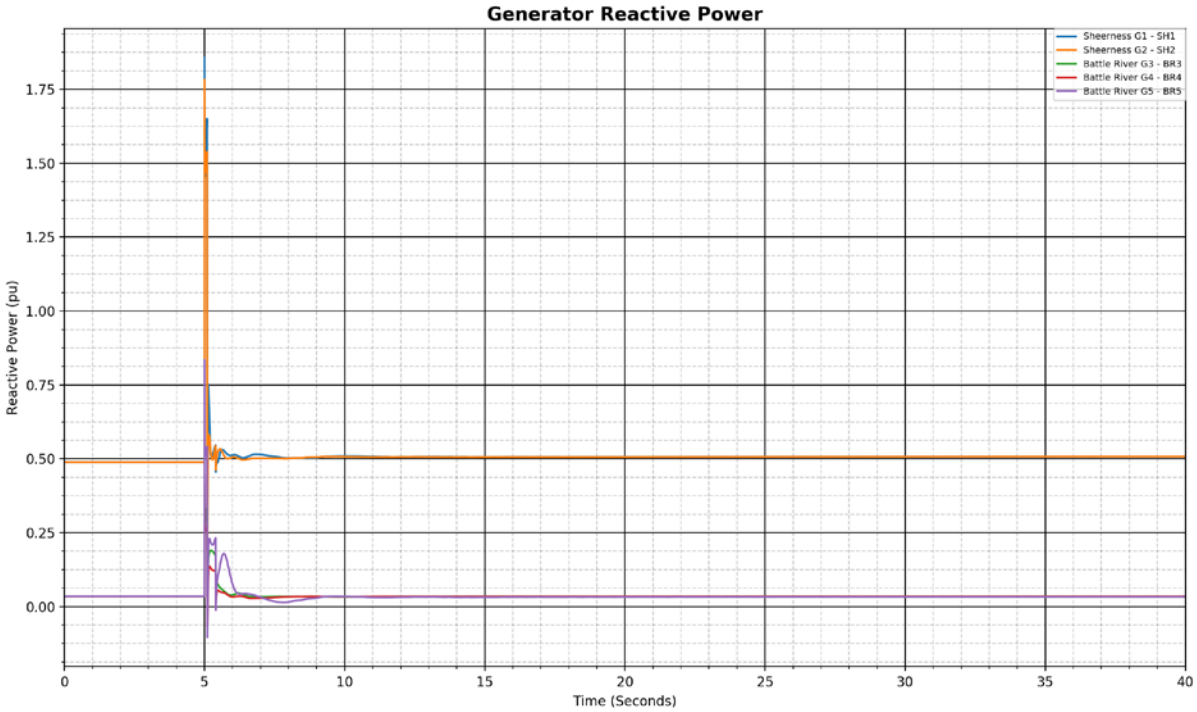
Figure A4-72: 7L25 (Rowley 768S - Michichi Creek 802S): 3-phase fault at Michichi Creek 802S

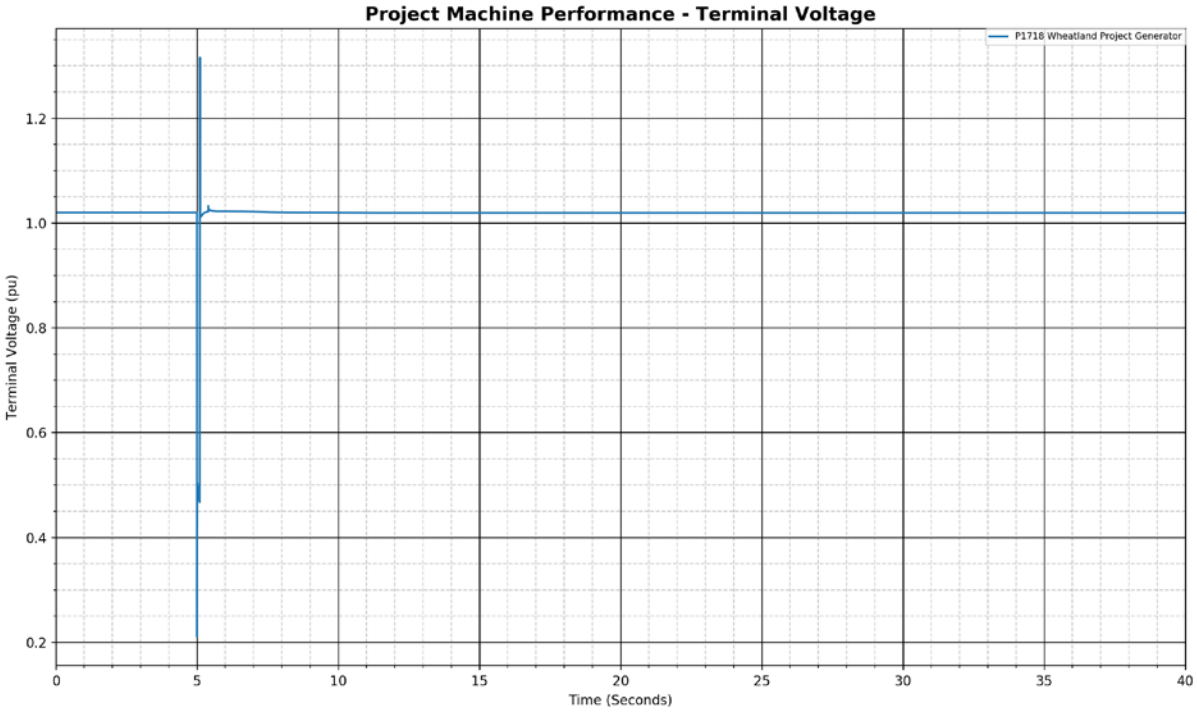


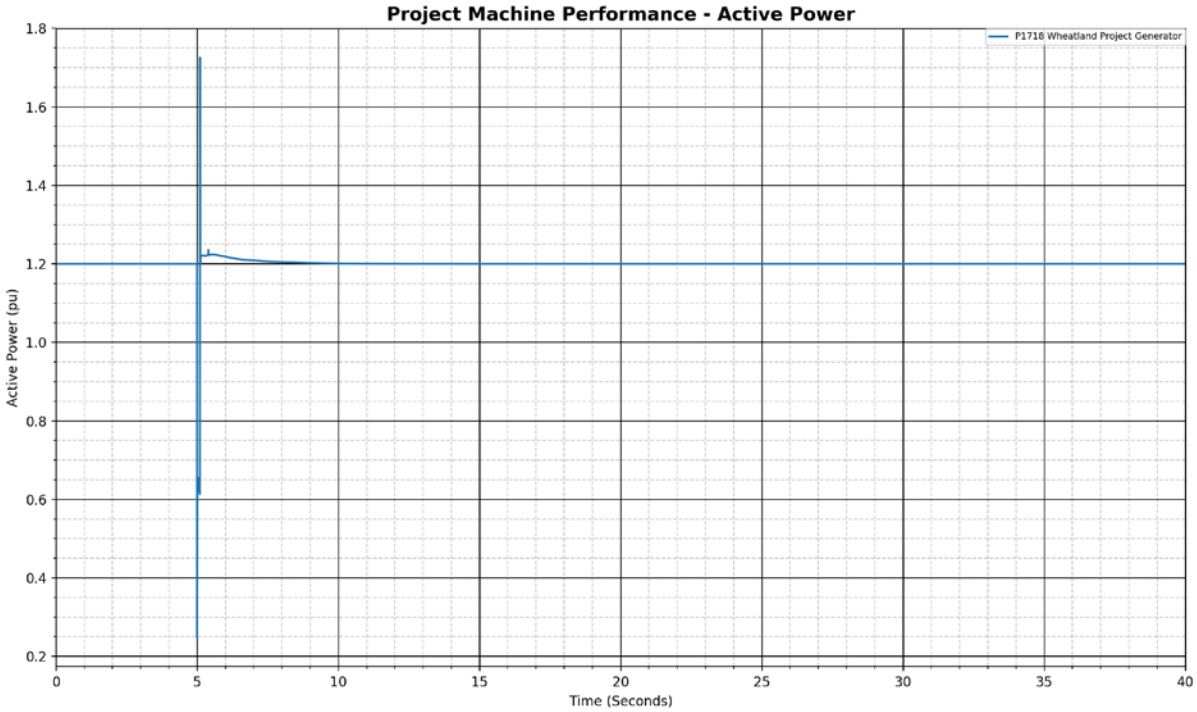


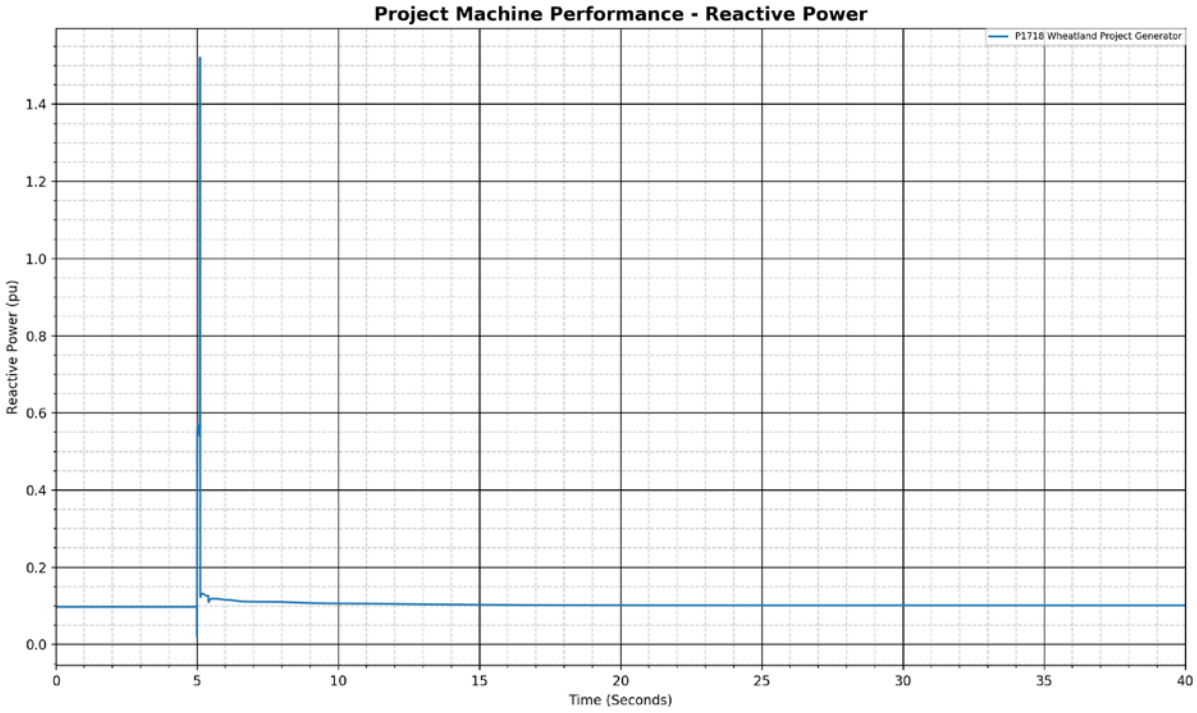

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

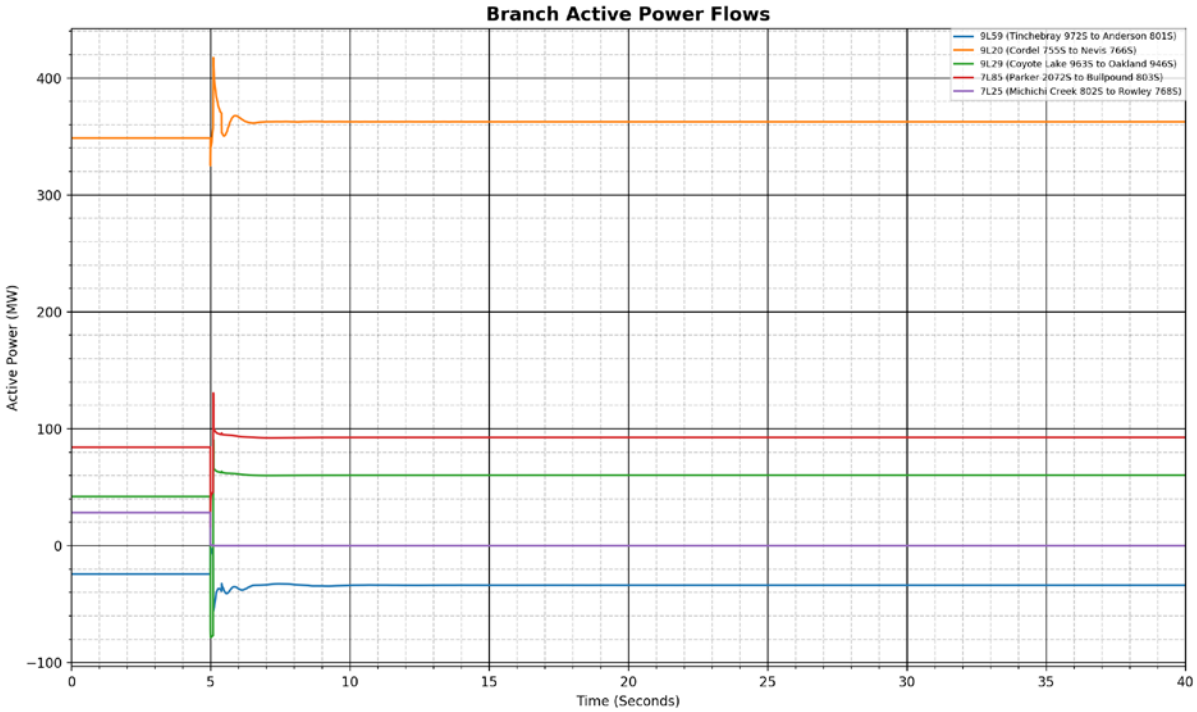

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Active Power (MW)
Time (Seconds)

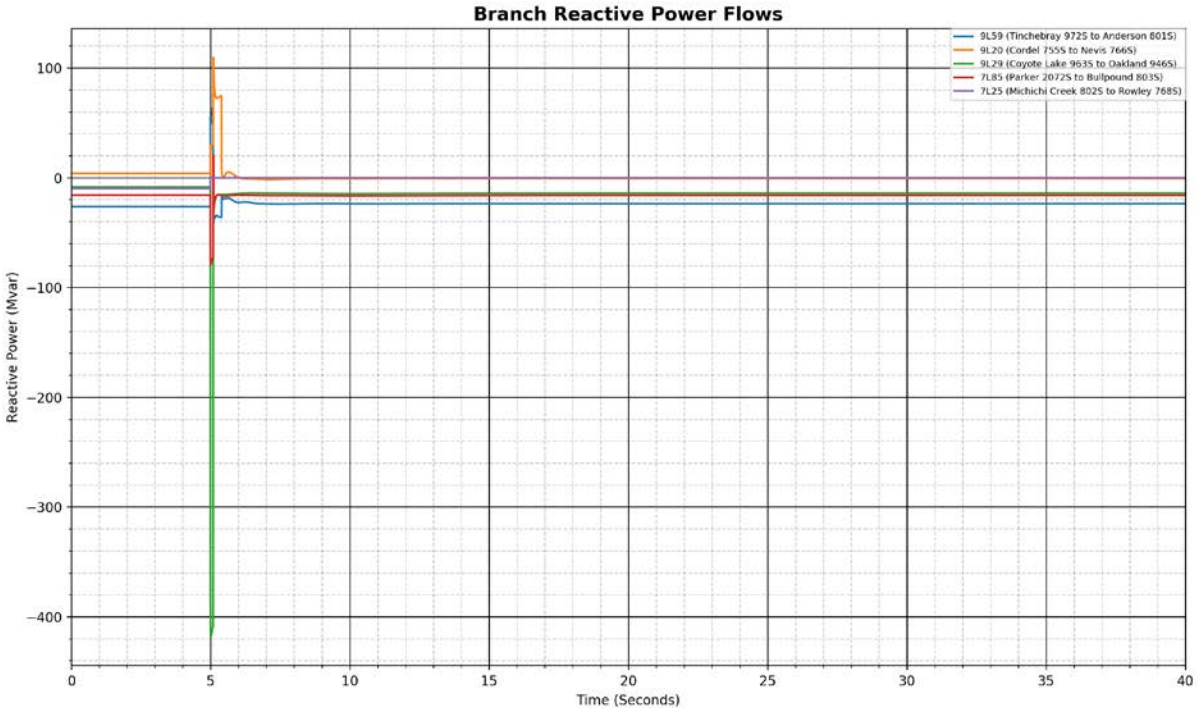
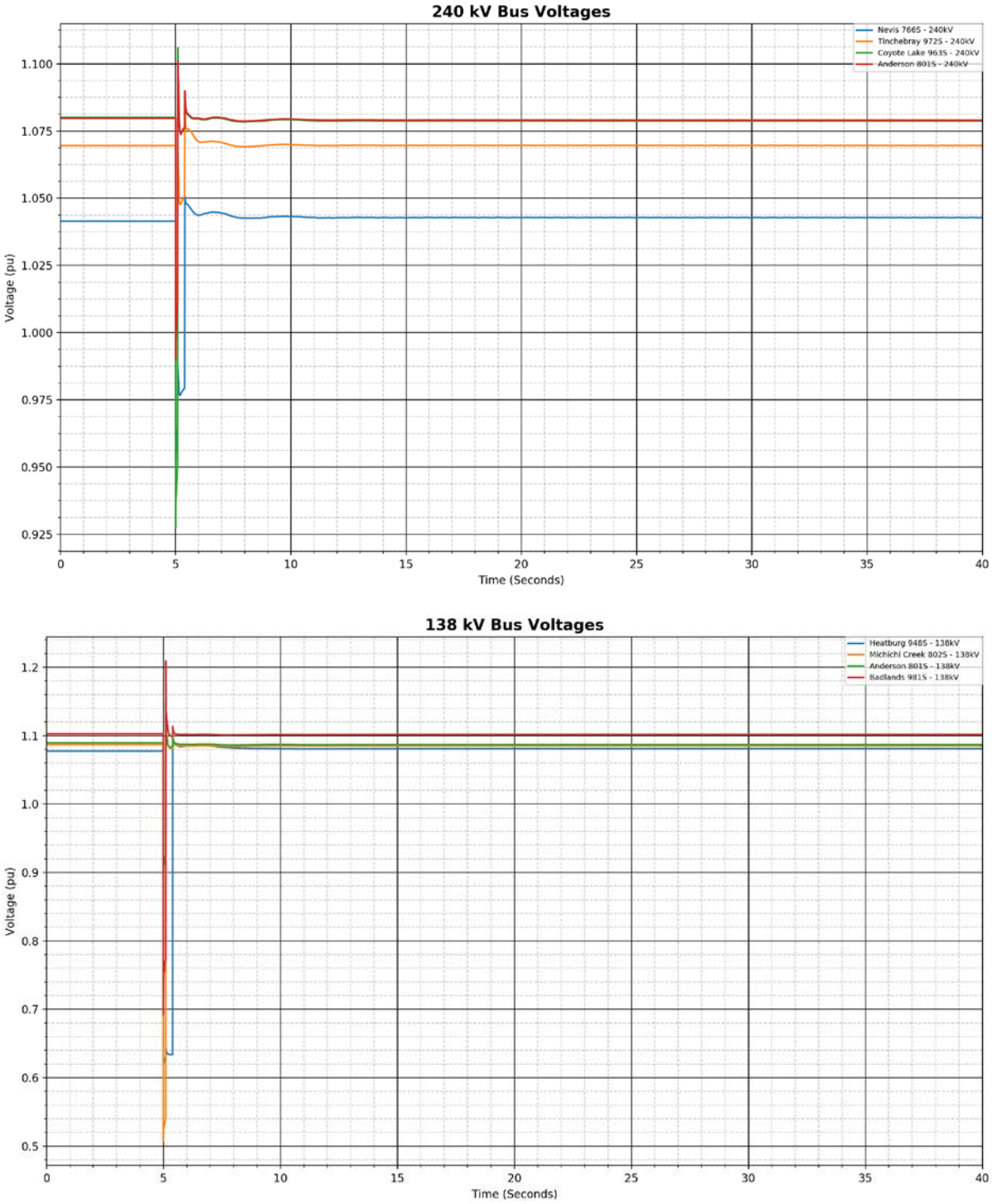
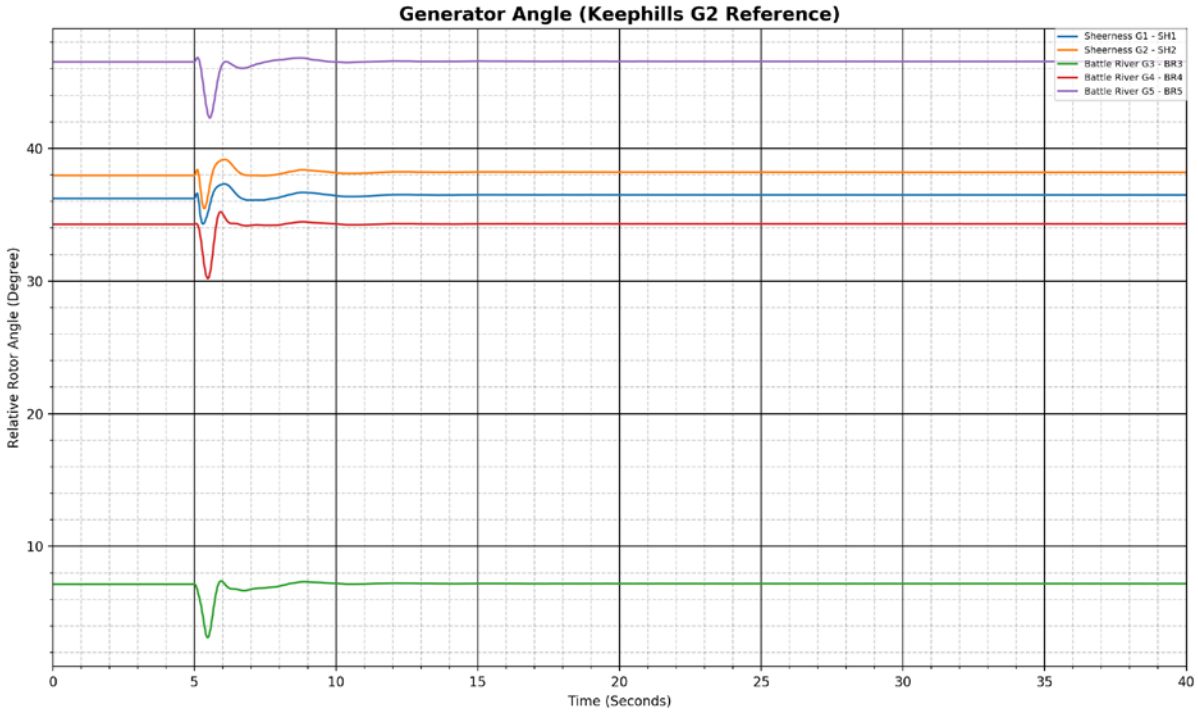
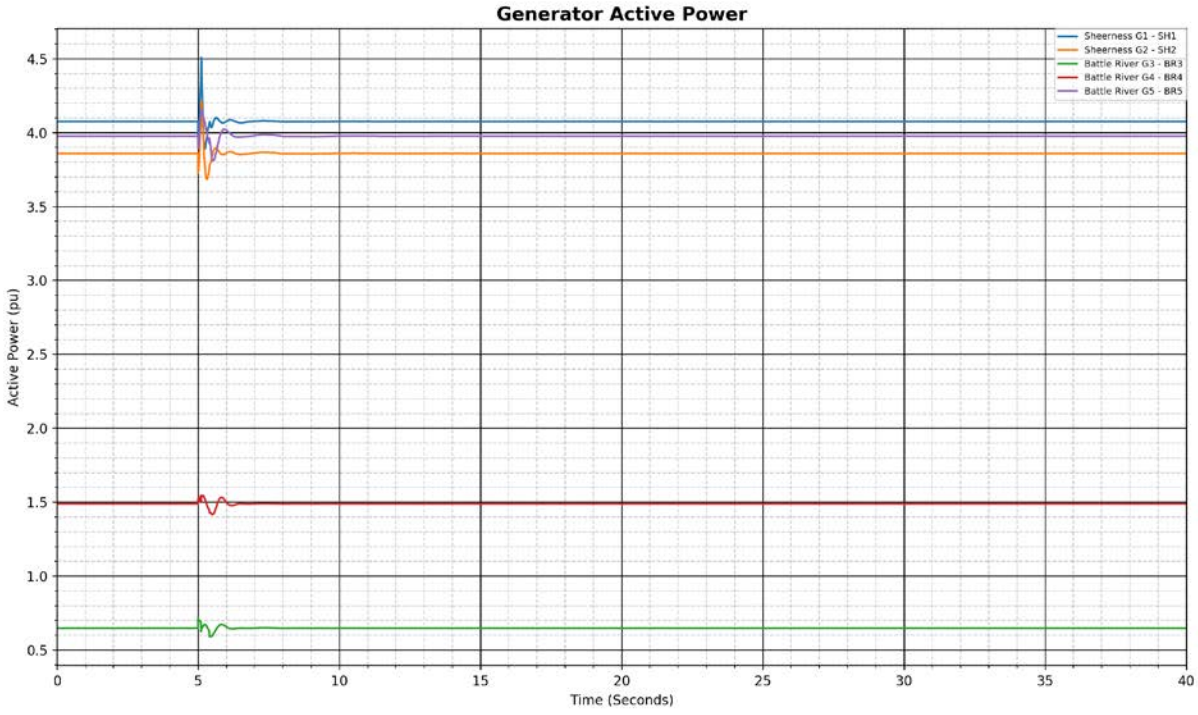
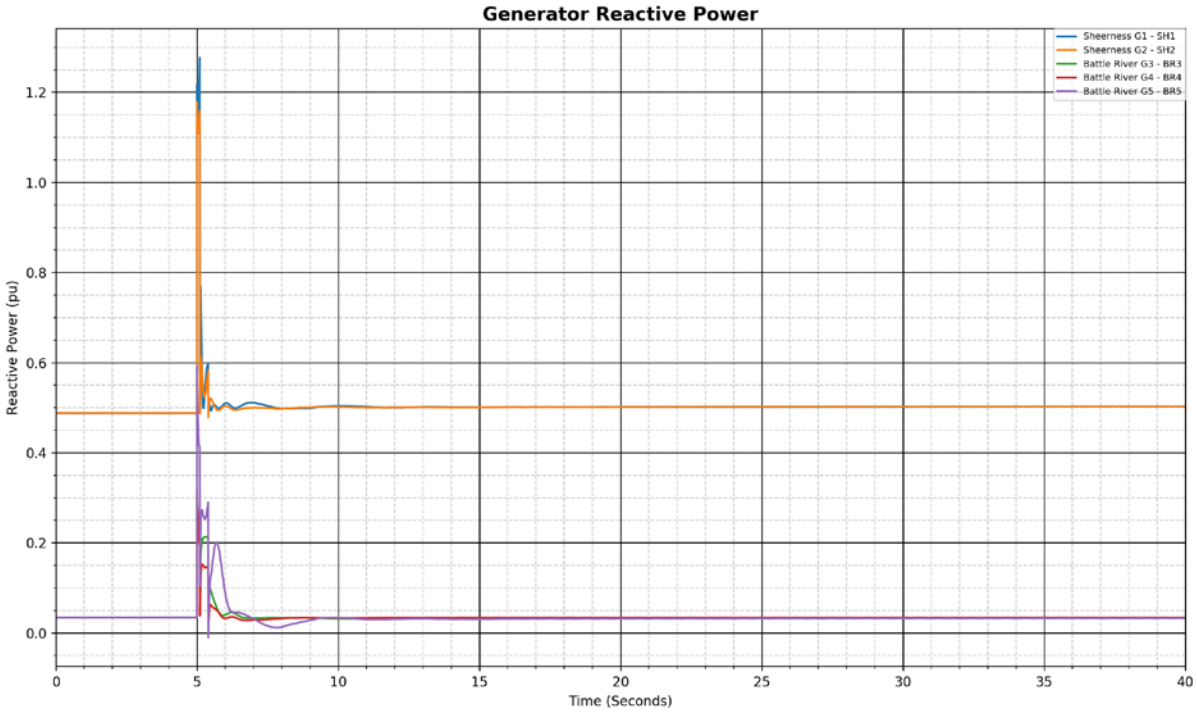

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
Reactive Power (Mvar)
Time (Seconds)

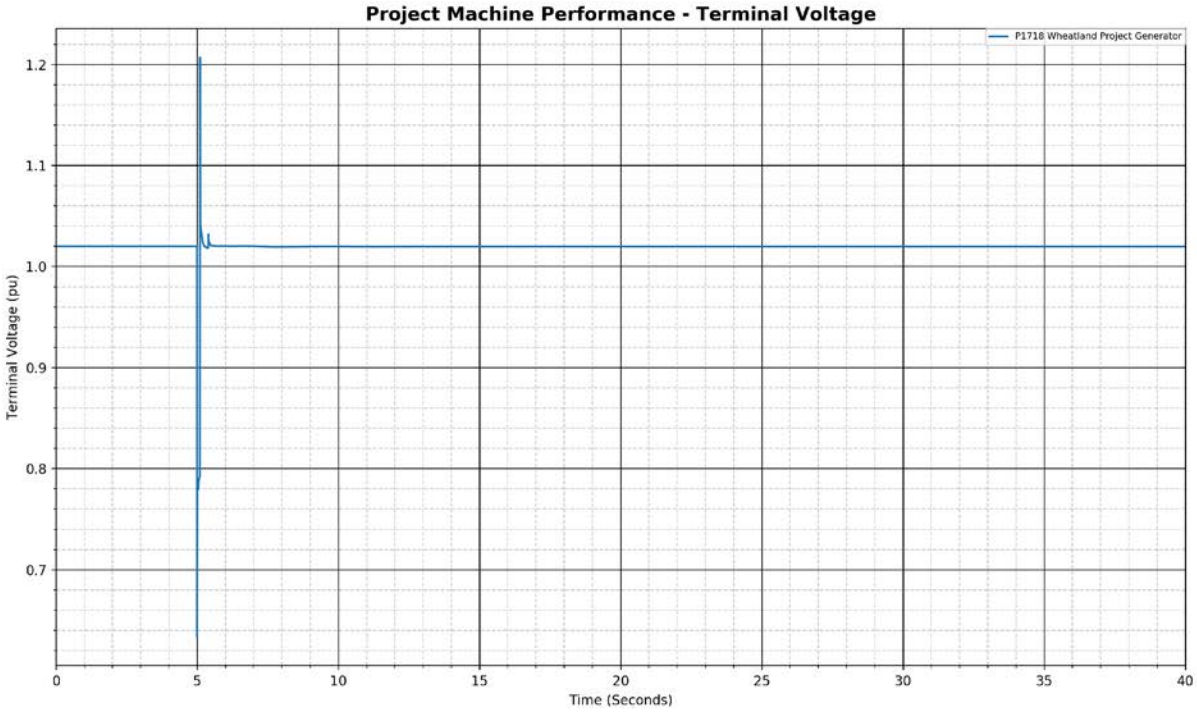
Figure A4-73: 7L137 (Rowley 768S - Three Hills 770S): 3-phase fault at Rowley 768S

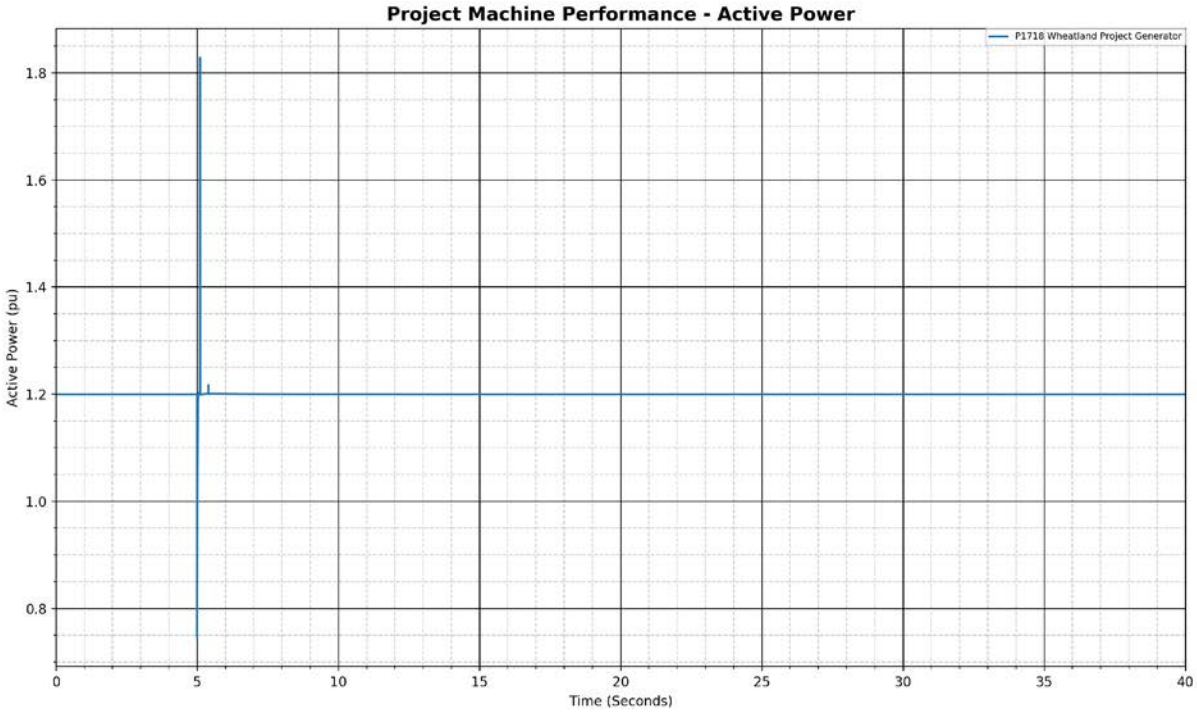


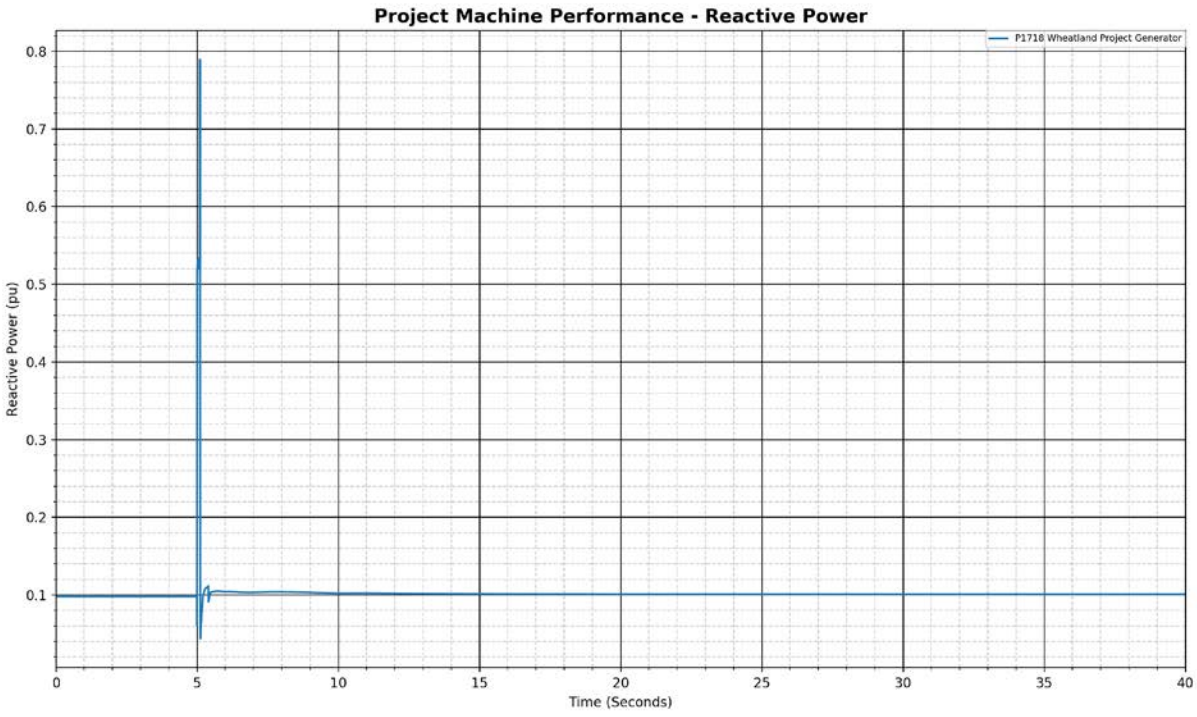

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

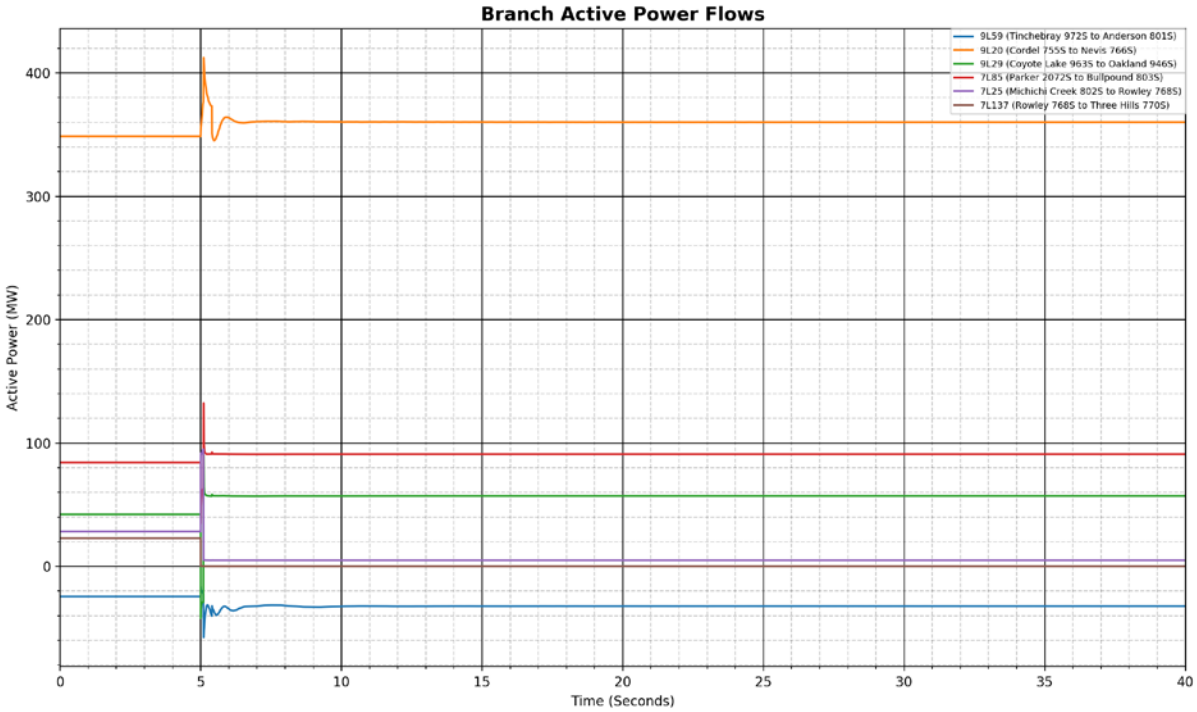

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.8
1.6
1.4
1.2
1.0
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Active Power (MW)
Time (Seconds)

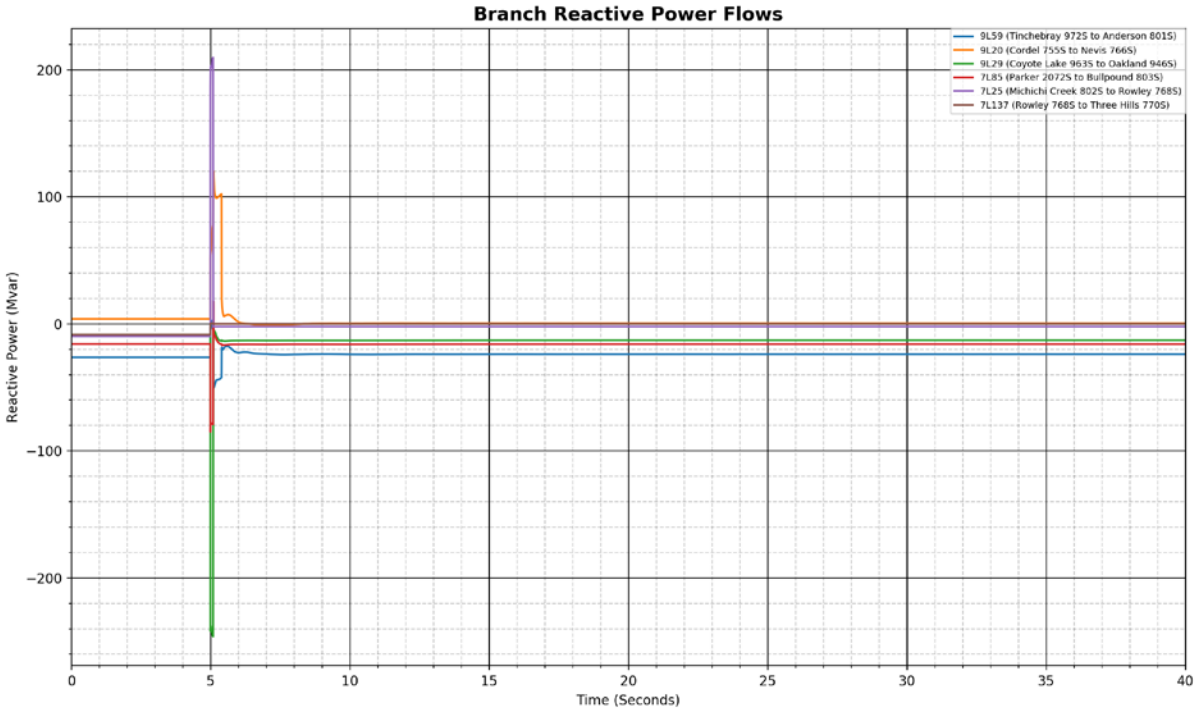
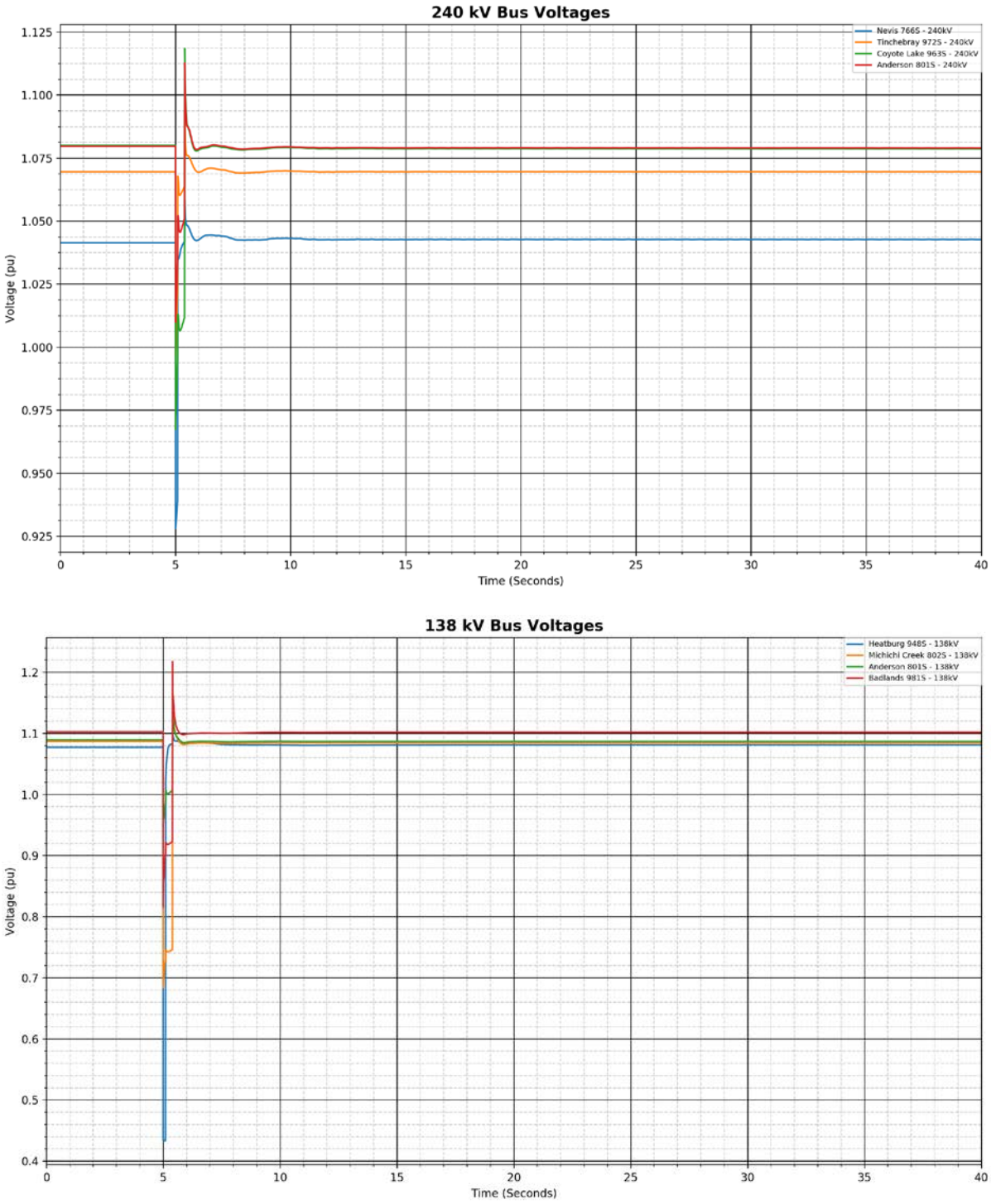
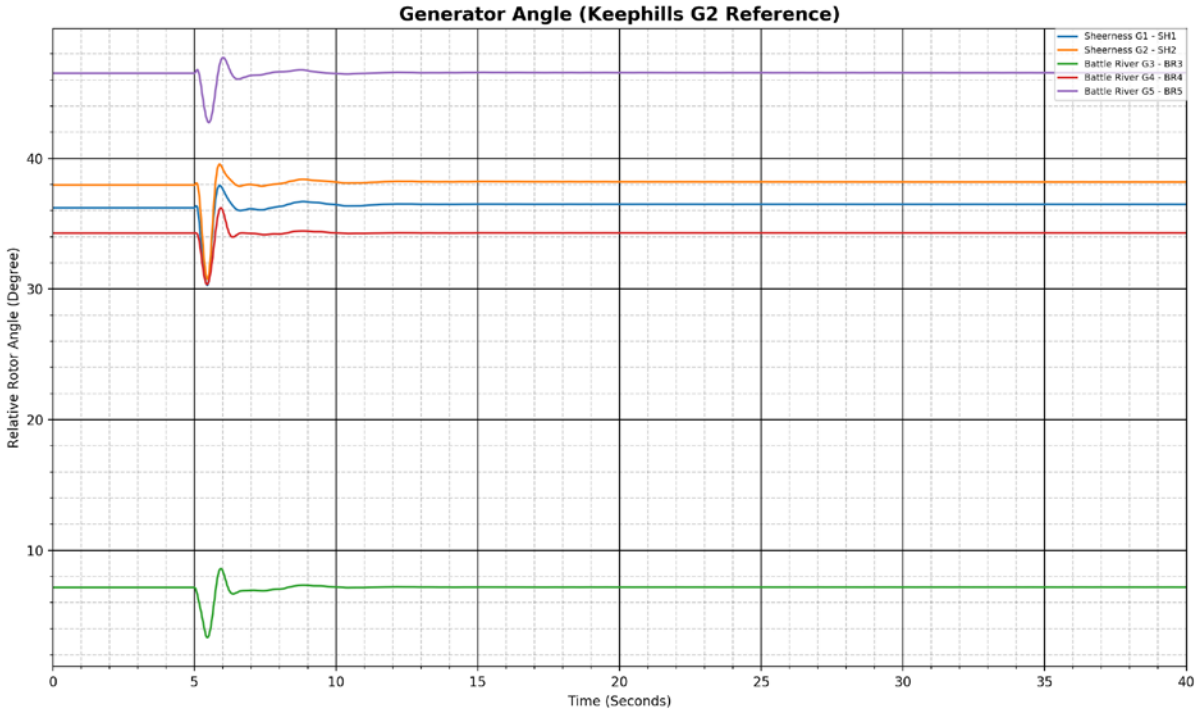
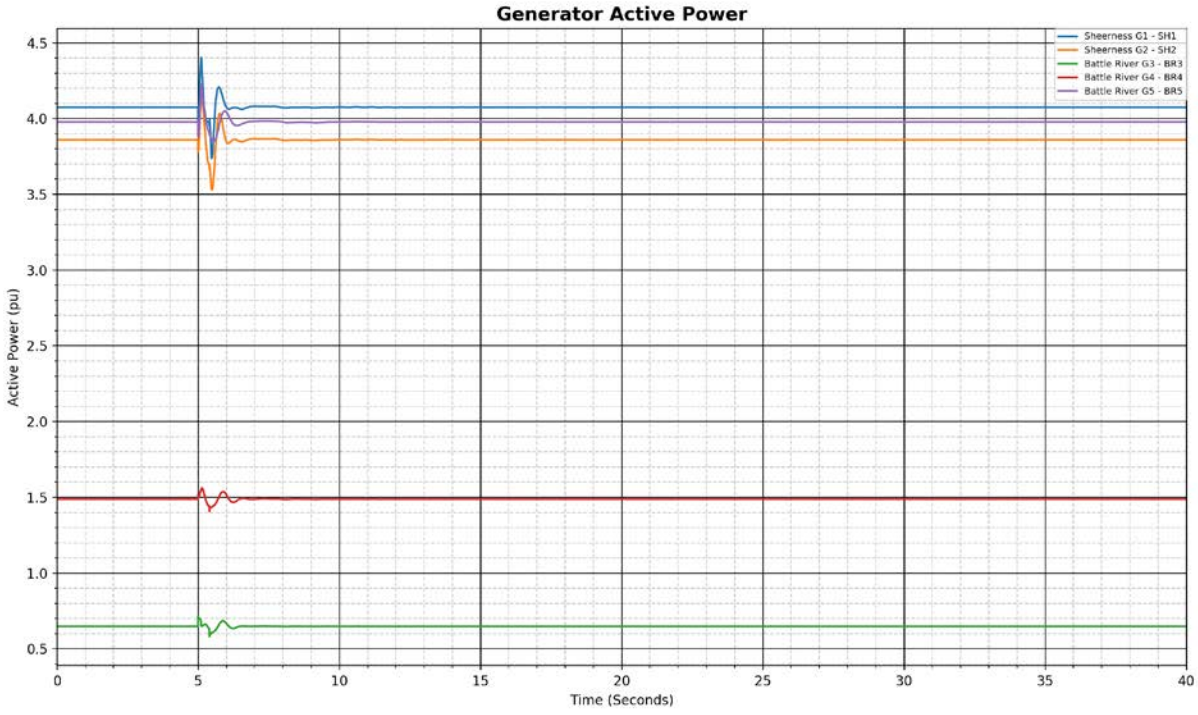
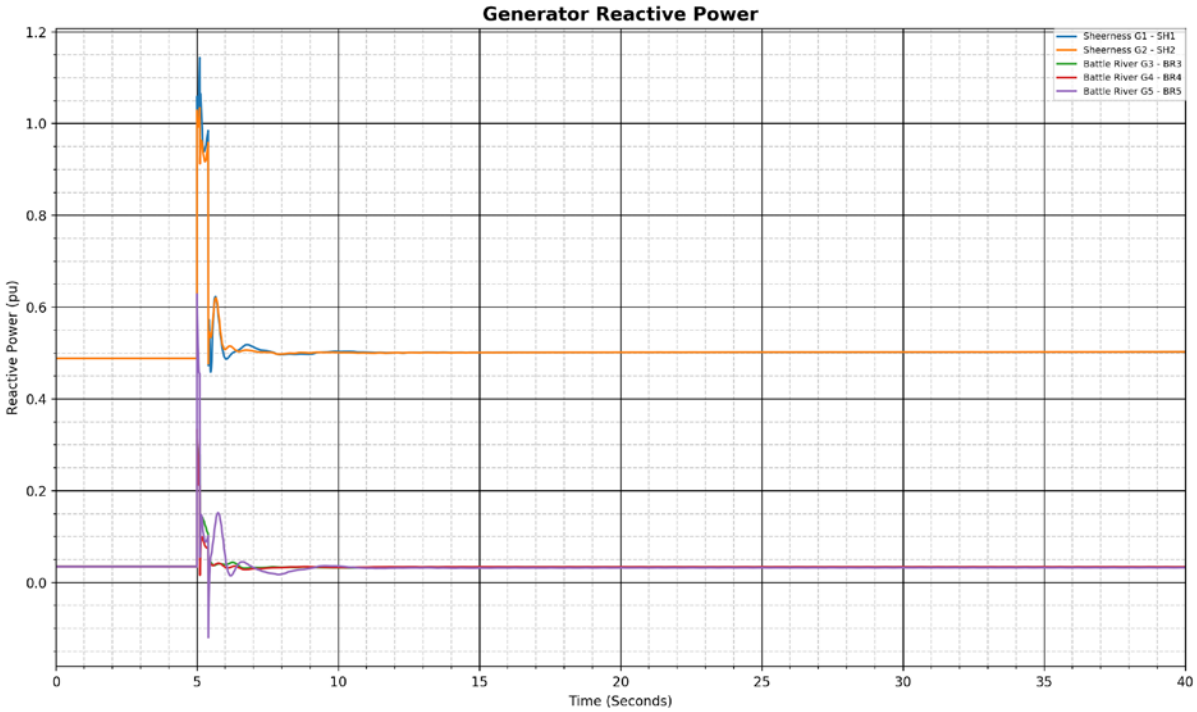

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Reactive Power (Mvar)
Time (Seconds)

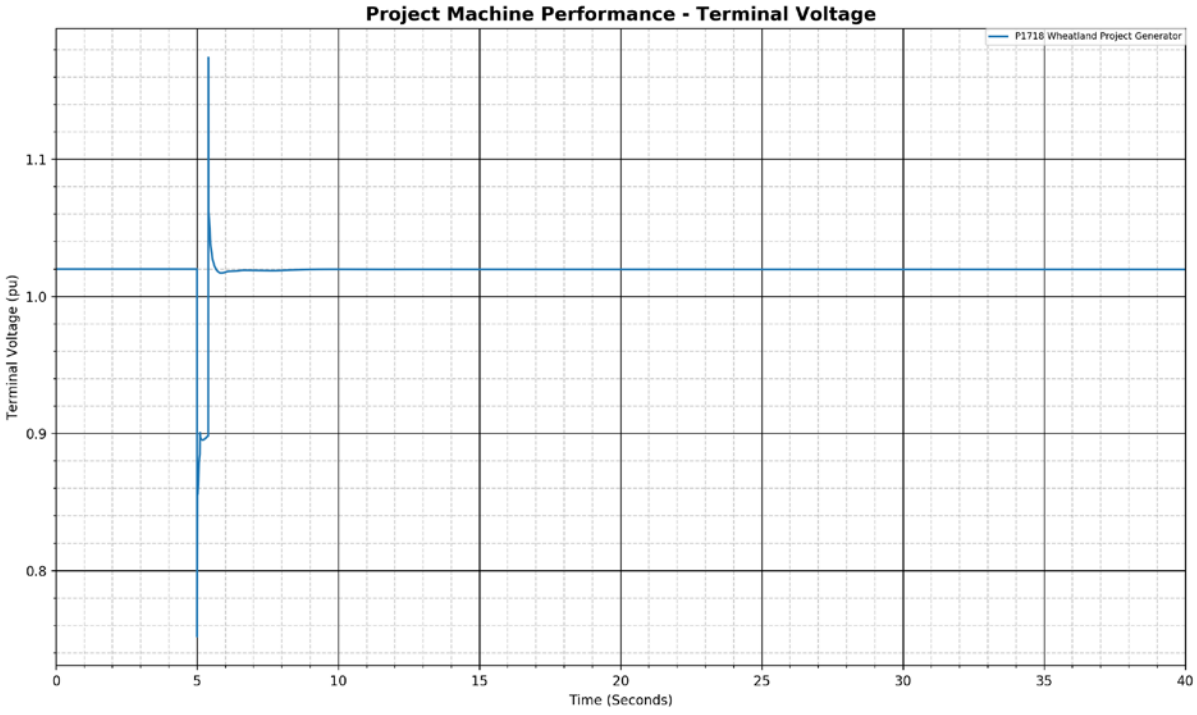
Figure A4-74: 7L137 (Rowley 768S - Three Hills 770S): 3-phase fault at Three Hills 770S

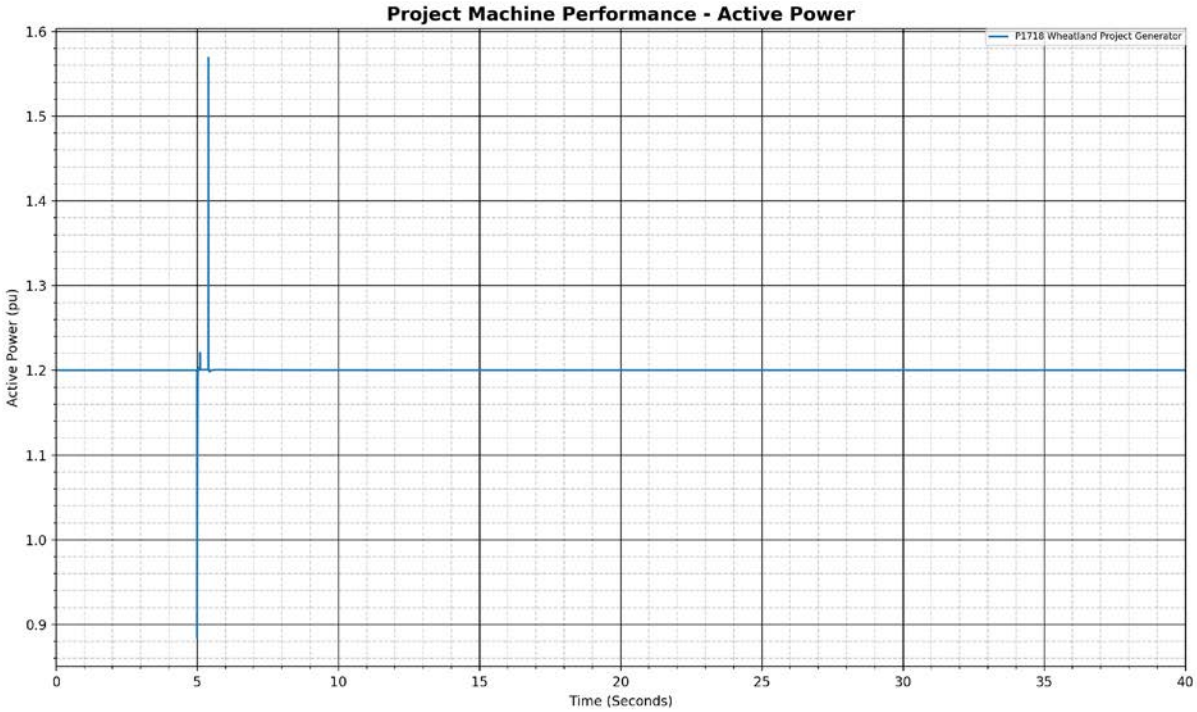


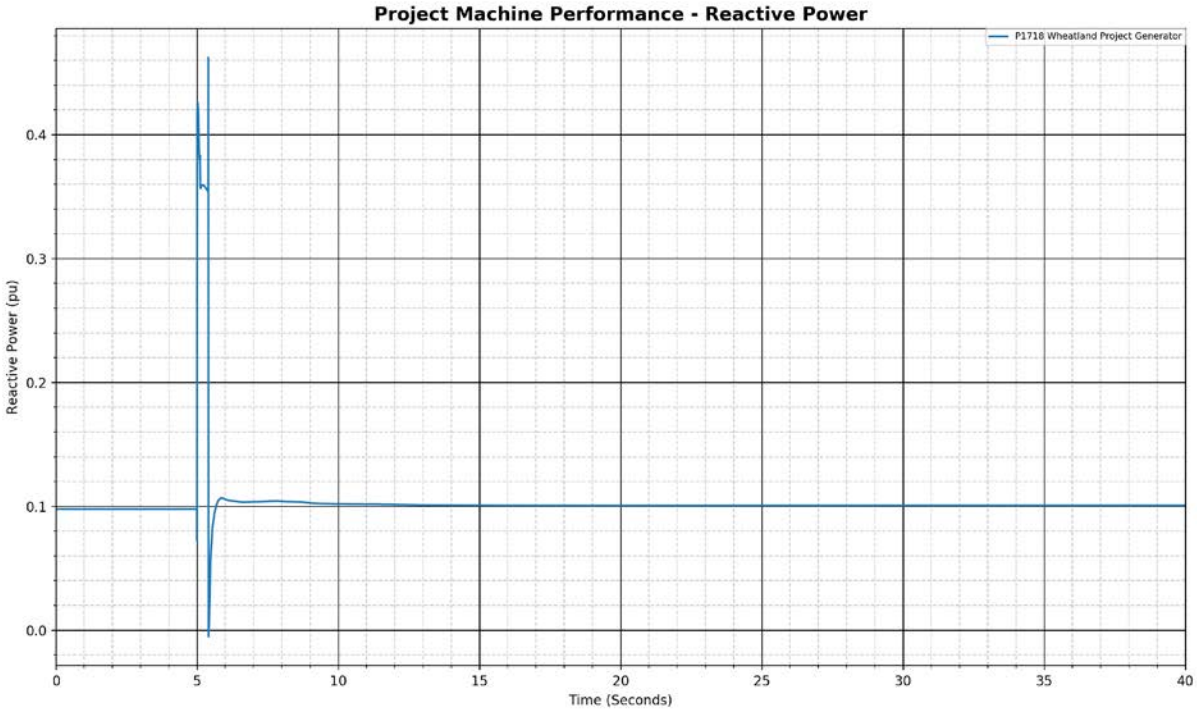

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

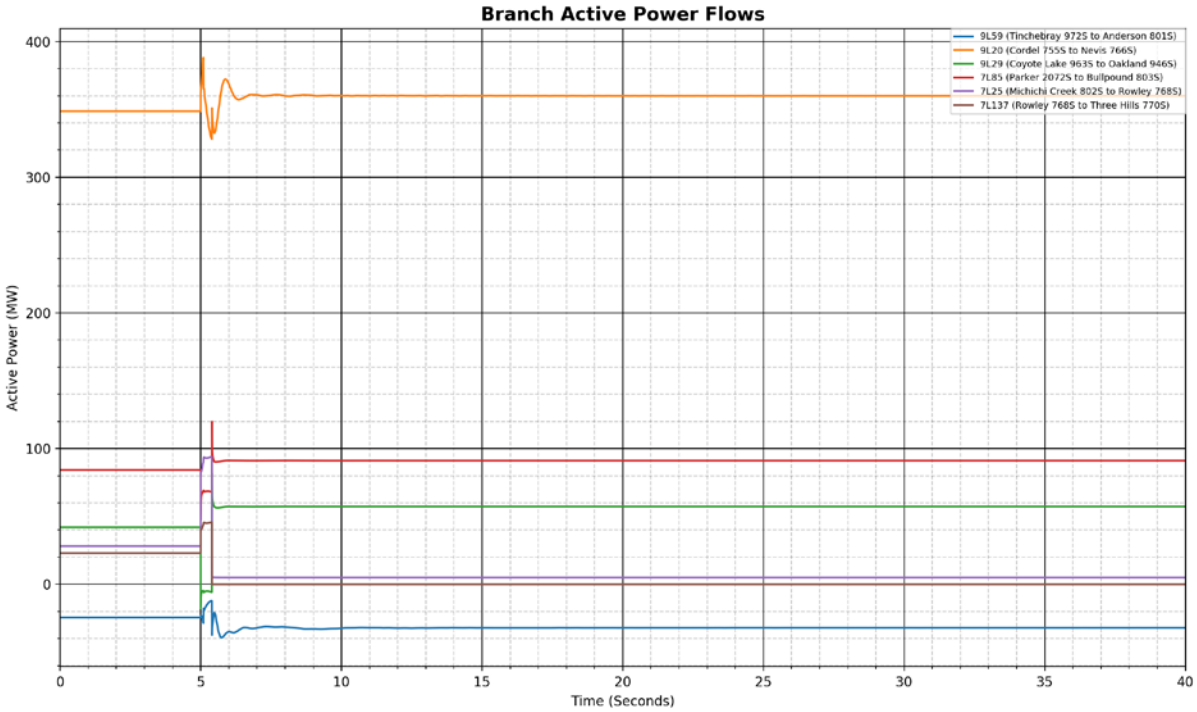

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.1
1.0
0.9
0.8
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Active Power (MW)
Time (Seconds)

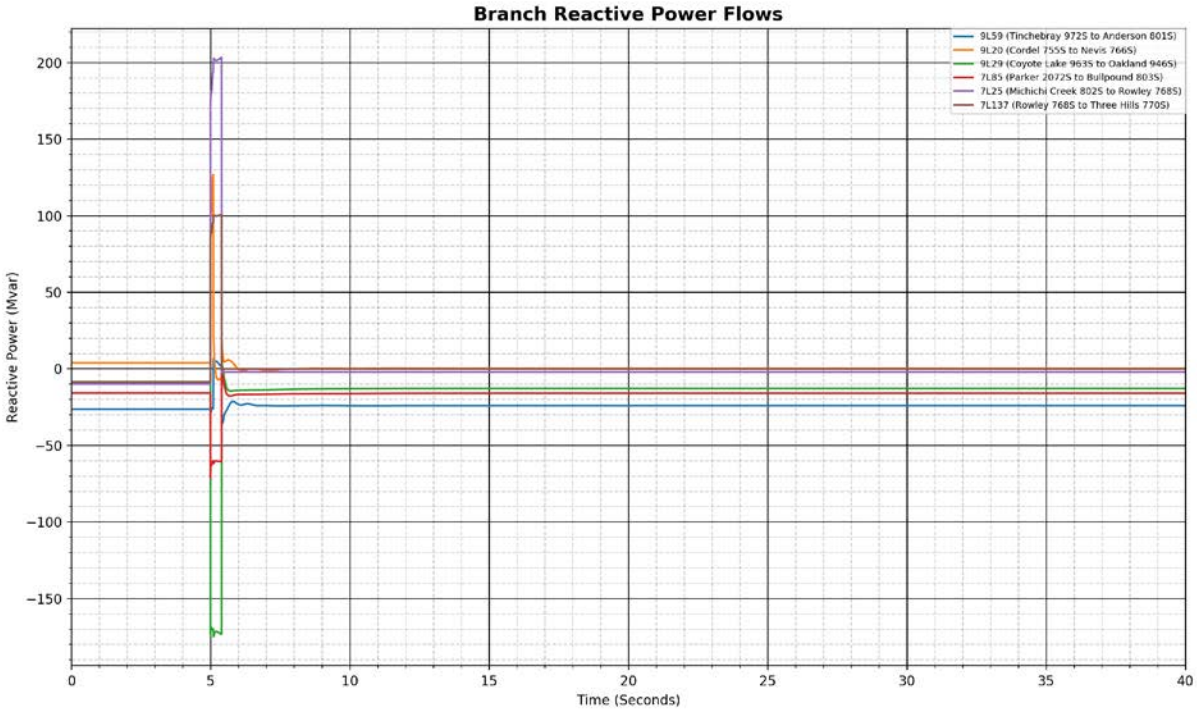
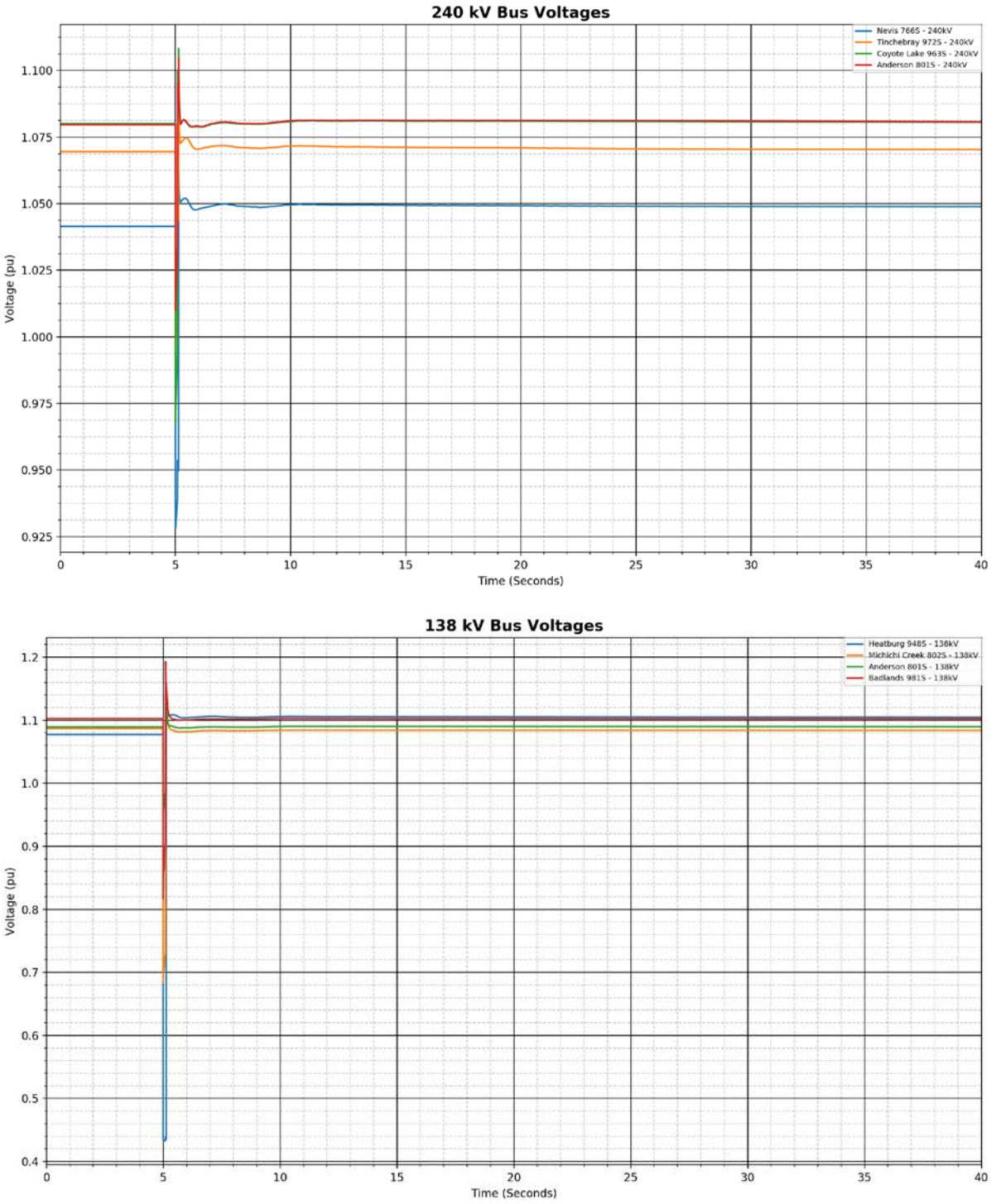
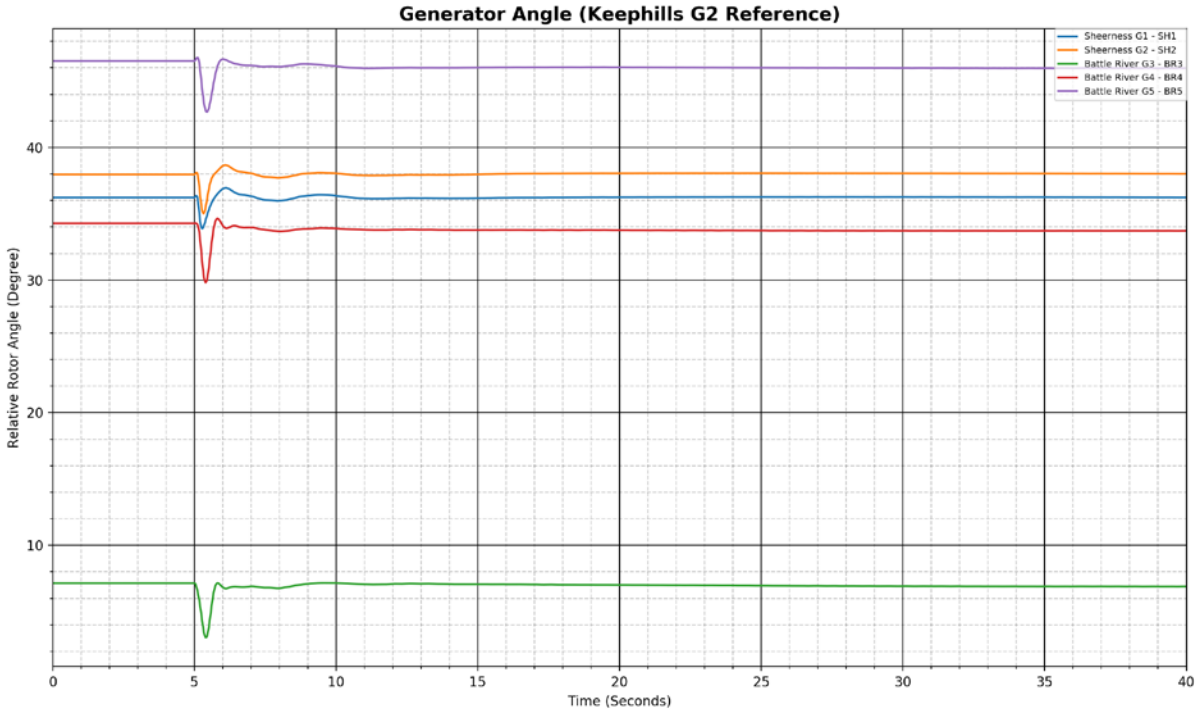
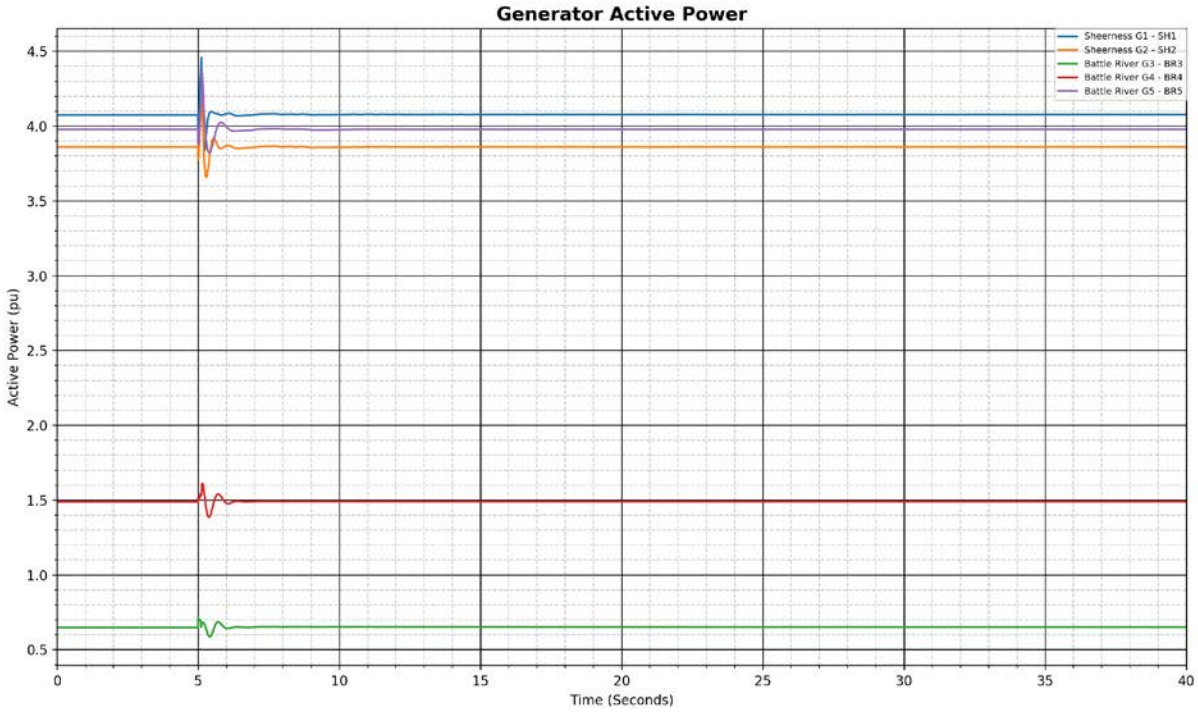
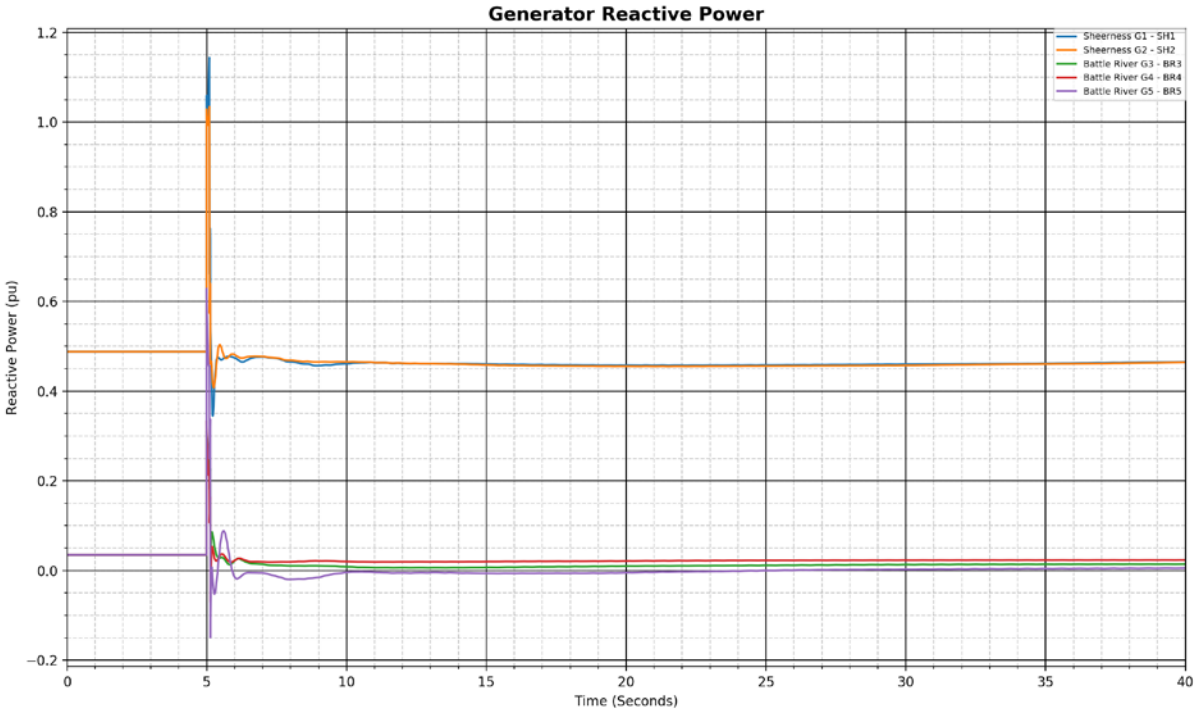

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L137 (Rowley 768S to Three Hills 770S)
Reactive Power (Mvar)
Time (Seconds)

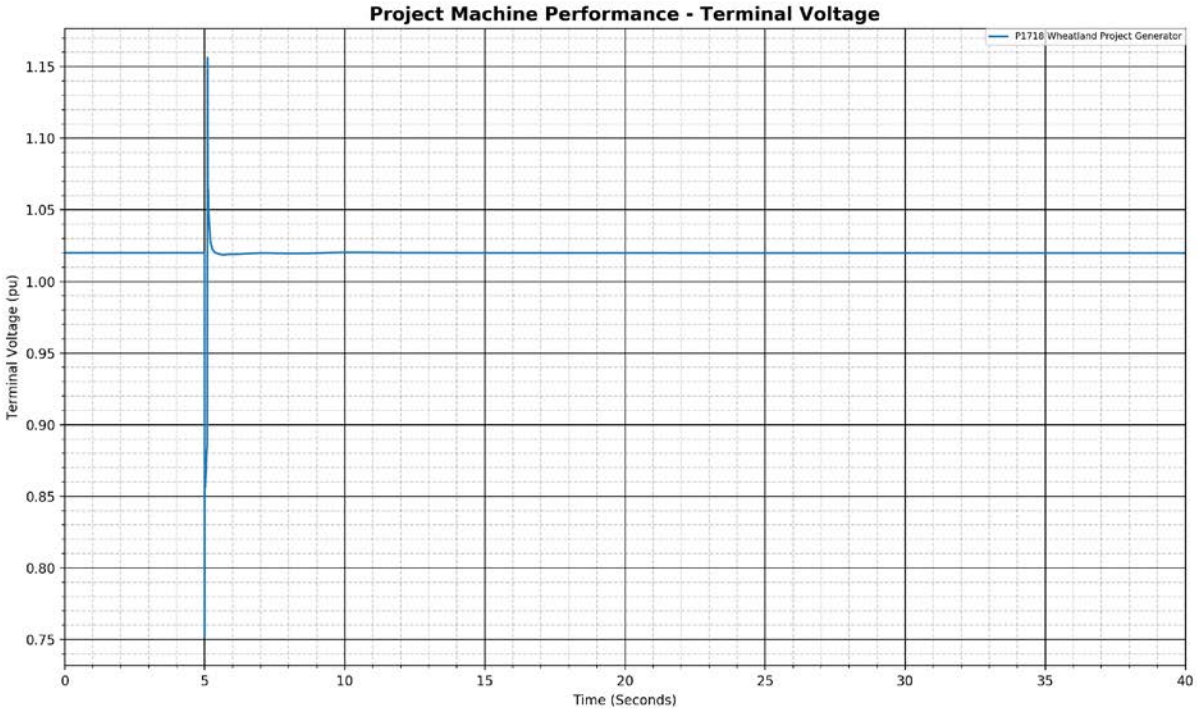
Figure A4-75: 7L159 (Three Hills 770S - Ghost Pine 114S - Heatburg 948S): 3-phase fault at Three Hills 770S

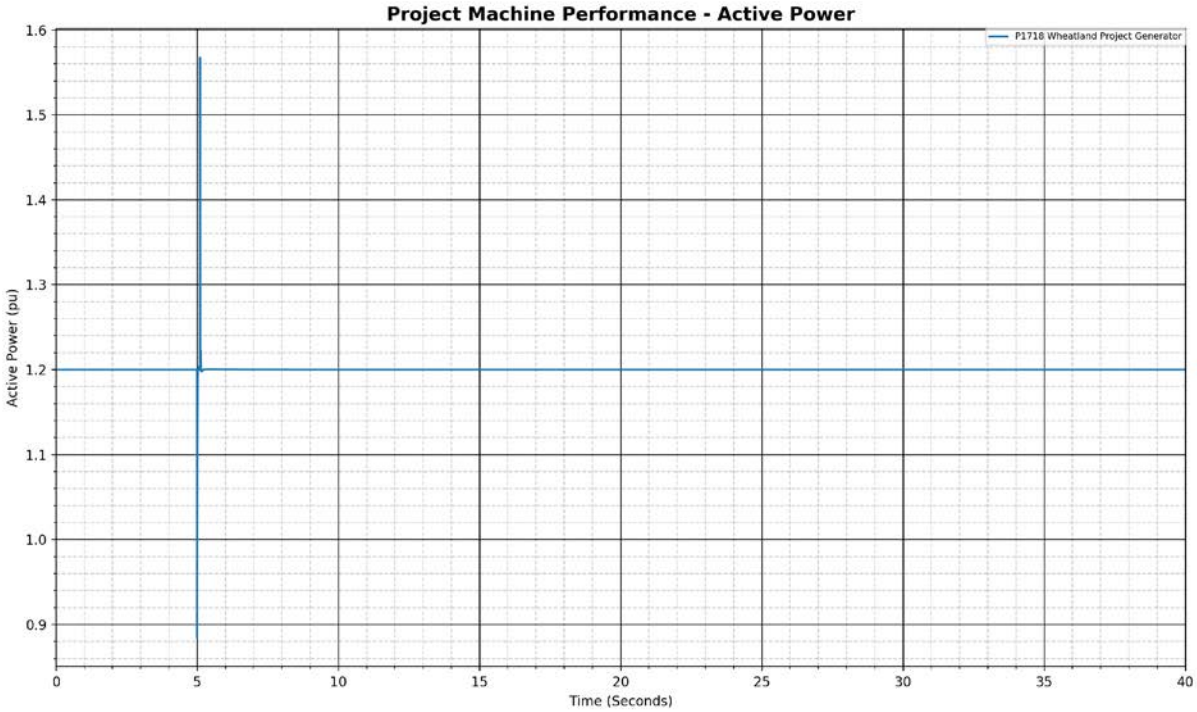


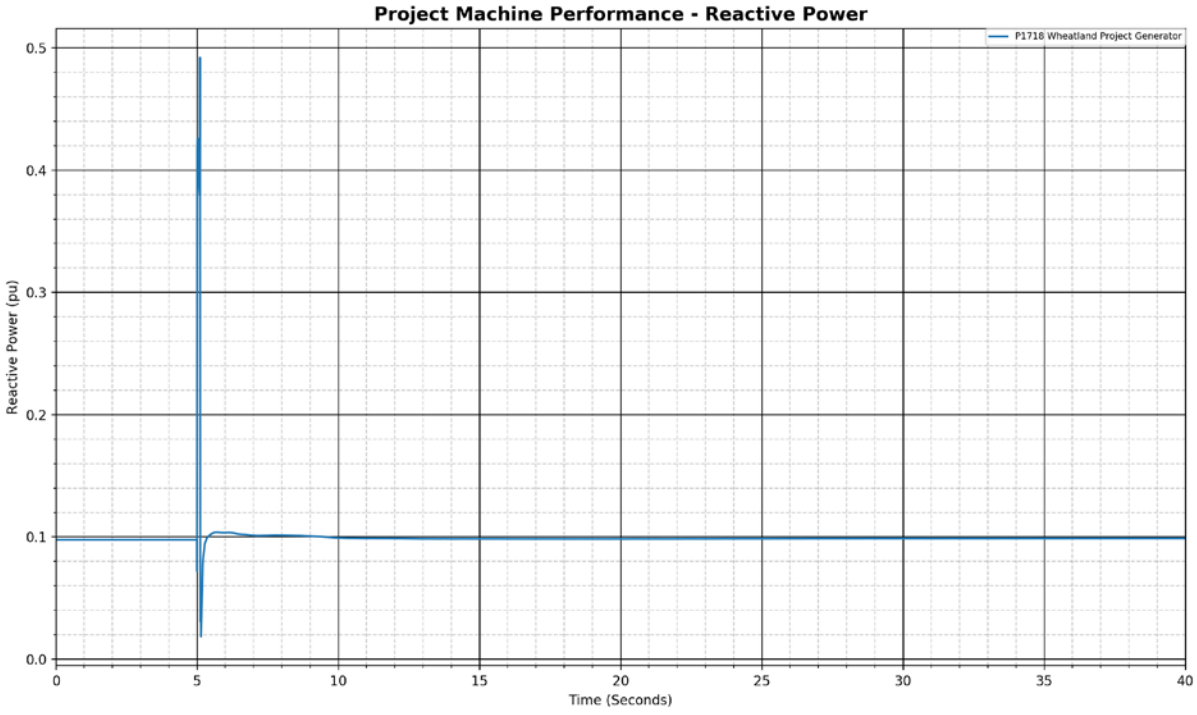

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

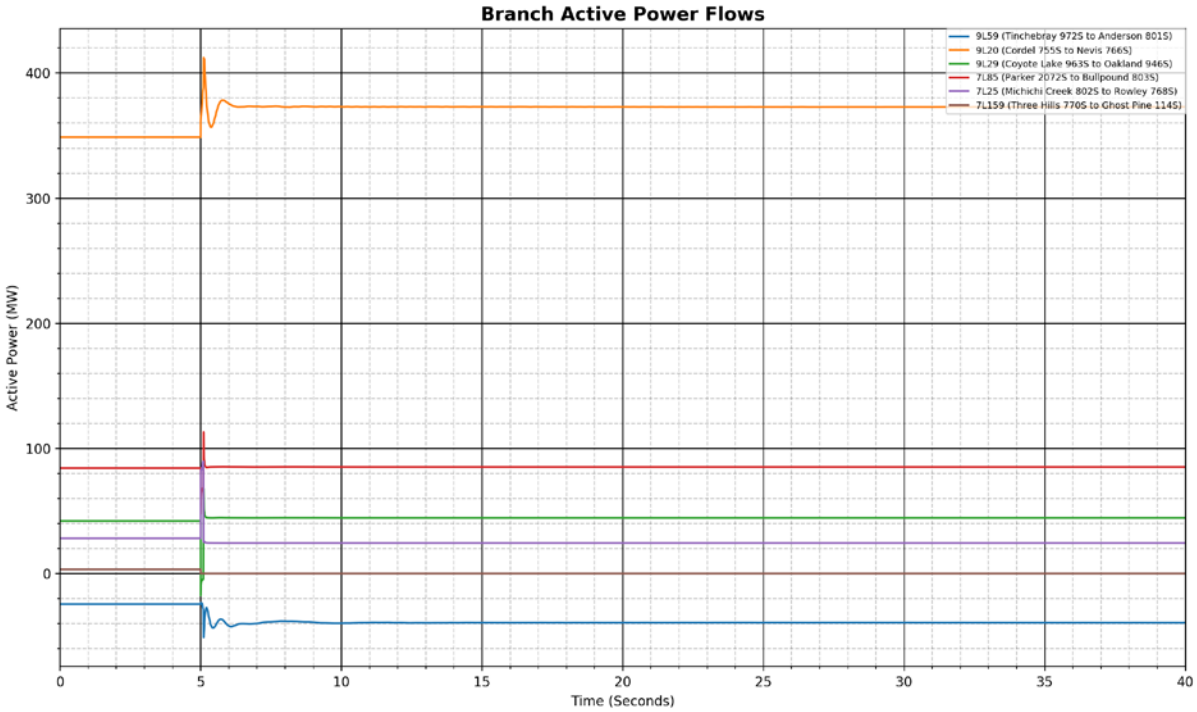

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Active Power (MW)
Time (Seconds)

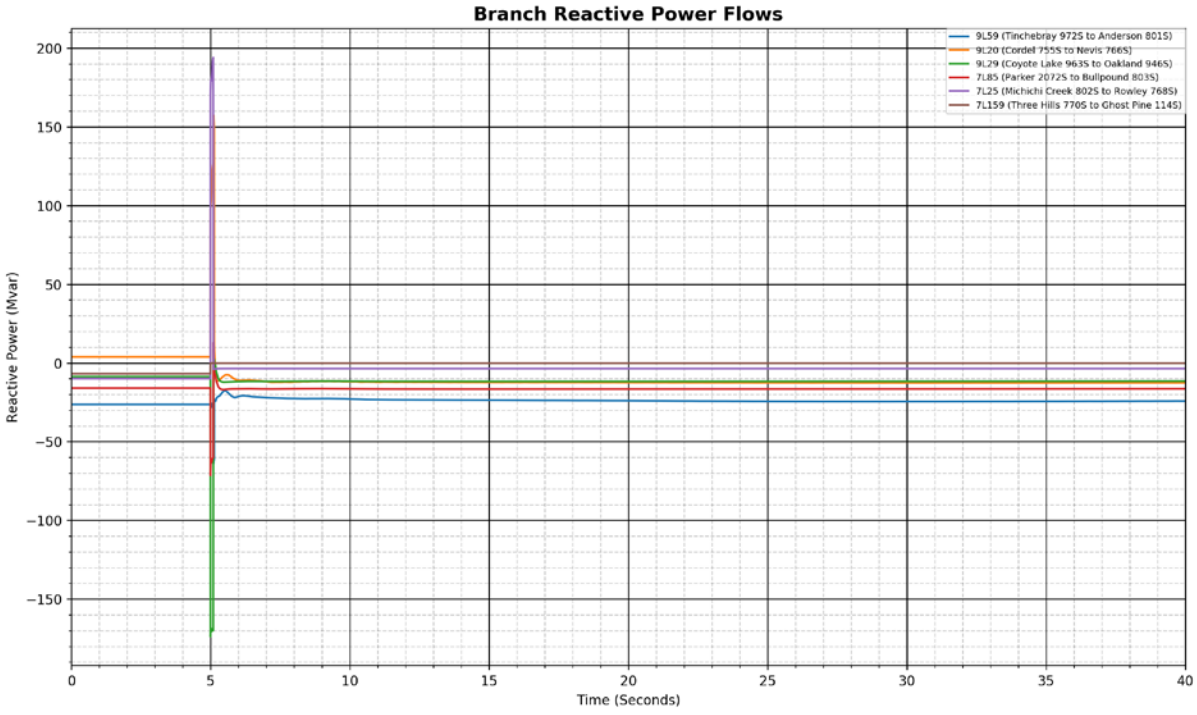
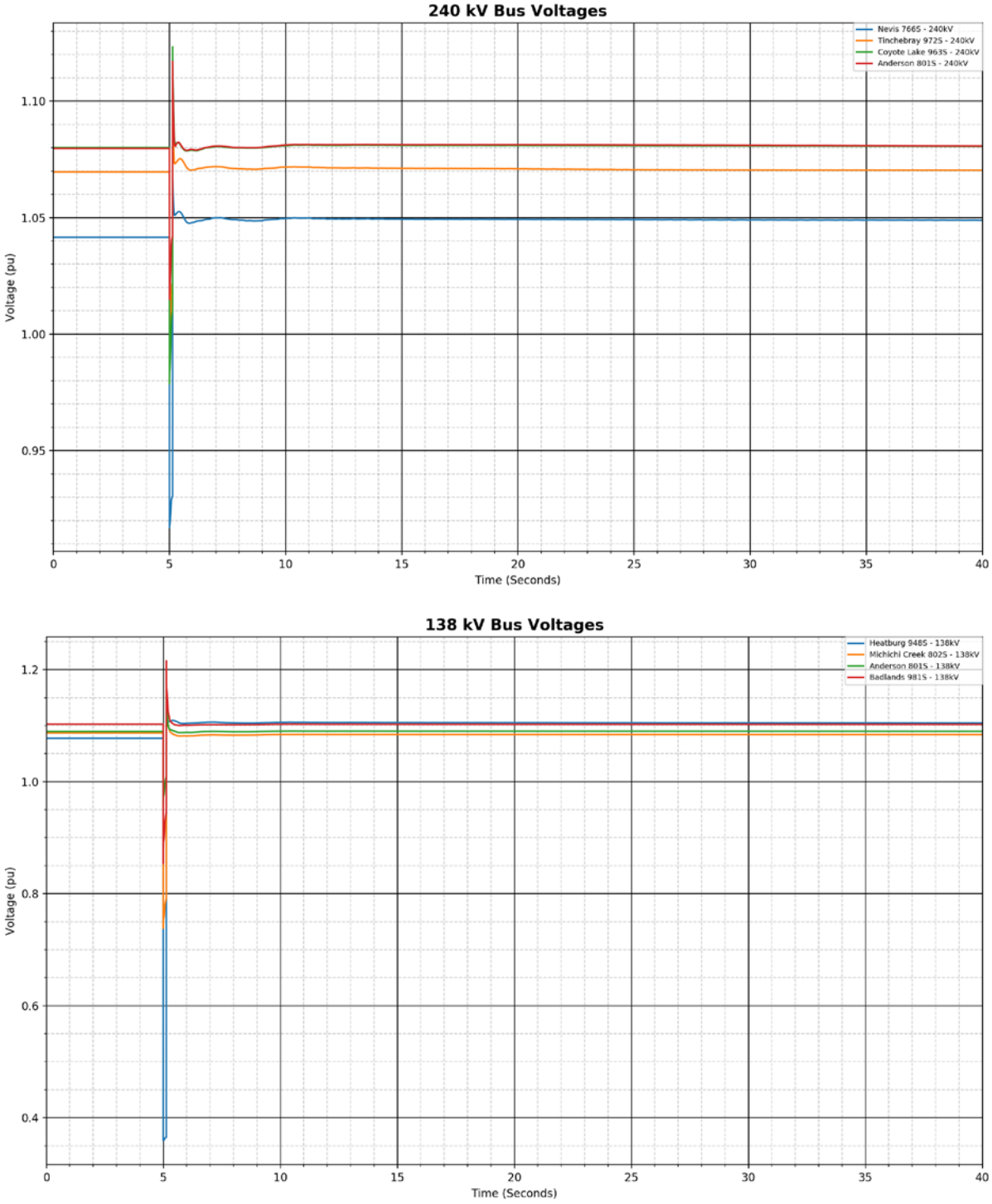
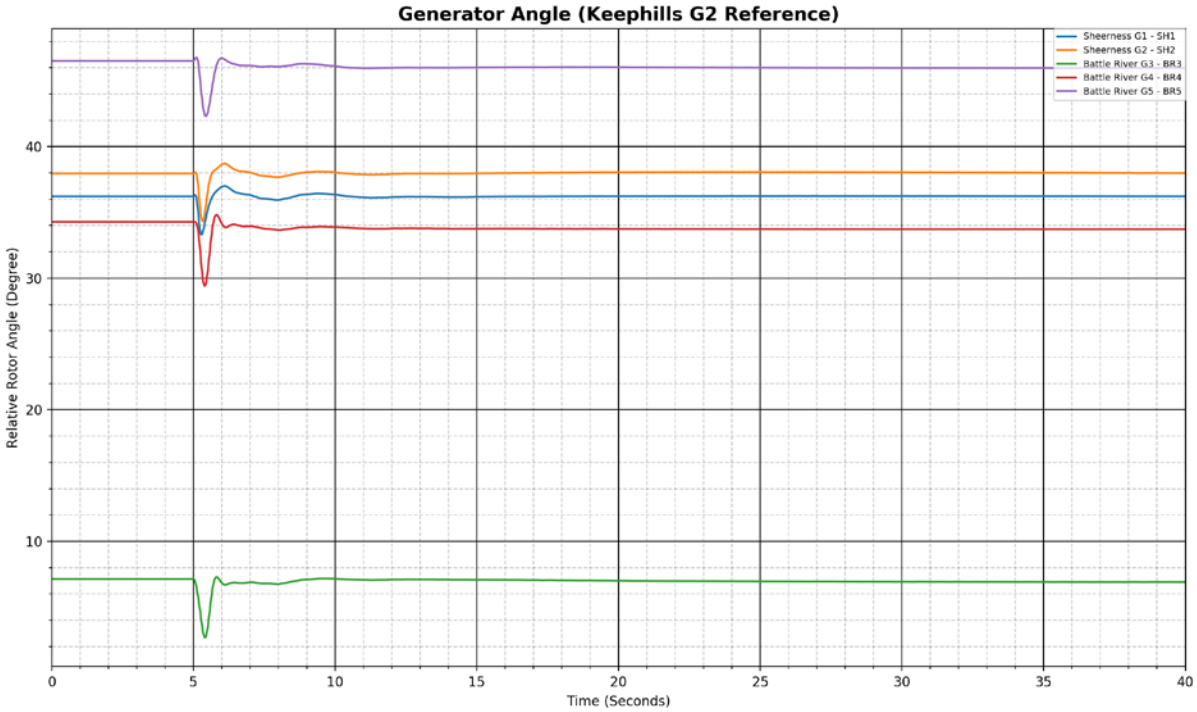
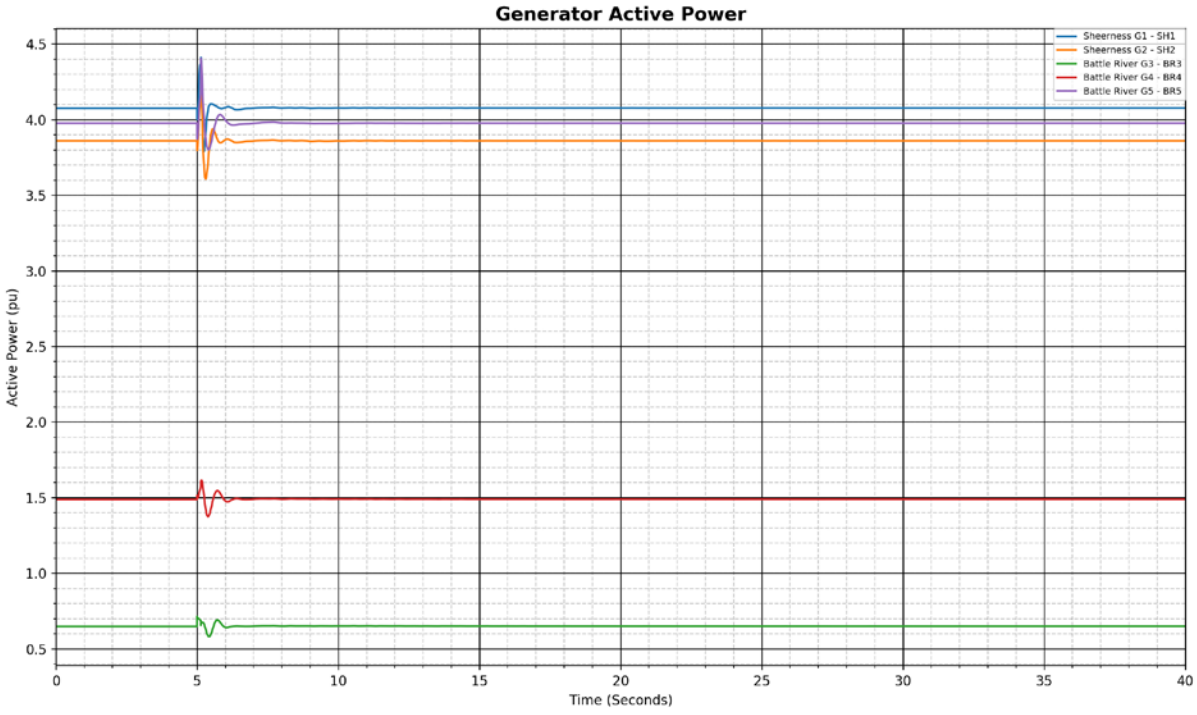
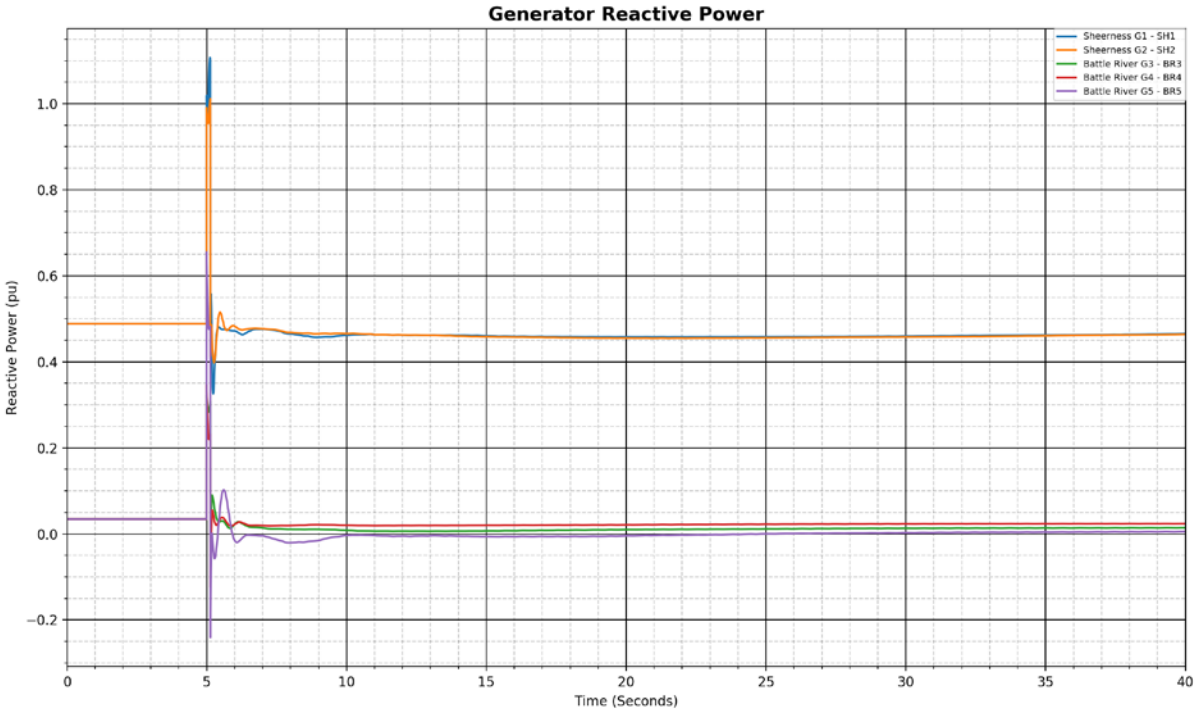

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Reactive Power (Mvar)
Time (Seconds)

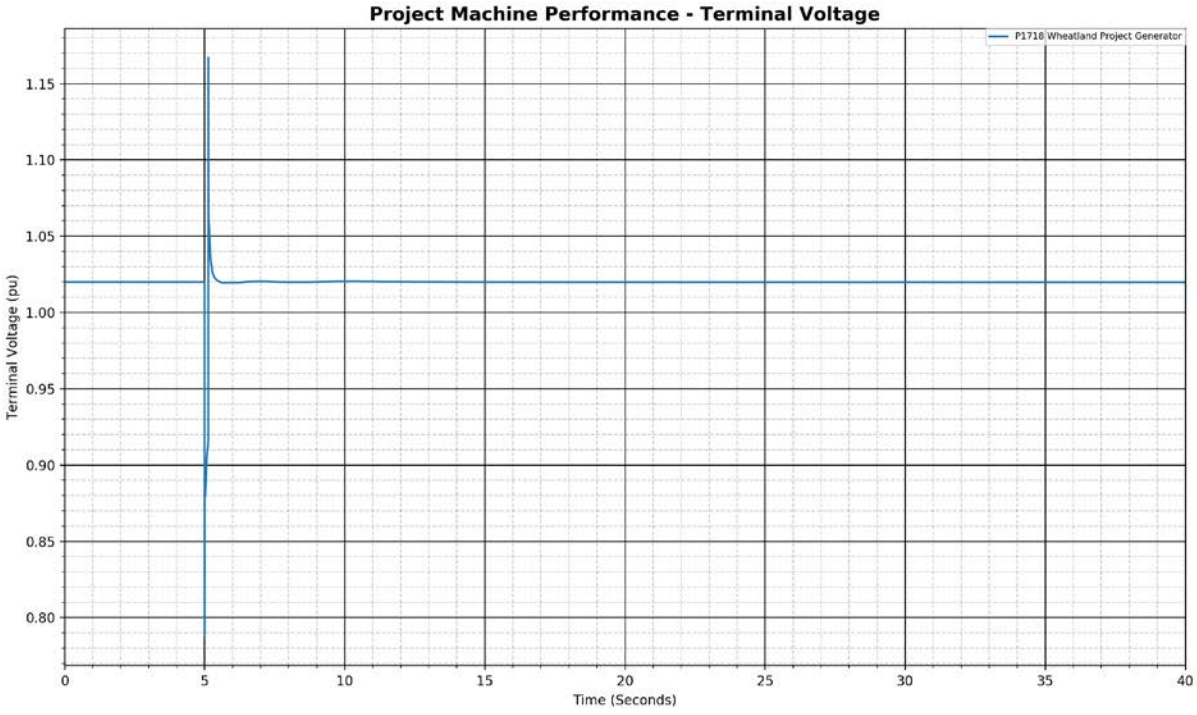
Figure A4-76: 7L159 (Three Hills 770S - Ghost Pine 114S - Heatburg 948S): 3-phase fault at Ghost Pine 114S

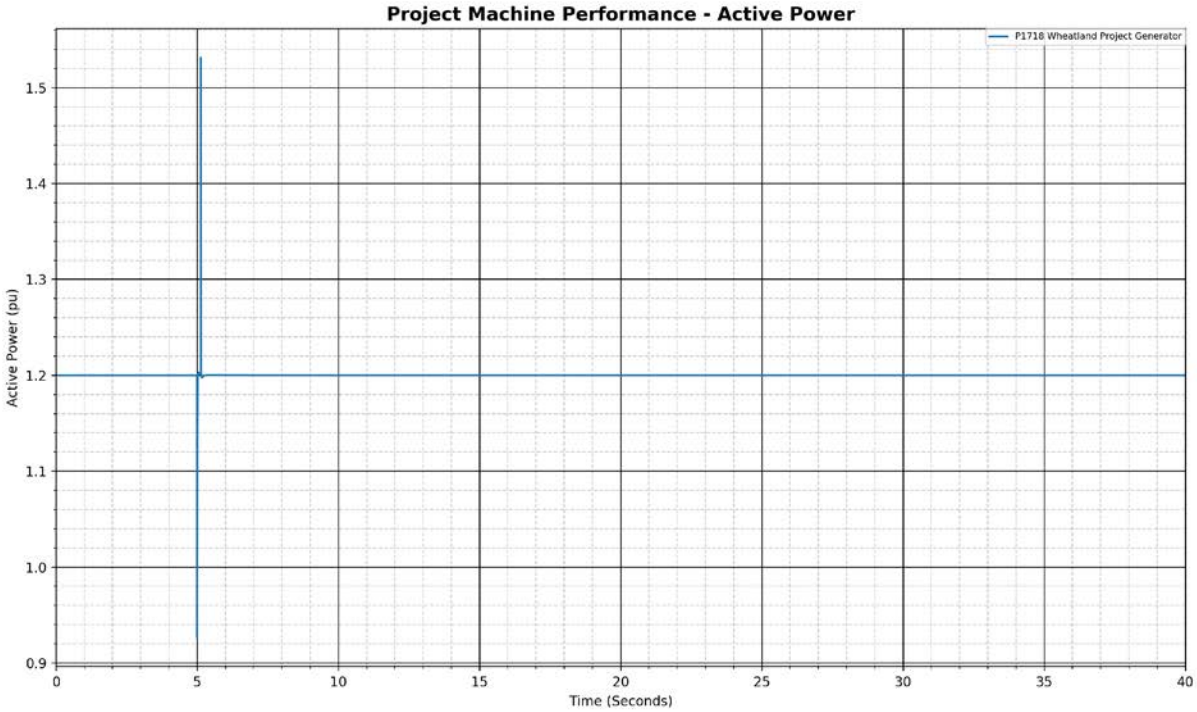


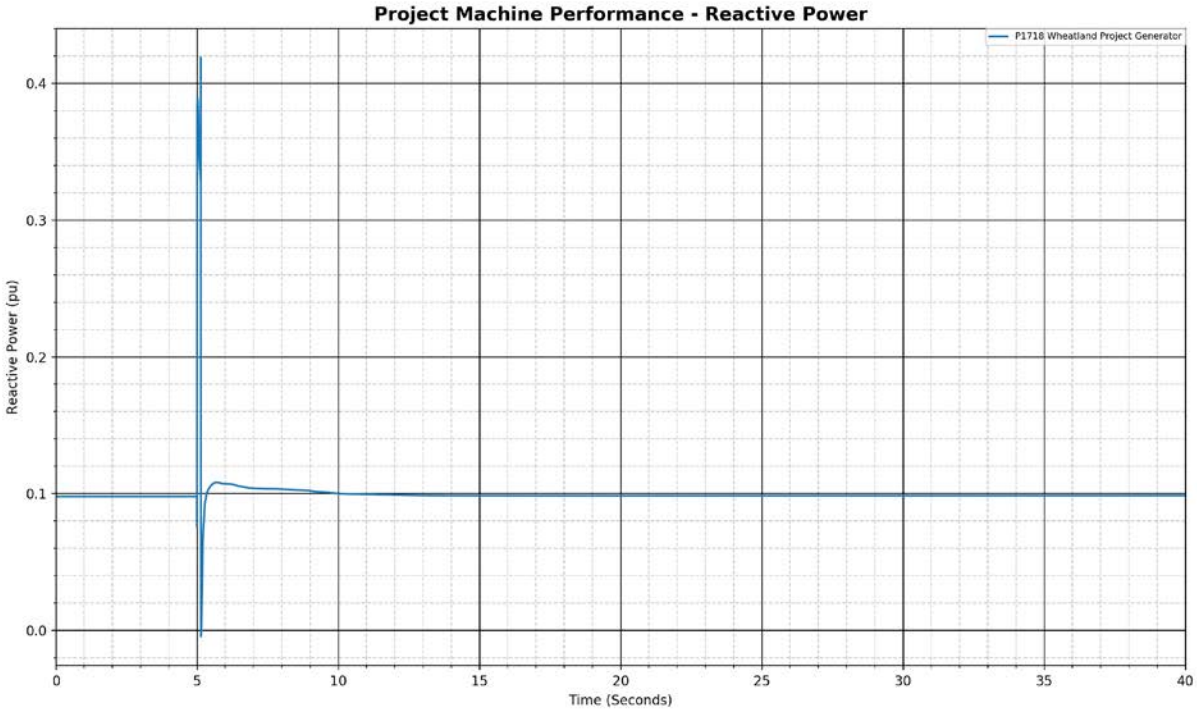

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

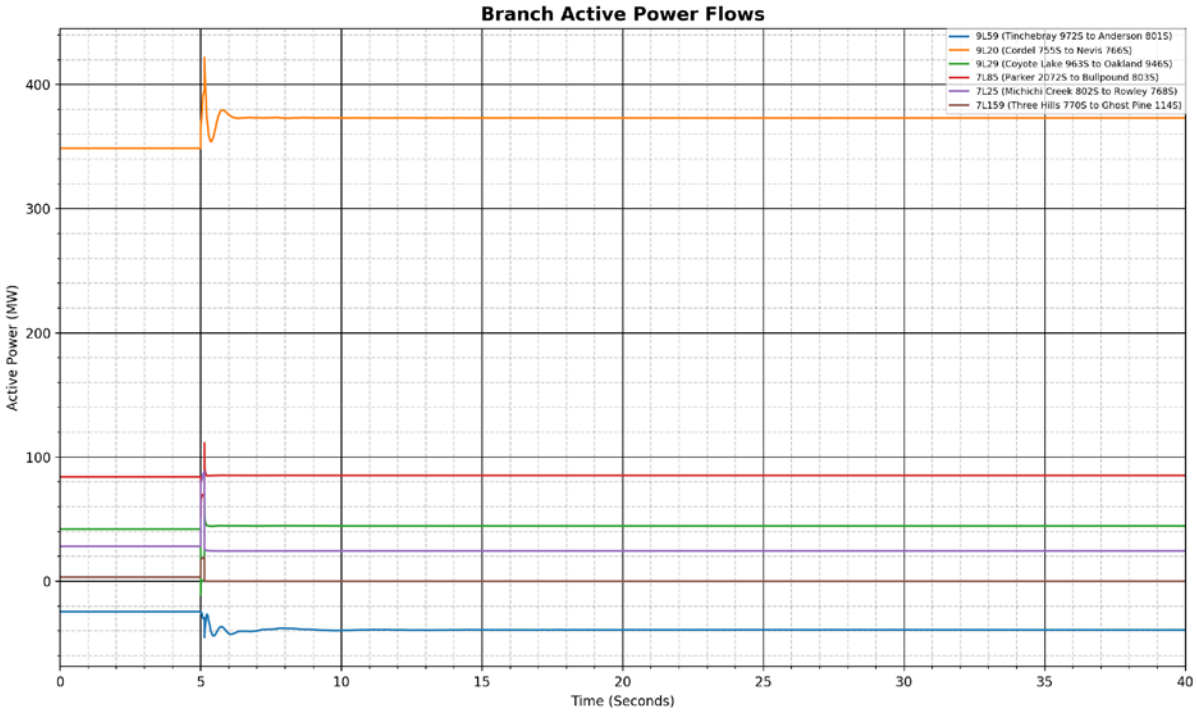

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Active Power (MW)
Time (Seconds)

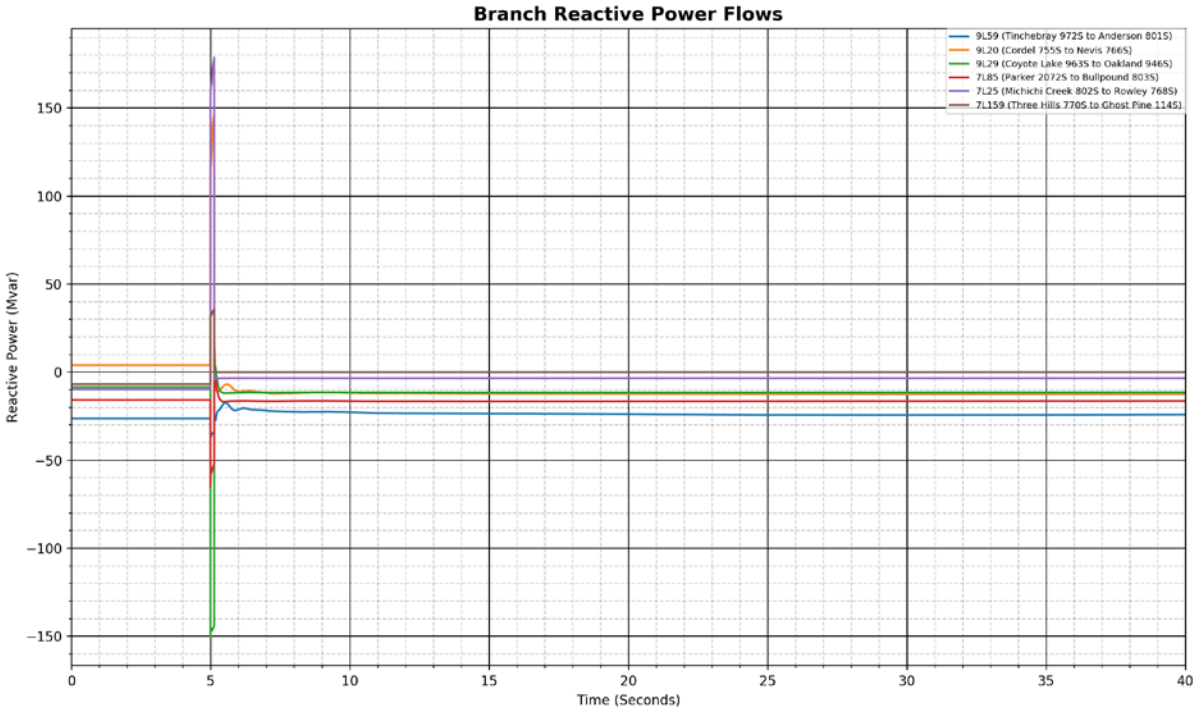
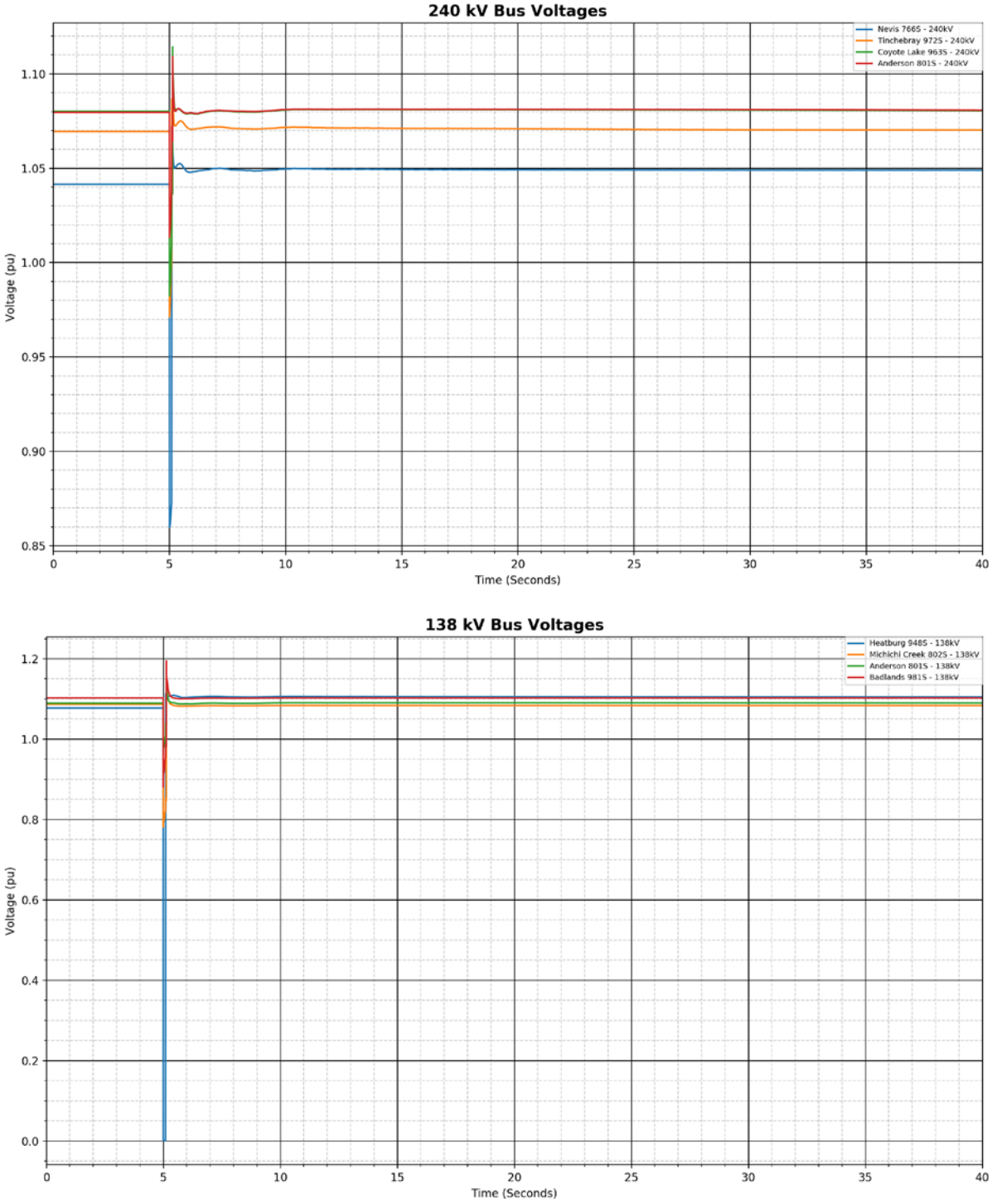
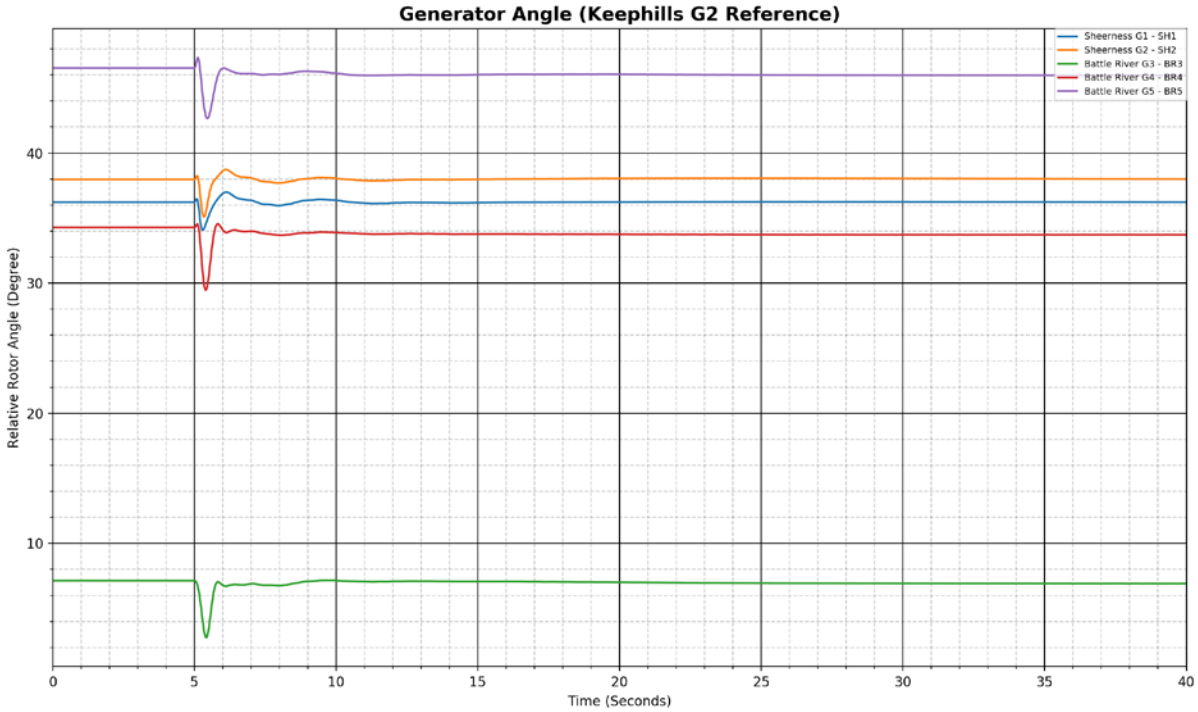
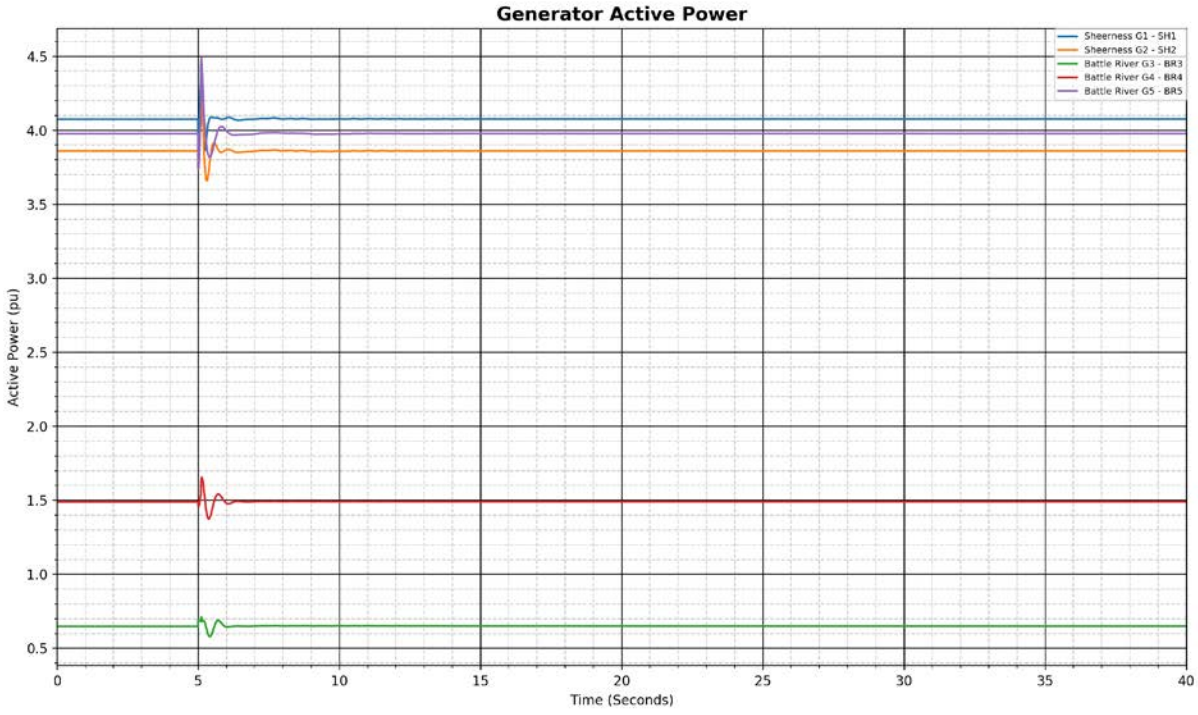
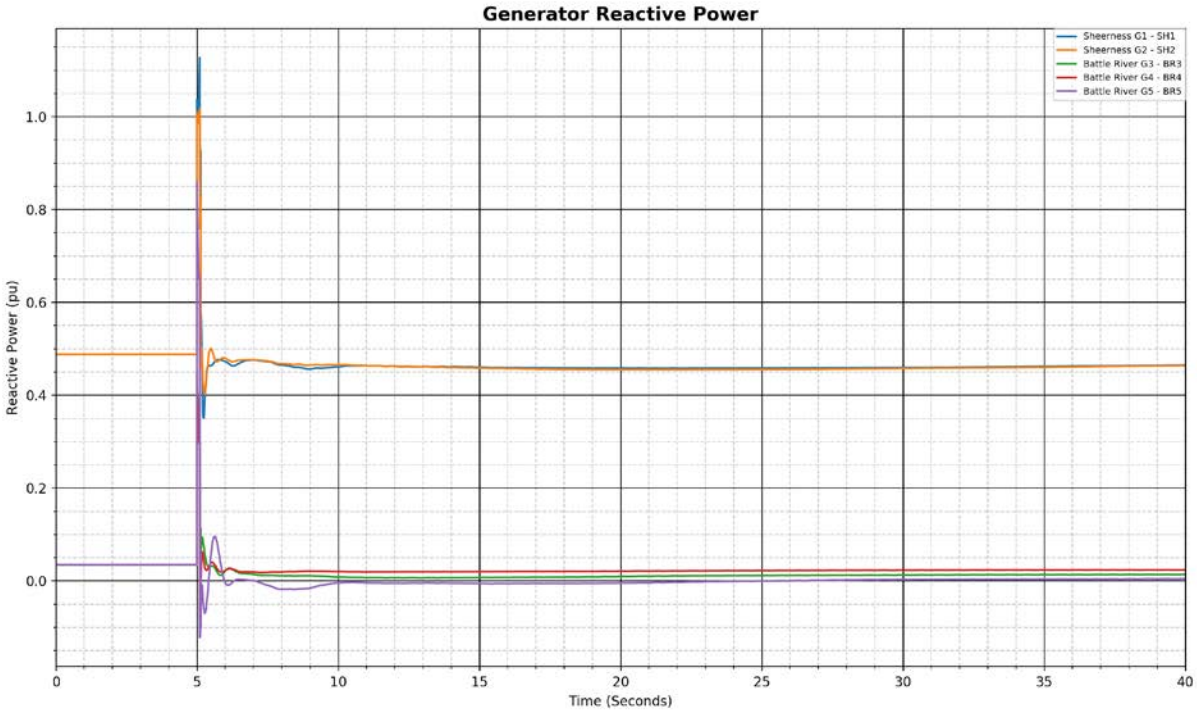

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Reactive Power (Mvar)
Time (Seconds)

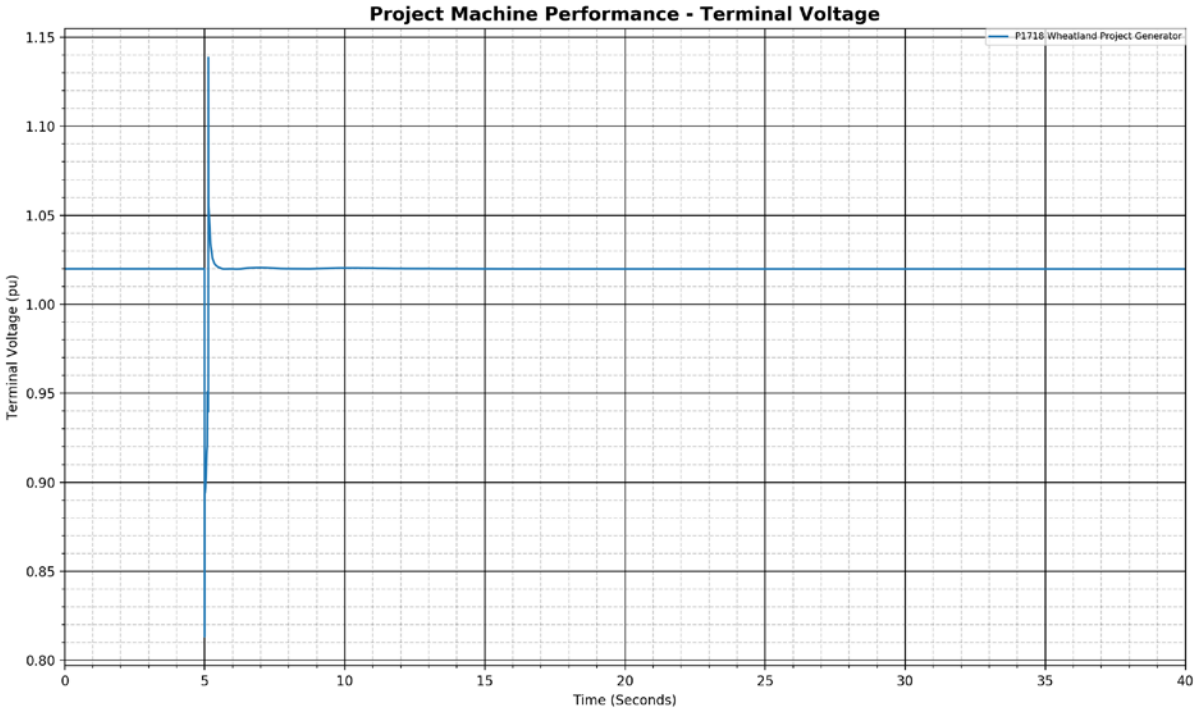
Figure A4-77: 7L159 (Three Hills 770S - Ghost Pine 114S - Heatburg 948S): 3-phase fault at Heatburg 948S

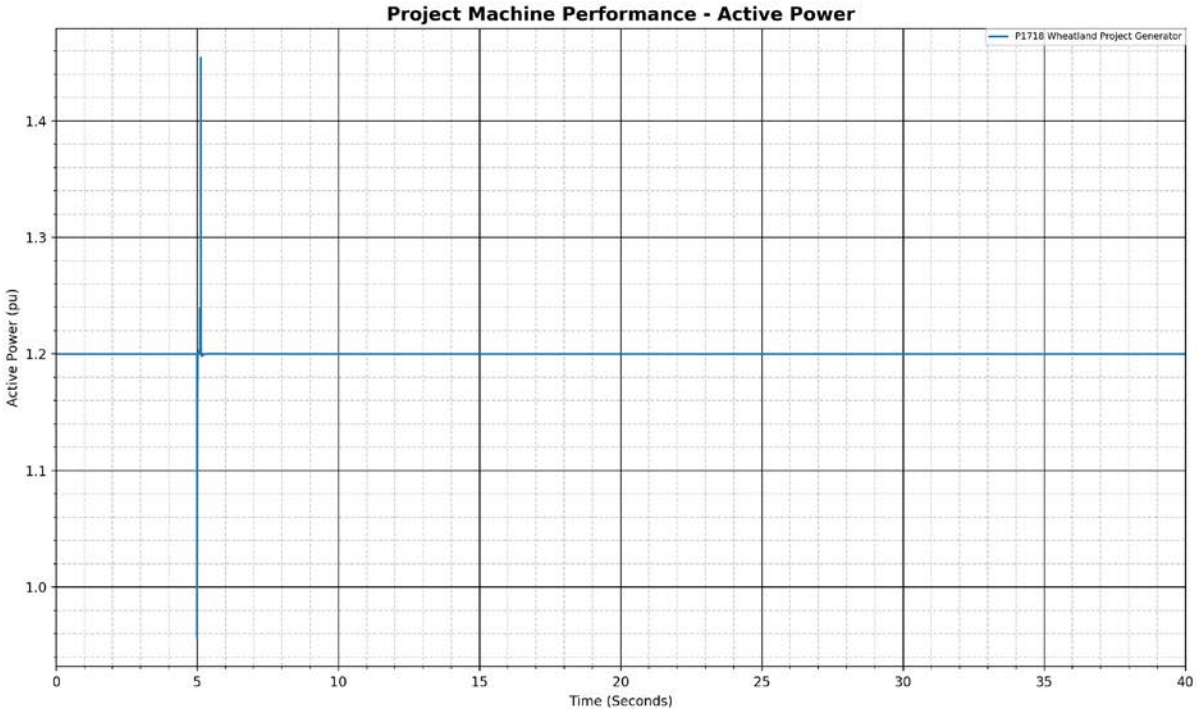


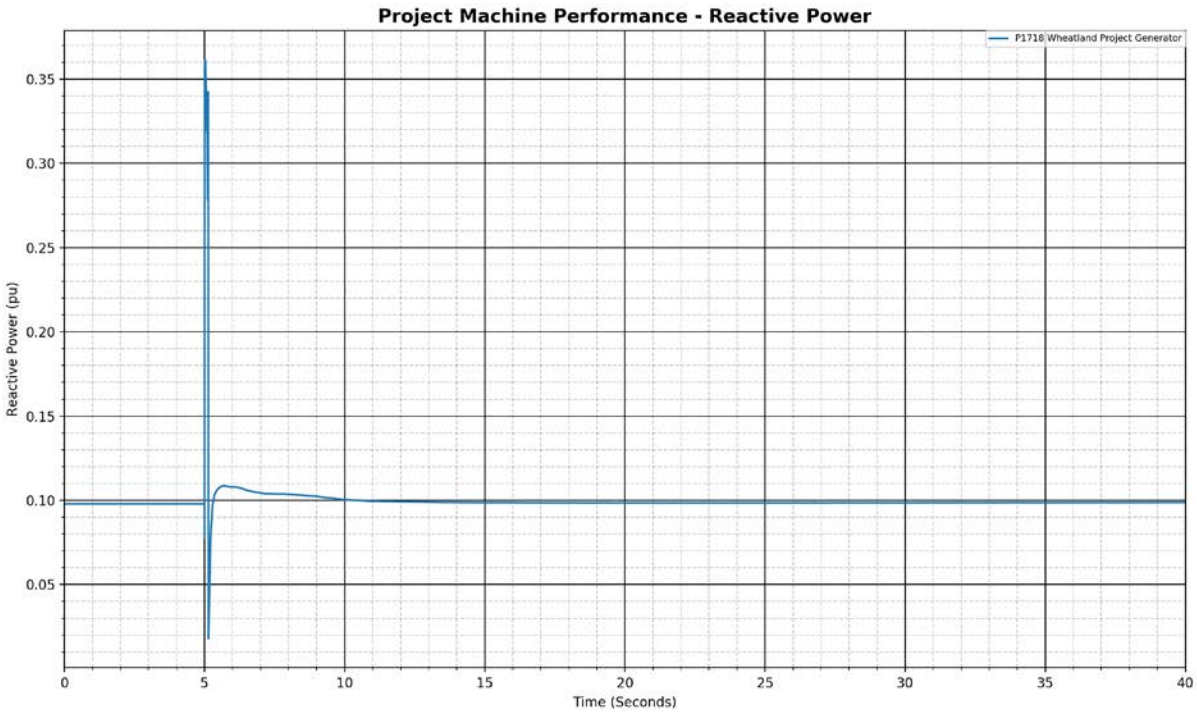

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

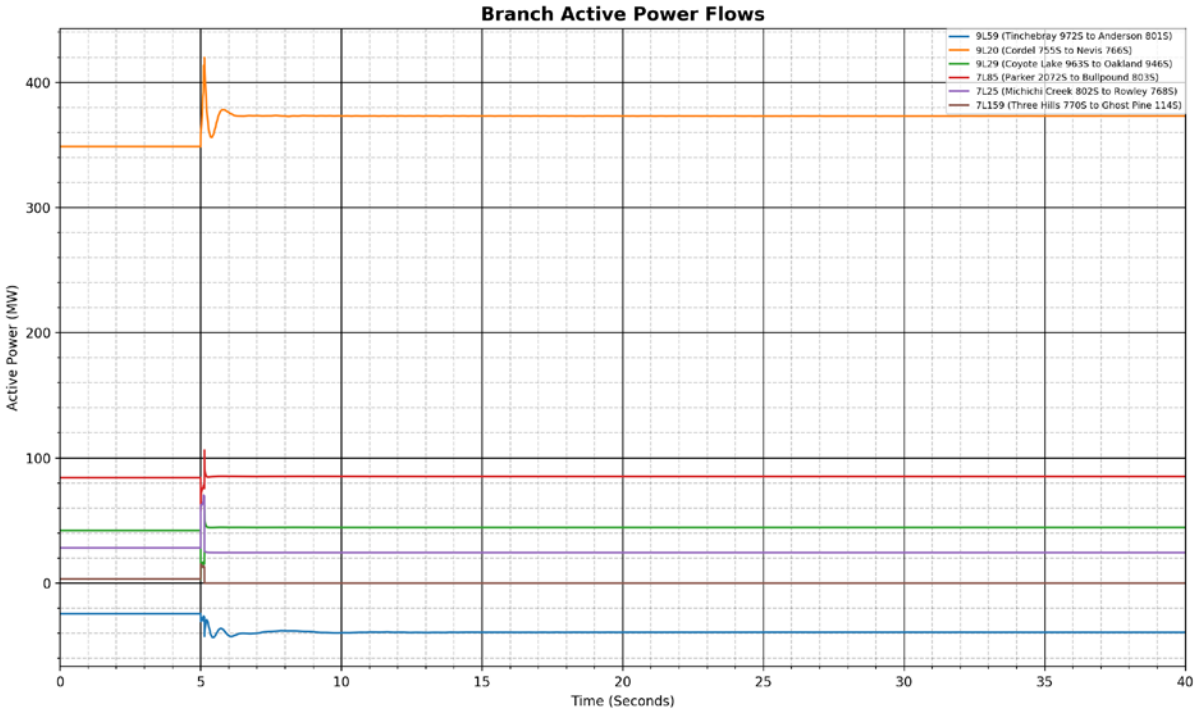

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Active Power (MW)
Time (Seconds)

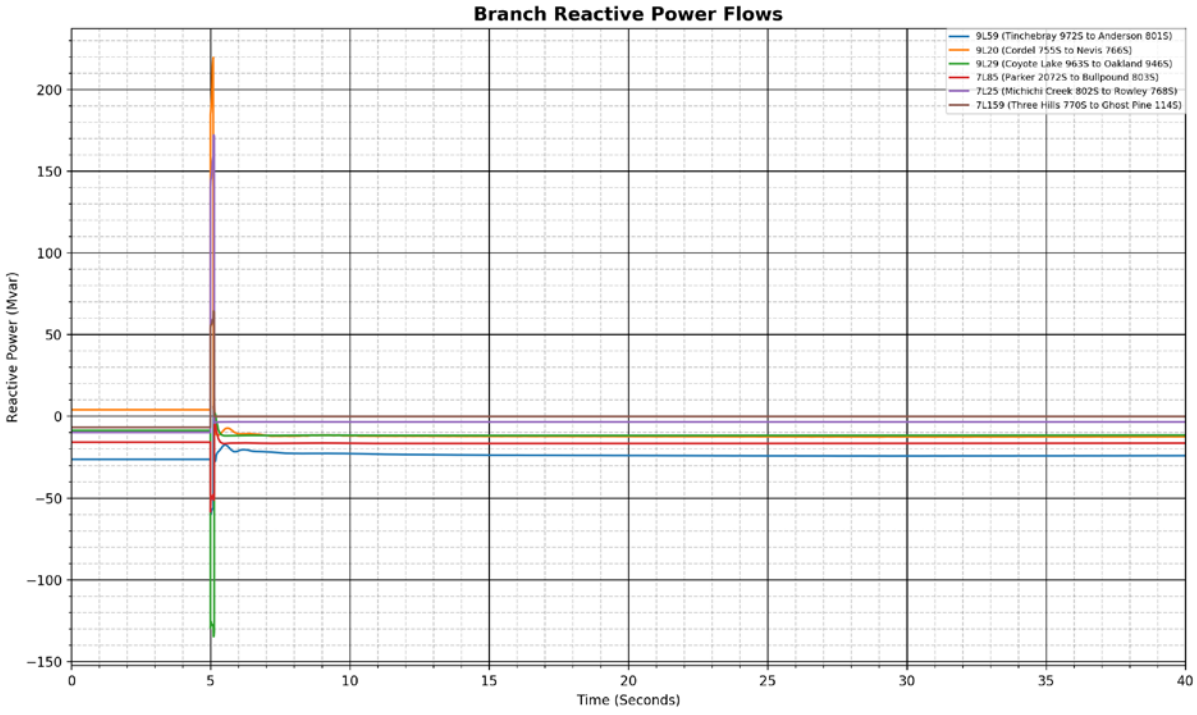
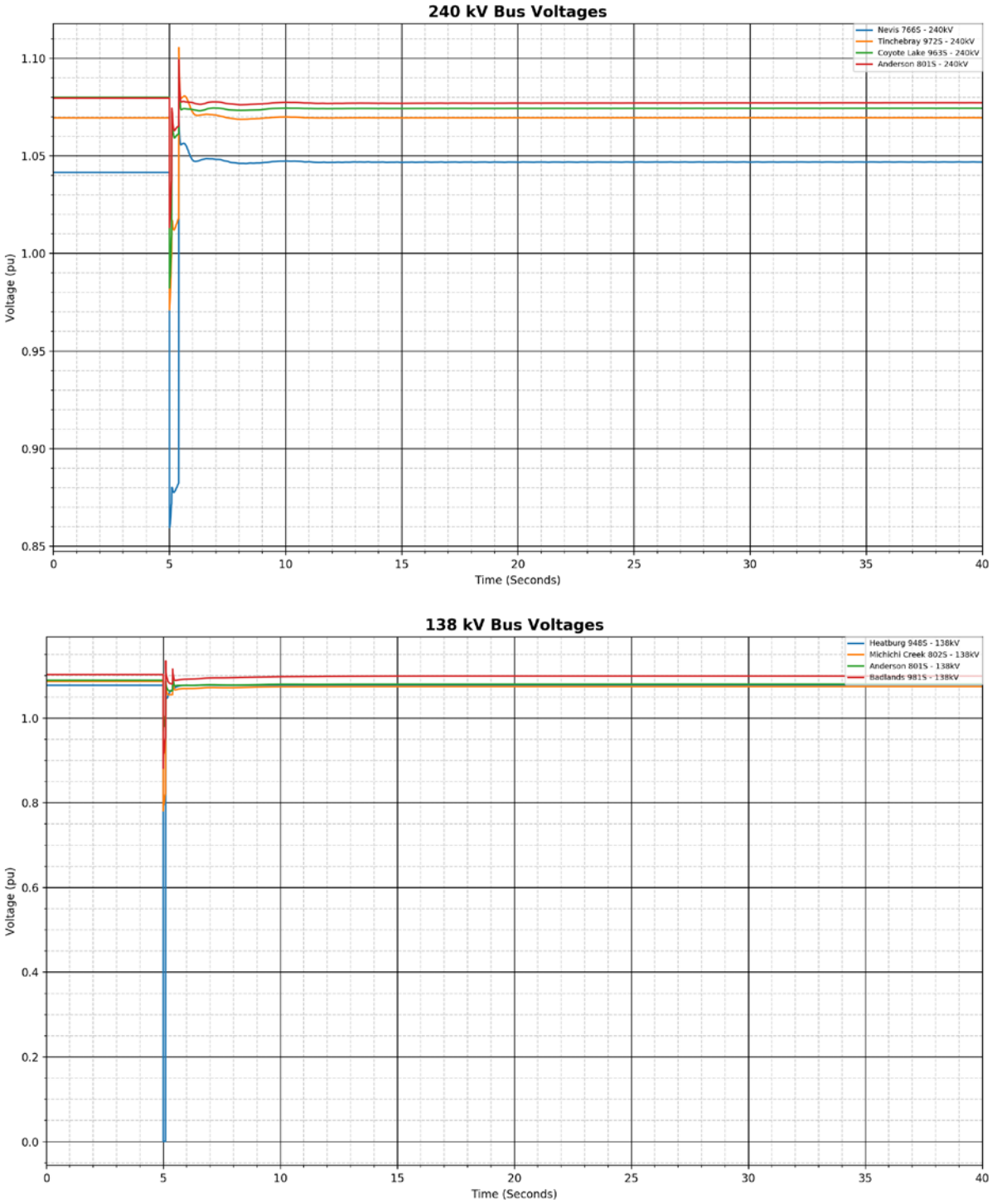
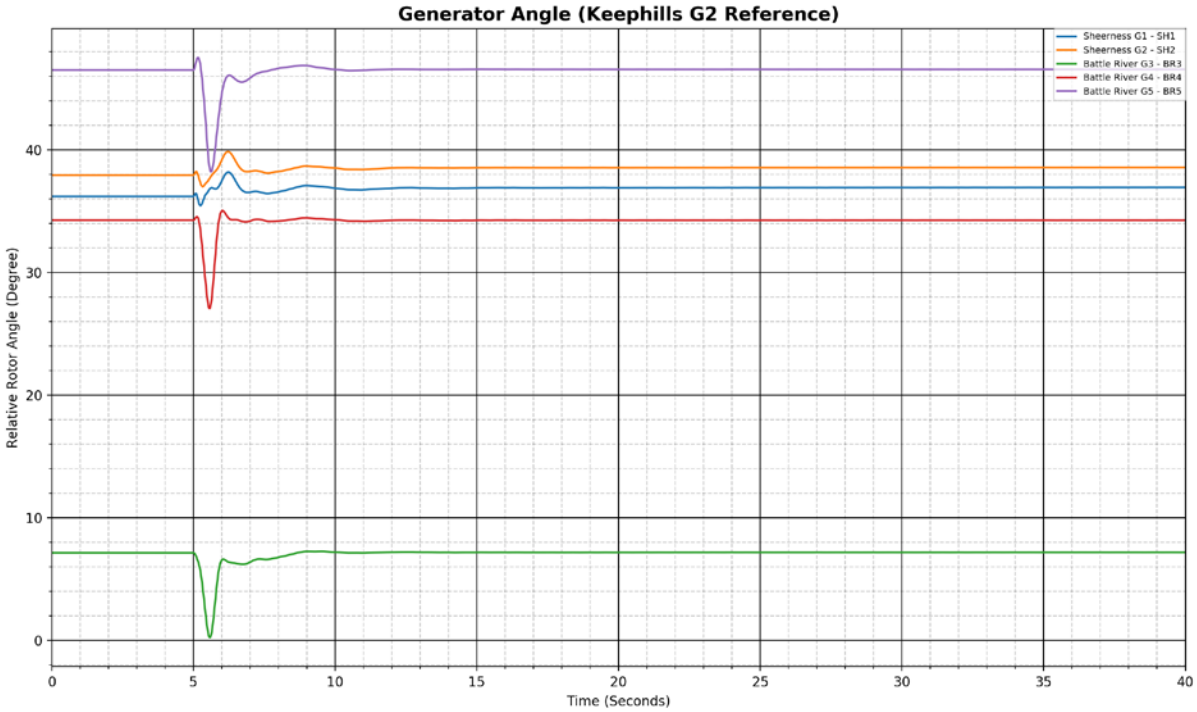
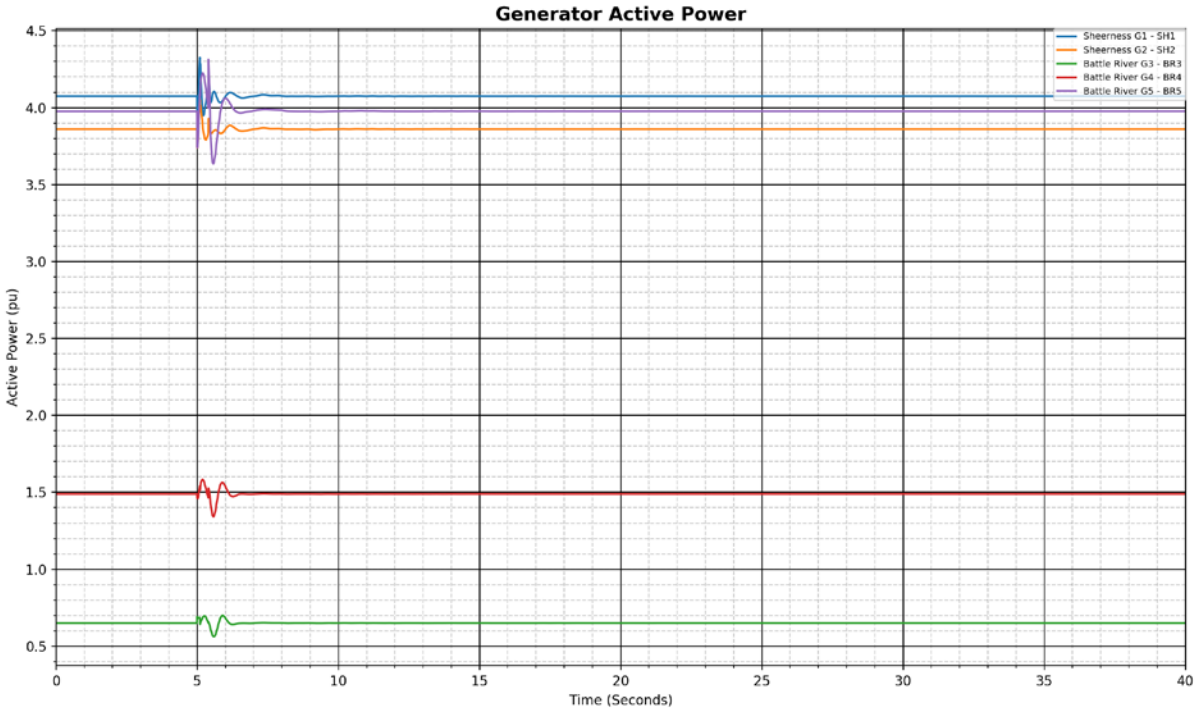
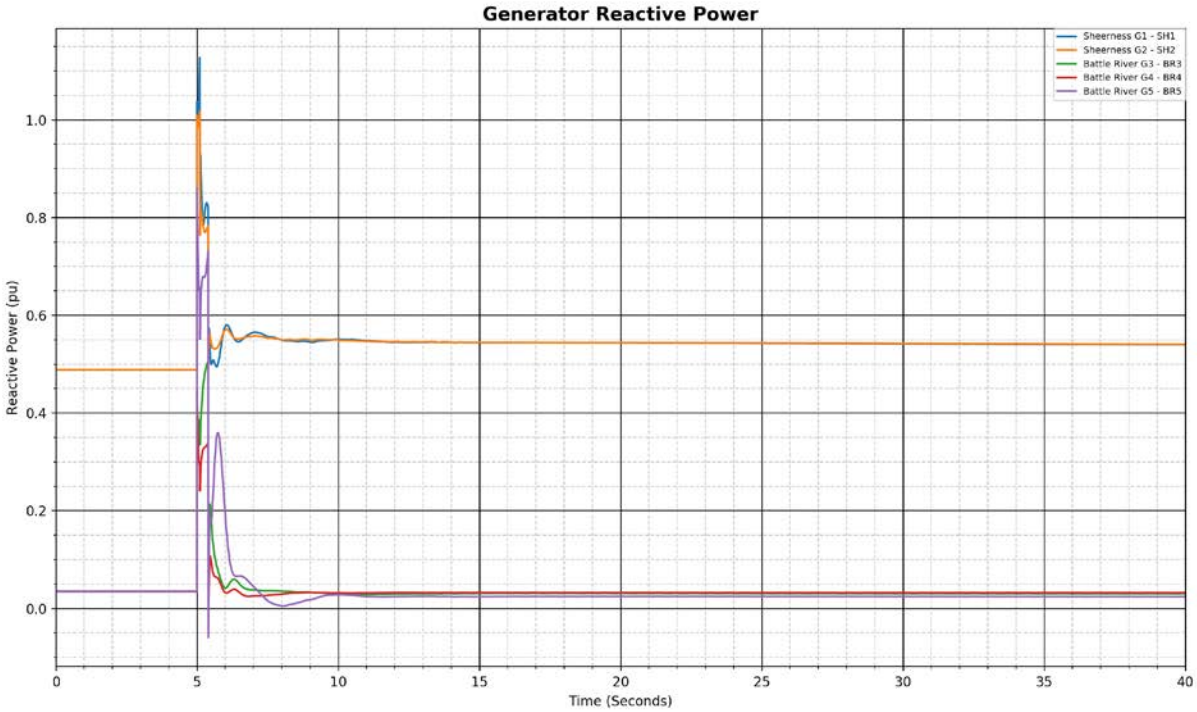

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L159 (Three Hills 770S to Ghost Pine 1145)
Reactive Power (Mvar)
Time (Seconds)

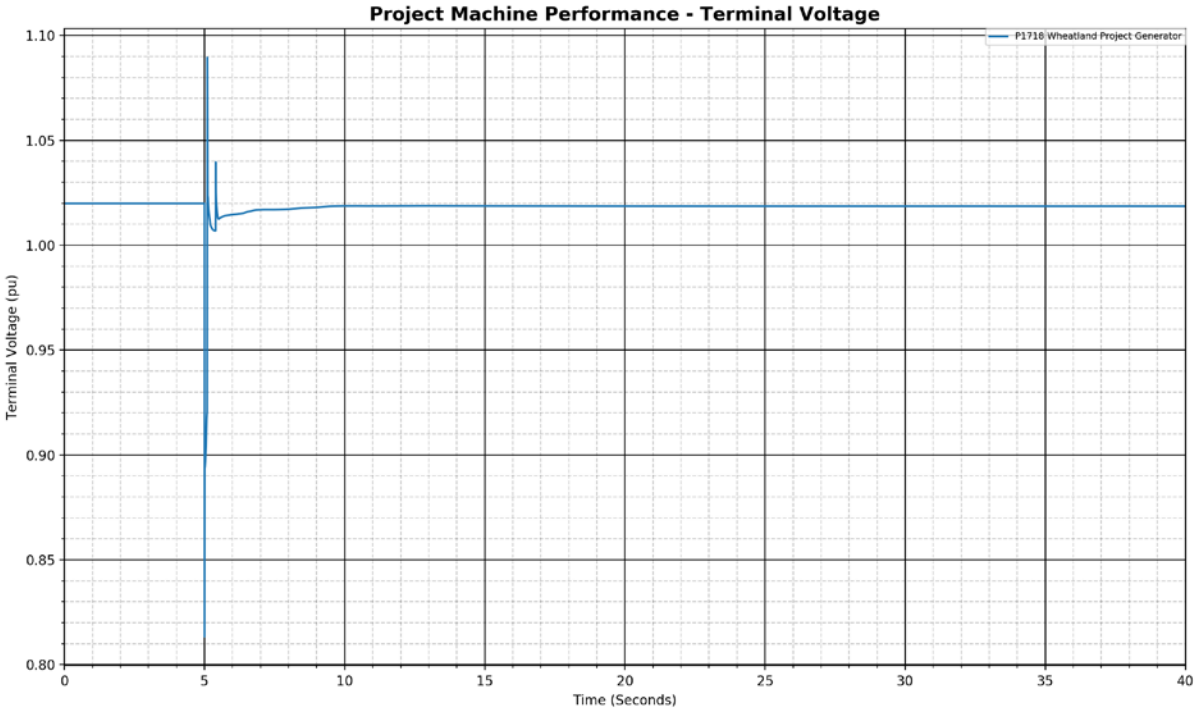
Figure A4-78: 7L16 (Heatburg 948S - Nevis 766S): 3-phase fault at Heatburg 948S

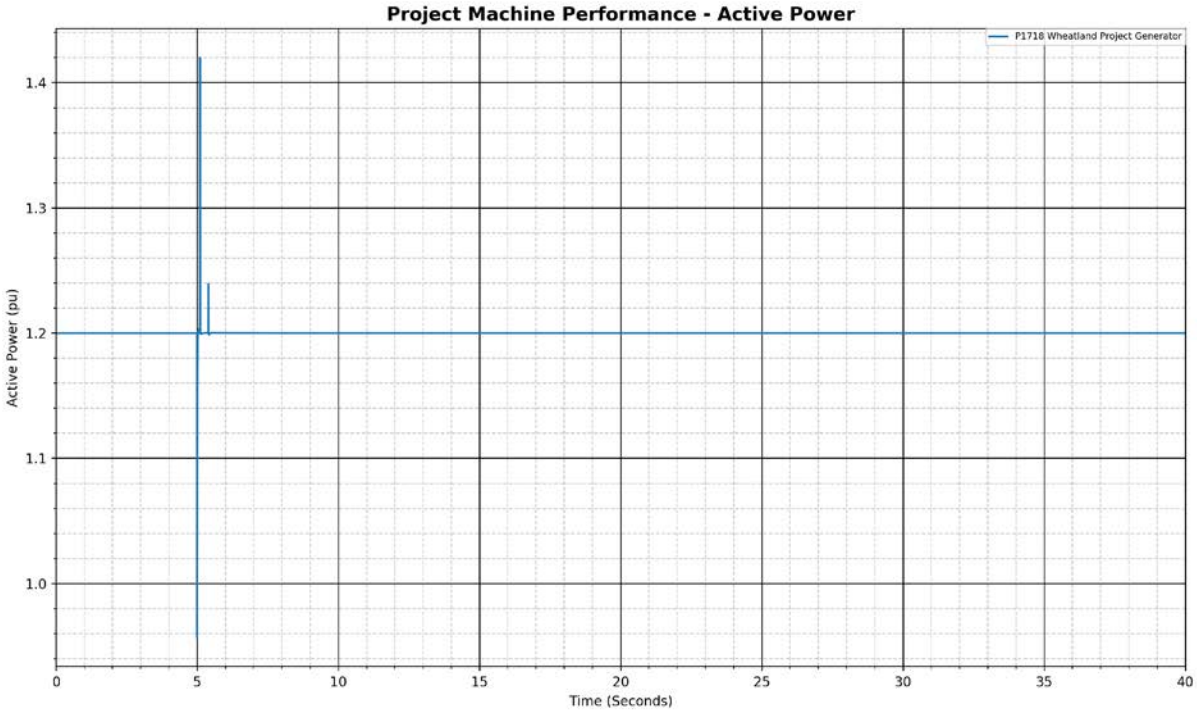


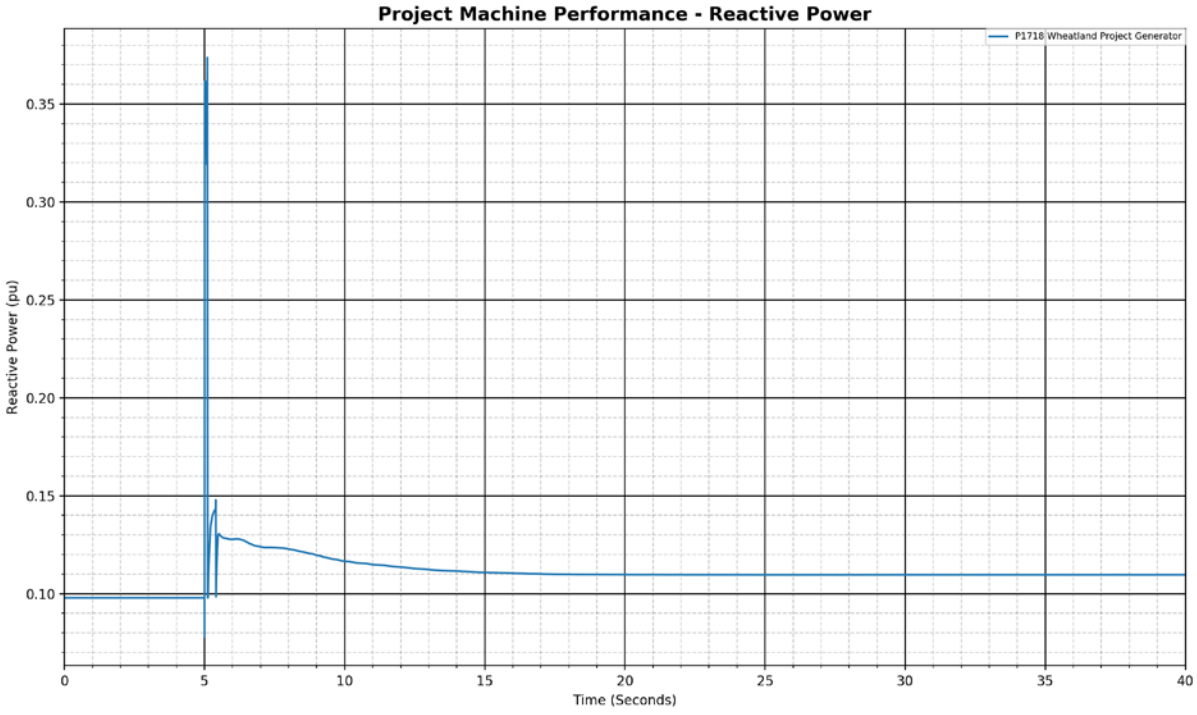

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

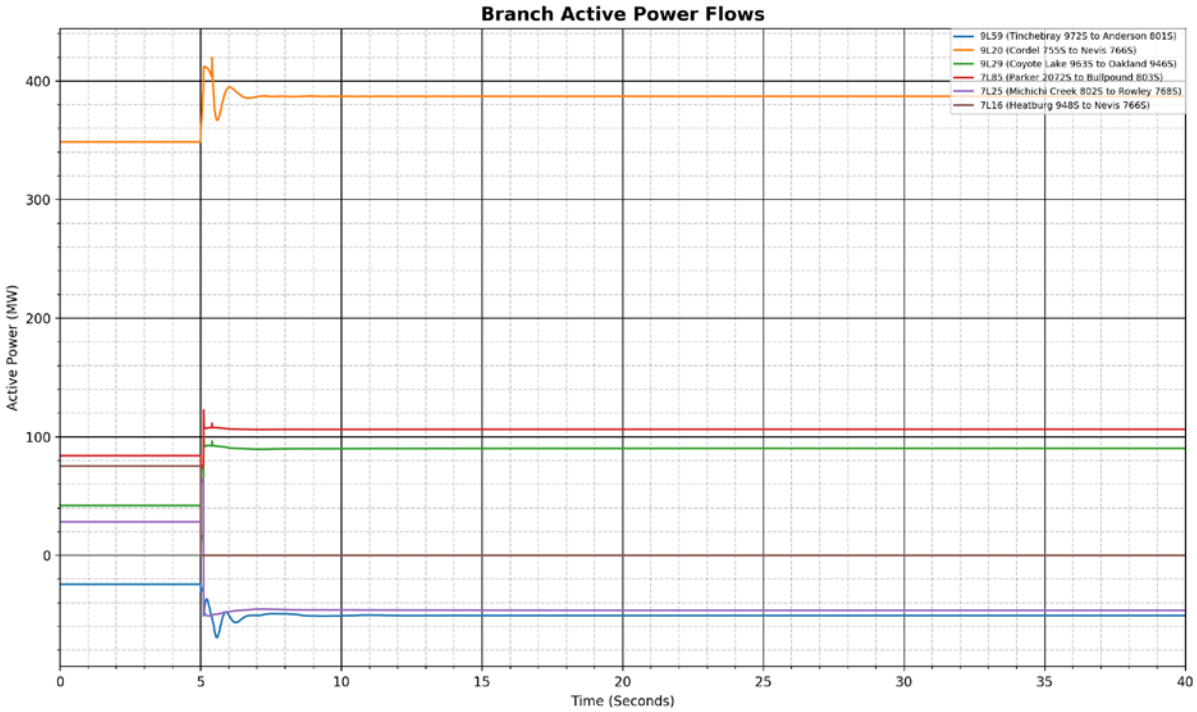

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.4
1.3
1.2
1.1
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.35
0.30
0.25
0.20
0.15
0.10
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Active Power (MW)
Time (Seconds)

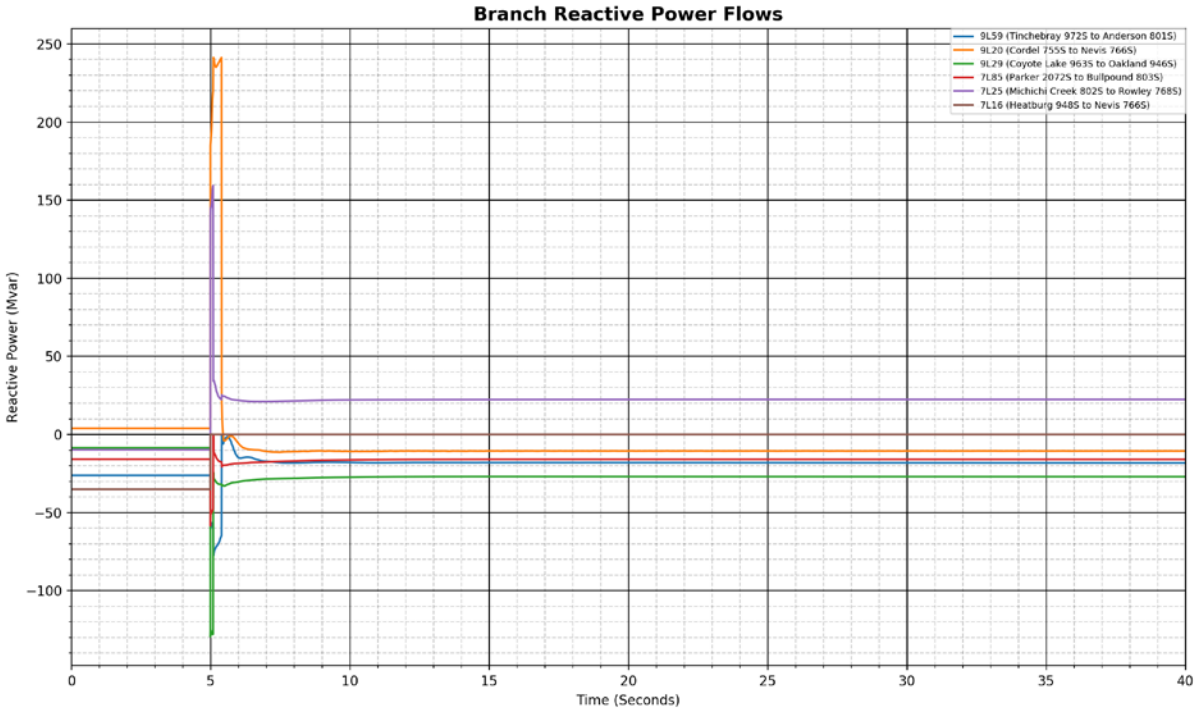
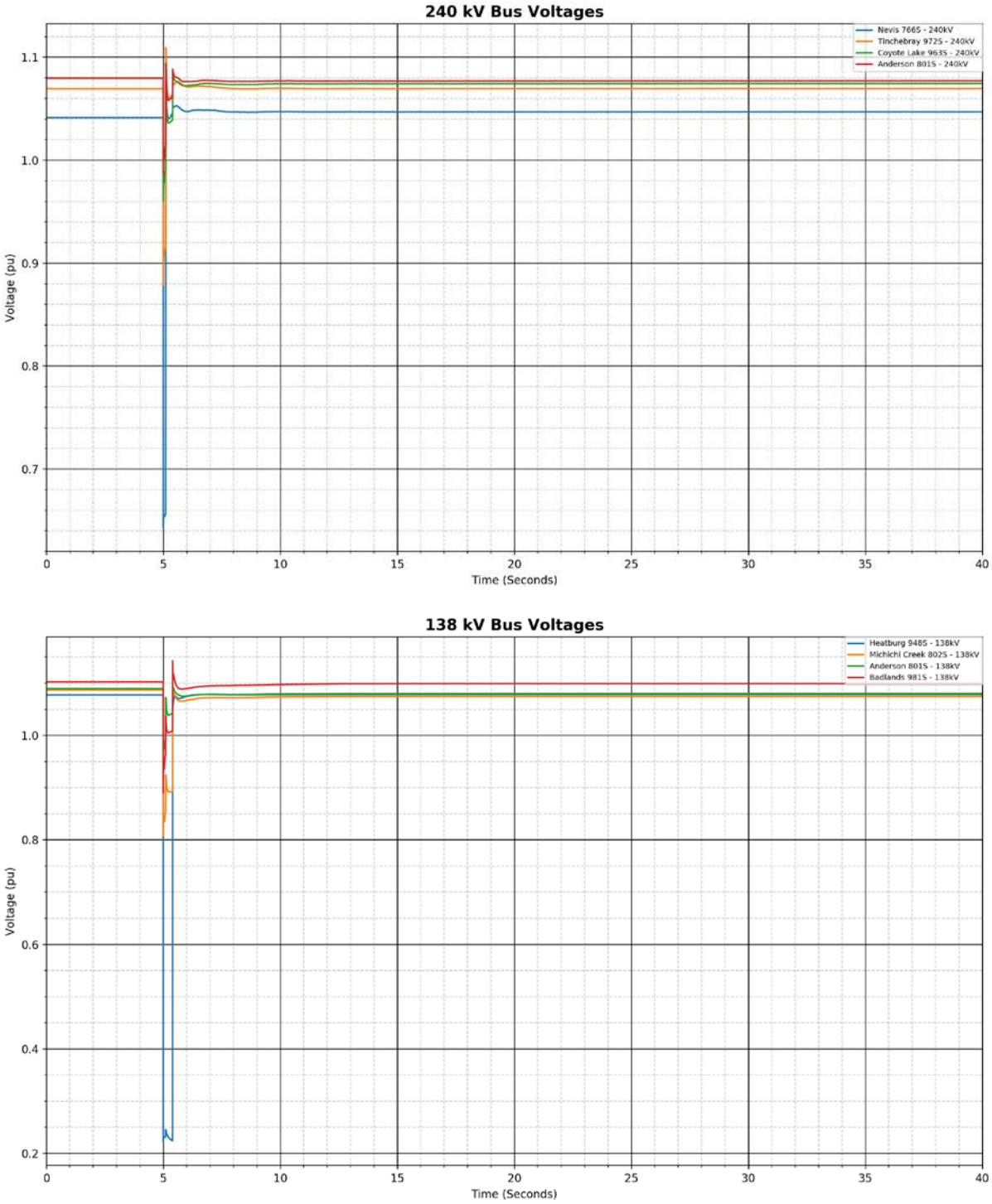
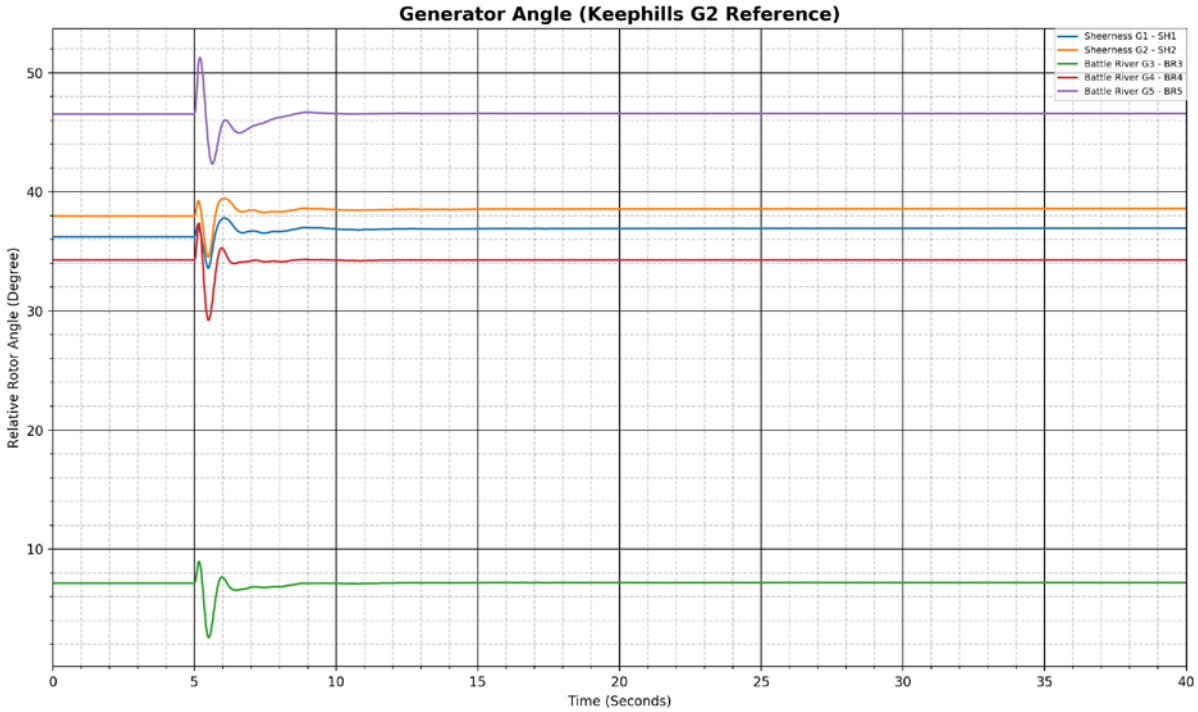
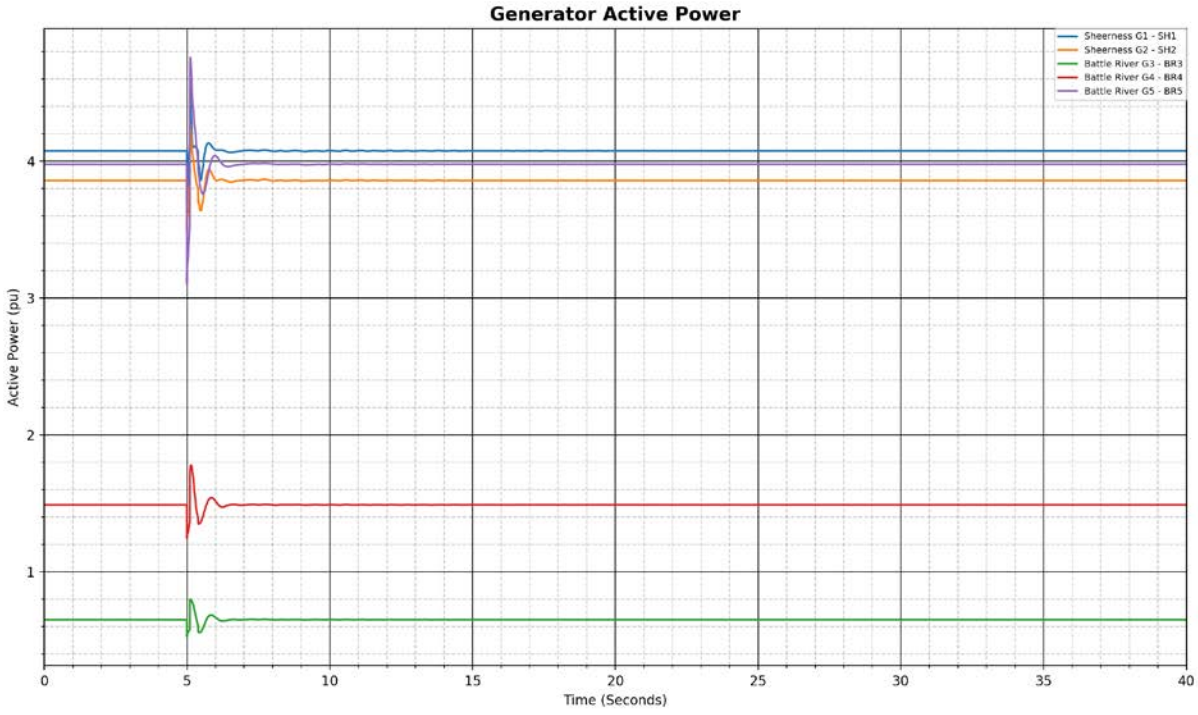
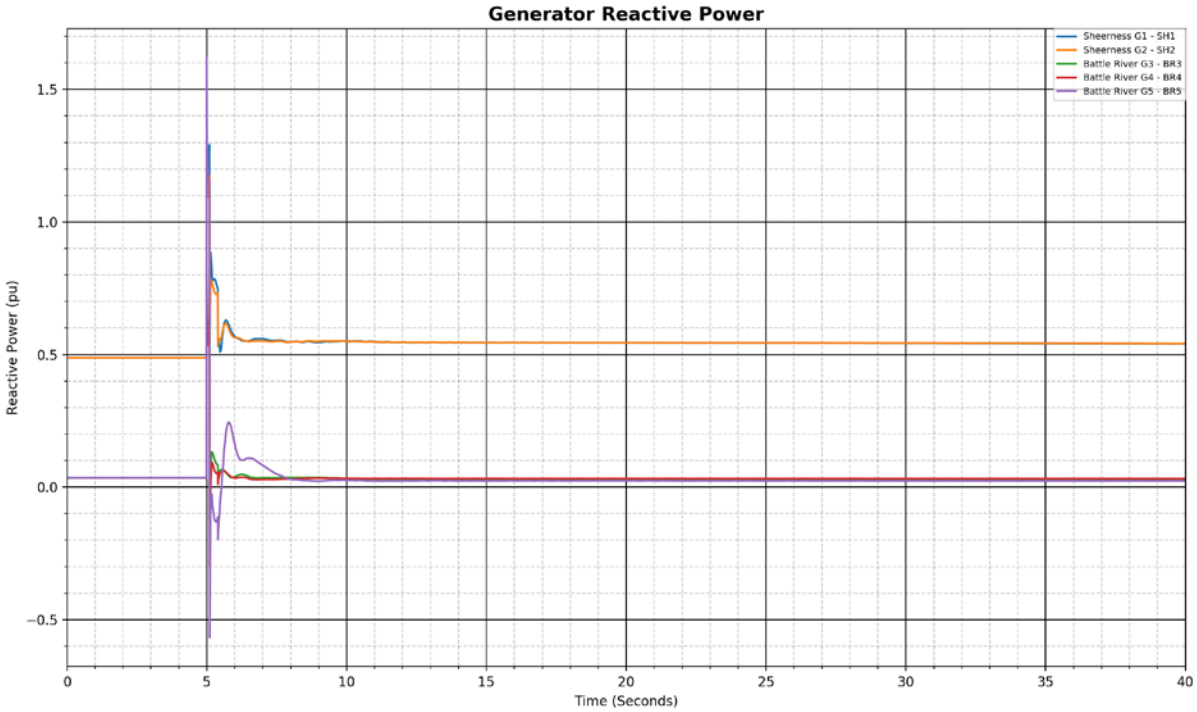

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

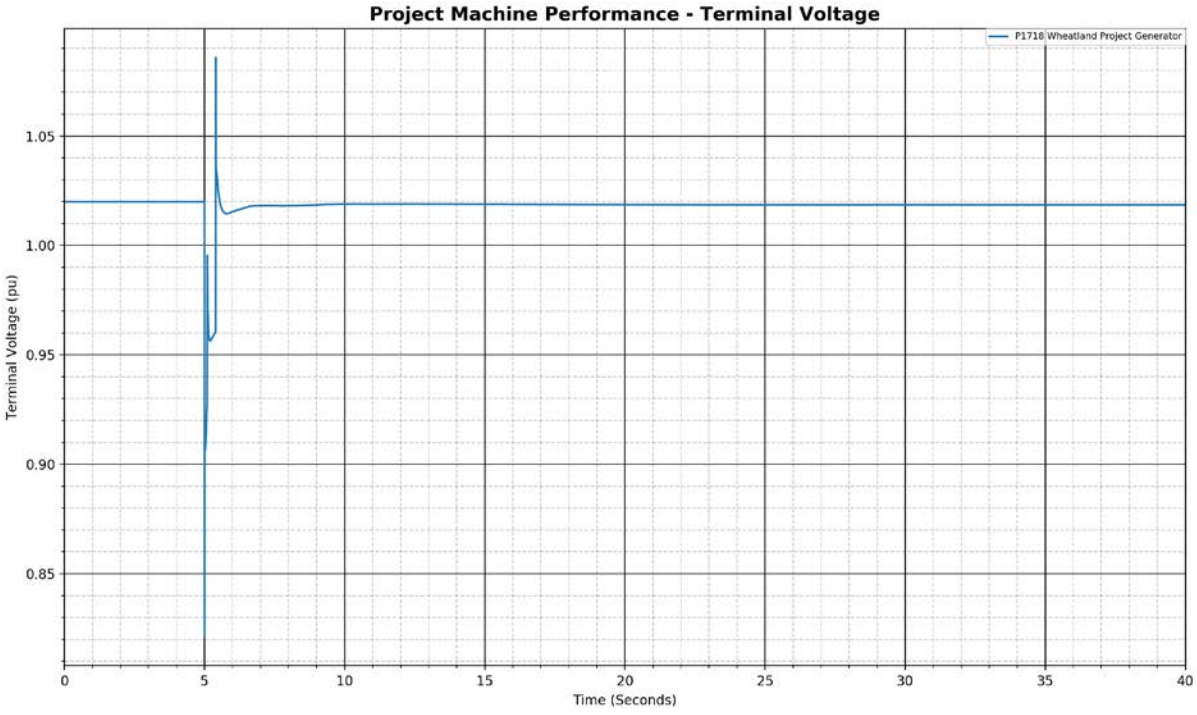
Figure A4-79: 7L16 (Heatburg 948S - Nevis 766S): 3-phase fault at Nevis 766S

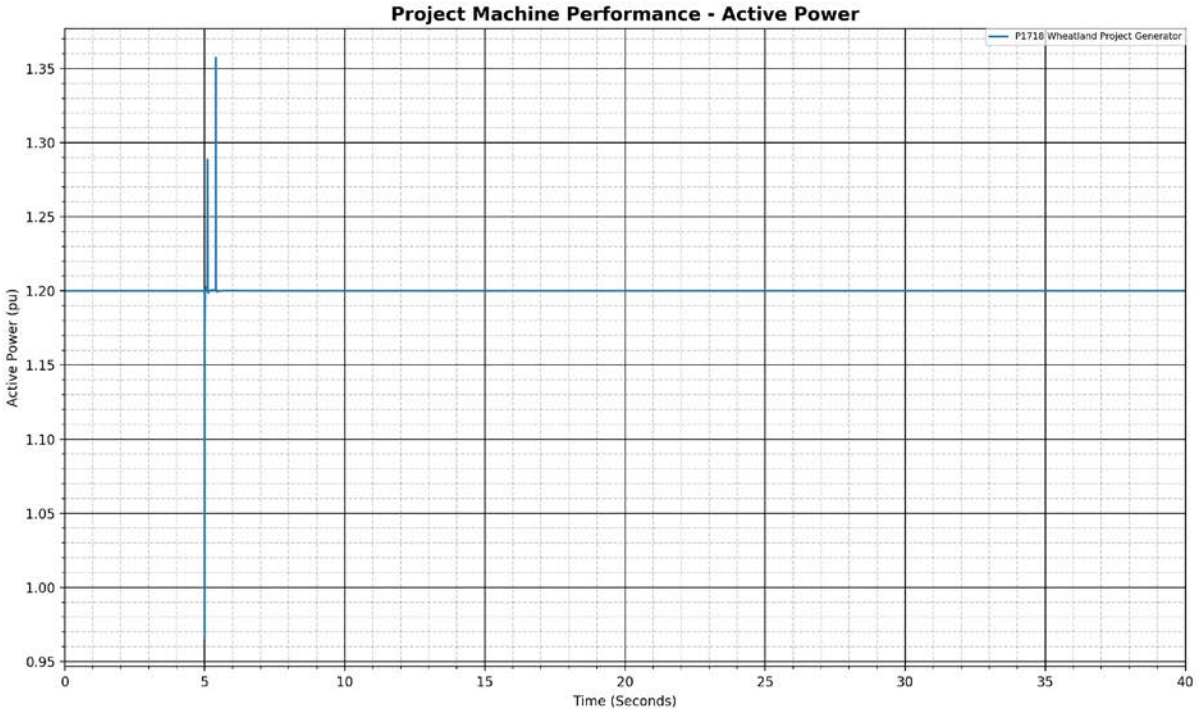


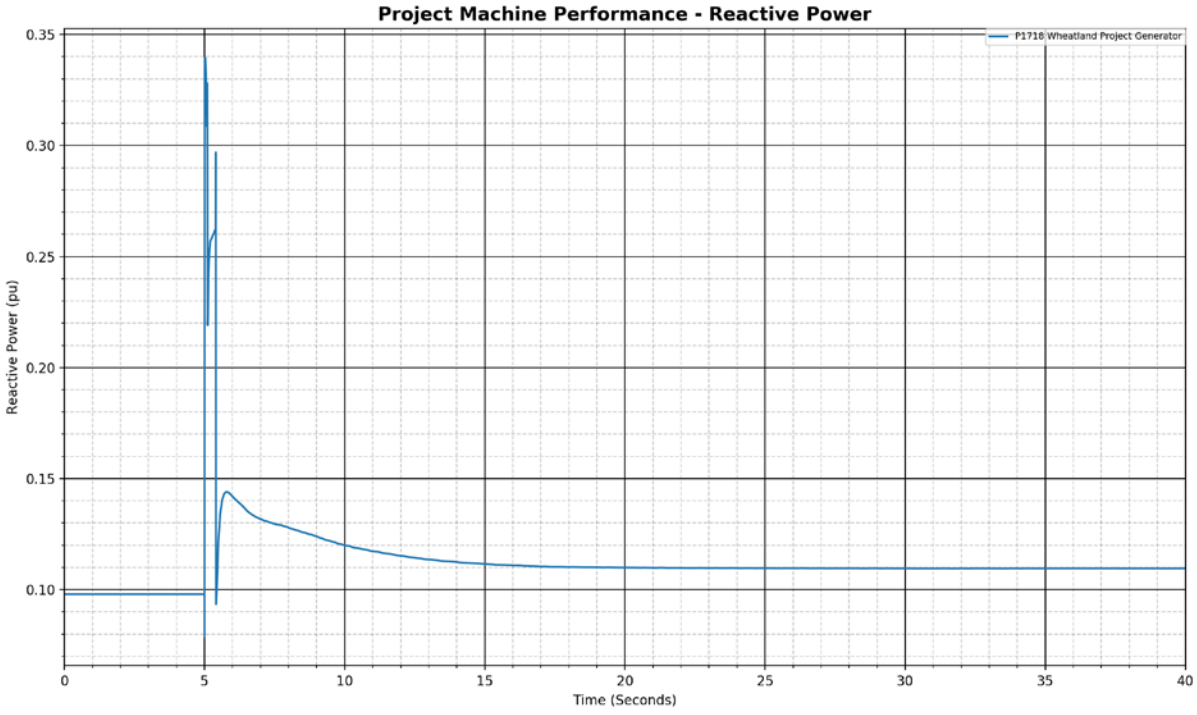

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
50
40
30
20
10
0
5
10
15
20
25
30
35
40
Time (Seconds)

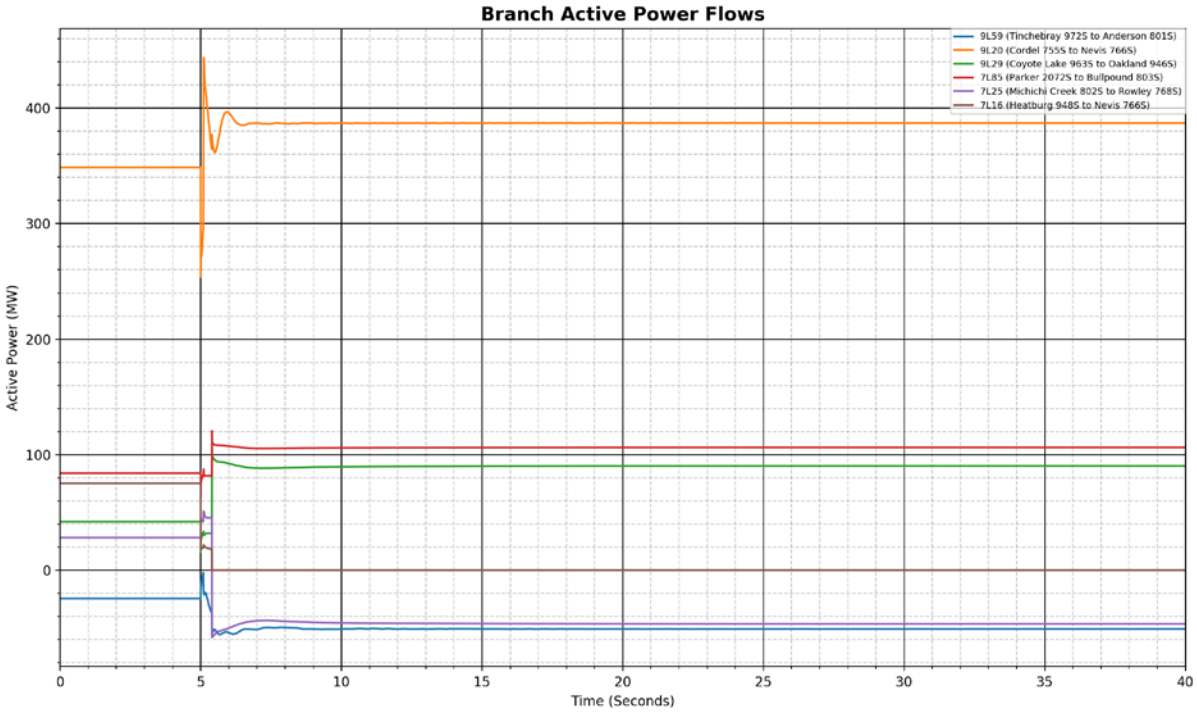

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
4
3
2
1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.5
1.0
0.5
0.0
−0.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.05
1.00
0.95
0.90
0.85
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
0.35
0.30
0.25
0.20
0.15
0.10
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Active Power (MW)
Time (Seconds)

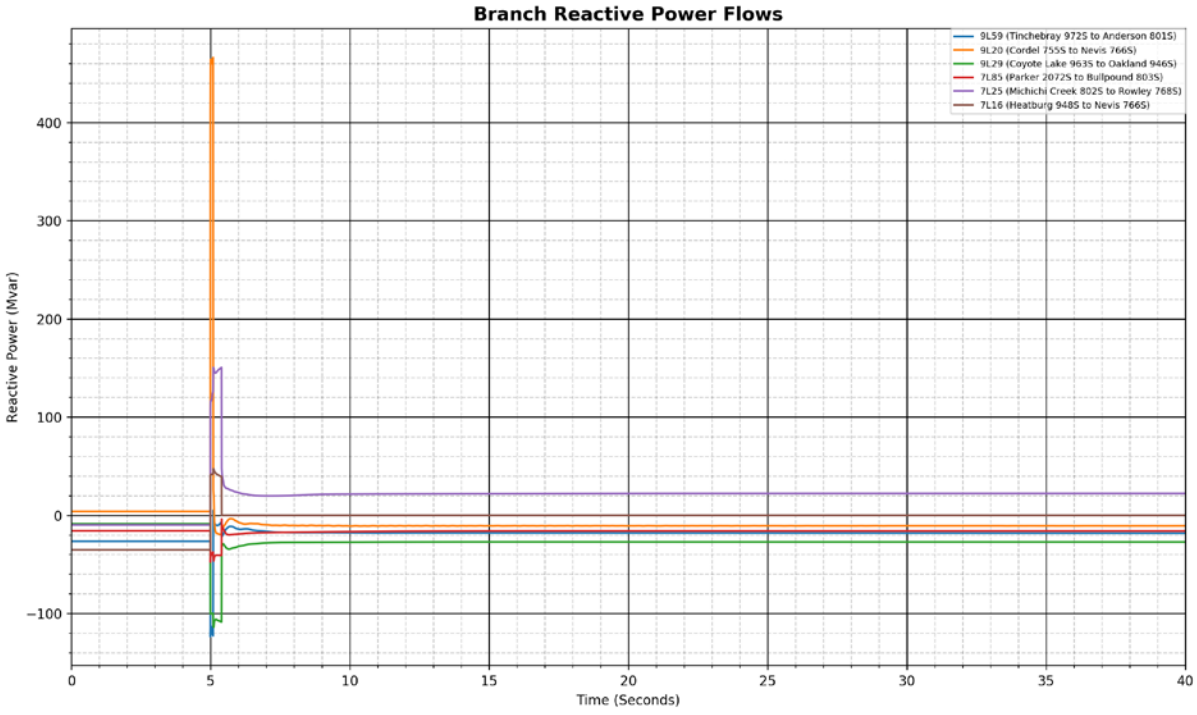
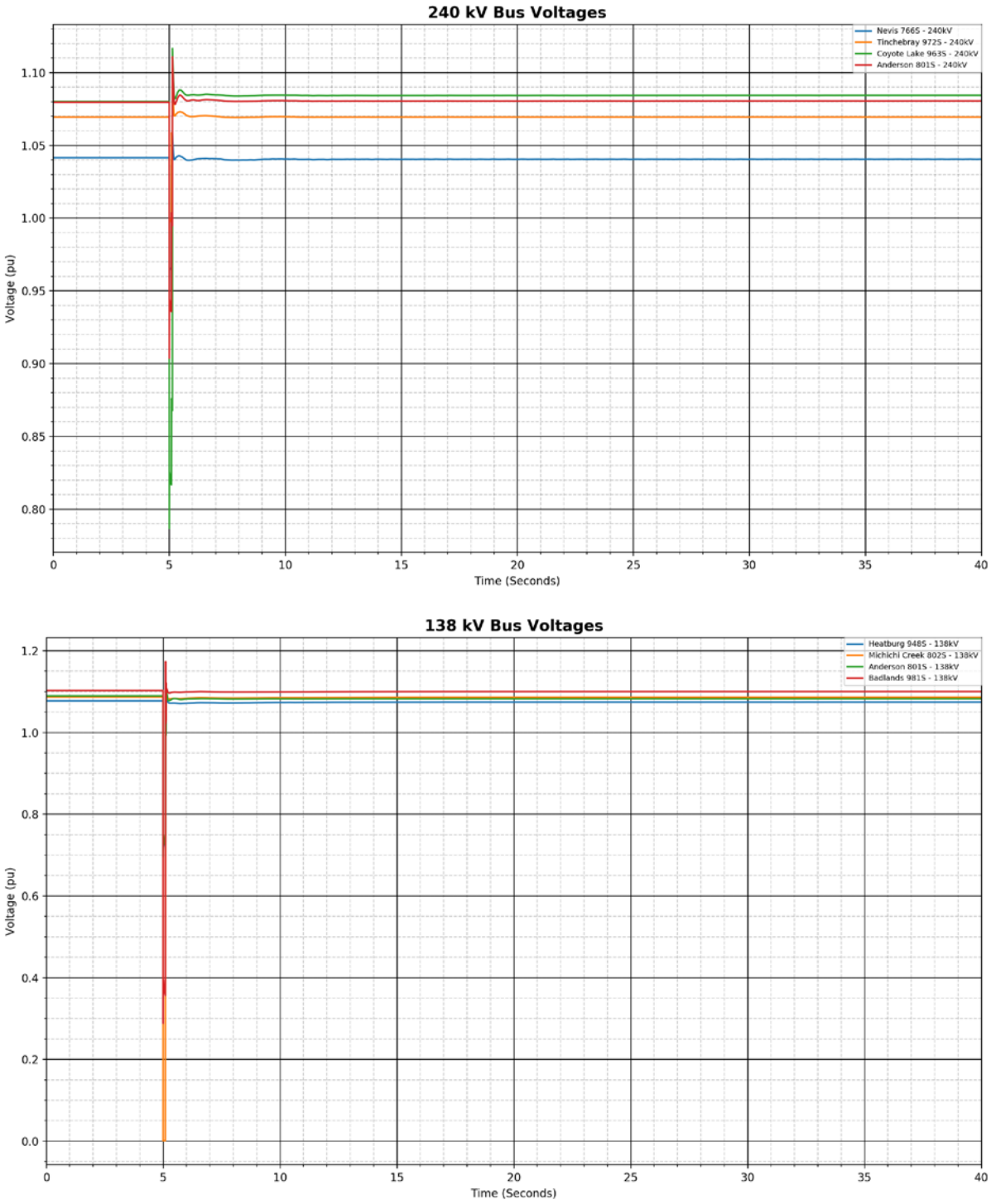
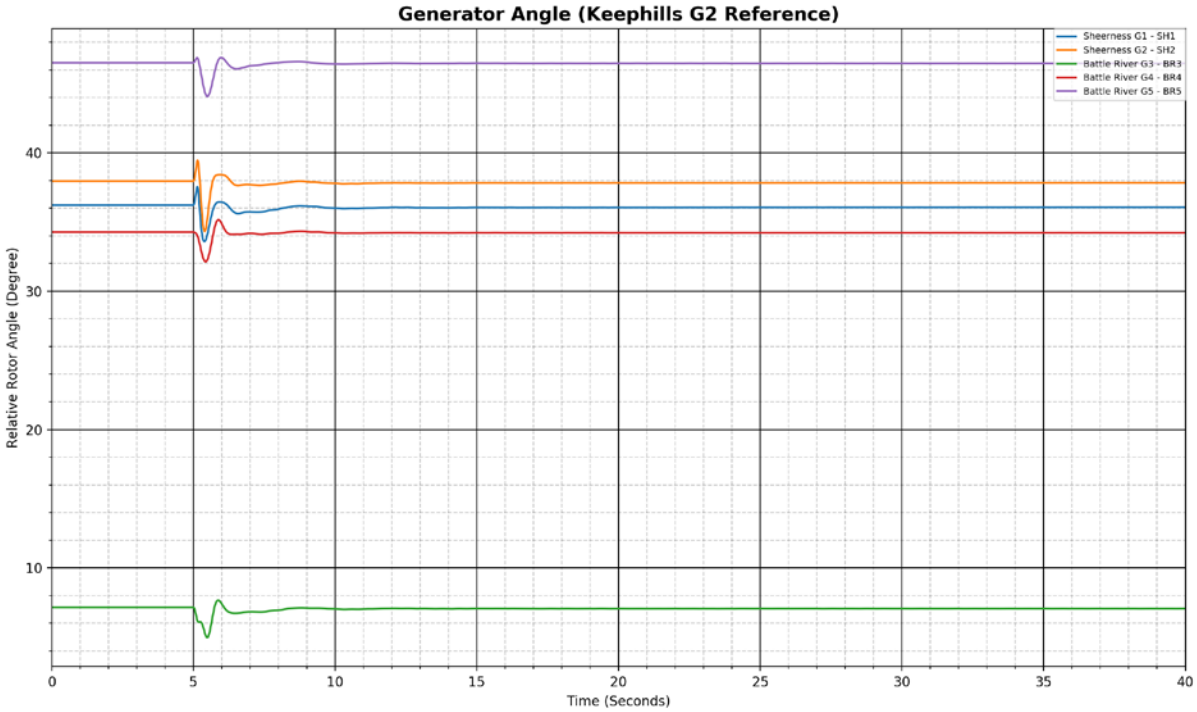
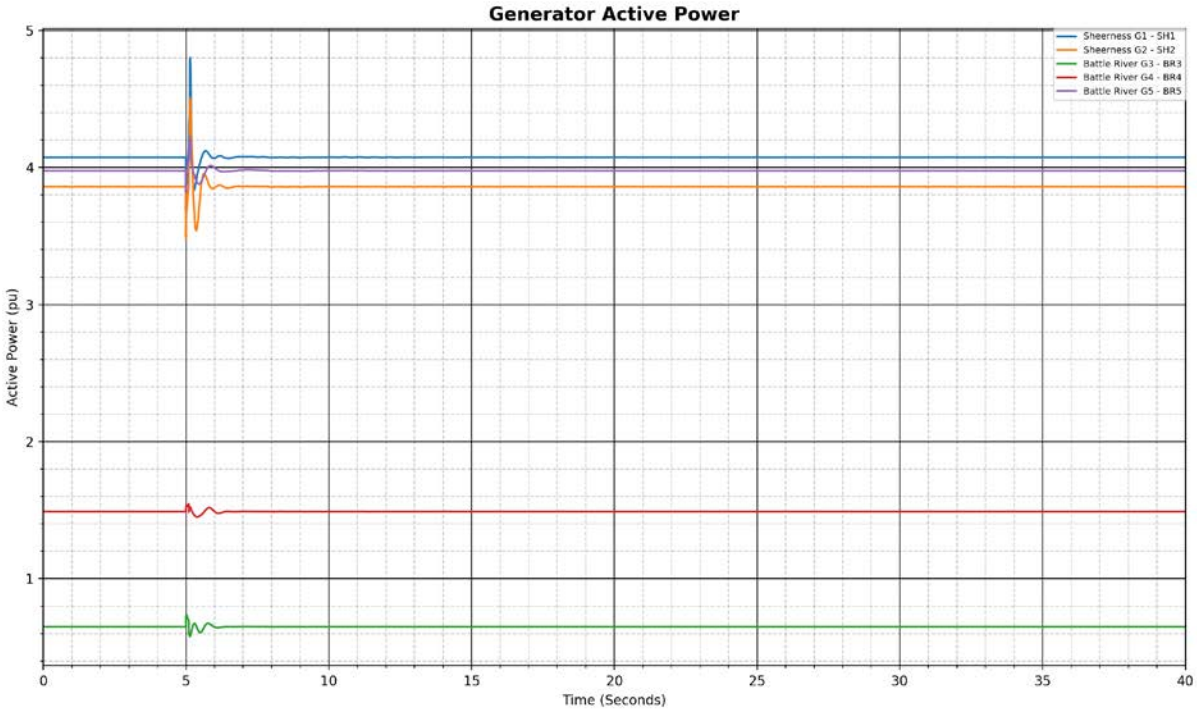
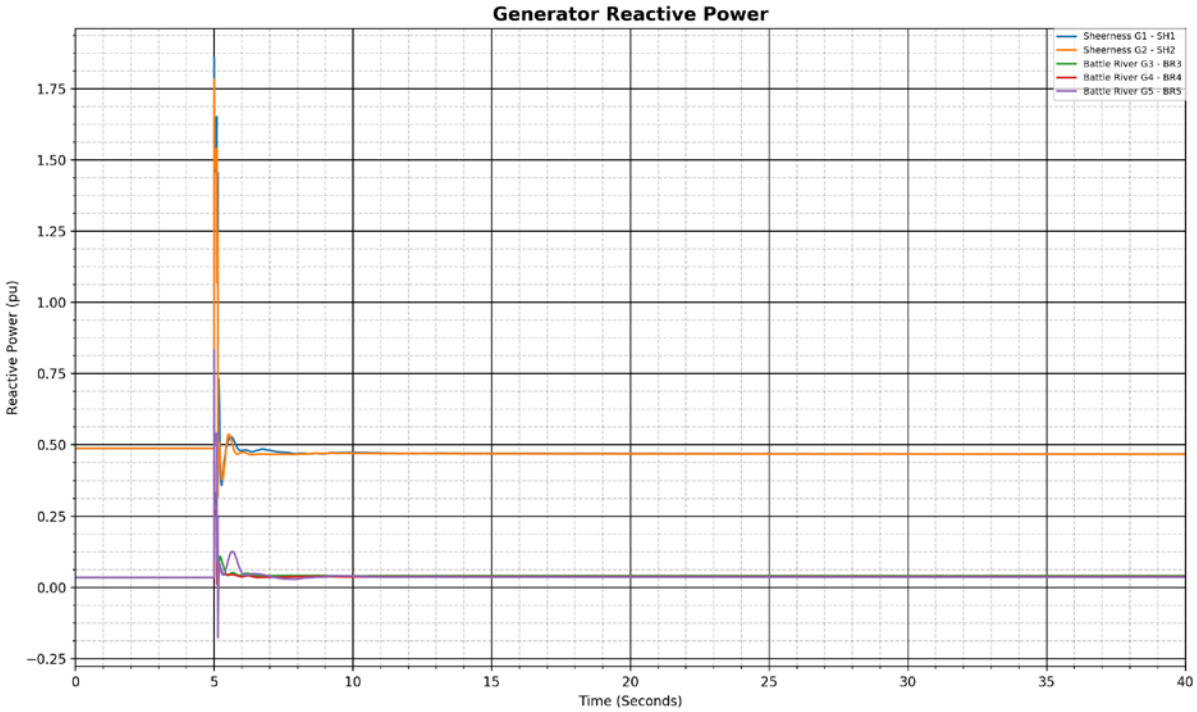

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L16 (Heatburg 948S to Nevis 766S)
Reactive Power (Mvar)
Time (Seconds)

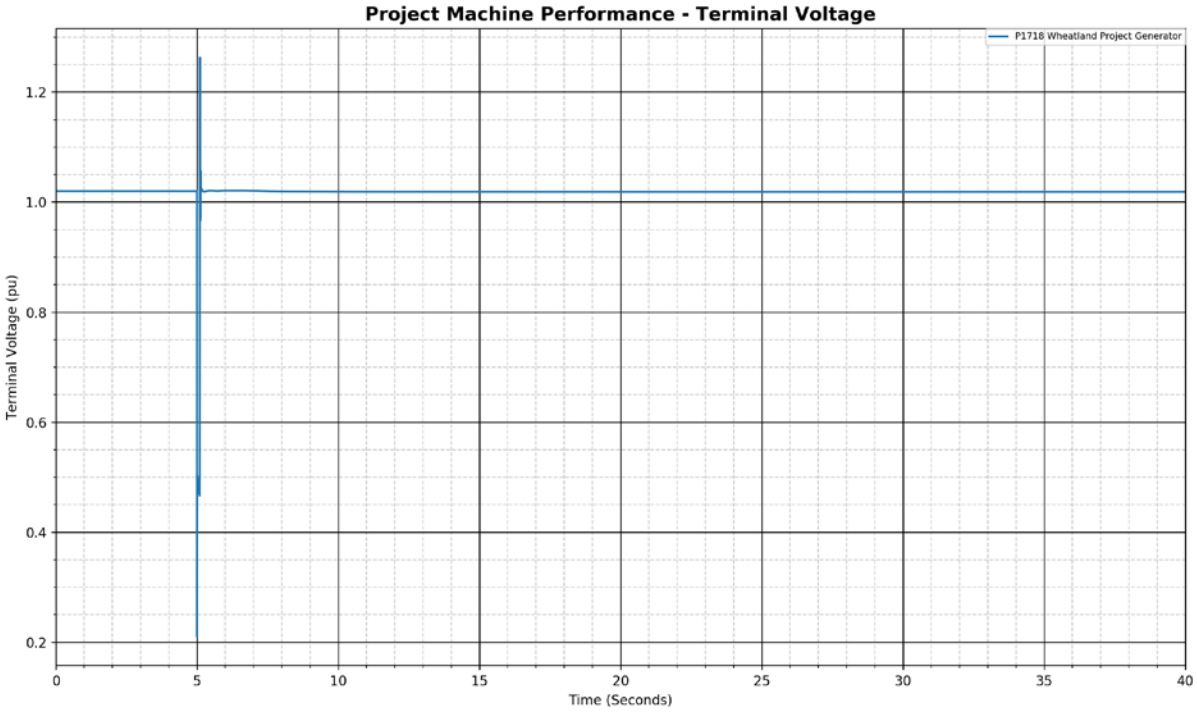
Figure A4-80: 7L128 (Michichi Creek 802S - Coyote Lake 963S): 3-phase fault at Michichi Creek 802S

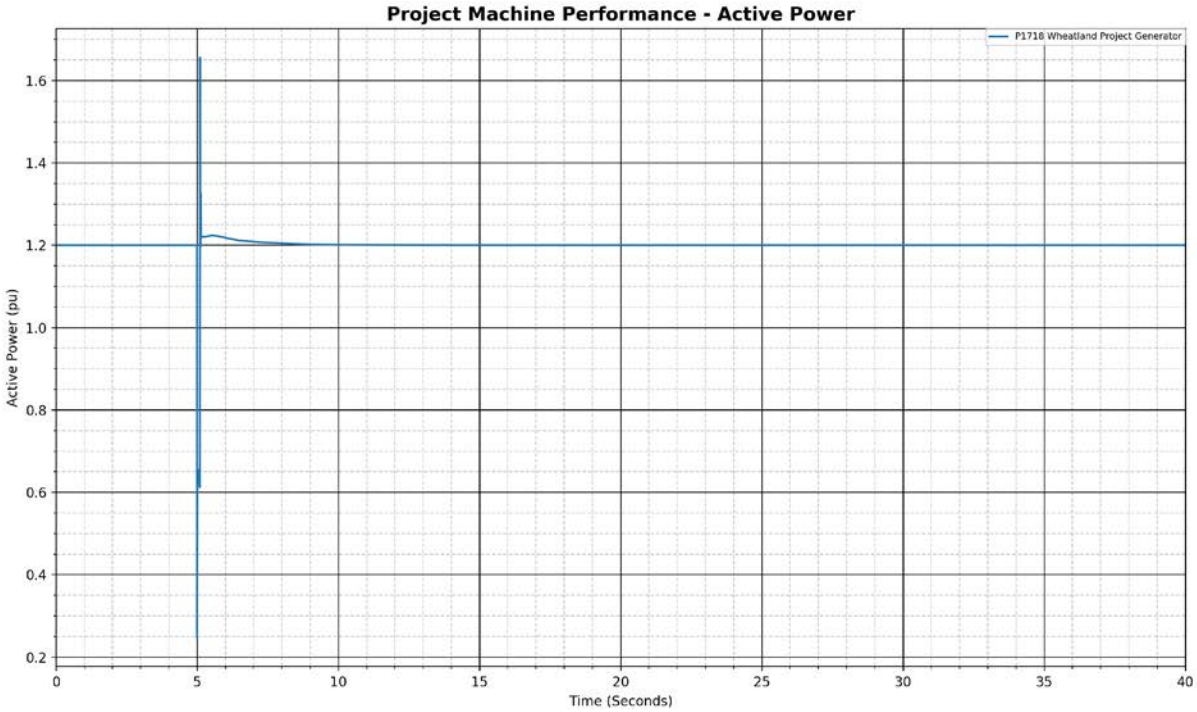


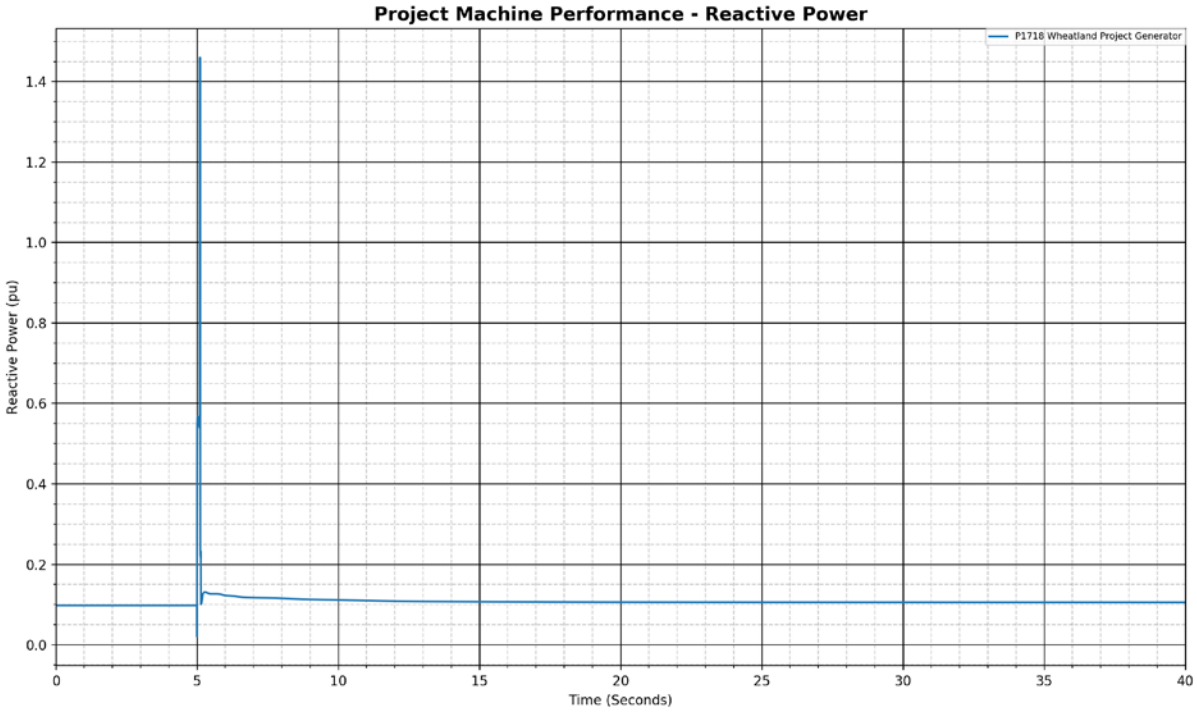

Generator Angle (Keephills G2 Reference)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Relative Rotor Angle (Degree)
Time (Seconds)

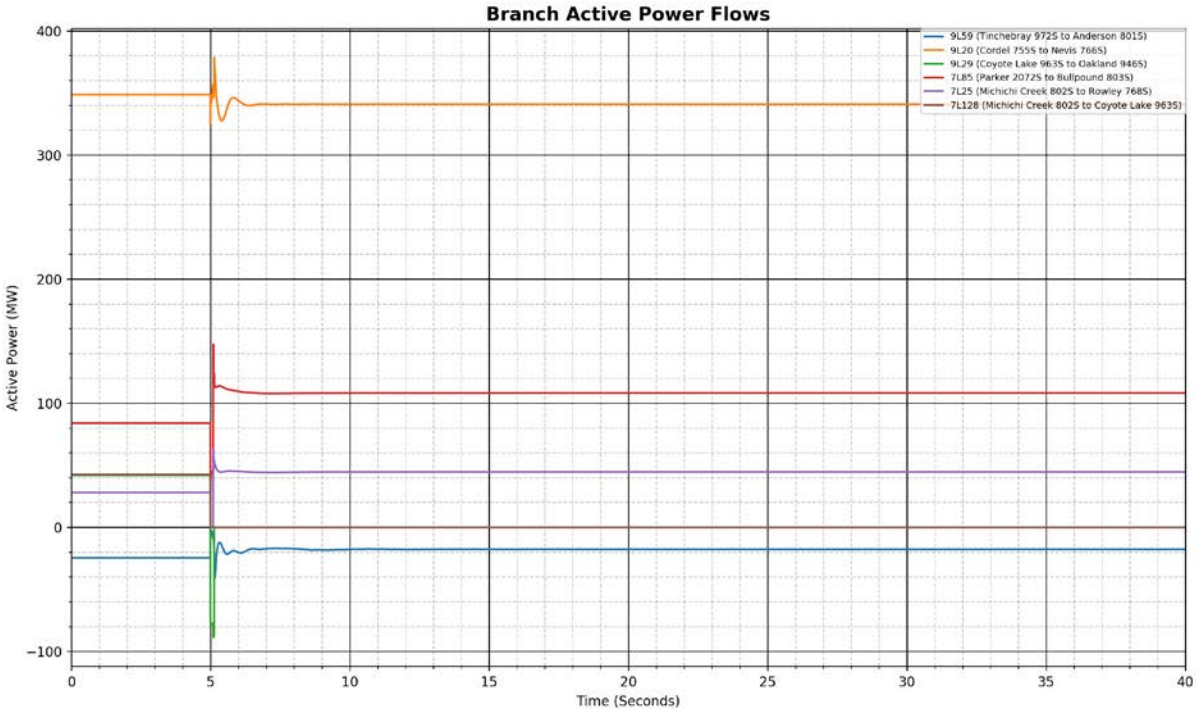

Generator Active Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Active Power (pu)
Time (Seconds)


Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
Time (Seconds)
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
Time (Seconds)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Active Power (MW)
Time (Seconds)

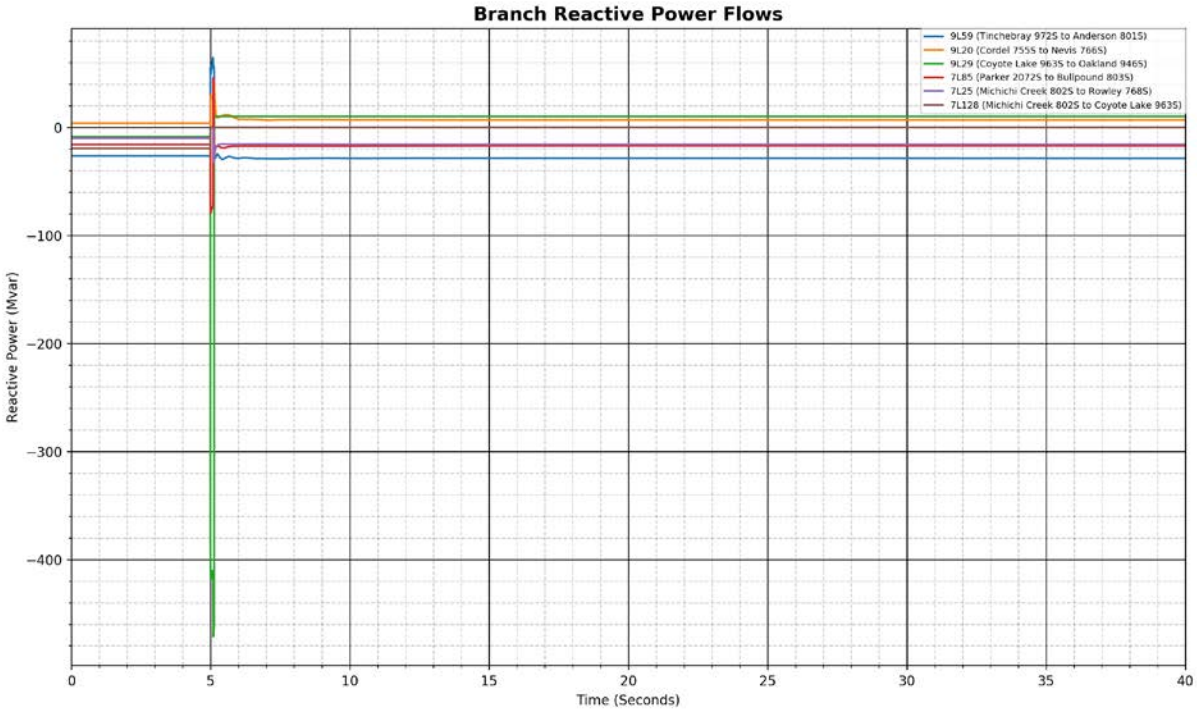
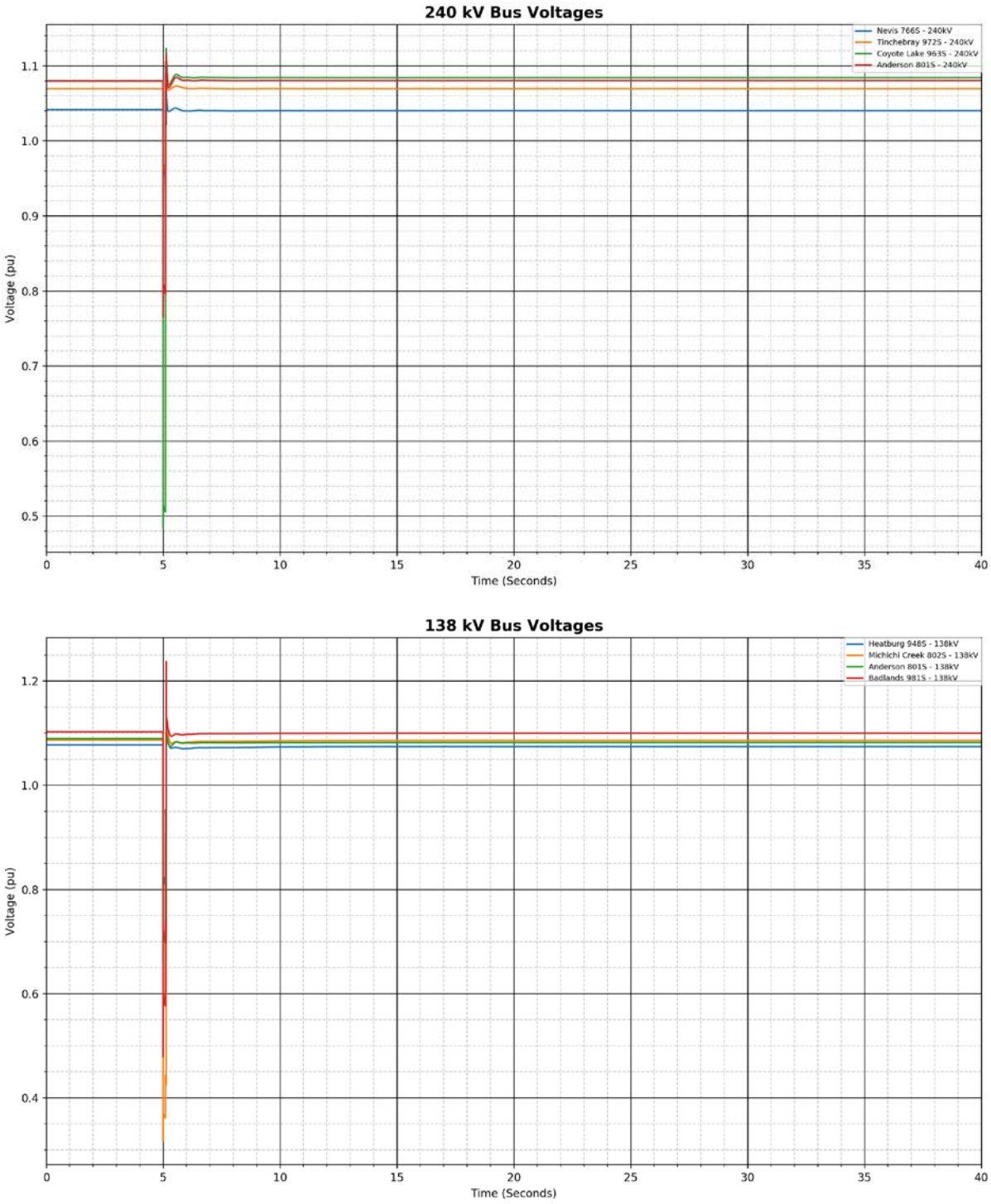
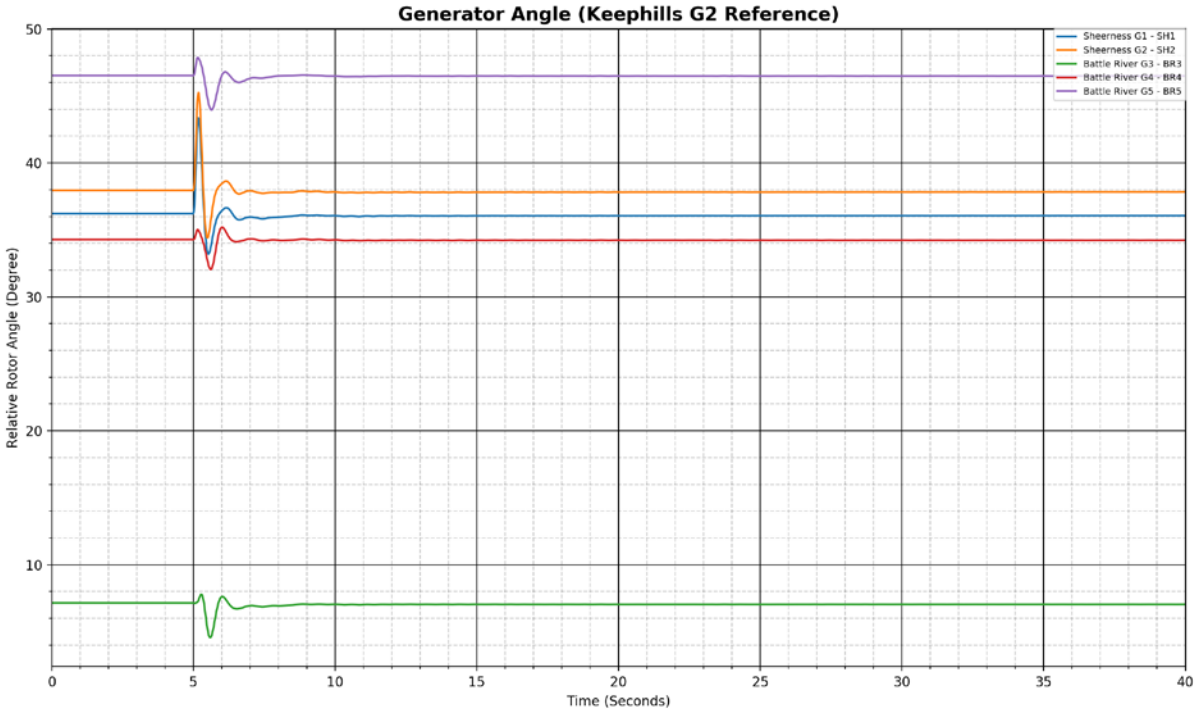
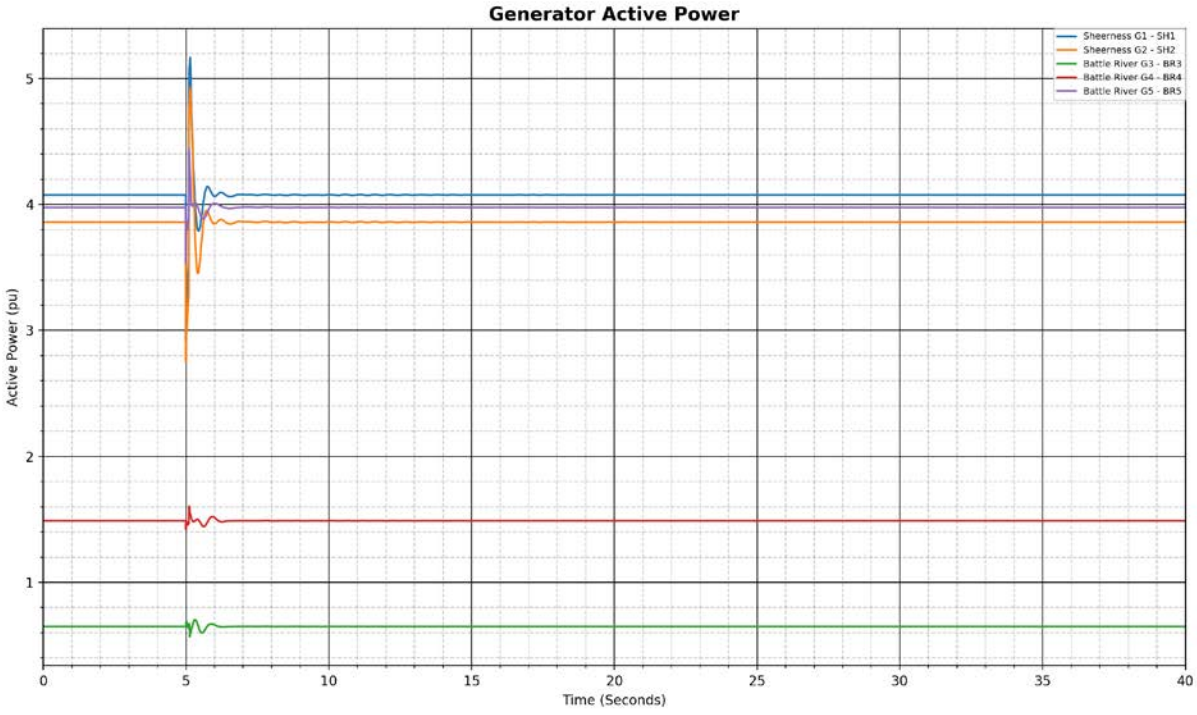
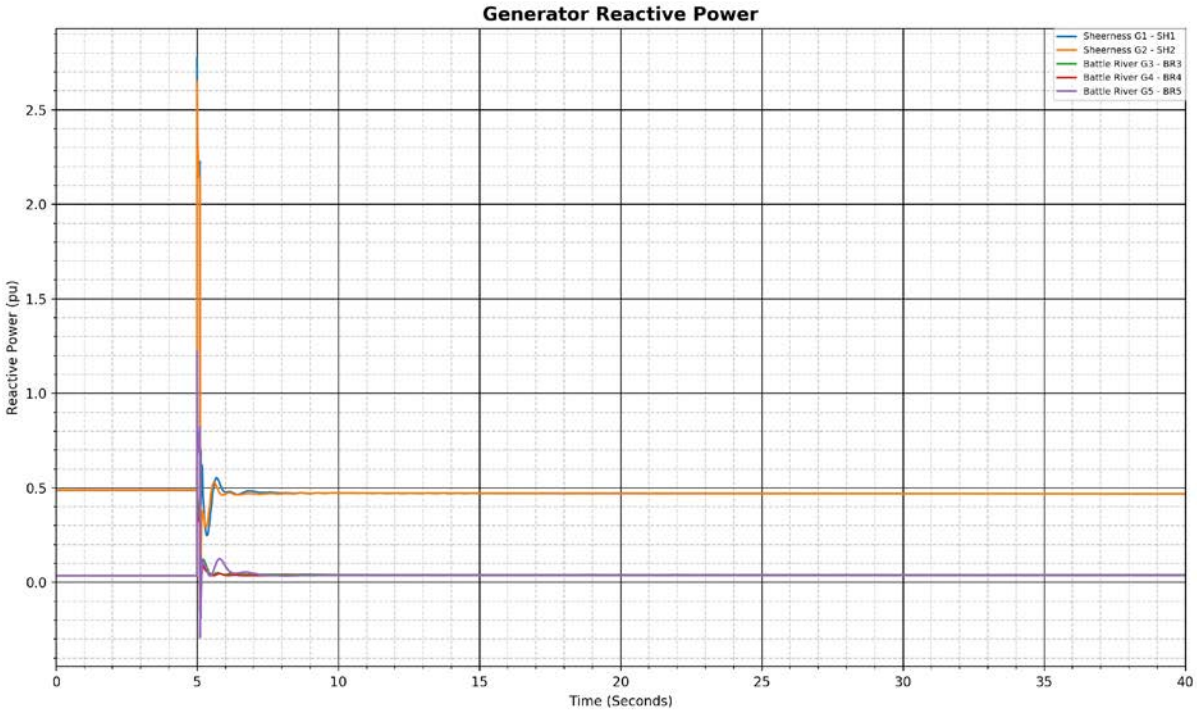

Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Reactive Power (Mvar)
Time (Seconds)

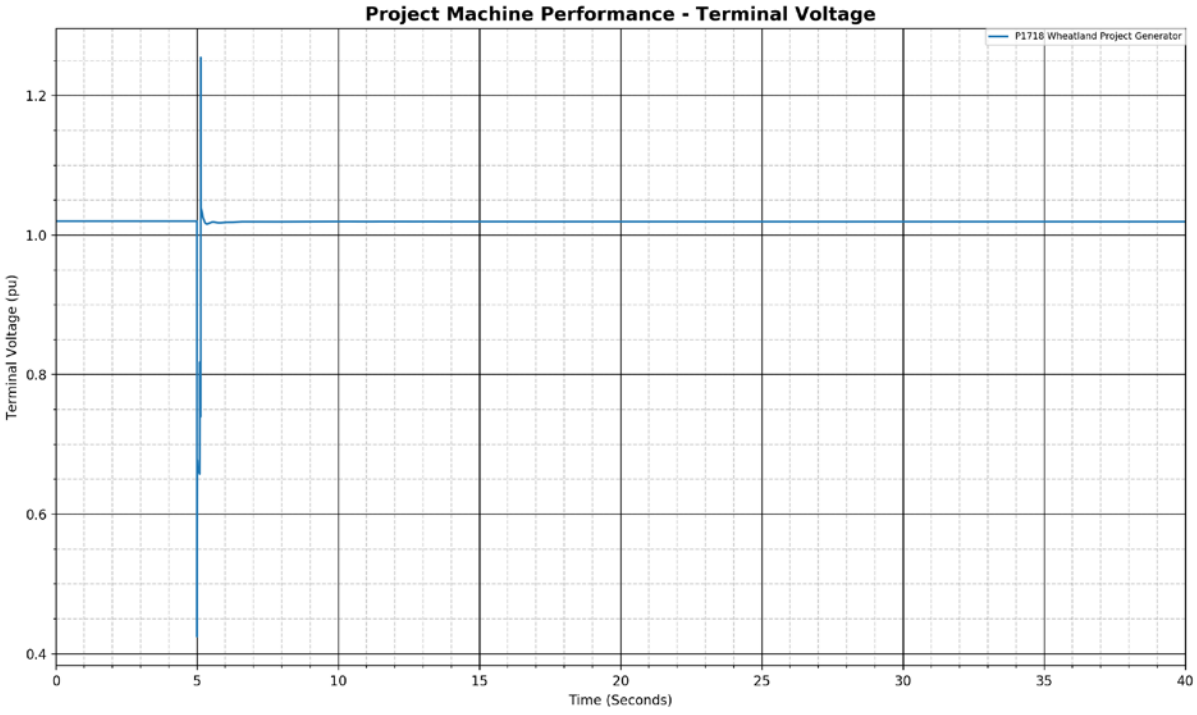
Figure A4-81: 7L128 (Michichi Creek 802S - Coyote Lake 963S): 3-phase fault at Coyote Lake 963S

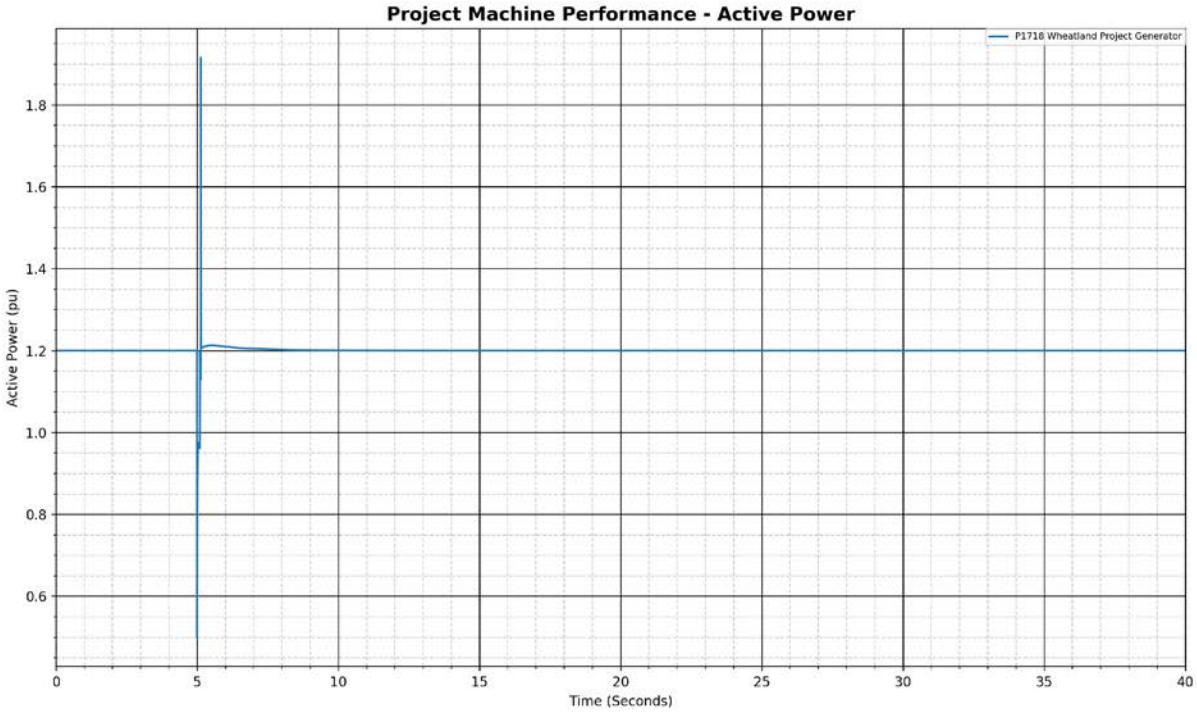


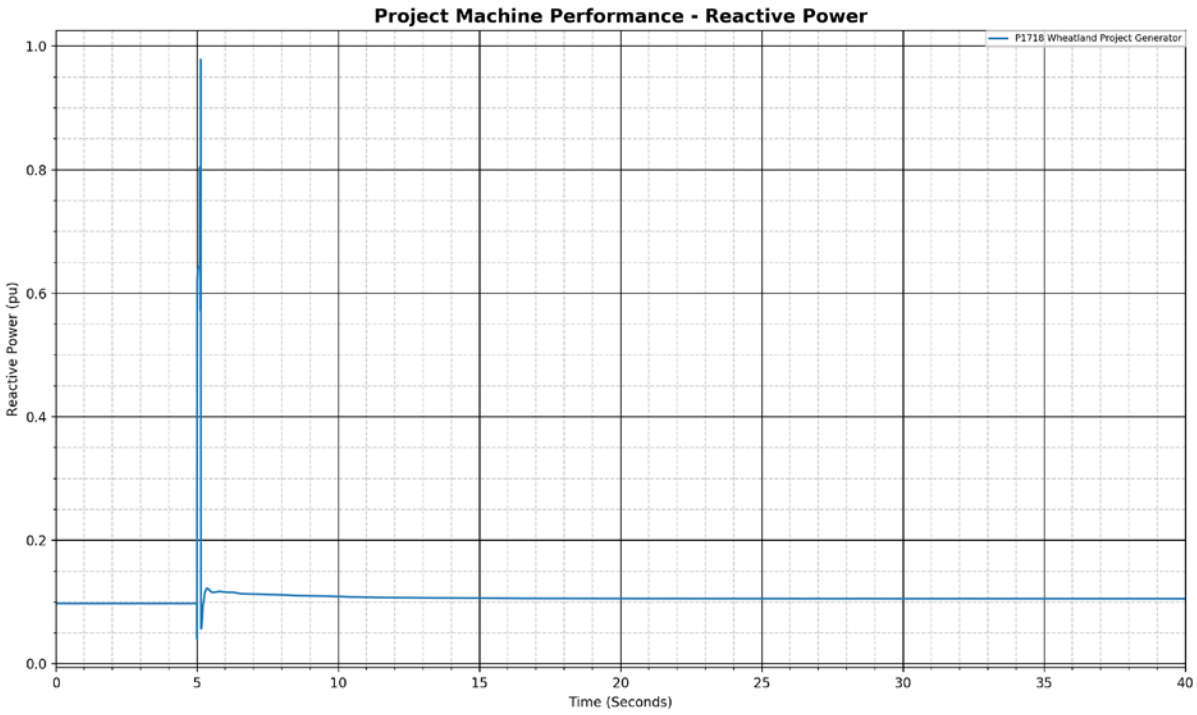

Generator Angle (Keephills G2 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

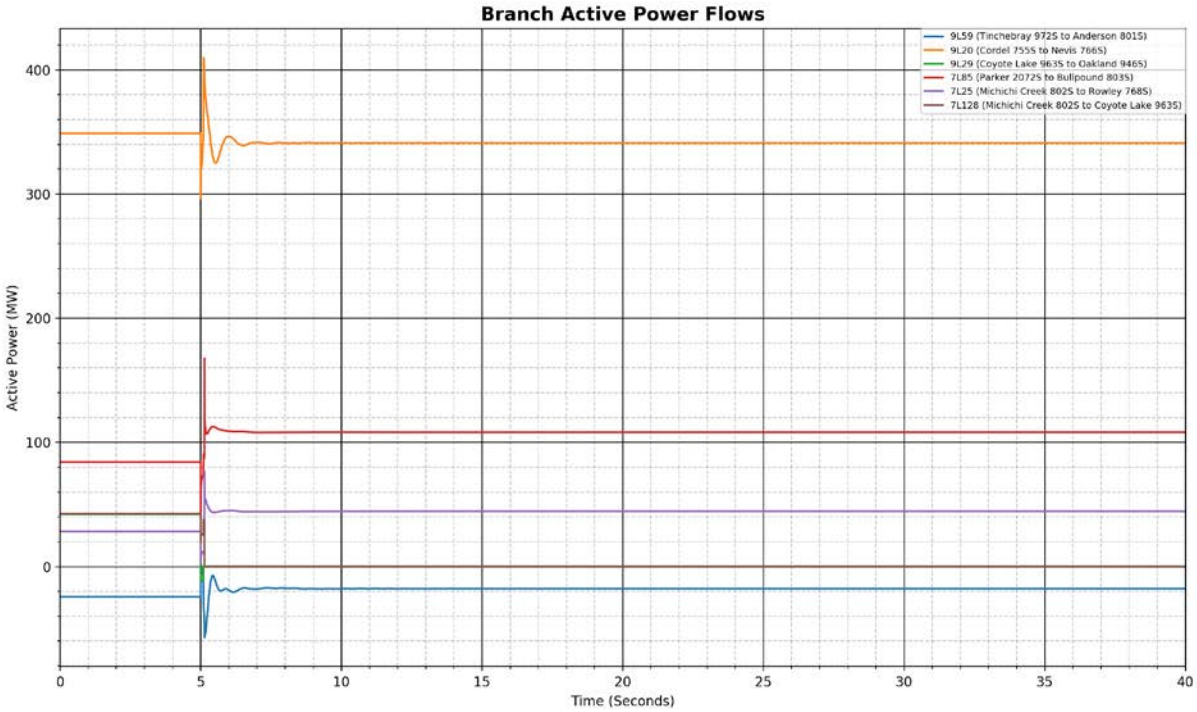

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

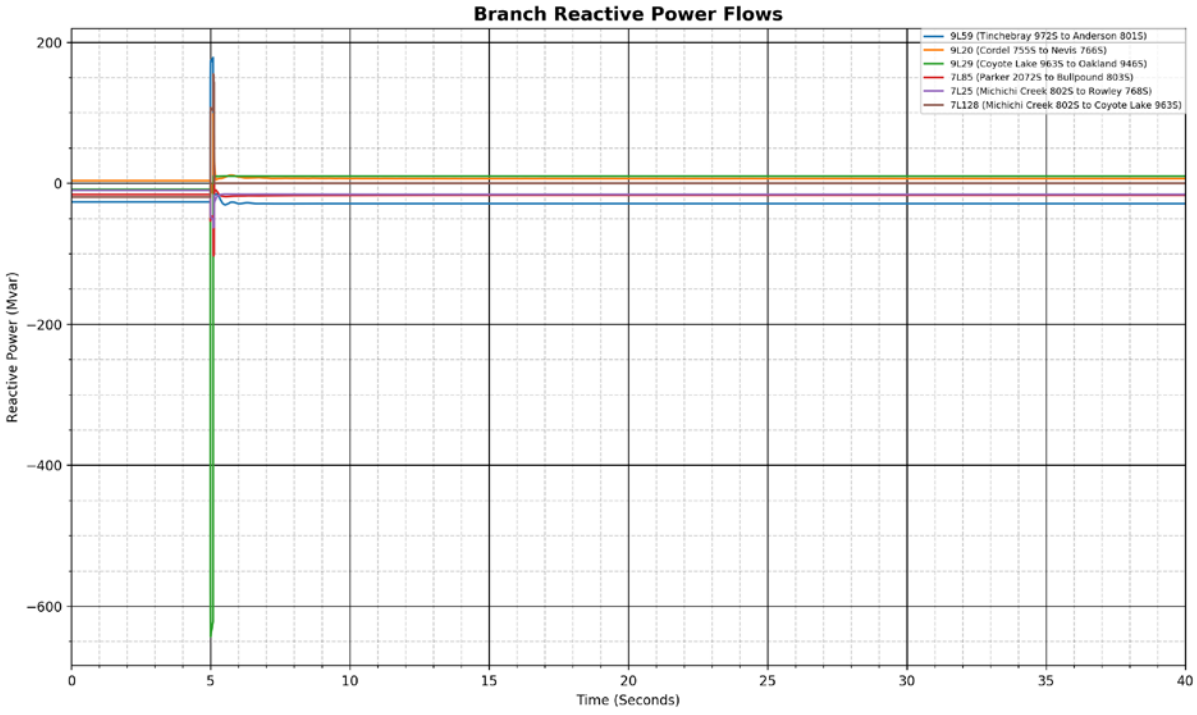

Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
P1718 Wheatland Project Generator
Terminal Voltage (pu)
1.2
1.0
0.8
0.6
0.4
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Active Power
P1718 Wheatland Project Generator
Active Power (pu)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
P1718 Wheatland Project Generator
Reactive Power (pu)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Active Power (MW)
Time (Seconds)


Branch Reactive Power Flows
9L59 (Tinchebray 972S to Anderson 801S)
9L20 (Cordel 755S to Nevis 766S)
9L29 (Coyote Lake 963S to Oakland 946S)
7L85 (Parker 2072S to Bullpound 803S)
7L25 (Michichi Creek 802S to Rowley 768S)
7L128 (Michichi Creek 802S to Coyote Lake 963S)
Reactive Power (Mvar)
Time (Seconds)

Attachment A5

Dynamic Data and Assumptions of All Equipment Proposed for Connection

Table A5-1: Generic Renewable Energy Generator/Converter Model

Renewable Energy Generator/Converter Model (REGCAU1)													
Tg	Rrpwr	Brkpt	Zerox	Lvpl1	Volim	Lvpnt1	Lvpnt0	Iolim	Tfltr	Khv	Iqrmax	Iqrmin	Accel
0.0036	10.0	0.2	0.1	0.9	0.0	0.001	0.0	-999999	0.005	0.0	10000000	-10000000	1
Lvplsw													
1													

Table A5-2: Generic Renewable Electrical Control Model

Generic Renewable Electrical Control Model (REECAU1)													
Vdip	Vup	Trv	dbd1	dbd2	Kqv	Iqhl	Iqll	Vref0	Iqfrz	Thld	Thld2	Tp	QMax
0.9	1.12	0.001	9999	9999	0.0	9999	-9999	1.0	0.0	9999	9999	0.001	0.5328
QMin	VMAX	VMIN	Kqp	Kqi	Kvp	Kvi	Vbias	Tiq	dPmax	dPmin	PMAX	PMIN	Imax
-0.3935	1.5	0.7	9999	9999	2.0	0.0	1.0	9999	0.3767	-0.3767	1.0	0.0	1.5
Tpord	Vq1	Iq1	Vq2	Iq2	Vq3	Iq3	Vq4	Iq4	Vp1	Ip1	Vp2	Ip2	Vp3
0.001	0.75	0.9444	0.85	0.5667	1.0	0.5667	1.195	0.4496	0.1	0.0	0.2	0.9	0.85
Ip3	Vp4	Ip4	Bus	PFFLAG	VFLAG	QFLAG	PFLAG	PQFLAG					
1.318	1.7	1.318	0	0	0	1	1	0					

Table A5-3: Generic Drive Train Model for Type 3 and Type 4 Wind Machines

Renewable Energy Generator/Converter Model (WTDTAU1)				
H	DAMP	Htfrac	Freq1	Dshaft
6.06089	37.1395	0.851785	1.428	1.0

Table A5-4: Generic Renewable Plant Control Model

Renewable Energy Generator/Converter Model (REPCAU1)													
Tfltr	Kp	Ki	Tft	Tfv	Vfrz	Rc	Xc	Kc	emax	emin	dbd1	dbd2	Qmax
0.04	0.0	0.726	0.0	0.02	0.9	0.0	0.0	0.15152	1.0	-1.0	0.0	0.0	0.2
Qmin	Kpg	Kig	Tp	Fdbd1	Fdbd2	femax	femin	Pmax	Pmin	Tg	Ddn	Dup	Bus
-0.2	0.0	0.6	0.1	-0.005	0.0	0.6667	-0.6667	1.0	0.1	0.02	25	0.0	0
FromBus	ToBus	ID	VCFlag	RefFlag	Fflag								
0	0	‘0’	0	1	1								

Attachment A6

Post-Mitigation Power Flow Diagrams

List of Figures

Scenario and Case Name	Contingency (System Element Lost)	Figure Number
P1718_2019SL_Post.sav 2019 Summer Light High Wind Economy Coal Post-Project	9L20 (Nevis 766S - Cordel 755S)	Figure A6-1
	7L128 (Michichi Creek 802S - Coyote Lake 963S)	Figure A6-2
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Figure A6-3
	9L29 (Oakland 946S - Coyote Lake 963S)	Figure A6-4
	963S901T (Coyote Lake 963S Transformer 901T)	Figure A6-5
	114ST1 (Ghost Pine 114S Transformer T1)	Figure A6-6
	801S901T (Anderson 801S Transformer 901T)	Figure A6-7
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	Figure A6-8
P1718_2019SP_Post.sav 2019 Summer Peak High Wind Economy Coal Post-Project	7L42 (Hill 751S - Lloydminster 716S)	Figure A6-9
	7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	Figure A6-10
	9L16 (Tinchebray 972S - Cordel 755S)	Figure A6-11
	9L20 (Nevis 766S - Cordel 755S)	Figure A6-12
	7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)	Figure A6-13
	749L\749AL (Metiskow 648S - Edgerton 899S)	Figure A6-14
	899ST3A (Edgerton 899S Transformer T3A)	Figure A6-15
	912L\9L912 (Red Deer 63S - Nevis 766S)	Figure A6-16
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Figure A6-17
	114ST1 (Ghost Pine 114S Transformer T1)	Figure A6-18
	766S901T (Nevis 766S Transformer 901T)	Figure A6-19
	801S901T (Anderson 801S Transformer 901T)	Figure A6-20
	701L (North Holden 395S - Strome 223S)	Figure A6-21
	395ST1 (North Holden 395S Transformer T1)	Figure A6-22
	EATL (Newell 2075S - Heathfield 2029S)	Figure A6-23
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	Figure A6-24
P1718_2019WP_Post.sav 2019 Winter Peak High Wind Economy Coal Post-Project	9L20 (Nevis 766S - Cordel 755S)	Figure A6-25
	912L\9L912 (Red Deer 63S - Nevis 766S)	Figure A6-26
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Figure A6-27
	766S901T (Nevis 766S Transformer 901T)	Figure A6-28
	801S901T (Anderson 801S Transformer 901T)	Figure A6-29
	EATL (Newell 2075S - Heathfield 2029S)	Figure A6-30
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	Figure A6-31
P1718_2019SP_Post_PENV.sav 2019 Summer Peak High Wind Economy Coal Post-Project Sensitivity with PENV	9L20 (Nevis 766S - Cordel 755S)	Figure A6-32
	912L\9L912 (Red Deer 63S - Nevis 766S)	Figure A6-33
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	Figure A6-34
	766S901T (Nevis 766S Transformer 901T)	Figure A6-35
	801S901T (Anderson 801S Transformer 901T)	Figure A6-36
	EATL (Newell 2075S - Heathfield 2029S)	Figure A6-37
	114ST1 (Ghost Pine 114S Transformer T1)	Figure A6-38
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	Figure A6-39

Figure A6-1 : 2019 Summer Light Post-Project - Contingency of 9L20 (Nevis 766S - Cordel 755S)

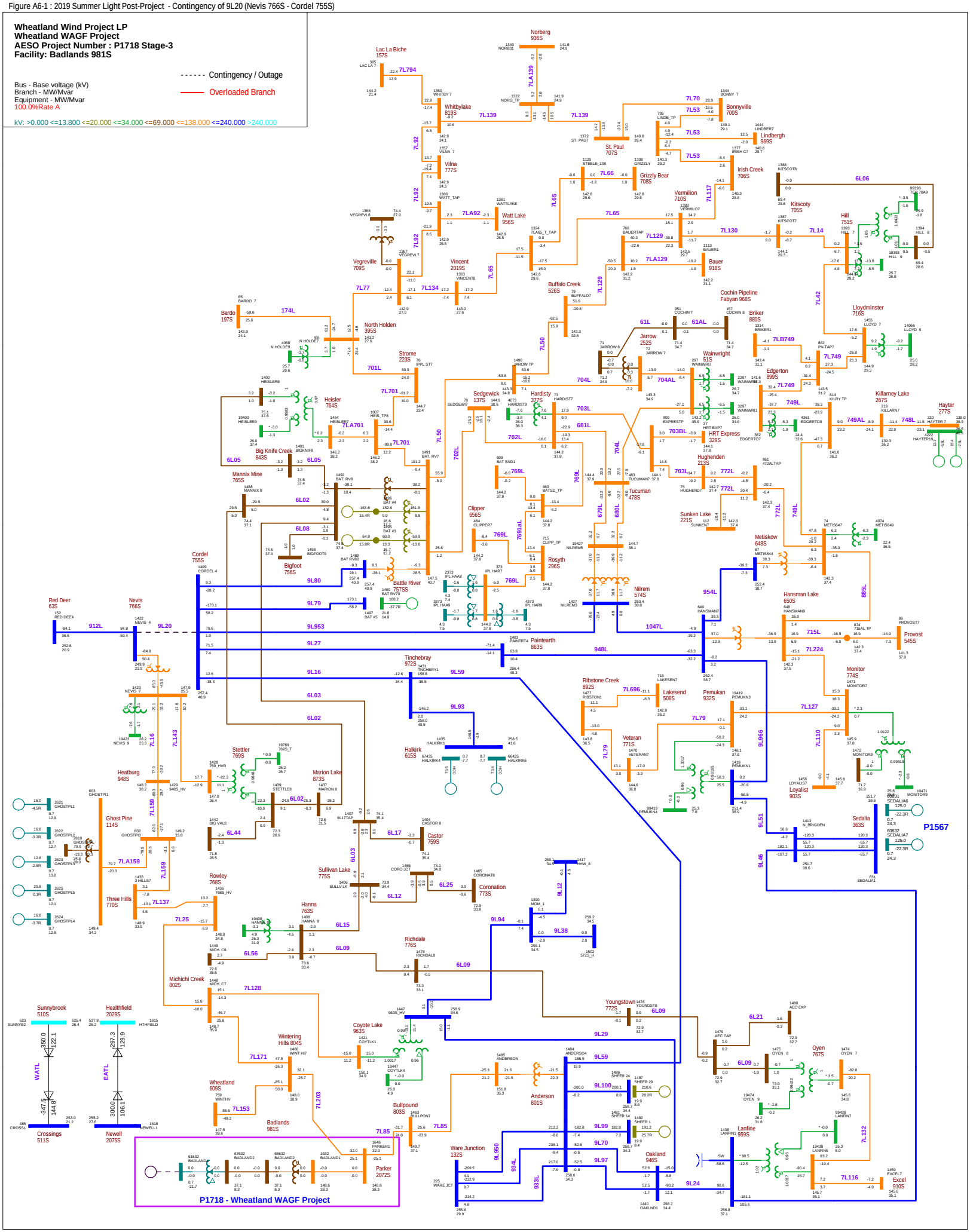


Figure A6-2 : 2019 Summer Light Post-Project - Contingency of 7L128 (Michichi Creek 802S - Coyote Lake 963S)

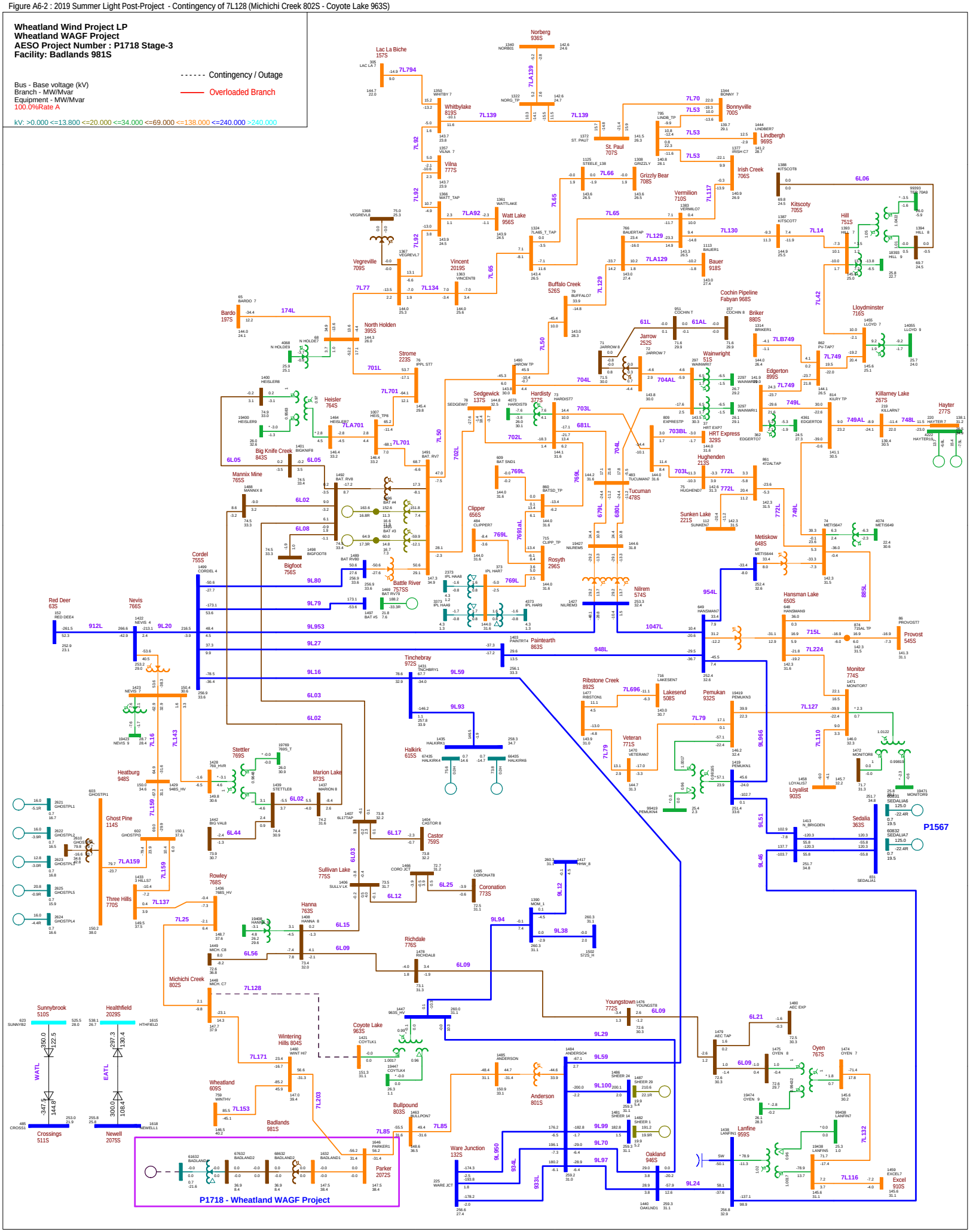


Figure A6-3 : 2019 Summer Light Post-Project - Contingency of 7L171 (Michichi Creek 802S - Wintering Hills 804S)

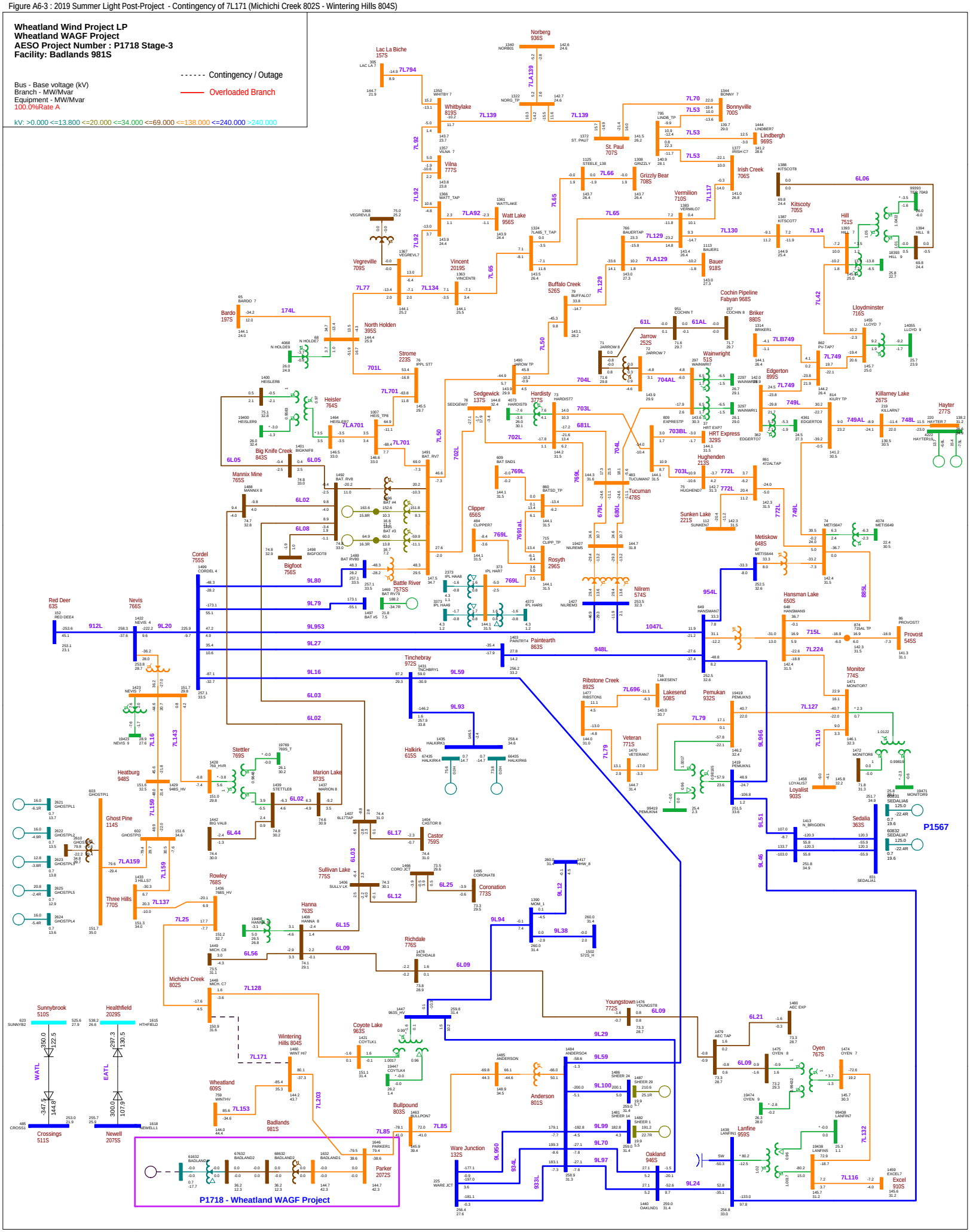


Figure A6-4 : 2019 Summer Light Post-Project - Contingency of 9L29 (Oakland 946S - Coyote Lake 963S)

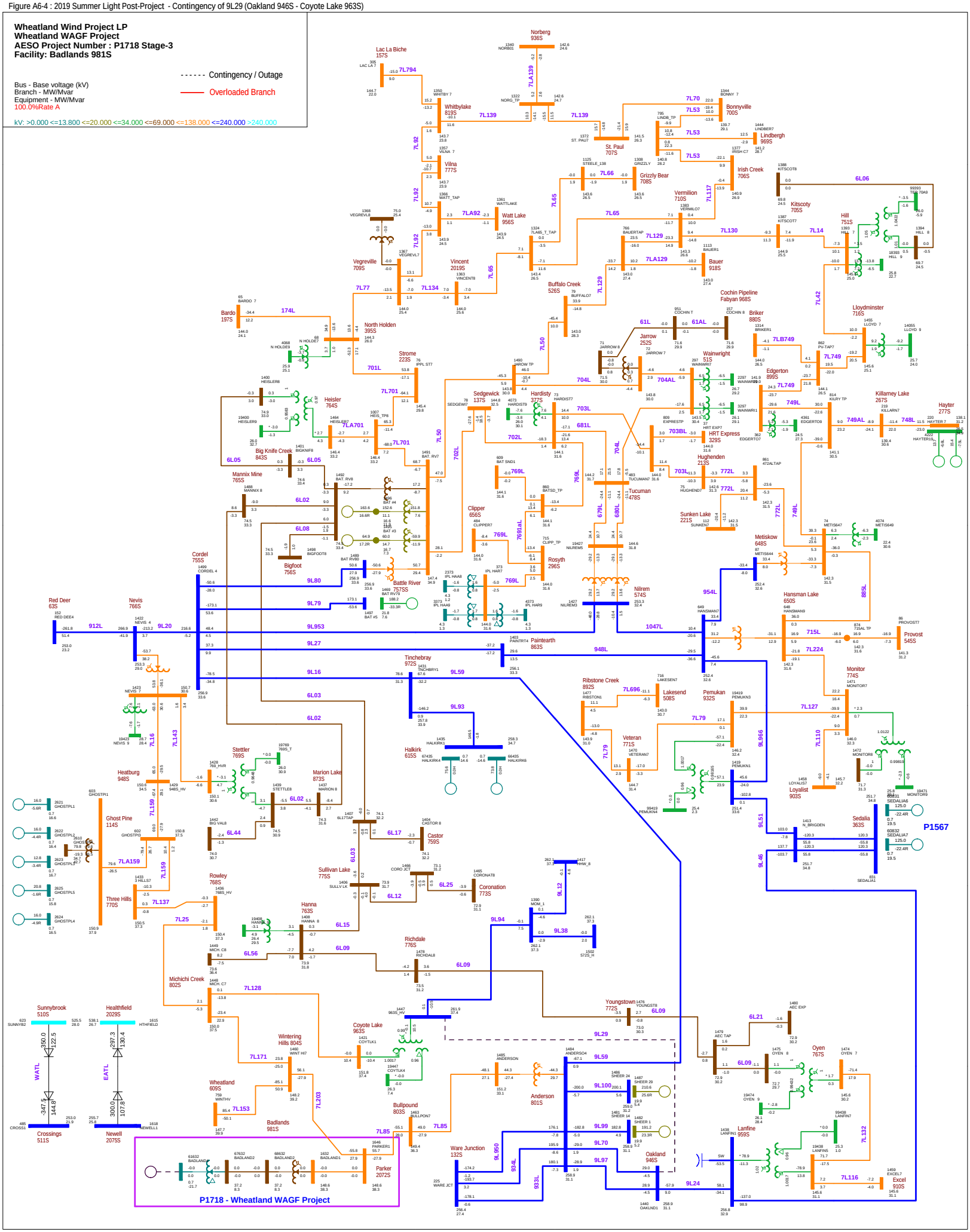


Figure A6-5 : 2019 Summer Light Post-Project - Contingency of 963S901T (Coyote Lake 963S Transformer 901T)

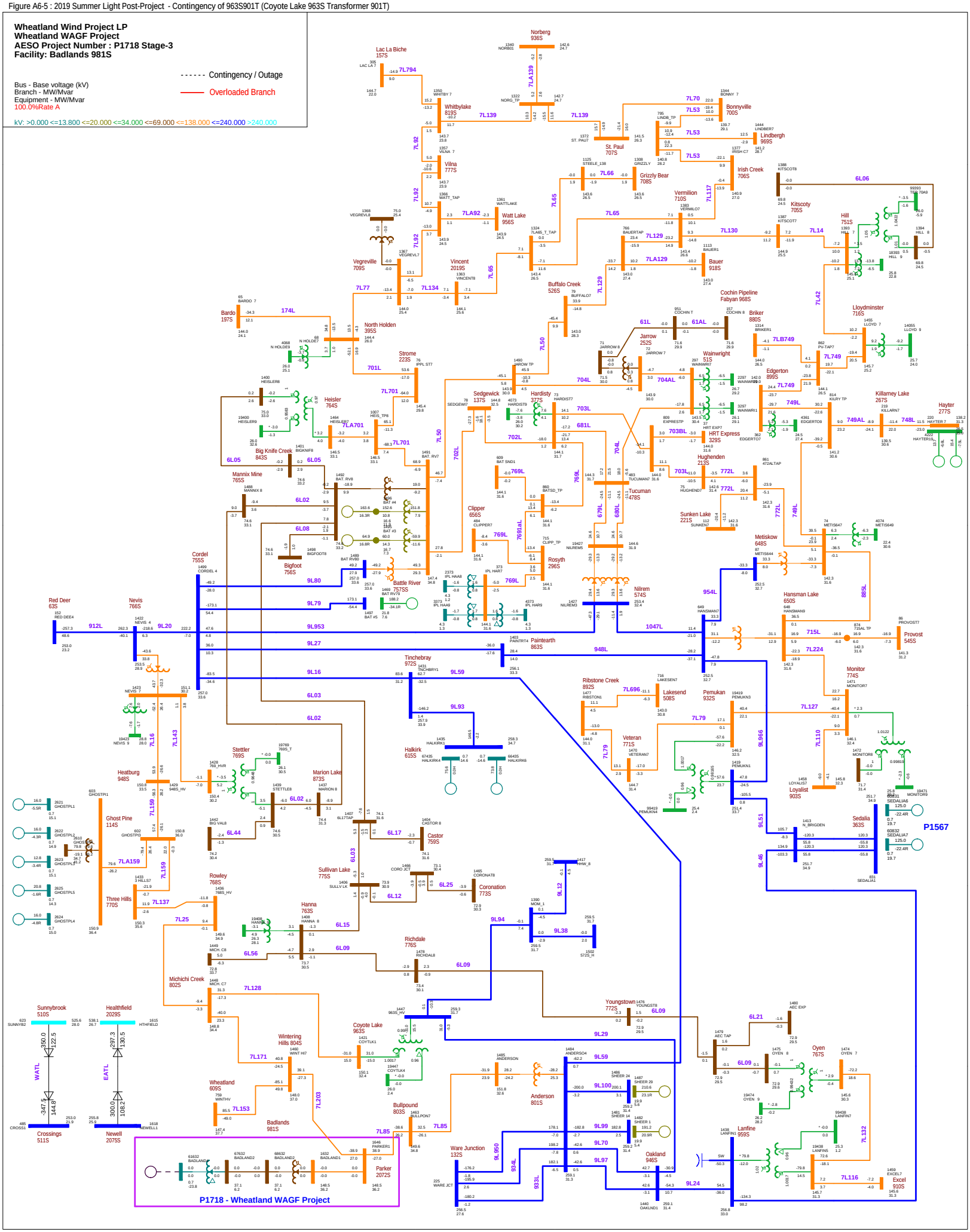


Figure A6-6 : 2019 Summer Light Post-Project - Contingency of 114ST1 (Ghost Pine 114S Transformer T1)

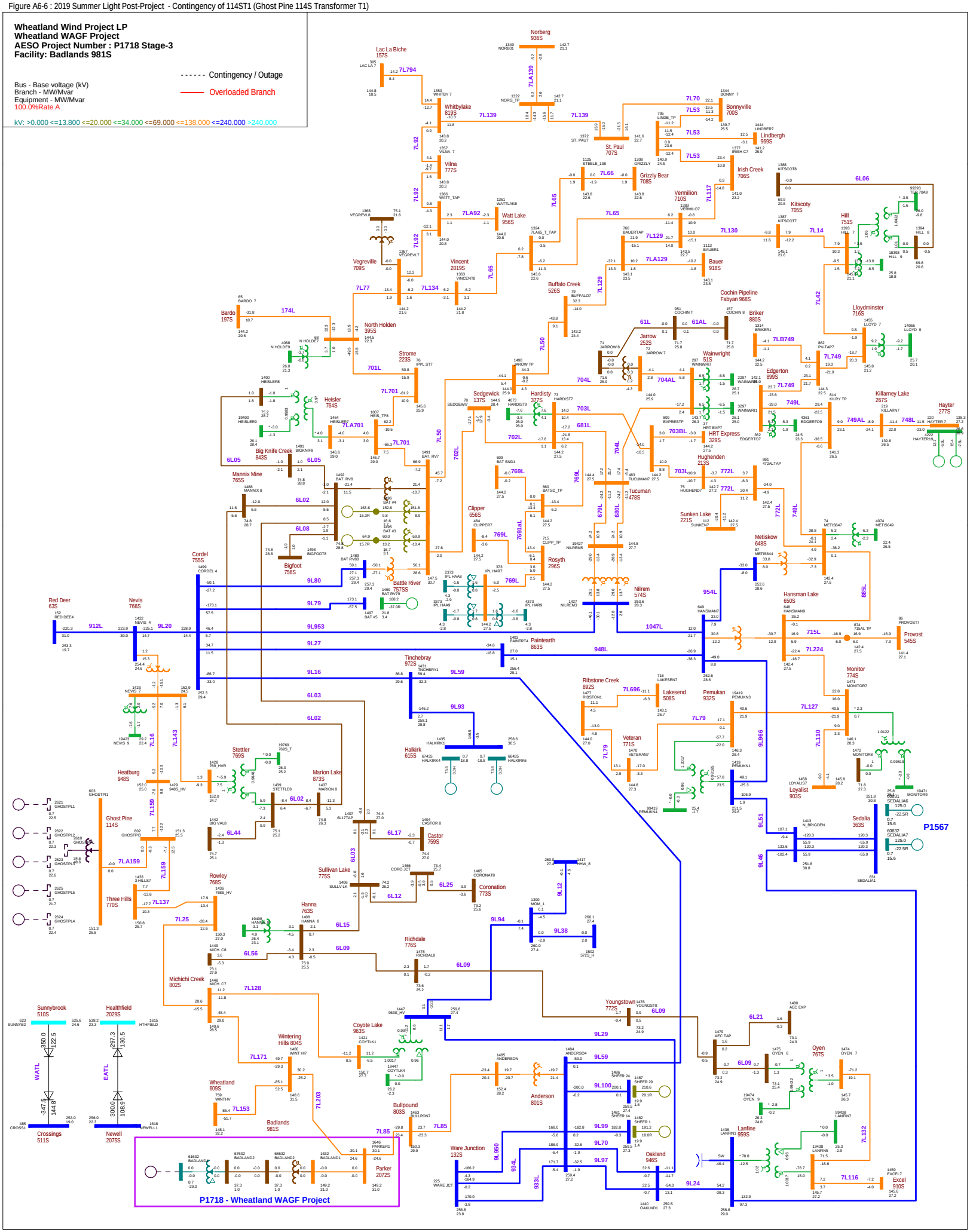


Figure A6-7 : 2019 Summer Light Post-Project - Contingency of 801S901T (Anderson 801S Transformer 901T)

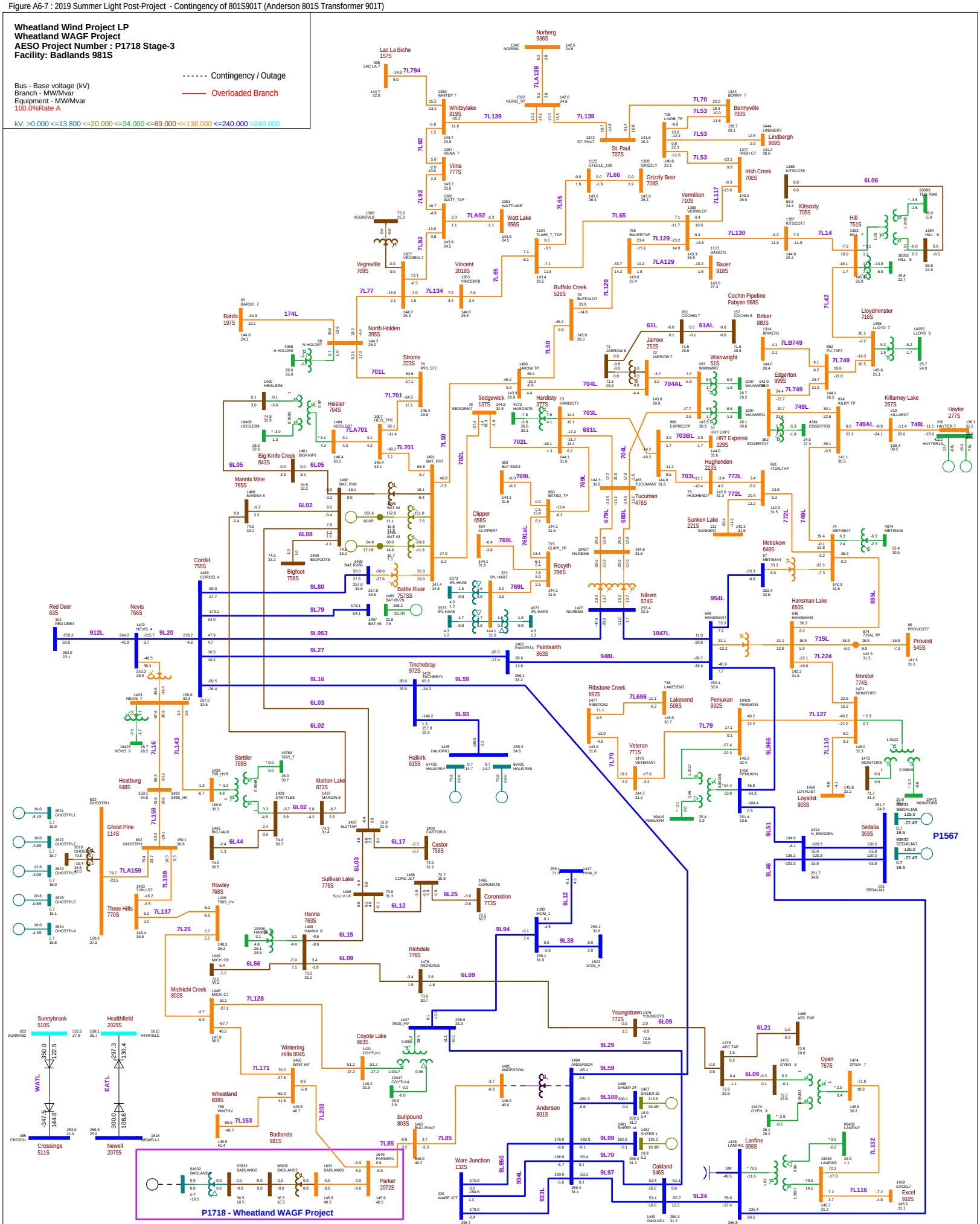


Figure A6-8 : 2019 Summer Light Post-Project - Contingency of 7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)

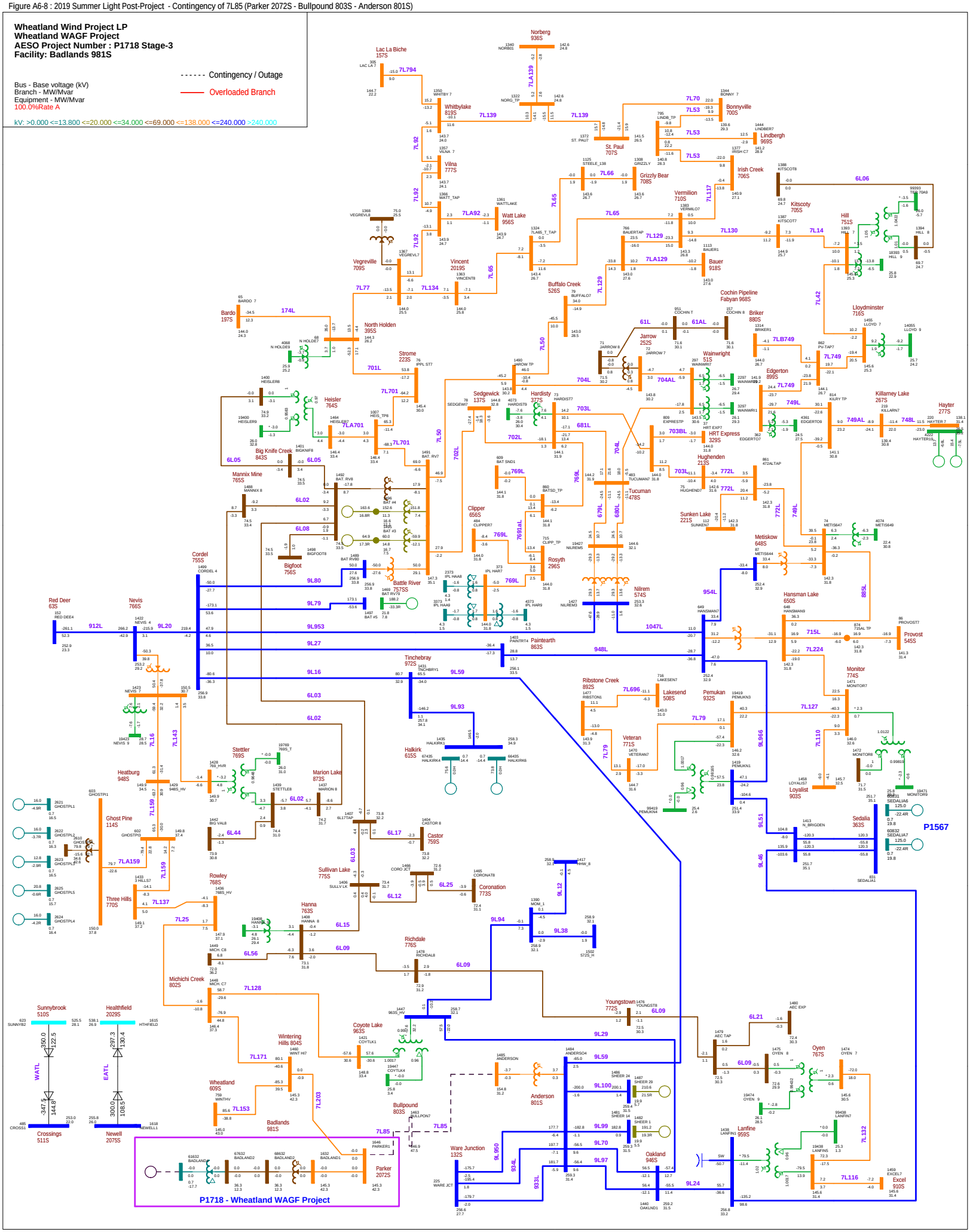


Figure A6-9 : 2019 Summer Peak Post-Project - Contingency of 7L42 (Hill 751S - Lloydminster 716S)

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000

Contingency / Outage
Overloaded Branch

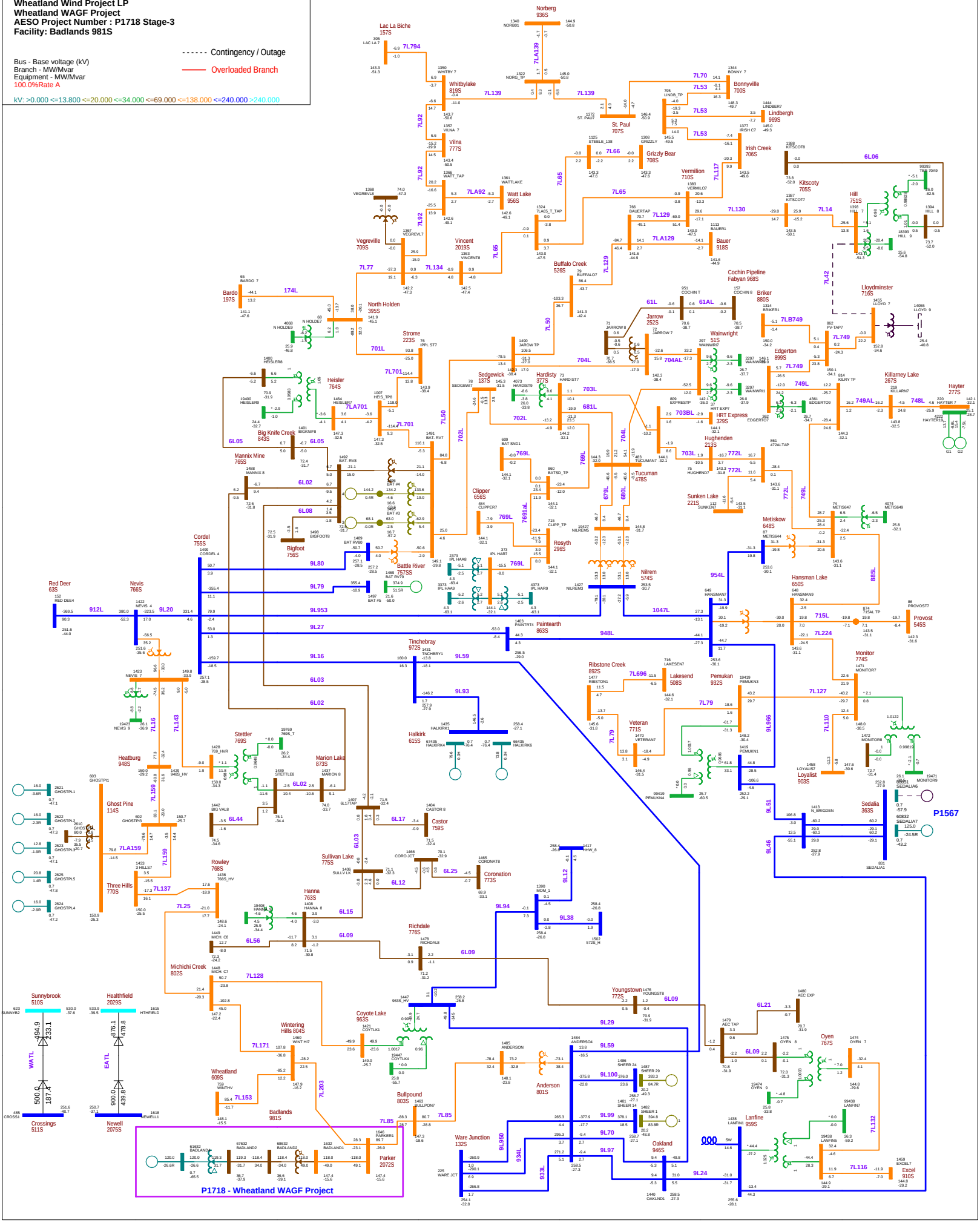


Figure A6-10 : 2019 Summer Peak Post-Project - Contingency of 7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)

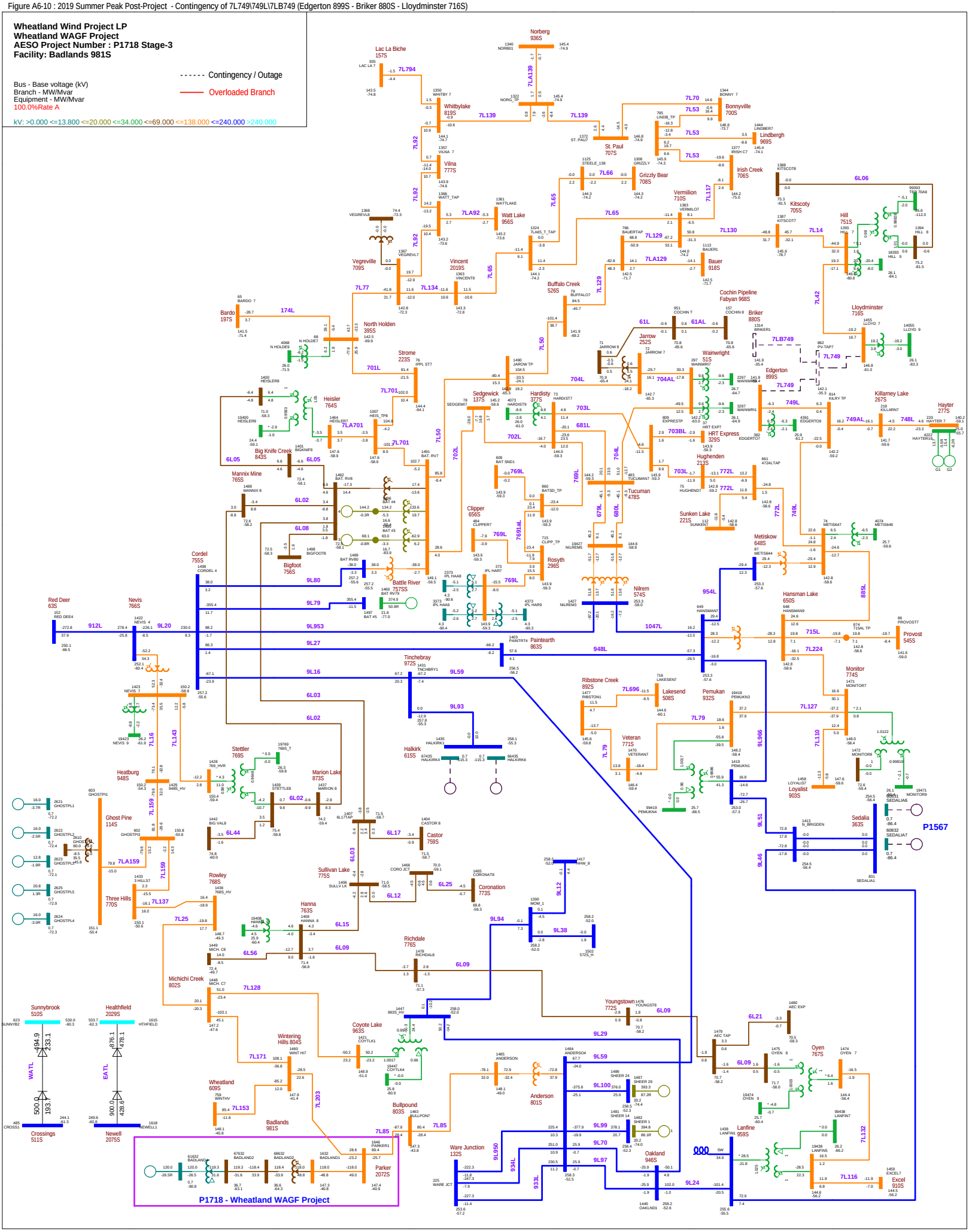


Figure A6-11 : 2019 Summer Peak Post-Project - Contingency of 9L16 (Tinchebray 972S - Cordel 755S)

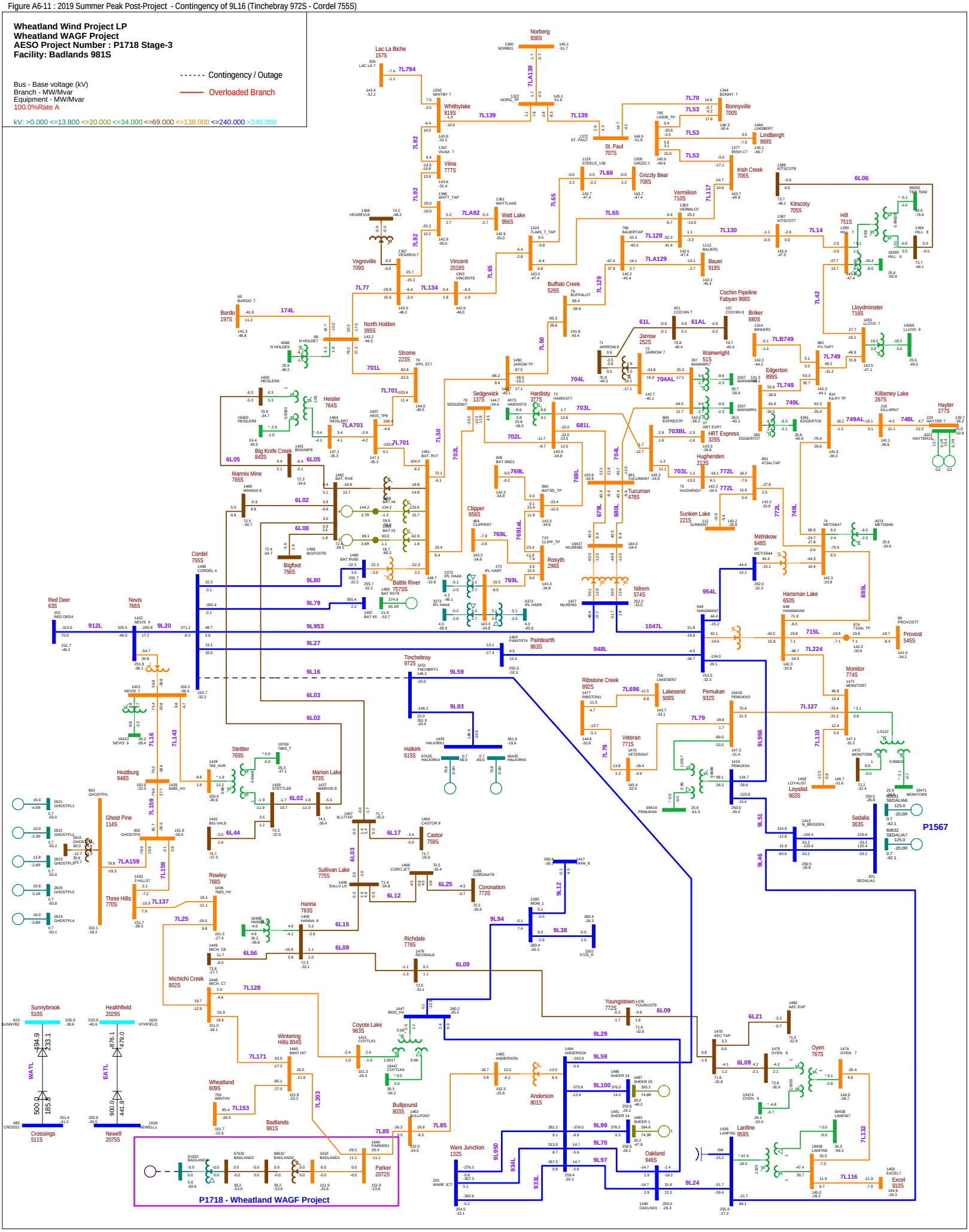


Figure A6-12 : 2019 Summer Peak Post-Project - Contingency of 9L20 (Nevis 766S - Cordel 755S)

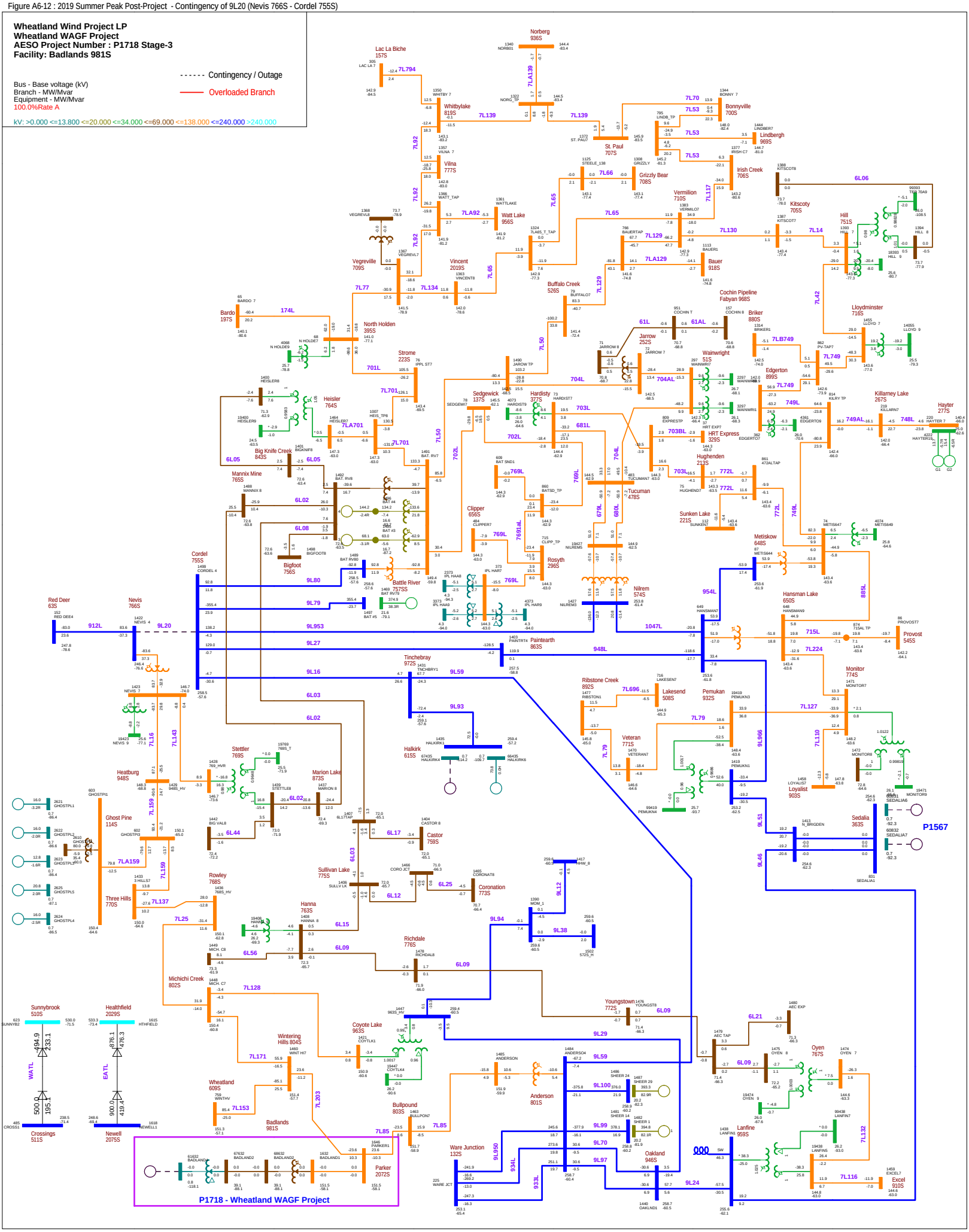


Figure A6-13 : 2019 Summer Peak Post-Project - Contingency of 7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)

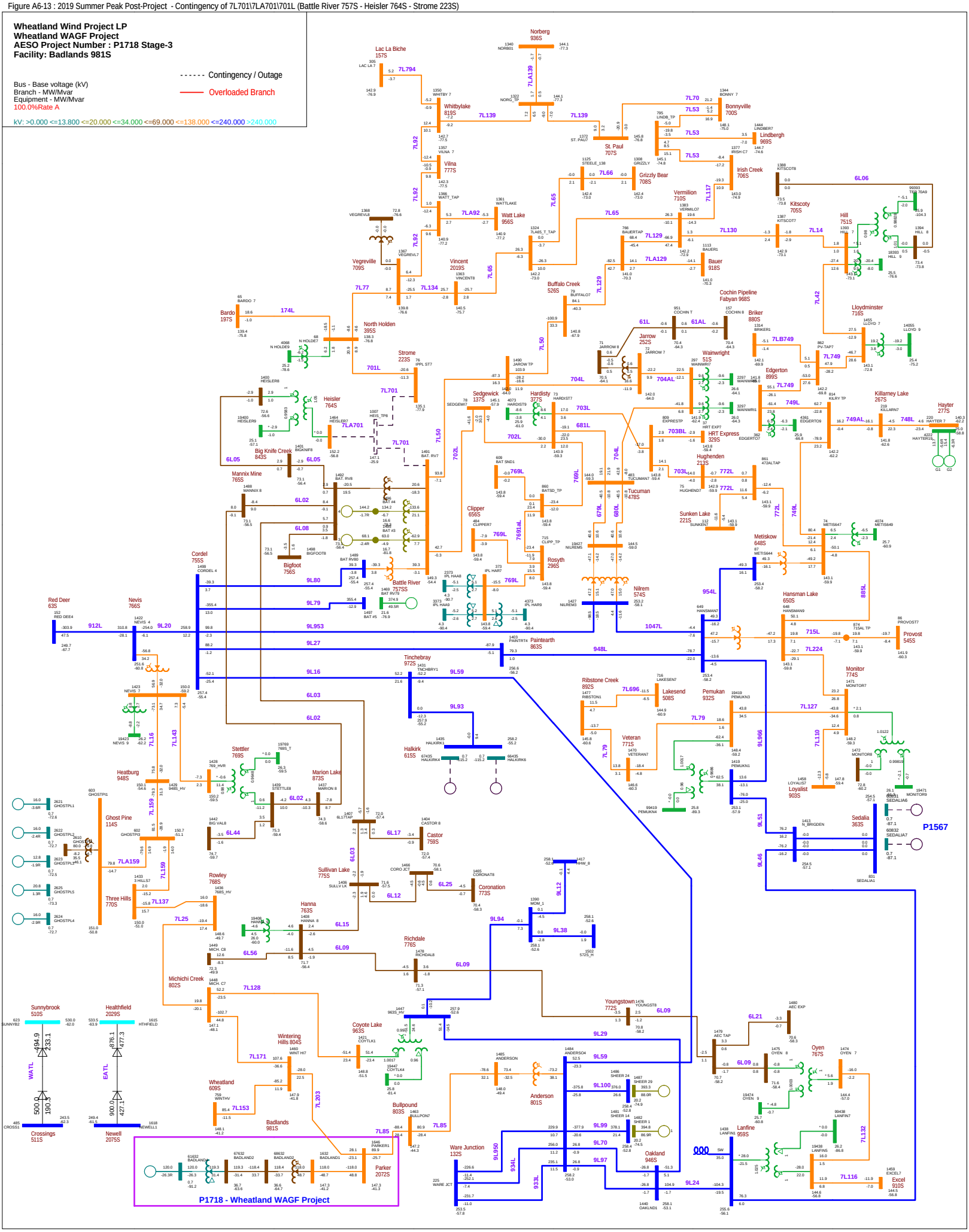


Figure A6-14 : 2019 Summer Peak Post-Project - Contingency of 749L\749AL (Metiskow 648S - Edgerton 899S)

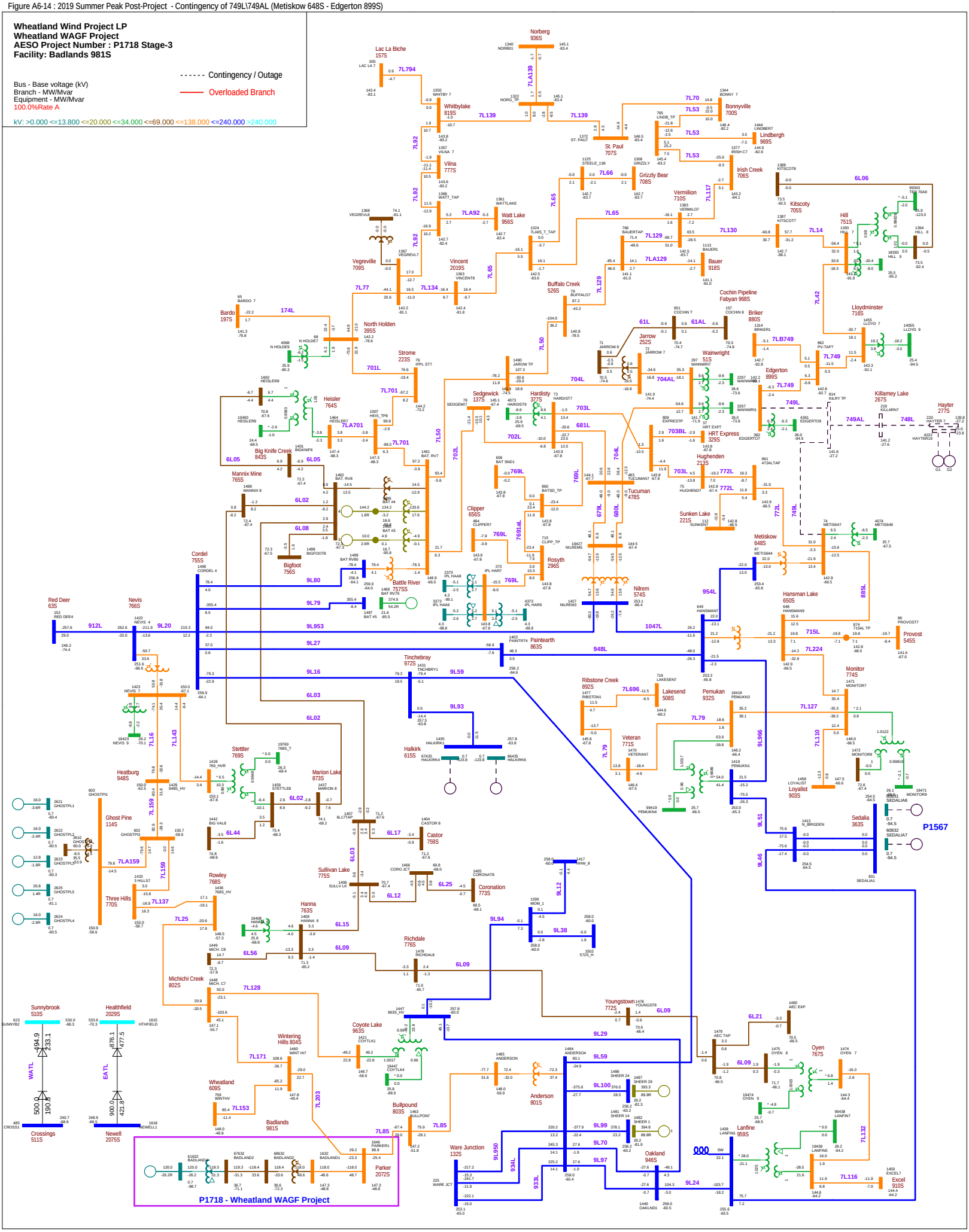


Figure A6-15 : 2019 Summer Peak Post-Project - Contingency of 899ST3A (Edgerton 899S Transformer T3A)

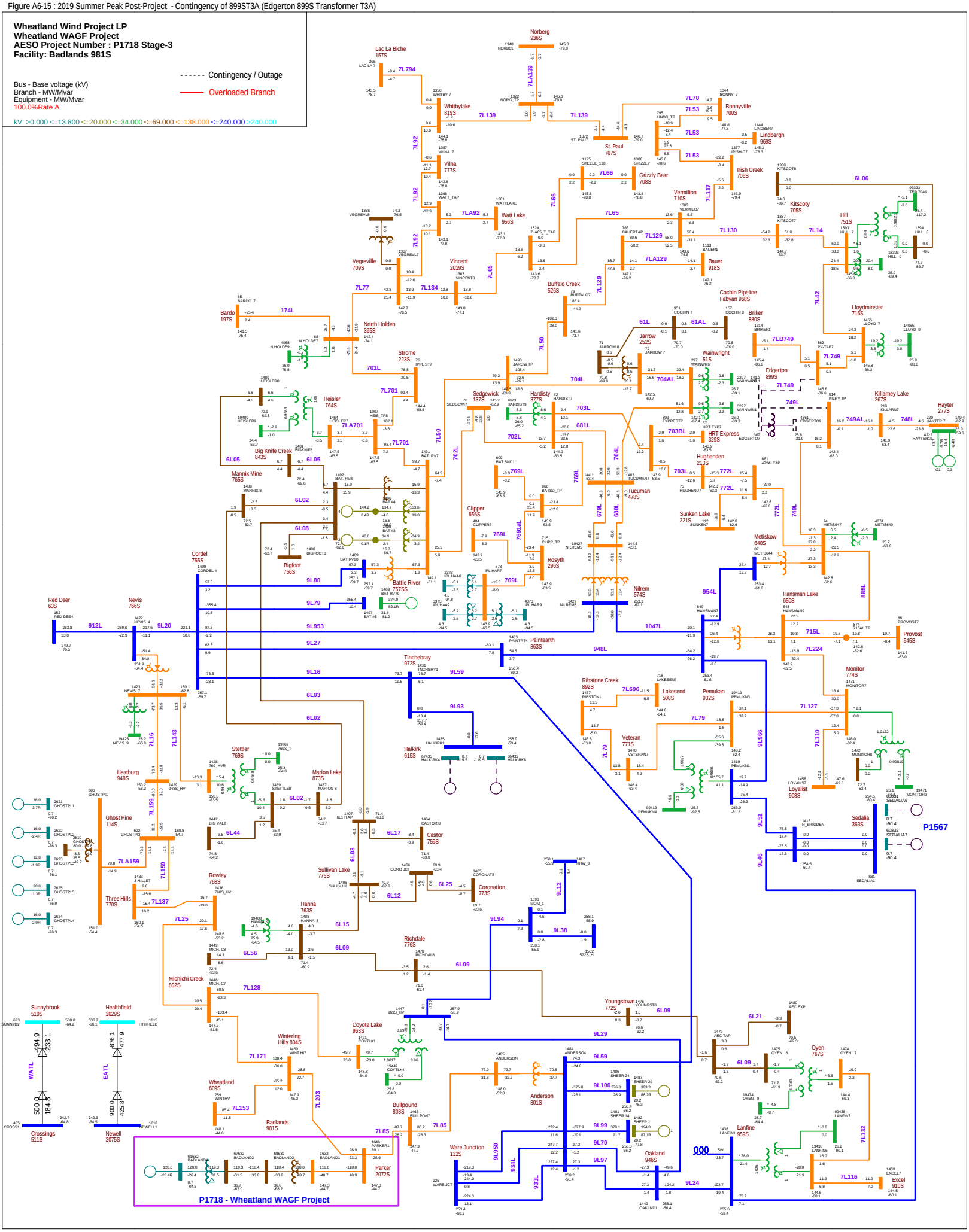


Figure A6-16 : 2019 Summer Peak Post-Project - Contingency of 912L\9L912 (Red Deer 63S - Nevis 766S)

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000

Contingency / Outage
Overloaded Branch

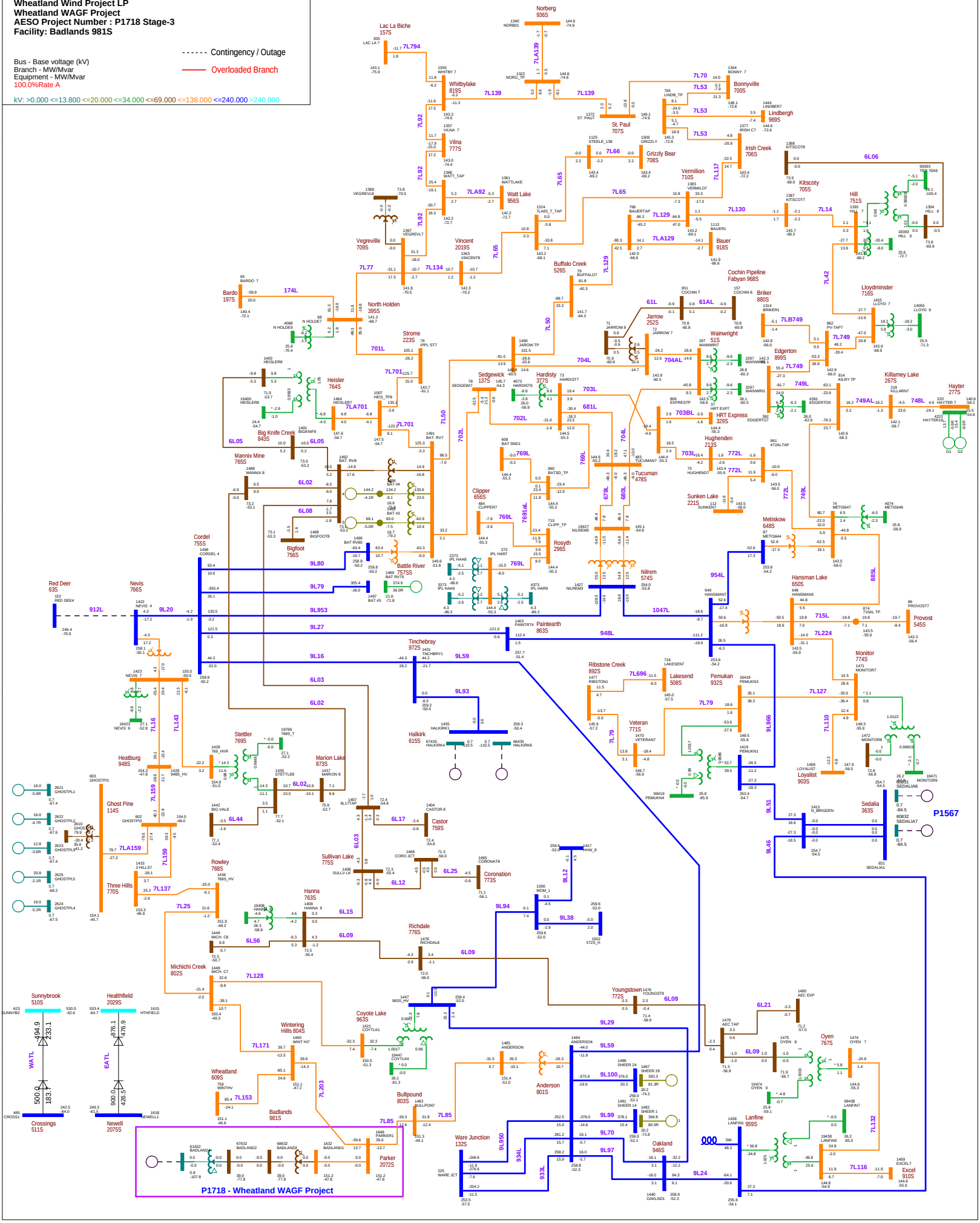


Figure A6-17 : 2019 Summer Peak Post-Project - Contingency of 7L171 (Michichi Creek 802S - Wintering Hills 804S)

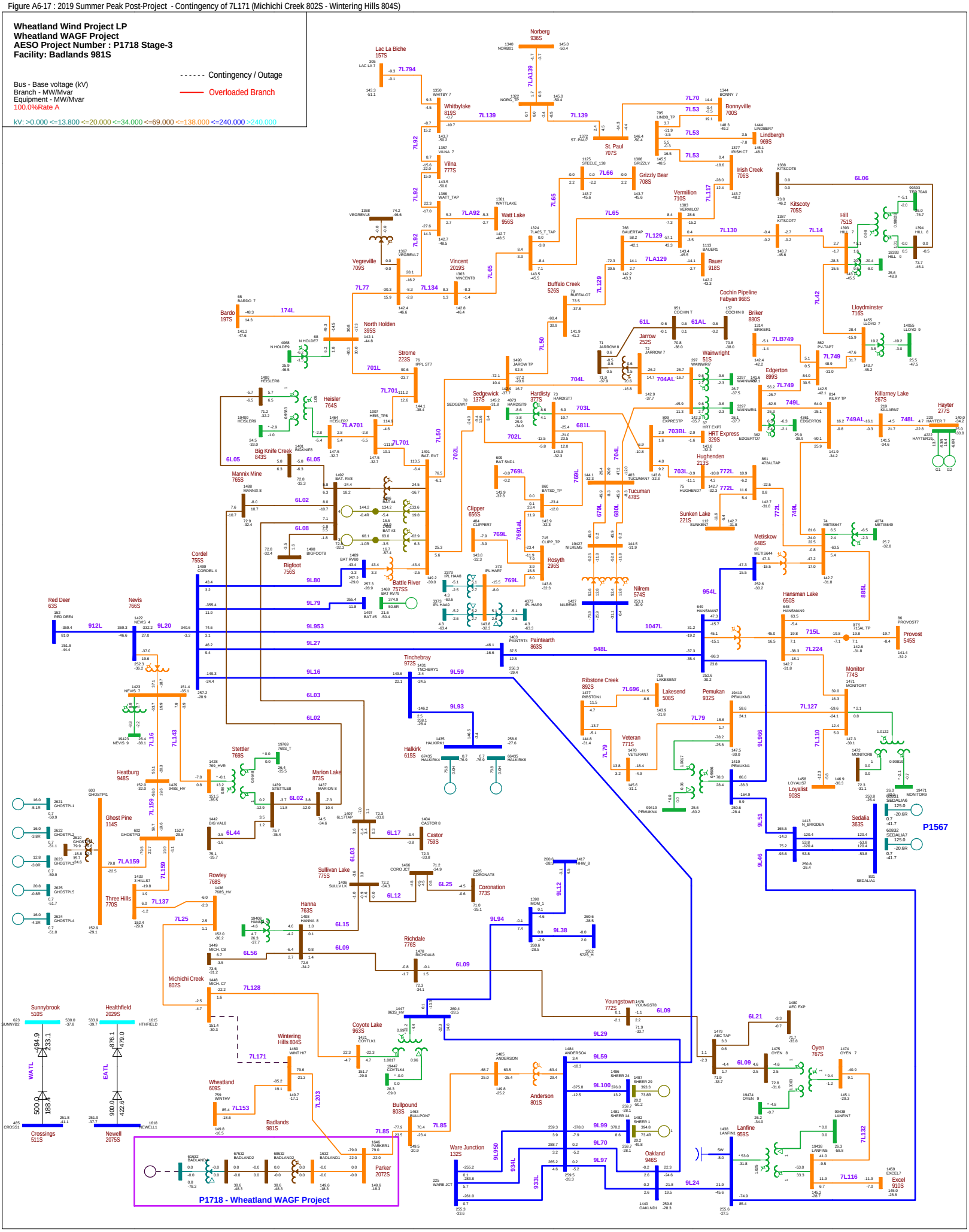


Figure A6-18 : 2019 Summer Peak Post-Project - Contingency of 114ST1 (Ghost Pine 114S Transformer T1)

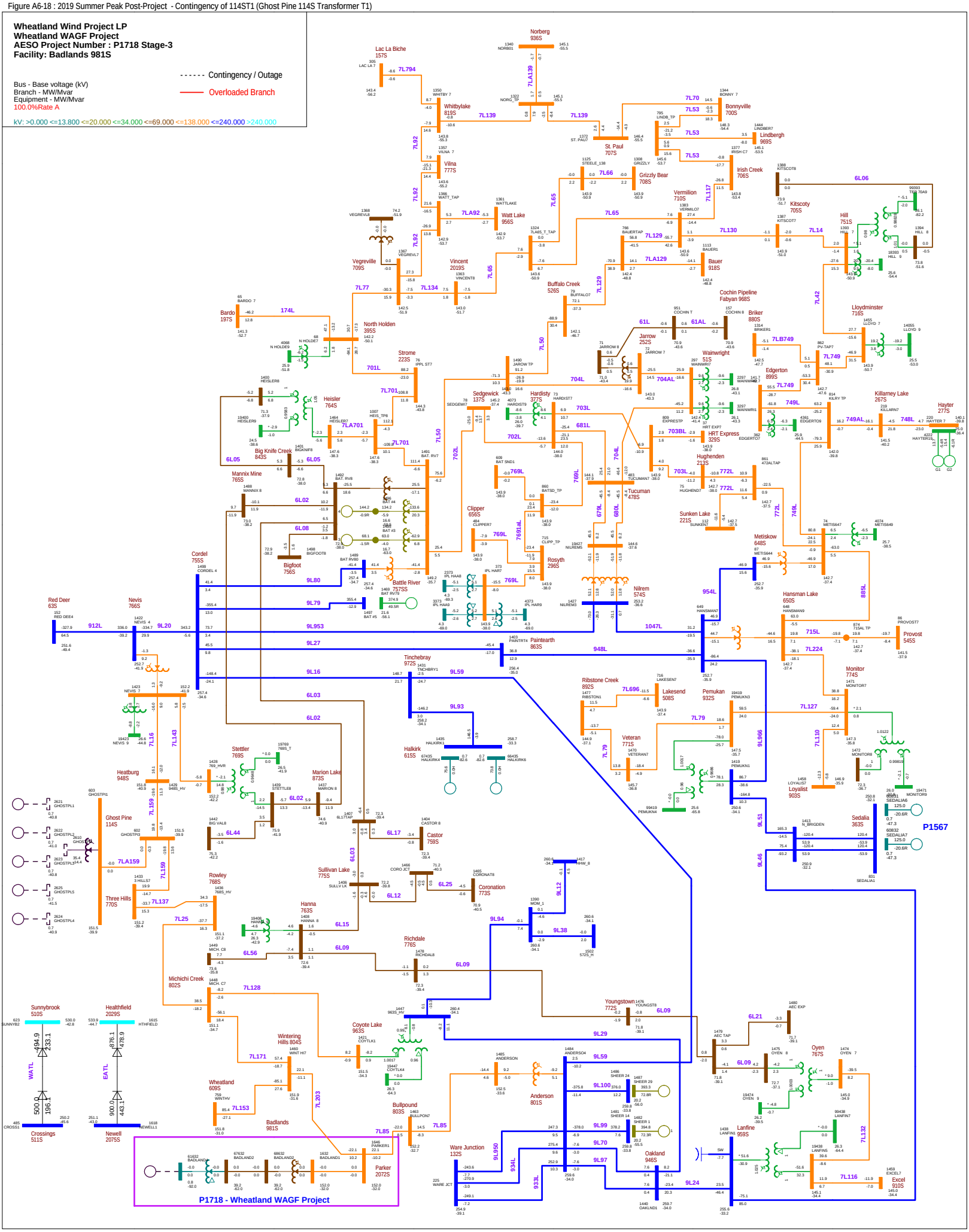


Figure A6-19 : 2019 Summer Peak Post-Project - Contingency of 766S901T (Nevis 766S Transformer 901T)

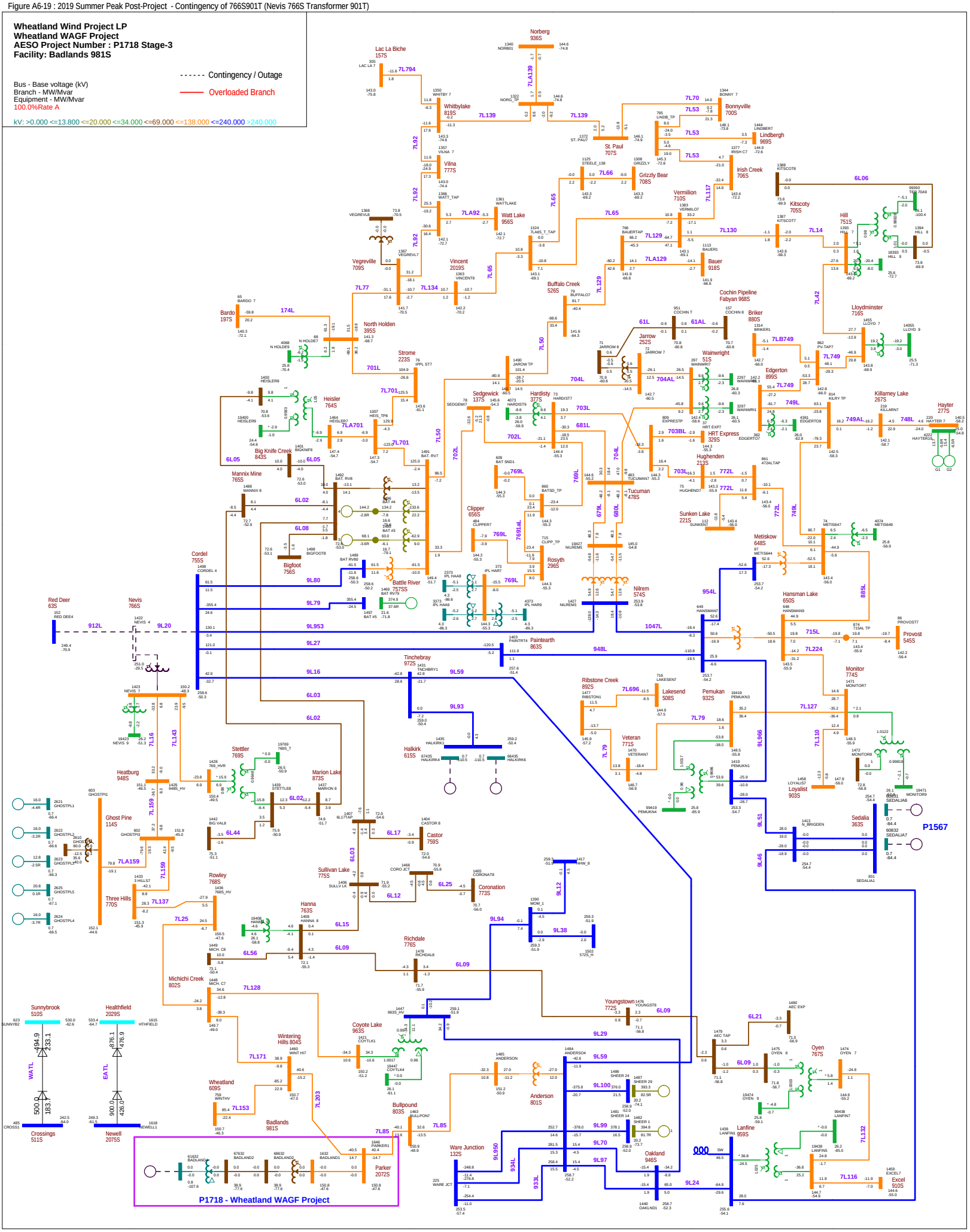


Figure A6-20 : 2019 Summer Peak Post-Project - Contingency of 801S901T (Anderson 801S Transformer 901T)

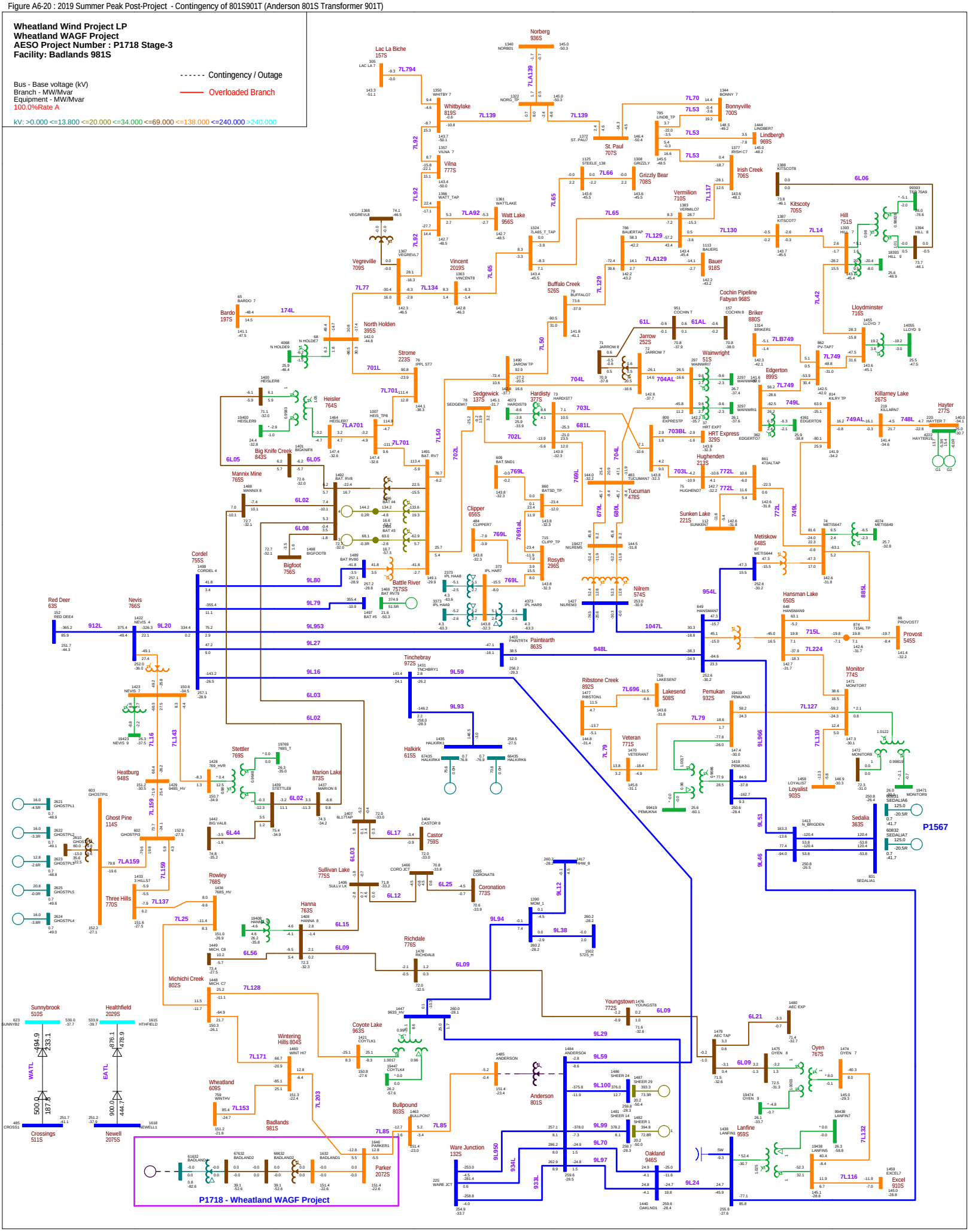


Figure A6-21 : 2019 Summer Peak Post-Project - Contingency of 701L (North Holden 395S - Strome 223S)

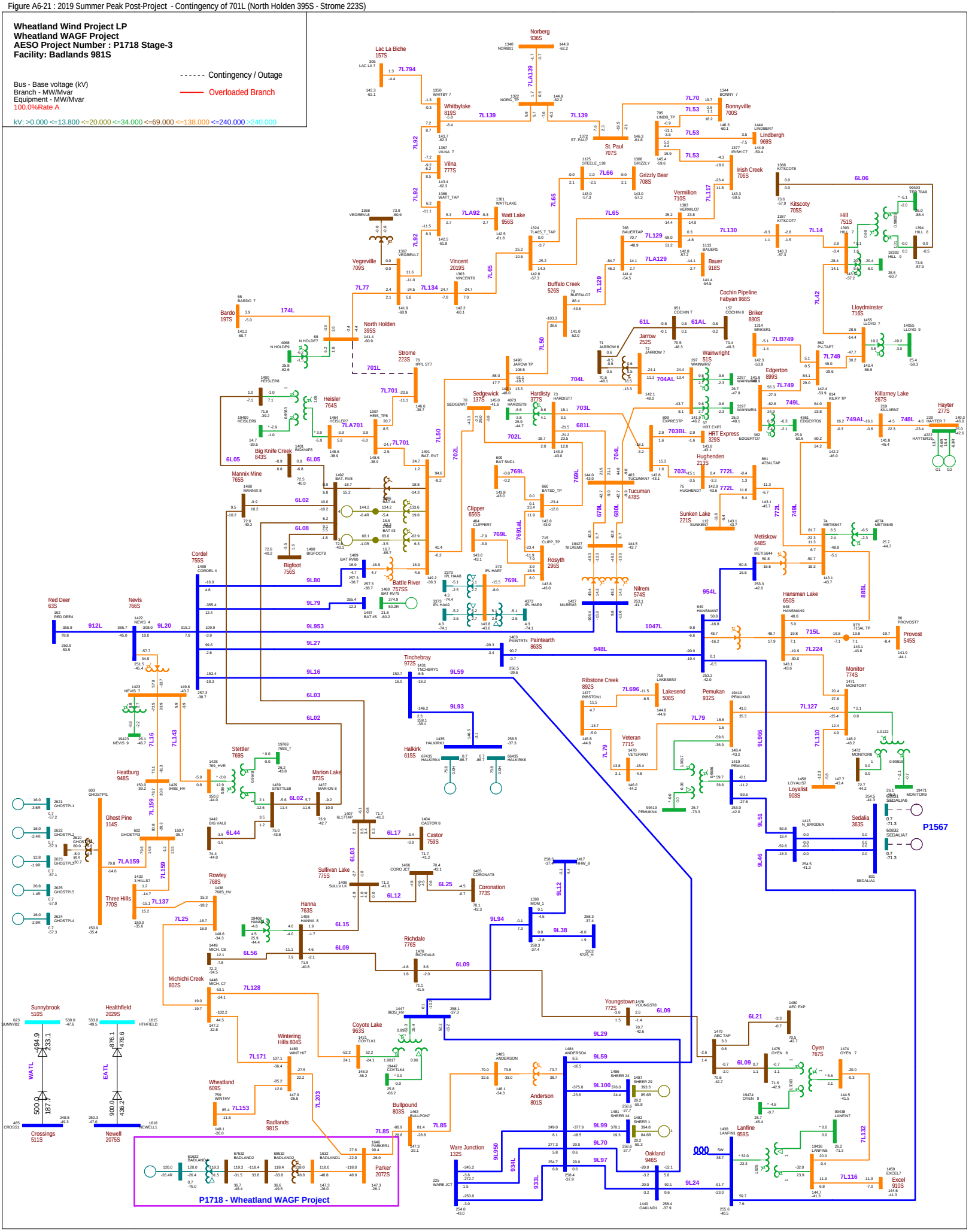


Figure A6-22 : 2019 Summer Peak Post-Project - Contingency of 395ST1 (North Holden 395S Transformer T1)

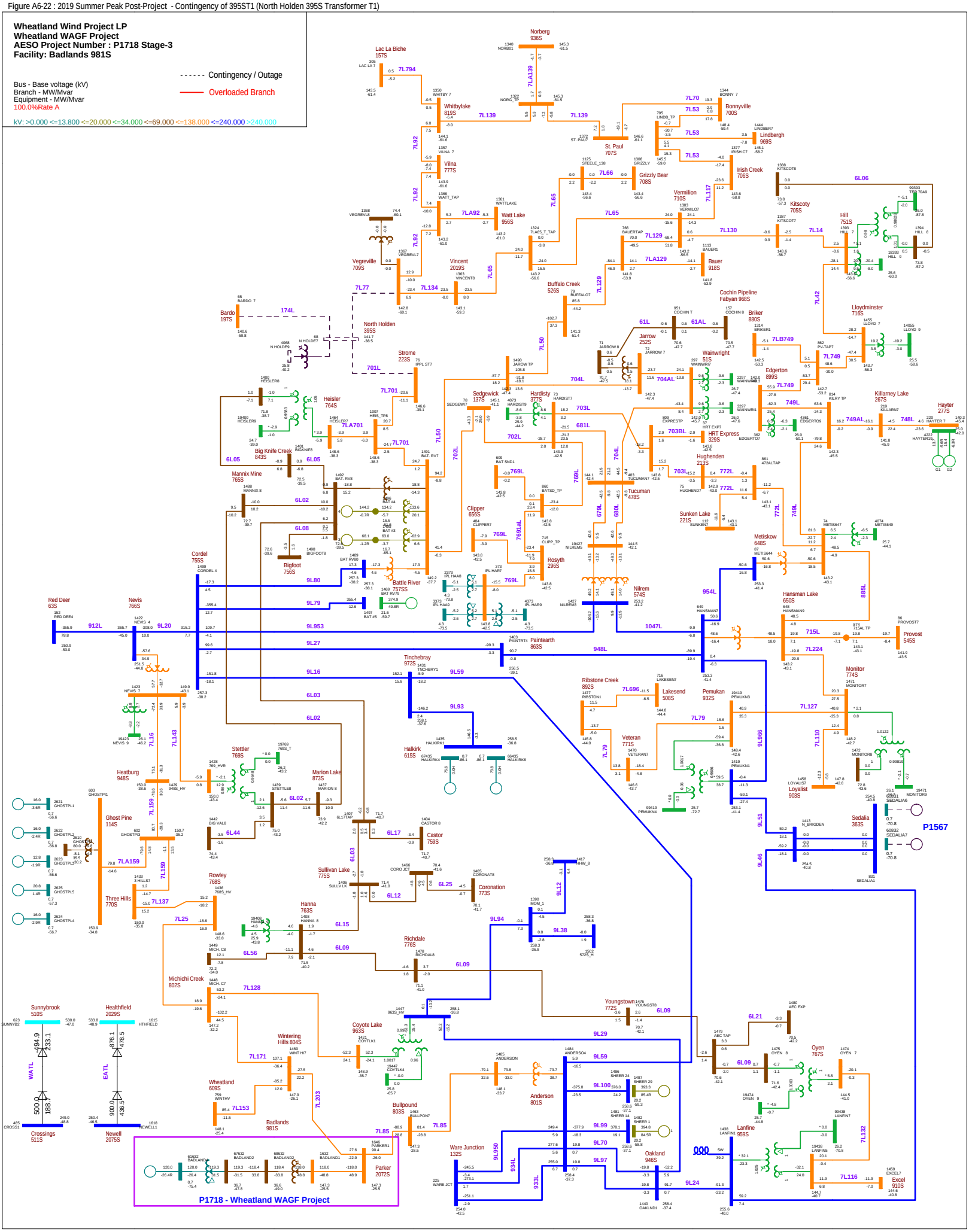

Wheatland Wind Project LP
Wheatland WAGF Project
AESO Project Number : P1718 Stage-3
Facility: Badlands 981S
Contingency / Outage
Overloaded Branch
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: >0.000 <=13.800 <=20.000 <=34.000 <=69.000 <=138.000 <=240.000 >240.000
Norberg 936S
Lac La Biche 157S
Whitbylake 819S
Vilna 777S
Watt Lake 956S
Vegreville 709S
Vincent 2019S
Bardo 197S
North Holden 395S
Strome 223S
Heisler 764S
Big Knife Creek 843S
Mannix Mine 765S
Cordel 755S
Red Deer 63S
Nevis 766S
Bigfoot 756S
Battle River 757SS
Heatburg 948S
Ghost Pine 114S
Three Hills 770S
Rowley 768S
Stettler 769S
Marion Lake 873S
Halkirk 615S
Castor 759S
Sullivan Lake 775S
Hanna 763S
Richdale 776S
Michichi Creek 802S
Wintering Hills 804S
Wheatland 609S
Badlands 981S
Coyote Lake 963S
Sunnybrook 510S
Crossings 511S
Healthfield 2029S
Newell 2075S
Parker 2072S
Ware Junction 132S
Anderson 801S
Bullpound 803S
Oakland 946S
Youngstown 772S
Lanfine 559S
Excel 910S
Yeo 767S
Loyalist 903S
Sedalia 363S
Monitor 774S
Provost 545S
Killarney Lake 267S
Hayter 277S
Lloydminster 716S
Kitscoty 705S
Hill 751S
Irish Creek 706S
Bonnyville 700S
Lindbergh 969S
St. Paul 707S
Grizzly Bear 708S
Vermilion 710S
Buffalo Creek 526S
Cochin Pipeline Fabyan 968S
Jarrow 252S
Wainwright 51S
Edgerton 699S
Briker 880S
Sedgewick 137S
Hardisty 377S
Tucumar 478S
Sunken Lake 221S
Hughenden 213S
HRT Express 329S
Metiskow 648S
Hansman Lake 650S
Lakesend 508S
Pemukan 932S
Ribstone Creek 892S
Veteran 771S
Nilrem 574S
Rosyth 296S
Clipper 656S
Paintearth 863S
Tinchebray 972S
Unknown
Unknown
Unknown

Figure A6-23 : 2019 Summer Peak Post-Project - Contingency of EATL (Newell 2075S - Heathfield 2029S)

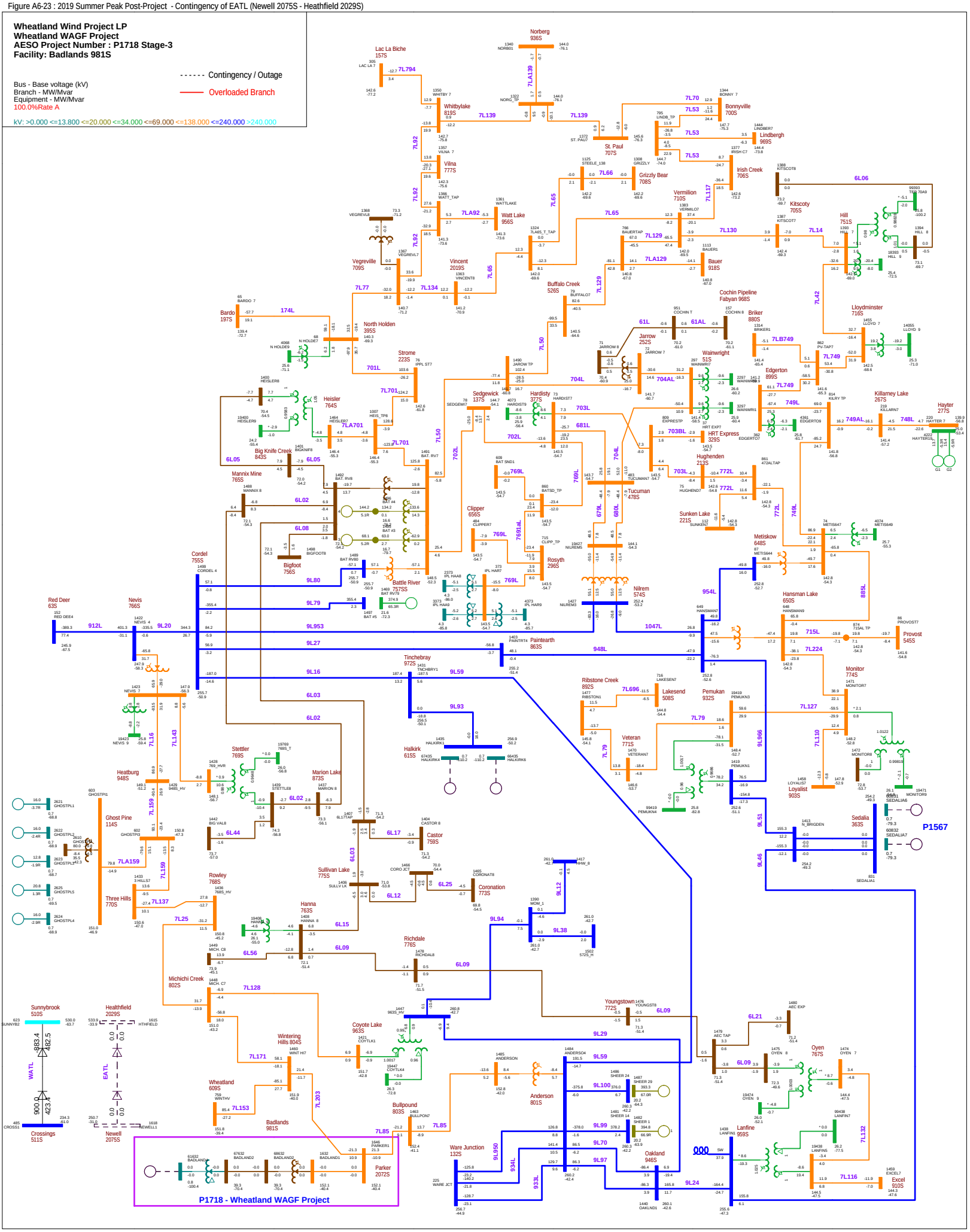


Figure A6-24 : 2019 Summer Peak Post-Project - Contingency of 7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)

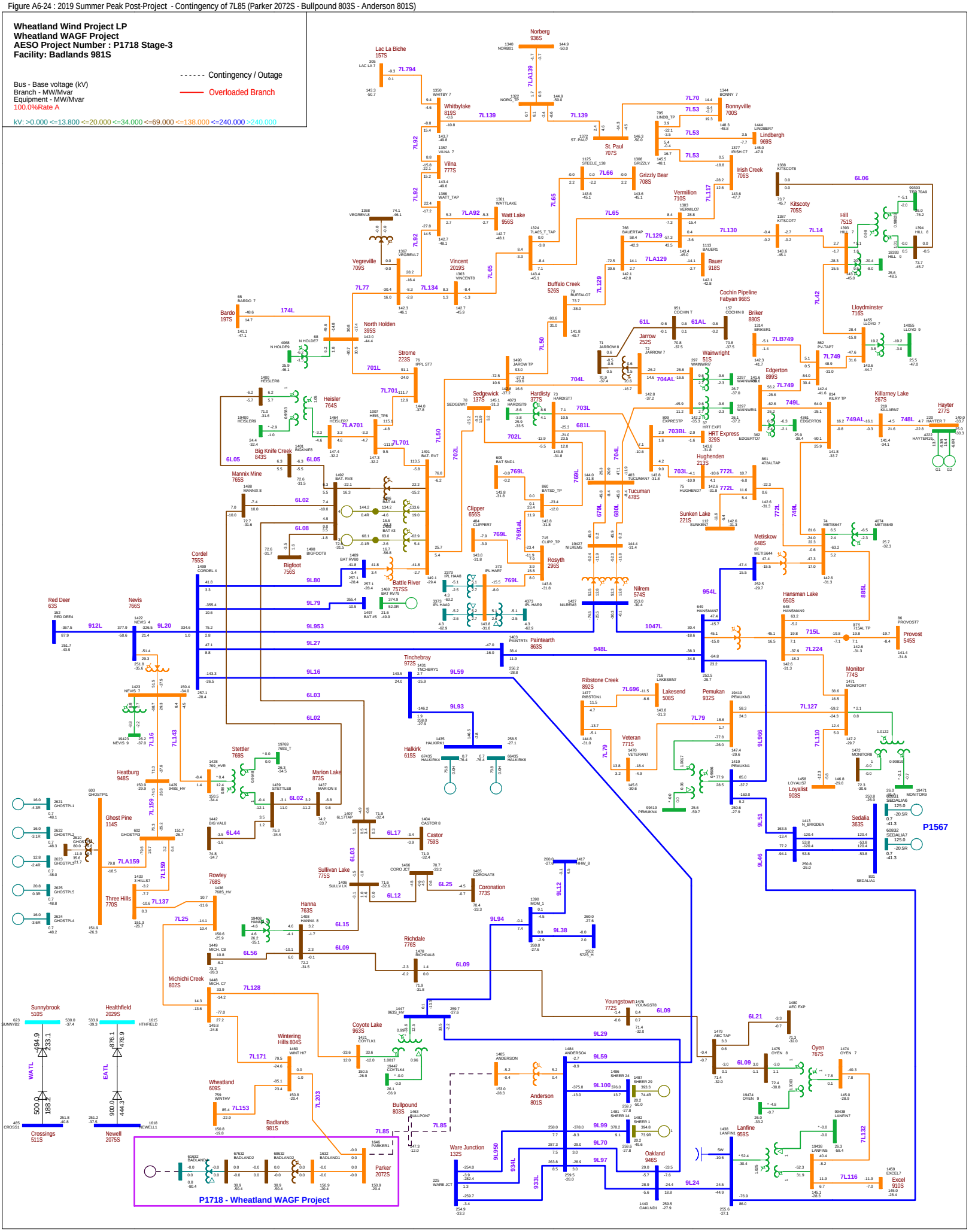


Figure A6-25 : 2019 Winter Peak Post-Project - Contingency of 9L20 (Nevis 766S - Cordel 755S)

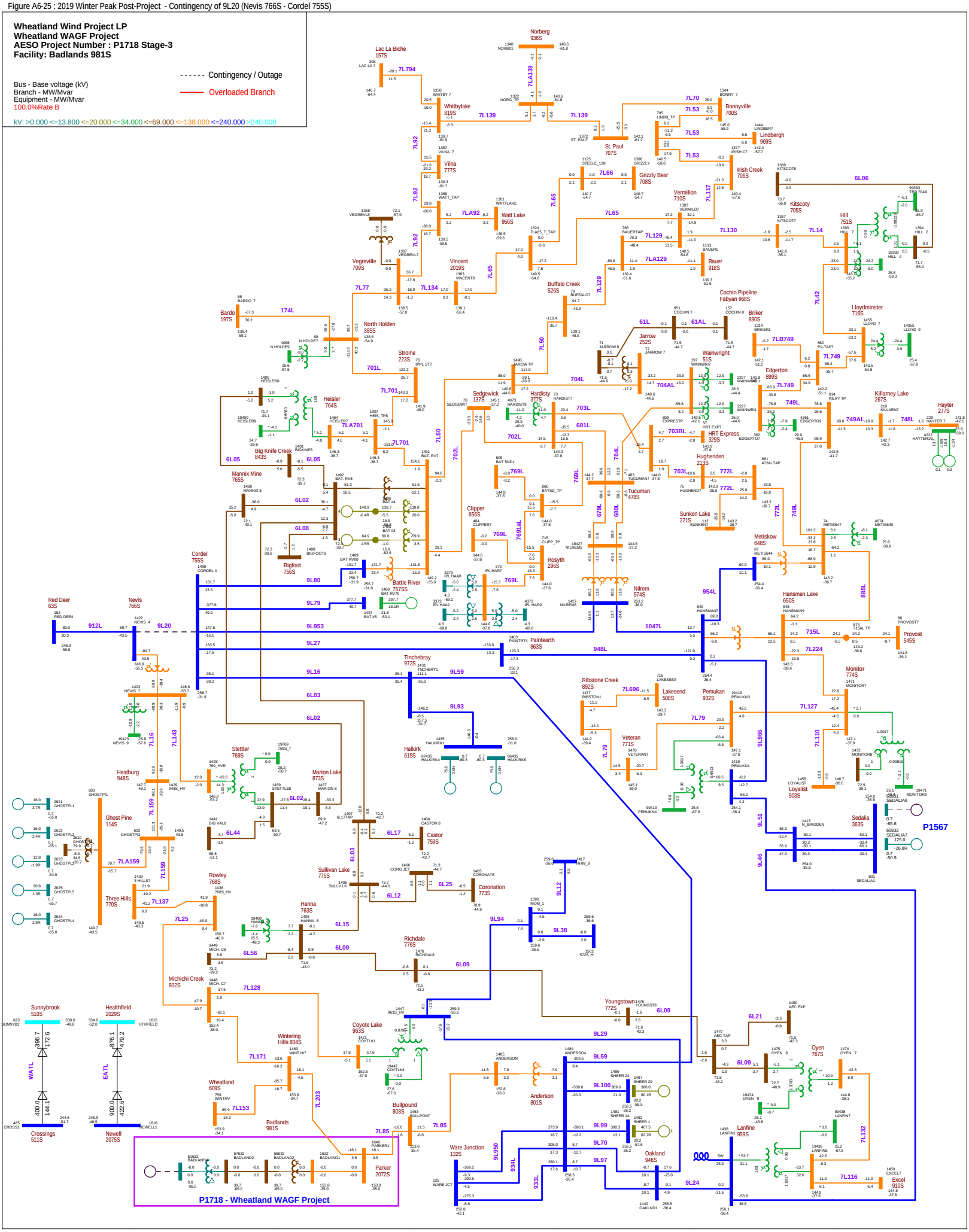


Figure A6-26 : 2019 Winter Peak Post-Project - Contingency of 912L\9L912 (Red Deer 63S - Nevis 766S)

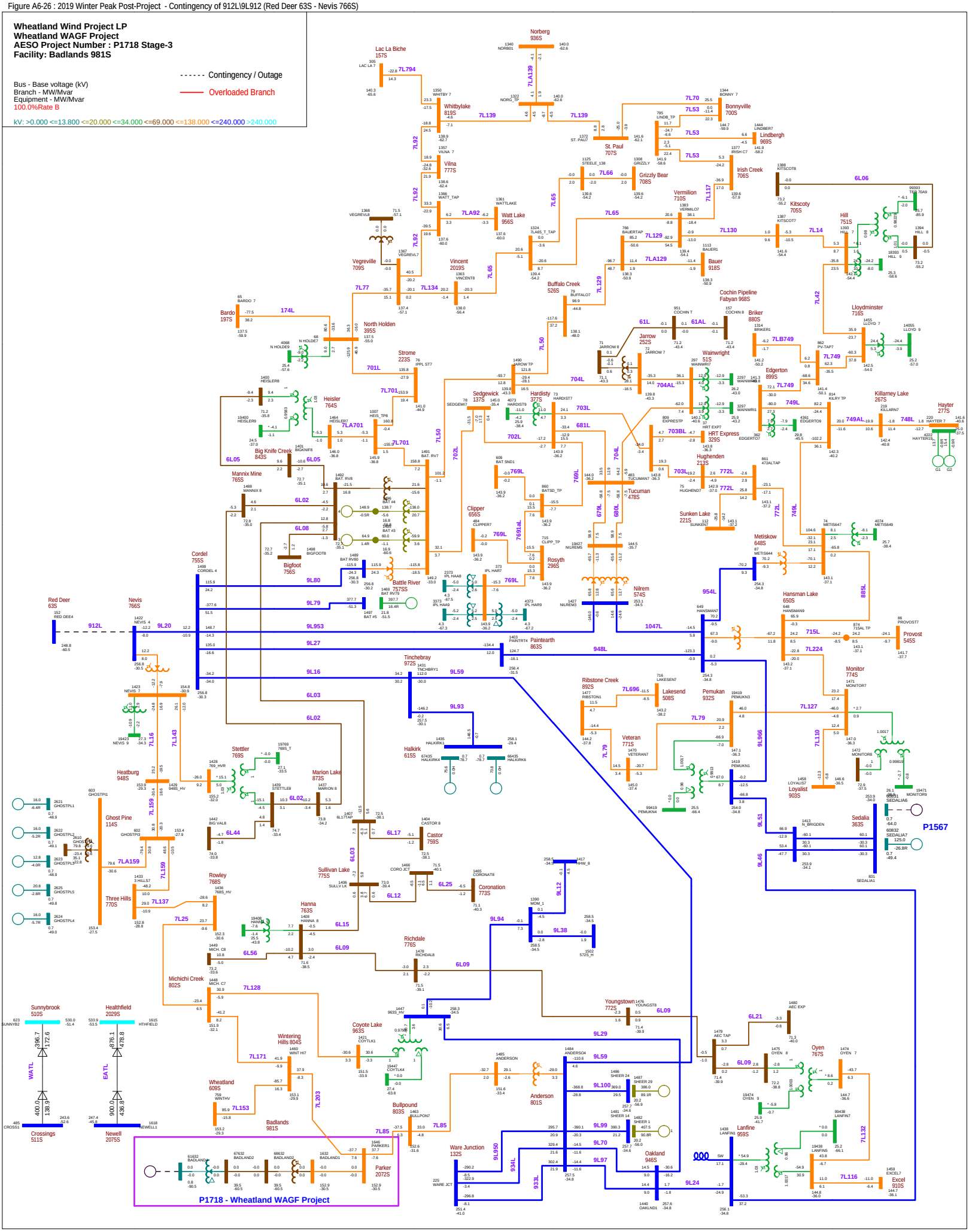


Figure A6-27 : 2019 Winter Peak Post-Project - Contingency of 7L171 (Michichi Creek 802S - Wintering Hills 804S)

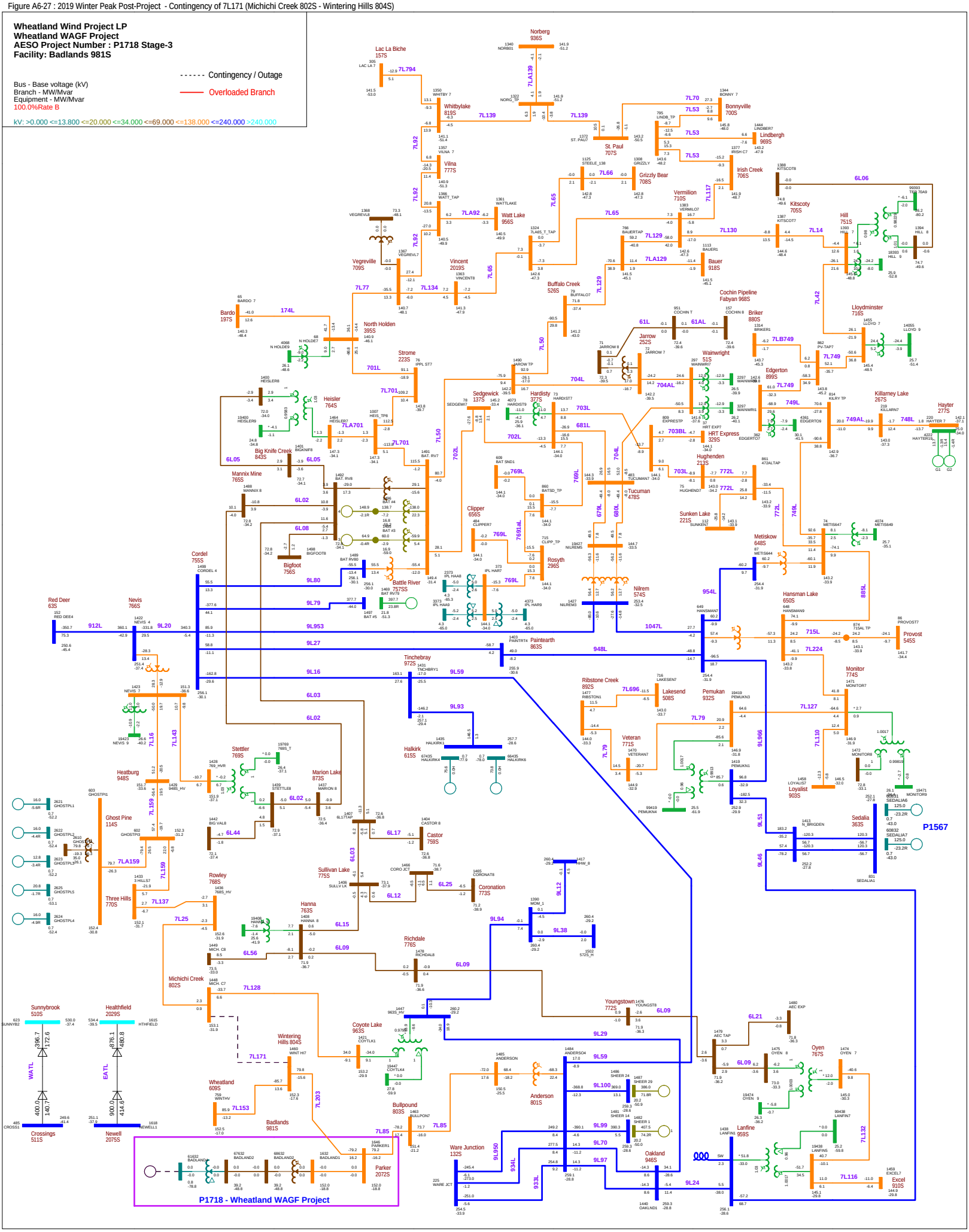


Figure A6-28 : 2019 Winter Peak Post-Project - Contingency of 766S901T (Nevis 766S Transformer 901T)

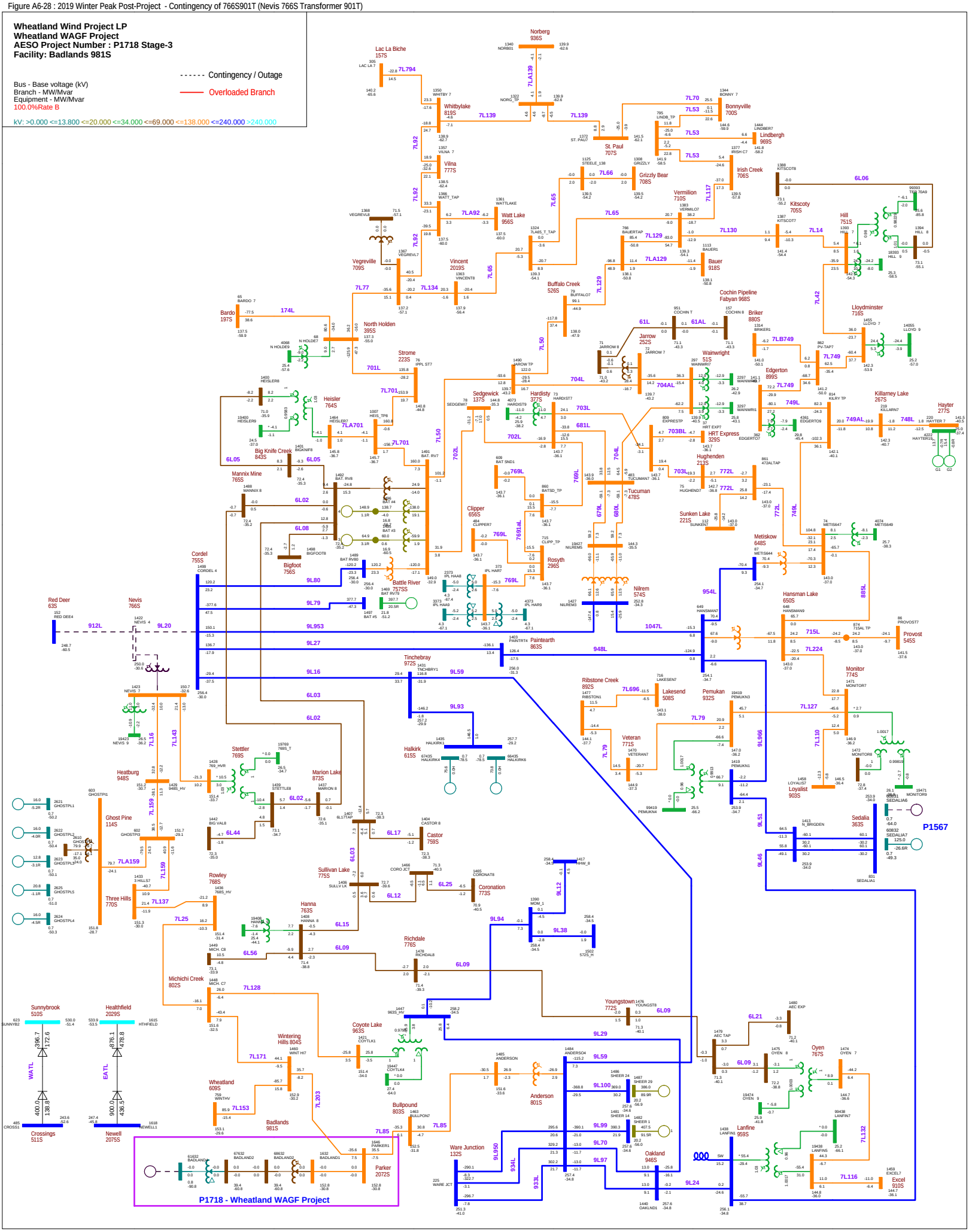


Figure A6-29 : 2019 Winter Peak Post-Project - Contingency of 801S901T (Anderson 801S Transformer 901T)

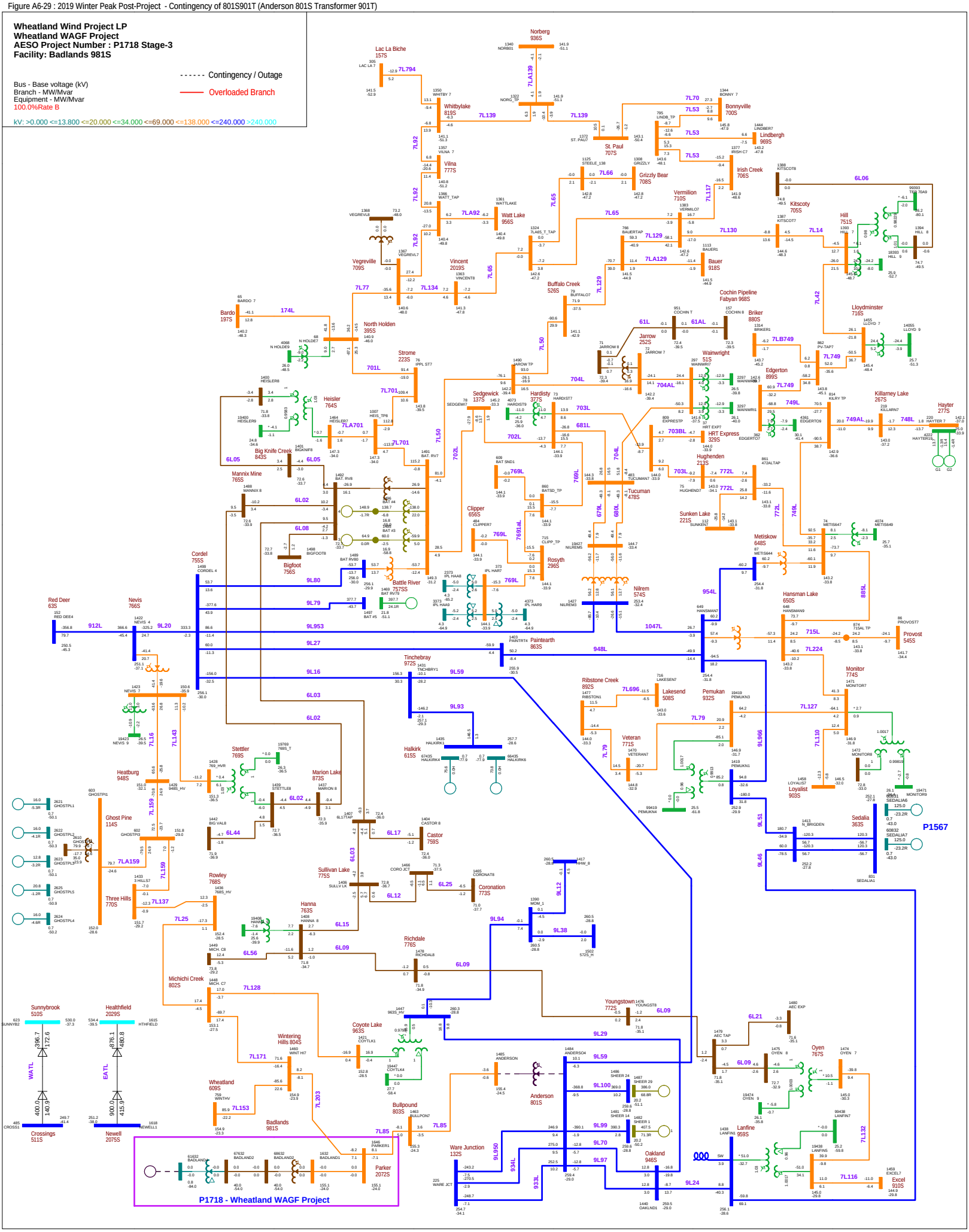


Figure A6-30 : 2019 Winter Peak Post-Project - Contingency of EATL (Newell 2075S - Heathfield 2029S)

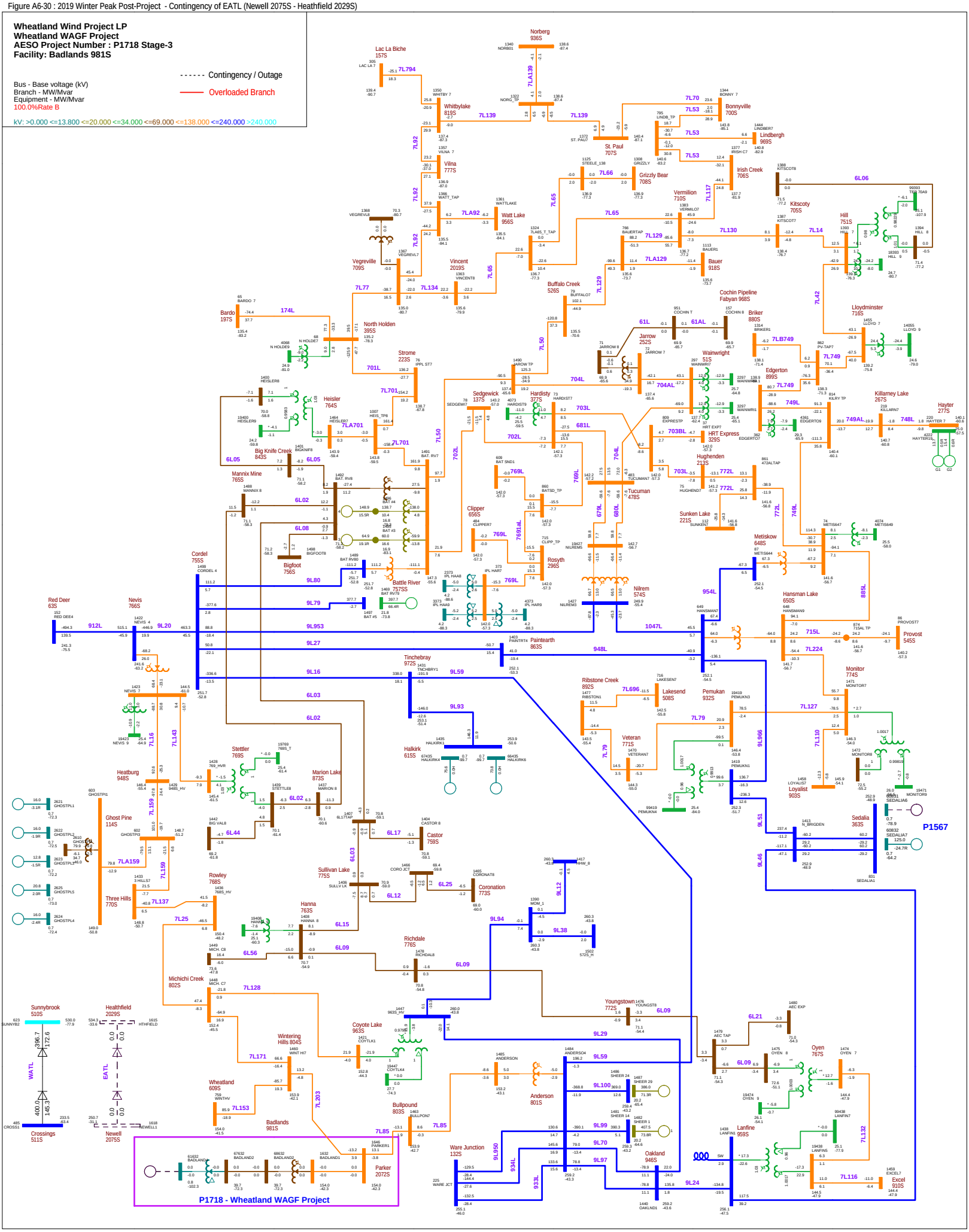


Figure A6-31 : 2019 Winter Peak Post-Project - Contingency of 7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)

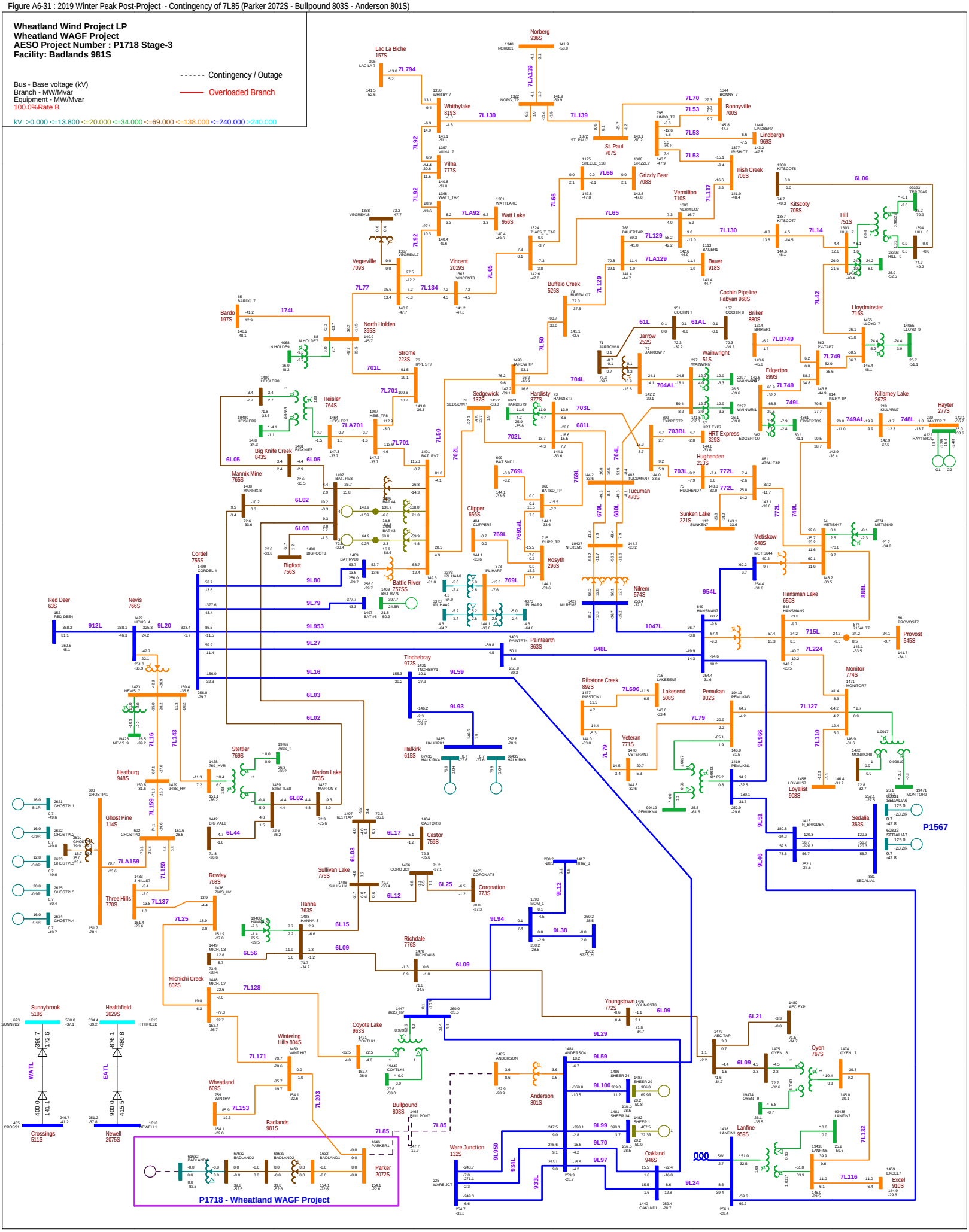


Figure A6-32 : 2019 Summer Peak Post-Project PENV - Contingency of 9L20 (Nevis 766S - Cordel 755S)

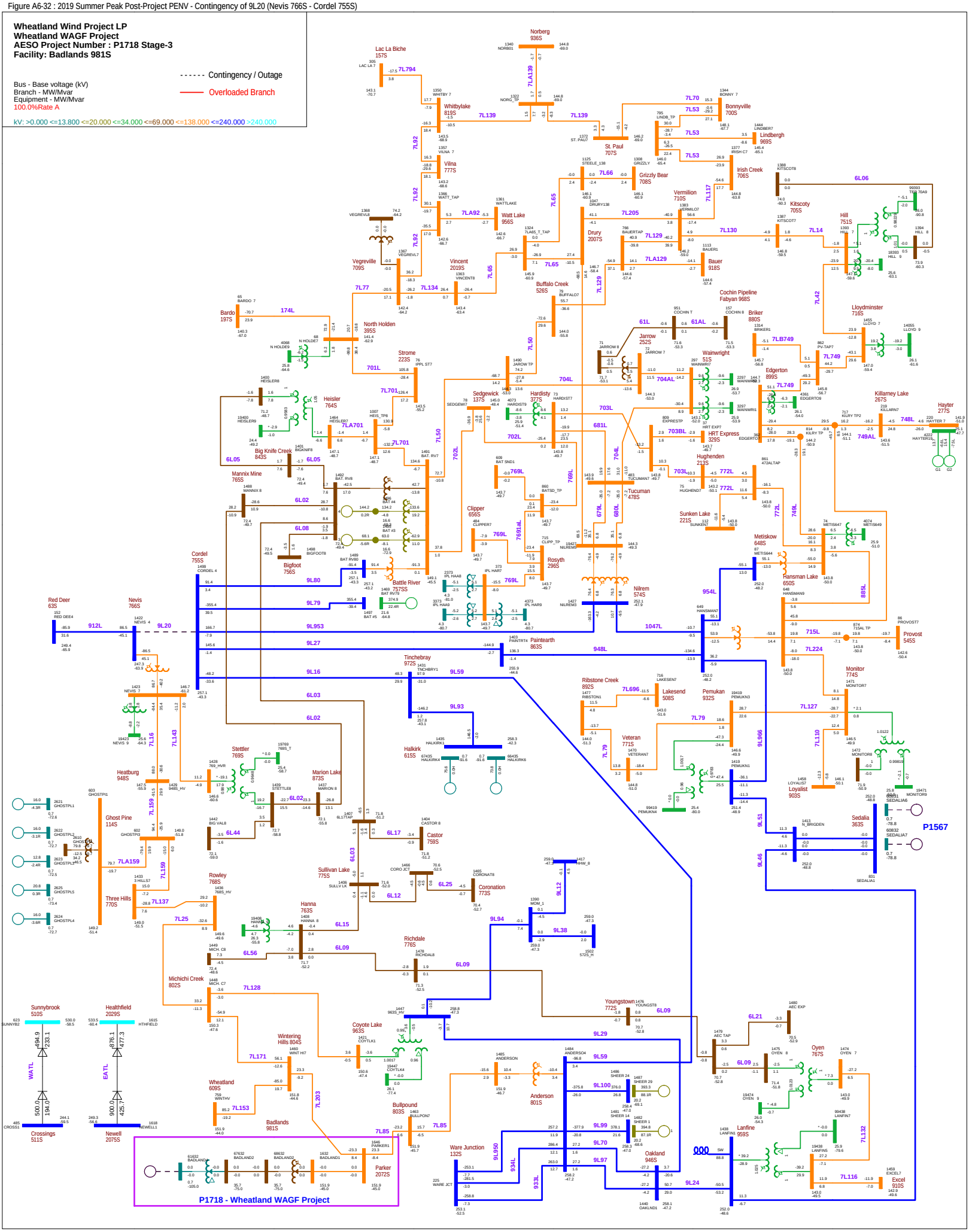


Figure A6-33 : 2019 Summer Peak Post-Project PENV - Contingency of 912L\9L912 (Red Deer 63S - Nevis 766S)

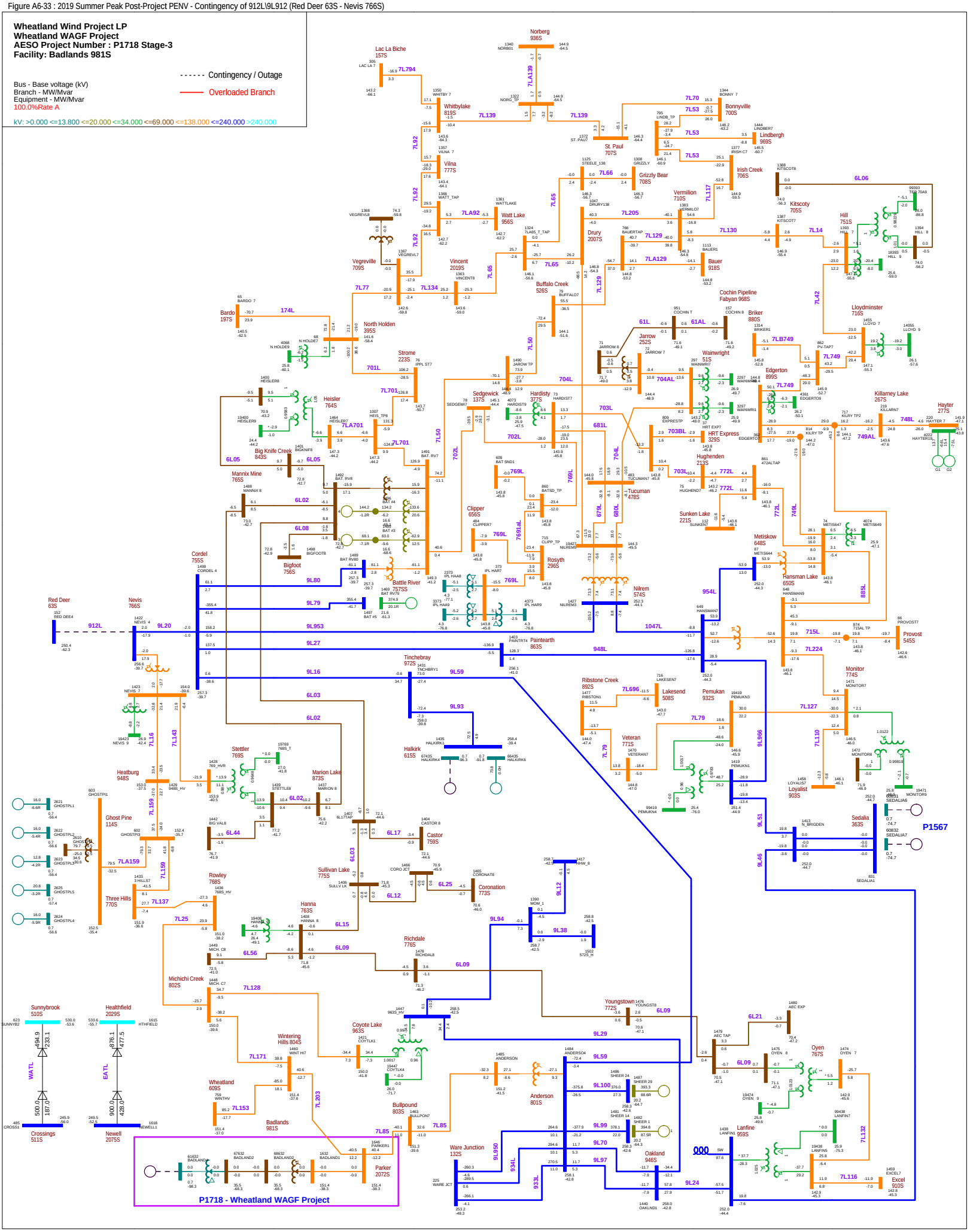


Figure A6-34 : 2019 Summer Peak Post-Project PENV - Contingency of 7L171 (Michichi Creek 802S - Wintering Hills 804S)

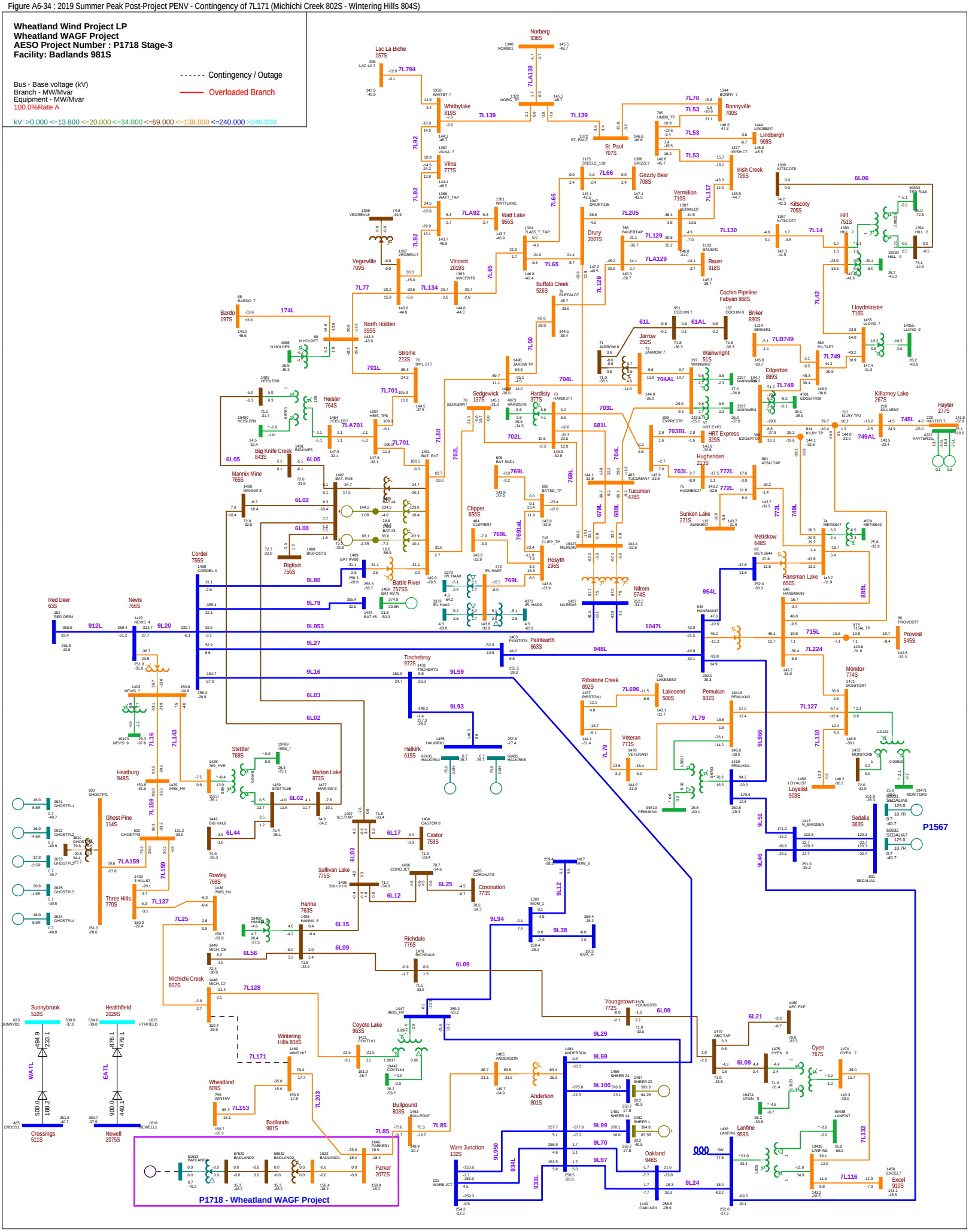


Figure A6-35 : 2019 Summer Peak Post-Project PENV - Contingency of 114ST1 (Ghost Pine 114S Transformer T1)

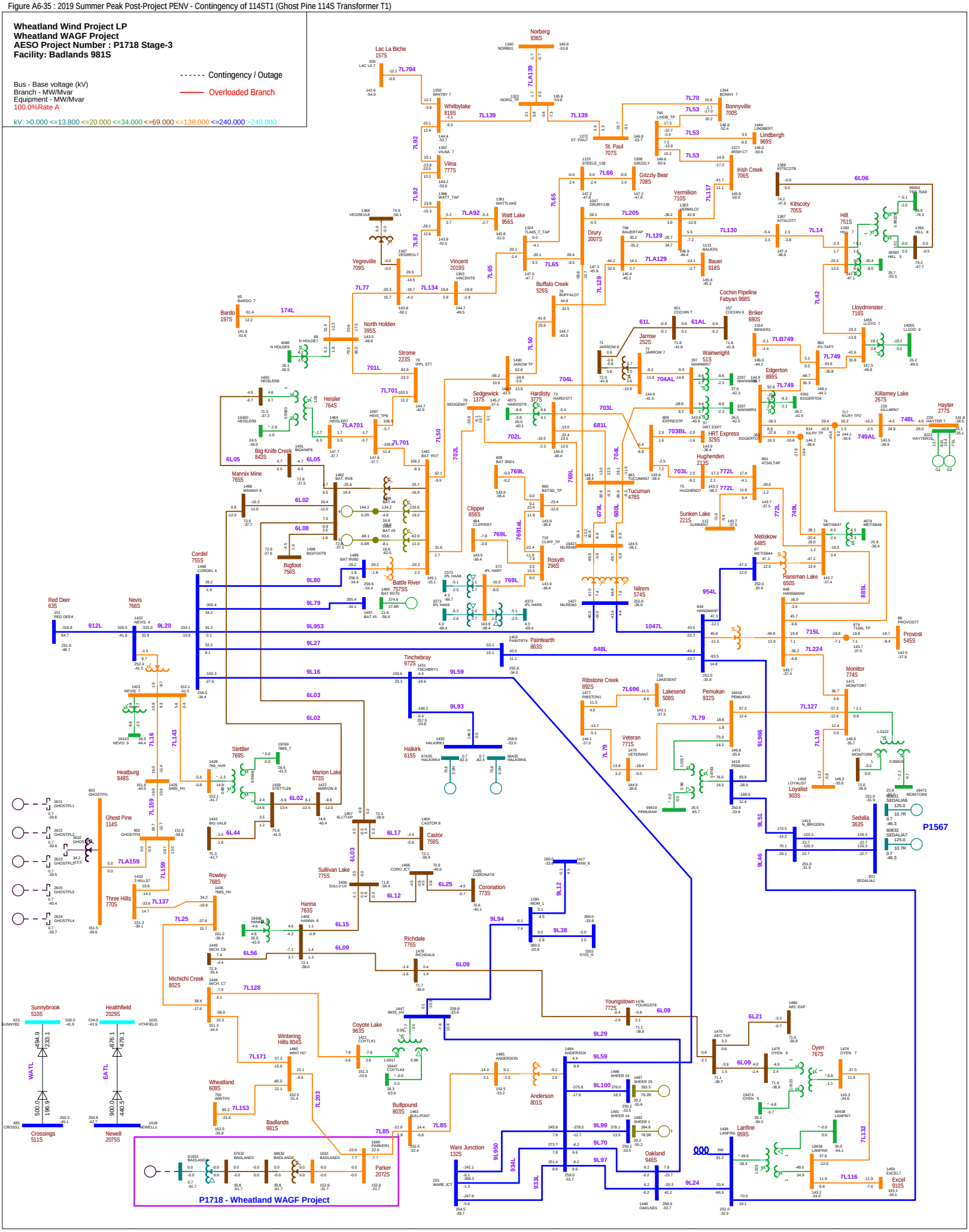


Figure A6-36 : 2019 Summer Peak Post-Project PENV - Contingency of 766S901T (Nevis 766S Transformer 901T)

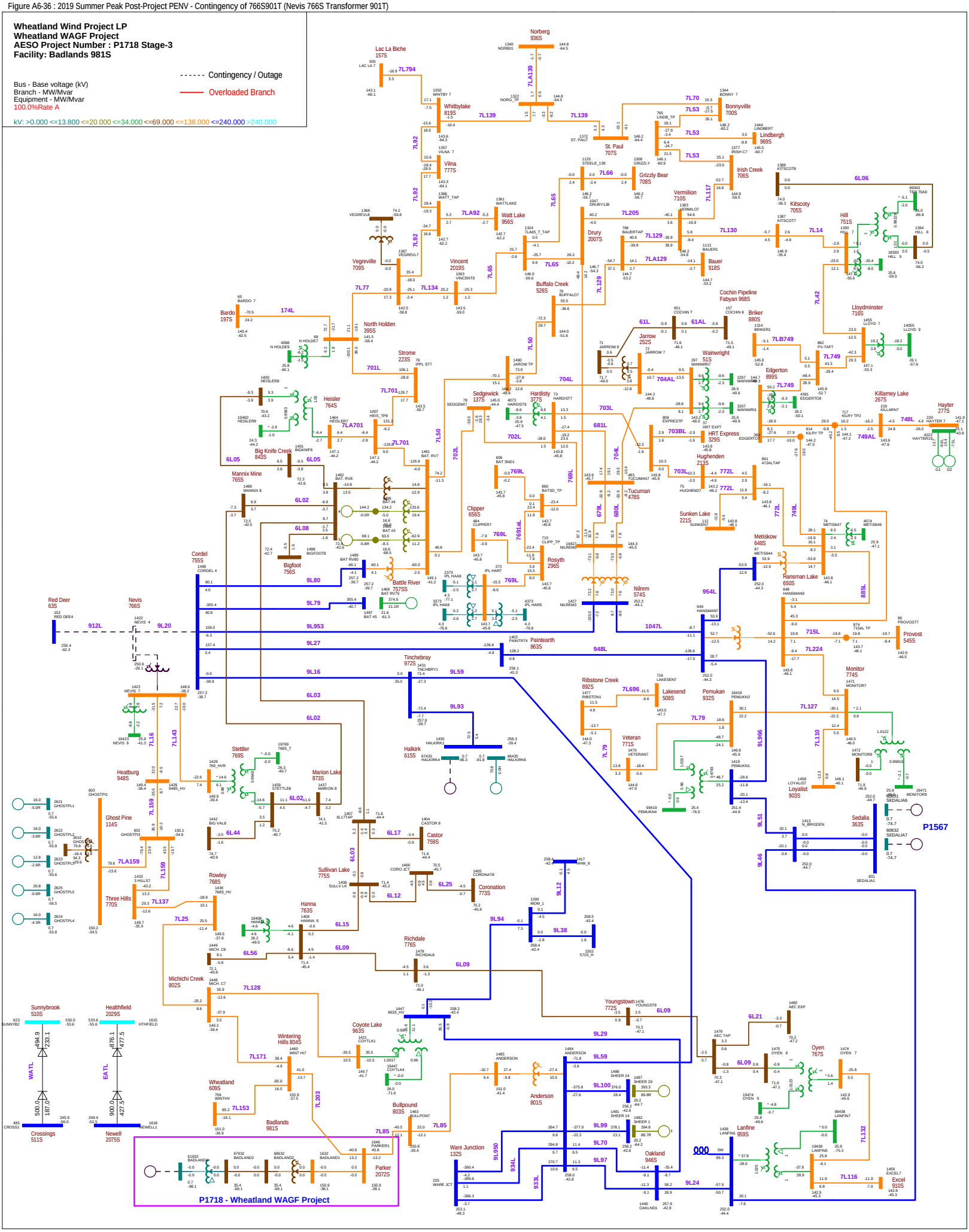


Figure A6-37 : 2019 Summer Peak Post-Project PENV - Contingency of 801S901T (Anderson 801S Transformer 901T)

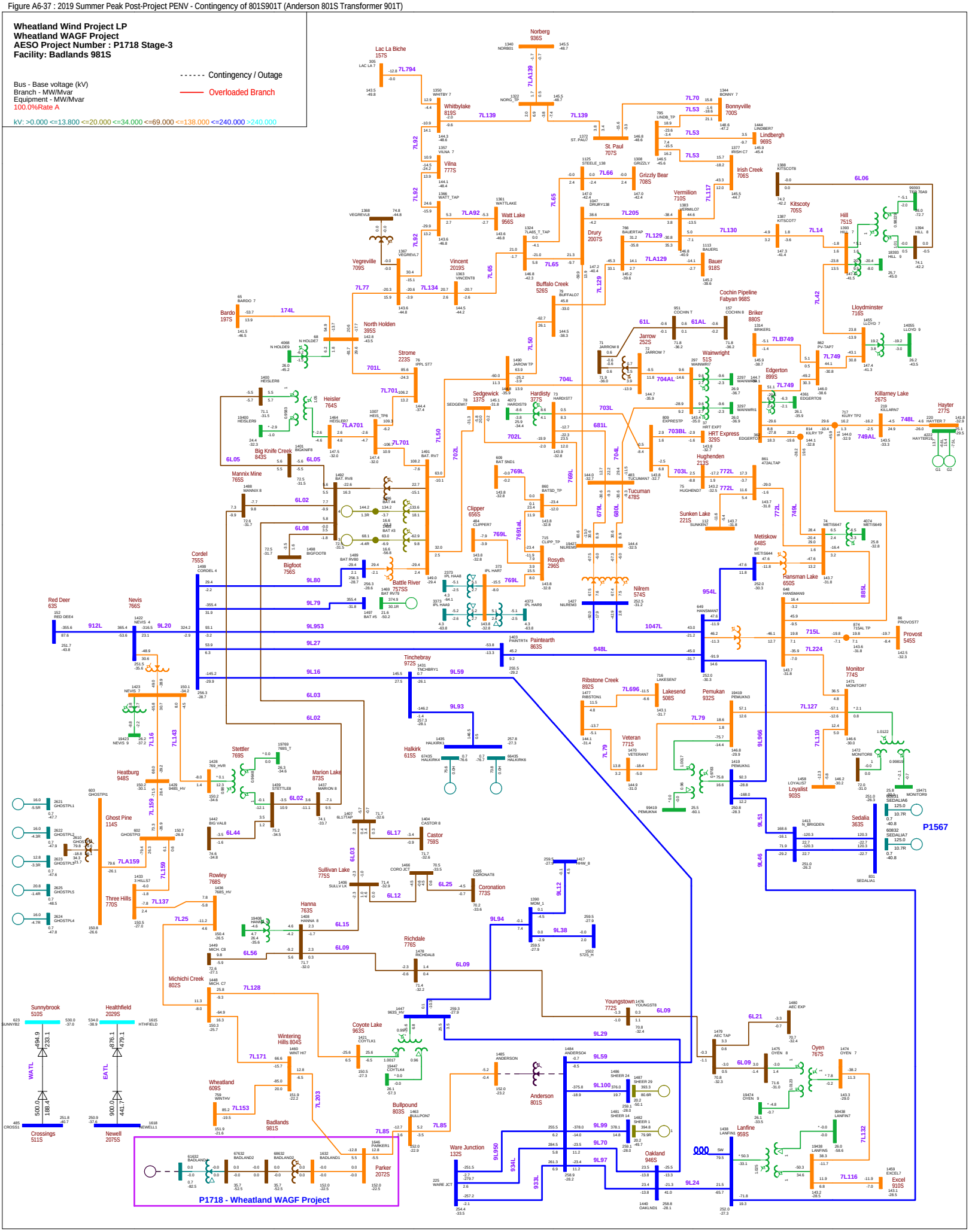


Figure A6-38 : 2019 Summer Peak Post-Project PENV - Contingency of EATL (Newell 2075S - Heathfield 2029S)

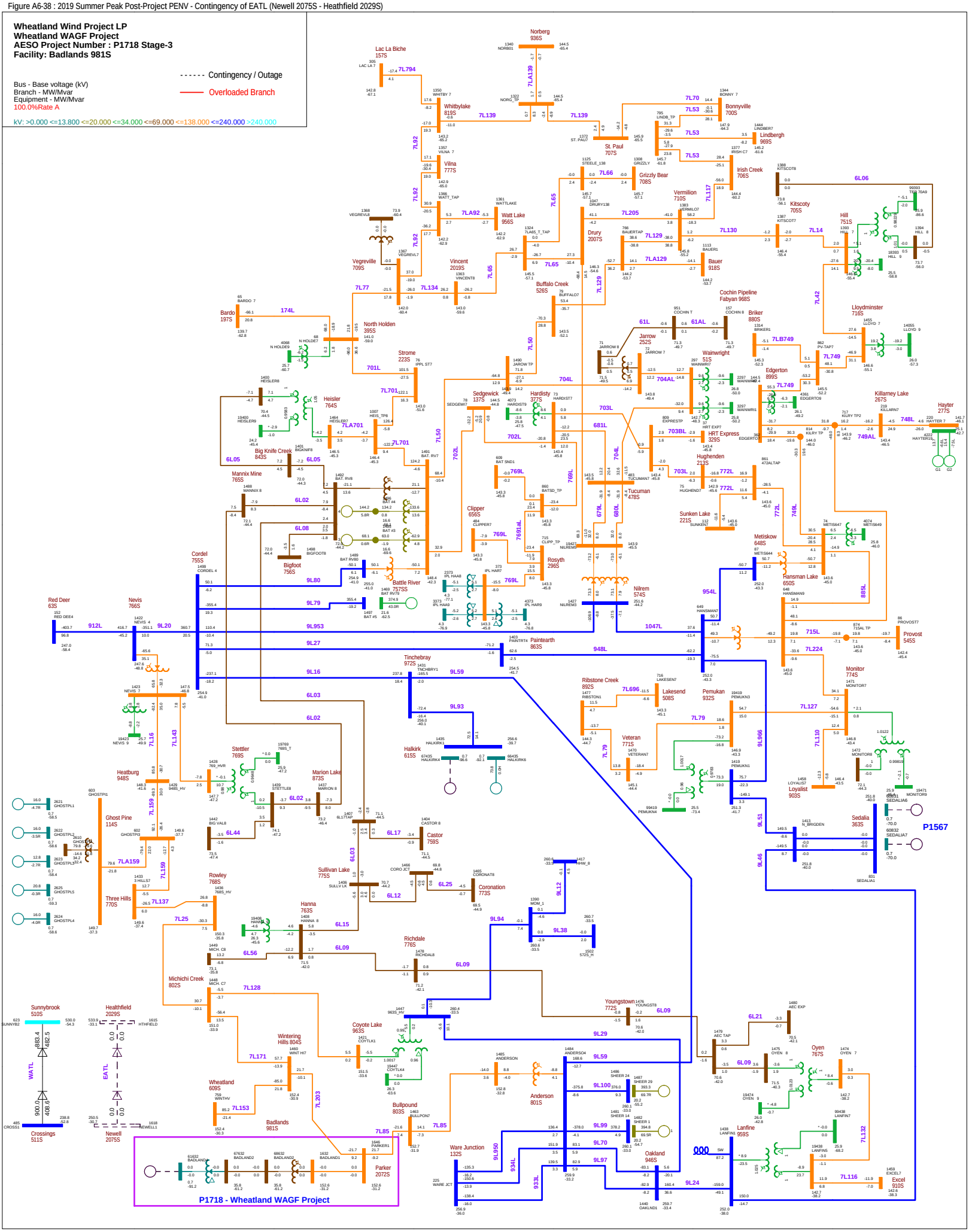
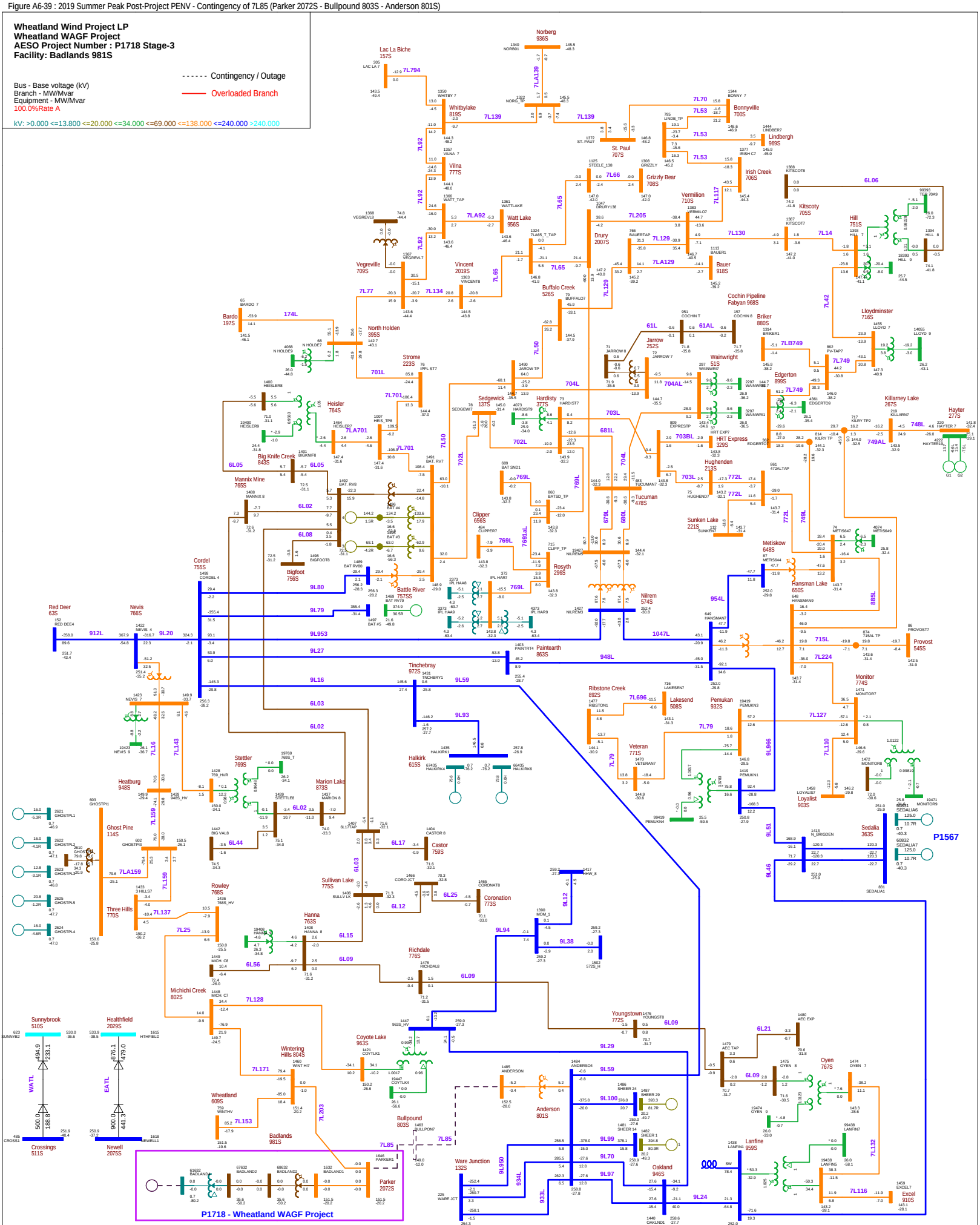


Figure A6-39 : 2019 Summer Peak Post-Project PENV - Contingency of 7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)



Attachment A7

Constraint Effective Factors

Table A7-1: Generator Type

Generating Facility Name and Unit Number	Wintering Hills	Sharp Hills	Halkirk	Ghostpine	Bull Creek DG	Battle River #3	Battle River #4	Battle River #5	Sheerness #1	Sheerness #2	Wheatland
Type	Wind	Wind	Wind	Wind	Wind	Coal	Coal	Coal	Coal	Coal	Wind

Table A7-2: Constraint Effective Factors under N-1 Contingencies for Post-Project Scenarios

Scenario and Case Name	Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Generating Facility Name and Unit Number										
			Wintering Hills	Sharp Hills	Halkirk	Ghostpine	Bull Creek DG	Battle River #3	Battle River #4	Battle River #5	Sheerness #1	Sheerness #2	Wheatland
P1718 2019 SL Post	9L20 (Nevis 766S - Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	13.3%	7.3%	7.8%	50.7%	7.4%	9.0%	8.9%	7.9%	6.9%	6.9%	12.4%
	7L128 (Michichi Creek 802S - Coyote Lake 963S)	801S901T (Anderson 801S Transformer 901T)	53.7%	-0.7%	0.5%	21.0%	0.3%	1.2%	1.2%	0.7%	-2.5%	-2.5%	57.9%
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	90.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	92.6%
		7L85 (Bullpound 803S - Parker 2072S)	97.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.9%
		801S901T (Anderson 801S Transformer 901T)	76.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	78.9%
	9L29 (Oakland 946S - Coyote Lake 963S)	801S901T (Anderson 801S Transformer 901T)	53.7%	-0.7%	0.5%	21.1%	0.3%	1.2%	1.2%	0.8%	-2.5%	-2.5%	57.8%
	963S901T (Coyote Lake 963S Transformer 901T)	801S901T (Anderson 801S Transformer 901T)	38.9%	-0.2%	0.2%	9.9%	0.2%	0.6%	0.6%	0.4%	-1.2%	-1.2%	44.8%
	114ST1 (Ghost Pine 114S Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	57.0%	0.2%	-0.2%	-	-0.2%	-0.7%	-0.6%	-0.4%	1.4%	1.4%	50.7%
	801S901T (Anderson 801S Transformer 901T)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	56.8%	0.2%	-0.2%	-10.9%	-0.2%	-0.7%	-0.6%	-0.4%	1.3%	1.3%	50.6%
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	99.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	97.9%
	7L42 (Hill 751S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	2.3%	4.3%	4.5%	2.3%	6.1%	6.6%	6.5%	4.6%	2.6%	2.6%	2.3%
	7L749\749L\7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	2.3%	4.2%	4.5%	2.3%	5.7%	6.6%	6.5%	4.6%	2.6%	2.6%	2.3%
	9L16 (Tinchebray 972S - Cordel 755S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	57.9%	0.1%	2.0%	-11.4%	-0.8%	-1.5%	-1.5%	-1.4%	2.0%	2.0%	51.6%
	9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	3.7%	6.7%	8.2%	1.8%	9.8%	11.4%	11.2%	8.5%	4.5%	4.5%	3.7%
		701L (North Holden 395S - Strome 223S)	4.4%	7.3%	9.9%	2.3%	8.1%	15.1%	14.9%	10.4%	5.2%	5.2%	4.4%
		7L50 (Buffalo Creek 526S - 7L50 Tap)	3.0%	5.3%	7.0%	1.4%	2.8%	9.3%	9.1%	7.2%	3.7%	3.7%	3.1%
		7L159 (7L159 Tap - Heatburg 948S)	13.6%	4.5%	3.9%	64.6%	3.8%	3.0%	3.0%	3.8%	5.3%	5.3%	12.5%
		7L701 (7L701 Tap - Battle River 757S)	4.8%	8.8%	12.0%	1.4%	10.0%	18.4%	18.1%	12.6%	6.2%	6.2%	4.9%
		766S901T (Nevis 766S Transformer 901T)	11.8%	6.5%	6.9%	50.1%	6.7%	8.1%	8.0%	7.1%	6.1%	6.1%	11.0%
		7L16 (Nevis 766S - Heatburg 948S)	12.4%	4.1%	3.6%	59.8%	3.5%	2.8%	2.8%	3.5%	4.8%	4.8%	11.3%
		7L171 (Michichi Creek 802S - Wintering Hills 804S)	58.0%	1.2%	1.2%	-12.0%	1.0%	0.6%	0.6%	1.1%	2.1%	2.1%	51.7%
	7L701\7LA701\701L (Battle River 757S - Heisler 764S - Strome 223S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	2.4%	3.8%	4.9%	2.6%	0.8%	8.7%	8.5%	5.1%	2.6%	2.6%	2.4%
	749L\749AL (Metiskow 648S - Edgerton 899S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	2.2%	4.1%	4.4%	2.2%	-	6.5%	6.4%	4.5%	2.5%	2.5%	2.2%
	899ST3A (Edgerton 899S Transformer T3A)	7L50 (Buffalo Creek 526S - 7L50 Tap)	2.3%	4.2%	4.4%	2.3%	5.6%	6.6%	6.4%	4.5%	2.6%	2.6%	2.3%
	648ST1 (Metiskow 648S Transformer T1)	7L129 (Buffalo Creek 526S - 7L129 Tap)	2.0%	3.6%	4.0%	2.0%	-45.2%	6.0%	5.8%	4.1%	2.2%	2.2%	2.0%
		7L50 (Buffalo Creek 526S - 7L50 Tap)	2.2%	4.0%	4.4%	2.2%	-49.1%	6.5%	6.4%	4.5%	2.5%	2.5%	2.2%
		7L129 (7L129 Tap - Vermilion 710S)	1.9%	3.4%	3.8%	1.9%	-42.9%	5.7%	5.5%	3.9%	2.1%	2.1%	1.9%
		7L130 (Vermilion 710S - Kitscoty 705S)	0.1%	0.1%	0.1%	0.1%	-129.4%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
		7L14 (Kitscoty 705S - Hill 751S)	0.0%	0.0%	0.0%	0.0%	-115.8%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%

Scenario and Case Name	Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Generating Facility Name and Unit Number										
			Wintering Hills	Sharp Hills	Halkirk	Ghostpine	Bull Creek DG	Battle River #3	Battle River #4	Battle River #5	Sheerness #1	Sheerness #2	Wheatland
P1718 2019 SP Post	912L\9L912 (Red Deer 63S - Nevis 766S)	174L (Bardo 197S - North Holden 395S)	4.9%	7.0%	8.5%	6.7%	10.1%	11.6%	11.4%	8.7%	5.0%	5.0%	4.9%
		701L (North Holden 395S - Strome 223S)	6.2%	8.2%	10.8%	8.7%	9.0%	16.0%	15.7%	11.2%	6.1%	6.1%	6.2%
		7L701 (Strome 223S - 7L701 Tap)	7.1%	9.2%	12.1%	9.9%	10.1%	17.9%	17.6%	12.6%	6.9%	6.9%	7.0%
		7L129 (Buffalo Creek 526S - 7L129 Tap)	3.9%	5.3%	6.8%	5.4%	3.2%	9.0%	8.9%	7.0%	3.9%	3.9%	3.9%
		7L50 (Buffalo Creek 526S - 7L50 Tap)	4.3%	5.9%	7.5%	5.9%	3.5%	9.9%	9.7%	7.7%	4.3%	4.3%	4.2%
		7L129 (7L129 Tap - Vermilion 710S)	3.6%	5.0%	6.4%	5.0%	3.0%	8.5%	8.3%	6.6%	3.7%	3.7%	3.6%
		7L701 (7L701 Tap - Battle River 757S)	6.5%	8.9%	11.9%	8.8%	10.0%	18.4%	18.1%	12.4%	6.6%	6.6%	6.5%
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	90.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	92.6%
		7L85 (Bullpound 803S - Parker 2072S)	97.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.8%
		801S901T (Anderson 801S Transformer 901T)	77.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	79.3%
	114ST1 (Ghost Pine 114S Transformer T1)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	57.5%	0.2%	-0.3%	-	-0.2%	-0.7%	-0.7%	-0.4%	1.4%	1.4%	51.2%
	766S901T (Nevis 766S Transformer 901T)	174L (Bardo 197S - North Holden 395S)	4.7%	7.0%	8.5%	6.0%	10.1%	11.6%	11.4%	8.7%	4.9%	4.9%	4.7%
		701L (North Holden 395S - Strome 223S)	6.1%	8.2%	10.8%	8.0%	9.0%	16.0%	15.7%	11.2%	6.1%	6.1%	6.0%
		7L701 (Strome 223S - 7L701 Tap)	6.9%	9.2%	12.1%	9.1%	10.1%	17.9%	17.6%	12.6%	6.8%	6.8%	6.8%
		7L129 (Buffalo Creek 526S - 7L129 Tap)	3.7%	5.4%	6.9%	4.6%	3.2%	9.0%	8.9%	7.1%	3.9%	3.9%	3.7%
		7L50 (Buffalo Creek 526S - 7L50 Tap)	4.1%	5.9%	7.6%	5.0%	3.5%	9.9%	9.7%	7.8%	4.2%	4.2%	4.1%
		7L129 (7L129 Tap - Vermilion 710S)	3.5%	5.1%	6.5%	4.3%	3.1%	8.5%	8.4%	6.7%	3.6%	3.6%	3.5%
		7L701 (7L701 Tap - Battle River 757S)	5.6%	9.1%	12.3%	4.3%	10.3%	18.5%	18.2%	12.8%	6.5%	6.5%	5.7%
	801S901T (Anderson 801S Transformer 901T)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	57.4%	0.2%	-0.3%	-11.1%	-0.2%	-0.7%	-0.7%	-0.4%	1.4%	1.4%	51.1%
	701L (North Holden 395S - Strome 223S)	7L50 (Buffalo Creek 526S - 7L50 Tap)	2.4%	3.8%	5.0%	2.6%	0.8%	8.8%	8.7%	5.2%	2.7%	2.7%	2.4%
	395ST1 (North Holden 395S Transformer T1)	7L50 (Buffalo Creek 526S - 7L50 Tap)	2.2%	3.2%	4.5%	2.4%	-0.5%	8.1%	7.9%	4.6%	2.3%	2.3%	2.1%
	EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	1.8%	3.4%	4.2%	2.1%	6.0%	7.7%	7.5%	4.3%	2.1%	2.1%	1.8%
		701L (North Holden 395S - Strome 223S)	2.4%	3.7%	5.2%	2.8%	3.9%	11.0%	10.8%	5.5%	2.6%	2.6%	2.4%
		7L701 (Strome 223S - 7L701 Tap)	2.7%	4.2%	5.8%	3.2%	4.4%	12.2%	12.0%	6.1%	2.9%	2.9%	2.7%
		7L129 (Buffalo Creek 526S - 7L129 Tap)	1.4%	2.4%	3.4%	1.7%	0.0%	5.9%	5.7%	3.5%	1.6%	1.6%	1.4%
		7L50 (Buffalo Creek 526S - 7L50 Tap)	1.6%	2.7%	3.7%	1.8%	0.0%	6.4%	6.2%	3.8%	1.8%	1.8%	1.6%
		7L159 (7L159 Tap - Heatburg 948S)	12.2%	1.5%	-0.5%	64.4%	0.0%	-0.9%	-0.9%	-0.8%	3.2%	3.2%	11.0%
		7L701 (7L701 Tap - Battle River 757S)	2.6%	4.2%	6.0%	2.5%	4.6%	13.1%	12.8%	6.4%	3.0%	2.9%	2.6%
		912L\9L912 (Red Deer 63S - Nevis 766S)	20.7%	27.5%	38.0%	41.6%	33.7%	35.9%	35.7%	39.6%	19.9%	19.9%	20.4%
		9L20 (Nevis 766S - Cordel 755S)	11.9%	27.7%	40.6%	-9.7%	35.1%	35.7%	35.6%	42.6%	18.4%	18.4%	12.5%
		7L171 (Michichi Creek 802S - Wintering Hills 804S)	57.4%	0.2%	-0.4%	-11.8%	-0.3%	-0.8%	-0.8%	-0.5%	1.4%	1.4%	51.1%
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	99.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	97.9%
	7L129\7LA129 (Buffalo Creek 526S - Vermilion 710S - Bauer 918S)	749L (Edgerton 899S - 749L Tap)	1.7%	4.4%	2.8%	1.5%	16.5%	2.2%	2.2%	2.8%	2.1%	2.1%	1.7%
	7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	749L (Edgerton 899S - 749L Tap)	1.6%	4.2%	2.7%	1.4%	16.4%	2.0%	2.0%	2.7%	2.0%	2.0%	1.7%
	9L20 (Nevis 766S - Cordel 755S)	174L (Bardo 197S - North Holden 395S)	3.7%	6.8%	8.3%	1.7%	10.2%	11.4%	11.2%	8.5%	4.5%	4.5%	3.7%
		766S901T (Nevis 766S Transformer 901T)	11.6%	6.4%	6.8%	50.2%	6.7%	7.9%	7.8%	6.9%	6.0%	6.0%	10.7%
	749L\749AL (Metiskow 648S - Edgerton 899S)	7L130 (Vermilion 710S - Kitscoty 705S)	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	648ST1 (Metiskow 648S Transformer T1)	7L50 (Buffalo Creek 526S - 7L50 Tap)	2.1%	3.8%	4.2%	2.1%	-53.8%	6.3%	6.1%	4.3%	2.3%	2.3%	2.1%
		7L130 (Vermilion 710S - Kitscoty 705S)	0.2%	0.2%	0.2%	0.2%	-149.7%	0.3%	0.3%	0.2%	0.1%	0.1%	0.2%
		7L14 (Kitscoty 705S - Hill 751S)	0.1%	0.1%	0.1%	0.1%	-128.1%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%
		174L (Bardo 197S - North Holden 395S)	5.0%	7.2%	8.6%	6.8%	10.5%	11.7%	11.5%	8.8%	5.0%	5.0%	4.9%

Scenario and Case Name	Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Generating Facility Name and Unit Number										
			Wintering Hills	Sharp Hills	Halkirk	Ghostpine	Bull Creek DG	Battle River #3	Battle River #4	Battle River #5	Sheerness #1	Sheerness #2	Wheatland
P1718 2019 WP Post	912L\9L912 (Red Deer 63S - Nevis 766S)	701L (North Holden 395S - Strome 223S)	6.2%	8.2%	10.7%	8.8%	9.1%	16.0%	15.7%	11.1%	6.1%	6.1%	6.2%
		7L701 (Strome 223S - 7L701 Tap)	7.0%	9.2%	12.0%	9.9%	10.2%	17.9%	17.5%	12.5%	6.9%	6.9%	6.9%
	7L171 (Michichi Creek 802S - Wintering Hills 804S)	7L85 (Bullpound 803S - Anderson 801S)	90.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	92.5%
		7L85 (Bullpound 803S - Parker 2072S)	97.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.8%
		801S901T (Anderson 801S Transformer 901T)	77.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	78.9%
	766S901T (Nevis 766S Transformer 901T)	174L (Bardo 197S - North Holden 395S)	4.8%	7.2%	8.6%	6.2%	10.6%	11.7%	11.5%	8.8%	5.0%	5.0%	4.8%
		701L (North Holden 395S - Strome 223S)	6.1%	8.2%	10.8%	8.2%	9.1%	16.0%	15.7%	11.2%	6.1%	6.1%	6.0%
		7L701 (Strome 223S - 7L701 Tap)	6.9%	9.2%	12.1%	9.2%	10.2%	17.9%	17.6%	12.6%	6.8%	6.8%	6.8%
	801S901T (Anderson 801S Transformer 901T)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	57.7%	0.2%	-0.3%	-11.2%	-0.3%	-0.7%	-0.7%	-0.4%	1.4%	1.4%	51.4%
	EATL (Newell 2075S - Heathfield 2029S)	174L (Bardo 197S - North Holden 395S)	1.8%	3.4%	4.1%	2.0%	6.3%	7.7%	7.5%	4.2%	2.0%	2.0%	1.8%
		701L (North Holden 395S - Strome 223S)	2.3%	3.6%	5.1%	2.7%	3.8%	10.8%	10.6%	5.4%	2.5%	2.5%	2.3%
		749L (Edgerton 899S - 749L Tap)	1.0%	3.2%	1.6%	0.8%	16.3%	0.3%	0.3%	1.6%	1.2%	1.2%	1.0%
	526ST1 OR 526ST2 (526ST1 or 526ST2 (Buffalo Creek 526S Transformer T1 or T2))	749L (Edgerton 899S - 749L Tap)	1.7%	4.3%	2.8%	1.5%	16.5%	2.2%	2.1%	2.8%	2.0%	2.0%	1.7%
	7L85 (Parker 2072S - Bullpound 803S - Anderson 801S)	7L171 (Michichi Creek 802S - Wintering Hills 804S)	99.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	97.9%