APPENDIX A CONNECTION ASSESSMENT

aeso ALBERTA ELECTRIC SYSTEM OPERATOR

Connection Engineering Study Report

EPCOR
Riverview Substation New POD

AESO Project Number: 1695

Role	Name	Date	Signature
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Executive Summary

Project Overview

EPCOR Distribution & Transmission Inc. (EDTI), in its capacity as the legal owner of the electric distribution system (DFO) in the City of Edmonton, submitted a request for system access service to the Alberta Electric System Operator (AESO) to reliably serve growing demand for electricity in southwest (SW) Edmonton. The DFO informed the AESO that this growing demand in SW Edmonton is currently served by its 25 kV distribution system.

The DFO's request includes a Rate DTS, *Demand Transmission Service*, contract capacity of 24 MW, and a request for transmission development in SW Edmonton (collectively, the Project). Specifically, the DFO requested a new 240/25 kV point of delivery (POD) substation with two 240/25 kV transformers, four 240 kV breakers and associated equipment in SW Edmonton.

The scheduled in-service date for the Project is October 1, 2019.

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

Existing System

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

From a transmission system perspective, Edmonton (Area 60) consists of 500 kV, 240 kV, 138/144 kV, and 69/72 kV transmission systems. The existing 25 kV distribution system in SW Edmonton is currently served by the Summerside and Poundmaker POD substations, which are supplied through the 240 kV transmission system in Edmonton (Area 60).

Existing constraints in the Edmonton Planning Region are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management*.

Study Summary

Study Area

The Study Area for the Project consists of all 240 kV transmission facilities in Edmonton (Area 60) and the tie lines connecting Edmonton (Area 60) to the rest of the AIES. All transmission facilities rated at 240 kV and above within the Study Area were studied and monitored to assess the impact of the Project on the performance of the AIES, including any violations of the Reliability Criteria (as defined in Section 2.1.1).

Studies Performed

2018 winter peak (WP) and 2019 summer peak (SP) scenarios were studied.

Power flow studies were performed for the 2018 WP and 2019 SP pre-Project and post-Project study scenarios.

Voltage stability studies were performed for the 2018 WP post-Project study scenario.

Results of the Pre-Project Studies

Under the Category A and Category B conditions studied, no Reliability Criteria violations were observed.

Connection Alternatives Examined for the Project

The DFO informed the AESO that it intends to request system access service to address capacity and reliability concerns on its 25 kV distribution system in southeast (SE) Edmonton in the near future. For the sake of ensuring transmission system planning efficiency, given the proximity of the 25 kV distribution system in SW Edmonton to SE Edmonton, six transmission alternatives were examined that address the current request for system access service (i.e., distribution system concerns in SW Edmonton), as well as the DFO's capacity and reliability concerns in SE Edmonton.

The AESO examined these six transmission alternatives in consultation with the DFO and the legal owners of transmission facilities (TFOs) that own facilities in the area.

Alternative 1 – Upgrade the existing Petrolia substation and add a new POD substation in SE Edmonton

This alternative involves the following transmission development:

- upgrading the existing Petrolia substation including adding two 240/25 kV transformers, two 240 kV circuit breakers, and eight 25 kV feeder breakers and associated equipment; and
- adding a new POD substation in SE Edmonton, including adding two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment; and connecting the new POD to the AIES.

Alternative 2 – Upgrade the existing Jasper substation and add a new POD substation in SE Edmonton

This alternative involves the following transmission development:

- upgrading the existing Jasper substation including the addition of two 240/25 kV transformers, two 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment; and
- adding a new POD substation in SE Edmonton including two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment ;and connecting it to the AIES.

Alternative 3 – Upgrade the existing Summerside and Poundmaker substations and add a new POD substation in SE Edmonton

This alternative involves the following transmission development:

- upgrading the existing Summerside substation including adding one 240/25 kV transformer, one 240 kV circuit breaker, and four 25 kV feeder circuit breakers and associated equipment ;
- upgrading the existing Poundmaker substation including adding one 240/25 kV transformer, one 240 kV circuit breaker, and four 25 kV feeder circuit breakers and associated equipment; and
- adding a new POD substation in SE Edmonton, including two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment ; and connecting it to the AIES.

Alternative 4 – Add a new POD substation in SW Edmonton, to be called the Riverview substation and upgrade the existing Summerside substation

This alternative involves the following transmission development:

- adding a new POD substation in SW Edmonton, to be called the Riverview substation, including two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment;
- connecting the proposed Riverview substation to the existing 240 kV transmission line 1043L (future 1139L) using an in-and-out configuration, between the approved Harry Smith 367S substation and the Petrolia substation, by adding two new 240 kV transmission circuits, each approximately 70 metres in length; and
- upgrading the existing Summerside substation, including adding one 240/25 kV transformer, one 240 kV circuit breaker, and four 25 kV feeder circuit breakers and associated equipment.

Alternative 5 – Add the proposed Riverview substation and add a new POD to SE Edmonton

This alternative involves the following transmission development:

- adding the proposed Riverview substation, including two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment;
- connecting the proposed Riverview substation to the existing 240 kV transmission line 1043L (future 1139L) using an in-and-out configuration, between the approved Harry Smith 367S substation and the Petrolia substation, by adding two new 240 kV transmission circuits, each approximately 70 metres in length; and
- adding a new POD substation in SE Edmonton, including two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment and connecting it to the AIES.

Alternative 6 – Upgrade the existing Summerside and Poundmaker substations

This alternative involves the following transmission development:

- upgrading the existing Summerside substation, including replacing the two existing 240/25 kV transformers with two 240/25 kV transformers of higher capacity and adding a third 240/25 kV transformer, one 240 kV circuit breaker, and eighteen 25 kV feeder circuit breakers and associated equipment; and

- upgrading the existing Poundmaker substation, including adding one 240/25 kV transformer, one 240 kV circuit breaker, and four 25 kV feeder circuit breakers and associated equipment.

Alternatives Not Selected for Further Examination

Alternative 1 and Alternative 2 were not selected for further study because the TFO advised that expanding the existing Petrolia and Jasper substations are not viable.

Alternative 3 and Alternative 6 were not selected for further study because the total costs are estimated to be higher than the total costs of Alternative 4 and Alternative 5.[1]

Alternatives Selected for Further Examination

Alternative 4 and Alternative 5 were selected for further study. Both Alternative 4 and Alternative 5 involve adding the proposed Riverview substation to meet the request for system access service.

Alternative 4 and Alternative 5 include different transmission facilities to address the capacity and reliability concerns in SE Edmonton, which the DFO has indicated will be the subject of a forthcoming request for system access service. Therefore, the selection of the preferred transmission development to address the DFO's capacity and reliability concerns in SE Edmonton will be assessed as a part of a separate project, and is not within the scope of this study.

For the purpose of responding to the DFO's current request for system access service, Alternative 4 and Alternative 5 are equivalent in scope. Therefore, only the addition of the proposed Riverview substation, connected to the existing 240 kV transmission line 1043L (future 1139L) in an in-and-out configuration, and including two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment, will be examined further.

Results of the Post-Project Studies

The post-Project studies were performed for the proposed Riverview substation with a Rate DTS request of 24 MW.

Under the Category A and Category B conditions studied, no Reliability Criteria violations were observed. The voltage stability margin was met for all studied conditions.

Conclusions and Recommendations

[1] Cost estimates for Alternative 3, Alternative 4, Alternative 5, and Alternative 6 are provided under a separate cover.

The connection assessment did not identify any pre-Project or post-Project system performance issues. The connection assessment indicates that the Project will not adversely impact the performance of the AIES.

Based on the connection assessment, adding the proposed Riverview substation to address the request for system access service is technically acceptable.

Based on the connection assessment, adding the proposed Riverview substation and the associated DTS is technically acceptable. The connection assessment did not identify any pre-Project or post-Project system performance issues. The connection assessment indicates that the Project will not adversely impact the performance of the AIES. No mitigation measures are required as no Reliability Criteria violations were observed.

It is recommended to proceed with the Project by adding a new POD substation in SW Edmonton as the preferred option to respond to the DFO's request for system access service. This includes: adding a new POD substation, to be designated the Riverview substation, including two 240/25 kV LTC transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment; and adding two 240 kV circuits, approximately 70 metres in length, to connect the Riverview substation to the existing 240 kV transmission line 1043L (future 1139L) using an in-and-out configuration between the approved Harry Smith 367S substation and the existing Petrolia substation.

A minimum rating equal or greater than the rating of the existing 240 kV transmission line 1043L is recommended for the two new 70 metres 240 kV circuits.

The 240/25 kV LTC transformers at the Riverview substation are recommended to have a rating of 75 MVA.

Contents

Attachments

Figures

Tables

1. Introduction

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

1.1. Project

1.1.1. Overview

EPCOR Distribution & Transmission Inc. (EDTI), in its capacity as the legal owner of the electric distribution system (DFO) in the City of Edmonton, submitted a request for system access service to the Alberta Electric System Operator (AESO) to reliably serve growing demand for electricity in southwest (SW) Edmonton.

The DFO's request includes a Rate DTS, *Demand Transmission Service*, contract capacity of 24 MW, and a request for transmission development in SW Edmonton (collectively, the Project). Specifically, the DFO requested a new point of delivery (POD) substation with two 240/25 kV transformers, four 240 kV breakers, two 25 kV busses with a total of eight 25 kV feeder breakers and associated equipment in SW Edmonton.

The scheduled in-service date for the Project is October 1, 2019.

1.1.2. Load Component

- New Rate DTS contract capacity: 24 MW in SW Edmonton
- Load type: Residential and Commercial
- Power Factor (PF) assumed for studies: 0.9 pf (lagging)
- Future expansion plans: EDTI has requested provisions to allow for future expansion.

1.1.3. Generation Component

There is no generation component associated with the Project.

1.2. Study Scope

1.2.1. Study Objectives

The objectives of the study are as follows:

- Assess the impact of the Project on the performance of the AIES.
- Identify any violations of the relevant AESO criteria, standards or requirements, both pre-Project and post-Project.

- Recommend the preferred Project alternative and mitigation measures, if required, to reliably connect the Project to the AIES.

1.2.2. Study Area

1.2.2.1. Study Area Description

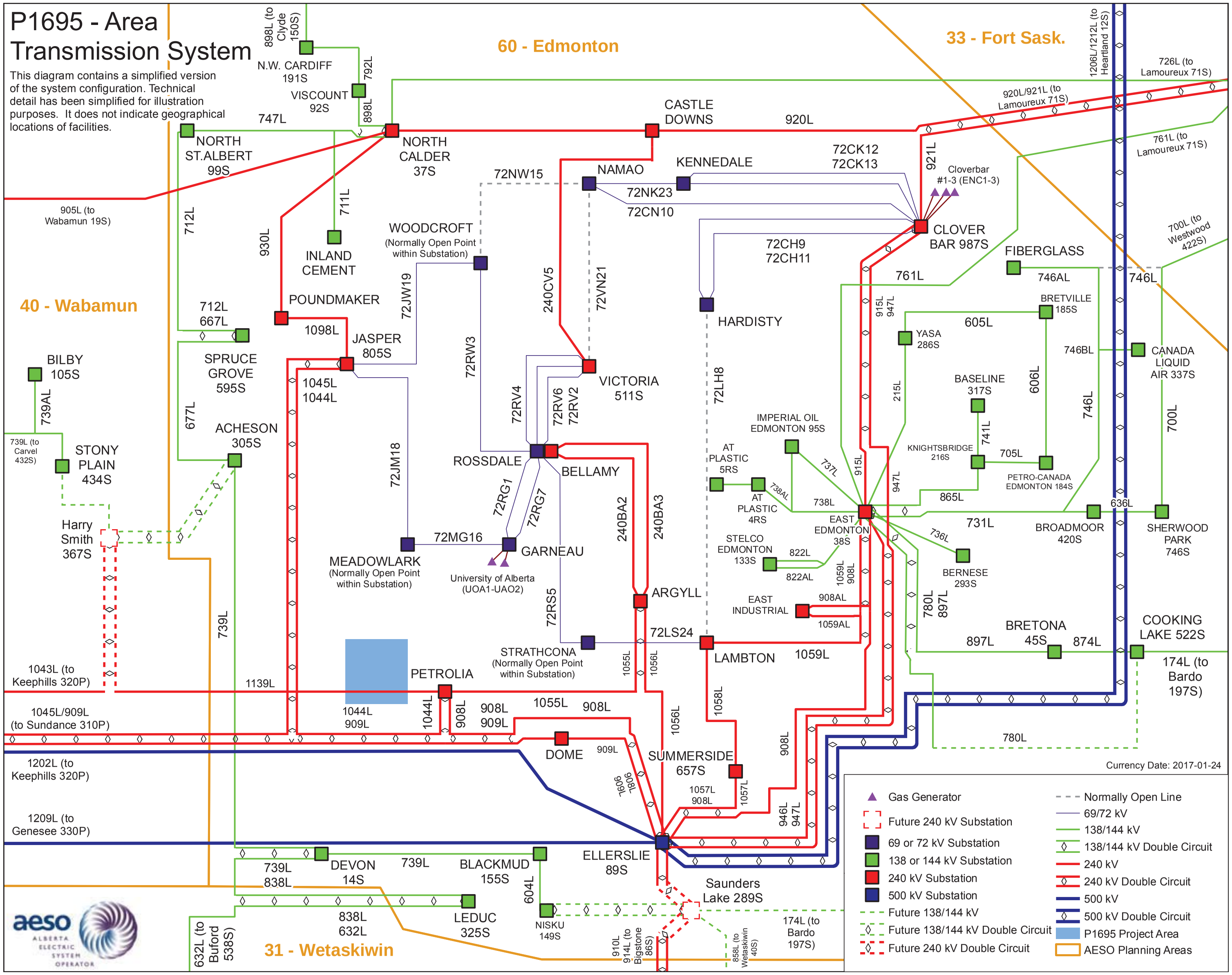
Geographically, the Project is located in the AESO planning area of Edmonton (Area 60), which is part of the AESO Edmonton Planning Region. Edmonton (Area 60) is surrounded by the AESO planning areas of Athabasca/Lac La Biche (Area 27), Fort Saskatchewan (Area 33), Wetaskiwin (Area 31), and Wabamun (Area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

From a transmission system perspective, Edmonton (Area 60) consists of 500 kV, 240 kV, 138/144 kV, and 69/72 kV transmission systems. The existing 25 kV distribution system in SW Edmonton is currently served by the Summerside and Poundmaker POD substations, which are supplied through the 240 kV transmission system in Edmonton (Area 60).

The Study Area for the Project consists of all 240 kV transmission facilities in Edmonton (Area 60) and the tie lines connecting Edmonton (Area 60) to the rest of the AIES.

Figure 1-1 shows the existing and approved transmission system in the vicinity of the Project.

Figure 1-1: Transmission System in vicinity of the Project



1.2.2.2. Existing Constraints

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

1.2.2.3. AESO Long-Term Transmission Plans

The approved South and West Edmonton Area Transmission Development (SWEATD) will be in the Study Area.[2] The Harry Smith 367S substation, which was approved as a part of SWEATD, is shown in Figure 1-1. The 240 kV transmission line between the Keephills 320P and the Petrolia substations is currently designated the 1043L. As Figure 1-1 shows, once the approved Harry Smith 367S substation is in service, the 240 kV transmission line between the Harry Smith 367S and the Petrolia substations will be designated the 1139L. The Harry Smith 367S substation is scheduled to be in-service December 5, 2017.

In addition to the approved SWEATD, the *AESO 2015 Long-term Transmission Plan* (2015 LTP)[3] provides a plan for system developments in the City of Edmonton in the near-term, medium-term, and long-term. According to the 2015 LTP, the following transmission system enhancements were identified and were considered to be needed in the near-term (by 2020):

- Convert Hardisty substation in east Edmonton to 240/15 kV from 72/15 kV
- Add new 240 kV loop from Lambton substation in southeast Edmonton to Hardisty substation and onto Bellamy substation at Rossdale
- Discontinue use of 72 kV lines from Rossdale substation (Bellamy) to Strathcona substation to Lambton substation
- Replace existing 240/72 kV transformers at Clover Bar substation in northeast Edmonton with larger units
- Add new 240/72 kV substation near Namao in northeast, cut into 240 kV line between Castle Downs substation and Victoria substation on north edge of downtown Edmonton
- Add new 72 kV line from new substation to existing Namao substation
- Add new 240/72 kV transformer at Castle Downs substation in northeast
- Add new 72 kV transmission lines from Castle Downs substation to Kennedale substation, and onto Namao substation
- Discontinue use of 72 kV lines between Clover Bar and Hardisty substations, and Hardisty and Lambton substations
- Discontinue use of existing 72 kV lines that connect Clover Bar, Victoria, Namao, Kennedale, and Woodcroft substations
- Convert Victoria substation from 240/72/15 kV to 240/15 kV
- Add new 240 kV line from Victoria substation to Bellamy substation
- Discontinue use of 72 kV lines between Rossdale and Victoria substations

[2] The *South and West of Edmonton Area Transmission Development Needs Identification Document* was originally approved by the Alberta Utilities Commission on May 5, 2014 in Approval No. U2014-183 and Decision 2014-126.

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

1.2.3. Studies Performed

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

- Power flow

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

- Power flow
- Voltage stability

1.3. Report Overview

The Executive Summary provides a high-level summary of the assessment and its conclusions. Section 1 provides an introduction of the Project. Section 2 describes the criteria, system data, and other study assumptions used in this study. Section 3 presents the methodology used for the studies. Section 4 presents the pre-Project study results. Section 5 presents the transmission alternatives examined. Section 6 provides the post-Project study results for the alternative that was selected for further study. Section 7 presents any dependencies the Project may have on other AESO plans to expand or enhance the transmission system, if any. Section 8 presents the conclusions and recommendations of this assessment.

2. Criteria, System Data, and Study Assumptions

2.1. Criteria, Standards, and Requirements

2.1.1. Transmission Planning Standards and Reliability Criteria

The Transmission Planning (TPL) Standards, which are included in the Alberta Reliability Standards, and the AESO's *Transmission Planning Criteria – Basis and Assumptions* [4] (collectively, the Reliability Criteria) were applied to evaluate system performance under Category A system conditions (i.e., all elements in-service) and following Category B contingencies (i.e., single element outage), prior to and following the studied alternatives. Below is a summary of Category A and Category B system conditions.

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

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

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

- Seasonal continuous thermal rating of the line's loading limits.
- Highest specified loading limits for transformers.
- For Category A conditions: Voltage range under normal operating condition follows the AESO Information Document ID# 2010-007RS, *General Operating Practices - Voltage Control* (ID #2010-007RS). ID#2010-007RS relates to Section 304.4 of the ISO rules, *Maintaining Network Voltage*. For the busses not listed in ID #2010-007RS, Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions* applies.
- For Category B conditions: The extreme voltage range values per Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions*.
- Desired post-contingency voltage change limits for three defined post event timeframes as provided in Table 2-1.

[4] Filed under a separate cover

Table 2-1: Post-Contingency Voltage Deviations Guidelines for Low Voltage POD Busses

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

2.1.2. ISO Rules and Information Documents

AESO ID# 2010-007RS was applied to establish pre-contingency voltage profiles in the Study Area. The TCM Rule was followed in setting up the study scenarios and assessing the study results. The Reliability Criteria is the basis for planning the AIES. In addition, due regard was given to the AESO's *Connection Study Requirements* Document and the AESO's *Generation and Load Interconnection Standard*.

2.2. Study Scenarios

At the time of study, the scheduled ISD for the Project was October 1, 2018. As a result, the studies were performed using 2018 winter peak (WP) and 2019 summer peak (SP) study scenarios. The scheduled ISD has since been revised from October 1, 2018 to October 1, 2019. The shift in the scheduled ISD does not materially impact the results of this connection assessment, and does not change the conclusions and recommendations contained in the report.

Table 2-2 provides a list of the study scenarios. The post-Project scenarios include the DFO-requested Rate DTS contract capacity of 24 MW. This connection assessment will assume a 0.9 lagging power factor for the load associated with the Project.

Table 2-2: List of the Connection Study Scenarios

Scenario	Year/Season Load	pre-Project/ post-Project	Project Load (MW)	Project Generation (MW)	System Generation Dispatch Conditions
1	2018 Winter Peak (WP)	pre-Project	0.0	0	Market Dispatch
2	2019 Summer Peak (SP)	pre-Project	0.0	0	Market Dispatch
3	2018 WP	post-Project	24.0	0	Market Dispatch
4	2019 SP	post-Project	24.0	0	Market Dispatch

2.3. Load and Generation Assumptions

2.3.1. Load Assumptions

The Study Area load forecast used for this connection study is shown in Table 2-3 and corresponds to the forecasted area load during the forecasted Edmonton Region seasonal peak load, which was based on the *AESO 2016 Long-term Outlook* (2016 LTO). As part of its planning responsibilities, the AESO updates its corporate forecasts routinely to ensure they reflect the latest economic projects, factors and timing. While the AESO has updated its regional forecasts since the connection studies were performed, the use of the current AESO forecast, the *AESO 2017 Long-term Outlook*, would not materially alter the connection study results or affect the conclusions and recommendations in this report.

For the studies, when loads are modified to align with the load forecast in the 2016 LTO, the active power to reactive power ratio in the base case scenarios were maintained.

Table 2-3: Forecast Area Load *(2016 LTO at Edmonton Region Peak)*

Area Name	Year/Season	Forecast Peak Load (MW)
Edmonton (Area 60)	2018 WP	2024
	2019 SP	2114
Edmonton Region	2018 WP	2367
	2019 SP	2428

2.3.2. Generation Assumptions

The key generation dispatch conditions for the study scenarios are described in Table 2-4. The Cloverbar #3 generating unit was identified as the critical generating unit, and was considered to be out-of-service to represent the N-G condition for all studies.

Table 2-4: Key System Generation Dispatch Conditions

Unit Name	Unit No.	Bus Number	AESO Planning Area	Pmax (MW)	2018 WP Unit Net Generation* (MW)	2019 SP Unit Net Generation (MW)
Clover Bar	G1	25516	60	44	0	0
	G2	26516	60	100	0	0
	G3	27516	60	101	N-G**	N-G
University of Alberta Cogeneration	G1	25352	60	39	14	2
	G2					

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

** "N-G" indicates the critical generating unit that is assumed by the AESO to be offline to test the N-G contingency condition

2.3.3. Intertie Flow Assumptions and HVDC Assumptions

The Alberta-BC, Alberta-Montana, and Alberta-Saskatchewan intertie points are deemed to be too far away from the Study Area to have any material impact on the results of the studies. Therefore, the AESO planning base case intertie flow assumptions were used for the study scenarios.

The Western Alberta Transmission HVDC Line (WATL) and the Eastern Alberta Transmission HVDC Line (EATL) assumptions were expected to have minimal impact for the results of the studies. Therefore, the AESO planning base case HVDC assumptions were used for the study scenarios.

2.4. System Projects

The approved transmission developments that are a part of the SW Edmonton project are assumed to be in service for the studies. This includes the approved Harry Smith 367S substation and its connection to the existing 240 kV transmission line 1043L, which will be designated the 1139L (between the Harry Smith 367S and the Petrolia substations) after the Harry Smith 367S is connected.

The remaining of the AESO long term plans described in Section 1.2.2.3 were not included in the study scenarios.

2.5. Customer Connection Projects

Customer connection projects within the Study Area that have passed Gate 2 of the AESO Connection Process as of October 2017 were modelled in the study scenarios based on their positions in the AESO Connection Queue. Table 2-5 summarizes the customer connection projects in Edmonton (Area 60) that were included in the studies.

Table 2-5: Summary of Included Customer Projects in Edmonton (Area 60)

Queue Position*	Scheduled In-Service Date	AESO Project Name	AESO Project No.	Gen (MW)	Load (MW)
32	Feb 1, 2019	Fortis New Anthony Henday Substation	P1442	0.0	21.0
37	Feb 1, 2020	CP Genesee Generating Units 4 and 5	P1440	1010.0	50.0
51	Dec 12, 2017	Fortis Cooking Lake 522A Capacity Increase	P1674	0.0	3.7
53	Nov 30, 2019	EPCOR Garneau Area Upgrade – Phase 2	P1649	0.0	0.0
54	Feb 28, 2019	EPCOR Garneau Area Upgrade – Phase 1	P1649	0.0	20.9
56	Dec 21, 2018	EPCOR Strathcona Capacity Increase	P1659	0.0	14.2

*Per the AESO Connection Queue posted in October 2017. The projects in the Study Area, if any, that have queue positions after the Project (AESO Project P1695) are not listed in this table and were not included in the study scenarios.

2.6. Facility Ratings and Shunt Elements

The legal owners of transmission facilities (TFOs) in the area provided the facility ratings for the existing transmission lines in the vicinity of the Study Area. The ratings of the key transmission lines are shown in Table 2-6 and the ratings of key transformers are shown in Table 2-7.

Table 2-6: Key Transmission Circuits in the vicinity of the Study Area

Line ID	Line Description	Voltage Class (kV)	Seasonal Continuous Rating (MVA)		Short-term Emergency Rating (MVA)	
			Summer	Winter	Summer	Winter
1055L	Petrolia-Argyll	240	419	517	503	620
1056L	Ellerslie 89S-Argyll	240	419	517	503	620
1058L	Summerside-Lambton	240	578	711	694	853
1139L*	Petrolia-Approved Harry Smith 367S	240	831	831	831	831
1043L	Approved Harry Smith 367S-Keephills 320P	240	989	1225	1187	1470
1044L	Petrolia-Jasper	240	481	581	577	697
1045L	Jasper-Sundance 310P	240	481	581	577	697
930L	Poundmaker-Jasper	240	481	581	577	697
1098L	Jasper-Poundmaker	240	481	581	577	697

*1139L is currently named the 1043L. It will be named the 1139L after the approved Harry Smith 367S substation is in service.

Table 2-7: Summary of Key Transformer Ratings in the Study Area

Substation Name and Number	Transformer ID	Transformer Voltages (kV)	Rating (MVA)
Heartland 12S	T1	500/240	1200
Ellerslie 89S	T1	500/240	1200
Ellerslie 89S	T2	500/240	1200

Table 2-8 below provides summary of shunt elements in the Study Area.

Table 2-8: Summary of Shunt Elements in the Study Area

Substation Name and Number*	Voltage Class (kV)	Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)
East Edmonton 38S	138	2 x 48.91 MVAr	97.82
Leduc 325S	138	1 x 30 MVAr	30.0

Substation Name and Number*	Voltage Class (kV)	Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)
Nisku 149S	138	1 x 30 MVAr	30.0
Acheson 305S	138	1 x 24.46 MVAr	24.46
Jasper	240	1 x 105.31 MVAr	105.31
Rossdale	69	2 x 47.76	95.51
Cloverbar	69	1 x 31.57	31.57
Stelco Edmonton 133S	34.5	1 x 16.8 + 1 x 30 MVAr	46.8

2.7. Voltage Profile Assumptions

The AESO ID# 2010-007RS is used to establish the pre-contingency voltage profiles for key area busses prior to commencing any studies. Table 2-1 of the *Transmission Planning Criteria – Basis and Assumptions* applies for all the busses not included in the ID# 2010-007RS. These voltages will be utilized to set the voltage profile for the study base cases prior to power flow analysis. A list of operating voltages for the key busses in the Study Area is shown in Table 2-9.

Table 2-9: Bus Voltages of Key Substations in the Study Area

Substation	Nominal Voltage (kV)	Minimum Operating Limit (kV)	Desired Range (kV)	Maximum Operating Limit (kV)
Genesee 330P	500	518	525 – 540	550
	138	124	124 – 152	152
Lambton	240	240	245 – 254	255
East Edmonton 38S	240	240	240 – 253	255
	138	139	139 – 144	145
Jasper	240	240	245 – 254	255
Petrolia	240	240	245 – 254	255
Clover Bar	240	240	245 – 254	255

3. Study Methodology

The studies performed in this connection assessment were completed using PTI PSS/E version 33.

3.1. Connection Studies Carried Out

The studies to be carried out for this connection study are identified in Table 3-1.

Table 3-1: Summary of Studies Performed

Study Scenario		System Conditions	Power Flow	Voltage Stability
1	2018 WP pre-Project	Category A and Category B	X	-
2	2019 SP pre-Project	Category A and Category B	X	
3	2018 WP post-Project	Category A and Category B	X	X
4	2019 SP post-Project	Category A and Category B	X	-

3.2. Power Flow Analysis

Pre-Project and post-Project power flow studies were conducted to identify and compare study scenario thermal and voltage criteria violations as per the Reliability Criteria, and to identify any POD low voltage bus deviations that are outside the guidelines, shown in Table 2-1. The purpose of the power flow analysis is to quantify any violations in the Study Area, for both pre-Project and post-Project study scenarios. For the Category B power flow studies, the transformer taps and switched shunt reactive compensation devices such as shunt capacitors and reactors were locked and continuous shunt devices were enabled.

POD low voltage bus deviations were assessed by both the pre-Project and post-Project networks by first locking all tap changers and area capacitors to identify any post-transient voltage deviations above 10%. Second, tap changers were then allowed to adjust, while shunt reactive compensating devices capacitors remained locked; to determine if any voltage deviations above 7% would occur in the area. Third, all taps and shunt reactive compensating devices were adjusted and voltage deviations above 5% would be reported.

3.2.1. Contingencies Studied

The power flow studies included the Category A and all Category B contingencies (240 kV facilities only) within the Study Area.

3.3. Voltage Stability Studies

The objective of the voltage stability studies is to determine the ability of the transmission system to maintain voltage stability at all busses in the system under Category A and 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 are reported to the collapse point.

For load connection projects, the load level modelled in post-Project scenarios are the same or higher than in pre-connection scenarios. Therefore, voltage stability studies for pre-Project scenarios would only be performed if the post-Project scenarios show voltage stability criteria violations.

The voltage stability analysis was 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 is required for the area modelled at a minimum of 105% of the reference load level for Category A and Category B conditions. For this standard, the reference load level is the maximum established planned load.

Typically, voltage stability analysis is carried out assuming worst case loading scenarios. For the Project's worst case scenario, load was increased in Edmonton (Area 60) and the corresponding generation was increased in Fort McMurray (Area 25).

3.3.1. Contingencies Studied

The voltage stability studies were performed for the Category A condition and all Category B contingencies (240 kV facilities only) in the Study Area for the 2018 WP post-Project scenario.

4. Results of Pre-Project Studies

4.1. Pre-Project Power Flow Studies

This section provides the results of the pre-Project power flow studies. The pre-Project power flow diagrams are provided in Attachment A.

4.1.1. Scenario 1 (2018 WP pre-Project)

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

No Reliability Criteria violations were observed under Category B conditions.

4.1.2. Scenario 2 (2019 SP pre-Project)

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

No Reliability Criteria violations were observed under Category B conditions.

5. Connection Alternatives

5.1. Overview

The DFO informed the AESO that it intends to request system access service to address capacity and reliability concerns on its 25 kV distribution system in southeast (SE) Edmonton in the near future.[5] For the sake of transmission system planning efficiency, given the proximity of the 25 kV distribution system in SW Edmonton to SE Edmonton, six transmission alternatives were examined that address the current request for system access service, as well as the DFO's SE Edmonton capacity and reliability concerns.

The AESO examined these six transmission alternatives in consultation with the DFO and the legal owners of transmission facilities (TFOs) that own facilities in the area.

5.2. Transmission Alternatives Identified

Alternative 1: Upgrade the existing Petrolia substation and add a new POD substation in SE Edmonton

Alternative 1 involves the following transmission development:

- upgrading the existing Petrolia substation including adding two 240/25 kV transformers, two 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment; and
- adding a new POD substation in SE Edmonton, including adding two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment and connection the new POD to the AIES

The DFO has advised that Alternative 1 would also require the addition of ten new 25 kV distribution circuits, with a total length of approximately 97 km.

Alternative 2: Upgrade the existing Jasper substation and add a new POD substation in SE Edmonton

Alternative 2 involves the following transmission development:

- upgrading the existing Jasper substation including adding two 240/25 kV transformers, two 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment; and
- adding a new POD substation in SE Edmonton, including adding two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment and connecting the new POD to the AIES.

The DFO has advised that Alternative 2 would also require the addition of ten new 25 kV distribution circuits, with a total length of approximately 162 km.

[5] See the EPCOR Distribution & Transmission Inc. *Distribution Deficiency Report (DDR) for Riverview Service Area,* which is attached under a separate cover.

Alternative 3: Upgrade the existing Summerside and Poundmaker substations and a new POD substation in SE Edmonton

Alternative 3 involves the following transmission development:

- upgrading the existing Summerside substation including adding one 240/25 kV transformer, one 240 kV circuit breaker, and four 25 kV feeder circuit breakers and associated equipment;
- upgrading the existing Poundmaker substation including adding one 240/25 kV transformer, one 240 kV circuit breaker, and four 25 kV feeder circuit breakers and associated equipment; and
- adding a new POD substation in SE Edmonton, including two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment and connecting it to the AIES.

The DFO has advised that Alternative 3 would also require the addition of ten new 25 kV distribution circuits, with a total length of approximately 97 km.

Alternative 4: Add a new POD substation in SW Edmonton, to be called the Riverview substation, and upgrades to the existing Summerside substation

Alternative 4 involves the following transmission developments:

- adding a new POD substation in SW Edmonton, to be called the Riverview substation, including two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment;
- connecting the proposed Riverview substation to the existing 240 kV transmission line 1043L (future 1139L) using an in-and-out configuration, between the approved Harry Smith 367S substation and the Petrolia substation, by adding two new 240 kV transmission circuits, each approximately 70 metres in length; and
- upgrading the existing Summerside substation, including adding one 240/25 kV transformer, one 240 kV circuit breaker, and four 25 kV feeder circuit breakers and associated equipment.

The DFO has advised that Alternative 4 would also require the addition of ten new 25 kV distribution circuits, with a total length of approximately 72 km.

Alternative 5: Add the proposed Riverview substation and add a new POD substation in SE Edmonton

Alternative 5 involves the following transmission development:

- adding the proposed Riverview substation, including two 240/25 kV transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment;
- connecting the proposed Riverview substation to the existing 240 kV transmission line 1043L (future 1139L) using an in-and-out configuration, between the approved

Harry Smith 367S substation and the Petrolia substation, by adding two new 240 kV transmission circuits, each approximately 70 metres in length; and

- adding a new POD substation in SE Edmonton, including two 240/25 kV transformers, four 240 kV circuit breakers and eight 25 kV feeder circuit breakers and associated equipment and connecting it to the AIES.

The DFO has advised that Alternative 5 would also require the addition of ten new 25 kV distribution circuits, with a total length of approximately 59 km.

Alternative 6: Upgrade the existing Summerside and the Poundmaker substations

Alternative 6 involves the following transmission developments:

- upgrading the existing Summerside substation, including replacing the two existing 240/25 kV transformers with two 240/25 kV transformers of higher capacity and adding a third 240/25 kV transformer, one 240 kV circuit breaker, and eighteen 25 kV feeder circuit breakers and associated equipment; and
- upgrading the existing Poundmaker substation, including adding one 240/25 kV transformer, one 240 kV circuit breaker, and four 25 kV feeder circuit breakers and associated equipment.

The DFO has advised that Alternative 6 would also require the addition of ten new 25 kV distribution circuits, with a total length of approximately 110 km.

5.2.1. Transmission Alternatives Not Selected for Further Examination

Alternative 1 and Alternative 2 were not selected for further study because the TFO advised that expansion of the Petrolia and Jasper substations is not viable, as explained further below.

The TFO has advised that Alternative 1 is not acceptable from an environmental and a stakeholder impact perspective. From an environmental perspective, the TFO advised that there was a spill on the Petrolia substation site in the early 1980s, which the TFO may not be able to manage if transmission facilities are added to the substation. The TFO has also advised that expanding the Petrolia substation would have an adverse impact to local residents, specifically because the expanded substation site would encroach on an existing community park and baseball diamond. As a result, Alternative 1 was not selected for further study.

Alternative 2 was not selected for further studies because the TFO has advised that there is insufficient space within and around the Jasper substation to accommodate the addition of the required transmission facilities. As a result, Alternative 2 was not selected for further study.

Alternative 3 and Alternative 6 were not selected for further study because the total combined costs of the distribution and transmission developments were estimated to be higher than the total combined costs of the distribution and transmission developments associated with Alternative 4 and Alternative 5.[6]

[6] Cost estimates for Alternative 3, Alternative 4, Alternative 5, and Alternative 6 are provided under a separate cover.

5.2.2. Transmission Alternatives Selected for Further Examination

Alternative 4 and Alternative 5 were both considered technically feasible and were selected for further study. Both Alternative 4 and Alternative 5 involve adding the proposed Riverview substation to address the DFO's request for system access service.

Alternative 4 and Alternative 5 include different transmission facilities[7] to address the capacity and reliability concerns in SE Edmonton, which the DFO has indicated will be the subject of a forthcoming request for system access service. Therefore, the selection of the preferred transmission development to address the DFO's capacity and reliability concerns in SE Edmonton will be assessed as a part of a separate project, and is not within the scope of this study.

For the purpose of responding to the DFO's current request for system access service, Alternative 4 and Alternative 5 are equivalent in scope; both alternatives address the current request for system access service by adding a proposed Riverview substation in SW Edmonton and connecting it to the existing 240 kV transmission line 1043L (future 1139L) in an in-and-out configuration. Therefore, only this scope will be examined further in this report.

[7] Alternative 4 includes adding a new POD substation in SE Edmonton and Alternative 5 includes upgrading the existing Summerside substation.

6. Results of Post-Project Studies

This section provides the results of the post-Project power flow and voltage stability, which includes the proposed Riverview substation with a Rate DTS request of 24 MW.

6.1. Post-Project Power Flow Studies

This section provides the results of the post-Project power flow studies. The post-Project power flow diagrams are provided in Attachment B.

6.1.1. Scenario 3 (2018 WP post-Project)

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

No Reliability Criteria violations were observed under Category B conditions.

6.1.2. Scenario 4 (2019 SP post-Project)

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

No Reliability Criteria violations were observed under Category B conditions.

6.2. Post-Project Voltage Stability Studies

Voltage stability analysis was performed for the 2018 WP post-Project scenario. The minimum incremental load transfer for the Category B conditions is 5.0% of the reference load or 105.7 MW to meet the voltage stability criteria. The table below summarizes the voltage stability study results for Category A and Category B conditions. The voltage stability diagrams are provided in Attachment C.

The voltage stability margin is met for all studied conditions.

Table 6-1: Voltage Stability Study Results for the 2018 WP post-Project Scenario

Contingency	From	To	Maximum incremental transfer (MW)	Meets 105% transfer criteria?
Category A			1153	Yes
908L	Ellerslie 89S	Petrolia	1152	Yes
1164L	Riverview	Petrolia	1148	Yes
1139L	Riverview	Harry Smith 367S	1147	Yes
1044L	Jasper	Petrolia	1152	Yes
1098L	Poundmaker	Jasper	1148	Yes

7. Project Dependencies

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

8. Conclusions and Recommendations

The connection assessment did not identify any pre-Project or post-Project system performance issues. The connection assessment indicates that the Project will not adversely impact the performance of the AIES. No mitigation measures are required as no Reliability Criteria violations were observed.

It is recommended to proceed with the Project by adding a new POD substation in SW Edmonton as the preferred option to respond to the DFO's request for system access service. This includes: adding a new substation, to be designated the Riverview substation, including two 240/25 kV LTC transformers, four 240 kV circuit breakers, and eight 25 kV feeder circuit breakers and associated equipment; and adding two 240 kV circuits, each approximately 70 metres in length, to connect the Riverview substation to the existing 240 kV transmission line 1043L (future 1139L) using an in-and-out configuration between the approved Harry Smith 367S substation and the existing Petrolia substation.

A minimum rating equal or greater than the rating of the existing 240 kV transmission line 1043L is recommended for the two new 240 kV circuits.

Transformer Sizing Recommendation

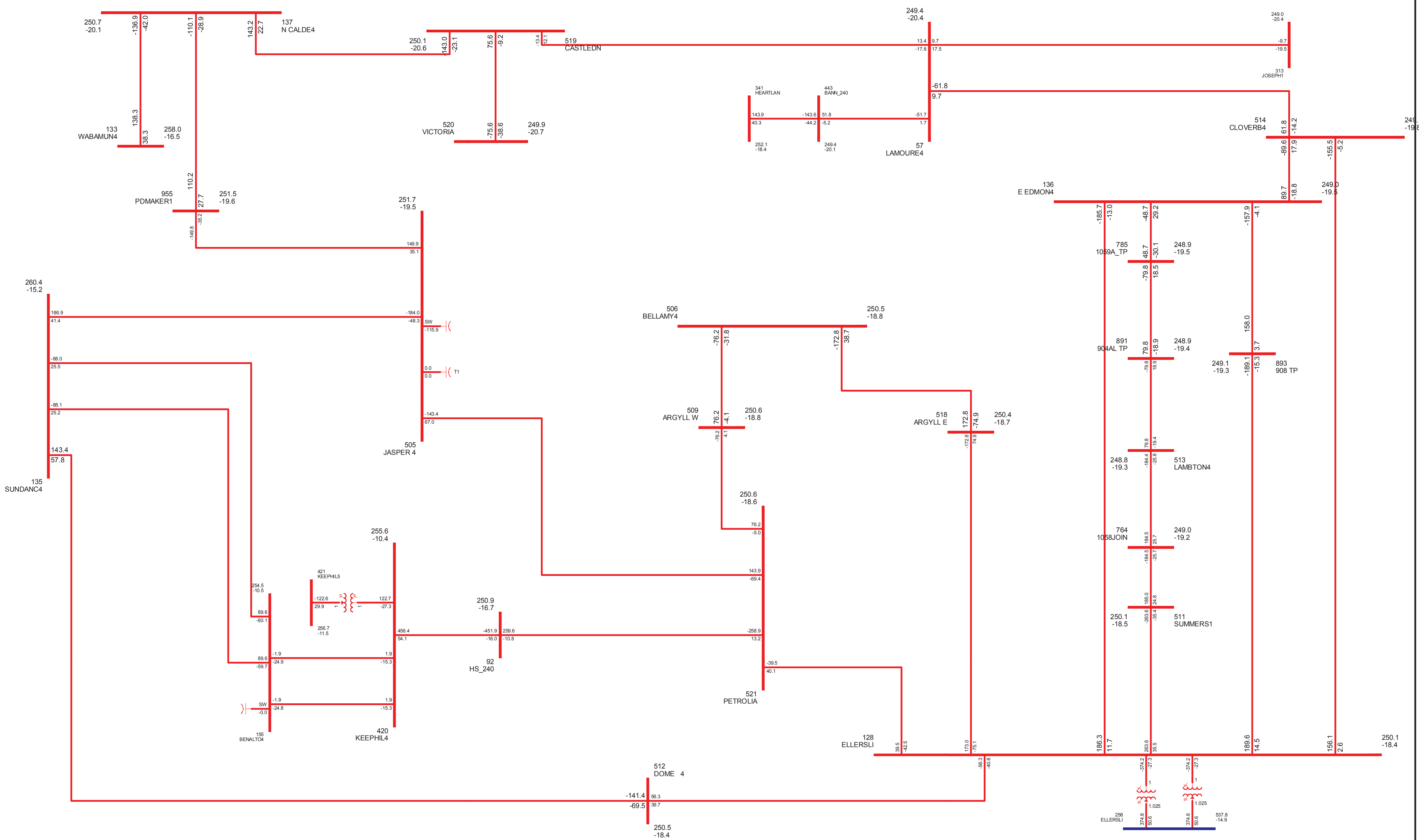
EDTI DFO has advised that it foresees a need for 6 feeders in SW Edmonton in the near term (within 10 years). EDTI DFO has also advised that provisions need to be made to eventually enable the connection of 8 feeders in the medium term at the Riverview substation. EDTI TFO has also advised that because it plans to install a 25 kV switchgear that will be gas-insulated (GIS), it is not practical to install 6 feeder breakers now and 2 additional feeder breakers in the future.

Since EDTI's transformers have an average life of 50 years, EDTI DFO has requested that, should the Riverview substation be chosen as the preferred alternative to address the Project need, provisions be made to enable the connection of 8 feeders in the medium term at the Riverview substation. EDTI DFO foresees that these feeders will eventually be loaded to their design load rating of 12 MVA each.

EDTI TFO has advised that it sizes transformers based on their ability to serve all substation load under an N-1 contingency of a transformer. For the proposed Riverview substation, that would mean that two transformers would be needed. Each transformer should be capable of serving all 8 feeders, given a diversity factor of 0.78 as per the EDTI DFO input; therefore based on the above information provided by EDTI, the AESO recommends that each transformer at the proposed Riverview substation have a rating of 75 MVA.

Attachment A

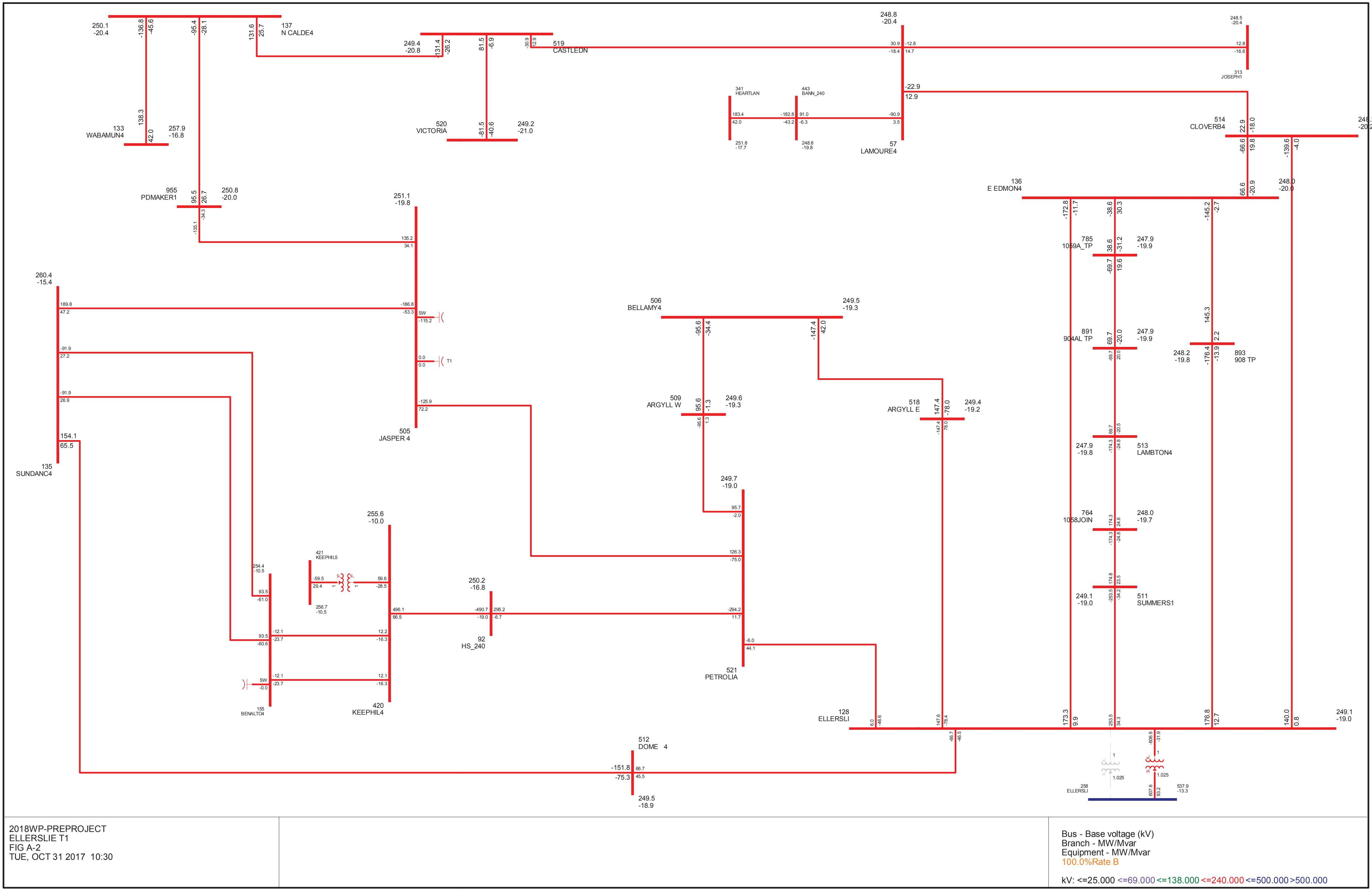
Power Flow Diagrams
2018 WP-2019SP Pre-Project

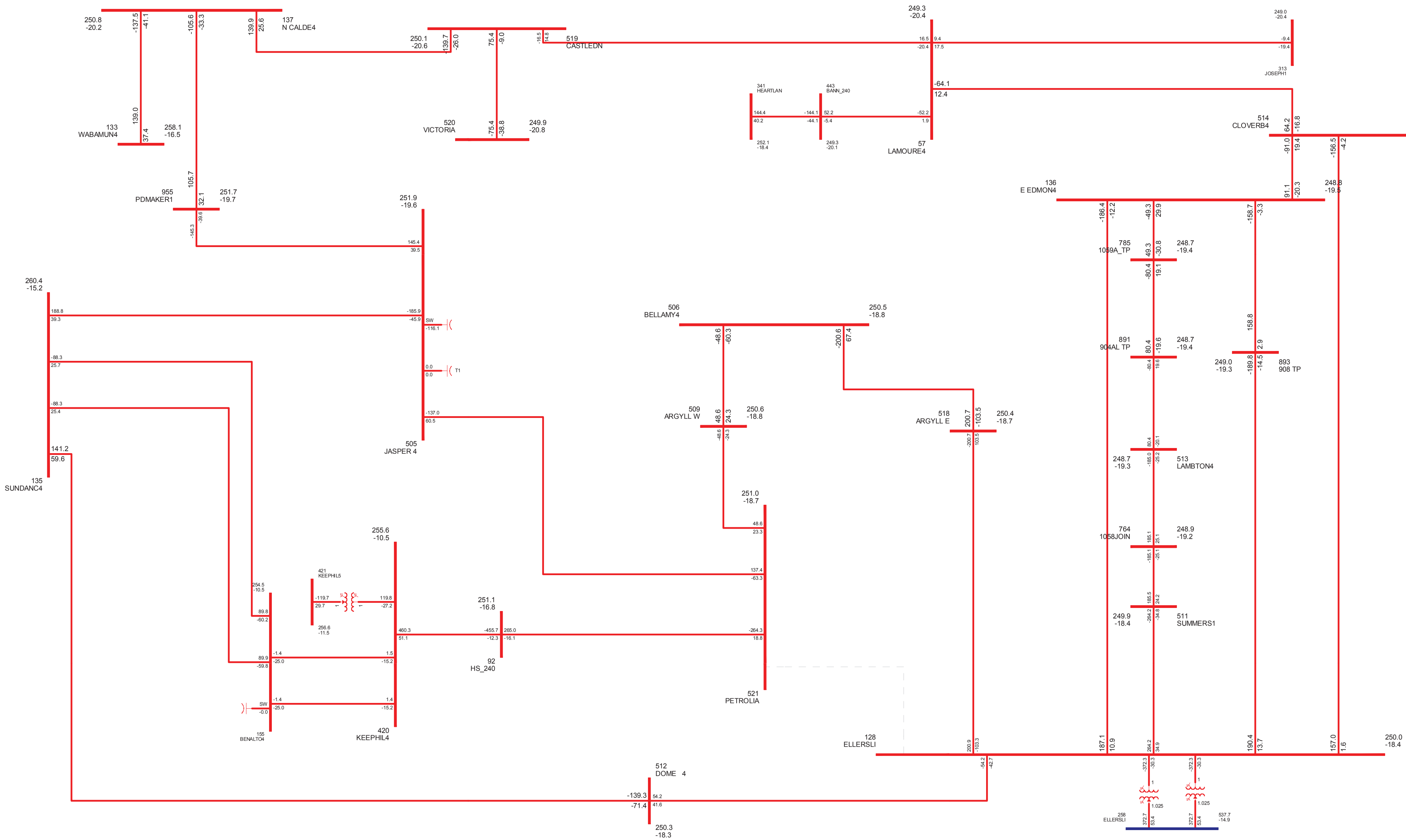


2018WP-PREPROJECT
BASE CASE
FIG A-1
TUE, OCT 31 2017 10:30

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

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

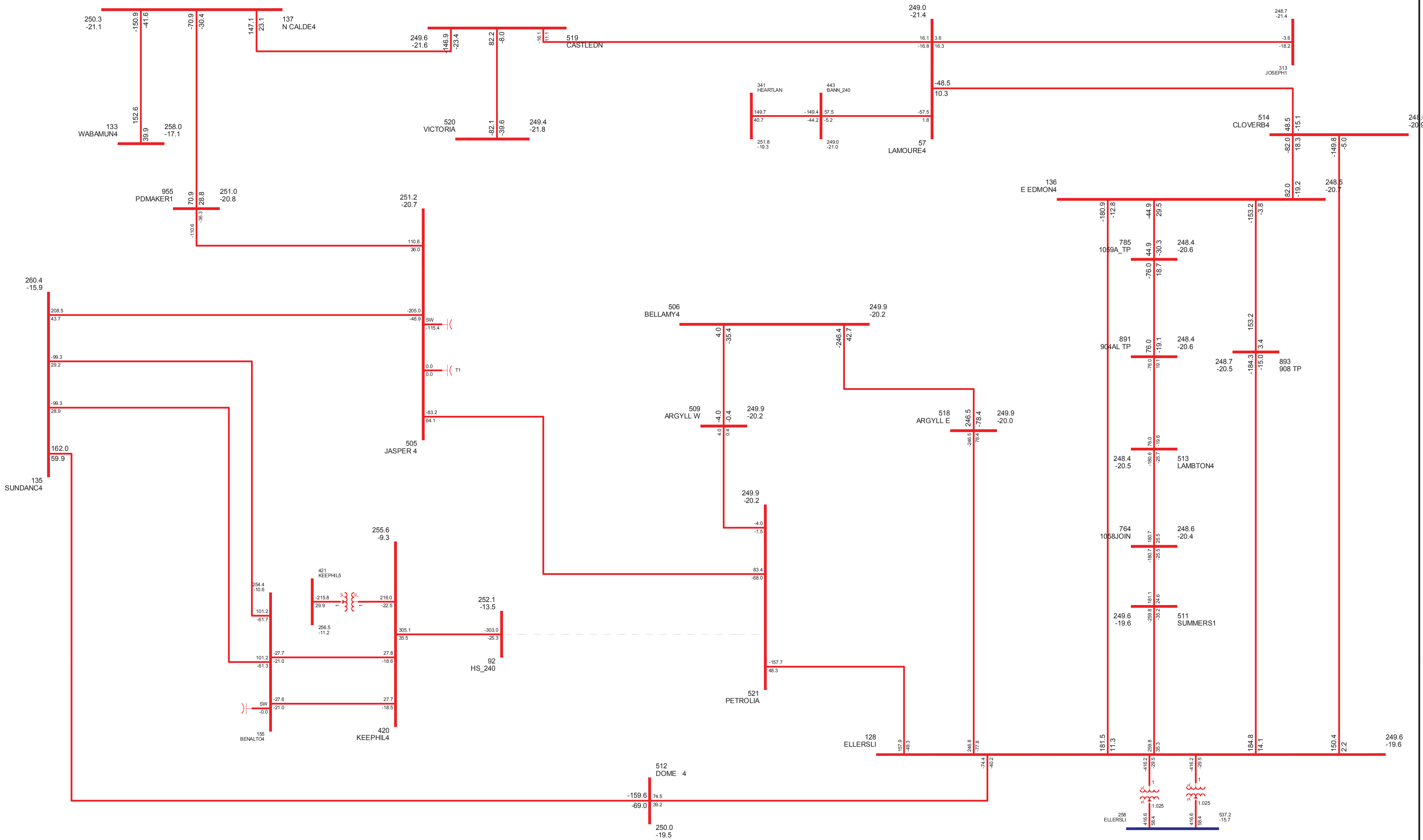

137 N CALDE4
133 WABAMUN4
955 PDMAKER1
519 CASTLEDN
520 VICTORIA
341 HEARTLAN
443 BANN_240
57 LAMOURE4
313 JOSEPH1
514 CLOVERB4
136 E EDMON4
785 1059A_TP
891 904AL TP
893 908 TP
513 LAMBTON4
764 1058JOIN
511 SUMMERS1
506 BELLAMY4
509 ARGYLL W
518 ARGYLL E
505 JASPER 4
135 SUNDANC4
421 KEEPHIL5
420 KEEPHIL4
155 BENALTO4
92 HS_240
521 PETROLIA
128 ELLERSLI
258 ELLERSLI
512 DOME 4
2018WP-PREPROJECT
ELLERSLIE T1
FIG A-2
TUE, OCT 31 2017 10:30
Bus - Base voltage (kV)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-PREPROJECT
908L (ELLERSLIE TO PETROLIA)
FIG A-3
TUE, OCT 31 2017 10:30

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

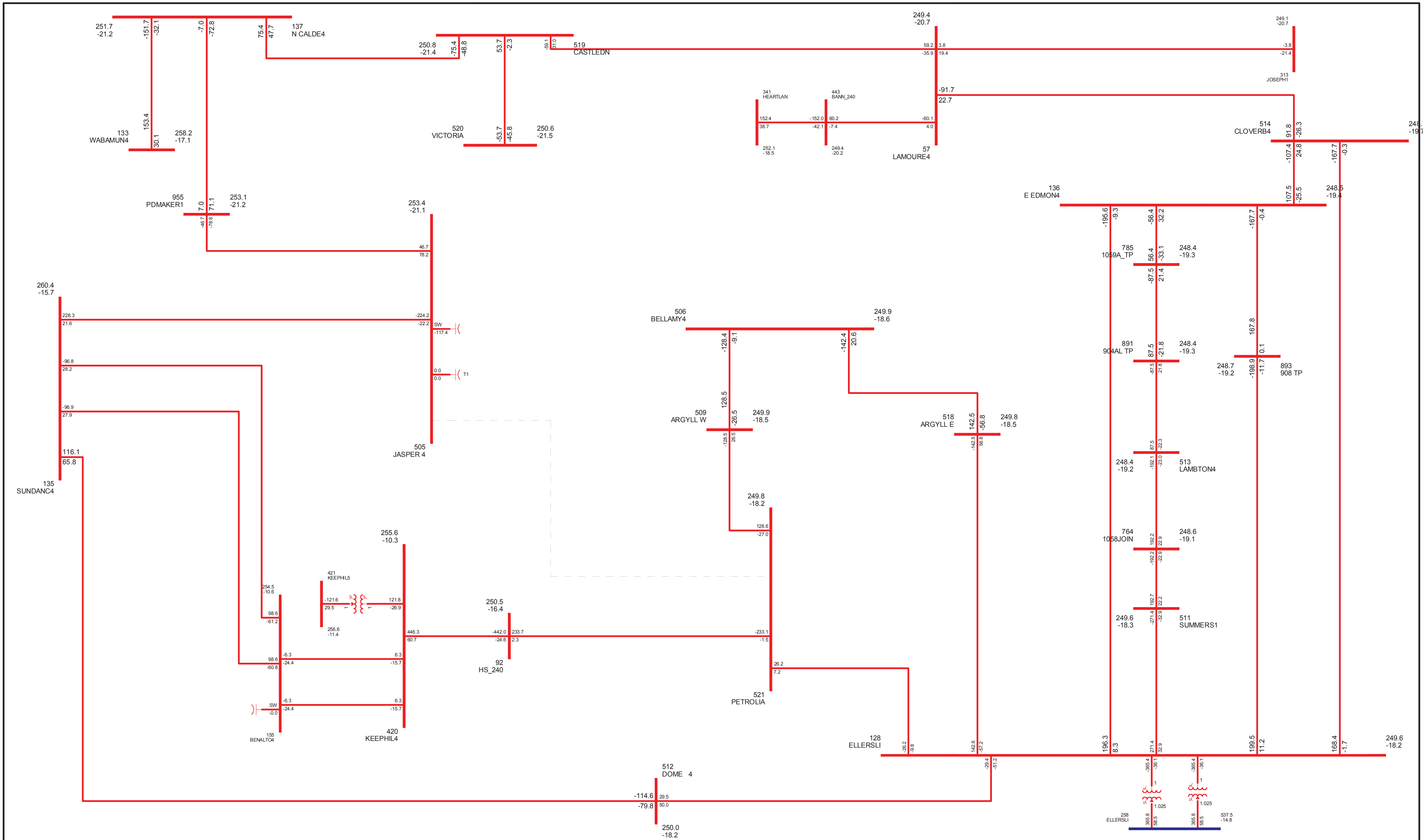
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-PREPROJECT
1139L (HARRY SMITH TO PETROLIA)
FIG A-4
TUE, OCT 31 2017 10:30

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

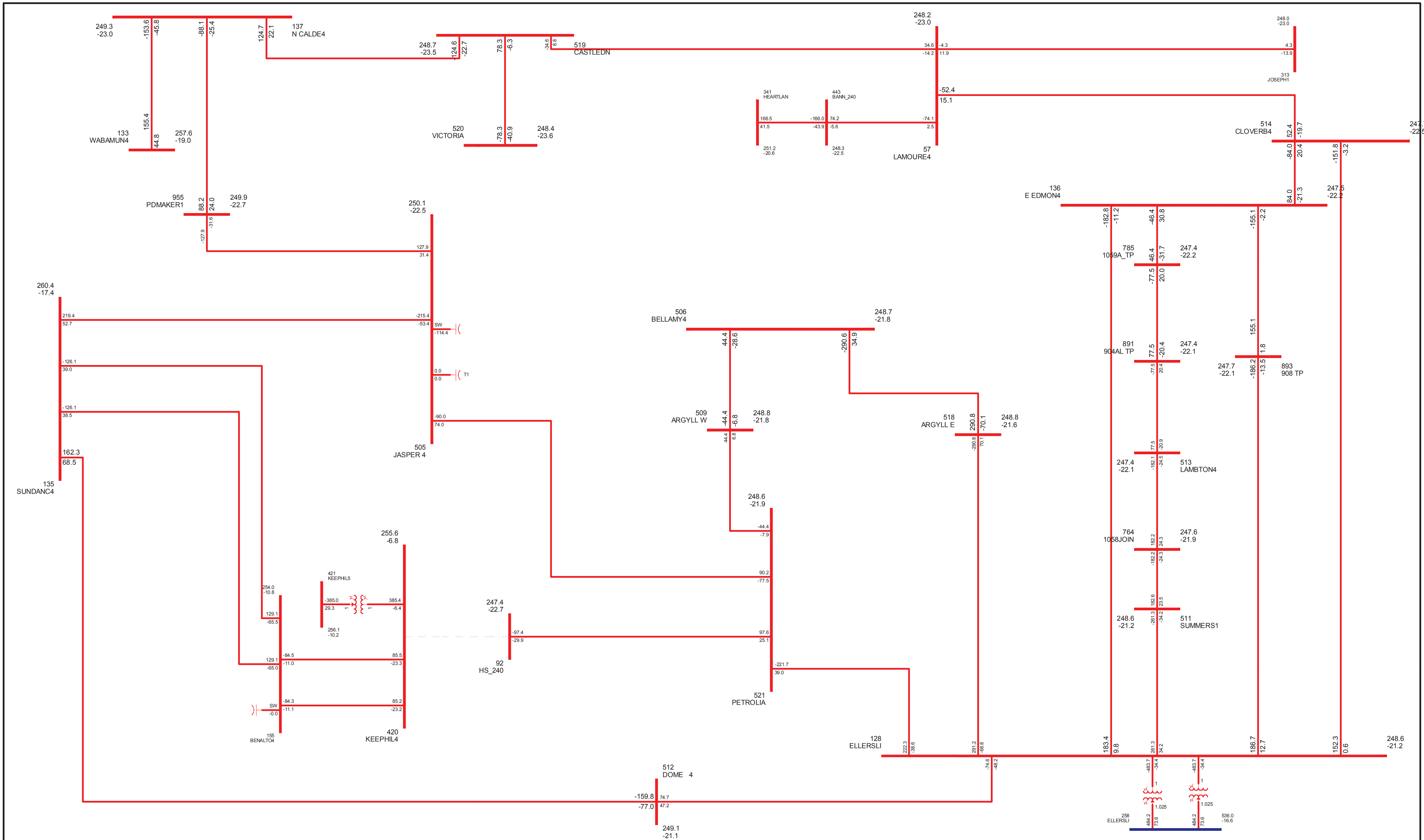
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-PREPROJECT
1044L (JASPER TO PETROLIA)
FIG A-5
TUE, OCT 31 2017 10:30

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

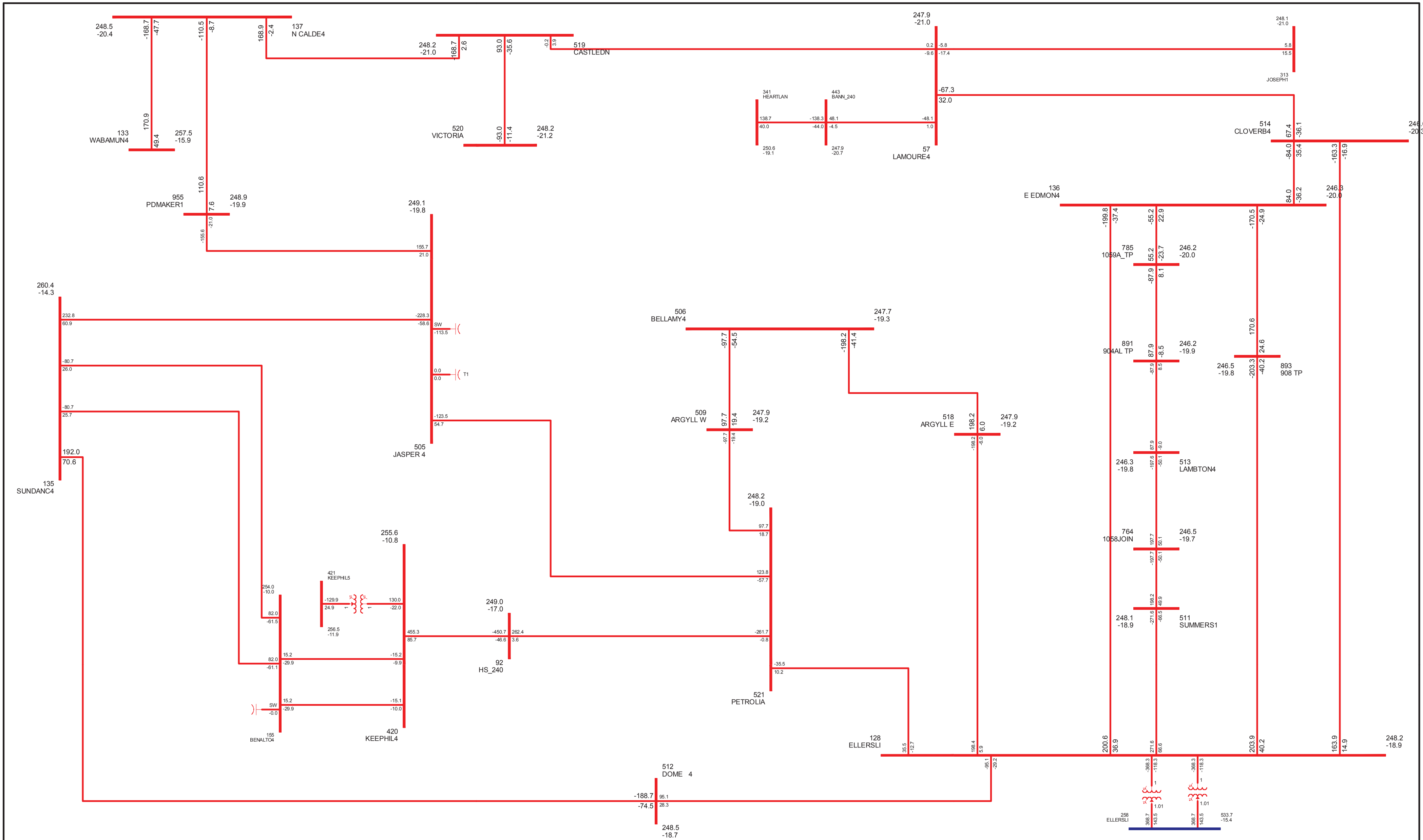
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-PREPROJECT
1043L (HARRY SMITH KEEPHILLS)
FIG A-6
TUE, OCT 31 2017 10:30

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

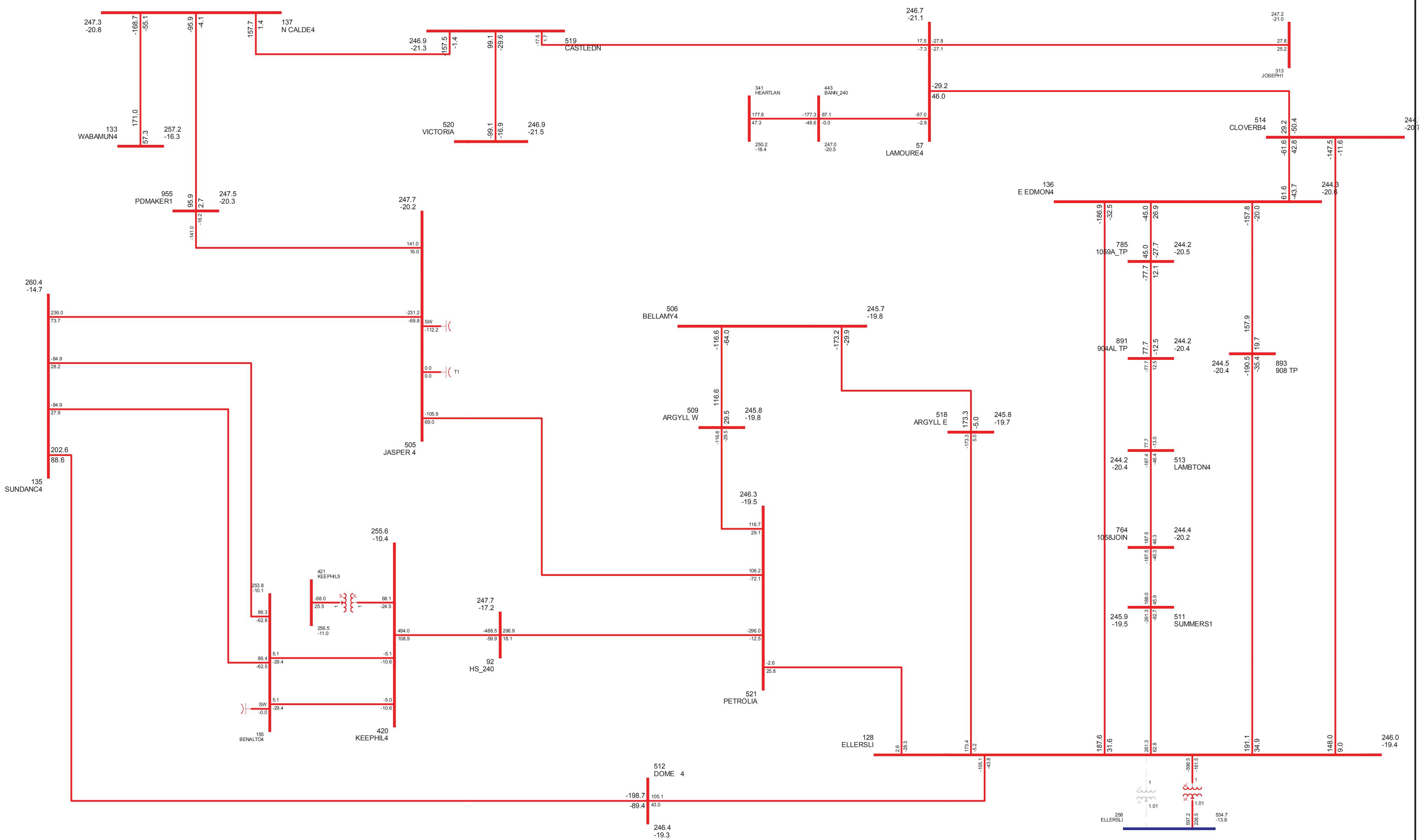
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-PREPROJECT
BASE CASE
FIG A-7
TUE, OCT 31 2017 10:30

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

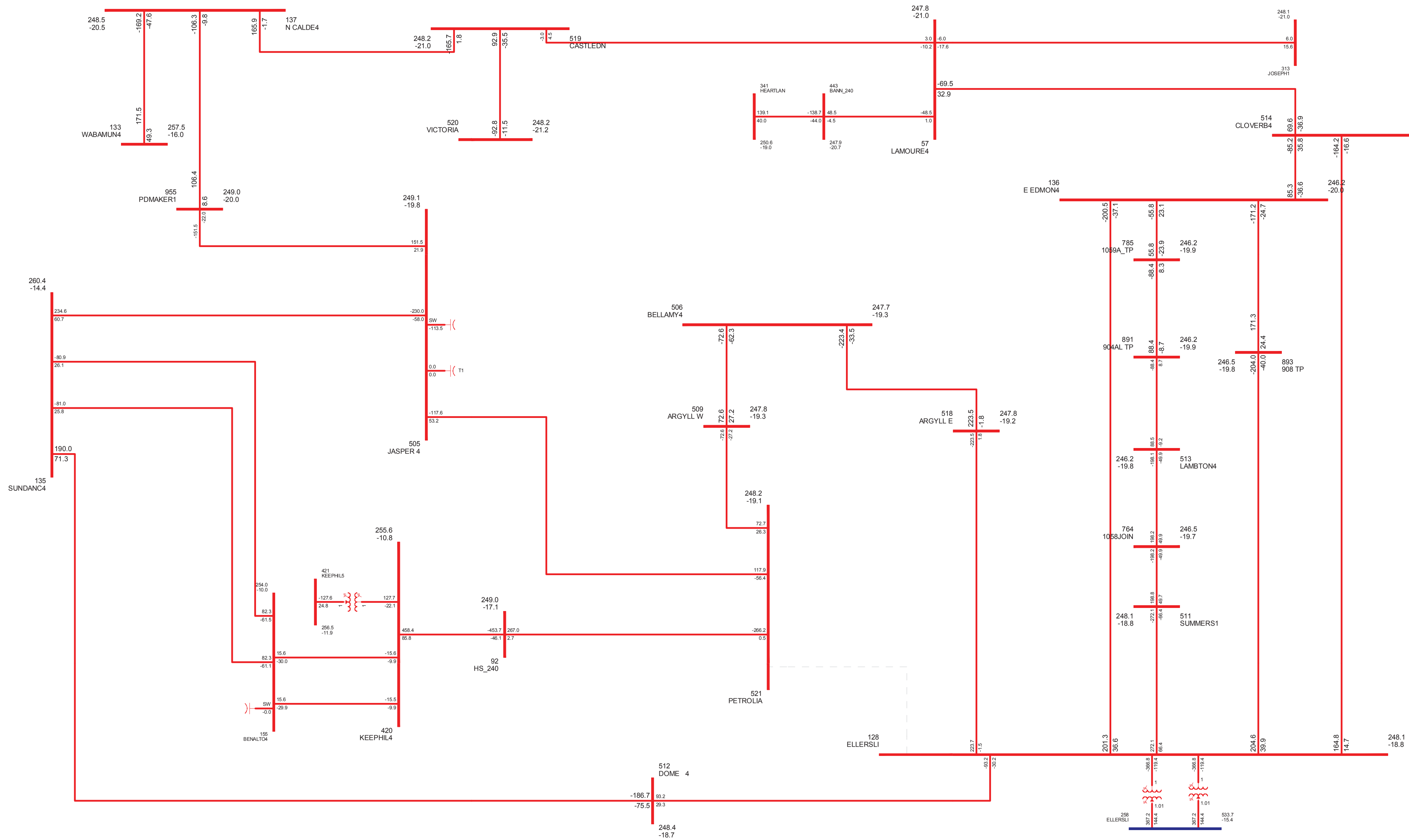
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-PREPROJECT
ELLERSLIE T1
FIG A-8
TUE, OCT 31 2017 10:31

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

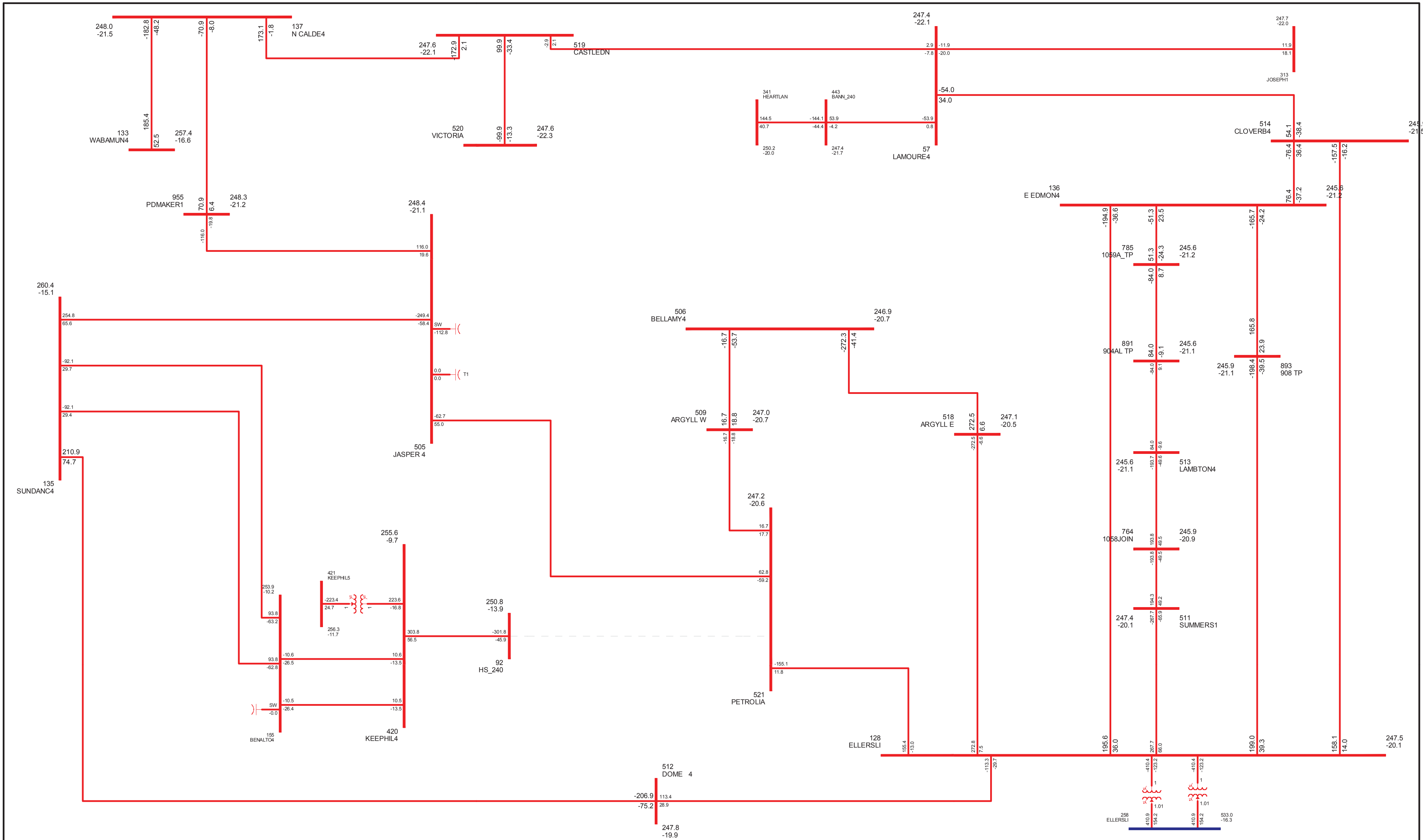
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-PREPROJECT
908L (ELLERSLIE TO PETROLIA)
FIG A-9
TUE, OCT 31 2017 10:31

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

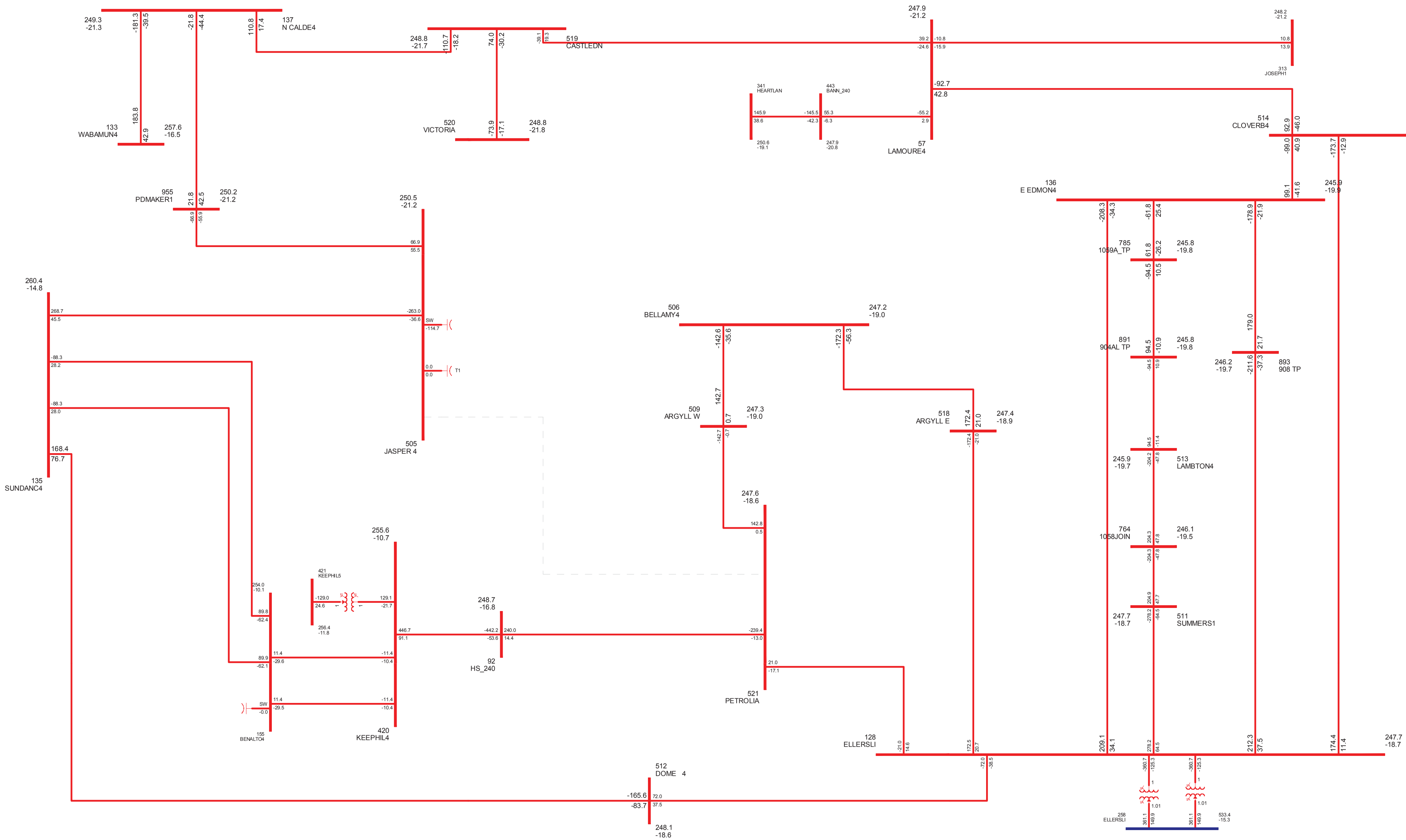
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-PREPROJECT
1139L (HARRY SMITH TO PETROLIA)
FIG A-10
TUE, OCT 31 2017 10:31

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

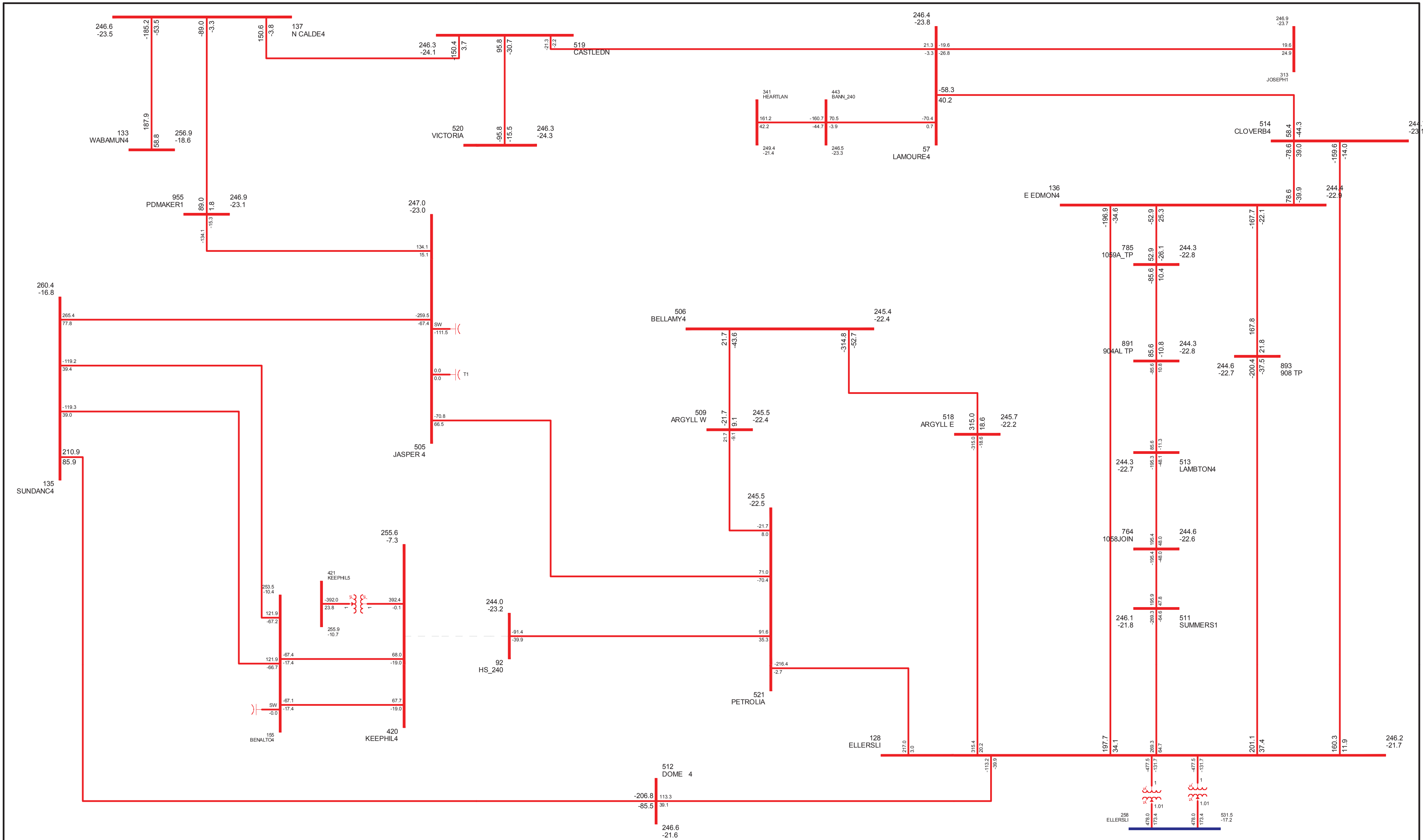
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-PREPROJECT
1044L (JASPER TO PETROLIA)
FIG A-11
TUE, OCT 31 2017 10:31

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

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



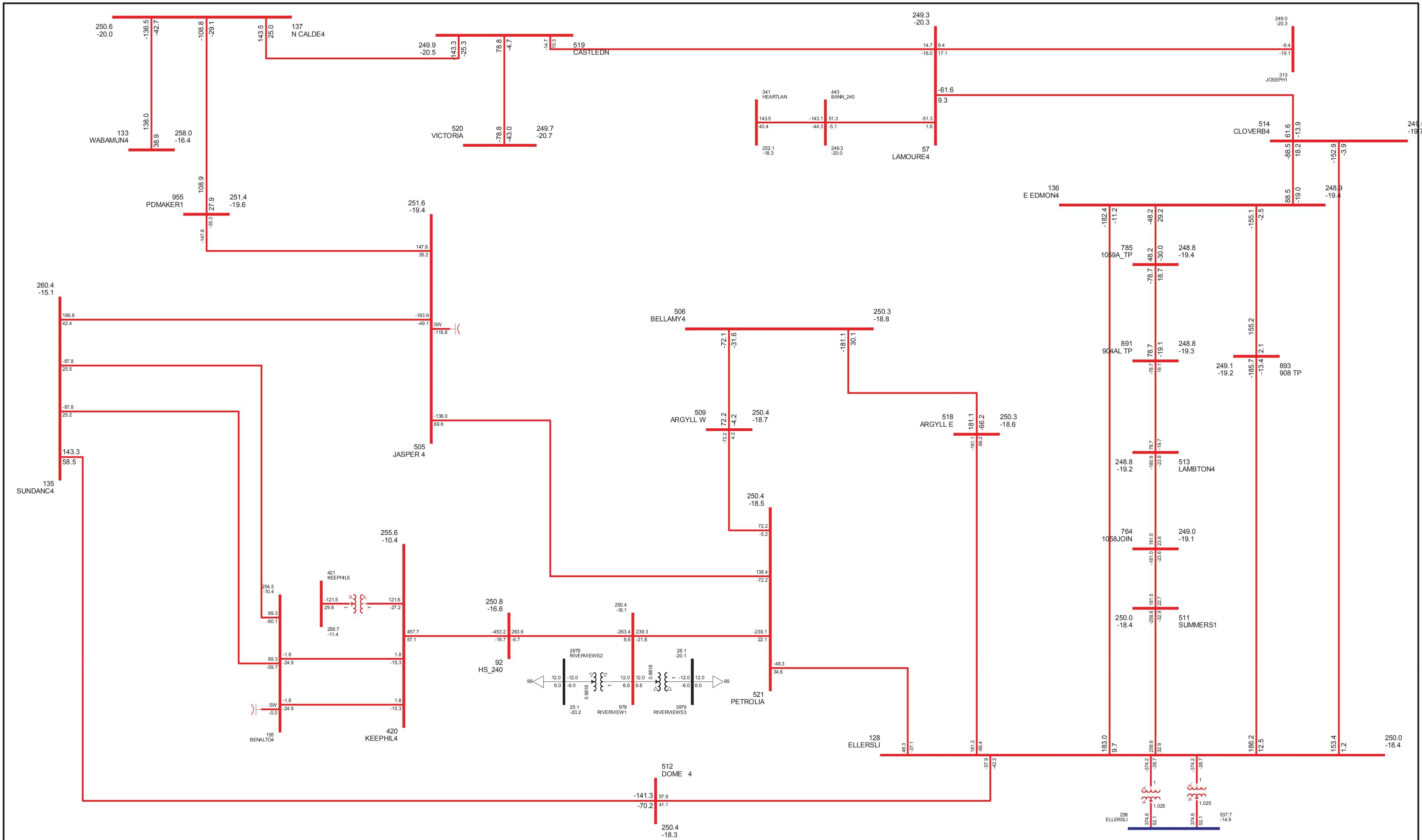
2019SP-PREPROJECT
1043L (HARRY SMITH KEEPHILLS)
FIG A-12
TUE, OCT 31 2017 10:31

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

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

Attachment B

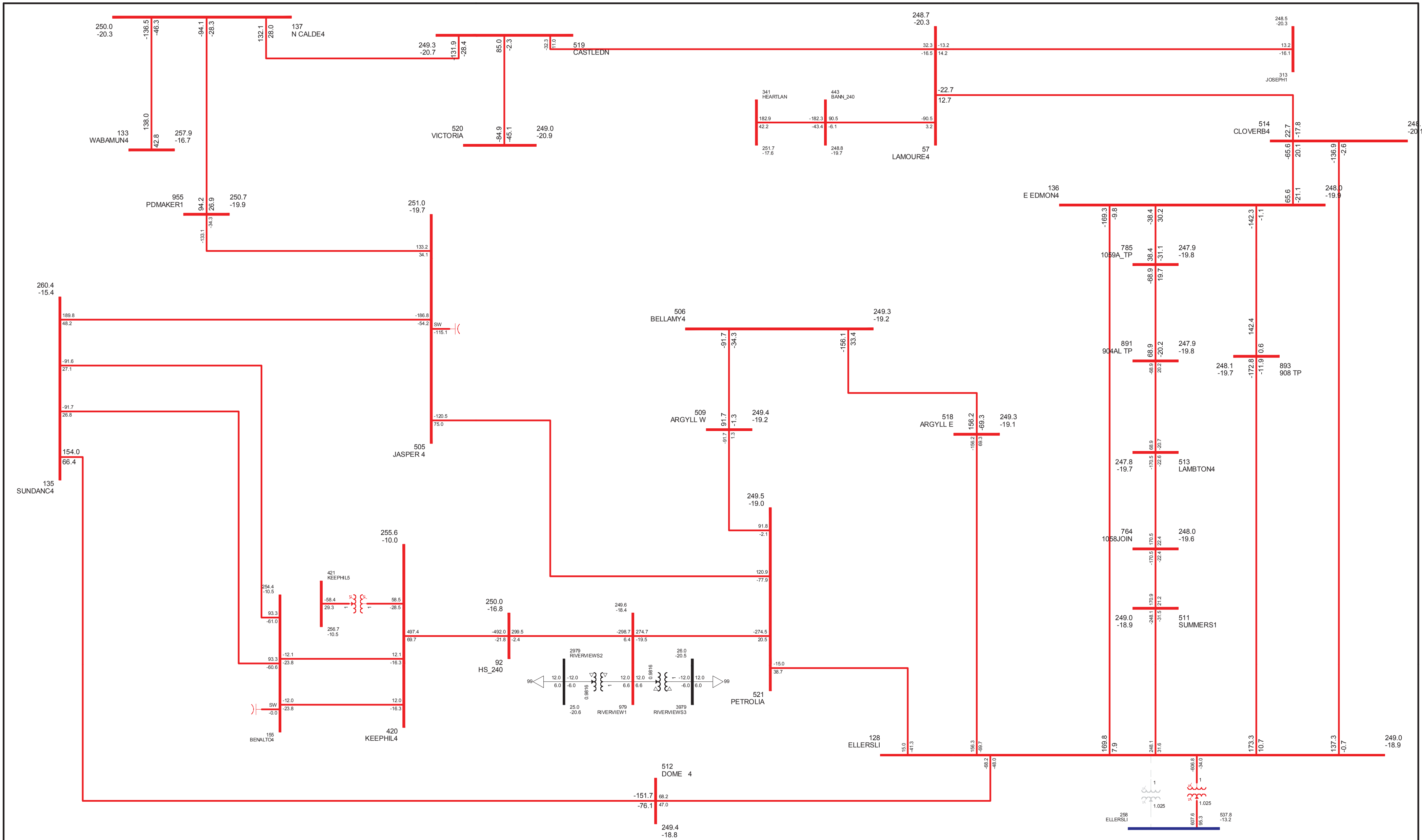
Power Flow Diagrams
2018 WP-2019SP Post-Project



2018WP-POSTPROJECT
BASE CASE
FIG B-1
TUE, OCT 31 2017 10:31

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

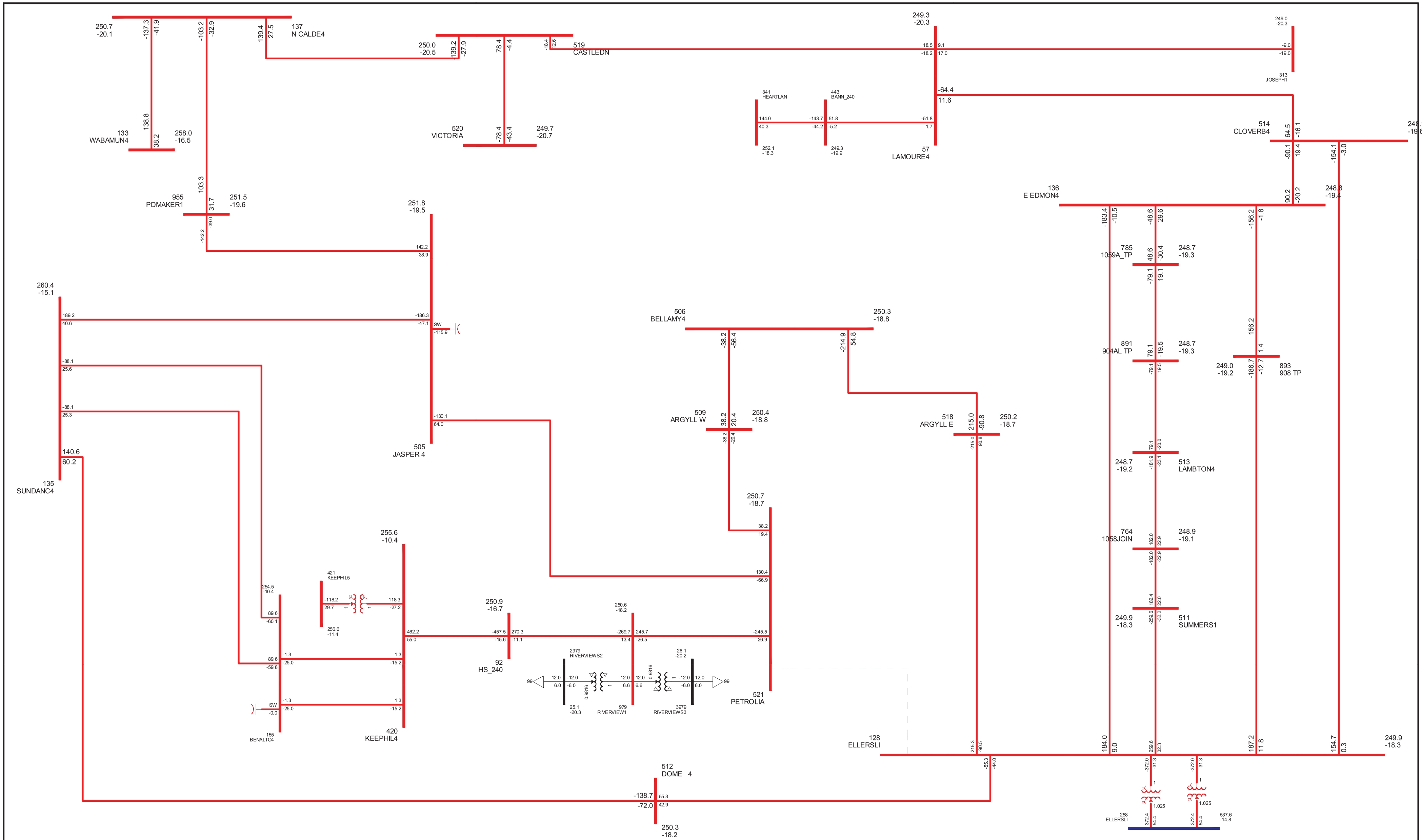
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-POSTPROJECT
ELLERSLIE T1
FIG B-2
TUE, OCT 31 2017 10:31

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

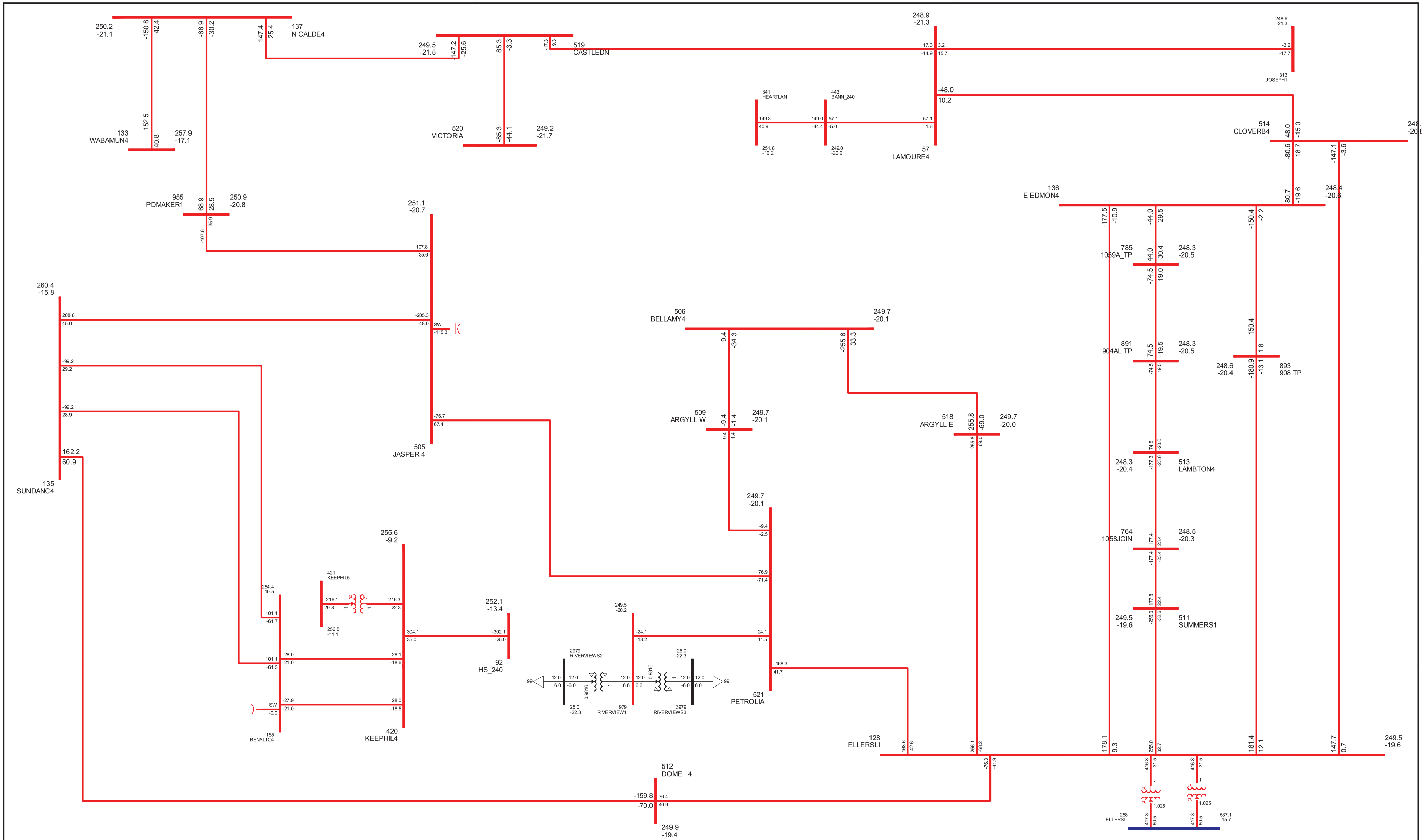
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-POSTPROJECT
908L (ELLERSLIE TO PETROLIA)
FIG B-3
TUE, OCT 31 2017 10:31

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

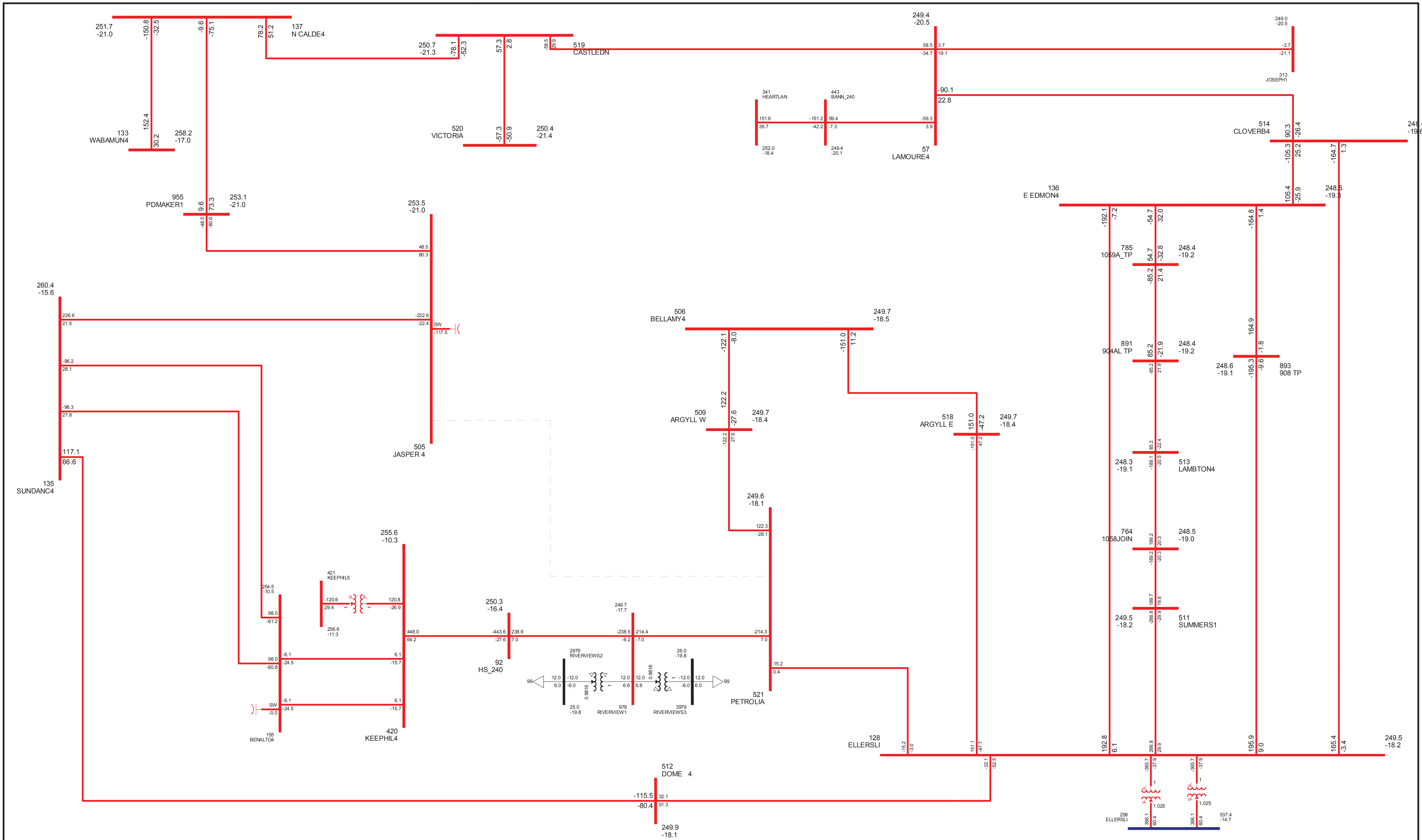
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-POSTPROJECT
1139L (HARRY SMITH TO RIVERVIEW)
FIG B-4
TUE, OCT 31 2017 10:31

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

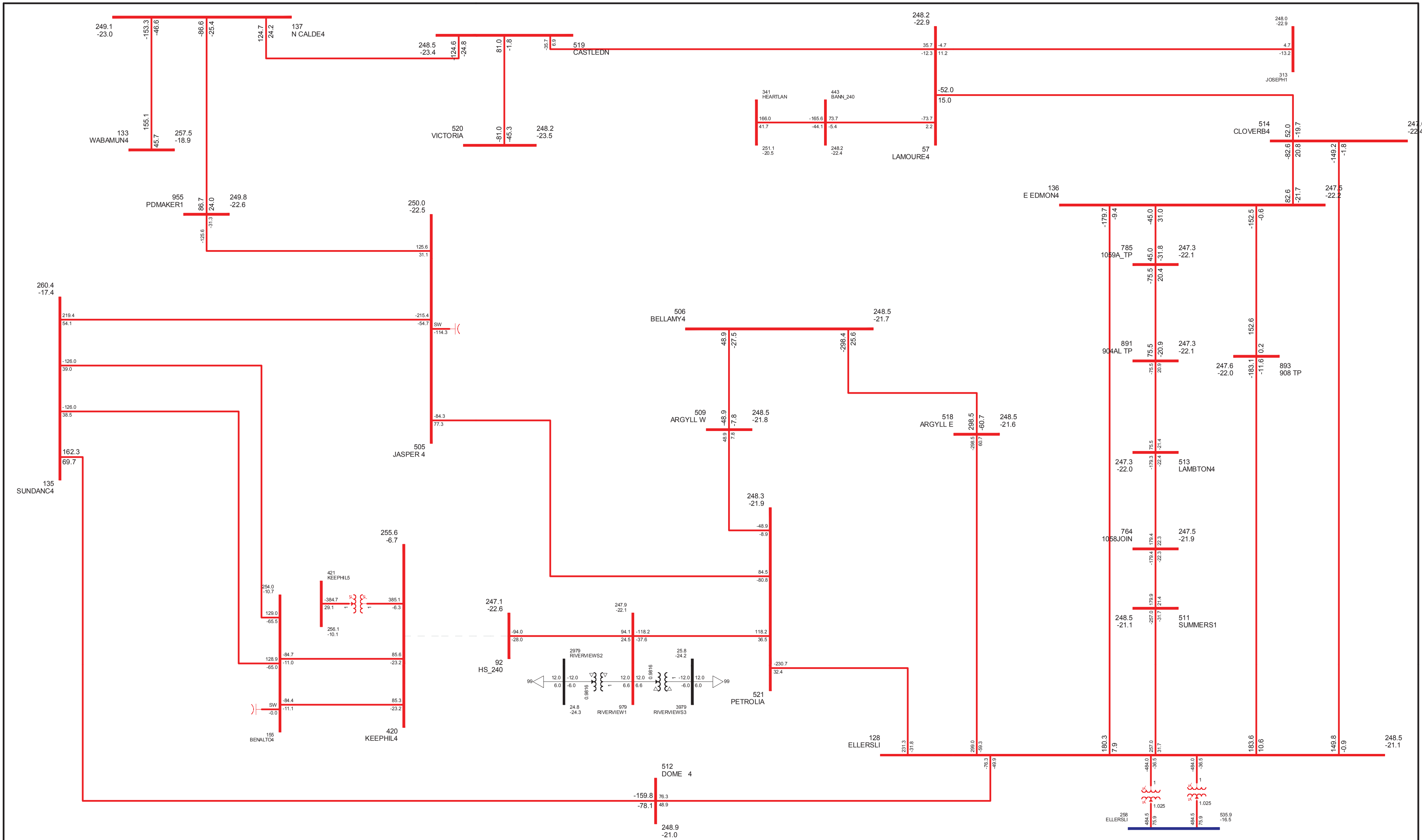
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-POSTPROJECT
1044L (JASPER TO PETROLIA)
FIG B-5
TUE, OCT 31 2017 10:31

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

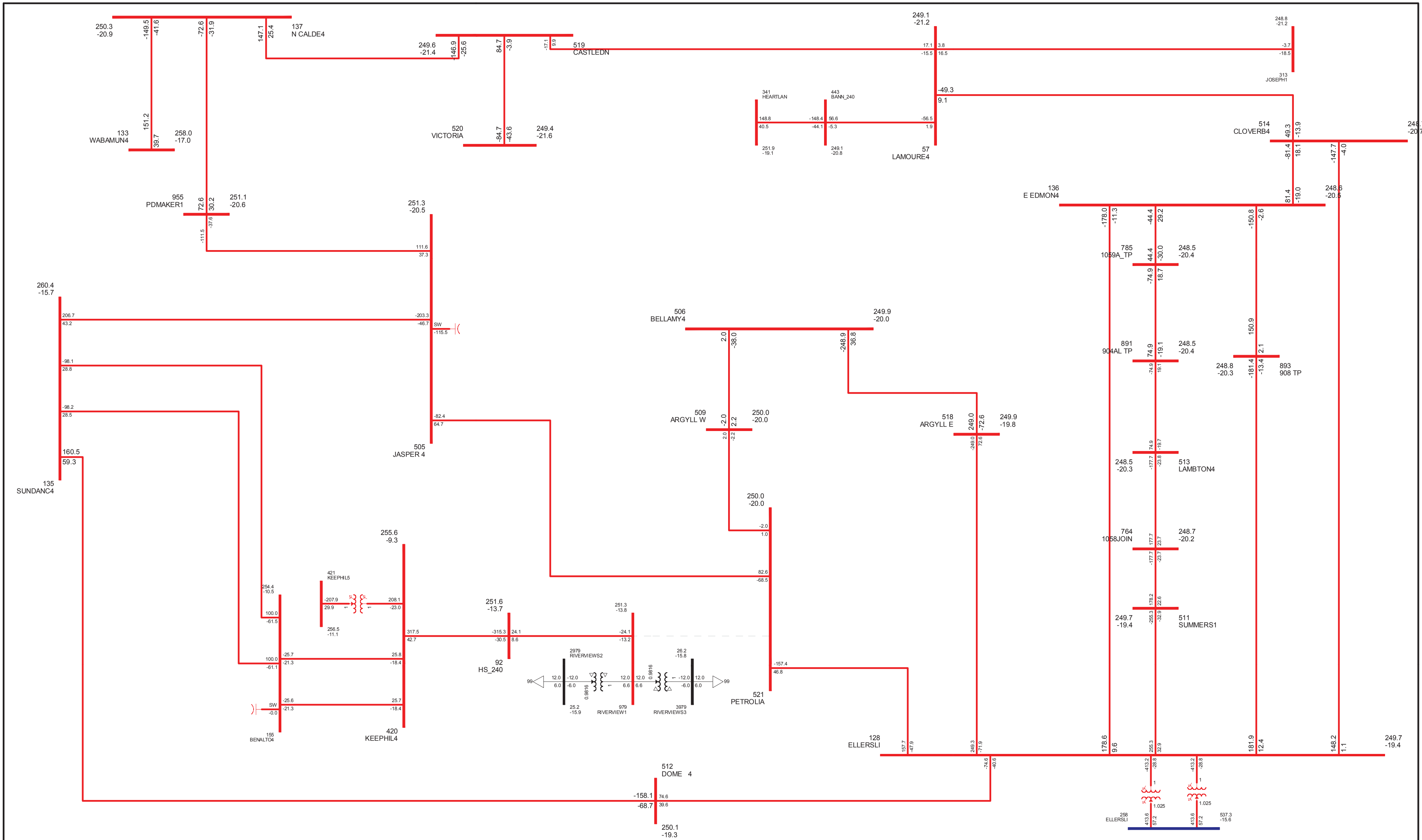
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-POSTPROJECT
1043L (HARRY SMITH KEEPHILLS)
FIG B-6
TUE, OCT 31 2017 10:31

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

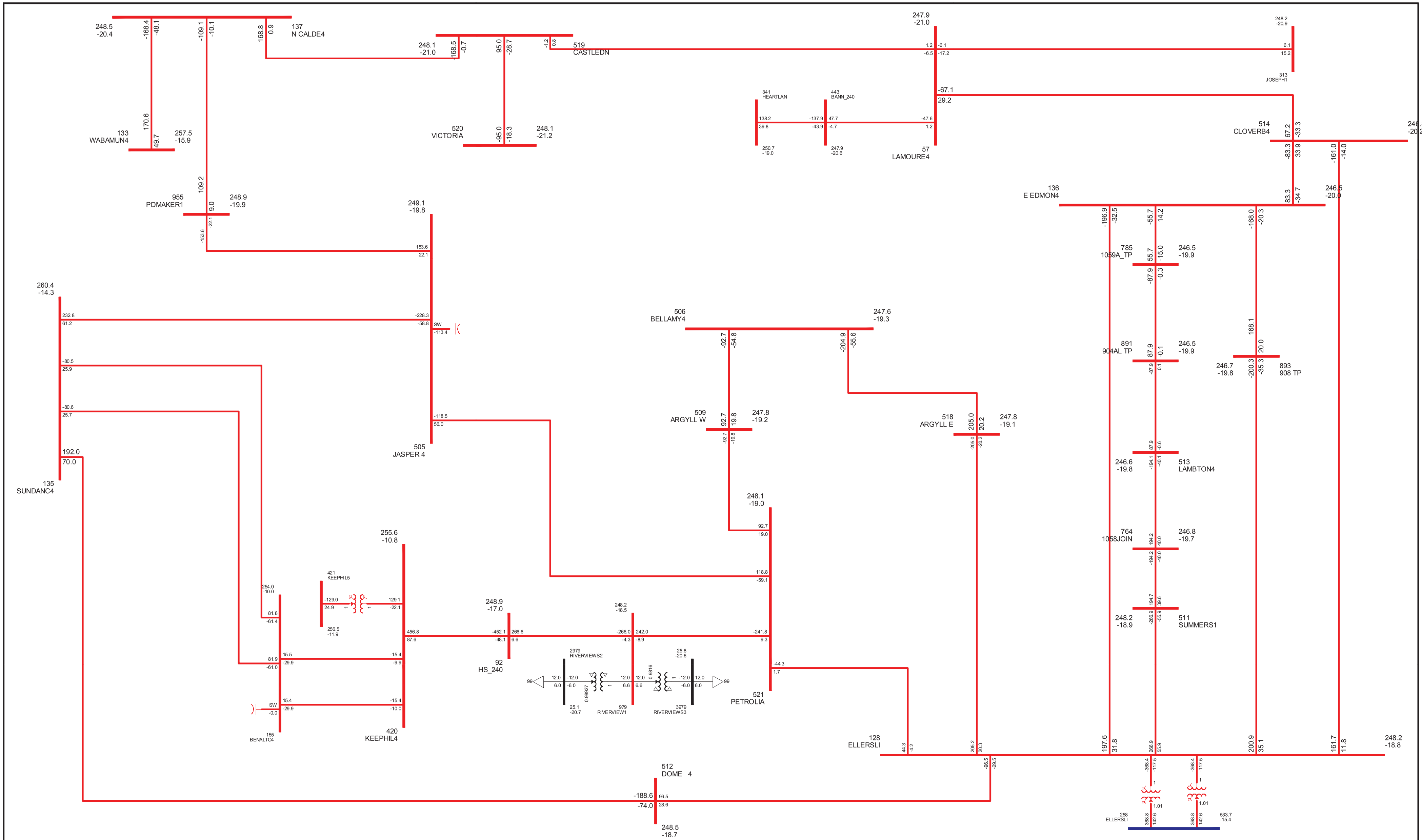
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2018WP-POSTPROJECT
1164L (PETROLIA TO RIVER VIEW)
FIG B-7
TUE, OCT 31 2017 10:31

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

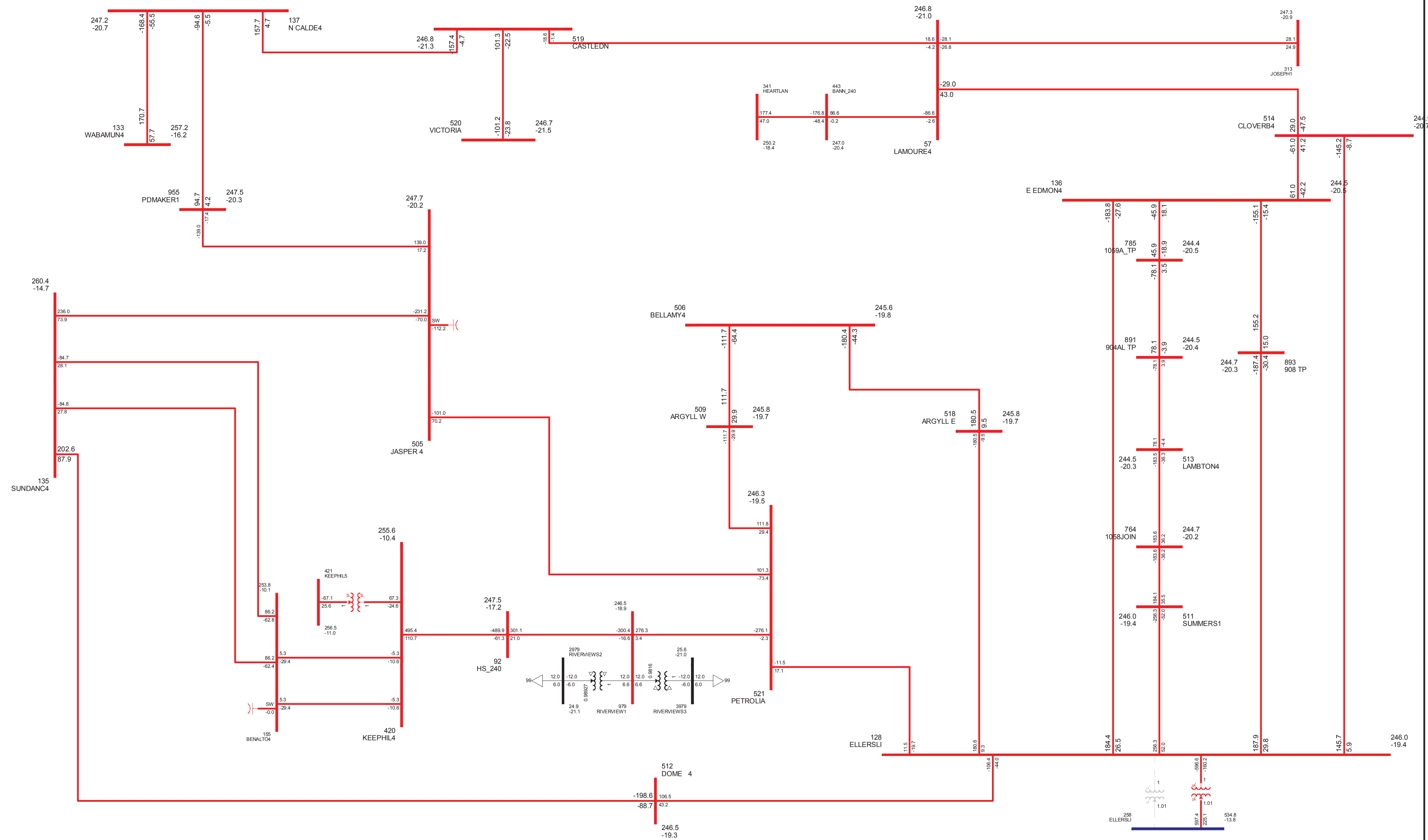
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-POSTPROJECT
BASE CASE
FIG B-8
TUE, OCT 31 2017 10:31

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

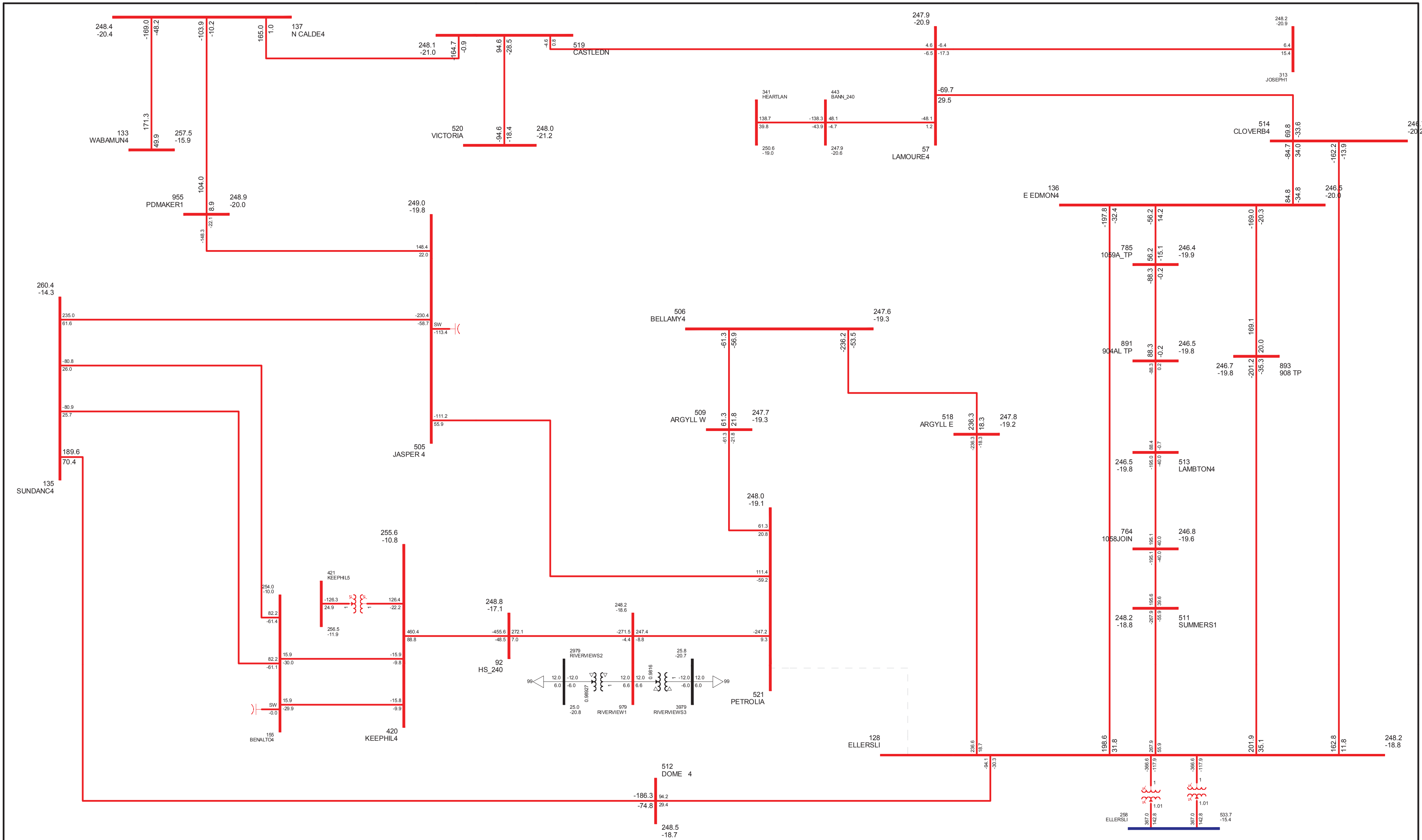
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-POSTPROJECT
ELLERSLIE T1
FIG B-9
TUE, OCT 31 2017 10:31

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

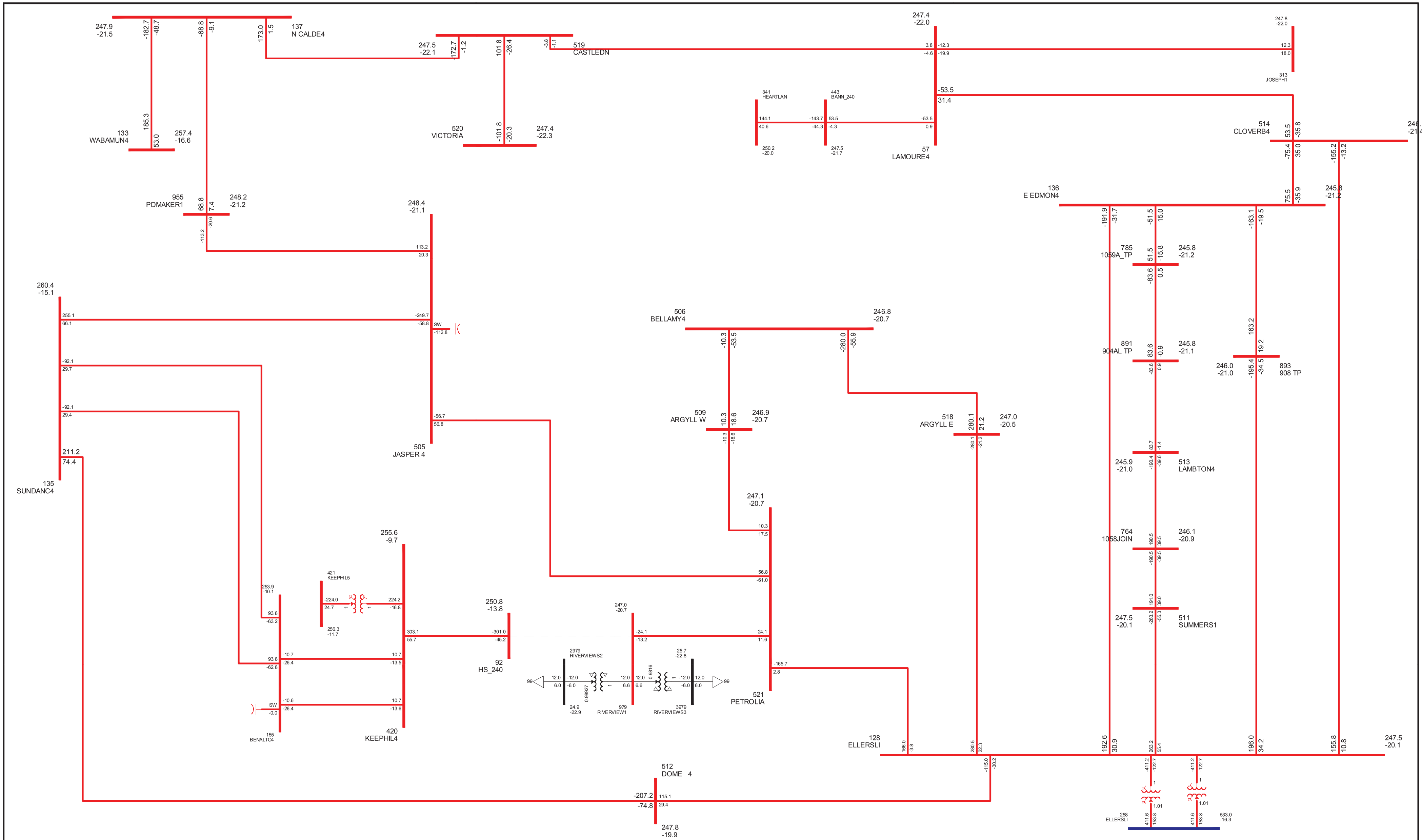
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-POSTPROJECT
908L (ELLERSLIE TO PETROLIA)
FIG B-10
TUE, OCT 31 2017 10:31

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

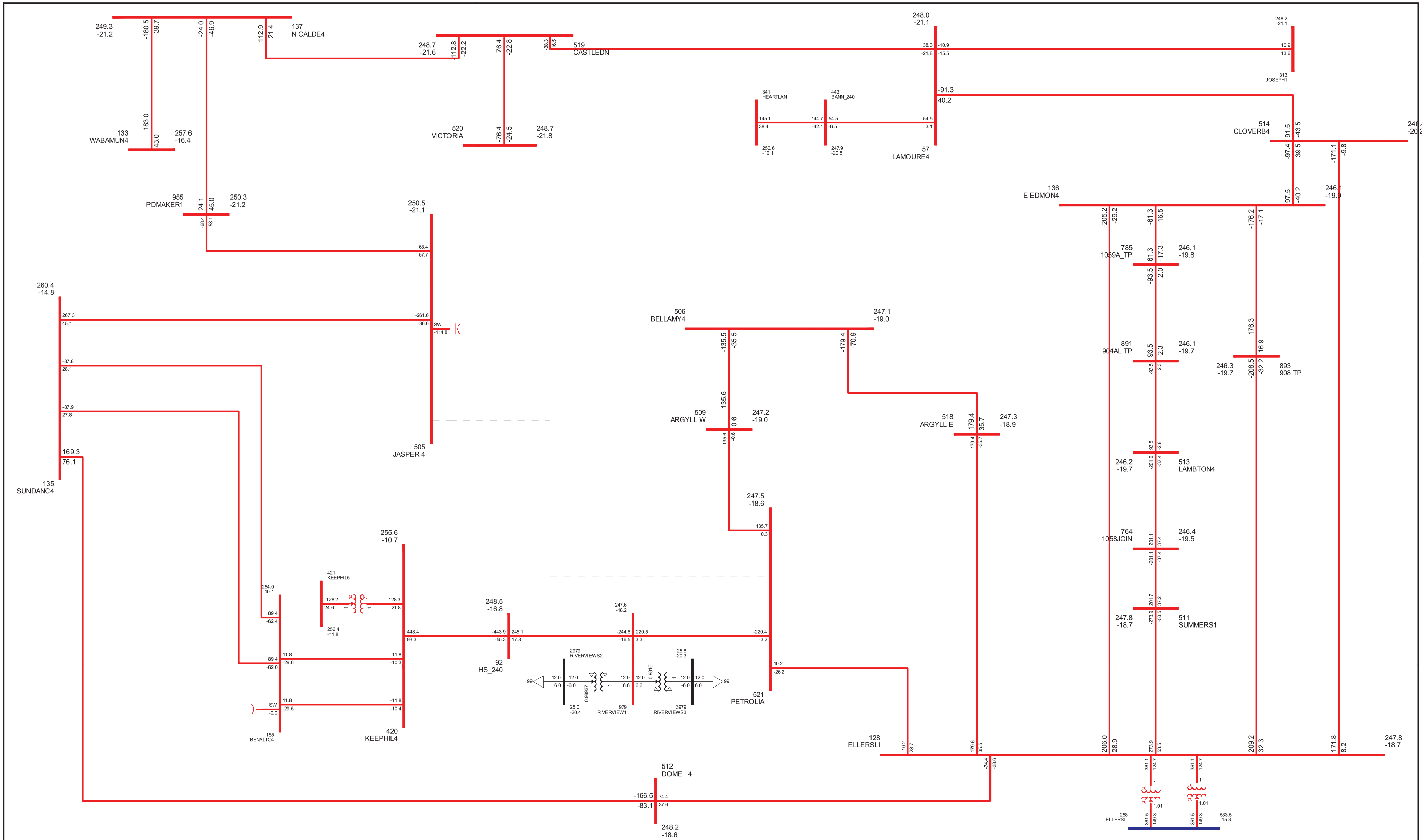
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-POSTPROJECT
1139L (HARRY SMITH TO RIVERVIEW)
FIG B-11
TUE, OCT 31 2017 10:31

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

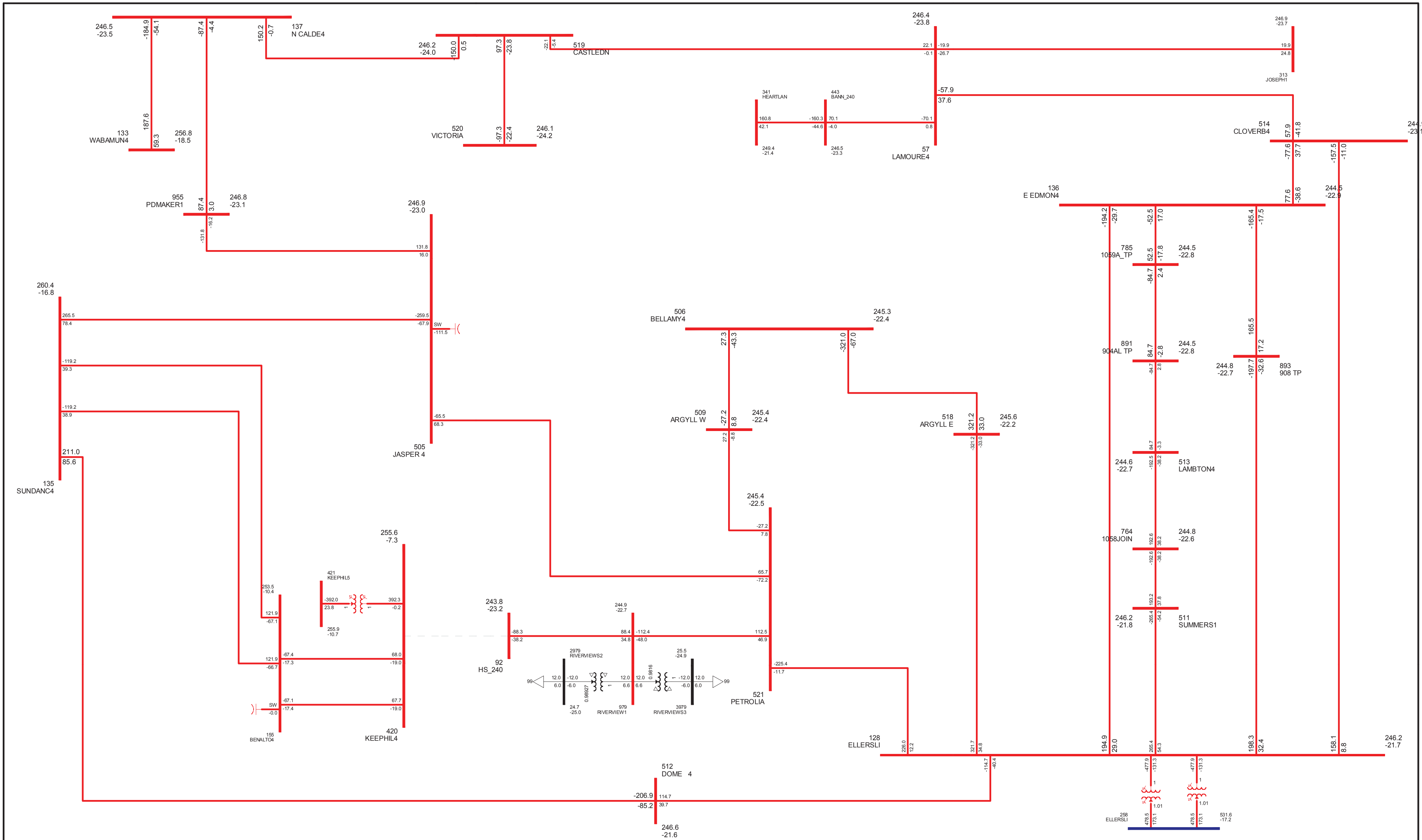
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-POSTPROJECT
1044L (JASPER TO PETROLIA)
FIG B-12
TUE, OCT 31 2017 10:31

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

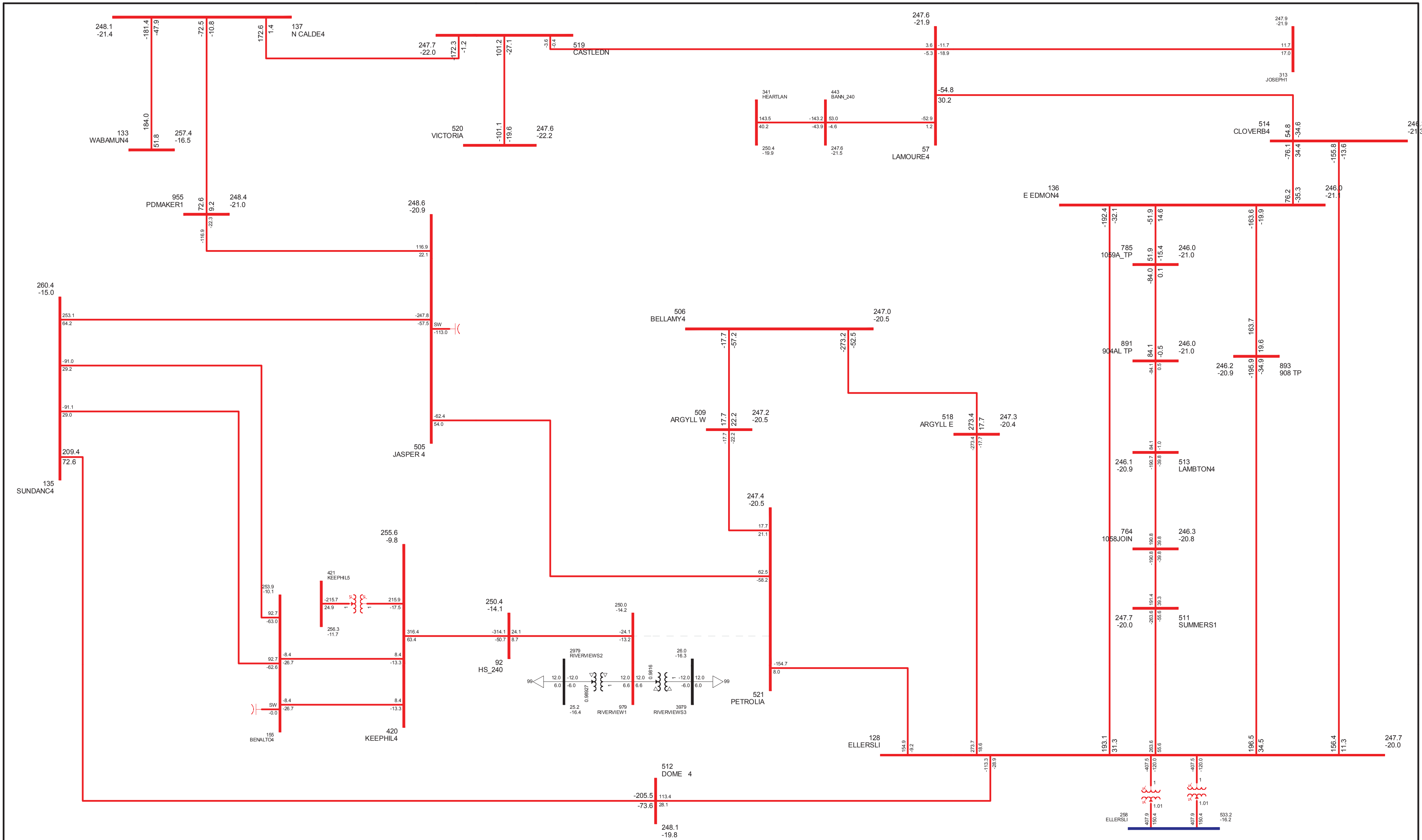
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



2019SP-POSTPROJECT
1043L (HARRY SMITH KEEPHILLS)
FIG B-13
TUE, OCT 31 2017 10:31

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

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



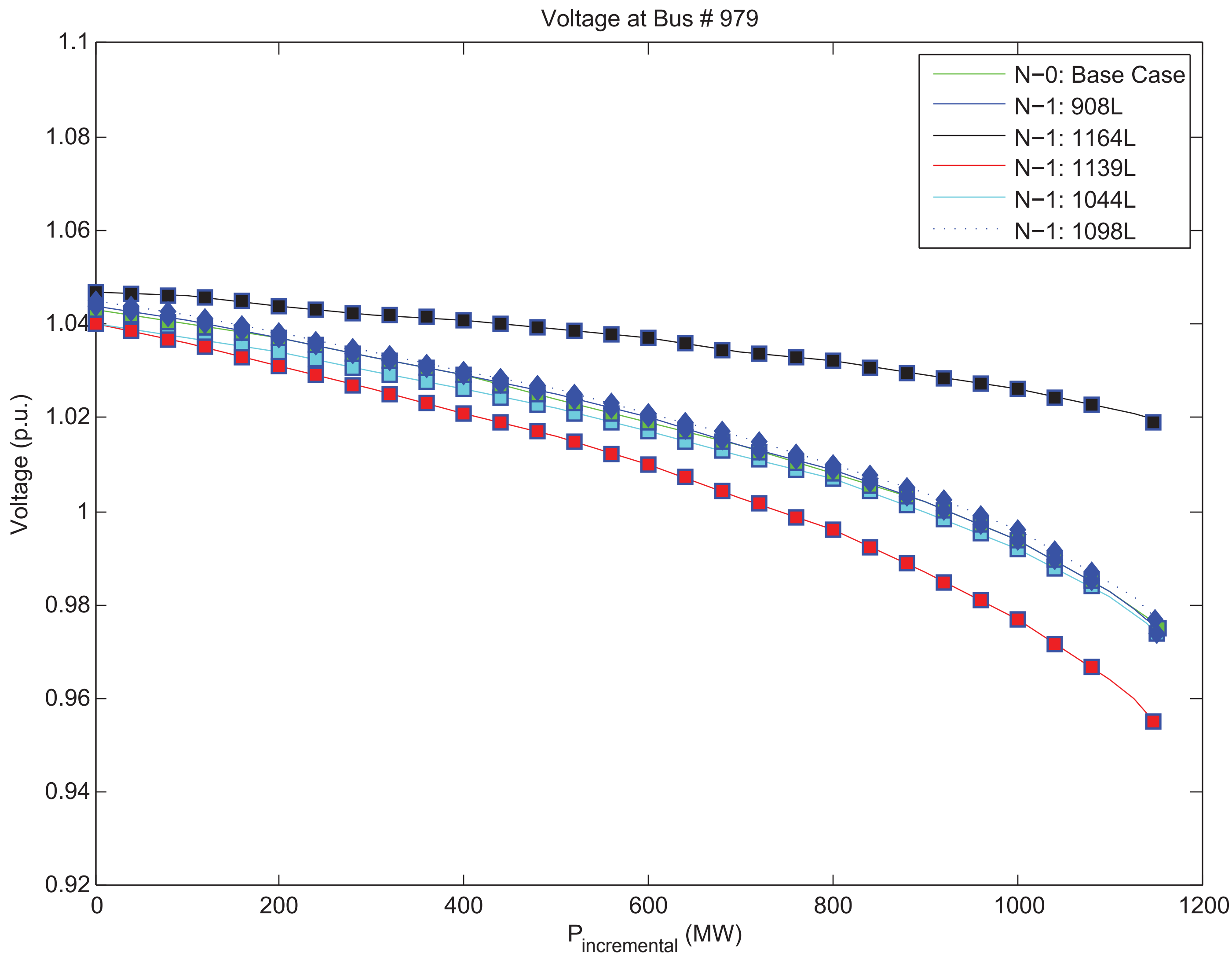
2019SP-POSTPROJECT
1164L (PETROLIA TO RIVER VIEW)
FIG B-14
TUE, OCT 31 2017 10:31

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

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

Attachment C

Voltage Stability Diagrams
2018 WP Post-Project


Voltage at Bus # 979
N−0: Base Case
N−1: 908L
N−1: 1164L
N−1: 1139L
N−1: 1044L
N−1: 1098L
Voltage (p.u.)
P incremental (MW)
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0
200
400
600
800
1000
1200