

APPENDIX A CONNECTION ASSESSMENT

FortisAlberta Chestermere New POD

Project Number: 1631

The attached engineering study report has been prepared by a third party as part of the AESO Connection Process. The AESO has reviewed the report and the conclusions that it contains, and finds it acceptable for the purpose of assessing potential impacts of the Project on the transmission system.

After completing the studies for the Project, the ISD of the Project shifted from October 2017 to September 2018. The shift in the ISD does not materially impact the results of this connection assessment, and does not change the conclusions and recommendations contained in this report.

Information regarding the AESO Connection Process can be found at:
<http://www.aeso.ca/8602.html>

Date: August 30, 2016

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While the DFO's plans are considered during the transmission planning process, the AESO, in exercising its duties to plan the transmission system, does not oversee distribution planning or the development of specific DFO planning criteria.

Public



Connection Engineering Study Report for AUC Application

FortisAlberta Chestermere New POD

AESO Project 1631

Revision: R1

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Executive Summary

Project Overview

FortisAlberta Inc. (FortisAlberta), in its capacity as the legal owner of distribution facilities (DFO), submitted a system access service request (SASR) to the Alberta Electric System Operator (AESO) to meet the DFO's distribution planning criteria and to serve new loads and load growth in the City of Chestermere and the surrounding area.

The SASR includes a request for a Rate DTS, *Demand Transmission Service*, contract capacity of 43.7 MW for new system access service in the area; a Rate DTS contract capacity increase of 1.4 MW (from 26.6 MW to 28 MW) for the system access service provided at the existing Turbo Balzac 391S substation; and a request for transmission development (collectively, the Project). Specifically, the DFO requested a new 138/25 kV point-of-delivery (POD) substation east of the City of Chestermere and modifications to the existing Turbo Balzac 391S substation.

The scheduled in-service date (ISD) for the Project is September 1, 2018.

This report details the engineering studies conducted to assess the impact of the Project on the performance of the Alberta interconnected electric system (AIES).

Existing System

Geographically, the Project is located in the AESO planning area of Calgary (Area 6), but the Project is electrically associated with the Strathmore/Blackie planning area (Area 45). For the purposes of these studies, the Project is considered to be a component of the Strathmore/Blackie (Area 45), which is part of the AESO South Planning Region.

From a transmission system perspective, Strathmore/Blackie (Area 45) consists primarily of a 138 kV transmission system. The 240 kV double-circuit transmission line 924L/927L passes through Strathmore/Blackie (Area 45), connecting the Milo 356S substation in the Brooks area (Area 47) to the Langdon 102S substation in the Calgary area (Area 6). There are two power plants in Strathmore/Blackie (Area 45), namely the Cavalier power plant and Carseland power plant. Strathmore/Blackie (Area 45) connects to High River (Area 46) via the 138 kV transmission lines 850L and 753L. The 240/138 kV Janet 74S substation serves as a main source for Strathmore/Blackie (Area 45). Five 138 kV transmission lines connect the adjacent planning areas to Strathmore/Blackie (Area 45): 765L, 161L, 853L, 850L and 753L. Shunt capacitor banks rated at 138 kV are installed at the Blackie 253S, Strathmore 151S, and Hussar 431S substations to support voltage levels in the area.

Existing constraints in South Planning Region are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management*. A remedial action scheme (RAS) is used in Strathmore/Blackie (Area 45) to mitigate constraints associated with thermal criteria violations on the existing 138 kV transmission line 876L.

Study Summary

Study Area

The Study Area consists of Strathmore/Blackie (Area 45), including the tie lines connecting this planning area to the rest of the AIES. All transmission facilities, 69 kV and above, within the Study

Area were 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 2.1.1).

Studies Performed

Power flow studies were performed for the 2017 winter peak (WP) and 2017 summer peak (SP) pre-Project and post-Project scenarios.

Voltage stability analysis was performed for the 2017 SP pre-Project and post-Project scenarios.

Results of Pre-Project Studies

The following is a summary of the pre-Project studies results.

Category A (N-G-0) conditions

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

Category B (N-G-1) contingencies

No Reliability Criteria violations were observed under Category B contingency conditions for any of the pre-Project scenarios.

Connection Alternatives examined for the Project

The AESO, in consultation with the DFO and the legal owner of transmission facilities (TFO), examined three transmission alternatives to meet the DFO's request for system access service.

Alternative 1 – Upgrades at the ENMAX SS-24, ENMAX SS-39 and Carseland 525S substations

Alternative 1 involves upgrading three substations, as follows.

- Upgrade the ENMAX SS-24 substation, including adding a 138/25 kV transformer and a minimum of two 25 kV circuit breakers to accommodate the addition of two 25 kV distribution feeders.
- Upgrade the ENMAX SS-39 substation, including adding one 138/25 kV transformer and a minimum of one 25 kV circuit breaker to accommodate the addition of one 25 kV distribution feeder.
- Upgrade the Carseland 525S substation, including adding one 138/25 kV transformer and a minimum of one 25 kV circuit breaker to accommodate the addition of one 25 kV distribution feeder.

Alternative 2 – New POD substation, with one transformer, in the Chestermere area

Alternative 2 involves adding a POD substation in the Chestermere area, to be designated as the Chestermere 419S substation, including a 138/25 kV transformer and a minimum of two 25 kV circuit breakers to accommodate the addition of two 25 kV distribution feeders. The proposed Chestermere 419S substation would be connected to the existing 138 kV transmission line 765L using an in-and-out configuration, which includes adding two 138 kV circuits.

Alternative 2 also involves upgrading the existing ENMAX SS-24 substation, including adding a 138/25 kV transformer.

Further, Alternative 2 involves modifying the existing Turbo Balzac 391S substation, including adding a minimum of two 25 kV circuit breakers to accommodate the addition of two 25 kV distribution feeders.

Alternative 3 – New POD substation, with two transformers, in the Chestermere area

Alternative 3 involves adding a POD substation in the Chestermere area, to be designated as the Chestermere 419S substation, including the following:

- Add two 138/25 kV transformers;
- Add three 138 kV circuit breakers;
- Add six 25 kV feeder breakers to accommodate the addition of six 25 kV distribution feeders; and
- Add other 25 kV equipment associated with the proposed substation design to meet the reliability requirements of the DFO's request for system access service.

The proposed Chestermere 419S substation would be connected to the existing 138 kV transmission line 765L using an in-and-out configuration, which includes adding two 138 kV circuits.

Alternative 3 also involves modifying the existing Turbo Balzac 391S substation, including adding one 25 kV circuit breaker to accommodate the addition of one 25 kV distribution feeder.

Connection Alternatives Selected for Further Study

Alternative 3 is considered technically feasible and was selected for further study.

Connection Alternatives Not Selected for Further Study

The DFO has advised the AESO that Alternative 1 and Alternative 2 are likely not technically acceptable methods to meet the DFO's restoration criteria. The DFO has advised that these alternatives are not technically feasible in light of the DFO's equipment standards, which are aligned with current distribution industry standards and practices. Based on these concerns, Alternative 1 and Alternative 2 were not selected for further study.

Results of the Post-Project Studies

The following is a brief summary of the post-Project studies results. The post-Project studies results, Project impact on the performance of the AIES, and applicable mitigation measures are summarized in Table E-1, below.

Category A (N-G-0) conditions

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

Category B (N-G-1) contingencies

The post-Project power flow studies identified a number of system performance issues under Category B contingency conditions, including voltage criteria violations, thermal criteria violations, and POD bus voltage deviations beyond the desired limits.

The post-Project voltage stability studies also identified a system performance issue under Category B contingency conditions.

Mitigation Measures

As shown in Table E-1, below, real-time operational practices can be used to manage a number of the post-Project system performance issues. The remaining post-Project system performance issues can be mitigated by using a proposed remedial action scheme (RAS) at the Chestermere 419S substation (hereafter referred to as the Chestermere RAS). The proposed Chestermere RAS has three components:¹

- **Undervoltage load shed scheme (UVLS Scheme):** The UVLS Scheme can be used to mitigate the voltage collapse that was observed following the contingency of the 138 kV transmission line 691L. This scheme would shed load at the Chestermere 419S substation following the 691L contingency with concurrent voltage collapse conditions at the substation's 138 kV bus.
- **691L Thermal protection scheme (691L Scheme):** The 691L Scheme can be used to mitigate thermal criteria violations on transmission line 691L. This scheme would shed the load served by one or both of the transformers at the Chestermere 419S substation when the loading on transmission line 691L is above its emergency rating. Real-time operational measures, as opposed to the 691L Scheme, can be used to manage thermal criteria violations on transmission line 691L when the loading is below the transmission line's emergency rating.
- **876L Thermal protection scheme (876L Scheme):** The 876L Scheme can be used to mitigate thermal criteria violations on transmission line 876L following the contingency of the transmission line 691L. This scheme would shed the load served by the Chestermere 419S substation following the 691L contingency and under conditions where the pre-contingency loading on transmission line 691L is above a specified threshold. This scheme can also mitigate the observed POD bus voltage deviations beyond the desired limits at the Chestermere 419S substation.

Impact of the AESO 2015 Long-term Transmission Plan

Additional studies were performed to assess the impact of certain medium-term system transmission developments that are included in the *AESO 2015 Long-term Transmission Plan* (hereafter referred to as the 2015 LTP System Developments). The results of these additional studies indicate that the 2015 LTP System Developments can address all of the identified post-Project Reliability Criteria violations. With the completion of the 2015 LTP System Developments, the use of real-time operational practices and the proposed Chestermere RAS would no longer be required to mitigate the identified post-Project system performance issues.

Conclusions and Recommendations

Analysis and Conclusions

Table E- 1 provides analysis of, and conclusions about, the impact of the Project for selected contingencies, including mitigation measures for observed Reliability Criteria violations. The

¹ The details of the Chestermere RAS are more specifically described in the AESO's Functional Specification document, which is included in the TFO's Facility Proposal to be filed with the Alberta Utilities Commission.

contingencies in Table E-1 were selected because, in the post-Project scenarios, new Reliability Criteria Violations were observed.

Table E- 1 Project Impact and Mitigation Measures

Identified Reliability Criteria Violation		Occurs in Pre- and Post-Project	Impact Level	Year/Season Load	Mitigation Measures (Pre- and Post-Project)
Violation	Contingency				
Voltage collapse	691L (Proposed Chestermere 419S - Janet 74S)	Post-Project only	Significant	2017 SP	Pre: None required
					Post: Chestermere RAS (UVLS Scheme)
876L (Blackie 253S - Gleichen 179S)	691L (Proposed Chestermere 419S - Janet 74S)	Post-Project only	Significant	2017 WP	Pre: None required
					Post: Chestermere RAS (876L Scheme)
691L (Proposed Chestermere 419S - Janet 74S)	876L (Blackie 253S - Gleichen 179S)	Post-Project only	Significant	2017 SP	Pre: None required
					Post: Chestermere RAS (691L Scheme)
		Post-Project only	Significant	2017 WP	Pre: None required
					Post: Real-time operational practice
	PCES01L (Namaka 428S -Cavalier Power Station)	Post-Project only	Significant	2017 SP	Pre: None required
					Post: Real-time operational practice
	138/13.8kV transformer at the Cavalier power plant	Post-Project only	Significant	2017 SP	Pre: None required
					Post: Real-time operational practice
	733L (Gleichen 179S - Namaka 428S)	Post-Project only	Significant	2017 SP	Pre: None required
					Post: Real-time operational practice
	782L (Wyndham 269S – Carseland 525S)	Post-Project only	Significant	2017 SP	Pre: None required
					Post: Real-time operational practice
	753L (Blackie 253S - High River 65S)	Post-Project only	Significant	2017 SP	Pre: None required
					Post: Real-time operational practice

The connection assessment identified a number of post-Project system performance issues. Real-time operational practices and the Chestermere RAS can be used to mitigate all of the identified system performance issues. With the completion of the 2015 LTP System Developments, the use of real-time operational practices and the Chestermere RAS would no longer be required. However, the Project is not dependent on the completion of the 2015 LTP System Developments in order to proceed.

Based on the study results, Alternative 3 is technically viable. The minimum transformation capacity required for the two 138/25 kV transformers at the proposed Chestermere 419S substation in Alternative 3 is 42 MVA.

Recommendations

It is recommended to proceed with the Project using Alternative 3 as the preferred option to respond to the DFO's request for system access service. It is also recommended to use real-time operational practices and the Chestermere RAS to mitigate the identified system performance issues.

A transformer size of 42 MVA is recommended for each transformer in Alternative 3, based on good electric industry practice and under advisement from the TFO regarding its asset management and inventory practices.

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Attachment F	Post-LTP Power Flow Diagrams

1 Introduction

This report details the engineering studies conducted to assess the impact of the Project (as defined below) on the performance of the Alberta interconnected electric system (AIES).

1.1 Project

1.1.1 Overview

FortisAlberta Inc. (FortisAlberta), in its capacity as the legal owner of distribution facilities (DFO), submitted a system access service request (SASR) to the Alberta Electric System Operator (AESO) to meet the DFO's distribution planning criteria and to serve new loads and load growth in the City of Chestermere and the surrounding area.

The SASR includes a request for a Rate DTS, *Demand Transmission Service*, contract capacity of 43.7 MW for new system access service in the area; a Rate DTS contract capacity increase of 1.4 MW (from 26.6 MW to 28 MW) for the system access service provided at the existing Turbo Balzac 391S substation; and a request for transmission development (collectively, the Project). Specifically, the DFO requested a new 138/25 kV point-of-delivery (POD) substation east of the City of Chestermere and modifications to the existing Turbo Balzac 391S substation.

The scheduled in-service date (ISD) for the Project is September 1, 2018.

1.1.2 Load Component

- The requested Rate DTS contract capacity for new system access service in the area is 43.7 MW.
- The existing Rate DTS contract capacity at the Turbo Balzac 391S substation is 26.6 MW.
- The requested Rate DTS contract capacity increase at the Turbo Balzac 391S substation is 1.4 MW.
- Load type: Residential, industrial and commercial loads.
- The load was studied assuming a 0.9 power factor (PF) lagging.
- Currently there is no plan for future expansion beyond the requested developments associated with the DFO's SASR.

1.1.3 Generation Component

There is no generation component associated with the Project.

1.2 Study Scope

1.2.1 Objectives

The objectives of the studies were as follows:

- Assess the impact of the Project on the performance of the AIES.

- Identify any violations of the relevant AESO criteria, standards, or requirements, both pre-Project and post-Project.
- Recommend mitigation measures, if required, to enable the reliable connection of the Project to the AIES.

1.2.2 Study Area

1.2.2.1 Study Area Description

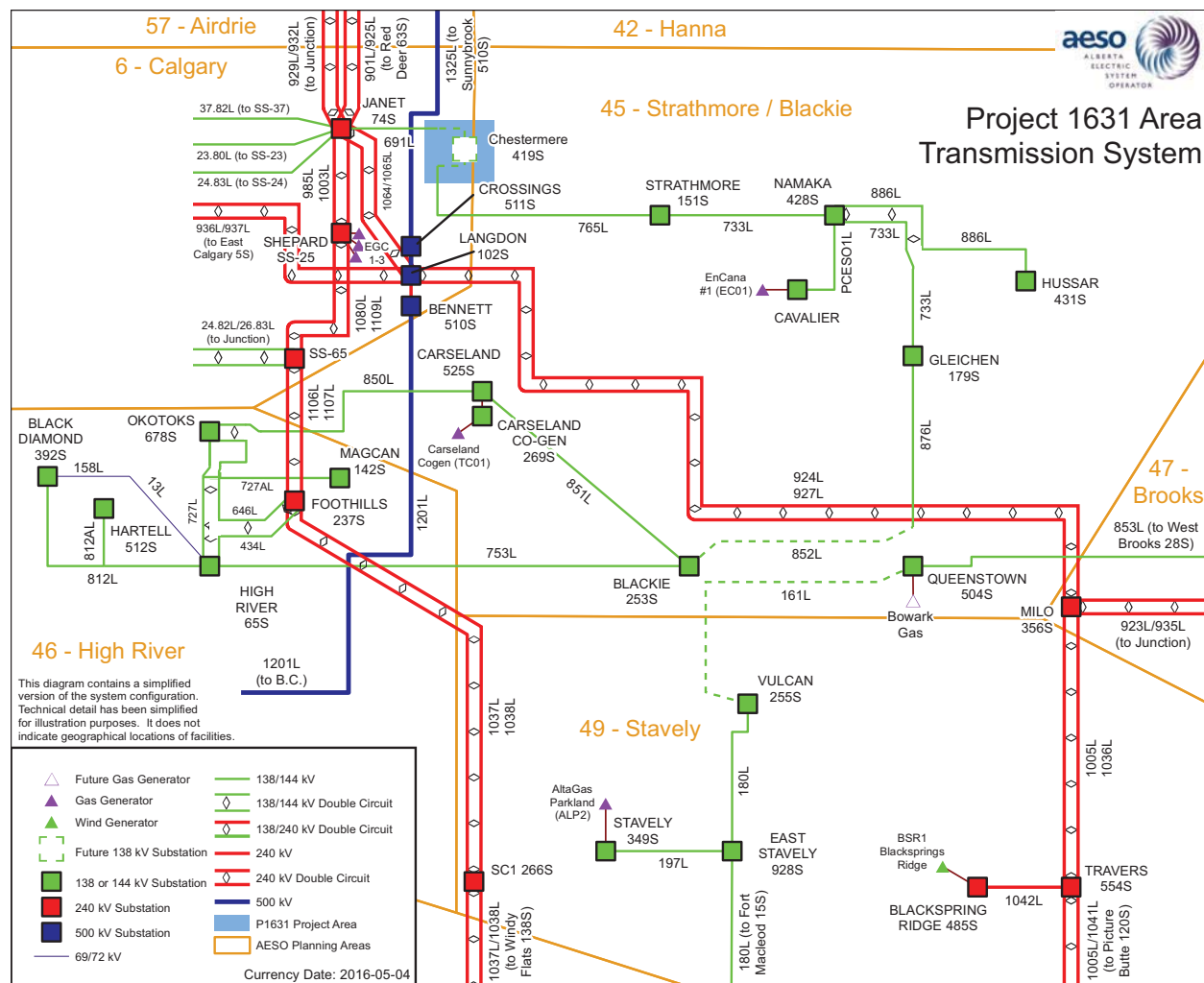
Geographically, the Project is located in the AESO planning area of Calgary (Area 6), but the Project is electrically associated with the Strathmore/Blackie planning area (Area 45). For the purposes of these studies, the Project is considered to be a component of Strathmore/Blackie (Area 45), which is part of the AESO South Planning Region.

From a transmission system perspective, Strathmore/Blackie (Area 45) consists primarily of a 138 kV transmission system. The 240 kV double-circuit transmission line 924L/927L passes through Strathmore/Blackie (Area 45), connecting the Milo 356S substation in the Brooks area (Area 47) to the Langdon 102S substation in the Calgary area (Area 6). There are two power plants in Strathmore/Blackie (Area 45), namely the Cavalier power plant and the Carseland power plant. Strathmore/Blackie (Area 45) connects to High River (Area 46) via the 138 kV transmission lines 850L and 753L. The 240/138 kV Janet 74S substation serves as a main source for the Strathmore/Blackie area (Area 45). Five 138 kV transmission lines connect the adjacent planning areas to Strathmore/Blackie (Area 45): 765L, 161L, 853L, 850L and 753L. Shunt capacitor banks rated at 138 kV are installed at the Blackie 253S, Strathmore 151S, and Hussar 431S substations to support voltage levels in the area.

The Study Area consists of Strathmore/Blackie (Area 45), including the tie lines connecting this planning area to the rest of the AIES. All transmission facilities, 69 kV and above, within the Study Area were 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 2.1.1).

Figure 1-1 shows the existing transmission system in the Study Area.

Figure 1-1: Existing Transmission System in the Study Area



1.2.2.2 Existing Constraints

Existing constraints in the South 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). A remedial action scheme (RAS) is used in Strathmore/Blackie (Area 45) to mitigate constraints associated with thermal criteria violations on the existing 138 kV transmission line 876L.

1.2.2.3 AESO Long-Term Transmission Plans

The *AESO 2015 Long-term Transmission Plan* (2015 LTP)³ includes the following system transmission developments in the Study Area:⁴

- In the near term (to 2020): Upgrade protection on 138 kV Strathmore–Namaka–Gleichen line
- In the medium term (to 2025): Build new 138 kV double-circuit line from Janet substation to East Chestermere substation
- In the medium term: Build new 138 kV double-circuit line from East Chestermere substation to Strathmore substation

The above developments were not included in the system topology for the post-Project studies, which are further described in Section 6. However, as discussed in Section 8, some of the above developments were included in the system topology as part of additional studies. The additional studies were performed to assess the effectiveness of the system transmission developments in terms of removing observed post-Project Reliability Criteria violations.

The Southern Alberta Transmission Reinforcement Project (SATR) is also progressing in southern Alberta. The relevant components of the SATR developments, which are nearby or in the Study Area, that were modeled in the studies, are listed in Table 2.4-1.⁵

1.2.3 Studies Performed

The following studies were performed for the pre-Project scenarios:

- Power flow studies (Category A conditions and Category B contingencies)
- Voltage stability studies (Category A conditions and Category B contingencies)

The following studies were performed for the post-Project scenarios:

- Power flow studies (Category A conditions and Category B contingencies)
- Voltage stability studies (Category A conditions and Category B contingencies)

1.3 Report Overview

The Executive Summary provides a high-level summary of the report and its conclusions. Section 1 provides an introduction to the Project. Section 2 describes the criteria, system data, and study assumptions used in the studies. Section 3 presents the study methodology used in the studies. Section 4 discusses the pre-Project system assessment. Section 5 presents the

³ The 2015 LTP document is available on the AESO website.

⁴ The 2015 LTP identifies the transmission developments in the Strathmore-Blackie-High River sub-region on page 36.

⁵ The *Southern Alberta Transmission Reinforcement* NID was originally approved by the Alberta Utilities Commission in Decision 2009-126 on September 8, 2009, and issued NID Approval No. U2009-340 on September 17, 2009.

connection alternatives examined and the alternatives that were studied. Section 6 presents the post-Project system assessment for the alternatives that were selected for further studies. Section 7 discusses the mitigation measures, if any, required to enable the reliable connection of the Project to the AES. Section 9 identifies project dependencies, if any. Section 10 presents the conclusions and recommendations of this report.

2 Criteria, System Data, and Study Assumptions

2.1 Criteria, Standards, and Requirements

2.1.1 Transmission Planning Standards and Reliability Criteria

The Transmission Planning (TPL) Standards, which are included in the Alberta Reliability Standards, and the AESO's *Transmission Planning Criteria – Basis and Assumptions*⁶ (collectively, the Reliability Criteria) were 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 Alberta Reliability Standards include the Transmission Planning (TPL) standards that specify the desired system performance under different contingency categories with respect to the Applicable Ratings. The transmission system performance under various system conditions is defined in Appendix 1 of the TPL standards. For the purpose of applying the TPL standards to this study, the Applicable Ratings shall mean:

- Seasonal continuous thermal rating of transmission lines.
- Highest specified loading limit for transformers.
- For Category A conditions: Voltage range under normal operating condition should follow the AESO Information Document #2010-007RS (ID #2010-007RS). For the buses not

⁶ Filed under a separate cover.

listed in ID #2010-007RS, Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions* applies.

- For Category B conditions: The extreme voltage range values per Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions*.
- Desired post-contingency voltage change limits for three defined post event timeframes as provided in Table 2.1-1.

Table 2.1-1: Post Contingency Voltage Deviation Guidelines

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

2.1.2 AESO Rules and IDs

AESO ID #2010-007RS, *General Operating Practices – Voltage Control*, relates to Section 304.4 of the ISO rules, *Maintaining Network Voltage*. ID #2010-007RS was applied to establish system normal (i.e., pre-contingency) voltage profiles for the Study Area.

The TCM Rule was followed to set up the study scenarios and assess the impact of the Project. In addition, due regard was given to the AESO's Connection Study Requirements and the AESO's Generation and Load Interconnection Standard.

2.2 Study Scenarios

The current scheduled ISD for the Project is September 1, 2018. However, at the time when the studies were performed, the scheduled ISD for the Project was in October, 2017; therefore, the studies were performed using the 2017 summer peak (SP) and 2017 winter peak (WP) scenarios.

Table 2.2-1 lists the study scenarios used to assess the Project. Scenario 1 and Scenario 2 are the pre-Project 2017 SP and 2017 WP scenarios, respectively. Scenario 3 and Scenario 4 are the post-Project 2017 SP and 2017 WP scenarios, respectively. The post-Project scenarios reflect the requested Rate DTS contract capacity of 43.7 MW for new system access service in the Chestermere area and the requested Rate DTS contract capacity increase of 1.4 MW at the existing Turbo Balzac 391S substation. A 0.9 PF lagging was used for the new Project load.

Table 2.2-1: Summary of Study Scenario Assumptions

Scenario No.	Year/ Season Load	Project Load (MW)		Generation Scenario
		Proposed Chestermere 419S substation*	Turbo Balzac 391S substation	
Pre-Project System				Moderate generation in Calgary (Area 6) and Strathmore/Blackie
1	2017 SP	N/A	26.6	

Scenario No.	Year/ Season Load	Project Load (MW)		Generation Scenario
		Proposed Chestermere 419S substation*	Turbo Balzac 391S substation	
2	2017 WP	N/A	26.6	(Area 45) with one unit at the Cavalier power plant offline
Post-Project System				
3	2017 SP	43.7	28	
4	2017 WP	43.7	28	

***Note:** As further discussed in Section 5, the connection alternative that was selected for post-Project studies included a proposed new POD, designated as the Chestermere 419S substation, in the Chestermere area. For the purposes of the connection assessment, the 43.7 MW Project load addition in the Chestermere area was modelled as a load addition at the proposed Chestermere 419S substation.

2.3 Load and Generation Assumptions

2.3.1 Load Assumptions

The load forecast used for the studies is shown in Table 2.3-1 and is based on the *AESO 2016 Long-term Outlook* (2016 LTO). For the studies, the active power to reactive power ratio in the study scenarios was maintained when modifying the loads to comply with the forecast, shown in Table 2.3-1.

Table 2.3-1: Forecast Area Load (2016 LTO at Alberta Internal Load Peak)

Area or Region Name	Forecast Peak Load (MW)	
	2017 SP	2017 WP
Strathmore/Blackie (Area 45)	150	147
South Planning Region*	1,407	1,458
Alberta Internal Load w/o Losses	10,940	11,899

***Note:** The South Planning Region comprises the following AESO planning areas: 4, 48, 43, 47, 52, 54, 55, 49, 45, 46, 53 and 44.

2.3.2 Generation Assumptions

The generation assumptions for the studies are described in Table 2.3-2. One of the gas turbine generating units, Cavalier 1, at the Cavalier power plant was identified as the critical generator. Cavalier 1 was considered to be out of service to simulate the N-G condition for all analyses.

Table 2.3-2: Local Generation in the Study Scenarios

Existing/Future	Unit Name	Bus Number	Area	Pmax (MW)	2017 SP Unit Net Generation (MW)	2017 WP Unit Net Generation (MW)
Existing	Shepard ST1	773	6	318.0	231	242
Existing	Shepard GT1	774	6	276.0	200	210
Existing	Shepard GT2	775	6	276.0	200	210
Existing	Calgary Energy Centre GT	4187	6	170.2	140	145
Existing	Calgary Energy Centre ST	3187	6	115.6	98	102
Existing	Balzac GT1	3290	6	64.1	38.5	43.9
Existing	Balzac GT1	4290	6	64.1	38.5	43.9
Existing	Balzac ST1	4290	6	26.5	15.9	18.1
Existing	Cavalier 1	3247	45	64.1	0	0
Existing	Cavalier 2	4247	45	64.1	11.7	14
Existing	Cavalier 3	4247	45	26.5	4.8	5.8
Existing	Carseland 1	4251	45	64.1	15.2	22.2
Existing	Carseland 2	3251	45	64.1	15.2	22.2
Existing	UofC	2556	6	15.0	9	27.2

2.3.3 Intertie Flow Assumptions

The British Columbia, Montana-Alberta Tie Line (MATL), and Saskatchewan interties were set to zero in all the studied scenarios.

2.3.4 HVDC Assumptions

The HVDC power orders were set based on the minimum loss per the assumptions in pre-Project and post-Project study scenarios as shown in Table 2.3-3. The MVar exchange between the HVDC terminals and the adjacent AC systems for the Western Alberta Transmission Line (WATL) and Eastern Alberta Transmission Line (EATL) were maintained within the reactive power limits shown in Table 2.3-4.

Table 2.3-3: HVDC Power Order by Scenario

Scenario No.	Year/Season Load	Power Order Settings	
		WATL	EATL
Pre-Project			
1	2017 SP	N → S*	Blocked

Scenario No.	Year/Season Load	Power Order Settings	
		WATL	EATL
2	2017 WP	N → S	Blocked
Post-Project			
3	2017 SP	N → S	Blocked
4	2017 WP	N → S	Blocked

* **Note:** N → S indicates that the HVDC flow direction is from North to South.

Table 2.3-4: HVDC to Adjacent AC System MVAR Exchange Limits

HVDC	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

2.4 System Projects

Table 2.4-1 lists the in-service system transmission projects in or near the Study Area that were modeled in the study scenarios.

Table 2.4-1: Summary of System Projects Included in the Study Cases

Project No.	Project Name	In-Service Date
719	East Calgary Transmission Project	In-service
1117	Foothills Area Transmission Development – East	In-service
737	EATL	In-service
737	WATL	In-service
882	240 kV 911L Line Replacement	In-service
1038	SATR – Blackie Area 138 kV Development	In-service

2.5 Customer Connection Projects

Customer connection projects that have passed Gate 2 of the AESO Connection Process as of August 2016 were modelled in the study scenarios based on their respective positions in the AESO Connection Queue. Table 2.5-1 summarizes the customer connection project assumptions that were used in the studies. It should be noted that the information in this table is subject to change as projects progress.

Table 2.5-1: Customer Connection Assumptions

Project No.	Planning Area	Queue Position	Planned In-Service Date	Project Name
1631	6	70	October 2, 2017	Fortis Chestermere New POD
1601	6	51	October 7, 2016	ENMAX SS-31 Substation 13 kV Breaker Addition
1644	6	65	December 1, 2017	ENMAX SS-162 138/25kV 2nd Transformer Addition
1336	45	24	February 28, 2018	Bow Ark Energy Queenstown Power Plant

Note: Per the AESO Connection Queue posted in August 2016. Projects that have queue positions after the Project are not listed in this table and were not modelled in the study cases.

2.6 Facility Ratings and Shunt Elements

The legal owner of transmission facilities (TFO) provided the seasonal continuous thermal ratings and the short-term emergency ratings for key the transmission lines in the Study Area, as shown in Table 2.6-1.

Table 2.6-1: Key Transmission Line Ratings in the Study Area

Line ID	Line Description	Voltage Class (kV)	Nominal Rating (MVA)	
			Summer	Winter
691L	Janet 74S to Chestermere 419S	138	85	90
765L	Chestermere to Strathmore 151S	138	85	90
733L	Strathmore 151S - Namaka 426S	138	120	143
733L	Namaka 428S - Gleichen 179S	138	120	148
886L	Namaka 428S - Hussar 431S	138	119	147
876L	Gleichen 179S - Blackie 253S	138	85	90
753L	Blackie 253S - High River 65S	138	121	143
851L	Blackie 253S - Carseland 525S	138	85	90
850L	Okotoks 678S - Carseland 525S	138	89	109
161L	Vulcan 255S - Blackie 253S	138	117	120
853L	Queenstown 504S - Bassano Tap	138	121	148
853L	Bassano Tap - West Brooks	138	121	148

The details of shunt elements in the Study Area are given in Table 2.6-2. No shunt reactors are present in the Study Area.

Table 2.6-2: Shunt Elements in the Study Area

Substation Name and Number	Voltage Class (kV)	Capacitors	
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVar)
Blackie 253S	138	1	24.46
Strathmore 151S	138	1	24.35
Hussar 431S	138	1	9.17

2.7 Voltage Profile Assumptions

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

The static VAr compensator (SVC) at the Langdon 102S substation was set in the range -80 to +40 MVar under pre-contingency conditions.

3 Study Methodology

Studies for this connection assessment were completed using PTI PSS/E version 33.

3.1 Connection Studies

Studies performed are summarized in Table 3.1-1.

Table 3.1-1: Studies Performed

Scenario No.	Year/ Season Load	Project Load (MW)		Power Flow	Voltage Stability
		Proposed Chestermere 419S Substation	Turbo Balzac 391S substation		
Pre-Project					
1	2017 SP	N/A	26.6	Yes	Yes
2	2017 WP	N/A	26.6	Yes	No
Post-Project					
3	2017 SP	43.7	28	Yes	Yes
4	2017 WP	43.7	28	Yes	No

3.2 Power Flow Analysis

Pre-Project and post-Project power flow studies were performed to identify thermal and voltage criteria violations as per the Reliability Criteria, and any deviations from the desired limits in Table 2.1-1. The purpose of the power flow analysis is to quantify any incremental violations in the Study Area after the Project is connected. For the Category B power flow studies, transformer taps and switched shunt reactive compensating devices such as shunt capacitors and reactors were locked and continuous shunt devices were enabled.

POD low voltage bus deviations were 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 were 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 taps and shunt reactive compensating devices were allowed to adjust, and voltage deviations above 5% were reported.

3.2.1 Contingencies Studied

Power flow analysis was completed for all Category B contingencies (69 kV facilities and above) within the Study Area. All transmission facilities in the Study Area were monitored for voltage criteria violations and thermal criteria violations under Category A conditions and under Category B contingency conditions.

3.3 Voltage Stability Analysis

The objective of the voltage stability studies is to determine the ability of the network to maintain voltage stability at all the buses in the Study Area under normal and abnormal system conditions. The power-voltage (PV) curve represents voltage change as a result of increased power transfer between the defined source and sink systems. The reported incremental transfers are to the collapse point. As per the AESO requirements, other criteria such as minimum voltage were not assessed at the PV minimum transfer.

Voltage stability analyses were performed for post-Project scenarios. For load connection projects, the load level modelled in the post-Project scenarios are either the same or higher than in pre-Project scenarios. Therefore, voltage stability analysis for pre-Project scenarios will only be performed if post-Project scenarios show voltage stability criteria violations.

Voltage stability analysis followed Western Electricity Coordinating Council (WECC) Voltage Stability Assessment Methodology. WECC voltage stability criteria states that for load areas modelled in the sink subsystem, post-transient voltage stability must persist up to at least 105% of the reference load level for system normal conditions (Category A) and for single contingencies (Category B). For this standard, the reference load level is the maximum forecasted load for the Study Area. The sink subsystem is defined by the load in the Study Area.

Typically, voltage stability analysis is carried out assuming the worst case scenarios in terms of loading. Voltage stability analysis was performed by increasing the load in the Study Area and increasing the generation in Wabamun (Area 40) and Fort McMurray (Area 25). The generation in the Wabamun (Area 40) and Fort McMurray (Area 25) areas constitute the source subsystem.

3.3.1 Contingencies Studied

Voltage stability analysis was performed for the Category A condition and all Category B contingency conditions (69 kV facilities and above) in the Study Area using the 2017 SP pre-Project scenario (i.e., Scenario 1) and the 2017 SP post-Project scenario (i.e., Scenario 3).

4 Pre-Project System Assessment

This section describes the results of the pre-Project power flow studies and voltage stability studies.

4.1 Power Flow Studies

Single line diagrams (SLDs) illustrating the pre-Project power flow studies results for Category A conditions and selected Category B contingency conditions in the Study Area are included in Attachment A.

4.1.1 Scenario 1 (2017 SP pre-Project)

Category A conditions (N-G-0)

No Reliability Criteria violations were observed under Category A conditions.

Category B contingency conditions (N-G-1)

No Reliability Criteria violations were observed under Category B contingency conditions.

4.1.2 Scenario 2 (2017 WP pre-Project)

Category A conditions (N-G-0)

No Reliability Criteria violations were observed under Category A conditions.

Category B contingency conditions (N-G-1)

No Reliability Criteria violations were observed under Category B contingency conditions.

4.2 Voltage Stability Studies

Voltage stability studies were performed using Scenario 1 to assess the pre-Project system active power margins under Category A conditions and under Category B contingency conditions. The voltage stability diagrams are provided in Attachment C.

4.2.1 Scenario 1 (2017 SP pre-Project)

For Scenario 1, the reference load level in the Study Area is 106.3 MW. For Category B contingency conditions, the minimum incremental load transfer to meet the voltage stability criteria is 5.0% of the reference load, or 5.3 MW.

Table 4.2-1 summarizes voltage stability studies results under Category A conditions and for the five worst contingencies under Category B conditions.

As can be seen in Table 4.2-1, the voltage stability margin was met for all studied conditions.

Table 4.2-1: Voltage Stability Analysis for Scenario 1 (2017 SP Pre-Project)

Contingency	From	To	Maximum incremental transfer (MW)	Meets 105% transfer criteria?
N-G-0	System Normal		135	Yes
765L	Strathmore 151S	Janet 74S	52.5	Yes
733L	Strathmore 151S	Namaka 428S	72.5	Yes
PCES01L	Namaka 428S	Cavalier Power Station	112.5	Yes
876L	Blackie 253S	Gleichen 179S	121.3	Yes
782L	Wyndham 269S	Carseland 525S	126.3	Yes

5 Connection Alternatives

5.1 Overview

The AESO, in consultation with the DFO and the TFO, examined three transmission alternatives to meet the DFO's request for system access service, as detailed in Section 5.2.

5.2 Connection Alternatives

Below is a description of the developments associated with the transmission alternatives that were examined for the Project.⁷

Alternative 1 – Upgrades at the ENMAX SS-24, ENMAX SS-39 and Carseland 525S substations

Alternative 1 involves upgrading three substations, as follows.

- Upgrade the ENMAX SS-24 substation, including adding a 138/25 kV transformer and a minimum of two 25 kV circuit breakers to accommodate the addition of two 25 kV distribution feeders.
- Upgrade the ENMAX SS-39 substation, including adding one 138/25 kV transformer and a minimum of one 25 kV circuit breaker to accommodate the addition of one 25 kV distribution feeder.
- Upgrade the Carseland 525S substation, including adding one 138/25 kV transformer and a minimum of one 25 kV circuit breaker to accommodate the addition of one 25 kV distribution feeder.

Alternative 2 – New POD substation, with one transformer, in the Chestermere area

Alternative 2 involves adding a POD substation in the Chestermere area, to be designated as the Chestermere 419S substation, including a 138/25 kV transformer and a minimum of two 25 kV circuit breakers to accommodate the addition of two 25 kV distribution feeders. The proposed Chestermere 419S substation would be connected to the existing 138 kV transmission line 765L using an in-and-out configuration, which includes adding two 138 kV circuits.

Alternative 2 also involves upgrading the existing ENMAX SS-24 substation, including adding a 138/25 kV transformer.

Further, Alternative 2 involves modifying the existing Turbo Balzac 391S substation, including adding a minimum of two 25 kV circuit breakers to accommodate the addition of two 25 kV distribution feeders.

Alternative 3 – New POD substation, with two transformers, in the Chestermere area

Alternative 3 involves adding a POD substation in the Chestermere area, to be designated as the Chestermere 419S substation, including the following:

⁷ These alternatives reflect more up to date engineering design than the alternatives identified in the FortisAlberta *Need for Development Transmission Facilities in the Chestermere Area* report, which is filed under a separate cover.

- Add two 138/25 kV transformers;
- Add three 138 kV circuit breakers;
- Add six 25 kV feeder breakers to accommodate the addition of six 25 kV distribution feeders; and
- Add other 25 kV equipment associated with the proposed substation design to meet the reliability requirements of the DFO's request for system access service.

The proposed Chestermere 419S substation would be connected to the existing 138 kV transmission line 765L using an in-and-out configuration, which includes adding two 138 kV circuits.

Alternative 3 also involves modifying the existing Turbo Balzac 391S substation, including adding one 25 kV circuit breaker to accommodate the addition of one 25 kV distribution feeder.

5.2.1 Connection Alternatives Selected for Further Studies

Alternative 3 is considered technically feasible and was selected for further study.

5.2.2 Connection Alternatives Not Selected for Further Studies

The DFO has advised the AESO that Alternative 1 and Alternative 2 are likely not technically acceptable methods to meet the DFO's restoration criteria. The DFO has advised that these alternatives are not technically feasible in light of the DFO's equipment standards, which are aligned with current distribution industry standards and practices. Based on these concerns, Alternative 1 and Alternative 2 were not selected for further study.

6 Technical Analysis of Connection Alternative 3

This section provides the results and analysis of the post-Project power flow studies and voltage stability studies.

6.1 Power Flow Studies

SLDs illustrating the post-Project power flow studies results for Category A conditions and Category B contingency conditions in the Study Area are included in Attachment B.

6.1.1 Scenario 3 (2017 SP post-Project)

Category A conditions (N-G-0)

No Reliability Criteria violations were observed under Category A conditions.

Category B contingency conditions (N-G-1)

A number of thermal criteria violations and voltage criteria violations were observed under Category B contingency conditions.

The Reliability Criteria violations, which are also described below, are shown in Table 6.1-1.

- Voltage collapse was observed in the Study Area following the loss of the 138 kV transmission line 691L. This violation was not observed in the pre-Project Scenario 1.
- Loading above the short-term emergency rating of transmission line 691L was observed following the loss of the 138 kV transmission line 876L. This violation was not observed in the pre-Project Scenario 1.
- Loading below the short-term emergency rating of transmission line 691L was observed following a number of Category B contingencies, as follows:
 - Loss of the 138 kV transmission line PCES01L or a 138/13.8 kV transformer at the Cavalier power plant
 - Loss of the 138 kV transmission line 733L
 - Loss of the 138 kV transmission line 782L
 - Loss of the 138 kV transmission line 753L

These violations were not observed in the pre-Project Scenario 1.

Table 6.1-1: Reliability Criteria Violations for Scenario 3 (2017 SP Post-Project)

Contingency	Limiting Branch	Seasonal Continuous Thermal Rating (MVA)	Short-term Emergency Rating (MVA)	Details of system performance issues				
				Pre-Project		Post-Project		% Loading Difference
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	Post-Project minus Pre-Project
691L (Proposed Chestermere 419S - Janet 74S)	Not converged as a voltage collapse occurs.							
876L (Blackie 253S - Gleichen 179S)	691L (Proposed Chestermere 419S – Janet 74S)	85	94	64.2	73.7	102.8	118.5	44.8
PCES01L (Namaka 428S - Cavalier power plant); or a 138/13.8 kV transformer at Cavalier power plant		85	94	53.2	61.2	91.6	107.5	46.3
733L (Gleichen 179S - Namaka 428S)		85	94	53.1	61	89.9	103.6	42.6
782L (Wyndham 269S – Carseland 525S)		85	94	55.3	63.6	88.9	102.5	38.9
753L (Blackie 253S - High River 65S)		85	94	53.2	61.1	87.8	101.2	40.1

6.1.2 Scenario 4 (2017 WP post-Project)

Category A conditions (N-G-0)

No Reliability Criteria violations were observed under Category A conditions.

Category B contingency conditions (N-G-1)

A number of thermal criteria violations and POD bus voltage deviations beyond the desired limits were observed under Category B contingency conditions.

The Reliability Criteria violations, which are also described below, are shown in Table 6.1-2.

- Loading above the short-term emergency rating of transmission line 876L was observed following the loss of the 138 kV transmission line 691L. This violation was not observed in the pre-Project Scenario 2.
- Loading below the short-term emergency rating of transmission line 691L was observed following the loss of transmission line 876L. This violation was not observed in the pre-Project Scenario 2.

Table 6.1-2: Reliability Criteria Violations for Scenario 4 (2017 WP Post-Project)

Contingency	Limiting Branch	Continuous Line Rating (MVA)	Short-term Rating (MVA)	Pre- Project		Post- Project		% Loading Difference
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	Post-Pre
691L (Proposed Chestermere 419S - Janet 74S)	876L (Blackie 253S - Gleichen 179S)	90	99	57.9	64	105	116.9	52.9
876L (Blackie 253S - Gleichen 179S)	691L (Proposed Chestermere 419S - Janet 74S)	90	99	63.5	68.6	97.1	105.4	36.8

The POD bus voltage deviations beyond the desired limits, which are also described below, are shown in Table 6.1-3.

- POD bus voltage deviations at the proposed Chestermere 491S substation were observed following the loss of the 138 kV transmission line 691L.⁸

Table 6.1-3: POD Bus Voltage Deviations for Scenario 4 (2017 WP Post-Project)

Contingency	Substation Name and Number	Bus No.	Nominal (kV)	Initial Voltage (kV)	Voltage Deviations for POD Busses Only					
					Post Transient (kV)	% Change	Post Auto (kV)	% Change	Post Manual (kV)	% Change
691L (Proposed Chestermere 419S - Janet 74S)	Proposed Chestermere 419S	3949	25	25.8	22.4	13.3%	-	-	-	-
		4949	25	25.8	22.4	13.3%	-	-	-	-

6.2 Voltage Stability Studies

Voltage stability studies were performed using Scenario 3 to assess the post-Project system active power margins under Category A conditions and under Category B contingency conditions. The voltage stability diagrams are provided in Attachment D.

6.2.1 Scenario 3 (2017 SP post-Project)

For Scenario 3, the reference load level for the sink subsystem (the Study Area) is 150 MW. For Category B contingency conditions, the minimum incremental load transfer to meet the voltage stability criteria is 5.0% of the reference load, or 7.5 MW.

⁸ 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 2.1-1 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 2.1-1.

Table 6.2-1 summarizes the voltage stability studies results under Category A conditions, and for the five worst contingencies under Category B conditions, using worst-case contingency conditions for voltage stability incremental transfer margins.

As can be seen in Table 6.2-1, a voltage stability criteria violation was observed following the loss of the 138 kV transmission line 691L. This violation was not observed in the pre-Project Scenario 1.

Table 6.2-1: Voltage Stability Analysis for Scenario 3 (2017 SP Post-Project)

Contingency	From	To	Maximum incremental transfer (MW)	Meets 105% transfer criteria?
N-G-0	System Normal		175	Yes
691L	Chestermere 419S	Janet 74S	0.0	No
765L	Chestermere 419S	Strathmore 151S	75.0	Yes
733L	Strathmore 151S	Namaka 428S	103.8	Yes
876L	Blackie 253S	Gleichen 179S	135.0	Yes
PCES01L	Namaka 428S	Cavalier Power Station	146.0	Yes

7 Mitigation Measures

As shown in Section 6, a number of post-Project system performance issues were identified under Category B contingency conditions. The post-Project system performance issues were not observed in the pre-Project scenarios. Mitigation measures are required to facilitate the reliable connection of the Project to the AIES.

7.1 Proposed Mitigation Measures

7.1.1 Overview of Mitigation Measures

Real-time operational practices

Real-time operational practices can be used to manage a number of the post-Project system performance issues. However, the following post-Project system performance issues cannot be managed using real-time operational practices:

- Scenario 3
 - Voltage collapse in the Study Area following the loss of transmission line 691L.
 - Loading above the short-term emergency rating of transmission line 691L following the loss of the 138 kV transmission line 876L.
- Scenario 4
 - Loading above the short-term emergency rating of transmission line 876L following the loss of the 138 kV transmission line 691L.
 - Post-transient POD bus voltage deviation beyond the desired limits at the proposed Chestermere 419S substation following the loss of transmission line 691L.

Proposed RAS

A RAS at the Chestermere 419S substation (hereafter referred to as the Chestermere RAS) is proposed to address the remaining system performance issues (in other words, the issues that cannot be managed by using real-time operational practices).

The proposed Chestermere RAS has three components:⁹

- **Undervoltage load shed scheme (UVLS Scheme):** The UVLS Scheme can be used to mitigate the voltage collapse that was observed following the contingency of the 138 kV transmission line 691L. This scheme would shed load at the Chestermere 419S substation following the 691L contingency with concurrent voltage collapse conditions occur at the substation's 138 kV bus.
- **691L Thermal protection scheme (691L Scheme):** The 691L Scheme can be used to mitigate thermal criteria violations on transmission line 691L. This scheme would shed the load served by one or both of the transformers at the Chestermere 419S substation when the loading on transmission line 691L is above its emergency rating. Real-time operational

⁹ The details of the Chestermere RAS are more specifically described in the AESO's Functional Specification document, which is included in the TFO's Facility Proposal to be filed with the Alberta Utilities Commission.

measures, as opposed to the 691L Scheme, can be used to manage thermal criteria violations on transmission line 691L when the loading is below the transmission line's emergency rating.

- 876L Thermal protection scheme (876L Scheme):** The 876L Scheme can be used to mitigate thermal criteria violations on transmission line 876L following the contingency of the transmission line 691L. This scheme would shed the load served by the Chestermere 419S substation following the 691L contingency and under conditions where the pre-contingency loading on transmission line 691L is above a specified threshold. This scheme can also mitigate the observed POD bus voltage deviations beyond the desired limits at the Chestermere 419S substation.

7.1.2 Impact of Chestermere RAS

Power flow studies and voltage stability studies were performed to assess the impact of the Chestermere RAS on the Reliability Criteria violations. The results of these studies are shown in Table 7.1-1. Table 7.1-1 demonstrates that the Chestermere RAS can mitigate the Reliability Criteria violations that cannot be managed by using real-time operational practices.

Power flow diagrams and PV curves for the post-RAS operation results are provided in Attachment E.

Table 7.1-1: Impact of the Chestermere RAS on the Reliability Criteria Violations

Scenario	Contingency	Limiting Branch	Seasonal Continuous Thermal Rating (MVA)	Pre-RAS		Post-RAS		Activated Scheme
				Flow (MVA)	% Loading	Flow (MVA)	% Loading	
3	691L (Proposed Chestermere 419S - Janet 74S)	876L (Blackie 253S - Gleichen 179S)	85	Voltage collapse		63	73	UVLS Scheme Stage 1*
3	876L (Blackie 253S - Gleichen 179S)	691L (Proposed Chestermere 419S - Janet 74S)	85	102.8	118.5	82	94.2	691L Scheme Stage 1
4	691L (Proposed Chestermere 419S - Janet 74S)	876L (Blackie 253S - Gleichen 179S)	90	105	116.9	58	63.6	876L Scheme Stage 1

***Note:** The maximum incremental transfer for this contingency is 53.5 MW post-RAS operation, which is above the required margin of 5%.

7.2 Summary of Project Impact and Mitigation Measures

The Reliability Criteria violations that were observed during the studies and the applicable mitigation measures are summarized in Table 7.2-1.

Table 7.2-1: Project Impact and Mitigation Measures

Identified Reliability Criteria Violation		Occurs in Pre- and Post-Project	Impact Level	Year/Season Load	Mitigation Measures (Pre- and Post-Project)
Violation	Contingency				
Voltage collapse	691L (Proposed Chestermere 419S - Janet 74S)	Post-Project only	Significant	2017 SP	Pre: None required Post: Chestermere RAS (UVLS Scheme)
876L (Blackie 253S - Gleichen 179S)	691L (Proposed Chestermere 419S - Janet 74S)	Post-Project only	Significant	2017 WP	Pre: None required Post: Chestermere RAS (876L Scheme)
691L (Proposed Chestermere 419S - Janet 74S)	876L (Blackie 253S - Gleichen 179S)	Post-Project only	Significant	2017 SP	Pre: None required Post: Chestermere RAS (691L Scheme)
		Post-Project only	Significant	2017 WP	Pre: None required Post: Real-time operational practice
	PCES01L (Namaka 428S -Cavalier Power Station)	Post-Project only	Significant	2017 SP	Pre: None required Post: Real-time operational practice
	138/13.8kV transformer at the Cavalier power plant	Post-Project only	Significant	2017 SP	Pre: None required Post: Real-time operational practice
	733L (Gleichen 179S - Namaka 428S)	Post-Project only	Significant	2017 SP	Pre: None required Post: Real-time operational practice
	782L (Wyndham 269S – Carseland 525S)	Post-Project only	Significant	2017 SP	Pre: None required Post: Real-time operational practice
	753L (Blackie 253S - High River 65S)	Post-Project only	Significant	2017 SP	Pre: None required Post: Real-time operational practice

8 Impact of 2015 LTP on Post-Project Scenarios

Further studies were performed to assess the impact of certain system transmission developments, which are identified in the 2015 LTP, on the post-Project scenarios.

8.1 Overview of 2015 LTP System Developments

As discussed in Section 1.2.2.3, the 2015 LTP includes two medium-term system transmission developments in the Study Area. These medium-term system transmission developments (hereafter referred to as the 2015 LTP System Developments) are shown in Table 8.1-1.

Table 8.1-1: 2015 LTP System Developments

Timeframe	Development
Medium term (to 2025)	- Build new 138 kV double-circuit line from Janet substation to East Chestermere substation - Build new 138 kV double-circuit line from East Chestermere substation to Strathmore substation

8.2 Impact of the 2015 LTP System Developments

To assess the impact of the 2015 LTP System Developments on the post-Project scenarios, power flow studies were repeated for Scenario 3 and Scenario 4 with the 2015 LTP System Developments included in the transmission system topology.

SLDs illustrating power flow studies results for Category A conditions and selected Category B contingency conditions are included in Attachment F.

8.2.1 Scenario 3 (2017 SP post-Project)

Category A conditions (N-G-0)

With the 2015 LTP System Developments, no Reliability Criteria violations were observed under Category A conditions.

Category B contingency conditions (N-G-1)

With the 2015 LTP System Developments, no Reliability Criteria violations were observed under Category B contingency conditions.

8.2.2 Scenario 4 (2017 WP post-Project)

Category A conditions (N-G-0)

With the 2015 LTP System Developments, no Reliability Criteria violations were observed under Category A conditions.

Category B contingency conditions (N-G-1)

With the 2015 LTP System Developments, no Reliability Criteria violations were observed under Category B contingency conditions. Further, the POD bus voltage deviations beyond the desired limits, which were identified in Section 6, were not observed.

9 Project Dependencies

The Project is not dependent on the AESO's plans to expand or enhance the transmission system.

10 Conclusions and Recommendations

Based on the study results, Alternative 3 is technically viable. The connection assessment identified a number of post-Project system performance issues.

Real-time operational practices and the proposed Chestermere RAS can be used to mitigate all of the identified post-Project system performance issues. With the completion of the 2015 LTP System Developments, the use of real-time operational practices and the proposed Chestermere RAS would no longer be required to mitigate the identified post-Project system performance issues. However, the Project is not dependent on the completion of the 2015 LTP System Developments in order to proceed.

It is recommended to proceed with Alternative 3 as the preferred alternative to respond to the DFO's request for system access service. It is also recommended to use real-time operational practices and the proposed Chestermere RAS to mitigate the identified system performance issues.

The minimum transformation capacity required for the two 138/25 kV transformers in Alternative 3 is 42 MVA. A transformer size of 42 MVA is recommended for each transformer, based on good electric industry practice and under advisement from the TFO regarding its asset management and inventory practices.

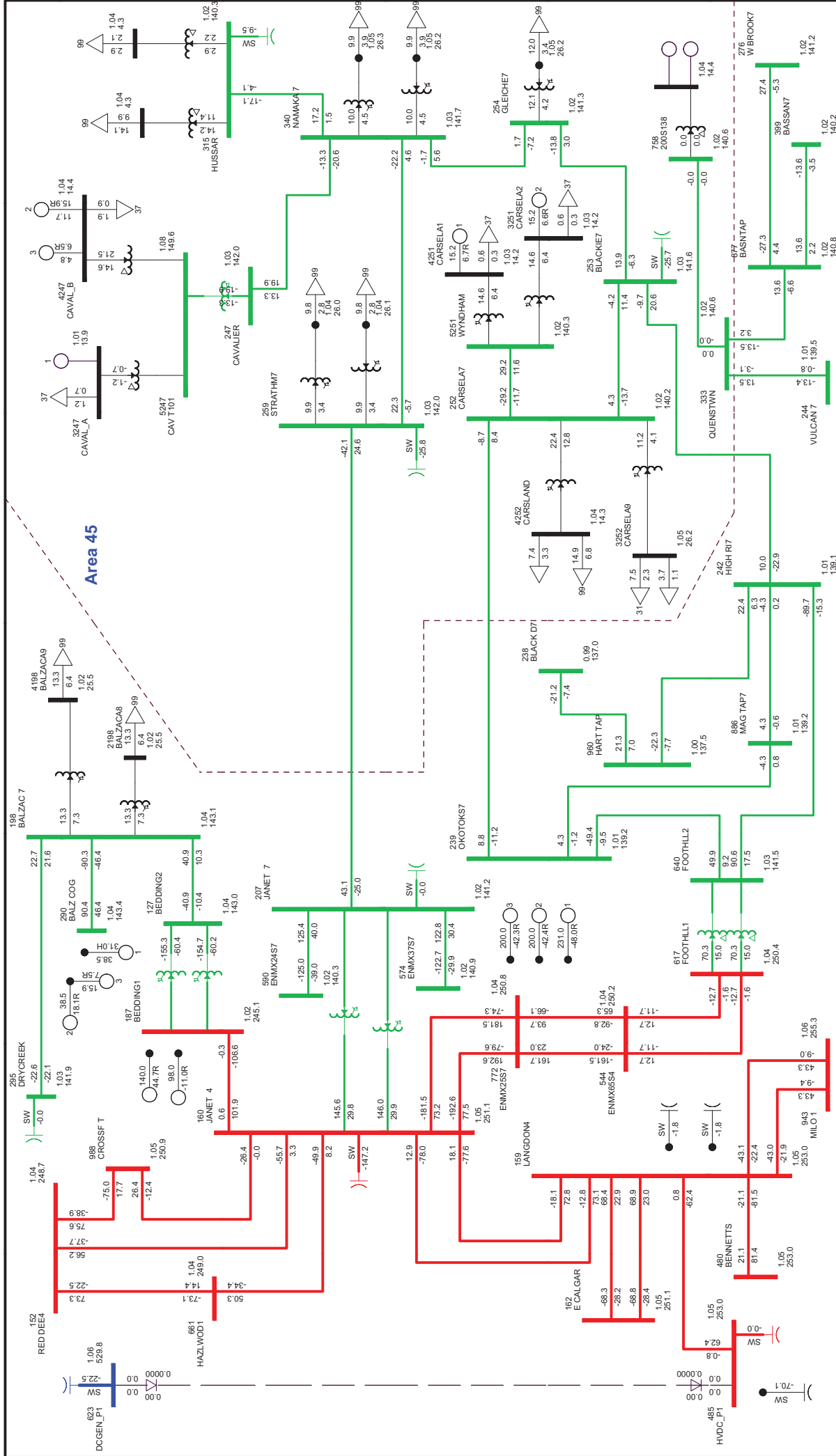
Attachment A

Pre-Project Power Flow Diagrams (Scenarios 1 & 2)

Steady-state power flow diagrams for Category A and selected Category B contingency conditions are provided in this section, as indicated in Table A-1.

Table A-1: Pre-Project Power Flow Diagrams

Category	Contingency	Figure	
		2017 SP Pret-Project	2017 WP Pre-Project
A	Normal operation (N-G-0)	Figure A-1	Figure A-14
B	765L (Strathmore 151S - Janet 74S)	Figure A-2	Figure A-15
B	733L (Strathmore 151S - Namaka 428S)	Figure A-3	Figure A-16
B	733L (Gleichen 179S - Namaka 428S)	Figure A-4	Figure A-17
B	876L (Blackie 253S - Gleichen 179S)	Figure A-5	Figure A-18
B	851L (Blackie 253S - Carseland 525S)	Figure A-6	Figure A-19
B	753L (Blackie 253S - High River 65S)	Figure A-7	Figure A-20
B	850L (Okotoks 678S - Carseland 525S)	Figure A-8	Figure A-21
B	PCES01L (Namaka 428S -Cavalier Power Station)	Figure A-9	Figure A-22
B	782L (Wyndham 269S – Carseland 525S)	Figure A-10	Figure A-23
B	611L (Turbo Balzac 391S - Dry Creek 186S)	Figure A-11	Figure A-24
B	162.81L (Turbo Balzac 391S - Beddington SS-162)	Figure A-12	Figure A-25
B	PCES02L (Turbo Balzac 391S – Balzac Power Station)	Figure A-13	Figure A-26



P1631 - Chestermere New POD

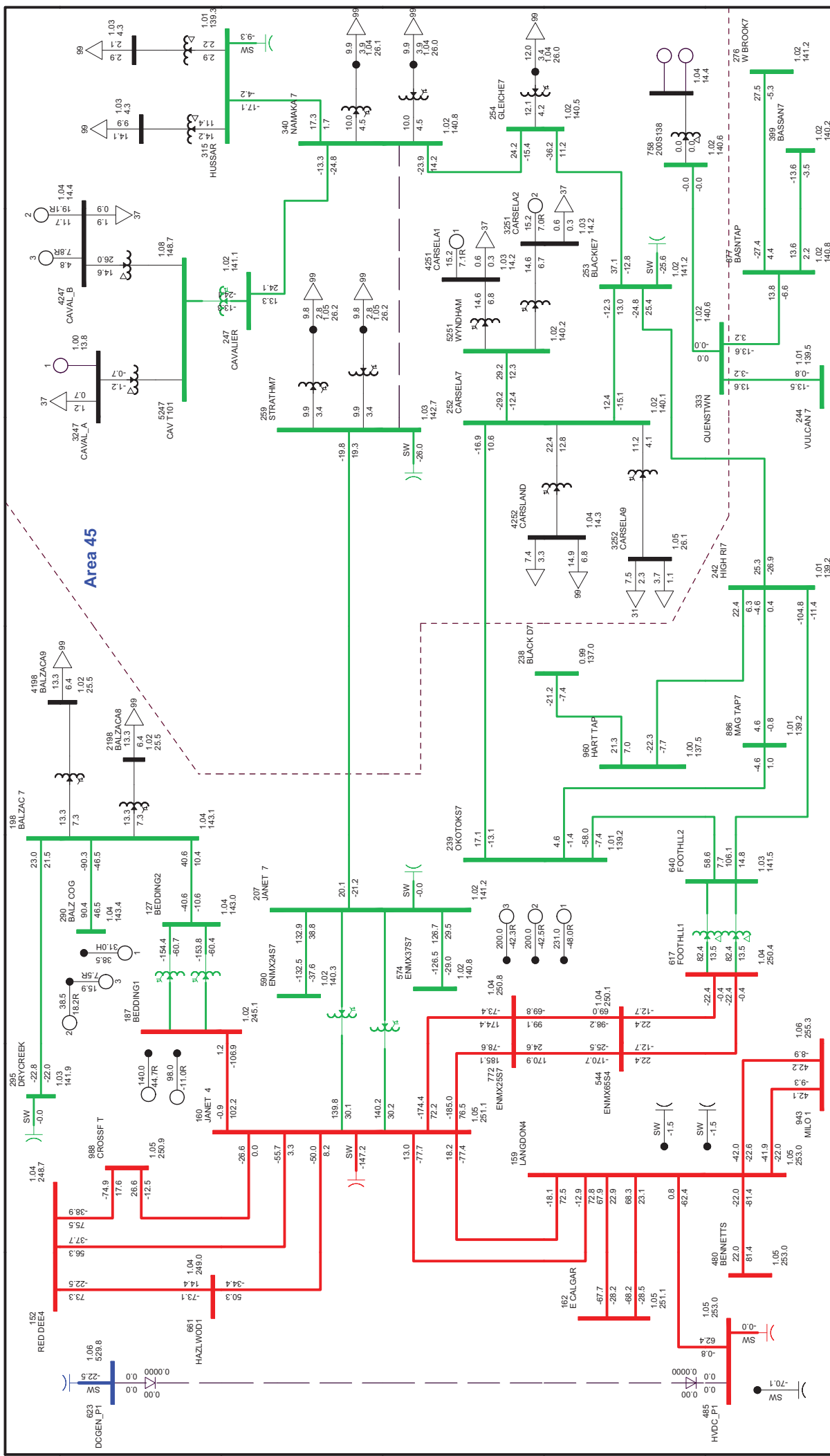
BC Import:0.0 MW Sask Import:-0.1 MW MATL Import:0.0 MW

Figure A-1:

CATEGORY A, N=0
2017SP PRE-CONNECTION
WED, MAY 18 2016 14:13

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000



CATEGORY B, LOSS OF 733L
2017SP PRE-CONNECTION
WED, MAY 18 2016 14:13

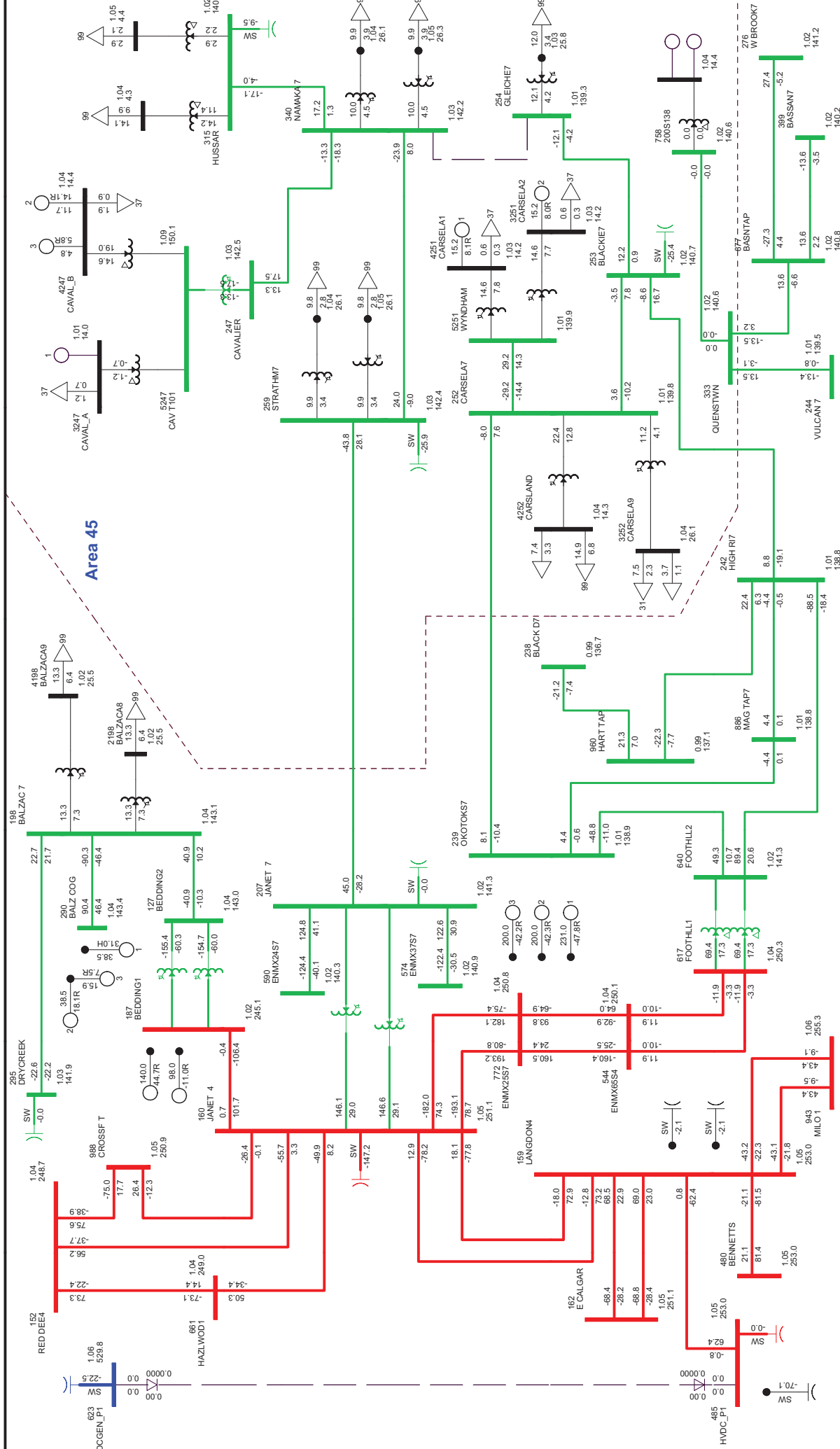
Figure A-3:

P1631 - Chestmere New POD

Sask Import:-0.1 MW MATL Import:0.0 MW

Bus - Voltage (kV/pu)	
Branch - MW/Mvar	
Equipment - MW/Mvar	
100.0%Rate A	

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000

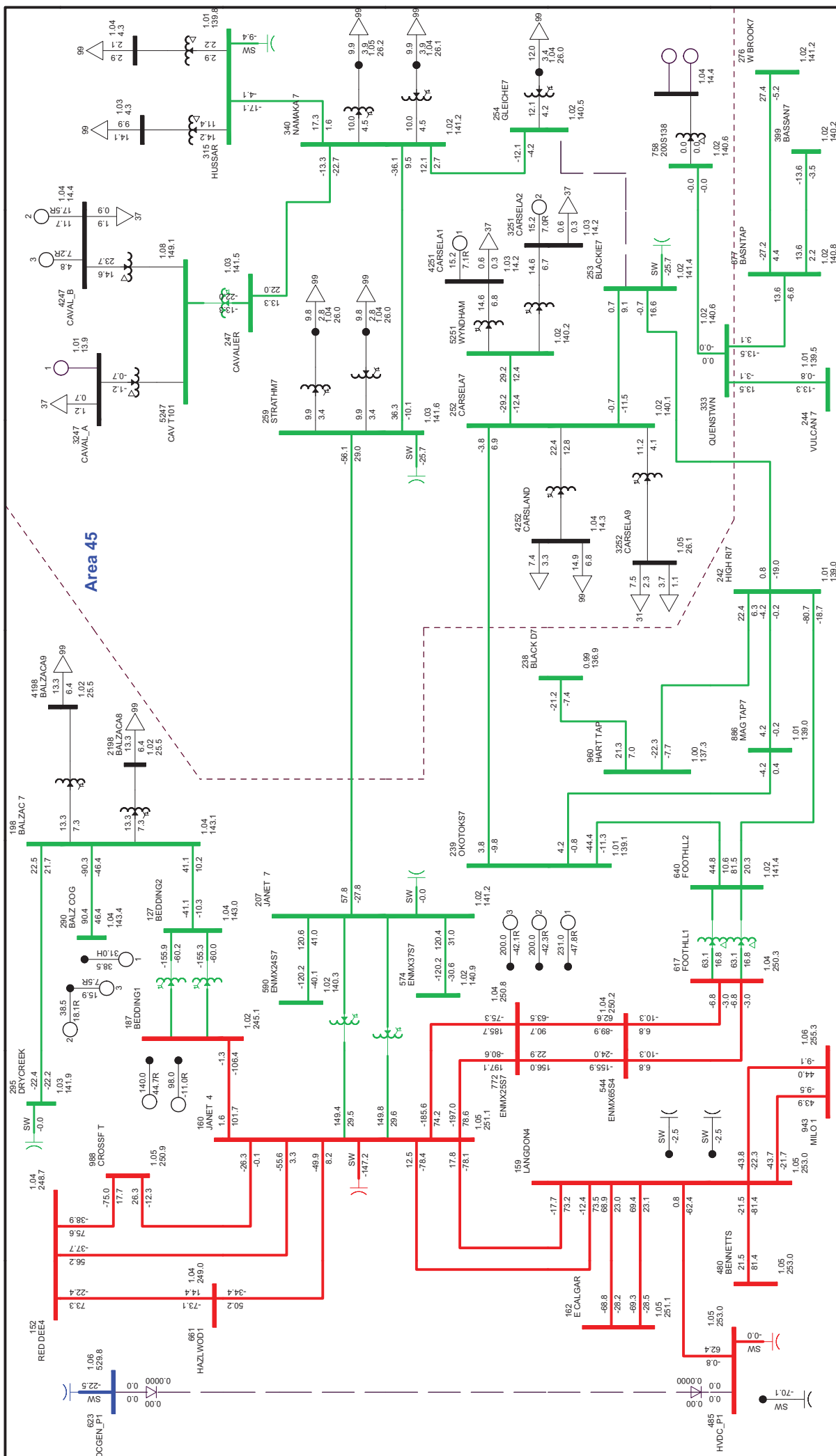


CATEGORY B, LOSS OF 733L
2017SP PRE-CONNECTION
WED, MAY 18 2016 14:13

Figure A-4:

P1631 - Chestermere New POD

BC Import-0.0 MW Sask Import-0.1 MW MATL Import0.0 MW



CATEGORY B, LOSS OF 876L
2017SP PRE-CONNECTION
WED, MAY 18 2016 14:13

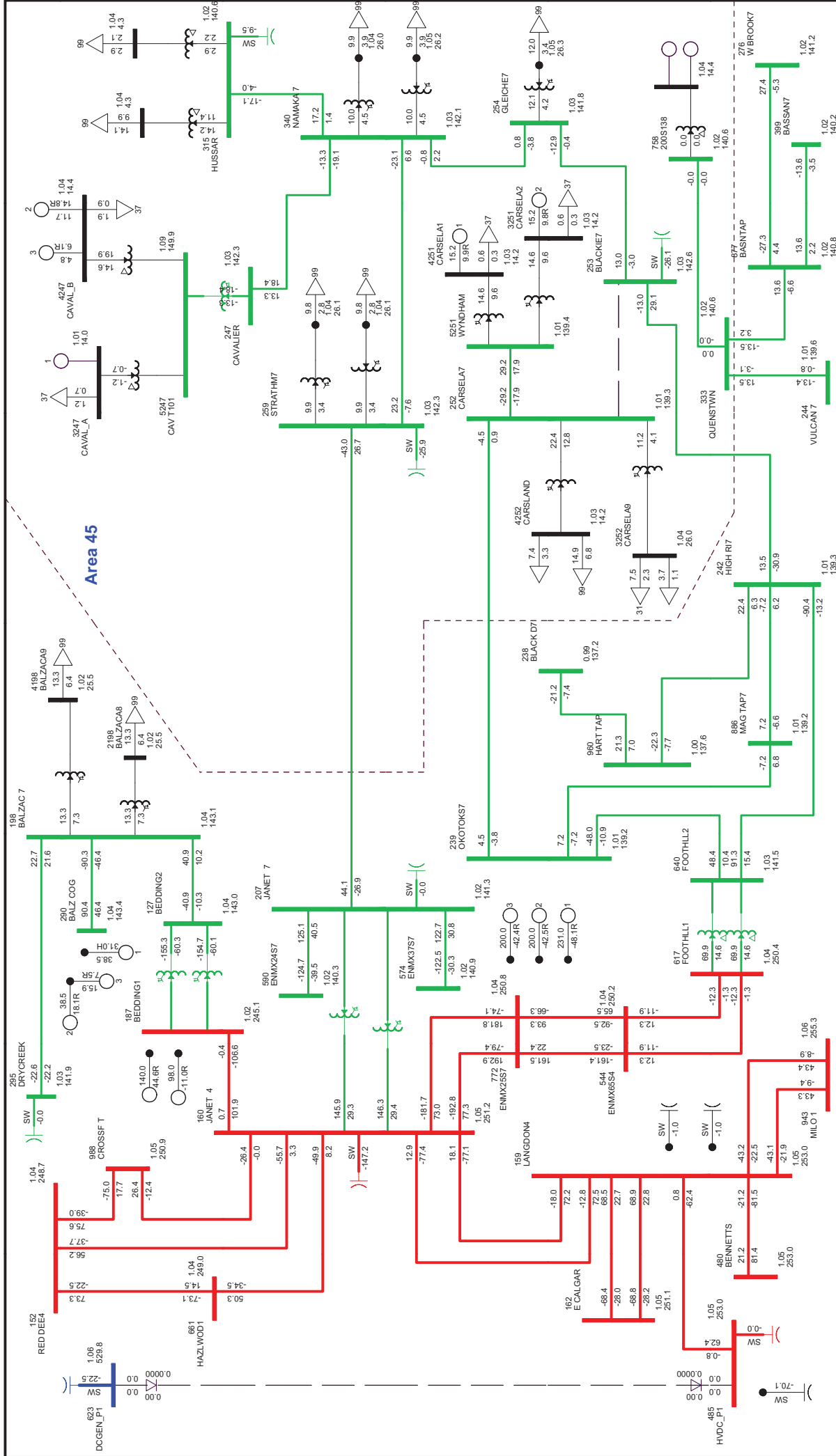
Figure A-5:

P1631 - Chestermere New POD

Sask Import:-0.1 MW	MATL Import:0.0 MW
---------------------	--------------------

Bus - Voltage (kV/pu)	
Branch - MW/Mvar	
Equipment - MW/Mvar	
100.0%Rate A	

KV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000

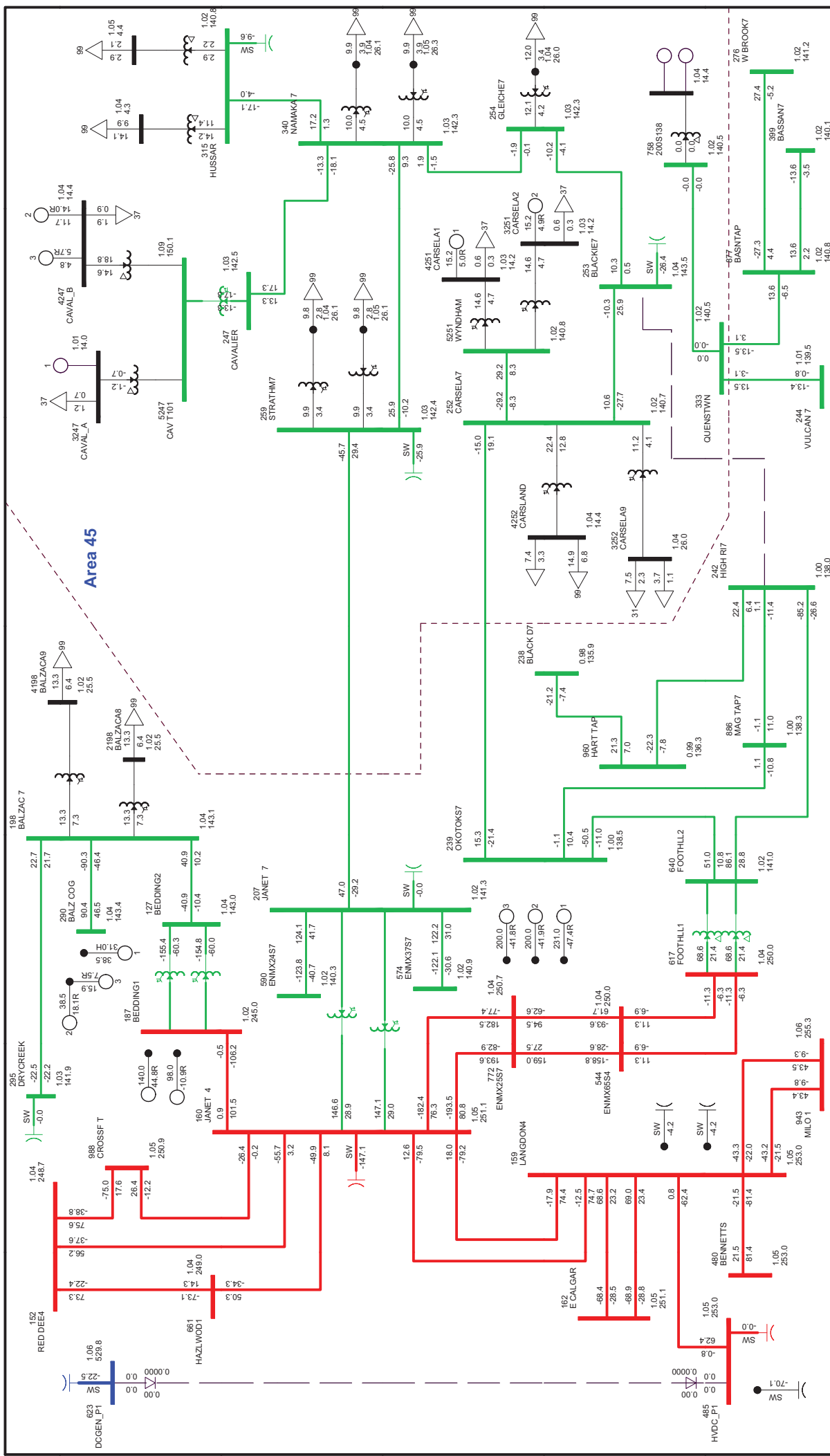


CATEGORY B, LOSS OF 851L
2017SP PRE-CONNECTION
WED, MAY 18 2016 14:13

Figure A-6:

P1631 - Chestermere New POD

BC Import:0.2 MW Sask Import:-0.1 MW MATL Import:0.0 MW



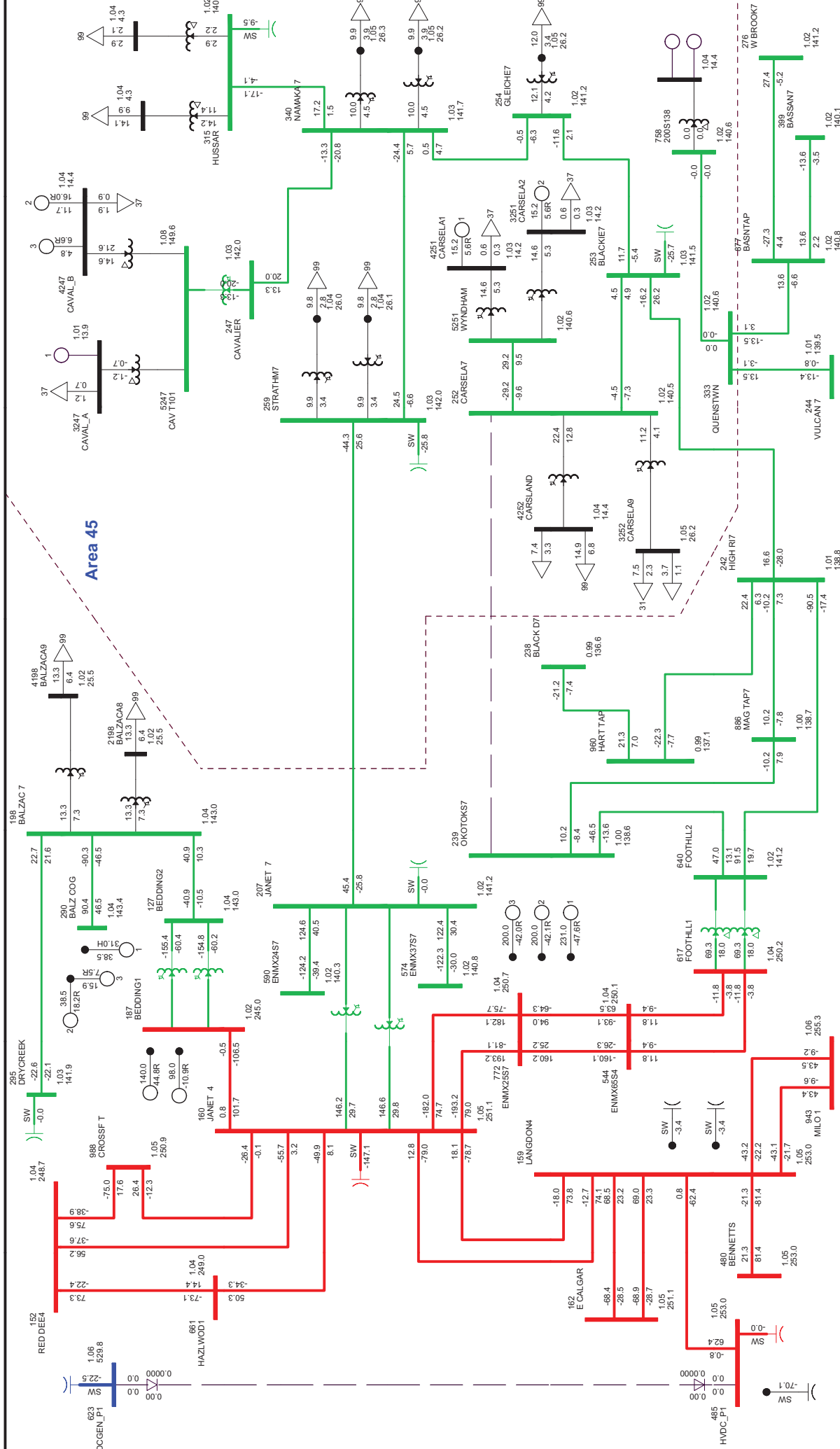
CATEGORY B, LOSS OF 753L
2017SP PRE-CONNECTION
WED, MAY 18 2016 14:13

P1631 - Chestermere New POD

Sask Import:-0.1 MW	MATL Import:0.0 MW
---------------------	--------------------

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: <=25 000 <=72 000 <=144 000 <=240 000 <=500 000 >500 000



CATEGORY B, LOSS OF 850L
2017SP PRE-CONNECTION
WED, MAY 18 2016 14:13

Figure A-8:

P1631 - Chestermere New POD
BC Import 0.2 MW Sask Import -0.1 MW MATL Import 0.0 MW

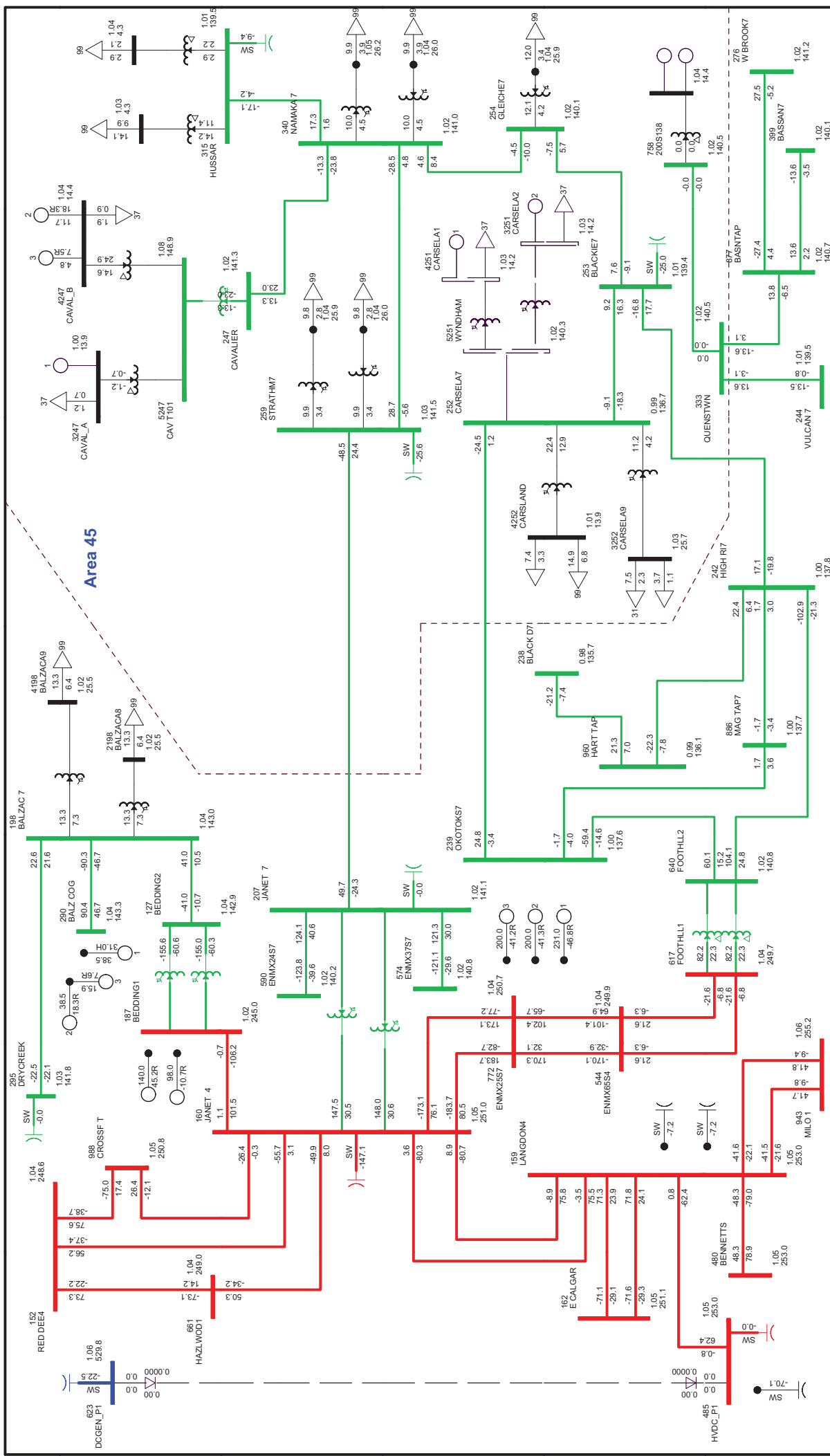


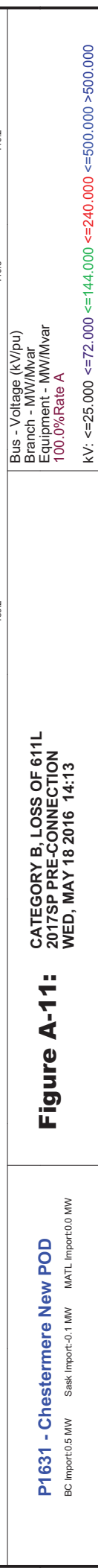
Figure A-10:
CATEGORY B, LOSS OF CARSELAND STATION
2017SP PRE-CONNECTION
WED, MAY 18 2016 14:13

P1631 - Chestermere New POD

BC Import:30.5 MW	Sask Import:-0.1 MW	MATL Import:0.0 MW
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Bus - Voltage (kV/pu)	
Branch - MW/Mvar	
Equipment - MW/Mvar	
100.0%Rate A	

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



P1631 - Chestermere New POD

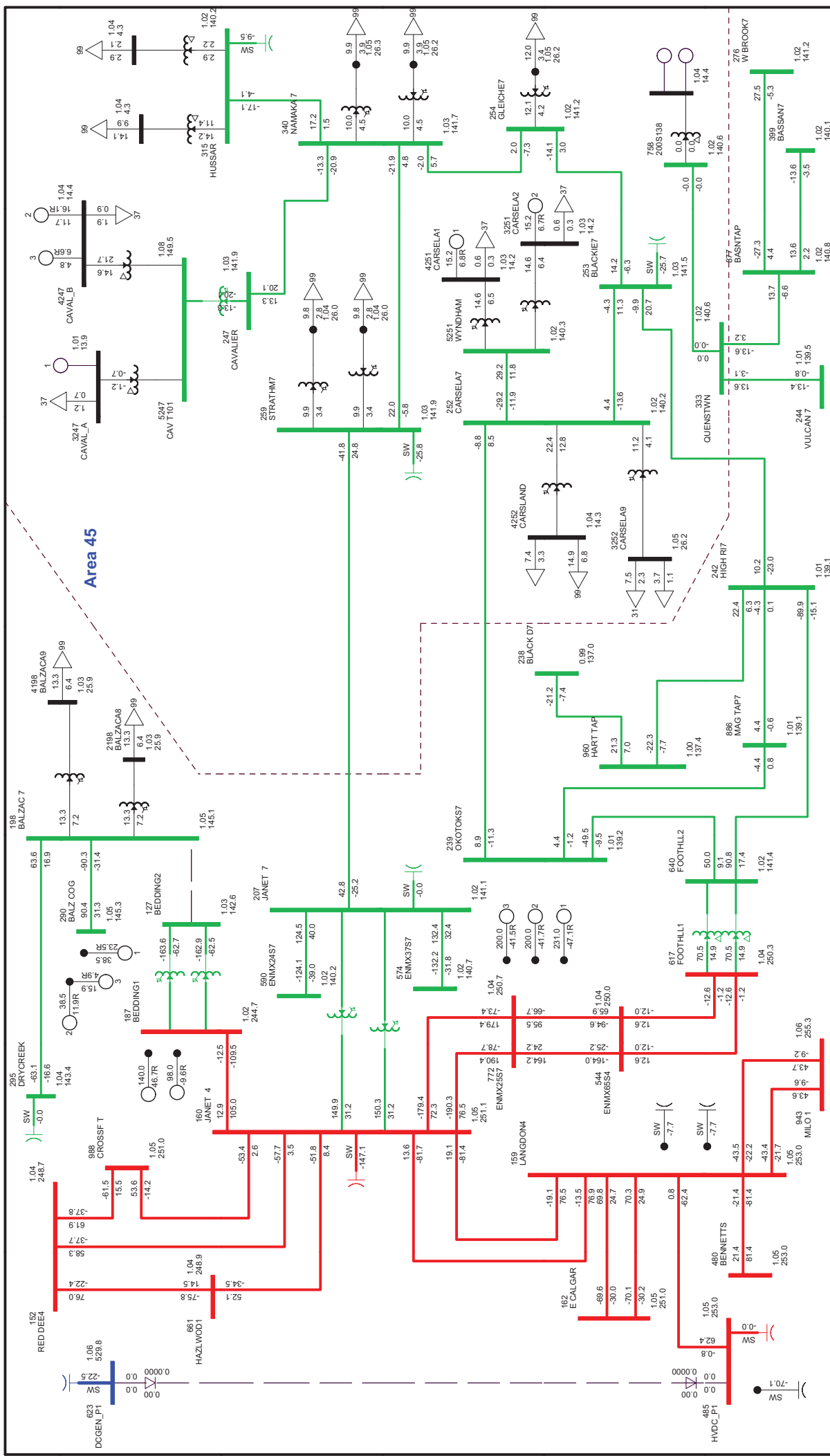


Figure A-12:
CATEGORY B, LOSS OF 162.81L
2017SP PRE-CONNECTION
WED, MAY 18 2016 14:13

P1631 - Chestermere New POD

Sask Import:-0.1 MW	MATL Import:0.0 MW
---------------------	--------------------

Bus - Voltage (kV/pu)

kV: <=25 000 <=72 000 <=144 000 <=240 000 <=500 000 >500 000

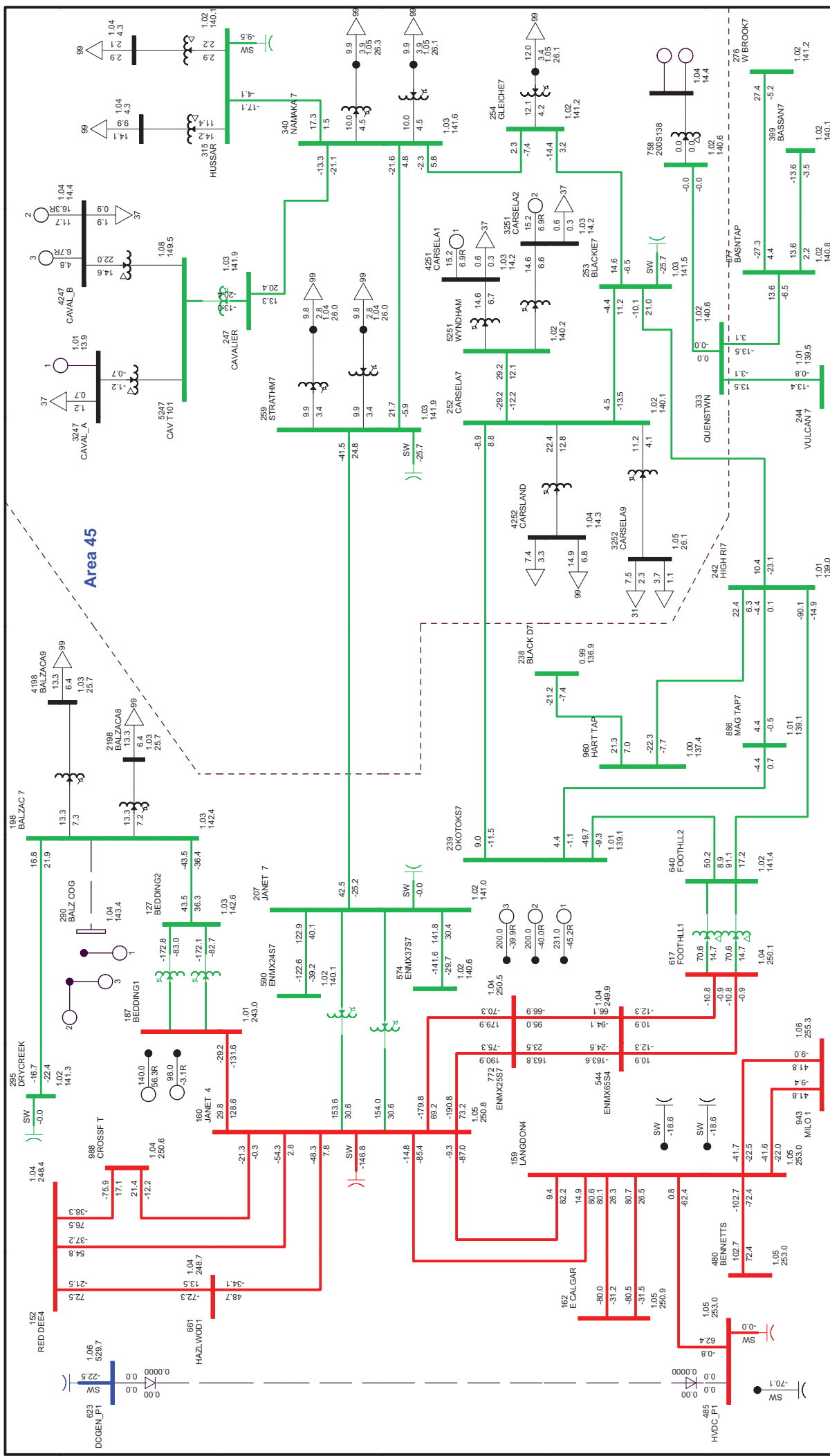


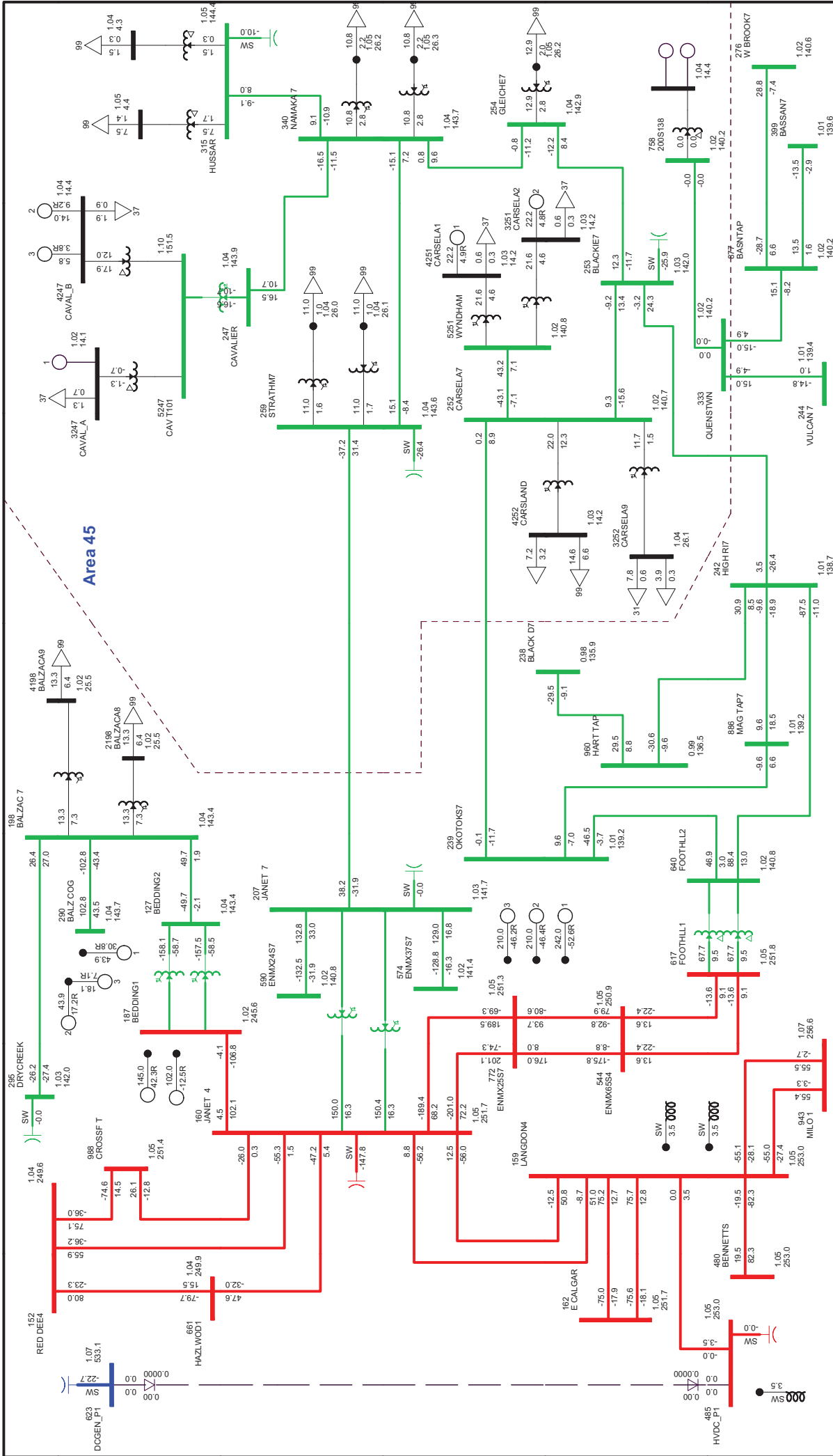
Figure A-13:
CATEGORY B, LOSS OF BALZAC STATION
2017SP PRE-CONNECTION
WED. MAY 18 2016 14:14

P1631 - Chestermere New POD

BC Import:91.0 MW	Sask Import:-0.1 MW	MATL Import:0.0 MW
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Bus - Voltage (kV/pu)

kV: <=25 000 <=72 000 <=144 000 <=240 000 <=500 000 >500 000



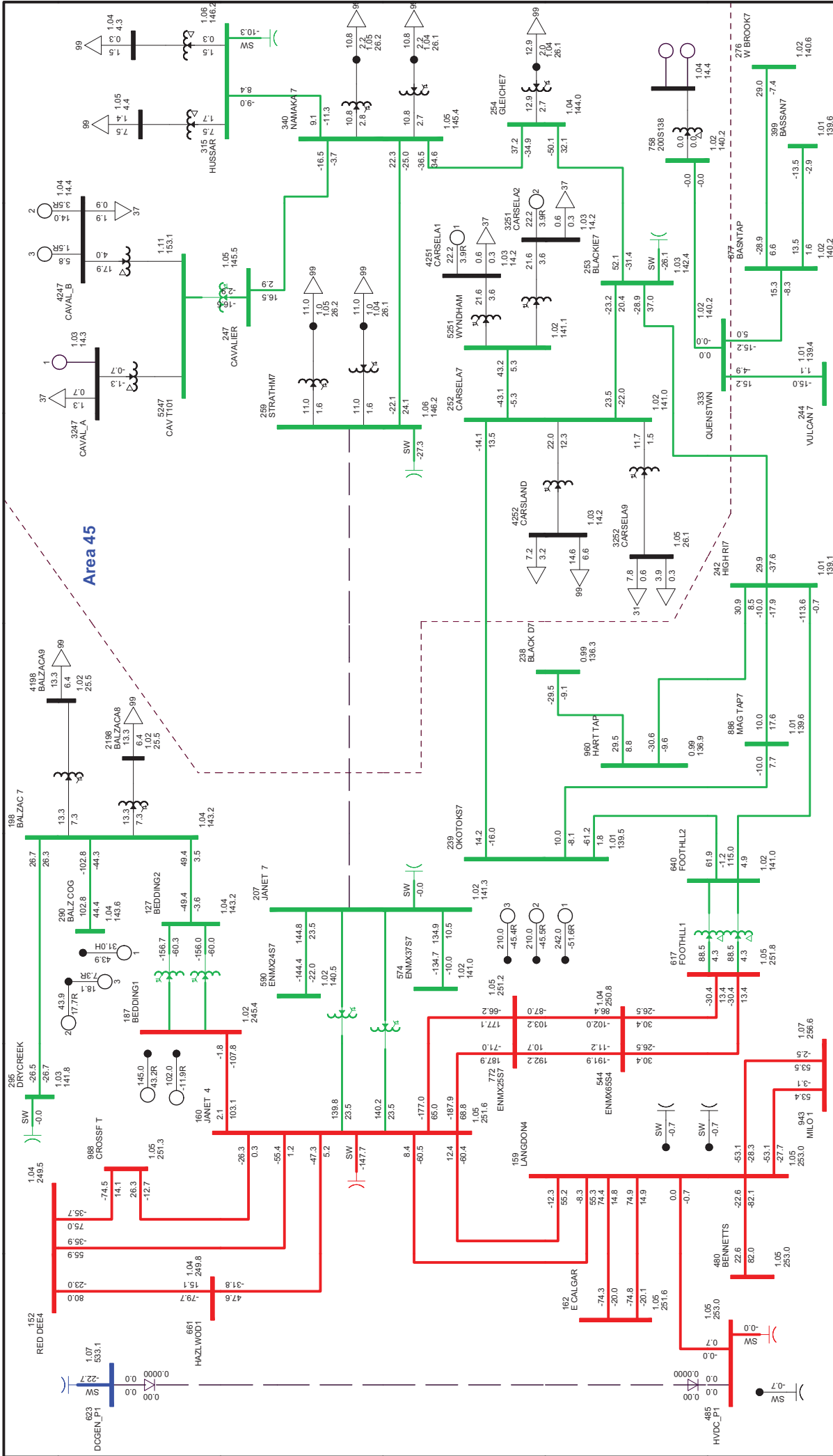
CATEGORY A, N-0
2017WP PRE-CONNECTION
WED, MAY 18 2016 14:10

P1631 - Chestermere New POD

BC Import:-0.0 MW	Sask Import:-0.1 MW	MATL Import:0.0 MW
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Bus - Voltage (kV/pu)	
Branch - MW/Mvar	
Equipment - MW/Mvar	
100.0%Rate B	

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



CATEGORY B, LOSS OF 765L
2017WP PRE-CONNECTION
WED, MAY 18 2016 14:10

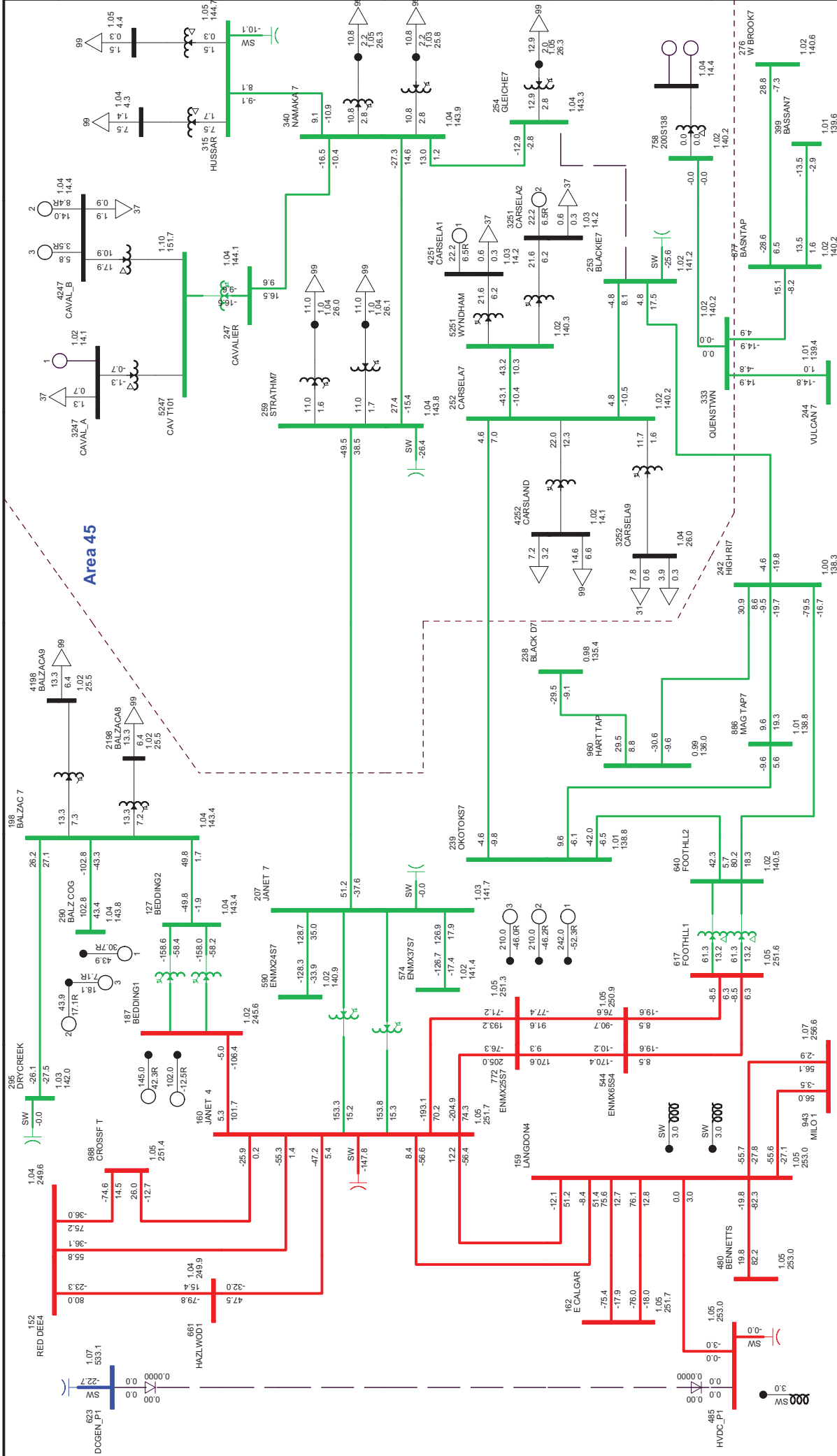
Figure A-15:

P1631 - Chestermere New POD

Scenario	Import	Export	Net
Sask Import	-0.1 MW	0.0 MW	-0.1 MW
MATL Import	0.0 MW	0.0 MW	0.0 MW

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



P1631 - Chestermere New POD

BC Import:0.2 MW Sask Import:0.1 MW MATL Import:0.0 MW

Figure A-18:

CATEGORY B, LOSS OF 876L

2017WP PRE-CONNECTION

WED, MAY 18 2016 14:10

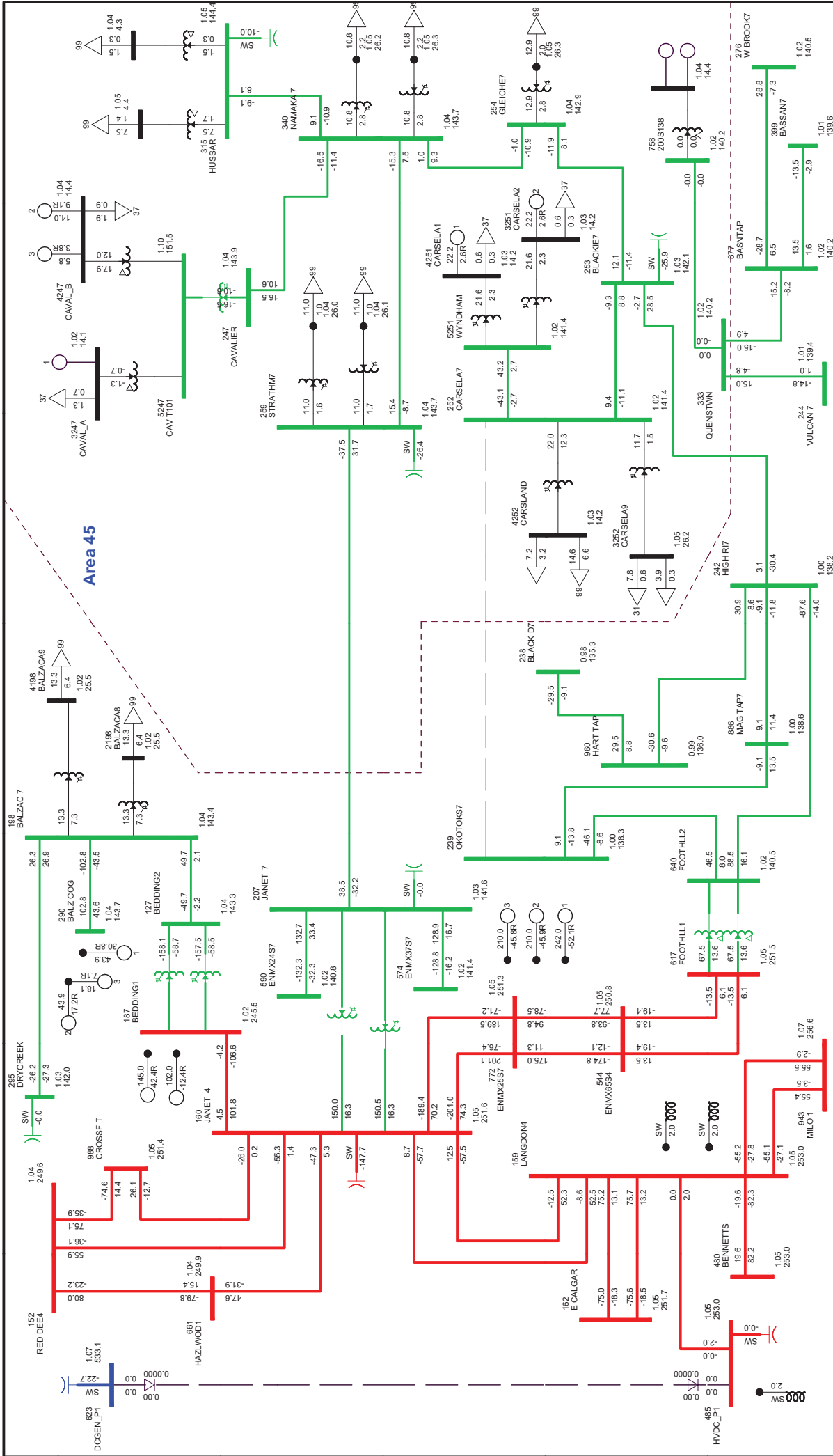
Bus - Voltage (kV/pu)

Branch - MW/Mvar

Equipment - MW/Mvar

100.0%Rate B

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



CATEGORY B, LOSS OF 850L
2017WP PRE-CONNECTION
WED. MAY 18 2016 14:10

P1631 - Chestermere New POD

Sask Import:-0.1 MW	MATL Import:-0.0 MW
---------------------	---------------------

Bus - Voltage (kV/pu)	
Branch - MW/Mvar	
Equipment - MW/Mvar	
100.0%Rate B	

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000

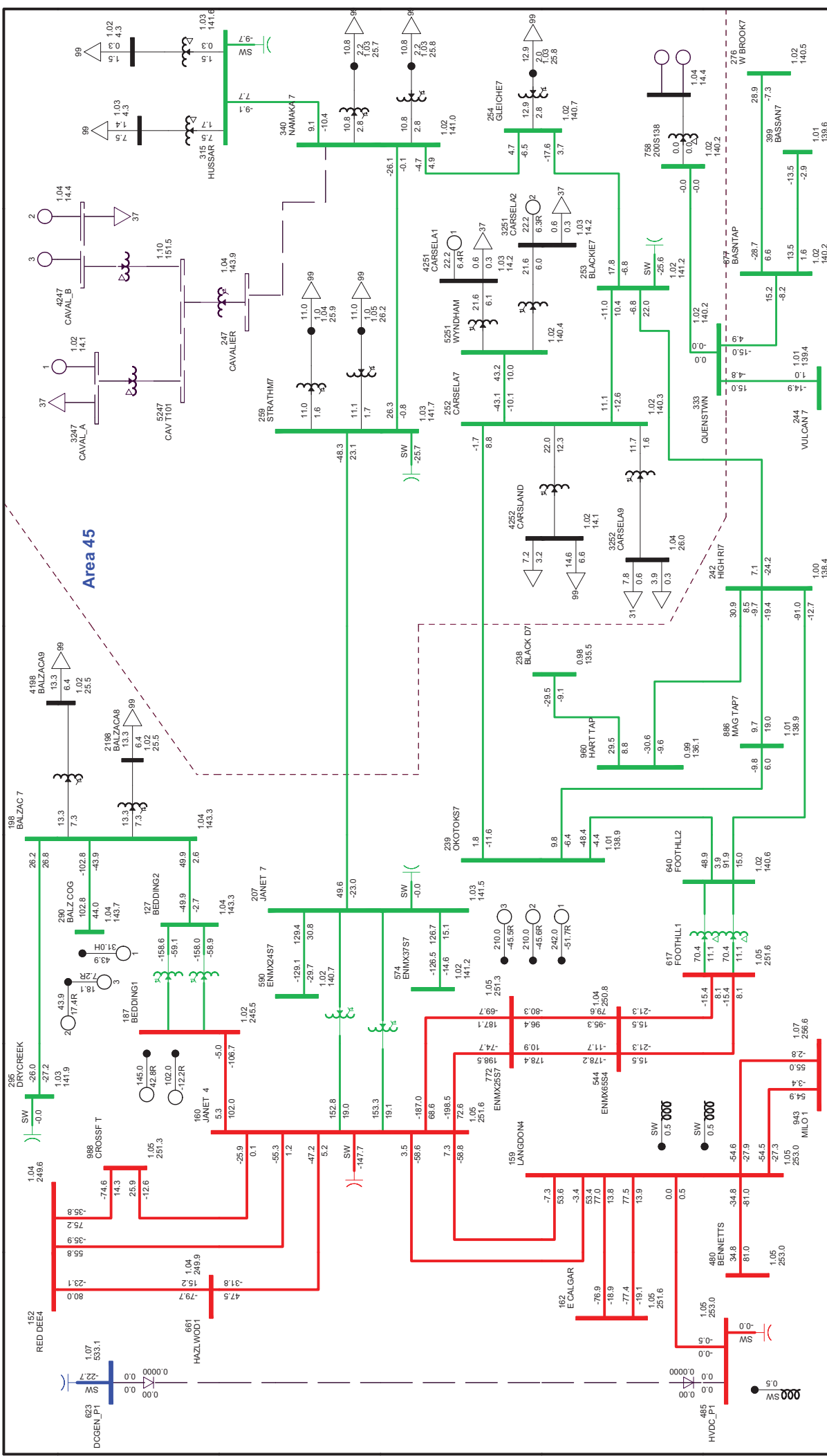


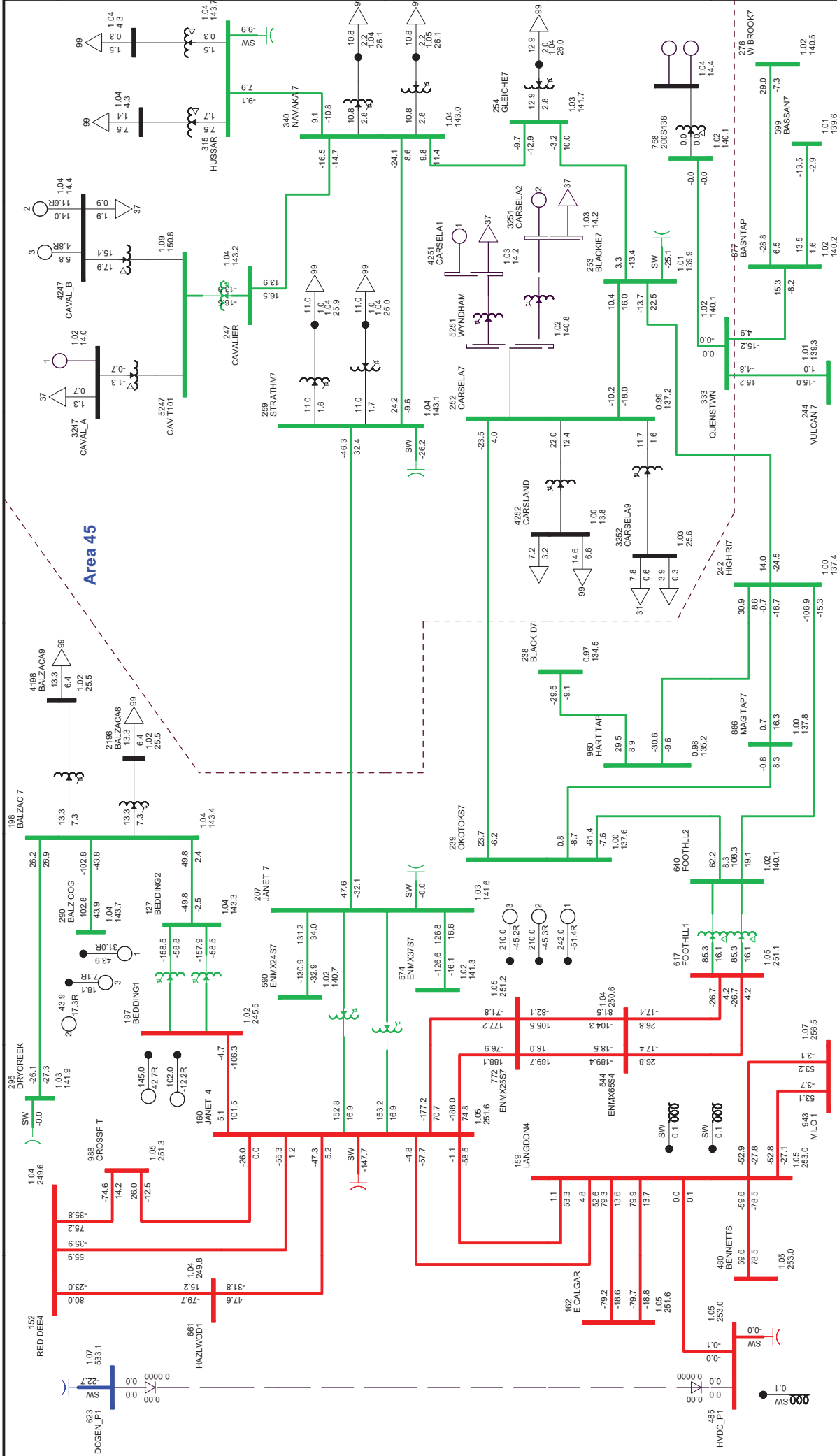
Figure A-22:
CATEGORY B, LOSS OF CAVALIER STATION
2017WP PRE-CONNECTION
WED. MAY 18 2016 14:10

P1631 - Chestermere New POD

BC Import:17.0 MW	Sask Import:-0.1 MW	MATL Import:0.0 MW
-------------------	---------------------	--------------------

Bus - Voltage (kV/pu)
 Branch - MW/Mvar
 Equipment - MW/Mvar
 100.0%Rate B

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



P1631 - Chestermere New POD
 BC Import:44.9 MW Sask Import:-0.1 MW MATL Import:0.0 MW

Figure A-23:
 CATEGORY B, LOSS OF CARCELAND STATION
 2017WP PRE-CONNECTION
 WED, MAY 18 2016 14:10

Bus - Voltage (kV/pu)
 Branch - MW/MWvar
 Equipment - MW/Mvar
100.0%Rate B
 kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000

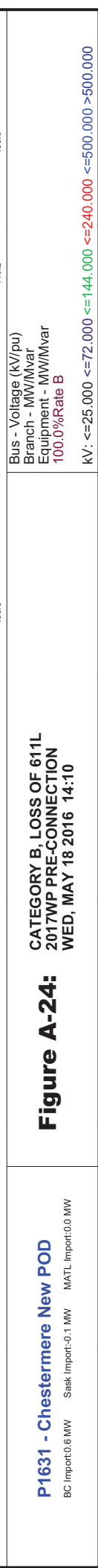
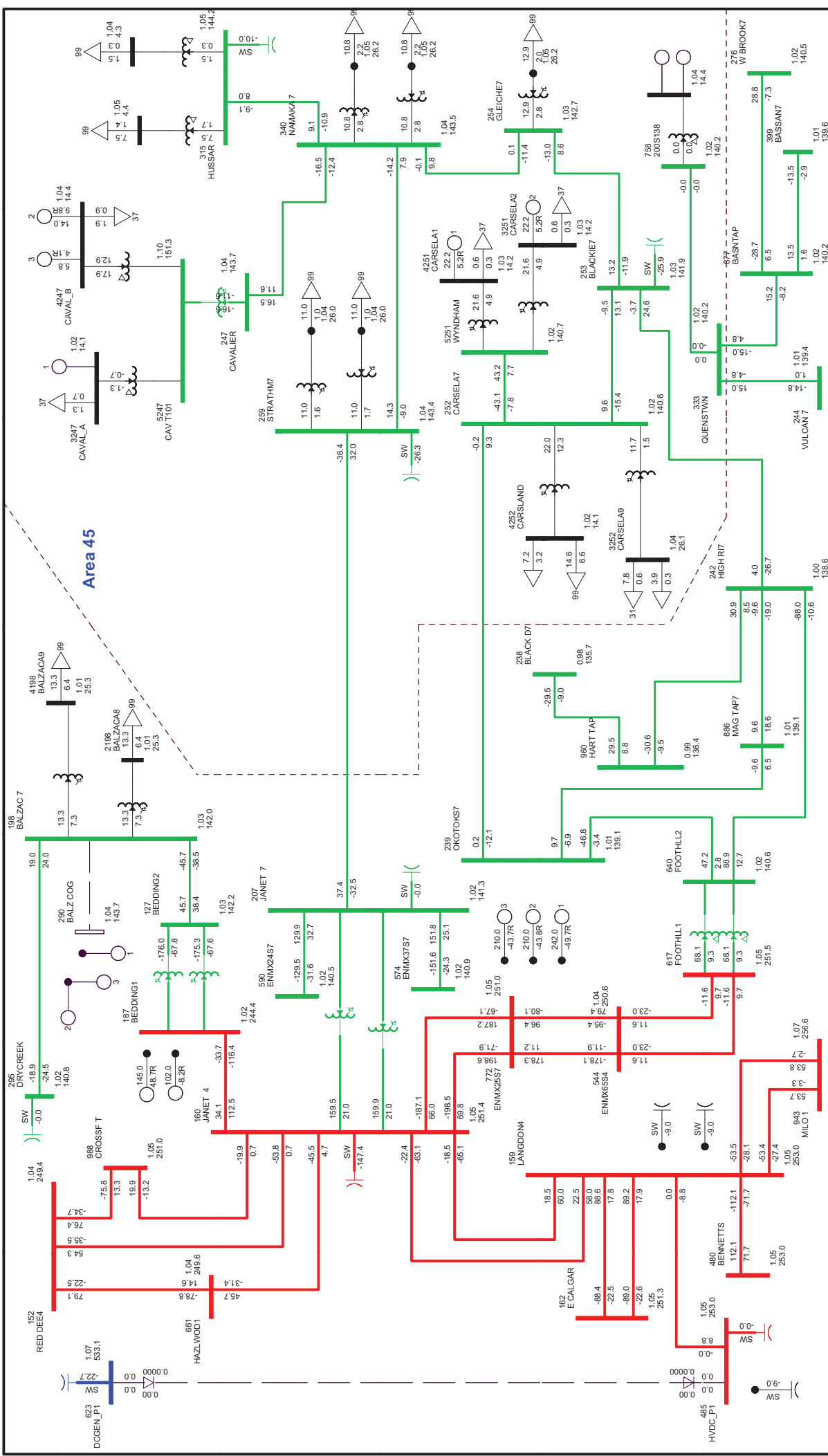


Figure A-24:

Sask Import:-0.1 MW	MATL Import:0.0 MW
---------------------	--------------------

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



CATEGORY B, LOSS OF BALZAC STATION
2017WP PRE-CONNECTION
WED, MAY 18 2016 14:11

P1631 - Chestermere New POD

BC Import:103.2 MW	Sask Import:-0.1 MW	MATL Import:0.0 MW
--------------------	---------------------	--------------------

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000

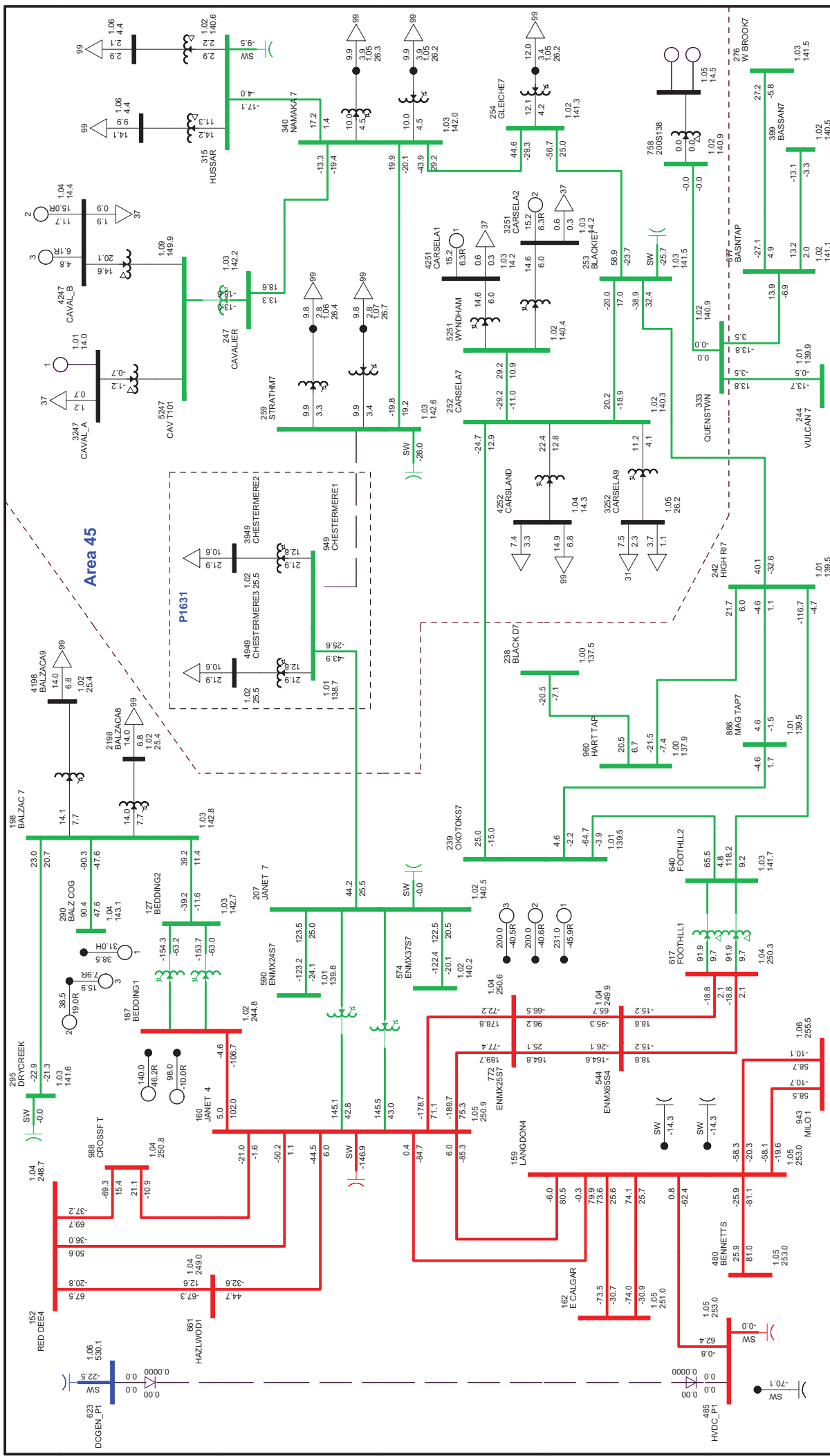
Attachment B

Alternative 3: Power Flow Diagrams (Scenarios 3 & 4)

Steady-state power flow diagrams for Category A and selected Category B contingency conditions are provided in this section. The following table presents the list of the power flow diagrams.

Table B-1: Post-Project Power Flow Diagrams

Category	Contingency	Figure	
		2017 SP Post-Project	2017 WP Post-Project
A	Normal operation	Figure B-1	Figure B-14
B	765L (Strathmore 151S - Chestermere 419S)	Figure B-2	Figure B-15
B	691L (Chestermere 419S - Janet 74S)	Not Converged	Figure B-16
B	733L (Strathmore 151S - Namaka 428S)	Figure B-3	Figure B-17
B	733L (Gleichen 179S - Namaka 428S)	Figure B-4	Figure B-18
B	876L (Blackie 253S - Gleichen 179S)	Figure B-5	Figure B-19
B	851L (Blackie 253S - Carseland 525S)	Figure B-6	Figure B-20
B	753L (Blackie 253S - High River 65S)	Figure B-7	Figure B-21
B	850L (Okotoks 678S - Carseland 525S)	Figure B-8	Figure B-22
B	PCES01L (Namaka 428S -Cavalier Power Station)	Figure B-9	Figure B-23
B	782L (Wyndham 269S – Carseland 525S)	Figure B-10	Figure B-24
B	611L (Turbo Balzac 391S - Dry Creek 186S)	Figure B-11	Figure B-25
B	162.81L (Turbo Balzac 391S - Beddington SS-162)	Figure B-12	Figure B-26
B	PCES02L (Turbo Balzac 391S – Balzac Power Station)	Figure B-13	Figure B-27



CATEGORY B, LOSS OF 765L
2017SP POST-CONNECTION
WED. MAY 18 2016 14:17

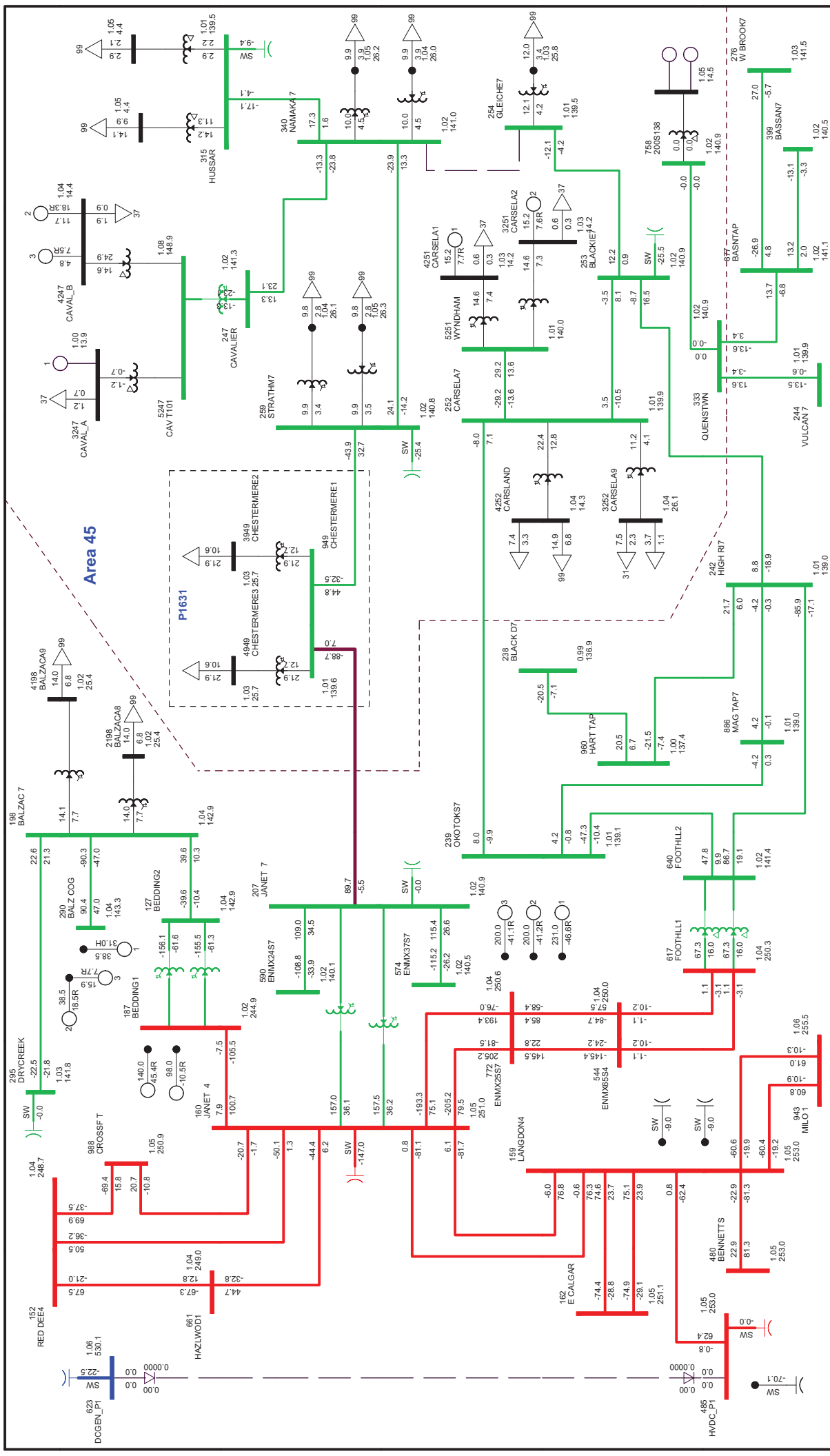
Figure B-2:

P1631 - Chestermere New POD

Sask Import:-0.1 MW MATL Import:0.0 MW

Bus - Voltage (kV/pu)	
Branch - MW/Mvar	
Equipment - MW/Mvar	
100.0%Rate A	

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



CATEGORY B, LOSS OF 733L
2017SP POST-CONNECTION
WED. MAY 18 2016 14:17

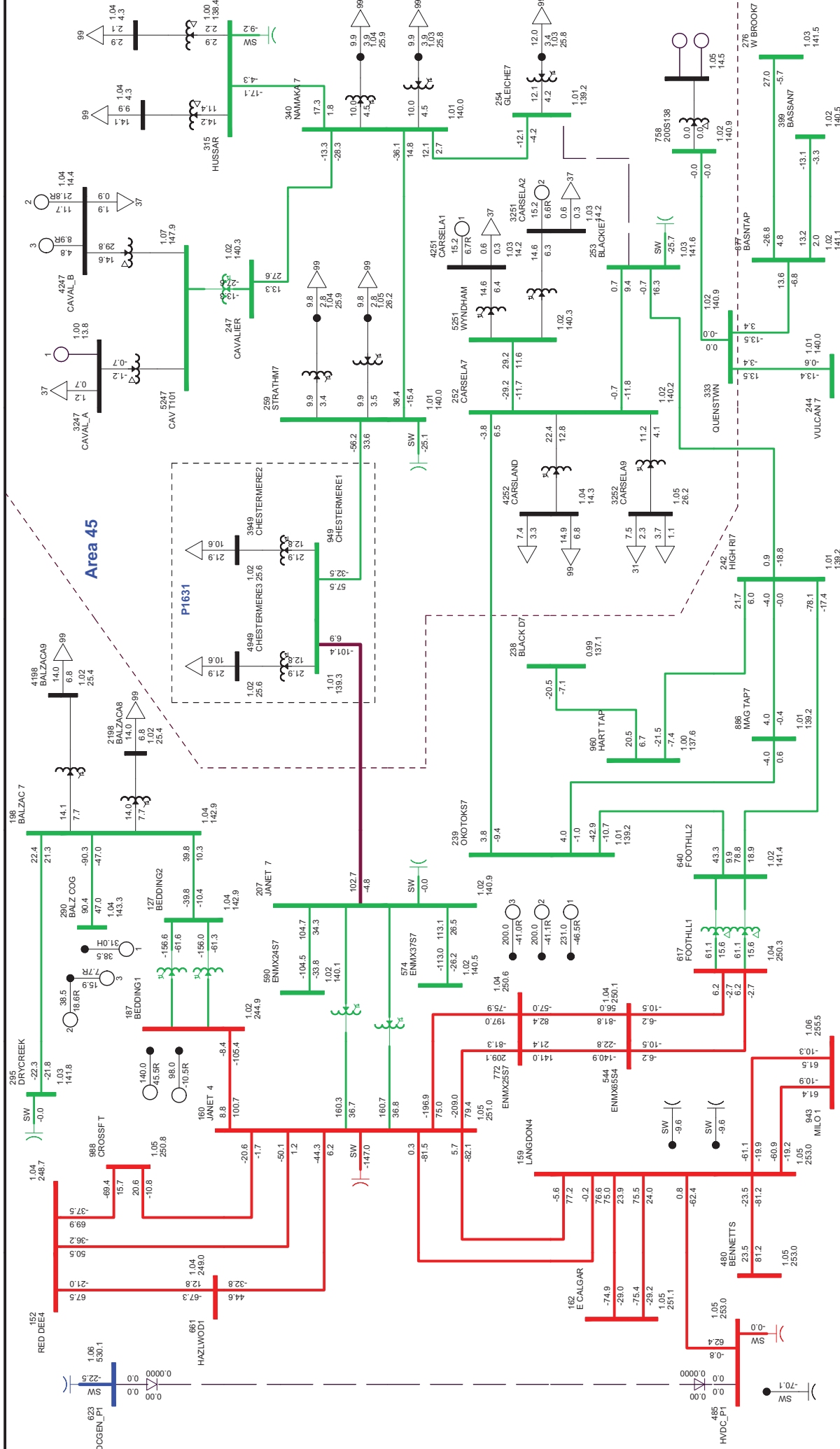
Figure B-4:

P1631 - Chestermere New POD

Sask Import:-0.1 MW	MATL Import:0.0 MW
---------------------	--------------------

Bus - Voltage (kV/pu)	
Branch - MW/Mvar	
Equipment - MW/Mvar	
100.0%Rate A	

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



P1631 - Chestermere New POD

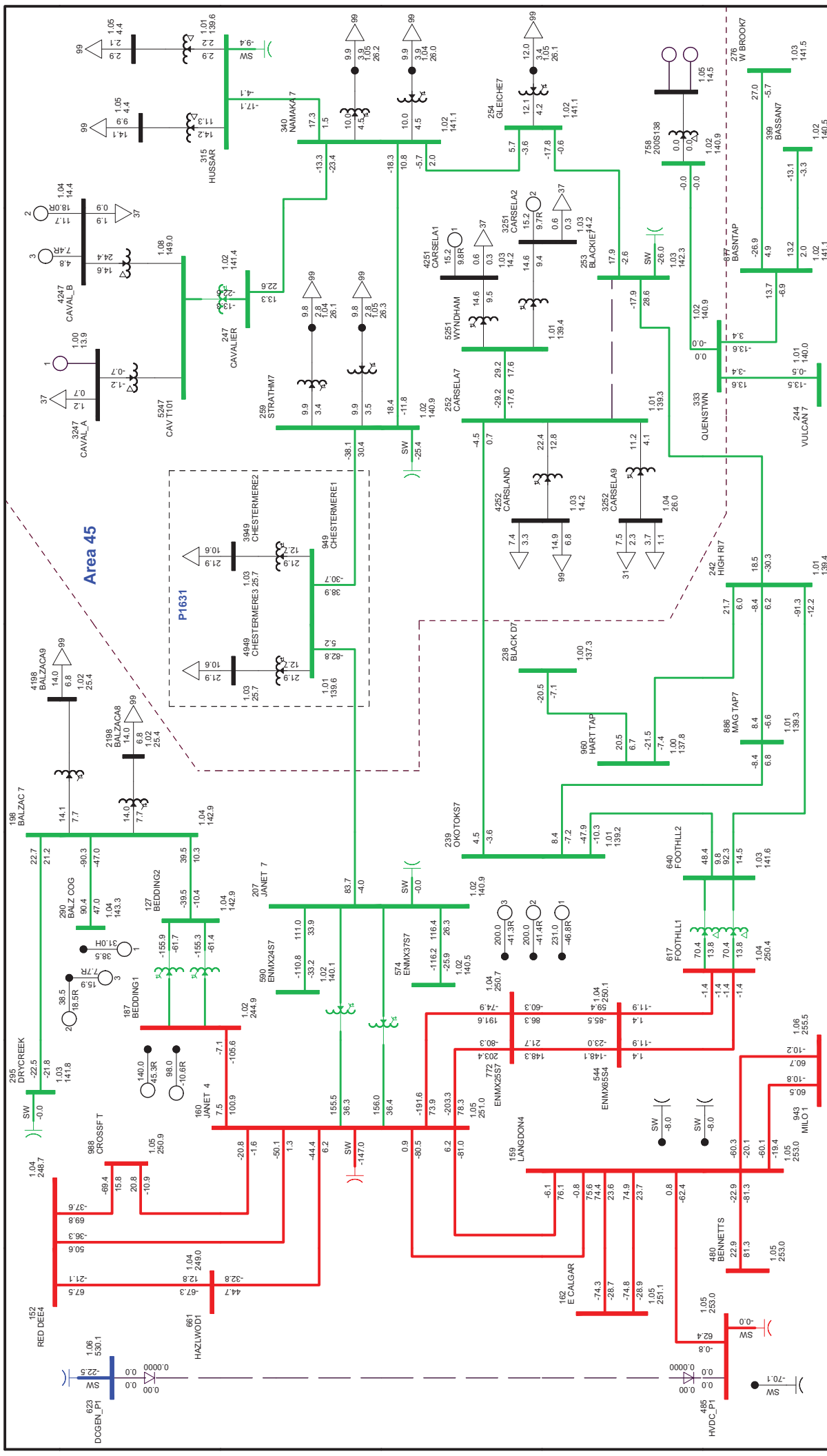
BC Import: 0.6 MW Sask Import: -0.1 MW MATL Import: 0.0 MW

Figure B-5:

CATEGORY B, LOSS OF 876L
2017SP POST-CONNECTION
WED, MAY 18 2016 14:17

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

KV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000



CATEGORY B, LOSS OF 851L
2017SP POST-CONNECTION
WED. MAY 18 2016 14:17

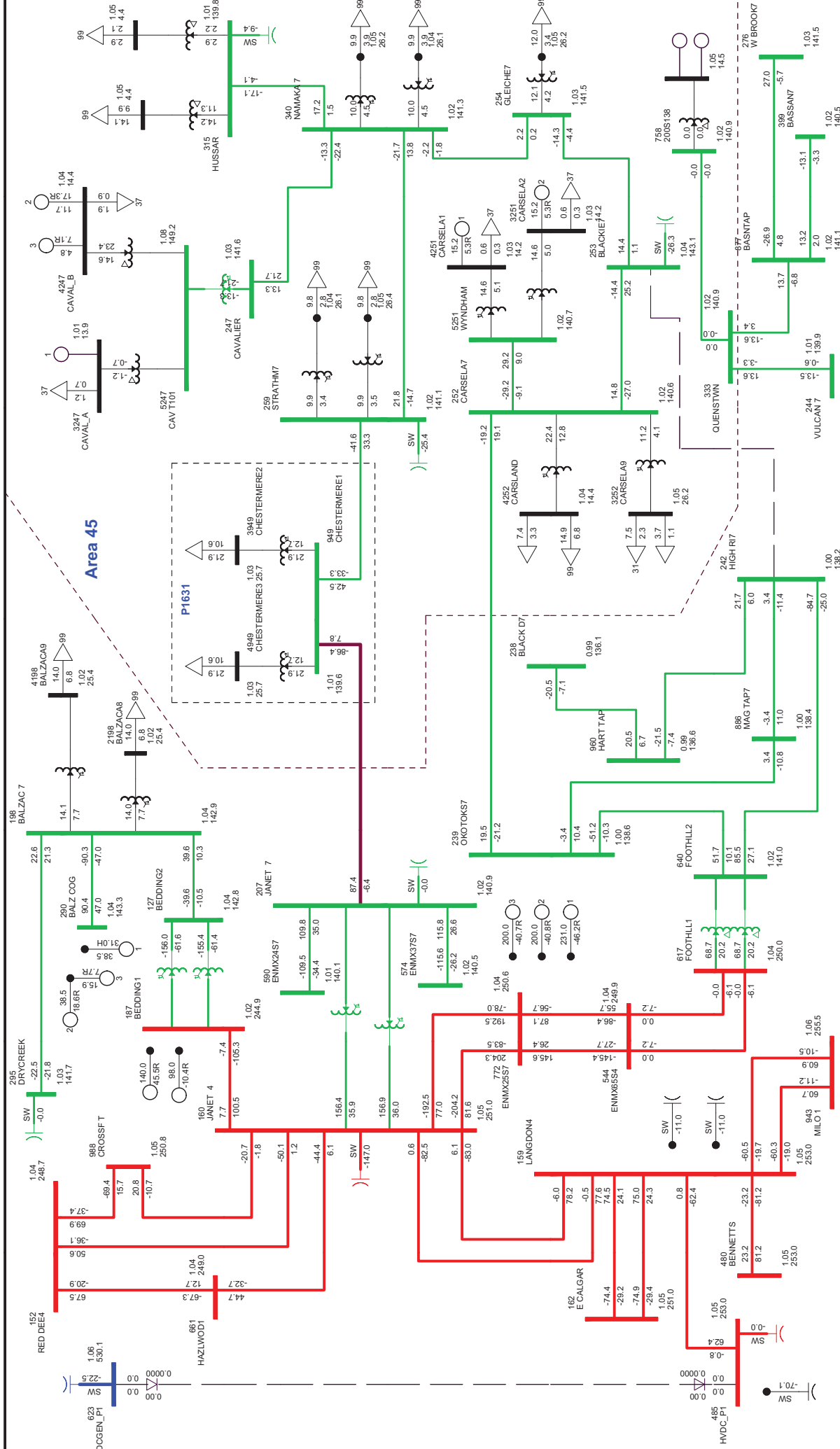
Figure B-6:

P1631 - Chestermere New POD

Sask Import:-0.1 MW	MATL Import:0.0 MW
---------------------	--------------------

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: <=25 000 <=72 000 <=144 000 <=240 000 <=500 000 >500 000



CATEGORY B, LOSS OF 753L
2017SP POST-CONNECTION
WED. MAY 18 2016 14:17

Figure B-7:

P1631 - Chestermere New POD

Sask Import:-0.1 MW MATL Import:0.0 MW

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000

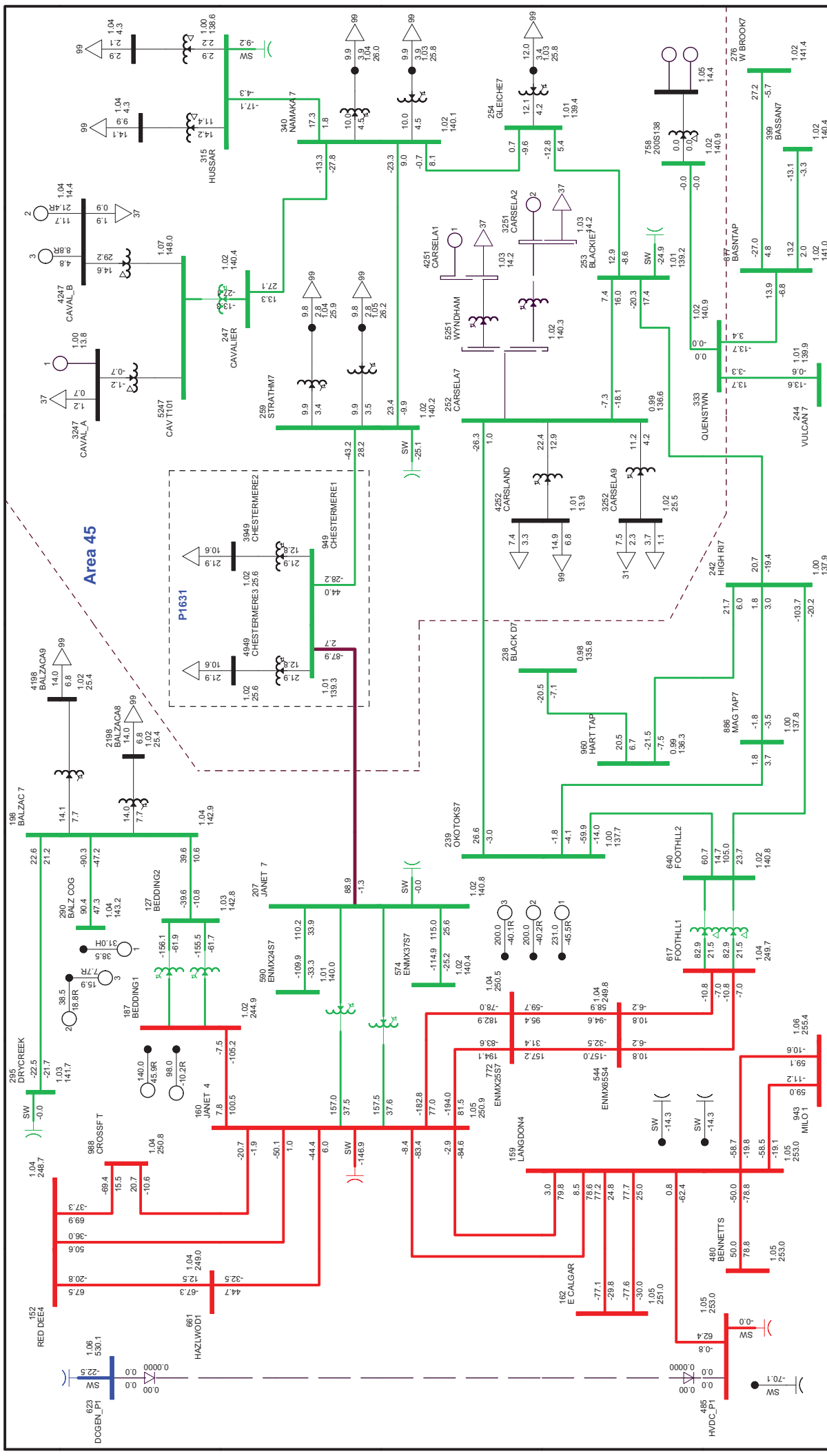


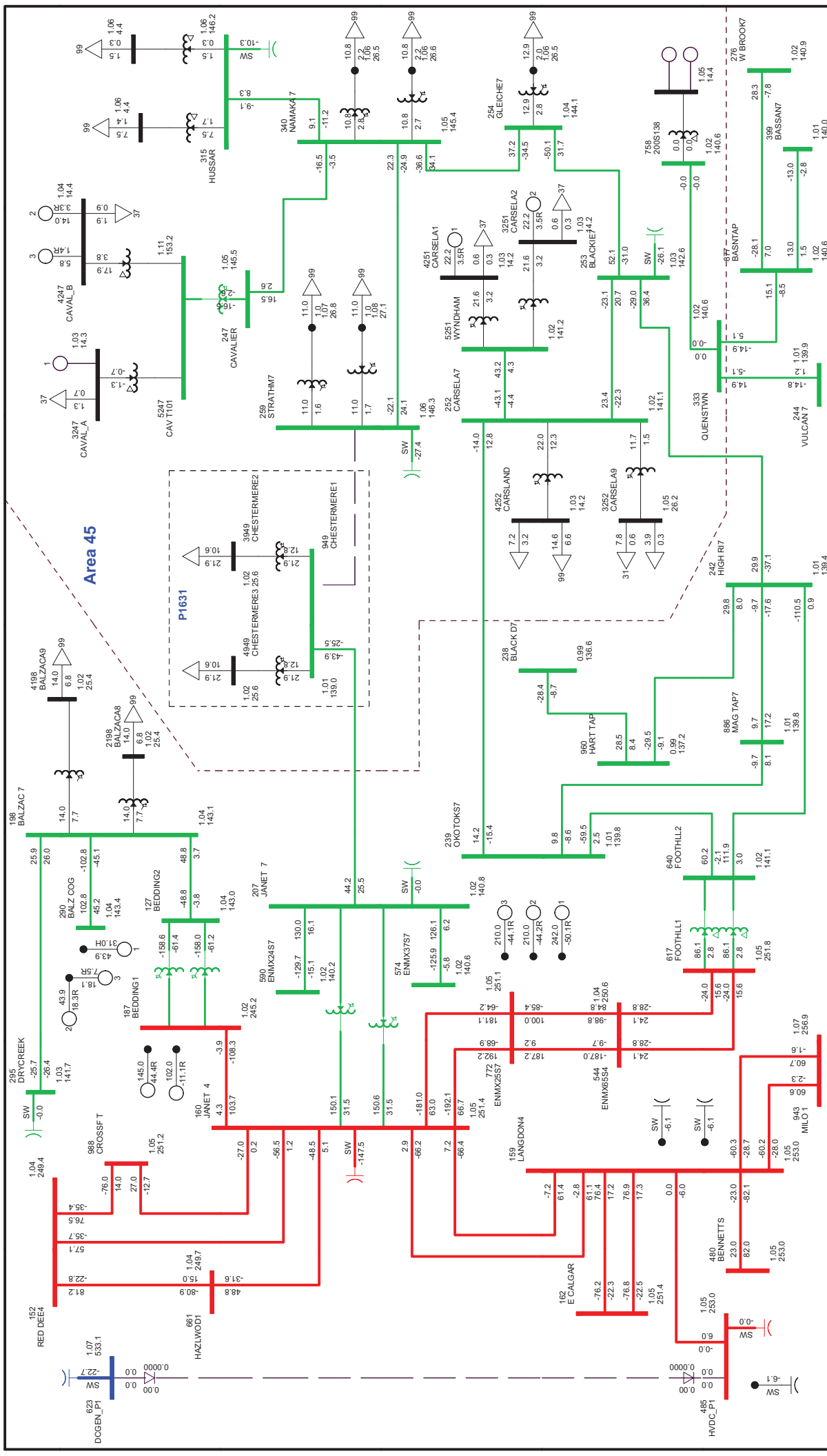
Figure B-10:
CATEGORY B, LOSS OF CARSELAND STATION
2017SP POST-CONNECTION
WED, MAY 18 2016 14:18

P1631 - Chestermere New POD

BC Import:30.5 MW	Sask Import:-0.1 MW	MATL Import:0.0 MW
-------------------	---------------------	--------------------

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



CATEGORY B, LOSS OF 765L
2017WP POST-CONNECTION
WED. MAY 18 2016 14:15

Figure B-15:

P1631 - Chestermere New POD

Sask Import:-0.1 MW	MATL Import:0.0 MW
---------------------	--------------------

Bus - Voltage (kV/pu)
 Branch - MW/Mvar
 Equipment - MW/Mvar
 100.0% Rate B

kV: <=25 000 <=72 000 <=144 000 <=240 000 <=500 000 >500 000

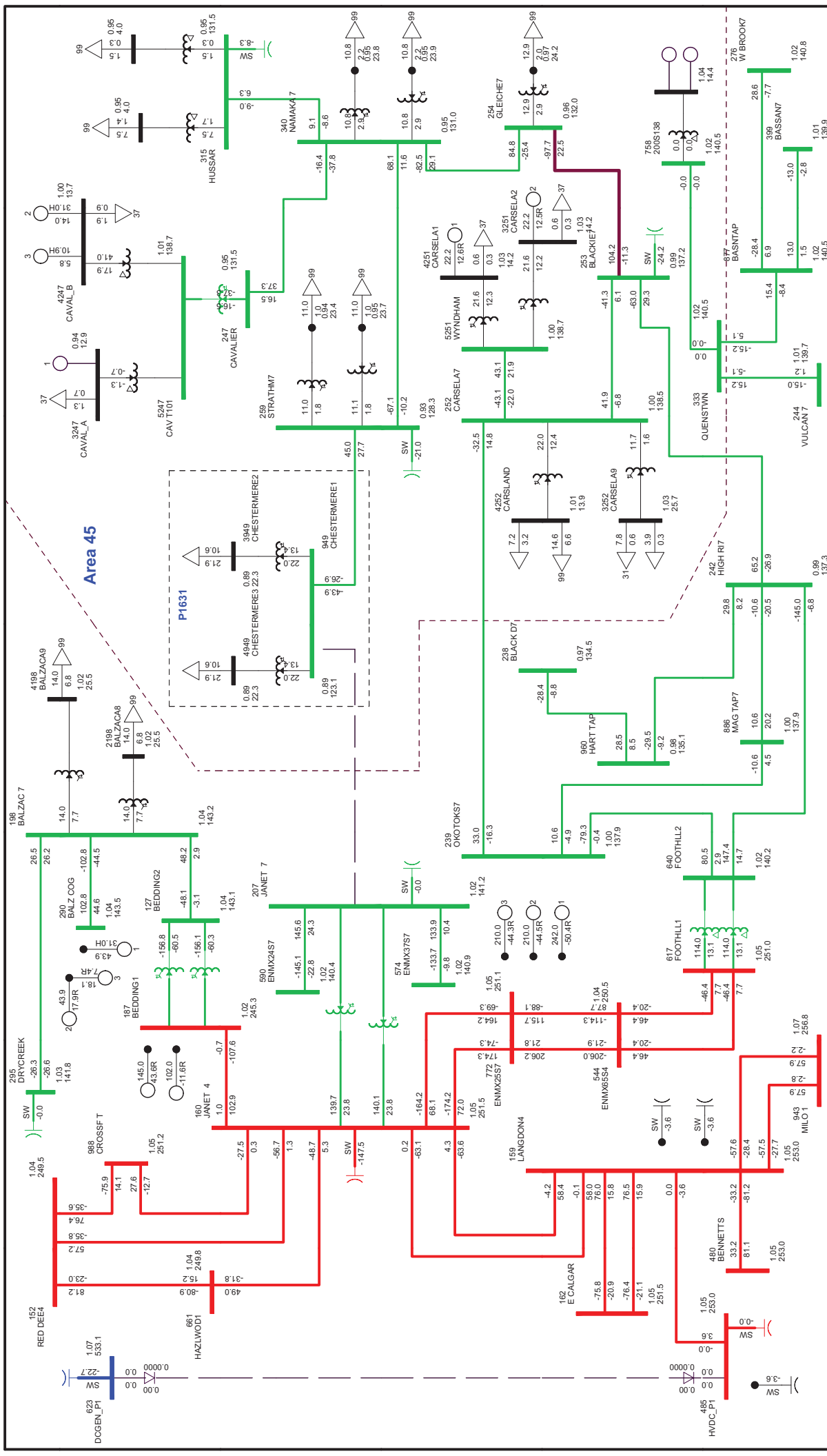


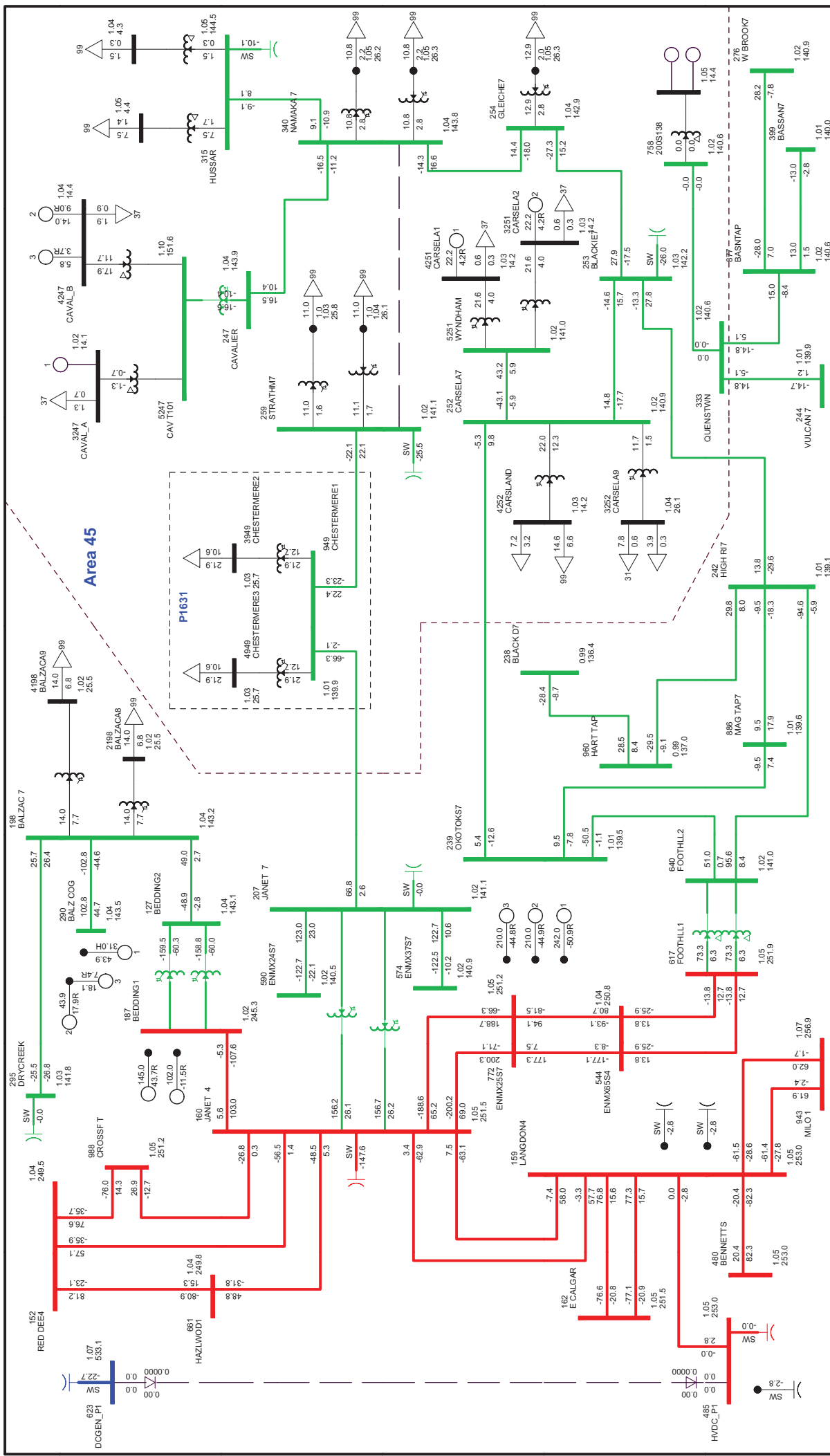
Figure B-16:
CATEGORY B, LOSS OF 691L
2017WP POST-CONNECTION
WED, MAY 18 2016 14:15

P1631 - Chestermere New POD

Sask Import:-0.1 MW MATL Import:0.0 MW

Bus - Voltage (kV/pu)
 Branch - MW/Mvar
 Equipment - MW/Mvar
 100.0%Rate B

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



CATEGORY B, LOSS OF 733L
2017WP POST-CONNECTION
WED. MAY 18 2016 14:15

Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

kV: <=25 000 <=72 000 <=144 000 <=240 000 <=500 000 >500 000

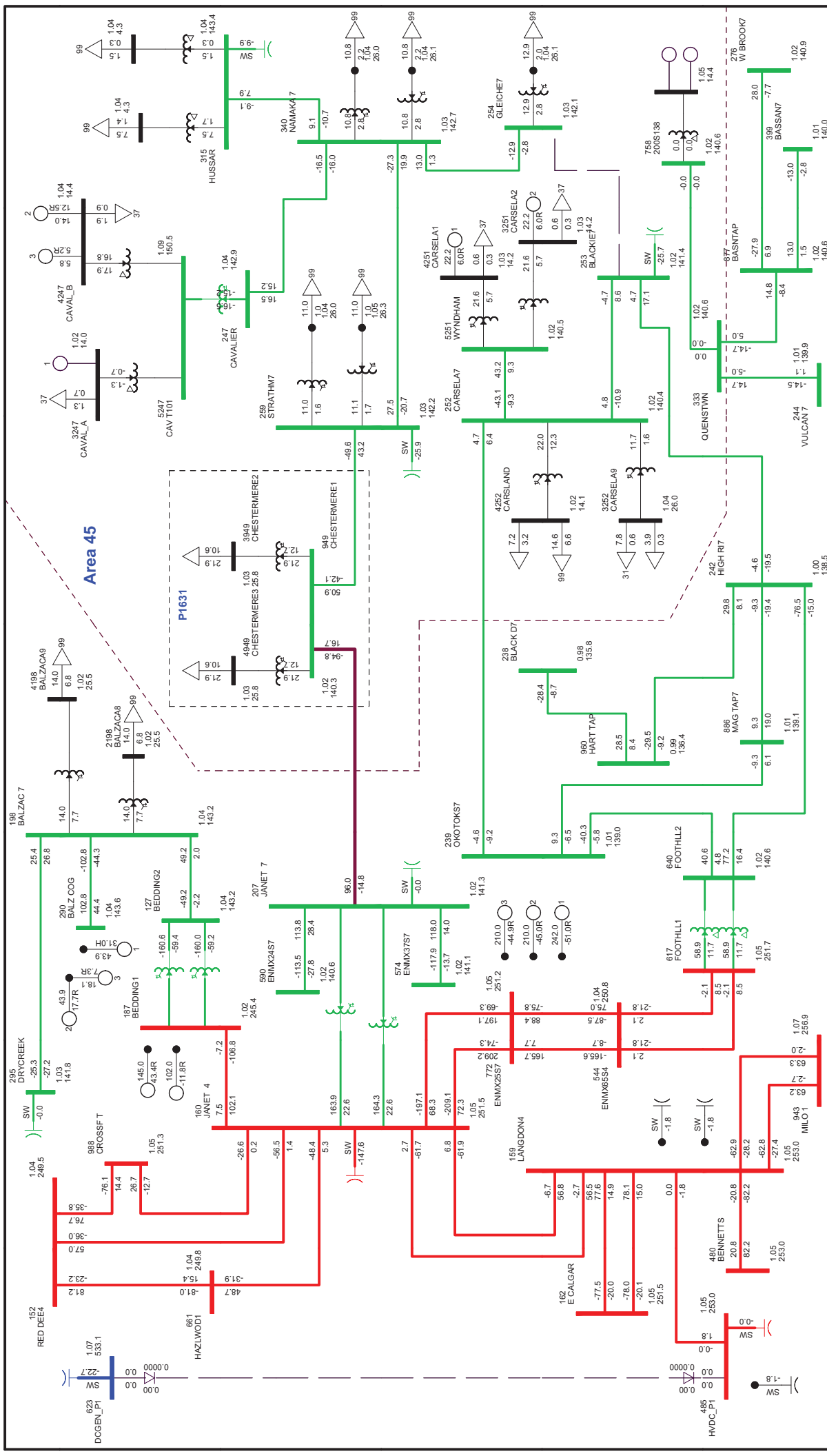


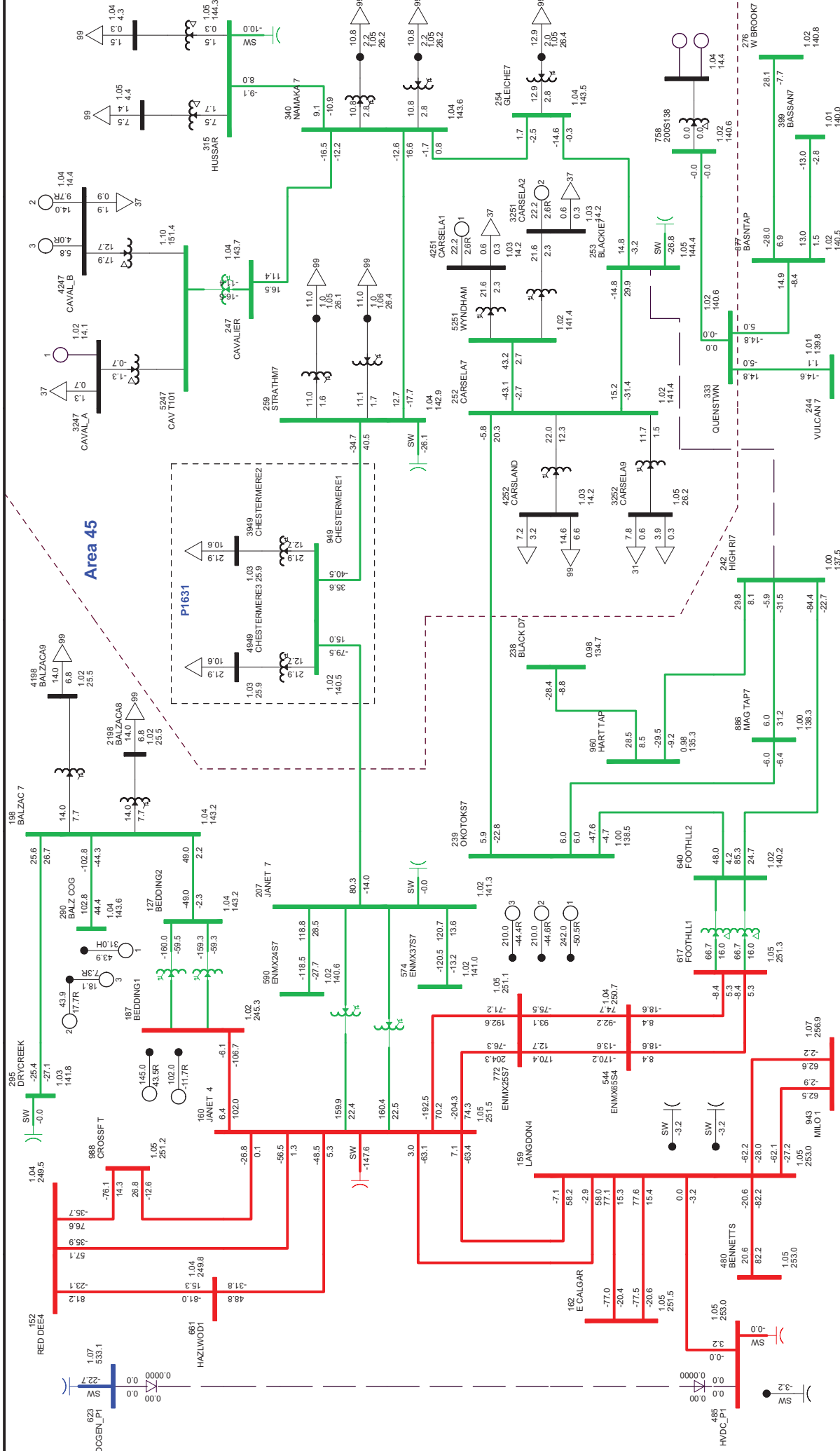
Figure B-19:
CATEGORY B, LOSS OF 876L
2017WP POST-CONNECTION
WED, MAY 18 2016 14:15

P1631 - Chestermere New POD

Sask Import:-0.1 MW MATL Import:0.0 MW

Bus - Voltage (kV/pu)
 Branch - MW/Mvar
 Equipment - MW/Mvar
 100.0% Rate B

kV: <=25 000 <=72 000 <=144 000 <=240 000 <=500 000 >500 000



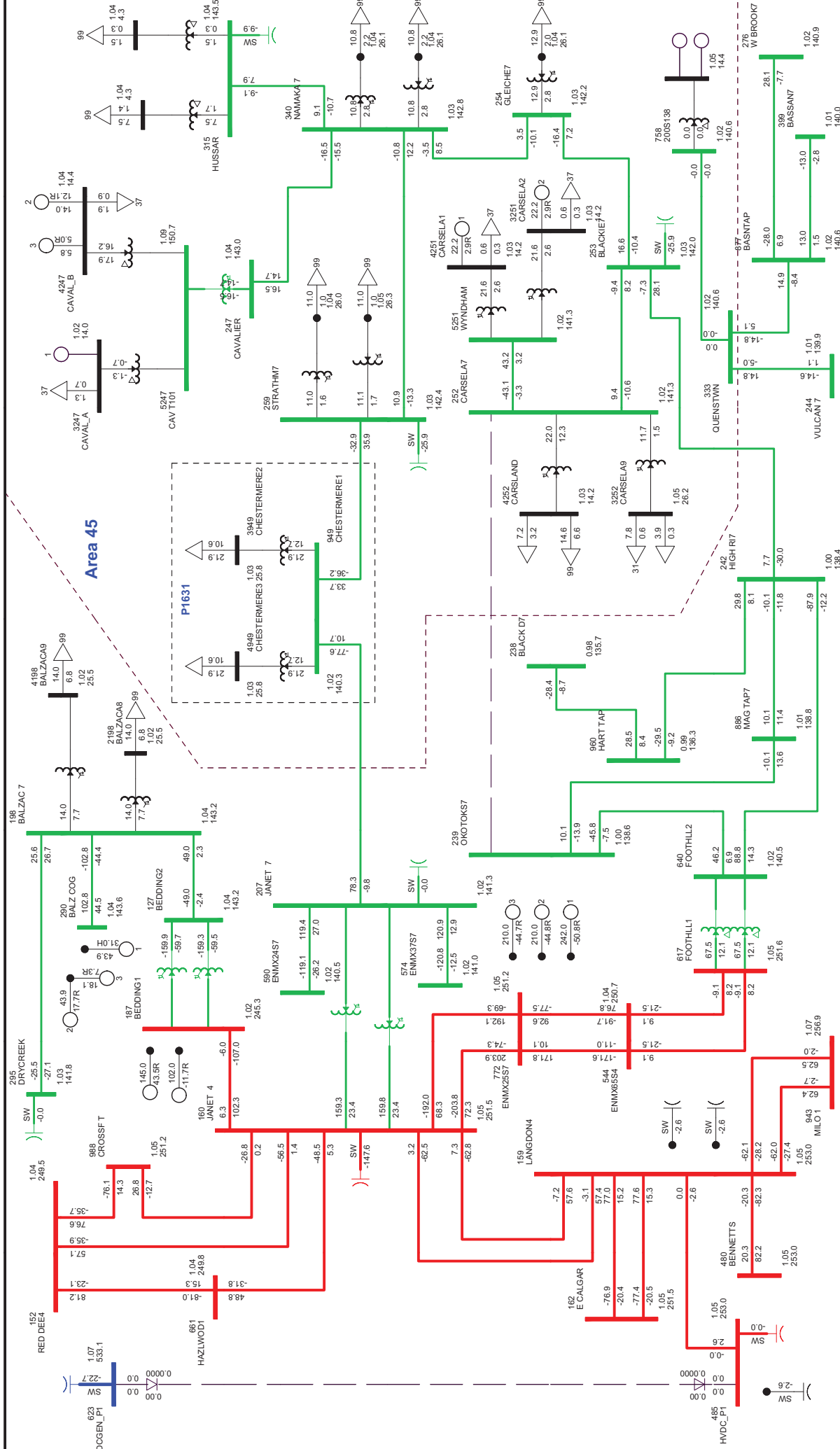


Figure B-22: P1631 - Chestermere New POD

CATEGORY B, LOSS OF 850L
2017WP POST-CONNECTION
WED, MAY 18 2016 14:15

BC Import: 0.1 MW Sask Import: -0.1 MW MATL Import: 0.0 MW

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

KV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000

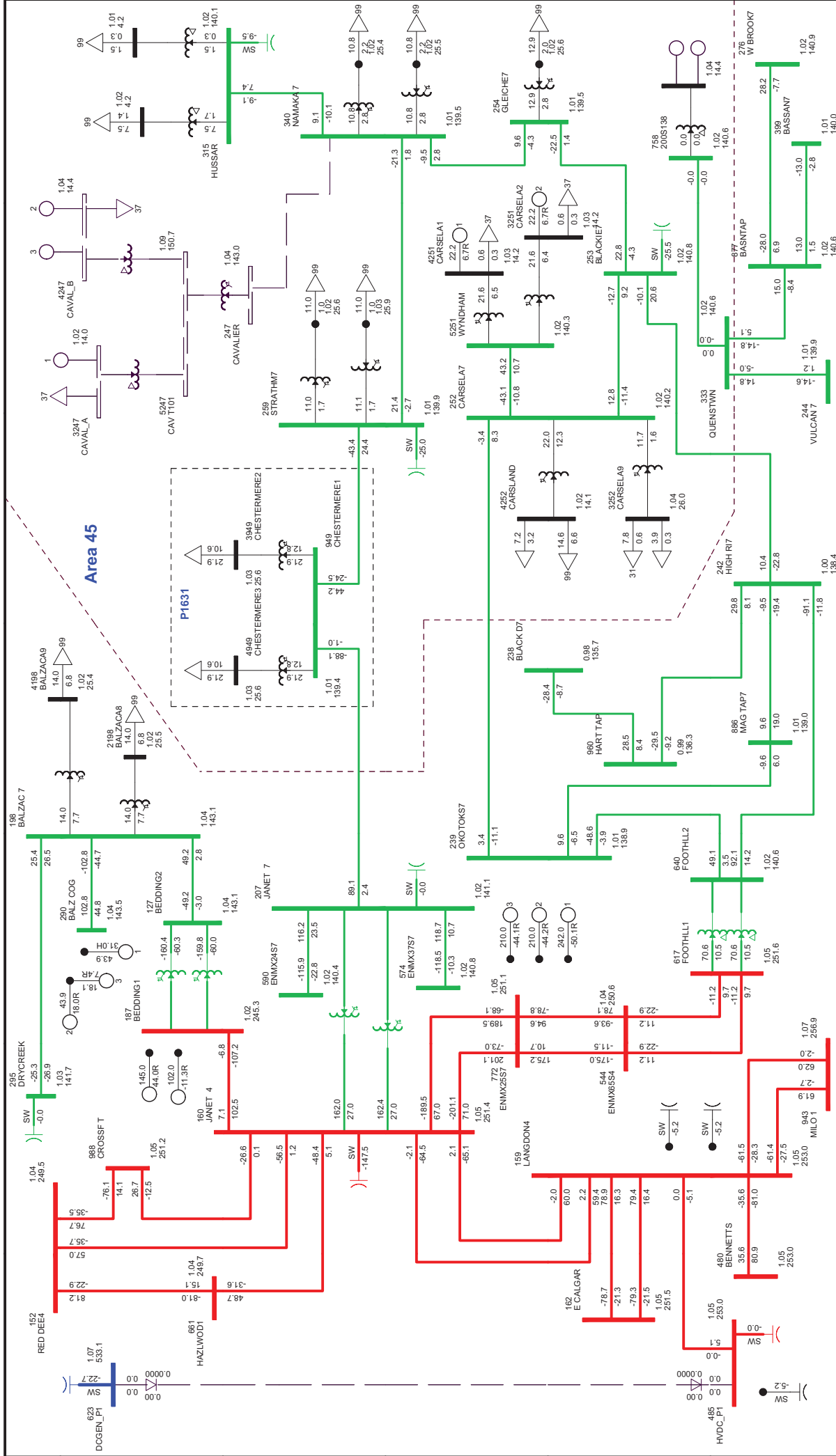


Figure B-23:
CATEGORY B, LOSS OF CAVALIER STATION
2017WP POST-CONNECTION
WED. MAY 18 2016 14:15

Bus - Voltage (kV/pu)	
Branch - MW/Mvar	
Equipment - MW/Mvar	
100.0%Rate B	

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000

P1631 - Chestermere New POD

BC Import:17.1 MW	Sask Import:-0.1 MW	MATL Import:0.0 MW
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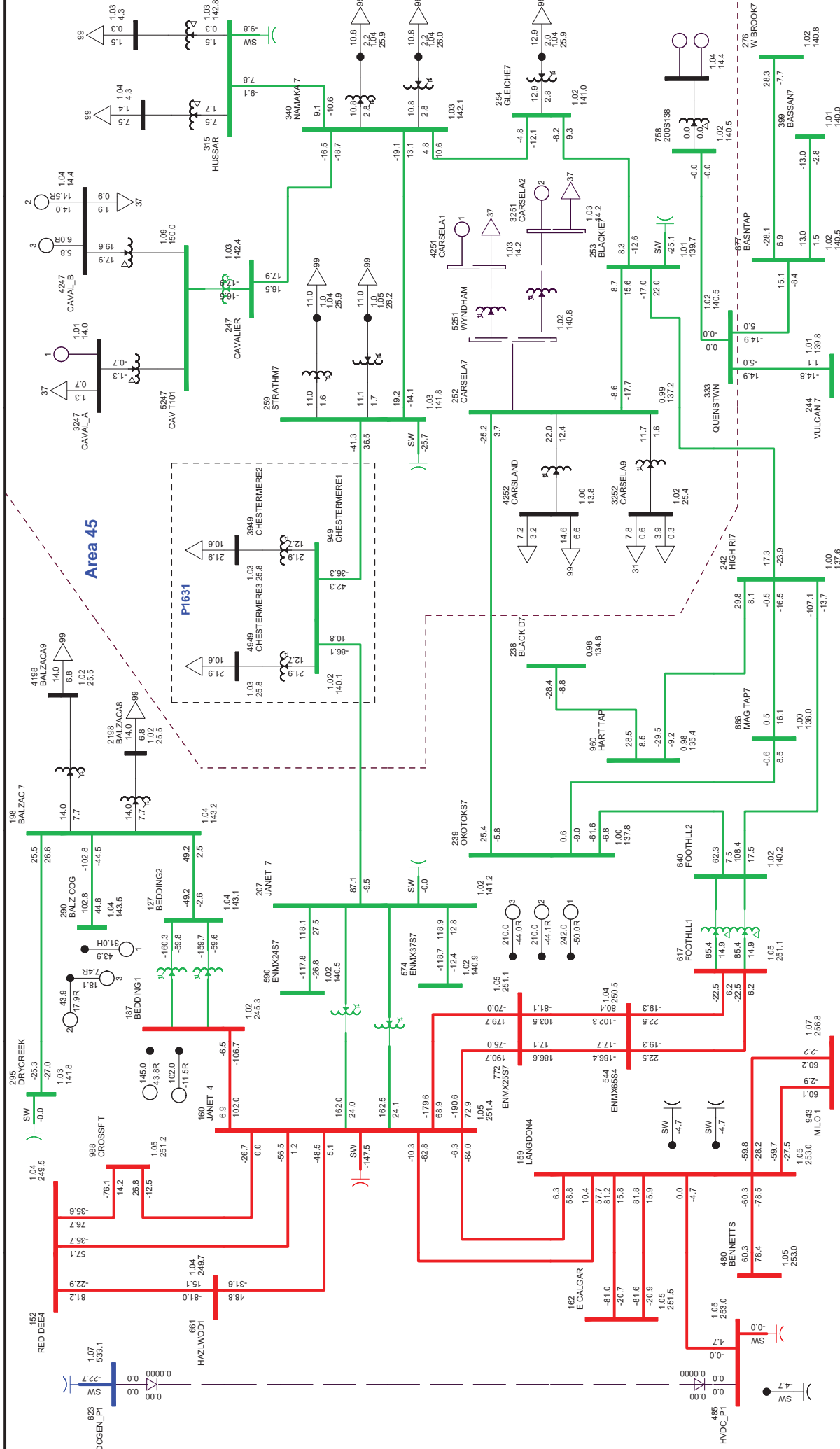
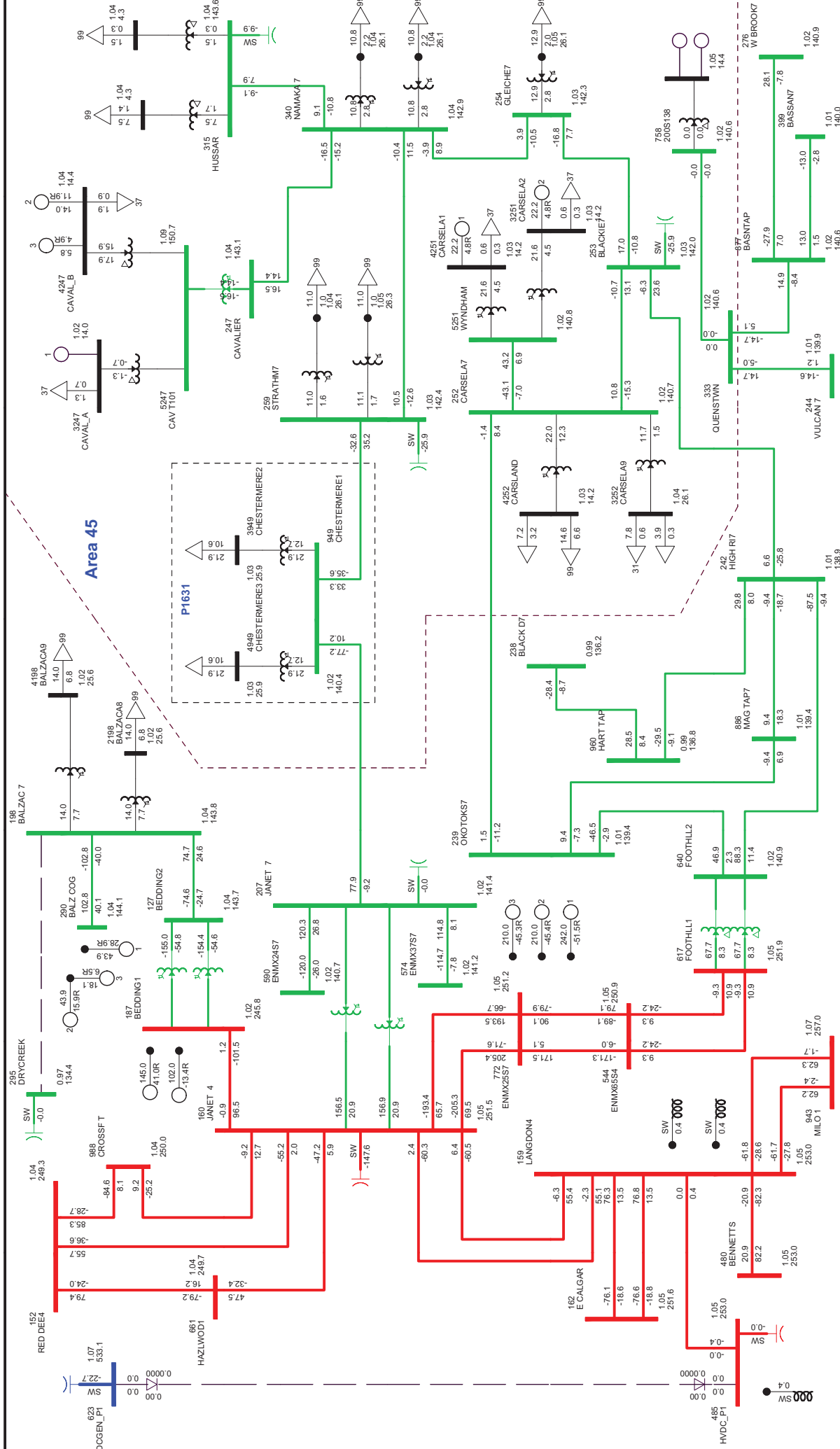


Figure B-24:
CATEGORY B, LOSS OF CARSELAND STATION
2017WP POST-CONNECTION
WED, MAY 18 2016 14:16

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

KV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000

P1631 - Chestermere New POD
BC Import:44.9 MW Sask Import:-0.1 MW MATL Import:0.0 MW



CATEGORY B, LOSS OF 611L
2017WP POST-CONNECTION
WED, MAY 18 2016 14:16

Figure B-25:

P1631 - Chestermere New POD

BC Import: 0.6 MW Sask Import: -0.1 MW MATL Import: 0.0 MW

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

KV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000

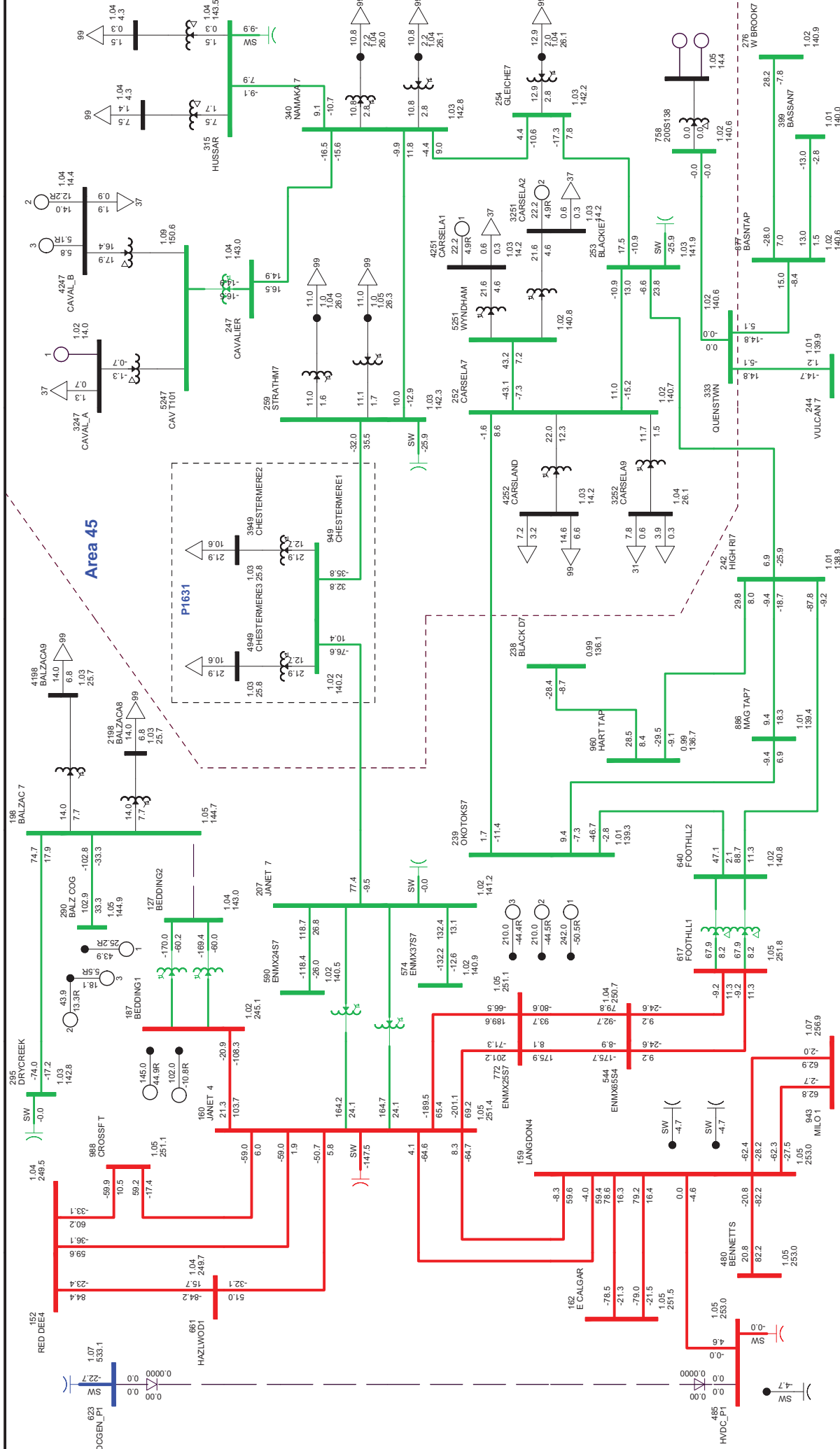


Figure B-26:

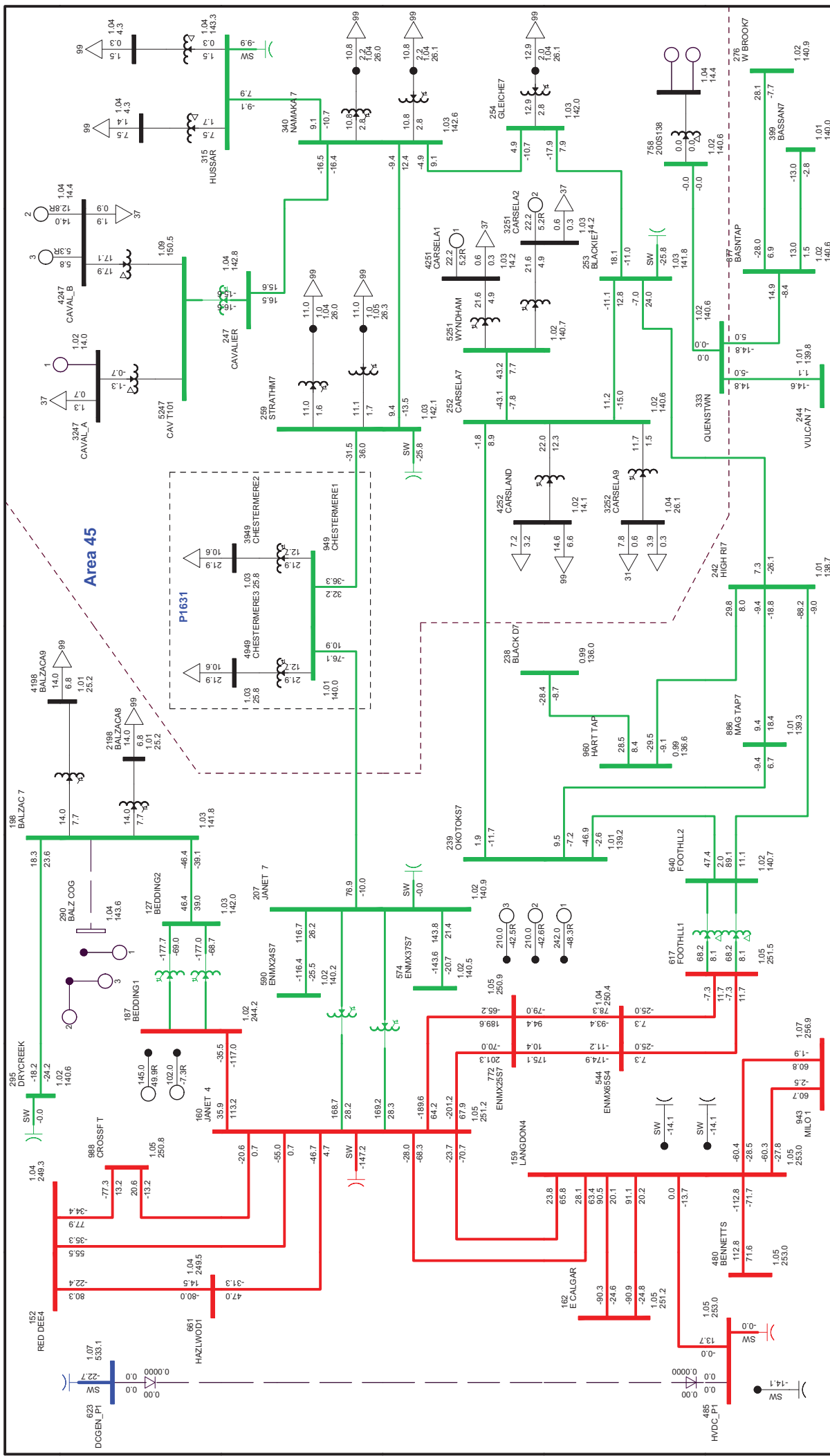
CATEGORY B, LOSS OF 162.81L
2017WP POST-CONNECTION
WED, MAY 18 2016 14:16

P1631 - Chestermere New POD

BC Import: 0.8 MW Sask Import: -0.1 MW MATL Import: 0.0 MW

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

KV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000



**CATEGORY B, LOSS OF BALZAC STATION
2017WP POST-CONNECTION**

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000

P1631 - Chestermere New POD

BC Import:103.3 MW	Sask Import:-0.1 MW	MATL Import:0.0 MW
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Attachment C

Pre-connection Voltage Stability Diagrams (Scenario 1)

PV curves for Category A conditions and for the top five worst Category B contingency conditions in 2017 SP pre-Project scenario are provided as listed in Table C-1.

Table C-1: Pre-Connection PV Curves for Scenario 1: 2017 SP–Pre-Project

Condition	From	To	Maximum incremental transfer (MW)	Meets 105% transfer criteria?	Figure
Category A	System Normal		135	Yes	Figure C-1
Category B Contingency					
765L	Strathmore 151S	Janet 74S	52.5	Yes	Figure C-2
733L	Strathmore 151S	Namaka 428S	72.5	Yes	Figure C-3
PCES01L	Namaka 428S	Cavalier Power Station	112.5	Yes	Figure C-4
876L	Blackie 253S	Gleichen 179S	121.3	Yes	Figure C-5
782L	Wyndham 269S	Carseland 525S	126.3	Yes	Figure C-6

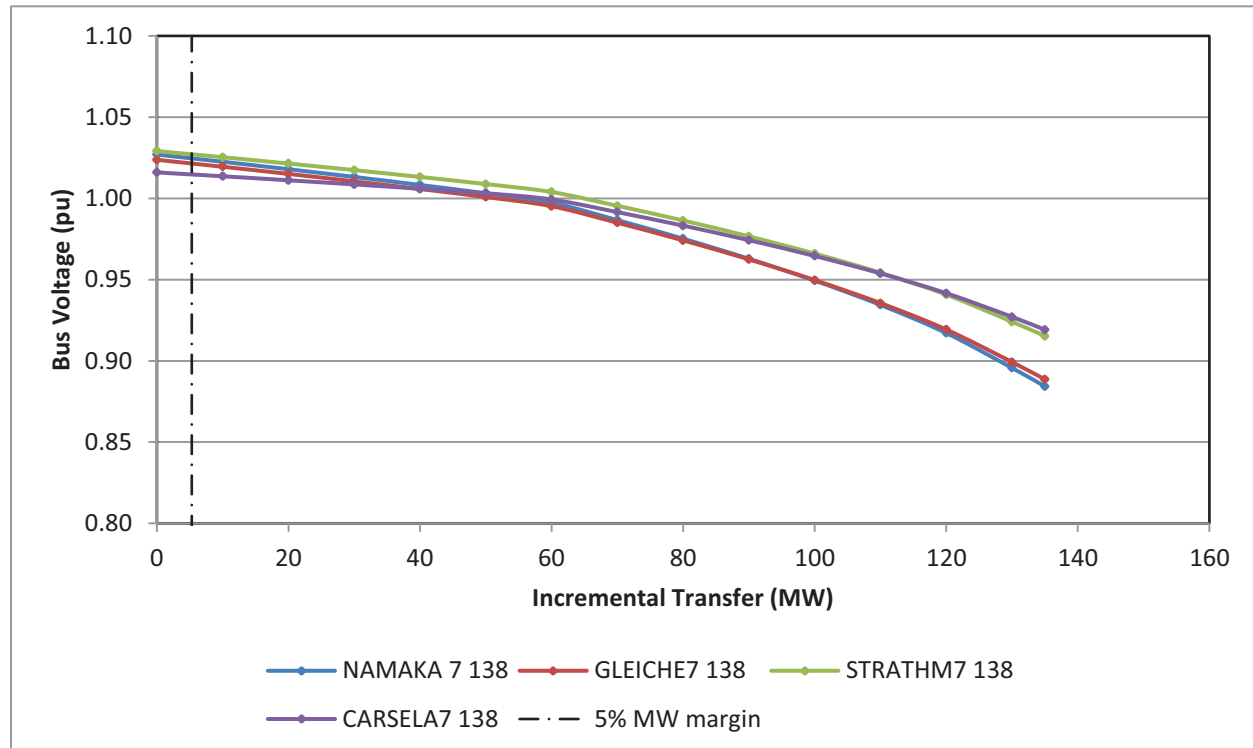


Figure C-1: PV Curves for Category A Conditions – Scenario 1: 2017 SP

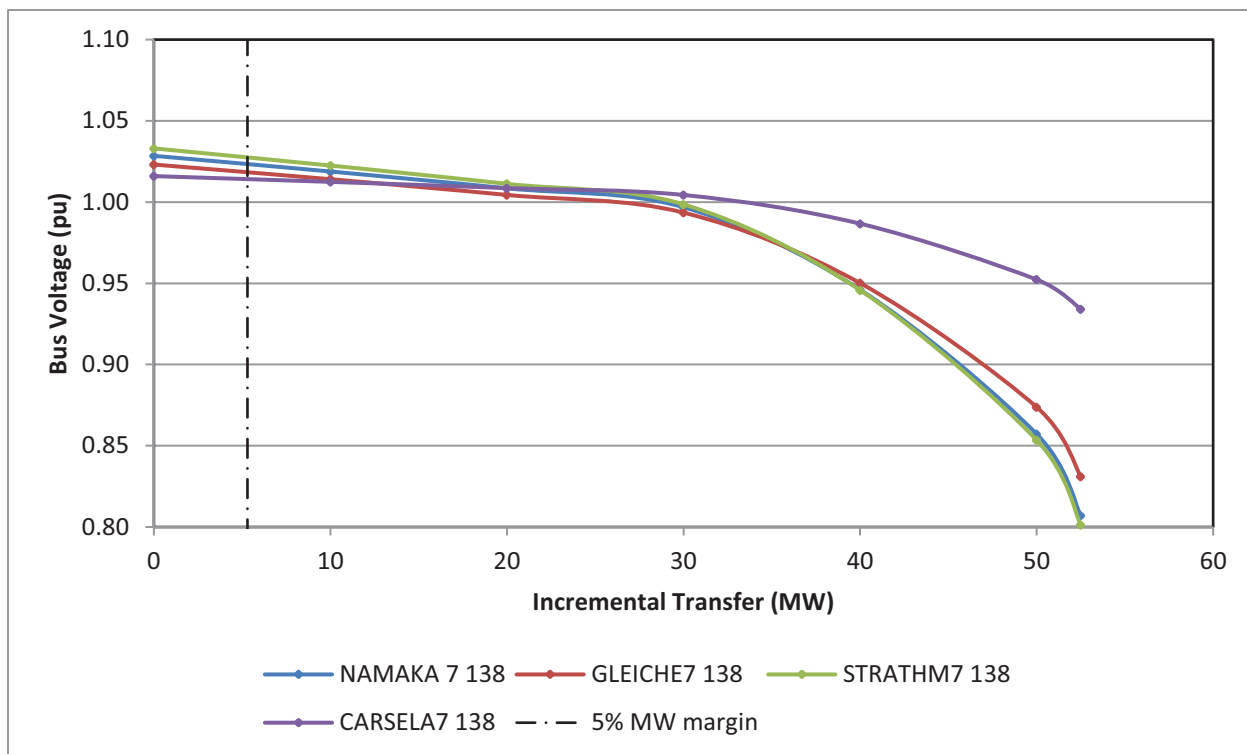


Figure C-2: PV Curves for Contingency of 765L (Strathmore 151S - Janet 74S)

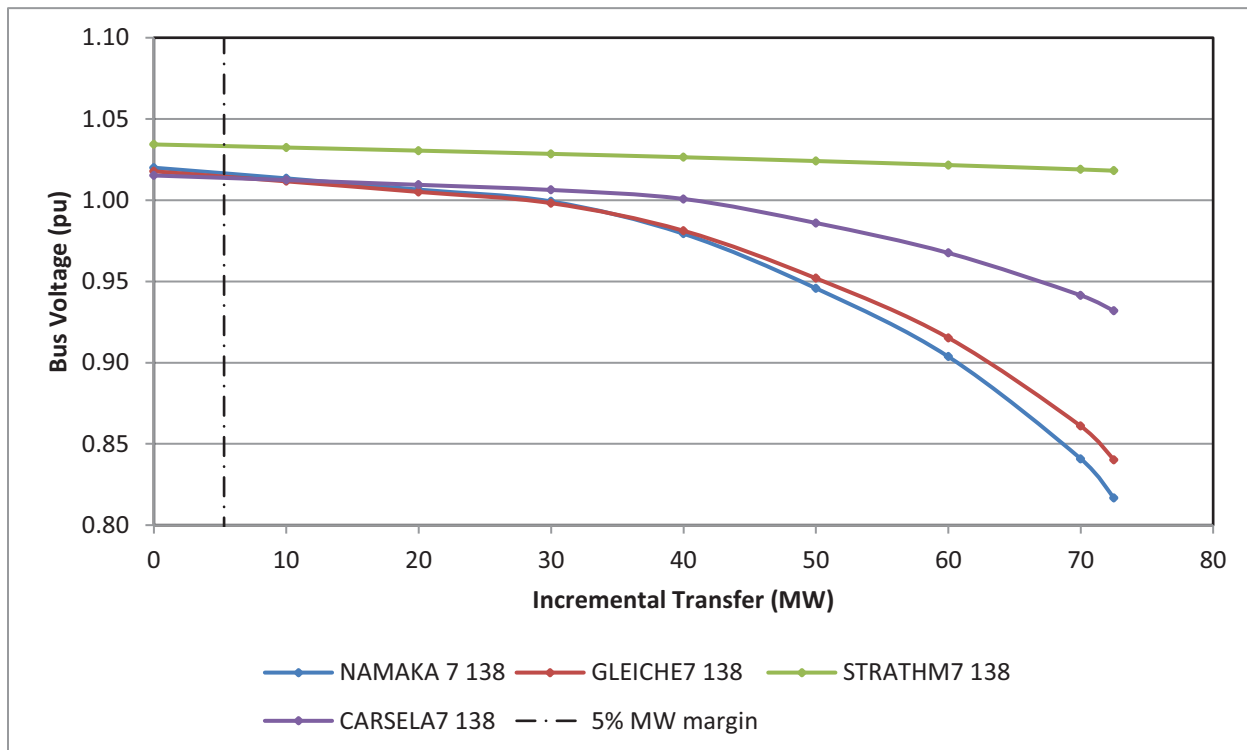


Figure C-3: PV Curves for Contingency of 733L (Strathmore 151S - Namaka 428S)

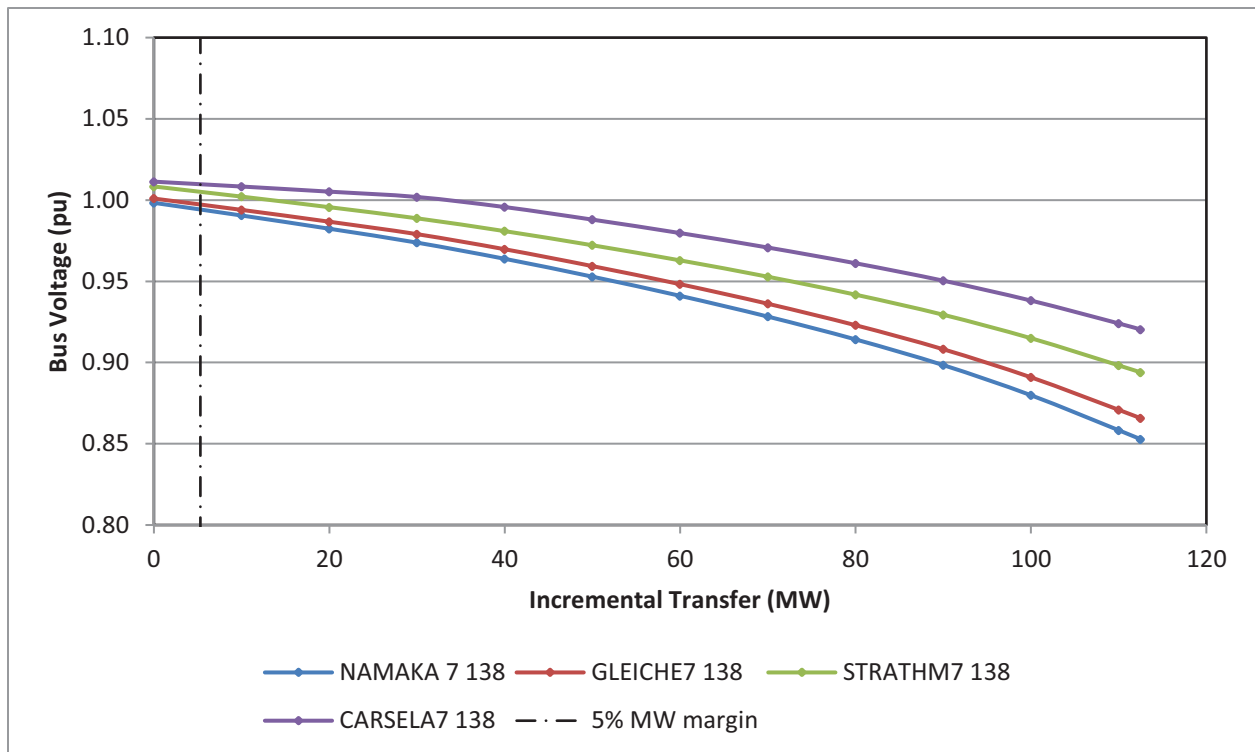


Figure C-4: PV Curves for Contingency of PCES01L (Namaka 428S -Cavalier Power Station)

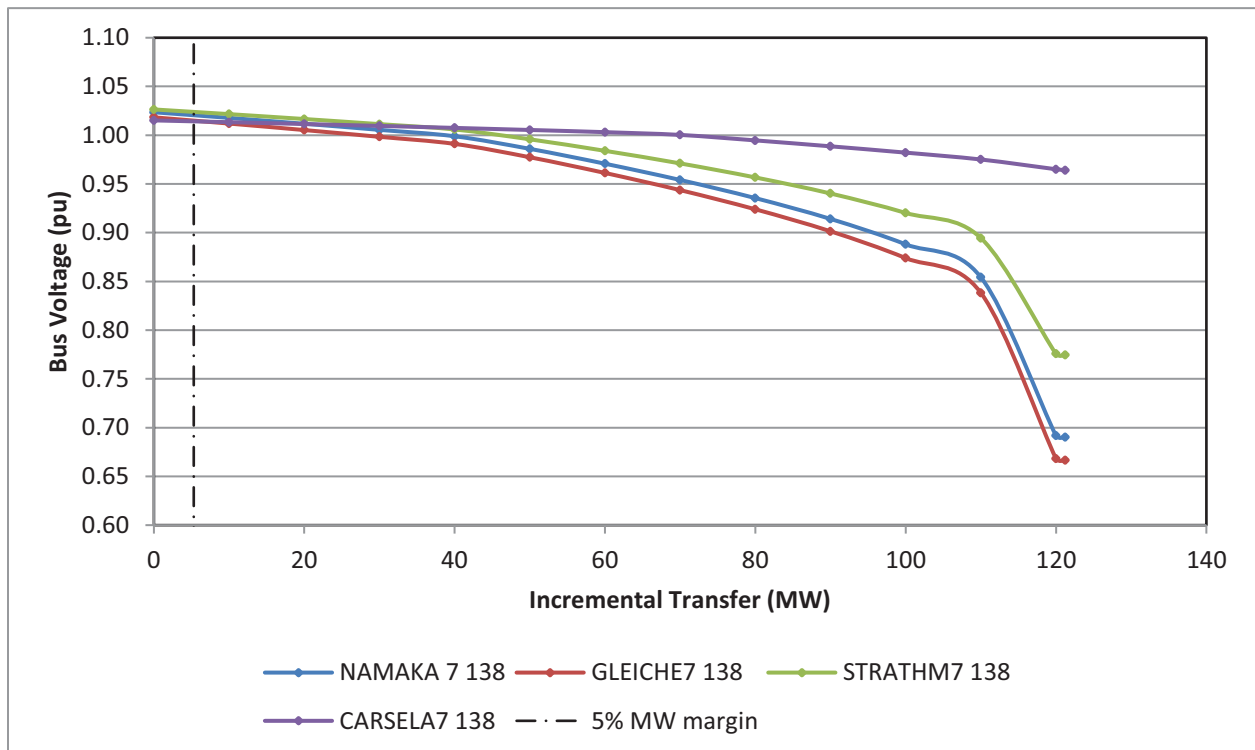


Figure C-5: PV Curves for Contingency of 876L (Blackie 253S - Gleichen 179S)

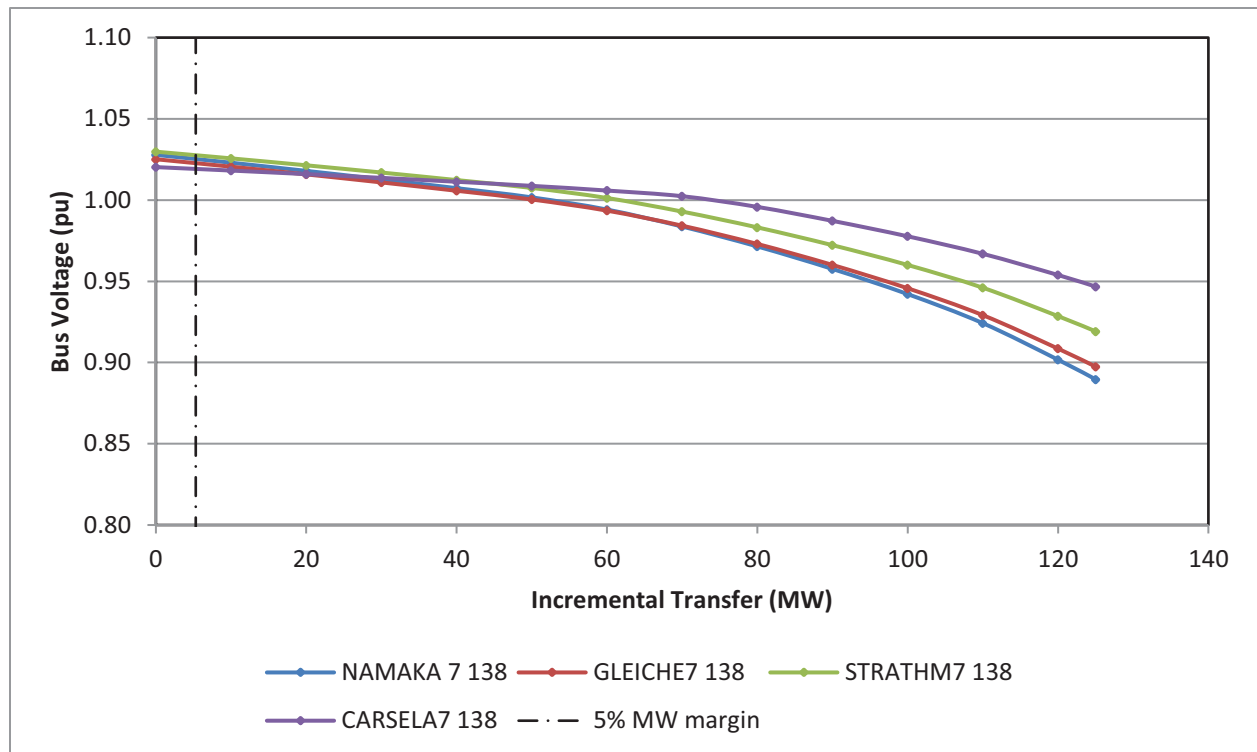


Figure C-6: PV Curves for Contingency of 782L (Wyndham 269S – Carseland 525S)

Attachment D

Alternative 3: Voltage Stability Diagrams (Scenario 3)

PV curves for Category A conditions and for the top five worst Category B contingency conditions in 2017 SP post-Project scenarios are provided as listed in Table D-1.

Table D-1: List of post-connection PV curves for Scenario 3: 2017 SP – Alternative 3

Category	From	To	Maximum incremental transfer (MW)	Meets 105% transfer criteria?	Figure
Category A	System Normal		175	Yes	Figure D-1
Category B Contingency					
691L	Chestermere 419S	Janet 74S	0.0	No	N/A
765L	Chestermere 419S	Strathmore 151S	75.0	Yes	Figure D-2
733L	Strathmore 151S	Namaka 428S	103.8	Yes	Figure D-3
876L	Blackie 253S	Gleichen 179S	135.0	Yes	Figure D-4
PCES01L	Namaka 428S	Cavalier Power Station	146.0	Yes	Figure D-5

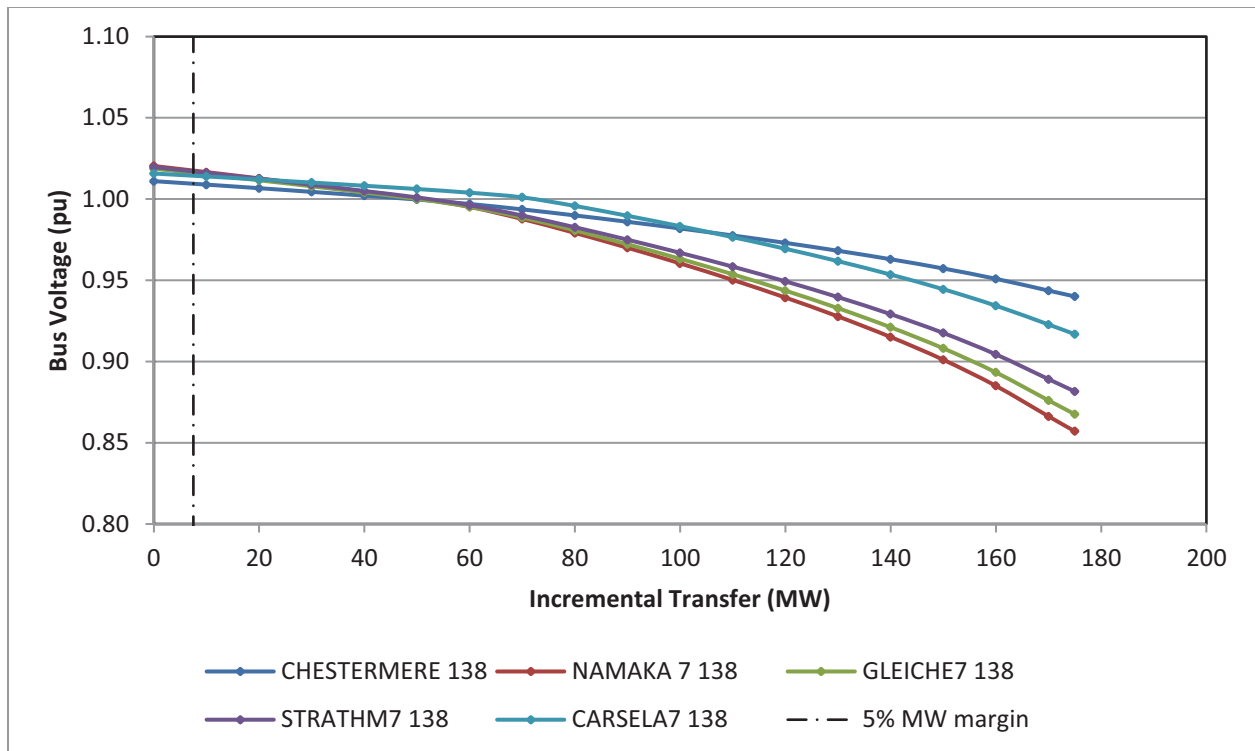


Figure D-1: PV Curves for Category A Conditions - Scenario 3: 2017 SP

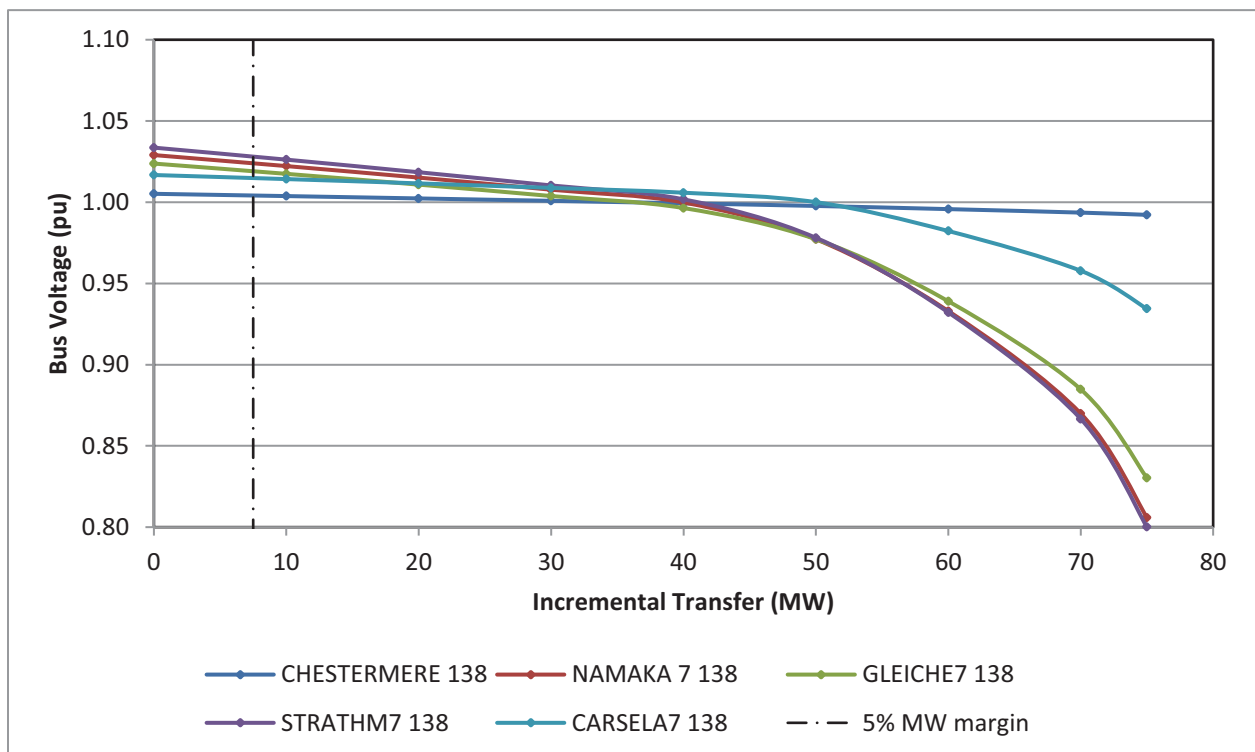


Figure D-2: PV Curves for Contingency of 765L (Strathmore 151S - Chestermere 419S)

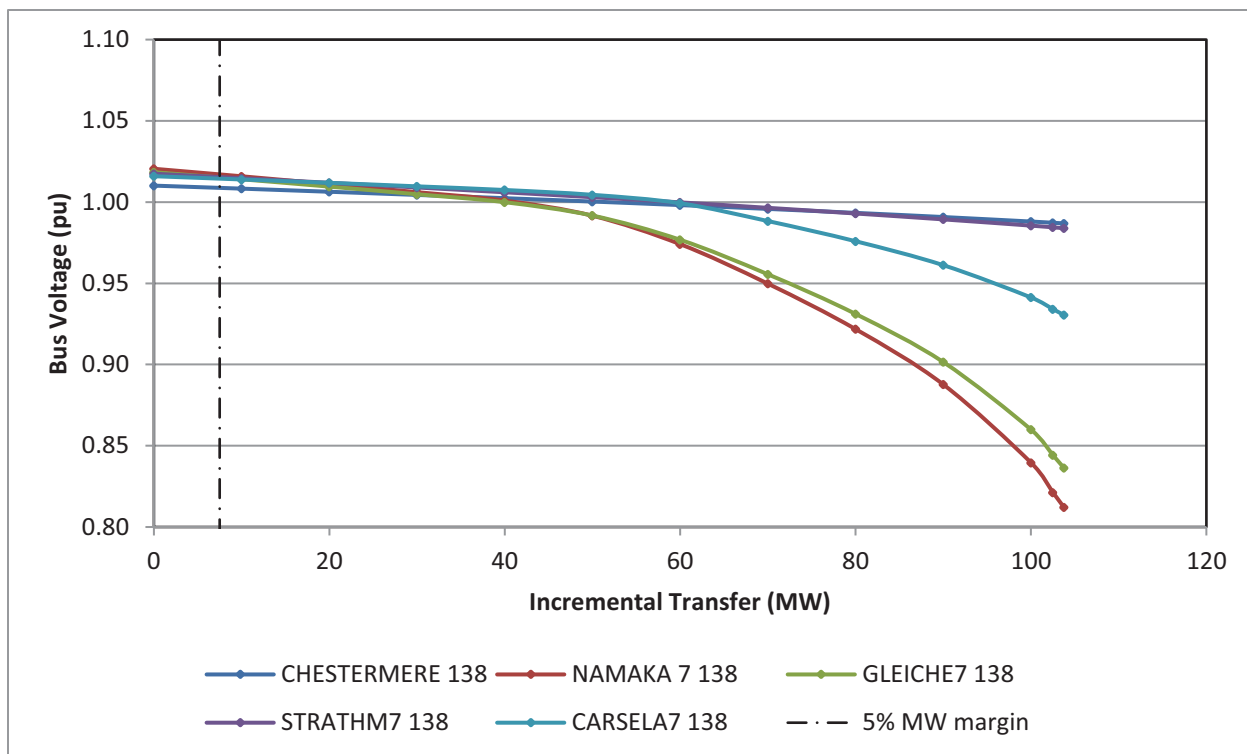


Figure D-3: PV Curves for Contingency of 733L (Strathmore 151S - Namaka 428S)

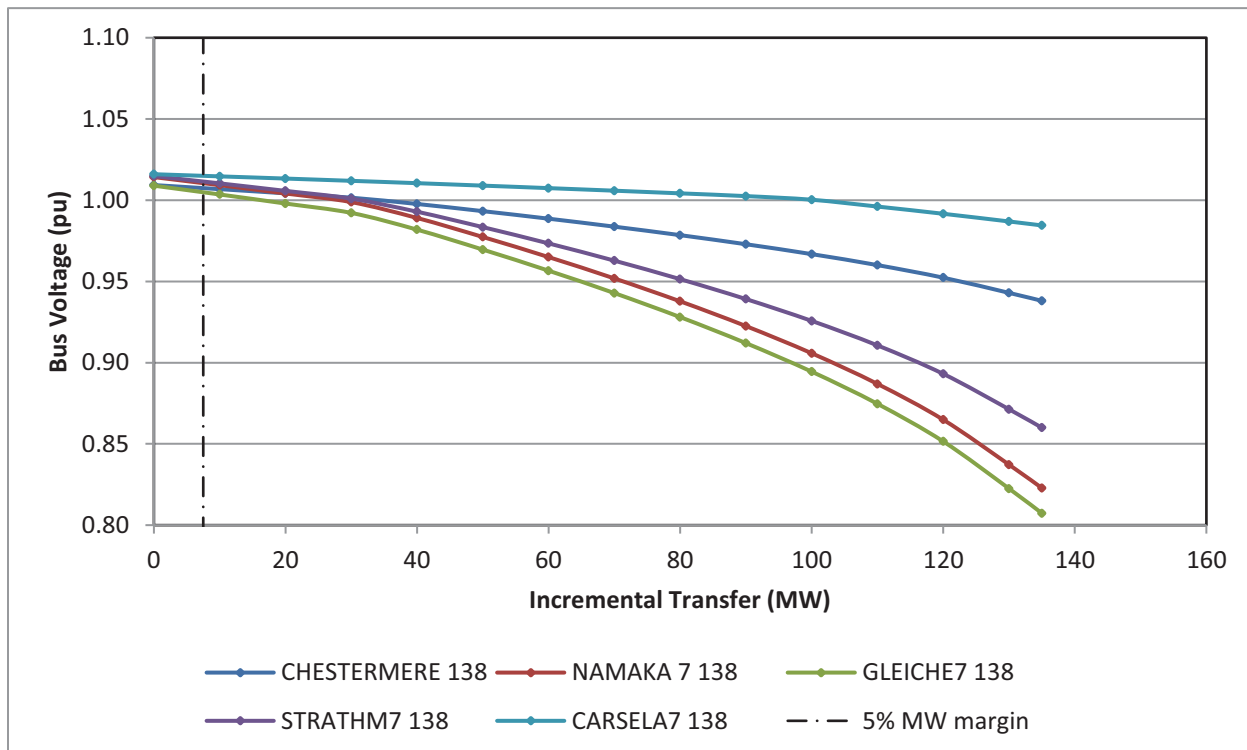


Figure D-4: PV Curves for Contingency of 876L (Blackie 253S - Gleichen 179S)

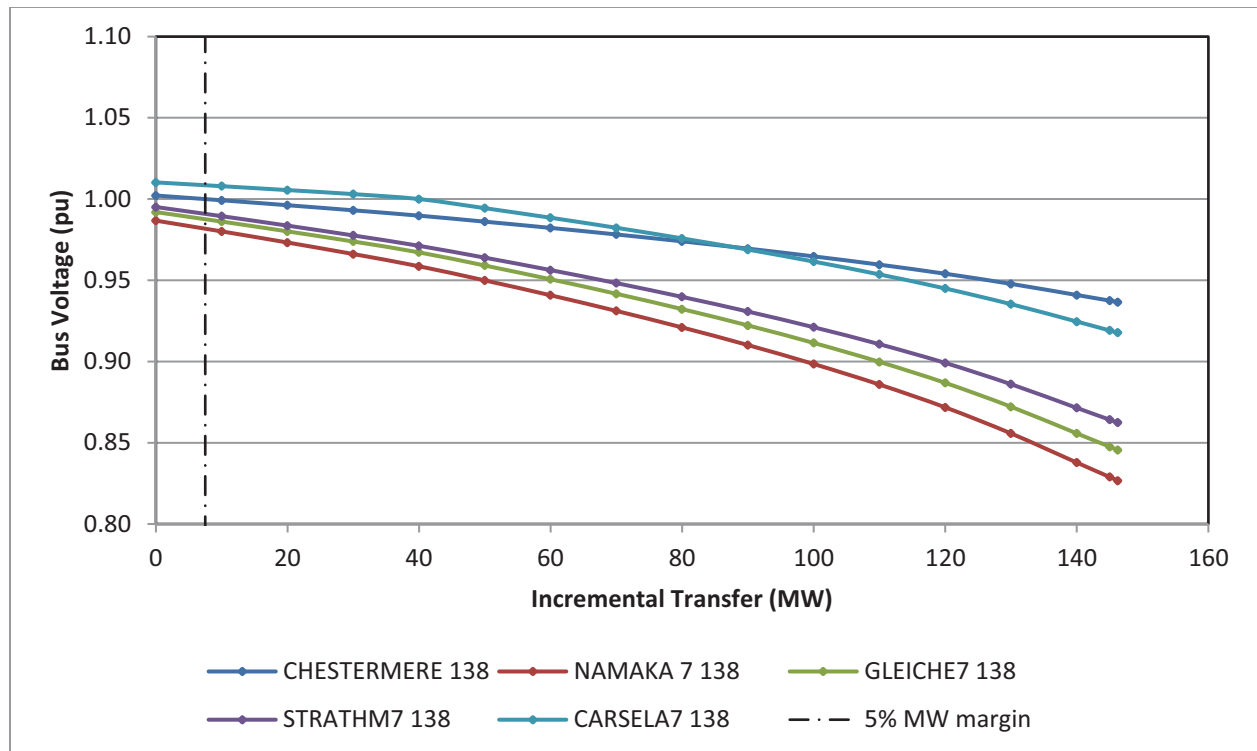


Figure D-5: PV Curves for Contingency of PCES01L (Namaka 428S -Cavalier Power Station)

Attachment E

Alternative 3: Post-RAS Operation Power Flow and Voltage Stability Diagrams (Scenarios 3 & 4)

Steady-state power flow diagrams for the Category B contingencies that activated the proposed RAS are provided in this section as listed in Table E-1. Table E-2 shows the voltage stability conditions after the RAS operation for 691L contingency.

Table E-1: Post-RAS Operation Power Flow Diagrams

Category	Contingency	Figure	
		2017 SP Post-Project	2017 WP Post-Project
B	691L (Chestermere 419S - Janet 74S)	Figure E-1	Figure E-3
B	876L (Blackie 253S - Gleichen 179S)	Figure E-2	N/A (RAS does not operate)

Table E-2: PV Curves for Post-RAS Operation in Scenario 3: 2017SP Post-Project

Contingency	From	To	Maximum incremental transfer (MW)	Meets 105% transfer criteria?	Figure
691L	Chestermere 419S	Janet 74S	53.5	Yes	Figure E-4

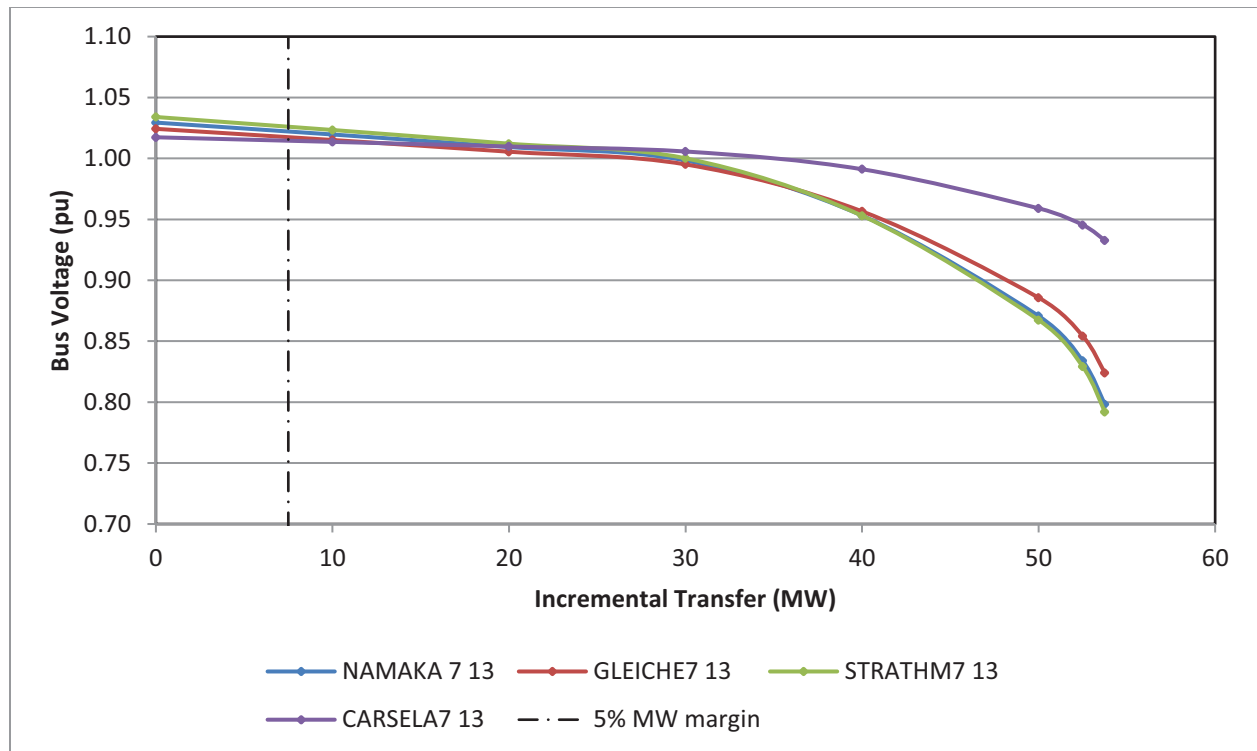


**Figure E-4: Post-RAS Operation PV Curves for Contingency of 691L
(Chestermere 419S - Janet 74S)**

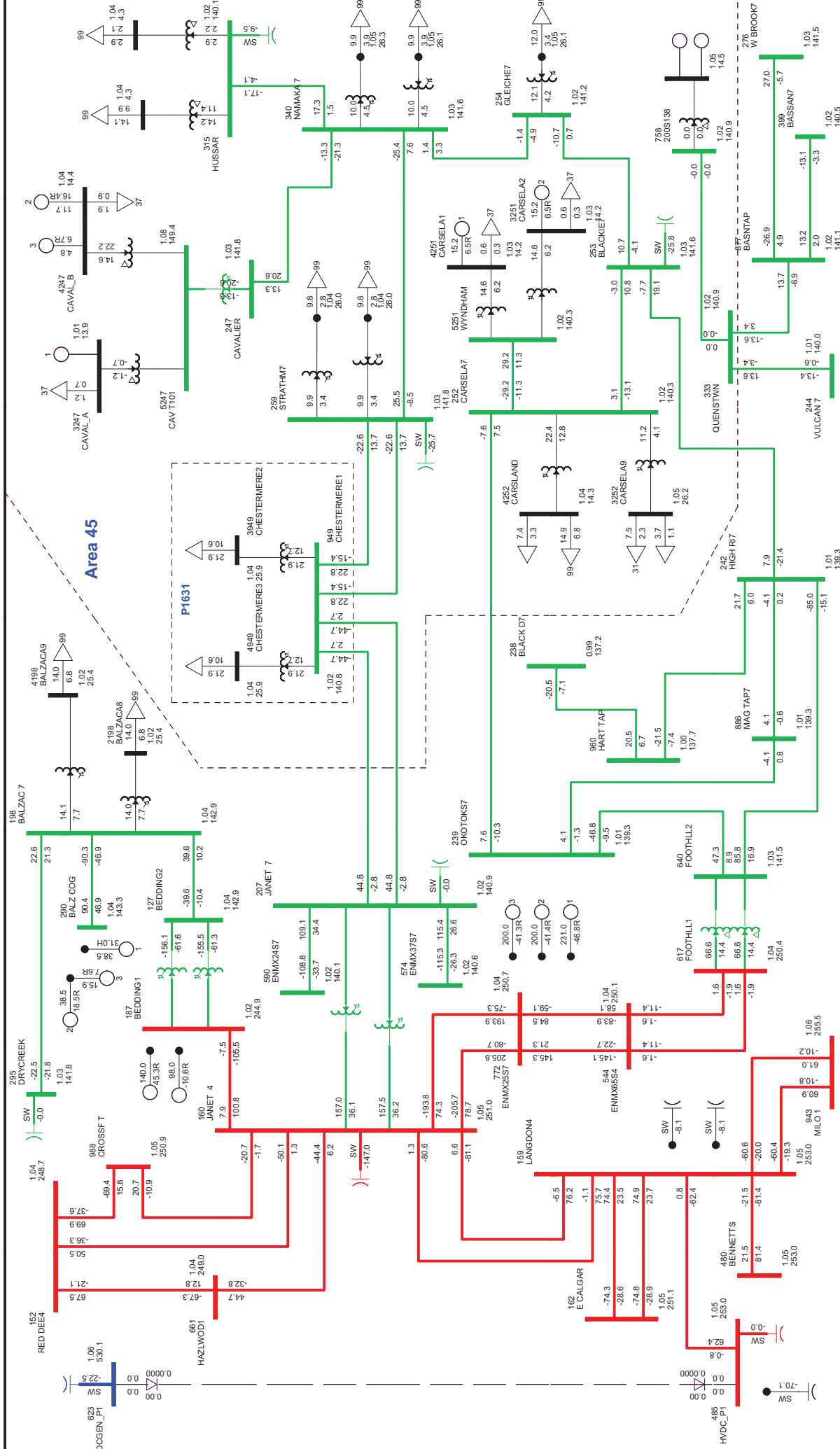
Attachment F

Post-2015 LTP System Developments Power Flow Diagrams

Steady-state power flow diagrams for Category A and selected Category B contingencies for post-LTP scenarios are provided in this section, as listed in Table F-1.

Table F-1: Post-LTP Power Flow Diagrams

Category	Contingency	Figure	
		2017 SP Post-Project	2017 WP Post-Project
A	Normal operation	Figure F-1	Figure F-15
B	765L (Strathmore 151S - Chestermere 419S)	Figure F-2	Figure F-16
B	691L (Chestermere 419S - Janet 74S)	Figure F-3	Figure F-17
B	733L (Strathmore 151S - Namaka 428S)	Figure F-4	Figure F-18
B	733L (Gleichen 179S - Namaka 428S)	Figure F-5	Figure F-19
B	876L (Blackie 253S - Gleichen 179S)	Figure F-6	Figure F-20
B	851L (Blackie 253S - Carseland 525S)	Figure F-7	Figure F-21
B	753L (Blackie 253S - High River 65S)	Figure F-8	Figure F-22
B	850L (Okotoks 678S - Carseland 525S)	Figure F-9	Figure F-23
B	PCES01L (Namaka 428S -Cavalier Power Station)	Figure F-10	Figure F-24
B	782L (Wyndham 269S – Carseland 525S)	Figure F-11	Figure F-25
B	611L (Turbo Balzac 391S - Dry Creek 186S)	Figure F-12	Figure F-26
B	162.81L (Turbo Balzac 391S - Beddington SS-162)	Figure F-13	Figure F-27
B	PCES02L (Turbo Balzac 391S – Balzac Power Station)	Figure F-14	Figure F-28



CATEGORY A, N-0
2017SP POST-CONNECTION POST-LTP
THU. MAY 19 2016 15:01

Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: <=25 000 <=72 000 <=144 000 <=240 000 <=500 000 >500 000

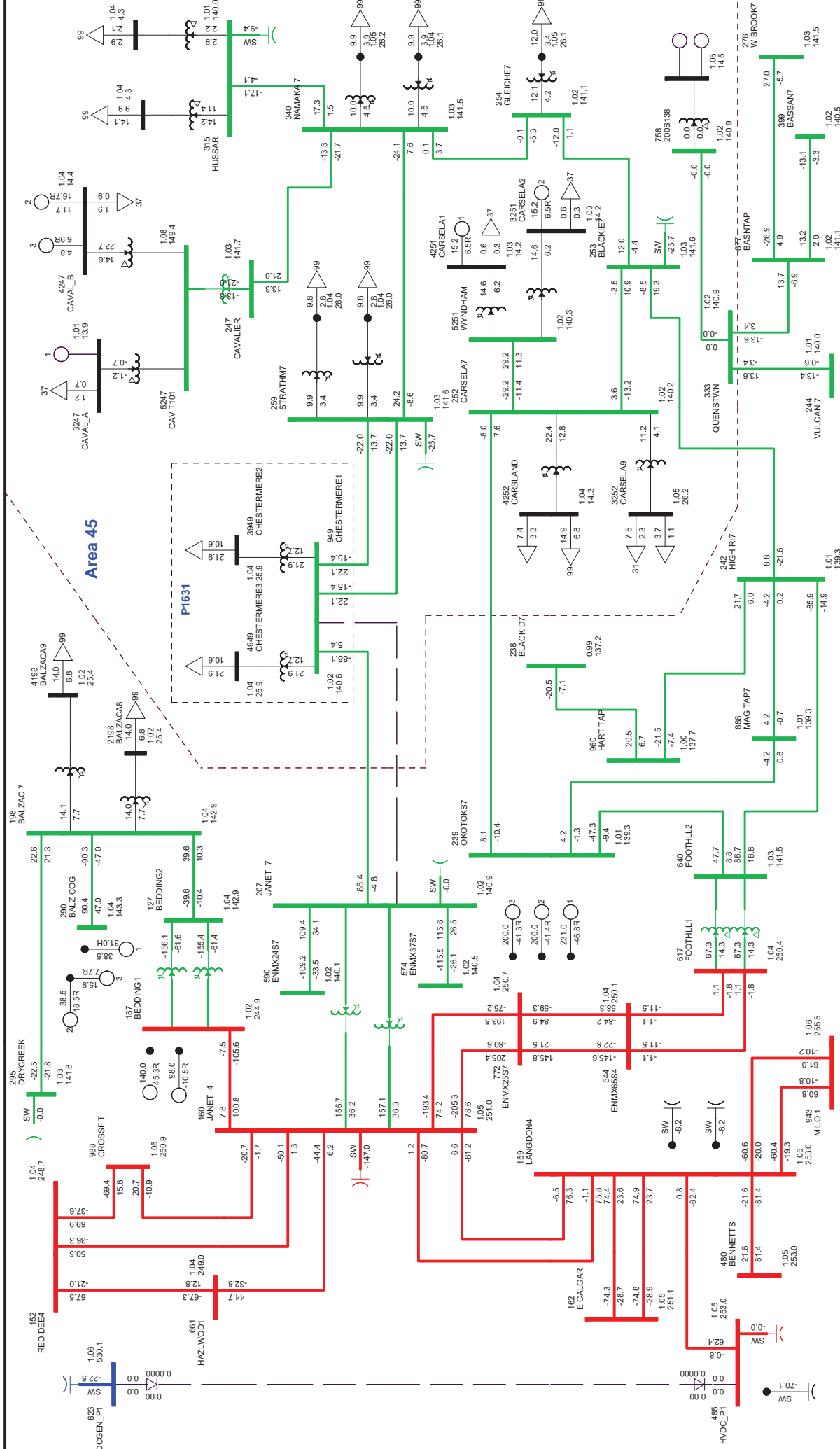


Figure F-3:

Category B, Loss of 691L

2017SP Post-Connection Post-LTP

THU, MAY 19 2016 15:01

P1631 - Chestermere New POD

BC Import: -1.4 MW Sask Import: -0.1 MW MATL Import: 0.0 MW

Bus - Voltage (kV/pu)

Branch - MW/Mvar

Equipment - MW/Mvar

100.0%Rate A

KV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000

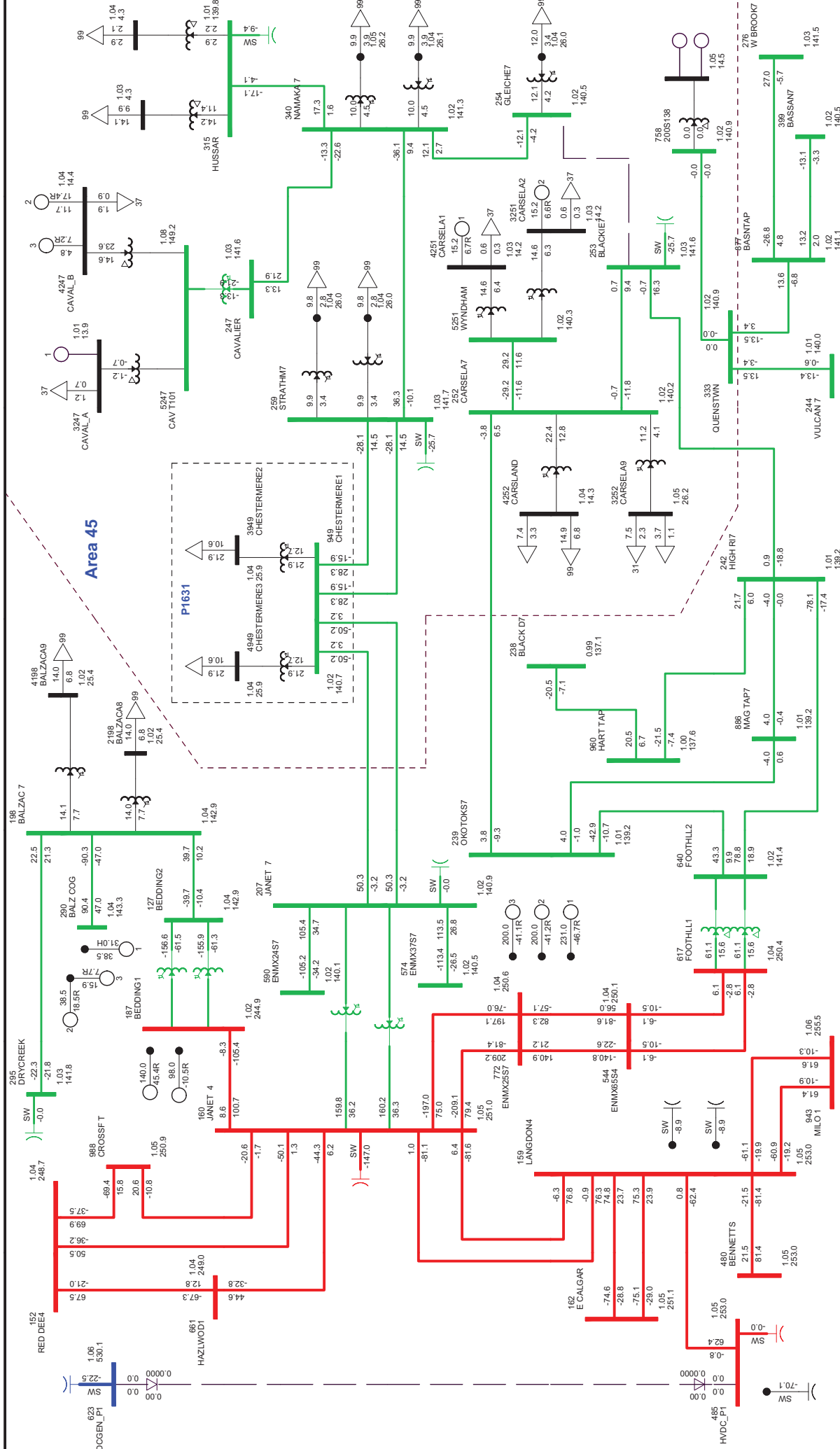


Figure F-6:

P1631 - Chestermere New POD

BC Import:-1.6 MW Sask Import:-0.1 MW MATL Import:0.0 MW

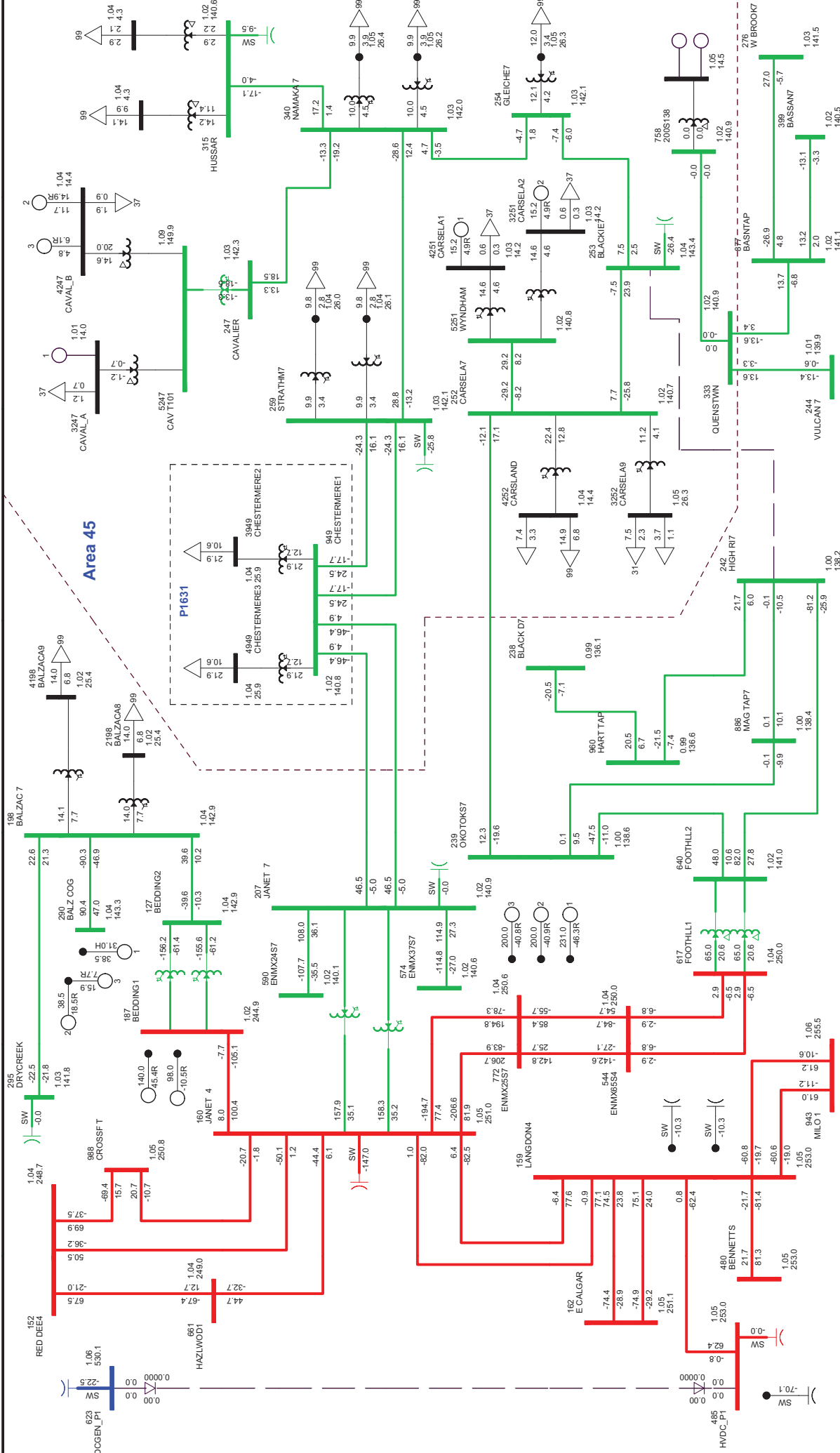
CATEGORY B, LOSS OF 876L

2017SP POST-CONNECTION POST-LTP

THU, MAY 19 2016 15:01

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

KV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000



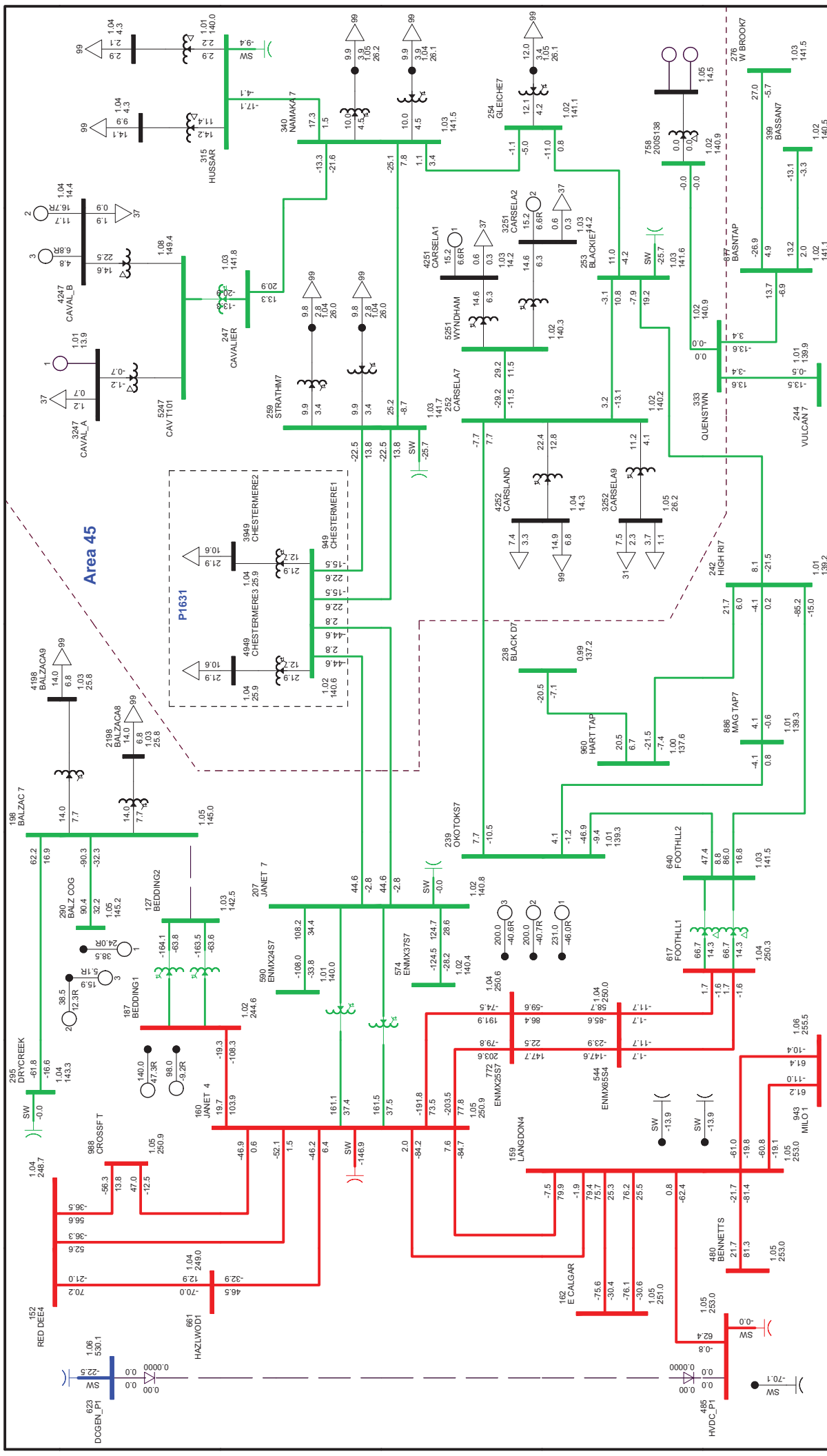
CATEGORY B, LOSS OF 753L
2017SP POST-CONNECTION POST-LTP
THU, MAY 19 2016 15:02

Figure F-8:

P1631 - Chestermere New POD
BC Import: -1.4 MW Sask Import: -0.1 MW MATL Import: 0.0 MW

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: <=25,000 <=72,000 <=144,000 <=500,000 >500,000



CATEGORY B, LOSS OF 162.81L
2017SP POST-CONNECTION POST-LTP
THU, MAY 19 2016 15:02

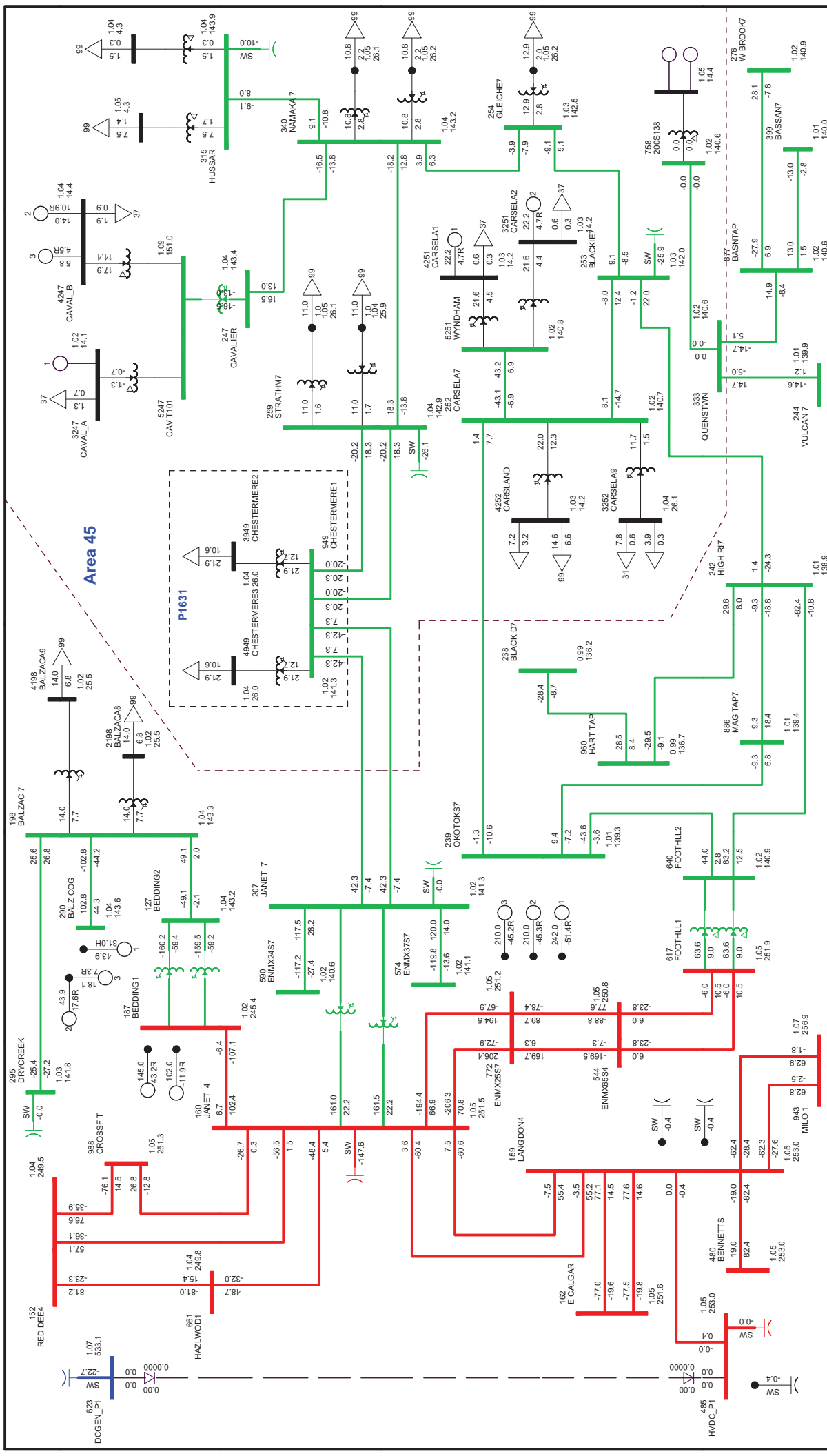
Figure F-13:

P1631 - Chestermere New POD

Sask Import:-0.1 MW MATL Import:0.0 MW

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



CATEGORY A, N-0
2017WP POST-CONNECTION POST-LTP
THU, MAY 19 2016 15:03

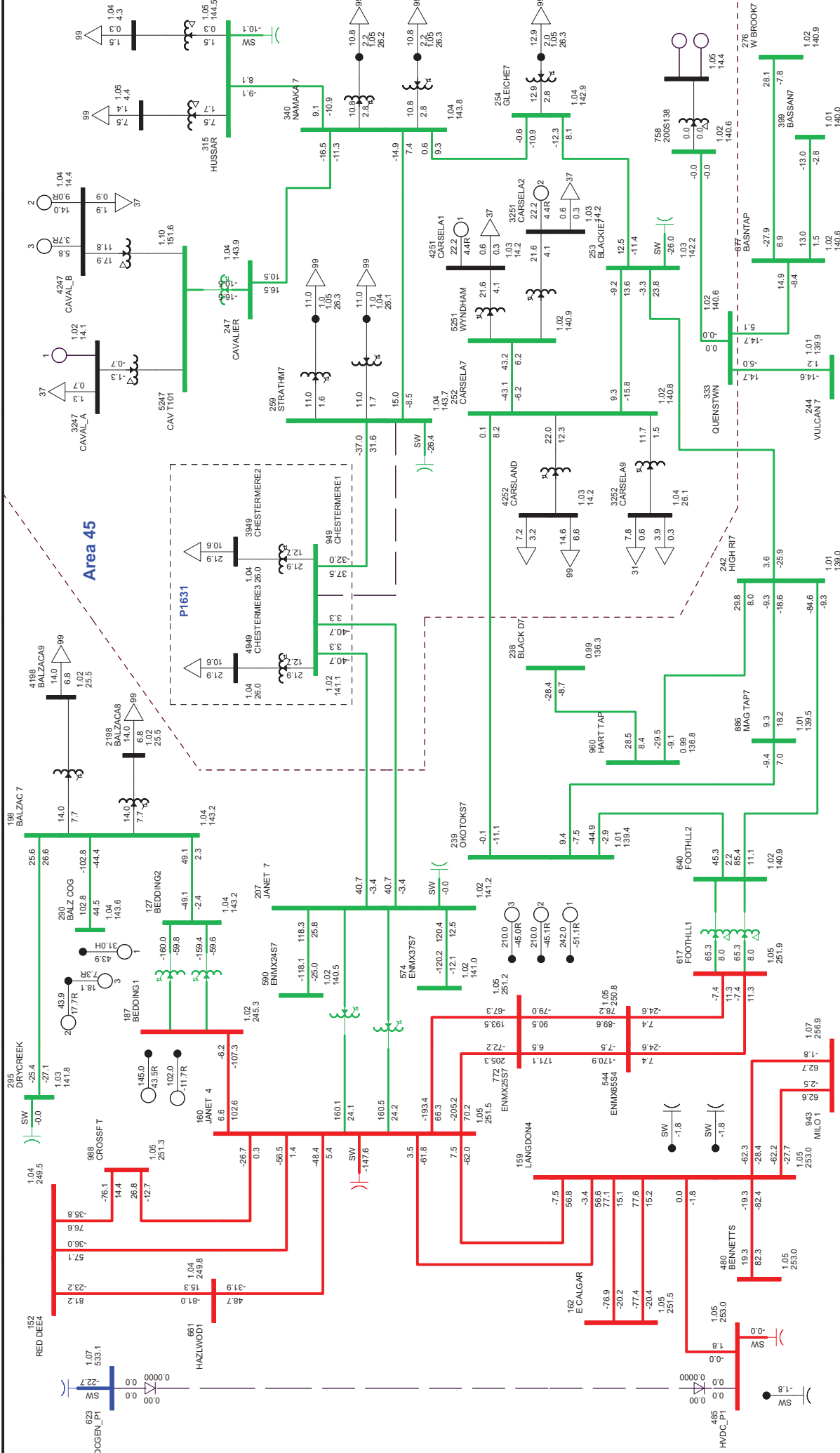
Figure F-15:

P1631 - Chestermere New POD

Scenario	Sask Import	MATL Import
Scenario 1	-0.1 MW	0.0 MW

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000



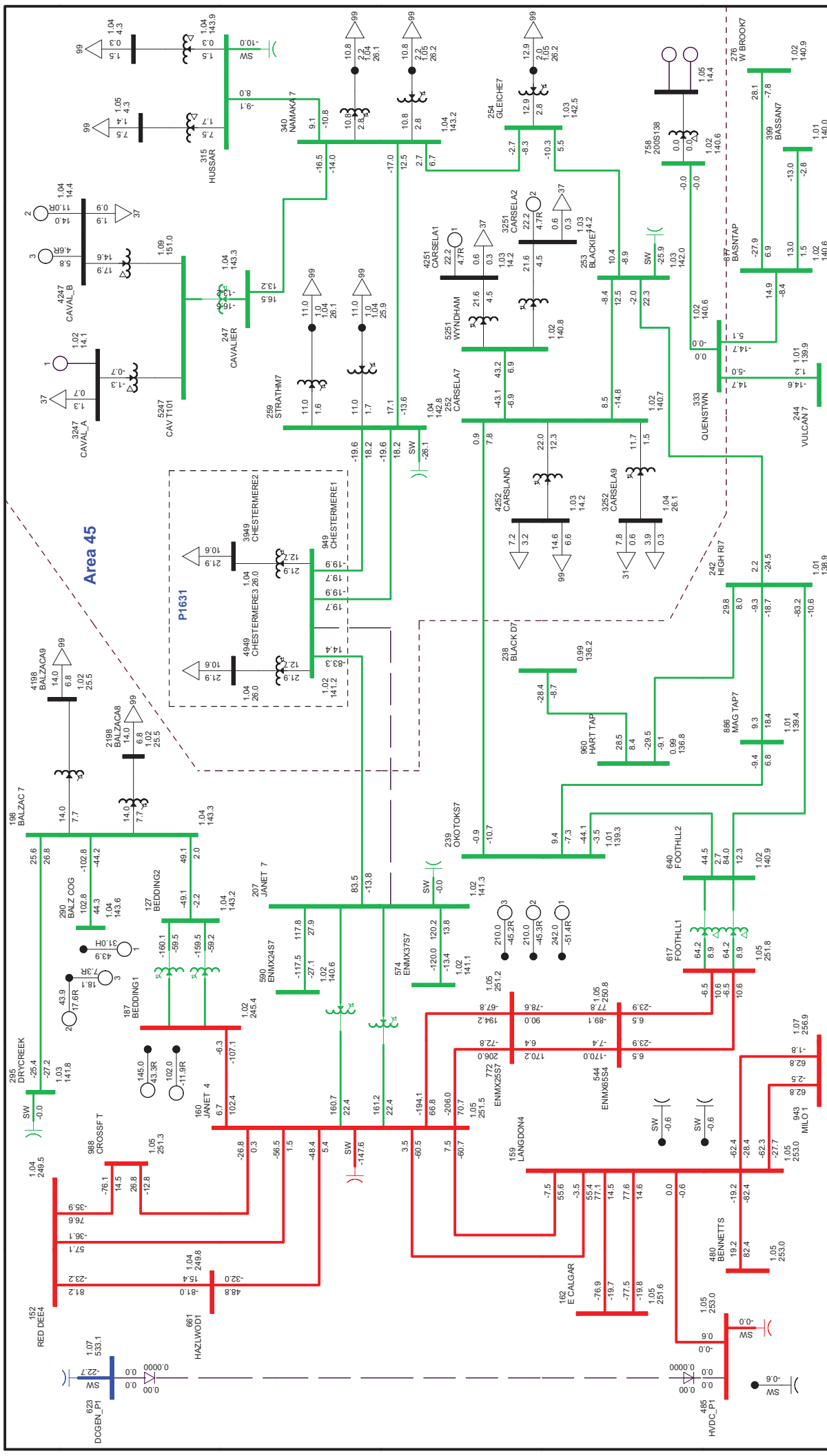
CATEGORY B, LOSS OF 765L
2017WP POST-CONNECTION POST-LTP
THU, MAY 19 2016 15:03

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

KV: <=25,000 <=72,000 <=144,000 <=500,000 >500,000

Figure F-16:

P1631 - Chestermere New POD
BC Import:-1.1 MW Sask Import:-0.1 MW MATL Import:0.0 MW



CATEGORY B, LOSS OF 691L
2017WP POST-CONNECTION POST-LTP
THU, MAY 19 2016 15:04

Figure F-17:

P1631 - Chestermere New POD

Sask Import:-0.1 MW	MATL Import:0.0 MW
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Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

kV: <=25.000 <=72.000 <=144.000 <=240.000 <=500.000 >500.000

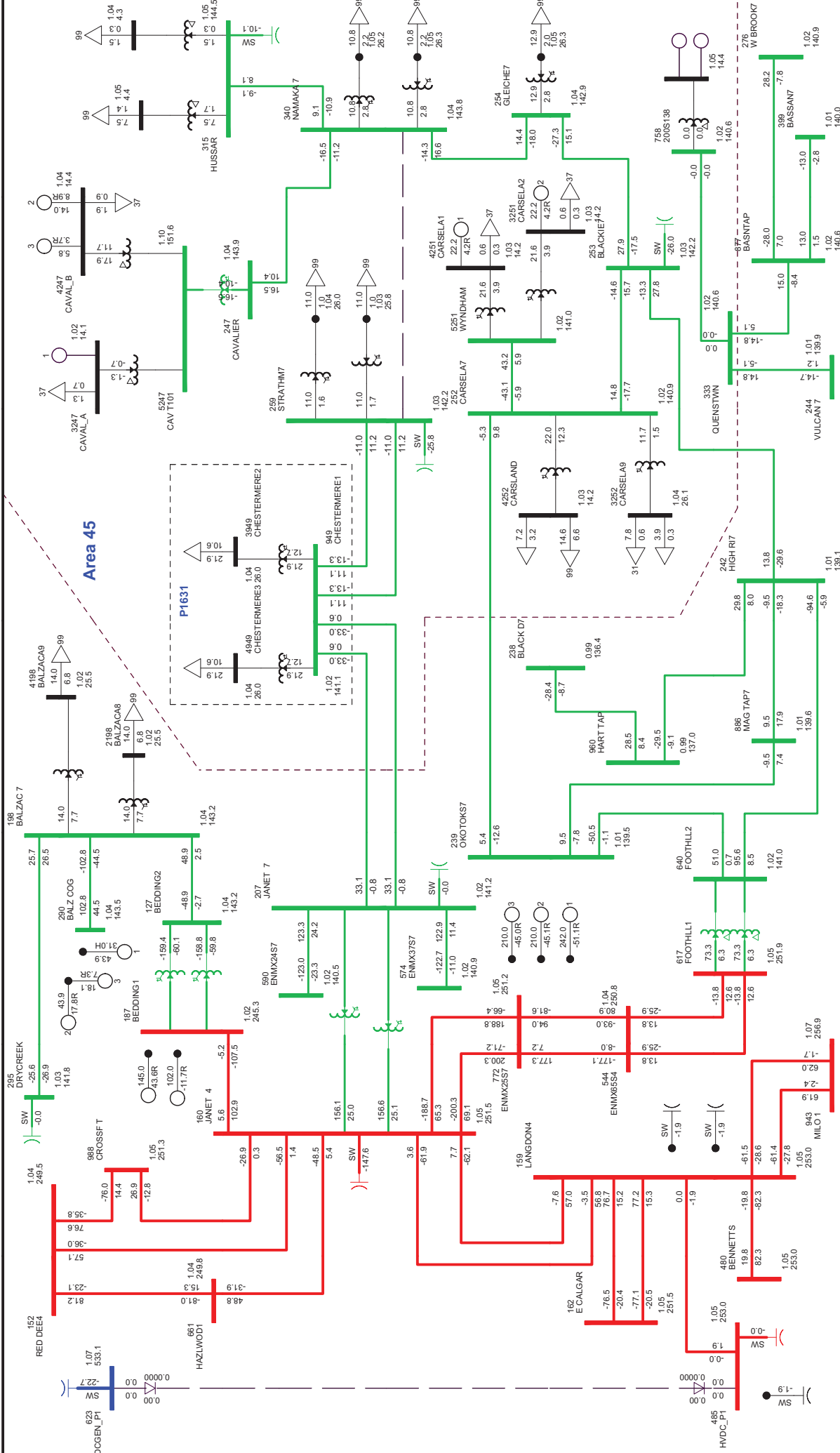
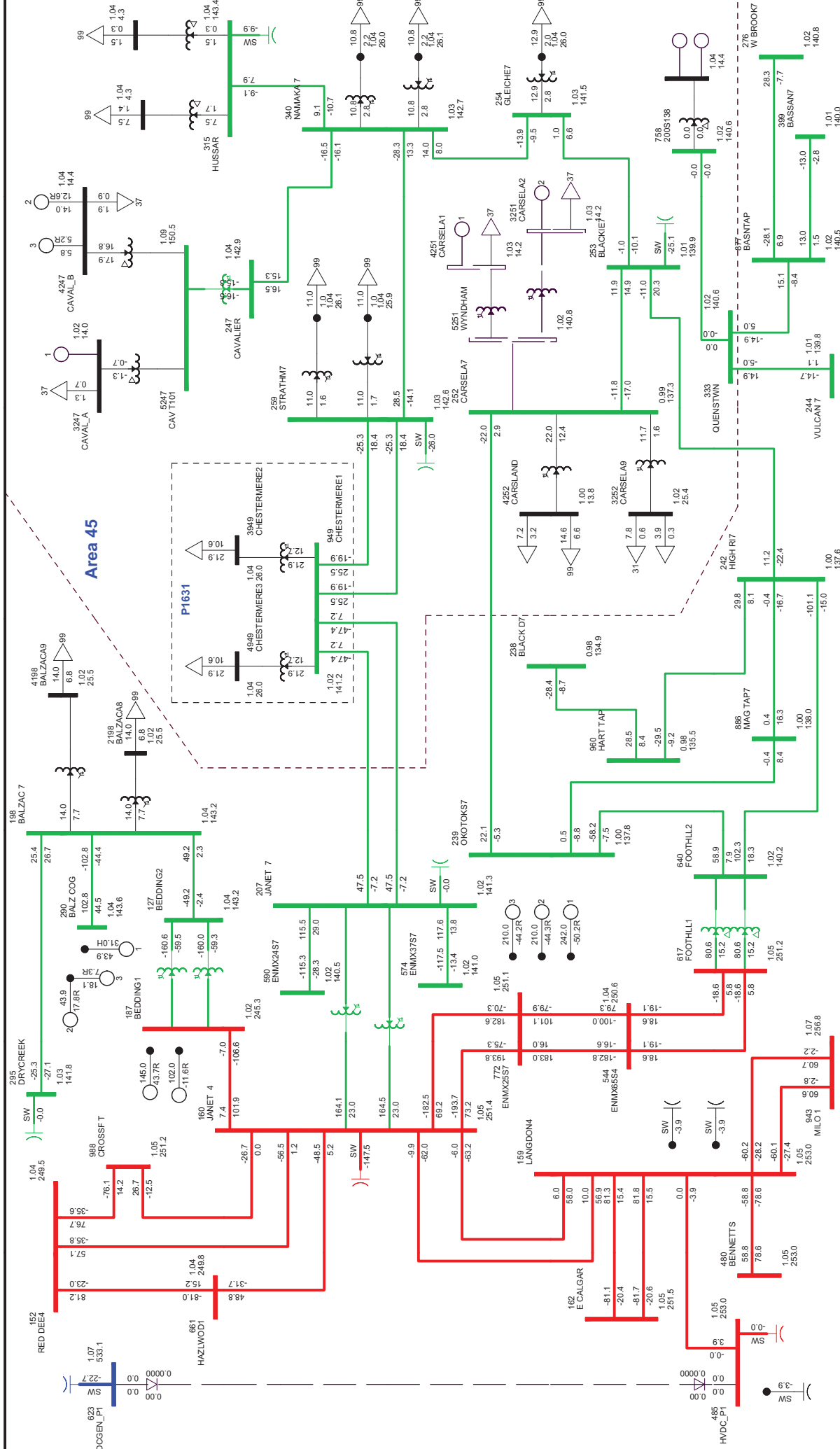


Figure F-18:
CATEGORY B, LOSS OF 733L
2017WP POST-CONNECTION POST-LTP
THU, MAY 19 2016 15:04

P1631 - Chestermere New POD
BC Import: -0.4 MW Sask Import: -0.1 MW MATL Import: 0.0 MW

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

KV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000



P1631 - Chestermere New POD
BC Import: 43.2 MW Sask Import: -0.1 MW MATL Import: 0.0 MW

Figure F-25:
CATEGORY B, LOSS OF CARSELAND STATION
2017WP POST-CONNECTION POST-LTP
THU, MAY 19 2016 15:04

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B

KV: <=25,000 <=72,000 <=144,000 <=240,000 <=500,000 >500,000

