APPENDIX A CONNECTION ASSESSMENT

AESO Engineering Connection Assessment

Sharp Hills Wind Farm Connection

AESO Project Number: 1567

Role	Name	Date	Signature
Prepared:	Jahnavi Gopi Krishnan, E.I.T.	24 Oct 2017	Jahnavi
Reviewed:	Maz Mazadi, PhD., P. Eng.	oct 24 2017	Mazadi
Approved:	Mohamed Kamh, Manager, Projects and System Access Studies, PhD., P. Eng.	Oct. 24, 2017	

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2500, 330-5th Avenue SW, Calgary, Alberta T2P 0L4 Phone: 403-539-2450 Fax: 403-539-2949
www.aeso.ca www.poweringalberta.com

Note:

The conclusion and recommendations stated in this Report are based on results listed in the Connection Assessment Results report prepared by a third party as part of the AESO's connection process (Attachment A of this report).

The AESO has reviewed the Connection Assessment Results Report, and finds it acceptable for the purpose of assessing potential impacts of the proposed connection on the transmission system.

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Introduction

This AESO Engineering Connection Assessment report 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 report 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

EDP Renewables SH Project Limited Partnership by its general partner, EDP Renewables SH Project GP Ltd. (EDPR) (Market Participant) has submitted a request for system access service to the Alberta Electric System Operator (AESO) to connect its proposed Sharp Hills Wind Project (Facility) to the AIES. The Facility is a 300 MW wind aggregated generating facility, and includes a proposed collector station, to be designated Sedalia 363S substation. The Facility is planned to be located in the Sedalia area in the AESO planning area of Hanna (Area 42).

The Market Participant's request includes: a request for a Rate STS, *Supply Transmission Service*, contract capacity of 300 MW; and a request for a Rate DTS, *Demand Transmission Service*, contract capacity of 1.0 MW for new system access service in the area; and a request for transmission development (collectively, the Project).

The scheduled in-service date (ISD) for the Project is May 1, 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. Study Area

The Study Area for the Project consists of the AESO Planning areas of Hanna (Area 42), Alliance/Battle River (Area 36), Vegreville (Area 56), Wainwright (Area 32), Lloydminster (Area 13), Provost (Area 37) and Sheerness (Area 43), including the tie lines connecting these planning areas to the rest of the AIES. All transmission facilities within the Study Area will be studied and monitored for violations of the Reliability Criteria (defined in Section 3.1 of Attachment A1).

3. Connection Alternatives

The AESO, in consultation with the legal owner of transmission facilities (TFO) in the Study Area and the Market Participant, examined and studied, one transmission alternative to meet the Market Participant's request for system access service, as detailed below.

Alternative 1 – In-and-out connection to the 240 kV transmission line 9L46

This alternative includes the following developments:

- Add a switching station, to be called New Brigden 2088S, including four 240 kV circuit breakers.
- Add two 240 kV circuits to connect the proposed New Brigden 2088S substation to the existing transmission line 9L46 (between the Pemukan 932S and Lanfine 959S substations) using an in-and-out configuration.
- Connect the Facility to the proposed New Brigden 2088S substation.
- Add or modify associated equipment as required for the above transmission developments.

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 can be found in Attachment A1 of Attachment A.

The AESO Planning Region load forecasts used for the connection studies were based on the *AESO 2016 Long-term Outlook* (2016 LTO). While the AESO has updated its regional forecasts since the connection studies were performed, the use of the current AESO forecast, the *AESO 2017 Long-term Outlook*, would not materially alter the connection study results or affect the conclusions and recommendations in this report.

4.2. Studies Performed

At the time of study, the scheduled ISD for the Project was June 30, 2018. Therefore, the studies were performed using the 2018 summer light (SL), summer peak (SP), and winter peak (WP) scenarios. The short-circuit studies were also performed using the 2026 WP scenario. The revised scheduled ISD (May 1, 2019) will not materially alter the connection study results or affect the conclusions and recommendations in this report.

Table 4-1 provides a list of the study scenarios. The post-Project scenarios reflect the requested Rate STS contract capacity of 300 MW.

Table 4-1: List of the Connection Study Scenarios

Scenario	Year/Season Load	Condition	Project Generation (MW)	System Generation Dispatch Conditions
1	2018 SL	Pre-Project	0	High Wind, Economy coal
2	2018 SP	Pre-Project	0	High Wind, Economy coal
3	2018 WP	Pre-Project	0	High Wind, Economy coal*
4	2018 SL	Post-Project	300	High Wind, Economy coal
5	2018 SP	Post Project	300	High Wind, Economy coal
6	2018 WP	Post-Project	300	High Wind, Economy coal
7	2026 WP	Post-Project	300	All generation in the Study Area on

*for short circuit studies all generation in the study area are assumed in service

As described in Section 3.3.2 of Attachment A1, two different renewable electricity generation dispatch cases were studied, Case A (without the planned Irma Wind Power Project [1]) and Case B (with the planned Irma Wind Power Project).

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 voltage deviations beyond the limits listed in Table 3-1 of Attachment A1 of Attachment A[2] at point of delivery (POD) low voltage busses.

Power flow studies were performed for the 2018 summer light (SL), summer peak (SP) and winter peak (WP) pre-Project and post-Project scenarios.

4.2.2. Transient Stability Studies

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

Transient stability studies were performed for the 2018 SL, SP and WP post-Project scenarios.

4.2.3. Short-Circuit Studies

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

Short-circuit studies were performed for the 2018 WP pre-Project scenario and for the 2018 WP and 2026 WP post-Project scenarios.

4.3. Mitigation Measure Development and Evaluation

As contemplated in Section 5 of Attachment A1, mitigation measures were developed to address the system performance issues that were identified in the post-Project scenarios. The studies that were performed to assess the effectiveness of the mitigation measures are briefly outlined below.

[1] Irma Wind Power Project is also referred to as Mainstream Wind Project. The *Irma Wind Power Project Connection Needs Identification Document* (NID) was filed with the AUC on August 3, 2017 in Proceeding 22857.

[2] 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.

4.3.1. Post-Mitigation Studies

Power flow studies were performed to assess the impact of the Project on the performance of the AIES following the 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 the thermal criteria violations that were observed under 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 connection assessment studies, and the proposed mitigation measures are summarized in Table 5-2 (Case A) and in Table 5-3 (Case B).

An overview of the connection studies results is provided in the following sections:

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

The detailed study results are provided in Attachment A.

Please note that, following the completion of the studies the TFO, provided updated thermal ratings for transmission lines 7L159, 9L27 and 9L912/912L, as shown in Table 5-1. The updated transmission line ratings are higher than those used in the studies. Using the new ratings will not impact the study results or the conclusions and recommendations contained herein.

Table 5-1: Updated Thermal Ratings for Selected Transmission Lines in the Study Area

Line ID	Line Description	Voltage Class (kV)	Seasonal Continuous Rating (MVA)		Short-term Emergency Rating (MVA)	
			Summer	Winter	Summer	Winter
7L159	Ghost Pine 114S - Three Hills 770S	138	109.3[a]	139.0	123.6[a]	150.5
9L27	Cordel 755S - Paintearth 863S	240	399 CT	399 CT	399 CT	399 CT
9L912/912L	Red Deer 63S - Nevis 766S	240	350.0[a]	541	420.0[a]	623 CT

a These values are identical to the ratings listed in Table 3-10 of Attachment A1

Table 5-2: Summary of Reliability Criteria Violations, Project Impact and Mitigation Measures for Case A

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project impact	Pre- Project Mitigation measures	Post- Project Mitigation measures
2018 SL	7L130 (Vermilion 710S - Kitscoty 705S)	648ST1 (Metiskow 648S Transformer T1)	Marginally increased thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L14 (Kitscoty 705S - Hill 751S)				
	766S901T (Nevis 766S Transformer 901T)	9L29 (Oakland 946S - Coyote Lake 963S)	Reduced thermal criteria violation	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS
	7L159 (Ghost Pine Tap - Heatburg 948S)		Marginally increased thermal criteria violation		
	7L16 (Heatburg 948S - Nevis 766S)		Marginally increased thermal criteria violation		
	7L85 (Bullpound 803S - Anderson 801S)		Marginally increased thermal criteria violation		
	7L85 (Wintering Hills 804S - Bullpound 803S)		Marginally increased thermal criteria violation		
2018 SP	7L129 (Buffalo Creek 526S - Bauer Tap)	267ST1 (Killarney Lake 267S Transformer T1)	New thermal criteria violation	N/A	Modify Existing RAS # 138 for P1567
	7L130 (Vermilion 710S - Kitscoty 705S)		No Change	Real-time operational practices	Real-time operational practices
	7L14 (Kitscoty 705S - Hill 751S)				
	7L50 (Jarrow Tap - Buffalo Creek 526S)		Materially increased thermal criteria violation	Existing RAS # 138	Modify Existing RAS # 138 for P1567
	749L (Killarney Tap - Edgerton 899S)	526ST1 OR 526ST2 (Buffalo Creek 526S Transformer T1 or T2)	New thermal criteria violation	N/A	Real-time operational practices
	701L (Heisler Tap - Strome 223S)	766S901T (Nevis 766S Transformer 901T)	New thermal criteria violation	N/A	Modify RAS # 138 for P1567
	701L (Strome 223S - North Holden 395S)		New thermal criteria violation		
	7L701 (Battle River 757S - Heisler Tap)		New thermal criteria violation		
	7L50 (Jarrow Tap - Buffalo Creek 526S)		Materially increased thermal criteria violation	Existing RAS # 138	

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project impact	Pre- Project Mitigation measures	Post- Project Mitigation measures
	749L (Killarney Tap - Edgerton 899S)	7L129_7LA129 (Buffalo Creek 526S - Vermilion 710S - Bauer 918S)	New thermal criteria violation	N/A	Real-time operational practices
	749L (Killarney Tap - Edgerton 899S)	7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	New thermal criteria violation	N/A	Real-time operational practices
	7L50 (Jarrow Tap - Buffalo Creek 526S)	7L701_7LA701_701L (Battle River 757S - Heisler 764S - Strome 223S)	New thermal criteria violation	N/A	Modify Existing RAS # 138 for P1567
	912L\9L912 (Nevis 766S - Red Deer 63S)		New thermal criteria violation		TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L
	7L50 (Jarrow Tap - Buffalo Creek 526S)	7L749_749L_7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	New thermal criteria violation	N/A	Modify Existing RAS # 138 for P1567
	7L130 (Vermilion 710S - Kitscoty 705S)	899ST3A (Edgerton 899S Transformer T3A)	Reduced thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L50 (Jarrow Tap - Buffalo Creek 526S)		Materially increased thermal criteria violation	Existing RAS # 138	Modify Existing RAS # 138 for P1567
	701L (Heisler Tap - Strome 223S)	912L_9L912 (Red Deer 63S - Nevis 766S)	New thermal criteria violation	N/A	Modify RAS # 138 for P1567
	701L (Strome 223S - North Holden 395S)		New thermal criteria violation	N/A	
	7L50 (Jarrow Tap - Buffalo Creek 526S)		Materially increased thermal criteria violation	Existing RAS # 138	
	7L701 (Battle River 757S - Heisler Tap)		New thermal criteria violation	N/A	
	7L127 (Pemukan 932S - Monitor 774S)	966L_9L966 (Hansman Lake 650S - Pemukan 932S)	New thermal criteria violation	N/A	TFO capital maintenance project to restore ratings on the 144 kV transmission line 7L127L
	766S901T (Nevis 766S Transformer 901T)	9L20 (Nevis 766S - Cordel 755S)	New thermal criteria violation	N/A	Modify planned RAS # 139 for P1567
	7L50 (Jarrow Tap - Buffalo Creek 526S)		New thermal criteria violation		Modify Existing RAS # 138 for P1567
	766S901T (Nevis 766S Transformer 901T)	9L29 (Oakland 946S - Coyote Lake 963S)	Marginally increased thermal criteria violation	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS
	7L159 (Ghost Pine Tap - Heatburg 948S)		Reduced thermal criteria violation		
	7L16 (Heatburg 948S - Nevis 766S)		Reduced thermal criteria violation		
	7L85 (Bullpound 803S - Anderson 801S)		Reduced thermal criteria violation		

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project impact	Pre- Project Mitigation measures	Post- Project Mitigation measures
2018 WP	7L85 (Wintering Hills 804S - Bullpound 803S)		Reduced thermal criteria violation		
	7L50 (Jarrow Tap - Buffalo Creek 526S)	EATL	Materially increased thermal criteria violation	Existing RAS # 138	Modify Existing RAS # 138 for P1567
	912L\9L912 (Nevis 766S - Red Deer 63S)		Materially increased thermal criteria violation	Real-time operational practices	TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L
	7L130 (Vermilion 710S - Kitscoty 705S)	267ST1 (Killarney Lake 267S Transformer T1)	Marginally increased thermal criteria violation	Real-time operational practices	Real-time operational practices
	749L (Killarney Tap - Edgerton 899S)	7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	New thermal criteria violation	N/A	Real-time operational practices
	7L127 (Pemukan 932S - Monitor 774S)	966L_9L966 (Hansman Lake 650S - Pemukan 932S)	New thermal criteria violation	N/A	TFO capital maintenance project to restore ratings on the 144 kV transmission line 7L127L
	766S901T (Nevis 766S Transformer 901T)	9L20 (Nevis 766S - Cordel 755S)	New thermal criteria violation	N/A	Modify planned RAS # 139 for P1567
	766S901T (Nevis 766S Transformer 901T)	9L29 (Oakland 946S - Coyote Lake 963S)	Marginally increased thermal criteria violation	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS

Notes:

Marginally increased refers to a thermal criteria violation that existed pre-Project and post-Project, and the percent loading difference (post-Project percent loading minus pre-Project percent loading) is below 3%.

Materially increased refers to a thermal criteria violation that existed pre-Project and post-Project, and the percent loading difference (post-Project percent loading minus pre-Project percent loading) above or equal to 3%.

Table 5-3: Summary of Reliability Criteria Violations, Project Impact and Mitigation Measures for Case B

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project impact	Pre- Project Mitigation measures	Post- Project Mitigation measures
2018SL Case B	7L130 (Vermilion 710S - Kitscoty 705S)	648ST1 (Metiskow 648S Transformer T1)	Reduced thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L14 (Kitscoty 705S - Hill 751S)				
	174L (North Holden 395S - Bardo 197S)	766S901T (Nevis 766S Transformer 901T)	New thermal criteria violation	N/A	Existing RAS # 134
	174L (North Holden 395S - Bardo 197S)	912L_9L912 (Red Deer 63S - Nevis 766S)	New thermal criteria violation	N/A	Existing RAS # 134
	766S901T (Nevis 766S Transformer 901T)	9L29 (Oakland 946S - Coyote Lake 963S)	Marginally increased thermal criteria violation	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS
	7L159 (Ghost Pine Tap - Heatburg 948S)		Marginally increased thermal criteria violation		
	7L16 (Heatburg 948S - Nevis 766S)		Marginally increased thermal criteria violation		
	7L85 (Bullpound 803S - Anderson 801S)		Marginally increased thermal criteria violation		
	7L85 (Wintering Hills 804S - Bullpound 803S)		Marginally increased thermal criteria violation		
2018SP Case B	7L129 (Bauer Tap - Vermilion 710S)	267ST1 (Killarney Lake 267S Transformer T1)	Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation		

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project impact	Pre- Project Mitigation measures	Post- Project Mitigation measures
	7L130 (Vermilion 710S - Kitscoty 705S)		Reduced thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L14 (Kitscoty 705S - Hill 751S)				
	912L\9L912 (Nevis 766S - Red Deer 63S)		New thermal criteria violation	N/A	TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L
	7L129 (Buffalo Creek 526S - Bauer Tap)	377ST1 (Hardisty 377S Transformer T1)	New thermal criteria violation	N/A	Modify Planned 7L129 RAS for P1567
	749L (Killarney Tap - Edgerton 899S)	526ST1 OR 526ST2 (Buffalo Creek 526S Transformer T1 or T2)	New thermal criteria violation	N/A	Real-time operational practices
	7L129 (Bauer Tap - Vermilion 710S)	701L (North Holden 395S - Strome 223S)	New thermal criteria violation	N/A	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	
	912L\9L912 (Nevis 766S - Red Deer 63S)		New thermal criteria violation	N/A	TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L
	174L (North Holden 395S - Bardo 197S)	766S901T (Nevis 766S Transformer 901T)	New thermal criteria violation	N/A	Existing RAS # 134
	701L (Heisler Tap - Strome 223S)		New thermal criteria violation	N/A	
	701L (Strome 223S - North Holden 395S)		New thermal criteria violation	N/A	
	7L129 (Bauer Tap - Vermilion 710S)		Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project impact	Pre- Project Mitigation measures	Post- Project Mitigation measures
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation		
	7L701 (Battle River 757S - Heisler Tap)		New thermal criteria violation	N/A	Existing RAS # 134
	749L (Killarney Tap - Edgerton 899S)	7L129_7LA129 (Buffalo Creek 526S - Vermilion 710S - Bauer 918S)	New thermal criteria violation	N/A	Real-time operational practices
	912L\9L912 (Nevis 766S - Red Deer 63S)		New thermal criteria violation		TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L
	7L129 (Bauer Tap - Vermilion 710S)	7L42 (Hill 751S - Lloydminster 716S)	New thermal criteria violation	N/A	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567
	7L129 (Bauer Tap - Vermilion 710S)	7L701_7LA701_701L (Battle River 757S - Heisler 764S - Strome 223S)	Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation		
	912L\9L912 (Nevis 766S - Red Deer 63S)		New thermal criteria violation	N/A	TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L
	7L129 (Bauer Tap - Vermilion 710S)	7L749_749L_7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation		
	7L129 (Buffalo Creek 526S - Bauer Tap)	7L77 (North Holden 395S - Vegreville 709S)	Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project impact	Pre- Project Mitigation measures	Post- Project Mitigation measures
	7L129 (Bauer Tap - Vermilion 710S)	899ST3A (Edgerton 899S Transformer T3A)	Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation		
	7L130 (Vermilion 710S - Kitscoty 705S)		Reduced thermal criteria violation	Real-time operational practices	Real-time operational practices
	174L (North Holden 395S - Bardo 197S)	912L_9L912 (Red Deer 63S - Nevis 766S)	New thermal criteria violation	N/A	Existing RAS # 134
	701L (Heisler Tap - Strome 223S)		New thermal criteria violation	N/A	
	701L (Strome 223S - North Holden 395S)		New thermal criteria violation	N/A	
	7L129 (Bauer Tap - Vermilion 710S)		Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation		
	7L701 (Battle River 757S - Heisler Tap)		New thermal criteria violation	N/A	Existing RAS # 134
	766S901T (Nevis 766S Transformer 901T)	9L20 (Nevis 766S - Cordel 755S)	Materially increased thermal criteria violation	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS	Modify planned RAS # 139 for P1567
	7L129 (Bauer Tap - Vermilion 710S)		Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation		

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project impact	Pre- Project Mitigation measures	Post- Project Mitigation measures
	766S901T (Nevis 766S Transformer 901T)	9L29 (Oakland 946S - Coyote Lake 963S)	Materially increased thermal criteria violation	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS
	7L159 (Ghost Pine Tap - Heatburg 948S)		Marginally increased thermal criteria violation		
	7L16 (Heatburg 948S - Nevis 766S)		Marginally increased thermal criteria violation		
	7L85 (Bullpound 803S - Anderson 801S)		Marginally increased thermal criteria violation		
	7L85 (Wintering Hills 804S - Bullpound 803S)		Marginally increased thermal criteria violation		
	912L\9L912 (Nevis 766S - Red Deer 63S)	9L46 (Lanfine 959S - Sedalia 363S)	New thermal criteria violation	N/A	TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L
	912L\9L912 (Nevis 766S - Red Deer 63S)	9L934_934L (Ware Junction 132S - Anderson 801S)	New thermal criteria violation	N/A	TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L
	7L129 (Bauer Tap - Vermilion 710S)	EATL	Materially increased thermal criteria violation	Planned 7L129 RAS for Irma Wind Power	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		Materially increased thermal criteria violation		

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project impact	Pre- Project Mitigation measures	Post- Project Mitigation measures
	912L\9L912 (Nevis 766S - Red Deer 63S)		Materially increased thermal criteria violation	Real-time operational practices	TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L
2018WP Case B	7L129 (Buffalo Creek 526S - Bauer Tap)	267ST1 (Killarney Lake 267S Transformer T1)	New thermal criteria violation	N/A	Modify Planned 7L129 RAS for P1567
	7L130 (Vermilion 710S - Kitscoty 705S)		Marginally increased thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L129 (Bauer Tap - Vermilion 710S)	766S901T (Nevis 766S Transformer 901T)	New thermal criteria violation	N/A	Modify Planned 7L129 RAS for P1567
	7L129 (Buffalo Creek 526S - Bauer Tap)		New thermal criteria violation		
	7L129 (Buffalo Creek 526S - Bauer Tap)	912L_9L912 (Red Deer 63S - Nevis 766S)	New thermal criteria violation	N/A	Modify Planned 7L129 RAS for P1567
	766S901T (Nevis 766S Transformer 901T)	9L20 (Nevis 766S - Cordel 755S)	Materially increased thermal criteria violation	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS	Modify planned RAS # 139 for P1567
	766S901T (Nevis 766S Transformer 901T)	9L29 (Oakland 946S - Coyote Lake 963S)	Reduced thermal criteria violation	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS	Planned RAS # 139 Suncor Hand Hills and BluEarth Hand Hills RAS

Notes:

Marginally increased refers to a thermal criteria violation that existed pre-Project and post-Project, and the percent loading difference (post-Project percent loading minus pre-Project percent loading) is below 3%.

Materially increased refers to a thermal criteria violation that existed pre-Project and post-Project, and the percent loading difference (post-Project percent loading minus pre-Project percent loading) above or equal to 3%.

5.2. Case A- Without the Planned Irma Wind Power Project

5.2.1. Pre-Project Studies Results

Category A condition

No Reliability Criteria violations were observed under the Category A condition (i.e., all elements in service) for any of the pre-Project scenarios.

Category B conditions

The pre-Project power flow studies identified a number of thermal criteria violations under Category B conditions (i.e., loss of a single system element). No voltage criteria violations or 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 under Category B conditions.

5.2.2. Post-Project Studies Results

Category A condition

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

Category B conditions

The post-Project power flow studies identified a number of thermal criteria violations under Category B conditions. No voltage criteria violations or POD bus voltage deviations were observed under Category B conditions.

5.3. Case B- With the Planned Irma Wind Power Project

5.3.1. Pre-Project Studies Results

Category A condition

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

Category B conditions

The pre-Project power flow studies identified a number of thermal criteria violations under Category B conditions. No voltage criteria violations or POD bus voltage deviations were observed under Category B conditions.

5.3.2. Post-Project Studies Results

Category A condition

No Reliability Criteria violations were observed under the Category A condition for any of the pre-Project scenarios. The post-Project short-circuit fault levels were not significantly higher than pre-Project levels. The long term short circuit levels were found to be within the designed capabilities of the nearby facilities.

Category B conditions

The post-Project power flow studies identified a number of thermal criteria violations under Category B conditions. No voltage criteria violations or POD bus voltage deviations were observed under Category B conditions. The results of the transient stability studies did not indicate any transient stability concerns, and the system showed acceptable dynamic response under all studied Category B contingencies.

5.4. Mitigation Measures

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

5.4.1. Case A- Without the Planned Irma Wind Power Project

Pre-Project

Prior to connection of the Project, the thermal criteria violations observed in the pre-Project scenarios can be mitigated by real-time operational practices, the existing RAS 138 and the planned modifications of the existing RAS 139 (these planned modifications were proposed for the planned Suncor Hand Hills Wind Energy Project and the planned BluEarth Hand Hills Wind Energy Project, referred to hereafter as "planned RAS 139").

Post-Project

After connection of the Project, some of the thermal criteria violations observed in the post-Project scenarios can be mitigated by real-time operational practices. The thermal criteria violations observed on the 144 kV transmission line 7L127 can be mitigated by TFO capital maintenance project to restore the line ratings on 7L127. The thermal criteria violations observed on the 240 kV transmission line 912L/9L912 will be mitigated by a TFO capital maintenance project to restore the thermal ratings on 912L. The remaining thermal criteria violations can be mitigated by modifications to existing RAS 138, planned RAS 139, and modification of planned RAS 139 (by including the Project to the RAS logic).

5.4.2. Case B- With the Planned Irma Wind Power Project

Pre-Project

Prior to connection of the Project, some of the thermal criteria violations observed in the pre-Project scenarios can be mitigated by real-time operational practices. The remaining thermal criteria violations can be mitigated by the planned RAS 139 and a modified version of the RAS planned for the Irma Wind Project, hereafter referred to as the “planned 7L129 RAS”.

Post-Project

After connection of the Project, some of the thermal criteria violations observed in the post-Project scenarios can be mitigated by real-time operational practices. The thermal criteria violations observed on the 240 kV transmission line 912L/9L912 will be alleviated by a TFO capital maintenance project to restore the line ratings on 912L. The remaining thermal criteria violations can be mitigated by existing RAS 134, planned RAS 139, modification of the planned RAS 139, and, a modified version of the planned 7L129 RAS.

5.5. Post-Mitigation Studies Results

5.5.1. Case A- Without the Planned Irma Wind Power Project

Category B conditions

After the developed RASs were applied, all of the observed Reliability Criteria violations requiring RAS were mitigated.

5.5.2. Case B- With the Planned Irma Wind Power Project

Category B conditions

After the developed RASs were applied, all of the observed Reliability Criteria violations requiring RAS were mitigated.

6. Project Dependencies

The 144 kV transmission line 7L127 is currently being limited to a seasonal continuous rating of 132 MVA (on 144 kV voltage class) in summer and winter. The TFO has a planned capital maintenance project that will restore 7L127 to a capacity of 164/211 MVA (on 144 kV voltage class), summer/winter, respectively. Restoring the capacity of 7L127 will mitigate the observed thermal criteria violations on 7L127. As this restoration work is part of TFO capital maintenance, it is outside the scope of the Project. The AESO has been advised by the TFO that 7L127 is scheduled to be restored in Q4 2018, which is prior to the scheduled Project ISD.

The 240 kV transmission line 912L is currently being limited to a seasonal continuous rating of 350 MVA in summer and 541 MVA in winter. The TFO has a planned capital maintenance project which will restore 912L to a capacity of 507/641 MVA[3], summer/winter, respectively. Restoring the capacity of 912L will mitigate the observed thermal criteria violations on 912L. As this restoration work is part of TFO capital maintenance, it is outside the scope of the Project. AESO has been advised by the TFO that 912L is scheduled to be restored in Q4 2017, which is prior to the scheduled Project ISD.

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

[3] This is AltaLink owned MVA rating. The ATCO owned portion remains the same. The overall line rating will be determined considering both TFO's rating.

7. Conclusions and Recommendations

Based on the study results, Alternative 1 is technically viable under both generation dispatch cases A and B (i.e., without and with the connection of the Irma Wind Power Project). The connection assessment identified a number of pre-Project and post-Project system performance issues. Many of these issues can be managed using real-time operational practices.

If the Irma Wind Power Project is not connected to the AIES prior to the ISD of the Project, then the following mitigation measures would mitigate the post-Project system performance issues that cannot be managed by real-time operational practices:

- modifications to the existing RAS 138,
- modifications to the planned RAS 139,
- TFO capital maintenance projects to restore the thermal ratings on the 240 kV transmission line 912L, and 144 kV line 7L127.

Should the Irma Wind Power Project be connected to the AIES prior to the ISD of the Project, then the following mitigation measures would mitigate the post-Project system performance issues that cannot be managed by real-time operational practices:

- the existing RAS 134,
- modifications to the planned RAS 139,
- modifications to the planned 7L129 RAS, and
- a TFO capital maintenance project to restore the thermal ratings on the 240 kV transmission line 912L.

It is recommended to proceed with the Project – after the completion of the TFO capital maintenance projects listed above – using Alternative 1 as the preferred option to respond to the Market Participant's request for system access service. It is also recommended to use real-time operational practices and the mitigation measures listed above to mitigate the identified system performance issues.

Alternative 1 involves connecting the Facility to the existing 240 kV transmission line 9L46 using an in-and-out configuration. Alternative 1 includes the addition of a switching station, to be called New Brigden 2088S, including four 240 kV circuit breakers. Alternative 1 also involves the addition of two 240 kV circuits to connect the proposed New Brigden 2088S substation to 9L46.

The conductor used for the 240 kV circuits should have a minimum thermal rating equal to the existing 240 kV transmission line 9L46.

Attachment A

Engineering Connection Assessment Results

Engineering Connection Assessment Results

Sharp Hills Wind Farm Connection

Date: 2017-10-23

Role	Name	Organization	Date	Signature
Prepared:	Mahmud Tariq Rashid, P.Eng.	Teshmont Consultants LP	October 23, 2017	Rashid
Reviewed:	Ashraf Ul Haque, P. Eng.	Teshmont Consultants LP	October 23, 2017	
Approved:	Ashraf Ul Haque, P. Eng.	Teshmont Consultants LP	October 23, 2017	

Version: V1

Engineering Stamp

PROFESSIONAL ENGINEER ALBERTA
ASHRAF UL HAQUE

October 23, 2017

APEGA Permit - Practice: 03012

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1. Introduction

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

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 conditions and selected Category B conditions for observed Reliability Criteria violations in the Study Area are included in Attachment A2.

2.1.1. 2018 Summer Light Pre-Project Case A[1]

Category A condition

No Reliability Criteria (as defined in Section 3.1.1 of Attachment A1) violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or 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. 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 the 2018 SL Pre-Project Scenario Case A

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)[a]	Short-term (Emergency) Rating (MVA)[a]	Pre-Project Results	
				Power Flow (MVA)	% Loading[b]
9L29 (Oakland 946S - Coyote Lake 963S)	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	117.9	107.9
	Nevis 766S Transformer 901T	100.0	100.0	104.6	104.6
	7L16 (Heatburg 948S - Nevis 766S)	109.3	123.6	114.4	104.7
	7L85 (Wintering Hills 804S - Bullpound 803S)	109.3	123.6	127.7	116.8

[1] Case A refers to the case without the Irma Wind Power Project (The Irma Wind Power Project Connection Needs Identification Document (NID) was filed with the AUC on August 3, 2017 in Proceeding 22857)

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)[a]	Short-term (Emergency) Rating (MVA)[a]	Pre-Project Results	
				Power Flow (MVA)	% Loading[b]
	7L85 (Bullpound 803S - Anderson 801S)	109.3	123.6	121.7	111.3
Metiskow 648S Transformer T1	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	78.6	109.3
	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	74.8	104.0

[a] The facility ratings shown in Attachment A1 have been adjusted from a 144 kV voltage base to a 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 seasonal continuous rating (also in MVA, as shown in Attachment A1, and then adjusted from a 144 kV voltage base - a 138 kV voltage base).

2.1.2. 2018 Summer Light Pre-Project Case B[2]

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. 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 the 2018 SL Pre-Project Scenario Case B

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
9L29 (Oakland 946S - Coyote Lake 963S)	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	119.8	109.6
	Nevis 766S Transformer 901T	100.0	100.0	102.7	102.7
	7L16 (Heatburg 948S - Nevis 766S)	109.3	123.6	116.4	106.5
	7L85 (Wintering Hills 804S - Bullpound 803S)	109.3	123.6	130.2	119.1
	7L85 (Bullpound 803S - Anderson 801S)	109.3	123.6	124.1	113.6
Metiskow 648S Transformer T1	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	77.9	108.4

[2] Case B refers to the case with the Irma Wind Power Project

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	74.1	103.1

2.1.3. 2018 Summer Peak Pre-Project Case A

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations were observed under certain Category B conditions, as shown in Table 2-3.

Table 2-3: Thermal Criteria Violations under Category B Conditions for the 2018 SP Pre-Project Scenario Case A

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
912L_9L912 (Red Deer 63S - Nevis 766S)	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	110.4	101.0
9L29 (Oakland 946S - Coyote Lake 963S)	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	128.1	117.2
	Nevis 766S Transformer 901T	100.0	100.0	110.5	110.5
	7L16 (Heatburg 948S - Nevis 766S)	109.3	123.6	124.3	113.7
	7L85 (Wintering Hills 804S - Bullpound 803S)	109.3	123.6	121.1	110.8
	7L85 (Bullpound 803S - Anderson 801S)	109.3	123.6	110.2	100.8
Killarney Lake 267S Transformer T1	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	116.7	106.7
	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	80.2	111.5
	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	75.6	105.2
Edgerton 899S Transformer T3A	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	112.0	102.5
	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	74.6	103.8
Nevis 766S Transformer 901T	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	110.5	101.1

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
EATL (Newell 2075S – Heathfield 2029S)	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	112.3	102.7
	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	385.7	110.2

2.1.4. 2018 Summer Peak Pre-Project Case B

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations were observed under certain Category B conditions, as shown in Table 2-4.

Table 2-4: Thermal Criteria Violations under Category B Conditions for the 2018 SP Pre-Project Scenario Case B

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
701L (North Holden 395S - Strome 223S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	118.0	107.9
7L77 (North Holden 395S - Vegreville 709S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	114.4	104.7
9L20 (Nevis 766S - Cordel 755S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	121.8	111.5
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	112.8	103.2
	Nevis 766S Transformer 901T	100.0	100.0	100.5	100.5
912L_9L912 (Red Deer 63S - Nevis 766S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	128.9	117.9
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	119.9	109.7
9L29 (Oakland 946S - Coyote Lake 963S)	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	124.0	113.5
	Nevis 766S Transformer 901T	100.0	100.0	108.7	108.7
	7L16 (Heatburg 948S - Nevis 766S)	109.3	123.6	120.2	109.9

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
	7L85 (Wintering Hills 804S - Bullpound 803S)	109.3	123.6	121.6	111.2
	7L85 (Bullpound 803S - Anderson 801S)	109.3	123.6	110.7	101.3
7L701_7LA701_701L (Battle River 757S - Heisler 764S - Strome 223S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	122.5	112.1
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	113.5	103.8
7L42 (Hill 751S - Lloydminster 716S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	110.6	101.2
7L749_749L_7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	120.5	110.2
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	111.8	102.2
Killarney Lake 267S Transformer T1	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	128.2	117.3
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	119.3	109.1
	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	80.3	111.7
	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	75.8	105.4
Edgerton 899S Transformer T3A	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	123.3	112.8
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	114.6	104.8
	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	74.8	104.1
Nevis 766S Transformer 901T	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	129.0	118.0
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	120.0	109.8
EATL (Newell 2075S – Heathfield 2029S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	128.5	117.6
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	119.5	109.3
	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	407.6	116.5

2.1.5. 2018 Winter Peak Pre-Project Case A

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations were observed under certain Category B conditions, as shown in Table 2-5.

Table 2-5: Thermal Criteria Violations under Category B Conditions for the 2018 WP Pre-Project Scenario Case A

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
9L29 (Oakland 946S - Coyote Lake 963S)	Nevis 766S Transformer 901T	100.0	100.0	104.9	104.9
Killarney Lake 267S Transformer T1	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	86.3	91.1	105.6

2.1.6. 2018 Winter Peak Pre-Project Case B

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations were observed under certain Category B conditions, as shown in Table 2-6.

Table 2-6: Thermal Criteria Violations under Category B Conditions for the 2018 WP Pre-Project Scenario Case B

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
9L20 (Nevis 766S - Cordel 755S)	Nevis 766S Transformer 901T	100.0	100.0	101.2	101.2
9L29 (Oakland 946S - Coyote Lake 963S)	Nevis 766S Transformer 901T	100.0	100.0	105.8	105.8
Killarney Lake 267S Transformer T1	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	86.3	90.5	104.8

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 conditions and selected Category B conditions for observed Reliability Criteria violations in the Study Area are included in Attachment A3.

3.1.1. 2018 Summer Light Post-Project Case A

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. 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 the 2018 SL Post-Project Scenario Case A

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre- Project Results		Post- Project Results		% Loading Difference (Post-Pre)
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	
9L29 (Oakland 946S - Coyote Lake 963S)	7L159 (Ghost Pine Tap - Heatburg 948S)	109.3	123.6	117.9	107.9	120.8	110.6	2.7
	Nevis 766S Transformer 901T	100.0	100.0	104.6	104.6	103.4	103.4	-1.2
	7L16 (Heatburg 948S - Nevis 766S)	109.3	123.6	114.4	104.7	117.4	107.4	2.7
	7L85 (Wintering Hills 804S - Bullpound 803S)	109.3	123.6	127.7	116.8	129.2	118.2	1.4
	7L85 (Bullpound 803S - Anderson 801S)	109.3	123.6	121.7	111.3	123.2	112.7	1.4

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre- Project Results		Post- Project Results		% Loading Difference (Post-Pre)
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	
Metiskow 648S Transformer T1	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	78.6	109.3	79.0	109.9	0.6
	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	74.8	104.0	75.2	104.6	0.5

3.1.2. 2018 Summer Light Post-Project Case B

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. 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 the 2018 SL Post-Project Scenario Case B

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre- Project Results		Post- Project Results		% Loading Difference (Post-Pre)
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	
912L_9L912 (Red Deer 63S - Nevis 766S)	174L (North Holden 395S - Bardo 197S)	85.1	94.0	67.1	78.9	87.9	103.3	24.4
9L29 (Oakland 946S - Coyote Lake 963S)	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	119.8	109.6	120.4	110.2	0.5
	Nevis 766S Transformer 901T	100.0	100.0	102.7	102.7	105.2	105.2	2.5
	7L16 (Heatburg 948S - Nevis 766S)	109.3	123.6	116.4	106.5	117.0	107.0	0.5
	7L85 (Wintering Hills 804S - Bullpound 803S)	109.3	123.6	130.2	119.1	131.0	119.9	0.8
	7L85 (Bullpound 803S - Anderson 801S)	109.3	123.6	124.1	113.6	125.0	114.4	0.8
Metiskow 648S Transformer T1	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	77.9	108.4	77.2	107.3	-1.0
	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	74.1	103.1	73.4	102.1	-1.0
Nevis 766S Transformer 901T	174L (North Holden 395S - Bardo 197S)	85.1	94.0	67.0	78.7	87.9	103.3	24.6

3.1.3. 2018 Summer Peak Post-Project Case A

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations were observed under certain Category B conditions, as shown in Table 3-3.

3.1.4. 2018 Summer Peak Post-Project Case B

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations were observed under certain Category B conditions, as shown in Table 3-4.

Table 3-3: Thermal Criteria Violations under Category B Conditions for the 2018 SP Post-Project Scenario Case A

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre- Project Results		Post- Project Results		% Loading Difference (Post-Pre)
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	
7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	749L (Killarney Tap - Edgerton 899S)	88.0	97.0	85.5	97.2	94.7	107.6	10.4
9L20 (Nevis 766S - Cordel 755S)	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	103.6	94.8	114.7	104.9	10.1
	Nevis 766S Transformer 901T	100.0	100.0	97.1	97.1	112.0	112.0	14.9
966L_9L966 (Hansman Lake 650S - Pemukan 932S)	7L127 (Pemukan 932S - Monitor 774S)	126.5	126.5	66.4	52.5	127.8	101.1	48.6
912L_9L912 (Red Deer 63S - Nevis 766S)	701L (Strome 223S - North Holden 395S)	119.0	167.0	109.6	92.1	128.5	108.0	15.9
	701L (Heisler Tap - Strome 223S)	139.9	160.0	127.5	91.1	146.6	104.8	13.7
	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	110.4	101.0	122.7	112.3	11.2
	7L701 (Battle River 757S - Heisler Tap)	139.9	160.0	124.0	88.6	140.8	100.6	12.0
9L29 (Oakland 946S - Coyote Lake 963S)	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	128.1	117.2	126.4	115.7	-1.5
	Nevis 766S Transformer 901T	100.0	100.0	110.5	110.5	111.9	111.9	1.5
	7L16 (Heatburg 948S - Nevis 766S)	109.3	123.6	124.3	113.7	122.6	112.1	-1.6
	7L85 (Wintering Hills 804S - Bullpound 803S)	109.3	123.6	121.1	110.8	120.9	110.6	-0.1
	7L85 (Bullpound 803S - Anderson 801S)	109.3	123.6	110.2	100.8	110.0	100.7	-0.2
7L701_7LA701_701L (Battle River 757S - Heisler 764S - Strome 223S)	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	106.0	97.0	113.6	104.0	7.0
	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	285.5	81.6	353.1	100.9	19.3
7L749_749L_7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	109.3	100.0	118.5	108.4	8.4
7L129_7LA129 (Buffalo Creek 526S - Vermilion 710S - Bauer 918S)	749L (Killarney Tap - Edgerton 899S)	88.0	97.0	80.7	91.7	89.8	102.0	10.4
Killarney Lake 267S Transformer T1	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	102.1	93.5	111.0	101.6	8.1
	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	116.7	106.7	125.8	115.1	8.4
	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	80.2	111.5	80.2	111.5	0.0
	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	75.6	105.2	75.6	105.1	0.0
Buffalo Creek 526S Transformer T1 or T2	749L (Killarney Tap - Edgerton 899S)	88.0	97.0	83.2	94.5	92.3	104.8	10.3
Edgerton 899S Transformer T3A	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	112.0	102.5	121.2	110.9	8.4
	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	74.6	103.8	74.5	103.6	-0.2
Nevis 766S Transformer 901T	701L (Strome 223S - North Holden 395S)	119.0	167.0	109.6	92.1	128.7	108.1	16.0
	701L (Heisler Tap - Strome 223S)	139.9	160.0	127.5	91.1	146.7	104.9	13.8
	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	110.5	101.1	122.9	112.5	11.4
	7L701 (Battle River 757S - Heisler Tap)	139.9	160.0	124.4	88.9	141.8	101.4	12.5
EATL (Newell 2075S – Heathfield 2029S)	7L50 (Jarrow Tap - Buffalo Creek 526S)	109.3	123.6	112.3	102.7	117.9	107.9	5.2
	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	385.7	110.2	447.7	127.9	17.7

Table 3-4: Thermal Criteria Violations under Category B Conditions for the 2018 SP Post-Project Scenario Case B

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre- Project Results		Post- Project Results		% Loading Difference (Post-Pre)
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	
701L (North Holden 395S - Strome 223S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	118.0	107.9	124.2	113.6	5.7
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	109.0	99.8	115.2	105.4	5.7
	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	298.8	85.4	366.9	104.8	19.5
7L77 (North Holden 395S - Vegreville 709S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	114.4	104.7	118.2	108.1	3.4
9L20 (Nevis 766S - Cordel 755S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	121.8	111.5	131.9	120.7	9.3
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	112.8	103.2	122.9	112.4	9.2
	Nevis 766S Transformer 901T	100.0	100.0	100.5	100.5	116.3	116.3	15.9
912L_9L912 (Red Deer 63S - Nevis 766S)	174L (North Holden 395S - Bardo 197S)	85.1	94.0	66.2	77.8	86.9	102.2	24.4
	701L (Strome 223S - North Holden 395S)	119.0	167.0	113.0	94.9	131.7	110.7	15.8
	701L (Heisler Tap - Strome 223S)	139.9	160.0	131.0	93.6	149.8	107.1	13.4
	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	128.9	117.9	140.3	128.3	10.4
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	119.9	109.7	131.1	120.0	10.3
	7L701 (Battle River 757S - Heisler Tap)	139.9	160.0	129.3	92.4	144.6	103.4	11.0
9L46 (Lanfine 959S - Sedalia 363S)	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	247.8	70.8	353.3	100.9	30.1
9L29 (Oakland 946S - Coyote Lake 963S)	7L159 (7L159 Tap - Heatburg 948S)	109.3	123.6	124.0	113.5	126.8	116.0	2.5
	Nevis 766S Transformer 901T	100.0	100.0	108.7	108.7	112.2	112.2	3.5
	7L16 (Heatburg 948S - Nevis 766S)	109.3	123.6	120.2	109.9	122.9	112.5	2.5
	7L85 (Wintering Hills 804S - Bullpound 803S)	109.3	123.6	121.6	111.2	122.8	112.3	1.1
	7L85 (Bullpound 803S - Anderson 801S)	109.3	123.6	110.7	101.3	111.9	102.4	1.0
9L934_934L (Ware Junction 132S - Anderson 801S)	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	281.0	80.3	350.3	100.1	19.8
7L701_7LA701_701L (Battle River 757S - Heisler 764S - Strome 223S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	122.5	112.1	128.6	117.7	5.6
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	113.5	103.8	119.6	109.4	5.6
	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	307.0	87.7	375.3	107.2	19.5
7L42 (Hill 751S - Lloydminster 716S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	110.6	101.2	119.0	108.9	7.7
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	101.8	93.2	110.2	100.8	7.7
7L749_749L_7LB749 (Edgerton 899S - Briker 880S - Lloydminster 716S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	120.5	110.2	128.8	117.8	7.6
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	111.8	102.2	120.0	109.8	7.6
7L129_7LA129 (Buffalo Creek 526S - Vermilion 710S - Bauer 918S)	749L (Killarney Tap - Edgerton 899S)	88.0	97.0	79.2	90.0	88.6	100.7	10.7
	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	297.9	85.1	364.8	104.2	19.1
Killarney Lake 267S Transformer T1	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	128.2	117.3	136.6	125.0	7.7
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	119.3	109.1	127.6	116.7	7.6
	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	80.3	111.7	80.3	111.6	-0.1

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre- Project Results		Post- Project Results		% Loading Difference (Post-Pre)
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	
	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	75.8	105.4	75.7	105.3	-0.1
	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	287.3	82.1	353.8	101.1	19.0
Buffalo Creek 526S Transformer T1 or T2	749L (Killarney Tap - Edgerton 899S)	88.0	97.0	79.5	90.3	88.9	101.0	10.7
Hardisty 377S Transformer T1	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	106.4	97.4	110.2	100.8	3.4
Edgerton 899S Transformer T3A	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	123.3	112.8	131.7	120.5	7.6
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	114.6	104.8	122.9	112.4	7.6
	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	74.8	104.1	74.7	103.9	-0.2
Nevis 766S Transformer 901T	174L (North Holden 395S - Bardo 197S)	85.1	94.0	66.3	77.9	87.1	102.4	24.5
	701L (Strome 223S - North Holden 395S)	119.0	167.0	113.0	95.0	131.9	110.8	15.8
	701L (Heisler Tap - Strome 223S)	139.9	160.0	131.0	93.7	149.9	107.2	13.5
	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	129.0	118.0	140.5	128.5	10.5
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	120.0	109.8	131.3	120.2	10.4
	7L701 (Battle River 757S - Heisler Tap)	139.9	160.0	129.9	92.8	145.7	104.1	11.3
EATL (Newell 2075S – Heathfield 2029S)	7L129 (Buffalo Creek 526S - Bauer Tap)	109.3	123.6	128.5	117.6	133.3	121.9	4.3
	7L129 (Bauer Tap - Vermilion 710S)	109.3	123.6	119.5	109.3	124.1	113.6	4.3
	912L\9L912 (Nevis 766S - Red Deer 63S)	350.0	420.0	407.6	116.5	471.7	134.8	18.3

3.1.5. 2018 Winter Peak Post-Project Case A

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations were observed under certain Category B conditions, as shown in Table 3-5.

Table 3-5: Thermal Criteria Violations under Category B Conditions for the 2018 WP Post-Project Scenario Case A

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre- Project Results		Post- Project Results		% Loading Difference (Post-Pre)
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	
7L50 (Battle River 757S - Jarrow 252S - Buffalo Creek 526S)	749L (Killarney Tap - Edgerton 899S)	96.0	140.0	88.6	92.3	98.0	102.1	9.8
9L20 (Nevis 766S - Cordel 755S)	Nevis 766S Transformer 901T	100.0	100.0	95.3	95.3	111.4	111.4	16.1
966L_9L966 (Hansman Lake 650S - Pemukan 932S)	7L127 (Pemukan 932S - Monitor 774S)	126.5	126.5	71.2	56.3	134.1	106.0	49.7
9L29 (Oakland 946S - Coyote Lake 963S)	Nevis 766S Transformer 901T	100.0	100.0	104.9	104.9	107.0	107.0	2.1
Killarney Lake 267S Transformer T1	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	86.3	91.1	105.6	91.2	105.7	0.1

3.1.6. 2018 Winter Peak Post-Project Case B

Category A condition

No Reliability Criteria violations were observed under the Category A condition.

Category B conditions

No voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations were observed under certain Category B conditions, as shown in Table 3-6.

Table 3-6: Thermal Criteria Violations under Category B Conditions for the 2018 WP Post-Project Scenario Case B

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Pre- Project Results		Post- Project Results		% Loading Difference (Post-Pre)
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	
9L20 (Nevis 766S - Cordel 755S)	Nevis 766S Transformer 901T	100.0	100.0	101.2	101.2	114.6	114.6	13.4
912L_9L912 (Red Deer 63S - Nevis 766S)	7L129 (Buffalo Creek 526S - Bauer Tap)	139.0	142.8	134.9	97.1	147.0	105.8	8.7
9L29 (Oakland 946S - Coyote Lake 963S)	Nevis 766S Transformer 901T	100.0	100.0	105.8	105.8	104.2	104.2	-1.6
Killarney Lake 267S Transformer T1	7L129 (Buffalo Creek 526S - Bauer Tap)	139.0	142.8	134.7	96.9	143.9	103.5	6.6
	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	86.3	90.5	104.8	90.6	105.0	0.2
Nevis 766S Transformer 901T	7L129 (Buffalo Creek 526S - Bauer Tap)	139.0	142.8	135.1	97.2	147.3	106.0	8.8
	7L129 (Bauer Tap - Vermilion 710S)	139.0	142.8	127.0	91.4	139.0	100.0	8.7

3.2. Transient Stability Studies

Transient stability studies were performed for the 2018 SL, 2018 SP and 2018 WP post-Project scenarios using Case B for the select Category B contingencies shown in Table 3-14 of Attachment A1.

The results did not indicate any transient stability concerns, and the system showed acceptable dynamic response to all studied Category B conditions, as shown in Table 3-7.

The post-Project transient stability plots are provided in Attachment A4. Dynamic data and assumptions of all equipment proposed for the Facility are provided in Attachment A5.

Table 3-7: Transient Stability Study Results for 2018 SL, 2018 SP and 2018 WP Post-Project Scenarios Case B

Studied Contingency (System Element Lost)	Fault Description and Location	Results
9L24 (Oakland 946S - Lanfine 959S)	3-phase fault at Oakland 946S	Stable
9L24 (Lanfine 959S - Oakland 946S)	3-phase fault at Lanfine 959S	Stable
9L46 (Lanfine 959S - Pemukan 932S)	3-phase fault at Lanfine 959S	Stable
9L46 (Pemukan 932S - Lanfine 959S)	3-phase fault at Pemukan 932S	Stable
9L966 (Pemukan 932S - Hansman Lake 650S)	3-phase fault at Pemukan 932S	Stable

Studied Contingency (System Element Lost)	Fault Description and Location	Results
9L966 (Hansman Lake 650S - Pemukan 932S)	3-phase fault at Hansman Lake 650S	Stable
912L (Red Deer 63S - Nevis 766S)	3-phase fault at Red Deer 63S	Stable
912L (Nevis 766S - Red Deer 63S)	3-phase fault at Nevis 766S	Stable
9L59 (Tinchebray 972S - Anderson 801S)	3-phase fault at Tinchebray 972S	Stable
9L59 (Anderson 801S - Tinchebray 972S)	3-phase fault at Anderson 801S	Stable

4. Short-Circuit Study Results

4.1. Pre-Project

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

Table 4-1: Short-Circuit Current Levels for the 2018 WP Pre-Project Scenario Case B

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	257.5	13.7	0.003 + 0.0197j	15.2	0.0016 + 0.0148j
Anderson 801S	138	150.2	4.8	0.0105 + 0.0985j	5.2	0.0041 + 0.0802j
Excel 910S	138	143.4	5.5	0.0153 + 0.0814j	7.0	0.0082 + 0.0267j
Hansman Lake 650S	138	141.6	8.0	0.0154 + 0.0527j	8.1	0.0055 + 0.0538j
Hansman Lake 650S	240	253.2	6.1	0.0109 + 0.0415j	6.6	0.0039 + 0.0329j
Lanfine 959S	240	256.8	5.5	0.0089 + 0.0476j	5.8	0.0047 + 0.0422j
Monitor 774S	138	146.1	5.9	0.0194 + 0.0755j	6.9	0.0057 + 0.0431j
Monitor 774S	69	74.3	1.5	0.0629 + 0.6101j	1.5	0.0359 + 0.5918j
Oakland 946S	240	257.2	12.4	0.0032 + 0.0216j	12.4	0.0041 + 0.0226j
Oyen 767S	138	143.1	5.3	0.0188 + 0.0827j	5.7	0.0202 + 0.0647j
Oyen 767S	69	74.5	2.0	0.1059 + 0.4482j	2.0	0.0523 + 0.4828j
Pemukan 932S	240	254.4	5.1	0.0116 + 0.0508j	5.2	0.0057 + 0.0464j
Sheerness 807S	240	257.7	13.2	0.003 + 0.0204j	14.5	0.0017 + 0.0161j
Sheerness 807S	240	257.7	13.2	0.003 + 0.0204j	14.5	0.0018 + 0.0161j

4.2. Post-Project

Post-Project short-circuit current levels are provided in Table 4-2 and Table 4-3.

[3] 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.

Table 4-2: Short-Circuit Current Levels for the 2018 WP Post-Project Scenario Case B

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	257.8	14.1	0.0028 + 0.0192j	15.4	0.0016 + 0.0148j
Anderson 801S	138	150.5	4.9	0.0104 + 0.0981j	5.2	0.0041 + 0.0802j
Excel 910S	138	143.9	5.8	0.0135 + 0.0769j	7.2	0.0082 + 0.0268j
Hansman Lake 650S	138	141.5	8.5	0.0139 + 0.0501j	8.2	0.0055 + 0.0538j
Hansman Lake 650S	240	253.2	6.6	0.0095 + 0.0385j	6.8	0.0039 + 0.0329j
Lanfine 959S	240	256.8	6.4	0.007 + 0.0415j	6.0	0.005 + 0.0432j
Monitor 774S	138	146.5	6.3	0.0167 + 0.0703j	7.1	0.0057 + 0.0434j
Monitor 774S	69	74.6	1.5	0.0598 + 0.6049j	1.5	0.0359 + 0.592j
Oakland 946S	240	257.5	12.8	0.003 + 0.021j	12.5	0.0042 + 0.0227j
Oyen 767S	138	143.7	5.6	0.0171 + 0.0789j	5.8	0.0202 + 0.0648j
Oyen 767S	69	75.2	2.1	0.1034 + 0.4454j	2.0	0.0524 + 0.4829j
Pemukan 932S	240	251.4	5.9	0.0089 + 0.043j	5.5	0.0056 + 0.0458j
Sheerness 807S	240	258.0	13.6	0.0029 + 0.0199j	14.6	0.0017 + 0.0161j
Sheerness 807S	240	258.0	13.6	0.0029 + 0.0199j	14.6	0.0018 + 0.0161j
Sedalia 363S	240	251.3	6.4	0.0071 + 0.04j	4.9	0.0114 + 0.0665j

Table 4-3: Short-Circuit Current Levels for the 2026 WP Post-Project Scenario

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	257.1	14.7	0.0024 + 0.0174j	16.0	0.0014 + 0.0138j
Anderson 801S	138	149.8	4.7	0.0099 + 0.0963j	5.0	0.004 + 0.0796j
Excel 910S	138	146.6	5.8	0.013 + 0.0757j	7.3	0.0081 + 0.0262j
Hansman Lake 650S	138	142.7	8.8	0.0129 + 0.0476j	8.9	0.0039 + 0.0455j
Hansman Lake 650S	240	256.8	7.0	0.0084 + 0.0357j	7.9	0.0023 + 0.0226j
Lanfine 959S	240	258.0	6.6	0.0064 + 0.0389j	6.7	0.0035 + 0.0334j
Monitor 774S	138	146.8	6.4	0.0154 + 0.0675j	7.2	0.0057 + 0.0422j
Monitor 774S	69	74.6	1.5	0.0598 + 0.6013j	1.5	0.0359 + 0.5907j
Oakland 946S	240	256.8	13.3	0.0026 + 0.0192j	13.2	0.0033 + 0.0198j
Oyen 767S	138	146.2	5.6	0.0167 + 0.0778j	5.8	0.0201 + 0.0641j
Oyen 767S	69	76.2	2.0	0.1038 + 0.4417j	2.0	0.0519 + 0.4805j
Pemukan 932S	240	253.8	6.1	0.0082 + 0.041j	5.7	0.0057 + 0.0444j

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)
Sheerness 807S	240	257.0	14.2	0.0024 + 0.0181j	15.2	0.0016 + 0.015j
Sheerness 807S	240	257.4	14.1	0.0025 + 0.0182j	15.0	0.0018 + 0.0154j
Sedalia 363S	240	252.9	6.6	0.0065 + 0.0381j	5.1	0.011 + 0.0625j

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 1.2.2.2 of Attachment A1.

5.1. Case A

5.1.1. Pre-Project

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

Table 5-1: Case A Pre-Project Mitigation Measures

Mitigation Measure	Mitigated Reliability Criteria Violation	
	Thermal Criteria Violation Type	Transmission Facility
Existing RAS 138	Above seasonal continuous rating	7L50 (Jarrow Tap - Buffalo Creek 526S)
Planned RAS 139[a]	Above short-term (emergency) rating	7L16 (Heatburg 948S - Nevis 766S)
		7L85 (Wintering Hills 804S - Bullpound 803S)
		7L159 (7L159 Tap - Heatburg 948S)
		Nevis 766S Transformer 901T
	Above seasonal continuous rating	7L16 (Heatburg 948S - Nevis 766S)
		7L85 (Bullpound803S - Anderson 801S)
		7L85 (Wintering Hills 804S - Bullpound 803S)
		7L159 (7L159 Tap - Heatburg 948S)
Real time operational practices	Above seasonal continuous rating	912L\9L912 (Nevis 766S - Red Deer 63S)
	Above short-term (emergency) rating	7L14 (Kitscoty 705S - Hill 751S)
		7L130 (Vermilion 710S - Kitscoty 705S)

[a] RAS 139 is an existing RAS (See Section 1.2.2.2 of Attachment A1). Modifications to RAS 139 are proposed for the planned Suncor Hand Hills Wind Energy Project and the BluEarth Hand Hills Wind Energy Project. This modified version of RAS 139 is referred to herein as "Planned RAS 139".

5.1.2. Post-Project

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

Table 5-2: Case A Post-Project Mitigation Measures

Mitigation Measure	Mitigated Reliability Criteria Violation

	Thermal Criteria Violation Type	Transmission Facility
Modify Existing RAS 138[a]	Above short-term (emergency) rating	7L50 (Jarrow Tap - Buffalo Creek 526S)
	Above seasonal continuous rating	701L (Heisler Tap - Strome 223S)
		701L (Strome 223S - North Holden 395S)
		7L50 (Jarrow Tap - Buffalo Creek 526S)
		7L129 (Bauer Tap - Vermilion 710S)
		7L701 (Battle River 757S - Heisler Tap)
Modify Planned RAS 139[a]	Above short-term (emergency) rating	Nevis 766S Transformer 901T
TFO capital maintenance project to restore ratings on the 144 kV transmission line 7L127L	Above short-term (emergency) rating	7L127 (Pemukan 932S - Monitor 774S)
Planned RAS 139	Above short-term (emergency) rating	7L85 (Wintering Hills 804S - Bullpound 803S)
		7L159 (7L159 Tap - Heatburg 948S)
		Nevis 766S Transformer 901T
	Above seasonal continuous rating	7L16 (Heatburg 948S - Nevis 766S)
		7L85 (Bullpound 803S - Anderson 801S)
		7L85 (Wintering Hills 804S - Bullpound 803S)
		7L159 (7L159 Tap - Heatburg 948S)
TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L	Above short-term (emergency) rating	912L\9L912 (Nevis 766S - Red Deer 63S)
	Above seasonal continuous rating	912L\9L912 (Nevis 766S - Red Deer 63S)
Real time operational practices	Above Short-term (emergency) rating	7L14 (Kitscoty 705S - Hill 751S)
		7L130 (Vermilion 710S - Kitscoty 705S)
	Above seasonal continuous rating	749L (Killarney Tap to Edgerton 899S)

[a] In this section, “Modify” refers to adding the Project to the logic of the respective RAS.

5.2. Case B

5.2.1. Pre-Project

Pre-Project mitigation measures are summarized in Table 5-3.

Table 5-3: Case B Pre-Project Mitigation Measures

Mitigation Measure	Mitigated Reliability Criteria Violation	
	Thermal Criteria Violation Type	Transmission Facility
Planned 7L129 RAS[a]	Above short-term (emergency) rating	7L129 (Buffalo Creek 526S - Bauer Tap)
	Above seasonal	7L129 (Buffalo Creek 526S - Bauer Tap)

Mitigation Measure	Mitigated Reliability Criteria Violation	
	Thermal Criteria Violation Type	Transmission Facility
	continuous rating	7L129 (Bauer Tap - Vermilion 710S)
Planned RAS 139	Above Short-term (emergency) rating	7L85 (Bullpound803S - Anderson 801S)
		7L85 (Wintering Hills 804S - Bullpound 803S)
		7L159 (7L159 Tap - Heatburg 948S)
		Nevis 766S Transformer 901T
	Above seasonal continuous rating	7L16 (Heatburg 948S - Nevis 766S)
		7L85 (Bullpound803S - Anderson 801S)
		7L85 (Wintering Hills 804S - Bullpound 803S)
		7L159 (7L159 Tap - Heatburg 948S)
Real time operational practices	Above seasonal continuous rating	912L\9L912 (Nevis 766S - Red Deer 63S)
	Above Short-term (emergency) rating	7L14 (Kitscoty 705S - Hill 751S)
		7L130 (Vermilion 710S - Kitscoty 705S)

[a] The planned 7L129L RAS is proposed for the planned Irma Wind Power Project Connection.

5.2.2. Post-Project

Post-Project mitigation measures are summarized in Table 5-4.

Table 5-4: Case B Post-Project Mitigation Measures

Mitigation Measure	Mitigated Reliability Criteria Violation	
	Thermal Criteria Violation Type	Transmission Facility
Existing RAS 134	Above seasonal continuous rating	701L (Heisler Tap - Strome 223S)
		701L (Strome 223S - North Holden 395S)
		174L (North Holden 395S - Bardo 197S)
		7L701 (Battle River 757S - Heisler Tap)
Modify Planned 7L129 RAS[a]	Above short-term (emergency) rating	7L129 (Bauer Tap - Vermilion 710S)
		7L129 (Buffalo Creek 526S - Bauer Tap)
	Above seasonal continuous rating	7L129 (Bauer Tap - Vermilion 710S)
		7L129 (Buffalo Creek 526S - Bauer Tap)
Modify Planned RAS 139	Above short-term (emergency) rating	Nevis 766S Transformer 901T
Planned RAS 139	Above short-term (emergency) rating	7L85 (Bullpound 803S - Anderson 801S)
		7L85 (Wintering Hills 804S - Bullpound 803S)
		7L159 (7L159 Tap - Heatburg 948S)
		Nevis 766S Transformer 901T
	Above seasonal continuous rating	7L16 (Heatburg 948S - Nevis 766S)
		7L85 (Bullpound 803S - Anderson 801S)
		7L85 (Wintering Hills 804S - Bullpound 803S)

Mitigation Measure	Mitigated Reliability Criteria Violation	
	Thermal Criteria Violation Type	Transmission Facility
		7L159 (7L159 Tap - Heatburg 948S)
TFO capital maintenance project to restore ratings on the 240 kV transmission line 912L	Above short-term (emergency) rating	912L\9L912 (Nevis 766S - Red Deer 63S)
	Above seasonal continuous rating	912L\9L912 (Nevis 766S - Red Deer 63S)
Real time operational practices	Above short-term (emergency) rating	7L14 (Kitscoty 705S - Hill 751S)
		7L130 (Vermilion 710S - Kitscoty 705S)
	Above seasonal continuous rating	749L (Killarney Tap to Edgerton 899S)

[a] The planned 7L129L RAS is proposed for the planned Irma Wind Power Project Connection.

5.3. Mitigation Measure Evaluation

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 the 2018 SL, SP and WP scenarios using Alternative 1 and the RASs described in Sections 5.1 and 5.2.

The post-mitigation power flow diagrams for selected Category B conditions are provided in Attachment A6. The post-mitigation power flow diagrams present only those post-Project contingencies that result in thermal criteria violations that require RAS mitigation. The 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. 2018 Summer Light Post-Project Case A

Category B conditions

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by the RASs described in Section 5.1, as shown in Table 5-5.

Table 5-5: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2018 SL Post-Project Scenario Case A

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

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
9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	103.4	103.4	76.5	76.5
	7L159 (7L159 Tap to Heatburg 948S)	109.3	123.6	120.8	110.6	94.1	86.1
	7L16 (Heatburg 948S to Nevis 766S)	109.3	123.6	117.4	107.4	90.6	82.9
	7L85 (Bullpound 803S to Anderson 801S)	109.3	123.6	123.2	112.7	86.5	79.1
	7L85 (Wintering Hills 804S to Bullpound 803S)	109.3	123.6	129.2	118.2	92.4	84.5

5.3.2. 2018 Summer Light Post-Project Case B

Category B conditions

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by the RASs described in Section 5.2, as shown in Table 5-6.

Table 5-6: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2018 SL Post-Project Scenario Case B

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
766S901T (Nevis 766S Transformer 901T)	174L (North Holden 395S to Bardo 197S)	85.1	94.0	87.9	103.3	0.0	0.0
912L_9L912 (Red Deer 63S to Nevis 766S)	174L (North Holden 395S to Bardo 197S)	85.1	94.0	87.9	103.3	0.0	0.0
9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	105.2	105.2	78.2	78.2
	7L159 (7L159 Tap to Heatburg 948S)	109.3	123.6	120.4	110.2	93.6	85.6
	7L16 (Heatburg 948S to Nevis 766S)	109.3	123.6	117.0	107.0	90.1	82.4
	7L85 (Bullpound 803S to Anderson 801S)	109.3	123.6	125.0	114.4	88.0	80.5
	7L85 (Wintering Hills 804S to Bullpound 803S)	109.3	123.6	131.0	119.9	94.0	86.0

5.3.3. 2018 Summer Peak Post-Project Case A

Category B conditions

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by the RASs described in Section 5.1, as shown in Table 5-7.

5.3.4. 2018 Summer Peak Post-Project Case B

Category B conditions

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by the RASs described in Section 5.2, as shown in Table 5-8.

Table 5-7: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2018 SP Post-Project Scenario Case A

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
267ST1 (Killarney Lake 267S Transformer T1)	7L50 (Jarrow Tap to Buffalo Creek 526S)	109.3	123.6	125.8	115.1	104.1	95.2
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	111.0	101.6	89.6	82.0
766S901T (Nevis 766S Transformer 901T)	701L (Heisler Tap to Strome 223S)	139.9	160.0	146.7	104.9	133.9	95.7
	701L (Strome 223S to North Holden 395S)	119.0	167.0	128.7	108.1	115.9	97.4
	7L50 (Jarrow Tap to Buffalo Creek 526S)	109.3	123.6	122.9	112.5	104.1	95.2
	7L701 (Battle River 757S to Heisler Tap)	139.9	160.0	141.8	101.4	129.7	92.7
7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)	7L50 (Jarrow Tap to Buffalo Creek 526S)	109.3	123.6	113.6	104.0	105.6	96.6
7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)	7L50 (Jarrow Tap to Buffalo Creek 526S)	109.3	123.6	118.5	108.4	107.0	97.9
899ST3A (Edgerton 899S Transformer T3A)	7L50 (Jarrow Tap to Buffalo Creek 526S)	109.3	123.6	121.2	110.9	104.9	96.0
912L_9L912 (Red Deer 63S to Nevis 766S)	701L (Heisler Tap to Strome 223S)	139.9	160.0	146.6	104.8	133.7	95.6
	701L (Strome 223S to North Holden 395S)	119.0	167.0	128.5	108.0	115.8	97.3
	7L50 (Jarrow Tap to Buffalo Creek 526S)	109.3	123.6	122.7	112.3	103.9	95.1
	7L701 (Battle River 757S to Heisler Tap)	139.9	160.0	140.8	100.6	128.8	92.1
9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	112.0	112.0	96.0	96.0
	7L50 (Jarrow Tap to Buffalo Creek 526S)	109.3	123.6	114.7	104.9	103.1	94.3
9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	111.9	111.9	84.9	84.9
	7L159 (7L159 Tap to Heatburg 948S)	109.3	123.6	126.4	115.7	100.1	91.6
	7L16 (Heatburg 948S to Nevis 766S)	109.3	123.6	122.6	112.1	96.3	88.1
	7L85 (Bullpound 803S to Anderson 801S)	109.3	123.6	110.0	100.7	73.1	66.9
	7L85 (Wintering Hills 804S to Bullpound 803S)	109.3	123.6	120.9	110.6	83.8	76.7
EATL (Newell 2075S – Heathfield 2029S)	7L50 (Jarrow Tap to Buffalo Creek 526S)	109.3	123.6	117.9	107.9	104.5	95.6

Table 5-8: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2018 SP Post-Project Scenario Case B

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
267ST1 (Killarney Lake 267S Transformer T1)	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	127.6	116.7	107.6	98.4
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	136.6	125.0	104.4	95.5
377ST1 (Hardisty 377S Transformer T1)	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	110.2	100.8	105.8	96.8
701L (North Holden 395S to Strome 223S)	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	115.2	105.4	101.9	93.2
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	124.2	113.6	106.3	97.3
766S901T (Nevis 766S Transformer 901T)	174L (North Holden 395S to Bardo 197S)	85.1	94.0	87.1	102.4	0.0	0.0
	701L (Heisler Tap to Strome 223S)	139.9	160.0	149.9	107.2	112.6	80.5
	701L (Strome 223S to North Holden 395S)	119.0	167.0	131.9	110.8	93.4	78.5
	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	131.3	120.2	107.2	98.1
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	140.5	128.5	99.1	90.7
	7L701 (Battle River 757S to Heisler Tap)	139.9	160.0	145.7	104.1	111.6	79.8
7L42 (Hill 751S to Lloydminster 716S)	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	110.2	100.8	106.3	97.3
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	119.0	108.9	103.3	94.5
7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	119.6	109.4	106.2	97.2
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	128.6	117.7	106.2	97.2
7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	120.0	109.8	104.3	95.4
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	128.8	117.8	105.0	96.1
7L77 (North Holden 395S to Vegreville 709S)	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	118.2	108.1	106.1	97.1
899ST3A (Edgerton 899S Transformer T3A)	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	122.9	112.4	107.0	97.9
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	131.7	120.5	107.8	98.6
912L_9L912 (Red Deer 63S to Nevis 766S)	174L (North Holden 395S to Bardo 197S)	85.1	94.0	86.9	102.2	0.0	0.0
	701L (Heisler Tap to Strome 223S)	139.9	160.0	149.8	107.1	112.5	80.4
	701L (Strome 223S to North Holden 395S)	119.0	167.0	131.7	110.7	93.3	78.4
	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	131.1	120.0	107.1	98.0
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	140.3	128.3	107.6	98.4
	7L701 (Battle River 757S to Heisler Tap)	139.9	160.0	144.6	103.4	110.5	79.0
9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	116.3	116.3	96.4	96.4
	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	122.9	112.4	104.1	95.2
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	131.9	120.7	103.6	94.8
9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	112.2	112.2	81.6	81.6
	7L159 (7L159 Tap to Heatburg 948S)	109.3	123.6	126.8	116.0	100.4	91.9
	7L16 (Heatburg 948S to Nevis 766S)	109.3	123.6	122.9	112.5	96.7	88.5

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
	7L85 (Bullpound 803S to Anderson 801S)	109.3	123.6	111.9	102.4	74.9	68.5
	7L85 (Wintering Hills 804S to Bullpound 803S)	109.3	123.6	122.8	112.3	85.6	78.3
EATL (Newell 2075S – Heathfield 2029S)	7L129 (Bauer Tap to Vermilion 710S)	109.3	123.6	124.1	113.6	106.2	97.2
	7L129 (Buffalo Creek 526S to Bauer Tap)	109.3	123.6	133.3	121.9	106.2	97.2

5.3.5. 2018 Winter Peak Post-Project Case A

Category B conditions

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by the RASs described in Section 5.1, as shown in Table 5-9.

Table 5-9: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2018 WP Post-Project Scenario Case A

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 to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	111.4	111.4	96.6	96.6
9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	107.0	107.0	80.3	80.3

5.3.6. 2018 Winter Peak Post-Project Case B

Category B conditions

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by the RASs described in Section 5.2, as shown in Table 5-10.

Table 5-10: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2018 WP Post-Project Scenario Case B

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
267ST1 (Killarney Lake 267S Transformer T1)	7L129 (Buffalo Creek 526S to Bauer Tap)	139.0	142.8	143.9	103.5	135.9	97.8
766S901T (Nevis 766S Transformer 901T)	7L129 (Bauer Tap to Vermilion 710S)	139.0	142.8	139.0	100.0	134.3	96.6
	7L129 (Buffalo Creek 526S to Bauer Tap)	139.0	142.8	147.3	106.0	133.0	95.7
912L_9L912 (Red Deer 63S to Nevis 766S)	7L129 (Buffalo Creek 526S to Bauer Tap)	139.0	142.8	147.0	105.8	132.7	95.5
9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	114.6	114.6	95.6	95.6

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
9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	100.0	100.0	104.2	104.2	77.1	77.1

5.4. Constraint Effective Factors

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

AESO Engineering Connection Assessment Scope

EDP Renewables SH Project Limited Partnership
Sharp Hills Wind Farm Connection

AESO Project Number: 1567

Company Name	Engineer Name P.Eng.	Date	Engineer Signature
Teshmont Consultants LP	Dibakar Shil, P.Eng.	23 OCT. 2017	
AESO (Project Studies Engineer)	Jahnavi Gopi Krishnan, E.I.T	23 Oct 2017	Jahnavi
	Maz Mazadi, PhD, P.Eng.	23 oct. 2017	Mazadi

Company Name	Name	Date	Signature
EDP Renewables SH Project Limited Partnership (EDPR)	Tom Loturco	23 OCT 2017	

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Attachments

Attachment A1.1 Transmission Planning Criteria – Basis and Assumptions

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1. Introduction

This AESO Engineering Connection Assessment Scope provides an overview of the engineering studies to be completed by Teshmont Consultants LP (the Studies Consultant) to assess the impact of the Project (as defined in Section 1.1) on the performance of the Alberta interconnected electric system (AIES). Technical criteria, assumptions and methods for performing these engineering studies are provided in this document.

1.1. Project

1.1.1. Project Overview

EDP Renewables SH Project Limited Partnership by its general partner, EDP Renewable SH Project GP Ltd. (EDPR) (Market Participant) has submitted a request for system access service to the Alberta Electric System Operator (AESO) to connect its proposed Sharp Hills Wind Project (Facility) to the AIES. The Facility is a wind aggregated generating facility, and includes a proposed collector station, to be designated the Sedalia 363S. The Facility is planned to be located in the Sedalia area in the AESO planning area of Hanna (Area 42).

The Market Participant's request includes: a request for a Rate STS, *Supply Transmission Service*, contract capacity of 300 MW and a request for a Rate DTS, *Demand Transmission Service*, contract capacity of 1.0 MW for new system access service in the area; and a request for transmission development (collectively, the Project).

The scheduled in-service date (ISD) for the Project is May 1, 2019.

1.1.2. Load Component

The Project includes a load component:

- Requested Rate DTS contract capacity: 1 MW
- Load type: substation service and auxiliary load.

1.1.3. Generation Component

The Project includes the following generation component:

- Requested Rate STS contract capacity: 300 MW

- Facility maximum authorized real power (MARP): 300 MW
- Facility maximum capability (MC): 300 MW
- Generator type: Wind
- Turbine size and type: V136- 3.6 MW, Type IV
- It is assumed that the aggregated generating facility has the minimum continuous reactive power capability of either supplying reactive power at 0.9 power factor (PF) lagging or absorbing reactive power at 0.95 PF leading, per the technical requirements of Section 502.1 of the ISO rules, *Wind Aggregated Generating Facilities Technical Requirements*
- The Market Participant advised that there is no future expansion planned.

1.2. Study Scope

1.2.1. Study Objectives

The objectives of the studies are as follows:

- Study the impact of the Project on the performance of the AIES.
- Identify any violations of the relevant AESO criteria, standards, or requirements, both pre-Project and post-Project.
- Recommend mitigation measures, if required, to reliably connect the Project to the AIES.

1.2.2. Study Area

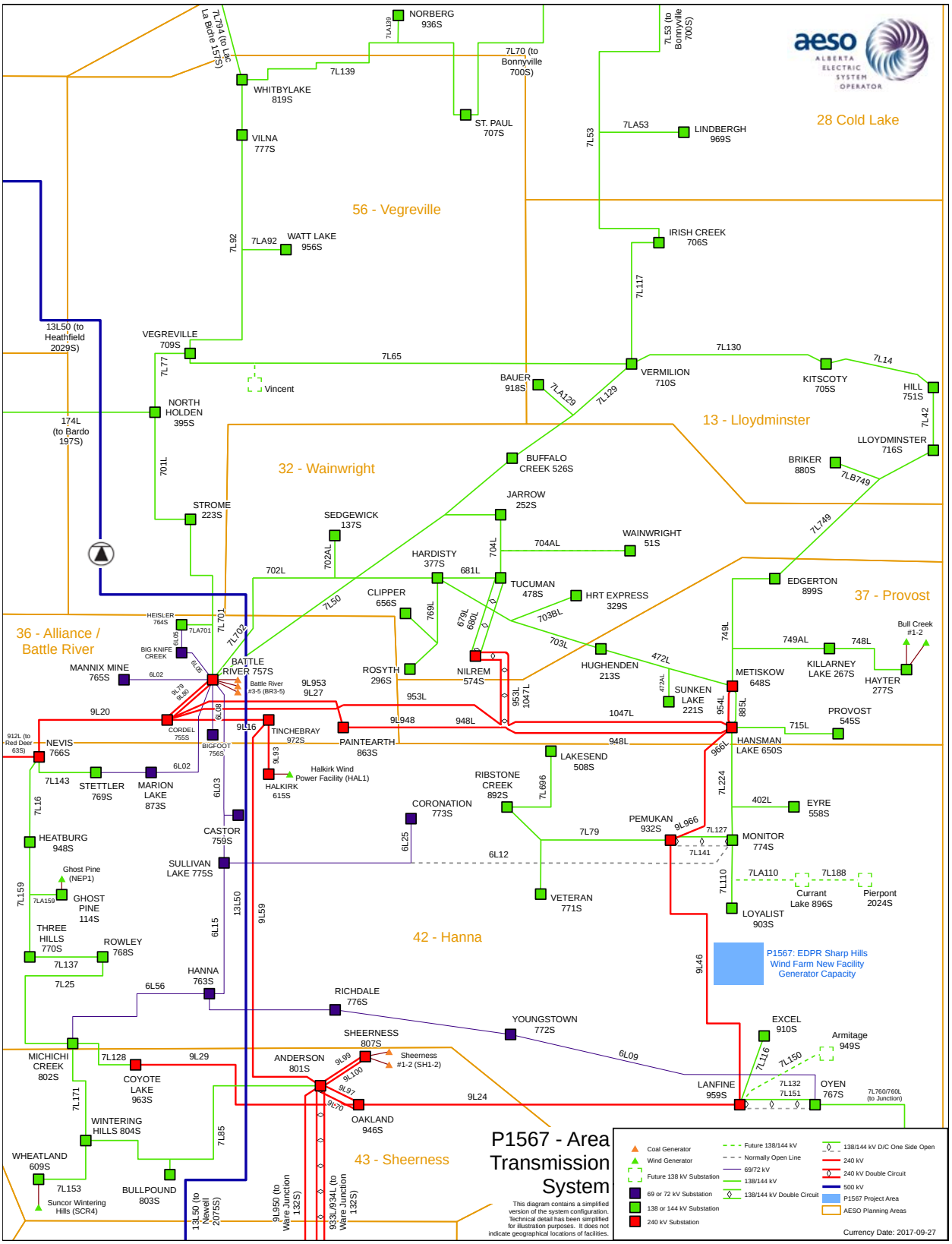
1.2.2.1. Study Area Description

Geographically, the Project is located in the AESO planning area of Hanna (Area 42), which is part of the AESO Central Planning Region.

The Study Area for the Project consists of the AESO Planning areas of Hanna (Area 42), Alliance/Battle River (Area 36), Vegreville (Area 56), Wainwright (Area 32), Lloydminster (Area 13), Provost (Area 37) and Sheerness (Area 43), including the tie lines connecting these planning areas to the rest of the AIES. All transmission facilities within the Study Area will be studied and monitored for violations of the Reliability Criteria (defined in Section 3.1).

Figure 1-1 shows the existing transmission system configuration in the Study Area. The Study Area is served by 240 kV, 138/144 kV, and 69/72 kV transmission systems. Generation in the Study Area includes coal generation facilities in Alliance/Battle River (Area 36) and Sheerness (Area 43); and wind generating facilities in Hanna (Area 42) and Provost (Area 37).

Figure 1-1: Existing Study Area Transmission System



1.2.2.2. 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 existing constraints in the Study Area that are mitigated by remedial action schemes (RASs).

The following mitigations are used to manage constraints in the area:

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

1.2.3. Engineering Studies Required

The following engineering studies are required for the pre-Project scenarios:

- Power flow studies
- Short-circuit studies

The following engineering studies are required for the post-Project scenarios:

- Power flow studies
- Transient stability studies
- Short-circuit studies

2. Connection Alternative to be Studied

The following alternative will be studied.

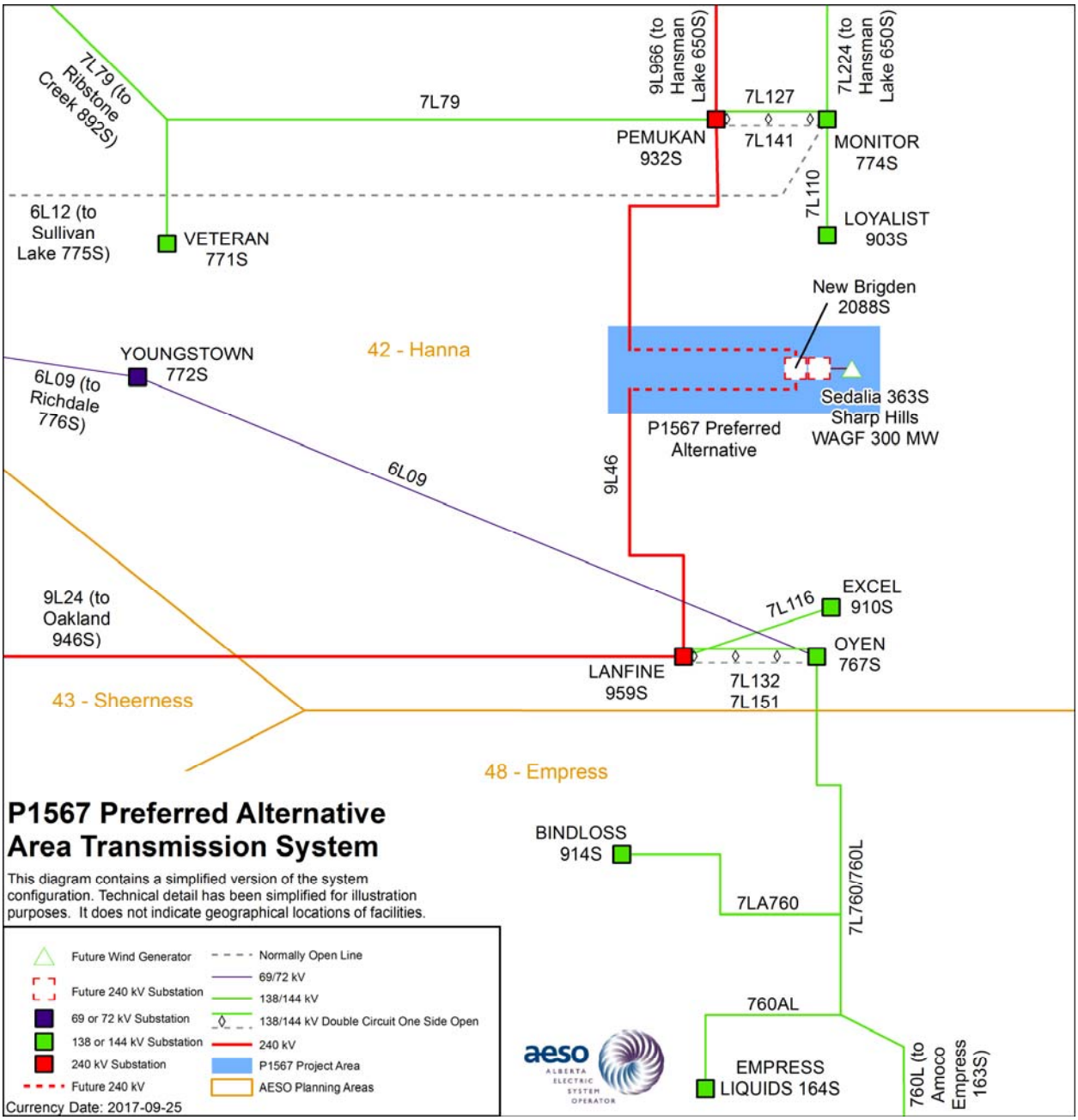
Alternative 1 – In-and-out connection to the 240 kV transmission line 9L46

This alternative includes the following developments:

- Add a switching station, to be called New Brigden 2088S, with four 240 kV circuit breakers.
- Add two 240 kV circuits to connect the proposed New Brigden 2088S substation to the existing transmission line 9L46 (between the Pemukan 932S and Lanfine 959S substations) using an in-and-out configuration.
- Connect the Facility to the proposed New Brigden 2088S 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



3. Criteria, System Data, and Study Assumptions

3.1. Criteria, Standards, and Requirements

3.1.1. AESO Reliability Criteria

The Transmission Planning (TPL) Standards, which are included in the Alberta Reliability Standards, and the AESO's *Transmission Planning Criteria – Basis and Assumptions* [1] (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 (i.e., single element outage), prior to and following the studied alternatives. Below is a summary of Category A and Category B system conditions.

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

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

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

- Seasonal continuous thermal rating of the line's loading limits.
- Highest specified loading limits for transformers.

[1] Please refer to Attachment A1.1

- For Category A conditions: Voltage range under normal operating condition per AESO Information Document ID #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 POD low voltage bus.	±10%	±7%	±5%

3.1.2. ISO Rules and IDs

ID #2010-007RS will be applied to establish system normal (i.e., pre- contingency) voltage profiles in 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* and the AESO's *Generation and Load Interconnection Standard*.

3.1.3. Wind Aggregated Generating Facility Requirements

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

3.2. Study Scenarios

At the time of study, the scheduled ISD for the Project was June 30, 2018. Therefore, the studies were performed using the 2018 summer light (SL), summer peak (SP), and winter peak (WP) scenarios. The short-circuit studies will also be performed using the 2026 WP scenario.

Table 3-2 provides a list of the study scenarios. The post-Project scenarios reflect the requested Rate STS contract capacity of 300 MW.

Table 3-2: List of the Connection Study Scenarios

Scenario	Year/Season Load	Condition	Project Generation (MW)	System Generation Dispatch Conditions
1	2018 SL	Pre-project	0	High Wind, Economic Coal
2	2018 SP	Pre-Project	0	High Wind, Economic Coal
3	2018 WP	Pre-project	0	High Wind, Economic Coal
4	2018 SL	Post-Project	300	High Wind, Economic Coal
5	2018 SP	Post Project	300	High Wind, Economic Coal
6	2018 WP	Post-Project	300	High Wind, Economic Coal
7	2026 WP	Post-Project	300	All generation in the Study Area on

3.3. Load and Generation Assumptions

3.3.1. Load Assumptions

The AESO Planning Region load forecasts to be used for this connection study are shown in Table 3-3 and are based on the *AESO 2016 Long-term Outlook* (2016 LTO), which was the available forecast at the time of the study.

Table 3-3: Forecast Area Load (2016 LTO at AIL Peak)

Region Name and Season		Forecast Peak Load (MW)
		2018
Central Planning Region*	SP	2,050
	SL	1,505
	WP	2,270

Note: *The Central Region comprises the following AESO planning areas: 56,13,32,37,36,42,35,39,38,30,29,34, and 28.

3.3.2. Generation Assumptions

The generation forecast to be used for the studies is based on the 2016 LTO. The generation assumptions for the studies will assume high wind and economic coal dispatch conditions.

The non-renewable generating units in the Study Area and their dispatch levels for the studies are shown in Table 3-4.

Table 3-4: Non-Renewable Generation (MW) in the Study Area

Existing/ Future	Unit Name	Pmax (MW)	AESO Planning Area	Unit Net Generation (MW)*		
				2018 SP	2018 SL	2018 WP
Existing	Battle River #3	149	36	103	60	112
Existing	Battle River #4	155	36	104	72	121
Existing	Battle River #5	385	36	262	180	304
Existing	Sheerness #1	400	43	237	160	261
Existing	Sheerness #2	390	43	224	143	263

Note: *Unit Net Generation refers to Gross Generating unit MW output less Unit Service Load.

Using the 2016 LTO's 2018 renewable generation forecast of 1,651 MW, the generation assumptions will dispatch the renewable generation facilities to yield the credible worst-case power flow conditions for the Study Area. Two different renewable generation dispatch cases, Case A (without the planned Irma Wind Power Project[2]) and Case B (with the planned Irma Wind Power Project) will be studied for each scenario (see Table 3-6). Two different renewable generation dispatch cases will be studied as it is expected that different mitigation measures will be required, depending on whether or not the Irma Wind Power Project is connected prior to the connection of the Project.

The pre-Project dispatch levels for the existing and under-construction renewable generation facilities are shown in Table 3-5.

Table 3-5: Pre-Project Scenario Dispatch Levels for Existing Renewable Generation in the Study Area

Renewable Generating Facility Name	AESO Planning Area No.	Busses	MC (MW)	2018 SP/SL/WP Unit Net Generation (MW)	
				Case A	Case B
Ardenville Wind	53	4735, 4740	68	0	0
Blue Trail Wind	53	66328, 67328	66	0	0
Castle River #1	53	2234, 3234	39	0	0
Castle Rock Ridge Wind Farm	53	67221	77	77	0
Cowley Ridge	53	255, 265, 4264	38	0	0
Enmax Taber	52	15343, 16343	81	81	70.5
Kettles Hill	53	2402, 3402	63	0	0
McBride Lake Wind farm	53	2901, 3901, 4901	73	0	0
Soderglen Wind	53	12358, 13358	71	0	0
Summerview 1	53	2338, 3338	66	0	0
Summerview 2	53	4339, 5337	66	0	0
Suncor Chin Chute	54	2389	30	0	0

[2] The Irma Wind Power Project is also referred to as the Mainstream Wind Project. The *Irma Wind Power Project Connection Needs Identification Document* (NID) was filed with the AUC on August 3, 2017 in Proceeding 22857.

Suncor Magrath	53	11002	30	2.5	0
Suncor Wintering Hills	43	60789, 60791, 60793, 60846, 60848,	88	88	88
Black Spring Ridge	49	61736, 61737	300	300	300
Oldman River	53	61543	46	46	46
AESO South Planning Region Subtotal			**1,202**	**594.5**	**504.5**
Ghost Pine	42	2621 to 2625	82	82	82
Halkirk	42	66435, 67435	150	150	150
Bull Creek DG	37	4222	29.5	29.5	29.5
AESO Central Planning Region Subtotal			**261.5**	**261.5**	**261.5**
Total Existing Renewable Generation			**1,463.5**	**856**	**766**

Planned renewable generation facilities will be dispatched according the AESO Connection Queue. Table 3-6 depicts the pre-Project dispatch levels for the planned renewable generation projects in the AESO South and Central planning regions that are ahead of the Project in the AESO Connection Queue, as of October 02, 2017. The planned renewable generation projects, if any, that have queue positions after the Project are not listed in this table and will not be dispatched.

Table 3-6: Pre-Project Scenario Dispatch Levels for Planned Renewable Generation in the Study Area

AESO Project Name	AESO Project Number	AESO Planning Area No.	Pmax (MW)	2018 SP/SL/WP Unit Net Generation (MW)	
				Case A	Case B
Irma Wind Power Project[a]	937	32	90	0	90
E.ON Grizzly Bear Wind[b]	1250	13	120	0	0
Suncor Hand Hills Wind Energy Project[c]	635	42	80	80	80
BluEarth Hand Hills Wind Energy Project[d]	678	42	80	80	80
Joss MPC WAGF[e]	1533	48	120	120	120
Naturener Wild Rose 1 Wind Farm[f]	479	4	210	210	210
Naturener Wild Rose 2 Wind Farm[f]	693	4	189	189	189
Pteragen Peace Butte 116 MW Wind Farm	513	4	116	116	116
Total Planned Renewable Generation				**795**	**885**

[a] The *Irma Wind Power Project Connection* NID, as filed with the AUC on August 3, 2017 in Proceeding 22857.
[b] The *Grizzly Bear Creek Wind Power Connection* NID, as originally approved by AUC Decision 21643-D01-2016 and Approval 21643-D02-2016.
[c] The *Suncor Hand Hills Wind Energy Connection* NID, as originally approved by AUC Decision 2482-D01-2015 and Approval 2482-D03-2015.
[d] The *BluEarth Hand Hills Wind Energy Connection* NID, as originally approved by AUC Decision 2482-D01-2015 and Approval 2482-D02-2015.
[e] The *Jenner Wind Energy Connection* NID, as originally approved by AUC Decision 21394-D01-2017 and Approval 21934-D02-2017.
[f] The *Wild Rose 1 and Wild Rose 2 Wind Energy Connections* NID, as originally approved by AUC Decision 211-352 and Approval U2011-266.

The post-Project scenario renewable generation dispatch levels were identical to the pre-Project scenario dispatch levels shown in Tables 3-5 and 3-6, except that the existing Black Spring Ridge facility was switched off (i.e., dispatched to 0 MW/MVAr) and the Facility was dispatched to 300 MW in all post-Project scenarios. This will result in a total renewable dispatch consistent with the 2016 LTO's 2018 renewable generation forecast of 1,651 MW.

3.3.3. Intertie Flow Assumptions

Intertie assumptions are included for the British Columbia-Alberta (BC-AB), Saskatchewan-Alberta (SK-AB), and Montana-Alberta (MATL) interties. Details on the assumptions can be found in Table 3-7. These export and import assumptions coincide with high export and high import conditions for the Study Area.

Table 3-7: Intertie Flow Assumptions

Scenario Number	Scenario Name	Intertie Flow Conditions	Intertie		
			Import (-) /Export (+) to BC BC-AB (MW)	Import (-) /Export (+) to Saskatchewan SK-AB (MW)	Import (-) /Export (+) to MATL MATL (MW)
1	2018 SL Pre-Project	High Export	700	150	300
2	2018 SP Pre-Project	High Import	-500	-150	-300
3	2018 WP Pre-Project	High Import	-500	-150	-300
4	2018 SL Post-Project	High Export	700	150	300
5	2018 SP Post-Project	High Import	-500	-150	-300
6	2018 WP Post-Project	High Import	-500	-150	-300

3.3.4. HVDC Power Order

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, as shown in Table 3-8.

Table 3-8: HVDC Power Order by Scenario

Scenario Number	Scenario	WATL (MW)	EATL (MW)
1	2018 SL Pre-Project	700 N → S	250 S → N
2	2018 SP Pre-Project	Blocked	700 S → N
3	2018 WP Pre-Project	Blocked	650 S → N
4	2018 SL Post-Project	700 N → S	250 S → N

Scenario Number	Scenario	WATL (MW)	EATL (MW)
5	2018 SP Post-Project	Blocked	700 S → N
6	2018 WP Post-Project	Blocked	650 S → N

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

S → N: HVDC flow direction is South to North

3.4. System Projects

No system transmission project will be considered in the system topology for the study scenarios because planned system transmission developments are not expected to be in service before the scheduled Project ISD.

3.5. Connection Projects

Connection projects within the Study Area that are ahead of the Project in the AESO Connection Queue as of October 2017 will be modelled in the study scenarios, unless otherwise indicated. Table 3-9 summarizes the connection project assumptions that will be used in the studies. Information in this table is subject to change as projects progress.

Table 3-9: Connection Project Assumptions within the Study Area

AESO Planning Area	Queue Position*	Scheduled In-Service Date	AESO Project Name	AESO Project Number	Gen (MW)	Load (MW)	Included/Excluded from Studies
42	6	12-Sep-19	Suncor Hand Hills Wind Energy Project	635	80	0.1	Included, see Table 3-6
42	7	01-Sep-19	BluEarth Hand Hills Wind Project	678	78.2	0	Included, see Table 3-6
32	15	01-Jul-19	Irma Wind Power	937	90	3	Included, see Table 3-6
13	21	01-Sep-19	E.ON Grizzly Bear Wind	1250	120	1.5	Included, see Table 3-6
56	29	13-Dec-19	ATCO Heartland Pump Station Connection	1410	0	20	Included
37	38	03-Dec-18	Enbridge Sunken Lake 221S Transformer Change	1516	0	14	Included
48	41	03-Dec-18	Joss MPC WAGF	1533	120	0	Included, see Table 3-6
32	43	01-Dec-18	Enbridge New Hardisty Substation	1558	0	0	Included
32	46	01-Mar-18	Fortis Wainwright Enhanced Reliability	1594	0	0	Included

Note: * Per the AESO Connection Queue posted in October 2017. The projects in the Study Area, if any, that have queue positions after the Project are not listed in this table and will not be modeled in the study scenarios

3.6. Facility Ratings and Shunt Elements

The legal owners of transmission facilities (TFOs) provided the thermal ratings assumptions for the existing transmission lines in the Study Area. Table 3-10 shows the seasonal continuous ratings and short-term (emergency) ratings for the key transmission lines in the Study Area, which will be used to perform the engineering studies.

Table 3-10: Thermal Rating Assumptions for Key Transmission Lines in the Study Area

Line ID	Line Description	Voltage Class (kV)	Seasonal Continuous Rating (MVA)		Short-term (Emergency) Rating (MVA)	
			Summer	Winter	Summer	Winter
704L	Jarrow 252S - Tucuman 478S	138	75	79	83	87
704L	Jarrow 252S - Jarrow 252S substation tap point	138	85	90	94	99
7L129	Buffalo Creek 526S - Vermilion 710S	138	109.3	139.0	123.6	142.8 CT
7L50	Buffalo Creek 526S - Jarrow 252S substation tap point	138	109.3	139.0	123.6	150.5
7L701/701L	Strome 223S - Battle River 757S	138	139.9	169	160.0	169
7L702/702L	Sedgewick 137S - Battle River 757S	138	109.3	118	123.6	130
748L	Killarney Lake 267S - Hayter 277S	138	119.0	146.0	131.0	161.0
749L	Metiskow 648S - Killarney Lake 267S substation tap point	138	121.0	149.0	133.0	164.0
749AL	Killarney Lake 267S - Killarney Lake 267S substation tap point	138	121.0	148.0	133.0	163.0
749L	Edgerton 899S - Killarney Lake 267S substation tap point	138	88.0	96.0 CT	97.0	140.0
749L/7L749	Edgerton 899S - Paradise Valley (PV) tap point	138	88.0	96.0 CT	97.0	140.0
7L749	Lloydminster 716S PV tap	138	109.3	139.0	123.6	150.5
7L159	Ghost Pine 114S - Three Hills 770S	138	109.3	126.5	123.6	126.5
7L159	Ghost Pine 114S - Heatburg 948S	138	109.3	126.5	123.6	126.5
7L16	Nevis 766S - Heatburg 948S	138	109.3	126.5	123.6	126.5
7L85	Wintering Hills 804S - Bullpound 803S	138	109.3	139.0	123.6	150.5
7L85	Bullpound 803S – Anderson 801S	138	109.3	126.5	123.6	126.5
7L25	Michichi Creek 802S - Rowley 768S	138	94.9 CT	94.9 CT	94.9 CT	94.9 CT
7L128	Michichi Creek 802S - Coyote Lake 963S	138	180.1	217.5	180.1	217.5
7L65	Vincent 2019S tap point - Vegreville 709S	138	94.9 CT	94.9 CT	94.9 CT	94.9 CT
7L53	Irish Creek 706S - Bonnyville 700S	138	71.9	86.3	71.9	86.3
7L117	Vermilion 710S - Irish Creek 706S	138	123.6	150.4	123.6	150.5
7L130	Kitscoty 705S - Vermilion 710S	138	71.9	86.3	71.9	86.3
7L14	Hill 751S - Kitscoty 705S	138	71.9	86.3	71.9	86.3
7L127	Pemukan 932S- Monitor 774S	138	126.5	126.5	126.5	126.5
9L912/912L	Red Deer 63S - Nevis 766S	240	350.0	498.0 CT	420.0 CT	498.0 CT

Line ID	Line Description	Voltage Class (kV)	Seasonal Continuous Rating (MVA)		Short-term (Emergency) Rating (MVA)	
			Summer	Winter	Summer	Winter
9L20	Nevis 766S - Cordel 755S	240	488.0	498.0 CT	498.0 CT	498.0 CT
9L29	Oakland 946S - Coyote Lake 963S	240	332 CT	332 CT	432 CT	432 CT
9L27	Cordel 755S - Paintearth 863S	240	332 CT	332 CT	332 CT	332 CT
9L953	Cordel 755S - Nilrem 574S	240	498 CT	498 CT	498 CT	498 CT
9L950	Anderson 801S - Ware Junction 132S	240	519	663	592	716
9L934	Anderson 801S - Ware Junction 132S	240	519	663	592	716
9L933	Anderson 801S - Ware Junction 132S	240	519	663	592	716
931L	Ware Junction 132S - West Brooks 28S	240	592	665	654	773
944L	Ware Junction 132S - Jenner 275S	240	550	679	660	815
951L	Ware Junction 132S - Jenner 275S	240	550	679	654	773
9L24	Oakland 946S - Lanfine 959S	240	332 CT	332 CT	432 CT	432 CT
9L59	Anderson 801S - Tinchebray 972S	240	549	701	627	759

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 3-11.

Table 3-11: Summary of Key Transformer Ratings in the Study Area

Substation Name and Number	Transformer ID	Transformer Voltages (kV)	Transformer Rating (MVA)
Pemukan 932S	901T	240/144/25	300/300/66.7
Coyote Lake 963S	901T	240/144/25	300/300/66.7
Lanfine 959S	901T	240/144/25	300/300/66.7
Anderson	901T	240/144	125
Battle River 757S	912T	240/144	224
Battle River 757S	701T	144/72	75
Nevis 766S	901T	240/144	100
Nevis 766S	701T	144/25	12/16/20
Nilrem 574S	T1	240/138	400
Nilrem 574S	T2	240/138	400
Metiskow 648S	T3	240/138	200
Hansman 650S	T1	240/138	200
	T3	240/18	200

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 3-12.

Table 3-12: Summary of Key Shunt Elements in the Study Area

Substation Name and Number	Voltage Class (kV)	Capacitors		Reactors	
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)	Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)
Buffalo Creek 526S	138	1 x 15.00 MVAr	15.00	-	-
Sunken Lake 221S	138	1 x 18.00 MVAr	18.00	-	-
Halkirk 615S	34.5	1 x 6.00 MVAr + 3 x 18.00 MVAr	60.00	2 x -14.00 MVAr	-14.00
	0.5	2 x 12.50 MVAr	25.00	2 x -12.50 MVAr	-25.00
Hansman Lake 650S	18.0	1 x 200.0 MVAr	200.0	1 x -100.0 MVAr	-100.0
Hardisty 377S	138	1 x 27.02 MVAr	27.02	-	-
Hill 751S	138	1 x 18.12 MVAr + 1 x 22.96 MVAr	41.08	-	-
Stettler 769S	138	1 x 13.78 MVAr	13.78	-	-
Killarney Lake 267S	138	1 x 9.10 MVAr + 2 x 10.90 MVAr	30.90	-	-
Lloydminster 716S	138	1 x 18.12 MVAr	18.12	-	-
Tucuman 478S	138	1 x 27.17 MVAr	27.17	-	-
Vermilion 710S	138	1 x 22.96 MVAr	22.96	-	-
Lanfine 959S	34.5	1 x 200 MVAr	200	1 x -100 MVAr	-100
	138	2 x 27.55 MVAr	55.10	-	-
Monitor 774S	138	1 x 18.38 MVAr + 1 x 27.55 MVAr	45.93	-	-
Pemukan 932S	138	2 x 27.55 MVAr	55.10	-	-

3.7. Protection Fault Clearing Times

The transient stability studies will be performed for the contingencies shown in Table 3-13. The studies will be performed using the actual fault clearing times for the selected contingencies, which will be provided by the TFOs. If the TFOs do not specify the fault clearing times for one of the selected contingencies, then the studies for that contingency will be performed using the standard fault clearing times that are specified in Table 2-3 of the *Transmission Planning Criteria – Basis and Assumptions*. Transient stability studies should be performed using PSS/E and with a bolted three phase to ground fault to be applied in the fault location shown below.

Table 3-13: Contingencies to be Studied for Transient Stability Assessment and the Respective Protection Fault Clearing Times

Contingency (System Element Lost)				Fault Location	Clearing Times	
Transmission Line ID	Nominal Bus Voltage (kV)	Terminal Location				
		Terminal 1	Terminal 2		Terminal 1	Terminal 2
9L24	240	Oakland 946S	Lanfine 959S	Oakland 946S	5 cycles	6 cycles
9L24	240	Lanfine 959S	Oakland 946S	Lanfine 959S	5 cycles	6 cycles

9L46	240	Lanfine 959S	Pemukan 932S	Lanfine 959S	5 cycles	6 cycles
9L46	240	Pemukan 932S	Lanfine 959S	Pemukan 932S	5 cycles	6 cycles
9L966	240	Pemukan 932S	Hansman Lake 650S	Pemukan 932S	5 cycles	6 cycles
9L966	240	Hansman Lake 650S	Pemukan 932S	Hansman Lake 650S	5 cycles	6 cycles
912L	240	Red Deer 63S	Nevis 766S	Red Deer 63S	5 cycles	6 cycles
912L	240	Nevis 766S	Red Deer 63S	Nevis 766S	5 cycles	6 cycles
9L59	240	Tinchebray 972S (Switch H)	Anderson 801S	Tinchebray 972S (Switch H)	5 cycles	6 cycles
9L59	240	Anderson 801S	Tinchebray 972S (Switch H)	Anderson 801S	5 cycles	6 cycles

3.8. Voltage Profile Assumption

ID #2010-007RS will be used to establish normal system (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 all the busses not included in the ID #2010-007RS. These voltages will be used to set the voltage profile for the study base cases prior to power flow studies.

4. Study Methodology

4.1. Engineering Studies to be Performed

The engineering studies to be performed for this connection assessment are identified in Table 4-1.

Table 4-1: Summary of Engineering Studies to be Performed

Scenario No. and Name		Renewable Generation Dispatch Case[a]	System Conditions	Power Flow	Transient Stability	Short-circuit
1	2018 SL Pre-Project	Case A	Category A and Category B	X		
		Case B	Category A and Category B	X		
2	2018 SP Pre-Project	Case A	Category A and Category B	X		
		Case B	Category A and Category B	X		
3	2018 WP Pre-Project	Case A	Category A and Category B	X		
		Case B	Category A and Category B	X		X[b]
4	2018 SL Post-Project	Case A	Category A and Category B	X		
		Case B	Category A and Category B	X	X	
5	2018 SP Post-Project	Case A	Category A and Category B	X		
		Case B	Category A and Category B	X	X	
6	2018 WP Post-Project	Case A	Category A and Category B	X		
		Case B	Category A and Category B	X	X	X[b]
7	2026 WP Post-Project	All generation in study area on Case B	Category A			X

Notes:
[a] As defined in Section 3.3.2.
[b] Only the Category A condition will be studied for short-circuit studies.

4.2. 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 remain locked to determine if any voltage deviations above 7% 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 and cases to be studied are as shown in Table 4-1.

4.2.1. Contingencies to be Studied

Power flow studies will be performed for all Category B contingencies in the Study Area.

4.3. Transient Stability Studies

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

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

The report presenting the results of the transient stability studies must provide response plots for multiple variables including rotor angle, and active and reactive power output for the following:

- the two Sheerness generating units in Sheerness (Area 43); and
- the three Battle River generating units in Alliance/Battle River (Area 36).

The results report must also provide the 240 kV and 138 kV bus voltage levels for substations near the point of connection (Sedalia 363S substation) including:

- the 240 kV busses at the New Brigden 2088S, Pemukan 932S, Lanfine 959S and Anderson 801S substations, and
- the 144 kV busses at the Hansman Lake 650S, Pemukan 932S, Lanfine 959S and Anderson 801S substations

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.

The scenarios and cases to be studied are as shown in Table 4-1.

4.3.1. Contingencies to be Studied

Transient stability studies will be performed for the contingencies shown in Table 3-13.

4.4. Short-circuit Studies

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.

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.

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

- Anderson 801S
- Sheerness 807S
- Oakland 946S 899S
- Hansman Lake 650S
- Lanfine 959S
- Excel 910S
- Monitor 774S
- Pemukan 932S
- Oyen 767S
- Sedalia 363S

The scenarios and cases to be studied are as shown in Table 4-1.

5. Mitigation Measures

5.1. Development

Mitigation measures may be required if the post-Project study results identify system performance issues. Mitigation measures for the Project may involve real-time operational practices and/or modifying or adding 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[3] 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 post-Project system reliability is maintained.

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 the AESO's system access business practices.

[3] 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.

5.2. Evaluation

5.2.1. 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 AESO Engineering Connection Assessment Scope and in accordance with further instructions from the AESO.

5.2.2. Constraint Effective Factor Studies

Constraint effective factor studies will be 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.

Attachment A1.1

Transmission Planning Criteria- Basis and Assumptions (Reliability Criteria)

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-AB-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-AB-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 are given in: AESO. *Alberta Reliability Standards*. Available from http://www.aeso.ca/rulesprocedures/17004.html

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	150
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 or 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

Performance Level	Disturbance (1)(2)(3)(4) Initiated by: Fault or No fault DC Disturbance	MW Margin (P-V method) (5)(6)(7)	MVAr Margin (V-Q method) (6)(7)
			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. i.e.: 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	Near End	Far End
kV	Cycles	Cycles
500	4	5
240	5	6
144/138	6	8

with telecommunications		
144/138 without telecommunications	6	30

Table 2-4: Stuck Breaker Clearing Times for Lines

Fault Clearing Time			Fault Clearing Time			Fault Clearing Time		
138/144 kV			240 kV			500 kV		
Near End	Far End	2nd Ckt (for C5 and C7 Only)	Near End	Far End	2nd Ckt (for C5 and C7 Only)	Near End	Far End	2nd Ckt (for C5 and C7 Only)
15	24	24	12	6	14	9	5	11

Table 2-5: Stuck Breaker Clearing Times for Transformers

Fault Clearing Time (Cycles)						Fault Clearing Time (Cycles)					
240/138 kV						500/240 kV					
Fault on 240 kV Side			Fault on 138 kV Side			Fault on 500 kV Side			Fault on 240 kV Side		
240 kV Side	138 kV Side	2nd Ckt (for Breaker Fail)	138 kV Side	240 kV Side	2nd Ckt (for Breaker Fail)	500 kV Side	240 kV Side	2nd Ckt (for Breaker Fail)	240 kV Side	500 kV Side	2nd Ckt (for Breaker Fail)
12	6	14	15	5	24	9	5	11	12	4	14

Attachment A2

Pre-Project Power Flow Diagrams

List of Figures

Scenario and Case Name	Contingency (System Element Lost)	Figure Number
2018 Summer Light Pre-Project Case A	N-0 (System Normal Condition)	Figure A2-1
	648ST1 (Metiskow 648S Transformer T1)	Figure A2-2
	9L29 (Oakland 946S to Coyote Lake 963S)	Figure A2-3
2018 Summer Light Pre-Project Case B	N-0 (System Normal Condition)	Figure A2-4
	648ST1 (Metiskow 648S Transformer T1)	Figure A2-5
	9L29 (Oakland 946S to Coyote Lake 963S)	Figure A2-6
2018 Summer Peak Pre-Project Case A	N-0 (System Normal Condition)	Figure A2-7
	766S901T (Nevis 766S Transformer 901T)	Figure A2-8
	9L29 (Oakland 946S to Coyote Lake 963S)	Figure A2-9
	EATL (Newell 2075S to Heathfield 2029S)	Figure A2-10
	899ST3A (Edgerton 899S Transformer T3A)	Figure A2-11
	912L_9L912 (Red Deer 63S to Nevis 766S)	Figure A2-12
	267ST1 (Killarney Lake 267S Transformer T1)	Figure A2-13
2018 Summer Peak Pre-Project Case B	N-0 (System Normal Condition)	Figure A2-14
	899ST3A (Edgerton 899S Transformer T3A)	Figure A2-15
	7L42 (Hill 751S to Lloydminster 716S)	Figure A2-16
	9L29 (Oakland 946S to Coyote Lake 963S)	Figure A2-17
	7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)	Figure A2-18
	267ST1 (Killarney Lake 267S Transformer T1)	Figure A2-19
	7L77 (North Holden 395S to Vegreville 709S)	Figure A2-20
	912L_9L912 (Red Deer 63S to Nevis 766S)	Figure A2-21
	766S901T (Nevis 766S Transformer 901T)	Figure A2-22
	9L20 (Nevis 766S to Cordel 755S)	Figure A2-23
	7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)	Figure A2-24
	701L (North Holden 395S to Strome 223S)	Figure A2-25
	EATL (Newell 2075S to Heathfield 2029S)	Figure A2-26
2018 Winter Peak Pre-Project Case A	N-0 (System Normal Condition)	Figure A2-27
	267ST1 (Killarney Lake 267S Transformer T1)	Figure A2-28
	9L29 (Oakland 946S to Coyote Lake 963S)	Figure A2-29
2018 Winter Peak Pre-Project Case B	N-0 (System Normal Condition)	Figure A2-30
	9L20 (Nevis 766S to Cordel 755S)	Figure A2-31
	9L29 (Oakland 946S to Coyote Lake 963S)	Figure A2-32
	267ST1 (Killarney Lake 267S Transformer T1)	Figure A2-33

Figure A2-1: 2018 Summer Light Pre-Project Case A - N-0 (System Normal Condition)

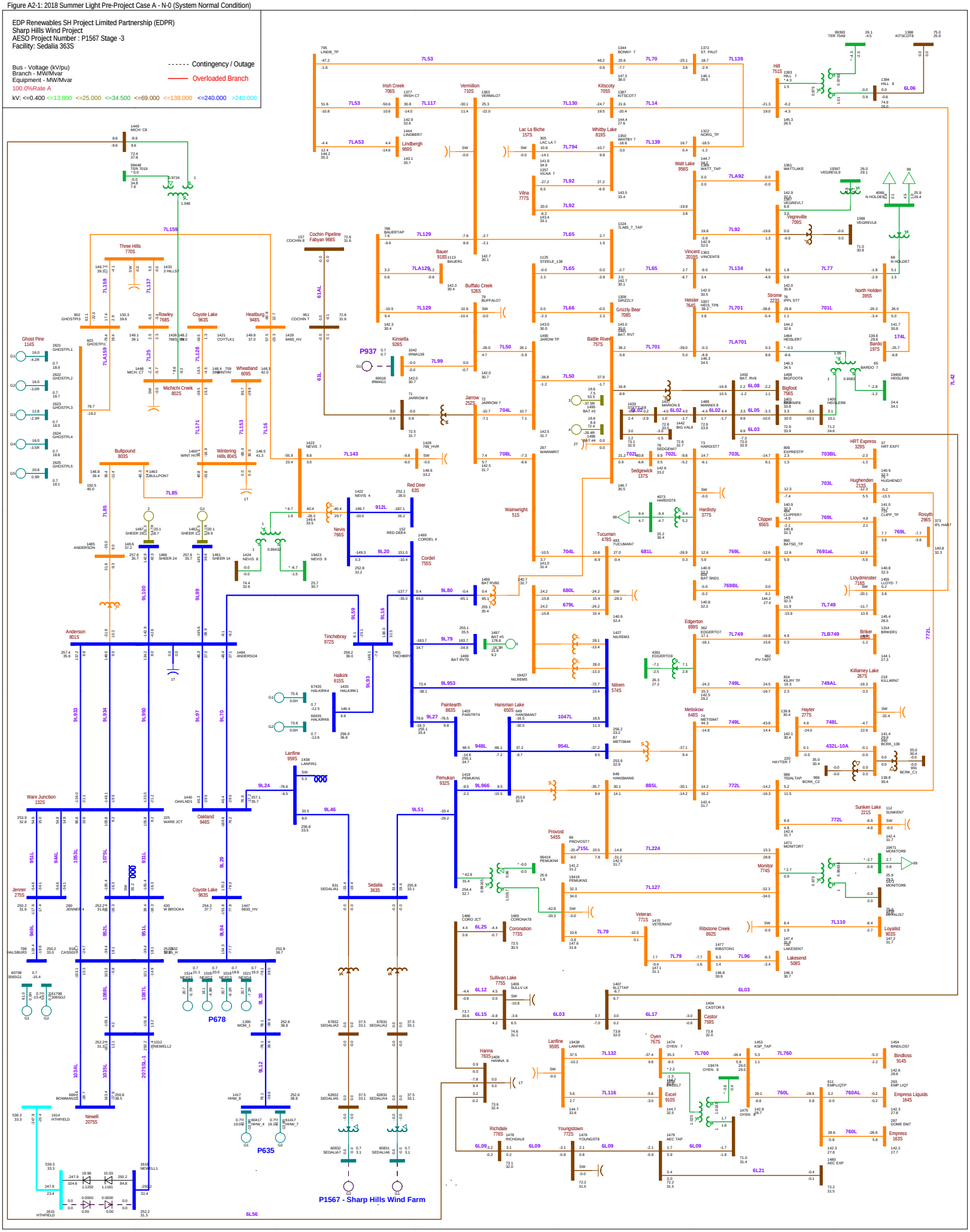


Figure A2-2: 2018 Summer Light Pre-Project Case A - Contingency of 648ST1 (Metiskow 648S Transformer T1)

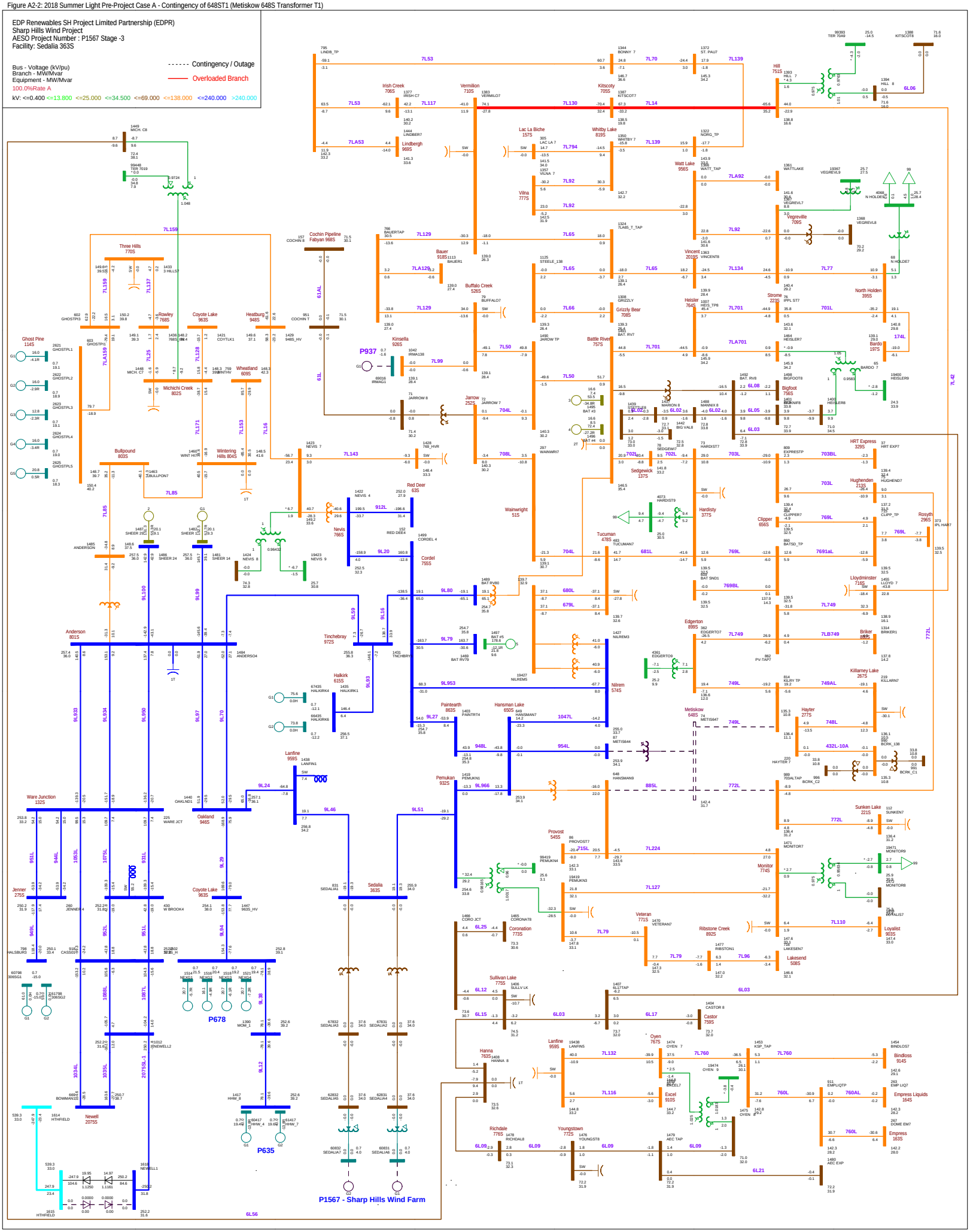


Figure A2-3: 2018 Summer Light Pre-Project Case A - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

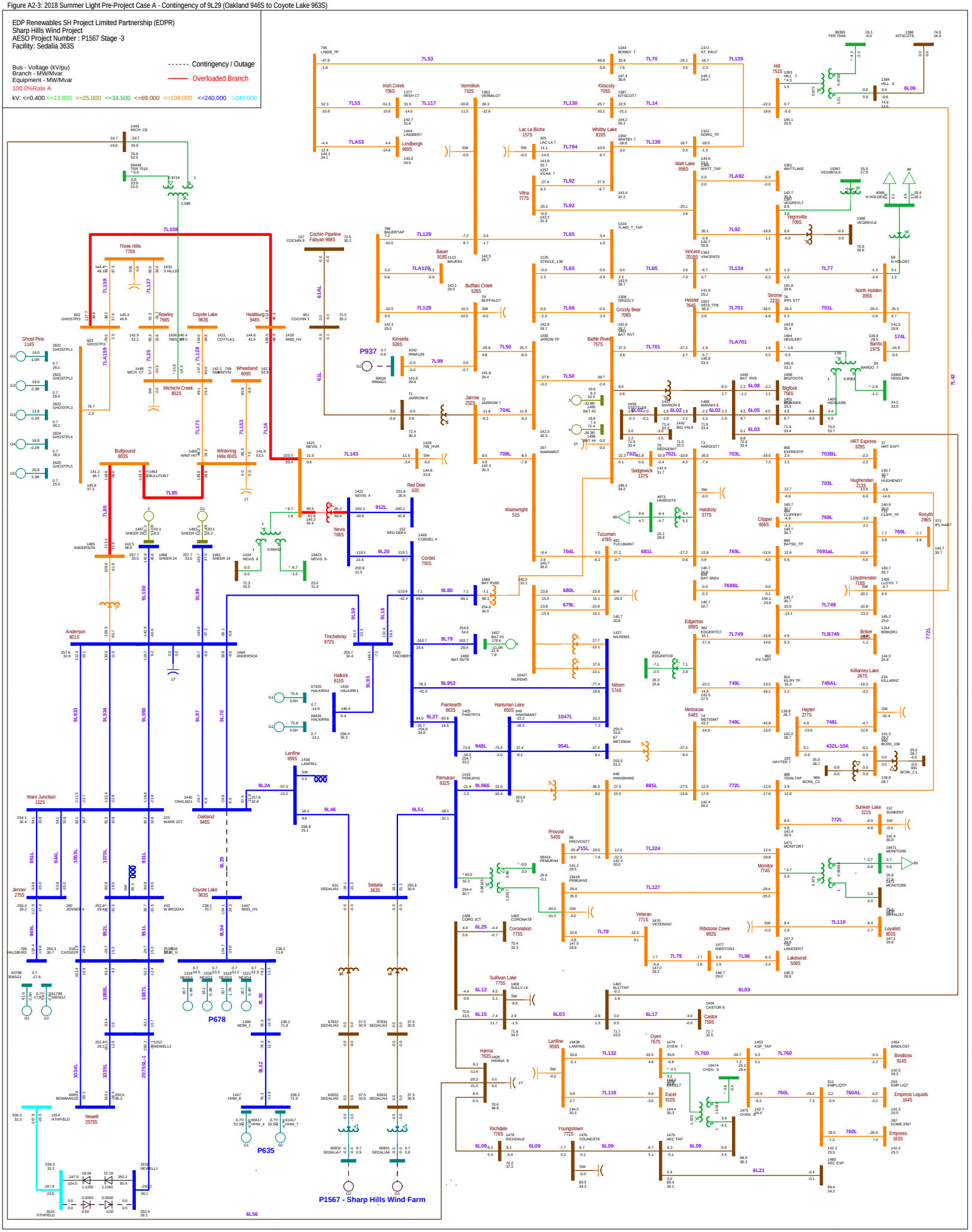


Figure A2-4: 2018 Summer Light Pre-Project Case B - N-0 (System Normal Condition)

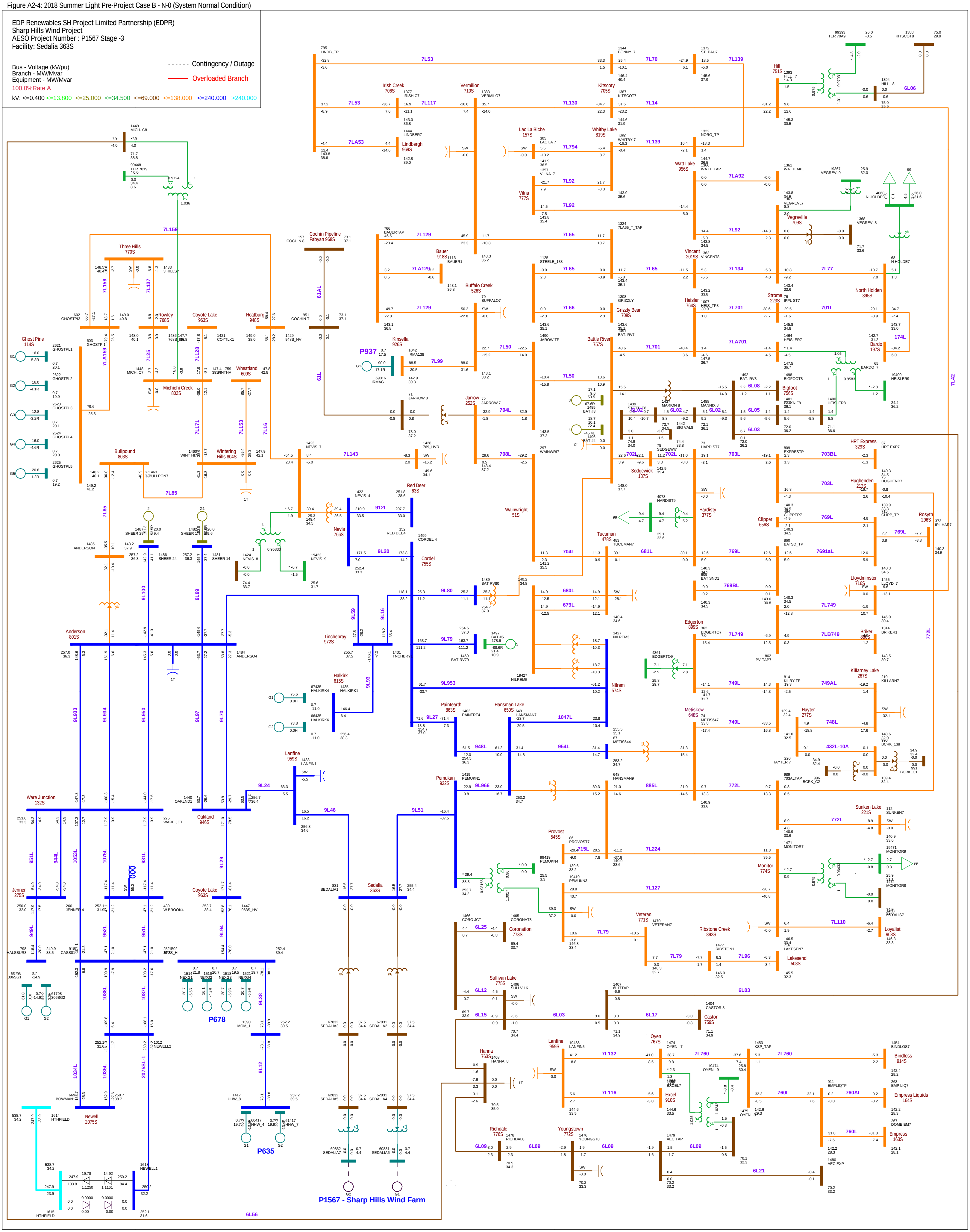


Figure A2-5: 2018 Summer Light Pre-Project Case B - Contingency of 648ST1 (Metiskow 648S Transformer T1)

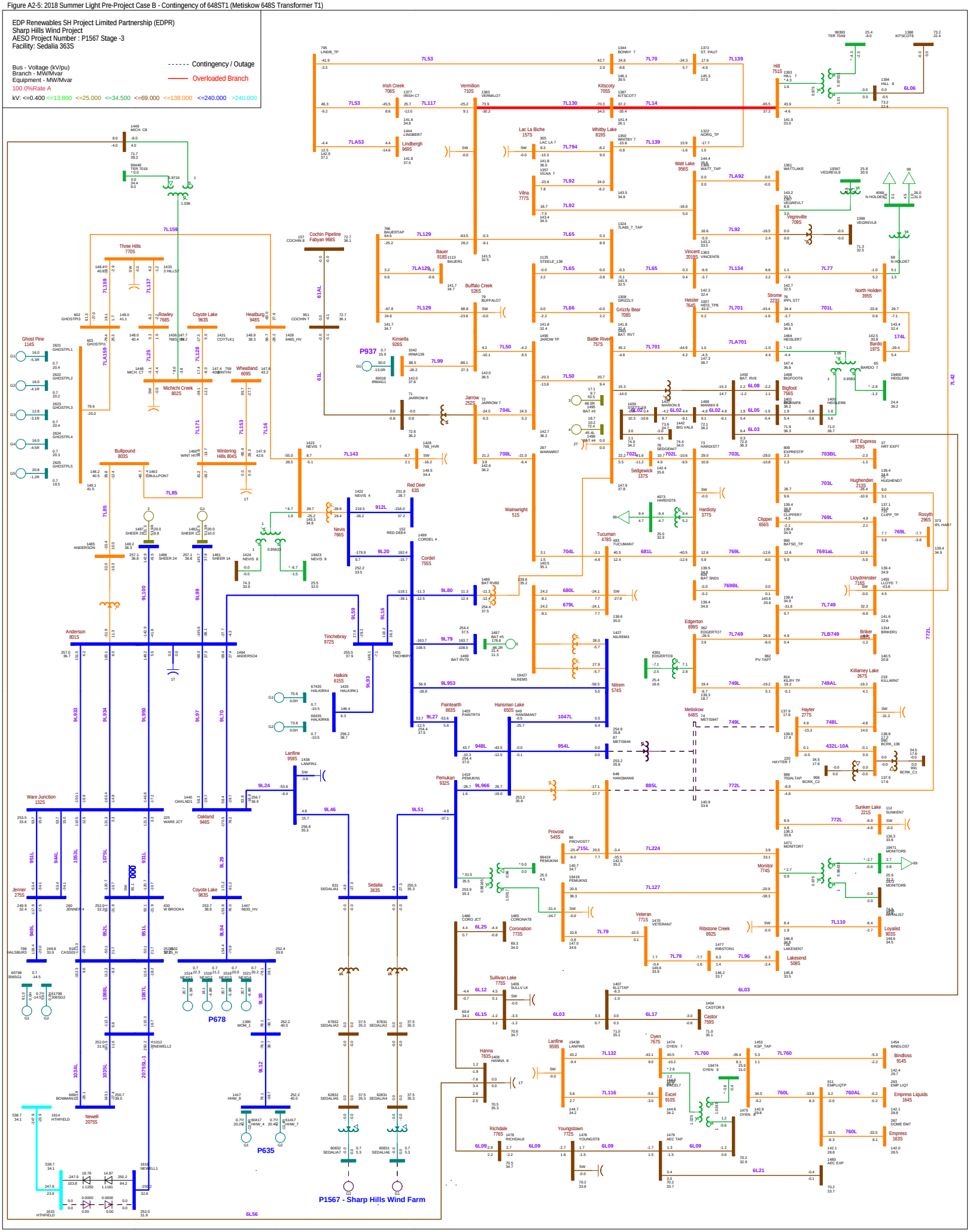


Figure A2-6: 2018 Summer Light Pre-Project Case B - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

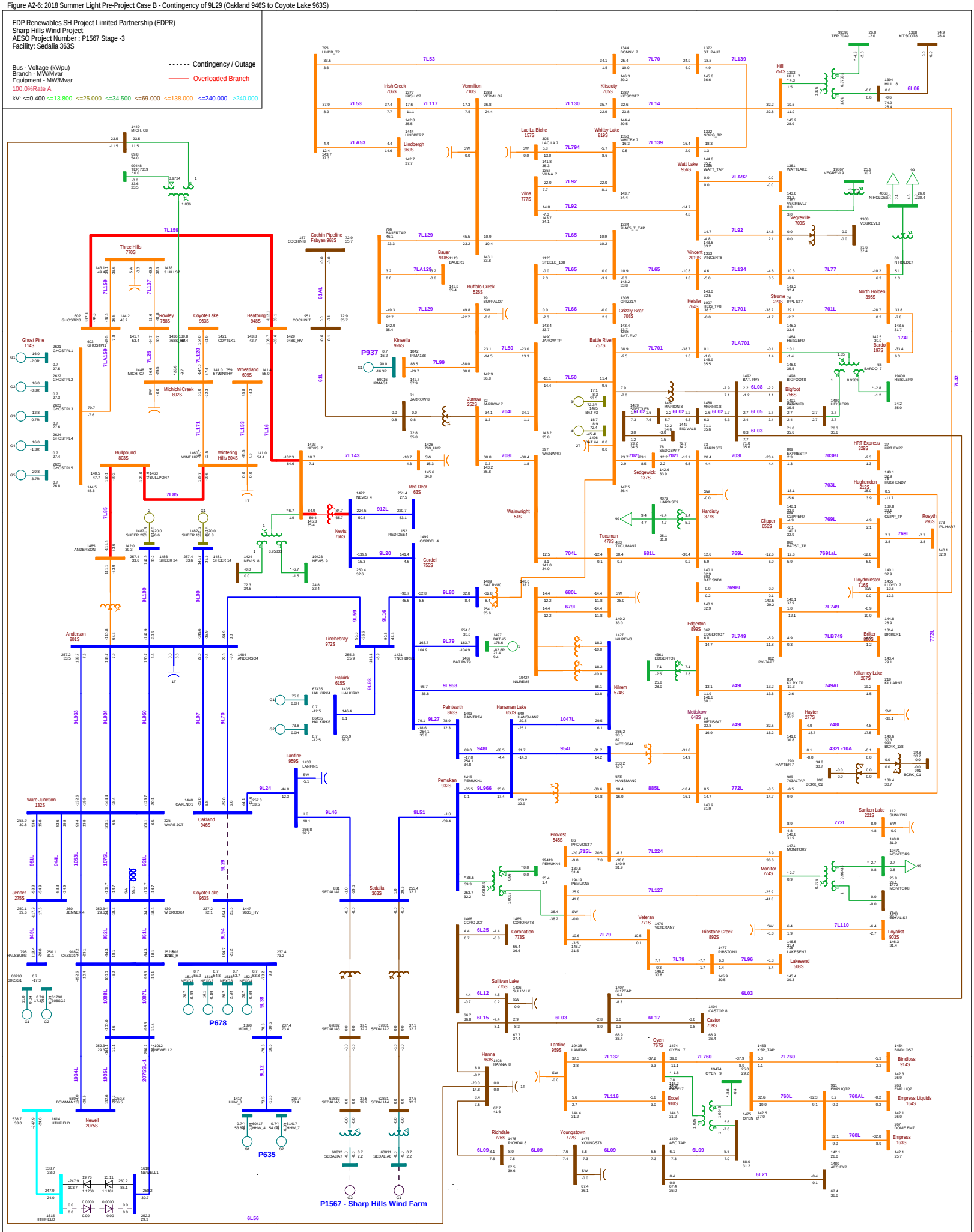


Figure A2-7: 2018 Summer Peak Pre-Project Case A - N-0 (System Normal Condition)

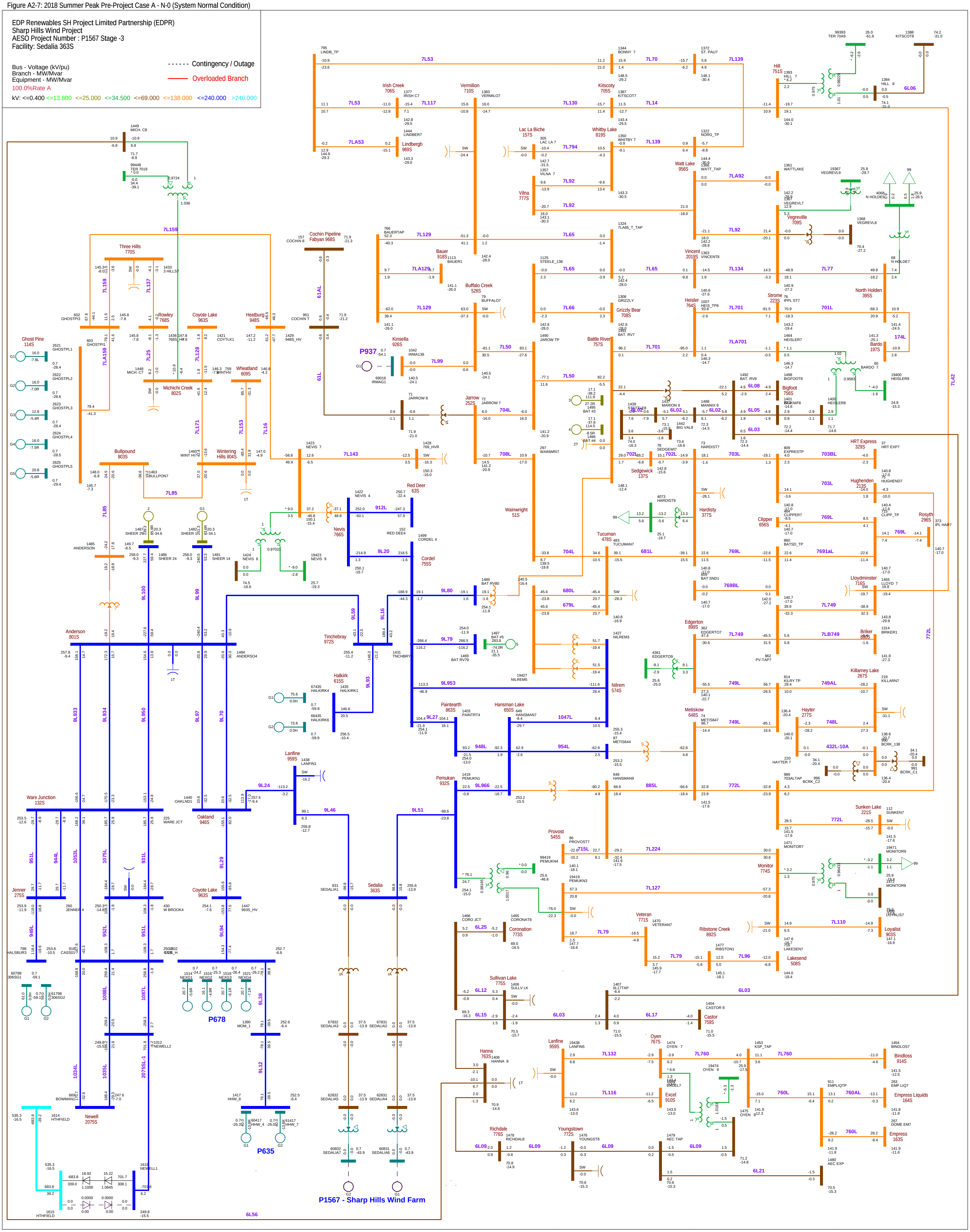


Figure A2-8: 2018 Summer Peak Pre-Project Case A - Contingency of 766S901T (Nevis 766S Transformer 901T)

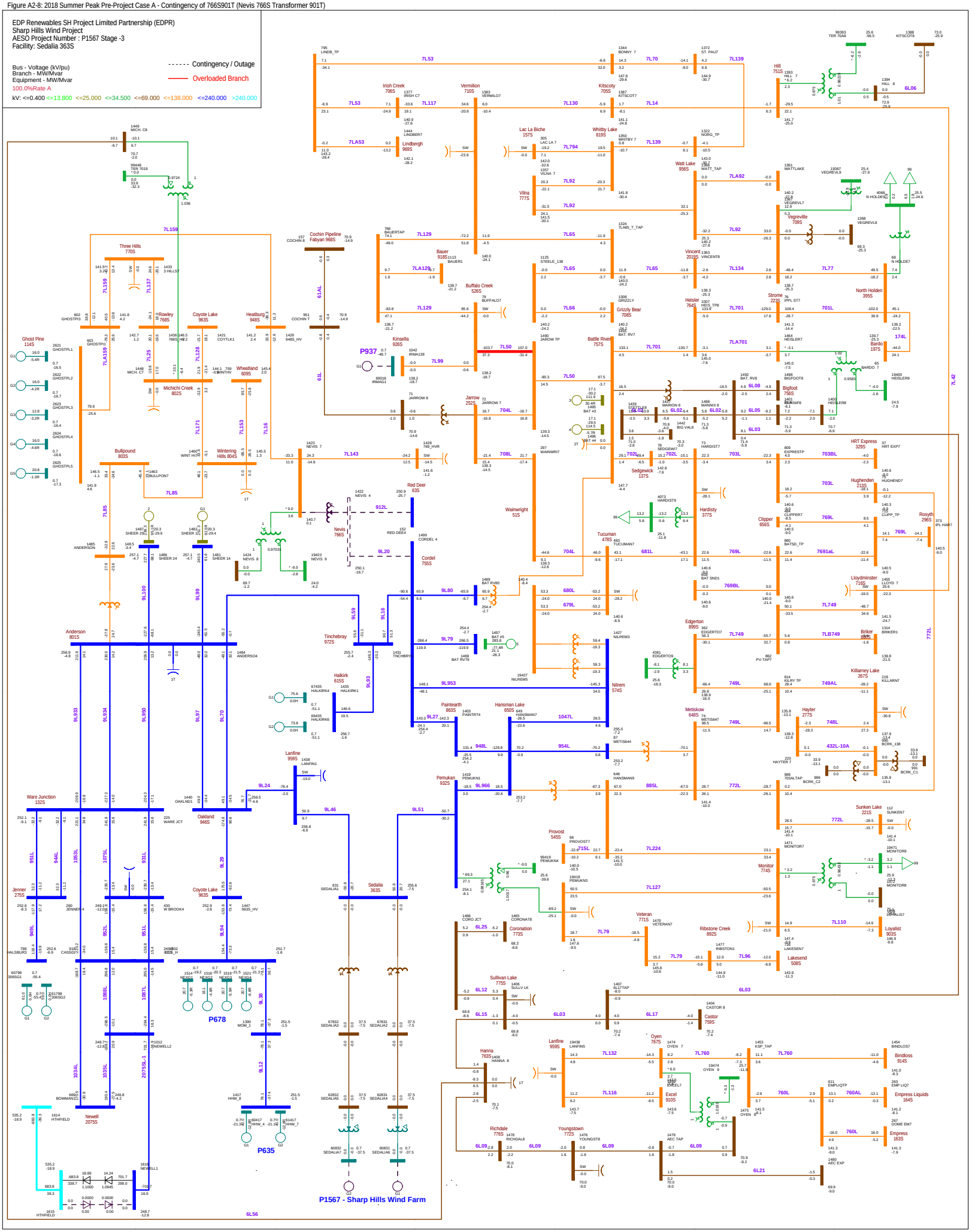


Figure A2-9: 2018 Summer Peak Pre-Project Case A - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

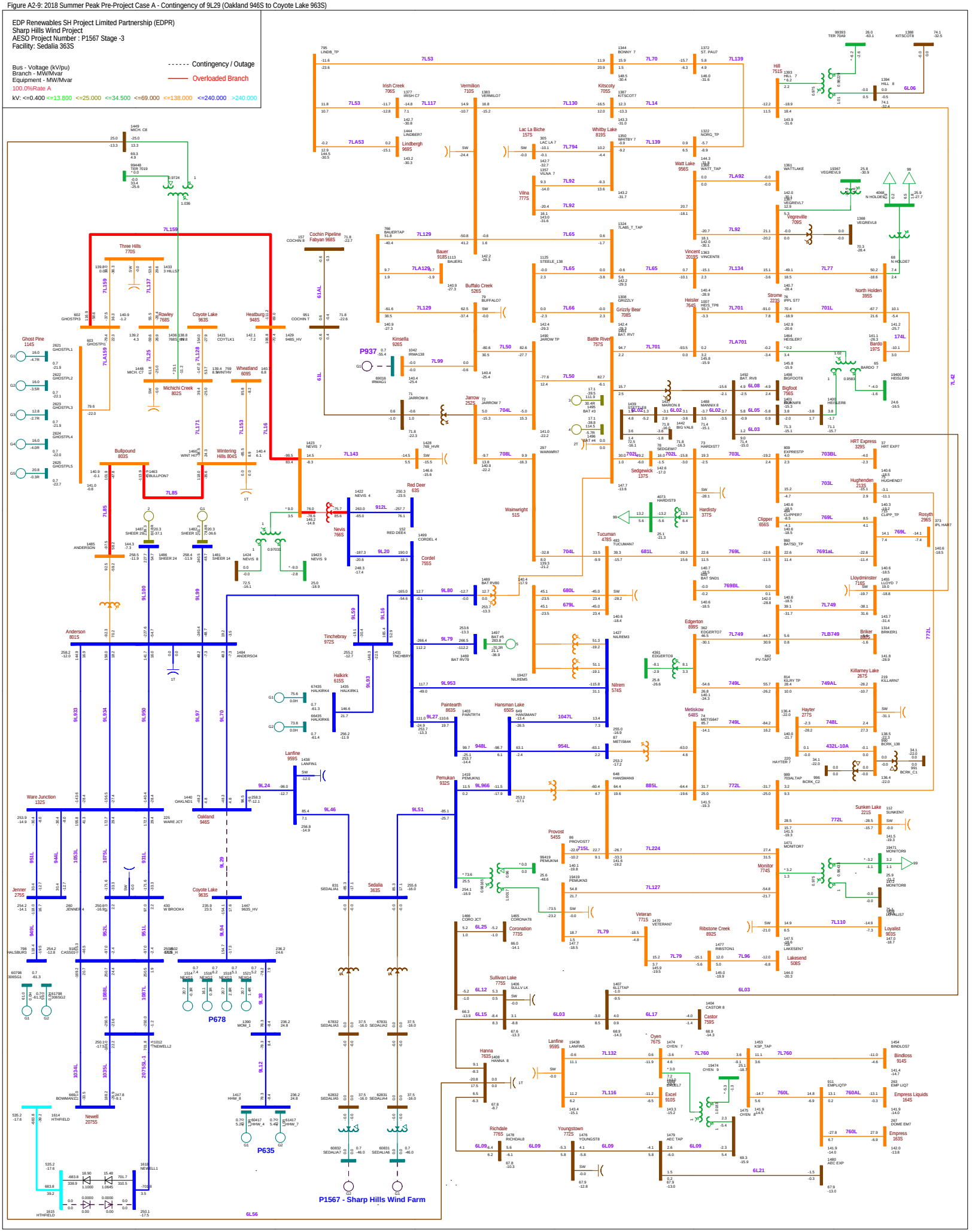


Figure A2-10: 2018 Summer Peak Pre-Project Case A - Contingency of EATL (Newell 2075S to Heathfield 2029S)

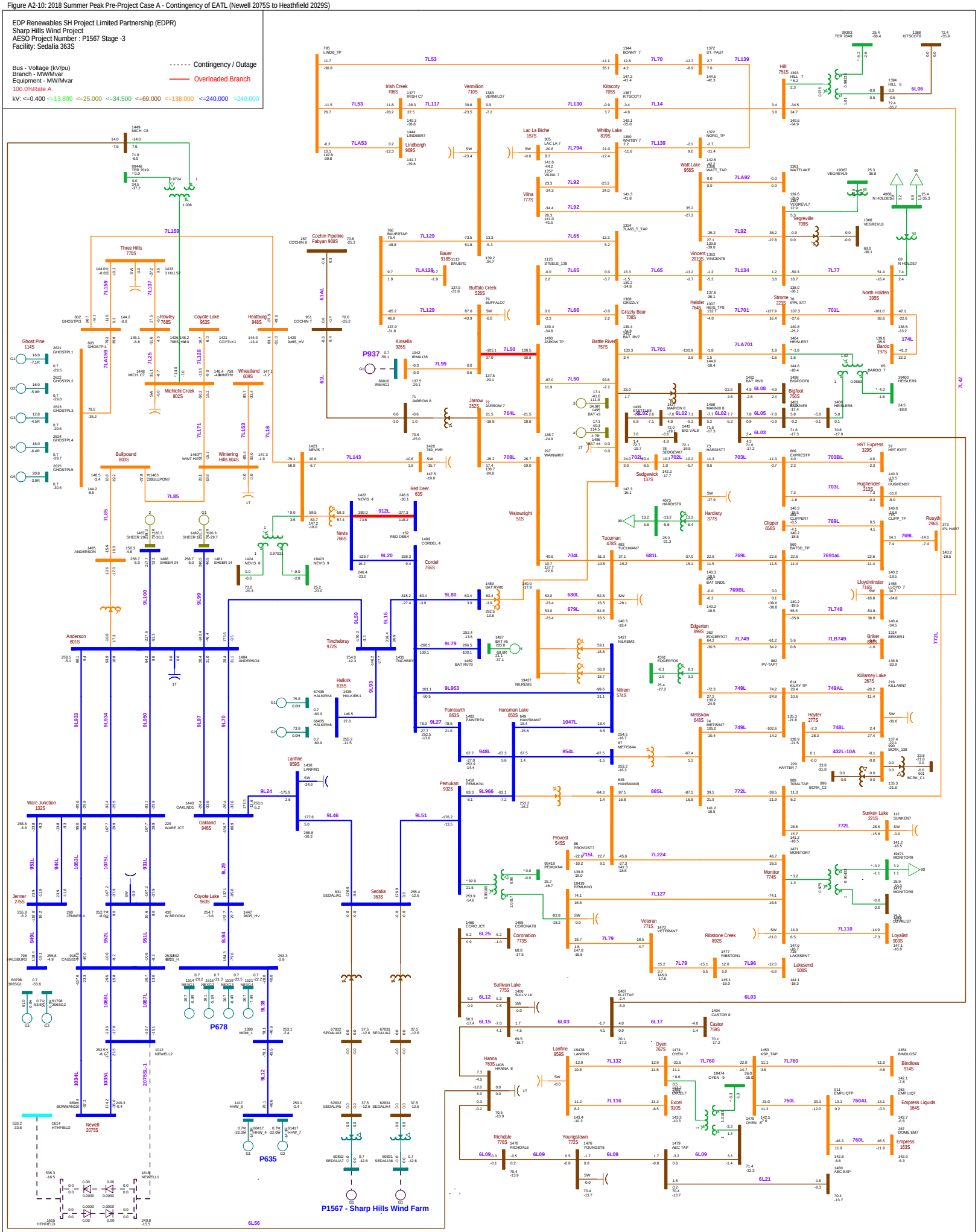


Figure A2-11: 2018 Summer Peak Pre-Project Case A - Contingency of 899ST3A (Edgerton 899S Transformer T3A)

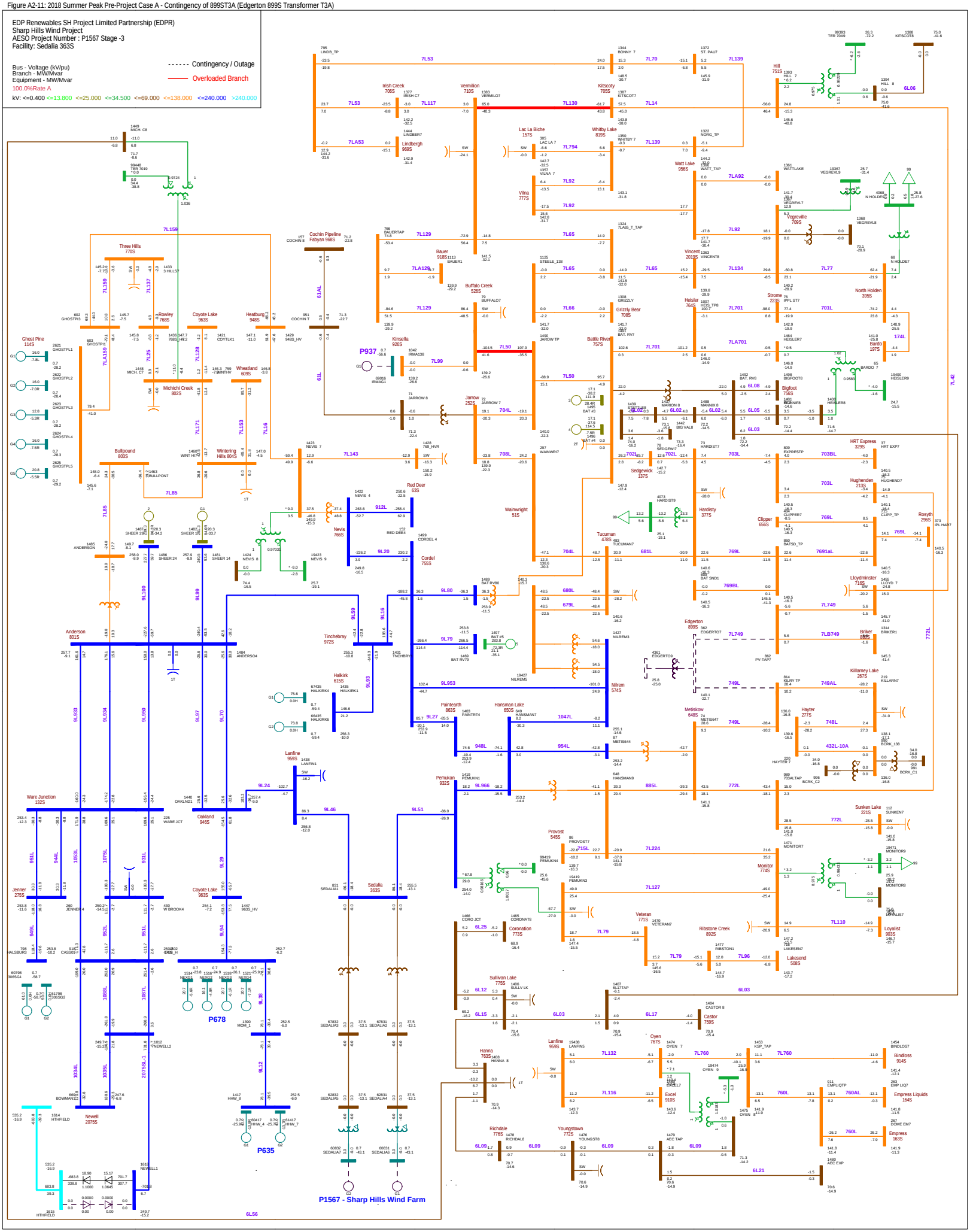


Figure A2-12: 2018 Summer Peak Pre-Project Case A - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

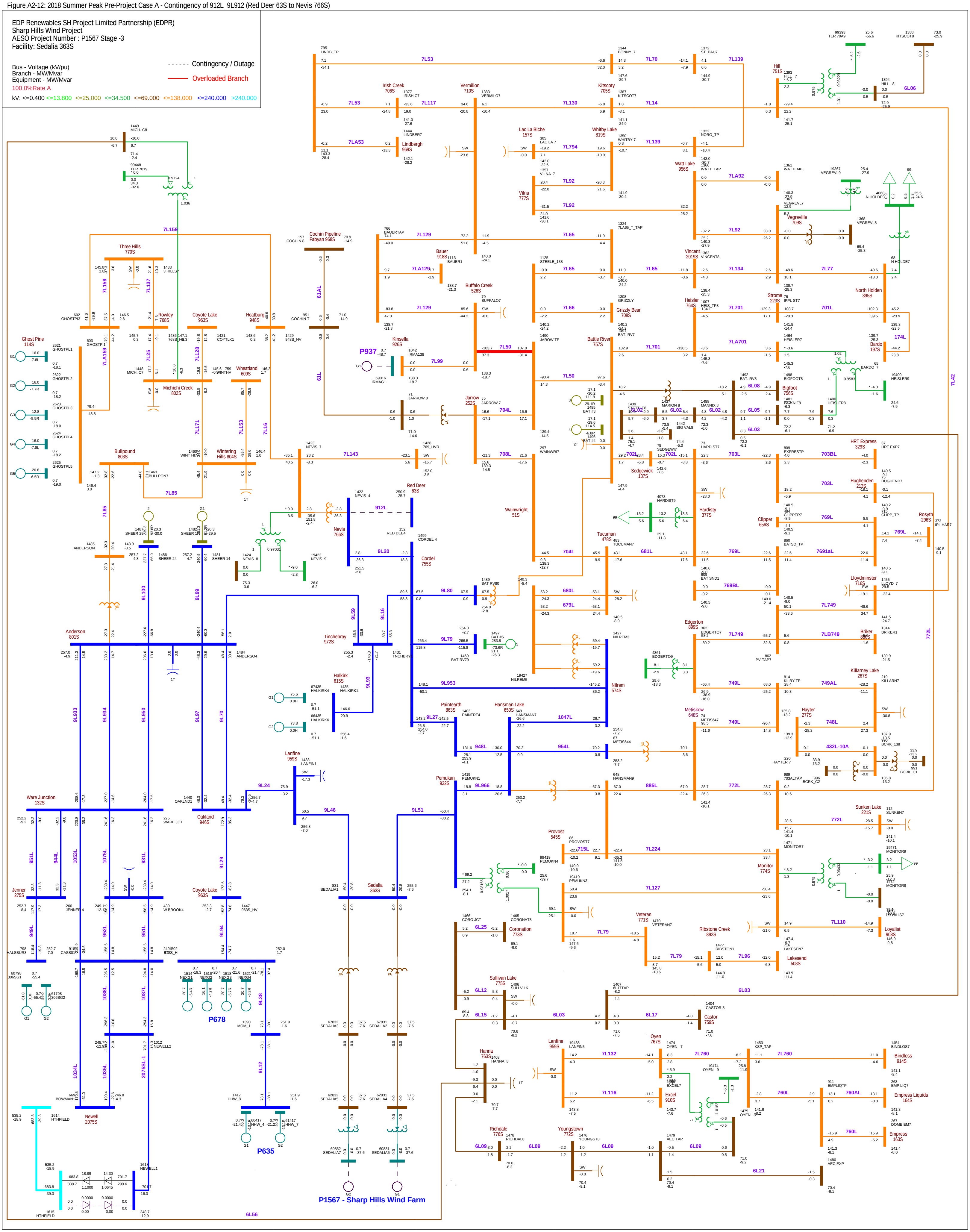


Figure A2-13: 2018 Summer Peak Pre-Project Case A - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

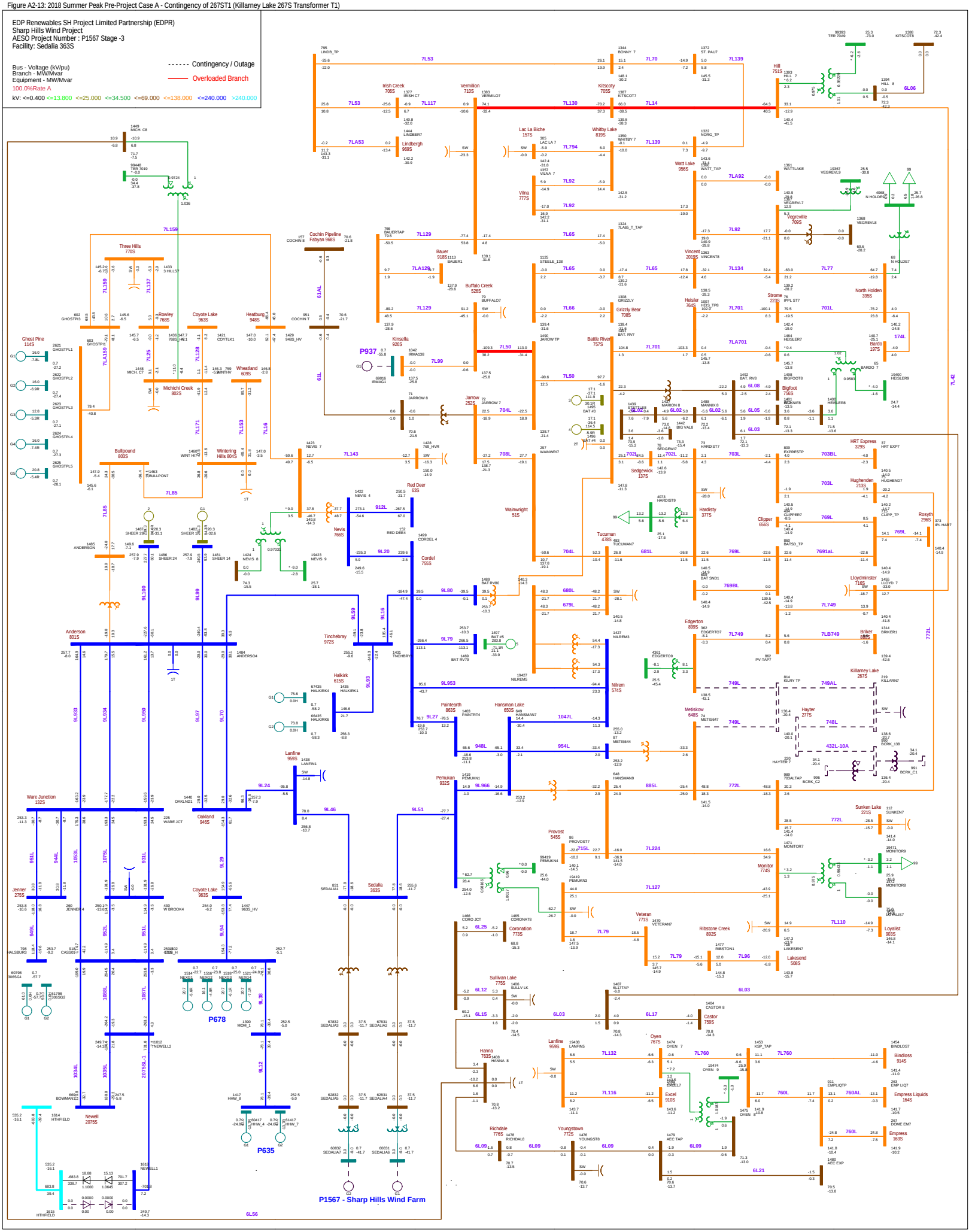


Figure A2-14: 2018 Summer Peak Pre-Project Case B - N-0 (System Normal Condition)

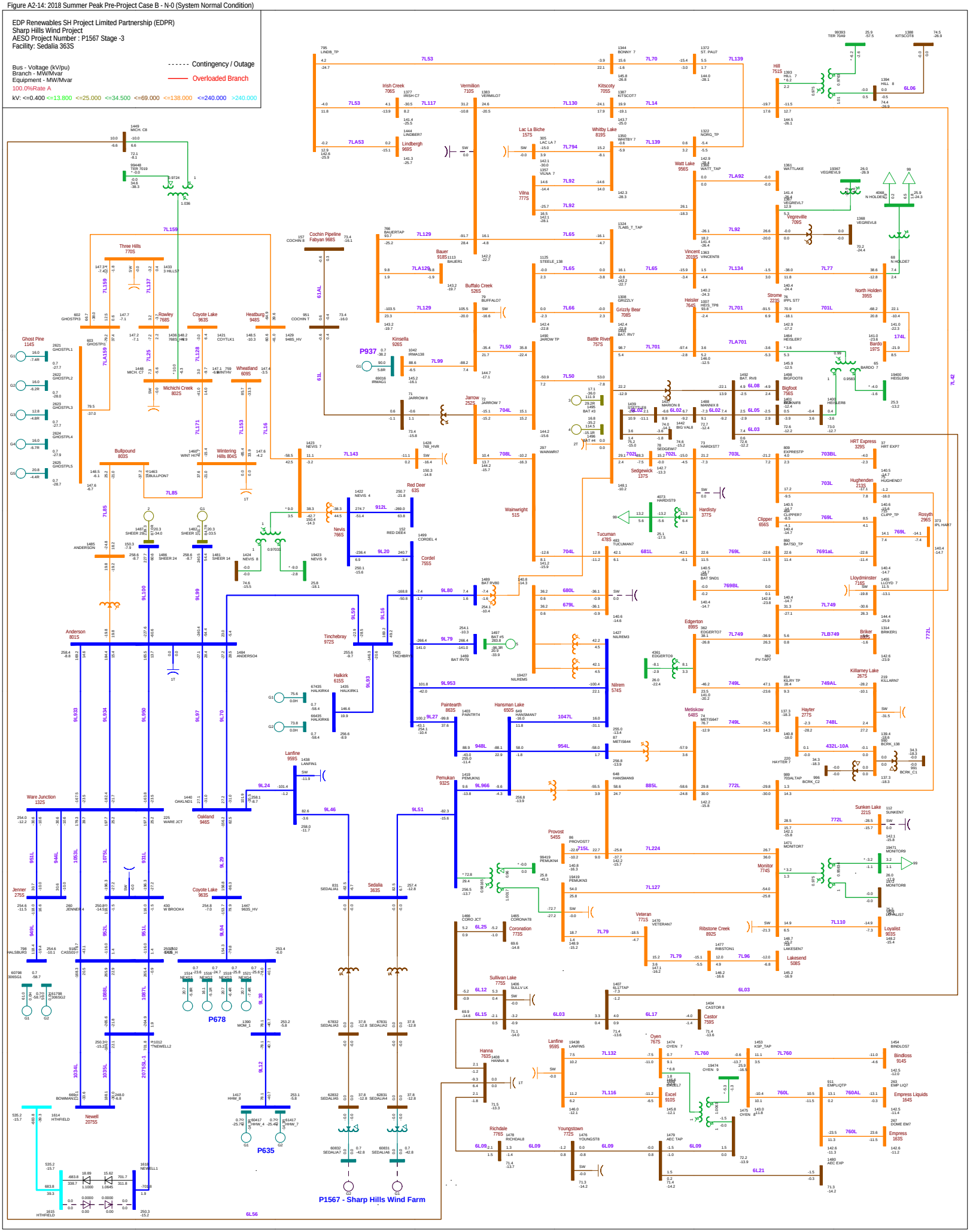


Figure A2-15: 2018 Summer Peak Pre-Project Case B - Contingency of 899ST3A (Edgerton 899S Transformer T3A)

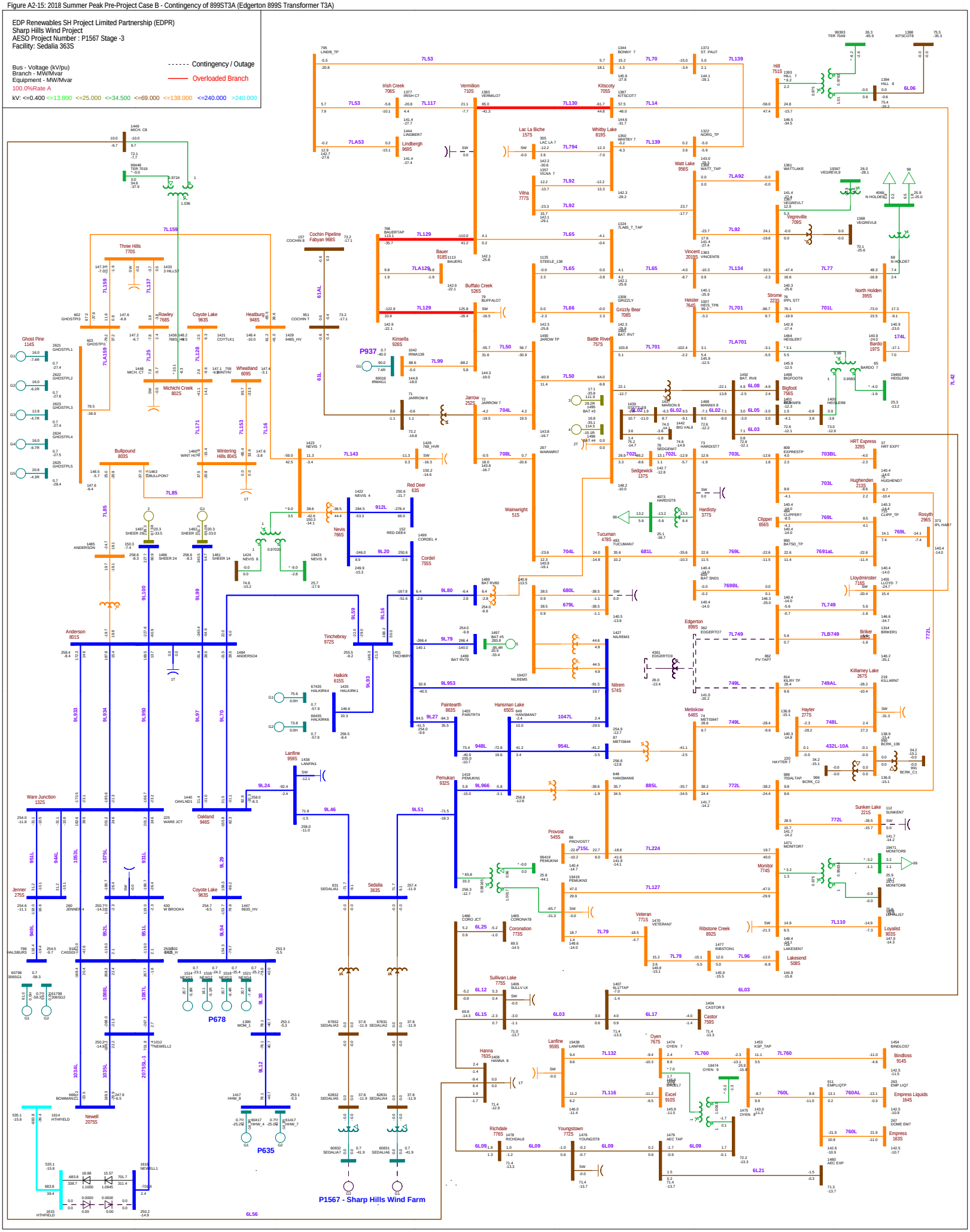


Figure A2-16: 2018 Summer Peak Pre-Project Case B - Contingency of 7L42 (Hill 751S to Lloydminster 716S)

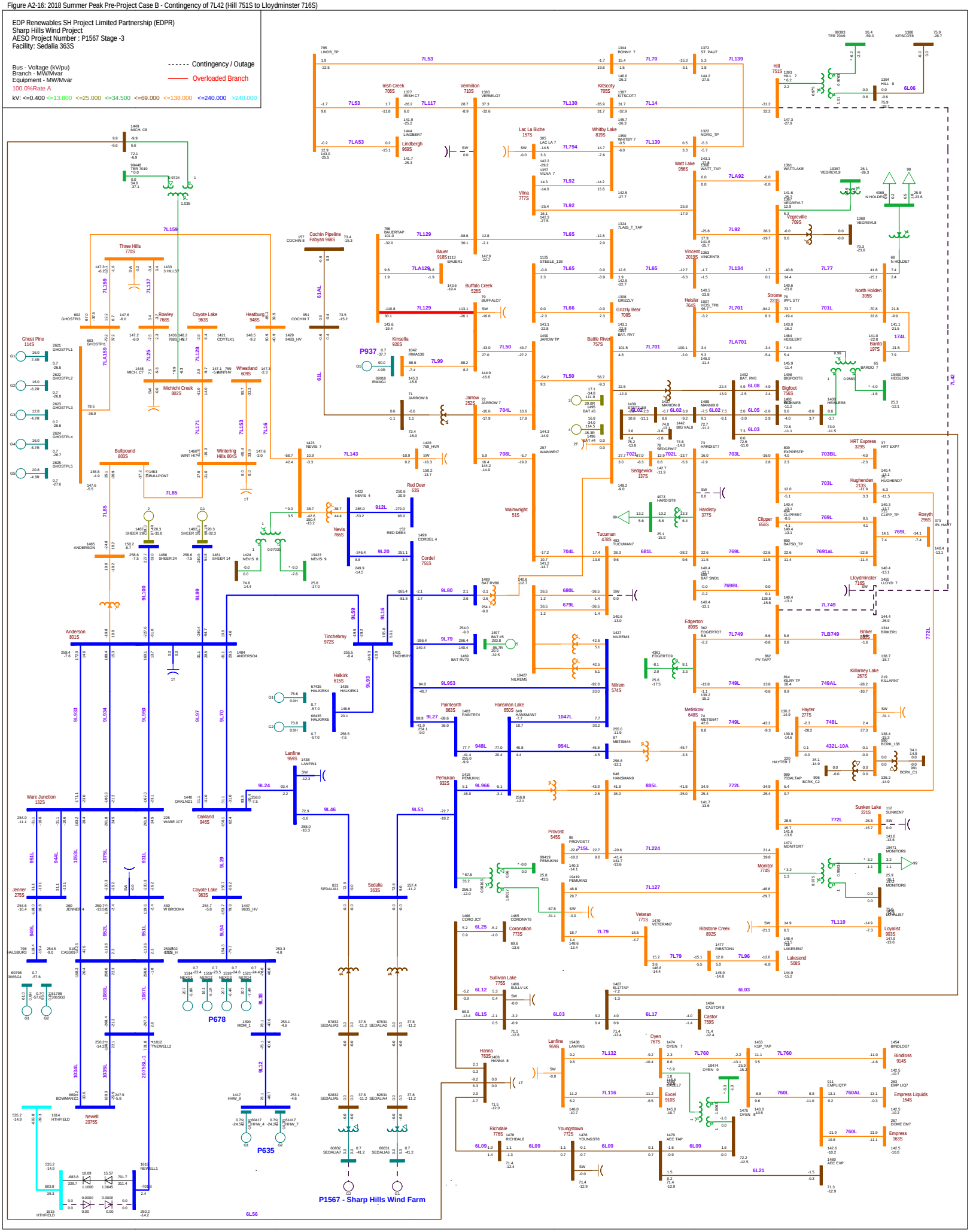


Figure A2-17: 2018 Summer Peak Pre-Project Case B - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

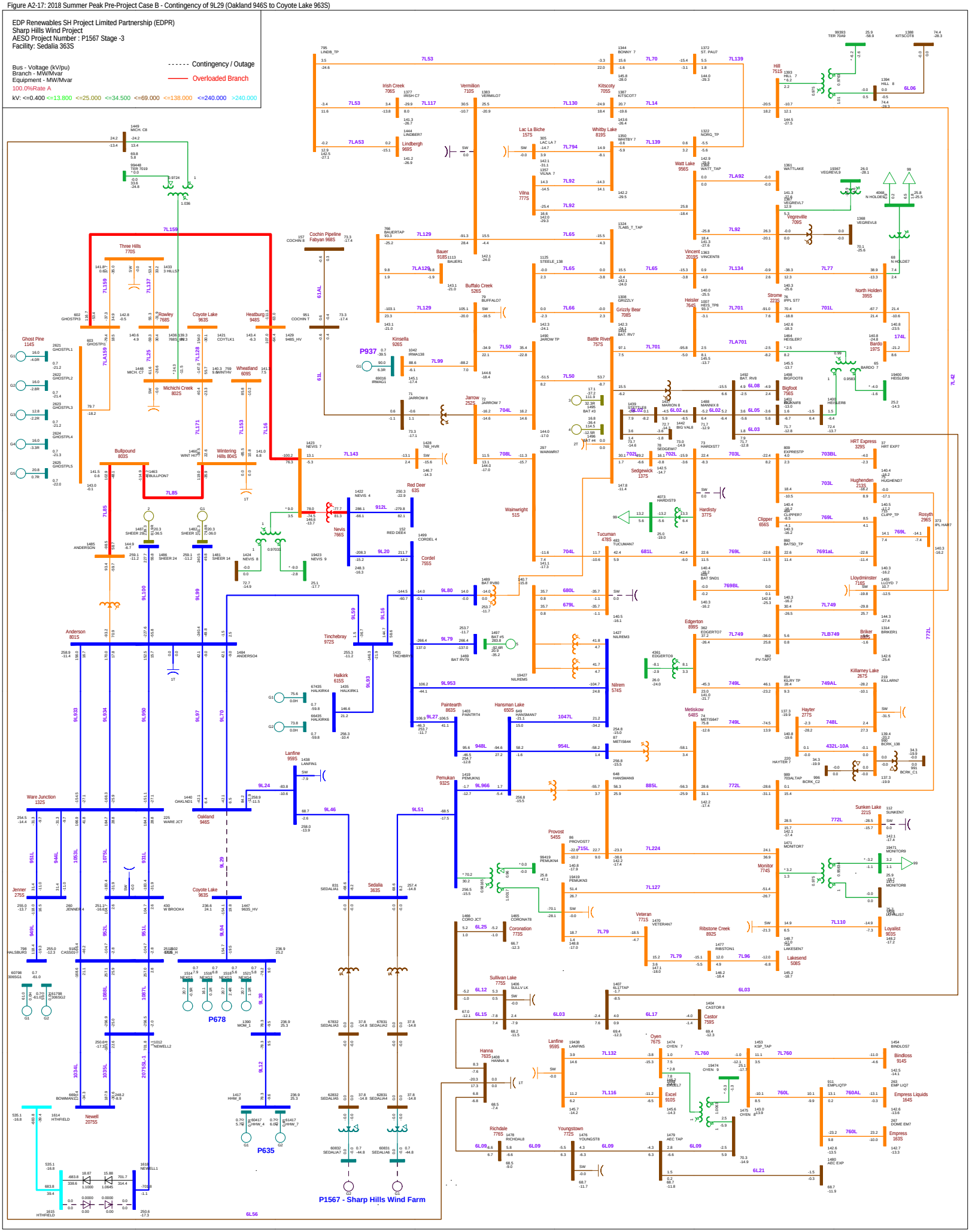


Figure A2-18: 2018 Summer Peak Pre-Project Case B - Contingency of 7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)

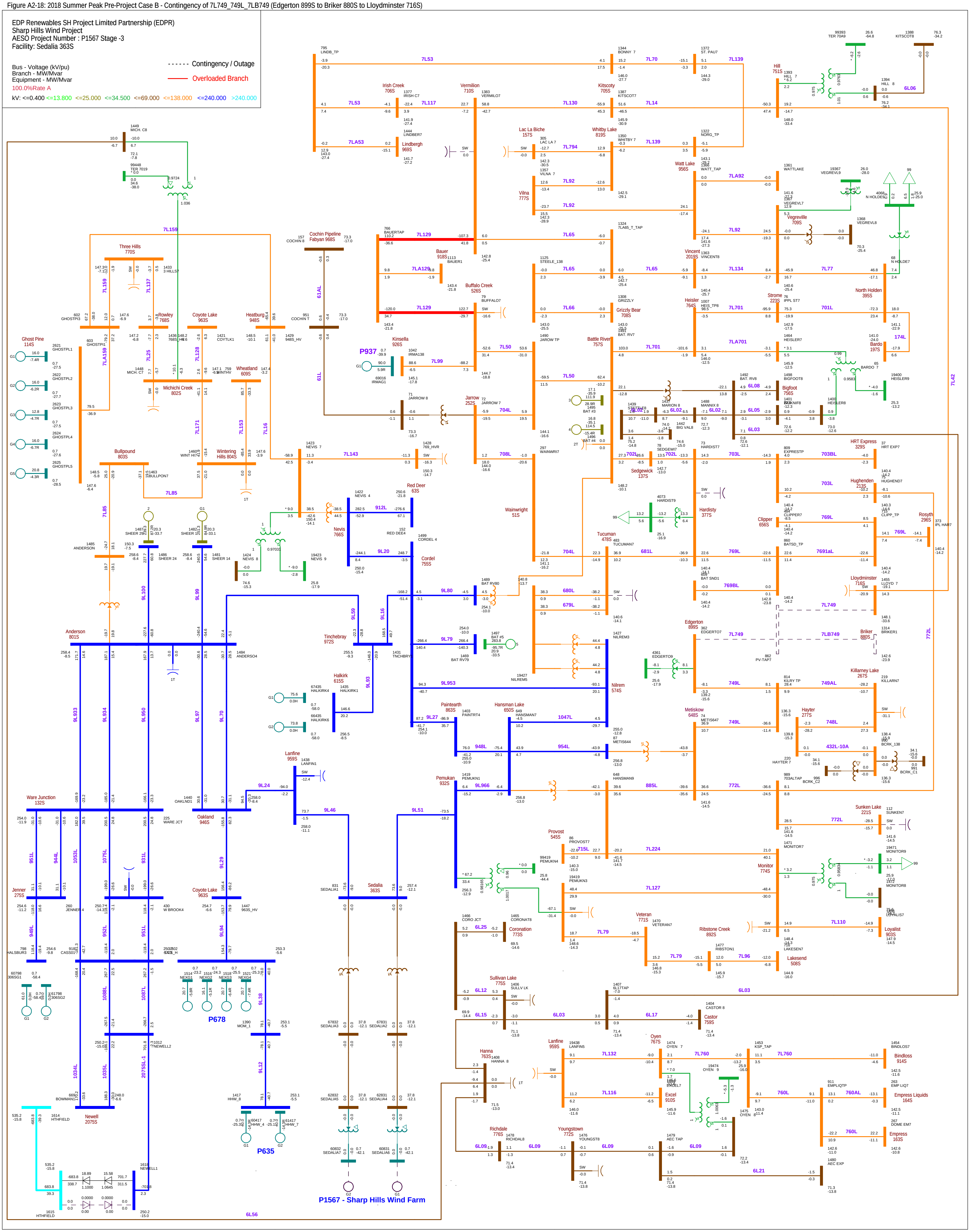


Figure A2-19: 2018 Summer Peak Pre-Project Case B - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

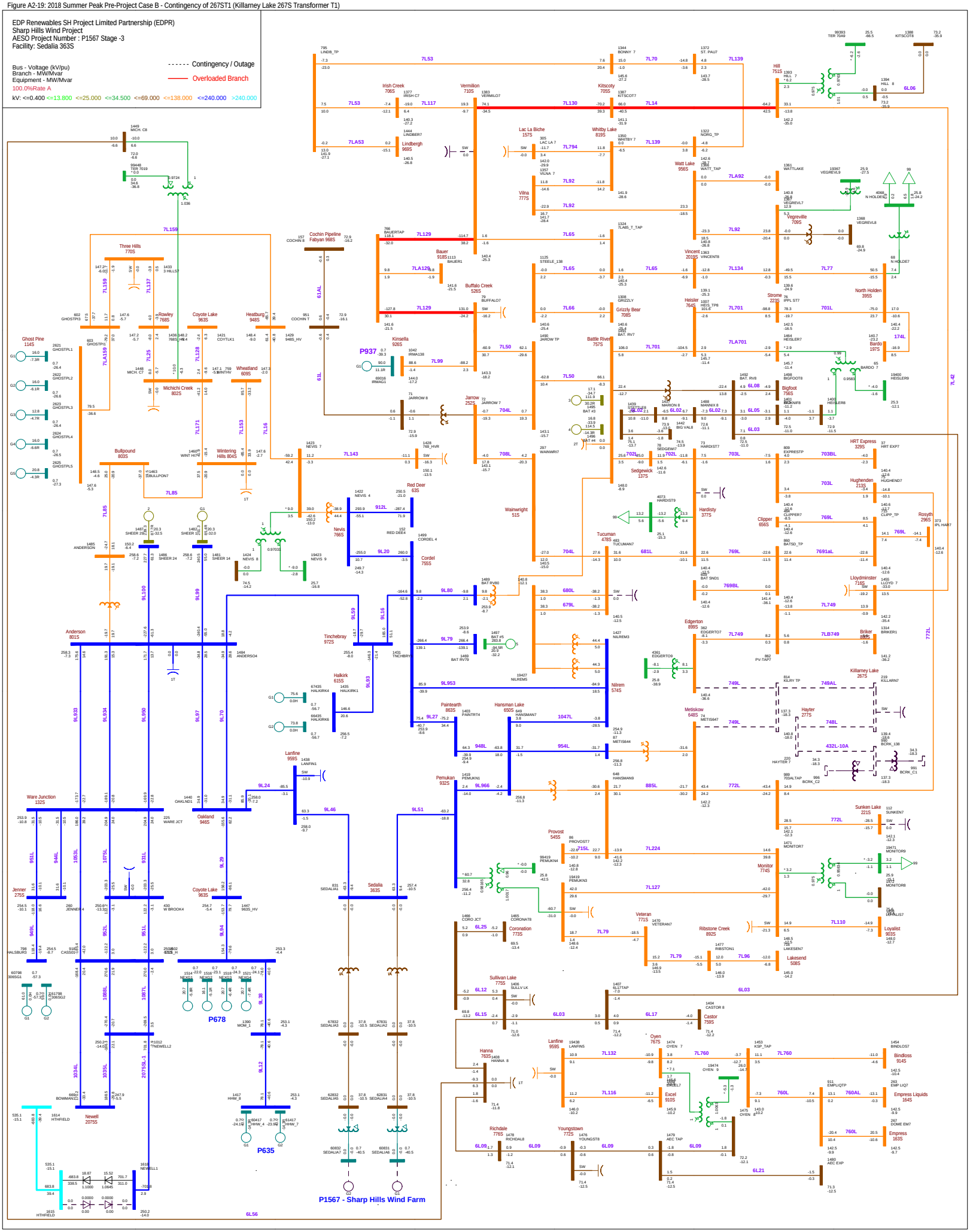


Figure A2-20: 2018 Summer Peak Pre-Project Case B - Contingency of 7L77 (North Holden 395S to Vegreville 709S)

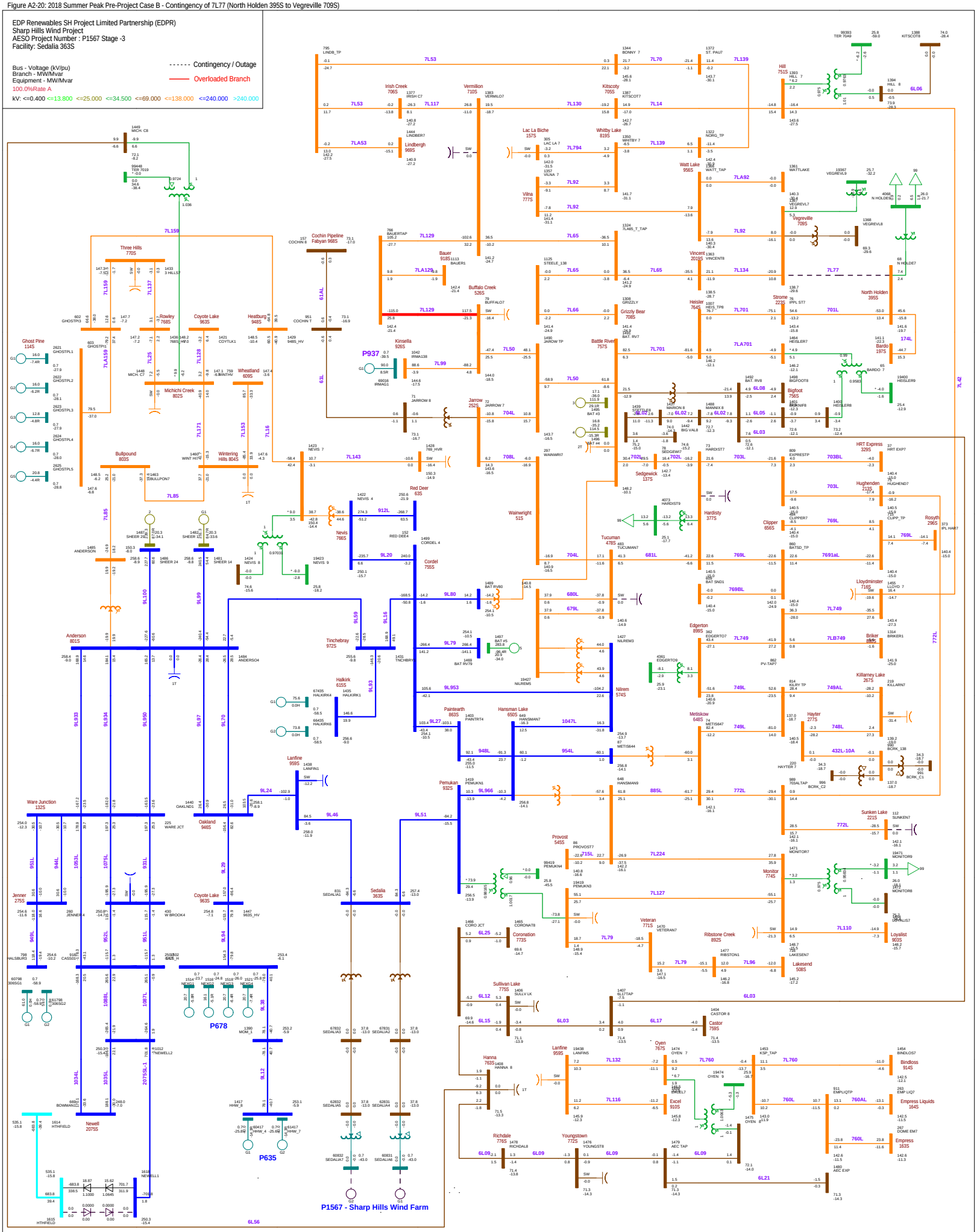


Figure A2-21: 2018 Summer Peak Pre-Project Case B - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

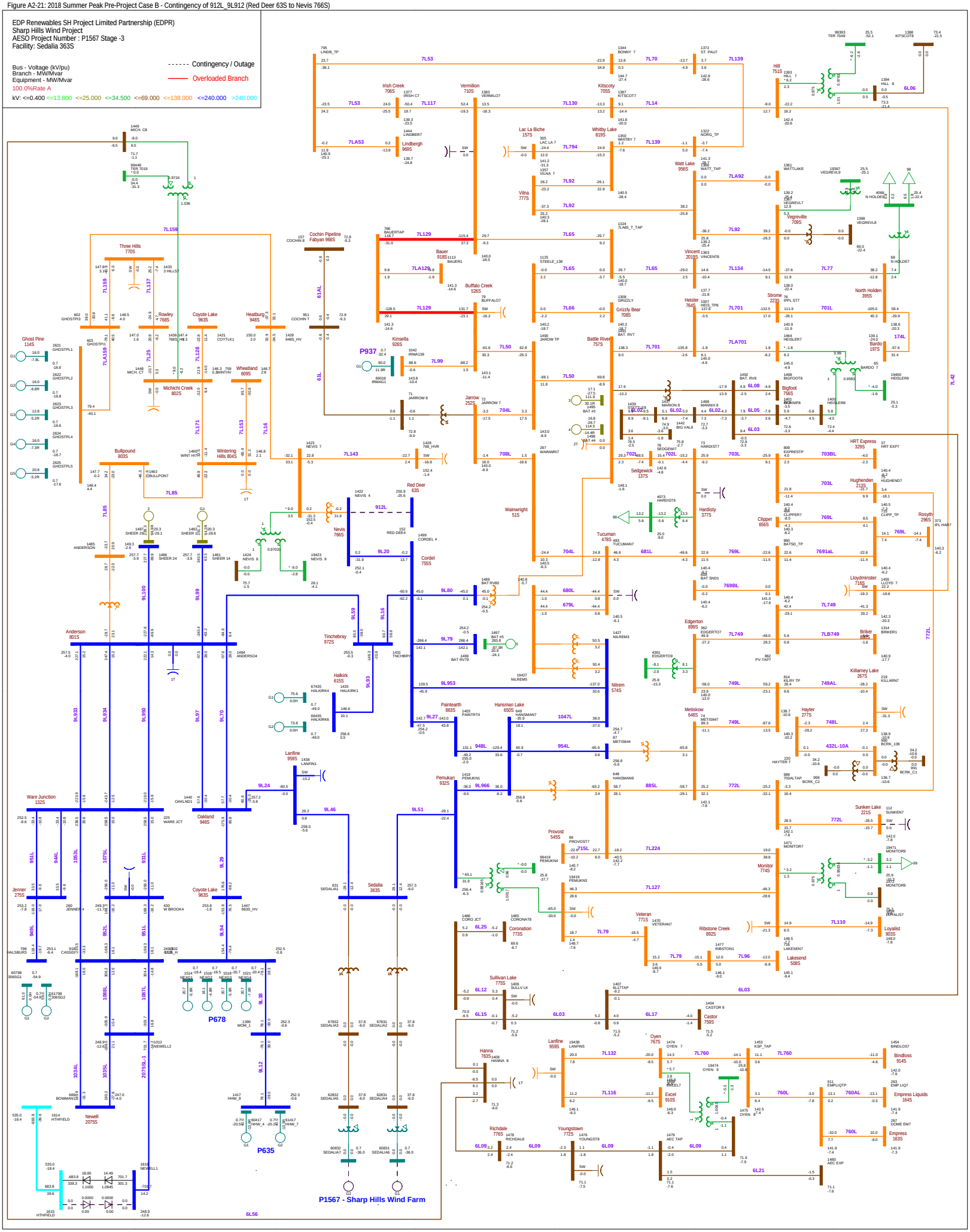


Figure A2-22: 2018 Summer Peak Pre-Project Case B - Contingency of 766S901T (Nevis 766S Transformer 901T)

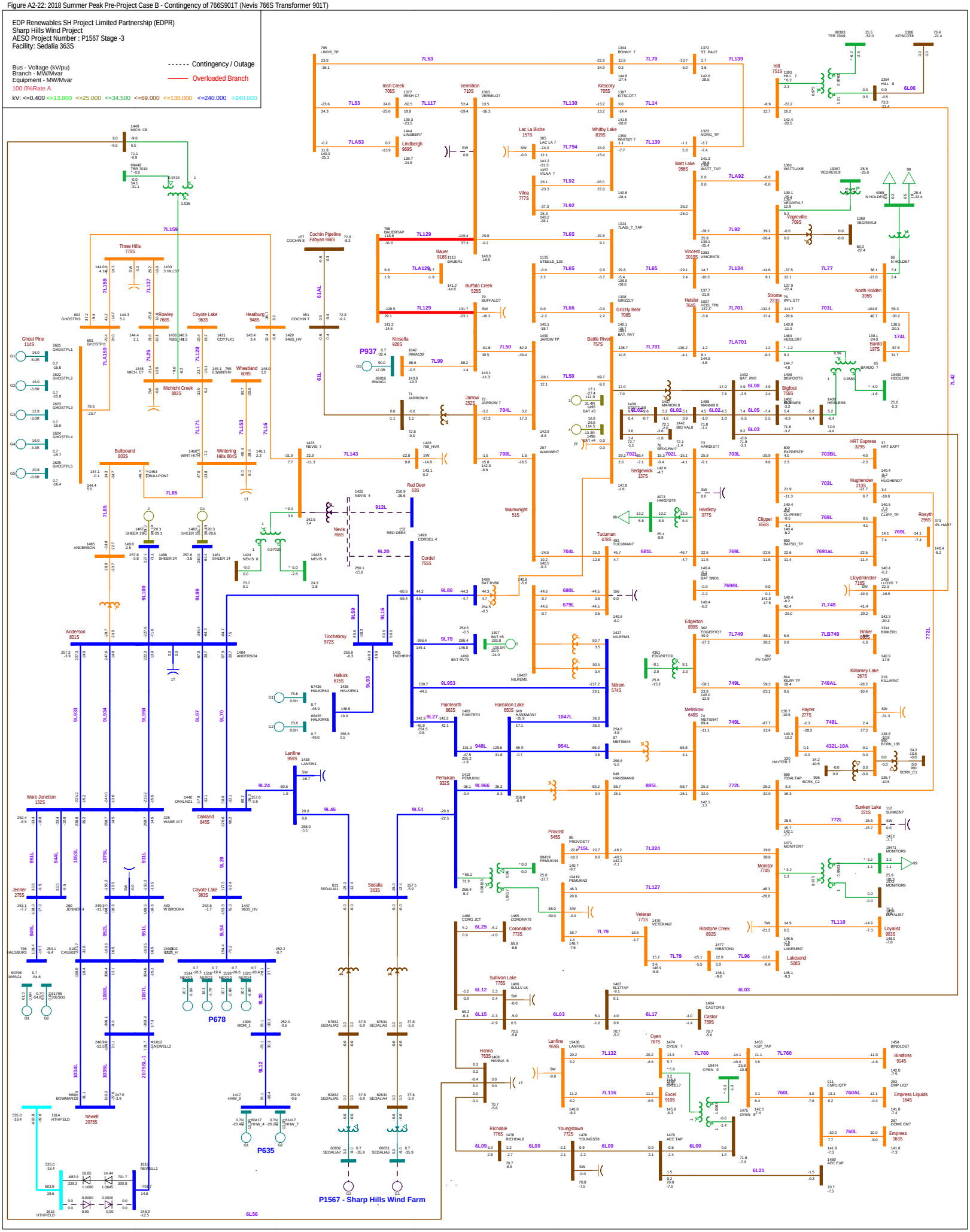


Figure A2-23: 2018 Summer Peak Pre-Project Case B - Contingency of 9L20 (Nevis 766S to Cordel 755S)

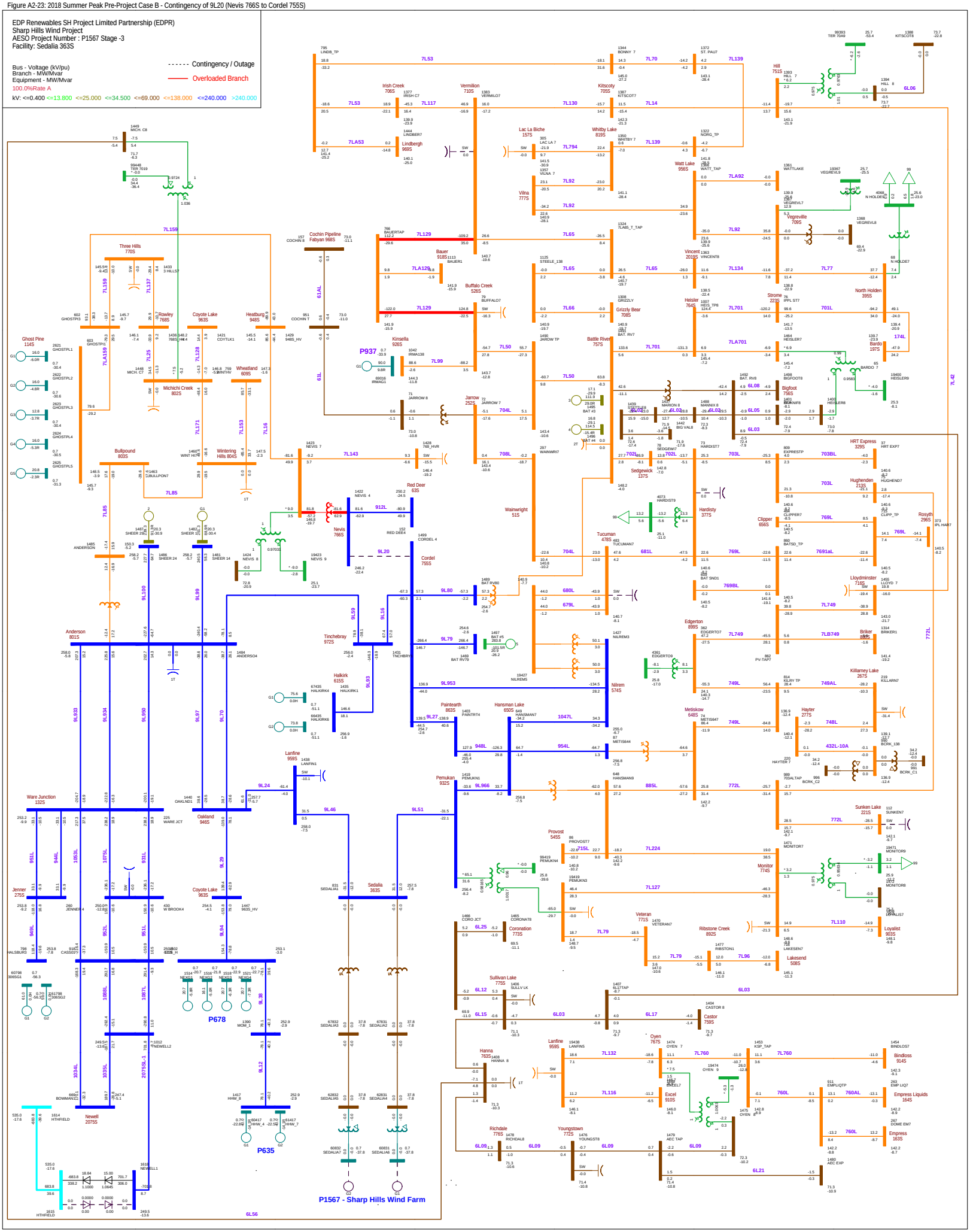


Figure A2-24: 2018 Summer Peak Pre-Project Case B - Contingency of 7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)

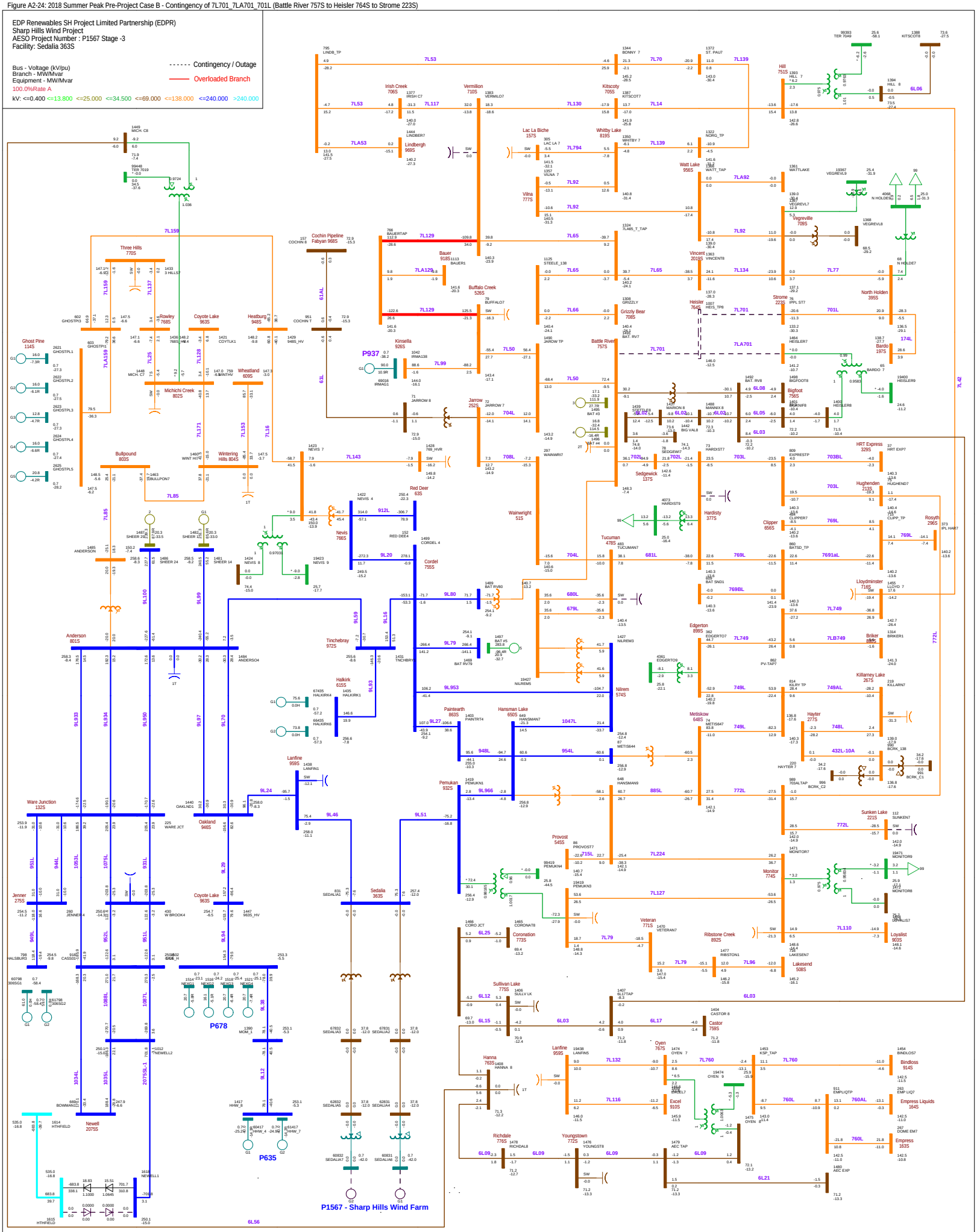


Figure A2-25: 2018 Summer Peak Pre-Project Case B - Contingency of 701L (North Holden 395S to Strome 223S)

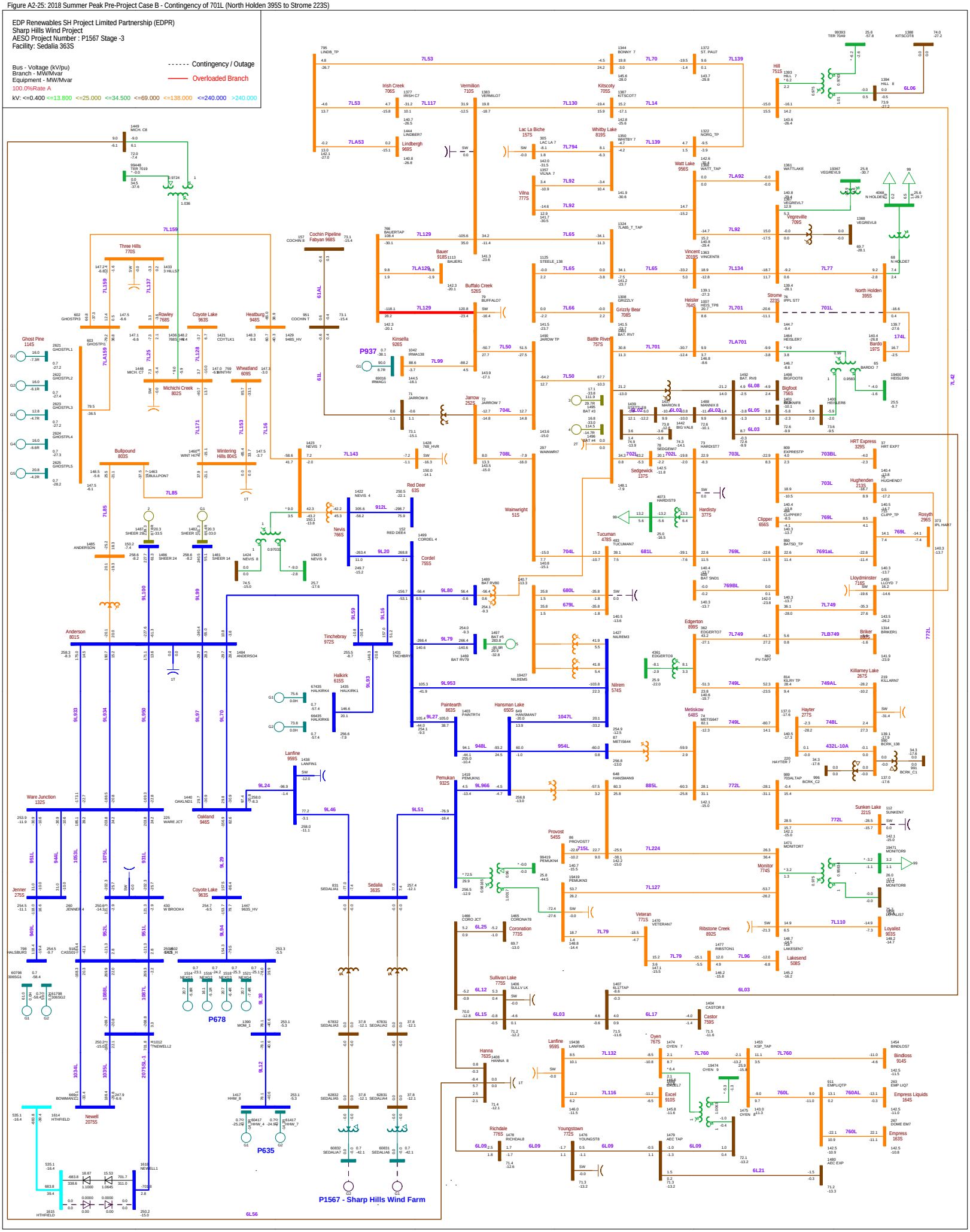


Figure A2-26: 2018 Summer Peak Pre-Project Case B - Contingency of EATL (Newell 2075S to Heathfield 2029S)

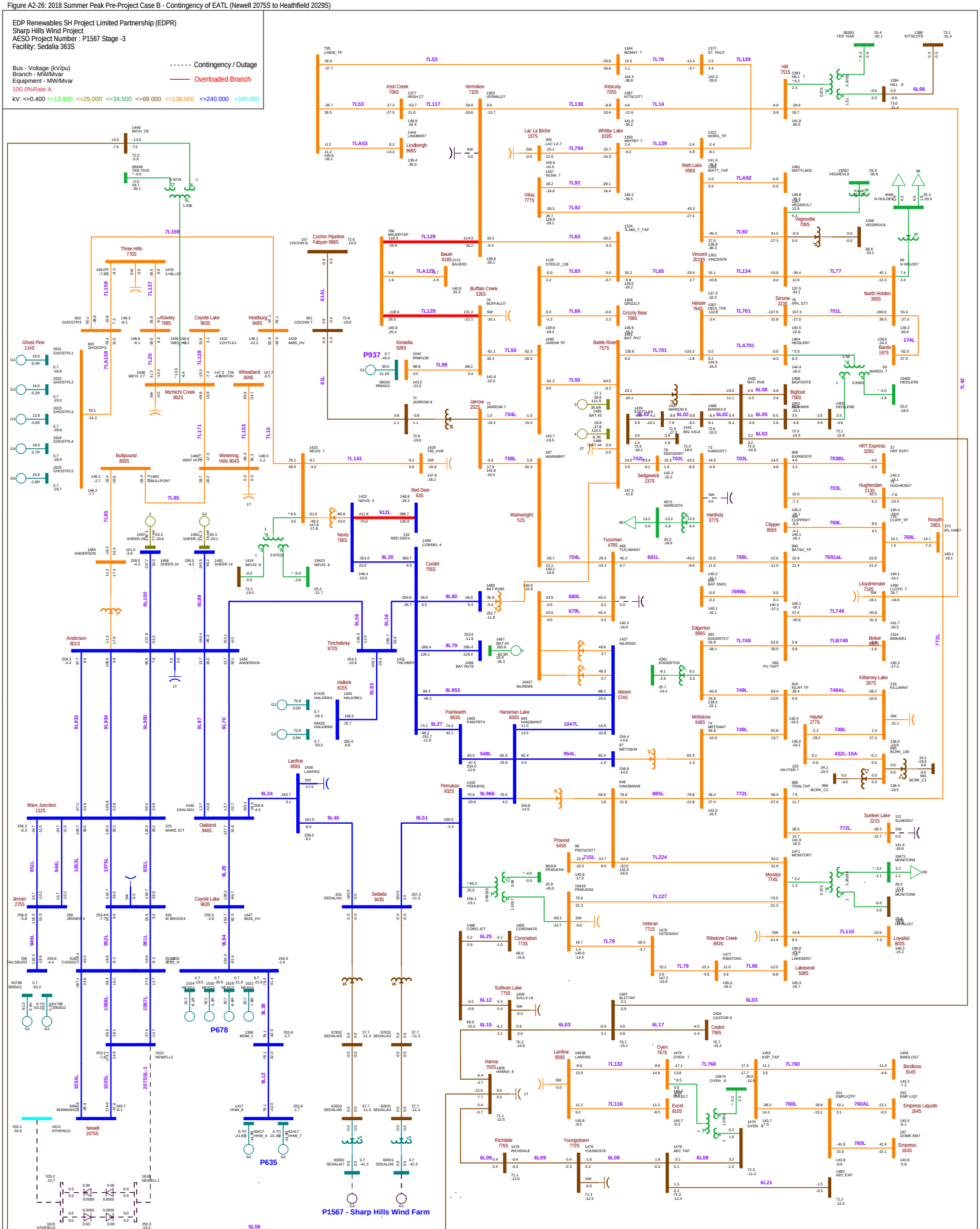


Figure A2-27: 2018 Winter Peak Pre-Project Case A - N-0 (System Normal Condition)

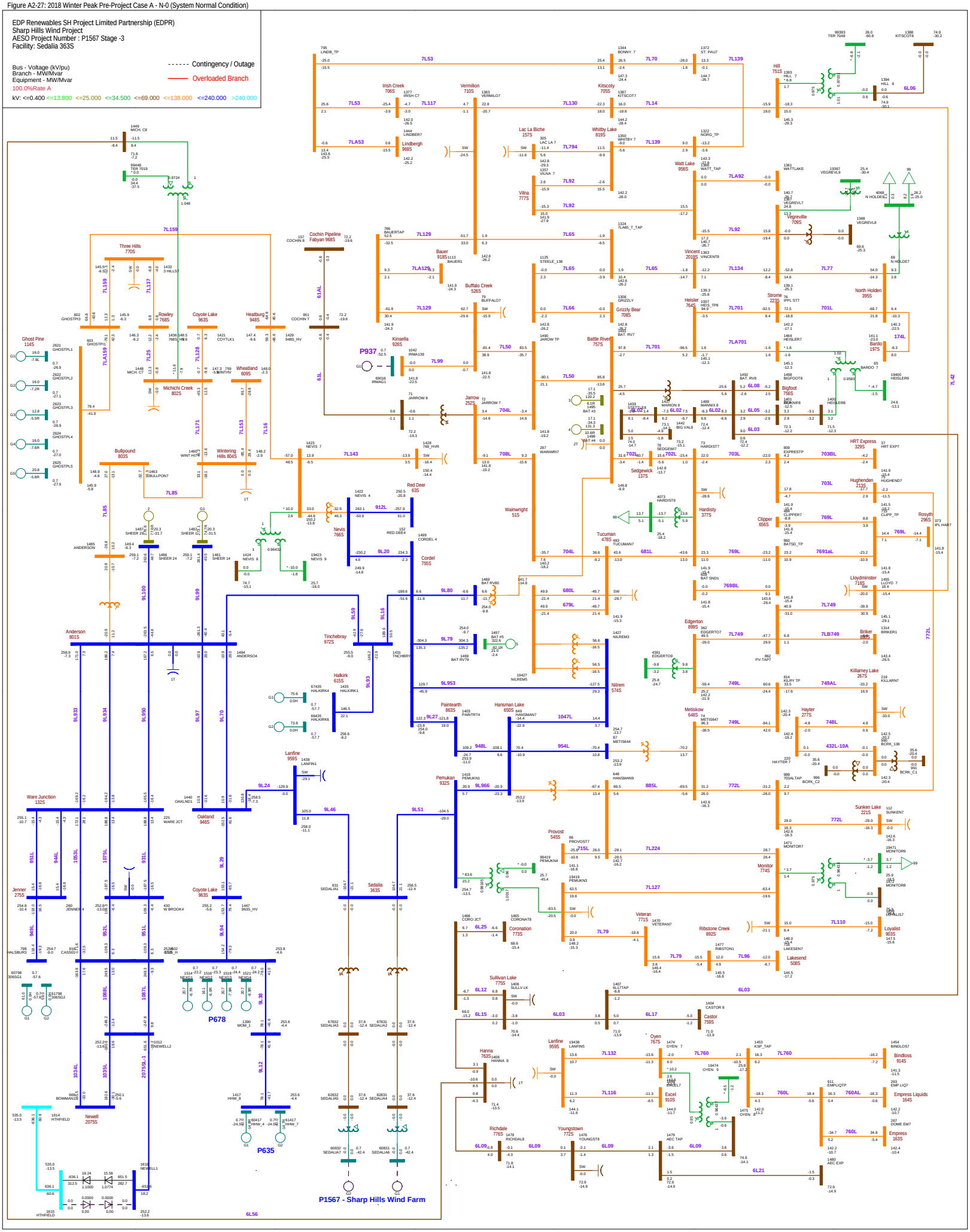


Figure A2-28: 2018 Winter Peak Pre-Project Case A - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

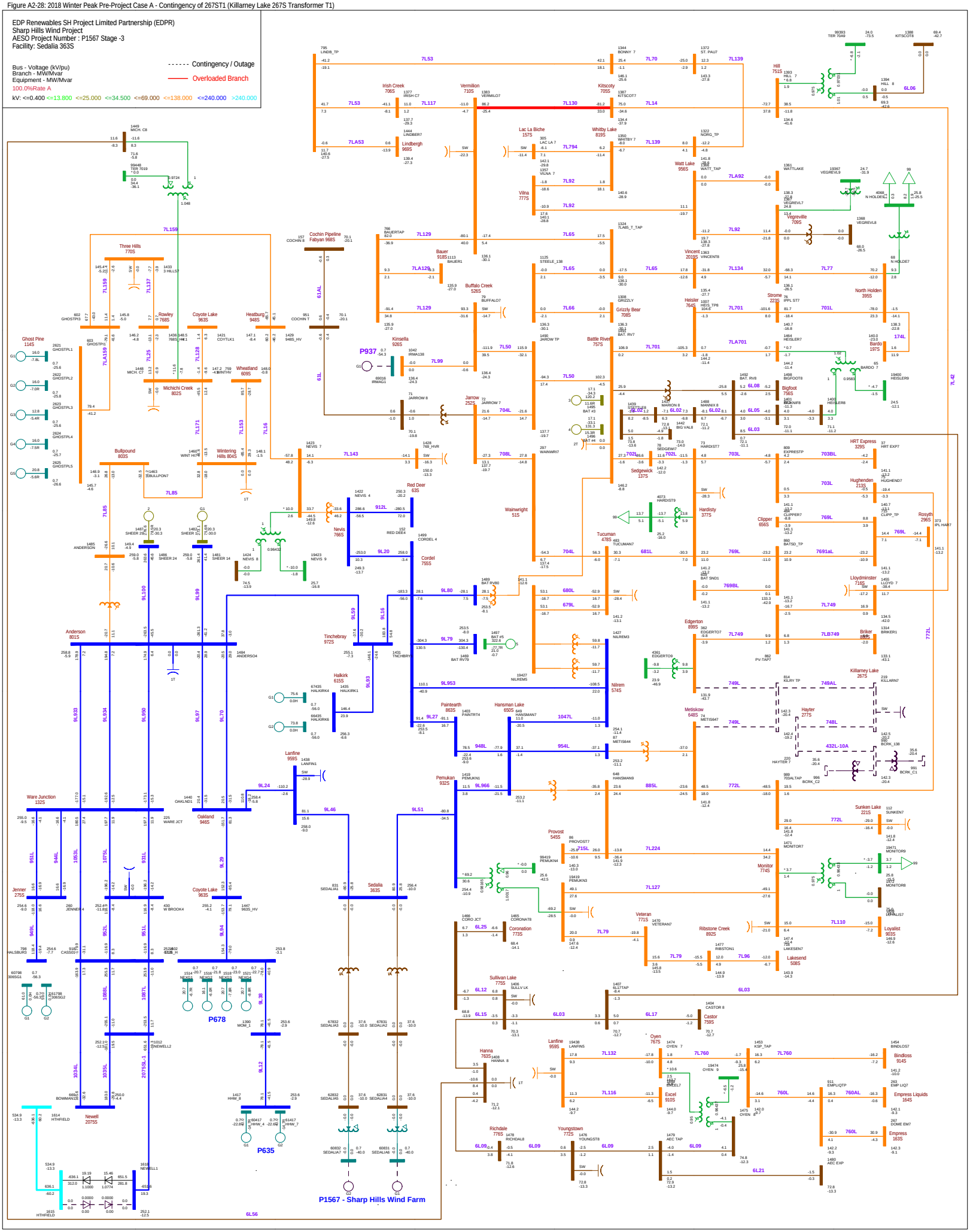


Figure A2-29: 2018 Winter Peak Pre-Project Case A - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

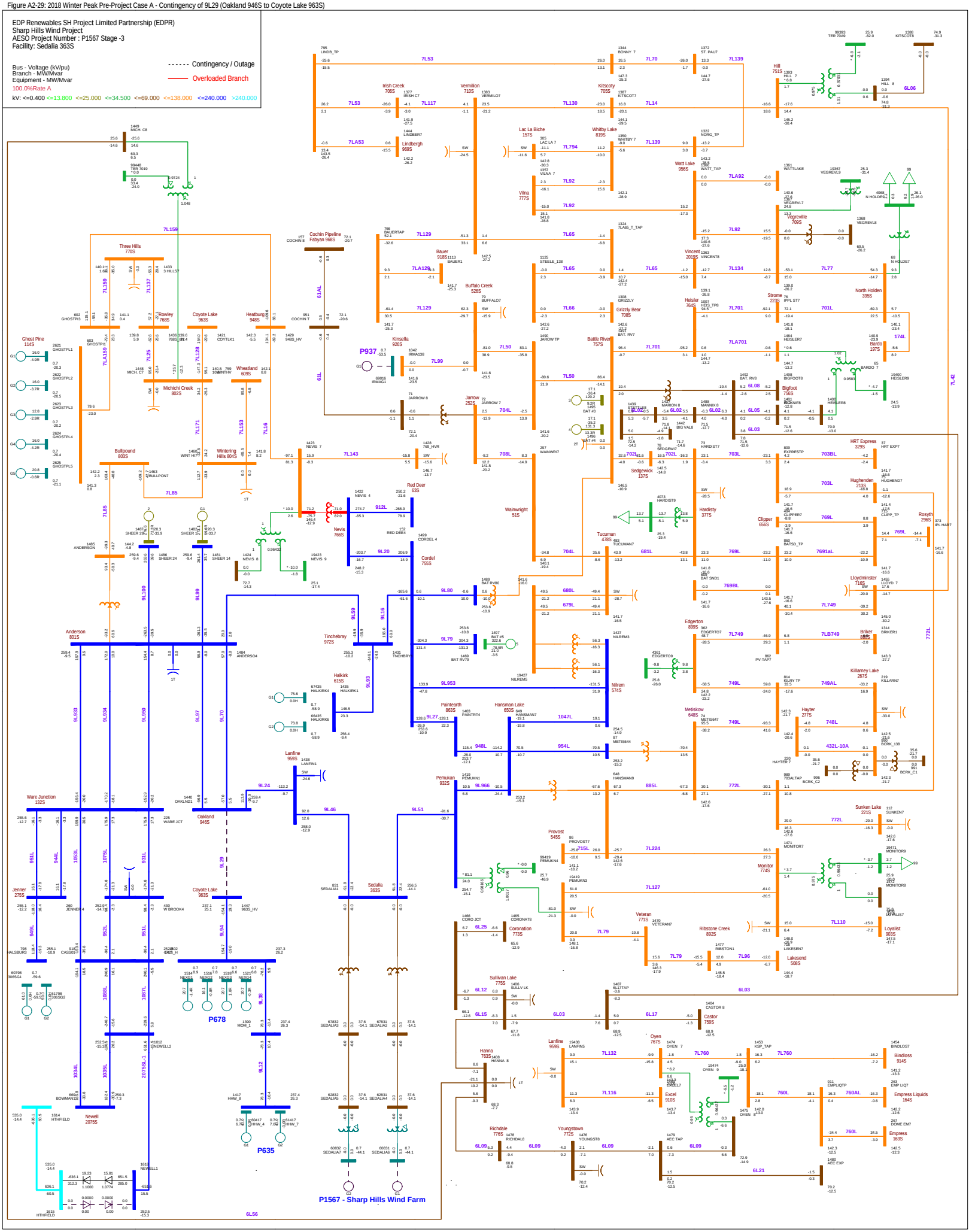


Figure A2-30: 2018 Winter Peak Pre-Project Case B - N-0 (System Normal Condition)

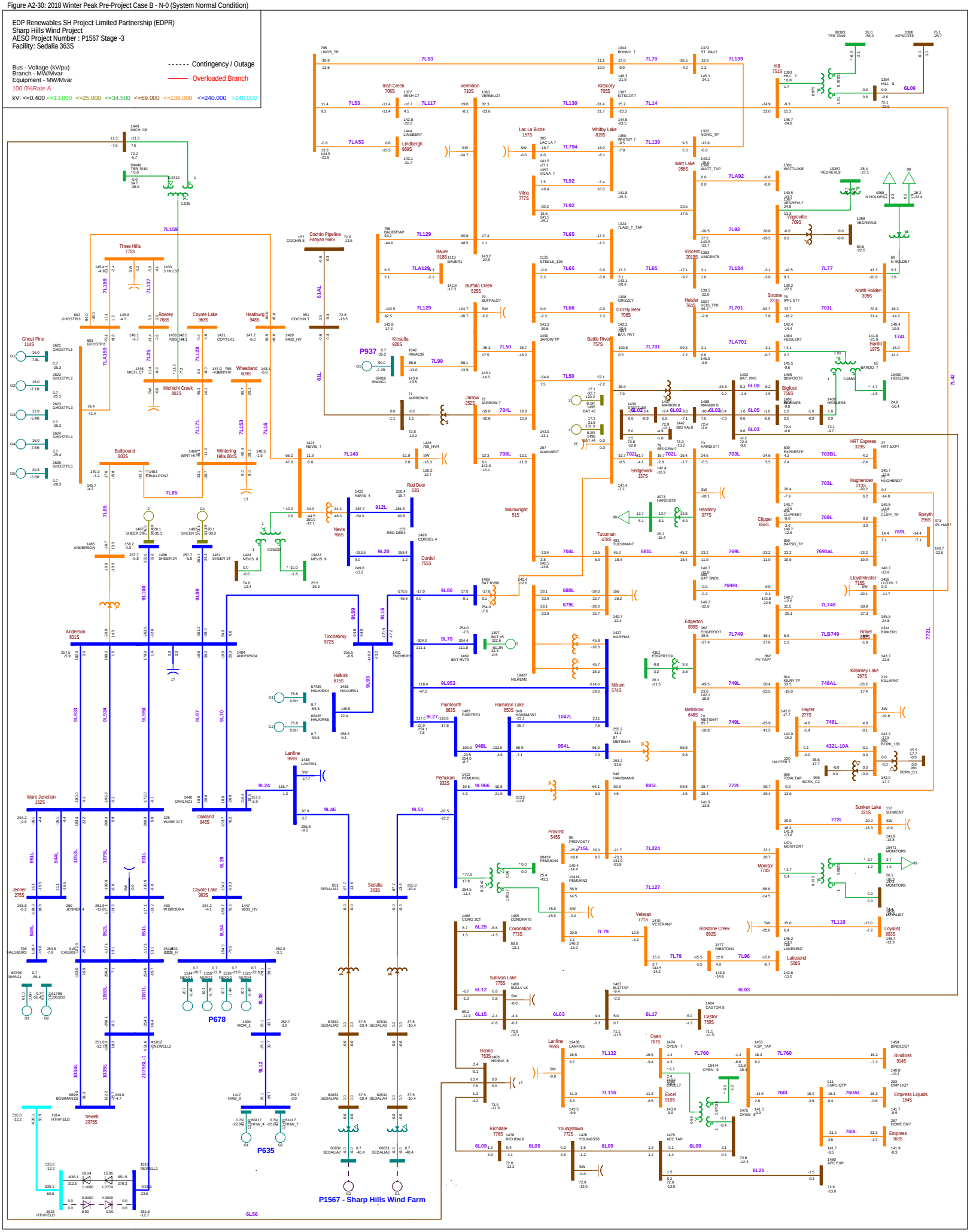


Figure A2-31: 2018 Winter Peak Pre-Project Case B - Contingency of 9L20 (Nevis 766S to Cordel 755S)

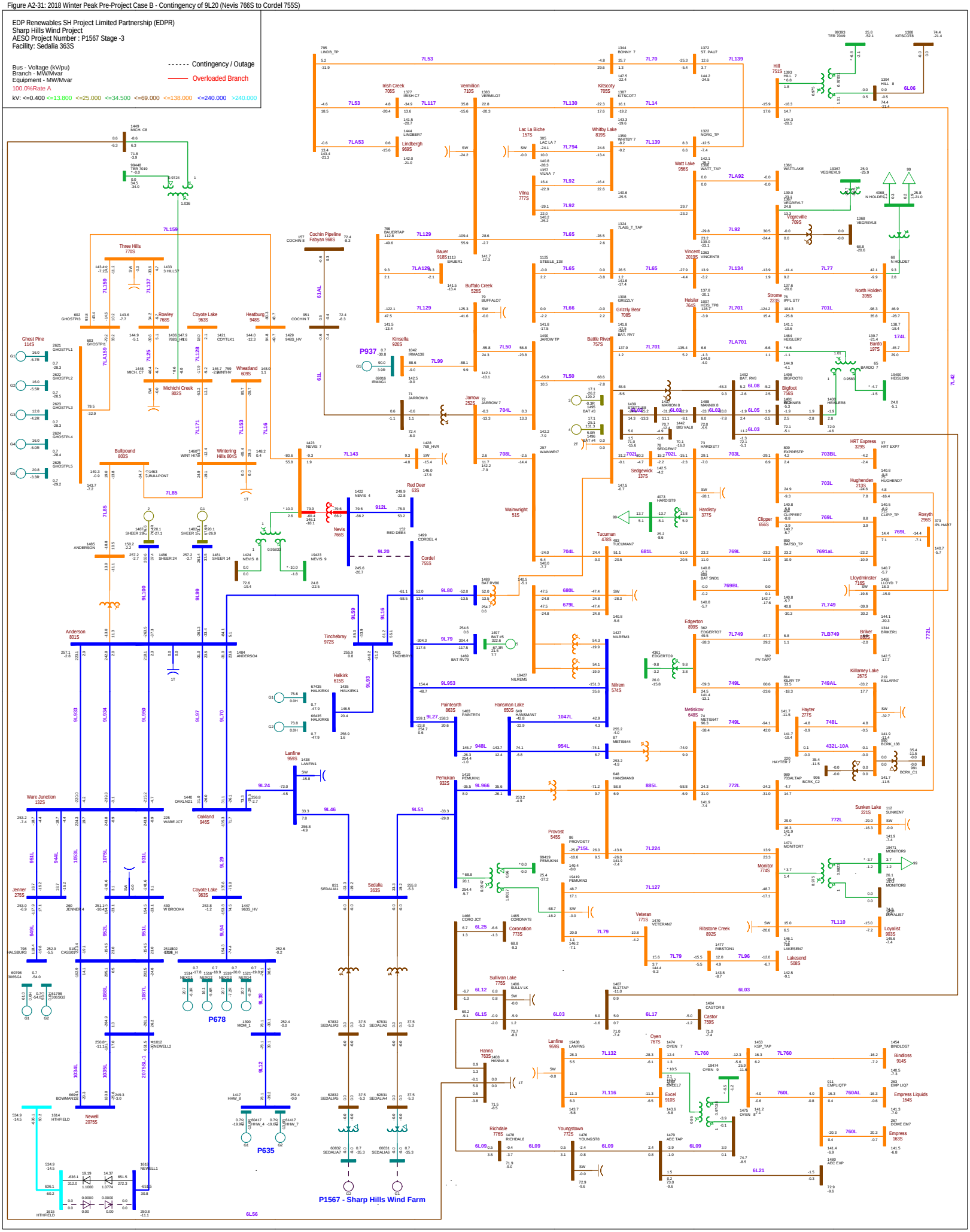


Figure A2-32: 2018 Winter Peak Pre-Project Case B - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

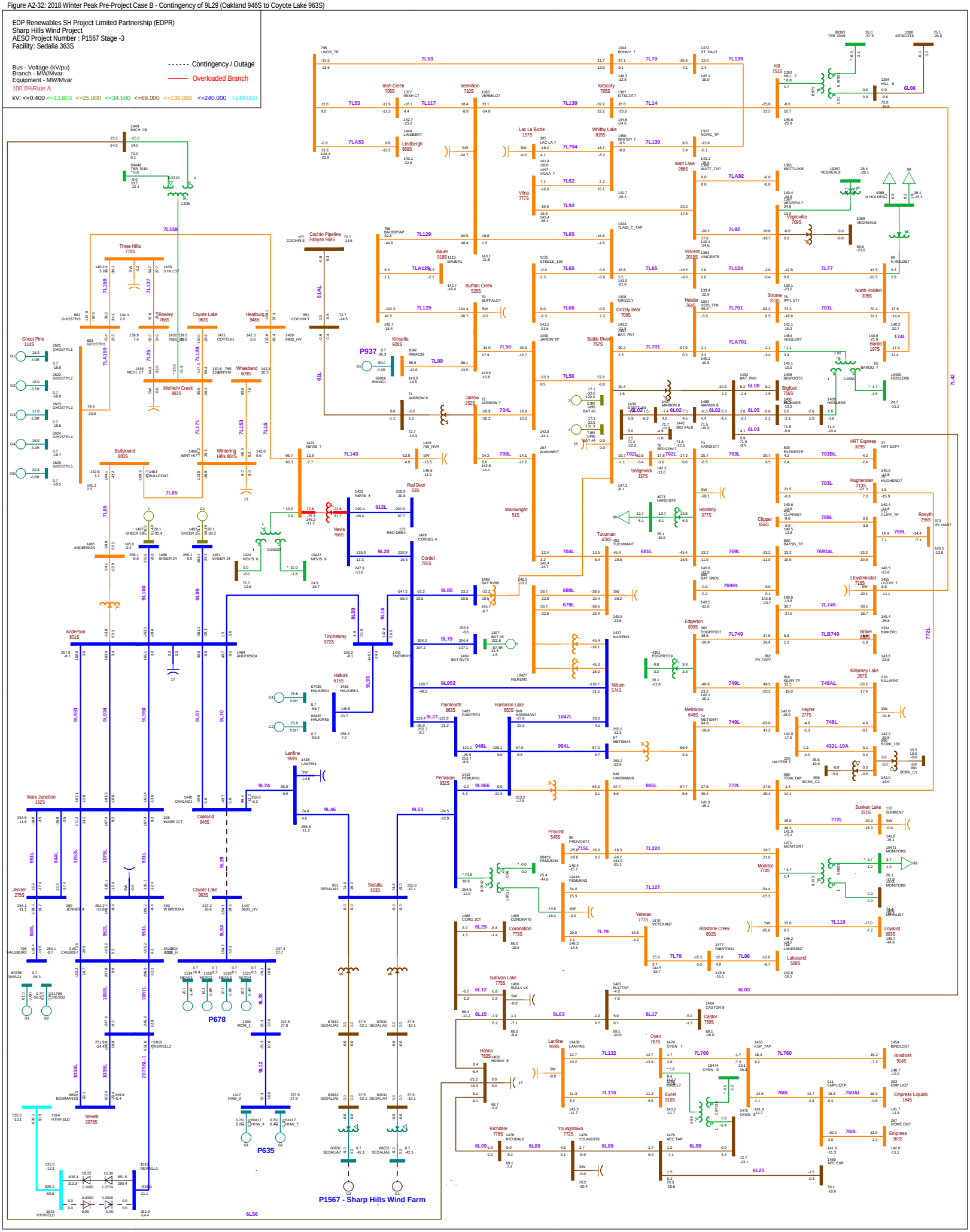
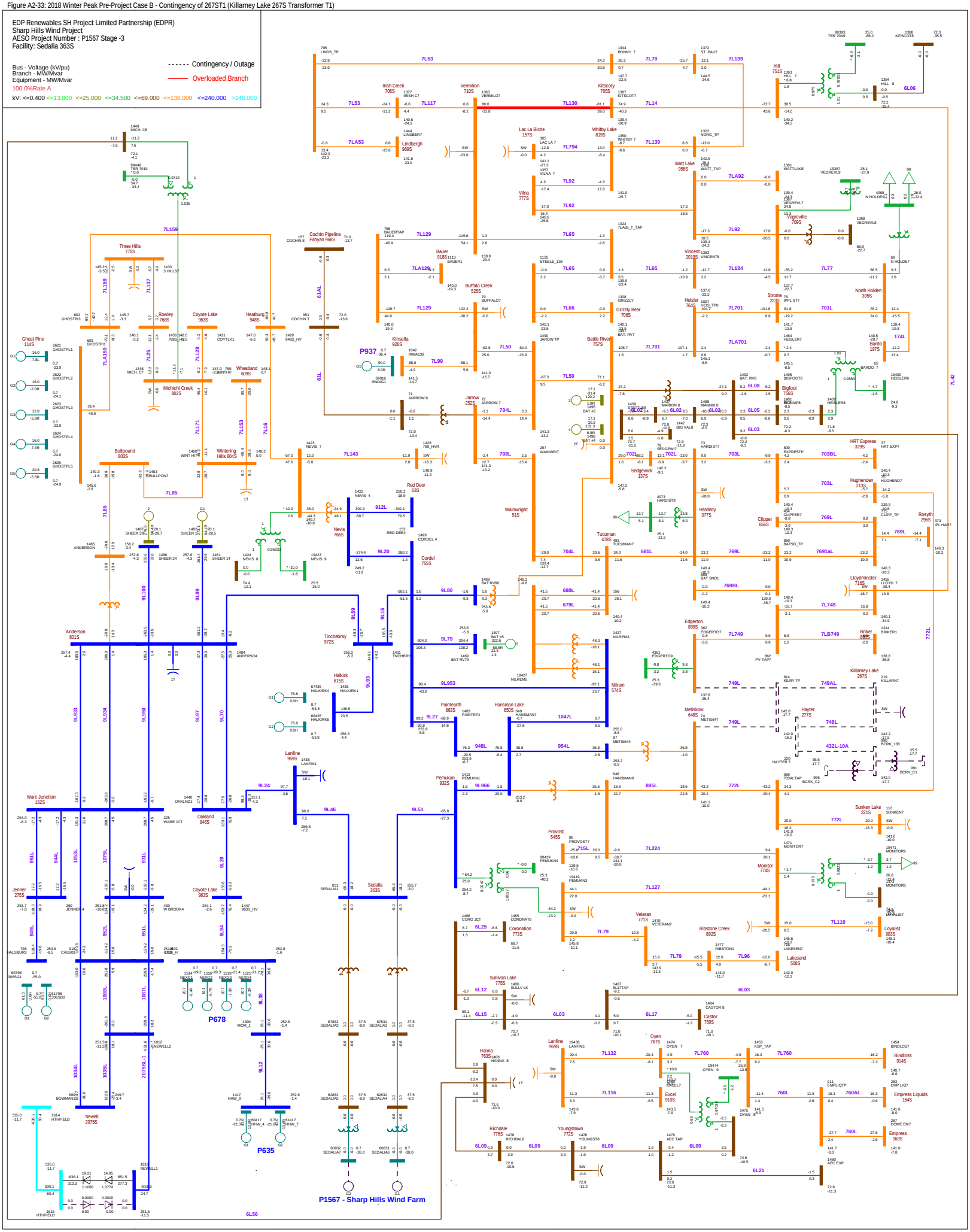


Figure A2-33: 2018 Winter Peak Pre-Project Case B - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)



Attachment A3

Post-Project Power Flow Diagrams

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Figure A3-1: 2018 Summer Light Post-Project Case A - N-0 (System Normal Condition)

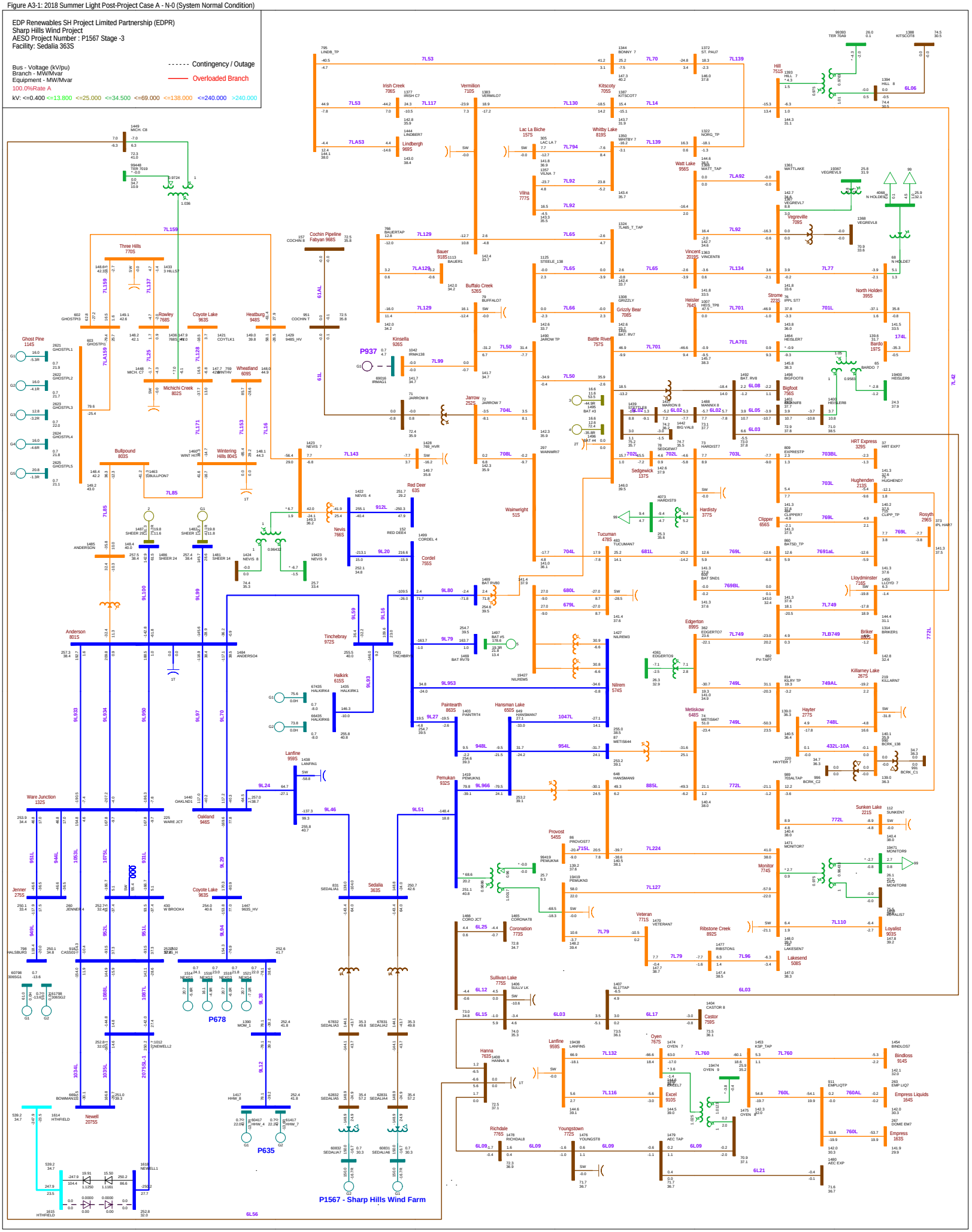
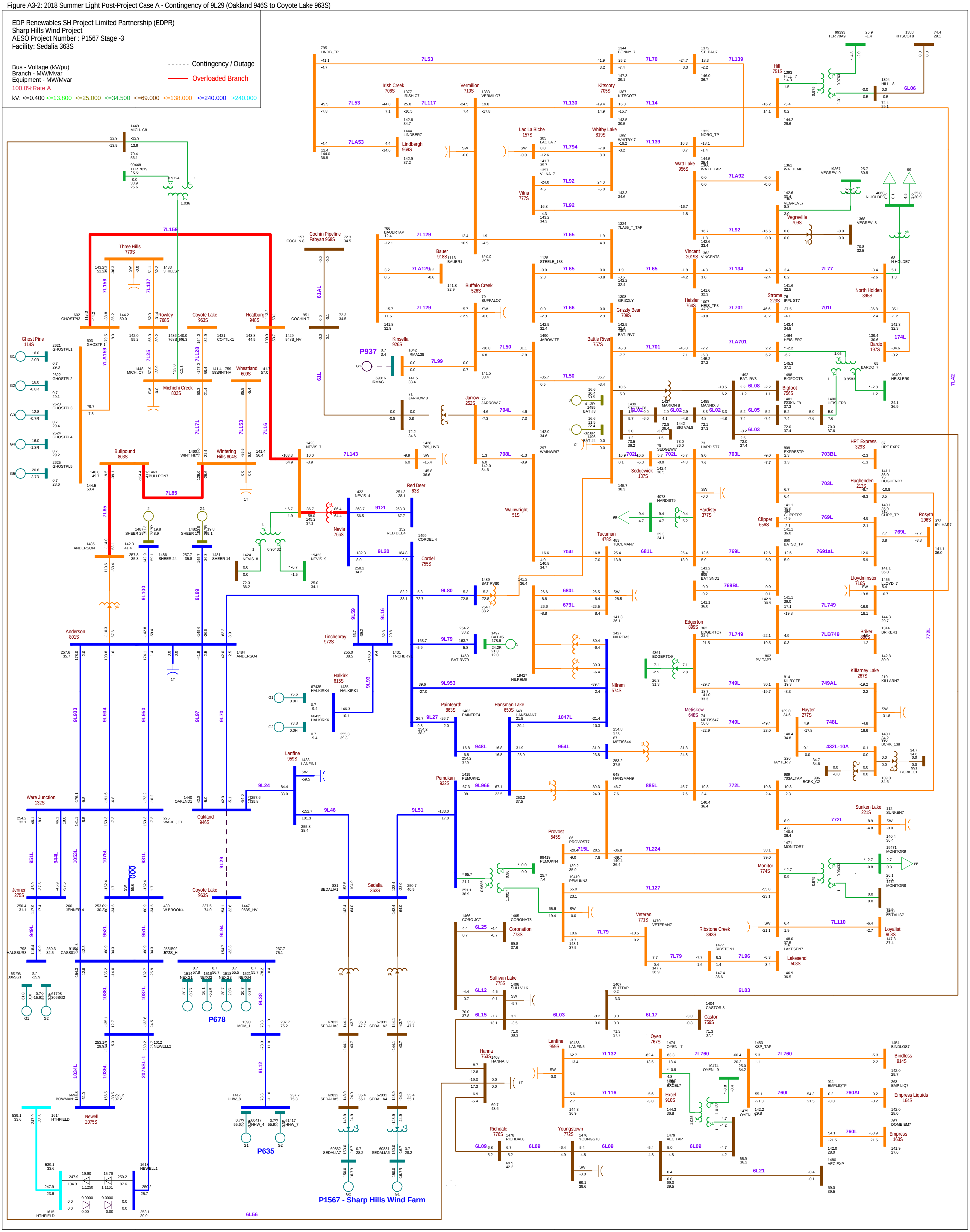


Figure A3-2: 2018 Summer Light Post-Project Case A - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)



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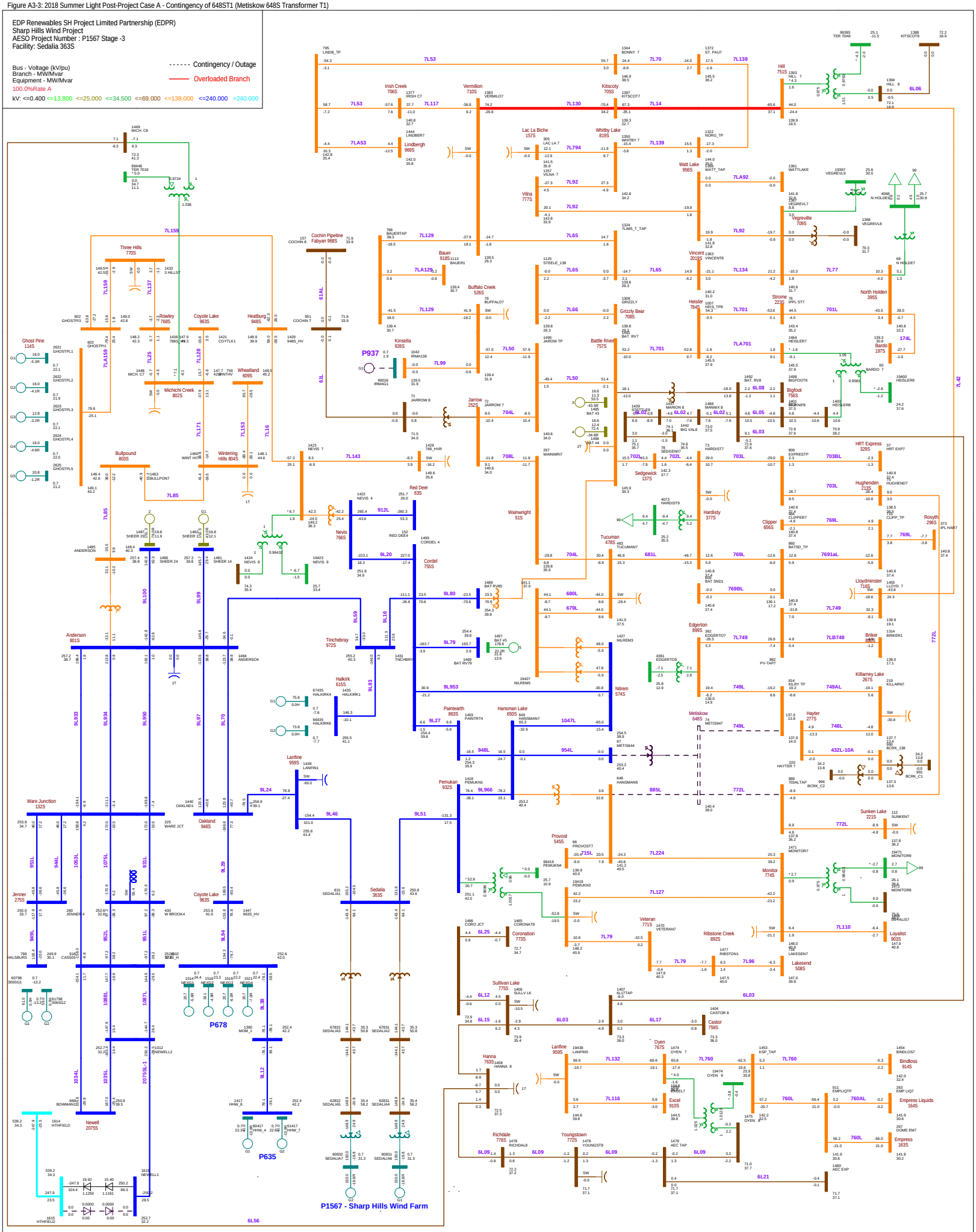

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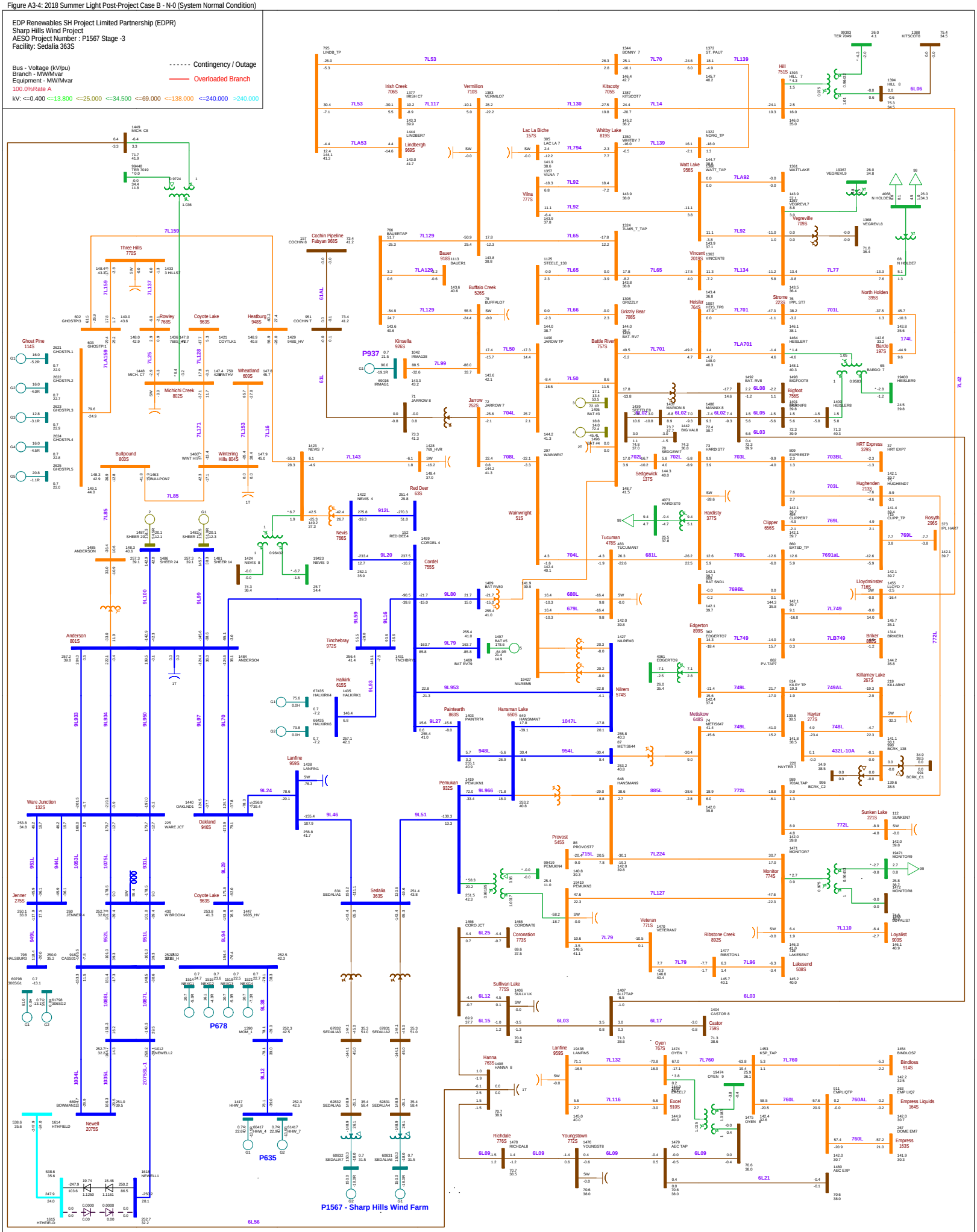


Figure A3-5: 2018 Summer Light Post-Project Case B - Contingency of 648ST1 (Metiskow 648S Transformer T1)

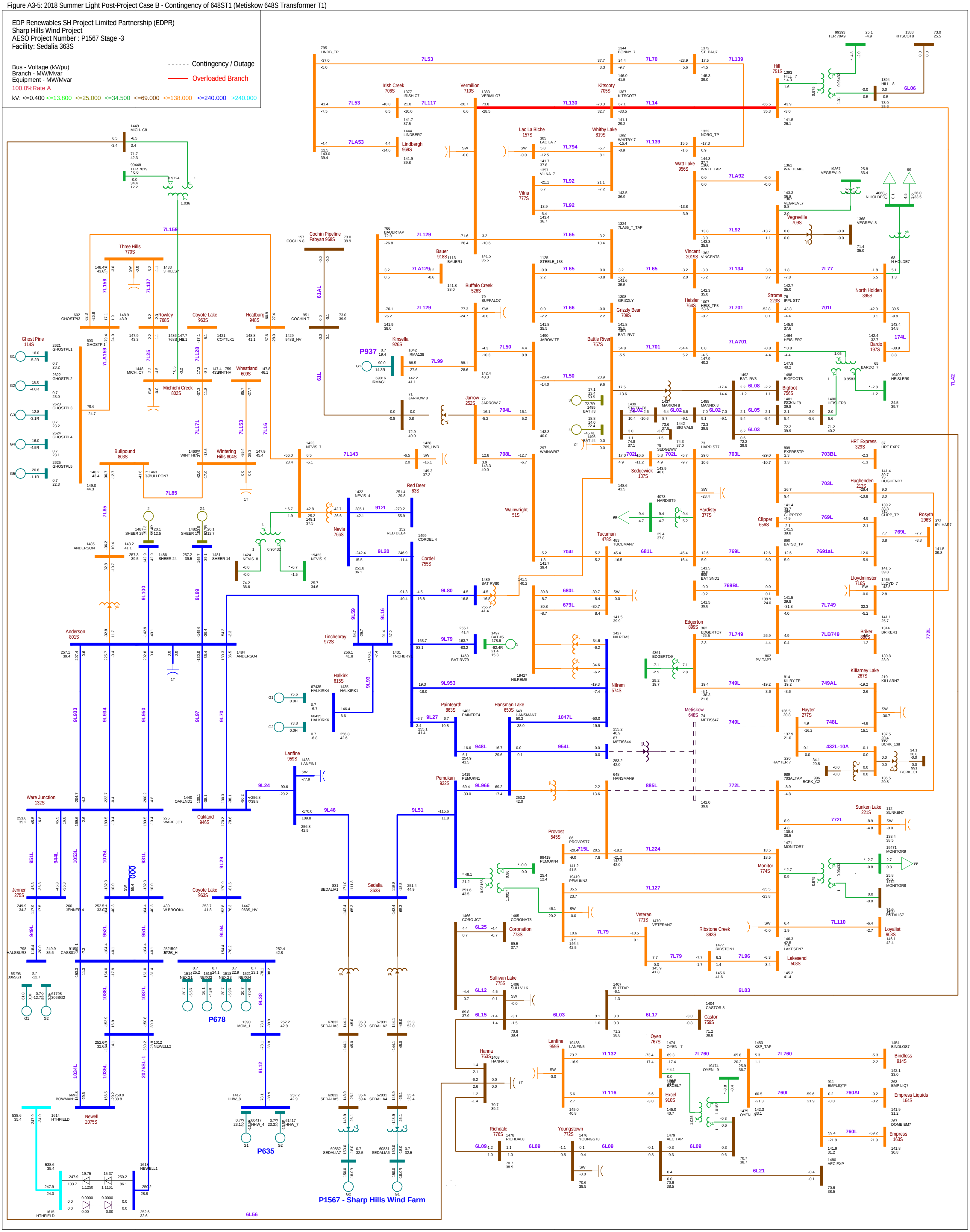


Figure A3-6: 2018 Summer Light Post-Project Case B - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

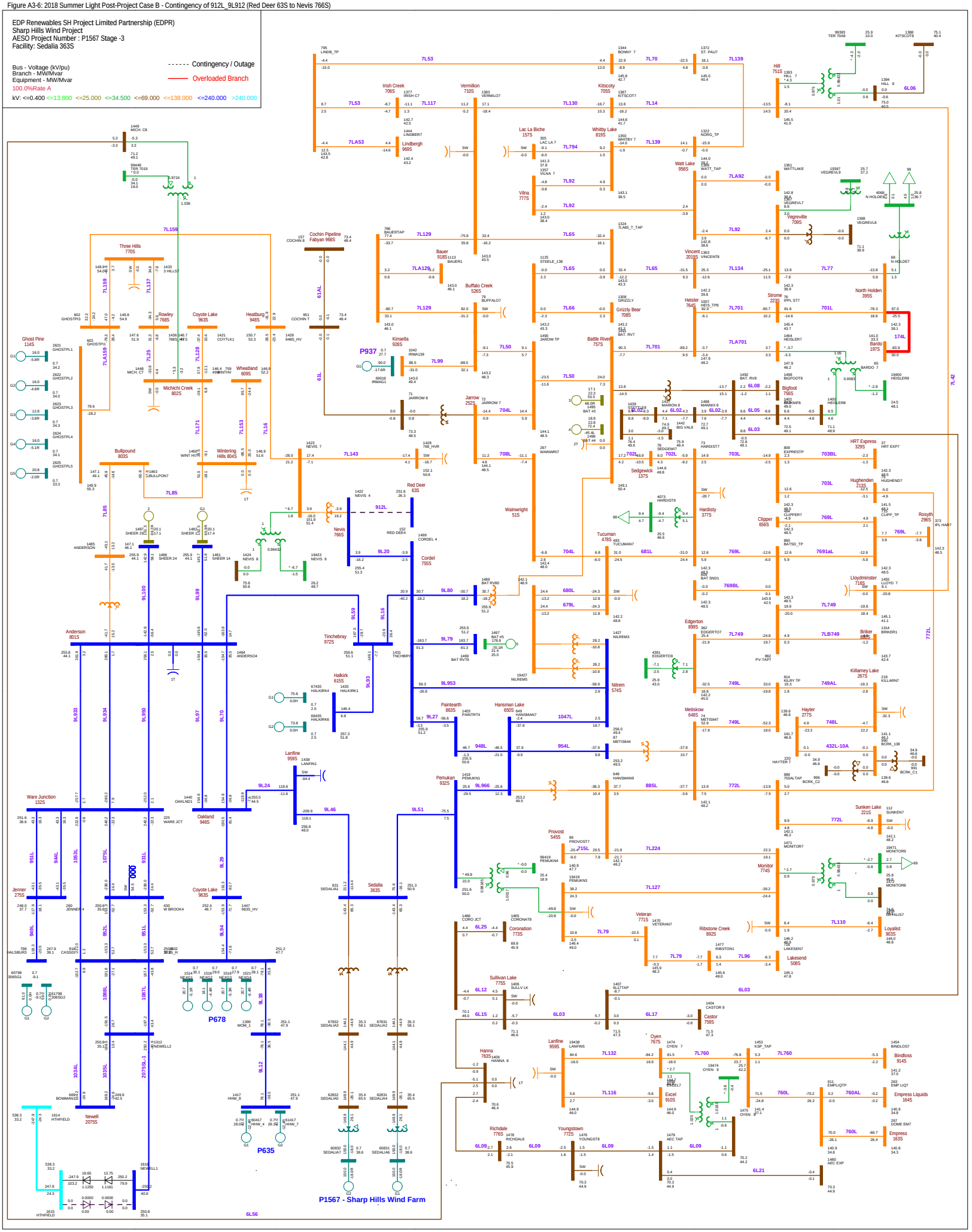


Figure A3-7: 2018 Summer Light Post-Project Case B - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

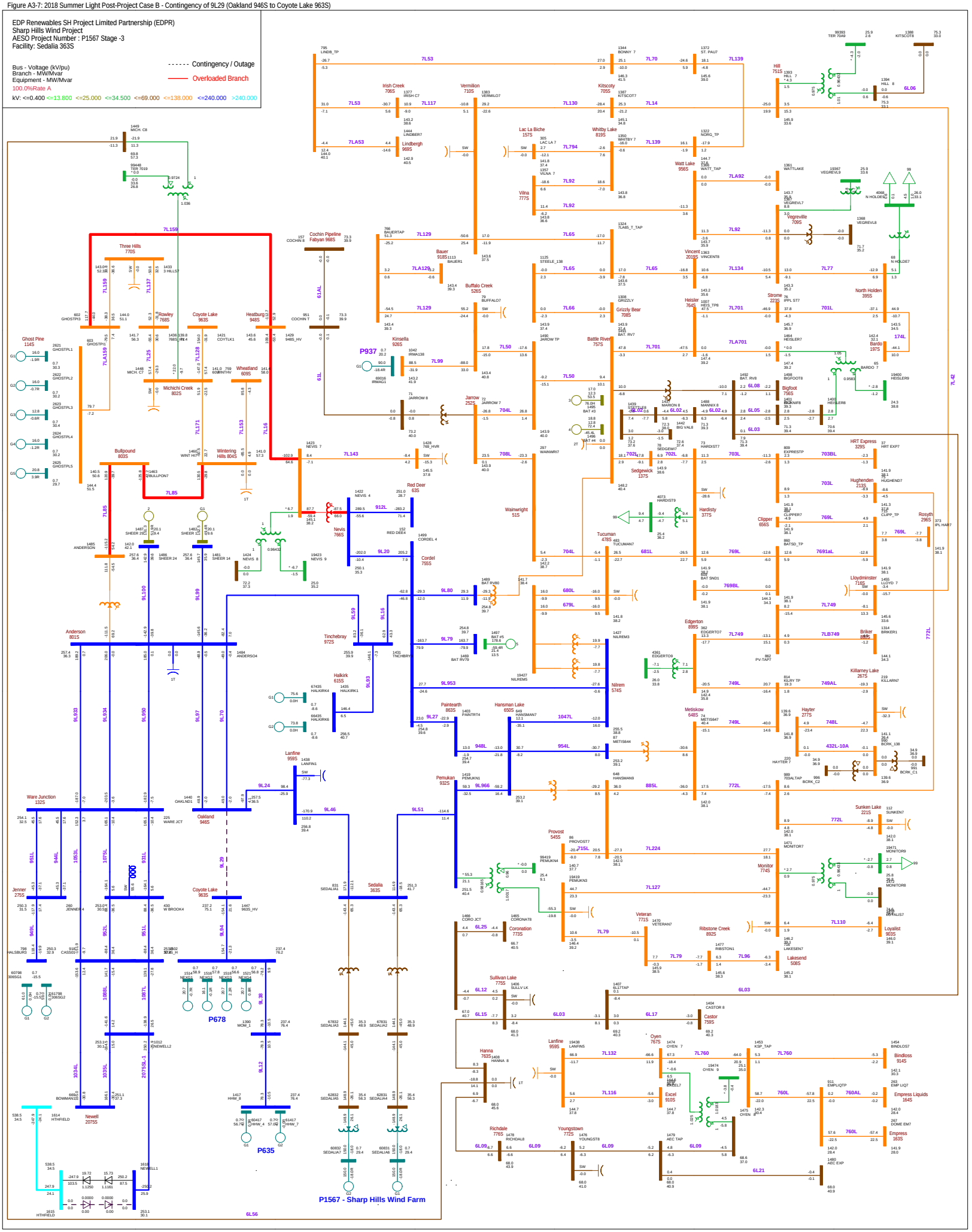


Figure A3-8: 2018 Summer Light Post-Project Case B - Contingency of 766S901T (Nevis 766S Transformer 901T)

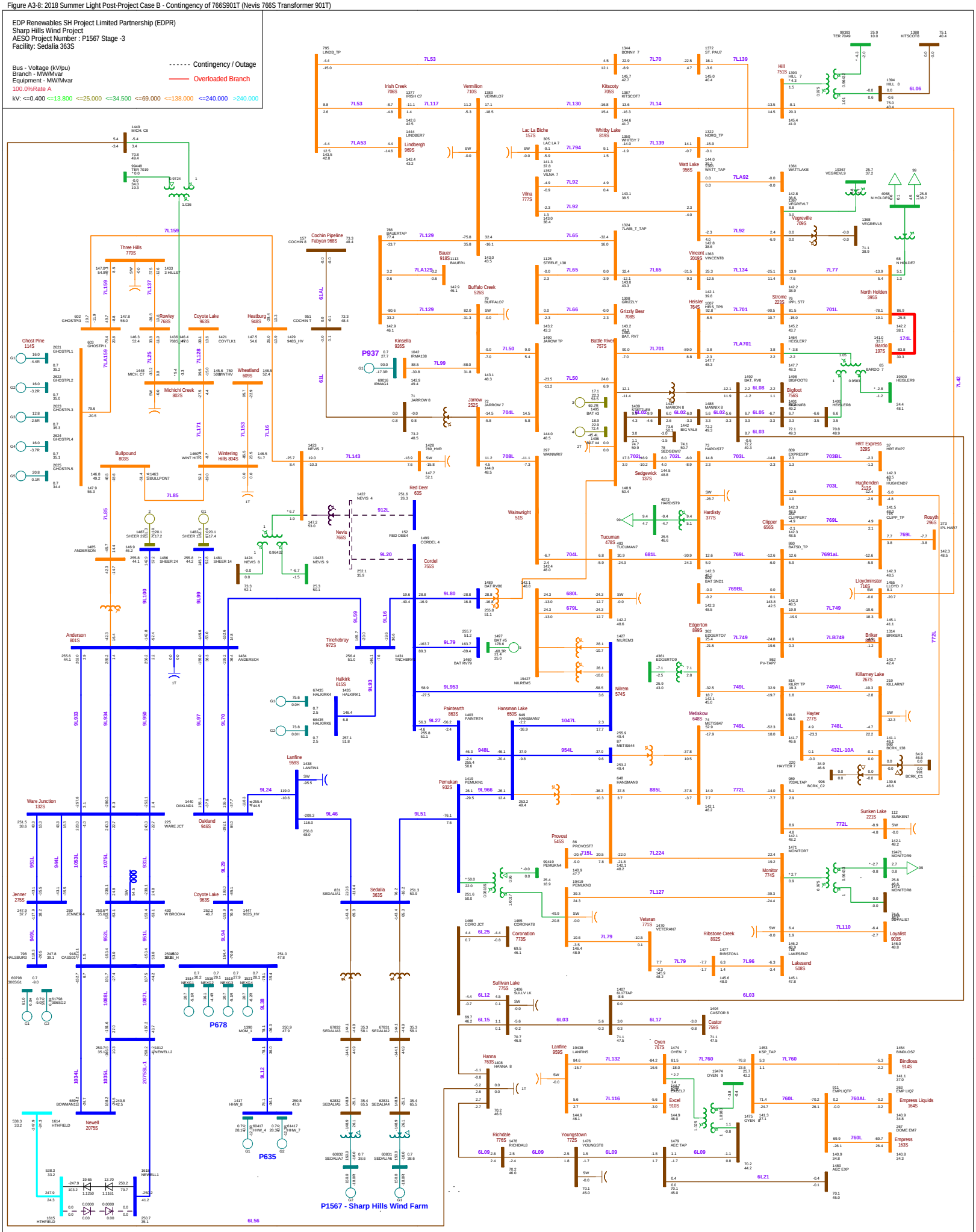


Figure A3-9: 2018 Summer Peak Post-Project Case A - N-0 (System Normal Condition)

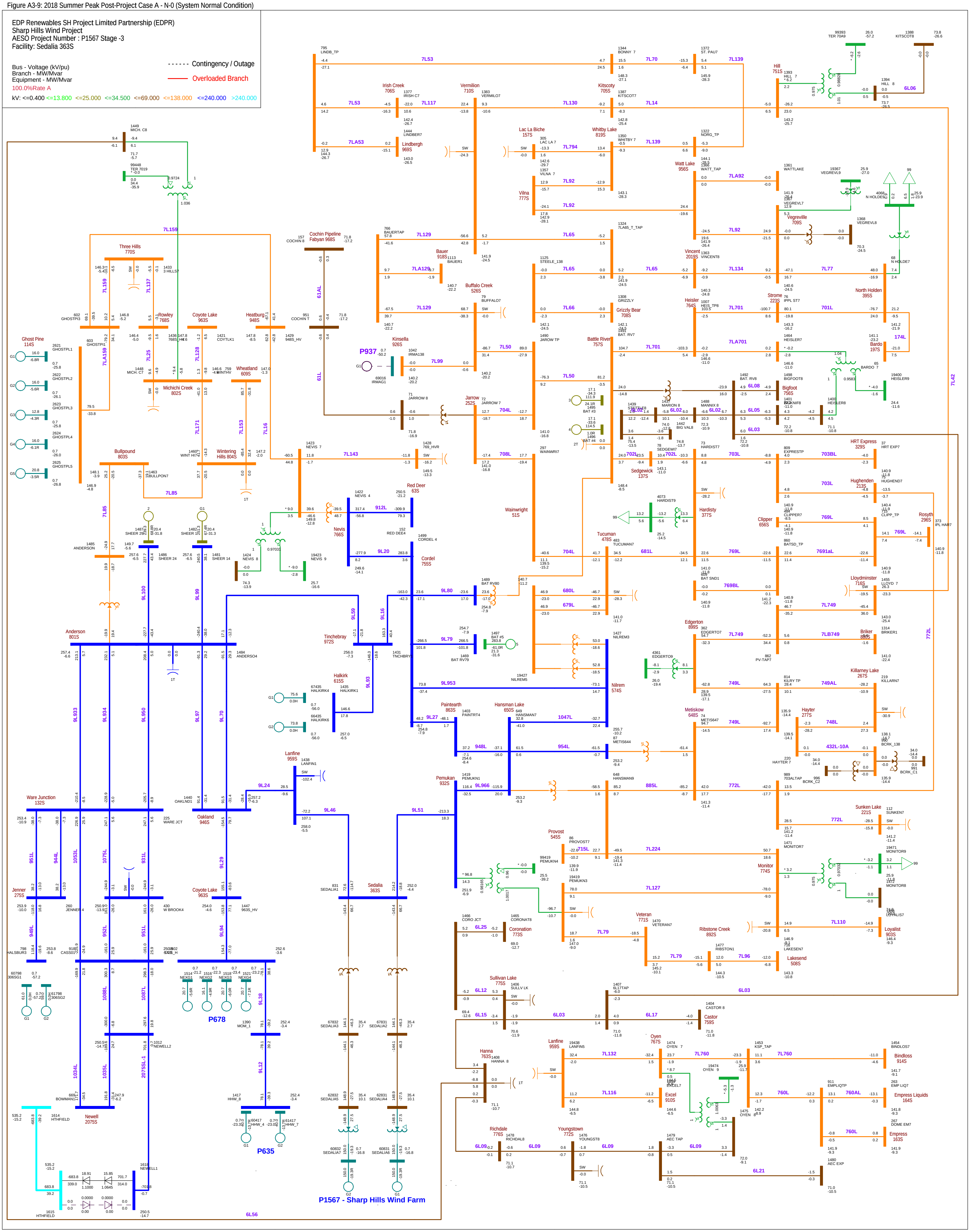


Figure A3-10: 2018 Summer Peak Post-Project Case A - Contingency of EATL (Newell 2075S to Heathfield 2029S)

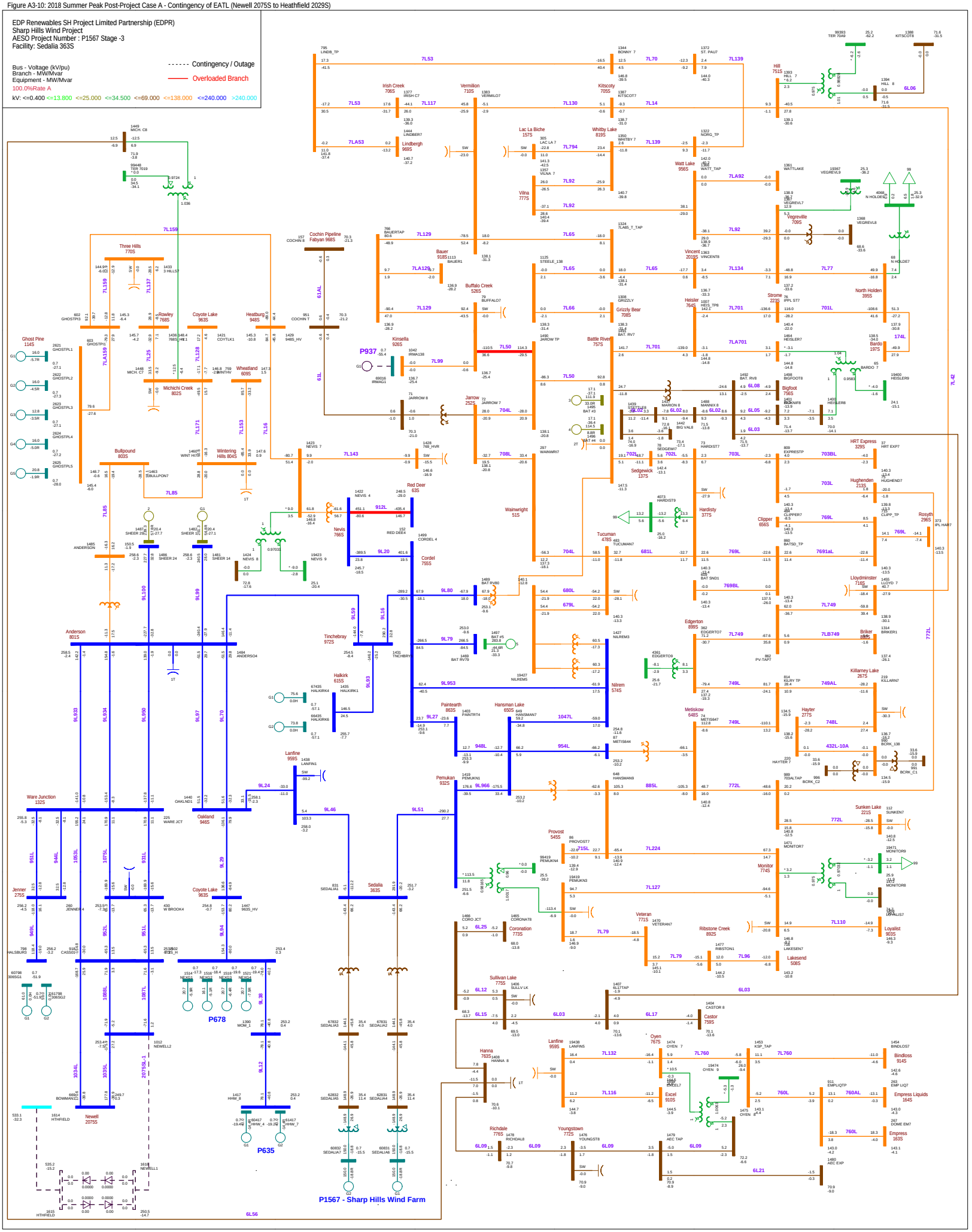


Figure A3-11: 2018 Summer Peak Post-Project Case A - Contingency of 526ST1 OR 526ST2 (Buffalo Creek 526S Transformer T1 or T2)

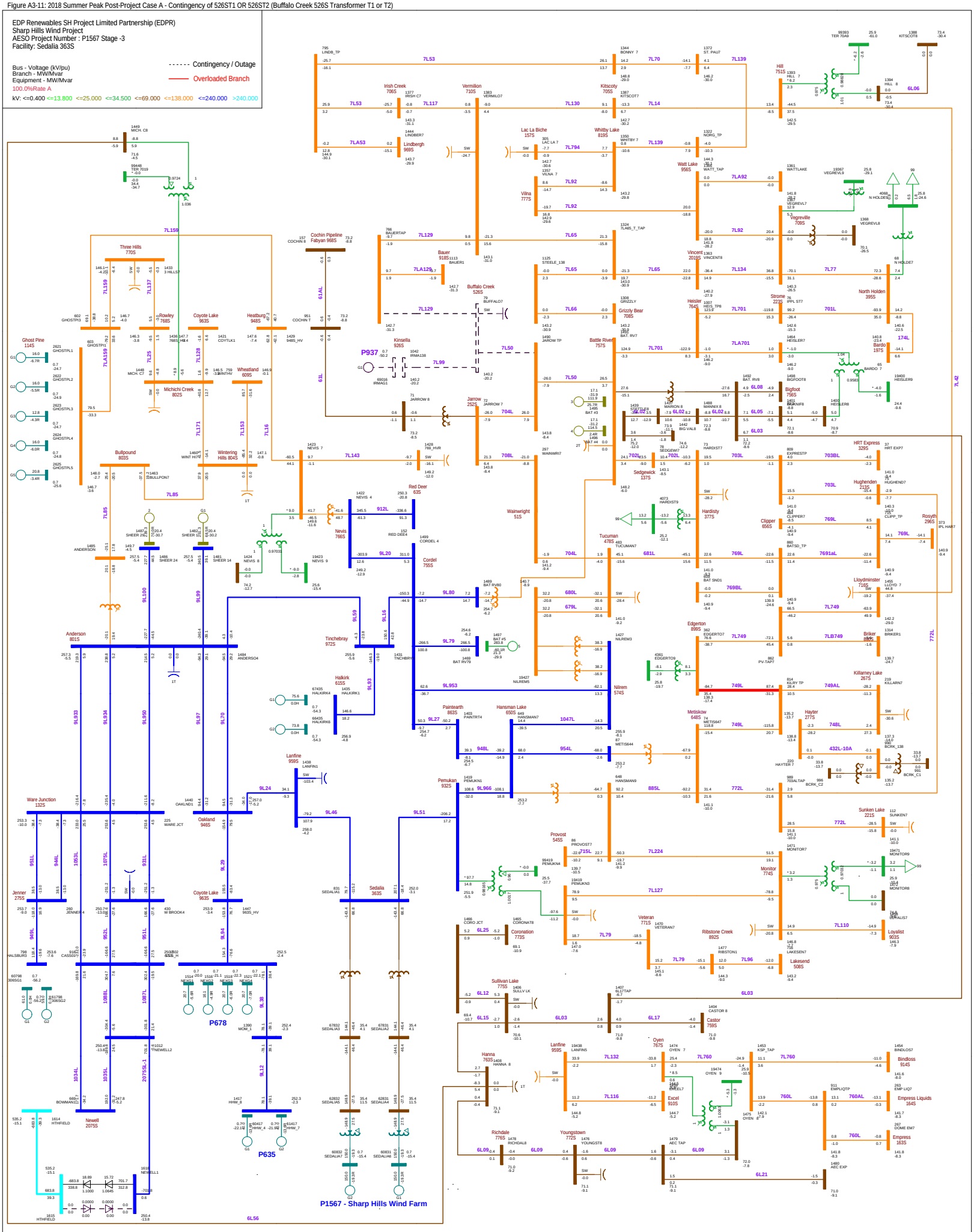


Figure A3-12: 2018 Summer Peak Post-Project Case A - Contingency of 9L20 (Nevis 766S to Cordel 755S)

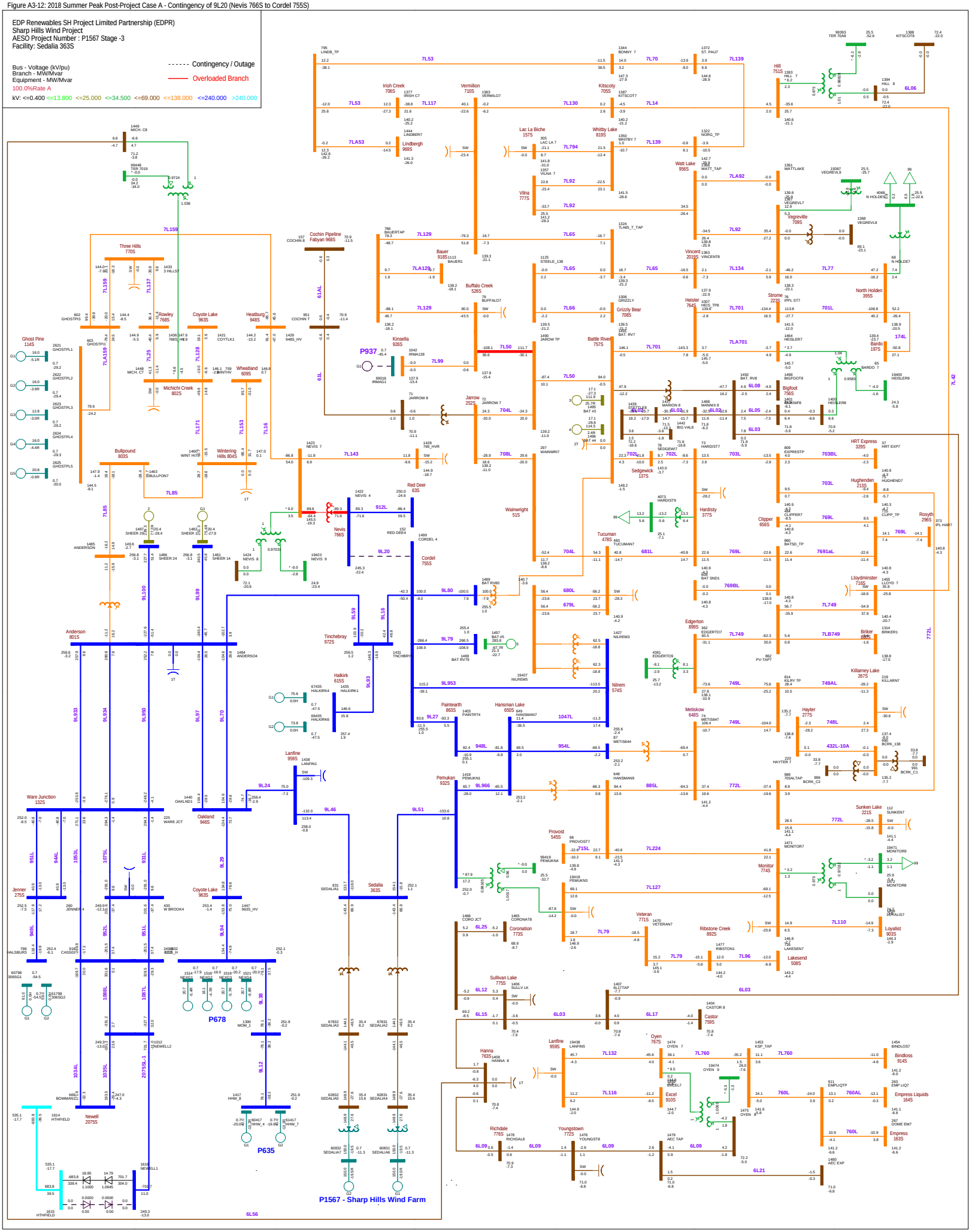


Figure A3-13: 2018 Summer Peak Post-Project Case A - Contingency of 7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)

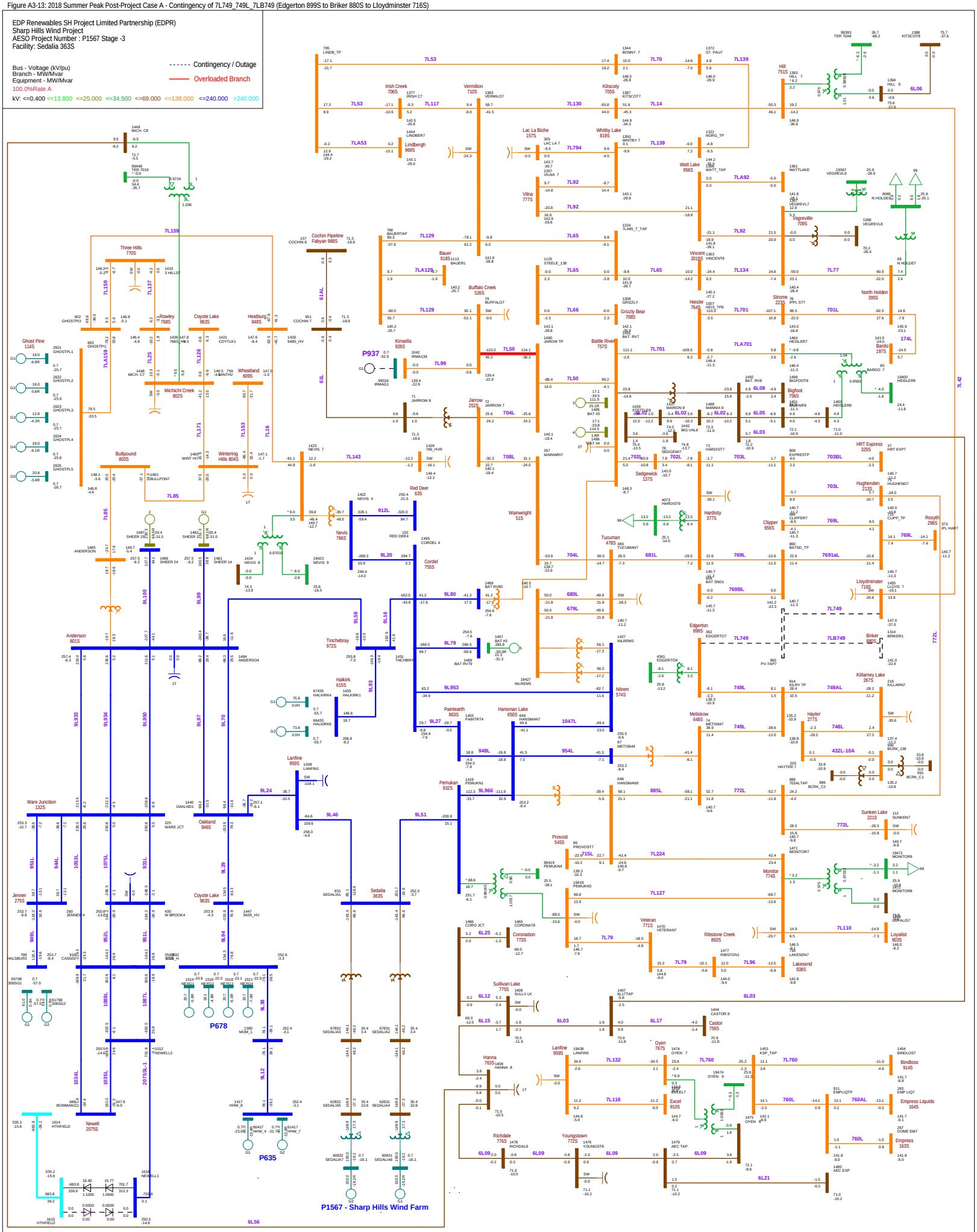


Figure A3-14: 2018 Summer Peak Post-Project Case A - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

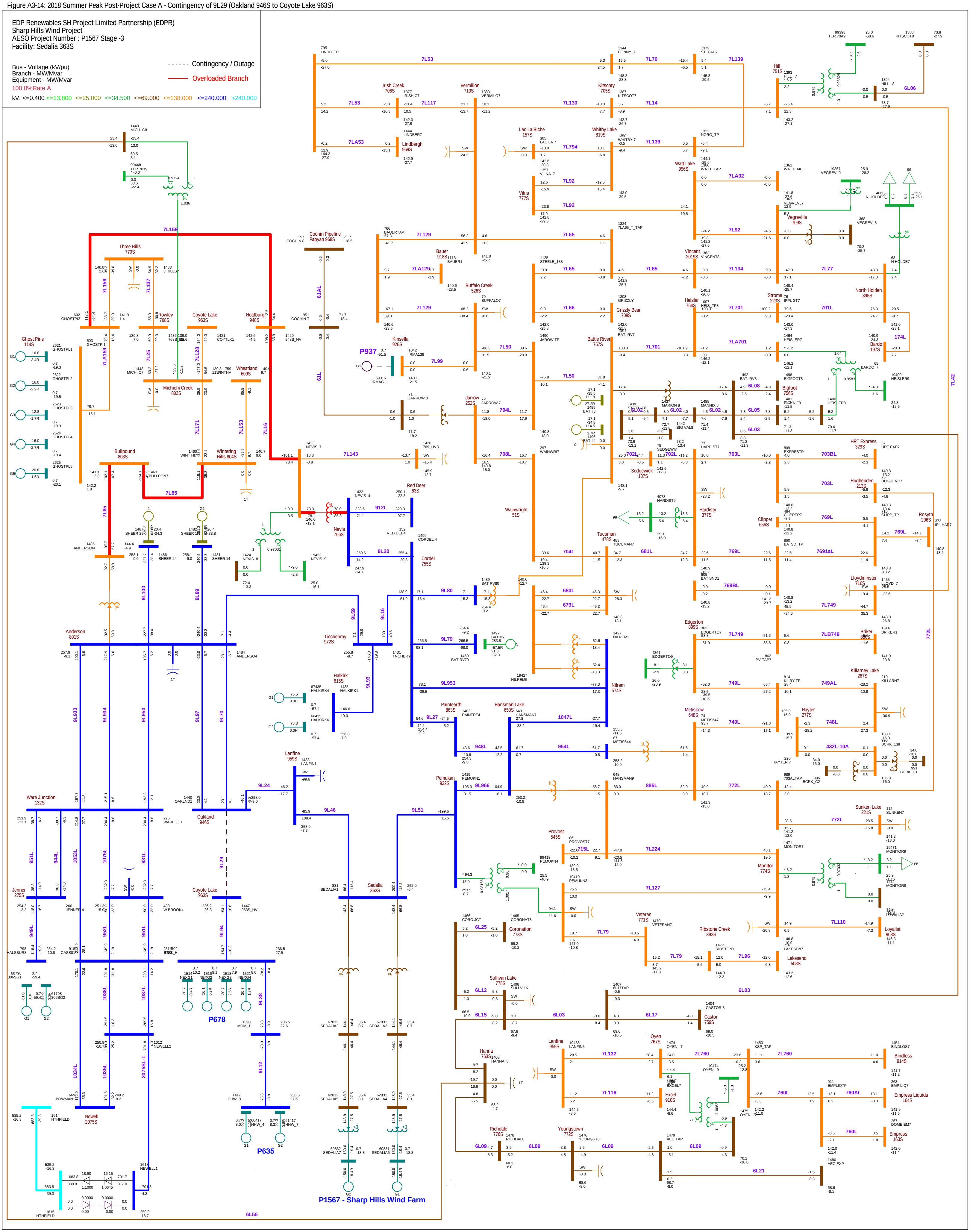


Figure A3-15: 2018 Summer Peak Post-Project Case A - Contingency of 7L50 (Battle River 757S to Jarrow 252S to Buffalo Creek 526S)

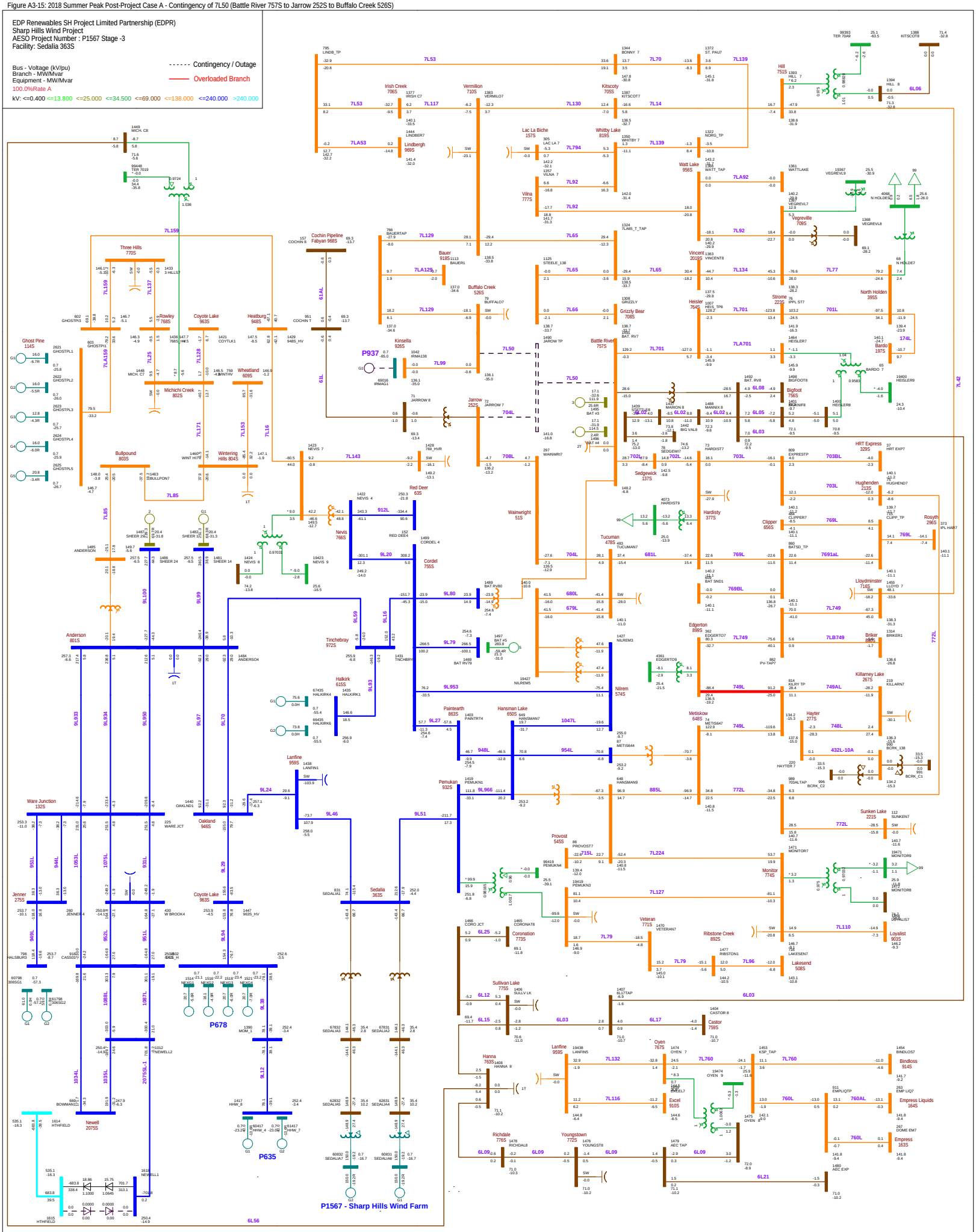


Figure A3-16: 2018 Summer Peak Post-Project Case A - Contingency of 7L129_7LA129 (Buffalo Creek 526S to Vermilion 710S to Bauer 918S)

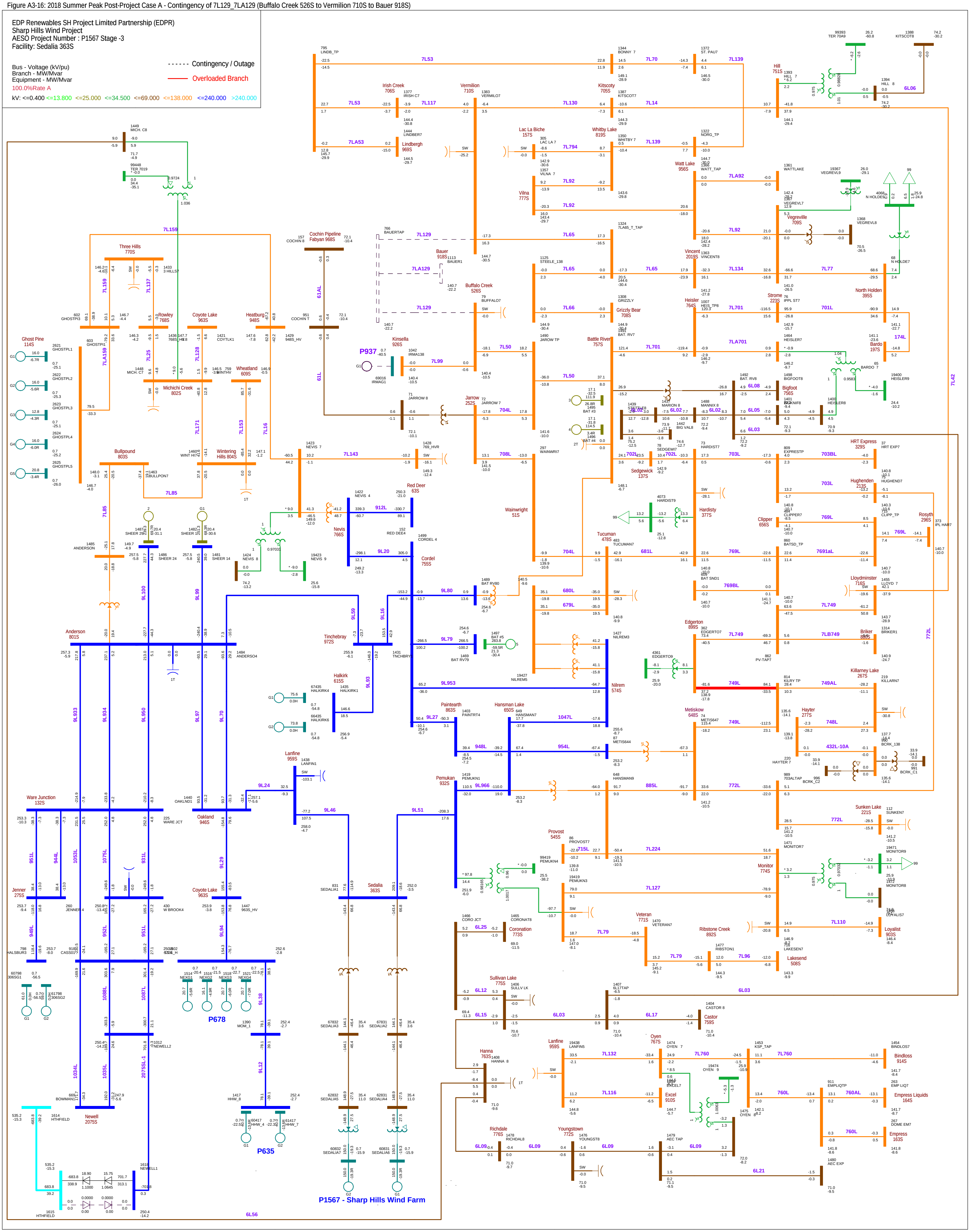


Figure A3-17: 2018 Summer Peak Post-Project Case A - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

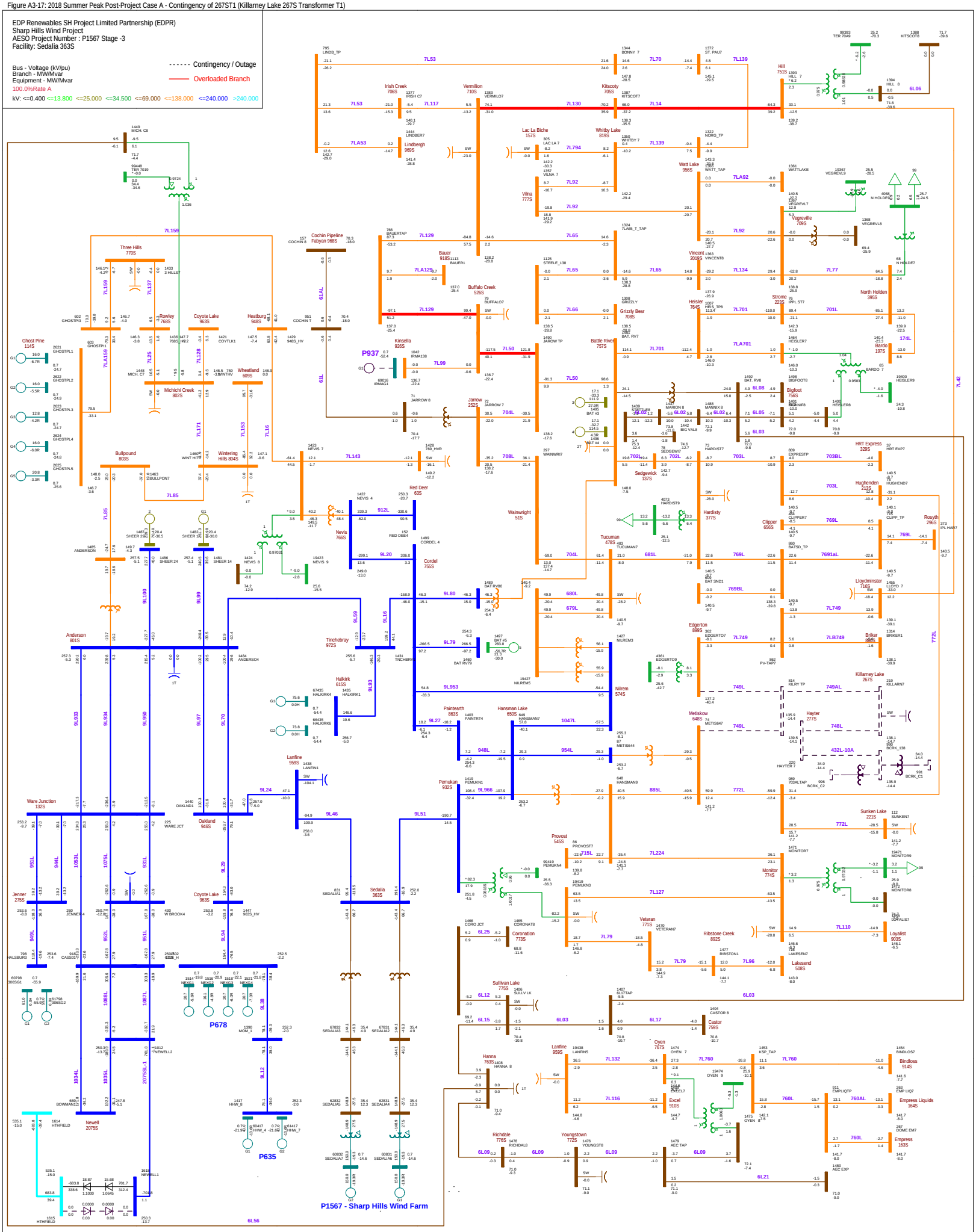


Figure A3-18: 2018 Summer Peak Post-Project Case A - Contingency of 966L_9L966 (Hansman Lake 650S to Pemukan 932S)

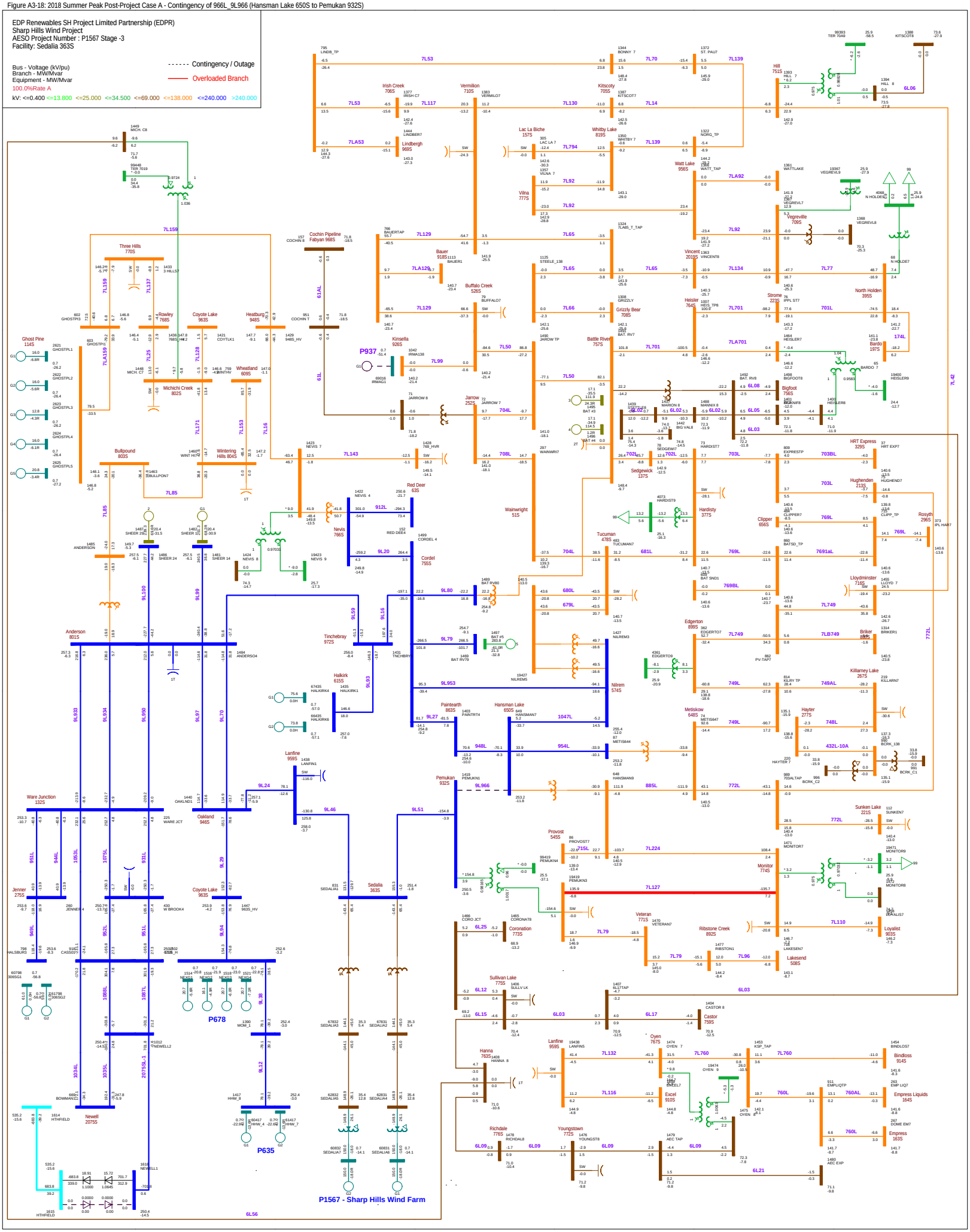


Figure A3-19: 2018 Summer Peak Post-Project Case A - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

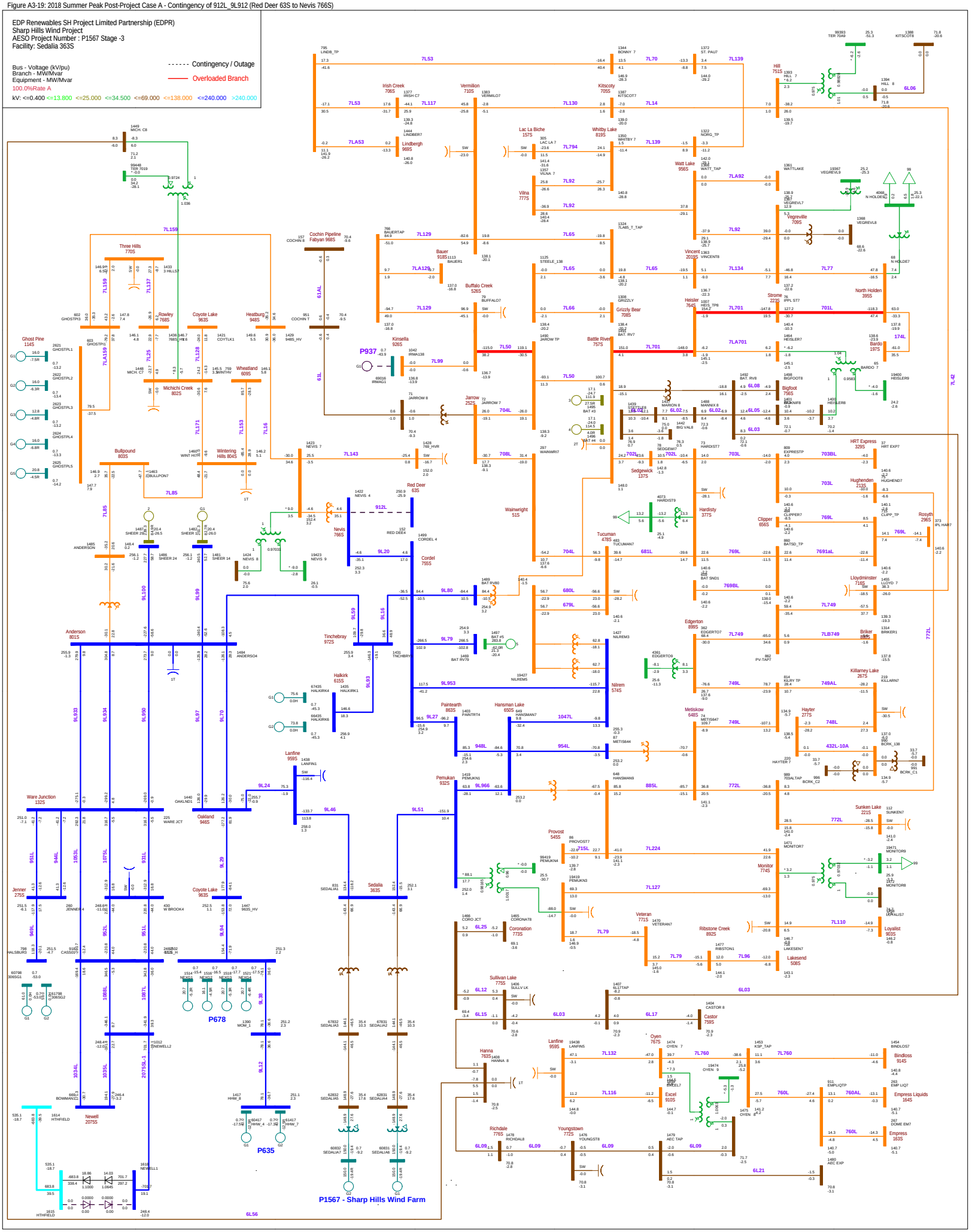


Figure A3-20: 2018 Summer Peak Post-Project Case A - Contingency of 7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)

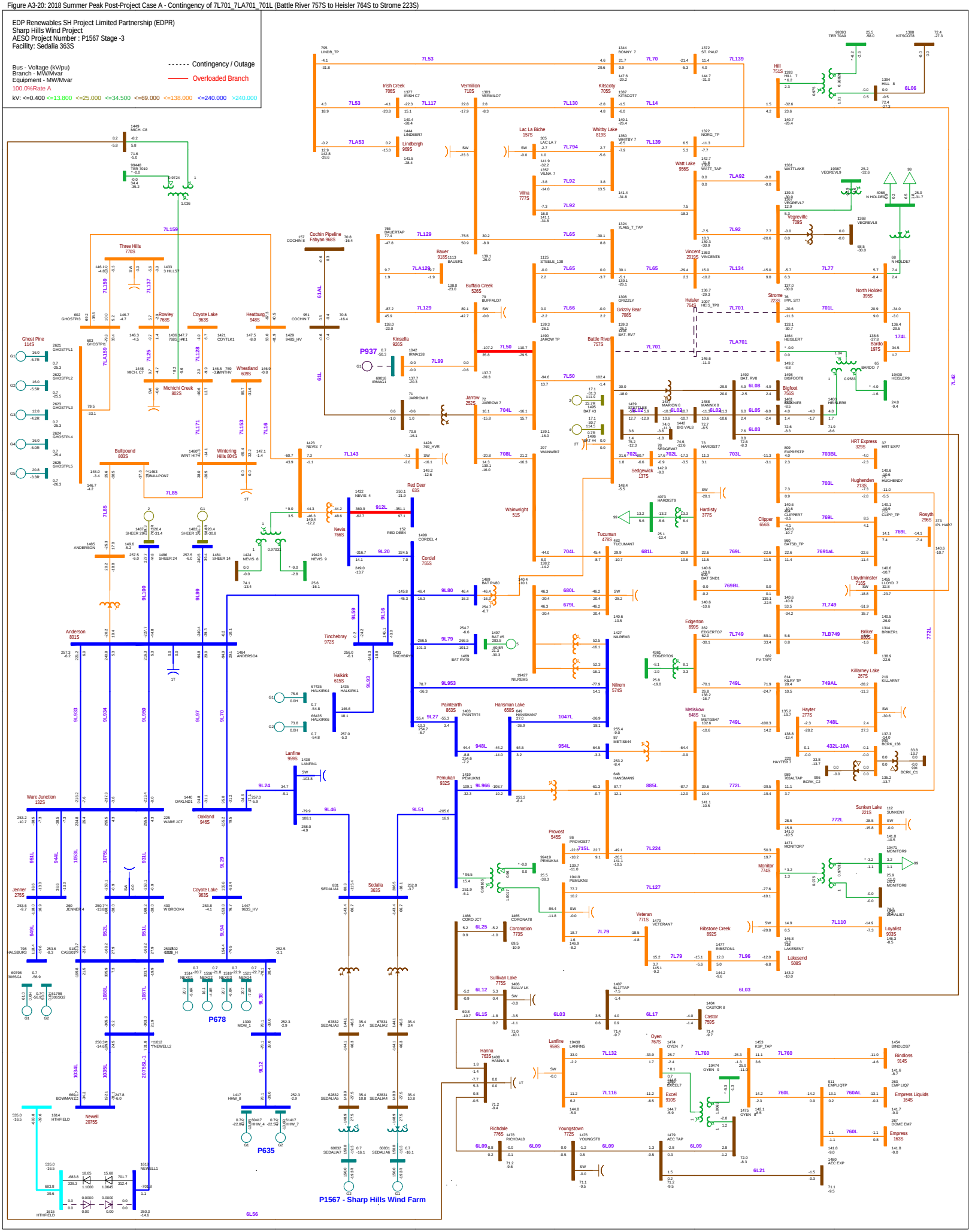


Figure A3-21: 2018 Summer Peak Post-Project Case A - Contingency of 766S901T (Nevis 766S Transformer 901T)

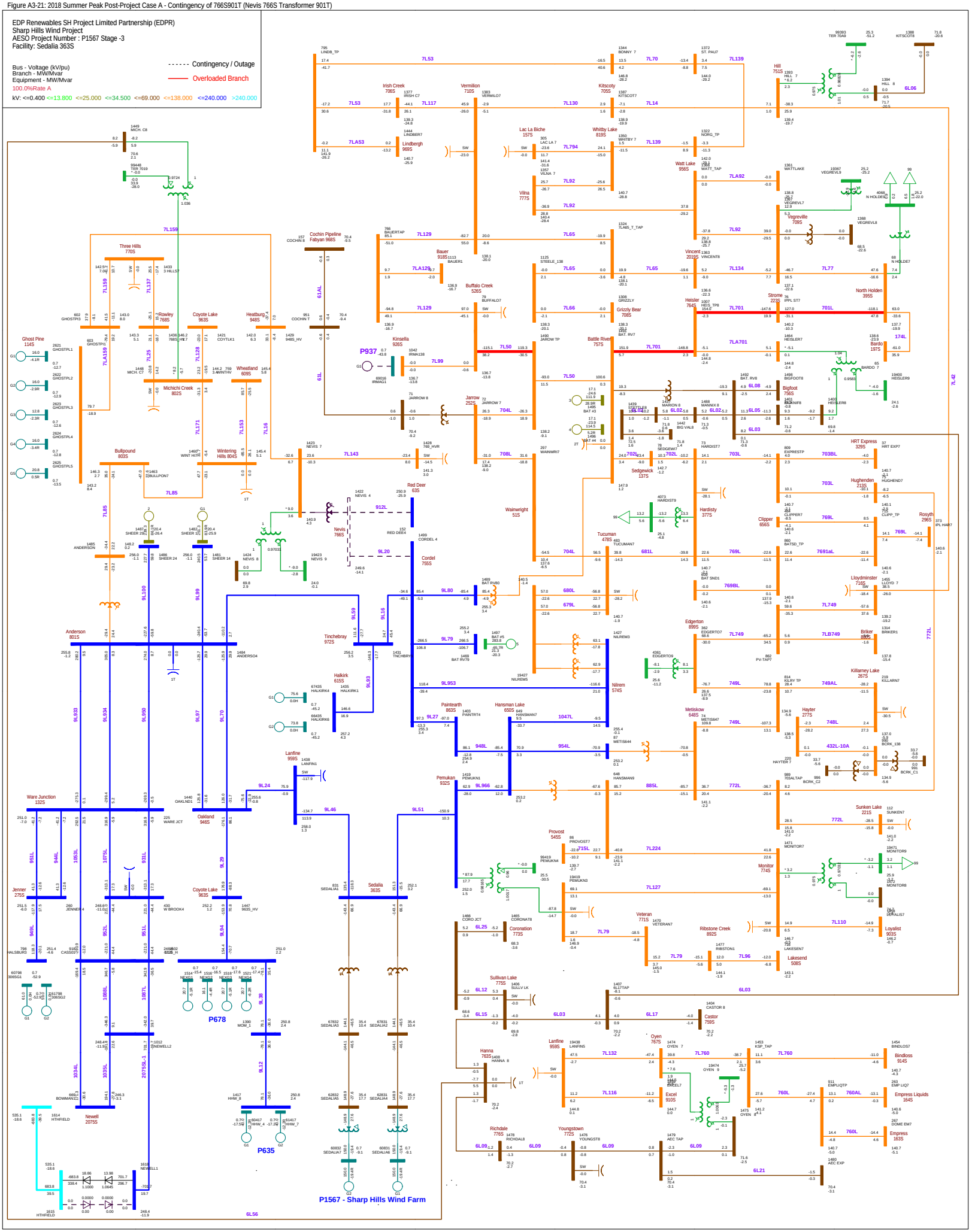


Figure A3-22: 2018 Summer Peak Post-Project Case A - Contingency of 899ST3A (Edgerton 899S Transformer T3A)

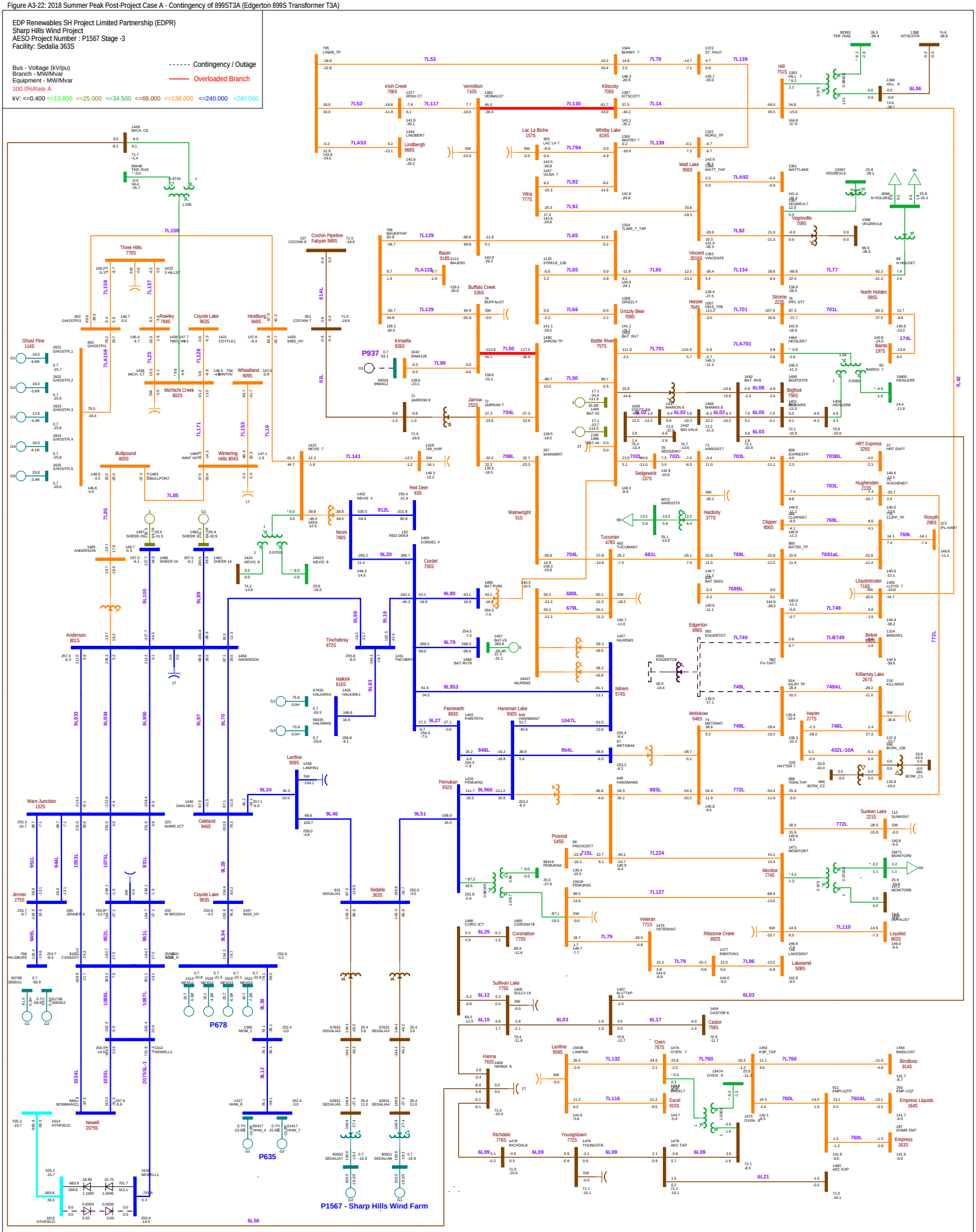


Figure A3-23: 2018 Summer Peak Post-Project Case B - N-0 (System Normal Condition)

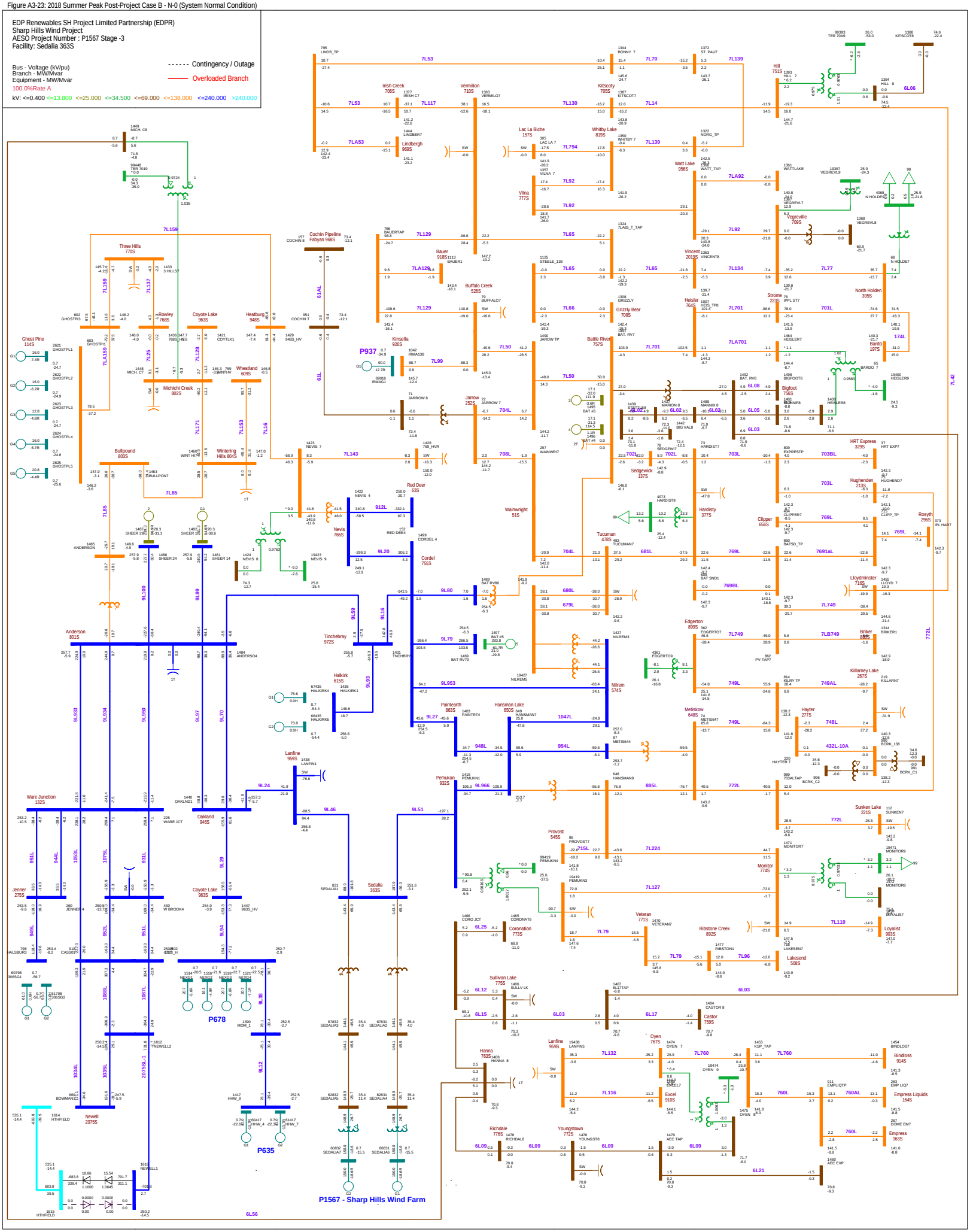


Figure A3-24: 2018 Summer Peak Post-Project Case B - Contingency of 7L77 (North Holden 395S to Vegreville 709S)

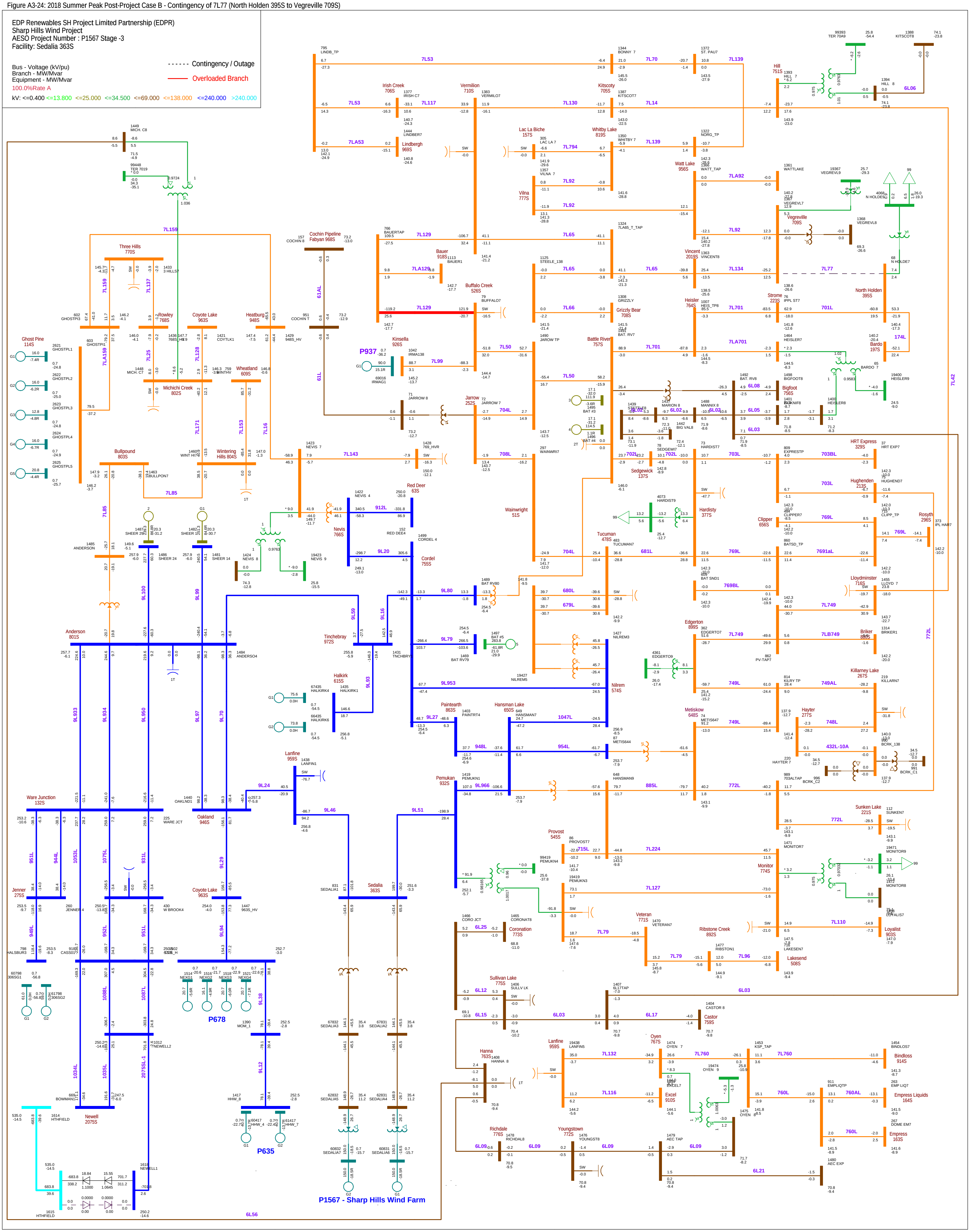


Figure A3-25: 2018 Summer Peak Post-Project Case B - Contingency of 526ST1 OR 526ST2 (Buffalo Creek 526S Transformer T1 or T2)

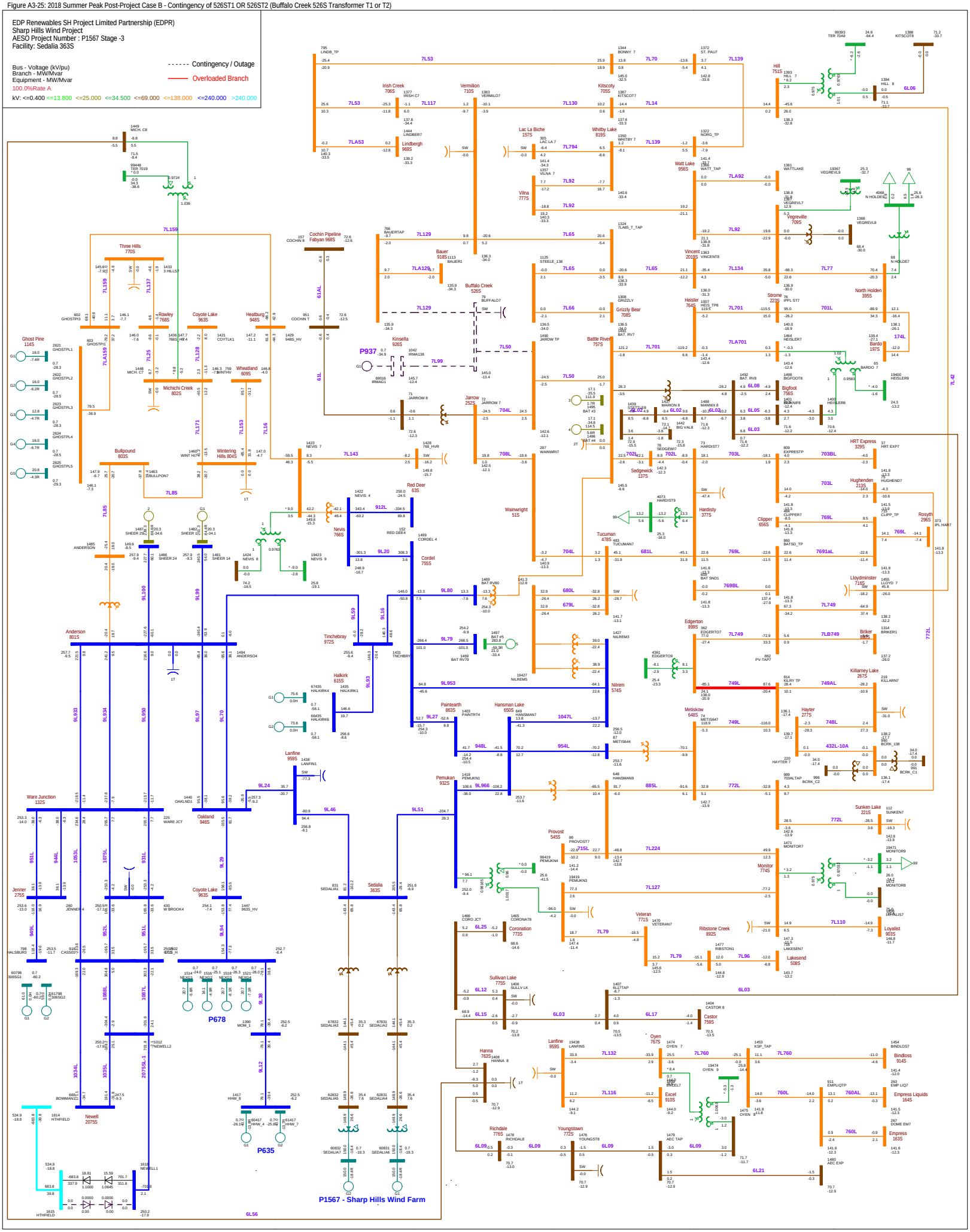


Figure A3-26: 2018 Summer Peak Post-Project Case B - Contingency of 766S901T (Nevis 766S Transformer 901T)

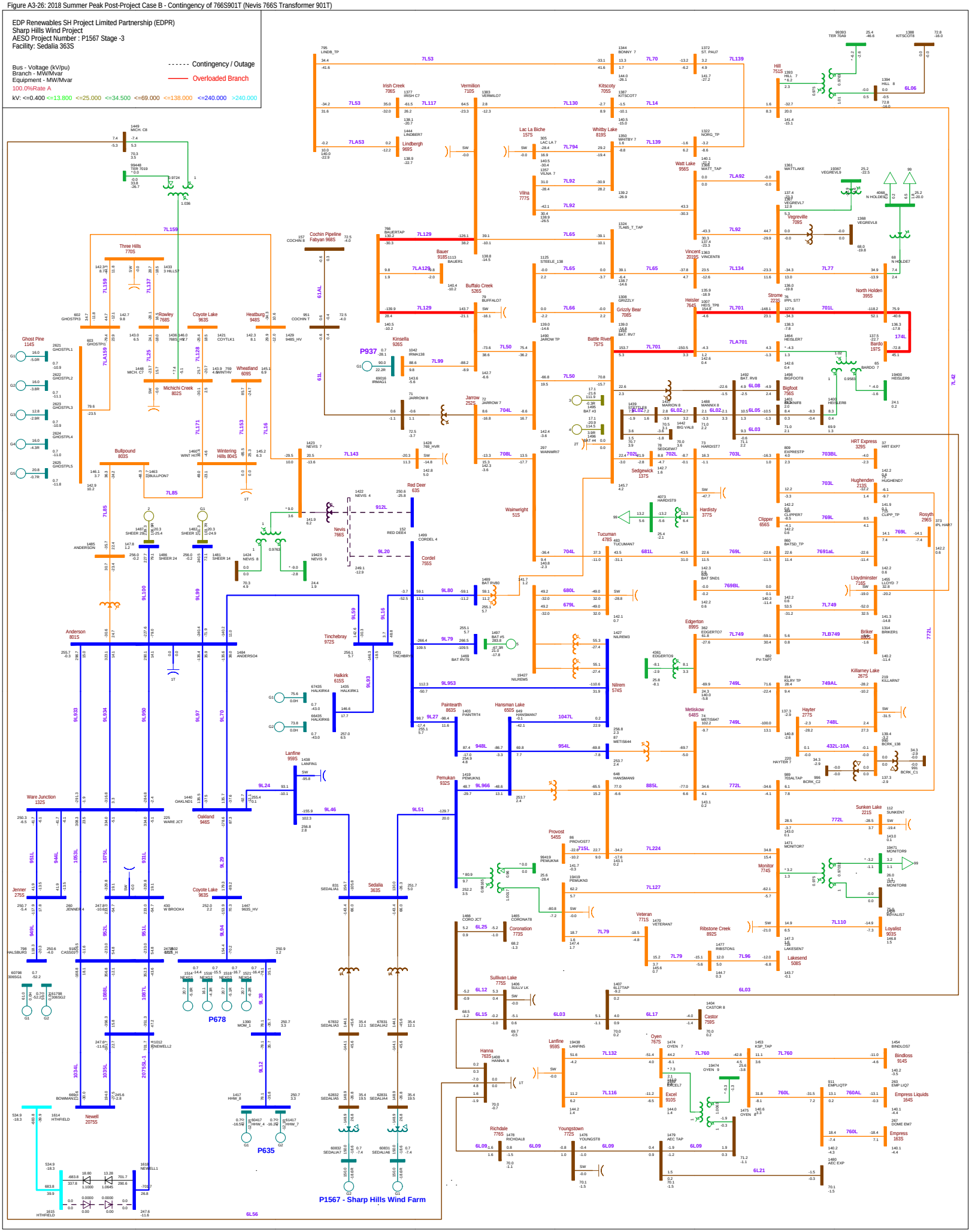


Figure A3-27: 2018 Summer Peak Post-Project Case B - Contingency of 899ST3A (Edgerton 899S Transformer T3A)

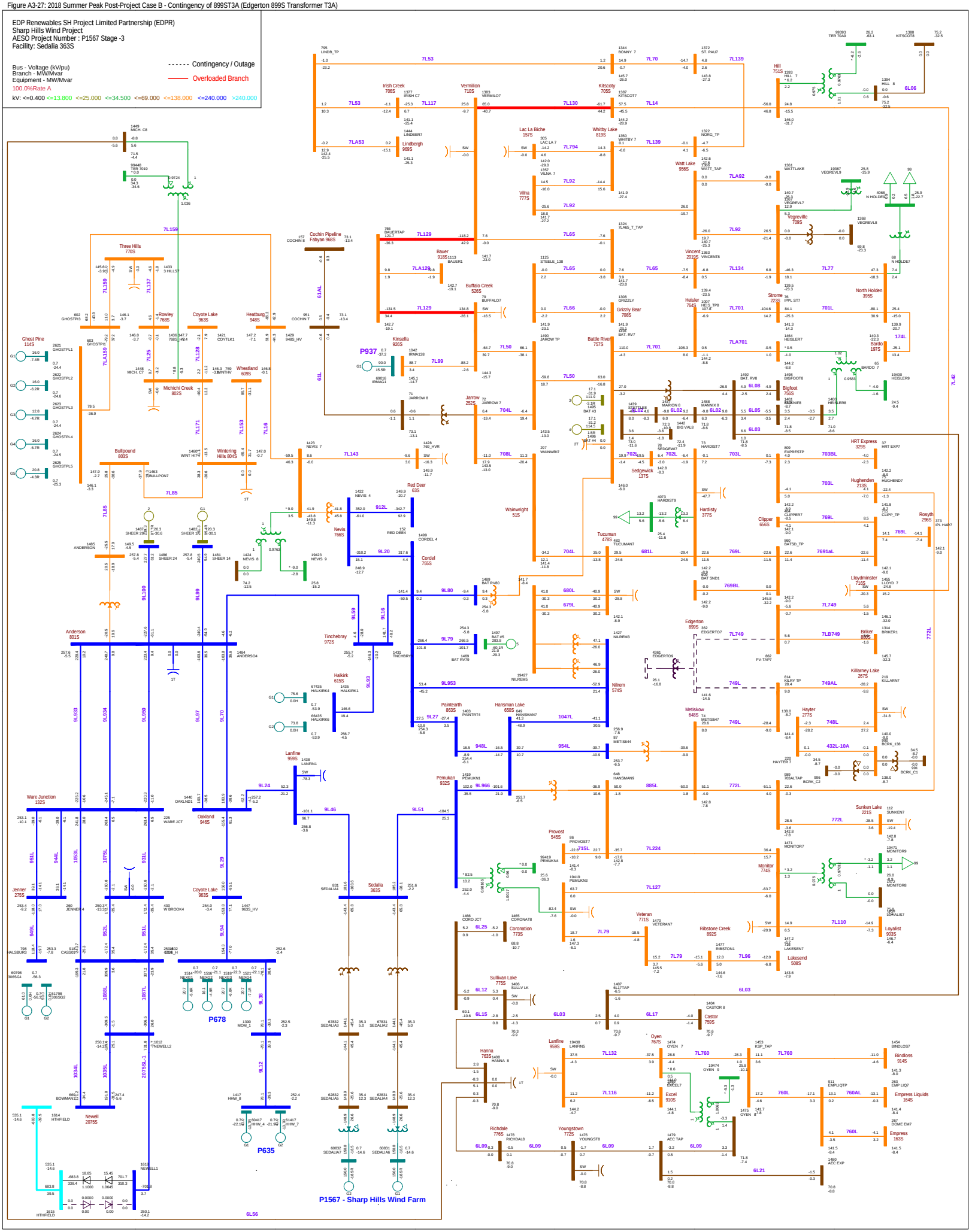


Figure A3-28: 2018 Summer Peak Post-Project Case B - Contingency of 377ST1 (Hardisty 377S Transformer T1)

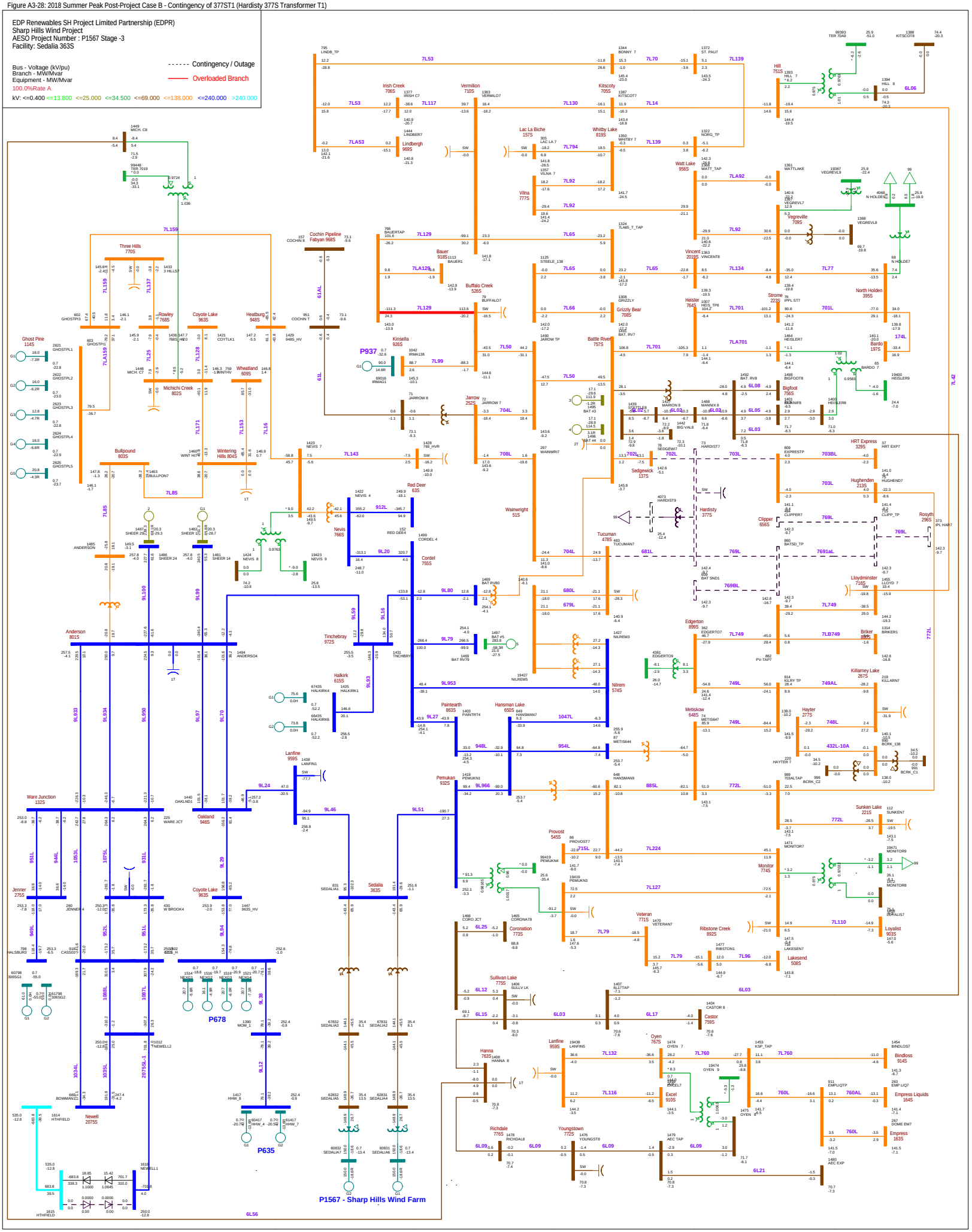


Figure A3-29: 2018 Summer Peak Post-Project Case B - Contingency of 9L46 (Lanfine 959S to Sedalia 363S)

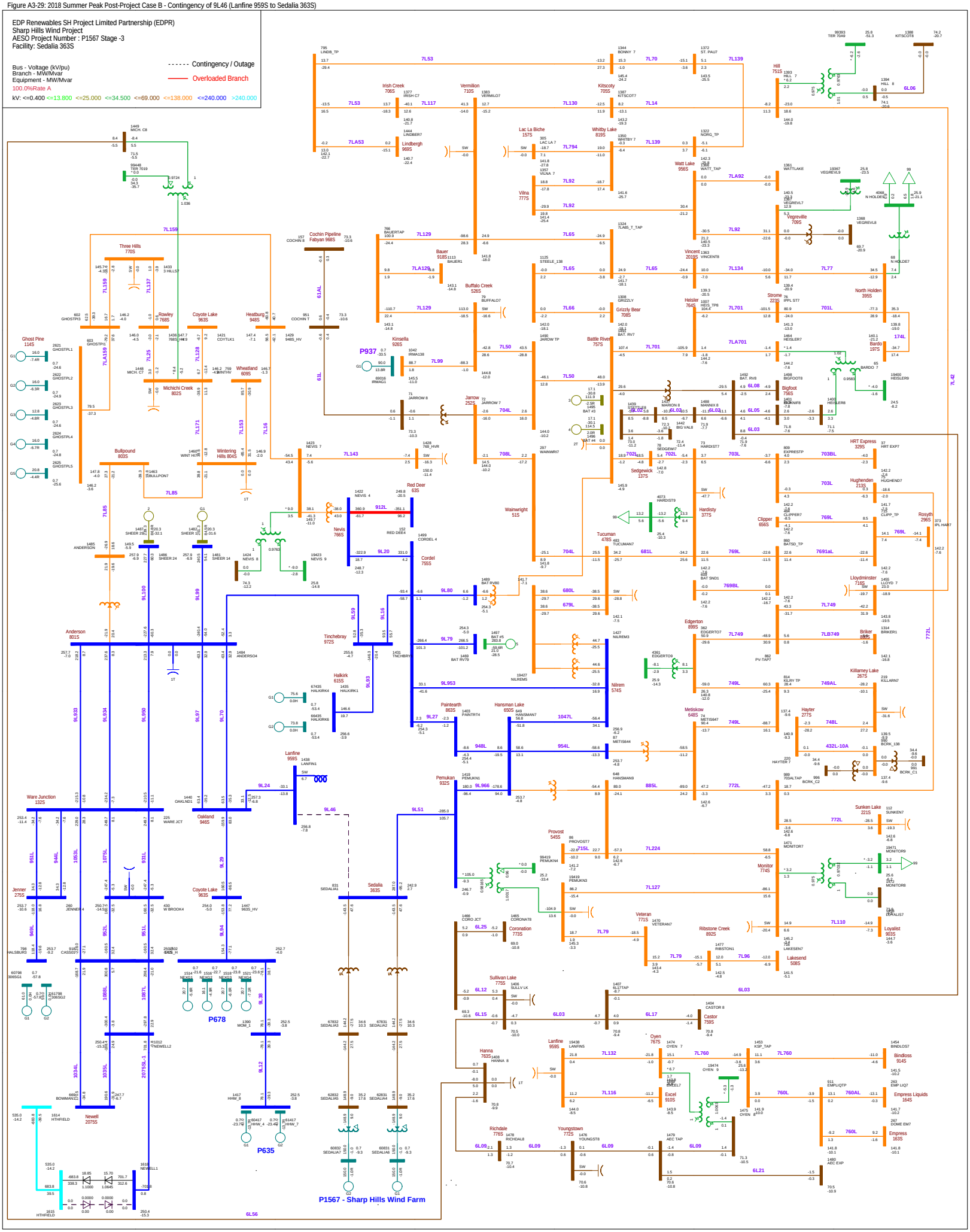


Figure A3-30: 2018 Summer Peak Post-Project Case B - Contingency of EATL (Newell 2075S to Heathfield 2029S)

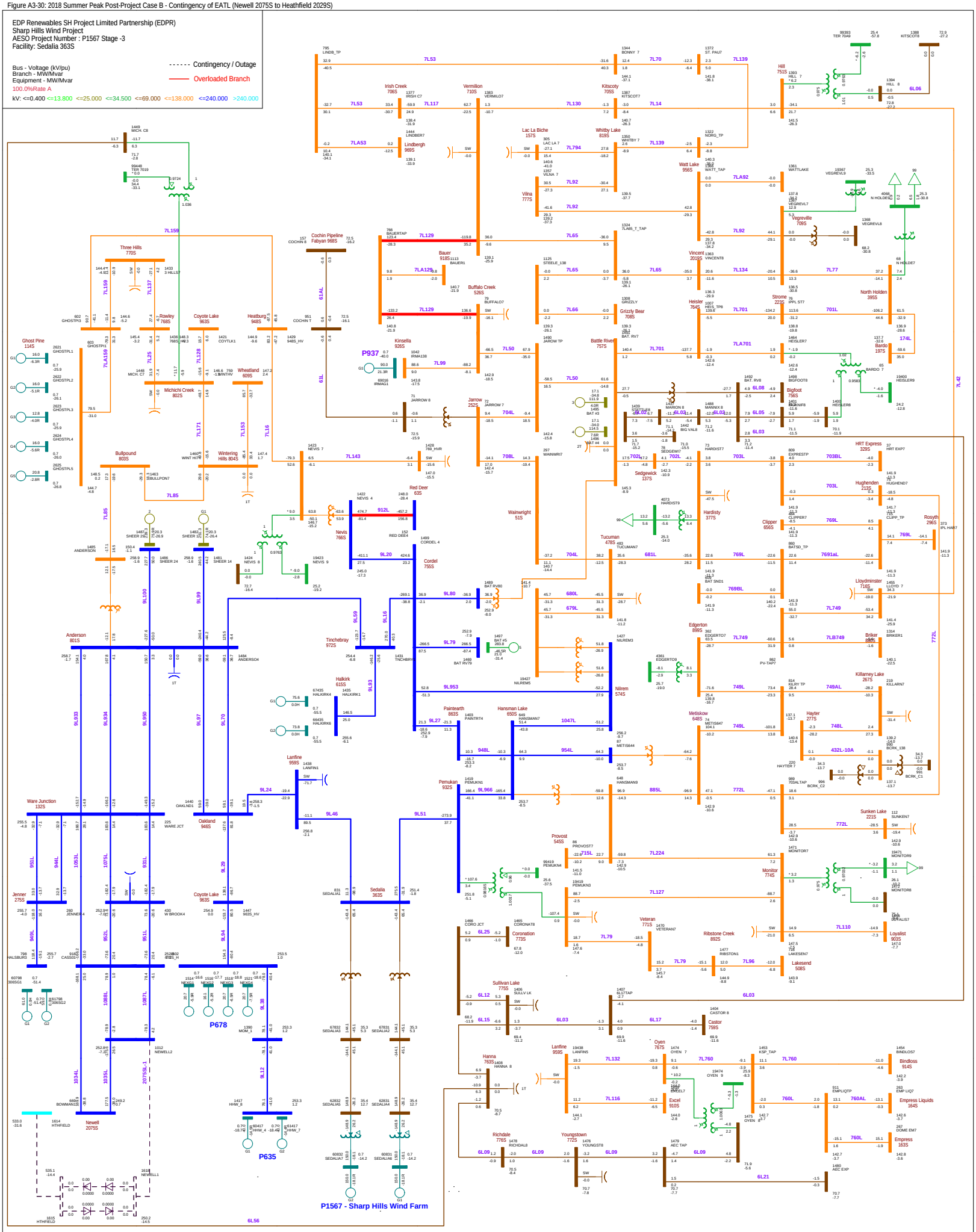


Figure A3-31: 2018 Summer Peak Post-Project Case B - Contingency of 9L934_934L (Ware Junction 132S to Anderson 801S)

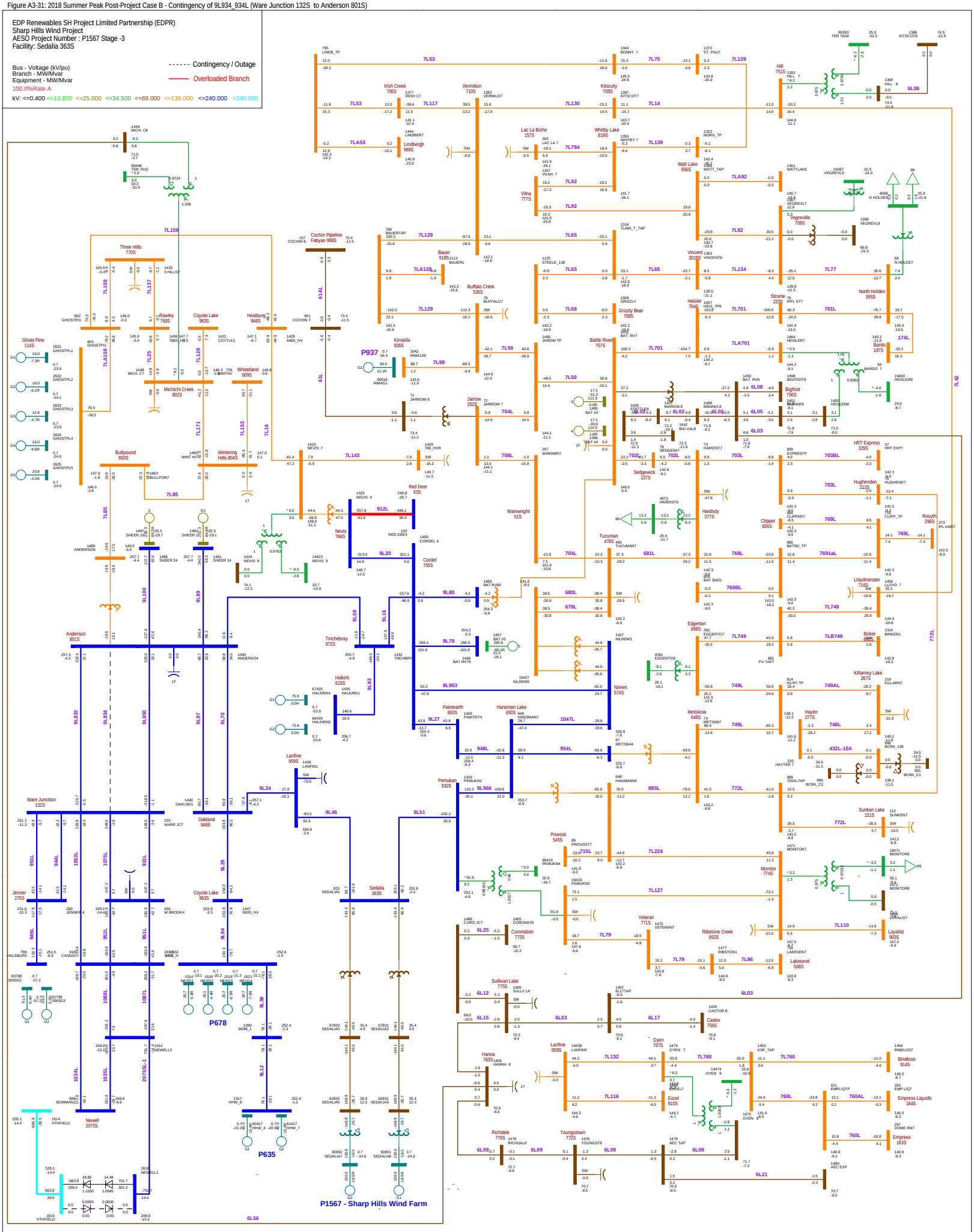


Figure A3-32: 2018 Summer Peak Post-Project Case B - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

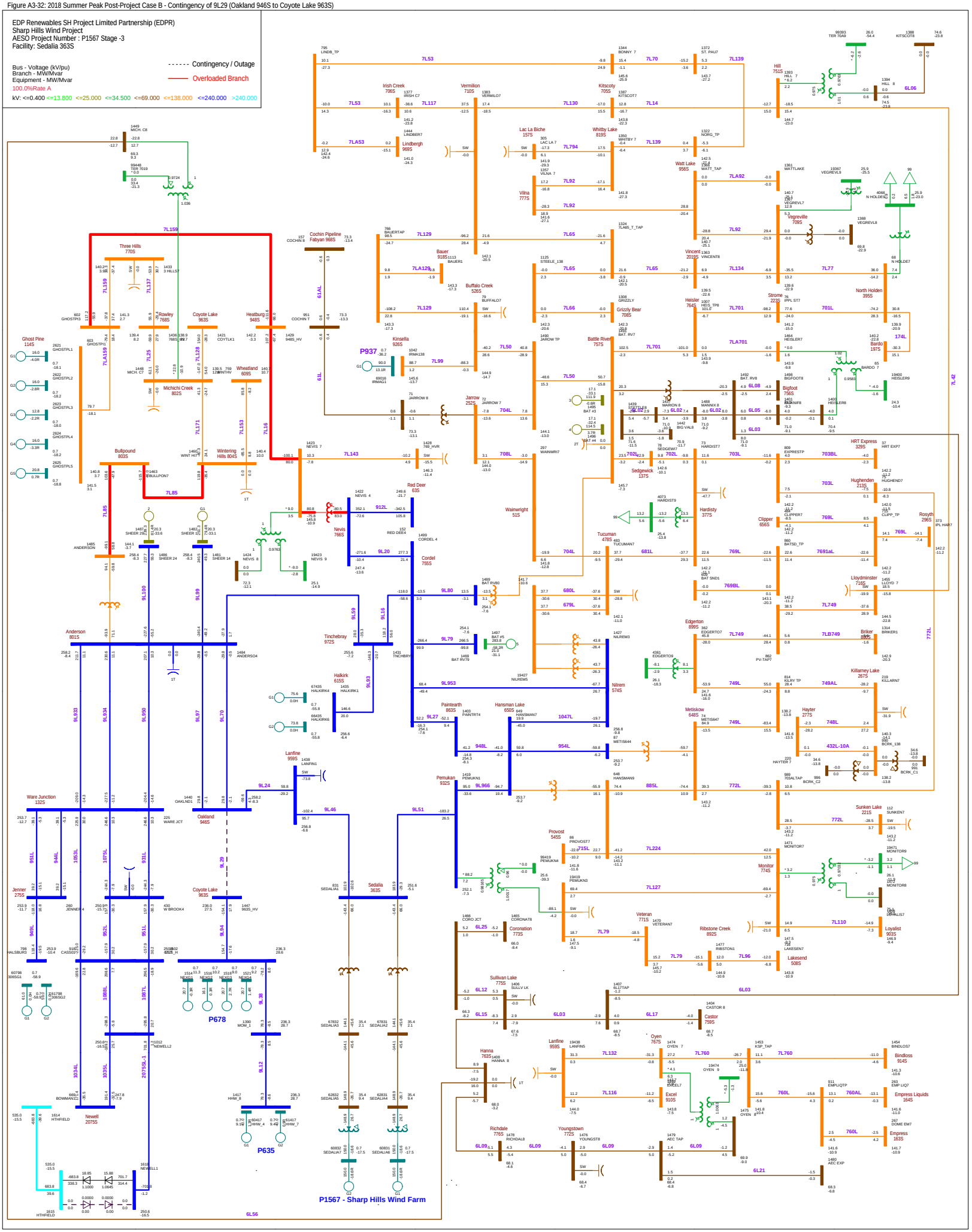


Figure A3-33: 2018 Summer Peak Post-Project Case B - Contingency of 7L129_7LA129 (Buffalo Creek 526S to Vermilion 710S to Bauer 918S)

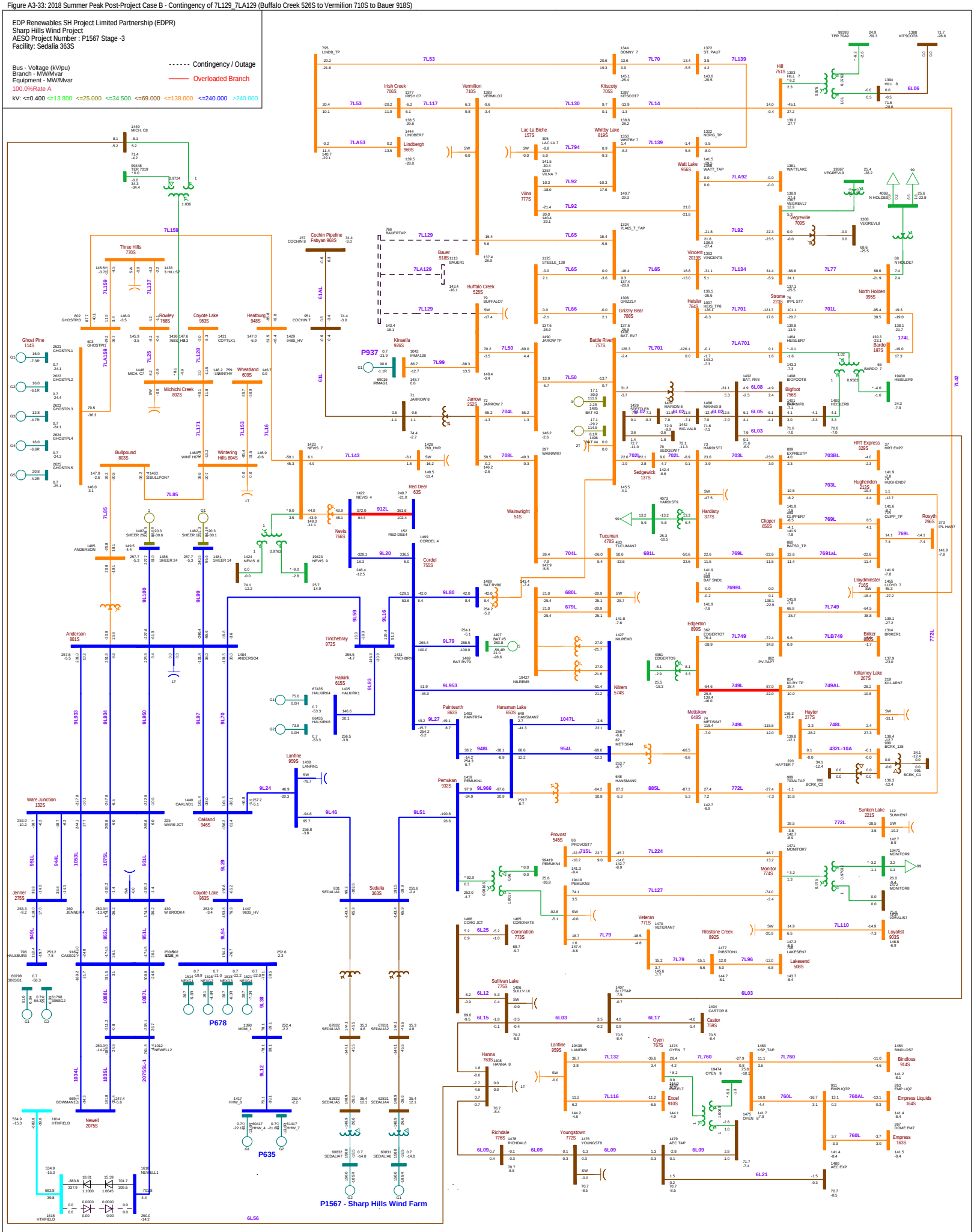


Figure A3-34: 2018 Summer Peak Post-Project Case B - Contingency of 9L20 (Nevis 766S to Cordel 755S)

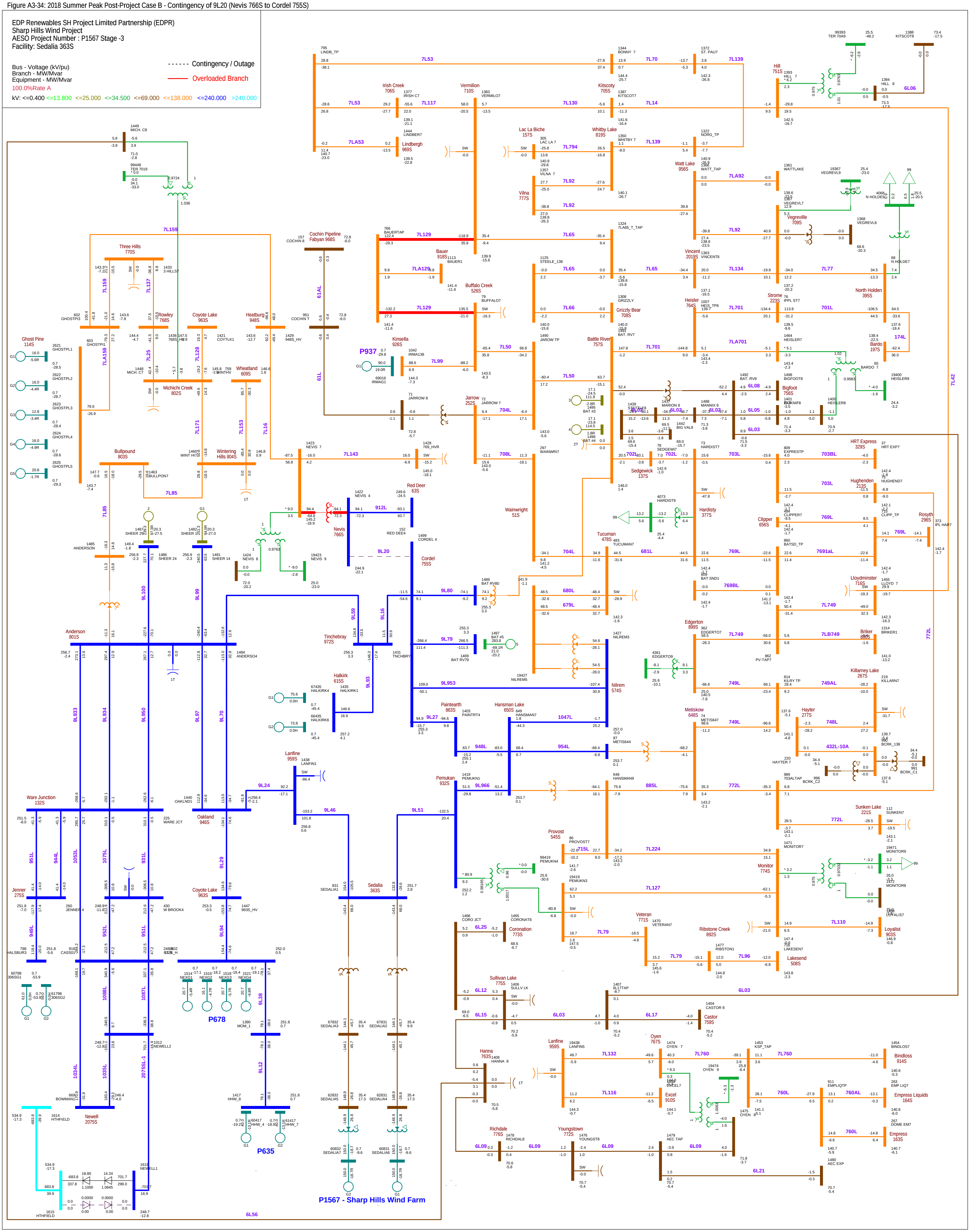


Figure A3-35: 2018 Summer Peak Post-Project Case B - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

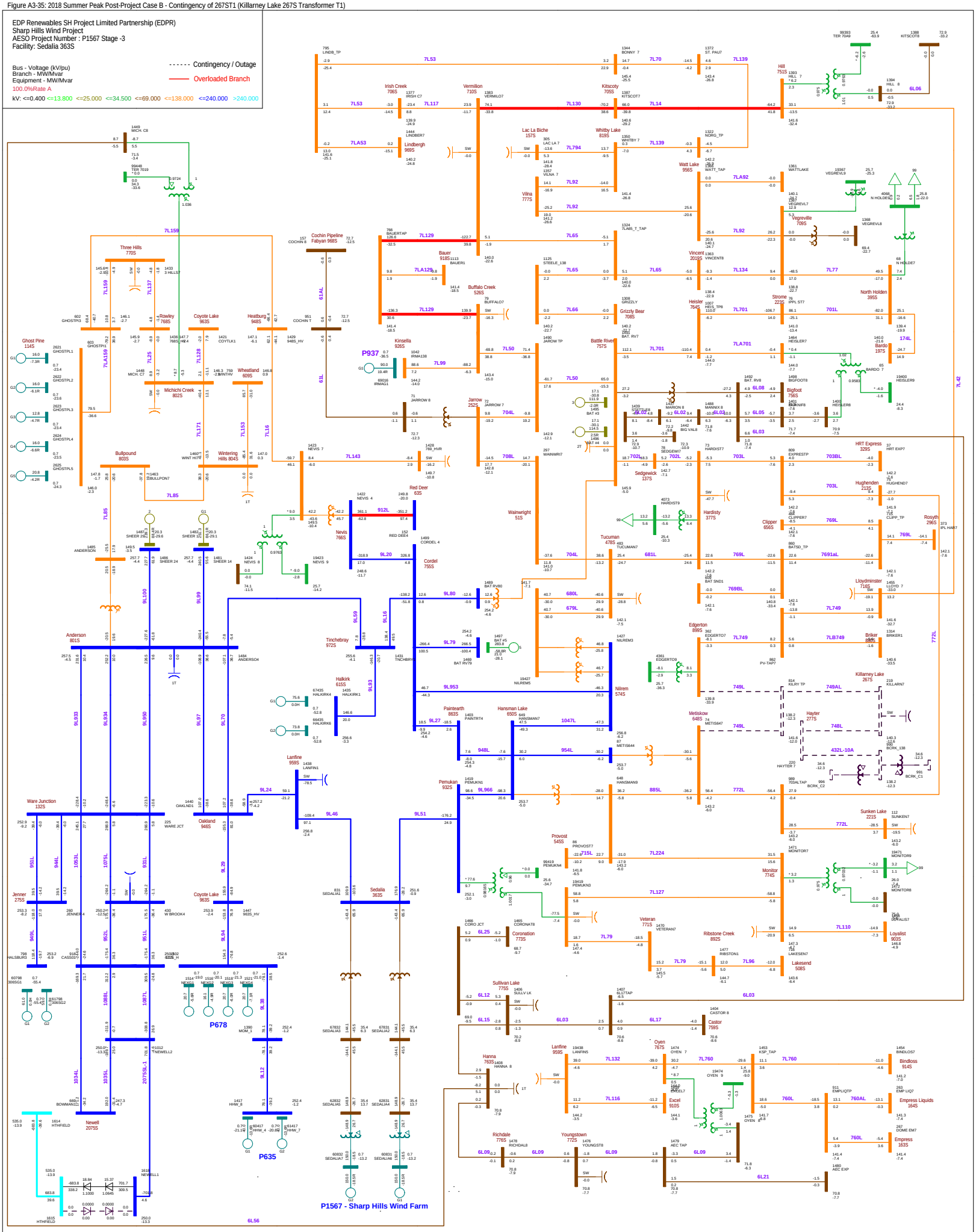


Figure A3-36: 2018 Summer Peak Post-Project Case B - Contingency of 7L42 (Hill 751S to Lloydminster 716S)

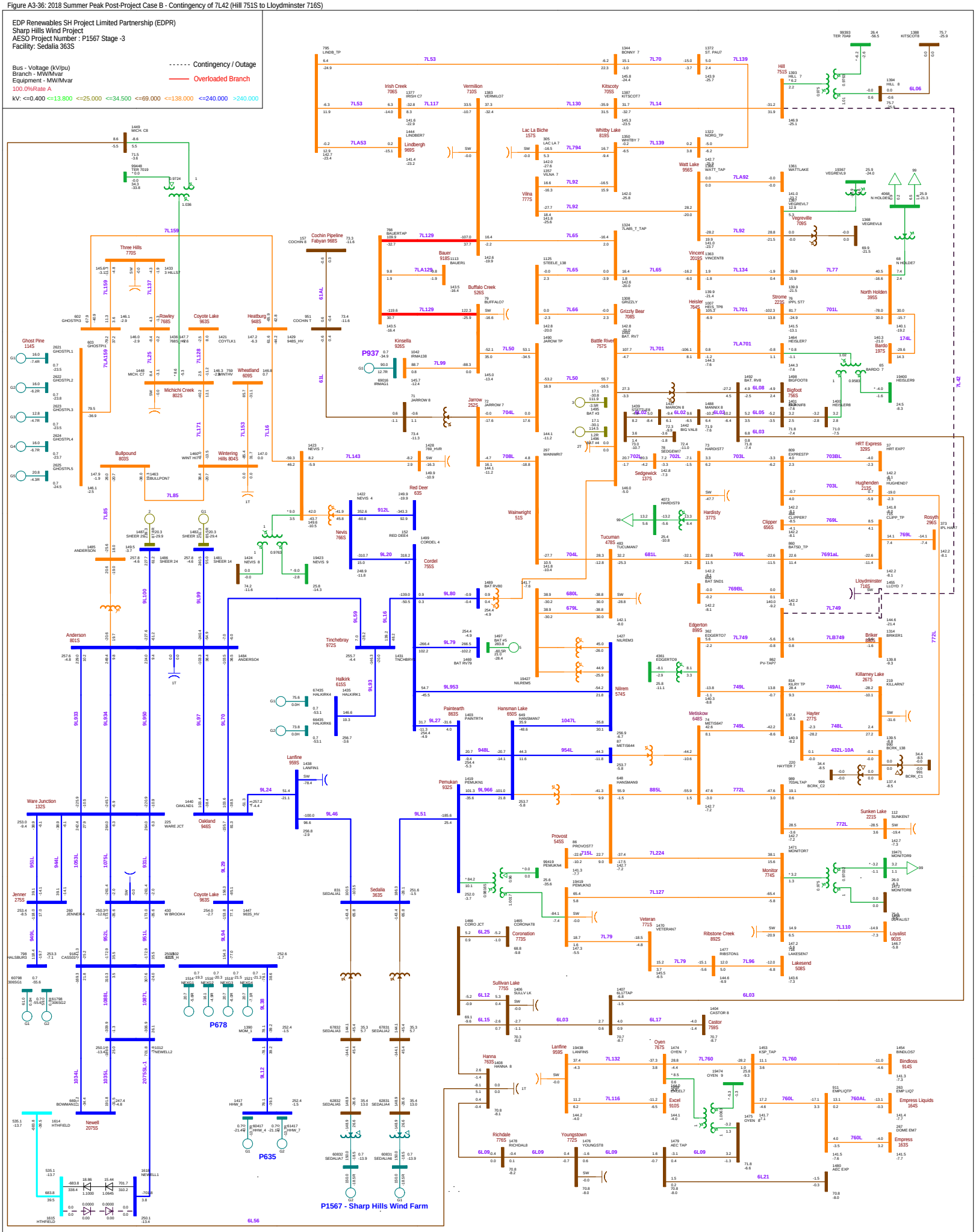


Figure A3-37: 2018 Summer Peak Post-Project Case B - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

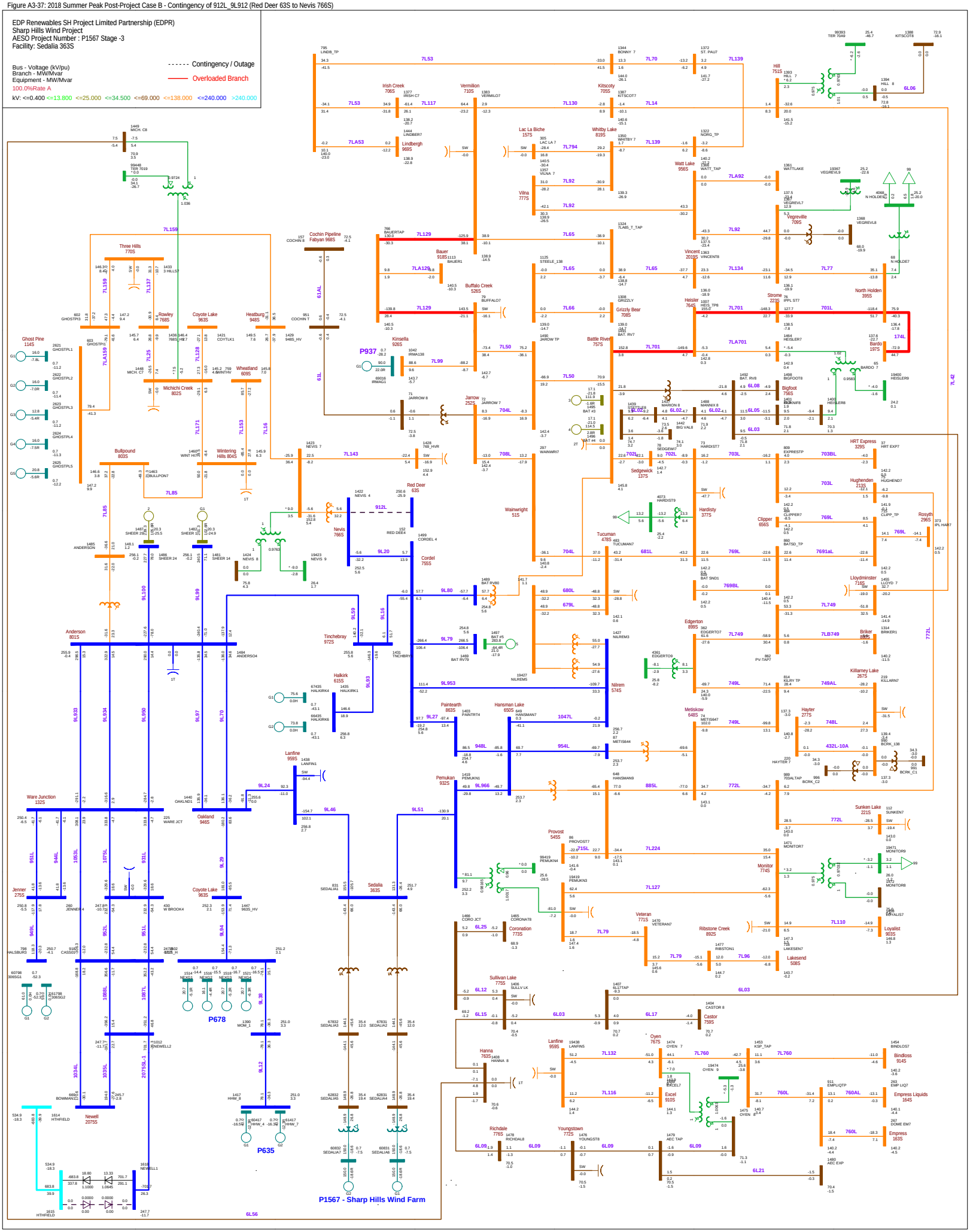


Figure A3-38: 2018 Summer Peak Post-Project Case B - Contingency of 7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)

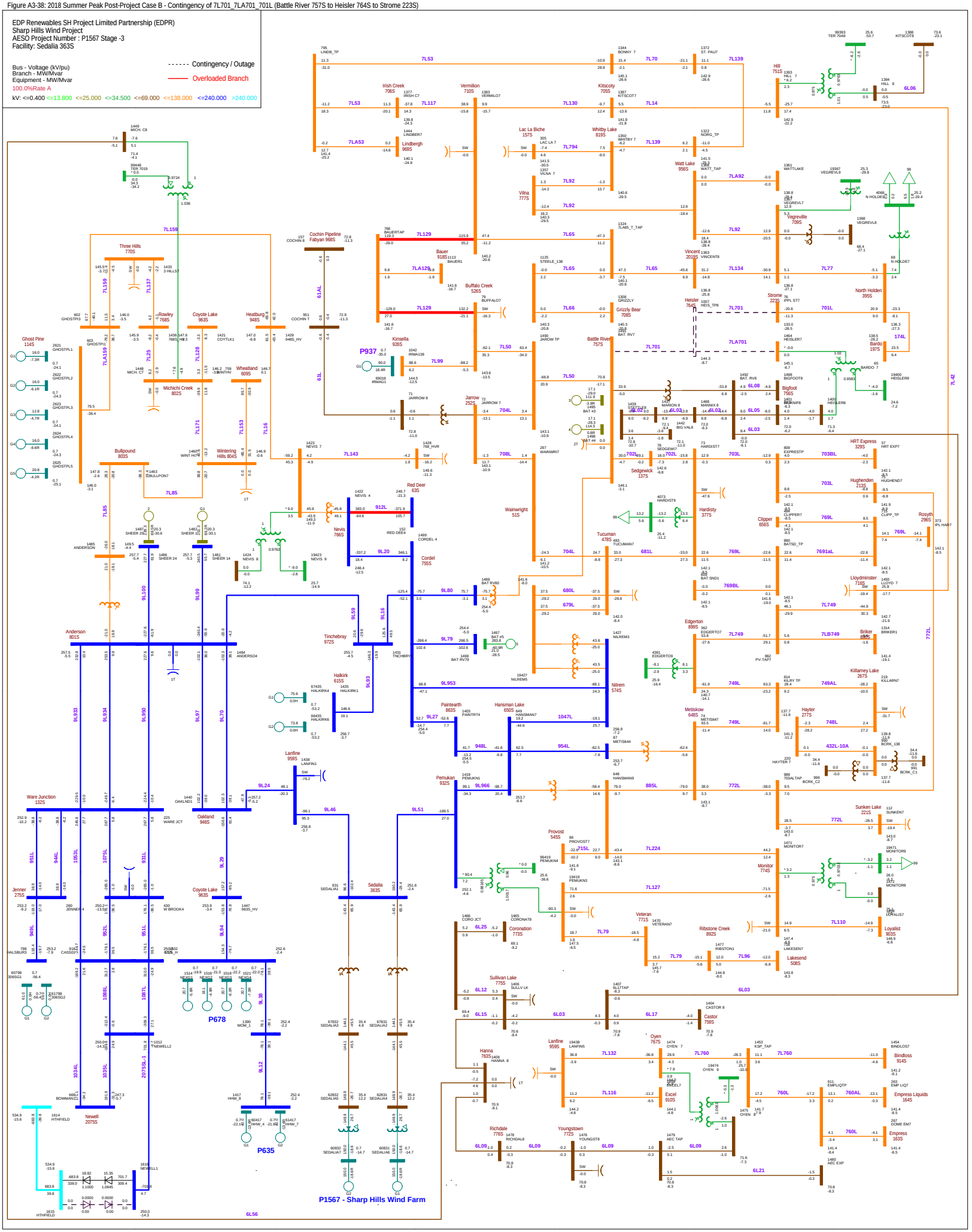


Figure A3-39: 2018 Summer Peak Post-Project Case B - Contingency of 7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)

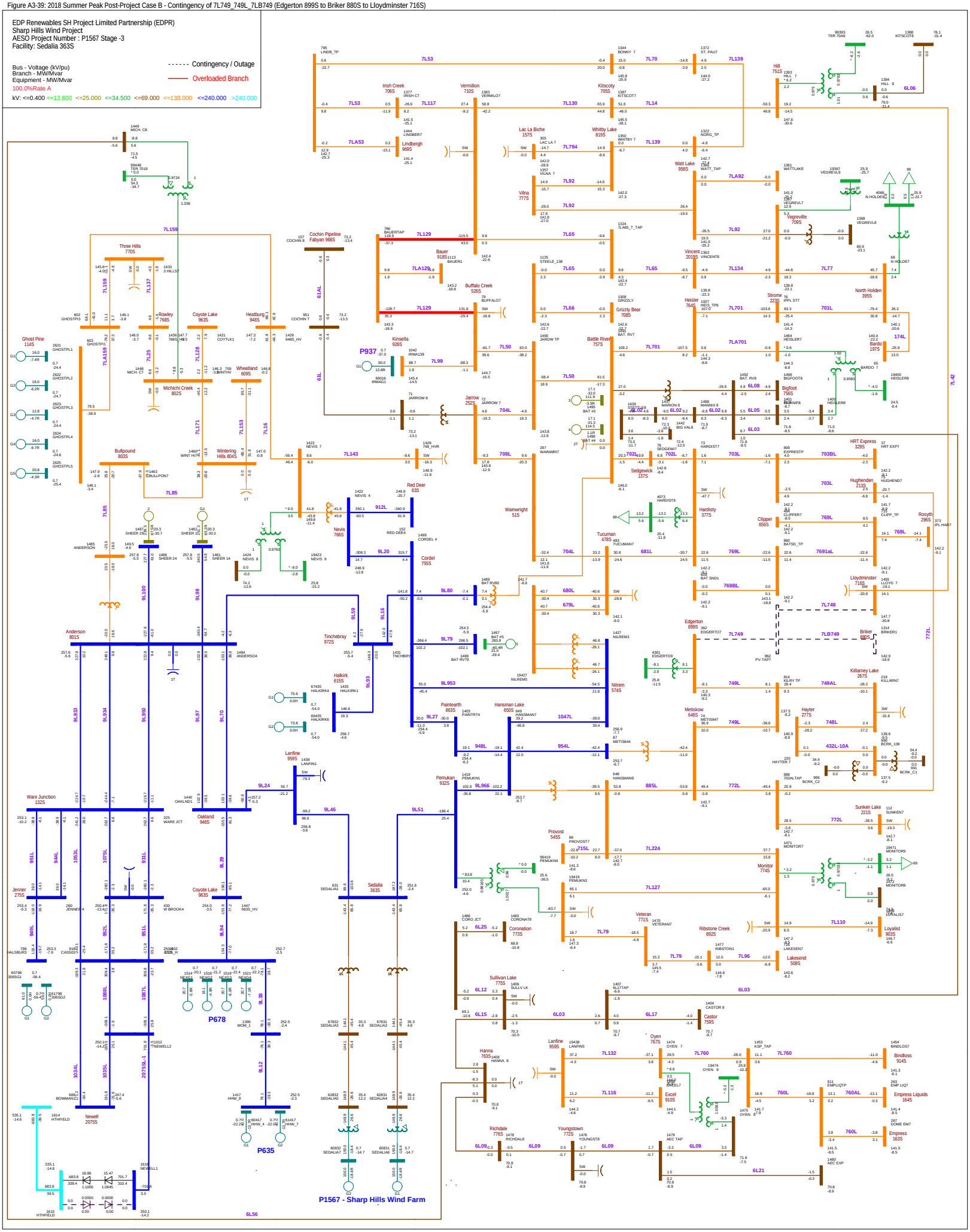


Figure A3-40: 2018 Summer Peak Post-Project Case B - Contingency of 701L (North Holden 395S to Strome 223S)

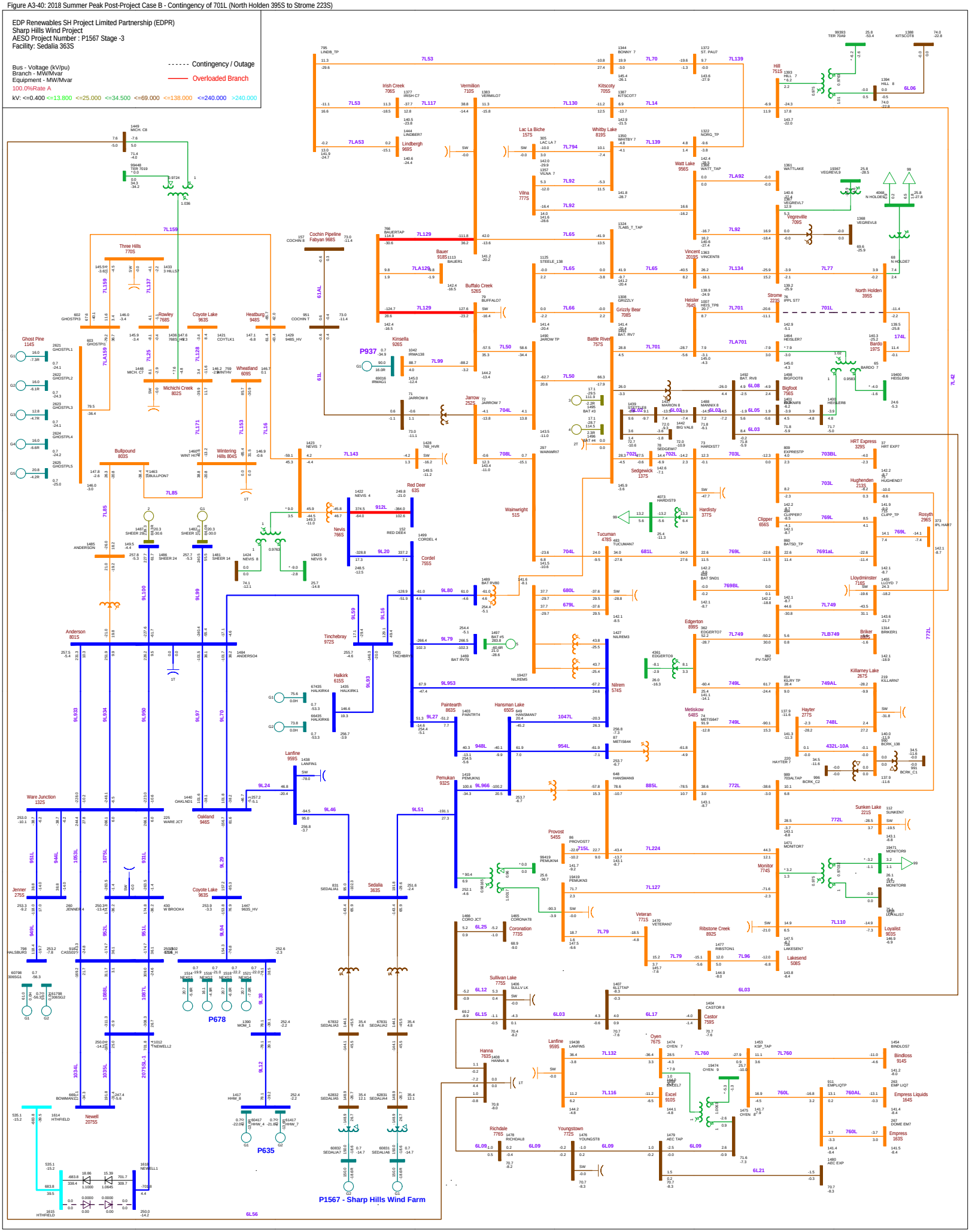


Figure A3-41: 2018 Winter Peak Post-Project Case A - N-0 (System Normal Condition)

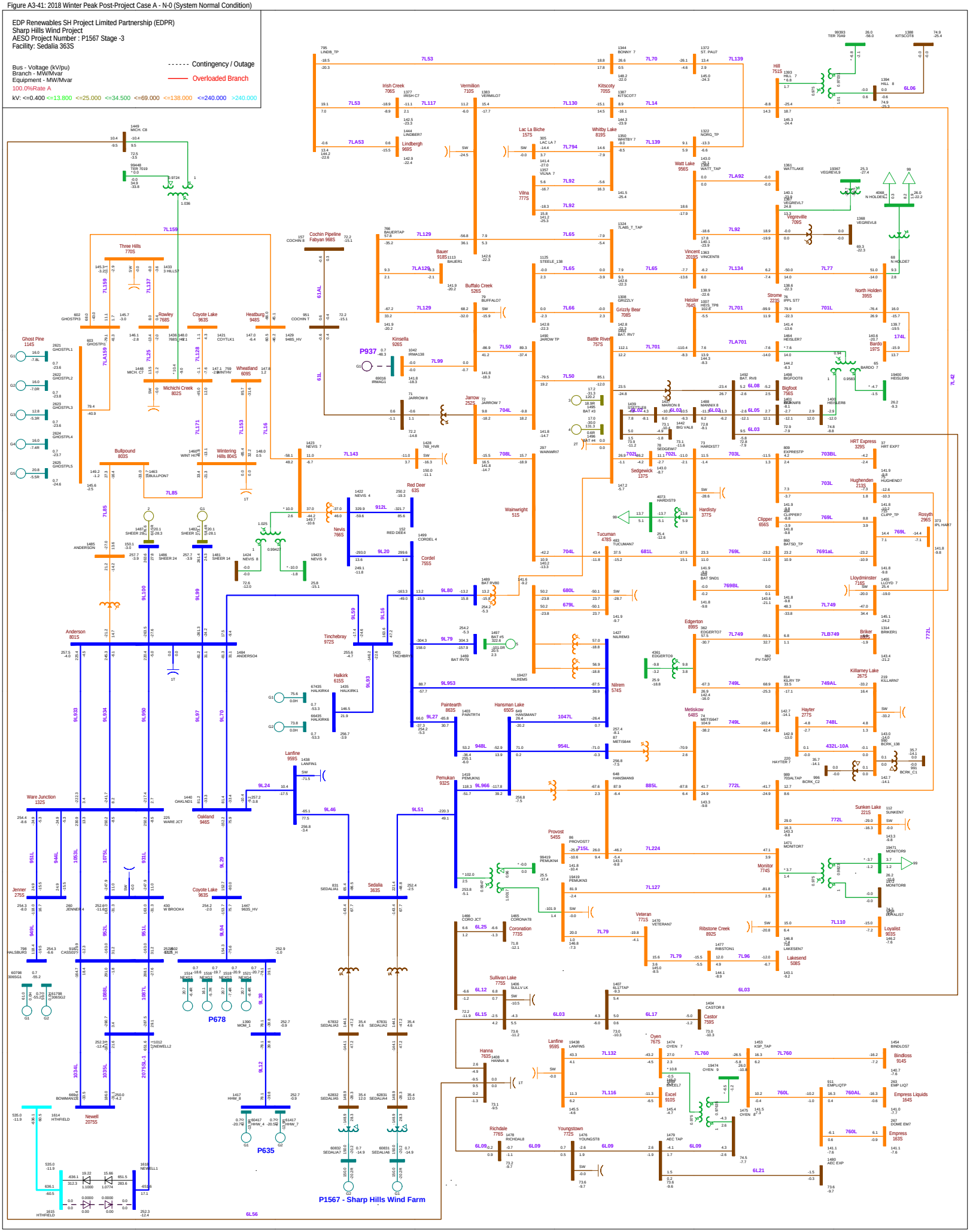


Figure A3-42: 2018 Winter Peak Post-Project Case A - Contingency of 9L20 (Nevis 766S to Cordel 755S)

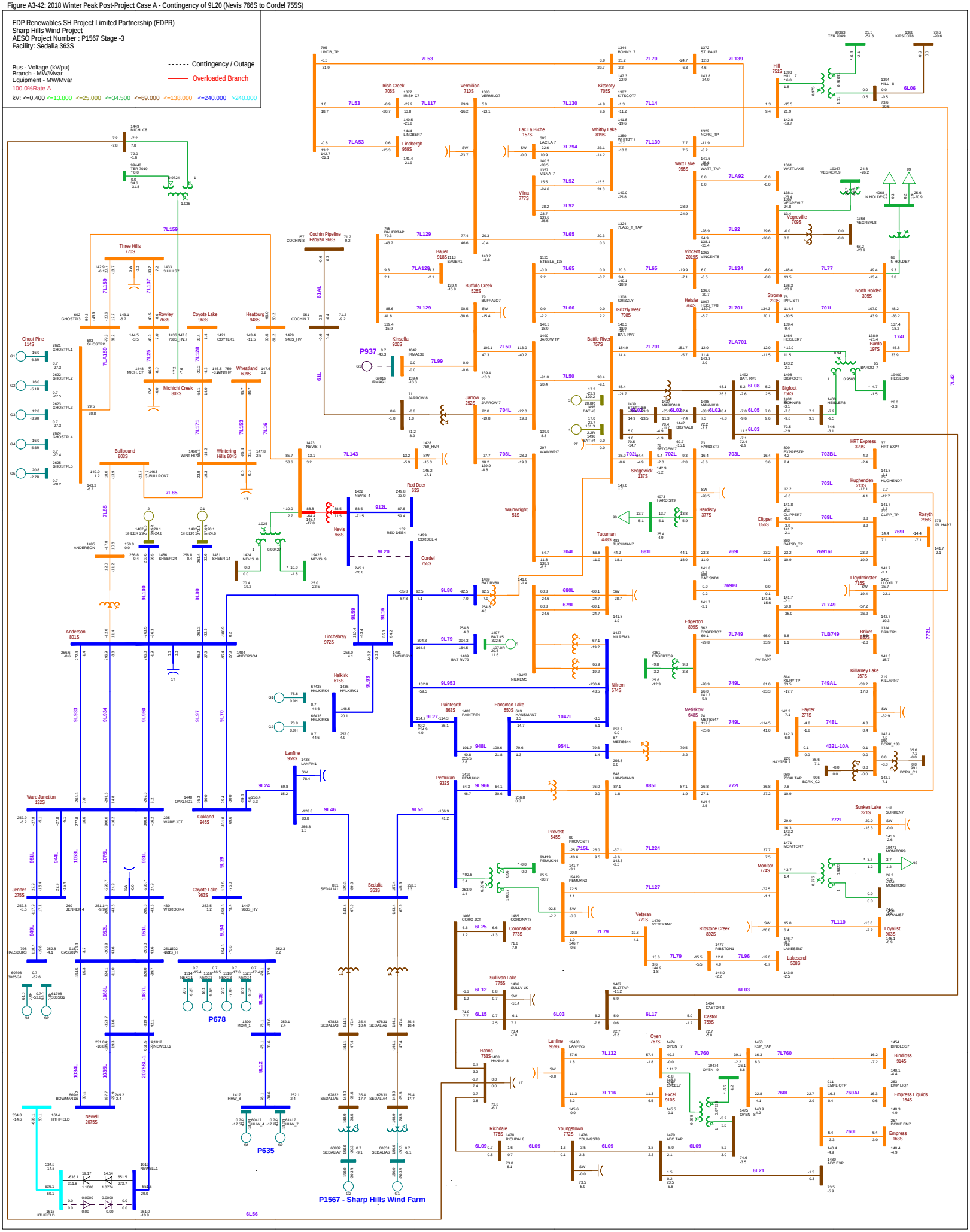


Figure A3-43: 2018 Winter Peak Post-Project Case A - Contingency of 966L_9L966 (Hansman Lake 650S to Pemukan 932S)

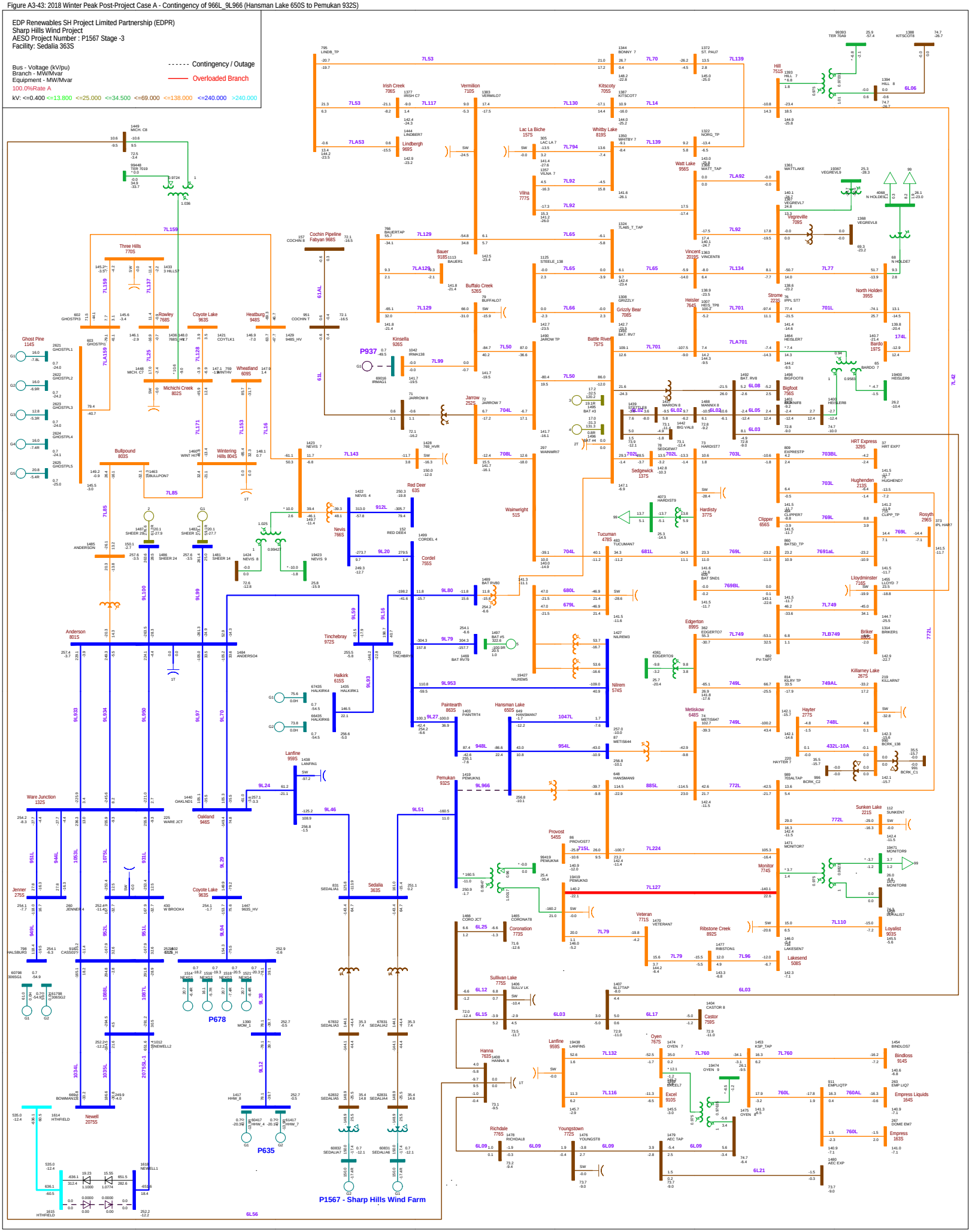


Figure A3-44: 2018 Winter Peak Post-Project Case A - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

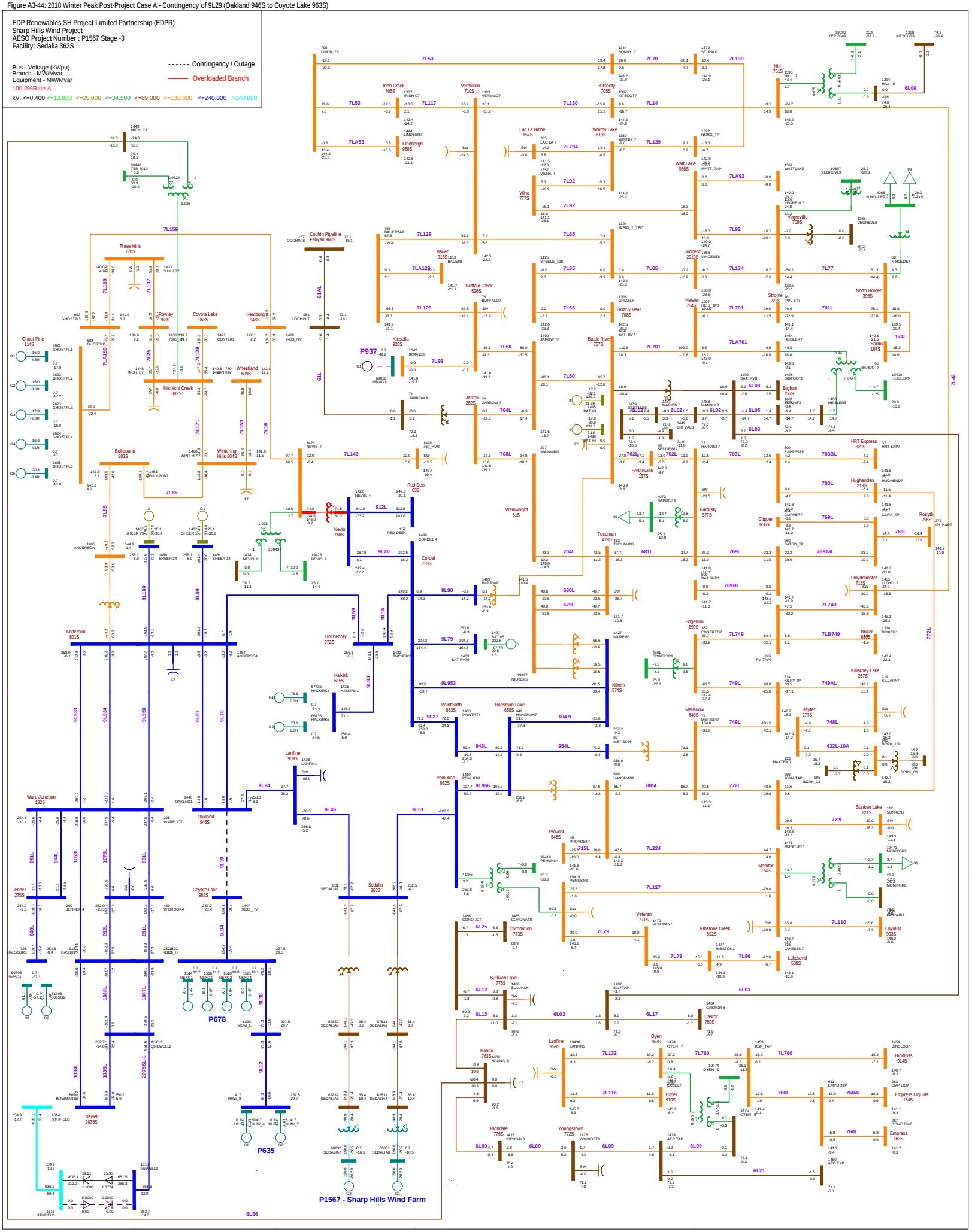


Figure A3-45: 2018 Winter Peak Post-Project Case A - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

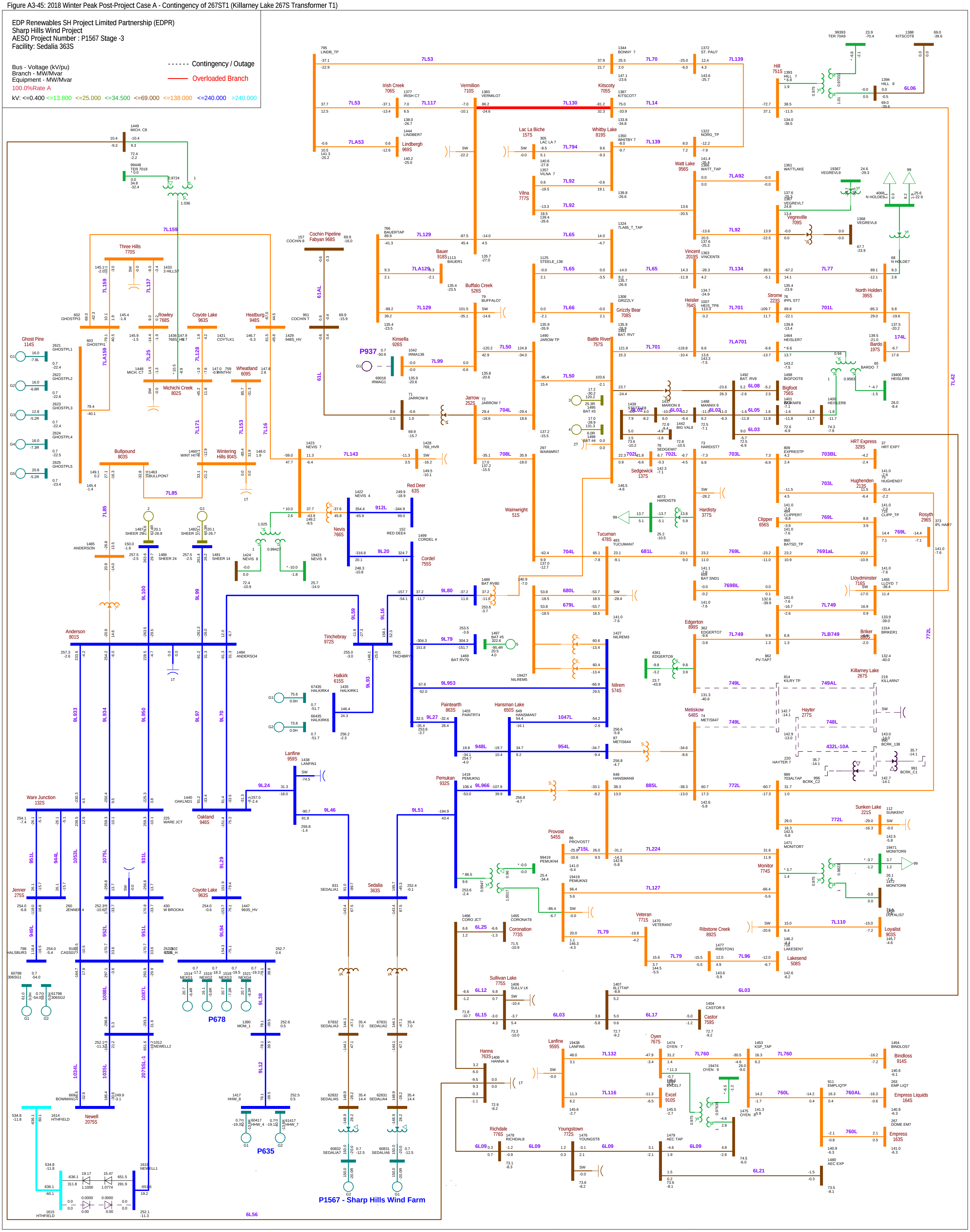


Figure A3-46: 2018 Winter Peak Post-Project Case A - Contingency of 7L50 (Battle River 757S to Jarrow 252S to Buffalo Creek 526S)

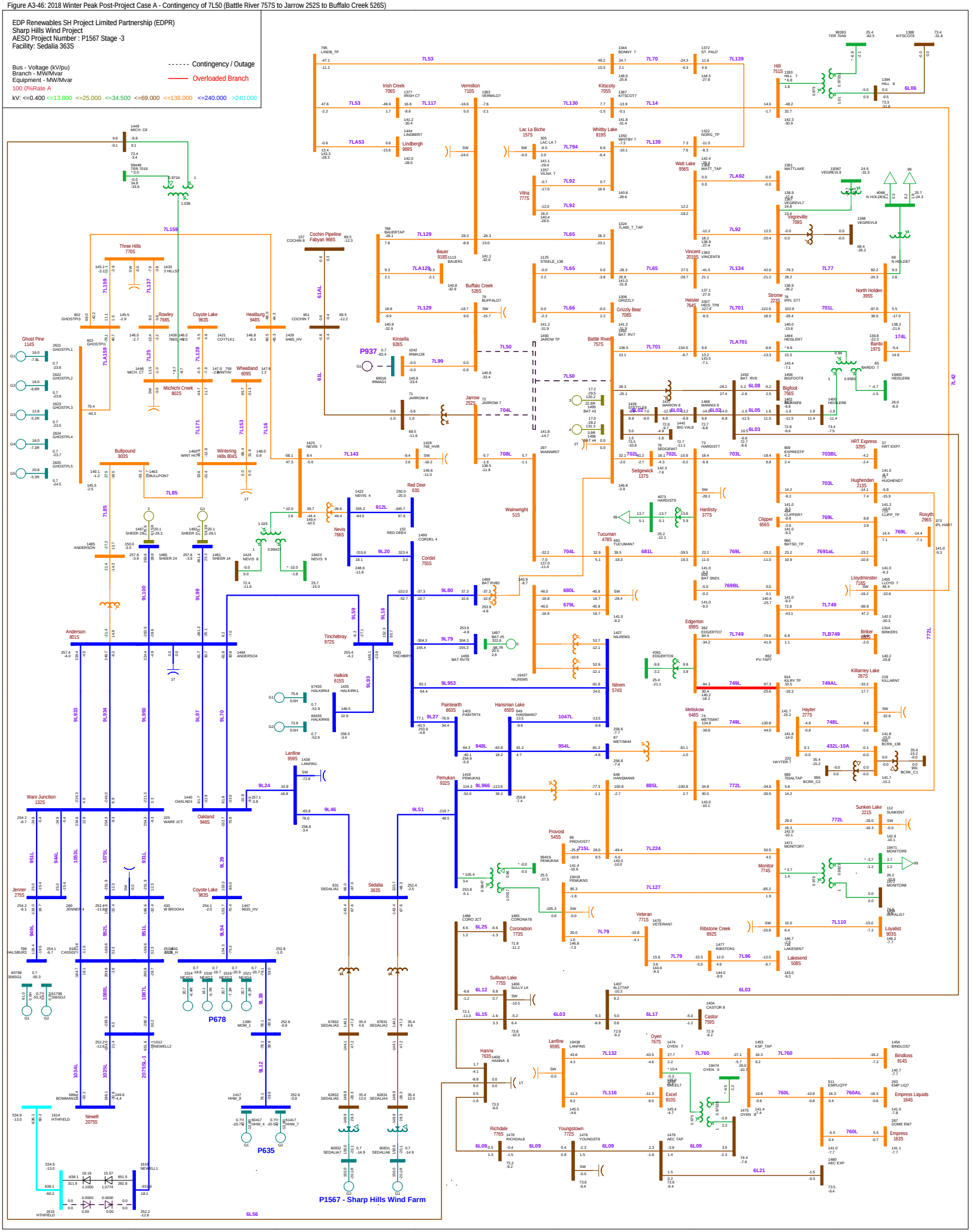


Figure A3-47: 2018 Winter Peak Post-Project Case B - N-0 (System Normal Condition)

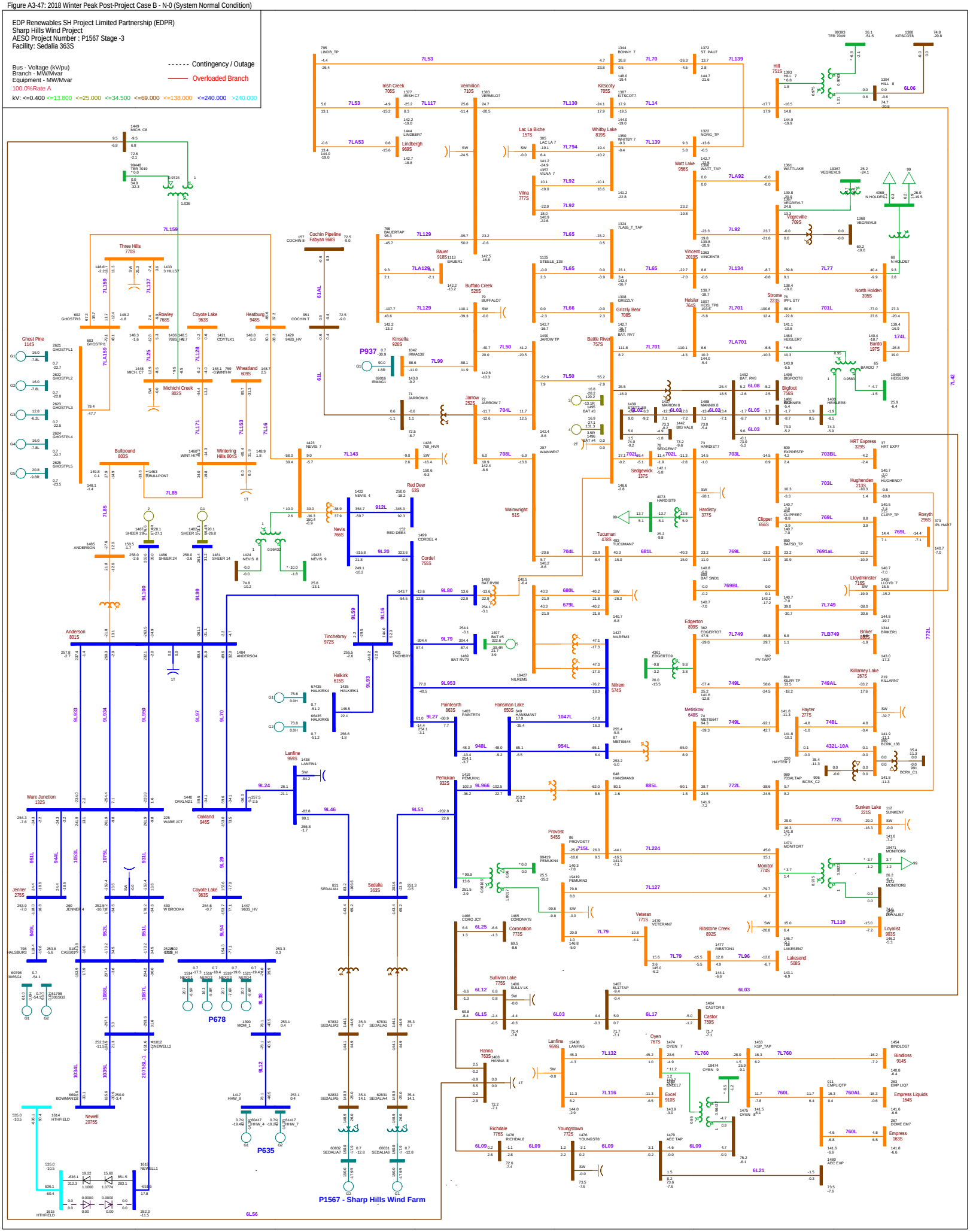


Figure A3-48: 2018 Winter Peak Post-Project Case B - Contingency of 766S901T (Nevis 766S Transformer 901T)

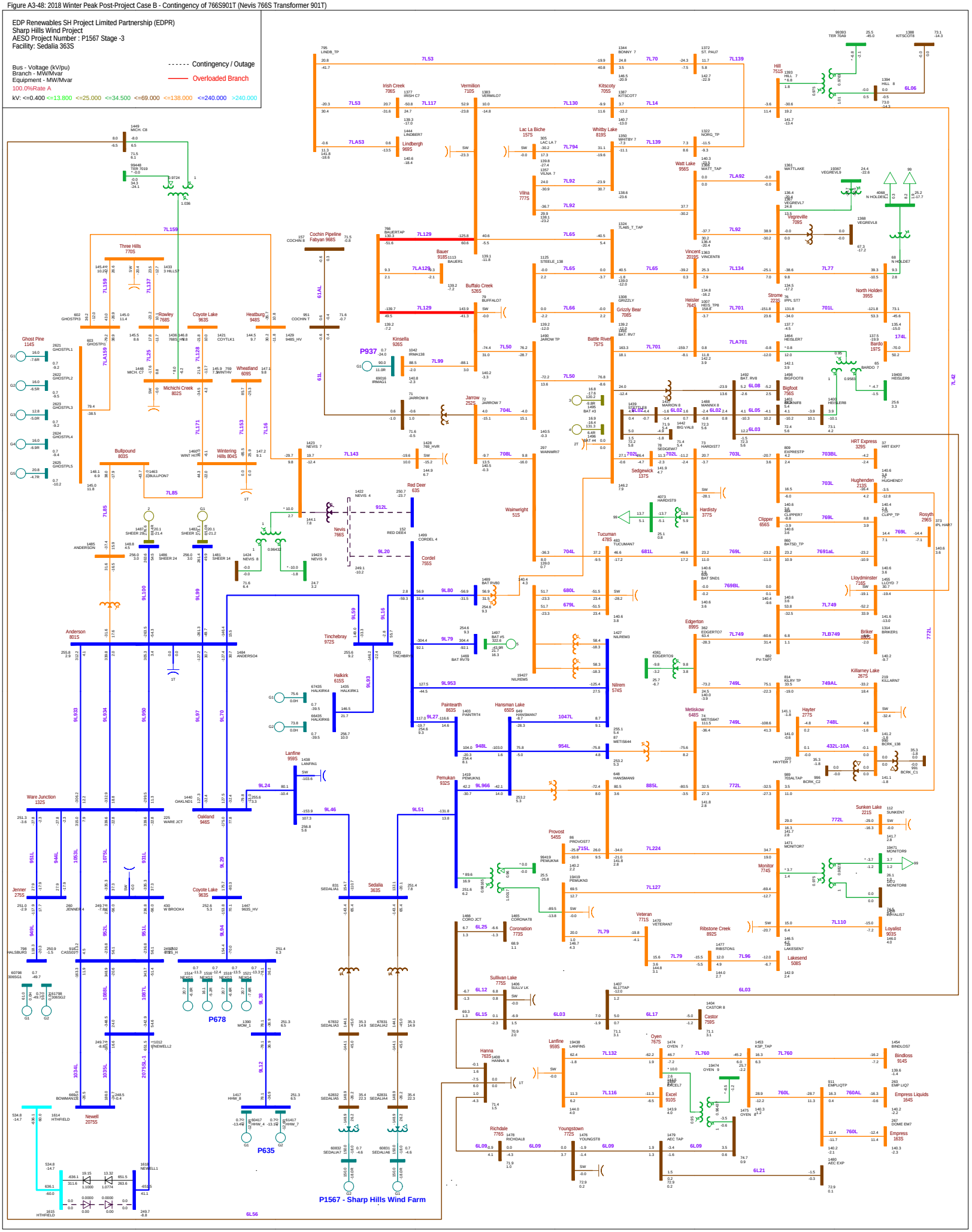


Figure A3-49: 2018 Winter Peak Post-Project Case B - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

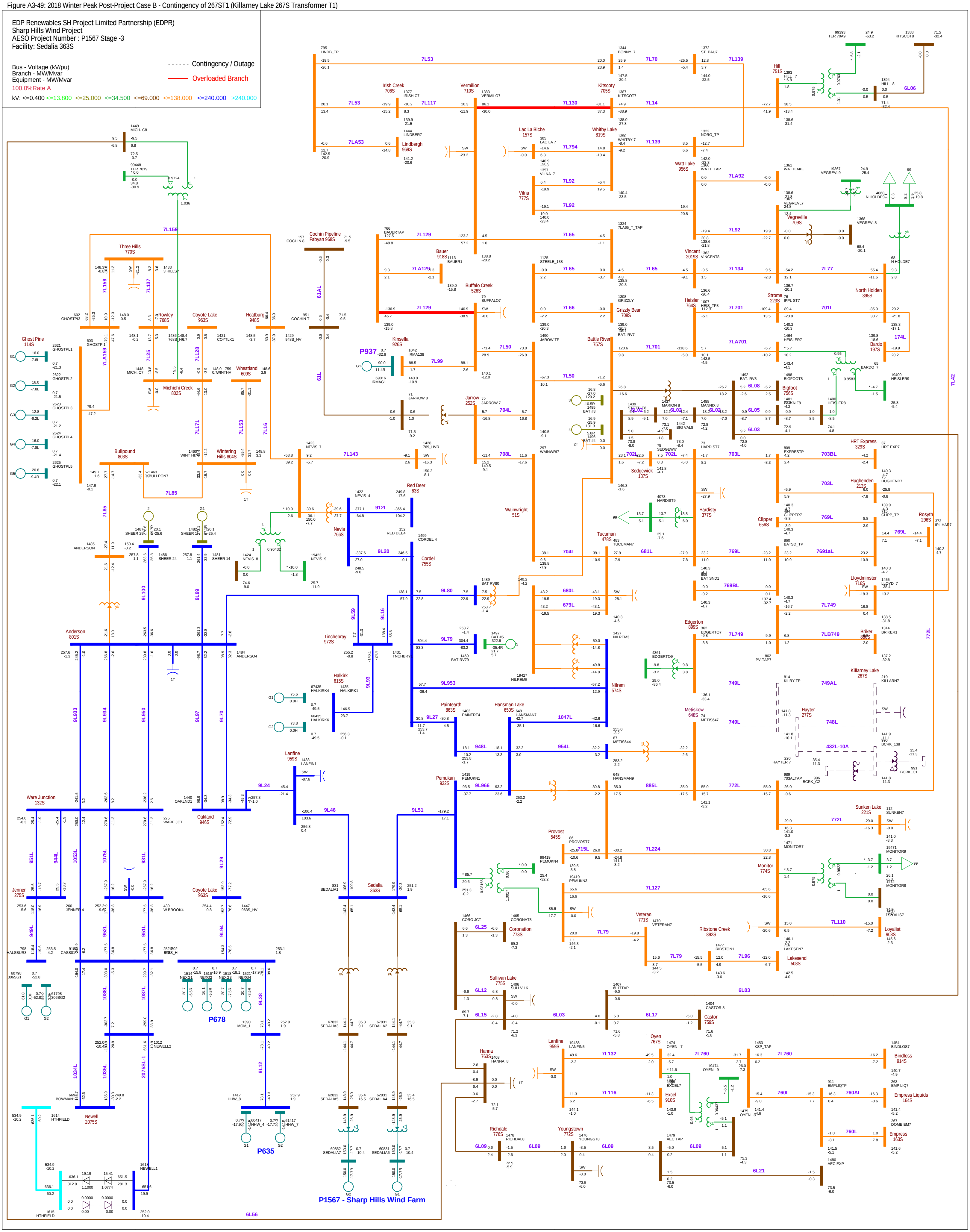


Figure A3-50: 2018 Winter Peak Post-Project Case B - Contingency of 9L20 (Nevis 766S to Cordel 755S)

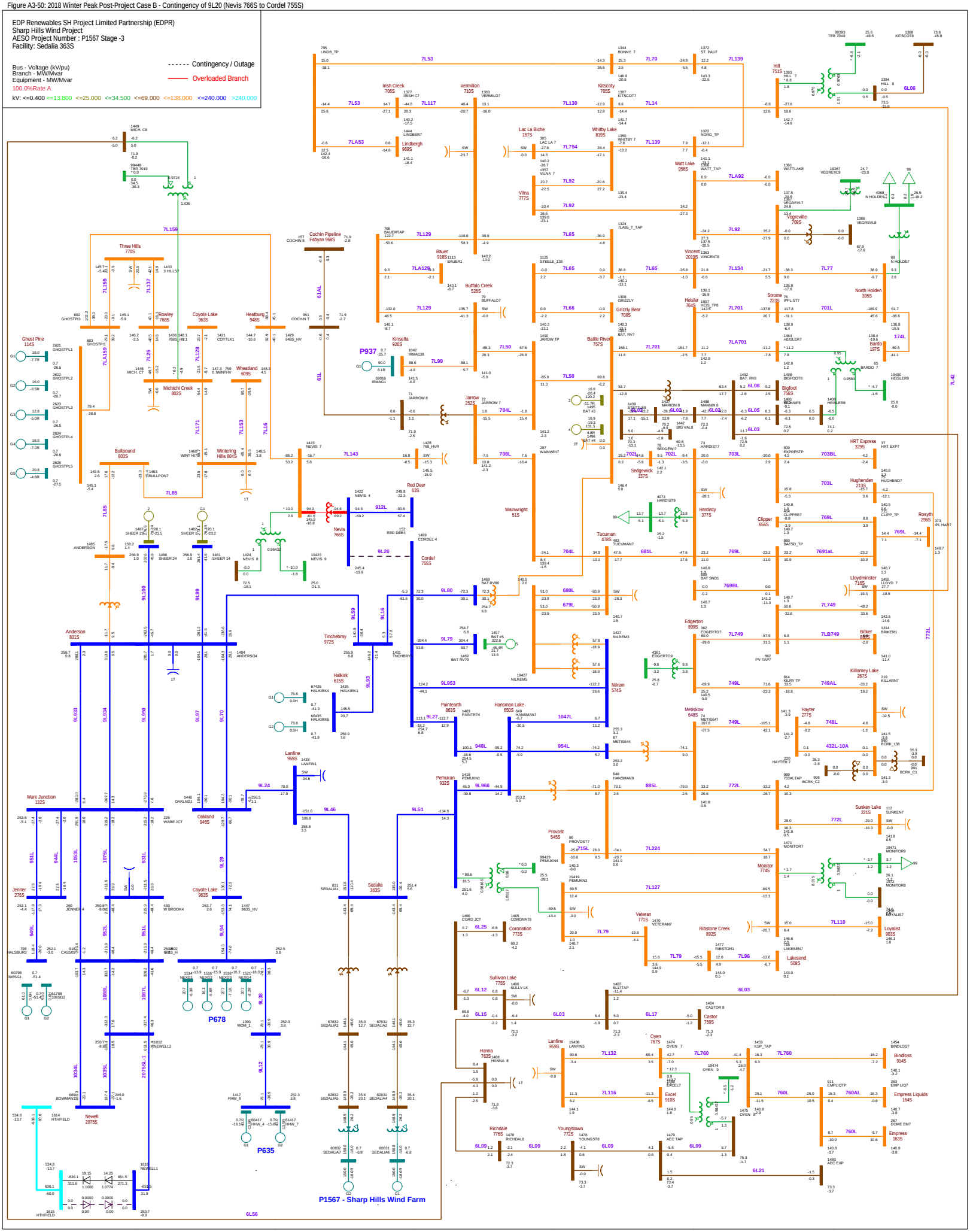


Figure A3-51: 2018 Winter Peak Post-Project Case B - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

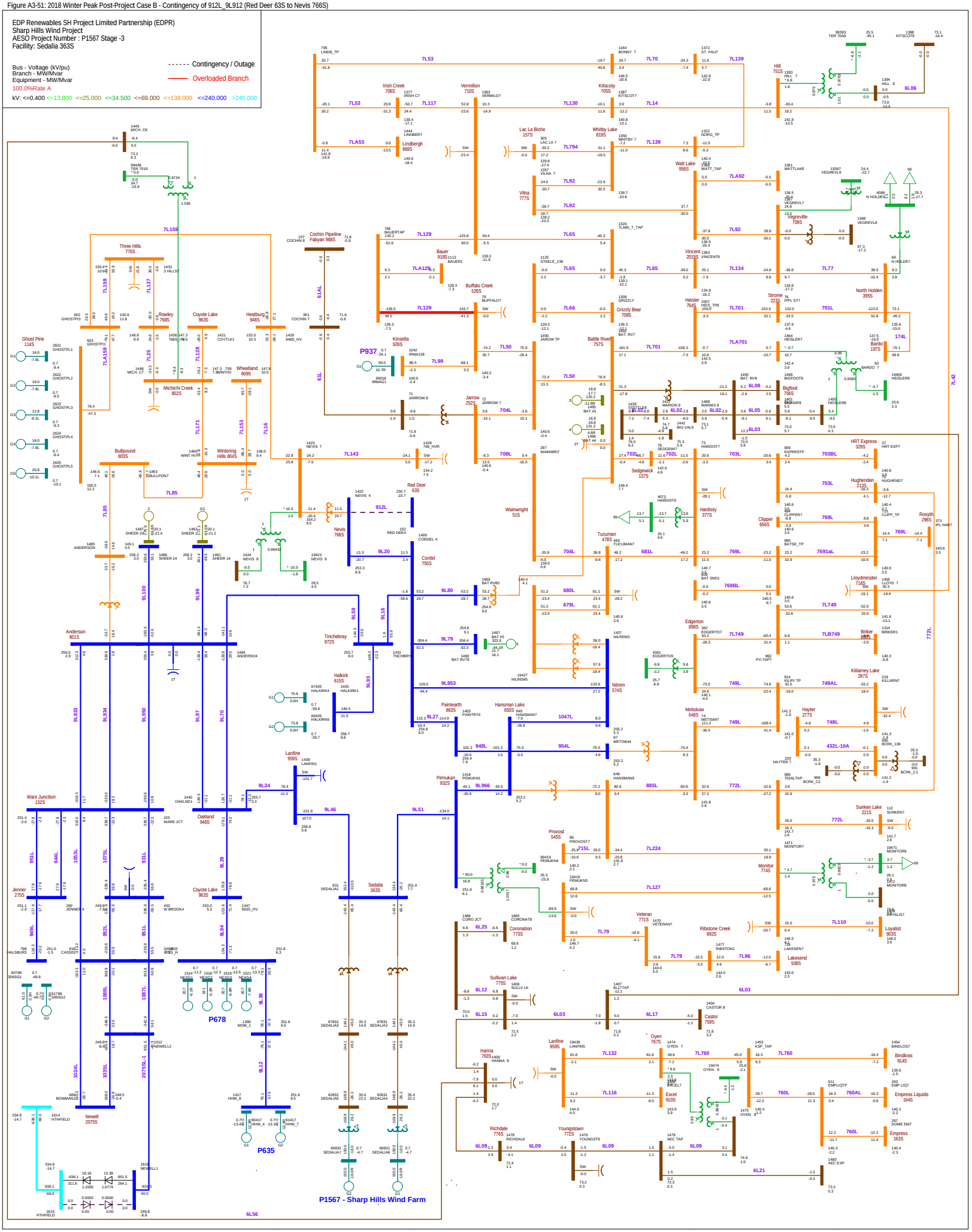
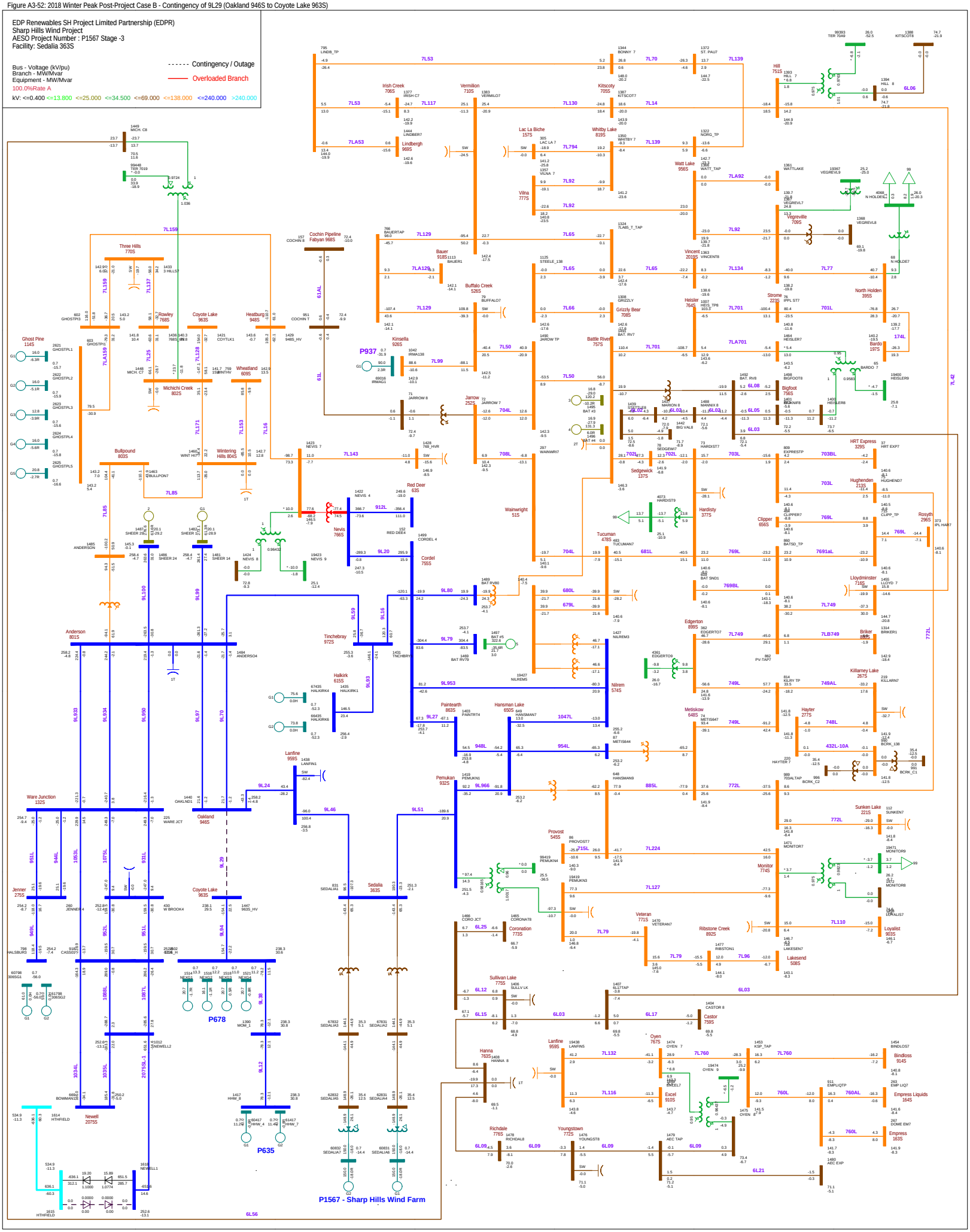


Figure A3-52: 2018 Winter Peak Post-Project Case B - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)



Attachment A4

Post-Project Transient Stability Diagrams

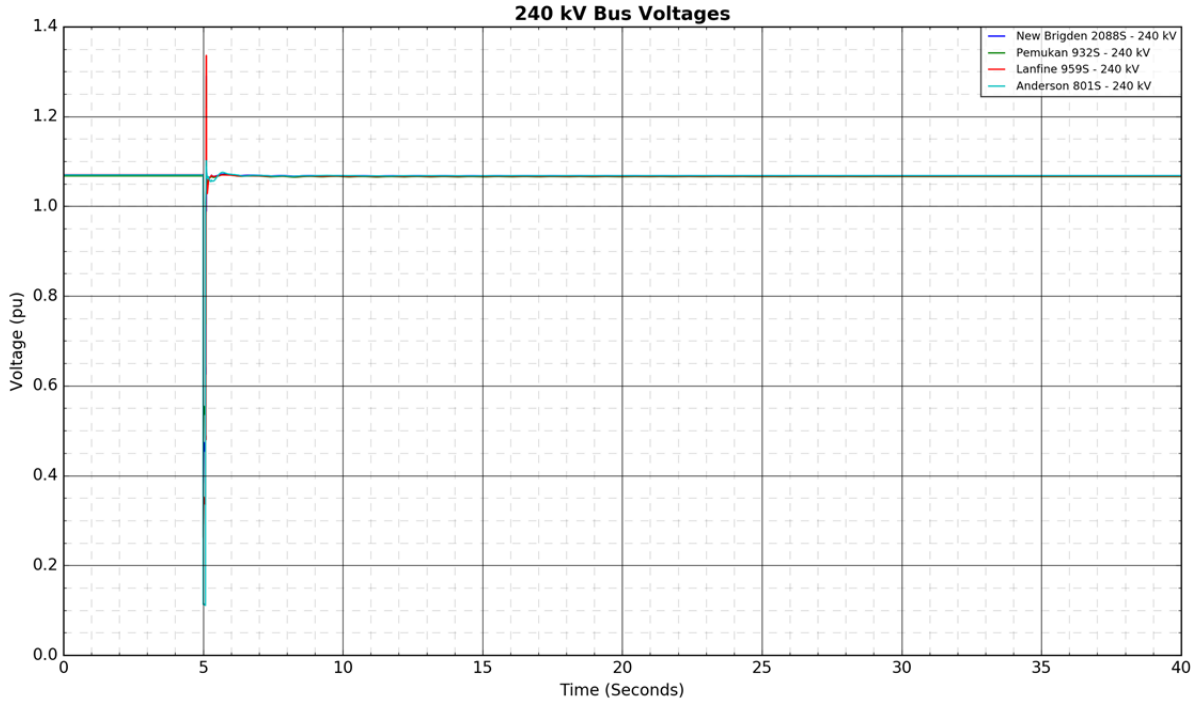
Table A4-1: Transient Stability Figures for Contingencies

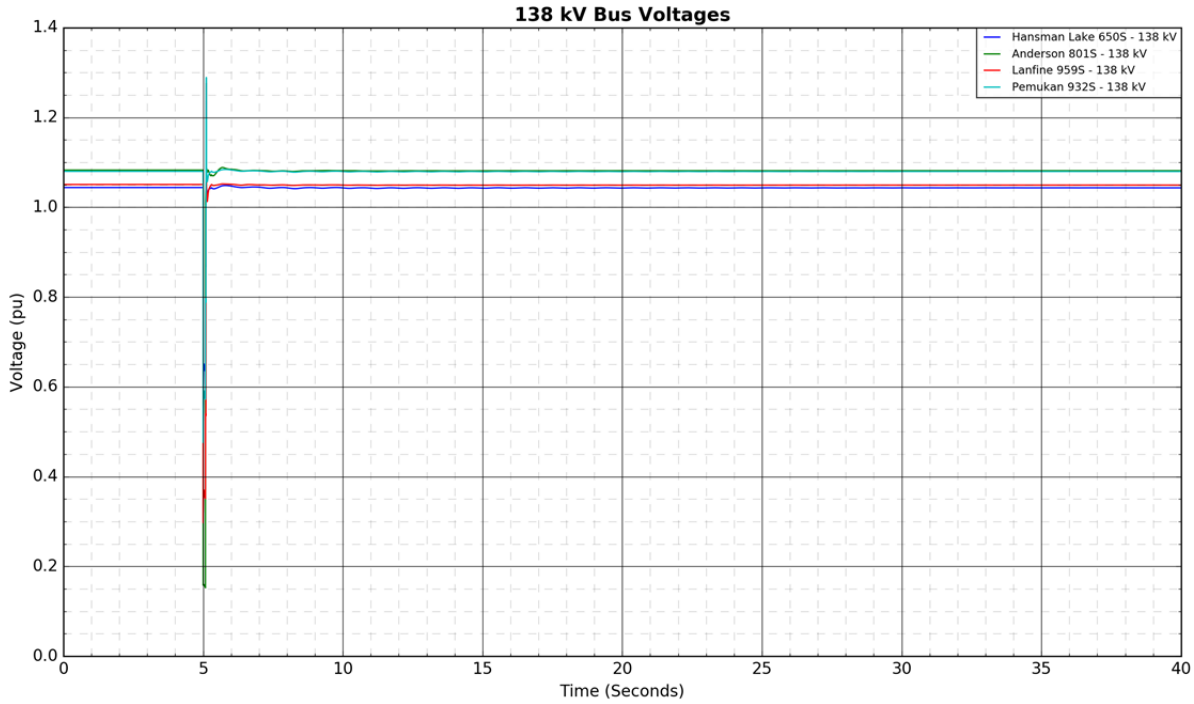
Category	Contingency	Fault Location	Fault Clearing Time		2018 SL	2018 SP	2018 WP
			Near End Cycle	Far End Cycle	Case B	Case B	Case B
N-1	9L24 Oakland 946S to Lanfine 959S	Oakland 946S	5	6	Figure A4-1	Figure A4-13	Figure A4-25
N-1	9L24 Oakland 946S to Lanfine 959S	Lanfine 959S	5	6	Figure A4-2	Figure A4-14	Figure A4-26
N-1	9L46 Lanfine 959S to New Brigden 2088S	Lanfine 959S	5	6	Figure A4-3	Figure A4-15	Figure A4-27
N-1	9L46 Lanfine 959S to New Brigden 2088S	New Brigden 2088S	5	6	Figure A4-4	Figure A4-16	Figure A4-28
N-1	9L51 New Brigden 2088S to Pemukan 932S	New Brigden 2088S	5	6	Figure A4-5	Figure A4-17	Figure A4-29
N-1	9L51 New Brigden 2088S to Pemukan 932S	Pemukan 932S	5	6	Figure A4-6	Figure A4-18	Figure A4-30
N-1	9L966 Pemukan 932S to Hansman Lake 650S	Pemukan 932S	5	6	Figure A4-7	Figure A4-19	Figure A4-31
N-1	9L966 Pemukan 932S to Hansman Lake 650S	Hansman Lake 650S	5	6	Figure A4-8	Figure A4-20	Figure A4-32
N-1	912L/9L912 Nevis 766S to Red Deer 63S	Red Deer 63S	5	6	Figure A4-9	Figure A4-21	Figure A4-33
N-1	912L/9L912 Nevis 766S to Red Deer 63S	Nevis 766S	5	6	Figure A4-10	Figure A4-22	Figure A4-34
N-1	9L59 Anderson 801S to Tinchebray 972S	Tinchebray 972S	5	6	Figure A4-11	Figure A4-23	Figure A4-35
N-1	9L59 Anderson 801S to Tinchebray 972S	Anderson 801S	5	6	Figure A4-12	Figure A4-24	Figure A4-36

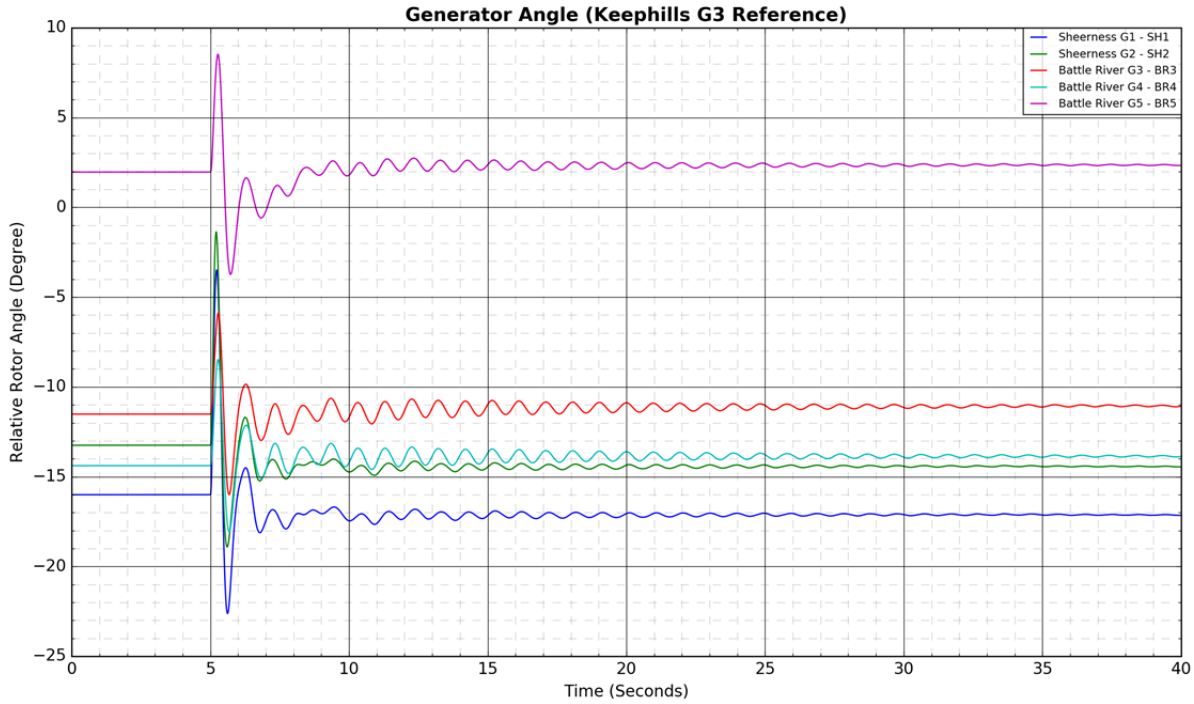
Transient Stability Results

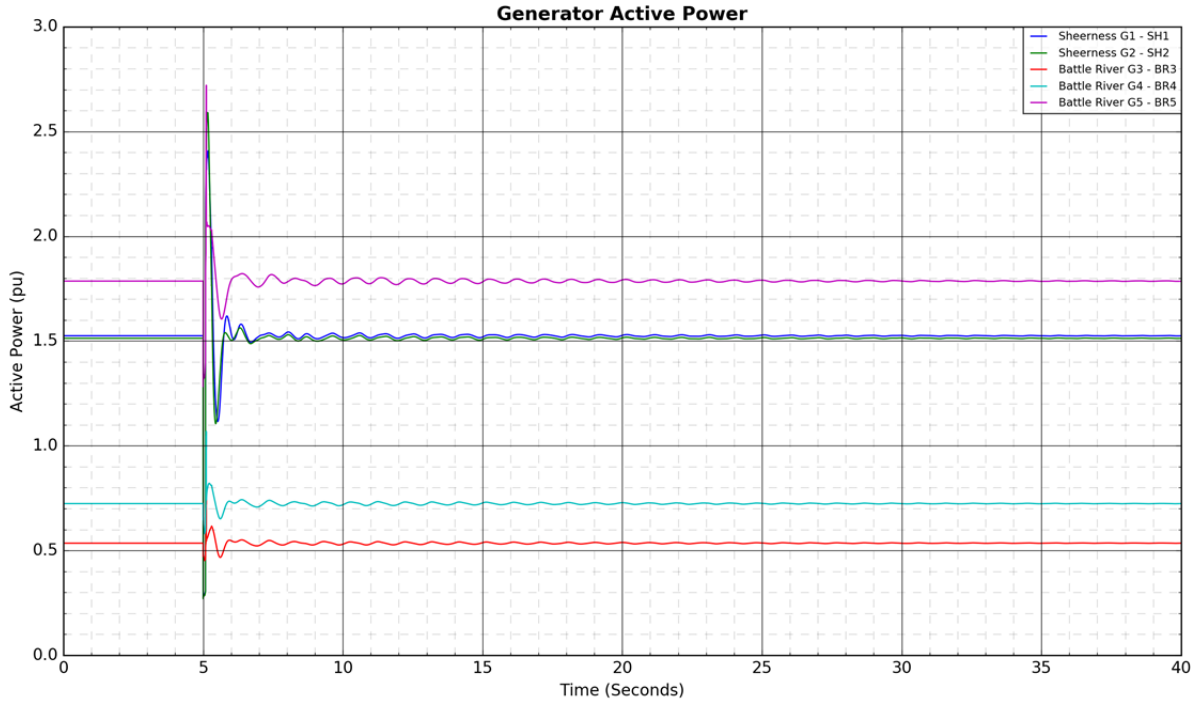
1. Stability Results 2018 Summer Light - Case B

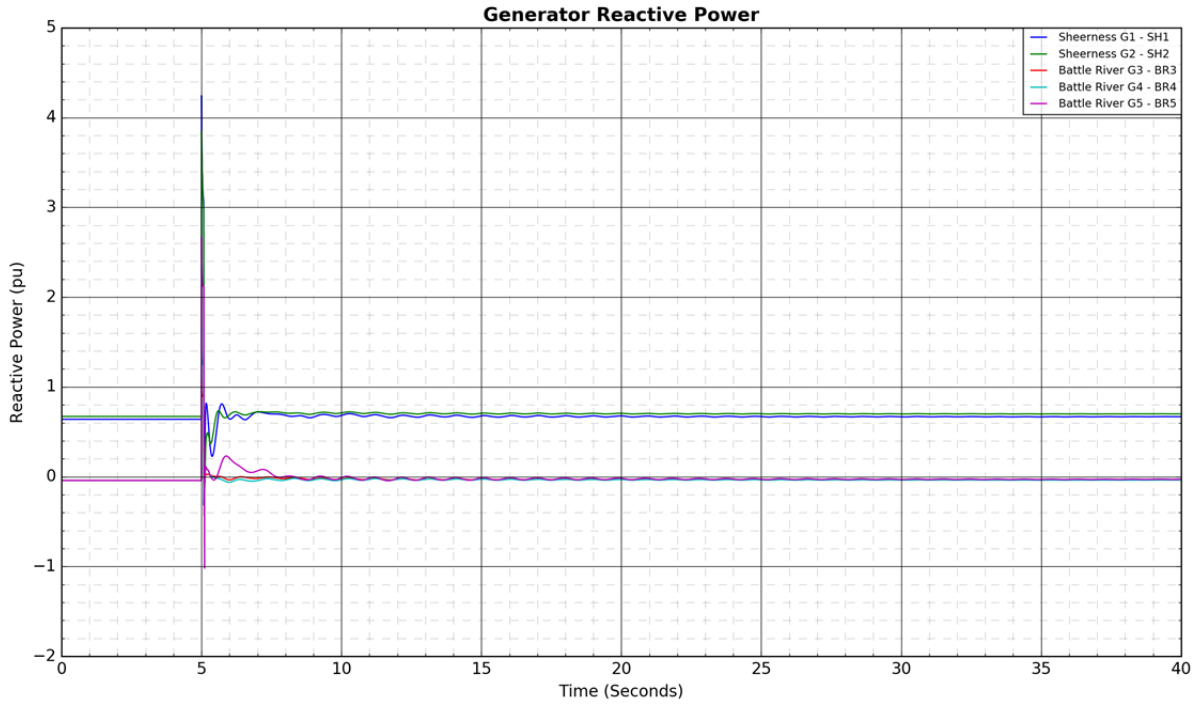
Figure A4-1: 9L24 Oakland 946S to Lanfine 959S: Fault Near Oakland 946S

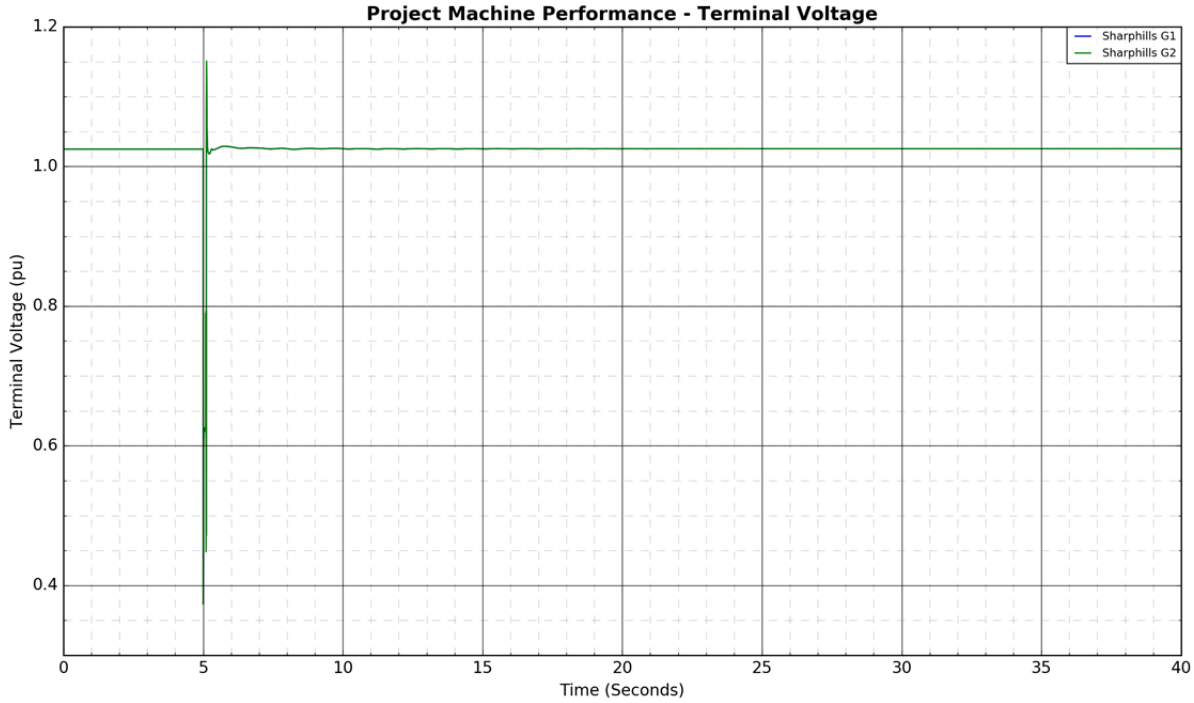


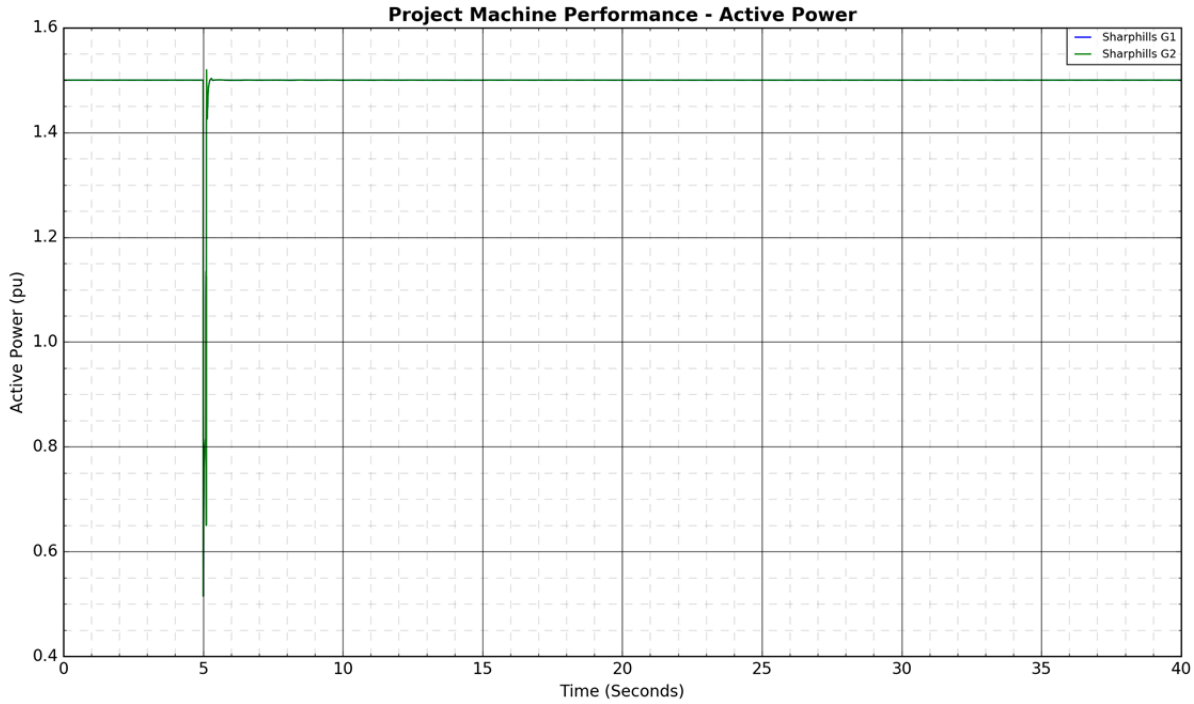


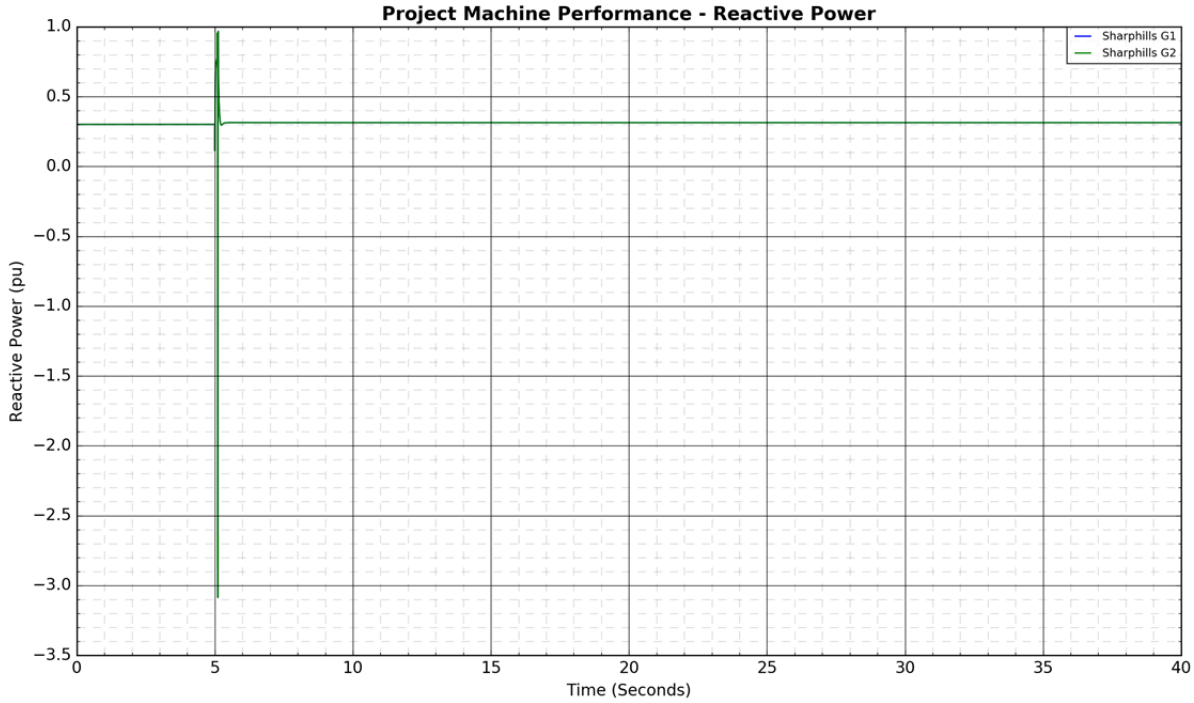

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

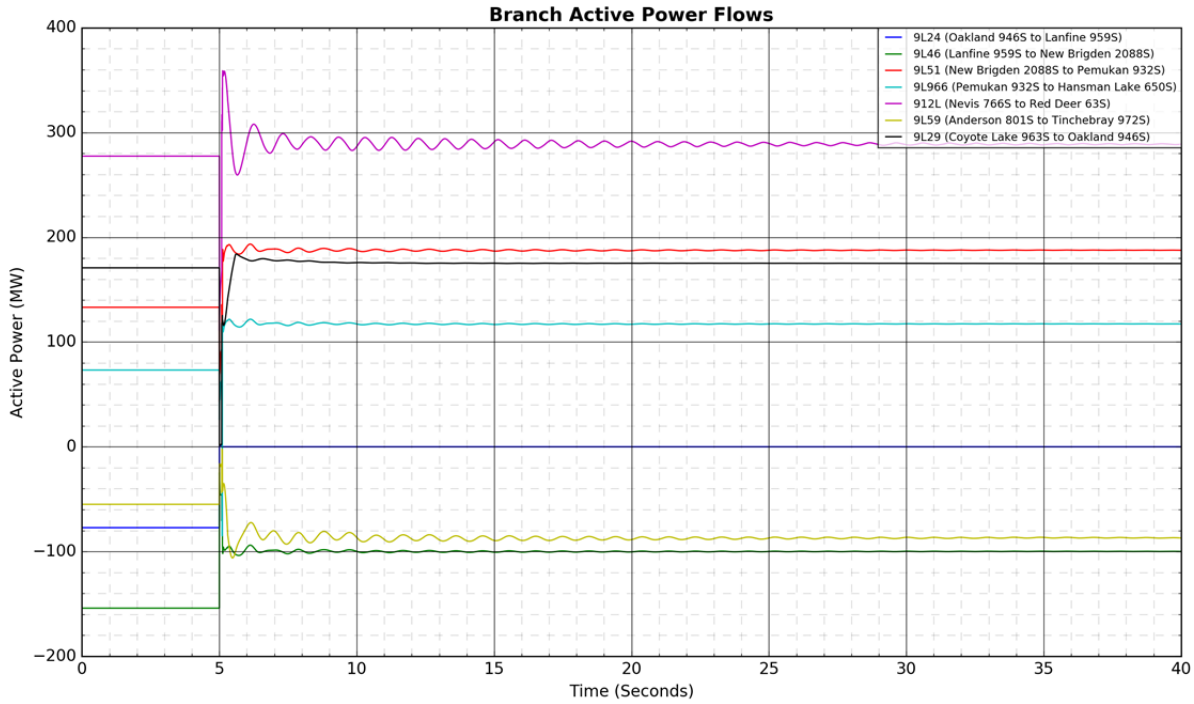

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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
Sharphills G1
Sharphills G2
Reactive Power (pu)
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

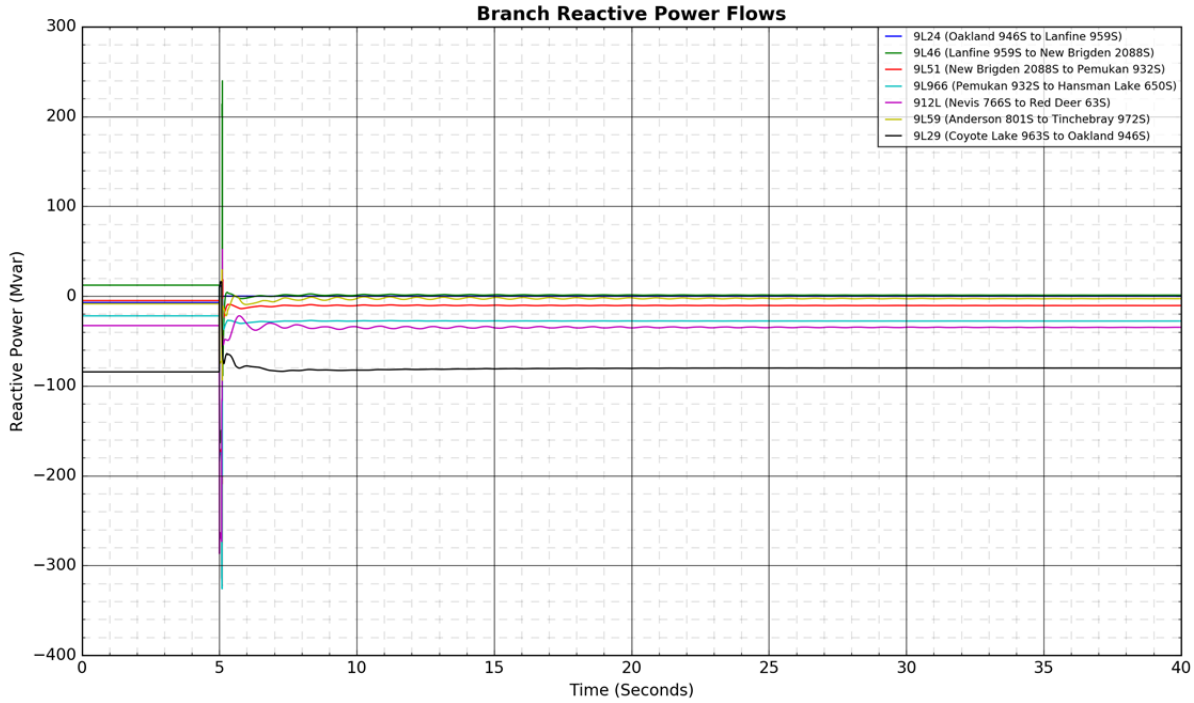
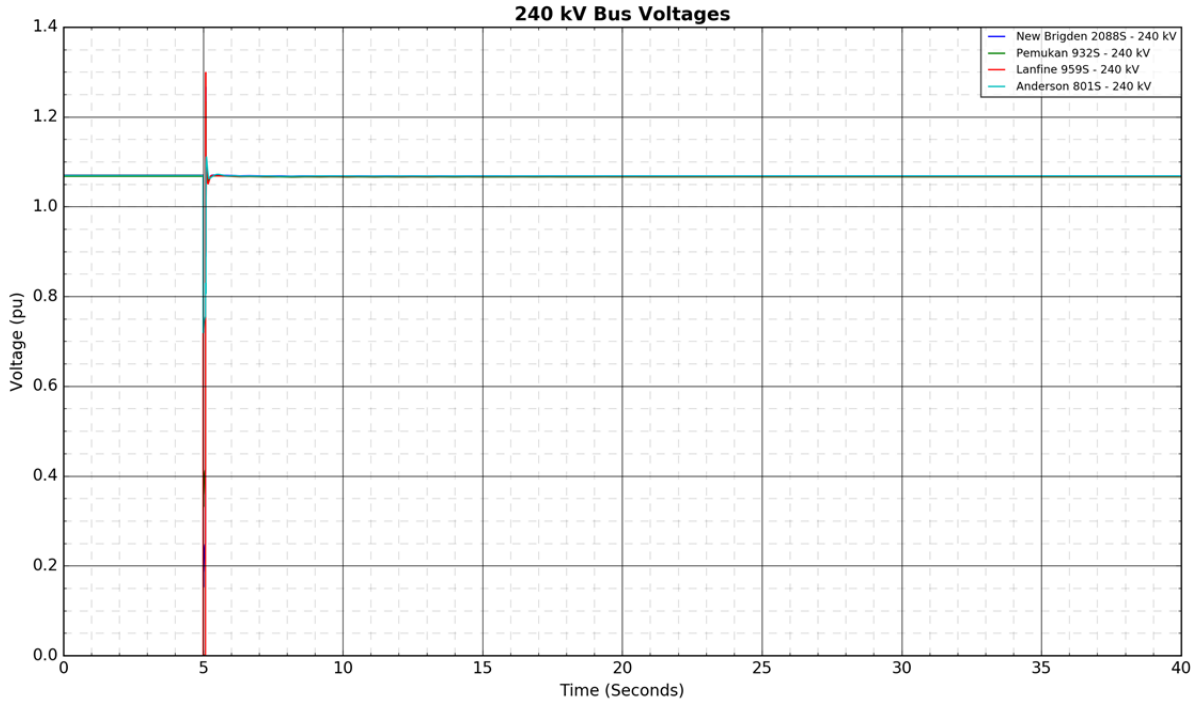
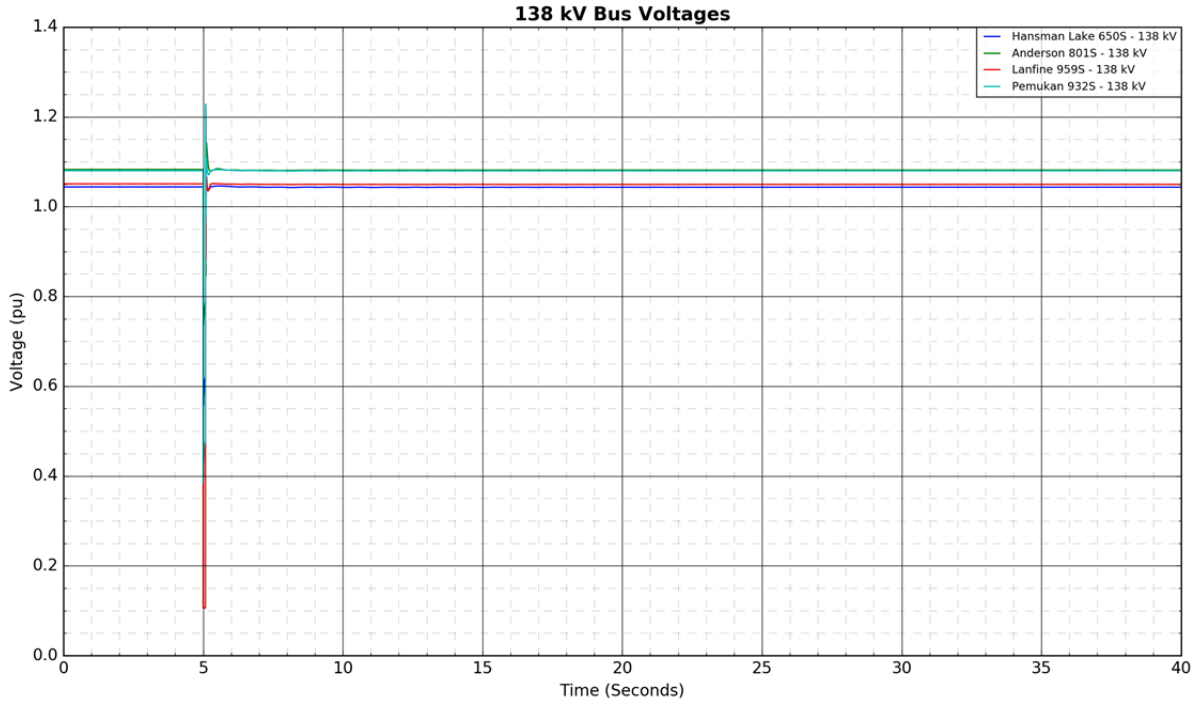
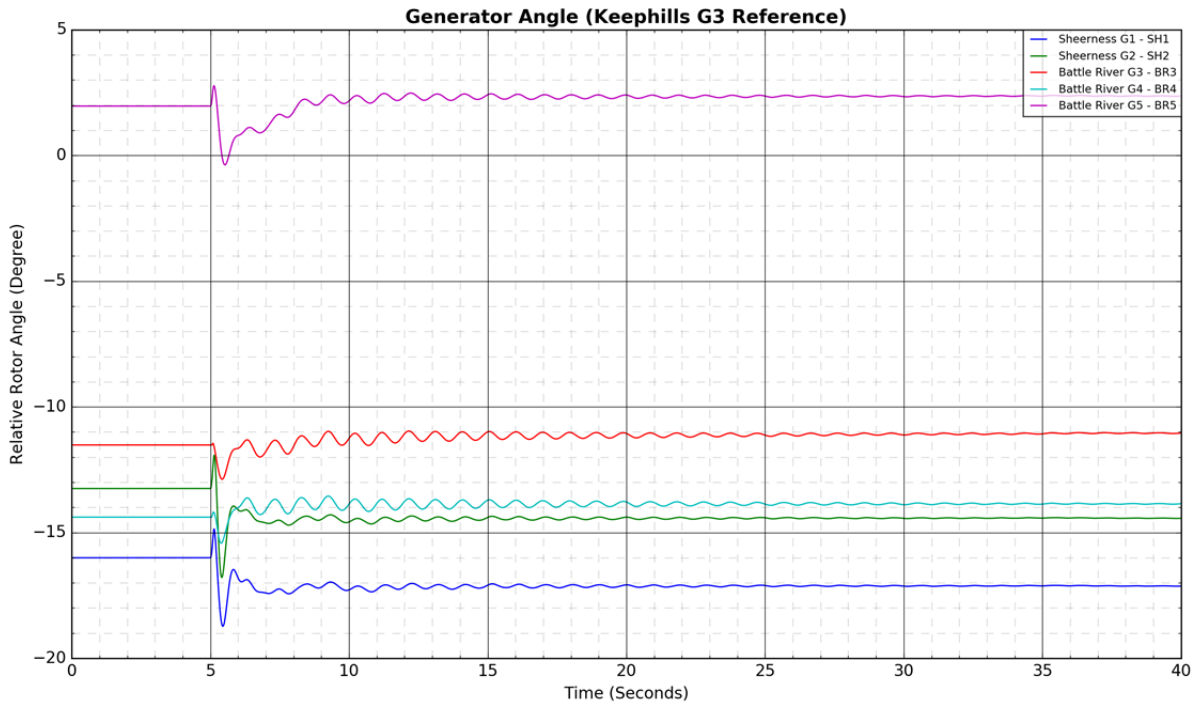
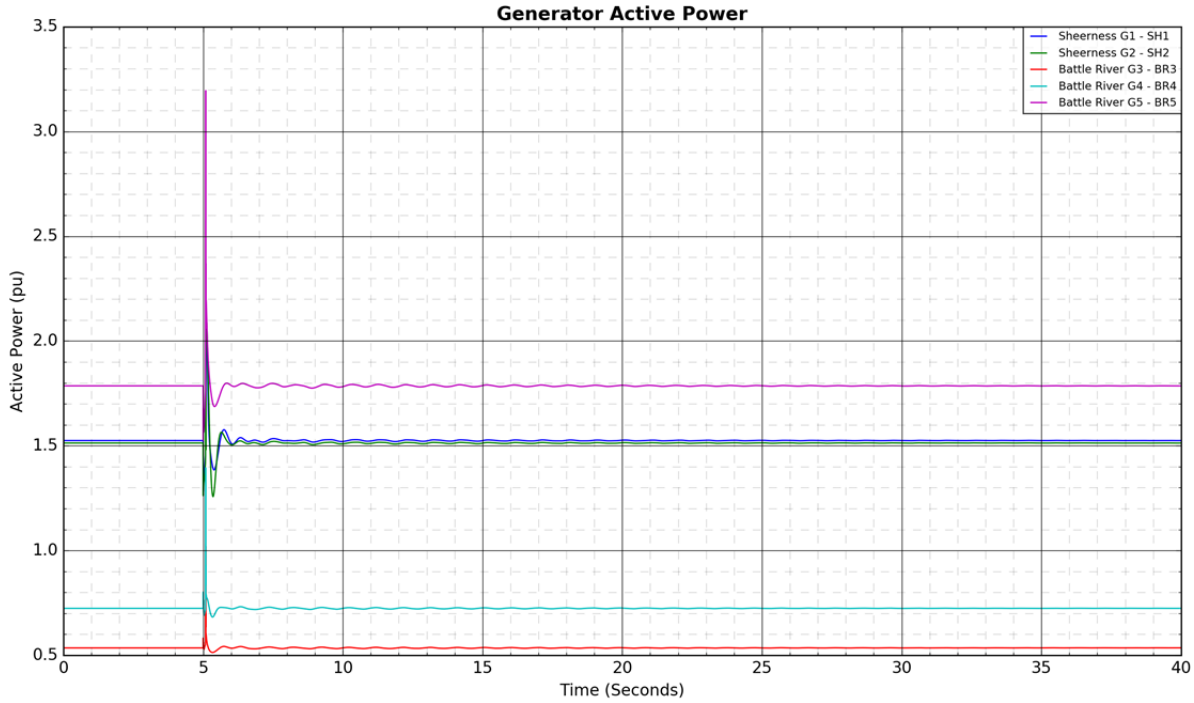

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

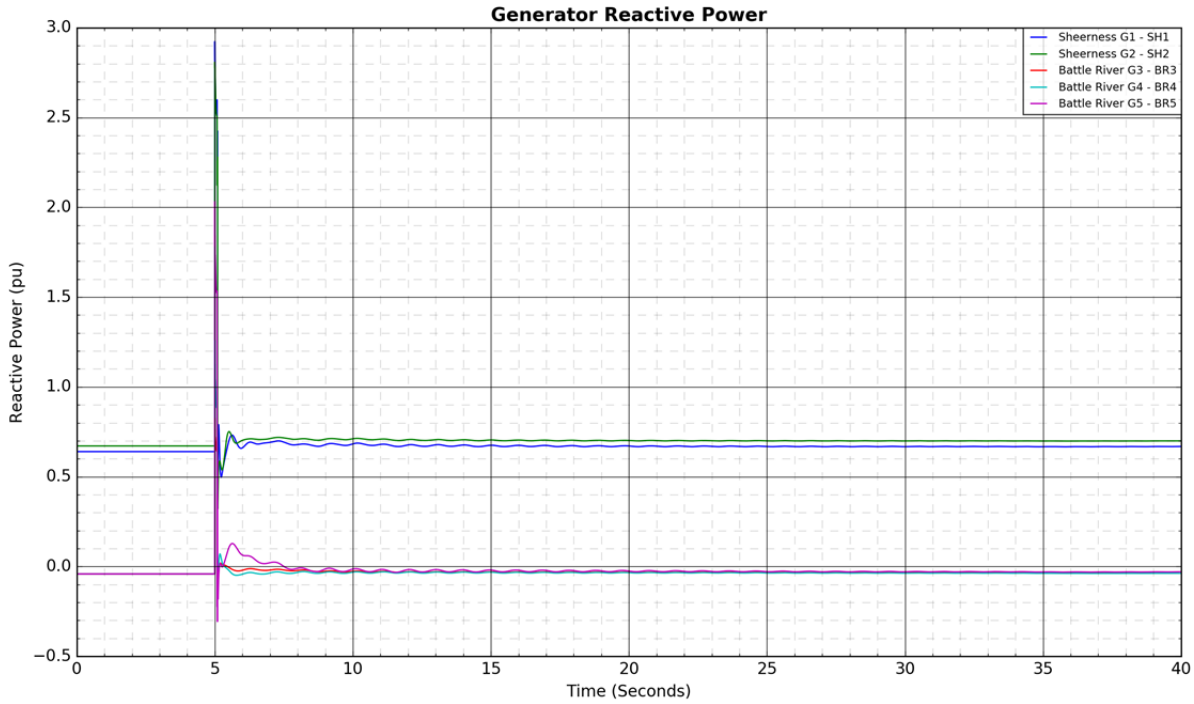
Figure A4-2: 9L24 Oakland 946S to Lanfine 959S: Fault Near Lanfine 959S

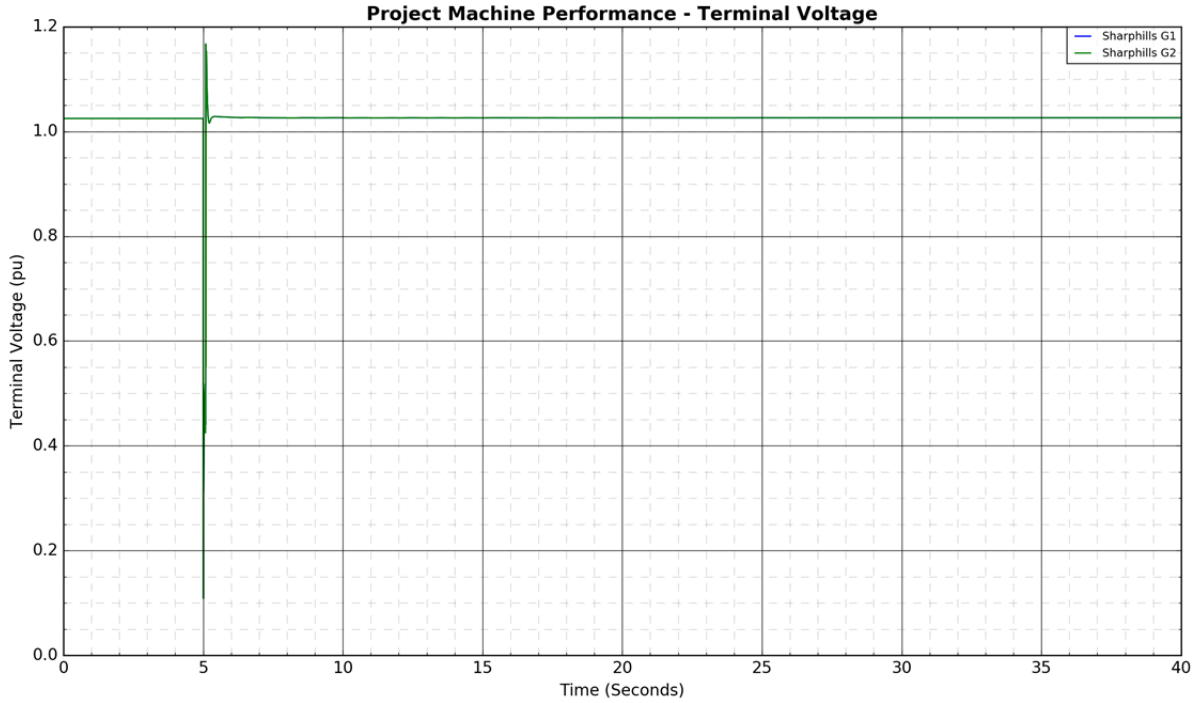


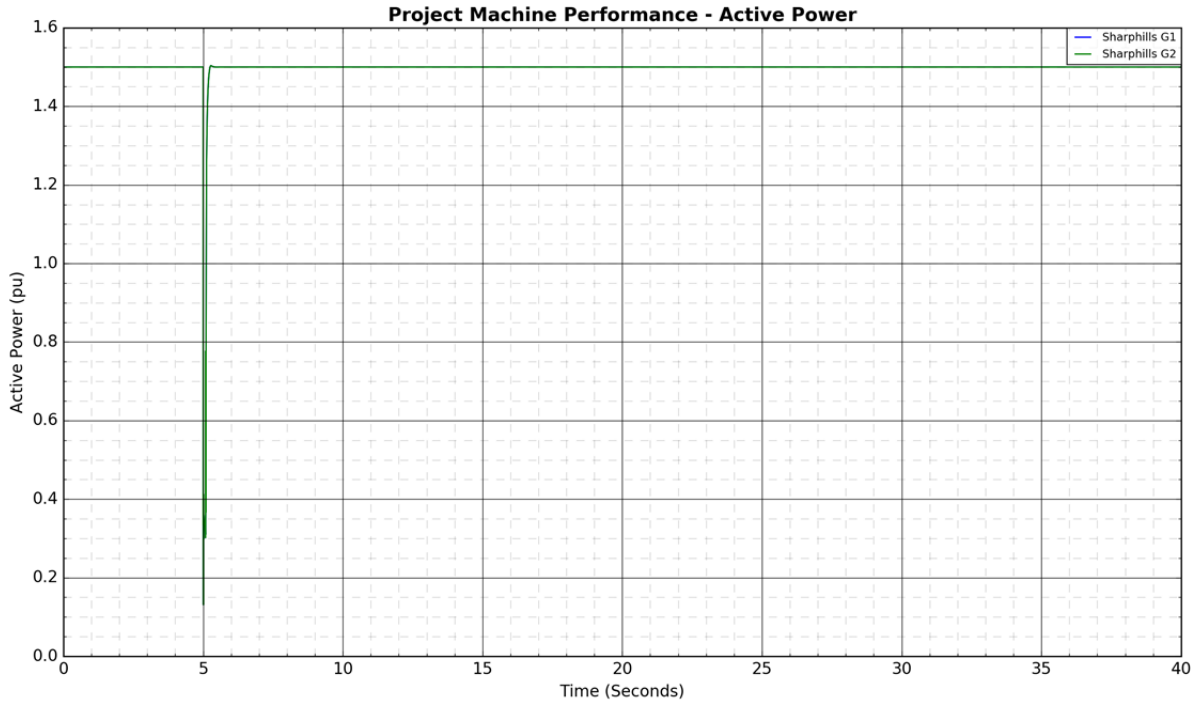


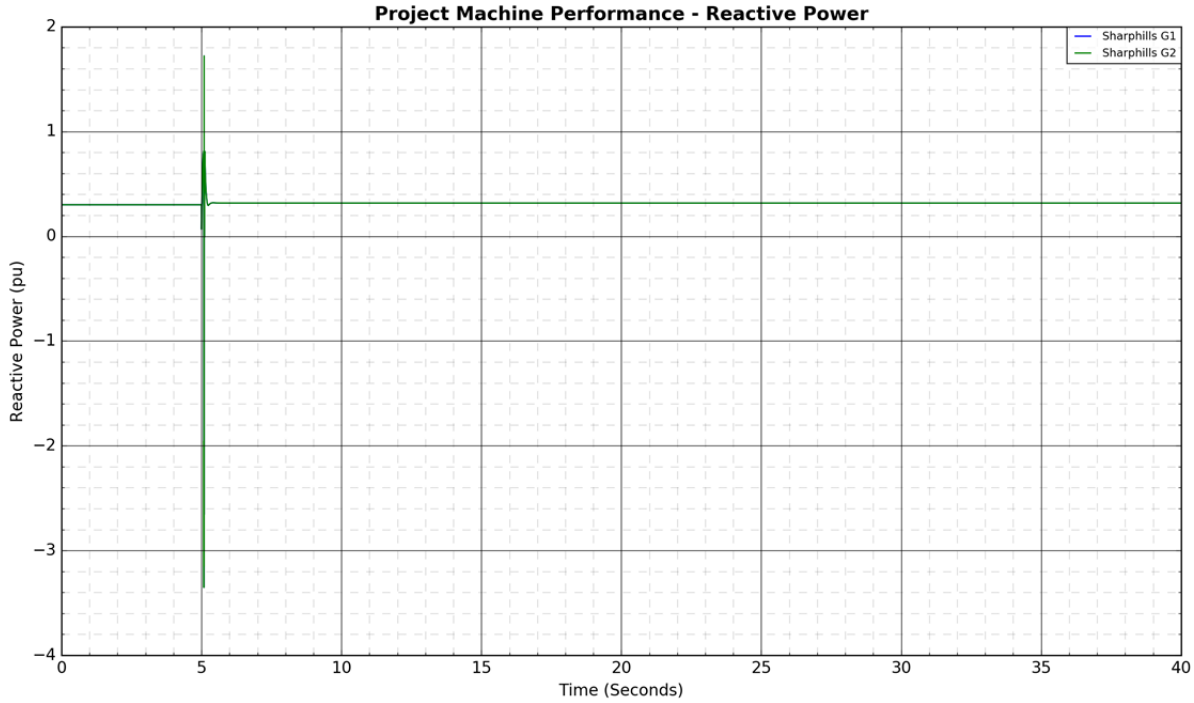

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
5
0
−5
−10
−15
−20
0
5
10
15
20
25
30
35
40

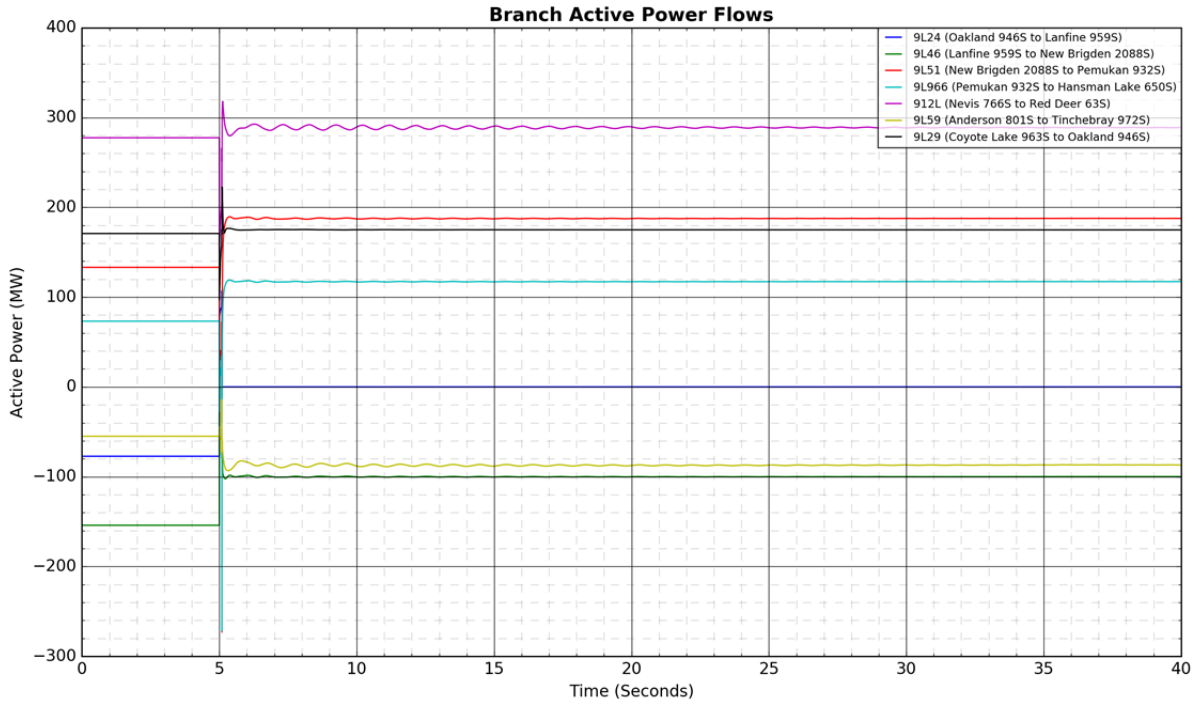

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
35
40


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
2
1
0
−1
−2
−3
−4
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

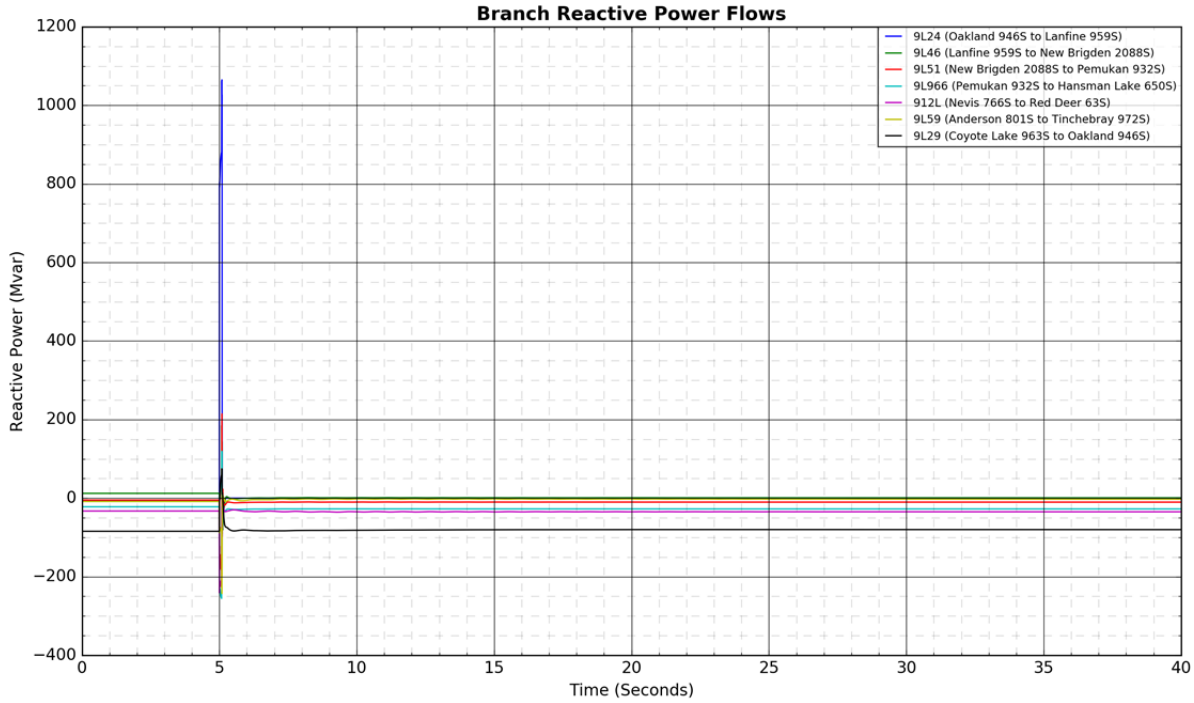
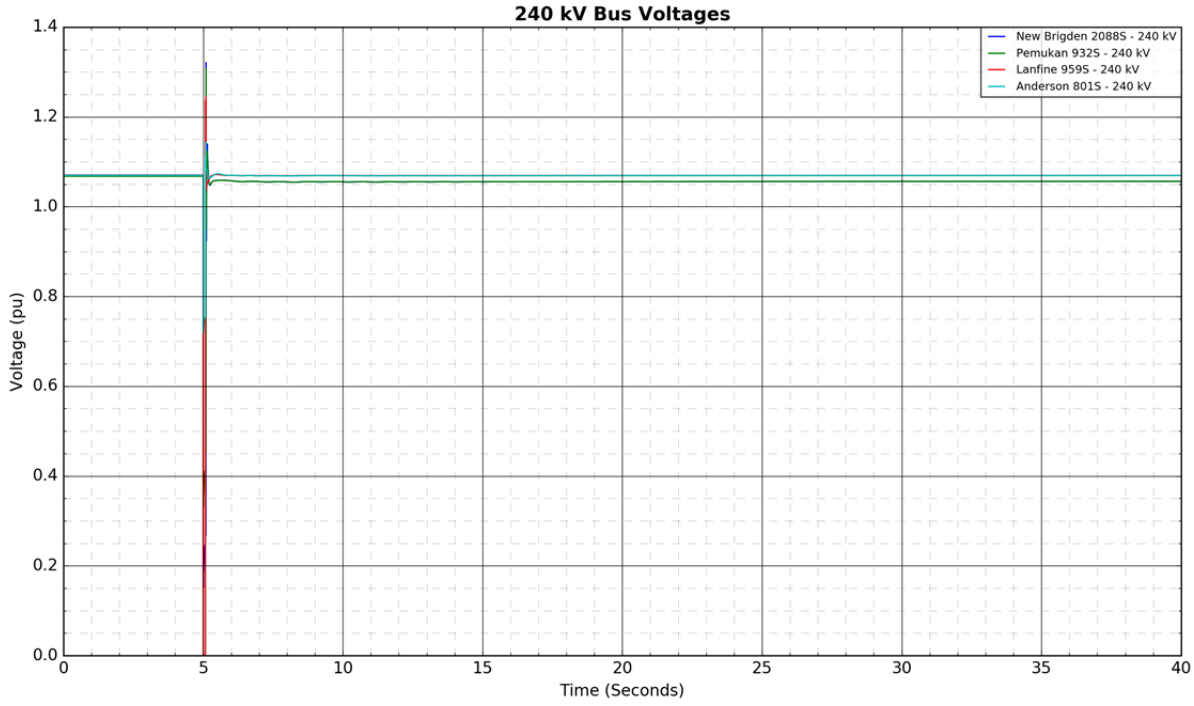
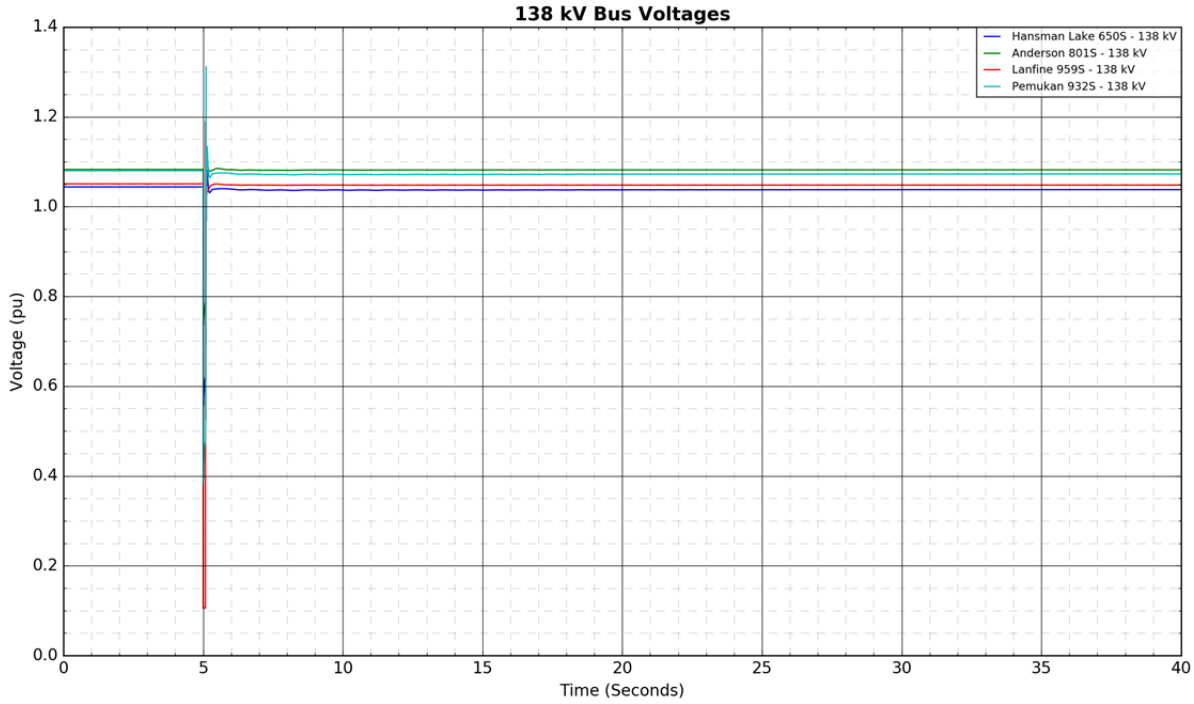
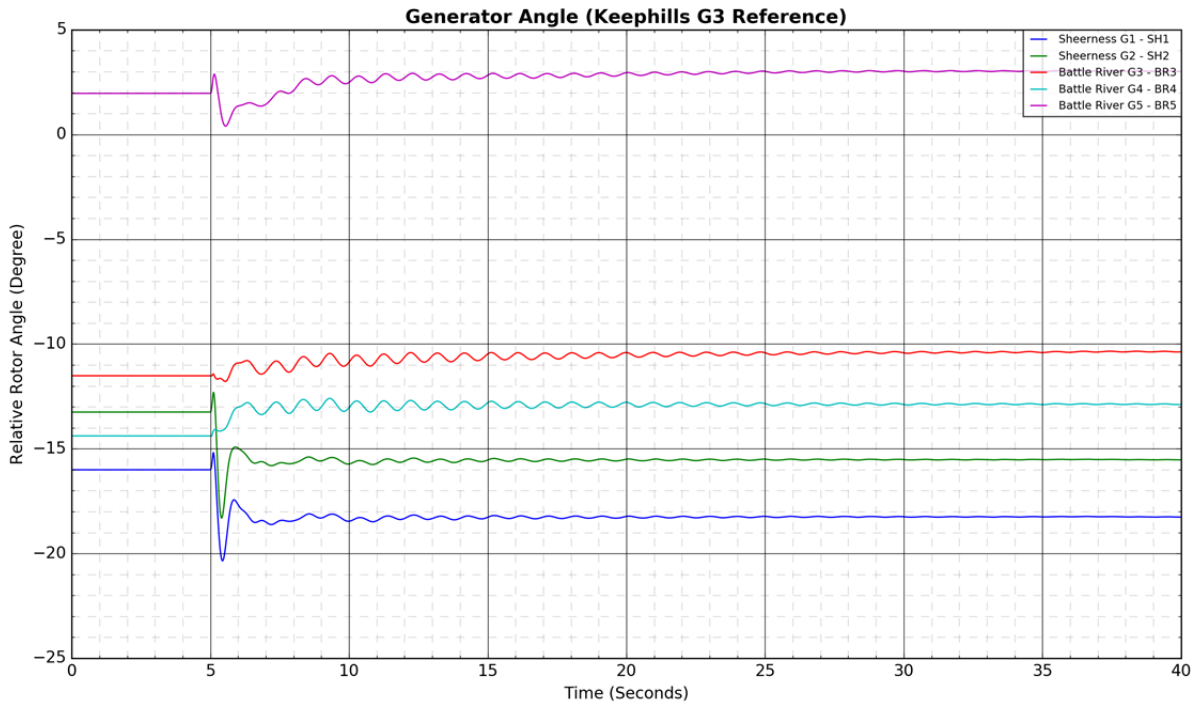
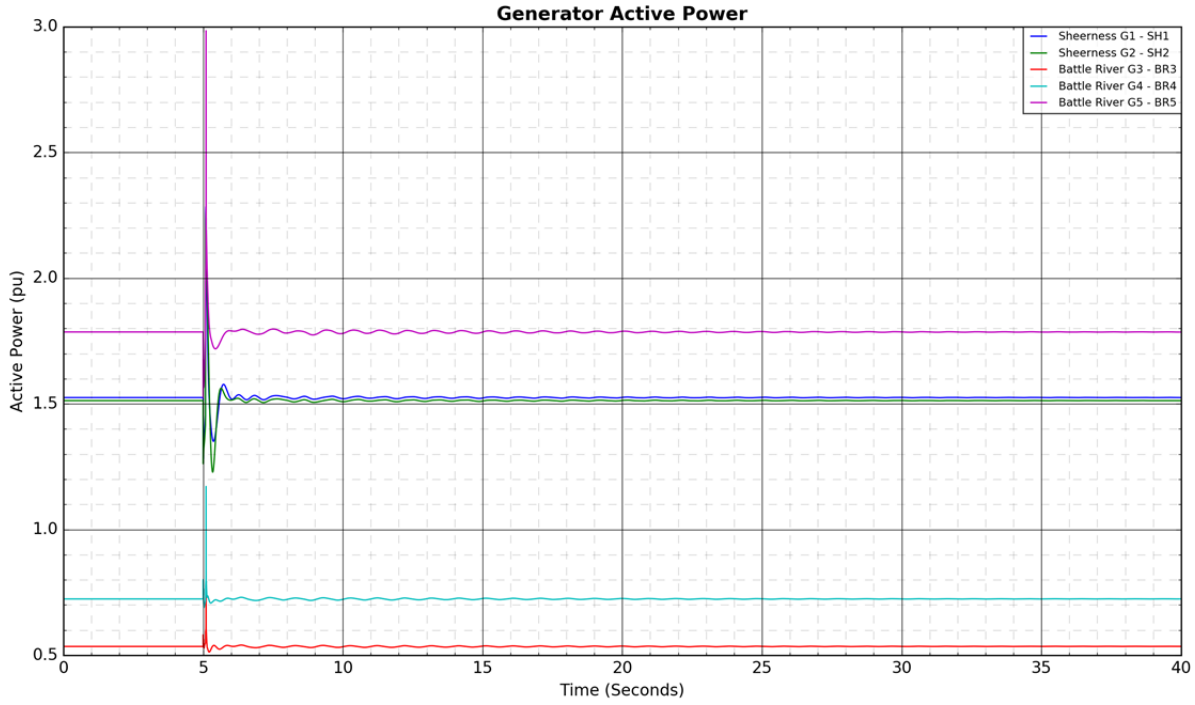

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

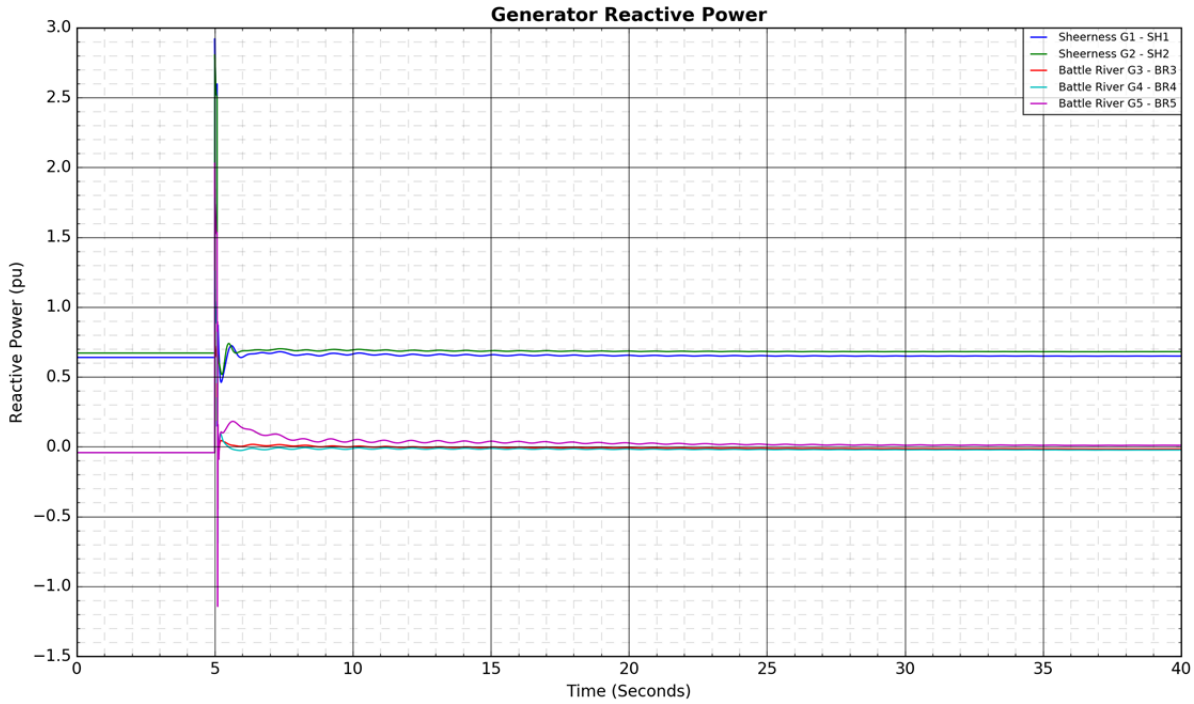
Figure A4-3: 9L46 Lanfine 959S to New Brigden 2088S: Fault Near Lanfine 959S

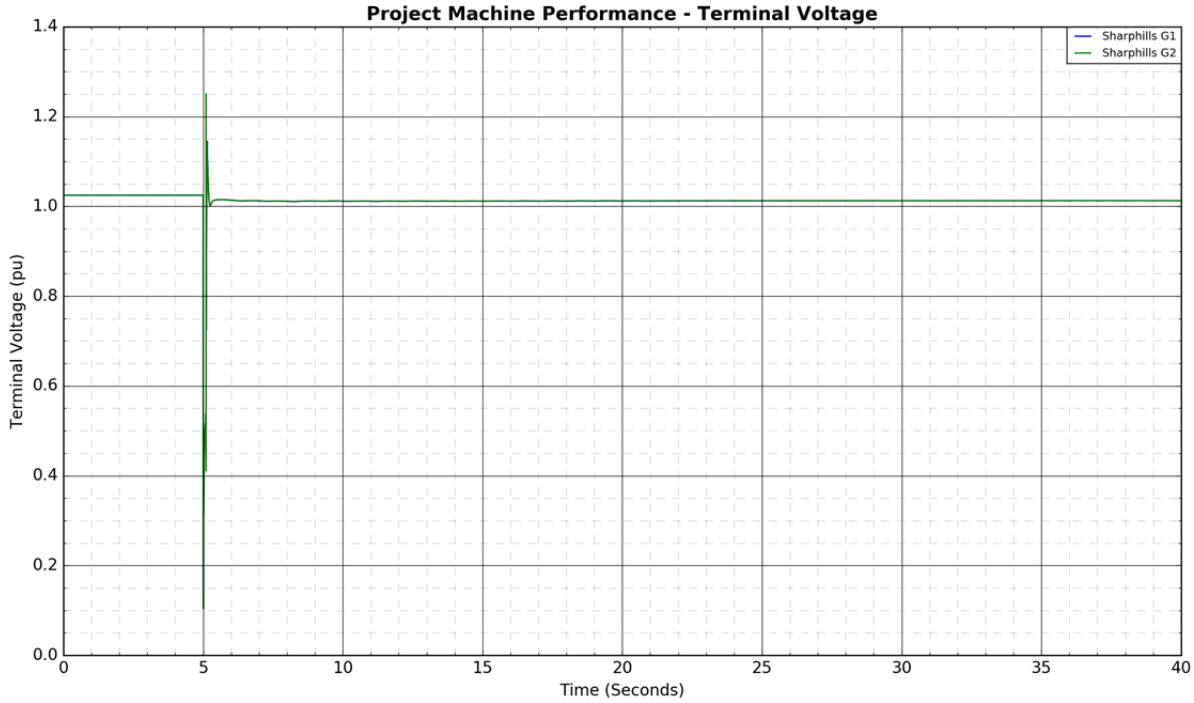


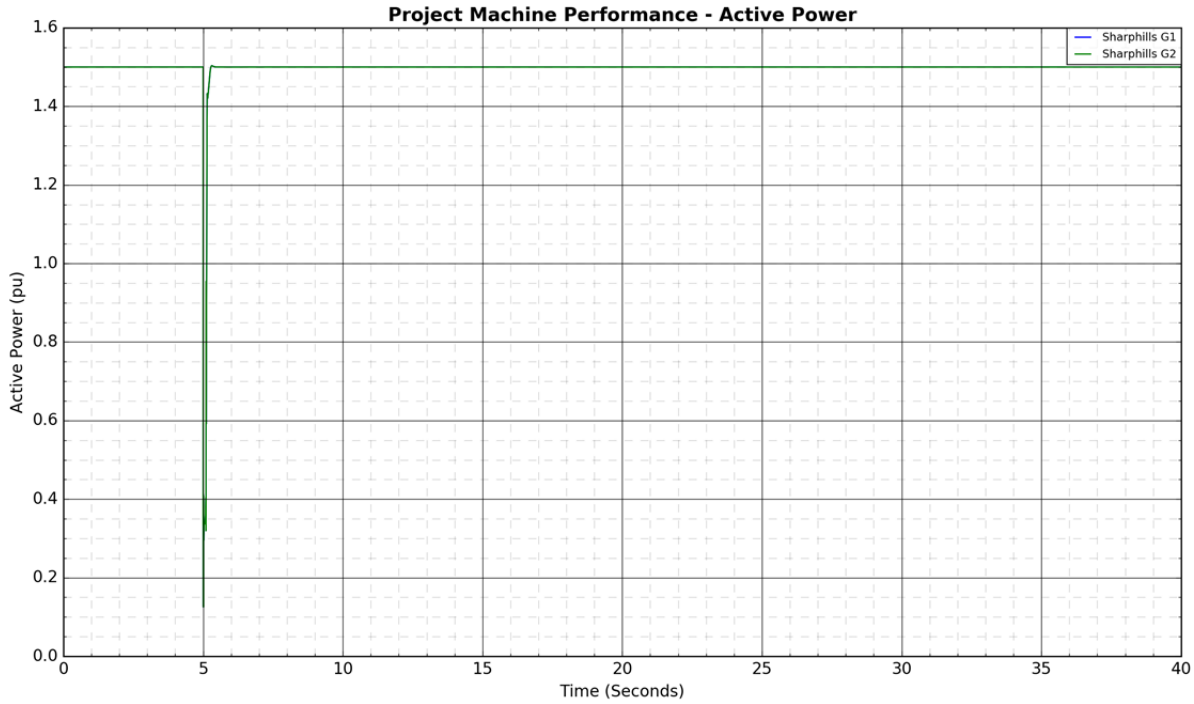


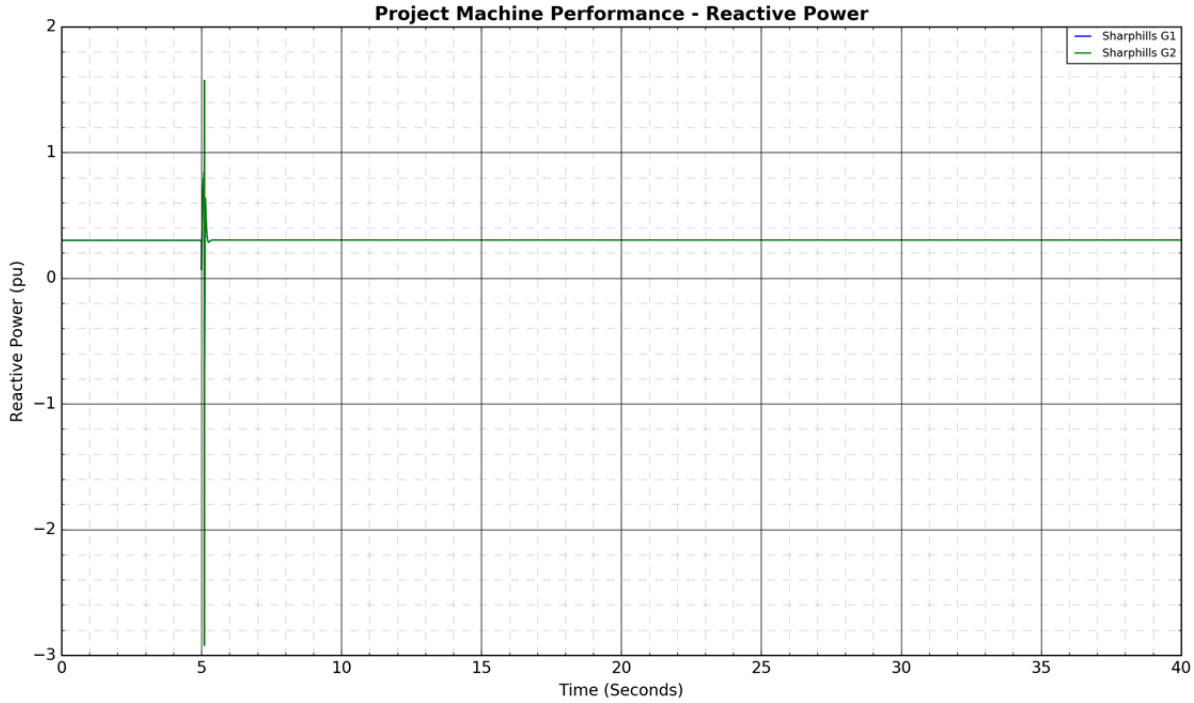

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

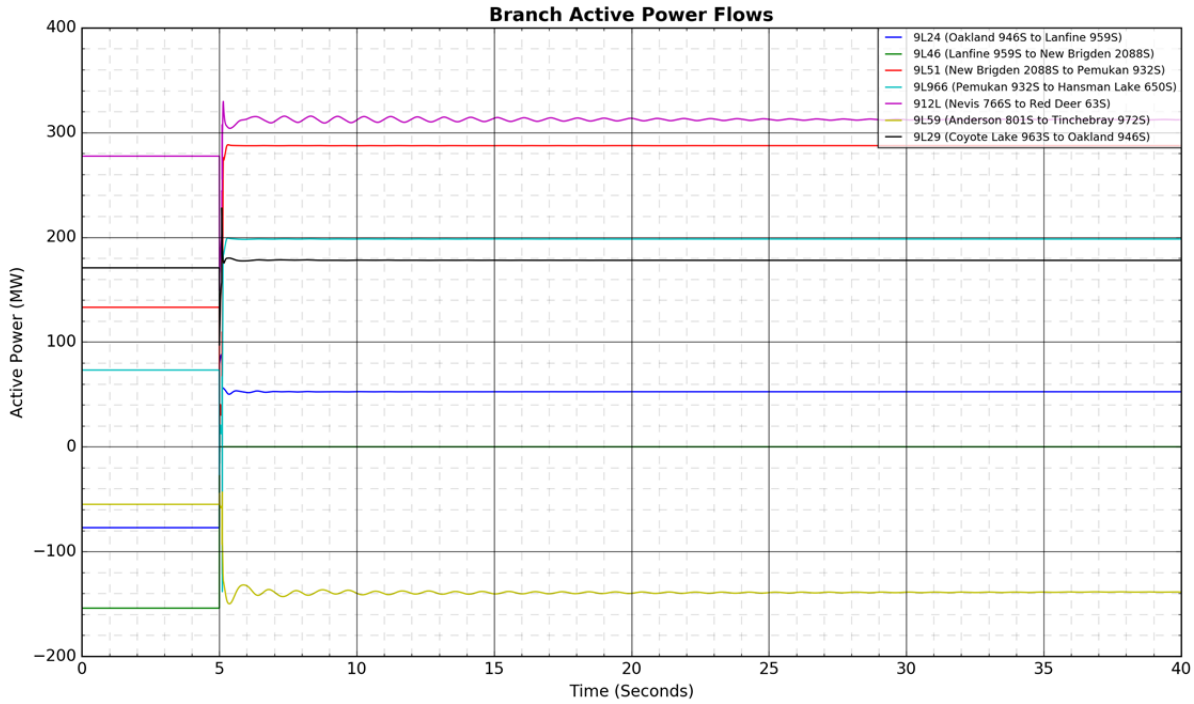

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
2
1
0
−1
−2
−3
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

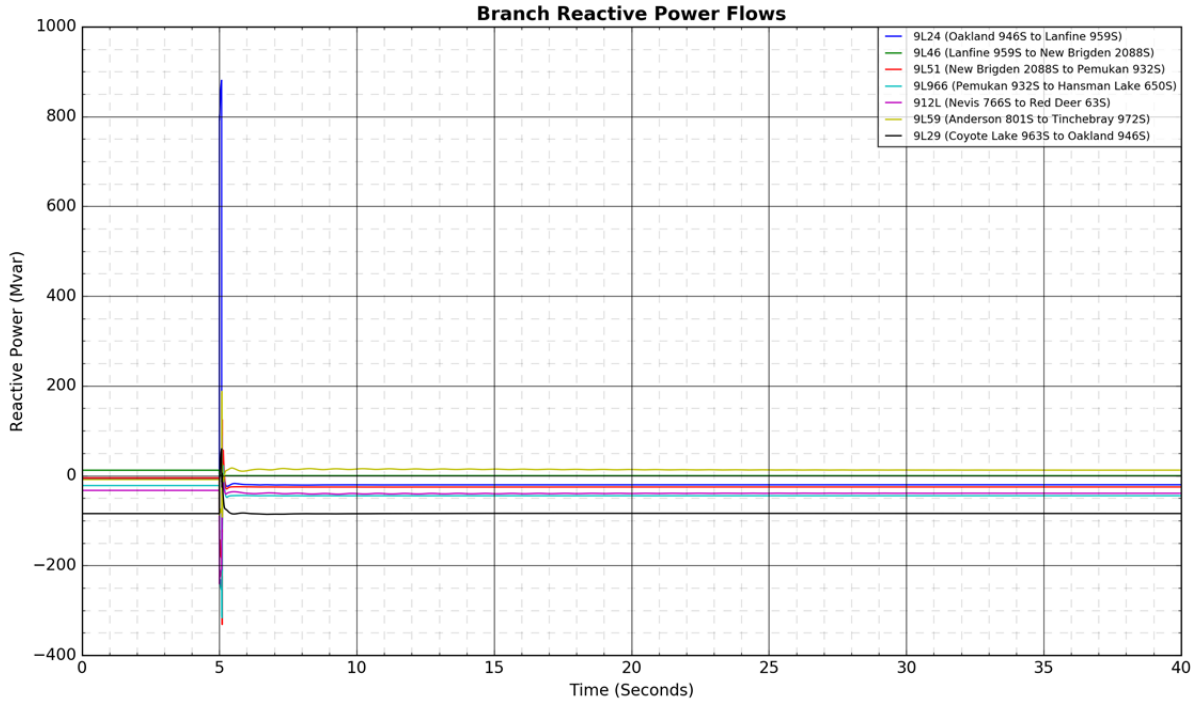
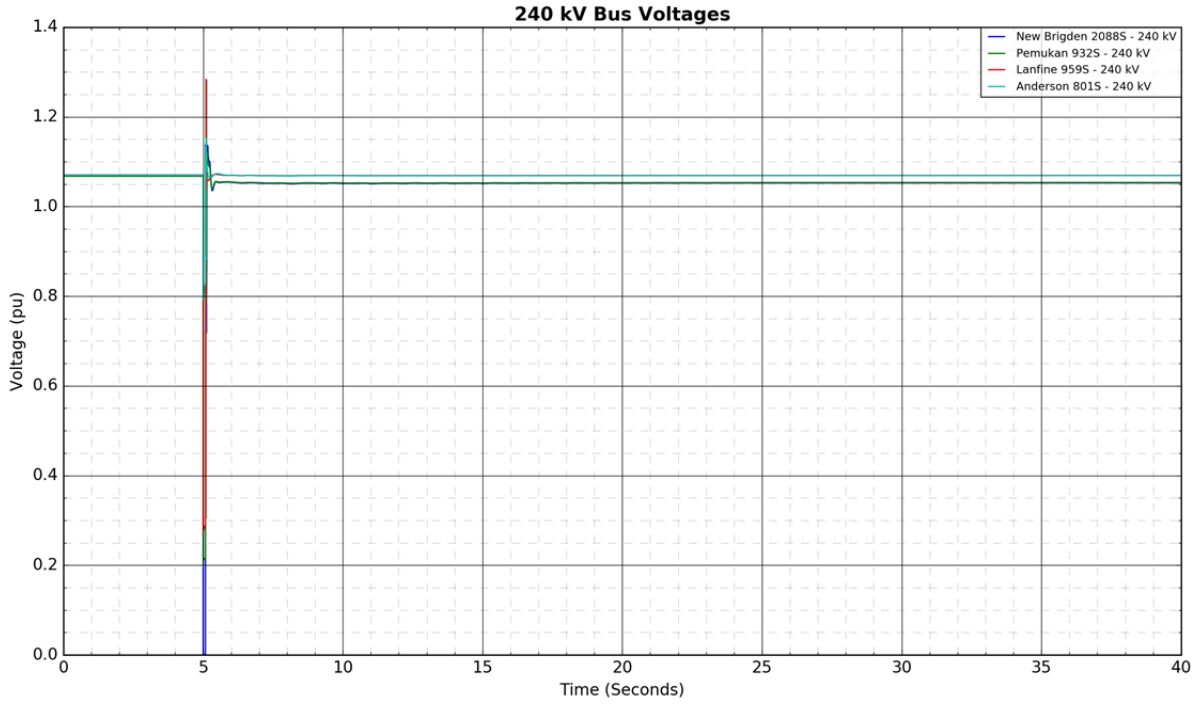
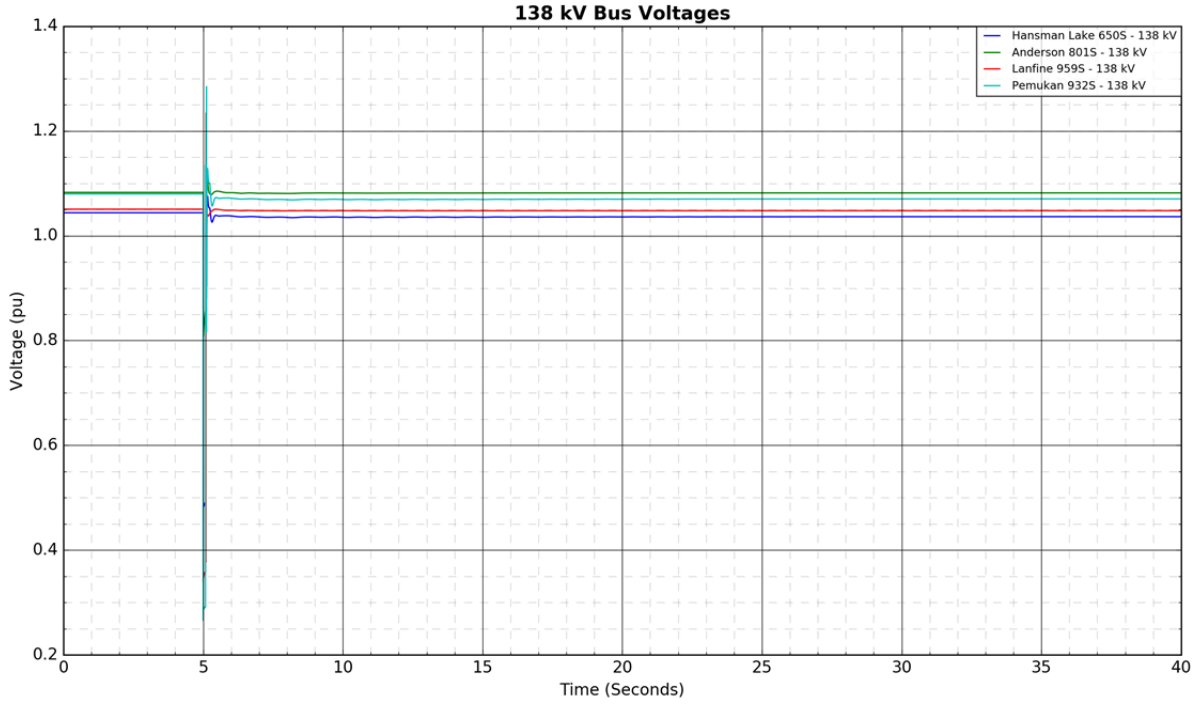
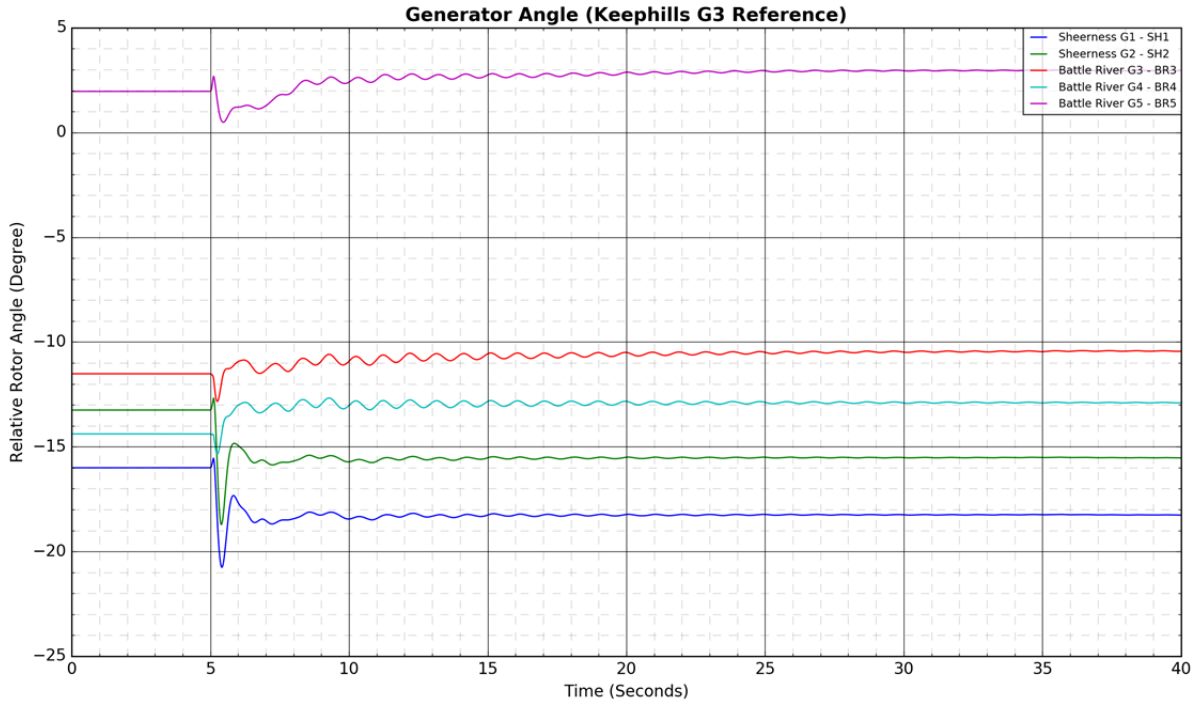
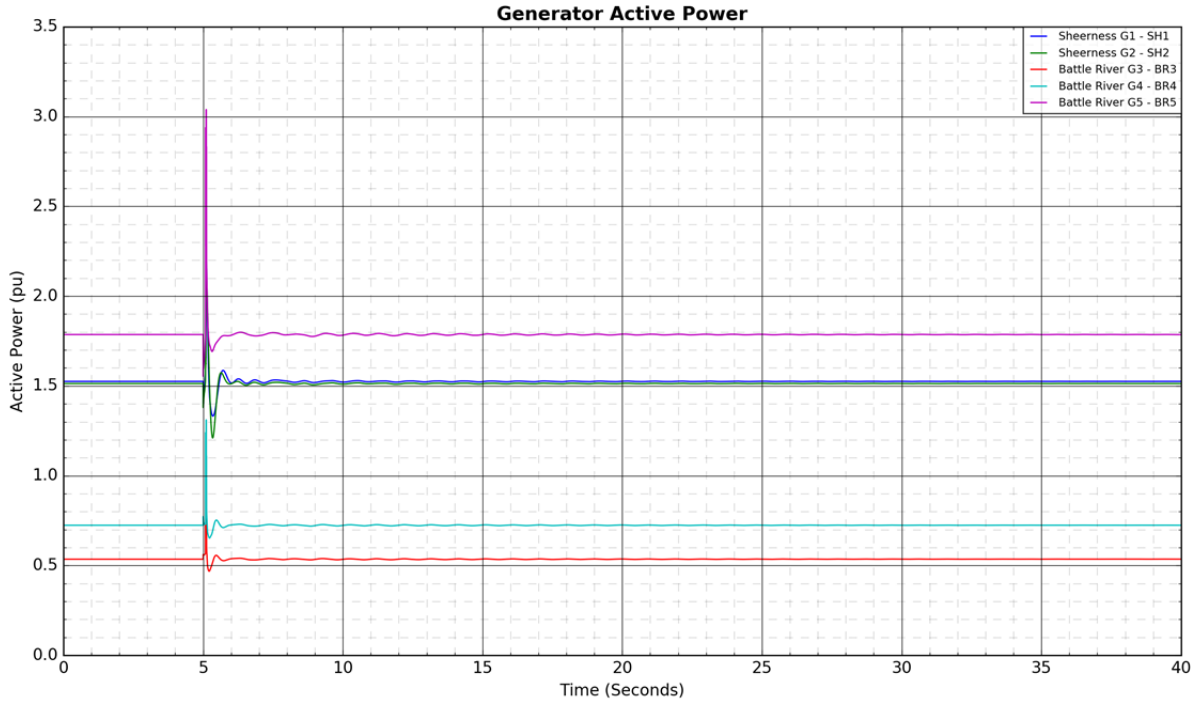

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

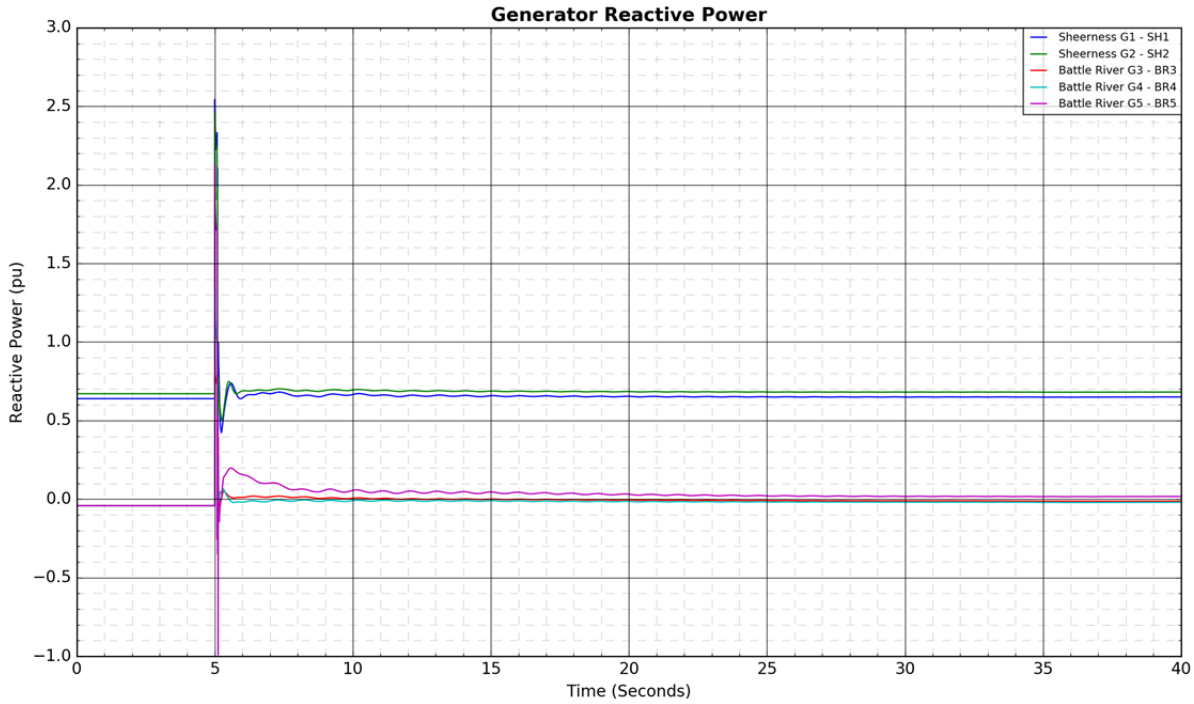
Figure A4-4: 9L46 Lanfine 959S to New Brigden 2088S: Fault Near New Brigden 2088S

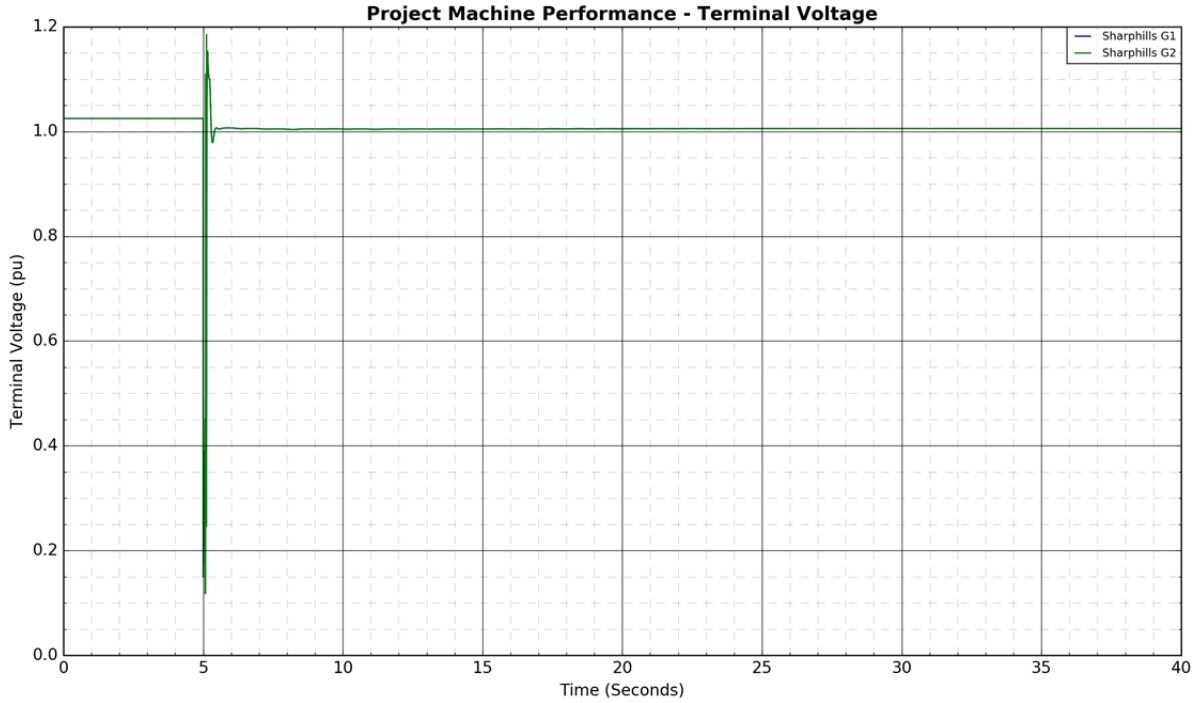


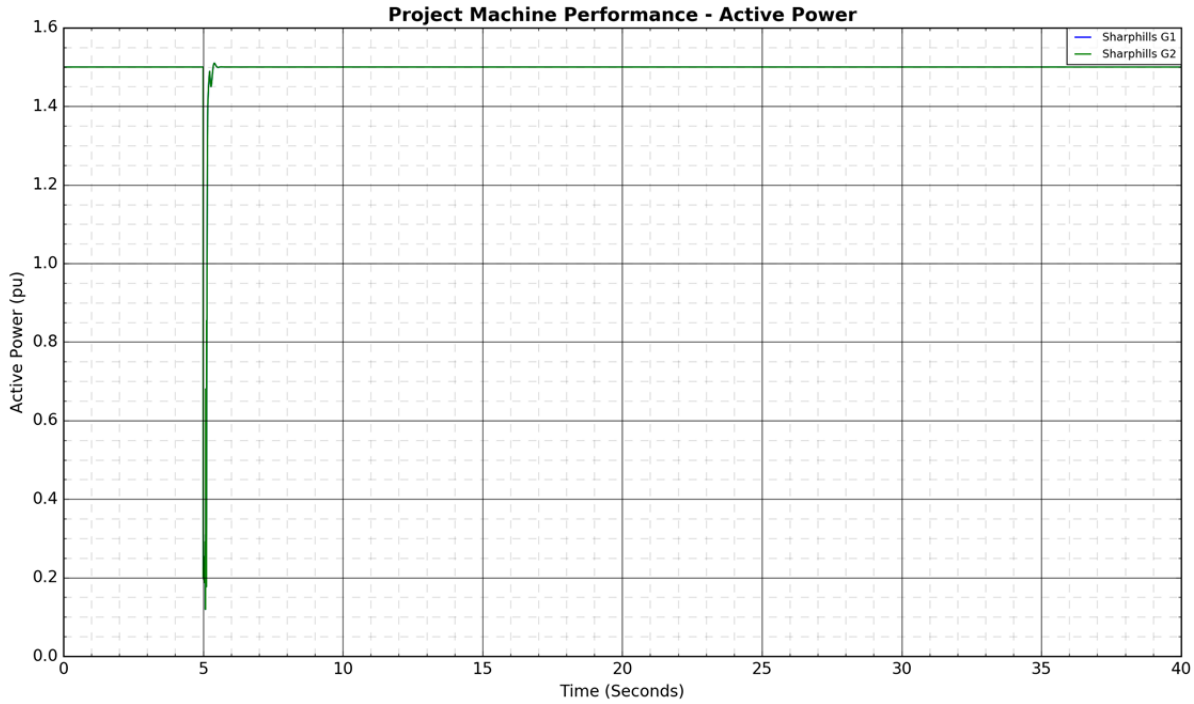


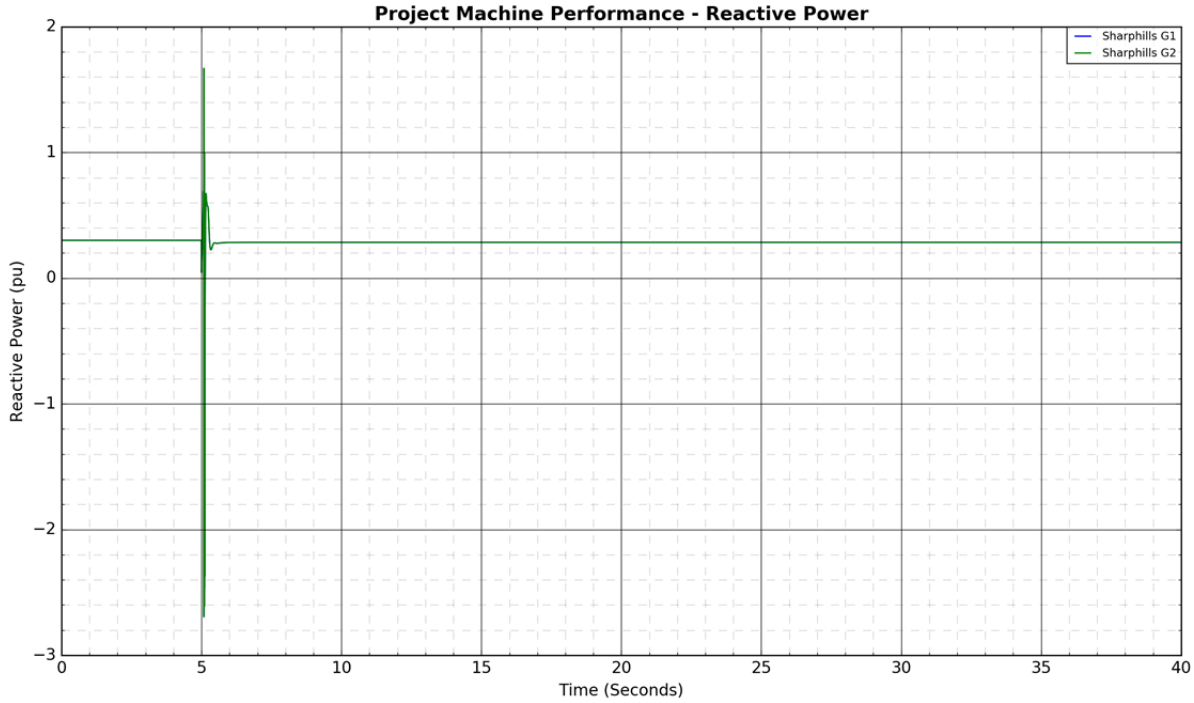

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

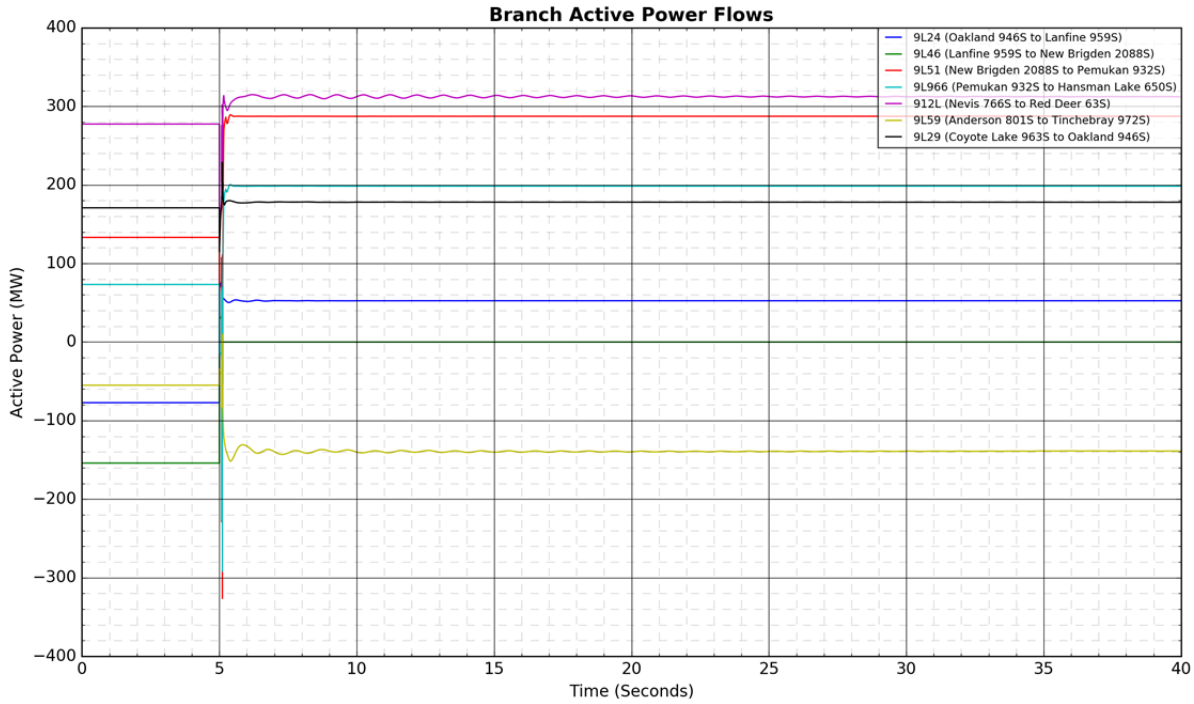

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
2
1
0
−1
−2
−3
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

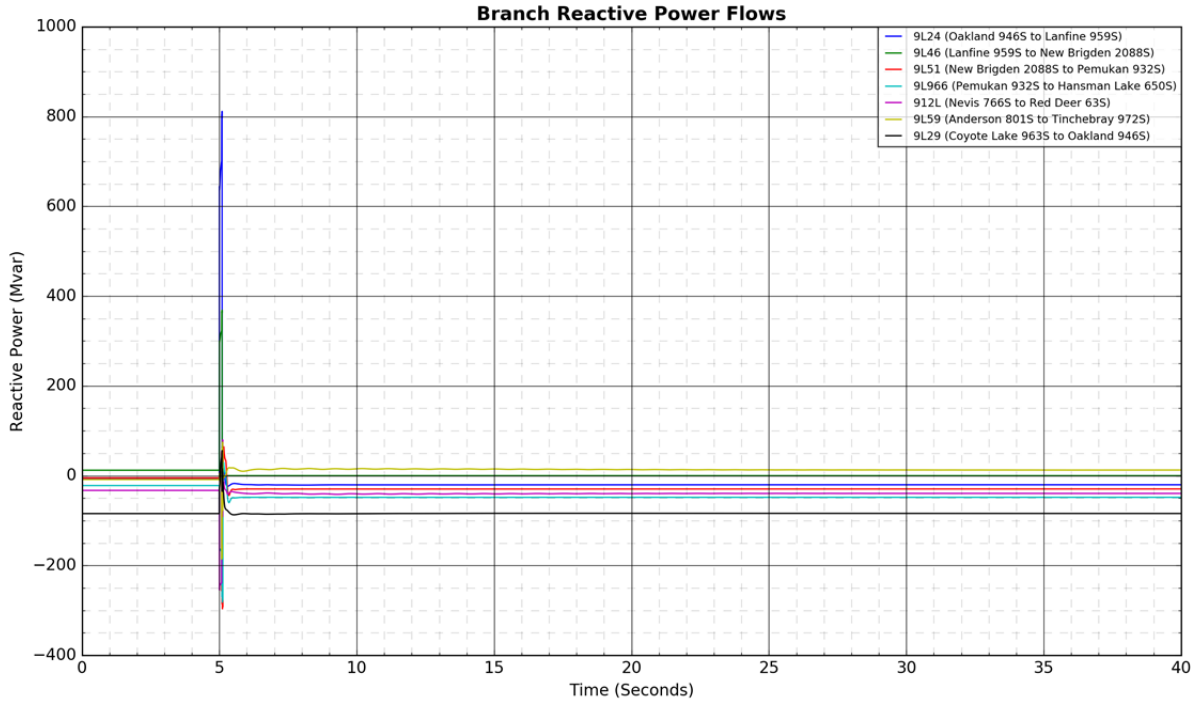
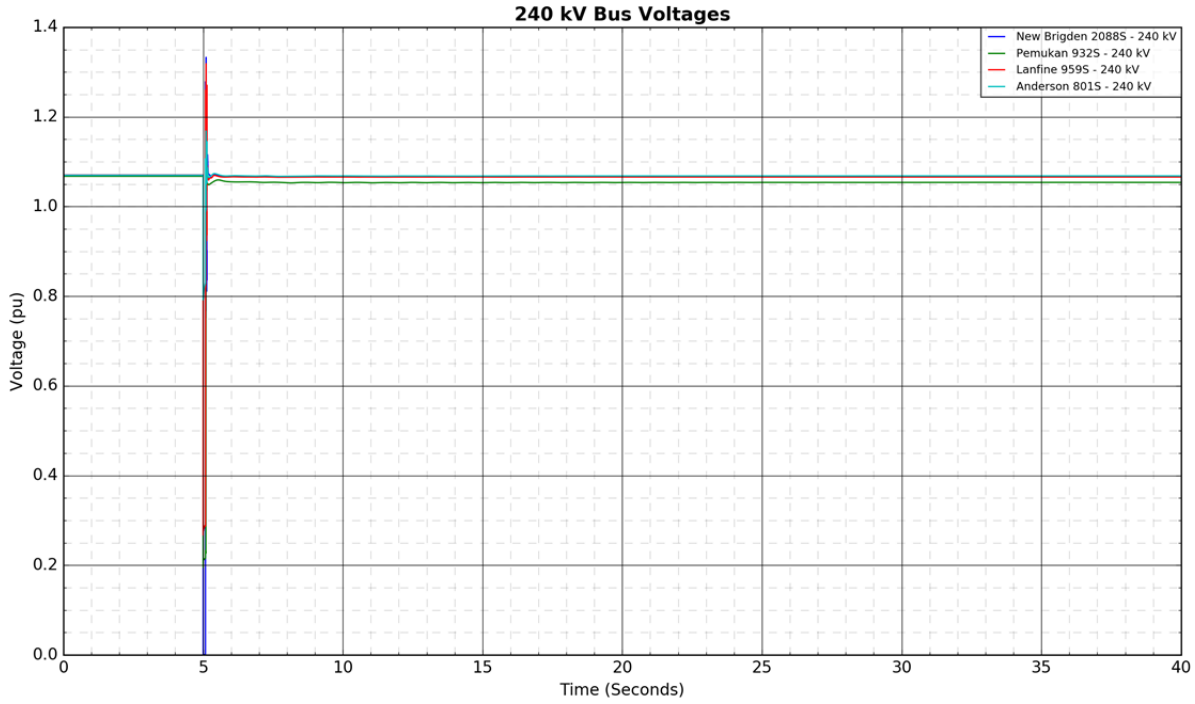
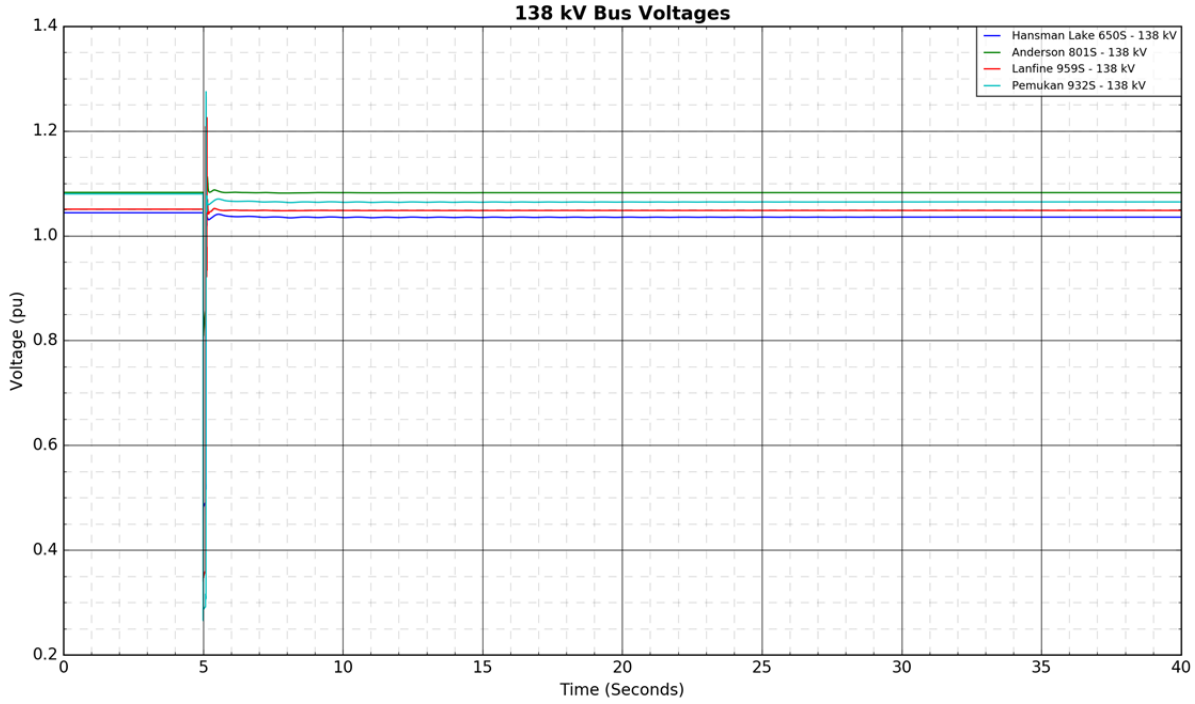
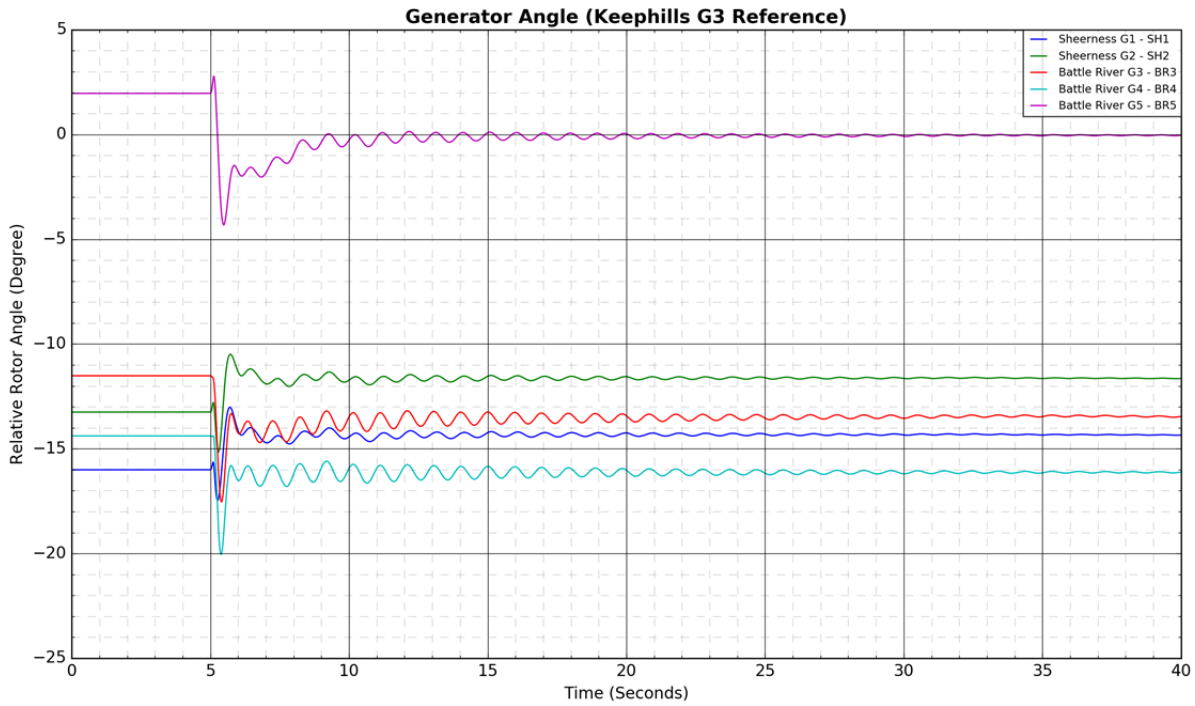
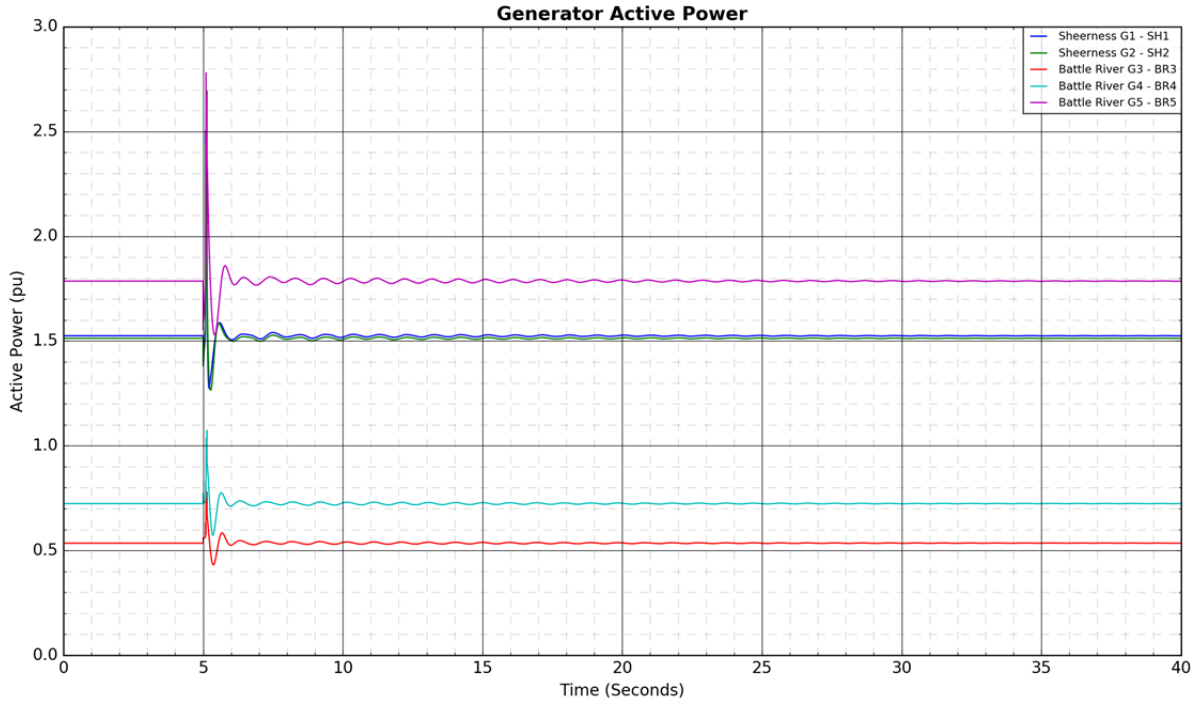

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

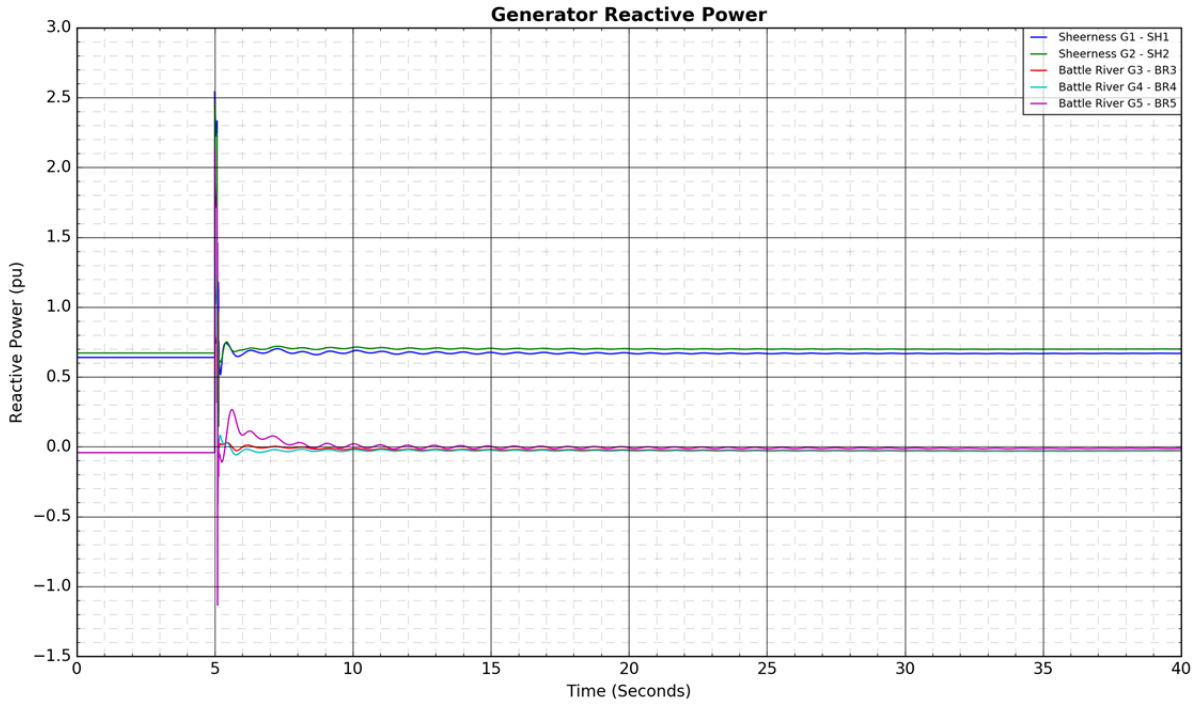
Figure A4-5: 9L51 New Brigden 2088S to Pemukan 932S: Fault Near New Brigden 2088S

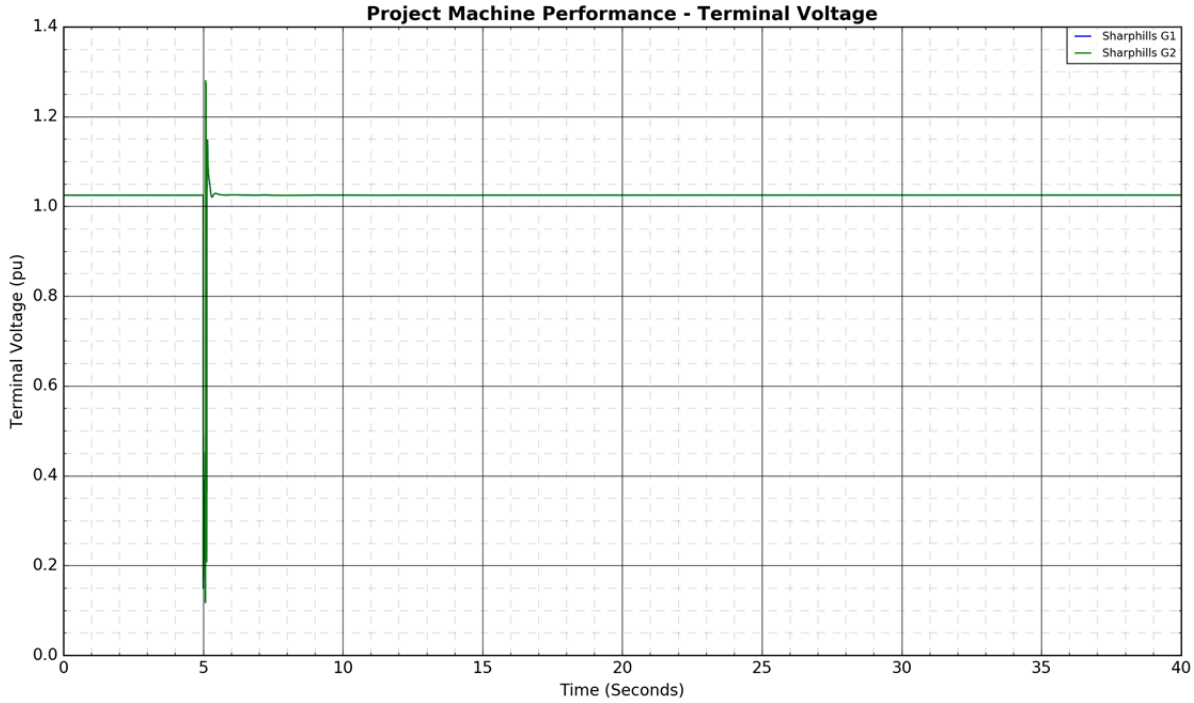


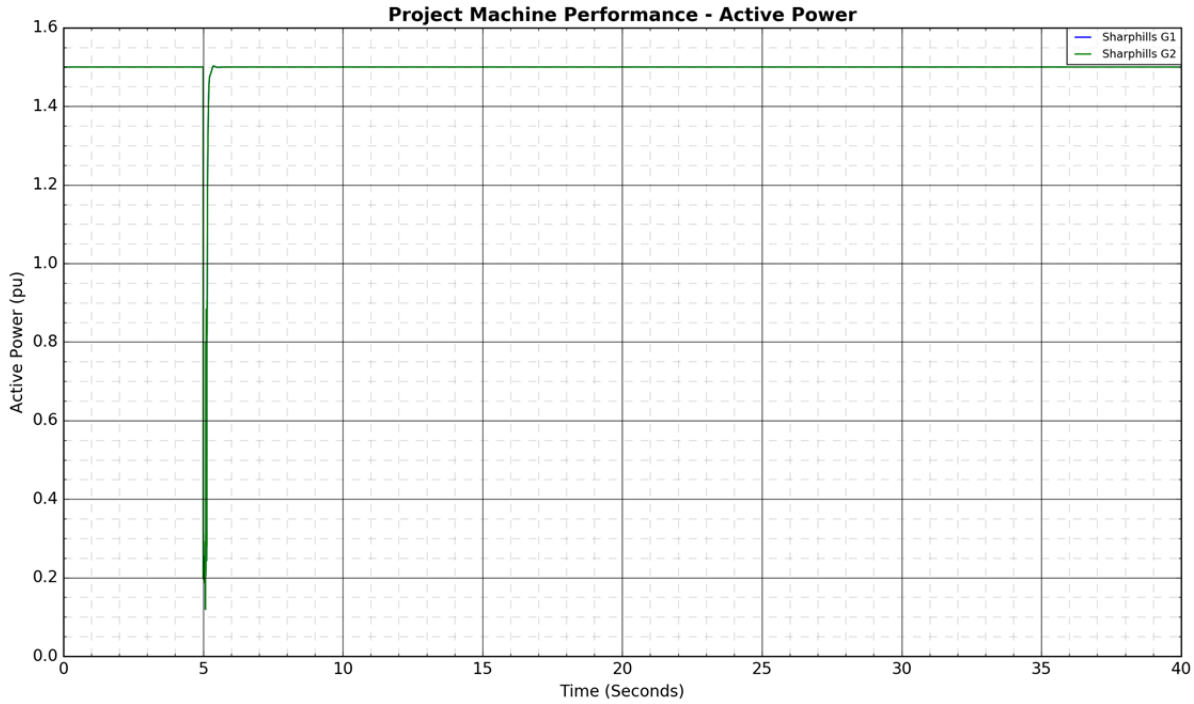


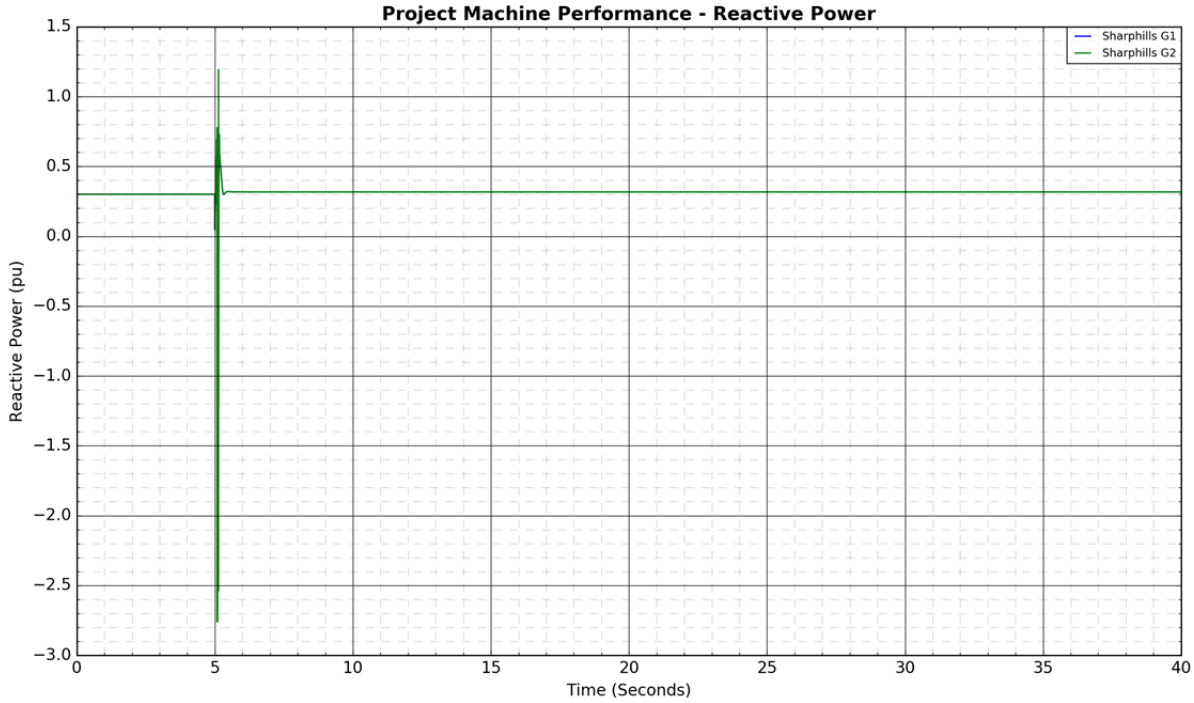

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
5
0
−5
−10
−15
−20
−25
0
5
10
15
20
25
30
35
40

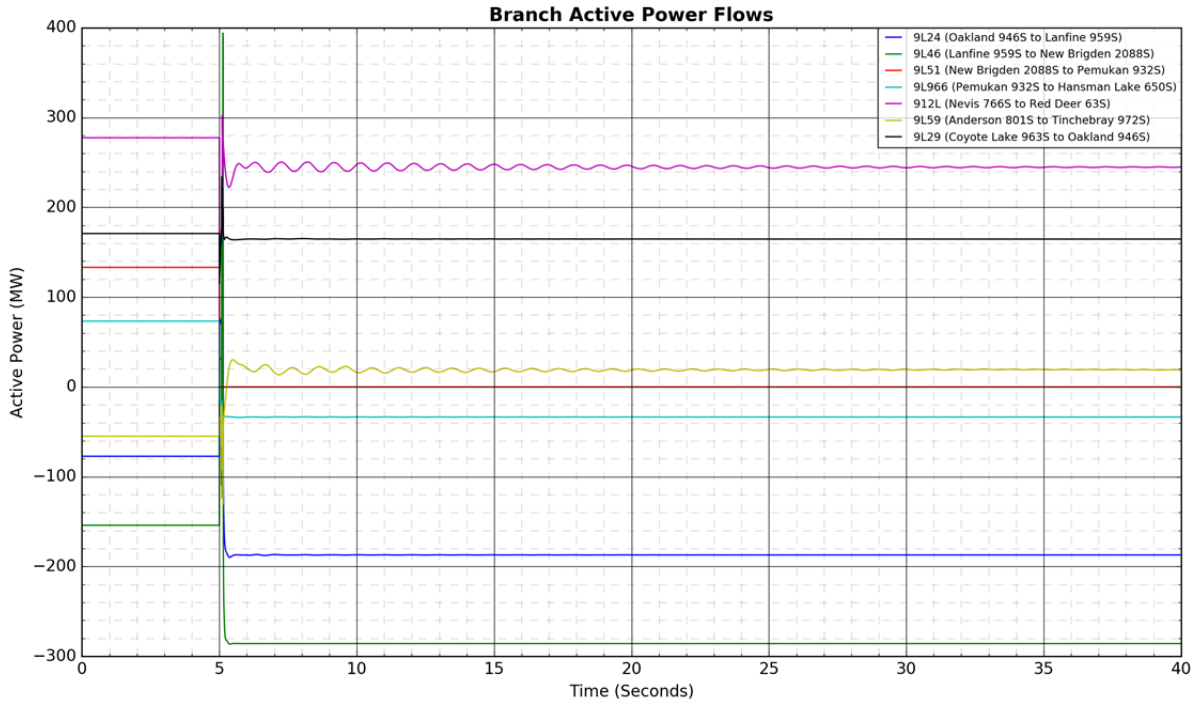

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

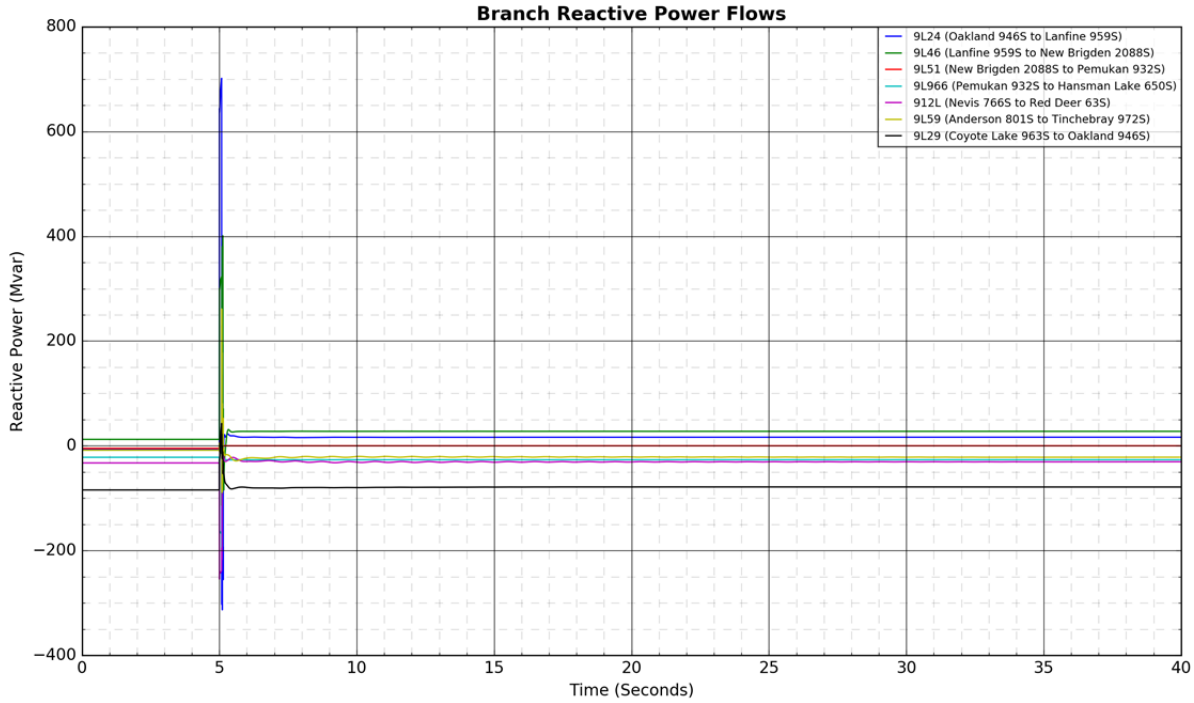
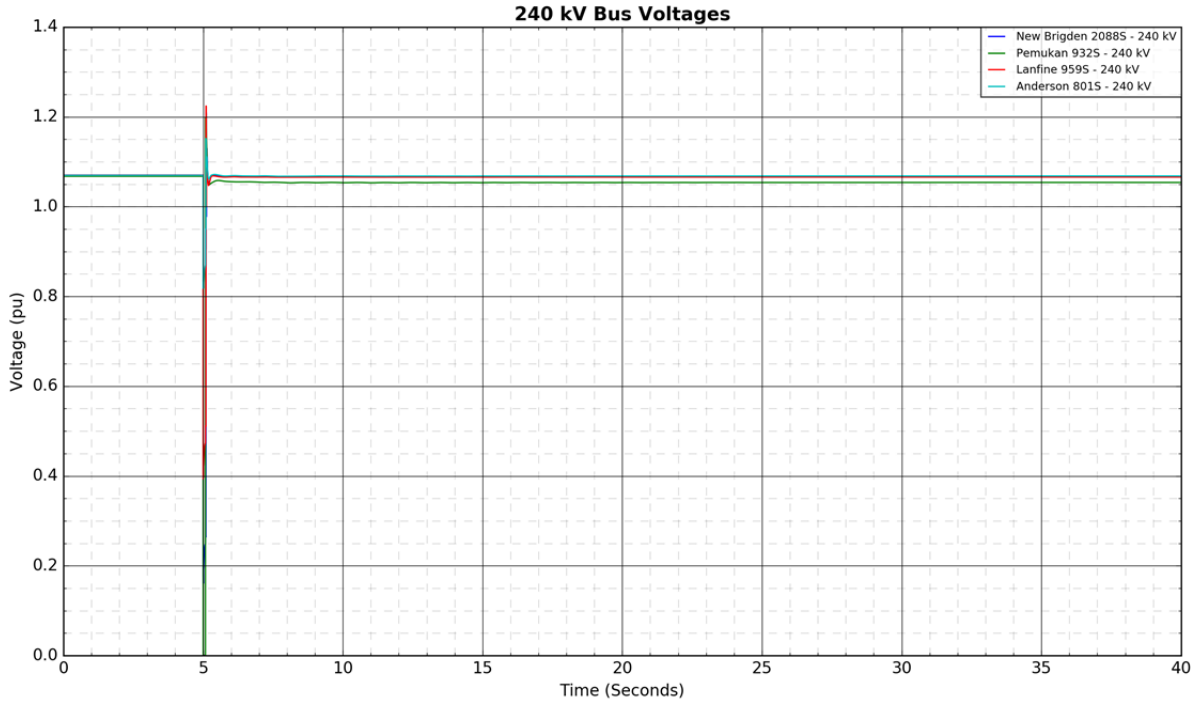
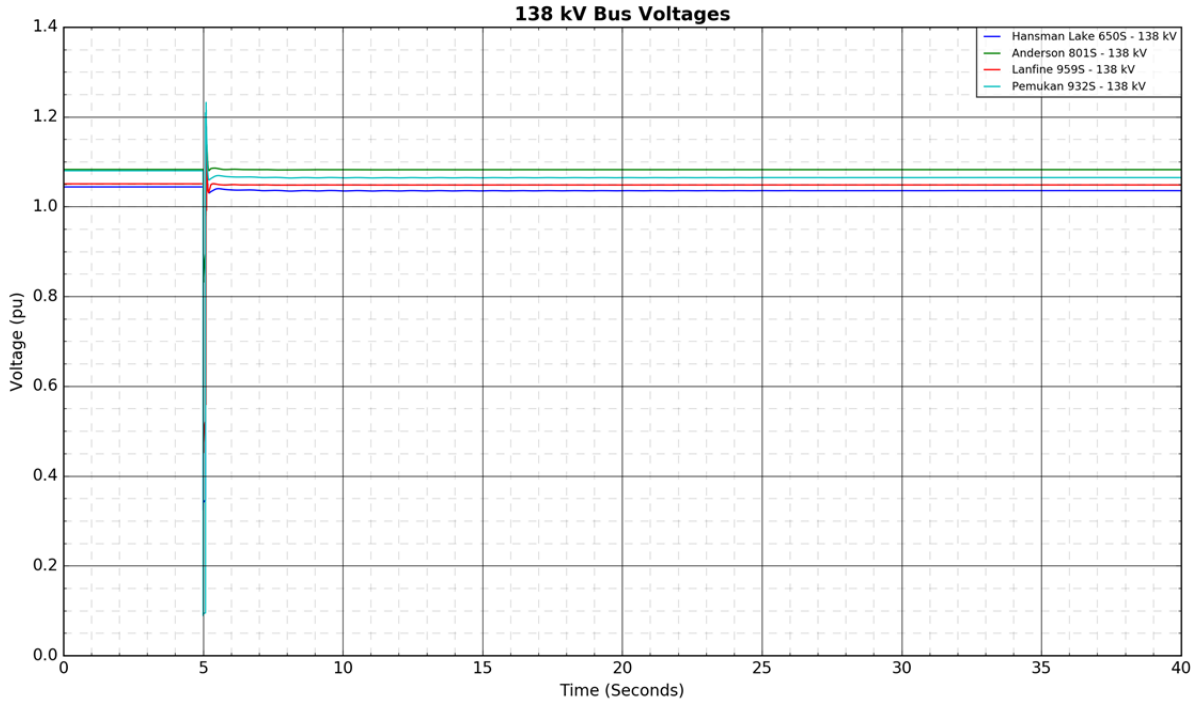
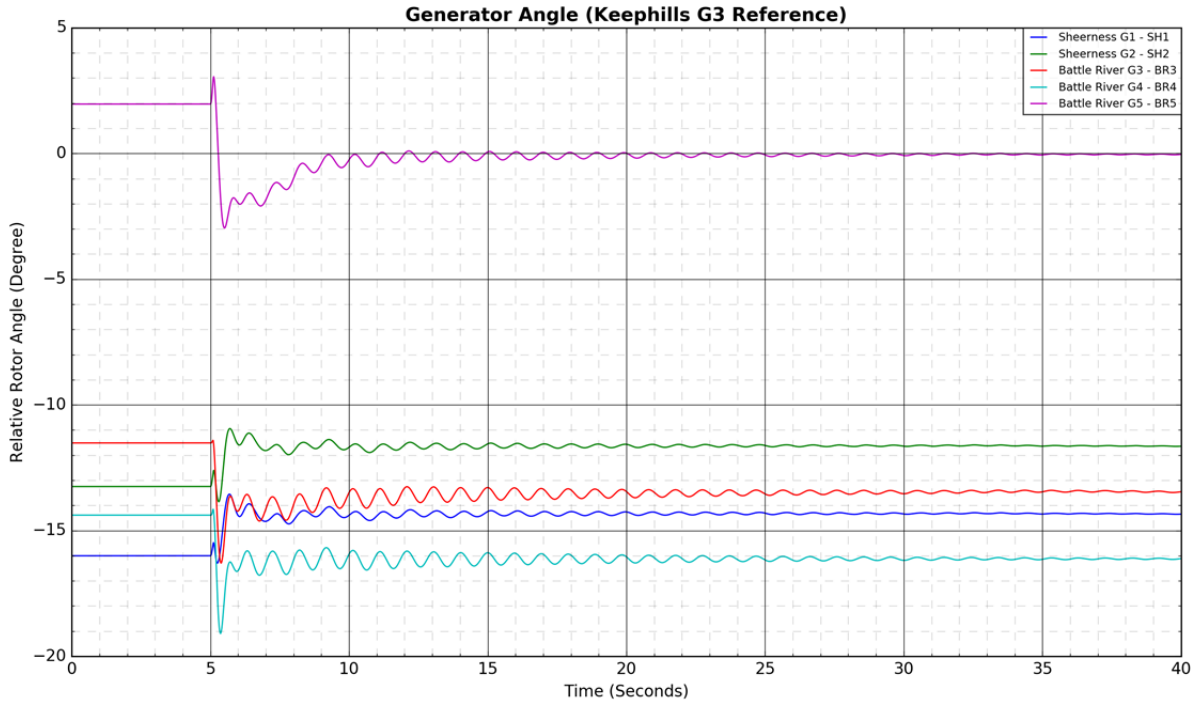
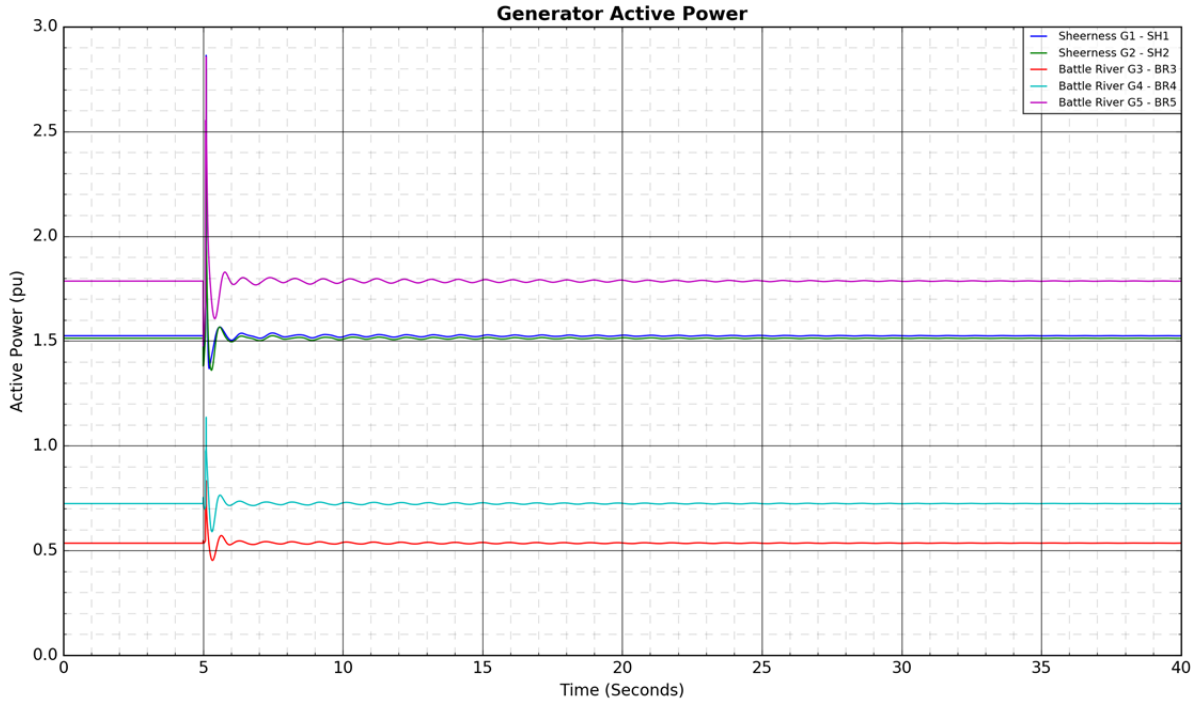

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

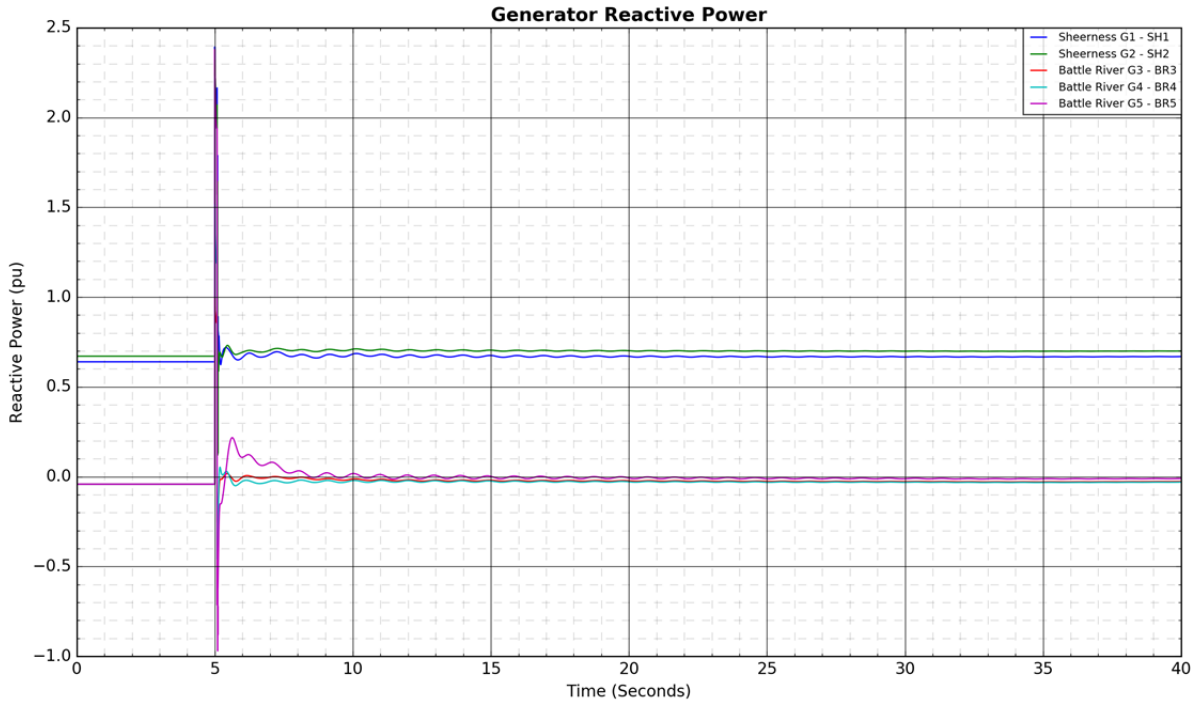
Figure A4-6: 9L51 New Brigden 2088S to Pemukan 932S: Fault Near Pemukan 932S

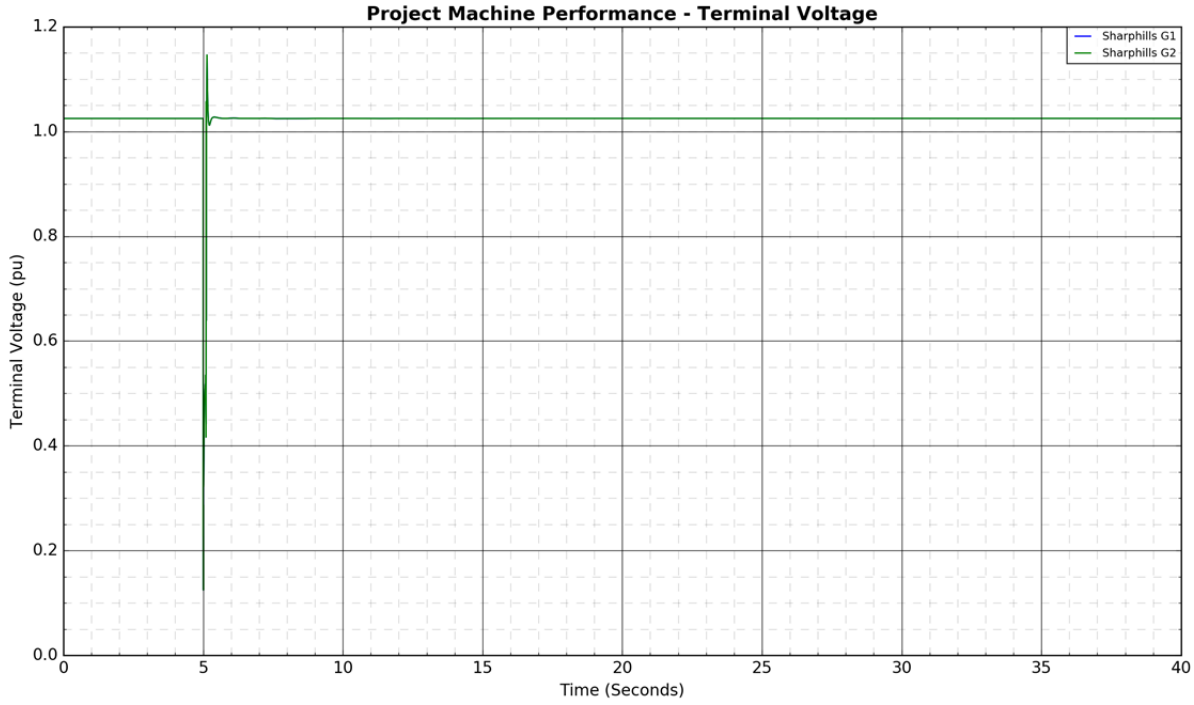


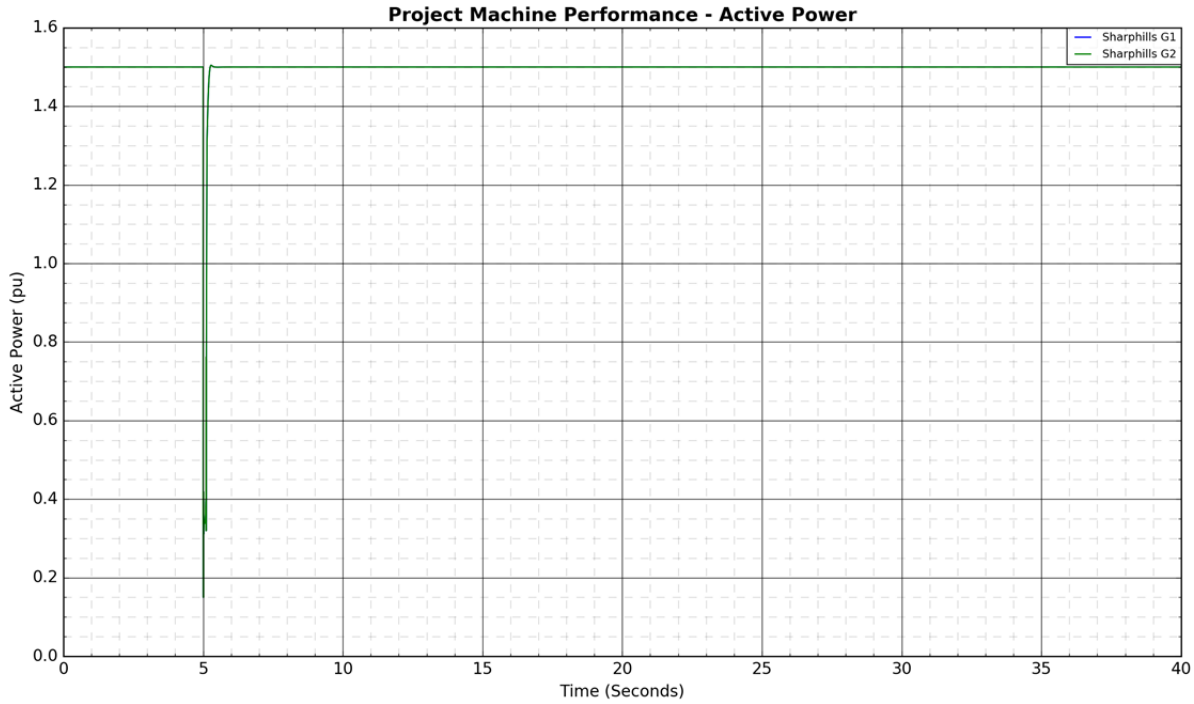


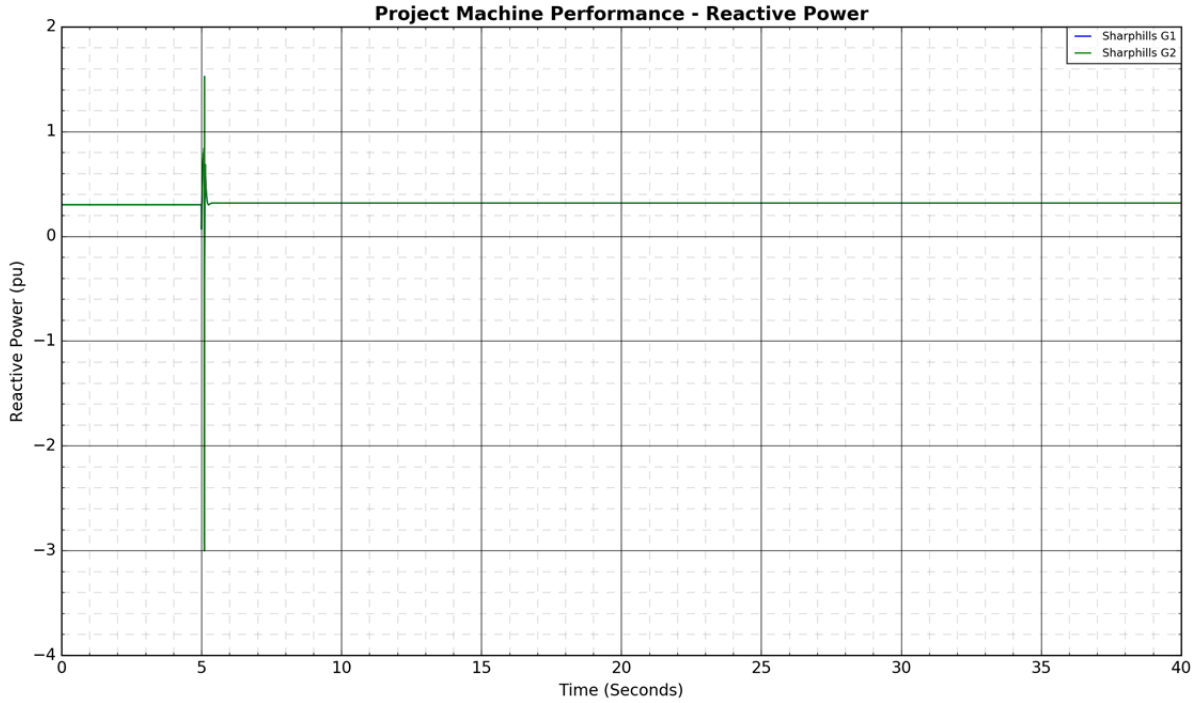

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
5
0
−5
−10
−15
−20
0
5
10
15
20
25
30
35
40

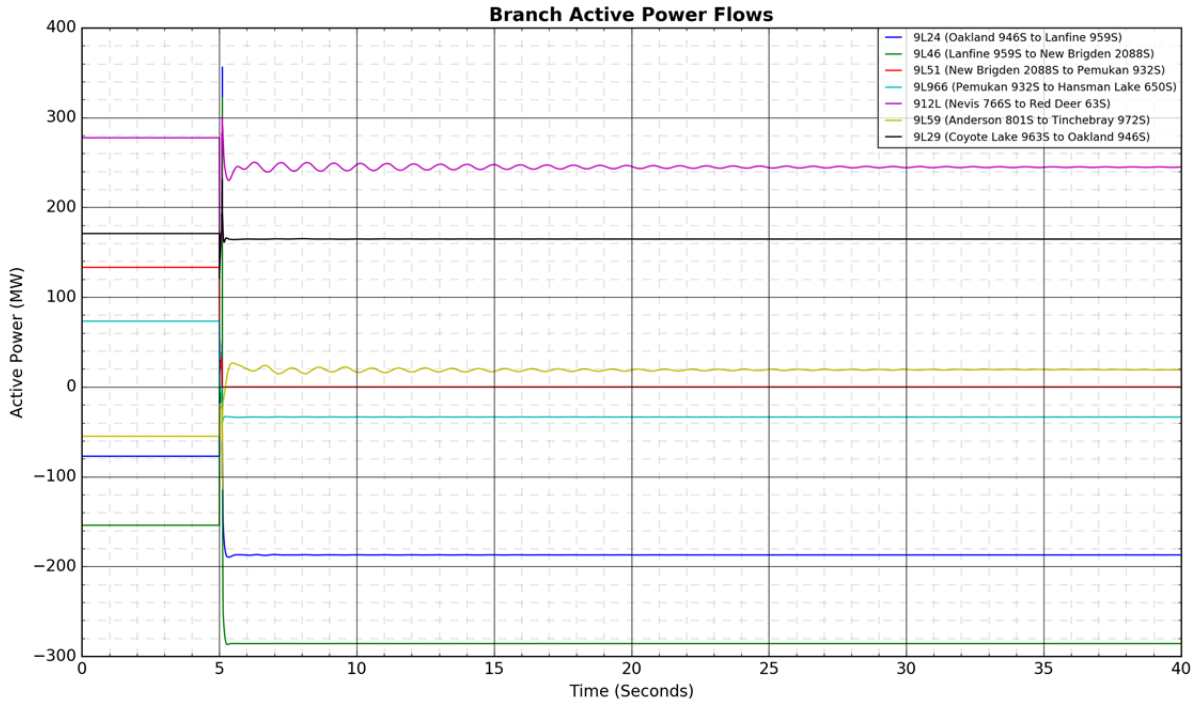

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
2
1
0
−1
−2
−3
−4
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

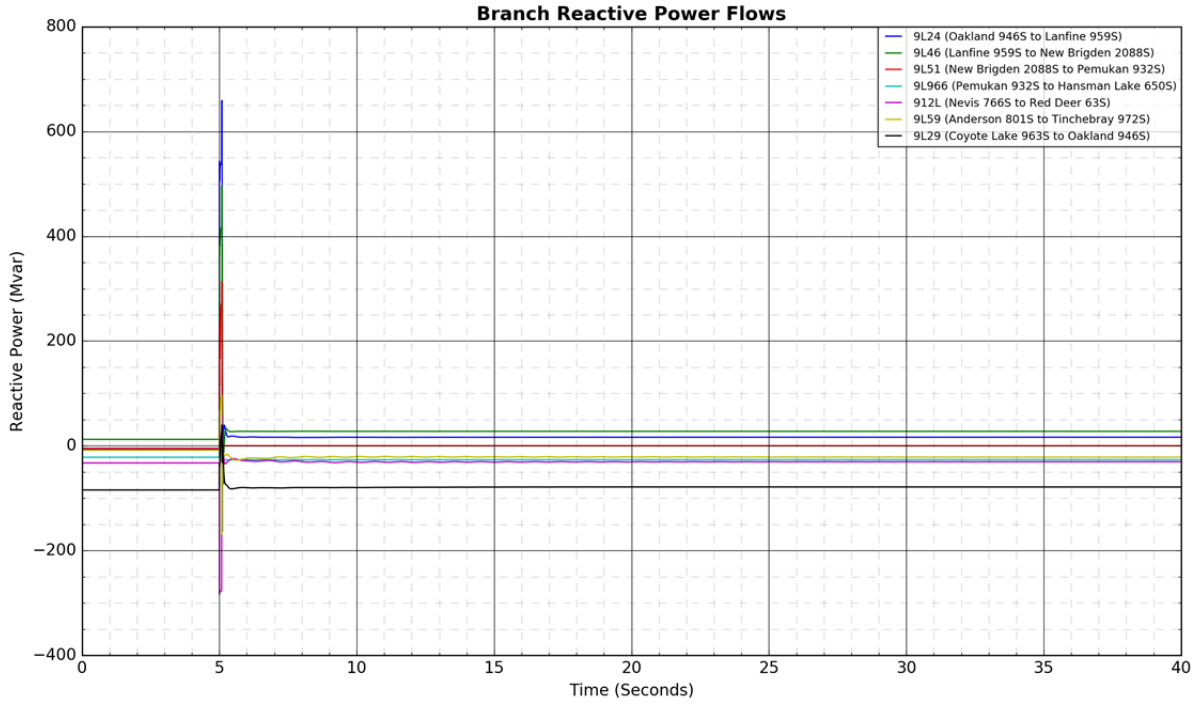
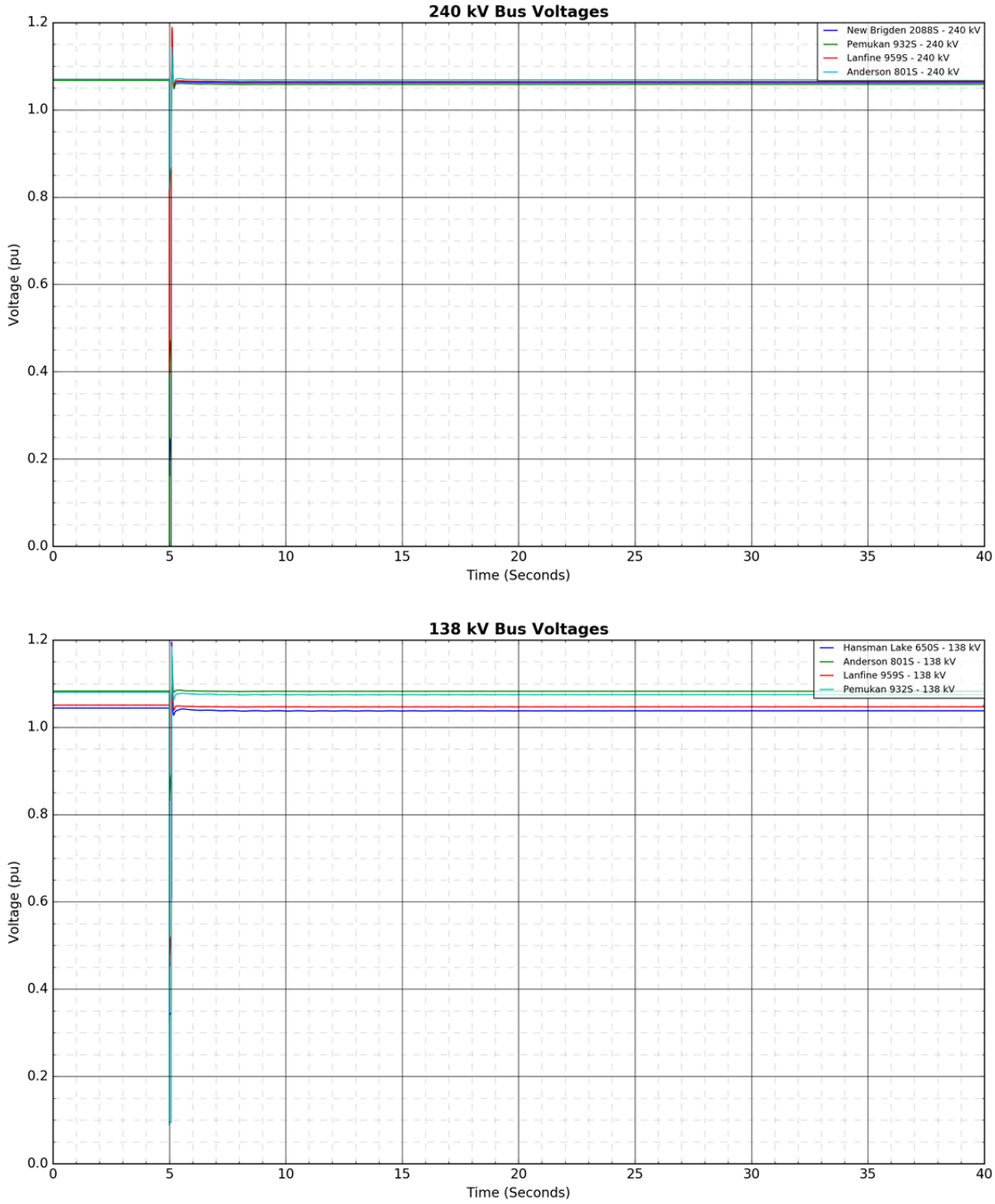
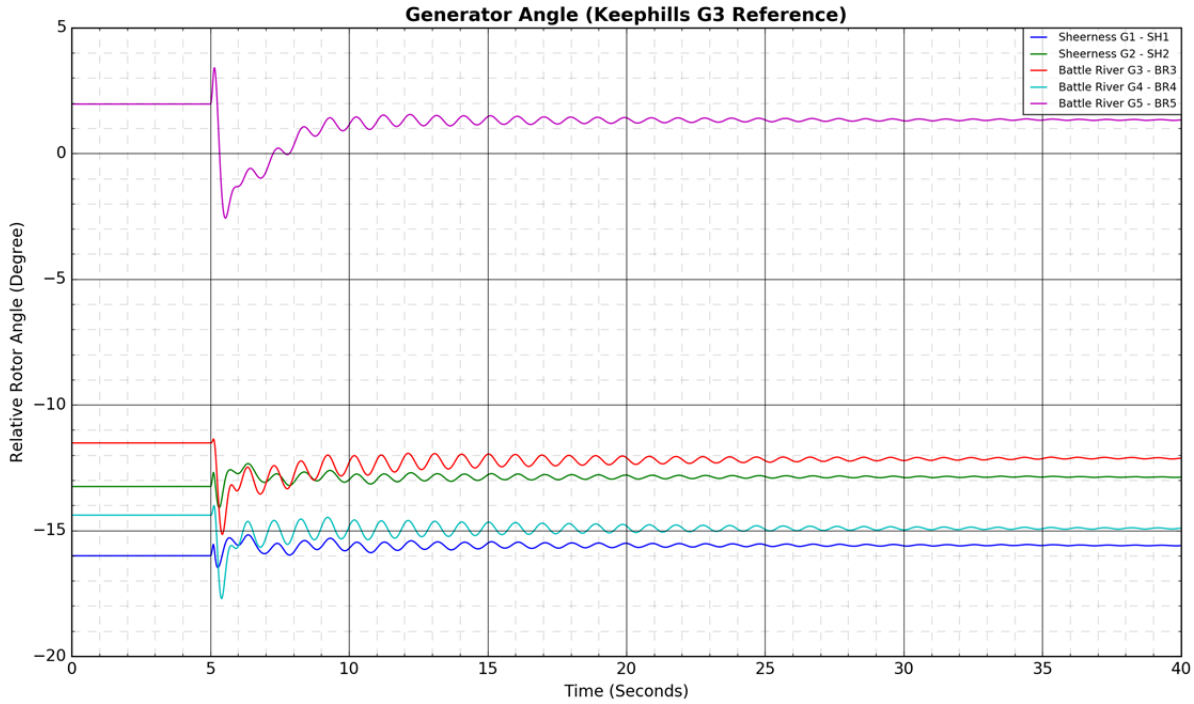
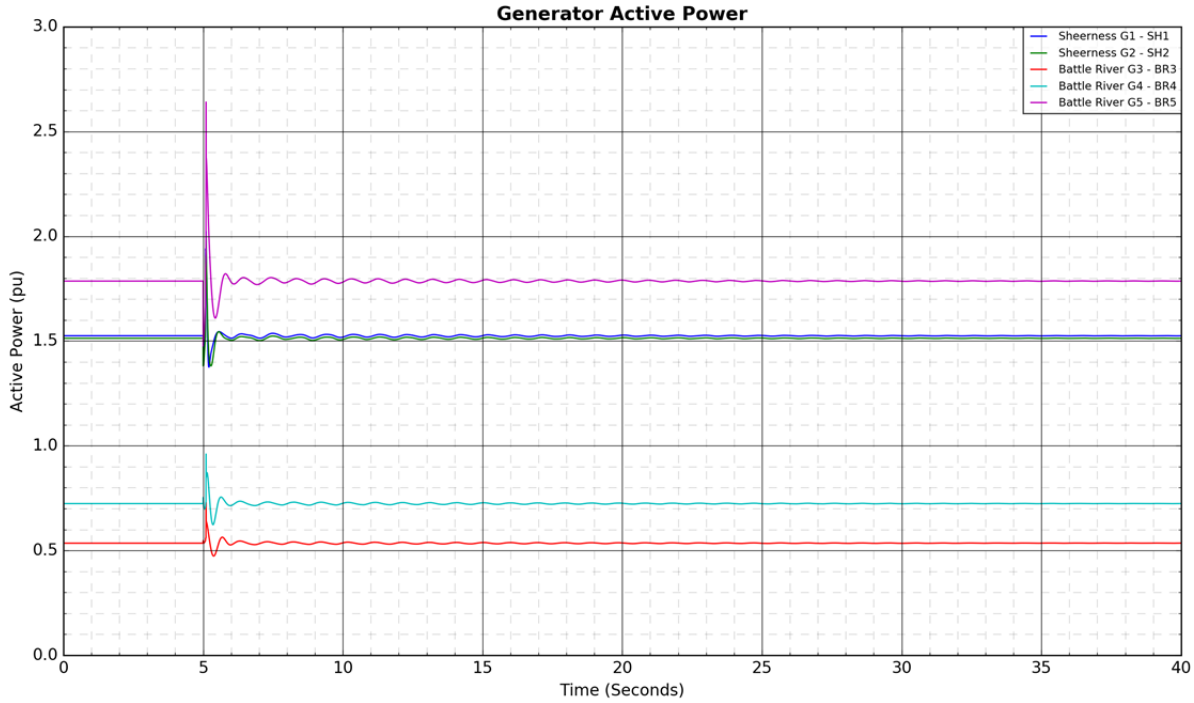
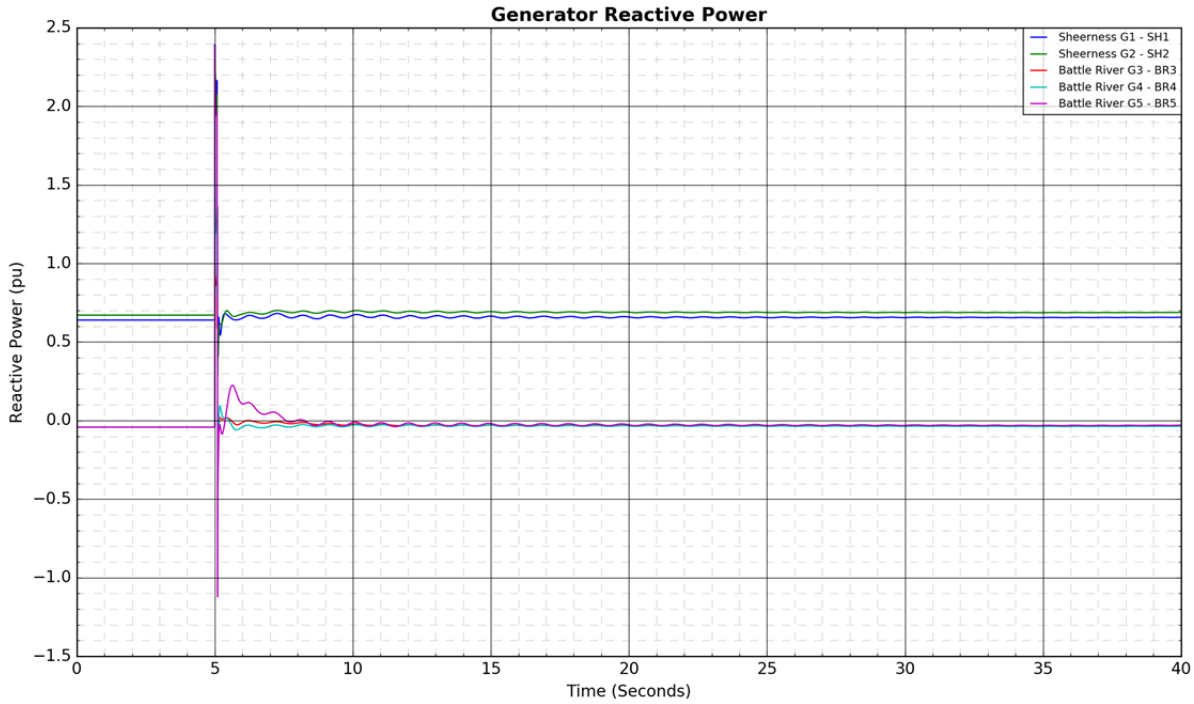

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

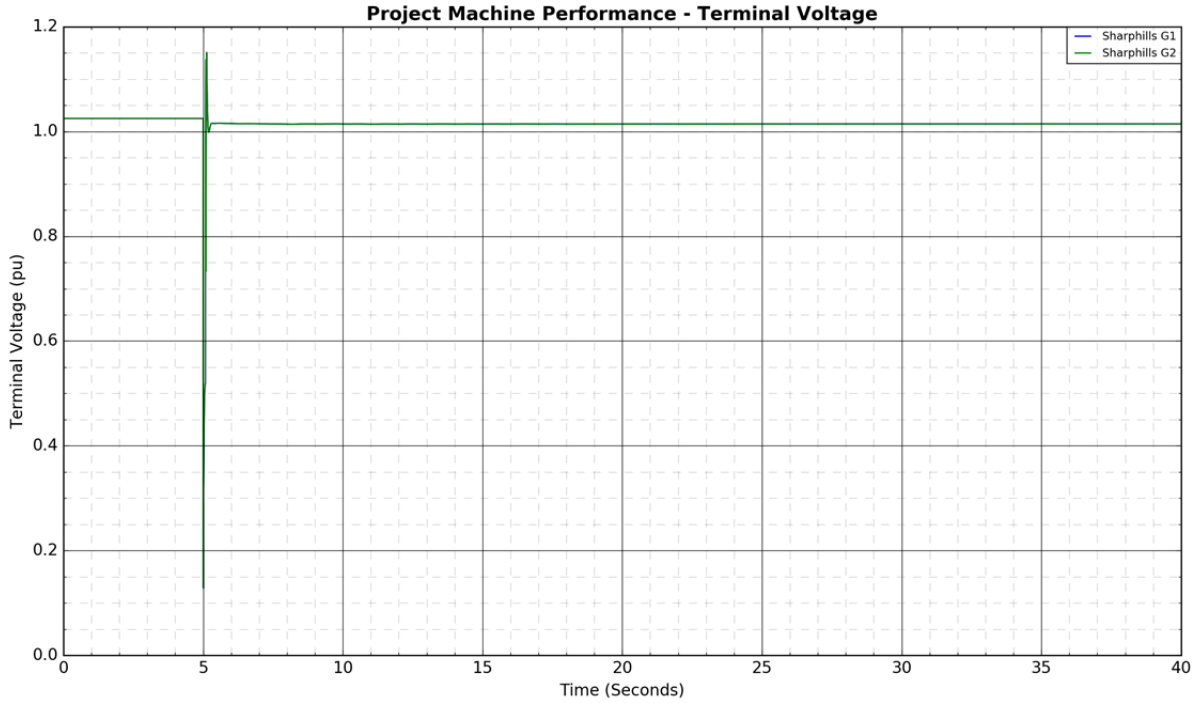
Figure A4-7: 9L966 Pemukan 932S to Hansman Lake 650S: Fault Near Pemukan 932S

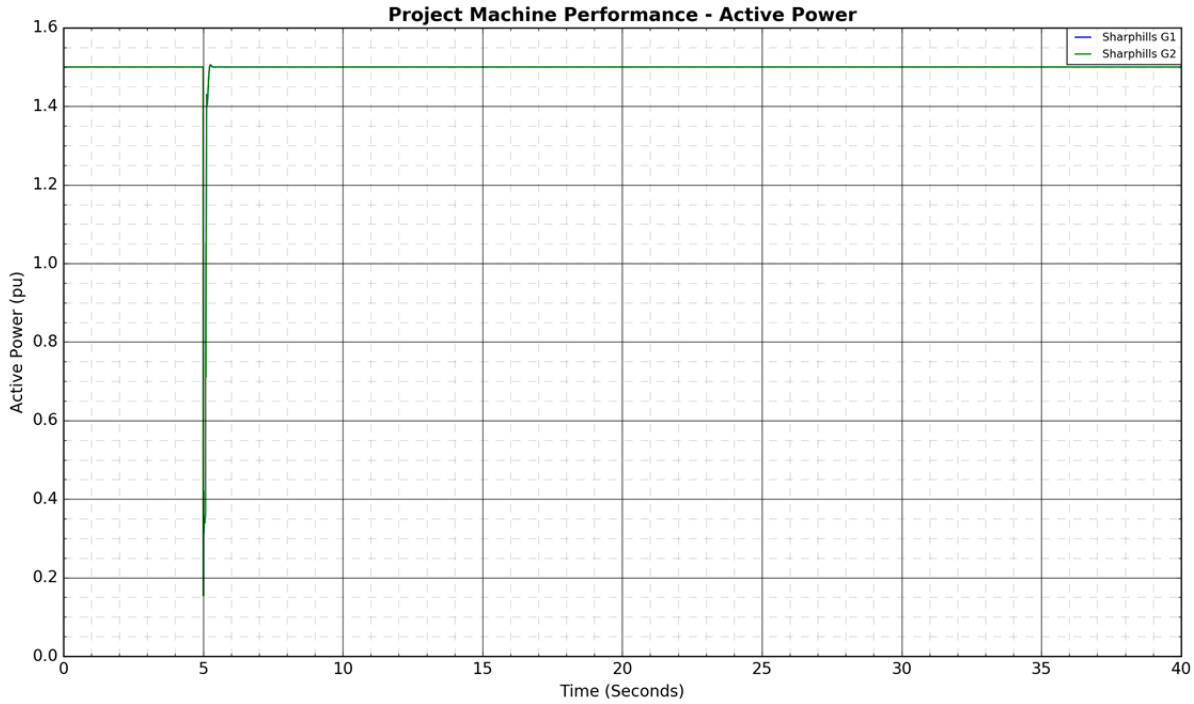


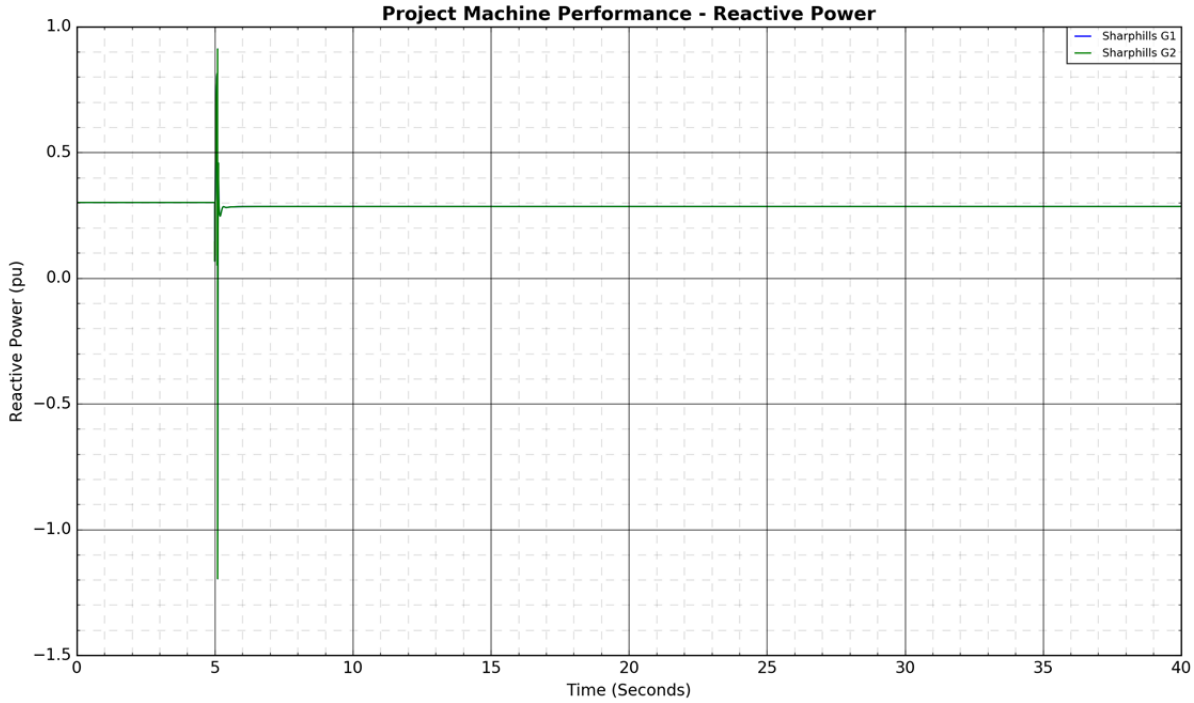

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
5
0
−5
−10
−15
−20
0
5
10
15
20
25
30
35
40

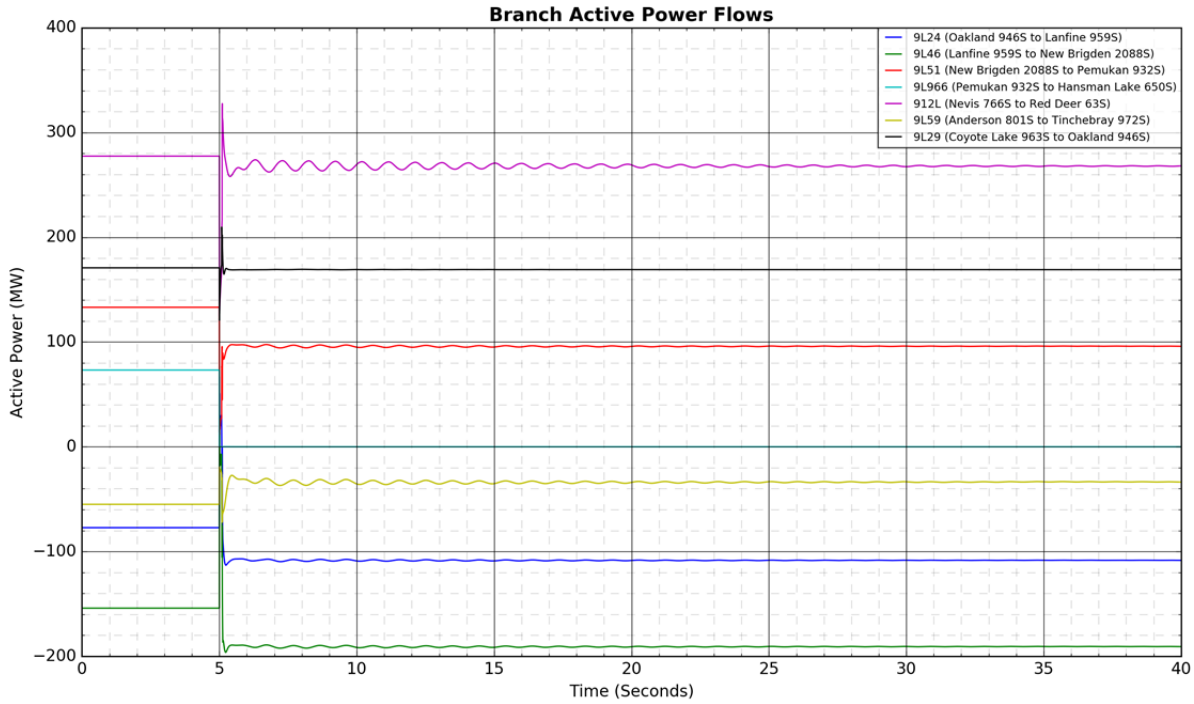

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

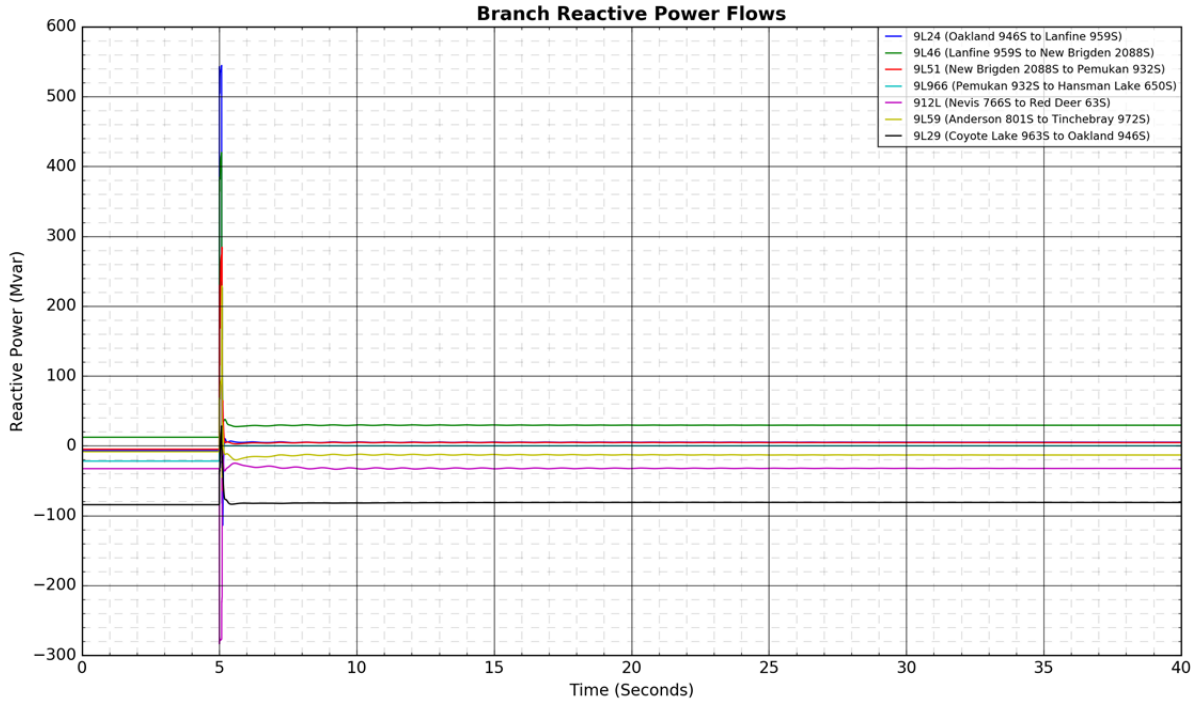
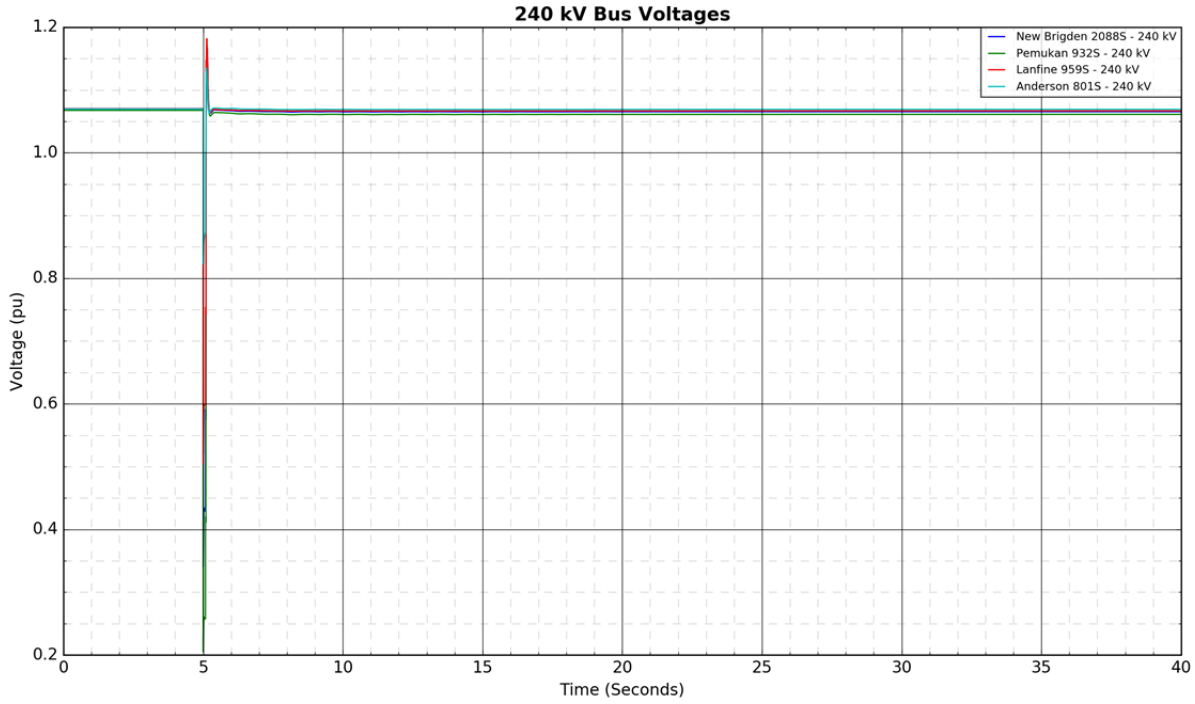
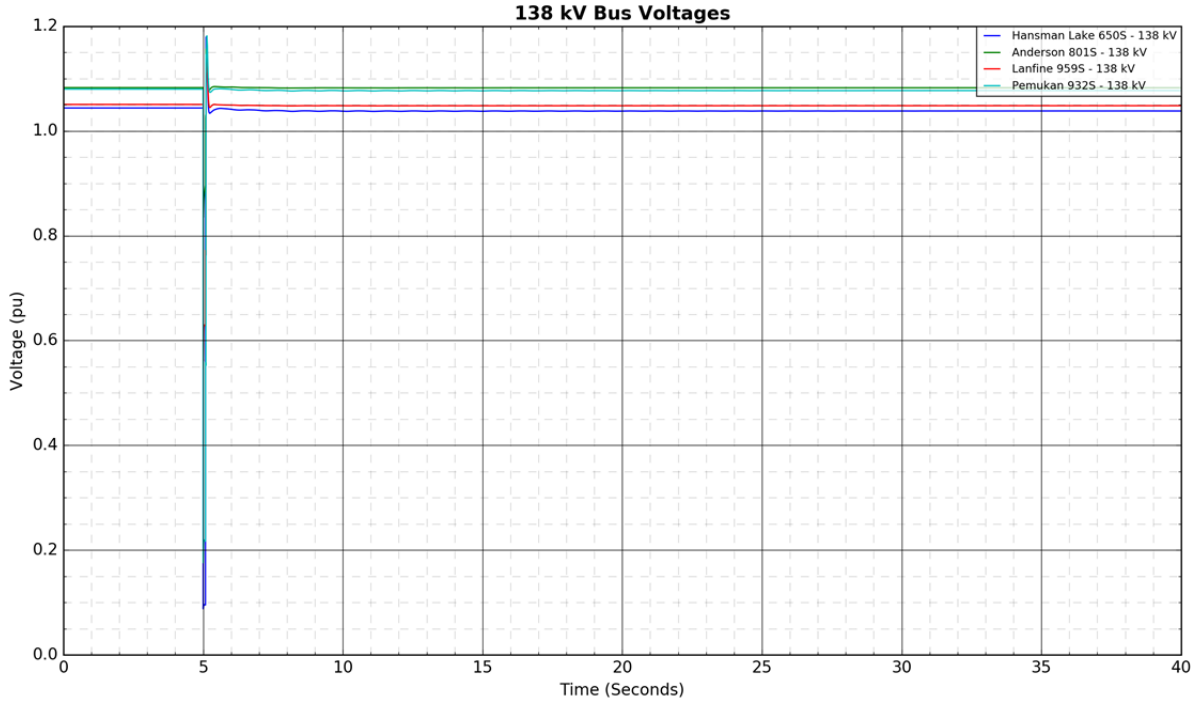
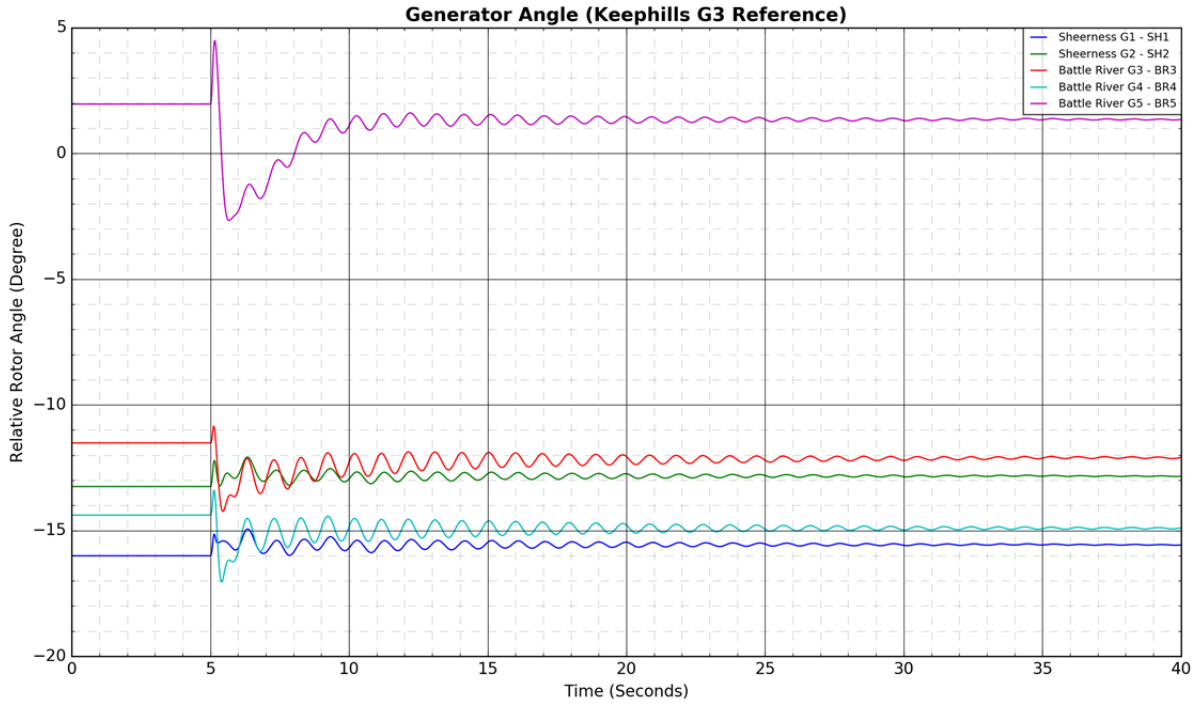
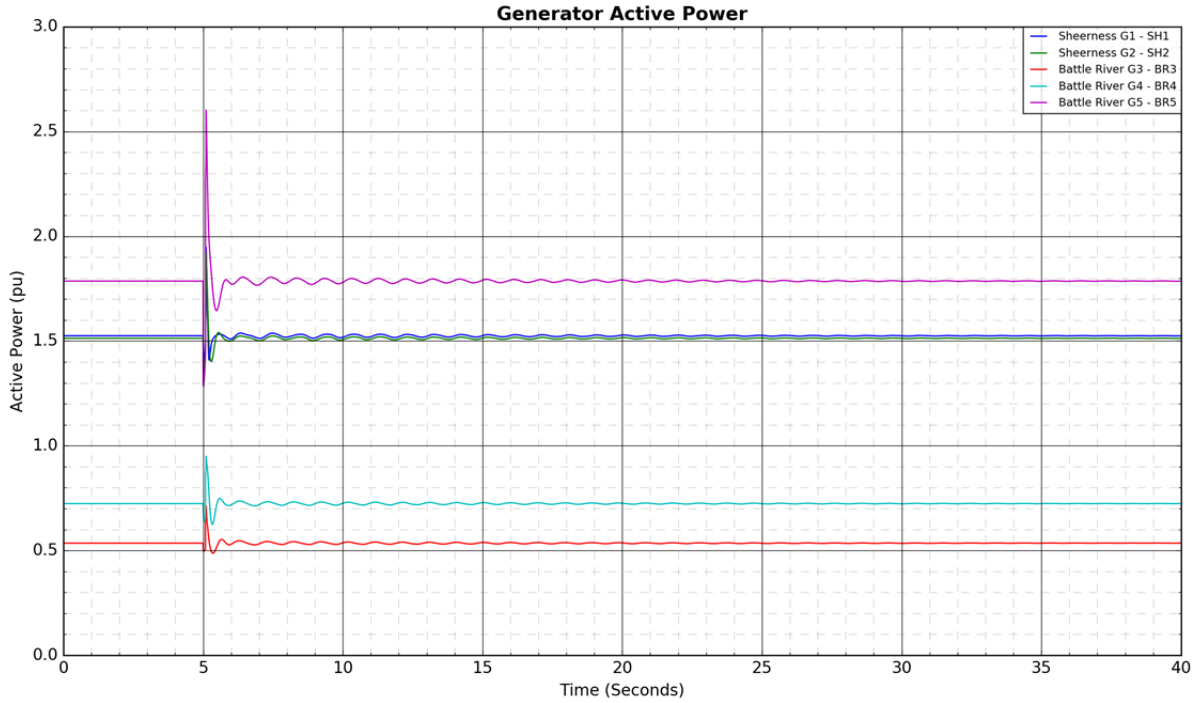

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

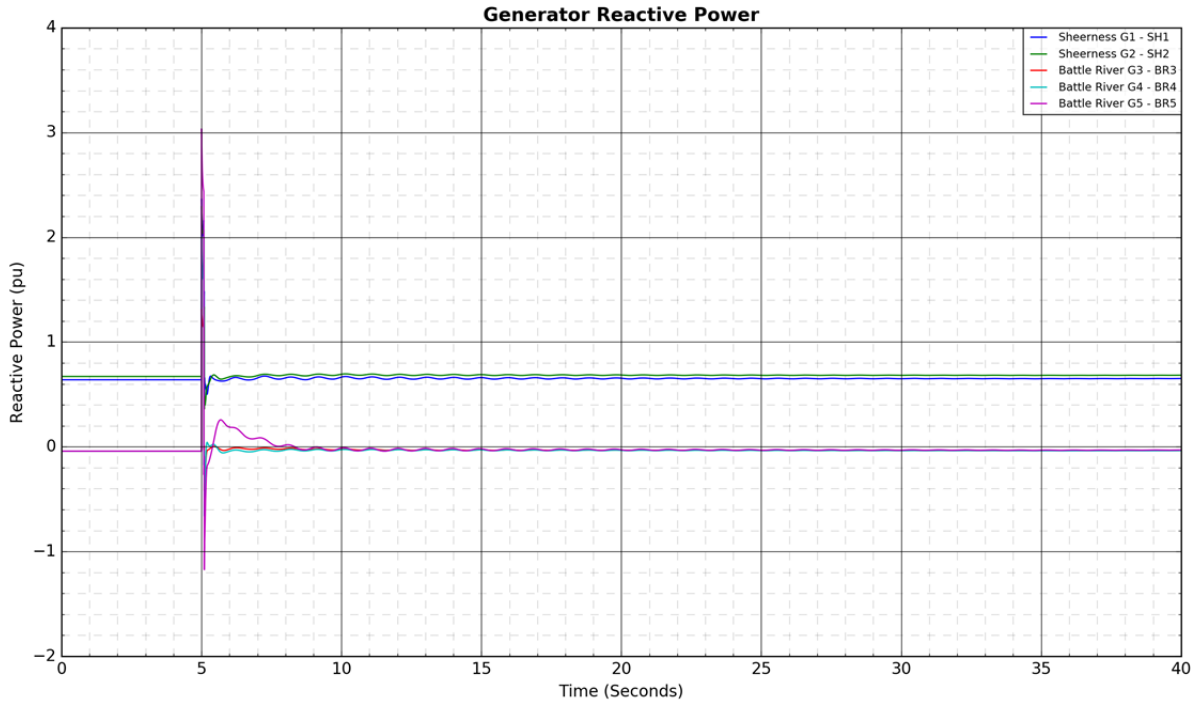
Figure A4-8: 9L966 Pemukan 932S to Hansman Lake 650S: Fault Near Hansman Lake 650S

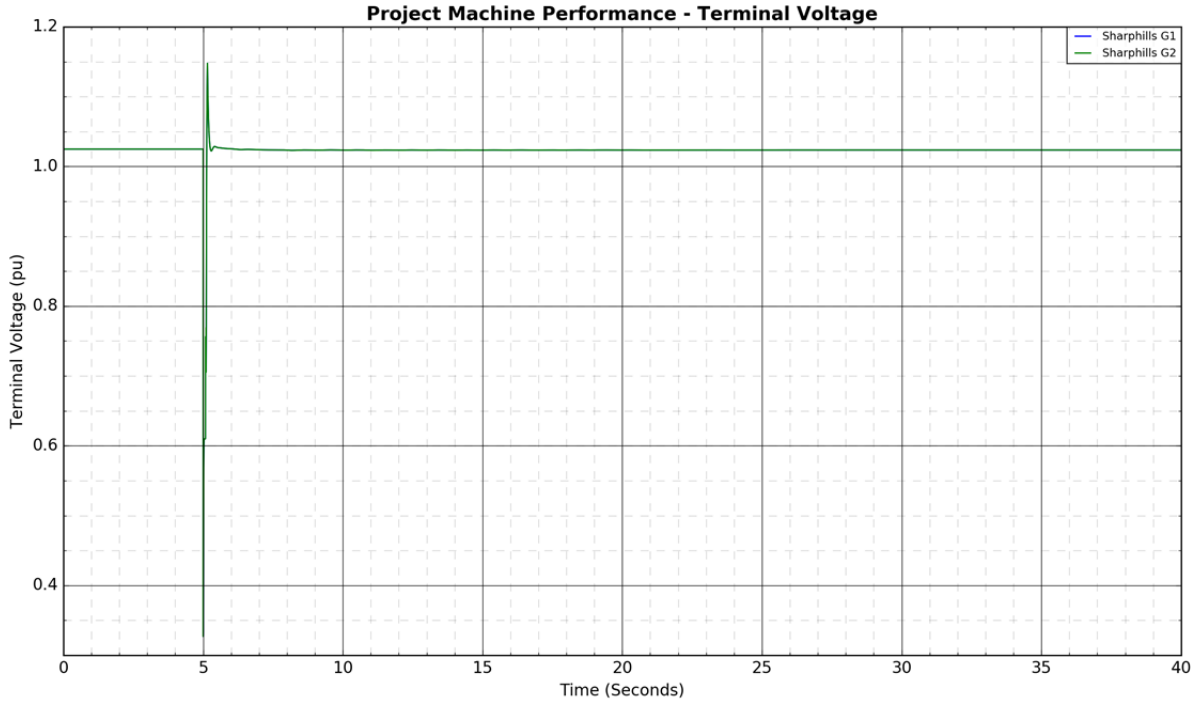


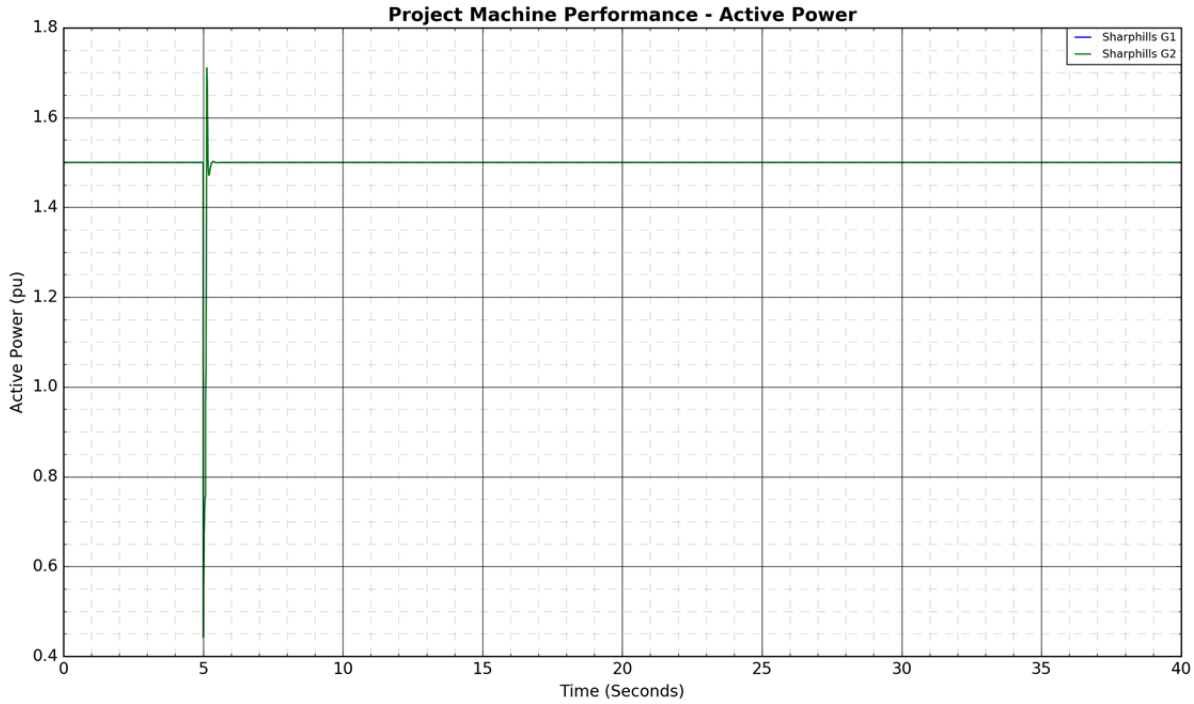


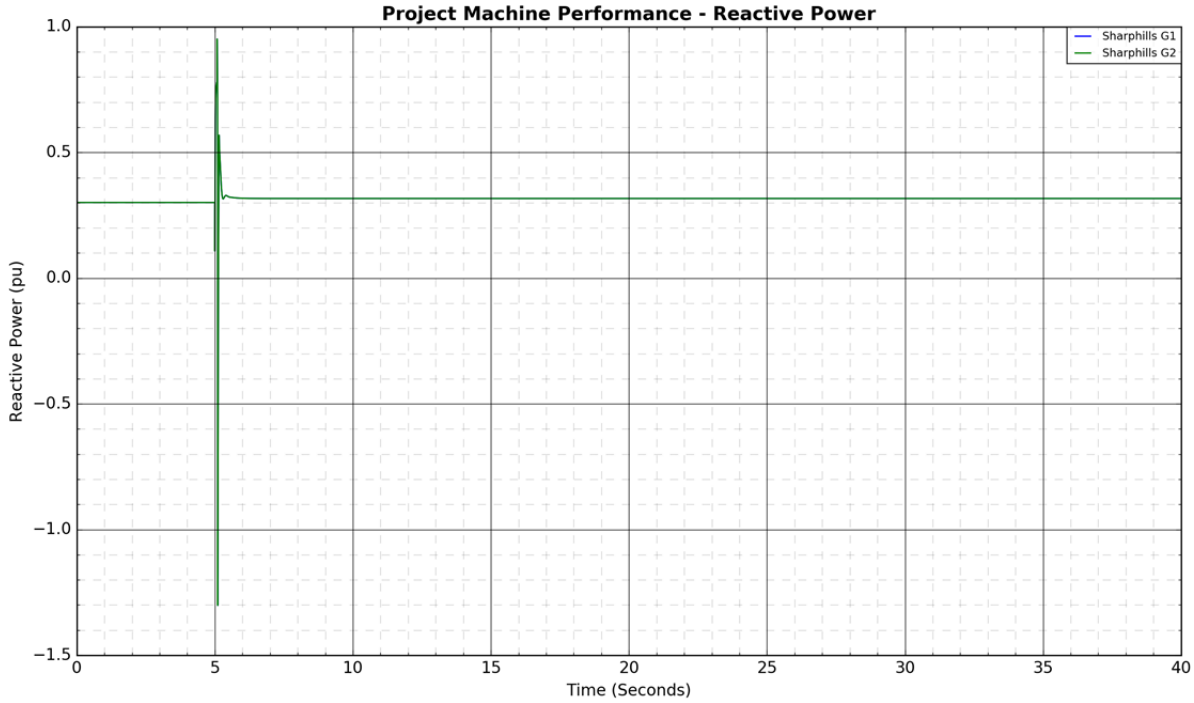

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

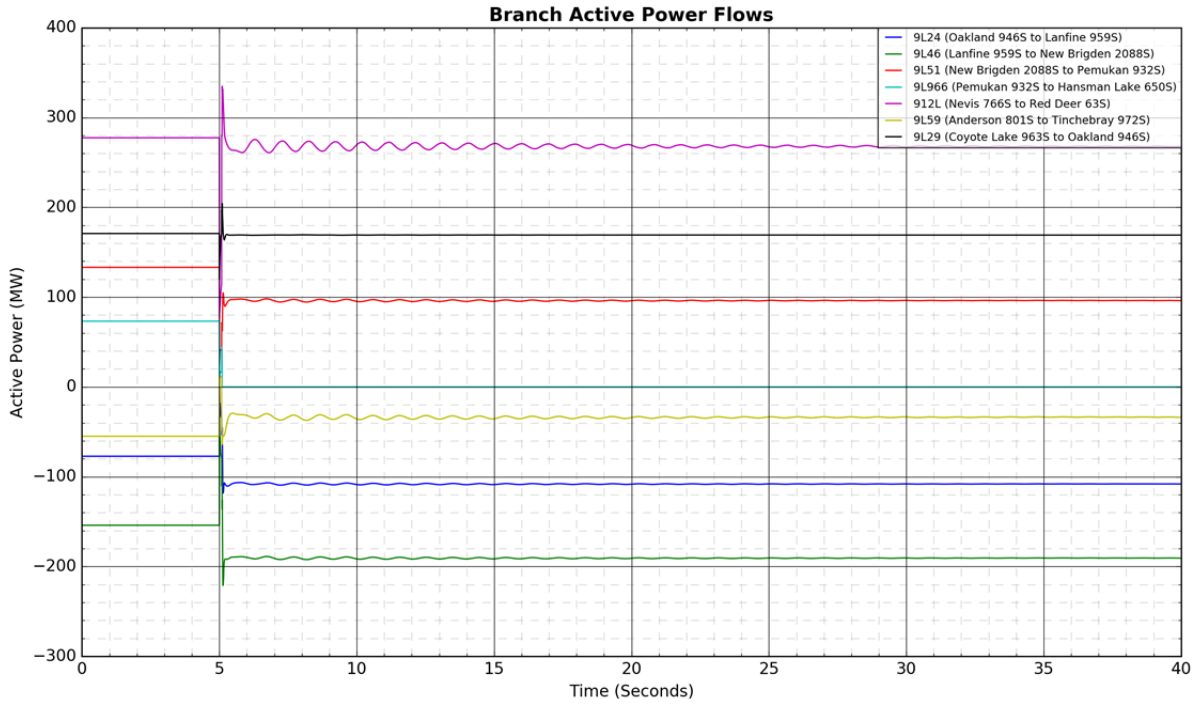

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active Power (pu)
Time (Seconds)
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
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

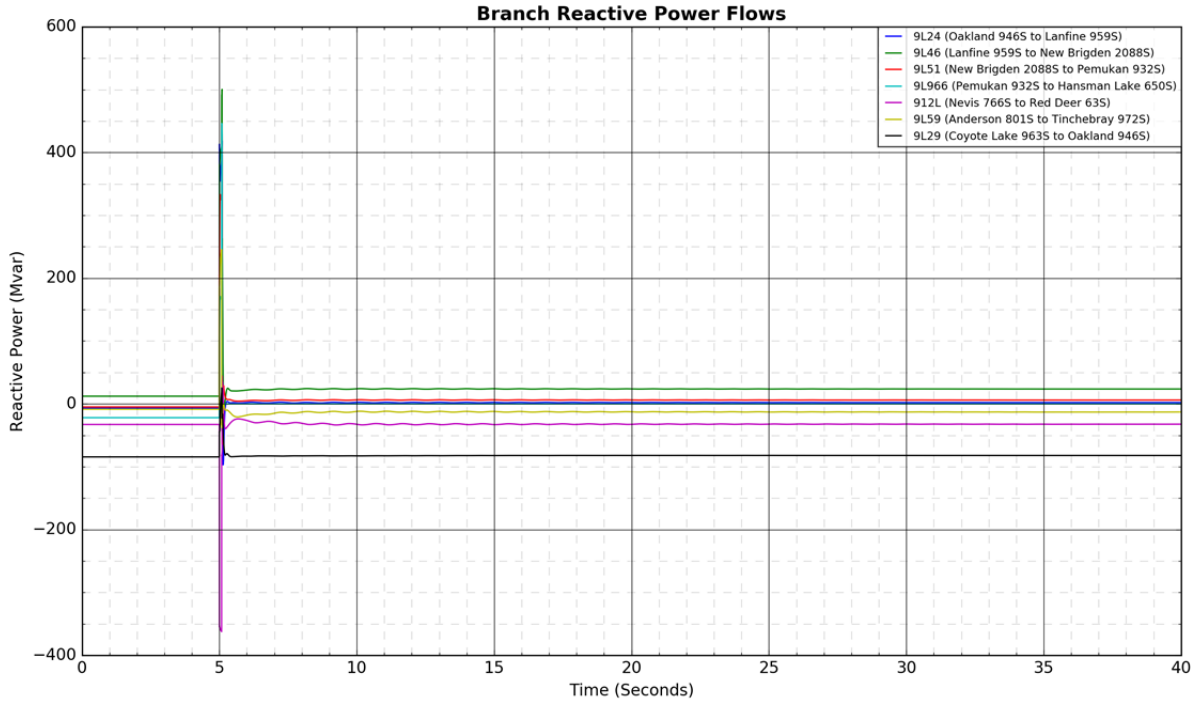
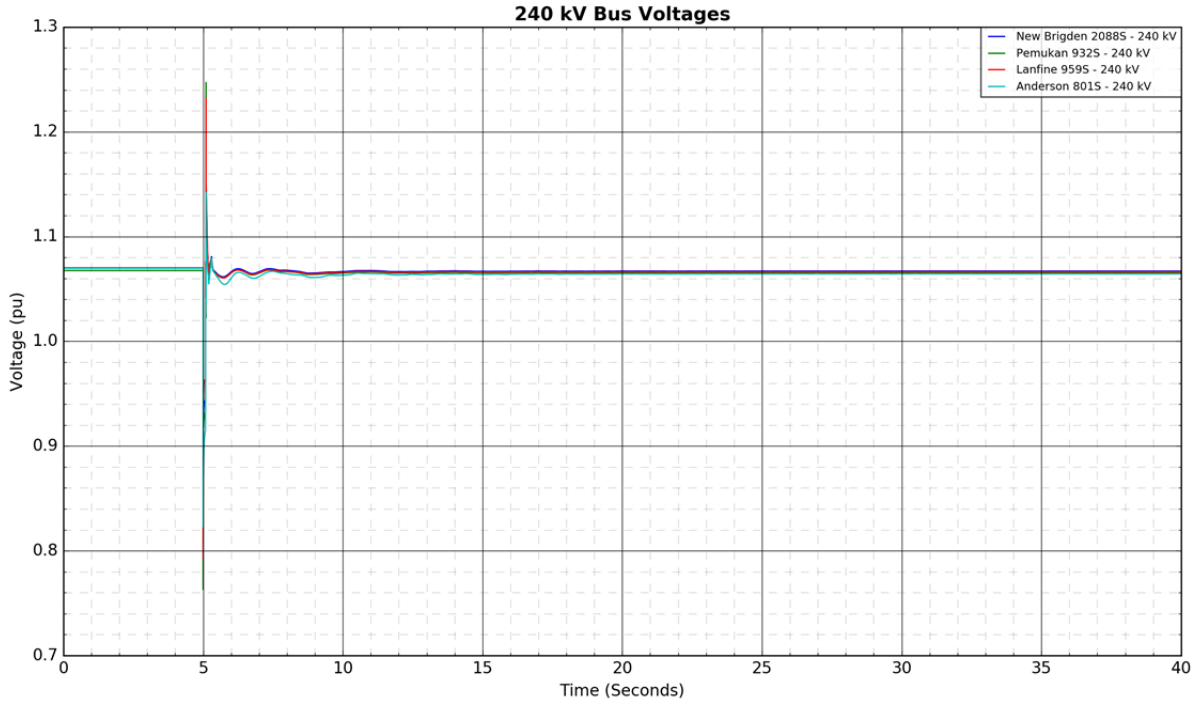
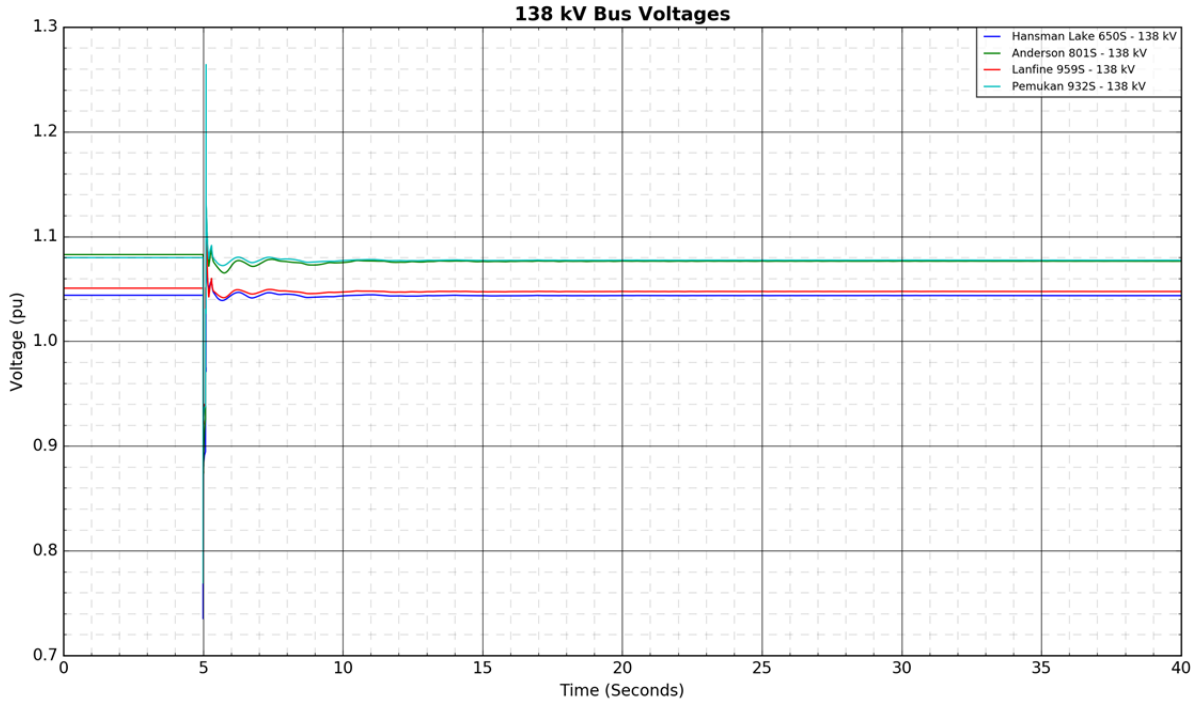
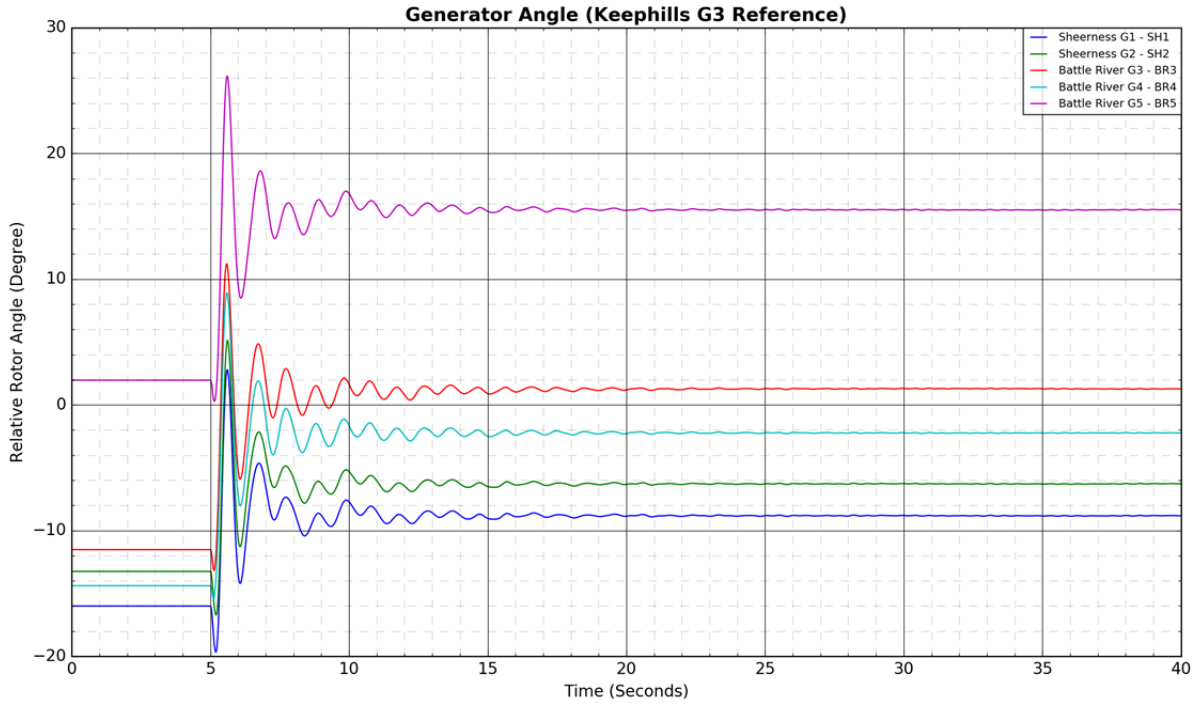
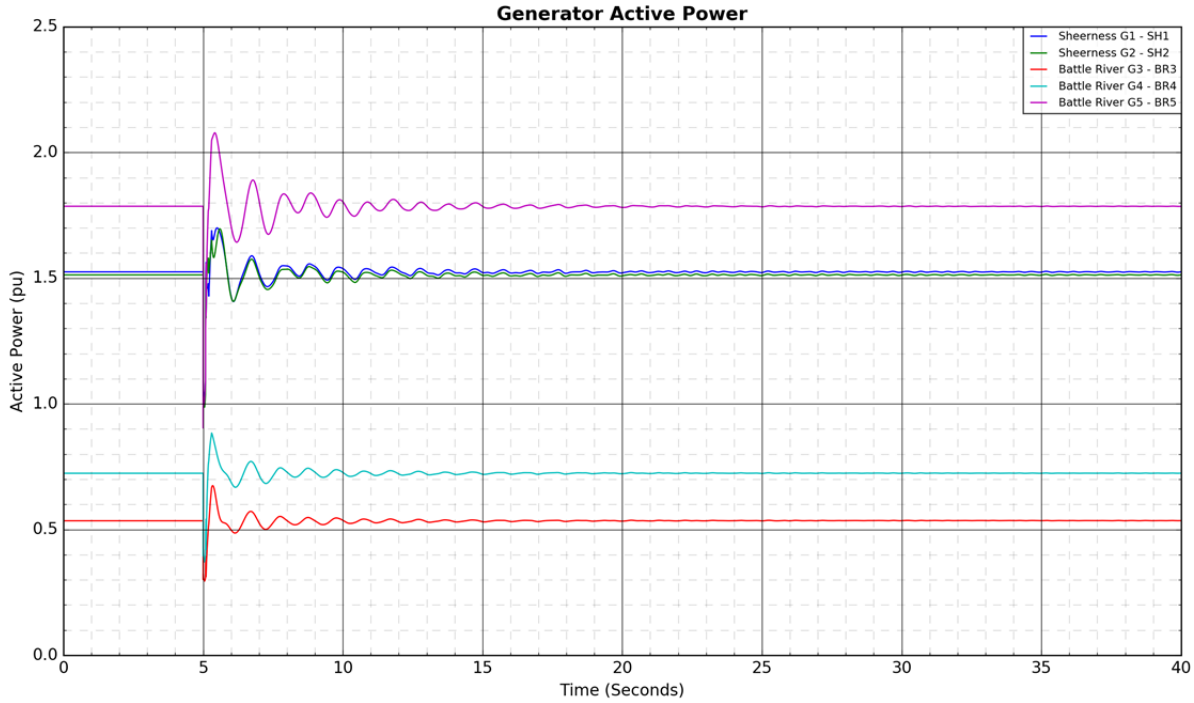

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

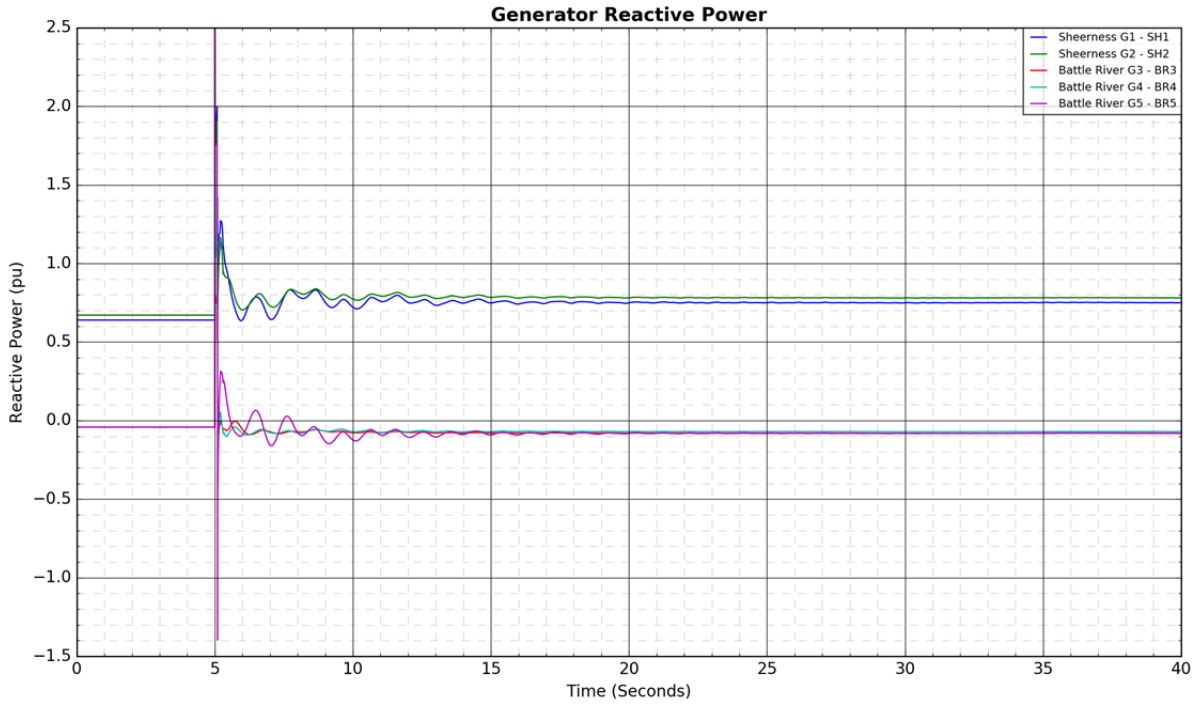
Figure A4-9: 912L/9L912 Nevis 766S to Red Deer 63S: Fault Near Red Deer 63S

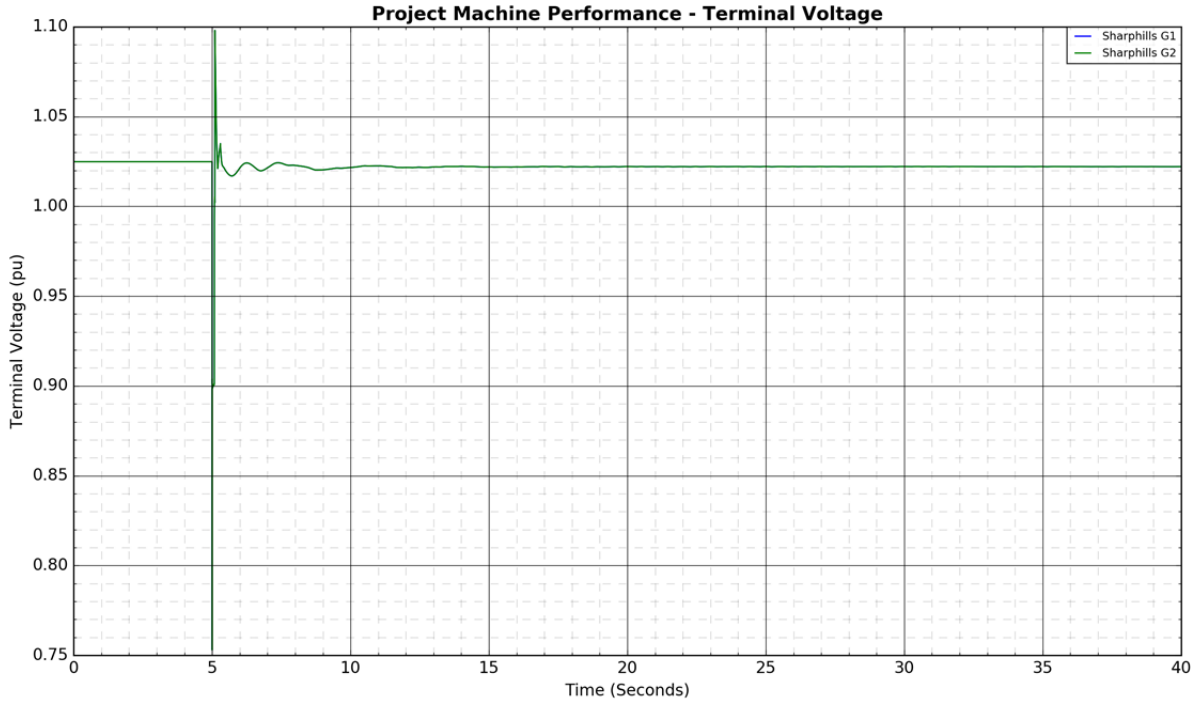


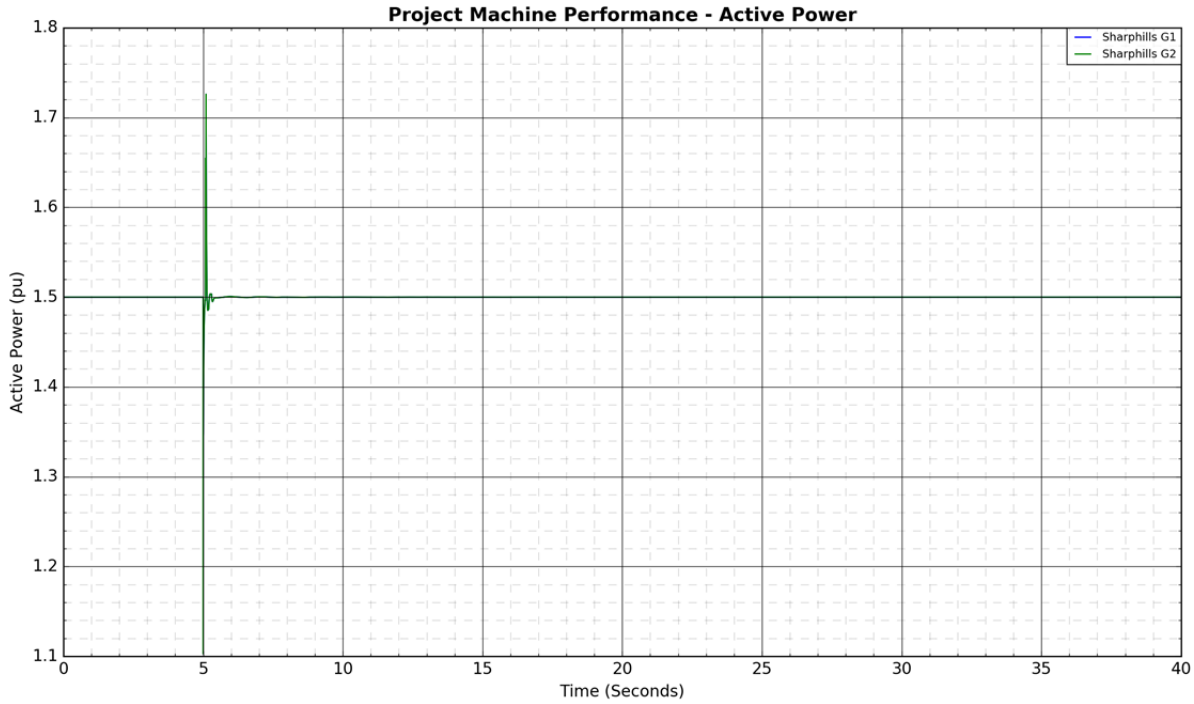


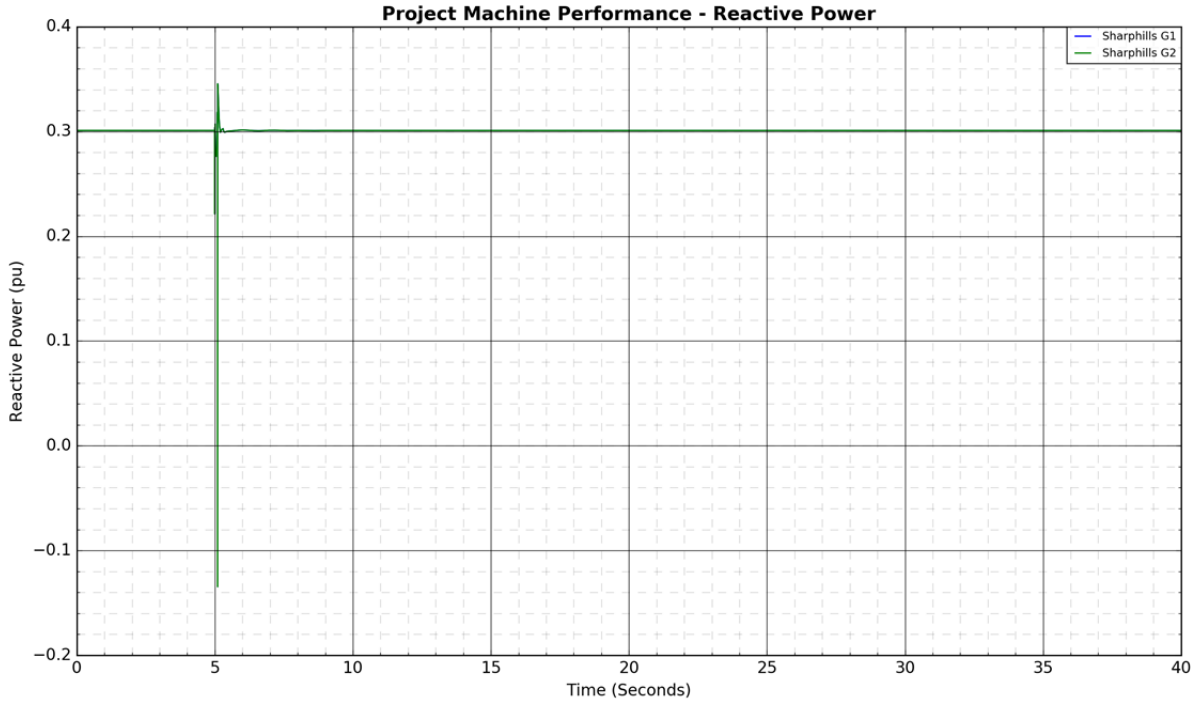

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

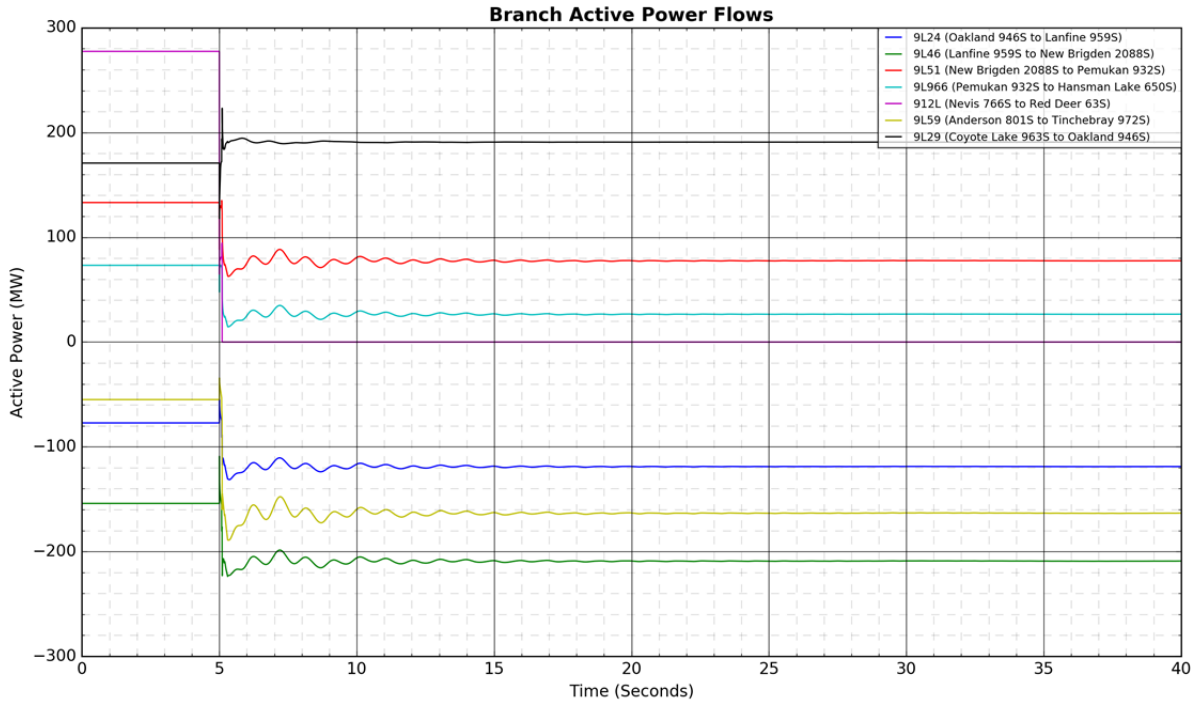

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
−1.0
−1.5
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Terminal Voltage
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
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
Sharphills G1
Sharphills G2
Active Power (pu)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

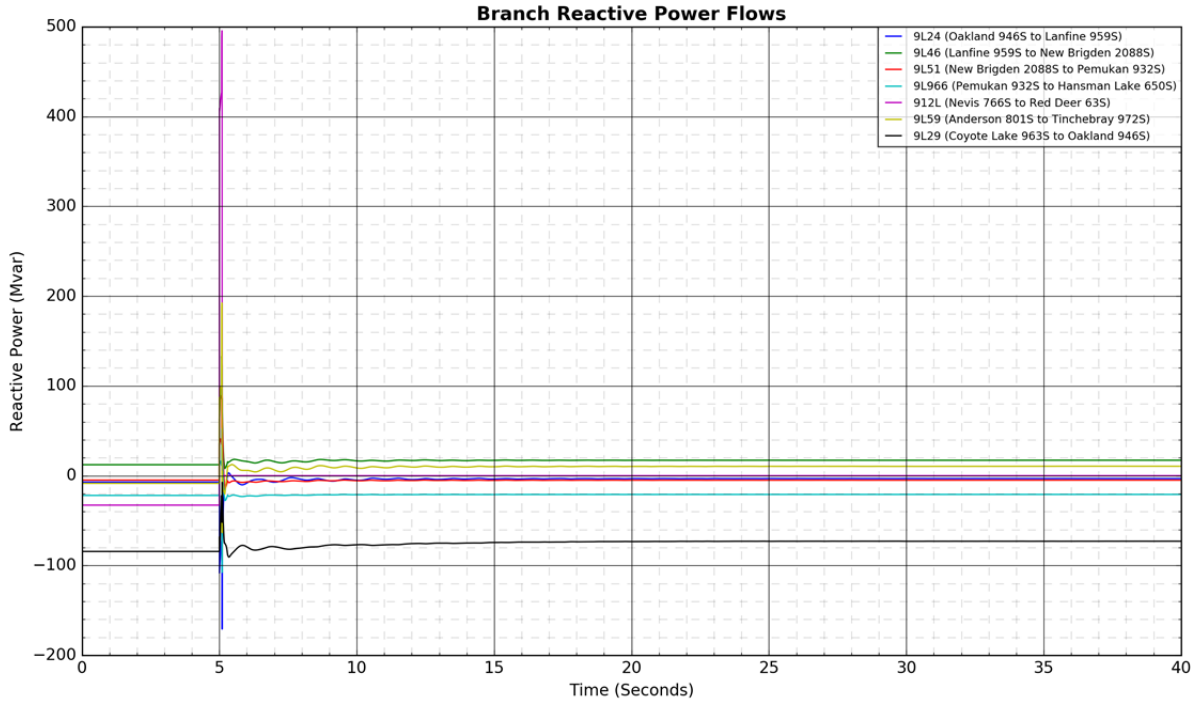
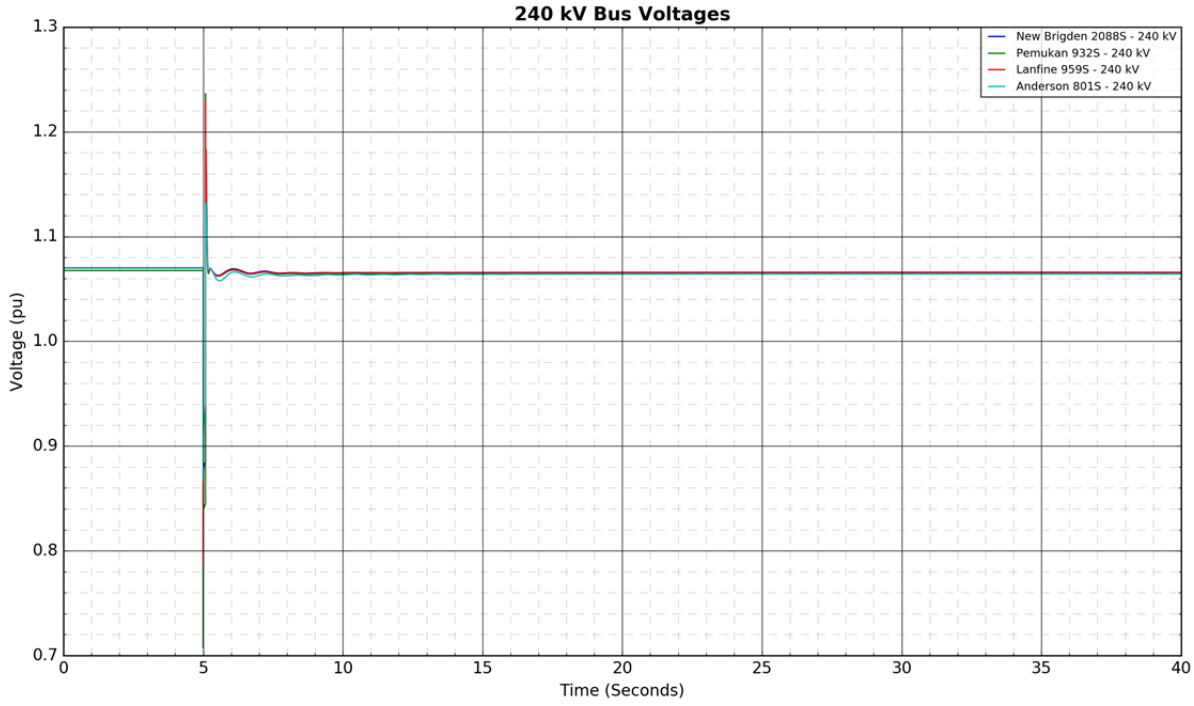
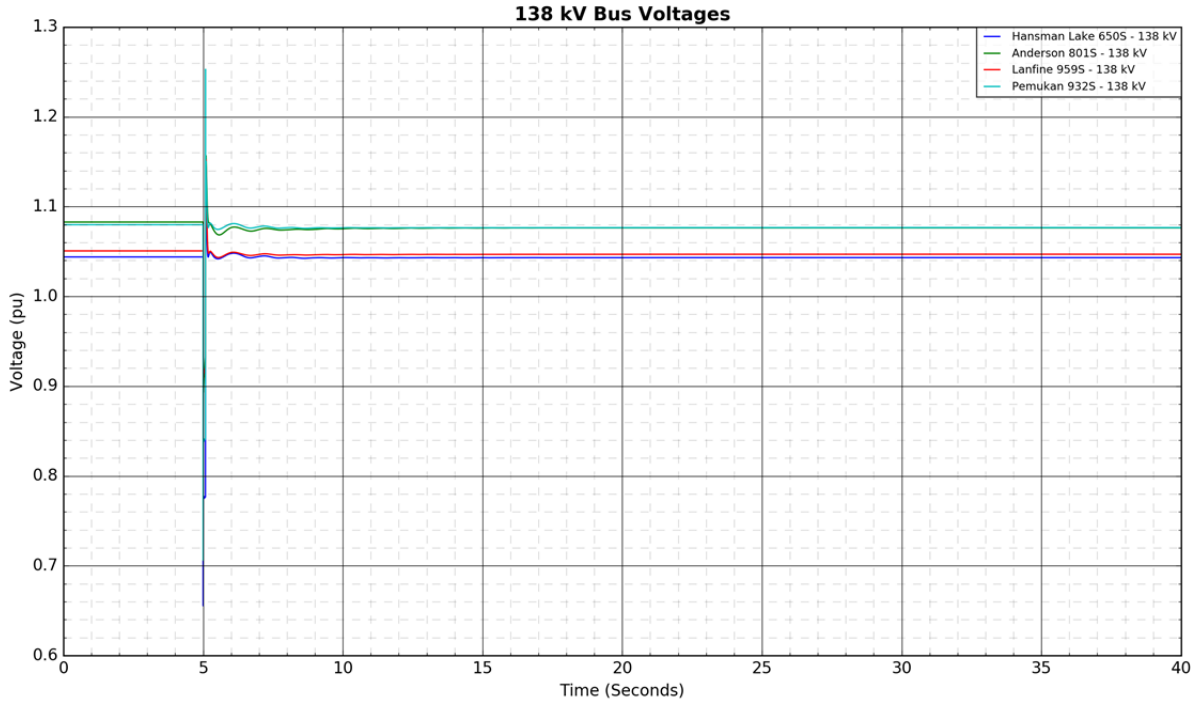
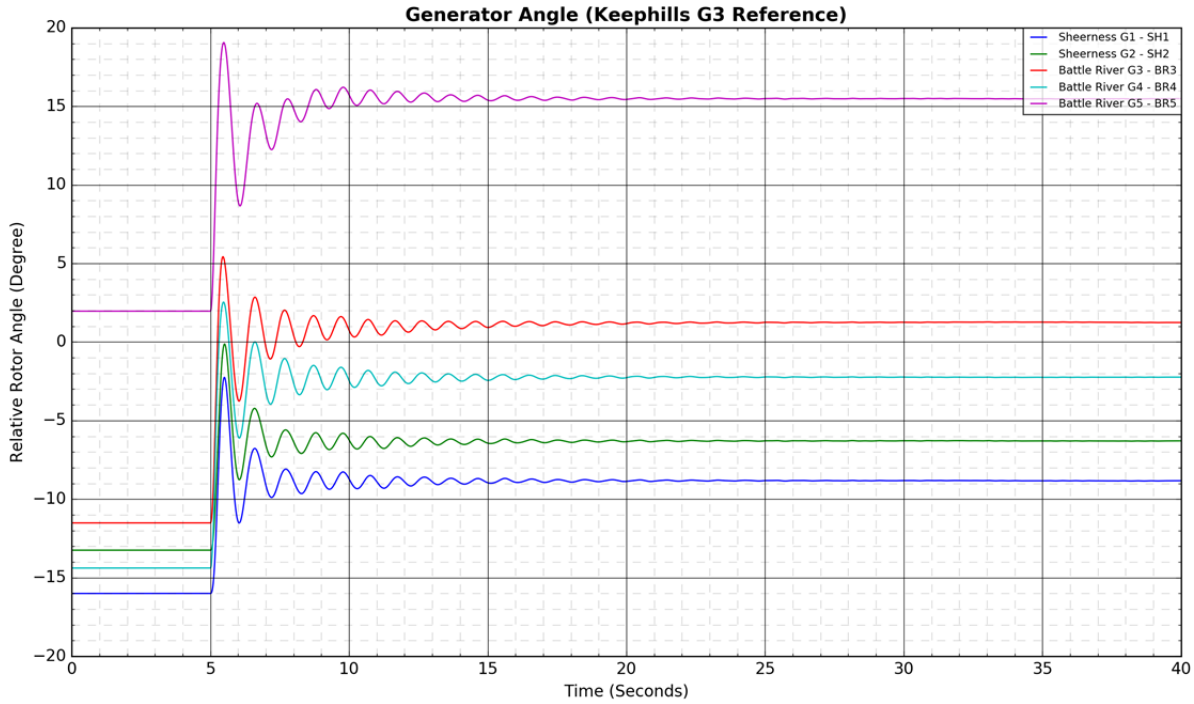
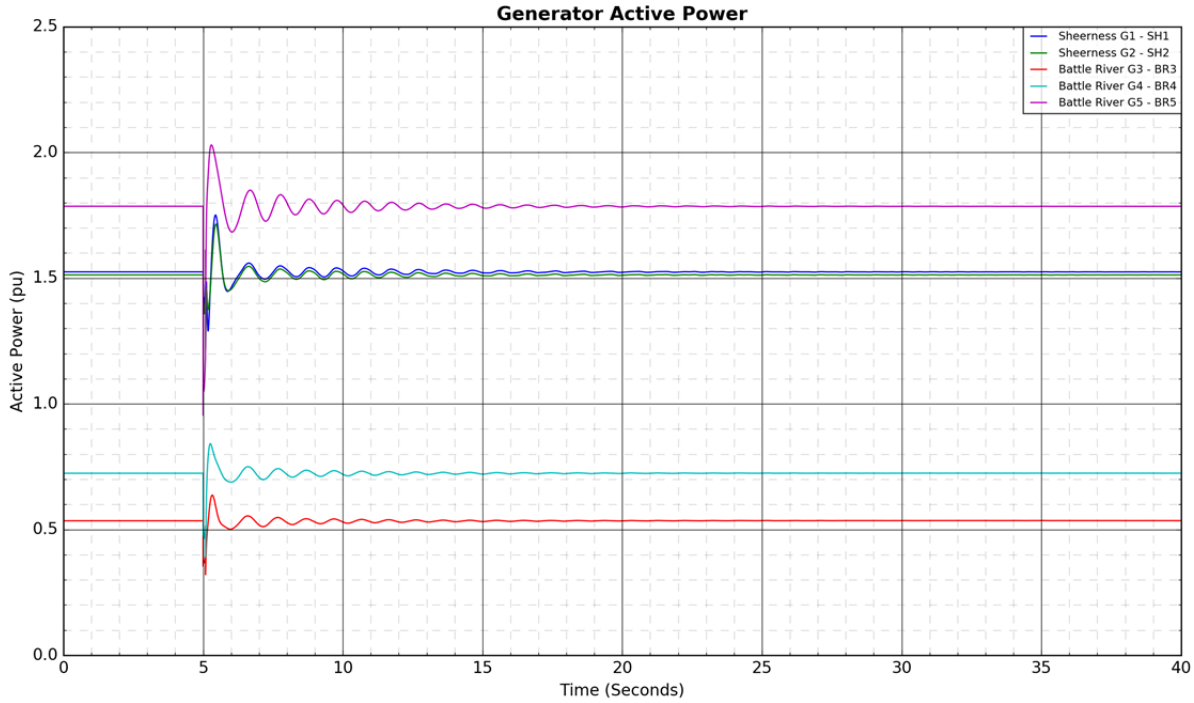

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

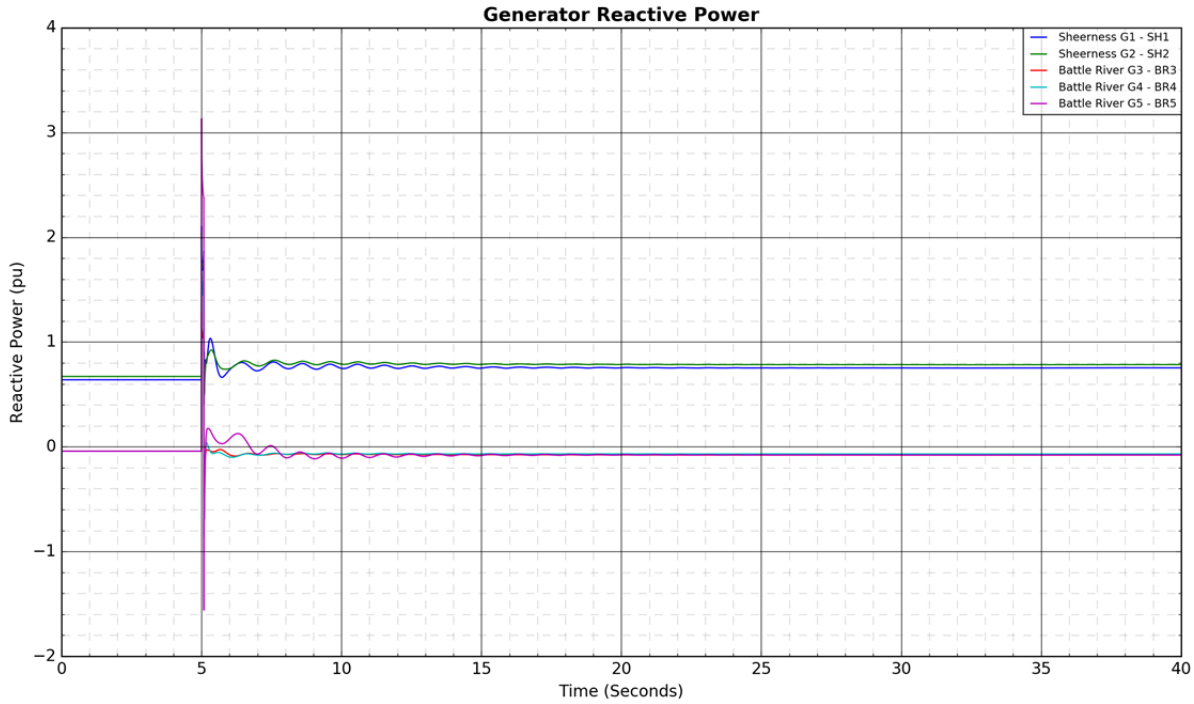
Figure A4-10: 912L/9L912 Nevis 766S to Red Deer 63S: Fault Near Nevis 766S

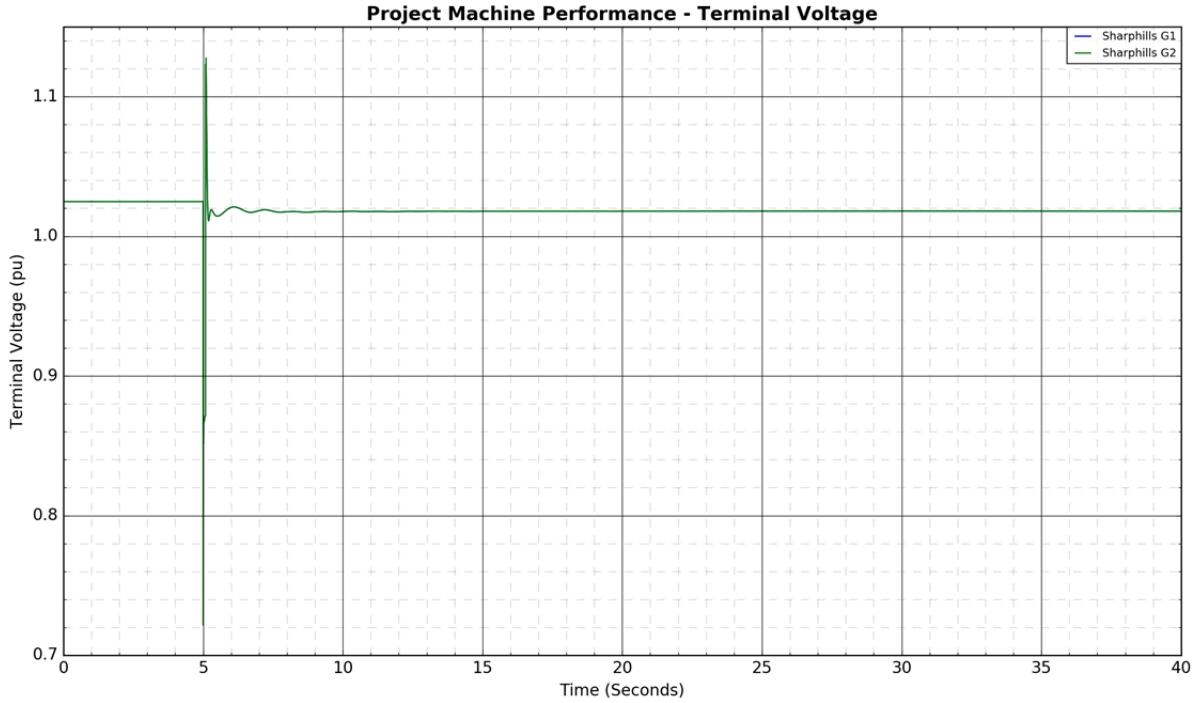


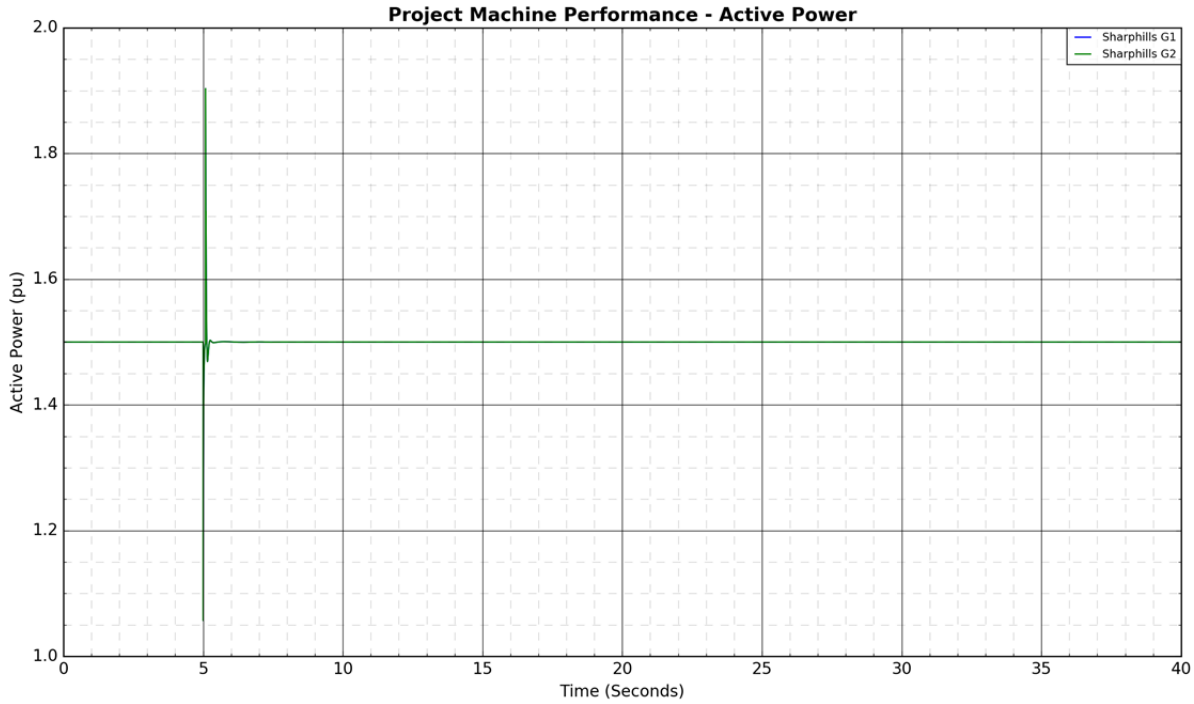


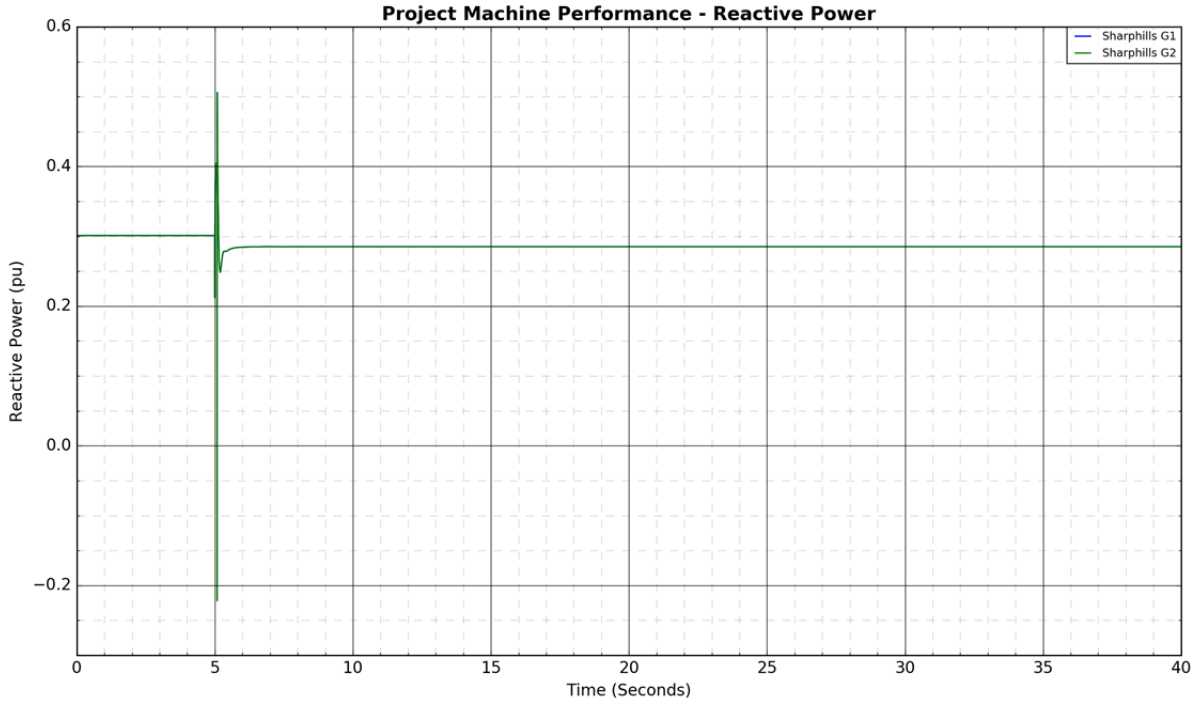

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

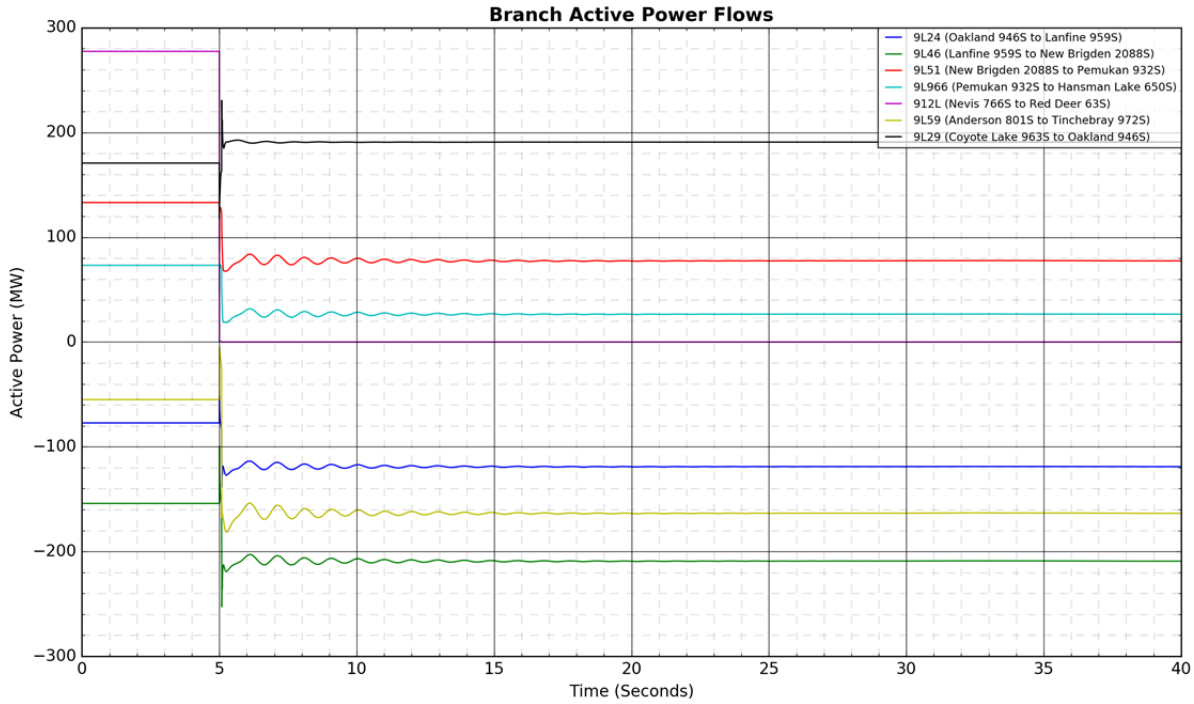

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active Power (pu)
2.0
1.8
1.6
1.4
1.2
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

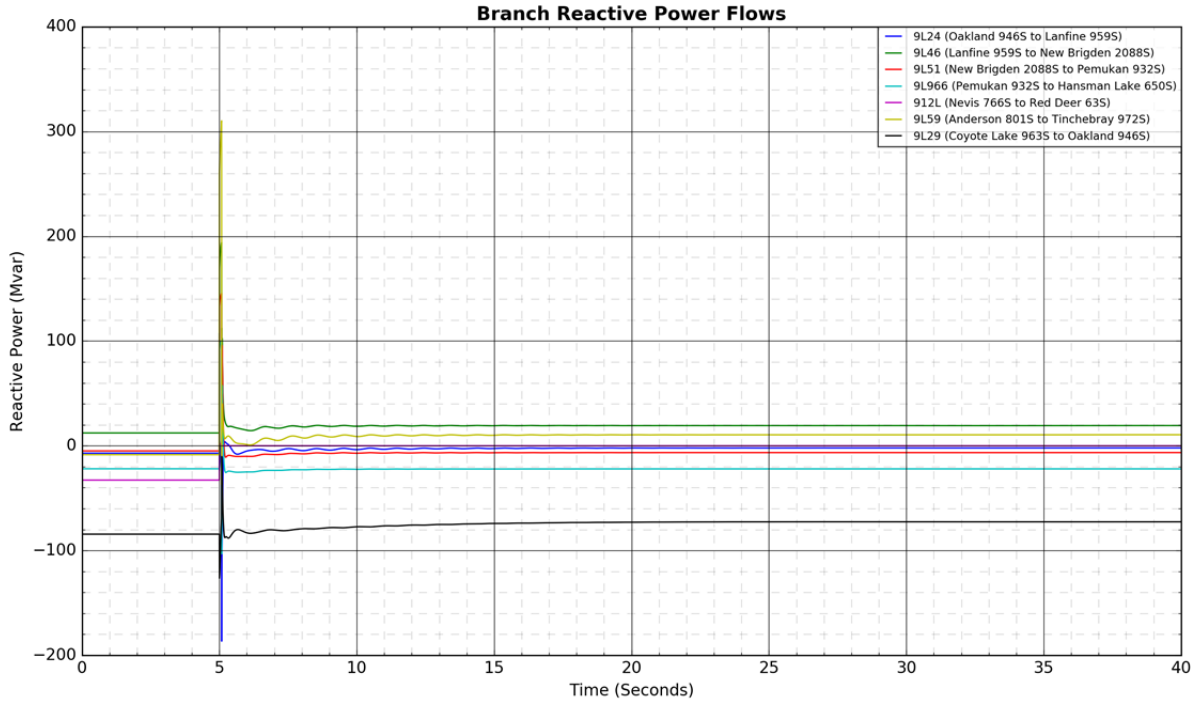
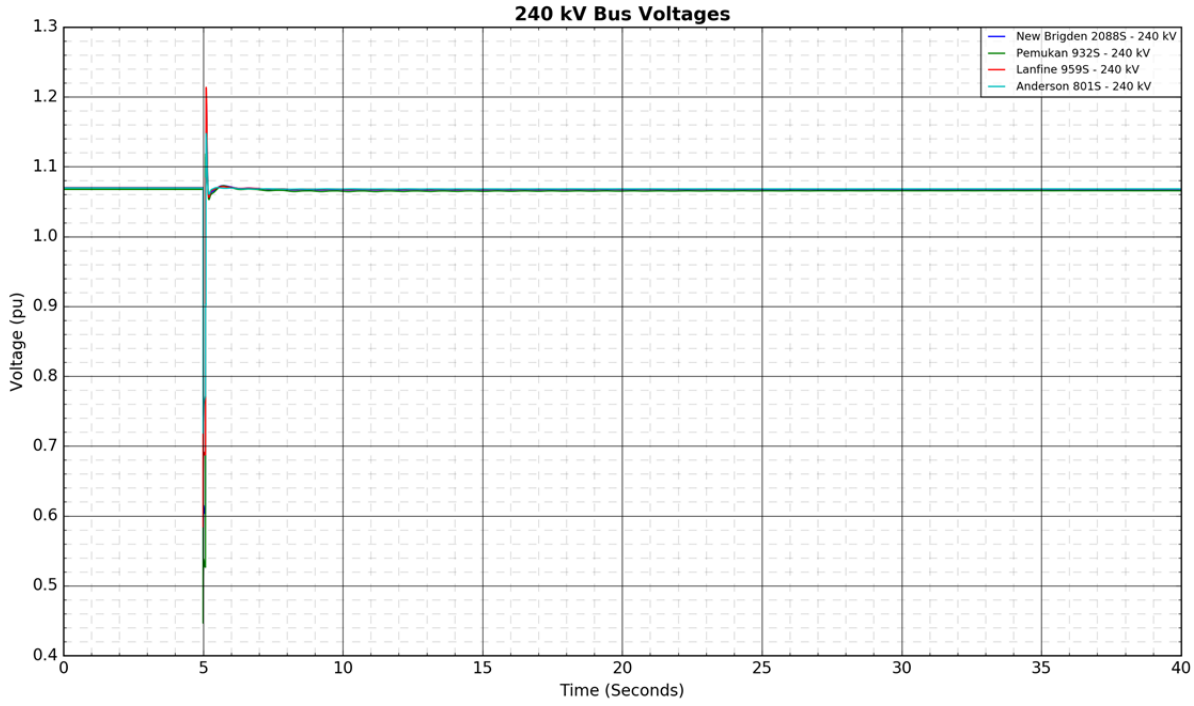
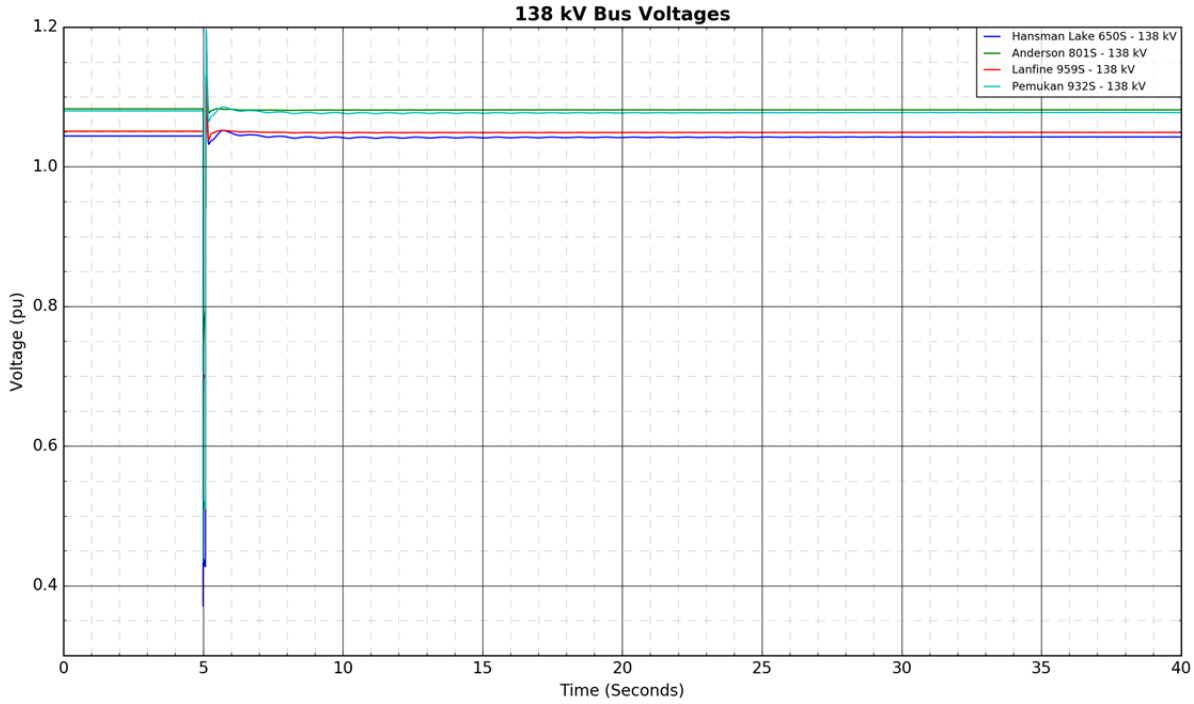
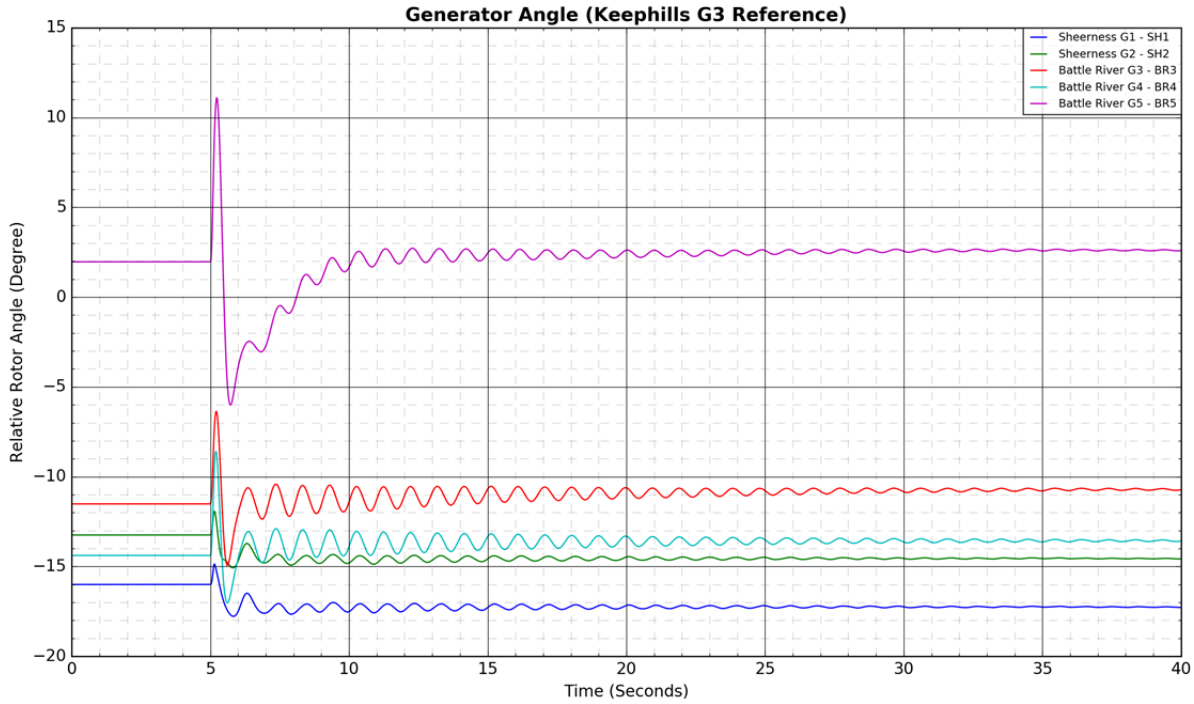
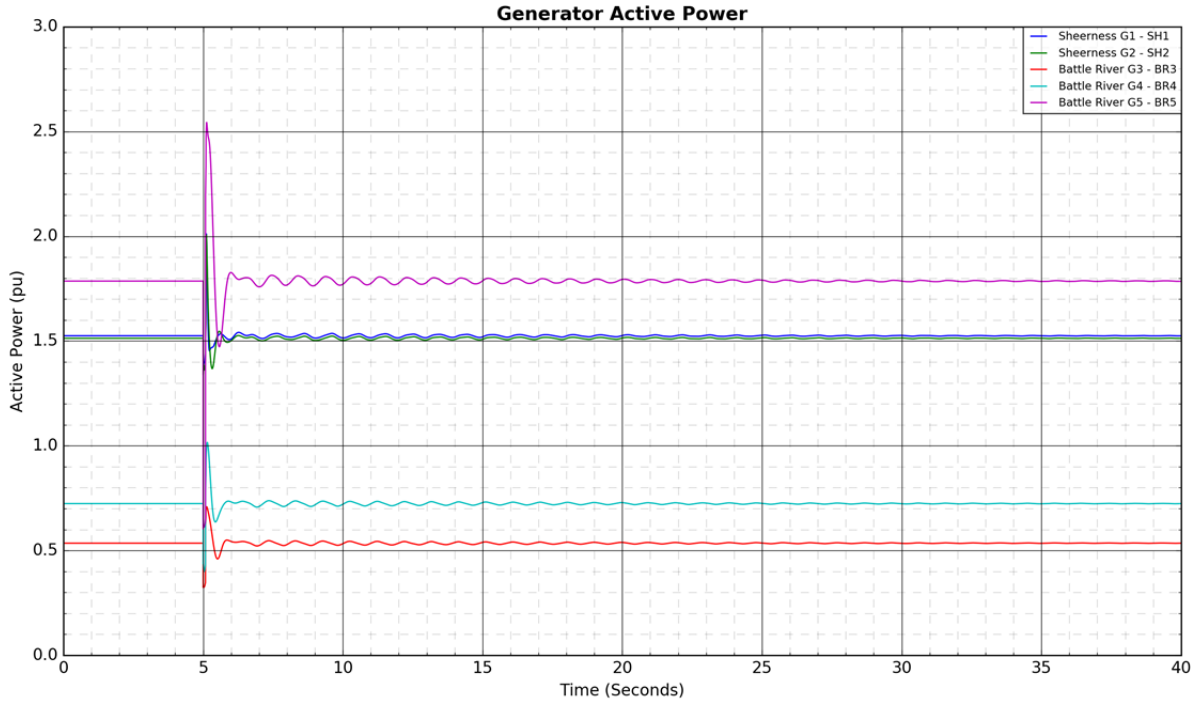

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

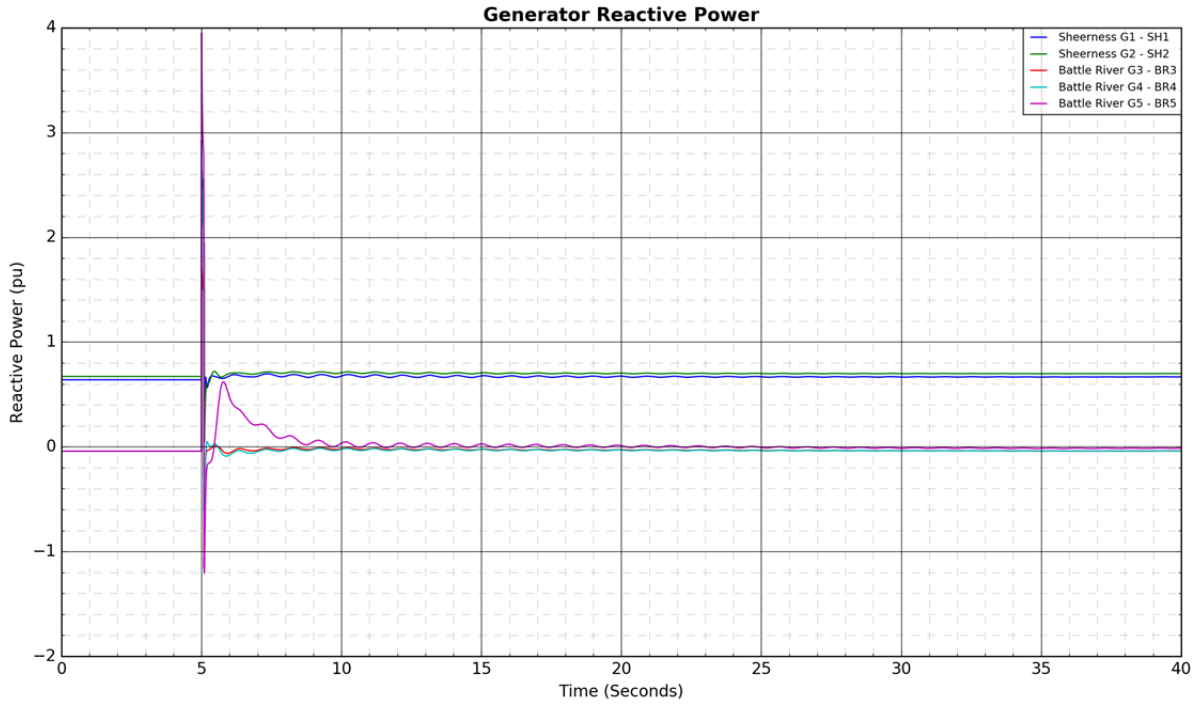
Figure A4-11: 9L59 Anderson 801S to Tinchebray 972S: Fault Near Tinchebray 972S

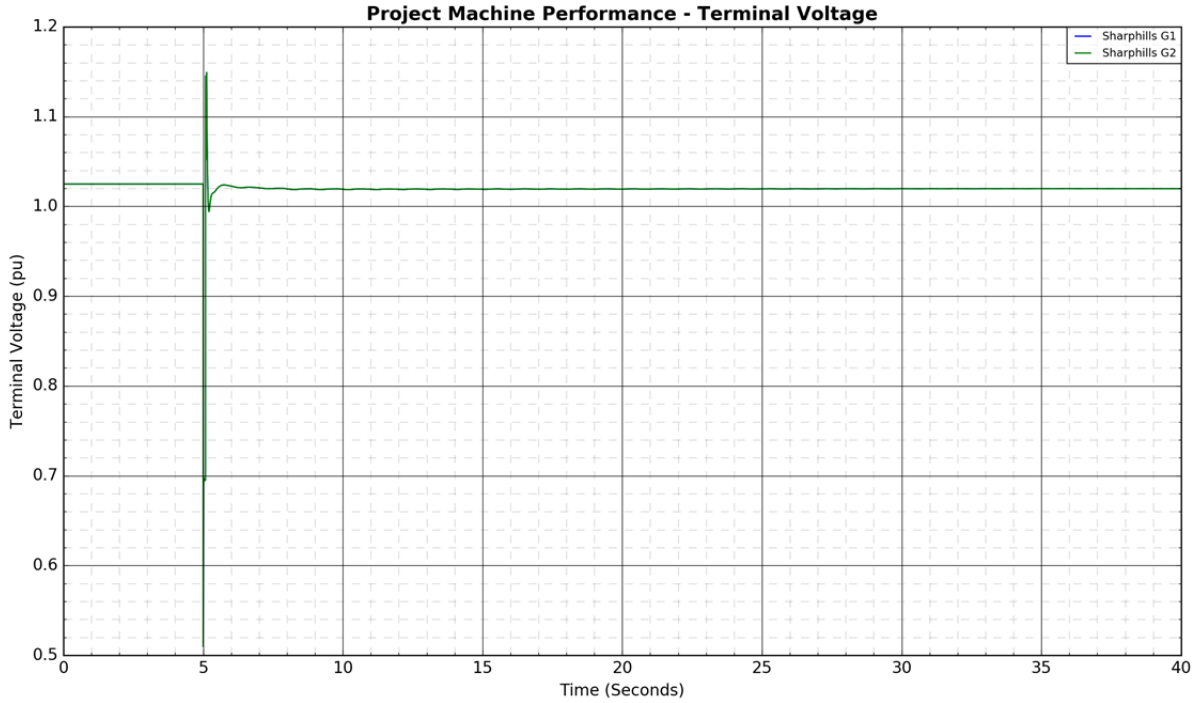


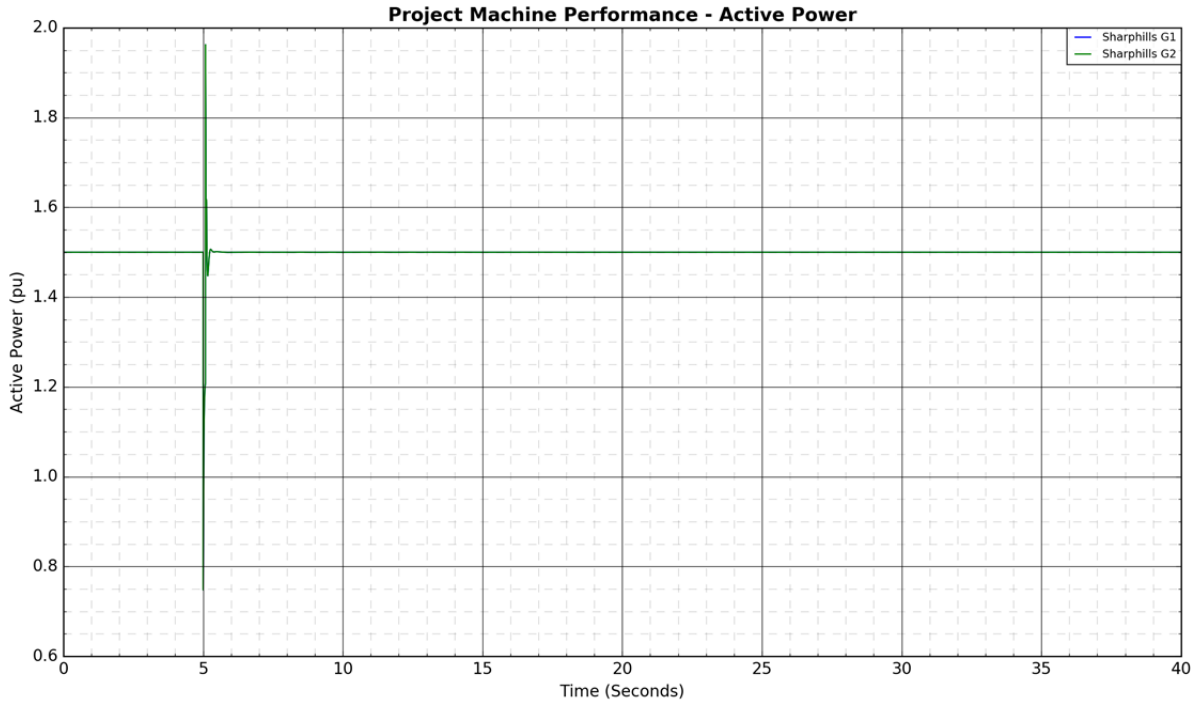


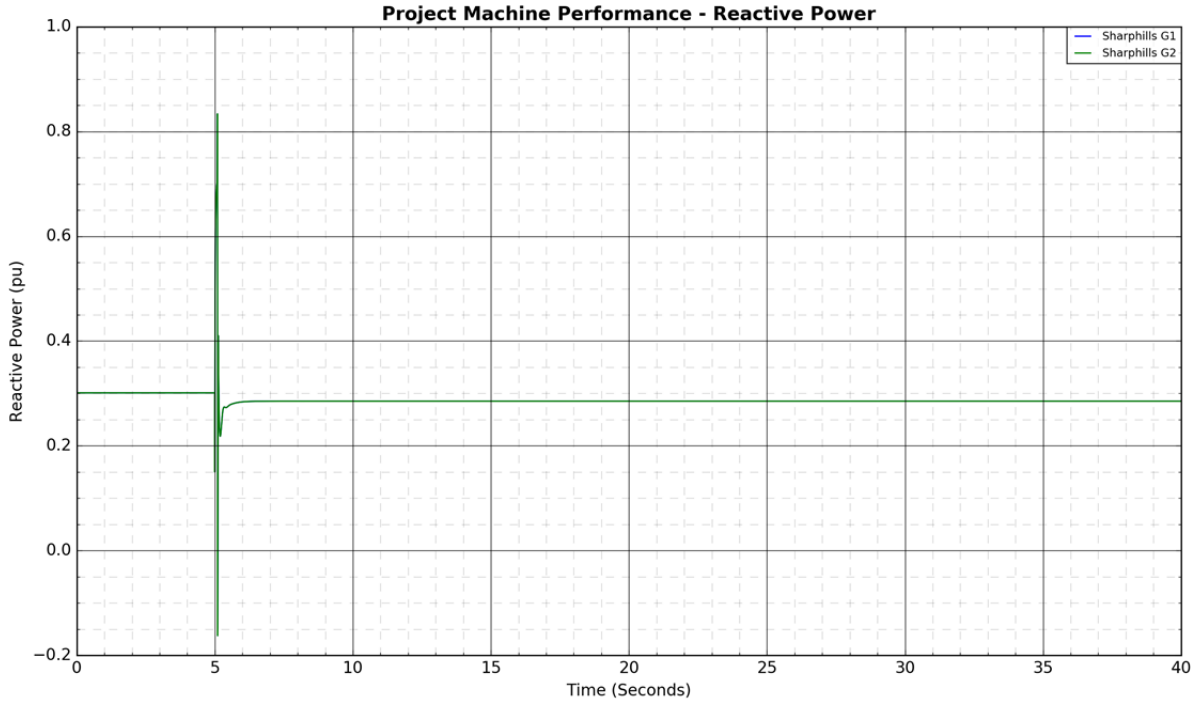

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

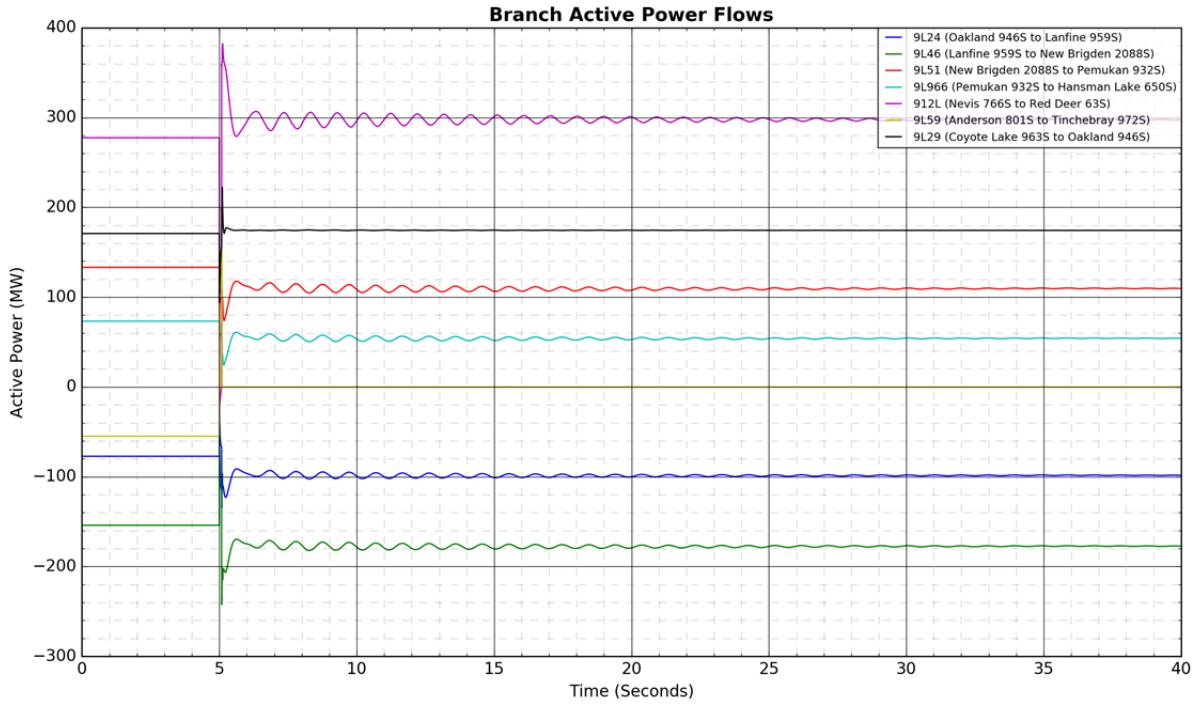

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

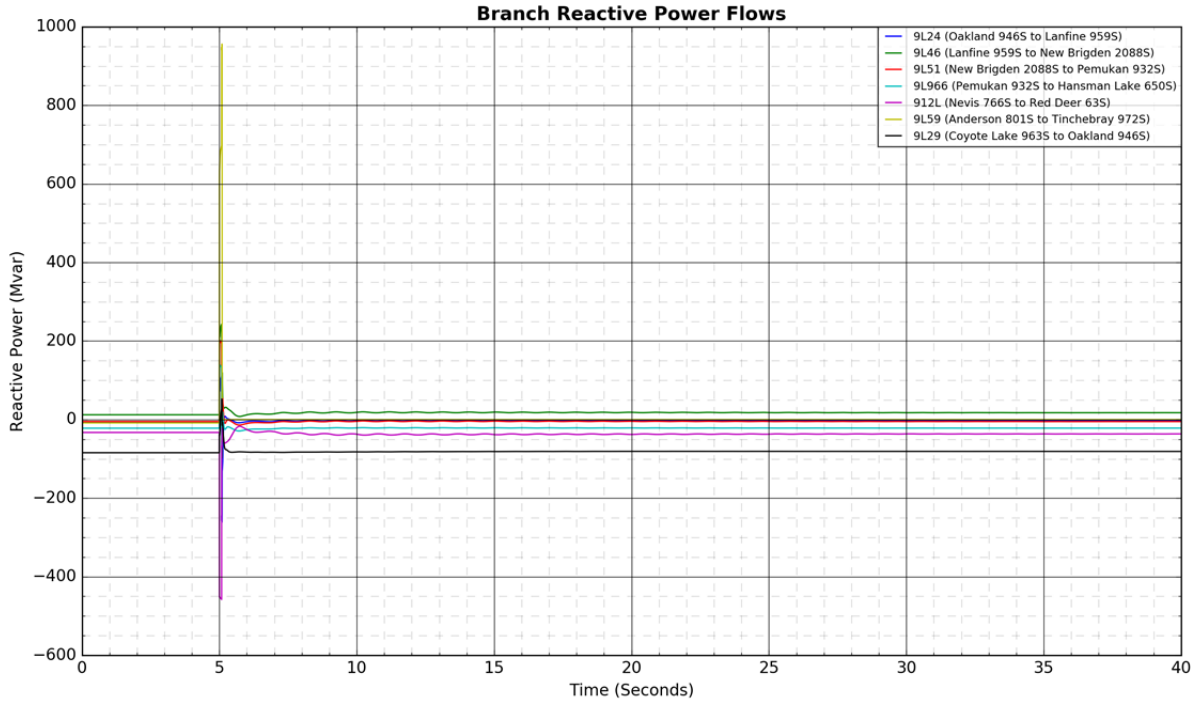
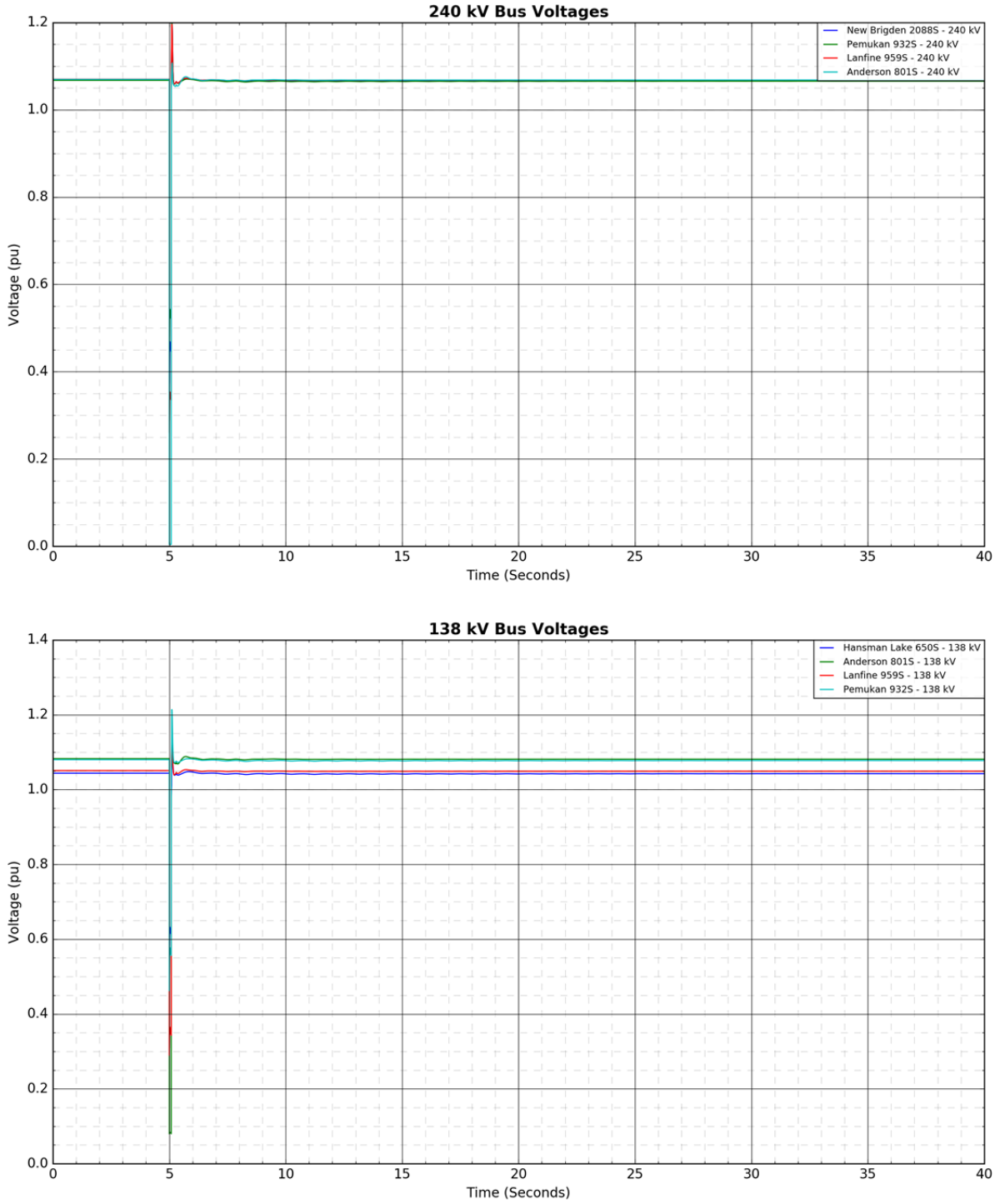
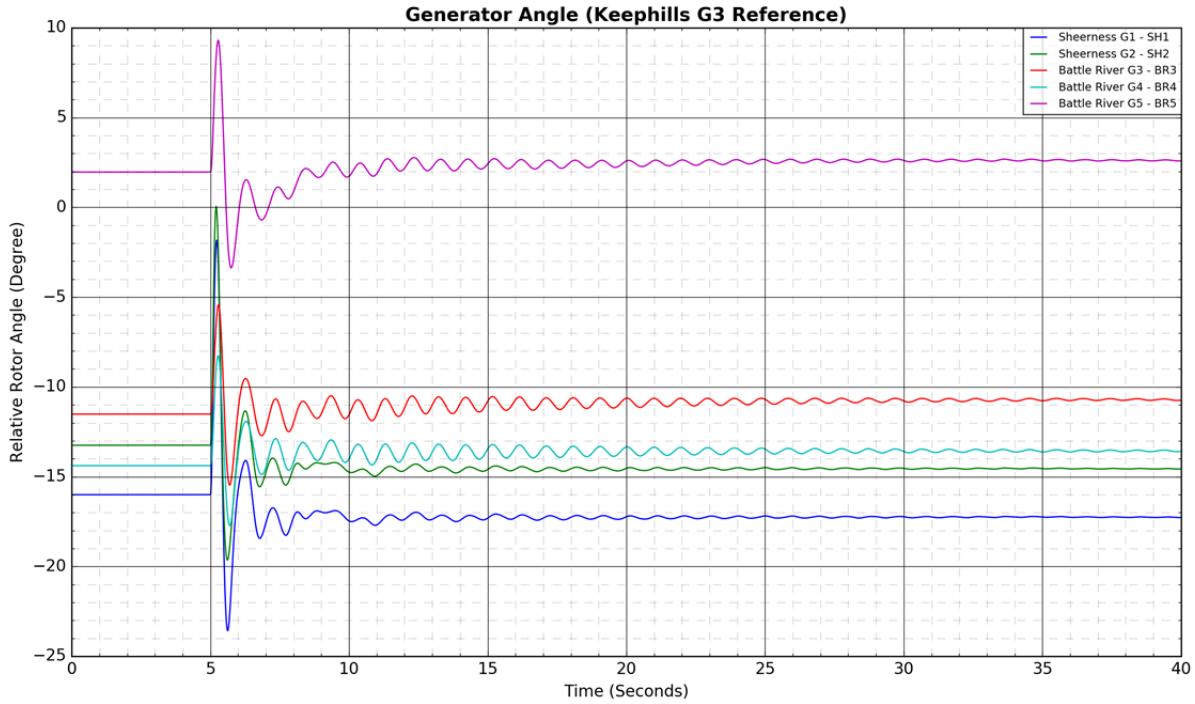
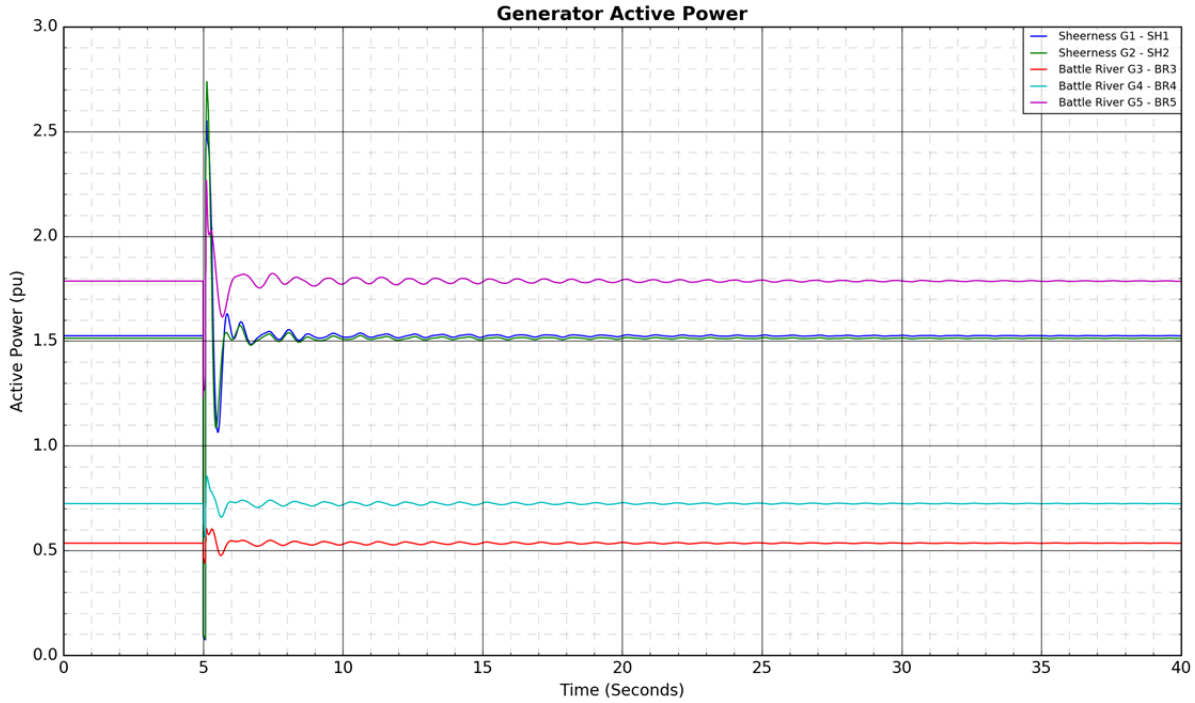
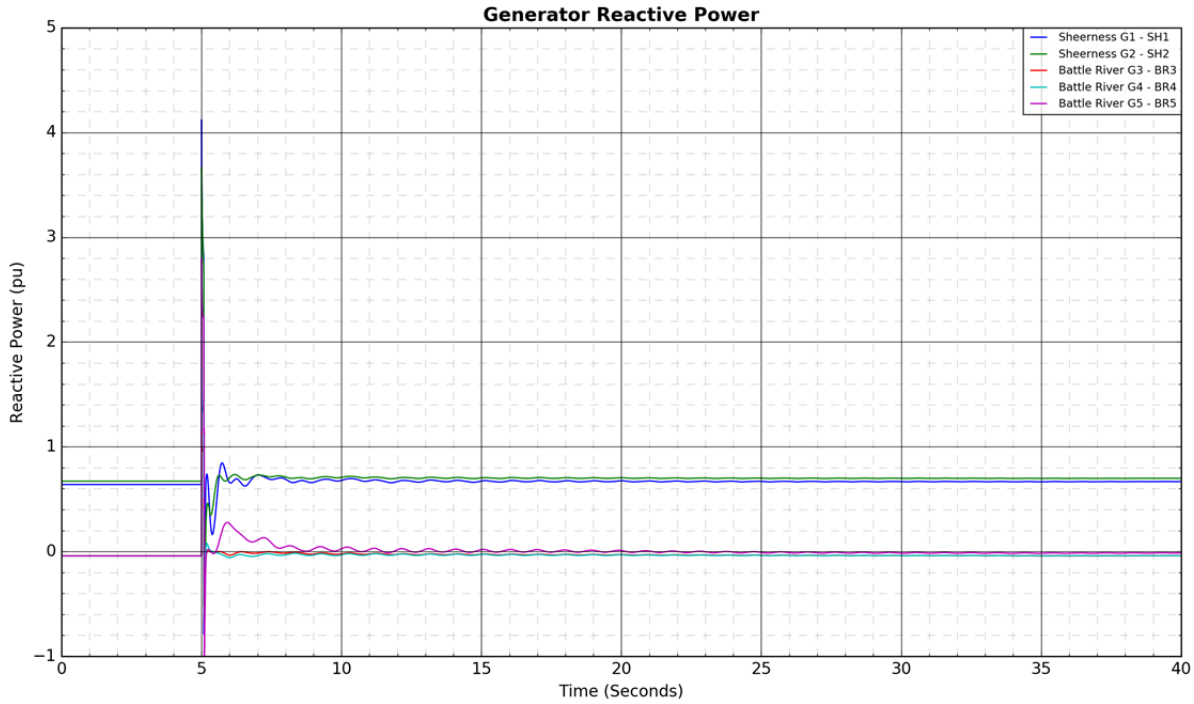

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

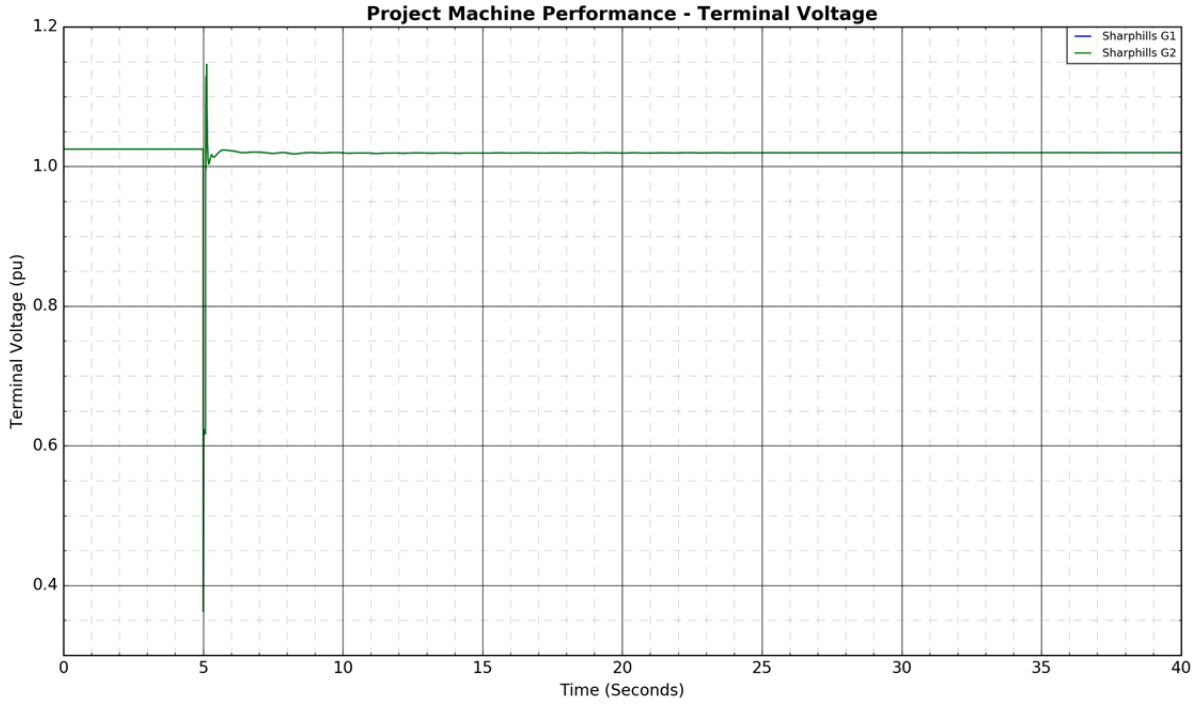
Figure A4-12: 9L59 Anderson 801S to Tinchebray 972S: Fault Near Anderson 801S

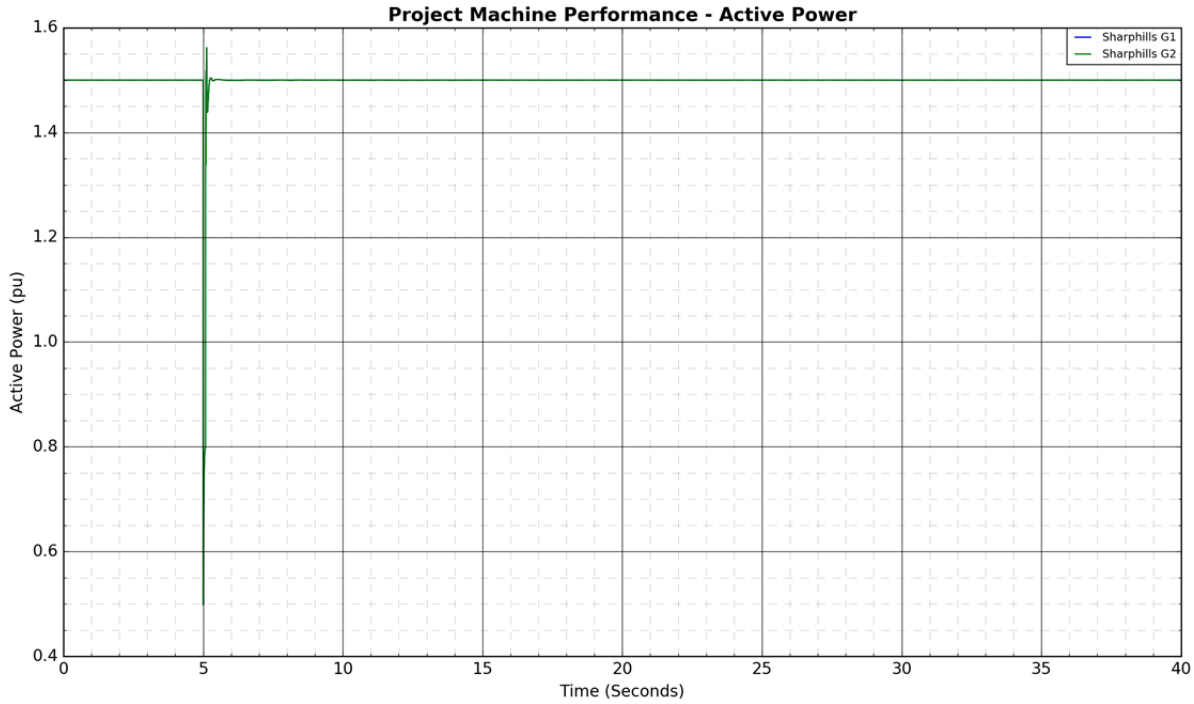


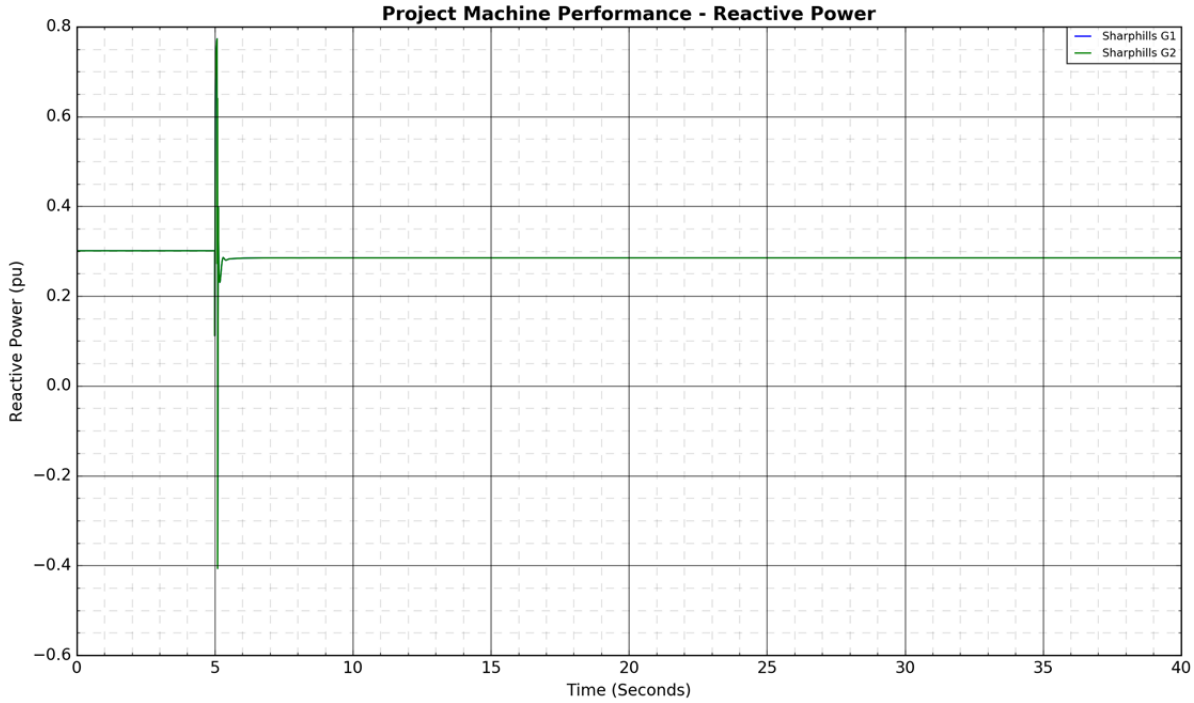

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

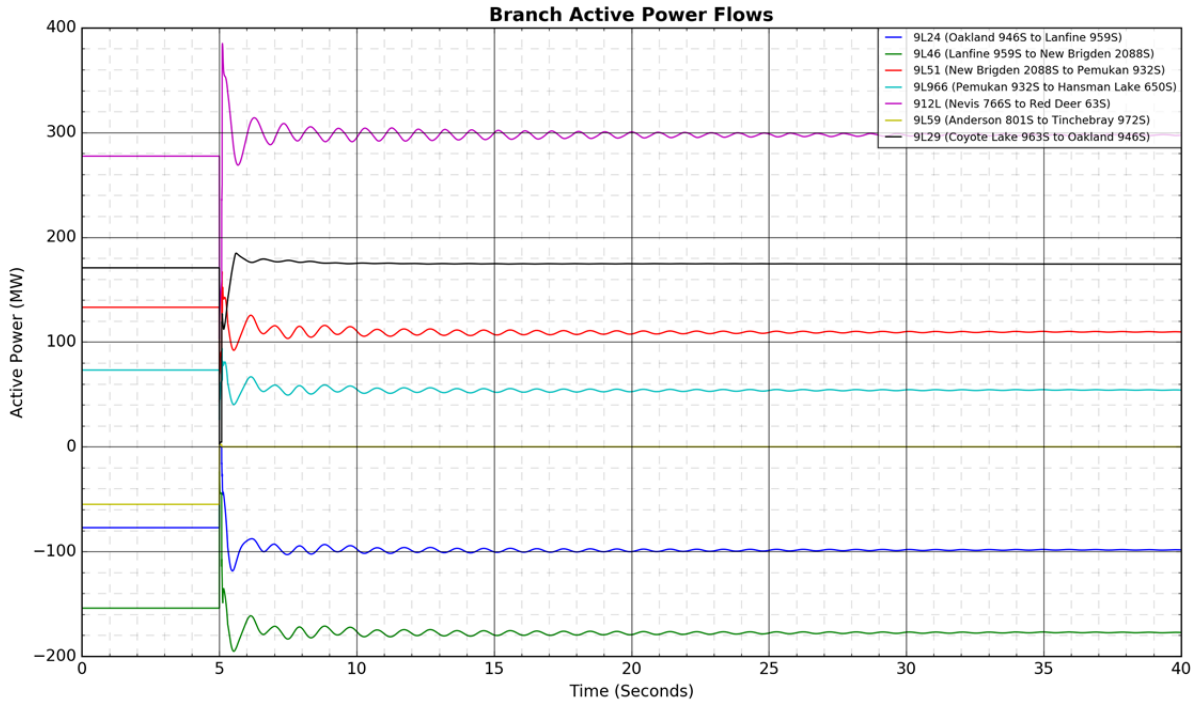

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

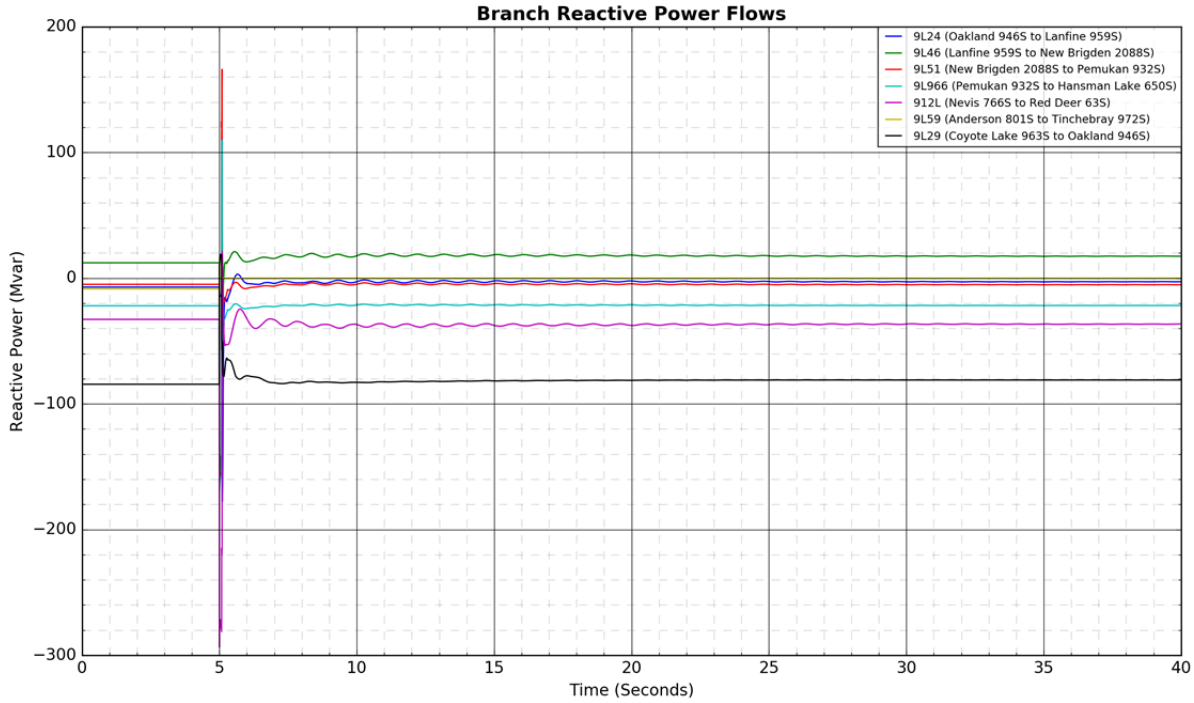

Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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)

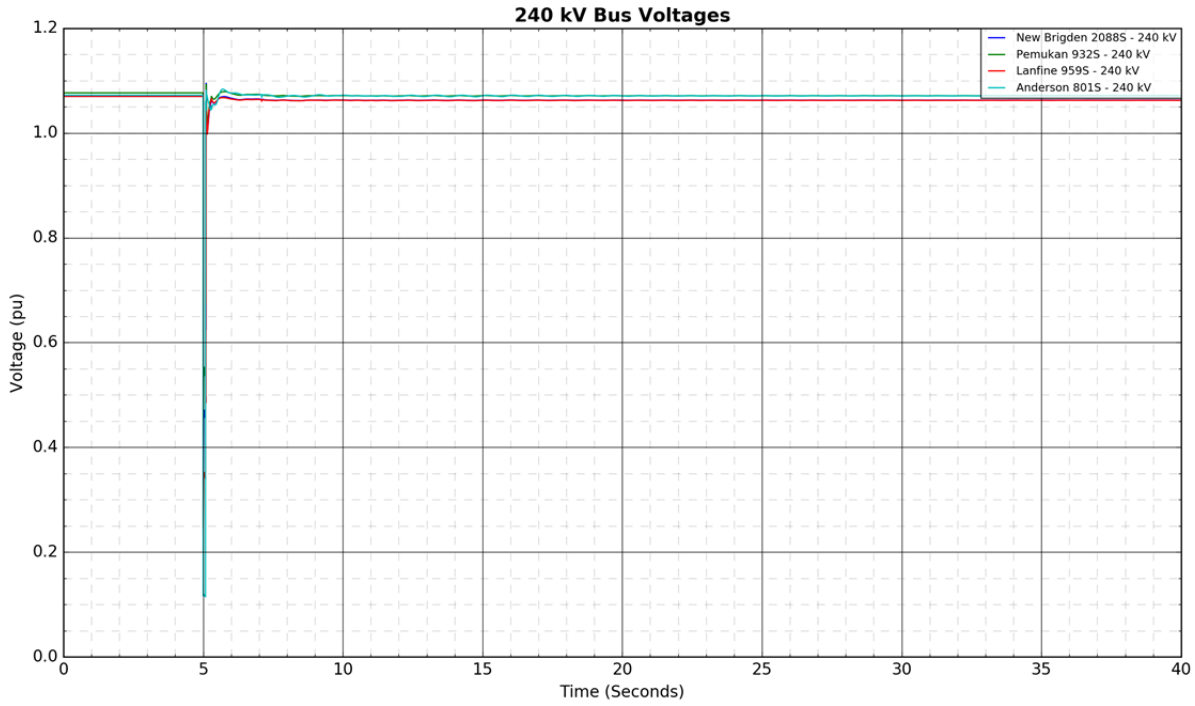

Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
0
5
10
15
20
25
30
35
40
Time (Seconds)

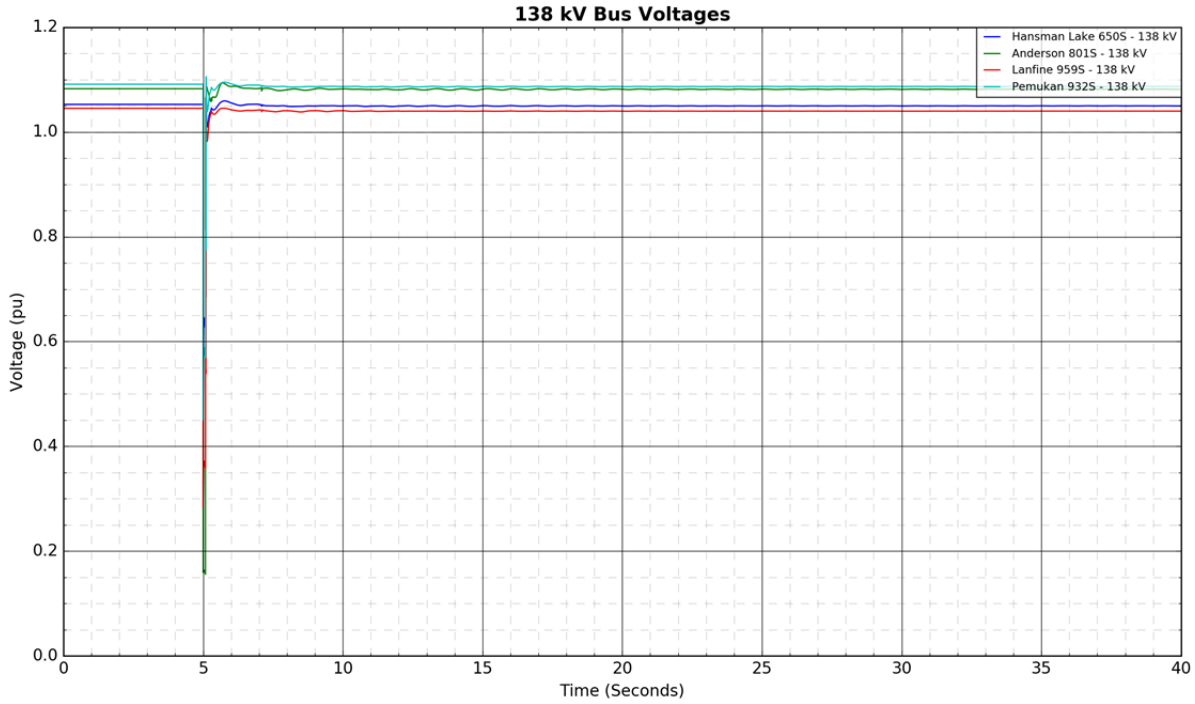

Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

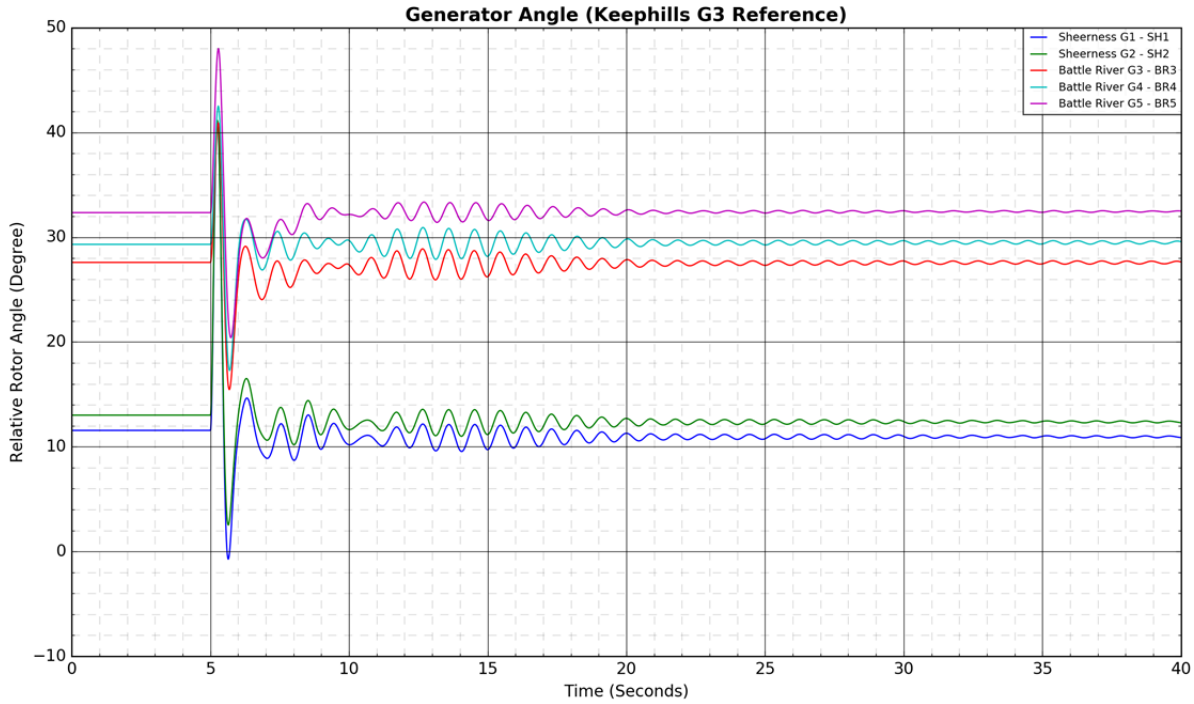

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

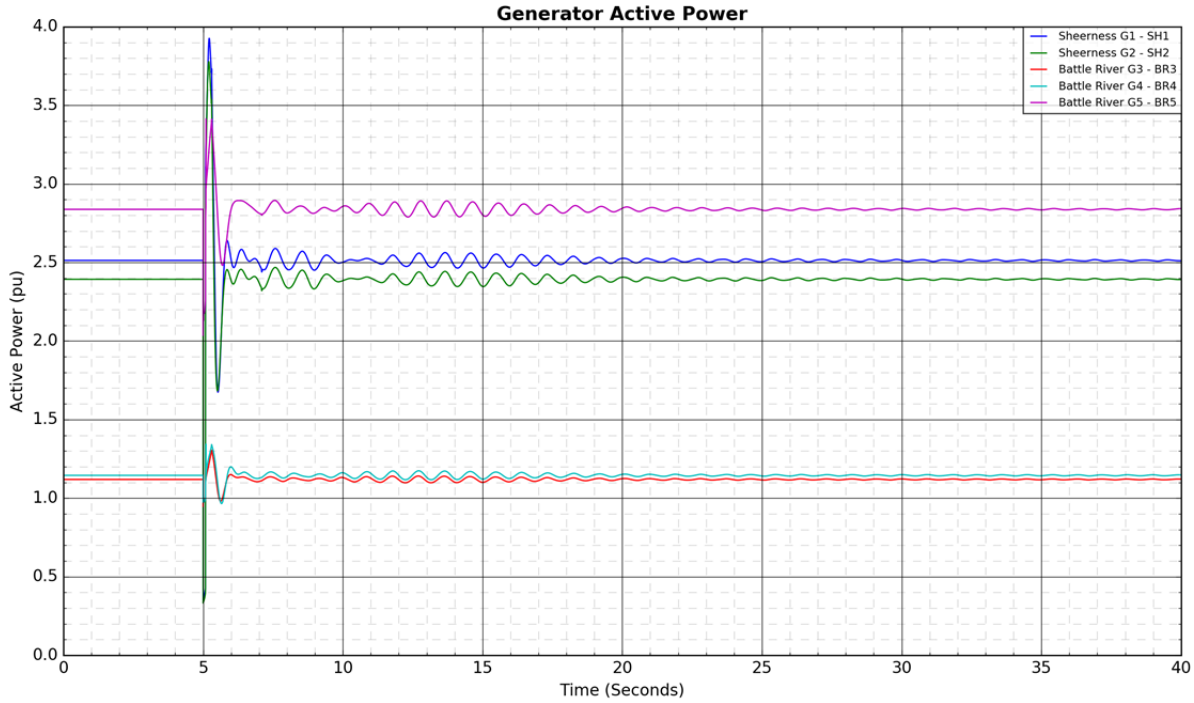
2. Stability Results 2018 Summer Peak - Case B

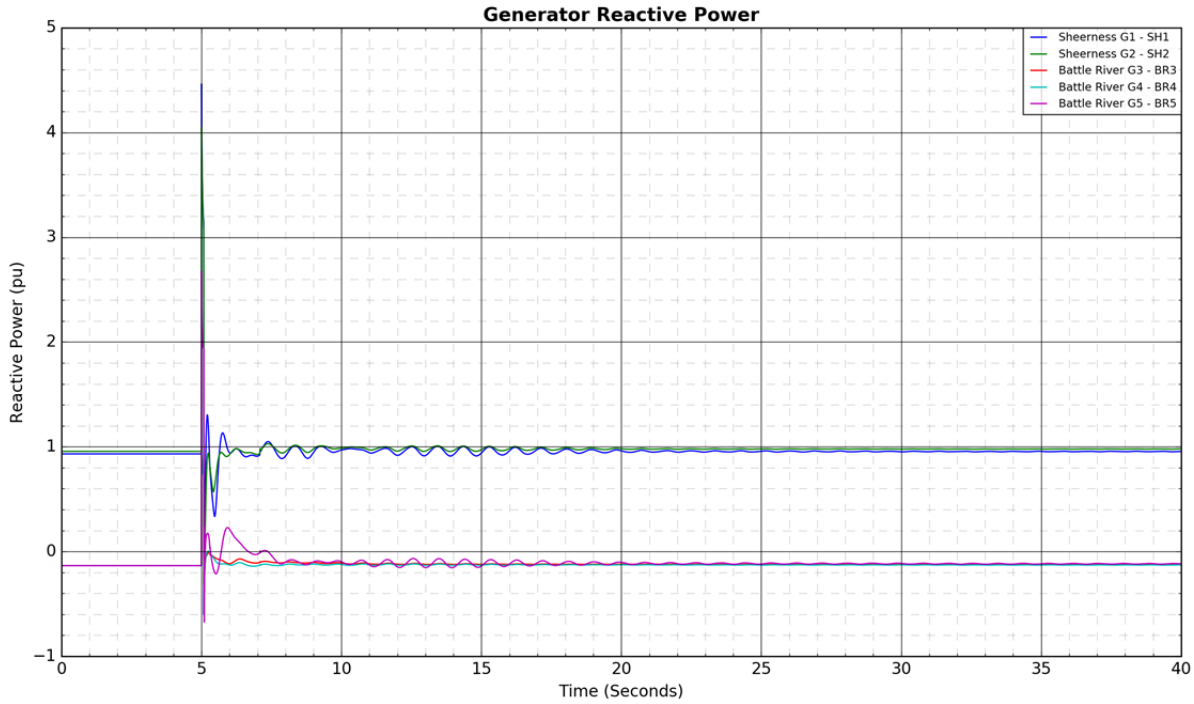
Figure A4-13: 9L24 Oakland 946S to Lanfine 959S: Fault Near Oakland 946S

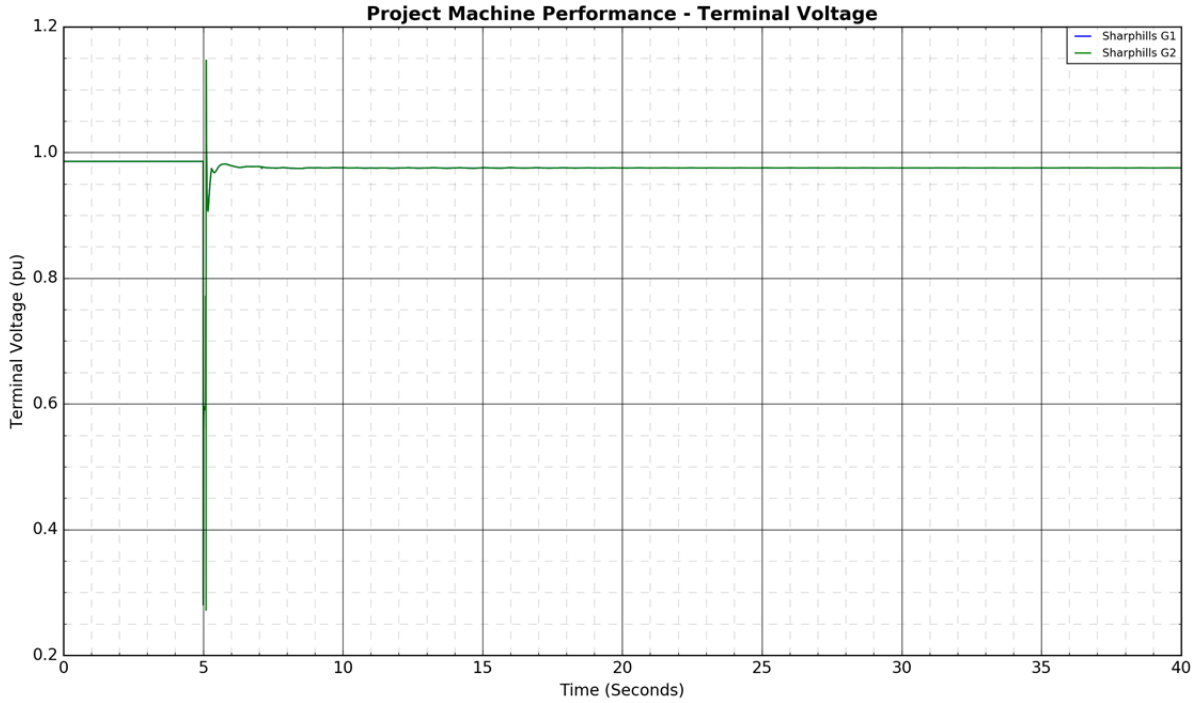


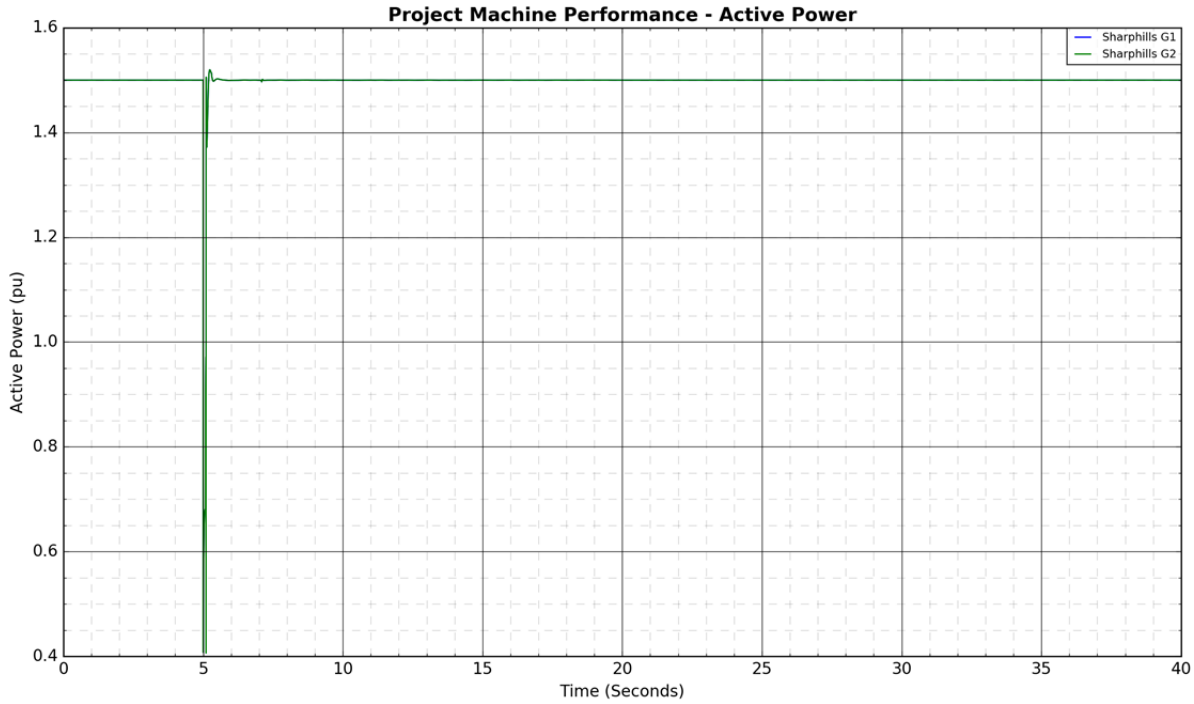


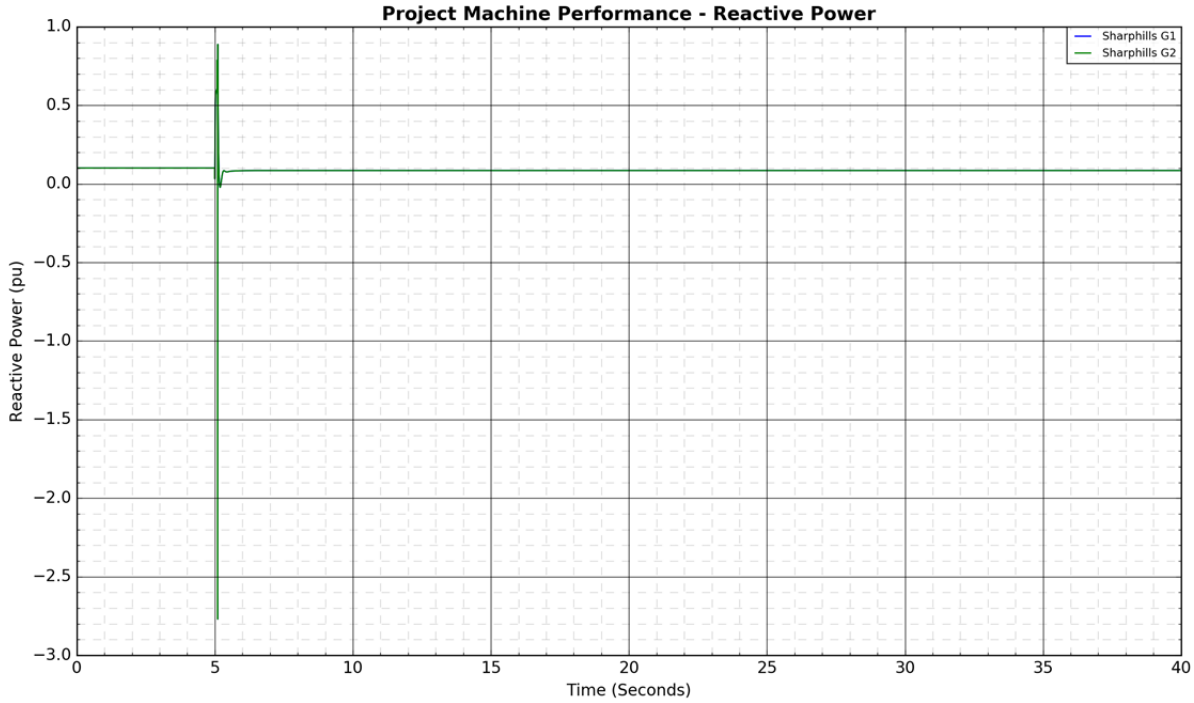

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

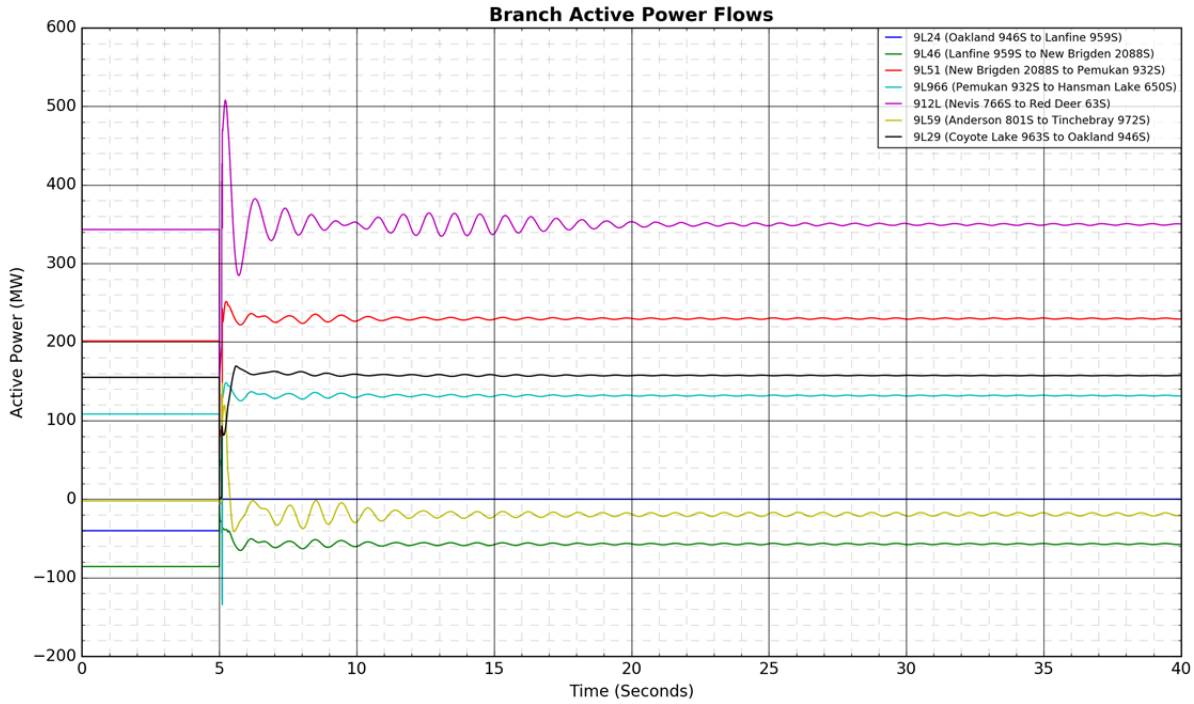

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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
Sharphills G1
Sharphills G2
Reactive Power (pu)
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

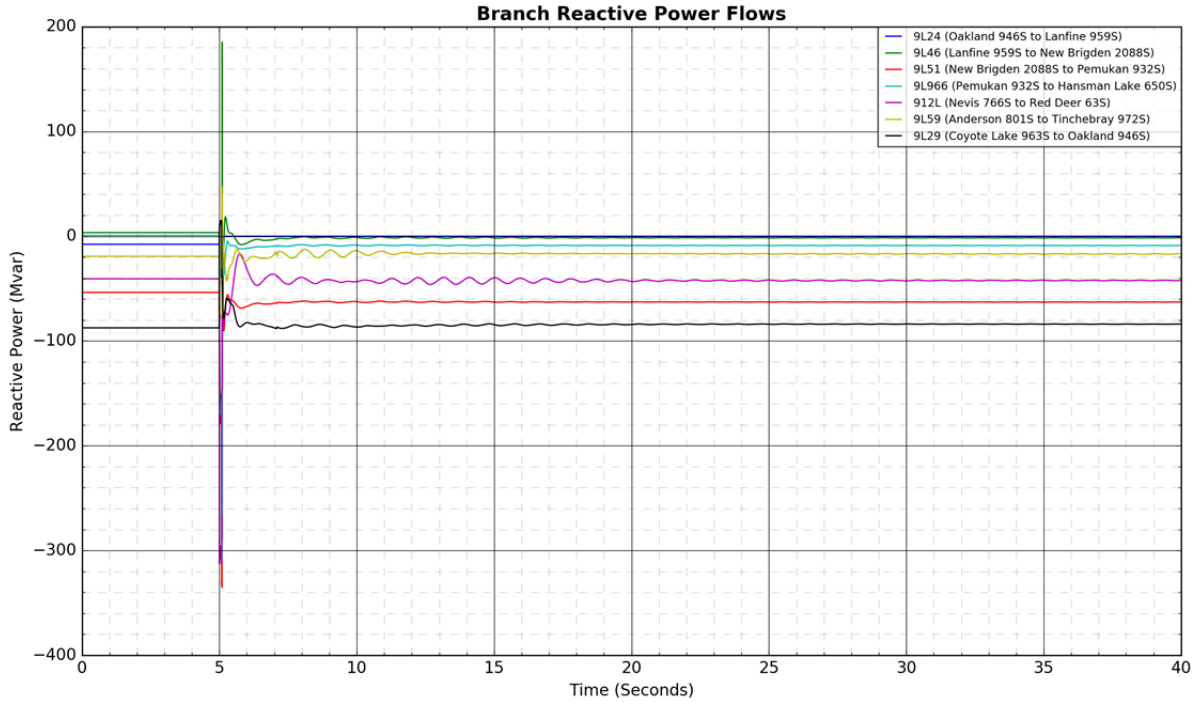
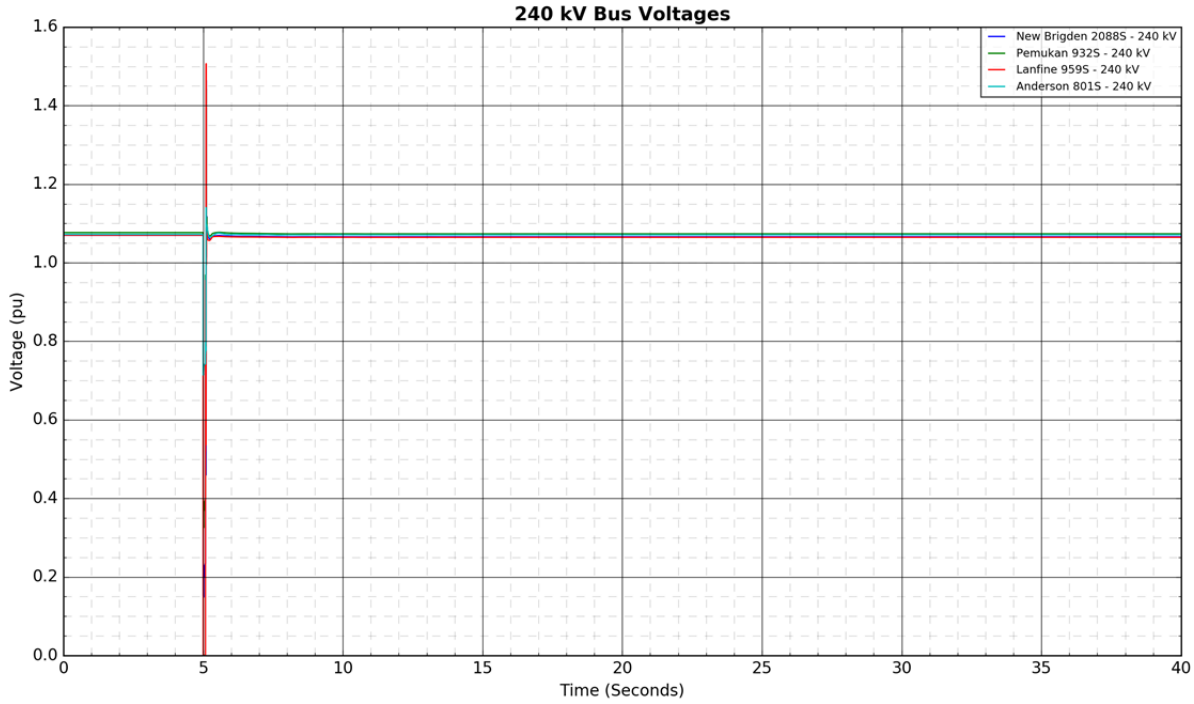
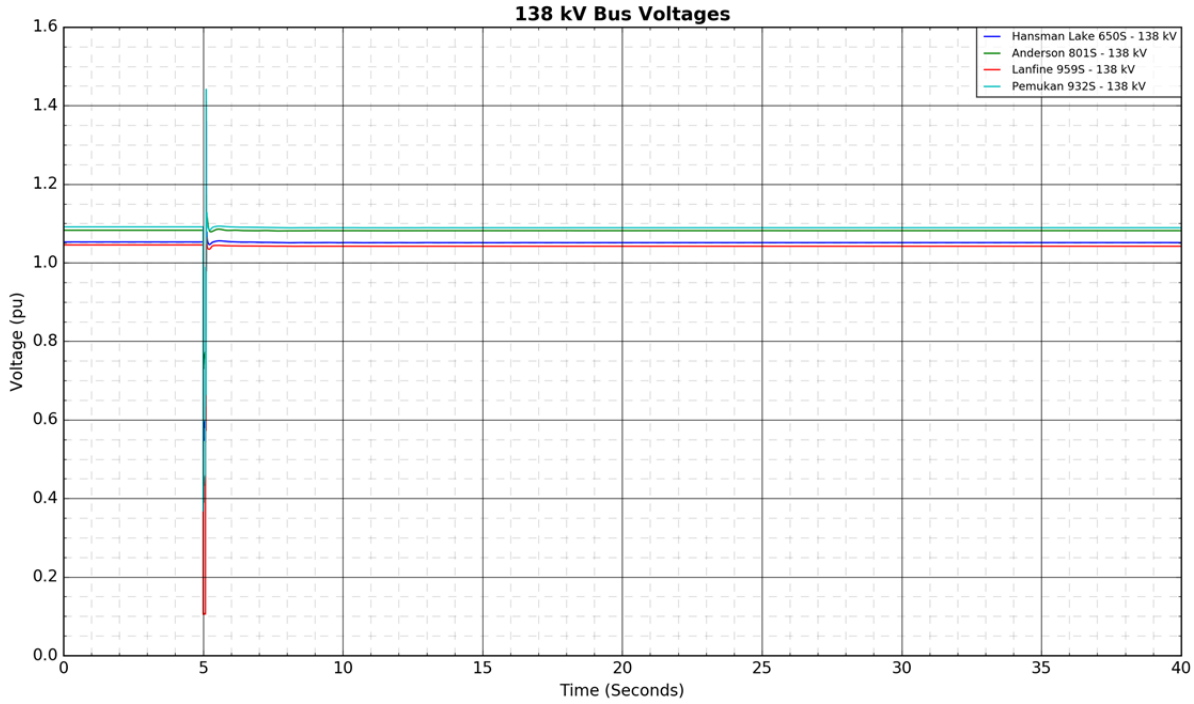
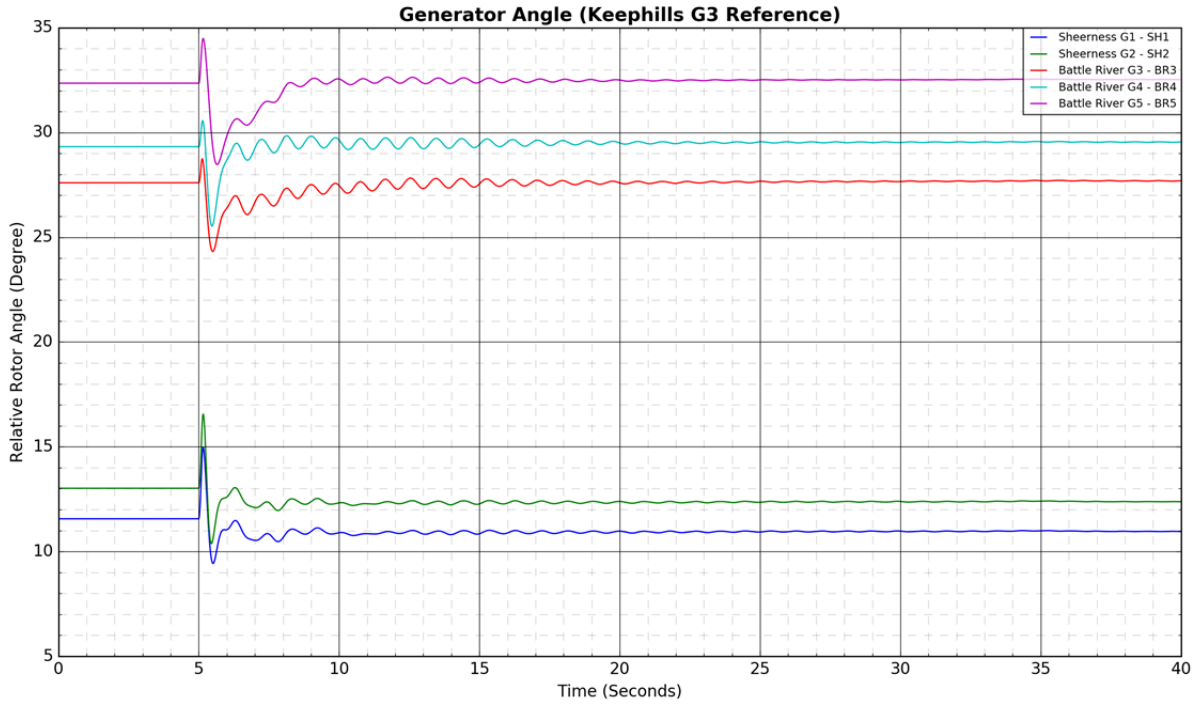
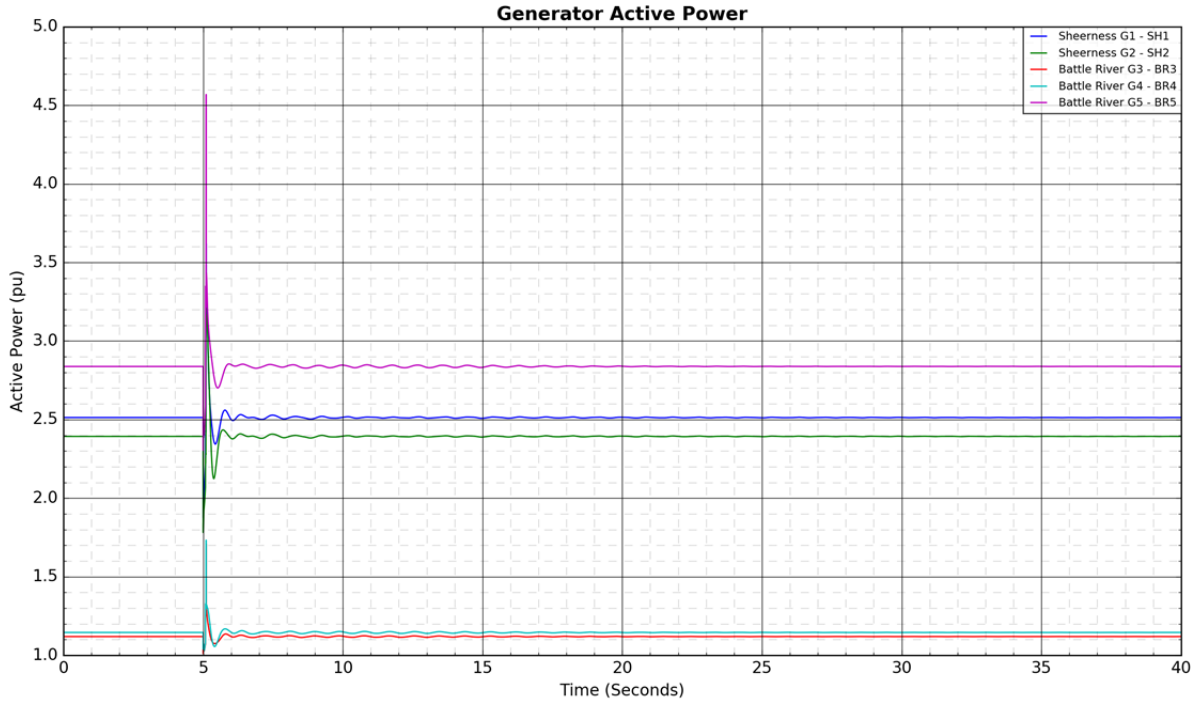

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

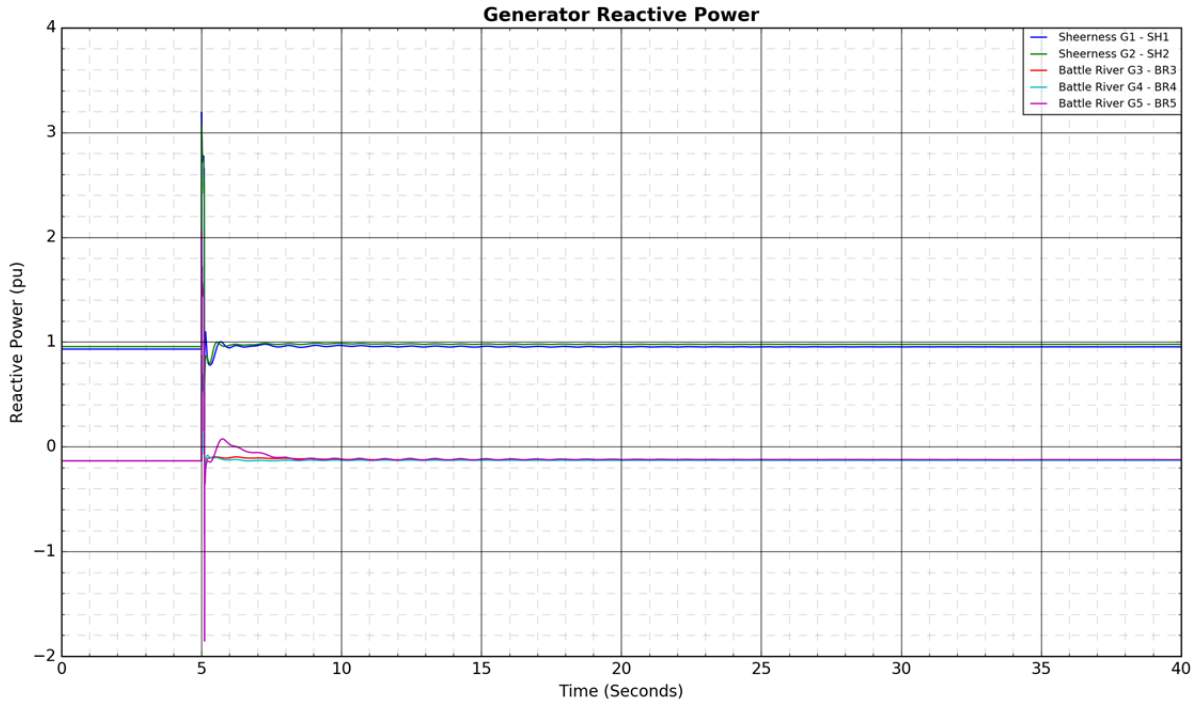
Figure A4-14: 9L24 Oakland 946S to Lanfine 959S: Fault Near Lanfine 959S

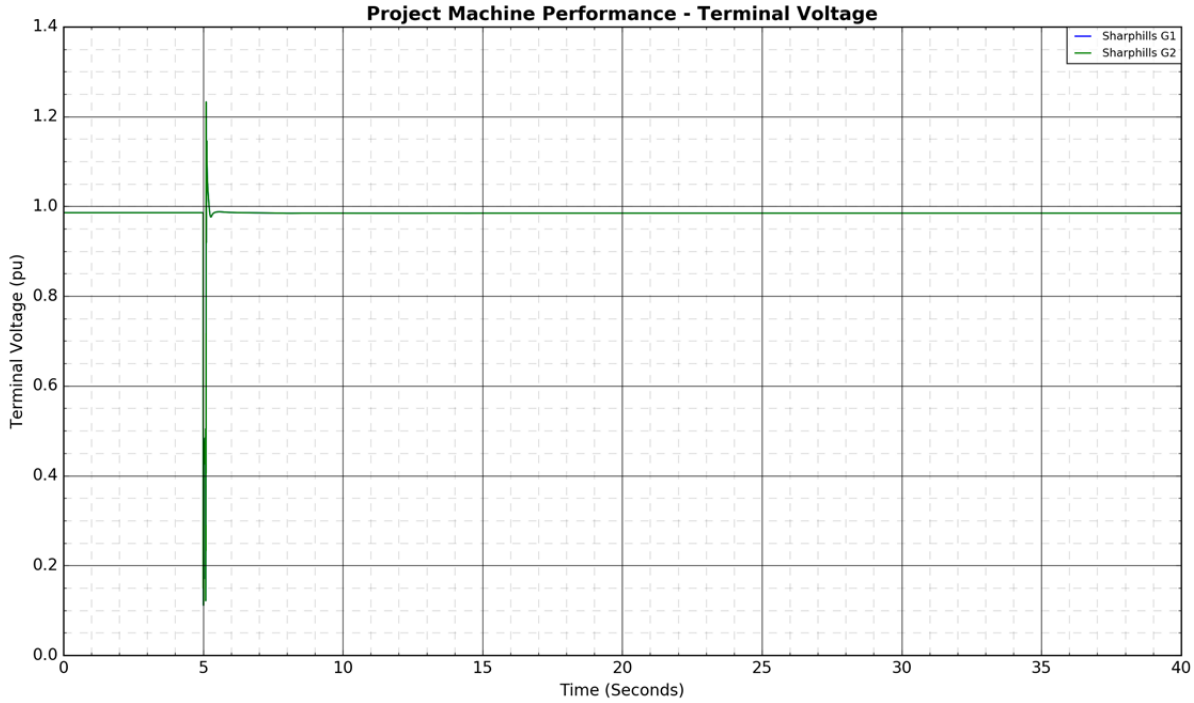


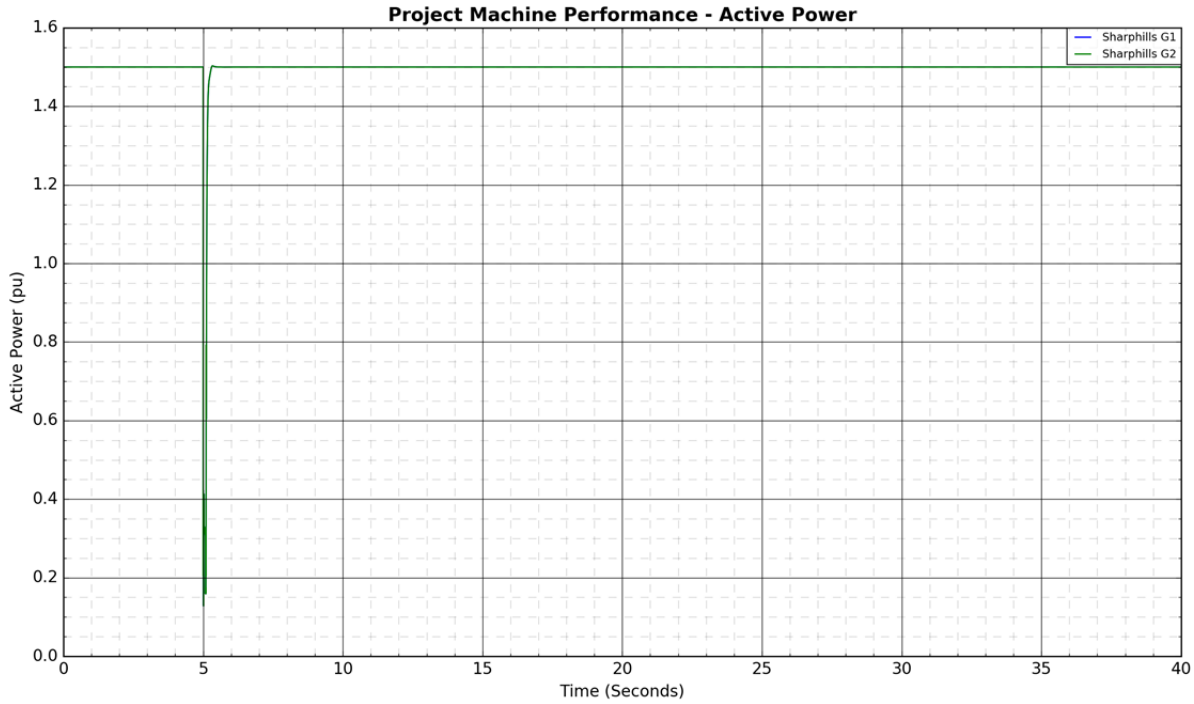


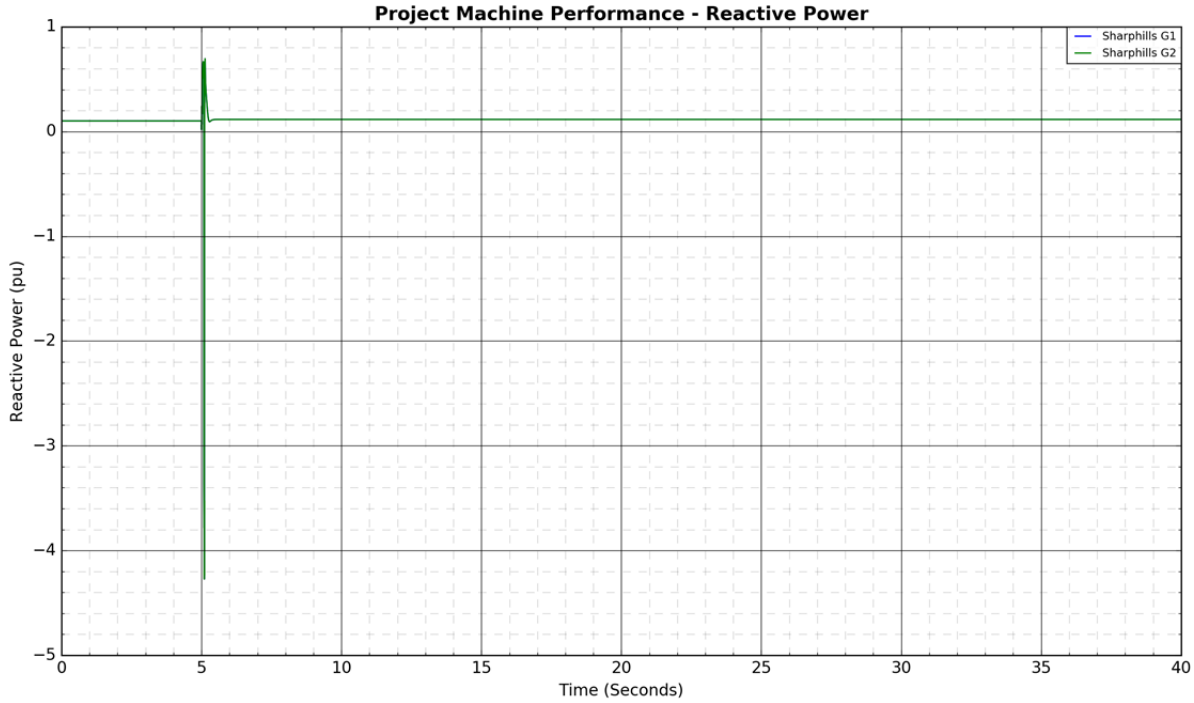

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

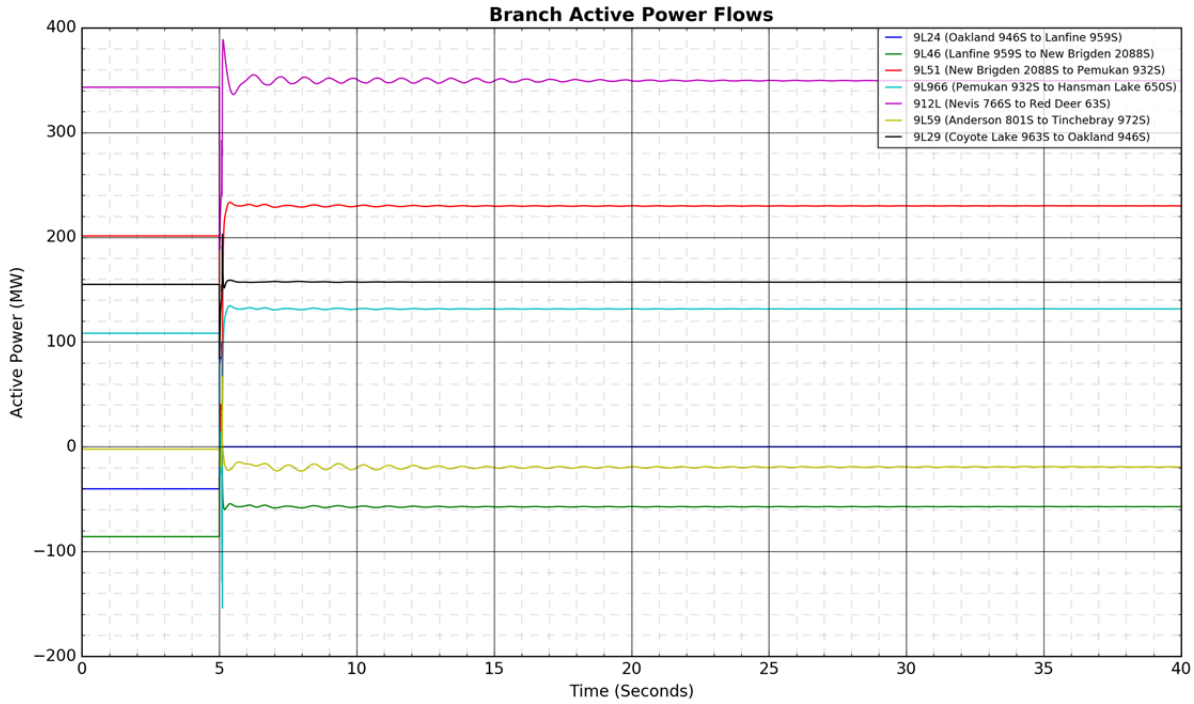

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1
0
−1
−2
−3
−4
−5
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

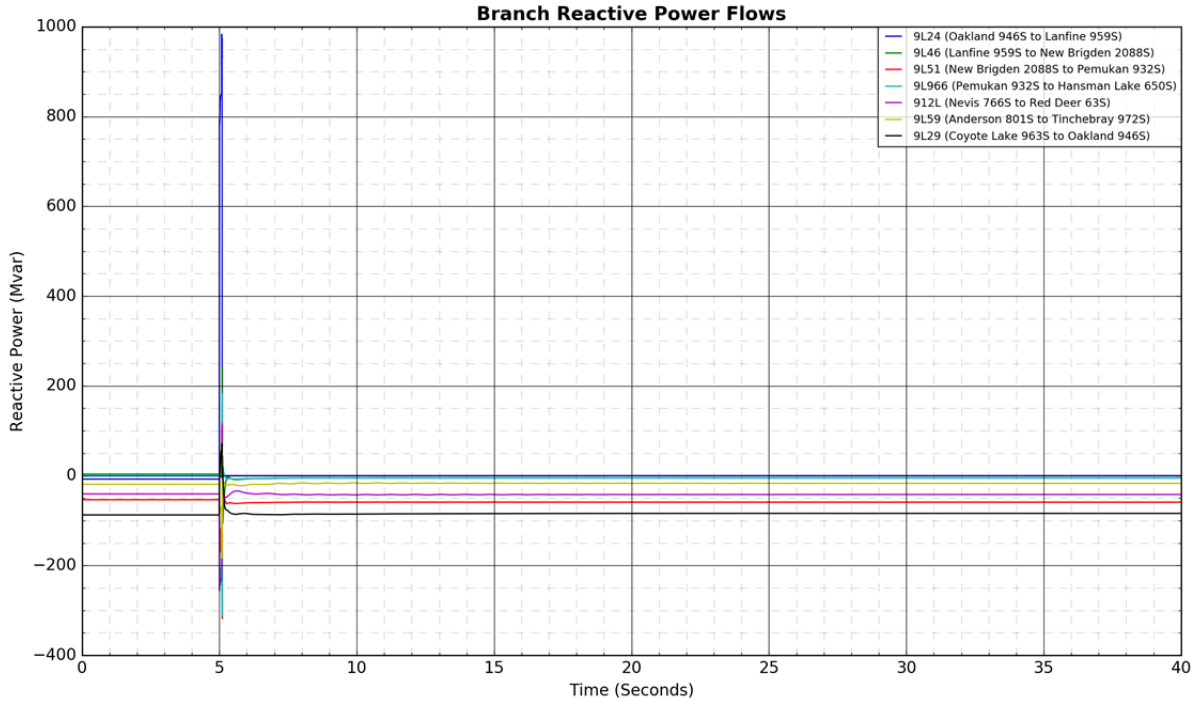
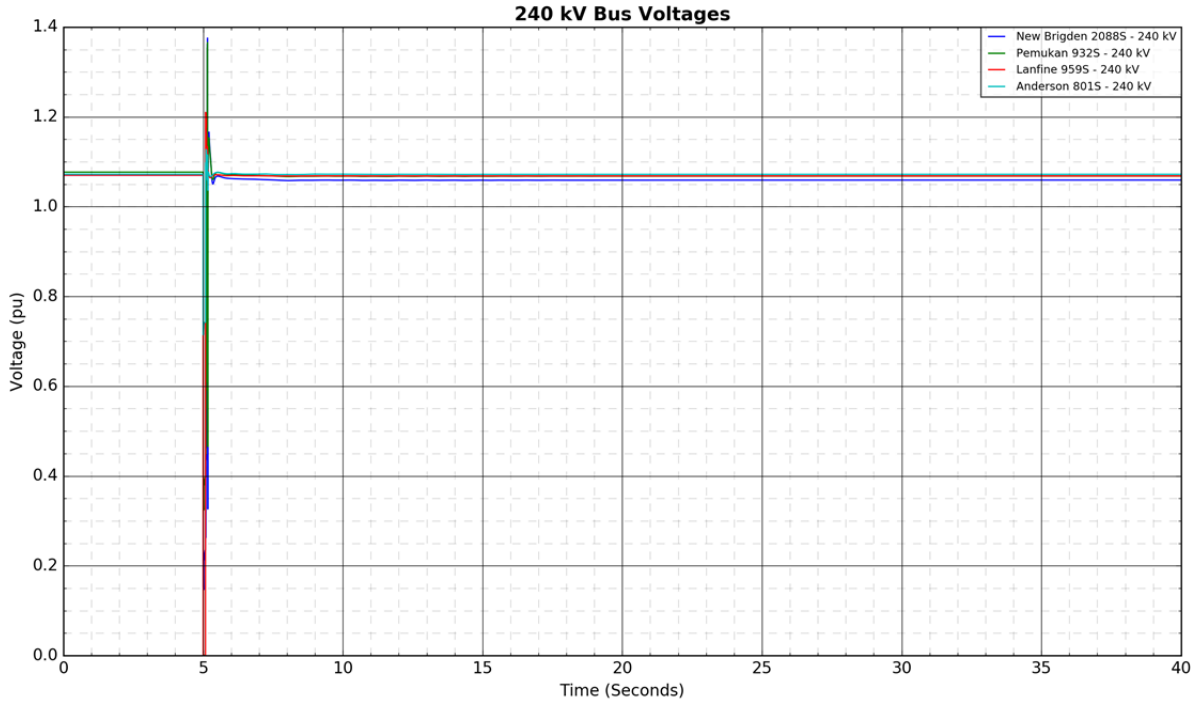
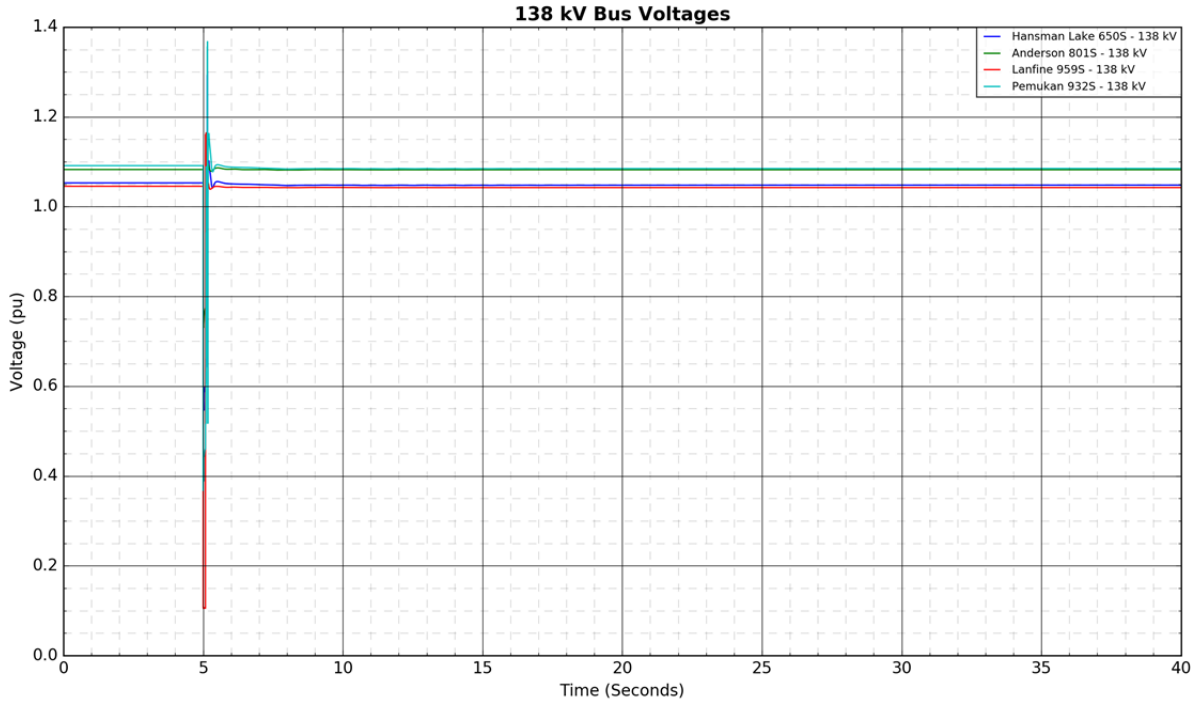
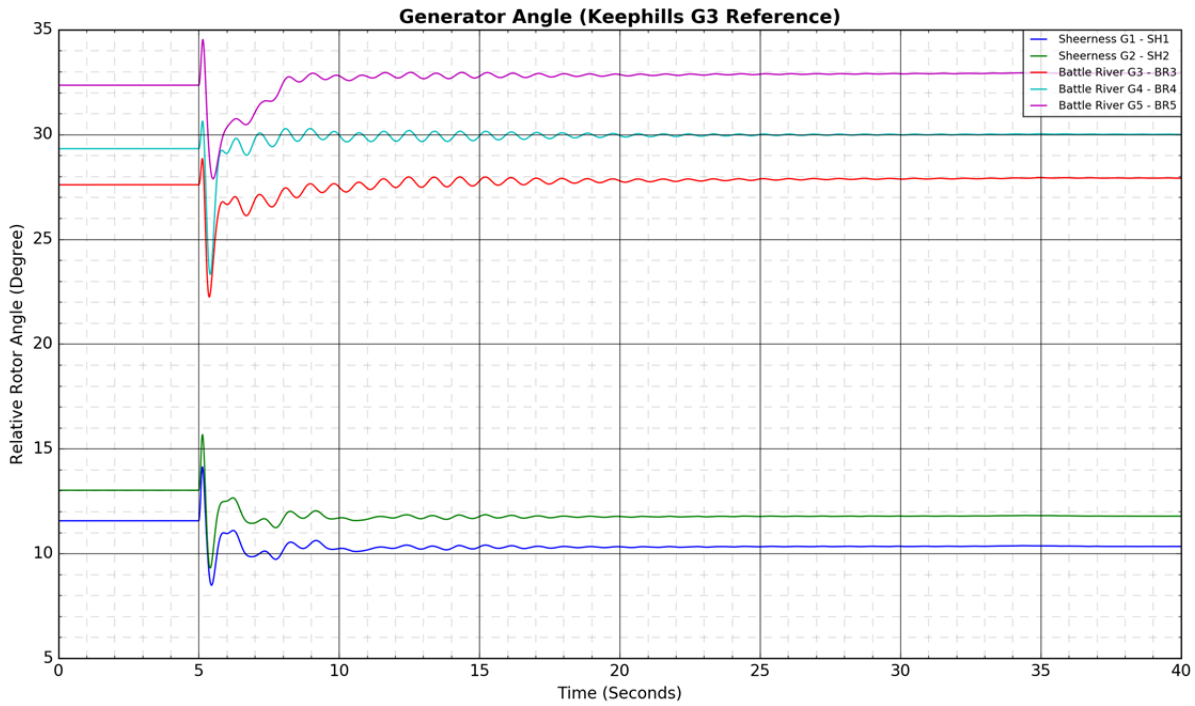
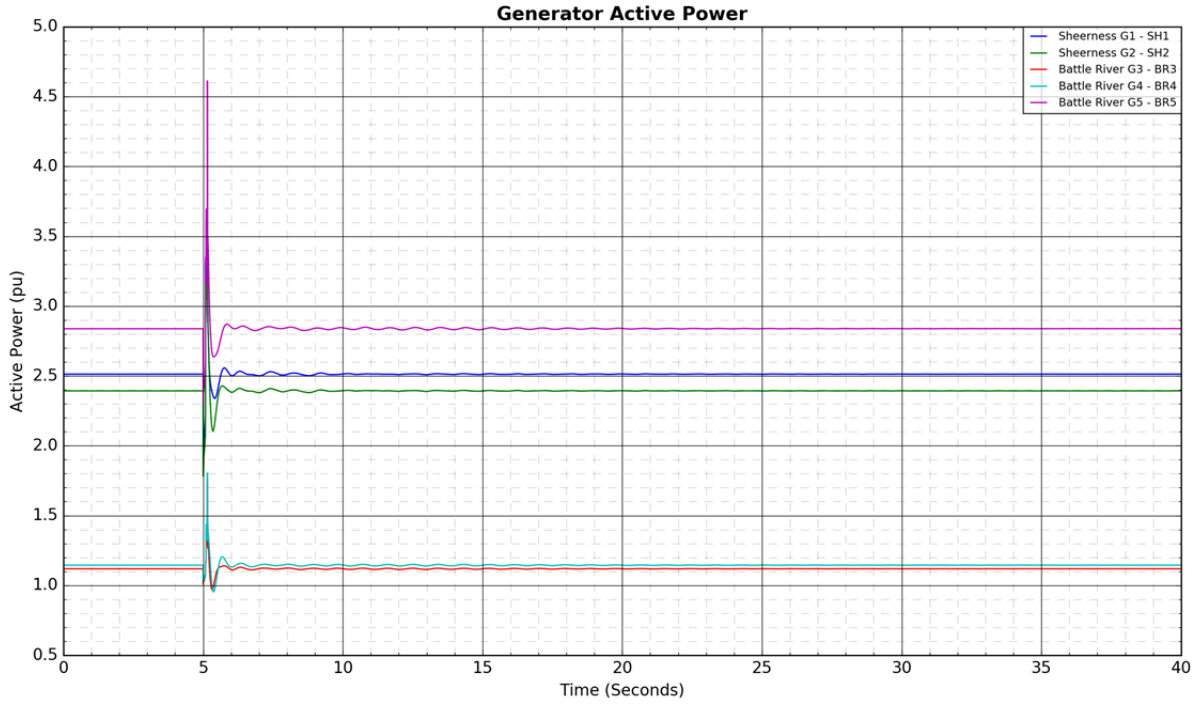

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

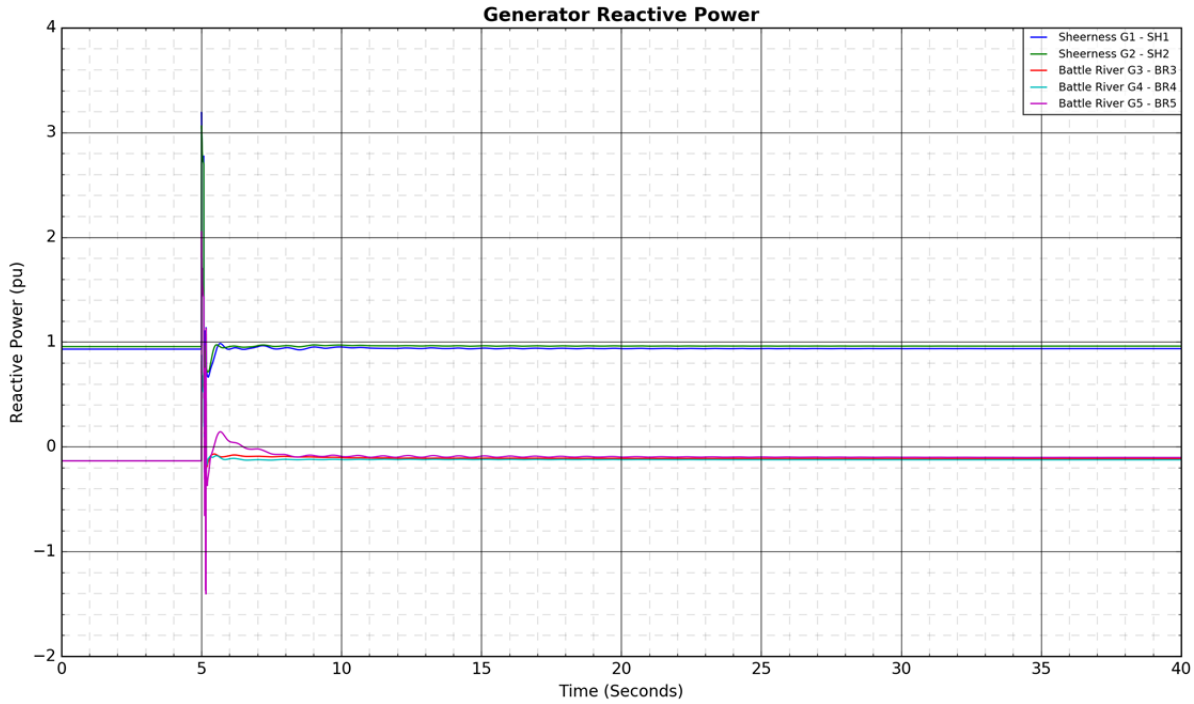
Figure A4-15: 9L46 Lanfine 959S to New Brigden 2088S: Fault Near Lanfine 959S

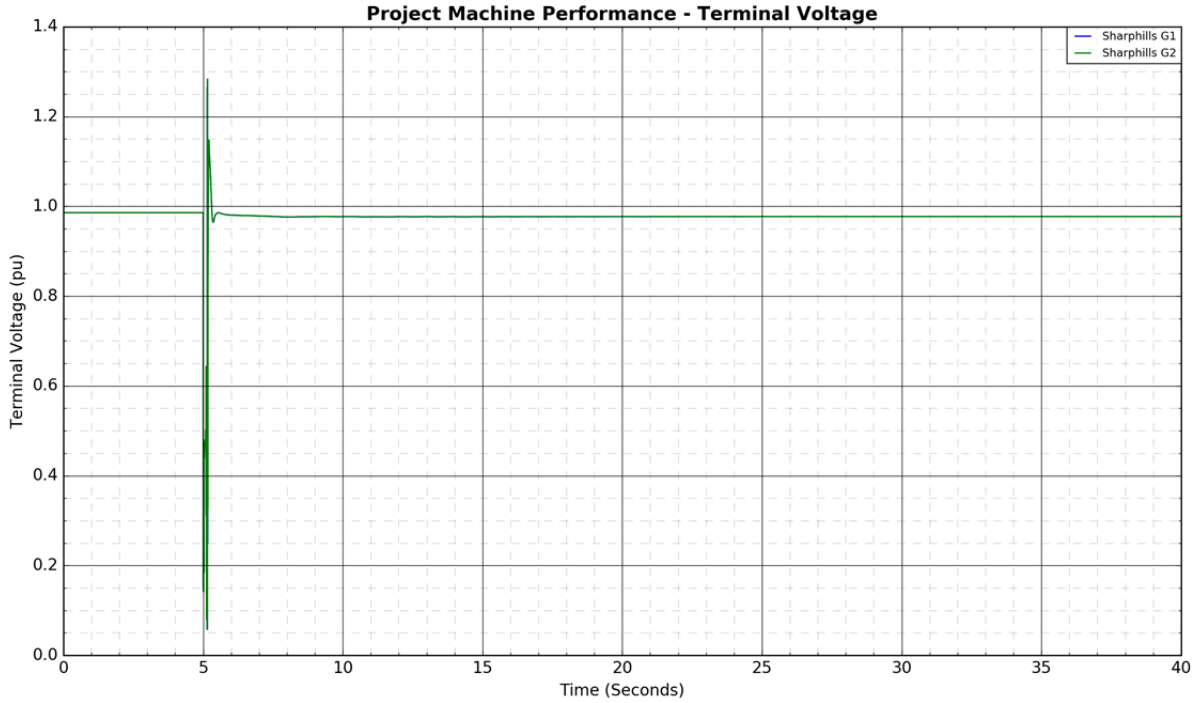


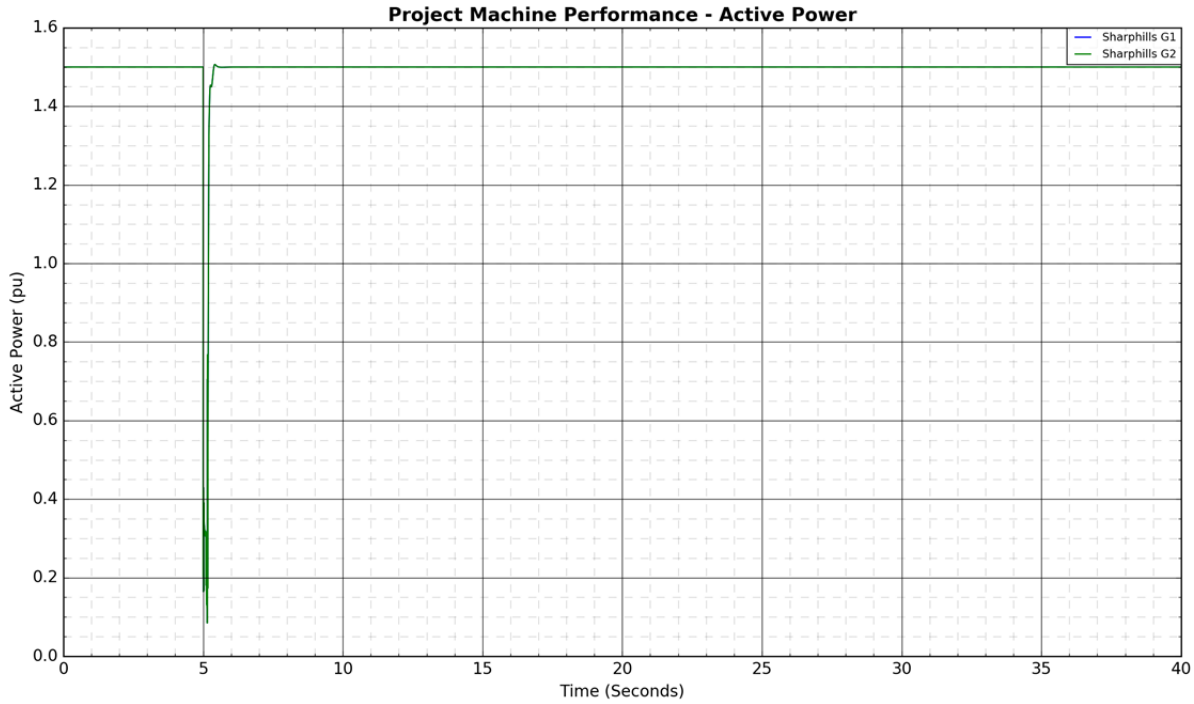


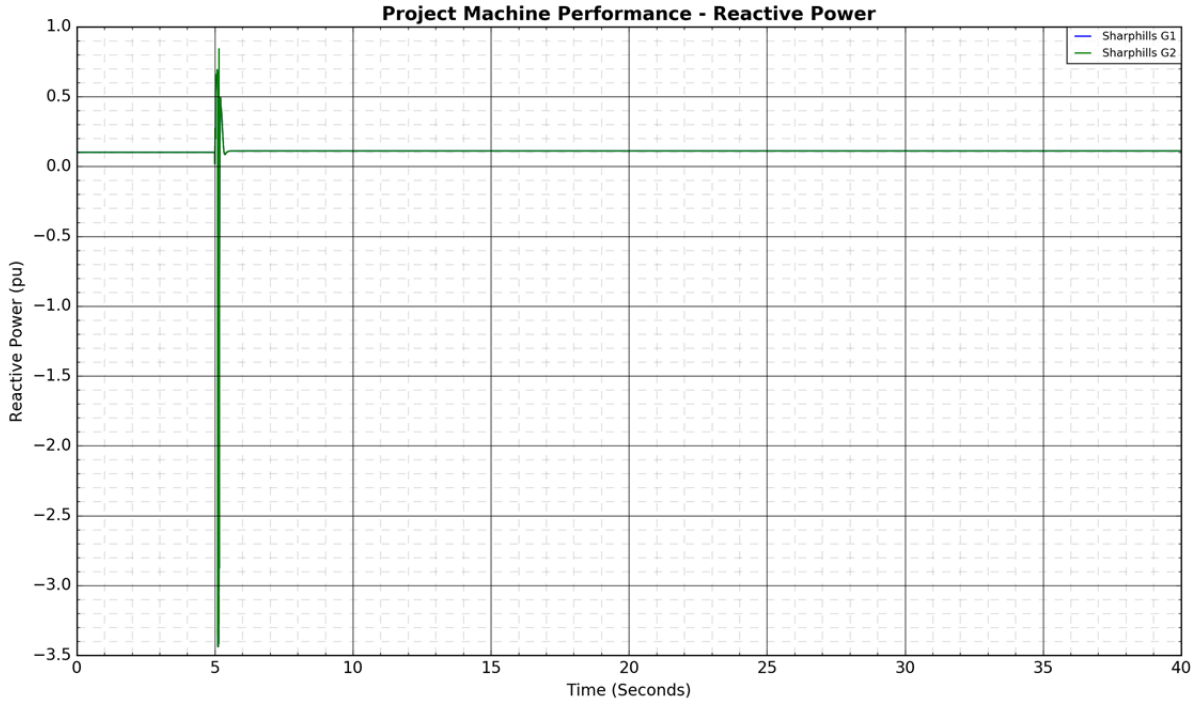

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

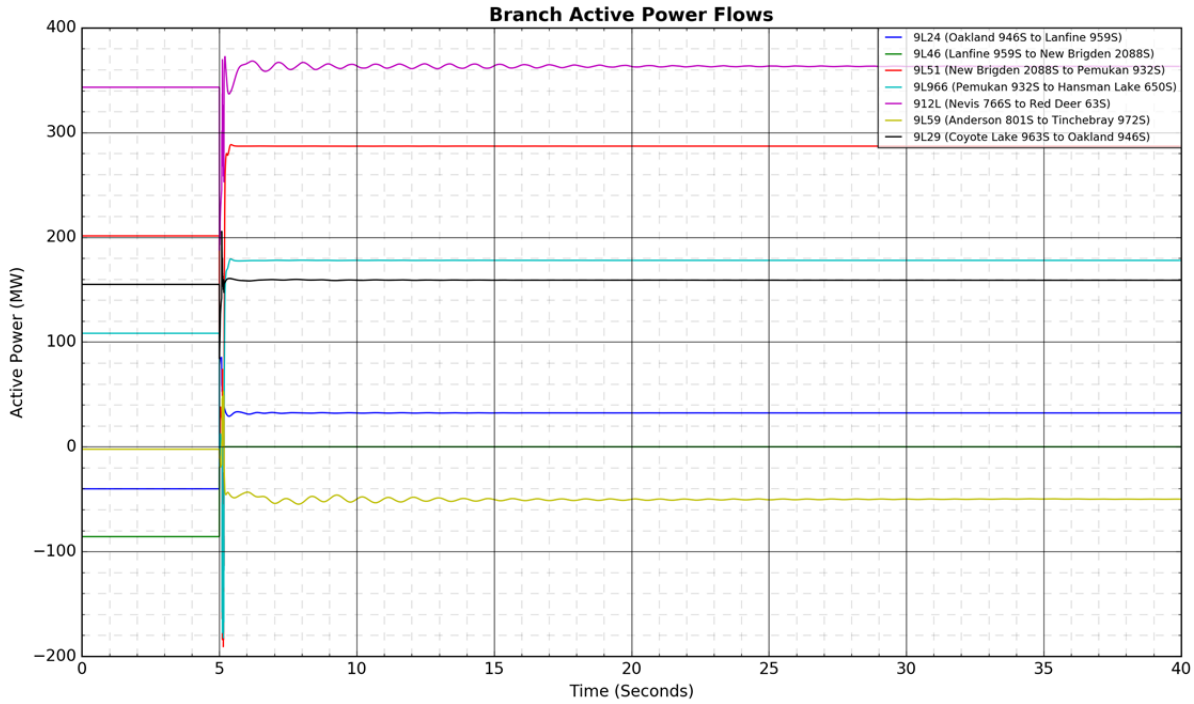

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

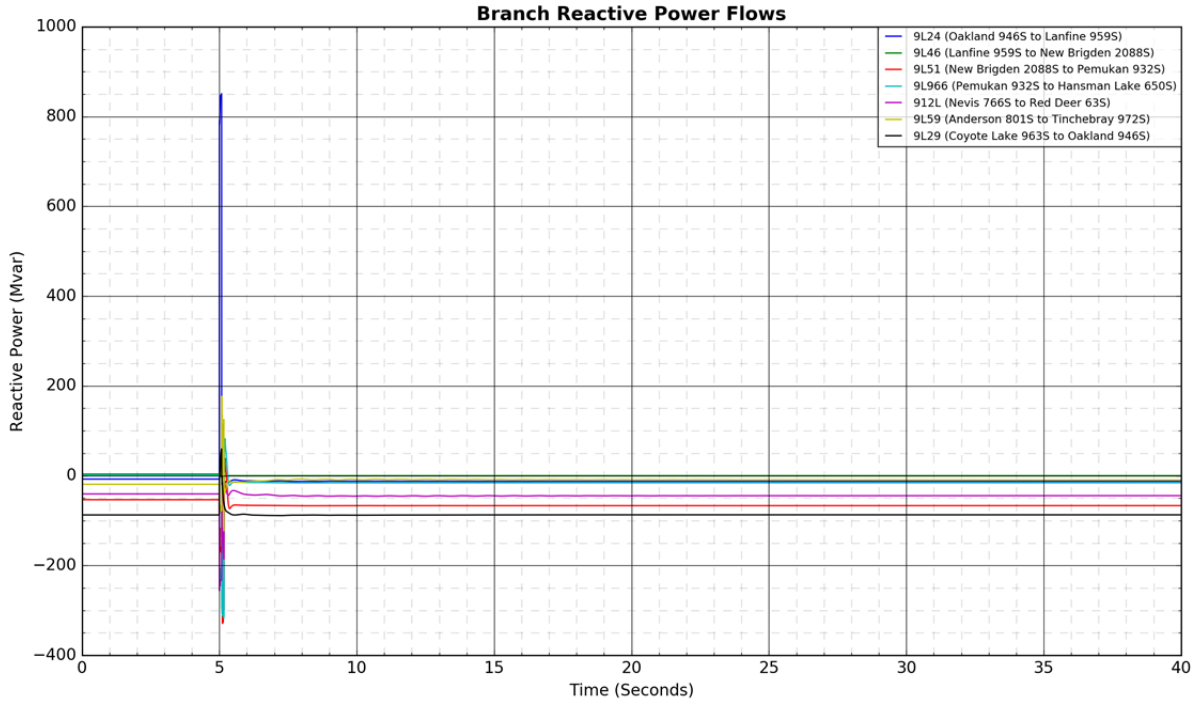
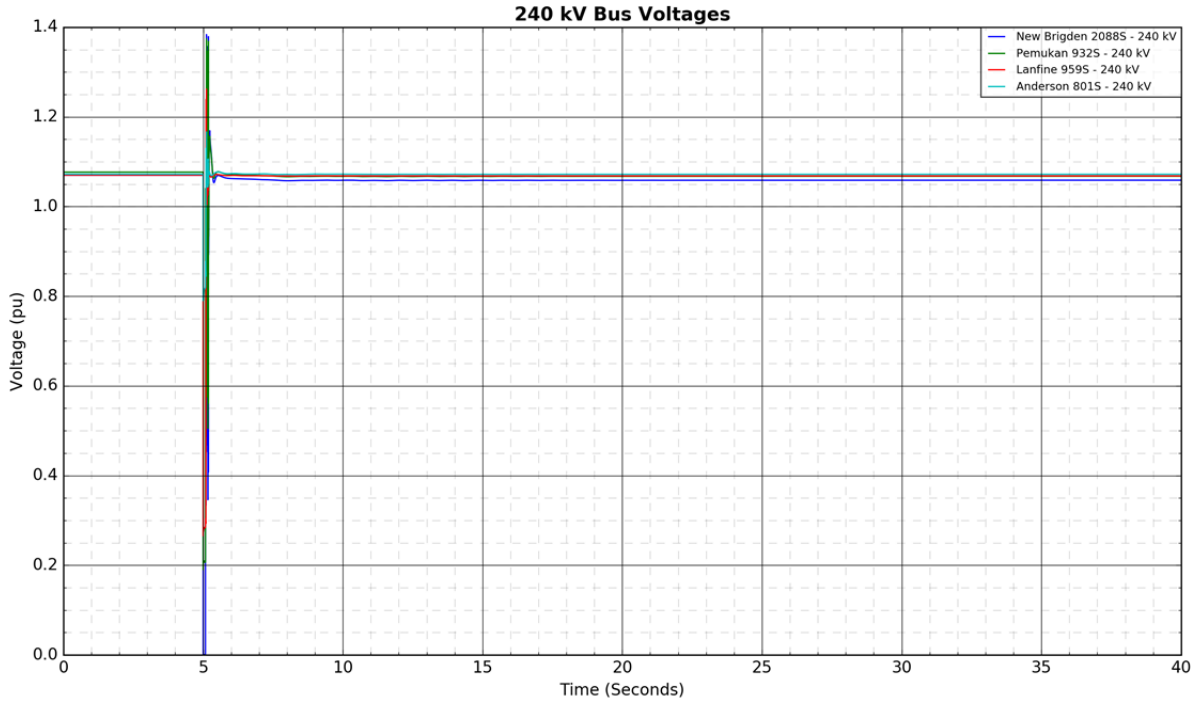
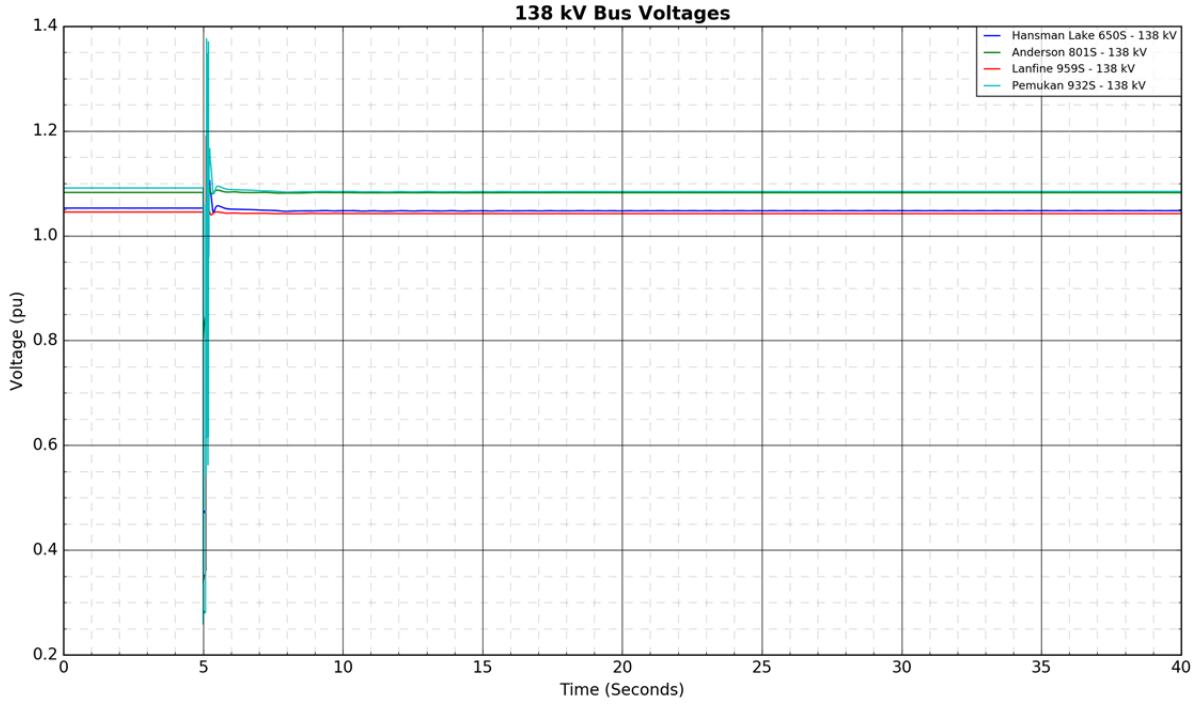
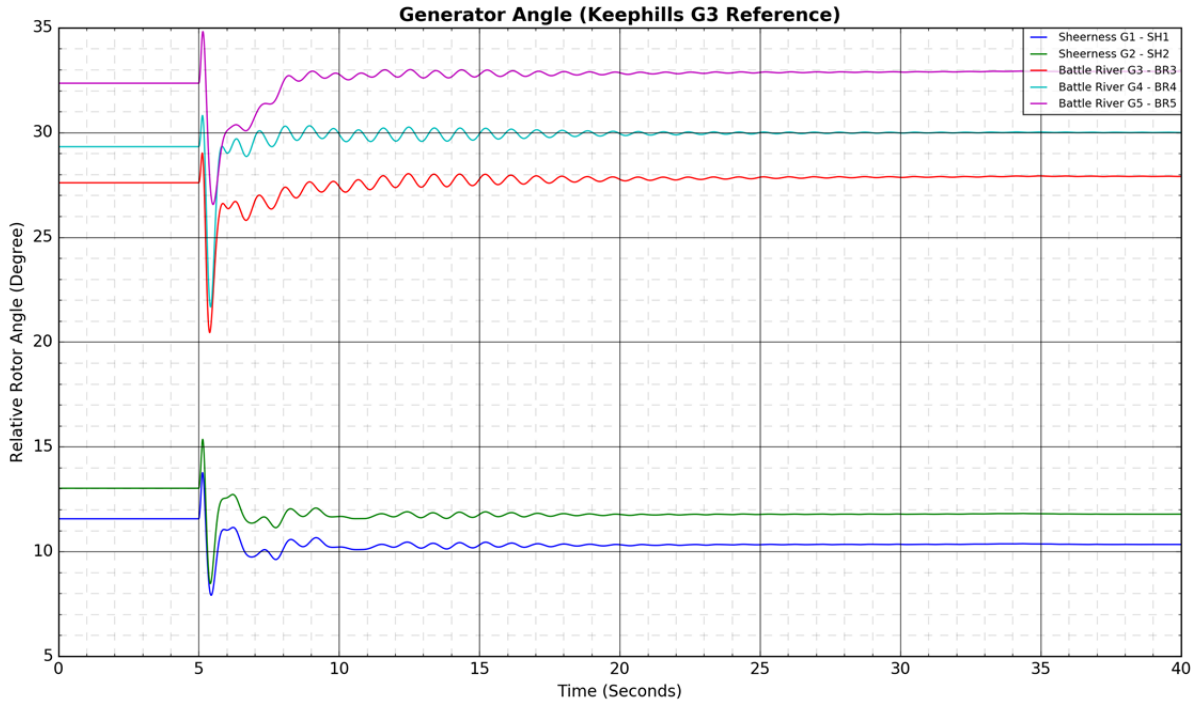
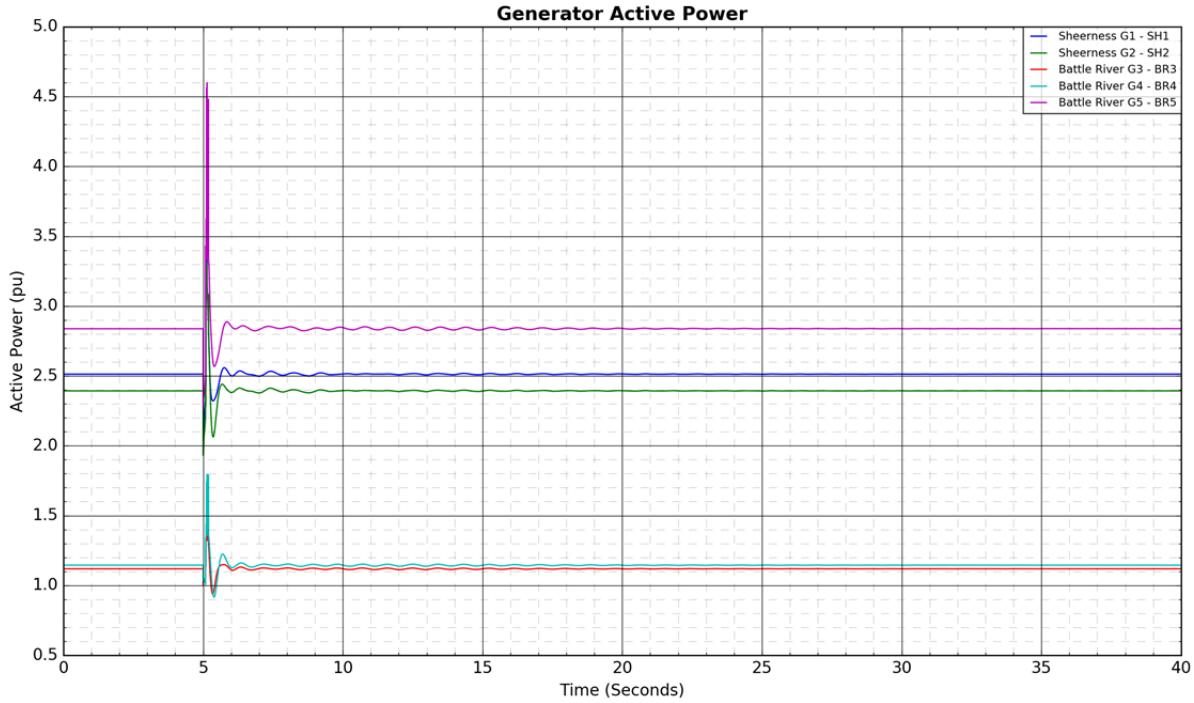

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

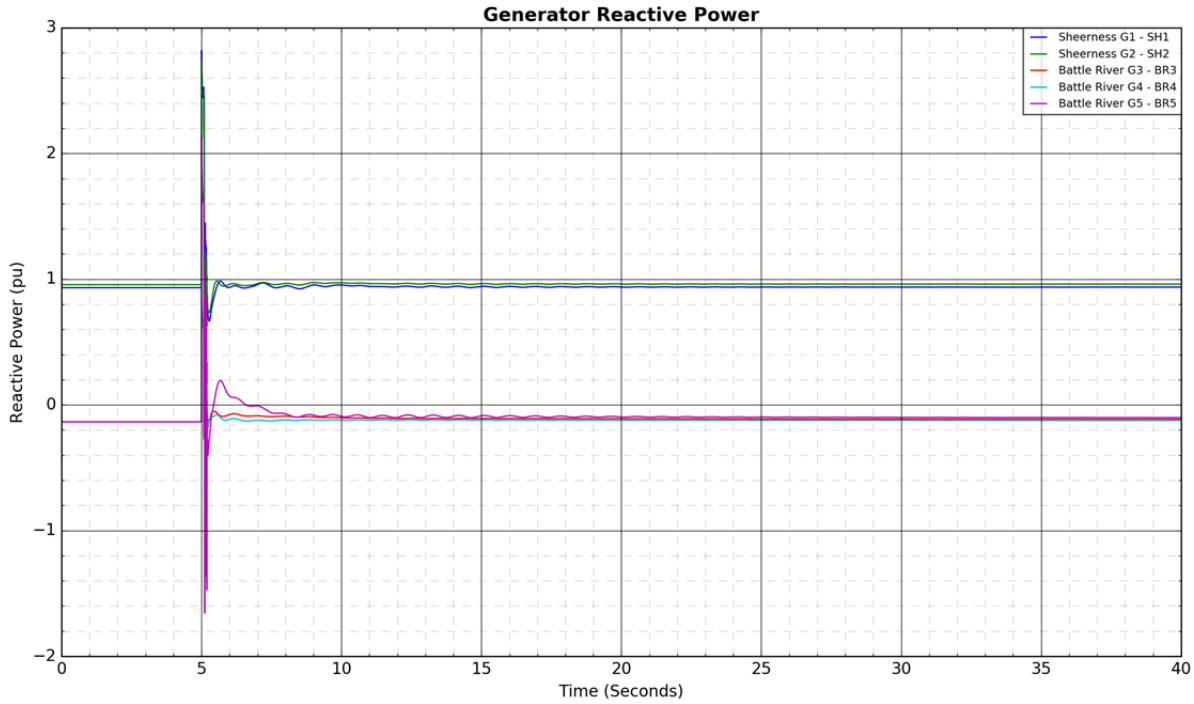
Figure A4-16: 9L46 Lanfine 959S to New Brigden 2088S: Fault Near New Brigden 2088S

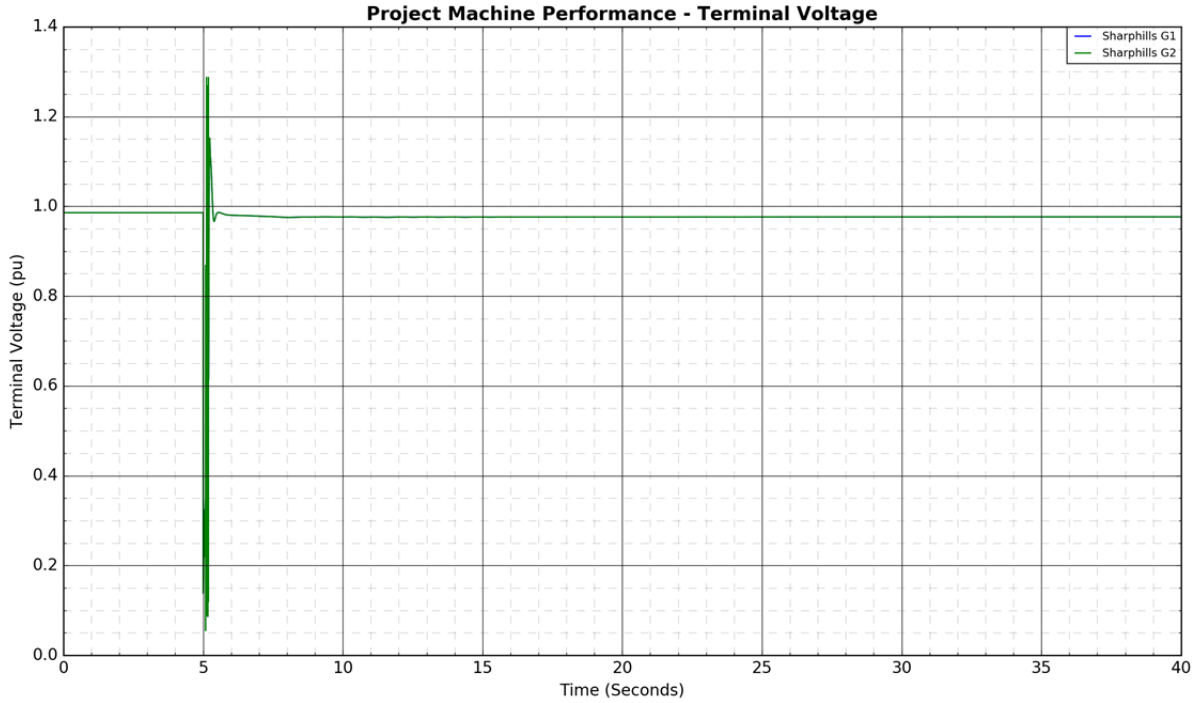


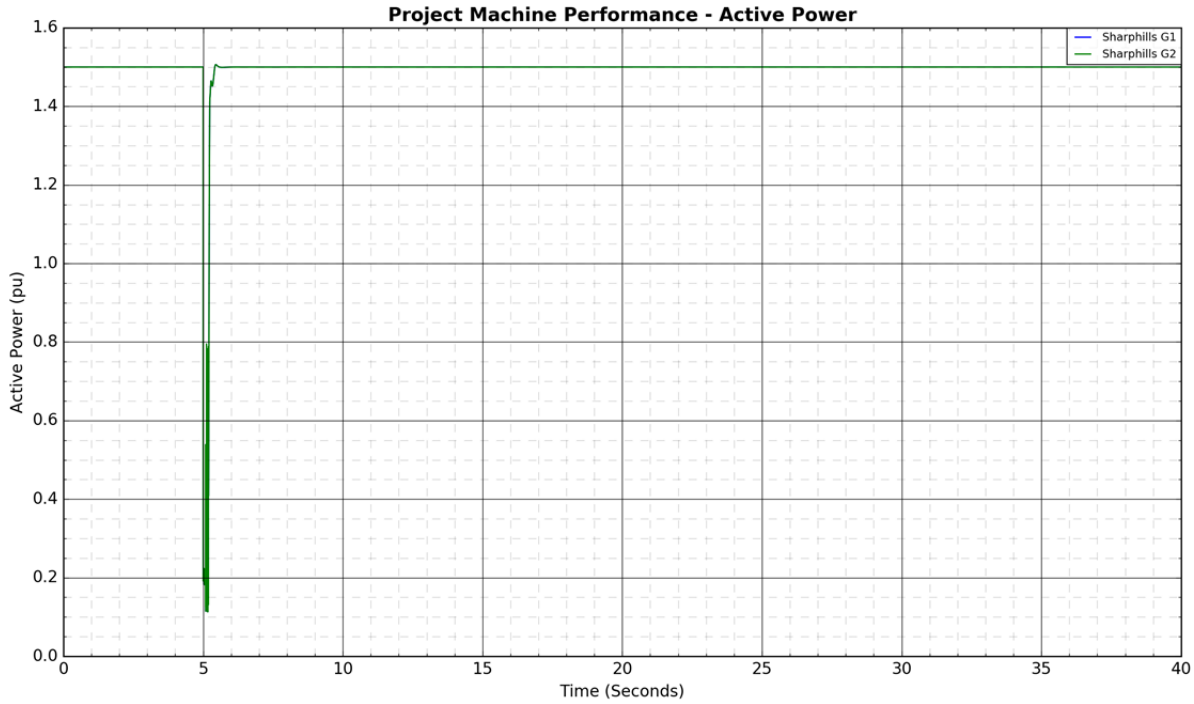


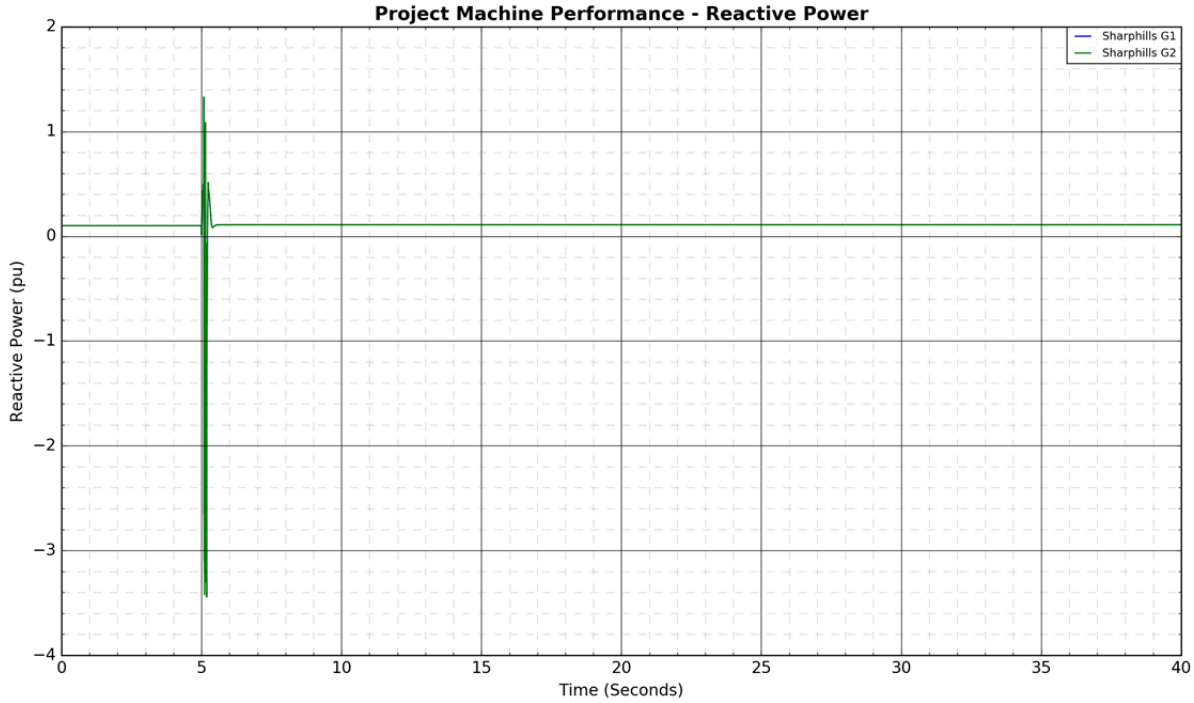

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

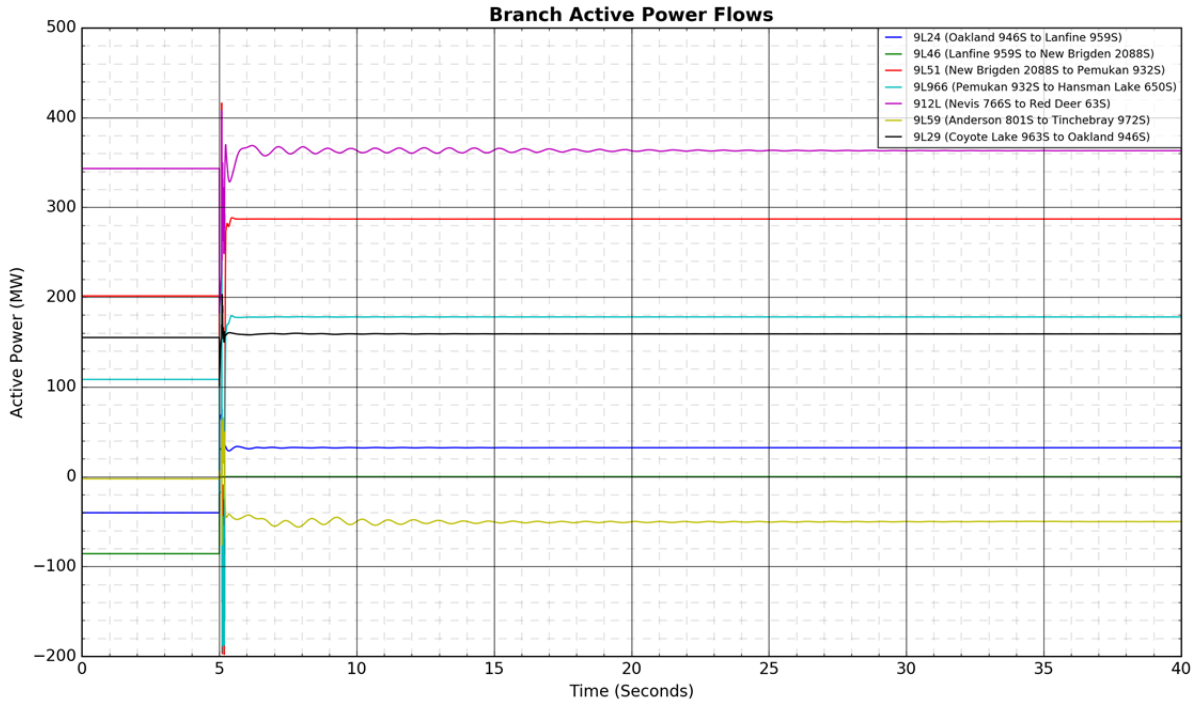

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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)
3
2
1
0
−1
−2
0
5
10
15
20
25
30
35
40


Project Machine Performance - Terminal Voltage
Sharphills G1
Sharphills G2
Terminal Voltage (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


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
2
1
0
−1
−2
−3
−4
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

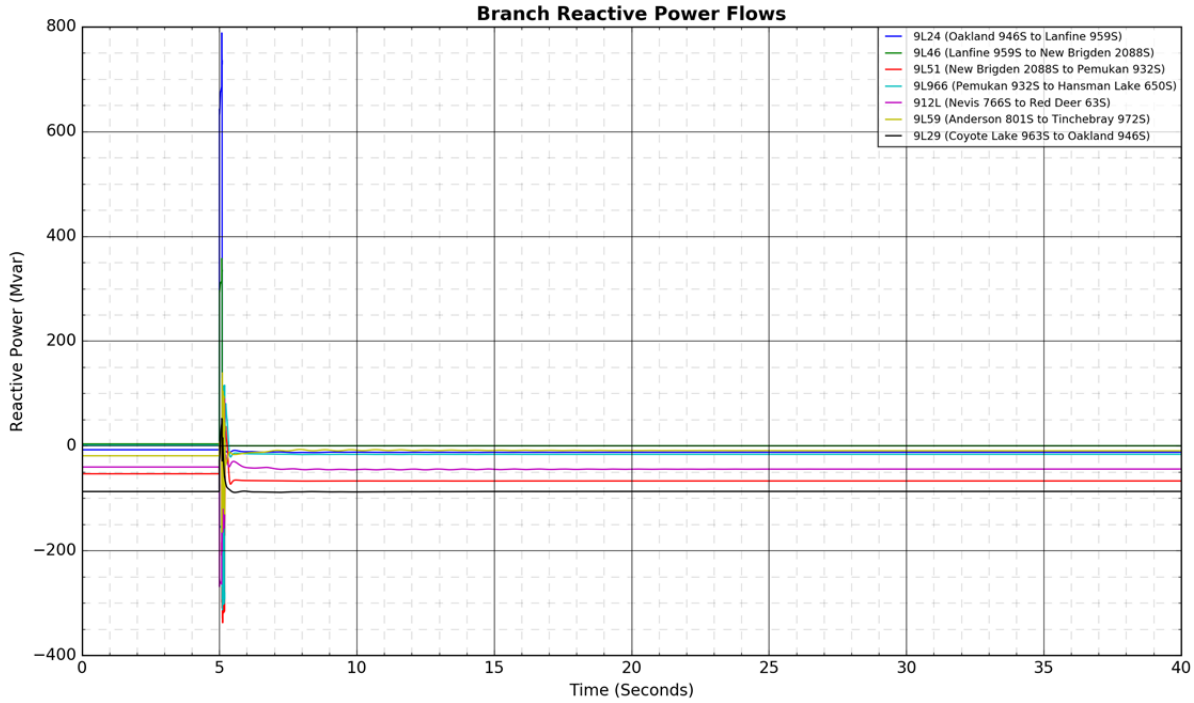
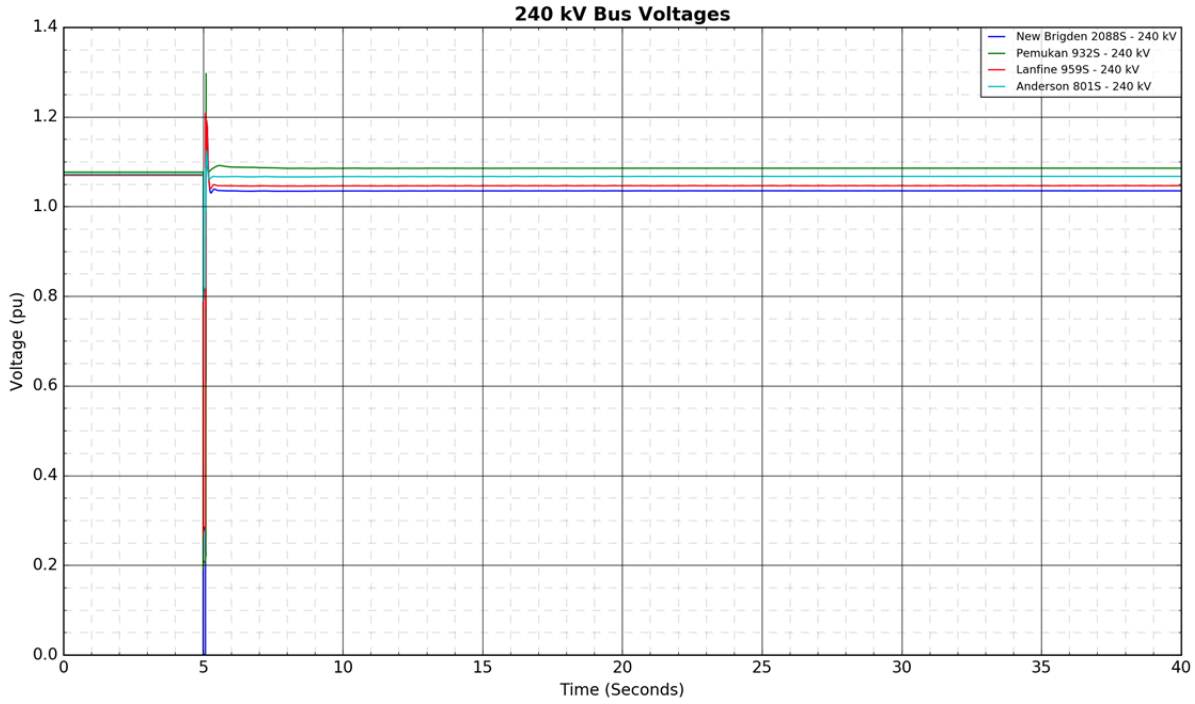
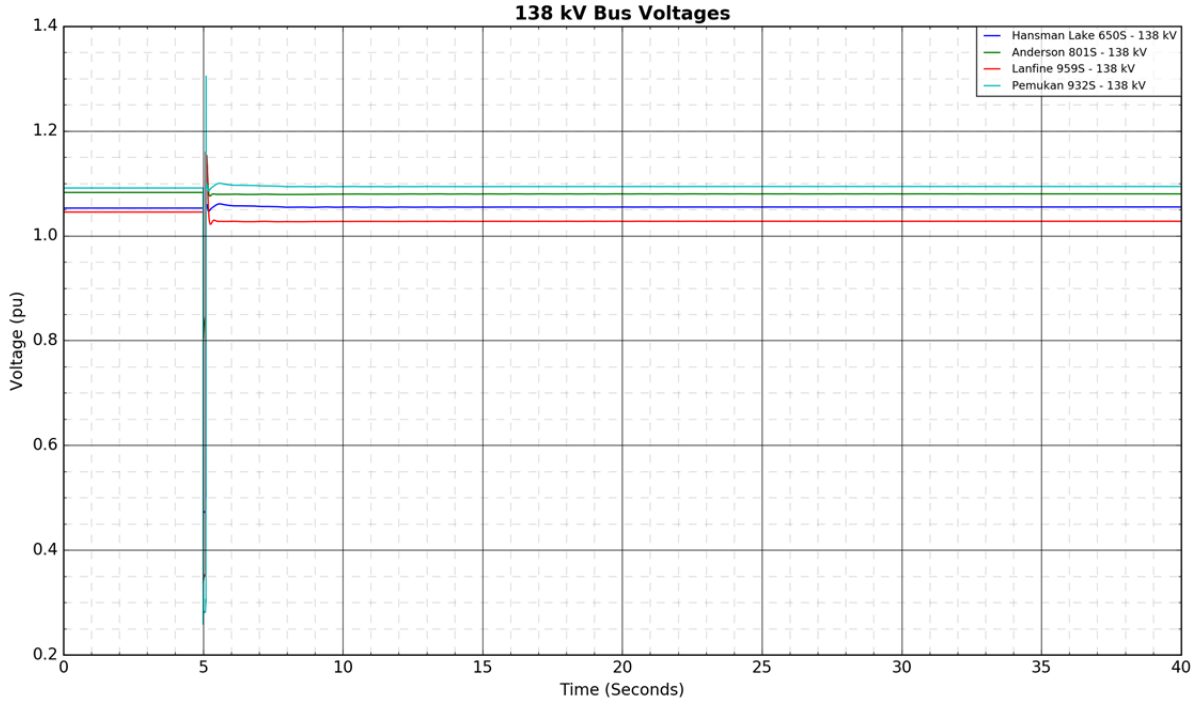
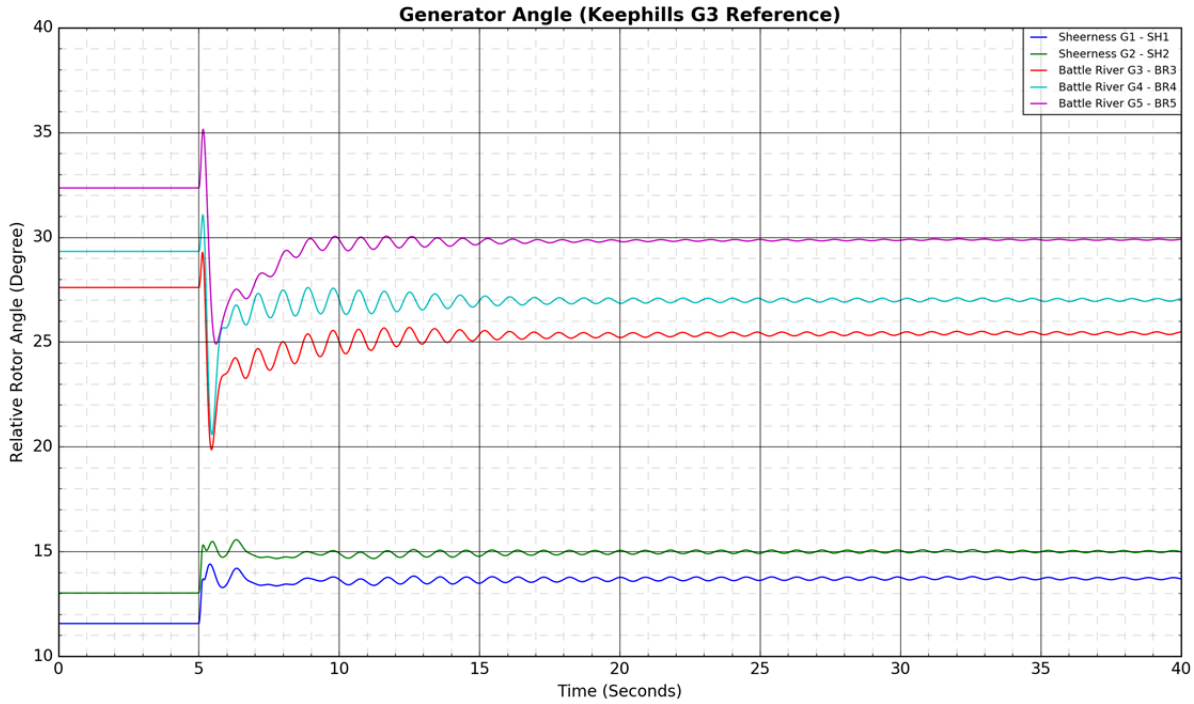
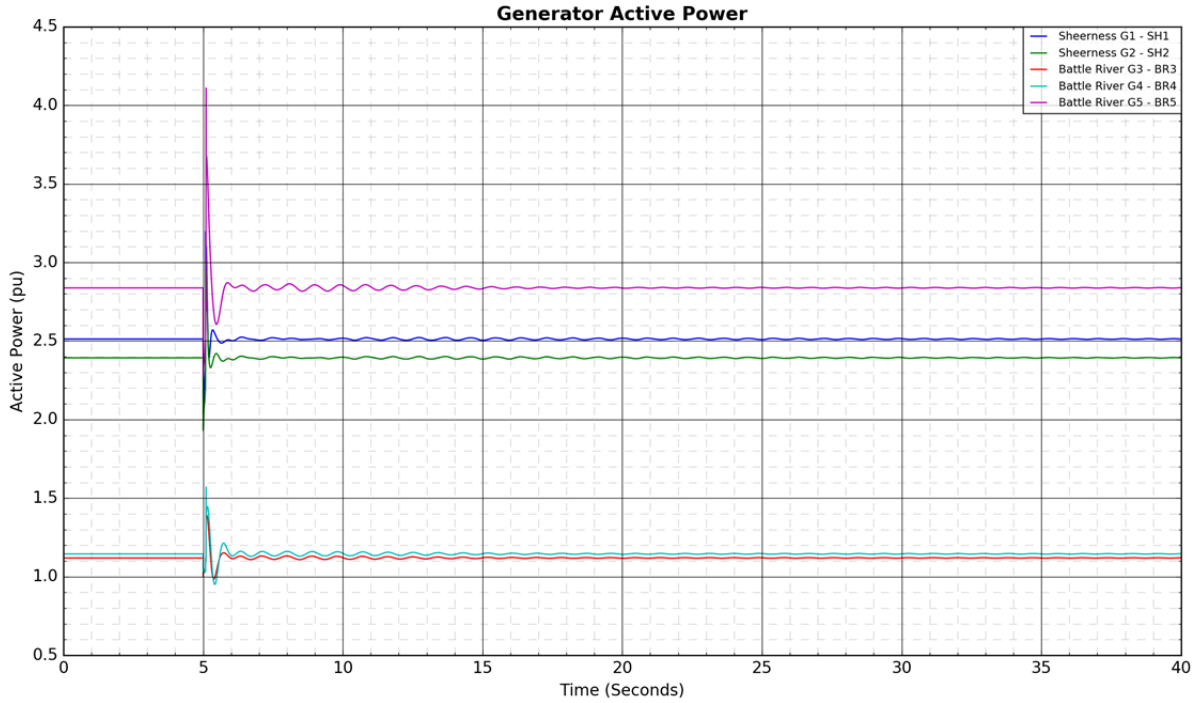

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

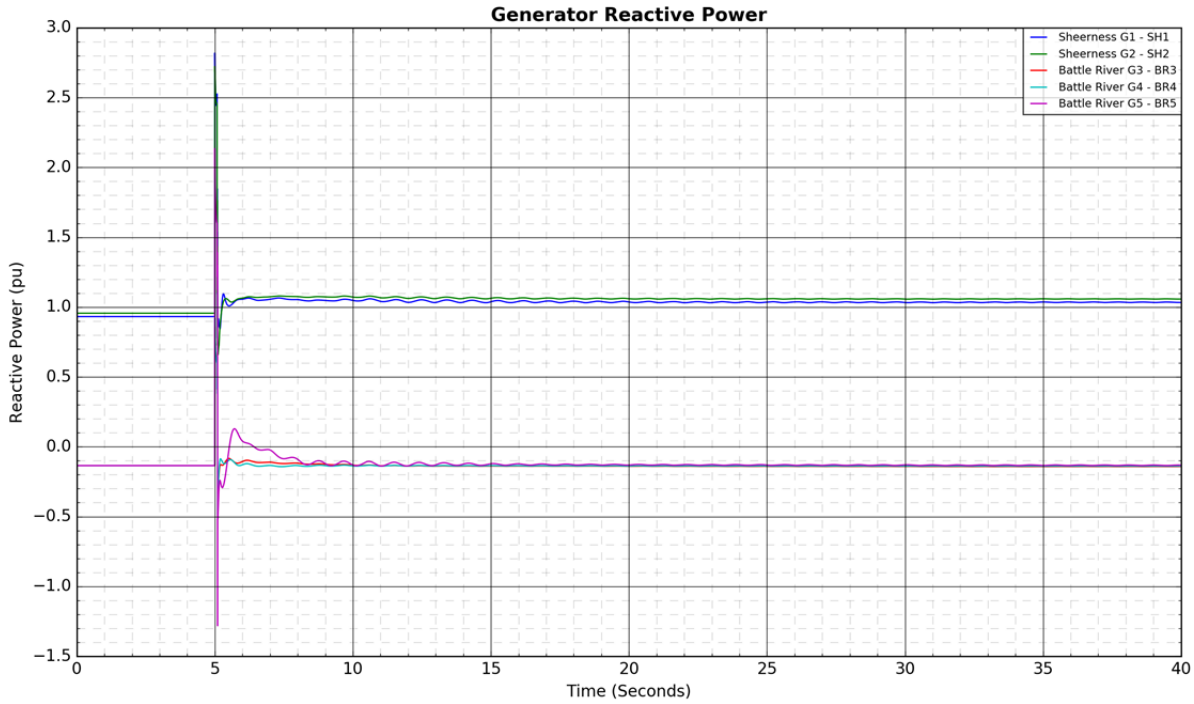
Figure A4-17: 9L51 New Brigden 2088S to Pemukan 932S: Fault Near New Brigden 2088S

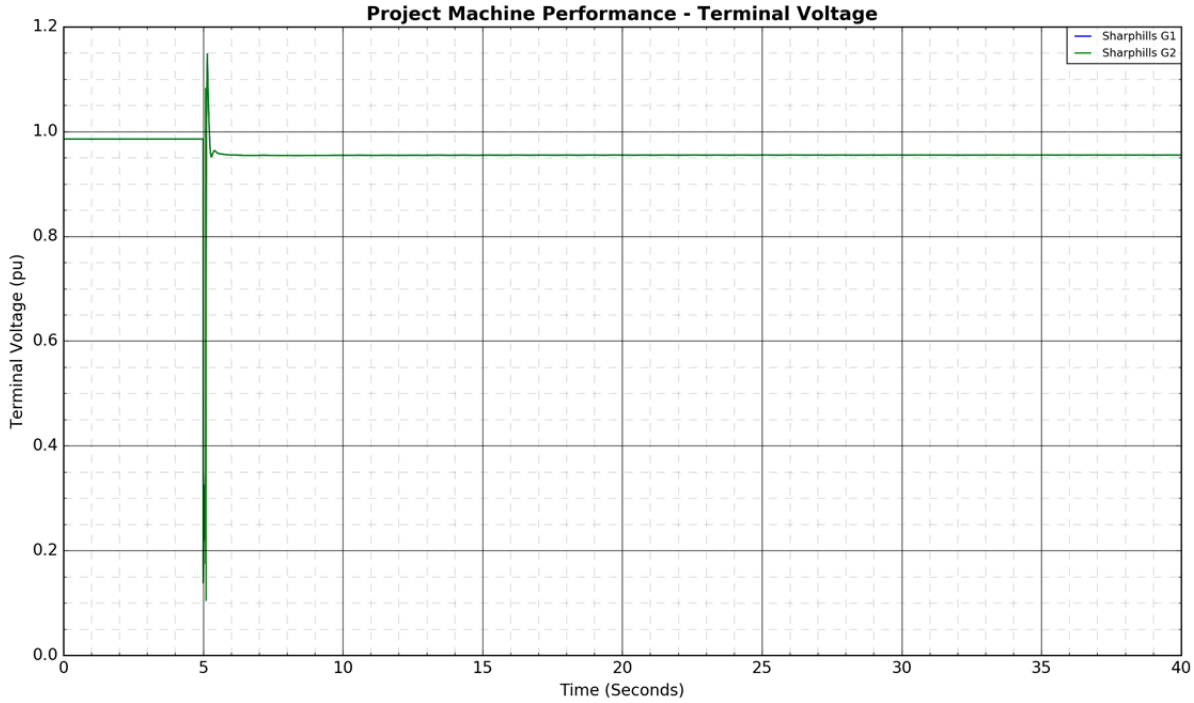


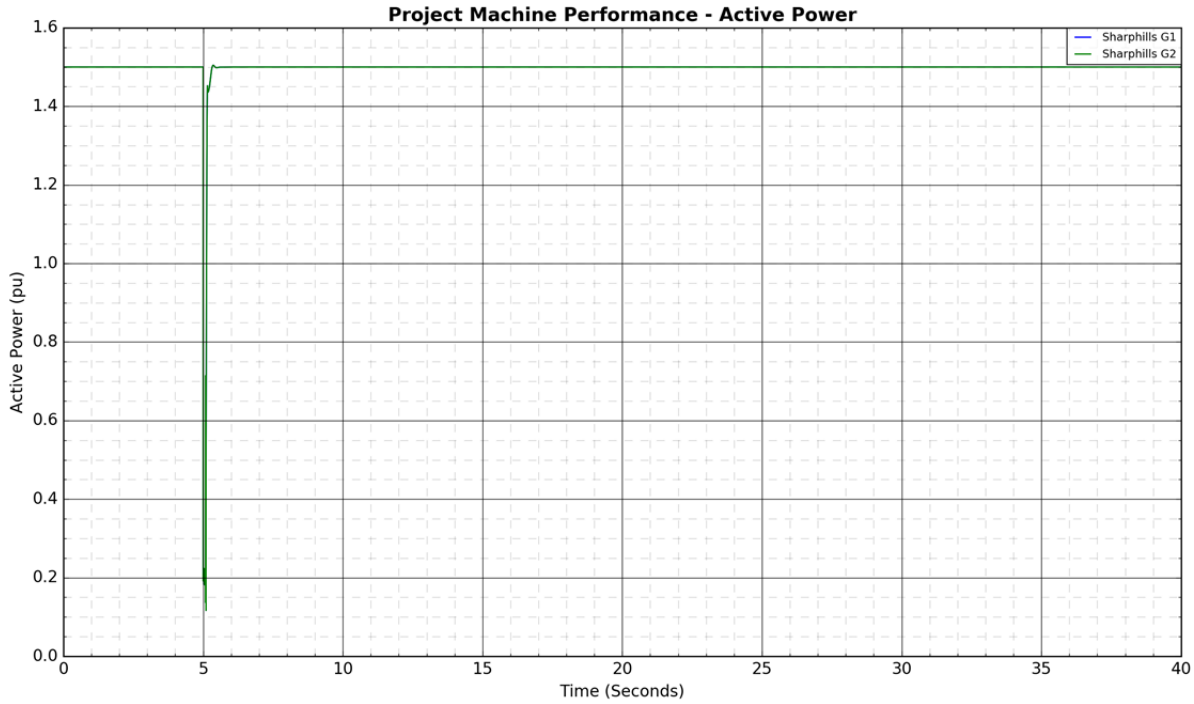


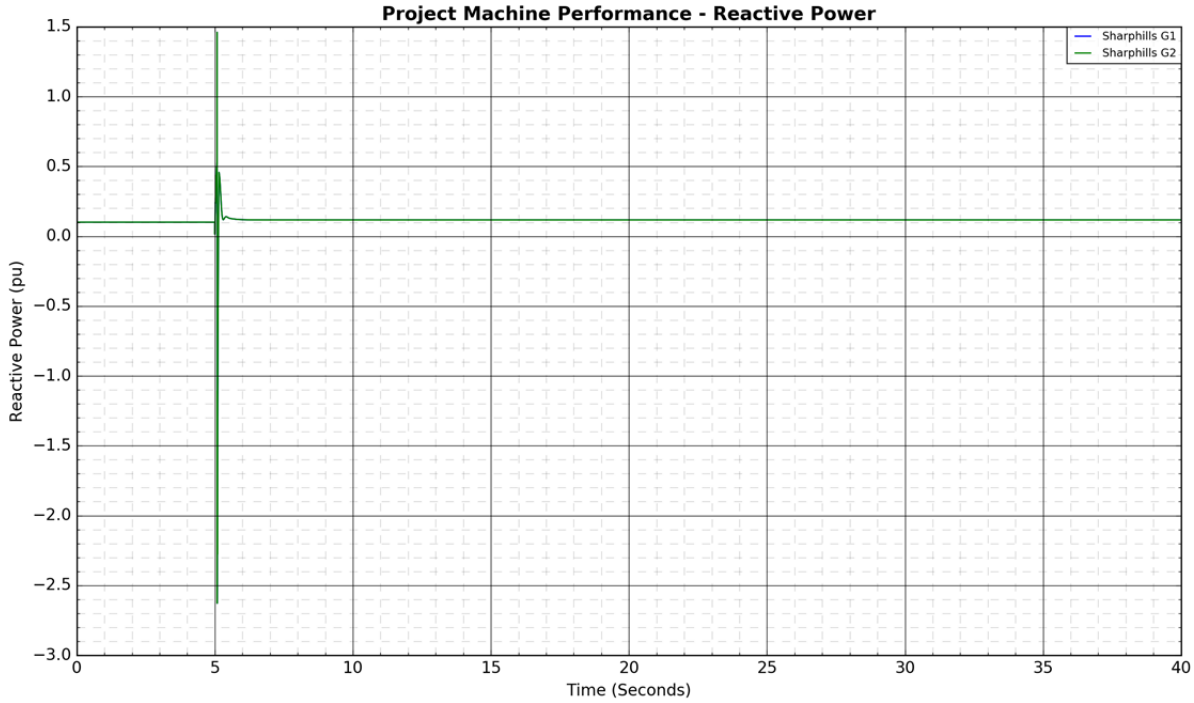

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

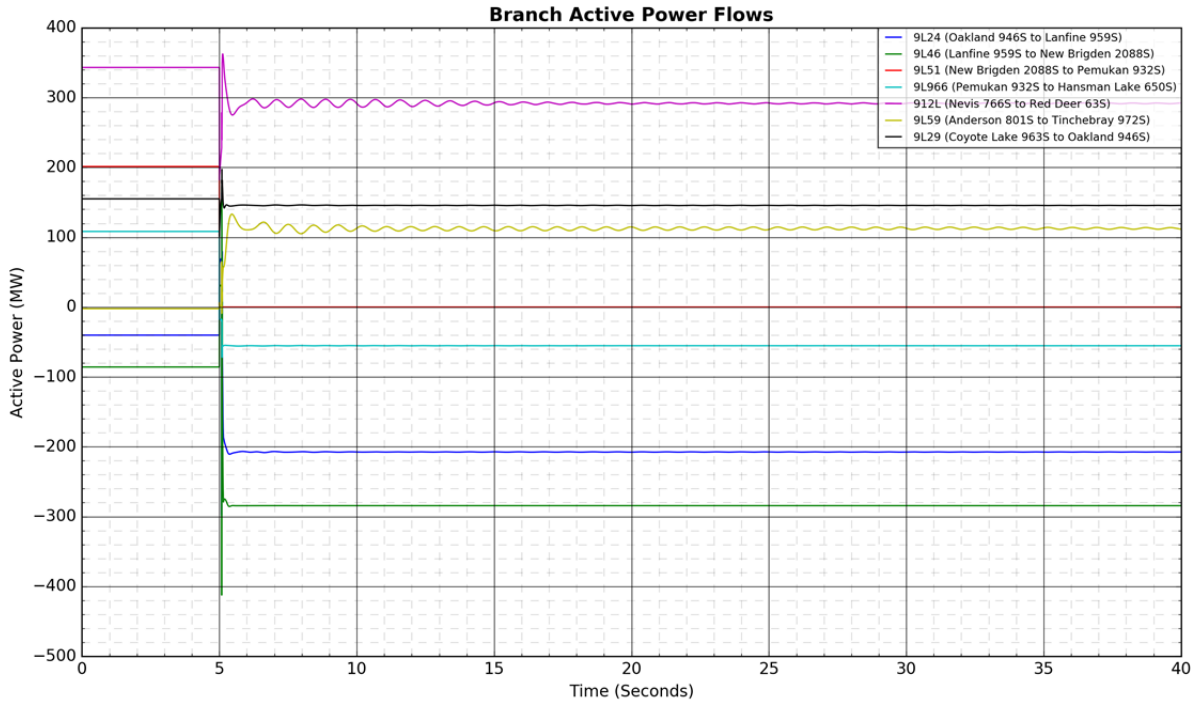

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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)
3.0
2.5
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


Project Machine Performance - Terminal Voltage
Sharphills G1
Sharphills G2
Terminal Voltage (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


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

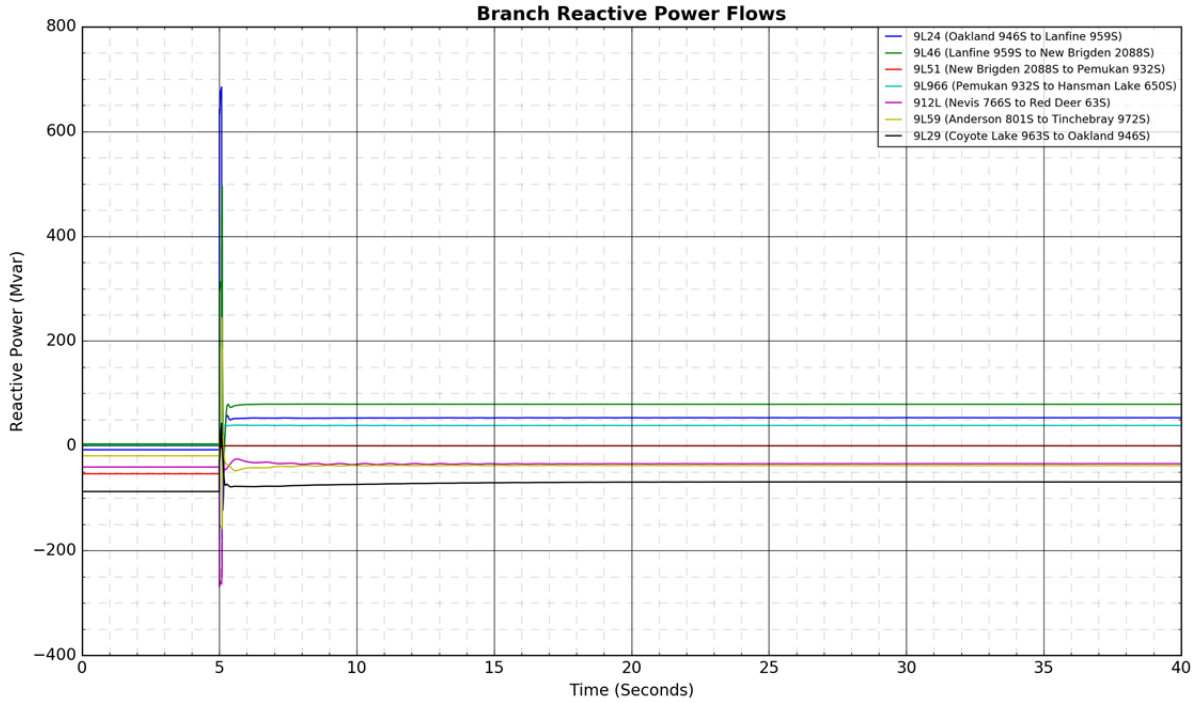
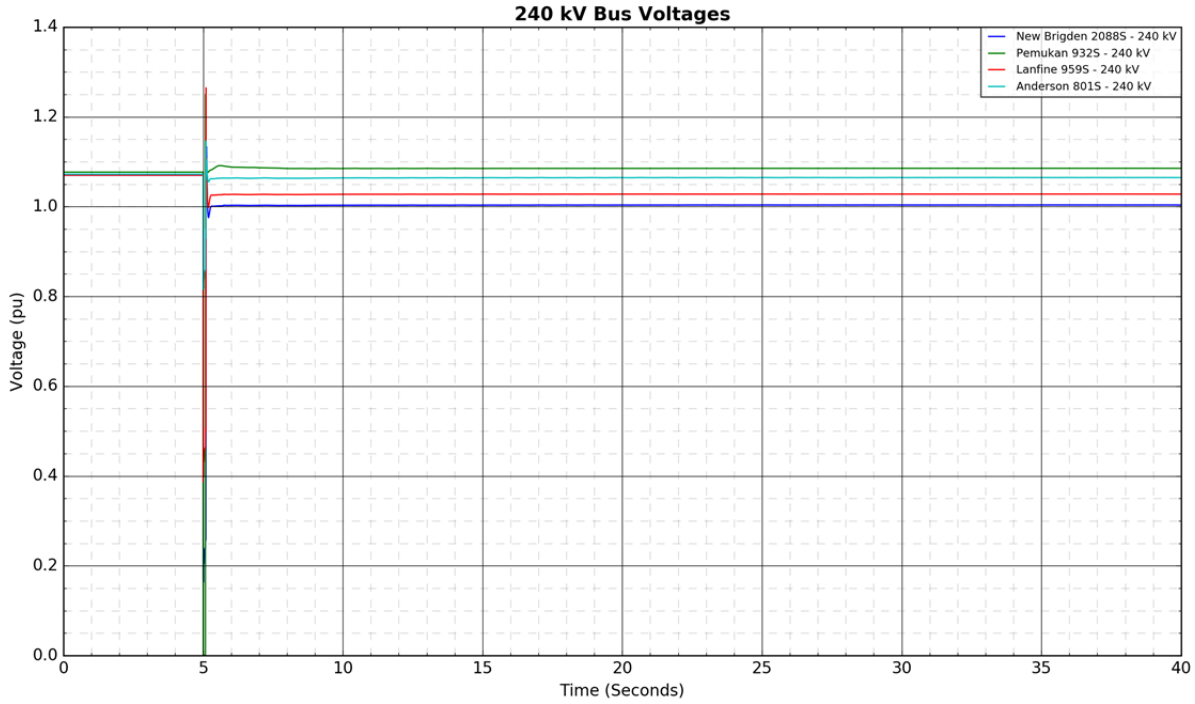
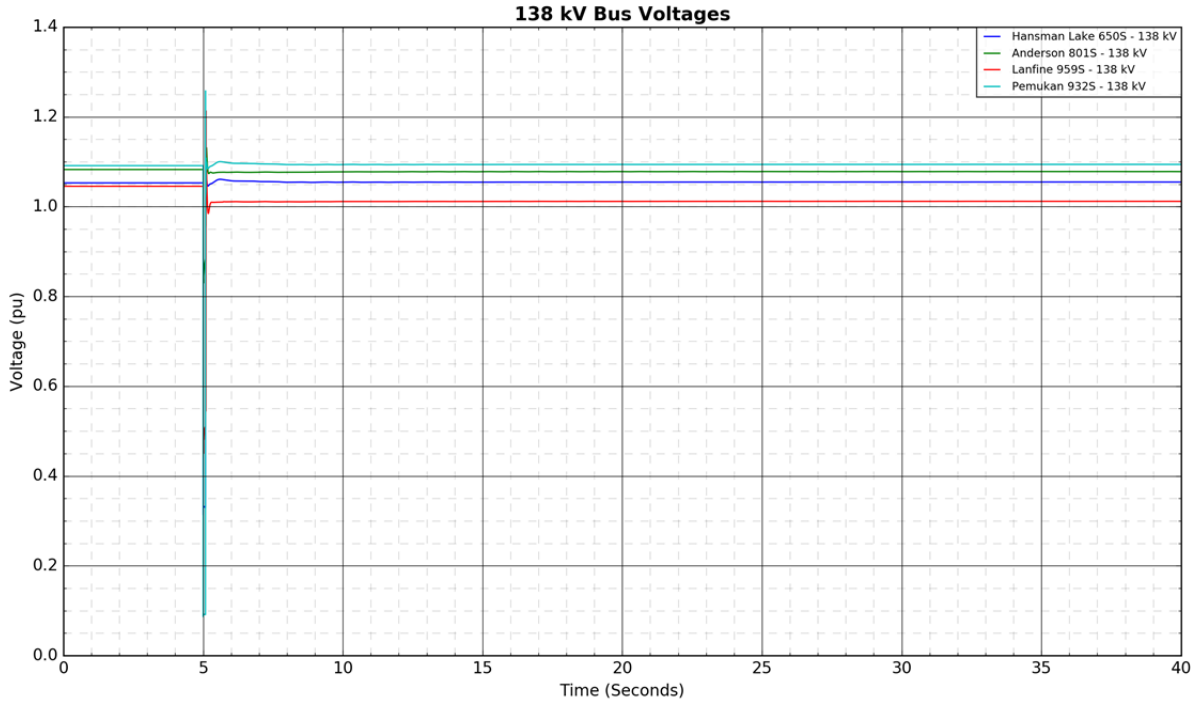
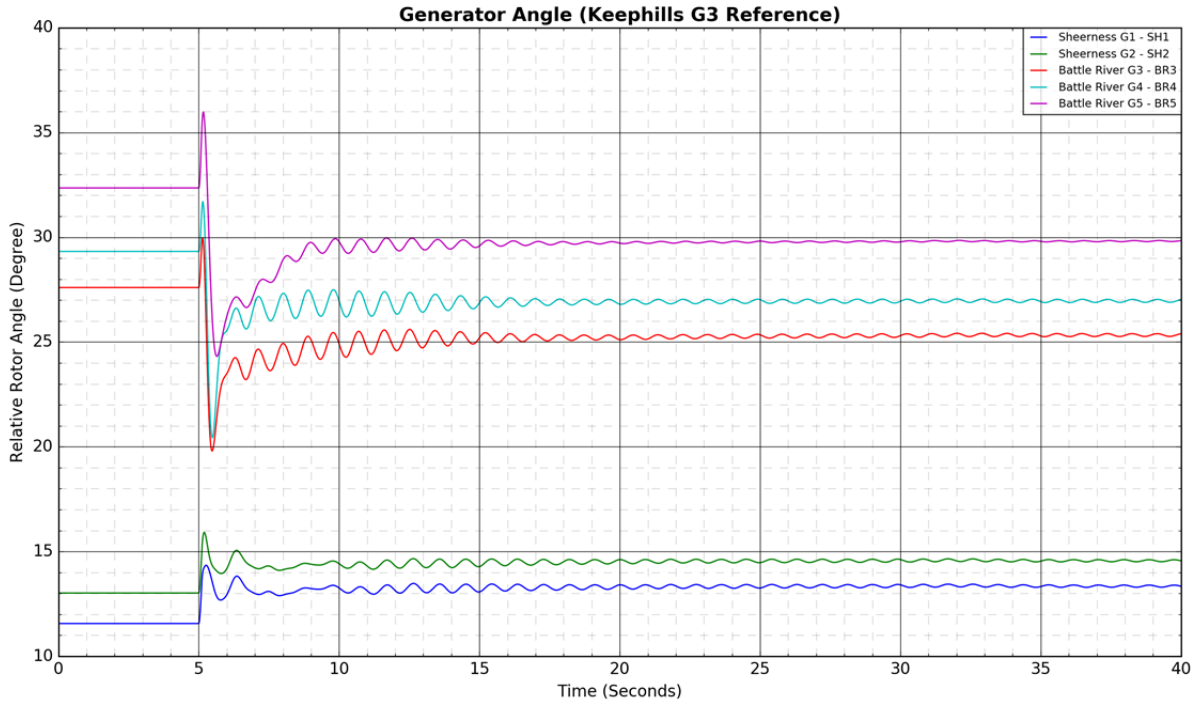
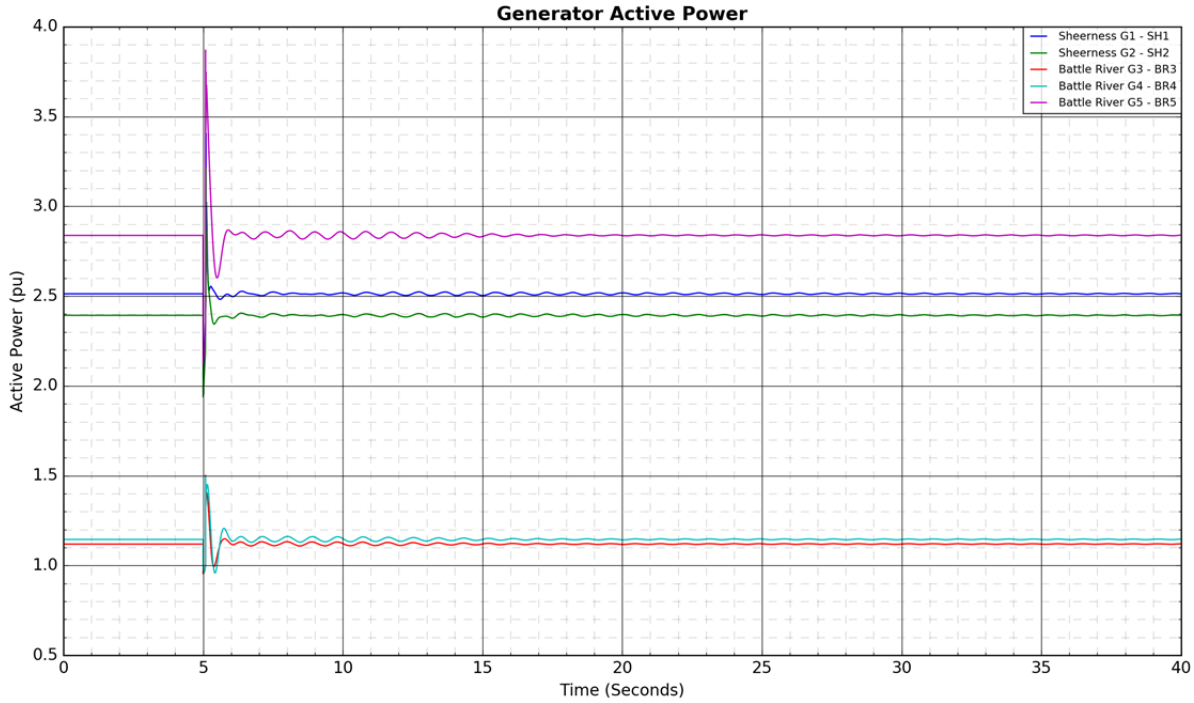

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

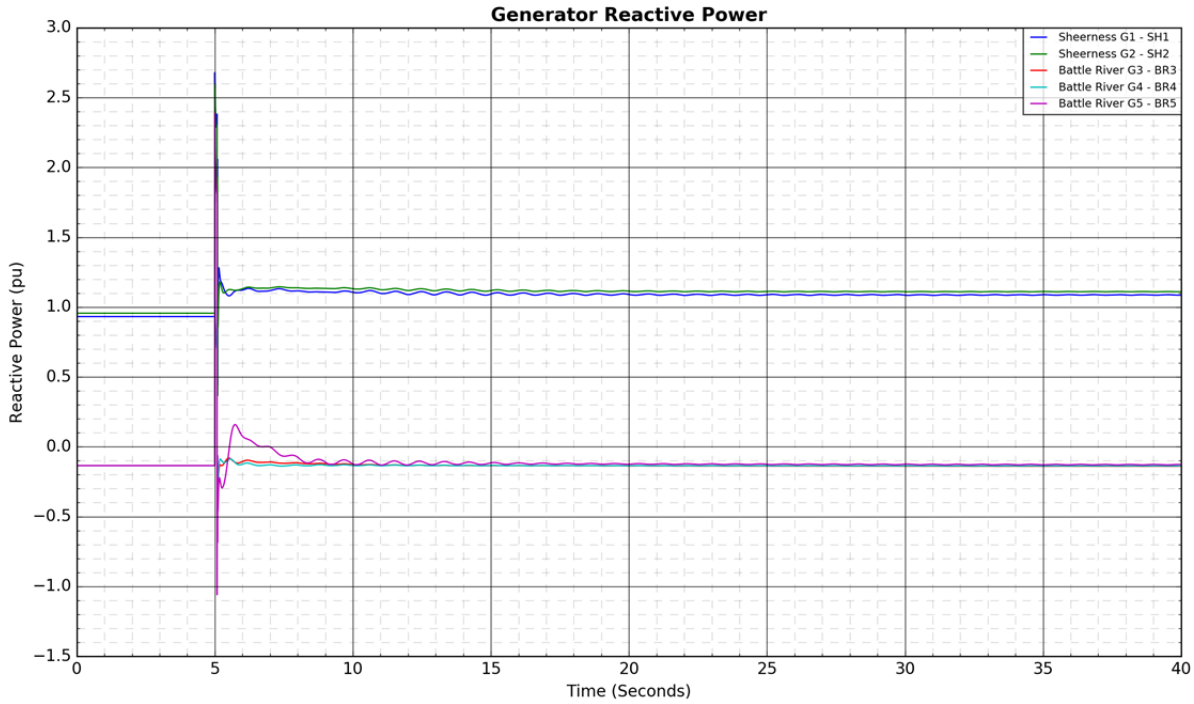
Figure A4-18: 9L51 New Brigden 2088S to Pemukan 932S: Fault Near Pemukan 932S

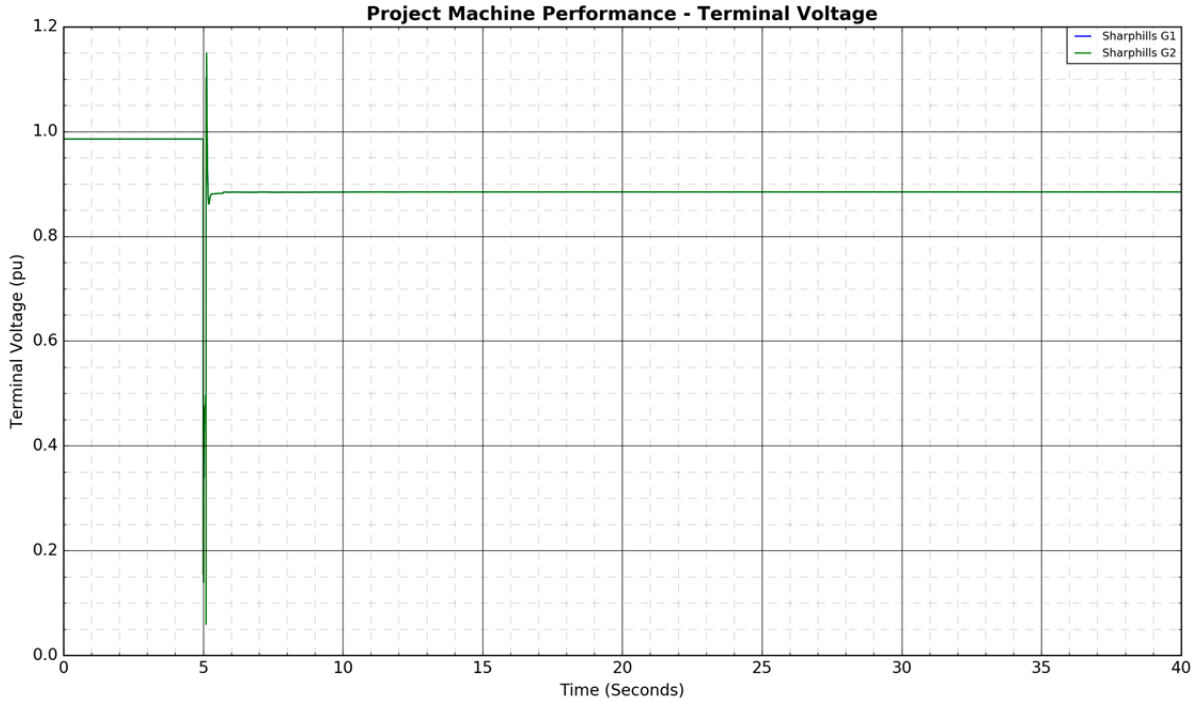


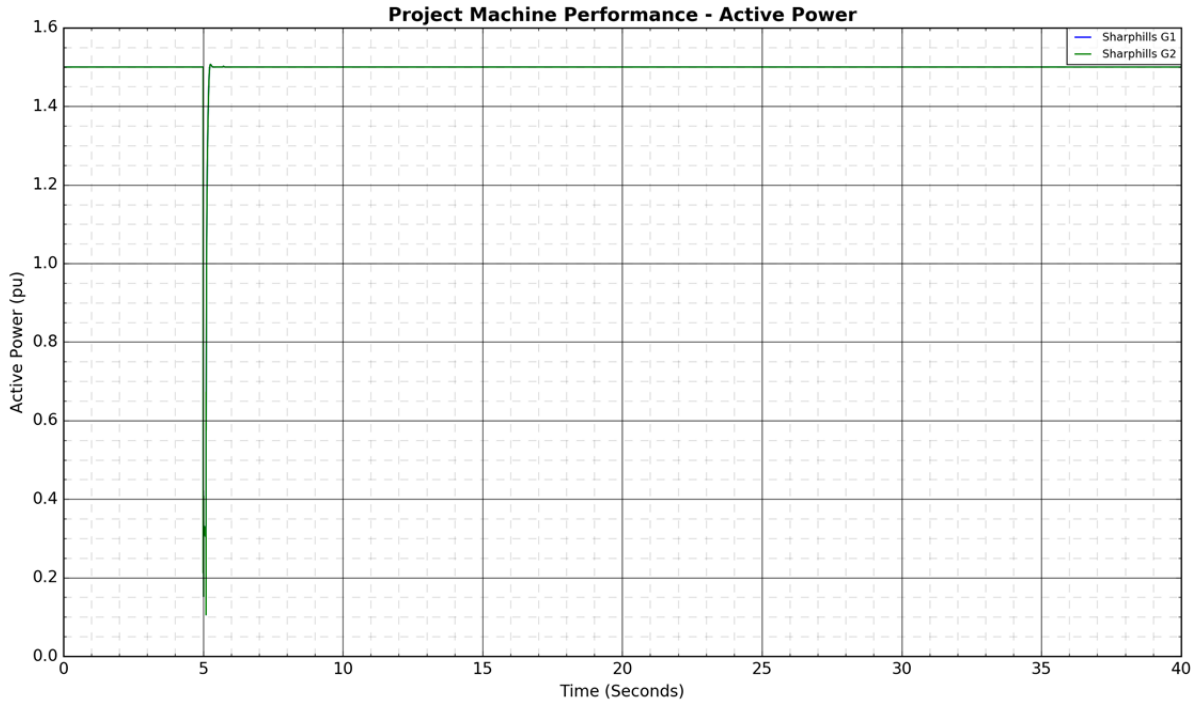


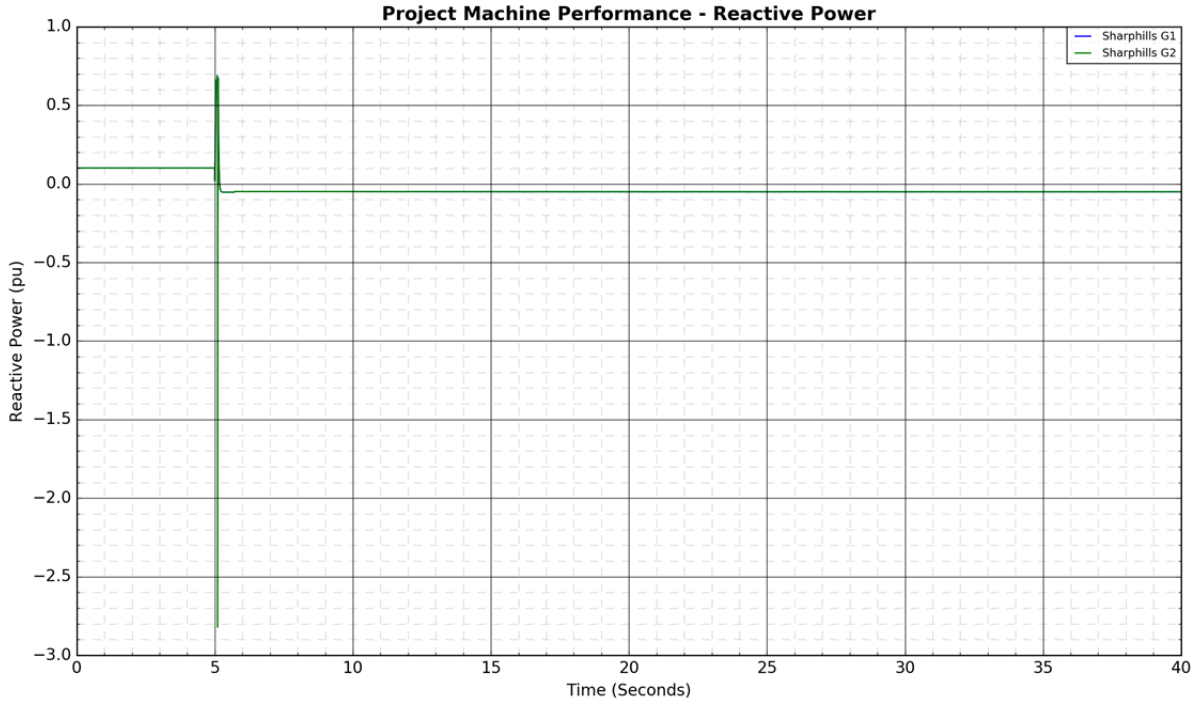

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

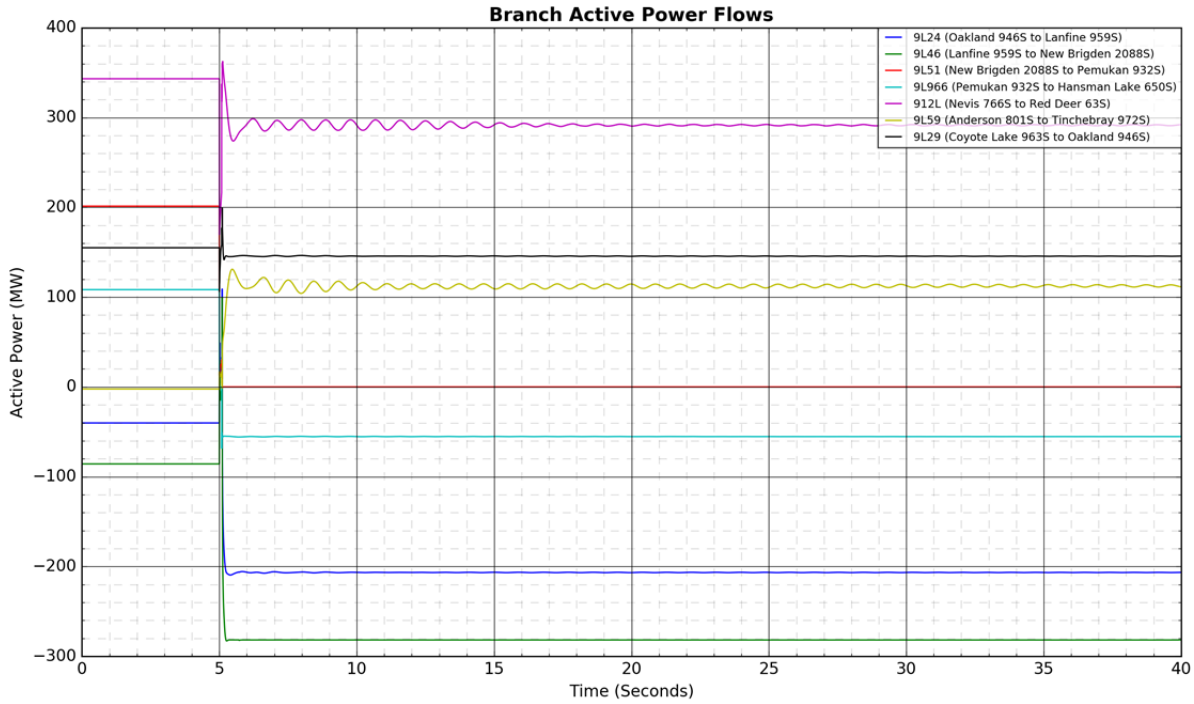

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

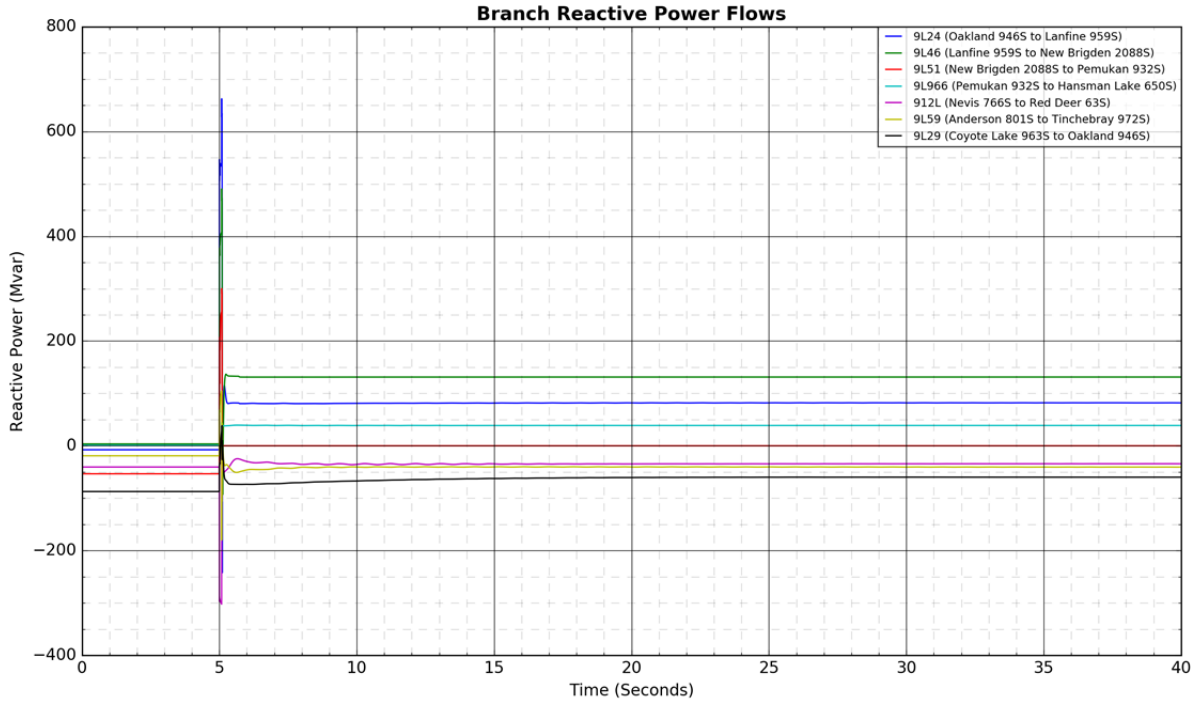
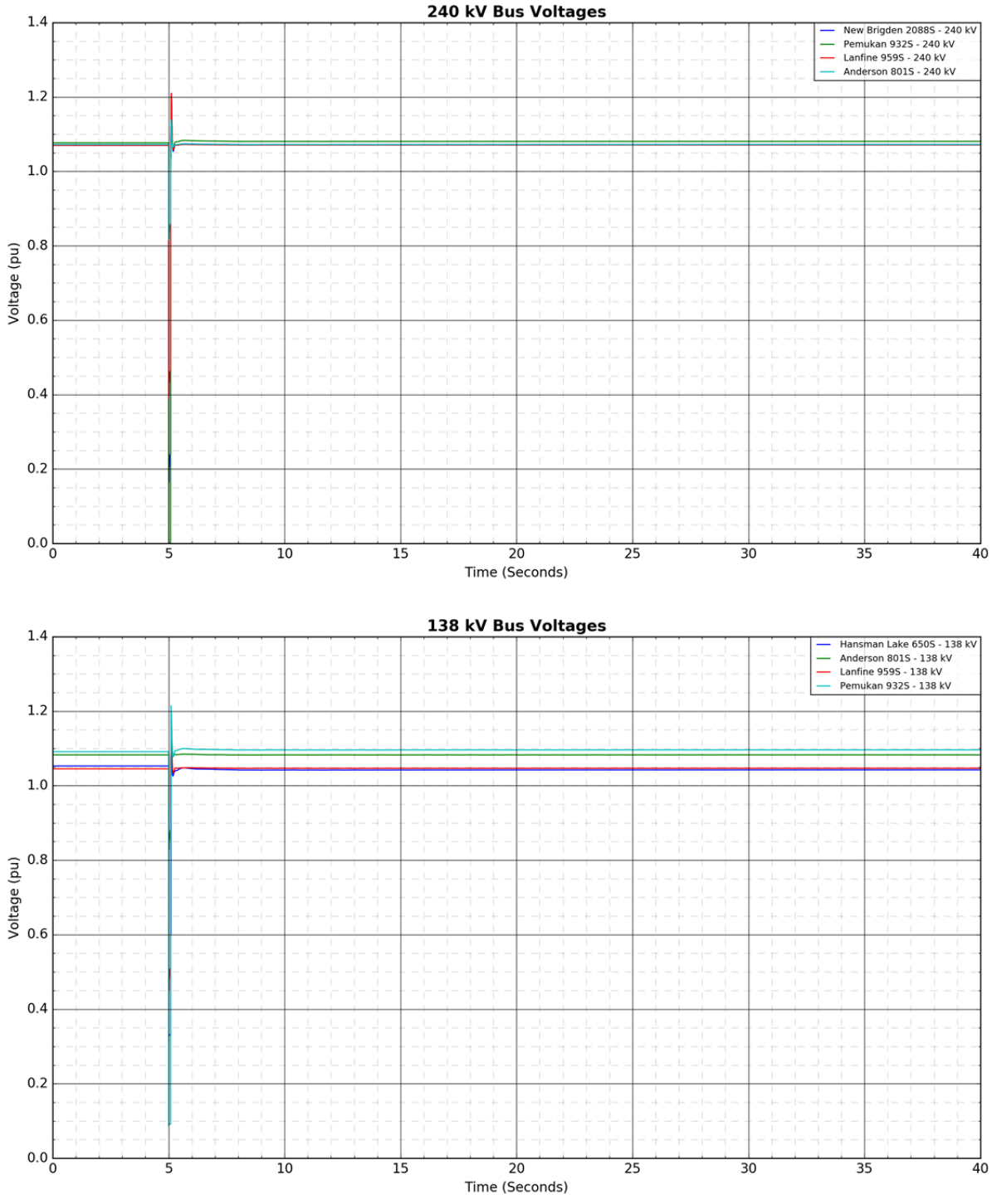
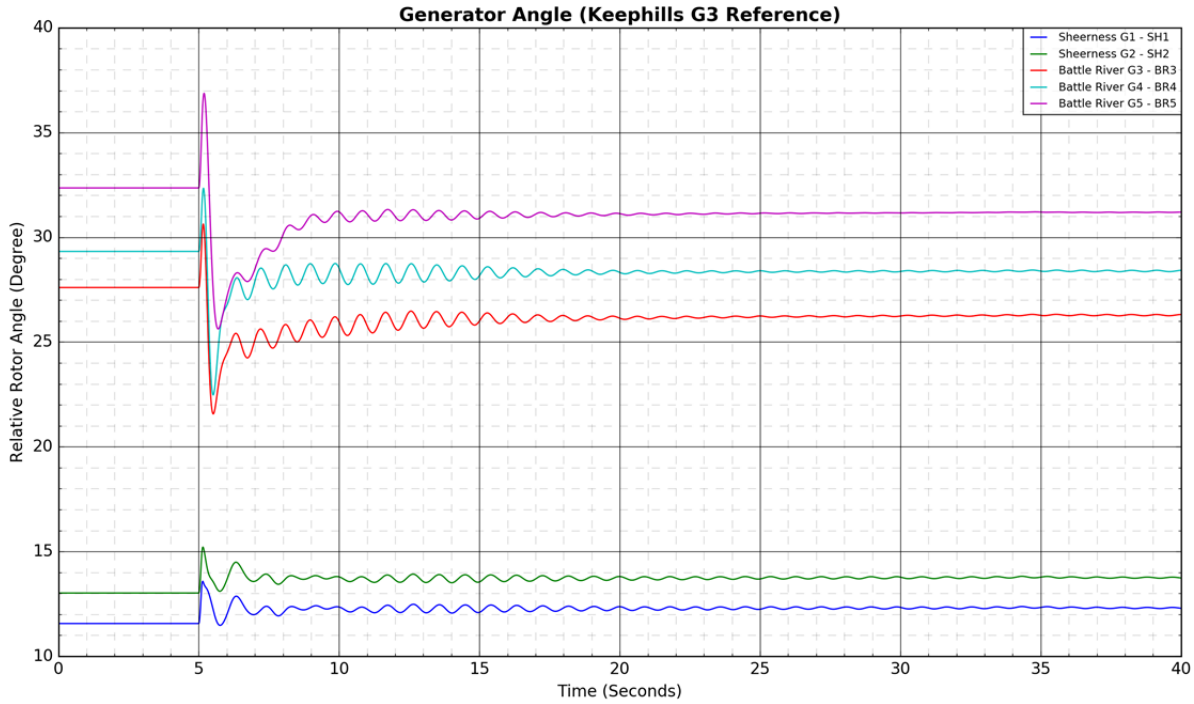
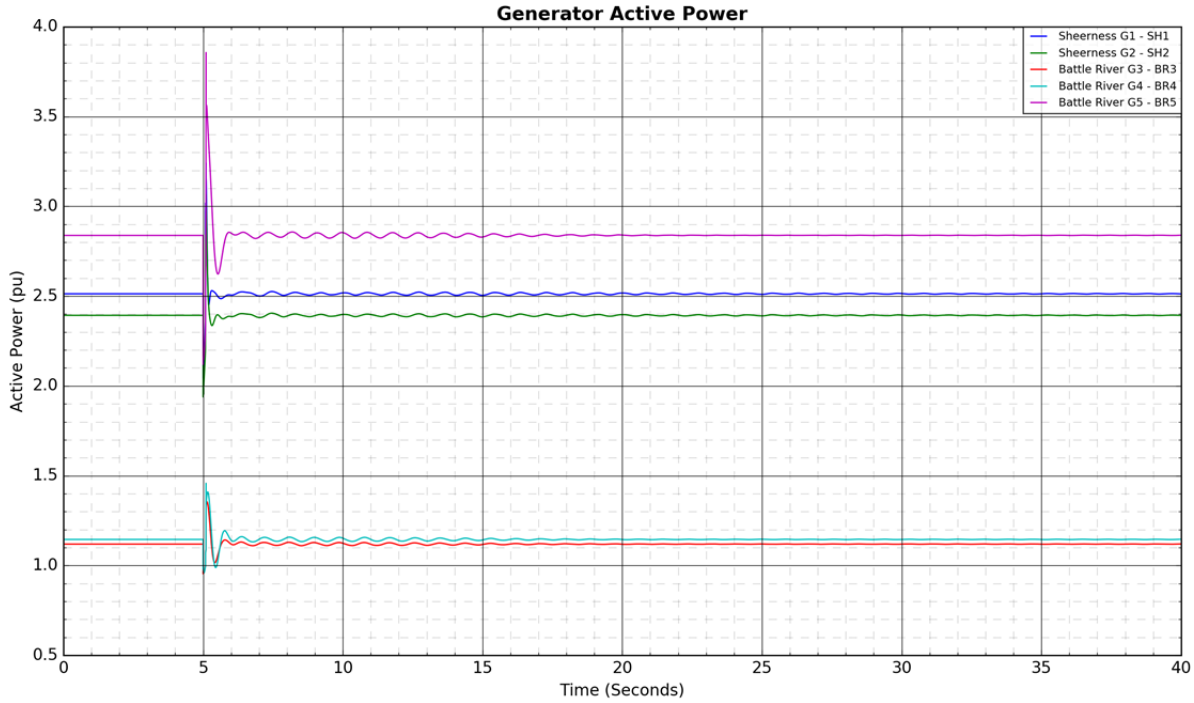
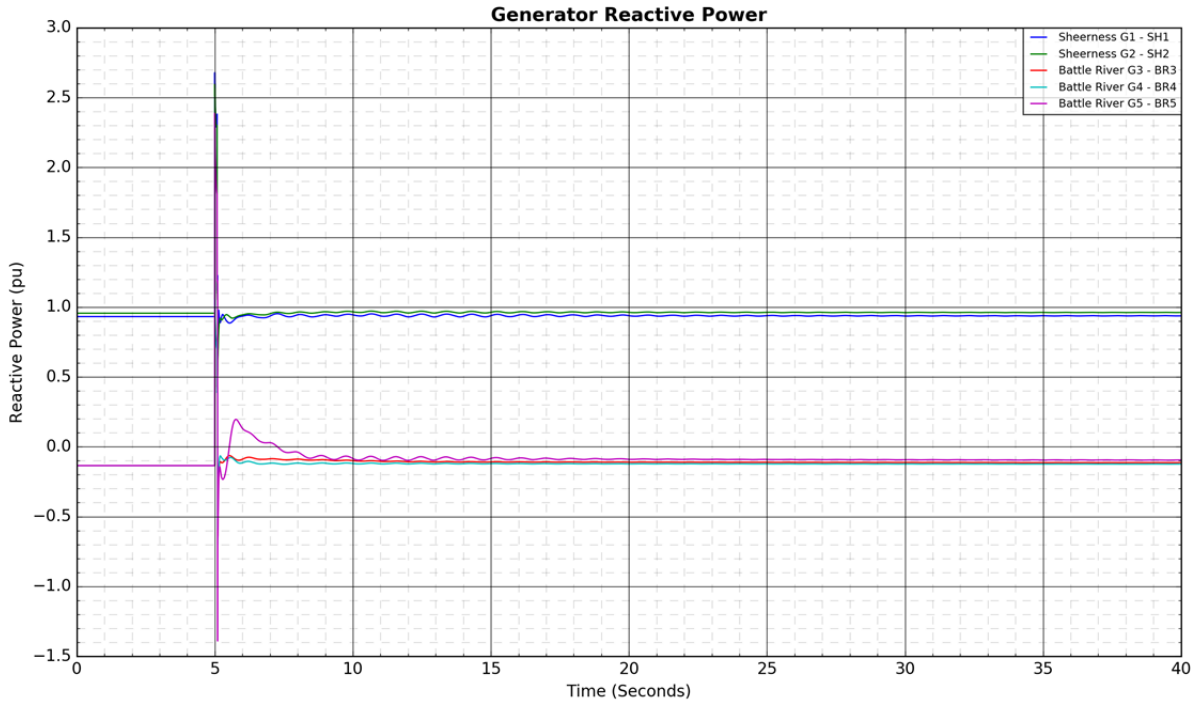

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

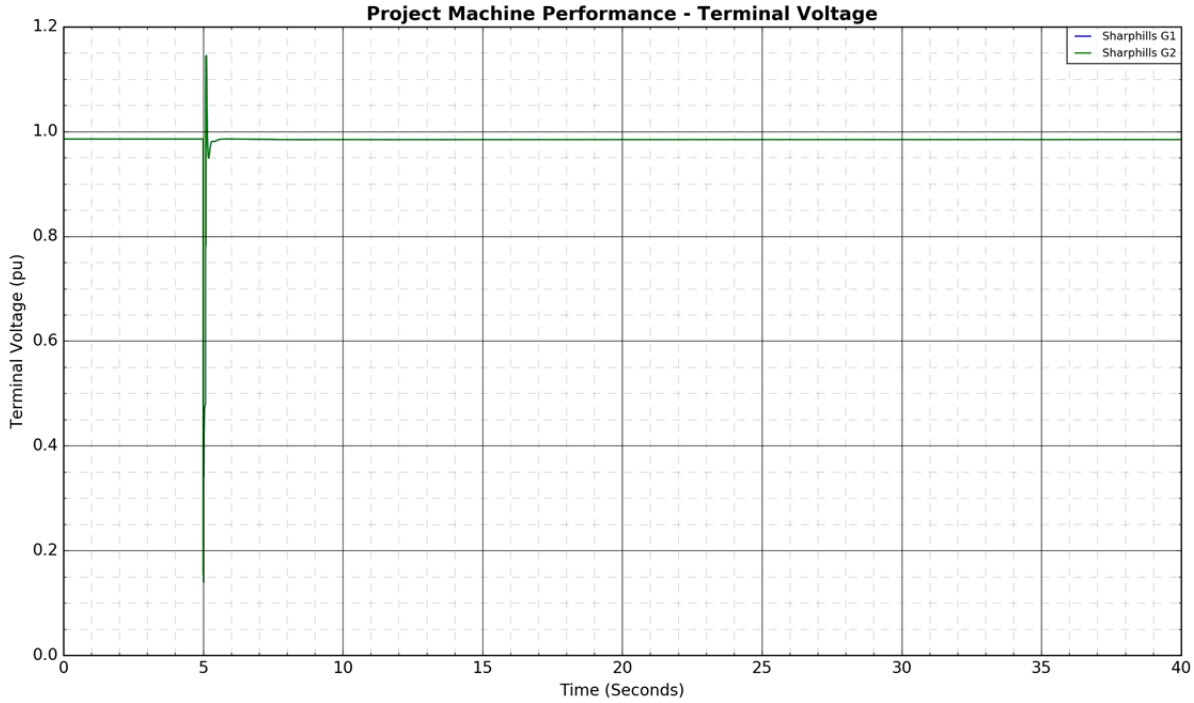
Figure A4-19: 9L966 Pemukan 932S to Hansman Lake 650S: Fault Near Pemukan 932S

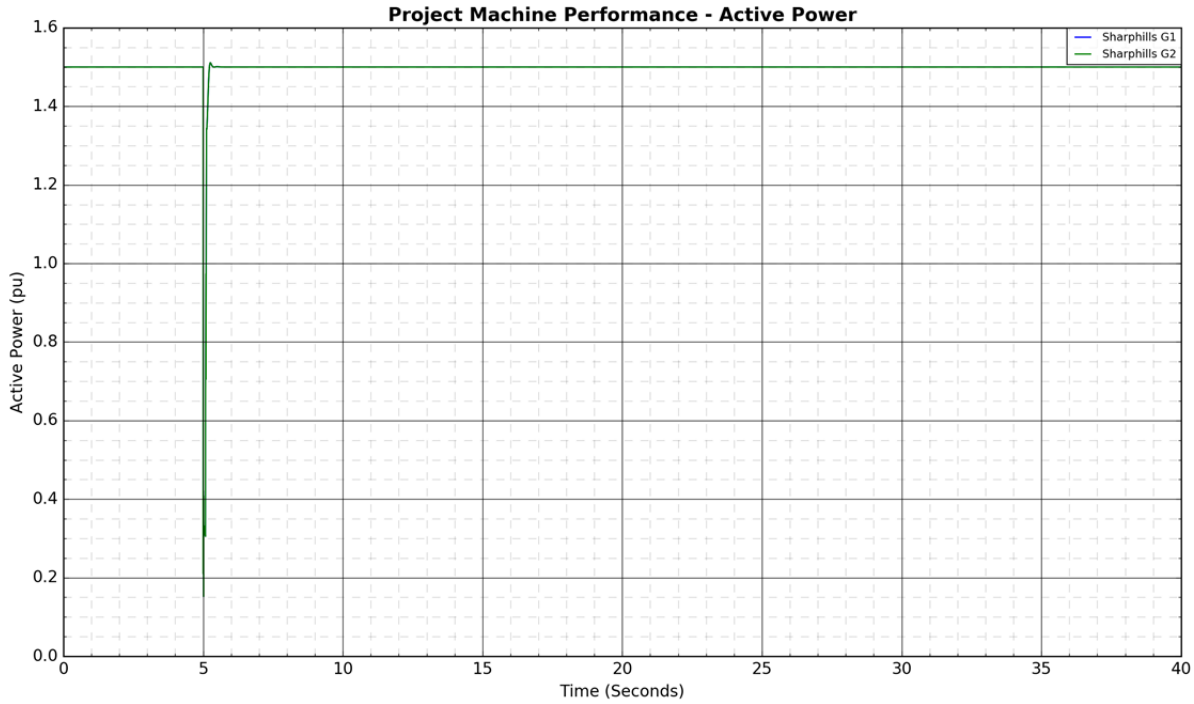


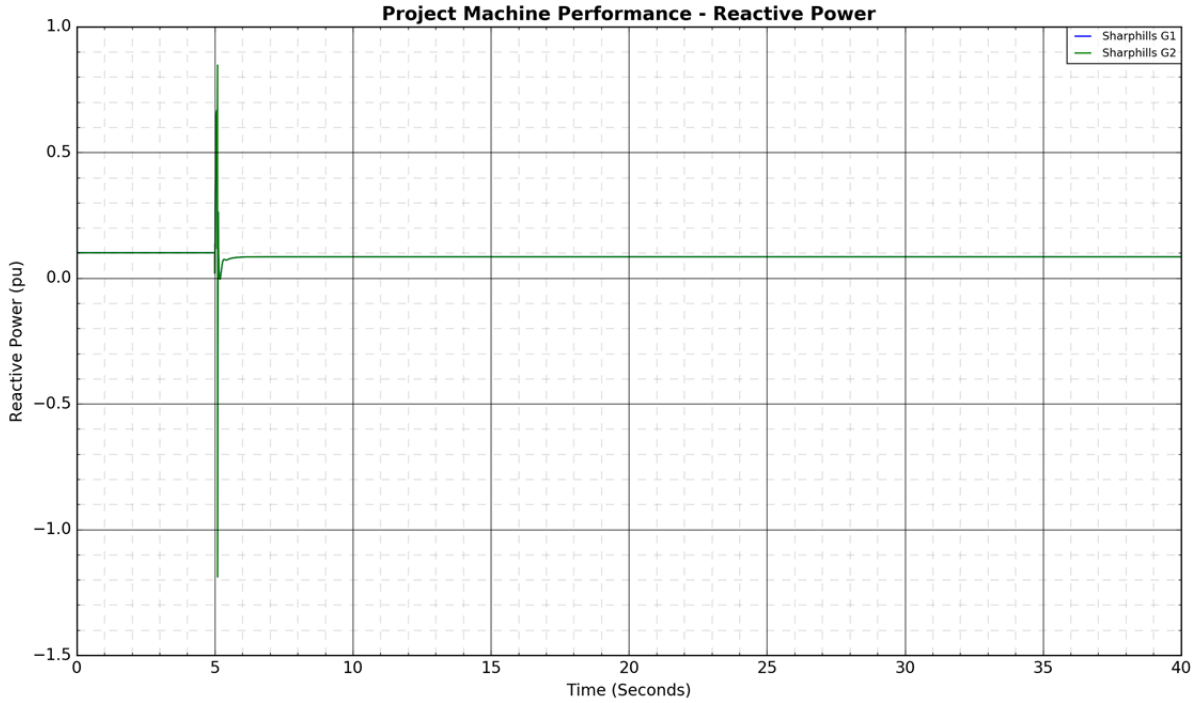

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

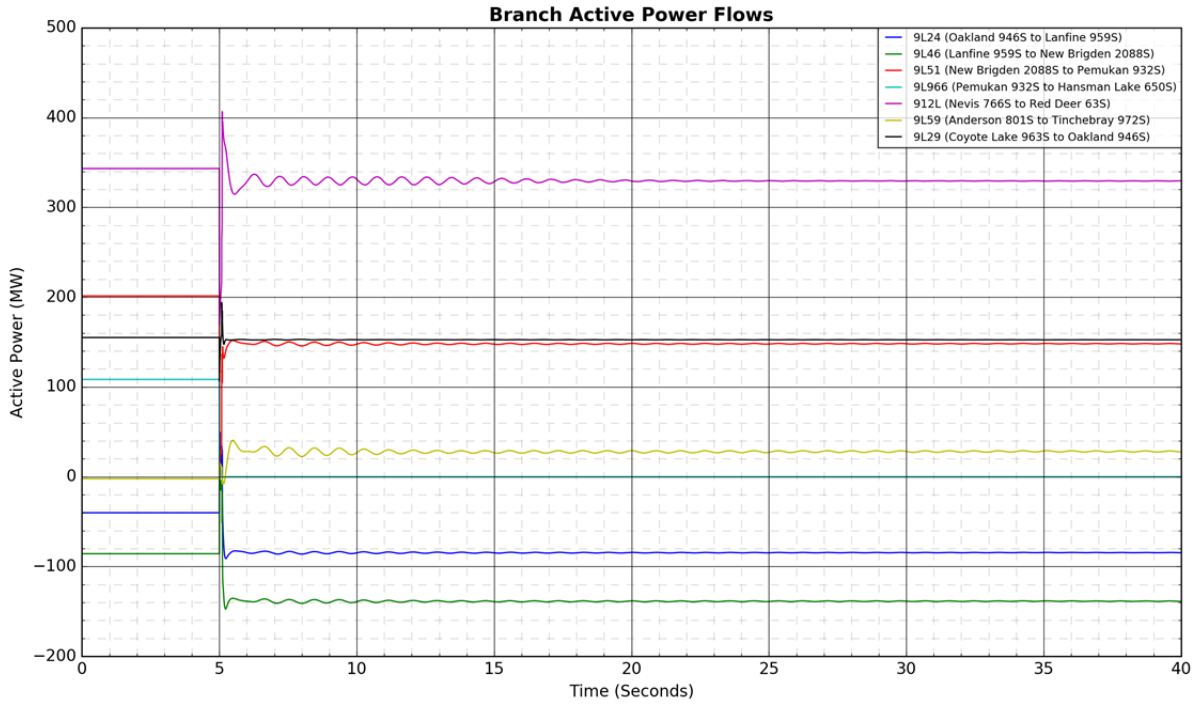

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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)
3.0
2.5
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


Project Machine Performance - Terminal Voltage
Sharphills G1
Sharphills G2
Terminal Voltage (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


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

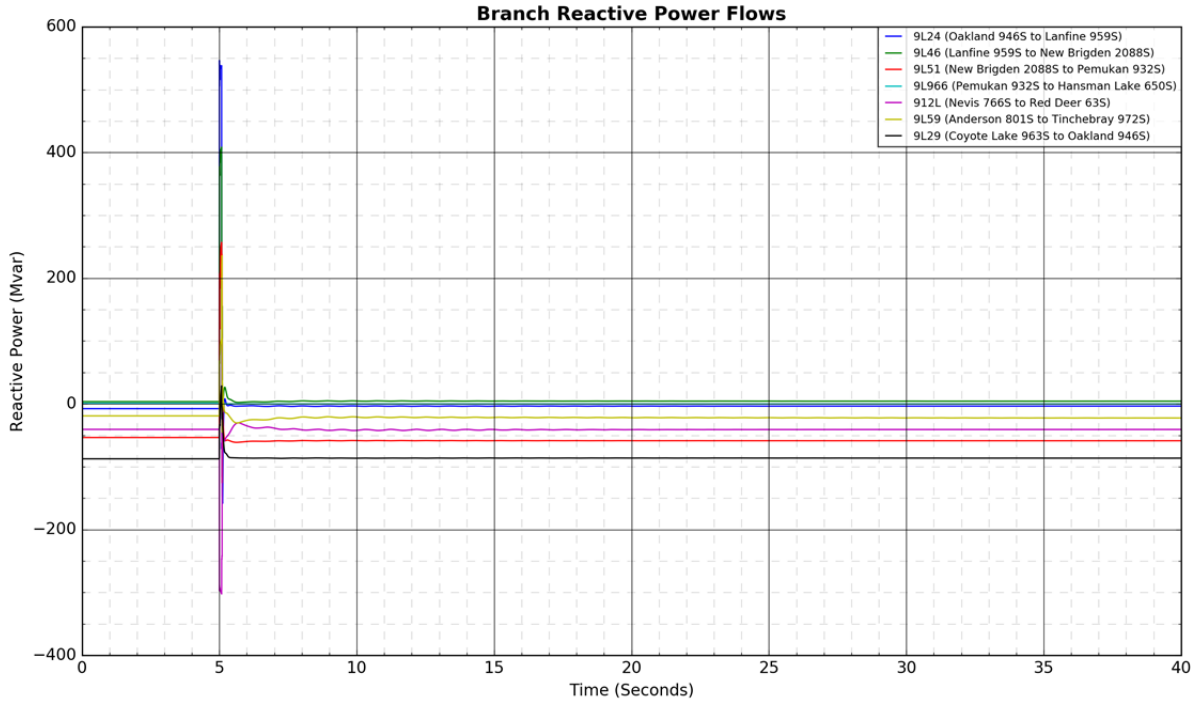
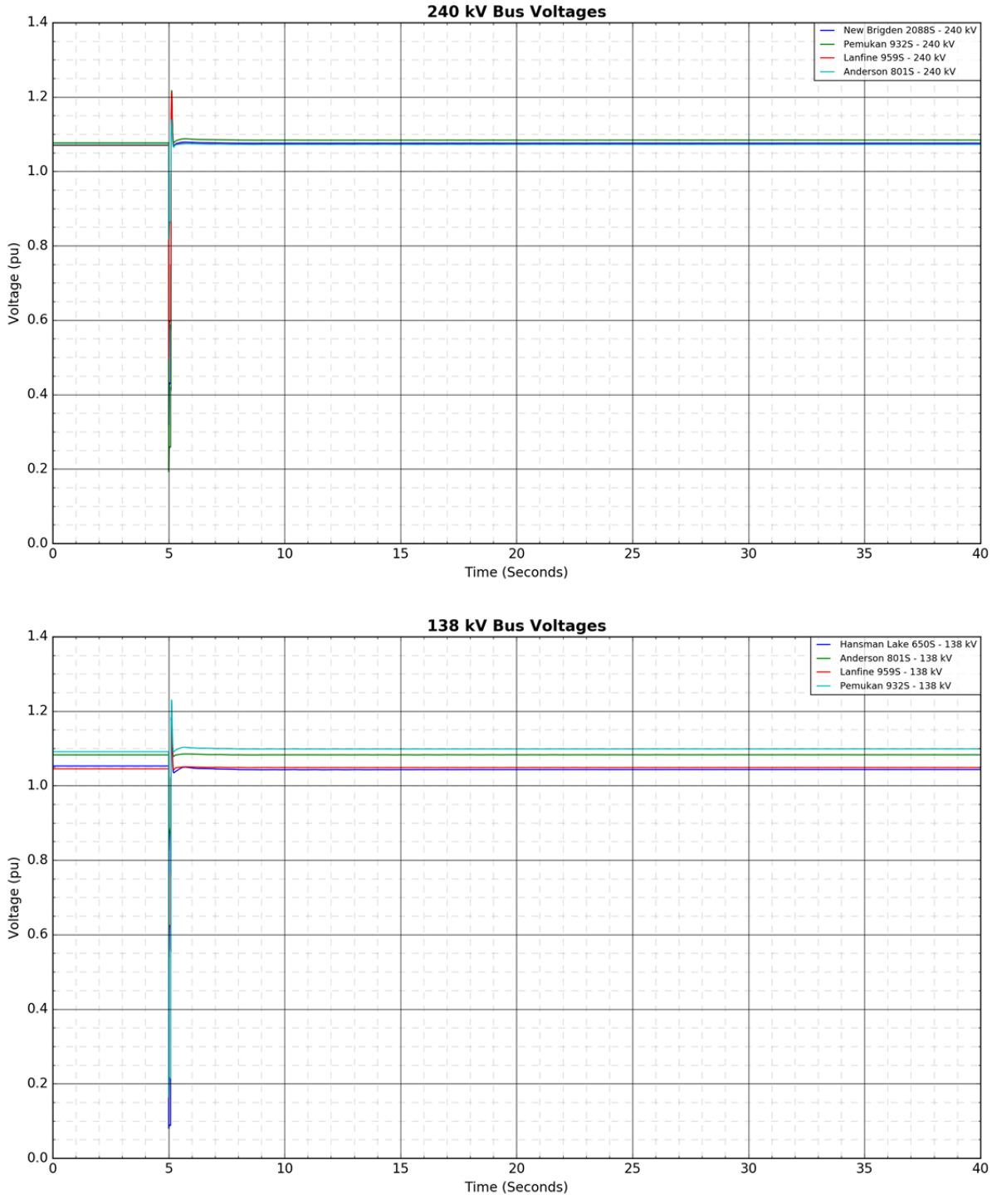
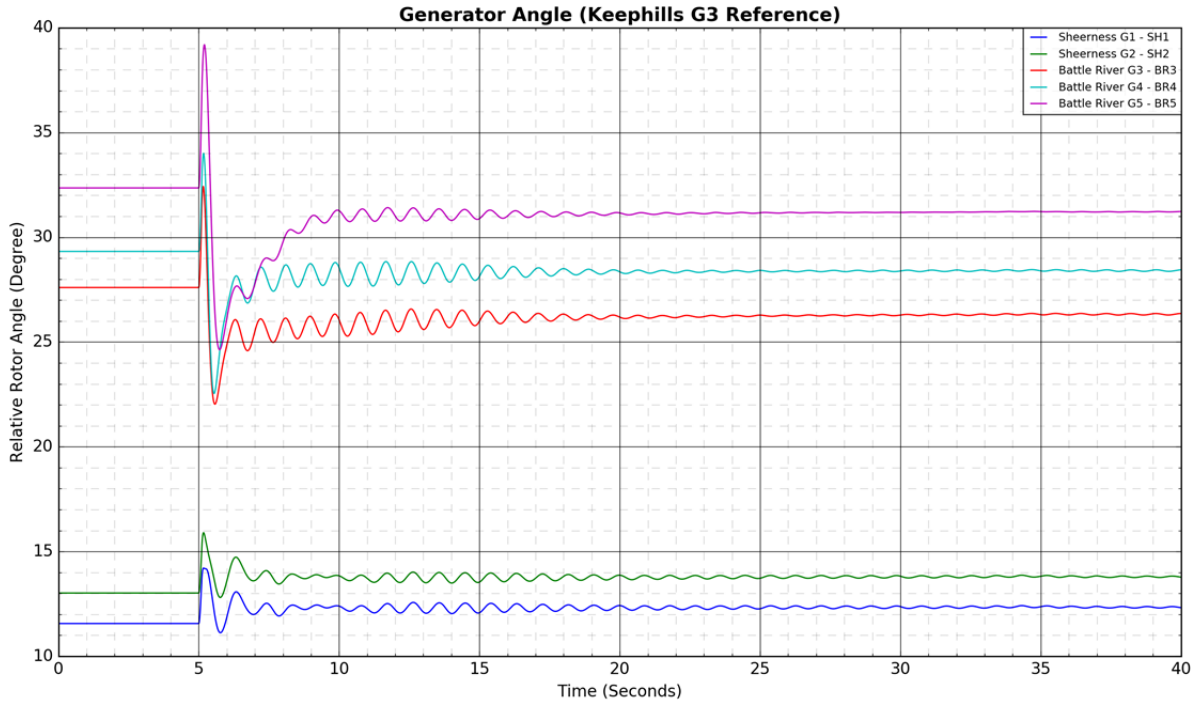
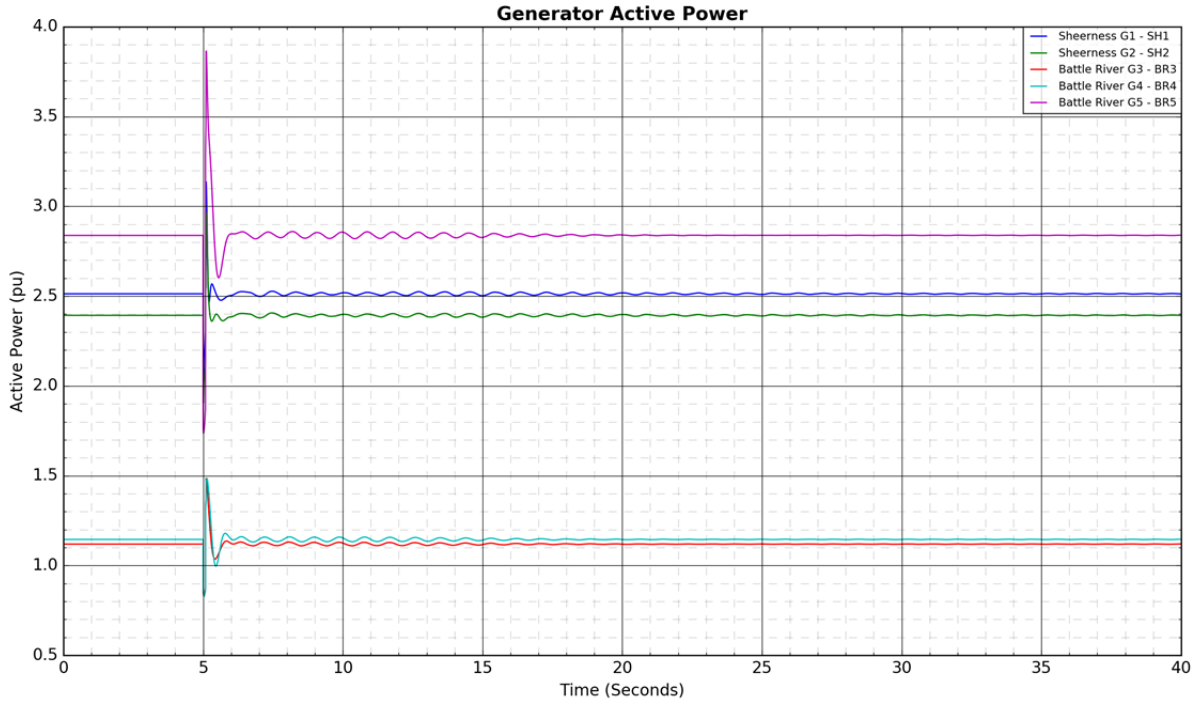
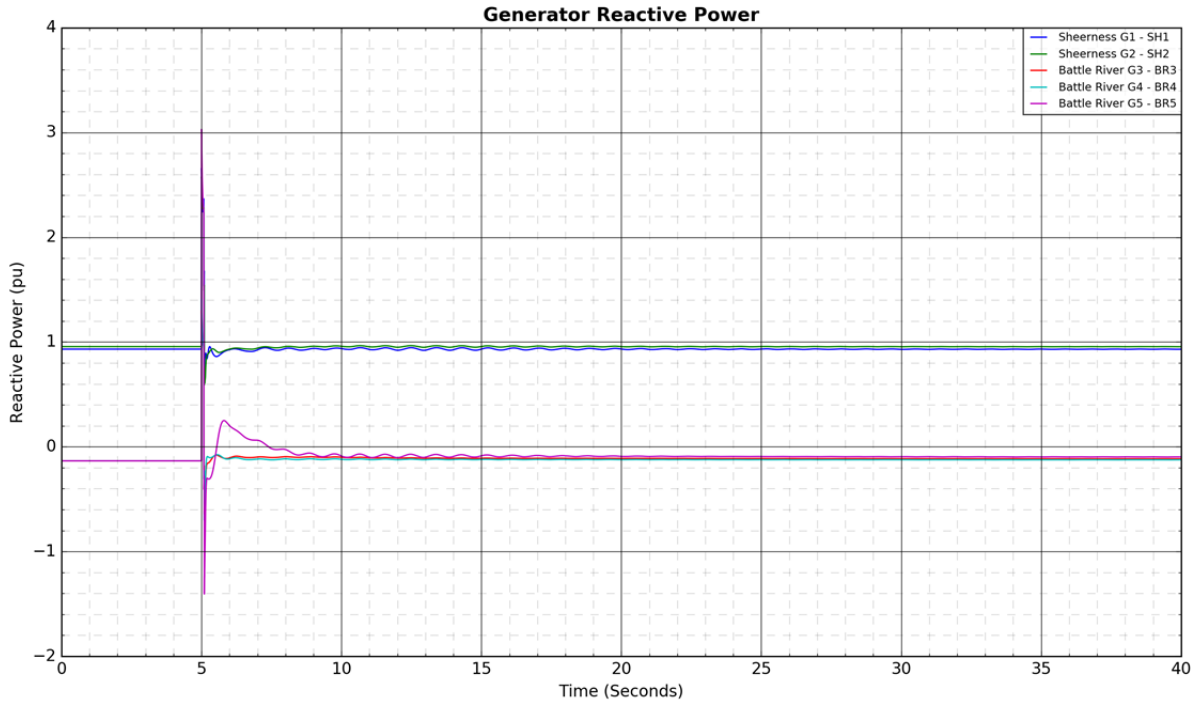

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

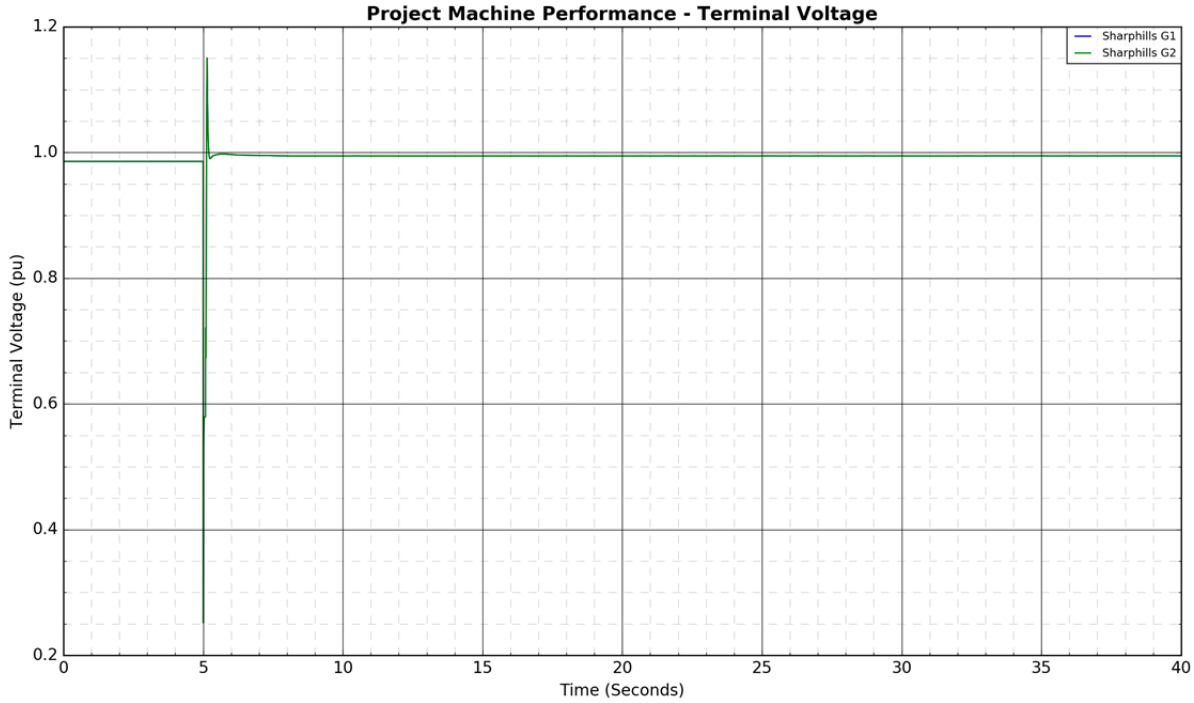
Figure A4-20: 9L966 Pemukan 932S to Hansman Lake 650S: Fault Near Hansman Lake 650S

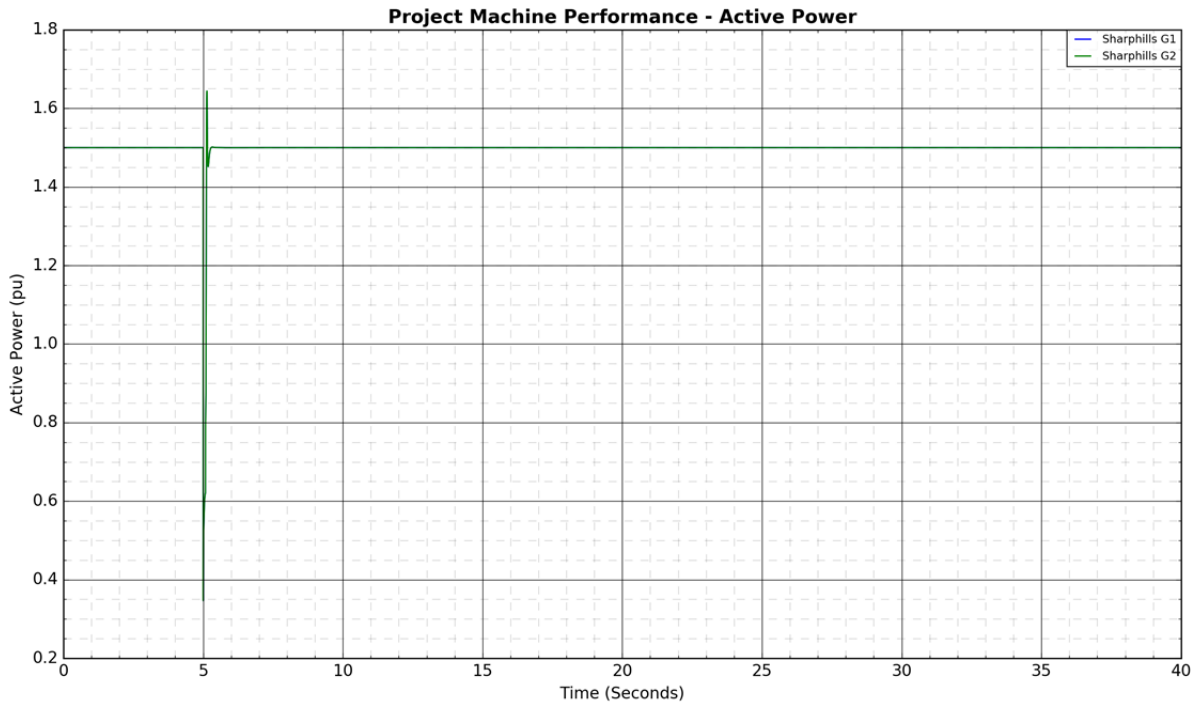


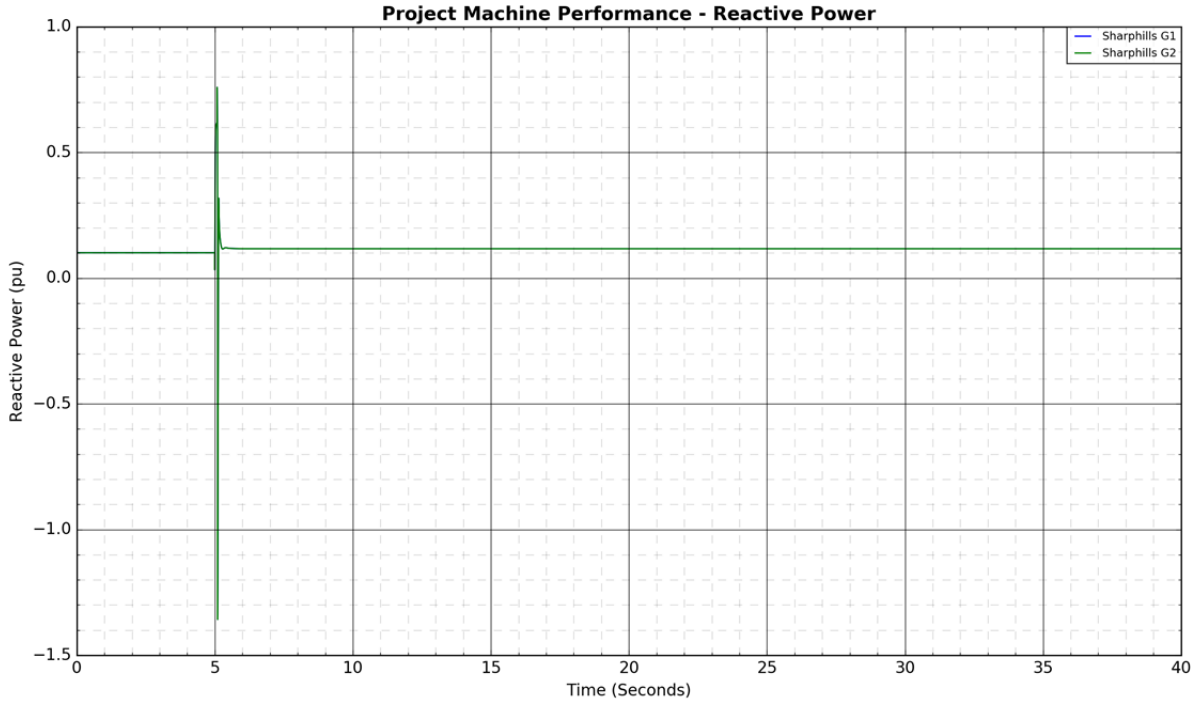

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

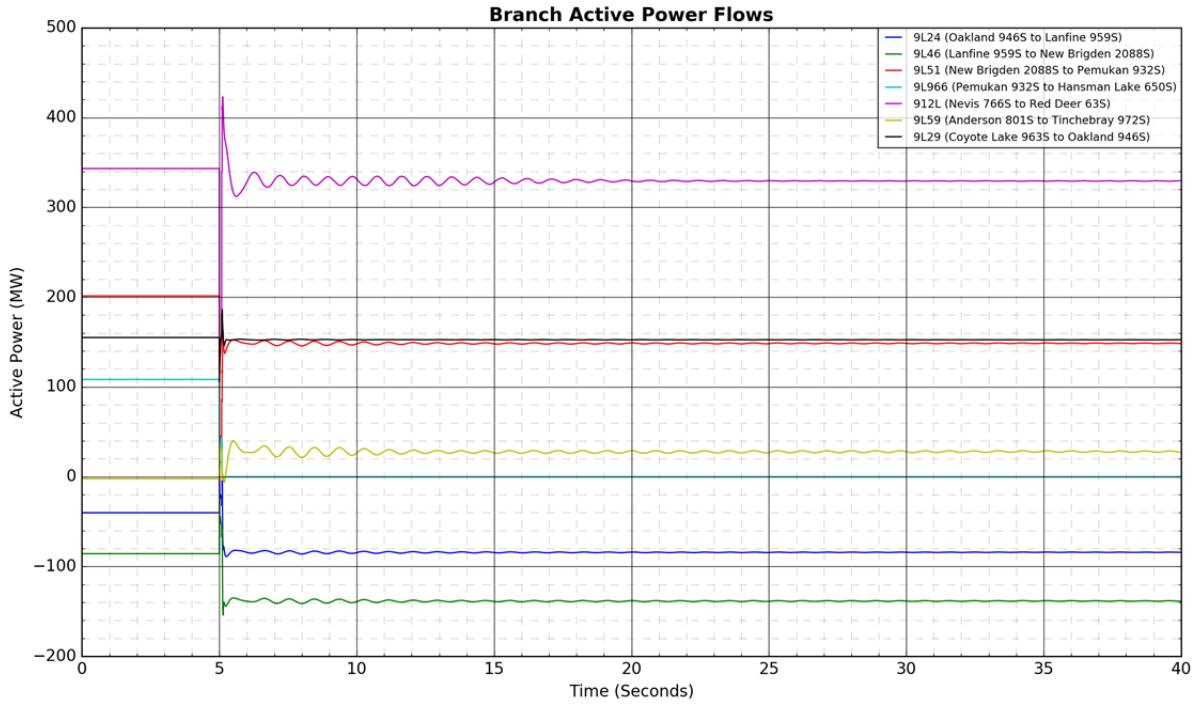

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

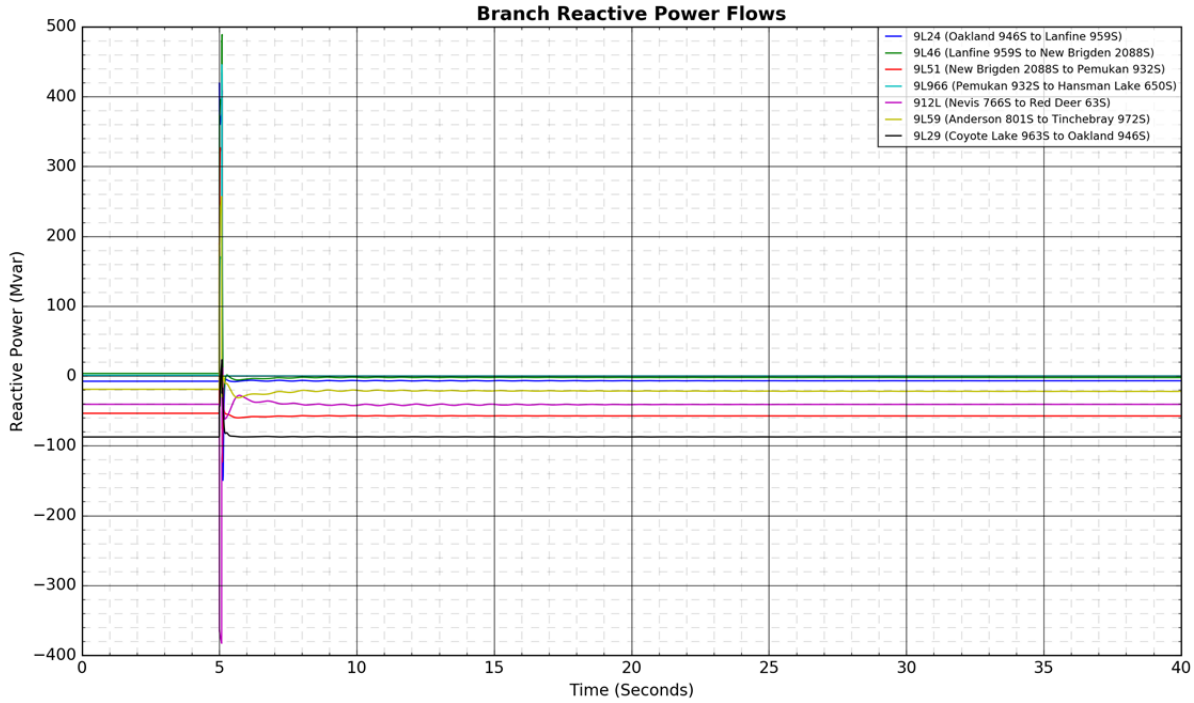
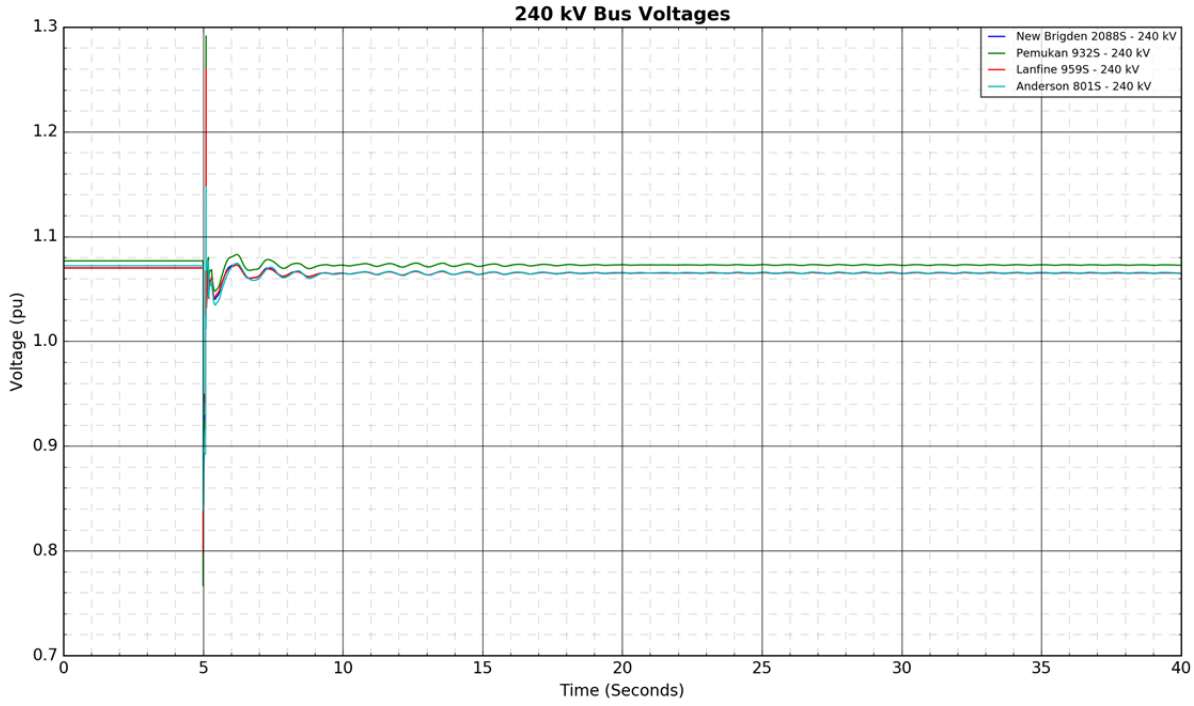
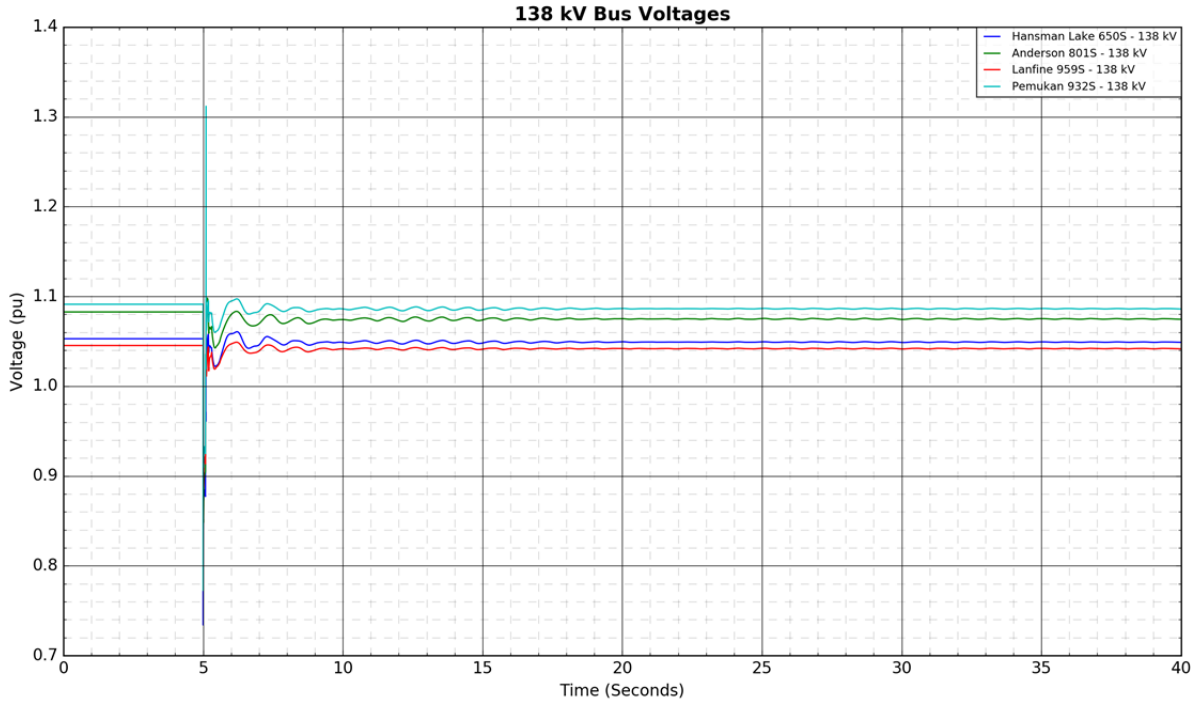
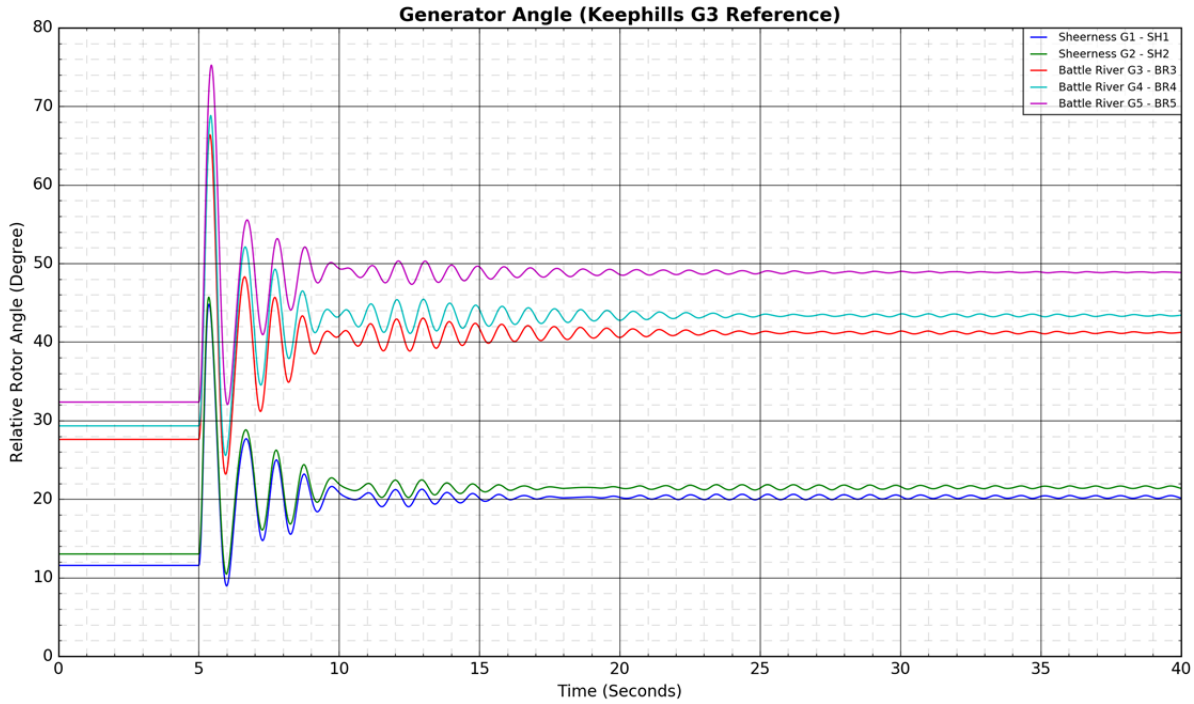
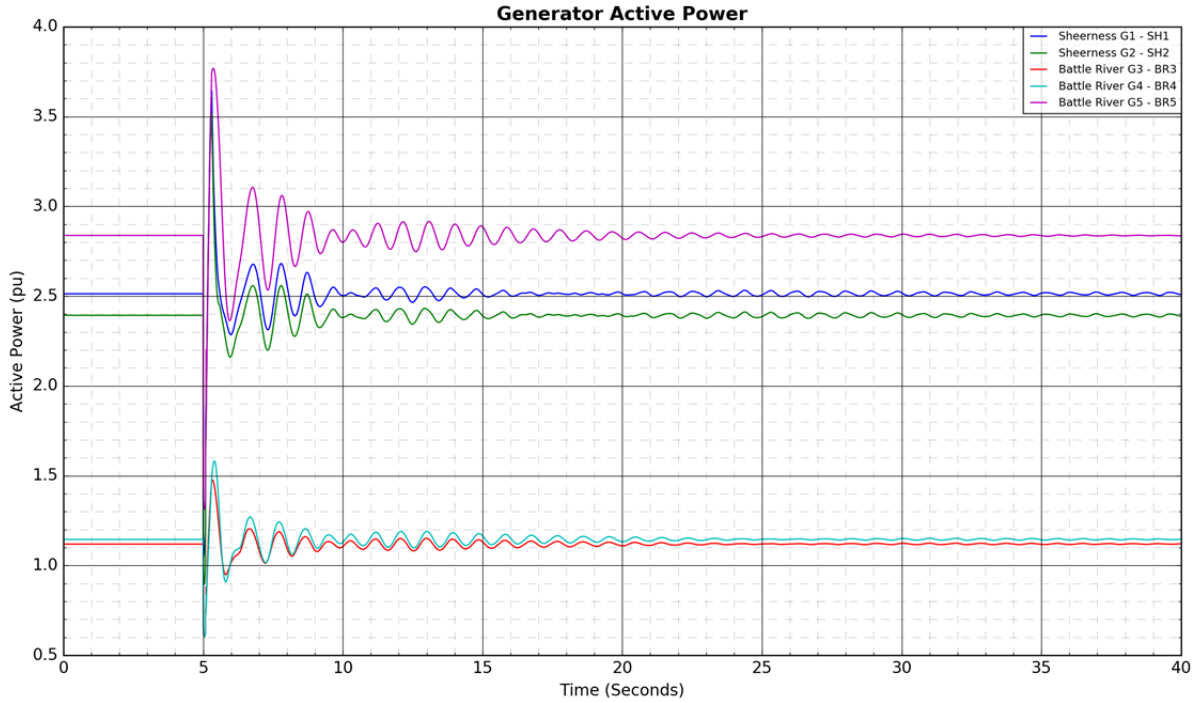

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

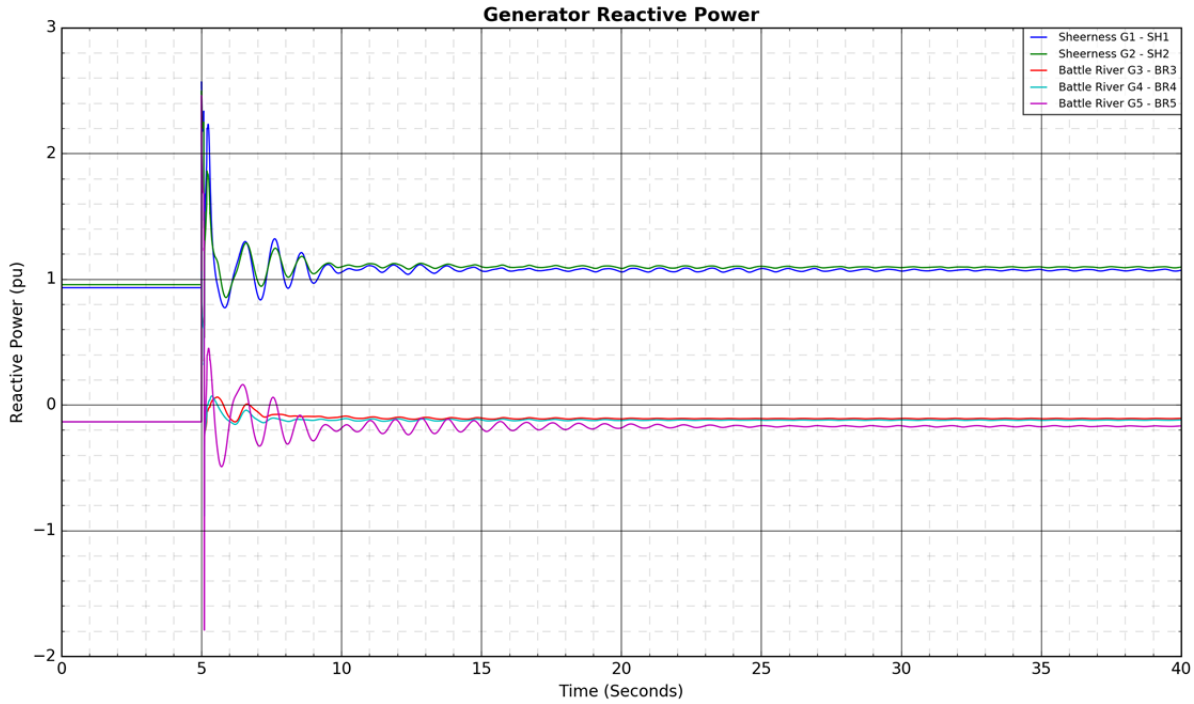
Figure A4-21: 912L/9L912 Nevis 766S to Red Deer 63S: Fault Near Red Deer 63S

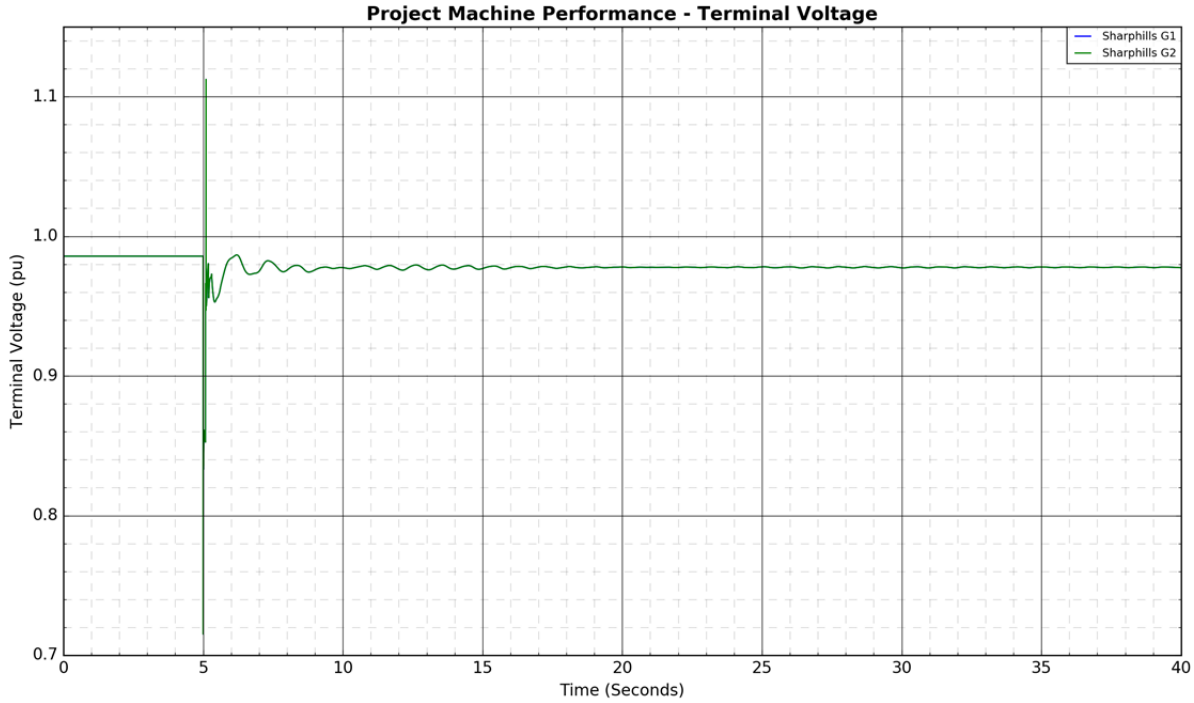


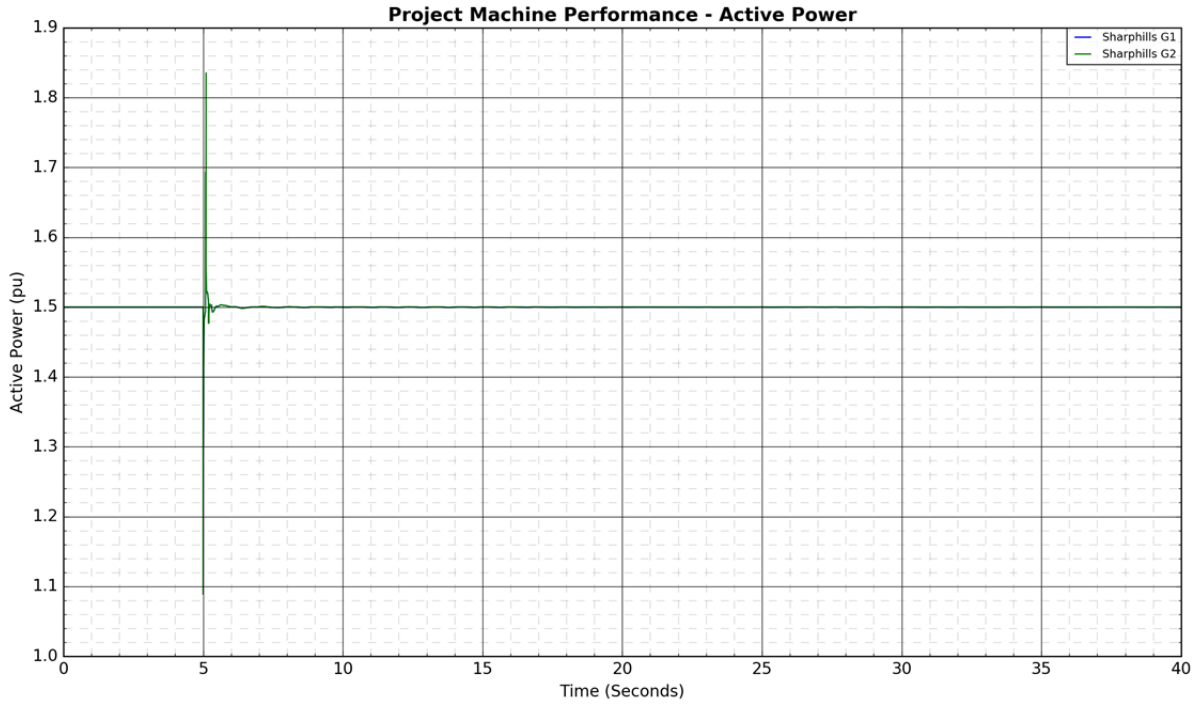


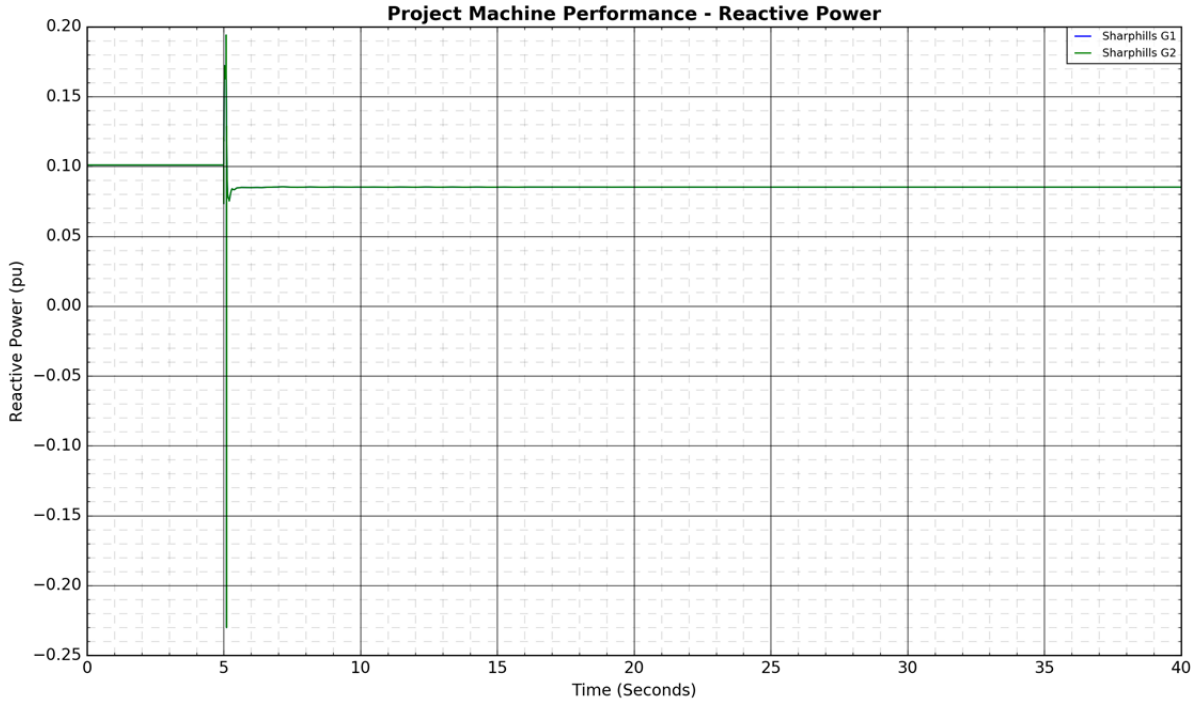

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

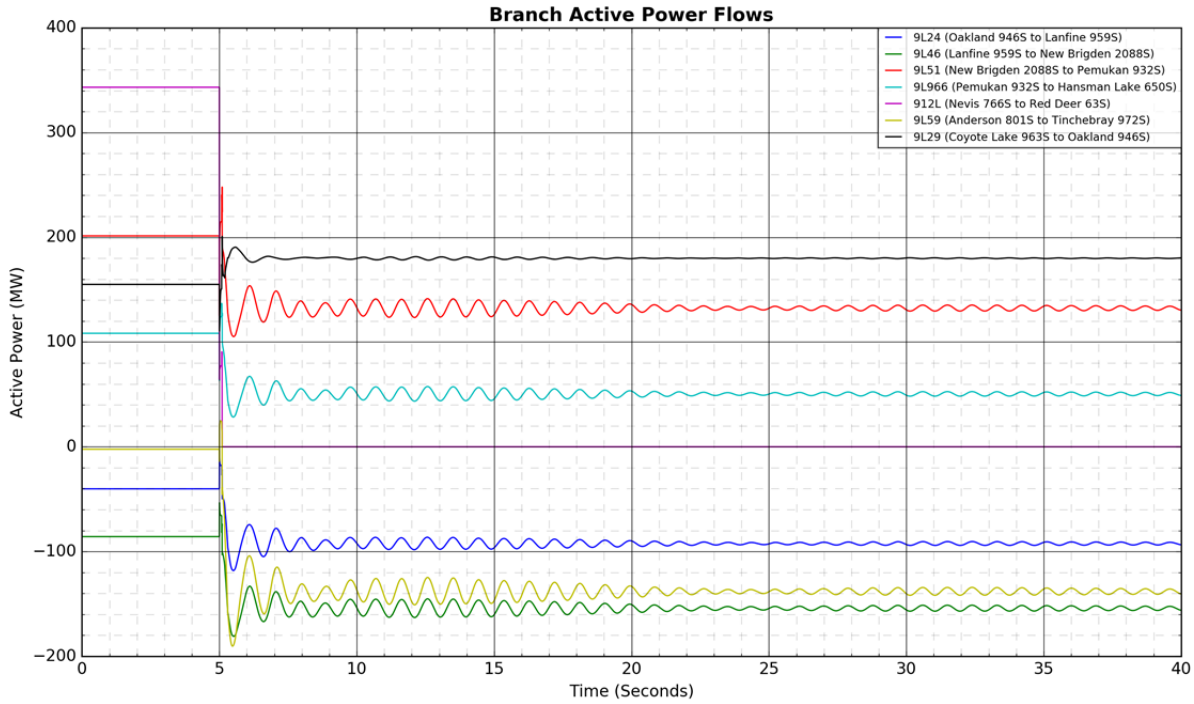

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active Power (pu)
Time (Seconds)
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
0.20
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
−0.20
−0.25
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

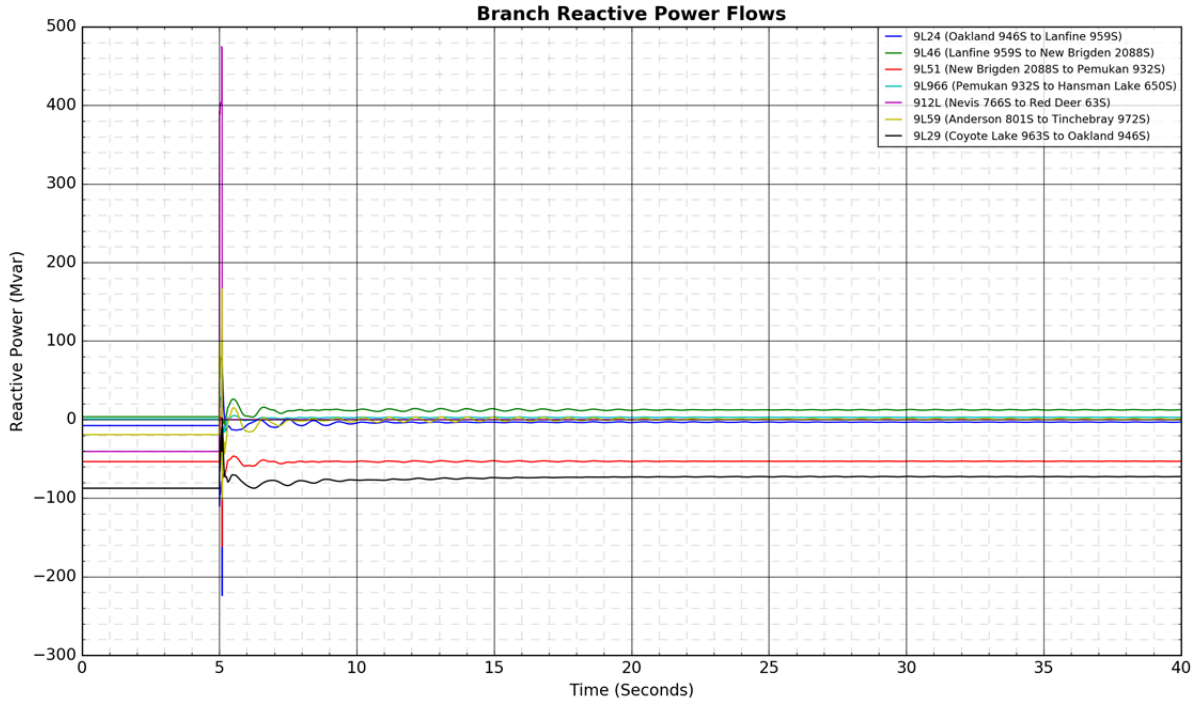
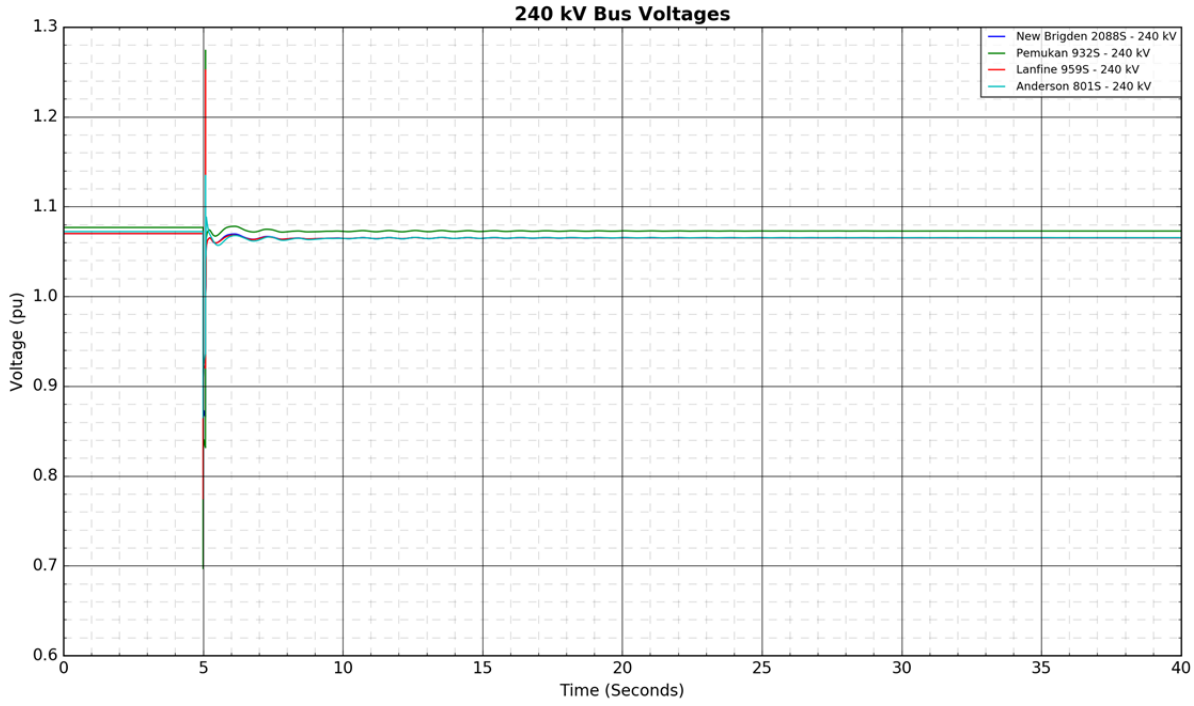
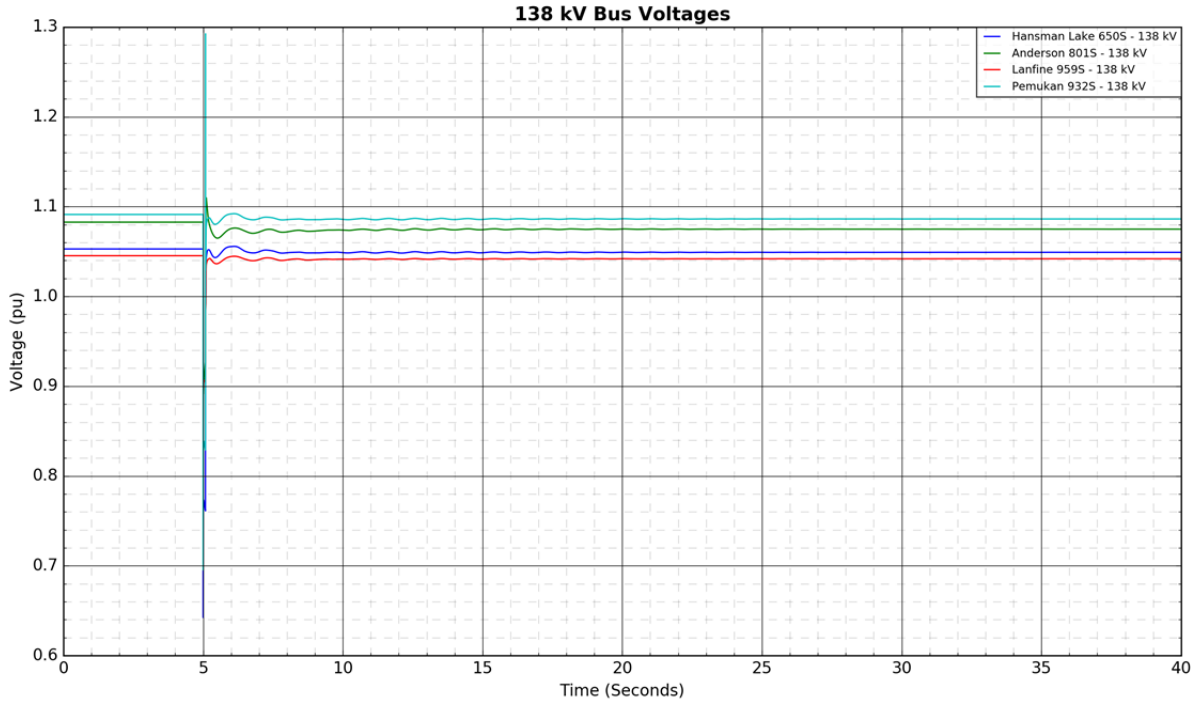
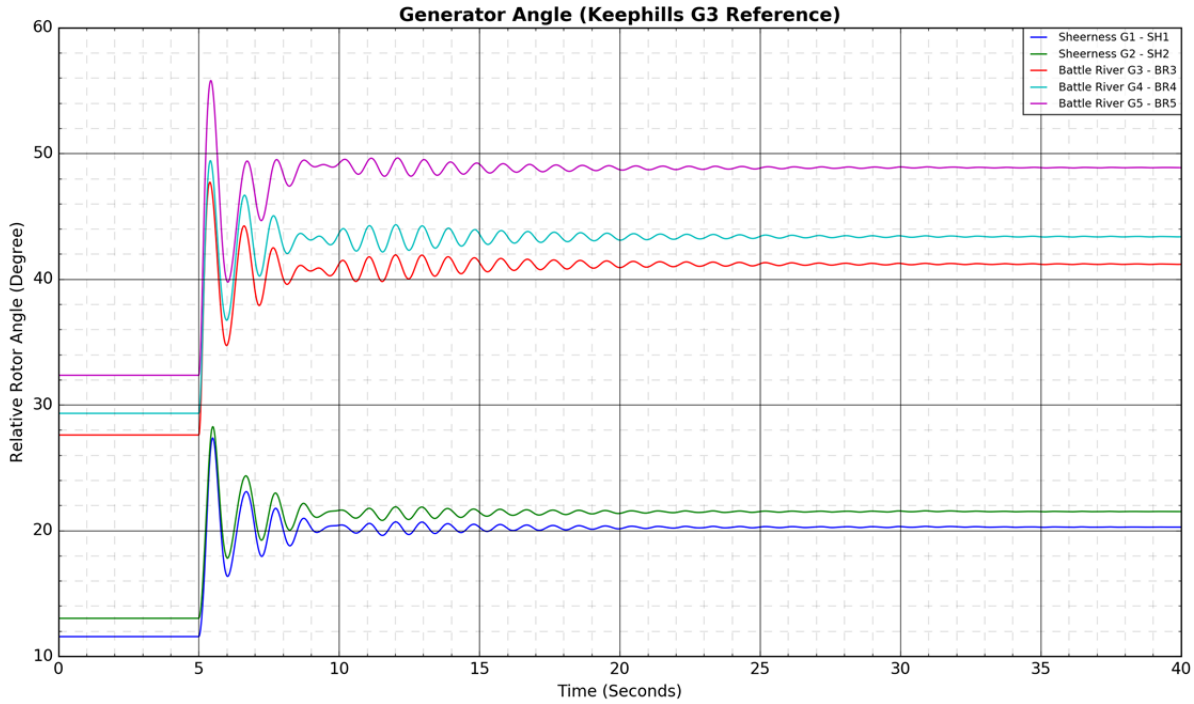
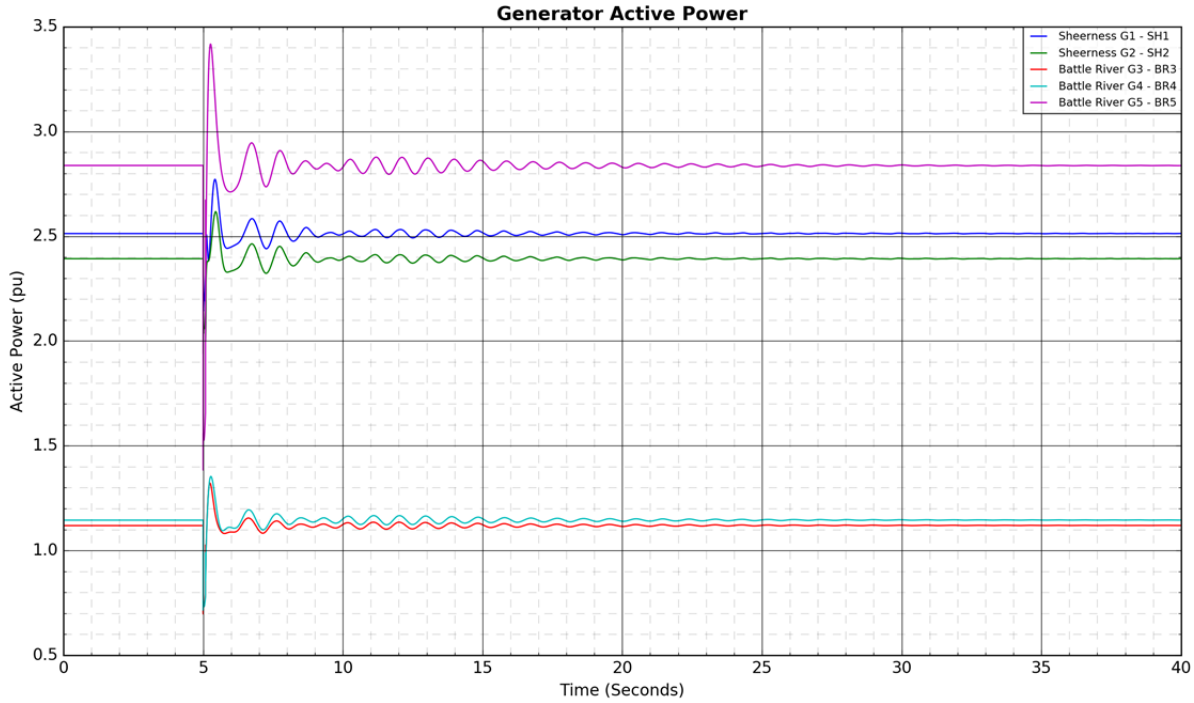

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

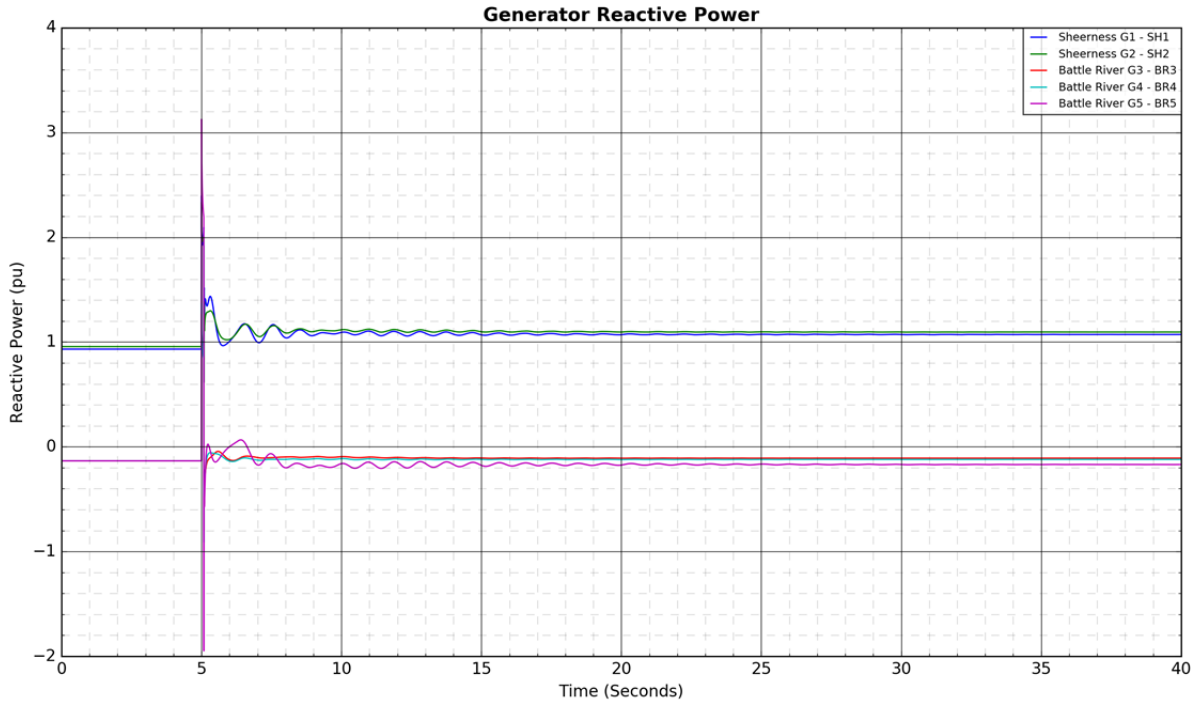
Figure A4-22: 912L/9L912 Nevis 766S to Red Deer 63S: Fault Near Nevis 766S

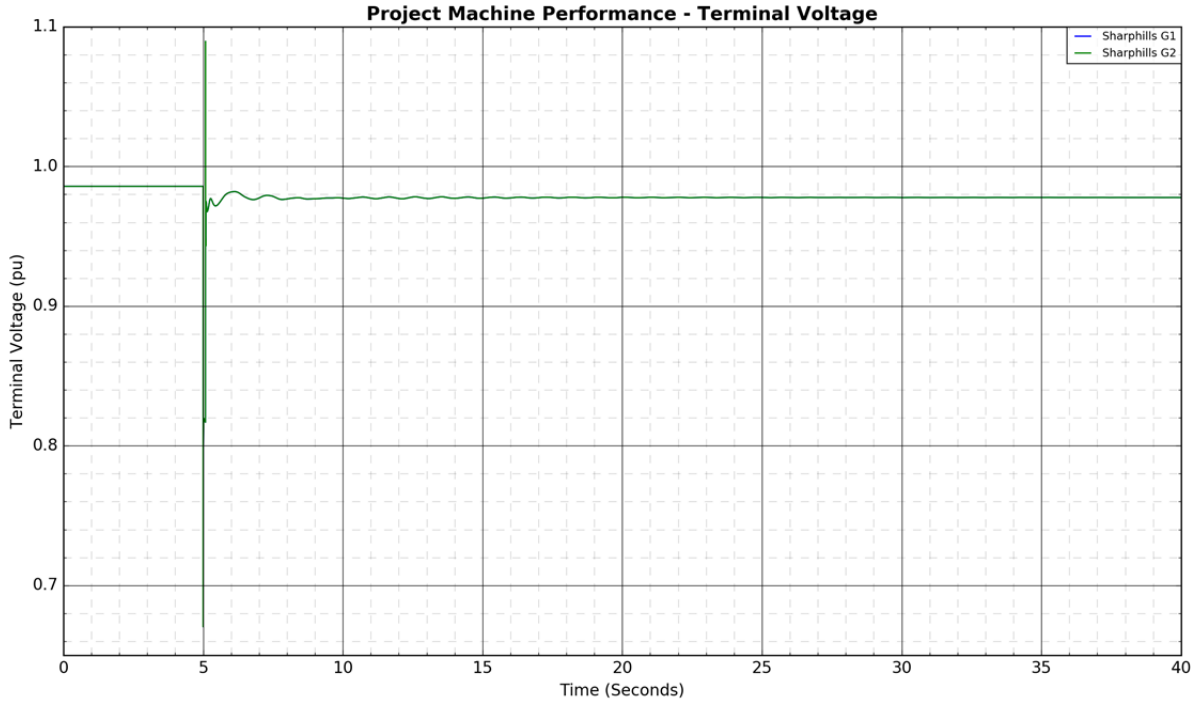


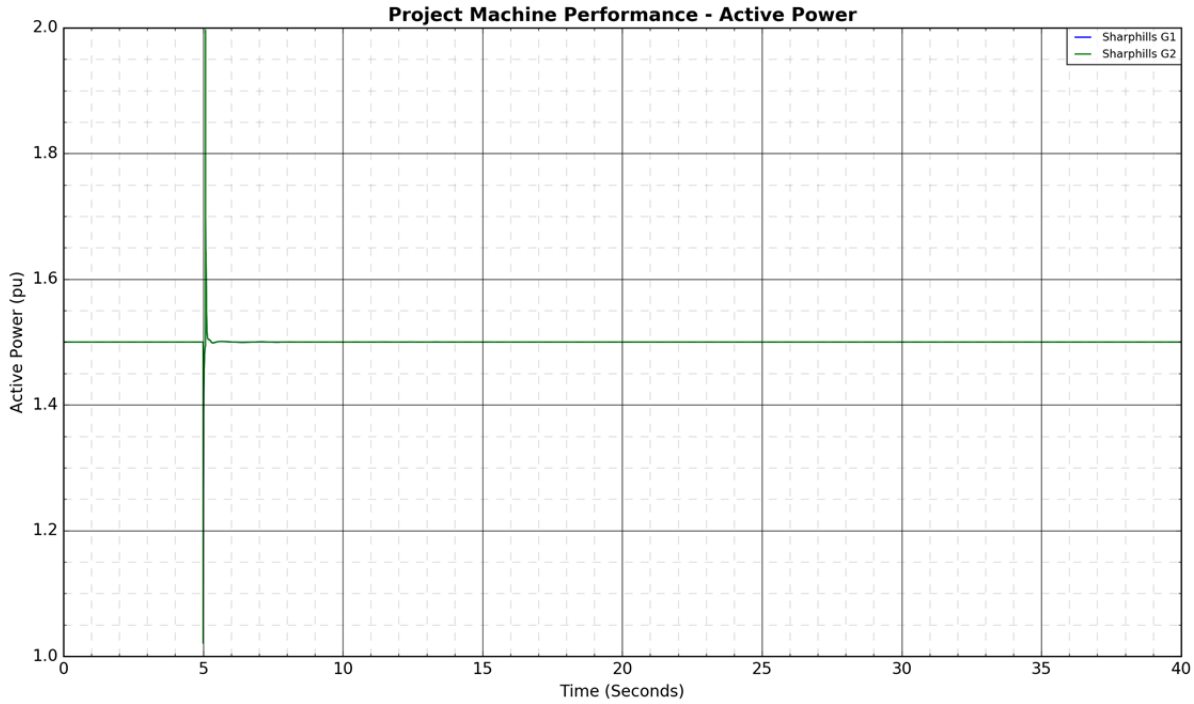


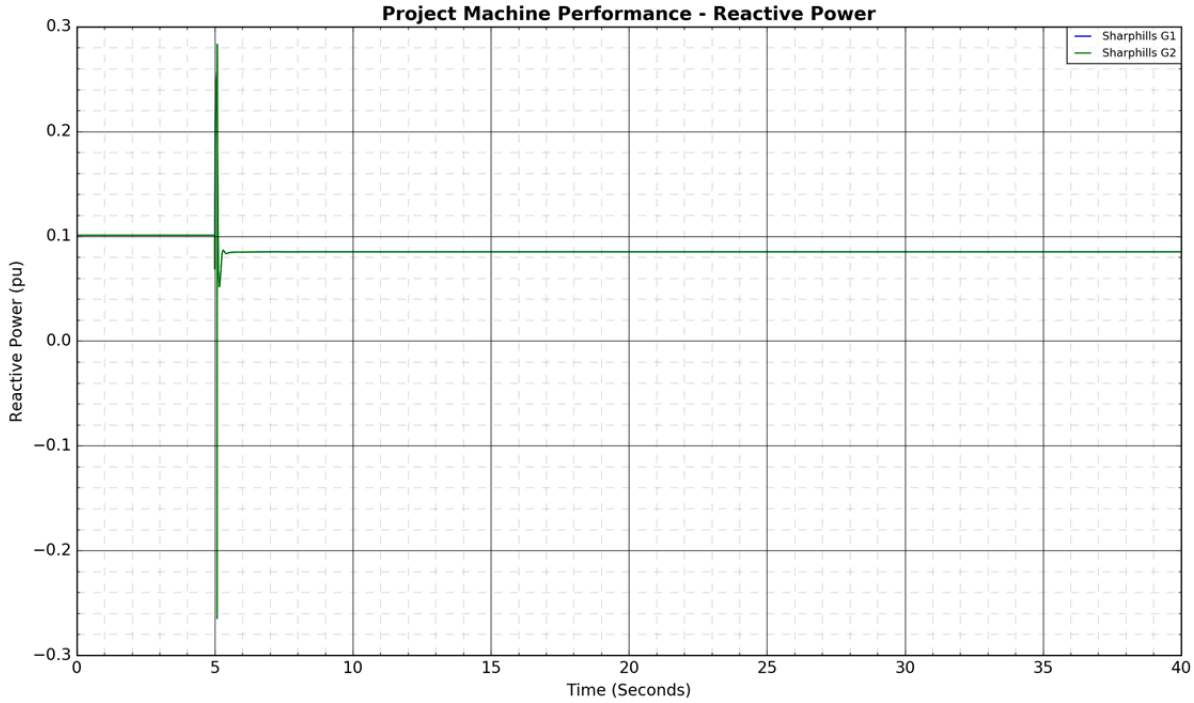

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

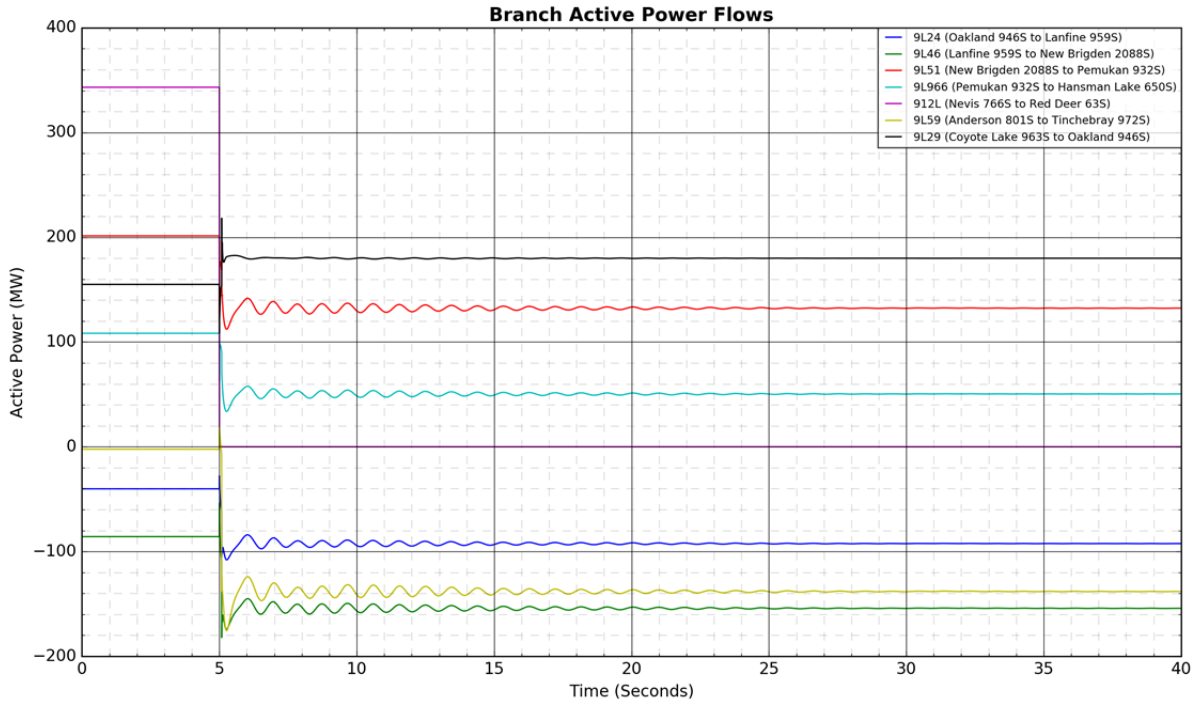

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active Power (pu)
2.0
1.8
1.6
1.4
1.2
1.0
0
5
10
15
20
25
30
35
40
Time (Seconds)


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
0
5
10
15
20
25
30
35
40
Time (Seconds)


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

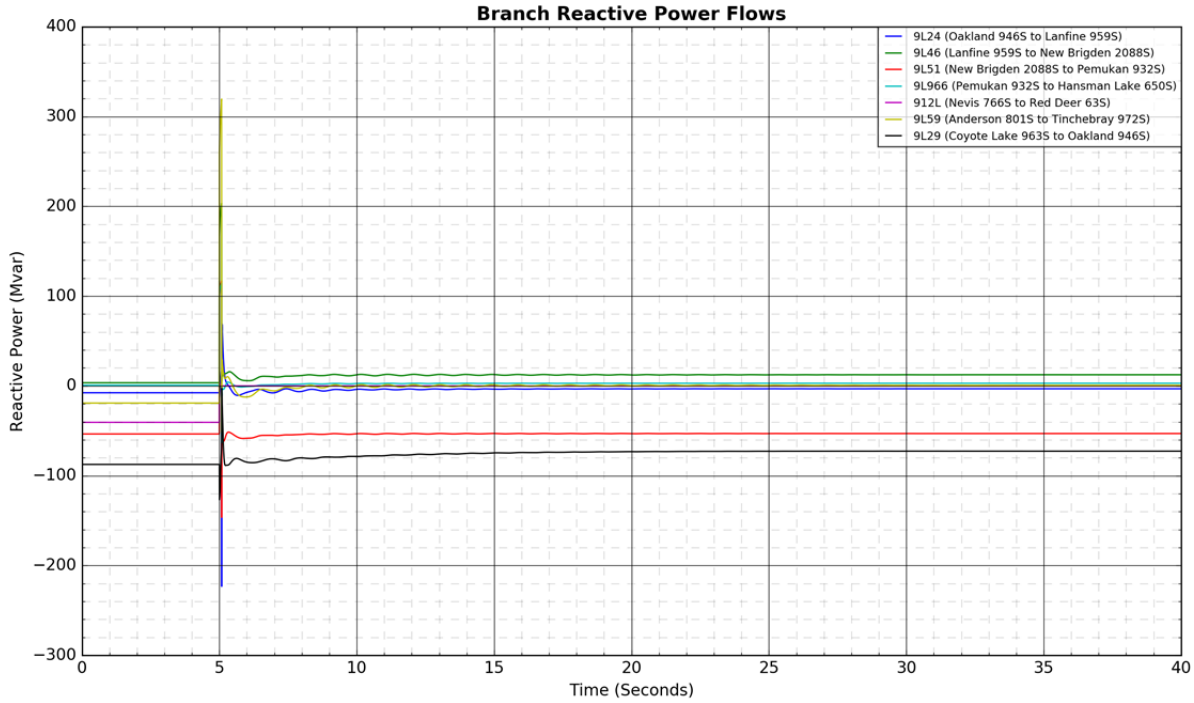
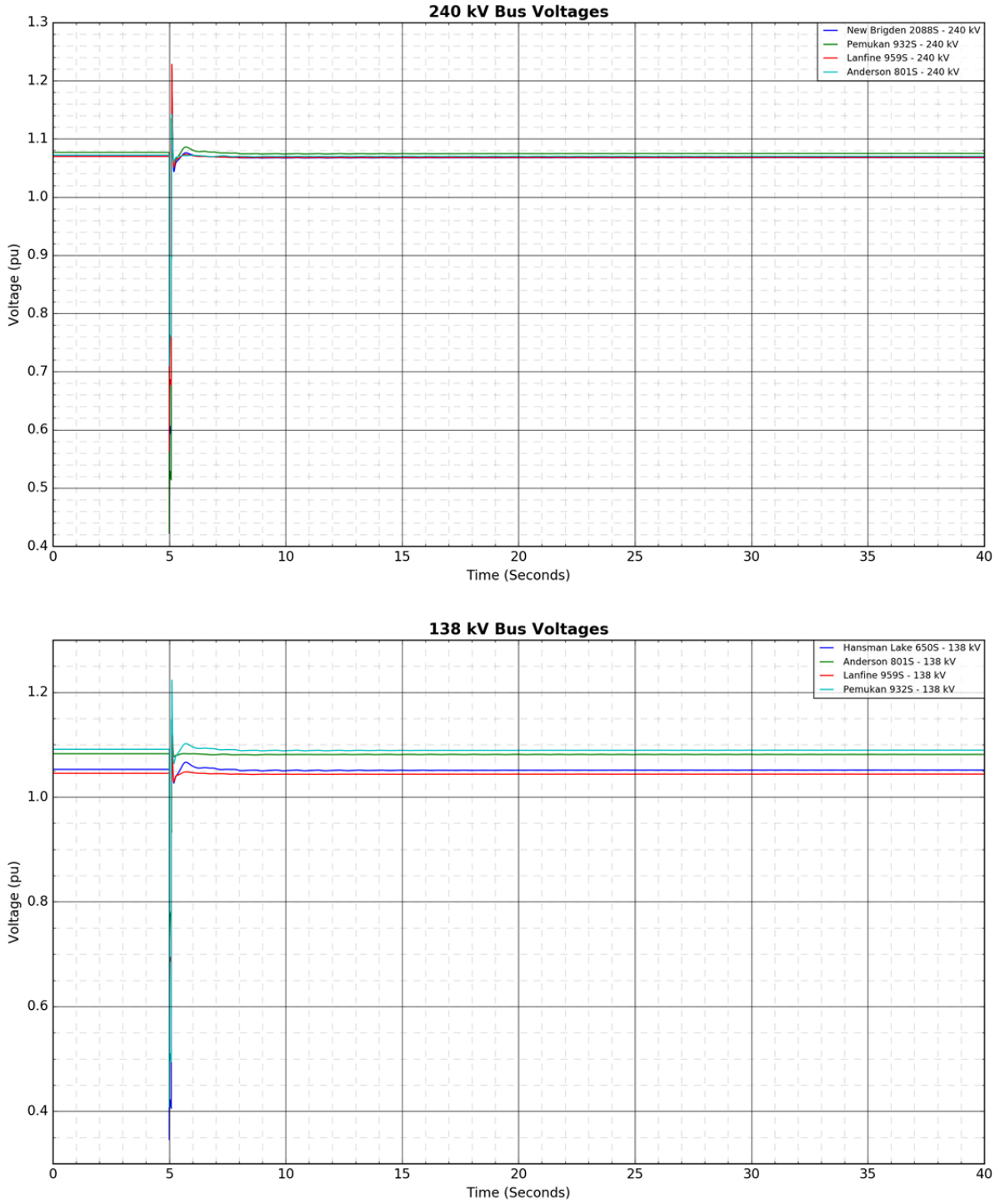
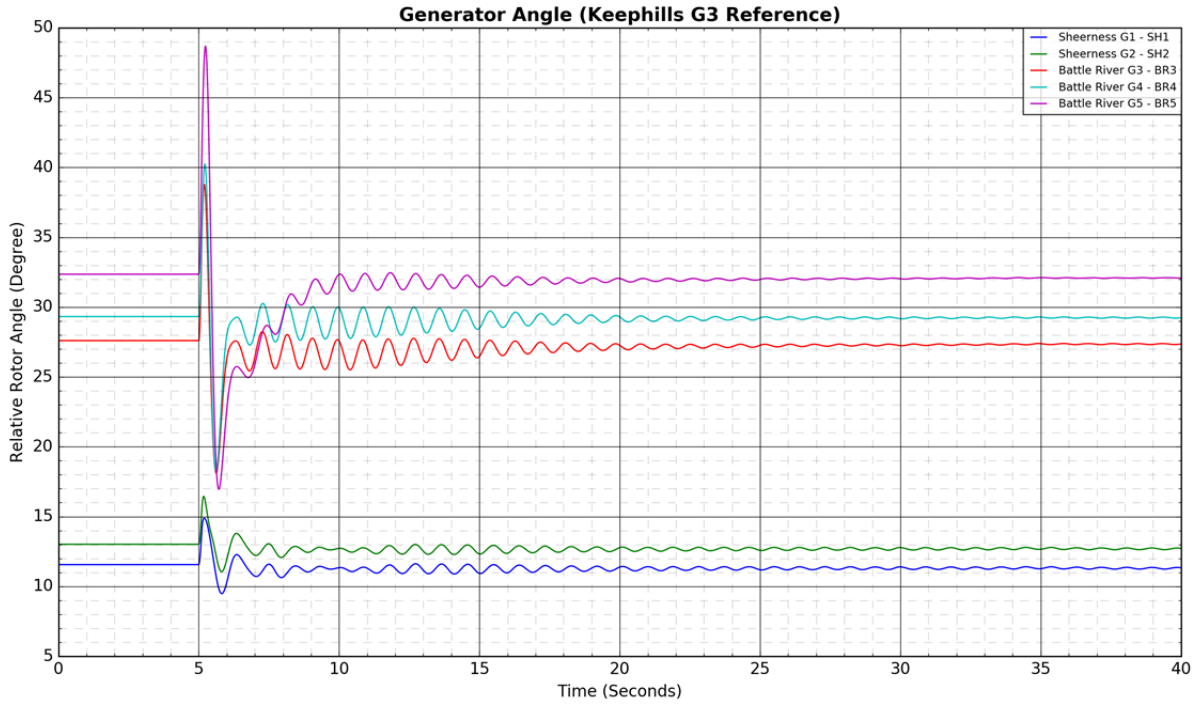
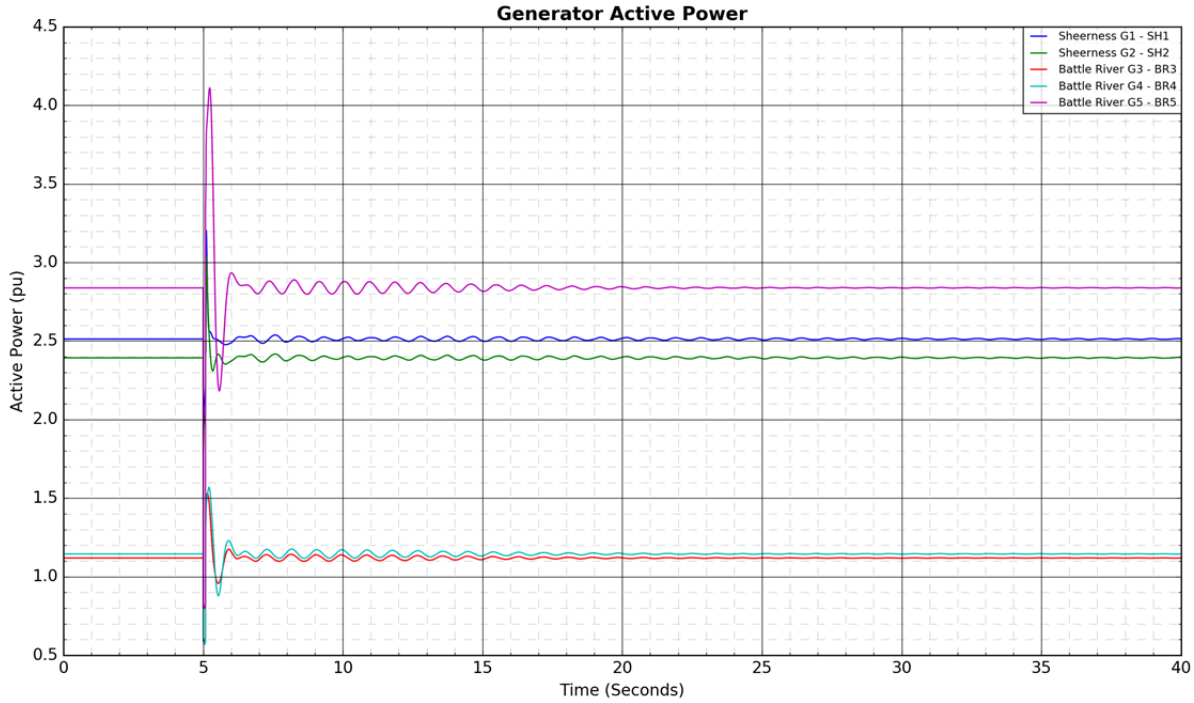
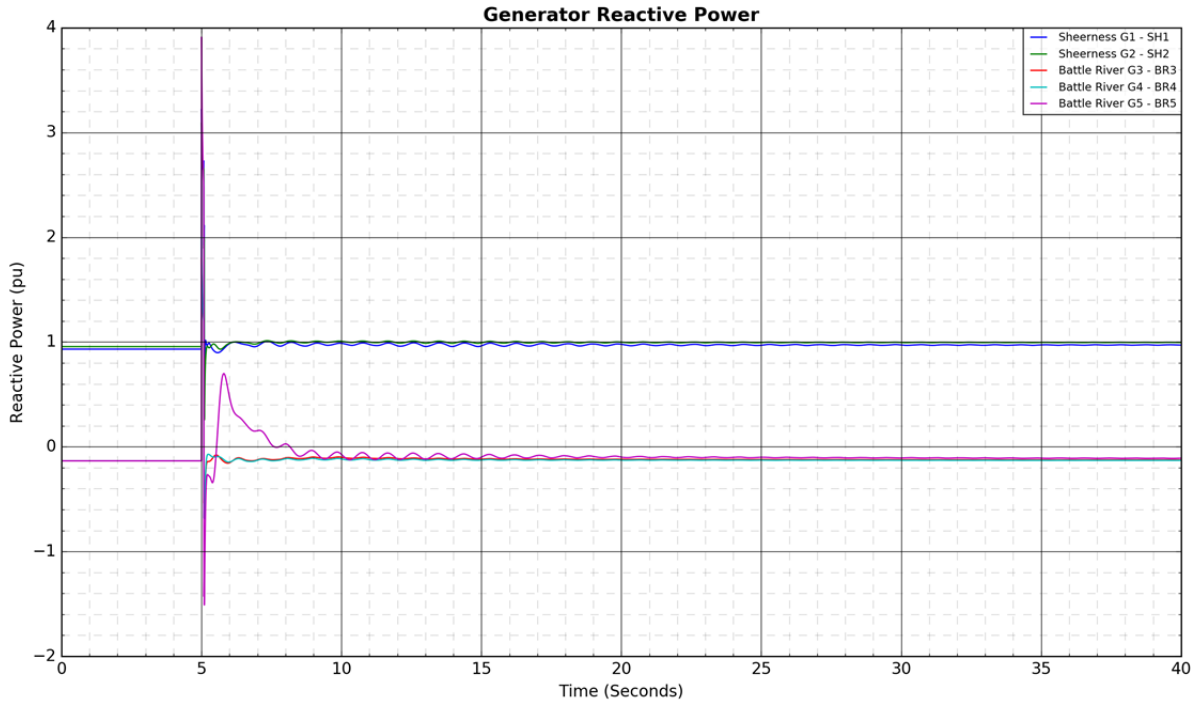

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

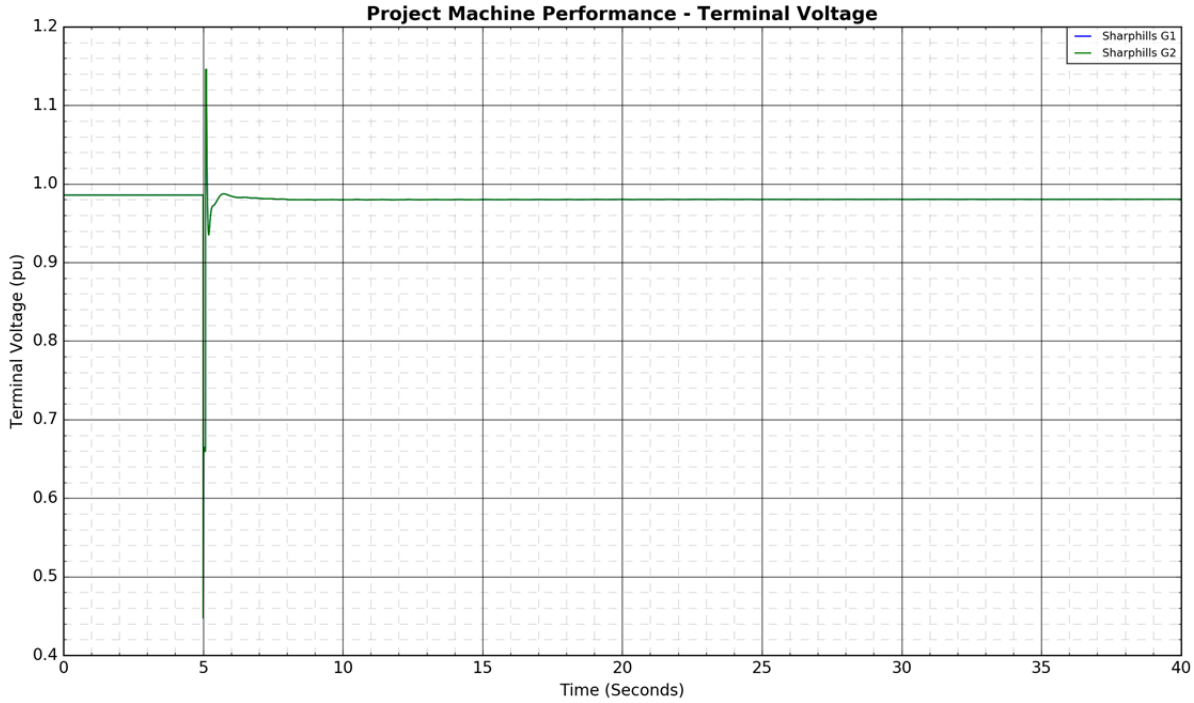
Figure A4-23: 9L59 Anderson 801S to Tinchebray 972S: Fault Near Tinchebray 972S

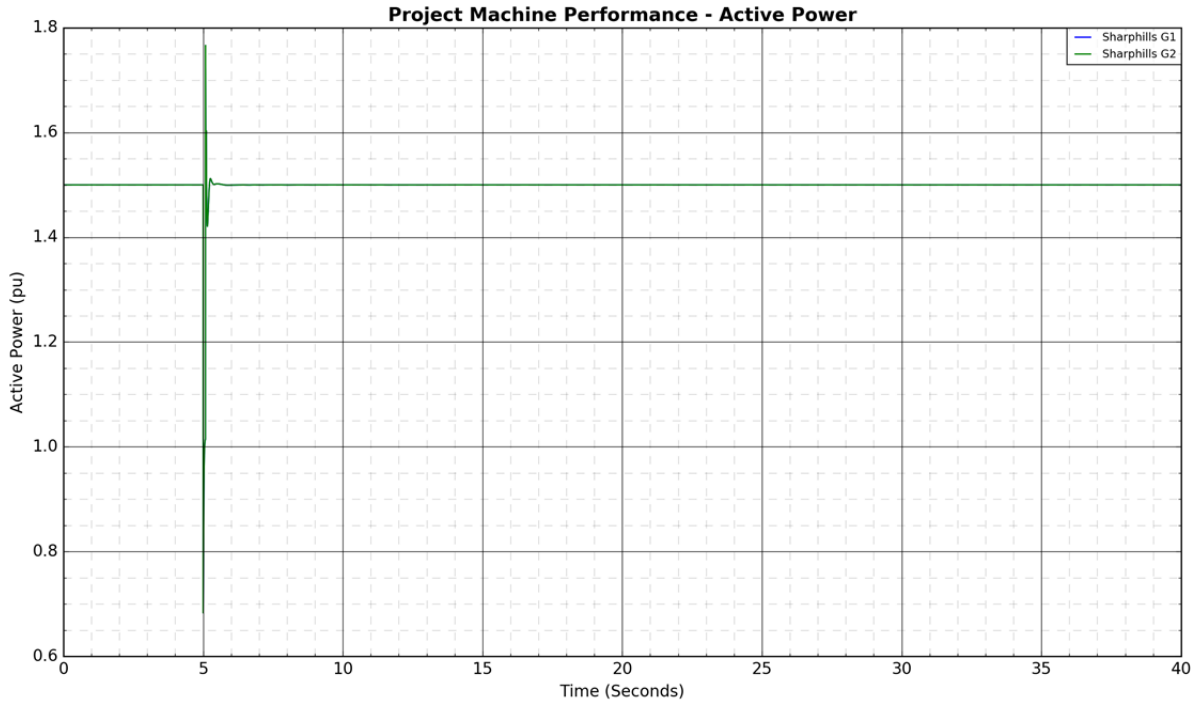


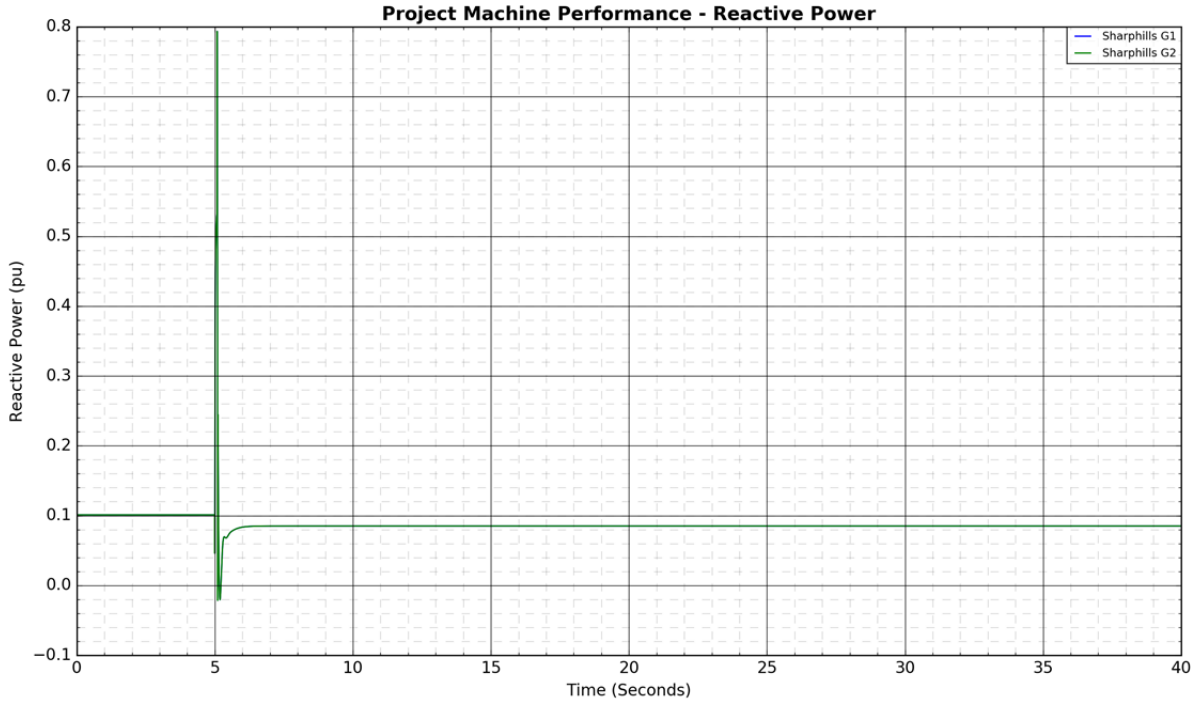

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

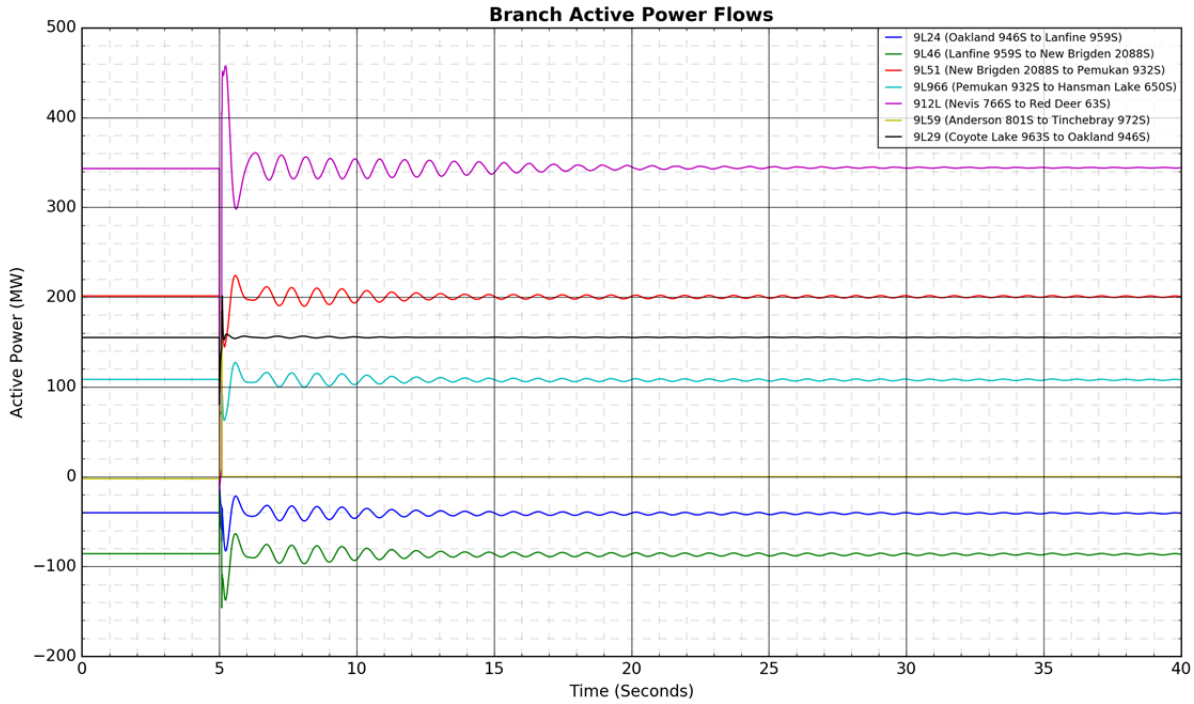

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

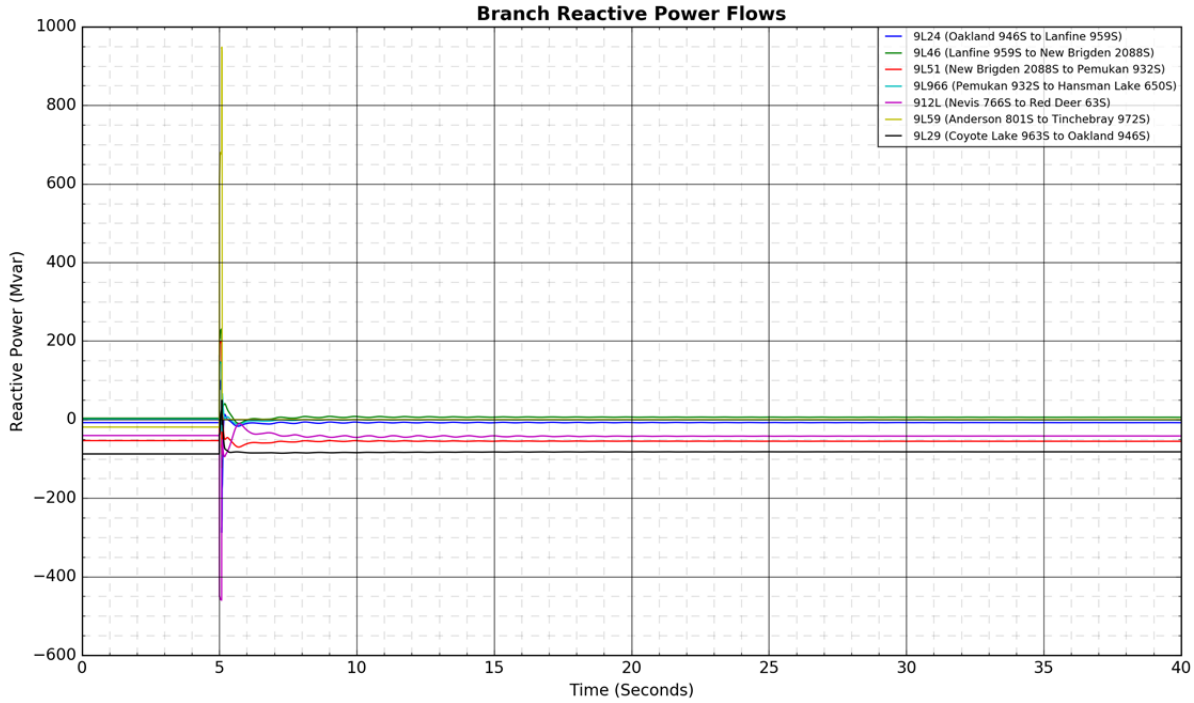
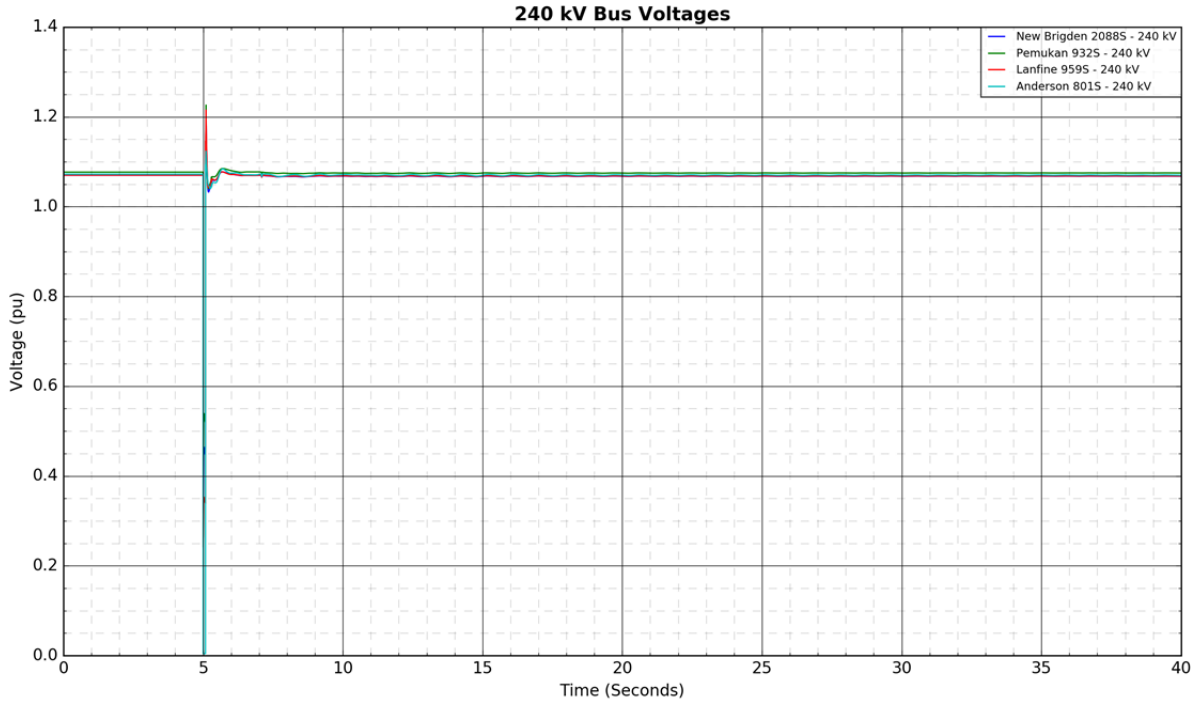
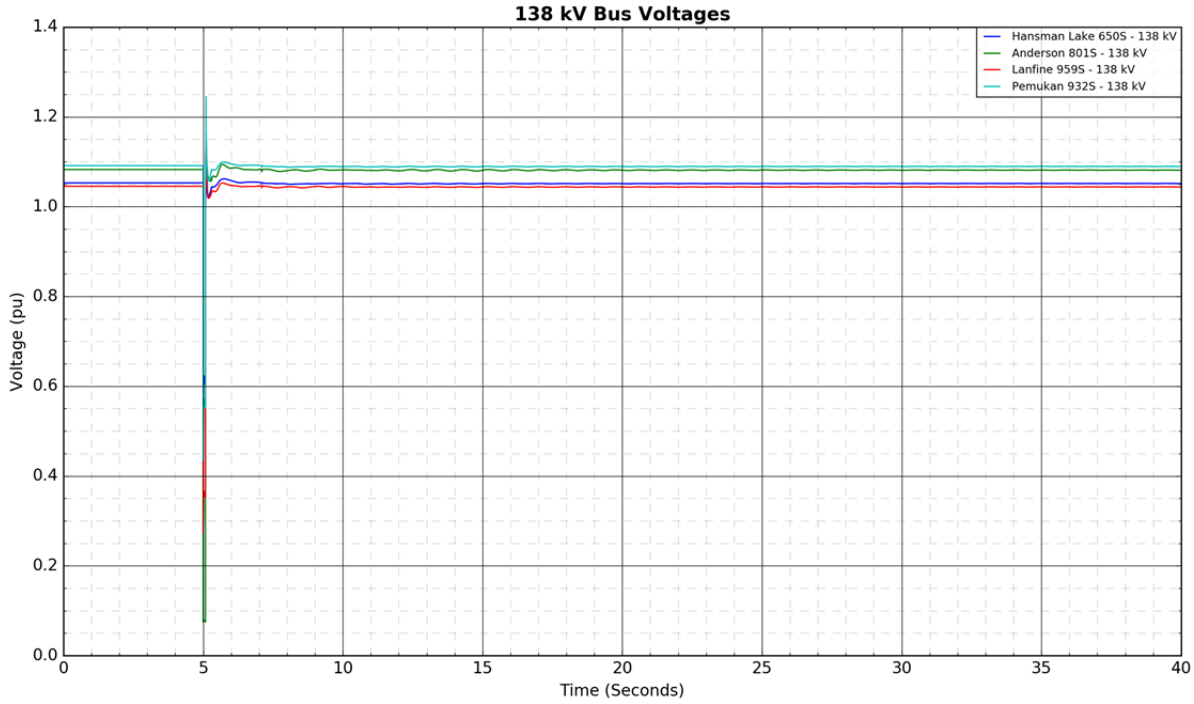
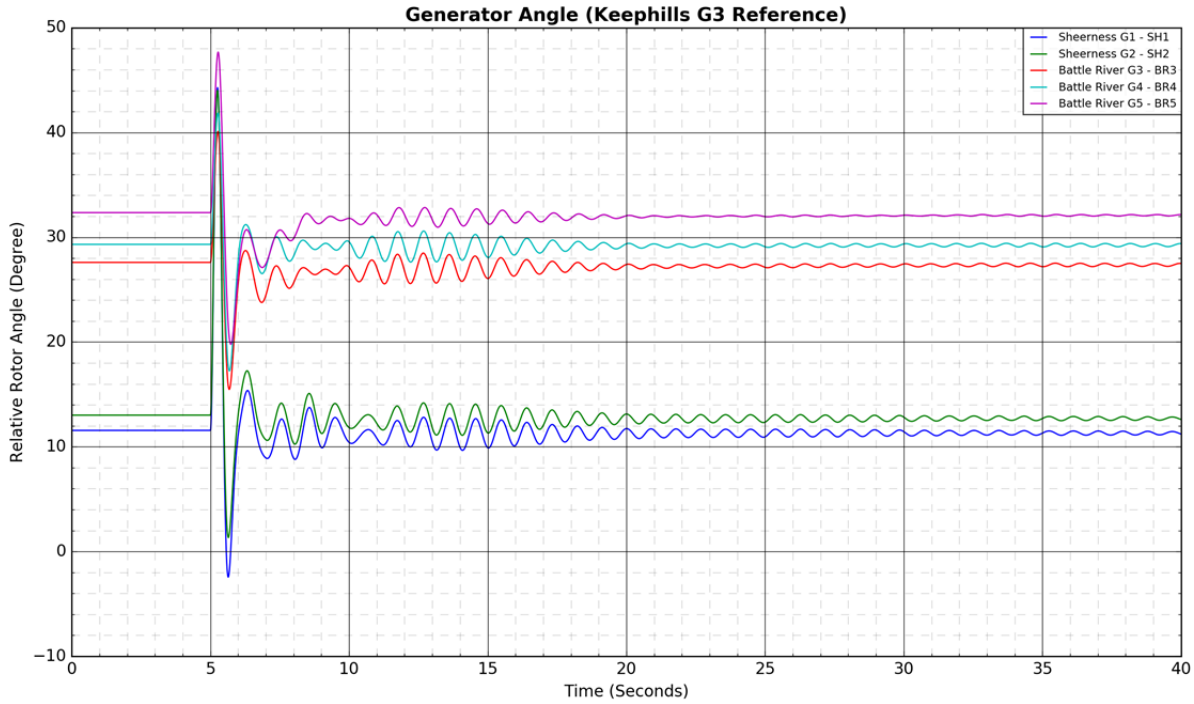
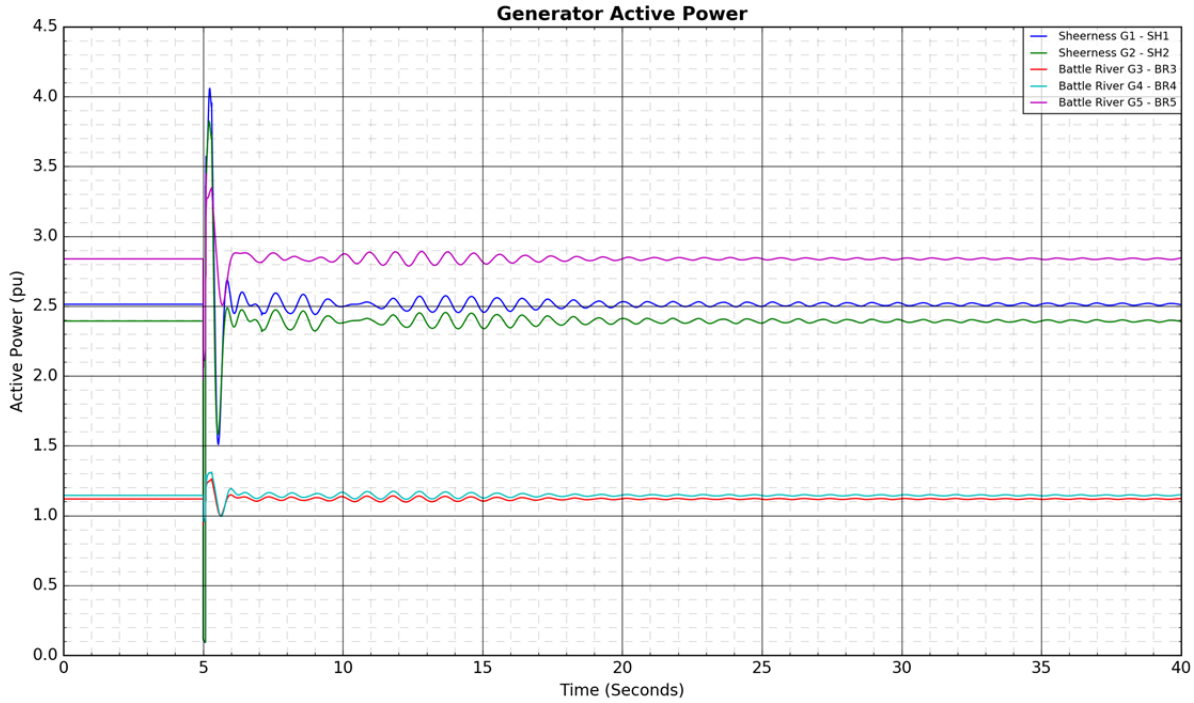

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

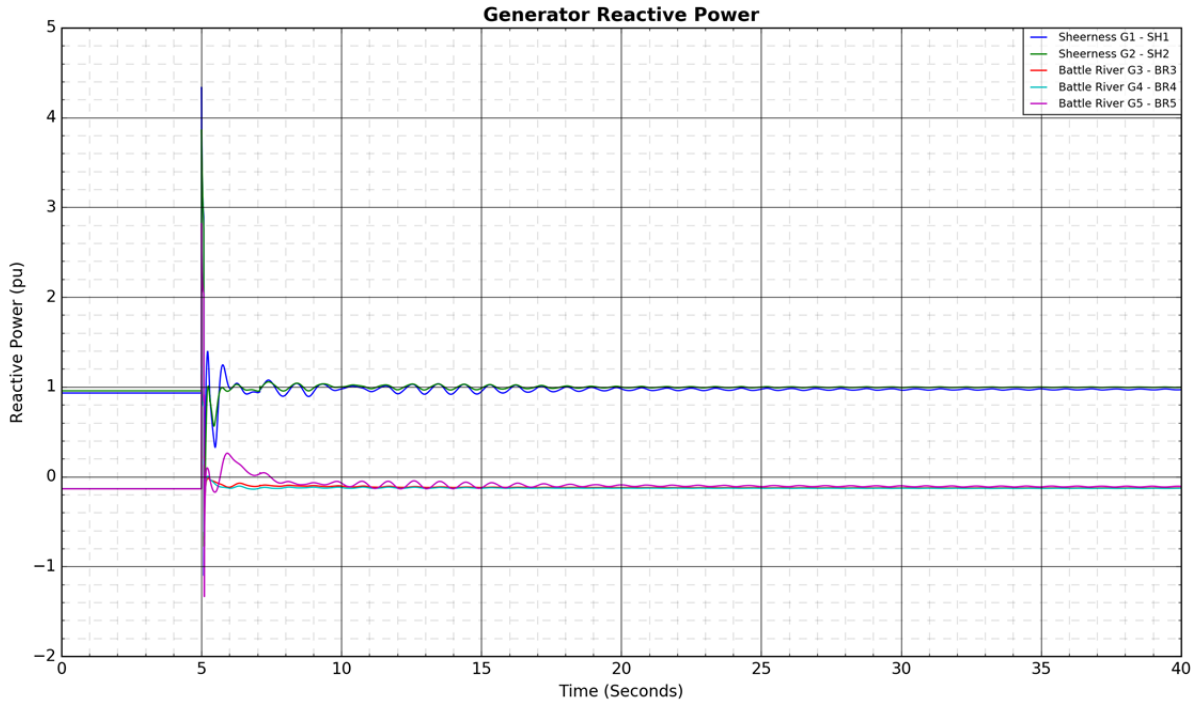
Figure A4-24: 9L59 Anderson 801S to Tinchebray 972S: Fault Near Anderson 801S

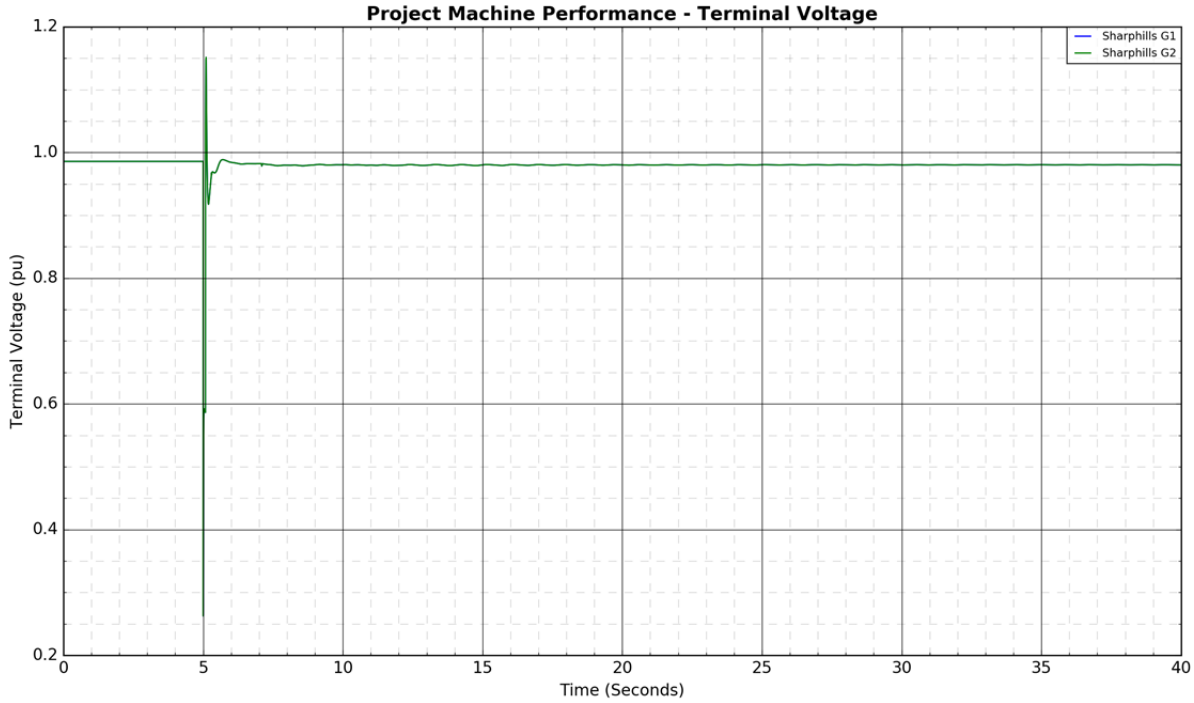


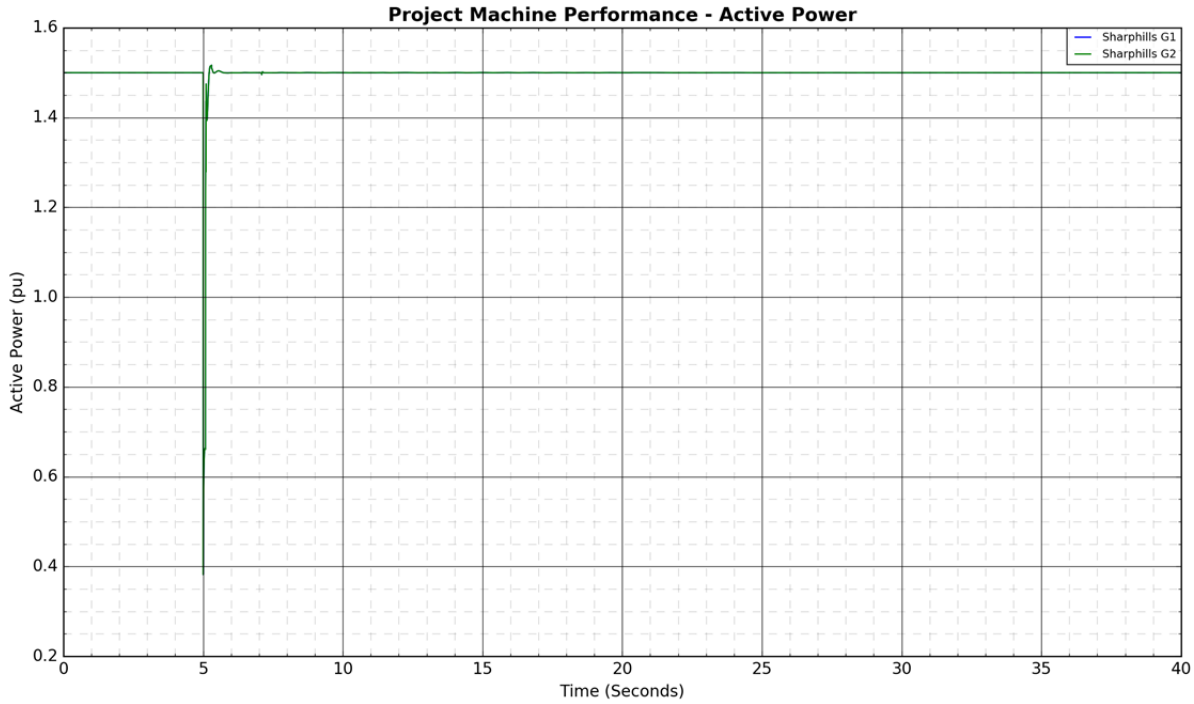


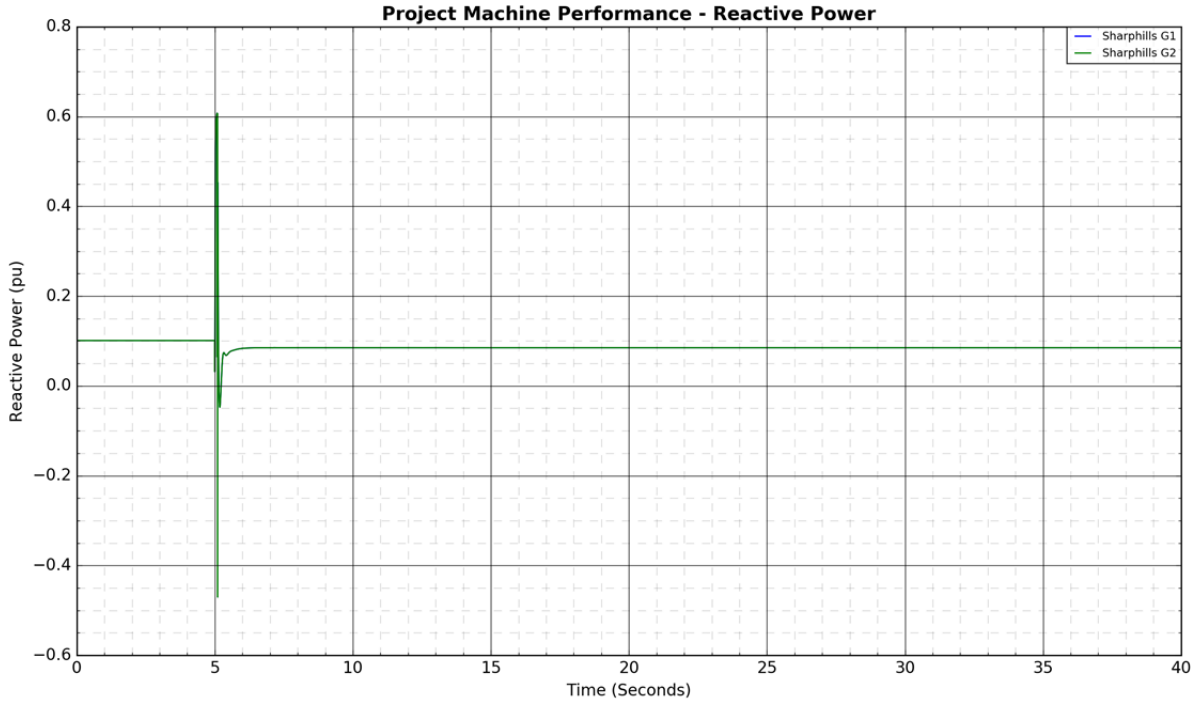

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

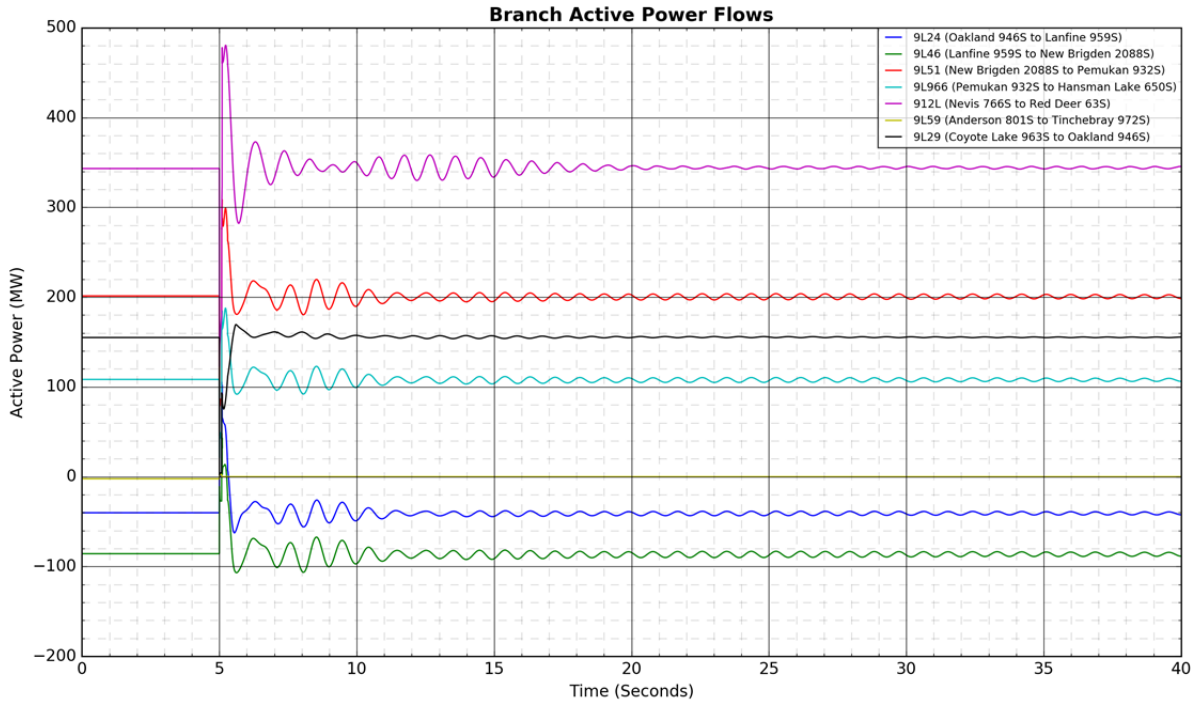

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

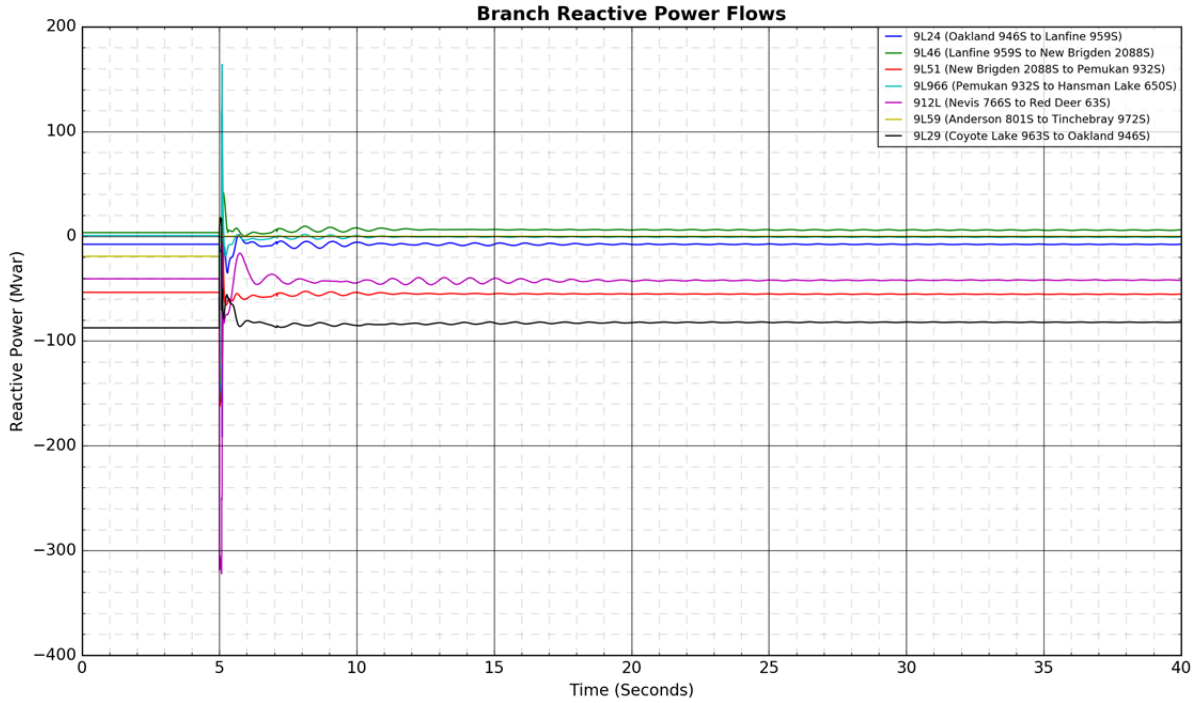

Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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

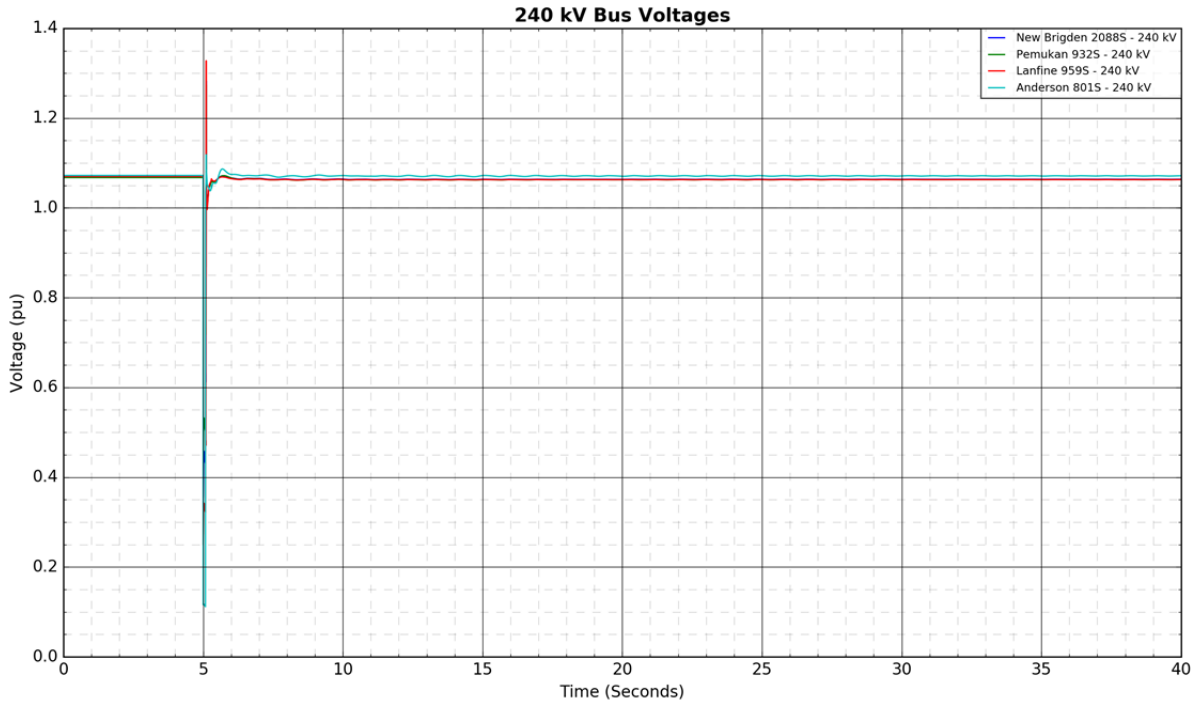

Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
0
5
10
15
20
25
30
35
40

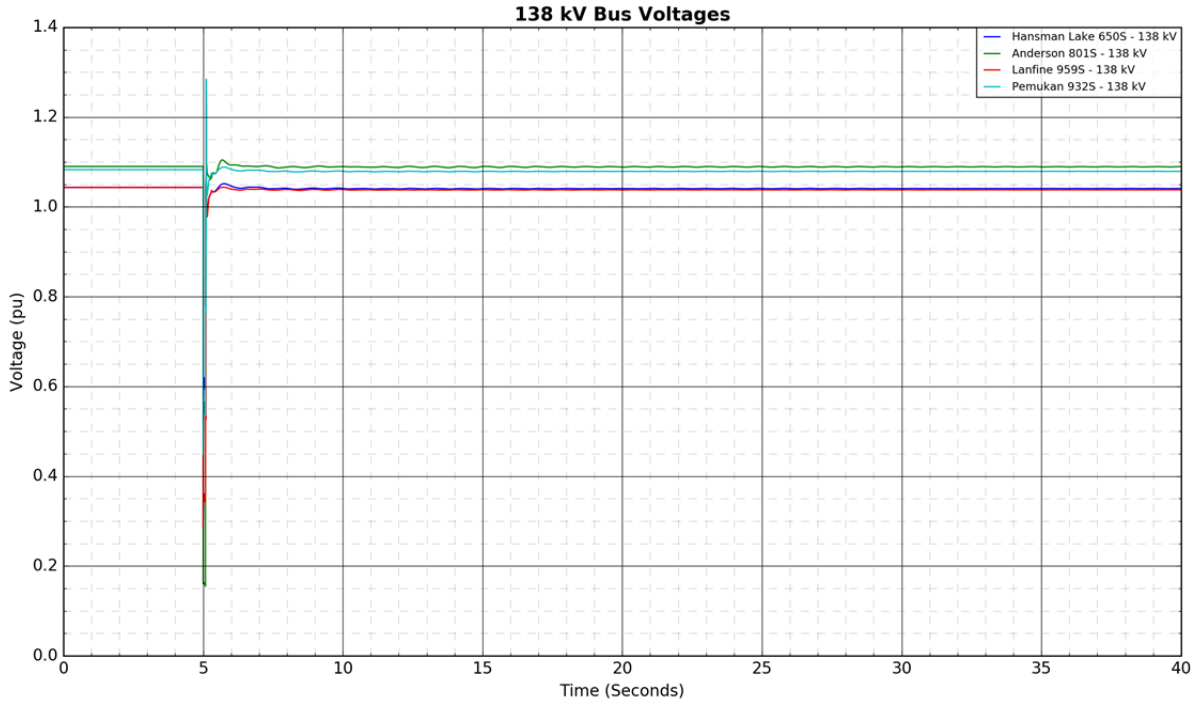

Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

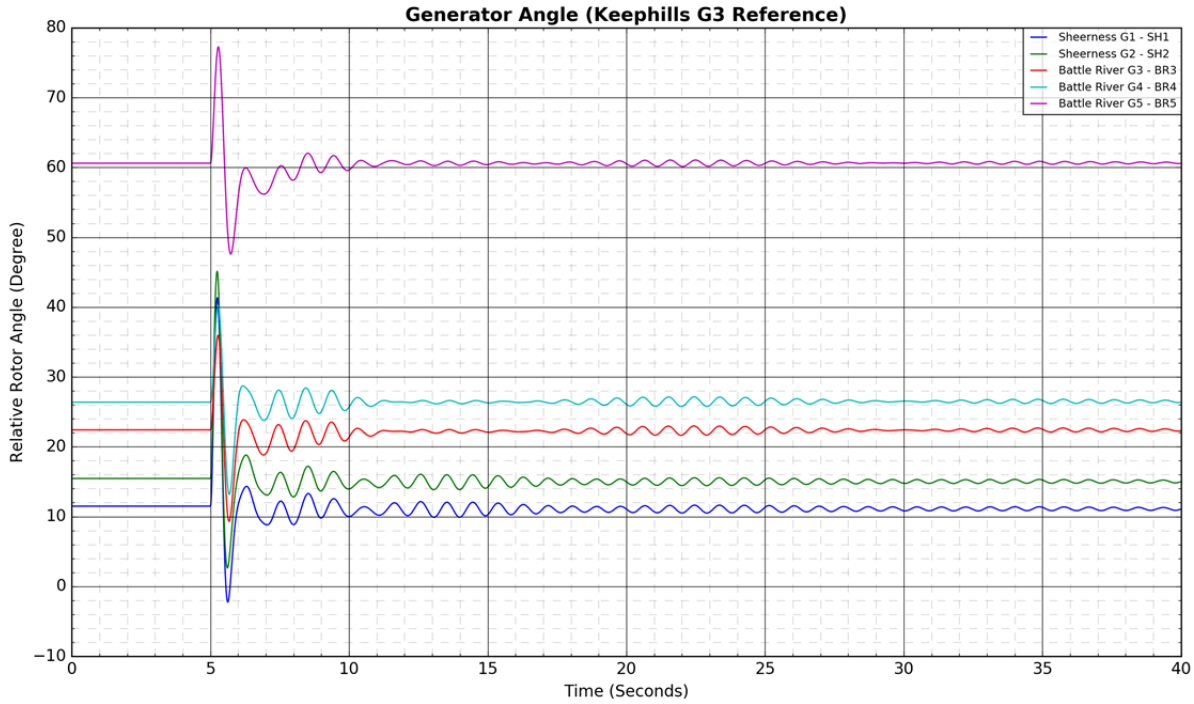

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

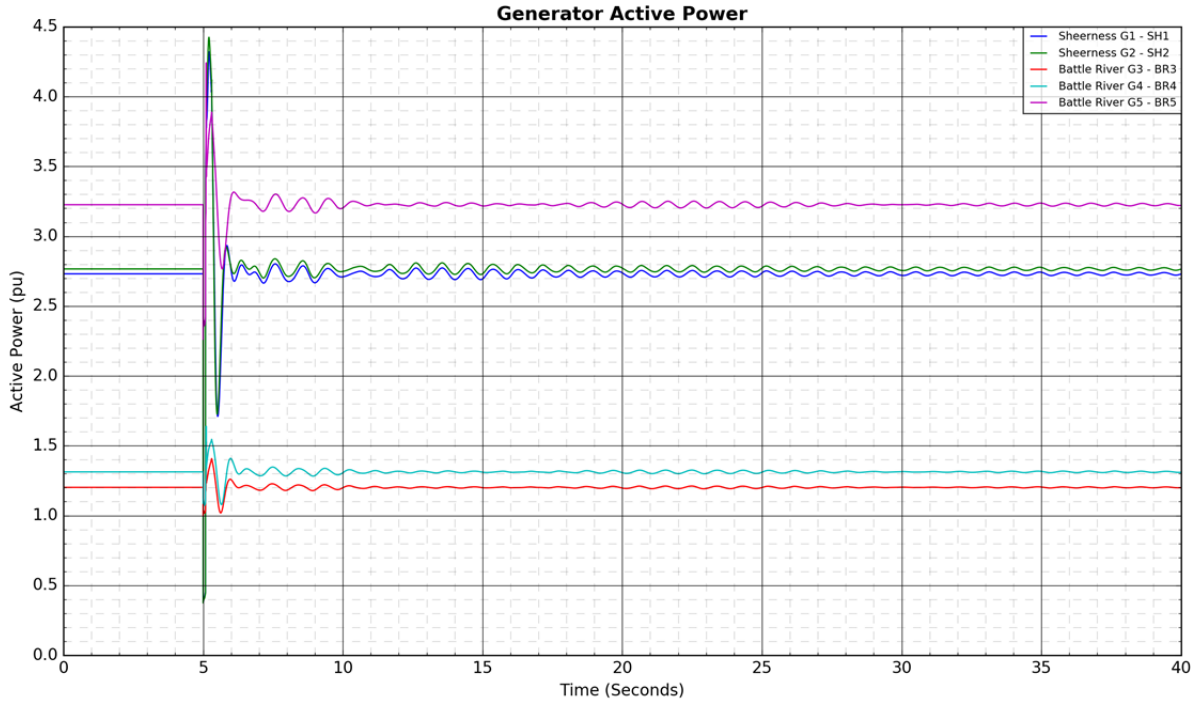
3. Stability Results 2018 Winter Peak - Case B

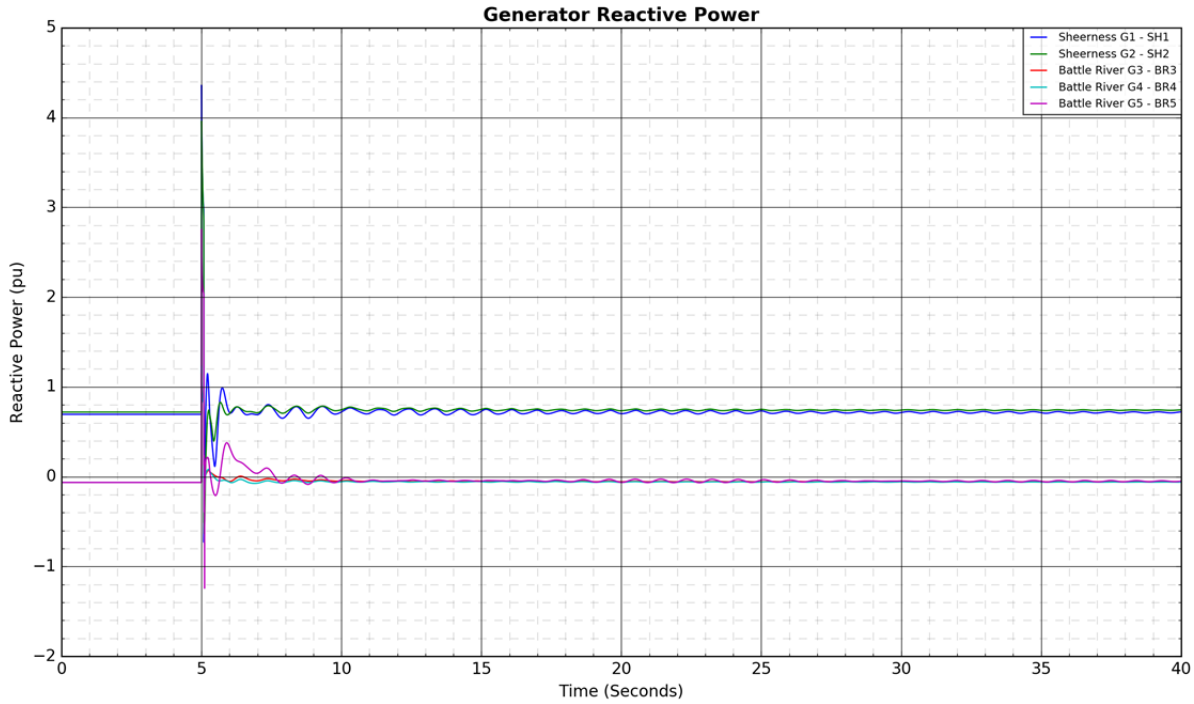
Figure A4-25: 9L24 Oakland 946S to Lanfine 959S: Fault Near Oakland 946S

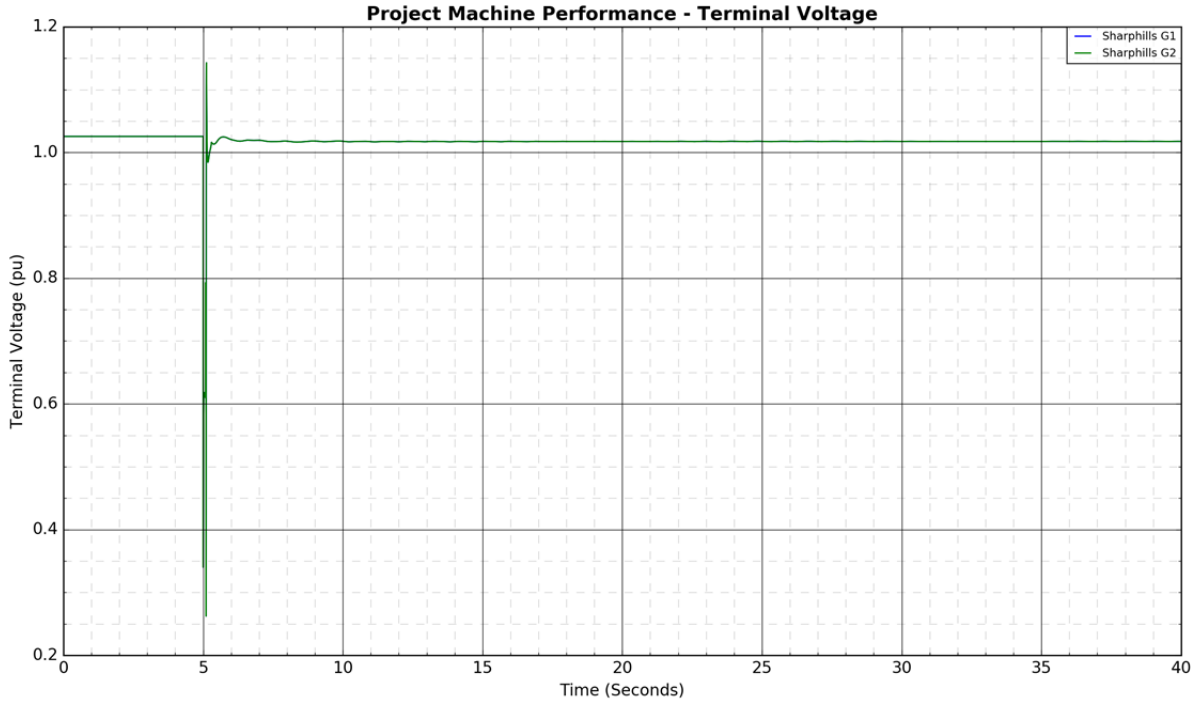


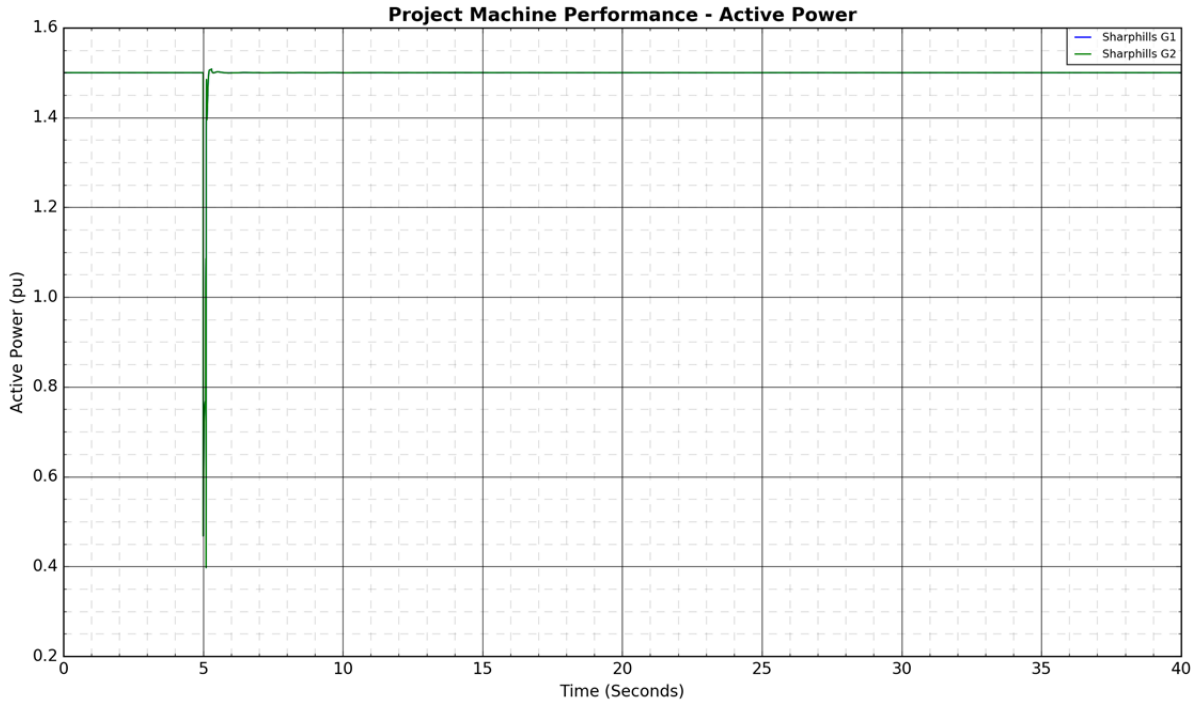


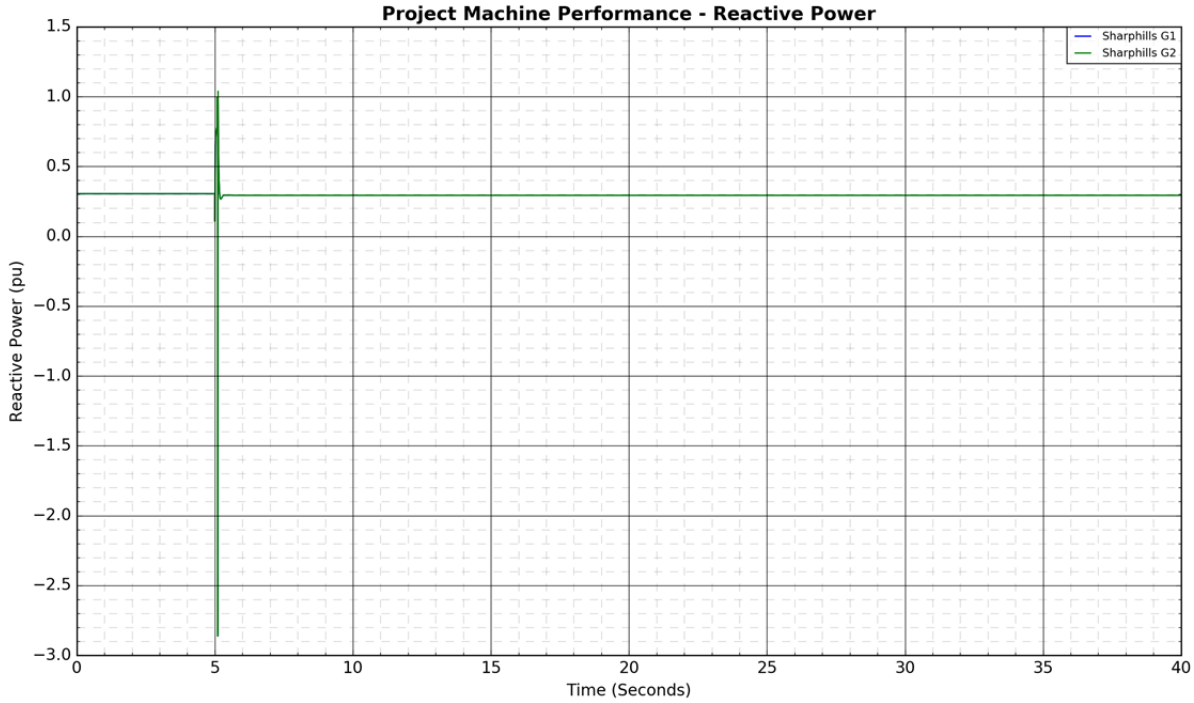

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

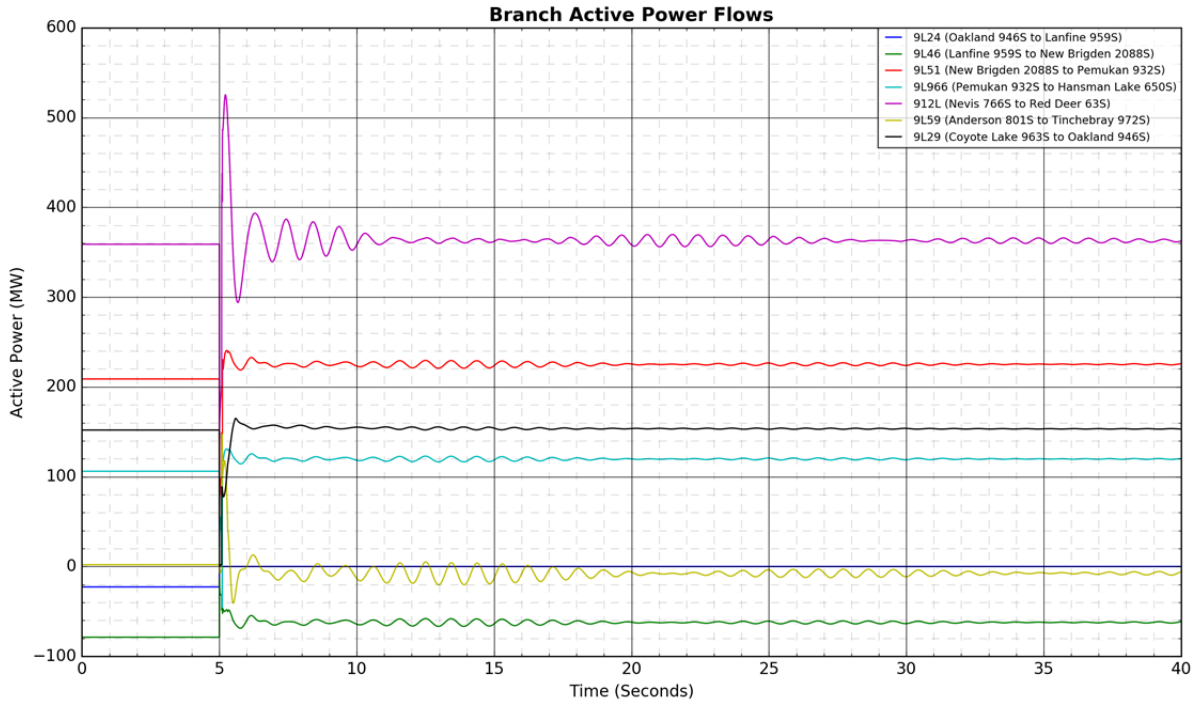

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

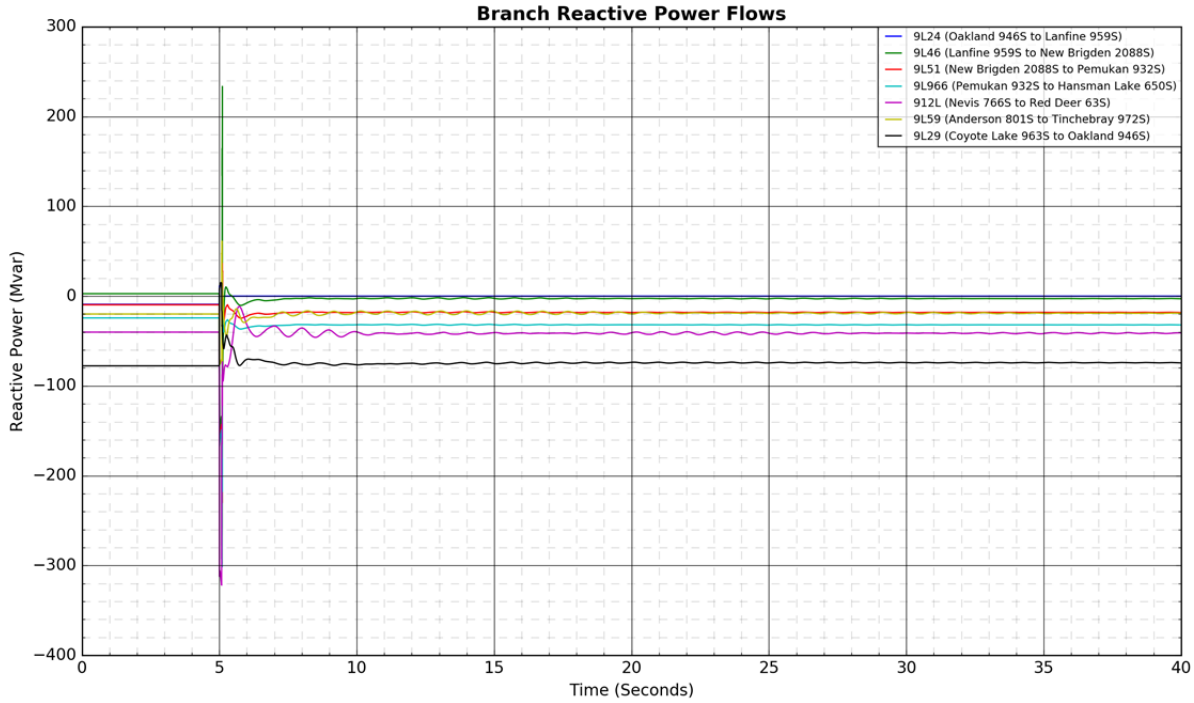
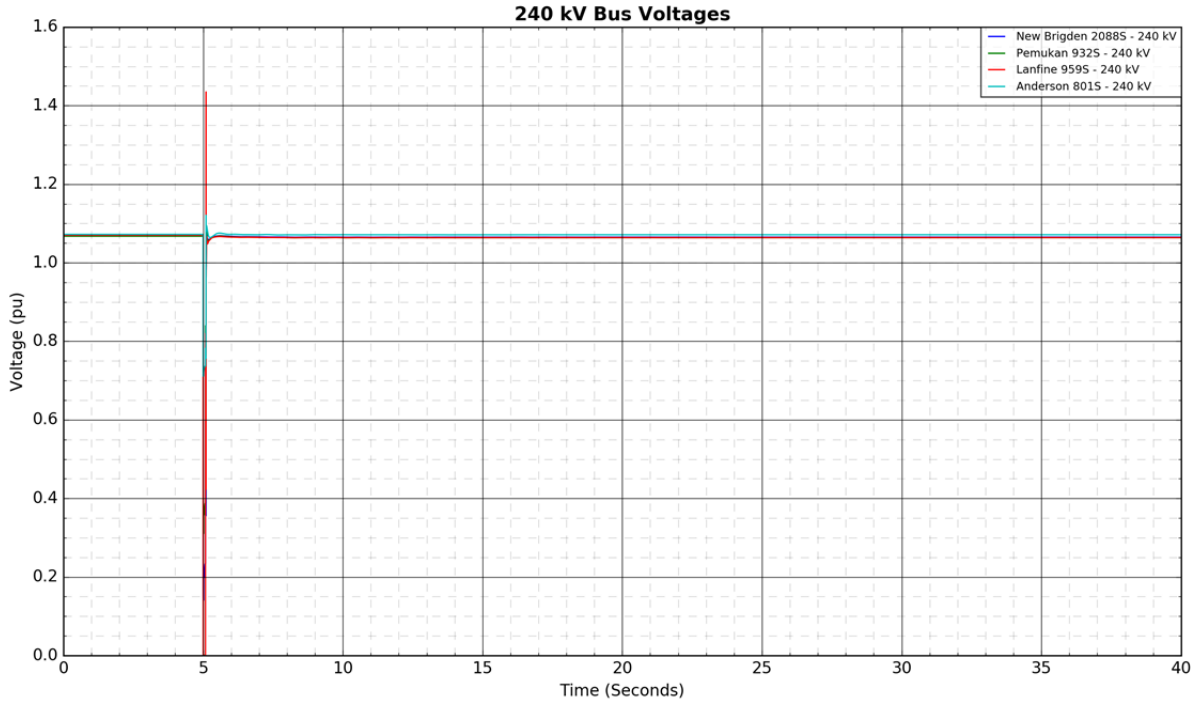
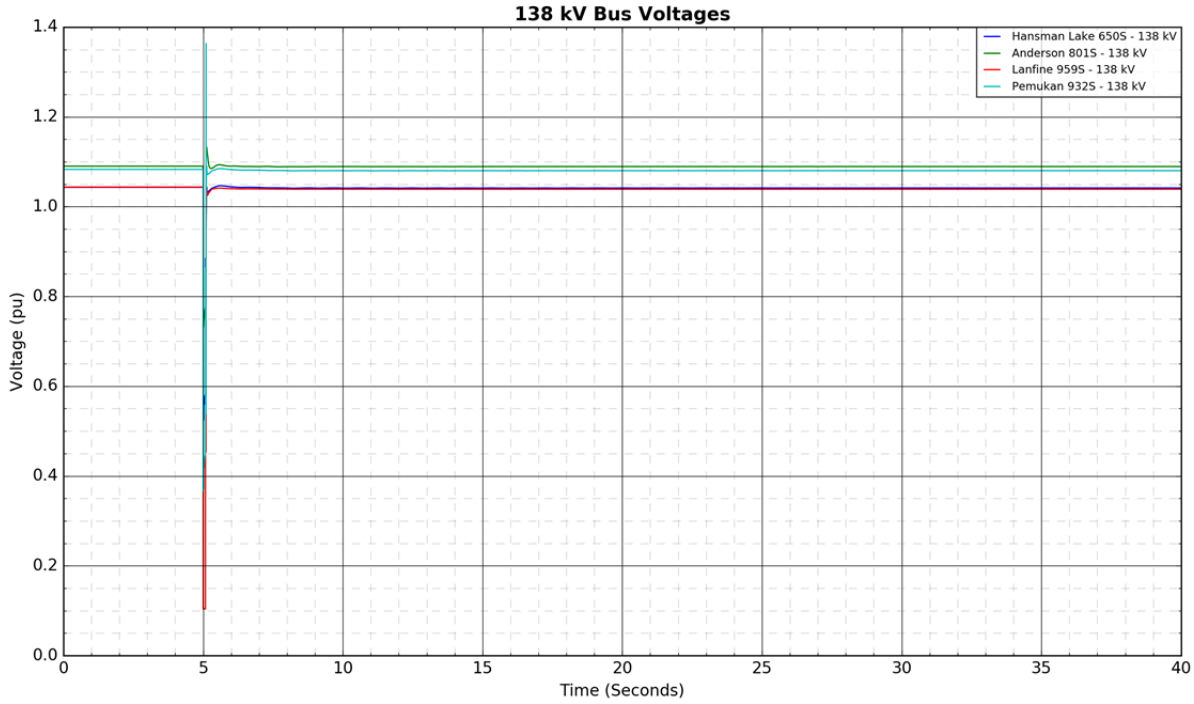
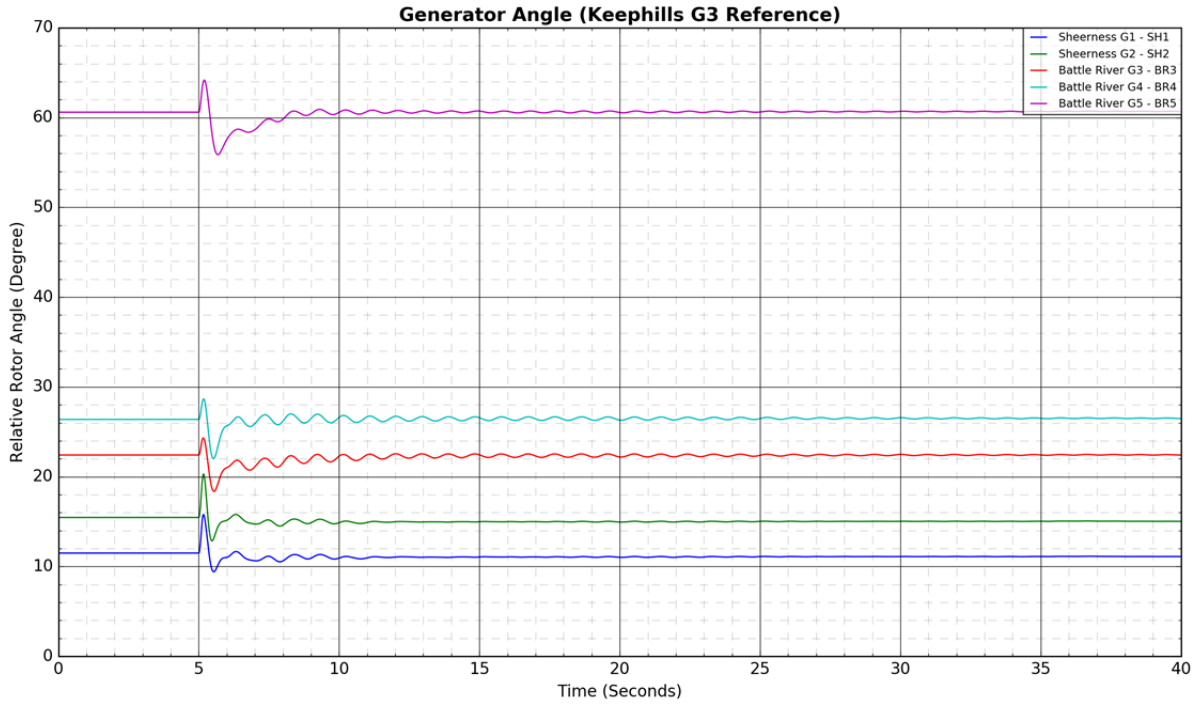
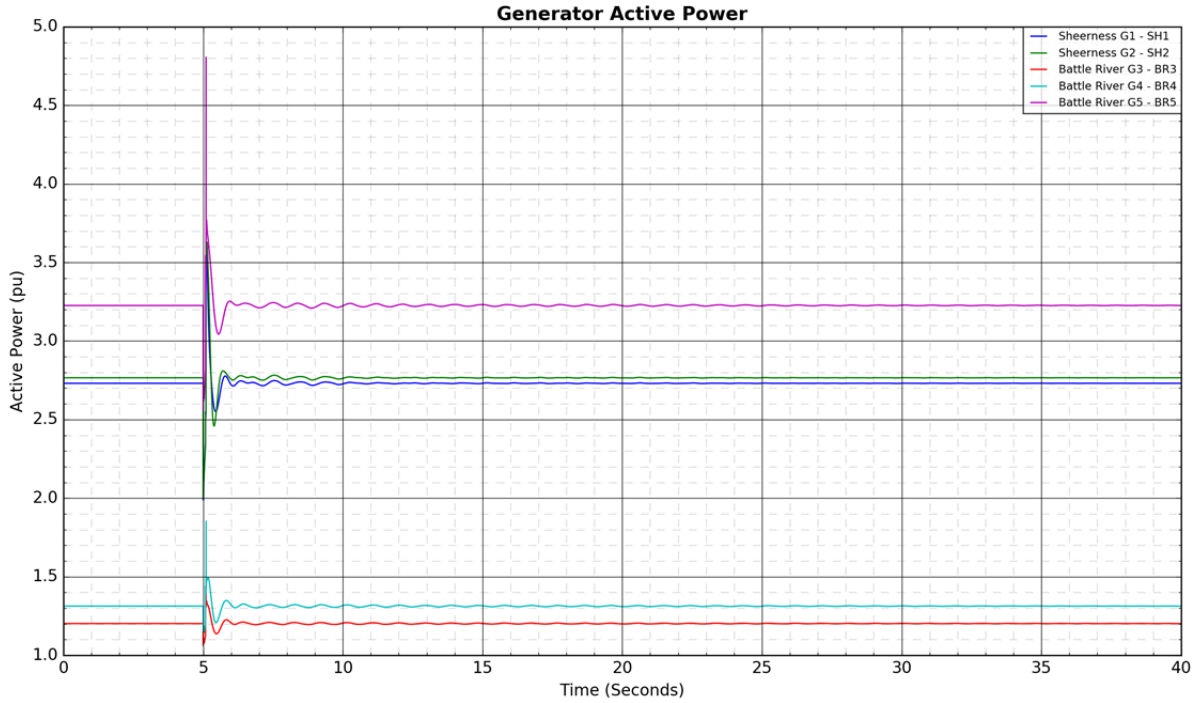

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

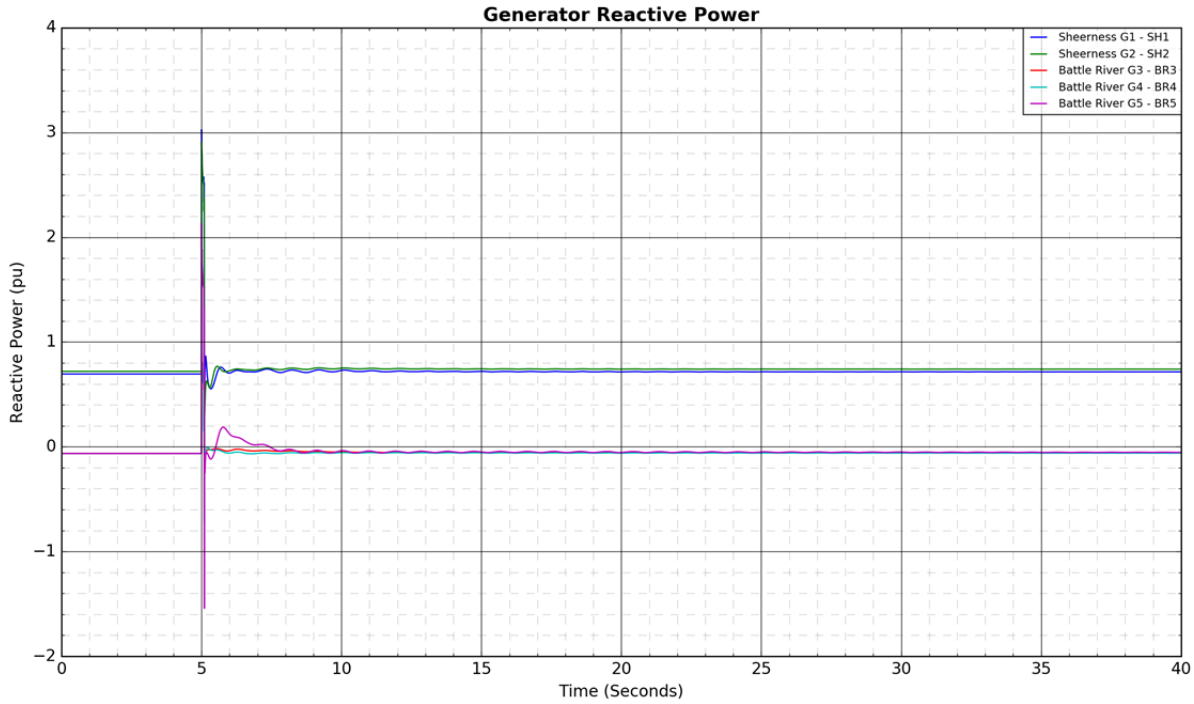
Figure A4-26: 9L24 Oakland 946S to Lanfine 959S: Fault Near Lanfine 959S

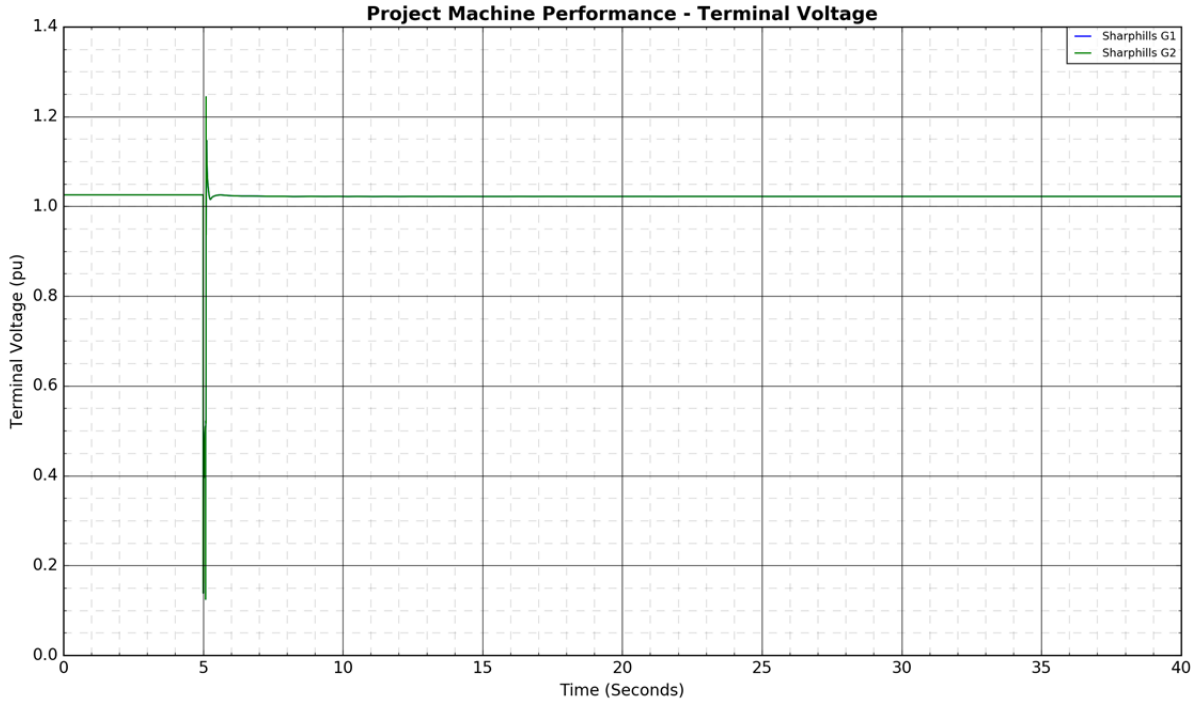


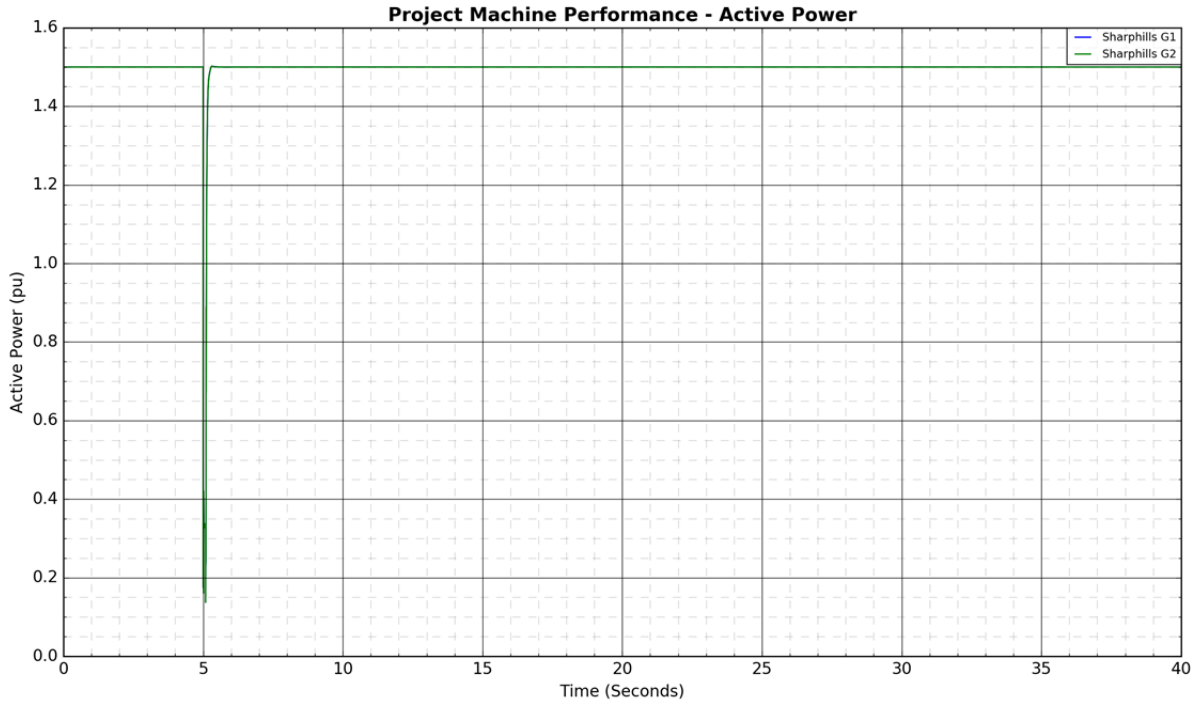


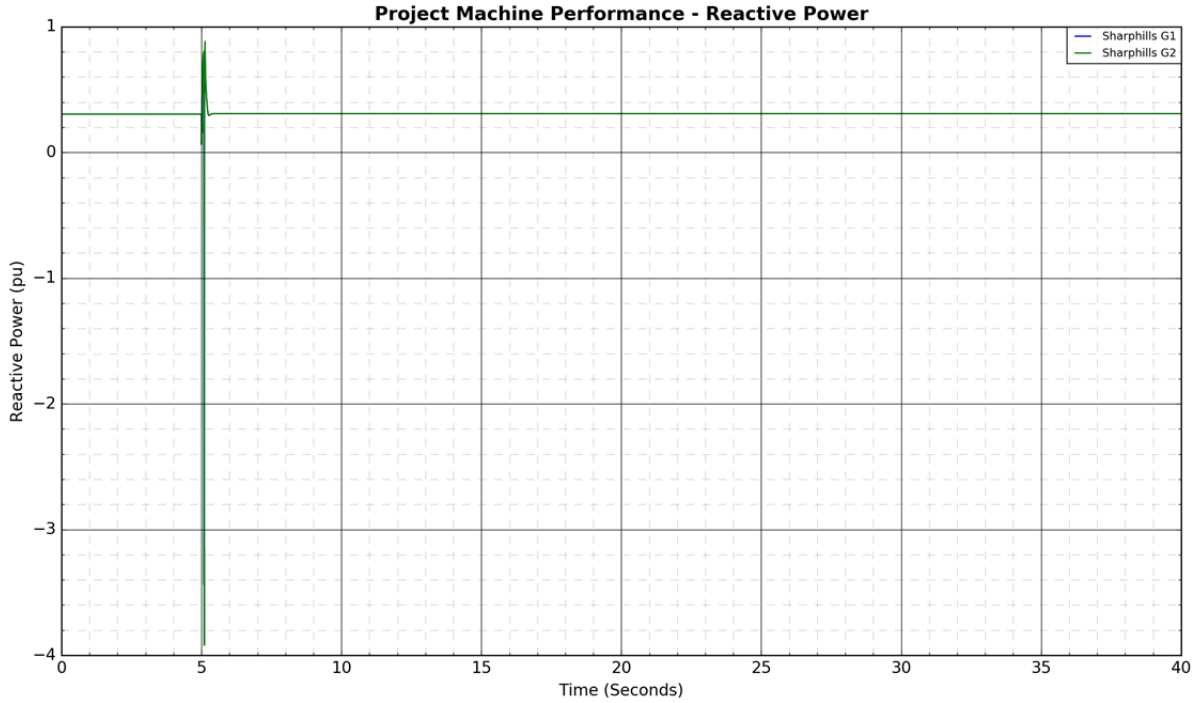

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

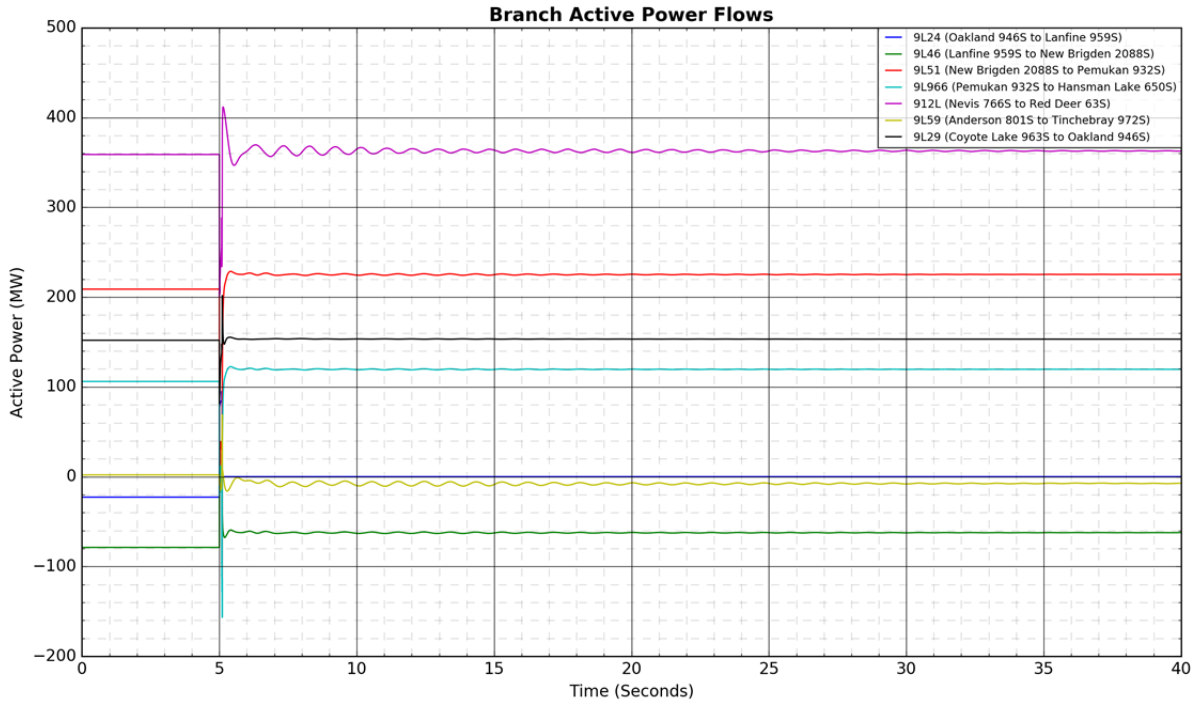

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1
0
−1
−2
−3
−4
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

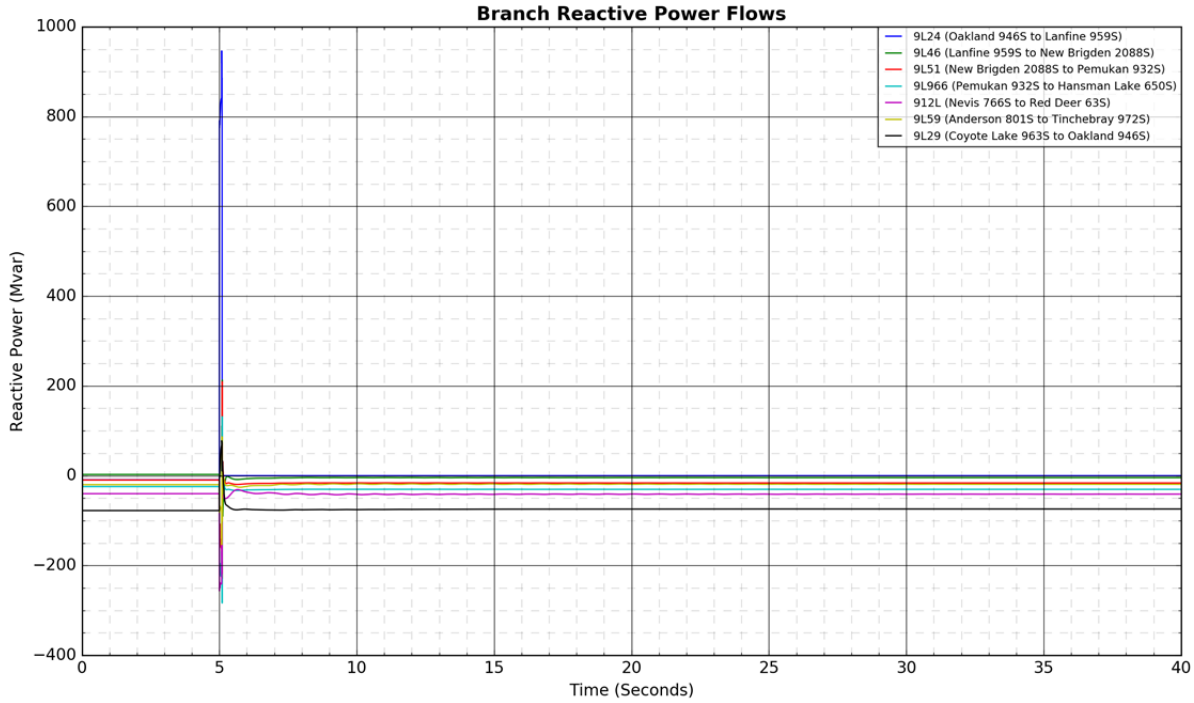
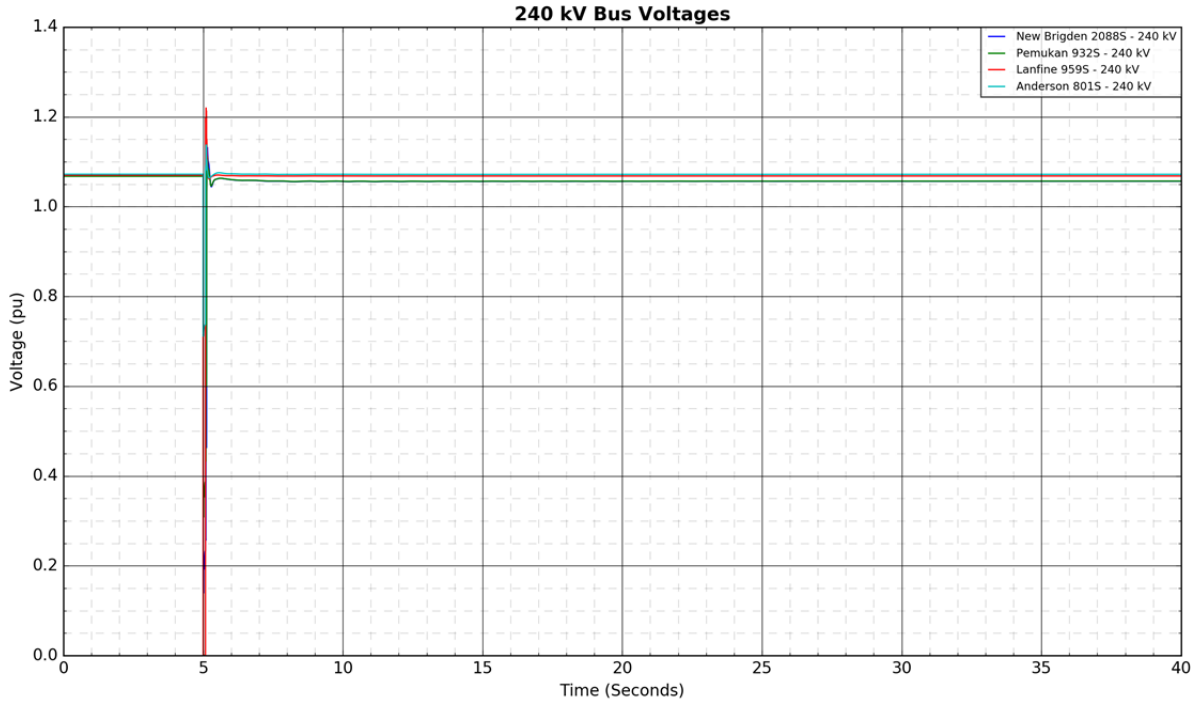
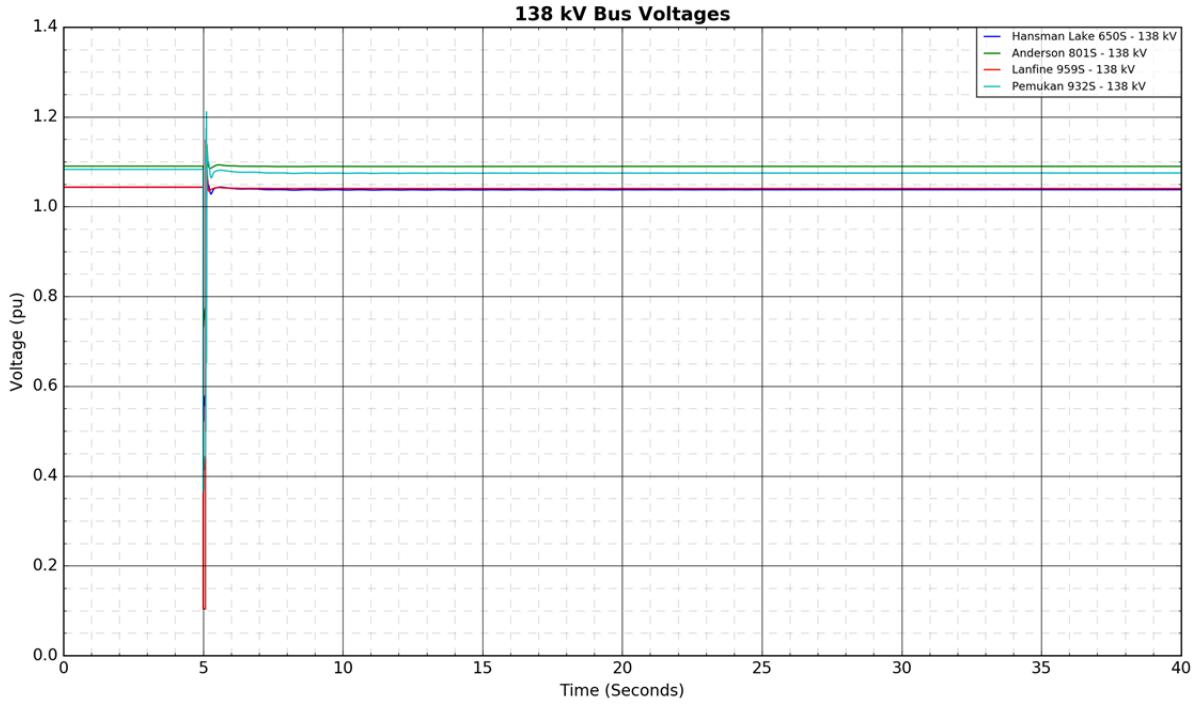
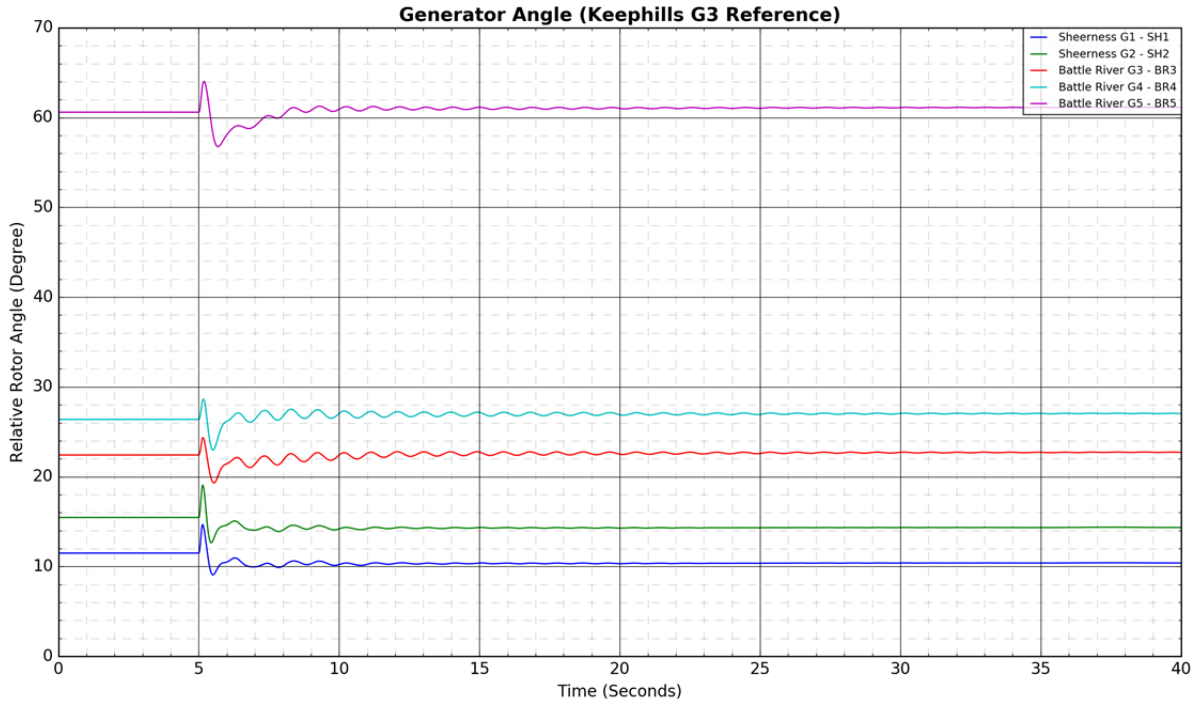
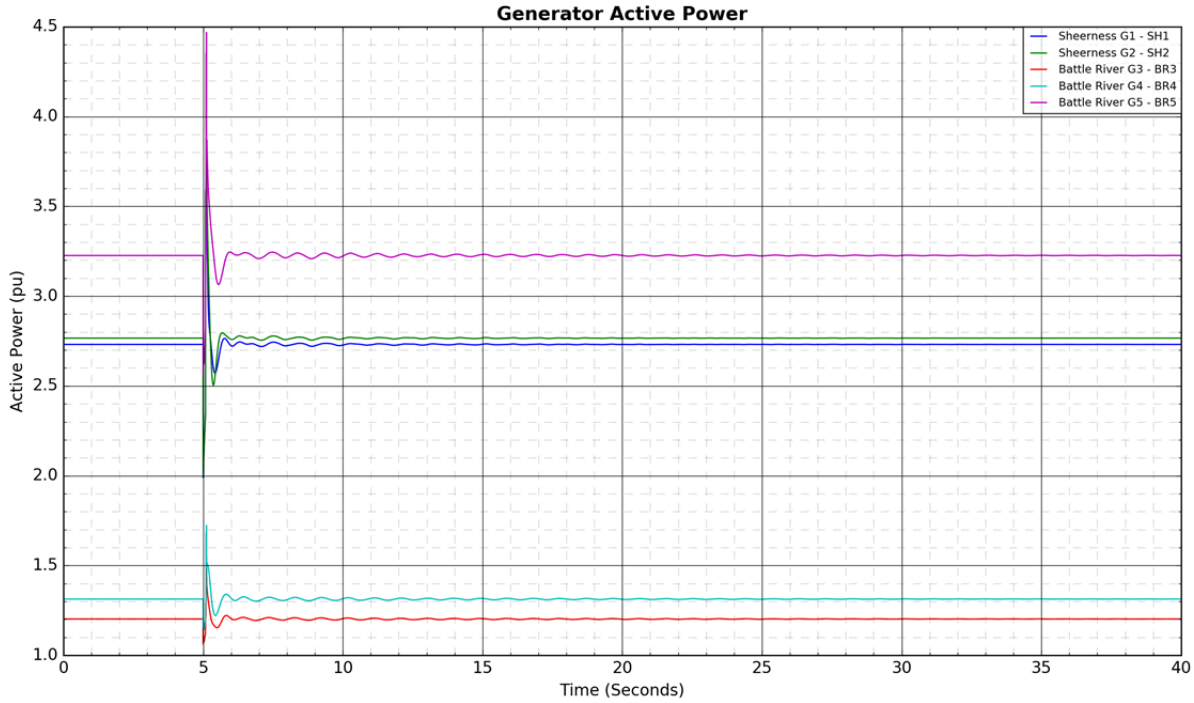

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

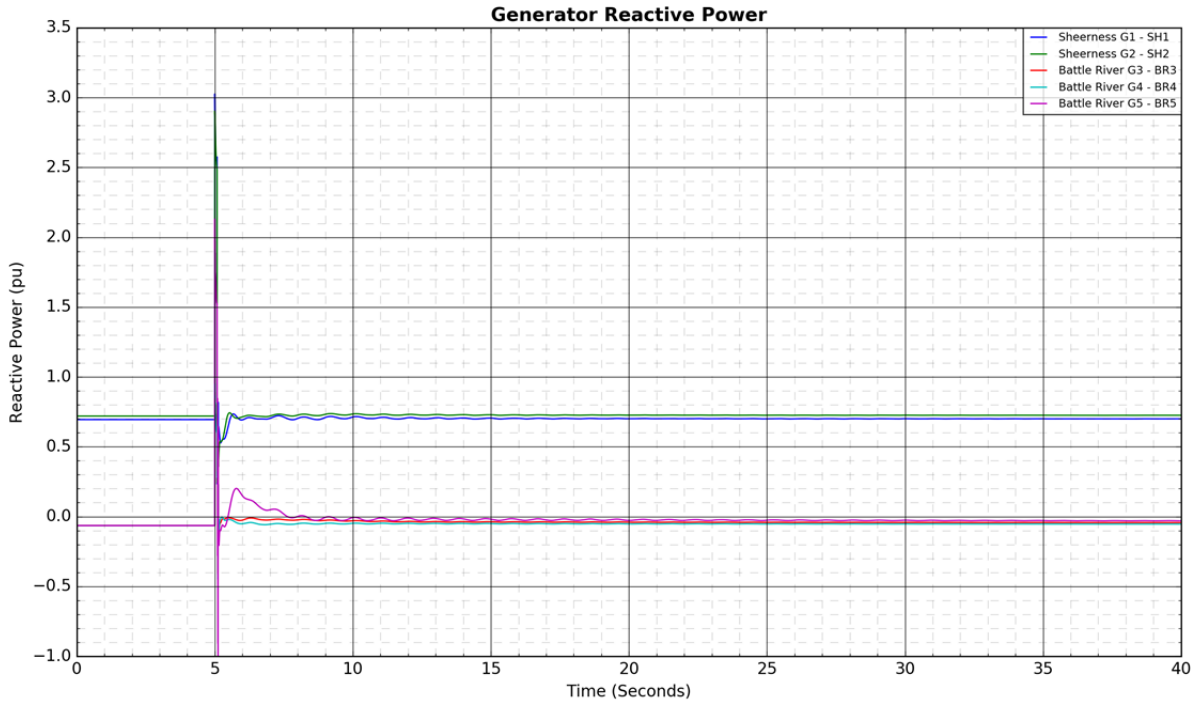
Figure A4-27: 9L46 Lanfine 959S to New Brigden 2088S: Fault Near Lanfine 959S

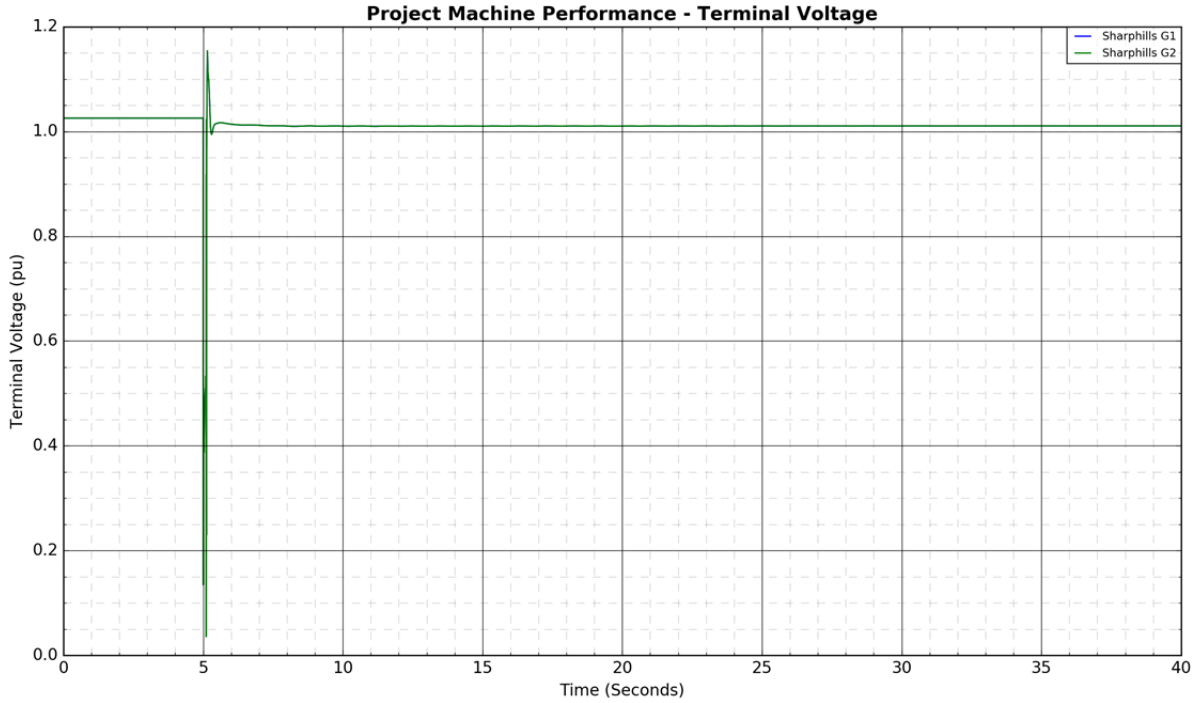


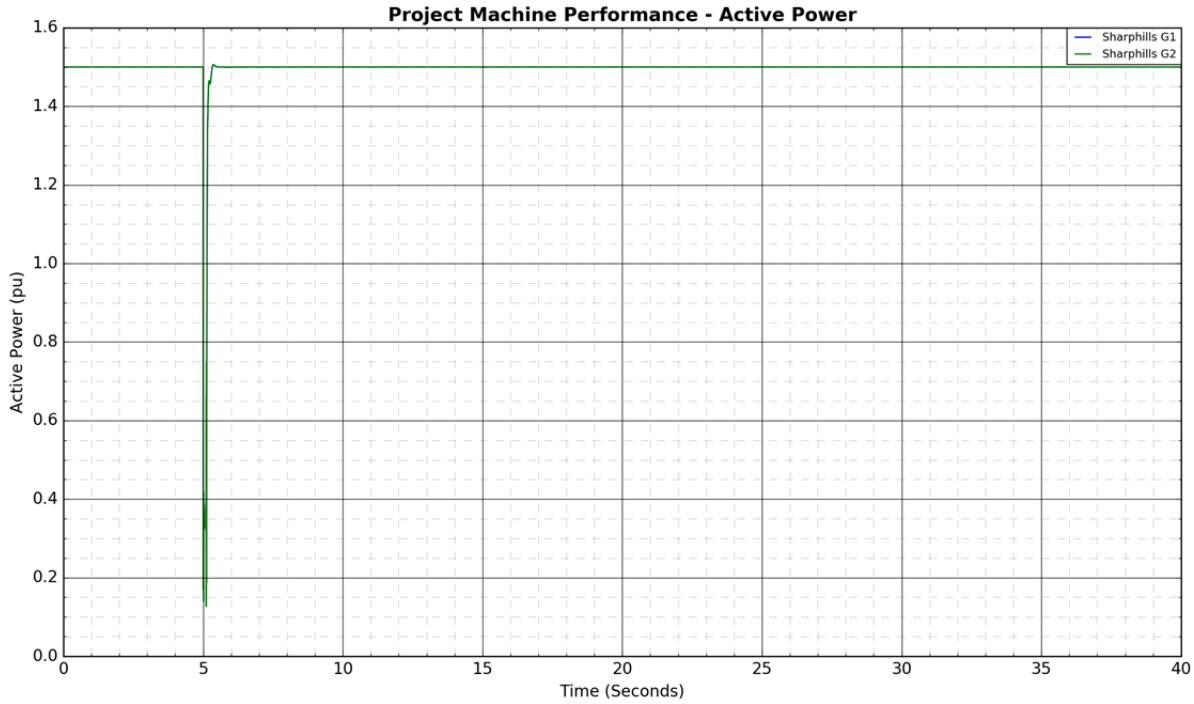


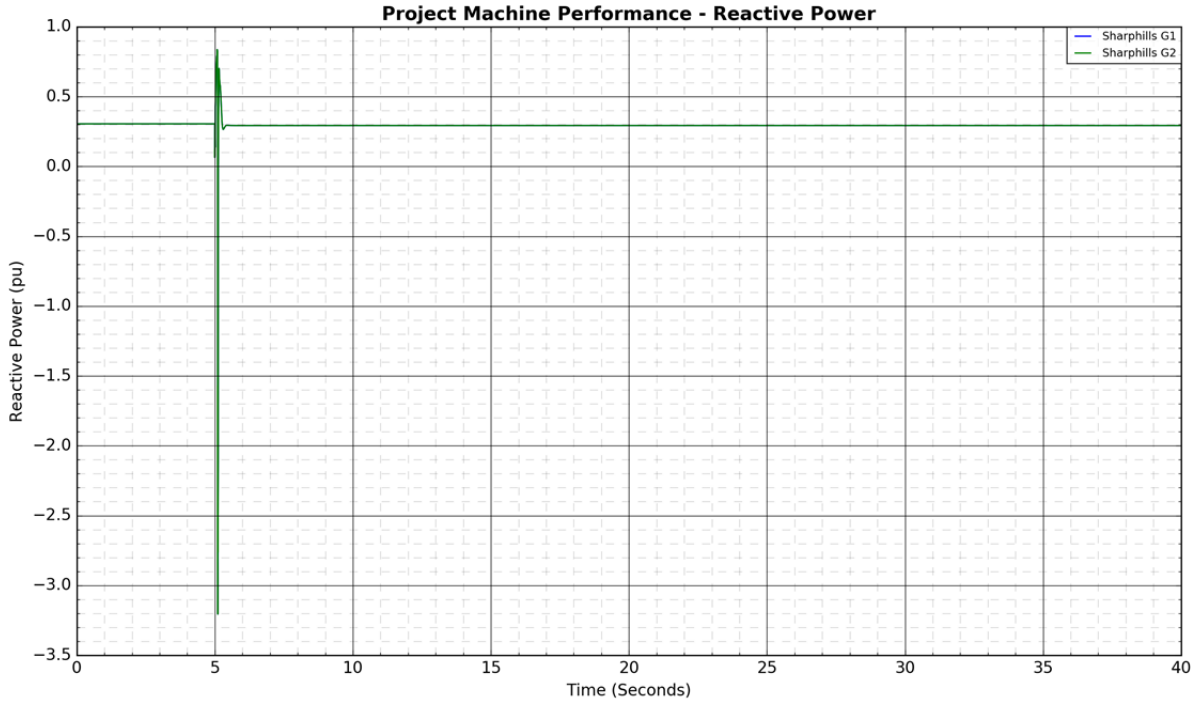

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

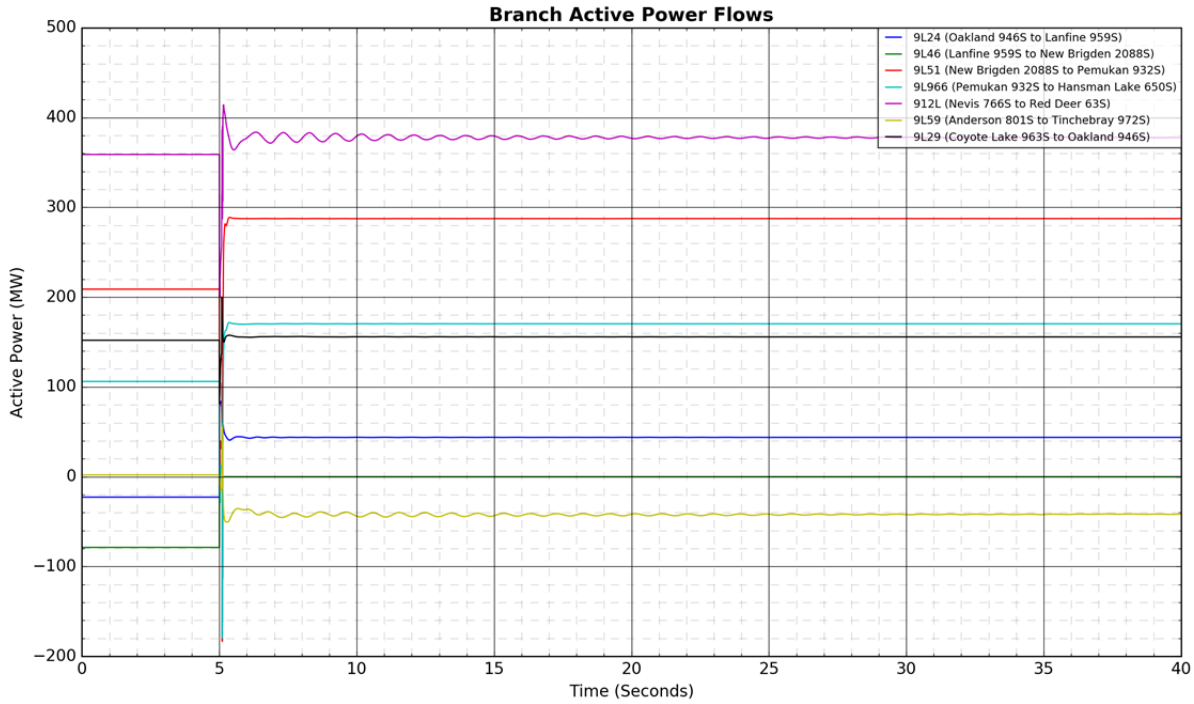

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

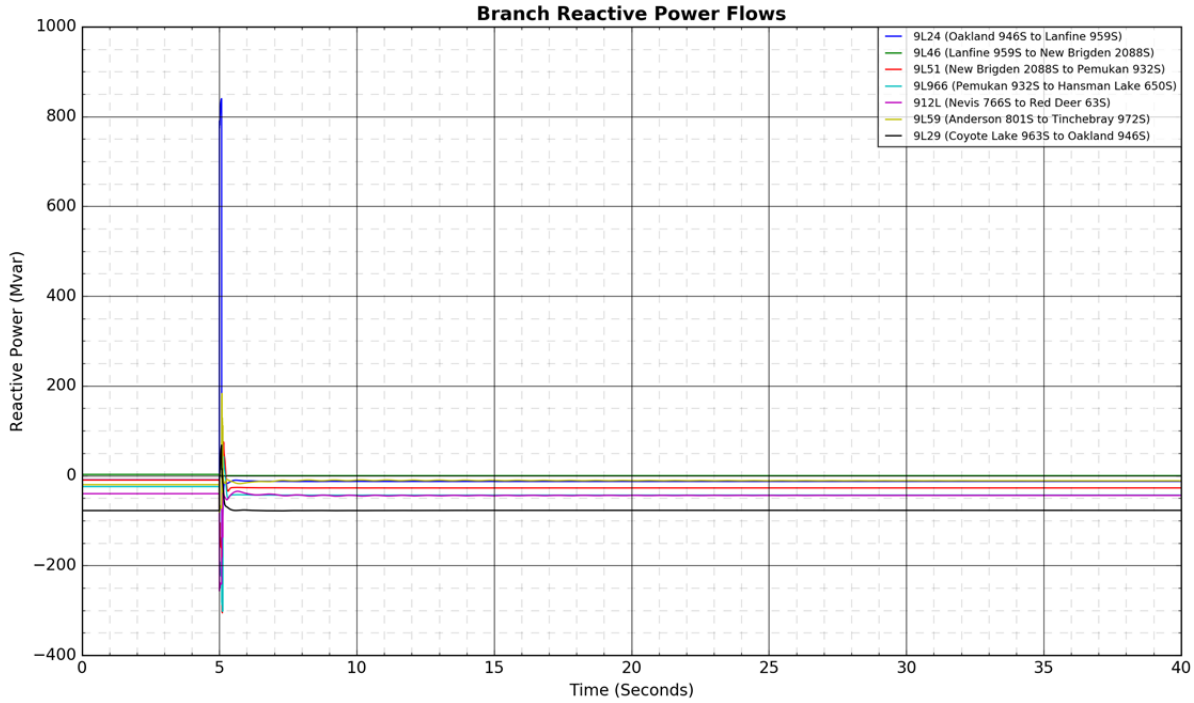
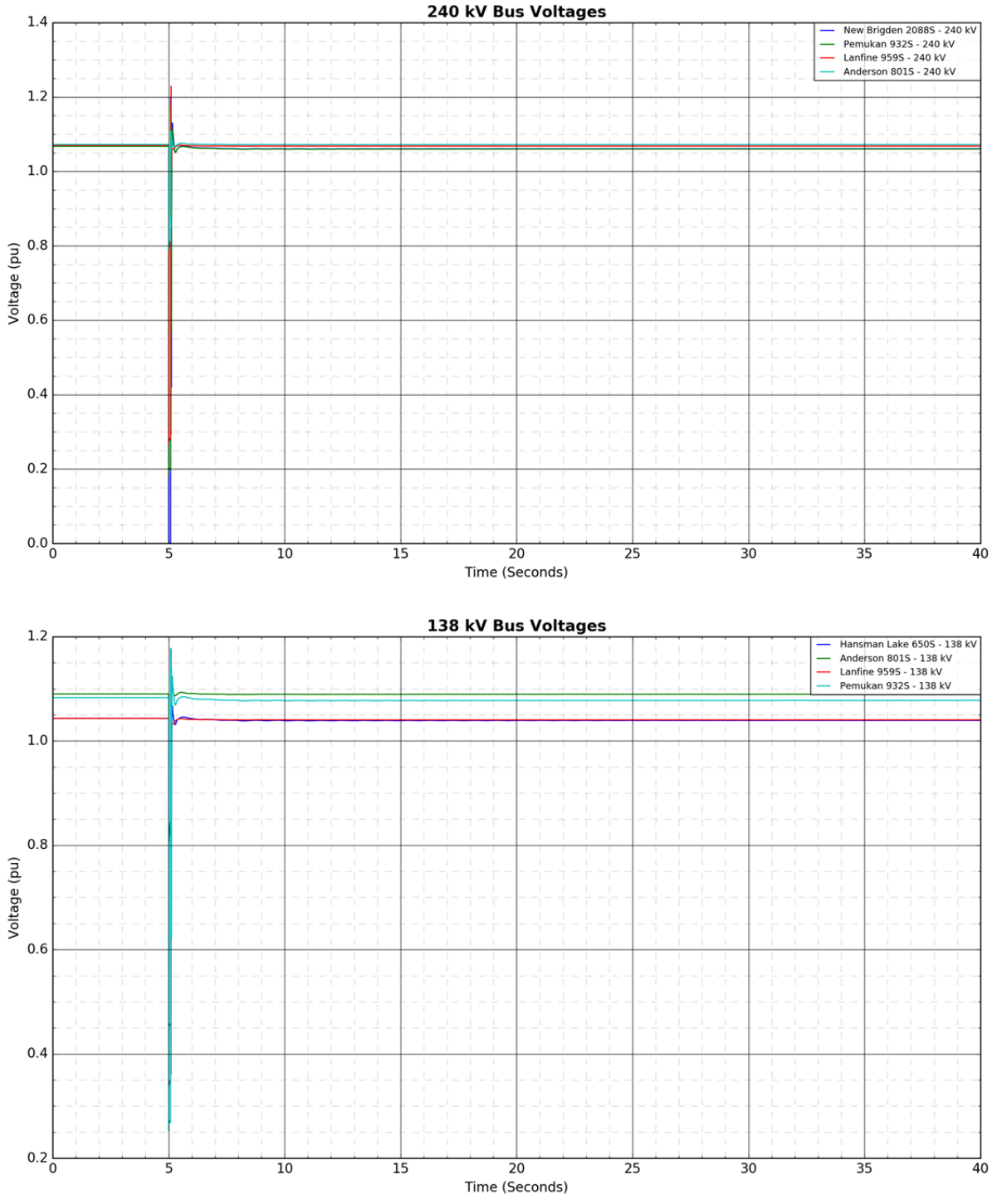
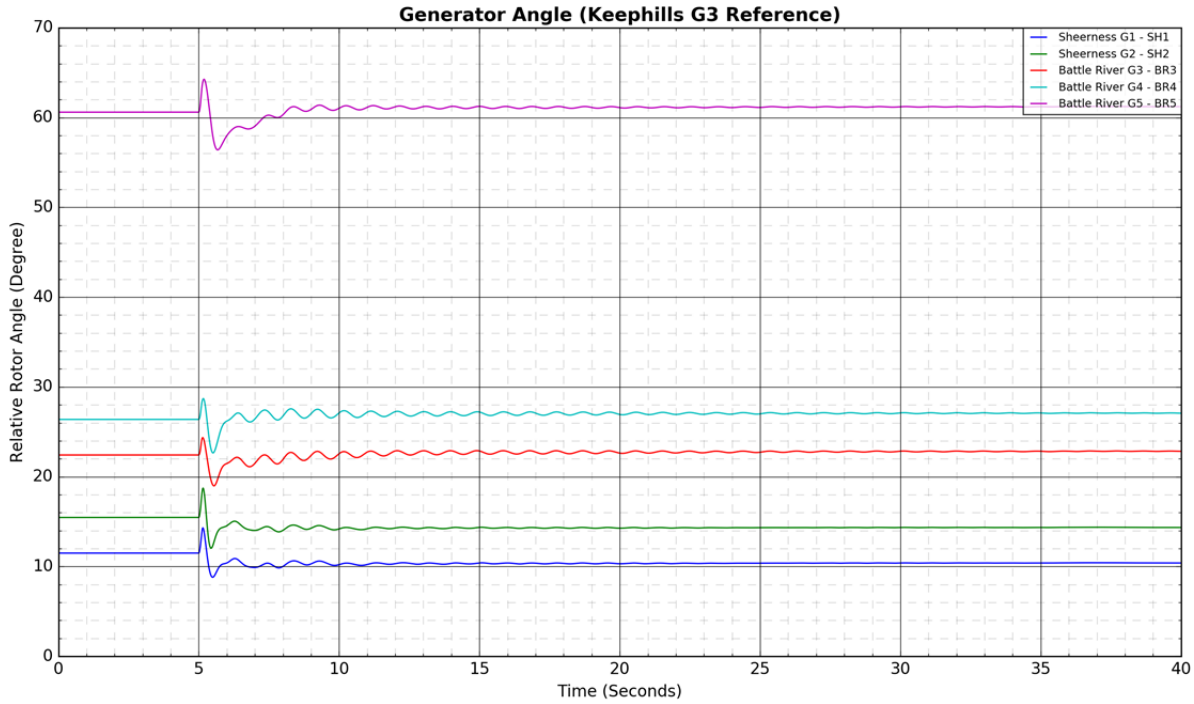
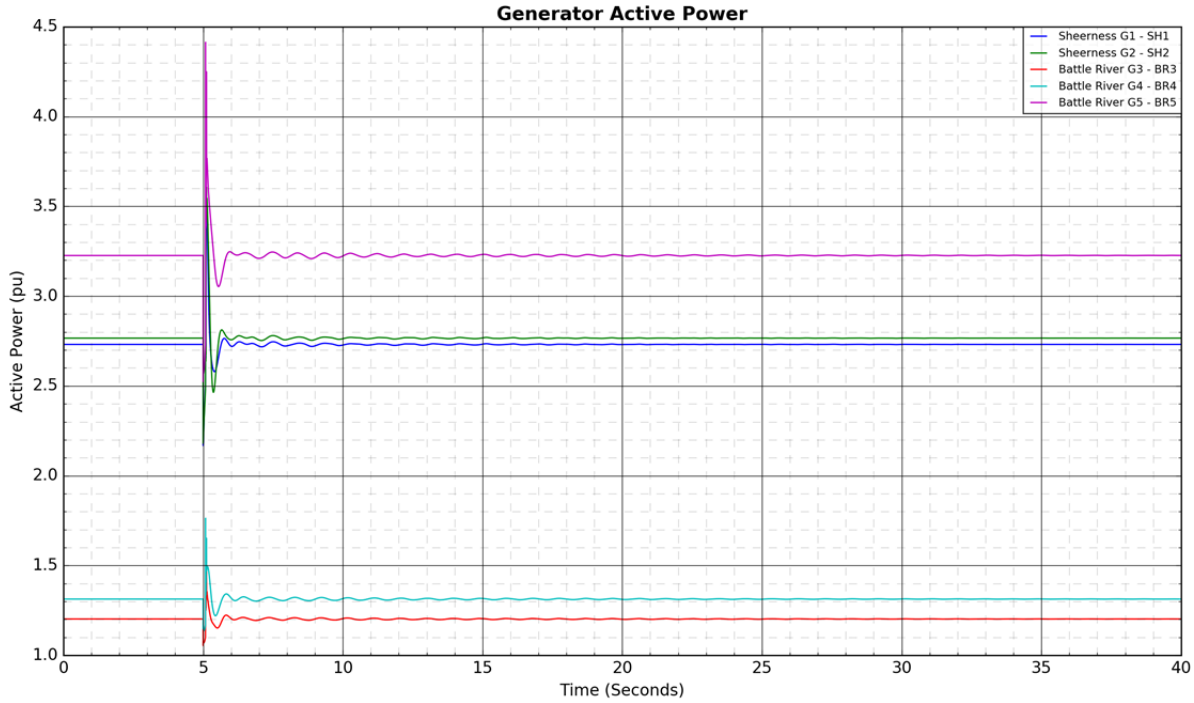
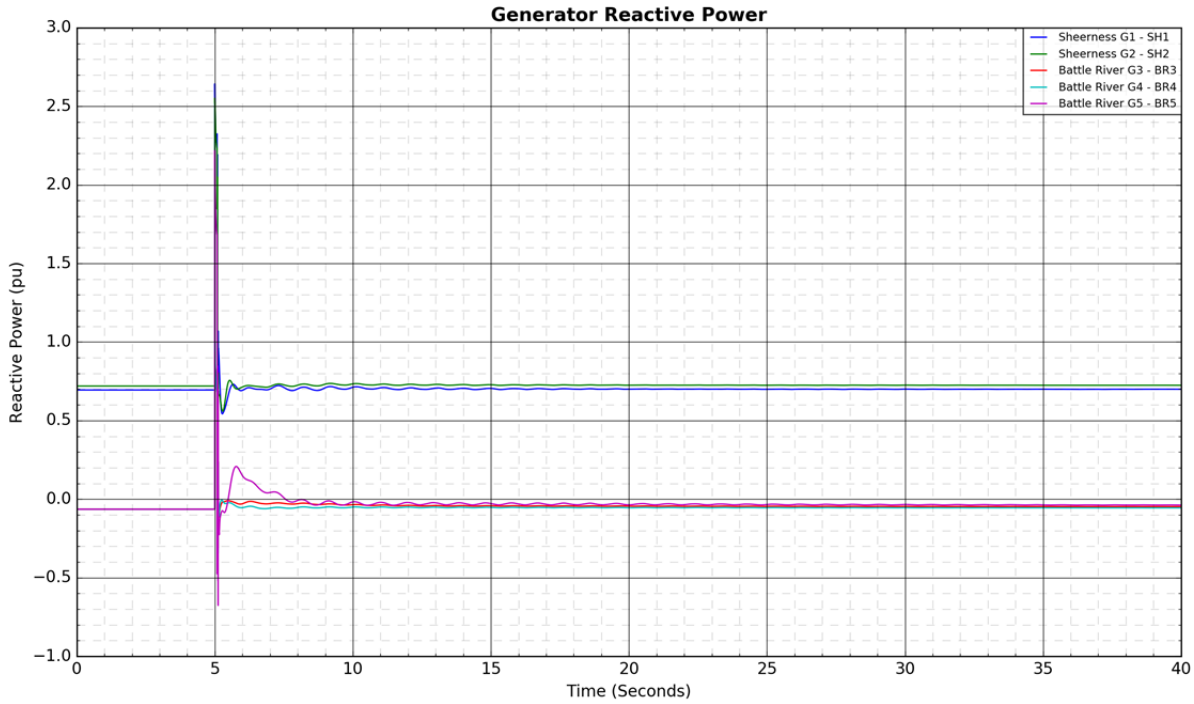

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

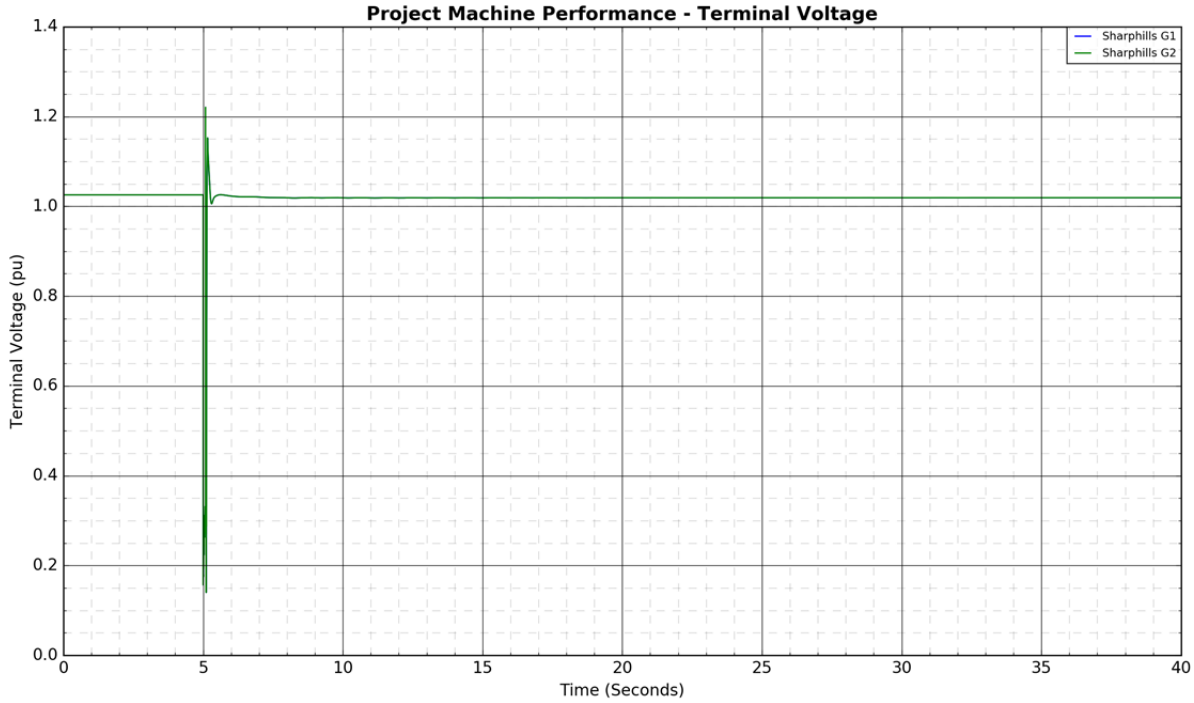
Figure A4-28: 9L46 Lanfine 959S to New Brigden 2088S: Fault Near New Brigden 2088S

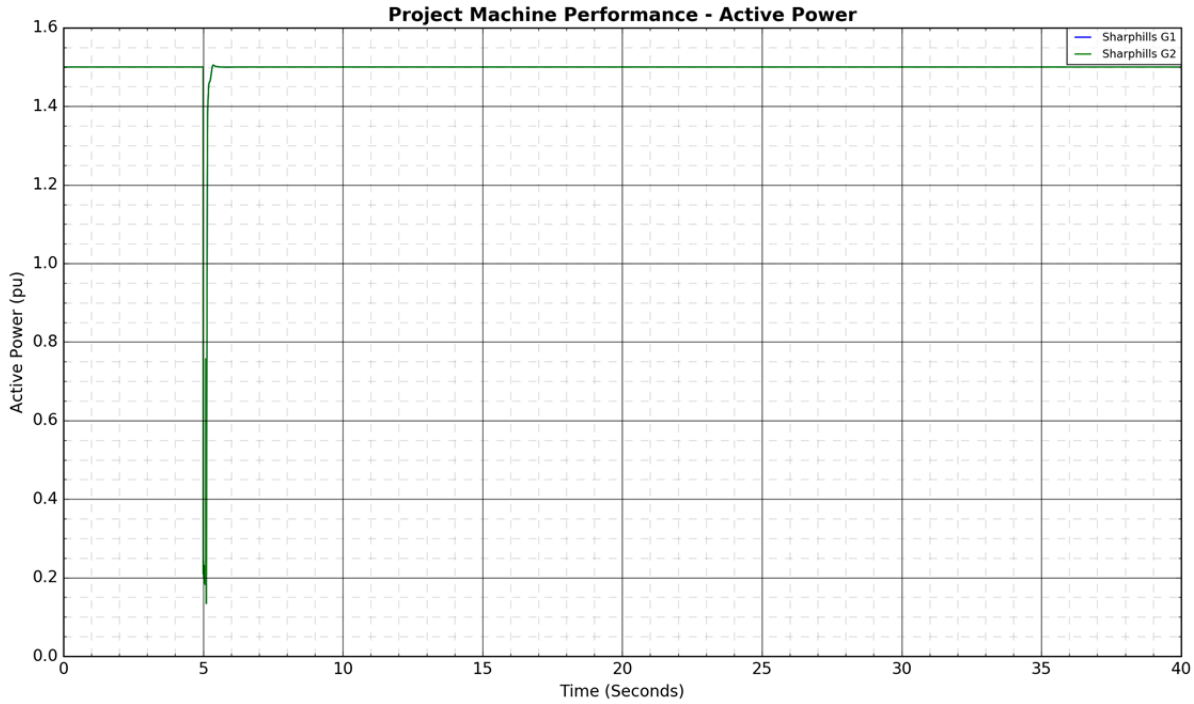


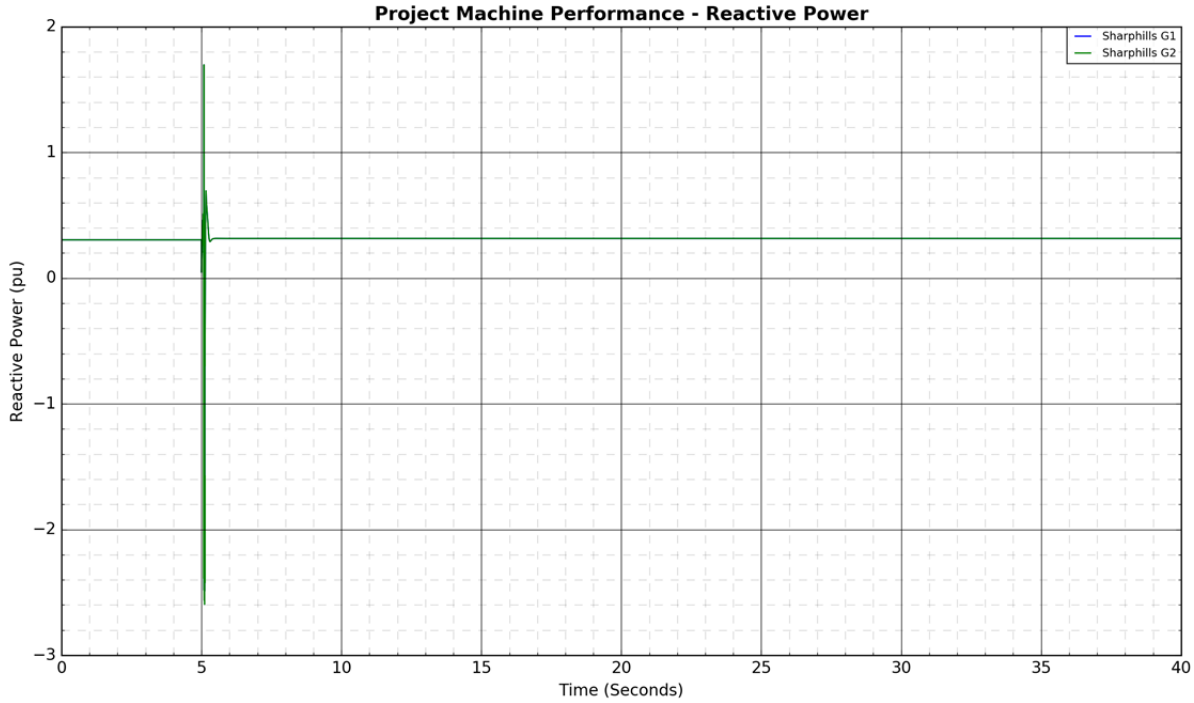

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

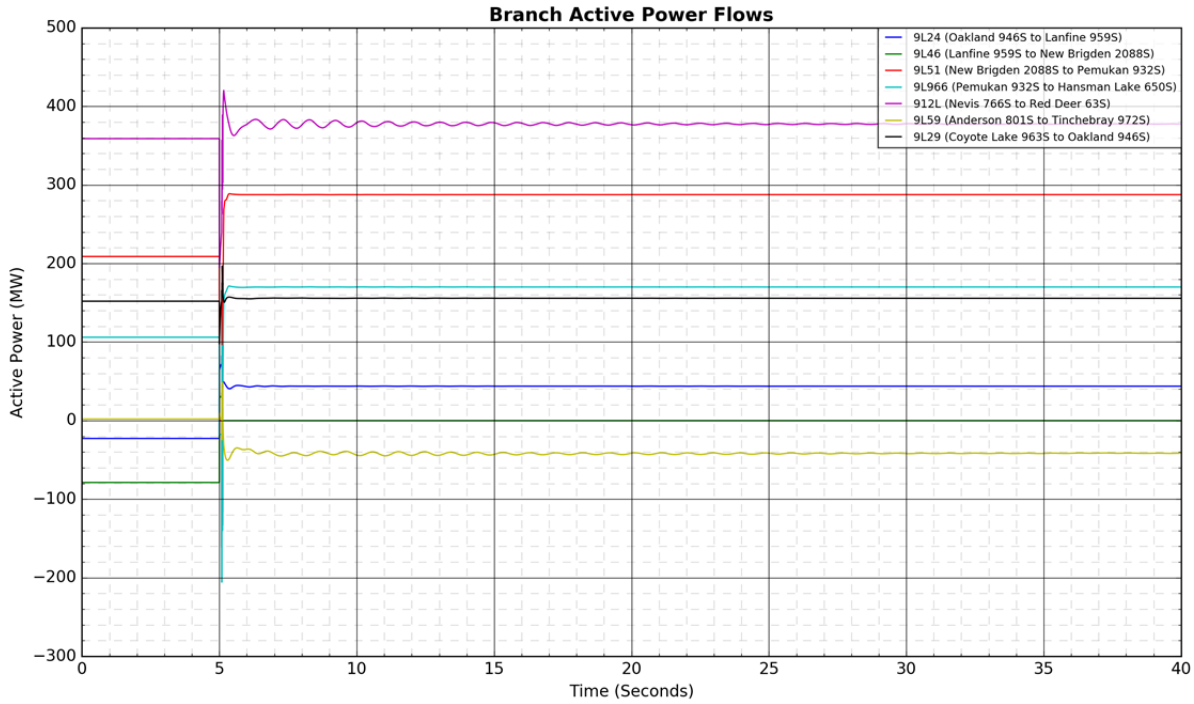

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
2
1
0
−1
−2
−3
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

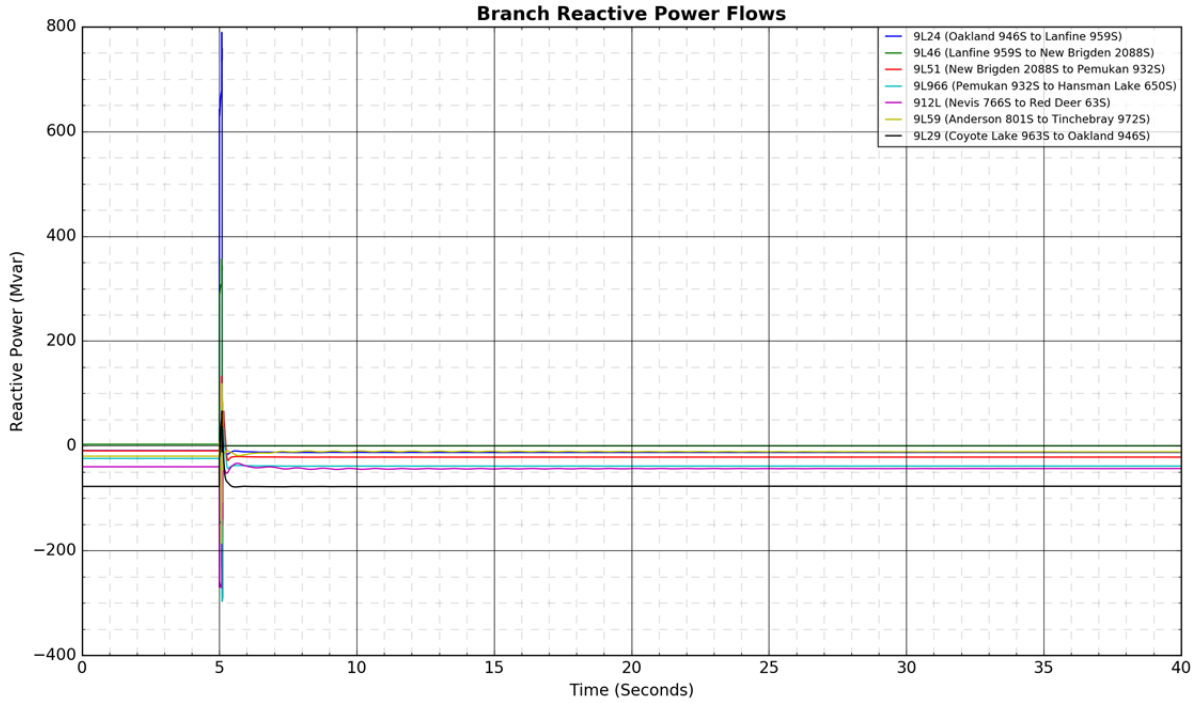
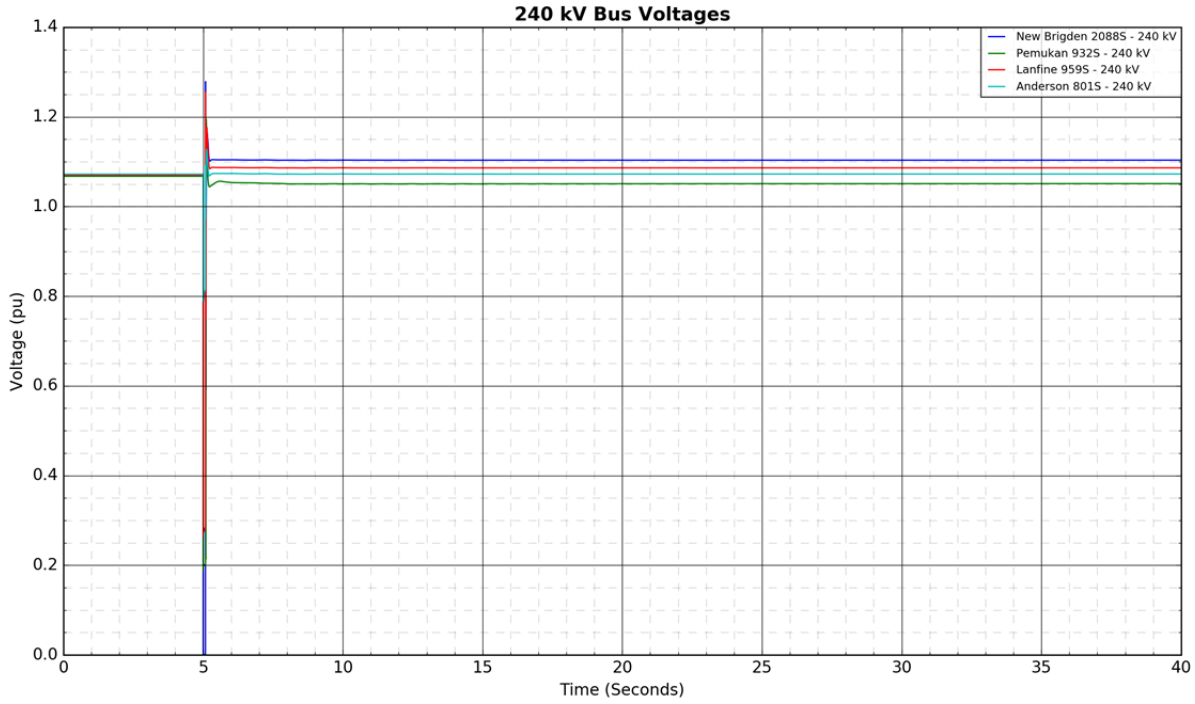
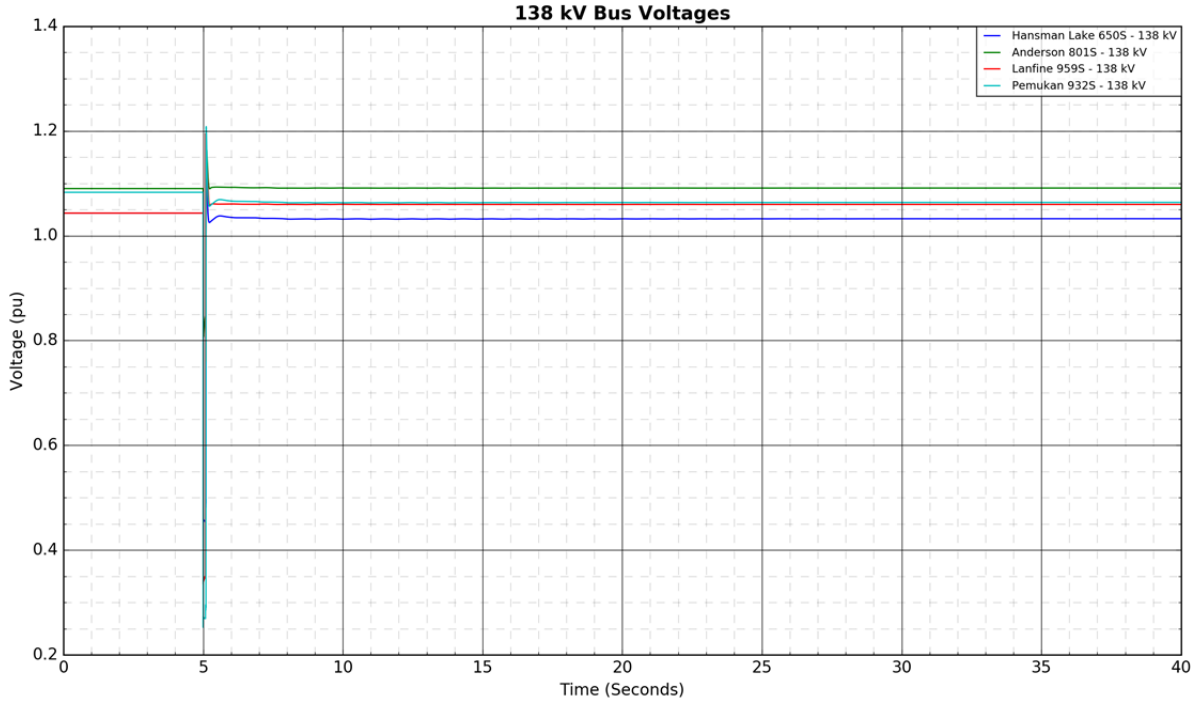
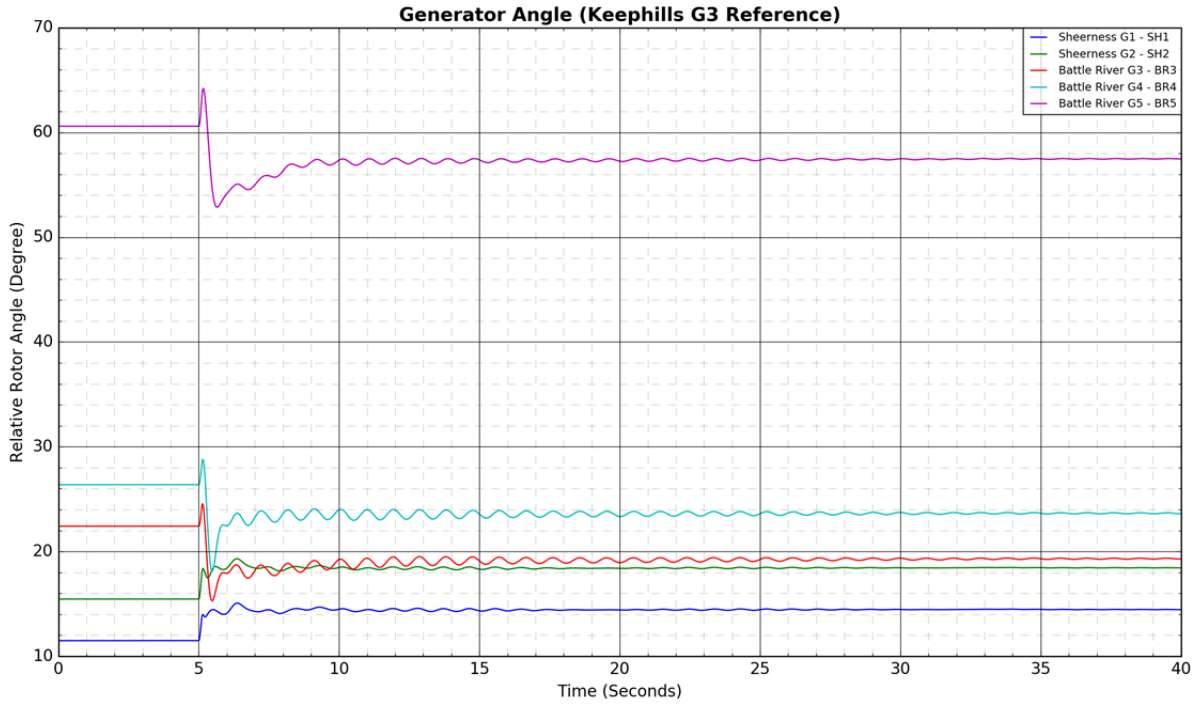
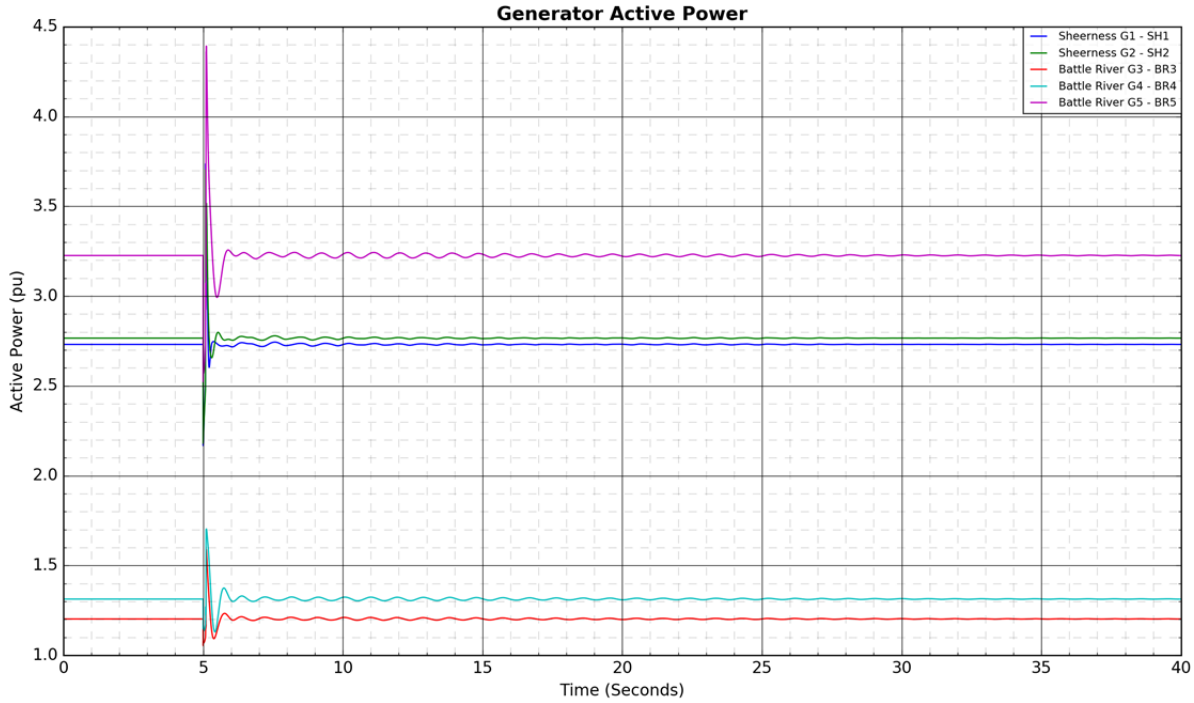

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

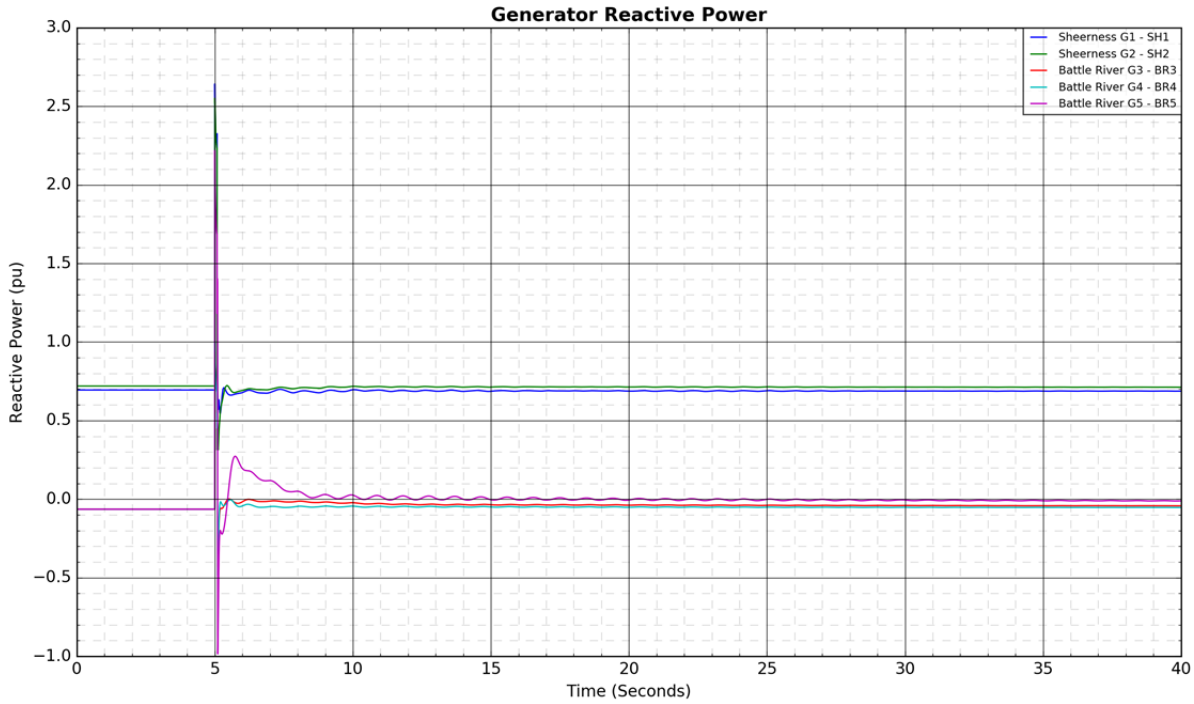
Figure A4-29: 9L51 New Brigden 2088S to Pemukan 932S: Fault Near New Brigden 2088S

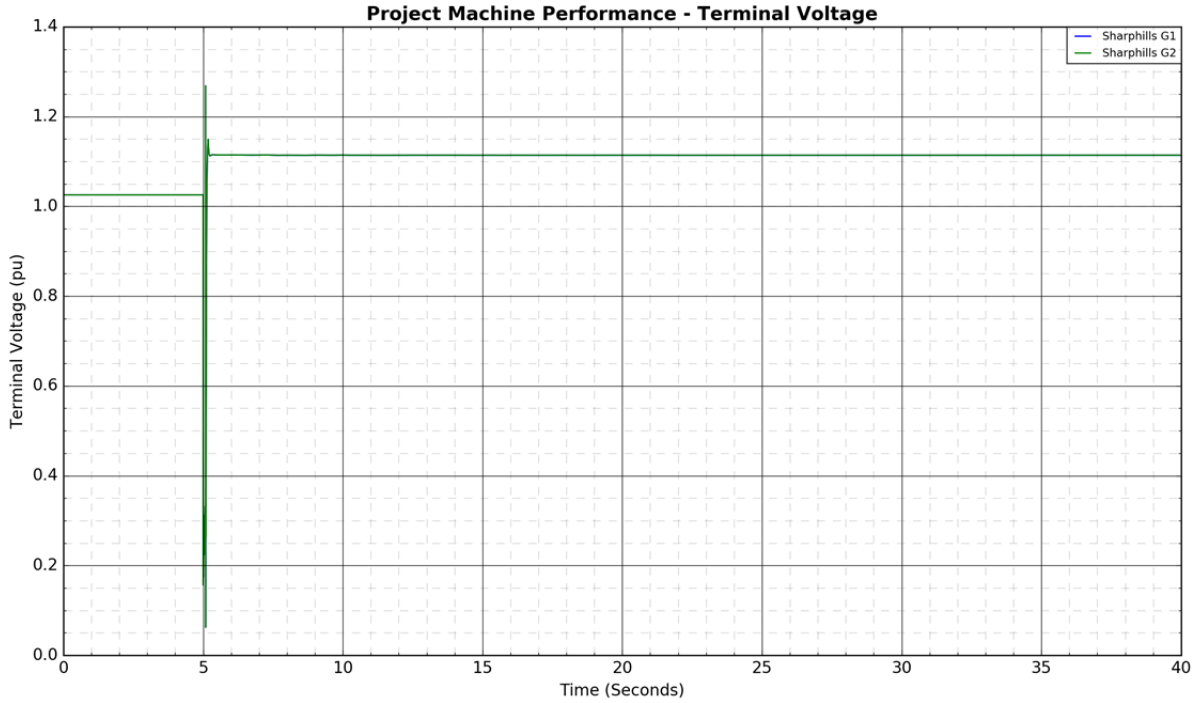


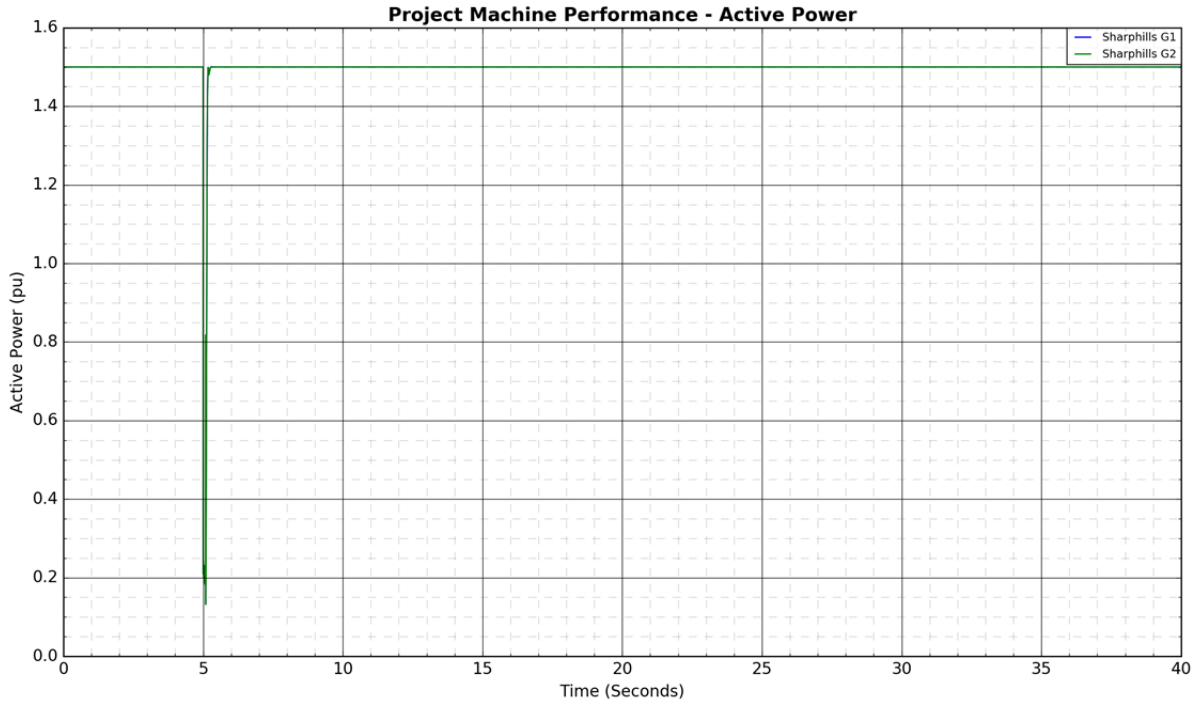


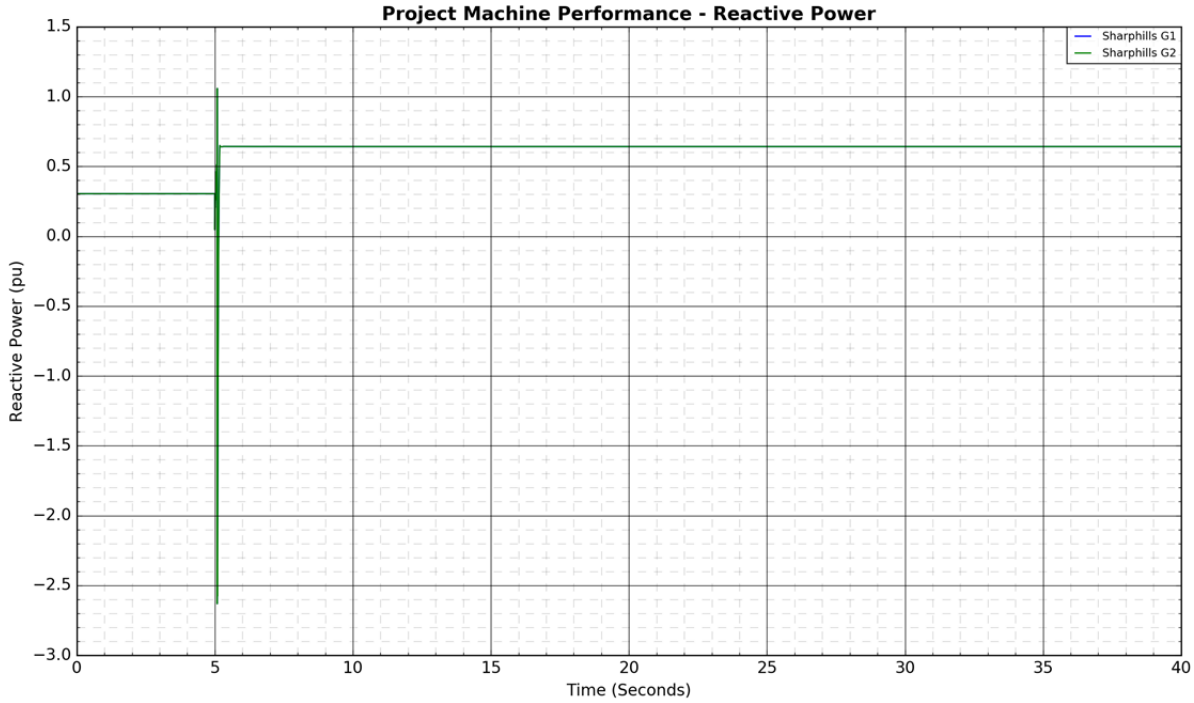

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

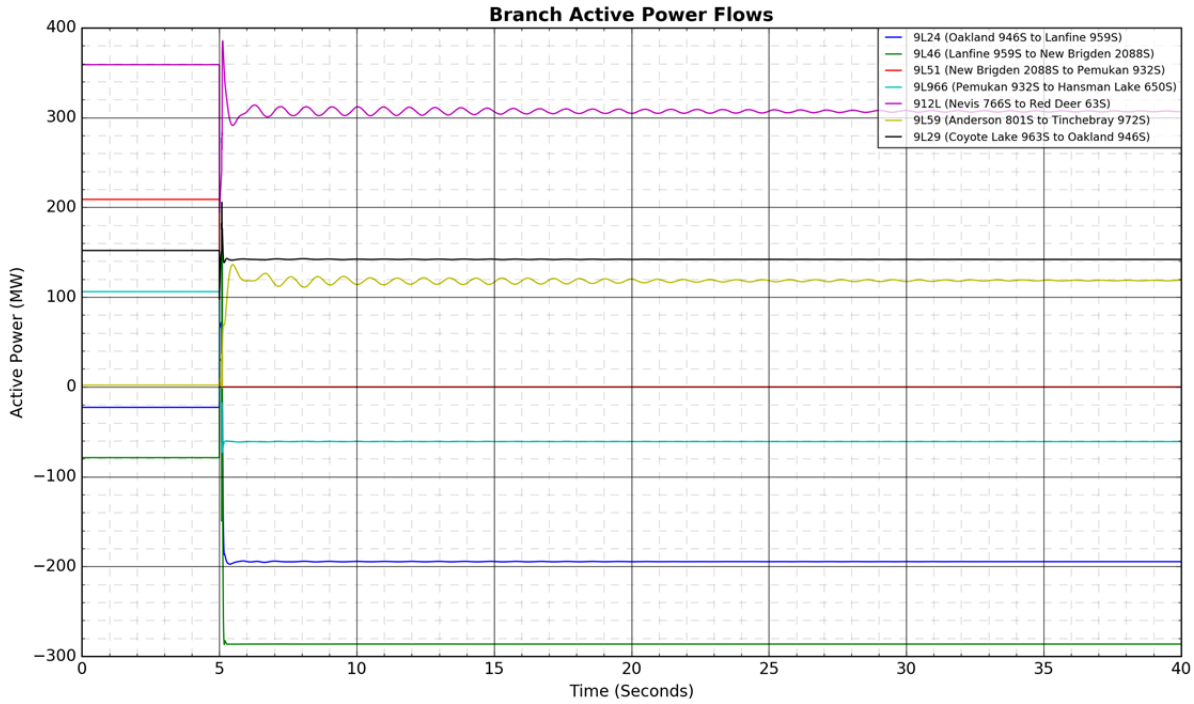

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

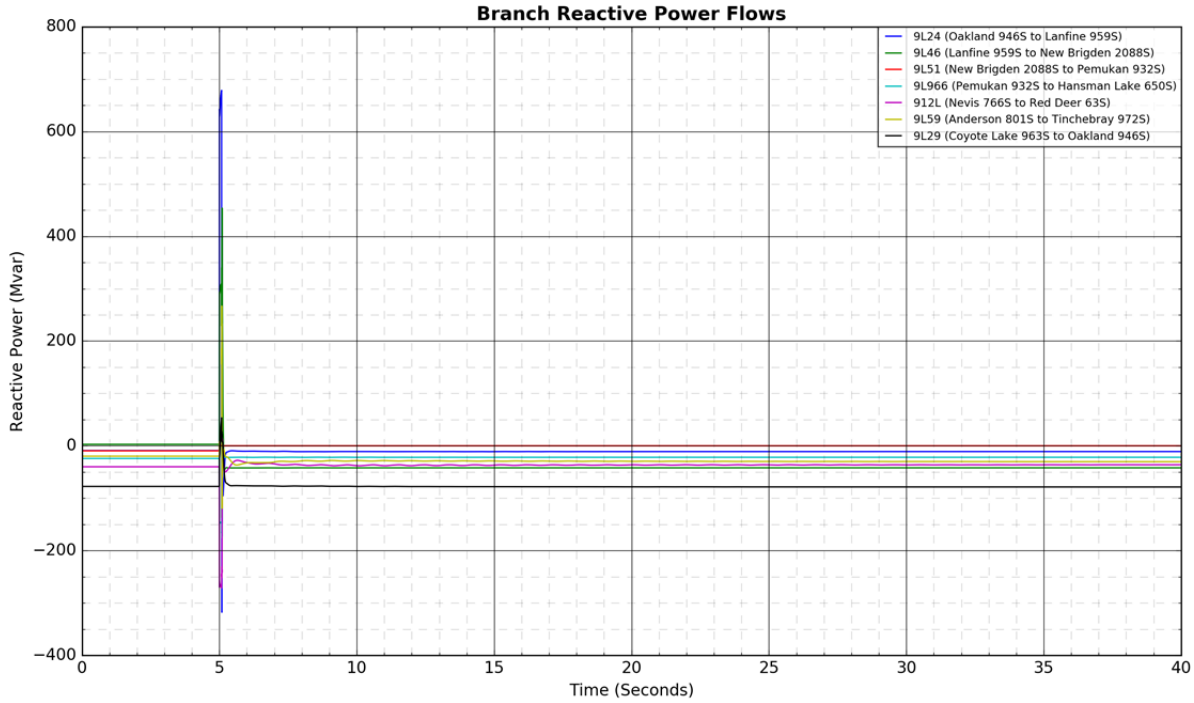
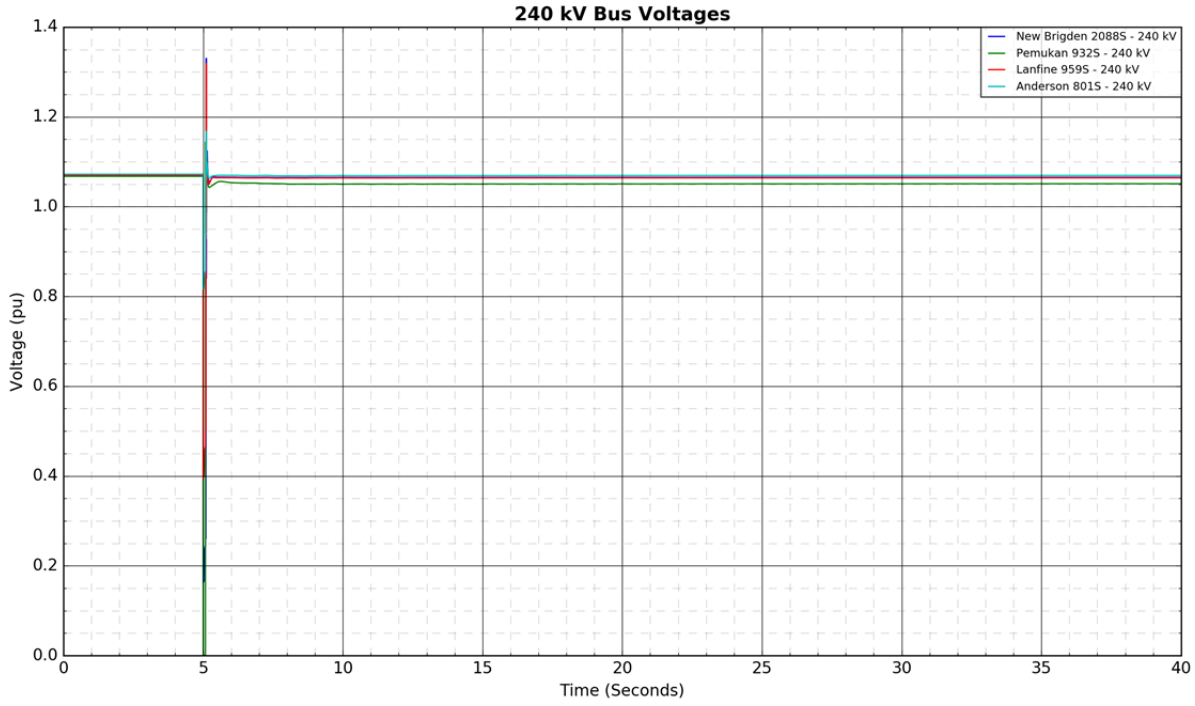
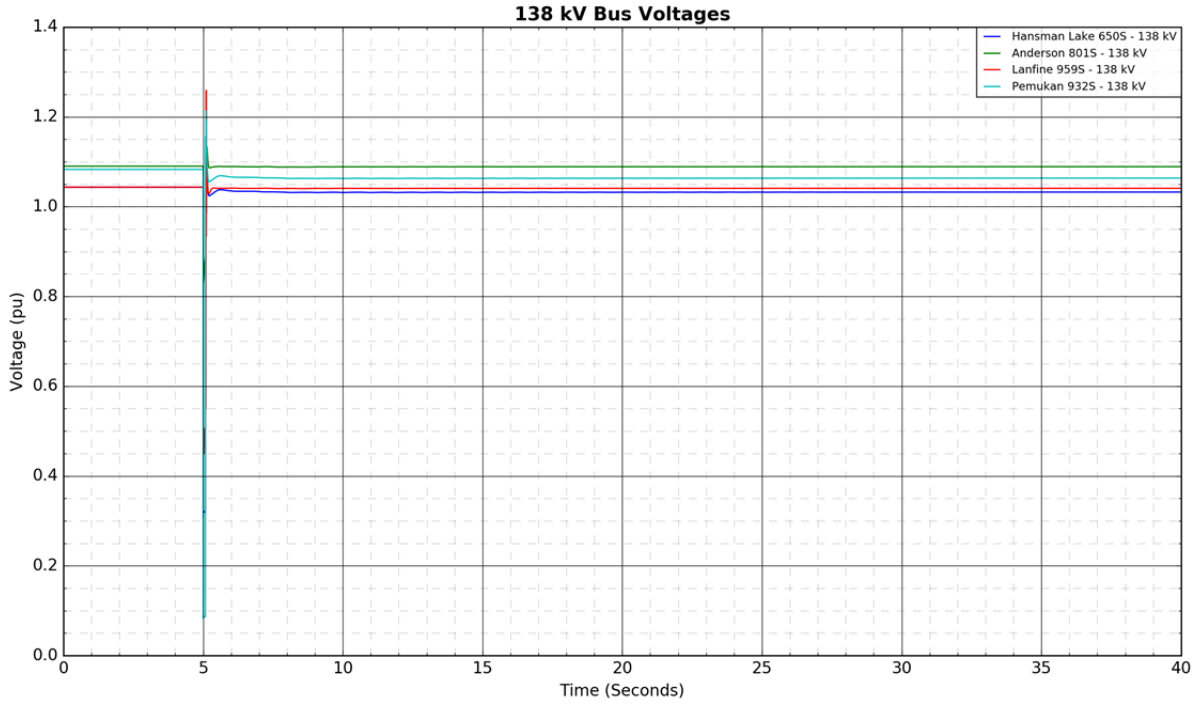
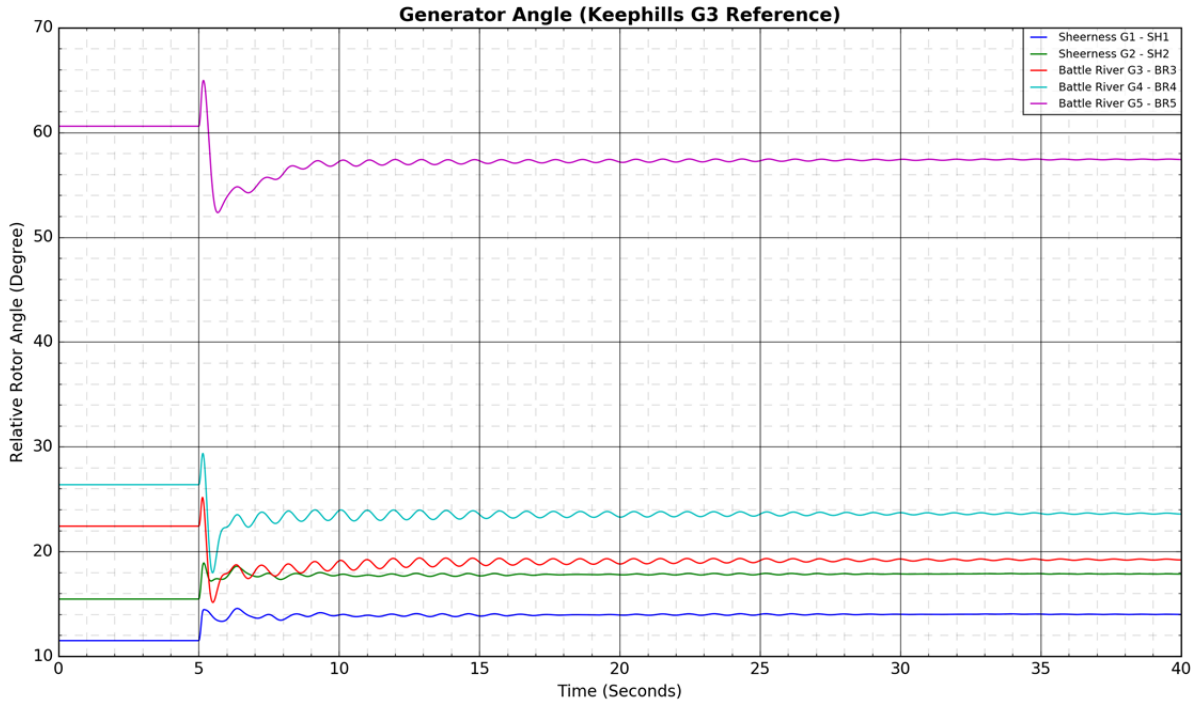
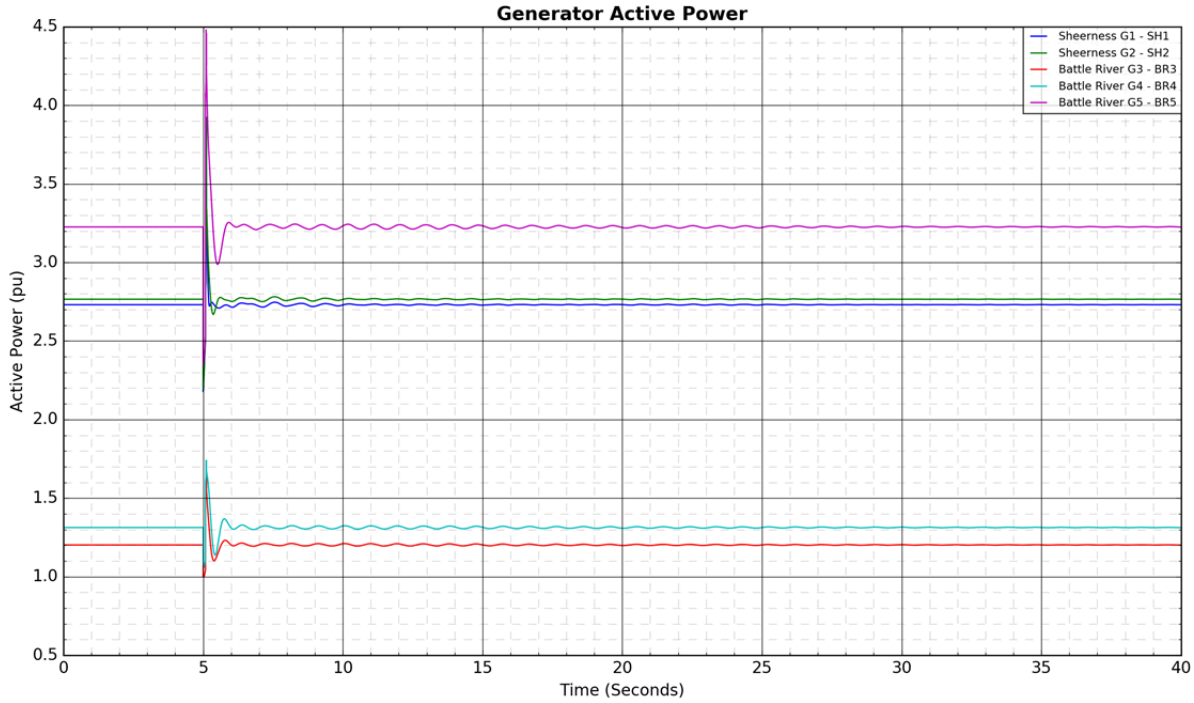

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

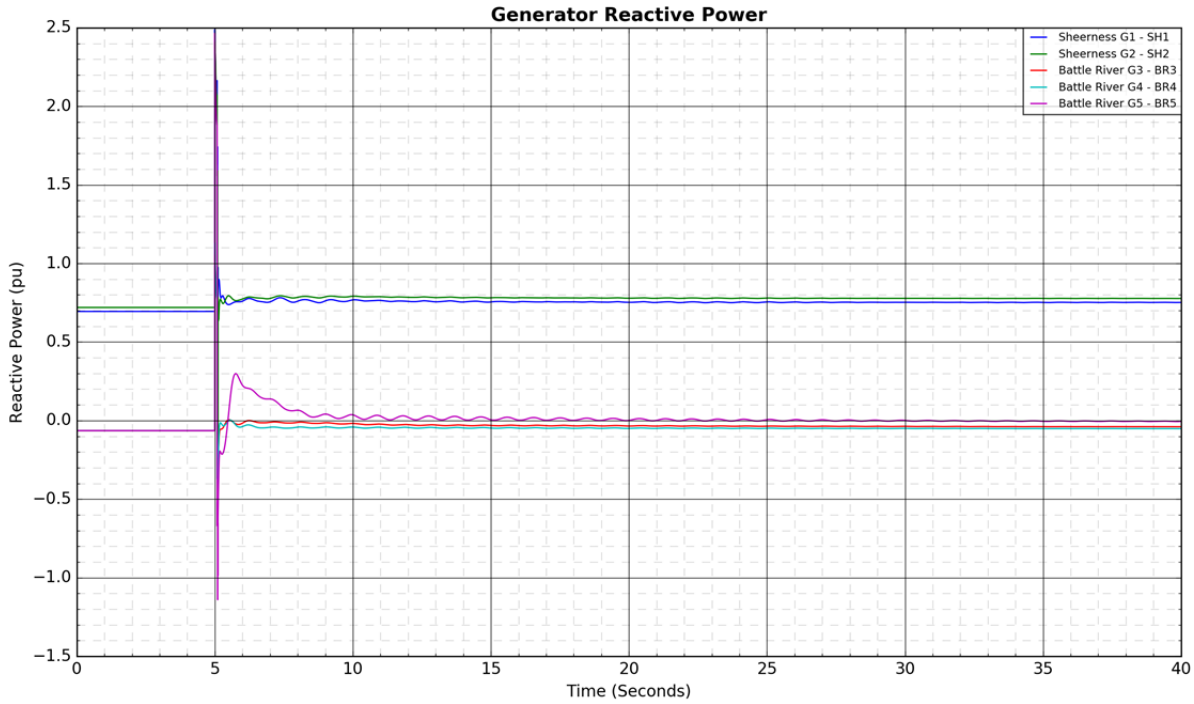
Figure A4-30: 9L51 New Brigden 2088S to Pemukan 932S: Fault Near Pemukan 932S

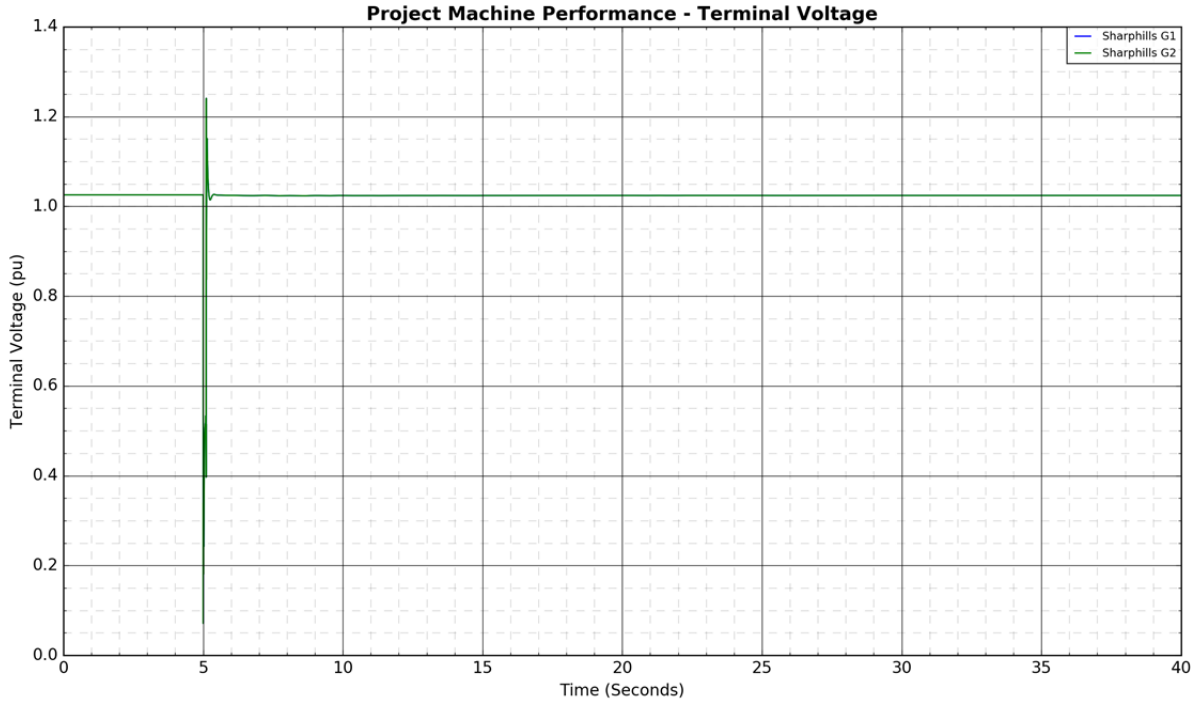


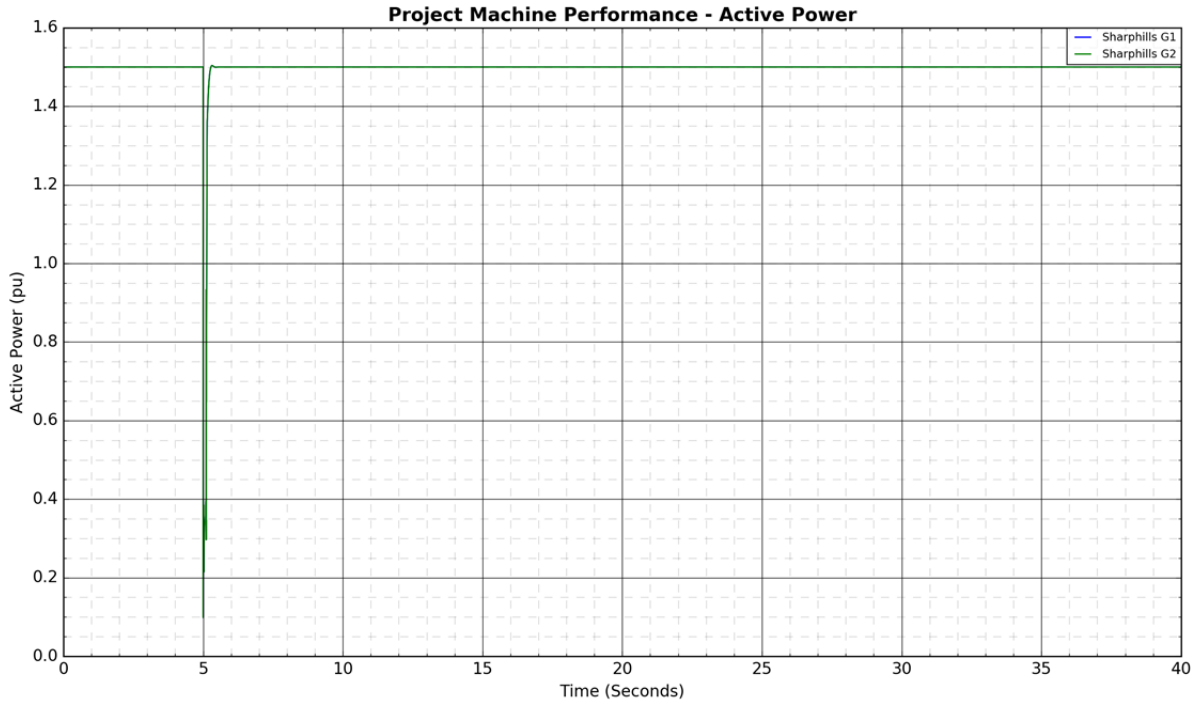


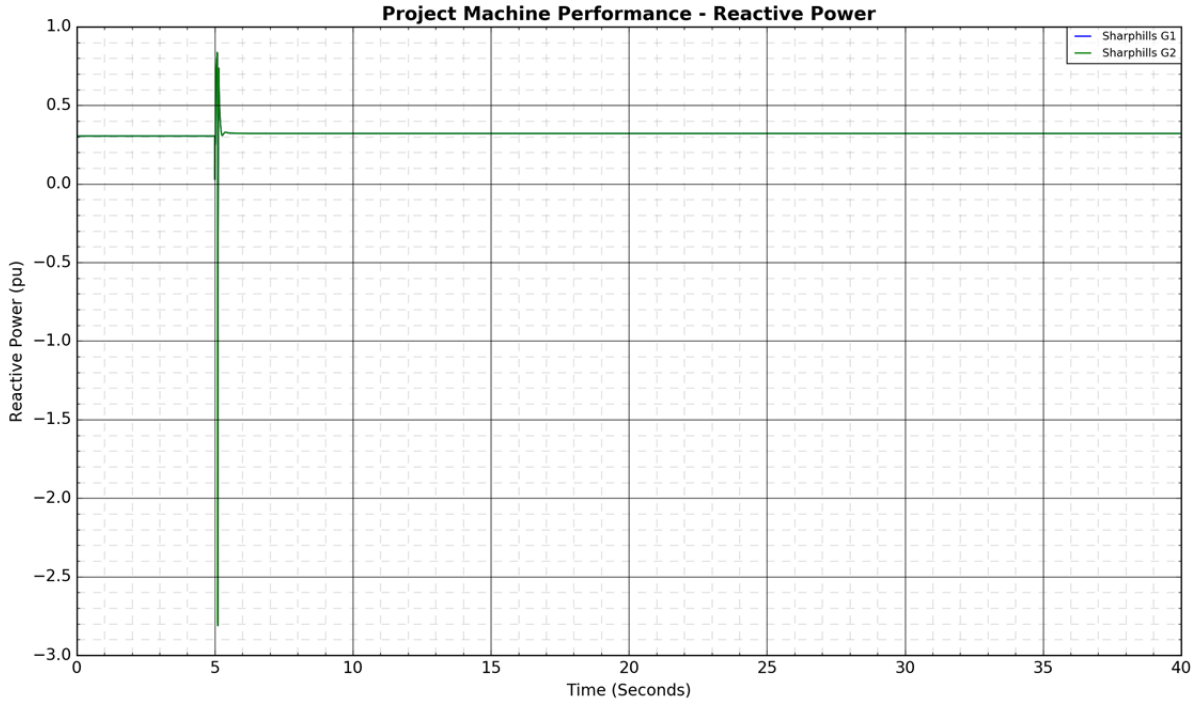

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

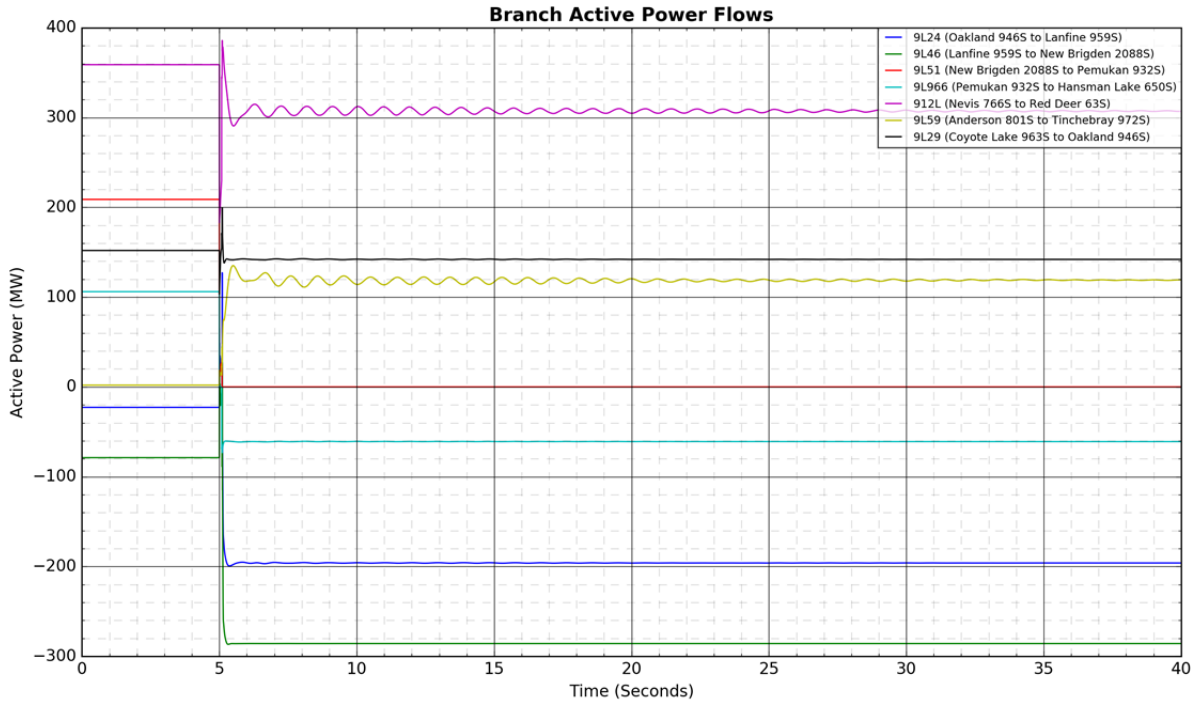

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
Active Power (MW)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

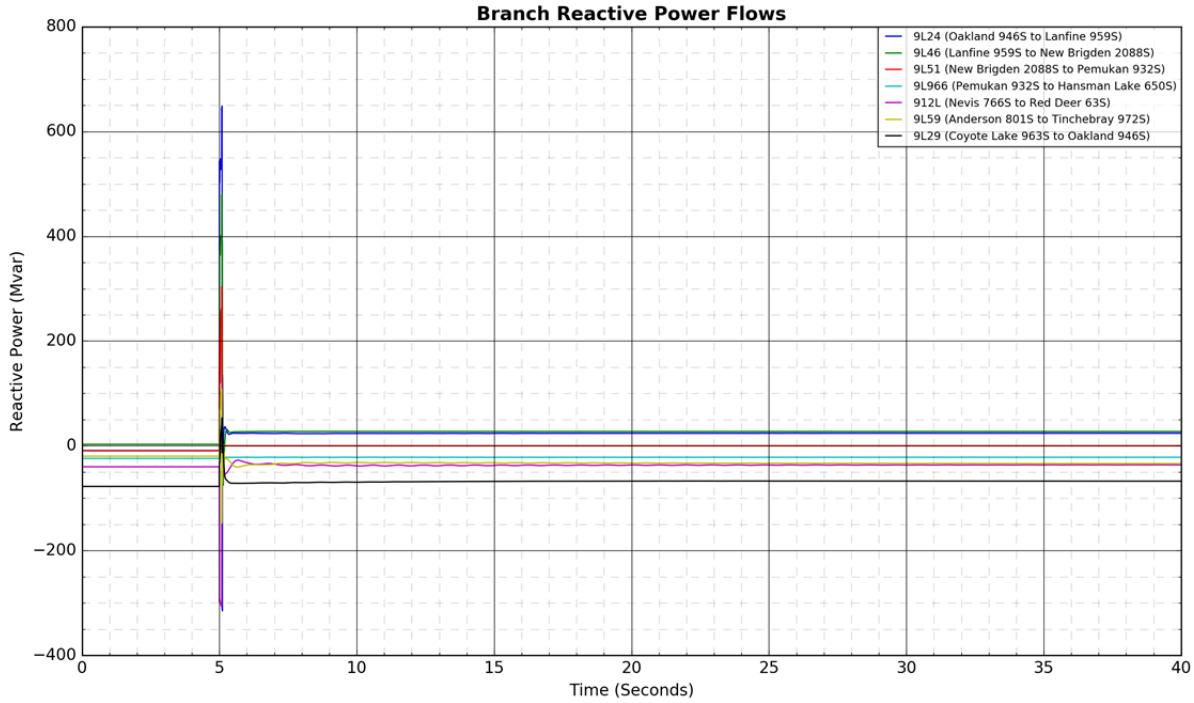
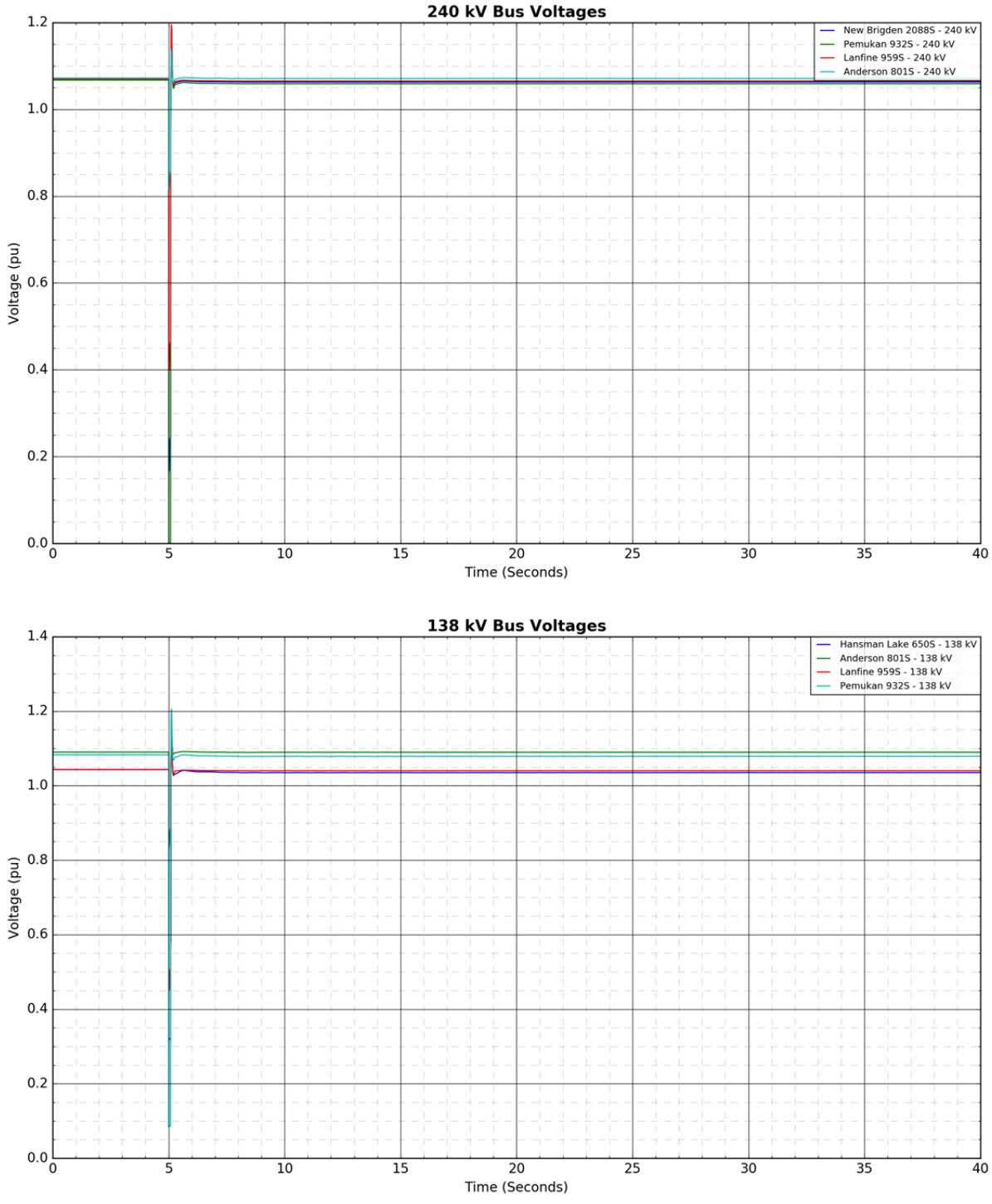
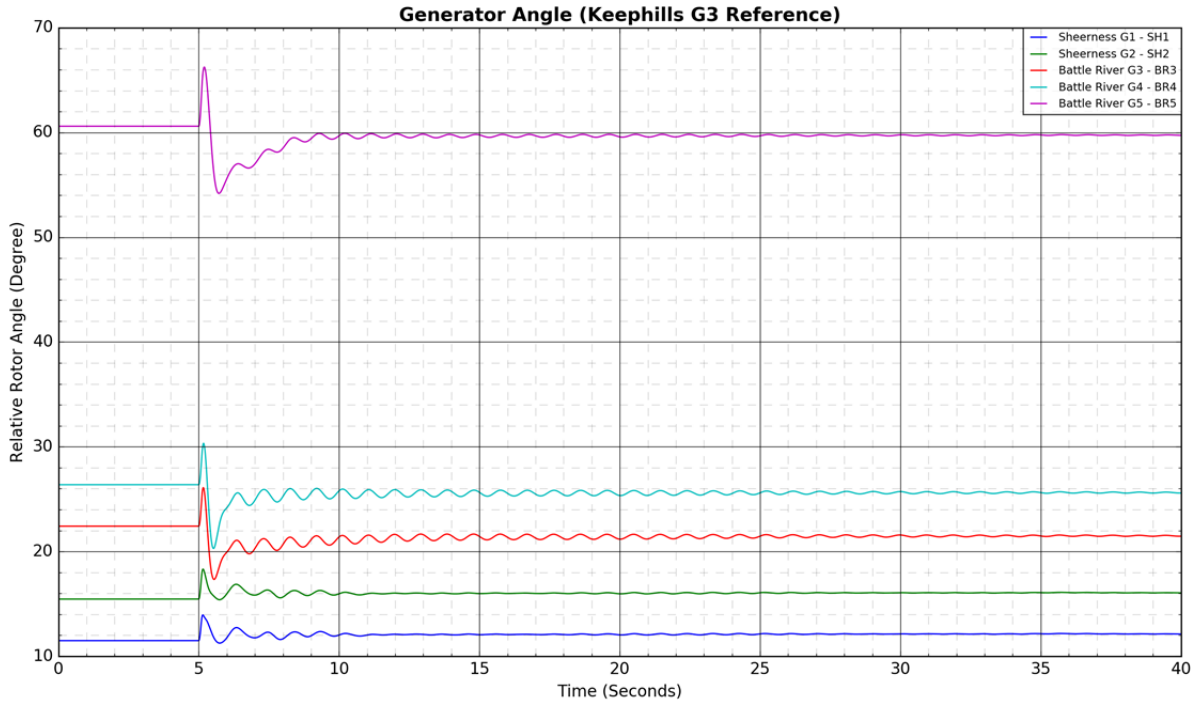
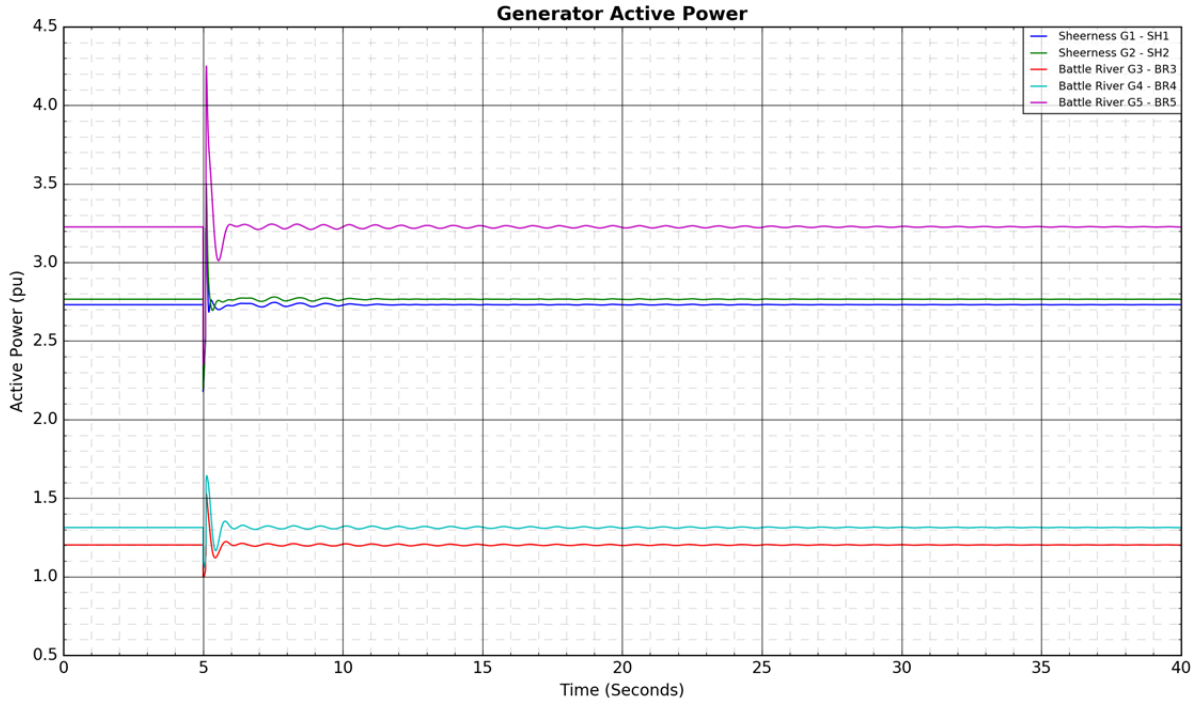
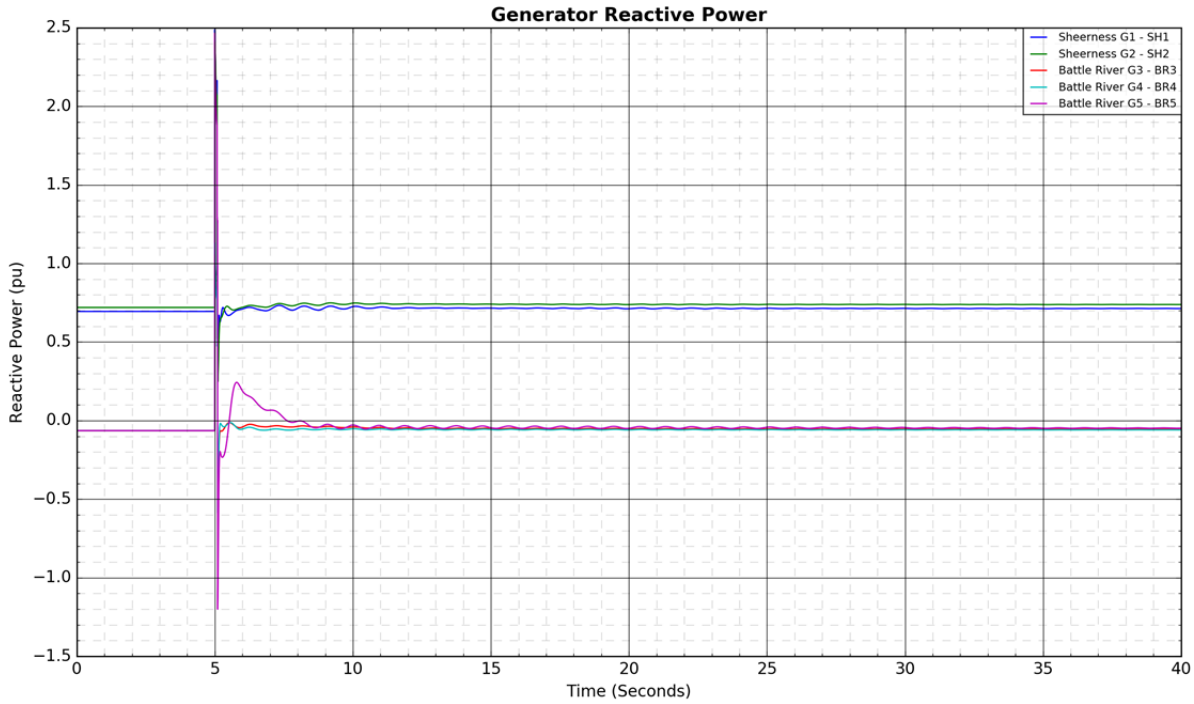

Branch Reactive Power Flows
Reactive Power (Mvar)
Time (Seconds)
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)

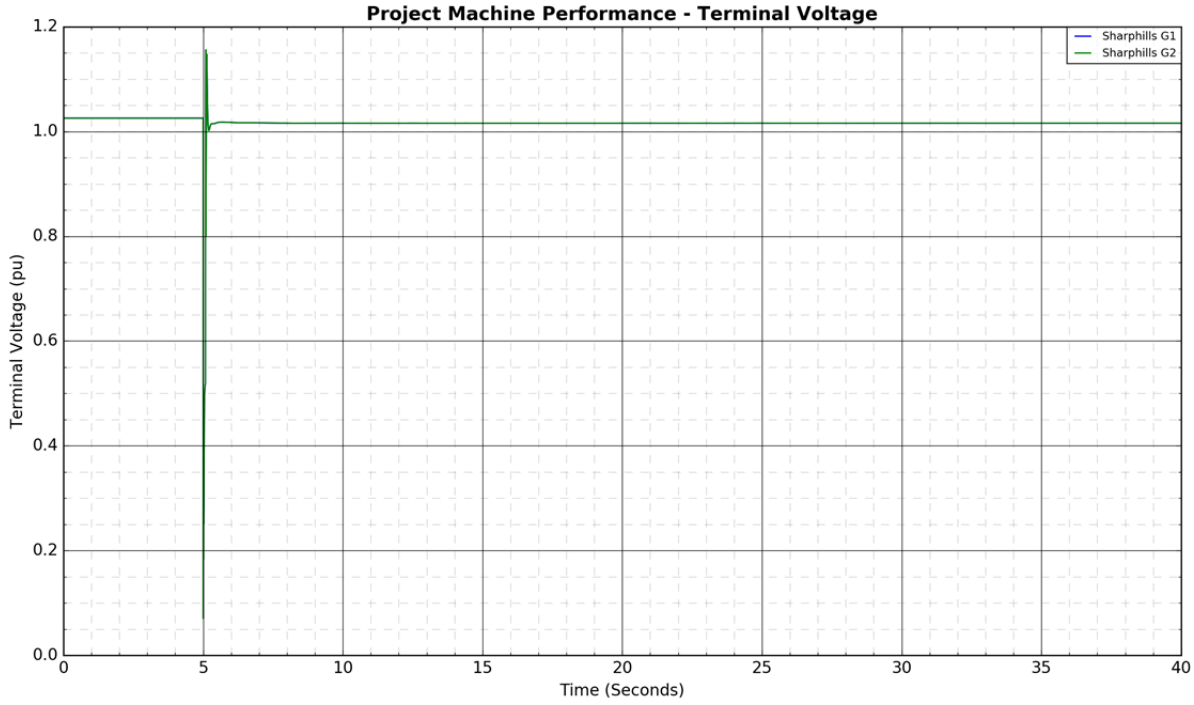
Figure A4-31: 9L966 Pemukan 932S to Hansman Lake 650S: Fault Near Pemukan 932S

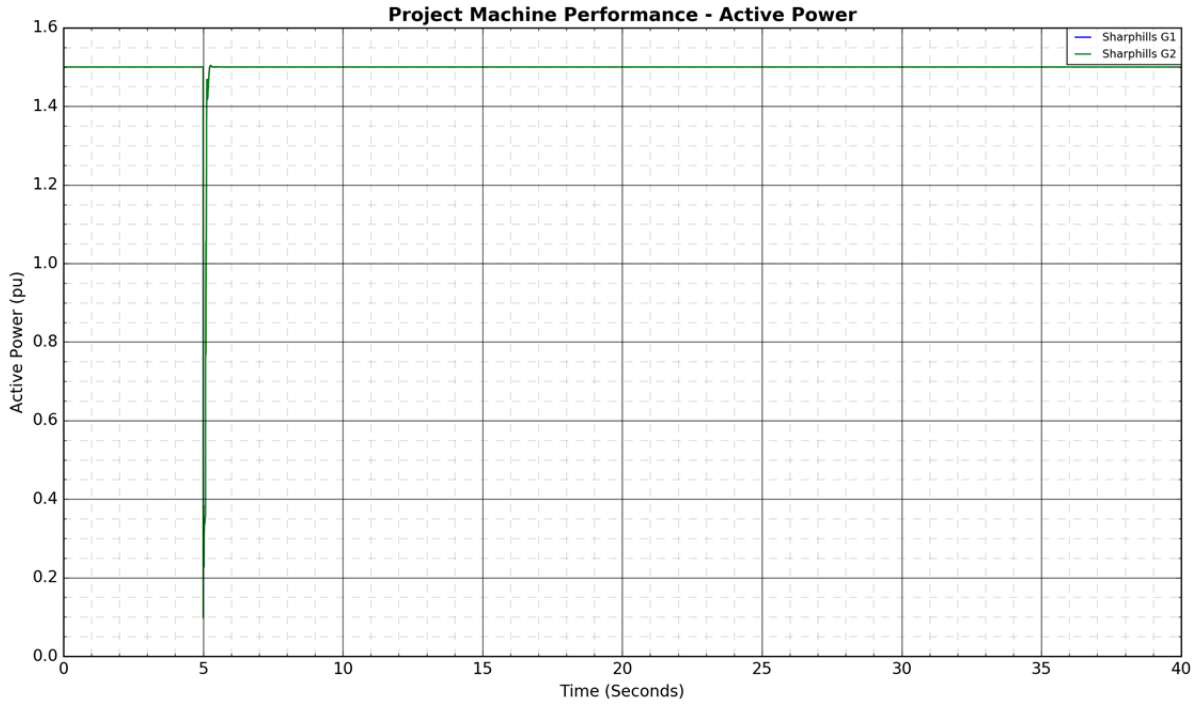


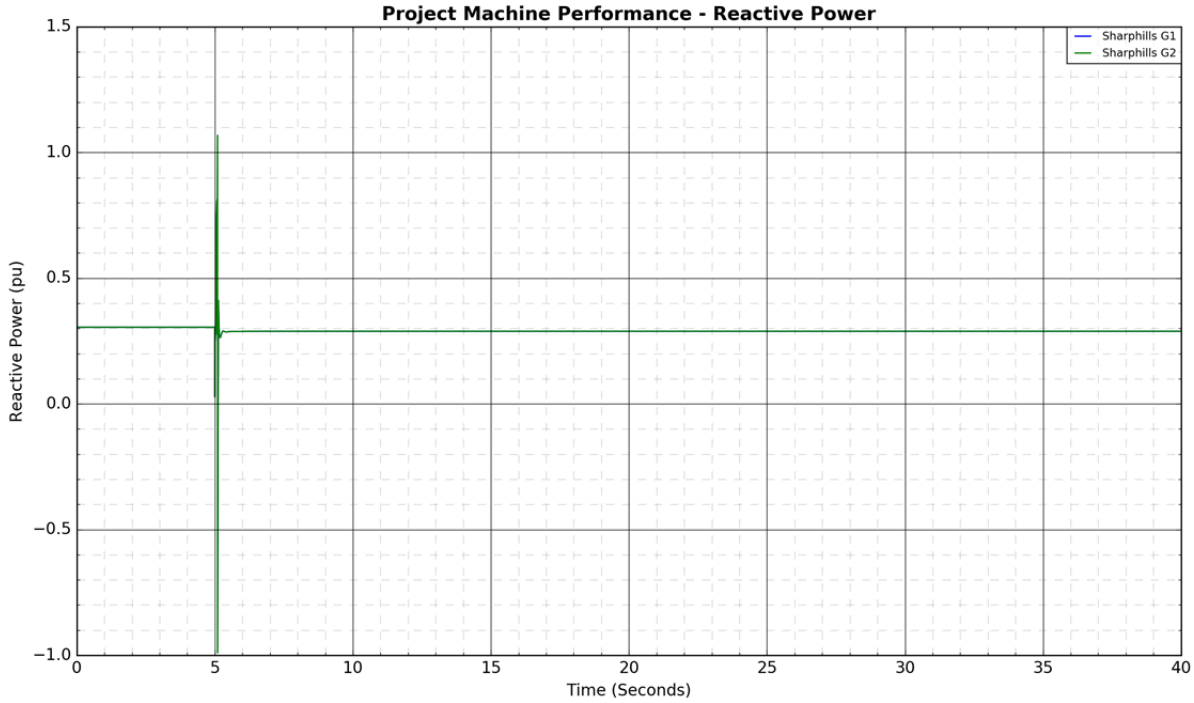

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

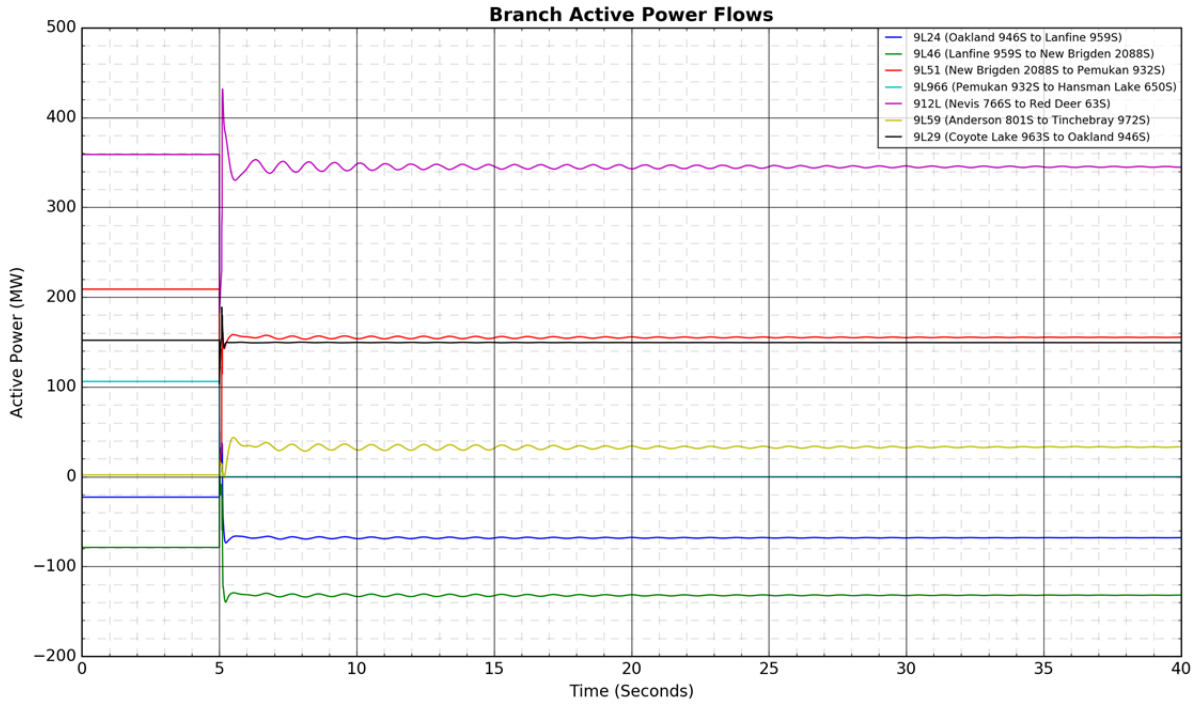

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active 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


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.5
1.0
0.5
0.0
−0.5
−1.0
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

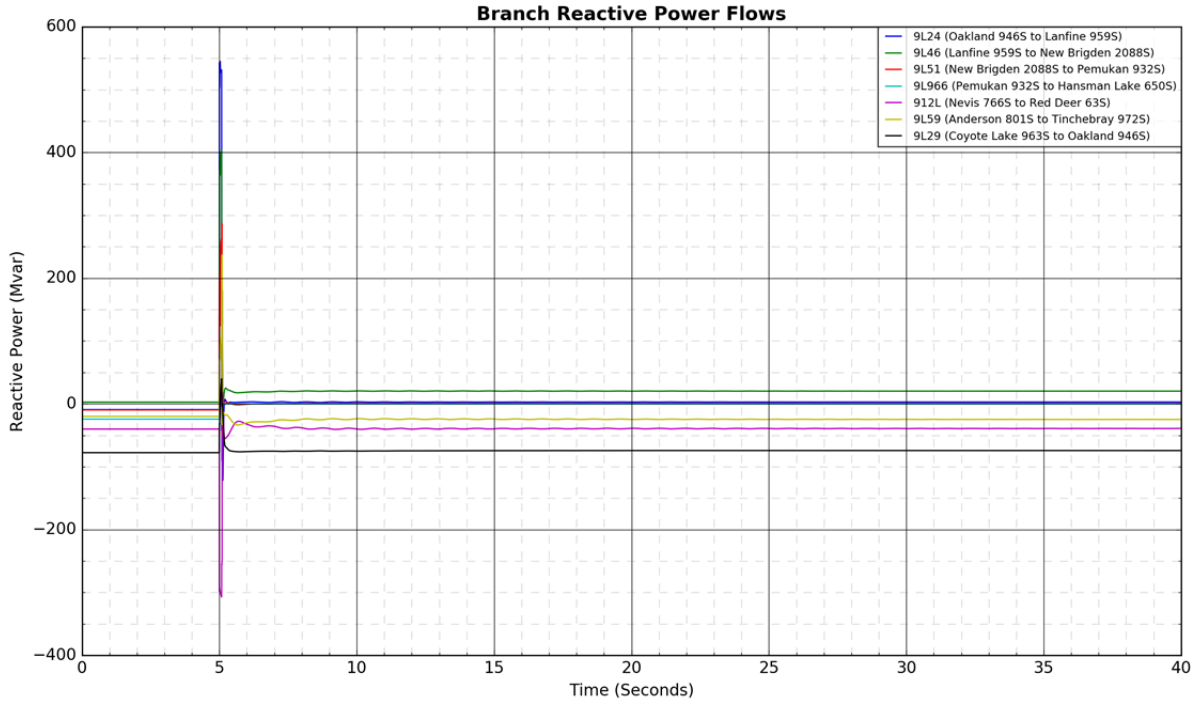
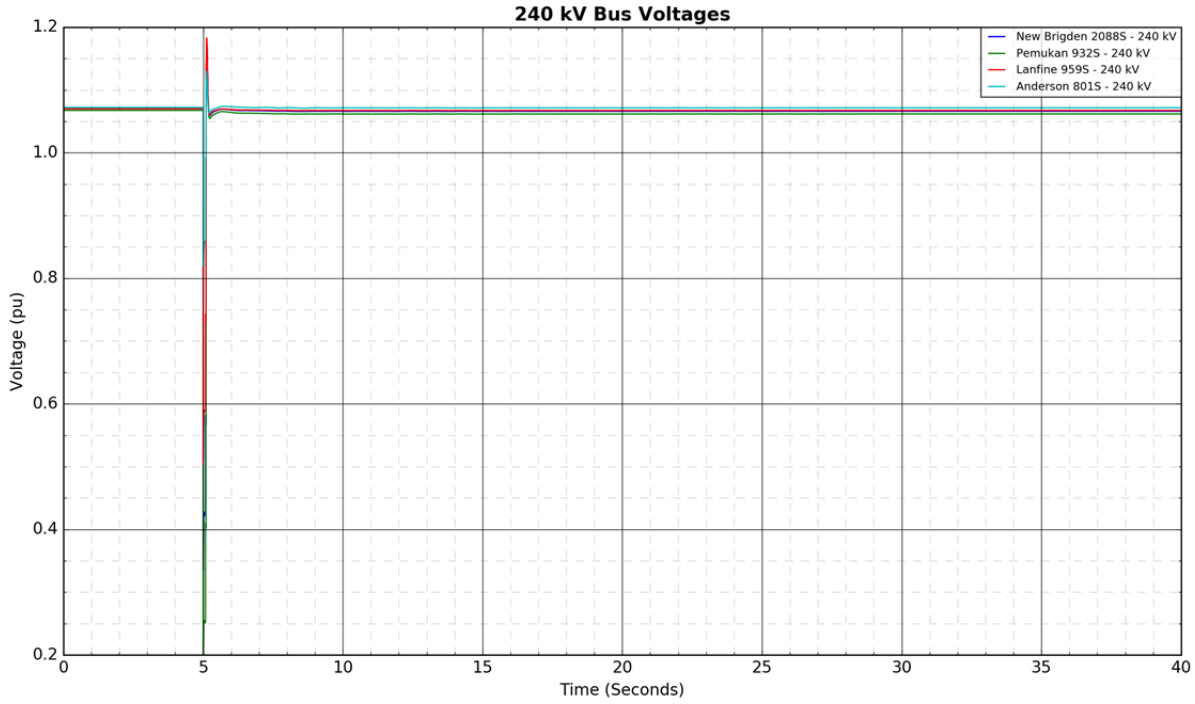
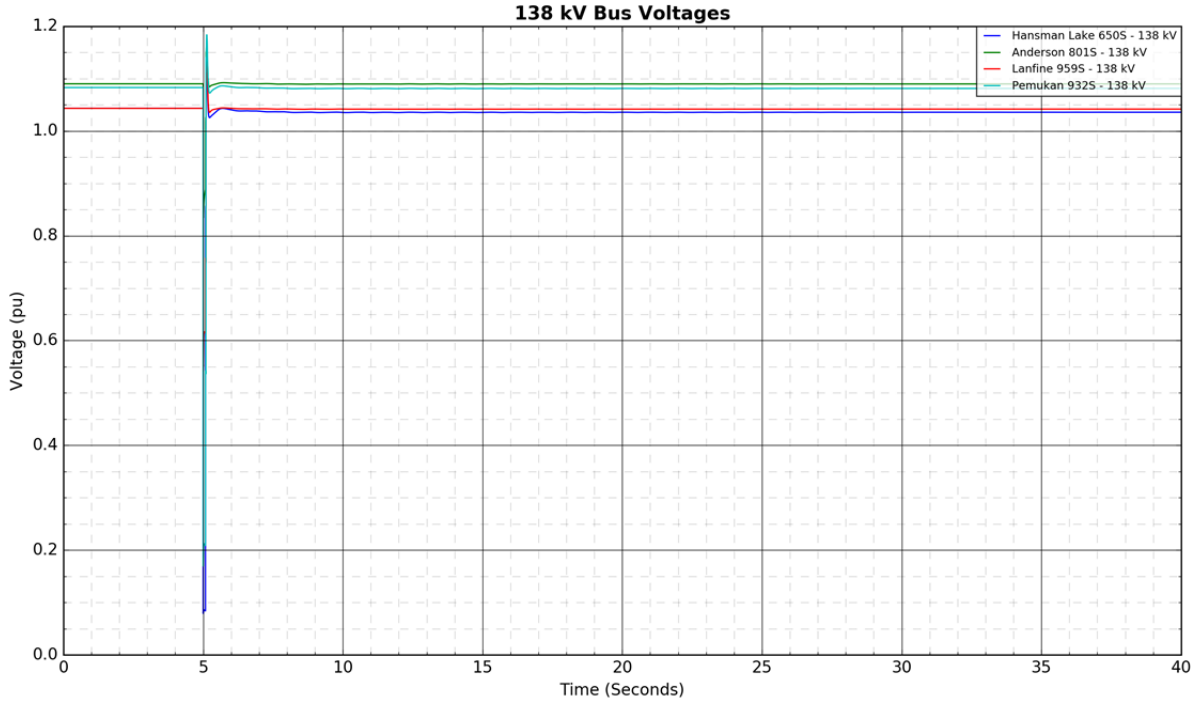
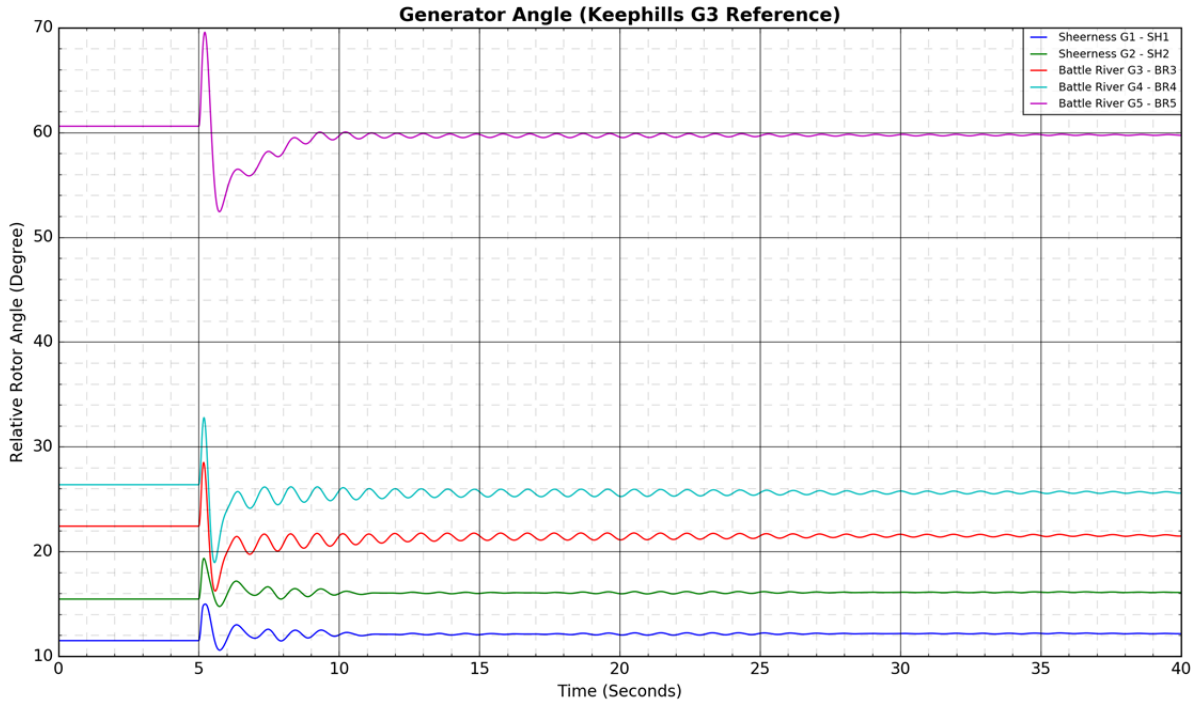
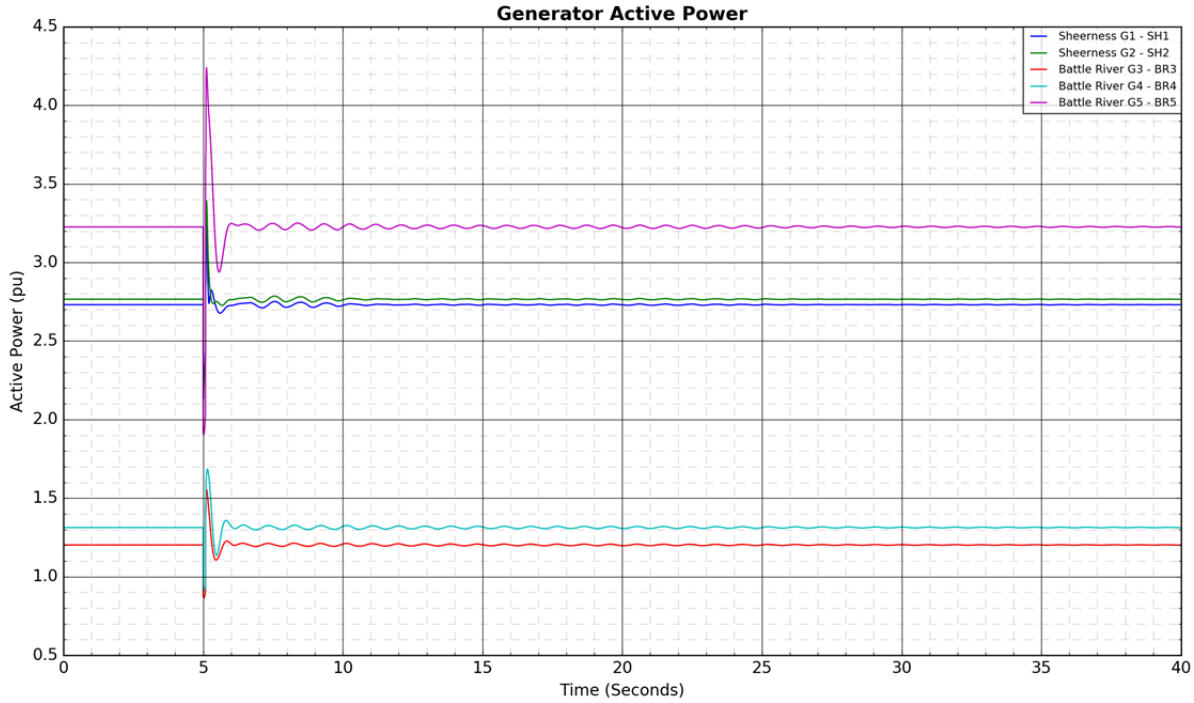

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

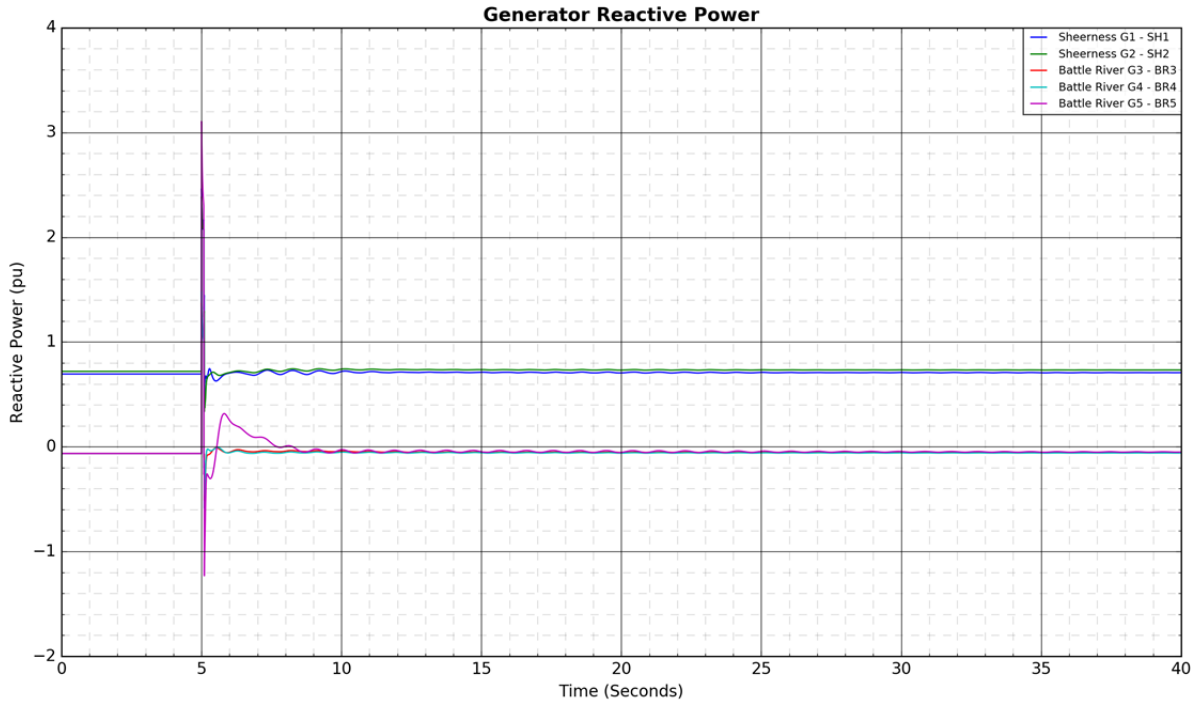
Figure A4-32: 9L966 Pemukan 932S to Hansman Lake 650S: Fault Near Hansman Lake 650S

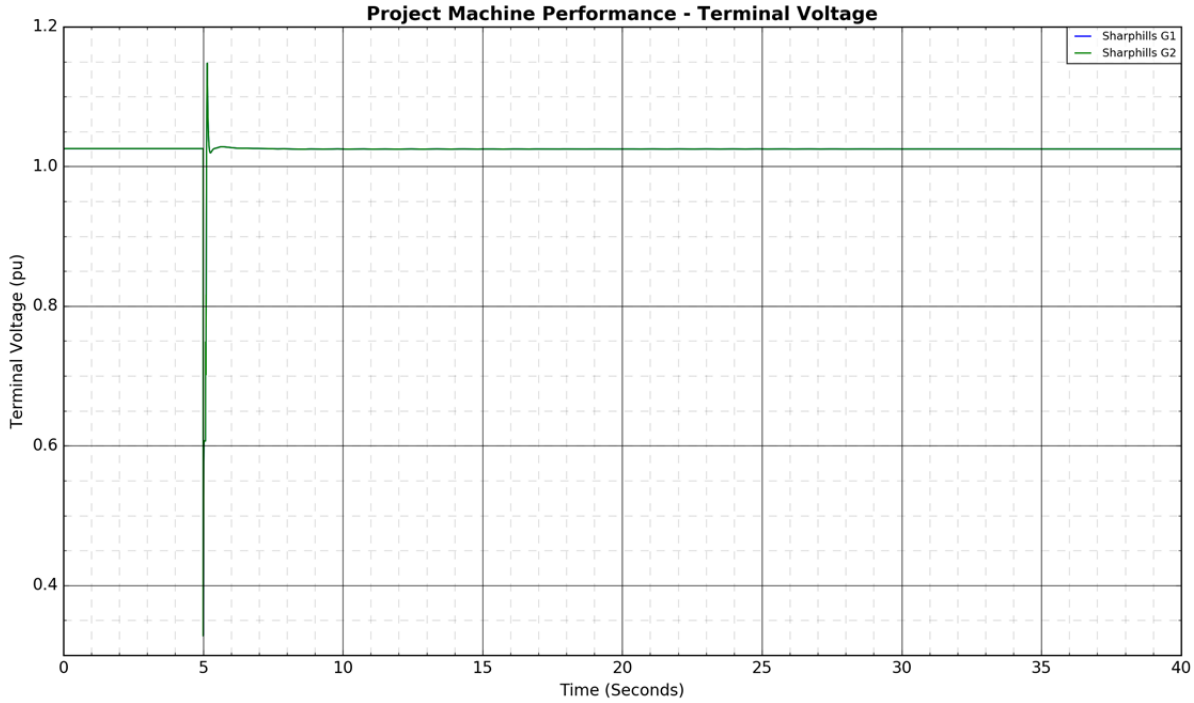


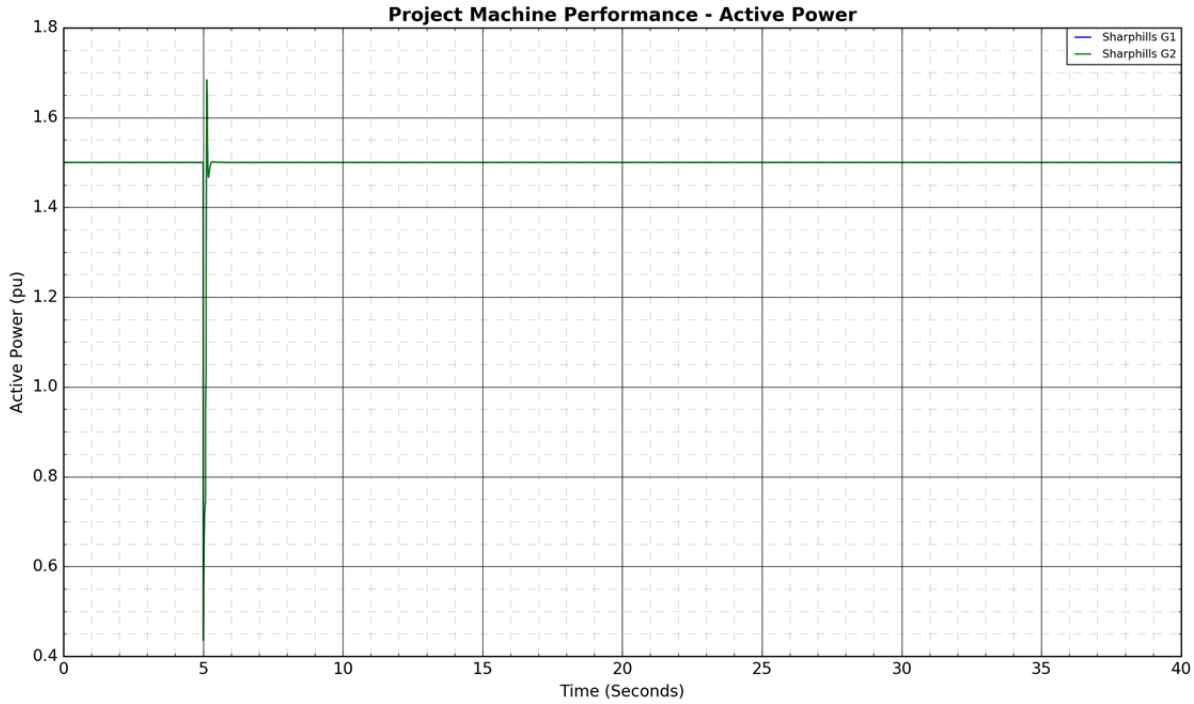


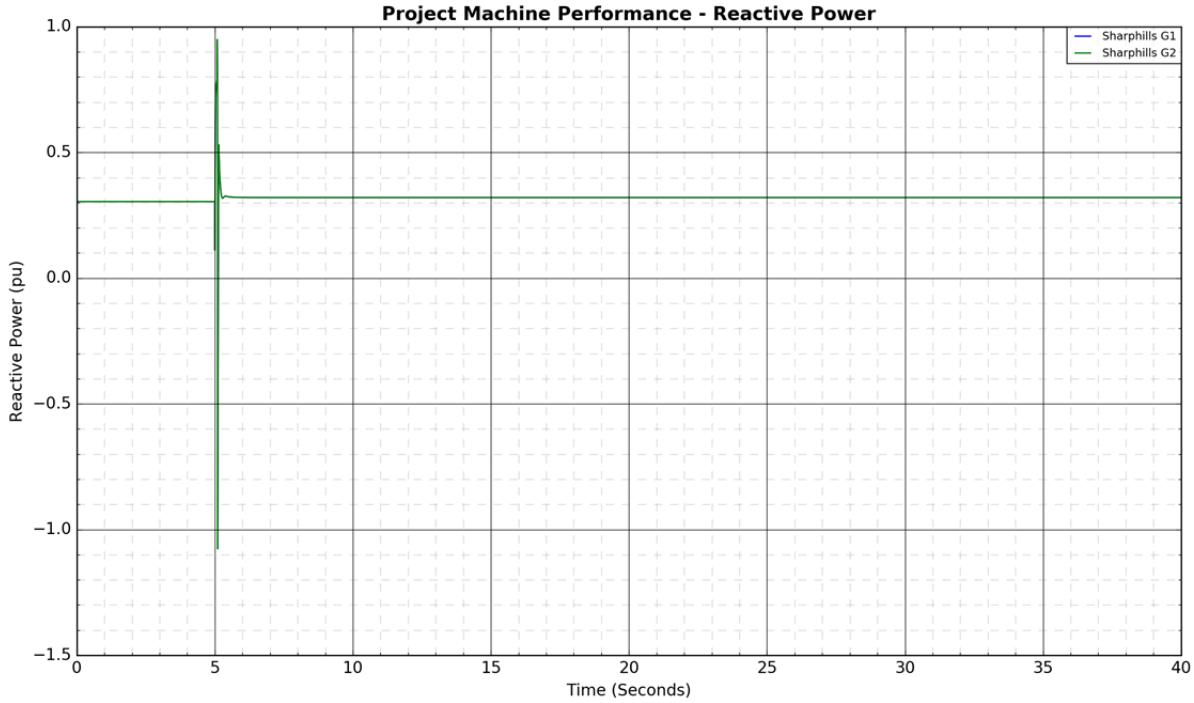

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
70
60
50
40
30
20
10
0
5
10
15
20
25
30
35
40

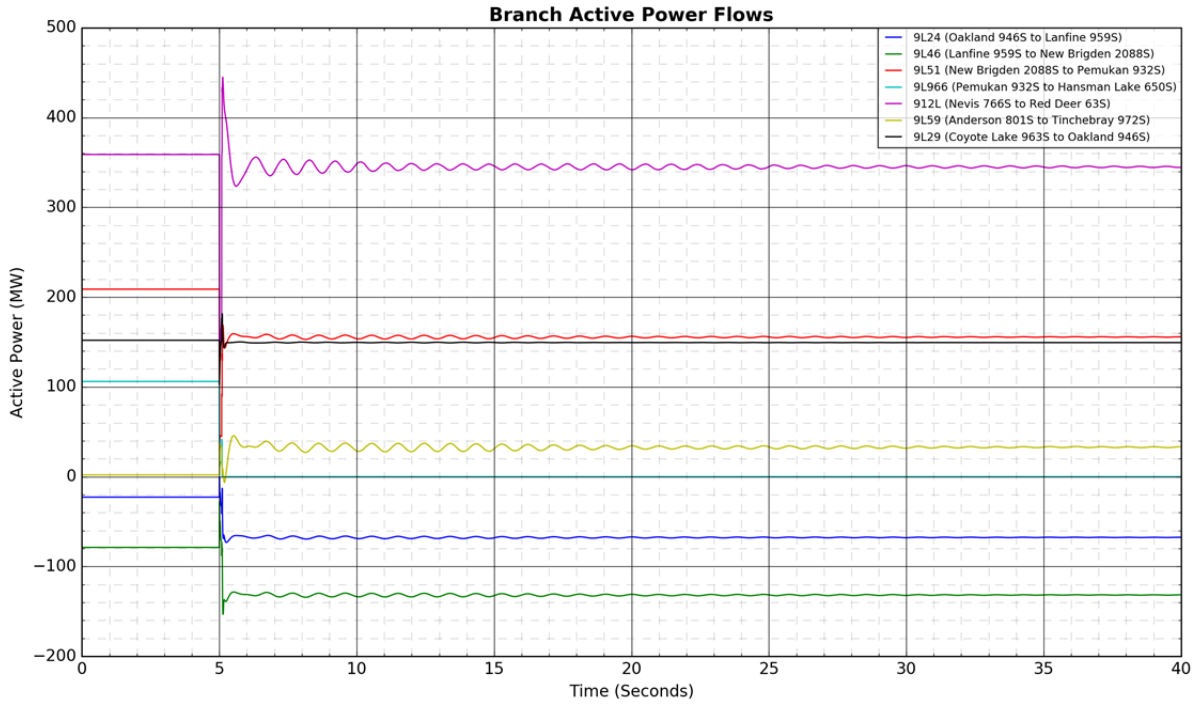

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
35
40


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active Power (pu)
Time (Seconds)
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
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

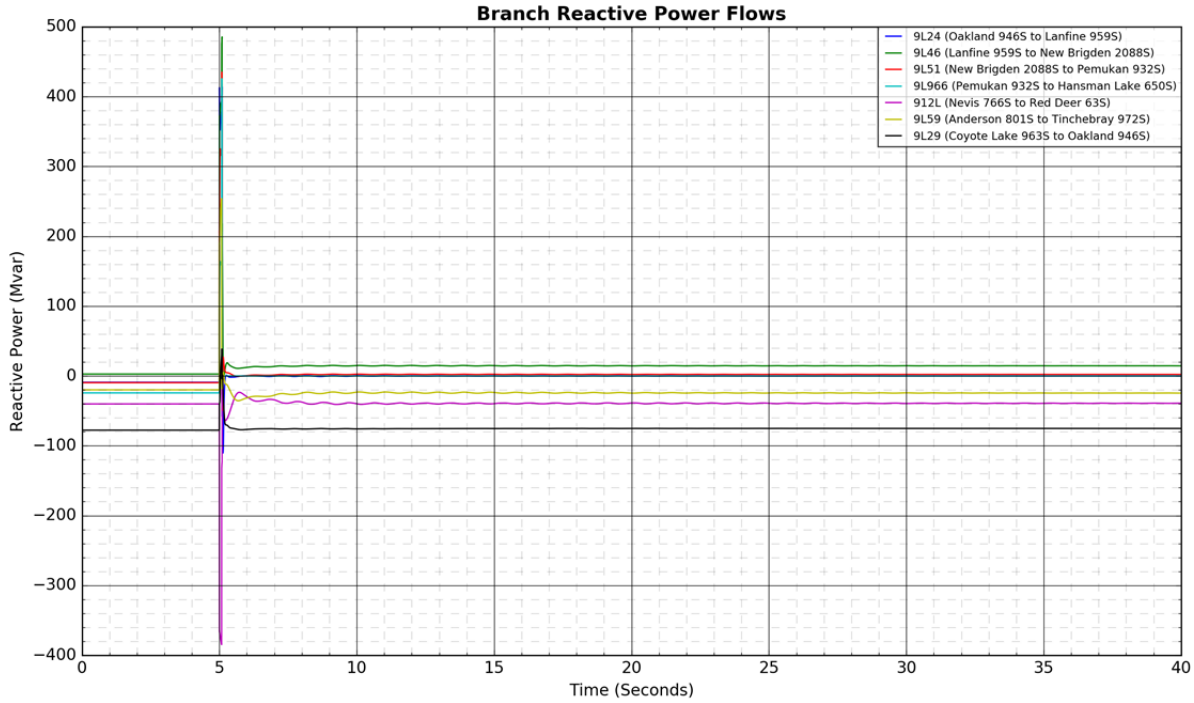
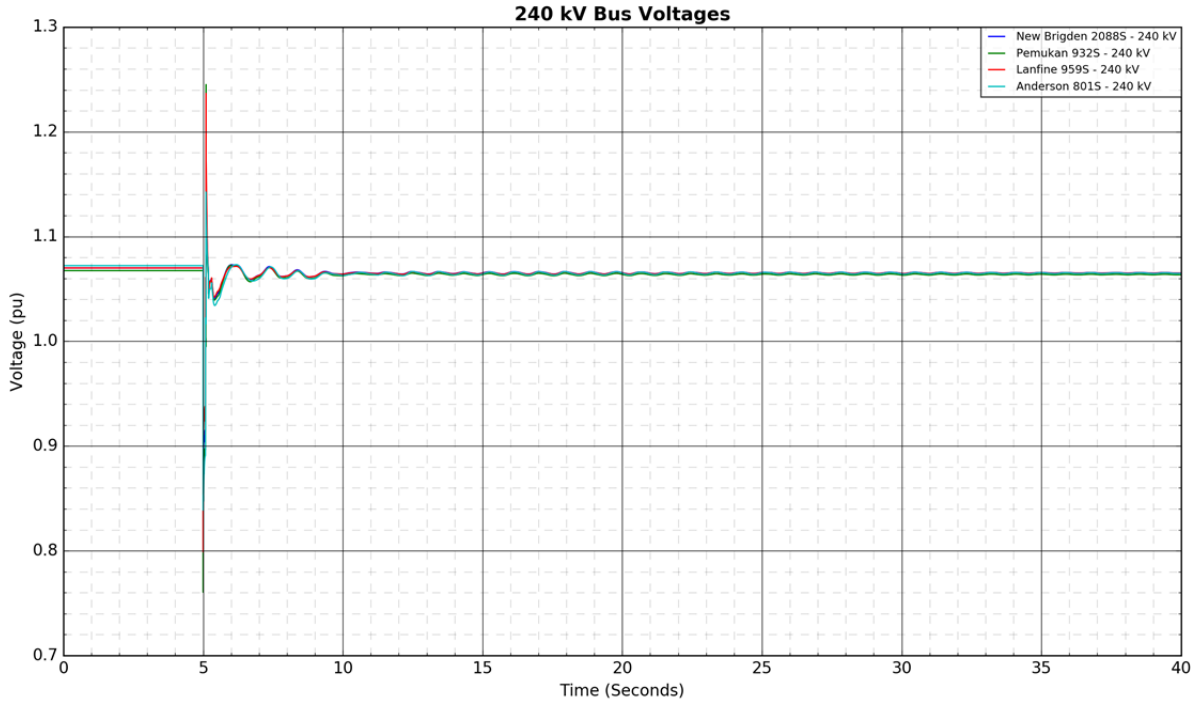
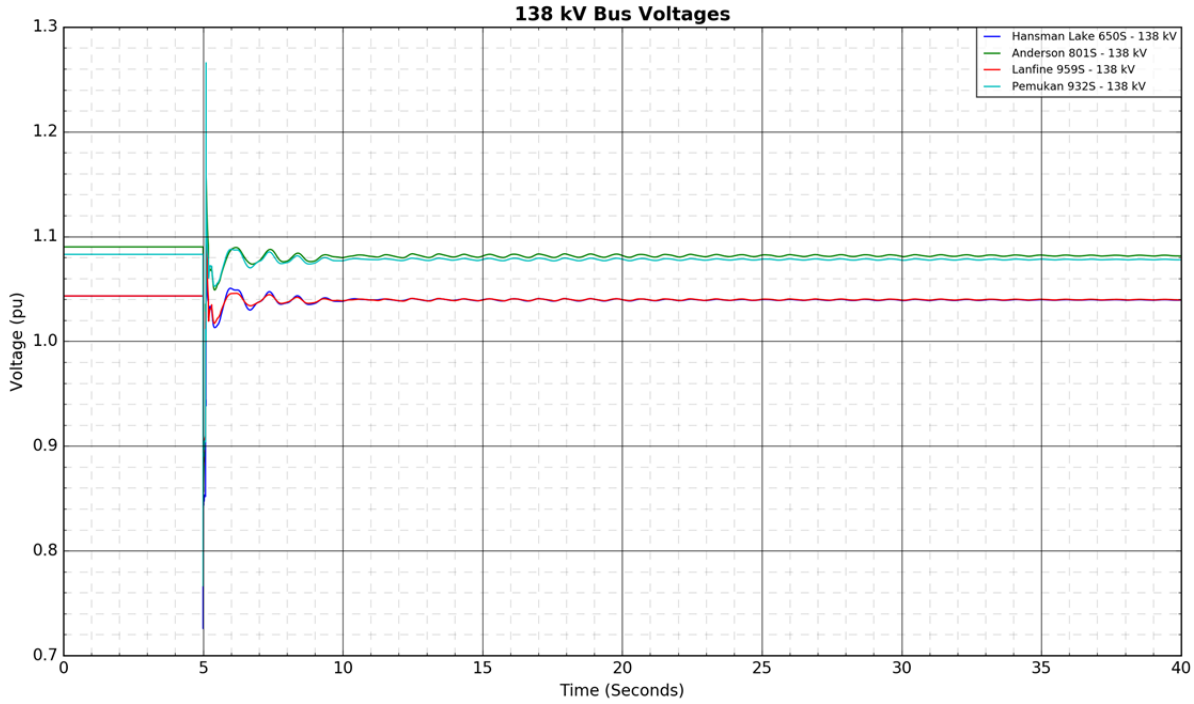
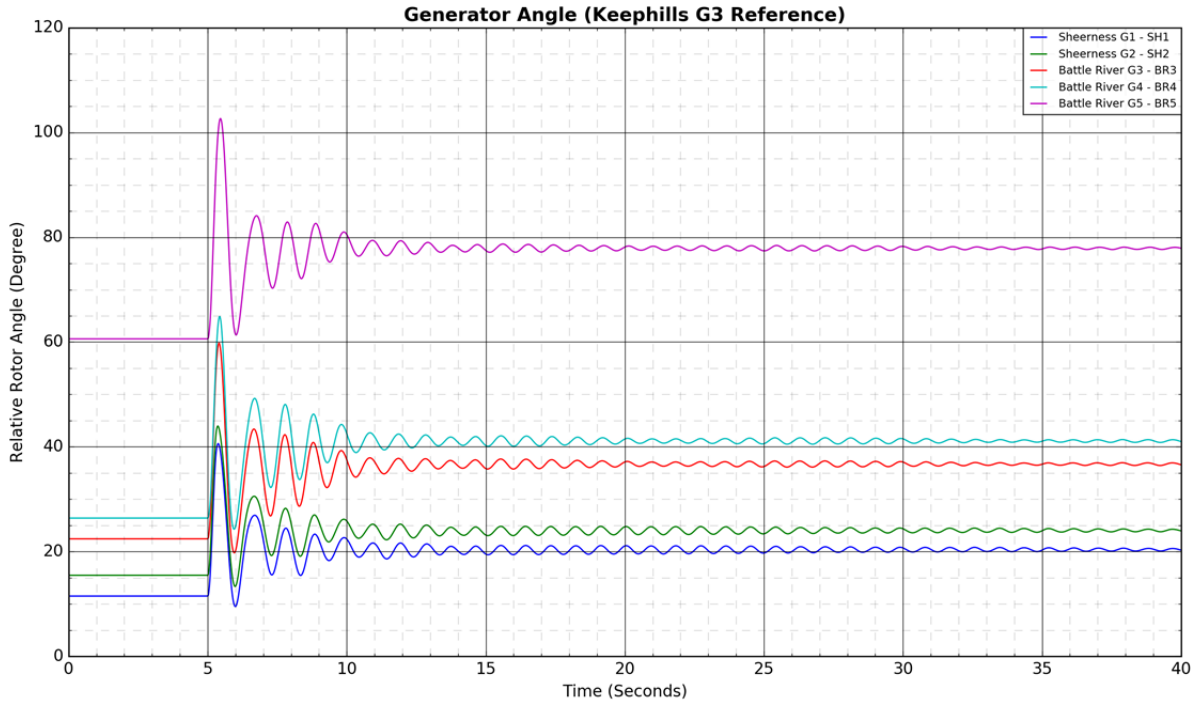
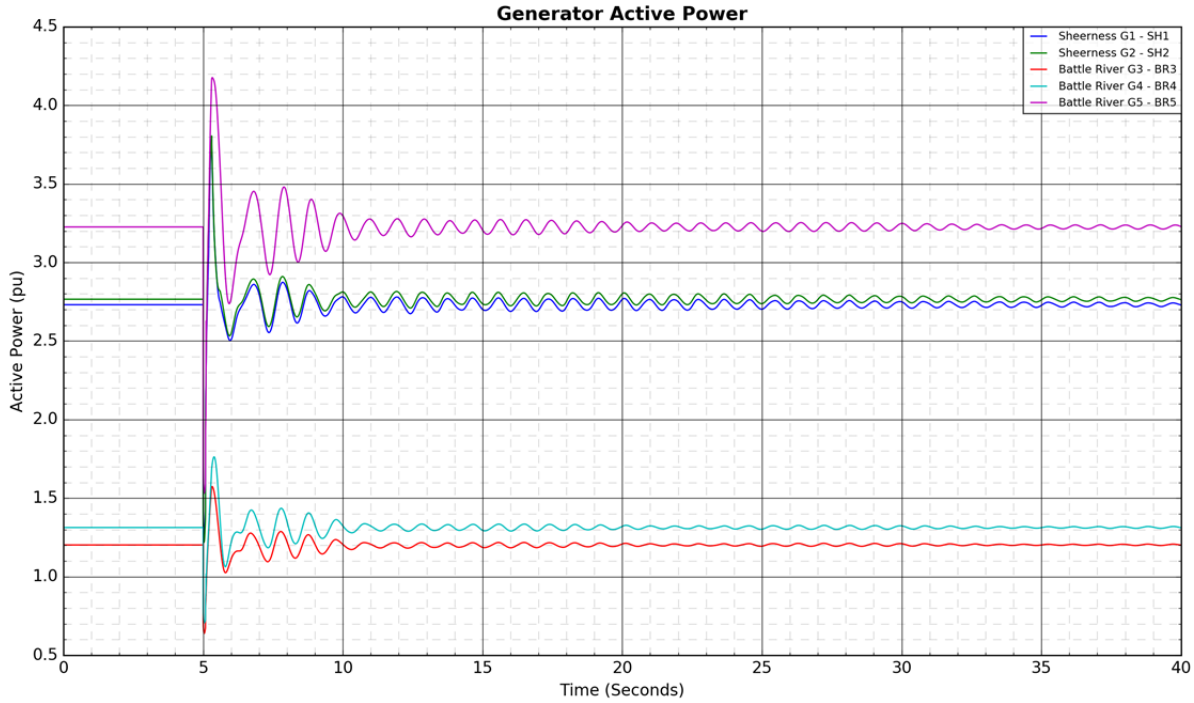

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

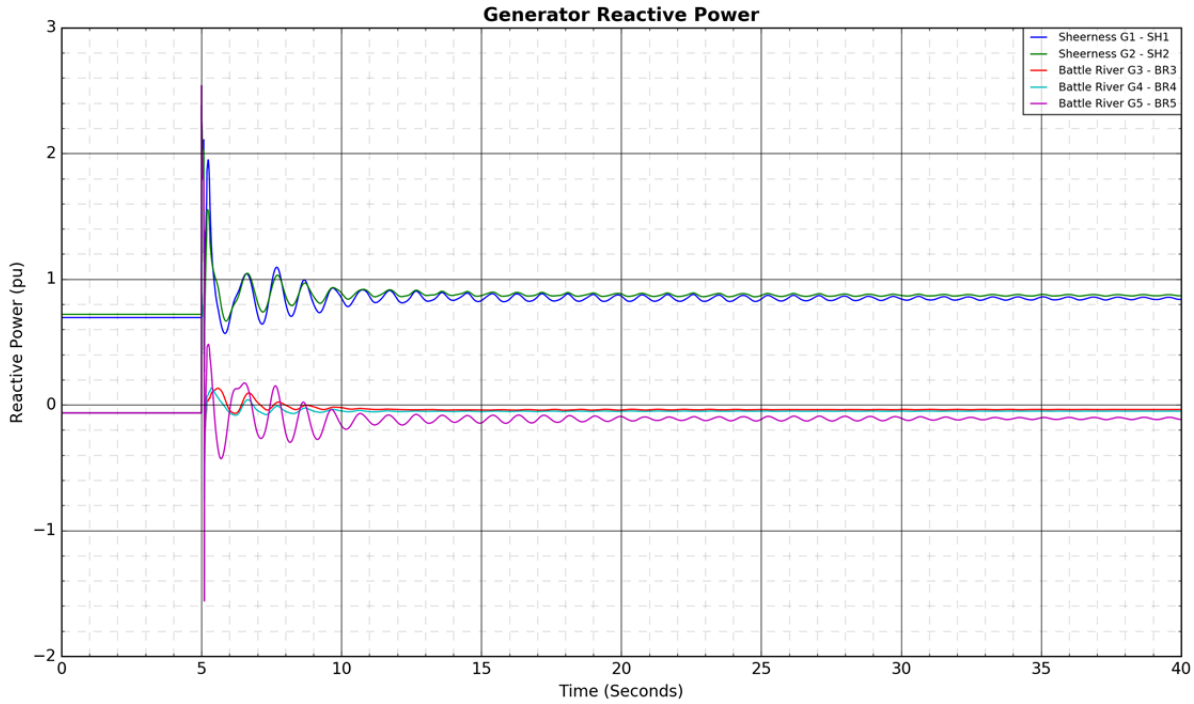
Figure A4-33: 912L/9L912 Nevis 766S to Red Deer 63S: Fault Near Red Deer 63S

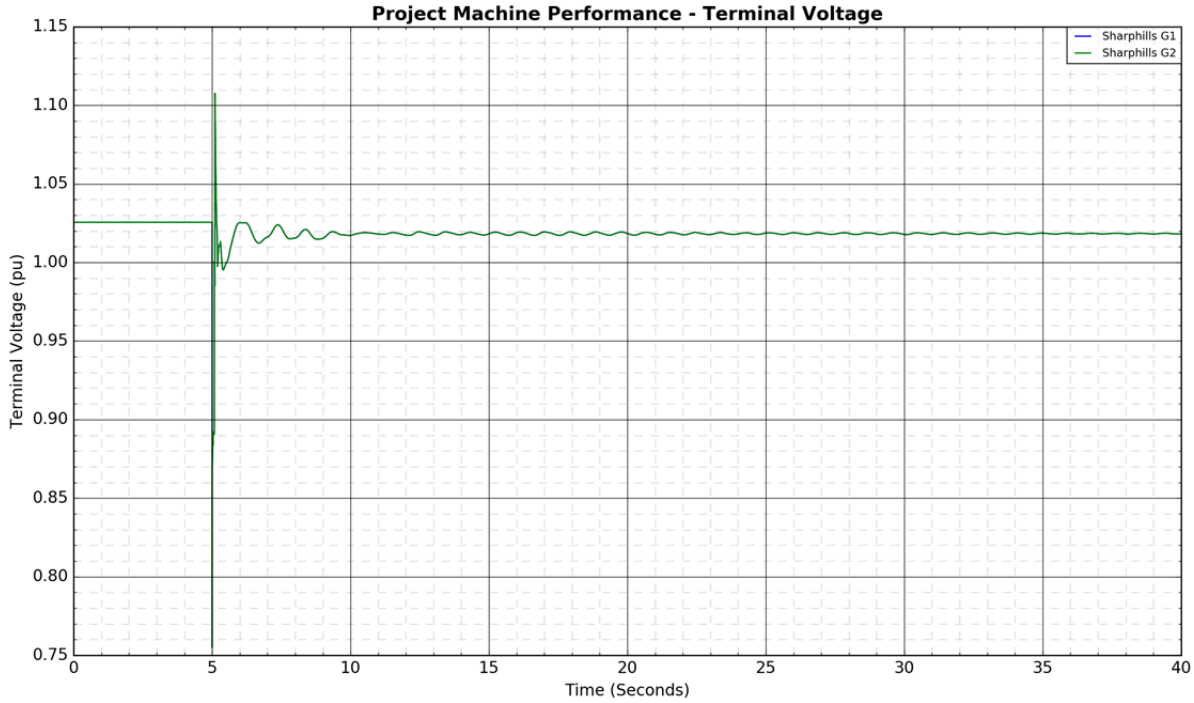


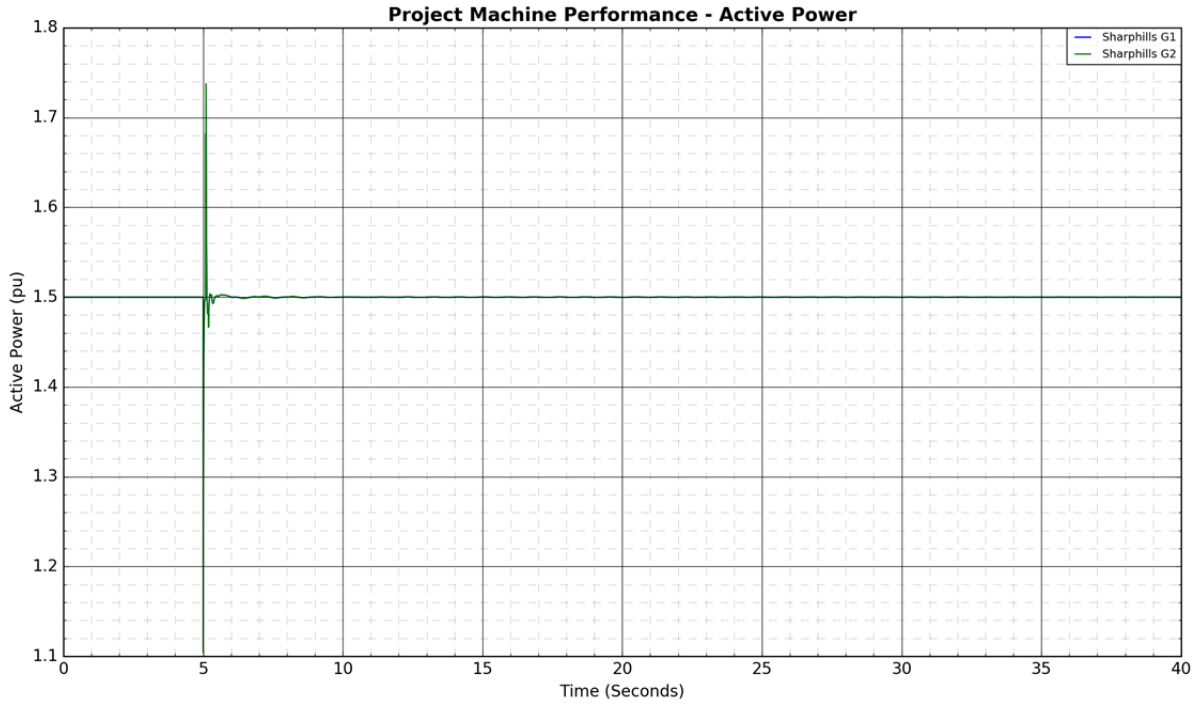


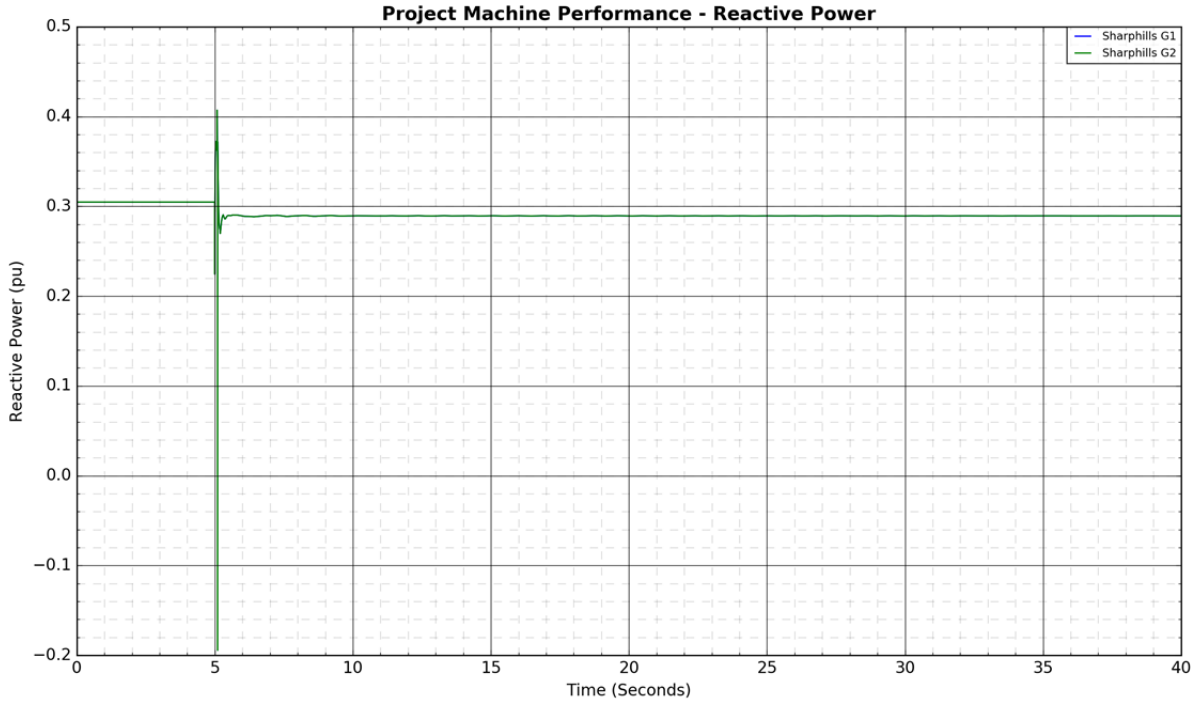

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
0
20
40
60
80
100
120
0
5
10
15
20
25
30
35
40

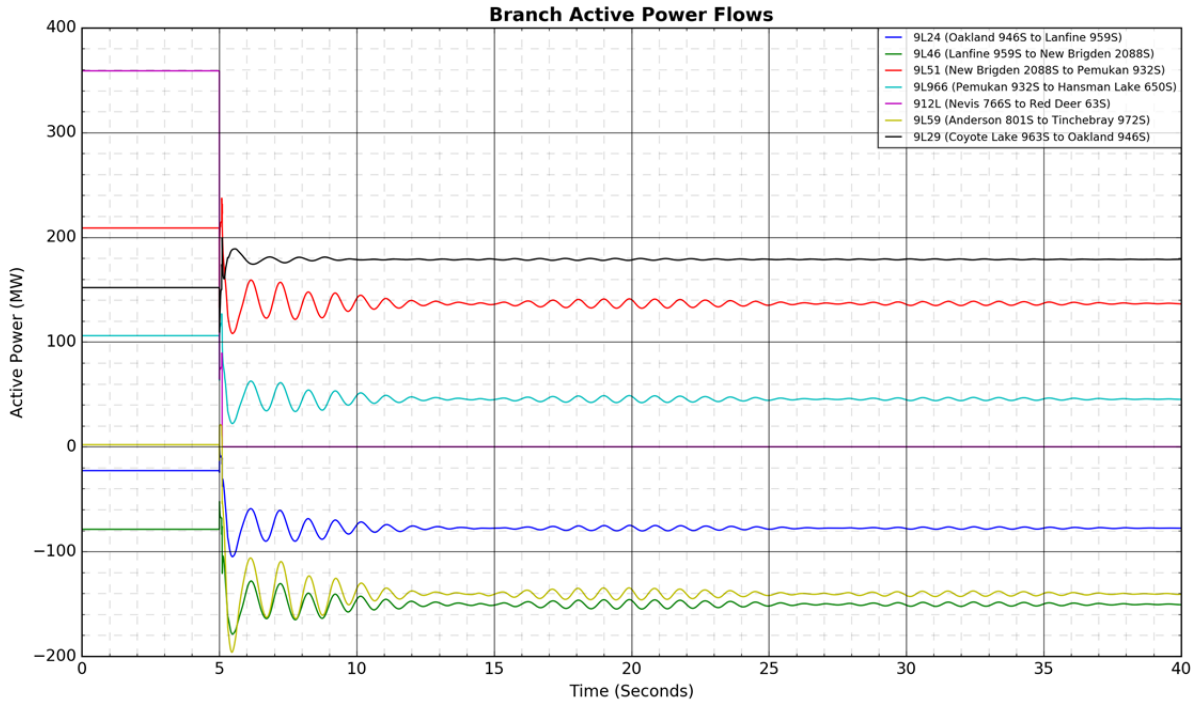

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
0
5
10
15
20
25
30
35
40


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active Power (pu)
Time (Seconds)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

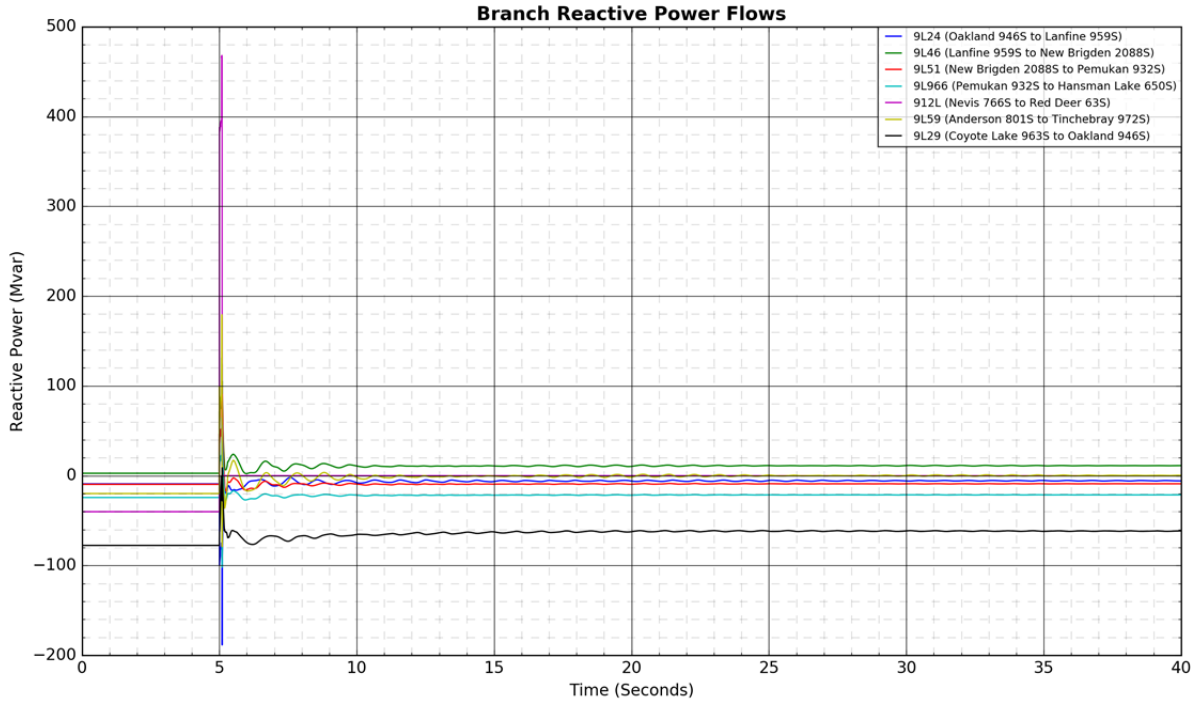
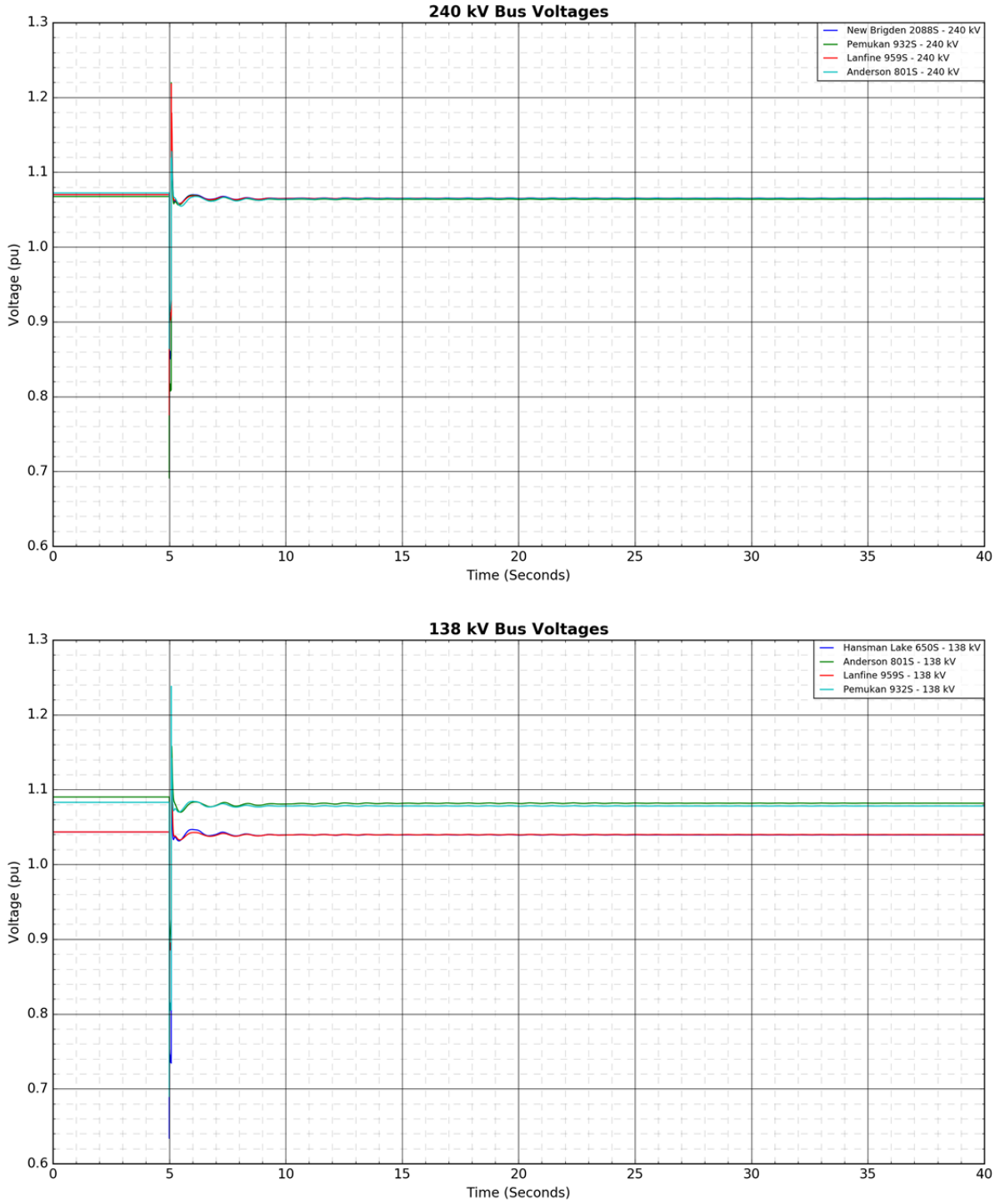
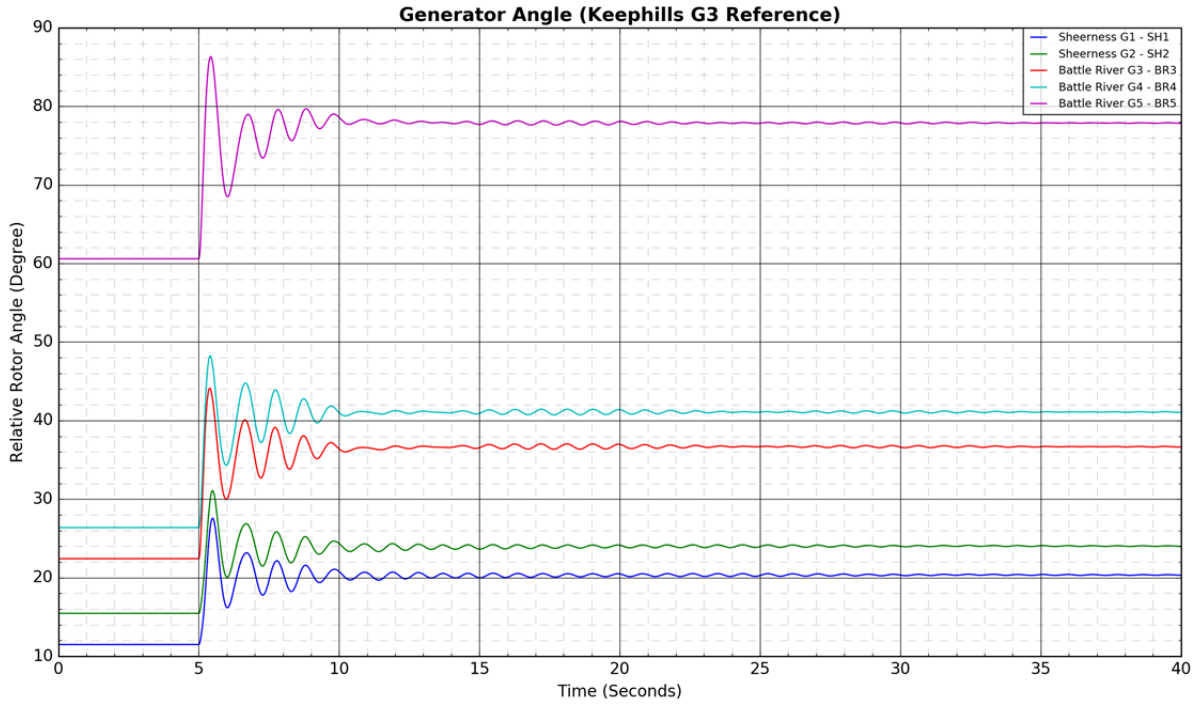
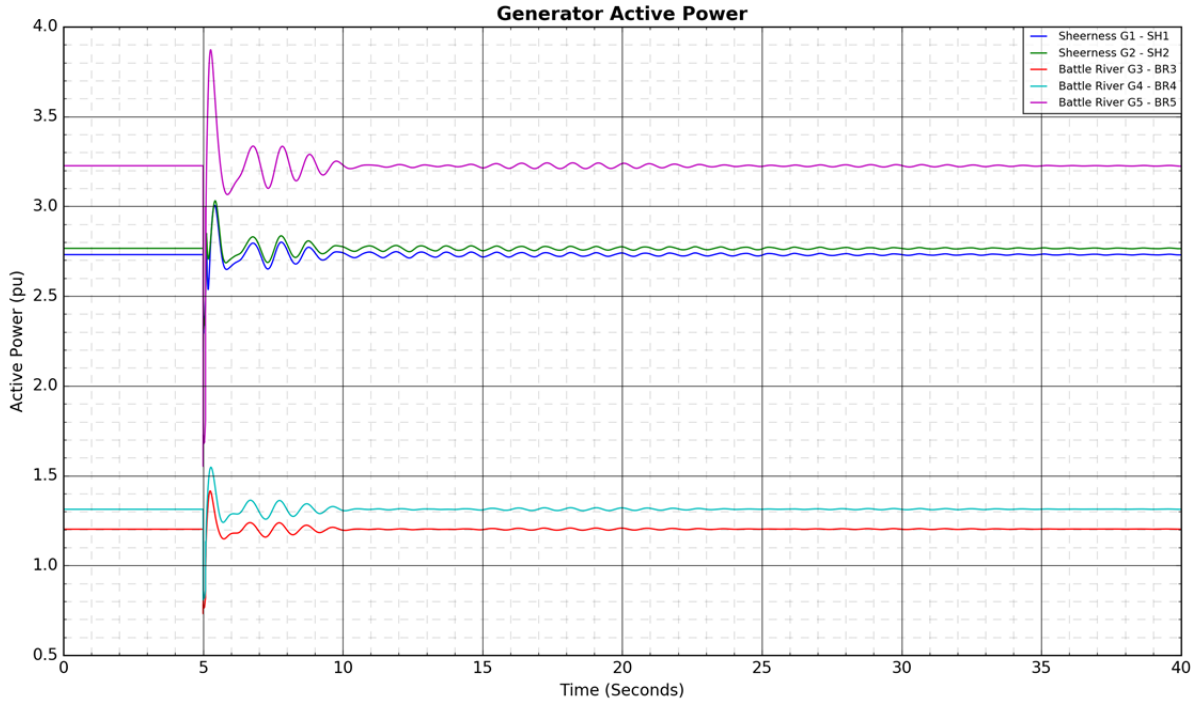
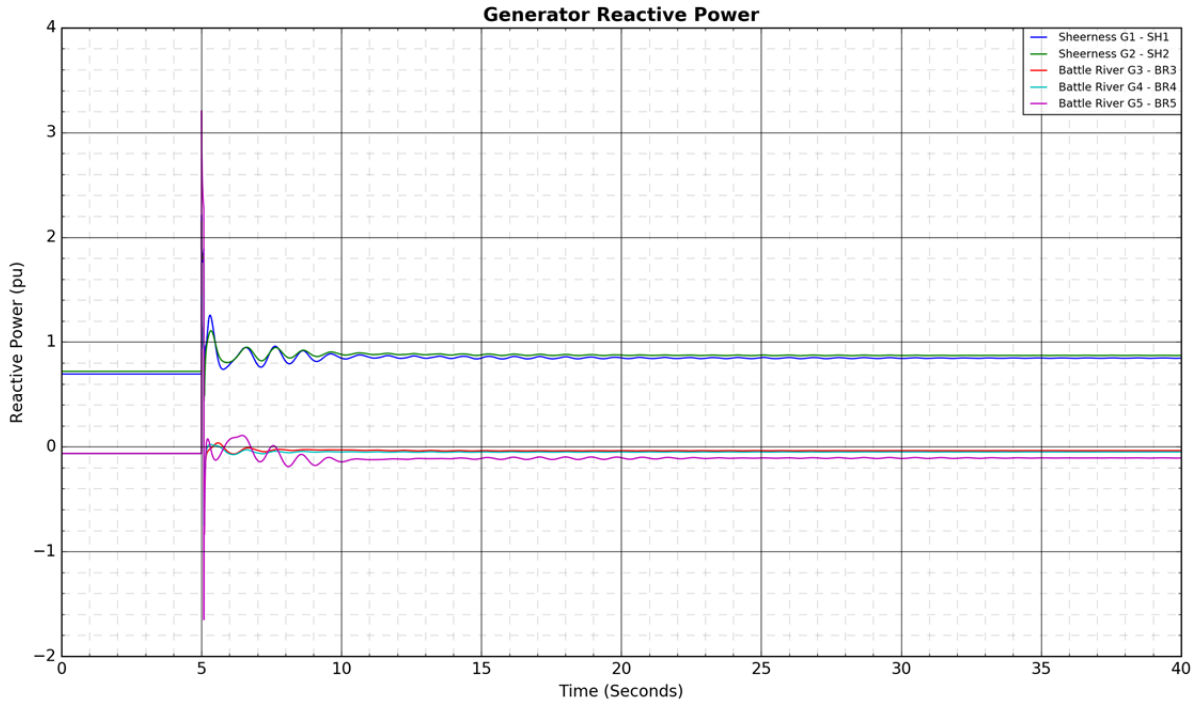

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

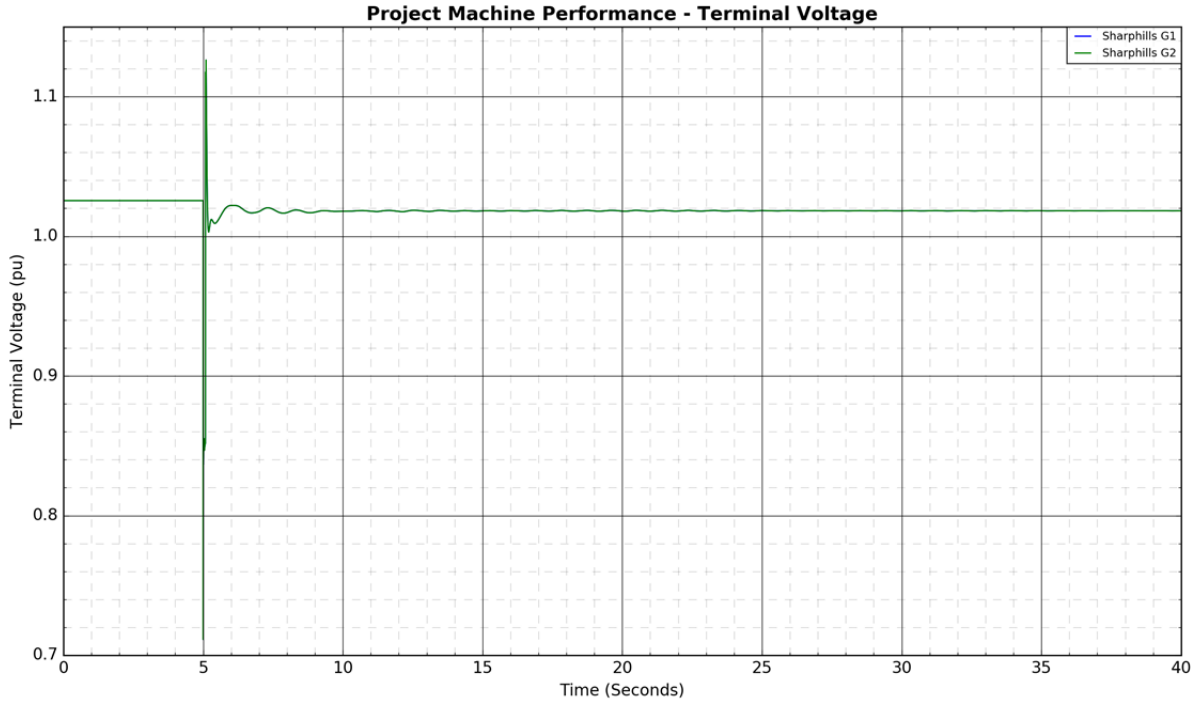
Figure A4-34: 912L/9L912 Nevis 766S to Red Deer 63S: Fault Near Nevis 766S

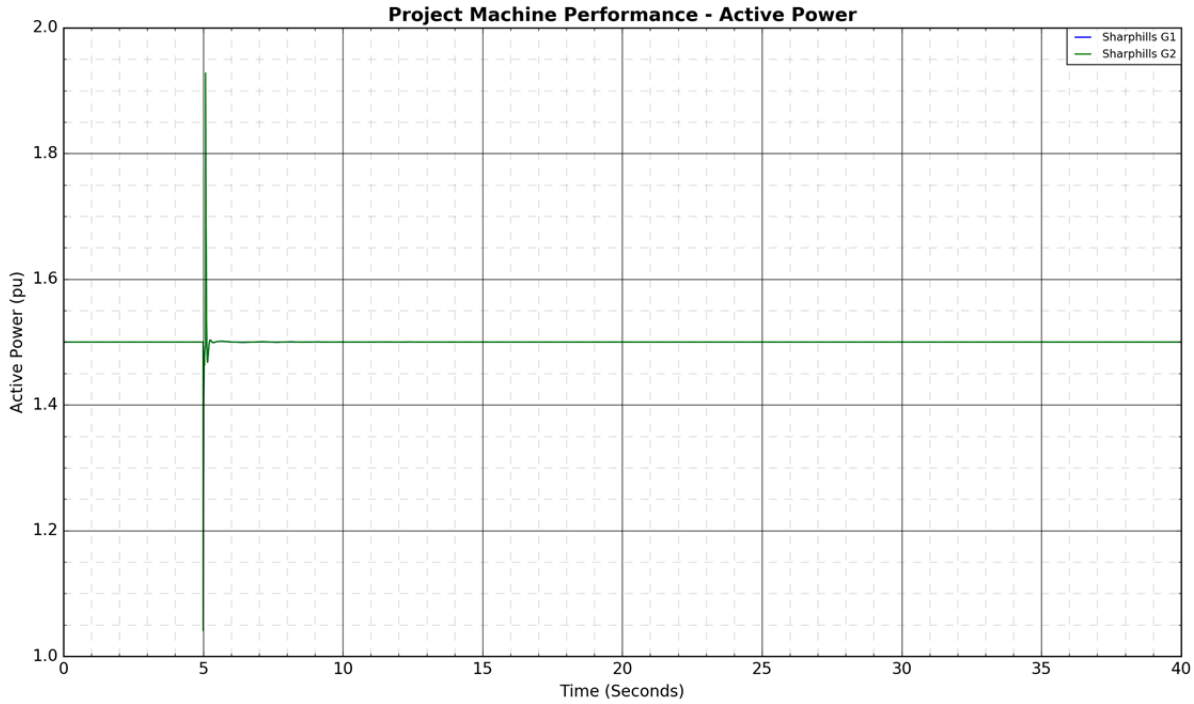


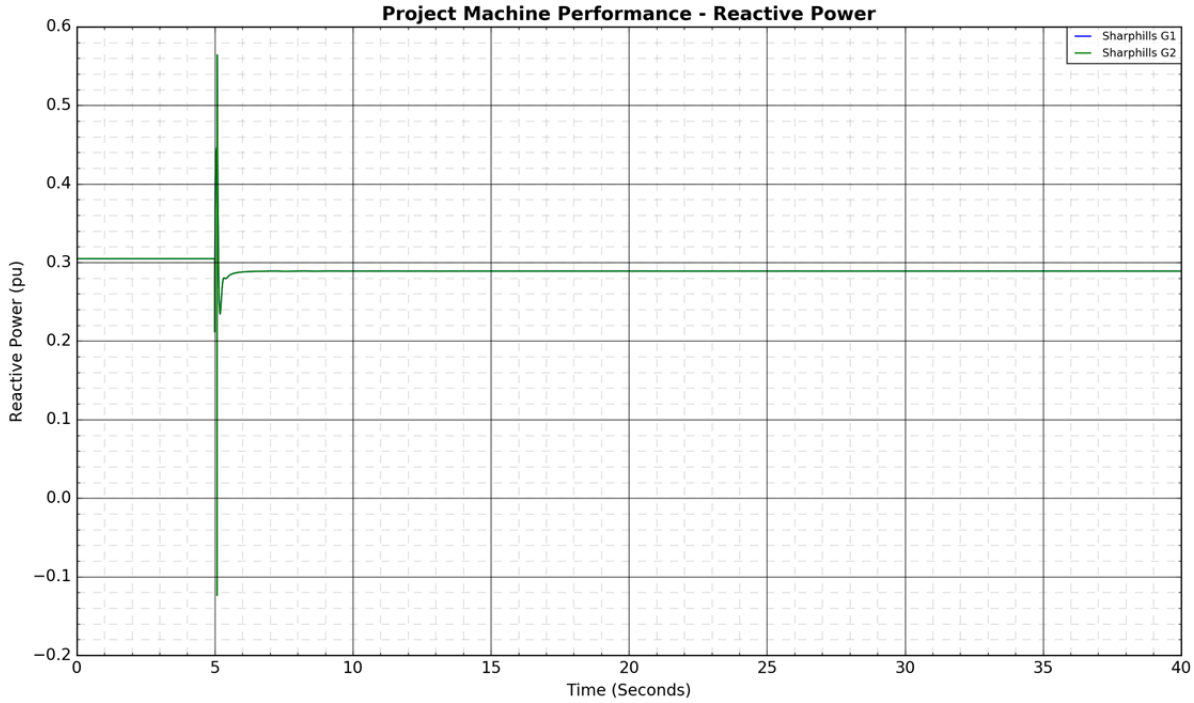

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

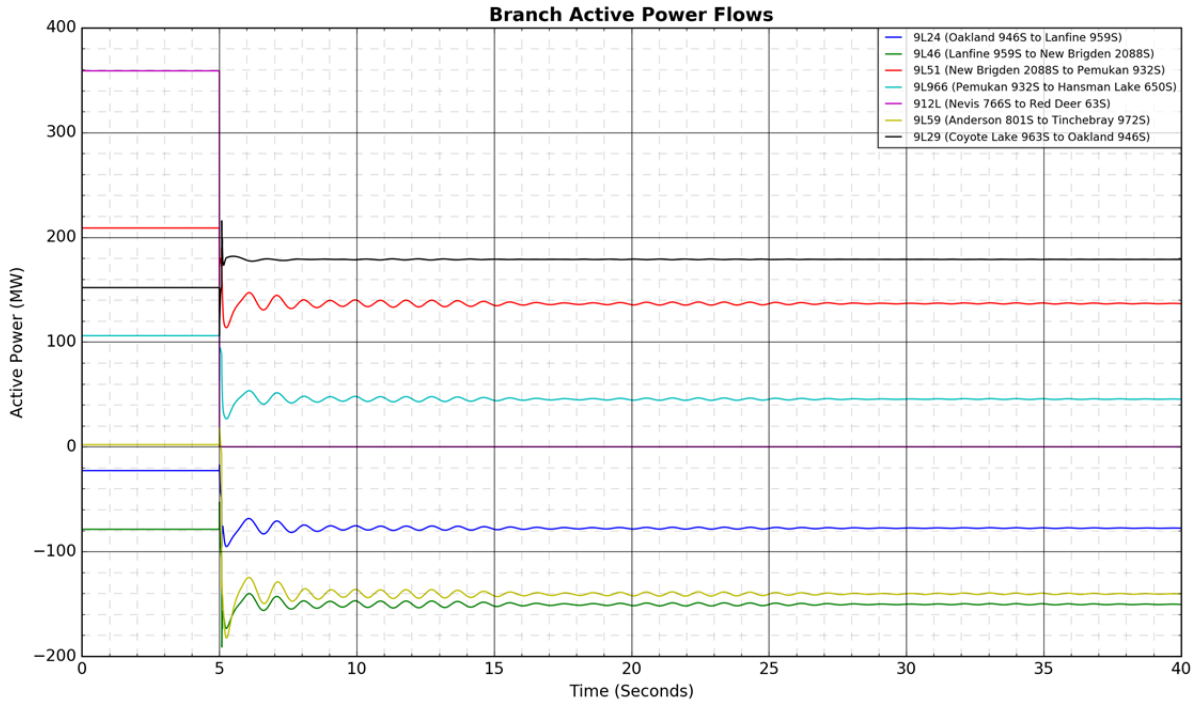

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
Active Power (pu)
Time (Seconds)
2.0
1.8
1.6
1.4
1.2
1.0
0
5
10
15
20
25
30
35
40


Project Machine Performance - Reactive Power
Sharphills G1
Sharphills G2
Reactive Power (pu)
Time (Seconds)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
0
5
10
15
20
25
30
35
40


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

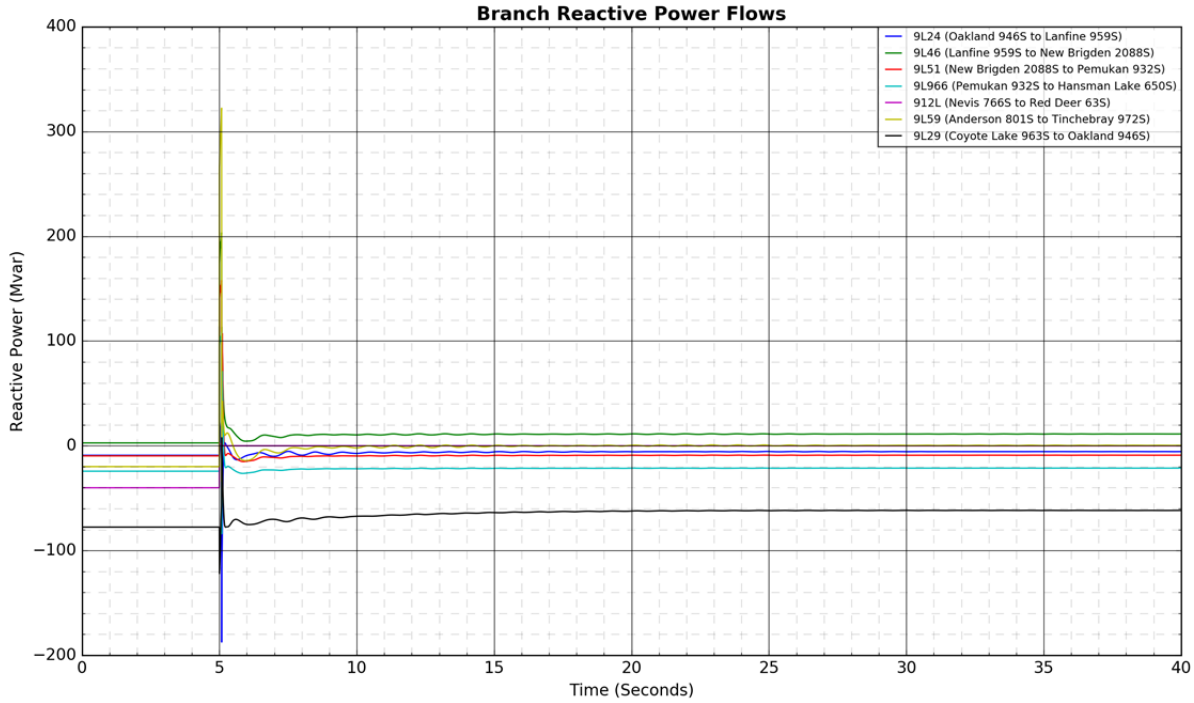
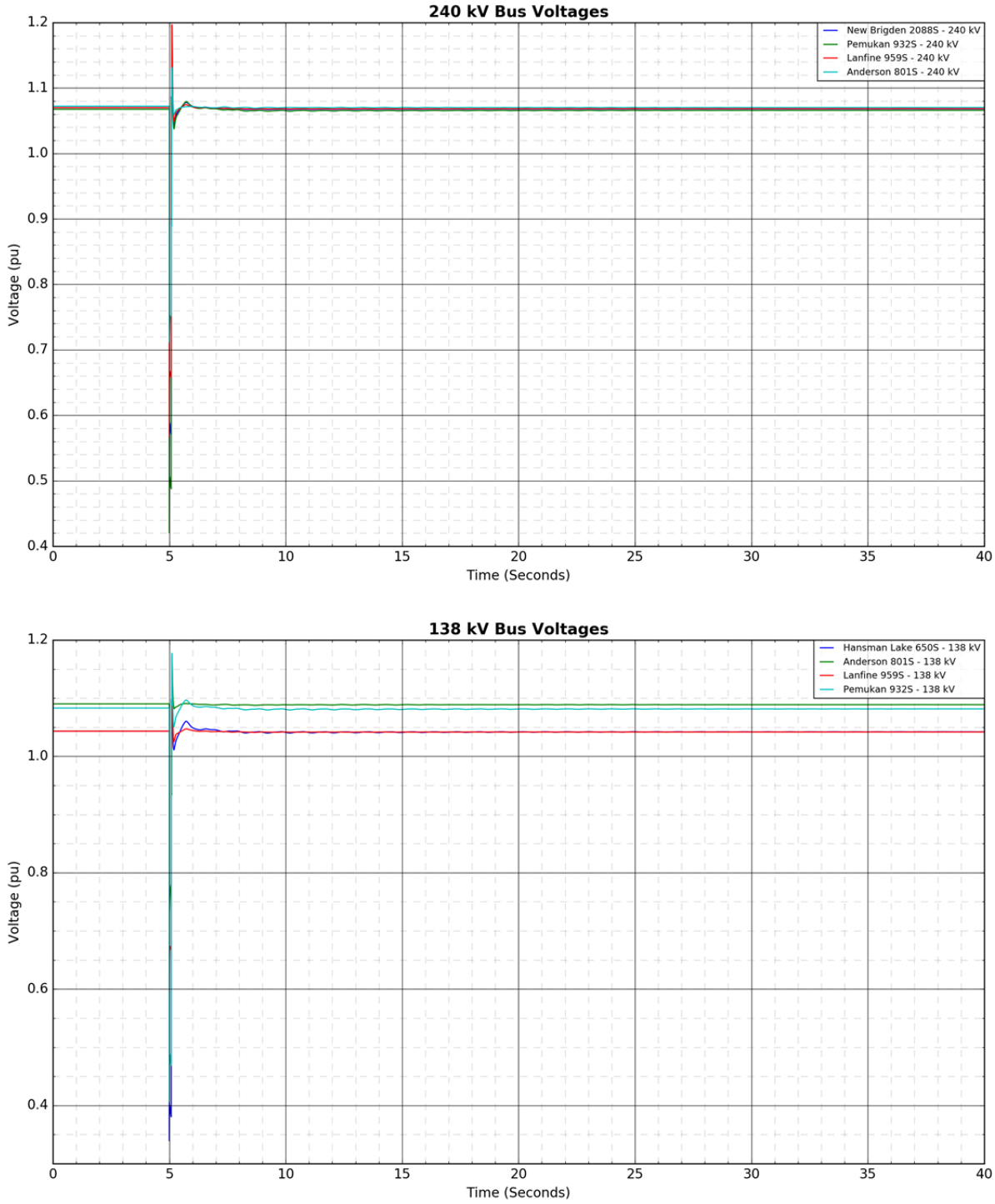
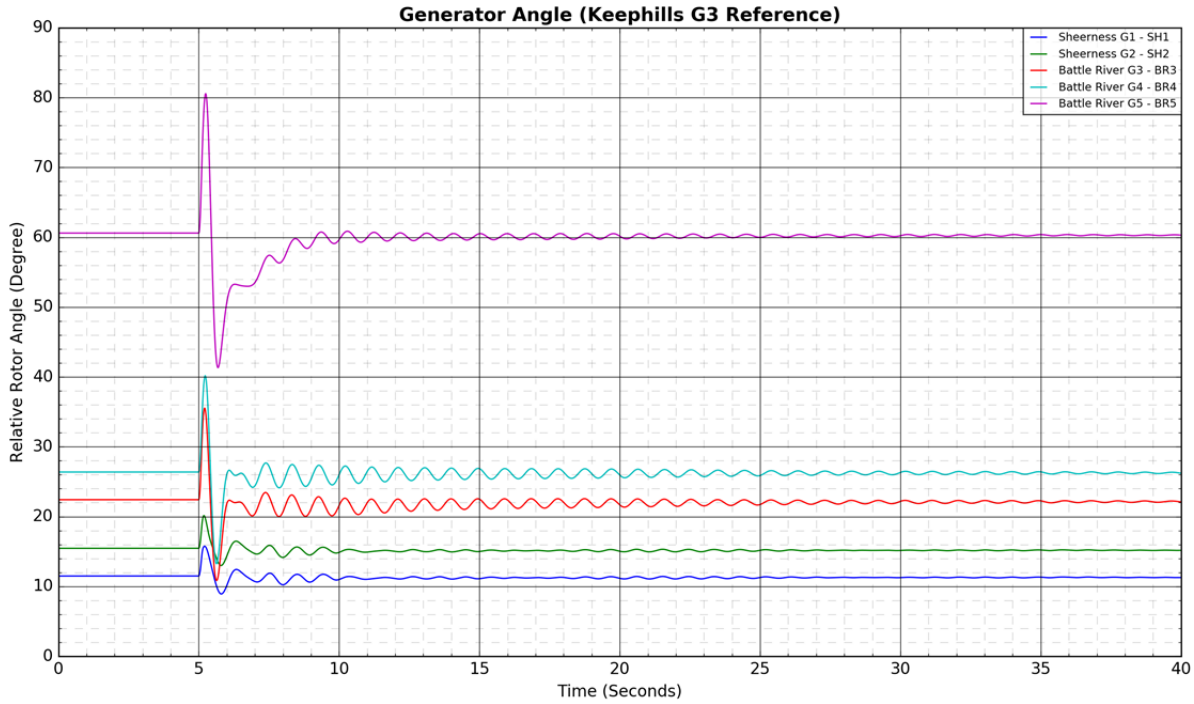
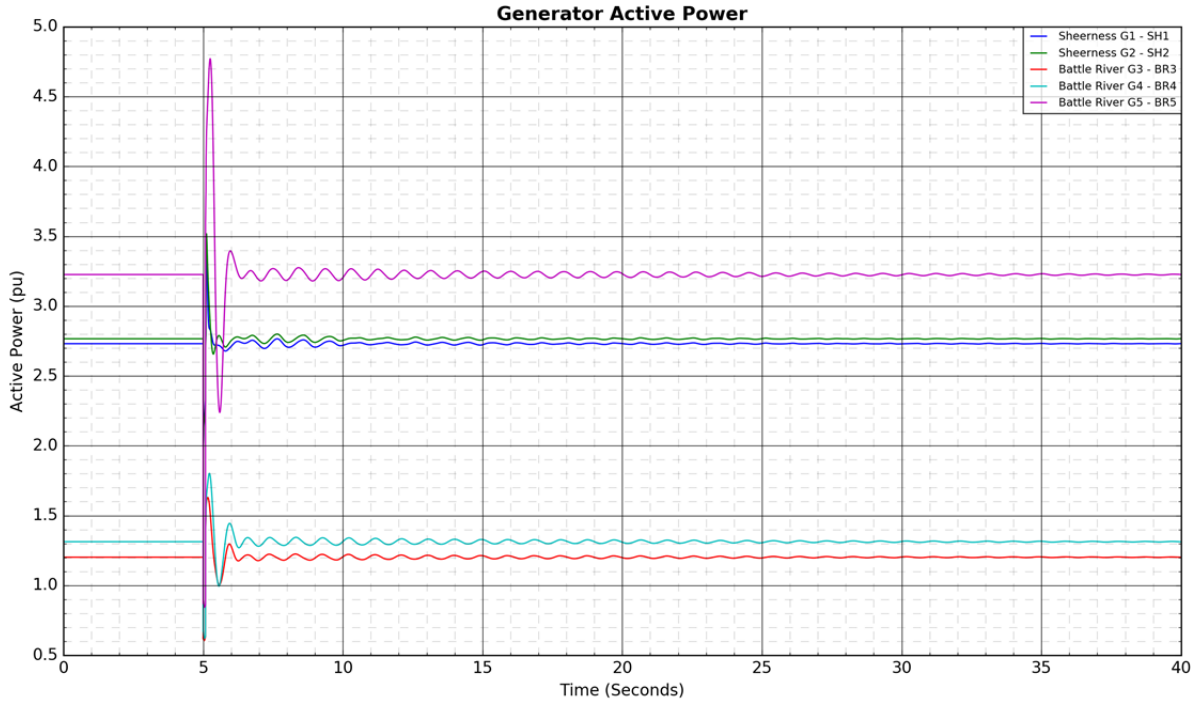
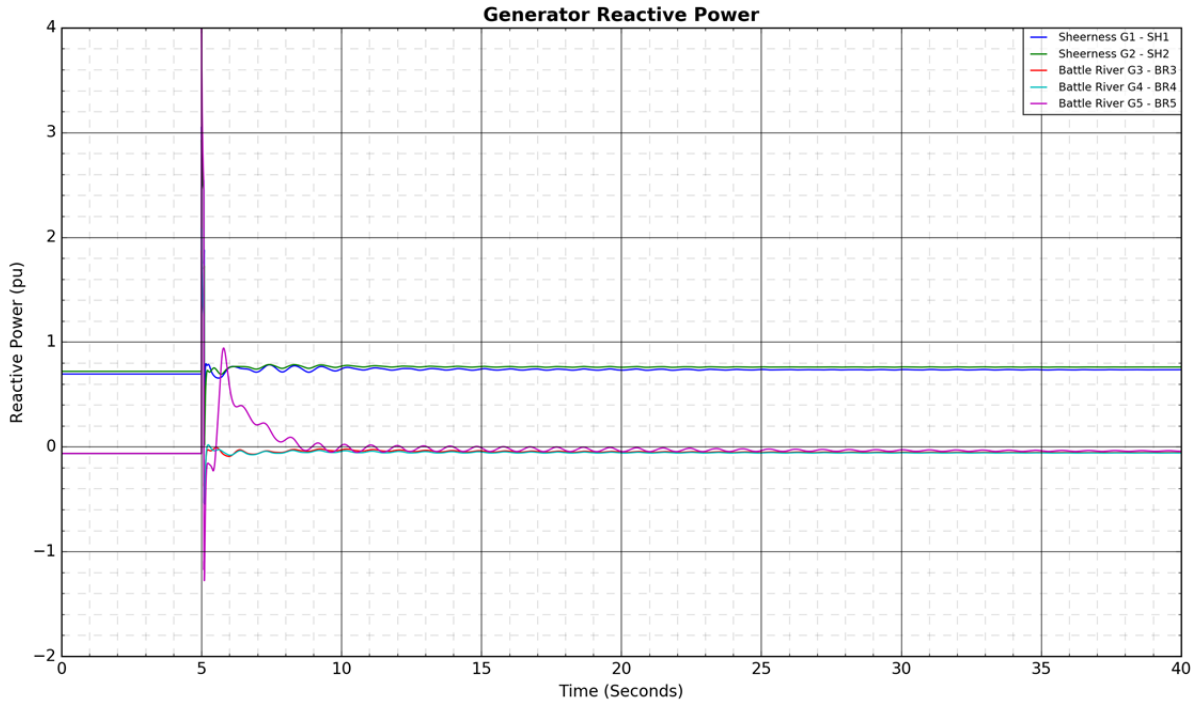

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

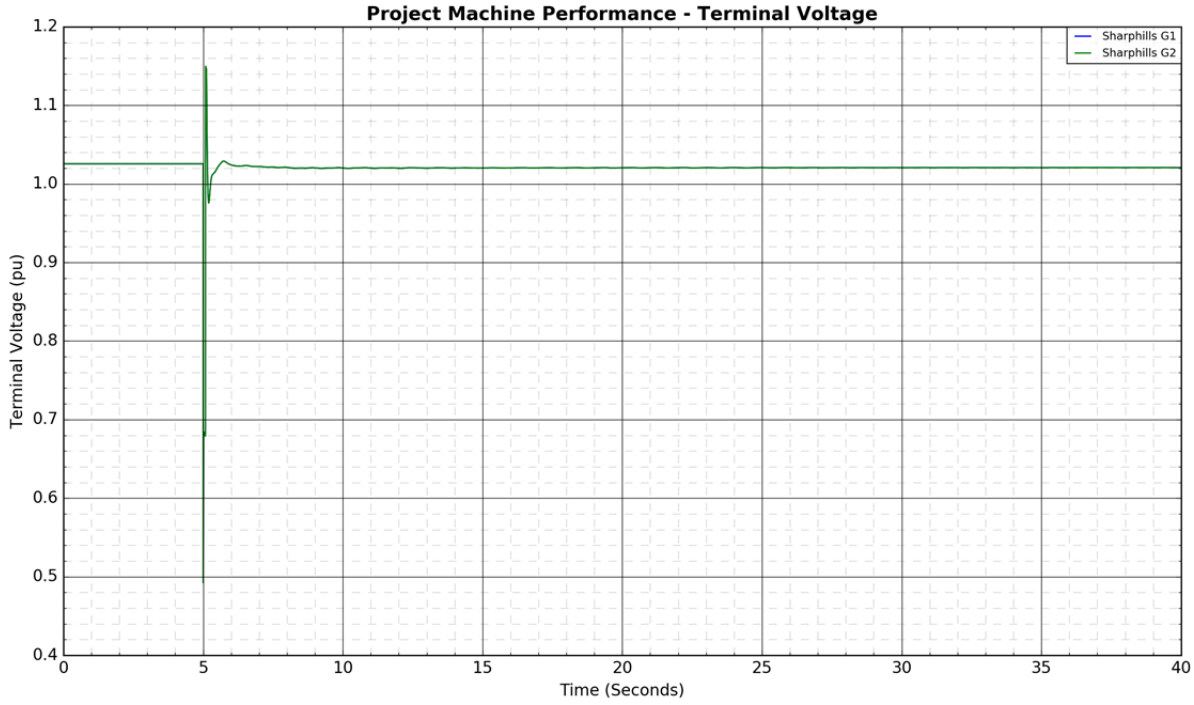
Figure A4-35: 9L59 Anderson 801S to Tinchebray 972S: Fault Near Tinchebray 972S

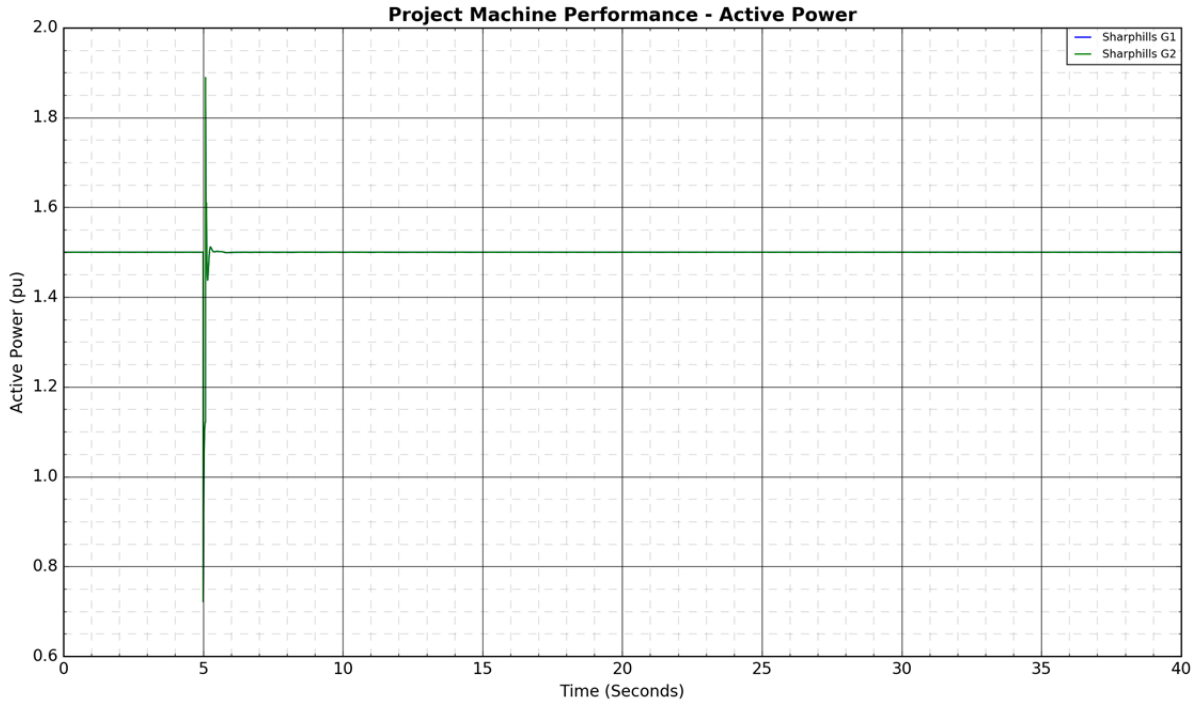


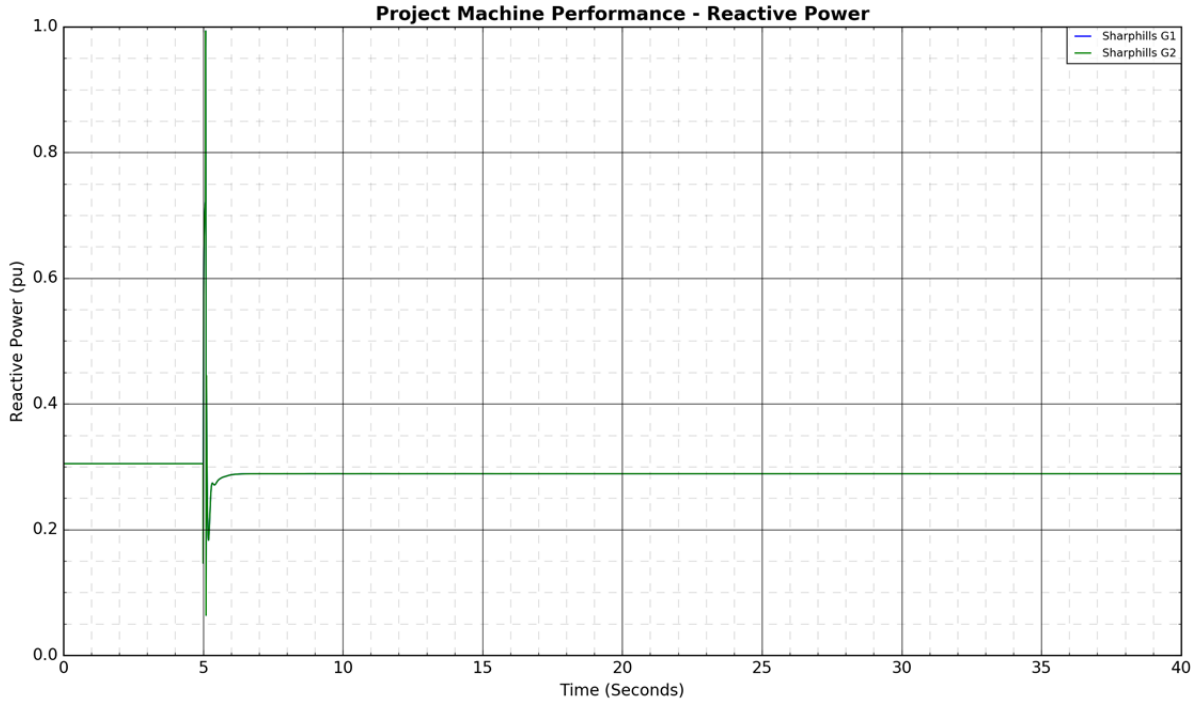

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

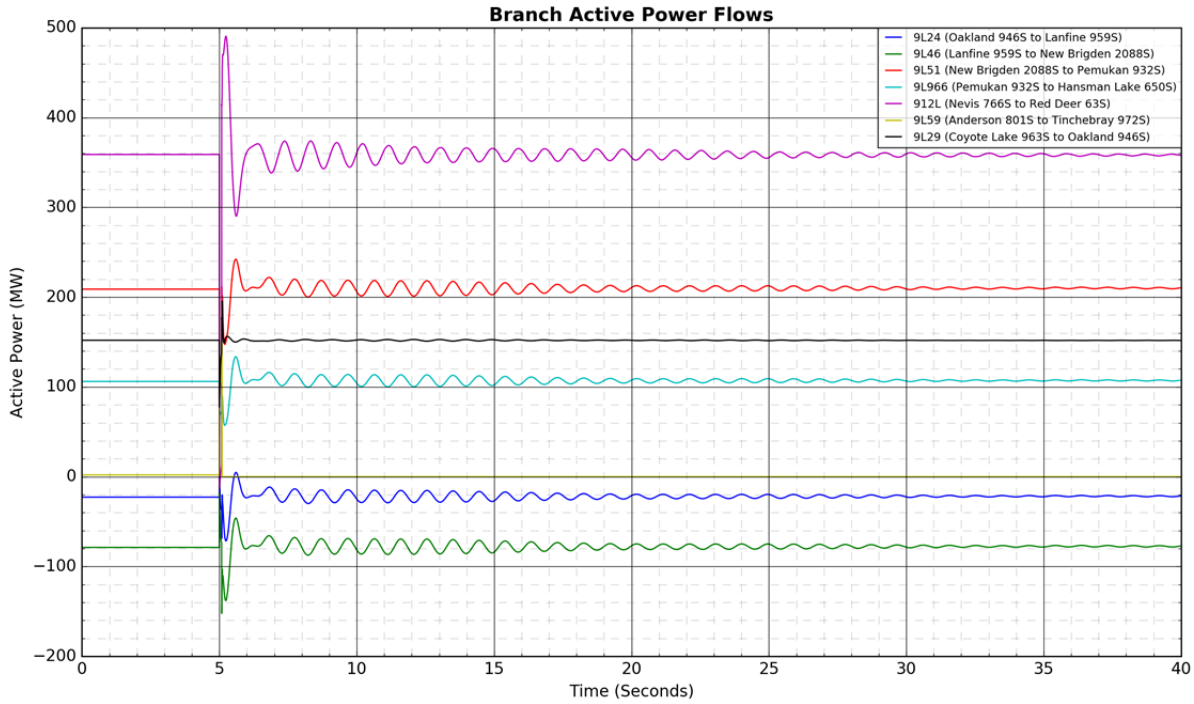

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5


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
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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
Sharphills G1
Sharphills G2
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
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)

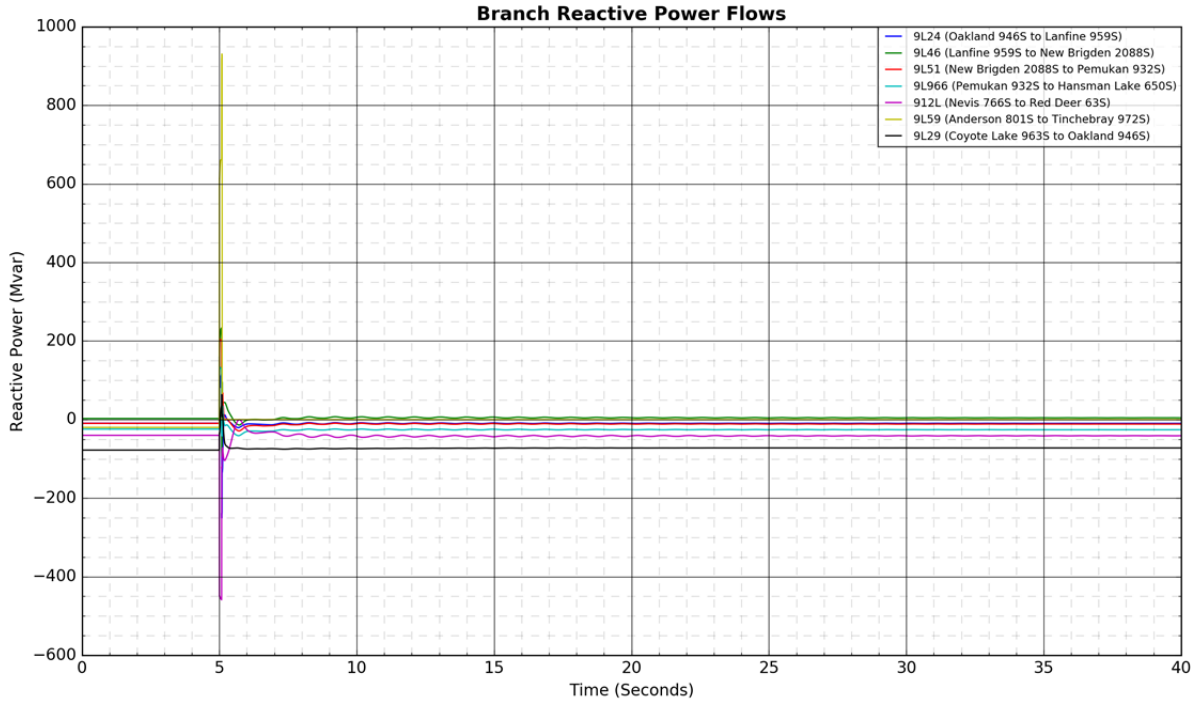
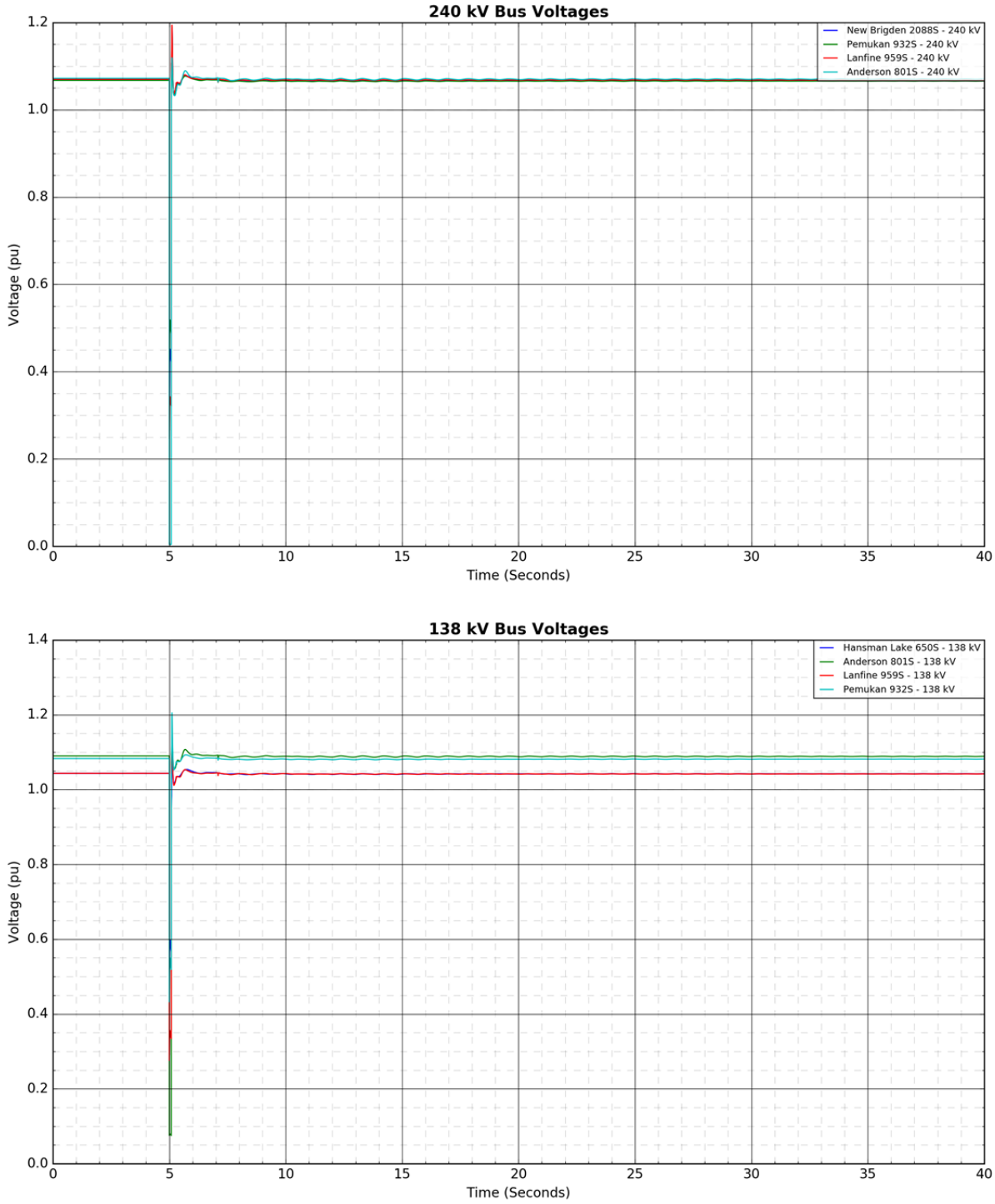
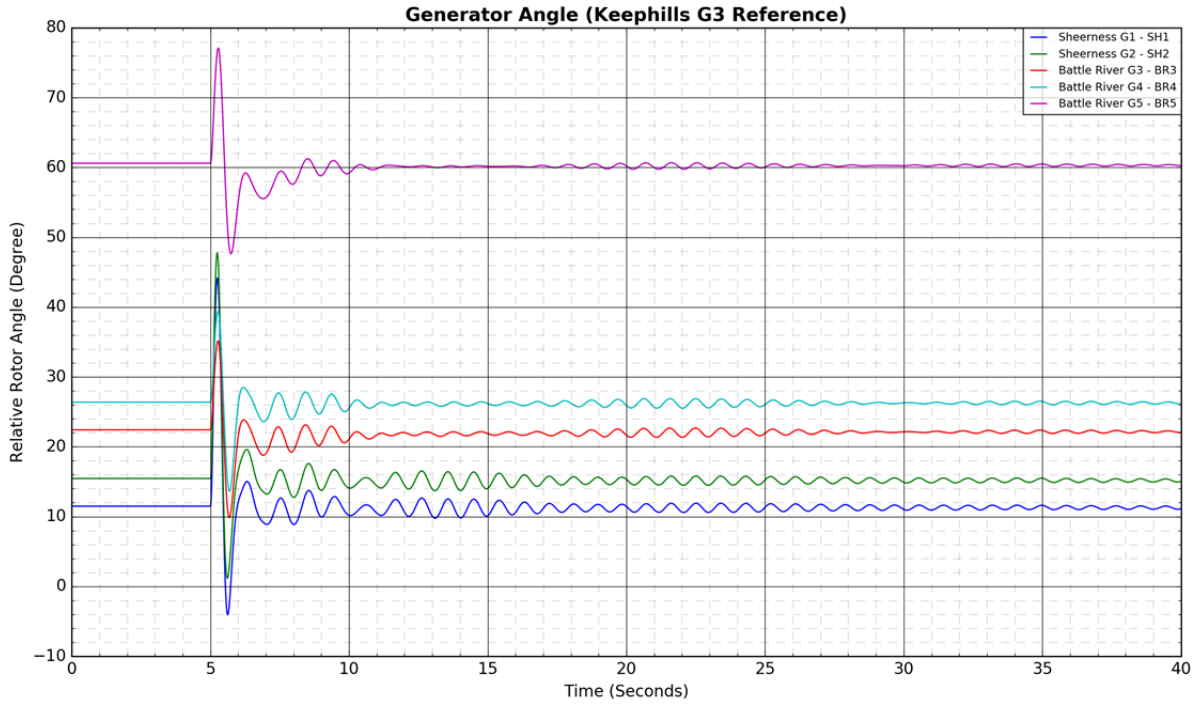
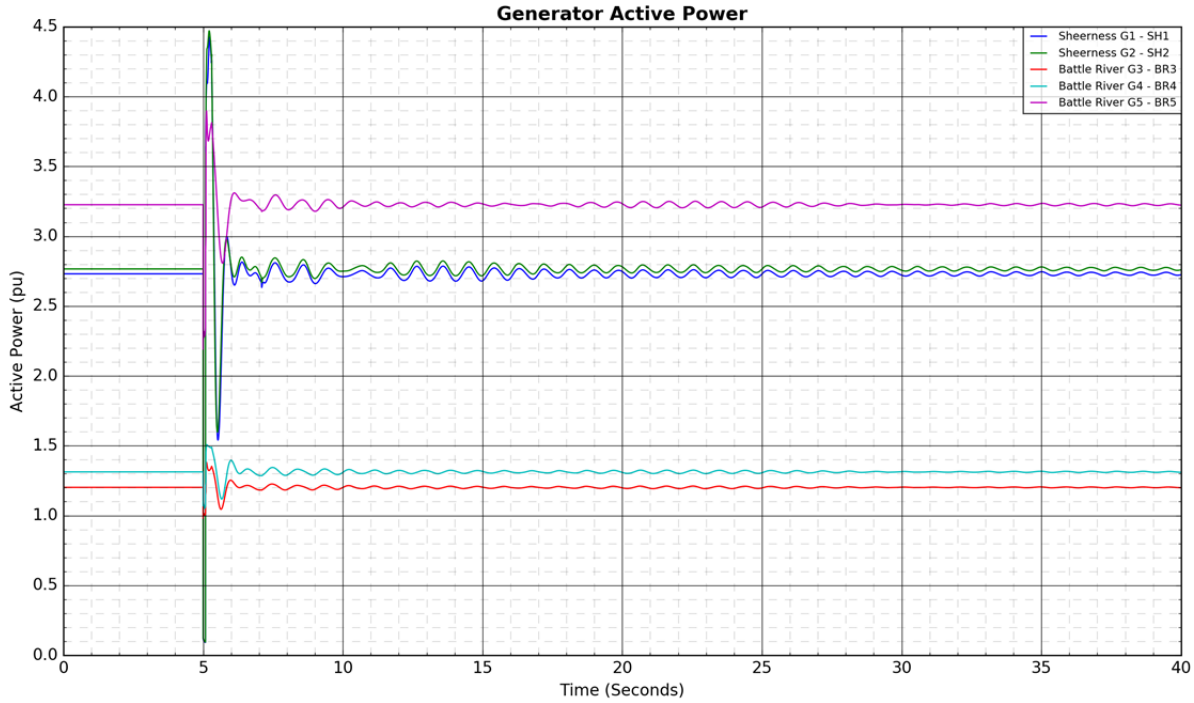
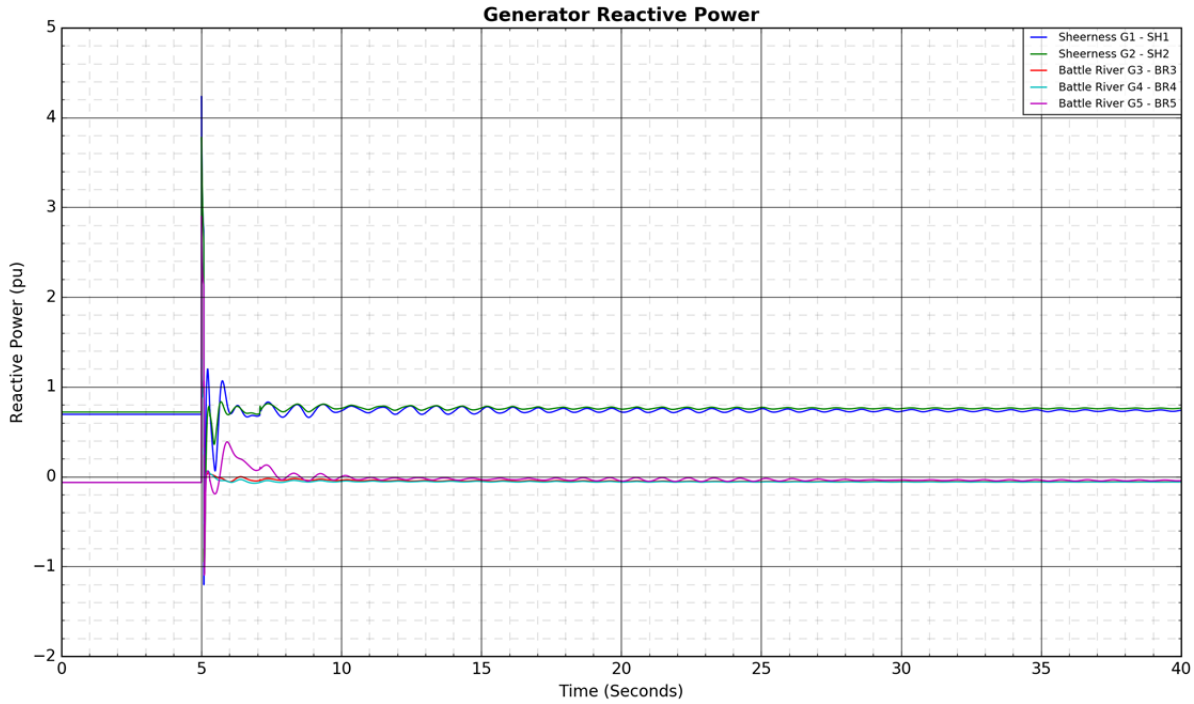

Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Reactive Power (Mvar)
Time (Seconds)

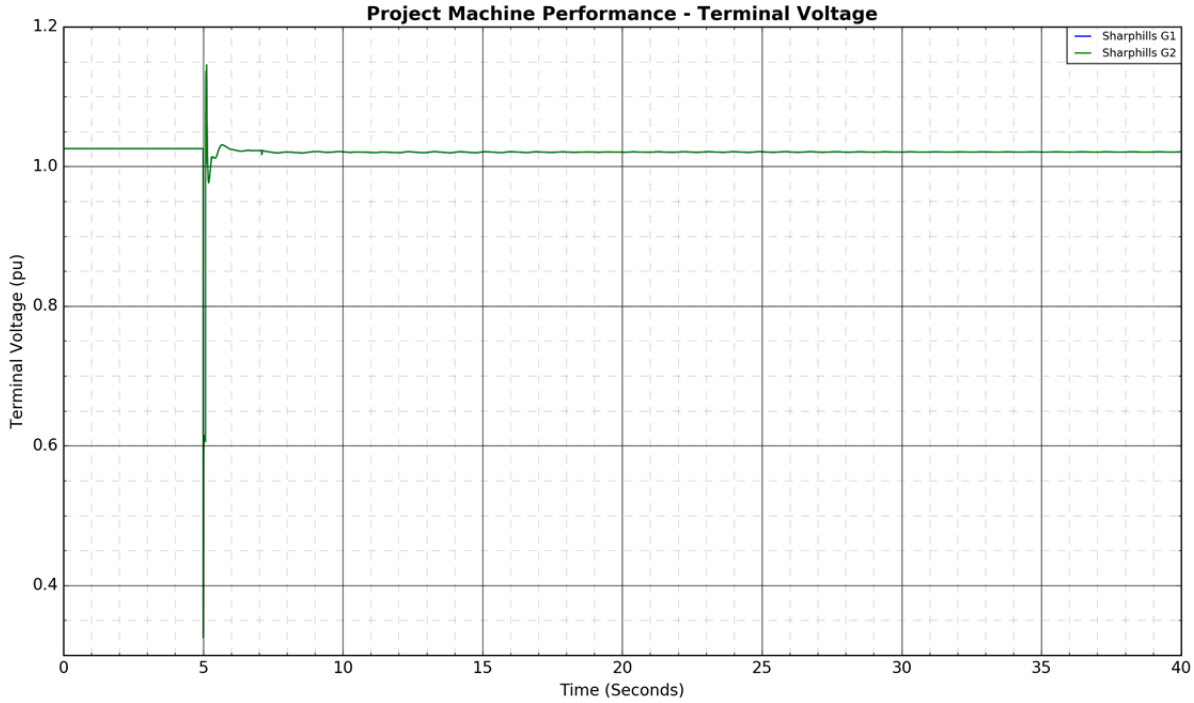
Figure A4-36: 9L59 Anderson 801S to Tinchebray 972S: Fault Near Anderson 801S

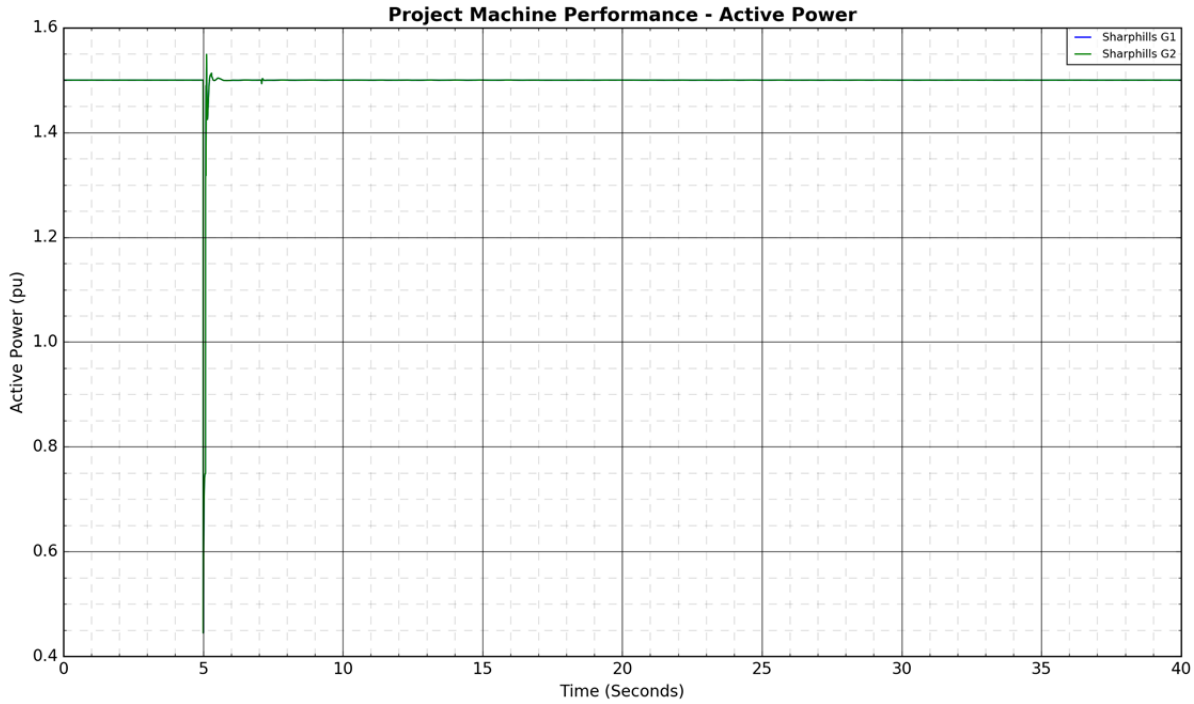


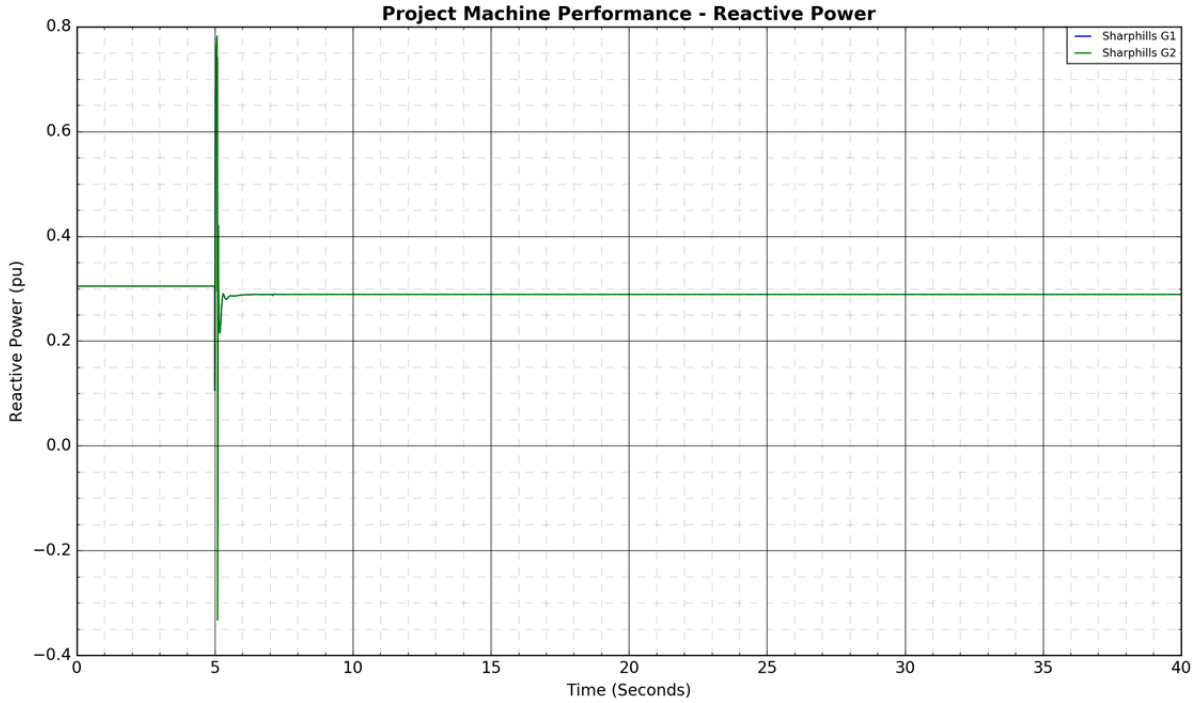

Generator Angle (Keephills G3 Reference)
Relative Rotor Angle (Degree)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

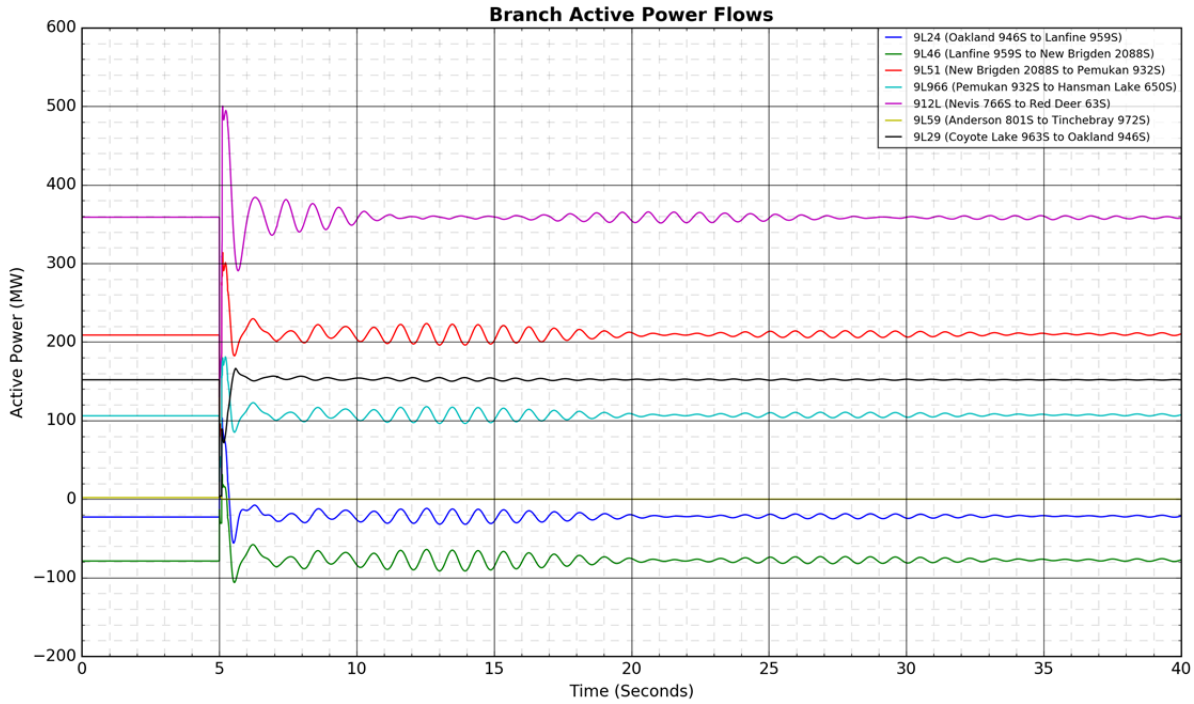

Generator Active Power
Active Power (pu)
Time (Seconds)
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5

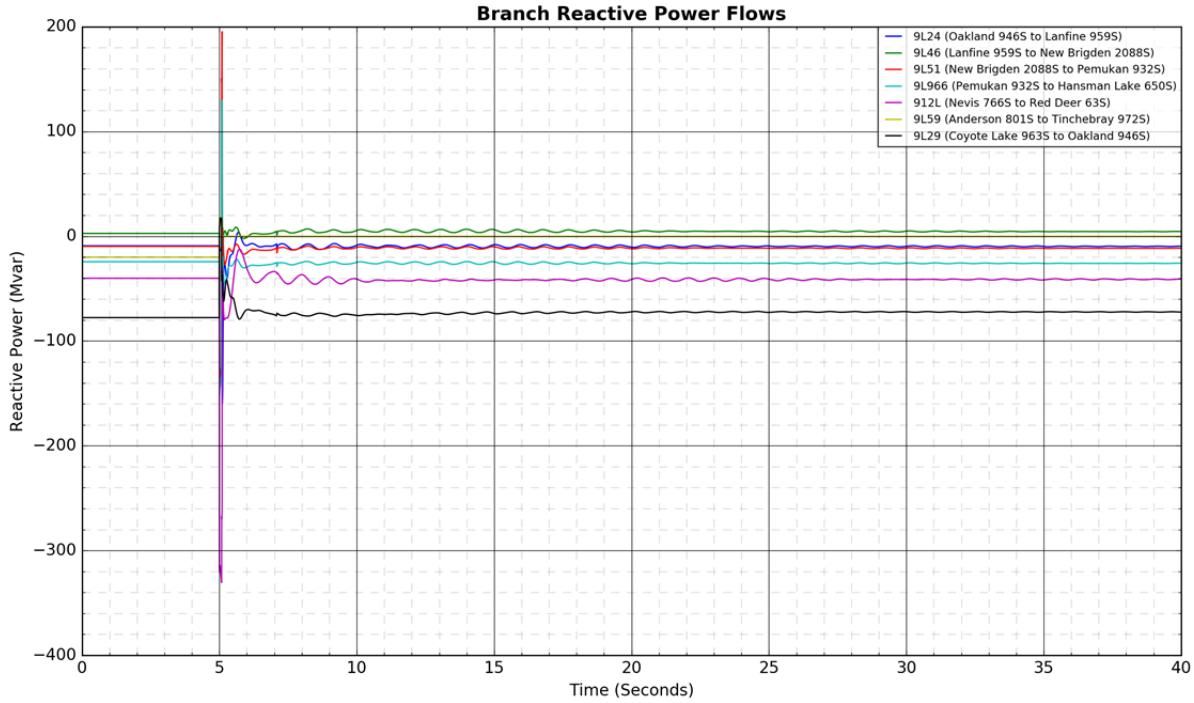

Generator Reactive Power
Sheerness G1 - SH1
Sheerness G2 - SH2
Battle River G3 - BR3
Battle River G4 - BR4
Battle River G5 - BR5
Reactive Power (pu)
Time (Seconds)


Project Machine Performance - Terminal Voltage
Sharphills G1
Sharphills G2
Terminal Voltage (pu)
Time (Seconds)


Project Machine Performance - Active Power
Sharphills G1
Sharphills G2
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
Sharphills G1
Sharphills G2
Reactive Power (pu)
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)


Branch Active Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
Active Power (MW)
Time (Seconds)


Branch Reactive Power Flows
9L24 (Oakland 946S to Lanfine 959S)
9L46 (Lanfine 959S to New Brigden 2088S)
9L51 (New Brigden 2088S to Pemukan 932S)
9L966 (Pemukan 932S to Hansman Lake 650S)
912L (Nevis 766S to Red Deer 63S)
9L59 (Anderson 801S to Tinchebray 972S)
9L29 (Coyote Lake 963S to Oakland 946S)
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

Generic Renewable Energy Generator/Converter Model (REGCAU1)													
Tg	Rrpwr	Brkpt	Zerox	Lvpl1	Volim	Lvpnt1	Lvpnt0	Iolim	Tfltr	Khv	Iqrmax	Iqrmin	Accel
0.02	10.00	0.15	0.06	1.22	1.15	0.20	-999.0	-1.30	0.03	2.0	106.15	-106.2	0.5
Lvplsw													
0													

Table A5-2: Generic Renewable Energy Electrical Control Model

Generic Renewable Energy Electrical Control Model (REECAU1)													
Vdip	Vup	Trv	dbd1	dbd2	Kqv	Iqhl	Iqll	Vref0	Iqfrz	Thld	Thld2	Tp	QMax
0.9	1.1	0	-0.1	0.1	1.98	1.0	-1.0	0	0	0.6	0	0.05	0.5
QMin	VMAX	VMIN	Kqp	Kqi	Kvp	Kvi	Vbias	Tiq	dPmax	dPmin	PMAX	PMIN	Imax
-0.5	1.1	0.9	0	3	18	5	0	0.05	106.2	-10.62	1.05	0.05	1.44
Tpord	Vq1	Iq1	Vq2	Iq2	Vq3	Iq3	Vq4	Iq4	Vp1	Ip1	Vp2	Ip2	Vp3
0.01	0.01	0.27	0.07	0.27	0.15	1	0.3507	1.0	0.08	0.12	0.1	0.39	0.5
Ip3	Vp4	Ip4	Bus	PFFLAG	VFLAG	QFLAG	PFLAG	PQFLAG					
0.39	0.79	1.44	0	0	0	0	0	0					

Table A5-3: Generic Renewable Energy Plant Control Model

Generic Renewable Energy Plant Control Model (REPCAU1)													
Tfltr	Kp	Ki	Tft	Tfv	Vfrz	Rc	Xc	Kc	emax	emin	dbd1	dbd2	Qmax
0.03	1.0	6.6667	0	0	0.85	0	0	0.05	999	-999	-0.01	0.01	0.6
Qmin	Kpg	Kig	Tp	Fdbd1	Fdbd2	femax	femin	Pmax	Pmin	Tg	Ddn	Dup	Bus
-0.6	0.4	2.6667	0.03	0	0	999	-999	1.1	0	0.10	0	0	0
FromBus	ToBus	ID	VCFlag	RefFlag	Fflag								
0	0	0	0	0	0								

Attachment A6

Post-Mitigation Power Flow Diagrams

List of Figures

Scenario and Case Name	Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Figure Number
2018 Summer Light Post-Project Case A	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-1
		7L159 (Ghost Tap to Heatburg 948S)	
		7L16 (Nevis 766S to Heatburg 948S)	
		7L85 (Bullpound 803S to Anderson 801S)	
		7L85 (Wintering Hills 804S to Bullpound 803S)	
2018 Summer Light Post-Project Case B	766S901T (Nevis 766S Transformer 901T)	174L (Bardo 197S to North Holden 395S)	Figure A6-2
	912L_9L912 (Red Deer 63S to Nevis 766S)	174L (Bardo 197S to North Holden 395S)	Figure A6-3
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-4
		7L159 (Ghost Tap to Heatburg 948S)	
		7L16 (Nevis 766S to Heatburg 948S)	
		7L85 (Bullpound 803S to Anderson 801S)	
		7L85 (Wintering Hills 804S to Bullpound 803S)	
2018 Summer Peak Post-Project Case A	267ST1 (Killarney Lake 267S Transformer T1)	7L129 (Buffalo Creek 526S to Bauer Tap)	Figure A6-5
		7L50 (Buffalo Creek 526S to Jarrow Tap)	
	766S901T (Nevis 766S Transformer 901T)	701L (North Holden 395S to Strome 223S)	Figure A6-6
		701L (Strome 223S to Heisler Tap)	
		7L50 (Buffalo Creek 526S to Jarrow Tap)	
		7L701 (Heisler Tap to Battle River 757S)	
	7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)	7L50 (Buffalo Creek 526S to Jarrow Tap)	Figure A6-7
	7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)	7L50 (Buffalo Creek 526S to Jarrow Tap)	Figure A6-8
	899ST3A (Edgerton 899S Transformer T3A)	7L50 (Buffalo Creek 526S to Jarrow Tap)	Figure A6-9
	912L_9L912 (Red Deer 63S to Nevis 766S)	701L (North Holden 395S to Strome 223S)	Figure A6-10

Scenario and Case Name	Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Figure Number
		701L (Strome 223S to Heisler Tap)	
		7L50 (Buffalo Creek 526S to Jarrow Tap)	
		7L701 (Heisler Tap to Battle River 757S)	
	9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-11
		7L50 (Buffalo Creek 526S to Jarrow Tap)	
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-12
		7L159 (Ghost Tap to Heatburg 948S)	
		7L16 (Nevis 766S to Heatburg 948S)	
		7L85 (Bullpound 803S to Anderson 801S)	
		7L85 (Wintering Hills 804S to Bullpound 803S)	
	EATL (Newell 2075S to Heathfield 2029S)	7L50 (Buffalo Creek 526S to Jarrow Tap)	Figure A6-13
2018 Summer Peak Post-Project Case B	267ST1 (Killarney Lake 267S Transformer T1)	7L129 (Bauer Tap to Vermilion 710S)	Figure A6-14
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	377ST1 (Hardisty 377S Transformer T1)	7L129 (Buffalo Creek 526S to Bauer Tap)	Figure A6-15
	701L (North Holden 395S to Strome 223S)	7L129 (Bauer Tap to Vermilion 710S)	Figure A6-16
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	766S901T (Nevis 766S Transformer 901T)	174L (Bardo 197S to North Holden 395S)	Figure A6-17
		701L (North Holden 395S to Strome 223S)	
		701L (Strome 223S to Heisler Tap)	
		7L701 (Heisler Tap to Battle River 757S)	
		7L129 (Bauer Tap to Vermilion 710S)	
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	7L42 (Hill 751S to Lloydminster 716S)	7L129 (Bauer Tap to Vermilion 710S)	Figure A6-18

Scenario and Case Name	Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Figure Number
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)	7L129 (Bauer Tap to Vermilion 710S)	Figure A6-19
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)	7L129 (Bauer Tap to Vermilion 710S)	Figure A6-20
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	7L77 (North Holden 395S to Vegreville 709S)	7L129 (Buffalo Creek 526S to Bauer Tap)	Figure A6-21
	899ST3A (Edgerton 899S Transformer T3A)	7L129 (Bauer Tap to Vermilion 710S)	Figure A6-22
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	912L_9L912 (Red Deer 63S to Nevis 766S)	174L (Bardo 197S to North Holden 395S)	Figure A6-23
		701L (North Holden 395S to Strome 223S)	
		701L (Strome 223S to Heisler Tap)	
		7L701 (Heisler Tap to Battle River 757S)	
		7L129 (Bauer Tap to Vermilion 710S)	
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-24
		7L129 (Bauer Tap to Vermilion 710S)	
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-25
		7L159 (Ghost Tap to Heatburg 948S)	
		7L16 (Nevis 766S to Heatburg 948S)	
		7L85 (Bullpound 803S to Anderson 801S)	
		7L85 (Wintering Hills 804S to Bullpound 803S)	
	EATL (Newell 2075S to Heathfield 2029S)	7L129 (Bauer Tap to Vermilion 710S)	Figure A6-26

Scenario and Case Name	Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Figure Number
		7L129 (Buffalo Creek 526S to Bauer Tap)	
2018 Winter Peak Post-Project Case A	9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-27
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-28
2018 Winter Peak Post-Project Case B	267ST1 (Killarney Lake 267S Transformer T1)	7L129 (Buffalo Creek 526S to Bauer Tap)	Figure A6-29
	766S901T (Nevis 766S Transformer 901T)	7L129 (Bauer Tap to Vermilion 710S)	Figure A6-30
		7L129 (Buffalo Creek 526S to Bauer Tap)	
	912L_9L912 (Red Deer 63S to Nevis 766S)	7L129 (Buffalo Creek 526S to Bauer Tap)	Figure A6-31
	9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-32
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	Figure A6-33

Figure A6-1 : 2018 Summer Light Post-Project Case A - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

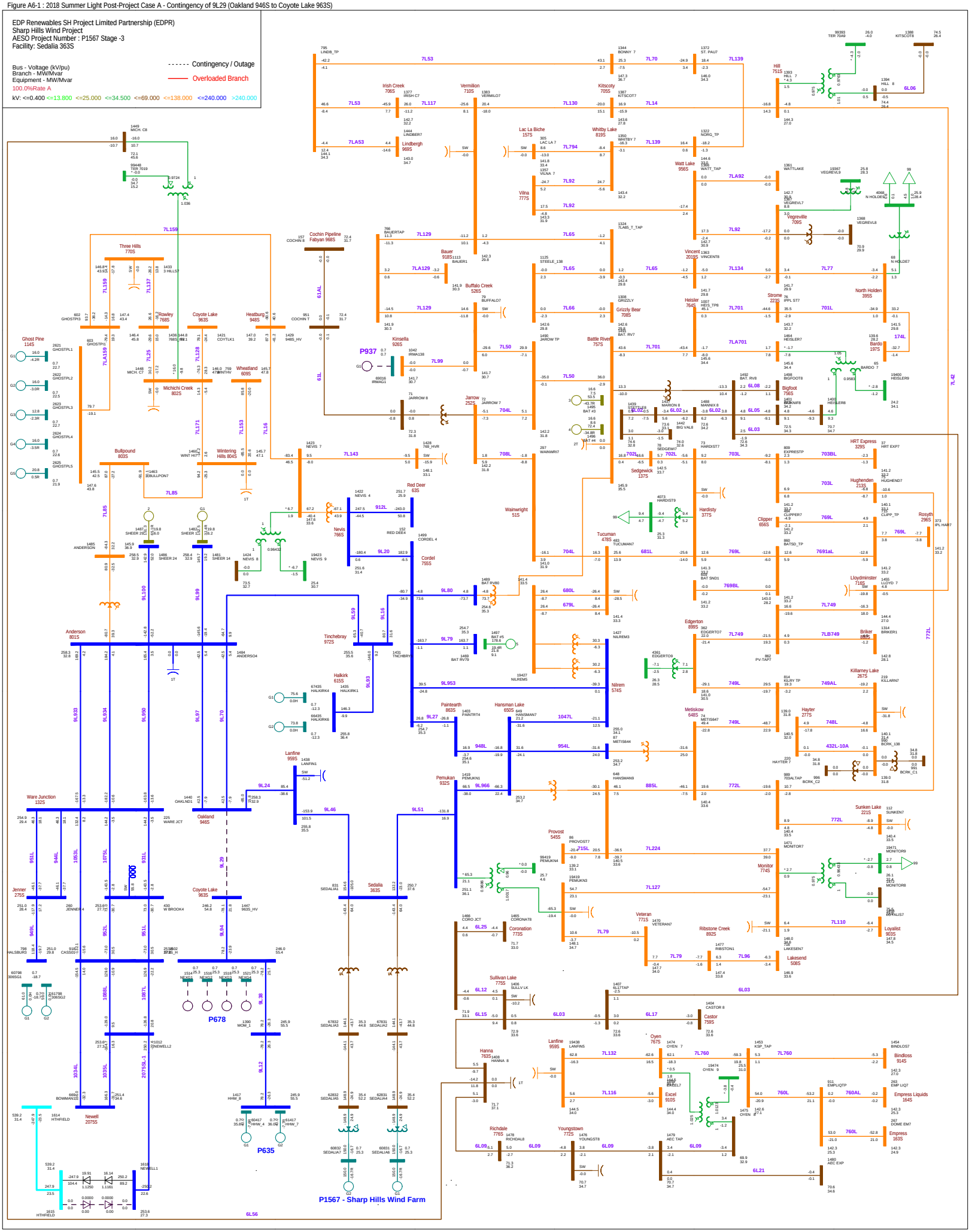


Figure A6-2 : 2018 Summer Light Post-Project Case B - Contingency of 766S901T (Nevis 766S Transformer 901T)

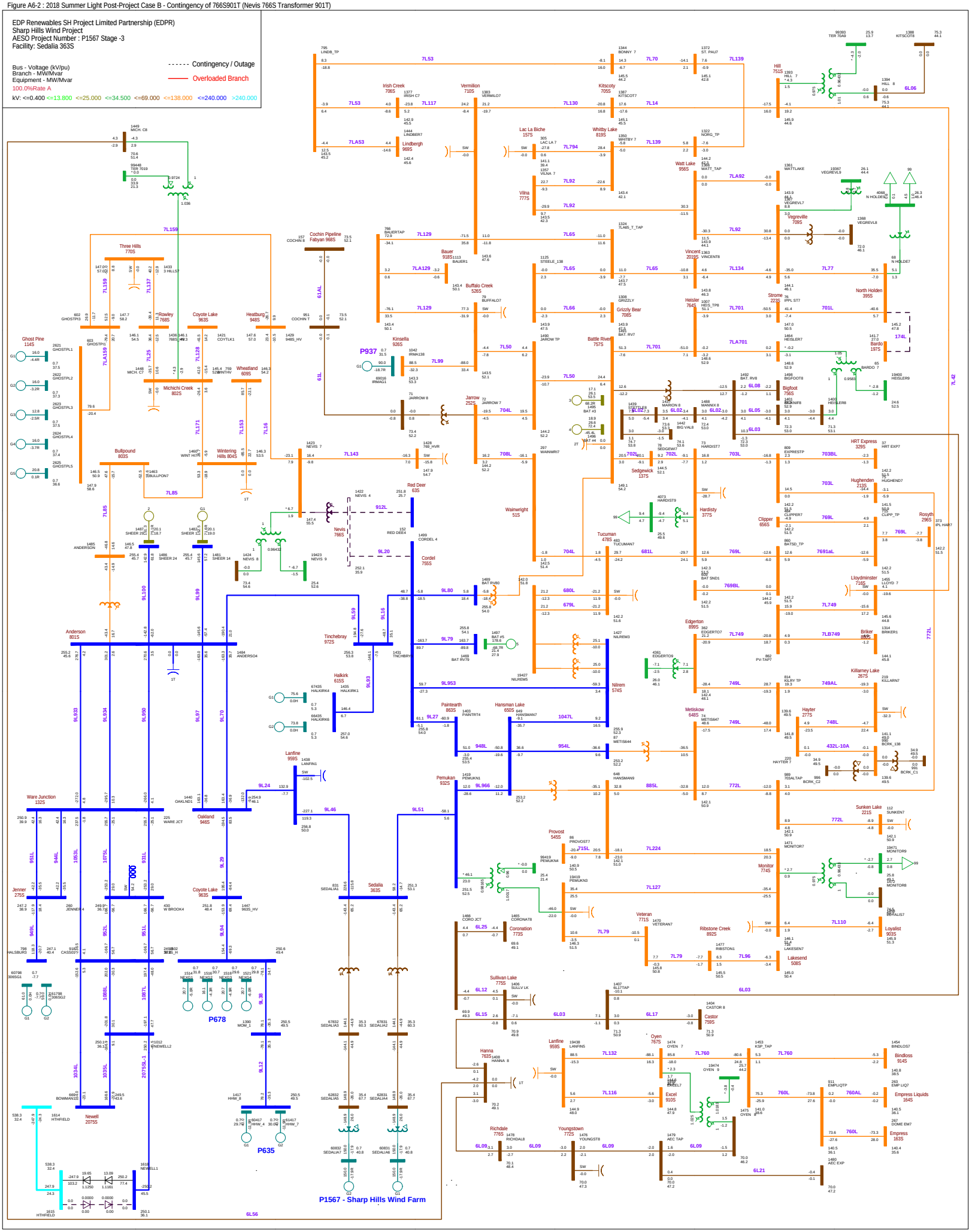


Figure A6-3 : 2018 Summer Light Post-Project Case B - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

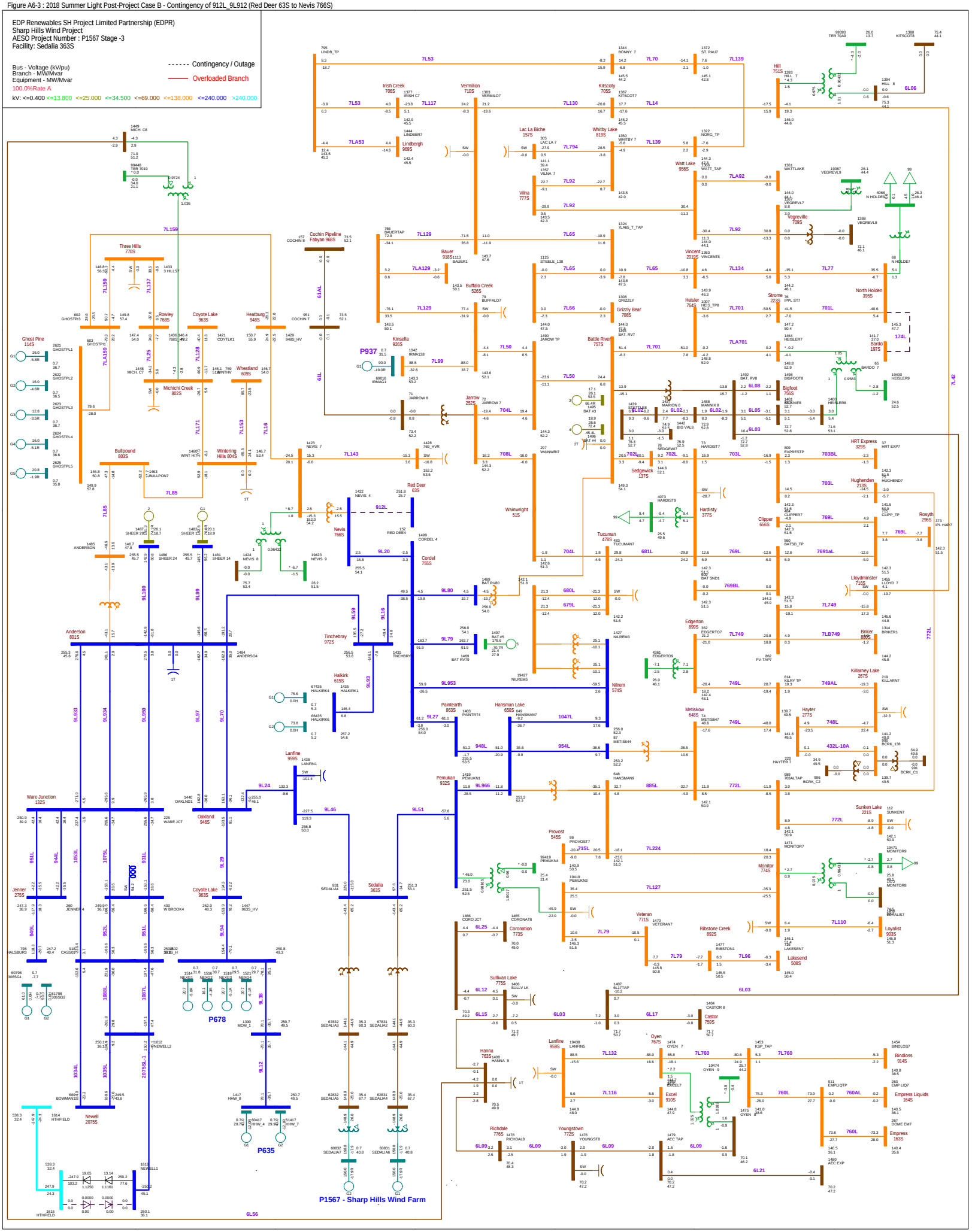


Figure A6-4 : 2018 Summer Light Post-Project Case B - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

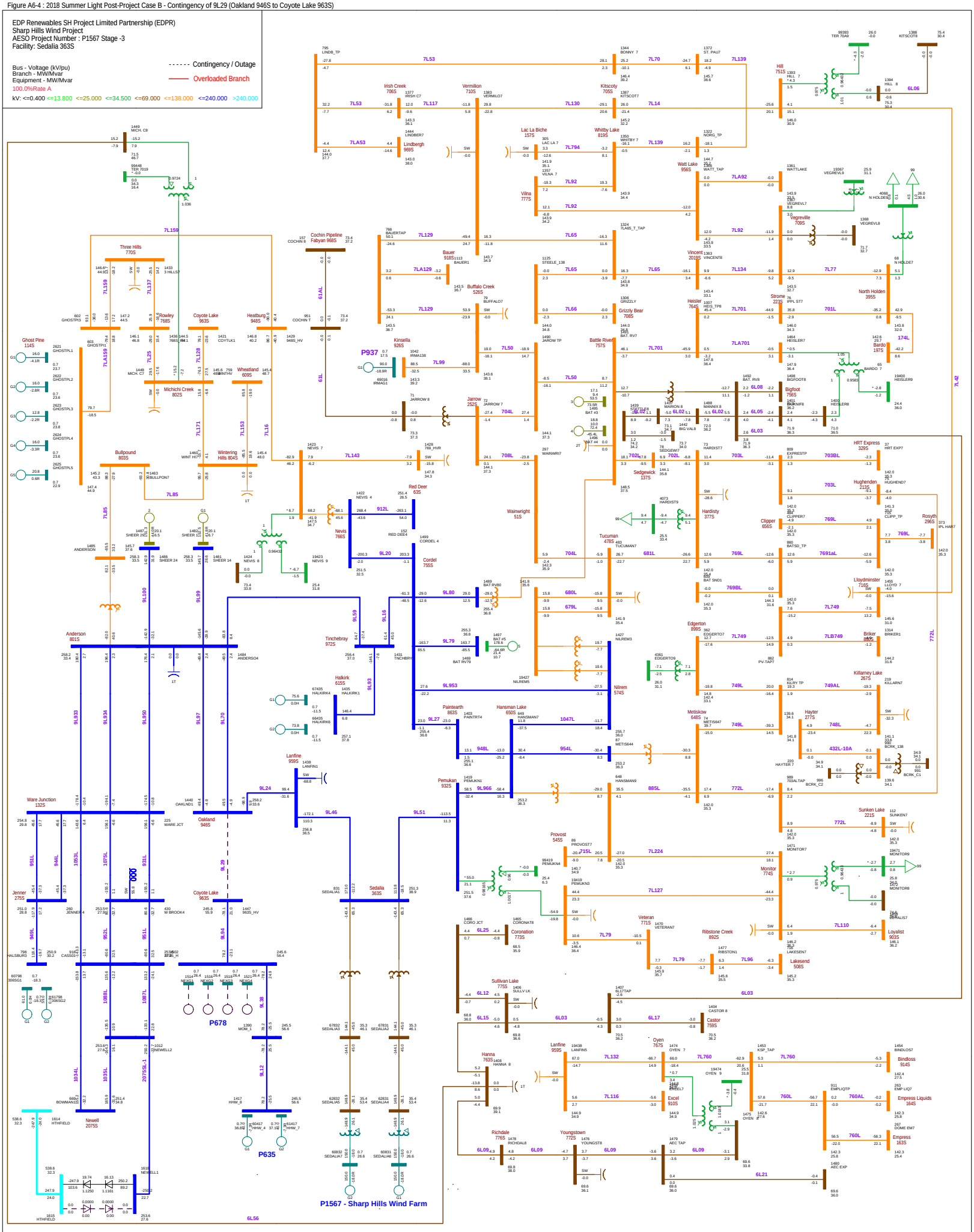


Figure A6-5 : 2018 Summer Peak Post-Project Case A - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

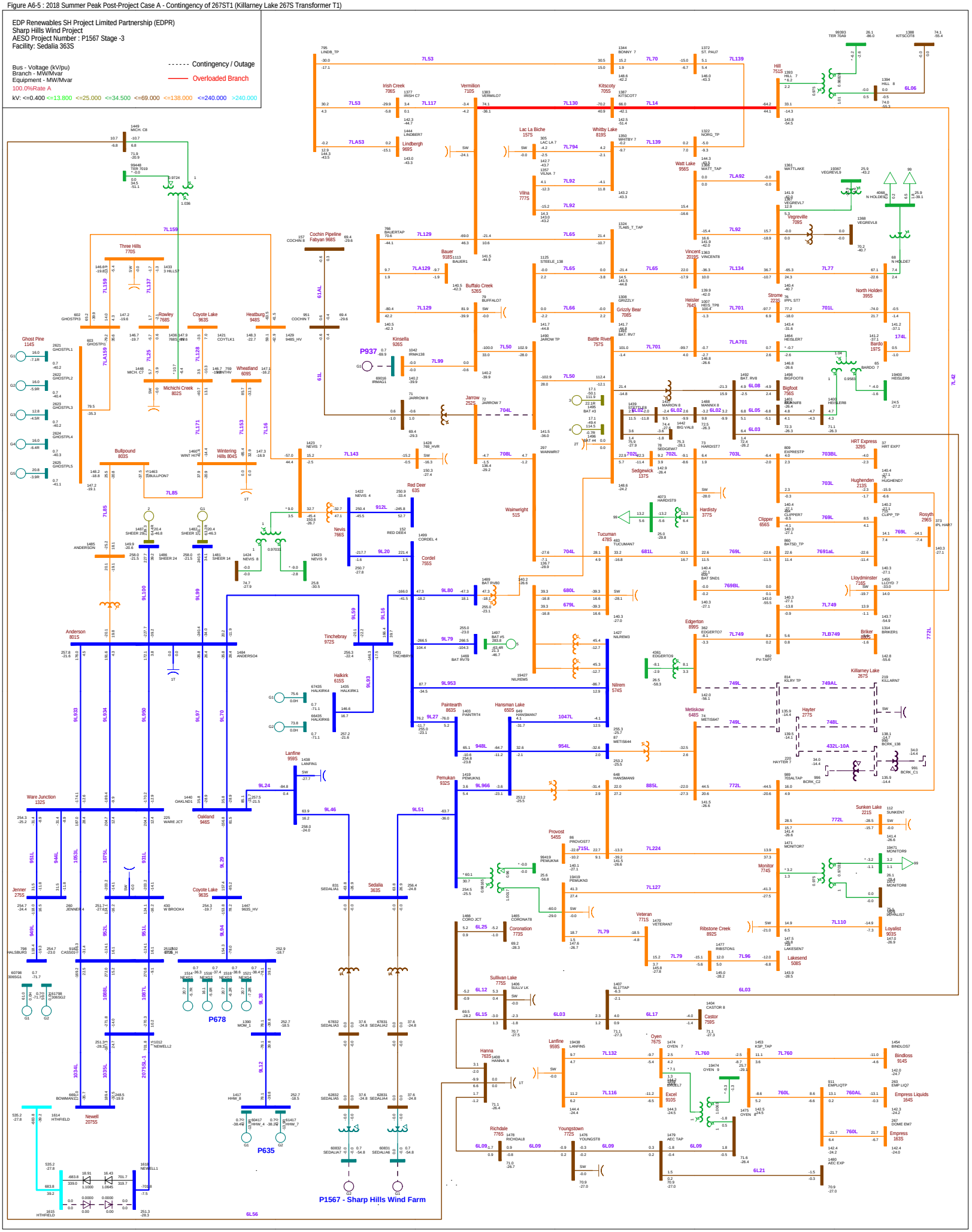


Figure A6-6 : 2018 Summer Peak Post-Project Case A - Contingency of 766S901T (Nevis 766S Transformer 901T)

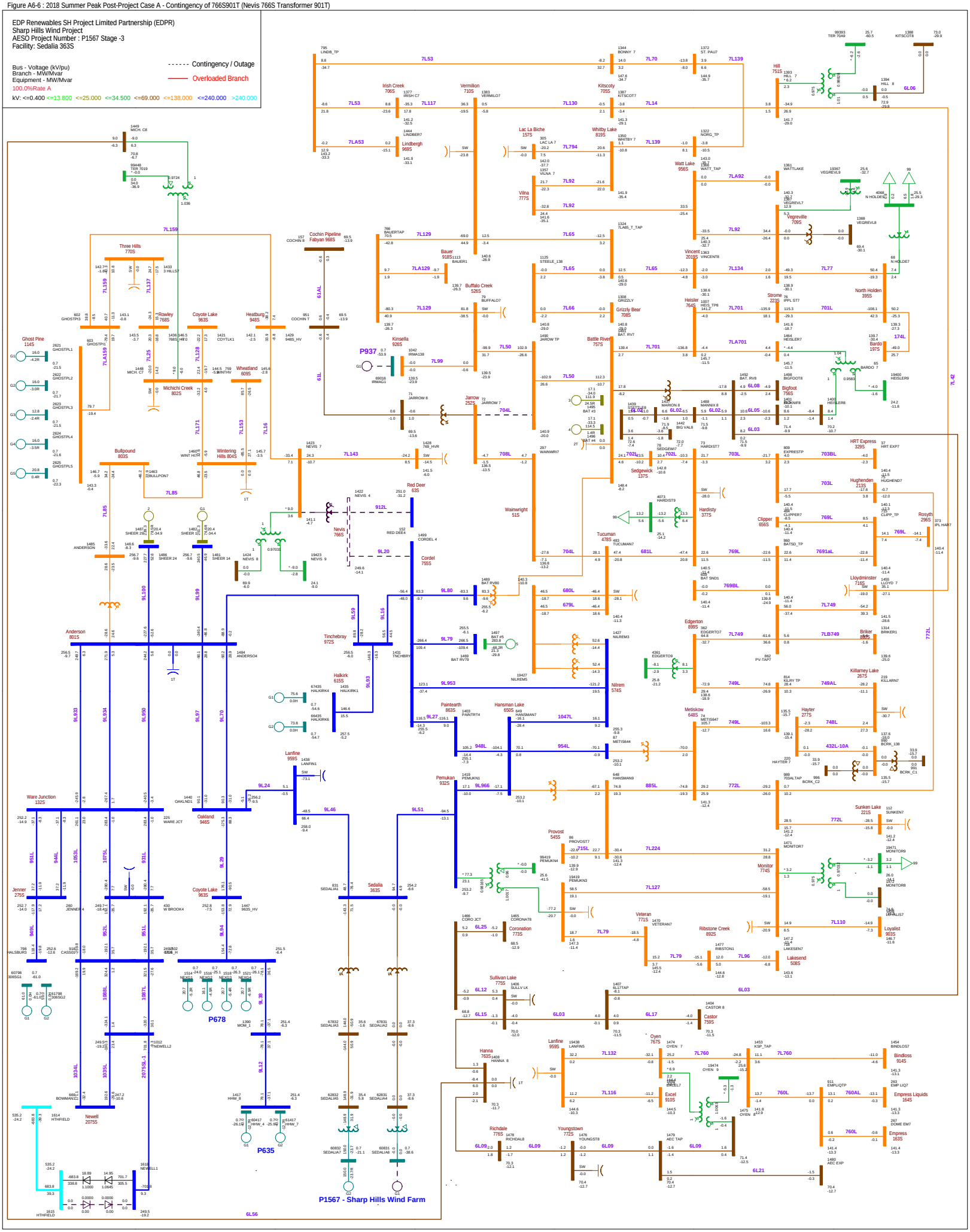


Figure A6-7 : 2018 Summer Peak Post-Project Case A - Contingency of 7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)

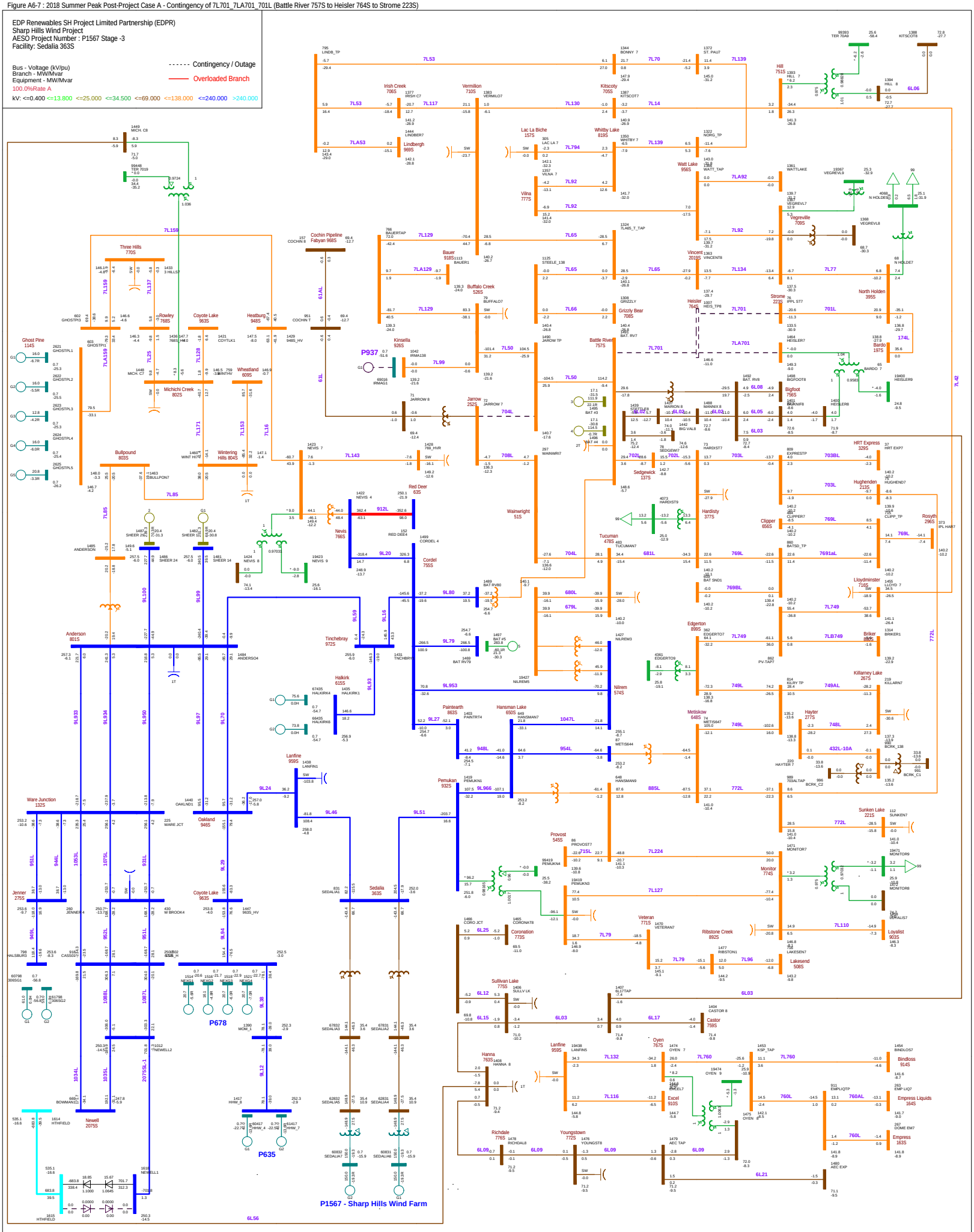


Figure A6-8 : 2018 Summer Peak Post-Project Case A - Contingency of 7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)

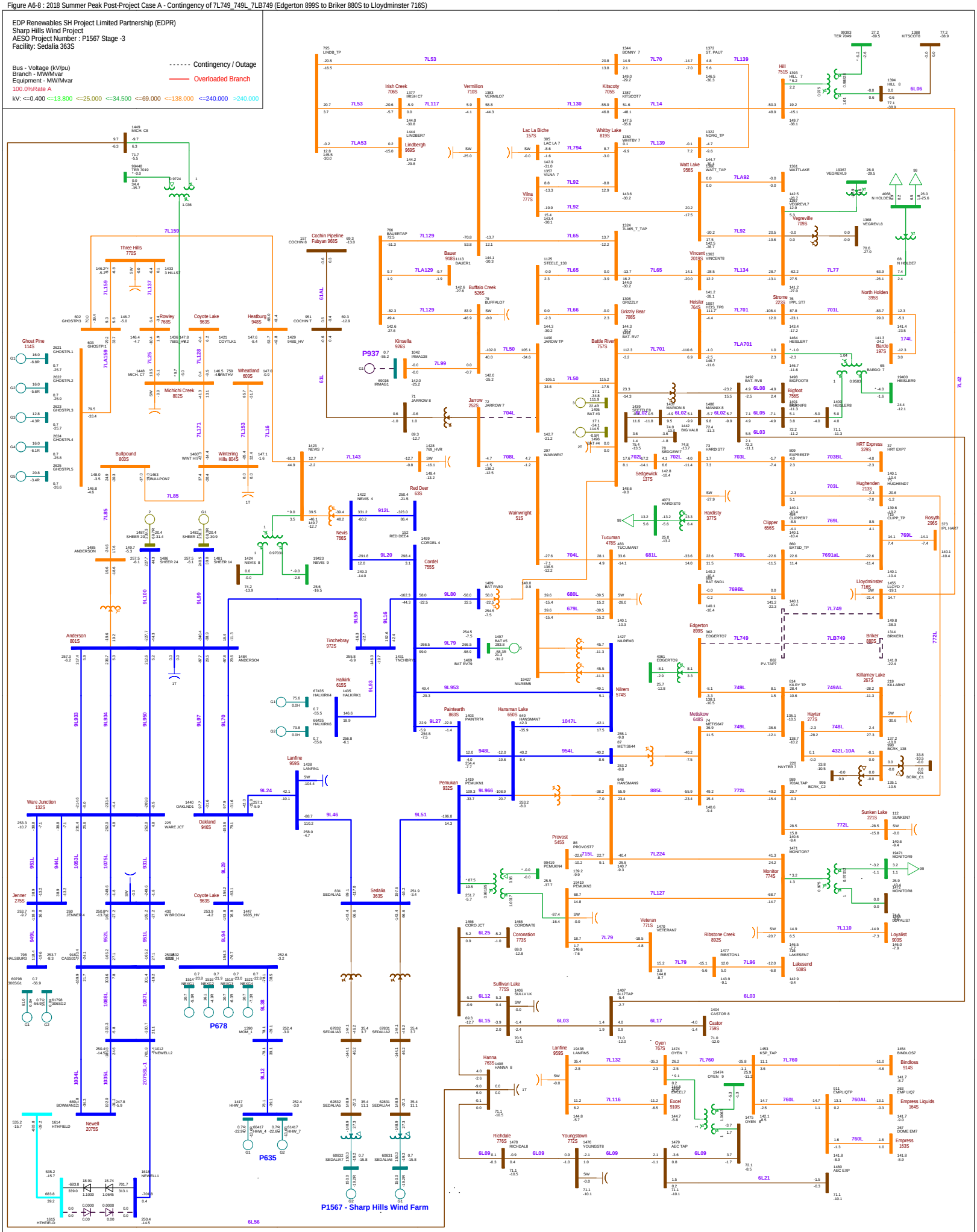


Figure A6-9 : 2018 Summer Peak Post-Project Case A - Contingency of 899ST3A (Edgerton 899S Transformer T3A)

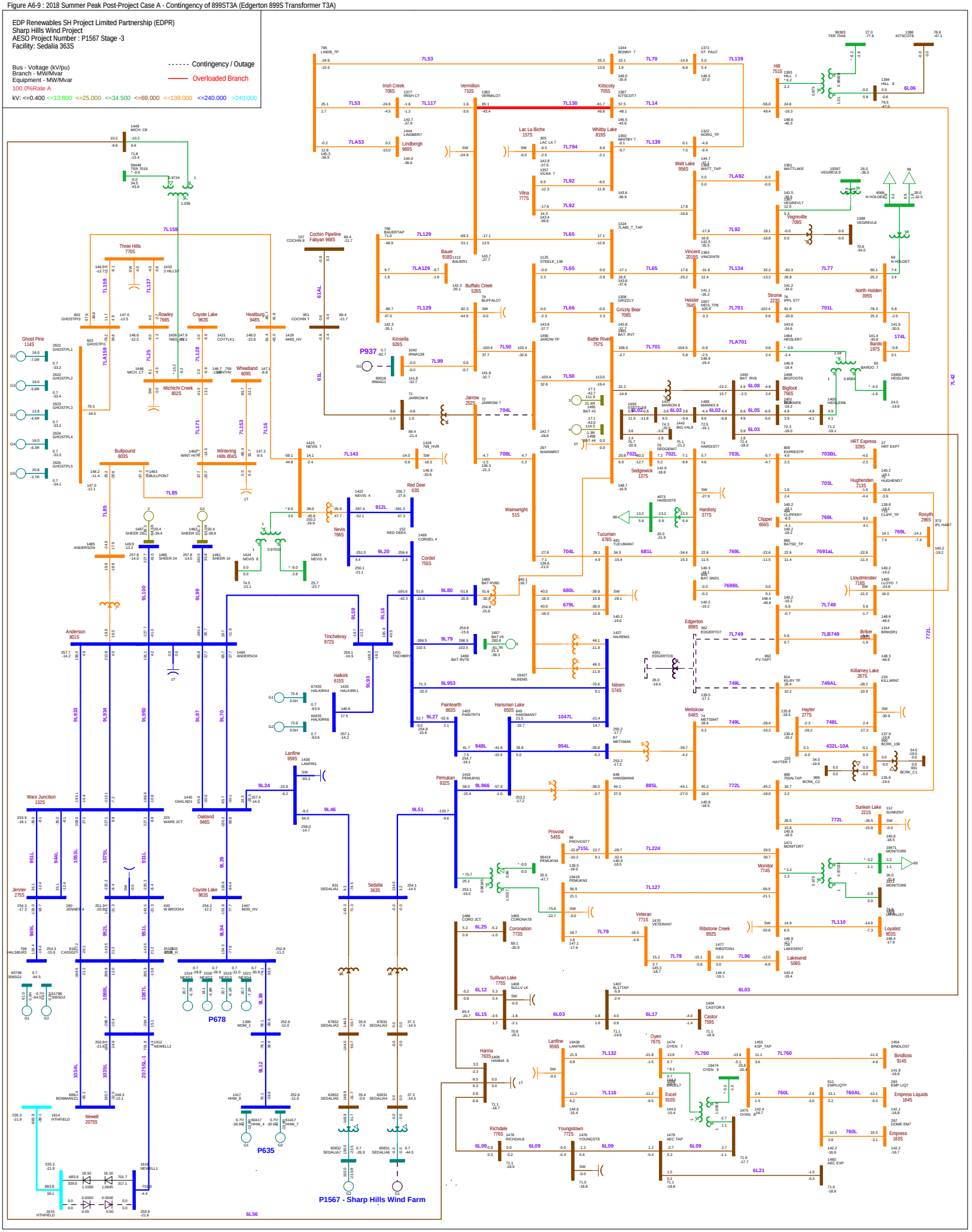


Figure A6-10 : 2018 Summer Peak Post-Project Case A - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

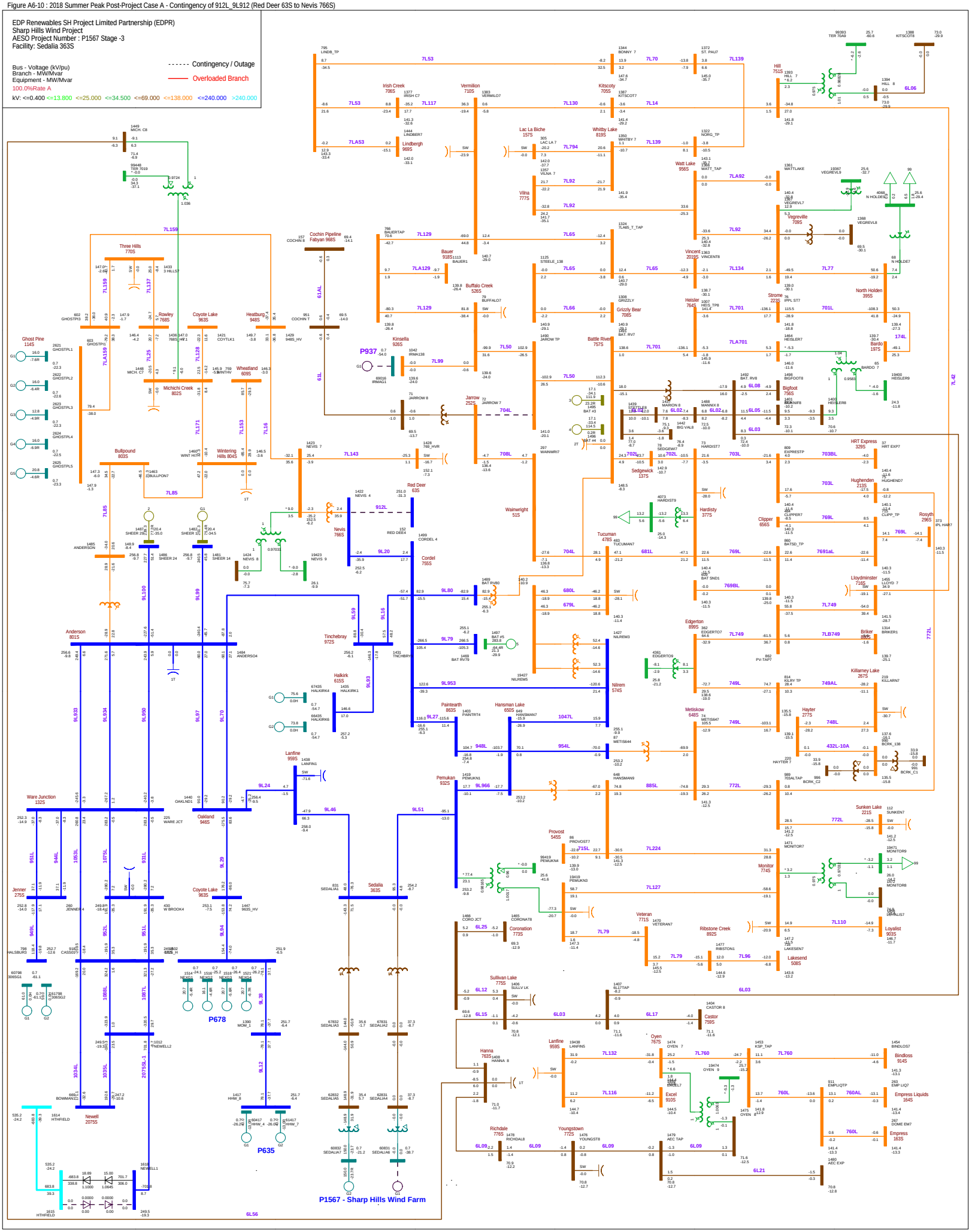


Figure A6-11 : 2018 Summer Peak Post-Project Case A - Contingency of 9L20 (Nevis 766S to Cordel 755S)

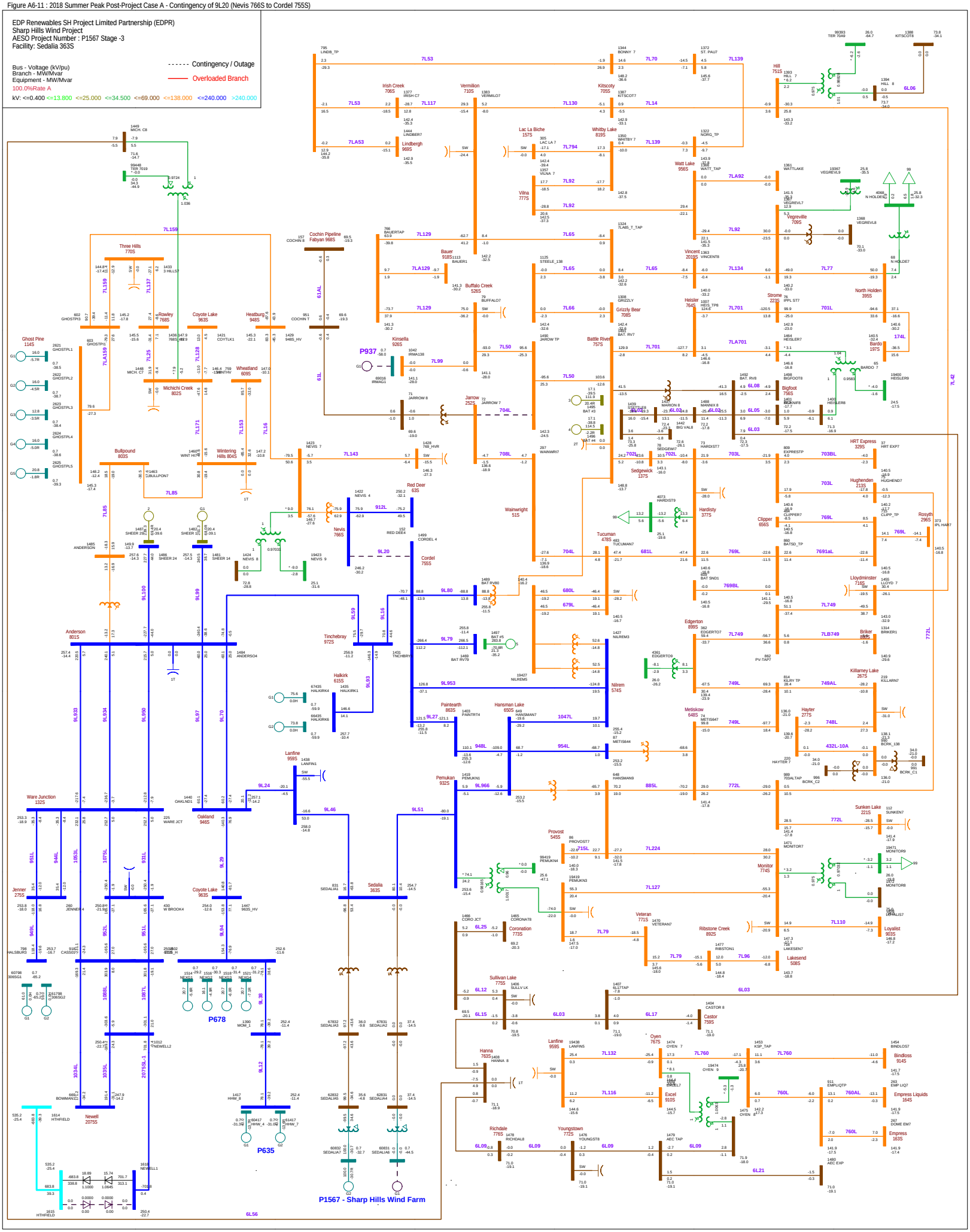


Figure A6-12 : 2018 Summer Peak Post-Project Case A - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

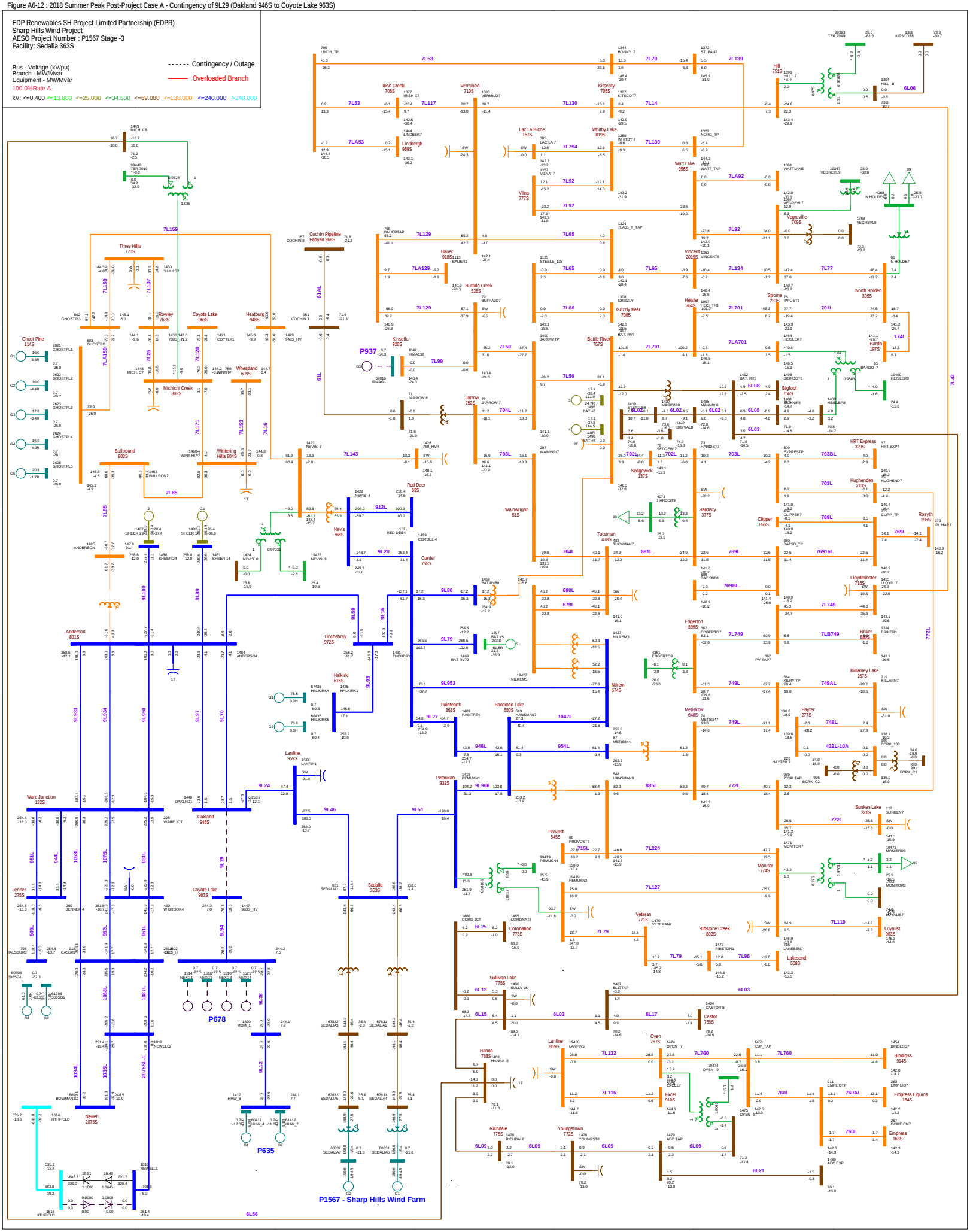


Figure A6-13 : 2018 Summer Peak Post-Project Case A - Contingency of EATL (Newell 2075S to Heathfield 2029S)

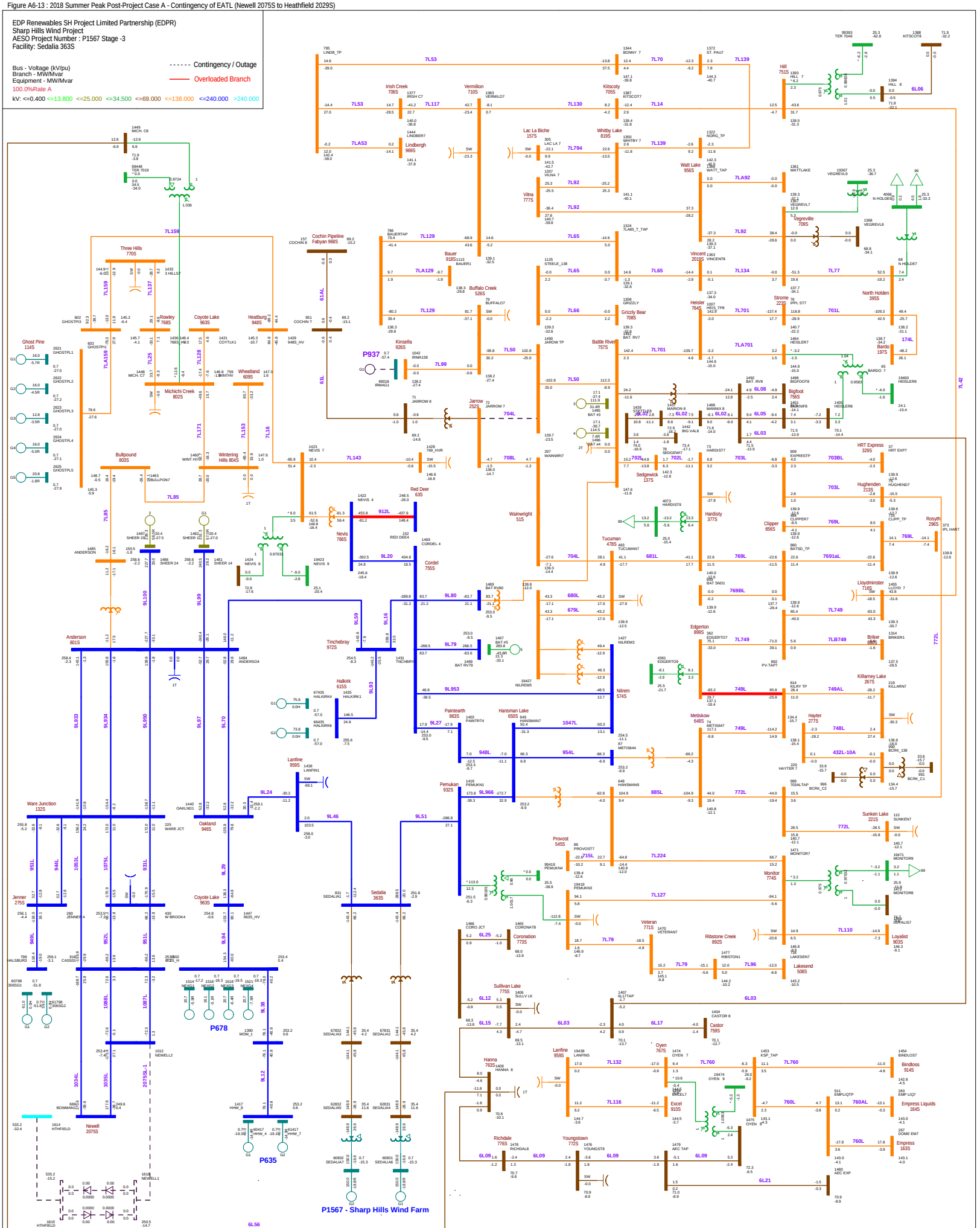


Figure A6-14 : 2018 Summer Peak Post-Project Case B - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

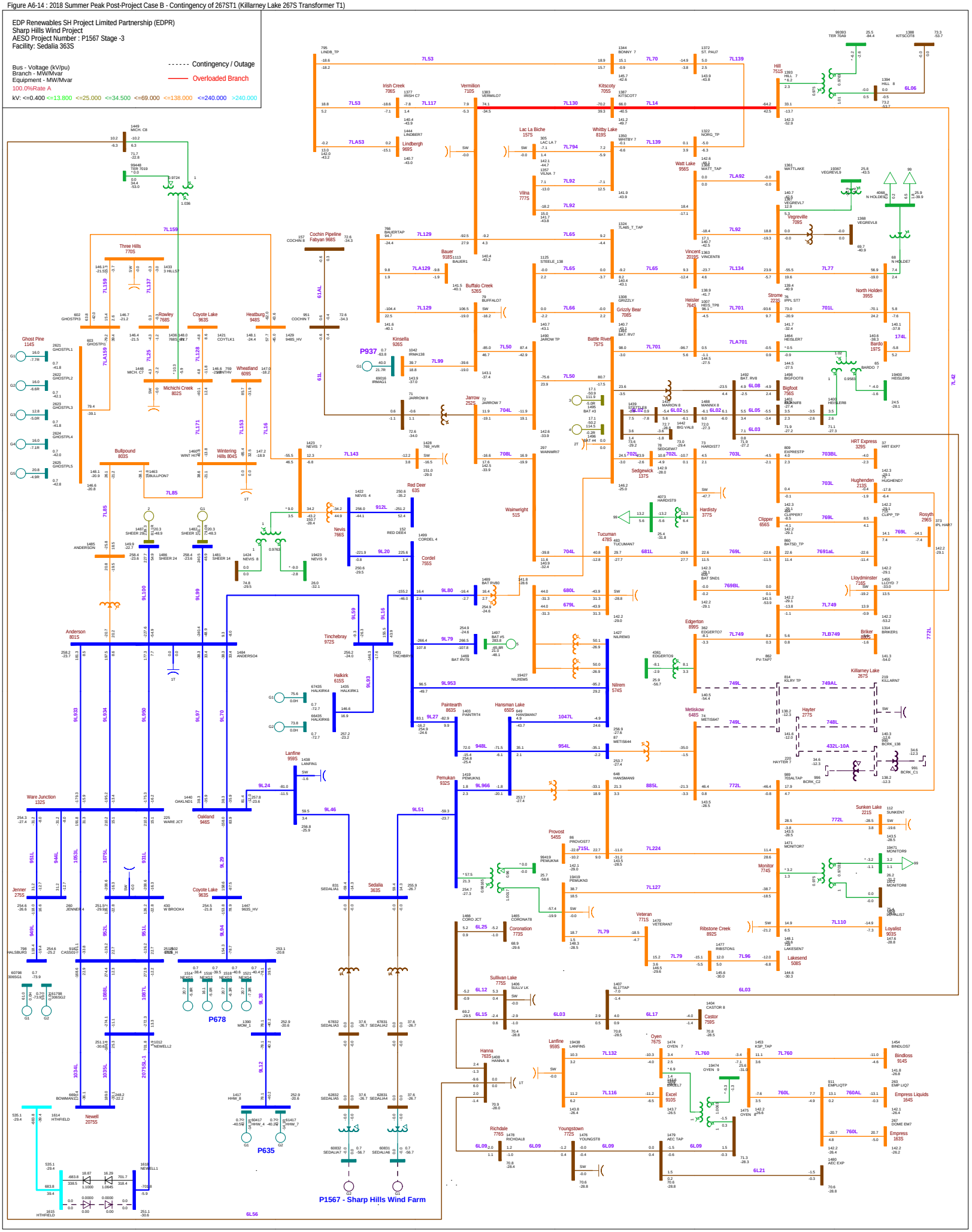


Figure A6-15 : 2018 Summer Peak Post-Project Case B - Contingency of 377ST1 (Hardisty 377S Transformer T1)

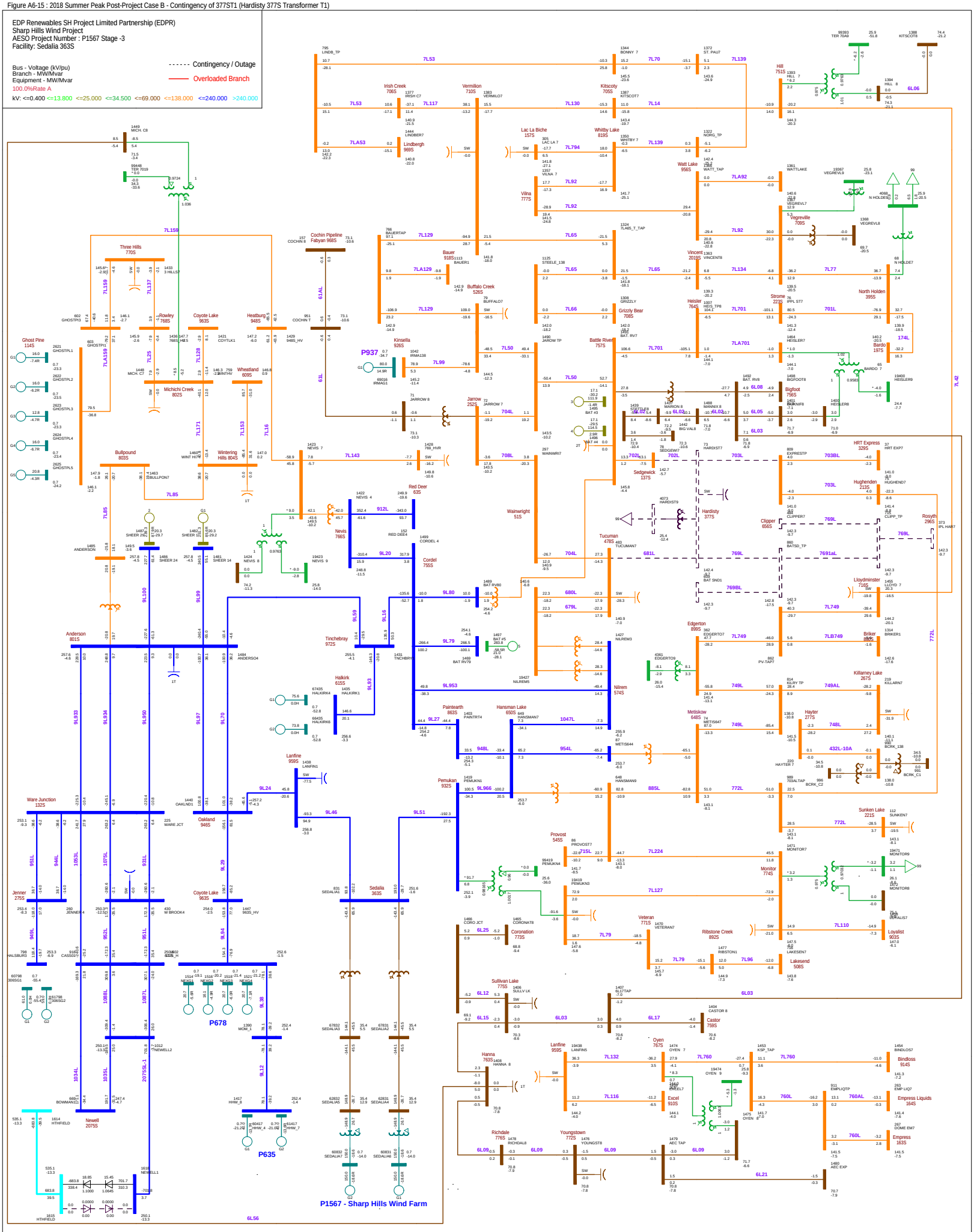


Figure A6-16 : 2018 Summer Peak Post-Project Case B - Contingency of 701L (North Holden 395S to Strome 223S)

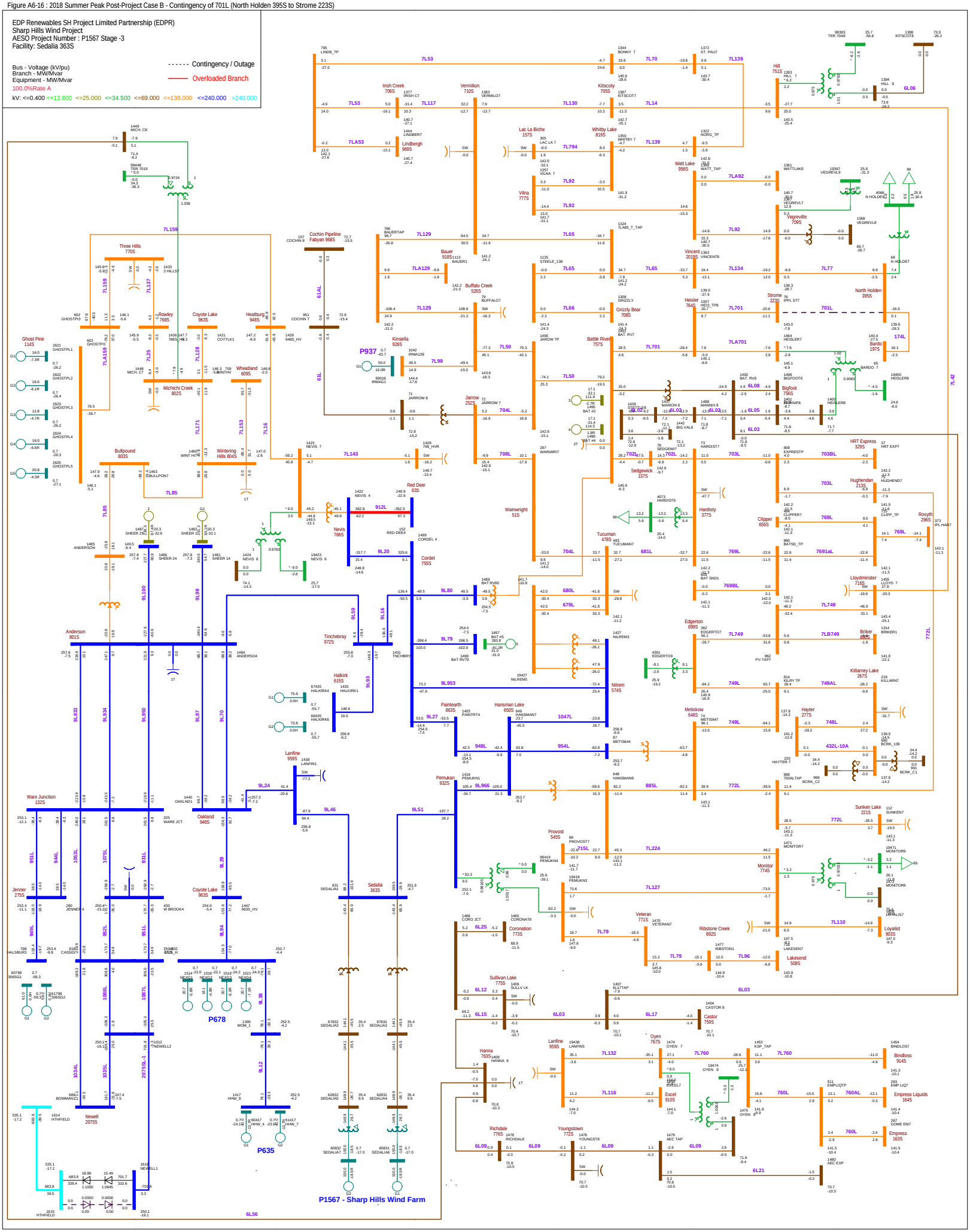


Figure A6-17 : 2018 Summer Peak Post-Project Case B - Contingency of 766S901T (Nevis 766S Transformer 901T)

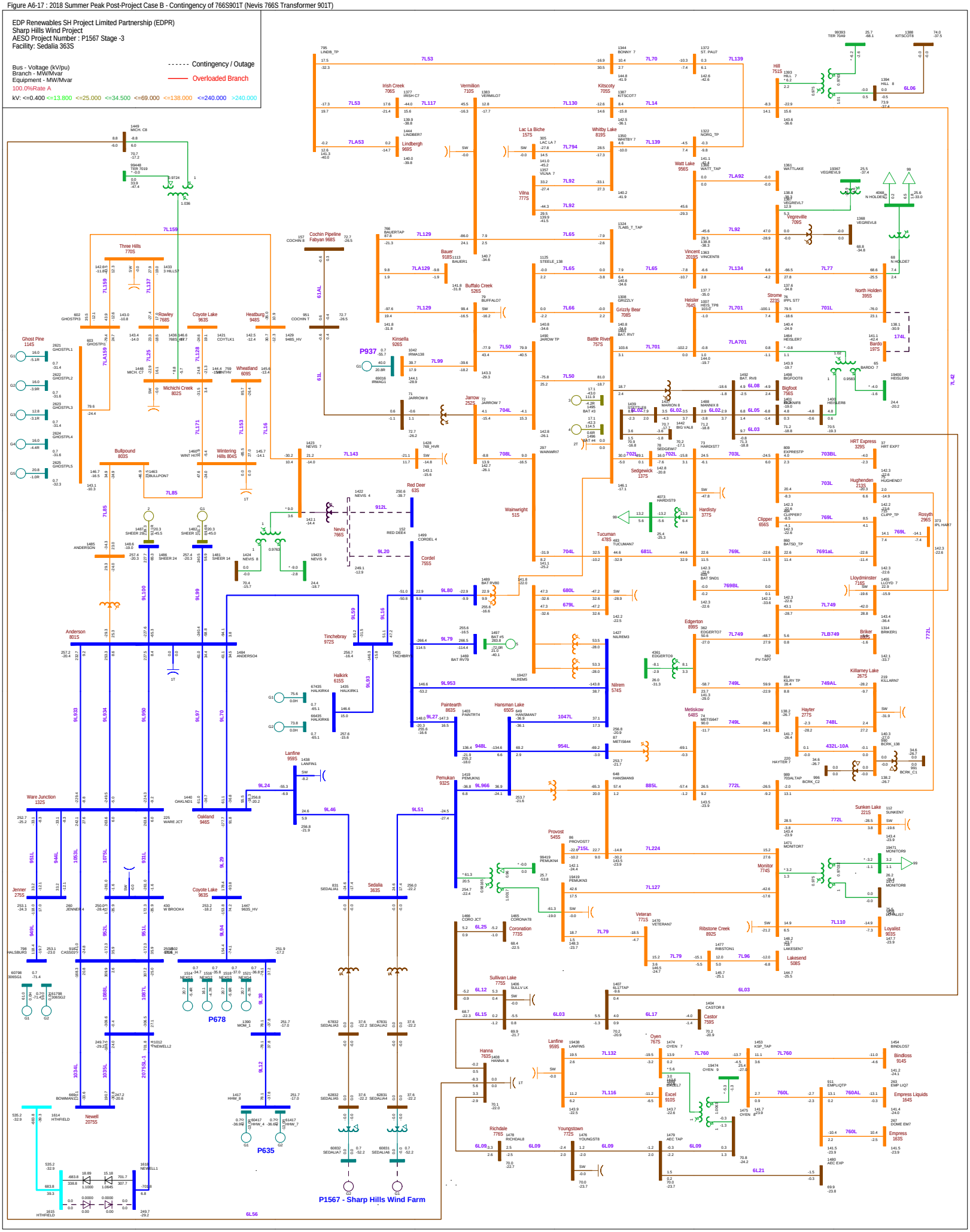


Figure A6-18 : 2018 Summer Peak Post-Project Case B - Contingency of 7L42 (Hill 751S to Lloydminster 716S)

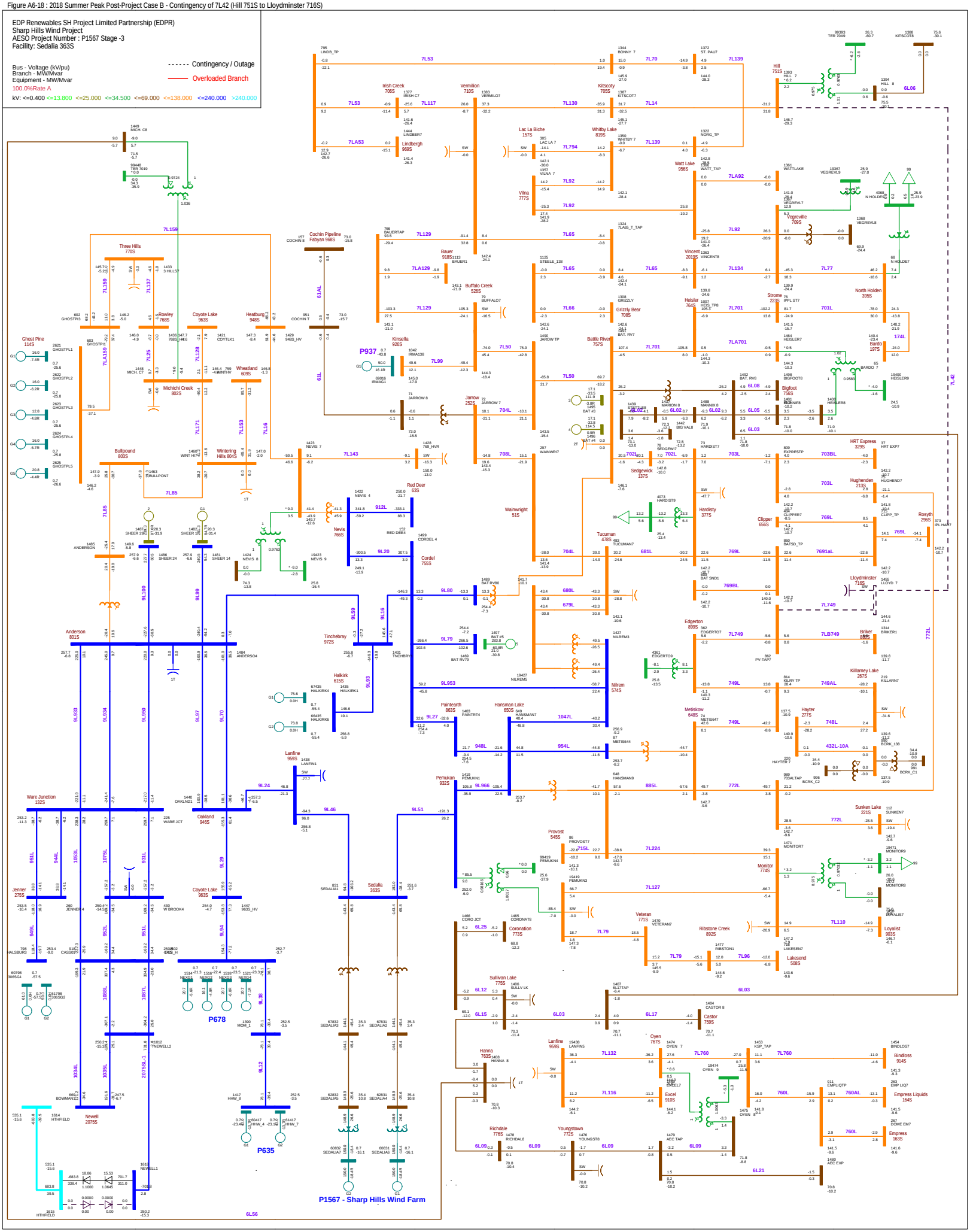


Figure A6-19 : 2018 Summer Peak Post-Project Case B - Contingency of 7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)

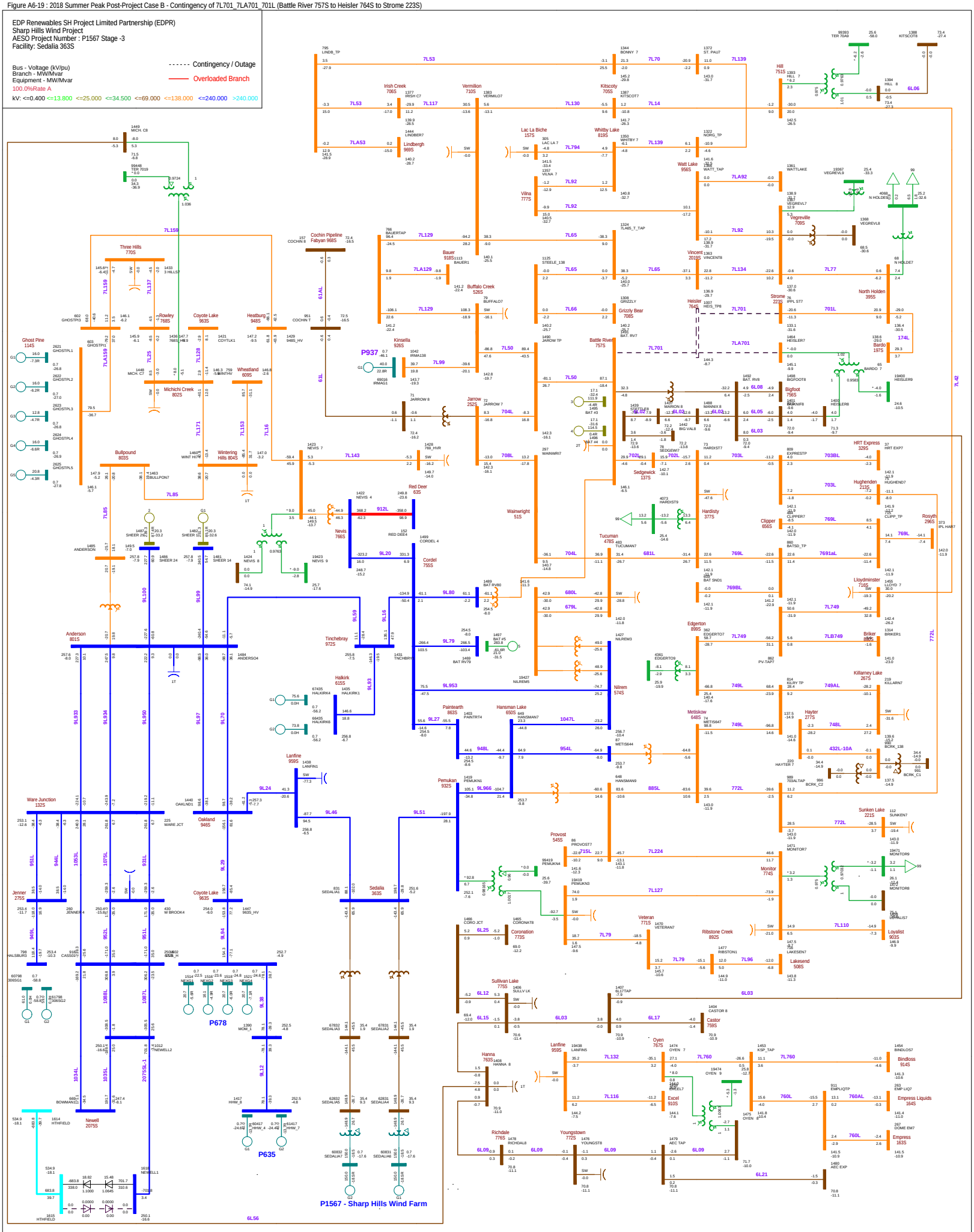


Figure A6-20 : 2018 Summer Peak Post-Project Case B - Contingency of 7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)

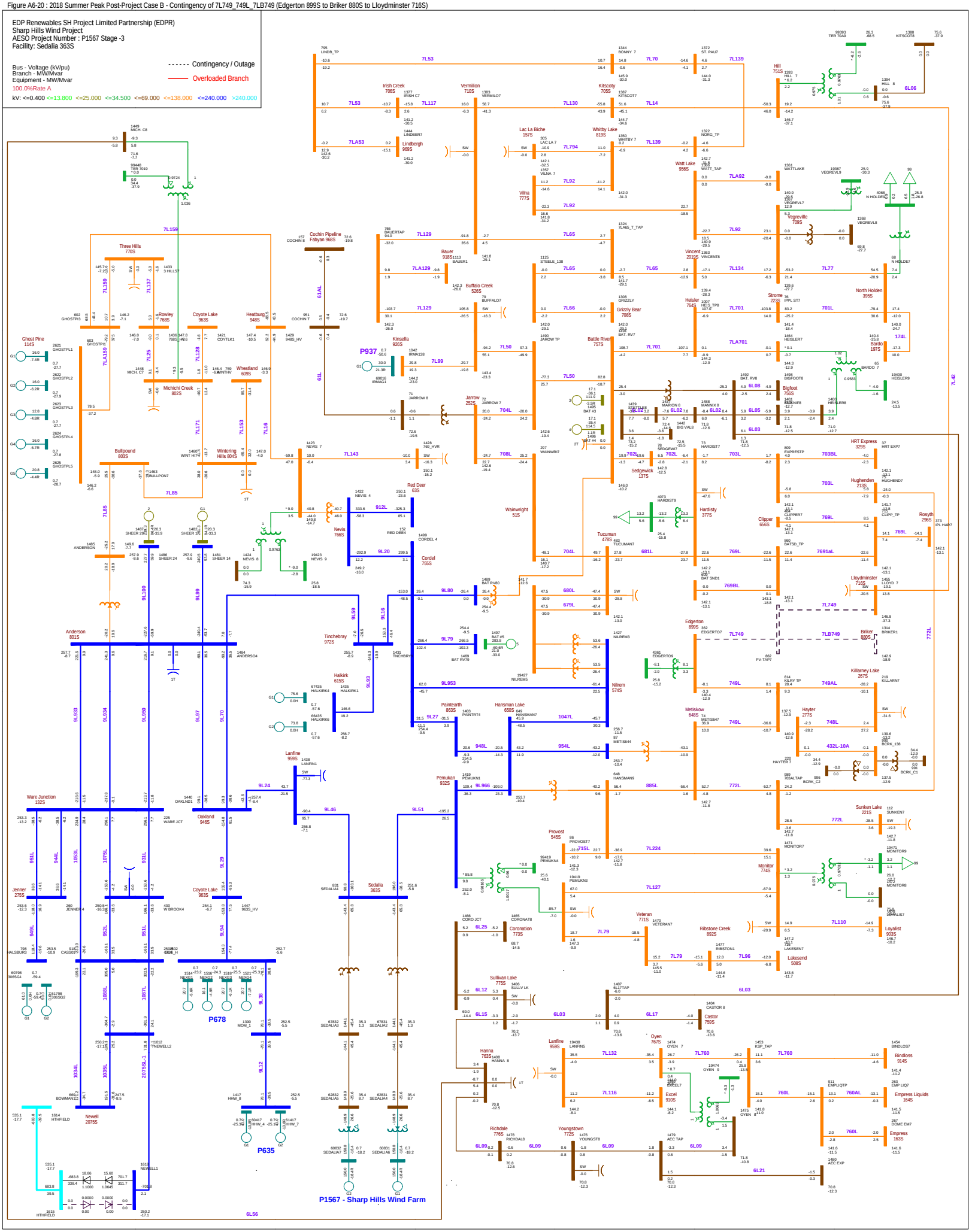


Figure A6-21 : 2018 Summer Peak Post-Project Case B - Contingency of 7L77 (North Holden 395S to Vegreville 709S)

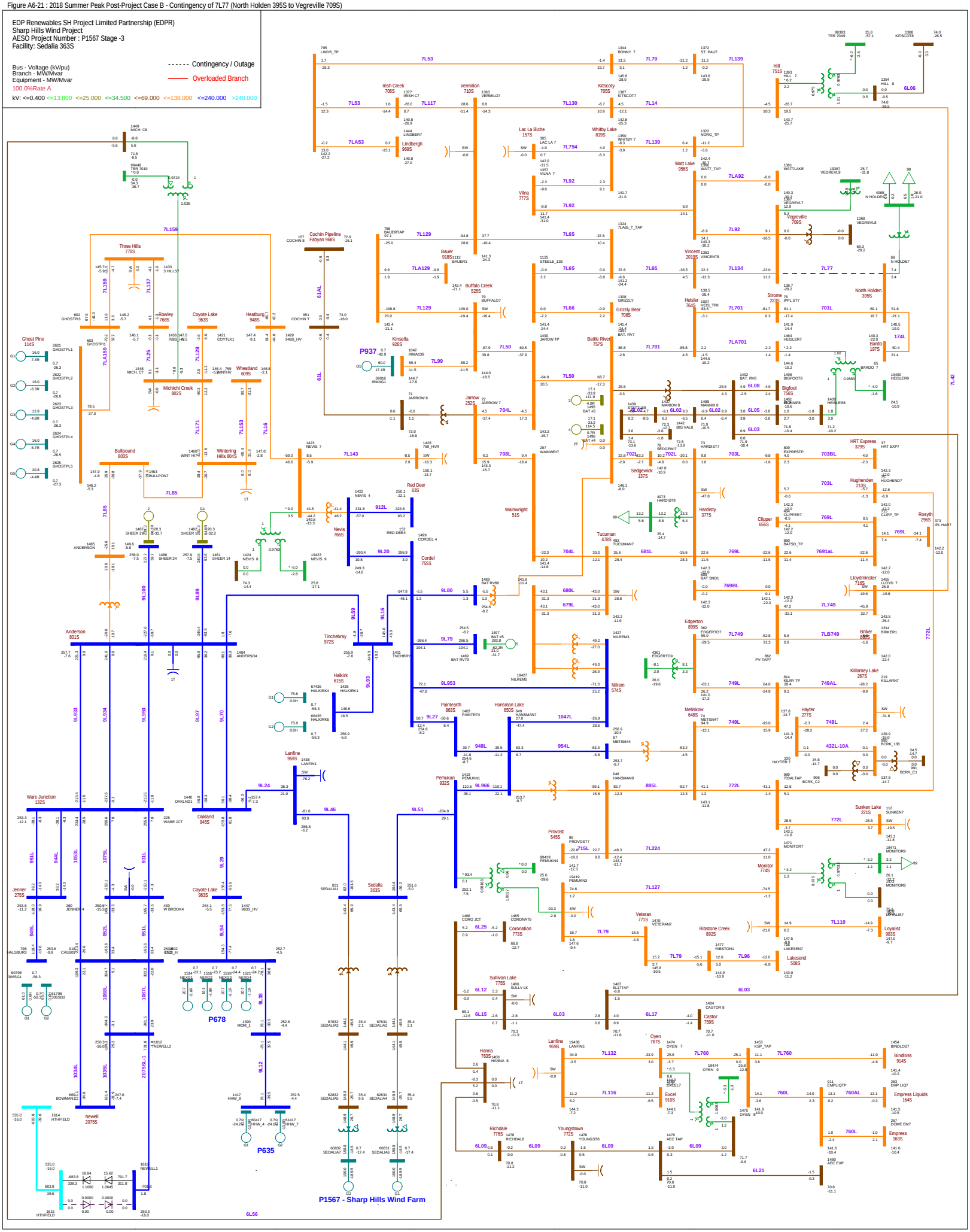


Figure A6-22 : 2018 Summer Peak Post-Project Case B - Contingency of 899ST3A (Edgerton 899S Transformer T3A)

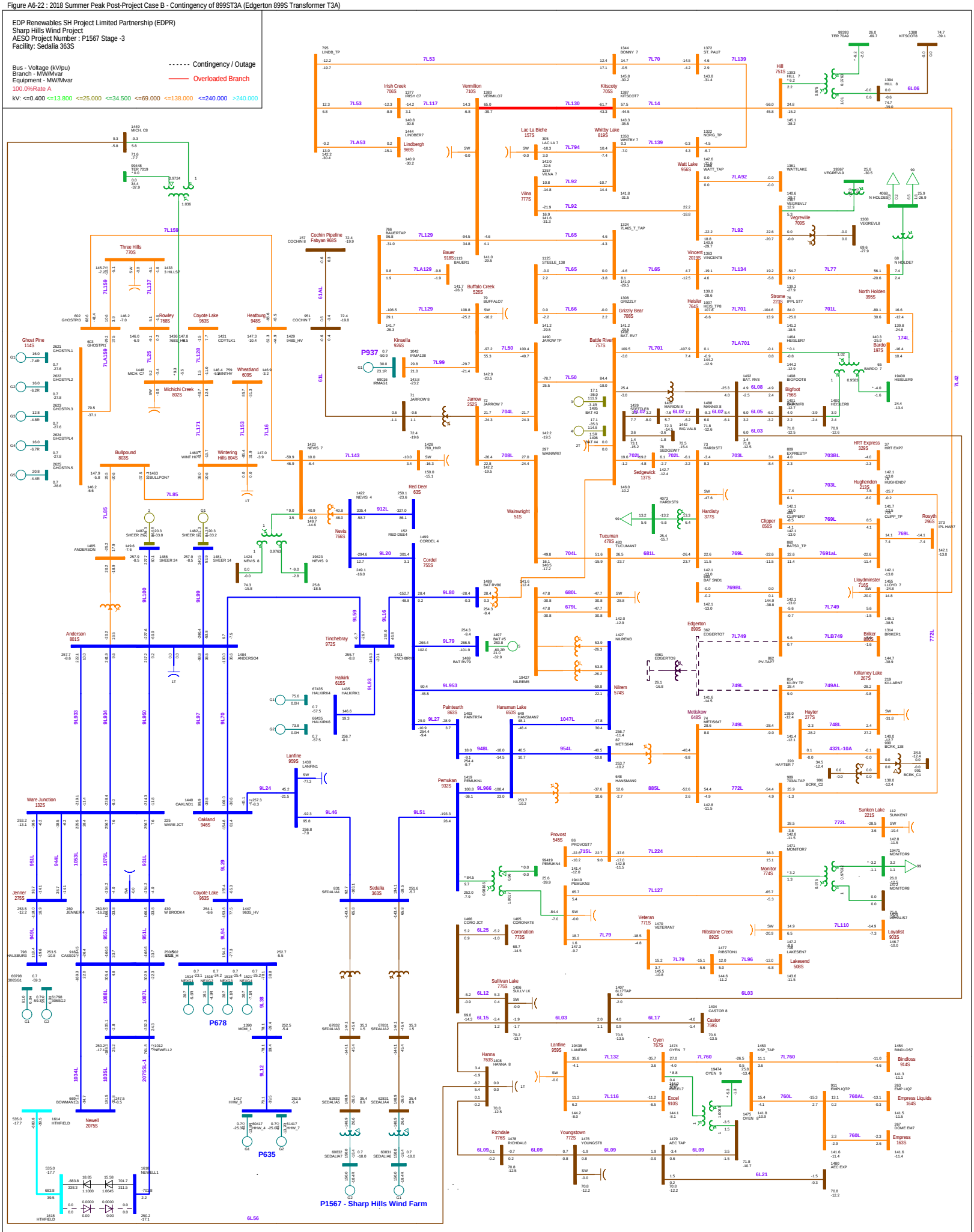


Figure A6-23 : 2018 Summer Peak Post-Project Case B - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

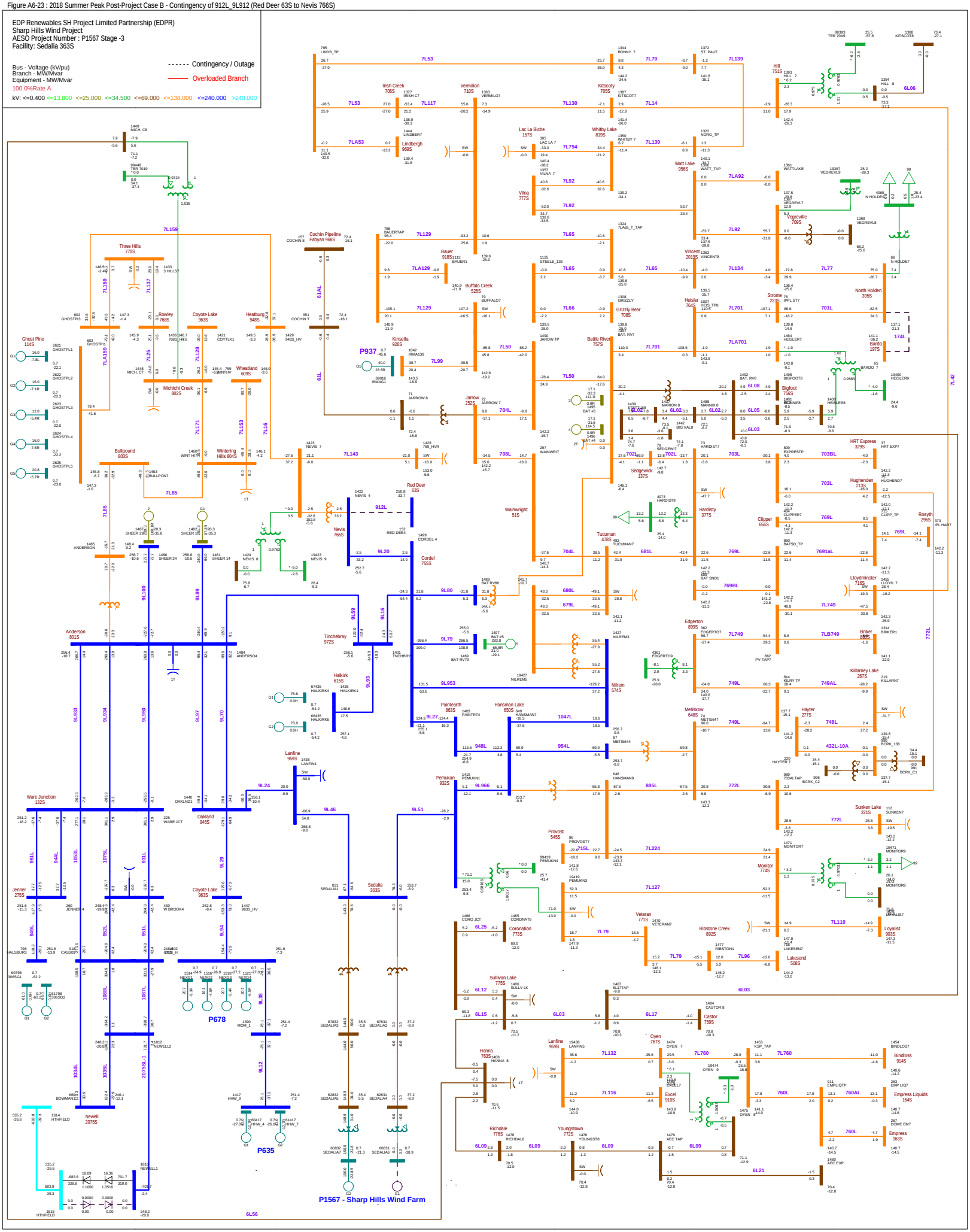


Figure A6-24 : 2018 Summer Peak Post-Project Case B - Contingency of 9L20 (Nevis 766S to Cordel 755S)

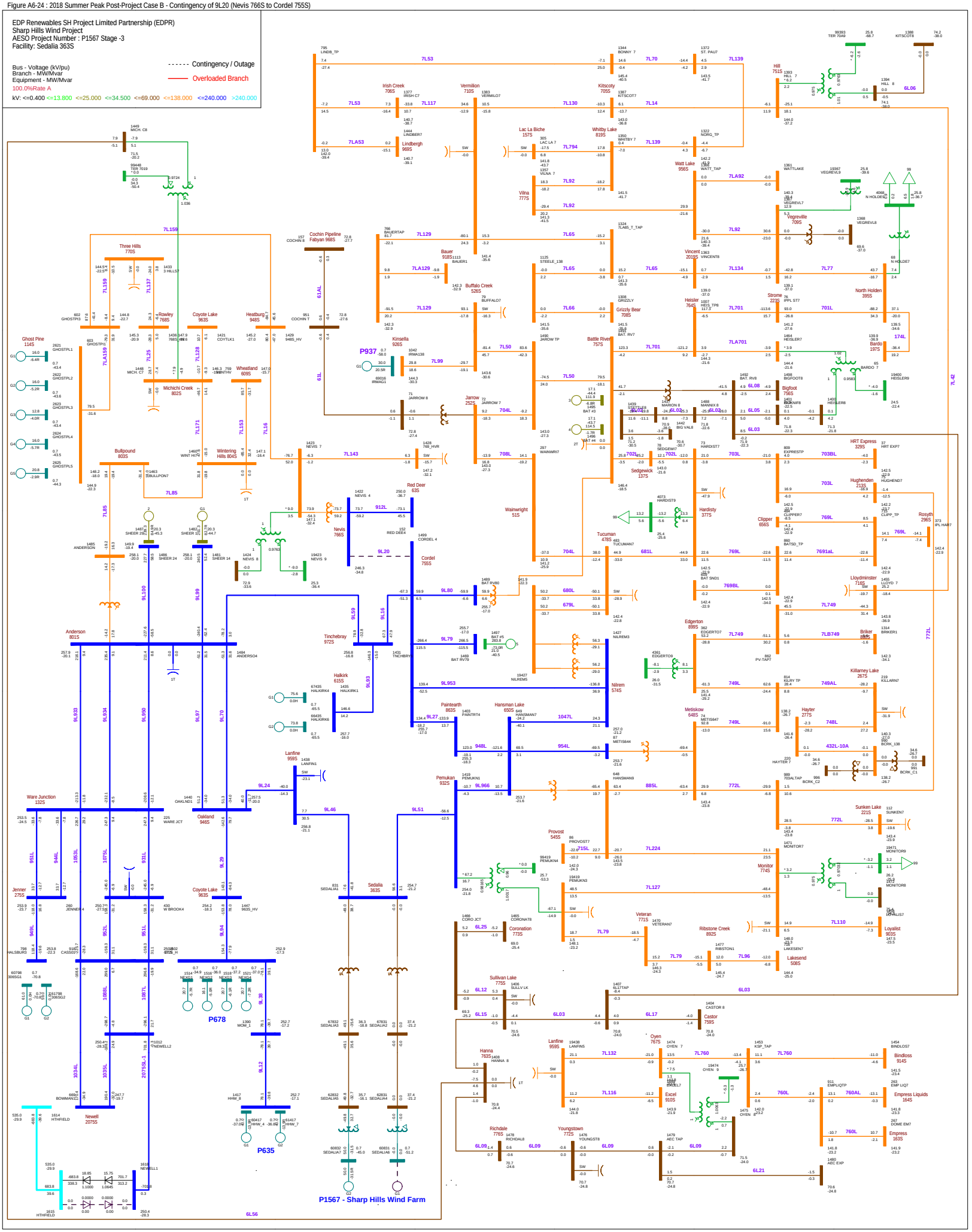


Figure A6-25 : 2018 Summer Peak Post-Project Case B - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

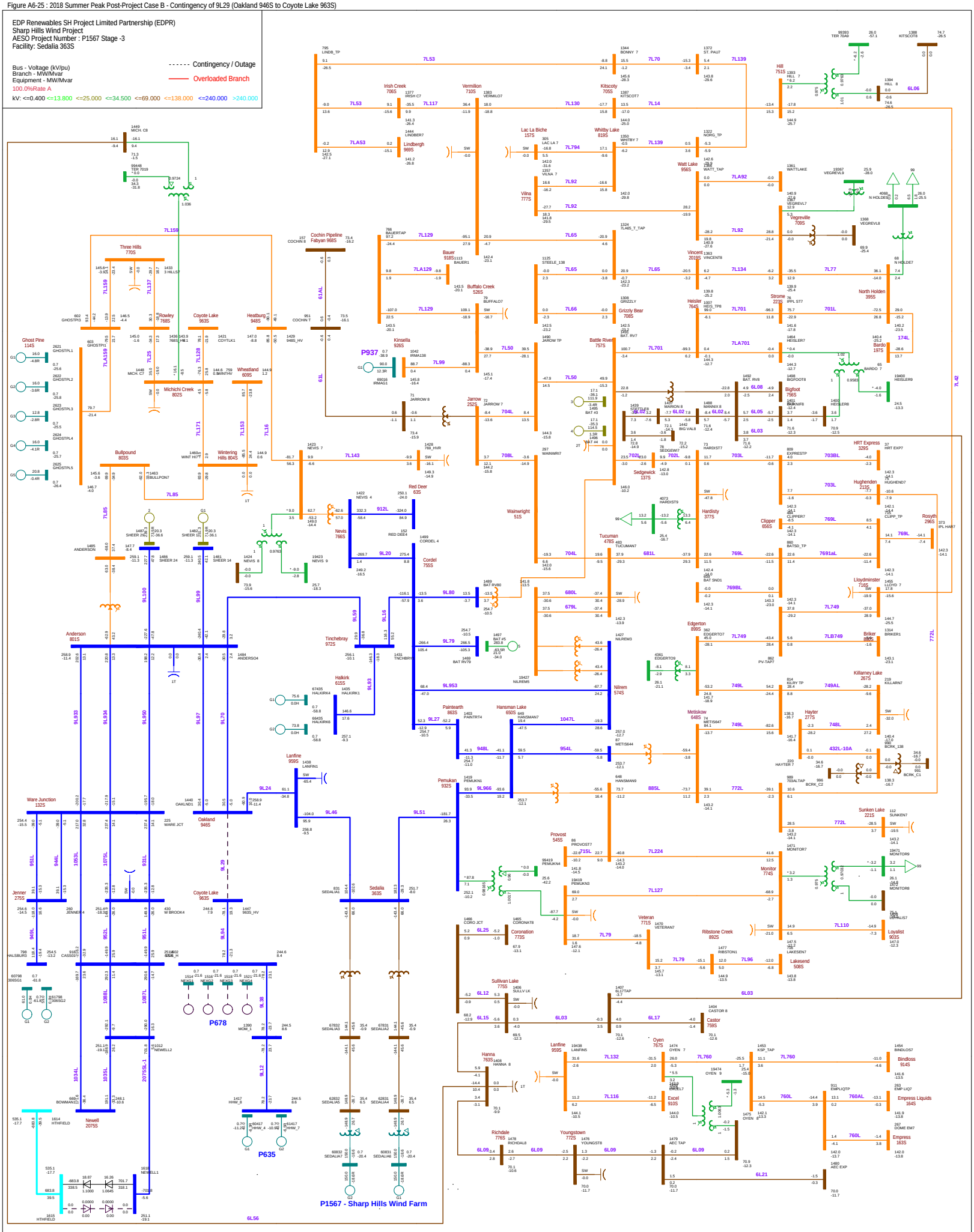


Figure A6-26 : 2018 Summer Peak Post-Project Case B - Contingency of EATL (Newell 2075S to Heathfield 2029S)

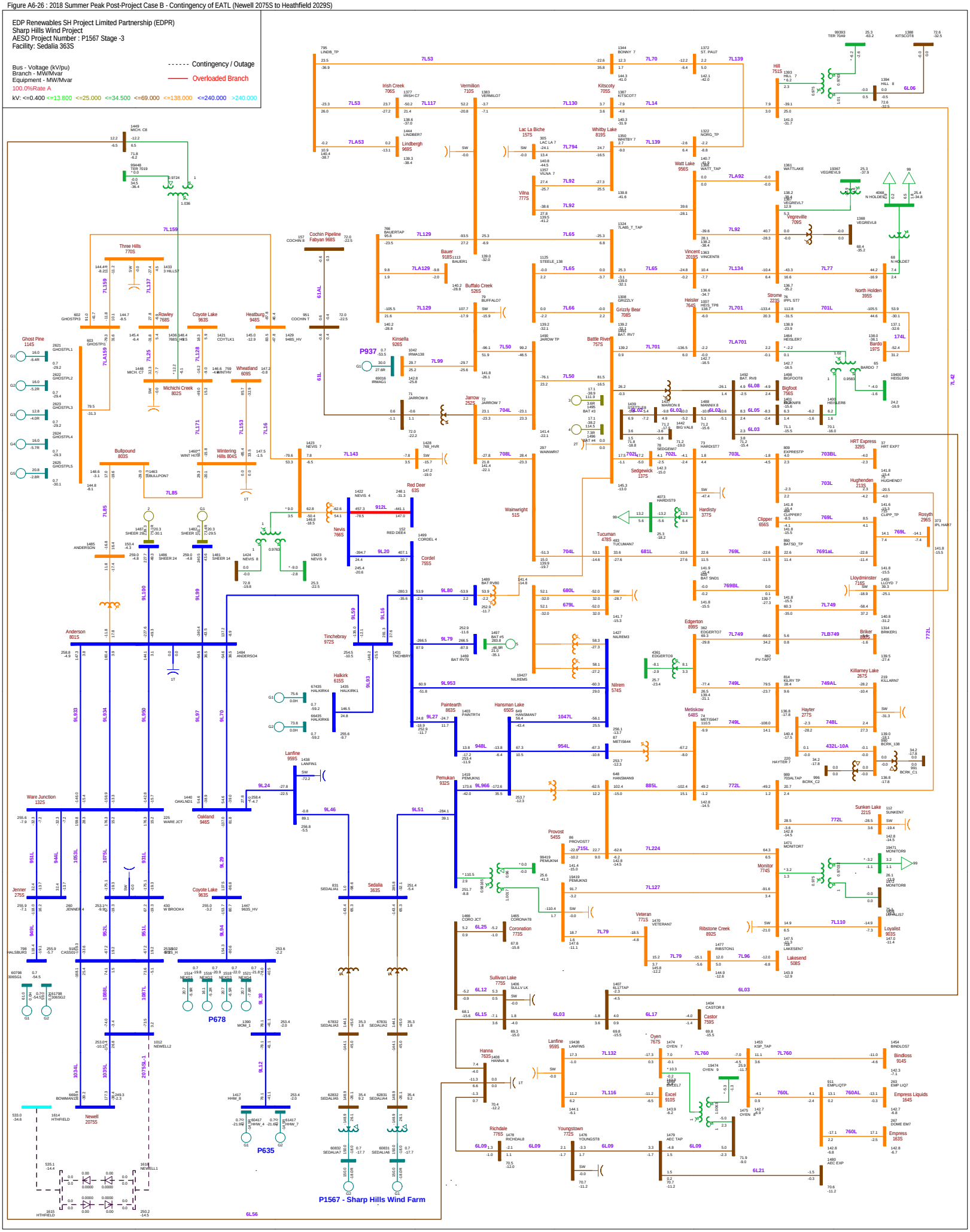


Figure A6-27 : 2018 Winter Peak Post-Project Case A - Contingency of 9L20 (Nevis 766S to Cordel 755S)

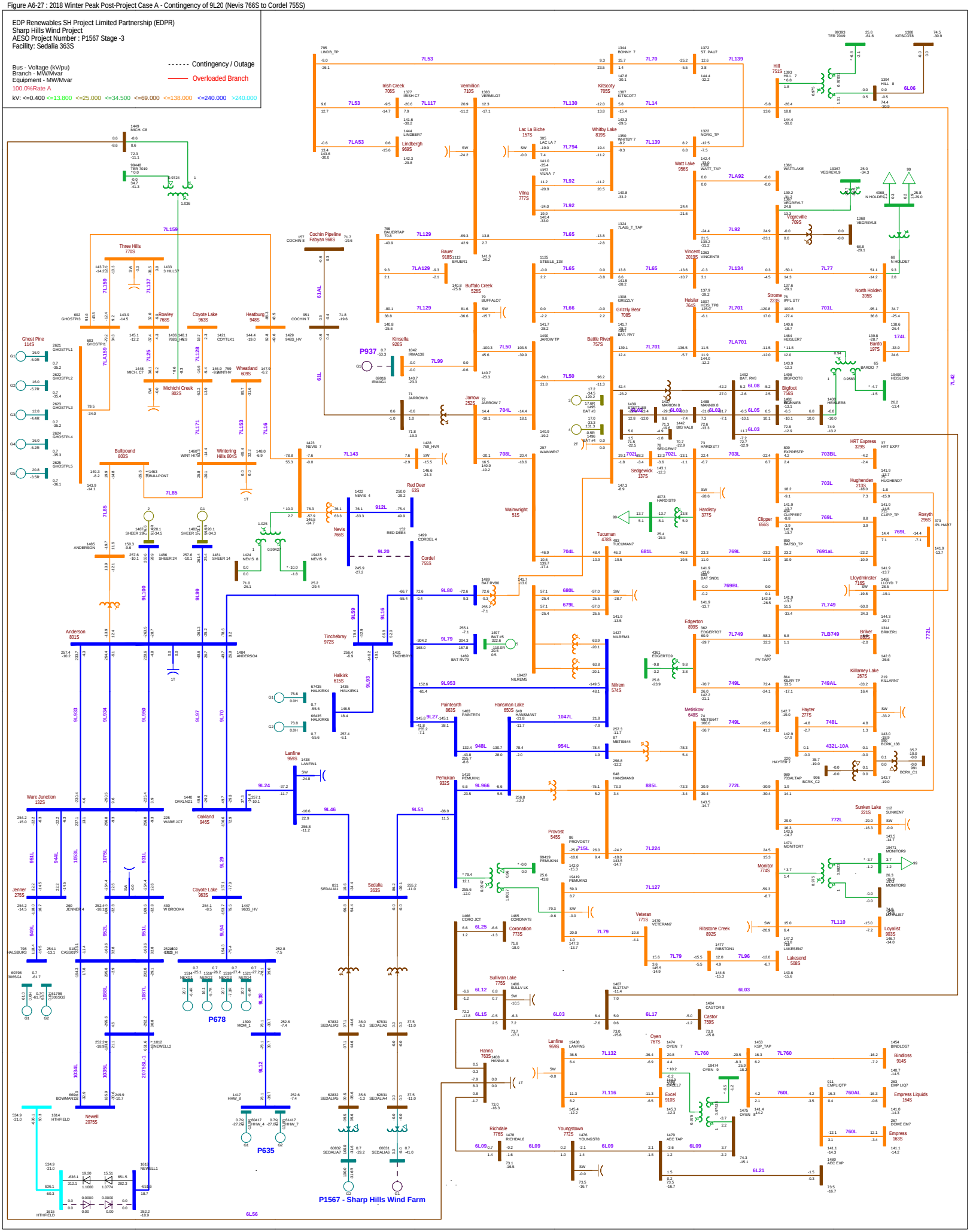


Figure A6-28 : 2018 Winter Peak Post-Project Case A - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)

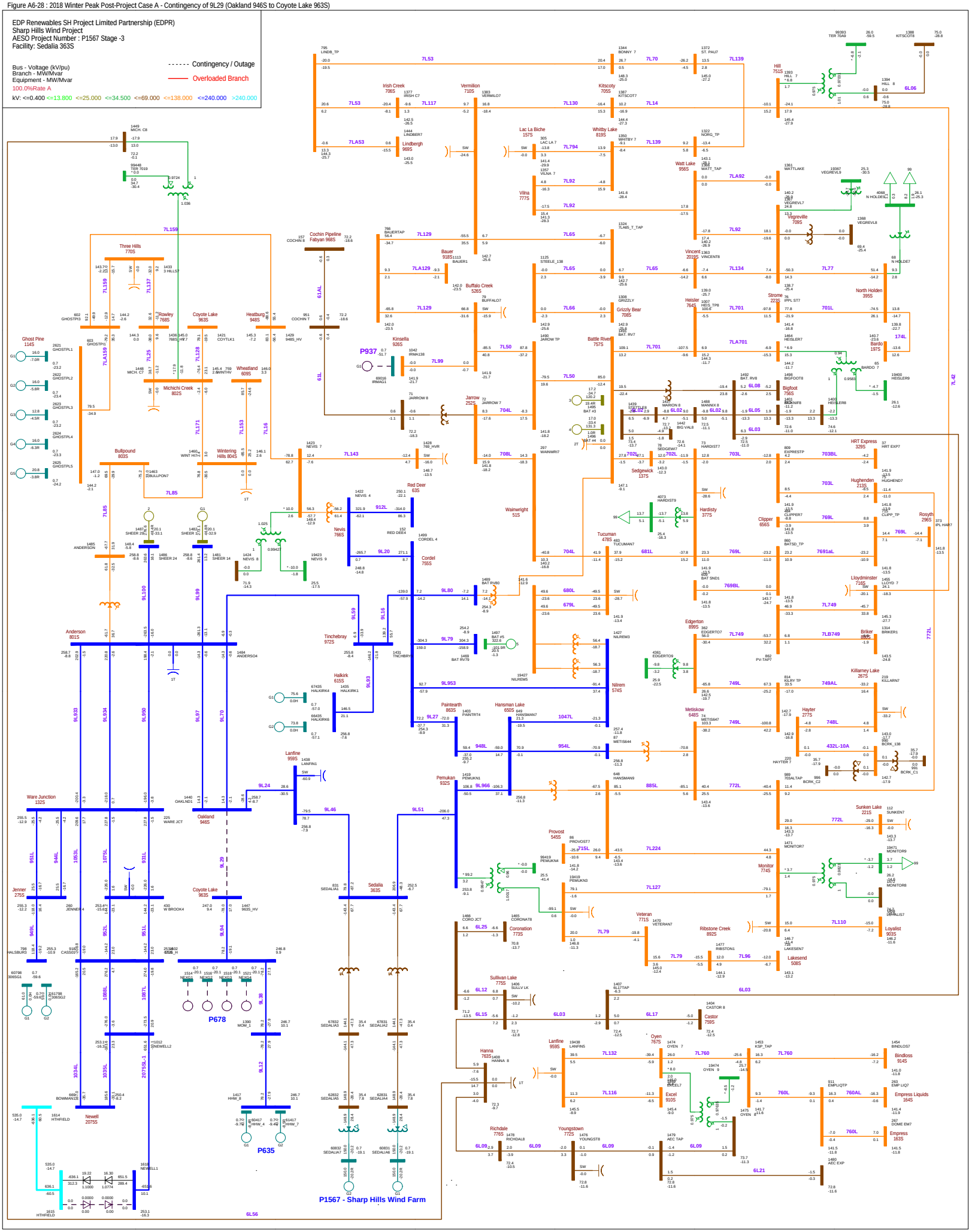


Figure A6-29 : 2018 Winter Peak Post-Project Case B - Contingency of 267ST1 (Killarney Lake 267S Transformer T1)

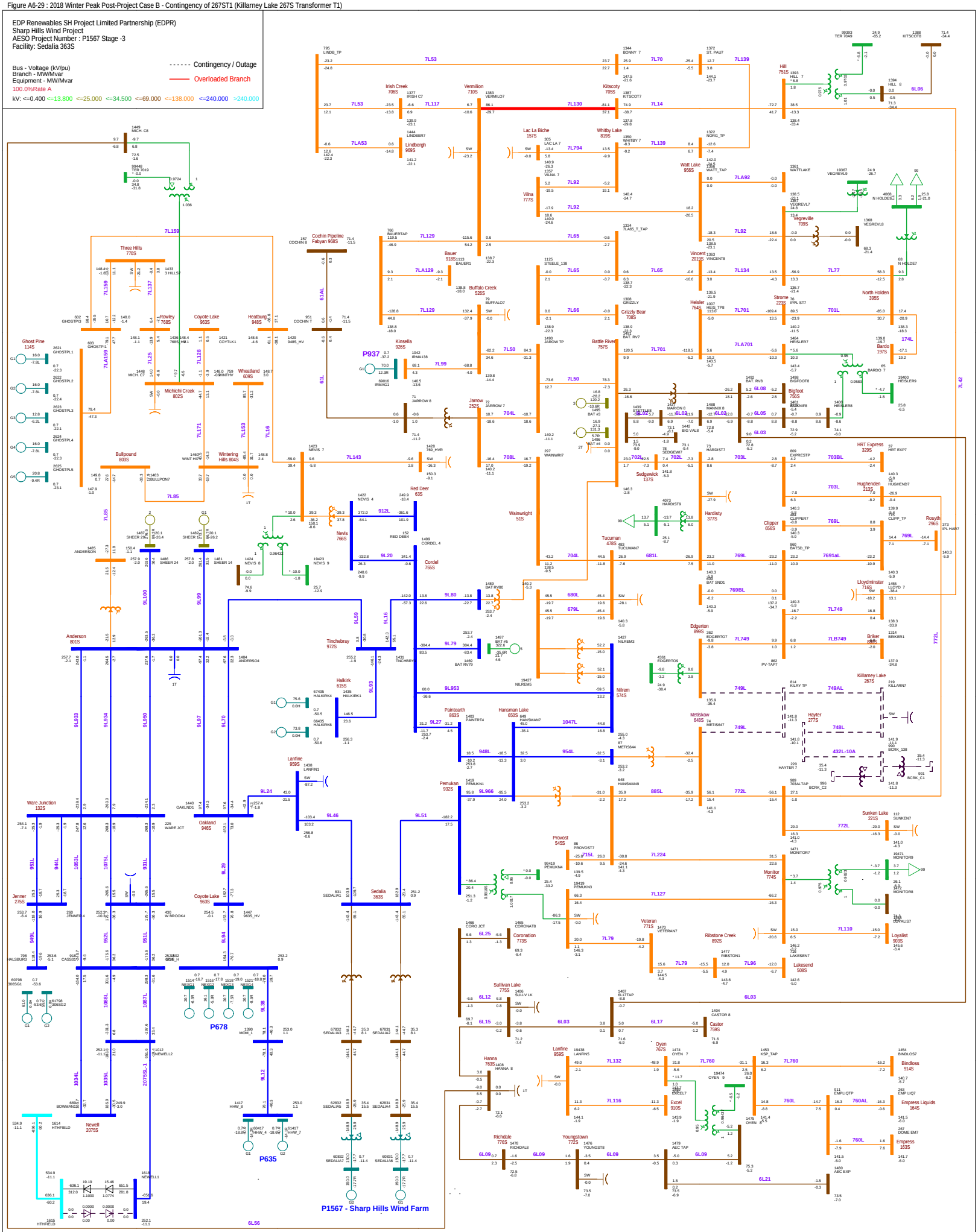


Figure A6-30 : 2018 Winter Peak Post-Project Case B - Contingency of 766S901T (Nevis 766S Transformer 901T)

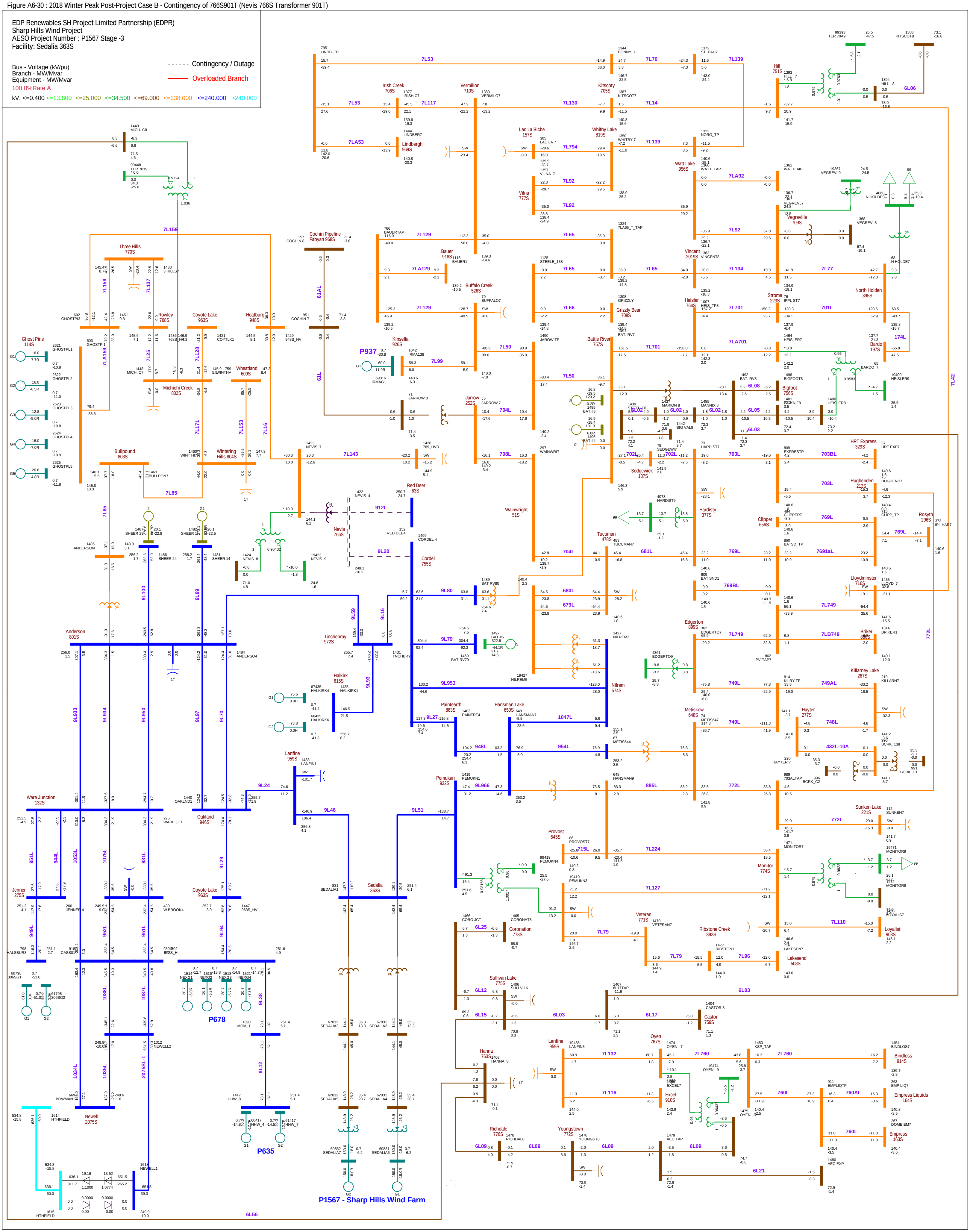


Figure A6-31 : 2018 Winter Peak Post-Project Case B - Contingency of 912L_9L912 (Red Deer 63S to Nevis 766S)

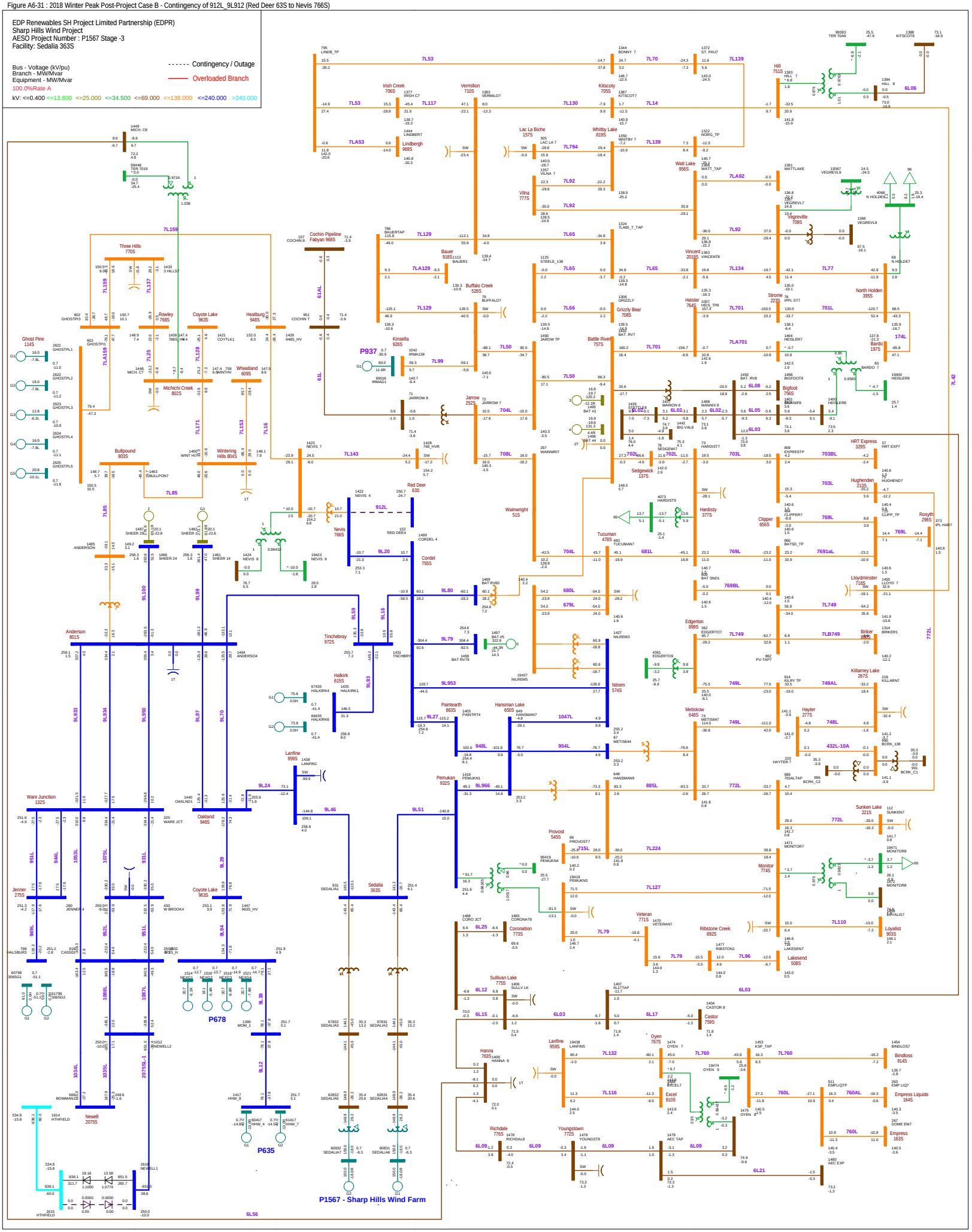


Figure A6-32 : 2018 Winter Peak Post-Project Case B - Contingency of 9L20 (Nevis 766S to Cordel 755S)

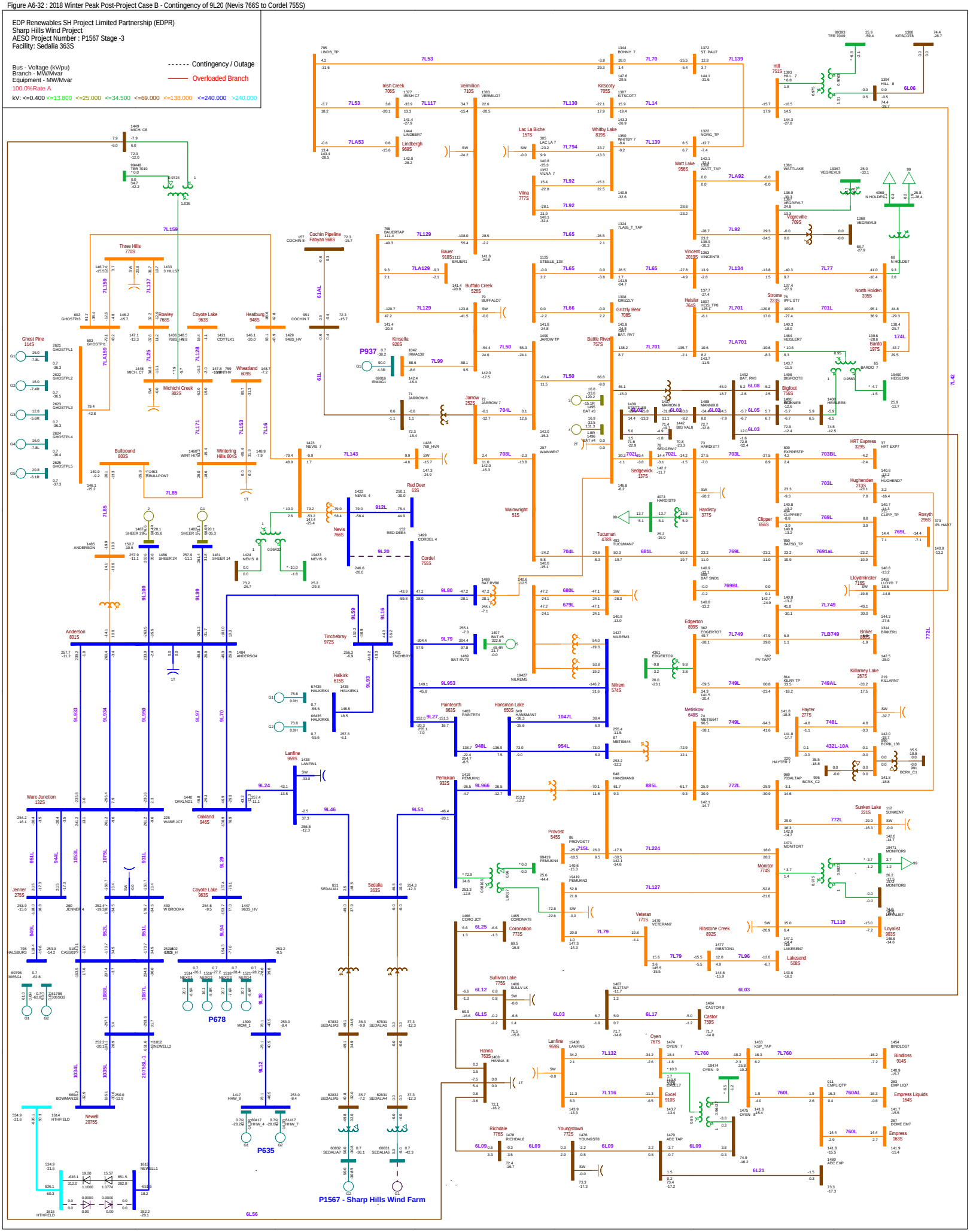
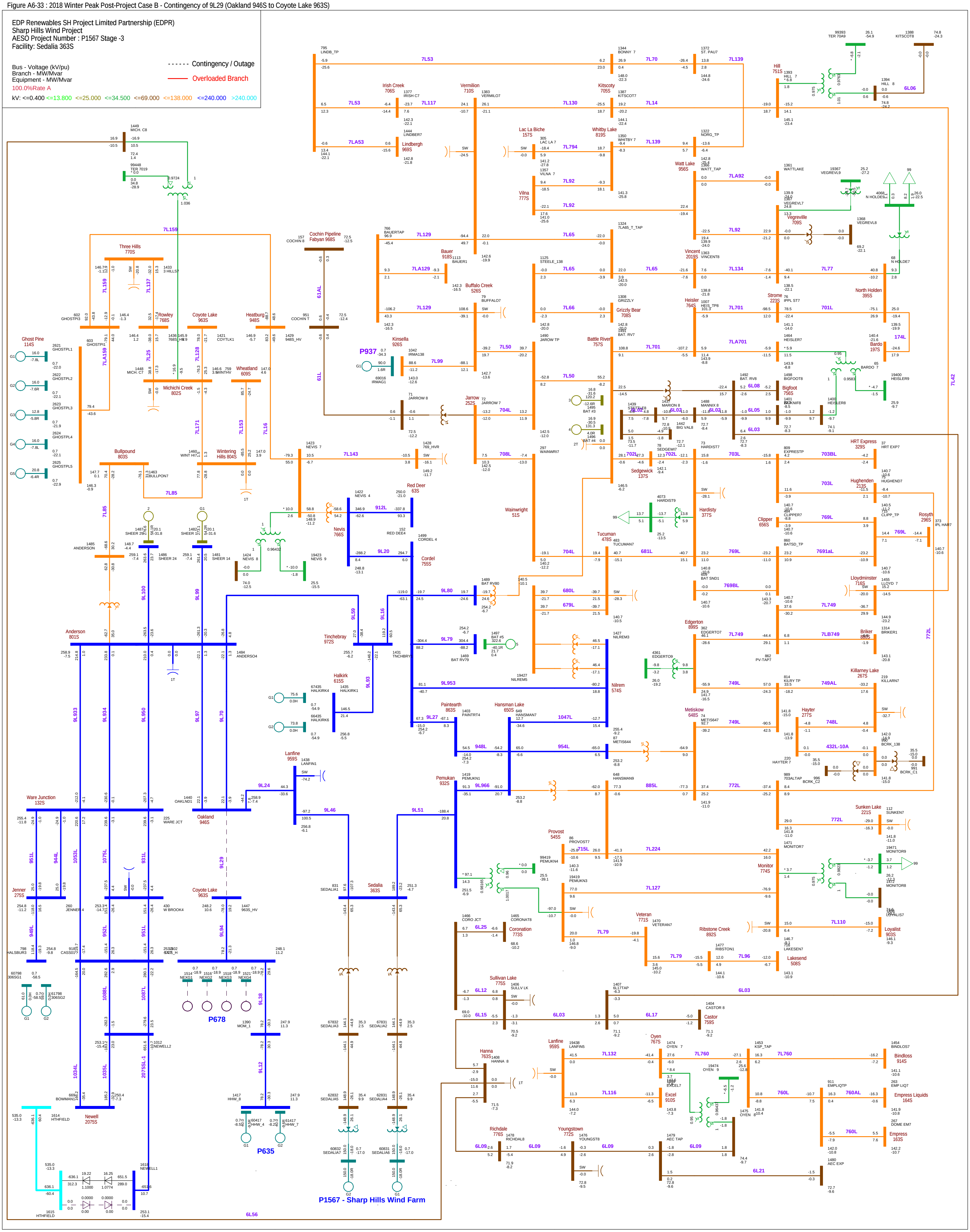


Figure A6-33 : 2018 Winter Peak Post-Project Case B - Contingency of 9L29 (Oakland 946S to Coyote Lake 963S)



Attachment A7

Constraint Effective Factors

Table A7-1: Generator Type

Generating Facility Name and Unit Number	Sharp Hills	Wintering Hills	Planned Irma Wind Power Project	Suncor Hand Hills	Halkirk	Sheerness # 1	Sheerness # 2	Battle River # 3	Battle River # 4	Battle River # 5	BluEarth Hand Hills	Ghost Pine	Bull Creek DG
Type	Wind	Wind	Wind	Wind	Wind	Coal	Coal	Coal	Coal	Coal	Wind	Wind	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											
			Sharp Hills	Wintering Hills	Planned Irma Wind Power Project	Suncor Hand Hills	Halkirk	Sheerness # 1	Sheerness # 2	Battle River # 3	Battle River # 4	Battle River # 5	BluEarth Hand Hills	Ghost Pine	Bull Creek DG
2018 Summer Light Post-Project Case A	648ST1 (Metiskow 648S Transformer T1)	7L130 (Vermilion 710S to Kitscoty 705S)	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-126.0%
		7L14 (Kitscoty 705S to Hill 751S)	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-114.9%
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	2.1%	21.7%	-	24.7%	1.1%	2.6%	2.6%	4.1%	4.1%	1.0%	24.7%	62.4%	1.7%
		7L159 (Ghost Tap to Heatburg 948S)	1.1%	25.4%	-	29.9%	-0.2%	2.2%	2.2%	-0.3%	-0.3%	-0.4%	29.9%	73.6%	0.2%
		7L16 (Nevis 766S to Heatburg 948S)	1.0%	23.2%	-	27.0%	-0.2%	2.0%	2.0%	-0.3%	-0.3%	-0.4%	27.0%	67.9%	0.2%
		7L85 (Bullpound 803S to Anderson 801S)	-0.7%	59.7%	-	39.6%	0.5%	-2.4%	-2.4%	1.3%	1.3%	0.8%	39.6%	21.7%	0.3%
		7L85 (Wintering Hills 804S to Bullpound 803S)	-0.7%	63.9%	-	43.0%	0.5%	-2.6%	-2.6%	1.4%	1.4%	0.8%	43.0%	23.4%	0.3%
2018 Summer Light Post-Project Case B	648ST1 (Metiskow 648S Transformer T1)	7L130 (Vermilion 710S to Kitscoty 705S)	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-124.1%
		7L14 (Kitscoty 705S to Hill 751S)	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-113.5%
	766S901T (Nevis 766S Transformer 901T)	174L (Bardo 197S to North Holden 395S)	9.5%	7.2%	16.8%	7.0%	11.7%	6.8%	6.8%	15.8%	15.8%	12.2%	7.0%	8.5%	12.8%
	912L_9L912 (Red Deer 63S to Nevis 766S)	174L (Bardo 197S to North Holden 395S)	9.5%	7.4%	16.8%	7.0%	11.6%	6.9%	6.9%	15.7%	15.7%	12.1%	7.0%	9.5%	12.8%
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	2.0%	21.7%	2.0%	24.8%	1.1%	2.6%	2.6%	4.0%	4.0%	0.9%	24.8%	62.5%	1.6%
		7L159 (Ghost Tap to Heatburg 948S)	1.1%	25.5%	-0.3%	30.0%	-0.2%	2.2%	2.2%	-0.3%	-0.3%	-0.4%	30.1%	73.7%	0.2%
		7L16 (Nevis 766S to Heatburg 948S)	1.0%	23.3%	-0.2%	27.1%	-0.2%	2.0%	2.0%	-0.3%	-0.3%	-0.4%	27.2%	68.0%	0.2%
		7L85 (Bullpound 803S to Anderson 801S)	-0.7%	59.8%	0.8%	39.6%	0.5%	-2.4%	-2.4%	1.3%	1.3%	0.8%	39.6%	21.7%	0.3%
		7L85 (Wintering Hills 804S to Bullpound 803S)	-0.7%	64.1%	0.9%	43.0%	0.5%	-2.6%	-2.6%	1.4%	1.4%	0.8%	43.1%	23.4%	0.3%
2018 Summer Peak Post-Project Case A	267ST1 (Killarney Lake 267S Transformer T1)	7L129 (Buffalo Creek 526S to Bauer Tap)	3.7%	2.1%	-	2.3%	4.0%	2.3%	2.3%	5.8%	5.8%	4.1%	2.3%	2.0%	-
		7L130 (Vermilion 710S to Kitscoty 705S)	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
		7L14 (Kitscoty 705S to Hill 751S)	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
		7L50 (Buffalo Creek 526S to Jarrow Tap)	4.0%	2.3%	-	2.5%	4.3%	2.5%	2.5%	6.3%	6.3%	4.4%	2.5%	2.2%	-
	526ST1 OR 526ST2 (Buffalo Creek 526S Transformer T1 or T2)	749L (Edgerton 899S to Killarney Tap)	4.2%	1.8%	-	2.0%	2.8%	2.0%	2.0%	2.0%	2.0%	2.8%	2.0%	1.4%	17.7%
	766S901T (Nevis 766S Transformer 901T)	701L (North Holden 395S to Strome 223S)	8.7%	6.9%	-	6.6%	11.5%	6.5%	6.5%	17.1%	17.1%	12.1%	6.6%	8.7%	9.6%
		701L (Strome 223S to Heisler Tap)	9.5%	7.6%	-	7.2%	12.7%	7.1%	7.1%	18.7%	18.8%	13.2%	7.3%	9.6%	10.5%
		7L50 (Buffalo Creek 526S to Jarrow Tap)	5.8%	4.4%	-	4.3%	7.6%	4.2%	4.2%	9.9%	10.0%	7.9%	4.3%	5.1%	3.5%
		7L701 (Heisler Tap to Battle River 757S)	9.3%	6.1%	-	6.6%	12.7%	6.7%	6.7%	19.2%	19.2%	13.3%	6.6%	4.6%	10.6%
	7L129_7LA129 (Buffalo Creek 526S to Vermilion 710S to Bauer 918S)	749L (Edgerton 899S to Killarney Tap)	4.3%	1.8%	-	2.0%	2.8%	2.0%	2.0%	2.0%	2.0%	2.8%	2.0%	1.4%	17.7%
	7L50 (Battle River 757S to Jarrow 252S to Buffalo Creek 526S)	749L (Edgerton 899S to Killarney Tap)	4.1%	1.7%	-	1.9%	2.7%	1.9%	1.9%	1.8%	1.8%	2.7%	1.9%	1.3%	17.6%
	7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)	7L50 (Buffalo Creek 526S to Jarrow Tap)	3.7%	2.5%	-	2.6%	4.9%	2.6%	2.6%	8.6%	8.6%	5.1%	2.6%	2.6%	0.6%
		912L\9L912 (Red Deer 63S to Nevis 766S)	32.5%	27.9%	-	25.1%	43.3%	24.3%	24.3%	43.0%	43.1%	45.3%	25.1%	46.6%	38.7%
	7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)	7L50 (Buffalo Creek 526S to Jarrow Tap)	4.1%	2.4%	-	2.5%	4.4%	2.5%	2.5%	6.4%	6.4%	4.5%	2.5%	2.2%	6.2%
	899ST3A (Edgerton 899S Transformer T3A)	7L130 (Vermilion 710S to Kitscoty 705S)	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		7L50 (Buffalo Creek 526S to Jarrow Tap)	4.1%	2.4%	-	2.5%	4.4%	2.5%	2.5%	6.4%	6.4%	4.5%	2.5%	2.2%	6.1%
	912L_9L912 (Red Deer 63S to Nevis 766S)	701L (North Holden 395S to Strome 223S)	8.7%	7.1%	-	6.6%	11.5%	6.5%	6.5%	17.0%	17.1%	12.0%	6.6%	9.4%	9.6%
		701L (Strome 223S to Heisler Tap)	9.5%	7.8%	-	7.3%	12.6%	7.1%	7.1%	18.7%	18.8%	13.2%	7.3%	10.3%	10.5%
		7L50 (Buffalo Creek 526S to Jarrow Tap)	5.8%	4.6%	-	4.3%	7.5%	4.3%	4.3%	9.9%	9.9%	7.8%	4.3%	5.9%	3.5%
		7L701 (Heisler Tap to Battle River 757S)	9.1%	7.0%	-	6.9%	12.2%	6.8%	6.8%	19.0%	19.1%	12.8%	6.9%	9.1%	10.2%
	966L_9L966 (Hansman Lake 650S to Pemukan 932S)	7L127 (Monitor 774S to Pemukan 932S)	26.5%	4.3%	-	5.9%	-6.8%	5.7%	5.7%	-8.2%	-8.2%	-8.1%	5.9%	-0.9%	-23.1%
	9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	7.6%	15.2%	-	8.6%	8.1%	7.1%	7.1%	9.4%	9.5%	8.3%	8.6%	54.8%	7.9%
		7L50 (Buffalo Creek 526S to Jarrow Tap)	5.2%	3.1%	-	3.6%	6.9%	3.6%	3.6%	9.2%	9.2%	7.2%	3.6%	1.5%	2.7%
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	2.0%	20.8%	-	23.6%	1.1%	2.5%	2.5%	4.0%	4.0%	1.0%	23.7%	62.5%	1.6%
		7L159 (Ghost Tap to Heatburg 948S)	1.1%	24.6%	-	29.0%	-0.2%	2.2%	2.2%	-0.3%	-0.3%	-0.4%	29.1%	74.0%	0.1%
		7L16 (Nevis 766S to Heatburg 948S)	1.0%	22.3%	-	26.0%	-0.1%	2.0%	2.0%	-0.2%	-0.2%	-0.4%	26.1%	68.2%	0.1%
		7L85 (Bullpound 803S to Anderson 801S)	-0.7%	60.6%	-	40.9%	0.5%	-2.4%	-2.4%	1.3%	1.3%	0.8%	40.9%	22.1%	0.4%
		7L85 (Wintering Hills 804S to Bullpound 803S)	-0.7%	64.5%	-	44.1%	0.5%	-2.6%	-2.6%	1.4%	1.4%	0.8%	44.1%	23.7%	0.4%
	EATL	7L50 (Buffalo Creek 526S to Jarrow Tap)	2.7%	1.8%	-	1.9%	3.8%	1.9%	1.9%	6.5%	6.5%	3.9%	1.9%	1.9%	-0.1%
		912L\9L912 (Red Deer 63S to Nevis 766S)	29.4%	24.7%	-	22.3%	40.1%	21.6%	21.6%	37.5%	37.6%	42.0%	22.4%	43.8%	36.3%
	267ST1 (Killarney Lake 267S Transformer T1)	7L129 (Bauer Tap to Vermilion 710S)	3.9%	2.3%	42.5%	2.5%	4.2%	2.4%	2.4%	6.1%	6.1%	4.3%	2.5%	2.2%	-
		7L129 (Buffalo Creek 526S to Bauer Tap)	4.2%	2.5%	44.6%	2.6%	4.4%	2.6%	2.6%	6.5%	6.5%	4.6%	2.6%	2.3%	-
		7L130 (Vermilion 710S to Kitscoty 705S)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
		7L14 (Kitscoty 705S to Hill 751S)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
		912L\9L912 (Red Deer 63S to Nevis 766S)	31.0%	26.7%	27.0%	23.9%	41.0%	23.1%	23.1%	37.7%	37.8%	42.9%	23.9%	45.2%	-
	377ST1 (Hardisty 377S Transformer T1)	7L129 (Buffalo Creek 526S to Bauer Tap)	2.7%	2.0%	48.2%	2.0%	3.9%	2.0%	2.0%	6.7%	6.7%	4.1%	2.0%	2.0%	-1.3%
	526ST1 OR 526ST2 (Buffalo Creek 526S Transformer T1 or T2)	749L (Edgerton 899S to Killarney Tap)	4.1%	1.7%	-	2.0%	2.7%	1.9%	1.9%	1.9%	1.9%	2.7%	2.0%	1.3%	16.9%
	701L (North Holden 395S to Strome 223S)	7L129 (Bauer Tap to Vermilion 710S)	3.6%	2.5%	47.0%	2.6%	4.7%	2.6%	2.6%	8.5%	8.5%	5.0%	2.6%	2.6%	0.5%
		7L129 (Buffalo Creek 526S to Bauer Tap)	3.8%	2.7%	49.0%	2.7%	5.0%	2.7%	2.7%	8.9%	9.0%	5.2%	2.7%	2.7%	0.5%
		912L\9L912 (Red Deer 63S to Nevis 766S)	32.4%	27.9%	29.0%	25.0%	43.1%	24.2%	24.2%	42.5%	42.7%	45.0%	25.1%	46.5%	38.4%
		174L (Bardo 197S to North Holden 395S)	7.9%	5.8%	16.3%	5.7%	9.6%	5.6%	5.6%	12.9%	13.0%	10.0%	5.7%	6.9%	11.6%

Scenario and Case Name	Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Generating Facility Name and Unit Number												
			Sharp Hills	Wintering Hills	Planned Irma Wind Power Project	Suncor Hand Hills	Halkirk	Sheerness # 1	Sheerness # 2	Battle River # 3	Battle River # 4	Battle River # 5	BluEarth Hand Hills	Ghost Pine	Bull Creek DG
2018 Summer Peak Post-Project Case B	766S901T (Nevis 766S Transformer 901T)	701L (North Holden 395S to Strome 223S)	8.5%	6.8%	5.5%	6.5%	11.3%	6.4%	6.4%	16.7%	16.8%	11.8%	6.5%	8.6%	9.4%
		701L (Strome 223S to Heisler Tap)	9.4%	7.6%	6.1%	7.2%	12.4%	7.0%	7.0%	18.4%	18.5%	13.0%	7.2%	9.5%	10.3%
		7L129 (Bauer Tap to Vermilion 710S)	5.7%	4.3%	50.0%	4.2%	7.4%	4.1%	4.1%	9.6%	9.6%	7.7%	4.2%	5.0%	3.3%
		7L129 (Buffalo Creek 526S to Bauer Tap)	6.0%	4.6%	52.5%	4.5%	7.8%	4.4%	4.4%	10.2%	10.2%	8.1%	4.5%	5.3%	3.5%
		7L701 (Heisler Tap to Battle River 757S)	9.2%	6.0%	6.5%	6.6%	12.5%	6.6%	6.6%	18.9%	18.9%	13.1%	6.6%	4.5%	10.4%
	7L129_7LA129 (Buffalo Creek 526S to Vermilion 710S to Bauer 918S)	749L (Edgerton 899S to Killarney Tap)	4.1%	1.8%	2.5%	2.0%	2.7%	2.0%	2.0%	1.9%	1.9%	2.7%	2.0%	1.4%	17.0%
		912L\9L912 (Red Deer 63S to Nevis 766S)	31.4%	27.1%	36.6%	24.3%	41.8%	23.5%	23.5%	39.5%	39.5%	43.7%	24.3%	45.7%	36.5%
	7L42 (Hill 751S to Lloydminster 716S)	7L129 (Bauer Tap to Vermilion 710S)	4.1%	2.4%	42.1%	2.6%	4.3%	2.5%	2.5%	6.3%	6.3%	4.5%	2.6%	2.3%	6.0%
		7L129 (Buffalo Creek 526S to Bauer Tap)	4.3%	2.6%	43.9%	2.7%	4.5%	2.7%	2.7%	6.6%	6.6%	4.7%	2.7%	2.4%	6.3%
	7L701_7LA701_701L (Battle River 757S to Heisler 764S to Strome 223S)	7L129 (Bauer Tap to Vermilion 710S)	3.5%	2.5%	46.9%	2.6%	4.7%	2.5%	2.5%	8.4%	8.4%	4.9%	2.6%	2.5%	0.5%
		7L129 (Buffalo Creek 526S to Bauer Tap)	3.7%	2.7%	49.1%	2.7%	4.9%	2.7%	2.7%	8.8%	8.9%	5.2%	2.7%	2.7%	0.5%
		912L\9L912 (Red Deer 63S to Nevis 766S)	32.3%	27.8%	29.2%	25.0%	43.0%	24.2%	24.2%	42.4%	42.6%	45.0%	25.0%	46.4%	38.4%
	7L749_749L_7LB749 (Edgerton 899S to Briker 880S to Lloydminster 716S)	7L129 (Bauer Tap to Vermilion 710S)	4.1%	2.4%	42.4%	2.5%	4.3%	2.5%	2.5%	6.2%	6.2%	4.4%	2.5%	2.2%	5.9%
		7L129 (Buffalo Creek 526S to Bauer Tap)	4.3%	2.5%	44.3%	2.7%	4.5%	2.6%	2.6%	6.5%	6.6%	4.7%	2.7%	2.4%	6.2%
	7L77 (North Holden 395S to Vegreville 709S)	7L129 (Buffalo Creek 526S to Bauer Tap)	2.6%	2.0%	44.7%	2.0%	3.8%	2.0%	2.0%	7.0%	7.0%	4.0%	2.0%	2.0%	-1.6%
	899ST3A (Edgerton 899S Transformer T3A)	7L129 (Bauer Tap to Vermilion 710S)	4.0%	2.4%	42.5%	2.5%	4.2%	2.5%	2.5%	6.2%	6.2%	4.4%	2.5%	2.2%	5.8%
		7L129 (Buffalo Creek 526S to Bauer Tap)	4.2%	2.5%	44.4%	2.6%	4.5%	2.6%	2.6%	6.5%	6.5%	4.6%	2.6%	2.3%	6.1%
		7L130 (Vermilion 710S to Kitscoty 705S)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	912L_9L912 (Red Deer 63S to Nevis 766S)	174L (Bardo 197S to North Holden 395S)	7.9%	6.0%	16.3%	5.7%	9.6%	5.6%	5.6%	12.9%	13.0%	9.9%	5.7%	7.7%	11.6%
		701L (North Holden 395S to Strome 223S)	8.5%	7.0%	5.5%	6.6%	11.2%	6.4%	6.4%	16.7%	16.8%	11.7%	6.6%	9.2%	9.4%
		701L (Strome 223S to Heisler Tap)	9.4%	7.7%	6.1%	7.2%	12.4%	7.1%	7.0%	18.4%	18.5%	12.9%	7.2%	10.2%	10.3%
		7L129 (Bauer Tap to Vermilion 710S)	5.6%	4.5%	49.9%	4.2%	7.3%	4.2%	4.2%	9.5%	9.6%	7.6%	4.3%	5.9%	3.2%
		7L129 (Buffalo Creek 526S to Bauer Tap)	6.0%	4.8%	52.5%	4.5%	7.7%	4.4%	4.4%	10.1%	10.2%	8.0%	4.5%	6.2%	3.4%
		7L701 (Heisler Tap to Battle River 757S)	9.0%	7.0%	6.3%	6.8%	12.0%	6.7%	6.7%	18.7%	18.8%	12.6%	6.8%	9.0%	10.0%
	9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	7.4%	15.0%	6.4%	8.5%	7.9%	7.0%	7.0%	9.1%	9.1%	8.0%	8.5%	54.7%	7.7%
		7L129 (Bauer Tap to Vermilion 710S)	5.0%	3.1%	49.1%	3.5%	6.7%	3.5%	3.5%	8.9%	8.9%	7.0%	3.5%	1.5%	2.6%
		7L129 (Buffalo Creek 526S to Bauer Tap)	5.3%	3.3%	51.4%	3.7%	7.1%	3.7%	3.7%	9.4%	9.4%	7.4%	3.7%	1.5%	2.7%
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	2.0%	20.7%	2.1%	23.6%	1.0%	2.5%	2.5%	3.9%	4.0%	0.9%	23.6%	62.4%	1.6%
		7L159 (Ghost Tap to Heatburg 948S)	1.1%	24.6%	-0.3%	29.1%	-0.2%	2.2%	2.2%	-0.3%	-0.3%	-0.4%	29.1%	74.0%	0.1%
		7L16 (Nevis 766S to Heatburg 948S)	1.0%	22.4%	-0.2%	26.1%	-0.1%	2.0%	2.0%	-0.2%	-0.2%	-0.3%	26.1%	68.1%	0.1%
		7L85 (Bullpound 803S to Anderson 801S)	-0.7%	60.6%	0.9%	40.8%	0.5%	-2.4%	-2.4%	1.3%	1.3%	0.8%	40.8%	22.1%	0.3%
		7L85 (Wintering Hills 804S to Bullpound 803S)	-0.7%	64.6%	1.0%	44.0%	0.5%	-2.6%	-2.6%	1.4%	1.4%	0.8%	44.1%	23.7%	0.4%
	9L46 (Lanfine 959S to Sedalia 363S)	912L\9L912 (Red Deer 63S to Nevis 766S)	42.1%	25.1%	32.1%	21.5%	43.3%	20.8%	20.8%	40.6%	40.7%	45.6%	21.6%	45.6%	43.0%
	9L934_934L (Ware Junction 132S to Anderson 801S)	912L\9L912 (Red Deer 63S to Nevis 766S)	31.7%	27.8%	29.4%	25.2%	41.8%	24.5%	24.5%	38.6%	38.7%	43.6%	25.3%	46.0%	37.7%
	EATL	7L129 (Bauer Tap to Vermilion 710S)	2.7%	1.9%	47.0%	1.9%	3.6%	1.9%	1.9%	6.3%	6.3%	3.8%	1.9%	1.9%	-0.2%
		7L129 (Buffalo Creek 526S to Bauer Tap)	2.9%	2.0%	49.3%	2.0%	3.9%	2.0%	2.0%	6.6%	6.7%	4.0%	2.0%	2.1%	-0.2%
		912L\9L912 (Red Deer 63S to Nevis 766S)	29.3%	24.6%	28.6%	22.3%	39.8%	21.6%	21.6%	37.1%	37.2%	41.7%	22.3%	43.6%	36.1%
2018 Winter Peak Post-Project Case A	267ST1 (Killarney Lake 267S Transformer T1)	7L130 (Vermilion 710S to Kitscoty 705S)	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	-
	7L50 (Battle River 757S to Jarrow 252S to Buffalo Creek 526S)	749L (Edgerton 899S to Killarney Tap)	4.2%	1.7%	-	1.9%	2.7%	1.9%	1.9%	1.8%	1.8%	2.6%	1.9%	1.3%	16.9%
	966L_9L966 (Hansman Lake 650S to Pemukan 932S)	7L127 (Monitor 774S to Pemukan 932S)	26.2%	3.9%	-	5.5%	-7.2%	5.2%	5.2%	-8.6%	-8.6%	-8.6%	5.5%	-1.2%	-24.0%
	9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	6.9%	14.5%	-	8.0%	7.5%	6.5%	6.5%	8.7%	8.8%	7.6%	8.0%	54.3%	7.4%
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	1.9%	20.4%	-	23.3%	0.9%	2.4%	2.4%	3.8%	3.8%	0.8%	23.4%	62.3%	1.5%
2018 Winter Peak Post-Project Case B	267ST1 (Killarney Lake 267S Transformer T1)	7L129 (Buffalo Creek 526S to Bauer Tap)	4.0%	2.3%	44.5%	2.4%	4.2%	2.4%	2.4%	6.2%	6.2%	4.3%	2.4%	2.2%	-
		7L130 (Vermilion 710S to Kitscoty 705S)	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
	766S901T (Nevis 766S Transformer 901T)	7L129 (Bauer Tap to Vermilion 710S)	5.3%	4.0%	49.9%	3.9%	7.0%	3.8%	3.8%	9.1%	9.2%	7.3%	3.9%	4.8%	3.0%
		7L129 (Buffalo Creek 526S to Bauer Tap)	5.7%	4.3%	52.6%	4.1%	7.4%	4.0%	4.0%	9.7%	9.8%	7.7%	4.1%	5.1%	3.2%
	912L_9L912 (Red Deer 63S to Nevis 766S)	7L129 (Buffalo Creek 526S to Bauer Tap)	5.6%	4.4%	52.5%	4.2%	7.3%	4.1%	4.1%	9.7%	9.7%	7.6%	4.2%	5.9%	3.1%
	9L20 (Nevis 766S to Cordel 755S)	766S901T (Nevis 766S Transformer 901T)	6.9%	14.6%	6.0%	8.0%	7.4%	6.5%	6.5%	8.6%	8.6%	7.5%	8.0%	54.4%	7.3%
	9L29 (Oakland 946S to Coyote Lake 963S)	766S901T (Nevis 766S Transformer 901T)	1.9%	20.9%	2.0%	24.0%	0.9%	2.4%	2.4%	3.8%	3.8%	0.8%	24.1%	62.6%	1.5%