

CONNECTION ASSESSMENT

Engineering Connection Assessment

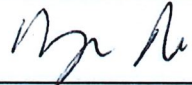
P2133 Summerside Substation Upgrade

EPCOR Distribution and Transmission Inc.

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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.

Contents

1	Introduction	1
1.1	Project Overview	1
2	Assessment Scope	2
2.1	Objectives	2
2.2	Existing System	2
2.3	Study Area	3
3	Connection Alternatives	4
3.1	Overview	4
3.2	Connection Alternatives Examined	4
3.3	Connection Alternatives Selected for Further Study	7
3.4	Connection Alternatives Not Selected for Further Study	7
4	Assessment Approach	8
4.1	Standards, Criteria and Assumptions	8
4.2	Studies Performed	8
4.2.1	<i>Power Flow Studies</i>	<i>8</i>
4.2.2	<i>Voltage Stability Studies</i>	<i>9</i>
4.2.3	<i>Short-Circuit Current Level Studies</i>	<i>9</i>
4.3	Mitigation Measure Development and Evaluation	9
4.3.1	<i>Post-Mitigation Studies</i>	<i>9</i>
5	Interpretation of Results	10
5.1	Results Overview	10
5.2	Pre-Project Study Results	13
5.2.1	<i>Category A Conditions</i>	<i>13</i>
5.2.2	<i>Category B Conditions</i>	<i>13</i>
5.3	Post-Project Study Results	13
5.3.1	<i>Category A Conditions</i>	<i>13</i>
5.3.2	<i>Category B Conditions</i>	<i>13</i>
5.4	Mitigation Measures	13
5.4.1	<i>Pre-Project</i>	<i>13</i>
5.4.2	<i>Post-Project</i>	<i>14</i>
5.4.3	<i>Post-Project Mitigation Study Results</i>	<i>14</i>
6	Project Dependencies	15
7	Conclusions and Recommendations	16

Tables

Table 4-1: Connection Study Scenarios.....	8
Table 5-1: Summary of Reliability Criteria Violations, Project Impact and Mitigation Measures	11

Figures

Figure 3-1: Connection Alternative 1.....	5
Figure 3-2: Connection Alternative 2.....	6
Figure 3-3: Connection Alternative 3.....	7

Attachments

Attachment A: Engineering Connection Assessment Results	
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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., 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 reliably serve growing demand for electricity in the City of Edmonton area.

The DFO's request includes a request for a Rate DTS, *Demand Transmission Service*, contract capacity increase of 5.82 MW, from 36.18 MW to 42 MW, for the system access service provided at the existing East Industrial substation, a DTS contract capacity increase of 31 MW, from 40 MW to 71 MW, for the system access service provided at the existing Summerside substation and a request for transmission development (collectively, the Project). Specifically, the DFO requested an enhancement to the existing Summerside 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 April 27, 2022.

2 Assessment Scope

2.1 Objectives

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

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

2.2 Existing System

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

From a transmission perspective, Edmonton (Area 60) consists of 500 kV, 240 kV, 138 kV, and 72 kV transmission systems.

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

There are several existing system performance issues within the study area. Under the loss of either 72CH9 or 72CH11, thermal criteria violations are observed on the remaining element. Under the loss of either 72CK12 or 72CK13, thermal criteria violations are observed on the remaining element. These violations are currently managed via real-time operational practices to shift load if required. Under the loss of 72RG1 or 72RG7, thermal criteria violations are observed on the remaining element which are mitigated by the planned RAS for the West Edmonton Transmission Upgrade Project. While the constraints observed on 72CH9, 72CH11, 72CK12 and 72CK13 are monitored and documented in this report, addressing these constraints is beyond the scope of the Project.

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

- RAS 149 EATL HVDC;
- RAS 150 WATL HVDC; and
- Garneau-Meadowlark Reconfiguration RAS, ¹.

¹ This RAS was part of the AESO's proposed transmission development, which was approved by the Alberta Utilities Commission in Decision 23943-D01-2020.

2.3 Study Area

The Study Area consists of the AESO planning area of Edmonton (Area 60), including the tie lines connecting this planning area 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 DFO, examined and eliminated several distribution-only options that either did not meet the DFO's request for system access service or were determined to involve greater development scope than the transmission alternatives described below.

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

3.2 Connection Alternatives Examined

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

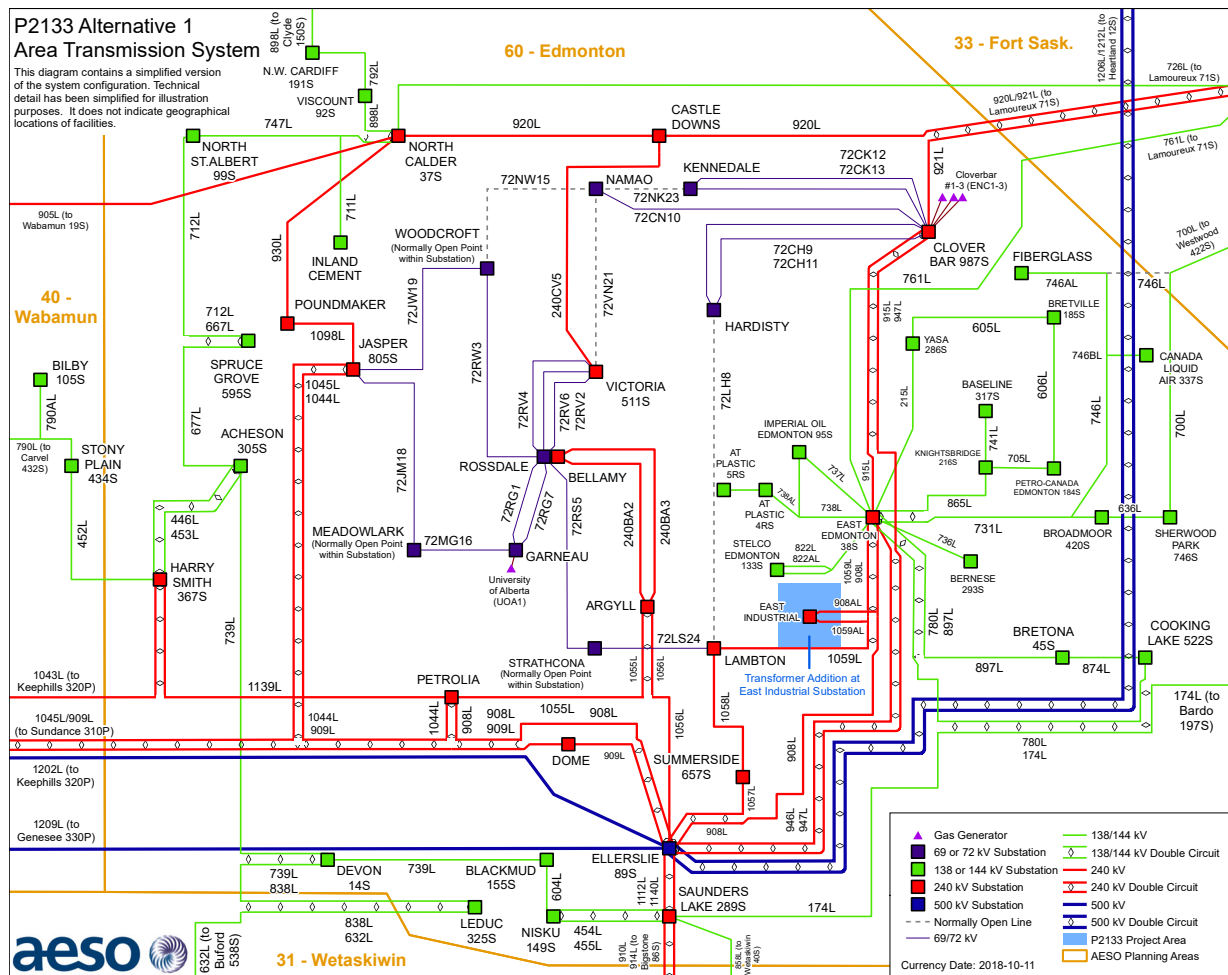
Alternative 1 – East Industrial Substation Upgrade

This alternative includes the following developments:

- Upgrade the East Industrial substation, including adding one 240/25 kV transformer, three 240 kV circuit breakers and four 25 kV feeder breakers;
- Add or modify associated equipment as required for the above developments

The proposed connection configuration is shown in Figure 3-1.

Figure 3-1: Connection Alternative 1



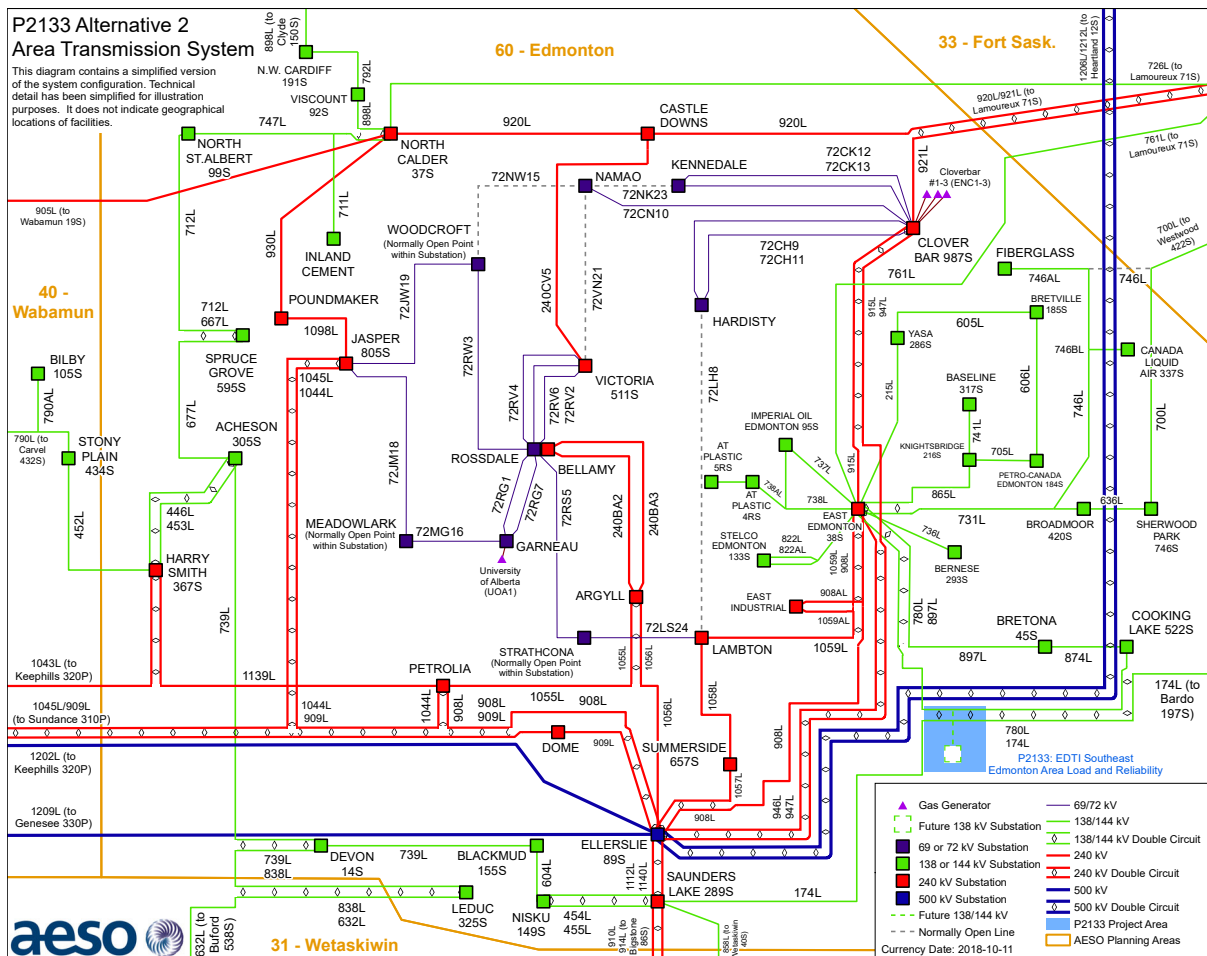
Alternative 2 – Add a new Southeast substation

This alternative includes the following developments:

- Add a 138/25 kV substation including two 138/25 kV transformers, three 138 kV circuit breakers, and eight 25 kV feeder breakers.
- Add or modify associated equipment as required for the above developments

The proposed connection configuration is shown in Figure 3-2.

Figure 3-2: Connection Alternative 2



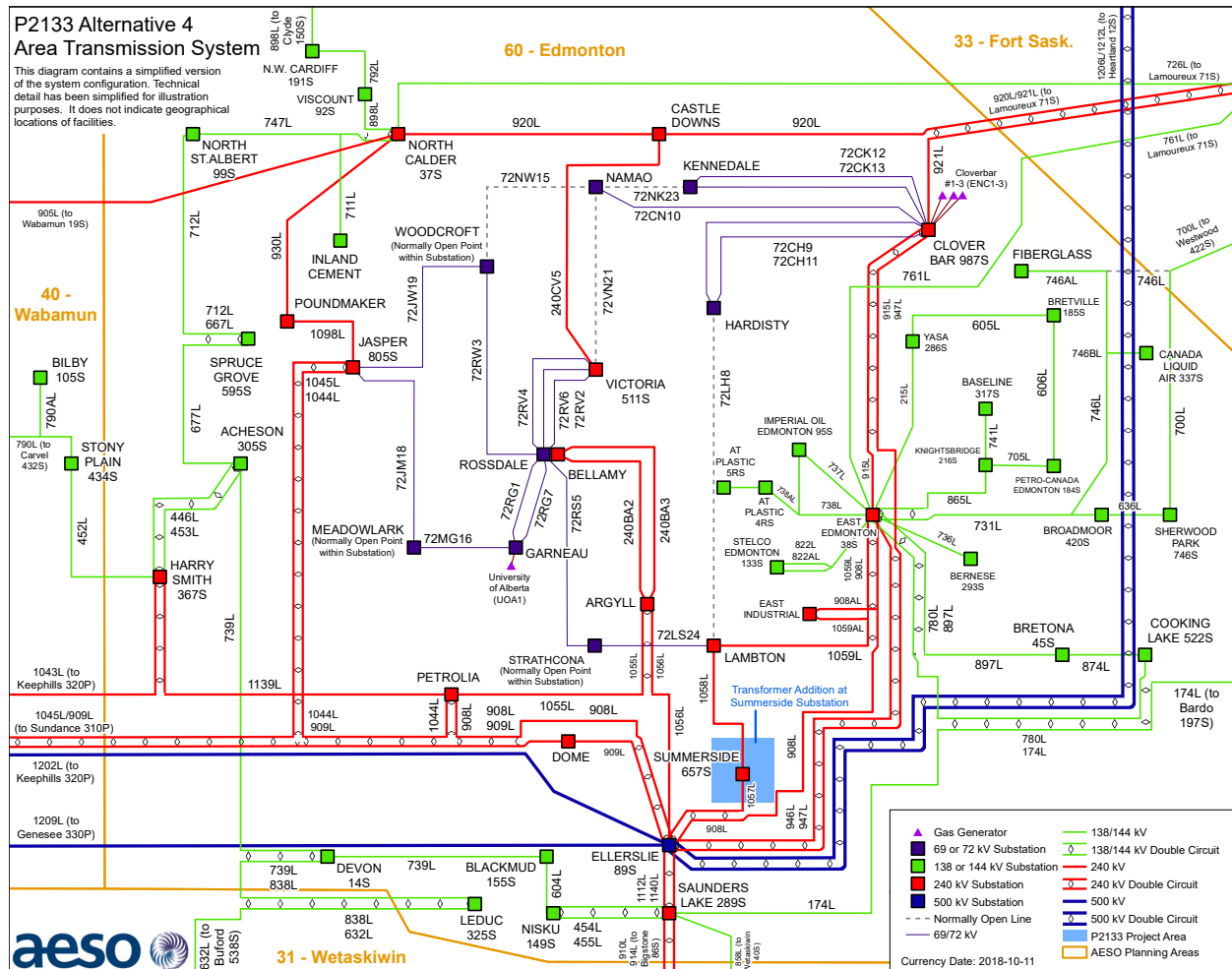
Alternative 3 – Summerside substation Upgrade (Transformer Addition)

This alternative includes the following developments:

- Upgrade the existing Summerside substation, including adding one 240/25 kV transformer, one 240 kV circuit breaker and four 25 kV feeder breakers;
- Add or modify associated equipment as required for the above developments

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

Figure 3-3: Connection Alternative 3



3.3 Connection Alternatives Selected for Further Study

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

3.4 Connection Alternatives Not Selected for Further Study

Based on the cost comparisons provided by the DFO in the DDR, the distribution costs for all three alternatives are similar. Alternative 2 includes the addition of a new substation, which would involve significantly increased transmission development and hence, increased cost, compared to Alternatives 1 and 3. Compared to Alternative 1, Alternative 3 requires less overall transmission development. Furthermore, Alternative 3 directly addresses the DFO's identified distribution deficiency at Summerside substation and provides capacity for future growth as forecast by the DFO. Therefore Alternatives 1 and 2 were not selected for further study.

4 Assessment Approach

4.1 Standards, Criteria and Assumptions

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

4.2 Studies Performed

At the time of study, the scheduled ISD for the Project is April 27, 2022. Therefore, studies were performed using scenarios for 2022 summer peak (SP) and 2022 winter peak (WP).

Short-circuit studies were performed using the 2022 WP pre-Project and post-Project scenarios as well as the 2029 WP post-Project scenario.

Table 4-1 lists the study scenarios. Post-Project scenarios reflect the requested Rate DTS contract capacity increases of 5.82 MW at the East Industrial substation and 31 MW at the Summerside substation.

Table 4-1: Connection Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	East Industrial Load (MW)	Summerside Load (MW)	Project Generation (MW)
Pre-Project						
1	2022 SP	Low Generation (LG)	2022 SP LG Pre-Project	36.18	40	0
2	2022 WP	LG	2022 WP LG Pre-Project	36.18	40	0
Post-Project						
3	2022 SP	LG	2022 SP LG Post-Project	42	71	0
4	2022 WP	LG	2022 WP LG Post-Project	42	71	0
5	2029 WP	All study area units in-service	2022 WP Post-Project	42	71	0

The AESO Planning Region load forecasts used for the connection studies were based on the *2019 Long-term Outlook* (2019 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 A1.²

Power flow studies were performed for 2022 SP and 2022 WP pre-Project scenarios, and for 2022 SP and 2022 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 2022 SP and 2022 WP pre-Project scenarios, and for 2022 SP and 2022 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 2022 WP pre-Project scenario and for 2022 WP and 2029 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 and voltage stability 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.

² The AESO's desired post-contingency voltage deviations for low voltage busses represent guidelines rather than criteria. A POD bus voltage deviation that exceeds the desired limits shown in Table 3-1 of Attachment A1 does not represent a Reliability Criteria violation. Mitigation measures would not be developed to specifically address POD bus voltage deviations that exceed the desired values in Table 3-1 of Attachment A1.

5 Interpretation of Results

5.1 Results Overview

This section provides an assessment of the impact of the Project on the performance of the AES. 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					
2022 Summer Peak	Thermal - above normal rating	Thermal - above normal rating	72CH9 (Clover Bar E987S - Hardisty)	72CH11 (Clover Bar E987S - Hardisty)	Marginally decreased violation	Real-time operational practices	Real-time operational practices
2022 Summer Peak	Thermal - above normal rating	Thermal - above normal rating	72CH11 (Clover Bar E987S - Hardisty)	72CH9 (Clover Bar E987S - Hardisty)	Marginally decreased violation	Real-time operational practices	Real-time operational practices
2022 Summer Peak	Thermal - above emergency rating	Thermal - above emergency rating	72CK12 (Clover Bar E987S - Kennedale)	72CK13 (Clover Bar E987S - Kennedale)	Marginally decreased violation	Real-time operational practices	Real-time operational practices
2022 Summer Peak	Thermal - above emergency rating	Thermal - above emergency rating	72CK13 (Clover Bar E987S - Kennedale)	72CK12 (Clover Bar E987S - Kennedale)	Marginally decreased violation	Real-time operational practices	Real-time operational practices
2022 Summer Peak	Thermal - above normal rating	Thermal - above normal rating	72RG7 (Rosssdale - Garneau)	72RG1 (Rosssdale - Garneau)	Marginally decreased violation	Garneau-Meadowlark Reconfiguration RAS	Garneau-Meadowlark Reconfiguration RAS
2022 Winter Peak	Thermal - above normal rating	Thermal - above normal rating	72CH9 (Clover Bar E987S - Hardisty)	72CH9 (Clover Bar E987S - Hardisty)	Materially increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above normal rating	Thermal - above normal rating	72CH11 (Clover Bar E987S - Hardisty)	72CH11 (Clover Bar E987S - Hardisty)	Materially increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above normal rating	Thermal - above normal rating	72CK13 (Clover Bar E987S - Kennedale)	72CK12 (Clover Bar E987S - Kennedale)	Materially increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above normal rating	Thermal - above normal rating	72CK12 (Clover Bar E987S - Kennedale)	72CK13 (Clover Bar E987S - Kennedale)	Materially increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	E987S CB-T1	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	E987S CB-T2	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	Ellerslie 89ST1 Transformer	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	Ellerslie 89ST2 Transformer	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	1057L (Summerside – Ellerslie 89S)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	947L (Cloverbar – Ellerslie 89S)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	915L (Cloverbar – East Edmonton 38S)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	905L (North Calder 37S – Wabamun 19S)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	1206L (Ellerslie 89S – Heartland 12S)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	1212L (Ellerslie 89S – Heartland 12S)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	1209L (Ellerslie 89S – Genesee 330P)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	1202L (Ellerslie 89S – Keephills 320P)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	1045L (Jasper 805S – Sundance 310P)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	909L (E665S – Sundance 310P)	72CN10 (Clover Bar E987S - Namao)	Marginally increased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	72PM25 (Poundmaker – Meadowlark)	72JM18 (Jasper E805S - Meadowlark)	Marginally decreased violation	Garneau-Meadowlark Reconfiguration RAS	Garneau-Meadowlark Reconfiguration RAS

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					
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	Poundmaker T4 Transformer	72JM18 (Jasper E805S - Meadowlark)	Marginally decreased violation	Garneau-Meadowlark Reconfiguration RAS	Garneau-Meadowlark Reconfiguration RAS
2022 Winter Peak	Thermal - above emergency rating	Thermal - above emergency rating	1098L (Poundmaker – Jasper 805S)	72JM18 (Jasper E805S - Meadowlark)	Marginally decreased violation	Garneau-Meadowlark Reconfiguration RAS	Garneau-Meadowlark Reconfiguration RAS
2022 Winter Peak	Voltage – below emergency minimum voltage	Voltage – below emergency minimum voltage	898L (North Calder 37S – Viscount 92S)	Viscount 92S	Marginally decreased violation	Real-time operational practices	Real-time operational practices
2022 Winter Peak	Voltage – below emergency minimum voltage	None	737L	Imperial Oil 95S	Resolved violation	Real-time operational practices	None
2022 Winter Peak	Voltage – below emergency minimum voltage	None	898L	NW Cardiff 191S	Resolved violation	Real-time operational practices	None

- Notes:
- Marginally increased (or marginally decreased) refers to a percent loading or voltage range difference (post-Project percent loading minus pre-Project percent loading) between 0% and 3% (or -3%)
 - Materially increased (or materially decreased) refers to a percent loading or voltage range difference (post-Project percent loading minus pre-Project percent loading) above or equal to 3% (or below or equal to -3%).
 - The Garneau-Meadowlark Reconfiguration RAS was proposed for the approved West Edmonton Transmission Upgrade Project in the *West Edmonton Transmission Upgrade Project NID*.

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 criteria violations and three voltage criteria violations under Category B conditions (i.e., loss of a single system element).

In addition, under Category B conditions, voltage deviations were observed that were beyond the limits listed in Table 3-1 of Attachment A1 at point-of-delivery (POD) low voltage busses (subsequently referred to as POD bus voltage deviations).

5.3 Post-Project Study Results

5.3.1 Category A Conditions

No Reliability Criteria violations were observed under Category A conditions for any pre-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 and voltage stability studies identified a number of system performance issues under Category B conditions, namely: thermal criteria violations and one voltage criteria violation. Overall, the impact of the Project on the observed thermal criteria violations was marginal.

The voltage stability margin was met for all studied conditions.

5.4 Mitigation Measures

This section discusses the AESO's proposed mitigation measures to address the system performance issues that were identified in the pre-Project and post-Project scenarios. As part of this Project, mitigation measures will not be specifically developed for the POD bus voltage deviations observed under certain Category B conditions during pre-Project and post-Project scenarios.

5.4.1 Pre-Project

Prior to connection of the Project, most of the observed thermal and voltage range criteria violations can be managed by using real-time operational practices. The remaining thermal criteria violations can be mitigated with the planned Garneau-Meadowlark Reconfiguration RAS.

5.4.2 Post-Project

After connection of the Project, most of the thermal and voltage range criteria violations observed can be mitigated by using real-time operational practices.

The remaining thermal criteria violations can be mitigated by the planned Garneau-Meadowlark Reconfiguration RAS.

5.4.3 Post-Project Mitigation Study Results

The observed Category B Reliability Criteria violations requiring use of the Garneau-Meadowlark Reconfiguration RAS are successfully mitigated and not impacted by the Project.

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 3 is technically viable. The connection assessment identified a number of pre-Project and post-Project system performance issues.

These issues can be mitigated using the Meadowlark-Garneau Reconfiguration RAS and real-time operational practices as appropriate. With implementation of these mitigation measures, connecting the project with the preferred alternative does not adversely affect the performance of the AIES.

The AESO recommends proceeding with the Project using Alternative 3 as the preferred alternative to respond to the DFO's request for system access service. Real-time operational practices and the RAS mentioned above are recommended to mitigate the identified system performance issues.

Alternative 3 involves upgrading the Summerside substation by adding one 240/25 kV transformer, one 240 kV circuit breaker, and four 25 kV feeder breakers.

It is recommended that the 240/25 kV transformer at Summerside substation have a transformation capability of 75 MVA summer to match the transformation capability of the existing Summerside substation transformers. Adding a 75 MVA 240/25 kV transformer at the Summerside substation (along with distribution work to be completed by the DFO) will meet the DFO's requested Rate DTS contract capacity increase and the DFO's distribution system planning criteria for electrical load restoration.

Attachment A: Engineering Connection Assessment Results

Engineering Connection Assessment: Study Results

P2133 EDTI Southeast Edmonton Area Load and Reliability

EPCOR Distribution & Transmission Inc.

Date: December 10, 2020

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Contents

1	Introduction	3
2	Pre-Project Study Results	4
2.1	Power Flow Studies	4
2.1.1	Scenario 1: 2022 Summer Peak Low Generation Pre-Project	4
2.1.2	Scenario 2: 2022-23 Winter Peak Low Generation Pre-Project	5
3	Post-Project Study Results	9
3.1	Power Flow Studies	9
3.1.1	Scenario 3: 2022 Summer Peak Low Generation Post-Project Alternative 1	9
3.1.2	Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1	11
3.2	Voltage Stability Studies	14
3.2.1	Scenario 3: 2022 Summer Peak Low Generation Post-Project Alternative 1	14
3.2.2	Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1	14
4	Short Circuit Studies	16
4.1	Pre-Project Results	16
4.2	Post-Project Results	16
4.2.1	Scenario 4: 2022-23 Winter Peak Post-Project Alternative 1	16
4.2.2	Scenario 5: 2029-30 Winter Peak Post-Project Alternative 1	17
5	Mitigation Measure Development and Evaluation	19
5.1	Pre-Project	19
5.2	Post-Project	20
5.3	Evaluation of Mitigation Measures	21
5.3.1	Scenario 3: 2022 Summer Peak Low Generation Post-Project Alternative 1	22
5.3.2	Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1	22

Tables

Table 2-1: Thermal Criteria Violations under Category B Conditions for Scenario 1: 2022 Summer Peak Low Generation Pre-Project.....	4
Table 2-2: Voltage Deviations at POD Low Voltage Busses under Category B Conditions for Scenario 1: 2022 Summer Peak Low Generation Pre-Project.....	5
Table 2-3: Thermal Criteria Violations under Category B Conditions for Scenario 2: 2022-23 Winter Peak Low Generation Pre-Project.....	6
Table 2-4: Voltage Criteria Violations under Category B Conditions for Scenario 2: 2022-23 Winter Peak Low Generation Pre-Project.....	7
Table 2-5: Voltage Deviations at POD Low Voltage Busses under Category B Conditions for Scenario 2: 2022-23 Winter Peak Low Generation Pre-Project.....	7
Table 3-1: Thermal Criteria Violations under Category B Conditions for Scenario 3: 2022 Summer Peak Low Generation Post-Project Alternative 1	9
Table 3-2: Voltage Deviations at POD Low Voltage Busses under Category B Conditions for the Scenario 3: 2022 Summer Peak Low Generation Post-Project Alternative 1	10
Table 3-3: Thermal Criteria Violations under Category B Conditions for Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1	11
Table 3-4: Voltage Criteria Violations under Category B Conditions for Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1	13
Table 3-5: Voltage Deviations at POD Low Voltage Busses under Category B Conditions for the Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1	13
Table 3-6: Voltage Stability Study Results under Category B Conditions for Scenario 3: 2022 Summer Peak Low Generation Post-Project Alternative 1	14
Table 3-7: Voltage Stability Study Results under Category B Conditions for Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1	15
Table 4-1: Pre-Project Short-Circuit Current Levels for Scenario 2: 2022-23 Winter Peak	16
Table 4-2: Post-Project Short-Circuit Current Levels for Scenario 4: 2022-23 Winter Peak	17
Table 4-3: Post-Project Short-Circuit Current Levels for Scenario 5: 2029-30 Winter Peak	17
Table 5-1: Pre-Project Mitigation Measures.....	19
Table 5-2: Post-Project Mitigation Measures	20
Table 5-3: Post-RAS Power Flow Study Results for Scenario 3.....	22
Table 5-4: Post-RAS Power Flow Study Results for Scenario 4.....	22

Attachments

- Attachment A1 Engineering Connection Assessment: Study Scope**
- Attachment A2 Pre-Project Power Flow Diagrams**
- Attachment A3 Post-Project Power Flow Diagrams**
- Attachment A4 Post-Project Voltage Stability Diagrams**
- Attachment A5 Post-Mitigation Power Flow Diagrams**

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: 2022 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: 2022 Summer Peak Low Generation Pre-Project

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings ^a (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow ^b (MVA)	% Loading ^c
72CH9	72CH11 (Clover Bar E987S - Hardisty)	38.3	76.5	59.1	154.3
72CH11	72CH9 (Clover Bar E987S - Hardisty)	38.3	76.5	59.1	154.2
72CK12	72CK13 (Clover Bar E987S - Kennedale)	59.4	61	62.4	105.1
72CK13	72CK12 (Clover Bar E987S - Kennedale)	56.5	61	62.4	110.5
72RG7	72RG1 (Rossdale - Garneau)	57.5	133.9	62.3	108.3

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., $S = \sqrt{3} \times V_{\text{base}} \times I_{\text{actual}}$)

^c Reported as a percentage of the power flow (in MVA, i.e., $S = \sqrt{3} \times V_{\text{base}} \times I_{\text{actual}}$) 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

Voltage deviations beyond the limits listed in Table 3-1 of Attachment A1 (hereafter referred to as point of delivery (POD) bus voltage deviations) were observed under certain Category B conditions as shown in Table 2-2.

Table 2-2: Voltage Deviations at POD Low Voltage Busses under Category B Conditions for Scenario 1: 2022 Summer Peak Low Generation Pre-Project

Contingency (System Element Lost)	Voltage Deviation Location Details			Pre-project Results						
	Substation Name and No.	Bus No.	Nominal Bus Voltage (kV)	Initial Voltage (kV)	Voltage Deviations at POD Low Voltage Buses					
					Post Transient (kV)	% Change	Post Auto Control (kV)	% Change	Post Manual (kV)	% Change
37ST6	Inland Cement E113S	25491	4.2	4.2	-	-	-	-	3.9	5.8
37ST6	Inland Cement E113S	25492	4.2	4.2	-	-	-	-	3.9	5.8
738L	Imperial Oil 95S	3069	13.8	14.0	-	-	-	-	13.0	6.8
95ST1	Imperial Oil 95S	3069	13.8	14.0	-	-	-	-	13.0	7.0
737L	Imperial Oil 95S	4066	13.8	14.0	-	-	12.8	8.7	12.8	8.7
95ST2	Imperial Oil 95S	4066	13.8	14.0	-	-	12.8	8.6	12.8	8.6
37ST6	Viscount 92S	2366	25.0	25.4	-	-	-	-	24.0	5.5
898L	Viscount 92S	2366	25.0	25.4	22.8	10.2	-	-	24.1	5.1

2.1.2 Scenario 2: 2022-23 Winter Peak Low Generation Pre-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 2-3.

Table 2-3: Thermal Criteria Violations under Category B Conditions for Scenario 2: 2022-23 Winter Peak Low Generation Pre-Project

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings ^a (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow ^b (MVA)	% Loading ^c
72CH11	72CH9 (Clover Bar E987S - Hardisty)	38.3	76.5	65.9	172.1
72CH9	72CH11 (Clover Bar E987S - Hardisty)	38.3	76.5	65.9	172.1
72CK13	72CK12 (Clover Bar E987S - Kennedale)	56.5	65.1	59.8	105.8
72CK12	72CK13 (Clover Bar E987S - Kennedale)	59.4	65.1	59.8	100.6
E987S CB-T1	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.6	101.9
E987S CB-T2	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.7	102.1
89ST1	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.4	101.5
89ST2	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.4	101.5
1057L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.5	100.0
947L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.7	100.4
915L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.6	100.2
905L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.7	100.4
1206L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.6	100.1
1212L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.6	100.1
1209L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.4	101.6
1202L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.2	101.3
1045L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.7	100.3
909L (E665S - 310P)	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.9	100.8

72PM25	72JM18 (Jasper E805S - Meadowlark)	62.3	62.3	64.3	103.2
Poundmaker T4	72JM18 (Jasper E805S - Meadowlark)	62.3	62.3	64.1	103.0
1098L	72JM18 (Jasper E805S - Meadowlark)	62.3	62.3	66.5	106.8

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., $S = \sqrt{3} \times V_{\text{base}} \times I_{\text{actual}}$)

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

Voltage Criteria Violations

Voltage criteria violations were observed under certain Category B conditions as shown in Table 2-4.

Table 2-4: Voltage Criteria Violations under Category B Conditions for Scenario 2: 2022-23 Winter Peak Low Generation Pre-Project

Contingency (System Element Lost)	Violation Location Details		Voltage Ratings (kV)			Pre-Project Results	
	Substation Name and Number	Bus No.	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post-contingency Steady State (kV)
737L	Imperial Oil 95S	66	138.0	124.0	152.0	142.3	123.8
898L	NW Cardiff 191S	363	138.0	124.0	152.0	139.3	123.9
898L	Viscount 92S	366	138.0	124.0	152.0	140.5	122.5

POD Bus Voltage Deviations

Several POD bus voltage deviations were observed under certain Category B conditions as shown in Table 2-5.

Table 2-5: Voltage Deviations at POD Low Voltage Busses under Category B Conditions for Scenario 2: 2022-23 Winter Peak Low Generation Pre-Project

Contingency (System Element Lost)	Voltage Deviation Location Details			Pre-project Results	
	Substation Name and No.	Bus No.	Nominal Bus Voltage	Initial Voltage (kV)	Voltage Deviations at POD Low Voltage Buses

Engineering Connection Assessment: Study Results
P2133 EDTI Southeast Edmonton Area Load and Reliability
V2

			(kV)		Post Transient (kV)	% Change	Post Auto Control (kV)	% Change	Post Manual (kV)	% Change
738L	Imperial Oil 95S	3069	13.8	13.8	-	-	12.6	8.7	12.6	8.7
95ST1	Imperial Oil 95S	3069	13.8	13.8	-	-	12.6	8.9	12.6	8.9
737L	Imperial Oil 95S	4066	13.8	13.9	12.4	10.8	12.4	10.9	12.4	10.9
95ST2	Imperial Oil 95S	4066	13.8	13.9	12.4	10.7	12.4	10.8	12.4	10.8
898L	NW Cardiff 191S	3363	25.0	26.3	23.1	12.2	-	-	-	-
898L	NW Cardiff 191S	4363	25.0	26.4	23.1	12.3	-	-	24.6	6.9
898L	Viscount 92S	2366	25.0	24.7	21.2	14.2	-	-	-	-

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 1.

3.1 Power Flow Studies

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

3.1.1 Scenario 3: 2022 Summer Peak Low Generation Post-Project Alternative 1

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: 2022 Summer Peak Low Generation Post-Project Alternative 1

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	72CH11 (Clover Bar E987S - Hardisty)	38.3	76.5	59.1	154.3	58.5	152.8	-1.5
72CH11	72CH9 (Clover Bar E987S - Hardisty)	38.3	76.5	59.1	154.2	58.5	152.8	-1.5
72CK12	72CK13 (Clover Bar E987S - Kennedale)	59.4	61	62.4	105.1	61.8	104.0	-1.1
72CK13	72CK12 (Clover Bar E987S - Kennedale)	56.5	61	62.4	110.5	61.8	109.3	-1.2

Engineering Connection Assessment: Study Results
P2133 EDTI Southeast Edmonton Area Load and Reliability
V2

72RG7	72RG1 (Rossdale - Garneau)	57.5	133.9	62.3	108.3	61.7	107.3	-1.0
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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., $S = \sqrt{3} \times V_{\text{base}} \times I_{\text{actual}}$)

^c Reported as a percentage of the power flow (in MVA, i.e., $S = \sqrt{3} \times V_{\text{base}} \times I_{\text{actual}}$) 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

Several POD bus voltage deviations were observed under certain Category B conditions as shown in Table 3-2.

Table 3-2: Voltage Deviations at POD Low Voltage Busses under Category B Conditions for the Scenario 3: 2022 Summer Peak Low Generation Post-Project Alternative 1

Contingency (System Element Lost)	Voltage Deviation Location Details			Post-project Results						
	Substation Name and No.	Bus No.	Nominal Bus Voltage (kV)	Initial Voltage (kV)	Voltage Deviations at POD Low Voltage Buses					
					Post Transient (kV)	% Change	Post Auto Control (kV)	% Change	Post Manual (kV)	% Change
738L	Imperial Oil 95S	3069	13.8	14.0	-	-	-	-	13.1	6.7
95ST1	Imperial Oil 95S	3069	13.8	14.0	-	-	-	-	13.0	6.9
737L	Imperial Oil 95S	4066	13.8	14.0	-	-	12.8	8.6	12.8	8.6
95ST2	Imperial Oil 95S	4066	13.8	14.0	-	-	12.8	8.5	12.8	8.5
898L	Viscount 92S	2366	25.0	25.0	-	-	-	-	23.8	5.1

3.1.2 Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1

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 3-3

Table 3-3: Thermal Criteria Violations under Category B Conditions for Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1

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	72CH11 (Clover Bar E987S - Hardisty)	38.3	76.5	65.9	172.1	67.3	175.7	3.5
72CH11	72CH9 (Clover Bar E987S - Hardisty)	38.3	76.5	65.9	172.1	67.3	175.6	3.5
72CK13	72CK12 (Clover Bar E987S - Kennedale)	56.5	65.1	59.8	105.8	59.9	106.1	0.3
72CK12	72CK13 (Clover Bar E987S - Kennedale)	59.4	65.1	59.8	100.6	59.9	100.9	0.3
1045L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.7	100.3	57.8	100.5	0.2
1057L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.5	100.0	57.7	100.3	0.3
1058L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.5	99.9	57.6	100.1	0.2
1058L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.4	99.9	57.6	100.1	0.2
1139L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.3	99.9	57.5	100.1	0.2
1202L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.2	101.3	58.4	101.5	0.2
1206L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.6	100.1	57.7	100.3	0.2
1209L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.4	101.6	58.6	101.9	0.2
1212L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.6	100.1	57.7	100.3	0.2
240BA2	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.4	99.8	57.5	100.0	0.2
240BA3	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.4	99.9	57.5	100.1	0.2

Engineering Connection Assessment: Study Results
P2133 EDTI Southeast Edmonton Area Load and Reliability
V2

240CV5	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.4	99.9	57.6	100.1	0.2
72CH11	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.5	100.0	57.6	100.2	0.2
72CH9	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.5	100.0	57.6	100.2	0.2
89ST1	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.4	101.5	58.5	101.7	0.2
89ST2	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.4	101.5	58.5	101.7	0.2
905L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.7	100.4	57.8	100.6	0.2
908L (89S - 38S)	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.5	100.0	57.6	100.2	0.2
908L (89S - 38S)	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.4	99.9	57.5	100.1	0.2
909L (89S - E665S)	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.4	99.8	57.5	100.1	0.2
909L (E665S - 310P)	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.9	100.8	58.1	101.0	0.3
915L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.6	100.2	57.7	100.3	0.2
946L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.5	100.0	57.6	100.2	0.2
947L	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	57.7	100.4	57.8	100.6	0.2
E987S CB-T1	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.6	101.9	58.8	102.3	0.3
E987S CB-T2	72CN10 (Clover Bar E987S - Namao)	57.4	57.4	58.7	102.1	58.9	102.4	0.3
1098L	72JM18 (Jasper E805S - Meadowlark)	62.7	62.7	66.5	106.8	65.5	105.1	-1.7
72PM25	72JM18 (Jasper E805S - Meadowlark)	62.7	62.7	64.3	103.2	63.0	101.2	-2.0
Poundmaker T4	72JM18 (Jasper E805S - Meadowlark)	62.7	62.7	64.1	103.0	62.9	101.0	-2.0

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., $S = \sqrt{3} \times V_{\text{base}} \times I_{\text{actual}}$)

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

Voltage Criteria Violations

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

Table 3-4: Voltage Criteria Violations under Category B Conditions for Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1

Contingency (System Element Lost)	Violation Location Details		Voltage Ratings (kV)			Pre-Project Results		Post-Project Results		Voltage Difference (kV)
	Substation Name and Number	Bus No.	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post- contingency Steady State (kV)	Initial Voltage (kV)	Post- contingency Steady State (kV)	
898L	Viscount 92S	366	138.0	124.0	152.0	140.5	122.5	140.6	123.0	0.5

POD Bus Voltage Deviations

Several POD bus voltage deviations were observed under certain Category B conditions as shown in Table 3-5.

Table 3-5: Voltage Deviations at POD Low Voltage Busses under Category B Conditions for the Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1

Contingency (System Element Lost)	Voltage Deviation Location Details			Post-project Results						
	Substation Name and No.	Bus No.	Nominal Bus Voltage (kV)	Initial Voltage (kV)	Voltage Deviations at POD Low Voltage Buses					
					Post Transient (kV)	% Change	Post Auto Control (kV)	% Change	Post Manual (kV)	% Change
738L	Imperial Oil 95S	3069	13.8	13.9	-	-	12.7	8.4	12.7	8.4
95ST1	Imperial Oil 95S	3069	13.8	13.9	-	-	12.7	8.6	12.7	8.6
737L	Imperial Oil 95S	4066	13.8	13.9	12.4	10.6	12.4	10.6	12.4	10.6
95ST2	Imperial Oil 95S	4066	13.8	13.9	12.4	10.4	12.4	10.4	12.4	10.4
898L	NW Cardiff 191S	3363	25.0	26.3	23.2	11.9	-	-	-	-
898L	NW Cardiff 191S	4363	25.0	26.4	23.3	12.0	-	-	24.7	6.5
898L	Viscount 92S	2366	25.0	24.7	21.3	13.8	-	-	-	-

3.2 Voltage Stability Studies

3.2.1 Scenario 3: 2022 Summer Peak Low Generation Post-Project Alternative 1

Voltage stability analysis was performed for the 2022 Summer Peak Low Generation Post-Project Alternative 1. The reference load level for the Study Area is 1887 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 94.4 MW ($0.05 \times 1887 \text{ MW} = 94.4 \text{ MW}$), in order to meet the voltage stability criteria.

Table 3-6 provides the voltage stability study results under the Category A condition and for the five 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 3: 2022 Summer Peak Low Generation Post-Project Alternative 1

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	System Normal		620	Yes
BELLTX1	Bellamy E814S 240/72 kV transformer		500	Yes
240CV5	Castle Downs E557S	Victoria E511S	500	Yes
BELLTX2	Bellamy E814S 240/72 kV transformer		510	Yes
VICTORIAT5	Victoria E511S 240/72 kV transformer		520	Yes
909L	Sundance 310P	Dome E665S	520	Yes

3.2.2 Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1

Voltage stability analysis was performed for the 2022-23 Winter Peak Low Generation Post-Project Alternative 1. The reference load level for the Study Area is 1941 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 97.0 MW ($0.05 \times 1941 \text{ MW} = 97.0 \text{ MW}$), in order to meet the voltage stability criteria.

Table 3-7 provides the voltage stability study results under the Category A condition and for the five 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 3-7: Voltage Stability Study Results under Category B Conditions for Scenario 4: 2022-23
Winter Peak Low Generation Post-Project Alternative 1**

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	System Normal		570	Yes
909L	Sundance 310P	Dome E665S	470	Yes
905L	Wabamun 19S	North Calder 37S	480	Yes
1209L	Ellerslie 89S	Genesee 330P	480	Yes
1202L	Ellerslie 89S	Keephills 320P	490	Yes
240CV5	Castle Downs E557S	Victoria E511S	500	Yes

4 Short Circuit Studies

4.1 Pre-Project Results

Pre-Project short-circuit current levels are provided in Table 4-1¹.

Table 4-1: Pre-Project Short-Circuit Current Levels for Scenario 2: 2022-23 Winter Peak

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)
East Edmonton 38S	138	142.7	20.6	0.004743 + j0.020631	18.0	0.004428 + j0.030236
Ellerslie 89S	240	249.3	27.3	0.002355 + j0.008963	25.1	0.002207 + j0.011646
East Edmonton 38S	240	245.9	22.2	0.002858 + j0.010837	18.3	0.00374 + j0.018199
Ellerslie 89S	500	520.4	12.6	0.001454 + j0.009568	12.0	0.001921 + j0.011
Summerside E657S	240	249.2	26.9	0.002367 + j0.009079	24.6	0.002272 + j0.011968
East industrial E52S	240	246.1	20.3	0.003064 + j0.011915	16.1	0.00452 + j0.021434
East industrial E52S	240	246.5	20.4	0.003045 + j0.011832	16.2	0.004123 + j0.021507
Riverview	240	248.1	19.4	0.002888 + j0.012632	15.1	0.005872 + j0.023479
Riverview	25	25.0	7.0	0.021859 + j0.330191	7.3	0.024864 + j0.294015
Riverview	25	24.8	6.8	0.022773 + j0.337707	6.8	0.002869 + j0.345767
East industrial E52S	25	24.8	6.9	0.030196 + j0.332717	6.8	0.01187 + j0.354944
East industrial E52S	25	24.9	7.0	0.030157 + j0.332669	6.8	0.011523 + j0.355007
Summerside E657S	25	24.8	7.0	0.029308 + j0.329862	7.0	-0.00016 + j0.335027
Summerside E657S	25	24.8	7.0	0.029046 + j0.328165	7.0	-0.00013 + j0.336142

4.2 Post-Project Results

4.2.1 Scenario 4: 2022-23 Winter Peak Post-Project Alternative 1

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: 2022-23 Winter Peak

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)
East Edmonton 38S	138	142.8	20.6	0.00473 + j0.020651	18.0	0.004445 + j0.030258
Ellerslie 89S	240	249.2	27.3	0.002363 + j0.008956	25.1	0.002203 + j0.011584
East Edmonton 38S	240	245.9	22.2	0.002864 + j0.010833	18.3	0.003759 + j0.018224
Ellerslie 89S	500	520.4	12.6	0.001457 + j0.009566	12.1	0.001916 + j0.010971
Summerside E657S	240	249.2	26.9	0.002376 + j0.009072	24.7	0.002267 + j0.011901
East industrial E52S	240	246.1	20.3	0.003071 + j0.01191	16.1	0.004538 + j0.021453
East industrial E52S	240	246.5	20.5	0.003052 + j0.011827	16.2	0.004142 + j0.021527
Riverview	240	248.2	19.4	0.00289 + j0.012635	15.1	0.005873 + j0.023459
Riverview	25	25.0	7.0	0.021618 + j0.330357	7.3	0.024863 + j0.294
Riverview	25	24.8	6.8	0.022518 + j0.337885	6.8	0.002871 + j0.345748
East industrial E52S	25	24.7	6.9	0.033358 + j0.330353	6.8	0.011888 + j0.354963
East industrial E52S	25	24.7	7.0	0.033309 + j0.330314	6.8	0.011542 + j0.355027
Summerside E657S	25	24.6	7.0	0.033276 + j0.326891	7.0	-0.00016 + j0.334962
Summerside E657S	25	24.6	7.0	0.032971 + j0.325231	7.0	-0.00014 + j0.336077
Summerside E657S	25	25.0	7.1	0.032313 + j0.326051	7.1	-0.00008 + j0.336436

4.2.2 Scenario 5: 2029-30 Winter Peak Post-Project Alternative 1

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: 2029-30 Winter Peak

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)
East Edmonton 38S	138.00]	140.3	21.2	0.004183 + j0.019812	18.4	0.004164 + j0.029097
Ellerslie 89S	240.00]	246.3	29.2	0.001968 + j0.008314	26.4	0.002053 + j0.011101
East Edmonton 38S	240.00]	245.1	23.8	0.002402 + j0.010134	18.9	0.003738 + j0.018149
Ellerslie 89S	500.00]	534.6	12.7	0.001278 + j0.00979	12.0	0.002054 + j0.011625
Summerside E657S	240.00]	246.3	28.8	0.00198 + j0.00843	25.9	0.002119 + j0.011423
East industrial E52S	240.00]	245.1	21.5	0.002621 + j0.011229	16.6	0.004517 + j0.021361
East industrial E52S	240.00]	245.3	21.7	0.002603 + j0.01114	16.7	0.004122 + j0.021437
Riverview	240.00]	245.6	20.0	0.002576 + j0.012153	15.3	0.005831 + j0.023275
Riverview	25.000]	24.7	7.0	0.02183 + j0.329567	7.2	0.024816 + j0.293869
Riverview	25.000]	24.9	6.9	0.022419 + j0.337719	6.8	0.002984 + j0.346253
East industrial E52S	25.000]	24.8	7.0	0.032672 + j0.330188	6.8	0.011959 + j0.355304

Engineering Connection Assessment: Study Results

P2133 EDTI Southeast Edmonton Area Load and Reliability

V2

East industrial E52S	25.000]	24.9	7.0	$0.032651 + j0.33012$	6.8	$0.011605 + j0.355372$
Summerside E657S	25.000]	24.9	7.1	$0.032397 + j0.327155$	7.0	$-0.00021 + j0.335018$
Summerside E657S	25.000]	24.9	7.1	$0.032098 + j0.325488$	7.0	$-0.00019 + j0.336134$
Summerside E657S	25.000]	24.7	7.1	$0.032437 + j0.32508$	7.0	$-0.00021 + j0.335955$

5 Mitigation Measure Development and Evaluation

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

As part of this Project, mitigation measures will not be specifically developed for the POD bus voltage deviations observed under certain Category B conditions during pre-Project and post-Project scenarios.²

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
Real time operational practices	72CH11 (Clover Bar E987S - Hardisty)	72CH9
Real time operational practices	72CH9 (Clover Bar E987S - Hardisty)	72CH11
Real time operational practices	72CK12 (Clover Bar E987S - Kennedale)	72CK13
Real time operational practices	72CK13 (Clover Bar E987S - Kennedale)	72CK12
Real time operational practices	72CN10 (Clover Bar E987S - Namao)	1045L
		1057L
		1202L
		1206L
		1209L
		1212L
		89ST1
		89ST1
		905L
		909L (E665S - 310P)

² The AESO's desired post-contingency voltage deviations for low voltage busses represent guidelines rather than criteria. A POD bus voltage deviation that exceeds the desired limits shown in Table 3-1 of Attachment A1 does not represent a Reliability Criteria violation.

		915L
		947L
		E987S CB-T1
		E987S CB-T2
Planned Meadowlark – Garneau Reconfiguration RAS (P1649 WETUP)	72JM18 (Jasper E805S - Meadowlark)	1098L
		72PM25
		Poundmaker T4
	72RG1 (Rosssdale - Garneau)	72RG7

Notes:

^a Planned Meadowlark – Garneau Reconfiguration RAS is a RAS proposed for the planned West Edmonton Transmission Upgrade Project, P1649.

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
Real time operational practice	72CH11 (Clover Bar E987S - Hardisty)	72CH9
Real time operational practice	72CH9 (Clover Bar E987S - Hardisty)	72CH11
Real time operational practice	72CK12 (Clover Bar E987S - Kennedale)	72CK13
Real time operational practice	72CK13 (Clover Bar E987S - Kennedale)	72CK12
Real time operational practice:	72CN10 (Clover Bar E987S - Namao)	1045L
		1057L
		1058L
		1058L
		1139L
		1202L
		1206L
		1209L
		1212L

		240BA2
		240BA3
		240CV5
		72CH11
		72CH9
		89ST1
		89ST1
		905L
		908L (89S - 38S)
		908L (89S - 38S)
		909L (89S - E665S)
		909L (E665S - 310P)
		915L
		946L
		947L
		E987S CB-T1
		E987S CB-T2
Planned Meadowlark – Garneau Reconfiguration RAS (P1649 WETUP)	72JM18 (Jasper E805S - Meadowlark)	1098L
		72PM25
		Poundmaker T4
	72RG1 (Rosssdale - Garneau)	72RG7

Notes:

^a Planned Meadowlark – Garneau Reconfiguration RAS is a RAS proposed for the planned West Edmonton Transmission Upgrade Project, P1649.

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 Scenarios 3 and 4 using Alternative 1 and the RASs described in the previous section.

The post-mitigation power flow diagrams for selected Category B conditions are provided in Attachment 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: 2022 Summer Peak Low Generation Post-Project Alternative 1

Category B Conditions

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

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

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating ^a (MVA)	Short-term (Emergency) Rating ^a (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow ^b (MVA)	% Loading ^c	Power Flow (MVA)	% Loading
72RG7	72RG1 (Rossdale - Garneau)	57.5	133.9	61.7	107.3	19.0	33.0

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., $S = \sqrt{3} \times V_{\text{base}} \times I_{\text{actual}}$)

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

5.3.2 Scenario 4: 2022-23 Winter Peak Low Generation Post-Project Alternative 1

Category B Conditions

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

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

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating ^a (MVA)	Short-term (Emergency) Rating ^a (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow ^b (MVA)	% Loading ^c	Power Flow ^b (MVA)	% Loading ^c
1098L	72JM18 (Jasper E805S - Meadowlark)	62.7	62.7	65.5	105.1	41.1	65.5
72PM25	72JM18 (Jasper E805S - Meadowlark)	62.7	62.7	63.0	101.2	41.6	66.4
Poundmaker T4	72JM18 (Jasper E805S - Meadowlark)	62.7	62.7	62.9	101.0	41.6	66.4

Notes:

Engineering Connection Assessment: Study Results

P2133 EDTI Southeast Edmonton Area Load and Reliability

V2

^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., $S = \sqrt{3} \times V_{\text{base}} \times I_{\text{actual}}$)

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

Attachment A1

Engineering Connection Assessment: Study Scope

Engineering Connection Assessment: Study Scope

P2133 EDTI Southeast Edmonton Area Load and Reliability

EPCOR Distribution & Transmission Inc.

Date: December 9, 2020

Version: V2

Classification: Public

Company Name	Name and Credentials	Date	Signature
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Contents

1	Introduction	1
1.1	Project Overview	1
1.2	Existing System Overview	2
1.2.1	Study Area	2
1.2.1.1	East Industrial and Summerside Substations	2
1.2.2	Existing Constraints	2
2	Connection Alternative to be Studied	4
2.1	Alternative 1 – Increase Capacity at Summerside 657S	4
3	Criteria, Standards and Requirements.....	5
3.1	AESO Reliability Criteria	5
3.2	ISO Rules and Information Documents	6
4	Scenarios and Assumptions	7
4.1	Scenarios	7
4.2	Assumptions	7
4.2.1	System Project Assumptions	7
4.2.2	Connection Project Assumptions	7
4.2.3	Load Assumptions	8
4.2.4	Generation Assumptions	8
4.2.5	Intertie Flow Assumptions	9
4.2.6	HVDC Power Order Assumptions	9
4.2.7	Transmission Facility Ratings	9
4.2.8	Voltage Profile Assumption	12
5	Study Methodology	13
5.1	Power Flow Studies	13
5.1.1	Contingencies to be Studied	14
5.2	Voltage Stability Studies	14
5.2.1	Contingencies to be Studied	14
5.3	Short-Circuit Current Level Studies	14
6	Mitigation Measures.....	16
6.1	Development.....	16
6.2	Evaluation	16
6.2.1	Post-Mitigation Studies	16
6.2.2	Constraint Effective Factor Studies.....	16
7	Changes to Study Assumptions	17

Tables

Table 1-1: Project Load and Generation Details	1
Table 3-1: Post-Contingency Voltage Deviation Guidelines for Low Voltage Busses	6

Table 4-1: Connection Study Scenarios.....	7
Table 4-2: Planned Connection Projects Included in the Studies	7
Table 4-3: Forecast Load (at AESO Edmonton Planning Region Peak)	8
Table 4-4: Existing Generation (excluding Wind and Solar) Dispatch Conditions	9
Table 4-5: HVDC to Adjacent AC System MVar Exchange Limits	9
Table 4-6: Thermal Rating Assumptions for Key Transmission Lines in the Study Area	10
Table 4-7: Summary of Key Transformer Ratings in the Study Area.....	11
Table 4-8: Summary of Key Shunt Elements in the Study Area	12
Table 5-1: Summary of the Studies to be Performed.....	13

Figures

Figure 1-1: Transmission System in the Study Area.....	3
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Attachments

Attachment A: Transmission Planning Criteria – Basis and Assumptions

1 Introduction

This Study Scope provides an overview of the engineering studies to be completed by EPCOR Distribution & Transmission Inc. (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., 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 serve residential, commercial, and industrial load growth forecasted as well as address existing reliability issues in the southeast Edmonton area (Area 60).

The DFO's request includes a request for a Rate DTS, Demand Transmission Service, contract capacity increase of 5.82 MW, from 36.18 MW to 42 MW, for the system access service provided at the existing East Industrial POD as well as a DTS contract capacity increase of 31 MW, from 40 MW to 71 MW, for the system access service provided at the existing Summerside POD. Also included is a request for transmission development (collectively, the Project). 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 April 27, 2022.

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

Table 1-1: Project Load and Generation Details

Project Component		Description
Load	Existing Rate DTS, <i>Demand Transmission Service</i> , contract capacity	36.18 MW at East Industrial 40 MW at Summerside
	Requested Rate DTS	An increase of 5.82 MW at East Industrial to 42 MW An increase of 31 MW at Summerside to 71 MW
	Type	Residential/Commercial/Industrial
	Motors (number and size)	Not applicable
	Power factor	0.9 pf (assumed)
	Future load expansion plans	No;

Note:

MARP and MC are defined in the AESO's *Consolidated Authoritative Document Glossary*, which can be found on the AESO's website.

1.2 Existing System Overview

1.2.1 Study Area

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

The Study Area consists of the AESO planning area of Edmonton (Area 60), including the tie lines connecting these planning areas to the rest of the AIES. Edmonton is surrounded by the AESO planning areas of Fort Saskatchewan (Area 33), Athabasca/Lac La Biche (Area 27), Wabamun (Area 40), and Wetaskiwin (Area 31).

From a transmission perspective, Edmonton consists of 500 kV, 240 kV, 138 kV, and 72 kV transmission systems.

1.2.1.1 East Industrial and Summerside Substations

East Industrial and Summerside are connected via the 240 kV Lambton substation. There are also feeder ties which can shift load between certain East Industrial and Summerside feeders.

Summerside and East Industrial each have two 240/25 kV transformers. Summerside transformers T1 and T2 were manufactured in 2010. East Industrial transformers T1 and T2 were manufactured in 1991 and 2006 respectively.

The DFO has advised that specific customers of note served by the Summerside substation include:

- Edmonton Fire Station
- Schools (17)
- EPCOR Water Services (2)
- EPCOR Drainage
- Alberta Health Services

The DFO has also advised that specific customers of note served by the East Industrial substation include:

- Schools (5)
- Edmonton Police Service
- Alberta Health Services (3)

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).

Under the loss of either 72CH9 or 72CH11, thermal criteria violations are observed on the remaining element. Under the loss of either 72CK12 or 72CK13, thermal criteria violations are observed on the remaining element. Under the loss of 72RG1 or 72RG7, thermal criteria violations are observed on the remaining element which are mitigated by the planned RAS for the West Edmonton Transmission Upgrade

Project. While the constraints observed on 72CH9, 72CH11, 72CK12 and 72CK13 are monitored and documented in this report, addressing these constraints is beyond the scope of the Project.

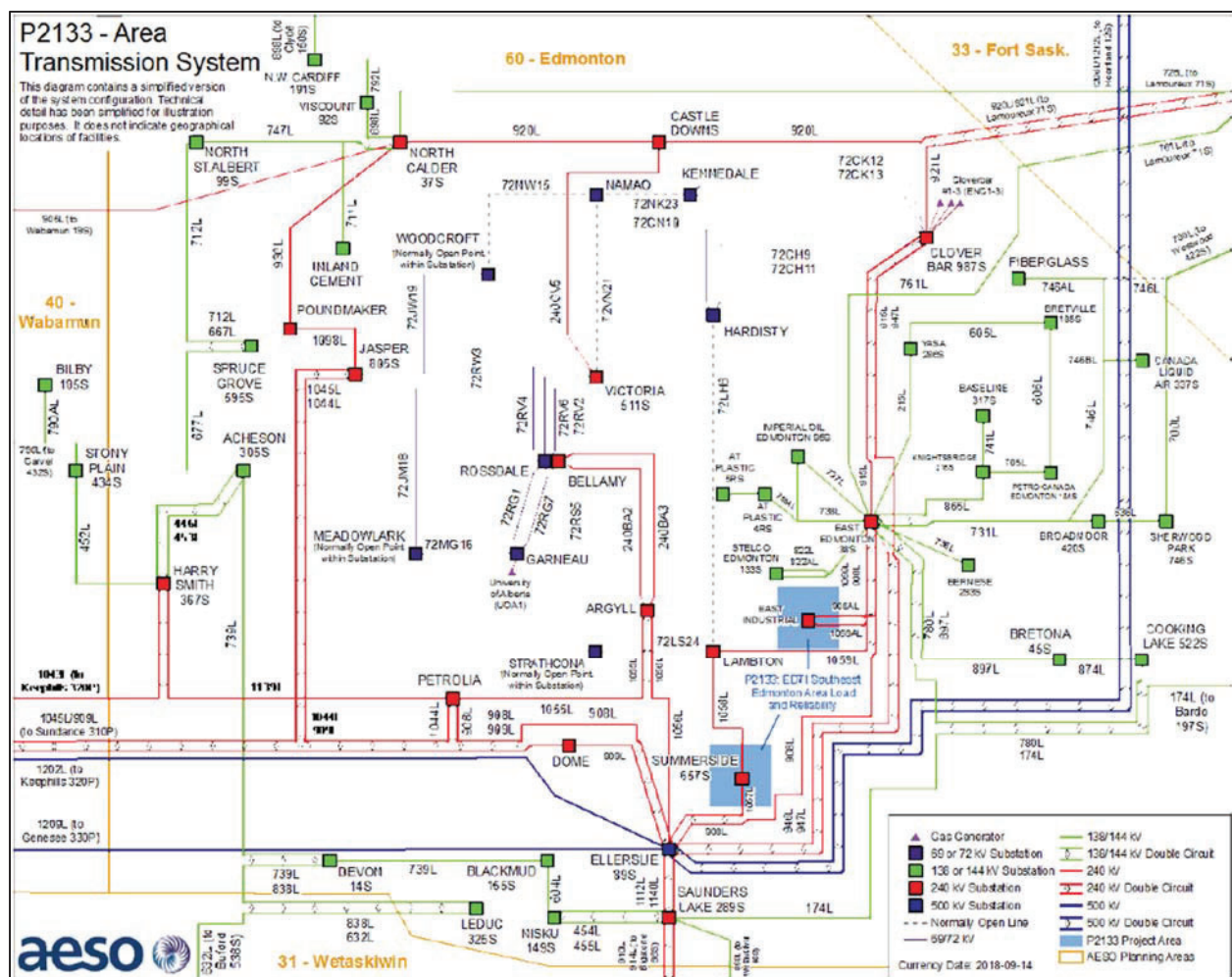
There are a existing constraints in the Study Area that are mitigated by existing remedial action schemes (RASs) and/or other protection schemes.

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

- RAS 149 EATL HVDC
- RAS 150 WATL HVDC

There is also a planned RAS, the Garneau-Meadowlark Reconfiguration RAS, which will come in service with the approved West Edmonton Transmission Upgrade Project (P1649).

Figure 1-1: Transmission System in the Study Area



2 Connection Alternative to be Studied

The following alternative will be studied:

2.1 Alternative 1 – Increase Capacity at Summerside 657S

This alternative included the following developments:

- Add one new 240/25 kV transformer and one (1) new 25 kV switchgear lineup;
- Add one (1) new 240 kV breaker
- Add two (2) new 25 kV feeder breakers;
- 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 and Category B events. For the purpose of applying the TPL standards to the studies documented in this report, Applicable Ratings are defined as follows:

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

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	East Industrial Load (MW)	Summerside Load (MW)	Project Generation (MW)
Pre-Project						
1	2022 SP	Low Generation (LG)	2022 SP LG Pre-Project	36.18	40	0
2	2022 WP	LG	2022 WP LG Pre-Project	36.18	40	0
Post-Project						
3	2022 SP	LG	2022 SP LG Post-Project	42	71	0
4	2022 WP	LG	2022 WP LG Post-Project	42	71	0
5	2029 WP	All study area units in-service	2022 WP Post-Project	42	71	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.

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

AESO Project No./Name	AESO Planning Area No.	Generation (MW)	Load (MW)	Scheduled ISD	AUC NID Decision No.
P1442 Fortis New Anthony Henday Substation	60-Edmonton	0.0	21.0	Jun 1, 2022	22244-D01-2018
P1649 EPCOR Garneau Area Upgrade	60-Edmonton	0.0	0.0	Oct 31, 2021	23943-D01-2020

AESO Project No./Name	AESO Planning Area No.	Generation (MW)	Load (MW)	Scheduled ISD	AUC NID Decision No.
P1659 EPCOR Strathcona Capacity Increase	60-Edmonton	0.0	14.2	Sep 1, 2020	23641-D01-2019
P2210 EDTI Strathcona Change	60-Edmonton	0.0	0.0	Oct 26, 2020	U2000-030

4.2.3 Load Assumptions

The load forecast to be used for the studies is shown in Table 4-3 and is a forecast for the AESO Edmonton Planning Region peak based on the AESO 2019 Long-Term Outlook¹ with modifications to incorporate the latest forecast intelligence. For the post-Project studies, when the Study Area loads are modified to align with the regional load forecast, the active power to reactive power ratio in the base case scenarios shall be maintained.

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

AESO Planning Region Name	Forecast Peak Load by Year/Season (MW)	
	2022SP	2022WP
Edmonton Planning Region ¹	2140	2277

Note:

¹ The Edmonton Region comprises the following AESO planning areas: 40, 60, 31

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

4.2.4 Generation Assumptions

The generation forecast to be used for the studies is based on the 2019 LTO with modifications to incorporate the latest forecast intelligence. The generation assumptions for the studies will assume low generation in the Study Area. 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 4-4.

Cloverbar was determined to be the critical generator, and shall be modelled as being offline to simulate the N-G condition in all the study.

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

Table 4-4: 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	
					2022SP	2022WP
Cloverbar	1	25516	48	60	Not in merit	Not in merit
Cloverbar	2	26516	101	60	Not in merit	Not in merit
Cloverbar	3	27516	101	60	Not in merit	Not in merit
University of Alberta		25352/25353	39	60	1.8	13.3

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

^c "Not in merit" means that the generating unit has operating blocks whose prices are above the system marginal price.

4.2.5 Intertie Flow Assumptions

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

4.2.6 HVDC Power Order Assumptions

The Western Alberta Transmission Line (WATL) and the Eastern Alberta Transmission Line (EATL) are high-voltage direct current (HVDC) transmission lines. WATL and EATL are not expected to have a material impact on the connection assessment. Therefore, the HVDC assumptions shall be the same as in the AESO planning base cases and will not be adjusted for the studies.

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 4-5. These limits must be maintained when performing the studies.

Table 4-5: 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 4-6 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 4-6: 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
921L	Clover Bar E987S to Lamoureux 71S	240	417	499	500	620
915L	Clover Bar E987S to East Edmonton 38S	240	492	499	590	648
947L	Clover Bar E987S to Ellerslie 89S	240	493	611	592	743
908AL	East Industrial E52S to JCT. 908AL	240	499	499	499	499
1059AL	East Industrial to JCT. EP 1059AL	240	499	499	499	499
1057L	Summerside E657S to Ellerslie 89S	240	594	713	654	733
1058L	Lambton E803S to Summerside E657S	240	499	499	499	499
908L	Petrolia E816S to Ellerslie 89S	240	505	648	606	706
909L	Dome E665S to Sundance 310P	240	481	499	499	499
909L	Ellerslie 89S to Dome E665S	240	499	499	499	499
908L	JCT. 908AL to East Edmonton 38S	240	499	499	599	648
1059L	JCT. EP 1059AL to East Edmonton 38S	240	499	499	599	648
1055L ^a	Petrolia E816S to Argyll E629S	240	419	517	419	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
780L	East Edmonton 38S to Cooking Lake	138	98	132	108	145
174L	Saunders Lake 289S to Bardo 197S	138	85	90	94	99
72CH9	Clover Bar E987S to Hardisty	69 ^g	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	56.5 ^c	56.5 ^c	61.0	65.1
72CK13	Clover Bar E987S to Kennedale	69 ^g	59.4 ^c	59.4 ^c	61.0	65.1
72CN10	Clover Bar E987S to Namao	69 ^g	57.4	57.4	57.4	57.4
72JM18	Jasper E805S to Meadowlark	69 ^g	57.4	62.7	57.4	62.7
72JW19	Jasper E805S to Woodcroft	69 ^g	57.4	62.7	57.4	62.7

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
72KN23	Kennedale to Namao	69 ^g	57.4	57.4	57.4	57.4
72LH8	Lambton E803S to Hardisty	69 ^g	86.6	118.9	101.0	129.7
72LS24	Lambton E803S to Strathcona	69 ^g	86.6	118.9	101.0	129.7
72MG16	Meadowlark to Garneau	69 ^g	57.4	62.7	57.4	62.7
72NW15	Namao to Woodcroft	69 ^g	61.5	84.9	71.7	92.6
72RG1	Rossdale to Garneau	69 ^g	57.5	62.7	133.9 ^d	133.9 ^d
72RG7	Rossdale to Garneau	69 ^g	76.5	86.0	133.9 ^d	133.9 ^d
72RV2	Rossdale to E511S Victoria ^e	69 ^g	71.6	81.7	89.8	99.2
72RV4	Rossdale to E511S Victoria ^e	69 ^g	89.9	100.3	126.2	135.0
72RV6	Rossdale to E511S Victoria ^e	69 ^g	82.3	87.1	100.3	104.5
72RW3	Rossdale to Woodcroft	69 ^g	57.4	62.7	57.4	62.7
72VN21	E511S Victoria to Namao	69 ^g	57.4	62.7	57.4	62.7

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 and winter rating with 72CK13 out of service is 479 A (56.5 MVA at 69 kV). 72CK13 normal summer and winter rating with 72CK12 out of service is 497 A (59.4 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.

The TFO provided the details of the substation transformers in the Study Area. The key transformers in the Study Area are shown in Table 4-7.

Table 4-7: Summary of Key Transformer Ratings in the Study Area

Substation Name and Number	Transformer ID	Transformer Voltages (kV)	MVA Rating
Ellerslie 89S	T1	500/240	1200.0
	T2	500/240	1200.0
East Edmonton 38S	T1	240/138	341.8
	T2	240/138	340.6
Clover Bar 987S	T1	240/69	200
	T2	240/69	200
	T1	240/25	63.0

Substation Name and Number	Transformer ID	Transformer Voltages (kV)	MVA Rating
<i>East Industrial E52S</i>	<i>T2</i>	<i>240/25</i>	<i>63.0</i>
<i>Summerside 657S</i>	<i>T1</i>	<i>240/25</i>	<i>75.0</i>
	<i>T2</i>	<i>240/25</i>	<i>75.0</i>

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 4-8.

Table 4-8: 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)	Status in Study (on or off)		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVar)	Status in Study (on or off)	
				2021 SP (MVar)	202 WP (MVar)			2017SP (MVar)	2017WP (MVar)
<i>East Edmonton 38S</i>	<i>138</i>	<i>2</i>	<i>48.91</i>	<i>both on</i>	<i>both on</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>
<i>Nisku 149S</i>	<i>138</i>	<i>1</i>	<i>30</i>	<i>on</i>	<i>on</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>
<i>Acheson 305S</i>	<i>138</i>	<i>1</i>	<i>24.46</i>	<i>on</i>	<i>on</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>
<i>Jasper 805S</i>	<i>240</i>	<i>1</i>	<i>105.31</i>	<i>on</i>	<i>on</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>
<i>Rossdale</i>	<i>69</i>	<i>2</i>	<i>90.58</i>	<i>both on</i>	<i>both on</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>
<i>Cloverbar 987S</i>	<i>69</i>	<i>1</i>	<i>31.57</i>	<i>both on</i>	<i>both on</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>
<i>Stelco Edmonton 133S</i>	<i>34.5</i>	<i>1</i>	<i>16.8</i>	<i>on</i>	<i>on</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>
		<i>1</i>	<i>30</i>	<i>on</i>	<i>on</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>

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	A	B	A	B	A	B	
Pre-Project										
1	2022 SP	X	X	X	X					
2	2022 WP	X	X	X	X					X
Post-Project										
3	2022 SP	X	X	X	X					
4	2022 WP	X	X	X	X					X
5	2029 WP	X	X	X	X					X

For the engineering studies, all transmission facilities 69 kV and above, within the Study Area and the transmission lines connecting this planning area 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 Power Flow Studies

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

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

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

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

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

5.1.1 Contingencies to be Studied

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

5.2 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 Edmonton (Area 60) and increasing generation in Calgary (Area 6).

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

5.2.1 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.

5.3 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:

- East Edmonton 38S
- East Industrial E52S
- Ellerslie 89S
- Riverview

- Summerside 657S

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 factors³ 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 AES.

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 (2019 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.

Transmission Planning Criteria – Basis and Assumptions

Date: July 9, 2019

Version: V1.2

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 Criteria¹

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	152
72	65	68.5	75.5	79
69	62	65.5	72.5	76

Table 2-2: Voltage Stability Criteria

Performance Level	Disturbance (1)(2)(3)(4) Initiated by: Fault or No Fault DC Disturbance	MW Margin (P-V method) (5)(6)(7)	MVAr Margin (V-Q method) (6)(7)
A	Any element such as: One Generator One Circuit One Transformer One Reactive Power Source One DC Monopole	$\geq 5\%$	Worst Case Scenario(8)
B	Bus Section	$\geq 5\%$	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	$\geq 2.5\%$	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	2 nd 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

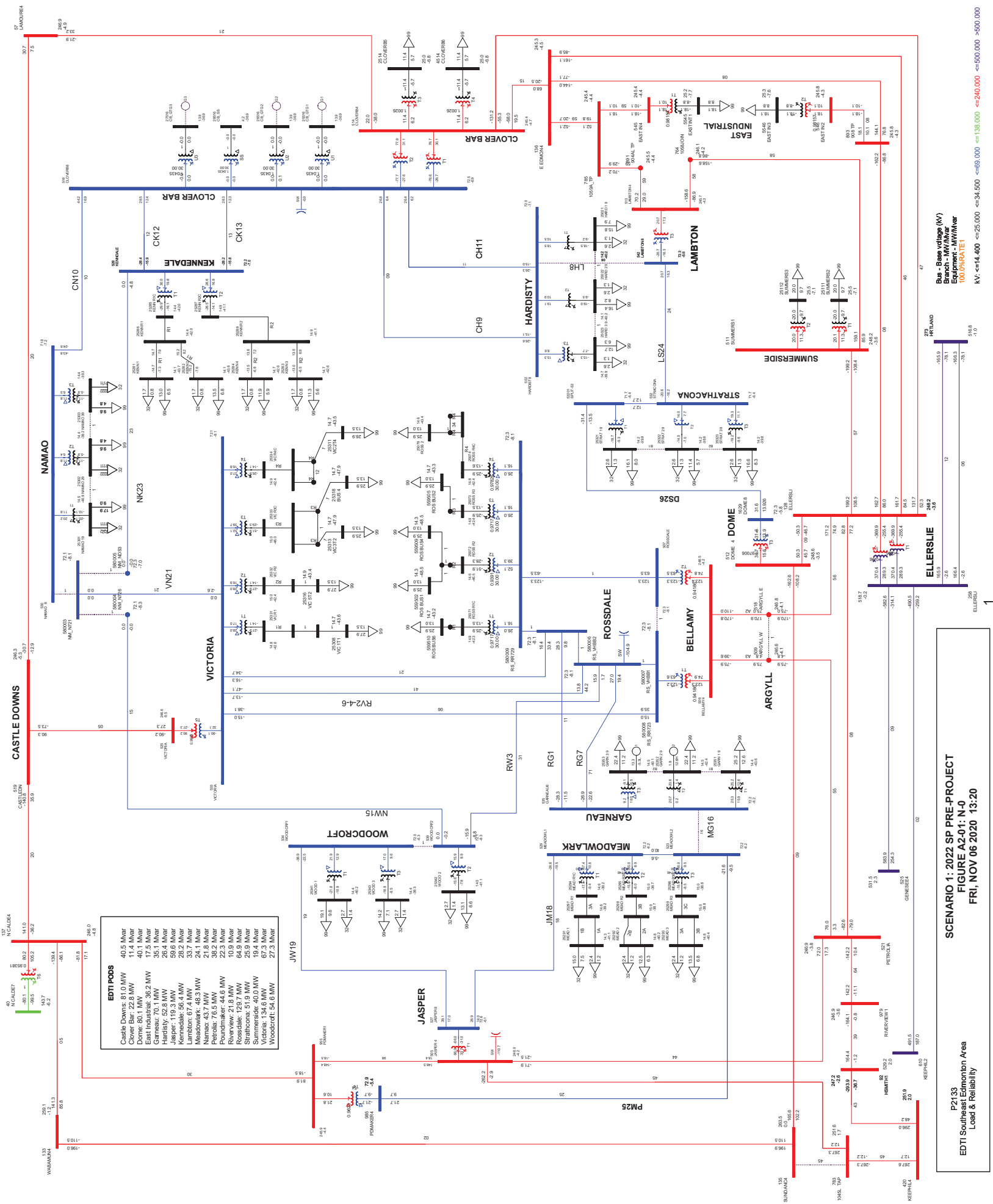
Voltage (kV)	Fault Location	Fault Clearing Times (Cycles)		
		High Side	Low Side	2 nd Ckt (breaker fail)
240/138	240 kV side	12	6	14
	138 kV side	5	15	24
500/240	500 kV side	9	5	11
	240 kV side	4	12	14

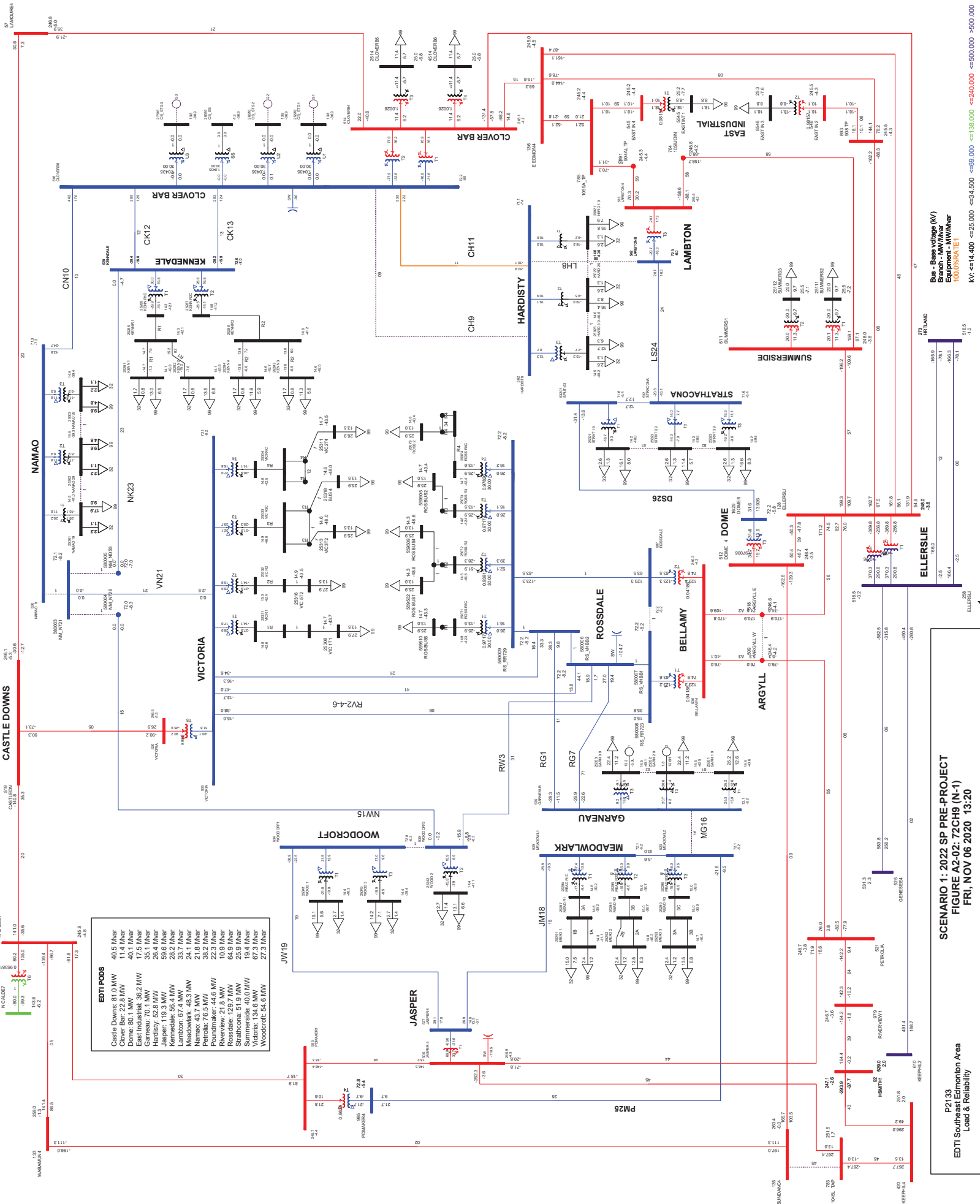
Attachment A2

Pre-Project Power Flow Diagrams

Attachment A2

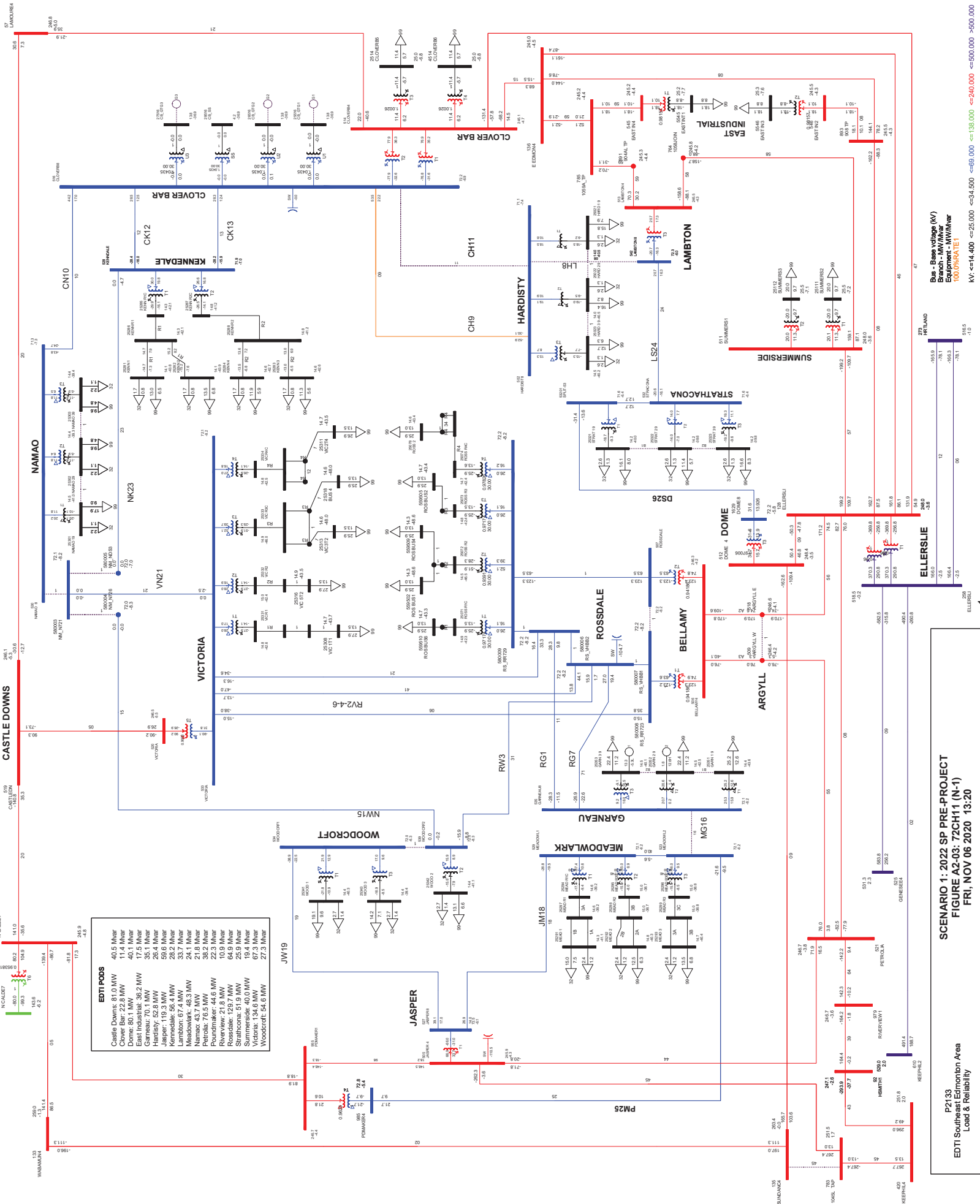
Pre-Project Power Flow Diagrams



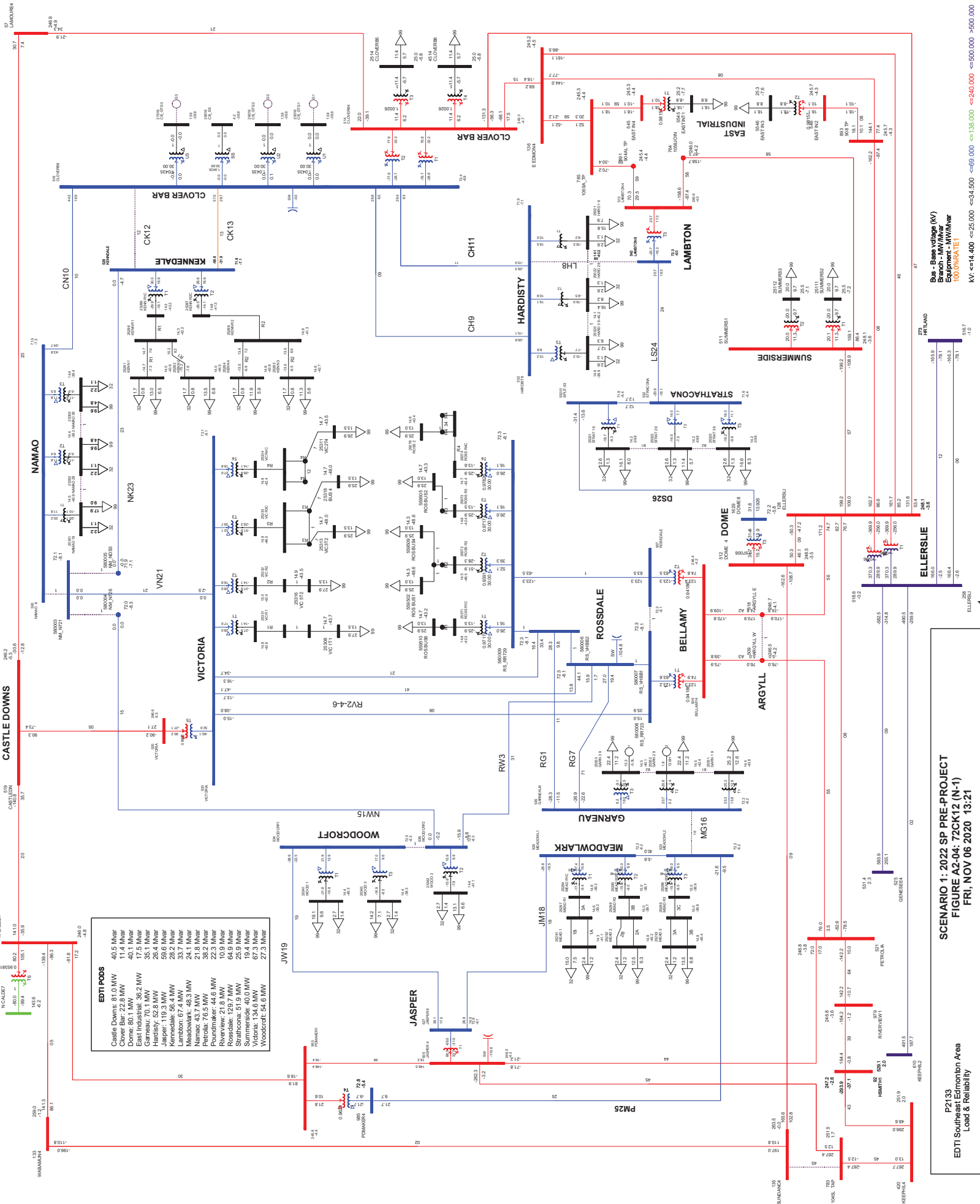


EDI POOLS	
Castle Downs: 81.0 MW	40.5 Mvar
Clover Bar: 22.8 MW	11.4 Mvar
Dome: 80.1 MW	40.1 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Edith Pools: 11.4 MW	3.0 Mvar
Hardisty: 52.8 MW	26.4 Mvar
Jasper: 119.3 MW	59.6 Mvar
Kennebec: 56.4 MW	28.2 Mvar
Lambton: 67.4 MW	33.7 Mvar
Meadowlark: 48.3 MW	24.1 Mvar
Namoo: 43.3 MW	21.7 Mvar
Poundmaker: 44.5 MW	22.3 Mvar
Riverview: 21.8 MW	10.9 Mvar
Rossdale: 125.7 MW	64.9 Mvar
Strathcona: 51.9 MW	25.9 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 54.6 MW	27.3 Mvar

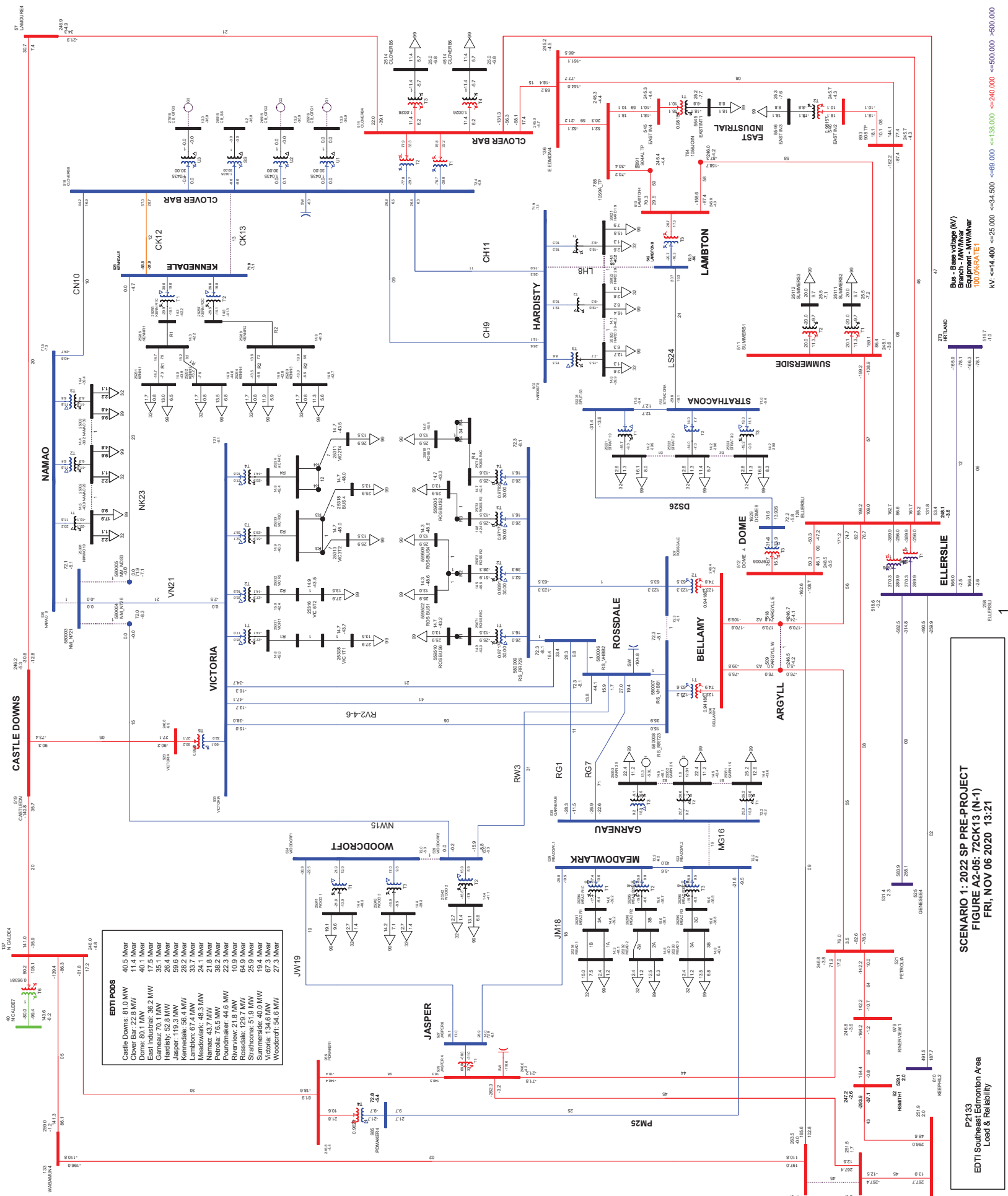
Bus - Base voltage (kV)
Bus - Base MVA
Equipment - MVA/Mvar
100% RATE
kv = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000

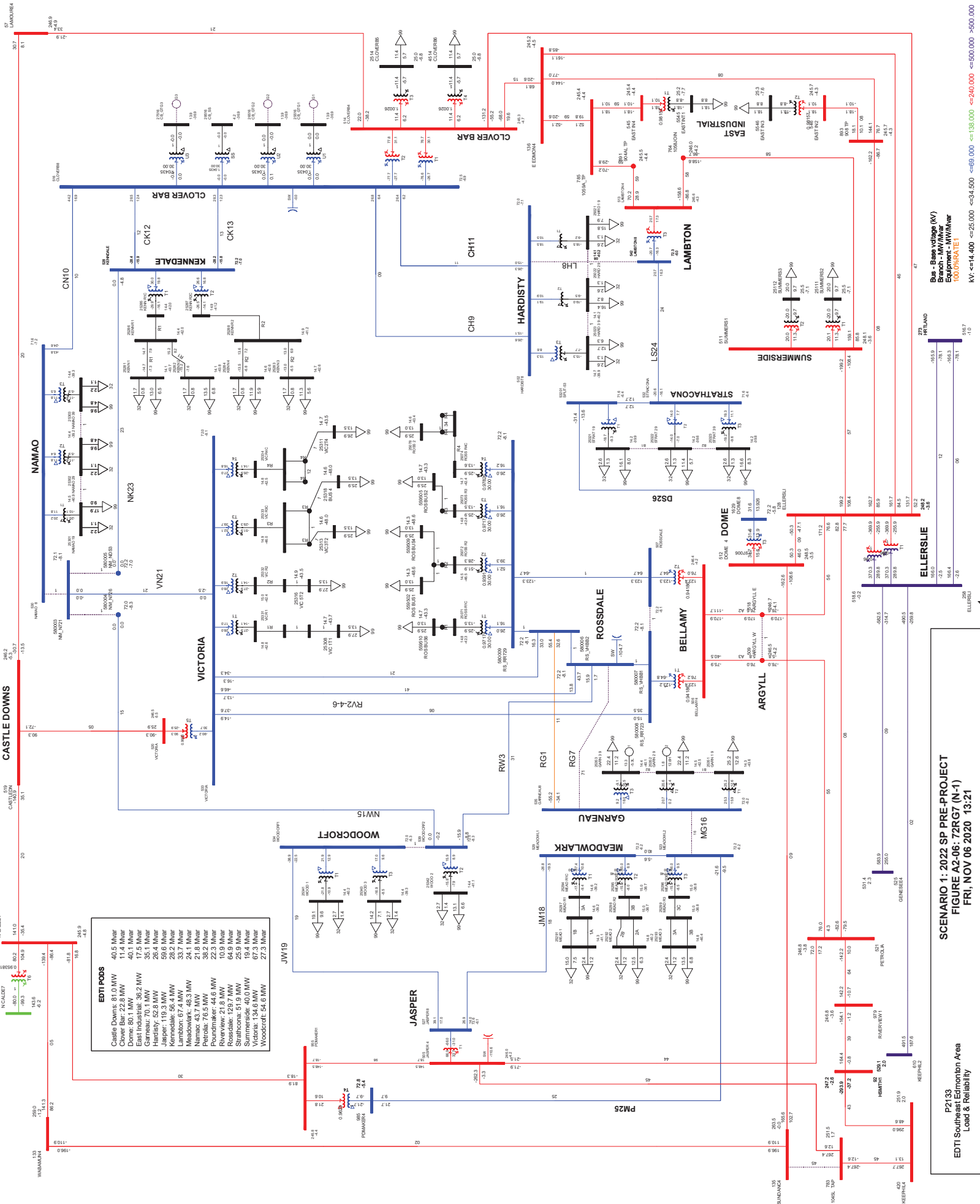


SCENARIO 1: 2022 SP PRE-PROJECT
FIGURE A2-03: 72CH11 (N-1)
FRI, NOV 06 2020 13:20



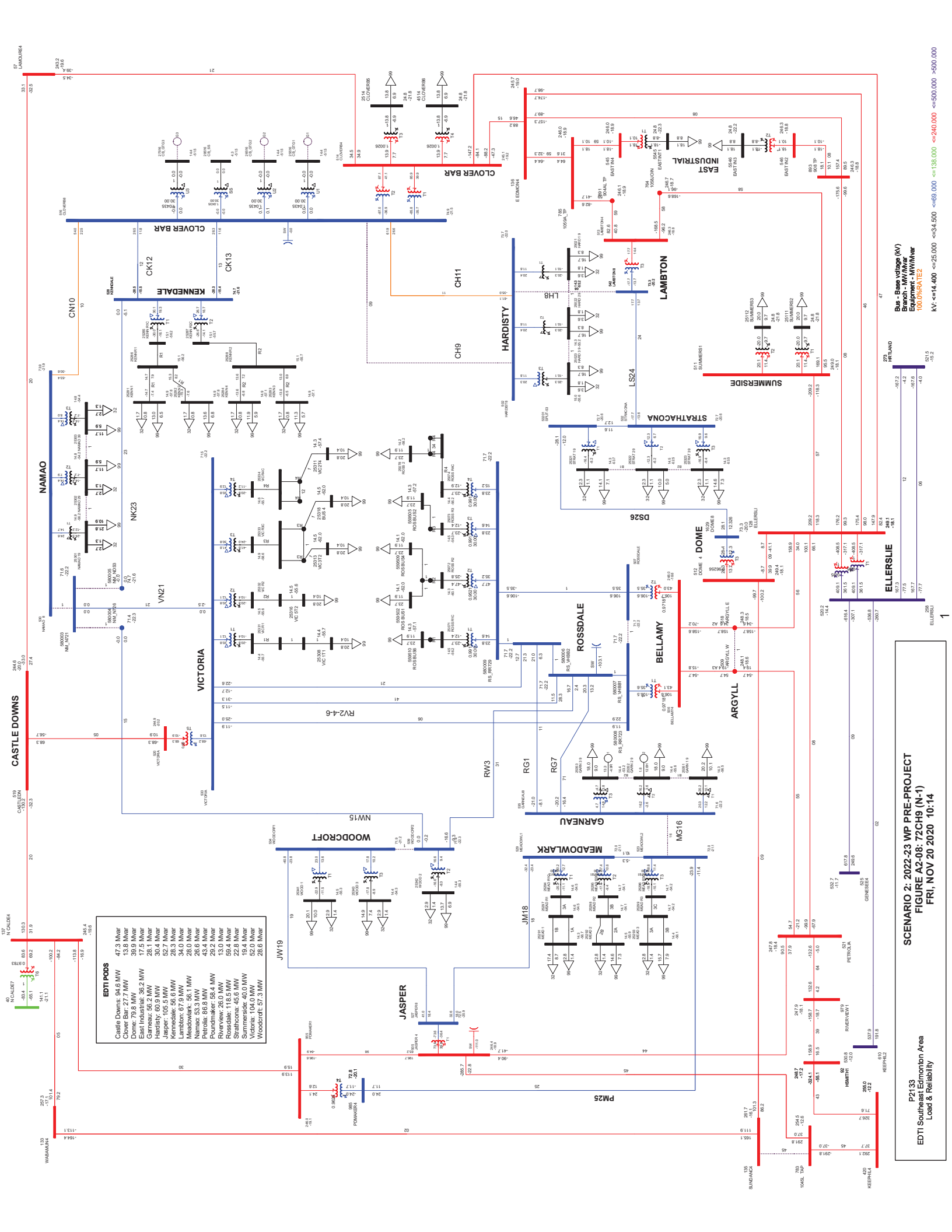
EDI POOS	
Castle Downs: 81.0 MW	40.5 Mvar
Clover Bar: 22.8 MW	11.4 Mvar
Dome: 80.1 MW	40.1 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Edinboro: 35.0 MW	18.0 Mvar
Hardisty: 52.8 MW	26.4 Mvar
Jasper: 119.3 MW	59.6 Mvar
Kennedale: 67.4 MW	28.2 Mvar
Lambton: 56.4 MW	33.7 Mvar
Meadowlark: 48.3 MW	24.1 Mvar
Namoo: 43.3 MW	21.7 Mvar
Poundmaker: 38.5 MW	19.5 Mvar
Riverview: 44.5 MW	22.3 Mvar
Riverview: 21.8 MW	10.9 Mvar
Rosedale: 125.7 MW	64.9 Mvar
Strathcona: 51.9 MW	25.9 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 54.6 MW	27.3 Mvar



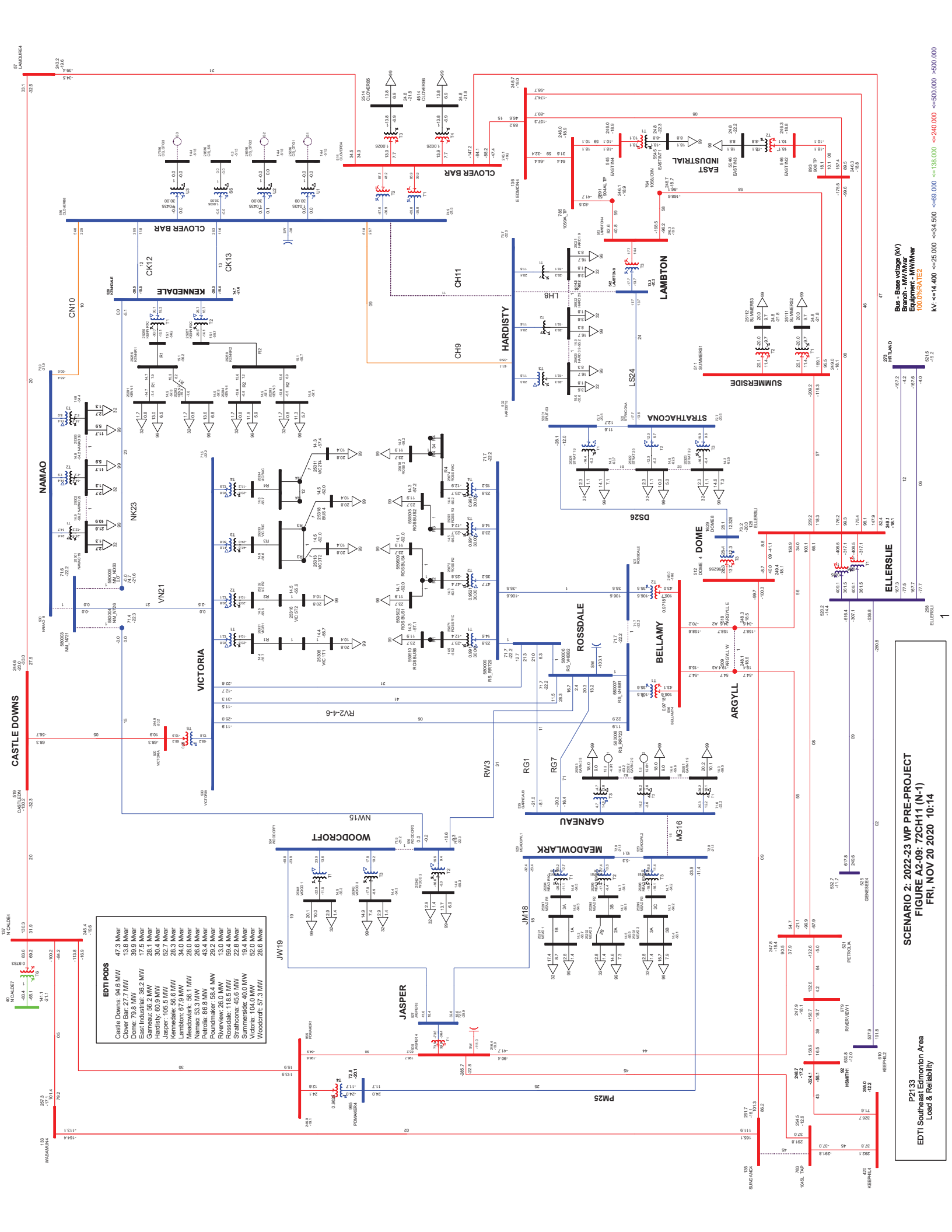


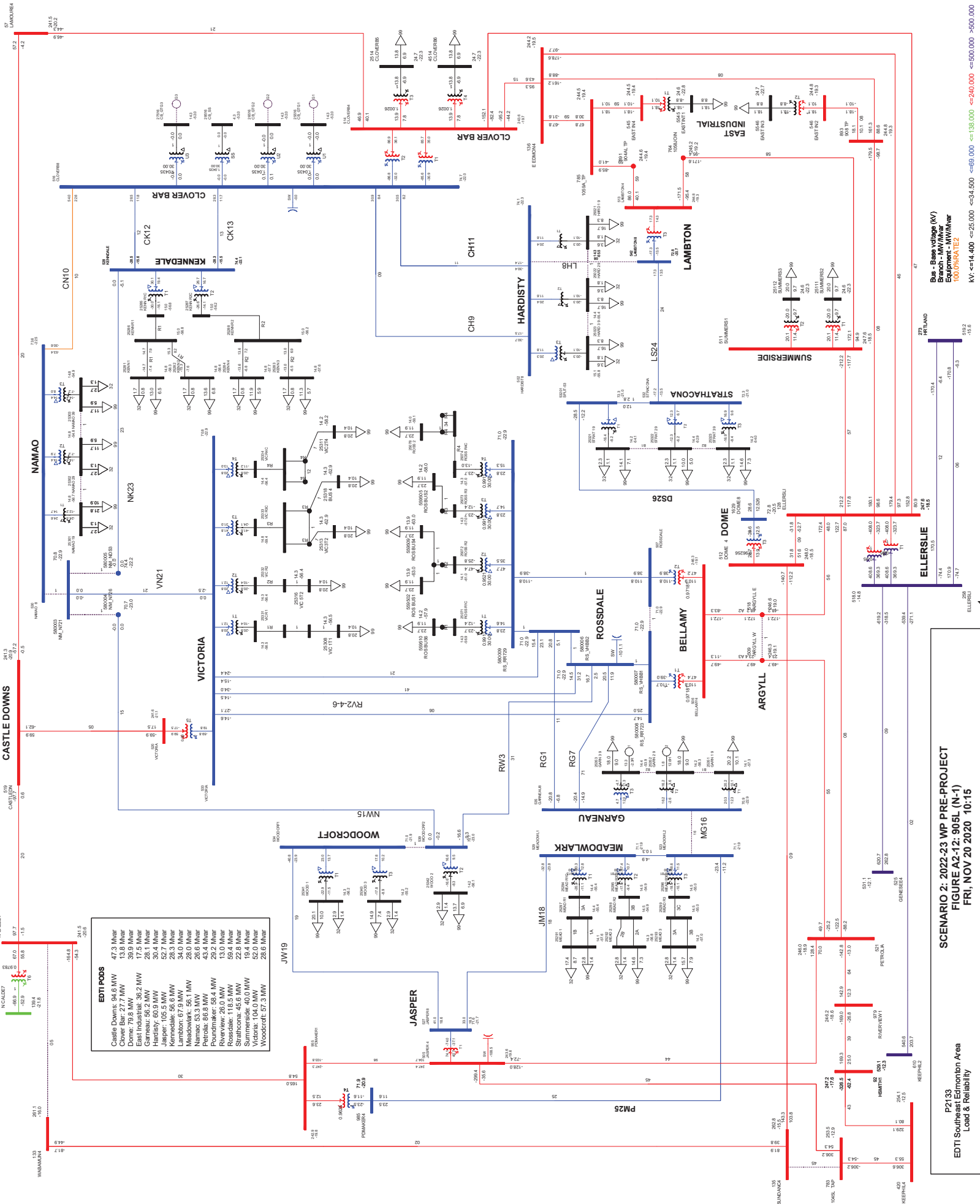
SCENARIO 1: 2022 SP PRE-PROJECT
FIGURE A2-06: 72RG7 (N-1)
FRI, NOV 06 2020 13:21

P2133
EDT Southeast Edmonton Area
Load & Reliability

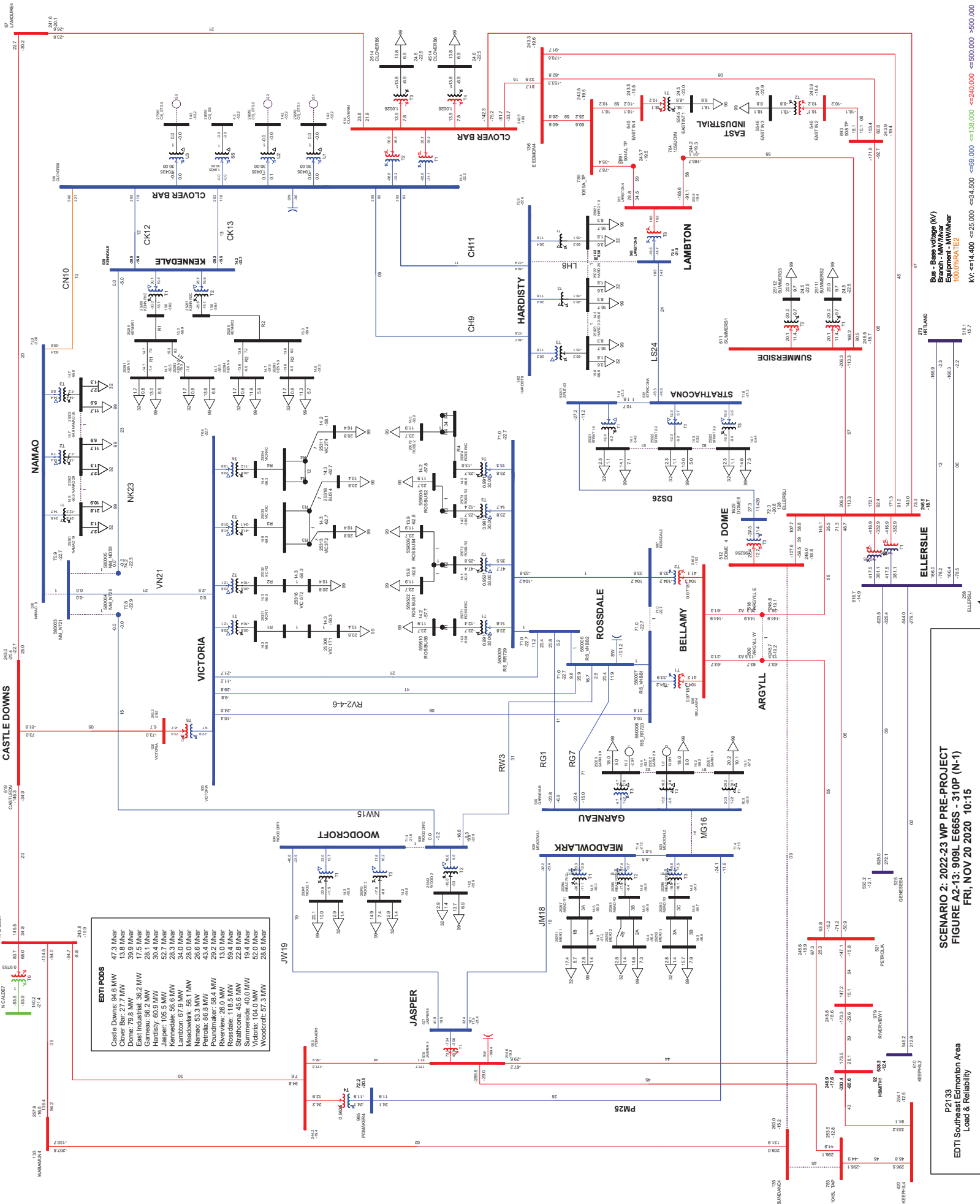


SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-08: 72CH9 (N-1)
FRI, NOV 20 2020 10:14



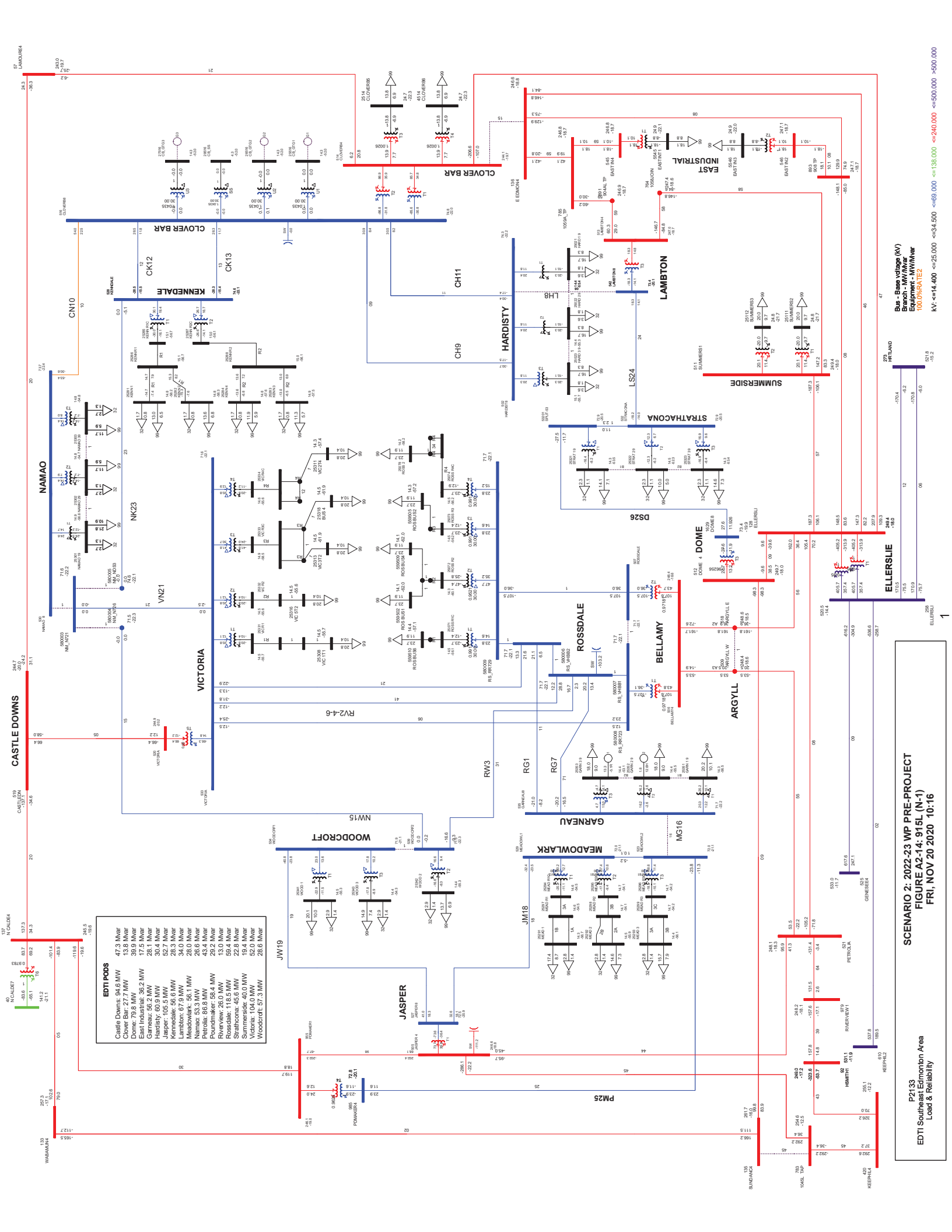


SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-12: 905L (N-1)
FRI, NOV 20 2020 10:15



EDI POOS	
Castle Downs: 94.6 MW	47.3 Mvar
Clover Bar: 27.7 MW	13.8 Mvar
Dome: 79.8 MW	39.9 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Hardley: 69.0 MW	30.4 Mvar
Jasper: 105.5 MW	52.7 Mvar
Kennedale: 56.6 MW	28.3 Mvar
Lambton: 67.9 MW	34.0 Mvar
Meadowlark: 55.1 MW	28.0 Mvar
Namoo: 53.3 MW	26.6 Mvar
Poundmaker: 58.4 MW	29.2 Mvar
Riverview: 26.0 MW	13.0 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Strathcona: 45.6 MW	22.8 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 57.3 MW	28.6 Mvar

SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-13: 909L E665S - 310P (N-1)
FRI, NOV 20 2020 10:15

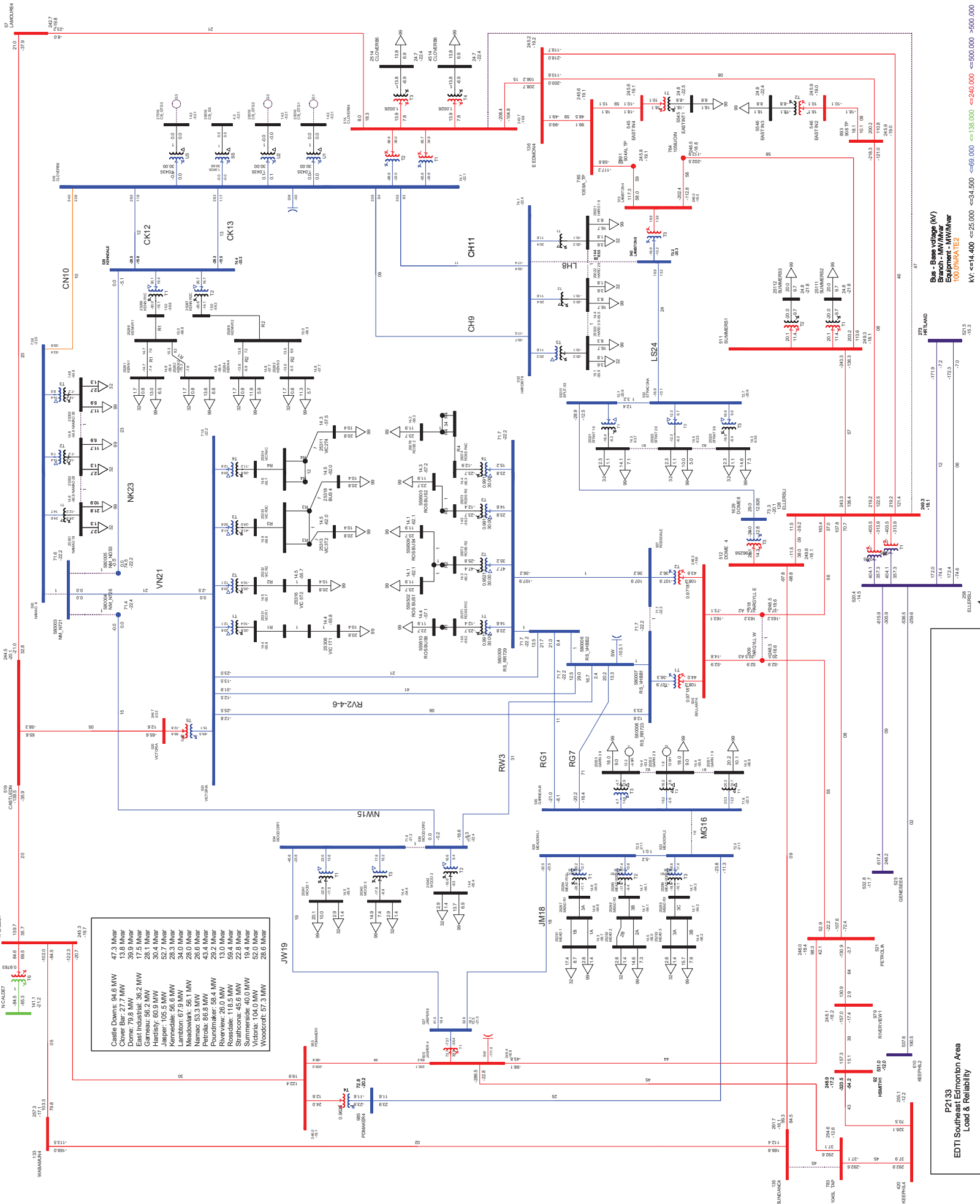


EDITH POOS	
Castle Downs: 94.6 MW	47.3 Mvar
Clover Bar: 27.7 MW	13.8 Mvar
Dome: 79.8 MW	39.9 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Edmonton: 105.5 MW	52.7 Mvar
Hardisty: 69.9 MW	30.4 Mvar
Jasper: 105.5 MW	52.7 Mvar
Kennedale: 56.6 MW	28.3 Mvar
Lambton: 67.9 MW	34.0 Mvar
Meadowbank: 56.1 MW	28.0 Mvar
Namao: 53.3 MW	26.6 Mvar
Poundmaker: 58.4 MW	29.2 Mvar
Riverview: 26.0 MW	13.0 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Strathcona: 45.6 MW	22.8 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 57.3 MW	28.6 Mvar

SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-14: 915L (N-1)
FRI, NOV 20 2020 10:16

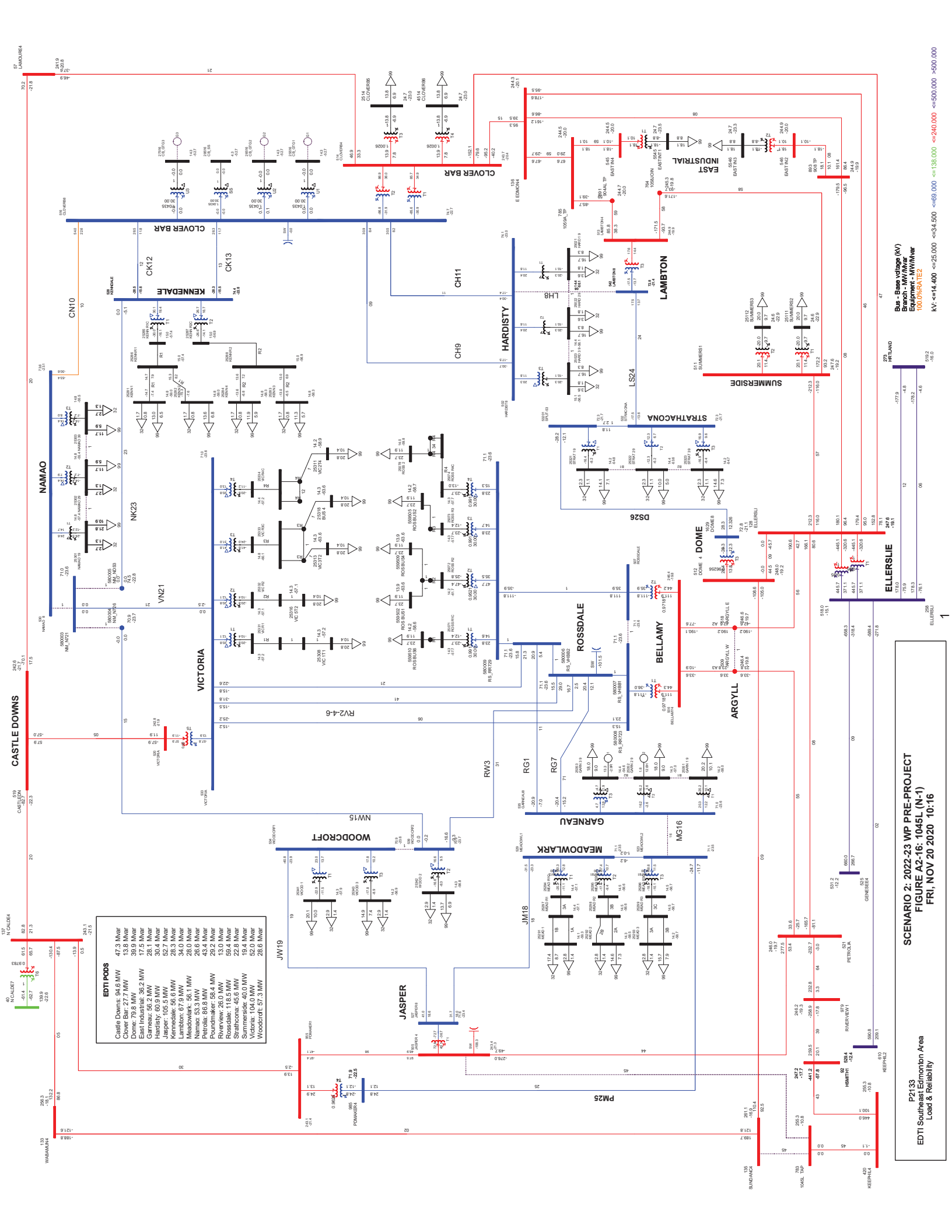
P2133
EDT Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Base power (MW)
Equipment - MVA/Mvar
100.0% RATE
kV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000



P2133
ED11 Southeast Edmonton Area
Load & Reliability

Bus - Base Voltage (kV)
Equipment - MVA/Mvar
100% RATE
kv = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000

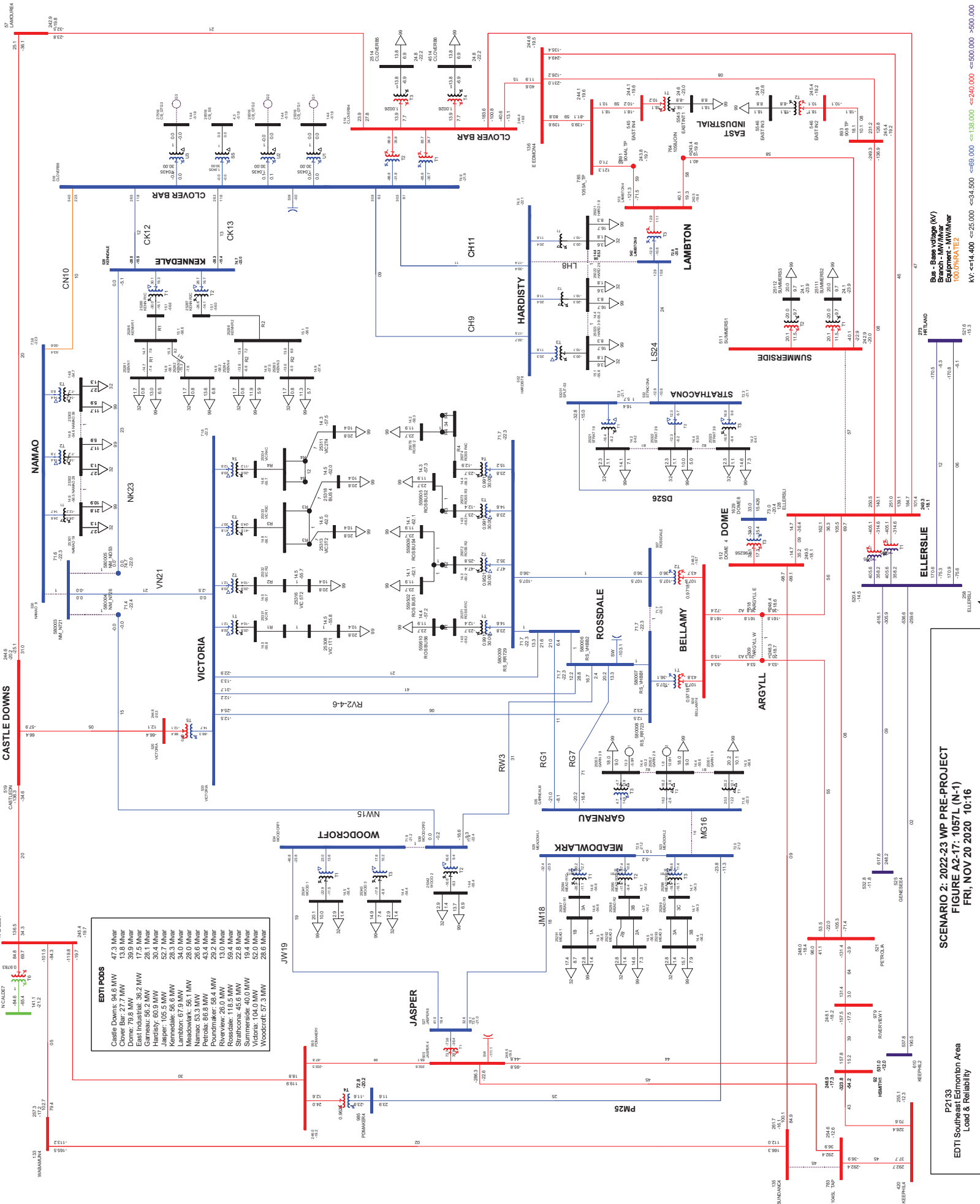


EDIN POOLS	
Castle Downs: 94.6 MW	47.3 Mvar
Clover Bar: 27.7 MW	13.8 Mvar
Dome: 79.8 MW	39.9 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Edin Pools: 105.5 MW	52.7 Mvar
Hardisty: 69.9 MW	30.4 Mvar
Jasper: 105.5 MW	52.7 Mvar
Kennebec: 56.6 MW	28.3 Mvar
Lambton: 67.9 MW	34.0 Mvar
Meadowlark: 56.1 MW	28.0 Mvar
Namao: 53.3 MW	26.6 Mvar
Poundmaker: 58.4 MW	29.2 Mvar
Riverview: 26.0 MW	13.0 Mvar
Rossdale: 116.5 MW	59.4 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 57.3 MW	28.6 Mvar

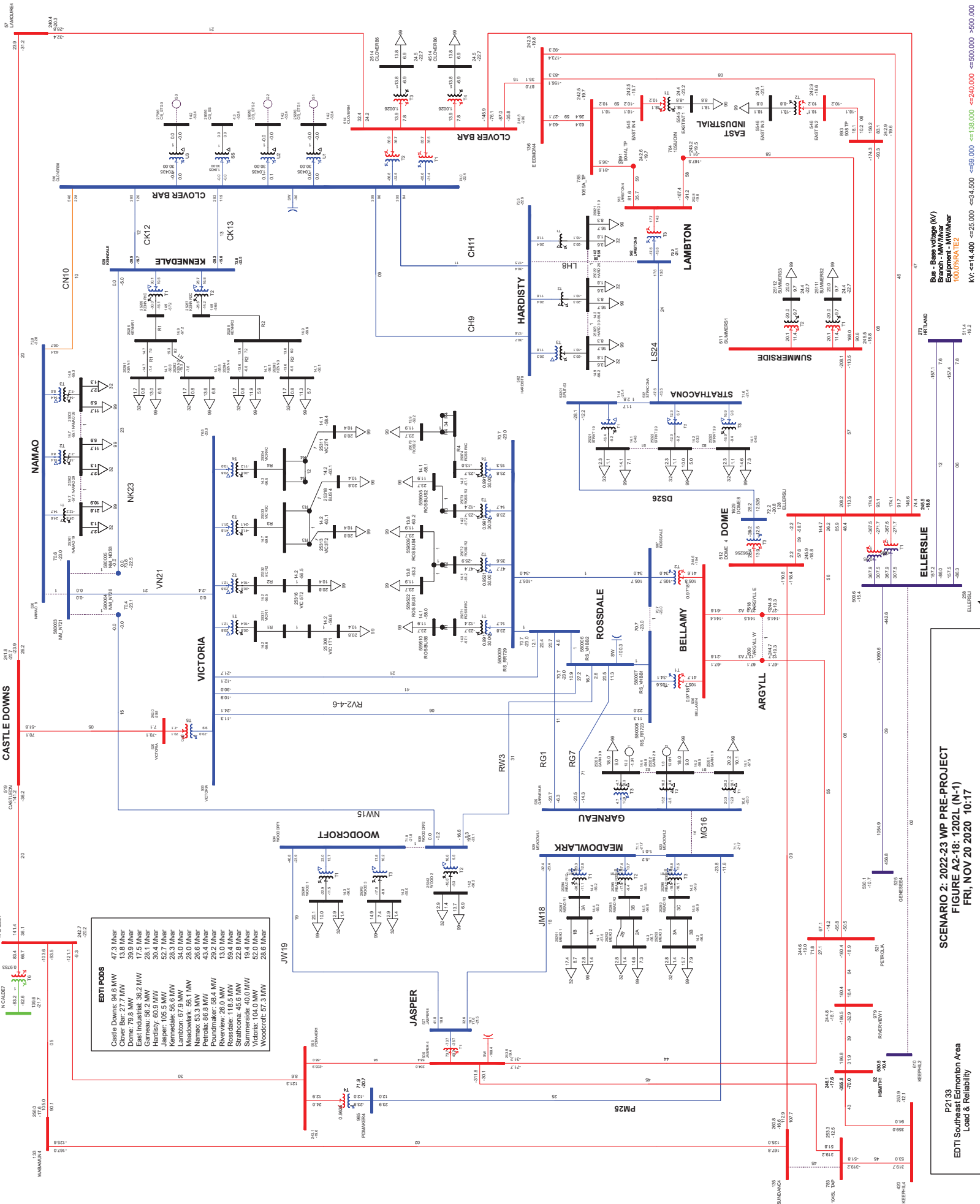
SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-16: 1045L (N-1)
FRI, NOV 20 2020 10:16

P2133
EDT Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Capacity (MW)
Equipment - MVA/Mvar
100% RATE
kv = 14.400 <= 25,000 <= 34,500 <= 69,000 <= 138,000 <= 240,000 <= 500,000 <= 500,000

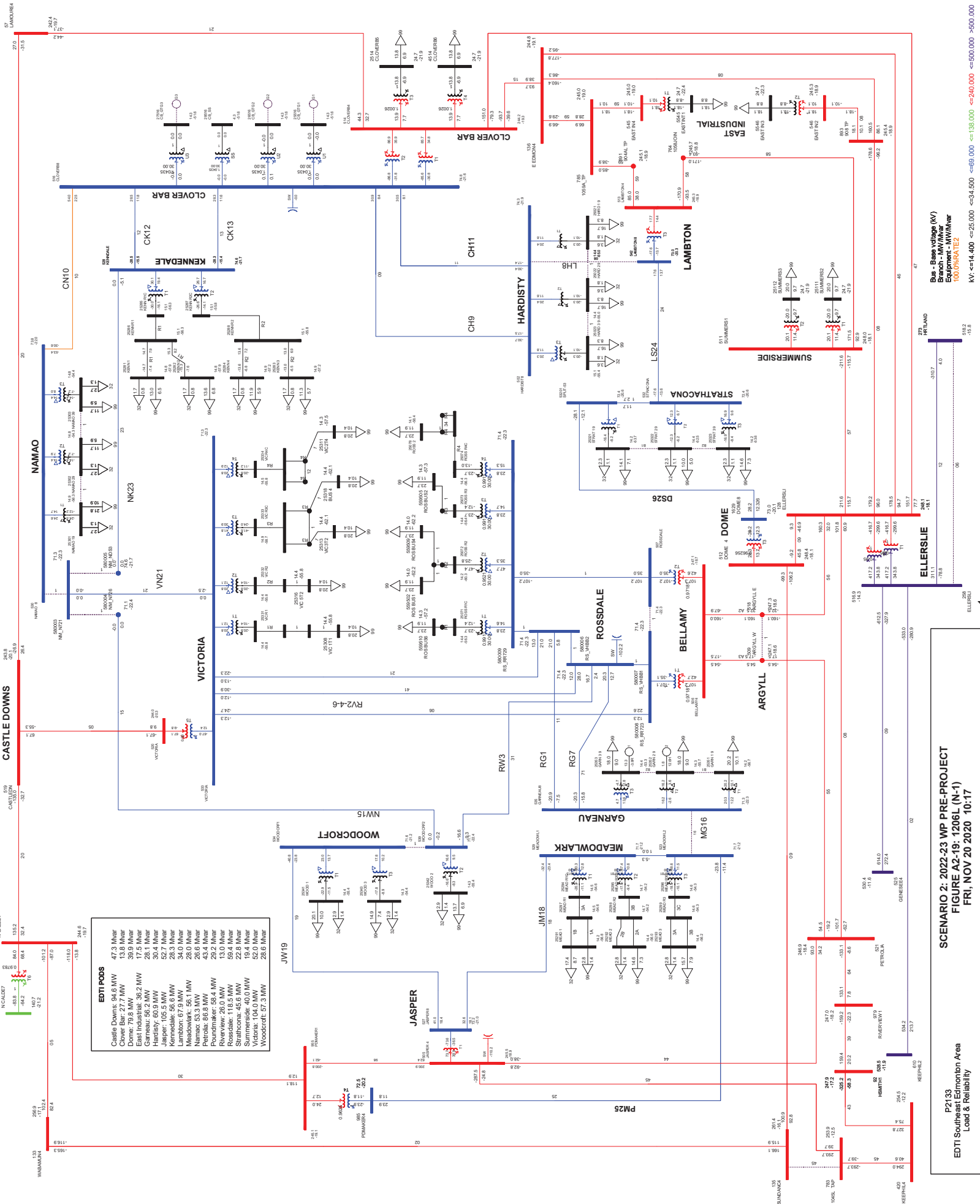


SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-17: 1057L (N-1)
FRI, NOV 20 2020 10:16

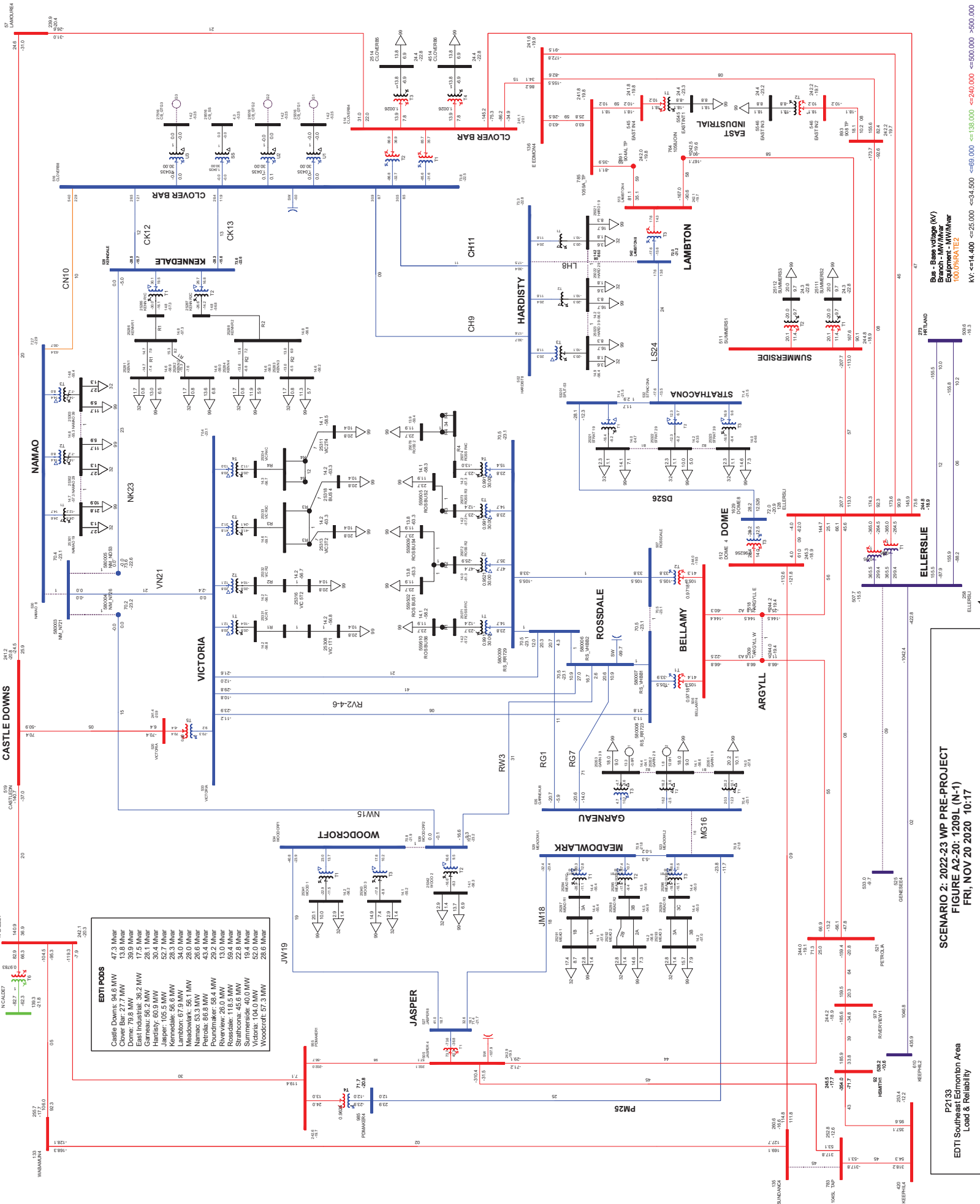


SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-18: 1202L (N-1)
FRI, NOV 20 2020 10:17

Bus - Base voltage (kV)
Bus - Base MVA
Equipment - MVA/Mvar
100% RATE
kV: <=14.400 <=25.000 <=34.500 <=49.000 <=138.000 <=240.000 <=500.000 <=500.000



SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-19: 1206L (N-1)
FRI, NOV 20 2020 10:17

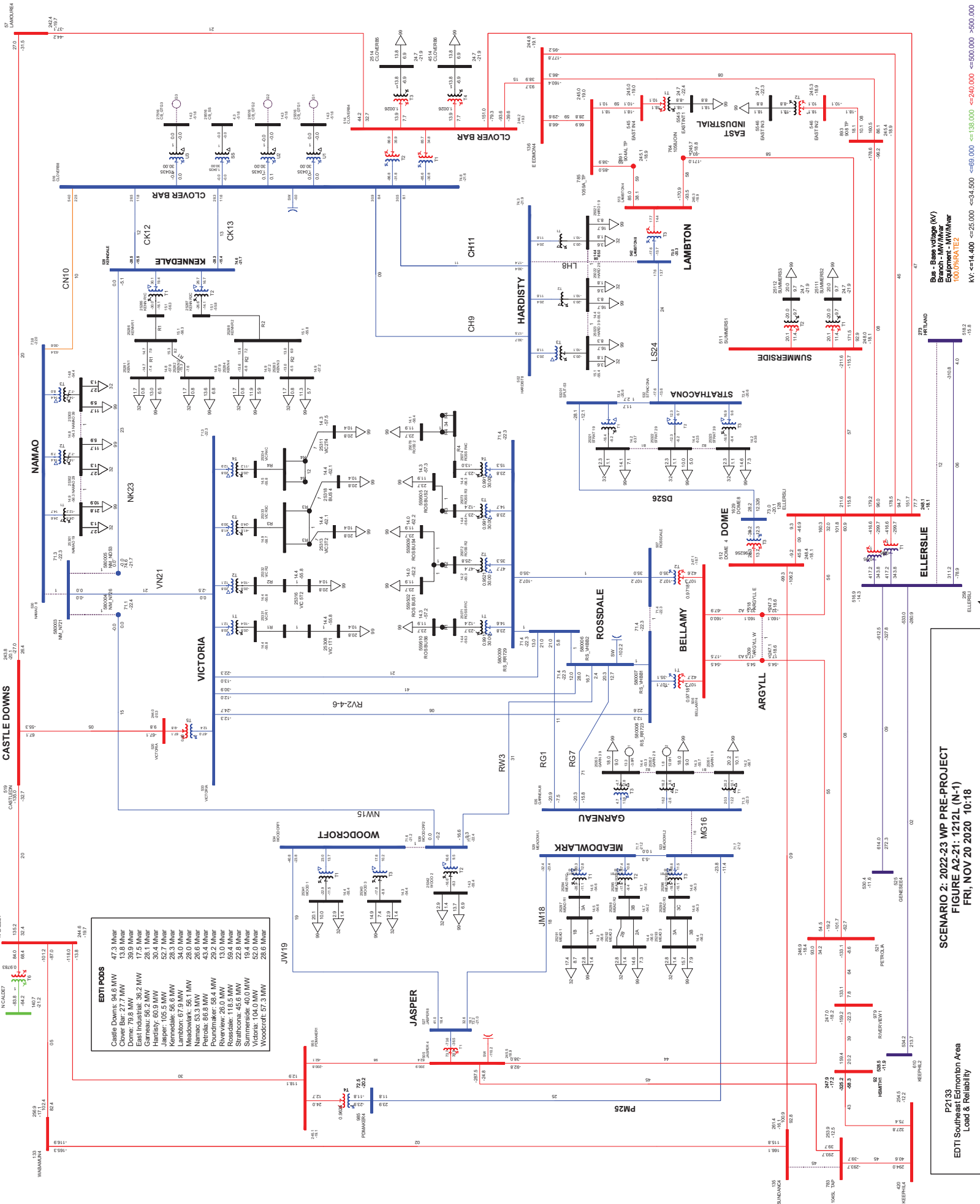


EDT POOL	
Castle Downs: 94.6 MW	47.3 Mvar
Clover Bar: 27.7 MW	13.8 Mvar
Dome: 79.8 MW	39.9 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Hardley: 69.9 MW	30.4 Mvar
Jasper: 105.5 MW	52.7 Mvar
Kennedale: 56.6 MW	28.3 Mvar
Lambton: 67.9 MW	34.0 Mvar
Meadowbank: 55.1 MW	28.0 Mvar
Namoo: 53.3 MW	26.6 Mvar
Poundmaker: 58.4 MW	29.2 Mvar
Riverview: 26.0 MW	13.0 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Strathcona: 45.6 MW	22.8 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 57.3 MW	28.6 Mvar

SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-20: 1209L (N-1)
FRI, NOV 20 2020 10:17

P2133
EDT Southeast Edmonton Area
Load & Reliability

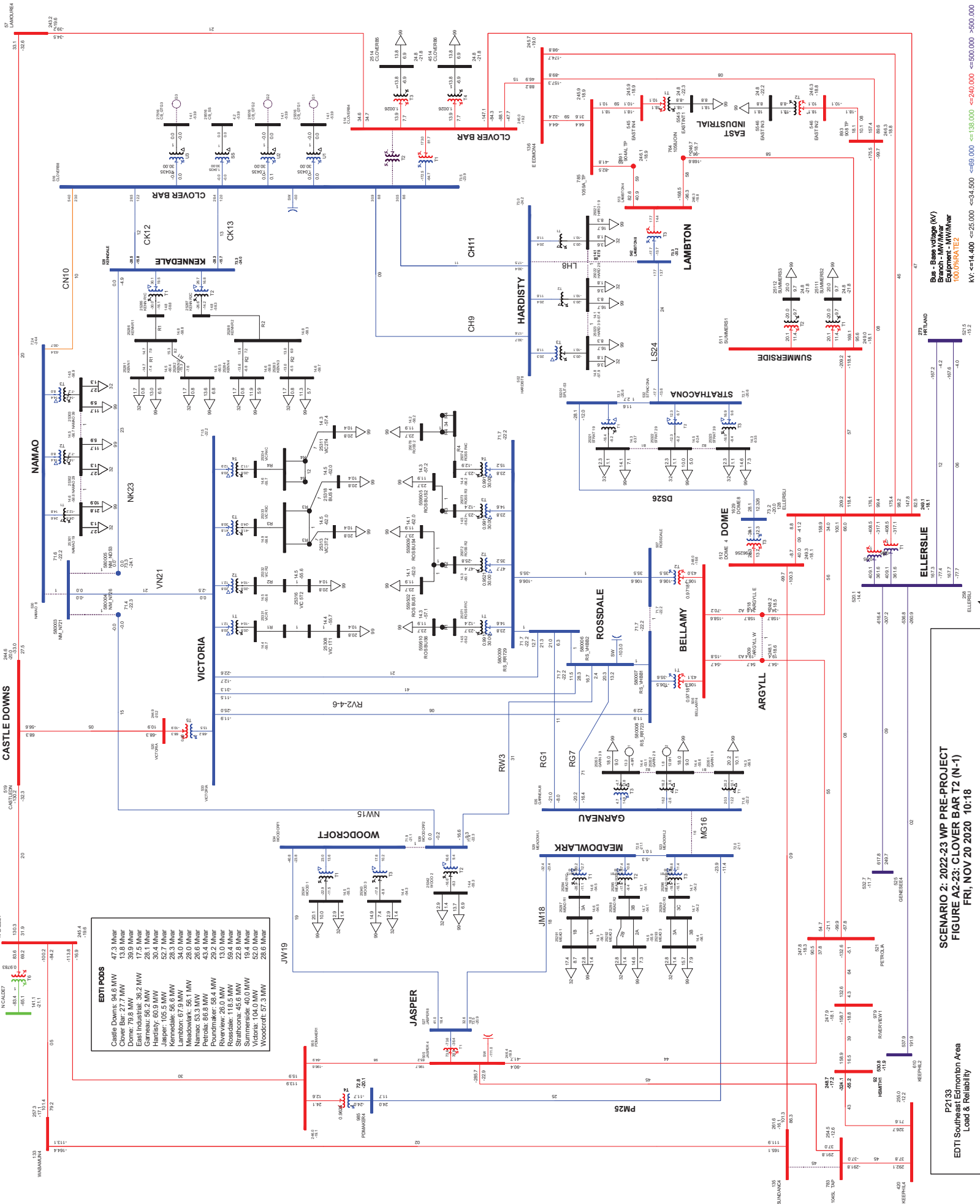
Bus - Base voltage (kV)
Bus - Base MVA
Equipment - MVA/Mvar
100% RATE
kv: <14.400 <25.000 <34.500 <49.000 <138.000 <240.000 <500.000 <500.000



ED1 POOS	
Castle Downs: 94.6 MW	47.3 Mvar
Clover Bar: 27.7 MW	13.8 Mvar
Dome: 79.8 MW	39.9 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Edmonton: 105.5 MW	52.7 Mvar
Hardisty: 69.9 MW	30.4 Mvar
Jasper: 105.5 MW	52.7 Mvar
Kennedale: 56.6 MW	28.3 Mvar
Lambton: 67.9 MW	34.0 Mvar
Meadowbank: 56.1 MW	28.0 Mvar
Namao: 53.3 MW	26.6 Mvar
Poundmaker: 58.4 MW	29.2 Mvar
Riverview: 26.0 MW	13.0 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 57.3 MW	28.6 Mvar

SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-21: 1212L (N-1)
FRI, NOV 20 2020 10:18

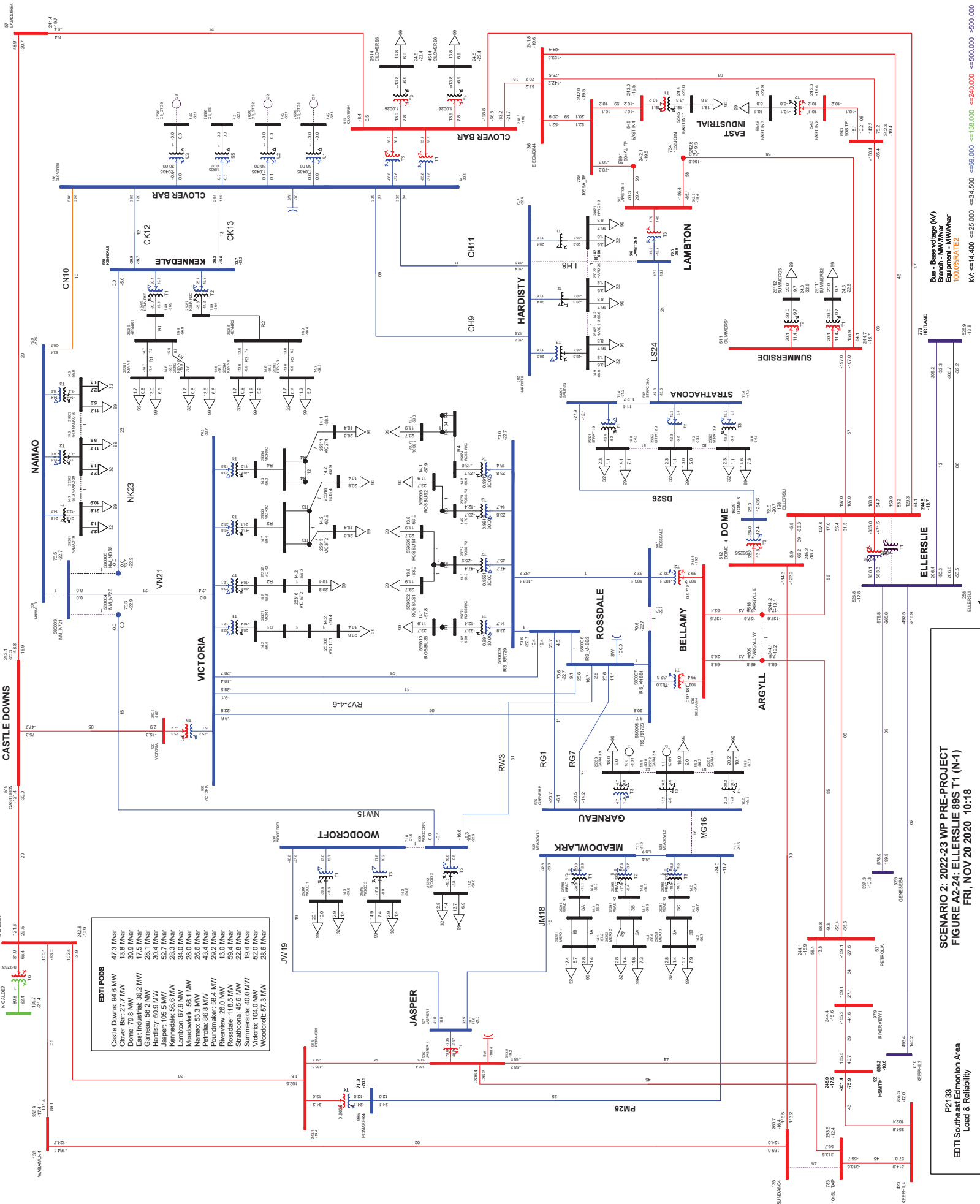
Bus - Base voltage (kV)
Equipment - MVA/Mvar
100% RATE
kv = 14.400 <= 25.000 <= 136.000 <= 240.000 <= 500.000 <= 500.000



SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-23: CLOVER BAR T2 (N-1)
FRI, NOV 20 2020 10:18

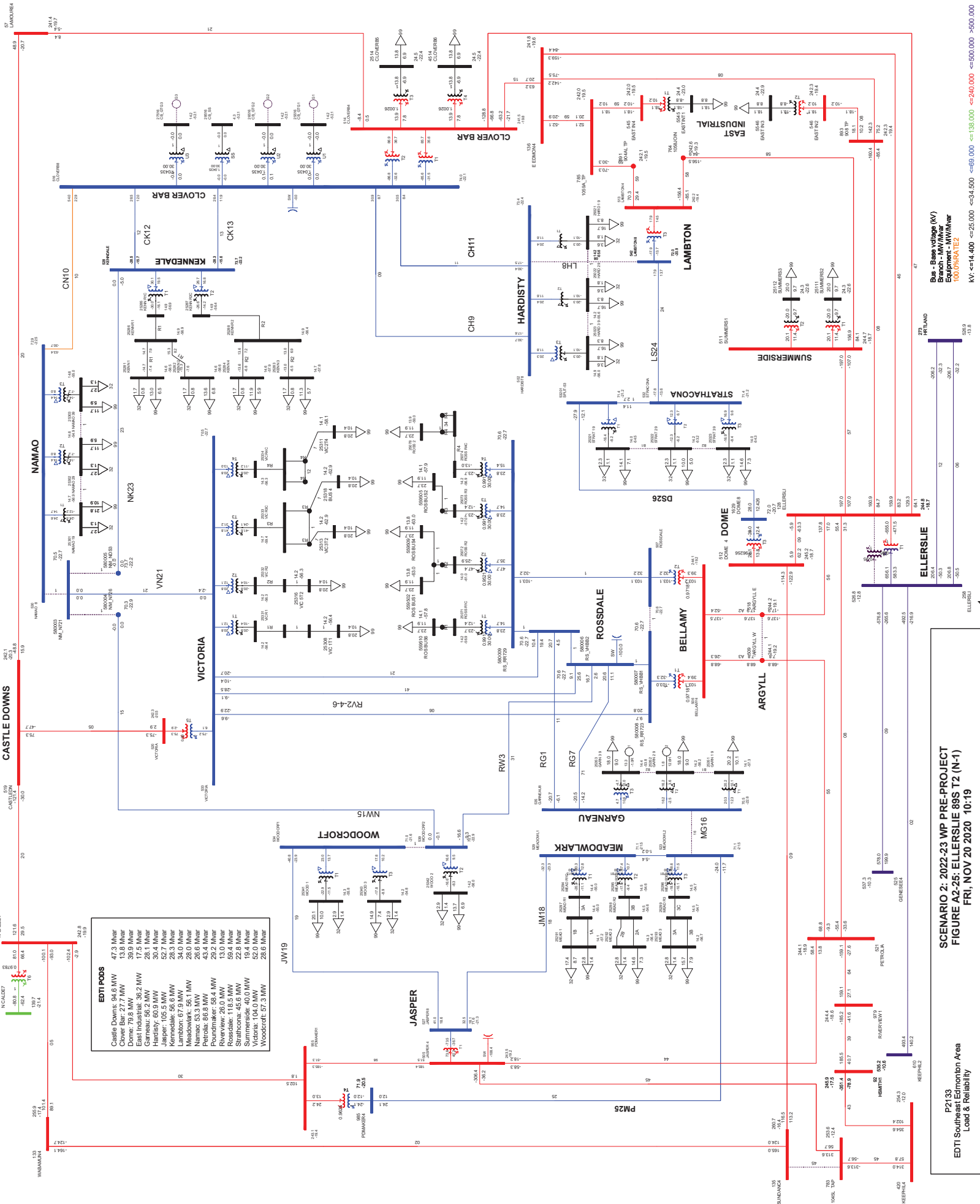
P2133
ED1 Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Base MVA
Equipment - MVA/Mvar
100.0% RATE
kv = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000



EDI POOLS	
Castle Downs: 94.6 MW	47.3 Mvar
Clover Bar: 27.7 MW	13.8 Mvar
Dome: 79.8 MW	39.9 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Edinboro: 105.5 MW	52.7 Mvar
Hardley: 69.9 MW	30.4 Mvar
Jasper: 105.5 MW	52.7 Mvar
Kennedale: 56.6 MW	28.3 Mvar
Lambton: 67.9 MW	34.0 Mvar
Meadowbank: 56.1 MW	28.0 Mvar
Namoo: 53.3 MW	26.6 Mvar
Poundmaker: 58.4 MW	29.2 Mvar
Riverview: 26.0 MW	13.0 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Strathcona: 45.6 MW	22.8 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 57.3 MW	28.6 Mvar

SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-24: ELLERSLIE 89S T1 (N-1)
FRI, NOV 20 2020 10:18

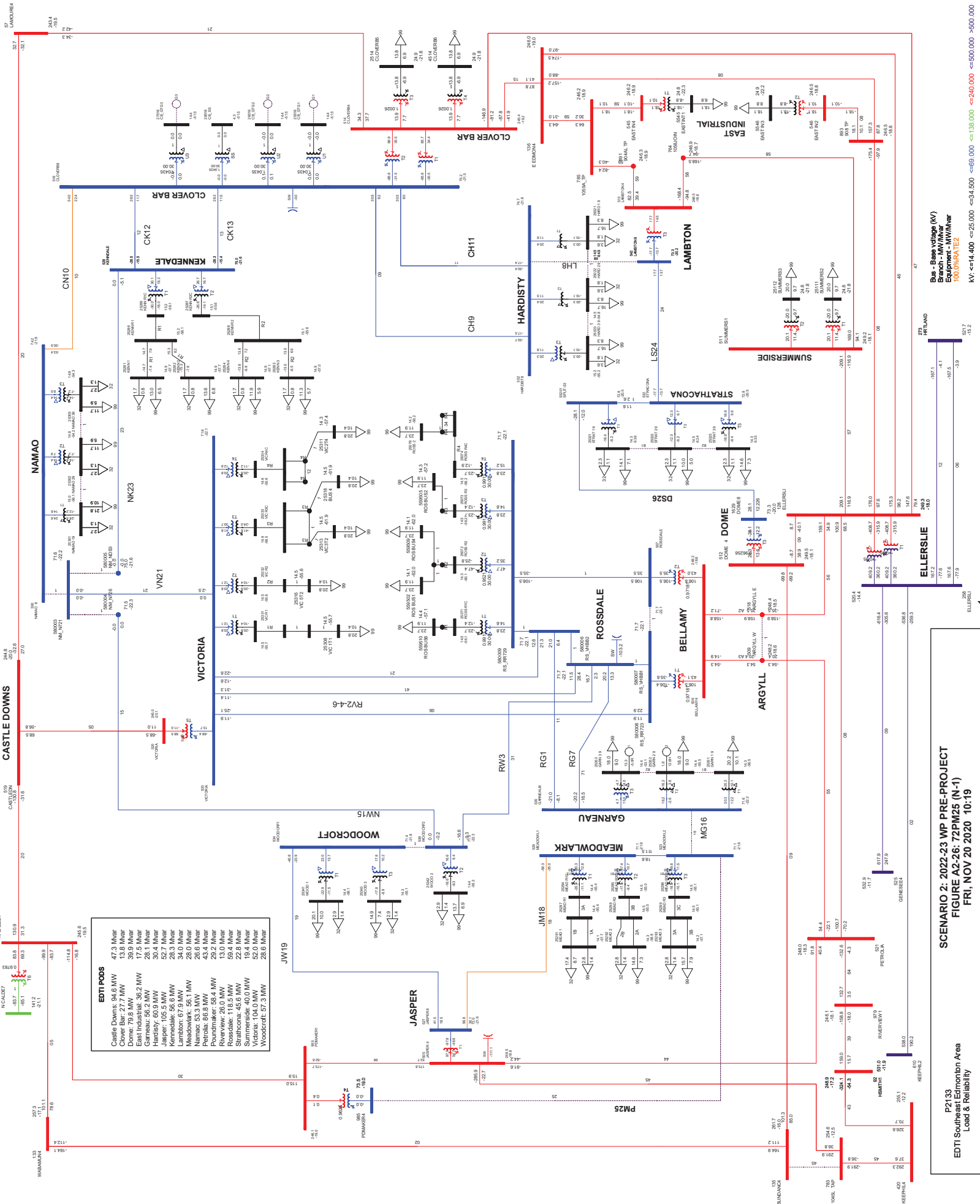


EDINBORO	
Castle Downs: 94.6 MW	47.3 Mvar
Clover Bar: 27.7 MW	13.8 Mvar
Dome: 79.8 MW	39.9 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Edinboro: 105.5 MW	52.7 Mvar
Hardley: 69.9 MW	30.4 Mvar
Jasper: 105.5 MW	52.7 Mvar
Kennebec: 56.6 MW	28.3 Mvar
Lambton: 67.9 MW	34.0 Mvar
Meadowbank: 56.1 MW	28.0 Mvar
Namoo: 53.3 MW	26.6 Mvar
Poundmaker: 58.4 MW	29.2 Mvar
Riverview: 26.0 MW	13.0 Mvar
Rosdale: 116.5 MW	59.4 Mvar
Strathcona: 45.6 MW	22.8 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 57.3 MW	28.6 Mvar

SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-25: ELLERSLIE 89S T2 (N-1)
FRI, NOV 20 2020 10:19

P2133
EDT Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Equipment - MVA/Mvar
100% RATE
KV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000

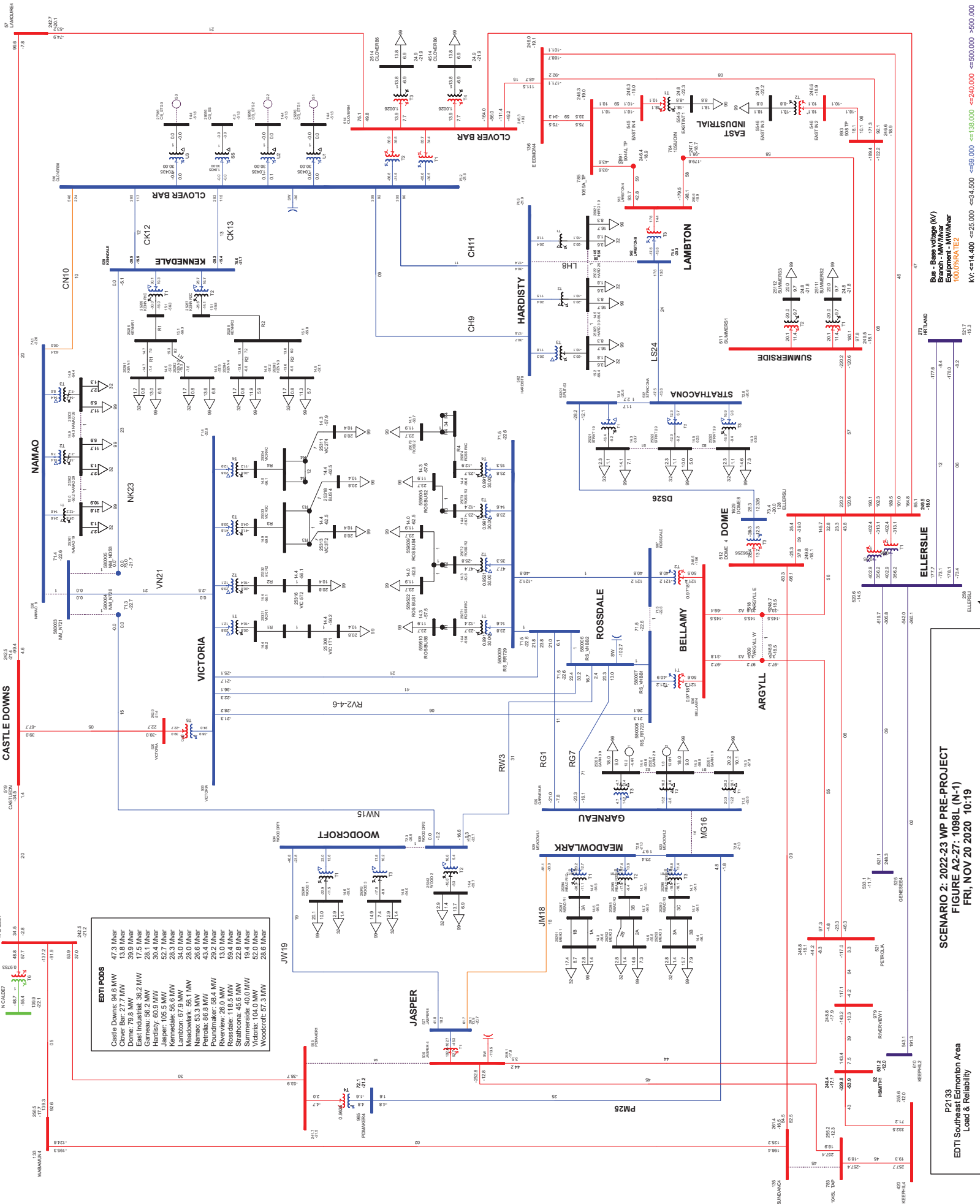


EDI POOLS	
Castle Downs: 94.6 MW	47.3 Mvar
Clover Bar: 27.7 MW	13.8 Mvar
Dome: 79.8 MW	39.9 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Edinboro: 60.0 MW	30.0 Mvar
Hardisty: 60.0 MW	30.0 Mvar
Jasper: 105.5 MW	52.7 Mvar
Kennedale: 56.6 MW	28.3 Mvar
Lambton: 67.9 MW	34.0 Mvar
Meadowbank: 56.1 MW	28.0 Mvar
Namao: 53.3 MW	26.6 Mvar
Poundmaker: 58.4 MW	29.2 Mvar
Riverview: 26.0 MW	13.0 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Strathcona: 45.6 MW	22.8 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 57.3 MW	28.6 Mvar

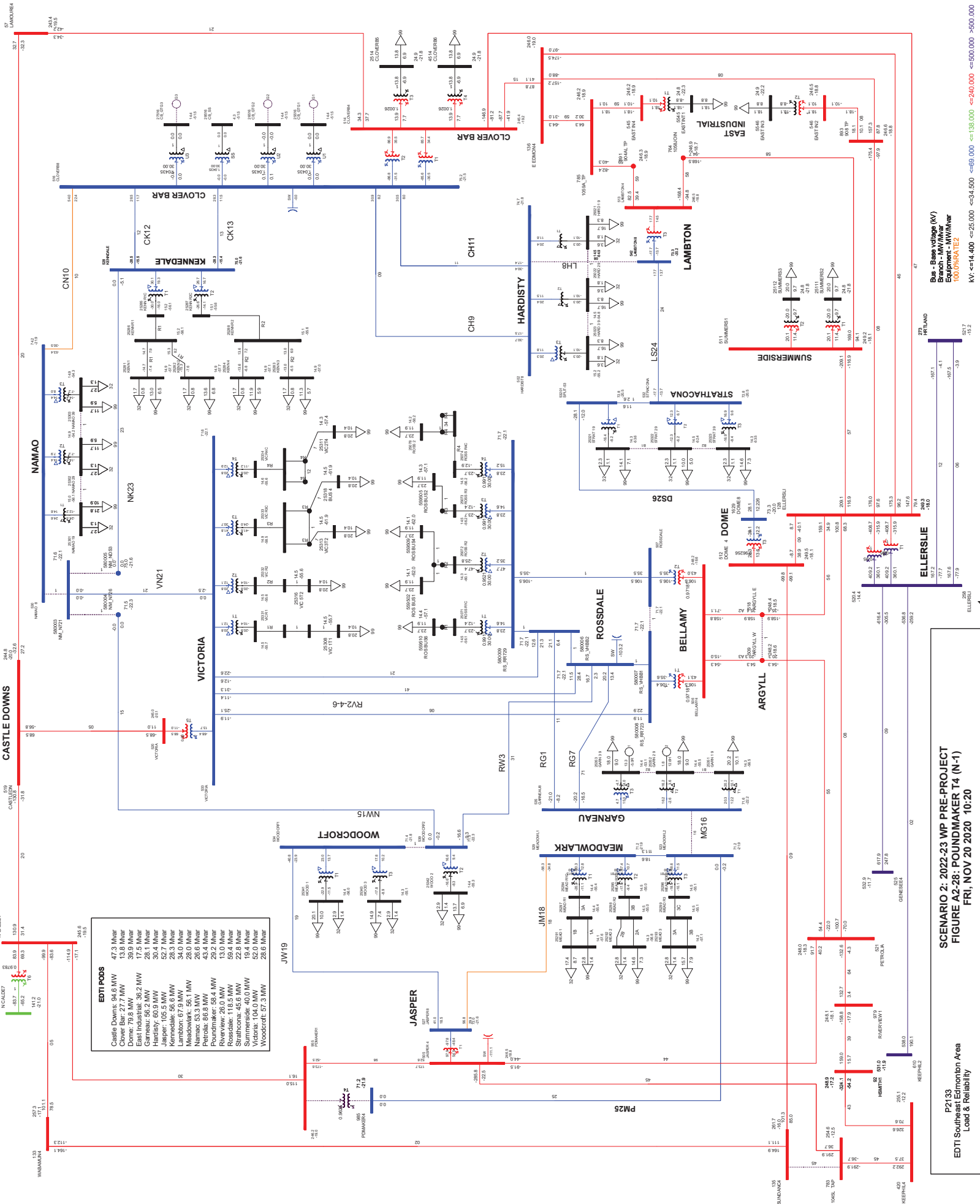
SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-26: 72PM25 (N-1)
FRI, NOV 20 2020 10:19

P2133
EDT Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Base MVA
Equipment - MVA/Mvar
100.0% RATE2
kV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000



SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-27: 1098L (N-1)
FRI, NOV 20 2020 10:19



ED1 POOLs	
Castle Downs: 94.6 MW	47.3 Mvar
Clover Bar: 27.7 MW	13.8 Mvar
Dome: 79.8 MW	39.9 Mvar
East Industrial: 36.2 MW	17.5 Mvar
Edmonton: 105.5 MW	52.7 Mvar
Hardisty: 69.0 MW	30.4 Mvar
Jasper: 105.5 MW	52.7 Mvar
Kennedale: 56.6 MW	28.3 Mvar
Lambton: 67.9 MW	34.0 Mvar
Meadowbank: 56.1 MW	28.0 Mvar
Namao: 53.3 MW	26.6 Mvar
Poundmaker: 58.4 MW	29.2 Mvar
Riverview: 26.0 MW	13.0 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Strathcona: 45.6 MW	22.8 Mvar
Summerside: 40.0 MW	19.4 Mvar
Woodcroft: 57.3 MW	28.6 Mvar

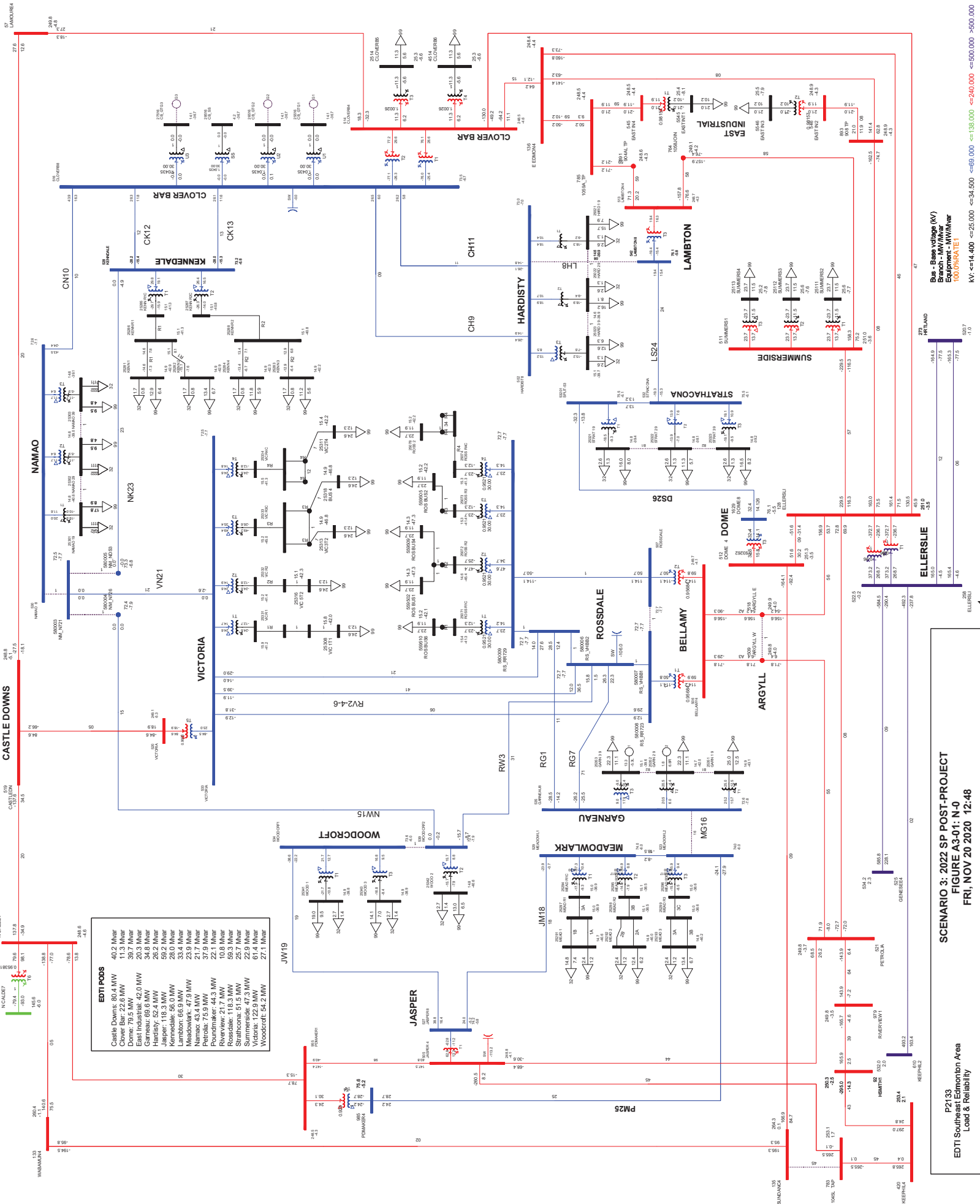
SCENARIO 2: 2022-23 WP PRE-PROJECT
FIGURE A2-28: POUNDMAKER T4 (N-1)
FRI, NOV 20 2020 10:20

P2133
ED1 Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Base power (MW)
Equipment - MVA/Mvar
100% RATED
kV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000

Attachment A3

Post-Project Power Flow Diagrams

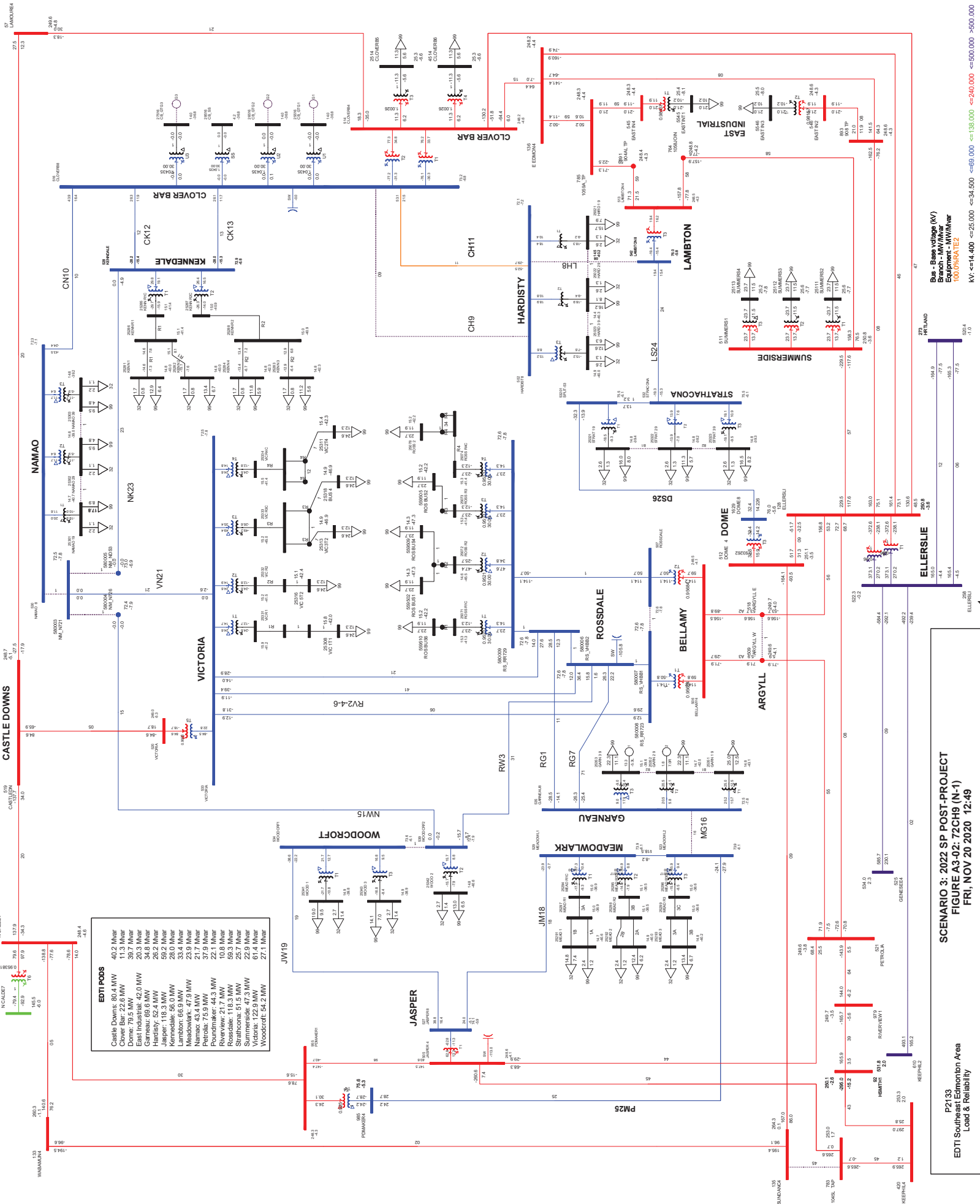


EDI POOLS	
Castle Downs: 80.4 MW	40.2 Mvar
Clover Bar: 22.6 MW	11.3 Mvar
Dome: 79.5 MW	39.7 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edmonton: 100.0 MW	50.0 Mvar
Hardisty: 52.4 MW	26.2 Mvar
Jasper: 116.3 MW	59.2 Mvar
Kennedale: 56.0 MW	28.0 Mvar
Lambton: 66.9 MW	33.4 Mvar
Meadowlark: 47.9 MW	23.9 Mvar
Namoo: 43.3 MW	21.6 Mvar
Poundmaker: 37.9 MW	18.9 Mvar
Riverview: 21.7 MW	10.8 Mvar
Rossdale: 116.3 MW	59.3 Mvar
Strathcona: 51.5 MW	25.7 Mvar
Summerside: 47.3 MW	22.9 Mvar
Woodcroft: 54.2 MW	27.1 Mvar

SCENARIO 3: 2022 SP POST-PROJECT
FIGURE A3-01: N-0
FRI, NOV 20 2020 12:48

P2133
EDI Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Equipment - MVA/Mvar
100% RATE
KV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000

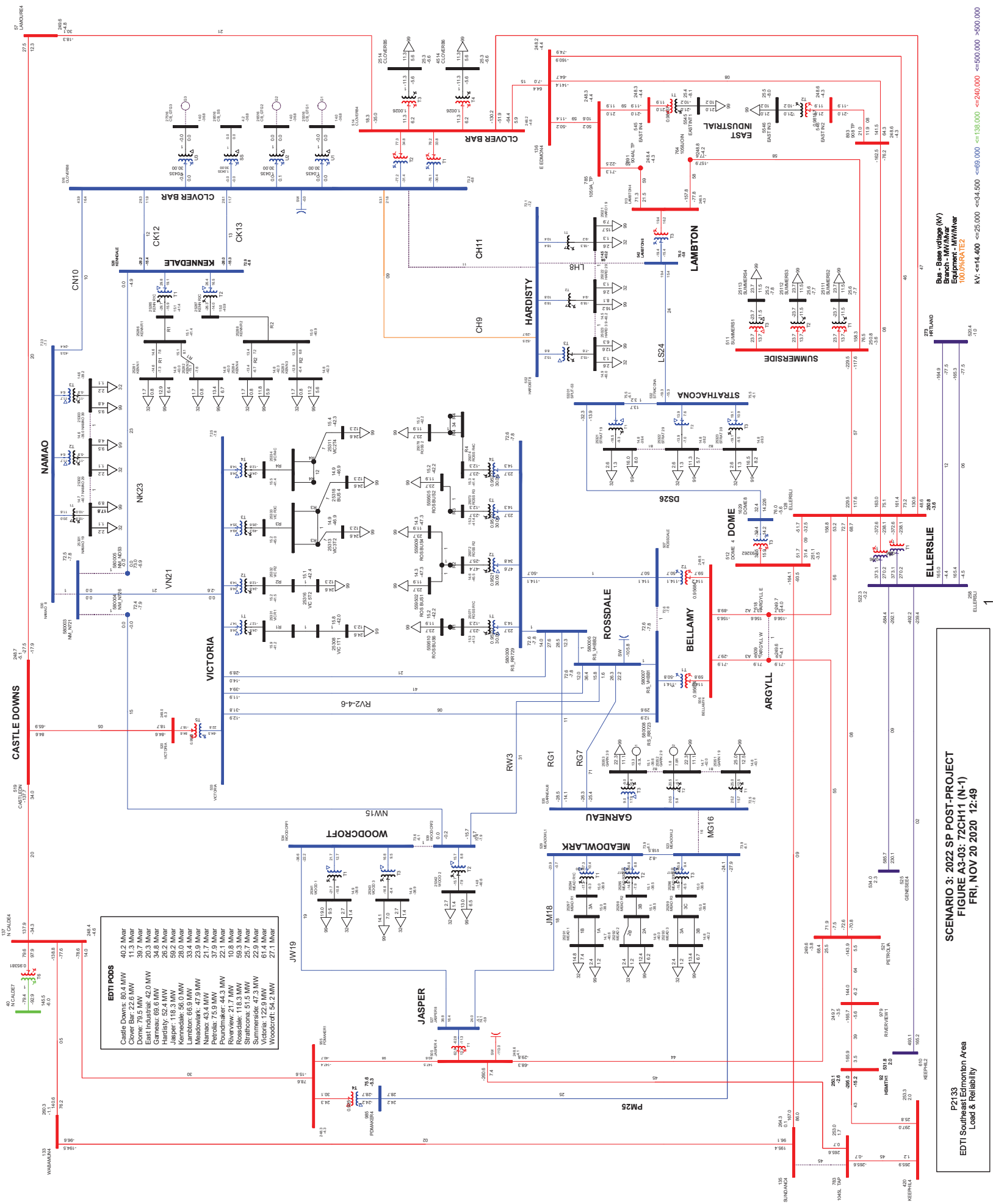


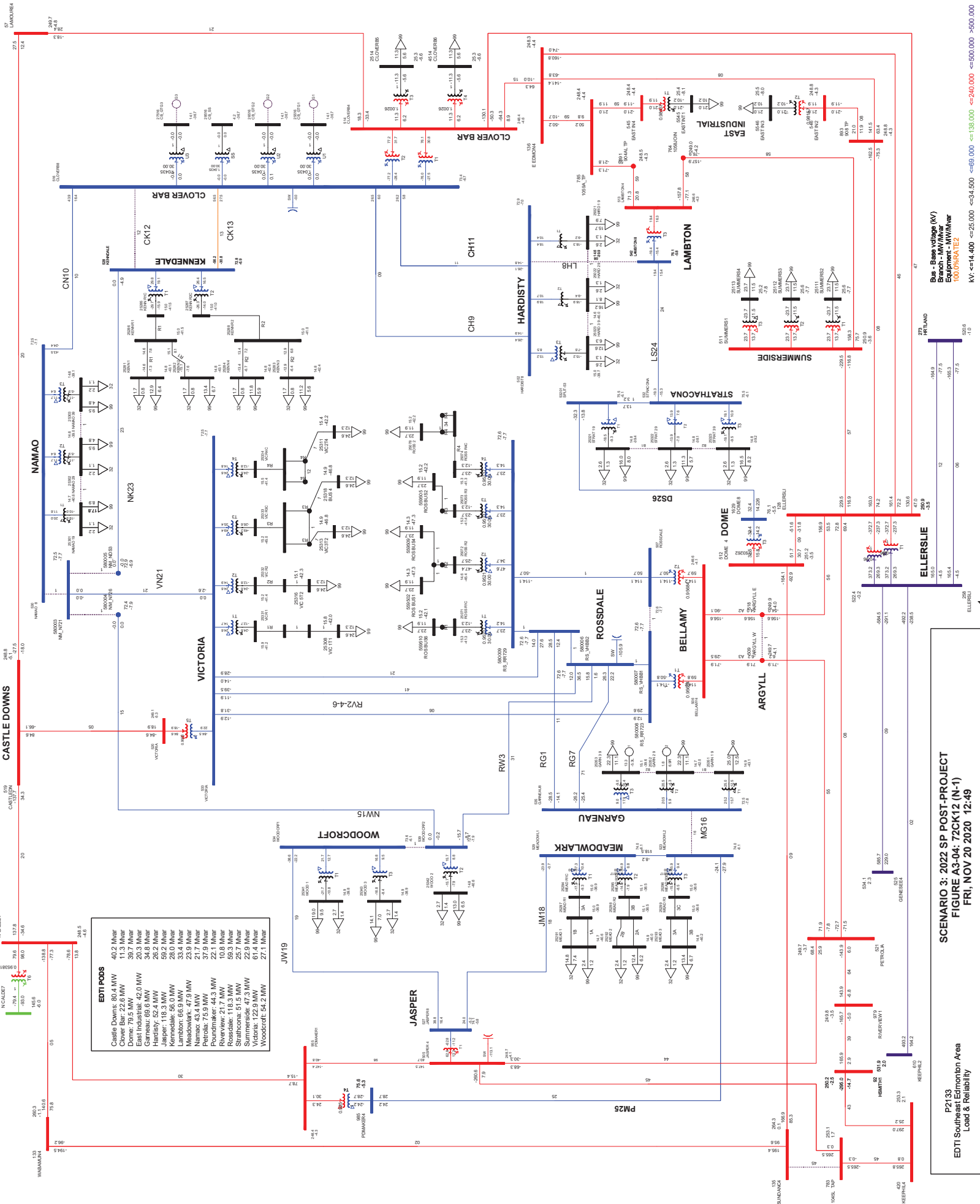
Edith Pools	
Castle Downs: 80.4 MW	40.2 Mvar
Clover Bar: 22.6 MW	11.3 Mvar
Dome: 79.5 MW	39.7 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edmonton: 116.3 MW	59.2 Mvar
Hardisty: 52.4 MW	26.2 Mvar
Jasper: 116.3 MW	59.2 Mvar
Kenedale: 56.0 MW	28.0 Mvar
Lambton: 66.9 MW	33.4 Mvar
Meadowlark: 47.9 MW	23.9 Mvar
Namao: 43.3 MW	21.7 Mvar
Poundmaker: 44.3 MW	22.1 Mvar
Riverview: 21.7 MW	10.8 Mvar
Rosdale: 116.3 MW	59.3 Mvar
Strathcona: 51.5 MW	25.7 Mvar
Summerside: 47.3 MW	22.9 Mvar
Victoria: 116.3 MW	59.3 Mvar
Woodcroft: 54.2 MW	27.1 Mvar

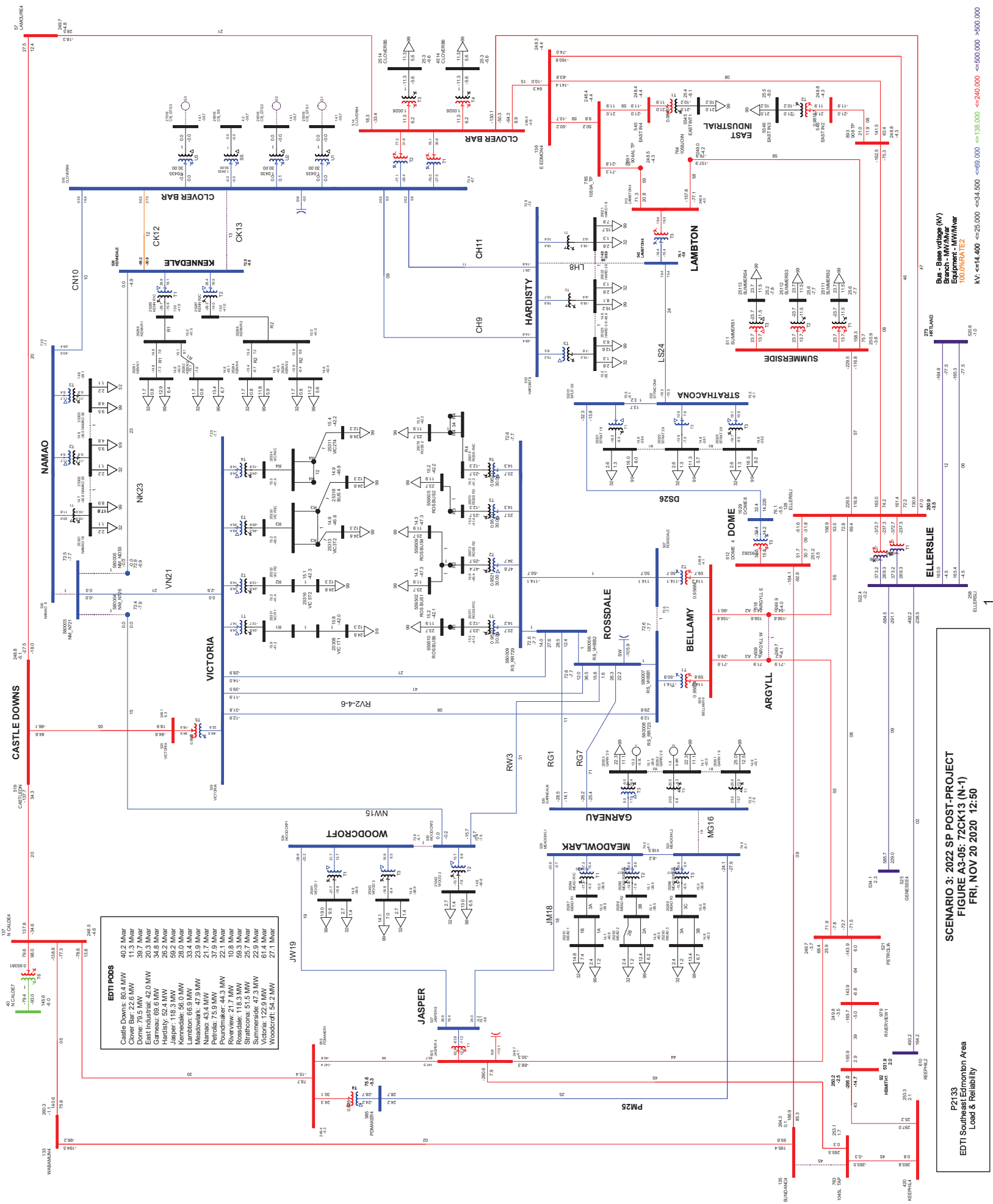
SCENARIO 3: 2022 SP POST-PROJECT
FIGURE A3-02: 72CH9 (N-1)
FRI, NOV 20 2020 12:49

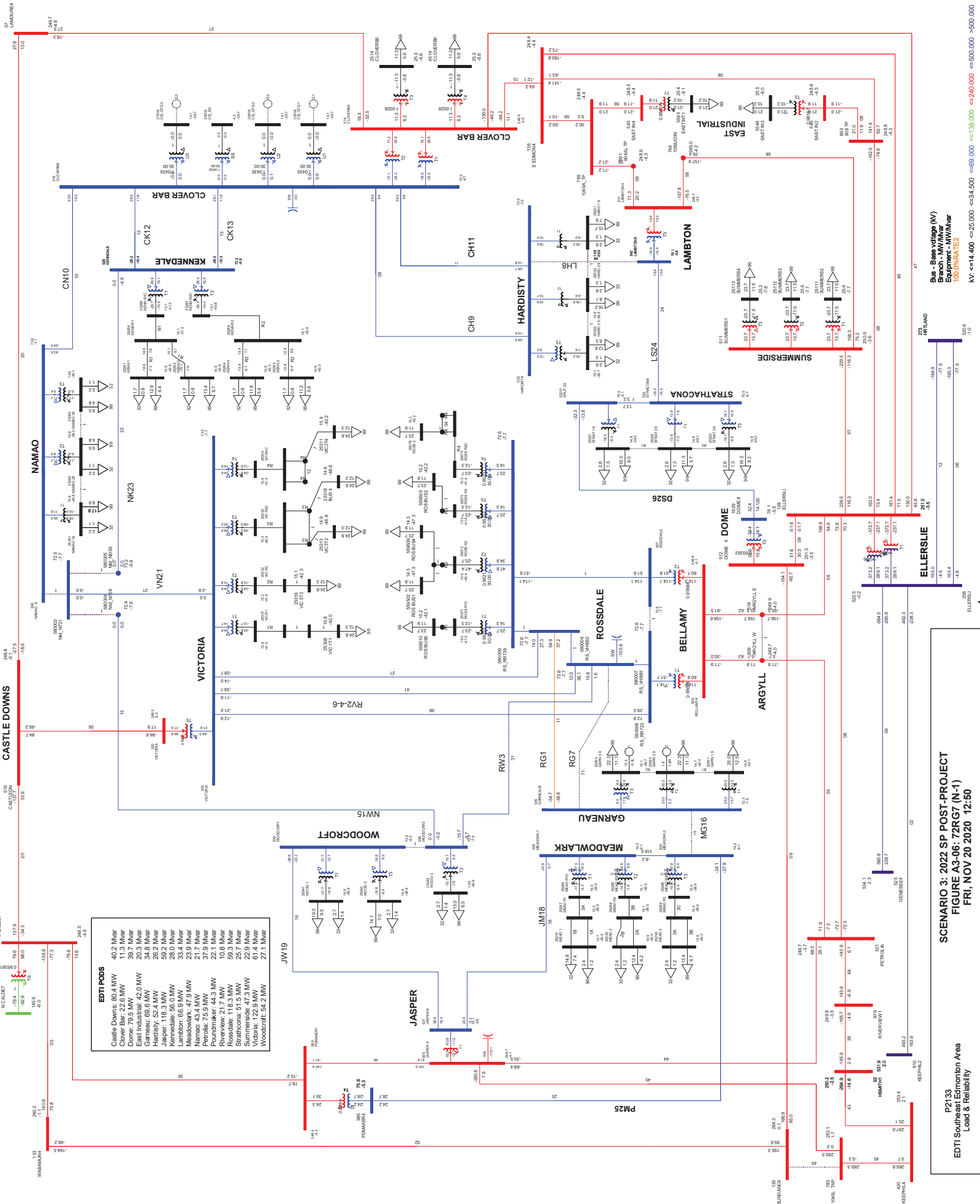
P2133
EDT Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Base power (MW)
Equipment - MVA/Mvar
100.0% RATE 2
KV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000





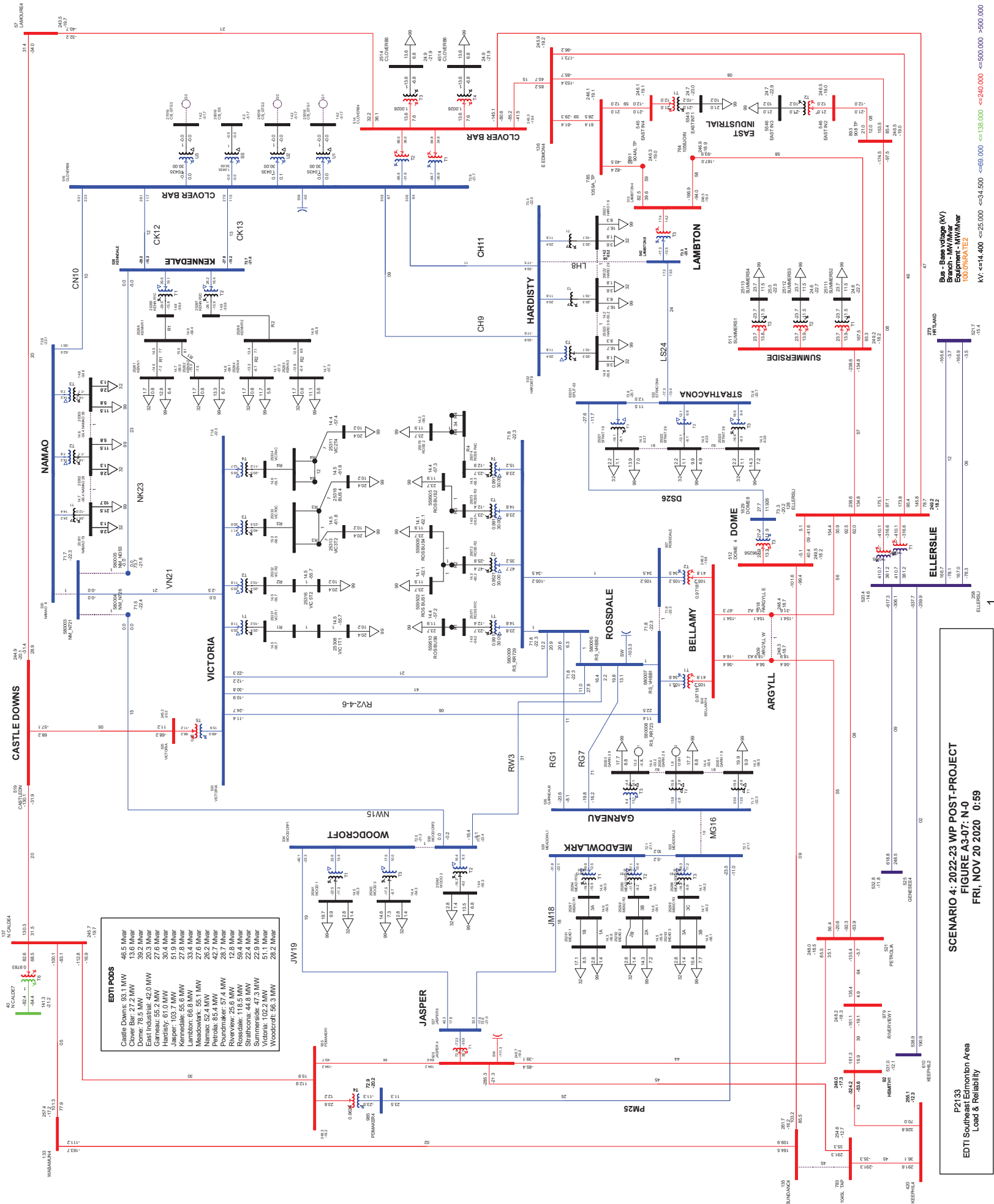




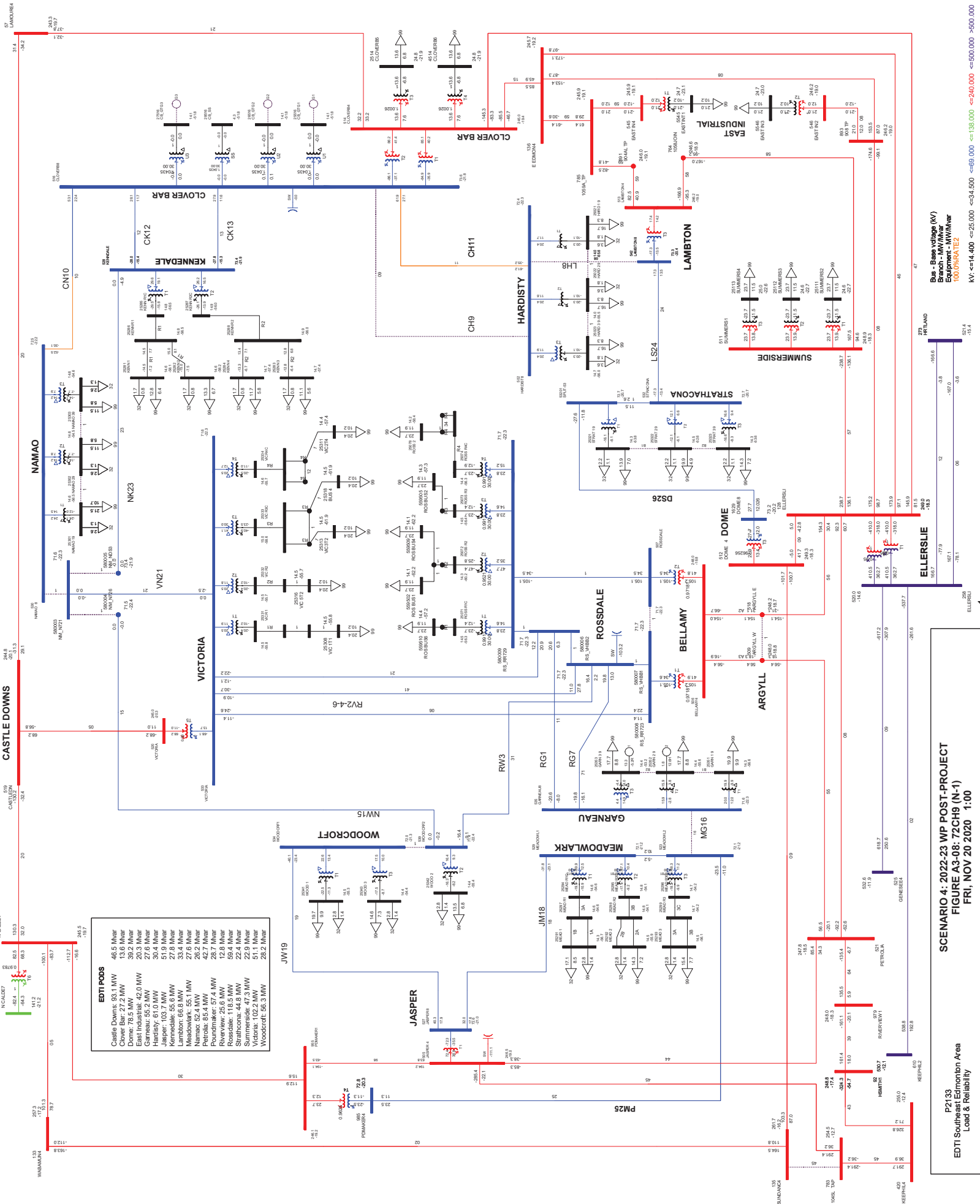
EDI POOLS	
Castle Downs: 80.4 MW	40.2 Mvar
Clover Bar: 22.6 MW	11.3 Mvar
Dome: 79.5 MW	39.7 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Eastview: 52.4 MW	26.2 Mvar
Jasper: 116.3 MW	59.2 Mvar
Kennebec: 56.0 MW	28.0 Mvar
Lambton: 66.9 MW	33.4 Mvar
Meadowlark: 47.9 MW	23.9 Mvar
Namoo: 43.3 MW	21.7 Mvar
Poundmaker: 44.3 MW	22.1 Mvar
Riverview: 21.7 MW	10.8 Mvar
Rosdale: 116.3 MW	59.3 Mvar
Summerside: 47.3 MW	22.9 Mvar
Woodcroft: 54.2 MW	27.1 Mvar

SCENARIO 3: 2022 SP POST-PROJECT
FIGURE A3-06: 72RG7 (N-1)
FRI, NOV 20 2020 12:50

P2133
EDT Southeast Edmonton Area
Load & Reliability



Bus - Base voltage (kV)
Bus - Base power (MW)
Equipment - MW/Mvar
100% RATE
kv = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000

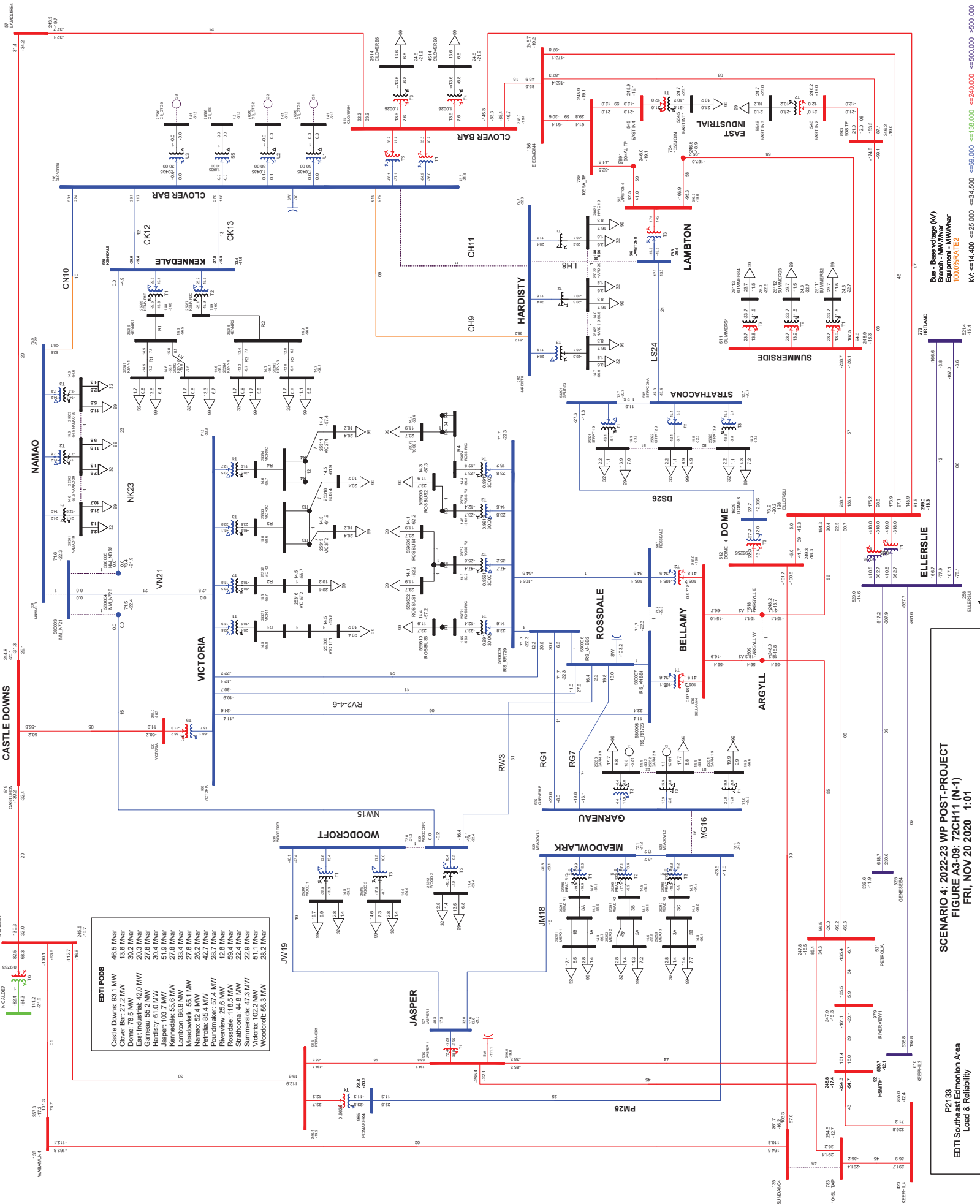


EDINBORO	
Castle Downs	93.1 MW
Clover Bar	27.2 MW
Dome	78.5 MW
East Industrial	42.0 MW
Edinboro	30.4 MW
Hardisty	61.0 MW
Jasper	103.7 MW
Kennebec	27.8 MW
Lambton	33.4 MW
Meadowbank	55.1 MW
Namoo	27.6 MW
Poundmaker	42.5 MW
Riverview	25.6 MW
Rosedale	118.5 MW
Summerside	47.3 MW
Strathcona	22.4 MW
Woodcroft	56.3 MW

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-08: 72CH9 (N-1)
FRI, NOV 20 2020 1:00

P2133
EDT Southeast Edmonton Area
Load & Reliability

Bus - Base Voltage (kV)
Bus - Capacity (MW)
Equipment - MVA
100% RATE
KV = 4.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000



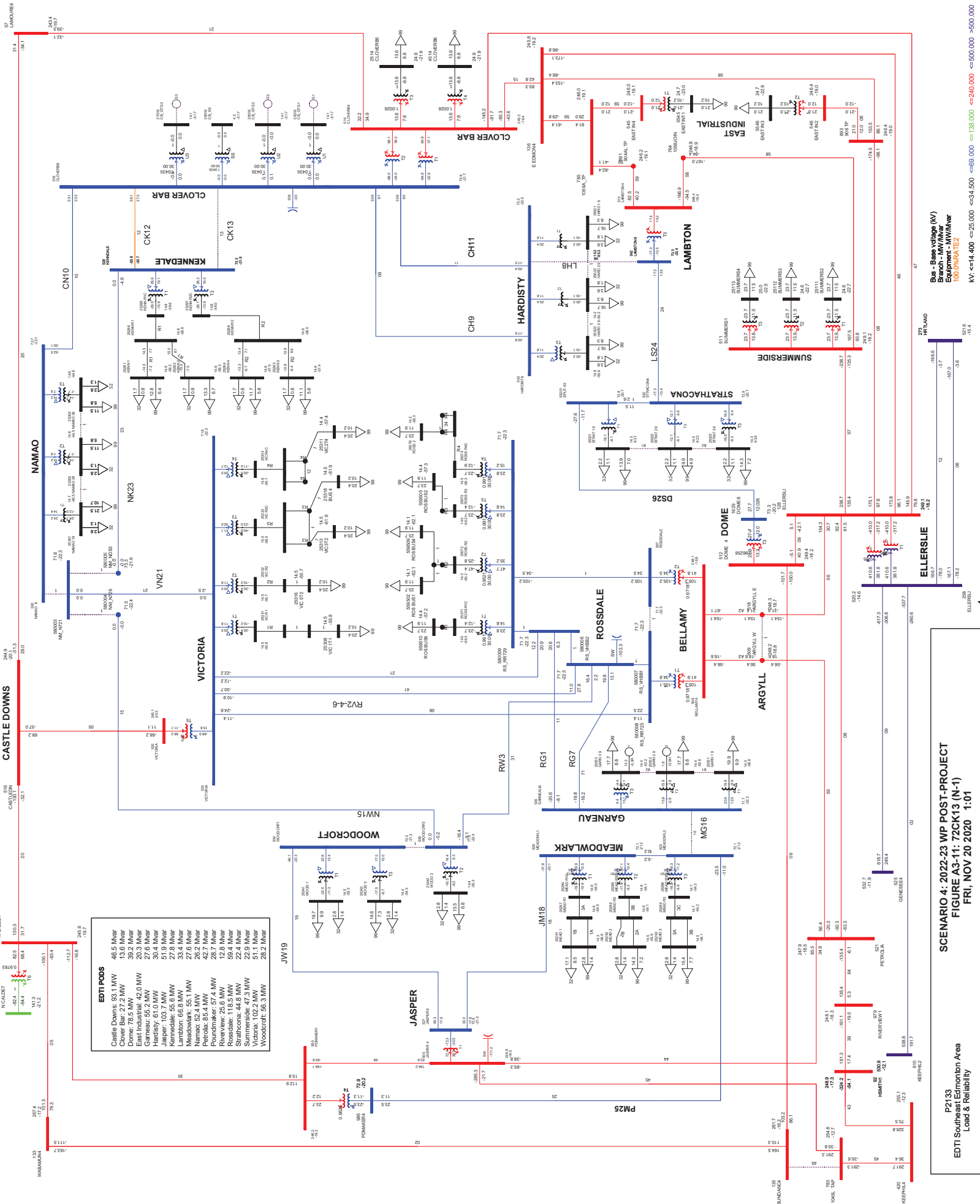
EDT POOS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Hardisty: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennedale: 55.6 MW	27.8 Mvar
Lambton: 66.8 MW	33.4 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namao: 52.4 MW	26.2 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Strathcona: 44.8 MW	22.4 Mvar
Summerside: 47.3 MW	23.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-09: 72CH11 (N-1)
FRI, NOV 20 2020 1:01

P2133
EDT Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Break voltage (kV)
Bus - Break current (kA)
Bus - Break time (s)
Bus - Break type (kV)
Bus - Break rating (kV)
Bus - Break status (kV)

100.000
100.000
100.000
100.000
100.000
100.000
100.000

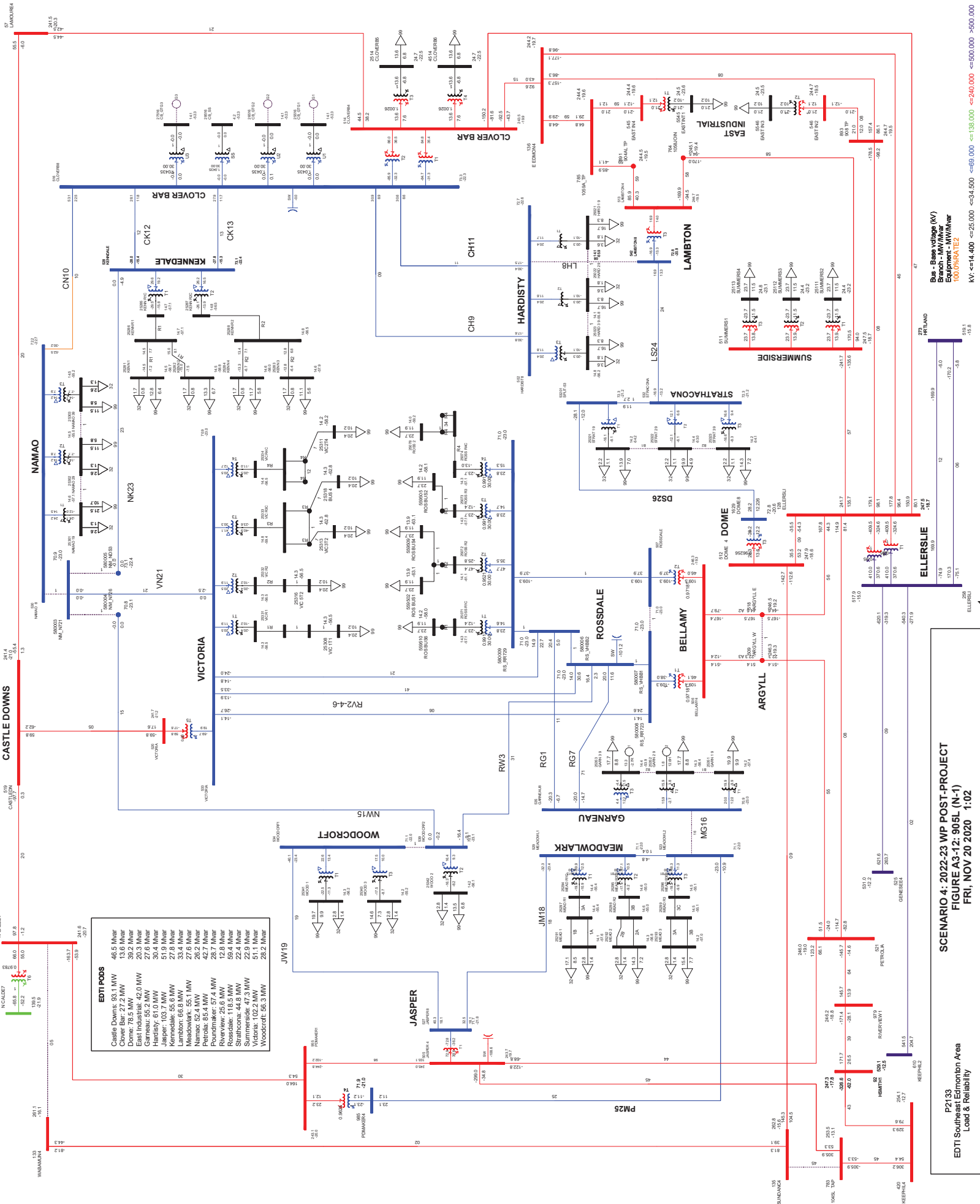


EDINBORO	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edinboro: 103.7 MW	51.9 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennebec: 66.8 MW	33.4 Mvar
Lambton: 55.6 MW	27.8 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namoo: 55.1 MW	27.6 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosdale: 116.5 MW	59.4 Mvar
Strathcona: 44.8 MW	22.4 Mvar
Summerside: 47.3 MW	23.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-11: 72CK13 (N-1)
FRI, NOV 20 2020 1:01

P2133
EDT Southeast Edmonton Area
Load & Reliability

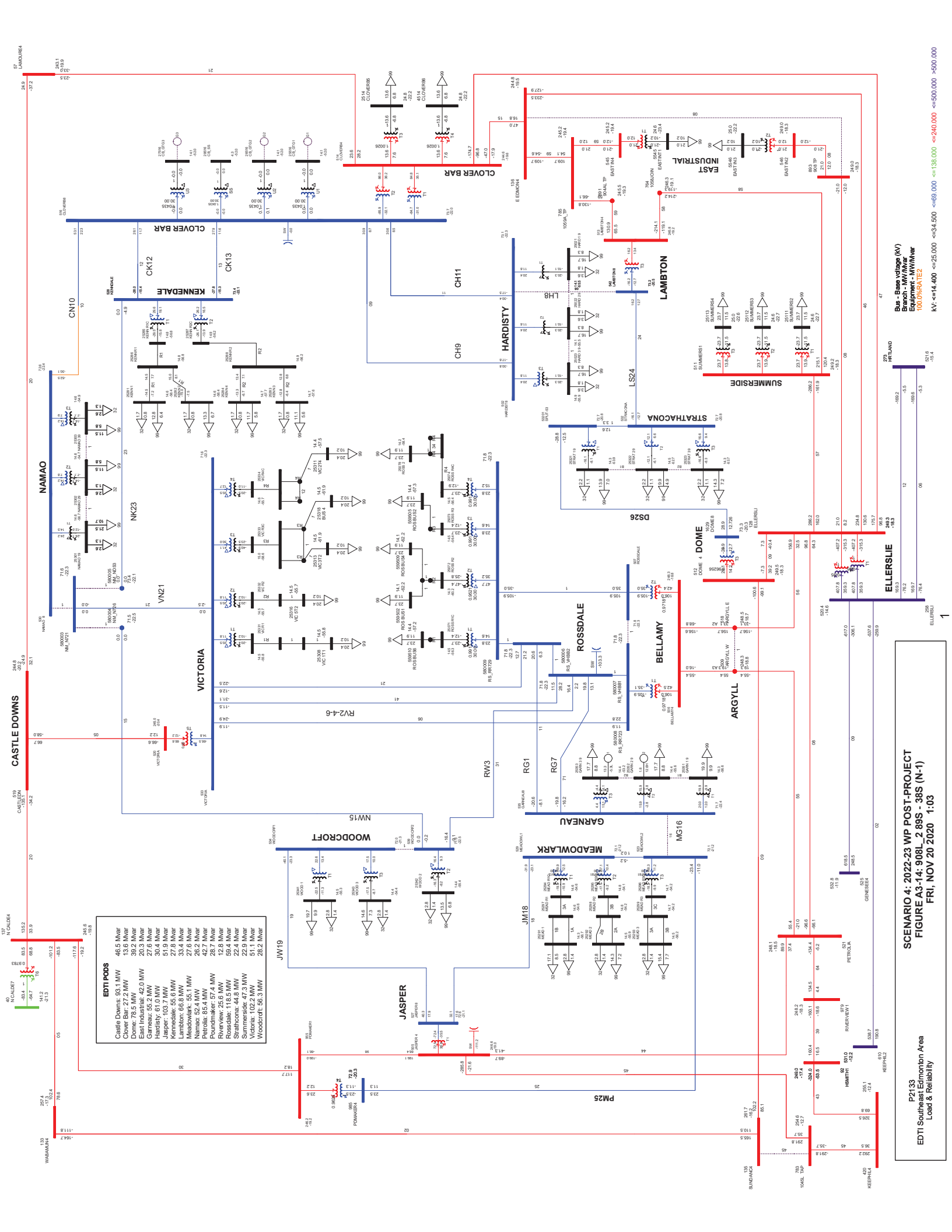
Bus - Base voltage (kV)
Bus - Base power (MW)
Equipment - MVA/Mvar
100.0% RATE
KV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000



EDT POIS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edith: 30.4 MW	15.2 Mvar
Hardisty: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennedale: 66.8 MW	27.8 Mvar
Lambton: 55.6 MW	27.6 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namook: 54.4 MW	27.6 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosdale: 116.5 MW	59.4 Mvar
Summerside: 47.3 MW	22.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-12: 905L (N-1)
FRI, NOV 20 2020 1:02

P2133
EDT Southeast Edmonton Area
Load & Reliability

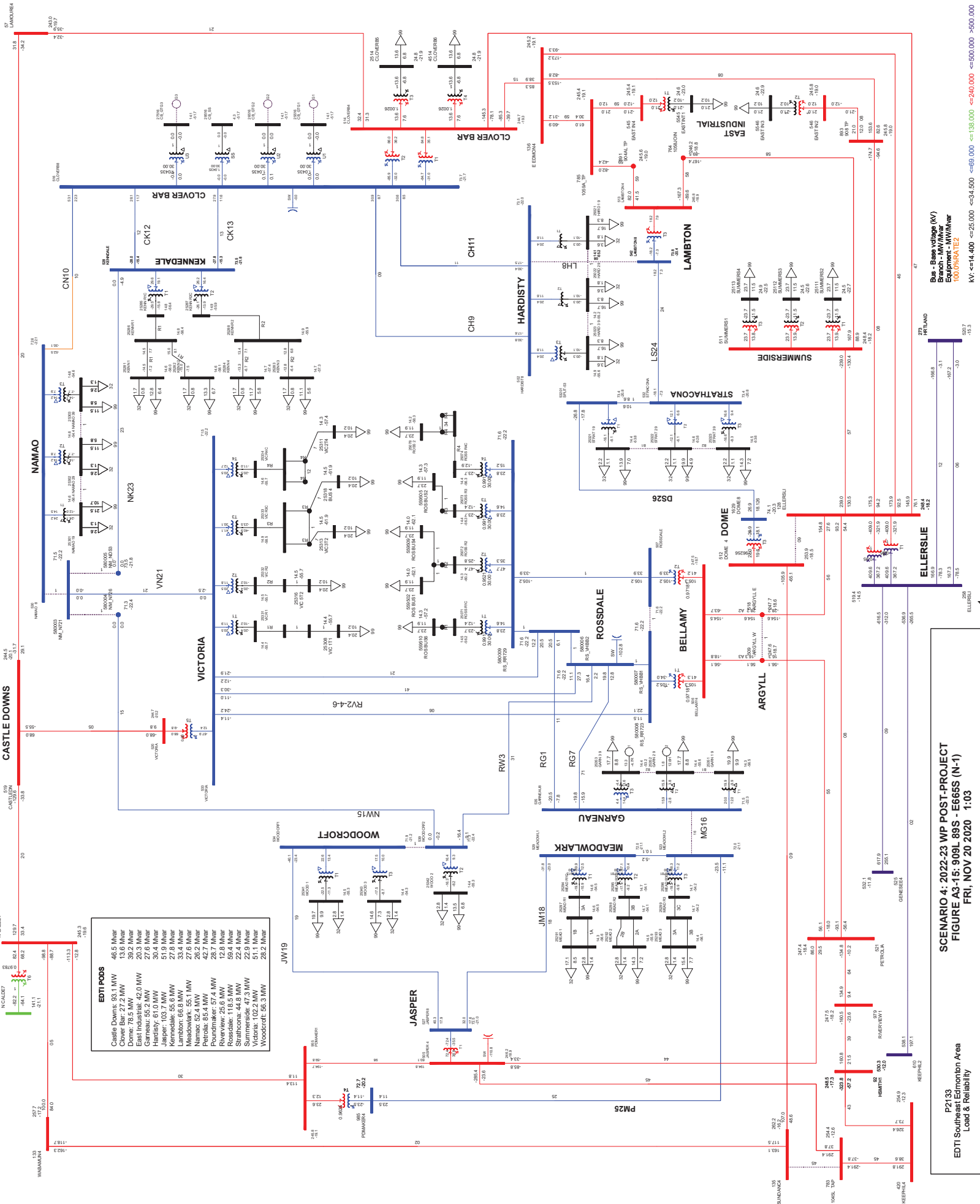


EDINBORO	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edinboro: 103.7 MW	51.9 Mvar
Hardley: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennedale: 55.6 MW	27.8 Mvar
Lambton: 66.8 MW	33.4 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namoo: 55.1 MW	27.6 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Summerside: 47.3 MW	23.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

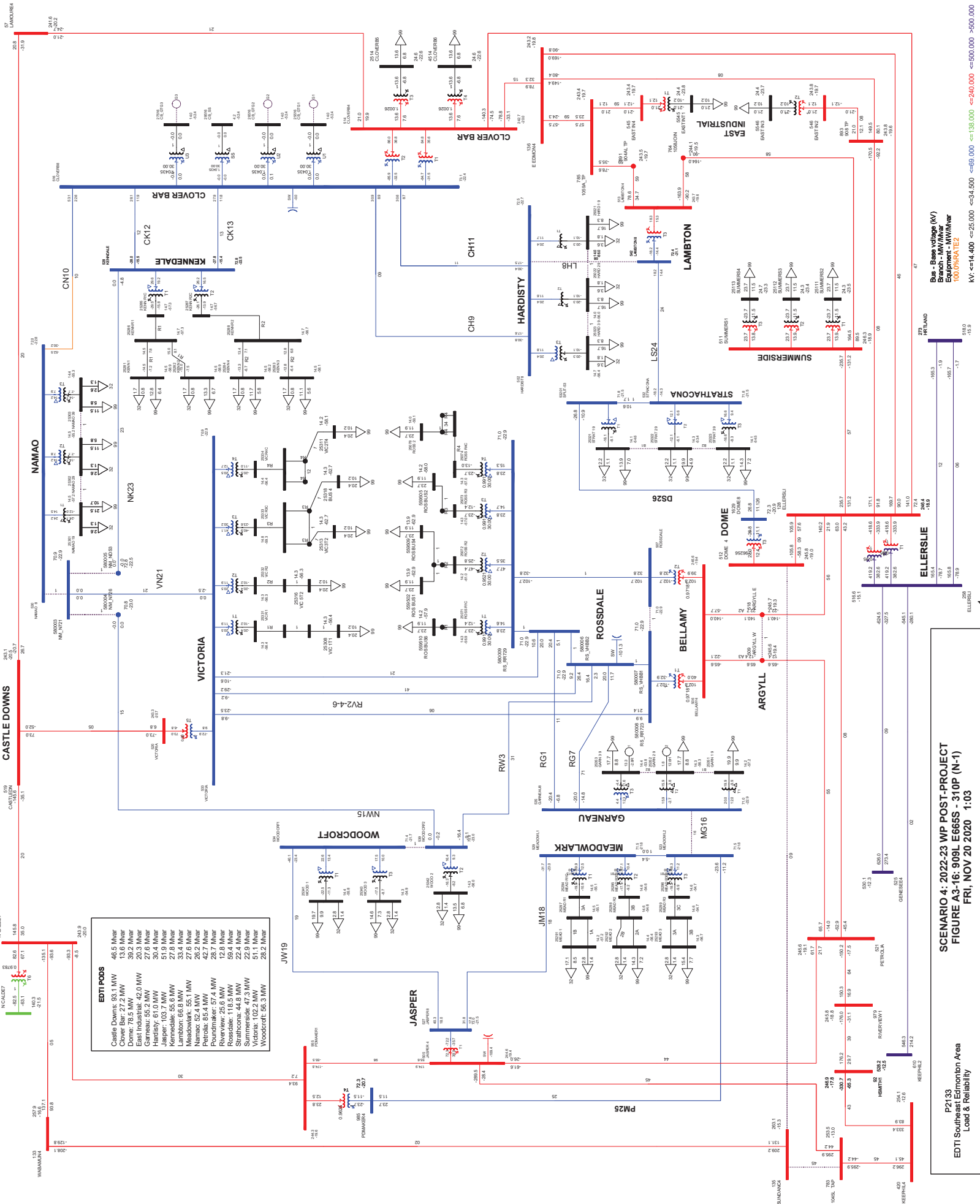
SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-14: 908L_2 89S - 38S (N-1)
FRI, NOV 20 2020 1:03

P2133
EDT Southeast Edmonton Area
Load & Reliability

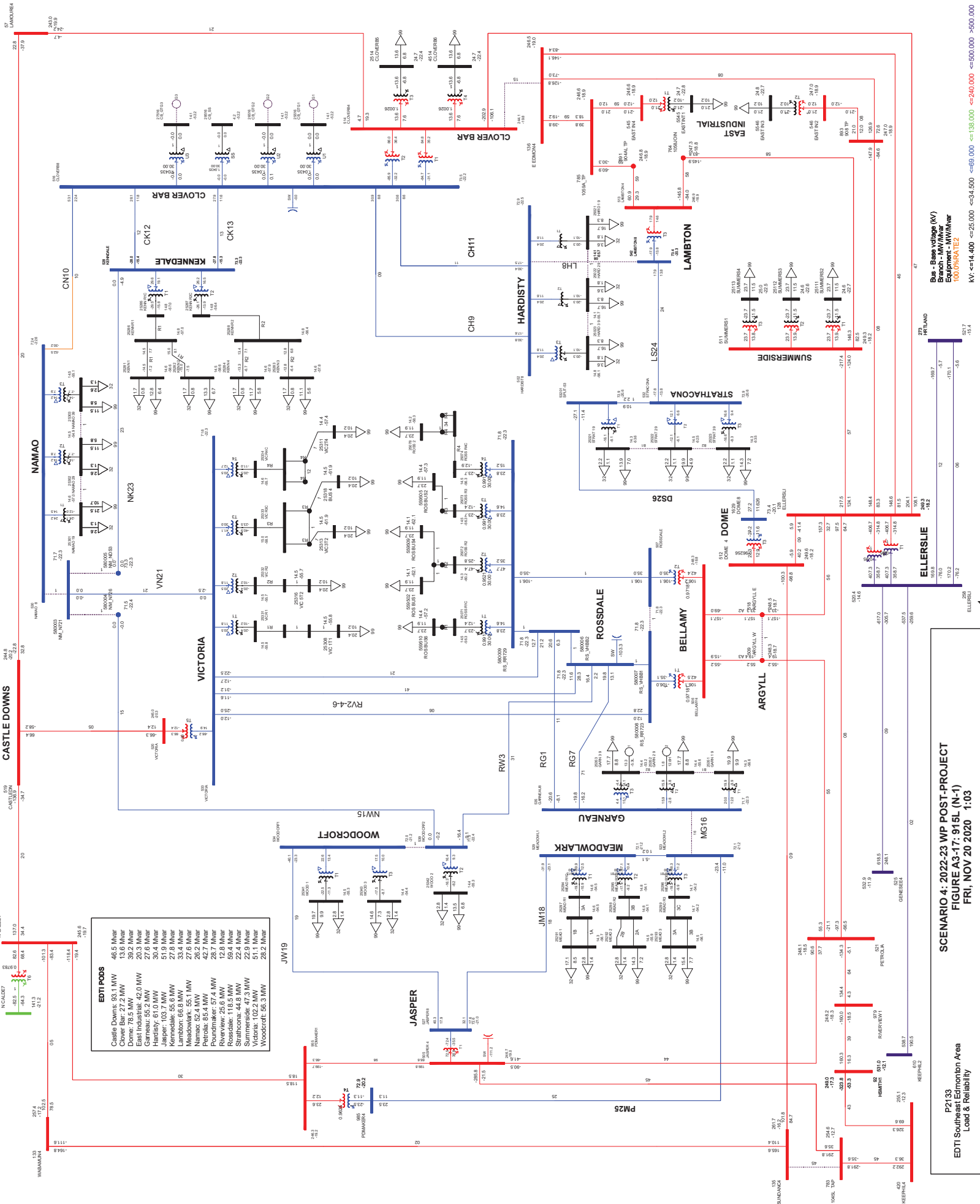
Bus - Base voltage (kV)
Bus - Capacity (MW)
Equipment - MVA
100% RATE
KV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000



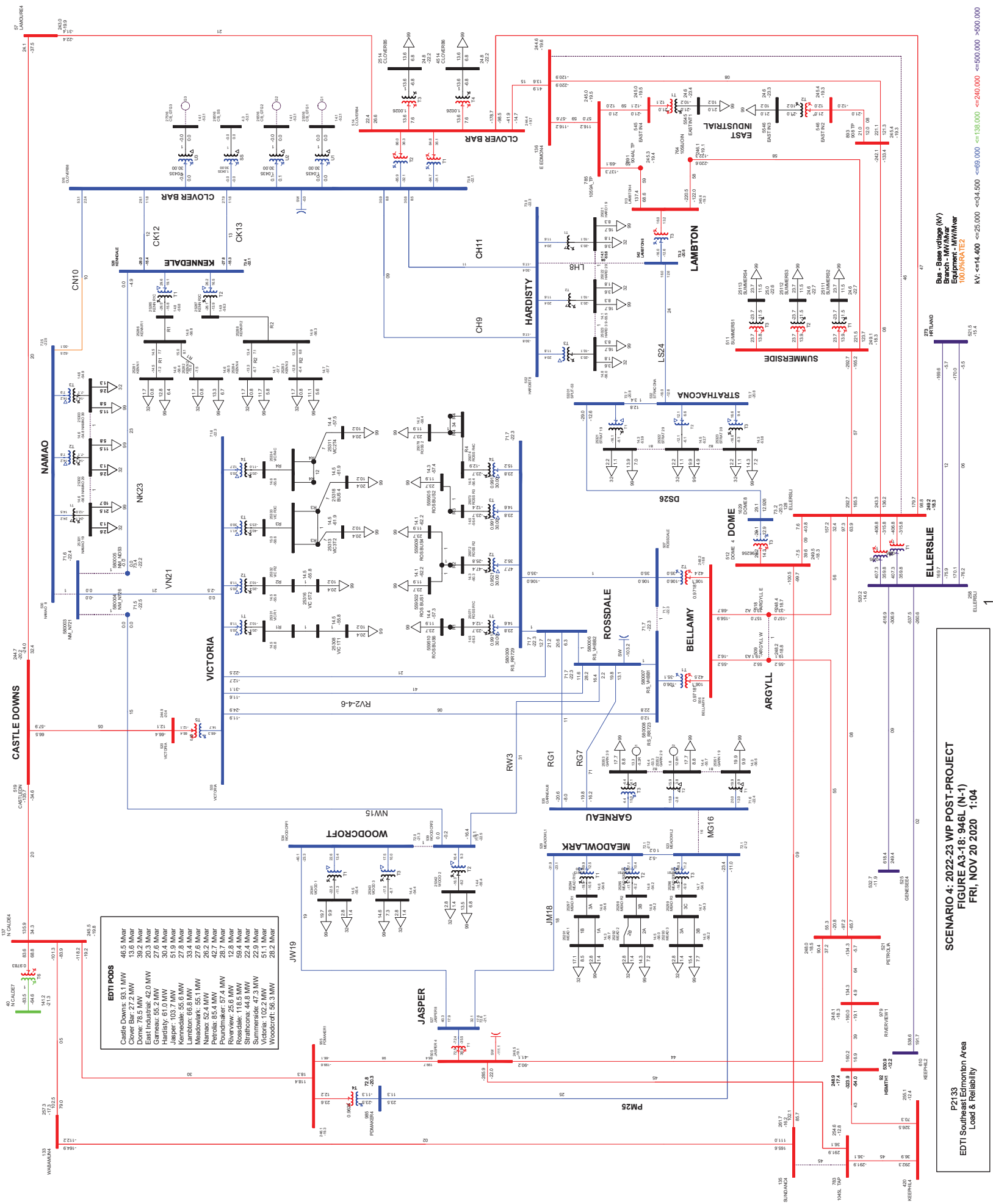
SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-15: 909L 89S - E665S (N-1)
FRI, NOV 20 2020 1:03

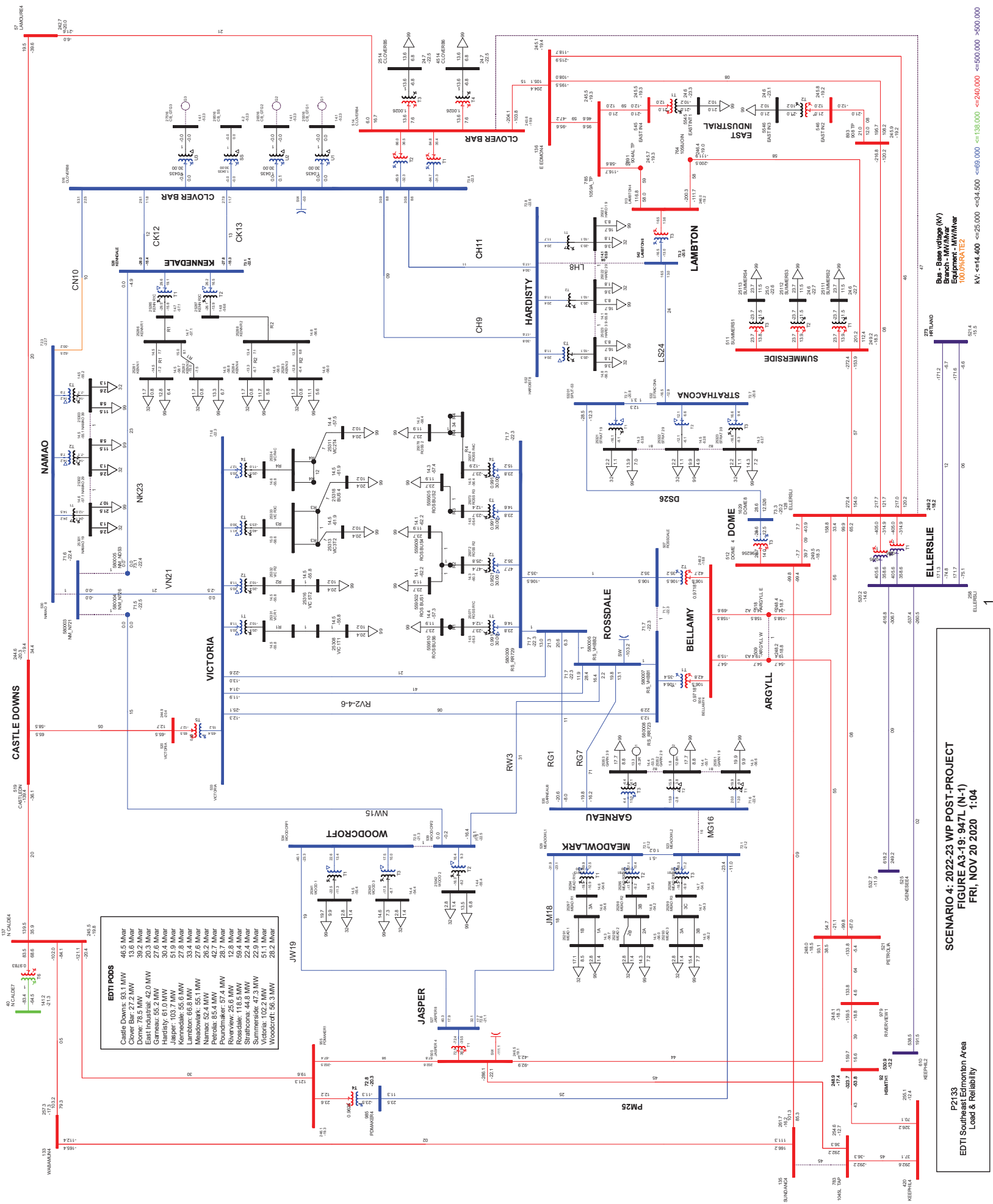


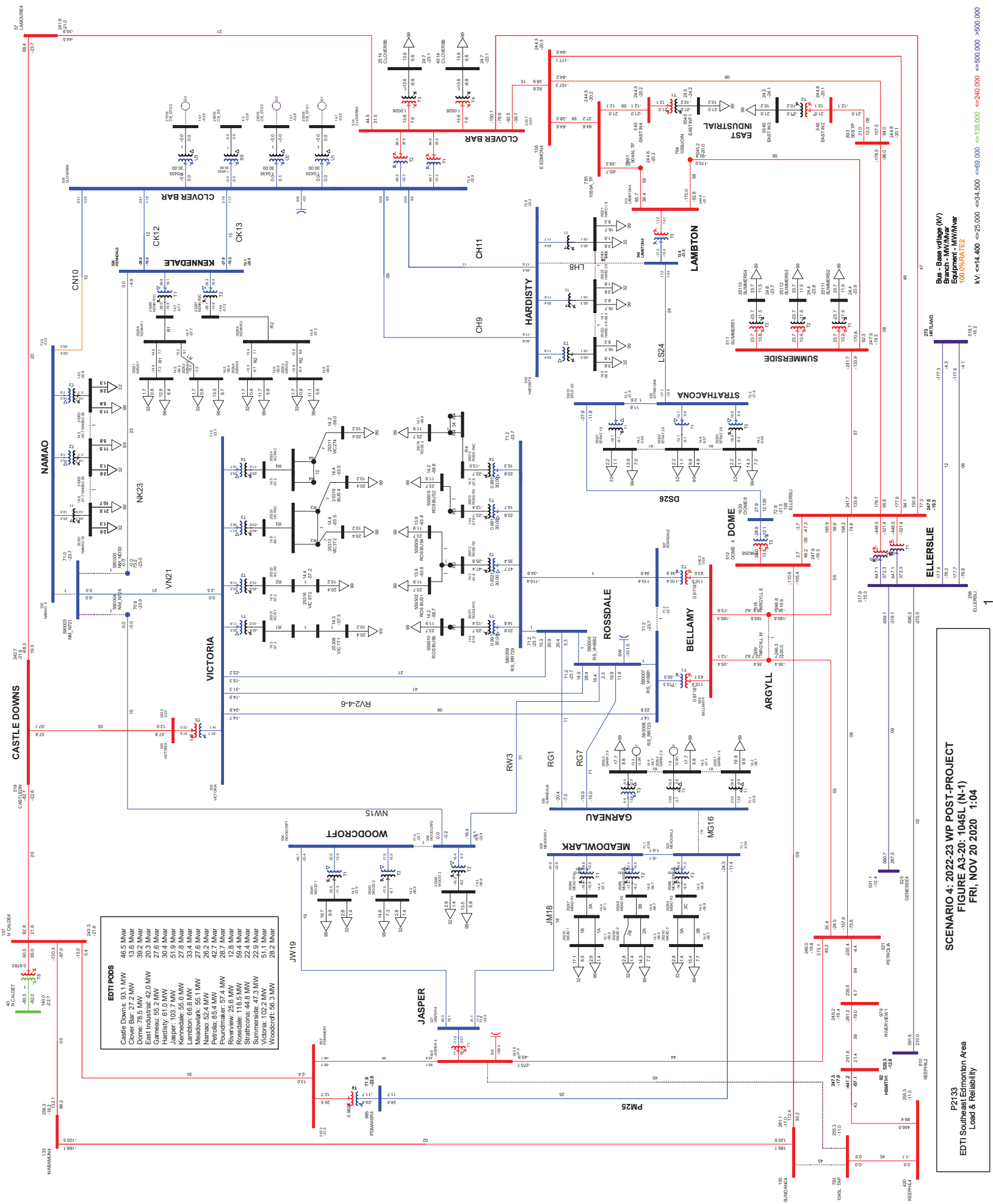
SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-16: 909L E665S - 310P (N-1)
FRI, NOV 20 2020 1:03

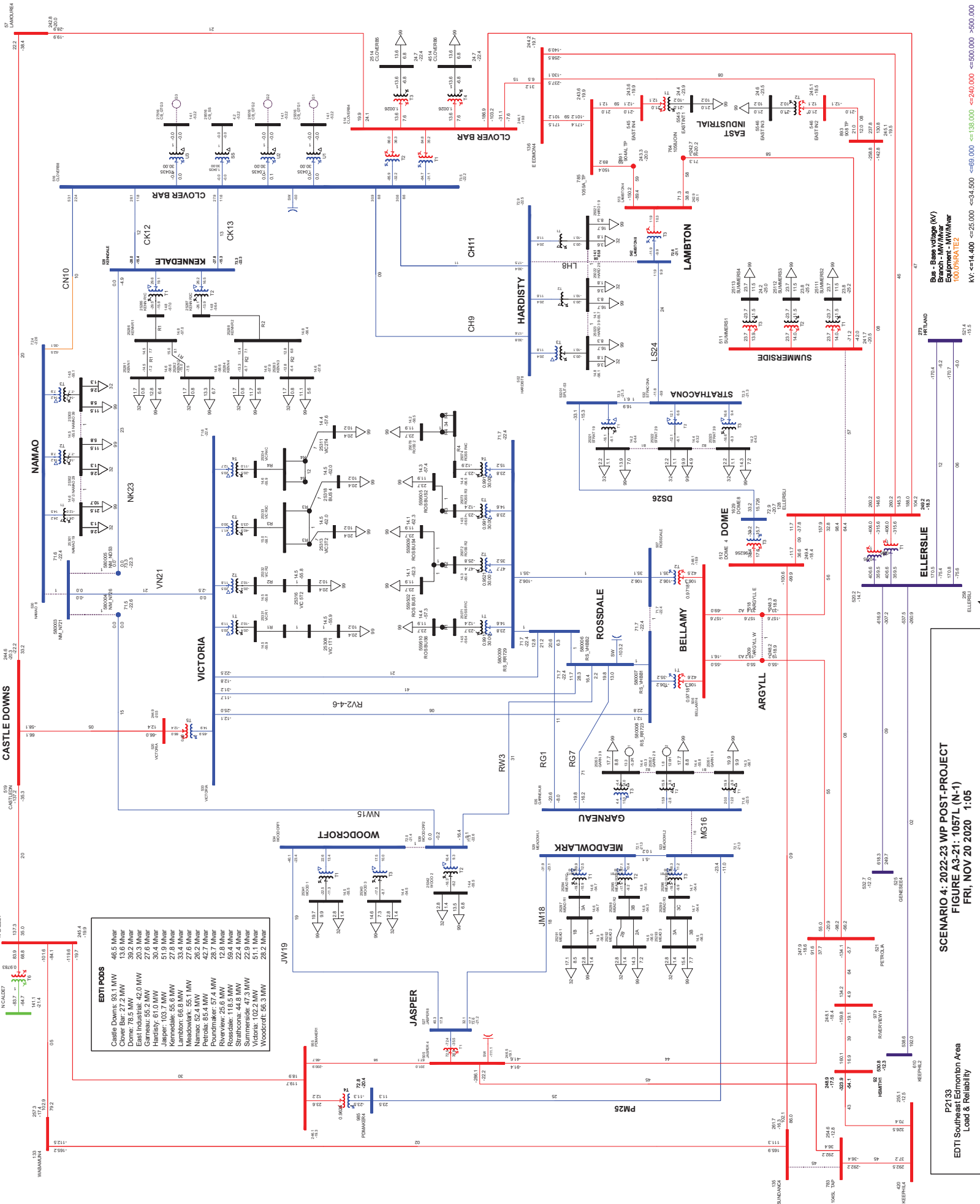


SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-17: 915L (N-1)
FRI, NOV 20 2020 1:03





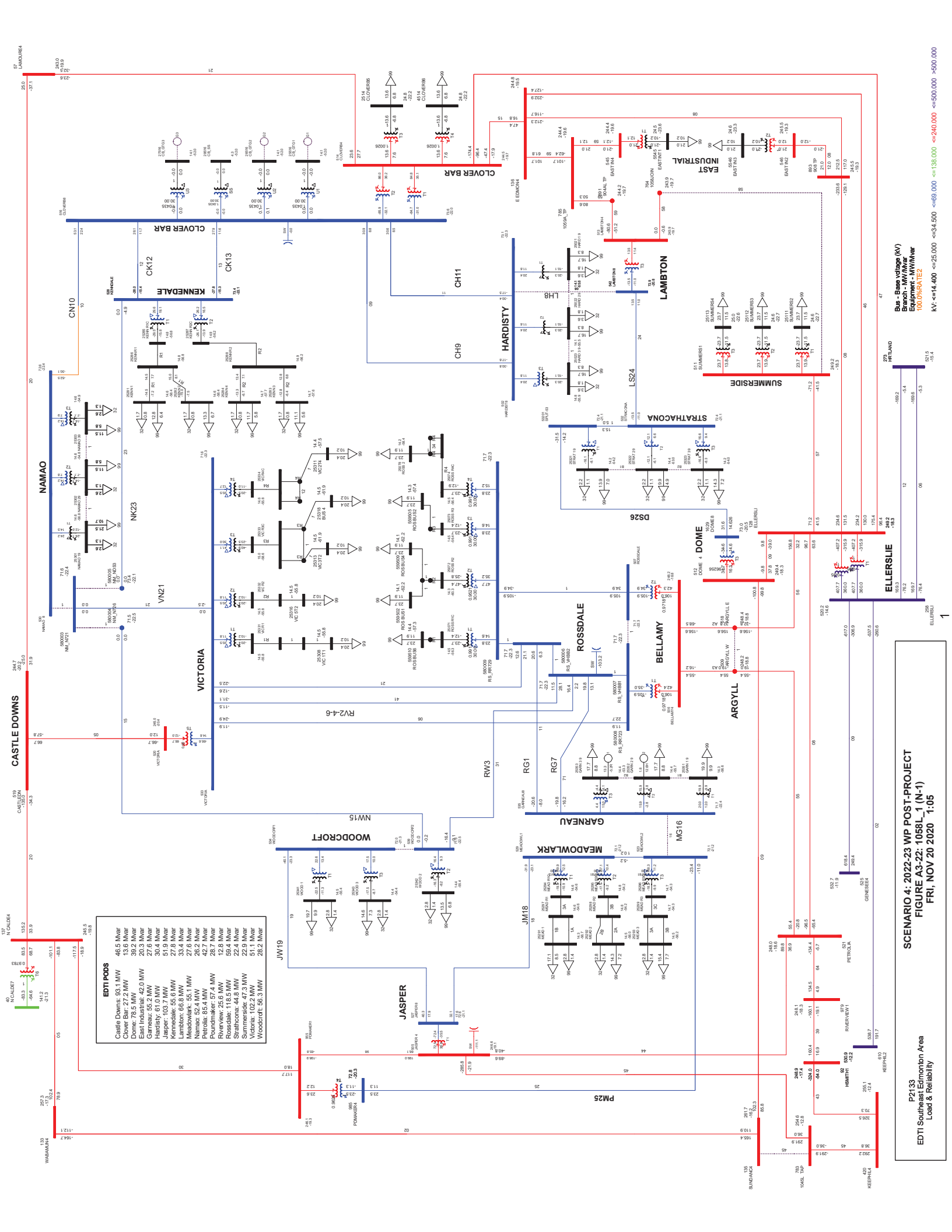




EDT POOS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edinboro: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennebec: 55.6 MW	27.8 Mvar
Lambton: 66.8 MW	33.4 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namoo: 52.4 MW	25.2 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosdale: 116.5 MW	59.4 Mvar
Summerside: 47.3 MW	22.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

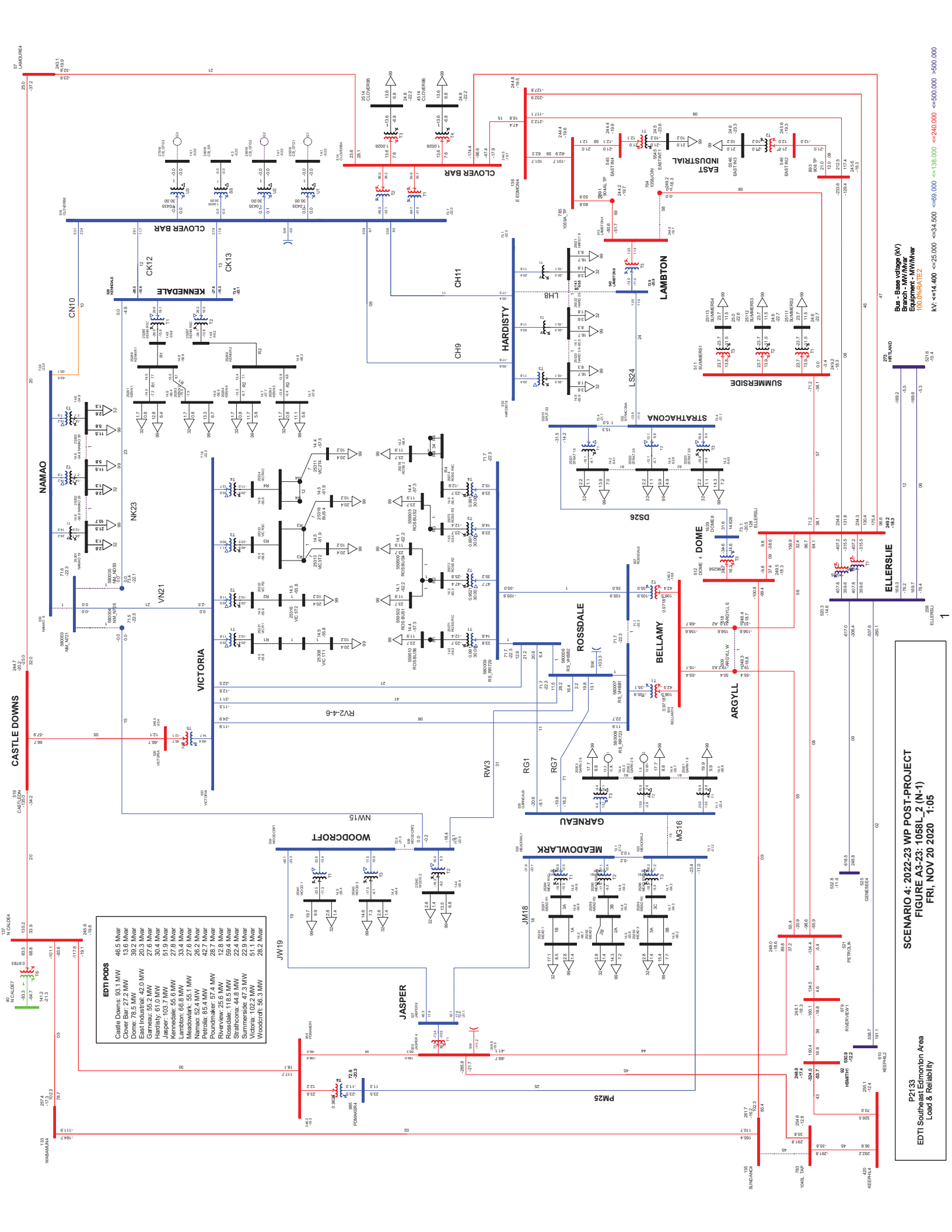
SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-21: 1057L (N-1)
FRI, NOV 20 2020 1:05

Bus - Base voltage (kV)
Bus - Base MVA
Equipment - MVA/Mvar
100.0% RATE
KV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000

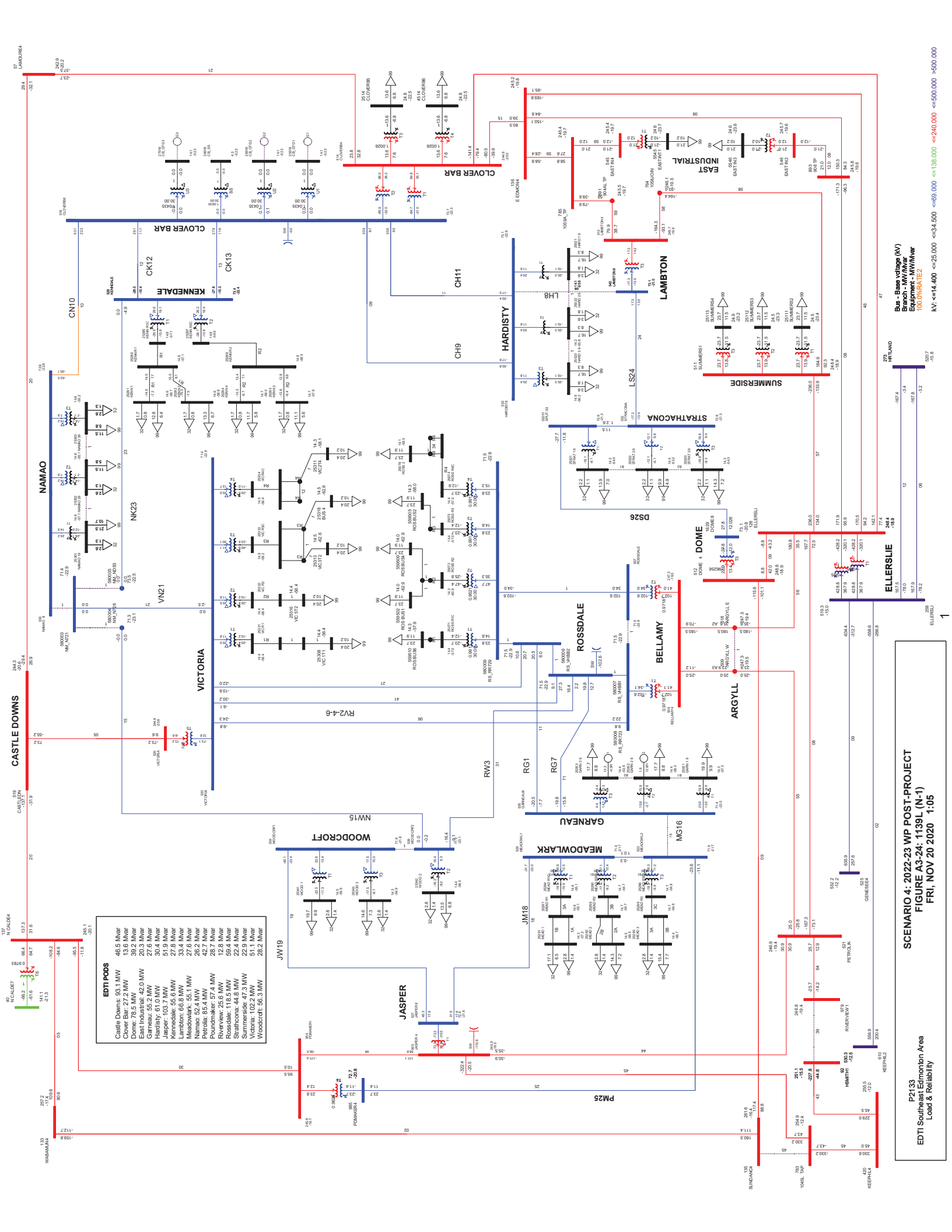


SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-22: 1058L_1 (N-1)
FRI, NOV 20 2020 1:05

P2133
EDT Southeast Edmonton Area
Load & Reliability



SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-23: 1058L_2 (N-1)
FRI, NOV 20 2020 1:05

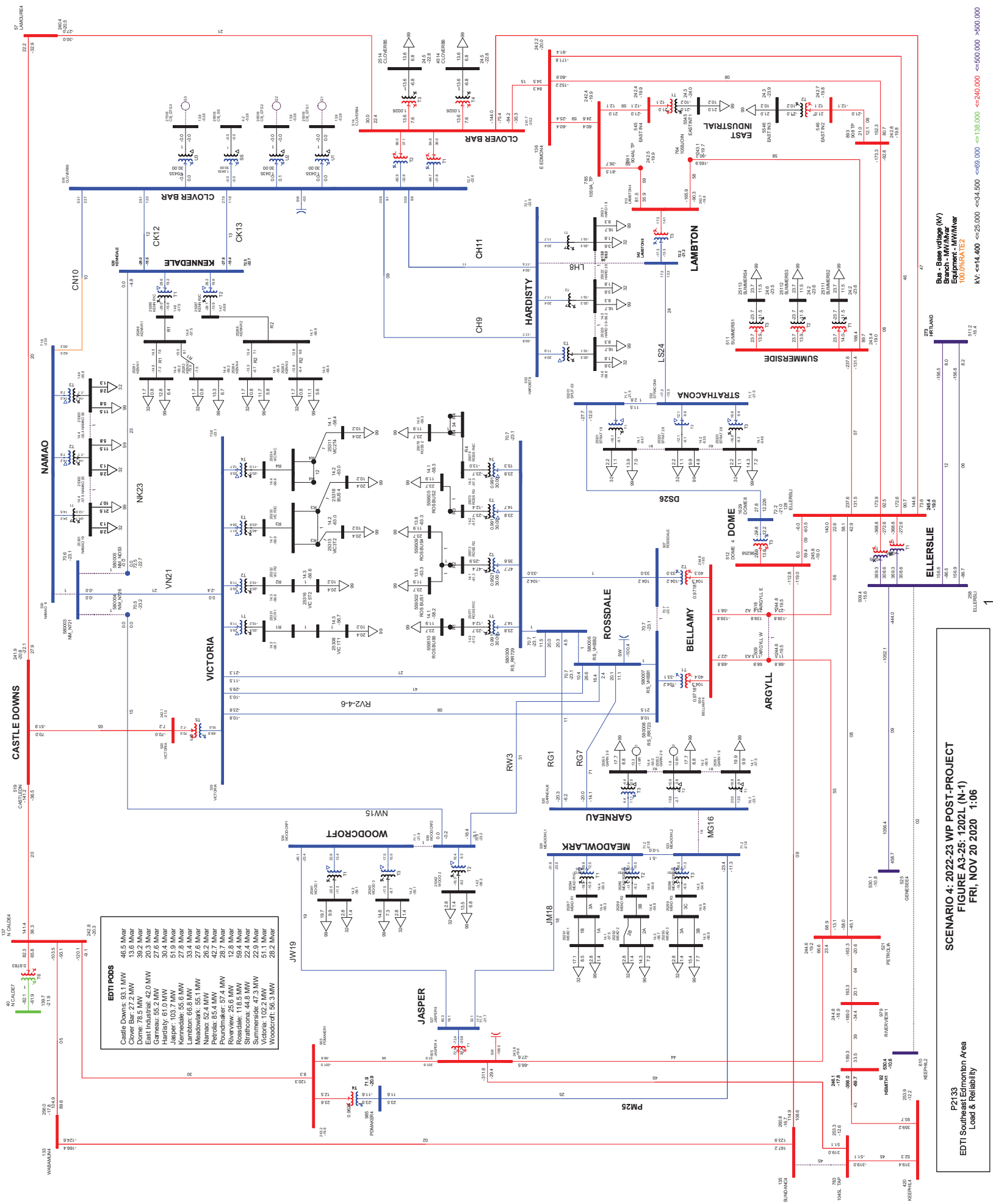


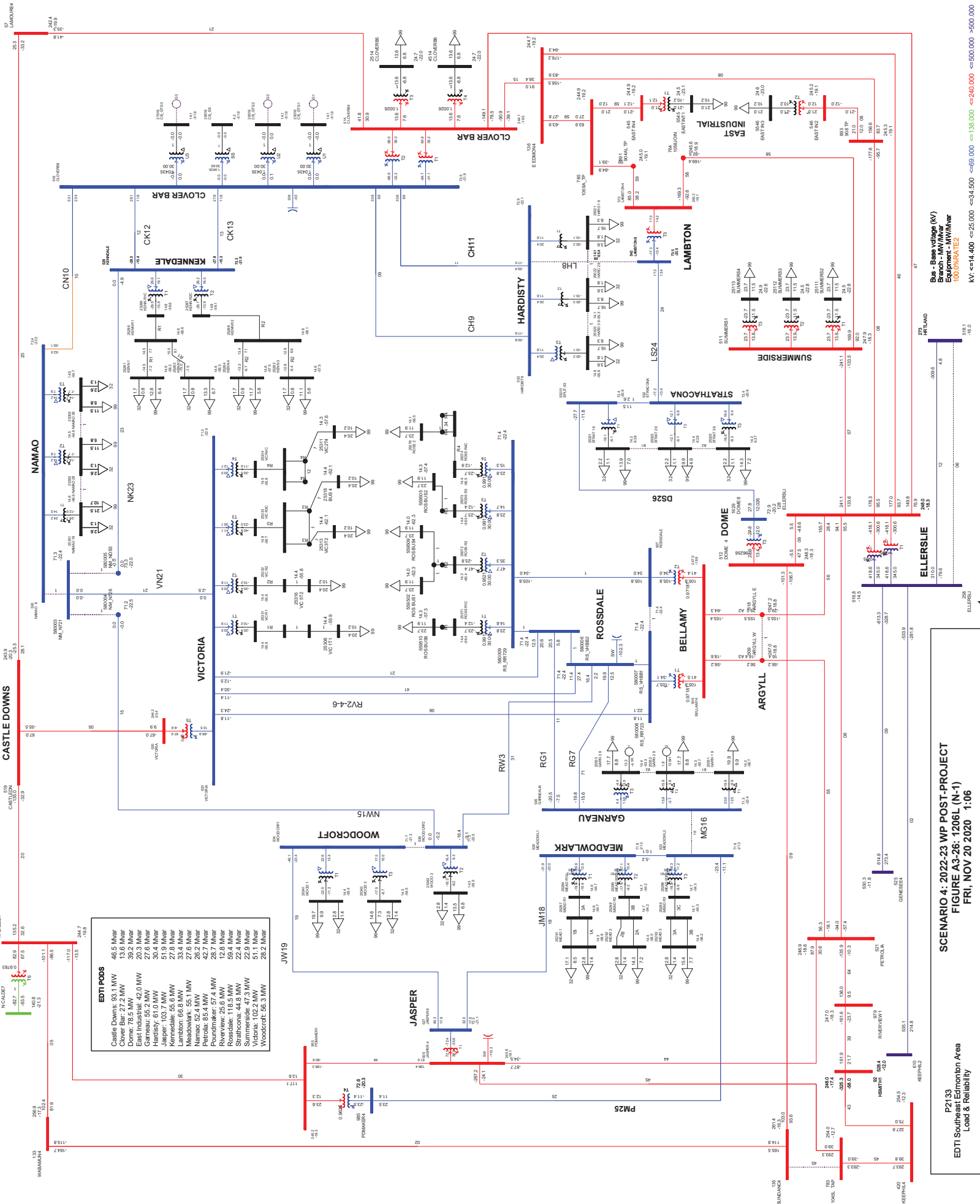
EDIT POOS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edmonton: 103.7 MW	51.9 Mvar
Hardisty: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kenedale: 55.6 MW	27.8 Mvar
Lambton: 66.8 MW	33.4 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namoo: 54.4 MW	27.2 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Summerside: 47.3 MW	22.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-24: 1139L (N-1)
FRI, NOV 20 2020 1:05

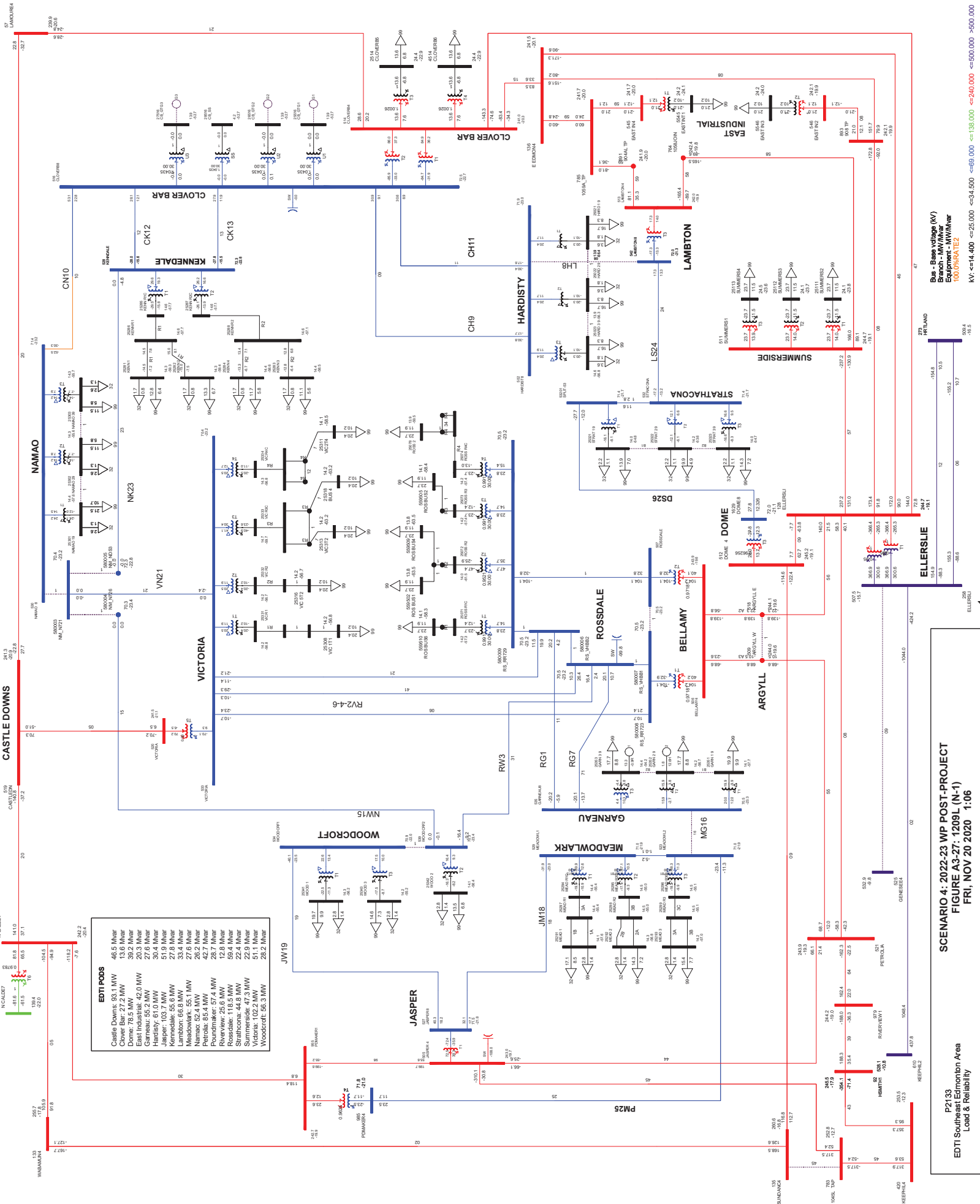
P2133
EDIT Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Base power (MW)
Equipment - MW/Mvar
100.0% RATE 2
kV <= 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000





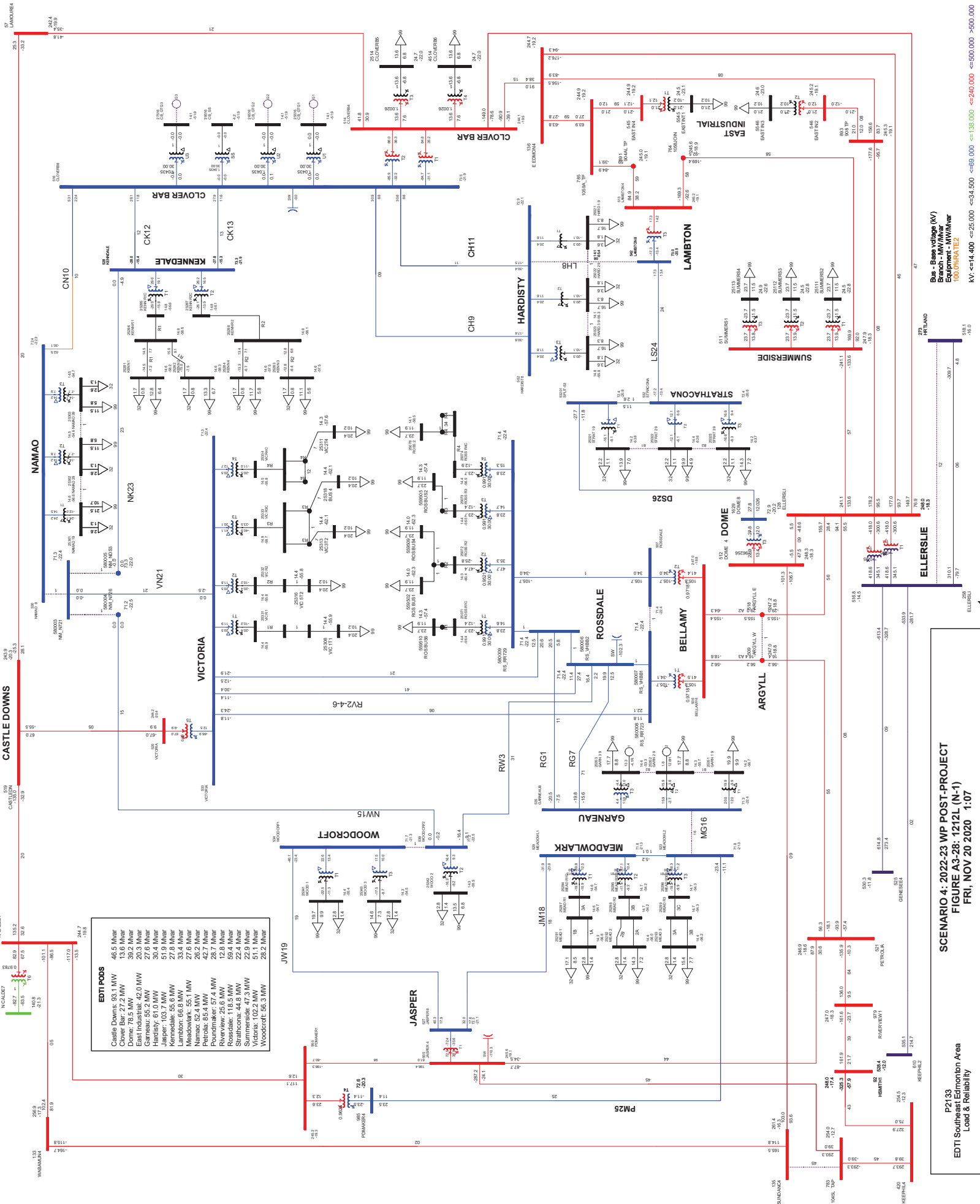
SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-26: 1206L (N-1)
FRI, NOV 20 2020 1:06



EDINBORO	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edinboro: 103.7 MW	51.9 Mvar
Hardisty: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennebec: 55.6 MW	27.8 Mvar
Lambton: 66.8 MW	33.4 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namoo: 54.4 MW	27.2 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosdale: 116.5 MW	59.4 Mvar
Summerside: 47.3 MW	22.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-27: 1209L (N-1)
FRI, NOV 20 2020 1:06

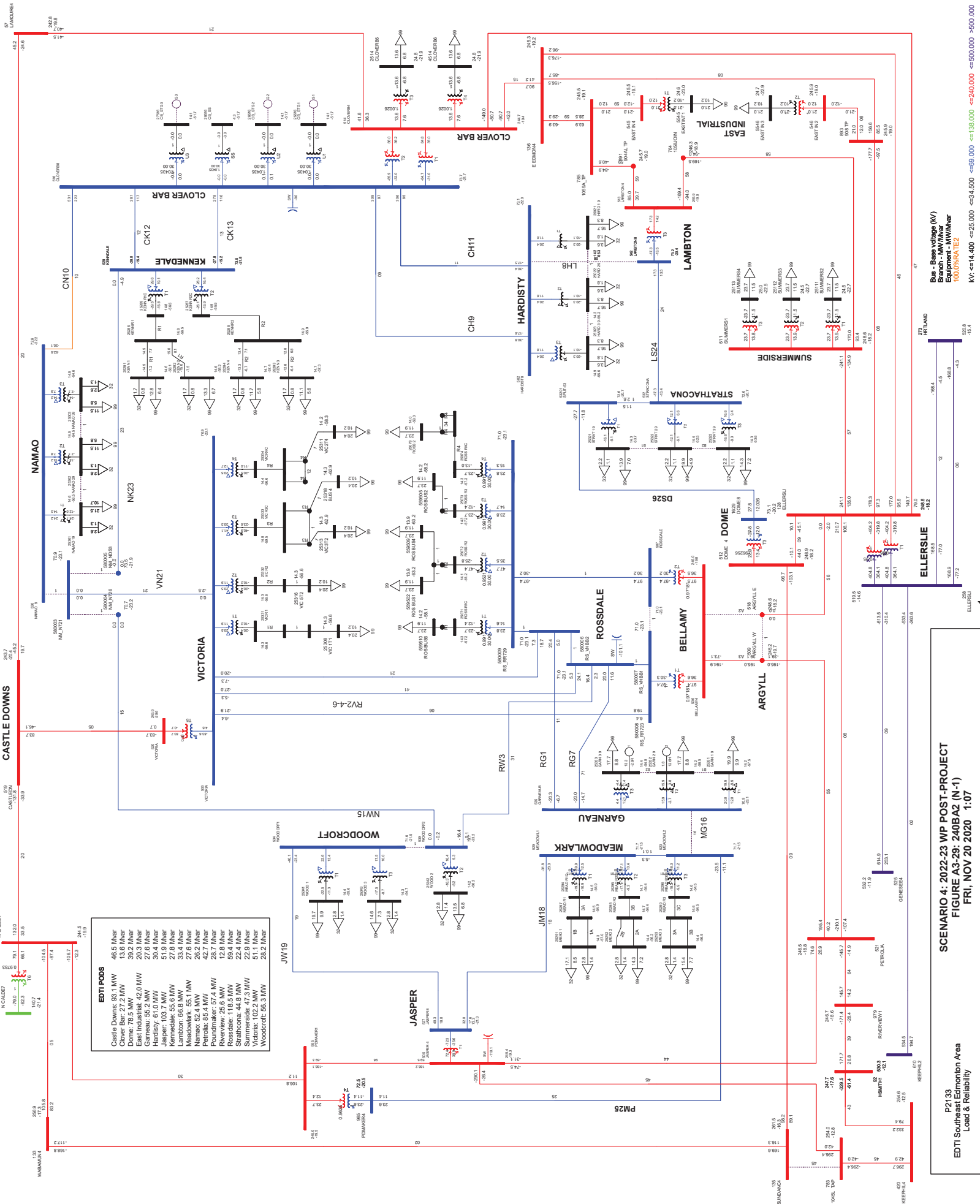
Bus - Base voltage (kV)
Equipment - MVA/Mvar
100% RATE
kv = 14.400 <= 25.000 <= 136.000 <= 240.000 <= 500.000 <= 500.000



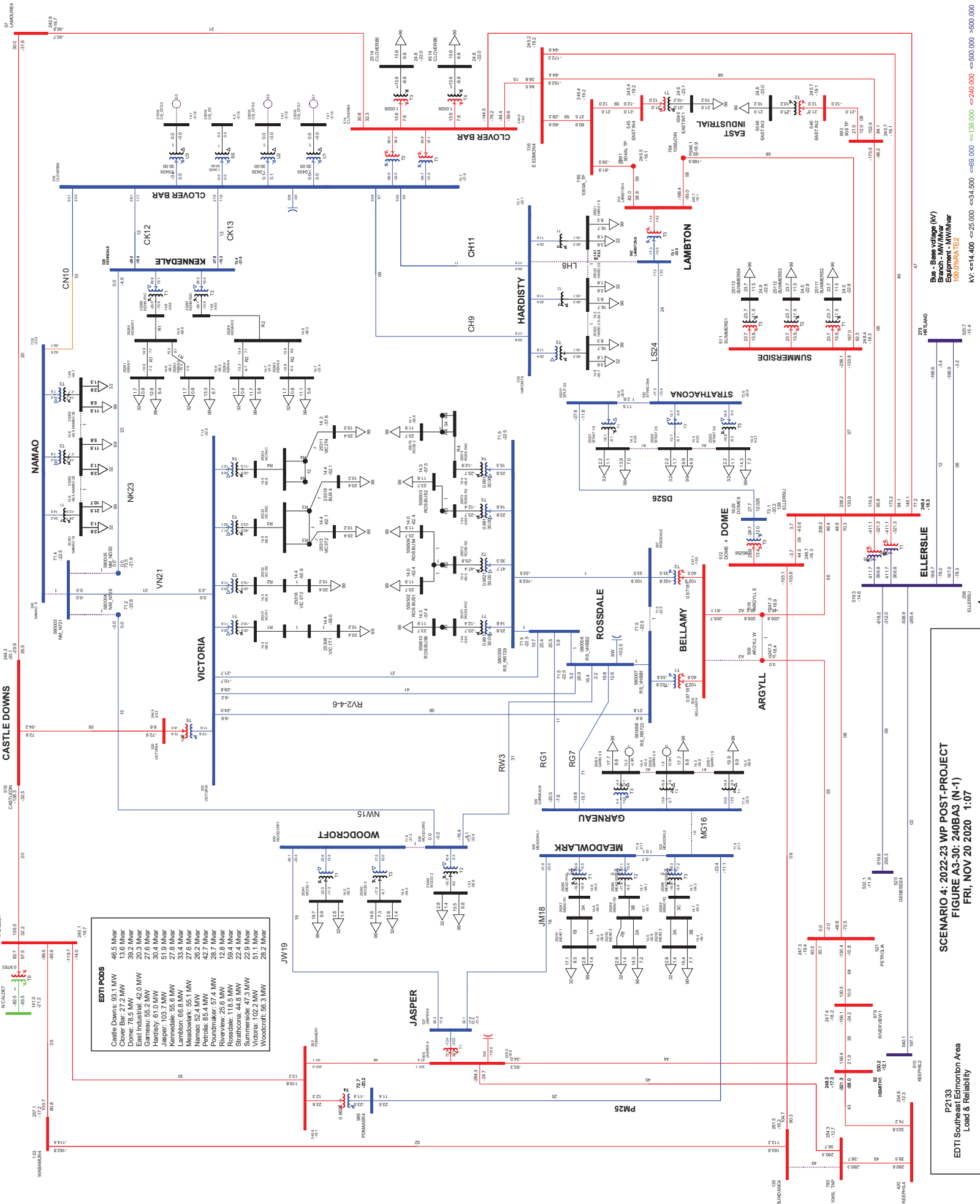
ED11 POOLS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edmonton: 103.7 MW	51.9 Mvar
Hardisty: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennedale: 55.6 MW	27.8 Mvar
Lambton: 66.8 MW	33.4 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namaco: 55.4 MW	27.8 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Strathcona: 44.8 MW	22.4 Mvar
Summerside: 47.3 MW	23.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-28: 1212L (N-1)
FRI, NOV 20 2020 1:07

Bus - Base voltage (kV)
Equipment - MVA/Mvar
100% RATE
KV: <14.400 <25.000 <49.000 <138.000 <240.000 <500.000 <500.000



EDT POOS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edmonton: 103.7 MW	51.9 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennedale: 66.8 MW	33.4 Mvar
Lambton: 55.6 MW	27.8 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namao: 55.4 MW	27.7 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosedale: 118.5 MW	59.4 Mvar
Summerside: 47.3 MW	22.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

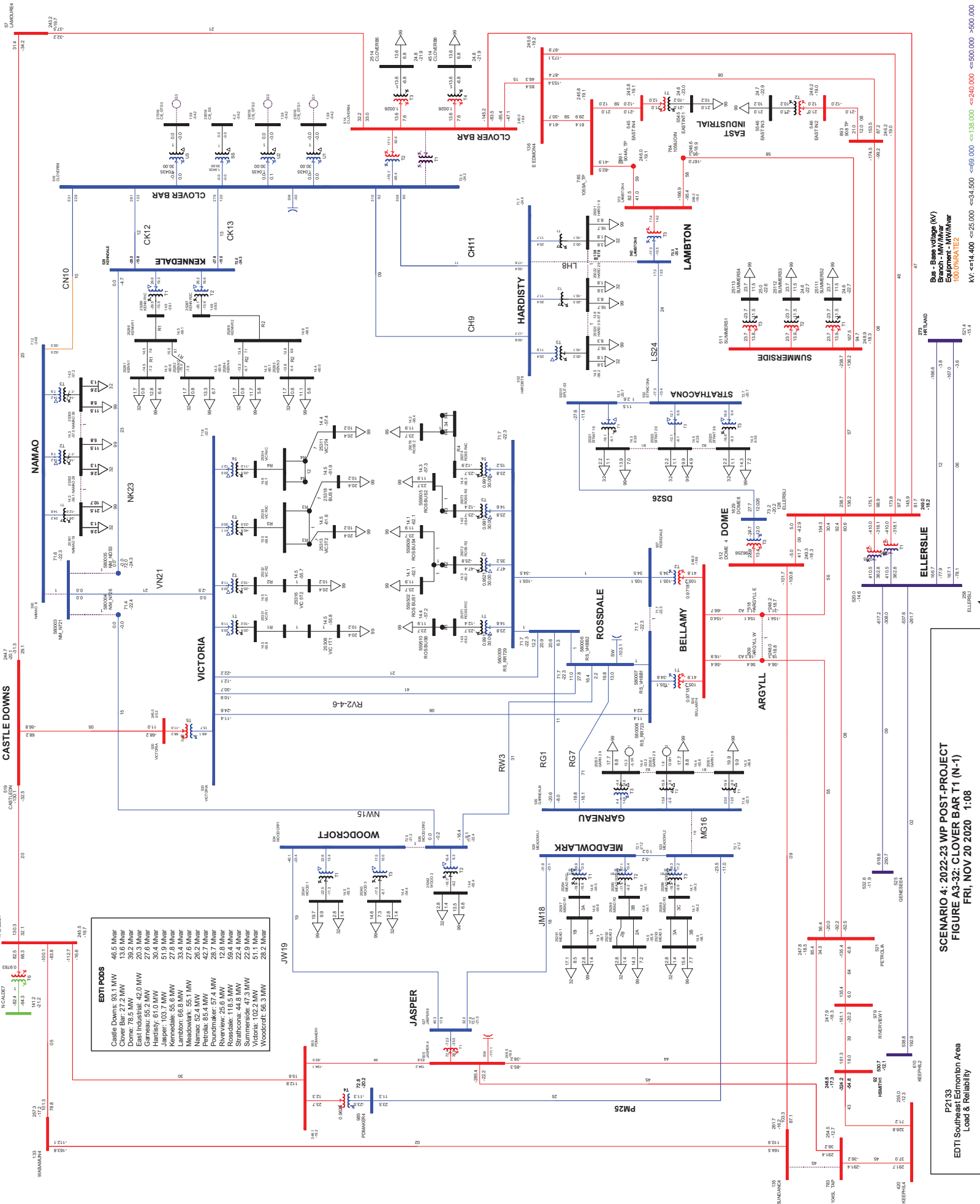


EDITH POOLS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edith Pools: 103.7 MW	51.9 Mvar
Hardisty: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennedale: 66.8 MW	33.4 Mvar
Lambton: 55.6 MW	27.8 Mvar
Meadowlark: 55.1 MW	27.6 Mvar
Namao: 55.1 MW	27.6 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosedale: 118.5 MW	59.4 Mvar
Summerside: 47.3 MW	22.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-30: 240BA3 (N-1)
FRI, NOV 20 2020 1:07

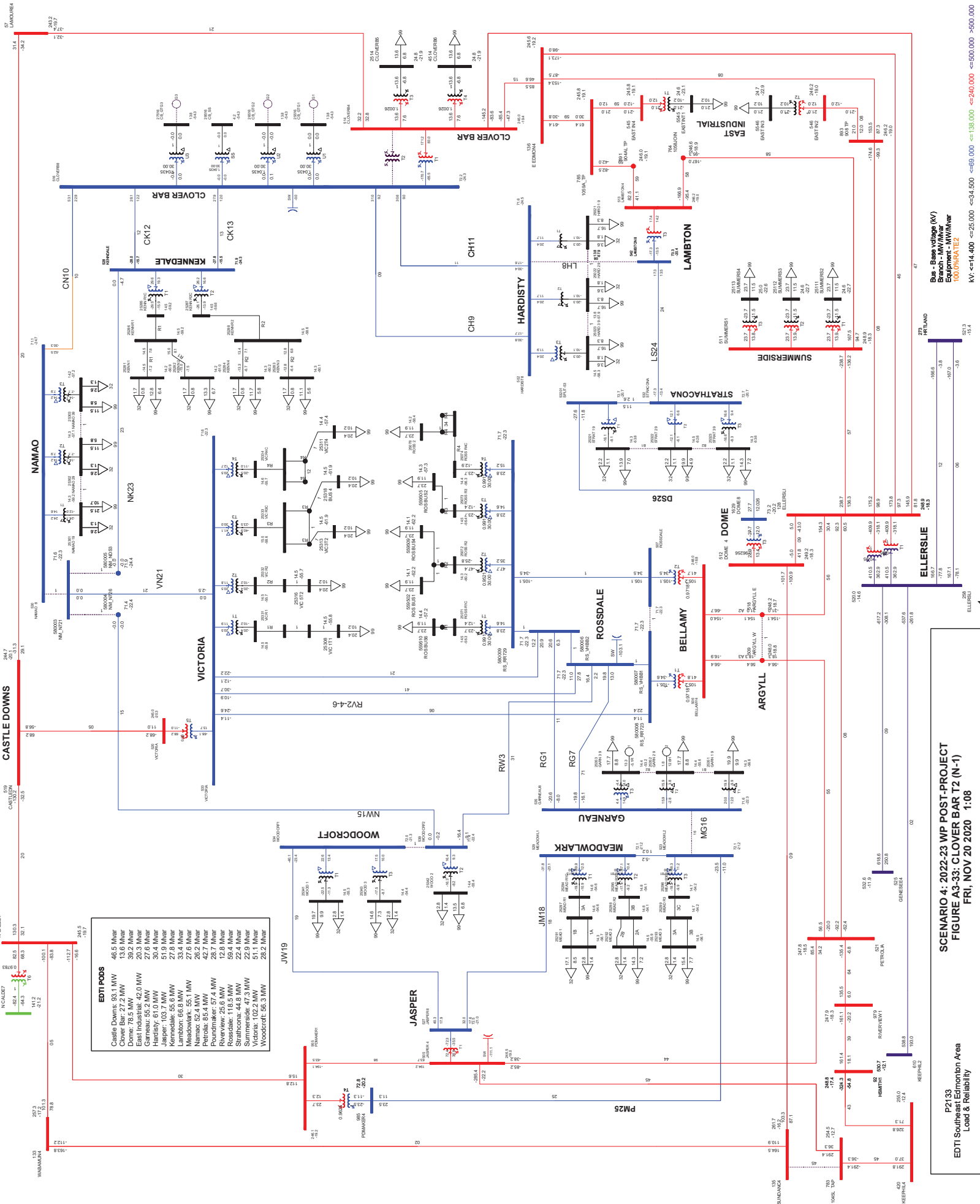
P2133
EDT Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Base power (MW)
Equipment - MVA/Mvar
100.0% RATE 2
KV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000



EDI POOS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edmonton: 100.0 MW	50.0 Mvar
Hardisty: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennedale: 55.6 MW	27.8 Mvar
Lambton: 66.8 MW	33.4 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namao: 52.4 MW	26.2 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Strathcona: 44.8 MW	22.4 Mvar
Summerside: 47.3 MW	23.9 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-32: CLOVER BAR T1 (N-1)
FRI, NOV 20 2020 1:08

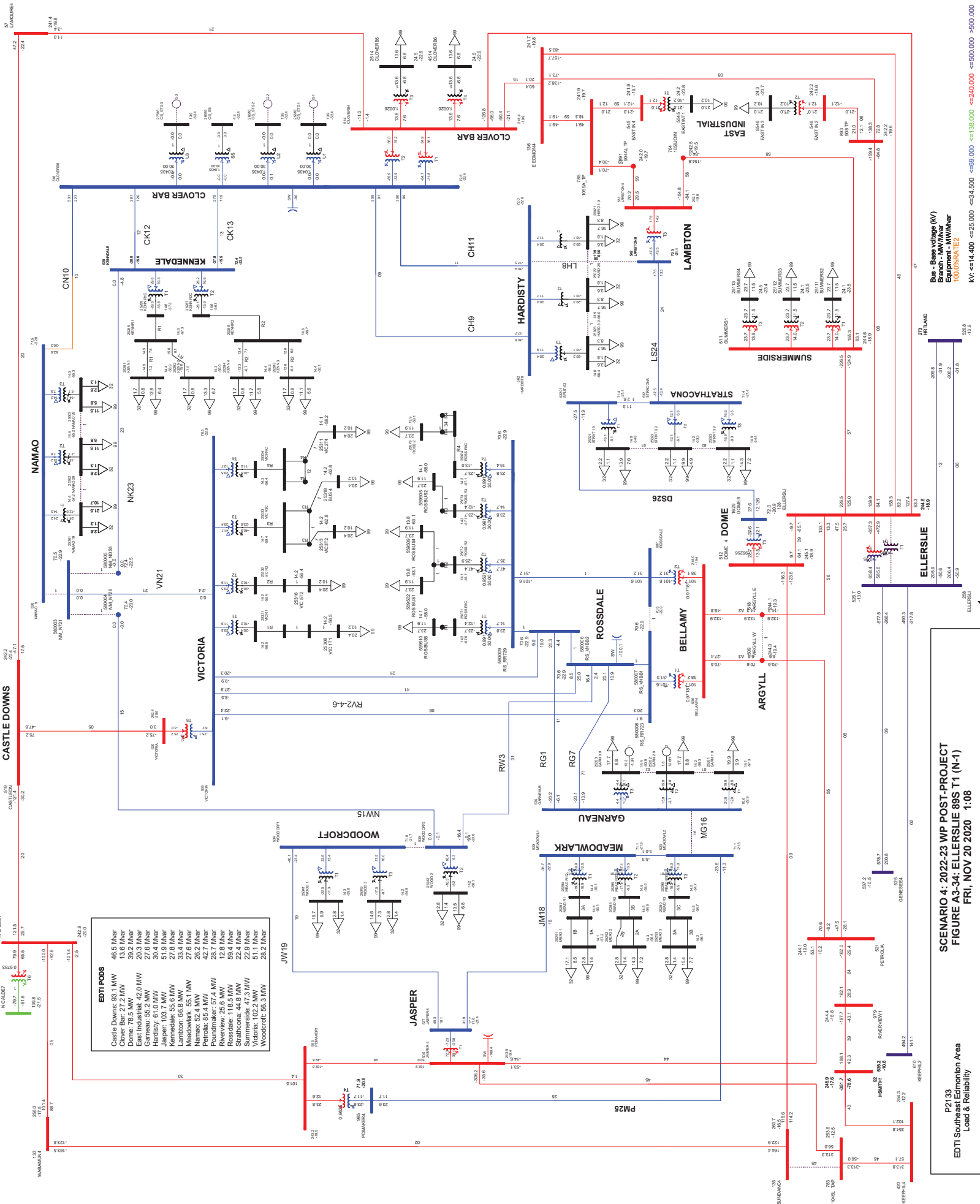


EDINBORO	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edinboro: 103.7 MW	51.9 Mvar
Hardisty: 61.0 MW	27.8 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennebec: 66.8 MW	33.4 Mvar
Lambton: 55.1 MW	27.6 Mvar
Namoo: 55.1 MW	27.6 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosdale: 118.5 MW	59.4 Mvar
Summerside: 47.3 MW	22.9 Mvar
Strathcona: 44.8 MW	22.4 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-33: CLOVER BAR T2 (N-1)
FRI, NOV 20 2020 1:08

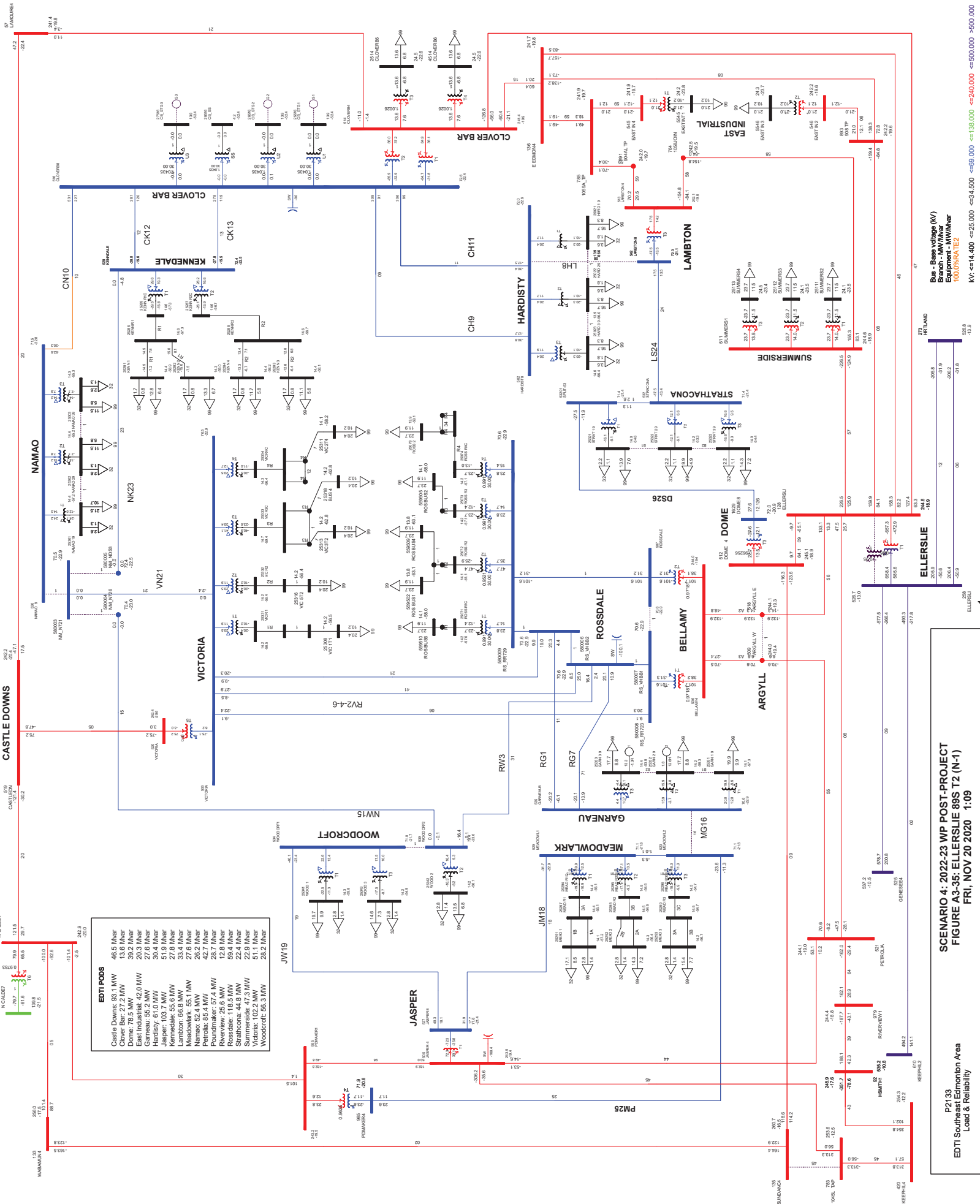
P2133
EDT Southeast Edmonton Area
Load & Reliability

Bus - Base voltage (kV)
Bus - Base power (MW)
Equipment - MVA/Mvar
100% RATE
KV: <14.400 <25.000 <34.500 <49.000 <138.000 <240.000 <500.000 <500.000



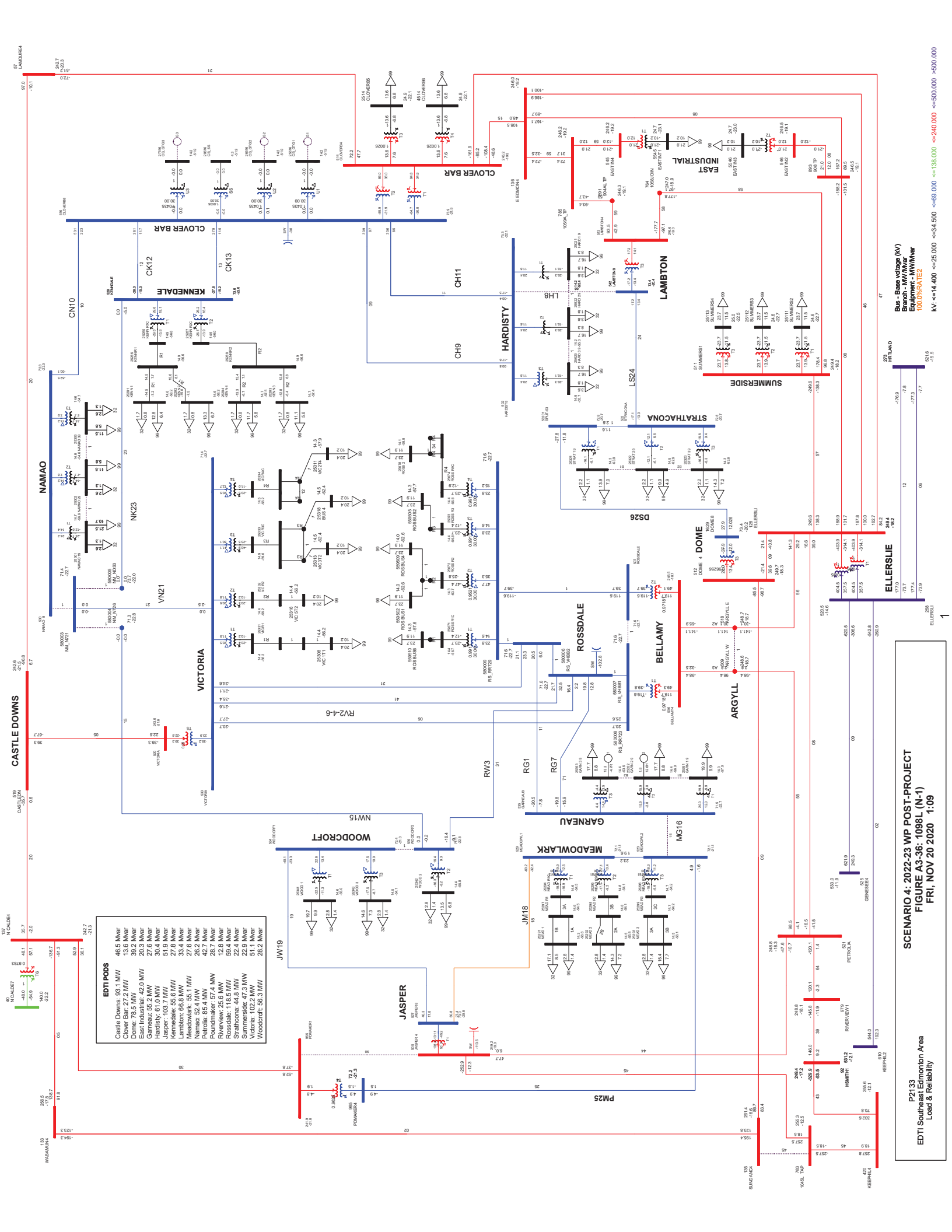
SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-34: ELLERSLIE 89S T1 (N-1)
FRI, NOV 20 2020 1:08

Bus - Base voltage (kV)
Equipment - MVA/Mvar
100% RATE
KV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000



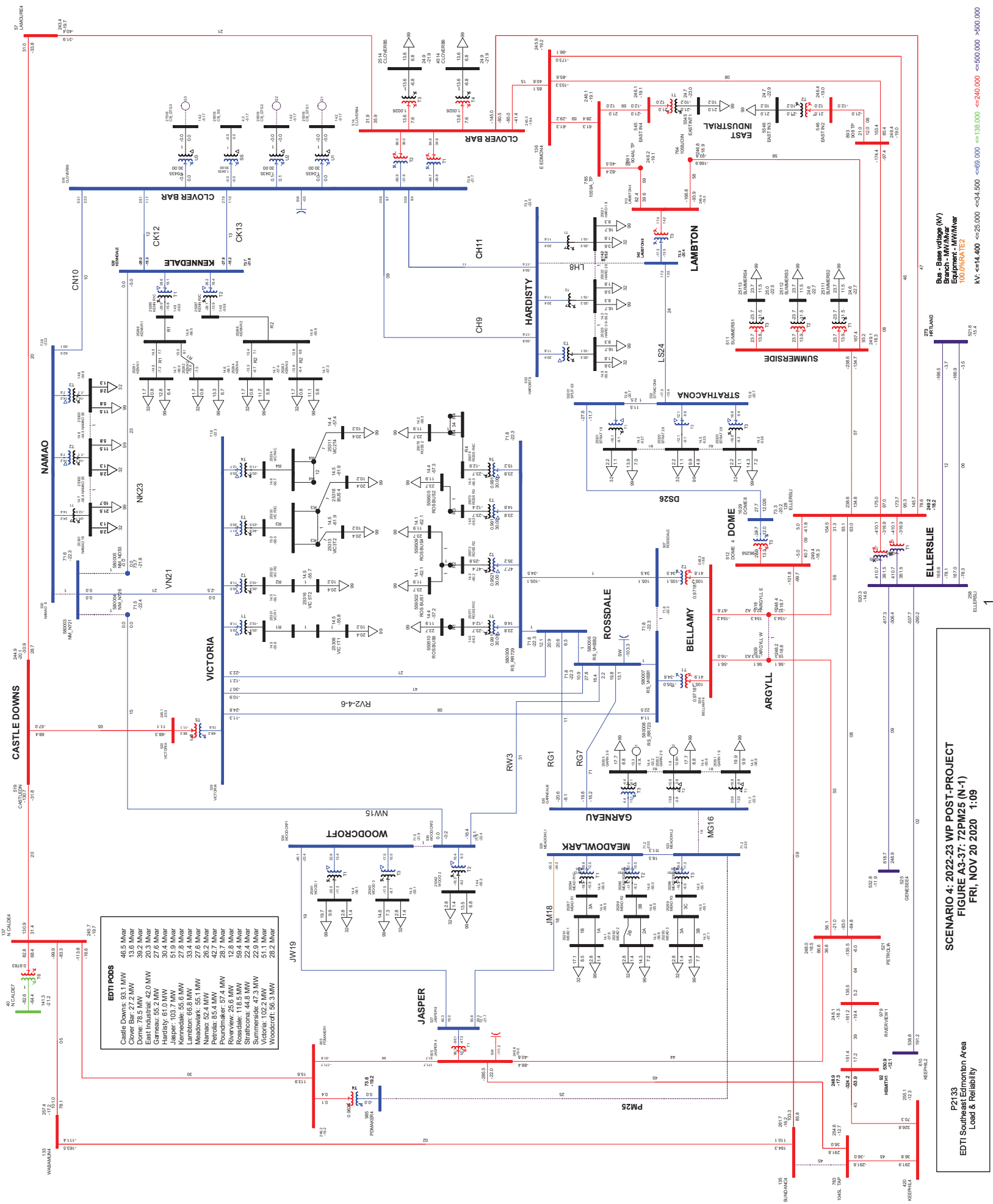
SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-35: ELLERSLIE 89S T2 (N1)
FRI, NOV 20 2020 1:09

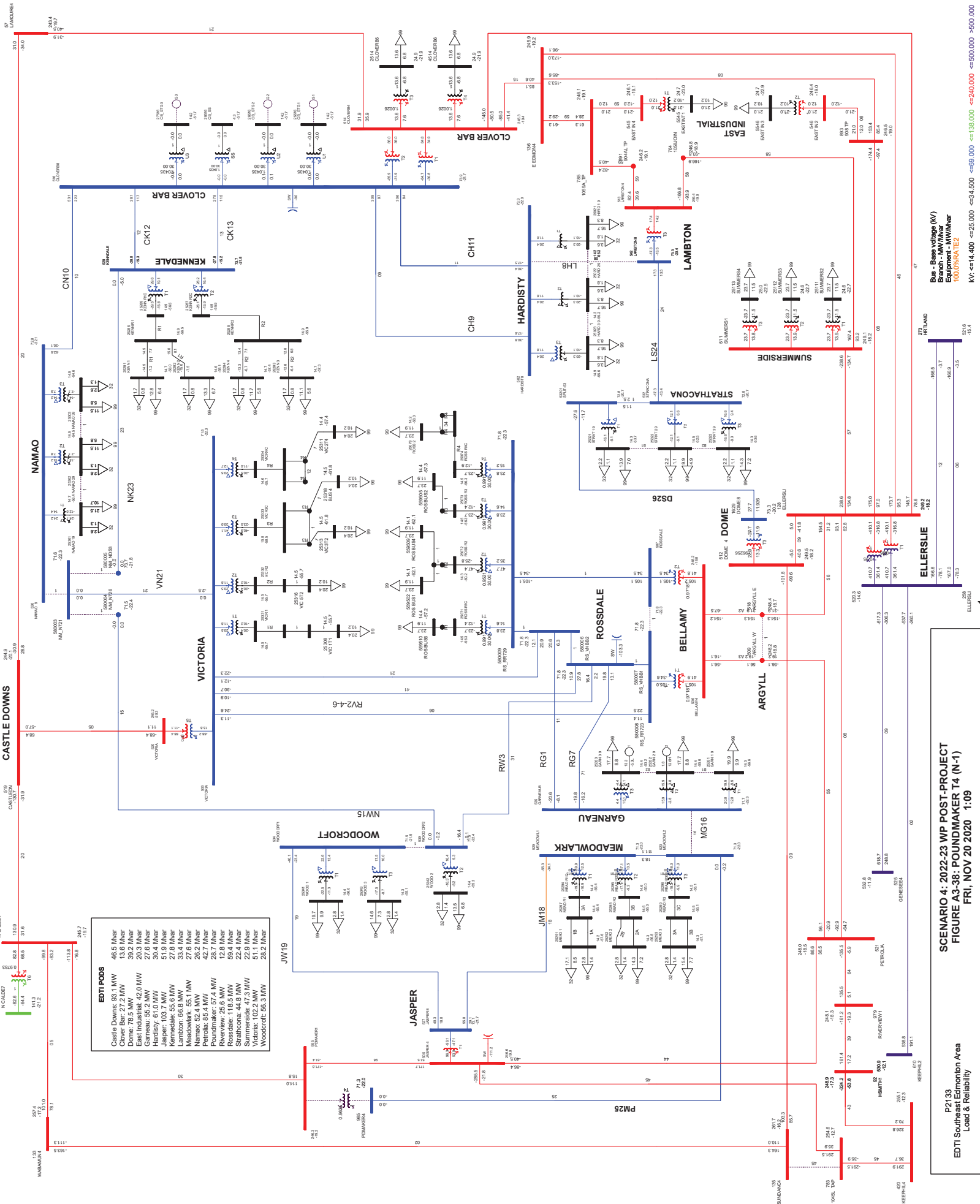
Bus - Base voltage (kV)
Equipment - MVA/Mvar
100% RATED
KV = 14.400 <= 25.000 <= 34.500 <= 69.000 <= 138.000 <= 240.000 <= 500.000 <= 500.000



EDI POOS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edinboro: 103.7 MW	51.9 Mvar
Hardisty: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennebec: 66.8 MW	33.4 Mvar
Lambton: 66.8 MW	33.4 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namoo: 55.1 MW	27.6 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Summerside: 47.3 MW	22.4 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-36: 1098L (N-1)
FRI, NOV 20 2020 1:09





EDIT POOS	
Castle Downs: 93.1 MW	46.5 Mvar
Clover Bar: 27.2 MW	13.6 Mvar
Dome: 78.5 MW	39.2 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Edmonton: 100.0 MW	50.0 Mvar
Hardisty: 61.0 MW	30.4 Mvar
Jasper: 103.7 MW	51.9 Mvar
Kennedale: 55.6 MW	27.8 Mvar
Lambton: 66.8 MW	33.4 Mvar
Meadowbank: 55.1 MW	27.6 Mvar
Namoo: 52.4 MW	26.2 Mvar
Poundmaker: 57.4 MW	28.7 Mvar
Riverview: 25.6 MW	12.8 Mvar
Rosedale: 116.5 MW	59.4 Mvar
Summerside: 47.3 MW	22.4 Mvar
Woodcroft: 56.3 MW	28.2 Mvar

SCENARIO 4: 2022-23 WP POST-PROJECT
FIGURE A3-38: POUNDMARKER T4 (N-1)
FRI, NOV 20 2020 1:09

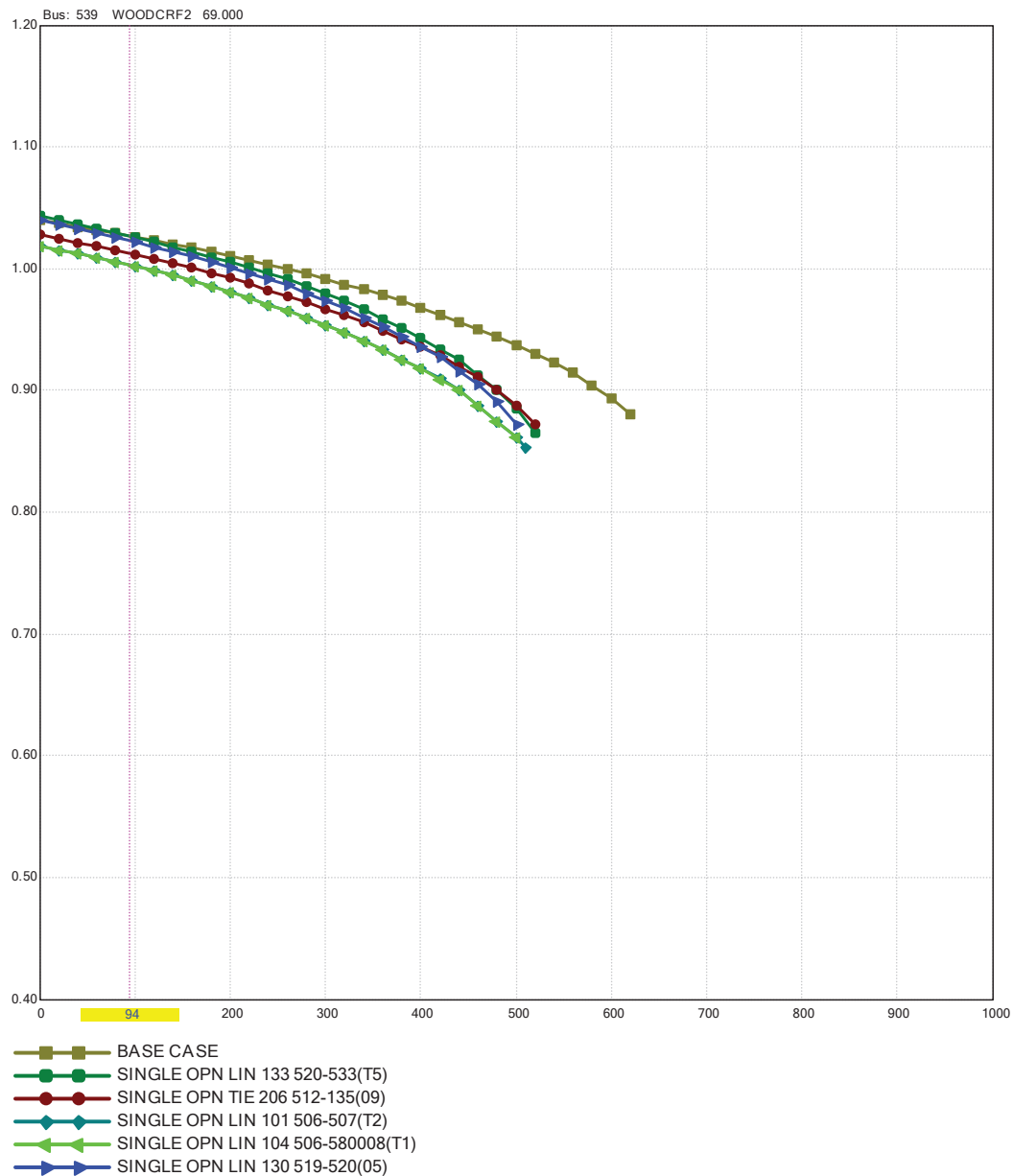
Attachment A4

Post-Project Voltage Stability Diagrams

Scenario 3: 2022 SP

Voltage stability analysis was performed for the 2022 SP scenario. The voltage stability results can be found in Figure A4-01.

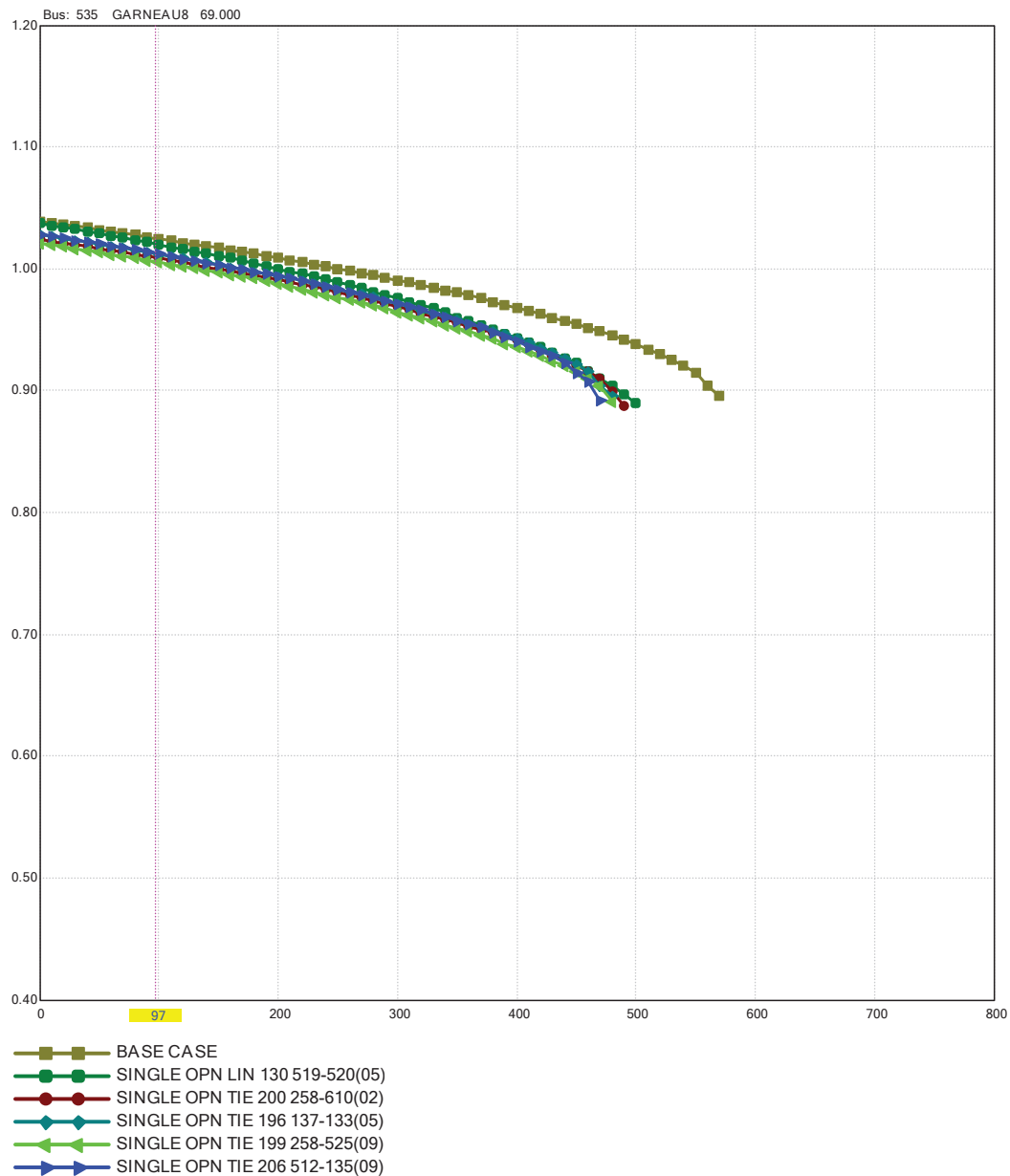
Figure A4-01: Scenario 3: 2022 SP - Overview of Voltage Stability Outages; Initial Load Level for Area 60 is 1887 MW



Scenario 4: 2022-23 WP

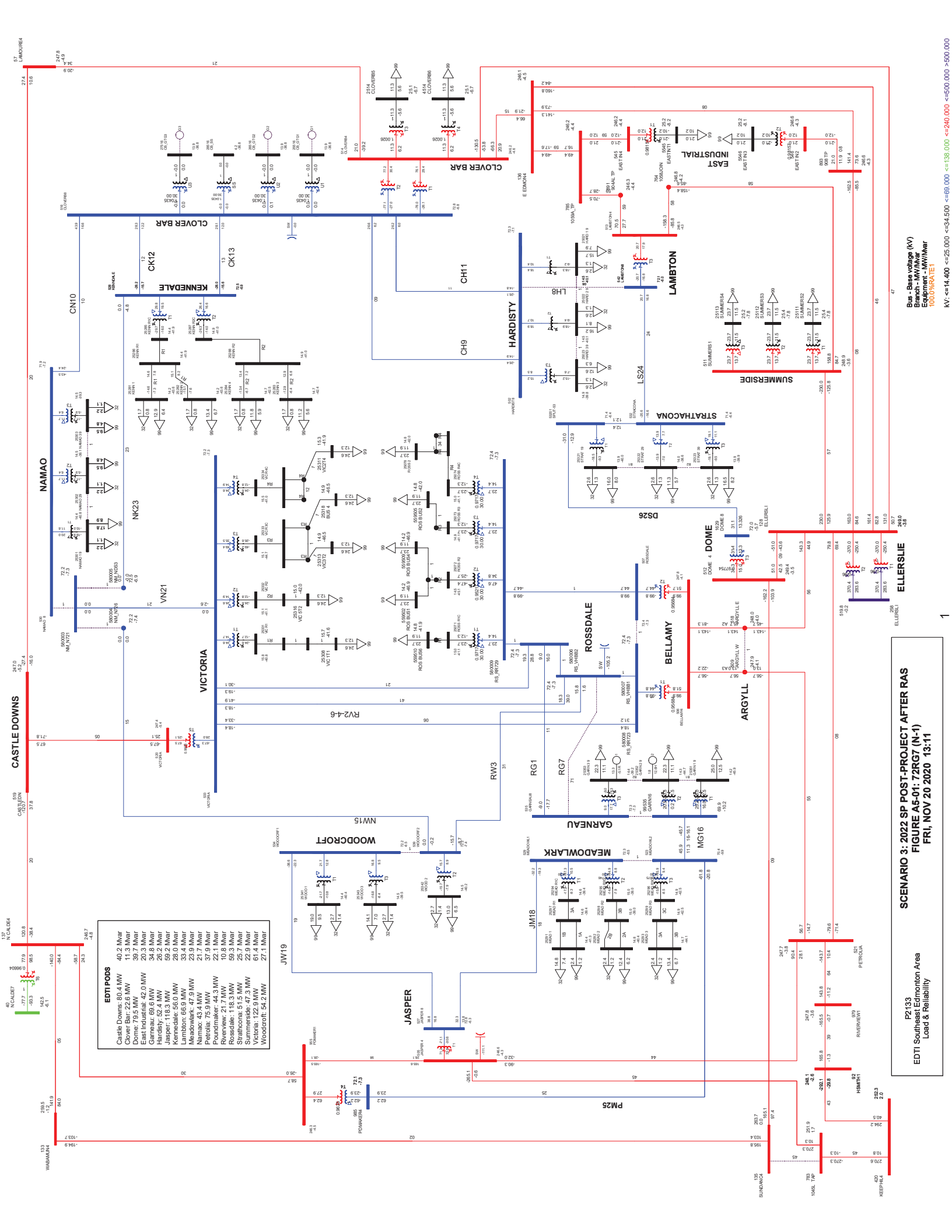
Voltage stability analysis was performed for the 2022-23 WP scenario. The voltage stability results can be found in Figure A4-02.

Figure A4-02: Scenario 4: 2022-23 WP - Overview of Voltage Stability Outages; Initial Load Level for Area 60 is 1941 MW



Attachment A5

Post-Mitigation Power Flow Diagrams



EDTI PODS	
Castle Downs: 80.4 MW	40.2 Mvar
Clover Bar: 22.6 MW	11.3 Mvar
Dome: 79.5 MW	39.7 Mvar
East Industrial: 42.0 MW	20.3 Mvar
Garneau: 69.6 MW	34.8 Mvar
Hardisty: 52.5 MW	26.2 Mvar
Jasper: 58.3 MW	29.1 Mvar
Kinnisdale: 56.0 MW	28.0 Mvar
Lambton: 66.9 MW	33.4 Mvar
Meadowlark: 47.9 MW	23.9 Mvar
Namoo: 43.4 MW	21.7 Mvar
Poundmaker: 44.3 MW	22.1 Mvar
Rosedale: 71.3 MW	35.6 Mvar
Strathcona: 51.5 MW	25.7 Mvar
Summerside: 47.3 MW	22.9 Mvar
Victoria: 122.9 MW	61.4 Mvar
Woodcroft: 54.2 MW	27.1 Mvar

P2133
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SCENARIO 3: 2022 SP POST-PROJECT AFTER RAS
FIGURE A5-01: 72RG7 (N-1)
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