Engineering Connection Assessment

P3076 Thornton 2091S Substation Upgrade

ATCO Electric Ltd.

Date: Oct. 19, 2026

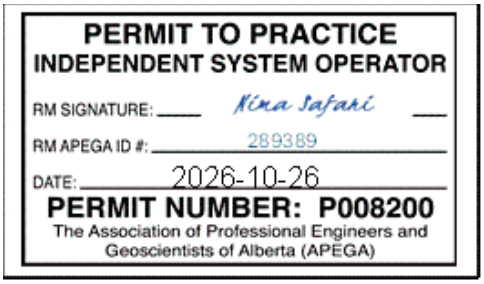
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2026-10-25



NOTE:

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

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

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Attachment A: Table A-1: Summary of Category B Reliability Criteria Violations, Project Impact and Mitigation Measures- All Scenarios

Appendix

Appendix A: Engineering Connection Assessment Results

1 Introduction

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

Attached to this Engineering Connection Assessment are the results of the engineering studies and the scope and methodology used to perform the studies (see Appendix 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

ATCO Electric Ltd. (Market Participant), in its capacity as the legal owner of an electric distribution system (DFO), has submitted a request for system access service to the AESO to serve growing demand for electricity in the Grand Cache area (Area 22).

The DFO's request includes a request for a Rate DTS, *Demand Transmission Service*, contract capacity increase of 26.5 MW, from 25 MW to 51.5 MW, at the existing Thornton 2091S substation and a request for transmission development (collectively, the Project). Details on the need for transmission development can be found in the DFO's Distribution Deficiency Report (DDR).

The scheduled in-service date (ISD) for the Project is September 1, 2027.

2 Assessment Scope

2.1 Objectives

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

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

2.2 Existing System

Geographically, the Project is located in the AESO planning area of Grand Cache (Area 22), which is part of the AESO's Northwest planning region. The Grande Cache area is surrounded by the planning areas of Grand Prairie (area 20), Valleyview (Area 23), Hinton/Edson (Area 29), and Fox Creek (Area 24).

From a transmission system perspective, the Grande Cache area consists primarily of a 144 kV transmission system. The Grande Cache area is connected to the Grand Prairie area by the 144 kV line 7L228, and the Valleyview area by the 144 kV line 7L40.

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

2.3 Study Area

The Study Area for the Project consists of the AESO planning areas of Grande Cache (Area 22), Grande Prairie (Area 20), Valleyview (Area 23), Fox Creek (Area 24), and Swan Hills (Area 26), 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 Appendix A – A1: Engineering Connection Assessment Scope).

3 Connection Alternatives

3.1 Overview

The AESO, in consultation with the TFO in the Study Area and the DFO, examined three transmission alternatives to meet the DFO's request for system access service, as detailed in Section 3.2.[1]

3.2 Connection Alternatives Examined

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

Alternative 1 – Upgrade Thornton 2091S substation

This alternative includes the following developments:

- Upgrade Thornton 2091S substation, including adding one 144/25 kV transformer with a minimum capacity of 7.2 MVA and one 144 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission developments.

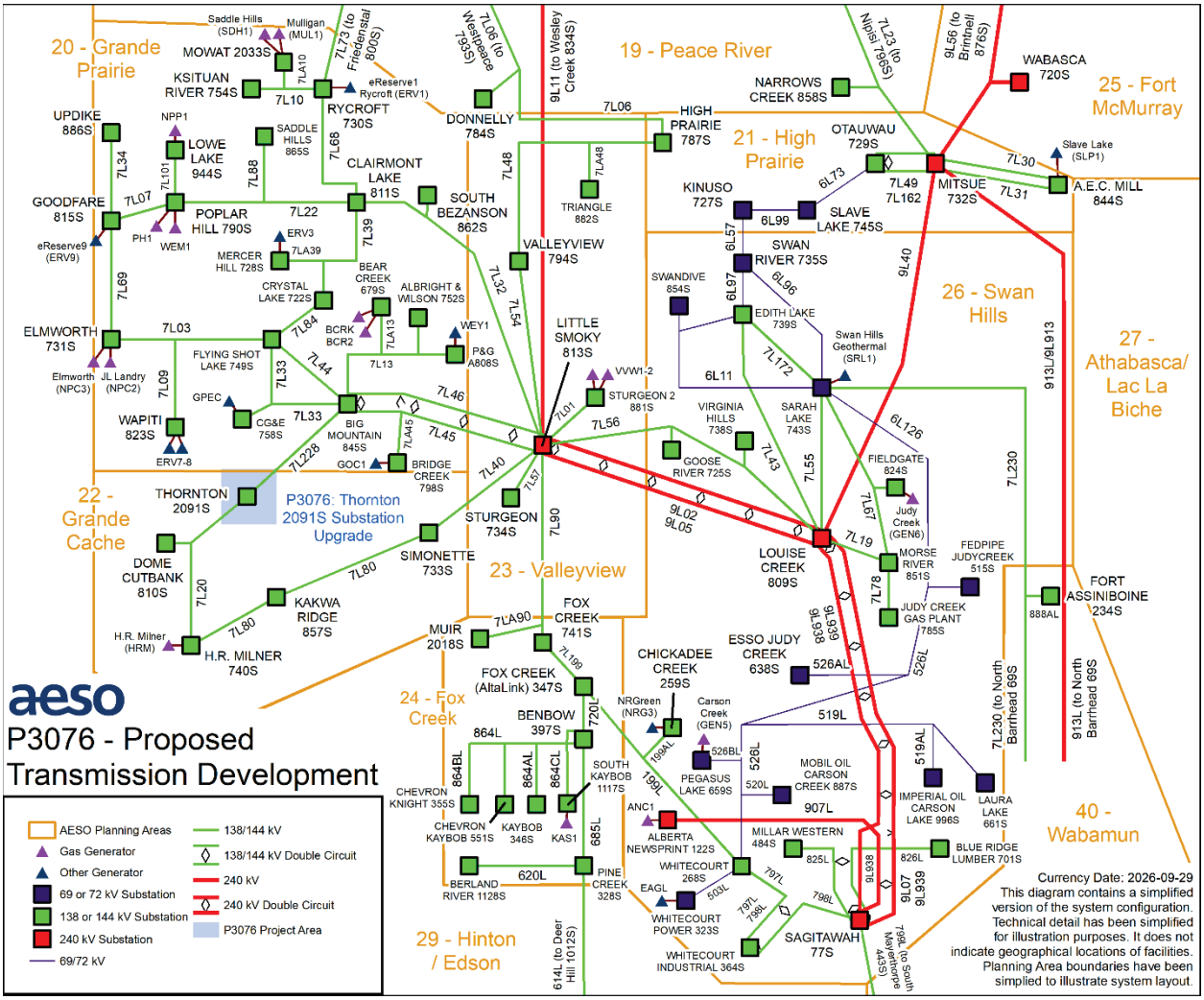
The DFO has advised that this alternative will require adding approximately 44 km[2] of distribution feeders.

The proposed connection configuration is shown in **Error! Reference source not found.**.

[1] ATCO also examined and ruled out distribution only alternatives, as detailed in Section 5 of their *Distribution Deficiency Report*, attached as Appendix D of the Needs Identification Document.

[2] Exact line length to be determined by the DFO.

Figure 3-1: Connection Alternative 1



Alternative 2 – Point of Delivery with a T-tap connection to the 144 kV transmission line 7L20

This alternative includes the following developments:

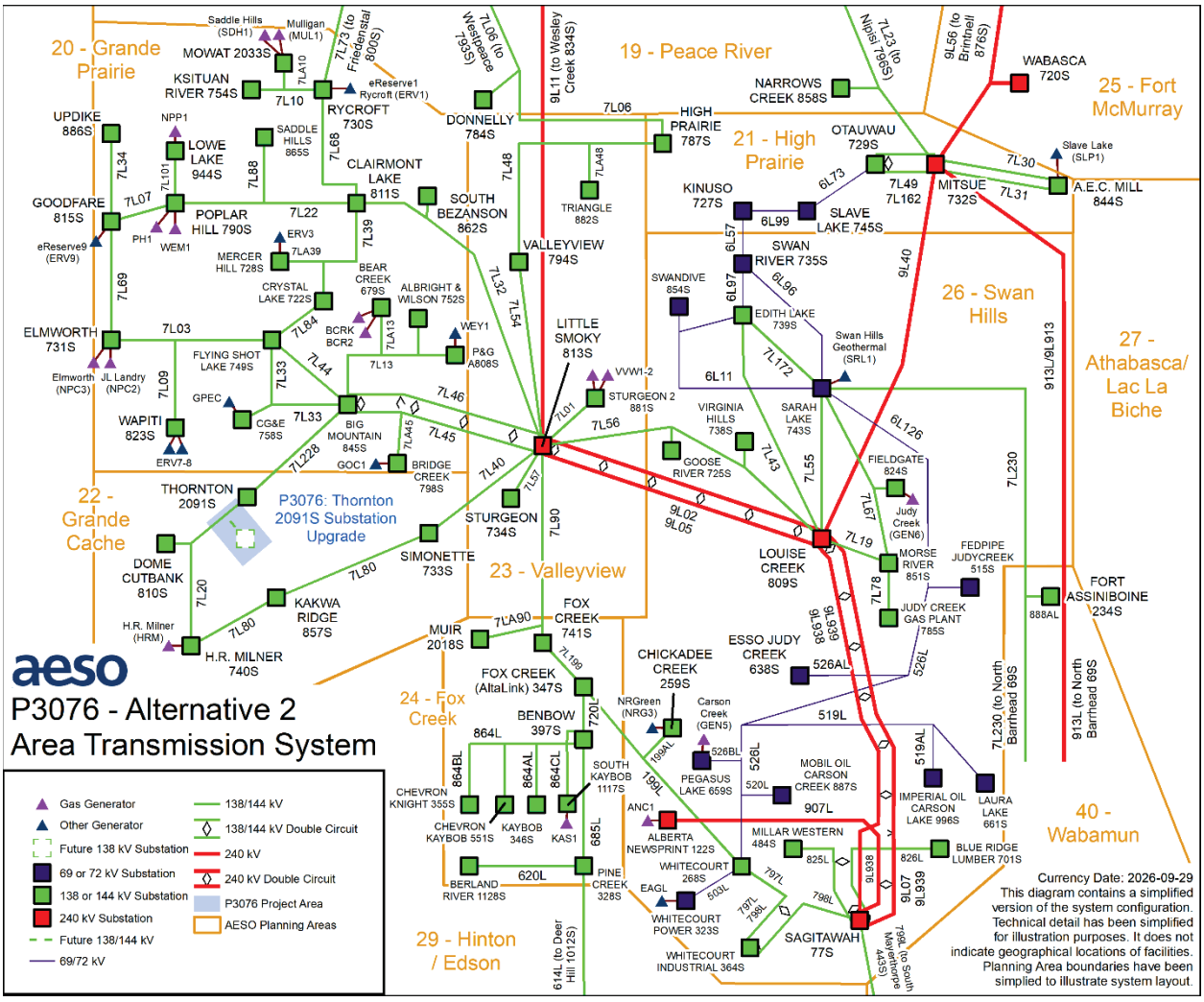
- Add one point of delivery (POD) substation, including one 144/25 kV transformer with a minimum capacity of 29.5MVA and one 144 kV circuit breaker;
- Add one 144 kV circuit, approximately 24 km[3] in length, to connect the POD to the existing 144 kV transmission line 7L20 using a T-tap configuration; and
- Add or modify associated equipment as required for the above transmission developments.

[3] Exact line length to be determined by the TFO.

The DFO has advised that this alternative will require adding approximately 2 km[4] of double circuit distribution feeders.

The proposed connection configuration is shown in Figure 3-2

Figure 3-2: Connection Alternative 2



Alternative 3 – Point of Delivery with a T-tap connection to the 144 kV transmission line 7L228

This alternative includes the following developments:

- Add one POD substation, including one 144/25 kV transformer with a minimum capacity of 29.5MVA, and one 144 kV circuit breaker;
- Add one 144 kV circuit, approximately 20 km[5] in length, to connect the POD to the existing 144 kV transmission line 7L228 using a T-tap configuration; and

[4] Exact line length to be determined by the DFO.

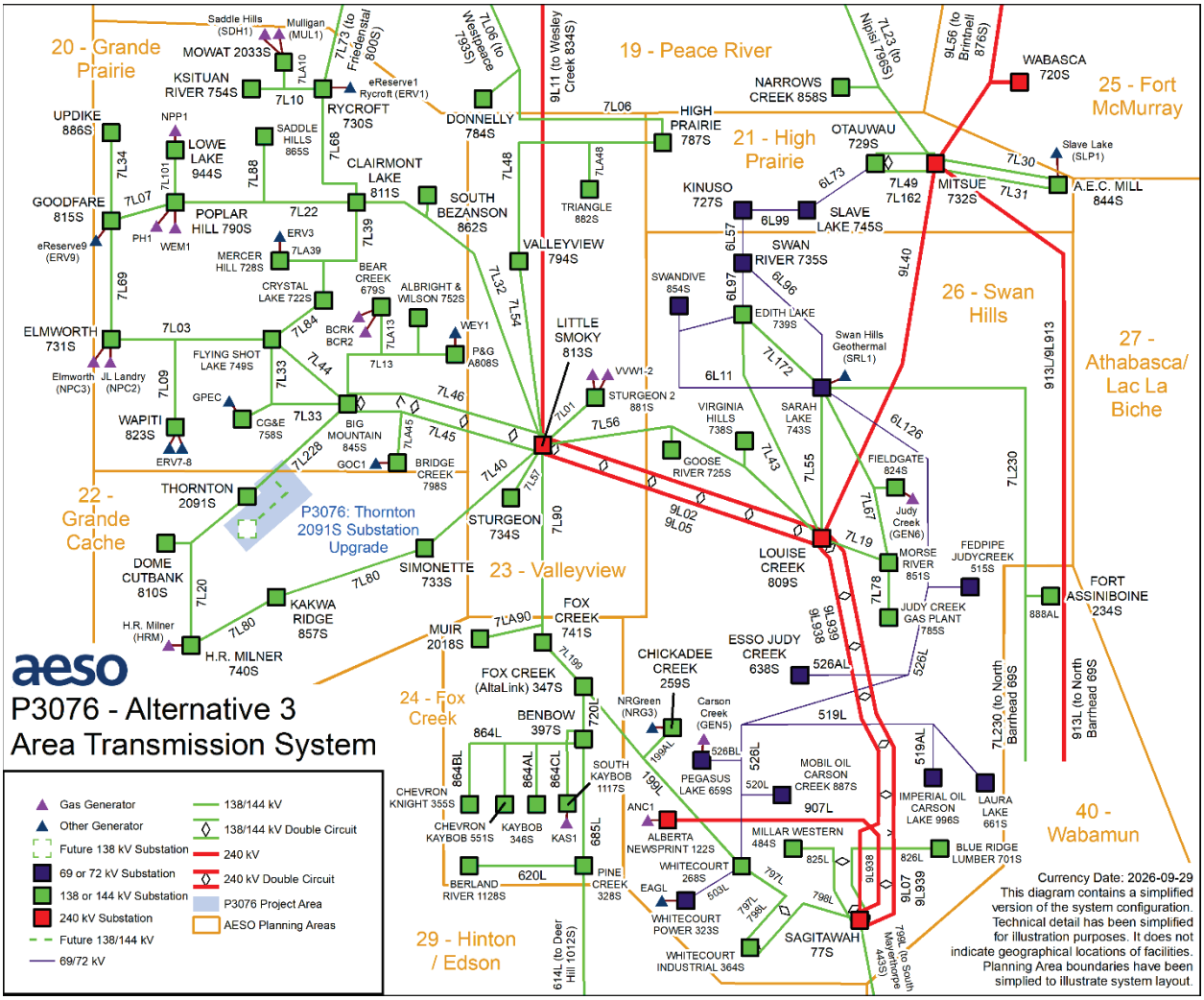
[5] Exact line length to be determined by the TFO.

- Add or modify associated equipment as required for the above transmission developments.

The DFO has advised that this alternative will require adding approximately 2 km[6] of double circuit distribution feeders.

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

Figure 3-3: Connection Alternative 3



3.3 Connection Alternatives Selected for Further Study

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

[6] Exact line length to be determined by the DFO.

3.4 Connection Alternatives Not Selected for Further Study

Alternatives 2 and 3 require overall increased development (combined transmission and distribution scope), and hence, overall increased cost compared to Alternative 1 and were therefore ruled out.

4 Assessment Approach

4.1 Standards, Criteria and Assumptions

A detailed description of the standards, criteria, and assumptions that were used for the connection assessment is provided in Appendix A.

4.2 Studies Performed

Studies were performed using scenarios for 2029 Summer Peak (SP) and 2029 Winter Peak (WP).

Short-circuit studies were performed using the 2029 WP pre-Project and post-Project scenarios and 2034 WP post-Project scenarios.

Table 4-1 lists the study scenarios. Post-Project scenarios reflect the requested Rate DTS contract capacity increase of 26.5 MW at the Thornton 2091S substation.

The AESO included five sensitivity scenarios to study the impacts of Rate DTS increases at the existing Muir 2018S (from 28 MW to 39.9 MW) and Simonette 733S (from 16.8 MW to 44 MW) substations, which were effective in March 2026. These DTS increases are being managed under AESO Project P3072 Greenview Area Load.

As the DTS increases at Muir 2018S and Simonette 733S substations were effective in March 2026, Scenarios 1-5 are no longer applicable. The subsequent sections will discuss only Scenarios 6 and 7 (Pre-Project) and Scenarios 8-10 (Post-Project).

Table 4-1: Connection Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	Project Load (MW)	Project Generation (MW)
Pre-Project					
1	2029 Summer Peak (SP)	Low Generation (LG)	2029 SP LG Pre-Project	0	0
2	2029 Winter Peak (WP)	LG	2029 WP LG Pre-Project	0	0
Post-Project					
3	2029 SP	LG	2029 SP LG Post-Project	26.5	0
4	2029 WP	LG	2029 WP LG Post-Project	26.5	0
5	2034 WP	All generators in study area in-service	2034 WP Post-Project	26.5	0
Pre-Project Sensitivity –P3072 Increases at Muir 2018S and Simonette 733S					
6	2029 SP	LG	2029 SP LG Post-Project	0	0
7	2029 WP	LG	2029 WP LG Post-Project	0	0
Post-Project Sensitivity –P3072 Increases at Muir 2018S and Simonette 733S					

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	Project Load (MW)	Project Generation (MW)
8	2029 SP	LG	2029 SP LG Post-Project	26.5	0
9	2029 WP	LG	2029 WP LG Post-Project	26.5	0
10	2034 WP	All generators in study area in-service	2034 WP Post-Project	26.5	0

The AESO Planning Region load forecasts used for the connection studies were based on the 2024 Long-term Outlook (2024 LTO).

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 POD low voltage bus voltage deviations beyond the limits listed in Table 3-1 of Appendix A – A1: Engineering Connection Assessment Scope.[7]

Power flow studies were performed for 2029 SP and 2029 WP pre-Project and post-Project scenarios.

4.2.2 Voltage Stability Studies

The purpose of the voltage stability studies is to determine the ability of the transmission system to maintain voltage stability at the busses in the Study Area.

Voltage stability studies were performed for 2029 WP post-Project scenarios.

4.2.3 Transient Stability Studies

Transient studies were performed to ensure adequate voltage recovery response after certain transmission line outages.

Transient stability studies were performed for 2029 WP pre-Project and post-Project scenarios.

4.2.4 Short-Circuit Current Level Studies

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

Short circuit studies were performed for the 2029 WP pre-Project scenario and for 2029 WP and 2034 WP post-Project scenarios.

[7] 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 Appendix A - Engineering Connection Assessment Scope 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 Appendix A.

4.3 Mitigation Measure Development and Evaluation

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

4.3.1 Post-Mitigation Studies

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

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 Attachment A.

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

Detailed study results are provided in Appendix A.

5.2 Pre-Project Sensitivity Study Results

5.2.1 Category A Condition

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

The short-circuit fault levels were found to be within the typical capabilities of the nearby facilities.

5.2.2 Category B Conditions

The pre-Project studies identified a number of thermal, voltage range, voltage stability and transient stability violations under Category B conditions.

Voltage deviations beyond the limits listed in Table 3-1 of Appendix A – A1: Engineering Connection Assessment Scope (hereafter referred to as POD bus voltage deviations) were observed under Category B conditions.

See Attachment A for details.

5.3 Post-Project Sensitivity Study Results

5.3.1 Category A Condition

No Reliability Criteria violations were observed under the Category A condition for any post-Project scenarios. Post-Project short-circuit fault levels were not significantly higher than pre-Project levels.

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

5.3.2 Category B Conditions

All of the thermal, voltage range, voltage stability and transient stability criteria violations observed in the pre-Project studies were also observed in the post-Project studies under Category B conditions.

Following the connection of the Project, some of these violations were exacerbated.

A new POD bus voltage deviation was also observed under Category B conditions.

See Attachment A for details.

5.4 Mitigation Measures

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

5.4.1 Pre-Project

Prior to the connection of the Project, the observed thermal violations can be mitigated by dispatching Transmission Must Run (TMR) generation and real-time operational practices (RTOP).

The AESO is advancing system project P7112 7L40 Fault Clearing Mitigation, which involves adding tele-protection grade telecommunications (TPR) to the existing Simonette 733S substation and modifying 7L40

line protection with a planned ISD of Q4 2027. In addition, the TFO has an ongoing capital maintenance project that adds TPR to H.R. Milner 740S substation, with a planned ISD of December 31, 2026.

Voltage range, voltage stability and transient stability violations can be mitigated by:

- Existing RAS 242 (before P7112 and the TFO capital maintenance project are in service); then
- Energization of P7112; then
- Planned RASs 245 246, 247[8] (after the TFO capital maintenance project is also in service); and finally, on a permanent basis
- The installation of capacitor banks at Simonette 733S, H.R. Milner 740S and the planned Pearson 2089S substation as part of P3072 Greenview Area Load,[9] which will remove the need for planned RASs 245, 246 and 247.

5.4.2 Post-Project

After the connection of the Project, the observed thermal violations under Category B system conditions can be mitigated by using RTOP, including the existing TMR service. This project is not expected to require any additional application of TMR service beyond the existing TMR requirements.

The voltage range, voltage stability and transient stability violations observed under Category B system conditions can be mitigated by:

- Existing RAS 242 and new RAS 248[10] (before P7112 and the TFO capital maintenance project are in service); then
- Energization of P7112; then
- Planned RASs 245 and 247 and modified planned RAS 246[11] (after the TFO capital maintenance project is also in service); and finally, on a permanent basis
- The installation of capacitor banks at Simonette 733S, H.R. Milner 740S and the planned Pearson 2089S substation as part of P3072 Greenview Area Load, which will remove the need for RASs 245, 246 and 247.

5.4.3 Post-Project Mitigation Study Results

Under Category B conditions, all of the observed Reliability Criteria violations were mitigated.

[8] Planned RASs 245, 246, and 247 are part of P3072 Greenview Area Load. These RASs, which replace existing RAS 242 after P7112 and the TFO capital maintenance project are in service, activate to trip load at Simonette 733S to mitigate voltage violations observed after the loss of 7L20 (Planned RAS 245), 7L40 (Planned RAS 246), and 7L228 (Planned RAS 247).

[9] The AESO expects to file its Needs Identification Document for P3072 Greenview Area Load in early 2027.

[10] New RAS 248 (which will be in use if the Project energizes before P7112 and the TFO capital maintenance project) operates based on undervoltage detection at Thornton 2091S to mitigate the voltage violations observed after the loss of 7L40.

[11] Modified RAS 246 (which replaces new RAS 248 after P7112 and TFO capital maintenance project are in service) activates to trip load at Thornton 2091S, in addition to tripping load at Simonette 733S, to mitigate voltage violations observed after the loss of 7L40.

6 Project Dependencies

The Project can be energized without the completion of any other AESO plans to expand or enhance the transmission system by using the RASs as identified in Section 5.

Removal of the RASs depends on the completion of system project P7112,[12] and the addition of capacitor banks under AESO Project P3072 Greenview Area Load which has a planned ISD of March 1, 2028. If the P3072 Greenview Area Load transmission development does not proceed, additional capacitor banks may be required in the area.

[12] AESO Project P7112 7L40 Fault Clearing Mitigation has a planned ISD of Q4 2027.

7 Conclusions and Recommendations

Based on the study results, Alternative 1 is technically viable. The connection assessment identified a number of pre-Project and post-Project system performance issues under Category B conditions.

All of the thermal criteria violations observed under Category B conditions can be mitigated through RTOP, including dispatching generation under TMR service, alone or in combination, as appropriate.

The voltage range, voltage stability and transient stability violations observed under Category B system conditions can be mitigated by using temporary RASs, as discussed in Section 5. These RASs will be removed following the addition of capacitor banks contemplated under AESO Project P3072 Greenview Area Load and the completion of AESO system project P7112. If the capacitor bank addition is cancelled, additional transmission development may be required.

The AESO recommends proceeding with the Project using Alternative 1 as the preferred alternative to respond to the DFO's request for system access service. Alternative 1 involves upgrading the existing Thornton 2091S substation, including adding one 144/25 kV transformer and one 144 kV circuit breaker. The transformer should have a minimum rating of 7.2 MVA to meet the DFO's requested DTS.

Attachment A:
Table A-1: Summary of Category B Reliability Criteria Violations, Project Impact and Mitigation Measures- All Scenarios

Table A-1: Summary of Category B Reliability Criteria Violations, Project Impact and Mitigation Measures

Scenario	Type of Reliability Criteria Violation		Contingency (System Element Lost)	Details of Violation	Project Impact	Pre-Project Mitigation Measures	Post-Project Mitigation Measures
	Pre-Project	Post-Project					
2029 SP Sensitivity	Thermal - above normal rating	Thermal - above normal rating	9L05 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	Materially increased violation	Dispatching TMR	Dispatching TMR
	Thermal - above normal rating	Thermal - above normal rating	7L13 (Big Mountain 845S - Procter & Gamble 808S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	Materially increased violation	Dispatching TMR	Dispatching TMR
	Thermal - above normal rating	Thermal - above normal rating	7L56 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	Materially increased violation	Dispatching TMR	Dispatching TMR
	Thermal - above normal rating	Thermal - above normal rating	7L75 (Friednestal 800S - West Peace River 793S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	Materially increased violation	Dispatching TMR	Dispatching TMR
	Thermal - above normal rating	Thermal - above normal rating	Bear Creek 679S 701T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	Materially increased violation	Dispatching TMR	Dispatching TMR
	Thermal - above normal rating	Thermal - above normal rating	Little Smoky 813S 901T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	Materially increased violation	Dispatching TMR	Dispatching TMR
	Thermal - above normal rating	Thermal - above normal rating		Little Smoky 813S 902T	Materially increased violation	Dispatching TMR	Dispatching TMR
	Thermal - above normal rating	Thermal - above normal rating	Little Smoky 813S 902T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	Materially increased violation	Dispatching TMR	Dispatching TMR
	Thermal - above normal rating	Thermal - above normal rating		Little Smoky 813S 902T	Materially increased violation	Dispatching TMR	Dispatching TMR
	Voltage – Low voltage	Voltage – Low voltage	7L228 (Big Mountain 845S - Thornton 2091S)	Dome Cutbank 810S	No impact	Existing RAS 242 Planned RAS 247 P3072 Capacitor bank additions	Existing RAS 242 Planned RAS 247 P3072 Capacitor bank additions
	Voltage – Low voltage	Voltage – Low voltage		H.R. Milner 740S	No impact		
2029 WP Sensitivity	Voltage stability	Voltage stability	7L40 (Little Smoky 813S – Simonette 733S)	Voltage collapse	Voltage collapse in both Pre and Post	Existing RAS 242 Planned RAS 246 P3072 Capacitor bank additions	Existing RAS 242 and New RAS 248 Modified RAS 246 P3072 Capacitor bank additions
	Voltage stability	Voltage stability	7L228 (Big Mountain 845S - Thornton 2091S)	Voltage collapse	Voltage collapse in both Pre and Post	Existing RAS 242 Planned RAS 247 P3072 Capacitor bank additions	Existing RAS 242 Planned RAS 247 P3072 Capacitor bank additions
	Transient stability – voltage recovery issue	Transient stability – voltage recovery issue	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	Materially increased violation	Existing RAS 242 Planned RAS 246 P3072 Capacitor bank additions AESO system project P7112	Existing RAS 242 and New RAS 248 Modified RAS 246 P3072 Capacitor bank additions AESO system project P7112
	Transient stability – voltage recovery issue	Transient stability – voltage recovery issue		H.R. Milner 740S	Materially increased violation		
	Transient stability – voltage recovery issue	Transient stability – voltage recovery issue		Dome Cutbank 810S	Materially increased violation		
	Transient stability – voltage recovery issue	Transient stability – voltage recovery issue	7L228 (Big Mountain 845S - Thornton 2091S)	H.R. Milner 740S	No impact	Existing RAS 242 Planned RAS 247 P3072 Capacitor bank additions	Existing RAS 242 Planned RAS 247 P3072 Capacitor bank additions
	Transient stability – voltage recovery issue	Transient stability – voltage recovery issue		Dome Cutbank 810S	No impact		
	Transient stability – voltage recovery issue	Transient stability – voltage recovery issue	7L20 (Thornton 2091S – H.R. Milner 740S)	Simonette 733S	No impact	Existing RAS 242 Planned RAS 245 P3072 Capacitor bank additions	Existing RAS 242 Planned RAS 245 P3072 Capacitor bank additions
	Transient stability – voltage recovery issue	Transient stability – voltage recovery issue		H.R. Milner 740S	No impact		

- Marginally increased (or marginally decreased) refers to a percent loading difference (post-Project percent loading minus pre-Project percent loading) between 0% and 3% (or -3%).
- Materially increased (or materially decreased) refers to a percent loading difference (post-Project percent loading minus pre-Project percent loading) above or equal to 3% (or below or equal to -3%).

Appendix A: Engineering Connection Assessment Results

Engineering Connection Assessment: Study Results

P3076 Thornton Capacity Addition

ATCO Electric Ltd.

Date: July 8, 2026

Version: V1

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1 Introduction

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

The power system network analysis tool that was used for the studies in this connection assessment was PSS/E version 35.

2 Pre-Project Study Results

This section describes the results of the pre-Project power flow studies. The following power flow studies were done without TMR.

2.1 Power Flow Studies

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

2.1.1 Scenario 1: 2029 Summer Peak LG Pre-Project

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

No Reliability Criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category B conditions.

2.1.2 Scenario 2: 2029 Winter Peak LG Pre-Project

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

No Reliability Criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

The following POD bus voltage deviations were observed under Category B conditions as shown in Table 2-1.

Table 2-1: POD Bus Voltage Deviations under Category B Conditions for Scenario 2

Contingency (System Element Lost)	Voltage Deviation Location Details			Pre-Project Results						
					Voltage Deviations at POD Low Voltage Buses					
	Substation Name and No.	Bus No.	Nominal Bus Voltage (kV)	Initial Voltage (kV)	Post Transient (kV)	% Change	Post Auto Control (kV)	% Change	Post Manual (kV)	% Change
7L228 (Big Mountain 845S - Thornton 2091S)	Dome Cutbank 810S	18144	25	24.5	22	10%	–	–	–	–
	Dome Cutbank 810S	19144	25	25.9	23.3	10.60%	–	–	–	–

2.1.3 Scenario 6: 2029 Summer Peak LG Pre-Project (Sensitivity)

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

Thermal Violations

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

Table 22-2: Thermal Criteria Violations under Category B Conditions for Scenario 6

Contingency (System Element Lost)	Violation Location Details	Thermal Rating (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow (MVA)	% Loading
9L05 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	121.3	101.9
7L13 (Big Mountain 845S - Procter & Gamble 808S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	124.25	104.4
Bear Creek 679S 701T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	124.16	104.3
Little Smoky 813S 901T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	119.86	100.7
Little Smoky 813S 902T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	120.27	101.1

Voltage Violations

Voltage Collapse was observed under certain Category B conditions as shown in Table 2-3.

Table 22-3: Voltage Criteria Violations under Category B Conditions for Scenario 6

Contingency (System Element Lost)	Violation Location Details		Voltage Ratings (kV)			Pre-Project Results	
	Substation Name and No.	Bus No.	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post-contingency Steady State (kV)
7L40 (Little Smoky 813S – Simonette 733S)	Pre-Project Area Voltage Collapse						

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category B conditions.

2.1.4 Scenario 7: 2029 Winter Peak LG Pre-Project (Sensitivity)

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

Thermal Violations

No Thermal violations were observed under Category B conditions.

Voltage Criteria Violations

Voltage Collapse was observed under Category B conditions as shown in table 2-4.

Table 22-4: Voltage Criteria Violations under Category B Conditions for Scenario 7

Contingency (System Element Lost)	Violation Location Details		Voltage Ratings (kV)			Pre-Project Results	
	Substation Name and No.	Bus No.	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post-contingency Steady State (kV)
7L40 (Little Smoky 813S – Simonette 733S)	Pre-Project Area Voltage Collapse						
7L228 (Big Mountain 845S - Thornton 2091S)	Pre-Project Area Voltage Collapse						

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category B conditions.

2.2 Voltage Stability Studies

Pre-project voltage stability studies were done for Scenario 7 because of post-Project Scenario 9 showing voltage stability violations. Voltage stability diagrams for pre-Project Scenario 7 for Category A and five worst Category B contingencies are provided in Attachment A3. The voltage stability study for pre-Project scenario 7 was performed with TMR (NPP1=50MW).

2.2.1 Scenario 7: 2029 Winter Peak LG Pre-Project (Sensitivity)

Voltage stability analysis was performed for Scenario 7 by increasing load in Grande Cache (Area 22), and Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 9 is 232 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 10.25 MW (0.05 x 232 MW = 10.25 MW) for Scenario 7.

The following Buses were selected for the study:

- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

Table 2-5 provides voltage stability study results under Category A conditions and for the five (5) worst contingencies under Category B conditions. Based on the study results; the voltage stability margin was met for all studied conditions.

Table 2-5: Voltage Stability Study Results under Category B Conditions for Scenario 7

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		181.3	Yes
7L228	Thornton 2091S	Big Mountain 845S	0	No
7L40	Little Smoky 813S	Simonette 733S	0	No
7L20	Thornton 2091S	HR Milner 740S	68.8	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	110.6	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		123.8	Yes

2.3 Transient Stability Studies

Transient stability studies were done for the following pre-Project scenarios because of post-Project results showing voltage recovery issues. Transient stability diagrams for pre-Project Scenarios 2 and 7 are provided in Attachment A4. Pre-Project scenarios 2 and 7 were studied with TMR (NPP1 generator dispatched at 50 MW).

2.3.1 Scenario 2: 2029 Winter Peak LG Pre-Project

Transient stability studies were completed for Scenario 2 2029 WP LG Pre-Project for Category B contingency of 7L40 at Little Smoky 813S end and monitored voltage recovery at the following substation buses.

- Simonette 733S bus
- HR Milner 740S bus
- Dome Cutbank 810S bus

The selected Category B contingency of 7L40 was simulated under following condition;

- With no tele-protection (TPR) available on line 7L40

The summary of the results is, as shown in Table 2-6.

Table 2-6: Transient Stability Study Results under Category B Condition for Scenario 2

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	No	Voltage recovery Issues at Simonette

2.3.2 Scenario 7: 2029 Winter Peak LG Pre-Project (Sensitivity)

Transient stability studies were completed for Scenario 7 2029 WP LG Pre-Project (Sensitivity) for selected Category B contingencies and monitored voltage recovery at the following substation buses.

- Simonette 733S bus
- HR Milner 740S bus
- Dome Cutbank 810S bus
- Thornton 2091S bus
- Little Smoky 813 bus
- Big Mountain 845S bus

The selected Category B contingencies (7L20, 7L40 and 7L228) were simulated under following conditions:

- With no tele-protection (TPR) available on lines 7L20, 7L40 and tele-protection available on line 7L228

The summary of the results for Scenario 7 is, as shown in Table 2-7.

Table 2-7: Transient Stability Study Results under Category B Conditions for Scenario 7

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	No	Voltage Recovery issues (HR Milner, Simonette)
	3-phase fault at H.R. Milner 740S	No	No Issue
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	No	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank and Thornton)
	3-phase fault at Simonette 733S	No	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank and Thornton)
7L228 (Big Mountain 845S – Thornton 2091S)	3-phase fault at Big Mountain 845S	Yes	Voltage recovery issues (Simonette, HR Milner, and Dome Cutbank)
	3-phase fault at Thornton 2091S	Yes	Voltage recovery issues (Simonette, HR Milner, and Dome Cutbank)

The studies were also done for scenario 7 with No TPR and new capacitors for Category B contingency of 7L40 and the summary of the results is, as shown in Table 2-8.

Table 2-8: Transient Stability Study Results under Category B Conditions for Scenario 7 (with No TPR and new Capacitors)

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	No	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank)
	3-phase fault at Simonette 733S	No	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank)

3 Post-Project Study Results

As described in Section 2 of Attachment A1, the post-Project studies were performed using Alternative 1. This section describes the results of the post-Project power flow studies, voltage stability studies and transient stability studies. For sensitivity studies with Scenario 8 and 9 the existing load at Simonette 733S was modelled at historical power factor of 0.96. Post-project power flow studies were done without TMR. Post-project voltage stability and transient stability studies were done with TMR (NPP1 generator dispatched at 50 MW).

3.1 Power Flow Studies

Power flow diagrams illustrating the post-Project power flow studies results for Category A and Category B, conditions are included in Attachment A5.

3.1.1 Scenario 3: 2029 Summer Peak LG Post-Project

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

No thermal criteria violations were identified under Category B condition.

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category B conditions.

3.1.2 Scenario 4: 2029 Winter Peak LG Post-Project

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

No Reliability Criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

The following POD bus deviations were observed under Category B conditions as shown in Table 3-1.

Table 3-1: POD Bus Voltage Deviations under Category B Conditions for Scenario 4

Contingency (System Element Lost)	Voltage Deviation Location Details			Post-Project Results						
					Voltage Deviations for POD Busses Only					
	Substation Name and No.	Bus No.	Nominal Bus Voltage (kV)	Initial Voltage (kV)	Post Transient (kV)	% Change	Post Auto Control (kV)	% Change	Post Manual (kV)	% Change
7L40 (Little Smoky 813S - Simonette 733S)	Simonette 733S	19170	25	26.1	23.2	11.5%	–	–	–	–

3.1.3 Scenario 8: 2029 Summer Peak LG Post-Project (Sensitivity)

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

Thermal Criteria Violations

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

Table 3-2: Thermal Criteria Violations under Category B Conditions for Scenario 8

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
9L05 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	121.3	101.9	127.3	107.0	5.0
7L13 (Big Mountain 845S - Procter & Gamble 808S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	124.2	104.4	129.2	108.6	4.2
7L56 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	114.0	95.8	119.4	100.3	4.5
7L75 (Friednestal 800S - West Peace River 793S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	116.5	97.9	122.0	102.5	4.6
Bear Creek 679S 701T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	124.1	104.3	129.5	108.8	4.5
Little Smoky 813S 901T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	120.3	101.1	126.1	106	4.9
	Little Smoky 813S 902T WDG1	200	214	201.0	100.5	217.0	108.5	8.0
	Little Smoky 813S 902T WDG2	200	214	201.6	100.8	217.6	108.8	8.0
Little Smoky 813S 902T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	120.3	101.1	126.1	106	4.9
	Little Smoky 813S 901T WDG1	200	214	200.0	100	215.8	107.9	7.9
	Little Smoky 813S 901T WDG2	200	214	200.4	100.2	216.4	108.2	8.0

Voltage Criteria Violations

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

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

Contingency (System Element Lost)	Details of Violation (Violation Observed On)		Voltage Ratings (kV)			Pre-Project Results		Post-Project Results		% Voltage Difference (kV)
	Substation Name and Number	Bus No.	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post-contingency Steady State (kV)	Initial Voltage (kV)	Post-contingency Steady State (kV)	
7L228 (Big Mountain 845S - Thornton 2091S)	Dome Cutbank 810S	1144	144	130	155	146.8	127.9	143.8	128.1	0.2%
	H.R. Milner 740S	1147	144	130	155	145.9	128.7	143	129	0.2%
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	-	-	**Pre-Project Area Voltage Collapse**		**Post-Project Area Voltage Collapse**		-

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category B conditions.

3.1.4 Scenario 9: 2029 Winter Peak LG Post-Project (Sensitivity)

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

Thermal Violations

No Thermal violations were observed under Category B conditions.

Voltage Criteria Violations

Voltage Collapse was observed under Category B conditions as shown in Table 3-4.

Table 33-4: Voltage Criteria Violations under Category B Conditions for Scenario 9

Contingency (System Element Lost)	Details of Violation (Violation Observed On)		Voltage Ratings (kV)			Pre-Project Results		Post-Project Results		% Voltage Difference (kV)
	Substation Name and Number	Bus No.	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post-contingency Steady State (kV)	Initial Voltage (kV)	Post-contingency Steady State (kV)	
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	-	-	**Pre-Project Area Voltage Collapse**		**Post-Project Area Voltage Collapse**		-
7L228 (Big Mountain 845S - Thornton 2091S)						**Pre-Project Area Voltage Collapse**		**Post-Project Area Voltage Collapse**		-

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category B conditions.

3.2 Voltage Stability Studies

This section describes the results of the post-Project voltage stability studies for Scenario 4 (Main study) and Scenario 9 (Sensitivity). The post-Project studies for voltage stability were performed for Scenario 4 and 9 using TMR with NPP1 dispatched to 50 MW.

Study results identified voltage stability violations for Scenario 9 under Category B contingencies of 7L40 and 7L228.

Mitigation with Temporary RAS:

To mitigate the observed violations, the following RASs were used.

Before TPR:

- New RAS 248 and existing RAS 242

After TPR:

- Planned RAS 247 and modified RAS 246

Mitigation with Permanent Capacitors:

With P3072 Final Stage energized: With P3072 Greenview project final stage energized, studies were done to determine a permanent mitigation measure to the identified area voltage stability violations using TMR (NPP1 dispatched to 50 MW) and the following new capacitor banks.

- At HR Milner 740S substation: New 15 MVAr cap bank
- At Simonette 733S substation: New 20 MVAr cap bank
- At New Pearson 2089S: New 2x15 MVAr (144kV) and 2x4.8 MVAr (25kV) cap banks

Without P3072 Final Stage energized: In case the final stage of the P3072 Greenview project was not energized studies were also done to determine a permanent mitigation measure to the identified voltage stability violations using TMR (NPP1 dispatched to 50 MW) and the following new capacitor banks.

- At HR Milner 740S substation: New 15 MVAr cap bank
- At Simonette 733S substation: New 20 MVAr cap bank
- At Thornton 2091S substation: New 2x15 MVAr cap banks

Please refer to section 5.4.2 for the design details of the proposed new capacitor banks. Voltage stability diagrams for Scenario 4 (with TMR) and Scenario 9 (with TMR) are included in Attachment A6. Voltage stability diagrams for Scenario 9 (with TMR and RAS), Scenario 9 (P3076 and P3072 Interim Stage with TMR and Caps) and Scenario 9 (P3076, P3072 Final Stage and P2716 with TMR and Caps) are provided in Attachments A9, Attachment A10 and Attachment A11 respectively.

3.2.1 Scenario 4: 2029 Winter Peak LG Post-Project

Voltage stability analysis was performed for Scenario 4 by increasing load in Grande Cache (Area 22), and Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 4 is 198 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 9.9 MW (0.05 x 198 MW = 9.9 MW) for Scenario 4.

The following Buses were selected for the study:

- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

Table 3-5 provides voltage stability study results under Category A conditions and for the five (5) worst contingencies under Category B conditions. Based on the study results, the voltage stability margin was met for all studied conditions.

Table 3-5: Voltage Stability Study Results under Category B Conditions for Scenario 4

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		180	Yes
7L228	Big Mountain 845S	Thornton 2091S	47.5	Yes
7L40	Little Smoky 813S	Simonette 733S	92.5	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	105	Yes
7L20	HR Milner 740S	Thornton 2091S	109.4	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		117.5	Yes

3.2.2 Scenario 9: 2029 Winter Peak LG Post-Project (Sensitivity)

Voltage stability analysis was performed for Scenario 9 by increasing load in Grande Cache (Area 22), and Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 9 is 232 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 11.6 MW (0.05 x 232 MW = 11.6 MW) for scenario 9.

The following Buses were selected for the study:

- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

Table 3-6 provides voltage stability study results under Category A conditions and for the five (5) worst contingencies under Category B conditions. Based on the study results the voltage stability margin was not met for the following conditions studied.

- 7L40 (Little Smoky 813S – Simonette 733S)
- 7L228 (Big Mountain 845S – Thornton 2091S)

Table 3-6: Voltage Stability Study Results under Category B Conditions for Scenario 9

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		151.3	Yes
7L228	Big Mountain 845S	Big Mountain 845S	0	No
7L40	Little Smoky 813S	Simonette 733S	0	No
7L20	HR Milner 740S	HR Milner 740S	58.8	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	73.8	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		90	90

3.2.3 Scenario 9: 2029 Winter Peak LG Post-Project (Sensitivity) with RAS

Voltage stability analysis was performed for scenario 9 by increasing load in Grande Cache (Area 22), and Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 9 is 232 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 11.6 MW (0.05 x 232 MW = 11.6 MW) for scenario 9.

The following Buses were selected for the study:

- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

To mitigate observed violations, the following RASs were used.

Before TPR:

- New RAS 248 and existing RAS 242

After TPR:

- Planned RAS 247 and modified RAS 246

Based on the study results the voltage stability margin was met for all studied conditions. Table 3-7 provides voltage stability study results under Category A conditions and for the five (5) worst contingencies under Category B conditions.

Table 3-7: Voltage Stability Study Results under Category B Conditions for Scenario 9 with RAS

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		160	Yes
7L228 (with RAS)	Big Mountain 845S	Big Mountain 845S	38.2	Yes
7L20	HR Milner 740S	HR Milner 740S	64.4	Yes
7L40 (with RAS)	Little Smoky 813S	Simonette 733S	65.6	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	78.8	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		96.3	90

3.2.4 Scenario 9: 2029 Winter Peak LG Post-Project (Sensitivity) with Capacitors if P3072 Final Stage Was Not Energized

Voltage stability analysis was performed for scenario 9 by increasing load in Grande Cache (Area 22), and Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 9 is 232 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 11.6 MW (0.05 x 232 MW = 11.6 MW) for Scenario 9.

The following Buses were selected for the study:

- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

The studies were done with the following new capacitors installed at the identified substations.

- 1x20 MVAr capacitor at Simonette 733S
- 1x15 MVAr capacitor at HR Milner 740S
- 2x15 MVAr capacitors at Thornton 2091S

Based on the study results, the voltage stability margin was met for all studied conditions. Table 3-8 provides voltage stability study results under Category A conditions and for the five (5) worst contingencies under Category B conditions.

Table 3-8: Voltage Stability Study Results under Category B Conditions for Scenario 9 with Capacitors

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		197.5	Yes
7L40	Little Smoky 813S	Simonette 733S	33.2	Yes
7L228	Big Mountain 845S	Big Mountain 845S	40	Yes
7L20	HR Milner 740S	HR Milner 740S	96.3	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	125	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		141.3	90

3.2.5 Scenario 9: 2029 Summer Peak LG Post-Project (Sensitivity) with Capacitors (P3072 Final Stage with P3076 and P2716)

Voltage stability analysis was performed for P3072 Scenario 9 by increasing load in Grande Cache (Area 22), and Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for P3072 scenario 9 is 290 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 14.5 MW (0.05 x 290 MW = 14.5 MW) for Scenario 9.

The following Buses were selected for the study:

- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)
- Pakenham 2103S 144 kV Bus (bus 542006)
- Pearson 2089S new POD 144 kV Bus (bus 990002)

The studies were done with the following new capacitors installed at the identified substations.

- 1x20 MVAr capacitor at Simonette 733S
- 1x15 MVAr capacitor at HR Milner 740S
- 2x15 MVAr (144kV) and 2x4.8 MVAr (25kV) capacitors at Pearson 2089S

Based on the study results, the voltage stability margin was met for all studied conditions. Table 3-9 provides voltage stability study results under Category A conditions and for the five (5) worst contingencies under Category B conditions.

Table 3-9: Voltage Stability Study Results under Category B Conditions for Scenario 9 with Capacitors (P3072 Final Stage with P3076 and P2716)

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		133.8	Yes
7L40	Little Smoky 813S	Simonette 733S	25.7	Yes
7L228	Big Mountain 845S	Big Mountain 845S	31.3	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	51.3	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		70.7	90
7L20	HR Milner 740S	HR Milner 740S	75	Yes

3.3 Transient Stability Studies

The transient studies were performed using fault clearing times as given in Table 3-10 for selected Category B contingencies and using the CLOD for load modeling.

CLOD Load Model: 30% Small Motors, 40% Large Motors, 30% Static Load

Table 3-10: Protection Fault Cleating Times

Contingency (System Element Lost)	Fault Location	Clearing-Times (Cycles)	
		Near End	Far End
7L40 (Simonette 733S – Little Smoky 813S)	Simonette 733S	6	24
7L40 (Simonette 733S – Little Smoky 813S)	Little Smoky 813S	6	42
7L20 (H.R. Milner 740S – Thornton 2091S)	H.R. Milner 740S	5	24
7L20 (H.R. Milner 740S – Thornton 2091S)	Thornton 2091S	6	24
7L228 (Thornton 2091S – Big Mountain 845S)	Thornton 2091S	5	8
7L228 (Thornton 2091S – Big Mountain 845S)	Big Mountain 845S	6	8

Based on ATCO's Zone 4 clearance time for the studied contingencies the required voltage recovery times are as given in Table 3-11.

Table 3-11: Required Voltage Recovery Times

Contingency (System Element Lost)	Fault Location	Recovery End	Required Voltage Recovery Time (sec)
7L40 (Simonette 733S – Little Smoky 813S)	Simonette 733S	Little Smoky 813S	1.5
7L40 (Simonette 733S – Little Smoky 813S)	Little Smoky 813S	Simonette 733S	1.5
7L20 (H.R. Milner 740S – Thornton 2091S)	H.R. Milner 740S	Thornton 2091S	1.5
7L20 (H.R. Milner 740S – Thornton 2091S)	Thornton 2091S	H.R. Milner 740S	1.5
7L228 (Thornton 2091S – Big Mountain 845S)	Thornton 2091S	Big Mountain 845S	1.5
7L228 (Thornton 2091S – Big Mountain 845S)	Big Mountain 845S	Thornton 2091S*	1.5

**Thornton 2091S bus is tripped under this contingency, therefore Dome Cutbank 810S bus is monitored.*

3.3.1 Scenario 4: 2029 Winter Peak LG Post-Project

Transient stability studies were completed for Scenario 4 2029 WP LG Post-Project for selected Category B contingencies and monitored voltage recovery at the following substation buses.

- Simonette 733S bus

- HR Milner 740S bus
- Dome Cutbank 810S bus
- Thornton 2091S bus
- Little Smoky 813 bus
- Big Mountain 845S bus

The selected Category B contingencies (7L20, 7L40 and 7L228) were simulated under following conditions.

- With no tele-protection (TPR) available on lines 7L20, 7L40 and tele-protection available on line 7L228

The summary of the results is, as shown in Table 3-12.

Table 3-12: Transient Stability Study Results under Category B Conditions for Scenario 4

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	No	No Issue
	3-phase fault at H.R. Milner 740S	No	No Issue
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	No	Voltage recovery Issues (HR Milner, Simonette, Dome Cutbank)
	3-phase fault at Simonette 733S	No	No Issue
7L228 (Big Mountain 845S – Thornton 2091S)	3-phase fault at Big Mountain 845S	Yes	No Issue
	3-phase fault at Thornton 2091S	Yes	No Issue

The transient stability studies were also completed for Scenario 4 2029 WP LG Post-Project under Category B contingency of line 7L40 (Little Smoky 813S – Simonette 733S) at Little Smoky 813S end under following condition.

- With tele-protection (TPR) available on line 7L40

The summary of the results is, as shown in Table 3-13.

Table 3-13: Transient Stability Study Results under Category B Conditions for Scenario 4 (with TPR on line 7L40)

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	Yes	No Issue

Transient stability plots for post-Project Scenario 4 in Table 3-13 are provided in Attachment A7.

3.3.2 Scenario 9: 2029 Winter Peak LG Post-Project (Sensitivity)

Transient stability studies were completed for Scenario 9 2029 WP LG Post-Project (Sensitivity) for selected Category B contingencies and monitored transient voltage recovery at the following substation buses.

- Simonette 733S bus
- HR Milner 740S bus
- Dome Cutbank 810S bus
- Thornton 2091S bus
- Little Smoky 813 bus
- Big Mountain 845S bus

The selected Category B contingencies (7L20, 7L40 and 7L228) were simulated under following conditions;

- With no tele-protection (TPR) available on lines 7L20, 7L40 and tele-protection available on line 7L228

The summary of the results is, as shown in Table 3-14.

Table 3-14: Transient Stability Study Results under Category B Conditions for Scenario 9

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	No	Voltage Recovery issues (HR Milner, Simonette)
	3-phase fault at H.R. Milner 740S	No	No Issue
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	No	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank and Thornton)
	3-phase fault at Little Smoky 813S	No	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank and Thornton)
7L228 (Big Mountain 845S – Thornton 2091S)	3-phase fault at Big Mountain 845S	Yes	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank)
	3-phase fault at Thornton 2091S	Yes	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank)

Transient stability plots for post-Project scenario 9 in Table 3-14 are provided in Attachment A7.

To mitigate transient voltage recovery issues observed above, the transient stability studies were completed for Scenario 9 2029 WP LG Post-Project (Sensitivity) under selected Category B contingencies with the following load RASs applied at Simonette 733S and Thornton 2091S.

- New RAS 248 and existing RAS 242

The summary of the results is, as shown in Table 3-15.

Table 3-15: Transient Stability Study Results under Category B Conditions for Scenario 9 (No TPR and RAS (RAS 248 and RAS 242)

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	No	No Issue
	3-phase fault at H.R. Milner 740S	No	No Issue
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	No	No Issue
	3-phase fault at Little Smoky 813S	No	No Issue
7L228 (Big Mountain 845S – Thornton 2091S)	3-phase fault at Big Mountain 845S	Yes	No Issue
	3-phase fault at Thornton 2091S	Yes	No Issue

Transient stability plots for post-Project scenario 9 in Table 3-15 are provided in Attachment A12.

Transient stability studies were also completed for Scenario 9 2029 WP LG Post-Project (Sensitivity) for selected Category B contingencies under the assumption that all three lines; 7L20, 7L40 and 7L228 have tele-protection available and following load RAS applied at Simonette 733S and Thornton 2091S.

- Planned RAS 245, planned RAS 247 and modified RAS 246

The summary of the results is, as shown in Table 3-16.

Table 3-16: Transient Stability Study Results under Category B Conditions for Scenario 9 (with TPR and RAS (RAS 245, 246 and 247)

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	Yes	No Issue
	3-phase fault at H.R. Milner 740S	Yes	No Issue
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	Yes	No Issue
	3-phase fault at Little Smoky 813S	Yes	No Issue
7L228 (Big Mountain 845S – Thornton 2091S)	3-phase fault at Big Mountain 845S	Yes	No Issue
	3-phase fault at Thornton 2091S	Yes	No Issue

Transient stability plots for post-Project scenario 9 in Table 3-16 are provided in Attachment A13.

Transient studies were also performed for Scenario 9 2029 WP LG Post-Project (Sensitivity) for selected Category B contingencies of 7L20 and 7L228 using following RASs in coordination with the existing RAS 171.

- With No TPR on line 7L20 (7L228 already has TPR):
    - Existing RAS 242
    - Existing RAS 171
- With TPR on both lines 7L20 and 7L228:
    - Planned RAS 245
    - Planned RAS 247
    - Existing RAS 171

The summary of the results with No TPR and with TPR are as shown in Table 3-17 and Table 3-18 respectively.

Table 3-17: Study Results for RAS 242 with RAS 171 under Category B Conditions for Scenario 9 (with No TPR on 7L20*)

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	No	No Issue
	3-phase fault at H.R. Milner 740S	No	No Issue
7L228 (Big Mountain 845S – Thornton 2091S)	3-phase fault at Big Mountain 845S	Yes	No Issue
	3-phase fault at Thornton 2091S	Yes	No Issue

**7L228 already has TPR*

Table 3-18: Study Results for RAS 245 and RAS 247 with RAS 171 under Category B Conditions for Scenario 9 (with TPR on 7L20 and 7L228)

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	Yes	No Issue
	3-phase fault at H.R. Milner 740S	Yes	No Issue
7L228 (Big Mountain 845S – Thornton 2091S)	3-phase fault at Big Mountain 845S	Yes	No Issue
	3-phase fault at Thornton 2091S	Yes	No Issue

Transient stability plots for post-Project scenario 9 in Table 3-17 and Table 3-18 are provided in Attachment A14 and A15 respectively.

To mitigate voltage recovery issues identified in Table 3-13, transient stability studies were also completed for Scenario 9 2029 WP LG Post-Project (Sensitivity) for selected Category B contingencies with following capacitors as the permanent mitigation measures (if the P3072 final stage did not

materialize). The studies were done for scenario 9 with and without TPR available on all three lines 7L20, 7L40 and 7L228.

- 15 MVAr new capacitor at HR Milner 740S
- 20 MVAr new capacitor at Simonette 733S
- 2x15 MVAr new capacitors at Thornton 2091S

The summary of the results with new Capacitors and No TPR available on all three lines is, as shown in Table 3-19.

Table 3-19: Transient Stability Study Results under Category B Conditions for Scenario 9 (with No TPR and new Capacitors) *

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	No	No Issue
	3-phase fault at H.R. Milner 740S	No	No Issue
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	No	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank)
	3-phase fault at Simonette 733S	No	Voltage recovery issues (Simonette, HR Milner, Dome Cutbank)

7L228 already has TPR so was not included in the table.

Transient stability plots for post-Project scenario 9 in Table 3-19 are provided in Attachment A16.

The summary of the results with new Capacitors and TPR is, as shown in Table 3-20.

Table 3-20: Transient Stability Study Results under Category B Conditions for Scenario 9 (with TPR and Capacitors)

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	Yes	No Issue
	3-phase fault at H.R. Milner 740S	Yes	No Issue
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	Yes	No Issue
	3-phase fault at Little Smoky 813S	Yes	No Issue
7L228 (Big Mountain 845S – Thornton 2091S)	3-phase fault at Big Mountain 845S	Yes	No Issue
	3-phase fault at Thornton 2091S	Yes	No Issue

Transient stability plots for post-Project scenario 9 in Table 3-20 are provided in Attachment A17.

3.3.3 Scenario 9: 2029 Summer Peak LG Post-Project (Sensitivity) for P3072 Final Stage with P3076 and P2716

Transient stability studies were also completed using P3072 Scenario 9 2029 SP LG Post-Project (Sensitivity) for selected Category B contingencies with following capacitors as the permanent mitigation measure for P3072 final stage with P3076 and P2716. The studies were done with TPR available on all three lines 7L20, 7L40 and 7L228.

- 15 MVAr new capacitor at HR Milner 740S
- 20 MVAr new capacitor at Simonette 733S
- 2x15 MVAr (144kV) and 2x4.8 MVAr (25kV) new capacitors at Pearson 2089S new POD

Transient voltage recovery at the following substation buses were monitored.

- Simonette 733S bus
- HR Milner 740S bus
- Dome Cutbank 810S bus
- Thornton 2091S bus
- Little Smoky 813 bus
- Big Mountain 845S bus

The summary of the results is, as shown in Table 3-21.

Table 3-21: Transient Stability Study Results under Category B Conditions for Scenario 9 P3072 final stage with P3076 and P2716 (with TPR and Capacitors)

Studied Contingency	Fault Description and Location	Tele-protection available on the line	Voltage Recovery
7L20 (Thornton 2091S – H.R. Milner 740S)	3-phase fault at Thornton 2091S	Yes	No Issue
	3-phase fault at H.R. Milner 740S	Yes	No Issue
7L40 (Little Smoky 813S – Simonette 733S)	3-phase fault at Little Smoky 813S	Yes	No Issue
	3-phase fault at Little Smoky 813S	Yes	No Issue
7L228 (Big Mountain 845S – Thornton 2091S)	3-phase fault at Big Mountain 845S	Yes	No Issue
	3-phase fault at Thornton 2091S	Yes	No Issue

Transient stability plots for post-Project scenario 9 in Table 3-21 are provided in Attachment A18.

4 Short Circuit Studies

4.1 Pre-Project Results

Pre-Project short-circuit current levels are provided in Table 4-1[1] and Table 4-1[2].

Table 4-1: Pre-Project Short-Circuit Current Levels for 2029 WP Pre-Project

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)
CG & E 758S	138	149.38	5.16	0.03112+j0.079282	5.39	0.012242+j0.074425
Thornton 2091S	138	145.30	2.86	0.05416+j0.143781	2.93	0.018523+j0.143492
Flyingshot Lake 749S	138	149.26	5.19	0.032835+j0.07808	5.54	0.011198+j0.06933
Albright & Wilson 752S	138	149.91	5.49	0.026099+j0.075574	6.08	0.006818+j0.058041
P&G A808S	138	150.05	5.48	0.025574+j0.075897	6.08	0.00599+j0.057725
Bear Creek 679S	138	150.04	5.49	0.025497+j0.075846	6.13	0.005467+j0.056299
Big Mountain 845S	138	149.39	5.77	0.026718+j0.071314	6.65	0.005761+j0.046745
Dome Cutbank 810S	138	145.01	2.68	0.058158+j0.153294	2.77	0.021363+j0.149553
Bridge Creek 798S	138	149.32	5.49	0.028107+j0.074993	6.05	0.008639+j0.058499
HR Milner 740S	138	144.43	2.19	0.073557+j0.186215	3.03	0.002136+j0.036554
Kakwa Ridge 857S	138	144.81	2.03	0.082479+j0.199868	2.12	0.046505+j0.184648
Little Smoky 813S	138	150.42	8.54	0.015528+j0.049048	12.21	0.0025+j0.00446

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

[2] 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: Pre-Project Short-Circuit Current Levels for 2029 WP Pre-Project Sensitivity

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)
CG & E 758S	138	151.47	5.62	0.025389+j0.073972	5.70	0.012276+j0.07471
Thornton 2091S	138	146.33	2.96	0.050475+j0.139314	3.00	0.018721+j0.144975
Flyingshot Lake 749S	138	151.33	5.72	0.026241+j0.072214	5.90	0.011266+j0.069761
Albright & Wilson 752S	138	152.23	5.88	0.021933+j0.071355	6.37	0.006821+j0.058159
P&G A808S	138	152.40	5.86	0.021522+j0.071746	6.37	0.00599+j0.057829
Bear Creek 679S	138	152.42	5.87	0.021459+j0.0717	6.42	0.005466+j0.056399
Big Mountain 845S	138	151.56	6.24	0.022078+j0.066821	7.05	0.005784+j0.046931
Dome Cutbank 810S	138	145.86	2.77	0.054672+j0.14866	2.83	0.021448+j0.150405
Bridge Creek 798S	138	151.49	5.90	0.023577+j0.070597	6.36	0.008694+j0.058753
HR Milner 740S	138	144.47	2.26	0.070902+j0.180745	3.11	0.002135+j0.036563
Kakwa Ridge 857S	138	144.12	2.10	0.080242+j0.193507	2.17	0.046504+j0.184658
Little Smoky 813S	138	151.80	8.79	0.014641+j0.047764	12.53	0.002521+j0.004628

4.2 Post-Project Results

4.2.1 2029 Winter Peak Post-Project

Post-Project short-circuit current levels for 2029 WP Post-Project are provided in Table 4-3.

Table 4-3: Post-Project Short-Circuit Current Levels for 2029 WP Post-Project

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)
CG & E 758S	138	149.16	5.21	0.031486+j0.078235	5.44	0.012232+j0.07409
Thornton 2091S	138	141.98	2.96	0.05644+j0.13748	3.44	0.008278+j0.088874
Flyingshot Lake 749S	138	149.05	5.24	0.033172+j0.077066	5.58	0.011193+j0.069043
Albright & Wilson 752S	138	149.91	5.55	0.026511+j0.07455	6.14	0.006816+j0.057638
P&G A808S	138	150.11	5.54	0.025983+j0.074898	6.14	0.005998+j0.057371
Bear Creek 679S	138	150.12	5.55	0.025906+j0.07485	6.19	0.005478+j0.055956
Big Mountain 845S	138	149.16	5.84	0.027141+j0.070189	6.74	0.005701+j0.046105
Dome Cutbank 810S	138	141.74	2.76	0.060241+j0.147276	3.03	0.016545+j0.118125
Bridge Creek 798S	138	149.10	5.55	0.028529+j0.073903	6.10	0.008644+j0.058181

HR Milner 740S	138	141.41	2.24	0.075022+j0.181286	3.09	0.002169+j0.036317
Kakwa Ridge 857S	138	142.08	2.06	0.083749+j0.195756	2.15	0.046531+j0.184458
Little Smoky 813S	138	150.97	8.49	0.015976+j0.049229	12.14	0.0025+j0.00446

4.2.2 2029 Winter Peak Post-Project (Sensitivity)

Post-Project short-circuit current levels for Post-Project (Sensitivity) are provided in Table 4-4.

Table 4-4: Post-Project Short-Circuit Current Levels for 2029 WP Post-Project (Sensitivity)

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)
CG & E 758S	138	151.71	5.59	0.026445+j0.073996	5.69	0.012322+j0.074678
Thornton 2091S	138	143.36	3.04	0.053317+j0.134086	3.50	0.008356+j0.09011
Flyingshot Lake 749S	138	151.56	5.69	0.027241+j0.072217	5.89	0.011305+j0.069731
Albright & Wilson 752S	138	152.48	5.85	0.023007+j0.071434	6.35	0.006879+j0.058127
P&G A808S	138	152.64	5.83	0.022572+j0.07183	6.35	0.006041+j0.057802
Bear Creek 679S	138	152.66	5.84	0.022507+j0.071785	6.40	0.005516+j0.056374
Big Mountain 845S	138	151.83	6.20	0.02325+j0.066881	7.02	0.00587+j0.046872
Dome Cutbank 810S	138	142.91	2.84	0.057294+j0.143629	3.09	0.016566+j0.118834
Bridge Creek 798S	138	151.75	5.87	0.024721+j0.070654	6.33	0.008801+j0.058889
HR Milner 740S	138	141.64	2.30	0.072704+j0.176641	3.16	0.002168+j0.036322
Kakwa Ridge 857S	138	141.51	2.12	0.08179+j0.190023	2.19	0.04653+j0.184465
Little Smoky 813S	138	151.80	8.76	0.014986+j0.047835	12.49	0.002521+j0.004628

4.2.3 2034 Winter Peak Post-Project

Post-Project short-circuit current levels for 2034 WP Post-Project are provided in Table 4-5.

Table 4-5: Post-Project Short-Circuit Current Levels for 2034 WP Post-Project

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)
CG & E 758S	138	150.95	7.93	0.014355+j0.05354	7.33	0.012218+j0.074108
Thornton 2091S	138	143.18	5.16	0.020356+j0.082741	4.87	0.010878+j0.102655
Flyingshot Lake 749S	138	150.44	8.23	0.014687+j0.051335	7.70	0.011136+j0.068913
Albright & Wilson 752S	138	152.04	8.13	0.01256+j0.052561	8.28	0.006834+j0.057836

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)
P&G A808S	138	152.13	8.02	0.012458+j0.053318	8.22	0.006009+j0.057545
Bear Creek 679S	138	152.12	8.03	0.012435+j0.053305	8.30	0.005488+j0.056125
Big Mountain 845S	138	151.72	9.17	0.011409+j0.046553	9.76	0.005758+j0.046416
Dome Cutbank 810S	138	142.79	5.18	0.019272+j0.082613	4.48	0.017769+j0.12605
Bridge Creek 798S	138	152.04	8.47	0.012811+j0.050257	8.52	0.00877+j0.058638
HR Milner 740S	138	142.94	7.40	0.008197+j0.058759	8.54	0.002151+j0.036301
Kakwa Ridge 857S	138	142.80	4.52	0.027434+j0.093244	3.43	0.046517+j0.184448
Little Smoky 813S	138	150.42	13.39	0.006881+j0.032082	18.84	0.002521+j0.004627

4.2.4 2034 Winter Peak Post-Project (Sensitivity)

Post-Project short-circuit current levels for 2034 WP Post-Project (Sensitivity) are provided in Table 4-6.

Table 4-6: Post-Project Short-Circuit Current Levels for 2034 WP Post-Project (Sensitivity)

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)
CG & E 758S	138	151.77	7.92	0.014378+j0.053539	7.33	0.012219+j0.074104
Thornton 2091S	138	143.49	5.16	0.020453+j0.082713	4.87	0.010878+j0.102658
Flyingshot Lake 749S	138	151.28	8.23	0.014699+j0.051315	7.71	0.011137+j0.068905
Albright & Wilson 752S	138	152.79	8.12	0.012596+j0.052587	8.28	0.006835+j0.057835
P&G A808S	138	152.86	8.02	0.012493+j0.053343	8.22	0.00601+j0.057544
Bear Creek 679S	138	152.85	8.02	0.012469+j0.05333	8.30	0.005488+j0.056124
Big Mountain 845S	138	152.53	9.16	0.011448+j0.04658	9.76	0.005759+j0.046415
Dome Cutbank 810S	138	142.98	5.18	0.019385+j0.082578	4.48	0.017769+j0.126057
Bridge Creek 798S	138	152.87	8.46	0.012855+j0.050292	8.52	0.00877+j0.058637
HR Milner 740S	138	142.54	7.41	0.008397+j0.058699	8.54	0.002161+j0.036375
Kakwa Ridge 857S	138	141.23	4.55	0.027665+j0.092533	3.44	0.046525+j0.184507
Little Smoky 813S	138	152.49	13.47	0.007308+j0.032795	18.93	0.002521+j0.004627

5 Mitigation Measure Development and Evaluation

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

As part of this Project, mitigation measures will not be specifically developed for the POD bus voltage deviations observed under certain Category B conditions during pre-Project and post-Project scenarios.[3]

5.1 Pre-Project (Main)

There are no pre-Project mitigation measures required for Scenario 3 and Scenario 4.

5.2 Pre-Project (Sensitivity)

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

Table 5-1: Pre-Project Mitigation Measures (No TPR on 7L20 and 7L40)

Mitigation Measure	Location of Observed Violation	Contingency
Switch the NPP1 online and dispatch to 50 MW	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	7L13 (Big Mountain 845S - Procter & Gamble 808S)
		Bear Creek 679S 701T
		Little Smoky 813S 901T
		Little Smoky 813S 902T
		9L05 (Little Smoky 813S - Louise Creek 809S)
Existing RAS 242	Voltage Collapse and transient voltage recovery issues	7L40 (Little Smoky 813S - Simonette 733S)
Existing RAS 242	Voltage Collapse and transient voltage recovery issues	7L228 (Big Mountain 845S - Thornton 2091S)
Existing RAS 242	Transient Voltage recovery issues at HR Milner 740S and Simonette 733S	7L20 (HR Milner 740S - Thornton 2091S)

[3] The AESO's desired post-contingency voltage deviations for low voltage busses represent guidelines rather than criteria. A POD bus voltage deviation that exceeds the desired limits shown in Table 3-1 of Attachment A1 does not represent a Reliability Criteria violation.

Table 5-2: Pre-Project Mitigation Measures (with TPR on 7L20 and 7L40)

Mitigation Measure	Location of Observed Violation	Contingency
Switch the Lowe Lake generator online and dispatch to 50 MW	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	7L13 (Big Mountain 845S - Procter & Gamble 808S)
		Bear Creek 679S 701T
		Little Smoky 813S 901T
		Little Smoky 813S 902T
		9L05 (Little Smoky 813S - Louise Creek 809S)
Planned RAS 246	Voltage collapse and transient voltage recovery issues	7L40 (Little Smoky 813S - Simonette 733S)
Planned RAS 247	Voltage collapse and transient voltage recovery issues	7L228 (Big Mountain 845S - Thornton 2091S)
Planned RAS 245	Transient Voltage recovery issues	7L20 (HR Milner 740S - Thornton 2091S)

5.3 Post-Project (Main)

There are no post-Project mitigation measures required for Scenario 3 and Scenario 4.

5.4 Post-Project (Sensitivity)

Post-Project mitigation measures are summarized in Table 5-3, Table 5-4, and Table 5-5.

Table 5-3: Post-Project (Sensitivity study) Mitigation Measures (with No TPR* and RAS)

Mitigation Measure	Location of Observed Violation	Contingency
Switch the Lowe Lake generator online and dispatch to 50 MW	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	9L05 (Little Smoky 813S - Louise Creek 809S)
		7L13 (Big Mountain 845S - Procter & Gamble 808S)
		7L56 (Little Smoky 813S - Louise Creek 809S)
		7L73 (Rycroft 730S - Friedenstal 800S)
		Bear Creek 679S 701T
		Little Smoky 813S 901T
		Little Smoky 813S 902T
New RAS 248 and existing RAS 242	Post-Project Voltage Collapse and transient voltage recovery issues	7L40 (Little Smoky 813S - Simonette 733S)
New RAS 248 and existing RAS 242	Post-Project Voltage Collapse and transient voltage recovery issues	7L228 (Big Mountain 845S - Thornton 2091S)
New RAS 248 and existing RAS 242	Transient Voltage recovery issues and HR Milner 740S and Simonette 733S	7L20 (HR Milner 740S - Thornton 2091S)
Planned Simonette 733S Overvoltage Protection	Over voltage at HR Milner 740S and Simonette 733S buses	Simonette 733S 702T

**No TPR on 7L20 and 7L40. 7L228 already has TPR.*

Table 5-4: Post-Project (Sensitivity study) Mitigation Measures (with TPR* and RAS)

Mitigation Measure	Location of Observed Violation	Contingency
TMR with NPP1=50 MW	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	9L05 (Little Smoky 813S - Louise Creek 809S)
		7L13 (Big Mountain 845S - Procter & Gamble 808S)
		7L56 (Little Smoky 813S - Louise Creek 809S)
		7L73 (Rycroft 730S - Friedenstal 800S)
		Bear Creek 679S 701T
		Little Smoky 813S 901T
		Little Smoky 813S 902T
Modified RAS 246	Post-Project voltage collapse and transient voltage recovery issues	7L40 (Little Smoky 813S - Simonette 733S)
Planned RAS 247	Post-Project voltage collapse and transient voltage recovery issues	7L228 (Big Mountain 845S - Thornton 2091S)
Planned RAS 245	Transient voltage recovery issues at HR Milner 740S and Simonette 733S	7L20 (HR Milner 740S - Thornton 2091S)

**TPR on all three lines 7L20, 7L40 and 7L228*

Table 5-5: Post-Project (Sensitivity study) Mitigation Measures (with new Capacitors)

Mitigation Measure	Location of Observed Violation	Contingency
With P3072 Final Stage: TMR with NPP1=50MW and new capacitors at HR Milner 740S (15MVAr@144kV), Simonette 733S (20MVAr@144kV) and Pearson 2089S (2x15MVAr@144kV + 2x4.8MVAr@25kV) Without P3072 Final Stage: TMR with NPP1=50MW and new capacitors at HR Milner 740S (15MVAr@144kV), Simonette 733S (20MVAr@144kV) and Thornton 2091S (2x15MVAr@144kV)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	9L05 (Little Smoky 813S - Louise Creek 809S)
		7L13 (Big Mountain 845S - Procter & Gamble 808S)
		7L56 (Little Smoky 813S - Louise Creek 809S)
		7L73 (Rycroft 730S - Friedenstal 800S)
		Bear Creek 679S 701T
		Little Smoky 813S 901T
		Little Smoky 813S 902T
With P3072 Final Stage: TMR with NPP1=50MW and new capacitors at HR Milner 740S (15MVAr@144kV), Simonette 733S (20MVAr@144kV) and Pearson 2089S (2x15MVAr@144kV + 2x4.8MVAr@25kV) AND TPR on line 7L40	Post-Project voltage collapse and transient voltage recovery issues	7L40 (Little Smoky 813S - Simonette 733S)

Without P3072 Final Stage: TMR with NPP1=50MW and new capacitors at HR Milner 740S (15MVAr@144kV), Simonette 733S (20MVAr@144kV) and Thornton 2091S (2x15MVAr@144kV) AND TPR on line 7L40		
With P3072 Final Stage: TMR with NPP1=50MW and new capacitors at HR Milner 740S (15MVAr@144kV), Simonette 733S (20MVAr@144kV) and Pearson 2089S (2x15MVAr@144kV + 2x4.8MVAr@25kV) Without P3072 Final Stage: TMR with NPP1=50MW and new capacitors at HR Milner 740S (15MVAr@144kV), Simonette 733S (20MVAr@144kV) and Thornton 2091S (2x15MVAr@144kV)	Post-Project voltage collapse and transient voltage recovery issues	7L228 (Big Mountain 845S - Thornton 2091S)
With P3072 Final Stage: TMR with NPP1=50MW and new capacitors at HR Milner 740S (15MVAr@144kV), Simonette 733S (20MVAr@144kV) and Pearson 2089S (2x15MVAr@144kV + 2x4.8MVAr@25kV) Without P3072 Final Stage: TMR with NPP1=50MW and new capacitors at HR Milner 740S (15MVAr@144kV), Simonette 733S (20MVAr@144kV) and Thornton 2091S (2x15MVAr@144kV)	Transient voltage recovery issues at HR Milner 740S and Simonette 733S	7L20 (HR Milner 740S - Thornton 2091S)

The proposed mitigation with new capacitors introduced new Category B voltage violations as shown in Table 5-6 and Table 5-7 and hence additional mitigation measures were developed as shown in the following Table 5-8.

Table 5-6: Voltage Criteria Violations under Category B Conditions for Scenario 8 (with TMR and Caps)

Contingency (System Element Lost)	Details of Violation (Violation Observed On)		Voltage Ratings (kV)			Pre-Project Results		Post-Project Results		% Voltage Difference (kV)
	Substation Name and Number	Bus No.	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post-contingency Steady State (kV)	Initial Voltage (kV)	Post-contingency Steady State (kV)	
Simonette 733S 702T	H.R. Milner 740S	1147	144	130	155	150.3	154.7	151	155.6	0.6%
	Kakwa Ridge 857S	1149	144	130	155	150.1	155.4	150.6	156.1	0.5%
	Simonette 733S	1170	144	130	155	148.1	157.3	148.1	157.5	0.1%

Table 55-7: Voltage Criteria Violations under Category B Conditions for Scenario 9 (with TMR and Caps)

Contingency (System Element Lost)	Details of Violation (Violation Observed On)		Voltage Ratings (kV)			Pre-Project Results		Post-Project Results		% Voltage Difference (kV)
	Substation Name and Number	Bus No.	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post-contingency Steady State (kV)	Initial Voltage (kV)	Post-contingency Steady State (kV)	
Simonette 733S 702T	H.R. Milner 740S	1147	144	130	155	149.7	154.4	150.4	155.3	0.6%
	Kakwa Ridge 857S	1149	144	130	155	149.5	155.1	150	155.8	0.5%
	Simonette 733S	1170	144	130	155	147.7	157.1	147.8	157.4	0.2%

Table 5-8: Post-Project (Sensitivity study) Additional Mitigation Measures

Mitigation Measure	Location of Observed Violation	Contingency
Planned Simonette 733S Overvoltage Protection	Over voltage at HR Milner 740S and Simonette 733S buses	Simonette 733S 702T

5.4.1 Mitigation Measures for Identified Thermal Criteria Violations for the Sensitivity study

Category B thermal violations identified in the power flow studies will be mitigated by TMR with NPP1 generator dispatched to 50 MW. Category B voltage criteria and stability violations will be mitigated as described in the following sections.

5.4.2 Mitigation Measures (Temporary) for Identified Voltage Criteria Violations for the Sensitivity study

As identified in the power flow, voltage stability and transient stability analysis, loss of any of the following lines caused transmission voltage range violation or voltage stability violation or transient voltage recovery issues at identified area substation buses.

- 7L20 (HR Milner 740S – Thornton 2091S)
- 7L40 (Little Smoky 813S – Simonette 733S)
- 7L228 (Big Mountain 845S – Thornton 2091S)

To mitigate the observed violations, the following RASs were used as a temporary measure.

Before TPR:

- New RAS 248 and existing RAS 242

After TPR:

- Planned RAS 245, planned RAS 247 and modified RAS 246

Existing RAS 242, which is in use before the installation of TPR in the area, operates based on undervoltage detection at Simonette 733S to mitigate the voltage violations observed after the loss of 7L40, 7L228, or 7L20, by tripping load at Simonette 733S. Planned RASs 245, 246, and 247, which replace Existing RAS 242 after TPR is installed in the area, activate to trip load at Simonette 733S to mitigate voltage violations observed after the loss of 7L20 (Planned RAS 245), 7L40 (Planned RAS 246), and 7L228 (Planned RAS 247).

As a result of this Project, New RAS 248 is introduced, and Planned RAS 246 is modified. The New RAS 248, which will be in use before the installation of TPR in the area, operates based on undervoltage detection at Thornton 2091S to mitigate the voltage violations observed after the loss of 7L40. Modified RAS 246, which replaces New RAS 248 after TPR is installed in the area, activates to trip load at Thornton 2091S, in addition to tripping load at Simonette 733S, to mitigate voltage violations observed after the loss of 7L40.

5.4.3 Mitigation Measures (Permanent) for Identified Voltage Criteria Violations for the Sensitivity study

As identified in the power flow, voltage stability and transient stability analysis, loss of lines 7L20, 7L40 or 7L228 caused transmission voltage range violation or voltage stability violation or transient voltage recovery issues at identified area substation buses.

5.4.3.1 QV Analysis for Scenario 9 2029 Winter Peak LG Post-Project Sensitivity (P3076 with P3072 Interim Stage) with TMR and Caps

P3072 Greenview project final stage requires to install following new area capacitors at the identified substations to mitigate area voltage range and stability violations.

- 20 MVAr@144kV new capacitor at Simonette 733S
- 15 MVAr@144kV new capacitor at HR Milner 740S
- 2x15 MVAr@144kV) and 2x4.8 MVAr@25kV new capacitors at new Pearson 2089S

If the P3072 final stage did not materialize then the above-mentioned capacitors would be used at the following area substations for fulfilling the need for new capacitors required for P3076 and P3072 interim stage as identified through the following QV analysis of P3076 including P3072 interim stage load.

- 20 MVAr new capacitor at Simonette 733S
- 15 MVAr new capacitor at HR Milner 740S
- 2x15 MVAr new capacitors at Thornton 2091S

The following QV analysis was done using Scenario 9 2029 WP Post-Project (Sensitivity) to determine the required VAR support in the region for the sensitivity study including P3072 interim load. The critical contingency and identified VAR support from Figure 1, Figure 2 and Figure 3 are summarized below (Figures provided are for the existing system without any new capacitors):

- Reference to Fig.1: For the loss of 7L40, a minimum of 29.21 MVAr on a base of 138 kV at HR Milner (31.81 MVAr on 144 kV base) is required. However, due to space limitation at HR Milner 740S only a capacitor size of 15 MVAr (on 144 kV base) can be accommodated. Based on area TFO's standard sizes for sparing a 15 MVAr capacitor was chosen at HR Milner 740S. The switching step voltages are as shown in Table 5-9. As can be seen from Table 5-9, the switching step voltages are less than AESO's maximum switching step of 4%.
- Reference to Fig.2: For the loss of 7L40, a minimum of 29.89 MVAr on a base of 138 kV at Simonette 733S (32.55 MVAr on 144 kV base) is required. However, due to space limitation at Simonette 733S only a capacitor size of 20 MVAr (on 144 kV base) can be accommodated. Based on area TFO's standard sizes for sparing, a 20 MVAr capacitor bank on a 144 kV base was chosen at Simonette 733S. The switching step voltages are as shown in Table 5-10. As can be seen from Table 5-10, the switching step voltages are less than AESO's maximum switching step of 4%.
- Reference to Fig.3: For the loss of 7L40, a minimum of 35.21 MVAr on a base of 138 kV at HR Milner (38.11 MVAr on 144 kV base) is required. Based on area TFO's standard sizes for sparing, 2x15 MVAr caps at 144 kV base were chosen at Thornton 2091S. The switching step voltages are as shown in Table 5-11 and 5-12. As can be seen from the Tables the switching step voltages are less than AESO's maximum switching step of 4%.

Figure 3: Scenario 9 2029 WP Post Project (Sensitivity) QV Analysis at HR Milner 740S (with no New Capacitors)

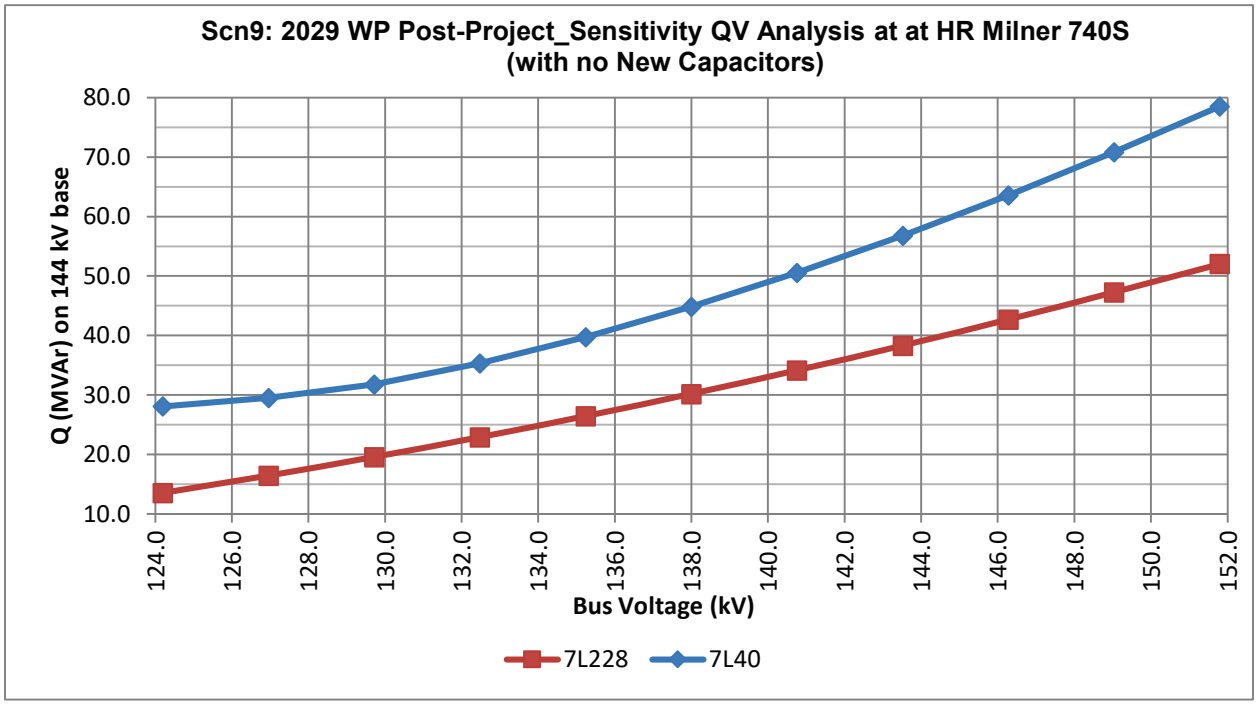


Figure 4: Scenario 9 2029 WP Post Project (Sensitivity) QV Analysis at Simonette 733S (with no New Capacitors)

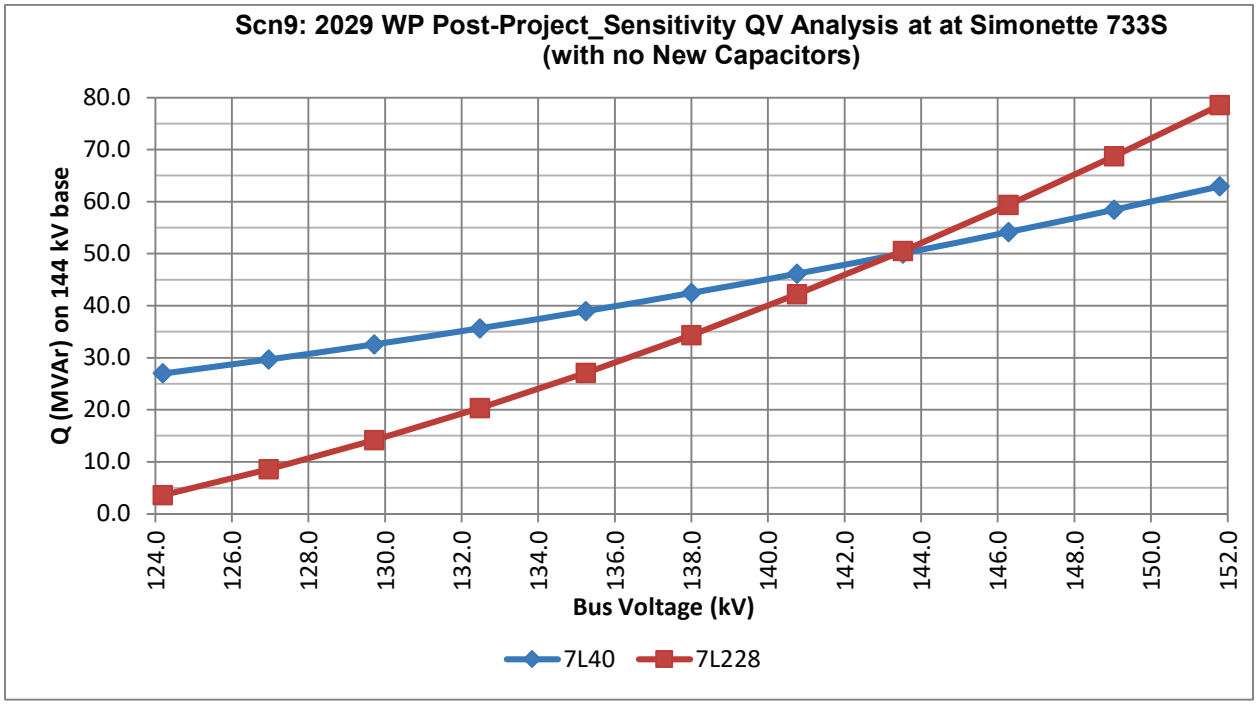


Figure 3: Scenario 9 2029 WP Post Project (Sensitivity) QV Analysis at Thornton 2091S (with no New Capacitors)

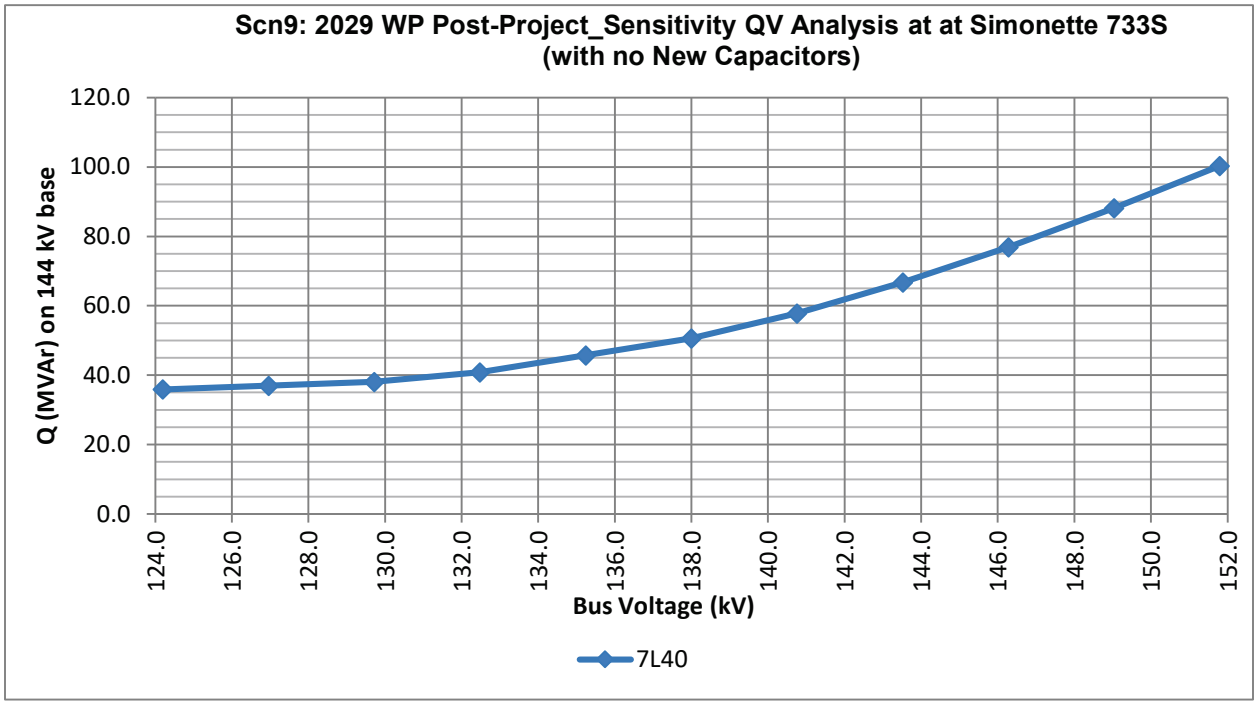


Table 5-9: Scenario 9 2029 WP Post Project (Sensitivity) 15 MVAr 144 kV Capacitor Switch Step at HR Milner 740S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	15 MVAr 144 kV Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0312	1.0503	1.85%
	18103	25	1.0389	1.0583	1.87%
	999000	25	1.0488	1.0684	1.87%
Dome Cutbank 810S	1144	138	1.0296	1.0505	2.03%
	18144	25	1.0436	1.0650	2.05%
HR Milner 740S	1147	138	1.0278	1.0566	2.80%
	16147	25	1.0483	1.0779	2.82%
	19147	25	1.0387	1.0679	2.81%
Kakwa Ridge	1149	138	1.0314	1.0577	2.55%

857S					
Simonette 733S	1170	138	1.0408	1.0567	1.53%
	19170	25	1.0470	1.0633	1.56%

Table 5-10: Scenario 9 2029 WP Post Project (Sensitivity) 20 MVAr 144 kV Capacitor Switch Step at Simonette 733S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	20 MVAr 144 kV Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0201	1.0353	1.49%
	18103	25	1.0390	1.0546	1.50%
	999000	25	1.0491	1.0648	1.50%
Dome Cutbank 810S	1144	138	1.0173	1.0336	1.60%
	18144	25	1.0397	1.0566	1.63%
HR Milner 740S	1147	138	1.0104	1.0317	2.11%
	16147	25	1.0408	1.0628	2.11%
	19147	25	1.0428	1.0648	2.11%
Kakwa Ridge 857S	1149	138	1.0111	1.0354	2.40%
Simonette 733S	1170	138	1.0087	1.0449	3.59%
	19170	25	1.0323	1.0699	3.64%

Table 5-11: Scenario 9 2029 WP Post Project (Sensitivity) 15 MVAr 144 kV 1st Capacitor Switch Step at Thornton 2091S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	15 MVAr 144 kV 1st Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0476	1.0703	2.17%
	18103	25	1.0325	1.0550	2.18%
	999000	25	1.0301	1.0527	2.19%
Dome Cutbank 810S	1144	138	1.0478	1.0700	2.12%
	18144	25	1.0340	1.0561	2.14%
HR Milner 740S	1147	138	1.0537	1.0737	1.90%
	16147	25	1.0326	1.0523	1.91%
	19147	25	1.0329	1.0525	1.90%
Kakwa Ridge 857S	1149	138	1.0547	1.0732	1.75%
Simonette 733S	1170	138	1.0532	1.0651	1.13%
	19170	25	1.0394	1.0513	1.14%

Table 5-12: Scenario 9 2029 WP Post Project (Sensitivity) 15 MVAr 144 kV 2nd Capacitor Switch Step at Thornton 2091S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	15 MVAr 144 kV 2nd Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0682	1.0919	2.22%
	18103	25	1.0307	1.0537	2.23%
	999000	25	1.0401	1.0633	2.23%
Dome Cutbank 810S	1144	138	1.0679	1.0911	2.17%
	18144	25	1.0352	1.0578	2.18%
HR Milner	1147	138	1.0716	1.0924	1.94%

740S	16147	25	1.0404	1.0608	1.96%
	19147	25	1.0400	1.0602	1.94%
Kakwa Ridge 857S	1149	138	1.0708	1.0900	1.79%
Simonette 733S	1170	138	1.0620	1.0743	1.16%
	19170	25	1.0492	1.0615	1.17%

5.4.3.2 QV Analysis confirmation of Capacitor Size Adequacy

As proposed in the previous section the capacitor size adequacy testing was done with the following capacitors in place.

- At H.R Milner 740S: 1x15 MVAr cap at 144 kV
- At Simonette 733S: 1x20 MVAr cap at 144 kV
- At Thornton 2091S: 2x15 MVAr caps at 144 kV

As shown in Figure 4, 5 and 6, with the above-described caps provide sufficient VAR support at HR Milner 740S, Simonette 733S and Thornton 2091S.

Figure 4: Scenario 9 2029 WP Post-Project (Sensitivity) QV Analysis Confirmation of Adequacy at HR Milner 740S

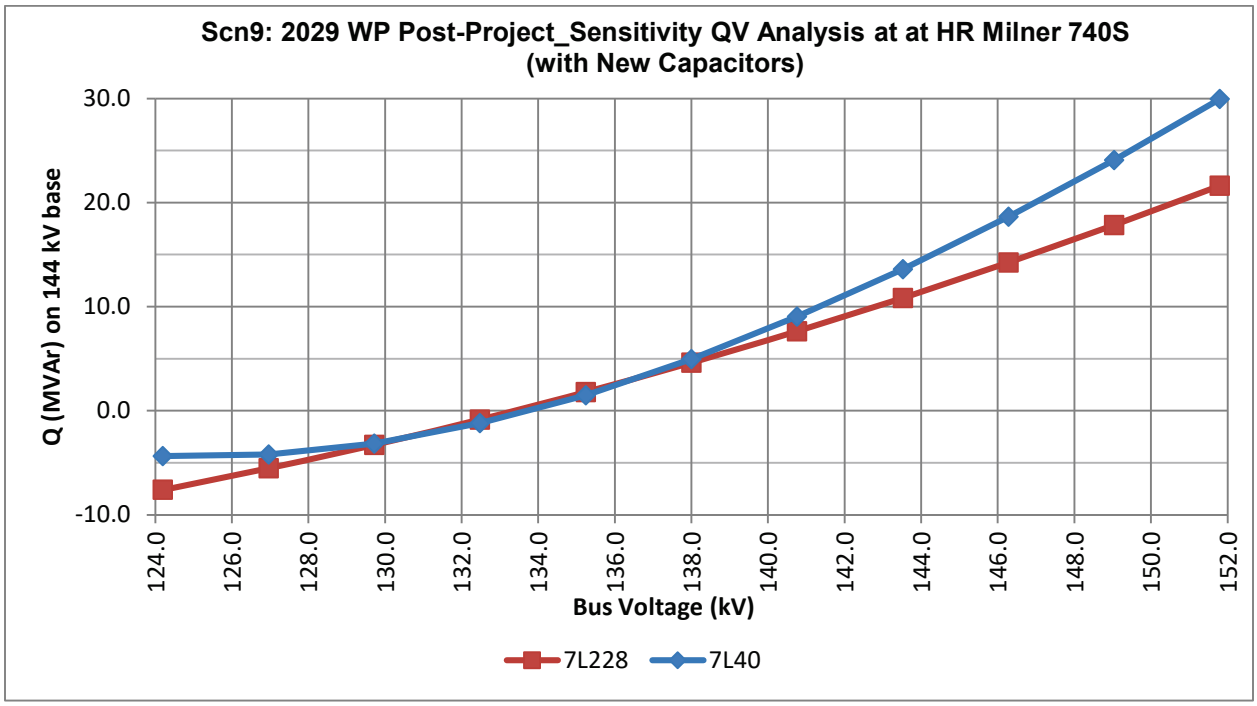


Figure 5: Scenario 9 2029 WP Post-Project (Sensitivity) QV Analysis Confirmation of Adequacy at Simonette 733S

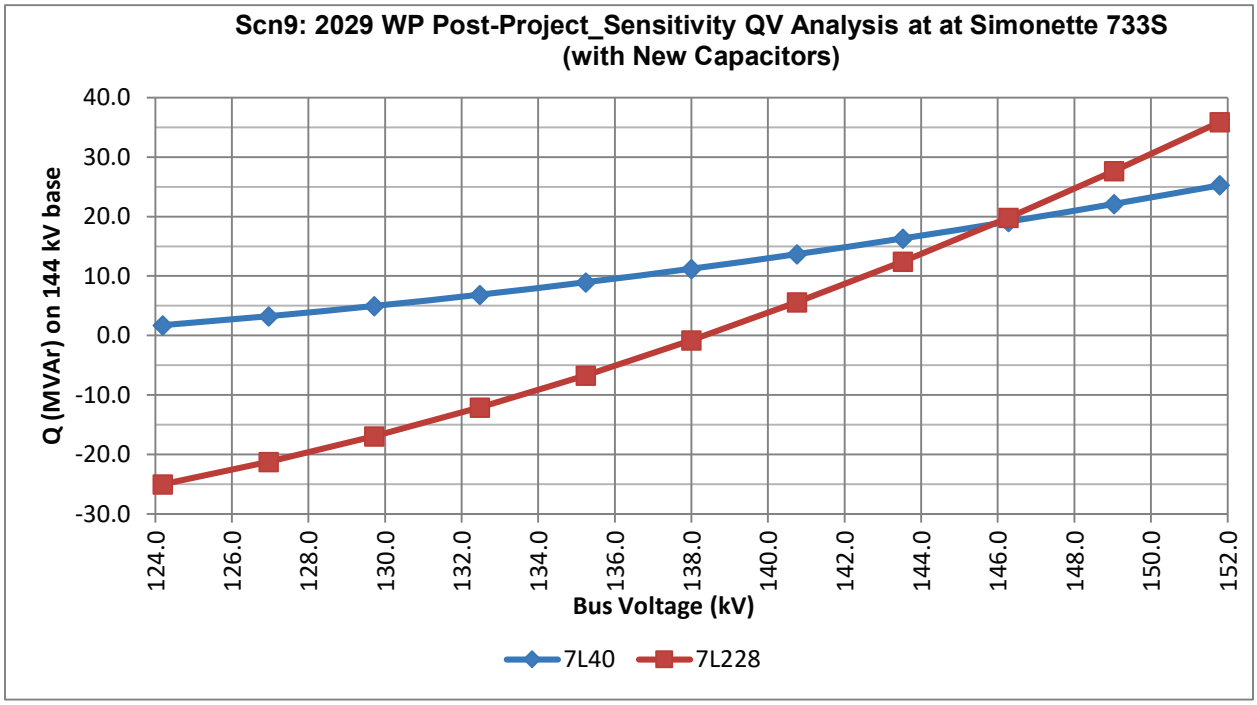
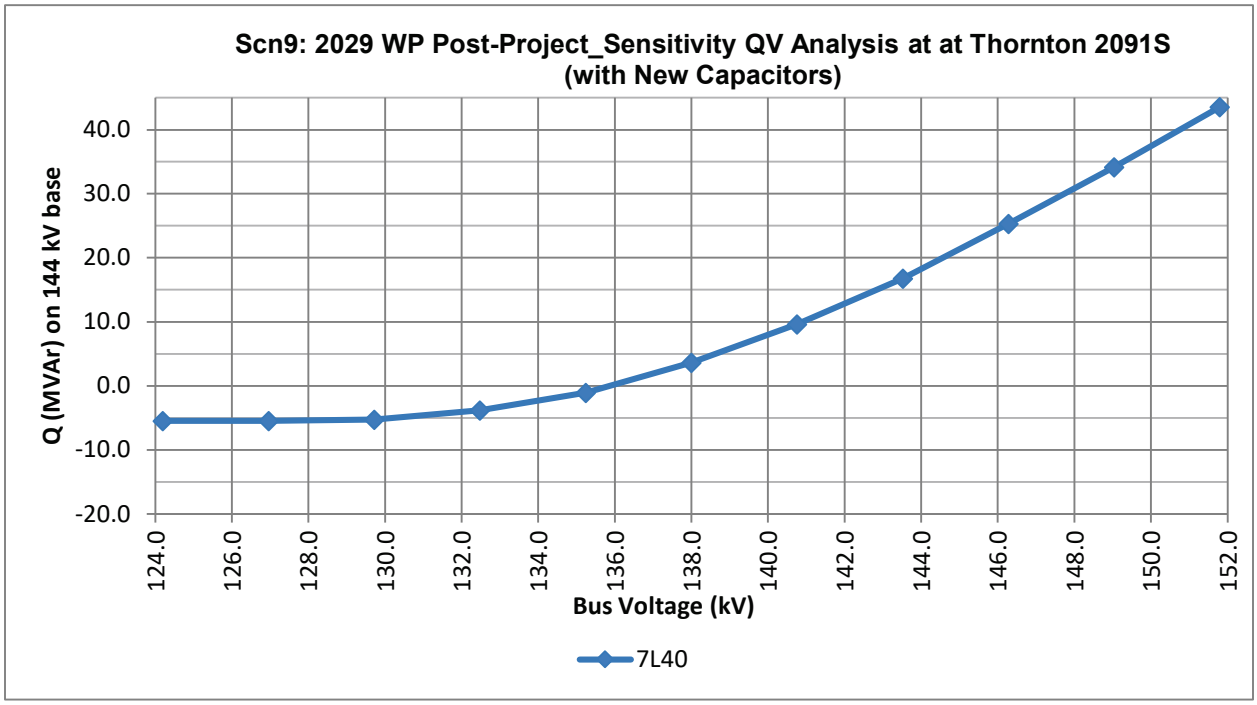


Figure 6: Scenario 9 2029 WP Post-Project (Sensitivity) QV Analysis Confirmation of Adequacy at Thornton 2091S



5.4.3.3 QV Analysis for Scenario 9 2029 Summer Peak LG Post-Project_ Sensitivity (P3076 with P3072 Final Stage and P2716) with TMR and Caps

The following QV analysis was done using Scenario 9 2029 SP Post-Project (Sensitivity) to determine the required VAR support in the region for the sensitivity study for P3076 with P3072 final stage and P2716. The critical contingency and identified VAR support from Figure 7, Figure 8 and Figure 9 are summarized below (Figures provided are for the existing system without any new capacitors):

- Reference to Fig.7: For the loss of 7L228, a minimum of 33.70 MVAr on a base of 138 kV at HR Milner (36.69 MVAr on 144 kV base) is required. However, due to space limitation at HR Milner 740S only a capacitor size of 15 MVAr (on 144 kV base) can be accommodated. Based on area TFO's standard sizes for sparing a 15 MVAr capacitor was chosen at HR Milner 740S. The switching step voltages are as shown in Table 5-13. As can be seen from Table 5-13, the switching step voltages are less than AESO's maximum switching step of 4%.
- Reference to Fig.8: For the loss of 7L228, a minimum of 45 MVAr on a base of 138 kV at Simonette 733S (49 MVAr on 144 kV base) is required. However, due to space limitation at Simonette 733S only a capacitor size of 20 MVAr (on 144 kV base) can be accommodated. Based on area TFO's standard sizes for sparing, a 20 MVAr capacitor bank on a 144 kV base was chosen at Simonette 733S. The switching step voltages are as shown in Table 5-14. As can be seen from Table 5-14, the switching step voltages are less than AESO's maximum switching step of 4%.
- Reference to Fig.9: For the loss of 7L228, a minimum of 44.63 MVAr on a base of 138 kV at HR Milner (48.60 MVAr on 144 kV base) is required. Based on area TFO's standard sizes for sparing, 2x15 MVAr (on 144kV base) and 2x4.8 MVAr (on 25kV base) caps were chosen at Pearson 2089S. The switching step voltages are as shown in Table 5-15, Table 5-16, Table 5-17 and 5-18. As can be seen from the Tables the switching step voltages are less than AESO's maximum switching step of 4%.

Figure7: Scenario 9 2029 SP Post Project (Sensitivity) QV Analysis at HR Milner 740S (with no New Capacitors)

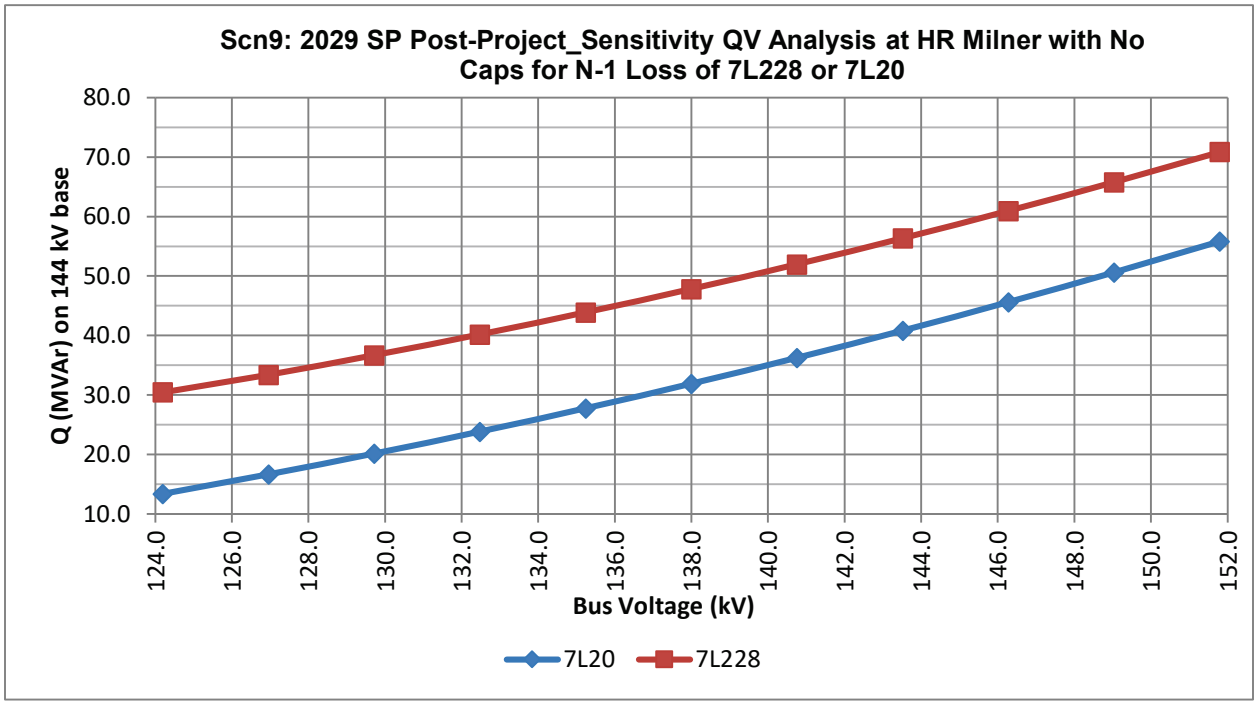


Figure 8: Scenario 9 2029 SP Post Project (Sensitivity) QV Analysis at Simonette 733S (with no New Capacitors)

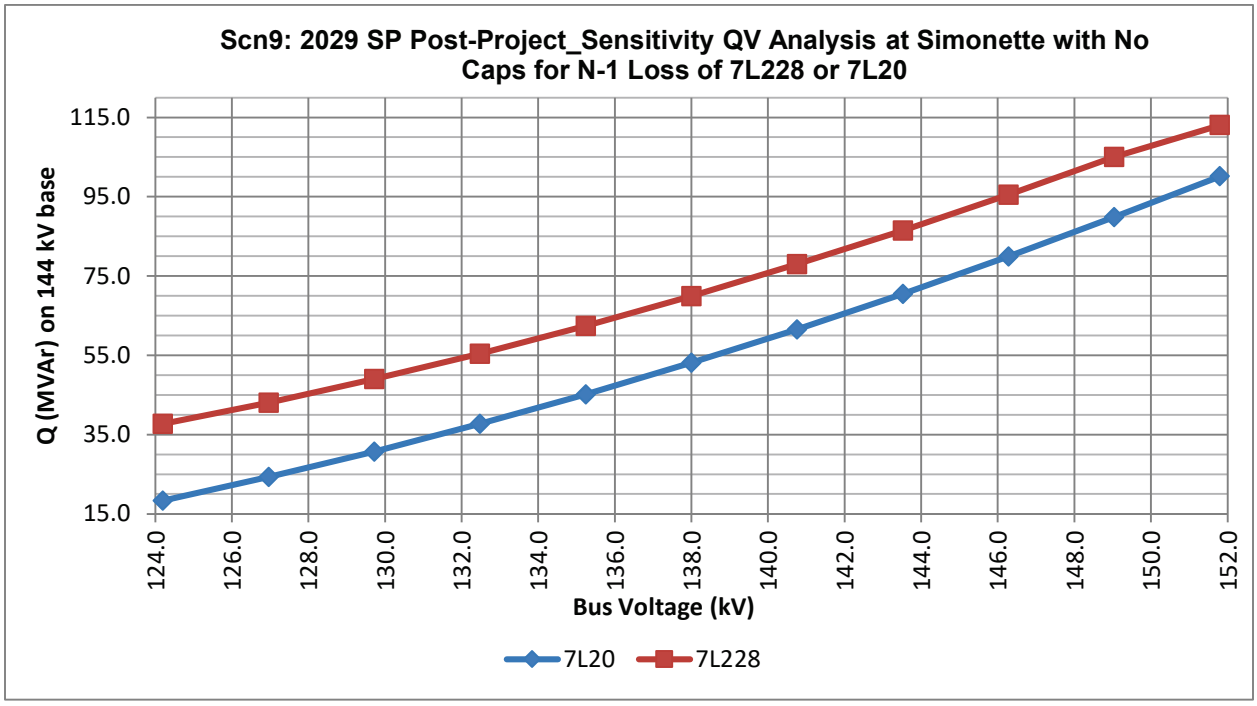


Figure 9: Scenario 9 2029 SP Post Project (Sensitivity) QV Analysis at Pearson 2089S (with no New Capacitors)

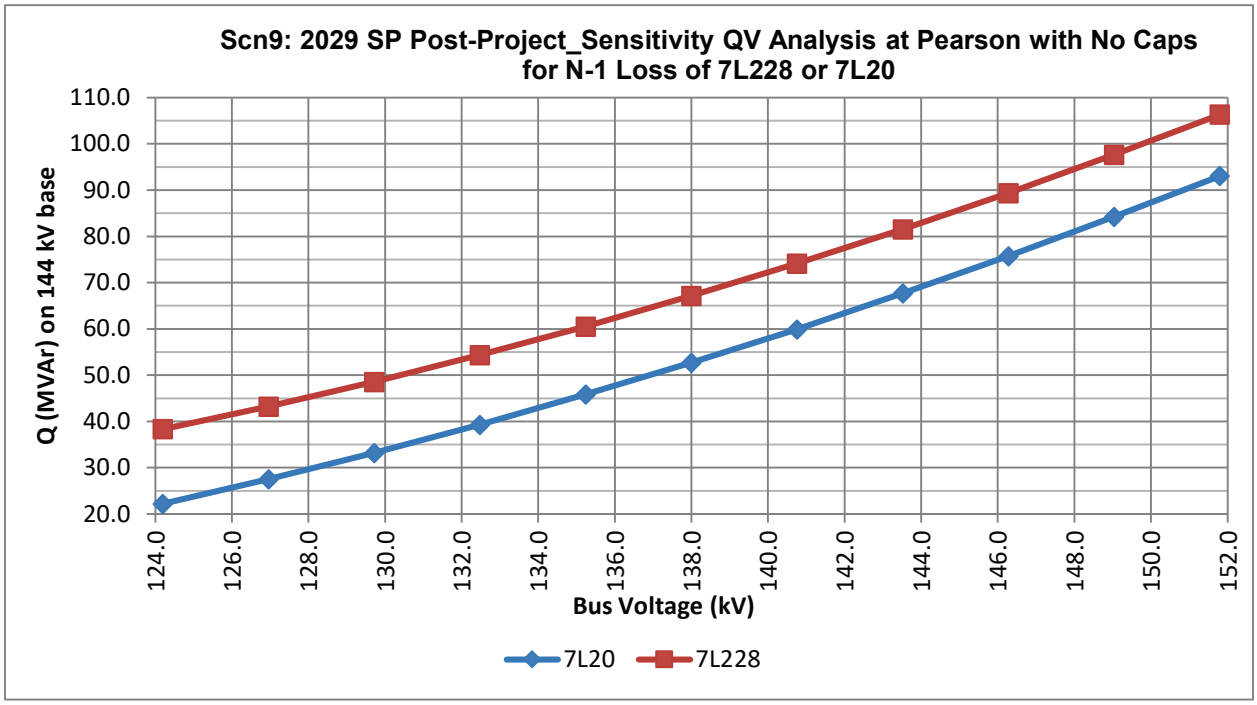


Table 5-13: Scenario 9 2029 SP Post Project (Sensitivity) 15 MVAr 144 kV Capacitor Switch Step at HR Milner 740S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	15 MVAr 144 kV Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0297	1.0488	1.85%
	18103	25	1.0373	1.0566	1.86%
Dome Cutbank 810S	1144	138	1.0279	1.0488	2.03%
	18144	25	1.0438	1.0652	2.05%
HR Milner 740S	1147	138	1.0242	1.0531	2.82%
	16147	25	1.0466	1.0763	2.84%
	19147	25	1.047	1.0765	2.82%
Kakwa Ridge 857S	1149	138	1.022	1.0484	2.58%

Simonette 733S	1170	138	1.0069	1.0227	1.57%
	19170	25	1.0347	1.0511	1.59%
Pearson 2089S	990002	138	0.9912	1.0064	1.53%
	990003	25	1.0153	1.0311	1.56%

Table 5-14: Scenario 9 2029 SP Post Project (Sensitivity) 20 MVAr 144 kV Capacitor Switch Step at Simonette 733S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	15 MVAr 144 kV Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0295	1.0448	1.49%
	18103	25	1.0493	1.065	1.50%
Dome Cutbank 810S	1144	138	1.0276	1.0441	1.61%
	18144	25	1.0436	1.0604	1.61%
HR Milner 740S	1147	138	1.0238	1.0454	2.11%
	16147	25	1.0462	1.0684	2.12%
	19147	25	1.0466	1.0686	2.10%
Kakwa Ridge 857S	1149	138	1.0215	1.0461	2.41%
Simonette 733S	1170	138	1.0061	1.0426	3.63%
	19170	25	1.0338	1.0717	3.67%
Pearson 2089S	990002	138	1.0042	1.0396	3.53%
	990003	25	1.0306	1.0674	3.57%

Table 5-15: Scenario 9 2029 SP Post Project (Sensitivity) 15 MVAr 144 kV 1st Capacitor Switch Step at Pearson 2089S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	15 MVAr 144 kV 1st Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0070	1.0162	0.91%
	18103	25	1.0368	1.0465	0.94%
Dome Cutbank 810S	1144	138	1.0026	1.0125	0.99%
	18144	25	1.0259	1.0361	0.99%
HR Milner 740S	1147	138	0.9885	1.0013	1.29%
	16147	25	1.0303	1.0438	1.31%
	19147	25	1.0319	1.0454	1.31%
Kakwa Ridge 857S	1149	138	0.9797	0.9944	1.50%
Simonette 733S	1170	138	0.9387	0.9603	2.30%
	19170	25	0.9561	0.9784	2.33%
Pearson 2089S	990002	138	0.9100	0.9394	3.23%
	990003	25	0.9188	0.9491	3.30%

Table 5-16: Scenario 9 2029 SP Post Project (Sensitivity) 15 MVAr 144 kV 2nd Capacitor Switch Step at Pearson 2089S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	15 MVAr 144 kV 2nd Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0217	1.0311	0.92%
	18103	25	1.0408	1.0504	0.92%
Dome Cutbank 810S	1144	138	1.0183	1.0284	0.99%
	18144	25	0.9482	0.9576	0.99%
HR Milner	1147	138	1.0072	1.0210	1.37%

740S	16147	25	1.0402	1.0538	1.31%
	19147	25	1.0412	1.0547	1.30%
Kakwa Ridge 857S	1149	138	1.0006	1.0164	1.58%
Simonette 733S	1170	138	0.9683	0.9915	2.40%
	19170	25	1.0340	1.0591	2.43%
Pearson 2089S	990002	138	0.9494	0.9810	3.33%
	990003	25	0.9659	0.9986	3.39%

Table 5-17: Scenario 9 2029 SP Post Project (Sensitivity) 4.8 MVAr 25 kV 2nd Capacitor Switch Step at Pearson 2089S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	4.8 MVAr 25 kV 1st Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0090	1.0125	0.35%
	18103	25	1.0392	1.0427	0.34%
Dome Cutbank 810S	1144	138	1.0065	1.0102	0.37%
	18144	25	1.0317	1.0355	0.37%
HR Milner 740S	1147	138	1.0000	1.0049	0.49%
	16147	25	1.0359	1.0410	0.49%
	19147	25	1.0330	1.0381	0.49%
Kakwa Ridge 857S	1149	138	0.9985	1.0041	0.56%
Simonette 733S	1170	138	0.9868	0.9950	0.83%
	19170	25	1.0422	1.0510	0.84%
Pearson 2089S	990002	138	0.9779	0.9892	1.16%
	990003	25	0.9997	1.0238	2.41%

Table 5-18: Scenario 9 2029 SP Post Project (Sensitivity) 4.8 MVAr 25 kV 2nd Capacitor Switch Step at Pearson 2089S

Substation Name and Number	Bus No.	kV Base	Pre-Cap Switching Voltage (p.u.)	4.8 MVAr 25 kV 2nd Capacitor	
				Post-Cap Switching Voltage (kV)	Step Change (%)
Thornton 2091S	1103	138	1.0127	1.0164	0.37%
	18103	25	1.0432	1.0471	0.37%
Dome Cutbank 810S	1144	138	1.0106	1.0146	0.40%
	18144	25	1.0361	1.0402	0.40%
HR Milner 740S	1147	138	1.0057	1.0110	0.53%
	16147	25	1.0418	1.0472	0.52%
	19147	25	1.0389	1.0443	0.52%
Kakwa Ridge 857S	1149	138	1.0053	1.0112	0.59%
Simonette 733S	1170	138	0.9975	1.0063	0.88%
	19170	25	1.0328	1.0420	0.89%
Pearson 2089S	990002	138	0.9931	1.0051	1.21%
	990003	25	1.0317	1.0574	2.49%

5.4.3.4 QV Analysis confirmation of Capacitor Size Adequacy

As proposed in the previous section, the capacitor size adequacy testing was done with the following capacitors in place.

- At H.R Milner 740S: 1x15 MVAr cap at 144 kV
- At Simonette 733S: 1x20 MVAr cap at 144 kV
- At Pearson 2089S: 2x15 MVAr caps at 144 kV and 2x4.8 MVAr caps at 25 kV

As shown in Figure 10, 11 and 12, with the above-described caps provide sufficient VAR support at HR Milner 740S, Simonette 733S and Pearson 2089S.

Figure 10: Scenario 9 2029 SP Post-Project (Sensitivity) QV Analysis Confirmation of Adequacy at HR Milner 740S

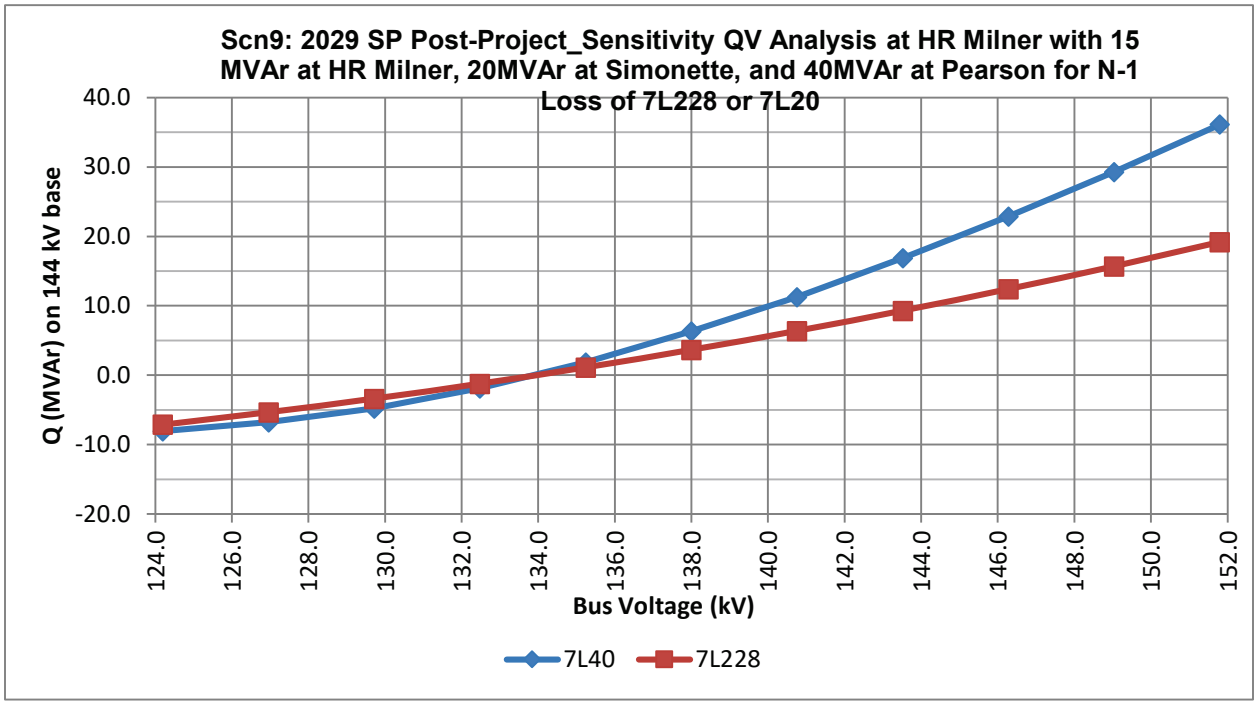


Figure 11: Scenario 9 2029 SP Post-Project (Sensitivity) QV Analysis Confirmation of Adequacy at Simonette 733S

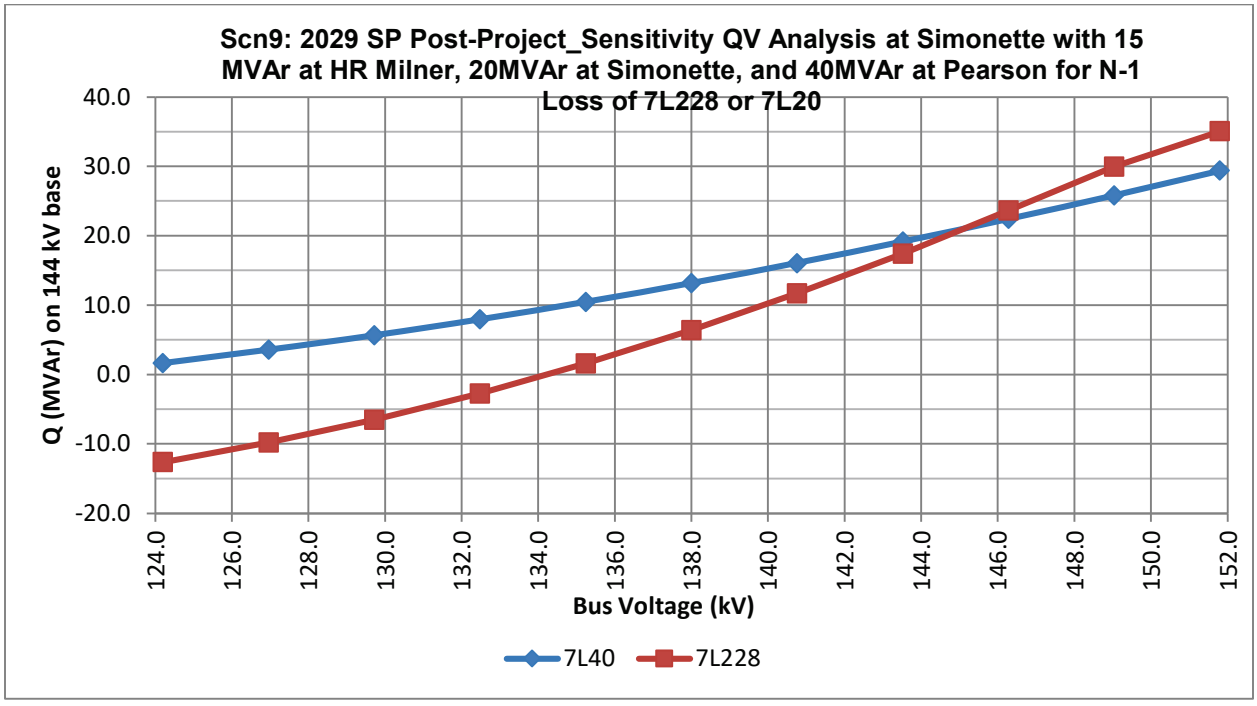
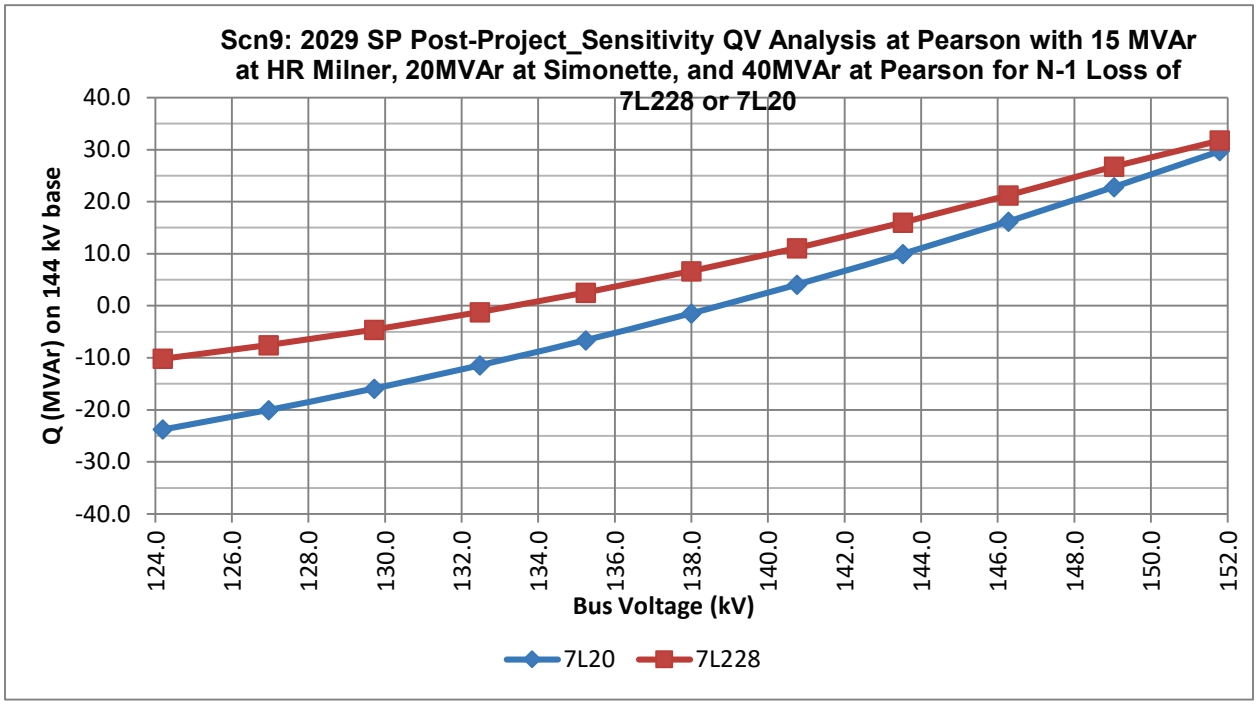


Figure 12: Scenario 9 2029 SP Post-Project (Sensitivity) QV Analysis Confirmation of Adequacy at Thornton 2091S



5.4.3.5 Scenario 8: 2029 Summer peak LG Post-Project (Sensitivity)

Post-Project permanent mitigation measures for Scenario 8 are summarized in Table 5-19 and Table 5-20.

Table 5-19: Post-Project Mitigation Measures for Scenario 8 with TMR and Caps (with P3072 final stage energized)

Mitigation Measure	Location of Observed Violation	Contingency
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8MVAr (25kV) capacitors at Pearson 2089S	Transient voltage recovery issues at HR Milner and Simonette	7L20 (Thornton 2091S – HR Milner 740S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8 MVAr (25kV) capacitors at Pearson 2089S	Post-Project Voltage Collapse	7L40 (Little Smoky 813S - Simonette 733S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8 MVAr (25kV)capacitors at Pearson 2089S	Post-Project Voltage Range Violations	7L228 (Big Mountain 845S - Thornton 2091S)

Table 5-20: Post-Project Mitigation Measures for Scenario 8 with TMR and Caps (Without P3072 final stage energized)

Mitigation Measure	Location of Observed Violation	Contingency
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr capacitors at Thornton 2091S	Transient voltage recovery issues at HR Milner and Simonette	7L20 (Thornton 2091S – HR Milner 740S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr capacitors at Thornton 2091S	Post-Project Voltage Collapse	7L40 (Little Smoky 813S - Simonette 733S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr capacitors at Thornton 2091S	Post-Project Voltage Range Violations	7L228 (Big Mountain 845S - Thornton 2091S)

5.4.3.6 Scenario 9: 2029 Winter Peak LG Post-Project (Sensitivity)

Post-Project permanent mitigation measures for Scenario 9 are summarized in Table 5-21 and Table 5-22.

Table 5-21: Post-Project Mitigation Measures for Scenario 9 with TMR and Caps (with P3072 final stage energized)

Mitigation Measure	Location of Observed Violation	Contingency
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8MVAr (25kV) capacitors at Pearson 2089S	Transient voltage recovery issues at HR Milner and Simonette	7L20 (Thornton 2091S – HR Milner 740S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8 MVAr (25kV) capacitors at Pearson 2089S	Post-Project Voltage Collapse	7L40 (Little Smoky 813S - Simonette 733S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8 MVAr (25kV) capacitors at Pearson 2089S	Post-Project Voltage Collapse	7L228 (Big Mountain 845S - Thornton 2091S)

Table 5-22: Post-Project Mitigation Measures for Scenario 9 with TMR and Caps (Without P3072 final stage energized)

Mitigation Measure	Location of Observed Violation	Contingency
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr capacitors at Thornton 2091S	Transient voltage recovery issues at HR Milner and Simonette	7L20 (Thornton 2091S – HR Milner 740S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr capacitors at Thornton 2091S	Post-Project Voltage Collapse	7L40 (Little Smoky 813S - Simonette 733S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr capacitors at Thornton 2091S	Post-Project Voltage Range Violations	7L228 (Big Mountain 845S - Thornton 2091S)

5.4.3.7 Scenario 9: 2029 Summer Peak LG Post-Project Sensitivity (P3072 Final Stage with P3076 and P2716)

Post-Project permanent mitigation measures for Scenario 9 (P3072 Final Stage with P3076 and P2716) are summarized in Table 5-23.

Table 5-23: Post-Project Mitigation Measures for Scenario 9 with TMR and Caps (with P3072 Final Stage)

Mitigation Measure	Location of Observed Violation	Contingency
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8 MVAr (25kV) capacitors at Pearson 2089S	Post-Project Voltage Collapse	7L40 (Little Smoky 813S - Simonette 733S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8 MVAr (25kV) capacitors at Pearson 2089S	Post-Project Voltage Collapse	7L228 (Big Mountain 845S - Thornton 2091S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8 MVAr (25kV) capacitors at Pearson 2089S	Post-Project Voltage Collapse	7L80 (HR Milner 740S - Simonette 733S)
TMR (NPP1=50MW) with Proposed 15MVAr capacitor at HR Milner 740S, 20MVAr capacitor at Simonette 733S, and 2x15 MVAr (144kV) + 2x4.8 MVAr (25kV) capacitors at Pearson 2089S	Post-Project Voltage Collapse	7L13 (Big Mountain 845S – Procter & Gamble 808S)

5.5 Evaluation of Mitigation Measures

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

Main Study (Scenario 3): The post-mitigation studies were performed under Category B conditions for Scenarios 3, and 4 using mitigations measures described in the previous section. The post-mitigation power flow diagrams for identified Category B conditions for scenario 3 with TMR are provided in Attachment A9. No Category B voltage stability margin or voltage range violations were identified for scenario 3 and scenario 4.

Sensitivity Study (Scenario 8 and 9): The post-mitigation studies were performed under Category B conditions for Scenario 8 and 9 using mitigations measures described in the previous section. The post-mitigation power flow and voltage violation diagrams for identified Category B conditions for Scenarios 8 and 9 are provided in Attachment A9. The post-mitigation voltage stability diagrams for identified Category B conditions for Scenarios 9 are provided in Attachment 10 (TMR and RAS) and Attachment 11 (TMR and Caps). Post-mitigation studies confirmed the following mitigations.

Scenario 8 and 9

- No voltage stability margin or voltage range violations were identified under Category B conditions after applying the following proposed mitigations.
    - Mitigation with the following RASs:
        - Before TPR (on 7L20 and 7L40): Apply New RAS 248 and existing RAS 242
        - After TPR (on 7L20 and 7L40): Apply planned RAS 245, modified RAS 246 and planned RAS 247
    - Mitigation with permanent Capacitors:
        - With P3072 Final Stage:
            - 15MVAr new capacitor bank at HR Milner 740S,
            - 20MVAr new capacitor bank at Simonette 733S,
            - 2x15 MVAr (144kV) + 2x4.8 MVAr (25kV) new capacitor banks at new Pearson 2089S.
            - Add TPR on line 7L40
        - Without P3072 Final Stage:
            - 15MVAr new capacitor bank at HR Milner 740S,
            - 20MVAr new capacitor bank at Simonette 733S,
            - 2x15 MVAr new capacitor bank at Thornton 2091S).
            - Add TPR on line 7L40

- All Category B thermal violations were mitigated except for the thermal violation on 7L199 due to Category B contingencies of 7L13 and Bear Creek 702T were remaining below emergency rating with TMR (NPP1=50MW).

Post-mitigation power flow diagrams present only those contingencies that result in thermal criteria violations that require TMR and/or RAS mitigation or mitigations with the proposed capacitor banks. Contingencies that result in thermal criteria violations that can be mitigated by real-time operational practices.

5.5.1 Scenario 3: 2029 Summer Peak LG Post-Project

Category B Conditions

No thermal and voltage criteria violations observed under certain Category B conditions in the post-Project studies and hence no mitigation measures were needed for Scenario 3.

5.5.2 Scenario 4: 2029 Winter Peak LG Post-Project

Category B Conditions

No thermal and voltage criteria violations observed under certain Category B conditions in the post-Project studies and hence no mitigation measures were needed for Scenario 4.

5.5.3 Scenario 8: 2029 Summer Peak LG Post-Project (Sensitivity)

Category B Conditions

The thermal and voltage criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by proposed mitigation measures as shown in Table 5-24, Table 5-25, Table 5-26, Table 5-27 and Table 5-28.

Table 5-24: Post-Mitigation (with TMR and RAS) Power Flow Study Results under Category B Conditions for Scenario 8

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
9L05 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	127.3	107.0	115.7	97.2
7L13 (Big Mountain 845S - Procter & Gamble 808S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	129.2	108.6	119.5	100.4[1]
7L56 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	119.4	100.3	108.9	91.5
7L75 (Friedenstal 800S - West Peace River 793S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	122.0	102.5	108.9	91.5
Bear Creek 679S 701T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	129.5	108.8	119.5	100.4[1]
Little Smoky 813S 901T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	126.1	106	114.4	96.1
	Little Smoky 813S 902T WDG1	200	214	217.0	108.5	188.2	94.1
	Little Smoky 813S 902T WDG2	200	214	217.6	108.8	188.6	94.3
Little Smoky 813S 902T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	126.1	106	114.8	96.5
	Little Smoky 813S 901T WDG1	200	214	215.8	107.9	187.2	93.6
	Little Smoky 813S 901T WDG2	200	214	216.4	108.2	187.6	93.8

Note 1: With TMR increased to 55 MW remaining violations were mitigated.

Table 5-25: Post-Mitigation (with TMR and RAS) Voltage Range Violations under Category B Conditions for Scenario 8

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Initial Voltage (kV)	Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
7L228 (Big Mountain 845S - Thornton 2091S)	Albright & Wilson 752S Tap	1137	144	130	155	152.5	155.7	155.4
	Bear Creek 679S Tap	1138	144	130	155	152.7	155.8	155.5
	Albright & Wilson 752S	1139	144	130	155	152.5	155.7	155.4
	Proctor & Gamble 808S	1140	144	130	155	152.7	155.8	155.5
	Bear Creek 679S	1142	144	130	155	152.8	155.8	155.6
	Dome Cutbank 810S	1144	144	130	155	143.8	128.1	140.5
	H.R. Milner 740S	1147	144	130	155	143	129	141.2
7L40 (Little Smoky 813S - Simonette 733S)	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations

Table 5-26: Post-Mitigation (with TMR and New Capacitors) Power Flow Study Results under Category B Conditions for Scenario 8

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-Mitigation Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
9L05 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	127.3	107.0	115.9	97.4
7L13 (Big Mountain 845S - Procter & Gamble 808S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	129.2	108.6	119.2	100.2[2]
7L56 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	119.4	100.3	108.9	91.5
7L75 (Friednestal 800S - West Peace River 793S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	122.0	102.5	108.9	91.5
Bear Creek 679S 701T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	129.5	108.8	119.4	100.3[2]
Little Smoky 813S 901T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	126.1	106	114.4	96.1
	Little Smoky 813S 902T WDG1	200	214	217.0	108.5	188.0	94
	Little Smoky 813S 902T WDG2	200	214	217.6	108.8	188.4	94.2
Little Smoky 813S 902T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	126.1	106	114.8	96.5
	Little Smoky 813S 901T WDG1	200	214	215.8	107.9	187.0	93.5
	Little Smoky 813S 901T WDG2	200	214	216.4	108.2	187.4	93.7

Note 2: With TMR increased to 55 MW remaining violations were mitigated.

Table 5-27: Post-Mitigation (with TMR and New Capacitors) Voltage Range Violations under Category B Conditions for Scenario 8

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Initial Voltage (kV)	Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
7L228 (Big Mountain 845S - Thornton 2091S)	Albright & Wilson 752S Tap	1139	144	130	155	152.5	155.7	No Voltage Range Violations
	Bear Creek 679S Tap	1138	144	130	155	152.7	155.8	
	Albright & Wilson 752S	1142	144	130	155	152.5	155.7	
	Proctor & Gamble 808S	1140	144	130	155	152.7	155.8	
	Bear Creek 679S	1145	144	130	155	152.8	155.8	
	Dome Cutbank 810S	1144	144	130	155	143.8	128.1	
	H.R. Milner 740S	1147	144	130	155	143	129	
7L40 (Little Smoky 813S - Simonette 733S)	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations

Table 5-28: Post-Mitigation (with Planned Simonette Over Voltage Mitigation Scheme) Voltage Range Violations under Category B Conditions for Scenario 8

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Initial Voltage (kV)	Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
Simonette 733S 702T	H.R. Milner 740S	1147	144	130	155	151	155.6	153.1
	Kakwa Ridge 857S	1149	144	130	155	150.6	156.1	153.2
	Simonette 733S	1170	144	130	155	148.1	157.5	152.8

5.5.4 Scenario 9: 2029 Winter Peak LG Post-Project (Sensitivity)

Category B Conditions

There were no thermal violations observed under Category B conditions in the post-Project power flow studies for Scenario 9. The voltage criteria violations observed under certain Category B conditions in the post-Project studies for Scenario 9 were mitigated by proposed mitigations as shown in Table 5-29, Table 5-30 and Table 5-31.

Table 5-29: Post-Mitigation (with TMR and RAS) Voltage Range Violations under Category B Conditions for Scenario 9

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Initial Voltage (kV)	Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
7L228 (Big Mountain 845S - Thornton 2091S)	Albright & Wilson 752S Tap	1137	144	130	155	Post-Project Voltage Collapse		No Voltage Range Violations
	Bear Creek 679S Tap	1138	144	130	155			
	Albright & Wilson 752S	1139	144	130	155			
	Proctor & Gamble 808S	1140	144	130	155			
	Bear Creek 679S	1142	144	130	155			
	Big Mountain 845S	1143	144	130	155			
	Dome Cutbank 810S	1144	144	130	155			
	H.R. Milner 740S	1147	144	130	155			
7L40 (Little Smoky 813S - Simonette 733S)	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations

Table 5-30: Post-Mitigation (with TMR and New Capacitors) Voltage Range Violations under Category B Conditions for Scenario 9

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Initial Voltage (kV)	Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
7L228 (Big Mountain 845S - Thornton 2091S)	Albright & Wilson 752S Tap	1139	144	130	155	152.5	155.7	152.6
	Bear Creek 679S Tap	1138	144	130	155	152.7	155.8	152.6
	Albright & Wilson 752S	1142	144	130	155	152.5	155.7	152.6
	Proctor & Gamble 808S	1140	144	130	155	152.7	155.8	152.6
	Bear Creek 679S	1145	144	130	155	152.8	155.8	152.3
	Dome Cutbank 810S	1144	144	130	155	143.8	128.1	150.8
	H.R. Milner 740S	1147	144	130	155	143	129	150.9
Thornton 2091S 702T	Thornton 2091S	1103	144	130	155	143.2	147.8	155.6
	Dome Cutbank 810S	1144	144	130	155	142.7	147.3	155.4
	H.R. Milner 740S	1147	144	130	155	141.3	145.6	155.3
7L40 (Little Smoky 813S - Simonette 733S)	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations
7L228 (Big Mountain 845S - Thornton 2091S)	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations

Table 5-31: Post-Mitigation (with Planned Simonette Over Voltage Mitigation Scheme) Voltage Range Violations under Category B Conditions for Scenario 9

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Initial Voltage (kV)	Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
Simonette 733S 702T	H.R. Milner 740S	1147	144	130	155	145.9	155.8	153.1
	Kakwa Ridge 857S	1149	144	130	155	146.7	156.2	153.2
	Simonette 733S	1170	144	130	155	149.6	157.6	152.9

5.5.5 Scenario 9: 2029 Winter Peak LG Post-Project Sensitivity (P3072 Final Stage with P3076 and P2716)

Category B Conditions

Thermal violations observed under Category B conditions in the post-Project power flow studies for Scenario 9 were mitigated as shown in Table 5-32. The voltage criteria violations observed under certain Category B conditions in the post-Project studies for Scenario 9 were mitigated by proposed mitigations as shown in Table 5-33. Proposed mitigation measures with new capacitors resulted in additional Category B voltage violations and hence were mitigated with planned over voltage protection schemes as shown in Table 5-34.

Table 5-32: Post-Mitigation (TMR and New Capacitors) Power Flow Study Results under Category B Conditions for Scenario 9 (P3072 final stage with P3076 and P2716)

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-Mitigation Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading [3]
Basecase	Pearson_701T	50	53	55.8	111.5	48.0	96
7L101 (Poplar Hill 790S-Lowe Lake 944S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	128.4	107.5	127.2	106.5
Lowe Lake 944S GT1	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	128.4	107.5	127.2	106.5
Bear Creek 679S 701T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	134.2	112.4	132.9	111.3
Little Smoky	Little Smoky 813S	200	214	226.0	113	224.6	112.3

813S 902T	901T WDG1						
	Little Smoky 813S 901T WDG2	200	214	226.4	113.2	225.0	112.5
	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	131.3	110	130.1	109
Little Smoky 813S 901T	Little Smoky 813S 902T WDG2	200	214	227.6	113.8	226.2	113.1
	Little Smoky 813S 902T WDG1	200	214	227.0	113.5	225.6	112.8
	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	130.9	109.6	129.8	108.7
9L05 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	132.4	110.9	131.2	109.9
SING OPN LIN 134 1260-542001(08)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	122.4	102.5	121.4	101.7
919L (Sagitawah 77S - Sundance Plant 310P)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	123.2	103.2	122.1	102.3
989L (Sagitawah 77S - Sundance Plant 310P)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	122.9	102.9	121.8	102
9L938 (Sagitawah 77S - P2499 Kiwetinohk Black Bear Gas)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	123.2	103.2	122.1	102.3
9L939 (Sagitawah 77S - P2499 Kiwetinohk Black Bear Gas)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	123.2	103.2	122.1	102.3
7L13 (Big Mountain 845S - Procter & Gamble 808S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	134.0	112.2	132.9	111.3
7L23 (Nipisi 796S - Mitsue 732S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	120.7	101.1	124.9	104.6
7L75 (Friedenstal 800S - West Peace River	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	126.1	105.6	124.9	104.6

793S)							

Note 3: With TMR increased to 105 MW remaining violations will be either mitigated or reduced below emergency rating.

Table 5-33: Post-Mitigation (with TMR and New Capacitors) Voltage Range Violations under Category B Conditions for Scenario 9 (P3072 final stage with P3076 and P2716)

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Initial Voltage (kV)	Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
Base case	Pearson 2089S	1170	144	130	155	126.5	125.6	145.8
	Simonette 733S	1170	144	130	155	130.4	129.6	146
Other Cat B contingencies	Pearson 2089S	1170	144	130	155	126.5	125.6	145.8
7L40 (Little Smoky 813S - Simonette 733S)	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations
7L228 (Big Mountain 845S - Thornton 2091S)	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations
7L20 (HR Milner 740S - Thornton 2091S	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations
7L13 (Big Mountain 845S - Procter & Gamble 808S)	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations
7L80 (Simonette 733S - HR Milner 740S)	Post-Project Voltage Range Violations and Voltage Stability Margin Violations							No Voltage Range or Stability Margin Violations

Table 5-34: Post-Mitigation (with Planned Over Voltage Mitigation Scheme) Voltage Range Violations under Category B Conditions for Scenario 9 (P3072 Final Stage with P3076 and P2716)

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Initial Voltage (kV)	Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
Simonette 733S 702T	Pearson 2089S	990002	144	130	155	145.8	156	150.9
	Simonette 733S	1170	144	130	155	146	156	150.9
Pearson 2089S 701T	Pearson 2089S	990002	144	130	155	145.8	158	153
	Simonette 733S	1170	144	130	155	146	155	151.4

Voltage stability studies

Voltage stability studies were done under Category A and Category B conditions for Scenario 9 by increasing load in Grande Cache (Area 22), Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 11.6 MW (0.05 x 232 MW = 11.6 MW) for Scenario 9. Voltage stability margins were not met under Category B contingencies of 7L40 and 7L228.

P3076 with P3072 (Interim Stage): Mitigation with Temporary RAS

The voltage stability margin violations were mitigated by the proposed RASs. The voltage stability study results under Category A conditions and for the five worst contingencies under Category B conditions are listed in Table 5-33, and the corresponding diagrams for Scenario 9 are listed in Attachment A10.

Table 5-35: Summary of Results under Category A and B Conditions for Scenario 9 with TMR and RAS

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		151.3	Yes
7L228(with RAS)	Thornton 2091S	Big Mountain 845S	40	Yes
7L20	Thornton 2091S	HR Milner 740S	68.8	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	73.8	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		90	Yes
7L40 (with RAS)	Little Smoky 813S	Simonette 733S	100.6	Yes

P3076 with P3072 (Interim Stage): Mitigation with proposed New Capacitors

The voltage stability margin violations were mitigated by the proposed new capacitors. The voltage stability study results under Category A conditions and for the five worst contingencies under Category B conditions are listed in Table 5-36, and the corresponding diagrams for Scenario 9 are listed in Attachment A11.

Table 5-36: Summary of Results under Category A and B Conditions for Scenario 9 with TMR and Capacitors

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		186.3	Yes
7L40	Little Smoky 813S	Simonette 733S	40	Yes
7L228	Thornton 2091S	Big Mountain 845S	40	Yes
7L20	Thornton 2091S	HR Milner 740S	95	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	111.3	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		127.5	Yes

5.6 Project Interdependencies

The P3076 sensitivity study with interim stage of project P3072 requires the introduction of temporary RASs to mitigate criteria violations. These RASs need to be removed with the addition of new capacitors at identified substations. The transient studies identified even with new capacitors, there would be voltage recovery issues at HR Milner 740S, Dome Cutbank 810S and Simonette 733S buses for the loss of line 7L40 when there is no tele-protection (TPR) on the line. The issue was identified as pre-existing with pre-Project scenario. Therefore, this Project is dependent on the eventual removal of the temporary RASs with the addition of new capacitors as well as installing tele-protection on the line 7L40.

Attachment A1

Engineering Connection Assessment

(Study Scope)

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Study Scope

P3076 ATCO Thornton

ATCO Electric LTD.

Date: Dec. 12, 2025

Version: V1

Classification: Public

Company Name	Name and Credentials	Date	Signature
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Attachment A: Transmission Planning Criteria – Basis and Assumptions

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1 Introduction

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

1.1 Project Overview

ATCO Electric Ltd. (Market Participant), in its capacity as the legal owner of an electric distribution system (DFO), has submitted a request for system access service to the Alberta Electric System Operator (AESO) to add new load in the region around the Thornton 2091S substation in the Grande Cache planning area (Area 22).

The DFO's request includes a request for a Rate DTS, Demand Transmission Service, contract capacity increase of 26.5 MW, from 25 MW to 51.5 MW, for the system access service provided at the Thornton 2091S substation and a request for transmission development (collectively, the Project). Specifically, the DFO requested an enhancement to the existing Thornton 2091S substation. Details on the need for the enhancement can be found in the DFO's DDR.

The Project in-service date (ISD) used for the purpose of the studies is Sept. 1, 2027.

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

Table 1-1: Project Load and Generation Details

Project Component		Description
Load	Existing Rate DTS, *Demand Transmission Service,* contract capacity	25 MW at Thornton 2091S
	Requested Rate DTS	51.5 MW at Thornton 2091S
	Type	Industrial
	Motors (number and size)	Not available at this point.
	Power factor	0.9 pf
	Future load expansion plans	23.2MW

1.2 Existing System Overview

1.2.1 Study Area

Geographically, the Project is located in the AESO planning area of Grande Cache Area 22.

The Study Area consists of the AESO planning areas of Grande Cache (Area 22), Grande Prairie (Area 20), Valleyview (Area 23), Fox Creek (Area 24), and Swan Hills (Area 26), including the tie lines connecting

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these planning areas to the rest of the AIES. The existing transmission system in the Study Area is shown in Figure 1-1.

1.2.2 Existing Constraints

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

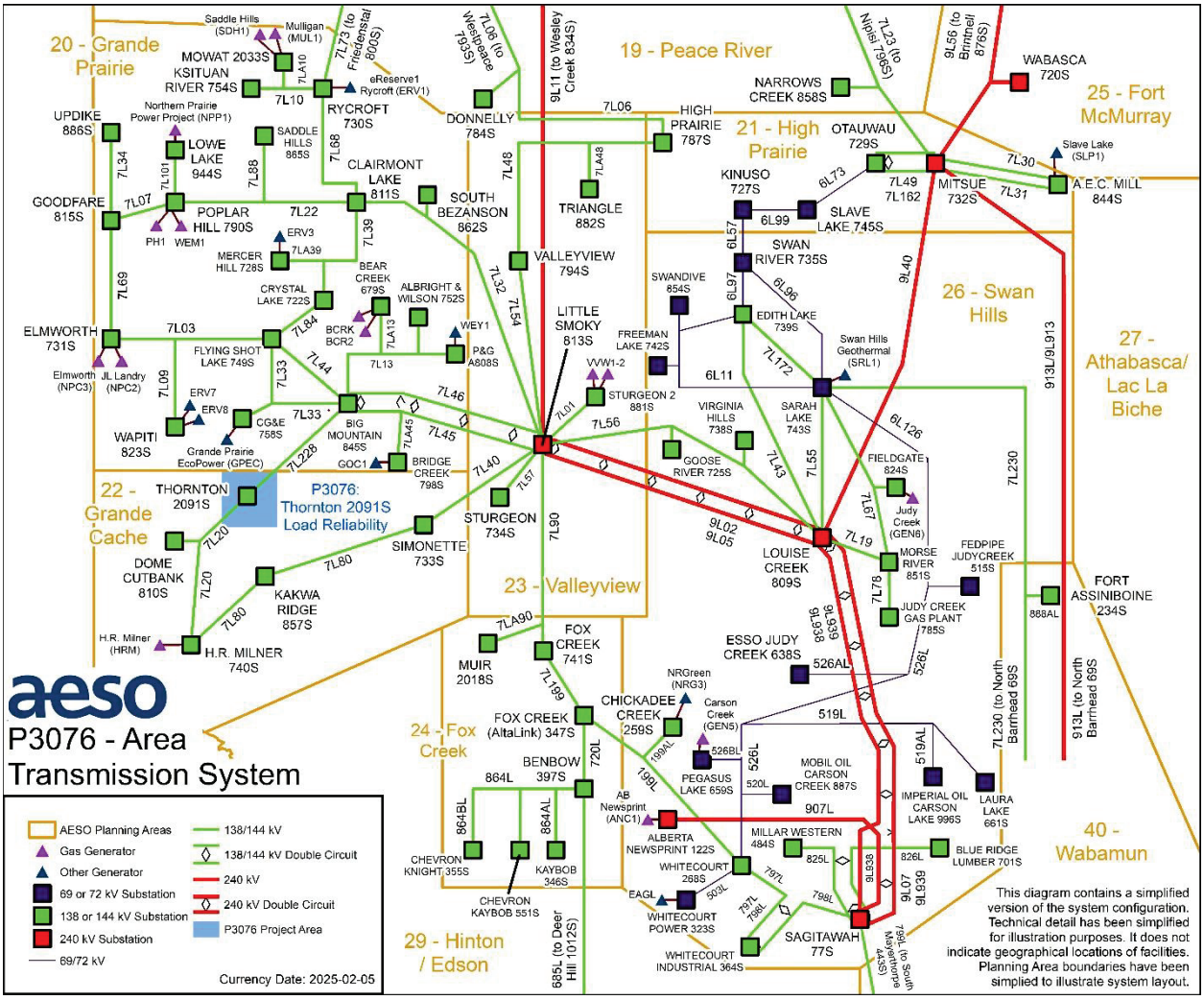
There are a number of constraints in the Study Area that are mitigated by existing remedial action schemes (RASs) and/or other protection schemes.

The following existing RASs and/or other protection schemes are used to manage constraints in the area:

- RAS 158 Ksituan 754S Voltage Stability Mitigation (normally disabled)
- RAS 171 H.R. Milner 740S Overload and Transient Instability Mitigation
- RAS 1127 CG&E 7L33 APS
- RAS 1128 P&G 7L13 APS
- RAS 1135 Elmworth and Area anti-islanding (AIS)
- RAS 1621 Mowat 2033S Exshaw Oil DER anti-islanding

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Figure 1-1: Transmission System in the Study Area



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2 Connection Alternatives

The following alternative will be studied:

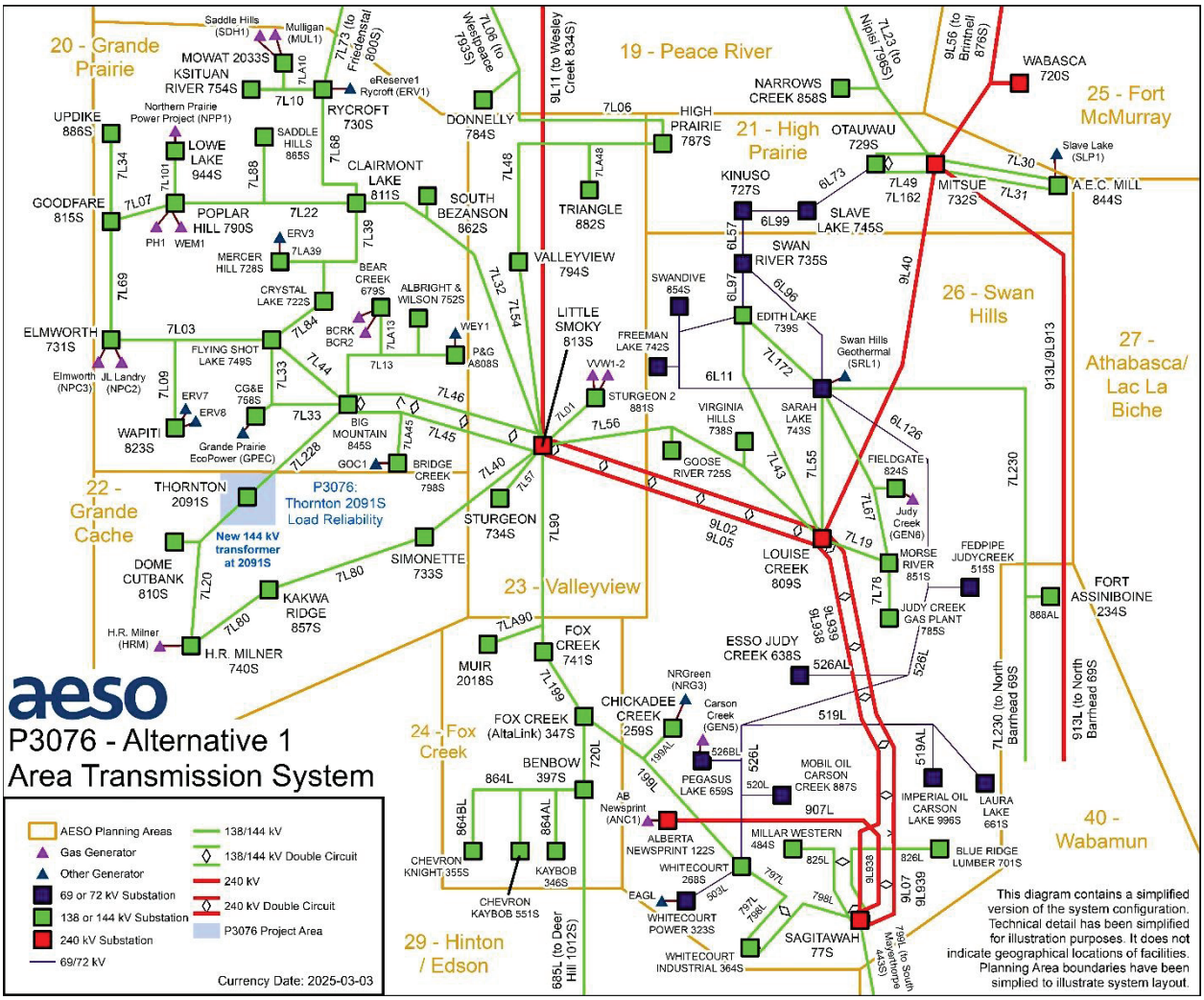
2.1 Alternative 1 – Adding a New Transformer to Thornton 2091S

This alternative included the following developments:

- Add a new 144/25kV transformer, one 144 kV breaker, and three 25 kV feeder breakers to the existing Thornton 2091S substation;
- Add or modify associated equipment as required for the above transmission developments.

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

Figure 2-1: Connection Alternative 1



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3 Criteria, Standards and Requirements

3.1 AESO Reliability Criteria

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

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

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

The TPL standards, TPL-001-AB-0, TPL-002-AB1-0, and TPL-003-AB-0, have referenced Applicable Ratings when specifying the required system performance under Category A, Category B, and Category C events. For the purpose of applying the TPL standards to the studies documented in this report, Applicable Ratings are defined as follows:

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

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

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

3.2 ISO Rules and Information Documents

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

The TCM Rule will be followed to set up the study scenarios and assess the impact of the Project. In addition, due regard will be given to the following:

- The AESO's *Connection Study Requirements*;
- All Applicable Sections under Division 503 - *Technical and Operating Requirements*

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4 Scenarios and Assumptions

4.1 Scenarios

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

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

Table 4-1: Connection Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	Project Load (MW)	Project Generation (MW)
Pre-Project					
1	2029 Summer Peak (SP)	Low Generation (LG)	2029 SP LG Pre-Project	0	0
2	2029 Winter Peak (WP)	LG	2029 WP LG Pre-Project	0	0
Post-Project					
3	2029 SP	LG	2029 SP LG Post-Project	26.5	0
4	2029 WP	LG	2029 WP LG Post-Project	26.5	0
5	2034 WP	All generators in study area in-service	2034 WP Post-Project	26.5	0
Pre-Project Sensitivity – Including Interim Stage of P3072					
6	2029 SP	LG	2029 SP LG Post-Project	0	0
7	2029 WP	LG	2029 WP LG Post-Project	0	0
Post-Project Sensitivity – Including Interim Stage of P3072					
8	2029 SP	LG	2029 SP LG Post-Project	26.5	0
9	2029 WP	LG	2029 WP LG Post-Project	26.5	0

Note: The MP has another project in the area, P3072, that is being studied in parallel with this Project. P3072 Study Scope includes a sensitivity scenario that involves studying this Project (P3076), Foma; Stage pf P3072, and P2716. If P3072 gets delayed or cancelled or otherwise the sensitivity scenario in P3072 doesn't get studied in time for this Project, then the Study Scope for this Project will be amended to require the sensitivity study to be performed under this Project.

4.2 Assumptions

4.2.1 System Project Assumptions

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

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4.2.2 Connection Project Assumptions

Table 4- summarizes the connection projects in the Study Area that should be included in the studies.

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

AESO Project No.	AESO Project Name	AESO Planning Area No.	Generation (MW)	Load (MW)	Scheduled ISD	AUC NID Decision No.
P3072	ATCO Greenview Area Load	22	0	Changing from 44.8 to 118.65	March 1, 2028	
P2716	ATCO Wapiti 823S Load	20	0	28	April 1, 2028	

4.2.3 Load Assumptions

The load forecast to be used for the studies is shown in Table 4- and is a forecast for the AESO Northwest Planning Region peak based on the AESO 2024 Long-term Outlook (2024 LTO) with modifications to incorporate the latest forecast intelligence. For the post-Project studies, when the Study Area loads are modified to align with the regional load forecast, the active power to reactive power ratio in the base case scenarios shall be maintained.

Table 4-3: Forecast Load (at AESO Northwest Planning Region Peak)

AESO Planning Region Name	Forecast Peak Load by Year/Season (MW)	
	2029 SP	2029 WP
Northwest Planning Region[1]	1001	1071

Note:
[1] The Northwest Region comprises the following AESO planning areas: 17, 18, 19, 20, 21, 22, 23, 24, and 26.

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

4.2.4 Generation Assumptions

The generation forecast to be used for the studies is based on the 2024 LTO with modifications to incorporate the latest forecast intelligence. The generation assumptions for the studies will assume low generation dispatch conditions. Additional studies may be required in the event of changes to the AESO's corporate forecast.

The existing generation dispatch conditions for the study scenarios are described in Table 4-4.

H.R. Milner (HRM) was determined to be the critical generator, and shall be modelled as being offline to simulate the N-G condition in all the study scenarios.

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Table 4-4: Existing Generation Dispatch Conditions

Facility Name	Unit No.	Bus No.	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario	
				2029 WP	2029 SP
Fort Nelson (FNG1)	1, 2	1019, 1015	17	71	69
Rainbow Lake (RB4)	4	1035	17	47	0
Rainbow #5 (RB5)	5	1037	17	0	0
DAI1 Daishowa (DAI1)	2, 1	1089, 1087	19	35	36
West Cadotte (WCD1)	G1	19083	19	20	20
Bear Creek 2 (BCR2)	2	18142	20	30	27
Bear Creek 1 (BCRK)	1	19142	20	64	57
Mulligan (MUL1)	G5, G6	557216	20	5	3
Saddle Hills (SDH1)	G1, G2, G3, G4	557116	20	10	5
Wembley (WEM1)	G1	18118	20	0	0
Gold Creek Facility (GOC1)	1	19145	20	0	0
Grande Prairie EcoPower (GPEC)	2	17101	20	11	11
Weyerhaeuser (WEY1)	1	1146	20	45	39
NPC3 Elmworth (NPC3)	G1	19134	20	8	8

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Facility Name	Unit No.	Bus No.	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario	
				2029 WP	2029 SP
NPC2 JL Landry (NPCD)	5	17134	20	0	0
Northern Prairie Power Project (NPP1)	1	17120	20	0	0
Poplar Hill #1 (PH1)	1	16118	20	0	0
Wapiti (WPT1)	D1, D2	19135	20	0	0
eReserve1 Rycroft (ERV1)	1	557100	20	0	0
eReserve3 Mercer Hill (ERV3)	1	19109	20	0	0
eReserve7 (ERV7)	G1	19135	20	0	0
eReserve8 (ERV8)	G2	19135	20	0	0
Slave Lake (SLP1)	G1, G2, G3	1232	21	9	9
H.R. Milner (HRM)	1, G2	557147, 1148	22	N-G[b]	N-G[b]
Valley View 1 (VVW1)	1	1171	23	0	0
Valley View 2 (VVW2)	2	1173	23	0	0
Whitecourt Power (EAGL)	1	408	26	25	25
NRGreen (NRG3)	G1	2674	26	12	11
Cascade 1 (CAS1)	G1	557014	29	303	298

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Facility Name	Unit No.	Bus No.	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario	
				2029 WP	2029 SP
Cascade 2 (CAS2)	G2	558014	29	303	298

Notes:
[a] "Unit Net Generation" refers to gross generating unit output (MW) less unit service load.
[b] "N-G" indicates the critical generating unit that is assumed by the AESO to be offline to test the N-G contingency condition

The planned generation dispatch conditions for the study scenarios are described in Table 4-5.

Table 4-5: Dispatch Conditions for Planned Generation Facilities

Facility Name	Unit No.	Bus No.	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario	
				2029 WP	2029 SP
P2499 Kiwetinohk Black Bear Gas	G1, S1	557027	26	0	0
P2676 Kaybob South 3 Cogen	G1, G2	558442, 558342	24	33	0
P2456 Kiwetinohk Opal Gas	6, 7, 8, 9, 1, 2, 3, 4, 5	557024, 557025	24	0	0
P2843 Prairie Lights Power Gas	G2	549758	20	0	0
P2713 UK LS1 Solar	G1, G2	561460, 561463	23	0	0
P2722 Sturgeon 734S DER Solar	1	561468	23	0	0
P2738 UK LS4 Solar	G1	561480	23	0	0

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Facility Name	Unit No.	Bus No.	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario	
				2029 WP	2029 SP
P2757 Sturgeon 734S DER Battery	G1	561495	23	0	0
P1885 Northern Lights WAGF	G1, G2	565005, 565006	26	36	79

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

4.2.5 Intertie Flow Assumptions

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

4.2.6 HVDC Power Order Assumptions

The Western Alberta Transmission Line (WATL) and the Eastern Alberta Transmission Line (EATL) are high-voltage direct current (HVDC) transmission lines. The HVDC power order assumptions for the studies will be set to minimize losses for the pre-Project and post-Project study scenarios.

The reactive power limits of the MVAr exchanges between the HVDC terminals (WATL and EATL) and the connected alternating current (AC) transmission systems are shown in Table 4-6. These limits must be maintained when performing the studies.

Table 4-6: HVDC to Adjacent AC System MVAr Exchange Limits

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

4.2.7 Transmission Facility Ratings

The legal owner of transmission facilities (TFO) provided the thermal ratings assumptions for the existing transmission lines in the Study Area. Table 4-7 shows the normal ratings and emergency ratings for the key transmission lines in the Study Area, which will be used to perform the engineering studies.

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Table 4-7: Thermal Rating Assumptions for Key Transmission Lines in the Study Area

Transmission Line	Voltage (kV)	Summer Normal (MVA)	Summer Emergency (MVA)	Winter Normal (MVA)	Winter Emergency (MVA)
7L40 Little Smoky 813S – Simonette 733S	138	123.6	128.4	155.3	171.5
7L90 Little Smoky 813S – Muir 7LA90 Tap	138	108.3	116.9	144.7	160.0
7L90 Fox Creek 741S – Muir 7LA90 Tap	138	108.3	116.9	143.8GS	143.8GS
7L80 Simonette 733S – H.R. Milner 740S	138	122.7	133.2	153.3	172.5
7L20 H.R. Milner 740S – Dome cutbank 810S	138	246.3	265.5	286.5GS	286.5GS
7L20 Thornton 2091S – Dome cutbank 810S	138	278.9	286.5GS	286.5GS	286.5GS
7L228 Thornton 2091S – Big Mountain 845S	138	250.1	254CT	254CT	254CT
7L46 Big Mountain 845S – Little Smoky 813S	138	139	159.1	186.9	219.5
7L45 Big Mountain 845S – Little Smoky 813S	138	139	159.1	186.9	219.5
7L32 Clairmont Lake 811S – South Bezanson 862S T-tap	138	109.3	116.9	144.7	158.1
7L32 Little Smoky 813S – South Bezanson 862S T-tap	138	109.3	115	144.7	156.2
7L33 Flyingshot 749S – CG & E 758S T-tap	138	160	186.9	201.3	240.5
7L33 Big Mountain 845S - CG & E 758S T-tap	138	160	188.8	254	254
7L44 Flyingshot 749S – Big Mountain 845S	138	160	182.1	201.3	237.7
7L84 Flyingshot 749S – Crystal 722S	138	161	189.8	202.3	245.3
7L13 Big Mountain 845S – A & W 752S T-tap	138	140.9	166.8	187.8	230
7L13 Procter & Gamble 808S – Bear Creek 679S T-tap	138	140.9	166.8	187.8	230
7L13 Bear Creek 679S T-tap – A & W 752S T-tap	138	140.9	166.8	187.8	229
7L13 A & W 752S – A & W T-tap	138	142.8	168.7	191.7	232.9
7L03 Flyingshot 749S – Wapiti 823S T-tap	138	124.6	138	155.3	176.3
7L03 Elmworth 731S – Wapiti 823S T-tap	138	124.6	139	155.3	177.3
7L69 Elmworth 731S – Goodfare 815S	138	110.2	123.6	148.5	170.6
7L07 Goodfare 815S – Poplar Hill 790S	138	108.3	120.8	144.7	165.8

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7L22 Clairmont Lake 811S – Saddle Hills 865S Tap	138	109.3	120.8	144.7	163.9
7L22 Poplar Hill 790S – Saddle Hills 865S Tap	138	108.3	120.8	144.7	164.8
7L39 Clairmont Lake 730S – Mercer Hill 728S T-tap	138	124.6	135.1	155.3	172.5
7L39 Crystal Lake 722S – Mercer Hill 728S T-tap	138	124.6	135.1	143.8	143.8
7L68 Clairmont Lake 811S – Rycroft 730S	138	111.2	123.6	148.5	170.6
7L10 Rycroft 703S – Mowat 2033S tap	138	123.6	138	143.8	143.8
7L10 Mowat 2033S tap – Ksituan 754S	138	123.6	138	155.3	176.3
7L73 Rycroft 730S – Boucher Creek 829S Tap	138	109.3	119.8	145.7	162.9
7L73 Friedenstal 800S – Boucher Creek 829S Tap	138	109.3	118.8	145.7	162
9L11 Little Smoky 813S – Wesley Creek 834S	240	499GS	499 GS	499 GS	499 GS
9L02 Little Smoky 813S – Louise Creek 809S	240	499 GS	499 GS	499 GS	499 GS
9L05 Little Smoky 813S – Louise Creek 809S	240	499 GS	499 GS	499 GS	499 GS

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

"L" indicates that the transmission line rating is limited by the line

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

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

The TFO provided the details of the substation transformers in the Study Area. The key transformers in the Study Area are shown in Table 4-8.

Table 4-8: Summary of Key Transformer Ratings in the Study Area

Substation Name and Number	Transformer ID	Transformer Voltages (kV)	Transformer Rating (MVA)
Little Smoky 813S	901T	240/144	200
Little Smoky 813S	902T	240/144	200

The TFO provided the details of the shunt elements in the Study Area. The key shunt elements in the Study Area are shown in Table 4-9.

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Table 4-9: Summary of Key Shunt Elements in the Study Area

Station Name and Number	Voltage (kV)	Capacitor (MVar)	Reactor (Mvar)	SVC (Mvar)	Synchronous Condenser (MVAR)
Big Mountain 845S	144	1 x 30	-	-	-
Clairmont Lake 811S	144	1 x 25	-	-	-
Crystal Lake 722S	144	1 x 30	-	-	-
Goodfare 815S	144	2 x 15	-	-	-
H.R. Milner 740S	25	1 x 5.4	-	-	-
Ksituan 754S	144	1 x 15	-	-	-
P&G 808S	13.8	1 x 6 1 x 11			
Little Smoky 813S	144	3 x 30	-	-	-
	34.5	-	-	+/- 100	-
	25	-	2x 20		
Poplar Hill 790S	144	1 x 24.7	-	-	-
	25	2 x 1.2 2 x 2.4 1 x 5.4	-	-	-
Mowat 2033S	144	1 x 10 1 x 15			
Friedenstal 800S	144	1 x 15			
	25	1 x 4.8			
Rycroft 730S	25			+/- 50	

4.2.8 Protection Fault Clearing Times

The transient stability studies will be performed using the actual fault clearing times for the selected contingencies, as provided by the TFO and as shown in Table 4- 4-10. Only those contingencies shown in Table 4-10 will be studied for transient stability studies. If the TFO did not specify the fault clearing times

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(e.g. for new transmission lines) for a selected contingency, then the studies for that contingency will be performed using the standard fault clearing times that are specified in Table 2-3 of the AESO's *Transmission Planning Criteria – Basis and Assumptions*.

Table 4-10: Protection Fault Clearing Times

Contingency (System Element Lost)	Fault Location	Clearing Times (Cycles)	
		Near End	Far End
7L40 (Simonette 733S – Little Smoky 813S)	Simonette 733S	6	24
7L40 (Simonette 733S – Little Smoky 813S)	Little Smoky 813S	6	42
7L20 (H.R. Milner 740S – Thornton 2091S)	H.R. Milner 740S	5	24
7L20 (H.R. Milner 740S – Thornton 2091S)	Thornton 2091S	6	24
7L228 (Thornton 2091S – Big Mountain 845S)	Thornton 2091S	5	8
7L228 (Thornton 2091S – Big Mountain 845S)	Big Mountain 845S	6	8

4.2.9 Voltage Profile Assumption

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

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5 Study Methodology

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

Table 5-1: Summary of the Studies to be Performed

Scenario No. and Name		Power Flow		Voltage Stability		Transient Stability		Motor Starting		Short Circuit
		Category		Category		Category		Category		Category A
		A	B	A	B	A	B	A	B	
Pre-Project										
1	2029 SP	X	X							
2	2029 WP	X	X	X*	X*	X	X			X
Post-Project										
3	2029 SP	X	X							
4	2029 WP	X	X	X	X	X	X			X
5	2034 WP									X
Pre-Project Sensitivity										
6	2029 SP	X	X							
7	2029 WP	X	X	X*	X*	X	X			
Post-Project Sensitivity										
8	2029 SP	X	X							
9	2029 WP	X	X	X	X	X	X			

*Only required if post-project results show potential stability issues.

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

5.1 Study Case Validation

The study will be conducted on the AIES system model using the AESO's planning base cases. The seasonal light/peak scenarios will be studied as required. The base cases will be modified by the AESO to include the corresponding load and generation forecast information. The resulting cases, or seed cases, along with the project IDEVs, will be provided by the AESO to the Studies Consultant. These cases are provided in PSS/E v34 and/or v33 format. Upon request, the AESO can provide RAW and SEQ files. Software used by the Studies Consultant must be able to read and write these file types. Manual adjustments may be required to ensure full alignment with the details outlined in this Study Scope, as described in the process outlined below. The AESO will provide guidance to the Studies Consultant with regard to the setup of the study cases should any questions arise.

The expected process for the creation of acceptable study cases is as follows:

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1. The AESO provides seed cases and the appropriate incremental IDEVs to use and any other applicable information required to the Studies Consultant.
2. The Studies Consultant applies the identified IDEVs to the seed cases to create the study cases. The Studies Consultant verifies and makes adjustments as required to ensure the study cases represent the assumptions outlined within the Study Scope.
3. Upon creating the study cases, all the study cases are forwarded to the AESO for approval.
4. The Studies Consultant proceeds with the required engineering studies only after the study cases are approved by the AESO.

5.2 Power Flow Studies

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

For information purposes, the Studies Consultant must also provide, as a separate file, a list of any transmission elements where the thermal loading exceeds 95% of the element's normal rating under Category A and Category B conditions.

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

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

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

5.2.1 Contingencies to be Studied

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

5.3 Voltage Stability Studies

The objective of the voltage stability studies is to determine the ability of the transmission system to maintain voltage stability margin at all busses under Category A and Category B conditions. The power-voltage (PV) curve is a representation of voltage change as a result of increased power transfer between two systems. The incremental transfers will be reported at the collapse point.

Voltage stability studies will be performed for the post-Project scenarios. For load connection projects, the load level modeled in post-Project scenarios is the same as, or higher than, in pre-Project scenarios. Therefore, voltage stability studies for pre-Project scenarios will only be performed if post-Project scenarios show voltage stability criteria violations.

Voltage stability studies will be performed according to the Western Electricity Coordinating Council (WECC) Voltage Stability Assessment Methodology. WECC voltage stability criteria states, for load areas,

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post-transient voltage stability margin is required for the area modeled at a minimum of 105% of the reference load level for Category A conditions and for Category B conditions. For this standard, the reference load level is the maximum established planned load.

Typically, voltage stability studies are carried out assuming the worst case scenarios in terms of loading. In this connection assessment, the voltage stability studies will be performed by increasing load in the Grande Cache area (Area 22) and Fox Creek area (Area 24) and increasing generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6), and Sheerness (Area 43).

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

5.3.1 Contingencies to be Studied

Voltage stability studies will be performed for all Category B contingencies in the Study Area. The Category A condition and the five contingencies with the smallest stability margin will be presented in the results.

5.4 Transient Stability Studies

The report presenting the results of the transient stability studies must provide response plots for voltages in the study area. The results report must also provide the 138 kV bus voltage levels for substations near the point of connection. Other busses will be monitored and will be reported as determined by the results.

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

5.5 Short-Circuit Current Level Studies

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

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

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

- Thornton 2091S
- Big Mountain 845S
- Bridge Creek 798S
- Little Smoky 813S
- Flying Shot Lake 749S
- CG&E 758S
- Bear Creek 679S
- Albright & Wilson 752S

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- P&G A808S
- Dome Cutbank 810S
- H.R. Milner 740S
- Kakwa Ridge 857S

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

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

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6 Mitigation Measures

6.1 Development

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

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

- Develop tables showing the constraint effective factors[1] for generation or load based on thermal criteria violations that are observed.
- Collaborate with the AESO to propose changes, if any, to the connection alternatives that could remove the requirement for a RAS.
- Collaborate with the AESO to study modifications to existing and/or planned RASs, proposed by the AESO, to ensure the coordination of existing protection schemes with the addition of any proposed protection schemes.
- Collaborate with the AESO to identify and study new RASs, if any, that may be required to ensure system reliability is maintained after connecting the Project to the AIES.

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

6.2 Evaluation

6.2.1 Post-Mitigation Studies

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

6.2.2 Constraint Effective Factor Studies

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

[1] 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.

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7 Changes to Study Assumptions

This study will utilize the AESO's planning base cases, which are based on the AESO's current corporate forecast (2024 LTO) with modifications to incorporate the latest forecast intelligence. Sensitivity studies or restudy may be required in the event of revisions to the AESO's corporate forecast, forecast intelligence, or other study assumptions. Additional engineering studies may also be required to assess new connection alternatives, changes to project ISD, or delays in proposed system developments. Any additional or revised study requirements shall be captured in a signed Study Scope Amendment document.

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Attachment A: Transmission Planning Criteria – Basis and Assumptions

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Transmission Planning Criteria – Basis and Assumptions

Date: July 9, 2019

Version: V1.2

Alberta Electric System Operator

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1. Introduction

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

2. Transmission Reliability Standards and Criteria[1]

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

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

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

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

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

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

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

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

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

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

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

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

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

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2.3 Transient Stability Analysis Assumptions

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

Table 2-3: Fault Clearing Times

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

Table 2-4: Stuck Breaker Clearing Times for Lines

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

Table 2-5: Stuck Breaker Clearing Times for Transformers

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

Attachment A2
Pre-Project Power Flow Diagrams without TMR
(Scenarios 1, 2, 6,7)

Pre-Project Power Flow Results

The pre-Project power flow diagrams without TMR for Scenario 1, 2,6 and 7 under Category A and Category B conditions identified with violations are provided in this attachment as per the following tables.

Table A2-1: List of Scenario 1: 2029 SP LG Pre-Project Power Flow Diagrams

Scenario	Power Flow Diagram	Page number
2029 SP Scenario 1	N-0, System Normal Condition	A2-1

Table A2-2: List of Scenario 2: 2029 WP LG Pre-Project Power Flow Diagrams

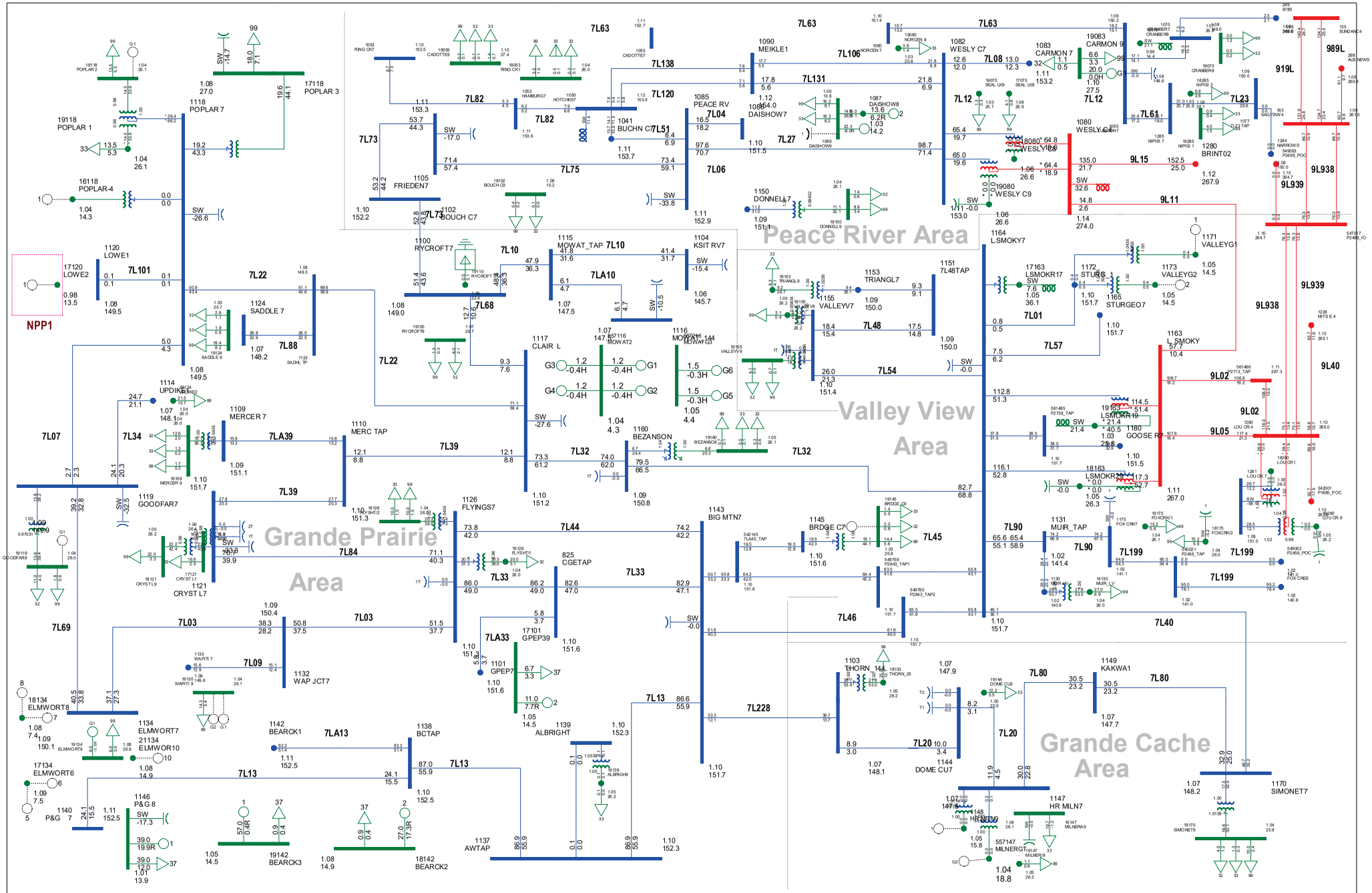
Scenario	Power Flow Diagram	Page number
2029 WP Scenario 2	N-0, System Normal Condition	A2-2

Table A2-3: List of Scenario 6: 2029 SP Sensitivity Pre-Project Power Flow Diagrams

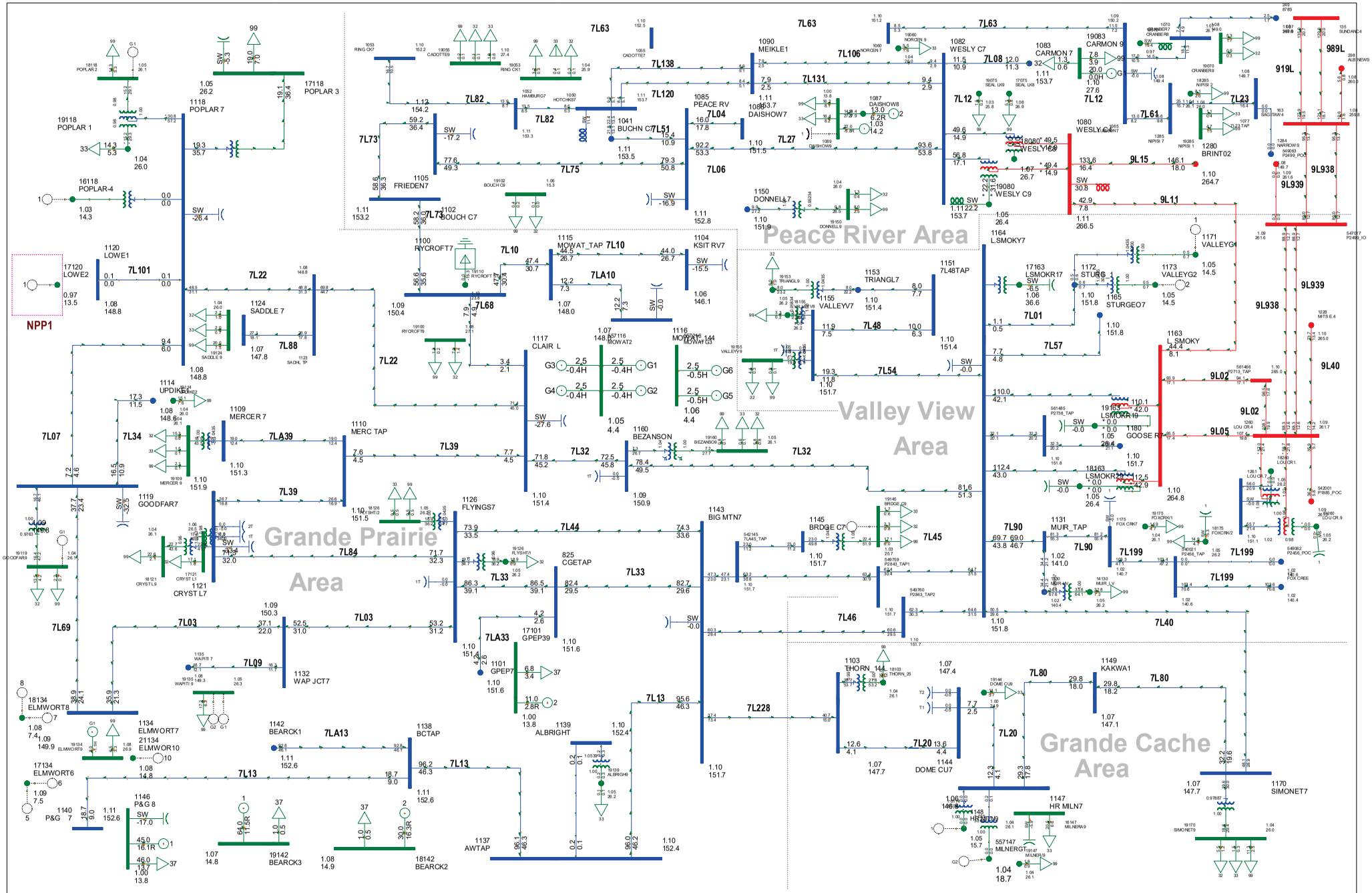
Scenario	Power Flow Diagram	Page number
2029 SP Scenario 6	N-0, System Normal Condition	A2-3
	N-1, Loss of 7L13	A2-4
	N-1, Loss of 7L40	A2-5
	N-1, Loss of 7L56	A2-6
	N-1, Loss of 7L75	A2-7
	N-1, Loss of 7L228	A2-8
	N-1, Loss of 9L05	A2-9
	N-1, Loss Of Bear Creek 679S 701T	A2-10
	N-1, Loss of Little Smoky 813S 901T	A2-11
	N-1, Loss of Little Smoky 813S 902T	A2-12

Table A2-4: List of Scenario 7: 2029 WP Sensitivity Pre-Project Power Flow Diagrams

Scenario	Power Flow Diagram	Page number
2029 WP Scenario 7	N-0, System Normal Condition	A2-13
	N-1, Loss of 7L40	A2-14
	N-1, Loss of 7L228	A2-15

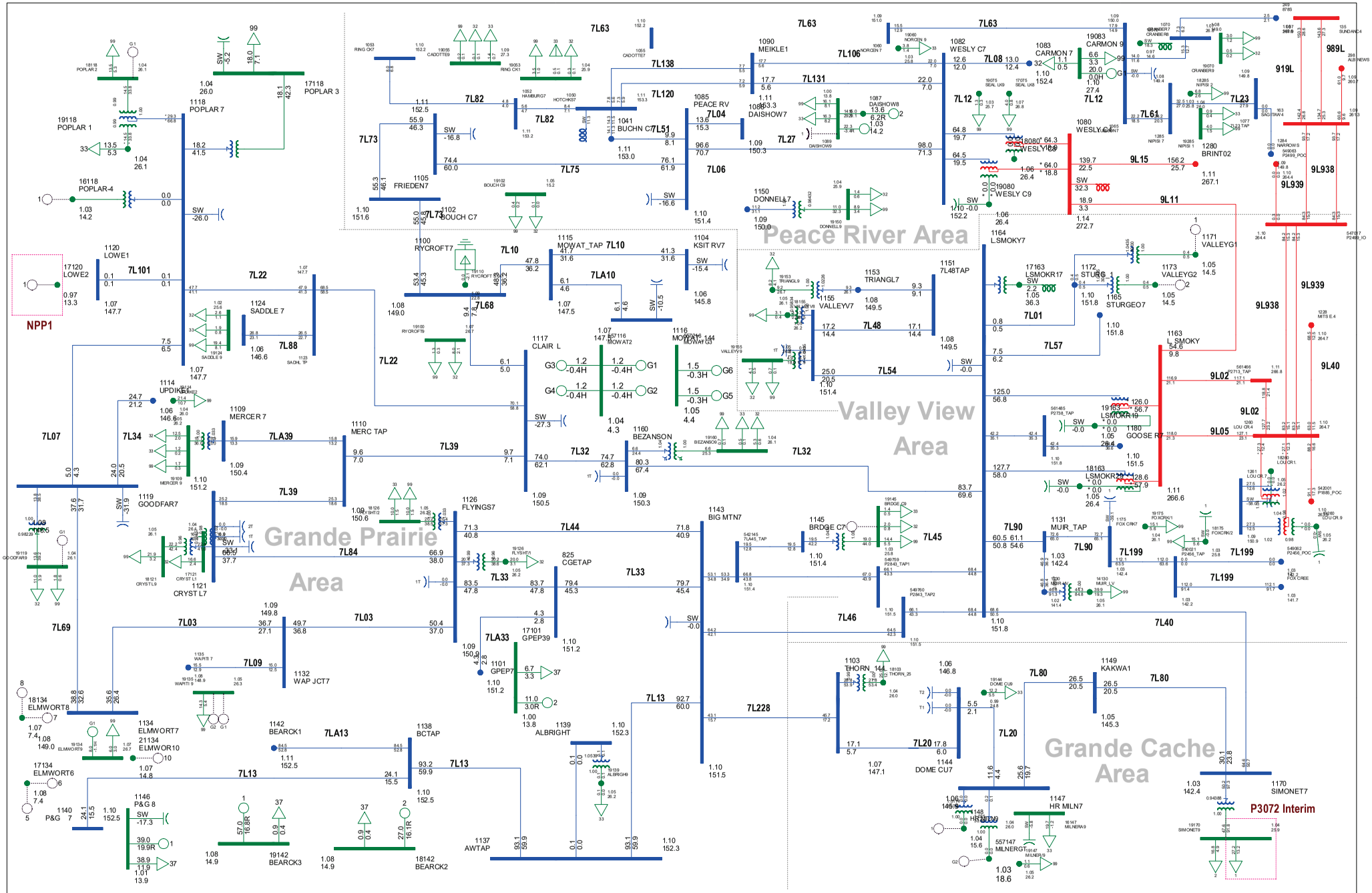


P3076 **ATCO Thornton Capacity Addition**	**CATEGORY A, N-0** **SCN1_2029 SP_PRE_MAIN_NOTMR** **THU, MAY 28 2026 13:43** **New Diagram**	Bus - Voltage (kV/pu) Branch - MVA/% RATE1 Equipment - MW/Mvar 100.0%RATE1 1.350OV 0.940UV kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



P3076 **ATCO Thornton Capacity Addition**	**CATEGORY A, N-0** **SCN2_2029 WP_PRE_MAIN_NOTMR** **THU, MAY 28 2026 13:42** **New Diagram**	Bus - Voltage (kV/pu) Branch - MVA/% RATE2 Equipment - MW/Mvar 100.0%RATE2 1.350OV 0.940UV kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A2-2

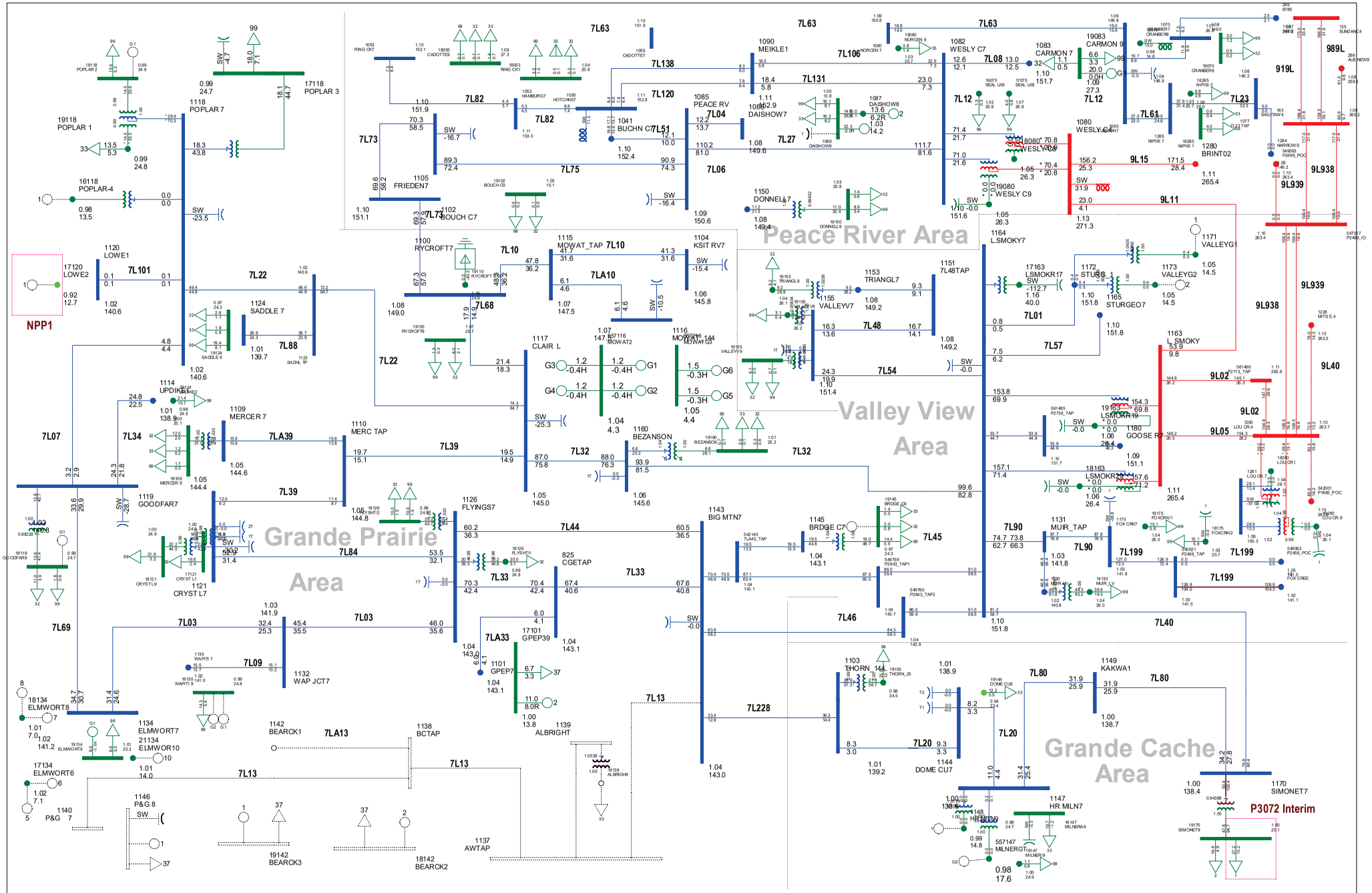


P3076
ATCO Thornton Capacity Addition

CATEGORY A, N-0
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

A2-3

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

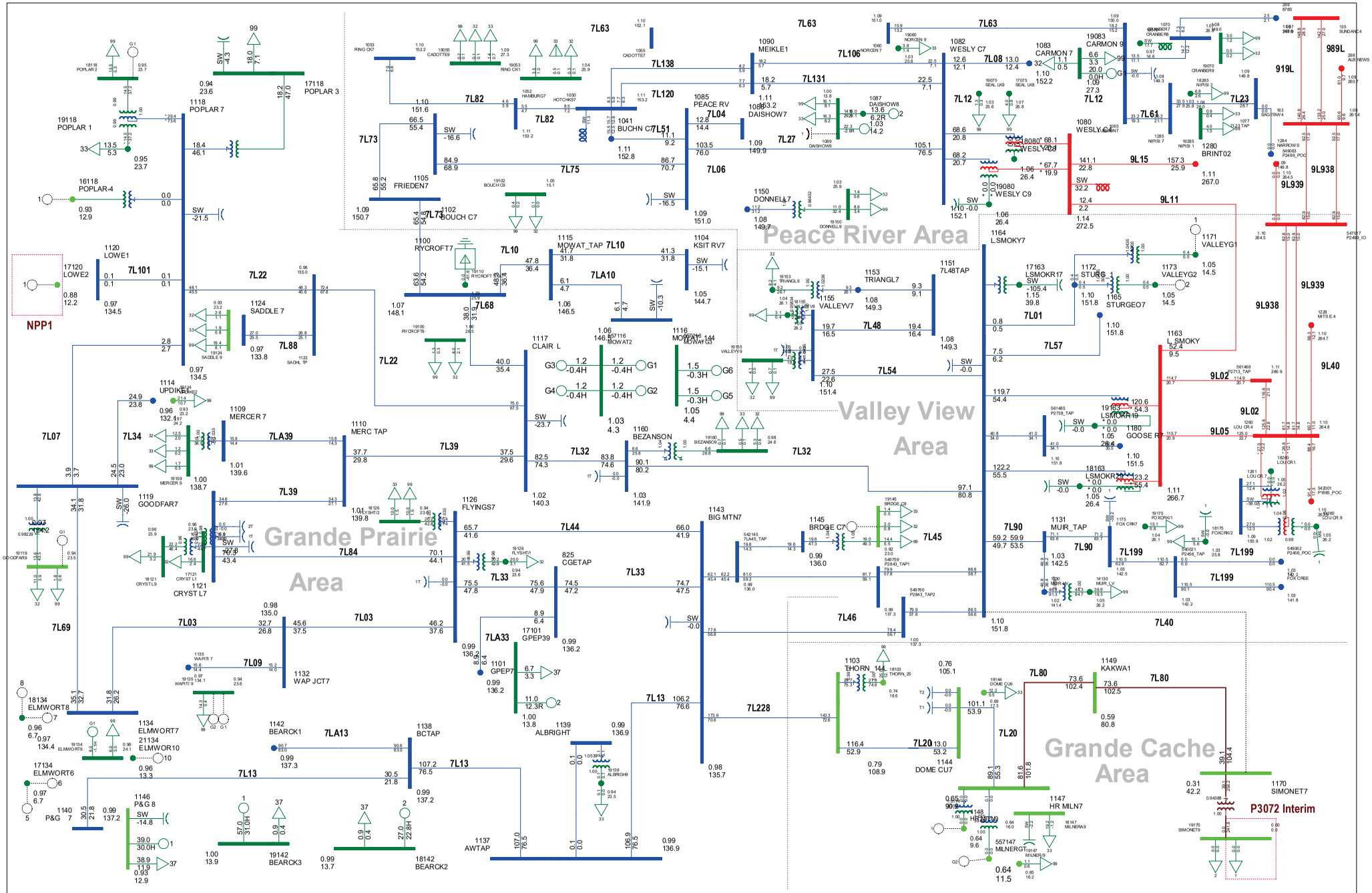


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L13 (BIG MOUNTAIN 845S - PROCTER & GAMB
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

A2-4

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

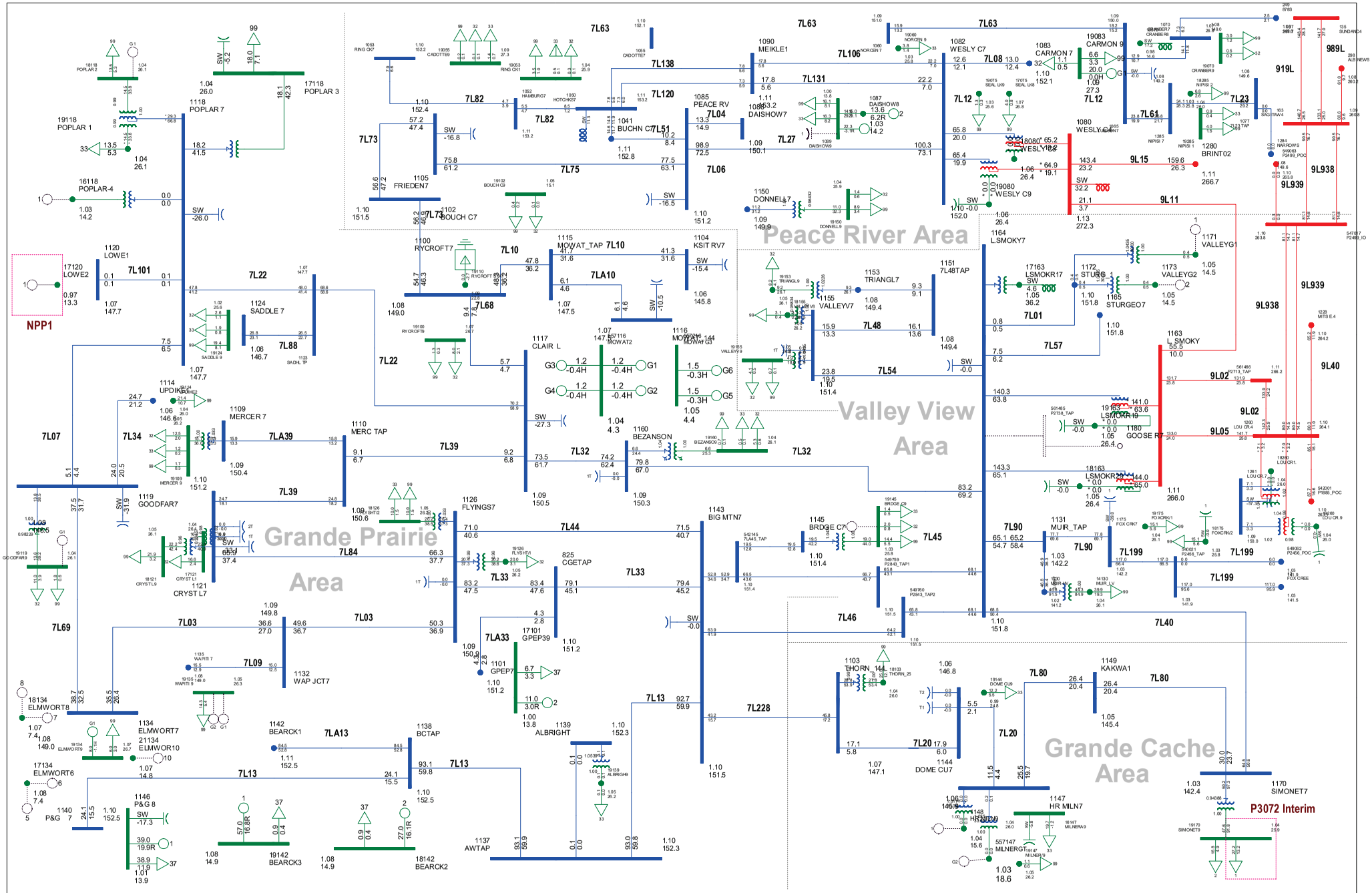


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L40 (LITTLE SMOKY 813S – SIMONETTE 733S
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

A2-5

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

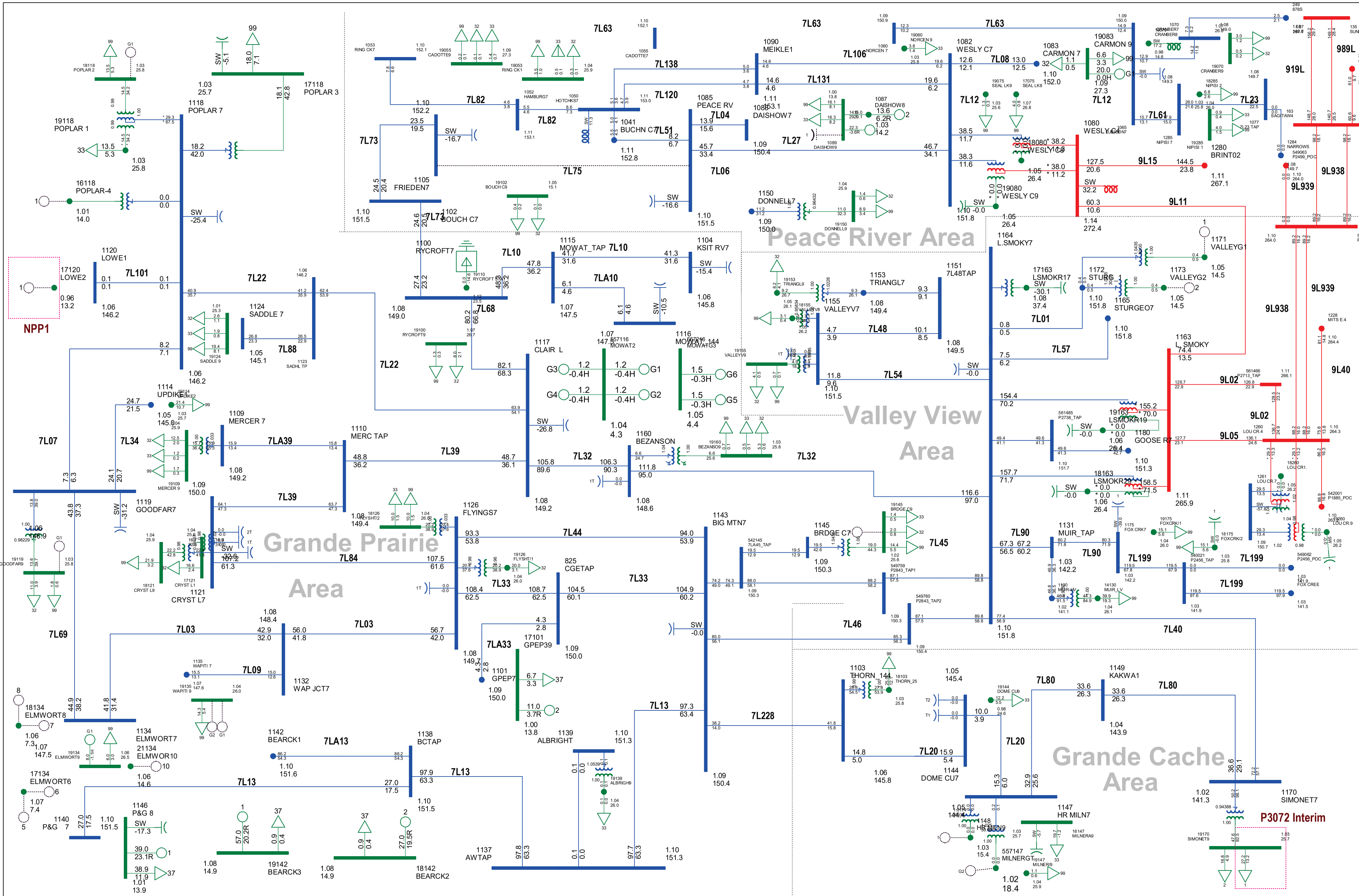


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L56 (LITTLE SMOKY 813S - LOUISE CREEK 8
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

A2-6

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

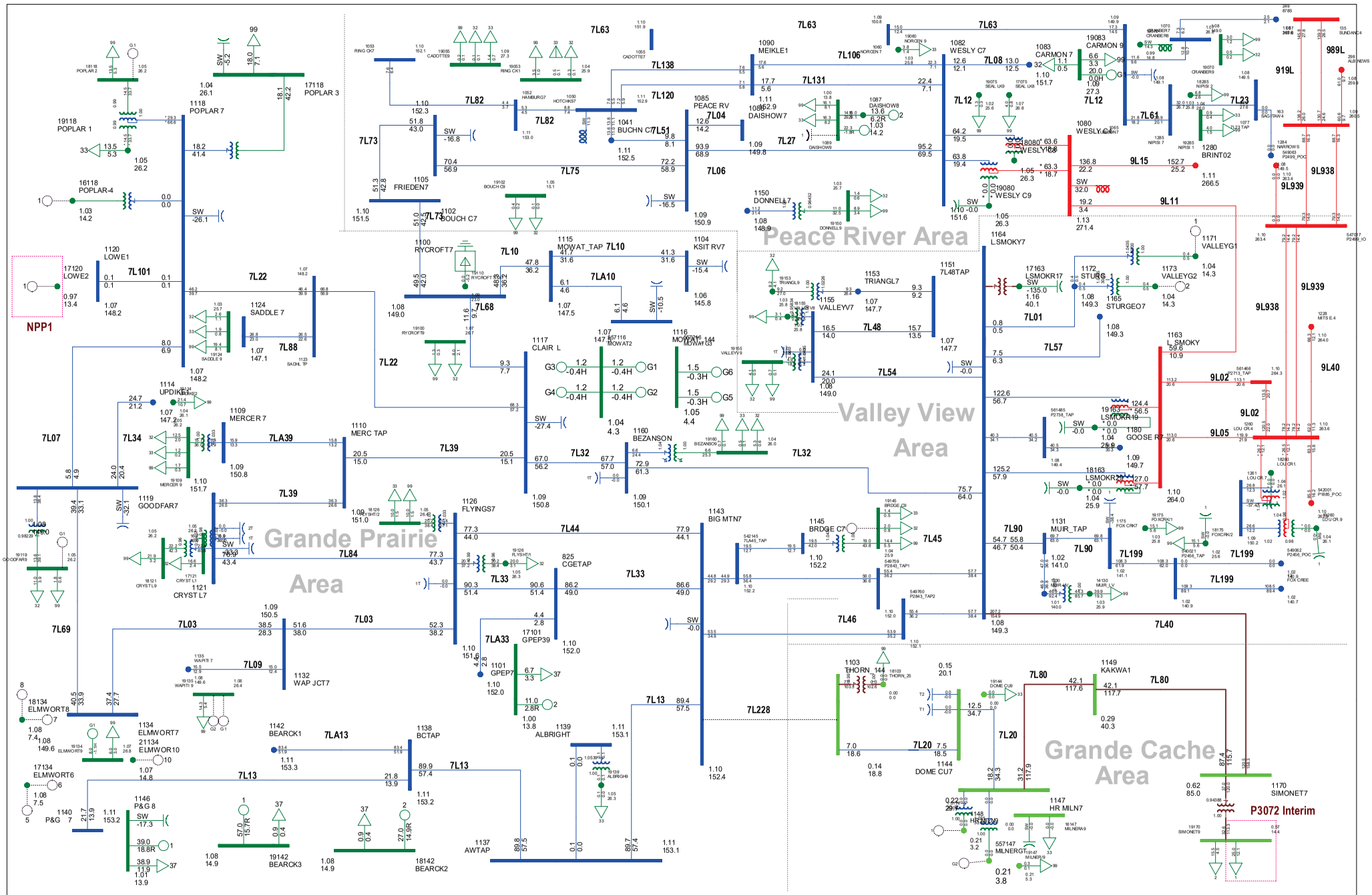


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L75 (FRIEDNESTAL 800S - WEST PEACE RIVE
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A2-7

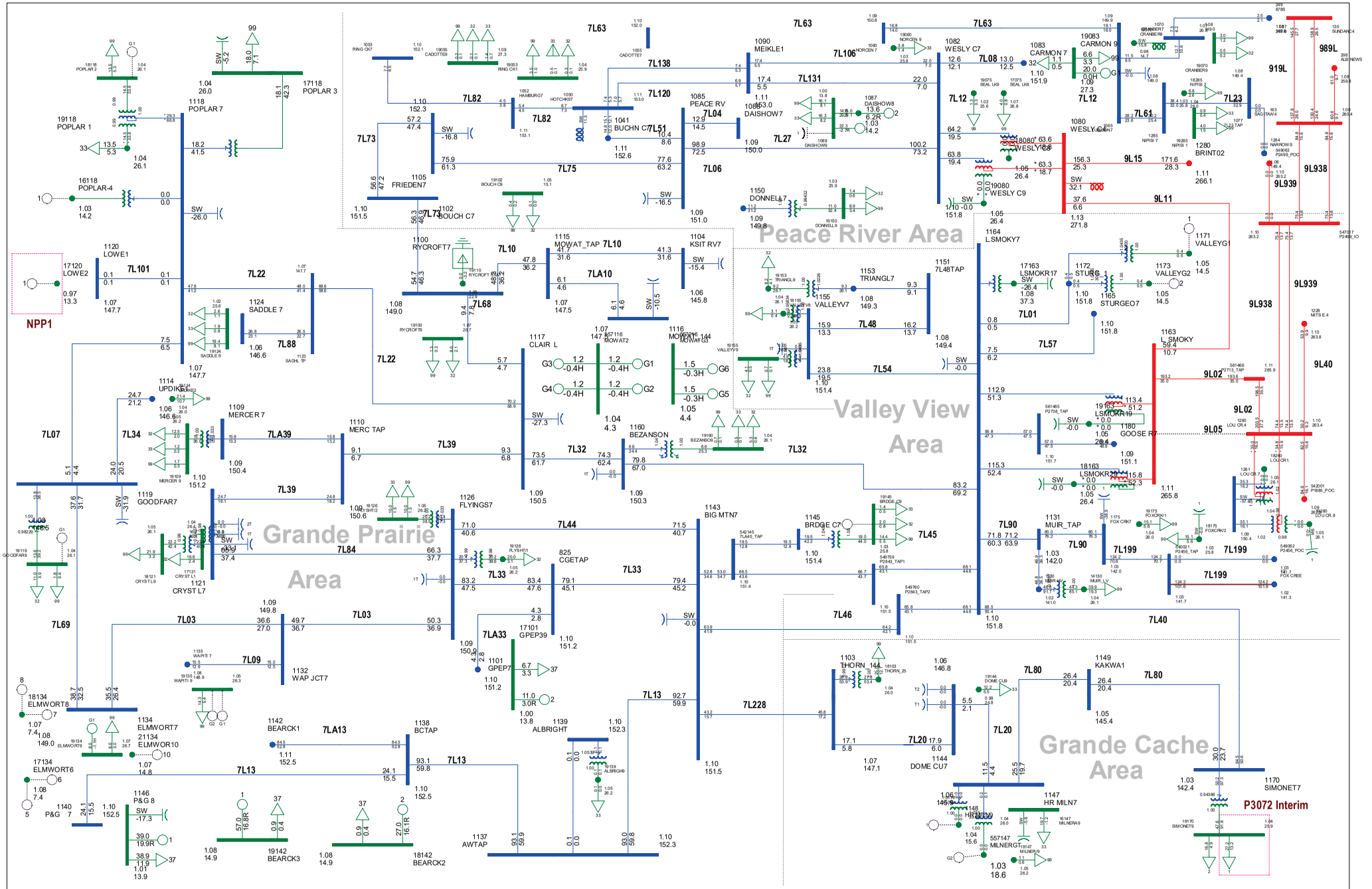


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L228 (BIG MOUNTAIN 845S - THORNTON 2091
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

A2-8

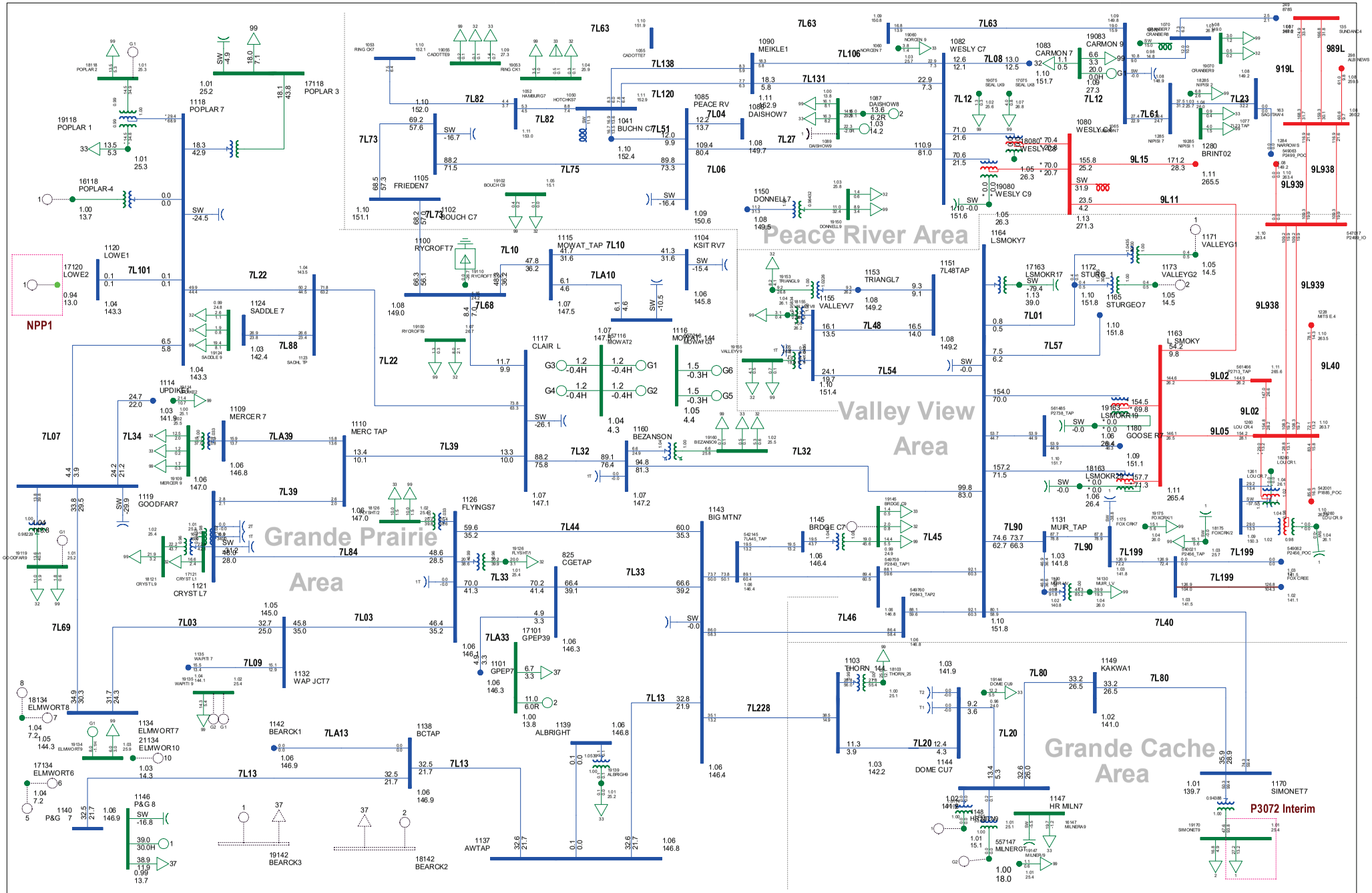
Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 9L05 (LITTLE SMOKY 813S - LOUISE CREEK 8
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

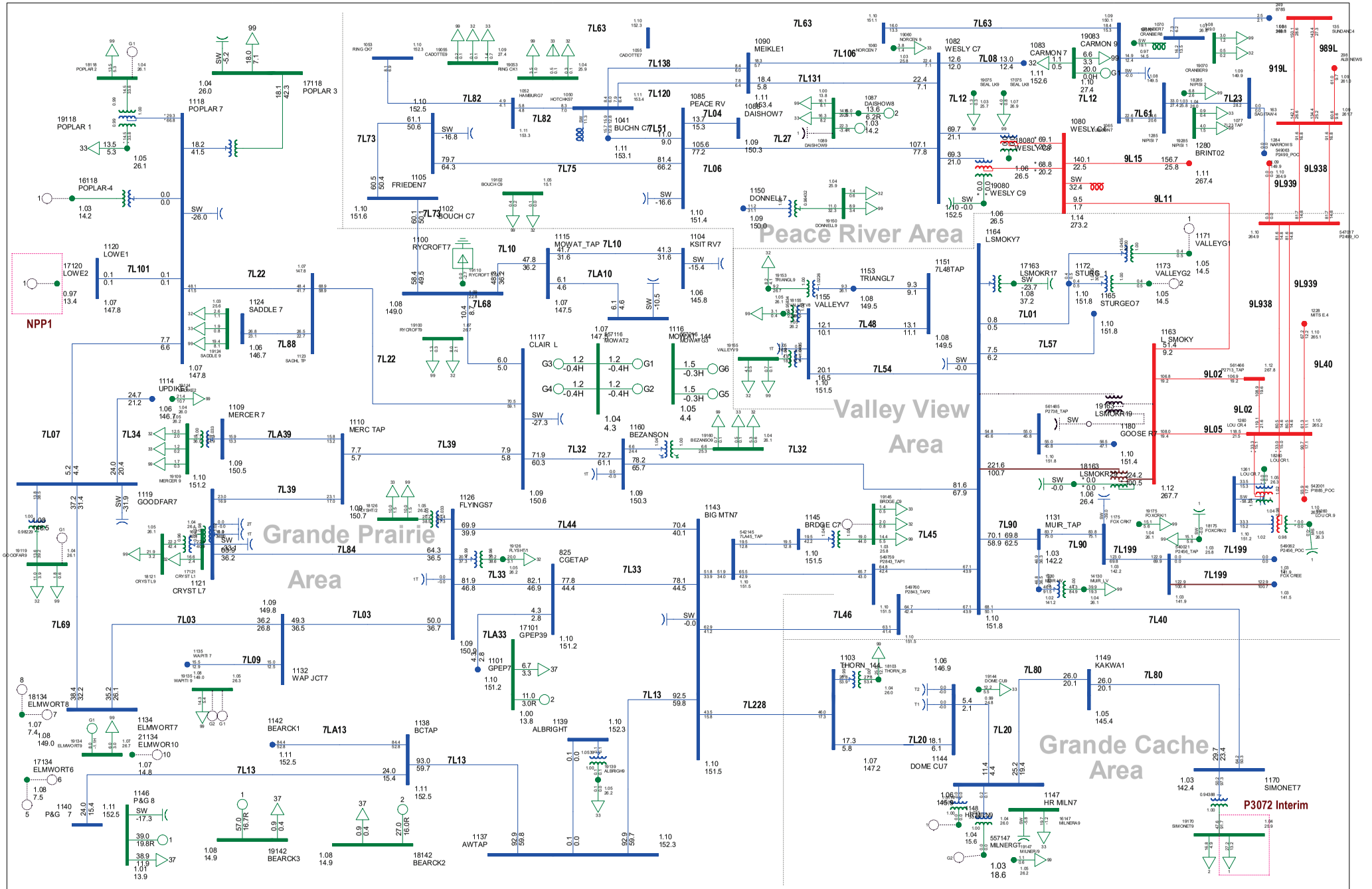


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF BEAR CREEK 679S 701T
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

A2-10

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

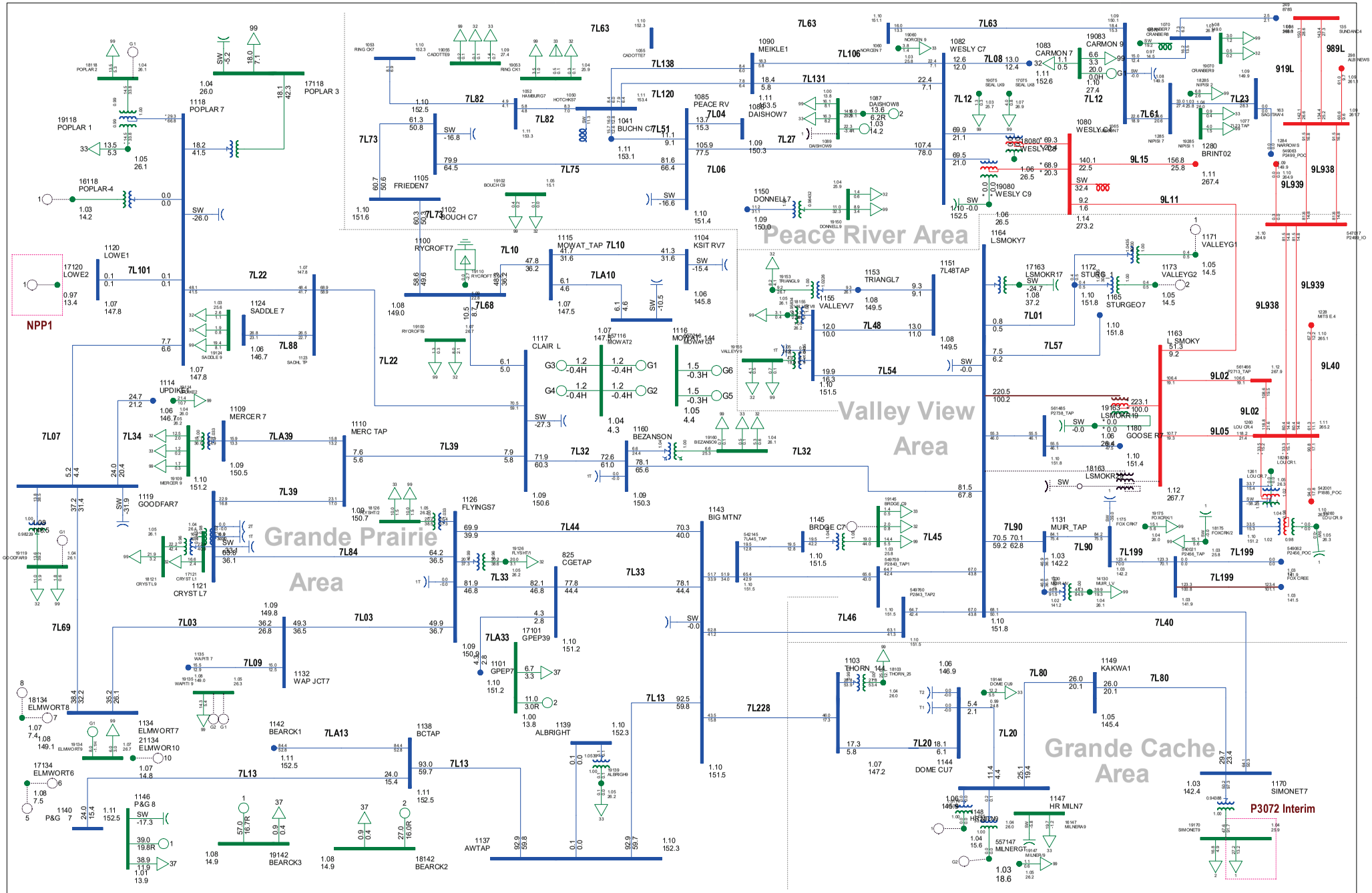


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF LITTLE SMOKY 813S 901T
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

A2-11

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

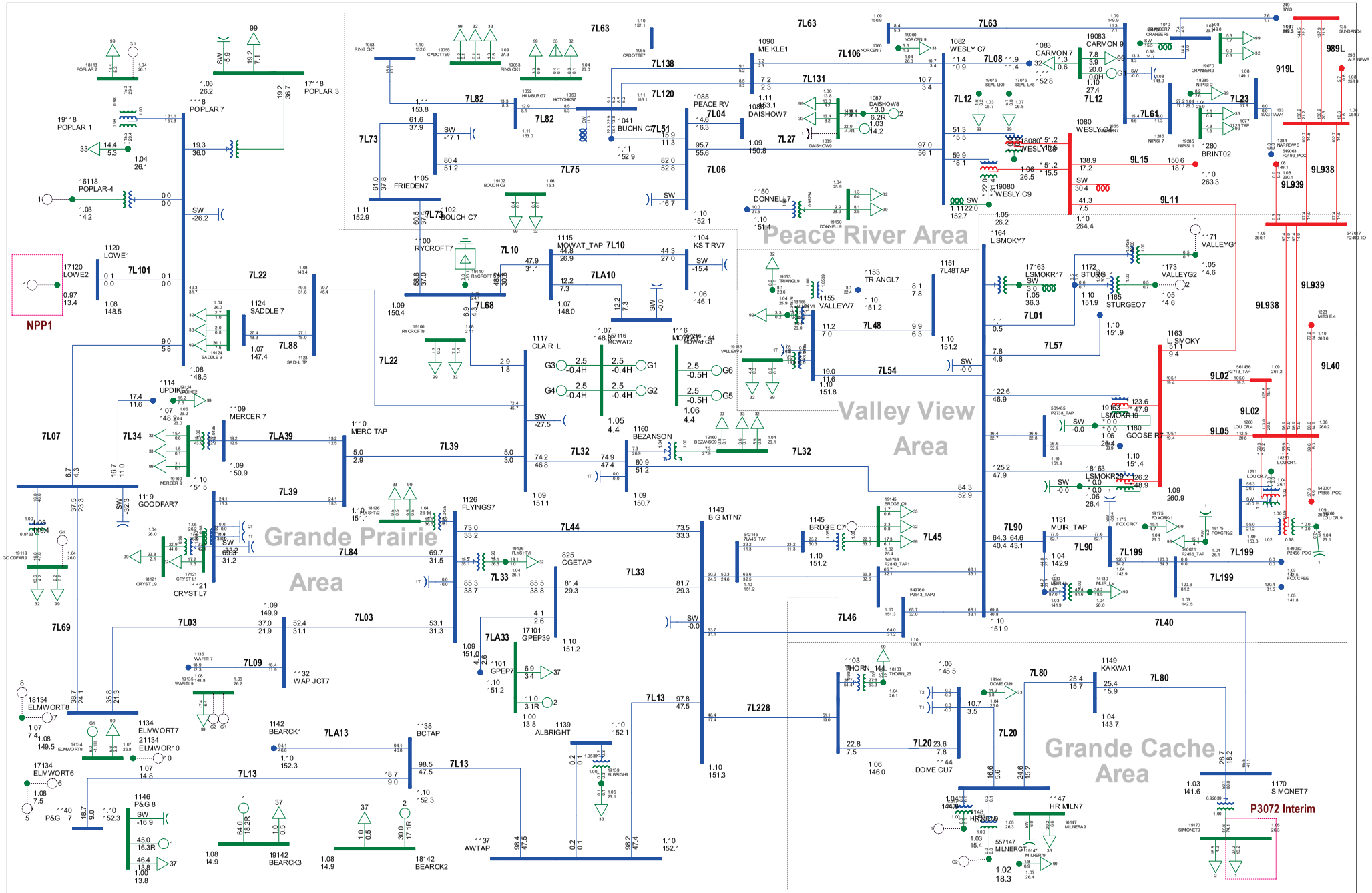


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF LITTLE SMOKY 813S 902T
SCN6_2029 SP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:30
New Diagram

A2-12

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

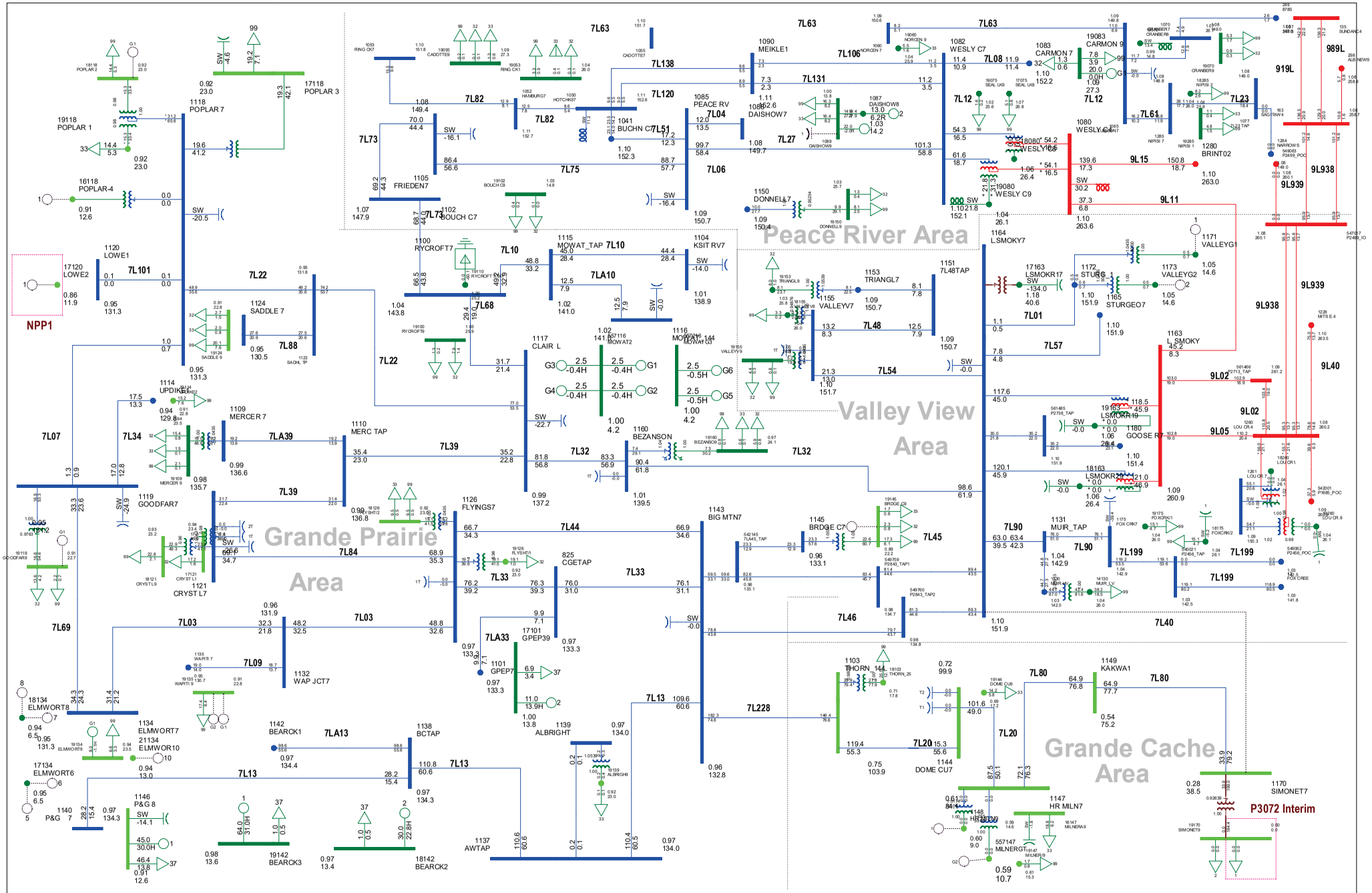


P3076
ATCO Thornton Capacity Addition

CATEGORY A, N-0
SCN7_2029 WP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:35
New Diagram

A2-13

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

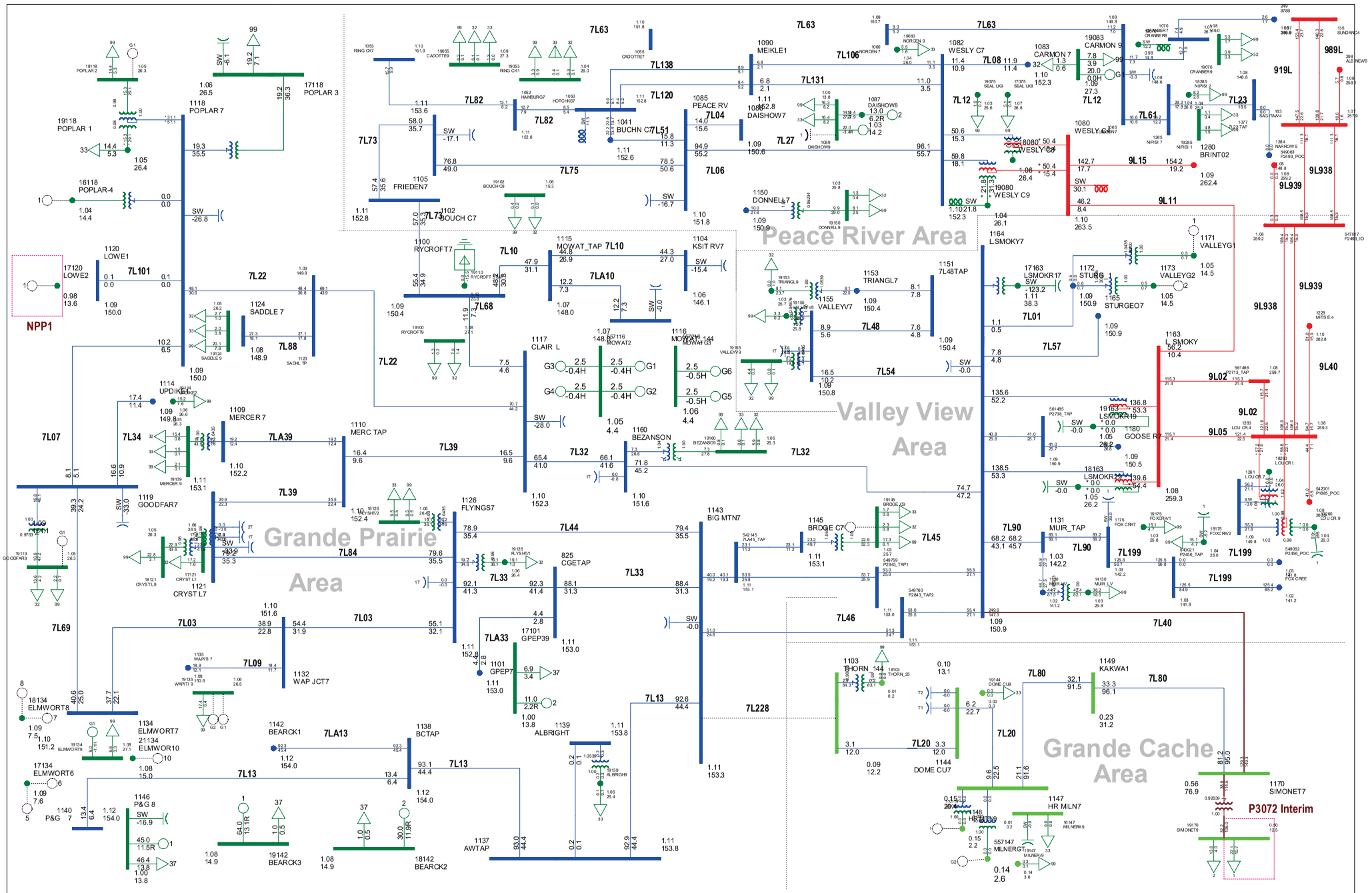


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L40 (LITTLE SMOKY 813S – SIMONETTE 733S
SCN7_2029 WP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:35
New Diagram

A2-14

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L228 (BIG MOUNTAIN 845S - THORNTON 2091
SCN7_2029 WP_PRE_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:35
New Diagram

A2-15

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

Attachment A3

Pre-Project Voltage Stability Diagrams (Scenario 7)

Scenario 7: P3076_P3072 2029 WP Pre-Project (Sensitivity)

Voltage stability analysis was performed for scenario 7 by increasing load in Grande Cache (Area 22), Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 7 is 205 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 10.25 MW (0.05 x 205 MW = 10.25 MW) for the scenario 7.

Table 1 provides voltage stability study results under Category A condition and for the five (5) worst contingencies under Category B conditions. The voltage stability diagrams are provided in Figure . Based on the study results, the voltage stability margin was met for all studied conditions.

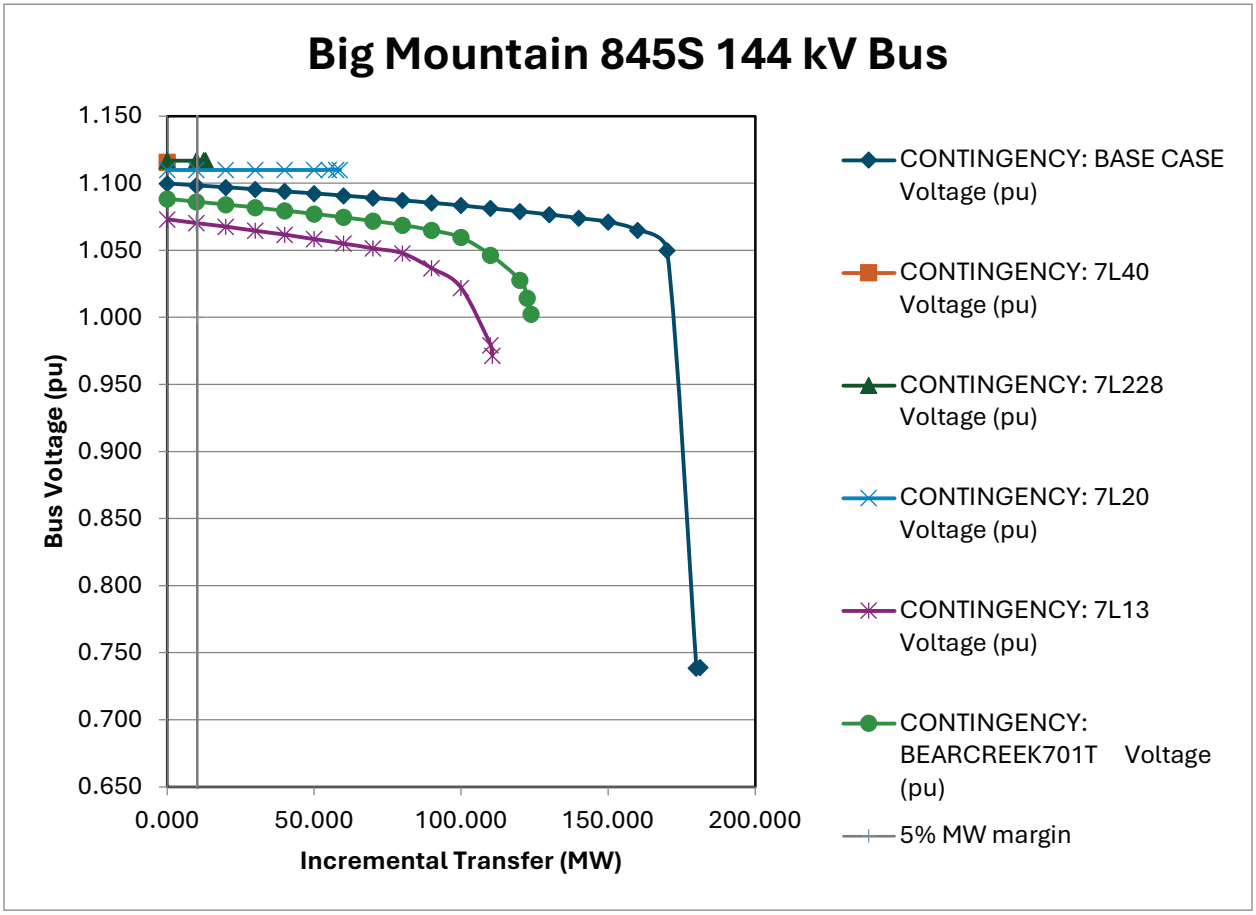
The following Buses were selected for the study:

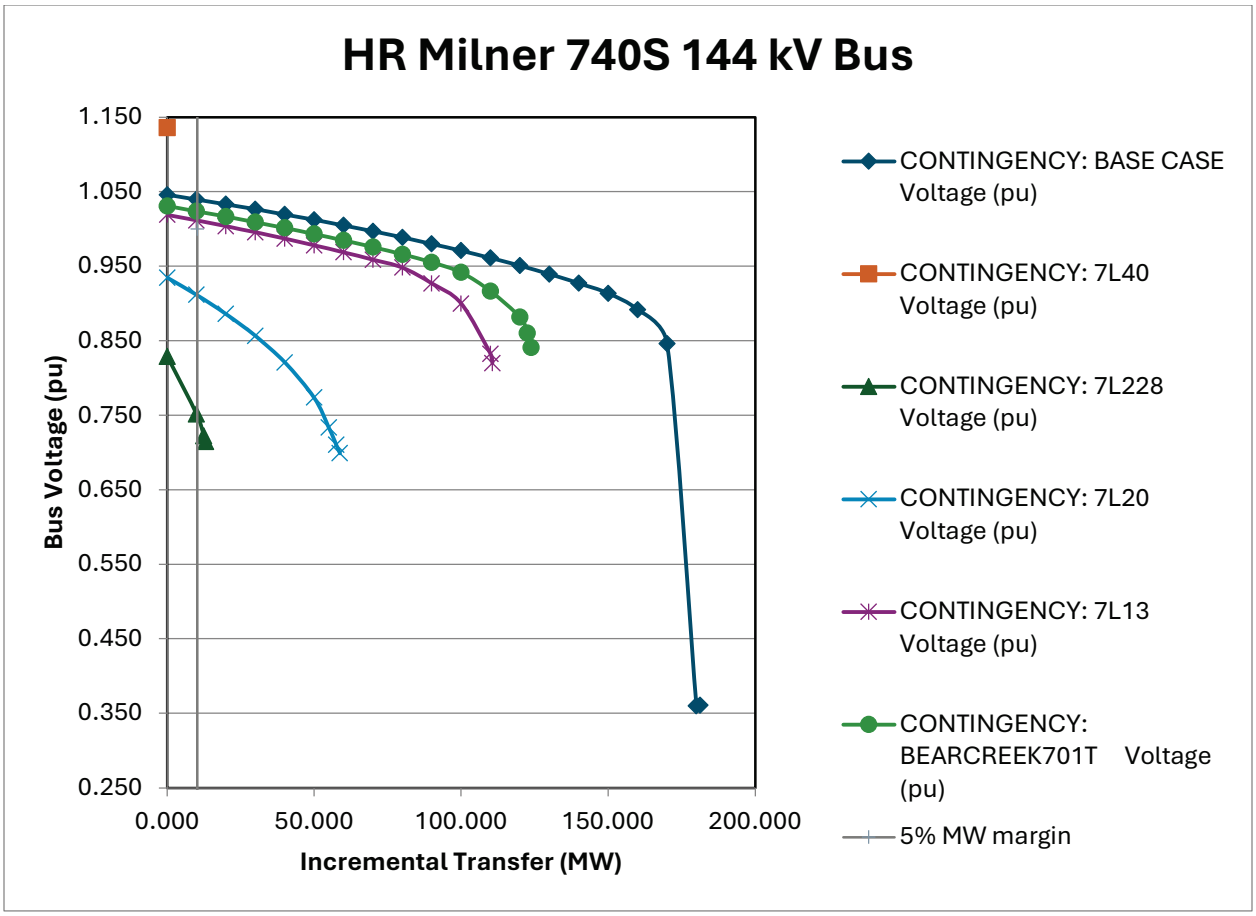
- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

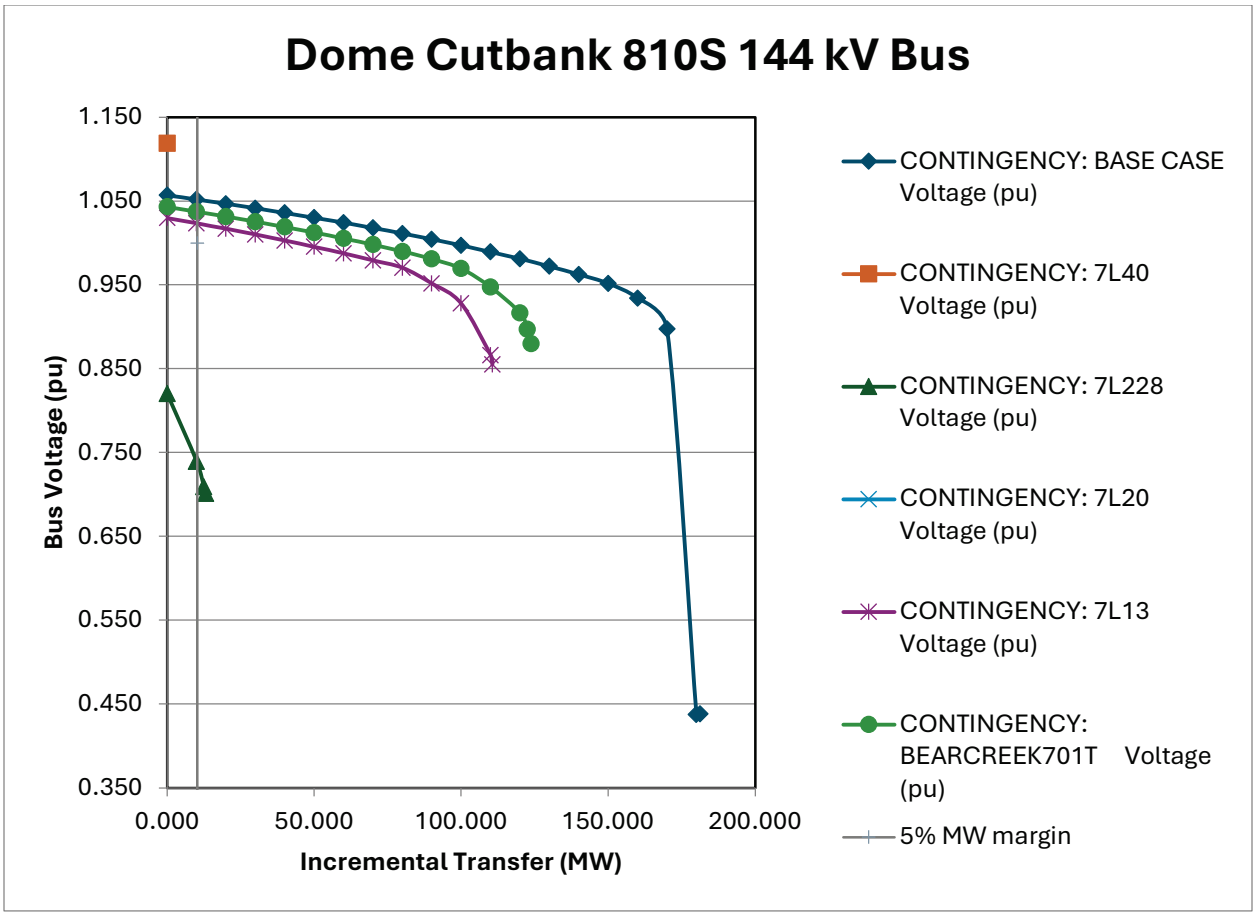
Table 1: Summary of Results under Category B Conditions for Scenario 7 (Alternative 1) No RAS

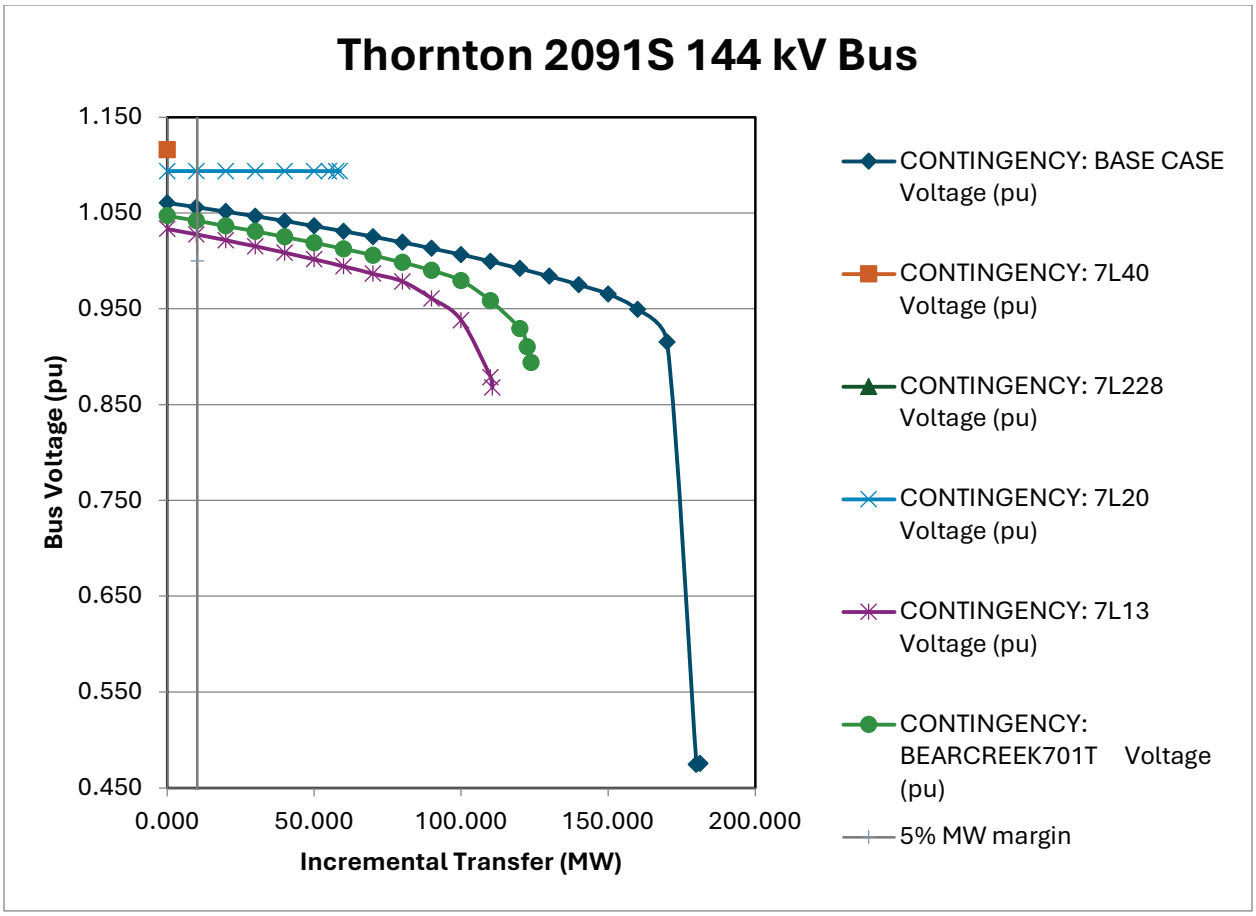
Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		181.3	Yes
7L228	Thornton 2091S	Big Mountain 845S	0	No
7L40	Little Smoky 813S	Simonette 733S	0	No
7L20	Thornton 2091S	HR Milner 740S	58.8	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	110.6	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		123.8	Yes

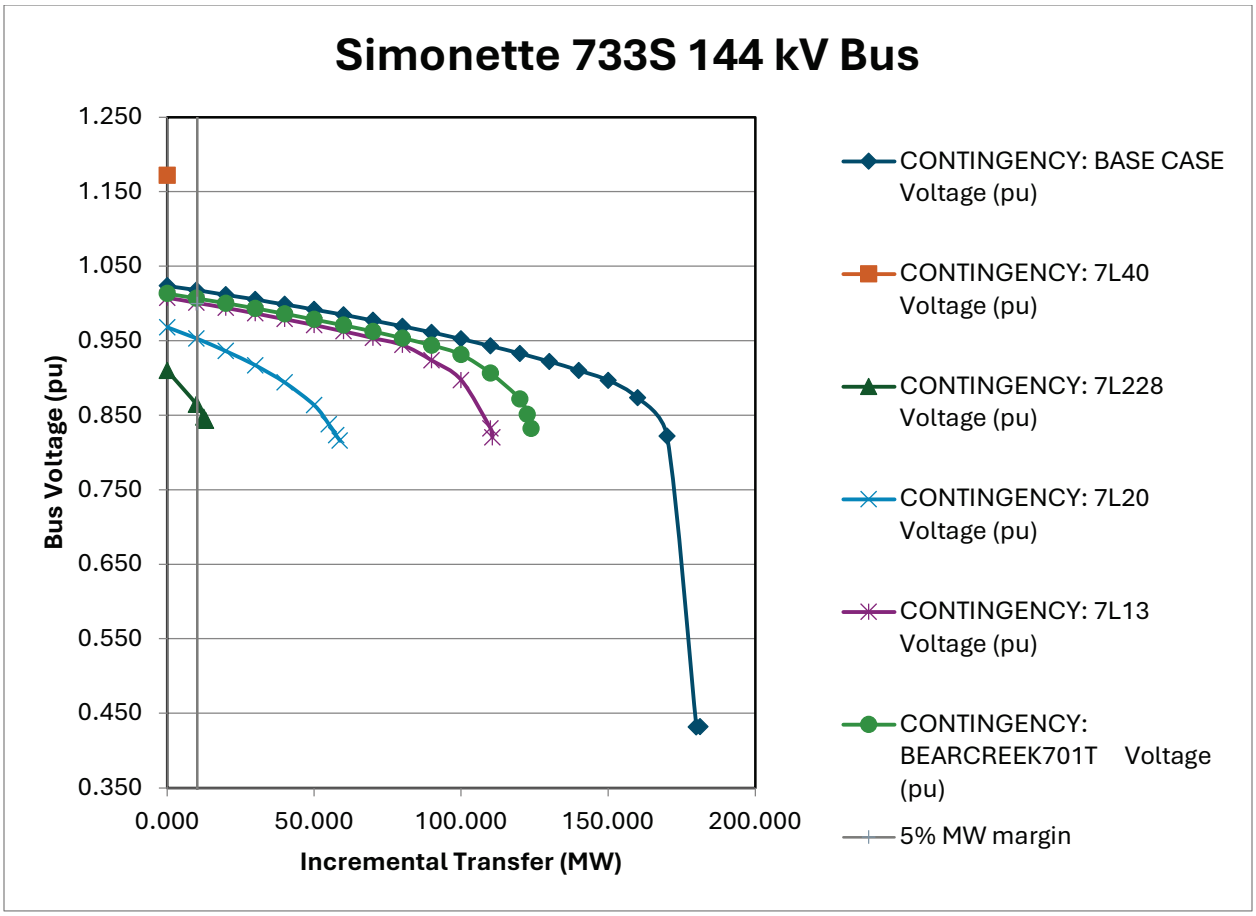
Figure 1:
Scenario 9: 2029_WP_Pre-Project (Sensitivity)




HR Milner 740S 144 kV Bus
1.150
1.050
0.950
0.850
0.750
0.650
0.550
0.450
0.350
0.250
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Dome Cutbank 810S 144 kV Bus
1.150
1.050
0.950
0.850
0.750
0.650
0.550
0.450
0.350
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Thornton 2091S 144 kV Bus
1.150
1.050
0.950
0.850
0.750
0.650
0.550
0.450
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Simonette 733S 144 kV Bus
1.250
1.150
1.050
0.950
0.850
0.750
0.650
0.550
0.450
0.350
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin

Attachment A4
Pre-Project Transient Stability Diagrams
(Scenario 2, 7)

Transient Stability Diagrams for 2029 WP Base case Scenario (2, 7)

Transient stability analysis was performed using the Scenario 2 and 7 for the Category B contingencies identified in Table A4-1, Table A4-2 and Table A4-3.

Table A4-1: List of Contingencies Studied for Transient Stability –Scenario 2 2029 WP-Pre Project Main study with No TPR

System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A4-1

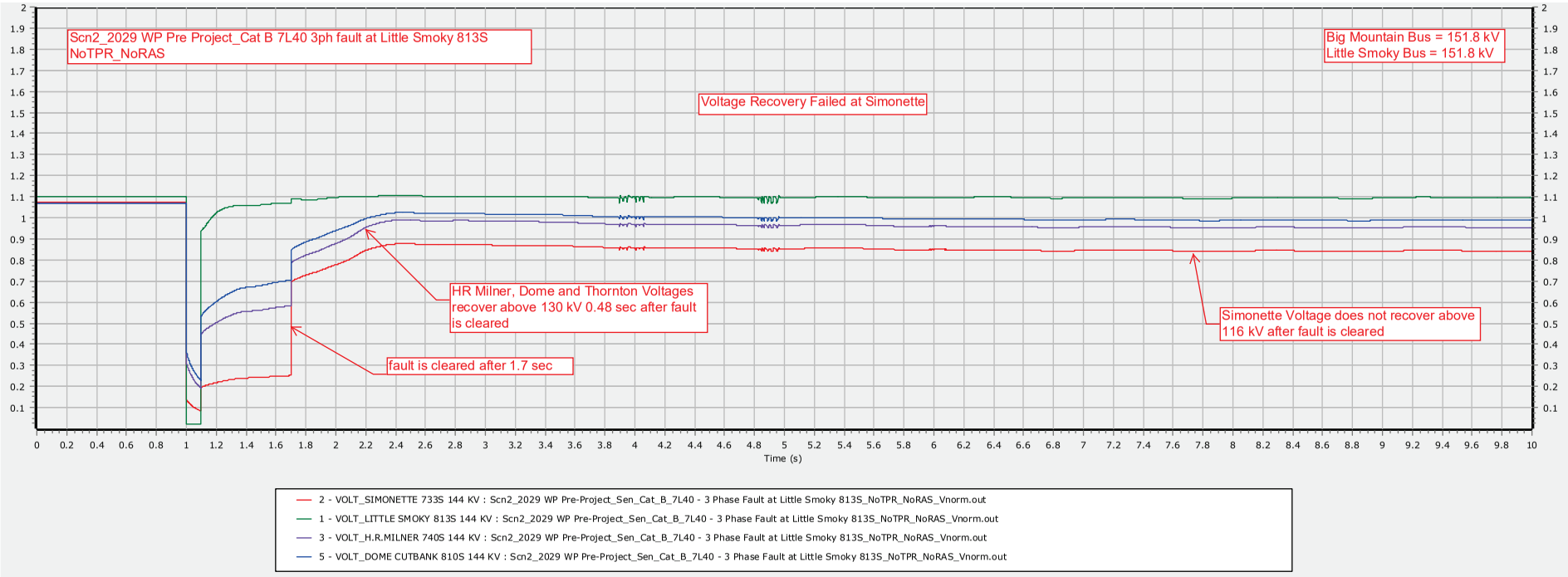
Table A4-2: List of Contingencies Studied for Transient Stability – Scenario 7 2029 WP-Pre Project Sensitivity study with No TPR (7L20 and 7L40)

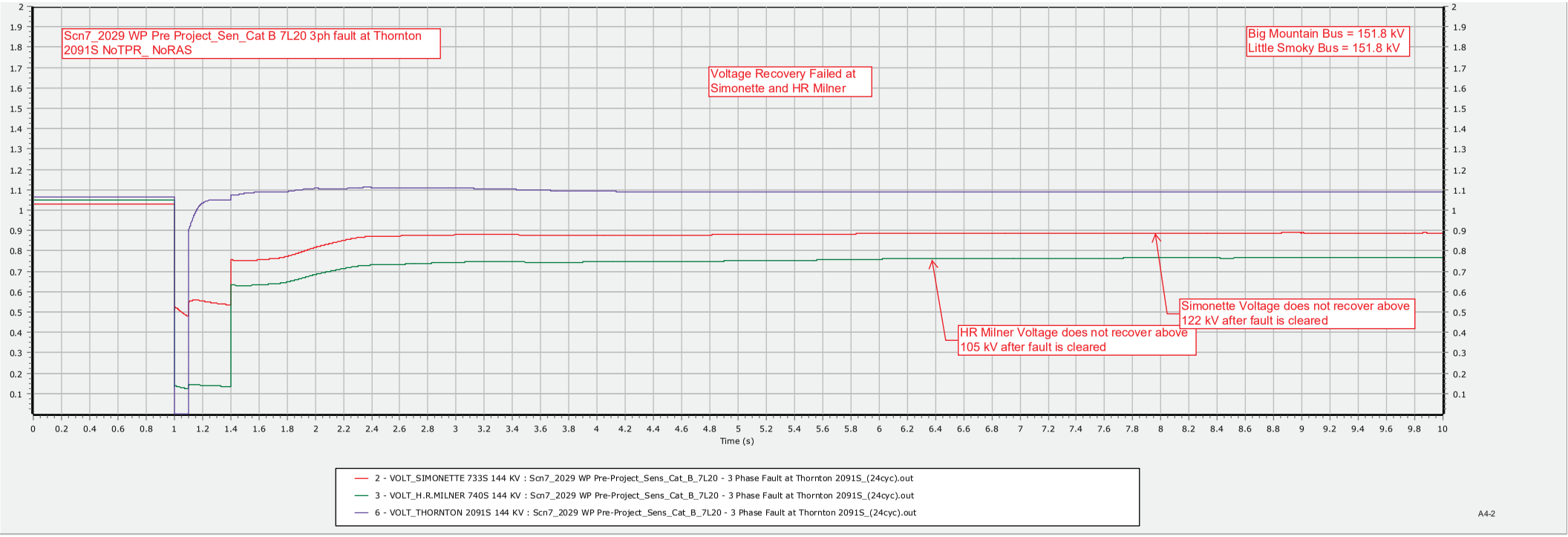
System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A4-2
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A4-3
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A4-4
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	A4-5
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)*	Big Mountain 845S	A4-6
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)*	Thornton 2091S	A4-7

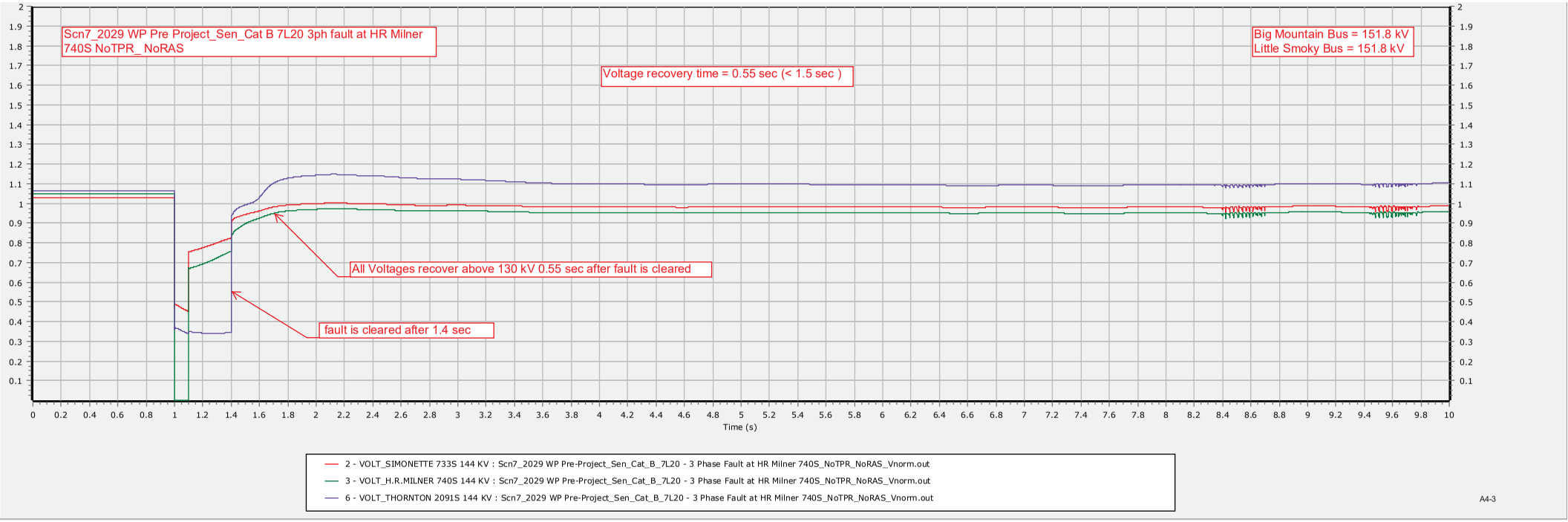
*7L228 already has TPR

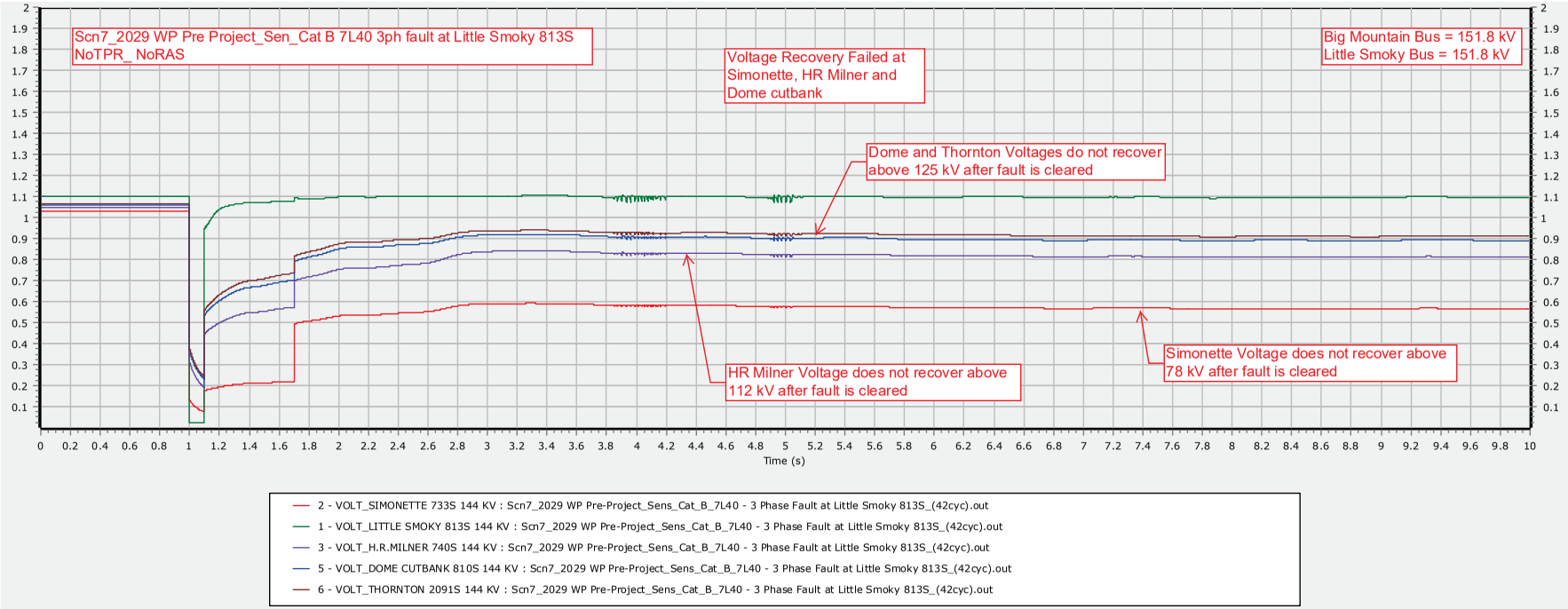
Table A4-3: List of Contingencies Studied for Transient Stability – Scenario 7 2029 WP-Pre Project Sensitivity study with new Capacitors and No TPR

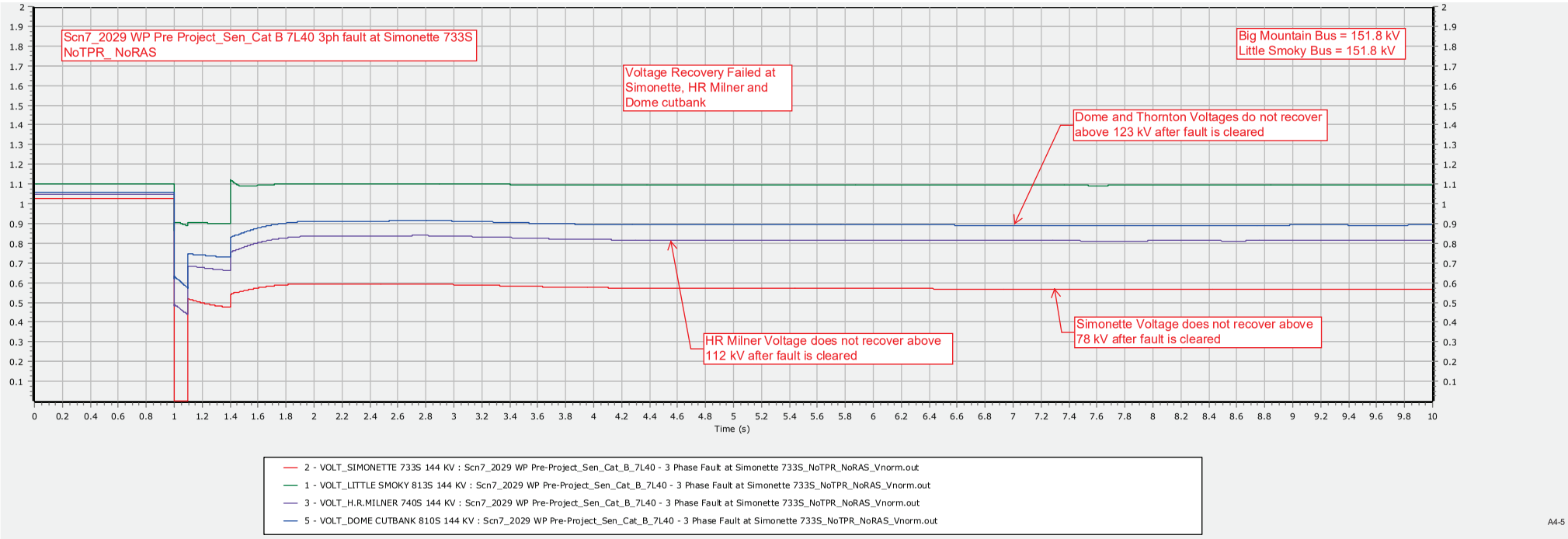
System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A4-8
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	A4-9

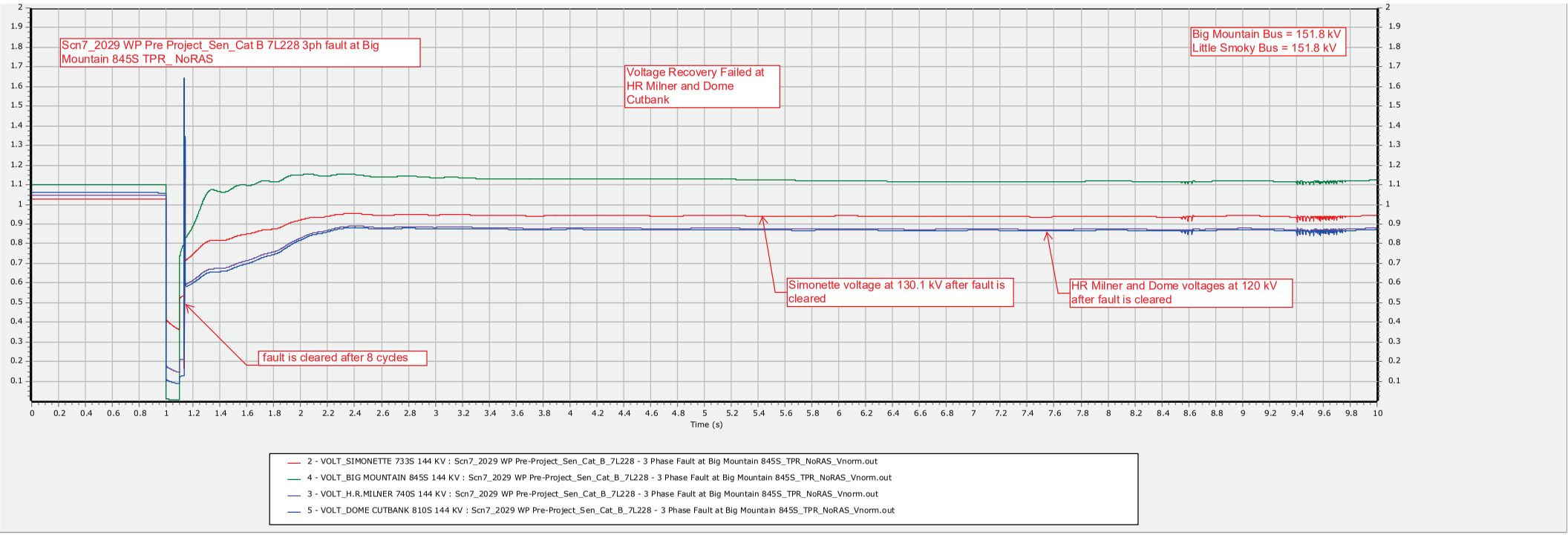

Scn2_2029 WP Pre Project_Cat B 7L40 3ph fault at Little Smoky 813S
NoTPR_NoRAS
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage Recovery Failed at Simonette
HR Milner, Dome and Thornton Voltages recover above 130 kV 0.48 sec after fault is cleared
Simonette Voltage does not recover above 116 kV after fault is cleared
fault is cleared after 1.7 sec
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn2_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_NoRAS_Vnorm.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn2_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn2_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn2_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_NoRAS_Vnorm.out

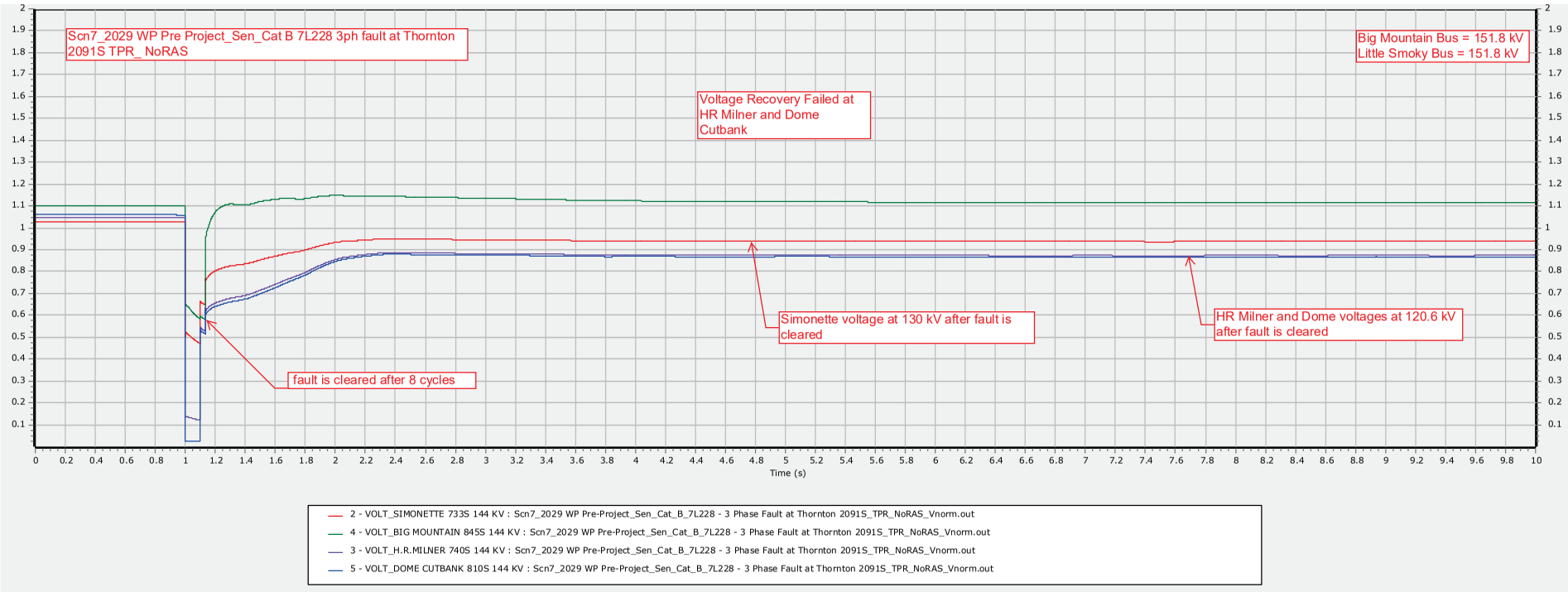

Scn7_2029 WP Pre Project_Sen_Cat B 7L20 3ph fault at Thornton 2091S NoTPR_ NoRAS
Voltage Recovery Failed at Simonette and HR Milner
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Simonette Voltage does not recover above 122 kV after fault is cleared
HR Milner Voltage does not recover above 105 kV after fault is cleared
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn7_2029 WP Pre-Project_Sens_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_(24cyc).out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn7_2029 WP Pre-Project_Sens_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_(24cyc).out
6 - VOLT_THORNTON 2091S 144 KV : Scn7_2029 WP Pre-Project_Sens_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_(24cyc).out

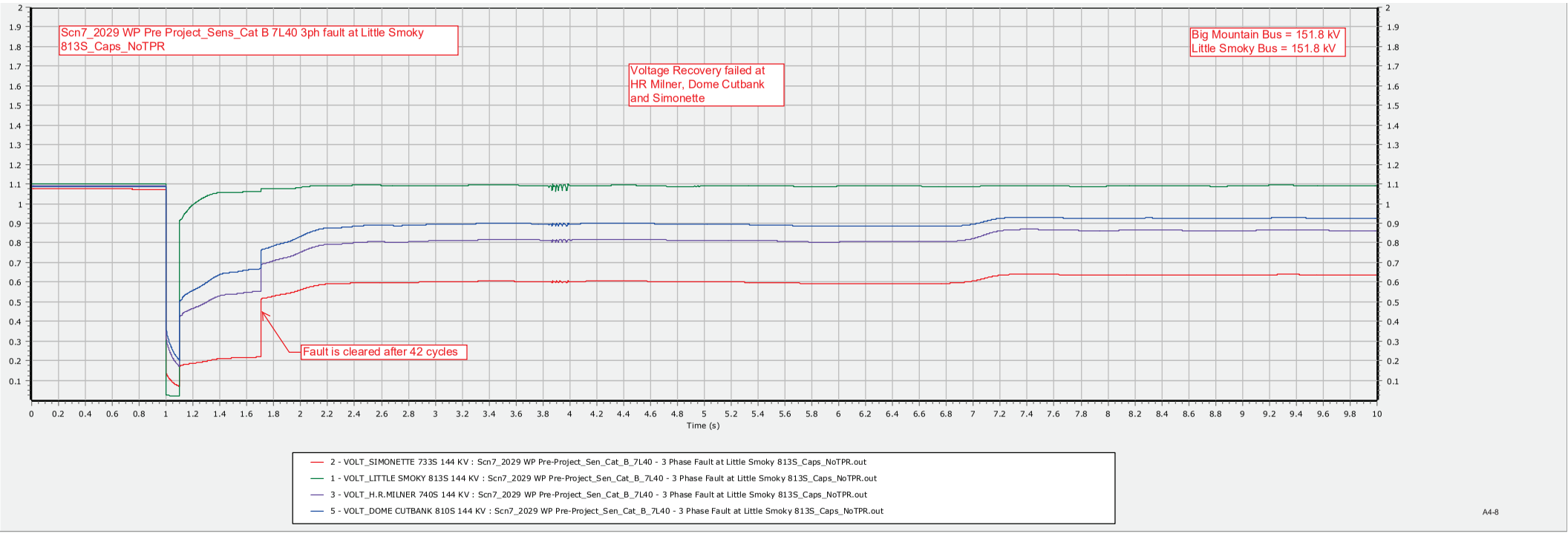

Scn7_2029 WP Pre Project_Sen_Cat B 7L20 3ph fault at HR Milner
740S NoTPR_ NoRAS
Voltage recovery time = 0.55 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.55 sec after fault is cleared
fault is cleared after 1.4 sec
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_NoRAS_Vnorm.out
6 - VOLT_THORNTON 2091S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_NoRAS_Vnorm.out

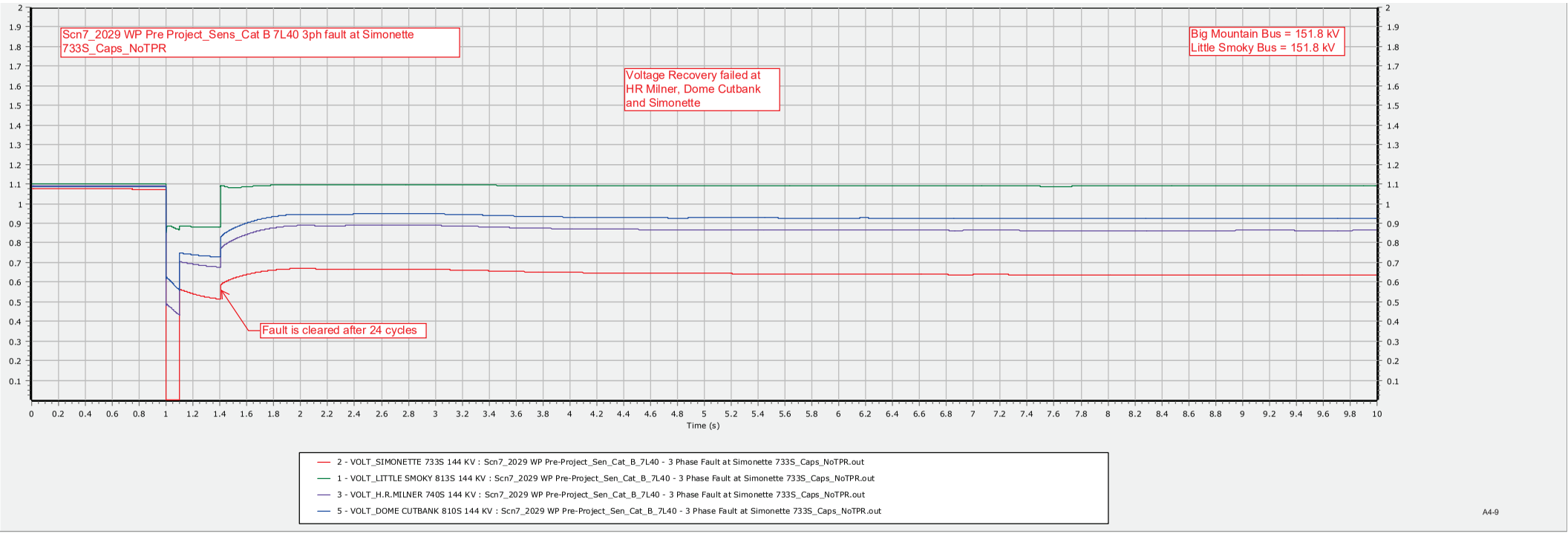

Scn7_2029 WP Pre Project_Sen_Cat B 7L40 3ph fault at Little Smoky 813S
NoTPR_ NoRAS
Voltage Recovery Failed at Simonette, HR Milner and Dome cutbank
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Dome and Thornton Voltages do not recover above 125 kV after fault is cleared
HR Milner Voltage does not recover above 112 kV after fault is cleared
Simonette Voltage does not recover above 78 kV after fault is cleared
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn7_2029 WP Pre-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn7_2029 WP Pre-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn7_2029 WP Pre-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn7_2029 WP Pre-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out
6 - VOLT_THORNTON 2091S 144 KV : Scn7_2029 WP Pre-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out


Scn7_2029 WP Pre Project_Sen_Cat B 7L40 3ph fault at Simonette 733S NoTPR_ NoRAS
Voltage Recovery Failed at Simonette, HR Milner and Dome cutbank
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Dome and Thornton Voltages do not recover above 123 kV after fault is cleared
HR Milner Voltage does not recover above 112 kV after fault is cleared
Simonette Voltage does not recover above 78 kV after fault is cleared
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out


Scn7_2029 WP Pre Project_Sen_Cat B 7L228 3ph fault at Big Mountain 845S TPR_ NoRAS
Voltage Recovery Failed at HR Milner and Dome Cutbank
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Simonette voltage at 130.1 kV after fault is cleared
HR Milner and Dome voltages at 120 kV after fault is cleared
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out


Scn7_2029 WP Pre Project_Sen_Cat B 7L228 3ph fault at Thornton 2091S TPR_ NoRAS
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage Recovery Failed at HR Milner and Dome Cutbank
Simonette voltage at 130 kV after fault is cleared
HR Milner and Dome voltages at 120.6 kV after fault is cleared
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out


Scn7_2029 WP Pre Project_Sens_Cat B 7L40 3ph fault at Little Smoky 813S_Caps_NoTPR
Voltage Recovery failed at HR Milner, Dome Cutbank and Simonette
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Fault is cleared after 42 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_NoTPR.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_NoTPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_NoTPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_NoTPR.out


Scn7_2029 WP Pre Project_Sens_Cat B 7L40 3ph fault at Simonette
733S_Caps_NoTPR
Voltage Recovery failed at
HR Milner, Dome Cutbank
and Simonette
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Fault is cleared after 24 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_Caps_NoTPR.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_Caps_NoTPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_Caps_NoTPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn7_2029 WP Pre-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_Caps_NoTPR.out

Attachment A5
Post-Project Power Flow Diagrams without TMR
(Scenarios 3, 4, 8, 9)

Post Project Power Flow Results

The post-Project power flow diagrams without TMR for Scenario 3,4,8, and 9 under Category A and Category B conditions identified with violations are provided in this attachment as per the following tables.

Table A5-1: List of Scenario 3: 2029 SP LG Post-Project Power Flow Diagrams

Scenario	Power Flow Diagram	Page number
2029 SP Scenario 3	N-0, System Normal Condition	A5-5-1

Table A5-2: List of Scenario 4: 2029 WP LG Post-Project Power Flow Diagrams

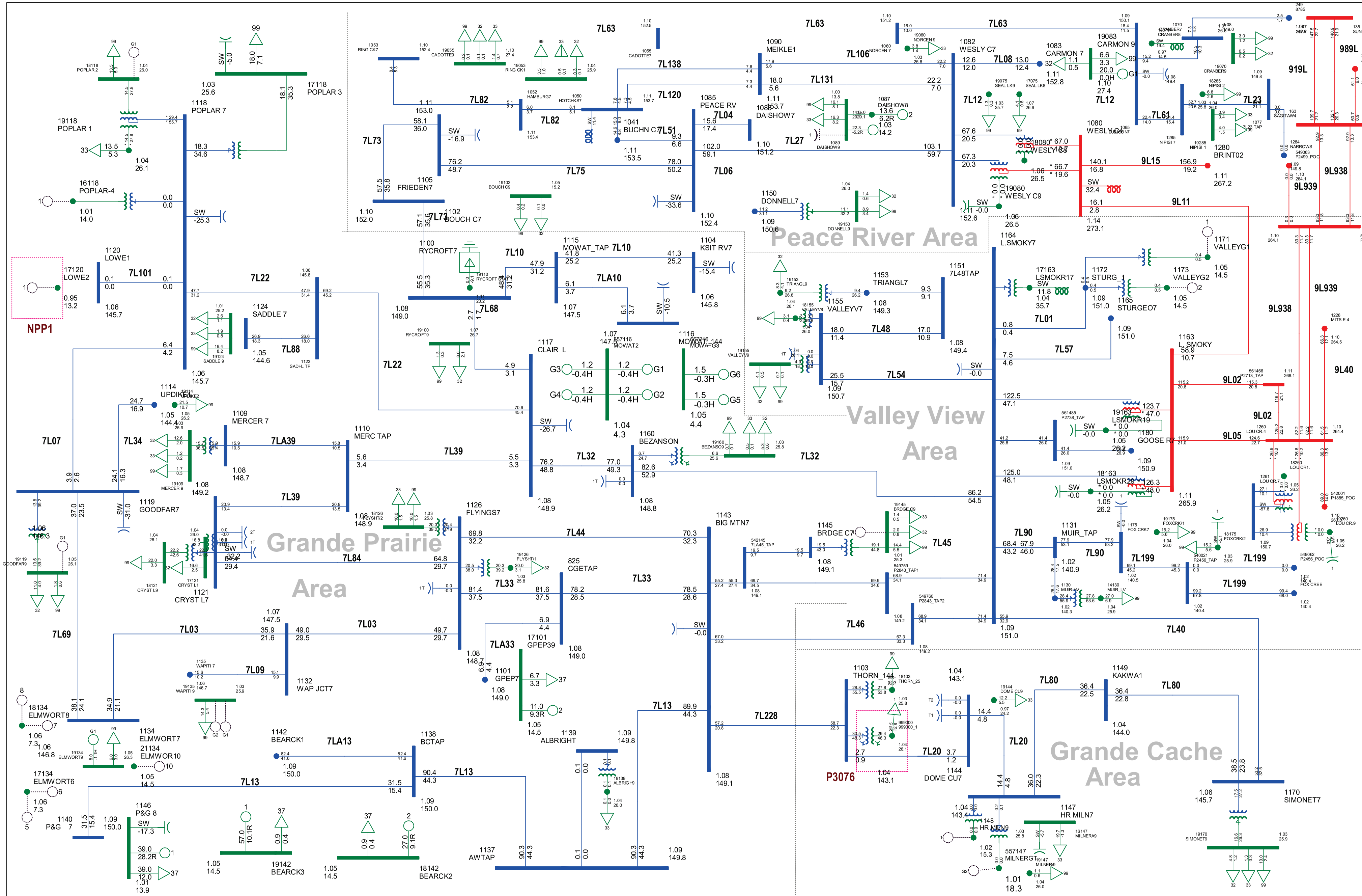
Scenario	Power Flow Diagram	Page number
2029 WP Scenario 4	N-0, System Normal Condition	A5-2

Table A5-3: List of Scenario 8: 2029 SP Sensitivity Post-Project Power Flow Diagrams

Scenario	Power Flow Diagram	Page number
2029 SP Scenario 8	N-0, System Normal Condition	A5-3
	N-1, Loss of 7L13	A5-4
	N-1, Loss of 7L40	A5-5
	N-1, Loss of 7L56	A5-6
	N-1, Loss of 7L75	A5-7
	N-1, Loss of 7L228	A5-8
	N-1, Loss of 9L05	A5-9
	N-1, Loss Of Bear Creek 679S 701T	A5-10
	N-1, Loss of Little Smoky 813S 901T	A5-11
	N-1, Loss of Little Smoky 813S 902T	A5-12

Table A5-4: List of Scenario 9: 2029 WP Sensitivity Post-Project Power Flow Diagrams

Scenario	Power Flow Diagram	Page number
2029 WP Scenario 9	N-0, System Normal Condition	A5-13
	N-1, Loss of 7L40	A5-14
	N-1, Loss of 7L228	A5-15

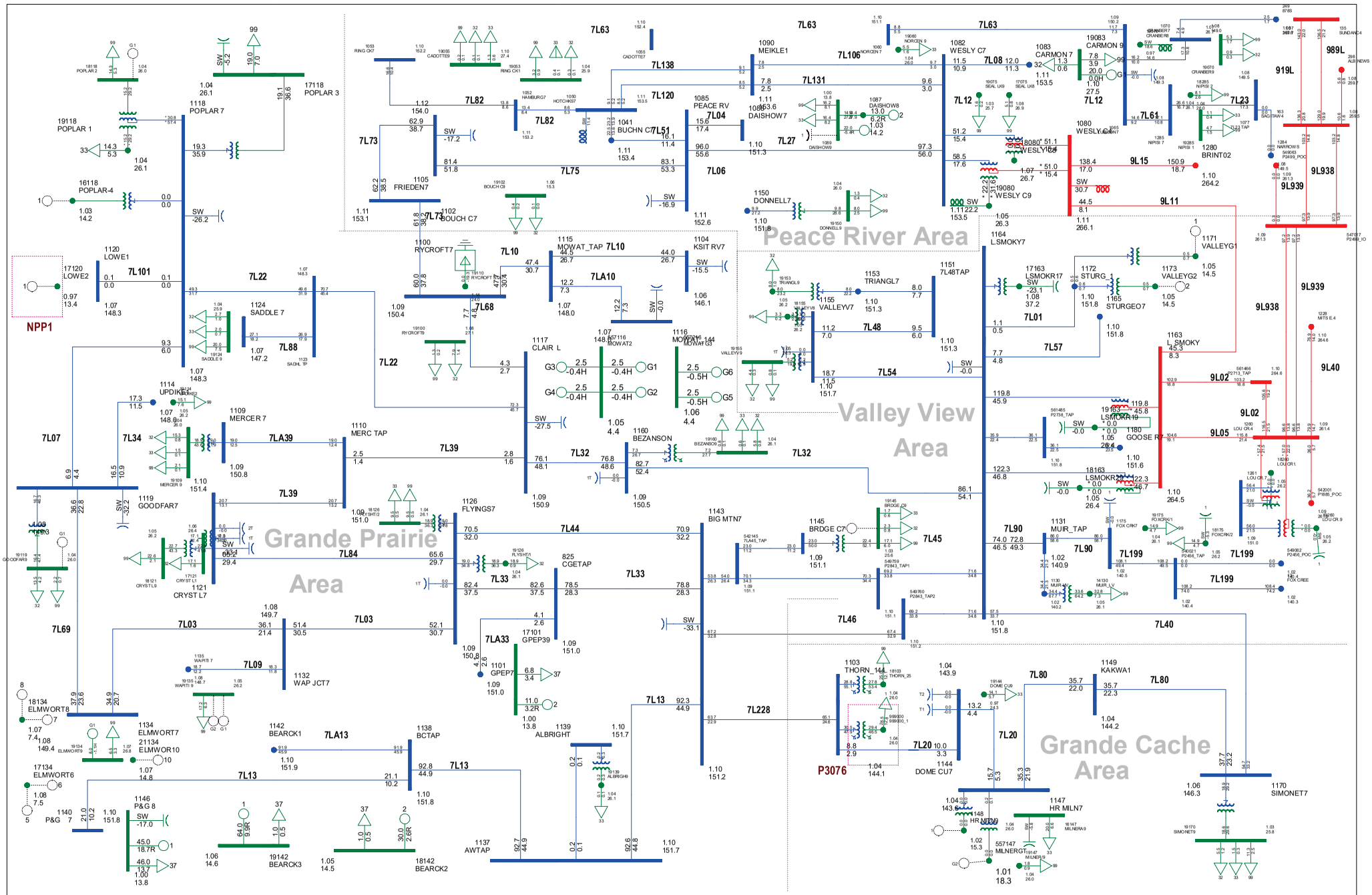


P3076
ATCO Thornton Capacity Addition

CATEGORY A, N-0
SCN3_2029 SP_MAIN_NOTMR
THU, MAY 28 2026 13:20
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

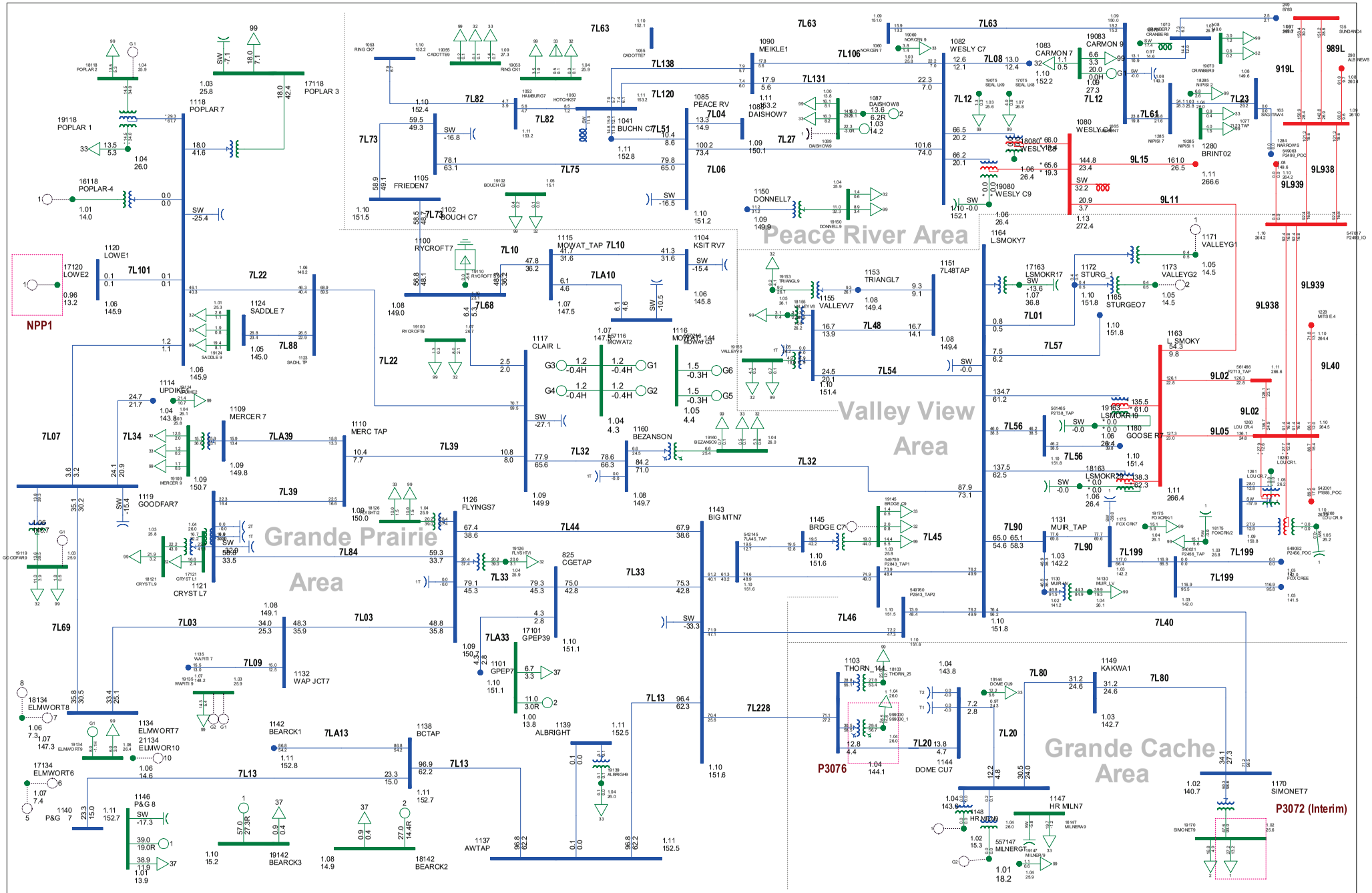
A5-1



P3076
ATCO Thornton Capacity Addition

CATEGORY A, N-0
SCN4_2029 WP_MAIN_NOTMR
THU, MAY 28 2026 13:22
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

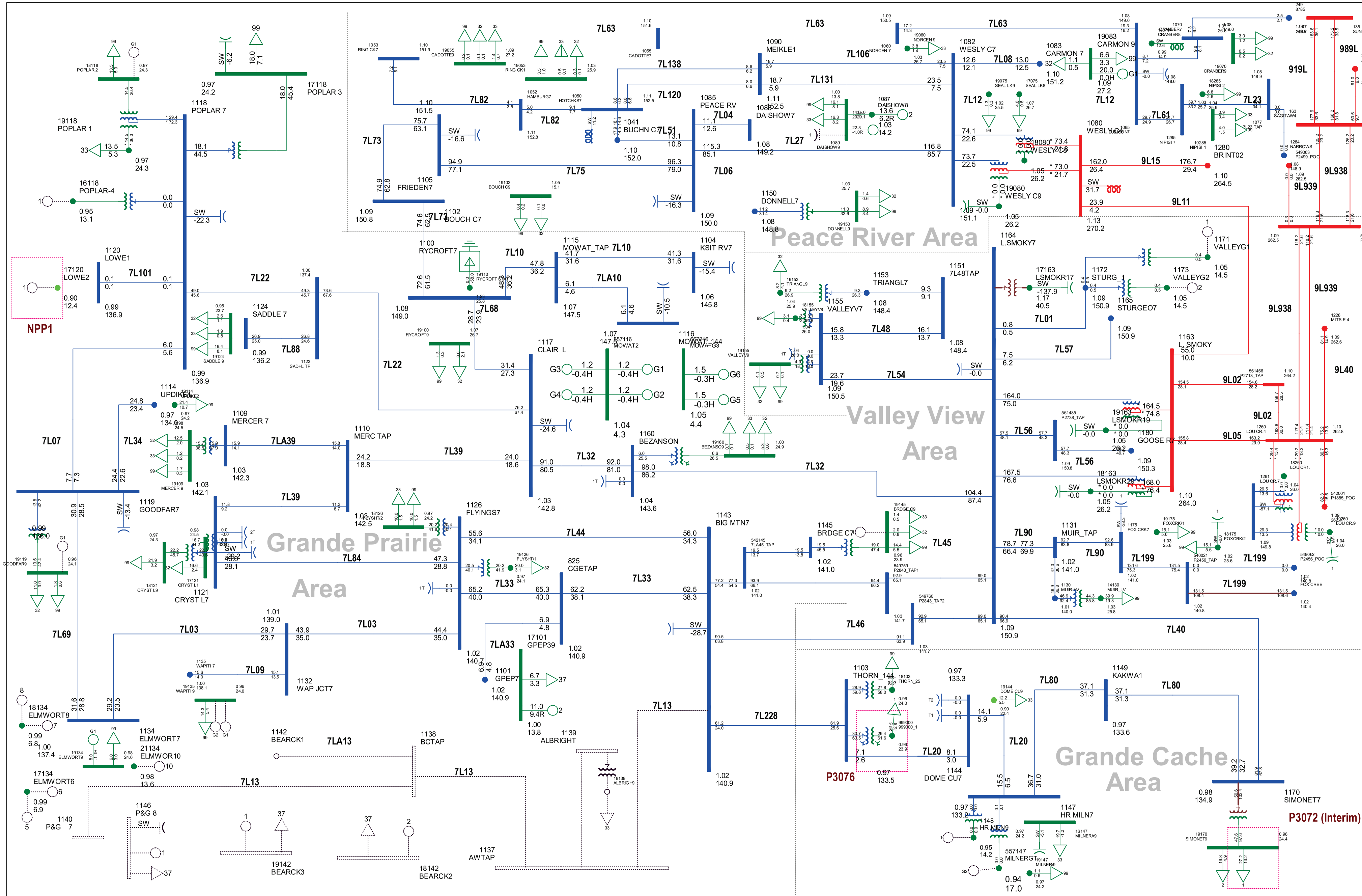


P3076
ATCO Thornton Capacity Addition

CATEGORY A, N-0
SCN8_2029 SP_SENSITIVITY_NOTMR
THU, MAY 28 2026 12:58
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A5-3

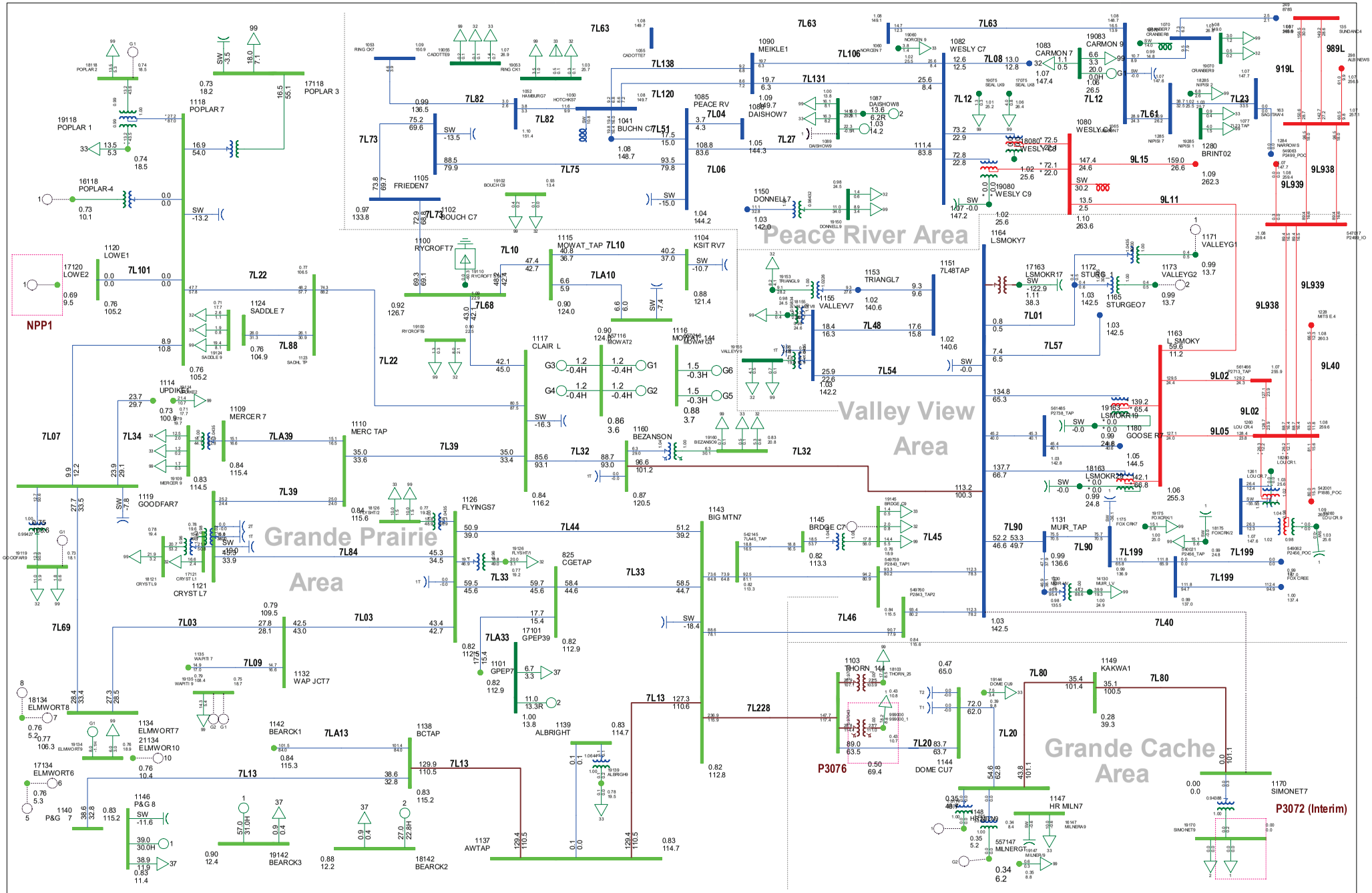


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L13 (BIG MOUNTAIN 845S - PROCTER & GAMB
SCN8_2029 SP_SENSITIVITY_NOTMR
THU, MAY 28 2026 12:58
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A5-4

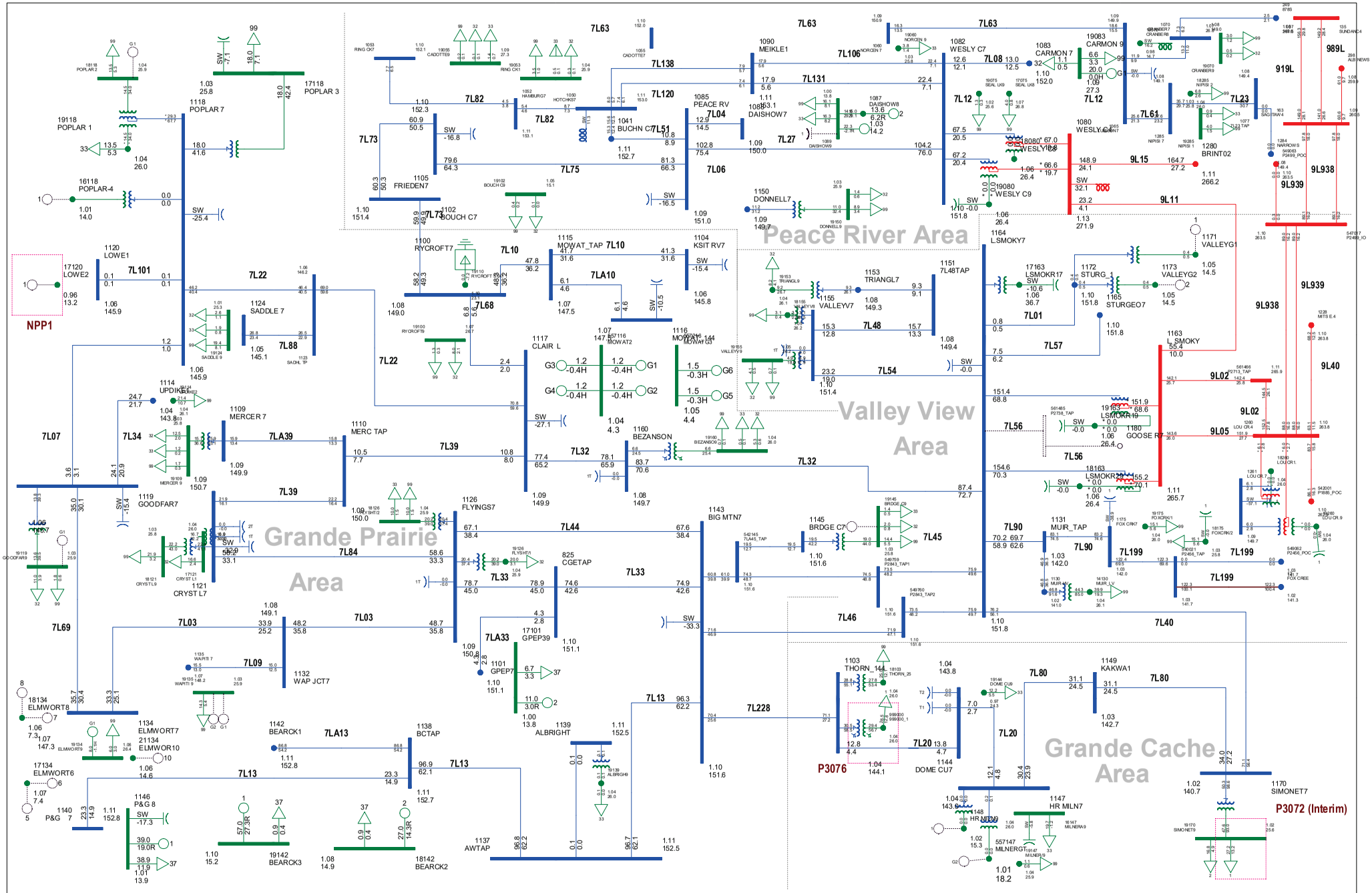


P3076

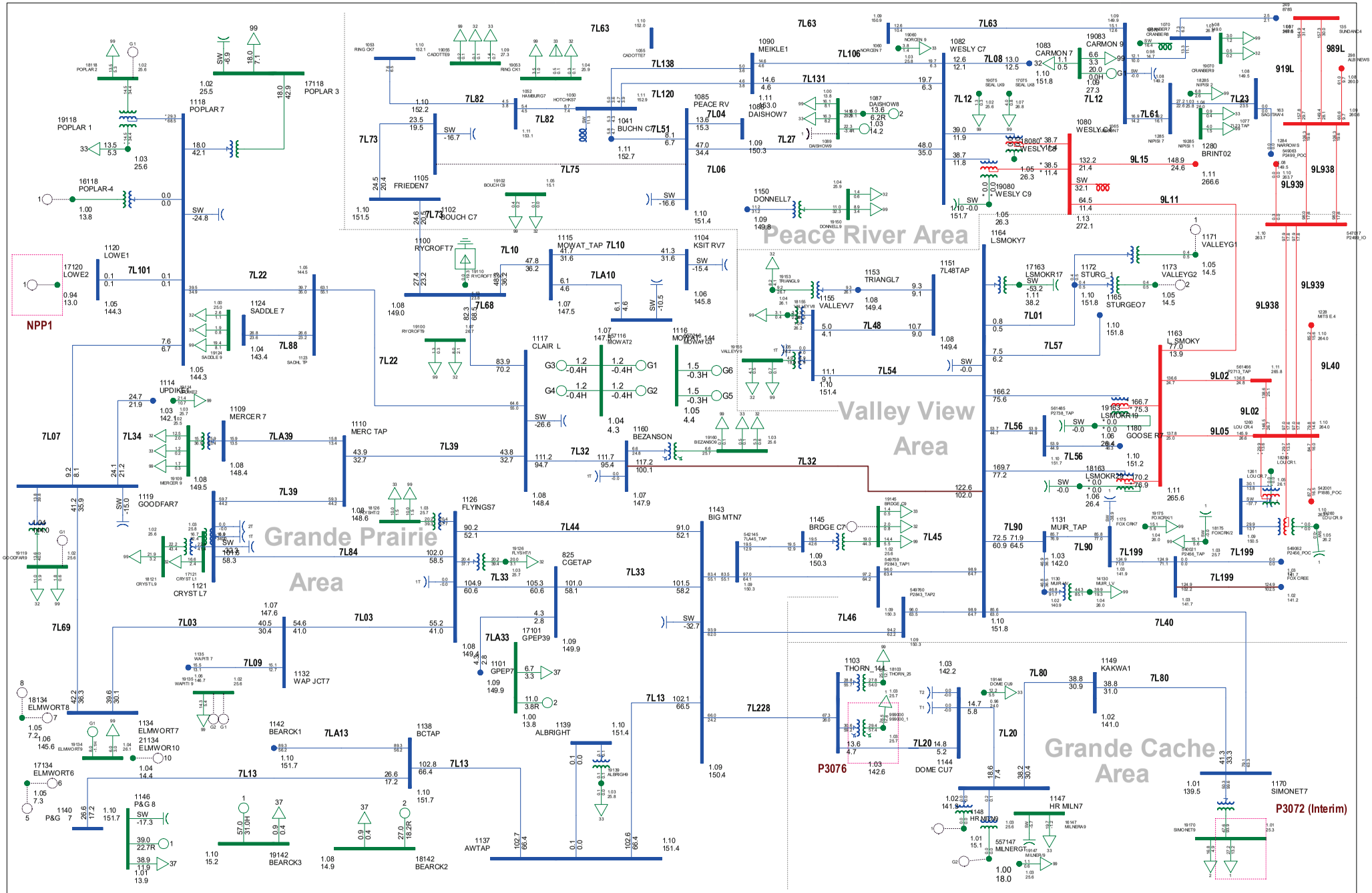
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L40 (L.Smoky 813S - Simonette 733S)
SCN8_2029 SP_POST_SENSITIVITY_NOTMR FRI, MAY 29 2026 7:33
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



P3076 **ATCO Thornton Capacity Addition**	**CATEGORY B, LOSS OF 7L56 (LITTLE SMOKY 813S - LOUISE CREEK 8** **SCN8_2029 SP_SENSITIVITY_NOTMR** **THU, MAY 28 2026 12:58** **New Diagram**	Bus - Voltage (kV/pu) Branch - MVA/% RATE1 Equipment - MW/Mvar 100.0%RATE1 1.350OV 0.940UV kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

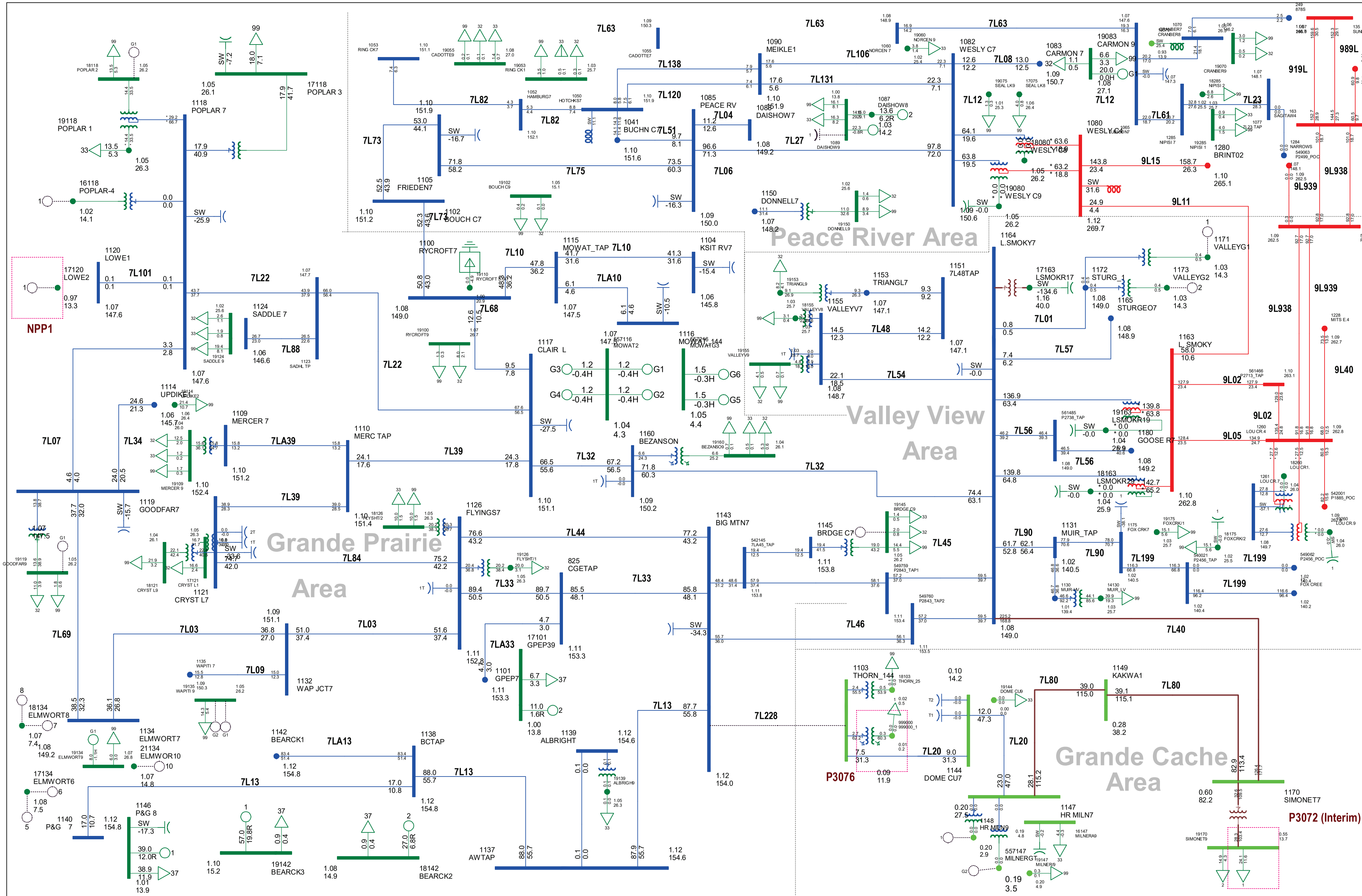


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L75 (FRIEDNESTAL 800S - WEST PEACE RIVE
SCN8_2029 SP_SENSITIVITY_NOTMR
THU, MAY 28 2026 12:58
New Diagram

A5-7

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

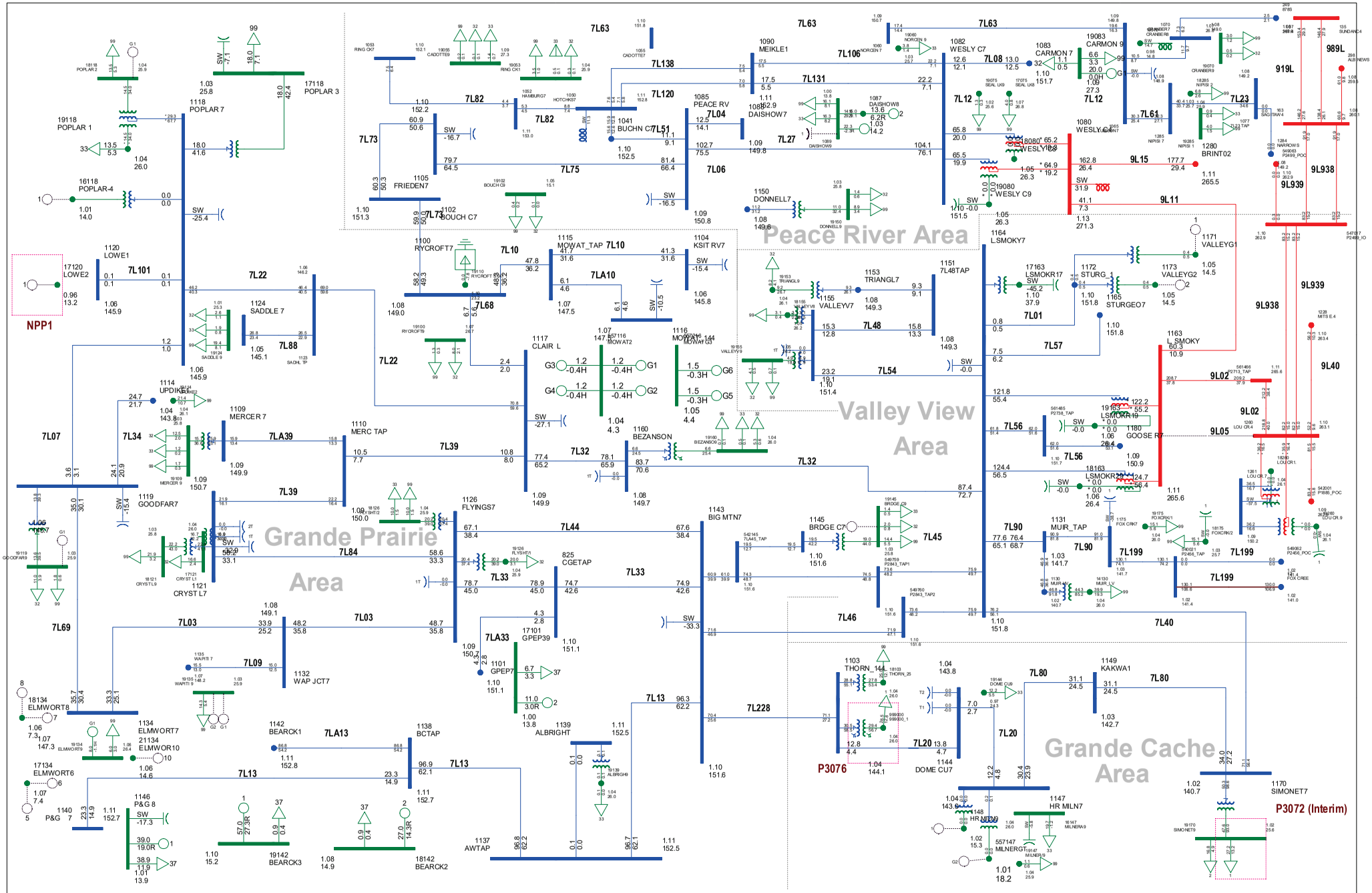


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L228 (BIG MOUNTAIN 845S - THORNTON 2091
SCN8_2029 SP_SENSITIVITY_NOTMR
THU, MAY 28 2026 12:58
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

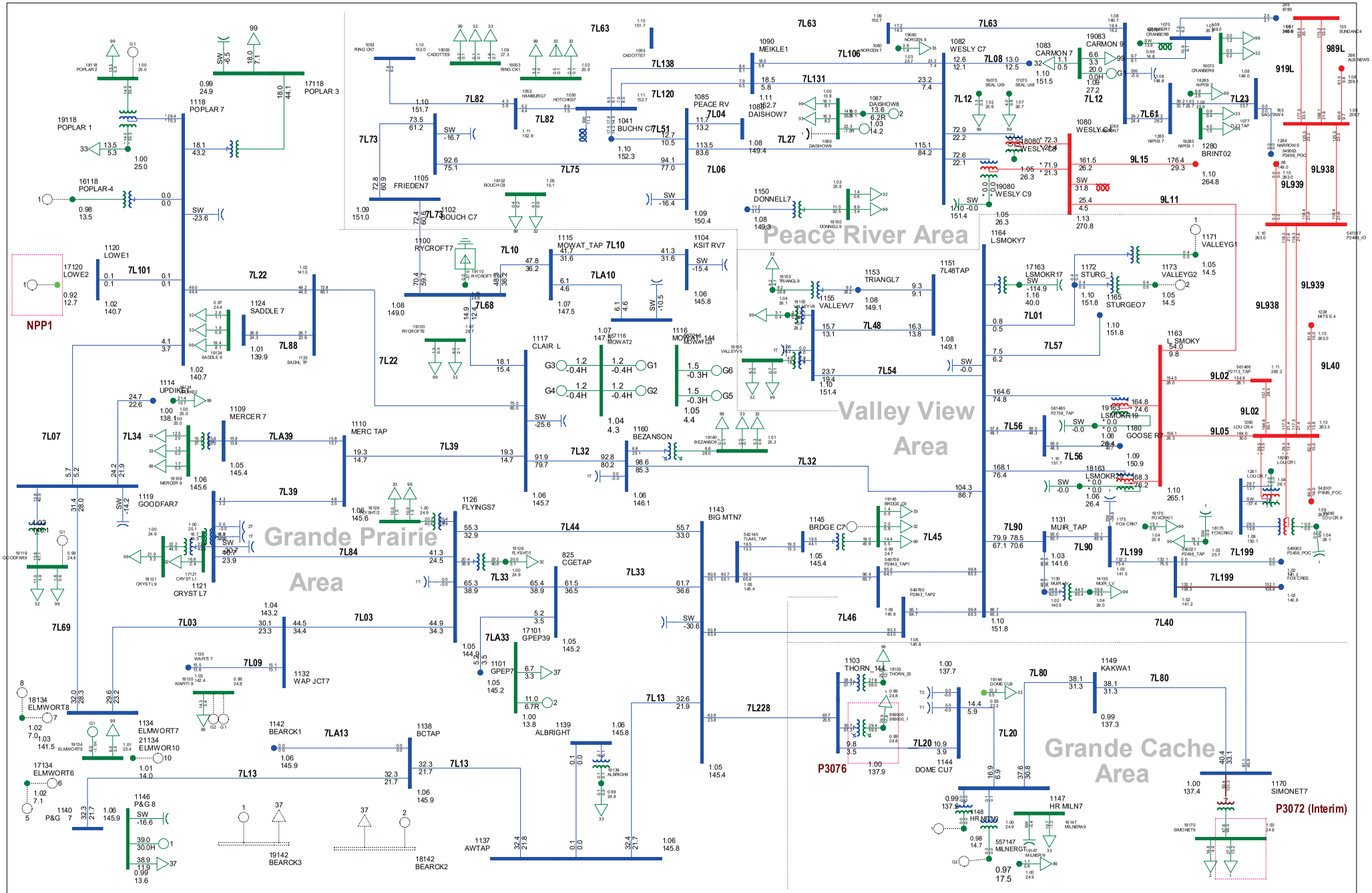
A5-8



P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 9L05 (LITTLE SMOKY 813S - LOUISE CREEK 8
SCN8_2029 SP_SENSITIVITY_NOTMR
THU, MAY 28 2026 12:58
New Diagram

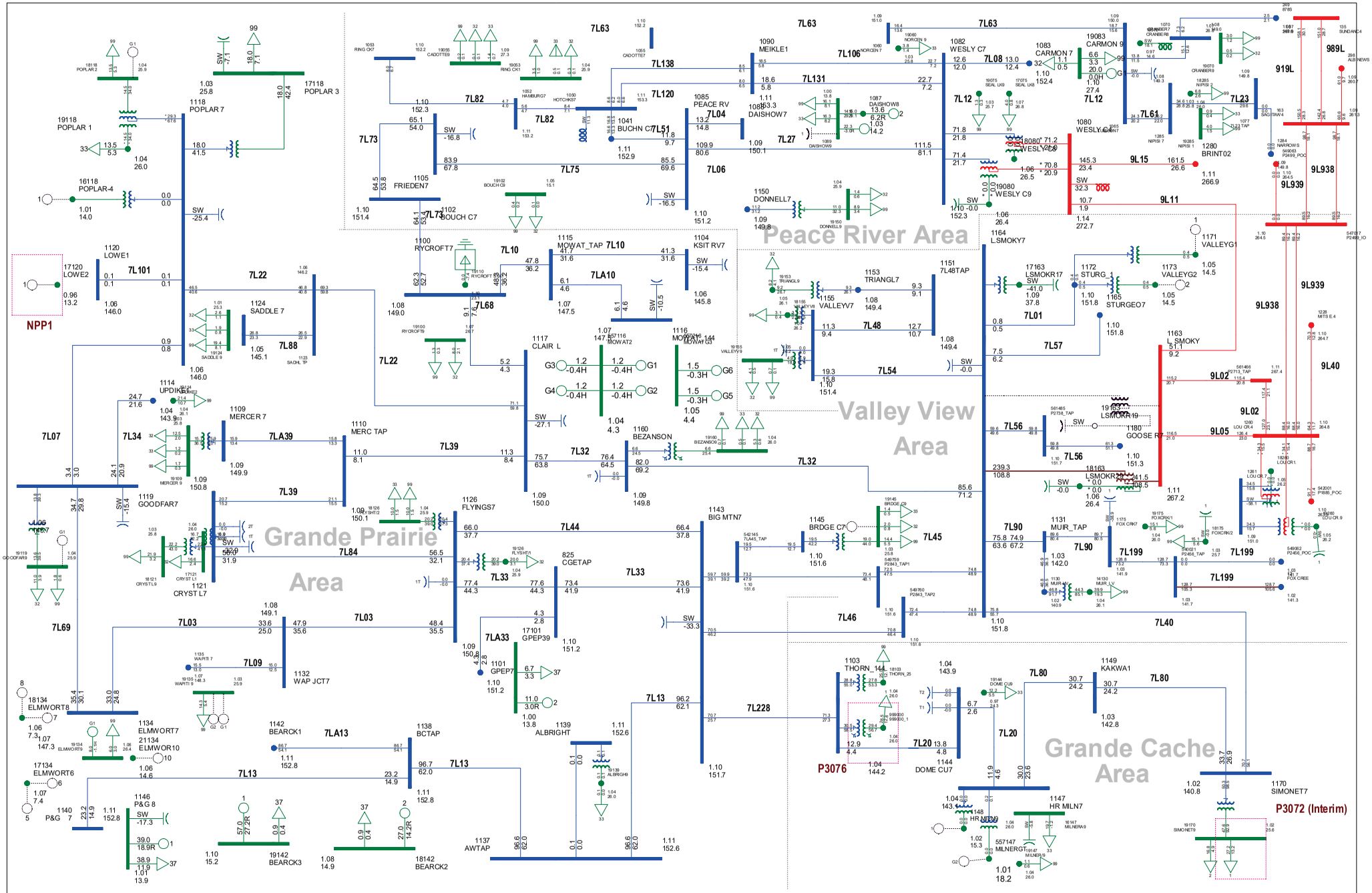
Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF BEAR CREEK 679S 701T
SCN8_2029 SP_SENSITIVITY_NOTMR
THU, MAY 28 2026 12:58
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

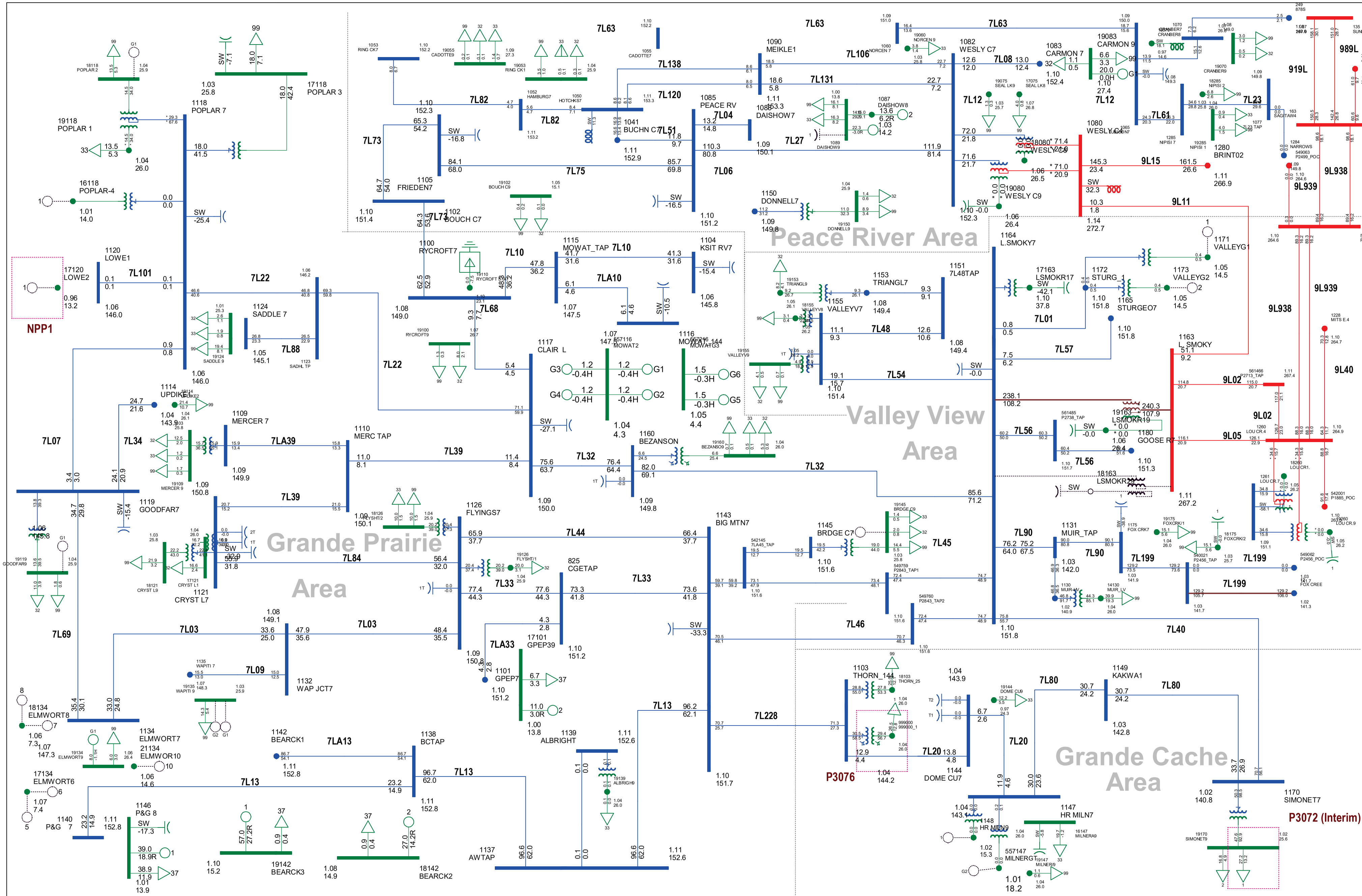


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF LITTLE SMOKY 813S 901T
SCN8_2029 SP_SENSITIVITY_NOTMR
THU, MAY 28 2026 12:58
New Diagram

A5-11

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

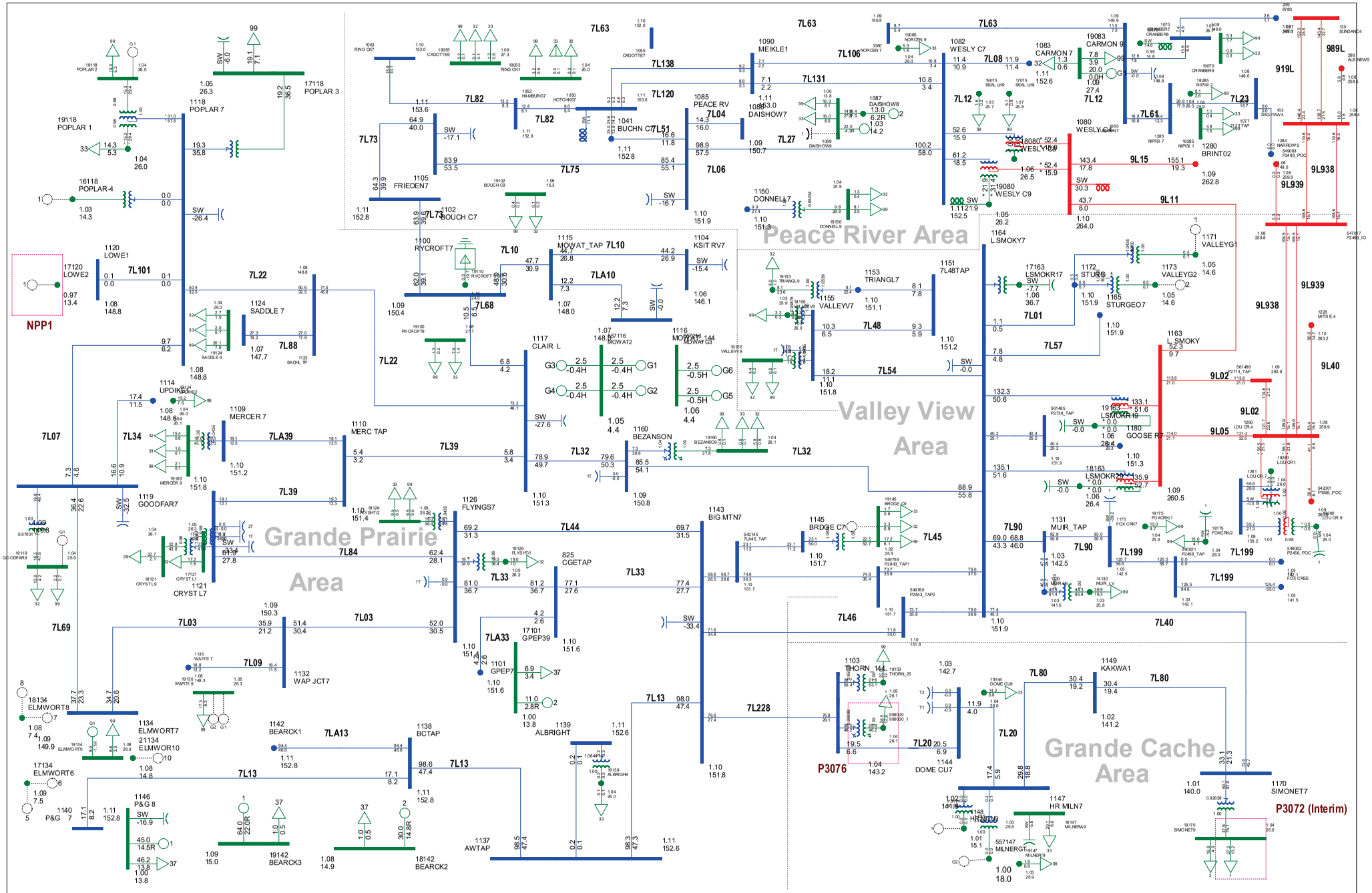


P3076
ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF LITTLE SMOKY 813S 902T
SCN8_2029 SP_SENSITIVITY_NOTMR
THU, MAY 28 2026 12:58
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A5-12



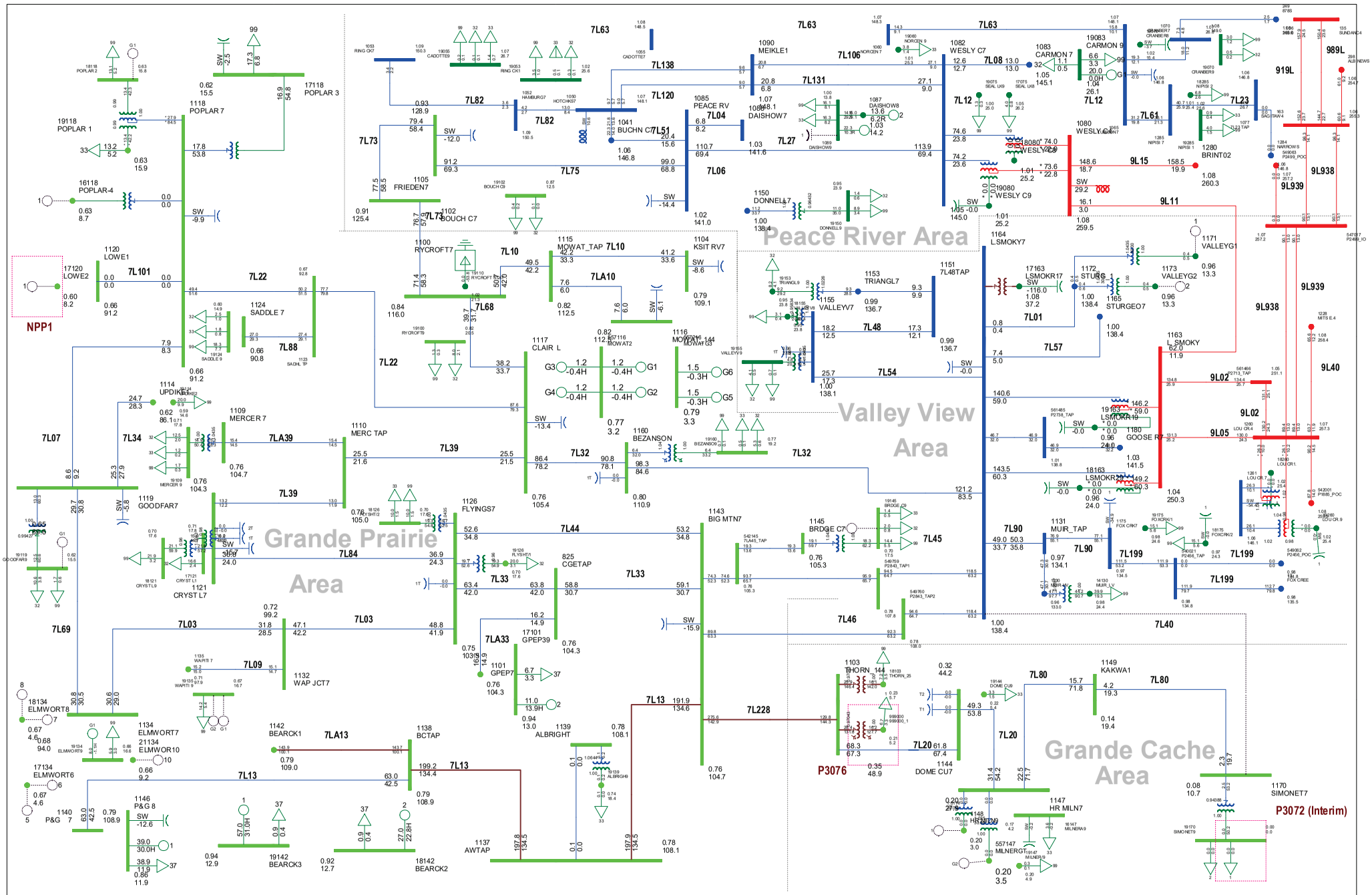
P3076

ATCO Thornton Capacity Addition

CATEGORY A, N-0
SCN9_2029 WP_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:03
New Diagram

A5-13

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

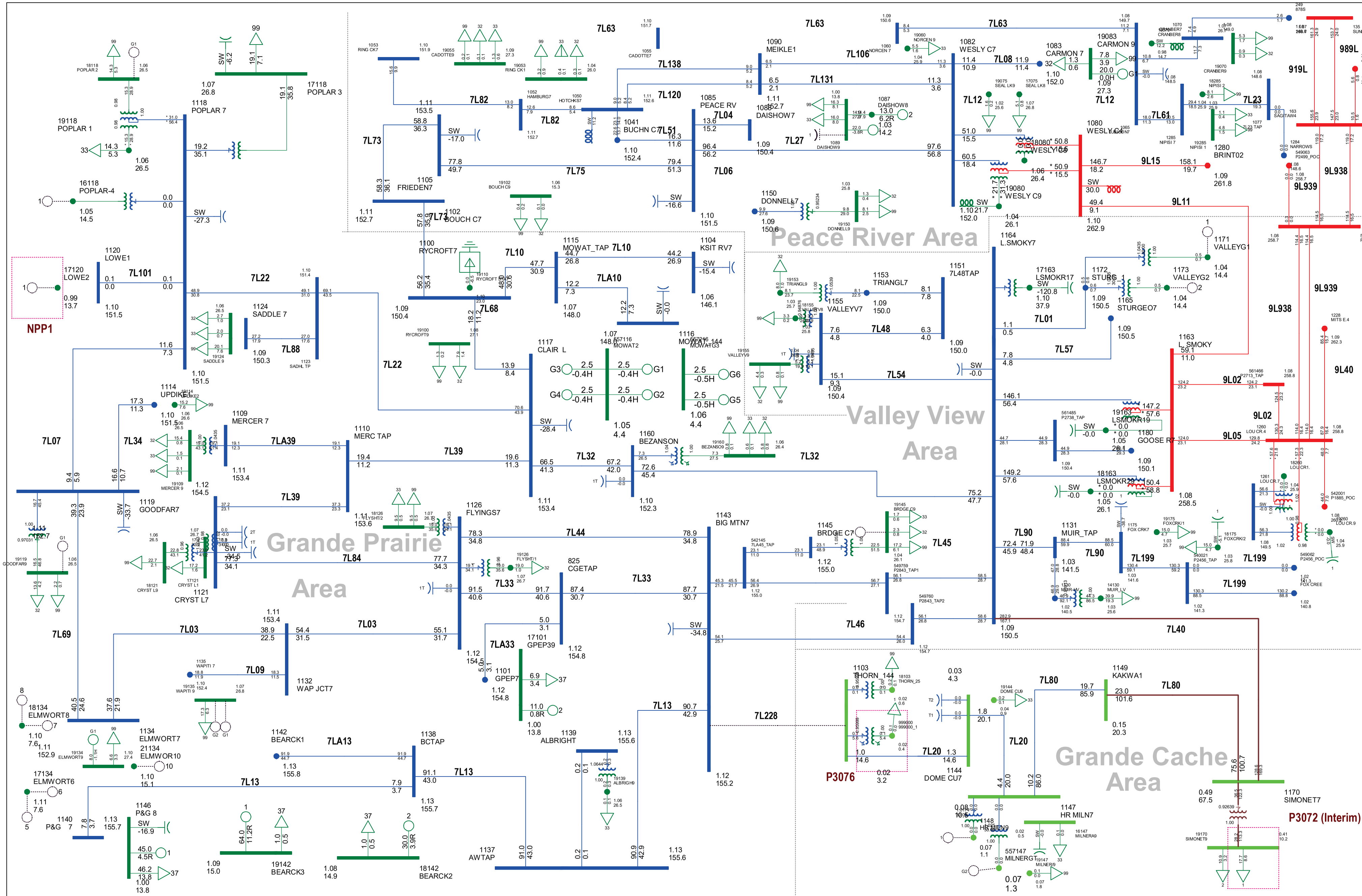


P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L40 (L.Smoky 813S - Simonette 733S)
SCN9_2029 WP_POST_SENSITIVITY_NOTMR FRI, MAY 29 2026 7:34
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



P3076

ATCO Thornton Capacity Addition

CAT B, LOSS OF 7L228 (BIG MOUNTAIN 845S-THORNTON 2091S)
SCN9_2029 WP_SENSITIVITY_NOTMR
THU, MAY 28 2026 13:03
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A5-15

Attachment A6

Post-Project Voltage Stability Diagrams (Scenario 4, 9)

Scenario 4: P3076 2029 WP Post-Project

Voltage stability analysis was performed for scenario 4 by increasing load in Grande Cache (Area 22), Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 4 is 198 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 9.9 MW (0.05 x 198 MW = 9.9 MW) for the scenario 4.

Table 1 provides voltage stability study results under Category A condition and for the five (5) worst contingencies under Category B conditions. The voltage stability diagrams are provided in Figure 1. Based on the study results, the voltage stability margin was met for all studied conditions.

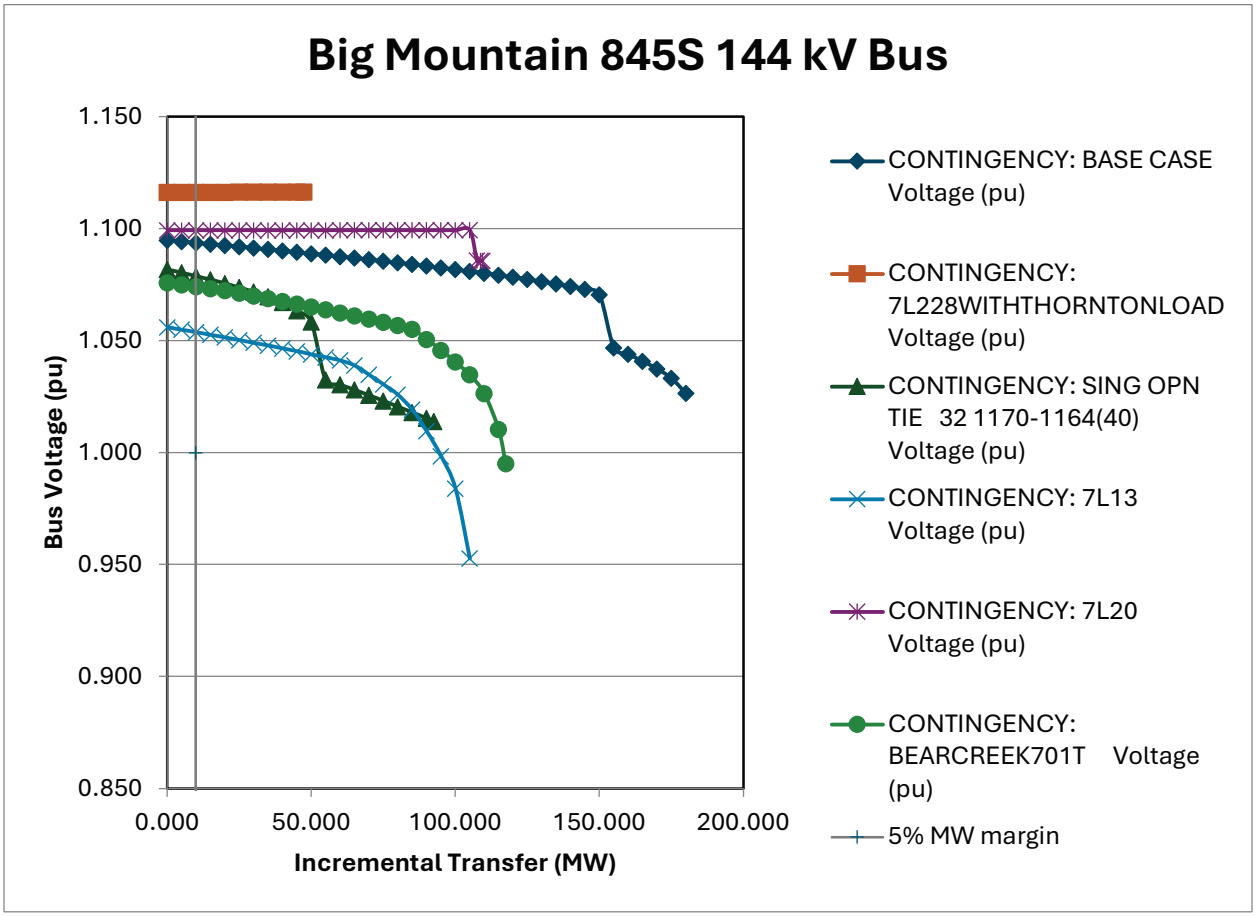
The following Buses were selected for the study:

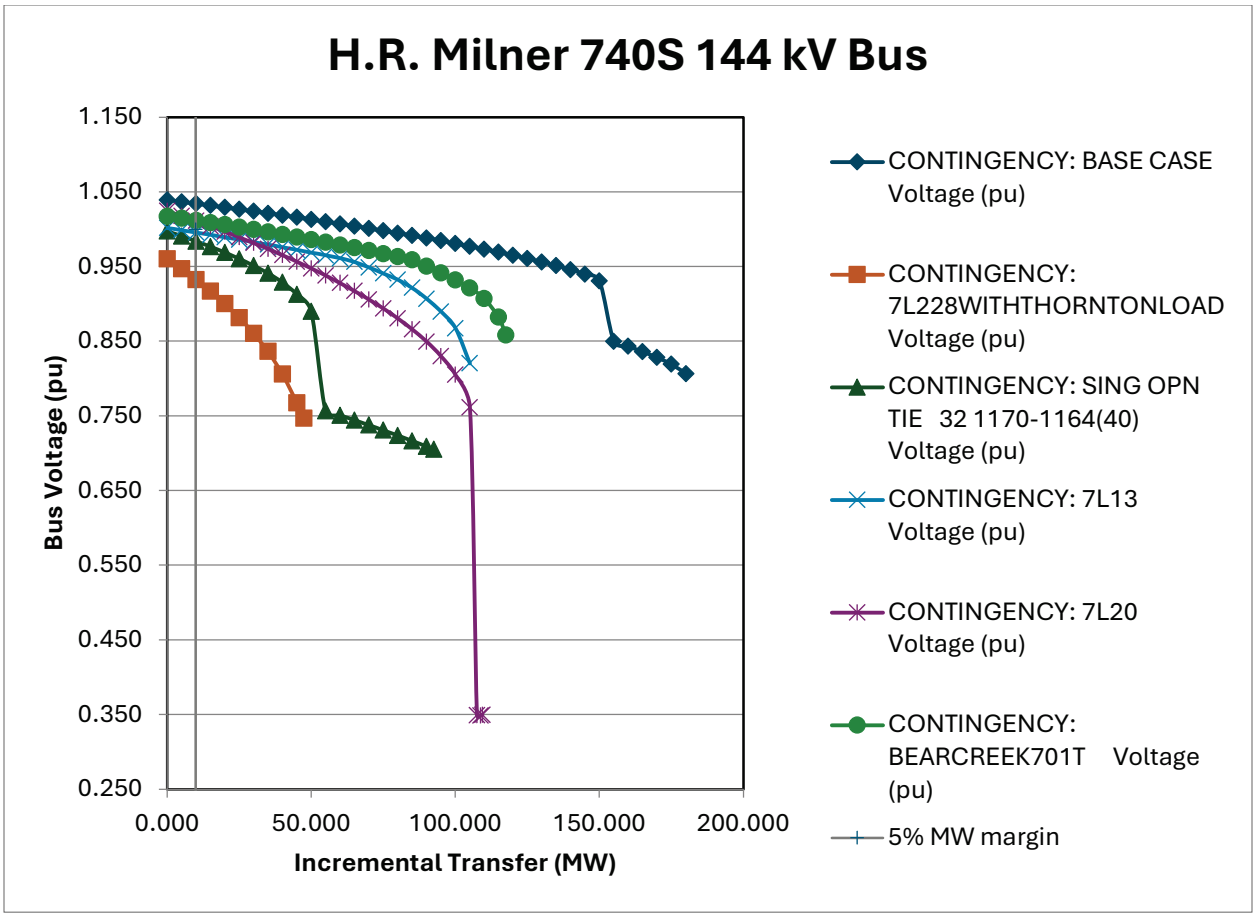
- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

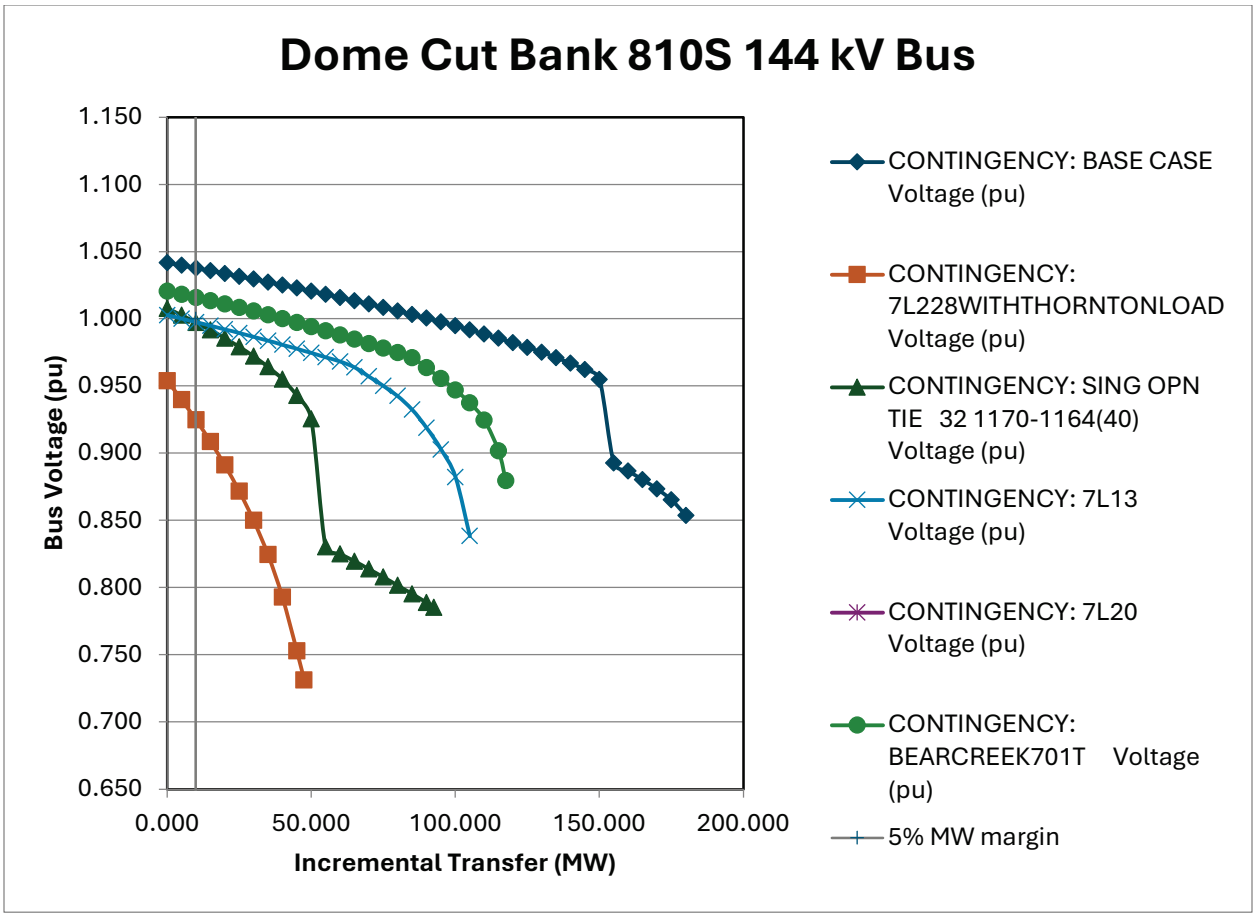
Table 1: Summary of Results under Category B Conditions for Scenario 4

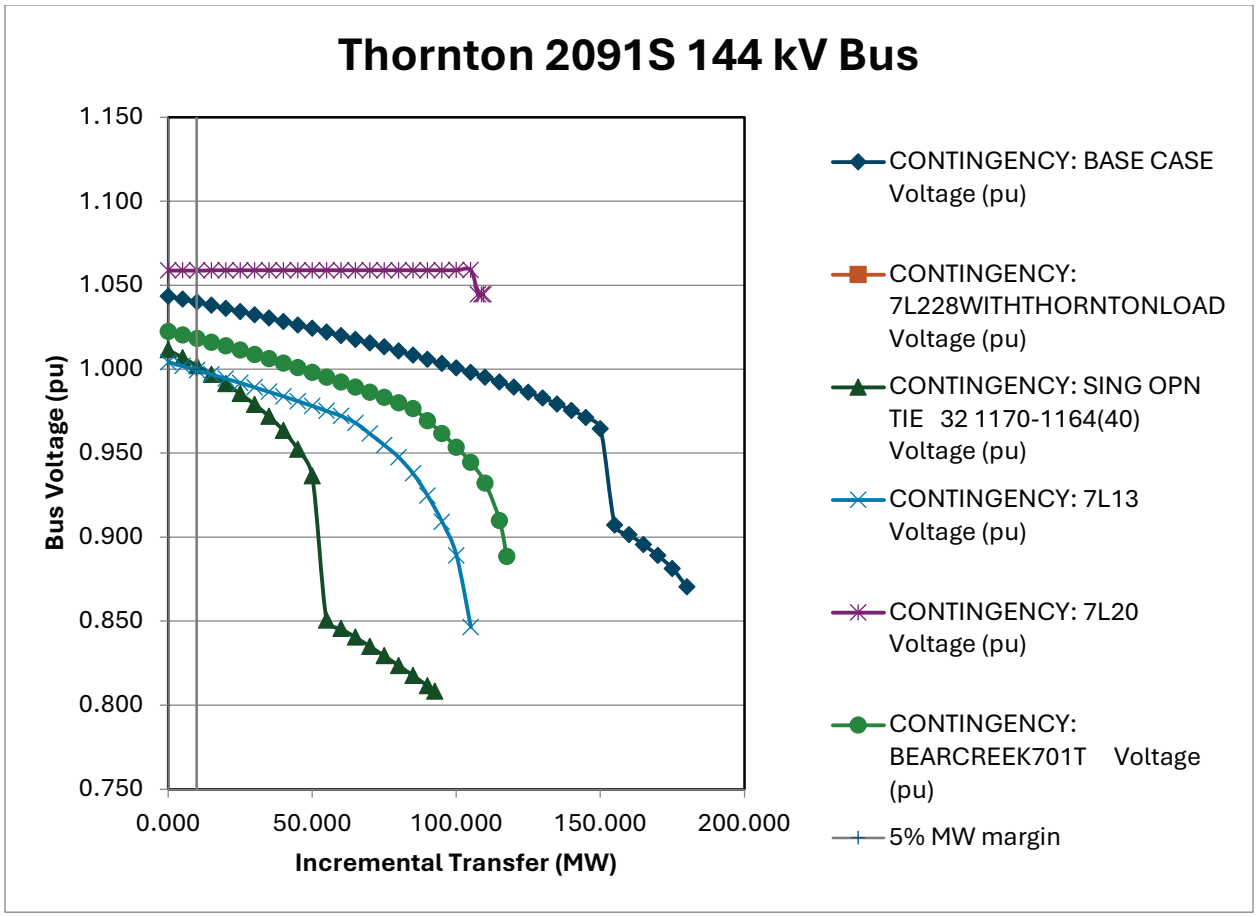
Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		180	Yes
7L228	Big Mountain 845S	Thornton 2091S	47.5	Yes
7L40	Little Smoky 813S	Simonette 733S	92.5	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	105	Yes
7L20	HR Milner 740S	Thornton 2091S	109.4	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		117.5	Yes

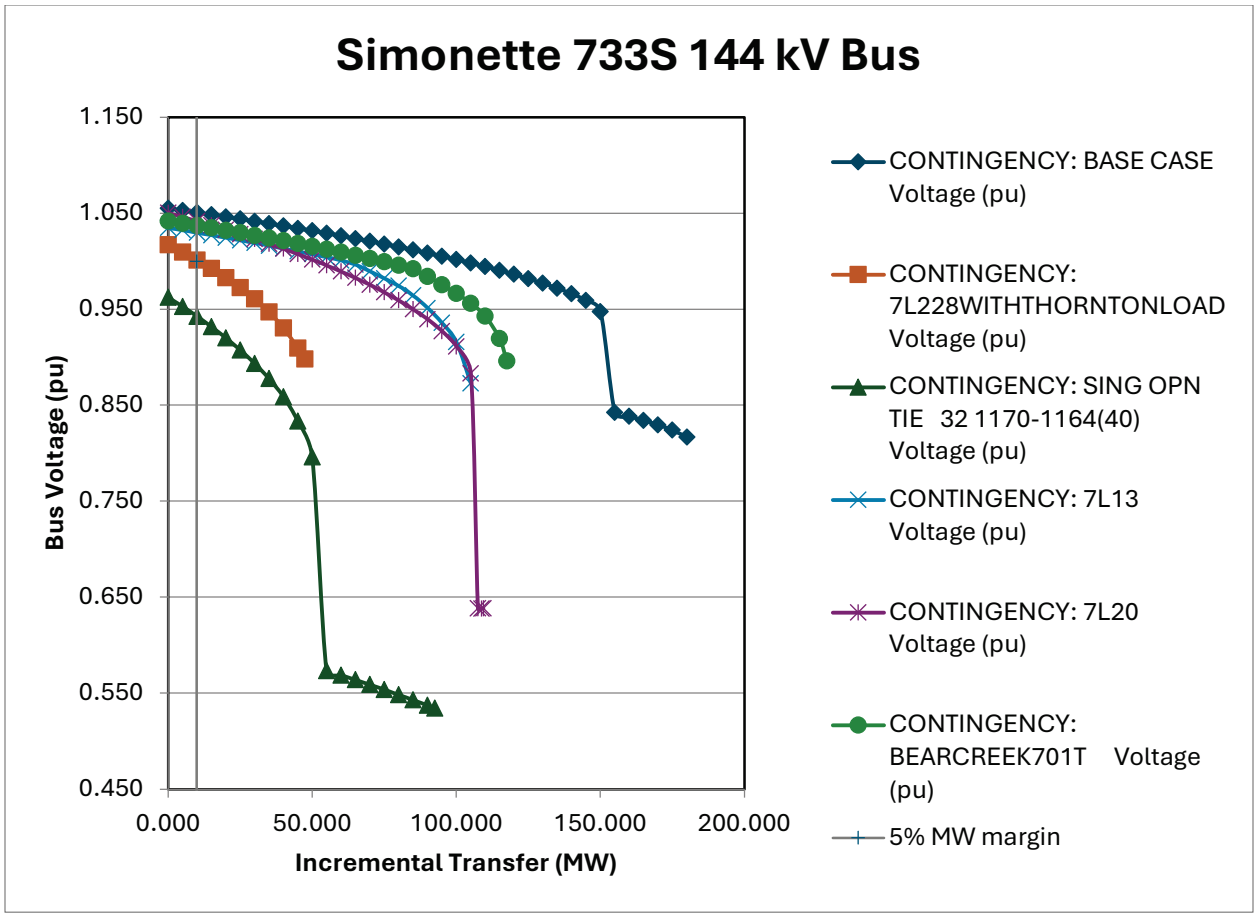
Figure 1:
Scenario 4: 2029_WP_POST-PROJECT




H.R. Milner 740S 144 kV Bus
1.150
1.050
0.950
0.850
0.750
0.650
0.550
0.450
0.350
0.250
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD Voltage (pu)
CONTINGENCY: SING OPN TIE 32 1170-1164(40) Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Dome Cut Bank 810S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD Voltage (pu)
CONTINGENCY: SING OPN TIE 32 1170-1164(40) Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Thornton 2091S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD Voltage (pu)
CONTINGENCY: SING OPN TIE 32 1170-1164(40) Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Simonette 733S 144 kV Bus
1.150
1.050
0.950
0.850
0.750
0.650
0.550
0.450
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD Voltage (pu)
CONTINGENCY: SING OPN TIE 32 1170-1164(40) Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin

Scenario 9: P3076_P3072 2029 WP Post-Project (Sensitivity)

Voltage stability analysis was performed for scenario 9 by increasing load in Grande Cache (Area 22), Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 9 is 232 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 11.6 MW (0.05 x 232 MW = 11.6 MW) for the scenario 9.

Table 2 provides voltage stability study results under Category A condition and for the five (5) worst contingencies under Category B conditions. The voltage stability diagrams are provided in Figure 2. Based on the study results, the voltage stability margin was not met for the following contingencies of 7L40 and 7L228.

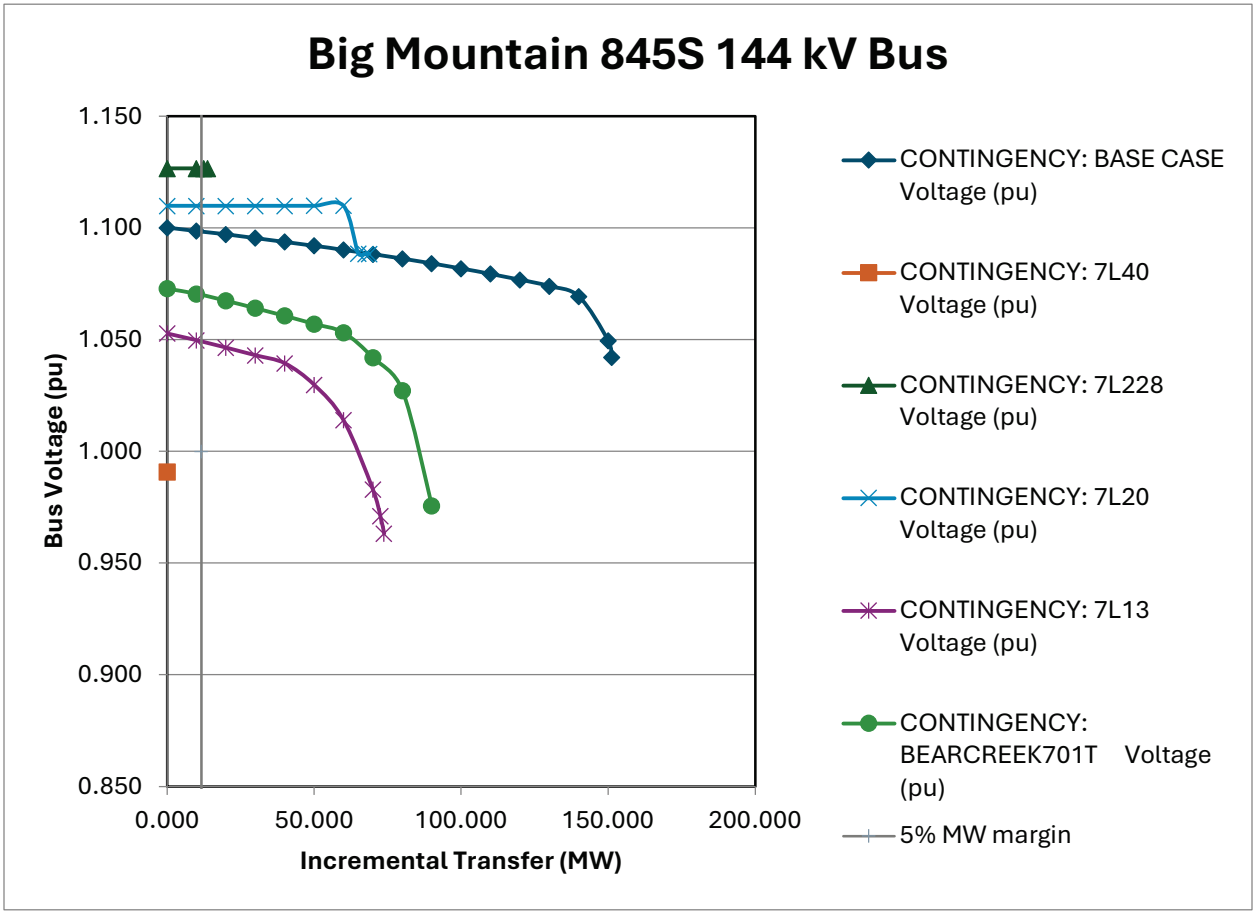
The following Buses were selected for the study:

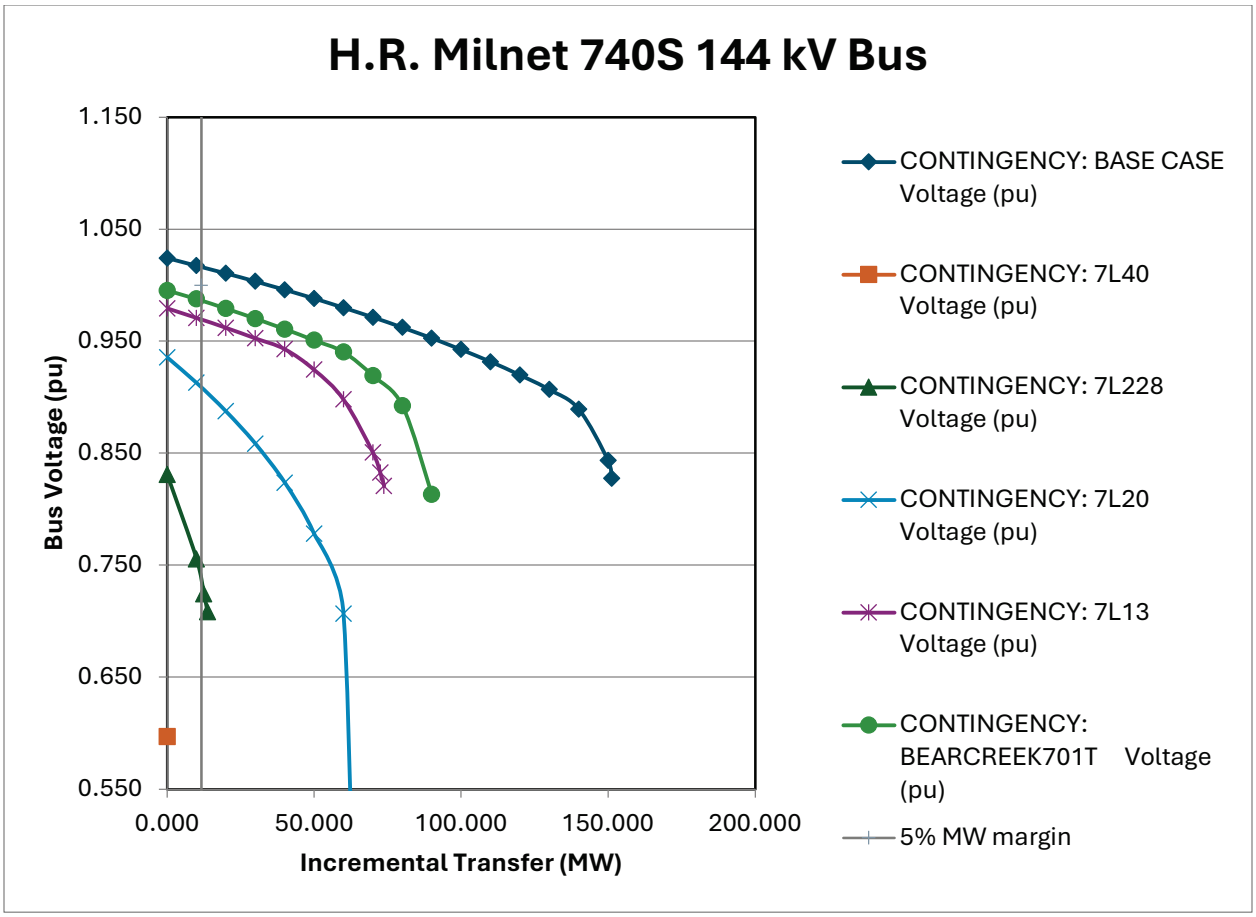
- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

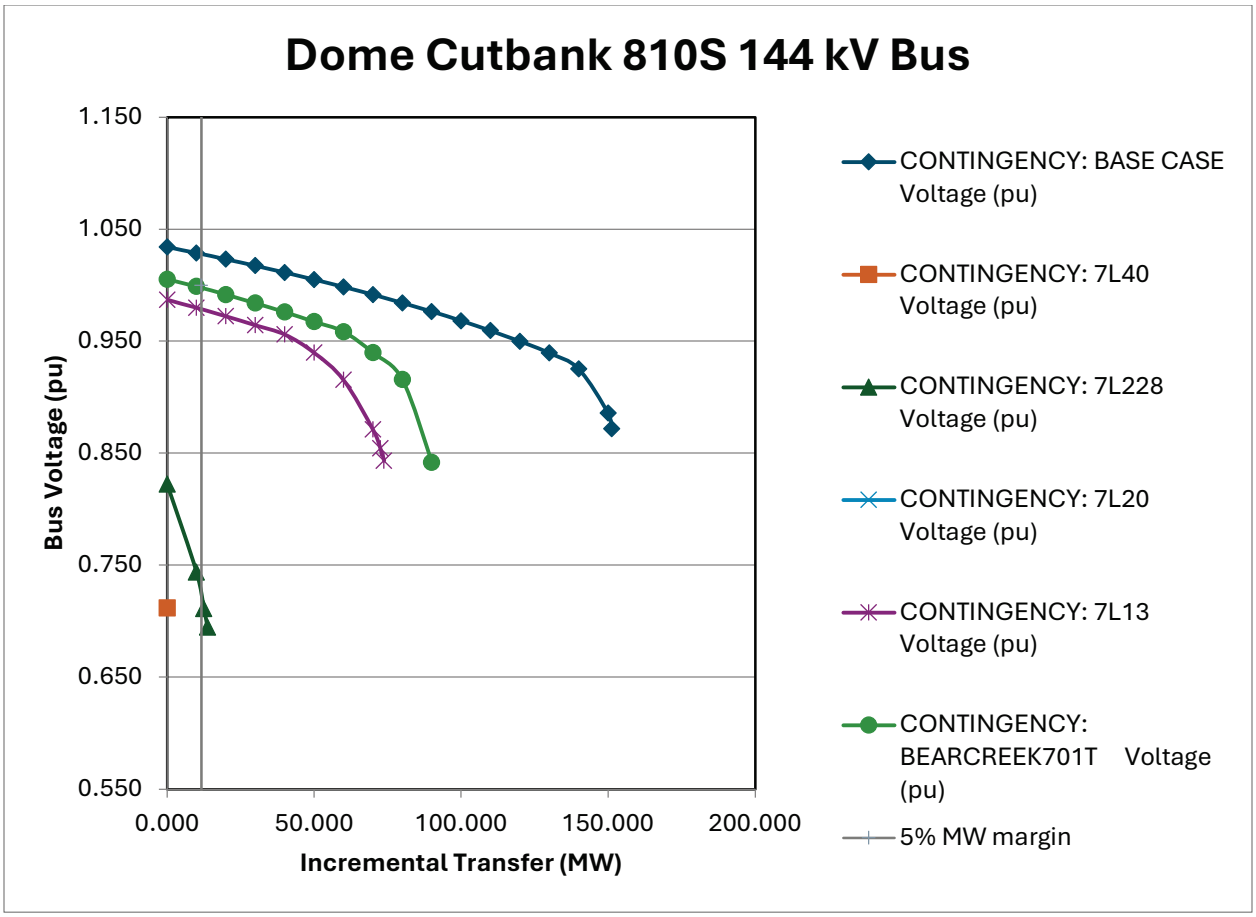
Table 2: Summary of Results under Category B Conditions for Scenario 9

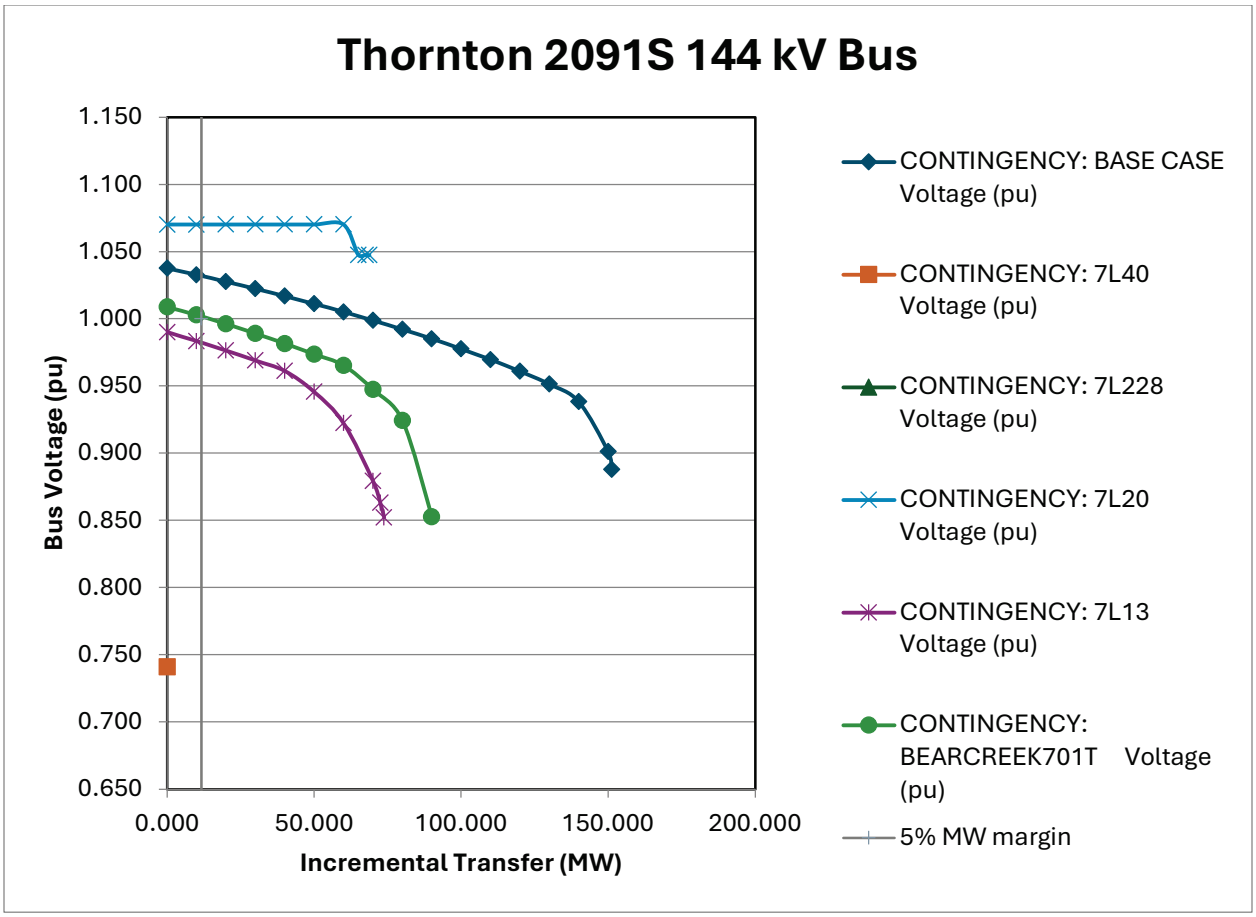
Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		151.3	Yes
7L228	Thornton 2091S	Big Mountain 845S	0	No
7L40	Little Smoky 813S	Simonette 733S	0	No
7L20	Thornton 2091S	HR Milner 740S	68.8	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	73.8	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		90	Yes

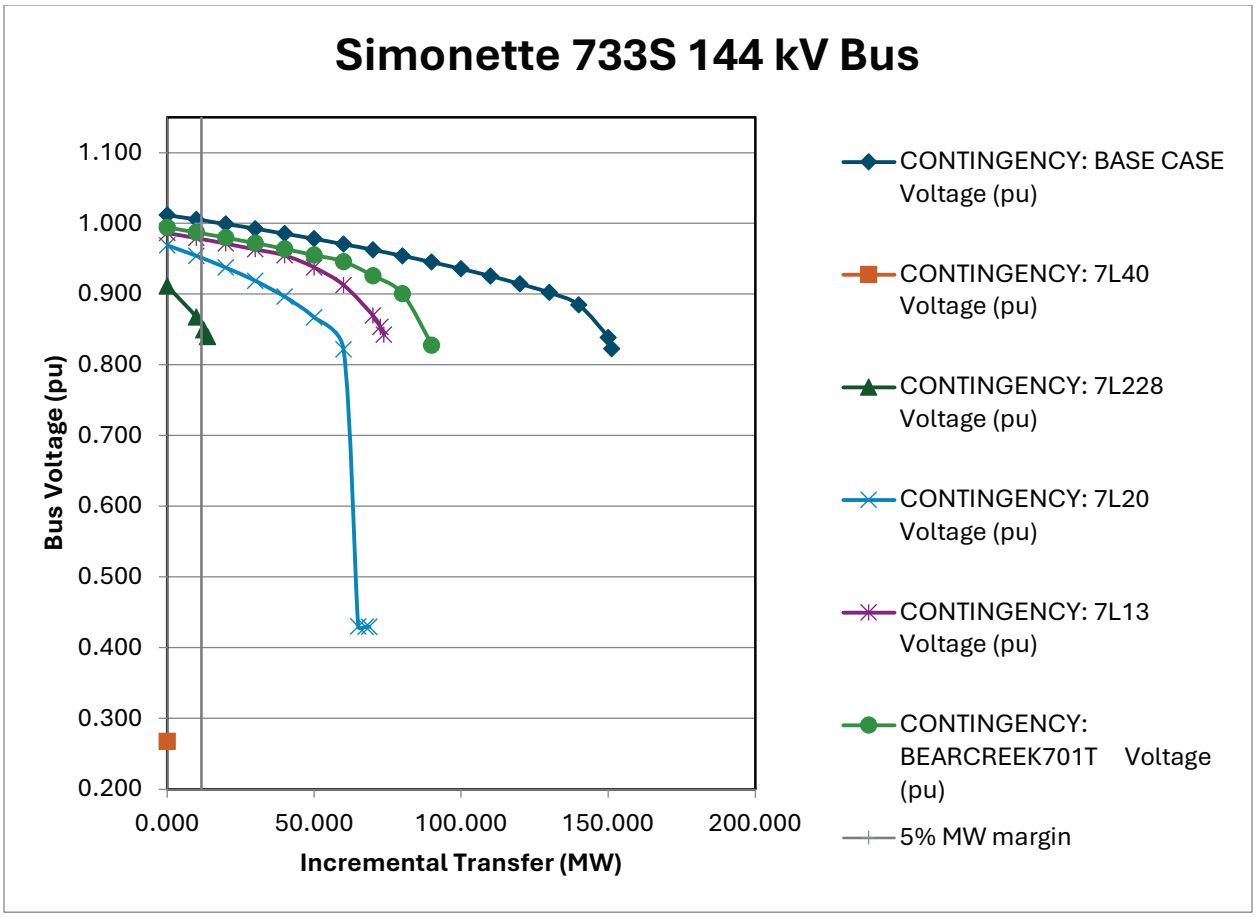
Figure 2:
Scenario 9: 2029_WP_POST-PROJECT (Sensitivity)




H.R. Milnet 740S 144 kV Bus
1.150
1.050
0.950
0.850
0.750
0.650
0.550
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Dome Cutbank 810S 144 kV Bus
1.150
1.050
0.950
0.850
0.750
0.650
0.550
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Thornton 2091S 144 kV Bus
Bus Voltage (pu)
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Simonette 733S 144 kV Bus
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin

Attachment A7
Post-Project Transient Stability Diagrams
(Scenario 4, 9)

Transient Stability Diagrams for Scenario 4 2029 WP Post-Project

Transient stability analysis was performed using the Scenario 4 for the Category B contingencies as identified in Table A7-1 and Table A7-2.

Table A7-1: List of Contingencies Studied for Transient Stability – Scenario 4 2029 WP-Post Project Main study (with No TPR)

System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A7-1
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A7-2
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A7-3
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	A7-4
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)*	Big Mountain 845S	A7-5
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)*	Thornton 2091S	A7-6

*7L228 already has TPR

Table A7-2: List of Contingencies Studied for Transient Stability – Scenario 4 2029 WP-Post Project Main study (with TPR)

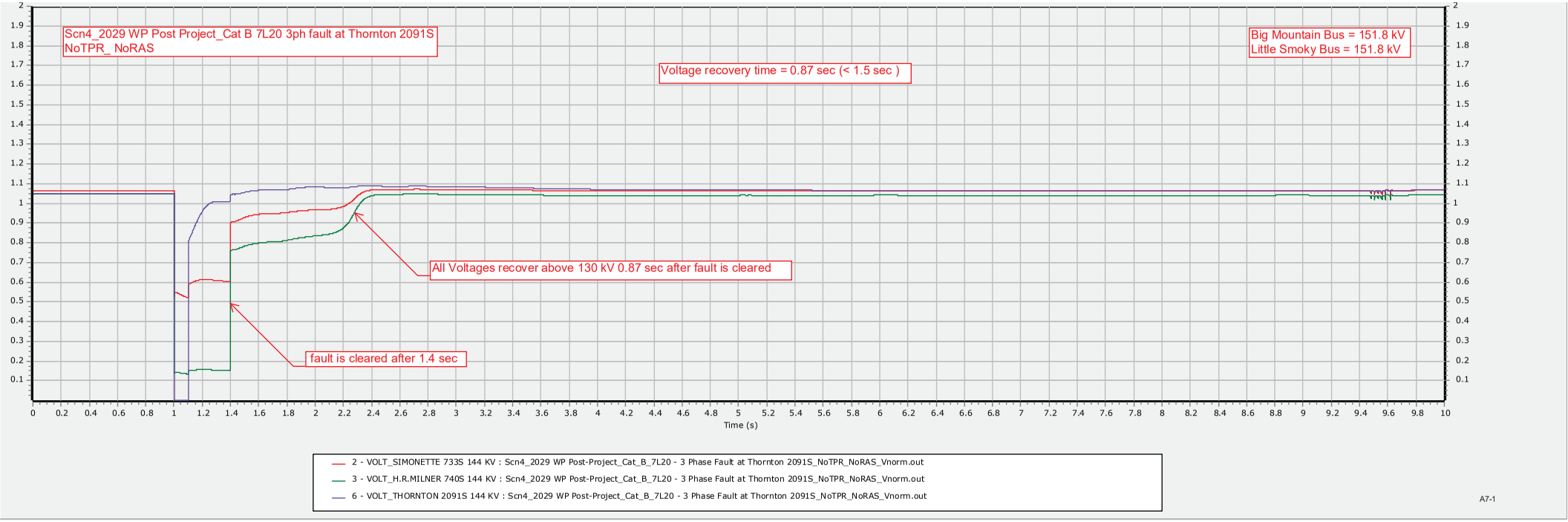
System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A7-7

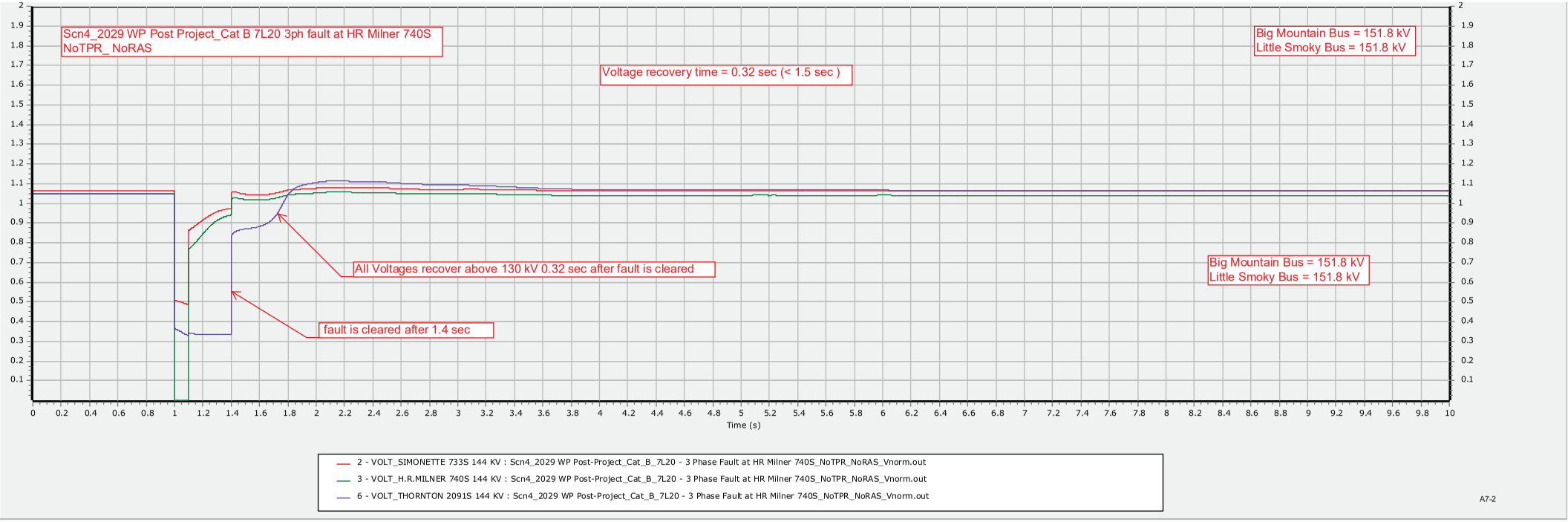
Transient Stability Diagrams for Scenario 9 2029 WP Post-Project

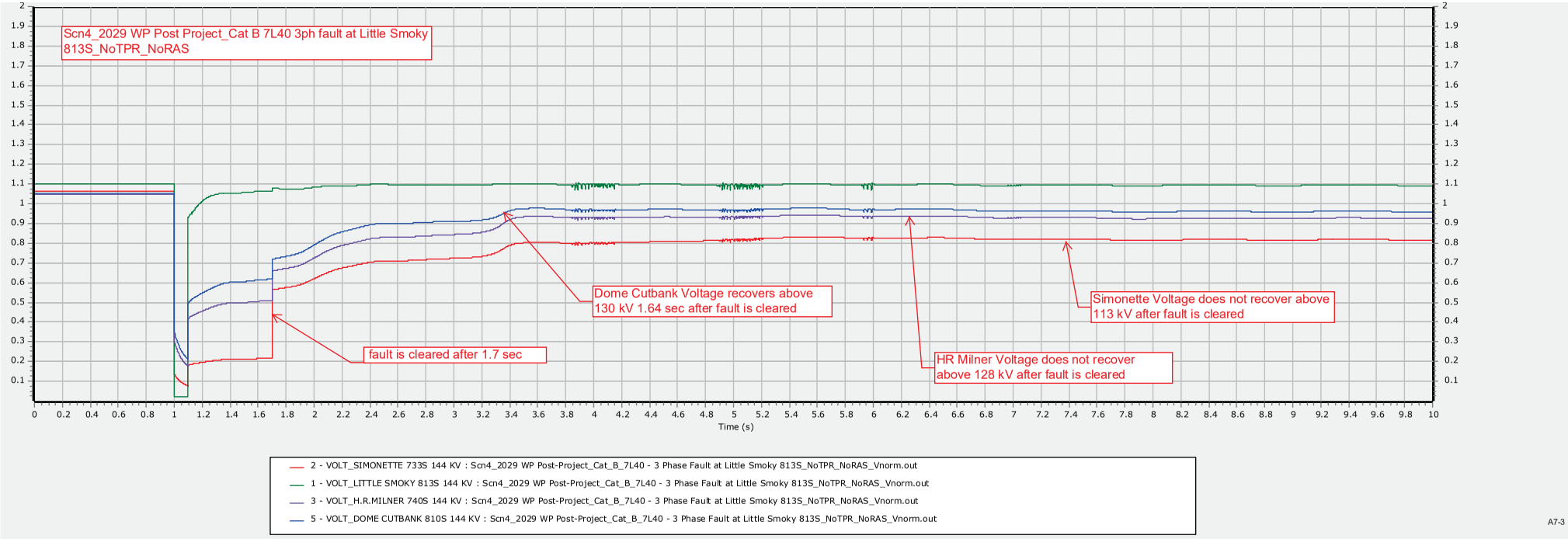
Transient stability analysis was performed using the Scenario 9 for the Category B contingencies as identified in Table A7-3.

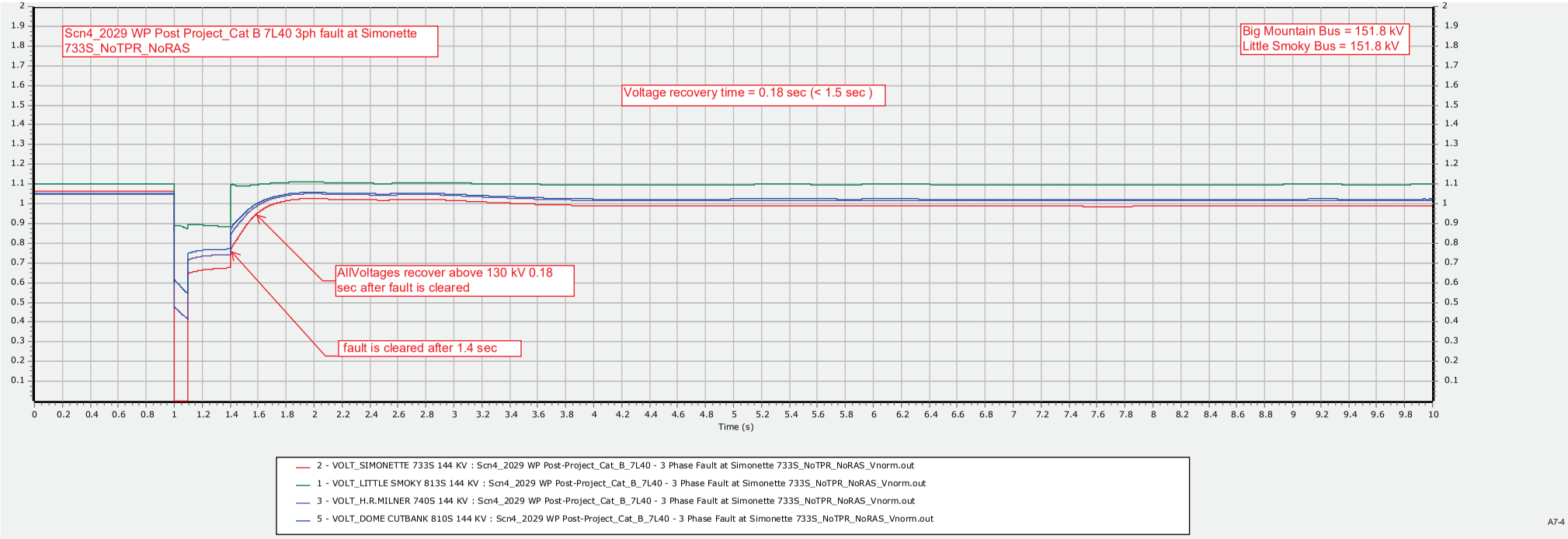
Table A7-3: List of Contingencies Studied for Transient Stability – Scenario 9 2029 WP-Post Project Sensitivity study (with No TPR)

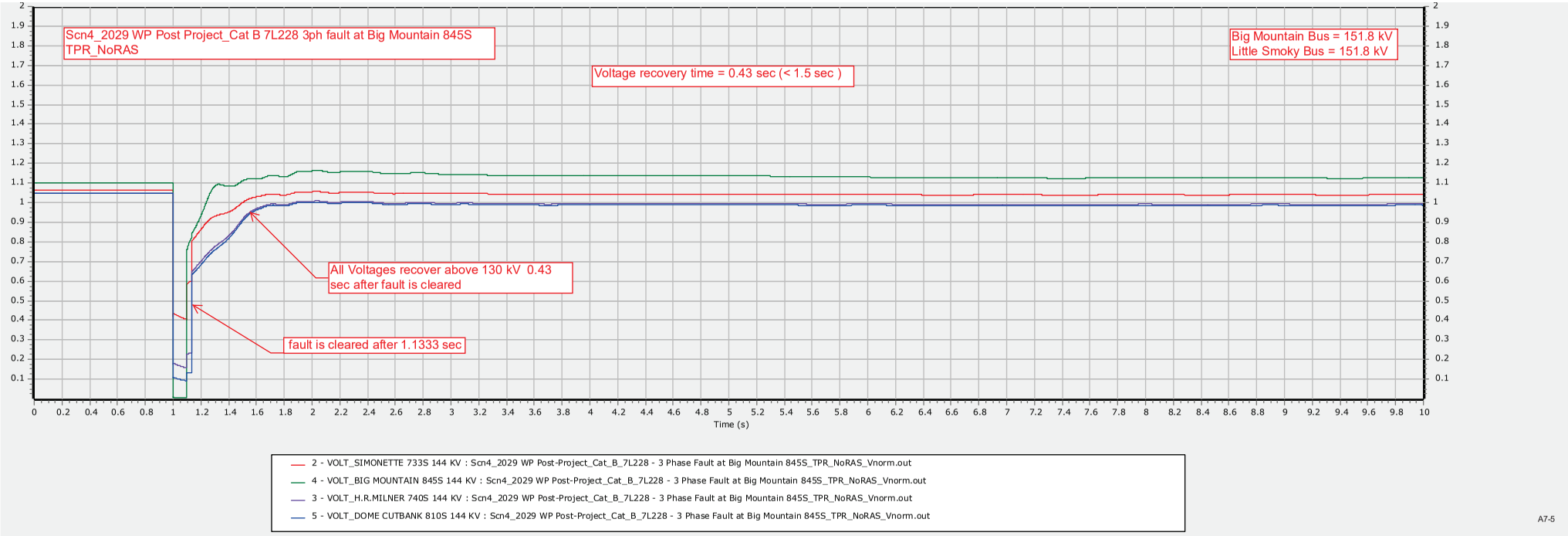
System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A7-8
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A7-9
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A7-10
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	A7-11
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Big Mountain 845S	A7-12
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Thornton 2091S	A7-13

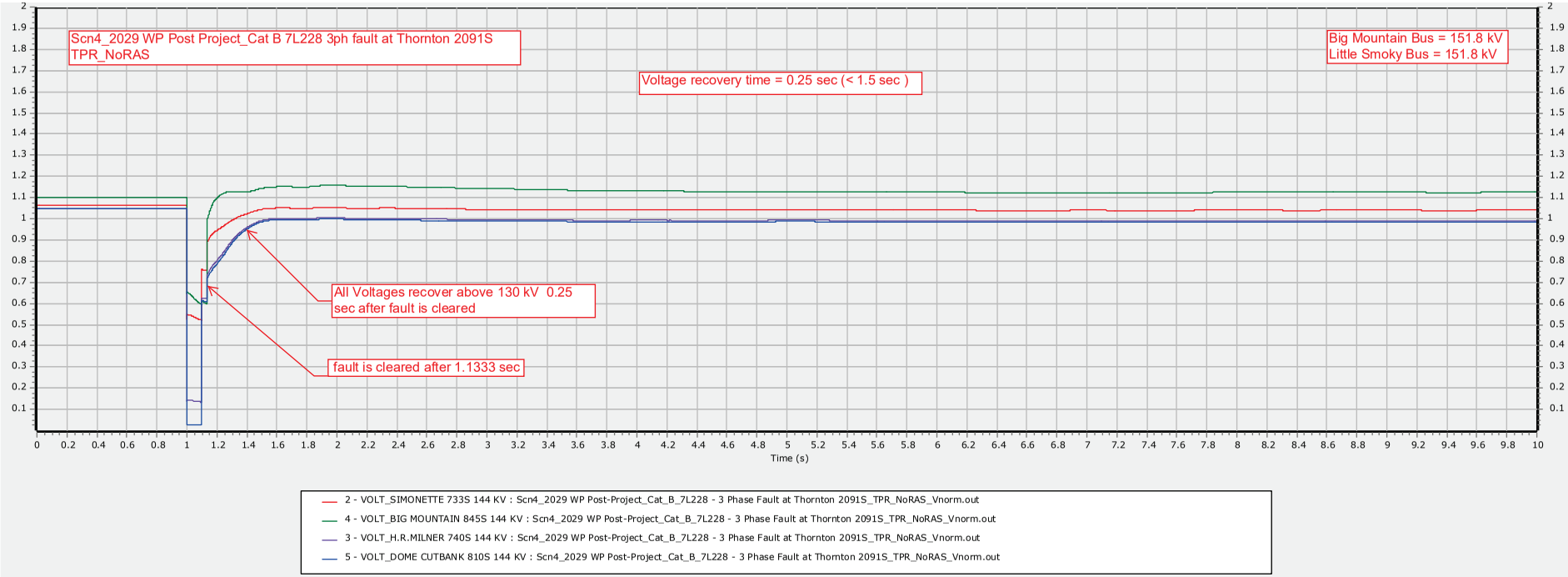

Scn4_2029 WP Post Project_Cat B 7L20 3ph fault at Thornton 2091S
NoTPR_ NoRAS
Voltage recovery time = 0.87 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.87 sec after fault is cleared
fault is cleared after 1.4 sec
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_NoTPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_NoTPR_NoRAS_Vnorm.out
6 - VOLT_THORNTON 2091S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_NoTPR_NoRAS_Vnorm.out

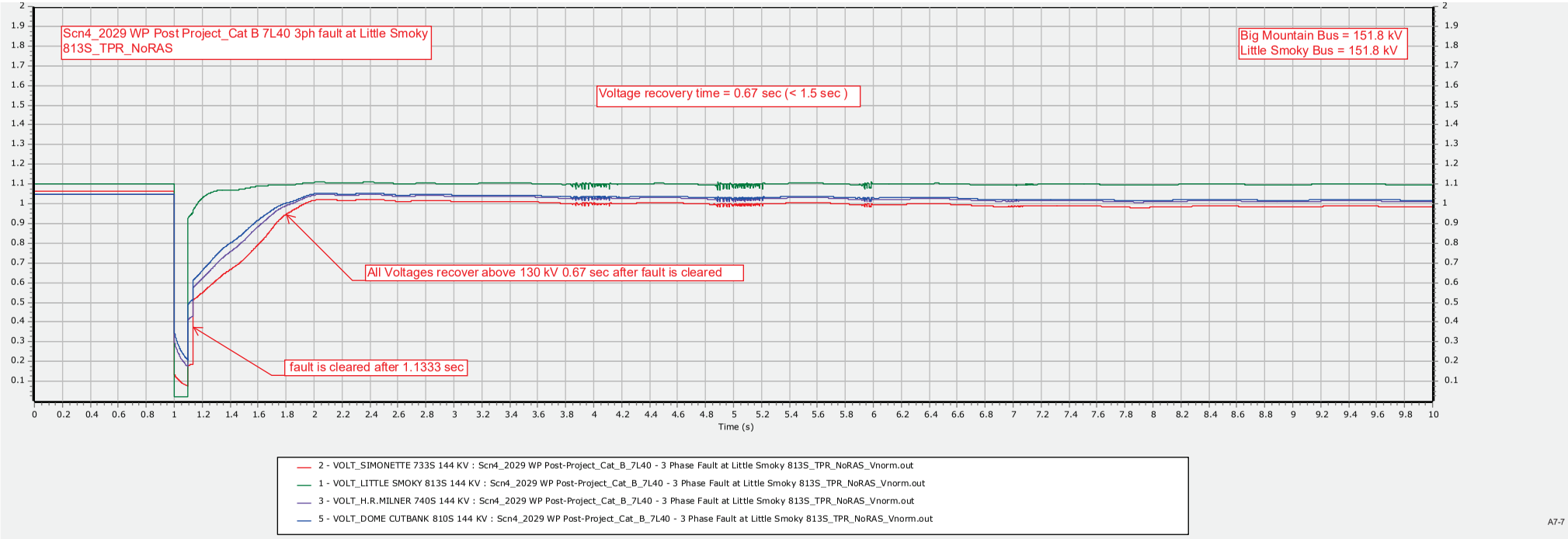

Scn4_2029 WP Post Project_Cat B 7L20 3ph fault at HR Milner 740S
NoTPR_ NoRAS
Voltage recovery time = 0.32 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.32 sec after fault is cleared
fault is cleared after 1.4 sec
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_NoRAS_Vnorm.out
6 - VOLT_THORNTON 2091S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_NoRAS_Vnorm.out

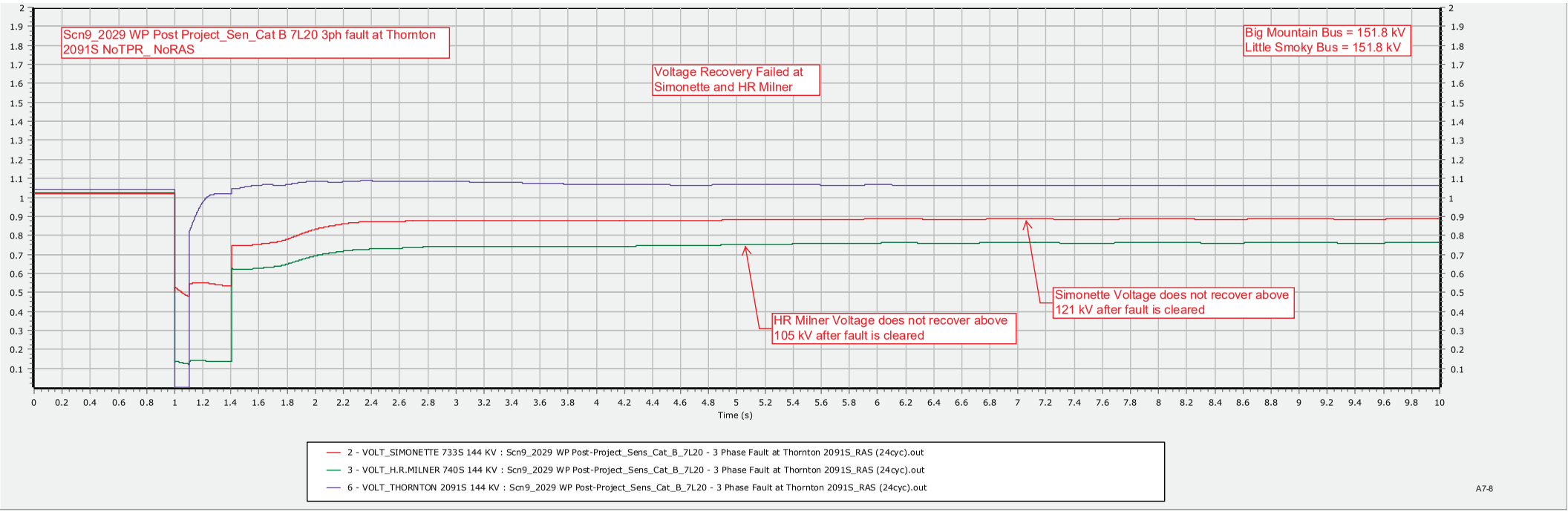

Scn4_2029 WP Post Project_Cat B 7L40 3ph fault at Little Smoky 813S_NoTPR_NoRAS
Dome Cutbank Voltage recovers above 130 kV 1.64 sec after fault is cleared
Simonette Voltage does not recover above 113 kV after fault is cleared
fault is cleared after 1.7 sec
HR Milner Voltage does not recover above 128 kV after fault is cleared
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_NoRAS_Vnorm.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_NoRAS_Vnorm.out

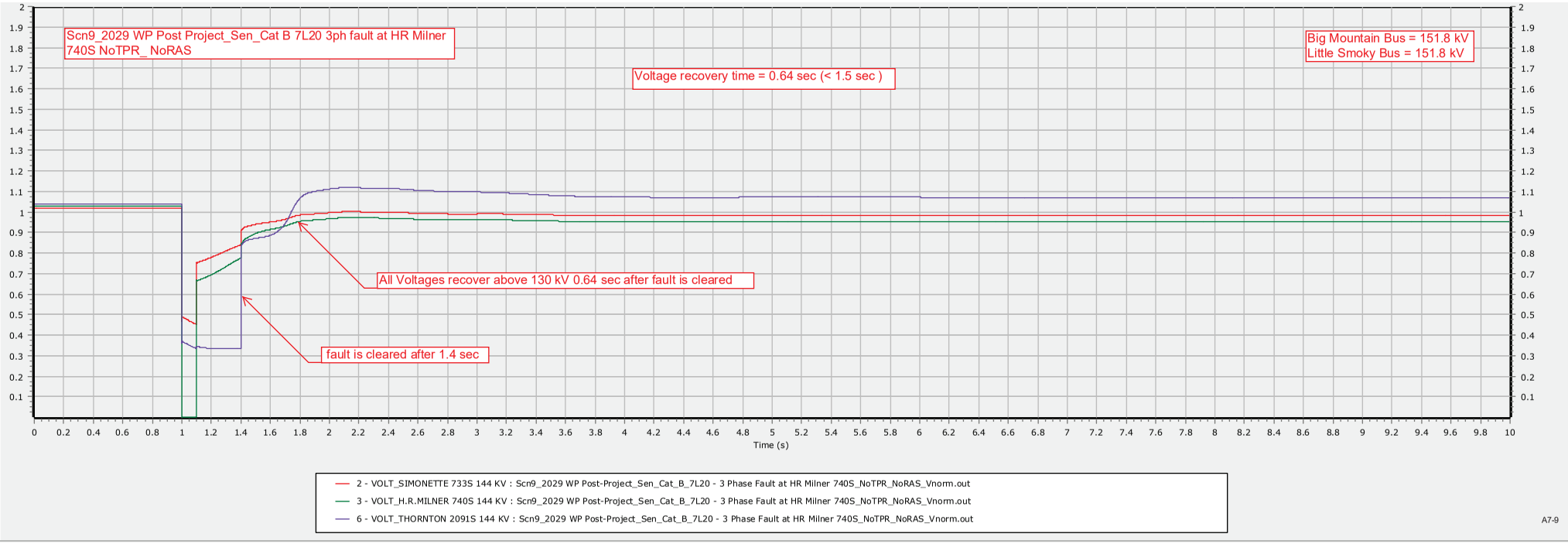

Scn4_2029 WP Post Project_Cat B 7L40 3ph fault at Simonette 733S_NoTPR_NoRAS
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage recovery time = 0.18 sec (< 1.5 sec)
AllVoltages recover above 130 kV 0.18 sec after fault is cleared
fault is cleared after 1.4 sec
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out

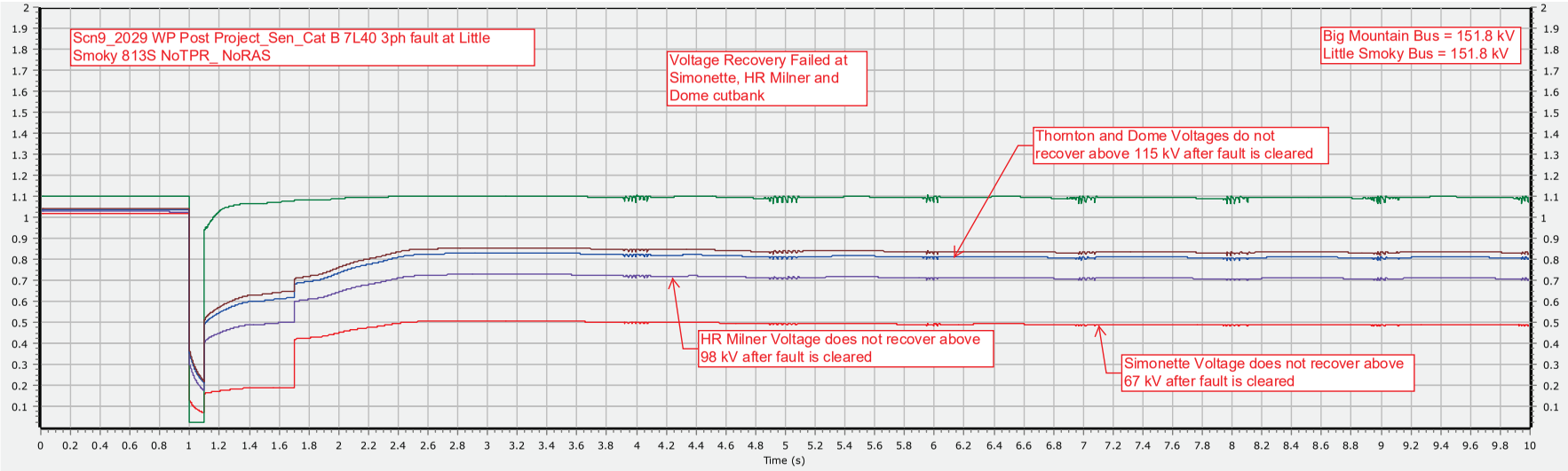

Scn4_2029 WP Post Project_Cat B 7L228 3ph fault at Big Mountain 845S TPR_NoRAS
Voltage recovery time = 0.43 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.43 sec after fault is cleared
fault is cleared after 1.1333 sec
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out

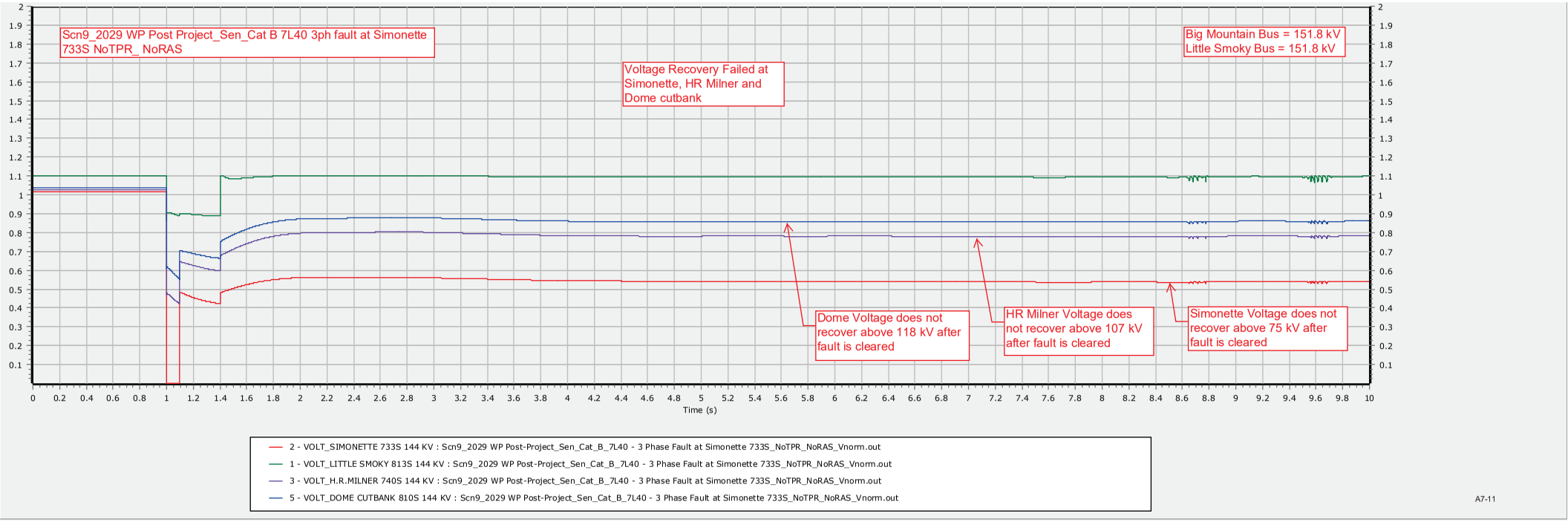

Scn4_2029 WP Post Project_Cat B 7L228 3ph fault at Thornton 2091S
TPR_NoRAS
Voltage recovery time = 0.25 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.25
sec after fault is cleared
fault is cleared after 1.1333 sec
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out

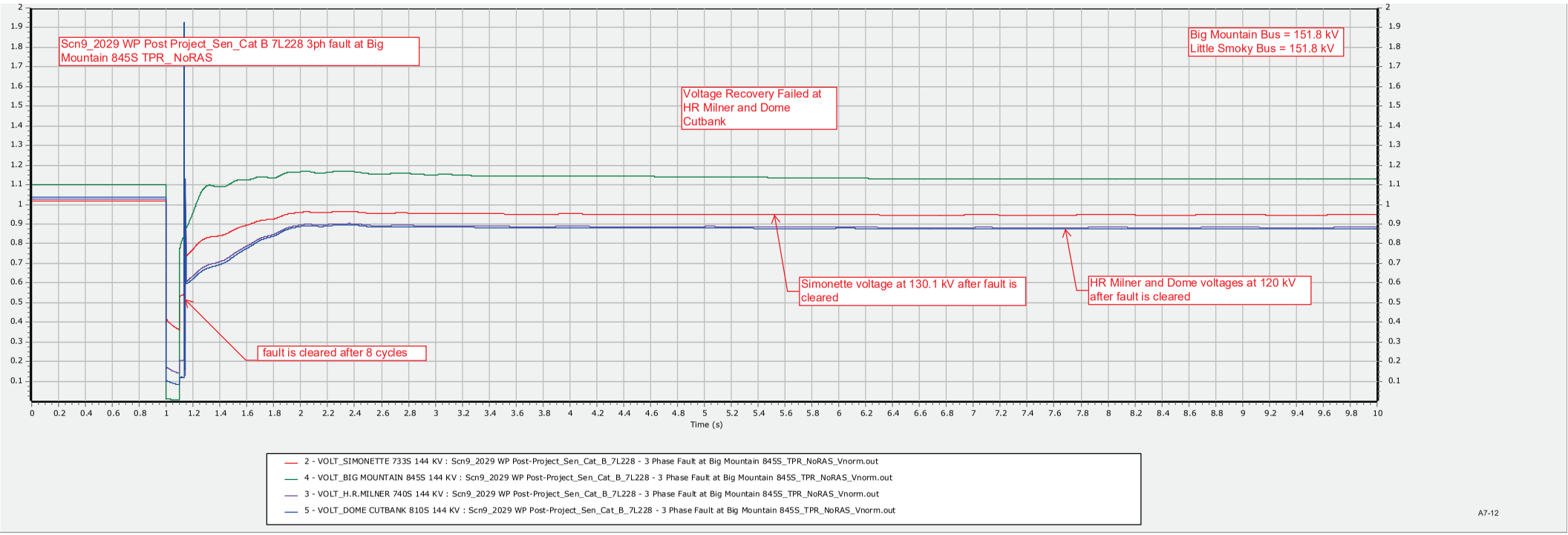

Scn4_2029 WP Post Project_Cat B 7L40 3ph fault at Little Smoky 813S_TPR_NoRAS
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage recovery time = 0.67 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.67 sec after fault is cleared
fault is cleared after 1.1333 sec
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_TPR_NoRAS_Vnorm.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_TPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_TPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn4_2029 WP Post-Project_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_TPR_NoRAS_Vnorm.out

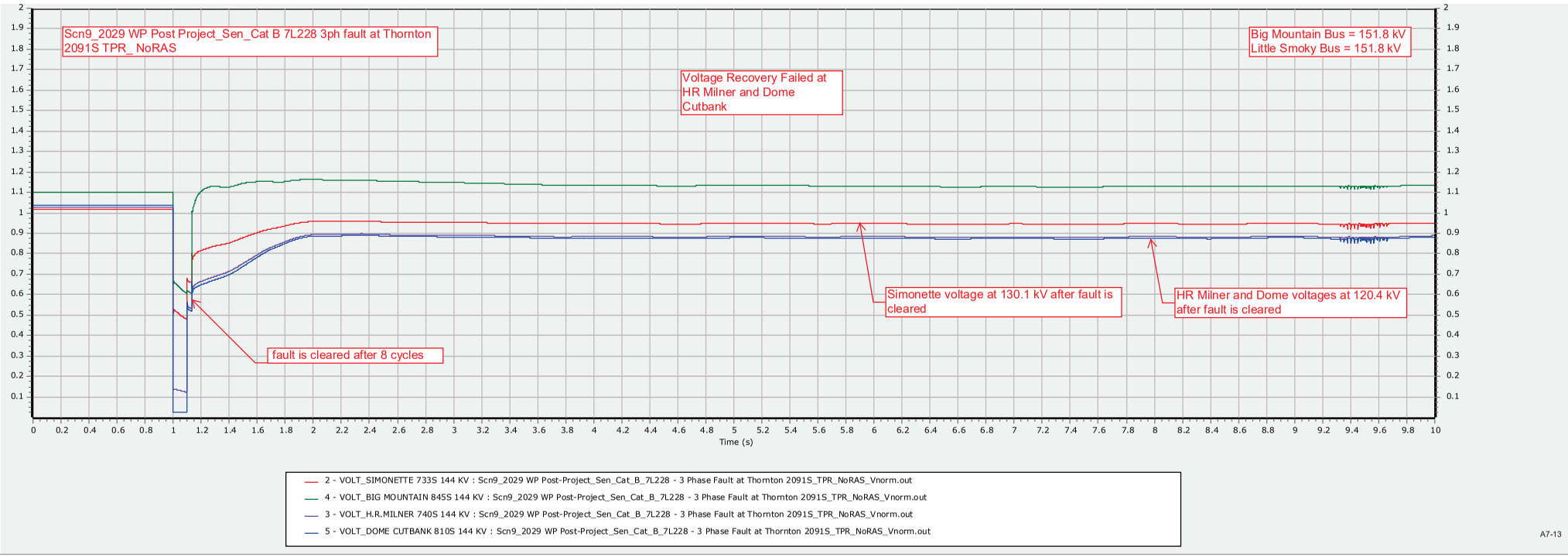

Scn9_2029 WP Post Project_Sen_Cat B 7L20 3ph fault at Thornton 2091S NoTPR_ NoRAS
Voltage Recovery Failed at Simonette and HR Milner
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
HR Milner Voltage does not recover above 105 kV after fault is cleared
Simonette Voltage does not recover above 121 kV after fault is cleared
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sens_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_RAS (24cyc).out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sens_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_RAS (24cyc).out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sens_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_RAS (24cyc).out


Scn9_2029 WP Post Project_Sen_Cat B 7L20 3ph fault at HR Milner
740S NoTPR_ NoRAS
Voltage recovery time = 0.64 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.64 sec after fault is cleared
fault is cleared after 1.4 sec
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_NoRAS_Vnorm.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_NoRAS_Vnorm.out


Scn9_2029 WP Post Project_Sen_Cat B 7L40 3ph fault at Little Smoky 813S NoTPR_ NoRAS
Voltage Recovery Failed at Simonette, HR Milner and Dome cutbank
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Thornton and Dome Voltages do not recover above 115 kV after fault is cleared
HR Milner Voltage does not recover above 98 kV after fault is cleared
Simonette Voltage does not recover above 67 kV after fault is cleared
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sens_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_(42cyc).out


Scn9_2029 WP Post Project_Sen_Cat B 7L40 3ph fault at Simonette 733S NoTPR_ NoRAS
Voltage Recovery Failed at Simonette, HR Milner and Dome cutbank
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Dome Voltage does not recover above 118 kV after fault is cleared
HR Milner Voltage does not recover above 107 kV after fault is cleared
Simonette Voltage does not recover above 75 kV after fault is cleared
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_NoRAS_Vnorm.out


Scn9_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Big Mountain 845S TPR_ NoRAS
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage Recovery Failed at HR Milner and Dome Cutbank
Simonette voltage at 130.1 kV after fault is cleared
HR Milner and Dome voltages at 120 kV after fault is cleared
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_NoRAS_Vnorm.out


Scn9_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Thornton 2091S TPR_ NoRAS
Voltage Recovery Failed at HR Milner and Dome Cutbank
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Simonette voltage at 130.1 kV after fault is cleared
HR Milner and Dome voltages at 120.4 kV after fault is cleared
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out

Attachment A8
Post-Mitigation Power Flow Diagrams
(Scenarios 8, 9)

Post-Mitigation with TMR and RAS

Post-Mitigation Power Flow Diagrams with TMR

The post-Mitigation power flow diagrams with TMR for Scenario 8 under Category B conditions are provided in this attachment as per the following Table A8-1.

Table A8-1: List of Scenario 8: 2029 SP LG Post-Mitigation Power Flow Diagrams with TMR

Scenario	Power Flow Diagram	Page number
2029 SP Scenario 8	N-1, Loss of 7L13	A8-1
	N-1, Loss of 7L56	A8-2
	N-1, Loss of 7L75	A8-3
	N-1, Loss of 9L05	A8-4
	N-1, Loss Of Bear Creek 679S 701T	A8-5
	N-1, Loss of Little Smoky 813S 901T	A8-6
	N-1, Loss of Little Smoky 813S 902T	A8-7

Post-Mitigation Power Flow Diagrams with TMR and RAS

The post-Mitigation power flow diagrams with TMR and RAS for Scenario 8, and 9 under Category B conditions are provided in this attachment as per the following Table A8-2 and Table A8-3.

Table A8-2: List of Scenario 8: 2029 SP LG Post-Mitigation Power Flow Diagrams with TMR and RAS

Scenario	Power Flow Diagram	Page number
2029 SP Scenario 8	N-1, Loss of 7L40	A8-8
	N-1, Loss of 7L228	A8-9

Table A8-3: List of Scenario 9: 2029 WP LG Post-Mitigation Power Flow Diagrams with TMR and RAS

Scenario	Power Flow Diagram	Page number
2029 WP Scenario 9	N-1, Loss of 7L40	A8-10
	N-1, Loss of 7L228	A8-11

Post-Mitigation with TMR and Caps

Post-Mitigation Power Flow Diagrams with TMR and Caps

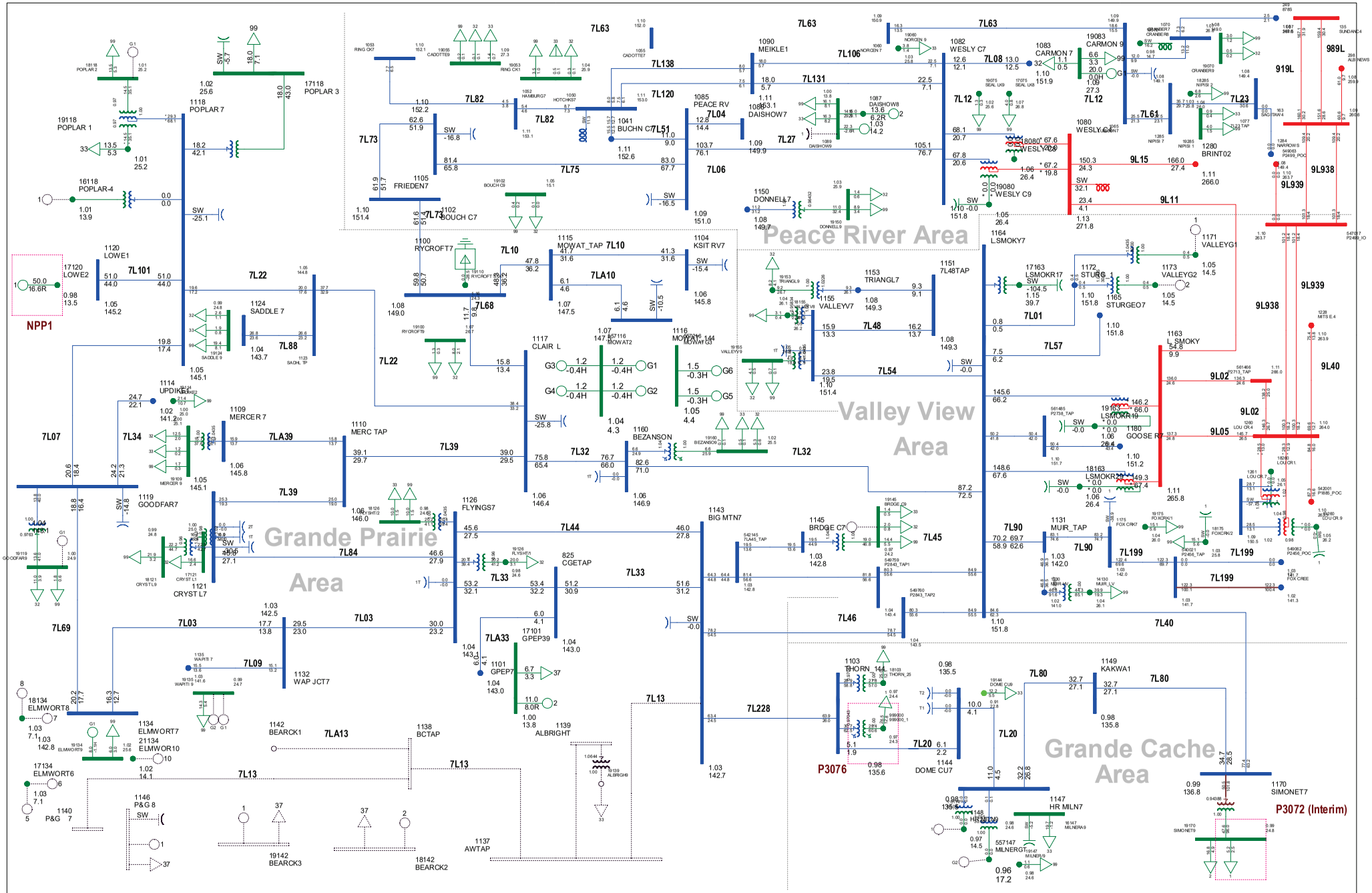
The post-Mitigation power flow diagrams with TMR and Caps for Scenario 8, and 9 under Category B conditions are provided in this attachment as per the following tables.

Table A8-4: List of Scenario 8: 2029 SP LG Post-Mitigation Power Flow Diagrams with TMR and Caps

Scenario	Power Flow Diagram	Page number
2029 SP Scenario 8	N-1, Loss of 7L13	A8-12
	N-1, Loss of 7L40	A8-13
	N-1, Loss of 7L56	A8-14
	N-1, Loss of 7L75	A8-15
	N-1, Loss of 7L228	A8-16
	N-1, Loss of 9L05	A8-17
	N-1, Loss Of Simonette 733S 702T	A8-18
	N-1, Loss Of Bear Creek 679S 701T	A8-19
	N-1, Loss of Little Smoky 813S 901T	A8-20
	N-1, Loss of Little Smoky 813S 902T	A8-21

Table A8-5: List of Scenario 9: 2029 WP LG Post-Mitigation Power Flow Diagrams with TMR and Caps

Scenario	Power Flow Diagram	Page number
2029 WP Scenario 9	N-1, Loss of 7L40	A8-22
	N-1, Loss of 7L228	A8-23
	N-1, Loss of Simonette 733S 702T	A8-24
	N-1, Loss of Thornton 2091S 701T	A8-25
	N-1, Loss of Thornton 2091S 702T	A8-26



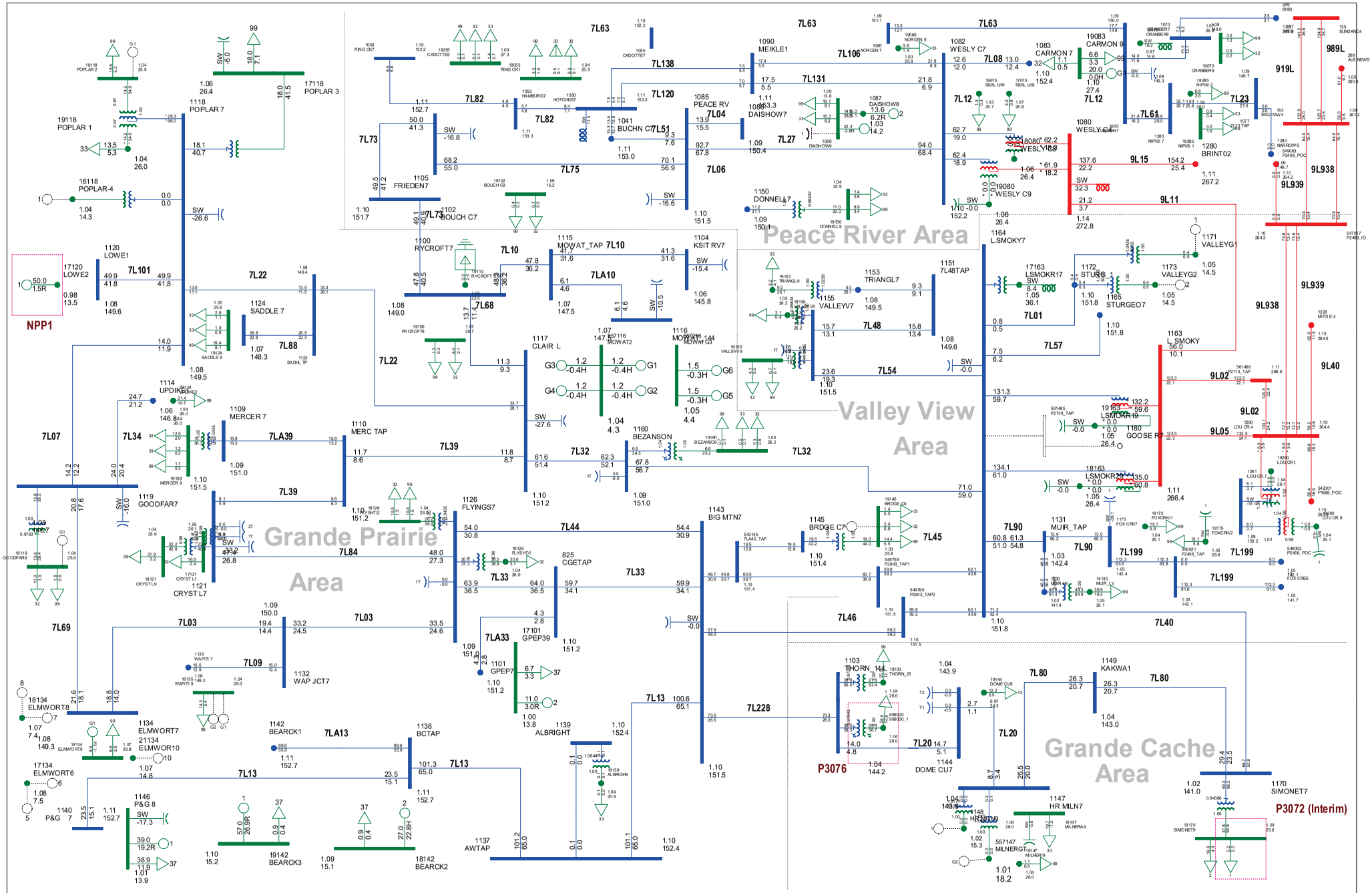
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L13 (BIG MOUNTAIN 845S - PROCTER & GAMB
SCN8_2029 SP_POST_SENSITIVITY_TMR
FRI, JUN 12 2026 14:49
New Diagram

A8-1

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



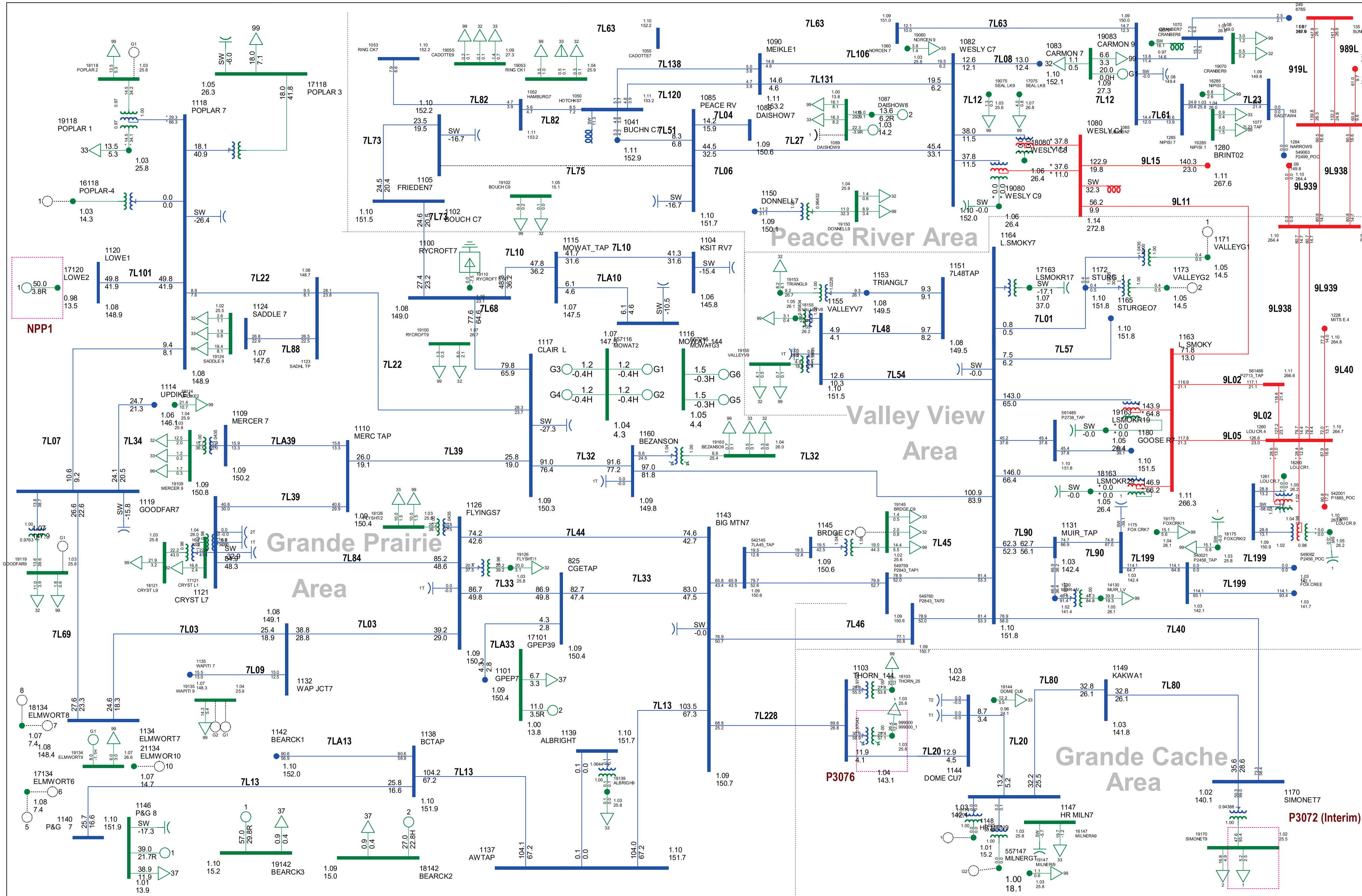
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L56 (LITTLE SMOKY 813S - LOUISE CREEK 8
SCN8_2029 SP_POST_SENSITIVITY_TMR
FRI, JUN 12 2026 14:50
New Diagram

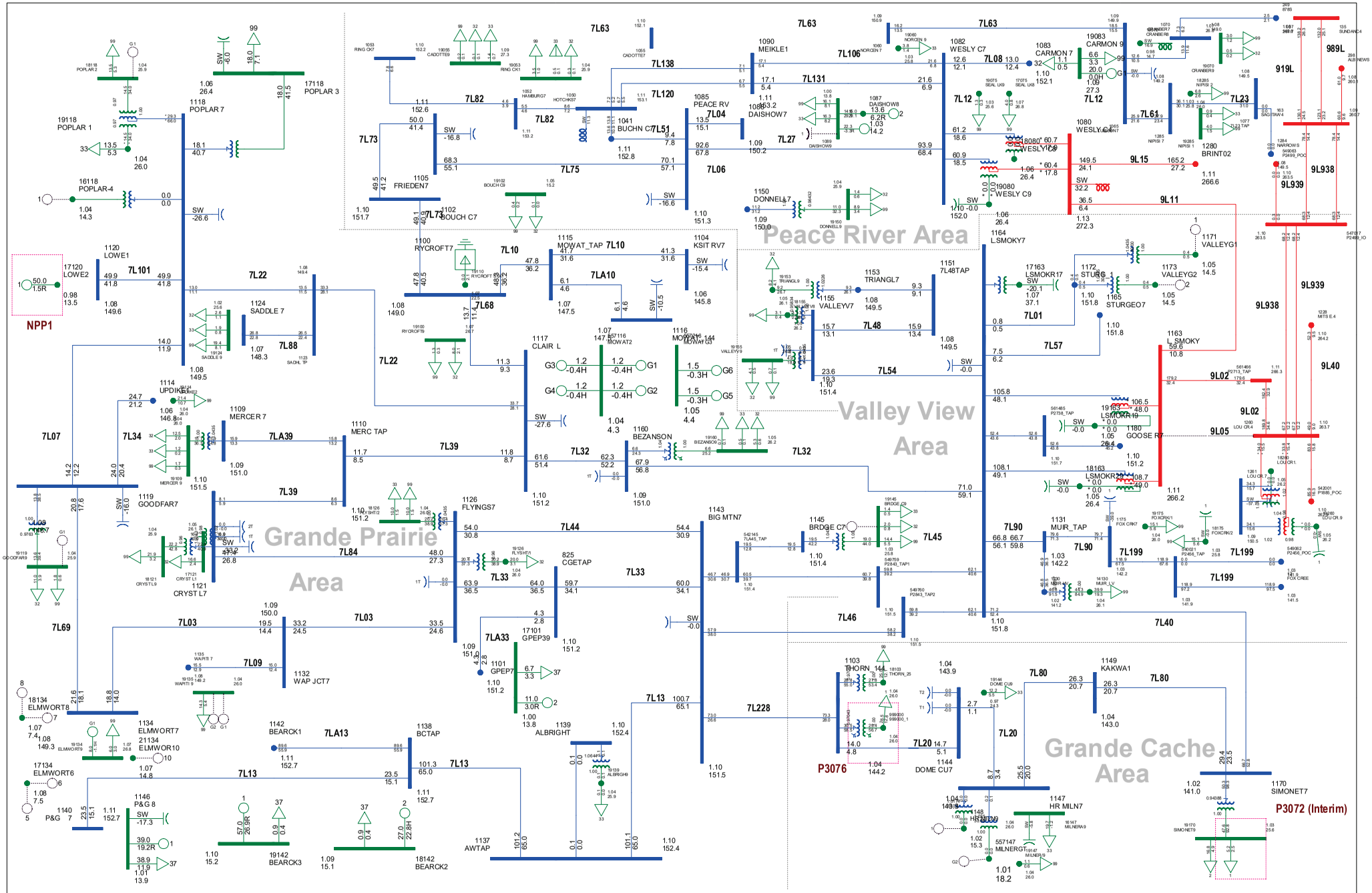
Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A8-2



P3076 **ATCO Thornton Capacity Addition**	**CATEGORY B, LOSS OF 7L75 (FRIEDNESTAL 800S - WEST PEACE RIVE** **SCN8_2029 SP_POST_SENSITIVITY_TMR** **FRI, JUN 12 2026 14:50** **New Diagram**	Bus - Voltage (kV/pu) Branch - MVA/% RATE1 Equipment - MW/Mvar 100.0%RATE1 1.350OV 0.940UV kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A8-3

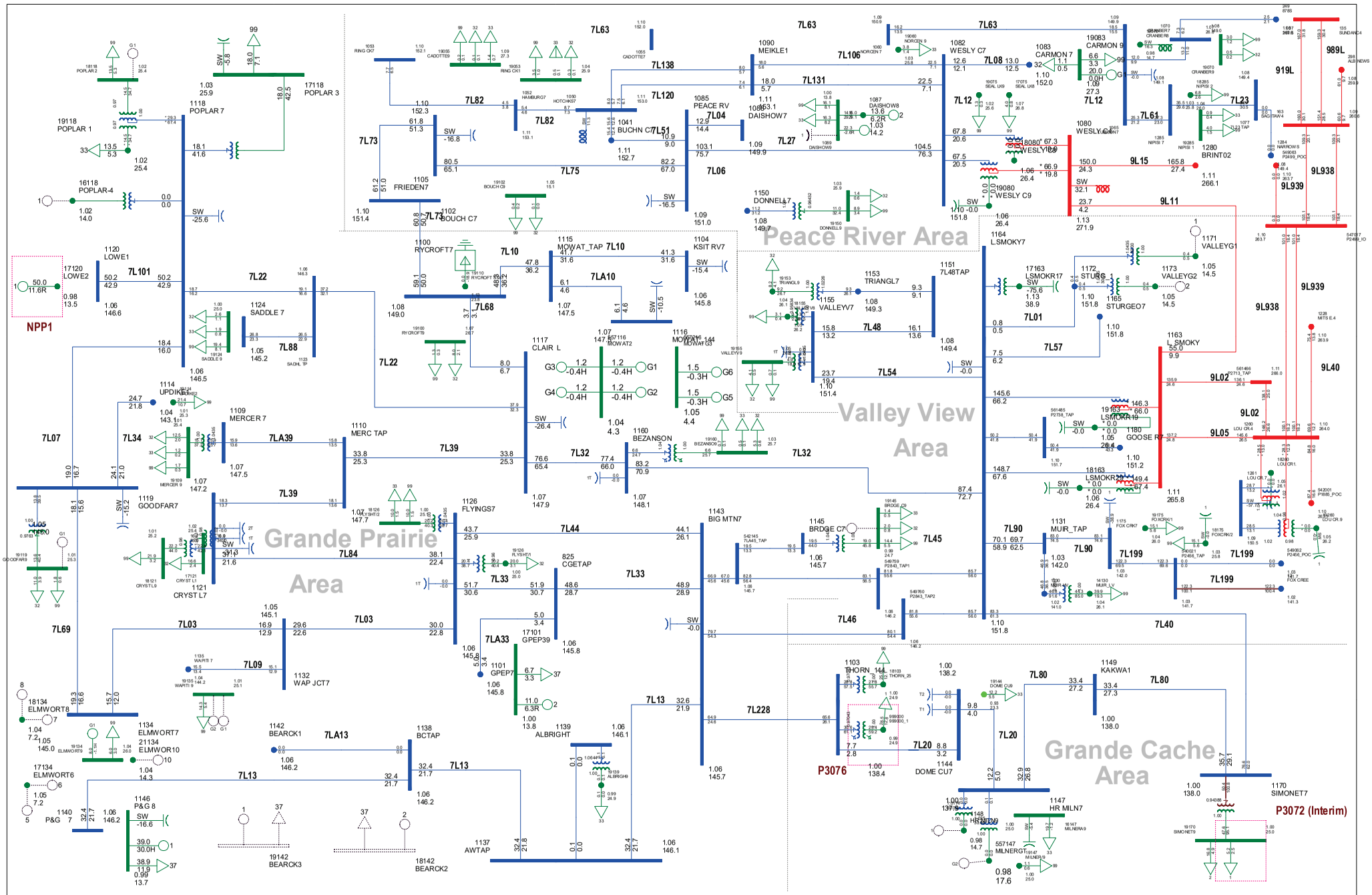


P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 9L05 (LITTLE SMOKY 813S - LOUISE CREEK 8
SCN8_2029 SP_POST_SENSITIVITY_TMR
FRI, JUN 12 2026 14:49
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

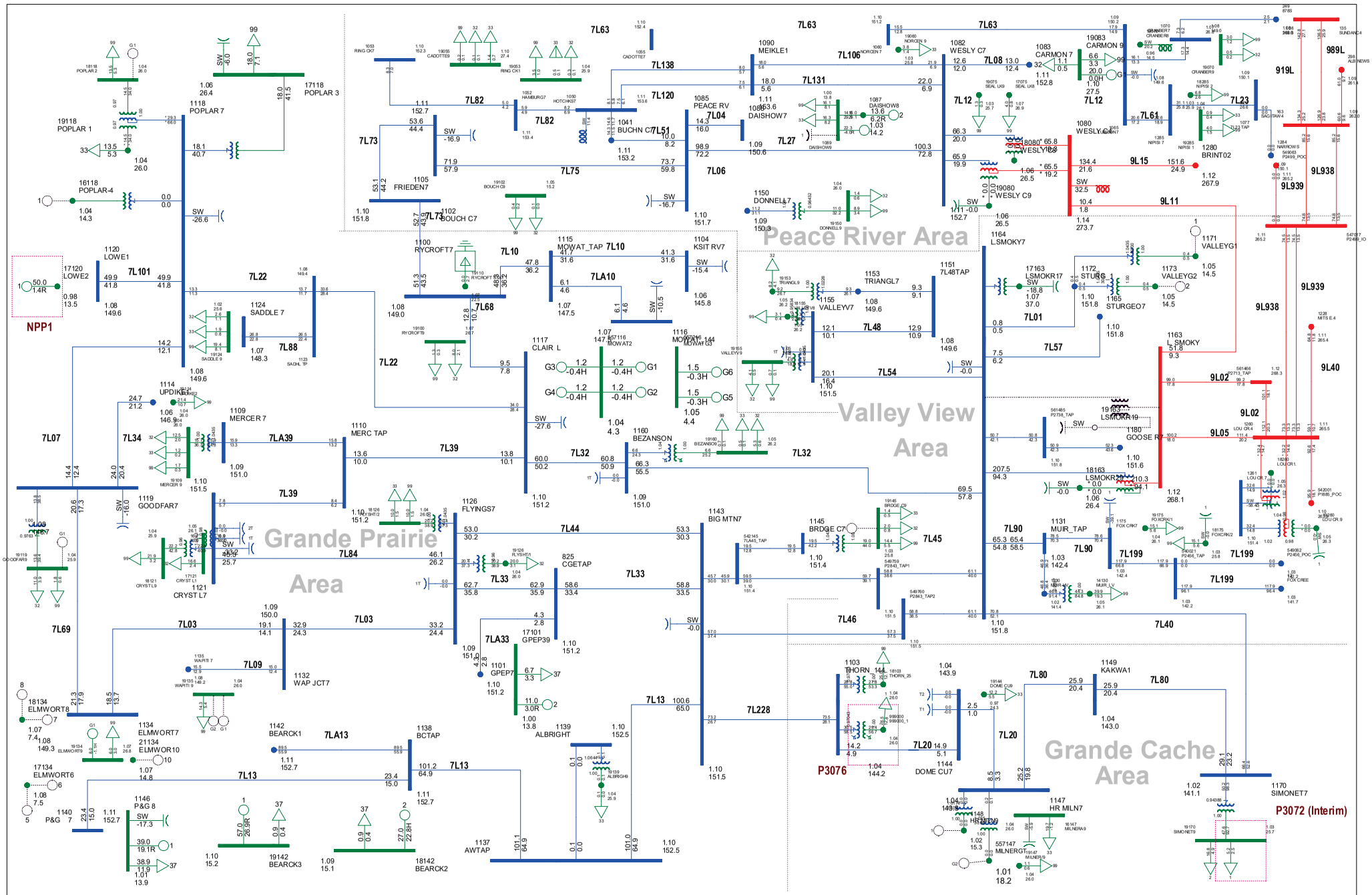


P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF BEAR CREEK 679S 701T
SCN8_2029 SP_POST_SENSITIVITY_TMR
FRI, JUN 12 2026 14:50
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



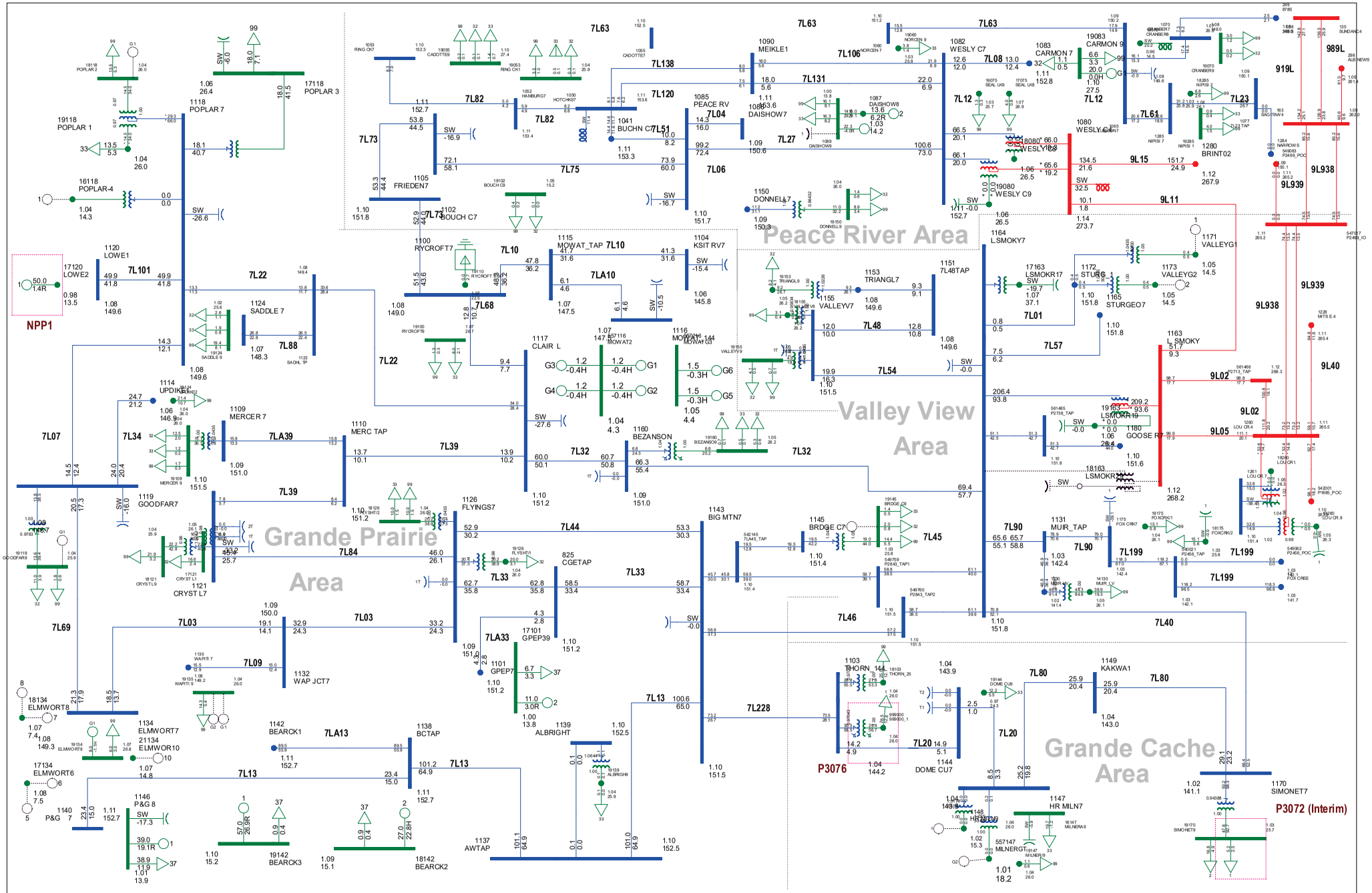
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF LITTLE SMOKY 813S 901T
SCN8_2029 SP_POST_SENSITIVITY_TMR
FRI, JUN 12 2026 14:49
New Diagram

A8-6

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



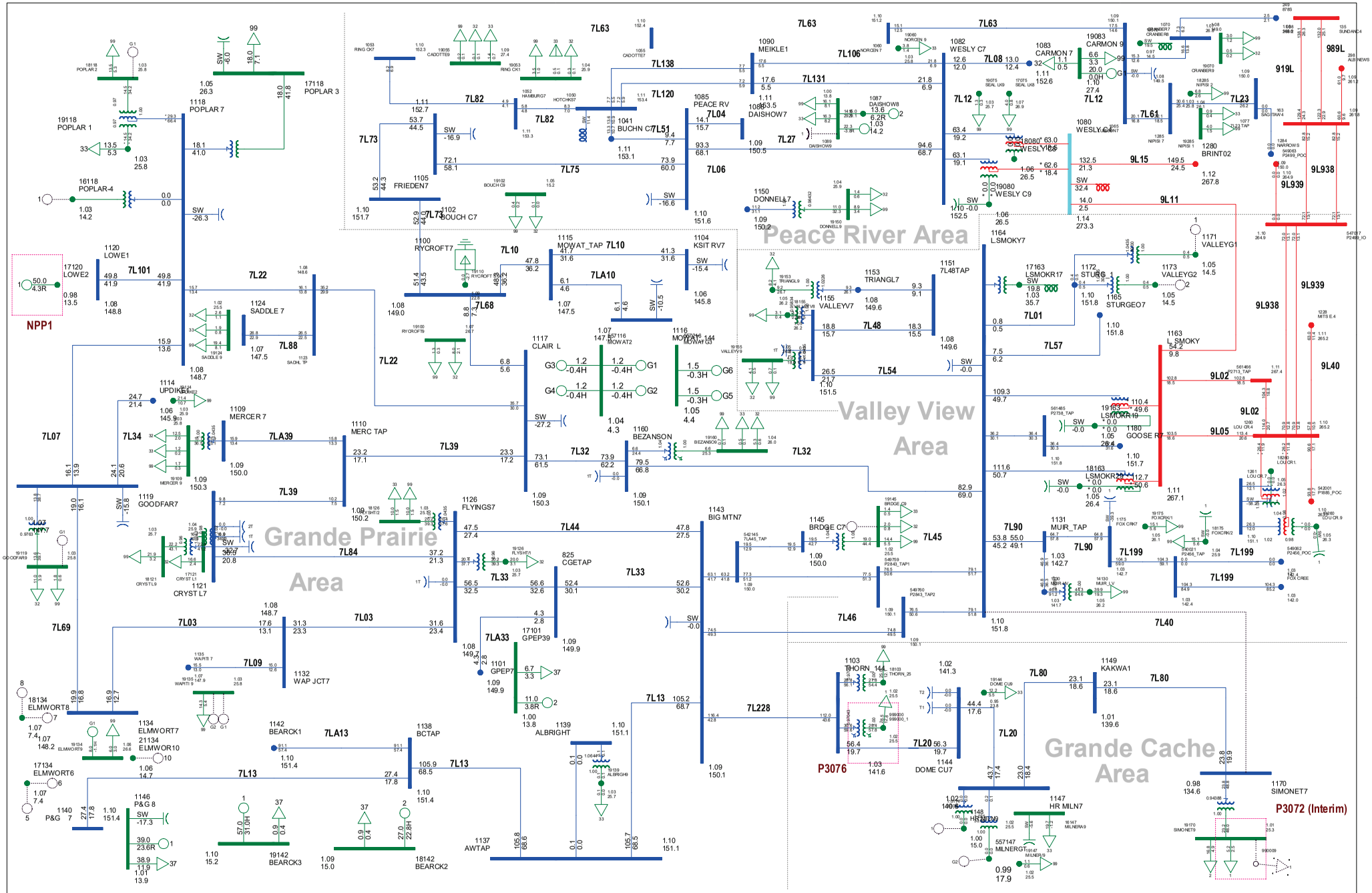
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF LITTLE SMOKY 813S 902T
SCN8_2029 SP_POST_SENSITIVITY_TMR
FRI, JUN 12 2026 14:49
New Diagram

A8-7

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.350OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

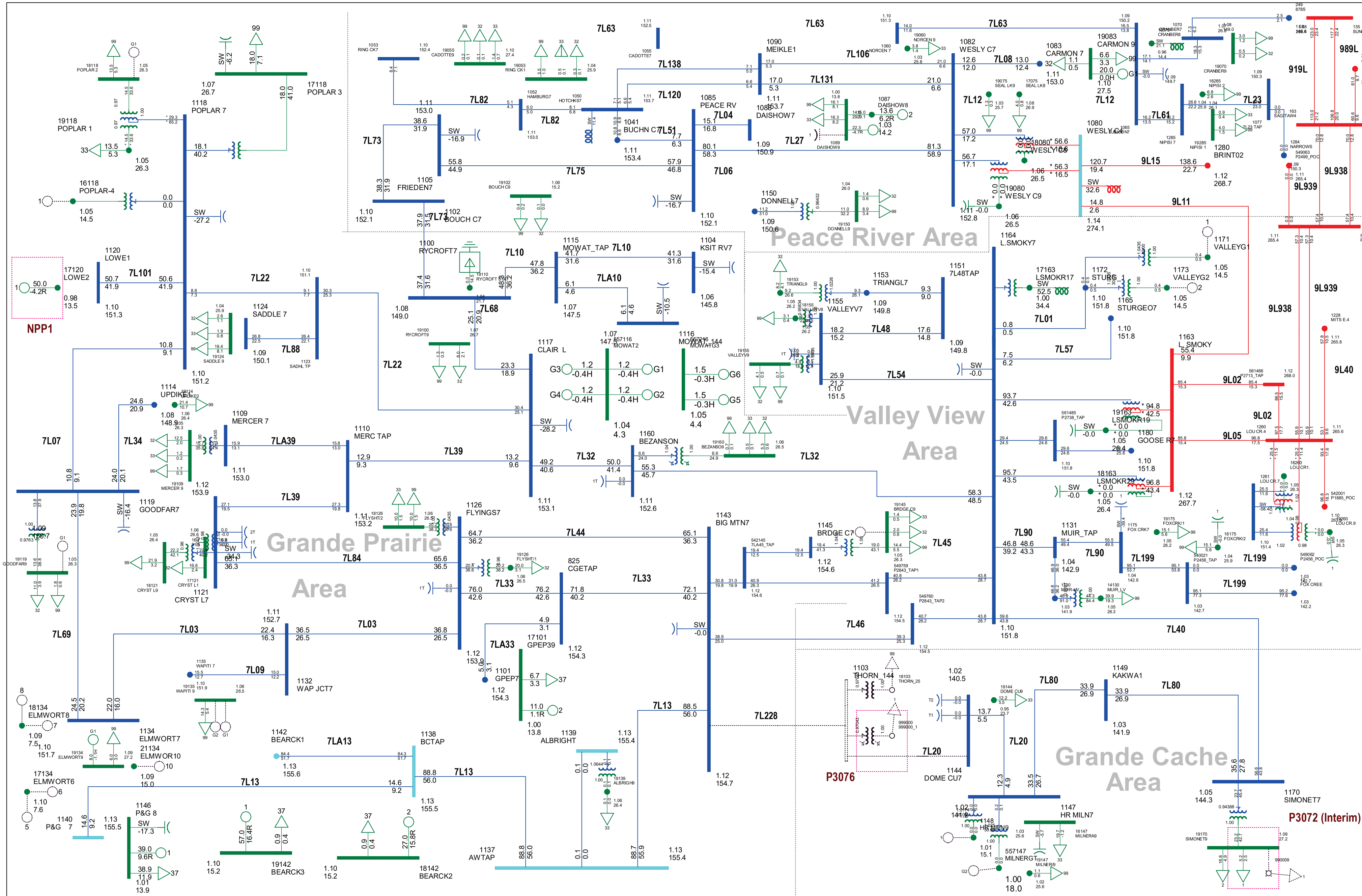


P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L40 (L.Smoky 813S - Simonette 733S)
SCN8_2029 SP_POST_SENSITIVITY_TMR_RAS
THU, MAY 28 2026 17:27 New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.942UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



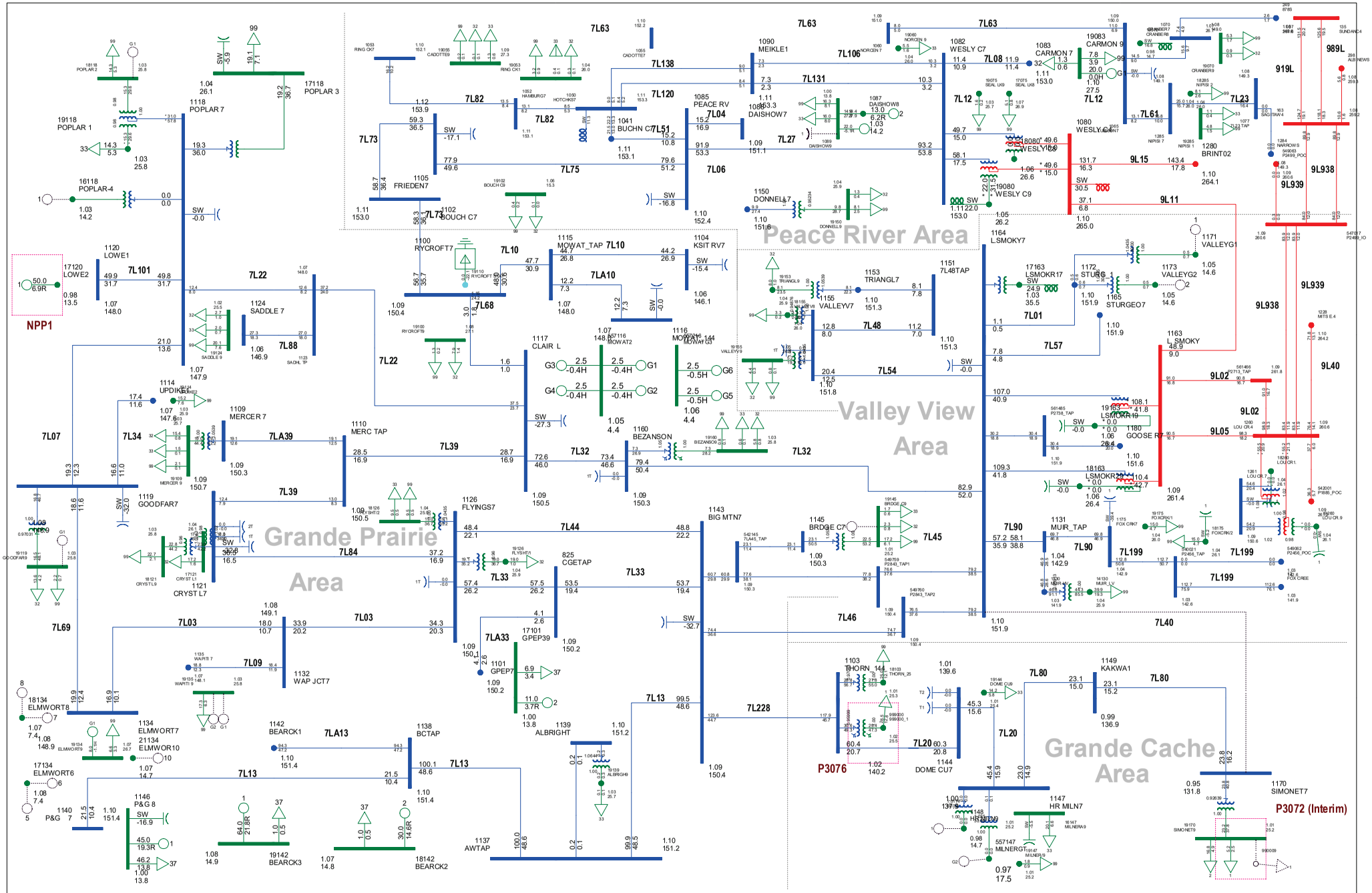
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L228 (Big Mountain 845S - Thornton 2091S)
SCN8_2029 SP_POST_SENSITIVITY_TMR_RAS
THU, MAY 28 2026 17:30 New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.942UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A8-9

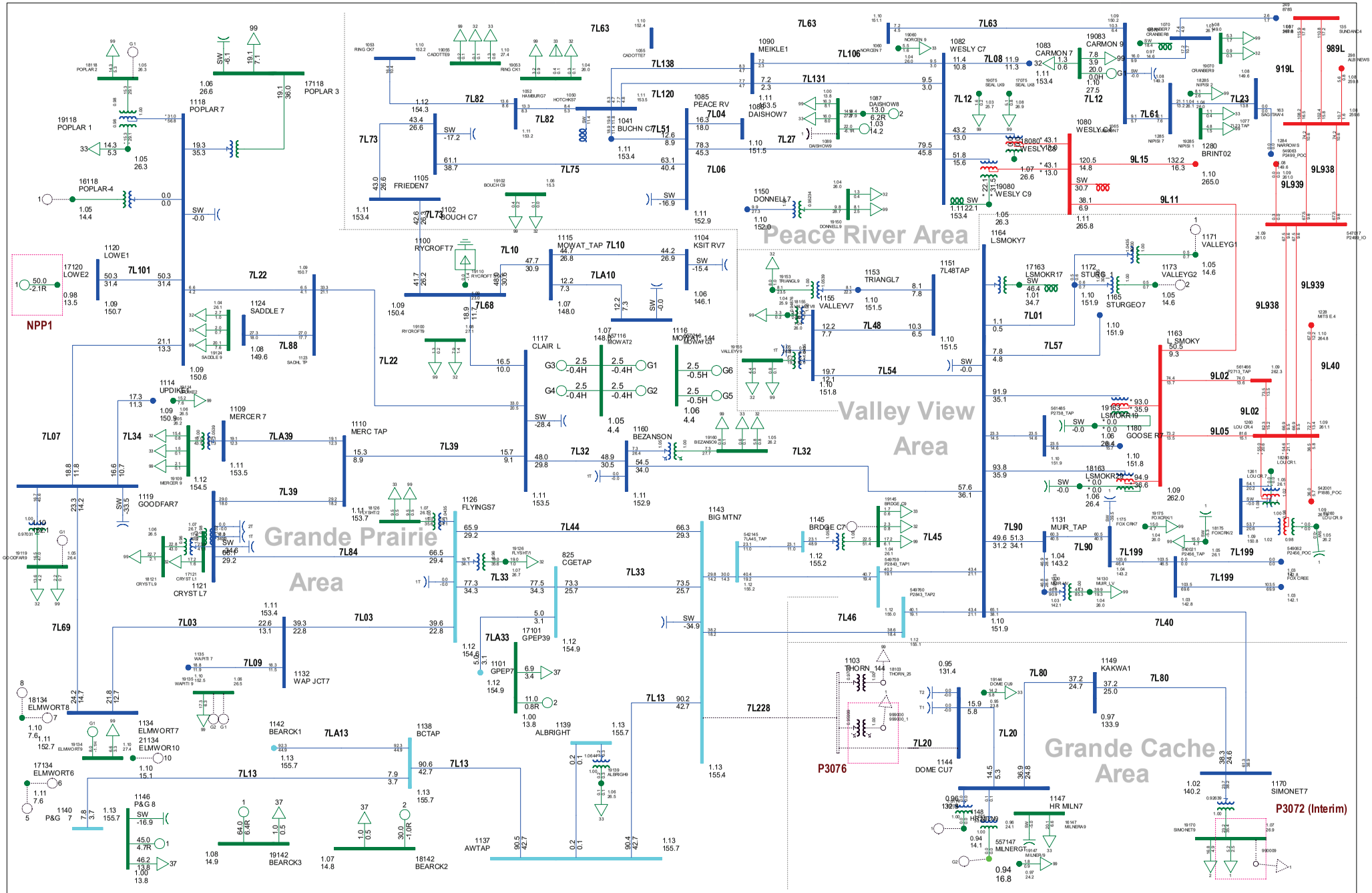


P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L40 (L.Smoky 813S - Simonette 733S)
SCN9_2029 WP_POST_SENSITIVITY_TMR_RAS
THU, MAY 28 2026 17:48 New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.120OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



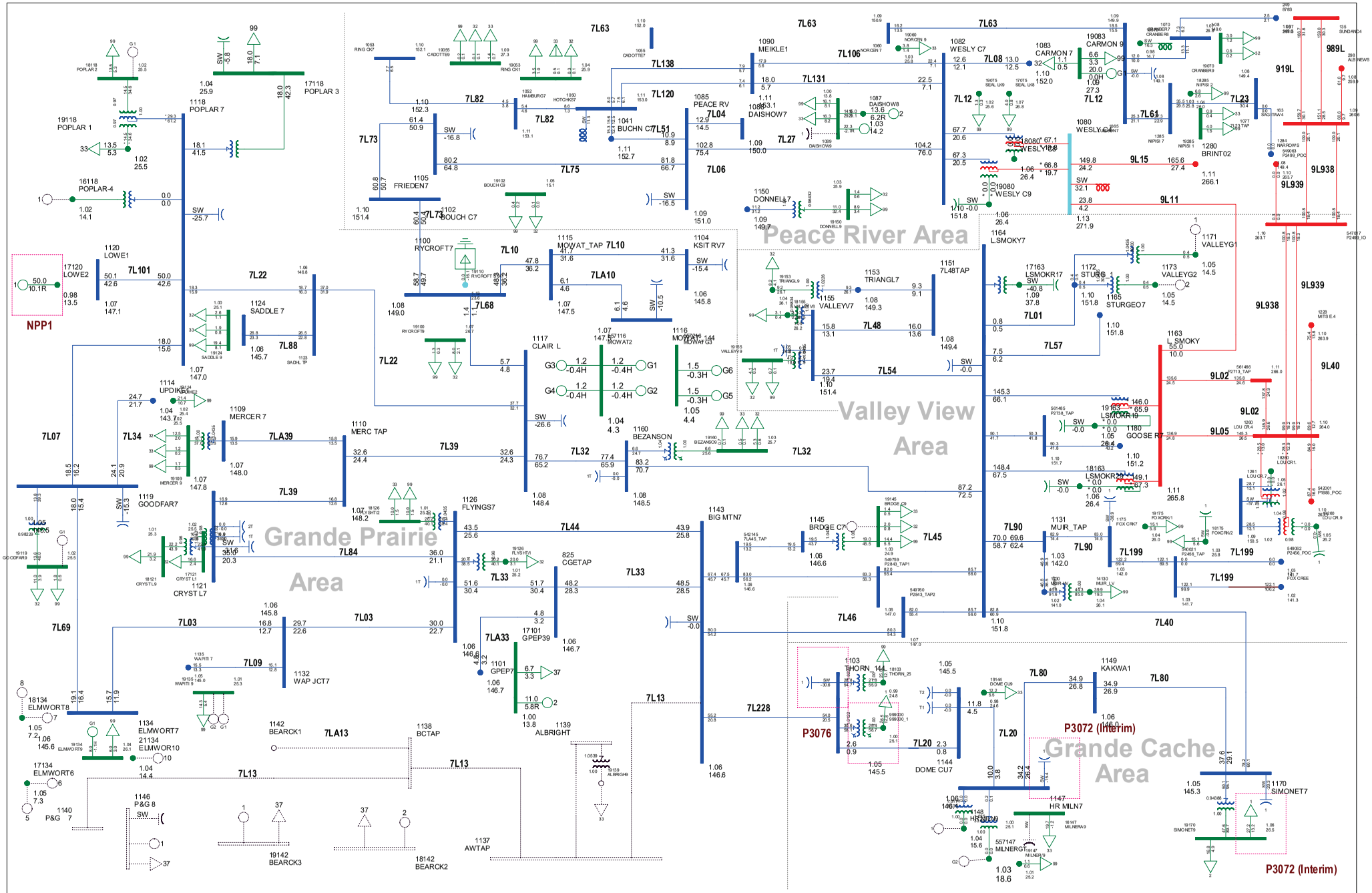
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L228 (Big Mountain 845S - Thornton 2091S)
SCN9_2029 WP_POST_SENSITIVITY_TMR_RAS
THU, MAY 28 2026 17:43
New Diagram

A8-11

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.120OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



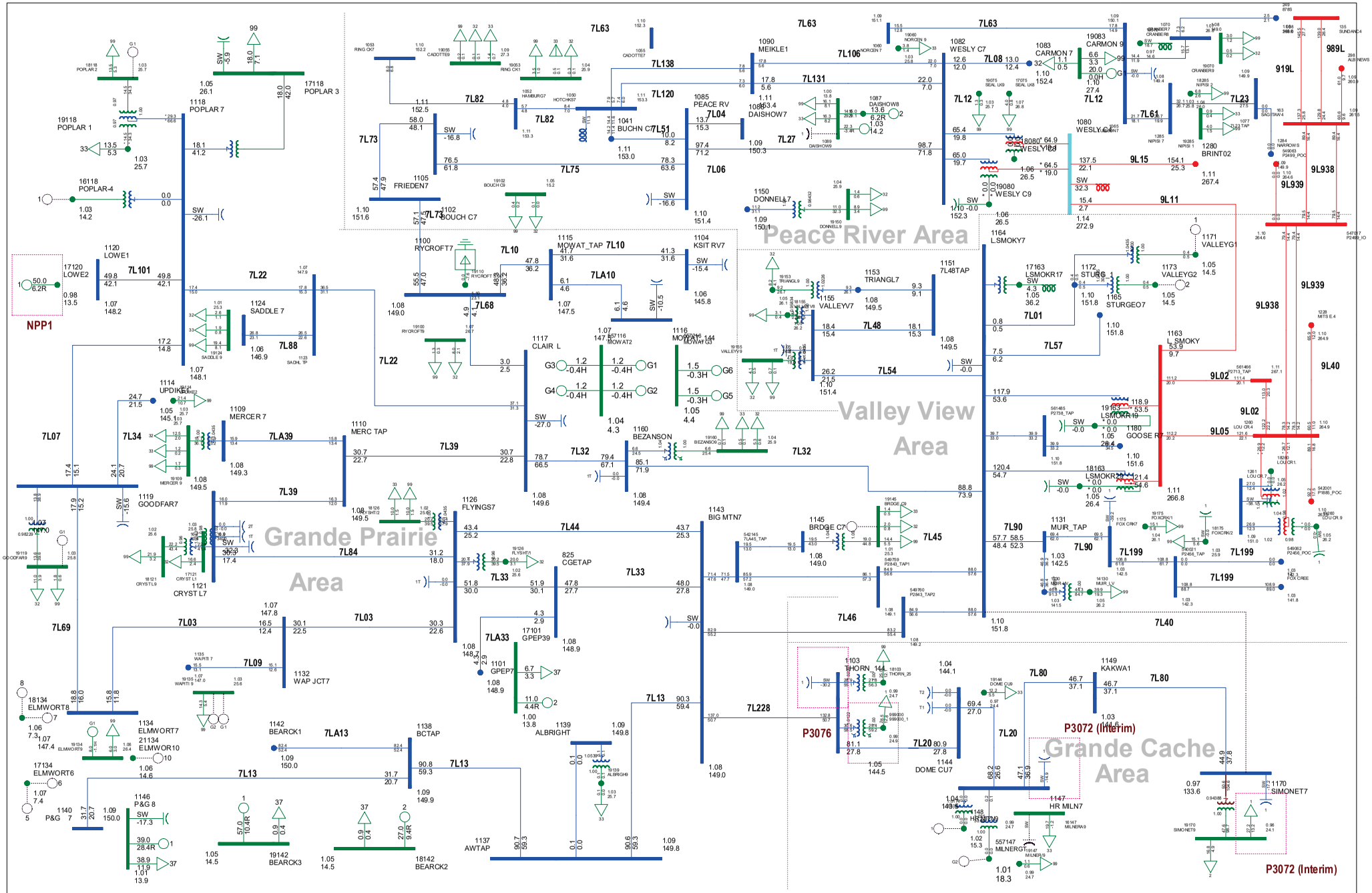
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L13 (BIG MOUNTAIN 845S - PROCTER & GAMB
SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 17:03
New Diagram

A8-12

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



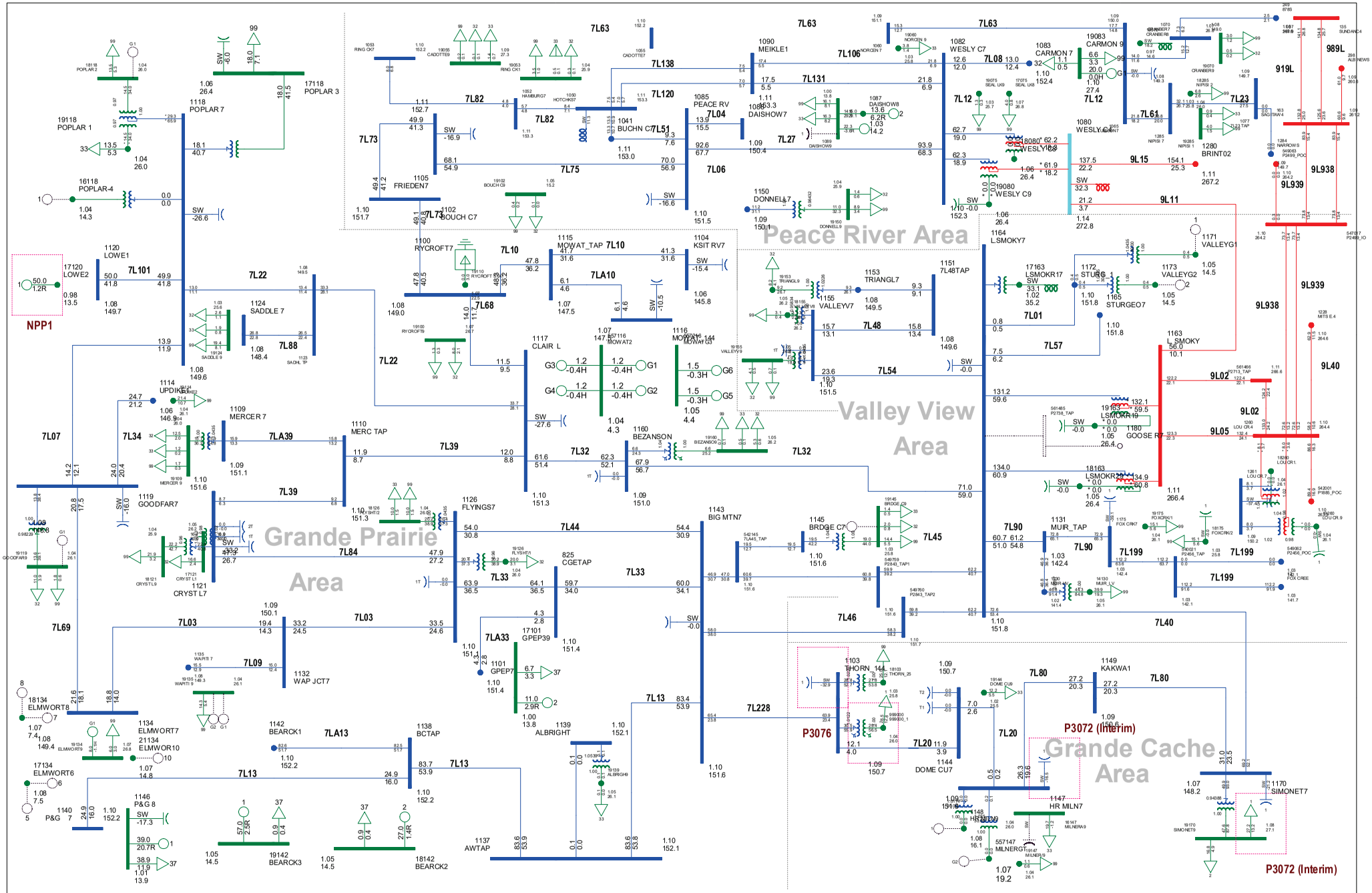
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L40 (LITTLE SMOKY 813S – SIMONETTE 733S
SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 17:03
New Diagram

A8-13

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



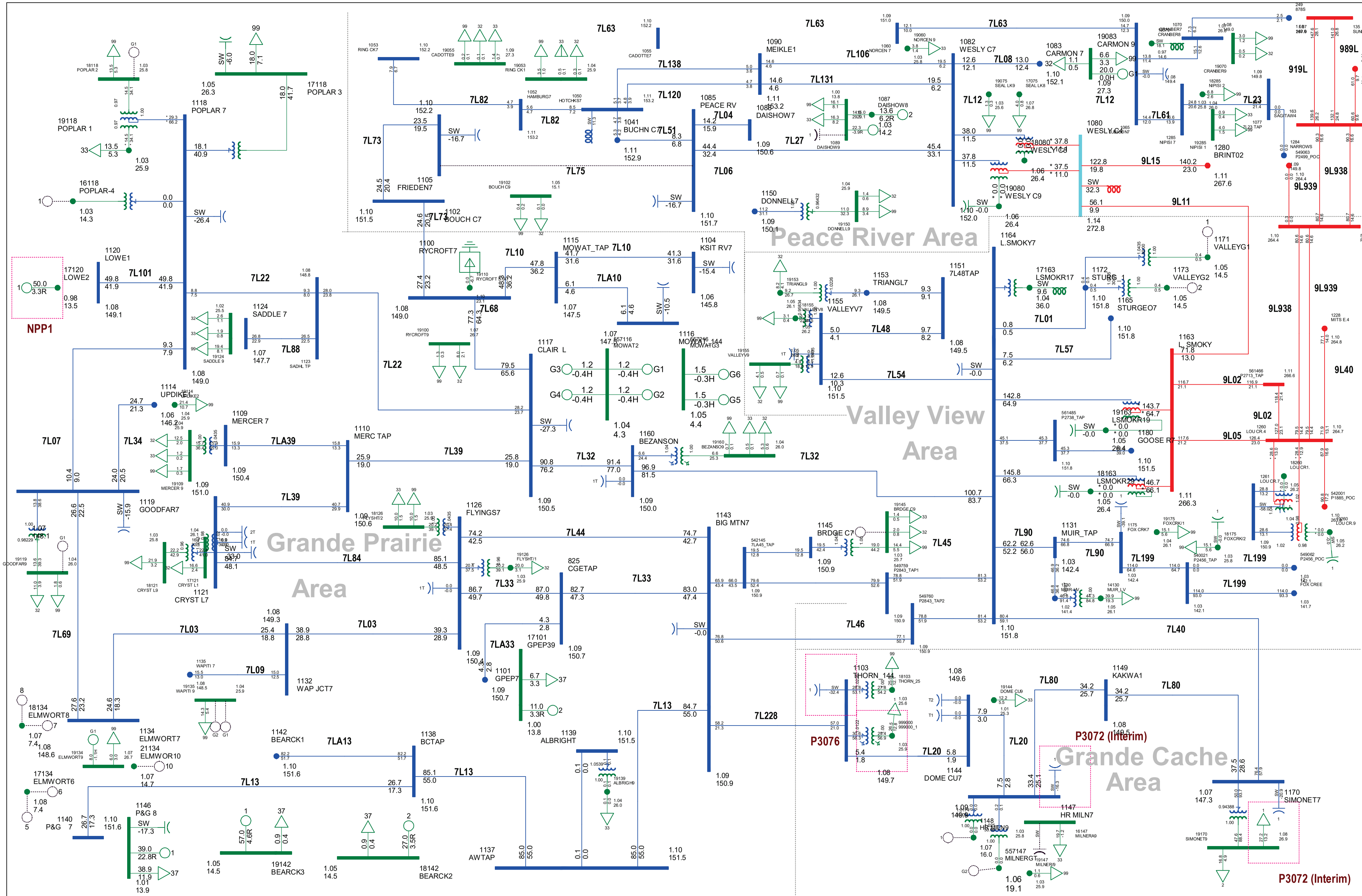
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L56 (LITTLE SMOKY 813S - LOUISE CREEK 8
SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 17:03
New Diagram

A8-14

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



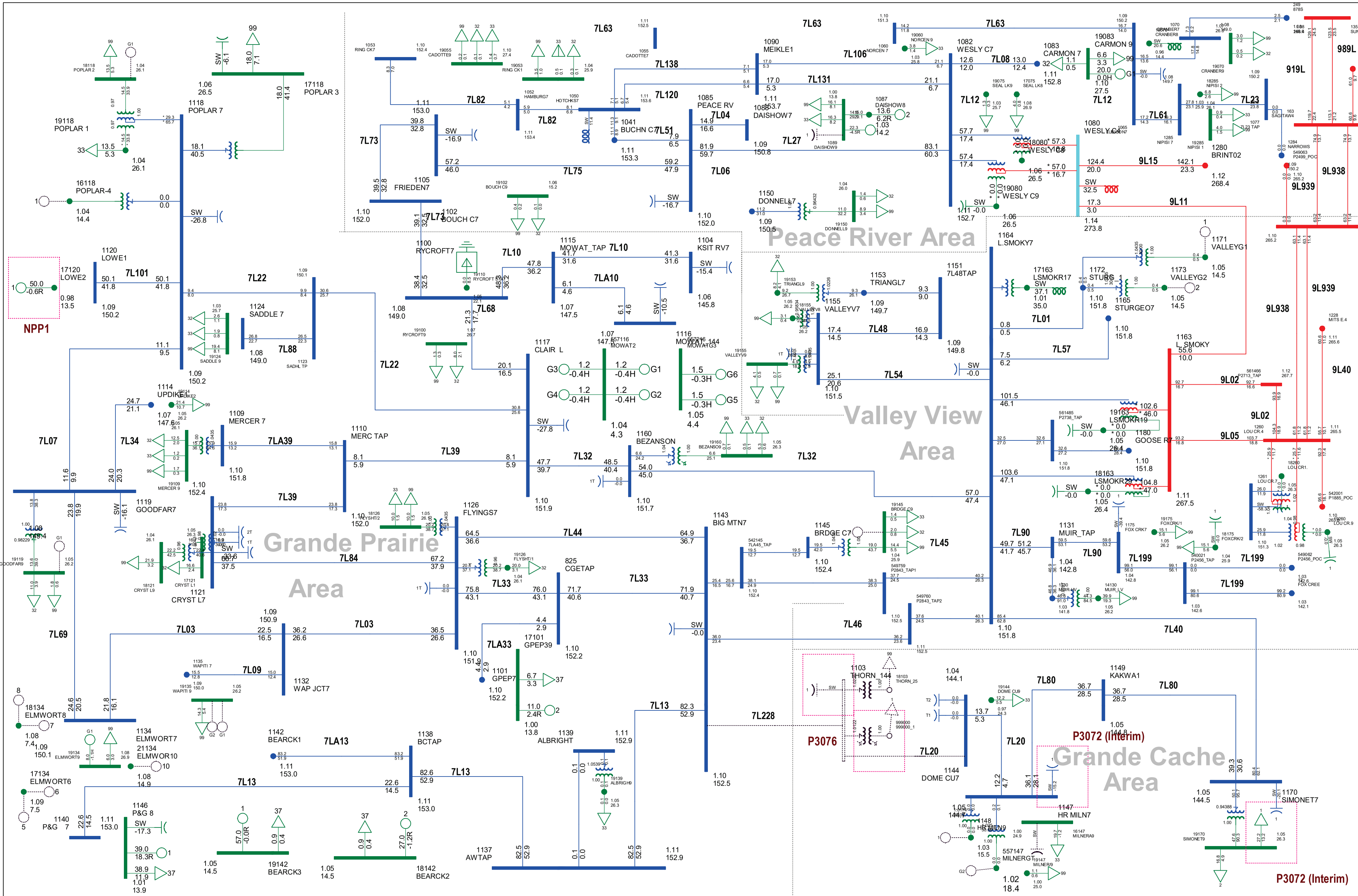
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L75 (FRIEDNESTAL 800S - WEST PEACE RIVE
SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 17:03
New Diagram

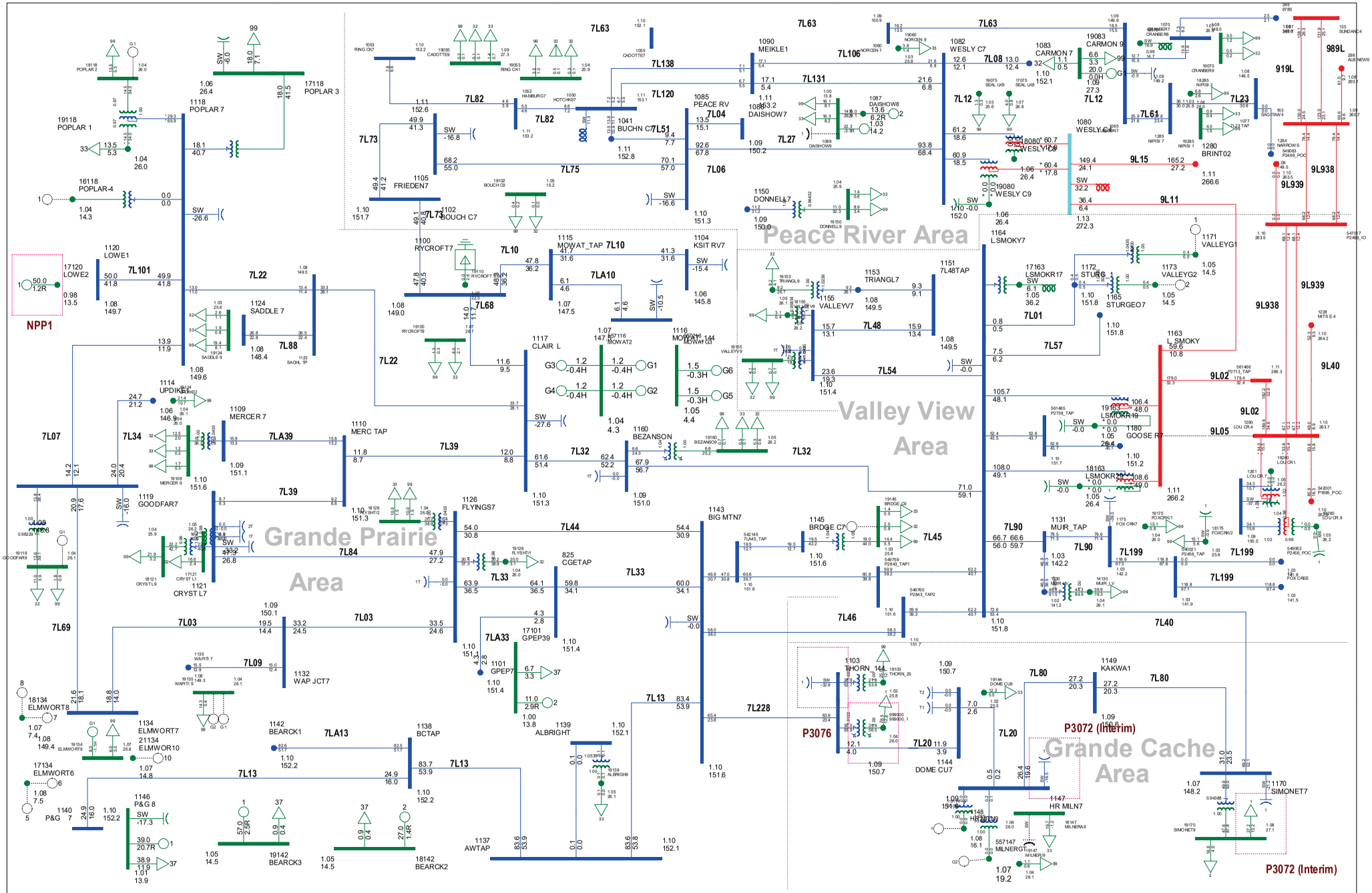
Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A8-15



P3076 **ATCO Thornton Capacity Addition**	**CATEGORY B, LOSS OF 7L228 (Big Mountain 845S - Thornton 2091S)** **SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS** **THU, MAY 28 2026 17:14 New Diagram**	Bus - Voltage (kV/pu) Branch - MVA/% RATE1 Equipment - MW/Mvar 100.0%RATE1 1.123OV 0.940UV kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A8-16



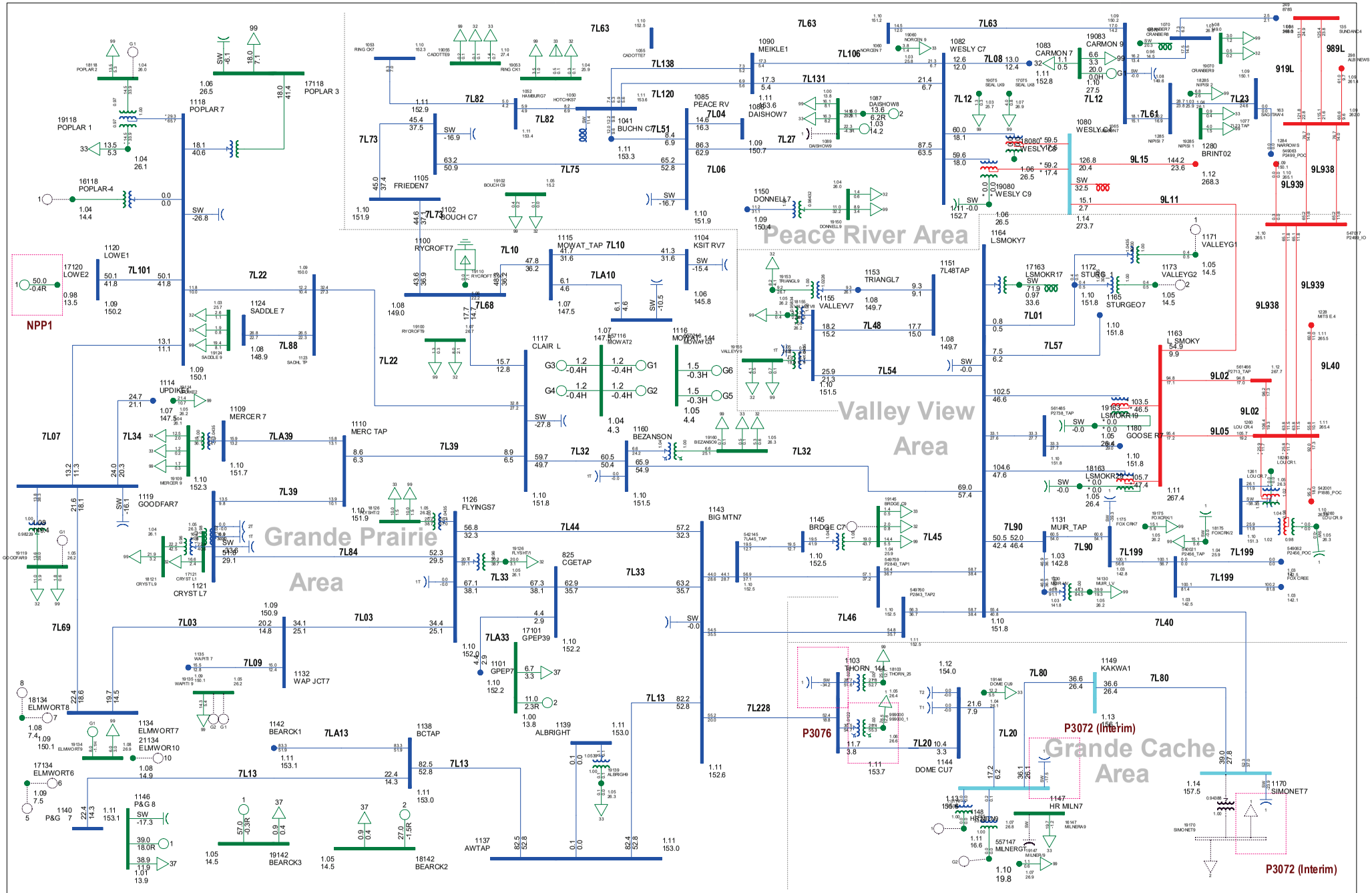
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 9L05 (LITTLE SMOKY 813S - LOUISE CREEK 8
SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 17:03
New Diagram

A8-17

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

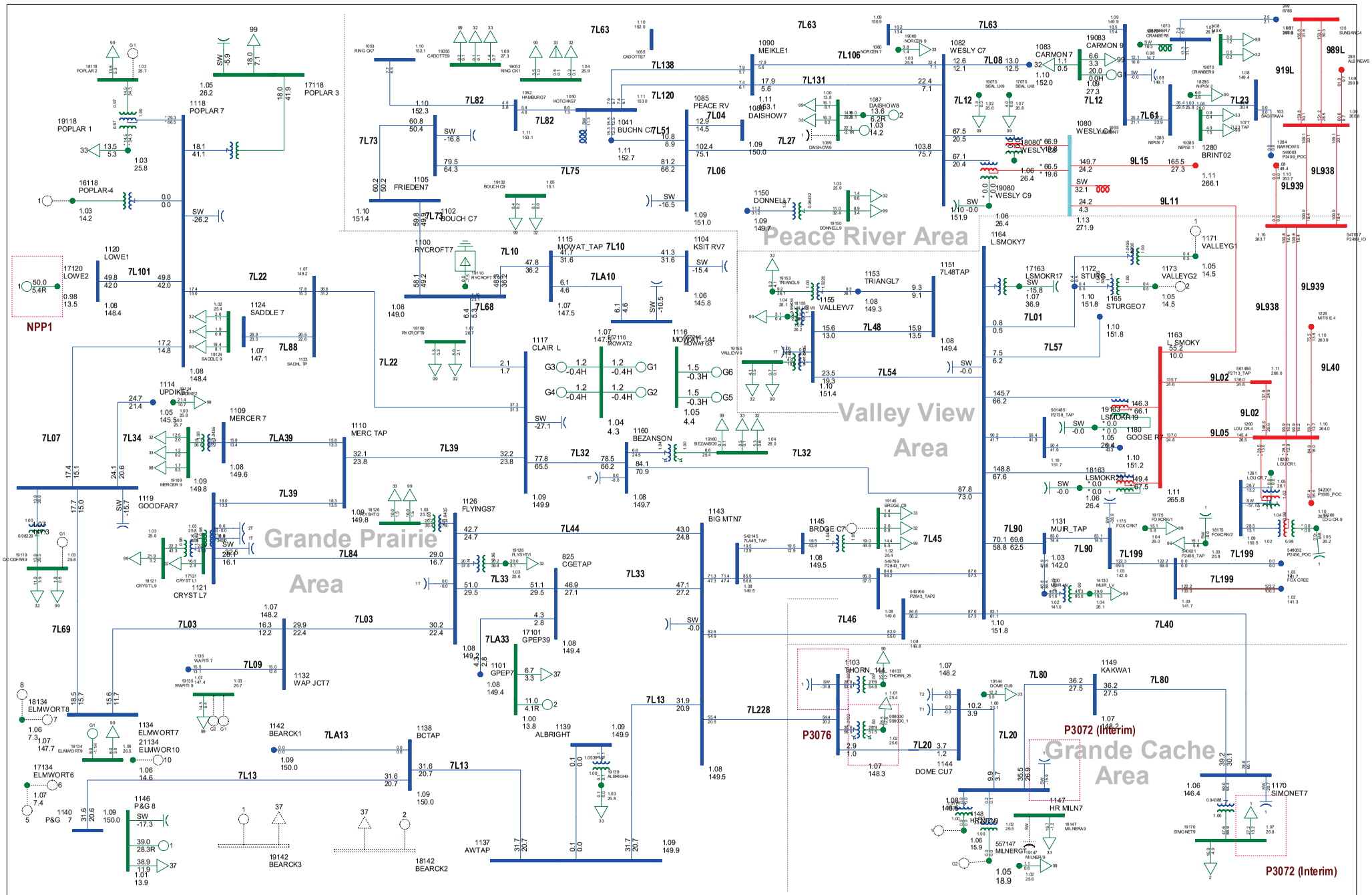


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ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF SIMONETTE 733S 702T
SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 17:08
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



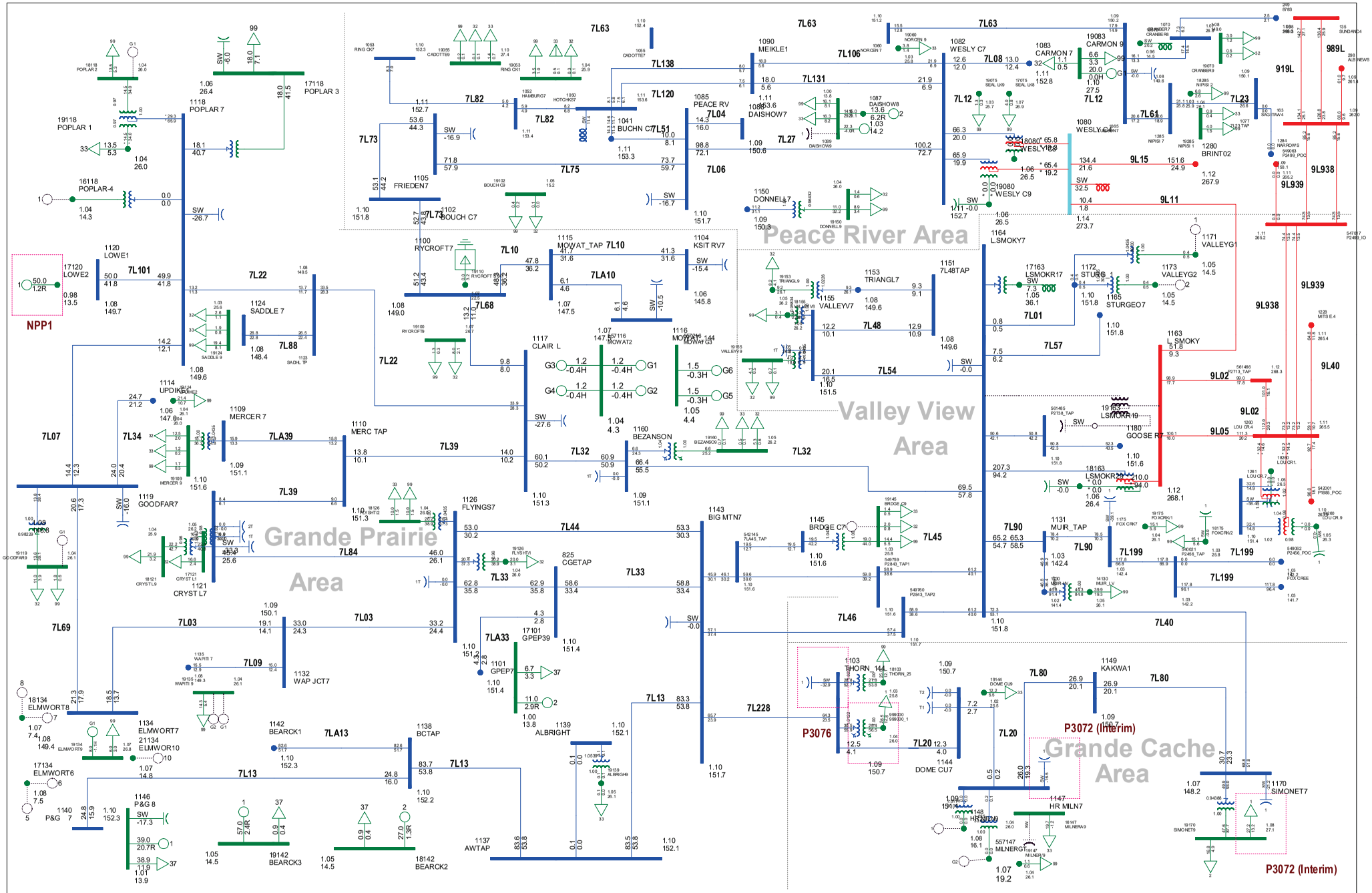
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF BEAR CREEK 679S 701T
SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 17:03
New Diagram

A8-19

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

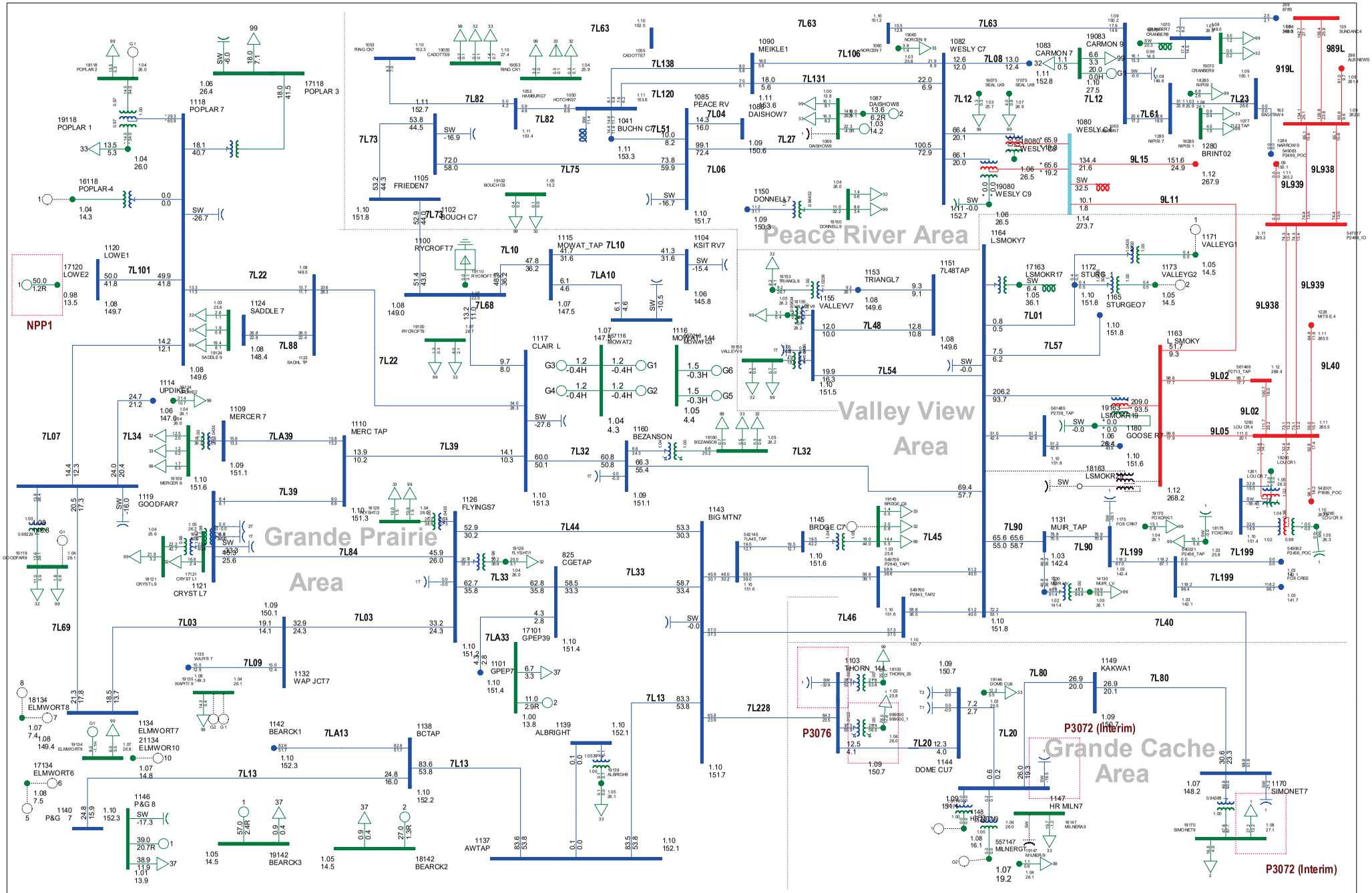


P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF LITTLE SMOKY 813S 901T
SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 17:03
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



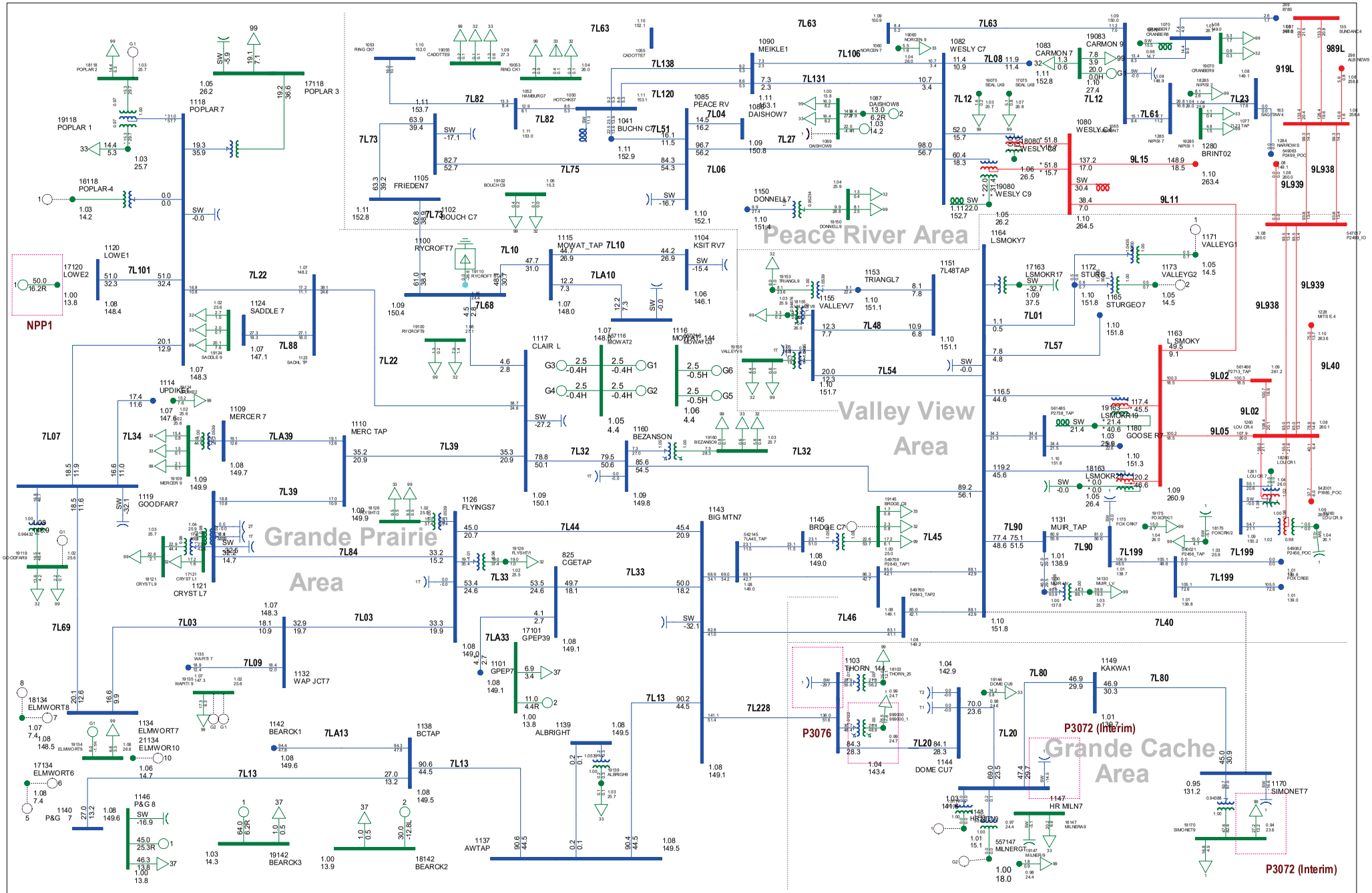
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF LITTLE SMOKY 813S 902T
SCN8_2029 SP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 17:06
New Diagram

A8-21

Bus - Voltage (kV/pu)
Branch - MVA/% RATE1
Equipment - MW/Mvar
100.0%RATE1
1.123OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



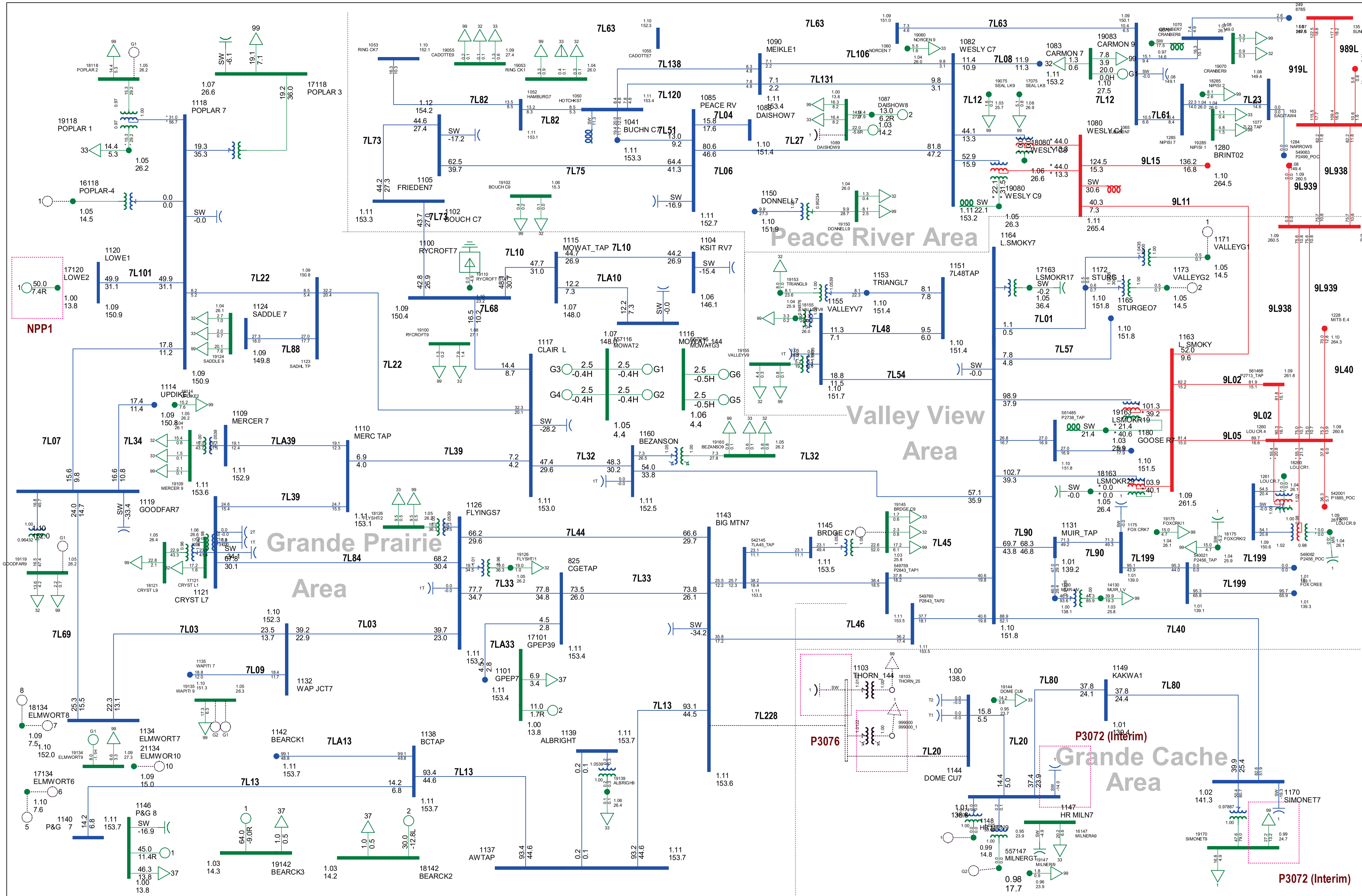
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L40 (LITTLE SMOKY 813S – SIMONETTE 733S
SCN9_2029 WP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 16:49
New Diagram

A8-22

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.120OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



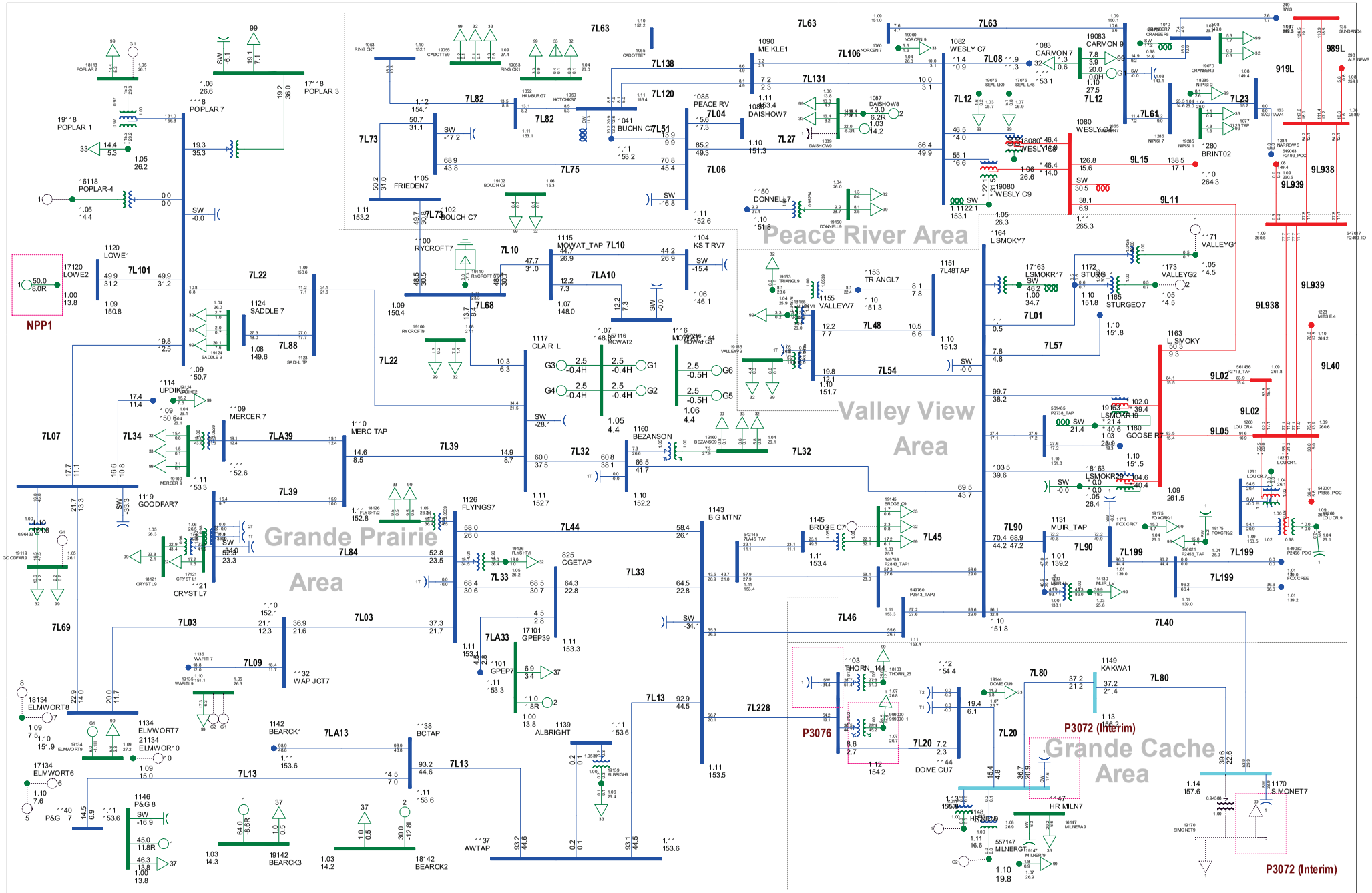
P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF 7L228 (Big Mountain 845S - Thornton 2091S)
SCN9_2029 WP_POST_SENSITIVITY_TMR_CAPS THU, MAY 28 2026 16:51
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.120OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A8-23

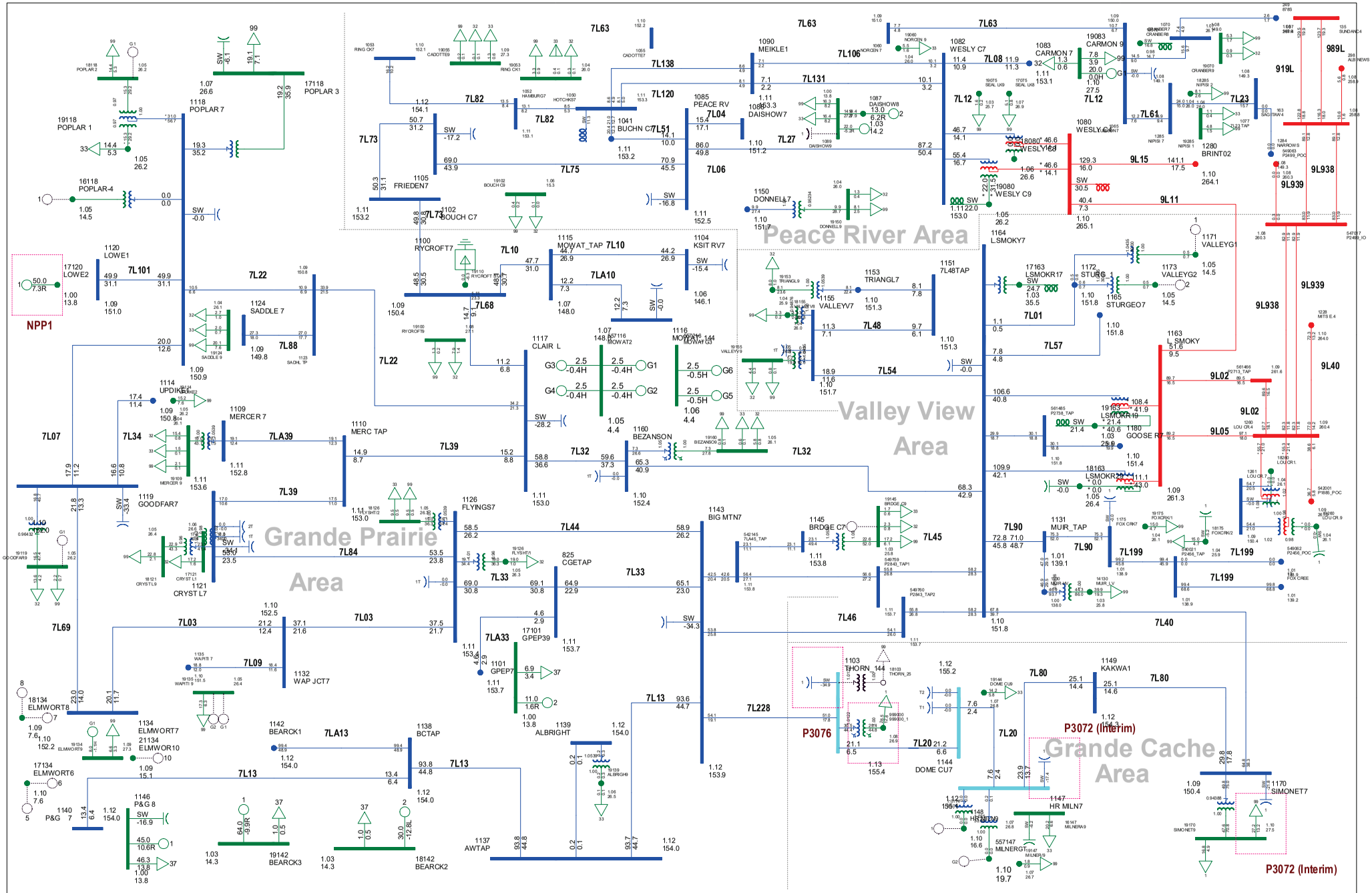


P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF SIMONETTE 733S 702T
SCN9_2029 WP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 16:49
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.120OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

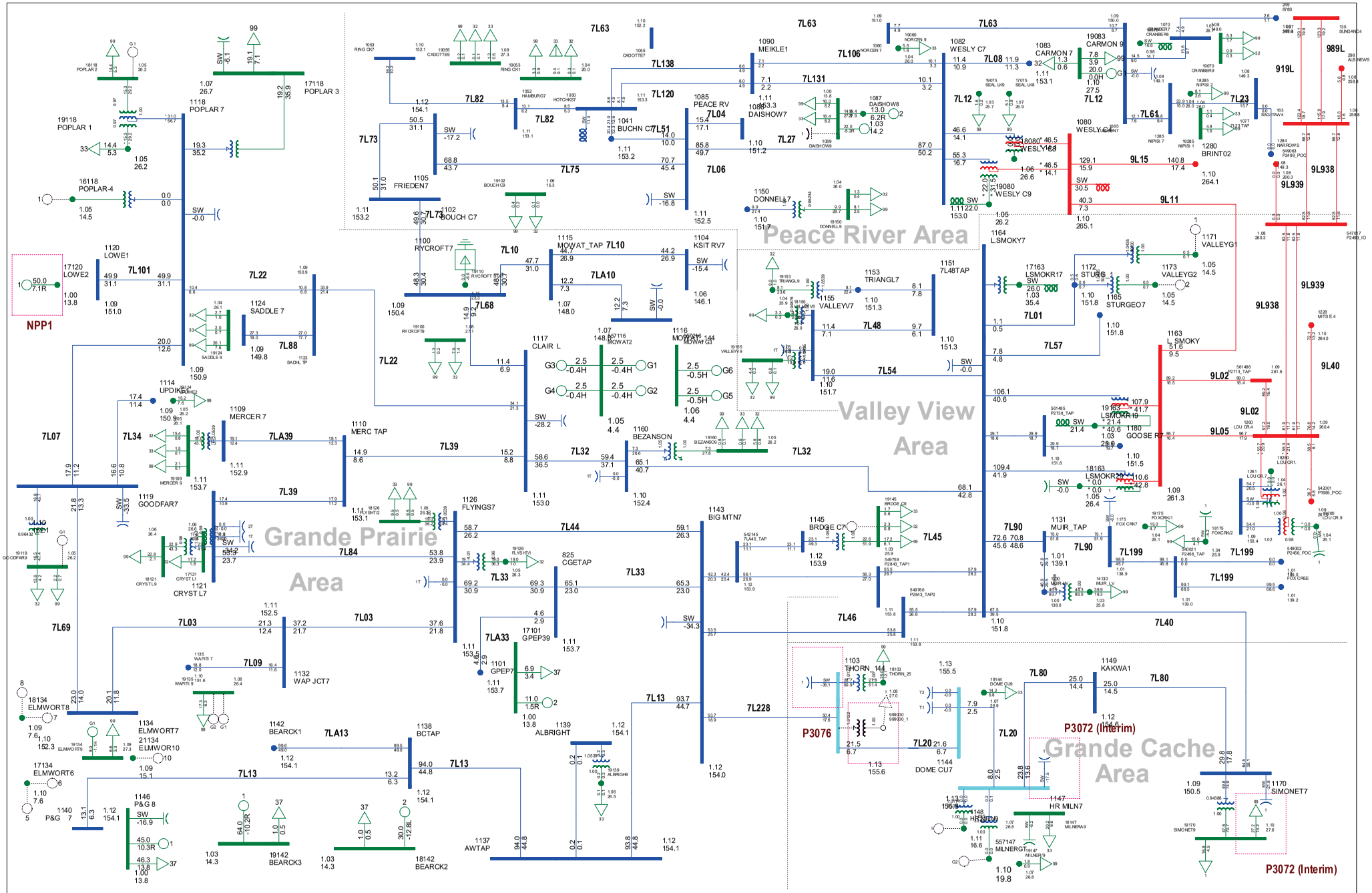


P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF THORNTON 2091S 701T
SCN9_2029 WP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 16:49
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.120OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000



P3076

ATCO Thornton Capacity Addition

CATEGORY B, LOSS OF THORNTON 2091S 702T
SCN9_2029 WP_POST_SENSITIVITY_TMR_CAPS
THU, MAY 28 2026 16:49
New Diagram

Bus - Voltage (kV/pu)
Branch - MVA/% RATE2
Equipment - MW/Mvar
100.0%RATE2
1.120OV 0.940UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000

A8-26

Attachment A9

Post-Mitigation Voltage Stability Diagrams with TMR and RAS (Scenario 9)

Scenario 9: P3076_P3072 2029 WP Post-Project (Sensitivity)

Voltage stability analysis was performed for scenario 9 by increasing load in Grande Cache (Area 22), Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 9 is 232 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 11.6 MW (0.05 x 232 MW = 11.6 MW) for the scenario 9.

Table 1 provides voltage stability study results under Category A condition and for the five (5) worst contingencies under Category B conditions. The voltage stability diagrams are provided in Figure 1. Based on the study results, the voltage stability margin was met for all studied conditions.

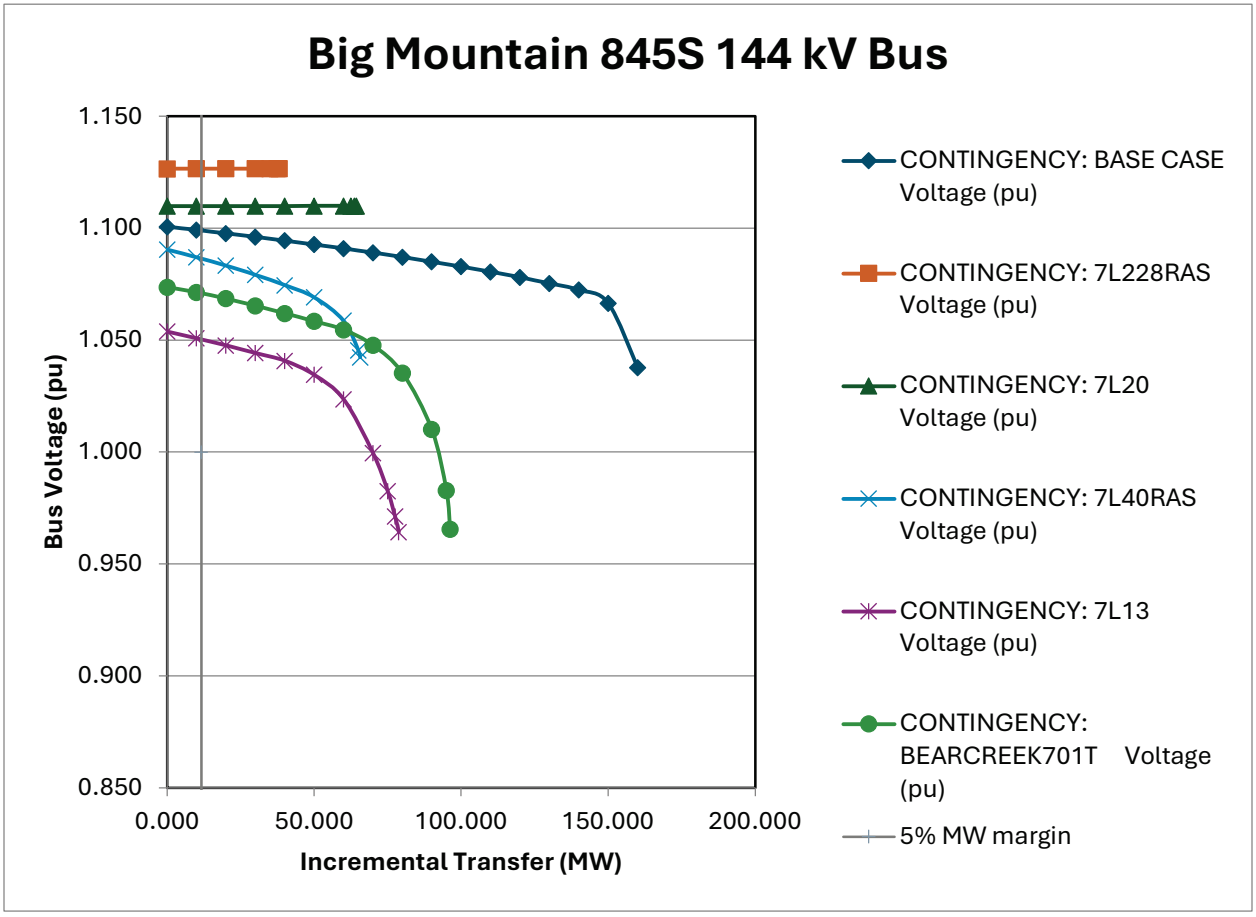
The following Buses were selected for the study:

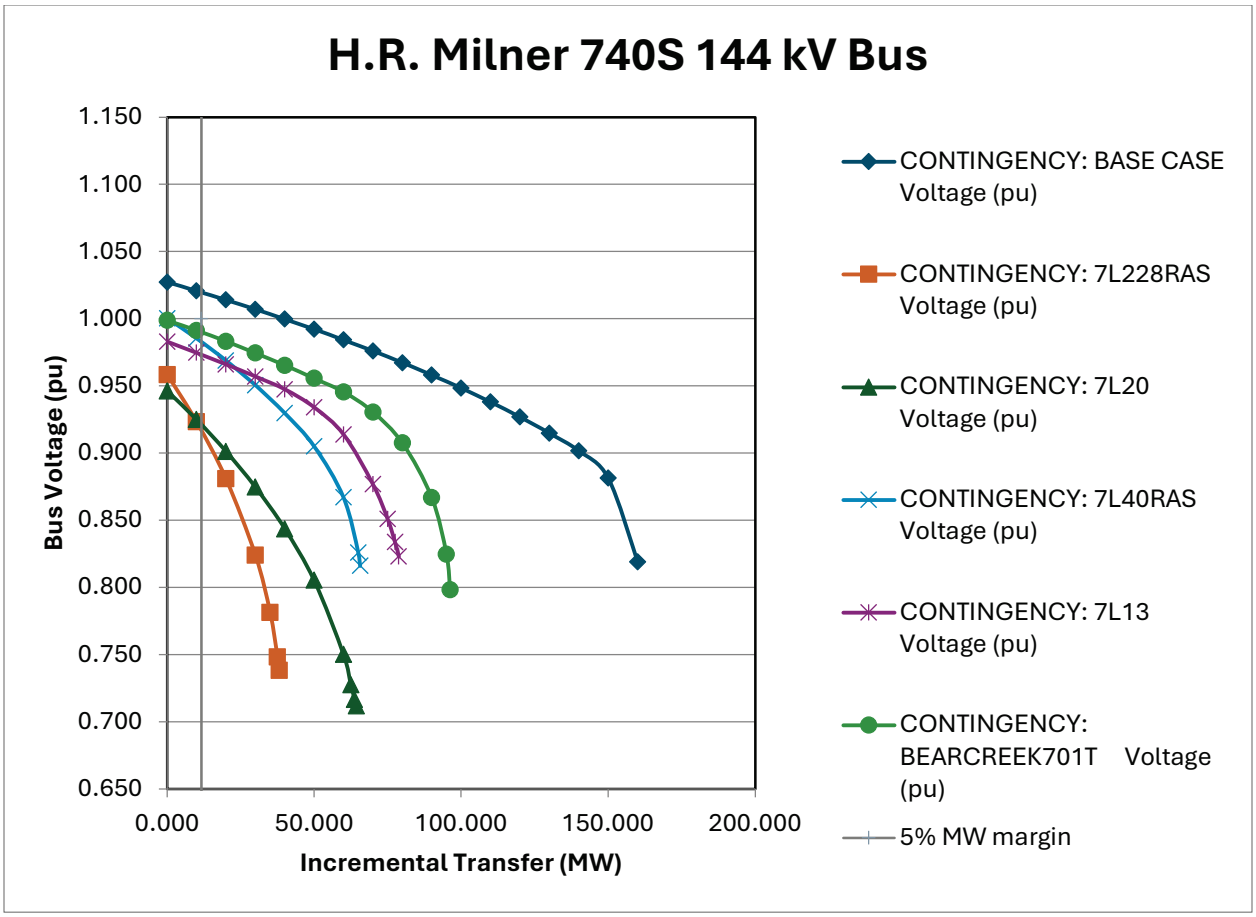
- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

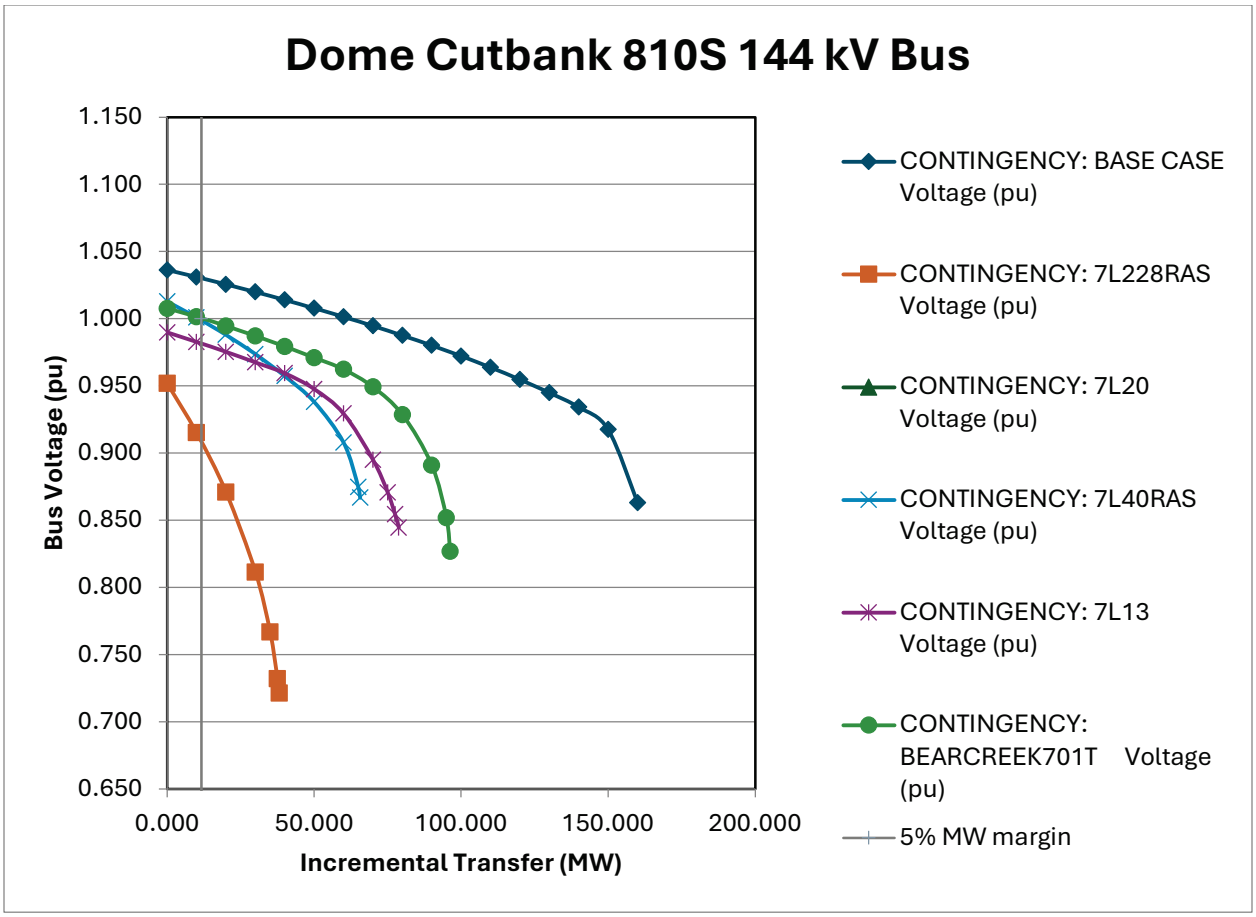
Table 1: Summary of Results under Category B Conditions for Scenario 9 with TMR and RAS

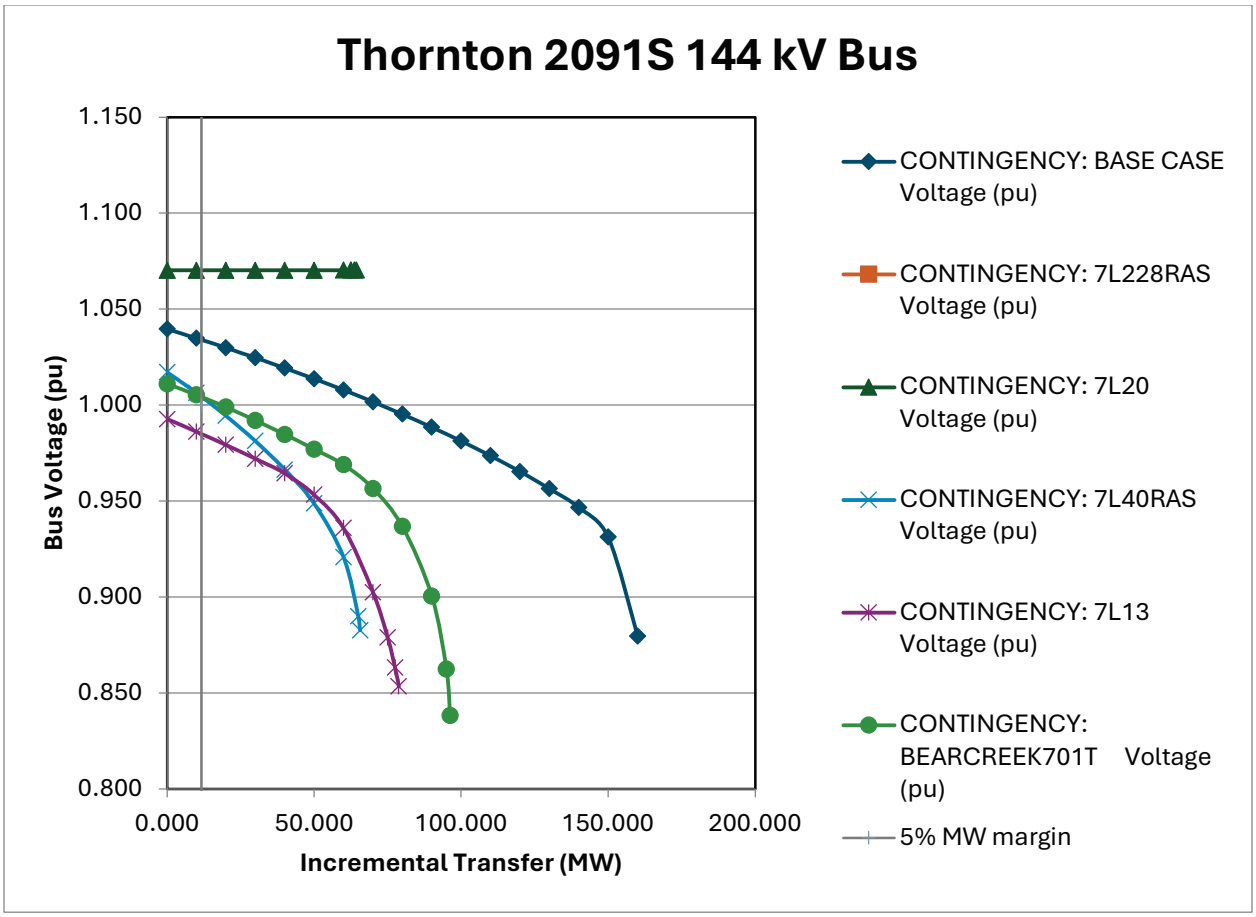
Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		160	Yes
7L228_RAS	Thornton 2091S	Big Mountain 845S	38.2	Yes
7L20	Thornton 2091S	HR Milner 740S	64.4	Yes
7L40_RAS	Little Smoky 813S	Simonette 733S	65.6	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	78.8	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		96.3	Yes

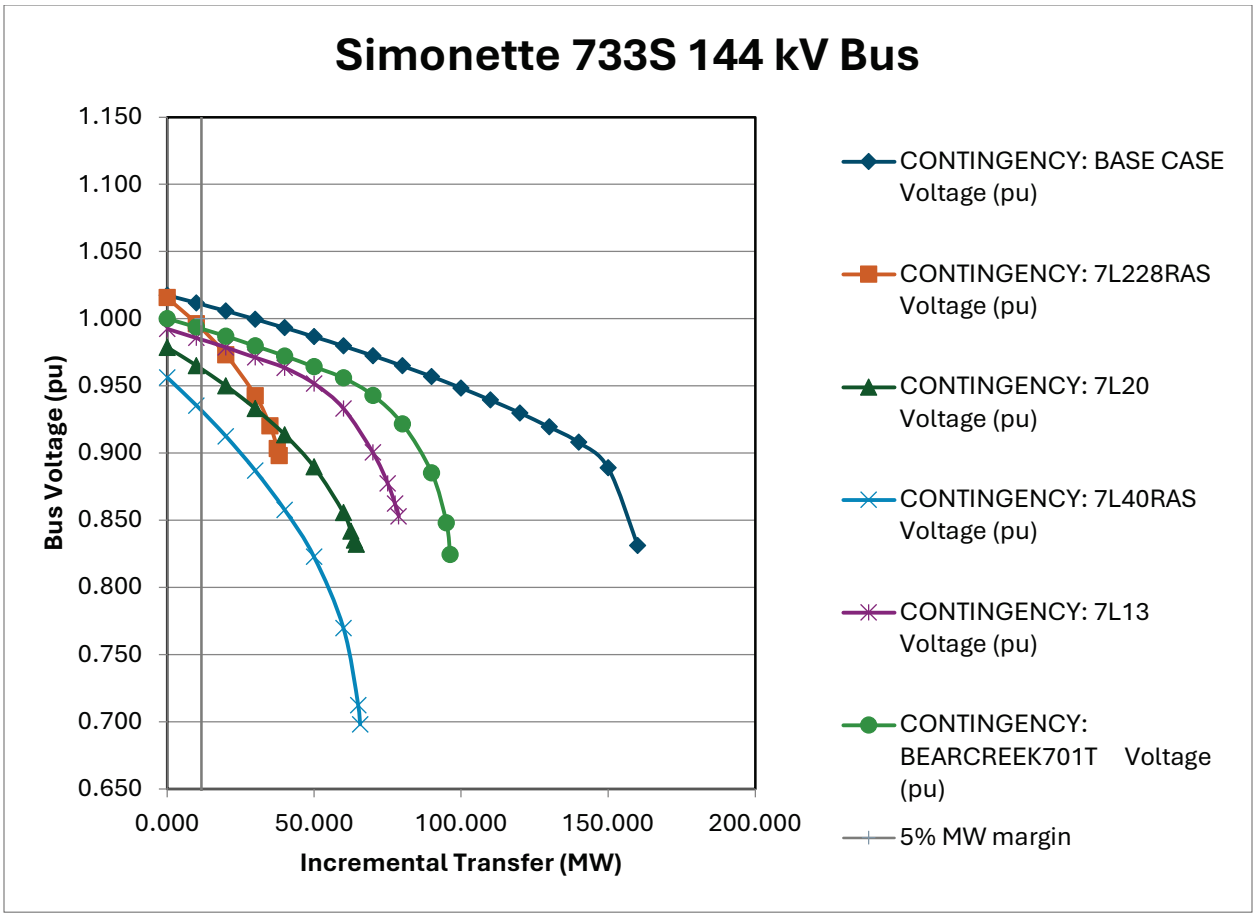
Figure 1:
Scenario 9: 2029_WP_POST-PROJECT_Sensitivity (with TMR and RAS)




H.R. Milner 740S 144 kV Bus
Bus Voltage (pu)
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228RAS Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L40RAS Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Dome Cutbank 810S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228RAS Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L40RAS Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Thornton 2091S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228RAS Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L40RAS Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Simonette 733S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228RAS Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L40RAS Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin

Attachment A10

Post-Mitigation Voltage Stability Diagrams with TMR and Capacitors
P3076 with P3072 Interim Stage
(Scenario 9)

Scenario 9: P3076_P3072 2029 WP Post-Project (Sensitivity)

Voltage stability analysis was performed for scenario 9 by increasing load in Grande Cache (Area 22), Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 9 is 232 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 11.6 MW (0.05 x 232 MW = 11.6 MW) for the scenario 9.

Table 1 provides voltage stability study results under Category A condition and for the five (5) worst contingencies under Category B conditions. The voltage stability diagrams are provided in Figure 1. Based on the study results, the voltage stability margin was met for all studied conditions.

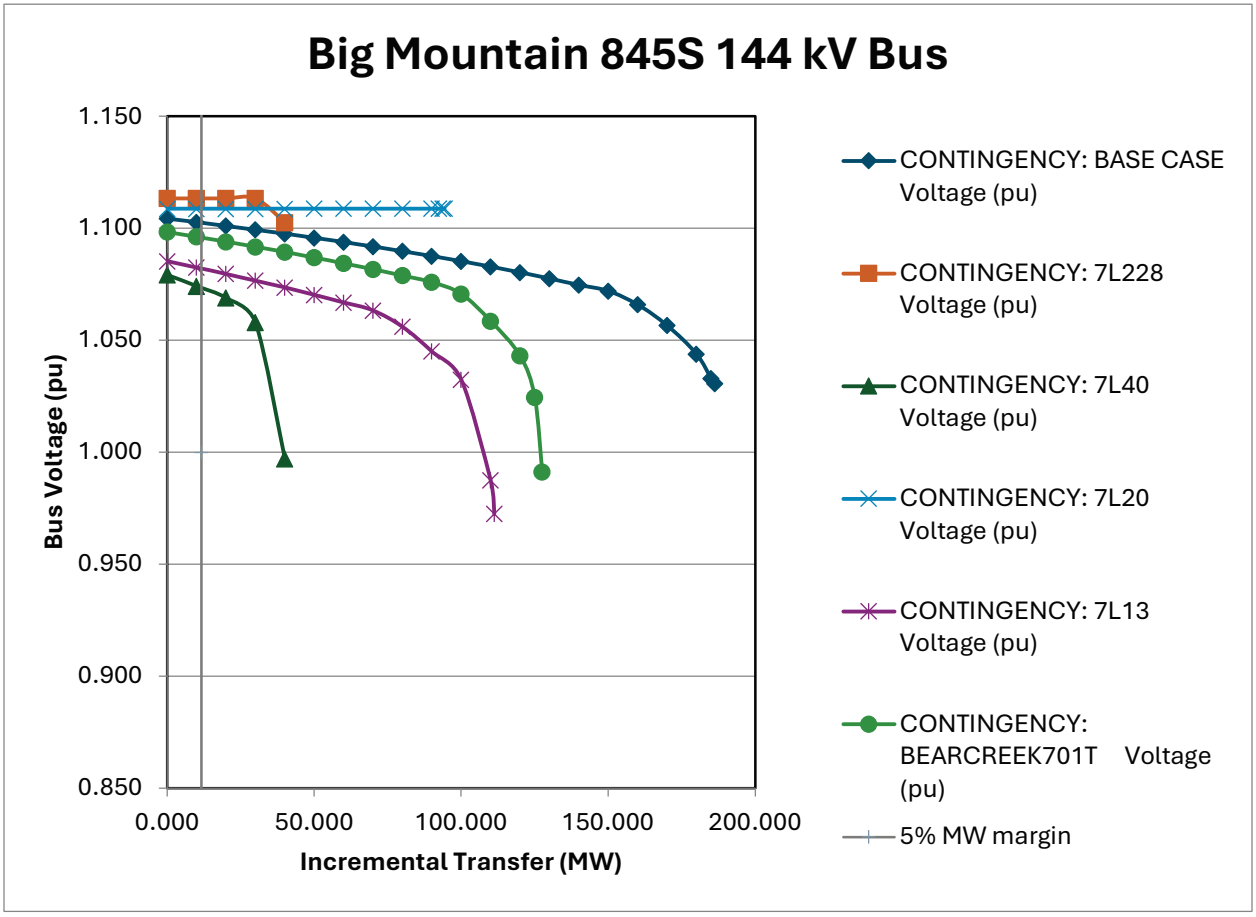
The following Buses were selected for the study:

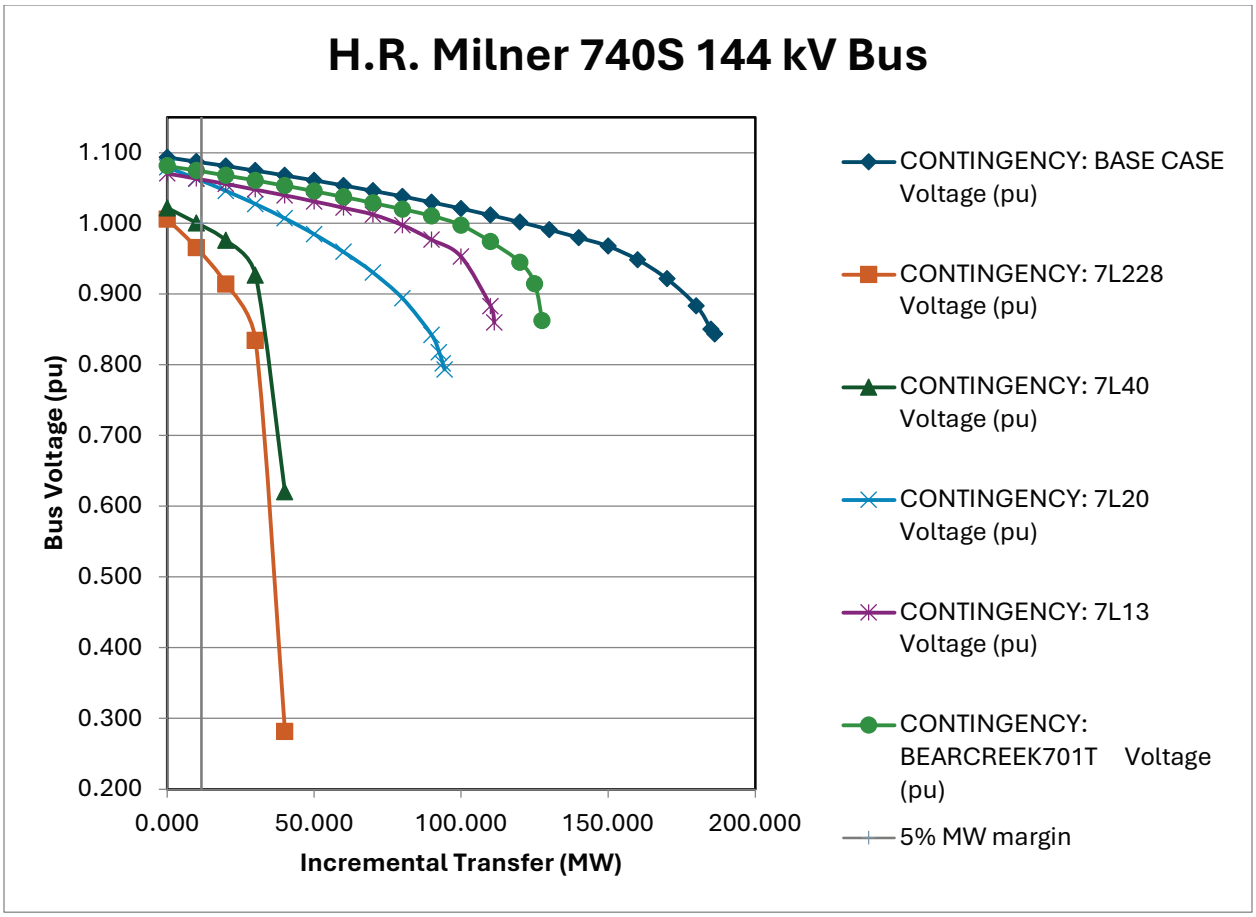
- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)

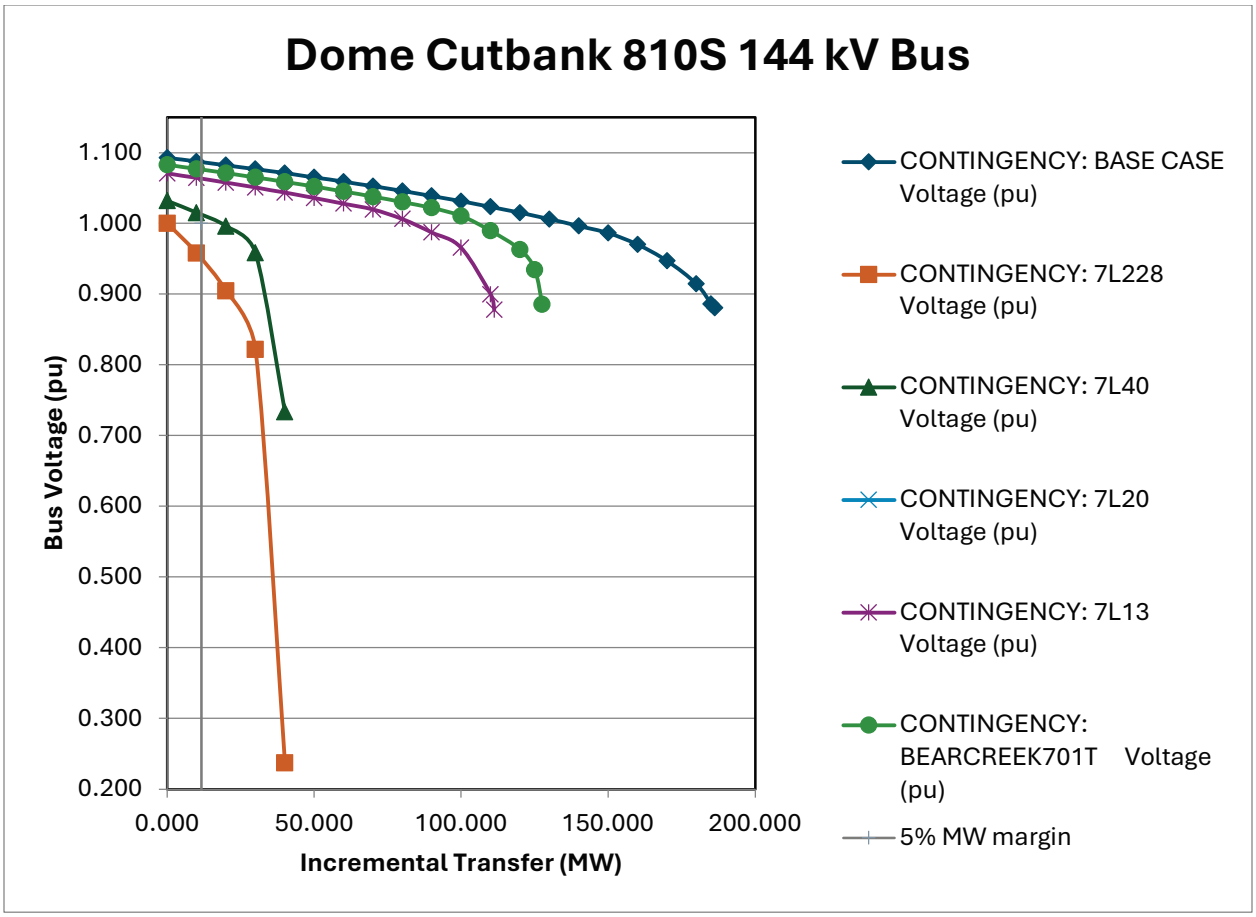
Table 1: Summary of Results under Category B Conditions for Scenario 9 with TMR and Capacitors

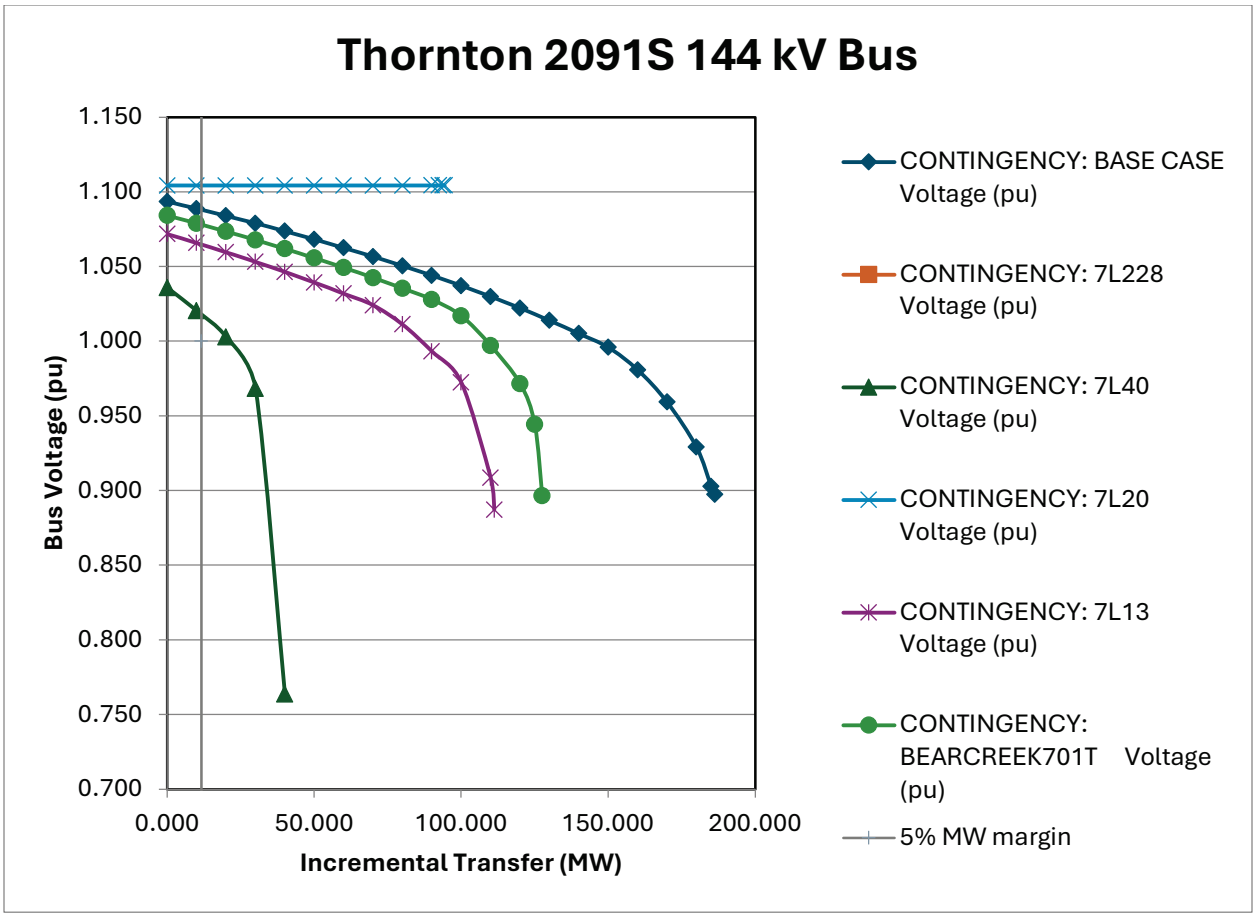
Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		186.3	Yes
7L40	Little Smoky 813S	Simonette 733S	40	Yes
7L228	Thornton 2091S	Big Mountain 845S	40	Yes
7L20	Thornton 2091S	HR Milner 740S	95	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	111.3	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		127.5	Yes

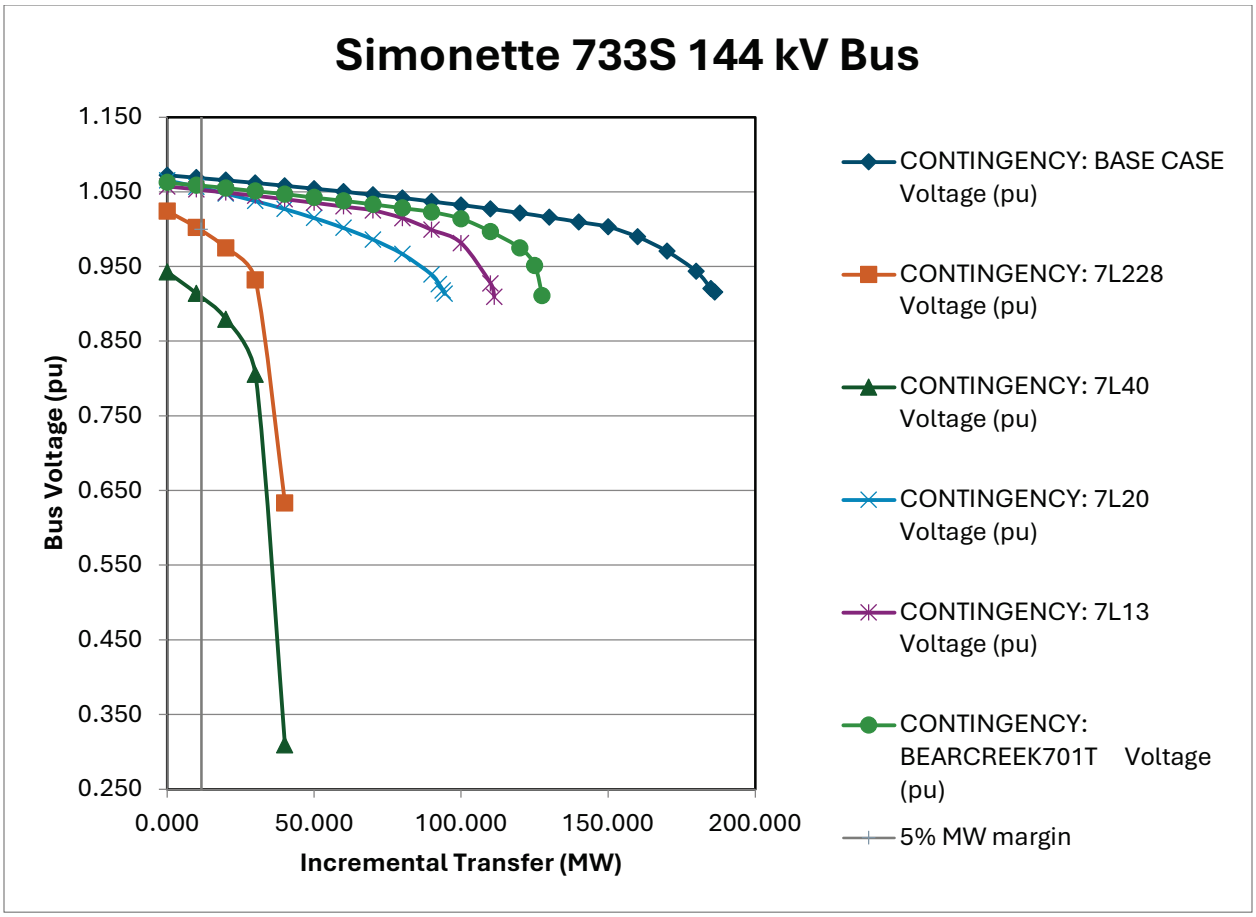
Figure 1:
Scenario 9: 2029_WP_POST-PROJECT_Sensitivity (TMR and Caps)




H.R. Milner 740S 144 kV Bus
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Dome Cutbank 810S 144 kV Bus
Bus Voltage (pu)
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Thornton 2091S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin


Simonette 733S 144 kV Bus
1.150
1.050
0.950
0.850
0.750
0.650
0.550
0.450
0.350
0.250
Bus Voltage (pu)
0.000
50.000
100.000
150.000
200.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: 7L228 Voltage (pu)
CONTINGENCY: 7L40 Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
5% MW margin

Attachment A11

Post-Mitigation Voltage Stability Diagrams with TMR and Capacitors
P3072 Final Stage with P3076 and P2716
(Scenario 9)

Scenario 9: 2029 SP Post-Project (Sensitivity)

Voltage stability analysis was performed for scenario 9 by increasing load in Grande Cache (Area 22), Fox Creek (Area 24) and increasing the generation in NE Region (Areas 25, 27, and 33), Calgary (Area 6) and Sheerness (Area 43). The reference load level for the study area for scenario 9 is 290 MW. To meet the voltage stability criteria for Category B contingencies, the required minimum incremental load transfer is 5% of the reference load, or 14.5 MW (0.05 x 290 MW = 14.5 MW) for the scenario 9.

Table 1 provides voltage stability study results under Category A condition and for the five (5) worst contingencies under Category B conditions. The voltage stability diagrams are provided in Figure 1. Based on the study results, the voltage stability margin was met for all studied conditions.

The following Buses were selected for the study:

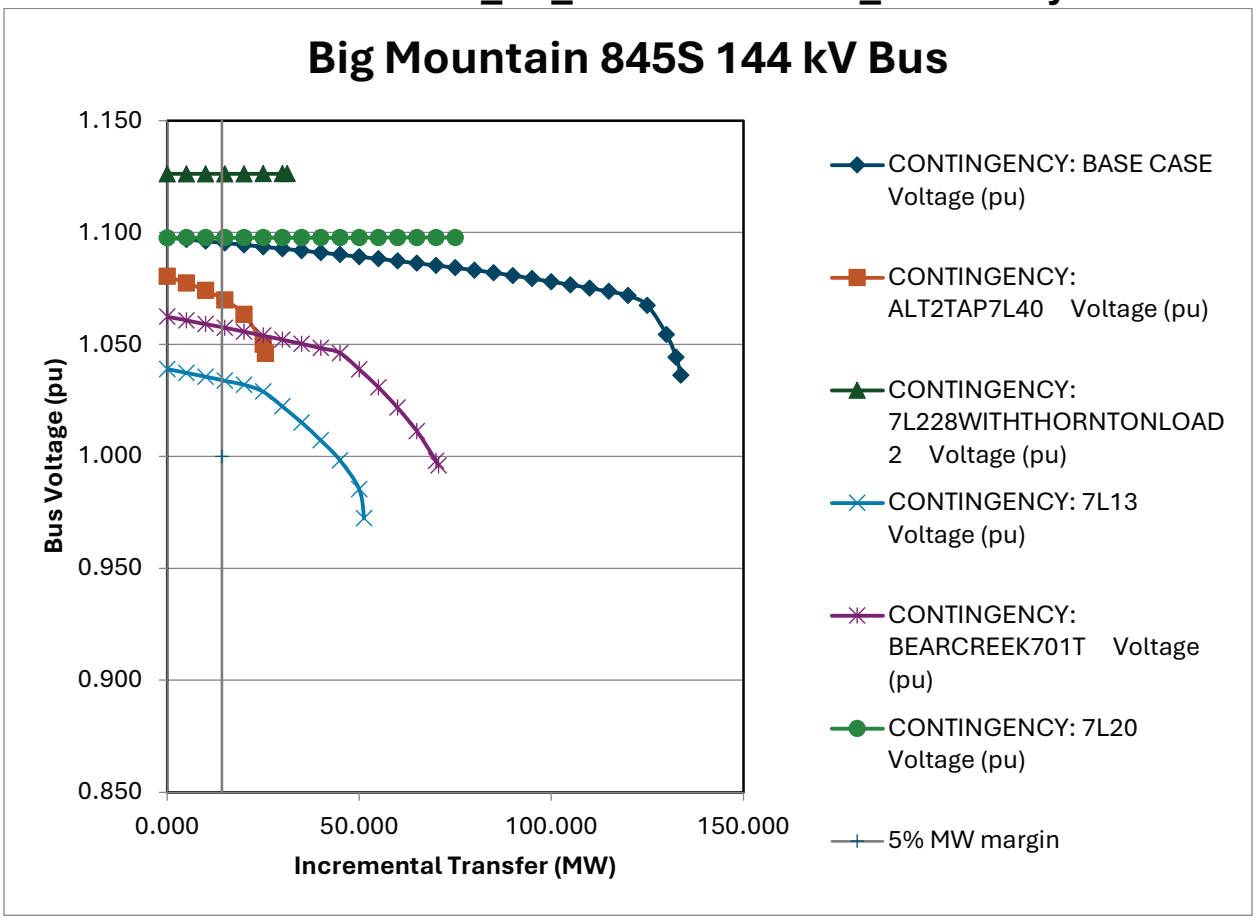
- Big Mountain 845S 144 kV Bus (bus 1143)
- H.R. Milner 740S 144 kV Bus (bus 1147)
- Thornton 2091S 144 kV Bus (bus 1103)
- Simonette 733S 144 kV Bus (bus 1170)
- Dome Cut Bank 810S 144 kV Bus (bus 1144)
- Pakenham 2103S 144 kV Bus (bus 542006)
- Pearson 2089S new POD 144 kV Bus (bus 990002)

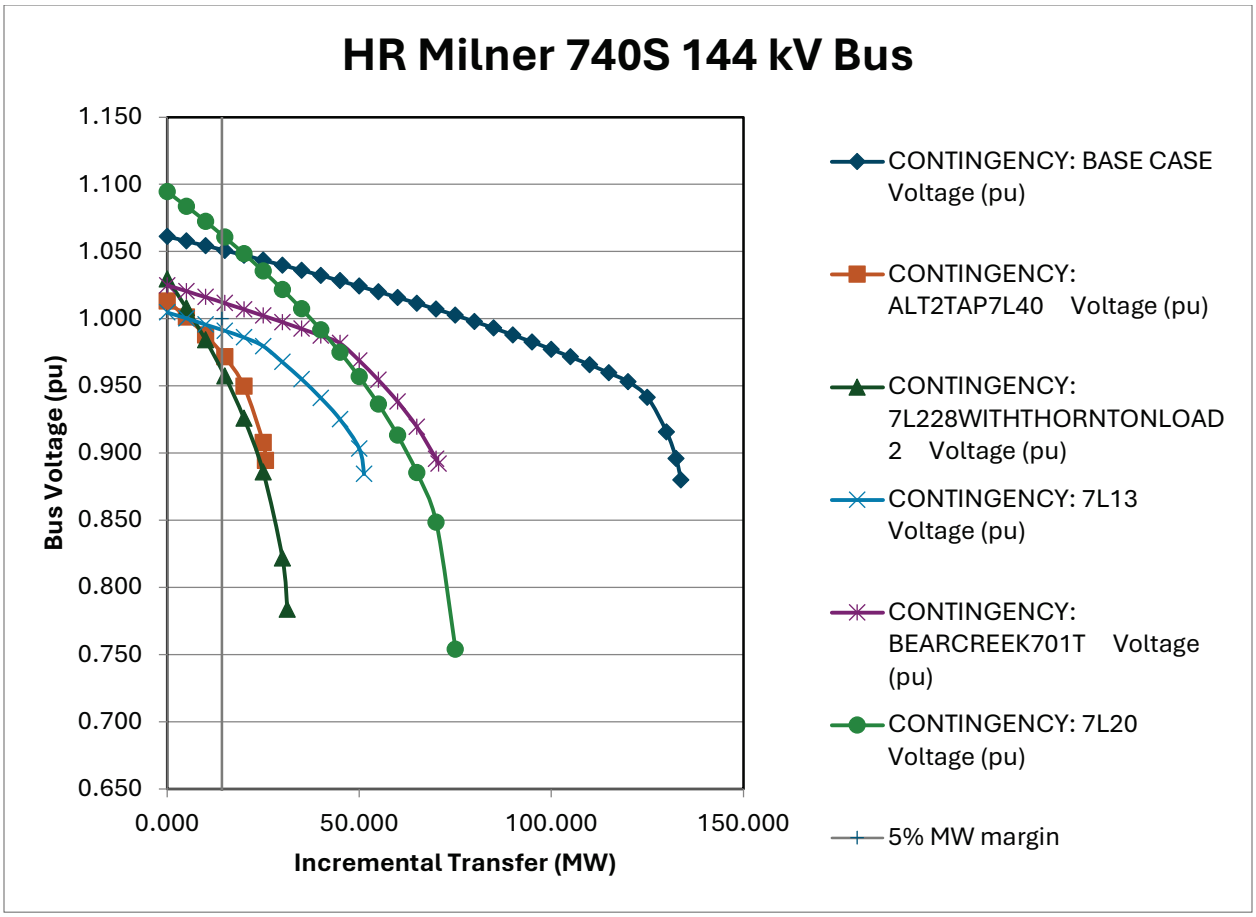
Table 1: Summary of Results under Category B Conditions for Scenario 9 (P3702 Final Stage with P3076 and P2716)

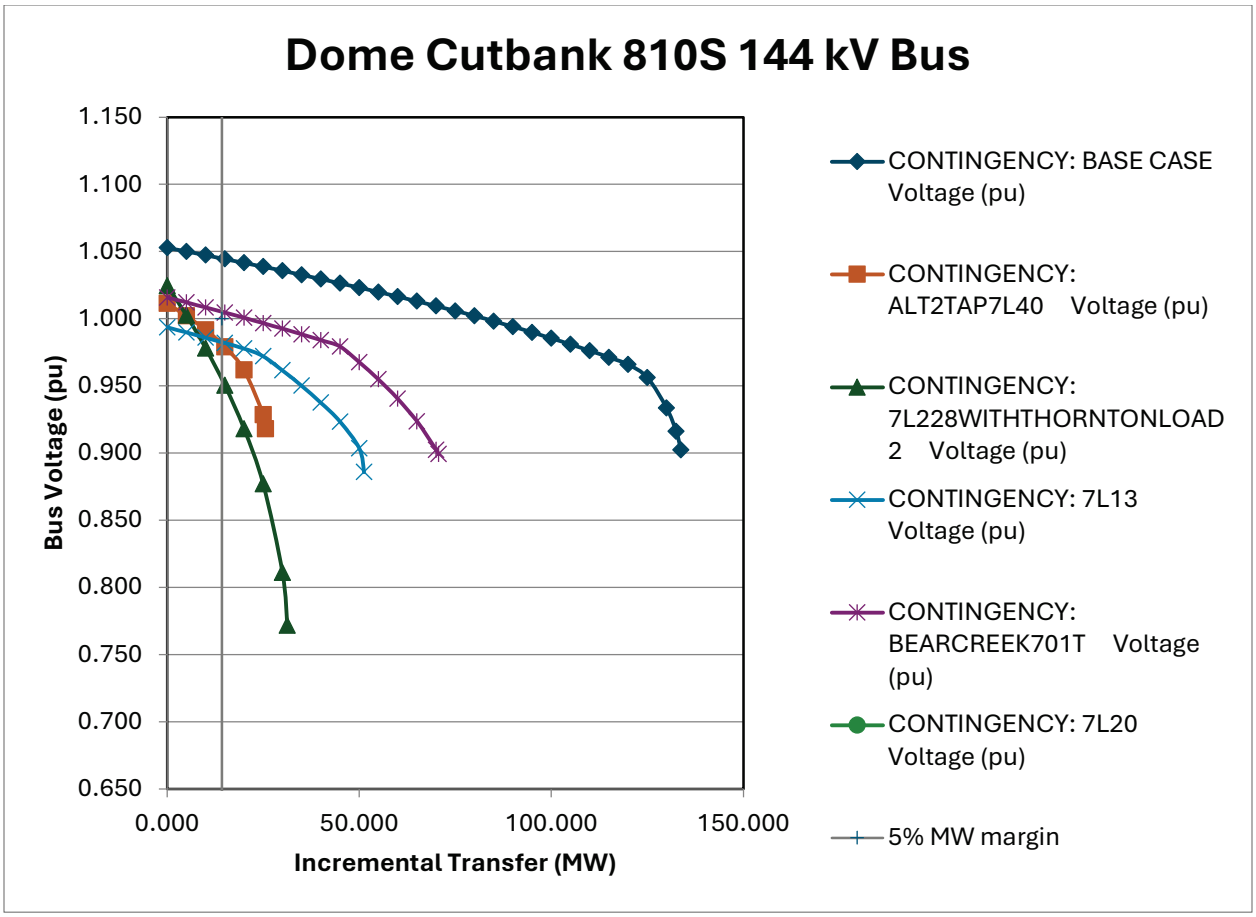
Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	Base case (System Normal)		133.8	Yes
7L40	Little Smoky 813S	Simonette 733S	25.7	Yes
7L228	Big Mountain 845S	Thornton 2091S	31.3	Yes
7L13	Big Mountain 845S	Proctor & Gamble 808S	51.3	Yes
Bear Creek 679S 701T	Bear Creek 679S 701T		70.7	Yes
7L20	Thornton 2091S	HR Milner 740S	75	Yes

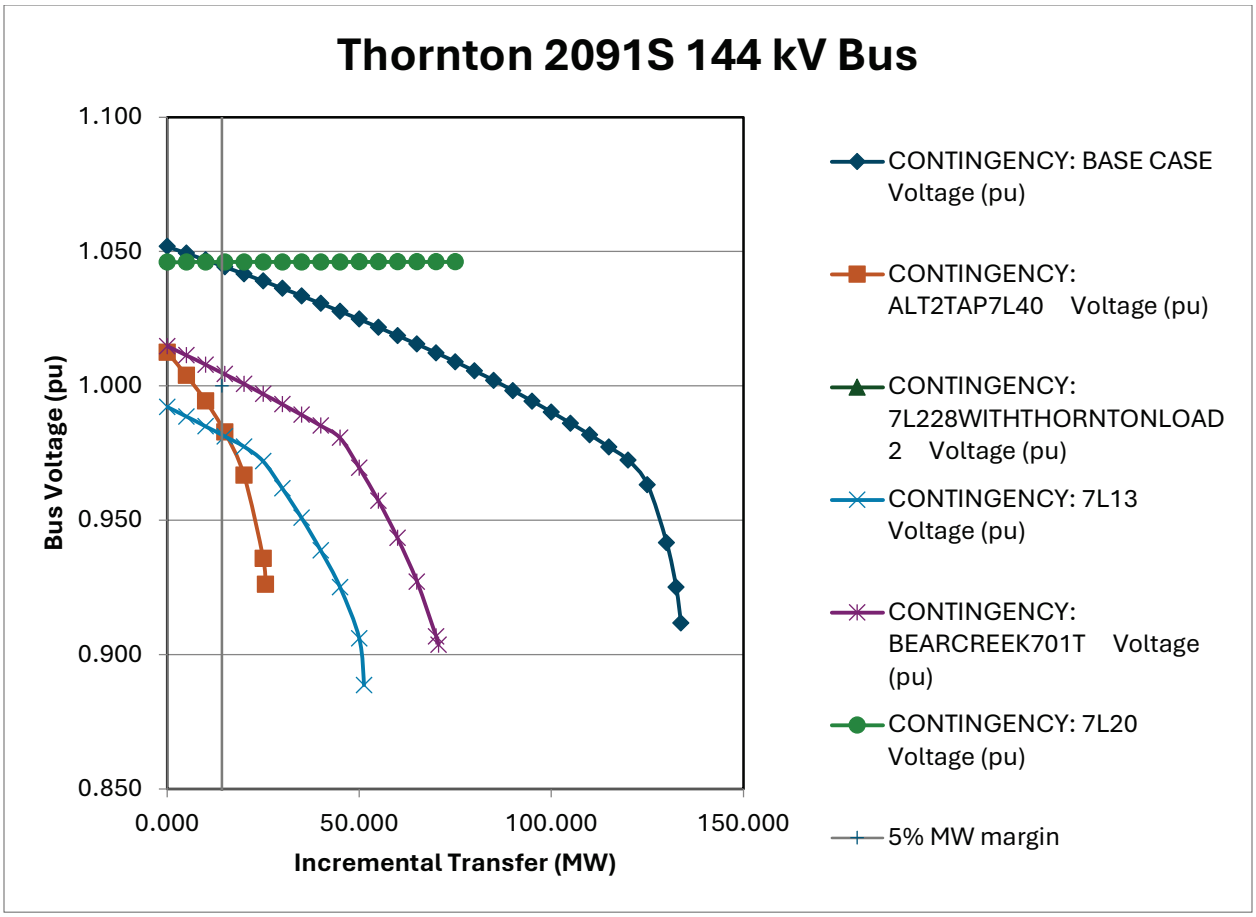
Figure 1:

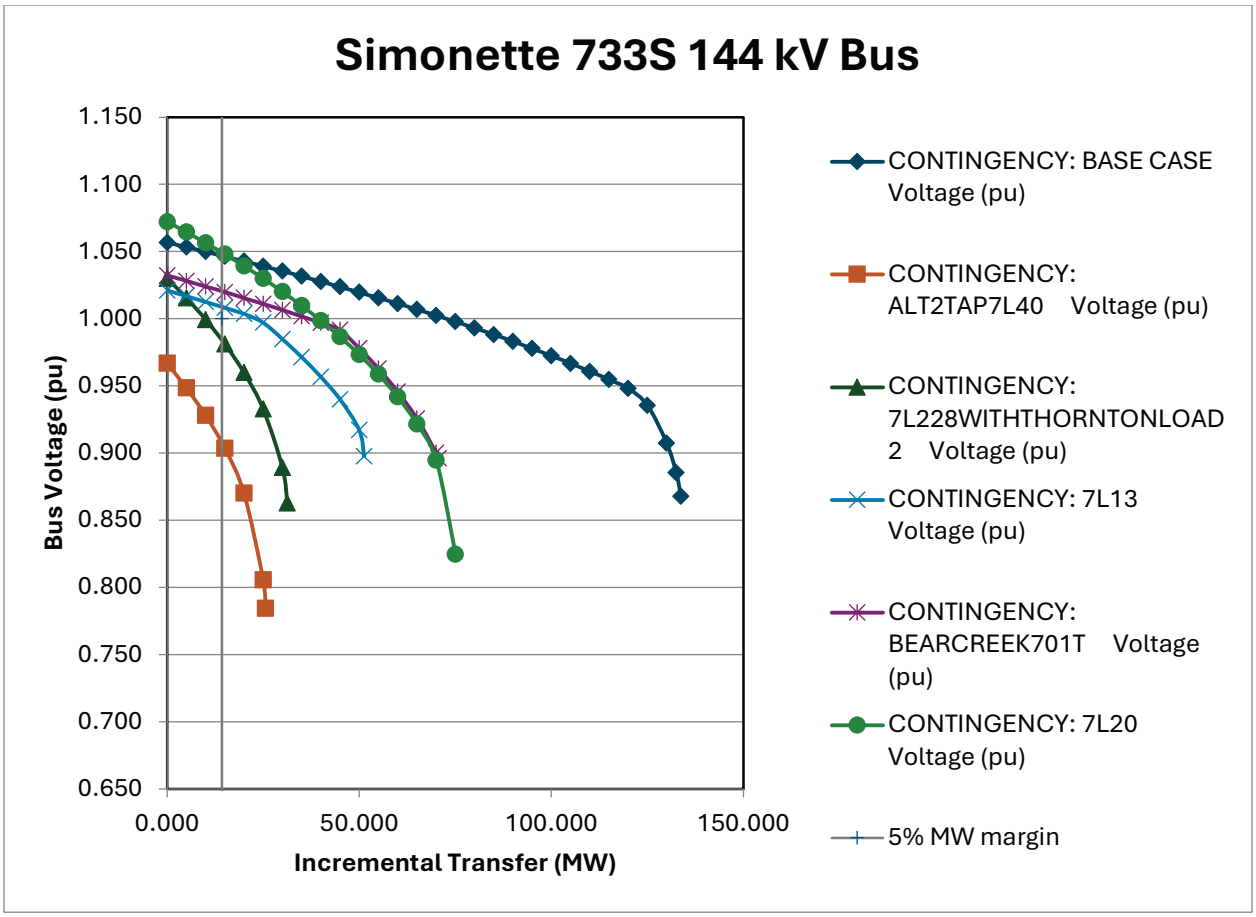
Scenario 9: 2029_SP_POST-PROJECT_Sensitivity

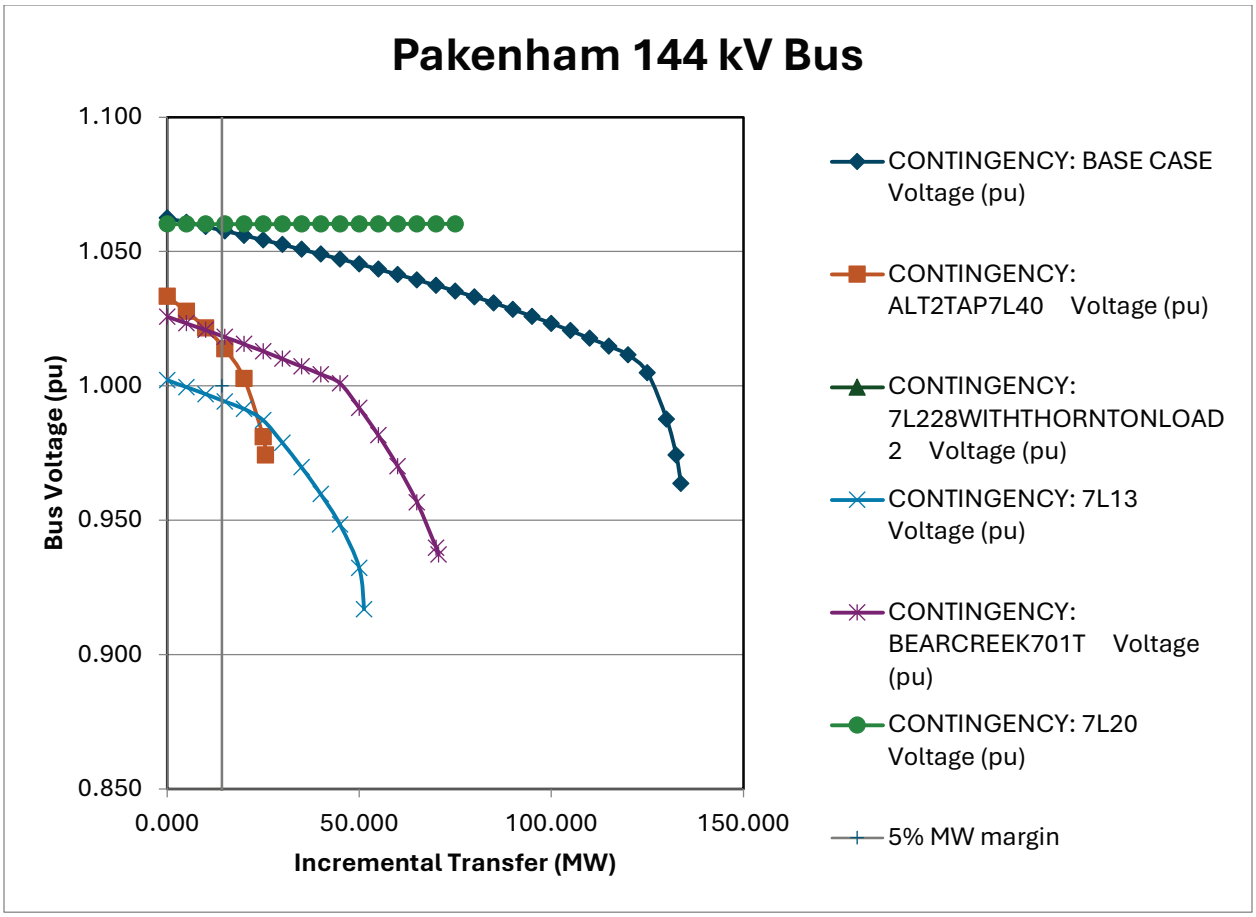


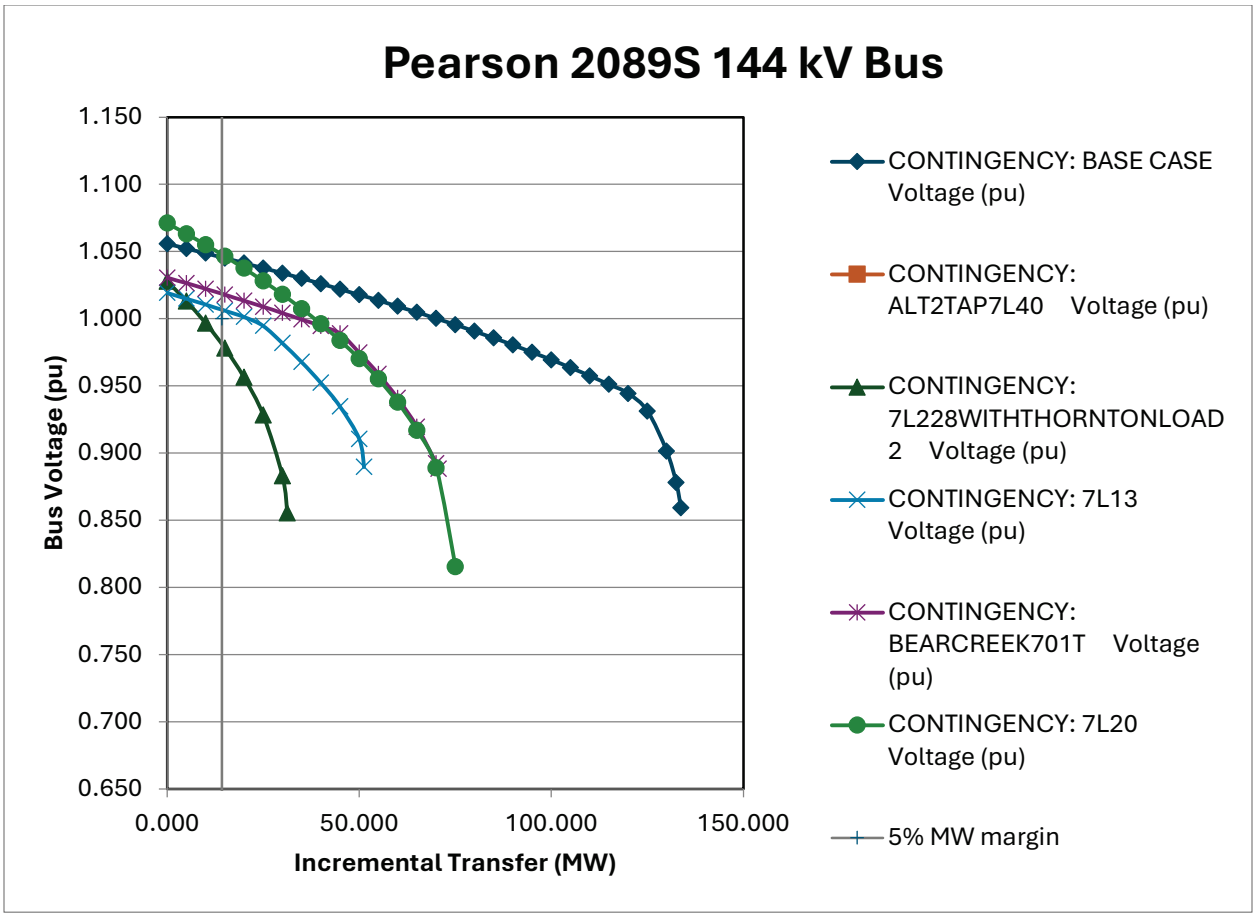

HR Milner 740S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
Bus Voltage (pu)
0.000
50.000
100.000
150.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: ALT2TAP7L40 Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD 2 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
5% MW margin


Dome Cutbank 810S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
Bus Voltage (pu)
0.000
50.000
100.000
150.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: ALT2TAP7L40 Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD 2 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
5% MW margin


Thornton 2091S 144 kV Bus
1.100
1.050
1.000
0.950
0.900
0.850
Bus Voltage (pu)
0.000
50.000
100.000
150.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: ALT2TAP7L40 Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD 2 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
5% MW margin


Simonette 733S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
Bus Voltage (pu)
0.000
50.000
100.000
150.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: ALT2TAP7L40 Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD 2 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
5% MW margin


Pakenham 144 kV Bus
1.100
1.050
1.000
0.950
0.900
0.850
Bus Voltage (pu)
0.000
50.000
100.000
150.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: ALT2TAP7L40 Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD 2 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
5% MW margin


Pearson 2089S 144 kV Bus
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
Bus Voltage (pu)
0.000
50.000
100.000
150.000
Incremental Transfer (MW)
CONTINGENCY: BASE CASE Voltage (pu)
CONTINGENCY: ALT2TAP7L40 Voltage (pu)
CONTINGENCY: 7L228WITHTHORNTONLOAD 2 Voltage (pu)
CONTINGENCY: 7L13 Voltage (pu)
CONTINGENCY: BEARCREEK701T Voltage (pu)
CONTINGENCY: 7L20 Voltage (pu)
5% MW margin

Attachment A12

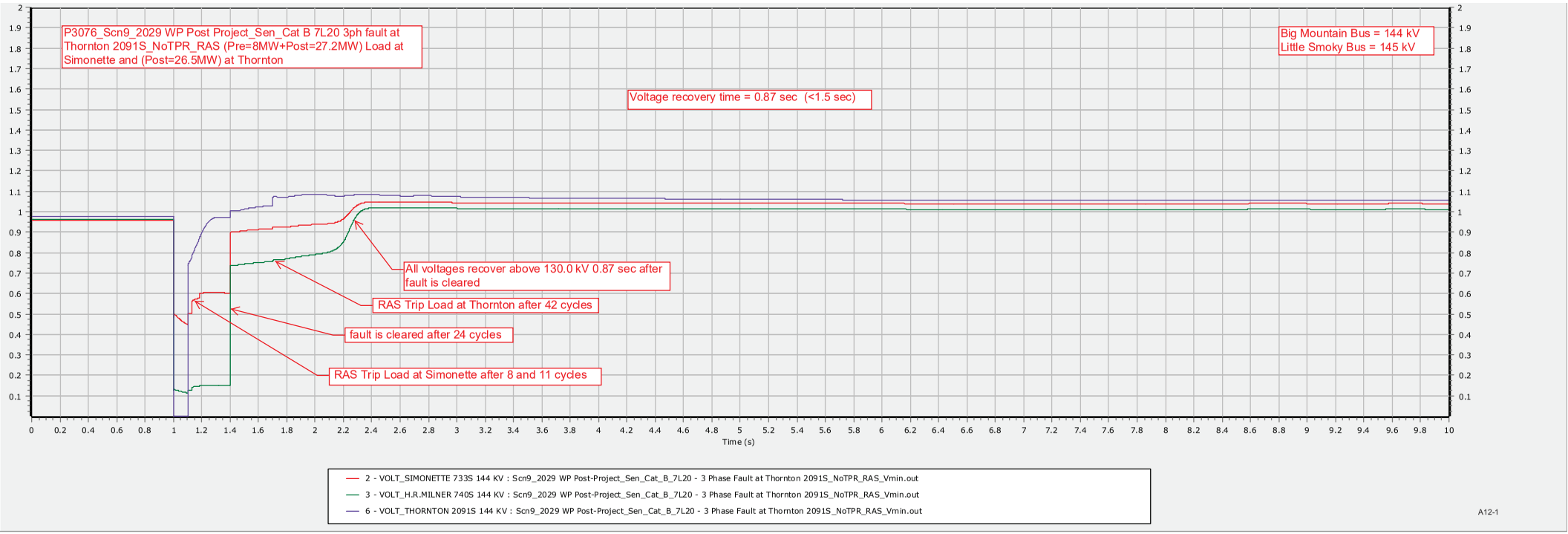
Post-Mitigation Transient Stability Diagrams with No TPR and RAS (Scenario 9)

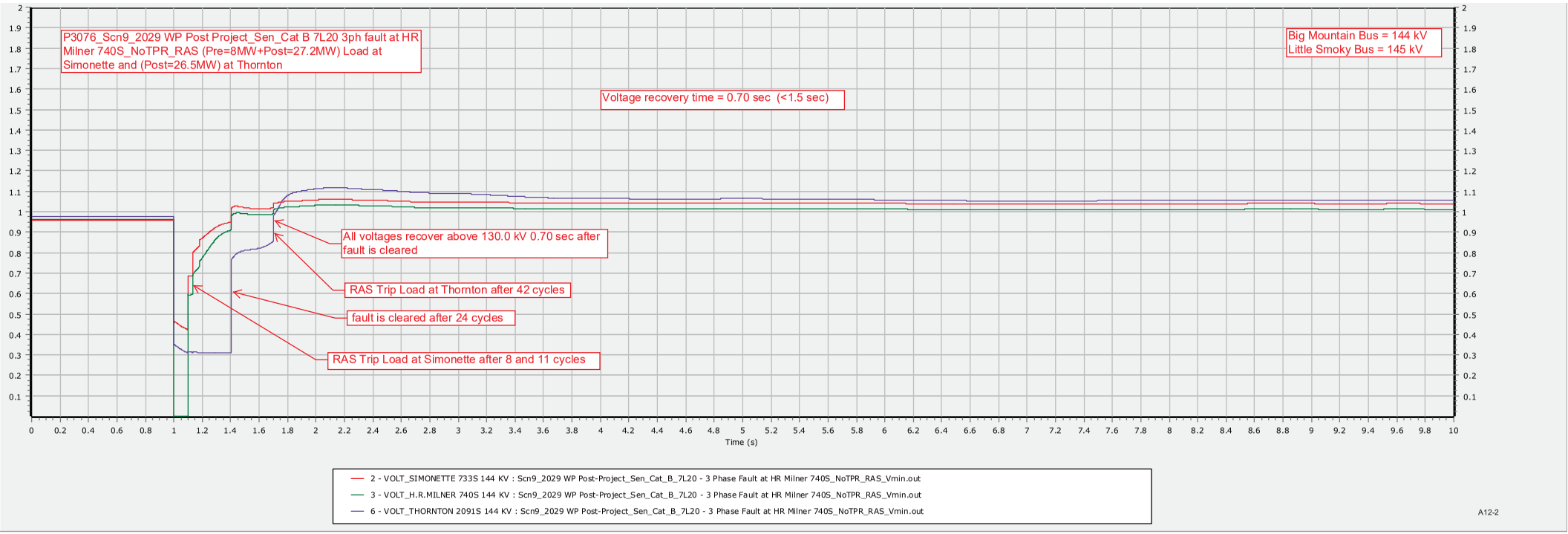
Transient Stability Diagrams for Scenario 9 2029 WP Post-Project

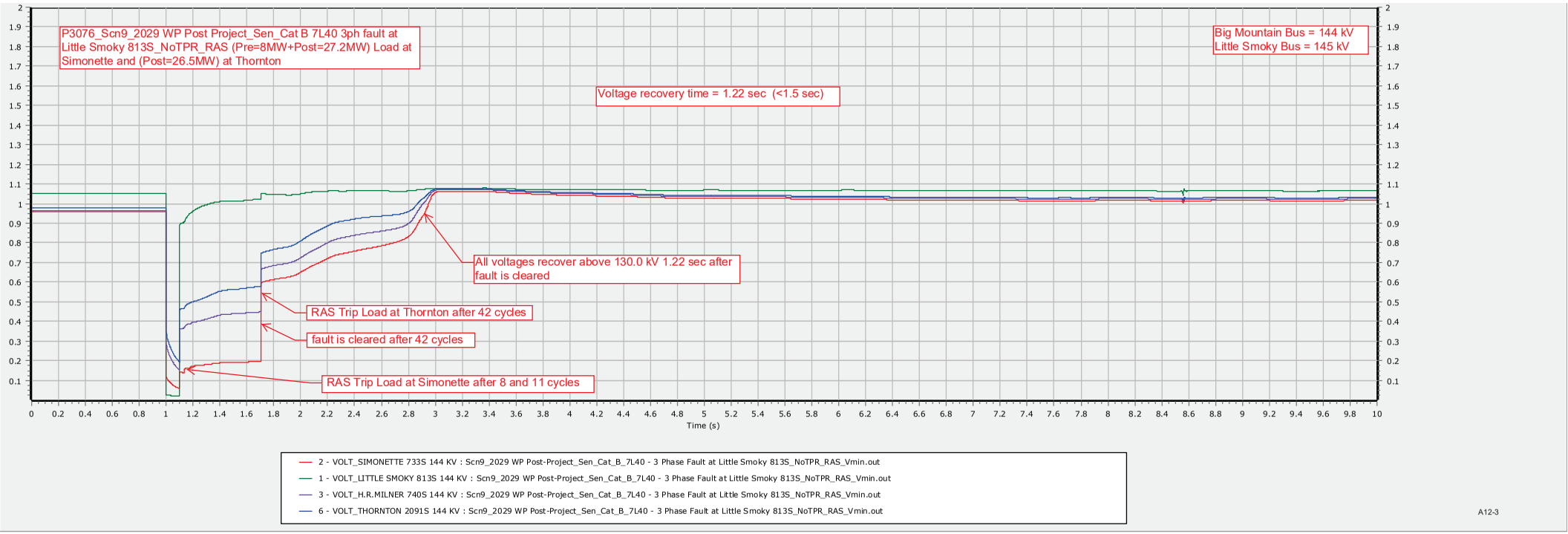
Post-Mitigation transient stability analysis with No TPR and RAS (planned RAS 248 and existing RAS 242) was performed using the Scenario 9 for the Category B contingencies identified in Table A12-1.

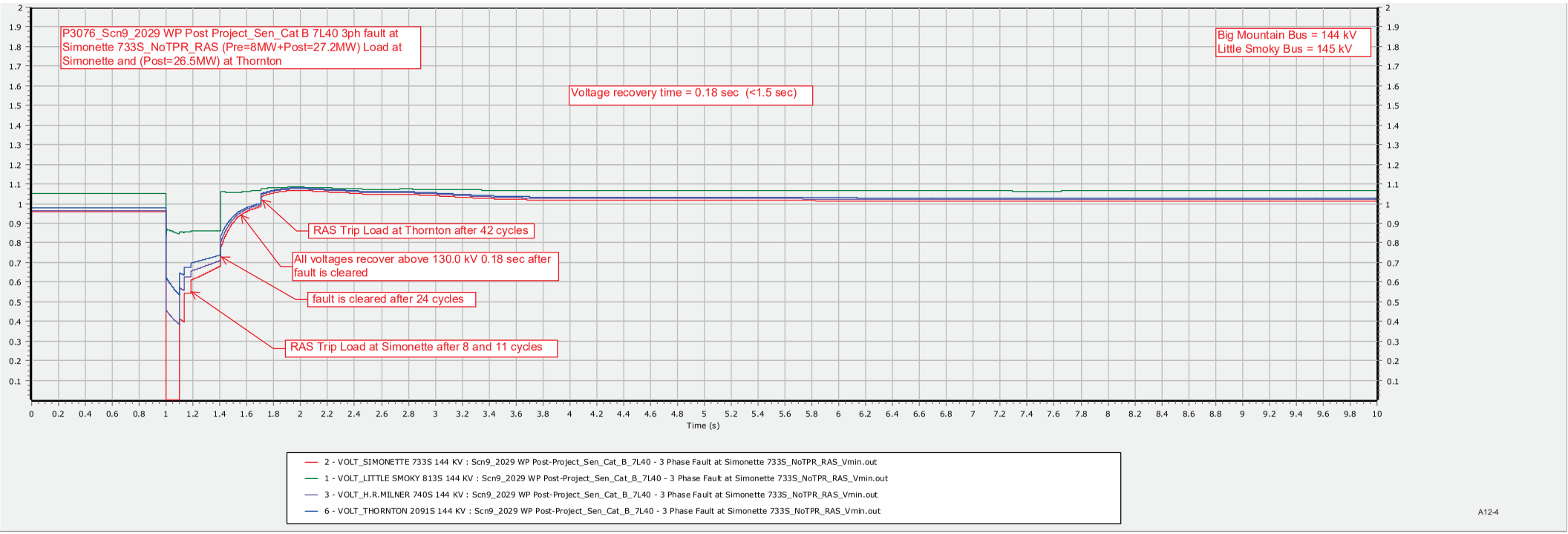
Table A12-1: List of Contingencies Studied for Transient Stability – Scenario 9 2029 WP-Post Project (Sensitivity) with No TPR and RAS

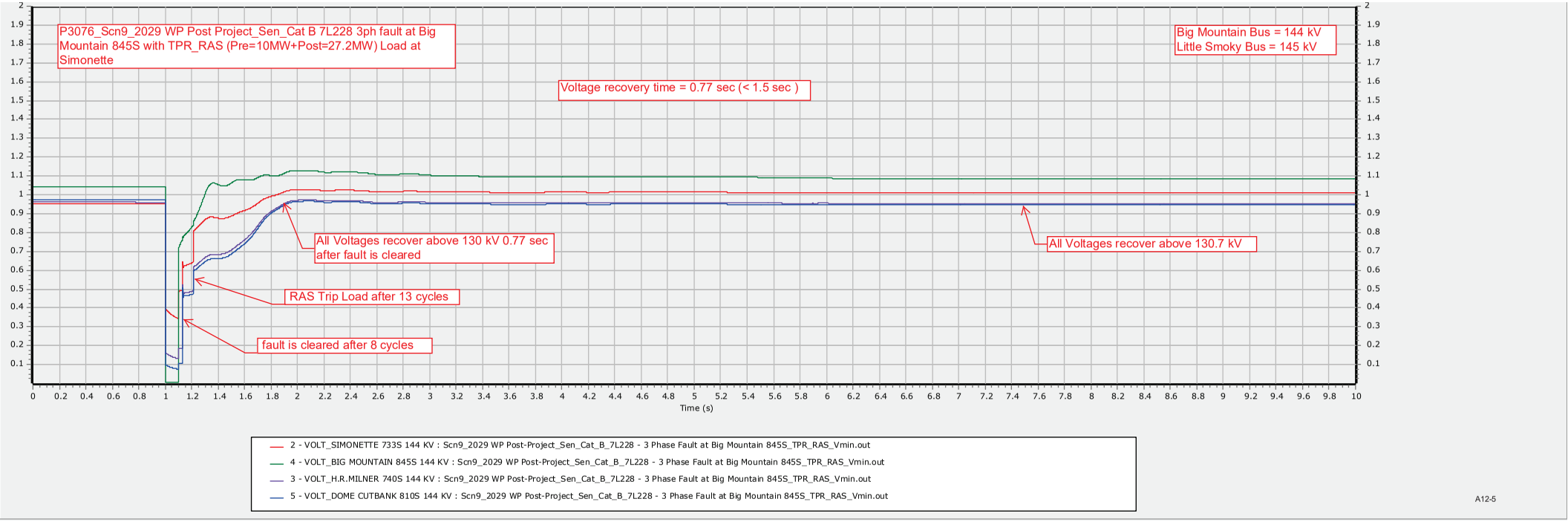
System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A12-1
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A12-2
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A12-3
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	A12-4
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Big Mountain 845S	A12-5
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Thornton 2091S	A12-6

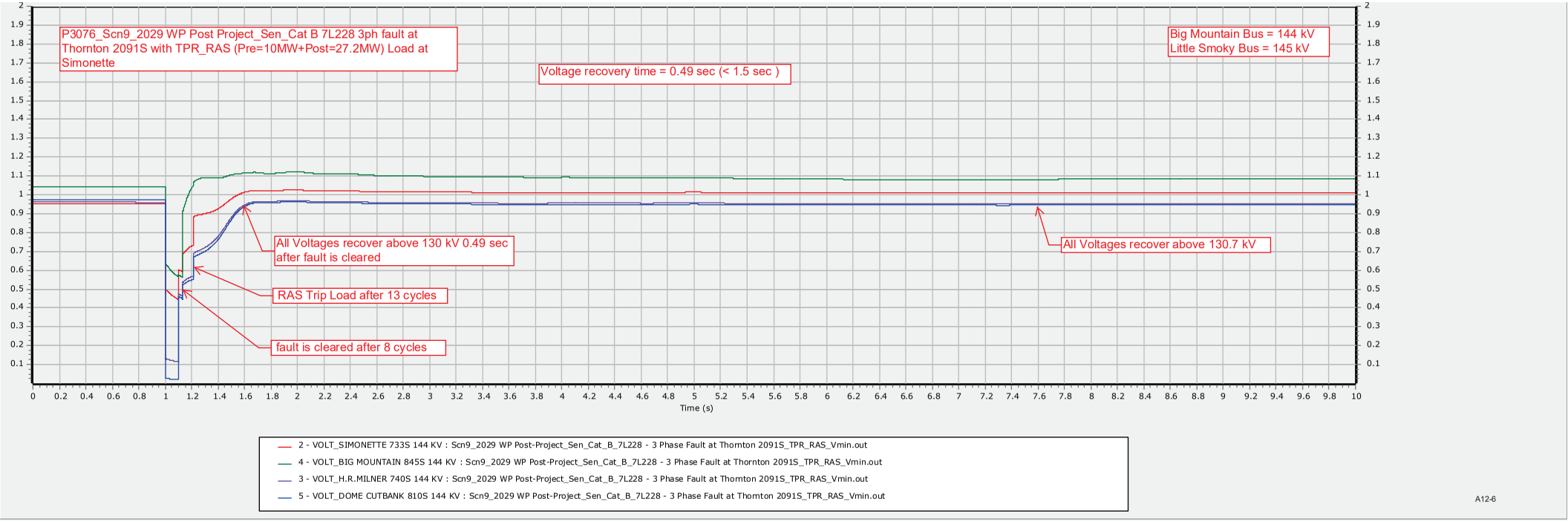

P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L20 3ph fault at Thornton 2091S_NoTPR_RAS (Pre=8MW+Post=27.2MW) Load at Simonette and (Post=26.5MW) at Thornton
Big Mountain Bus = 144 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 0.87 sec (<1.5 sec)
All voltages recover above 130.0 kV 0.87 sec after fault is cleared
RAS Trip Load at Thornton after 42 cycles
fault is cleared after 24 cycles
RAS Trip Load at Simonette after 8 and 11 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_NoTPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_NoTPR_RAS_Vmin.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_NoTPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L20 3ph fault at HR Milner 740S_NoTPR_RAS (Pre=8MW+Post=27.2MW) Load at Simonette and (Post=26.5MW) at Thornton
Big Mountain Bus = 144 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 0.70 sec (<1.5 sec)
All voltages recover above 130.0 kV 0.70 sec after fault is cleared
RAS Trip Load at Thornton after 42 cycles
fault is cleared after 24 cycles
RAS Trip Load at Simonette after 8 and 11 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_RAS_Vmin.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_NoTPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L40 3ph fault at Little Smoky 813S_NoTPR_RAS (Pre=8MW+Post=27.2MW) Load at Simonette and (Post=26.5MW) at Thornton
Big Mountain Bus = 144 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 1.22 sec (<1.5 sec)
All voltages recover above 130.0 kV 1.22 sec after fault is cleared
RAS Trip Load at Thornton after 42 cycles
fault is cleared after 42 cycles
RAS Trip Load at Simonette after 8 and 11 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_RAS_Vmin.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_RAS_Vmin.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_NoTPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L40 3ph fault at Simonette 733S_NoTPR_RAS (Pre=8MW+Post=27.2MW) Load at Simonette and (Post=26.5MW) at Thornton
Big Mountain Bus = 144 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 0.18 sec (<1.5 sec)
RAS Trip Load at Thornton after 42 cycles
All voltages recover above 130.0 kV 0.18 sec after fault is cleared
fault is cleared after 24 cycles
RAS Trip Load at Simonette after 8 and 11 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_RAS_Vmin.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_RAS_Vmin.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_NoTPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Big Mountain 845S with TPR_RAS (Pre=10MW+Post=27.2MW) Load at Simonette
Big Mountain Bus = 144 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 0.77 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.77 sec after fault is cleared
All Voltages recover above 130.7 kV
RAS Trip Load after 13 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_RAS_Vmin.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_RAS_Vmin.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Thornton 2091S with TPR_RAS (Pre=10MW+Post=27.2MW) Load at Simonette
Voltage recovery time = 0.49 sec (< 1.5 sec)
Big Mountain Bus = 144 kV
Little Smoky Bus = 145 kV
All Voltages recover above 130 kV 0.49 sec after fault is cleared
All Voltages recover above 130.7 kV
RAS Trip Load after 13 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_RAS_Vmin.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_RAS_Vmin.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_RAS_Vmin.out

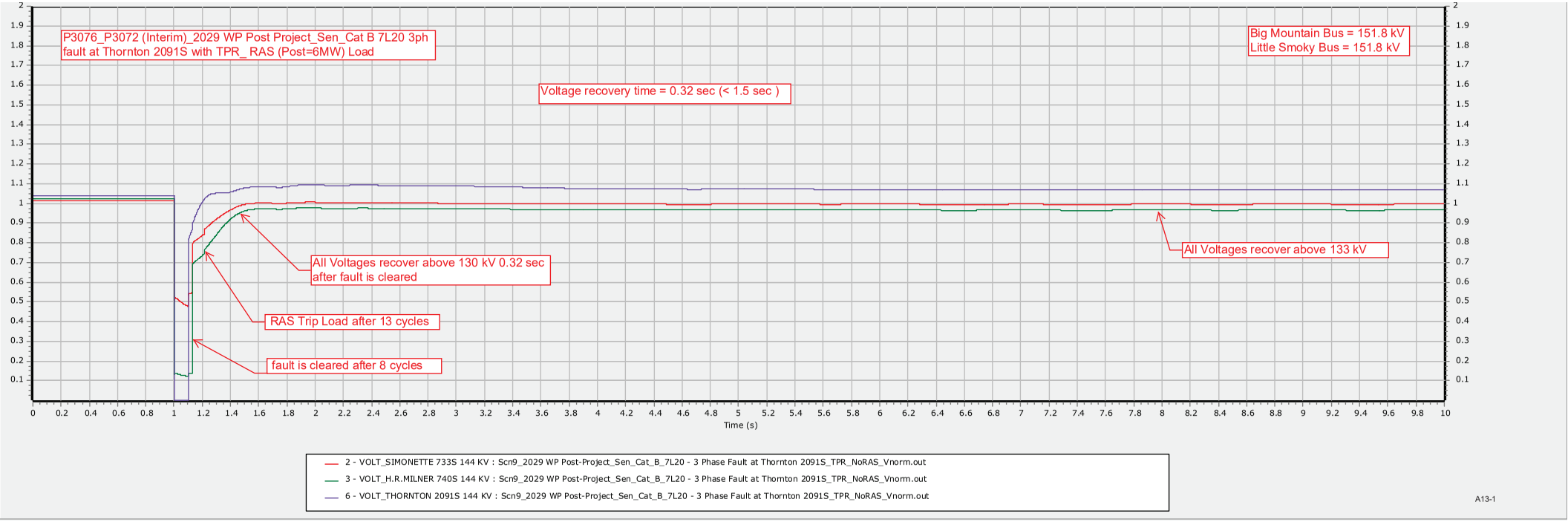
Attachment A13
Post-Mitigation Transient Stability Diagrams with TPR and RAS
(Scenario 9)

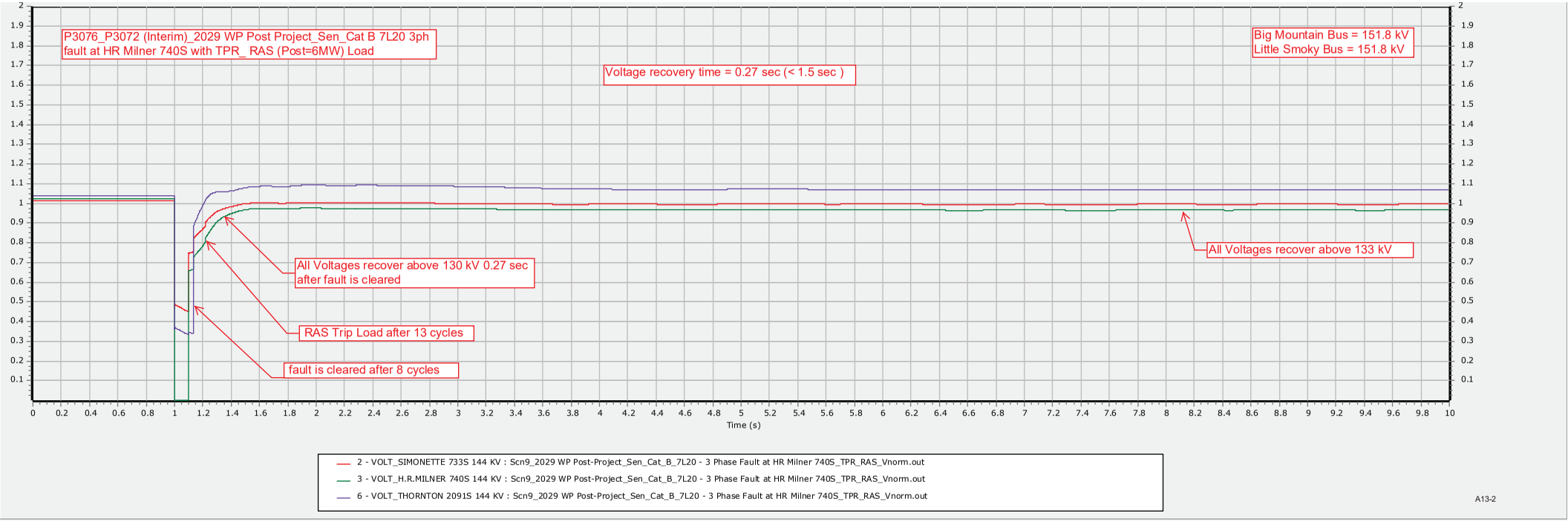
Transient Stability Diagrams for Scenario 9 2029 WP Post-Project

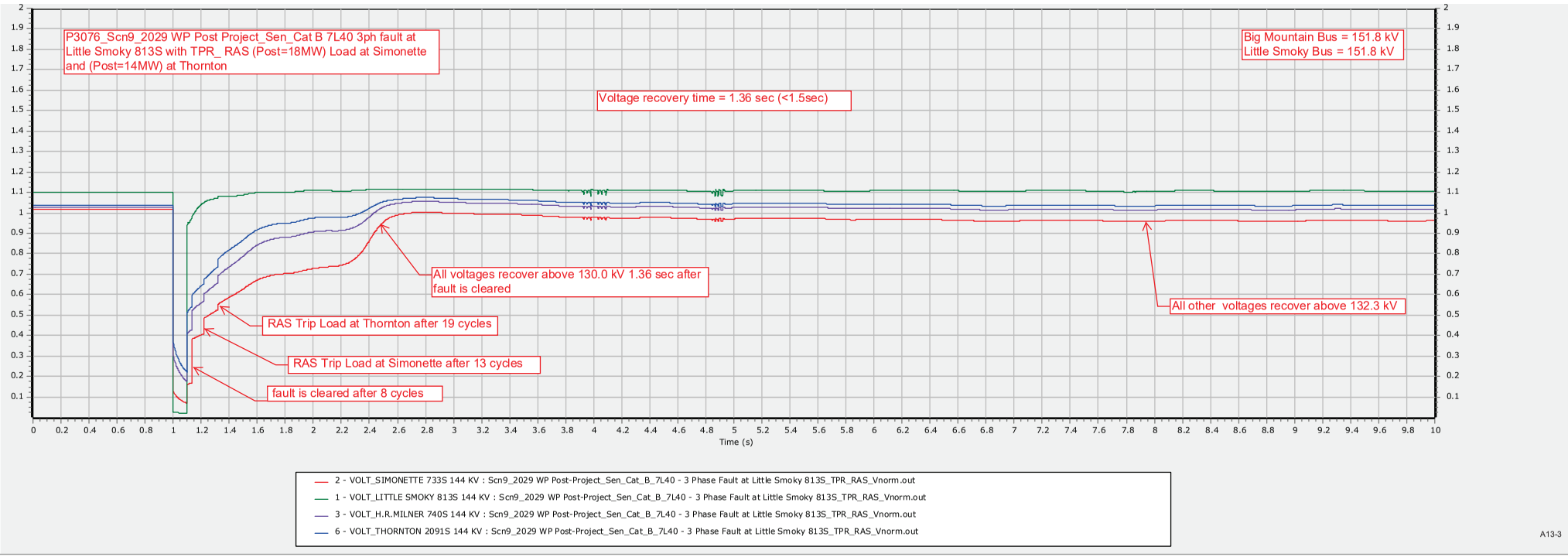
Post-Mitigation transient stability analysis with TPR and RAS (using planned RAS 245, modified RAS 246 and planned RAS 247) was performed using the Scenario 9 for the Category B contingencies identified in Table A13-1.

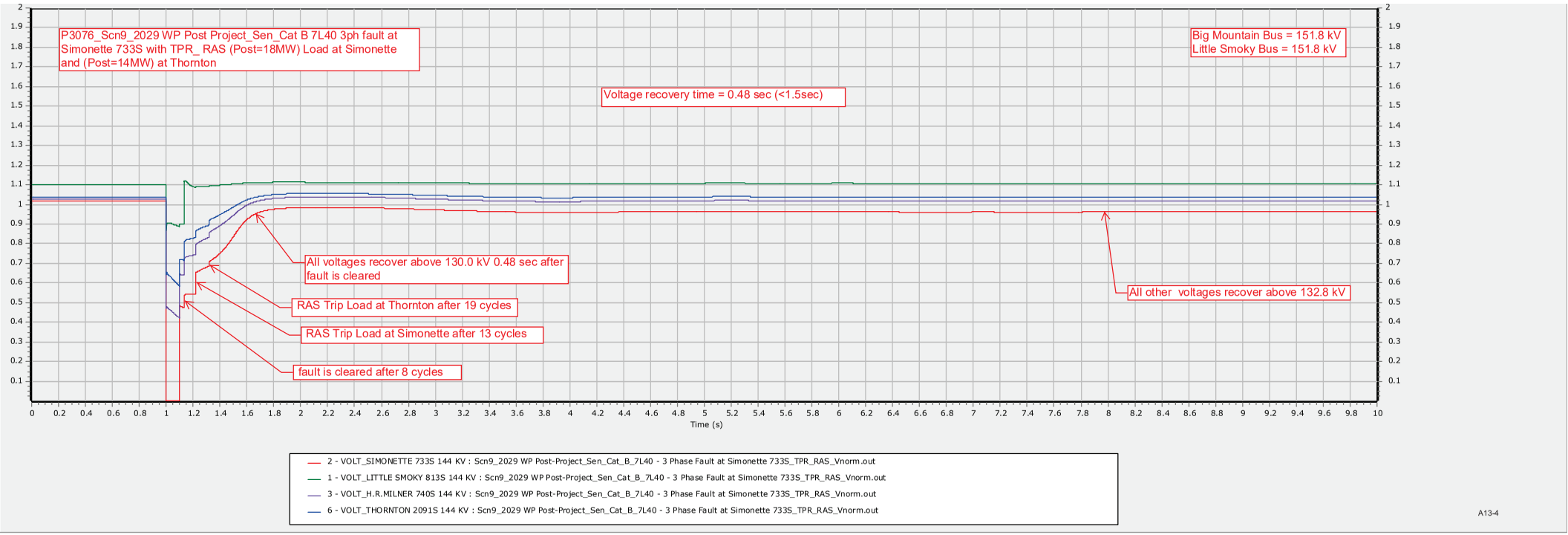
Table A13-1: List of Contingencies Studied for Transient Stability – Scenario 9 2029 WP-Post Project (Sensitivity) with TPR and RAS

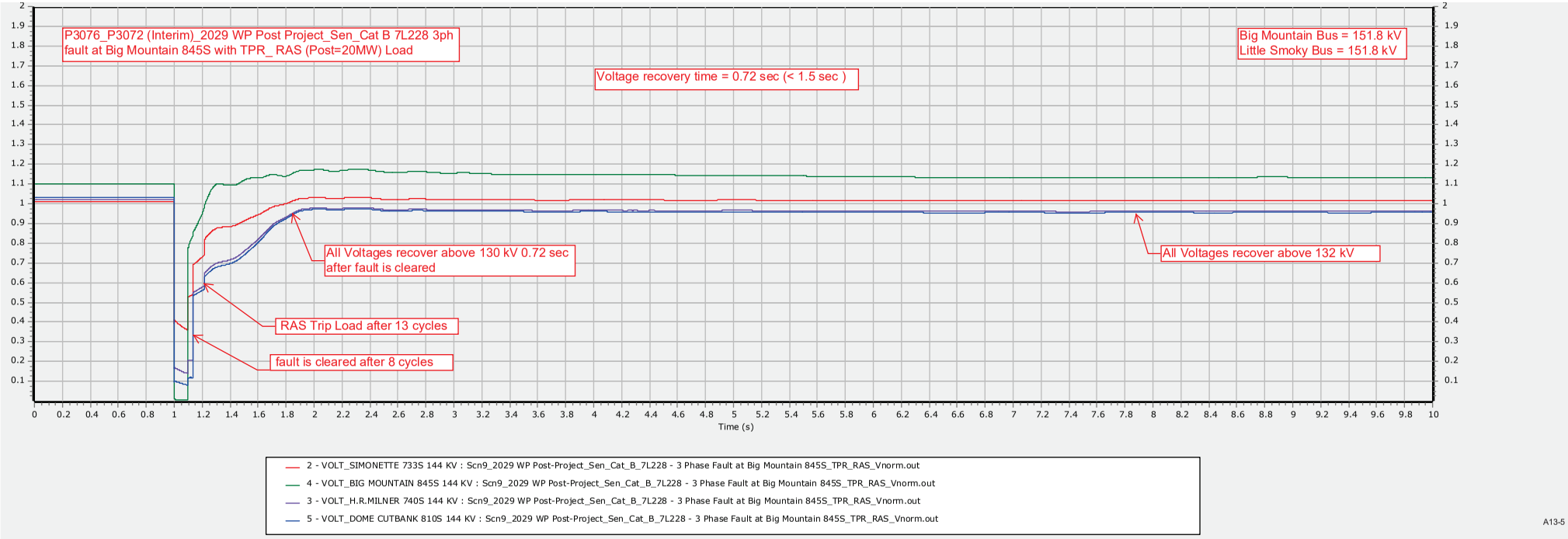
System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A13-1
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A13-2
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A13-3
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	A13-4
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Big Mountain 845S	A13-5
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Thornton 2091S	A13-6

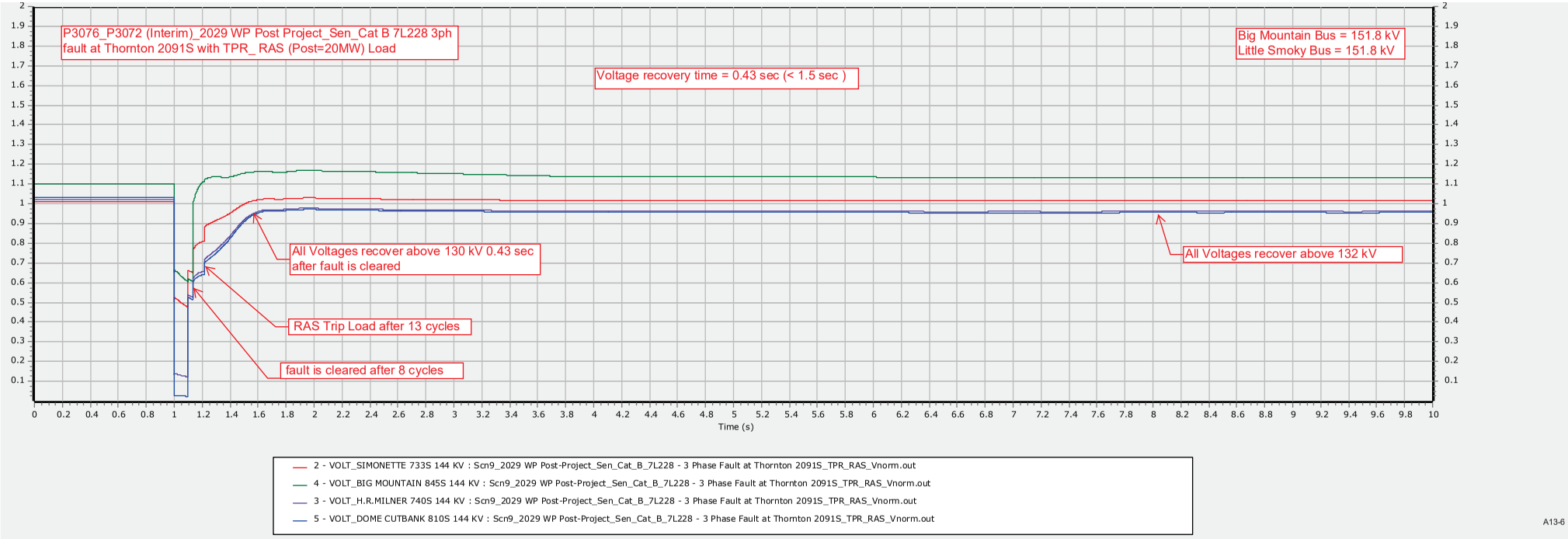

P3076_P3072 (Interim)_2029 WP Post Project_Sen_Cat B 7L20 3ph fault at Thornton 2091S with TPR_ RAS (Post=6MW) Load
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage recovery time = 0.32 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.32 sec after fault is cleared
All Voltages recover above 133 kV
RAS Trip Load after 13 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_TPR_NoRAS_Vnorm.out


P3076_P3072 (Interim)_2029 WP Post Project_Sen_Cat B 7L20 3ph
fault at HR Milner 740S with TPR_ RAS (Post=6MW) Load
Voltage recovery time = 0.27 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.27 sec
after fault is cleared
All Voltages recover above 133 kV
RAS Trip Load after 13 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_TPR_RAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_TPR_RAS_Vnorm.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_TPR_RAS_Vnorm.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L40 3ph fault at Little Smoky 813S with TPR_ RAS (Post=18MW) Load at Simonette and (Post=14MW) at Thornton
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage recovery time = 1.36 sec (<1.5sec)
All voltages recover above 130.0 kV 1.36 sec after fault is cleared
All other voltages recover above 132.3 kV
RAS Trip Load at Thornton after 19 cycles
RAS Trip Load at Simonette after 13 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_TPR_RAS_Vnorm.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_TPR_RAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_TPR_RAS_Vnorm.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_TPR_RAS_Vnorm.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L40 3ph fault at Simonette 733S with TPR_ RAS (Post=18MW) Load at Simonette and (Post=14MW) at Thornton
Voltage recovery time = 0.48 sec (<1.5sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All voltages recover above 130.0 kV 0.48 sec after fault is cleared
RAS Trip Load at Thornton after 19 cycles
RAS Trip Load at Simonette after 13 cycles
fault is cleared after 8 cycles
All other voltages recover above 132.8 kV
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_TPR_RAS_Vnorm.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_TPR_RAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_TPR_RAS_Vnorm.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_TPR_RAS_Vnorm.out


P3076_P3072 (Interim)_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Big Mountain 845S with TPR_ RAS (Post=20MW) Load
Voltage recovery time = 0.72 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.72 sec after fault is cleared
All Voltages recover above 132 kV
RAS Trip Load after 13 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_RAS_Vnorm.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_RAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_RAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_TPR_RAS_Vnorm.out


P3076_P3072 (Interim)_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Thornton 2091S with TPR_ RAS (Post=20MW) Load
Voltage recovery time = 0.43 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.43 sec after fault is cleared
All Voltages recover above 132 kV
RAS Trip Load after 13 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_RAS_Vnorm.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_RAS_Vnorm.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_RAS_Vnorm.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_TPR_RAS_Vnorm.out

Attachment A14

Post-Mitigation Transient Stability Diagrams with No TPR and RAS 242, RAS 171

(Scenario 9)

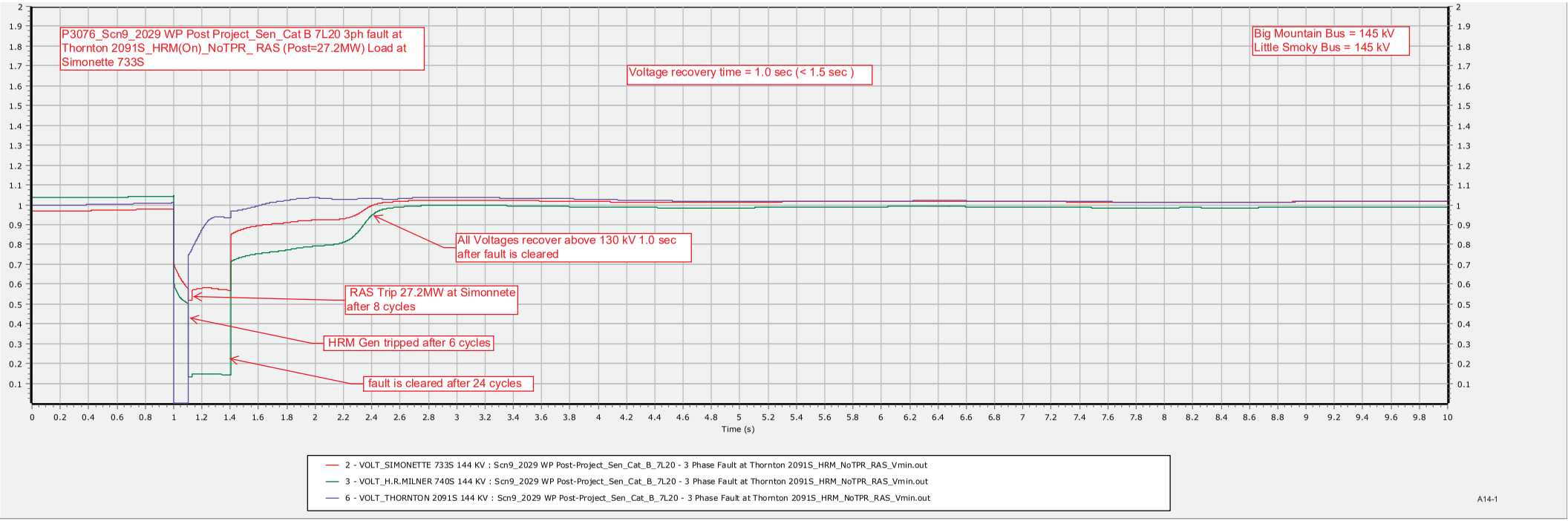
Transient Stability Diagrams for Scenario 9 2029 WP Post-Project

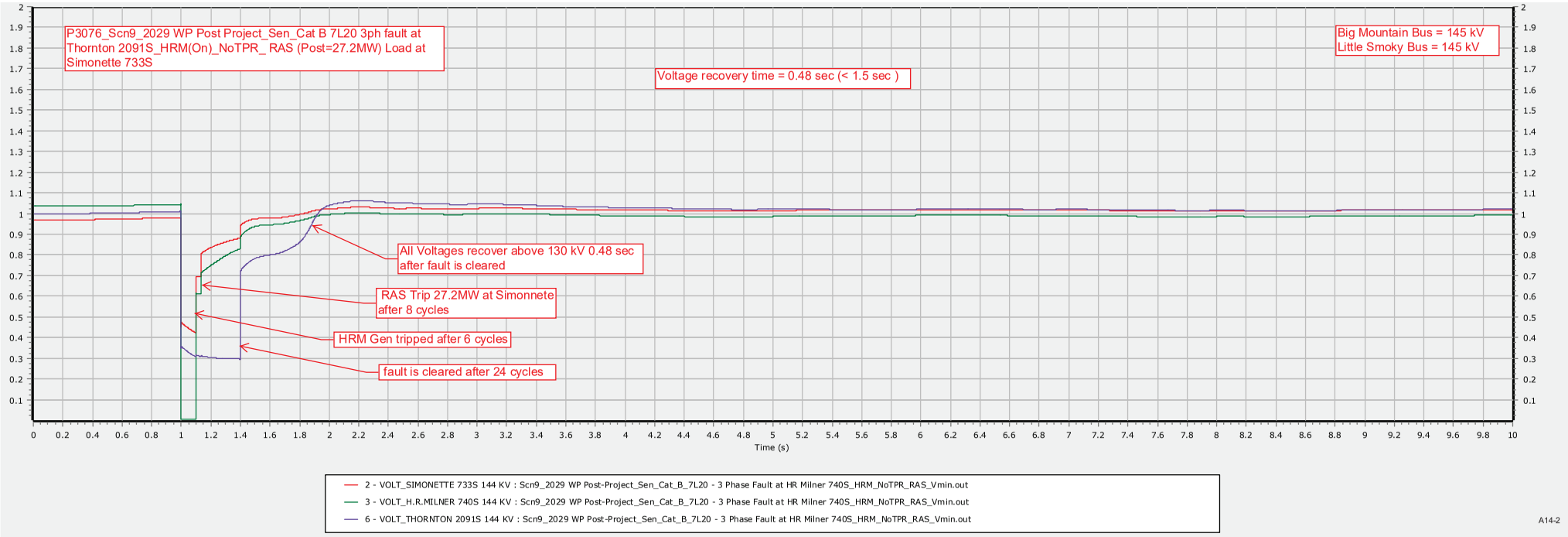
Post-Mitigation transient stability analysis with No TPR and RAS (using RAS 242, and RAS 171) was performed using the Scenario 9 for the Category B contingencies identified in Table A14-1.

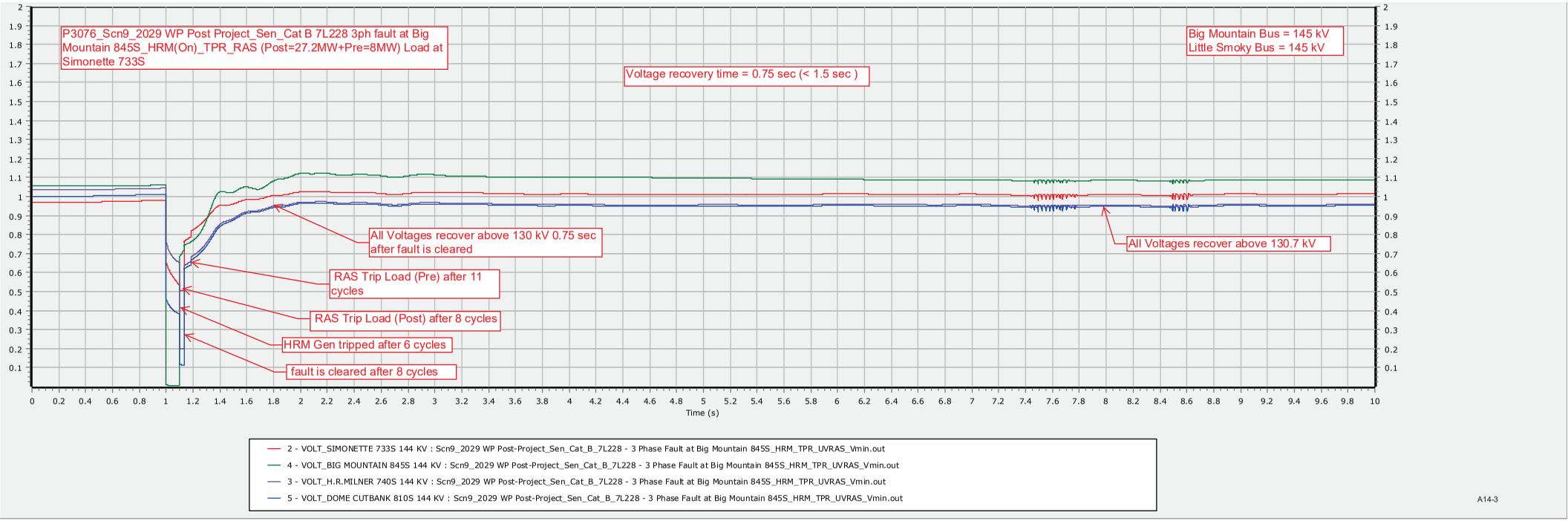
Table A14-1: List of Contingencies Studied for Transient Stability – Scenario 9 2029 WP-Post Project (Sensitivity) with No TPR* and RAS 242, RAS 171

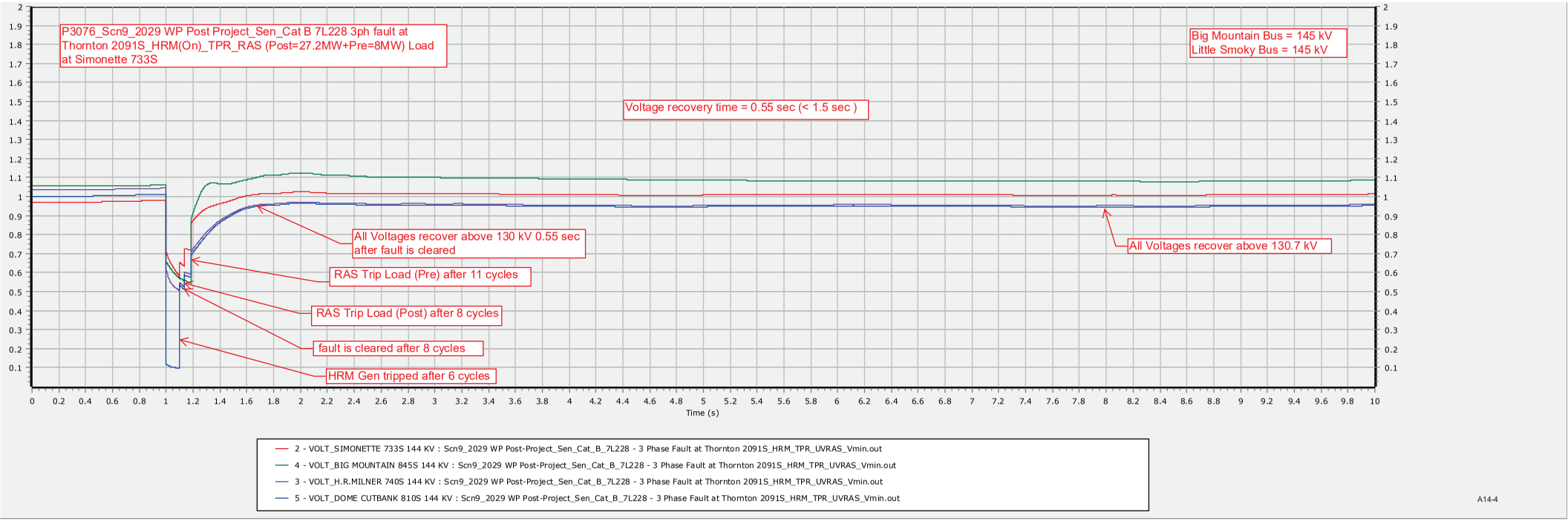
System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A14-1
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A14-2
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Big Mountain 845S	A14-3
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Thornton 2091S	A14-4

**7L228 already has TPR*


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L20 3ph fault at Thornton 2091S_HRM(On)_NoTPR_ RAS (Post=27.2MW) Load at Simonette 733S
Voltage recovery time = 1.0 sec (< 1.5 sec)
Big Mountain Bus = 145 kV
Little Smoky Bus = 145 kV
All Voltages recover above 130 kV 1.0 sec after fault is cleared
RAS Trip 27.2MW at Simonnete after 8 cycles
HRM Gen tripped after 6 cycles
fault is cleared after 24 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_HRM_NoTPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_HRM_NoTPR_RAS_Vmin.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_HRM_NoTPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L20 3ph fault at Thornton 2091S_HRM(On)_NoTPR_ RAS (Post=27.2MW) Load at Simonette 733S
Voltage recovery time = 0.48 sec (< 1.5 sec)
Big Mountain Bus = 145 kV
Little Smoky Bus = 145 kV
All Voltages recover above 130 kV 0.48 sec after fault is cleared
RAS Trip 27.2MW at Simonnete after 8 cycles
HRM Gen tripped after 6 cycles
fault is cleared after 24 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_HRM_NoTPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_HRM_NoTPR_RAS_Vmin.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_HRM_NoTPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Big Mountain 845S_HRM(On)_TPR_RAS (Post=27.2MW+Pre=8MW) Load at Simonette 733S
Voltage recovery time = 0.75 sec (< 1.5 sec)
Big Mountain Bus = 145 kV
Little Smoky Bus = 145 kV
All Voltages recover above 130 kV 0.75 sec after fault is cleared
All Voltages recover above 130.7 kV
RAS Trip Load (Pre) after 11 cycles
RAS Trip Load (Post) after 8 cycles
HRM Gen tripped after 6 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_HRM_TPR_UVRAS_Vmin.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_HRM_TPR_UVRAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_HRM_TPR_UVRAS_Vmin.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_HRM_TPR_UVRAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Thornton 2091S_HRM(On)_TPR_RAS (Post=27.2MW+Pre=8MW) Load at Simonette 733S
Big Mountain Bus = 145 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 0.55 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.55 sec after fault is cleared
RAS Trip Load (Pre) after 11 cycles
RAS Trip Load (Post) after 8 cycles
fault is cleared after 8 cycles
HRM Gen tripped after 6 cycles
All Voltages recover above 130.7 kV
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_HRM_TPR_UVRAS_Vmin.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_HRM_TPR_UVRAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_HRM_TPR_UVRAS_Vmin.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_HRM_TPR_UVRAS_Vmin.out

Attachment A15

Post-Mitigation Transient Stability Diagrams with TPR and RAS 245, RAS247, RAS 171

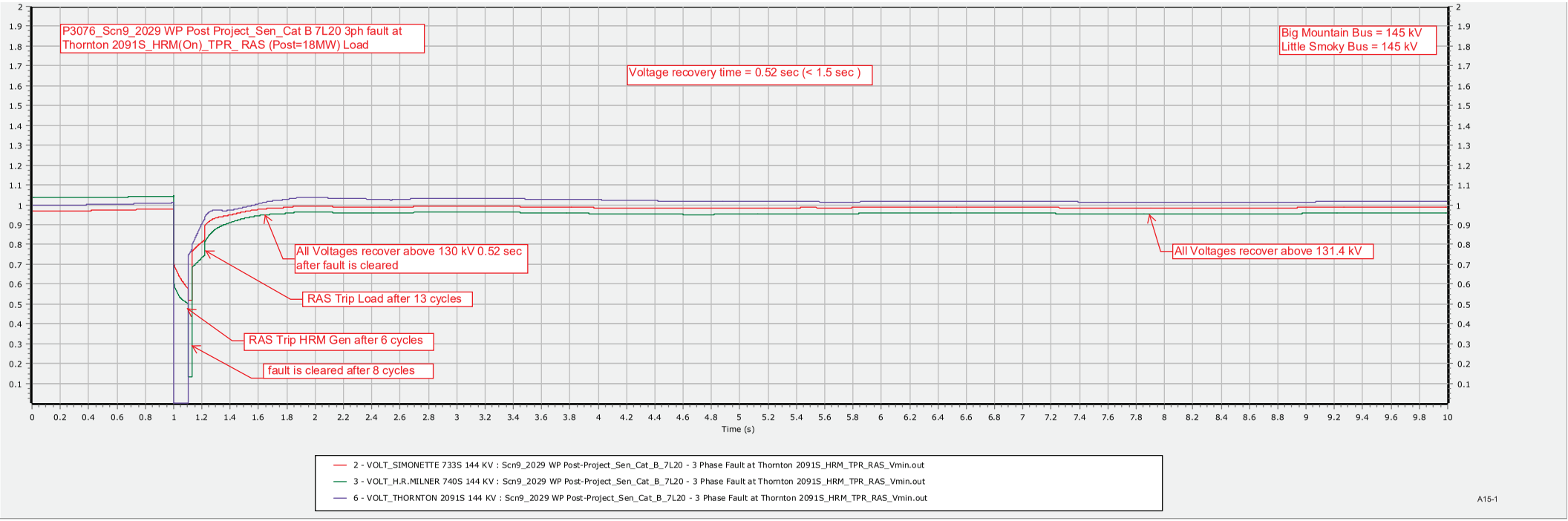
(Scenario 9)

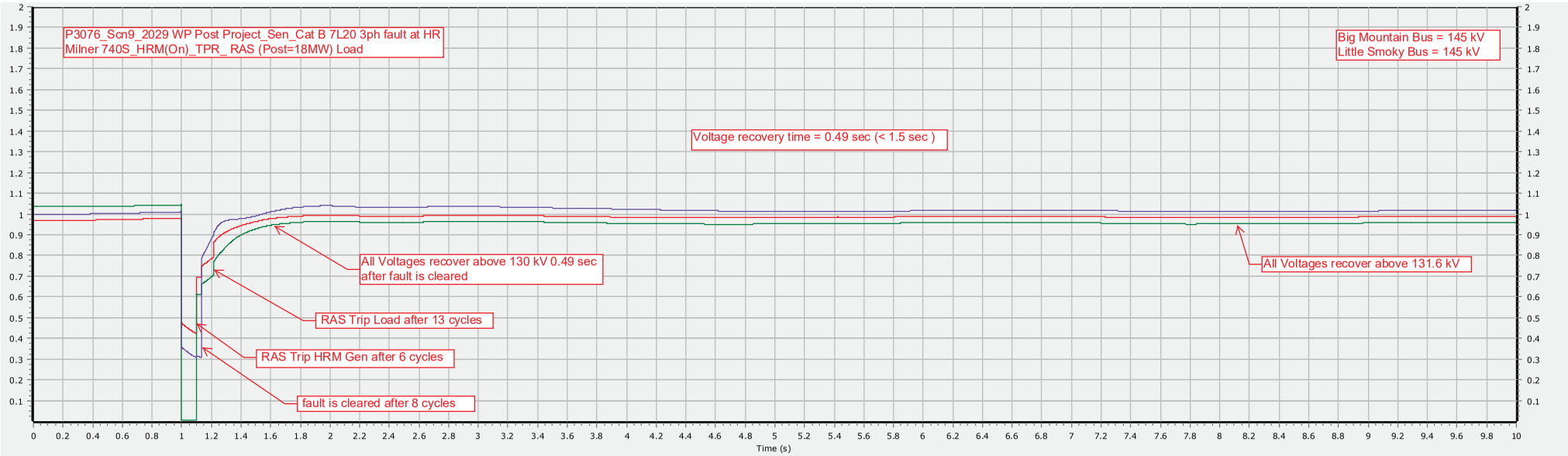
Transient Stability Diagrams for Scenario 9 2029 WP Post-Project

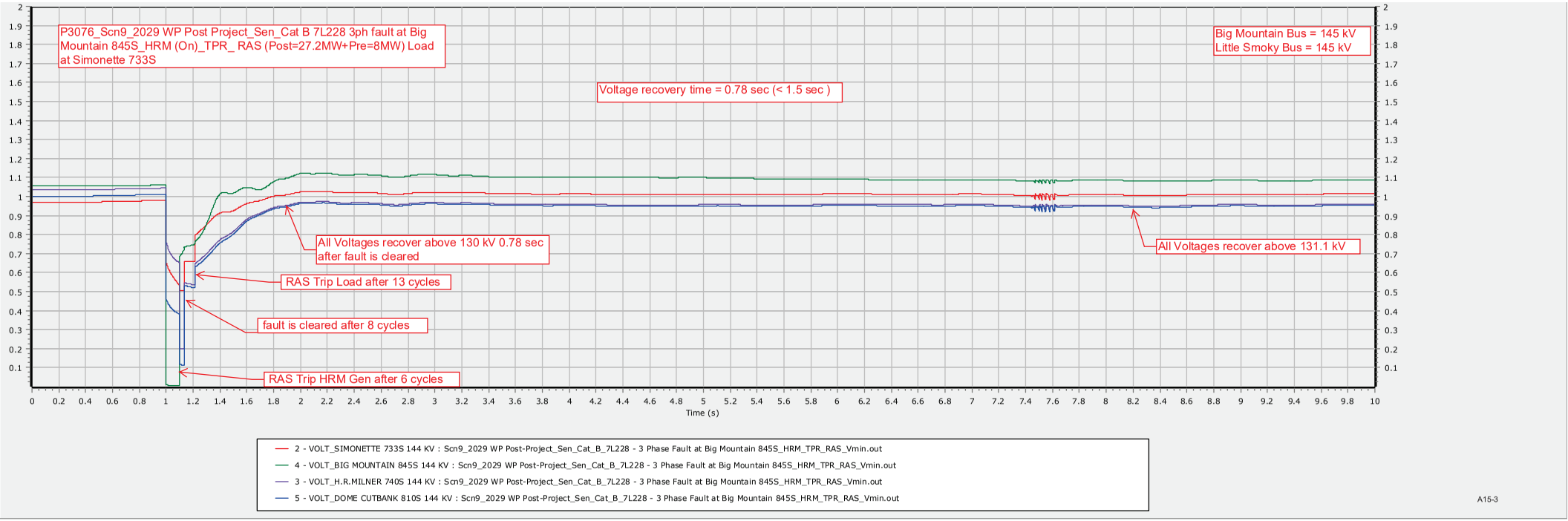
Post-Mitigation transient stability analysis with TPR and RAS (using RAS 245, RAS 247, and RAS 171) was performed using the Scenario 9 for the Category B contingencies identified in Table A15-1.

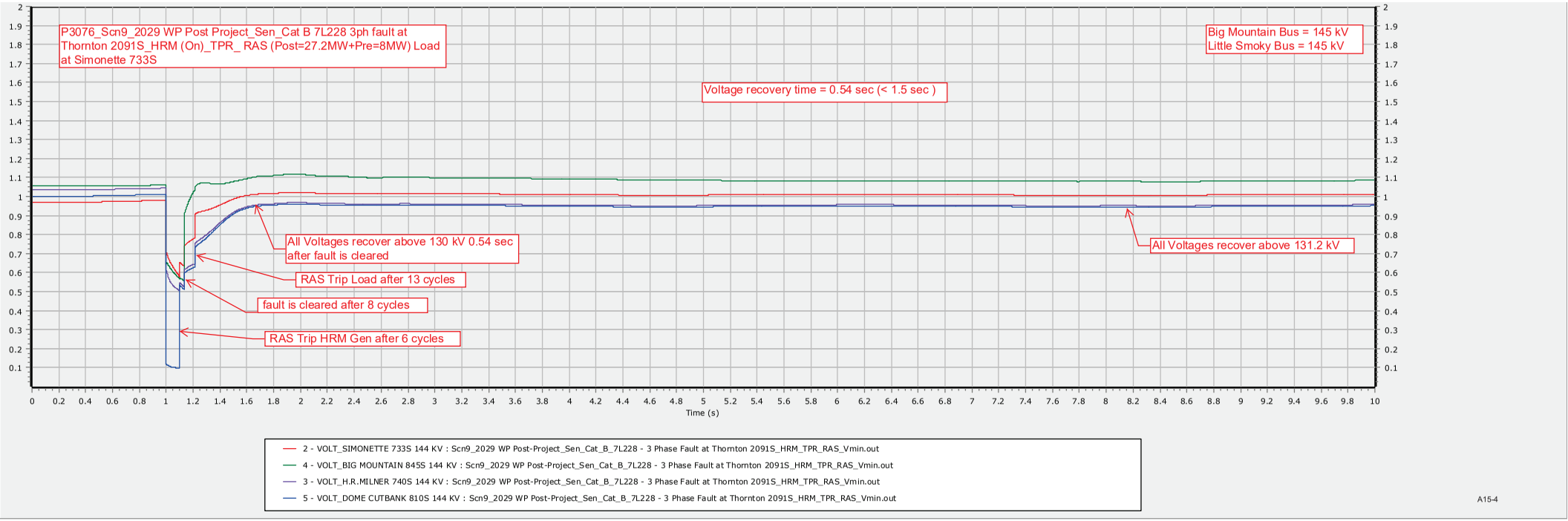
Table A15-1: List of Contingencies Studied for Transient Stability – Scenario 9 2029 WP-Post Project (Sensitivity) with TPR and RAS 245, RAS 247, RAS 171

System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A15-1
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A15-2
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Big Mountain 845S	A15-3
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Thornton 2091S	A15-4


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L20 3ph fault at Thornton 2091S_HRM(On)_TPR_ RAS (Post=18MW) Load
Big Mountain Bus = 145 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 0.52 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.52 sec after fault is cleared
All Voltages recover above 131.4 kV
RAS Trip Load after 13 cycles
RAS Trip HRM Gen after 6 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_HRM_TPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_HRM_TPR_RAS_Vmin.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_HRM_TPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L20 3ph fault at HR Milner 740S_HRM(On)_TPR_ RAS (Post=18MW) Load
Big Mountain Bus = 145 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 0.49 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.49 sec after fault is cleared
All Voltages recover above 131.6 kV
RAS Trip Load after 13 cycles
RAS Trip HRM Gen after 6 cycles
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_HRM_TPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_HRM_TPR_RAS_Vmin.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_HRM_TPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Big Mountain 845S_HRM (On)_TPR_ RAS (Post=27.2MW+Pre=8MW) Load at Simonette 733S
Big Mountain Bus = 145 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 0.78 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.78 sec after fault is cleared
All Voltages recover above 131.1 kV
RAS Trip Load after 13 cycles
fault is cleared after 8 cycles
RAS Trip HRM Gen after 6 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_HRM_TPR_RAS_Vmin.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_HRM_TPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_HRM_TPR_RAS_Vmin.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_HRM_TPR_RAS_Vmin.out


P3076_Scn9_2029 WP Post Project_Sen_Cat B 7L228 3ph fault at Thornton 2091S_HRM (On)_TPR_ RAS (Post=27.2MW+Pre=8MW) Load at Simonette 733S
Big Mountain Bus = 145 kV
Little Smoky Bus = 145 kV
Voltage recovery time = 0.54 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.54 sec after fault is cleared
RAS Trip Load after 13 cycles
fault is cleared after 8 cycles
RAS Trip HRM Gen after 6 cycles
All Voltages recover above 131.2 kV
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_HRM_TPR_RAS_Vmin.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_HRM_TPR_RAS_Vmin.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_HRM_TPR_RAS_Vmin.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_HRM_TPR_RAS_Vmin.out

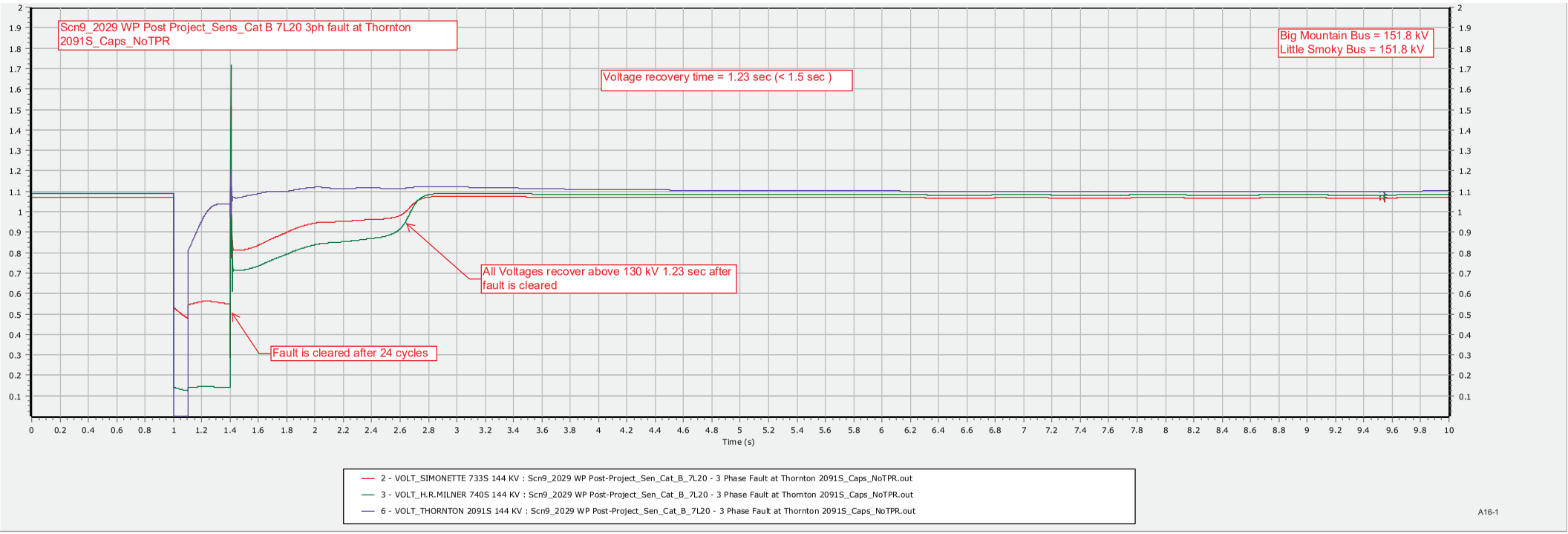
Attachment A16
Post-Mitigation Transient Stability Diagrams with No TPR and Capacitors (Scenario 9)

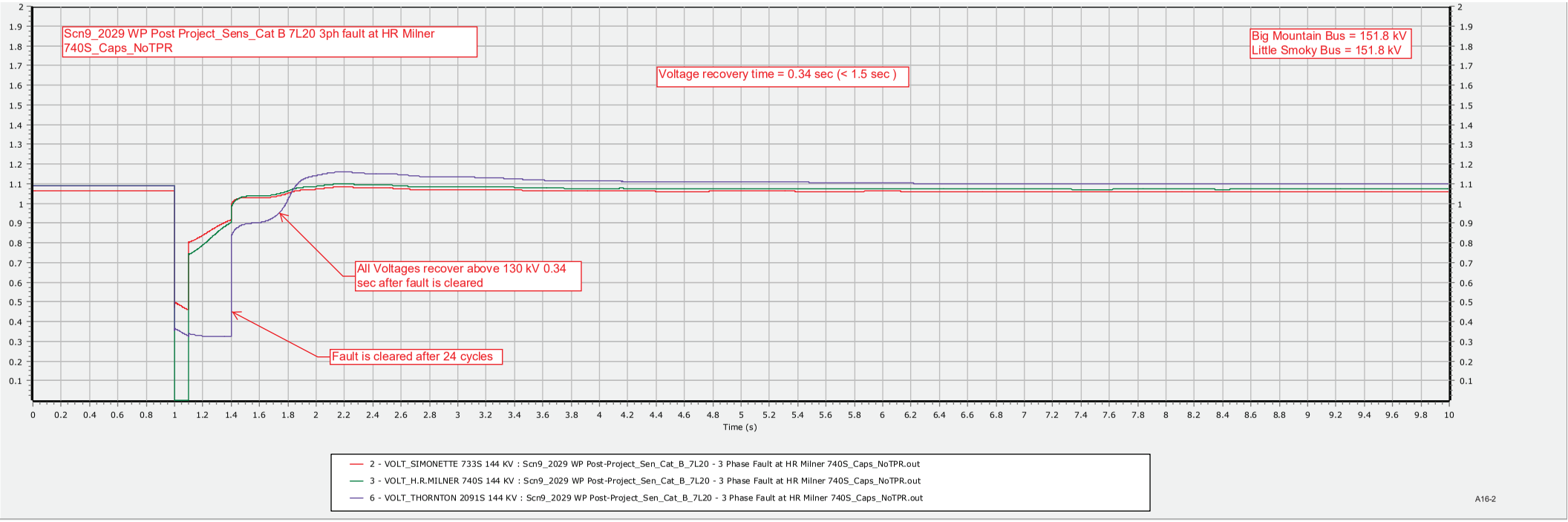
Transient Stability Diagrams for Scenario 9 2029 WP Post-Project

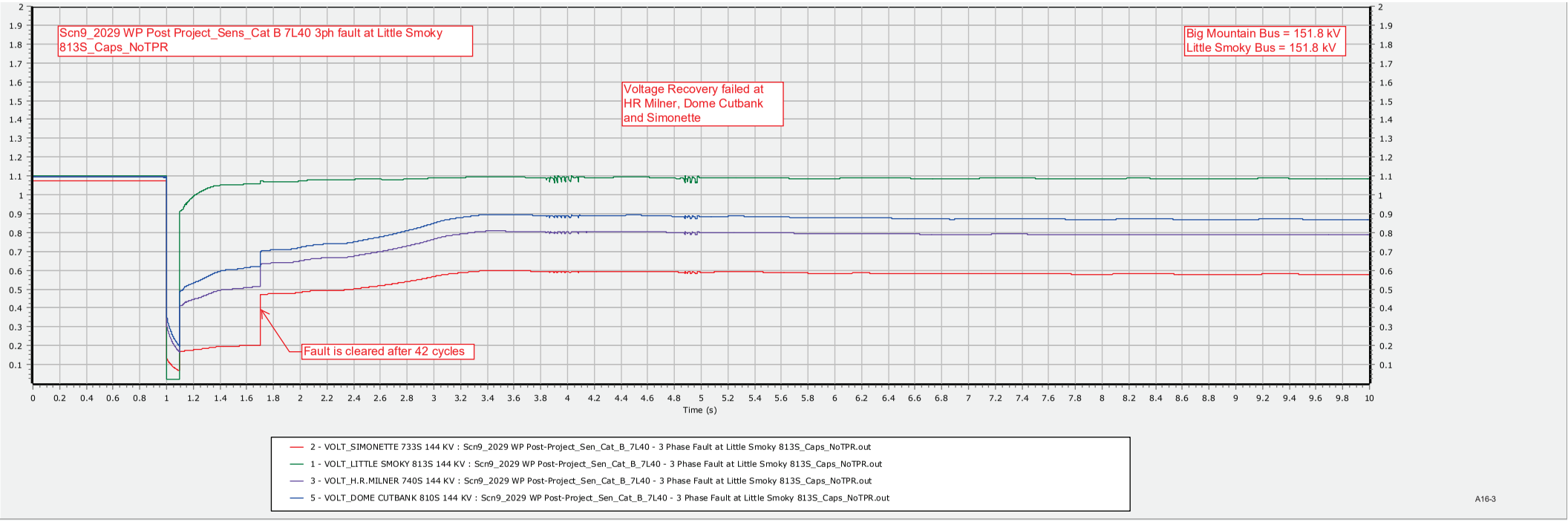
Post-Mitigation transient stability analysis with No TPR and Capacitors was performed using the Scenario 9 for the Category B contingencies identified in Table A16-1.

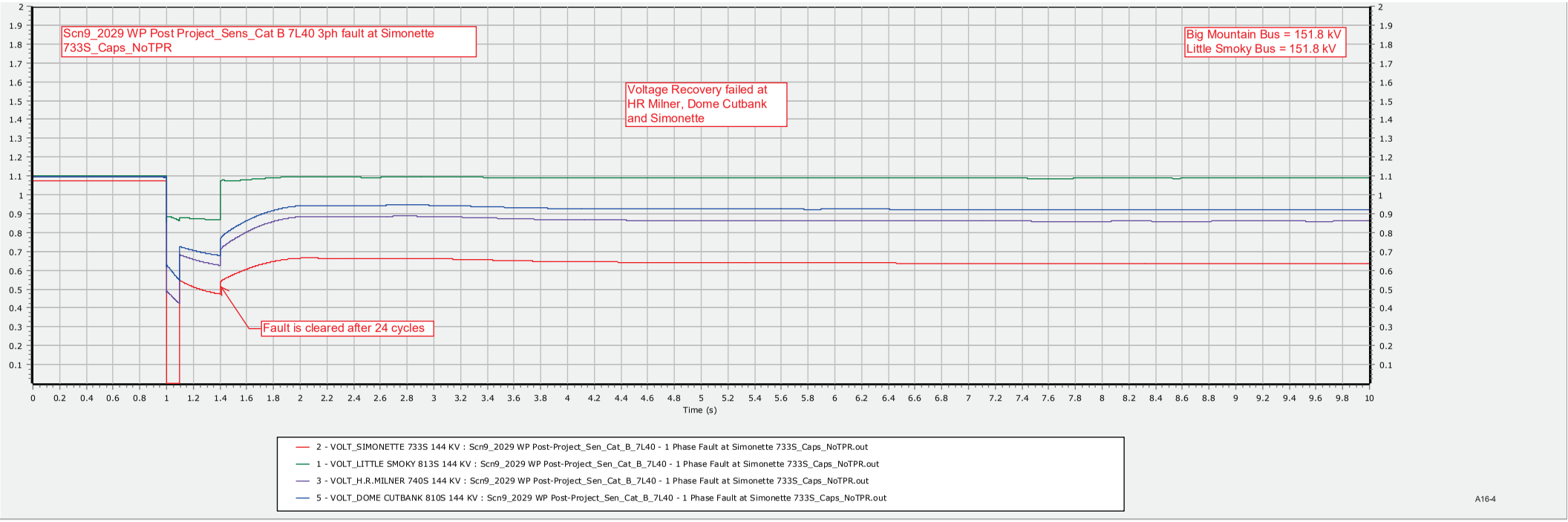
Table A13-1: List of Contingencies Studied for Transient Stability – Scenario 9 2029 WP-Post Project (Sensitivity) with No TPR and Capacitors

System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A16-1
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A16-2
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A16-3
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	A16-4


Scn9_2029 WP Post Project_Sens_Cat B 7L20 3ph fault at Thornton 2091S_Caps_NoTPR
Voltage recovery time = 1.23 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 1.23 sec after fault is cleared
Fault is cleared after 24 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_Caps_NoTPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_Caps_NoTPR.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_Caps_NoTPR.out


Scn9_2029 WP Post Project_Sens_Cat B 7L20 3ph fault at HR Milner 740S_Caps_NoTPR
Voltage recovery time = 0.34 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.34 sec after fault is cleared
Fault is cleared after 24 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_Caps_NoTPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_Caps_NoTPR.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_Caps_NoTPR.out


Scn9_2029 WP Post Project_Sens_Cat B 7L40 3ph fault at Little Smoky 813S_Caps_NoTPR
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage Recovery failed at HR Milner, Dome Cutbank and Simonette
Fault is cleared after 42 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_NoTPR.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_NoTPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_NoTPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_NoTPR.out


Scn9_2029 WP Post Project_Sens_Cat B 7L40 3ph fault at Simonette 733S_Caps_NoTPR
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage Recovery failed at HR Milner, Dome Cutbank and Simonette
Fault is cleared after 24 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 1 Phase Fault at Simonette 733S_Caps_NoTPR.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 1 Phase Fault at Simonette 733S_Caps_NoTPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 1 Phase Fault at Simonette 733S_Caps_NoTPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 1 Phase Fault at Simonette 733S_Caps_NoTPR.out

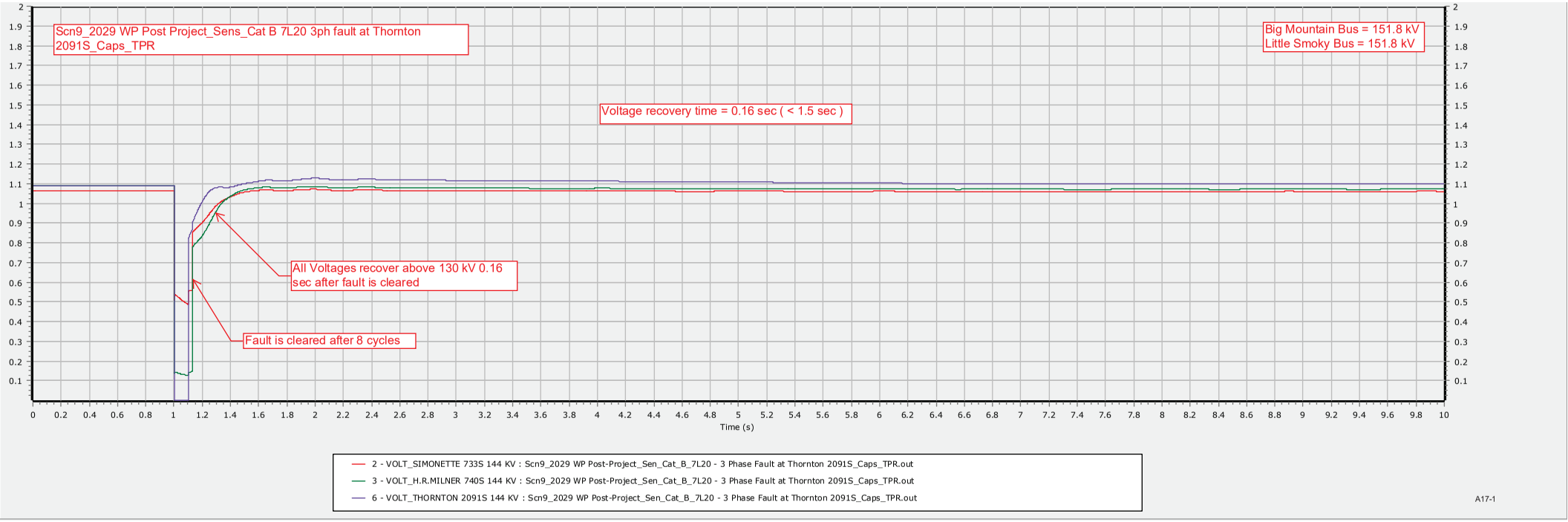
Attachment A17
Post-Mitigation Transient Stability Diagrams with TPR and Capacitors (Scenario 9)

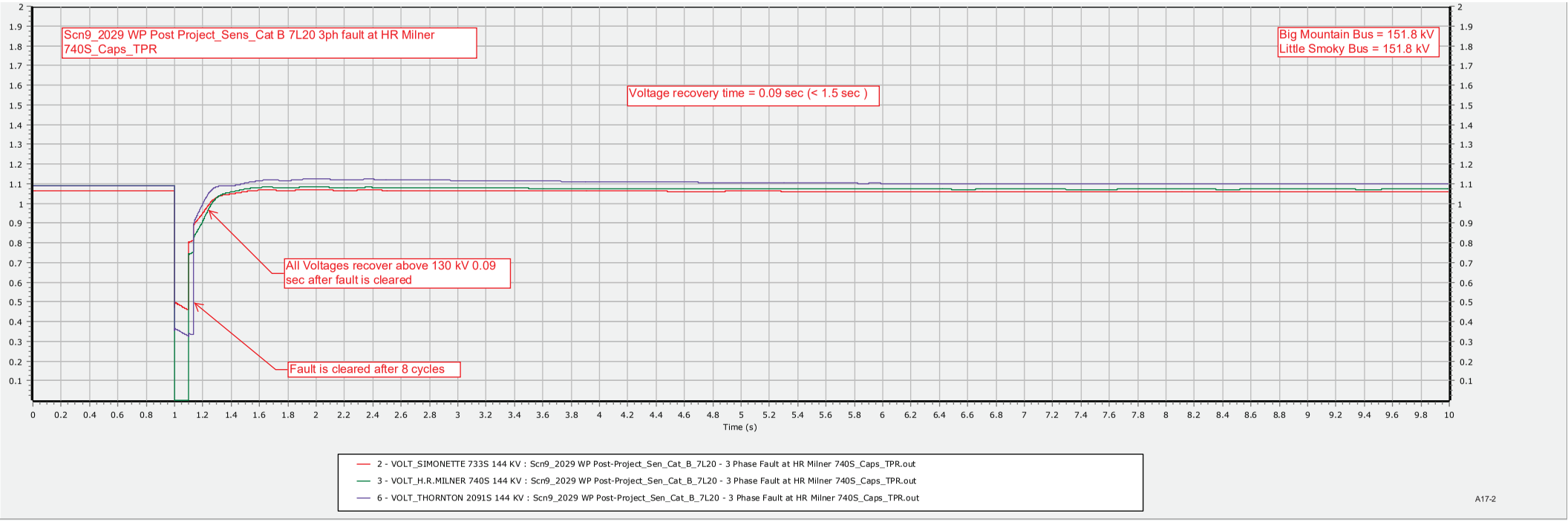
Transient Stability Diagrams for Scenario 9 2029 WP Post-Project

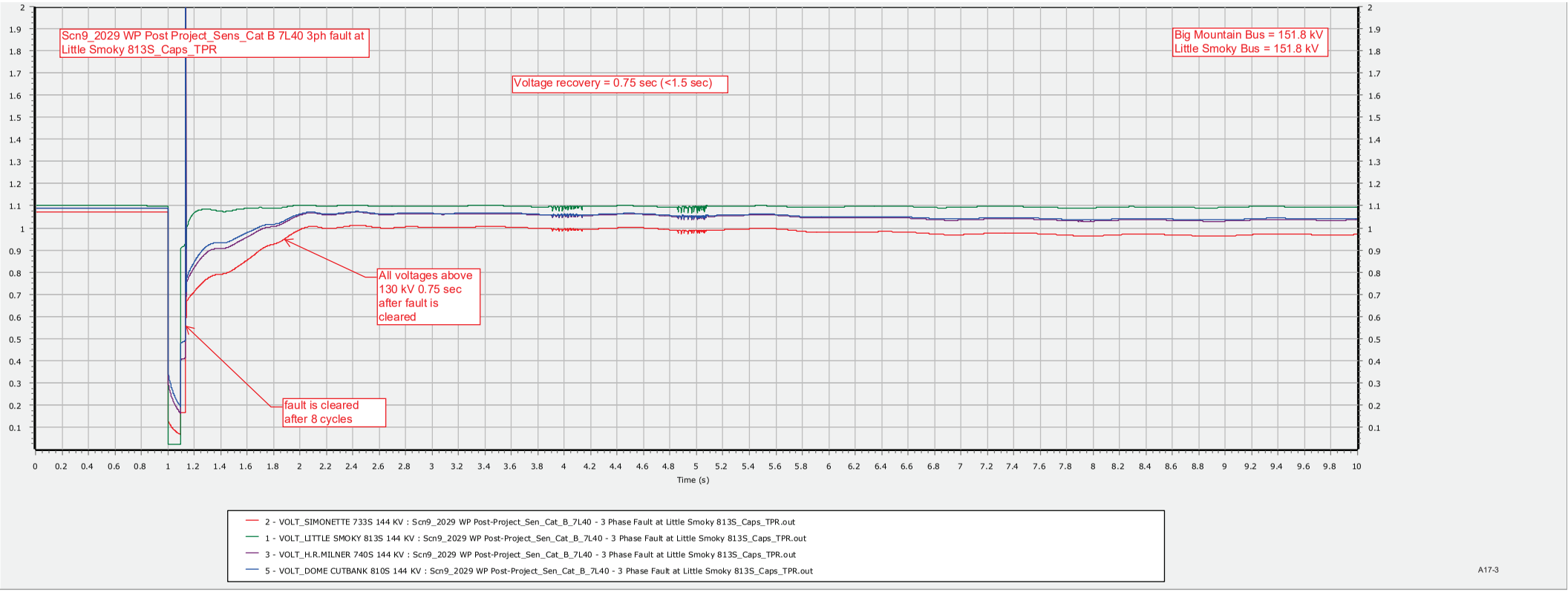
Post-Mitigation transient stability analysis with TPR and Capacitors was performed using the Scenario 9 for the Category B contingencies identified in Table A17-1.

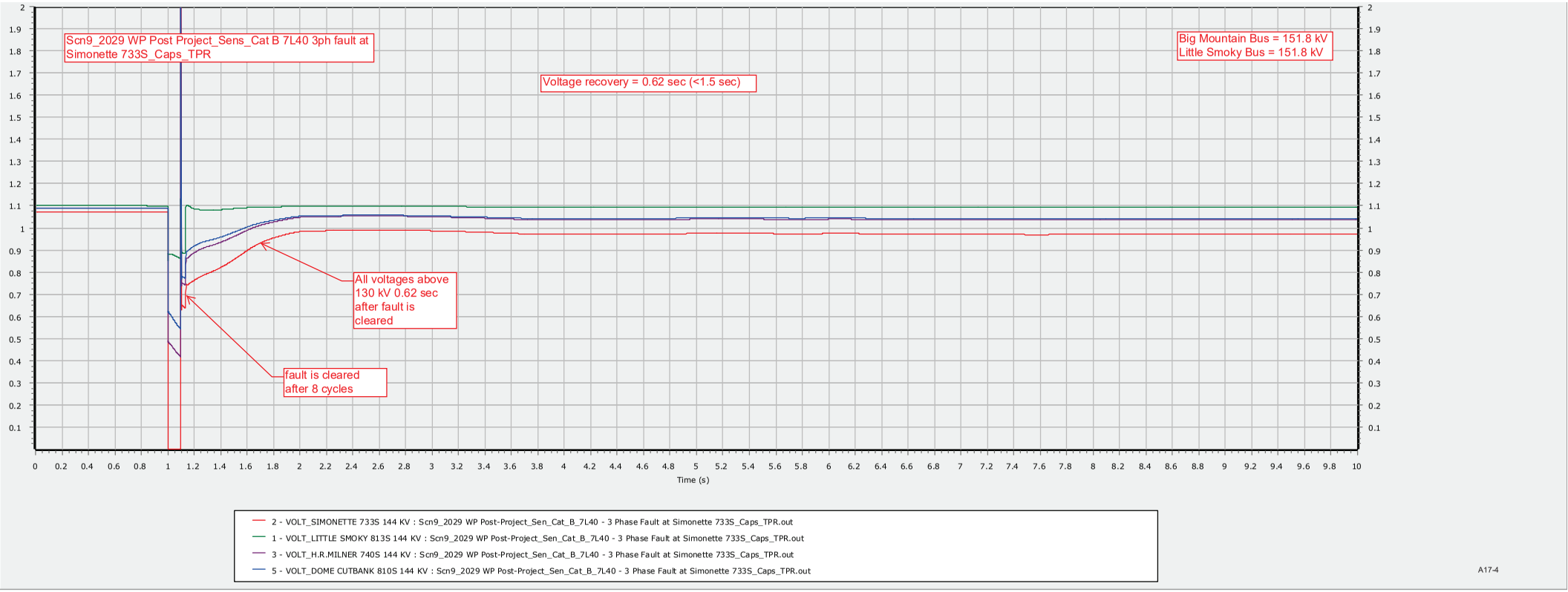
Table A14-1: List of Contingencies Studied for Transient Stability – Scenario 9 2029 WP-Post Project (Sensitivity) with TPR and Capacitors

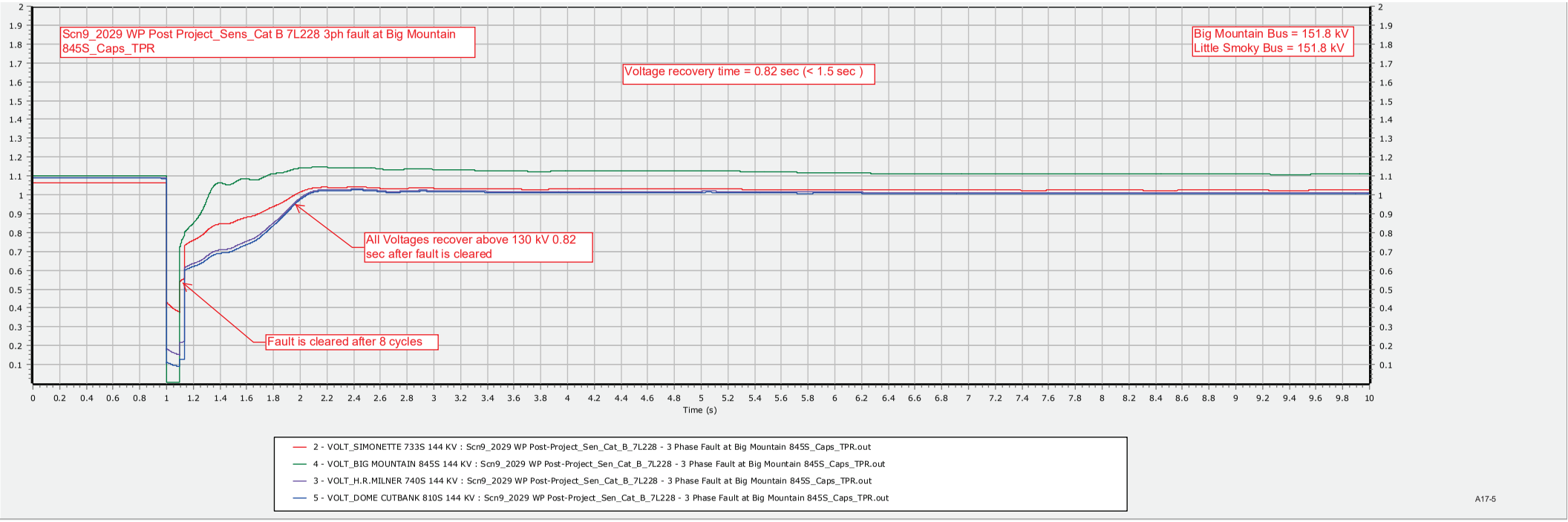
System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A17-1
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A17-2
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A17-3
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	A17-4
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Big Mountain 845S	A17-5
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Thornton 2091S	A17-6

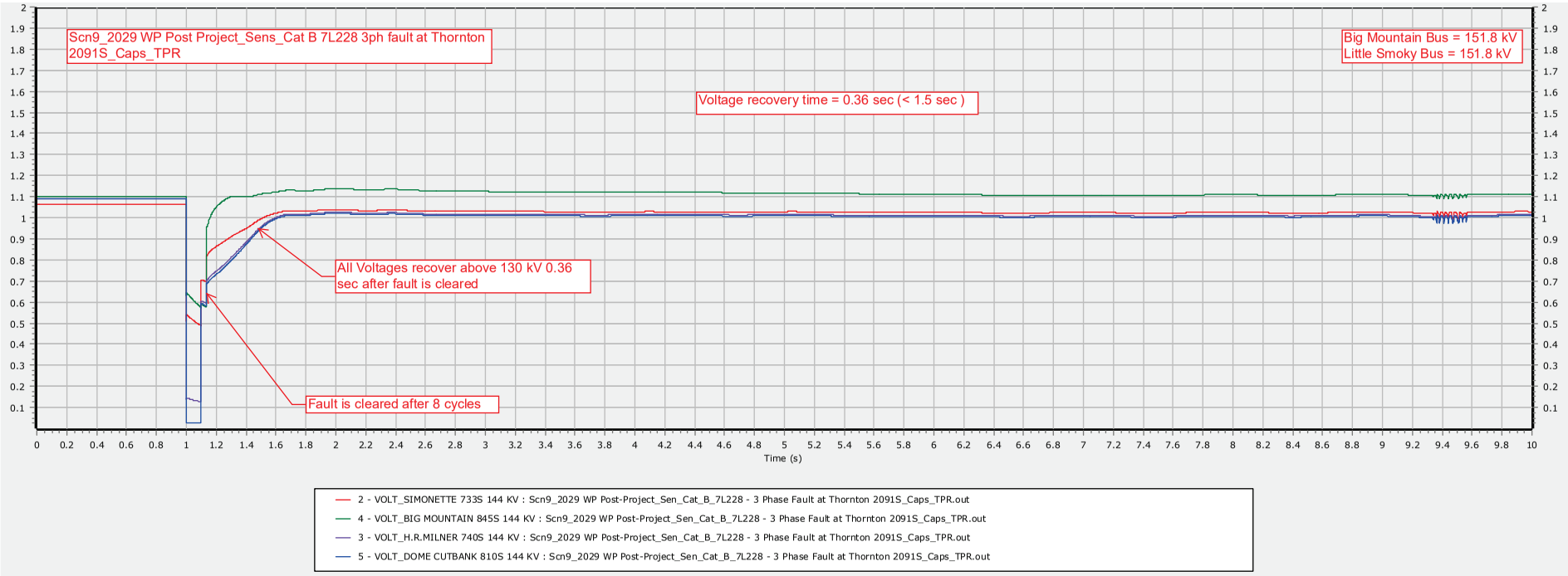

Scn9_2029 WP Post Project_Sens_Cat B 7L20 3ph fault at Thornton 2091S_Caps_TPR
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage recovery time = 0.16 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.16 sec after fault is cleared
Fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_Caps_TPR.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_Caps_TPR.out


Scn9_2029 WP Post Project_Sens_Cat B 7L20 3ph fault at HR Milner 740S_Caps_TPR
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage recovery time = 0.09 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.09 sec after fault is cleared
Fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_Caps_TPR.out
6 - VOLT_THORNTON 2091S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_Caps_TPR.out


Scn9_2029 WP Post Project_Sens_Cat B 7L40 3ph fault at Little Smoky 813S_Caps_TPR
Voltage recovery = 0.75 sec (<1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All voltages above 130 kV 0.75 sec after fault is cleared
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_TPR.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_TPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_Caps_TPR.out


Scn9_2029 WP Post Project_Sens_Cat B 7L40 3ph fault at Simonette 733S_Caps_TPR
Voltage recovery = 0.62 sec (<1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All voltages above 130 kV 0.62 sec after fault is cleared
fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_Caps_TPR.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_Caps_TPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_Caps_TPR.out


Scn9_2029 WP Post Project_Sens_Cat B 7L228 3ph fault at Big Mountain 845S_Caps_TPR
Voltage recovery time = 0.82 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All Voltages recover above 130 kV 0.82 sec after fault is cleared
Fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_Caps_TPR.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_Caps_TPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_Caps_TPR.out


Scn9_2029 WP Post Project_Sens_Cat B 7L228 3ph fault at Thornton 2091S_Caps_TPR
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
Voltage recovery time = 0.36 sec (< 1.5 sec)
All Voltages recover above 130 kV 0.36 sec after fault is cleared
Fault is cleared after 8 cycles
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_Caps_TPR.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_Caps_TPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : Scn9_2029 WP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_Caps_TPR.out

Attachment A18

Post-Mitigation Transient Stability Diagrams with TPR and Capacitors

P3072 Final Stage with P3076 and P2716

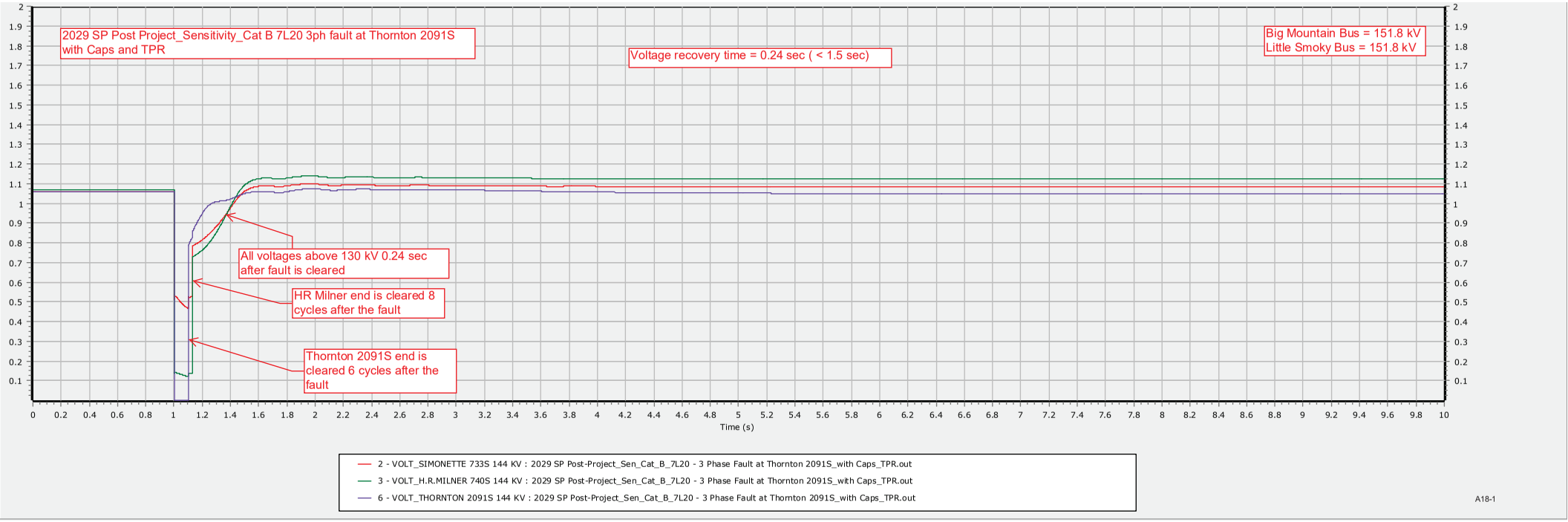
(Scenario 9)

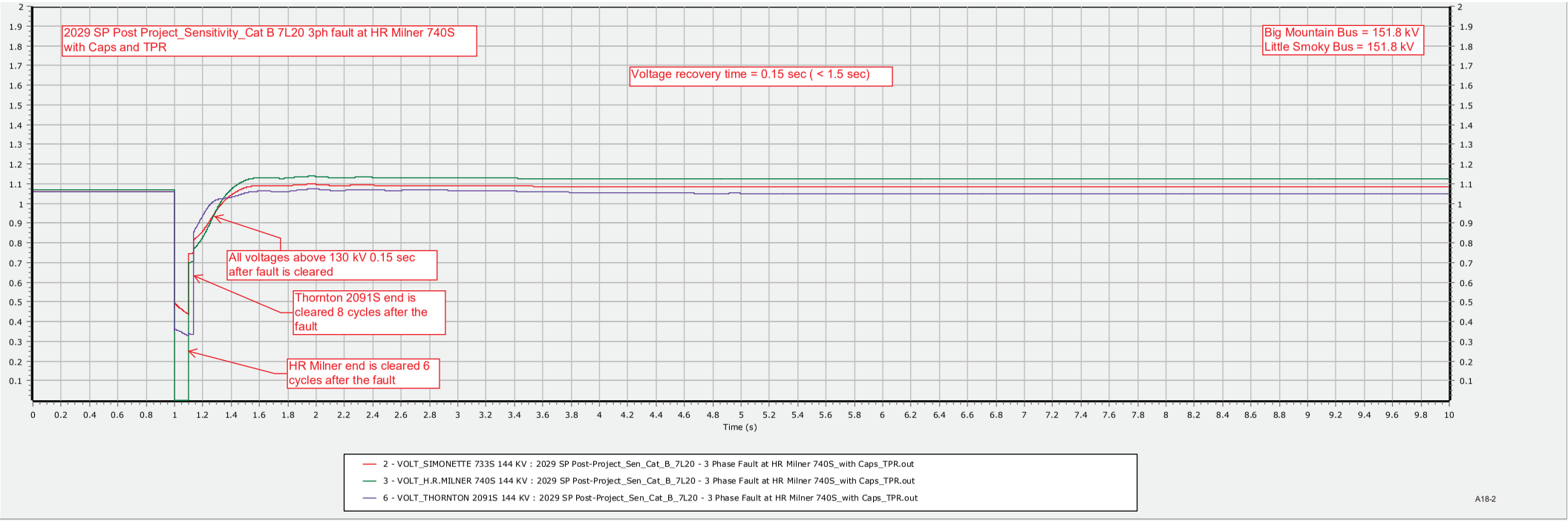
Transient Stability Diagrams for Scenario 9 2029 SP Post-Project (Sensitivity)

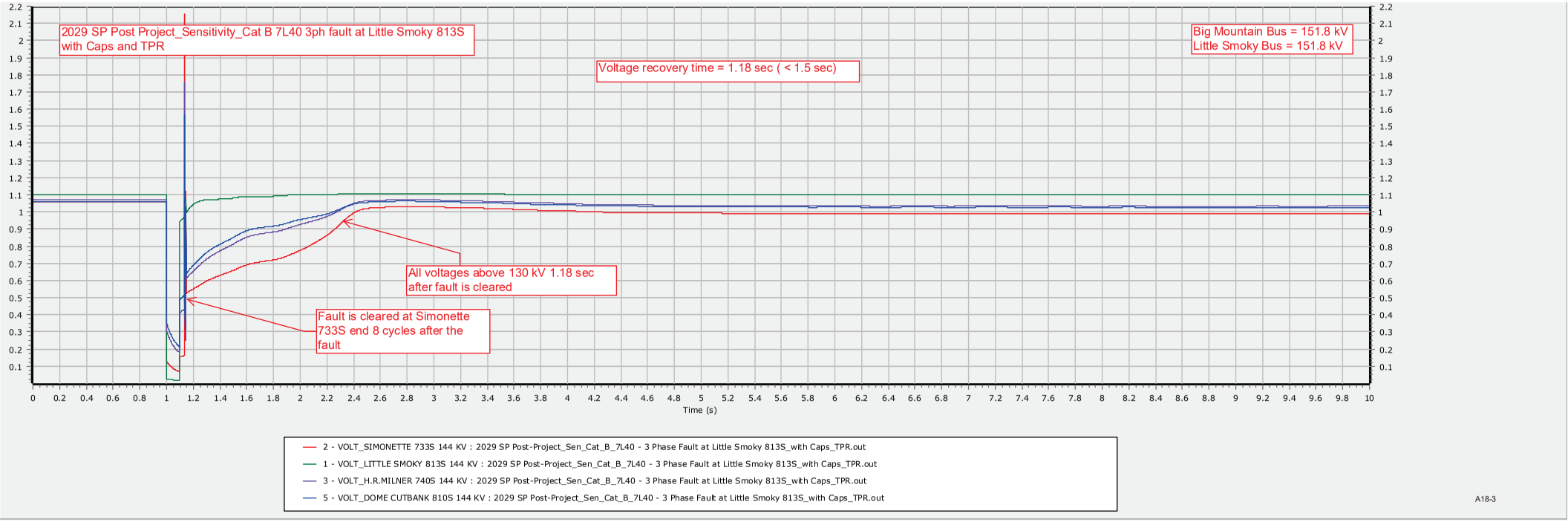
Post-Mitigation transient stability analysis with TPR and Capacitors was performed using the Scenario 9 for P3072 Final Stage with P3076 and P2716 for Category B contingencies identified in Table A18-1.

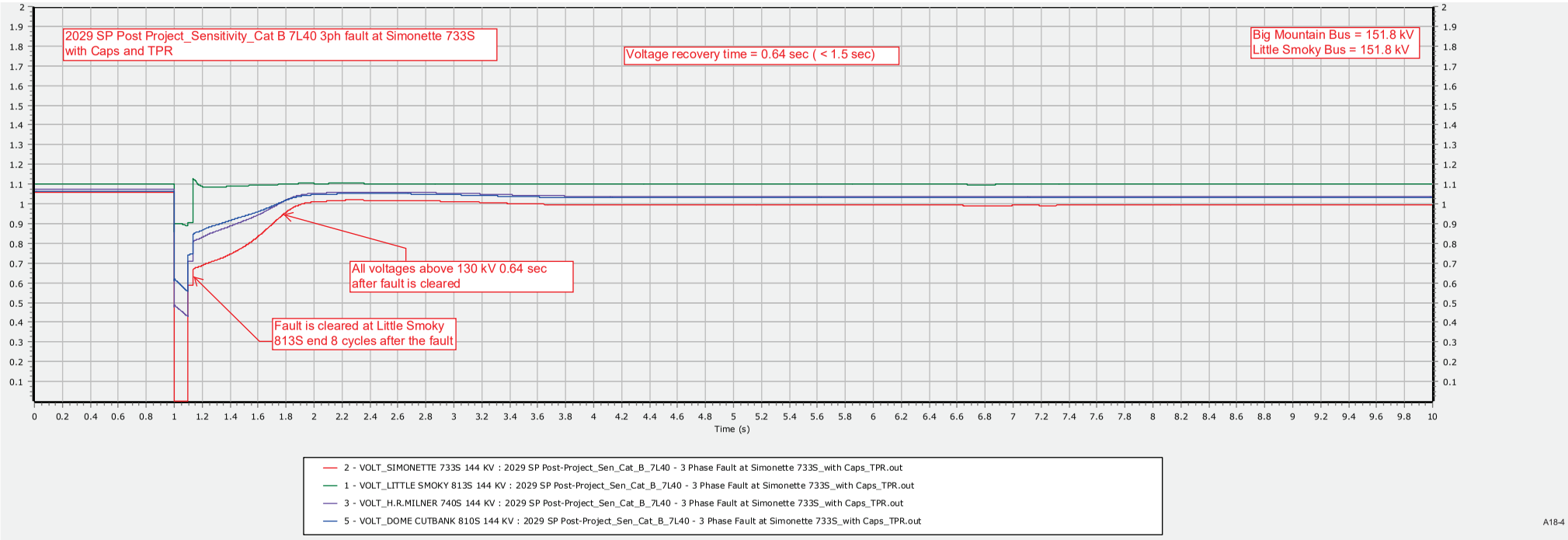
Table A18-1: List of Contingencies Studied for Transient Stability – Scenario 9 2029 SP-Post Project (Sensitivity) with TPR and Capacitors

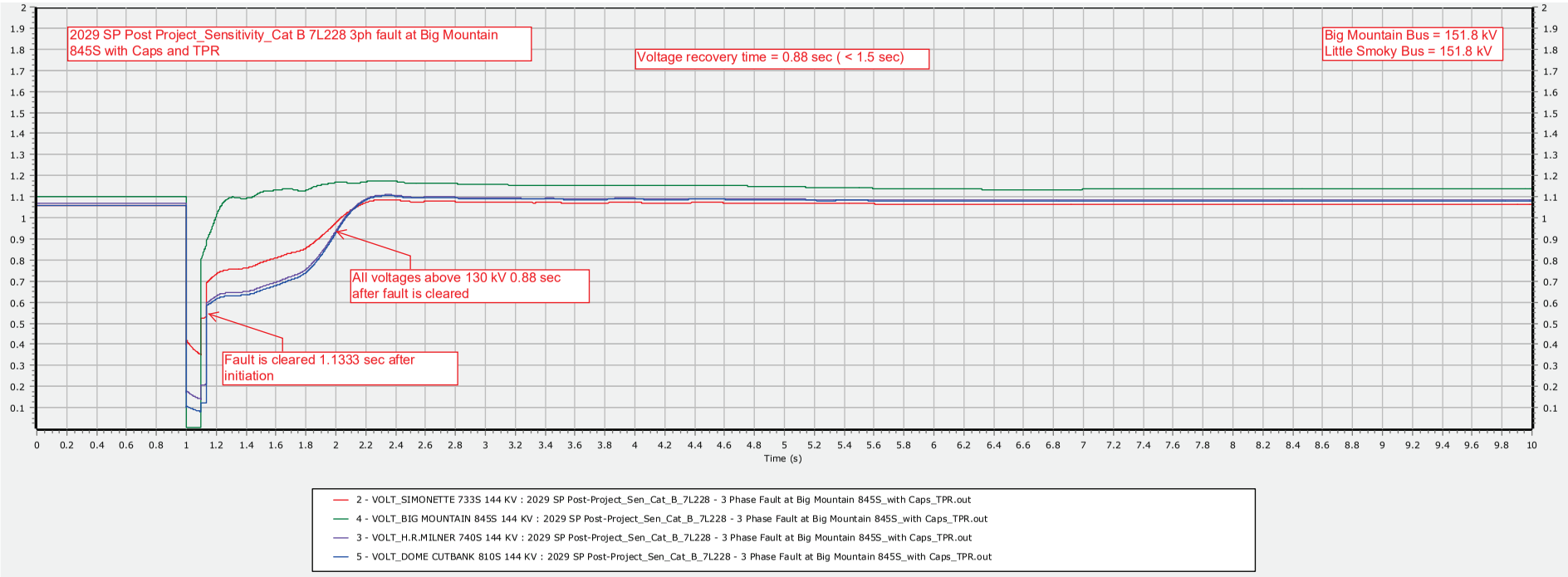
System Condition	Contingency	Fault Description (fault location)	Page #
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	Thornton 2091S	A18-1
Category B (N-1)	7L20 (Thornton 2091S – HR Milner 740S)	HR Milner 740S	A18-2
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Little Smoky 813S	A18-3
Category B (N-1)	7L40 (Little Smoky 813S – Simonette 733S)	Simonette 733S	A18-4
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Big Mountain 845S	A18-5
Category B (N-1)	7L228 (Big Mountain 845S – Thornton 2091S)	Thornton 2091S	A18-6

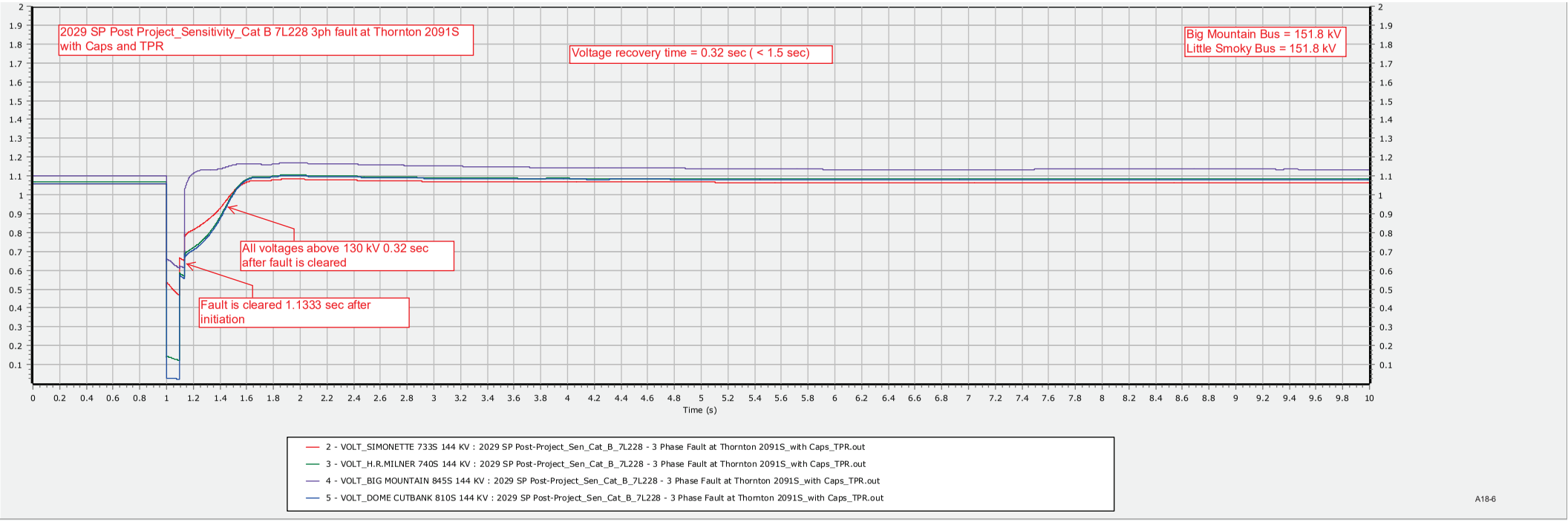

2029 SP Post Project_Sensitivity_Cat B 7L20 3ph fault at Thornton 2091S with Caps and TPR
Voltage recovery time = 0.24 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All voltages above 130 kV 0.24 sec after fault is cleared
HR Milner end is cleared 8 cycles after the fault
Thornton 2091S end is cleared 6 cycles after the fault
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_with Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_with Caps_TPR.out
6 - VOLT_THORNTON 2091S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at Thornton 2091S_with Caps_TPR.out


2029 SP Post Project_Sensitivity_Cat B 7L20 3ph fault at HR Milner 740S with Caps and TPR
Voltage recovery time = 0.15 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All voltages above 130 kV 0.15 sec after fault is cleared
Thornton 2091S end is cleared 8 cycles after the fault
HR Milner end is cleared 6 cycles after the fault
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_with Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_with Caps_TPR.out
6 - VOLT_THORNTON 2091S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L20 - 3 Phase Fault at HR Milner 740S_with Caps_TPR.out


2029 SP Post Project_Sensitivity_Cat B 7L40 3ph fault at Little Smoky 813S with Caps and TPR
Voltage recovery time = 1.18 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All voltages above 130 kV 1.18 sec after fault is cleared
Fault is cleared at Simonette 733S end 8 cycles after the fault
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_with Caps_TPR.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_with Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_with Caps_TPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Little Smoky 813S_with Caps_TPR.out


2029 SP Post Project_Sensitivity_Cat B 7L40 3ph fault at Simonette 733S with Caps and TPR
Voltage recovery time = 0.64 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All voltages above 130 kV 0.64 sec after fault is cleared
Fault is cleared at Little Smoky 813S end 8 cycles after the fault
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_with Caps_TPR.out
1 - VOLT_LITTLE SMOKY 813S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_with Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_with Caps_TPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L40 - 3 Phase Fault at Simonette 733S_with Caps_TPR.out


2029 SP Post Project_Sensitivity_Cat B 7L228 3ph fault at Big Mountain 845S with Caps and TPR
Voltage recovery time = 0.88 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All voltages above 130 kV 0.88 sec after fault is cleared
Fault is cleared 1.1333 sec after initiation
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_with Caps_TPR.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_with Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_with Caps_TPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Big Mountain 845S_with Caps_TPR.out


2029 SP Post Project_Sensitivity_Cat B 7L228 3ph fault at Thornton 2091S with Caps and TPR
Voltage recovery time = 0.32 sec (< 1.5 sec)
Big Mountain Bus = 151.8 kV
Little Smoky Bus = 151.8 kV
All voltages above 130 kV 0.32 sec after fault is cleared
Fault is cleared 1.1333 sec after initiation
Time (s)
2 - VOLT_SIMONETTE 733S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_with Caps_TPR.out
3 - VOLT_H.R.MILNER 740S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_with Caps_TPR.out
4 - VOLT_BIG MOUNTAIN 845S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_with Caps_TPR.out
5 - VOLT_DOME CUTBANK 810S 144 KV : 2029 SP Post-Project_Sen_Cat_B_7L228 - 3 Phase Fault at Thornton 2091S_with Caps_TPR.out

Attachment A19
Constraint Summary Table with TMR and RAS
(Scenario 8, 9)

Triggering Events (Element out of Service)	Type of System Constraint (Nature of constraint) (ex. thermal violation, instability, voltage range violation)	Details of Constraint (ex. %I of MVA loading of nominal rating, nominal and short-term emergency rating, and direction of flow, or what type of instability, or voltage level)																			Assumed System Conditions (ex. Summer peak, year, and other critical project assumptions)	Overall Mitigation Approach TMR=50 MW at NPP1 (Lowe Lake) and RAS 242				Comments
		Thermal								Voltage (Steady State)														Mitigation Approach	Post (TMR + RAS) Action			
		Nominal Rating (MVA)	Short-term Rating (MVA)	Pre-Project (No TMR)		Post-Project (No TMR)		Post - Pre (%)	Does Loading Exceed Emergency Rating?	Substation	Bus #	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Pre-Project (No TMR)		Post-Project (No TMR)		% Voltage Difference (kV)	Stability			Action 1 Power Flow (MVA) / Voltage (kV)	Action 1 % of MVA Continuous Rating	Does Loading Exceed Emergency Rating?	
				Load Flow (MVA)	%I of MVA Continuous Ratings	Load Flow (MVA)	%I of MVA Continuous Ratings								Initial Voltage (kV) Pre	Voltage (KV) Pre	Initial Voltage (kV) Post	Voltage (KV) Post							
9L05 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	121.3	101.9	127.3	107.0	5.0	*No*	-	-	-	-	-	-	-	-	-	-	-	2029SP	**TMR =50 MW**	115.7	97.2	*No*	
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	Pre Project Voltage Collapse		Post Project Voltage Collapse		-	-	-	-	-	-	-	-	-	-	-	-	-	2029SP	**TMR = 50 MW and 7L40 RAS (Trips 22 MW at Simonette 733S)**	No Post-Mitigation Violations			
7L13 (Big Mountain 845S - Procter & Gamble 808S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	124.2	104.4	129.2	108.6	4.2	*No*	-	-	-	-	-	-	-	-	-	-	-	2029SP	**TMR =50 MW**	119.5	100.4	*No*	**With TMR=55 MW No Cat A or Cat B thermal violations**
7L56 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	114.0	95.8	119.4	100.3	4.5	*No*	-	-	-	-	-	-	-	-	-	-	-	2029SP	**TMR =50 MW**	108.9	91.5	*No*	
7L75 (Friednestal 800S - West Peace River 793S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	116.5	97.9	122.0	102.5	4.4	*No*	-	-	-	-	-	-	-	-	-	-	-	2029SP	**TMR =50 MW**	108.9	91.5	*No*	
	7L32 (Little Smoky 813S - Bezanson)	109	115	76.1	69.6	111.5	102	32.4	*No*												2029SP	**TMR =50 MW**	64.9	59.4	*No*	
Bear Creek 679S 701T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	124.1	104.3	129.5	108.8	4.4	*No*	-	-	-	-	-	-	-	-	-	-	-	2029SP	**TMR =50 MW**	119.5	100.4	*No*	**With TMR=55 MW No Cat A or Cat B thermal violations**
Little Smoky 813S 901T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	120.3	101.1	126.1	106	4.9	*No*	-	-	-	-	-	-	-	-	-	-	-	2029SP	**TMR =50 MW**	114.4	96.1	*No*	
	Little Smoky 813S 902T WDG1	200	214	201.0	100.5	217.0	108.5	8.0	*Yes*												2029SP	**TMR =50 MW**	188.2	94.1	*No*	
	Little Smoky 813S 902T WDG2	200	214	201.6	100.8	217.6	108.8	8.0	*Yes*												2029SP	**TMR =50 MW**	188.6	94.3	*No*	
Little Smoky 813S 902T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	120.3	101.1	126.1	106	4.9	*No*	-	-	-	-	-	-	-	-	-	-	-	2029SP	**TMR =50 MW**	114.8	96.5	*No*	
	Little Smoky 813S 901T WDG1	200	214	200.0	100	215.8	107.9	7.9	*Yes*												2029SP	**TMR =50 MW**	187.2	93.6	*No*	
	Little Smoky 813S 901T WDG2	200	214	200.4	100.2	216.4	108.2	8.0	*Yes*												2029SP	**TMR =50 MW**	187.6	93.8	*No*	
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	Pre Project Voltage Collapse		Post Project Voltage Collapse		-	-	-	-	-	-	-	-	-	-	-	-	-	2029WP	**TMR = 50 MW and 7L40 RAS (Trips 22 MW at Simonette 733S)**	No Post-Mitigation Violations			
7L228 (Big Mountain 845S - Thornton 2091S)	-	-	-	Pre Project Voltage Collapse		Post Project Voltage Collapse		-	-	-	-	-	-	-	-	-	-	-	-	-	2029WP	**TMR = 50 MW and 7L228 RAS (Trips 22 MW at Simonette 733S)**	No Post-Mitigation Violations			
Voltage Violations																										
7L228 (Big Mountain 845S - Thornton 2091S)	-	-	-	-	-	-	-	-	-	Dome Cutbank 810S	1144	144	130	155	146.8	127.9	143.8	128.1	0.2%	-	2029SP	**TMR = 50 MW and 7L228 RAS (Trips 22 MW at Simonette 733S)**	139.7			
	-	-	-	-	-	-	-	-	-	H.R. Milner 740S	1147	144	130	155	145.9	128.7	143	129	0.2%	-	2029SP		140.4			
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Pre-Project Voltage Collapse		Post-Project Voltage Collapse		--	-	2029SP	**TMR = 50 MW and 7L40 RAS (Trips 22 MW at Simonette 733S)**	No Post-Mitigation Violations			
7L228 (Big Mountain 845S - Thornton 2091S)	-	-	-	-	-	-	-	-	-	--	--	--	--	--	Pre-Project Voltage Collapse		Post-Project Voltage Collapse		--	-	2029WP	**TMR = 50 MW and 7L228 RAS (Trips 22 MW at Simonette 733S)**	No Post-Mitigation Violations			
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	-	-	-	-	-	-	--	--	--	--	--	Pre-Project Voltage Collapse		Post-Project Voltage Collapse		--	-	2029WP	**TMR = 50 MW and 7L40 RAS (Trips 22 MW at Simonette 733S)**	No Post-Mitigation Violations			

Attachment A20

Constraint Summary Table with TMR and Capacitors

P3076 with P3072 Interim Stage (Scenario 8, 9)

Triggering Events (Element out of Service)	Type of System Constraint (Nature of constraint) (ex. thermal violation, instability, voltage range violation)	Details of Constraint (ex. %I of MVA loading of nominal rating, nominal and short-term emergency rating, and direction of flow, or what type of instability, or voltage level)																			Assumed System Conditions (ex. Summer peak, year, and other critical project assumptions)	Overall Mitigation Approach TMR=50 MW at NPP1 (Lowe Lake) and New Caps (15MVAr at HR Milner 740S + 20MVAr at Simonette 733S + 2x15MVAr at Thornton 2091S)				Comments
		Thermal								Voltage (Steady State)													Mitigation Approach	Post (TMR + CAPS) Action			
		Nominal Rating (MVA)	Short-term Rating (MVA)	Pre-Project (No TMR)		Post-Project (No TMR)		Post - Pre (%)	Does Loading Exceed Emergency Rating?	Substation	Bus #	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Pre-Project (No TMR)		Post-Project (No TMR)		% Voltage Difference (kV)	Stability			Action 1 Power Flow (MVA) / Voltage (kV)	Action 1 % of MVA Continuous Rating	Does Loading Exceed Emergency Rating?	
				Load Flow (MVA)	%I of MVA Continuous Ratings	Load Flow (MVA)	%I of MVA Continuous Ratings								Initial Voltage (kV) Pre	Voltage (KV) Pre	Initial Voltage (kV) Post	Voltage (KV) Post							
9L05 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	121.3	101.9	127.3	107.0	5.1	No	-	-	-	-	-	-	-	-	-	-	-	2029SP	TMR = 50 MW and Caps	115.9	97.4	No	
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	Pre Project Voltage Collapse		Post Project Voltage Collapse		-	-	-	-	-	-	-	-	-	-	-	-	-	-	2029SP		No Post-Mitigation Violations			
7L13 (Big Mountain 845S - Procter & Gamble 808S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	124.2	104.4	129.2	108.6	4.2	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		119.2	100.2	No	With TMR=55 MW No Cat A or Cat B thermal violations
7L56 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	114.0	95.8	119.4	100.3	4.5	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		108.9	91.5	No	
7L75 (Friednestal 800S - West Peace River 793S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	116.5	97.9	122.0	102.5	4.6	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		108.9	91.5	No	
Bear Creek 679S 701T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	124.1	104.3	129.5	108.8	4.5	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		119.4	100.3	No	With TMR=55 MW No Cat A or Cat B thermal violations
Little Smoky 813S 901T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	120.3	101.1	126.1	106	4.9	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		114.4	96.1	No	
	Little Smoky 813S 902T WDG1	200	214	201.0	100.5	217.0	108.5	8.0	Yes												2029SP		188.0	94	No	
	Little Smoky 813S 902T WDG2	200	214	201.6	100.8	217.6	108.8	8.0	Yes												2029SP		188.4	94.2	No	
Little Smoky 813S 902T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119	131	120.3	101.1	126.1	106	4.9	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		114.8	96.5	No	
	Little Smoky 813S 901T WDG1	200	214	200.0	100	215.8	107.9	7.9	Yes												2029SP		187.0	93.5	No	
	Little Smoky 813S 901T WDG2	200	214	200.4	100.2	216.4	108.2	8.0	Yes												2029SP		187.4	93.7	No	
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	Pre Project Voltage Collapse		Post Project Voltage Collapse		-	-	-	-	-	-	-	-	-	-	-	-	-	2029WP	TMR = 50 MW and Caps	No Post-Mitigation Violations			
7L228 (Big Mountain 845S - Thornton 2091S)	-	-	-	Pre Project Voltage Collapse		Post Project Voltage Collapse		-	-	-	-	-	-	-	-	-	-	-	-	-	2029WP					
Voltage Violations																										
7L228 (Big Mountain 845S - Thornton 2091S)	-	-	-	-	-	-	-	-	-	Albright & Wilson 752S Tap	1139	144	130	155	152.3	154	152.5	155.7	1.1%	-	2029SP	TMR = 50 MW and Caps	No Post-Mitigation Violations			
	-	-	-	-	-	-	-	-	-	Bear Creek 679S Tap	1140	144	130	155	152.5	154.2	152.7	155.8	1.1%	-	2029SP					
	-	-	-	-	-	-	-	-	-	Albright & Wilson 752S	1142	144	130	155	152.3	154	152.5	155.7	1.1%	-	2029SP					
	-	-	-	-	-	-	-	-	-	Proctor & Gamble 808S	1143	144	130	155	152.5	154.2	152.7	155.8	1.1%	-	2029SP					
	-	-	-	-	-	-	-	-	-	Bear Creek 679S	1145	144	130	155	152.5	154.2	152.8	155.8	1.1%	-	2029SP					
	-	-	-	-	-	-	-	-	-	Dome Cutbank 810S	1144	144	130	155	146.8	127.9	143.8	128.1	0.2%	-	2029SP					
	-	-	-	-	-	-	-	-	-	H.R. Milner 740S	1147	144	130	155	145.9	128.7	143	129	0.2%	-	2029SP					
Simonette 733S 702T										H.R. Milner 740S	1147	144	130	155	No Pre-Project Voltage Violations		No Post-Project Voltage Violations				2029SP	Planned Simonette 733S Overvoltage Protection	155.6	153.1*		*Post-mitigated voltages after applying OV protection, are shown in column Y
										Kakwa Ridge 857S	1149	144	130	155							2029SP		156.1	153.2*		
										Simonette 733S	1170	144	130	155							2029SP		157.5	152.8*		
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Pre-Project Voltage Collapse		Post-Project Voltage Collapse		–	-	2029SP	TMR = 50 MW and Caps	No Post-Mitigation Violations			
7L228 (Big Mountain 845S - Thornton 2091S)	-	-	-	-	-	-	-	-	-						Pre-Project Voltage Collapse		Post-Project Voltage Collapse		–	-	2029WP	TMR = 50 MW and Caps	No Post-Mitigation Violations			
7L40 (Little Smoky 813S – Simonette 733S)	-	-	-	-	-	-	-	-	-	–	–	–	–	–	Pre-Project Voltage Collapse		Post-Project Voltage Collapse		–	-	2029WP		No Post-Mitigation Violations			
Simonette 733S 702T										H.R. Milner 740S	1147	144	130	155							2029WP	Planned Simonette 733S Overvoltage Protection	155.8	153.1*		*Post-mitigated voltages after applying OV protection, are shown in column Y
										Kakwa Ridge 857S	1149	144	130	155							2029WP		156.2	153.2*		
										Simonette 733S	1170	144	130	155							2029WP		157.6	152.9*		

Attachment A21
Constraint Summary Table with TMR and Capacitors
P3076 with P3072 Final Stage and P2716
(Scenario 9)

Triggering Events (Element out of Service)	Type of System Constraint (Nature of constraint) (ex. thermal violation, instability, voltage range violation)	Details of Constraint (ex. %I of MVA loading of nominal rating, nominal and short-term emergency rating, and direction of flow, or what type of instability, or voltage level)																			Assumed System Conditions (ex. Summer peak, year, and other critical project assumptions)	Overall Mitigation Approach (TMR (50MW) and Cap Banks at HRM (15MVAr@144kV) + Simonette (20MVAr@144kV) + Pearson (2x15MVAr@144kV+2x4.8MVAr@25kV))				Comments
		Thermal								Voltage (Steady State)														Mitigation Approach (TMR + Caps)	Post (TMR50MWandCaps) Action			
		Nominal Rating (MVA)	Short-term Rating (MVA)	Pre-Project (withTMR=50MW)		Post-Project (with TMR=50MW)		Post - Pre (%)	Does Loading Exceed Emergency Rating?	Substation	Bus #	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Pre-Project (withTMR=50MW)		Post-Project (with TMR=50MW)		% Voltage Difference (kV)	Stability			Action 1 Power Flow (MVA) / Voltage (kV)	Action 1 % of MVA Continuous Rating	Does Loading Exceed Emergency Rating?	
				Load Flow (MVA)	%I of MVA Continuous Ratings	Load Flow (MVA)	%I of MVA Continuous Ratings								Pre Initial Voltage (kV)	Pre Steady State Voltage	Post Initial Voltage (kV)	Post Steady State Voltage							
Basecase	Pearson_701T	50	53	–	–	55.8	111.5	–	Yes	-	-	-	-	-	-	-	-	-	-	-	2029SP		48.0	96	No	
7L101 (Poplar Hill 790S- Lowe Lake 944S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	112.5	94.2	128.4	107.5	13.3	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		127.2	106.5	No	
Lowe Lake 944S GT1	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	112.5	94.2	128.4	107.5	13.3	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		127.2	106.5	No	
Bear Creek 679S 701T	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	117.8	98.7	134.2	112.4	13.7	Yes	-	-	-	-	-	-	-	-	-	-	-	2029SP		132.9	111.3	Yes	
Little Smoky 813S 902T	Little Smoky 813S 901T WDG1	200	214	182.2	91.1	226.0	113	21.9	Yes	-	-	-	-	-	-	-	-	-	-	-	2029SP		224.6	112.3	Yes	
	Little Smoky 813S 901T WDG2	200	214	182.6	91.3	226.4	113.2	21.9	Yes	-	-	-	-	-	-	-	-	-	-	-	2029SP		225.0	112.5	Yes	
	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	113.2	94.8	131.3	110	15.2	Yes	-	-	-	-	-	-	-	-	-	-	-	2029SP		130.1	109	No	With TMR=105 MW, remaining Cat B Thermal violations will be reduced to below Emergency ratings.
Little Smoky 813S 901T	Little Smoky 813S 902T WDG2	200	214	183.6	91.8	227.6	113.8	22	Yes	-	-	-	-	-	-	-	-	-	-	-	2029SP		226.2	113.1	Yes	
	Little Smoky 813S 902T WDG1	200	214	183.2	91.6	227.0	113.5	21.9	Yes	-	-	-	-	-	-	-	-	-	-	-	2029SP		225.6	112.8	Yes	
	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	112.8	94.5	130.9	109.6	15.1	No	-	-	-	-	-	-	-	-	-	-	-	2029SP	***TMR=50 MW + Caps***	129.8	108.7	No	
9L05 (Little Smoky 813S - Louise Creek 809S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	114.1	95.6	132.4	110.9	15.3	Yes	-	-	-	-	-	-	-	-	-	-	-	2029SP		131.2	109.9	Yes	
SING OPN LIN 134 1260-542001(08)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	106.7	89.4	122.4	102.5	13.1	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		121.4	101.7	No	
919L (Sagitawah 77S - Sundance Plant 310P)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	107.0	89.6	123.2	103.2	13.6	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		122.1	102.3	No	
989L (Sagitawah 77S - Sundance Plant 310P)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	106.7	89.4	122.9	102.9	13.5	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		121.8	102	No	
9L938 (Sagitawah 77S - P2499 Kiwetinohk Black Bear Gas)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	106.7	89.4	123.2	103.2	13.8	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		122.1	102.3	No	
9L939 (Sagitawah 77S - P2499 Kiwetinohk Black Bear Gas)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	106.7	89.4	123.2	103.2	13.8	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		122.1	102.3	No	
7L13 (Big Mountain 845S - Procter & Gamble 808S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	117.8	98.7	134.0	112.2	13.5	Yes	-	-	-	-	-	-	-	-	-	-	-	2029SP		132.9	111.3	Yes	
7L23 (Nipisi 796S - Mitsue 732S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	109.8	92	120.7	101.1	9.1	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		124.9	104.6	No	
7L75 (Friednestal 800S - West Peace River 793S)	7L199 (Fox Creek 347S - P2456 Kiwetinohk Opal Gas T-tap)	119.4	131	109.8	92	126.1	105.6	13.6	No	-	-	-	-	-	-	-	-	-	-	-	2029SP		124.9	104.6	No	
VOLTAGE VIOLATIONS																											
Basecase	-	-	-	-	-	-	-	-	-	Pearson 2089S	1170	144	130	155	-	-	125.6	125.6	0.0%	-	2029SP		145.8			
	-	-	-	-	-	-	-	-	-	Simonette 733S	1170	144	130	155	148.3	148.3	129.6	129.6	0.0%	-	2029SP		146			
7L228 (Big Mountain 845S - Thornton 2091S)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Post-Project Voltage Collapse		-	-	2029SP					
7L13 (Big Mountain 845S - Procter & Gamble 808S)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Post-Project Voltage Collapse		-	-	2029SP					
7L40 (Simonette 733S - Little Smoky 813S)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Post-Project Voltage Collapse		-	-	2029SP	**TMR=50 MW + Caps**	No Post-Mitigation Violations			
7L80 (Simonette 733S - HR Milner 740S)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Post-Project Voltage Collapse		-	-	2029SP					
7L20 (HR Milner 740S - Thornton 2091S)										-	-	-	-	-	-	-	Post-Project Voltage Collapse				2029SP					
Other Cat B Contingencies	-	-	-	-	-	-	-	-	-	Pearson 2089S	1170	144	130	155	-	-	126.5	125.4	-0.9%	-	2029SP					
Simonette 733S 702T										Simonette 733S	1170	144	130	155	–	–	129.6	140	8.0%	-	2029SP	**Planned Simonette 733S Overvoltage Protection**	156	150.9*	*Post-mitigated voltage with planned OV protection scheme at Simonette	
										Pearson 2089S	990002	144	130	155	–	–	125.6	136.1	8.4%	-	2029SP		156	150.9*		
Pearson 2089S 701T										Simonette 733S	1170	144	130	155	–	–	129.6	142	9.6%	-	2029SP	**Planned Pearson 2089S Overvoltage Protection**	155	151.4*	*Post-mitigated voltage with planned OV protection scheme at Pearson	
										Pearson 2089S	990002	144	130	155	–	–	125.6	142.6	13.5%	-	2029SP		158	153*		