APPENDIX A CONNECTION ASSESSMENT

Engineering Connection Assessment

P2543 Castle Downs Substation Modification

EPCOR Distribution & Transmission Inc.

Date: Sept 20, 2023

Version: Final

Classification: Public

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NOTE:

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

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

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1 Introduction

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

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

1.1 Project Overview

EPCOR Distribution & Transmission Inc. (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 a Rate DTS increase at Castle Downs substation in Edmonton Area (Area 60).

The DFO's request includes a request for a Rate DTS, Demand Transmission Service, contract capacity increase of 14.58 MW, from 84.67 MW to 99.25 MW, for the system access service provided at the existing Castle Downs substation, and a request for transmission development (collectively, the Project).

The scheduled in-service date (ISD) for the Project is September 30, 2024.

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 Edmonton Area (Area 60), which is part of the AESO Edmonton planning region. Edmonton planning area (Area 60) is surrounded by the planning areas of Wabamun (Area 40), Athabasca/Lac La Biche (Area 27), Fort Saskatchewan (Area 33), and Wetaskiwin (Area 31).

From a transmission system perspective, Edmonton planning area (Area 60) consists primarily of a 72 kV, 138 kV and 240 kV transmission system.

Existing constraints in the Edmonton 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 Edmonton area (Area 60), including the tie lines connecting these planning areas to the rest of the AIES. All transmission facilities within the Study Area will be studied and monitored for violations of the Reliability Criteria (defined in Section 3.1 of Attachment A1).

3 Connection Alternatives

3.1 Overview

The AESO, in consultation with the transmission facility owner (TFO) in the Study Area and the DFO, examined two 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 alternative that was examined for the Project.

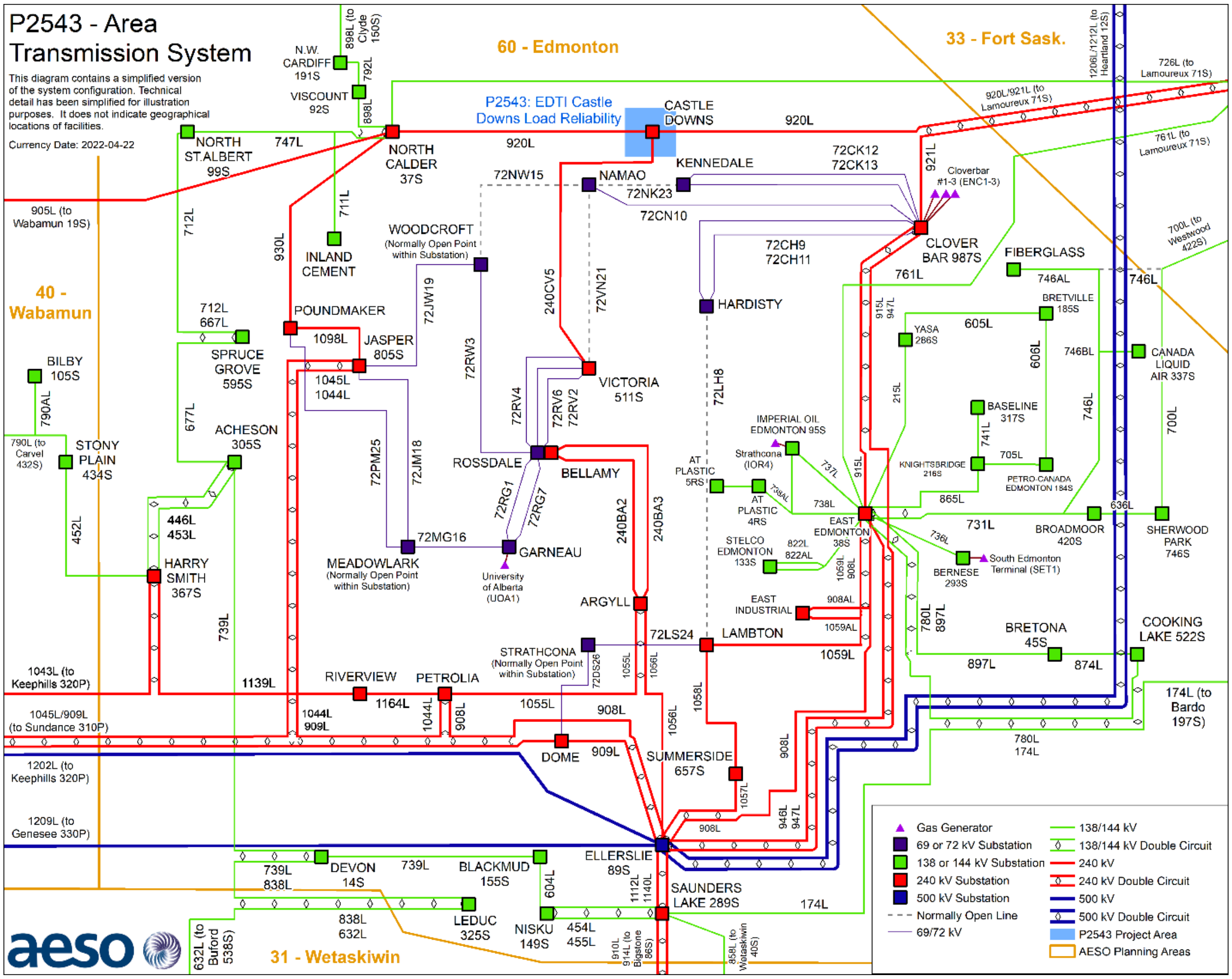
Alternative 1 –Castle Downs substation modification

This alternative includes the following developments:

- Modify the Castle Downs substation including adding fourteen (14) 15 kV feeder breakers; and
- Add or modify associated equipment as required for the above transmission development.

[1] These alternatives reflect more up to date engineering design than the alternatives identified in the DFO's DDR, which is filed under a separate cover.

Figure 3-1: Connection Alternative 1



Alternative 2 – Modify the planned Fort Road substation and the existing Namao substation

This alternative includes the following developments:

- Modify the planned Fort Road substation,[2] including adding two (2) 15 kV feeder breakers;
- Modify the existing Namao substation including adding one (1) 15 kV feeder breaker and
- Add or modify associated equipment as required for the above transmission development.

[2] P7078 City of Edmonton Transmission Reinforcement project is contemplated in the AESO's *2022 Long-term Plan*, available on the AESO website.

3.3 Connection Alternatives Selected for Further Study

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

3.4 Connection Alternatives Not Selected for Further Study

Alternative 2 was ruled out because it is dependent upon the completion of the City of Edmonton Transmission Reinforcement Project and the DFO advised that Alternative 2 would require additional transmission and distribution development to serve load growth over the long-term. The DFO's assessment of Alternative 2 is included in the DFO's DDR, which is provided under a separate cover.

4 Assessment Approach

4.1 Standards, Criteria and Assumptions

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

4.2 Studies Performed

The scheduled ISD for the Project is Sept 30, 2024. Therefore, studies were performed using scenarios for 2024 SP and 2024 WP.

Short-circuit studies were performed using the 2031 WP scenario.

Table 4-1 lists the study scenarios. Post-Project scenarios reflect the requested Rate DTS contract capacity increase of 14.58 MW at the Castle Downs substation. P2538 EDTI Inland Cement Load and Reliability and P2478 Fortis North Calder 37S Contract Change were included in the sensitivity study scenarios.

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	2024 Summer Peak (SP)	Low Generation (LG)	2024 SP LG Pre-Project	84.67	0
2	2024 Winter Peak (WP)		2024 WP LG Pre-Project	84.67	0
Post-Project					
3	2024 Summer Peak (SP)	Low Generation (LG)	2024 SP LG Post-Project	99.25	0
4	2024 Winter Peak (WP)		2024 WP LG Post-Project	99.25	0
5	2031 Winter Peak (WP)	All Study Area Generators In-Service	2031 WP Post-Project	99.25	0
Pre-Project Sensitivity with P2538 & P2478					
6	2024 Summer Peak (SP)	Low Generation (LG)	2024 SP LG Pre-Project	84.67	0
7	2024 Winter Peak (WP)		2024 WP LG Pre-Project	84.67	0
Post-Project Sensitivity with P2538 & P2478					
8	2024 Summer Peak (SP)	Low Generation (LG)	2024 SP LG Post-Project	99.25	0
9	2024 Winter Peak (WP)		2024 WP LG Post-Project	99.25	0

The AESO Planning Region load forecasts used for the connection studies were based on the *AESO 2021 Long-term Outlook (2021 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 point of delivery (POD) low voltage bus voltage deviations beyond the limits listed in Table 3-1 of Attachment A1.[3]

Power flow studies were performed for 2024 SP and 2024 WP pre-Project scenarios, and for 2024 SP and 2024 WP 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 2024 WP post-Project scenarios.

4.2.3 Short-Circuit Current Level Studies

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

Short circuit studies were performed for the 2024 WP pre-Project scenario and for 2024 WP and 2031 WP post-Project scenarios.

4.3 Mitigation Measure Development and Evaluation

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

4.3.1 Post-Mitigation Studies

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

4.3.2 Constraint Effective Factor Studies

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

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

5 Interpretation of Results

5.1 Results Overview

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

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

Detailed study results are provided in Attachment A.

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

Scenario	Type of Reliability Criteria Violation		Contingency (System Element Lost)	Details of Violation	Project Impact	Pre-Project Mitigation Measures	Post-Project Mitigation Measures
	Pre-Project	Post-Project					
2024 SP	Thermal - above normal rating	Thermal - above normal rating	72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	No impact	Real-time operational practices (RTOPs)	RTOPs
	Thermal - above normal rating	Thermal - above normal rating	72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	No impact	RTOPs	RTOPs
	Thermal - above normal rating	Thermal - above normal rating	72RG7 (Rossdale to Garneau)	72RG1 (Rossdale to Garneau)	No impact	RAS 172	RAS 172
2024 WP	Thermal - above normal rating	Thermal - above normal rating	72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	No impact	RTOPs	RTOPs
	Thermal - above normal rating	Thermal - above normal rating	72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	No impact	RTOPs	RTOPs
2024 SP (Sensitivity)	Thermal - above normal rating	Thermal - above normal rating	72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	No impact	RTOPs	RTOPs
	Thermal - above normal rating	Thermal - above normal rating	72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	No impact	RTOPs	RTOPs
	Thermal - above normal rating	Thermal - above normal rating	72RG7 (Rossdale to Garneau)	72RG1 (Rossdale to Garneau)	No impact	RAS 172	RAS 172
2024 WP (Sensitivity)	Thermal - above normal rating	Thermal - above normal rating	72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	No impact	RTOPs	RTOPs
	Thermal - above normal rating	Thermal - above normal rating	72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	No impact	RTOPs	RTOPs

Notes:
- RAS 172 is an existing RAS (see Section 1.2.2 of Attachment A1).

5.2 Pre-Project Study Results

5.2.1 Category A Conditions

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

5.2.2 Category B Conditions

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

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

5.3 Post-Project Study Results

5.3.1 Category A Conditions

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

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

5.3.2 Category B Conditions

Post-Project power flow studies identified the same thermal criteria violations that were observed under Category B conditions in the pre-Project scenarios. The Project does not impact any of these thermal criteria violations.

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

The voltage stability margin was met for all studied conditions.

5.4 Mitigation Measures

The Project does not require the addition of any new or modified mitigation measures. Both before and after connection of the Project, most of the observed thermal criteria violations under the Category B conditions can be managed by using real-time operational practices. The remaining thermal criteria violations can be mitigated with the existing RAS 172.

6 Project Dependencies

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

7 Conclusions and Recommendations

Based on the study results, Alternative 1 is technically viable. While the connection assessment identified system performance issues under Category B conditions, the connection of the Project has no impact on these observed issues. Existing mitigation measures can be used to manage the system performance issues; no new or modified mitigations are required post-Project. The Project does not adversely affect the performance of the AIES.

The AESO recommends proceeding with the Project using Alternative 1 as the preferred alternative to respond to the Market Participant's request for system access service. Alternative 1 involves modifying the Castle Downs substation, including adding fourteen 15 kV circuit breakers.

Attachment A:
Engineering Connection Assessment Results

Engineering Connection Assessment: Study Results

P2453 EDTI Castle Downs Load Reliability

EPCOR Distribution & Transmission Inc.

Date: June 22, 2023

Version: V1D1

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1 Introduction

This report presents the results of the engineering studies that were completed by EPCOR Distribution & Transmission Inc. (EDTI) (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 34.8.

2 Pre-Project Study Results

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

2.1 Power Flow Studies

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

2.1.1 Scenario 1: 2024 Summer Peak Low Generation Pre-Project

Category A Conditions

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

Category B Conditions

Thermal Criteria Violations

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

Table 2-1: Thermal Criteria Violations under Category B Conditions for Scenario 1: 2024 Summer Peak Low Generation Pre-Project

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings (MVA) [a]		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow [b] (MVA)	% Loading [c]
72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	44.9	117.3
72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	45.0	117.4
72RG7 (Rossdale to Garneau)	72RG1 (Rossdale to Garneau)	58.7	117.6	67.2	114.5

Notes:

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

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

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

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

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

2.1.2 Scenario S1: 2024 Summer Peak Low Generation Pre-Project Sensitivity

Category A Conditions

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

Category B Conditions

Thermal Criteria Violations

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

Table 2-2: Thermal Criteria Violations under Category B Conditions for Scenario S1: 2024 Summer Peak Low Generation Pre-Project Sensitivity

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings (MVA) [a]		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow [b] (MVA)	% Loading [c]
72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	44.8	117.0
72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	44.8	117.0
72RG7 (Rossdale to Garneau)	72RG1 (Rossdale to Garneau)	58.7	117.6	67.0	114.2

Notes:

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

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

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

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No point of delivery (POD) bus voltage deviations were observed.

2.1.3 Scenario 2: 2024 Winter Peak Low Generation Pre-Project

Category A Conditions

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

Category B Conditions

Thermal Criteria Violations

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

Table 2-3: Thermal Criteria Violations under Category B Conditions for Scenario 2: 2024 Winter Peak Low Generation Pre-Project

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings (MVA) [a]		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow [b] (MVA)	% Loading [c]
72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	57.2	149.4
72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	57.3	149.5

Notes:

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

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

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

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No point of delivery (POD) bus voltage deviations were observed.

2.1.4 Scenario S2: 2024 Winter Peak Low Generation Pre-Project Sensitivity

Category A Conditions

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

Category B Conditions

Thermal Criteria Violations

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

Table 2-4: Thermal Criteria Violations under Category B Conditions for Scenario S2: 2024 Winter Peak Low Generation Pre-Project Sensitivity

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings (MVA) [a]		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow [b] (MVA)	% Loading [c]
72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	56.5	147.6
72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	56.6	147.8

Notes:

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

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

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

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No point of delivery (POD) bus voltage deviations were observed.

3 Post-Project Study Results

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

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

3.1 Power Flow Studies

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

3.1.1 Scenario 3: 2024 Summer Peak Low Generation Post-Project

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 3-1.

Table 3-1: Thermal Criteria Violations under Category B Conditions for Scenario 3: 2024 Summer Peak Low Generation Post-Project

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating [a] (MVA)	Emergency Rating [a] (MVA)	Pre-Project Results: Observed Power Flow [b] (MVA)	Pre-Project Results: % Loading [c]	Post-Project Results: Observed Power Flow [b] (MVA)	Post-Project Results: % Loading [c]	% Loading Difference (Post-Pre)
72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	44.9	117.3	44.6	116.4	-0.9
72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	45.0	117.4	44.6	116.5	-0.9
72RG7 (Rossdale to Garneau)	72RG1 (Rossdale to Garneau)	58.7	117.6	67.2	114.5	66.7	113.6	-0.9

Notes:

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

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

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

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

3.1.2 Scenario S3: 2024 Summer Peak Low Generation 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 3-1.

Table 3-2: Thermal Criteria Violations under Category B Conditions for Scenario S3: 2024 Summer Peak Low Generation Post-Project Sensitivity

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating [a] (MVA)	Emergency Rating [a] (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow [b] (MVA)	% Loading [c]	Observed Power Flow [b] (MVA)	% Loading [c]	
72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	44.8	117.0	44.4	116.0	-0.9
72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	44.8	117.0	44.5	116.1	-0.9
72RG7 (Rossdale to Garneau)	72RG1 (Rossdale to Garneau)	58.7	117.6	67.0	114.2	66.5	113.2	-0.9

Notes:

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

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

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

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

3.1.3 Scenario 4: 2024 Winter Peak Low Generation Post-Project

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 3-1.

Table 3-3: Thermal Criteria Violations under Category B Conditions for Scenario 4: 2024 Winter Peak Low Generation Post-Project

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating [a] (MVA)	Emergency Rating [a] (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow [b] (MVA)	% Loading [c]	Observed Power Flow [b] (MVA)	% Loading [c]	
72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	57.3	149.5	56.8	148.4	-1.1
72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	57.2	149.4	56.8	148.3	-1.1

Notes:

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

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

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

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

3.1.4 Scenario S4: 2024 Winter Peak Low Generation 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 3-1.

Table 3-4: Thermal Criteria Violations under Category B Conditions for Scenario S4: 2024 Winter Peak Low Generation Post-Project Sensitivity

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating [a] (MVA)	Emergency Rating [a] (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow [b] (MVA)	% Loading [c]	Observed Power Flow [b] (MVA)	% Loading [c]	
72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	56.5	147.6	56.1	146.5	-1.1
72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)	38.3	76.5	56.6	147.8	56.2	146.7	-1.1

Notes:

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

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

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

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed.

3.2 Voltage Stability Studies

3.2.1 Scenario 4: 2024 Winter Peak Low Generation Post-Project

Voltage stability analysis was performed for the 2024 winter peak, low generation, post-project Scenario 4. The reference load level for the Study Area is 1964.3 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 98.21 MW (0.05 x 1964.3 MW = 98.21 MW), in order to meet the voltage stability criteria.

Table 3-5 provides the voltage stability study results under the Category A condition and for the four worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment A4.

The voltage stability margin was met for all studied conditions.

Table 3-5: Voltage Stability Study Results under Category B Conditions for Scenario 4: 2024 Winter Peak Low Generation Post-Project

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	System Normal		1044	Yes
838L	Devon 14S	Leduc 325S	650	Yes
909L	Sundance 310P	Dome E665S	931	Yes
1209L	Ellerslie 38S	Keephills 330P	938	Yes
89ST1	Ellerslie 89S, 500/240 kV transformer		950	Yes

3.2.2 Scenario S4: 2024 Winter Peak Low Generation Post-Project Sensitivity

Voltage stability analysis was performed for the 2024 winter peak, low generation, post-project sensitivity scenario S4. The reference load level for the Study Area is 1967.9 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 98.4 MW (0.05 x 1967.9 MW = 98.4 MW), in order to meet the voltage stability criteria.

Table 3-5 provides the voltage stability study results under the Category A condition and for the four worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment A4.

The voltage stability margin was met for all studied conditions.

Table 3-6: Voltage Stability Study Results under Category B Conditions for Scenario S4: 2024 Winter Peak Low Generation Post-Project Sensitivity

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	System Normal		1038	Yes
838L	Devon 14S	Leduc 325S	650	Yes
909L	Sundance 310P	Dome E665S	925	Yes
1209L	Ellerslie 38S	Keephills 330P	931	Yes
89ST1	Ellerslie 89S, 500/240 kV transformer		944	Yes

4 Short Circuit Studies

4.1 Pre-Project Results

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

Table 4-1: Pre-Project Short-Circuit Current Levels for Scenario 2: Winter Peak Low Generation 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)
North Calder 37S	240	246.2	16.56	0.003426+j0.014642	14.28	0.003925+j0.022012
Castle Down	240	245.5	15.23	0.003502+j0.015926	13.86	0.003321+j0.020956
Victoria	240	245.1	12.97	0.003751+j0.018735	12.38	0.004038+j0.021551
Poundmaker	240	245.9	16.61	0.003622+j0.014536	14.80	0.003099+j0.020408

4.2 Post-Project Results

4.2.1 Scenario 4: 2024 Winter Peak Low Generation Post-Project

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

[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.

Table 4-2: Post-Project Short-Circuit Current Levels for Scenario 4: 2024 Winter Peak Low Generation 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)
37S North Calder	240	246.1	16.56	0.003438+j0.014631	14.28	0.003925+j0.022012
E557S Castle Down	240	245.3	15.23	0.003526+j0.015906	13.87	0.003321+j0.020956
E511S Victoria	240	244.9	12.98	0.003772+j0.018716	12.38	0.004038+j0.021551
Poundmaker	240	245.9	16.62	0.003626+j0.014532	14.80	0.003099+j0.020408

4.2.2 Scenario 5: 2031 Winter Peak Post-Project

Post-Project short-circuit current levels for Scenario 5 are provided in Table 4-3.

Table 4-3: Post-Project Short-Circuit Current Levels for Scenario 5: 2031 Winter Peak 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)
37S North Calder	240	247.3	17.26	0.003136+j0.014175	14.63	0.003917+j0.022104
E557S Castle Down	240	246.5	15.88	0.003189+j0.015408	14.25	0.003314+j0.020983
E511S Victoria	240	246.1	13.46	0.003433+j0.018221	12.69	0.004029+j0.021575
Poundmaker	240	247.0	17.33	0.003324+j0.014069	15.14	0.003085+j0.020590

5 Mitigation Measure Development and Evaluation

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

5.1 Pre-Project

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

Table 5-1: Pre-Project Mitigation Measures

Mitigation Measure	**Location of Observed Violation**	**Contingency**
Existing RAS No. 172 [a]	72RG1 (Rossdale to Garneau)	72RG7 (Rossdale to Garneau)
Real time operational practices [b]	72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)
	72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)

Notes:

[a] RAS No. 172 is an existing RAS (see Section 1.2.2 of the AESO’s Connection Study Scope).

[b] EDTI real time operational practices include post-contingency switching on EDTI’s 72 kV system.

5.2 Post-Project

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

Table 5-2: Post-Project Mitigation Measures

Mitigation Measure	**Location of Observed Violation**	**Contingency**
Existing RAS No. 172 [a]	72RG1 (Rossdale to Garneau)	72RG7 (Rossdale to Garneau)
Real time operational practices [b]	72CH9 (Clover Bar E987S to EPCOR Hardisty)	72CH11 (Clover Bar E987S to EPCOR Hardisty)
	72CH11 (Clover Bar E987S to EPCOR Hardisty)	72CH9 (Clover Bar E987S to EPCOR Hardisty)

Notes:

[a] RAS No. 172 is an existing RAS (see Section 1.2.2 of the AESO's Connection Study Scope).

[b] EDTI real time operational practices include post-contingency switching on EDTI's 72 kV system.

5.3 Evaluation of Mitigation Measures

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

The post-mitigation measures studies were performed under Category B conditions for Post-project Scenarios 3 and S3 using the RASs described in the previous section.

The post-mitigation power flow diagrams for selected Category B conditions are provided in Attachment A5. Post-mitigation power flow diagrams present only those post-Project contingencies that result in thermal criteria violations that require RAS mitigation. Post-Project contingencies that result in thermal criteria violations that can be mitigated by real-time operational practices or TFO capital maintenance projects were not studied.

5.3.1 Scenario 3: 2024 Summer Peak Low Generation Post-Project

Category B Conditions

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

Table 5-3: Post-RAS Power Flow Study Results for Scenario 3: 2024 Summer Peak Low Generation Post-Project

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
72RG7 (Rossdale to Garneau)	72RG1 (Rossdale to Garneau)	58.7	117.6	66.7	113.6	21.0	34.2

5.3.2 Scenario S3: Summer Peak Low Generation 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 RASs as shown in Table 5-4.

Table 5-4: Post-RAS Power Flow Study Results for Scenario S3: Summer Peak Low Generation Post-Project Sensivity

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
72RG7 (Rossdale to Garneau)	72RG1 (Rossdale to Garneau)	58.7	117.6	66.5	113.2	20.9	34.1

Attachment A1
Engineering Connection Assessment: Study Scope

Engineering Connection Assessment: Study Scope

P2543 EDTI Castle Downs Load Reliability

EPCOR Distribution & Transmission Inc.

Date: Mar 31 , 2023

Version: V1Final

Classification: Public

Company Name	Name and Credentials	Date	Signature
EDTI (TFO)	Kelly Yagelniski		
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Contents

Tables

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1 Introduction

This Study Scope provides an overview of the engineering studies to be completed by EDTI (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

EPCOR Distribution & Transmission Inc. 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 request a Rate DTS increase at Castle Downs substation in Edmonton Area (Area 60).

The DFO's request includes a request for a Rate DTS, *Demand Transmission Service*, contract capacity increase of 14.58 MW, from 84.67 MW to 99.25 MW, for the system access service provided at the existing Castle Downs. and a request for transmission development (collectively, the Project). Specifically, the DFO requested an enhancement to the existing Castle Downs 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 30, 2024.

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

Table 1-1: Project Load and Generation Details

Project Component		Description
Load	Existing Rate DTS, *Demand Transmission Service,* contract capacity	84.67 MW at Castle Downs
	Requested Rate DTS	An increase of 14.58 MW at Castle Downs
	Type	Residential and Commercial
	Motors (number and size)	Not Applicable
	Power factor	0.989 pf[a]
	Future load expansion plans	No

Note:

1. For the new portion of the Castle Downs load, use the historical pf 0.989.

1.2 Existing System Overview

1.2.1 Study Area

Geographically, the Project is located in the AESO planning area of Edmonton Area (Area 60).

The Study Area consists of the AESO planning area of Edmonton Area (Area 60), including the tie lines connecting these planning areas to the rest of the AIES.

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

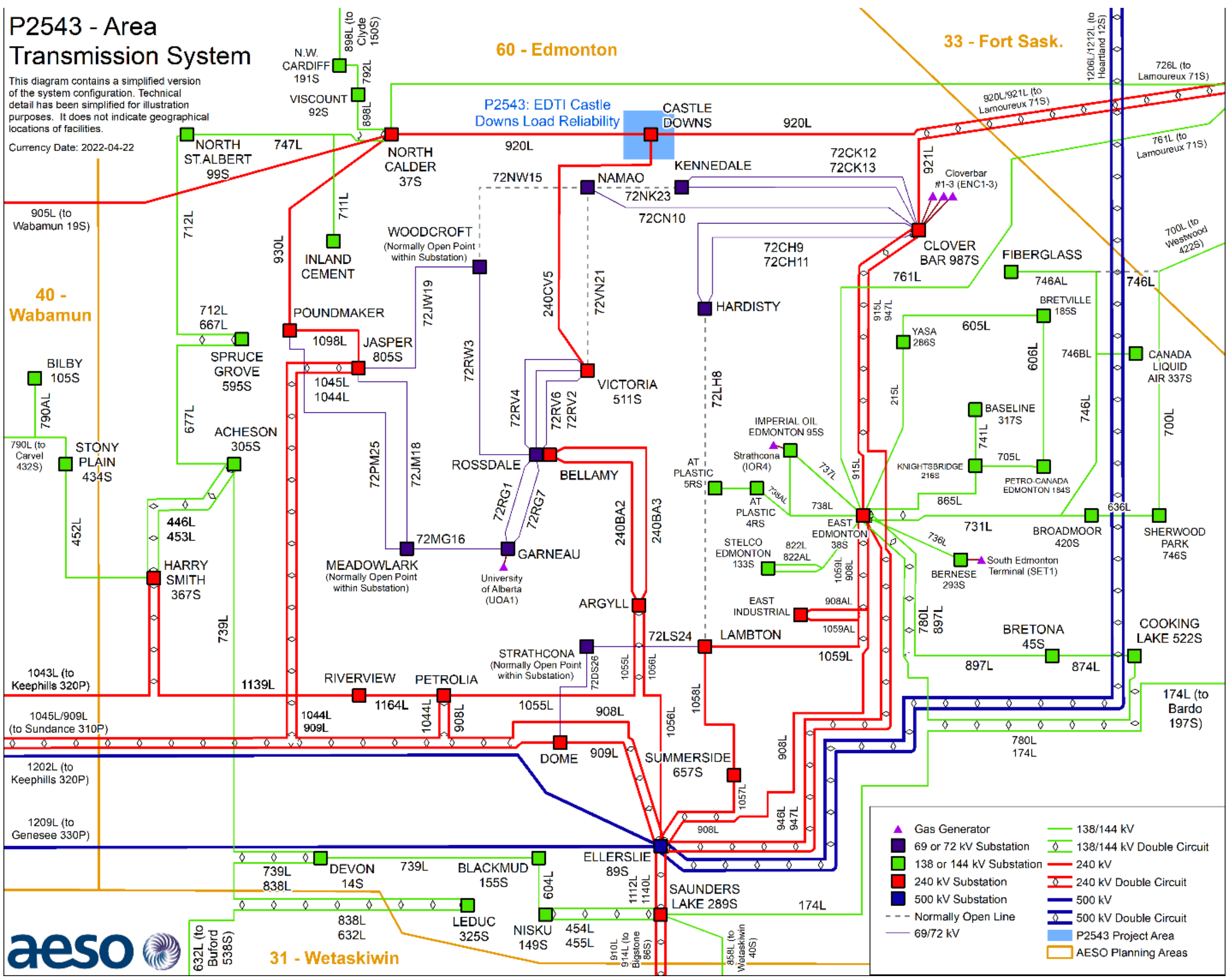
1.2.2 Existing Constraints

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

The following future RAS and/or other protection scheme is used to manage constraints in the area:

- RAS 172: Garneau – Meadowlark Reconfiguration Scheme (P1649)

Figure 1-1: Transmission System in the Study Area



2 Connection Alternative

There is only one study alternative to be studied which is increasing load from 84.67 MW to 99.25 MW.

Alternative 2 –Capacity Increase of Castle Downs POD

This alternative includes the following developments:

- Add one (1) 15 kV switchgear building capable of accommodating fourteen (14) new 15 kV feeder breakers.
- Add fourteen (14) 15 kV feeder breakers (with associated switches) and two (2) 15 kV busses.
- Add or modify associated equipment as required for the above transmission developments.

3 Criteria, Standards and Requirements

3.1 AESO Reliability Criteria

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

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

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

The TPL standards, TPL-001-AB-0 and TPL-002-AB1-0, have referenced Applicable Ratings when specifying the required system performance under Category A, Category B and Category C5 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 and Category C5 conditions: The extreme voltage range values per Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions; and*
- Desired post-contingency voltage deviation limits for three defined post-event timeframes as provided in Table 3-1.

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

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

3.2 ISO Rules and Information Documents

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

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

- The AESO's *Connection Study Requirements*;
- Section 502.7 of the ISO rules, Load Facility Technical Requirements;

4 Scenarios and Assumptions

4.1 Scenarios

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

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

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	2024 Summer Peak (SP)	Low Generation (LG)	2024 SP LG Pre-Project	84.67	0
2	2024 Winter Peak (WP)	Low Generation (LG)	2024 WP LG Pre-Project	84.67	0
Post-Project					
3	2024 Summer Peak (SP)	Low Generation (LG)	2024 SP LG Post-Project	99.25	0
4	2024 Winter Peak (WP)	Low Generation (LG)	2024 WP LG Post-Project	99.25	0
5	2031 Winter Peak (WP)	All Study Area Generators In-Service	2031 WP Post-Project	99.25	0
Pre-Project Sensitivity with P2538 (DTS 28 MW) & P2478 (DTS 43 MW)					
S1	2024 Summer Peak (SP)	Low Generation (LG)	2024 SP LG Pre-Project	84.67	0
S2	2024 Winter Peak (WP)	Low Generation (LG)	2024 WP LG Pre-Project	84.67	0
Post-Project Sensitivity with P2538 (DTS 28 MW) & P2478 (DTS 43 MW)					
S3	2024 Summer Peak (SP)	Low Generation (LG)	2024 SP LG Post-Project	99.25	0
S4	2024 Winter Peak (WP)	Low Generation (LG)	2024 WP LG Post-Project	99.25	0

4.2 Assumptions

4.2.1 System Project Assumptions

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

4.2.2 Connection Project Assumptions

Table 4-2 summarizes the connection projects in the Study Area that should be included in the studies. P1649, P1442, and P2133 have met the AESO inclusion criteria and have been included in the seed cases provided by the AESO. The above 3 projects will be included for all the study scenarios in the Table 4-1.

P2548 and P2478 will be only included in the sensitivity scenarios S1 to S4 in the Table 4-1. The POD load levels associated with those 2 projects are provided in the Table 4-4.

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
P1442	Fortis New Anthony Henday Substation	60	0	21	Sep 1, 2022
P2133	EDTI Southeast Edmonton Area Load and Reliability	60	0	31	Apr 27, 2022
P1649	EPCOR Garneau Area Upgrade	60	0	20.9	Oct 31, 2023
P2538	EDTI Inland Cement Load and Reliability	60	0	7.5	Oct 26, 2023
P2478	Fortis North Calder 37S Contract Change	60	0	19.58	Nov 1, 2022

4.2.3 Load Assumption

The load forecast to be used for the studies is shown in Table 4-3 and is a forecast for the AESO Edmonton Region peak based on the AESO 2021 Long-term Outlook (2021 LTO)[1] 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.

[1] The 2021 LTO is available on the AESO website.

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

AESO Planning Region Name	Forecast Peak Load by Year/Season (MW)	
	2024 SP	2024 WP
Edmonton Region[1]	2119	2277

Note:
[1] The Edmonton Region comprises the following AESO planning areas: 31, 40, 60.

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.

Table 4-4: Forecasted Project Load (at AESO Edmonton Planning Region Peak)

Connection Projects (Sensitivity only)	Forecast Peak Load by Year/Season (MW)	
	2024 SP	2024 WP
P2548 EDTI Inland Cement Load and Reliability	28	28
P2478 Fortis North Calder 37S Contract Change	43	43

4.2.4 Generation Assumptions

The generation forecast to be used for the studies is based on the 2021 LTO with modifications to incorporate the latest forecast intelligence. The generation assumptions for the studies will assume low generation dispatch condition. Additional studies may be required in the event of changes to the AESO's corporate forecast.

The existing generation (excluding wind and solar) dispatch conditions for the study scenarios are described in Table 4-5.

Table 4-5: Existing Generation (excluding Wind and Solar) Dispatch Conditions

Facility Name	Unit No.	Bus No.	MC (MW)	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario	
					2024 SP	2024 WP
Strathcona (IOR4)	G1	5069	43	60	N-G[b]	N-G[b]
University of Alberta	1	25353	16	60	1.8	13.3
	2	25352	26	60		
Cloverbar (ENC1)	G1	25516	48	60	0	0
Cloverbar (ENC2)	G2	26516	101	60	0	0

Facility Name	Unit No.	Bus No.	MC (MW)	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario	
					2024 SP	2024 WP
Cloverbar (ENC3)	G3	27516	101	60	0	0
South Edmonton Terminal (SET1)	G1,G2,G3 G4,G5,G6	3436	20	60	0	0

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.

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.

For the 2031 Winter Peak scenario, the intertie flow values should be set to the AESO planning base cases.

4.2.6 HVDC Power Order Assumptions

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

For the 2031 Winter Peak scenario, the HVDC power order should be as per the AESO base cases and will not be adjusted.

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.

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

Line ID	Line Description	Voltage Class (kV)	Nominal Rating (MVA)		Short-term[2] Rating (MVA)	
			Summer	Winter	Summer	Winter
747L	North ST. Albert 99S to JCT.711L	138	114	127	125	140
747L	North Calder 37S to JCT.711L	138	119	146	131	161
712L	North ST. Albert 99S to Spruce Grove 595S	138	108	114	119	125
677L	Spruce Grove 595S to Acheson 305S	138	115	146	127	161
739L	Acheson 305S to Devon 14S	138	110 LTD-L	131 LTD-L	121 LTD-L	143 LTD-L
446L	Acheson 305S to Harry Smith 367S	138	284	287 M	287 M	287 M
453L	Acheson 305S to Harry Smith 367S	138	284	287 M	287 M	287 M
898L	North Calder 37S to Viscount 92S	138	85	90	94	99
726L	North Calder 37S to Lamoureux 71S	138	169	191 CT	186	228
792L	N.w.cardiff 191S to Viscount 92S	138	85	90	94	99
920L	North Calder37S to Lamoureux 71S	240	419	499 CT	503	620
930L	Poundmaker to North Calder37S	240	481	499 CT	481	499
1098L	Jasper 805S to Poundmaker	240	487	599	487	599
921L	Clover Bar E987S to Lamoureux 71S	240	417	499 CT	500	620
915L	Clover Bar E987S to East Edmonton 38S	240	492	499 CT	590	648 M
947L	Clover Bar E987S to Ellerslie 89S	240	493	611	592	733
908L	East Edmonton 38S to JCT. 908AL	240	499 M	499 CT	599 CT	648 CT
1059L	East Edmonton 38S to JCT. EP 1059AL	240	499 M	499 CT	599 M	648 M
1057L	Summerside E657S to Ellerslie 89S	240	594 M	713 M	654 M	773 M
1058L	EP 1058L to Summerside E657S	240	499	499	499	499

[2] When line loading in post Category B contingency is observed to exceed nominal rating and is less than the Short-term (emergency) rating, it is assumed that AESO and TFO operating practices can manage the constraint within the time requirements of TFO short time (emergency) rating.

Line ID	Line Description	Voltage Class (kV)	Nominal Rating (MVA)		Short-term[2] Rating (MVA)	
			Summer	Winter	Summer	Winter
908L	Petrolia E816S to Ellerslie 89S	240	383 TD-L	572 TD-L	460 TD-L	686 TD-L
909L	Dome E665S to Sundance 310P	240	481	499	481	499
909L	Ellerslie 89S to Dome E665S	240	499	499	499	499
1055L [a]	Petrolia E816S to Argyll E629S	240	331 TD-L	459 TD-L	397 TD-L	517
1056L [b]	Ellerslie 89S to Argyll E629S	240	419	517	419	517
240BA2 [b]	Argyll E629S to Bellamy E814S	240	400	479	473	540
240BA3 [a]	Argyll E629S to Bellamy E814S	240	400	479	473	540
240CV5	Castle Downs E557S to Victoria E511S	240	475	503	475	503
72CH9	Clover Bar E987S to Hardisty	69 [e]	38.3	38.3	76.5	76.5
72CH11	Clover Bar E987S to Hardisty	69 [g]	38.3	38.3	76.5	76.5
72CK12	Clover Bar E987S to Kennedale	69 [g]	57.2 [c]	63.8 [c]	110.7	129.2
72CK13	Clover Bar E987S to Kennedale	69 [g]	57.2 [c]	63.8 [c]	110.7	129.2
72CN10	Clover Bar E987S to Namao	69 [g]	52.7	60.6	115.0	121.4
72DS26	Dome to Strathcona	69	78.3	87.4	92.0	102.8
72JM18	Jasper E805S to Meadowlark	69 [g]	58.4	65.3	117.1	130.9
72JW19	Jasper E805S to Woodcroft	69 [g]	58.4	65.3	117.1	130.9
72KN23	Kennedale to Namao	69 [g]	55.0	61.3	110.2	122.9
72LH8	Lambton E803S to Hardisty	69 [g]	86.3	118.8	100.6	129.4
72LS24	Lambton E803S to Strathcona	69 [g]	86.3	118.8	100.6	129.4
72MG16	Meadowlark to Garneau	69 [g]	53.4	69.2	107.1	138.8
72NW15	Namao to Woodcroft	69 [g]	61.3	85.29	71.9	92.9
72PM25	Poundmaker to Meadowlark	69	120.7	120.7	120.7	120.7
72RG1	Rossdale to Garneau	69 [g]	58.7	61.3	117.6	122.9
72RG7	Rossdale to Garneau	69 [g]	89.9	94.2	180.2	188.8
72RV2	Rossdale to E511S Victoria [e]	69 [g]	71.6	81.7	131.9	137.7

Line ID	Line Description	Voltage Class (kV)	Nominal Rating (MVA)		Short-term[2] Rating (MVA)	
			Summer	Winter	Summer	Winter
72RV4	Rossdale to E511S Victoria [e]	69 [g]	89.9	100.3	249.7	254.0
72RV6	Rossdale to E511S Victoria [e]	69 [g]	82.3	87.1	142.5	145.3
72RW3	Rossdale to Woodcroft	69 [g]	62.6	75.7	125.5	151.7
72VN21	E511S Victoria to Namao	69 [g]	61.3	72.7	122.9	145.7

NOTES:

a 1055L and 240BA3 are one circuit under normal operating mode. The overall rating is 400 MVA (summer) and 479 MVA (winter). If either 240BA2 or 1056L is out of service, the overall rating will be 419 MVA (summer) and 517 MVA (winter).

b 1056L and 240BA2 are one circuit under normal operating mode. The overall rating is 400 MVA (summer) and 479 MVA (winter). If either 240BA3 or 1055L is out of service, the overall rating will be 419 MVA (summer) and 517 MVA (winter).

c 72CK12 normal summer / winter rating with 72CK13 out of service is 479 A / 534 A (57.2 MVA / 63.8 MVA at 69 kV). 72CK13 normal summer / winter rating with 72CK12 out of service is 479 A / 534 A (57.2 MVA / 63.8 MVA at 69 kV)

d 72RG1 and 72RG7 can be operated to emergency ratings for a maximum duration of 10 minutes.

e Ratings for 72kV facilities in this table and in the study cases have been converted to MVA ratings based on 69 kV.

“CT” indicates that the transmission line is limited by current transformer.

“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.

“TD-L” indicate Temporary Derate from LiDAR surveys

“LTD-L” indicate Long-Term Derate from LiDAR surveys

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)	MVA Rating
Saunders Lake 289S	T1	240/138	400
	T2	240/138	400
North Calder 37S	T6	240/138	286.8
East Edmonton 38S	T1	240/138	340.6
	T4	240/138	340.6
Ellerslie 89S	T1	500/240	1200.0
	T2	500/240	1200.0
Jasper 805S	T1	240/69	300

Substation Name and Number	Transformer ID	Transformer Voltages (kV)	MVA Rating
Bellamy	T2	240/69	375
	T1	240/69	375
Dome	T3	240/69	100
Lambton	T3	240/69	80
Clover Bar 987S	T1	240/69	200
	T2	240/69	200
Victoria	T5	240/69	450
Poundmaker	T4	240/69	133

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.

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

Substation Name and Number	Voltage Class (kV)	Capacitors		Reactors	
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)	Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)
East Edmonton 38S	138	2	2 x 48.91	-	-
Nisku 149S	138	1	30	-	-
Leduc 325S	138	1	27		
Acheson 305S	138	1	24.46	-	-
Jasper 805S	240	1	105.31	-	-
Clover Bar 987S	69	1	31.57	-	-
Rossdale	69	2	2 x 45.28	-	-
Stelco Edmonton 133S	34.5	1	16.8	-	-
		1	30		

4.2.8 Voltage Profile Assumption

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

5 Study Methodology

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

Table 5-1: 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	C5	A	B	C5	A	B	C5	A	B	
Pre-Project													
1	2024 SP LG Pre	X	X										
2	2024 WP LG Pre	X	X										X
Post-Project													
3	2024 SP LG Post	X	X										
4	2024 WP LG Post	X	X		X	X							X
5	2031 WP Post												X
Pre-Project Sensitivity													
S1	2024 SP LG Pre	X	X										
S2	2024 WP LG Pre	X	X										
Post-Project Sensitivity													
S3	2024 SP LG Post	X	X										
S4	2024 WP LG Post	X	X		X	X							

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

5.1 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:

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 and selected C5 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 contingencies.

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, 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 Area 60 (Edmonton) and increasing generation in Area 6 (Calgary) and Area 25 (Fort McMurray).

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 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:

- North Calder 37S
- Castle Downs
- Victoria
- Poundmaker

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

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

6 Mitigation Measures

6.1 Development

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

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

- Develop tables showing the constraint effective factors[3] for generation or load based on thermal criteria violations that are observed.
- Collaborate with the AESO to propose changes, if any, to the connection alternatives that could remove the requirement for a RAS.
- Collaborate with the AESO to study modifications to existing and/or planned RASs, proposed by the AESO, to ensure the coordination of existing protection schemes with the addition of any proposed protection schemes.
- Collaborate with the AESO to identify and study new RASs, if any, that may be required to ensure 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.

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

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 (2021 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.

Attachment A: Transmission Planning Criteria – Basis and Assumptions

Transmission Planning Criteria – Basis and Assumptions

Date: July 9, 2019

Version: V1.2

Alberta Electric System Operator

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1. Introduction

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

2. Transmission Reliability Standards and Criteria[1]

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

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

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

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

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

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

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

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

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

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

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

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

2.1 Thermal Loading Criteria

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

2.2 Voltage Range and Voltage Stability Criteria

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

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

Nominal Voltage	Extreme Minimum	Normal Minimum	Normal Maximum	Extreme Maximum
500	475	500	525	550
240	216	234	252	264
260 (Northeast & Northwest)*	234	247	266	275
144	130	137	151	155
138	124	135	145	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

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

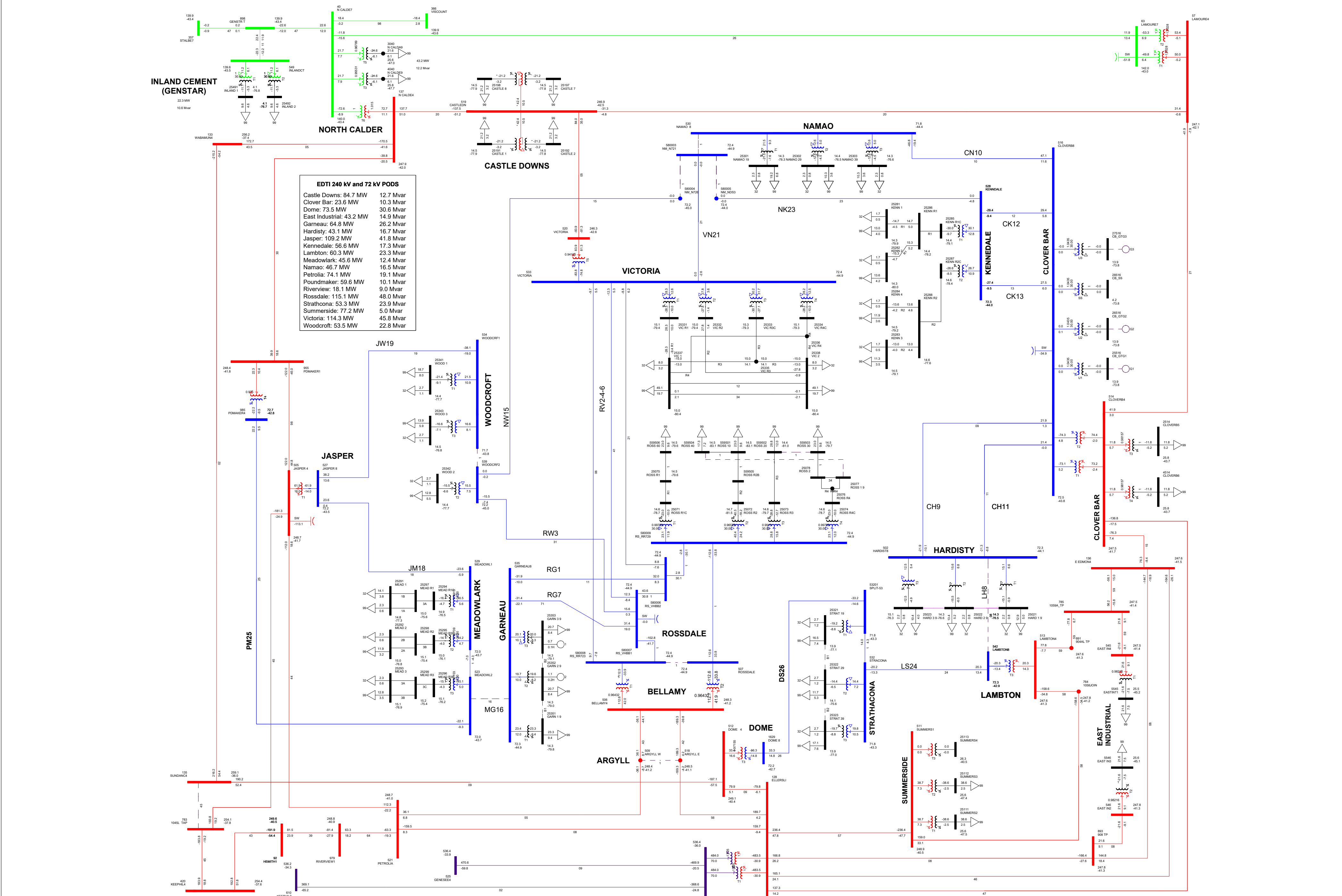
Table 2-4: Stuck Breaker Clearing Times for Lines

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

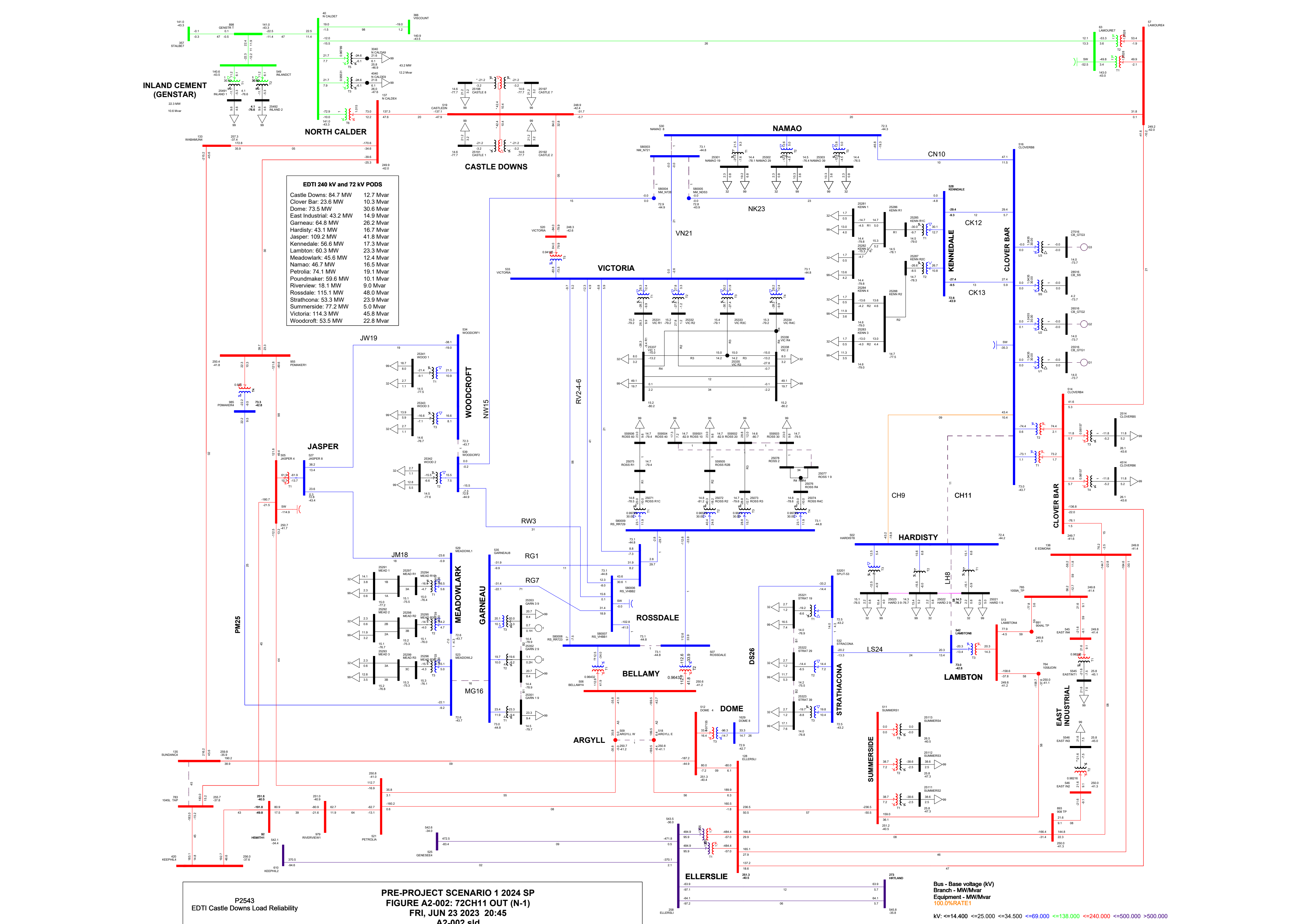


P2543
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO 1 2024 SP
FIGURE A2-001: (N-0)
FRI, JUN 23 2023 20:45
A2-001.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

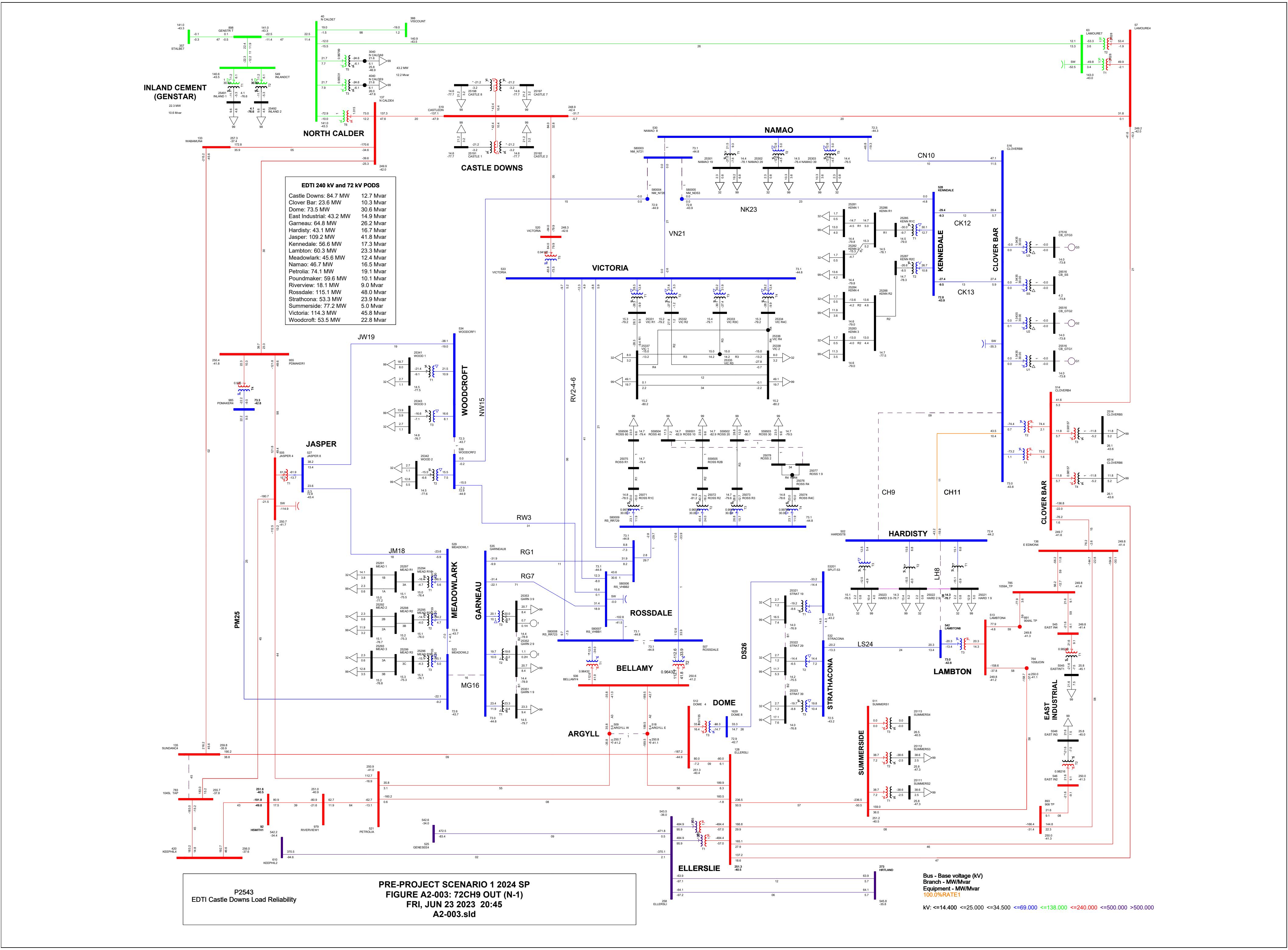
Castle Downs: 84.7 MW	12.7 Mvar
Clover Bar: 23.6 MW	10.3 Mvar
Dome: 73.5 MW	30.6 Mvar
East Industrial: 43.2 MW	14.9 Mvar
Garneau: 64.8 MW	26.2 Mvar
Hardisty: 43.1 MW	16.7 Mvar
Jasper: 109.2 MW	41.8 Mvar
Kennedale: 56.6 MW	17.3 Mvar
Lambton: 60.3 MW	23.3 Mvar
Meadowlark: 45.6 MW	12.4 Mvar
Namao: 46.7 MW	16.5 Mvar
Petrolia: 74.1 MW	19.1 Mvar
Poundmaker: 59.6 MW	10.1 Mvar
Riverview: 18.1 MW	9.0 Mvar
Rossdale: 115.1 MW	48.0 Mvar
Strathcona: 53.3 MW	23.9 Mvar
Summerside: 77.2 MW	5.0 Mvar
Victoria: 114.3 MW	45.8 Mvar
Woodcroft: 53.5 MW	22.8 Mvar

P2543
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO 1 2024 SP
FIGURE A2-002: 72CH11 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-002.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

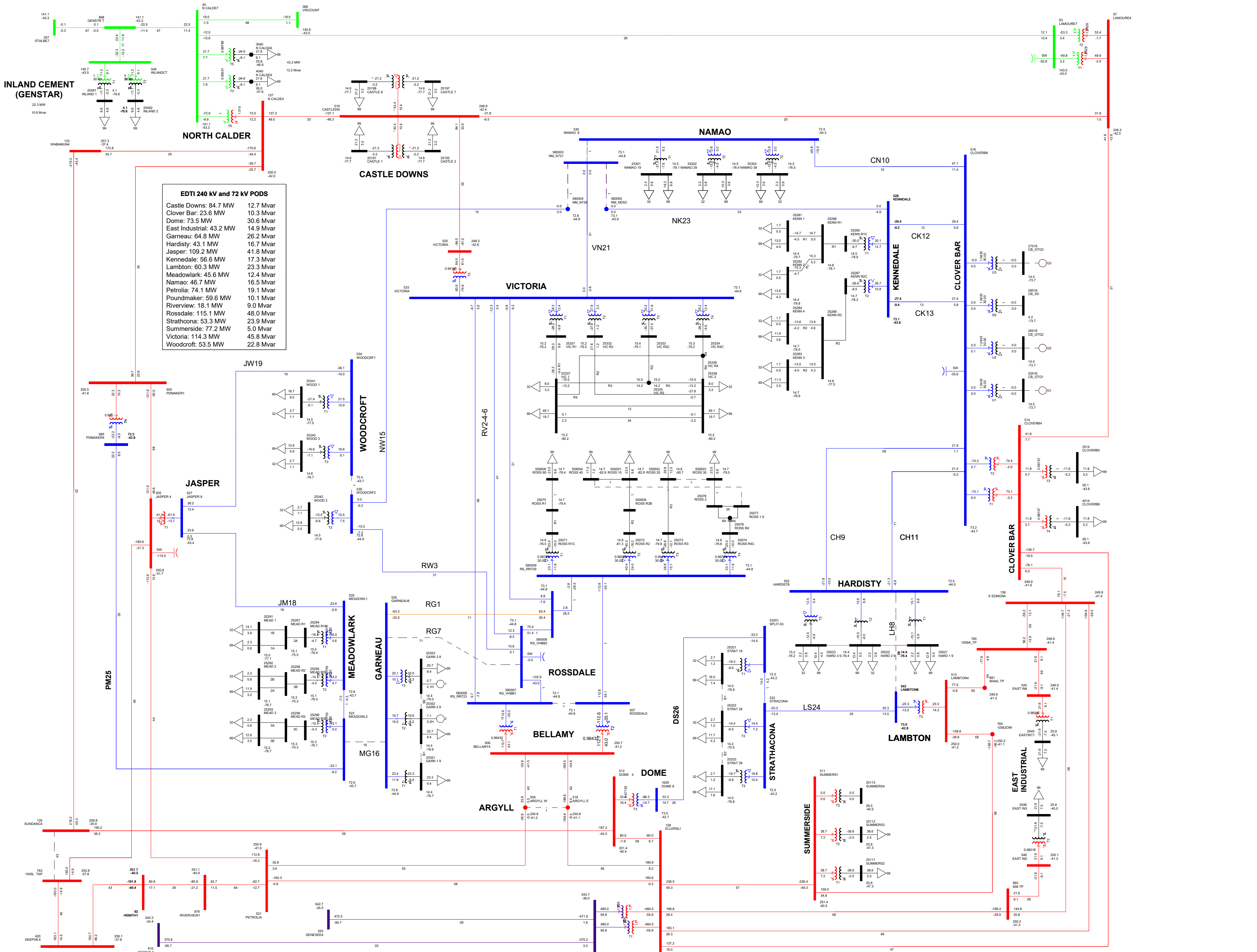


EDTI 240 kV and 72 kV PODS

Castle Downs: 84.7 MW	12.7 Mvar
Clover Bar: 23.6 MW	10.3 Mvar
Dome: 73.5 MW	30.6 Mvar
East Industrial: 43.2 MW	14.9 Mvar
Garneau: 64.8 MW	26.2 Mvar
Hardisty: 43.1 MW	16.7 Mvar
Jasper: 109.2 MW	41.8 Mvar
Kennedale: 56.6 MW	17.3 Mvar
Lambton: 60.3 MW	23.3 Mvar
Meadowlark: 45.6 MW	12.4 Mvar
Namao: 46.7 MW	16.5 Mvar
Petrolia: 74.1 MW	19.1 Mvar
Poundmaker: 59.6 MW	10.1 Mvar
Riverview: 18.1 MW	9.0 Mvar
Rossdale: 115.1 MW	48.0 Mvar
Strathcona: 53.3 MW	23.9 Mvar
Summerside: 77.2 MW	5.0 Mvar
Victoria: 114.3 MW	45.8 Mvar
Woodcroft: 53.5 MW	22.8 Mvar

P2543
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO 1 2024 SP
FIGURE A2-003: 72CH9 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-003.sld



EDTI 240 kV and 72 kV PODS

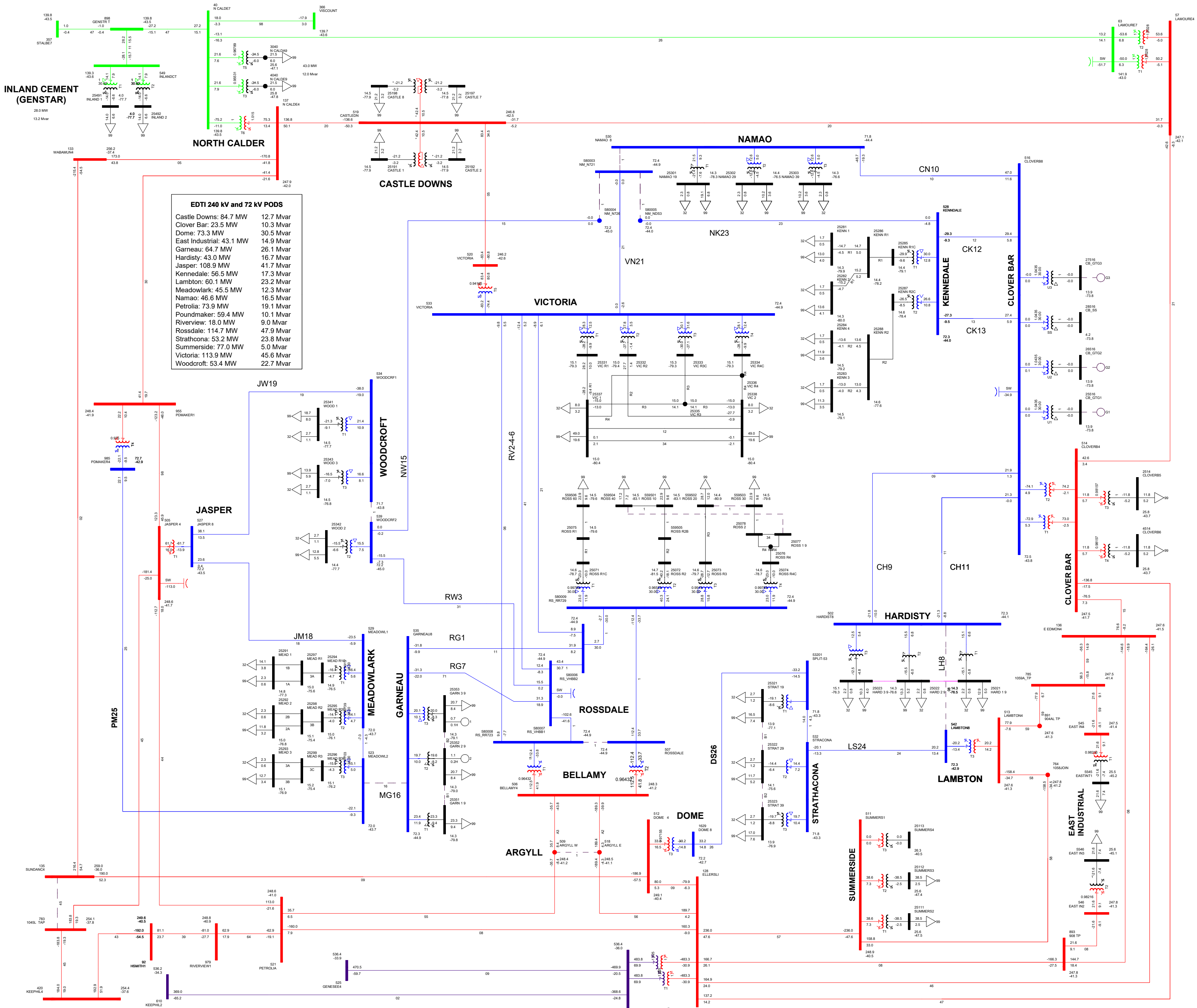
Castle Downs: 84.7 MW	12.7 Mvar
Clover Bar: 23.6 MW	10.3 Mvar
Dome: 73.5 MW	30.6 Mvar
East Industrial: 43.2 MW	14.9 Mvar
Garneau: 64.8 MW	26.2 Mvar
Hardisty: 43.1 MW	16.7 Mvar
Jasper: 109.2 MW	41.8 Mvar
Kennedale: 56.6 MW	17.3 Mvar
Lambton: 60.3 MW	23.3 Mvar
Meadowlark: 45.6 MW	12.4 Mvar
Namao: 46.7 MW	16.5 Mvar
Petrolia: 74.1 MW	19.1 Mvar
Poundmaker: 59.6 MW	10.1 Mvar
Riverview: 18.1 MW	9.0 Mvar
Rossdale: 115.1 MW	48.0 Mvar
Strathcona: 53.3 MW	23.9 Mvar
Summerside: 77.2 MW	5.0 Mvar
Victoria: 114.3 MW	45.8 Mvar
Woodcroft: 53.5 MW	22.8 Mvar

P2543
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO 1 2024 SP
FIGURE A2-004: 72RG7 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-004.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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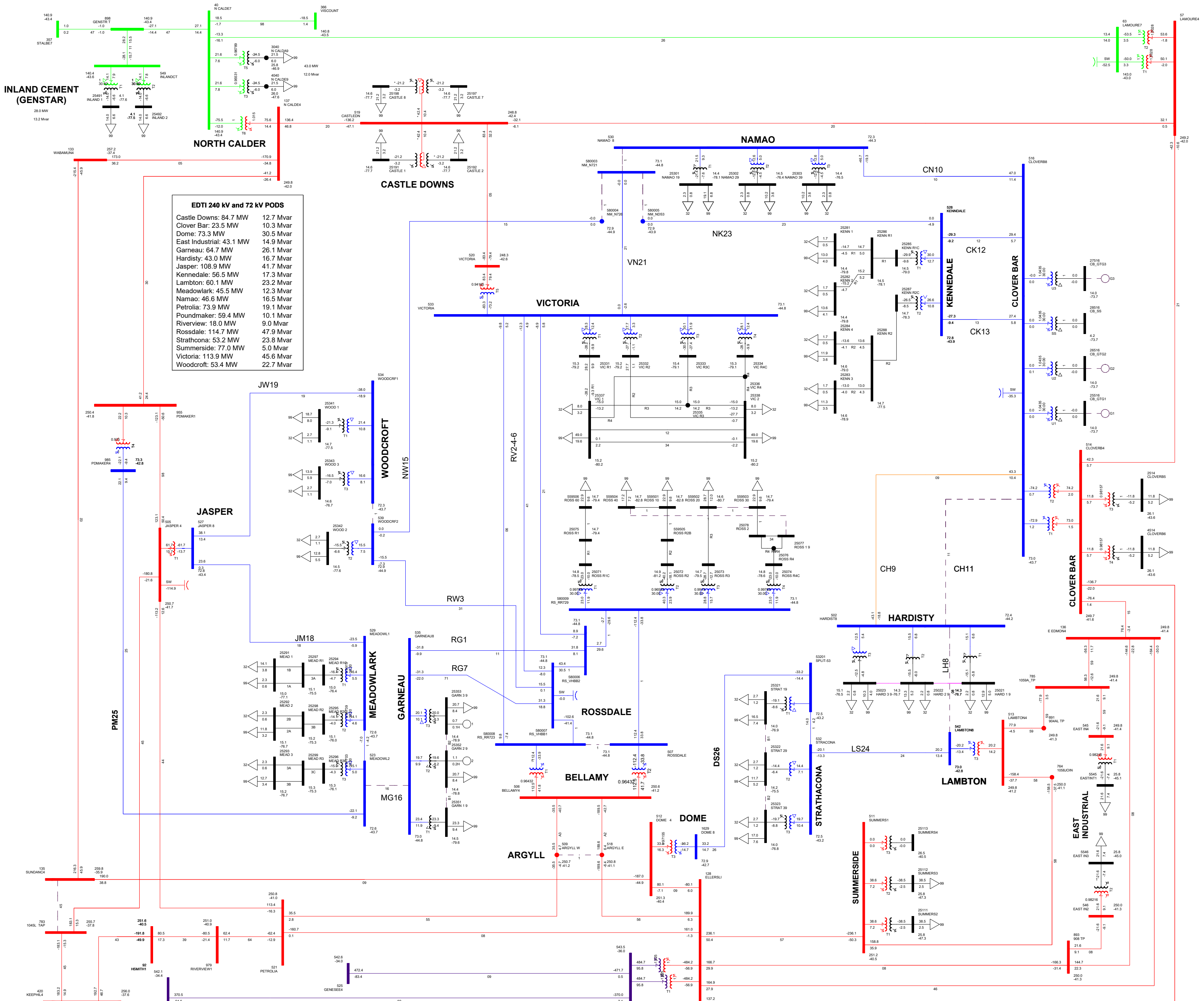
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO S1 2024 SP (SENSITIVITY)
FIGURE A2-005: (N-0)
FRI, JUN 23 2023 20:45
A2-005.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

Castle Downs: 84.7 MW	12.7 Mvar
Clover Bar: 23.5 MW	10.3 Mvar
Dome: 73.3 MW	30.5 Mvar
East Industrial: 43.1 MW	14.9 Mvar
Garneau: 64.7 MW	26.1 Mvar
Hardisty: 43.0 MW	16.7 Mvar
Jasper: 108.9 MW	41.7 Mvar
Kennedale: 56.5 MW	17.3 Mvar
Lambton: 60.1 MW	23.2 Mvar
Meadowlark: 45.5 MW	12.3 Mvar
Namao: 46.6 MW	16.5 Mvar
Petrolia: 73.9 MW	19.1 Mvar
Poundmaker: 59.4 MW	10.1 Mvar
Riverview: 18.0 MW	9.0 Mvar
Rossdale: 114.7 MW	47.9 Mvar
Strathcona: 53.2 MW	23.8 Mvar
Summerside: 77.0 MW	5.0 Mvar
Victoria: 113.9 MW	45.6 Mvar
Woodcroft: 53.4 MW	22.7 Mvar

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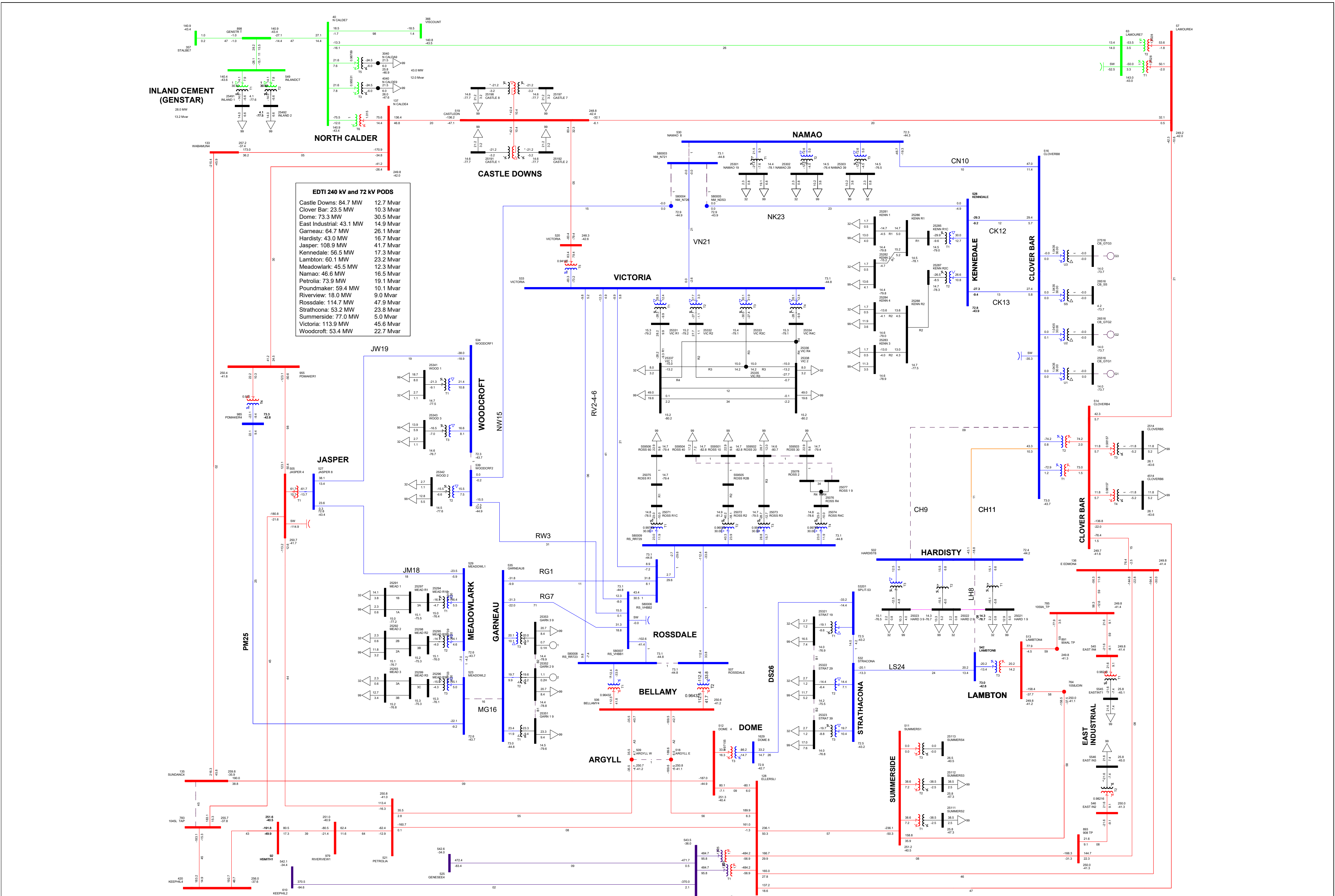
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO S1 2024 SP (SENSITIVITY)
FIGURE A2-006: 72CH11 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-006.sld



EDTI 240 kV and 72 kV PODS

Castle Downs: 84.7 MW	12.7 Mvar
Clover Bar: 23.5 MW	10.3 Mvar
Dome: 73.3 MW	30.5 Mvar
East Industrial: 43.1 MW	14.9 Mvar
Garneau: 64.7 MW	26.1 Mvar
Hardisty: 43.0 MW	16.7 Mvar
Jasper: 108.9 MW	41.7 Mvar
Kennedale: 56.5 MW	17.3 Mvar
Lambton: 60.1 MW	23.2 Mvar
Meadowlark: 45.5 MW	12.3 Mvar
Namao: 46.6 MW	16.5 Mvar
Petrolia: 73.9 MW	19.1 Mvar
Poundmaker: 59.4 MW	10.1 Mvar
Riverview: 18.0 MW	9.0 Mvar
Rossdale: 114.7 MW	47.9 Mvar
Strathcona: 53.2 MW	23.8 Mvar
Summerside: 77.0 MW	5.0 Mvar
Victoria: 113.9 MW	45.6 Mvar
Woodcroft: 53.4 MW	22.7 Mvar

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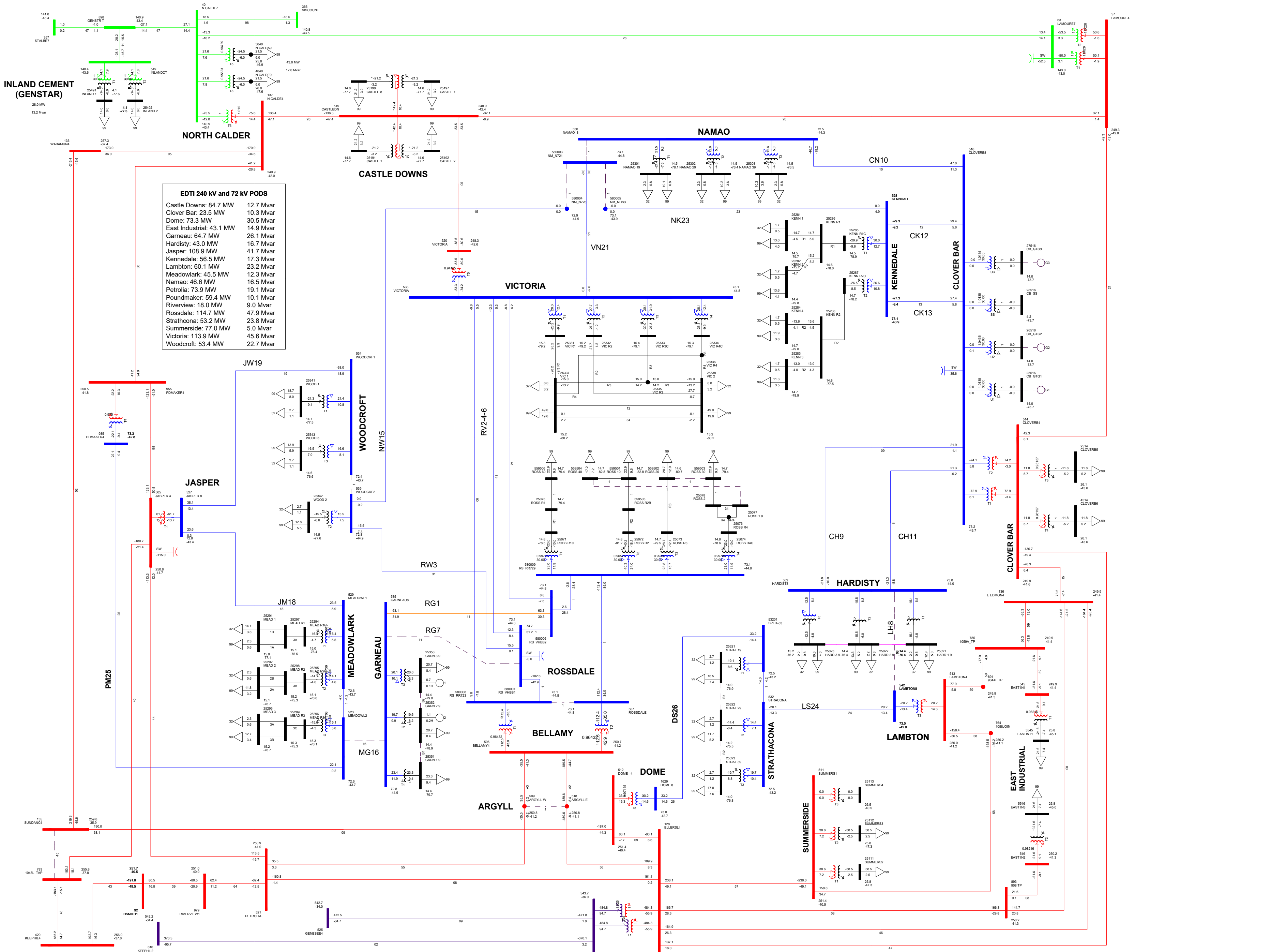
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO S1 2024 SP (SENSITIVITY)
FIGURE A2-007: 72CH9 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-007.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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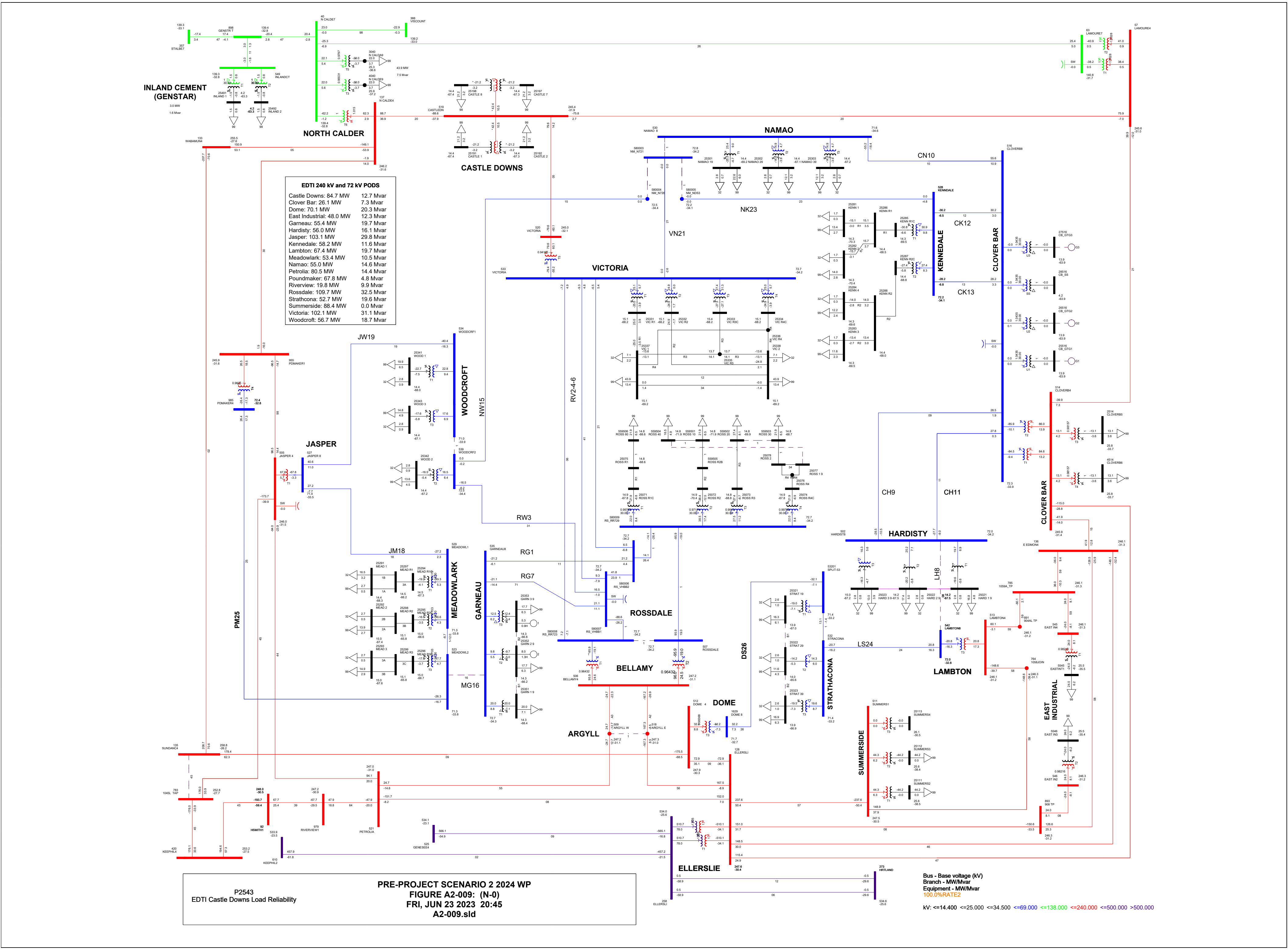
EDTI Castle Downs Load Reliability

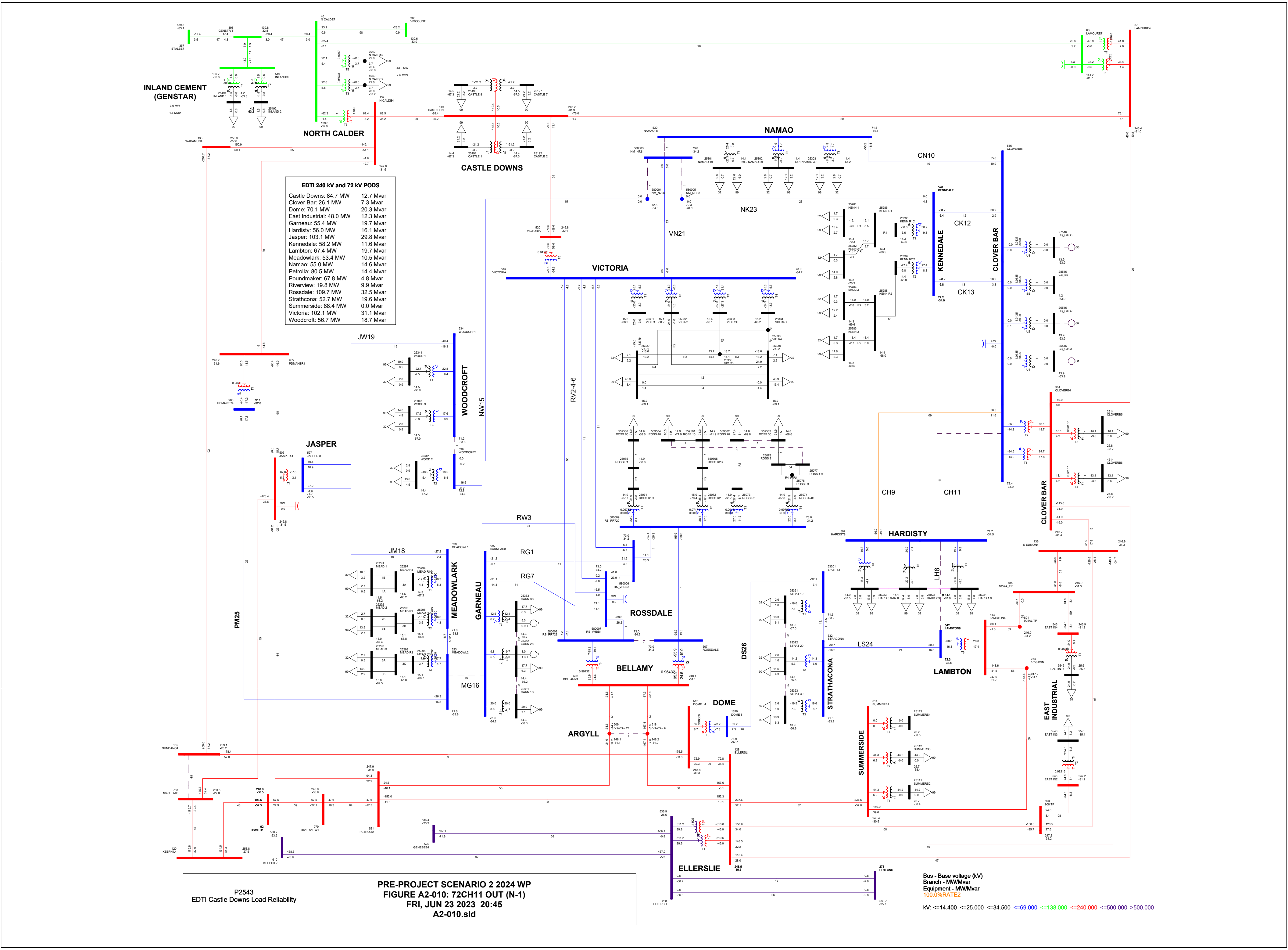
PRE-PROJECT SCENARIO S1 2024 SP (SENSITIVITY)
FIGURE A2-008: 72RG7 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-008.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



INLAND CEMENT (GENSTAR)
NORTH CALDER
CASTLE DOWNS
NAMAO
CN10
NK23
VN21
CK12
CK13
KENNEDALE
CLOVER BAR
VICTORIA
EDTI 240 kV and 72 kV PODS
Castle Downs: 84.7 MW 12.7 Mvar
Clover Bar: 26.1 MW 7.3 Mvar
Dome: 70.1 MW 20.3 Mvar
East Industrial: 48.0 MW 12.3 Mvar
Garneau: 55.4 MW 19.7 Mvar
Hardisty: 56.0 MW 16.1 Mvar
Jasper: 103.1 MW 29.8 Mvar
Kennedale: 58.2 MW 11.6 Mvar
Lambton: 67.4 MW 19.7 Mvar
Meadowlark: 53.4 MW 10.5 Mvar
Namao: 55.0 MW 14.6 Mvar
Petrolia: 80.5 MW 14.4 Mvar
Poundmaker: 67.8 MW 4.8 Mvar
Riverview: 19.8 MW 9.9 Mvar
Rossdale: 109.7 MW 32.5 Mvar
Strathcona: 52.7 MW 19.6 Mvar
Summerside: 88.4 MW 0.0 Mvar
Victoria: 102.1 MW 31.1 Mvar
Woodcroft: 56.7 MW 18.7 Mvar
JW19
WOODCROFT
NW15
RV24-6
JASPER
PM25
CH9
CH11
HARDISTY
RW3
JM18
MEADOWLARK
GARNEAU
RG1
RG7
ROSSDALE
MG16
BELLAMY
LH8
LAMBTON
LS24
STRATHCONA
DS26
DOME
ARGYLL
EAST INDUSTRIAL
SUMMERSIDE
ELLERSLIE
P2543
EDTI Castle Downs Load Reliability
PRE-PROJECT SCENARIO 2 2024 WP
FIGURE A2-009: (N-0)
FRI, JUN 23 2023 20:45
A2-009.sld
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



INLAND CEMENT (GENSTAR)
NORTH CALDER
CASTLE DOWNS
NAMAO
CN10
NK23
VN21
VICTORIA
CK12
CK13
KENNEDALE
CLOVER BAR
JW19
WOODCROFT
NW15
RV24-6
JASPER
RW3
JM18
MEADOWLARK
GARNEAU
RG1
RG7
ROSSDALE
BELLAMY
MG16
ARGYLL
DOME
DS26
STRATHACONA
LS24
LAMBTON
HARDISTY
CH9
CH11
LH8
EAST INDUSTRIAL
SUMMERSIDE
ELLERSLIE
PM25
EDTI 240 kV and 72 kV PODS
Castle Downs: 84.7 MW 12.7 Mvar
Clover Bar: 26.1 MW 7.3 Mvar
Dome: 70.1 MW 20.3 Mvar
East Industrial: 48.0 MW 12.3 Mvar
Garneau: 55.4 MW 19.7 Mvar
Hardisty: 56.0 MW 16.1 Mvar
Jasper: 103.1 MW 29.8 Mvar
Kennedale: 58.2 MW 11.6 Mvar
Lambton: 67.4 MW 19.7 Mvar
Meadowlark: 53.4 MW 10.5 Mvar
Namao: 55.0 MW 14.6 Mvar
Petrolia: 80.5 MW 14.4 Mvar
Poundmaker: 67.8 MW 4.8 Mvar
Riverview: 19.8 MW 9.9 Mvar
Rossdale: 109.7 MW 32.5 Mvar
Strathcona: 52.7 MW 19.6 Mvar
Summerside: 88.4 MW 0.0 Mvar
Victoria: 102.1 MW 31.1 Mvar
Woodcroft: 56.7 MW 18.7 Mvar
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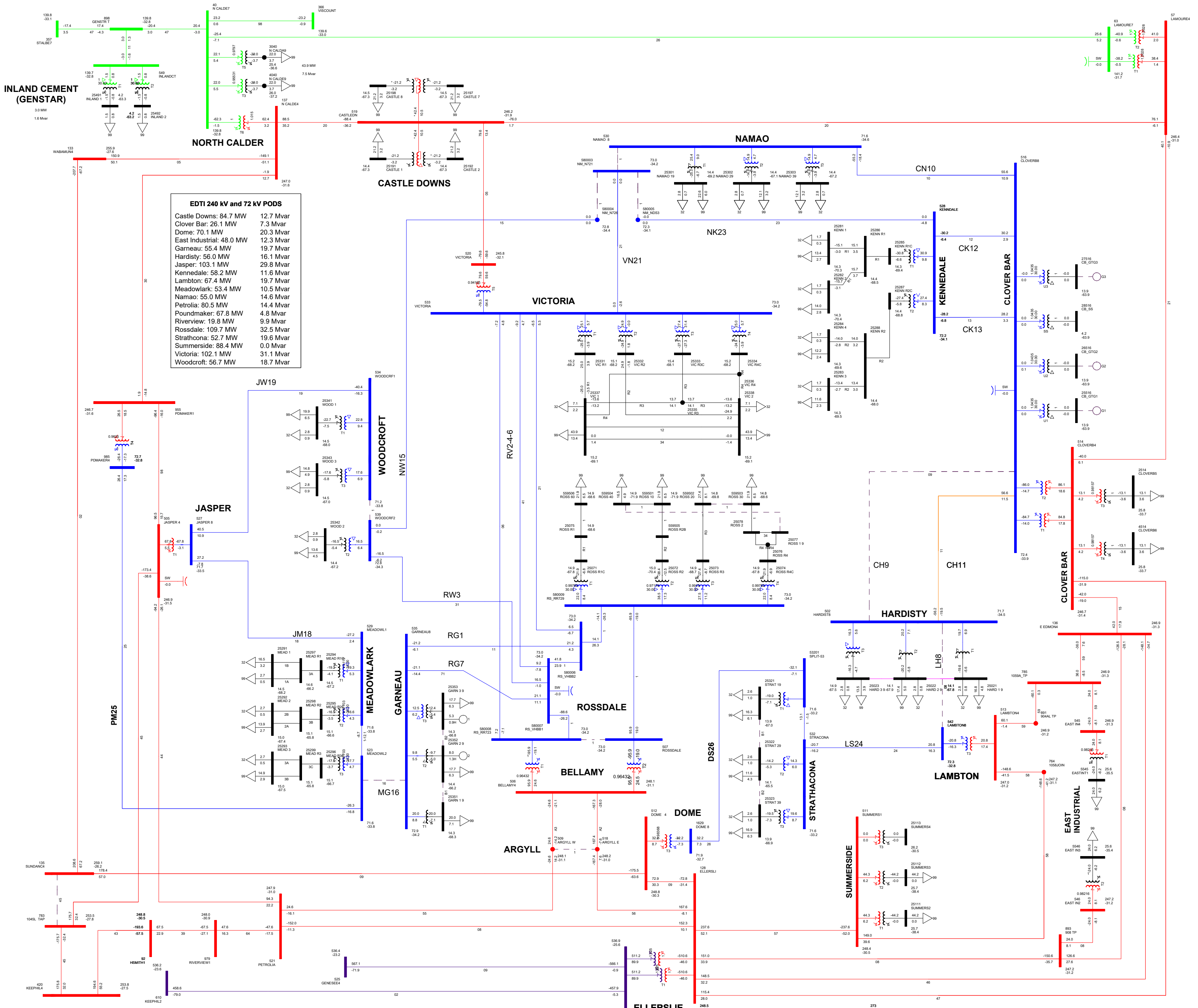
EDTI Castle Downs Load Reliability
PRE-PROJECT SCENARIO 2 2024 WP
FIGURE A2-010: 72CH11 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-010.sld
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

Castle Downs: 84.7 MW	12.7 Mvar
Clover Bar: 26.1 MW	7.3 Mvar
Dome: 70.1 MW	20.3 Mvar
East Industrial: 48.0 MW	12.3 Mvar
Garneau: 55.4 MW	19.7 Mvar
Hardisty: 56.0 MW	16.1 Mvar
Jasper: 103.1 MW	29.8 Mvar
Kennedale: 58.2 MW	11.6 Mvar
Lambton: 67.4 MW	19.7 Mvar
Meadowlark: 53.4 MW	10.5 Mvar
Namao: 55.0 MW	14.6 Mvar
Petrolia: 80.5 MW	14.4 Mvar
Poundmaker: 67.8 MW	4.8 Mvar
Riverview: 19.8 MW	9.9 Mvar
Rossdale: 109.7 MW	32.5 Mvar
Strathcona: 52.7 MW	19.6 Mvar
Summerside: 88.4 MW	0.0 Mvar
Victoria: 102.1 MW	31.1 Mvar
Woodcroft: 56.7 MW	18.7 Mvar

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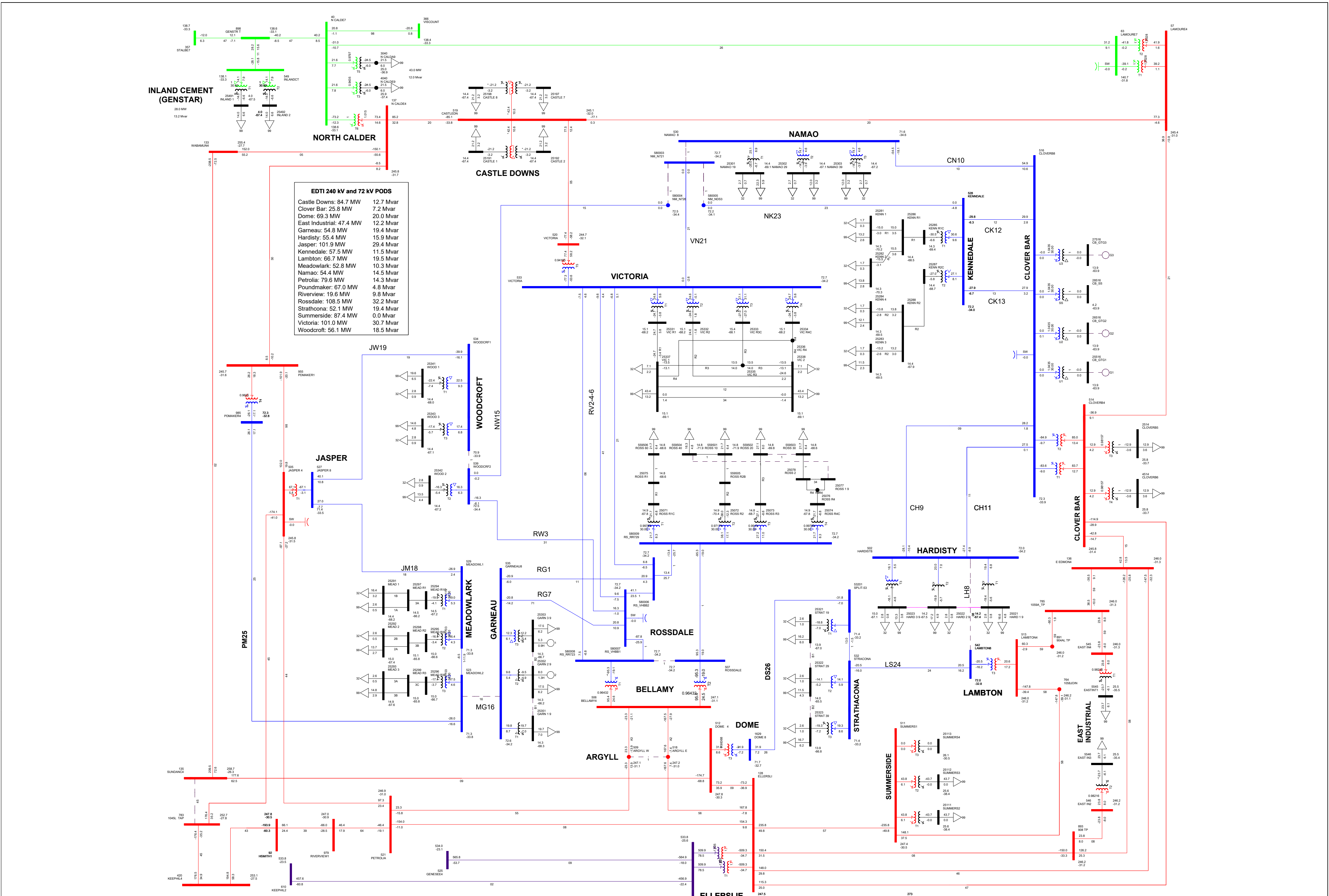
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO 2 2024 WP
FIGURE A2-011: 72CH9 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-011.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

Castle Downs: 84.7 MW	12.7 Mvar
Clover Bar: 25.8 MW	7.2 Mvar
Dome: 69.3 MW	20.0 Mvar
East Industrial: 47.4 MW	12.2 Mvar
Garneau: 54.8 MW	19.4 Mvar
Hardisty: 55.4 MW	15.9 Mvar
Jasper: 101.9 MW	29.4 Mvar
Kennedale: 57.5 MW	11.5 Mvar
Lambton: 66.7 MW	19.5 Mvar
Meadowlark: 52.8 MW	10.3 Mvar
Namao: 54.4 MW	14.5 Mvar
Petrolia: 79.6 MW	14.3 Mvar
Poundmaker: 67.0 MW	4.8 Mvar
Riverview: 19.6 MW	9.8 Mvar
Rossdale: 108.5 MW	32.2 Mvar
Strathcona: 52.1 MW	19.4 Mvar
Summerside: 87.4 MW	0.0 Mvar
Victoria: 101.0 MW	30.7 Mvar
Woodcroft: 56.1 MW	18.5 Mvar

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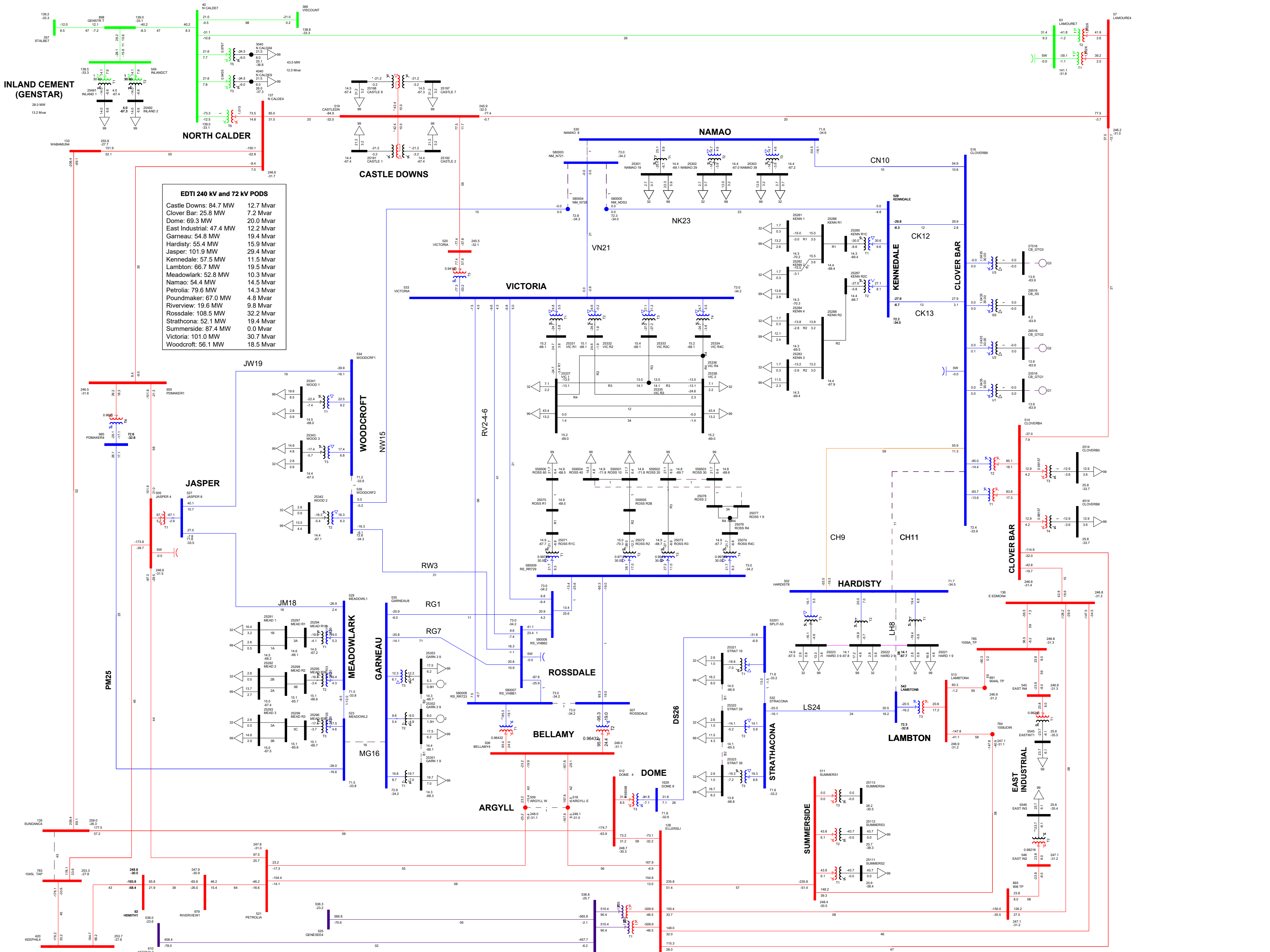
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO S2 2024 WP (SENSITIVITY)
FIGURE A2-012: (N-0)
FRI, JUN 23 2023 20:45
A2-012.sld



EDTI 240 kV and 72 kV PODS

Castle Downs: 84.7 MW	12.7 Mvar
Clover Bar: 25.8 MW	7.2 Mvar
Dome: 69.3 MW	20.0 Mvar
East Industrial: 47.4 MW	12.2 Mvar
Garneau: 54.8 MW	19.4 Mvar
Hardisty: 55.4 MW	15.9 Mvar
Jasper: 101.9 MW	29.4 Mvar
Kennedale: 57.5 MW	11.5 Mvar
Lambton: 66.7 MW	19.5 Mvar
Meadowlark: 52.8 MW	10.3 Mvar
Namao: 54.4 MW	14.5 Mvar
Petrolia: 79.6 MW	14.3 Mvar
Poundmaker: 67.0 MW	4.8 Mvar
Riverview: 19.6 MW	9.8 Mvar
Rossdale: 108.5 MW	32.2 Mvar
Strathcona: 52.1 MW	19.4 Mvar
Summerside: 87.4 MW	0.0 Mvar
Victoria: 101.0 MW	30.7 Mvar
Woodcroft: 56.1 MW	18.5 Mvar

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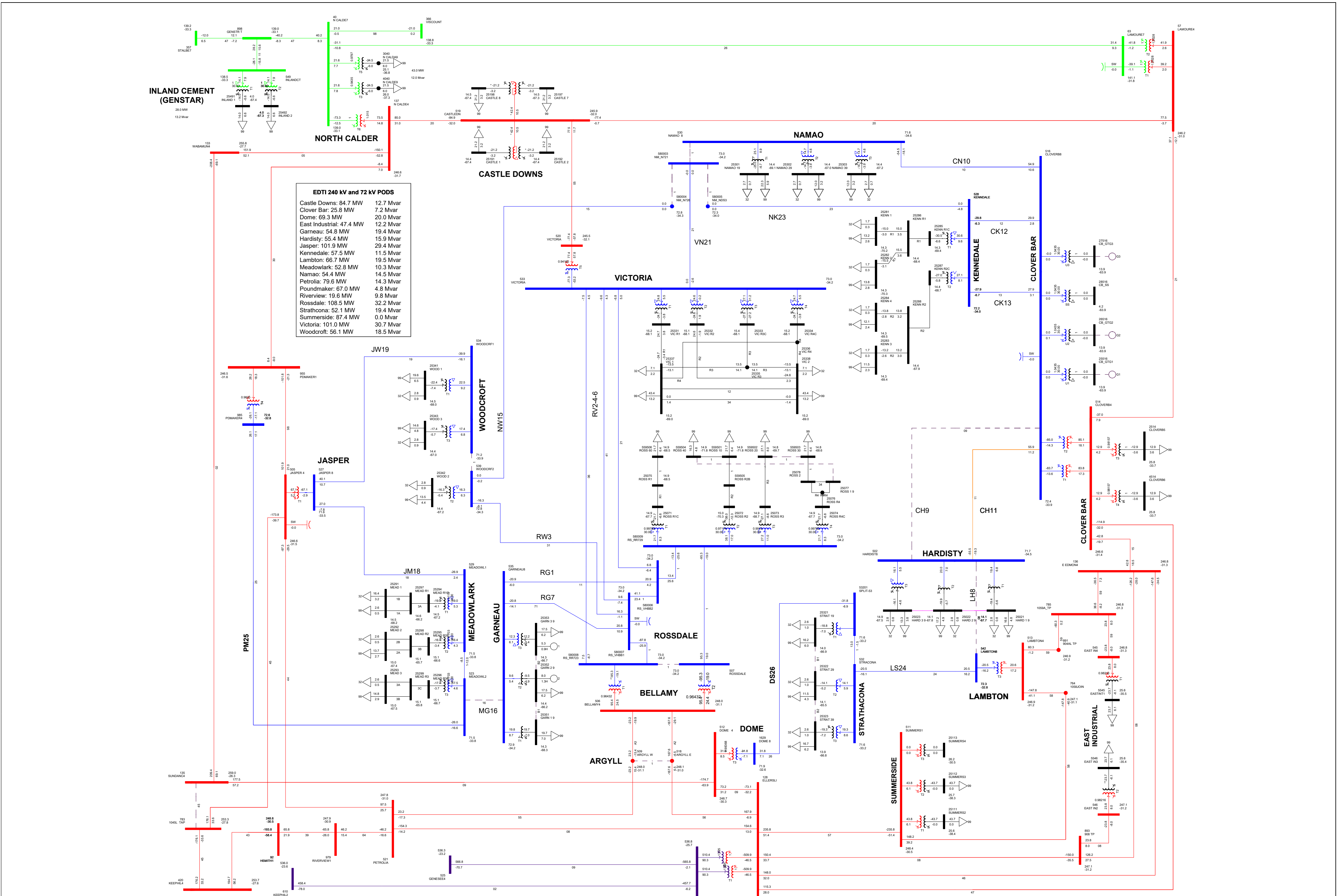
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO S2 2024 WP (SENSITIVITY)
FIGURE A2-013: 72CH11 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-013.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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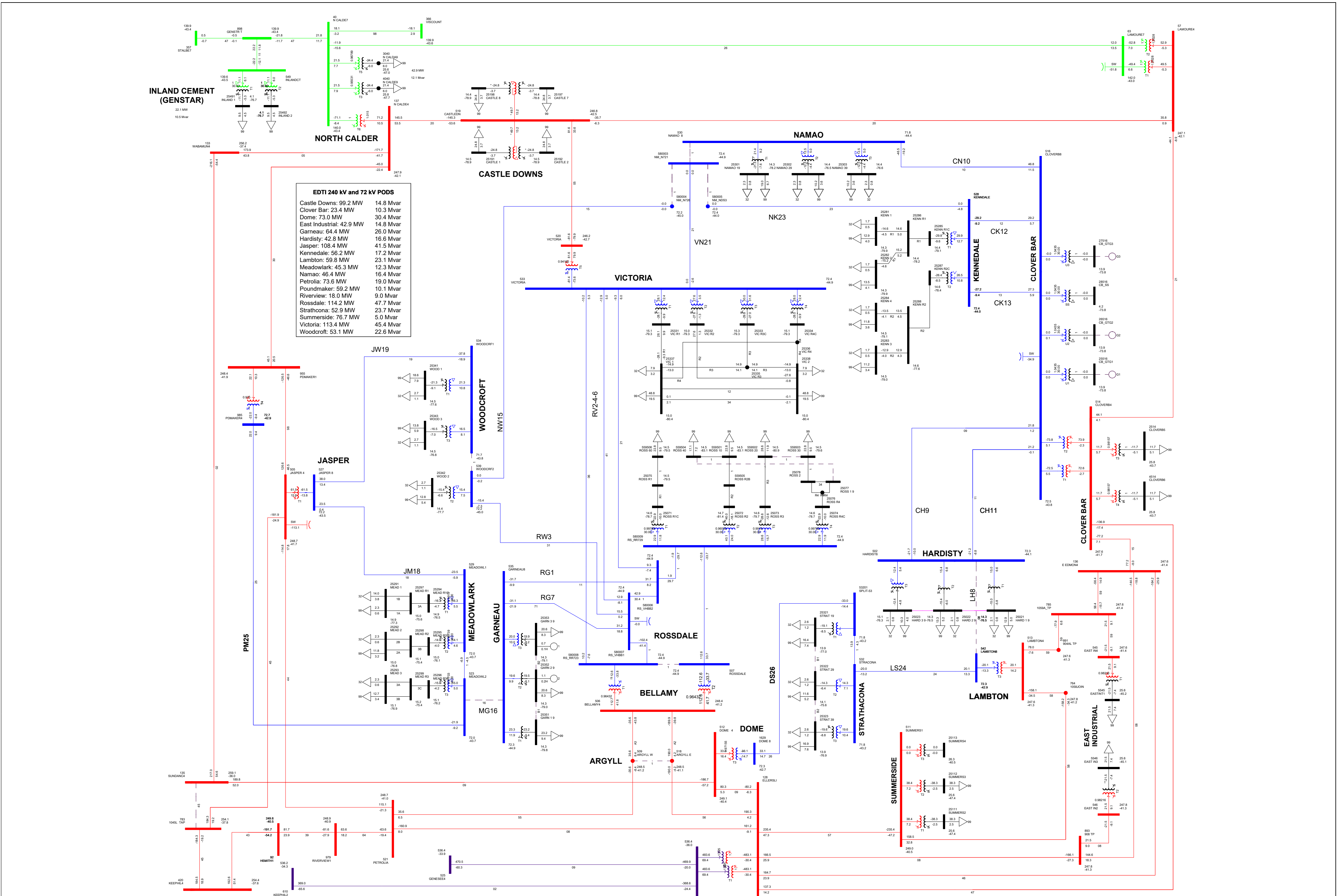
EDTI Castle Downs Load Reliability

PRE-PROJECT SCENARIO S2 2024 WP (SENSITIVITY)
FIGURE A2-014: 72CH9 OUT (N-1)
FRI, JUN 23 2023 20:45
A2-014.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Attachment A3
Post-Project Power Flow Diagrams



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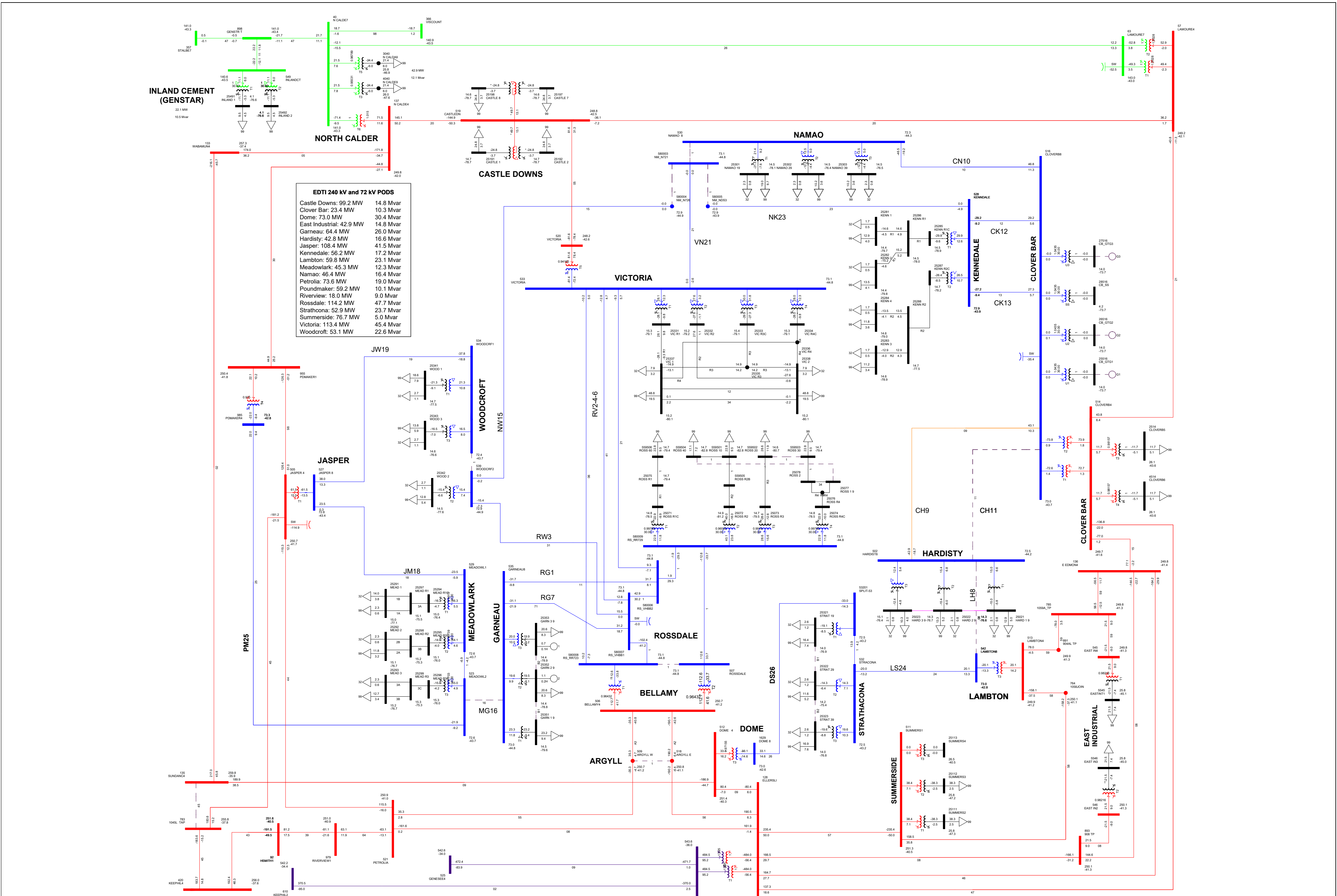
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO 3 2024 SP
FIGURE A3-001: (N-0)
FRI, JUN 23 2023 20:50
A3-001.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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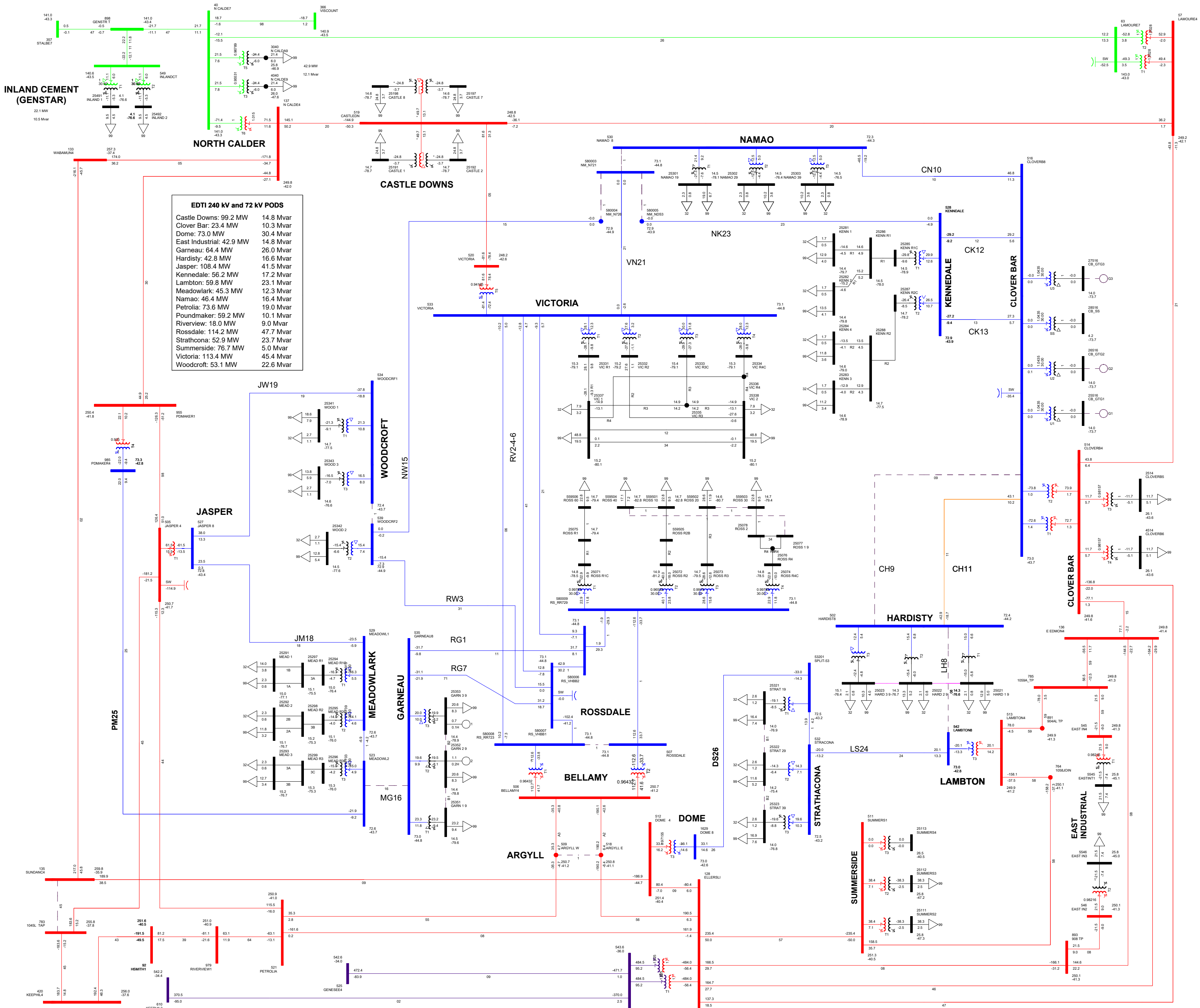
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO 3 2024 SP
FIGURE A3-002: 72CH11 OUT (N-1)
FRI, JUN 23 2023 20:50
A3-002.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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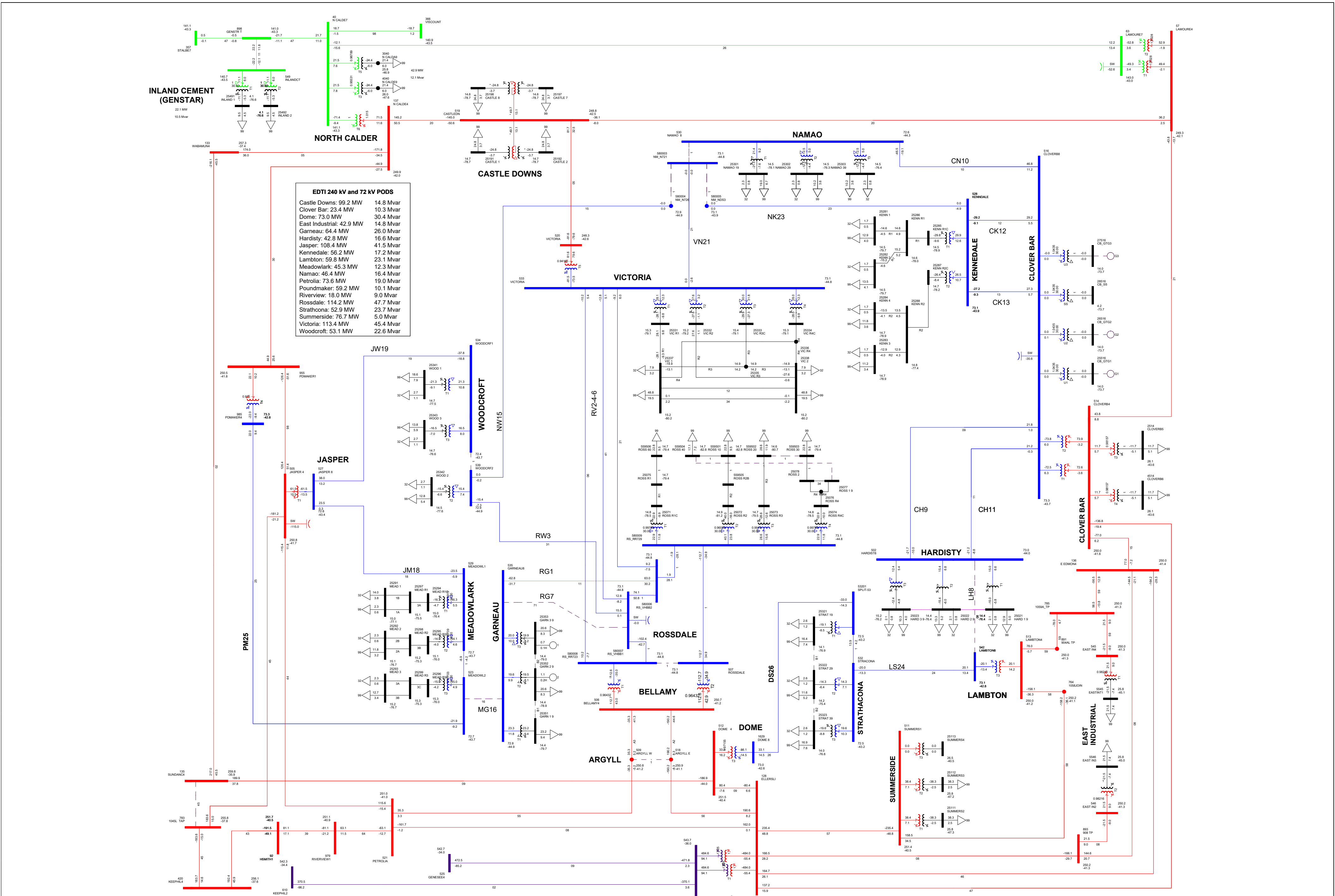
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO 3 2024 SP
FIGURE A3-003: 72CH9 OUT (N-1)
FRI, JUN 23 2023 20:50
A3-003.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

Castle Downs: 99.2 MW	14.8 Mvar
Clover Bar: 23.4 MW	10.3 Mvar
Dome: 73.0 MW	30.4 Mvar
East Industrial: 42.9 MW	14.8 Mvar
Garneau: 64.4 MW	26.0 Mvar
Hardisty: 42.8 MW	16.6 Mvar
Jasper: 108.4 MW	41.5 Mvar
Kennedale: 56.2 MW	17.2 Mvar
Lambton: 59.8 MW	23.1 Mvar
Meadowlark: 45.3 MW	12.3 Mvar
Namao: 46.4 MW	16.4 Mvar
Petrolia: 73.6 MW	19.0 Mvar
Poundmaker: 59.2 MW	10.1 Mvar
Riverview: 18.0 MW	9.0 Mvar
Rossdale: 114.2 MW	47.7 Mvar
Strathcona: 52.9 MW	23.7 Mvar
Summerside: 76.7 MW	5.0 Mvar
Victoria: 113.4 MW	45.4 Mvar
Woodcroft: 53.1 MW	22.6 Mvar

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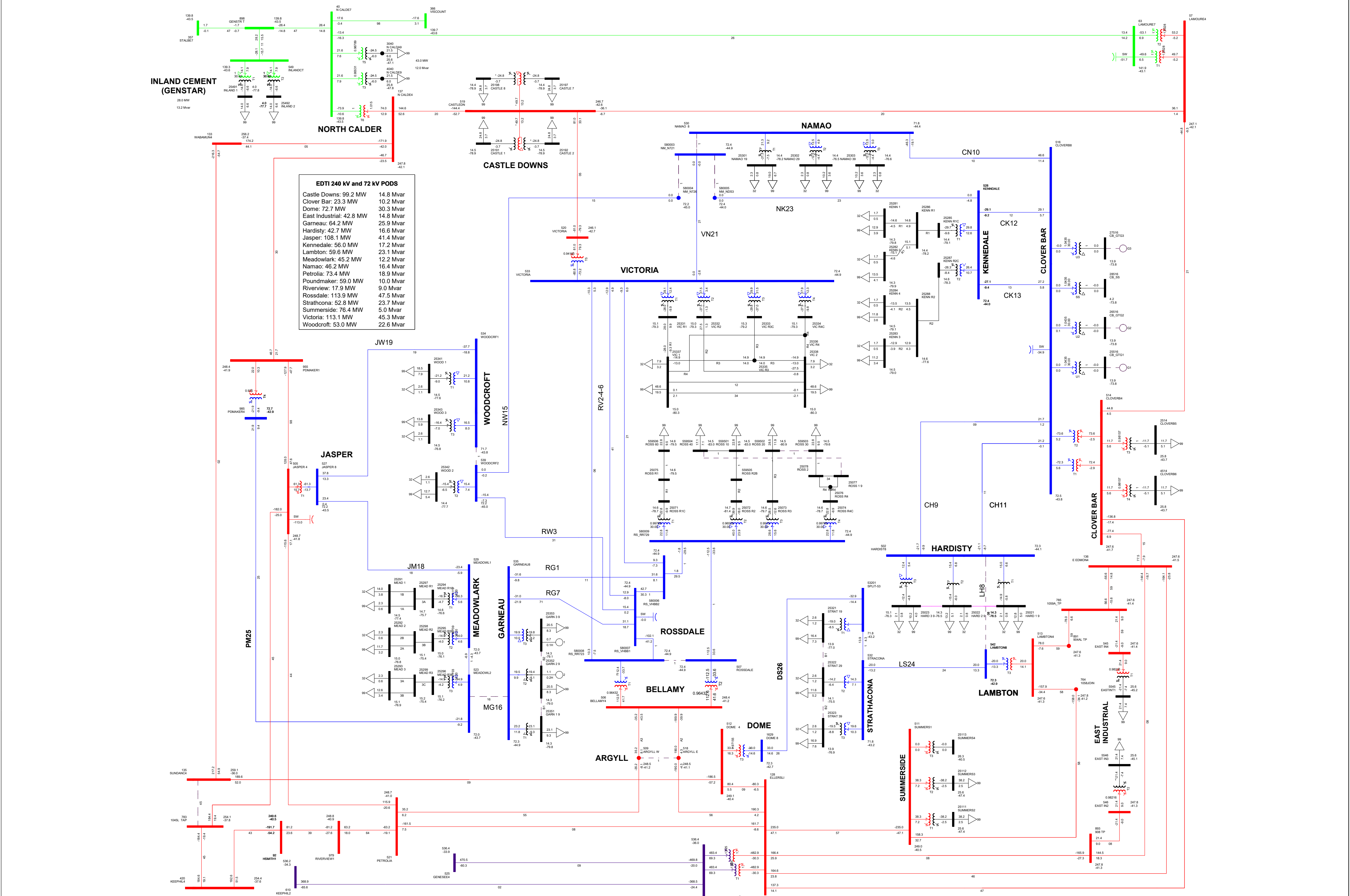
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO 3 2024 SP
FIGURE A3-004: 72RG7 OUT (N-1)
FRI, JUN 23 2023 20:50
A3-004.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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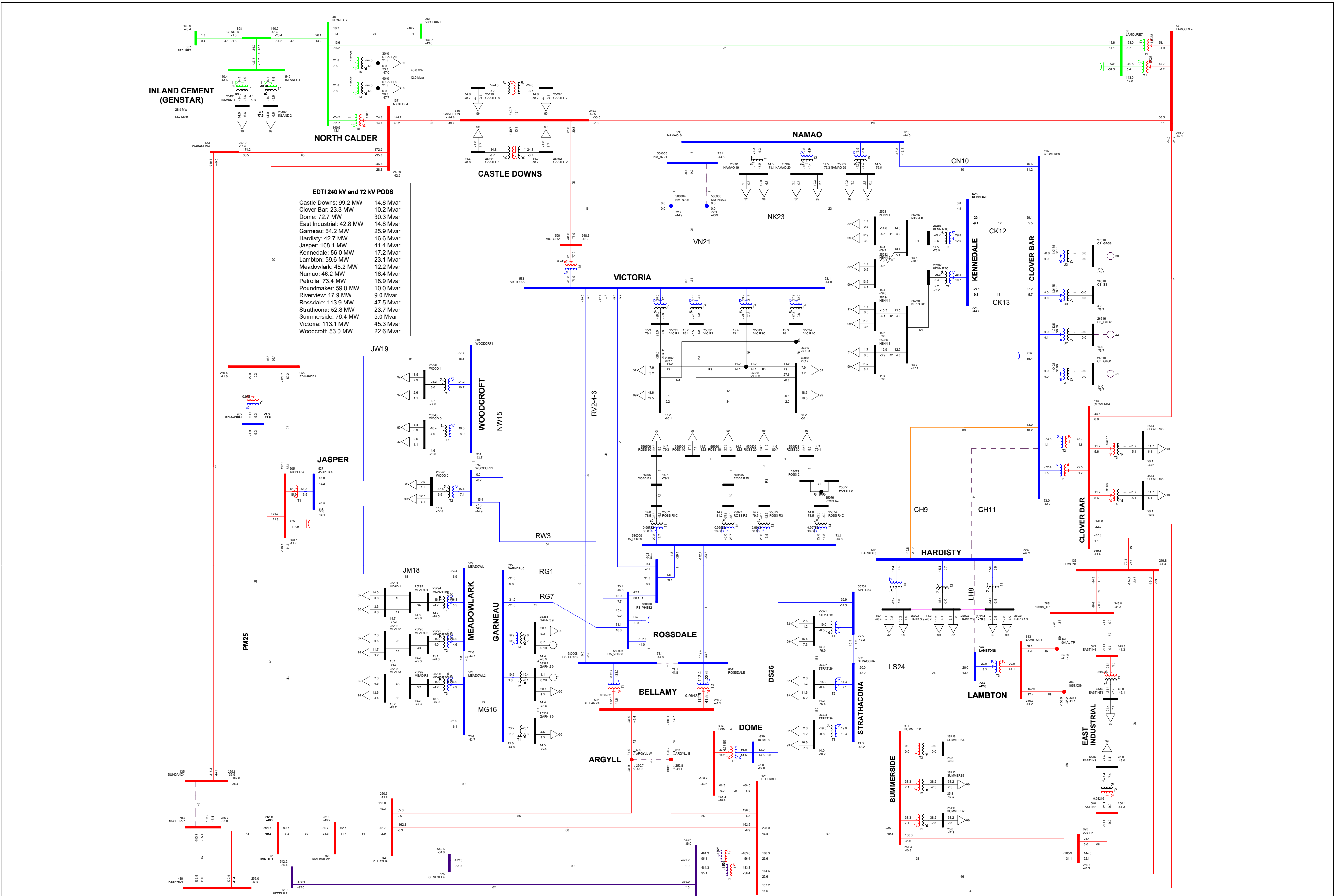
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO S3 2024 SP (SENSITIVITY)
FIGURE A3-005: (N-0)
FRI, JUN 23 2023 20:50
A3-005.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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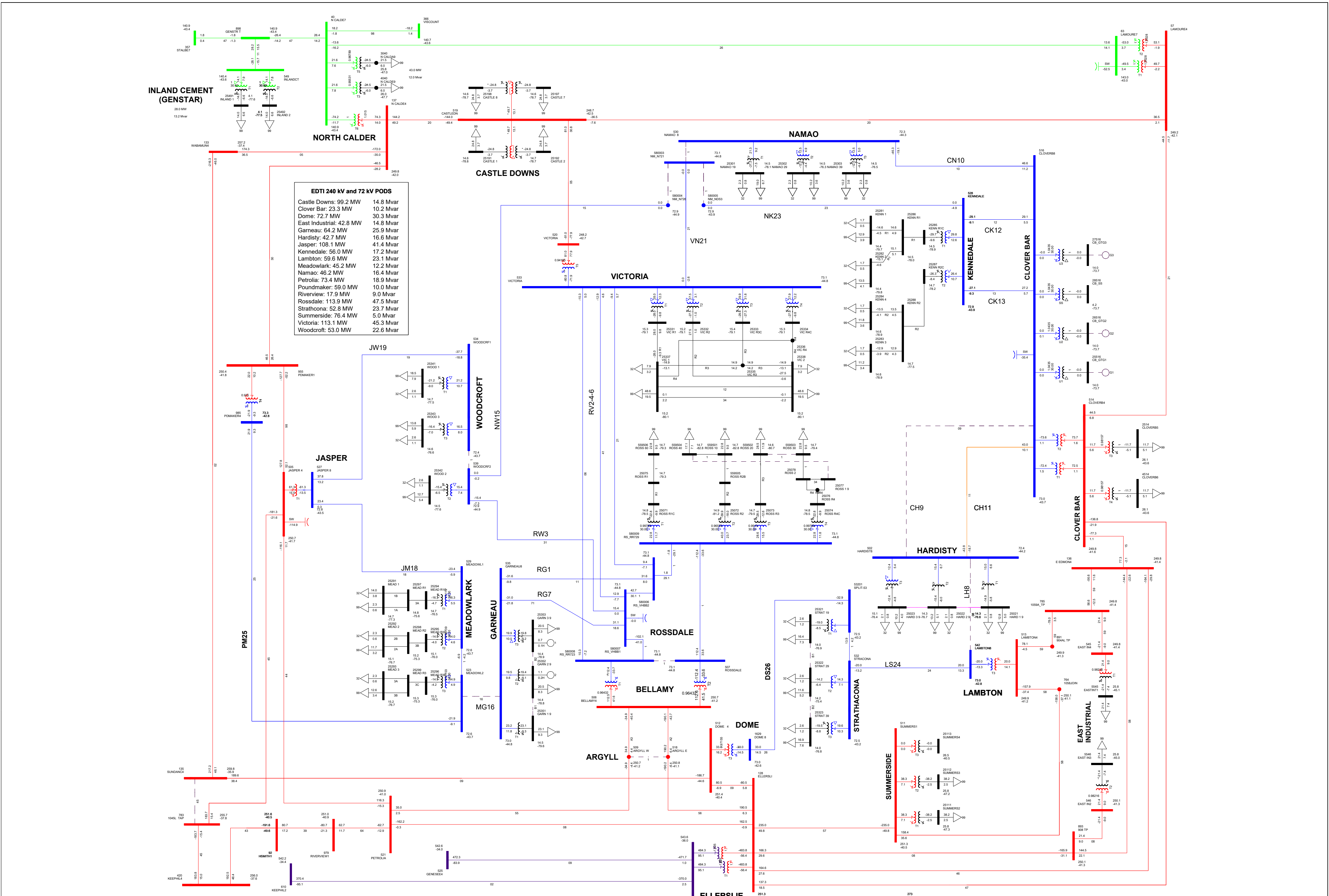
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO S3 2024 SP (SENSITIVITY)
FIGURE A3-006: 72CH11 OUT (N-1)
FRI, JUN 23 2023 20:50
A3-006.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

Castle Downs: 99.2 MW	14.8 Mvar
Clover Bar: 23.3 MW	10.2 Mvar
Dome: 72.7 MW	30.3 Mvar
East Industrial: 42.8 MW	14.8 Mvar
Garneau: 64.2 MW	25.9 Mvar
Hardisty: 42.7 MW	16.6 Mvar
Jasper: 108.1 MW	41.4 Mvar
Kennedale: 56.0 MW	17.2 Mvar
Lambton: 59.6 MW	23.1 Mvar
Meadowlark: 45.2 MW	12.2 Mvar
Namao: 46.2 MW	16.4 Mvar
Petrolia: 73.4 MW	18.9 Mvar
Poundmaker: 59.0 MW	10.0 Mvar
Riverview: 17.9 MW	9.0 Mvar
Rossdale: 113.9 MW	47.5 Mvar
Strathcona: 52.8 MW	23.7 Mvar
Summerside: 76.4 MW	5.0 Mvar
Victoria: 113.1 MW	45.3 Mvar
Woodcroft: 53.0 MW	22.6 Mvar

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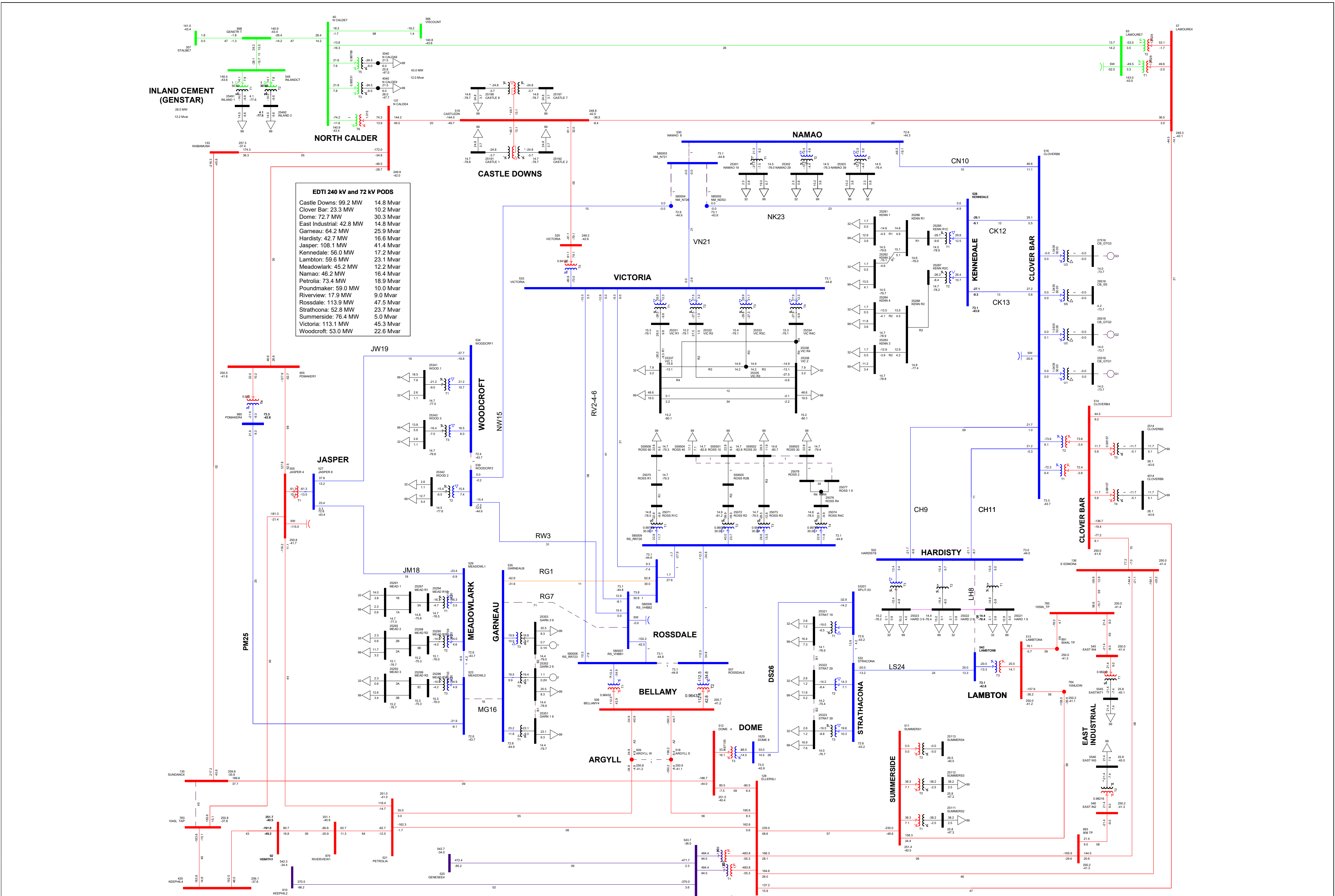
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO S3 2024 SP (SENSITIVITY)
FIGURE A3-007: 72CH9 OUT (N-1)
FRI, JUN 23 2023 20:50
A3-007.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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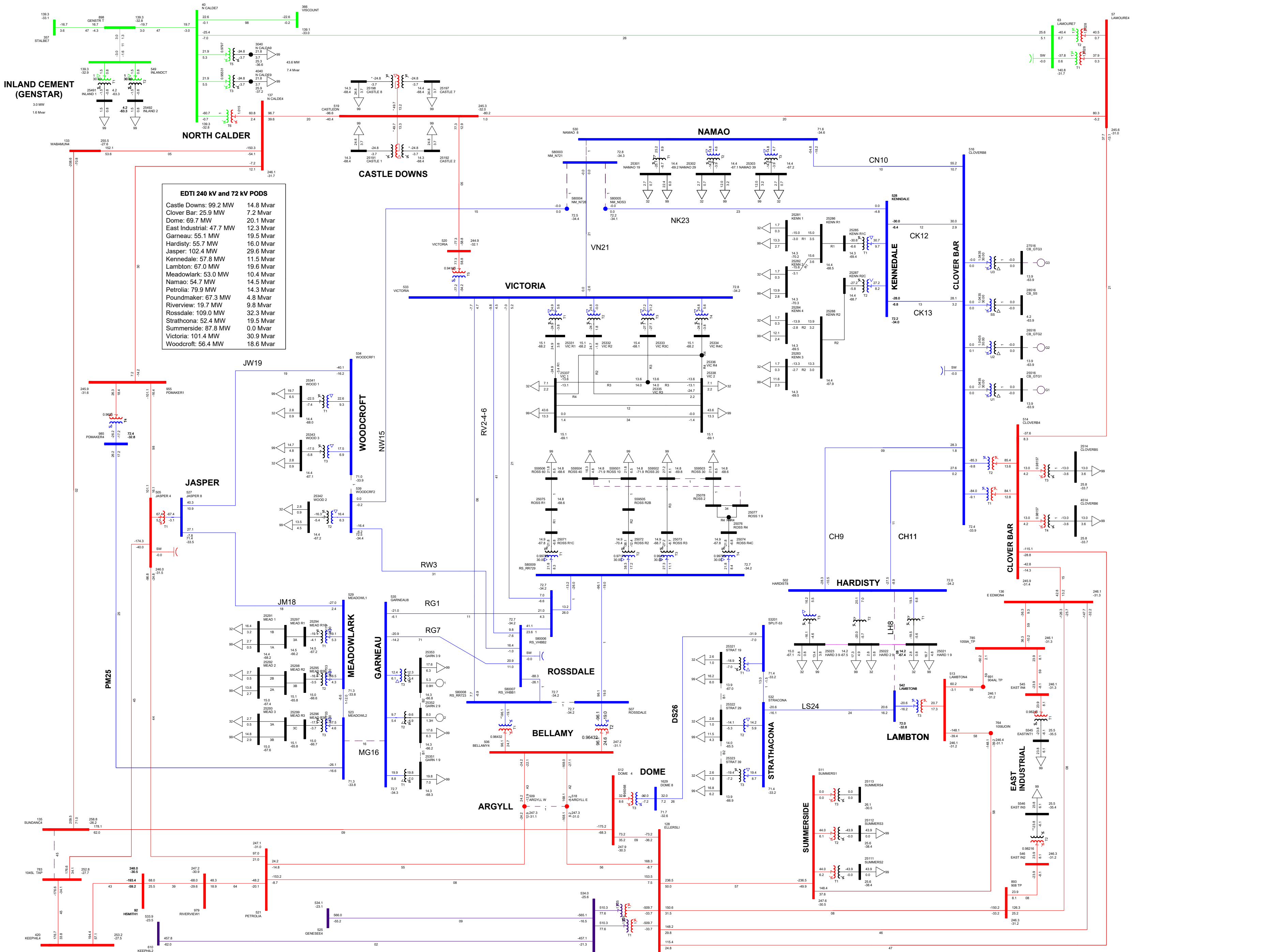
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO S3 2024 SP (SENSITIVITY)
FIGURE A3-008: 72RG7 OUT (N-1)
FRI, JUN 23 2023 20:50
A3-008.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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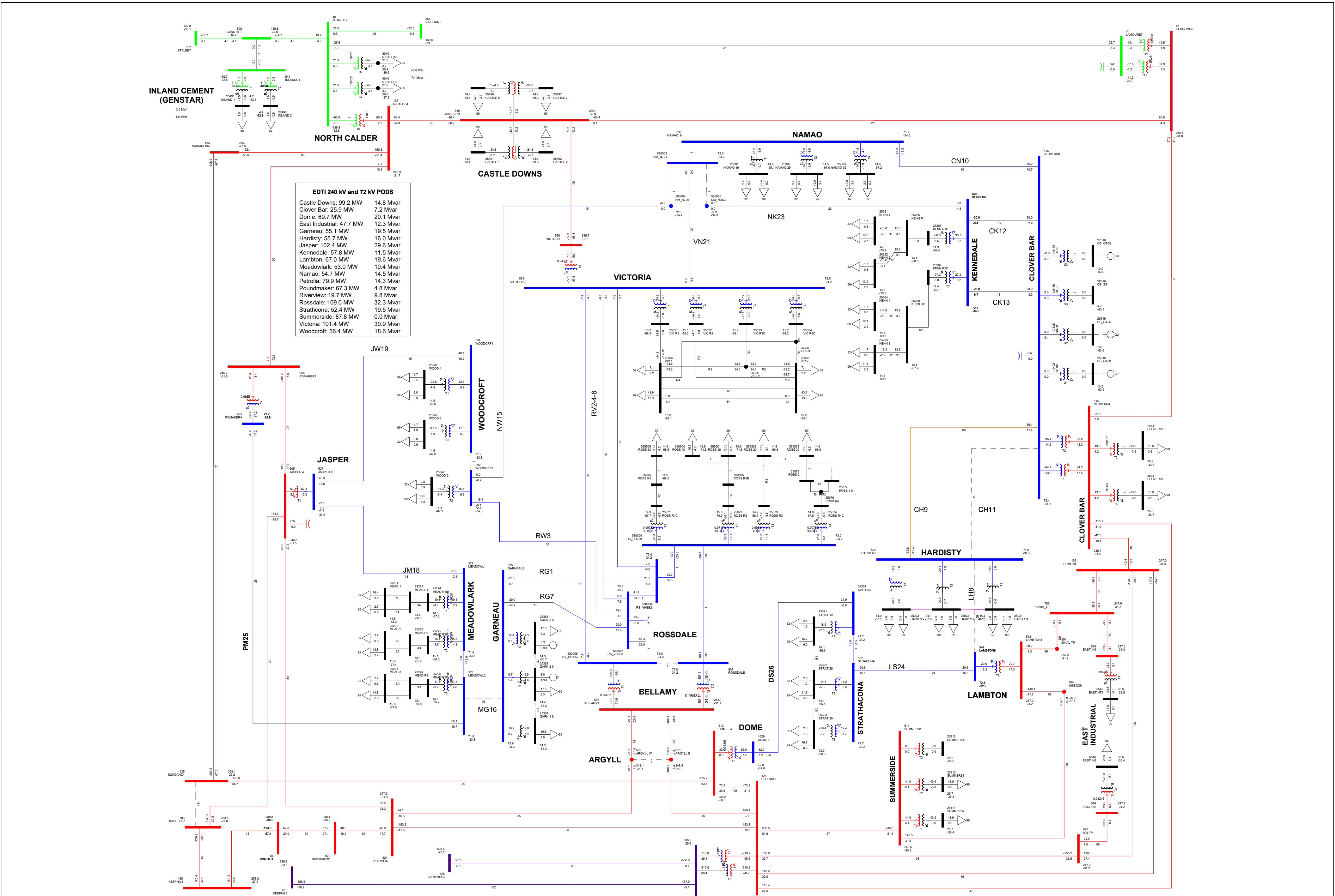
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO 4 2024 WP
FIGURE A3-009: (N-0)
FRI, JUN 23 2023 20:50
A3-009.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

Castle Downs: 99.2 MW	14.8 Mvar
Clover Bar: 25.9 MW	7.2 Mvar
Dome: 69.7 MW	20.1 Mvar
East Industrial: 47.7 MW	12.3 Mvar
Garneau: 55.1 MW	19.5 Mvar
Hardisty: 55.7 MW	16.0 Mvar
Jasper: 102.4 MW	29.6 Mvar
Kennedale: 57.8 MW	11.5 Mvar
Lambton: 67.0 MW	19.6 Mvar
Meadowlark: 53.0 MW	10.4 Mvar
Namao: 54.7 MW	14.5 Mvar
Petrolia: 79.9 MW	14.3 Mvar
Poundmaker: 67.3 MW	4.8 Mvar
Riverview: 19.7 MW	9.8 Mvar
Rossdale: 109.0 MW	32.3 Mvar
Strathcona: 52.4 MW	19.5 Mvar
Summerside: 87.8 MW	0.0 Mvar
Victoria: 101.4 MW	30.9 Mvar
Woodcroft: 56.4 MW	18.6 Mvar

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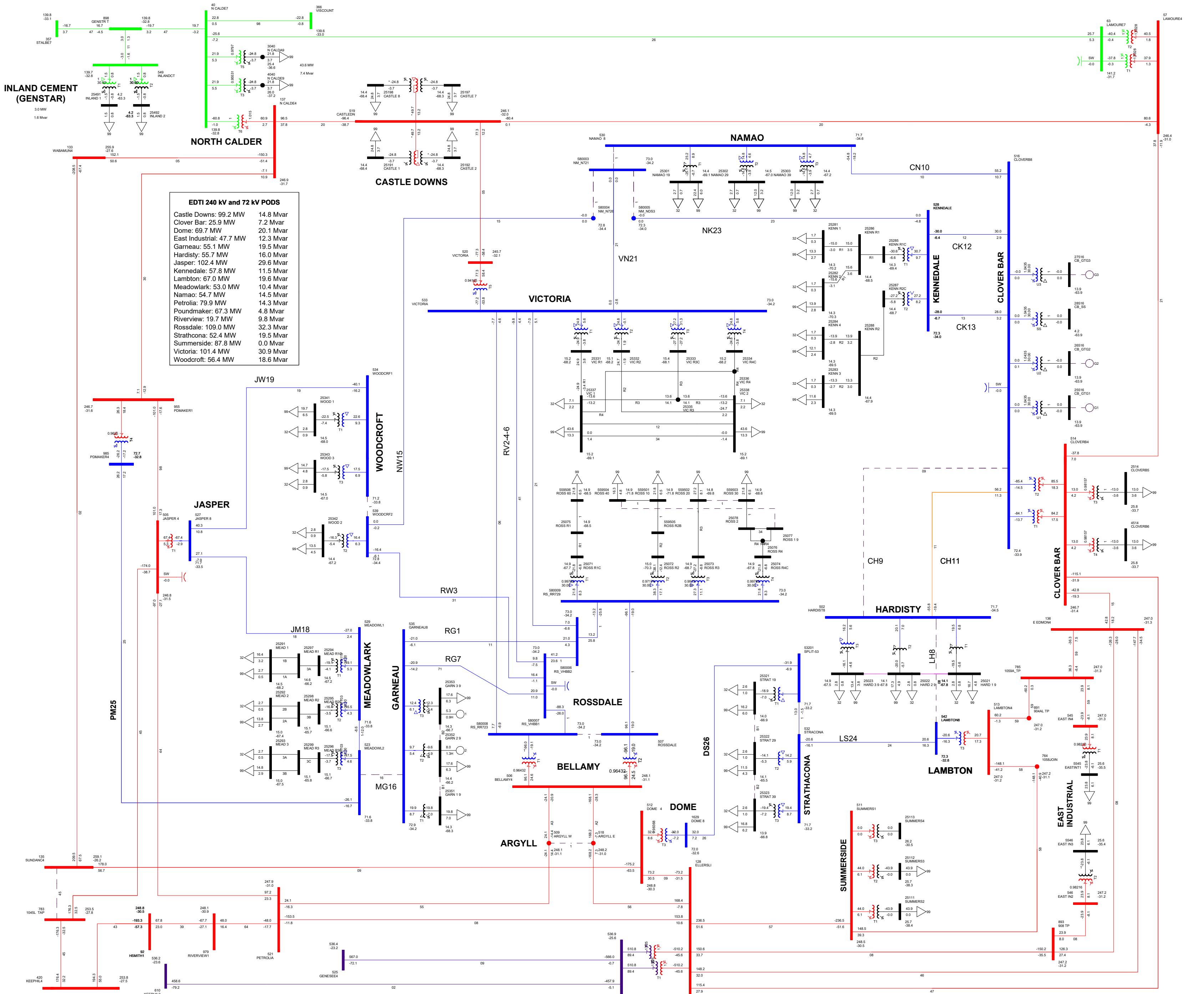
POST-PROJECT SCENARIO 4 2024 WP
FIGURE A3-010: 72CH11 OUT (N-1)
FRI, JUN 23 2023 20:51
A3-010.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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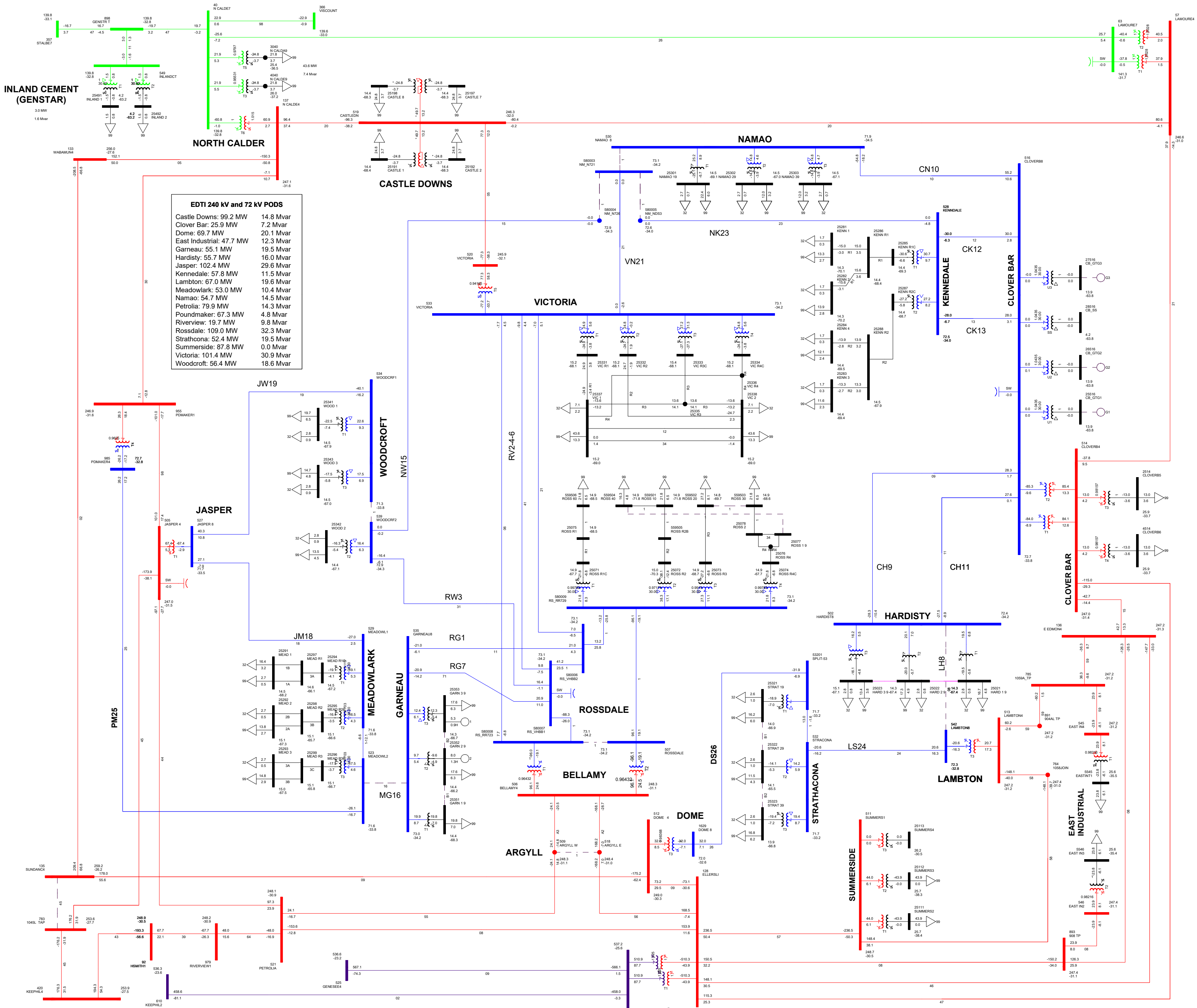
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO 4 2024 WP
FIGURE A3-011: 72CH9 OUT (N-1)
FRI, JUN 23 2023 20:51
A3-011.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

Castle Downs:	99.2 MW	14.8 Mvar
Clover Bar:	25.9 MW	7.2 Mvar
Dome:	69.7 MW	20.1 Mvar
East Industrial:	47.7 MW	12.3 Mvar
Garneau:	55.1 MW	19.5 Mvar
Hardisty:	55.7 MW	16.0 Mvar
Jasper:	102.4 MW	29.6 Mvar
Kennedale:	57.8 MW	11.5 Mvar
Lambton:	67.0 MW	19.6 Mvar
Meadowlark:	53.0 MW	10.4 Mvar
Namao:	54.7 MW	14.5 Mvar
Petrolia:	79.9 MW	14.3 Mvar
Poundmaker:	67.3 MW	4.8 Mvar
Riverview:	19.7 MW	9.8 Mvar
Rossdale:	109.0 MW	32.3 Mvar
Strathcona:	52.4 MW	19.5 Mvar
Summerside:	87.8 MW	0.0 Mvar
Victoria:	101.4 MW	30.9 Mvar
Woodcroft:	56.4 MW	18.6 Mvar

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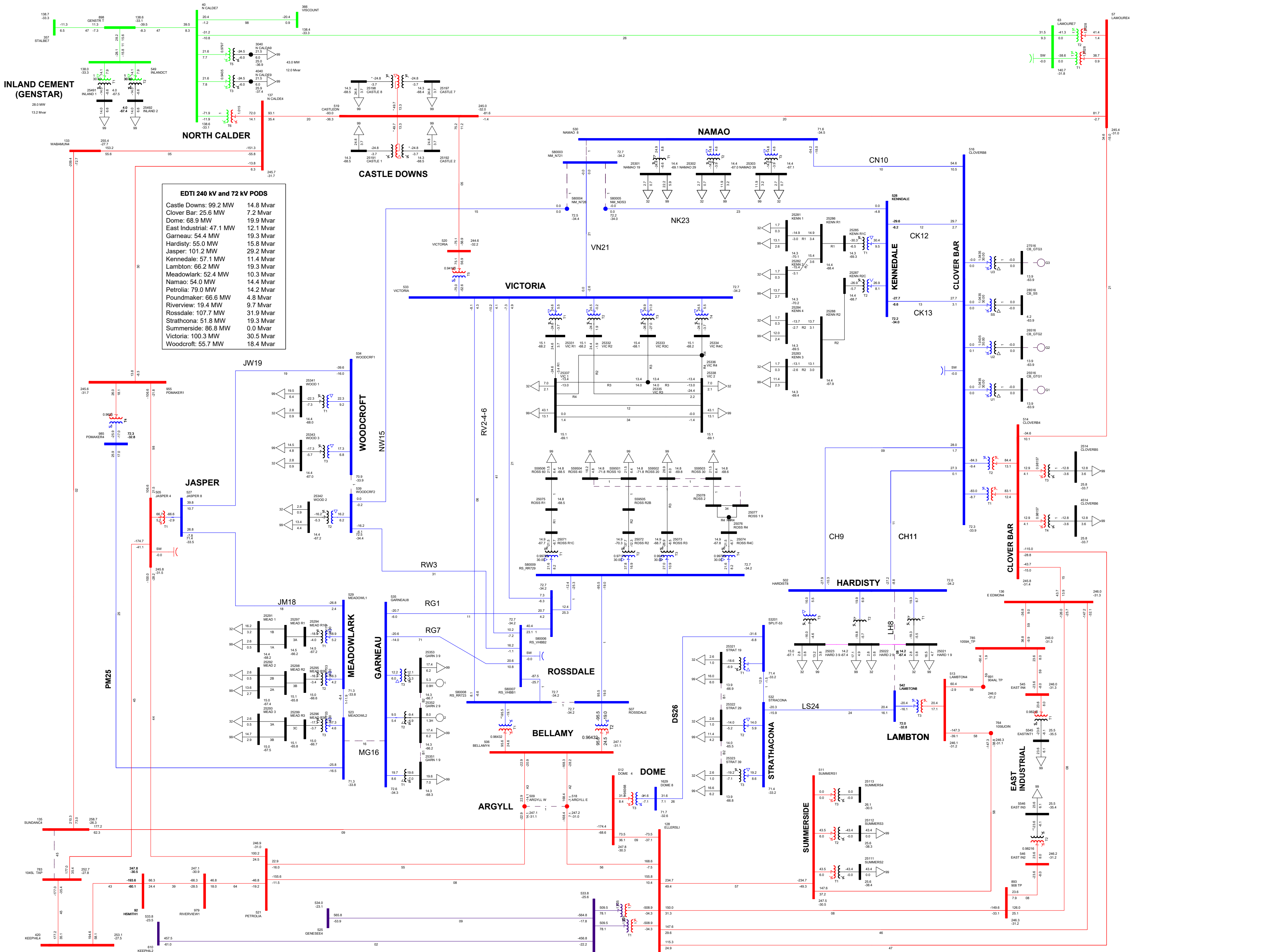
POST-PROJECT SCENARIO 4 2024 WP
FIGURE A3-012: OUT (N-1)
FRI, JUN 23 2023 20:51
A3-012.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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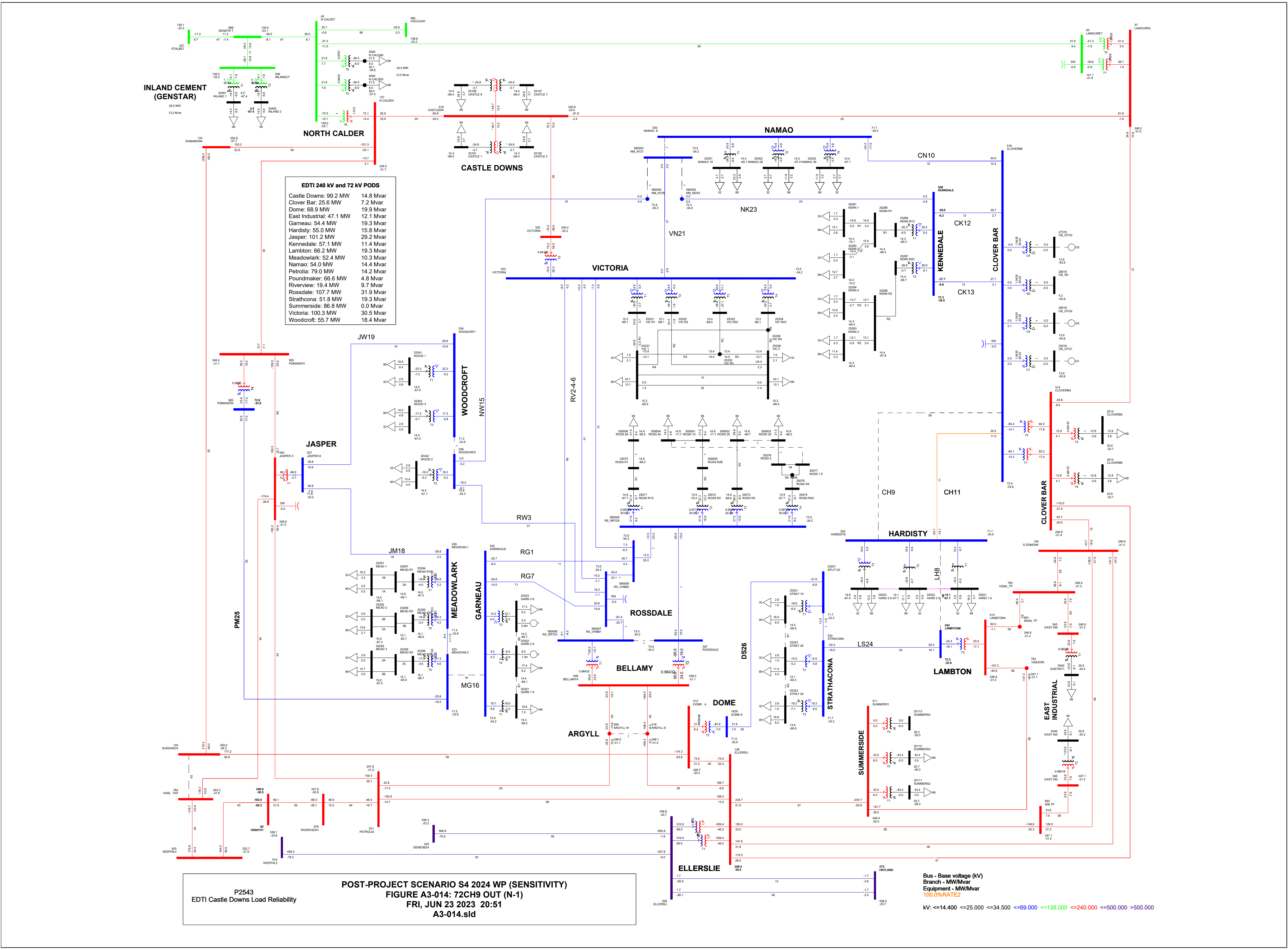
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO S4 2024 WP (SENSITIVITY)
FIGURE A3-013: 72CH11 (N-0)
FRI, JUN 23 2023 20:51
A3-013.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

Castle Downs: 99.2 MW	14.8 Mvar
Clover Bar: 25.6 MW	7.2 Mvar
Dome: 68.9 MW	19.9 Mvar
East Industrial: 47.1 MW	12.1 Mvar
Garneau: 54.4 MW	19.3 Mvar
Hardisty: 55.0 MW	15.8 Mvar
Jasper: 101.2 MW	29.2 Mvar
Kennedale: 57.1 MW	11.4 Mvar
Lambton: 66.2 MW	19.3 Mvar
Meadowlark: 52.4 MW	10.3 Mvar
Namao: 54.0 MW	14.4 Mvar
Petrolia: 79.0 MW	14.2 Mvar
Poundmaker: 66.6 MW	4.8 Mvar
Riverview: 19.4 MW	9.7 Mvar
Rossdale: 107.7 MW	31.9 Mvar
Strathcona: 51.8 MW	19.3 Mvar
Summerside: 86.8 MW	0.0 Mvar
Victoria: 100.3 MW	30.5 Mvar
Woodcroft: 55.7 MW	18.4 Mvar

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EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO S4 2024 WP (SENSITIVITY)
FIGURE A3-014: 72CH9 OUT (N-1)
FRI, JUN 23 2023 20:51
A3-014.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Attachment A4
Post-Project Voltage Stability Diagrams

Table A4-1: Summary of Voltage Stability Outages

System Condition	Worst Case Outage	Initial Load Level for Area 60 (MW)	Incremental Area Load Increase before Collapse Point (MW)	Available Voltage Stability Margin (%)
Scenario 4: 2024 Winter Peak Low Generation Post-Project	838L (Devon 14S – Leduc 325S)	1964.3	650	33.1 %
Scenario S4: 2024 Winter Peak Low Generation Post-Project Sensitivity	838L (Devon 14S – Leduc 325S)	1967.9	650	33.0 %

Figure A4-1: Voltage Stability Study Results under Category B Conditions for Scenario 4: 2024 Winter Peak Low Generation Post-Project

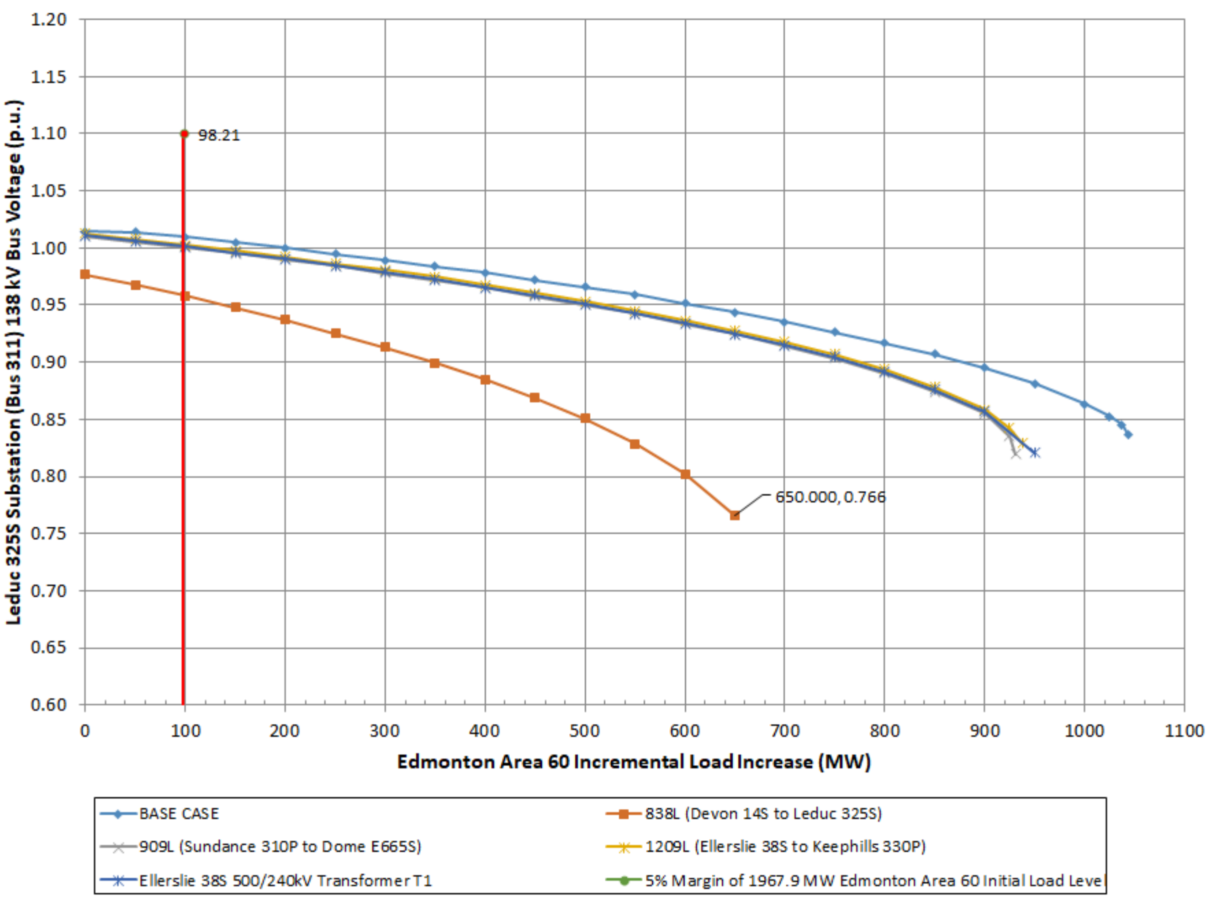
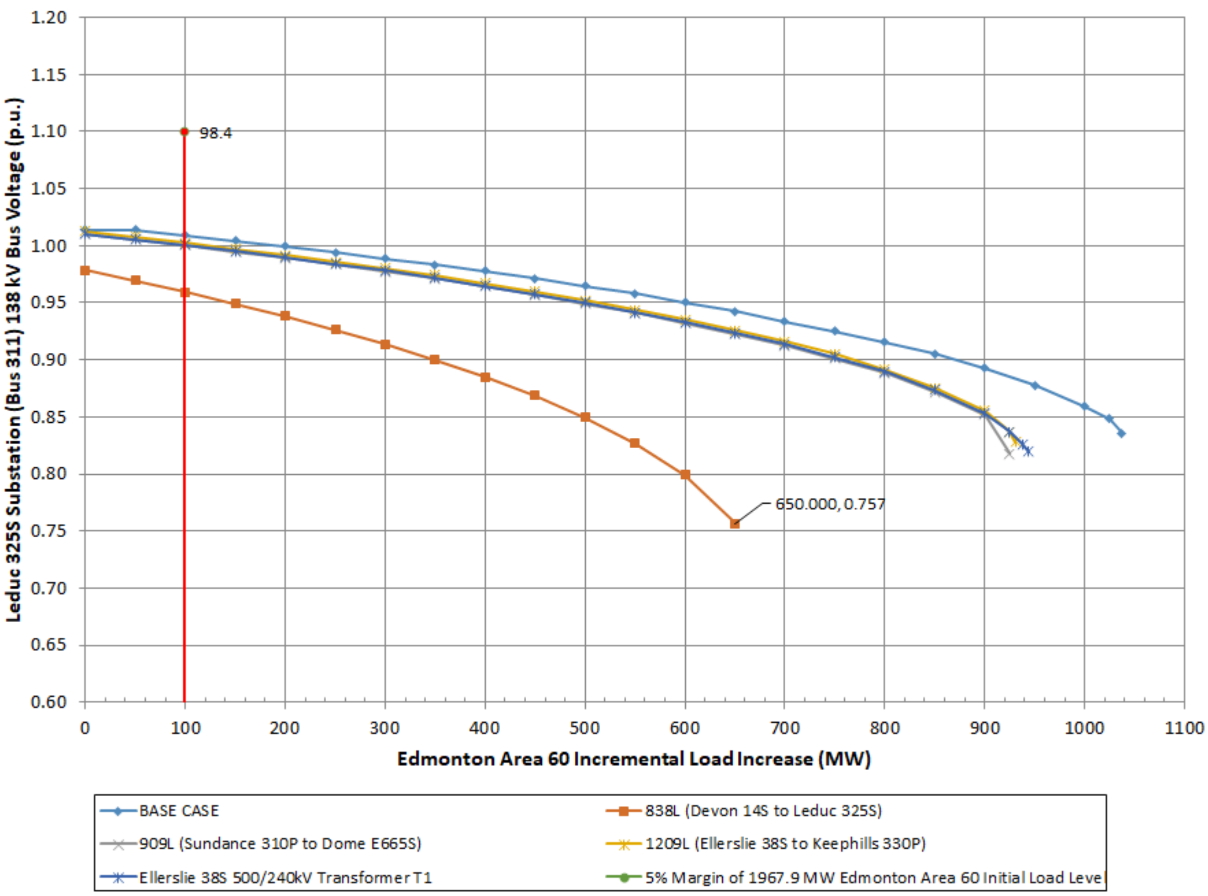
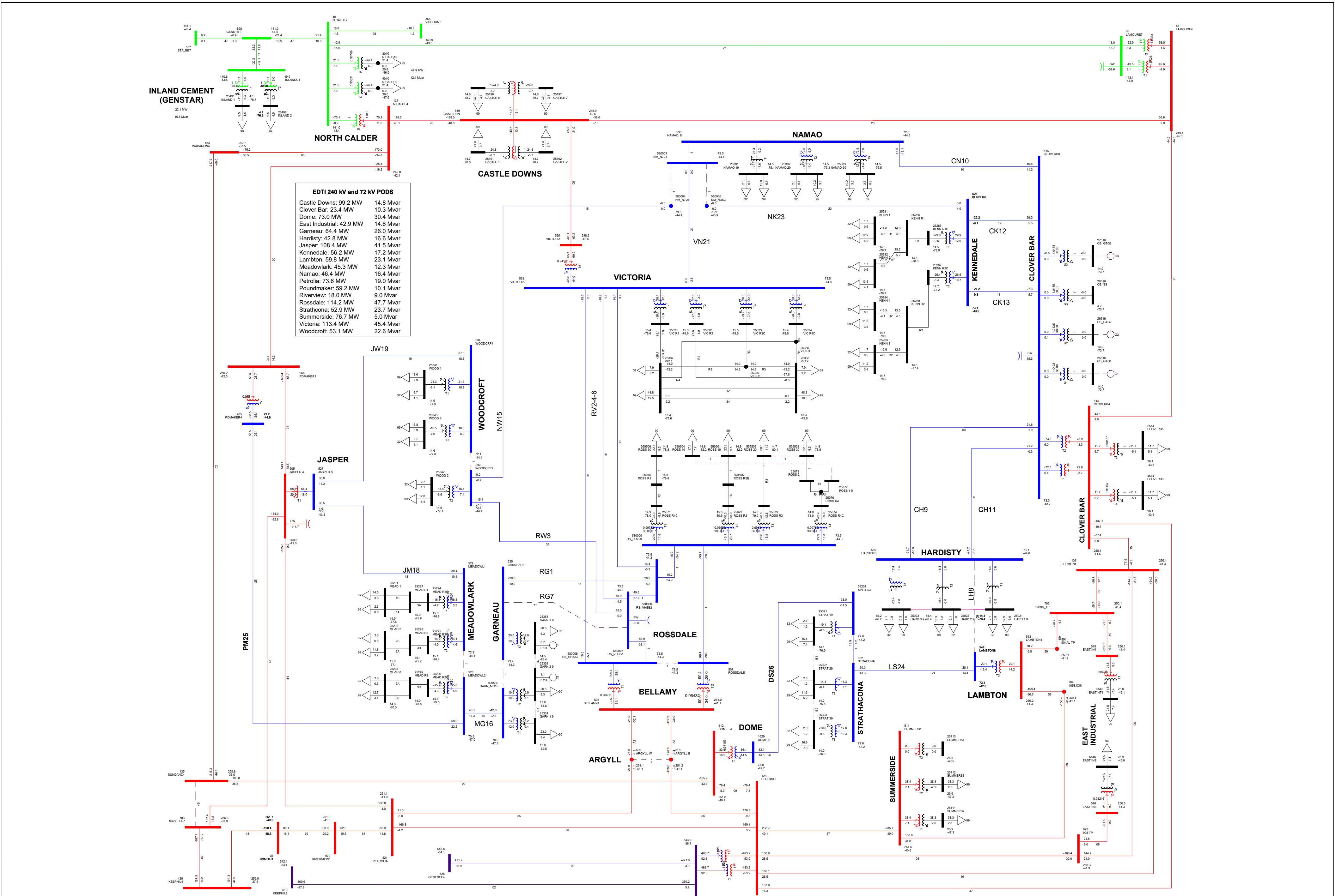


Figure A4-2: Voltage Stability Study Results under Category B Conditions for Scenario S4: 2024 Winter Peak Low Generation Post-Project Sensitivity



Attachment A5
Post-Mitigation Power Flow Diagram



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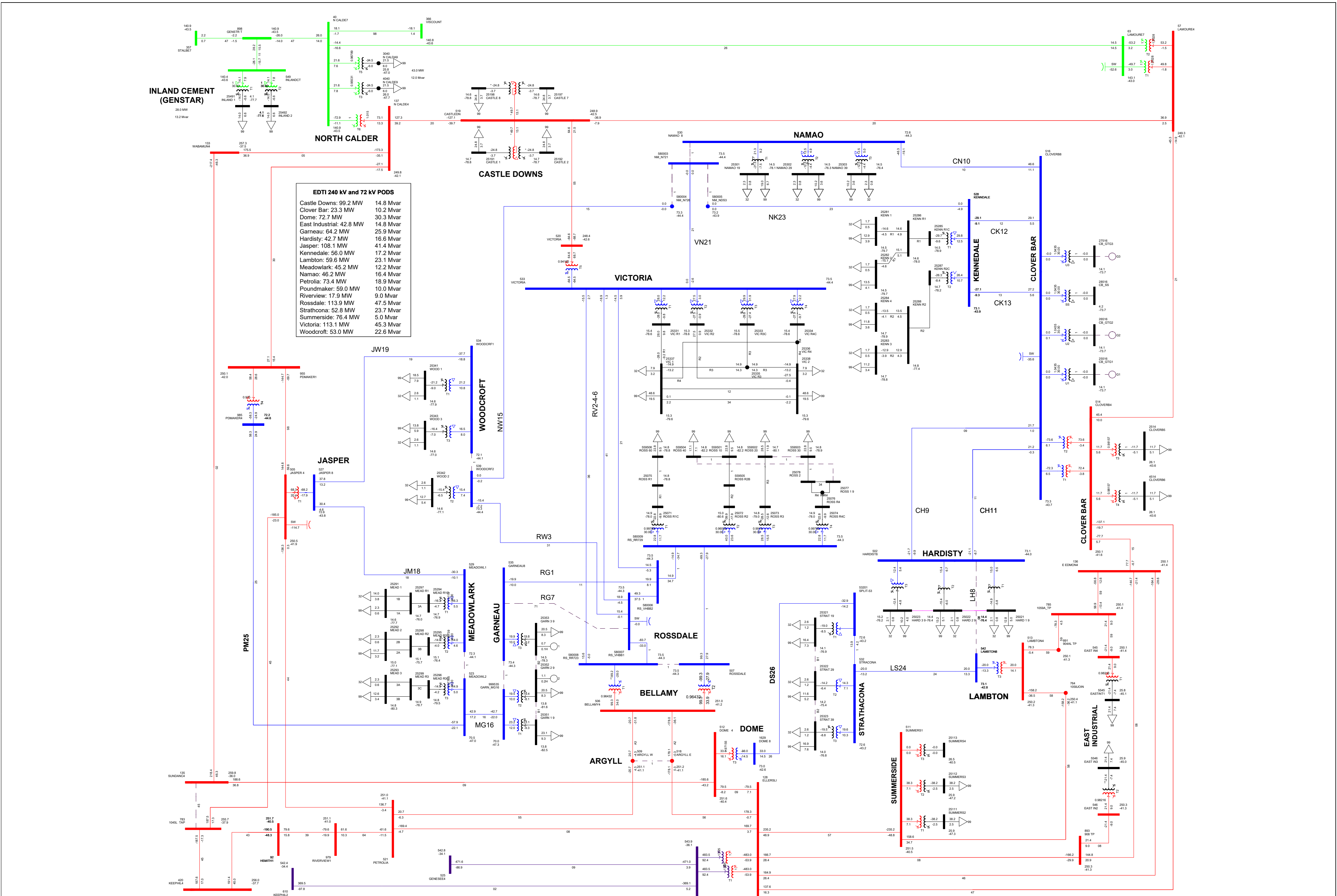
EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO 3 2024 SP
FIGURE A5-001: POST RAS 72RG7 OUT (N-1)
FRI, JUN 23 2023 20:54
A5-001.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



EDTI 240 kV and 72 kV PODS

Castle Downs: 99.2 MW	14.8 Mvar
Clover Bar: 23.3 MW	10.2 Mvar
Dome: 72.7 MW	30.3 Mvar
East Industrial: 42.8 MW	14.8 Mvar
Garneau: 64.2 MW	25.9 Mvar
Hardisty: 42.7 MW	16.6 Mvar
Jasper: 108.1 MW	41.4 Mvar
Kennedale: 56.0 MW	17.2 Mvar
Lambton: 59.6 MW	23.1 Mvar
Meadowlark: 45.2 MW	12.2 Mvar
Namao: 46.2 MW	16.4 Mvar
Petrolia: 73.4 MW	18.9 Mvar
Poundmaker: 59.0 MW	10.0 Mvar
Riverview: 17.9 MW	9.0 Mvar
Rossdale: 113.9 MW	47.5 Mvar
Strathcona: 52.8 MW	23.7 Mvar
Summerside: 76.4 MW	5.0 Mvar
Victoria: 113.1 MW	45.3 Mvar
Woodcroft: 53.0 MW	22.6 Mvar

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EDTI Castle Downs Load Reliability

POST-PROJECT SCENARIO S3 2024 SP (SENSITIVITY)
FIGURE A5-002: POST RAS 72RG7 OUT (N-1)
FRI, JUN 23 2023 20:54
A5-002.sld

Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1

kV: <=14.400 <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000