APPENDIX A CONNECTION ASSESSMENT

AESO Engineering Connection Assessment

EPCOR

Transmission Enhancements in the West Edmonton Area

AESO Project Number: 1649

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1. Introduction

This Engineering Connection Assessment presents the results of the studies conducted to assess the impact of the Project (as defined below) on the performance of the Alberta interconnected electric system (AIES).

1.1. Project

1.1.1. Project Overview

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

The DFO's request for system access service includes a Rate DTS, *Demand Transmission Service*, contract capacity increase of 20.9 MW, from 52.1 MW to 73 MW, for the system access service provided at the existing Garneau substation and a request for transmission development (collectively, the Project). The DFO identified existing and forecast violations of the DFO's Distribution Planning Criteria at the existing Garneau and Meadowlark substations.

The scheduled in-service date for the Proposed Transmission Development (as defined in Section 9) is staged. The first stage has a scheduled in-service date of June 30, 2020 and includes the addition of the 72 kV transmission circuit, upgrades at Poundmaker substation, modifications at Meadowlark substation and upgrades at Garneau substation, including replacement of one transformer. The remaining upgrades at Garneau substation have scheduled in-service dates of September 30, 2021 and September 30, 2022, for the second and third transformer replacements.

1.1.2. Load Component

The Project includes a load component:

- Existing DTS contract capacities: 52.1 MW at Garneau and 62 MW at Meadowlark substations
- The DFO requested a Rate DTS contract capacity increase of 20.9 MW, to 73 MW, at Garneau substation
- No changes to the existing Rate DTS contract capacities at Meadowlark substation
- The Project load will be studied assuming a 0.9 power factor (PF) lagging.
- Load type: Residential, Commercial (University of Alberta)

1.1.1. 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 the following:

- Assess the impact of the Project on the performance of the AIES.
- Identify any violations of the relevant criteria, standards or requirements of the AESO, both pre-Project and post-Project.
- Evaluate Project connection alternatives and identify the AESO's preferred alternative
- Recommend 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 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. The Garneau and Meadowlark substations are connected through the underground 72kV transmission line 72MG16. Garneau substation is supplied by Rossdale substation through the underground 72 kV transmission lines 72RG1 and 72RG7. The 72 kV bus at the Meadowlark substation is currently split via opening of a 72 kV breaker, which results in approximately two thirds of the load being supplied from Jasper substation (via underground 72kV transmission line 72MJ18) and the remaining load being supplied from Garneau substation (via underground 72kV transmission line 72MG16).

The DFO has advised that the specific customers (load) served by the Garneau substation include:

- University of Alberta campus, including the University of Alberta North Campus and public health facilities (including the University of Alberta Hospital, the Stollery Children's Hospital, the Mazankowski Alberta Heart Institute, and the Kaye Edmonton Clinic)
- Old Strathcona Police Station
- Lendrum EMS Station
- Schools including 1 senior high school, 3 junior high schools, 5elementary schools
- 2 LRT Stations[1]

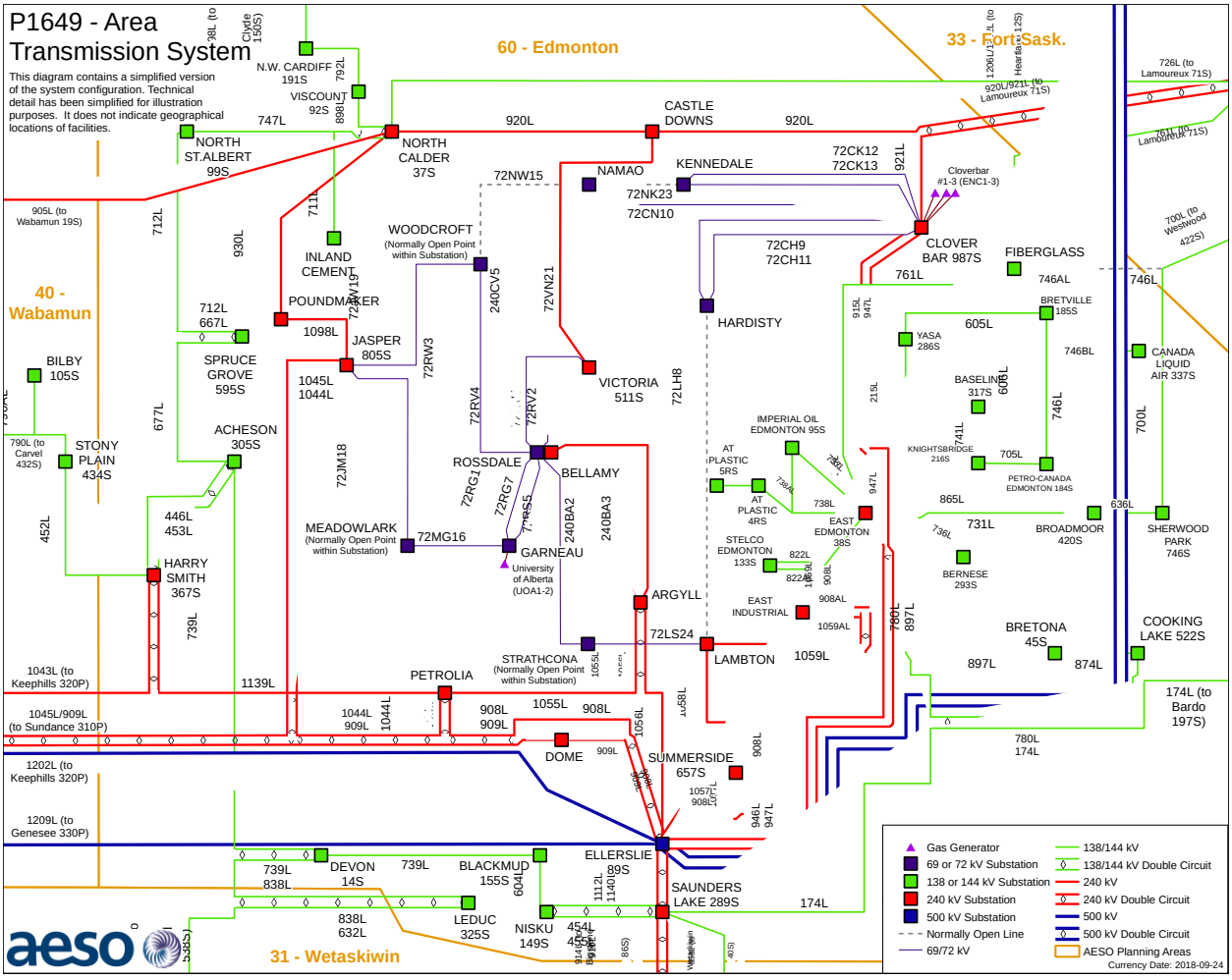
[1] See EDTI-AESO-2019APR09-009 and EDTI-AESO-2019APR09-010 in NID Appendix G.

Generation in the area includes two distribution-connected generators at the University of Alberta main campus which are connected to the distribution side at Garneau: a 31 MVA condensing steam turbine generator and a 15.5 MVA cogeneration unit. Most of the power produced from the 15.5 MVA cogeneration unit is unavailable during the summer months as it is directly related to the campus heating load while power production from the 31 MVA steam turbine operates independently of the heating load.[2]

The Study Area for the Project consists of Edmonton (Area 60) and the tie lines connecting Edmonton (Area 60) to neighbouring AESO planning areas. All transmission facilities 72 kV and above within the Study Area were studied and monitored to assess the impact of the Project on the AIES, including any violations of the Reliability Criteria (as defined in Section 2.1.1).

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

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



[2] See EDTI-AESO-2019APR09-008 in NID Appendix G.

1.2.2.2. Existing Constraints

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

This engineering connection assessment identifies existing constraints in the Study Area which includes the following:

a) Under the loss of 72RG7 between Rossdale and Garneau substations during a peak load scenario, thermal violations are observed on 72RG1. The DFO has advised that this results in forced interruption of customer load at the Garneau substation. The DFO has advised that contingencies on 72RG1, 72JM18/Jasper T1, or Garneau T1/T2/T3 will also result in forced interruption of customer load.[3]

b) Under the loss of either 72CH9 or 72CH11, thermal criteria violations are observed on the remaining element.

c) Under the loss of either 72CK12 or 72CK13, thermal criteria violations are observed on the remaining element.

While the constraints observed on 72CH9, 72CH11, 72CK12 and 72CK13 are monitored and documented in this engineering connection assessment, addressing these constraints is beyond the scope of the Project and will be reviewed as part of the AESO's long term planning process.

1.2.2.3. AESO Long-Term Transmission Plans

The *AESO 2017 Long-term Transmission Plan* (2017 LTP)[4] includes the following system developments that are in the Edmonton Planning Region in the near term (by 2020):

Table 1-1: 2017 LTP Near Term Developments in the Edmonton Planning Region

Development	Description
Yasa-to-East Edmonton – 138kV circuit	• Build a 138 kV circuit between the Yasa 286S and E Edmonton 38S substations
East Edmonton – transformer capacity increase	• Replace or add new transformers at the E Edmonton 38S substation
Acheson to North St. Albert – 138 kV circuit	• Build a new 138 kV circuit from the Acheson 305S substation to North St. Albert 99S substation
City of Edmonton 72 kV upgrades	• Build a new 240/72 kV transformer at Castle Downs substation and a new 240/72 kV Blatchford substation near Namao
	• Build a new 72 kV circuit from Castle Downs substation to Kennedale substation, a new 72 kV circuit from Namao substation to Kennedale substation and a new 72 kV circuit from the new Blatchford substation to Namao substation

[3] See EDTI-AESO-2019APR09-008 in NID Appendix G.

[4] The 2017 LTP document is available on the AESO website.

Development	Description
	• Discontinue use of 72CK12 and 72CK13 from Clover Bar substation to Kennedale substation
	• Upgrade 72 kV circuit between Clover Bar–Hardisty substations and Garneau–Rossdale substations
North Calder– to– Viscount−rebuild of 138 kV line	• Rebuild 898L from North Calder substation to Viscount substation

None of the system developments described in this section are included in the studies.

1.2.3. Studies Performed

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

- Power flow analysis
- Short-circuit analysis

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

- Power flow analysis
- Short-circuit analysis
- Voltage stability analysis

2. Criteria, System Data, and Study Assumptions

2.1. Criteria, Standards, and Requirements

2.1.1. AESO 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* [5] (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-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:

- 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 per AESO Information Document ID# 2010-007RS, *General Operating Practices - Voltage Control*, which 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*.

[5] See NID Appendix F.

- Desired post-contingency voltage change limits for three defined post event timeframes as provided in Table 2-1, below.

Table 2-1: Post-Contingency Voltage Deviations Guidelines

Parameter and reference point	Time Period		
	Post Transient (up to 30 sec)	Post Auto Control (30 sec to 5 min)	Post Manual Control (Steady State)
Voltage deviation from steady state at point-of-delivery (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 in assessing the impact of the Project. 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

The first scheduled ISD for the Project is June 30, 2020. Therefore, the studies were performed using the 2020 summer peak (SP) and 2020 winter peak (WP) scenarios.

Table 2-2 provides a list of the study scenarios. The post-Project scenarios include the DFO-requested Rate DTS contract capacity of 73 MW at Garneau substation. This connection assessment assumed a 0.9 lagging power factor for the Project load.

Table 2-2: List of the Connection Study Scenarios

Scenario	Year/Season Load	Condition	Project Load (Garneau) (MW)	Project Load Meadowlark Load (MW)	Project Generation (MW)	System Generation Dispatch Conditions
1	2020SP	Pre-Project	52.1	62	0	Low Generation (N-G)
2	2020WP	Pre-Project	52.1	62	0	Low Generation (N-G)
3	2020SP	Post-Project	73	62	0	Low Generation (N-G)
4	2020WP	Post-Project	73	62	0	Low Generation (N-G)
5	2028WP	Post-Project	73	62	0	All study area generation online

2.3. Load and Generation Assumptions

2.3.1. Load Assumptions

The Study Area and AESO Planning Region load forecast used for this connection study are reflected in Table 2-3 and are based on the *AESO 2017 Long-term Outlook* (2017 LTO) at Edmonton Region Peak. For the studies, when POD loads for the Alberta internal load (AIL) were modified to align with the load forecast from the 2017 LTO, the active power to reactive power ratio in the base case scenarios was maintained.

Table 2-3: Forecast Area Load *(2017 LTO at Edmonton Planning Region Peak)*

AESO Planning Area or Region Name	Season	Forecast Peak Load (MW)
Edmonton (Area 60)	2020 SP	2350
	2020 WP	2343

2.3.2. Generation Assumptions

The generation assumptions for the studies are based on the 2017 LTO. The dispatch assumptions used for the existing generating units in the vicinity of the Study Area are shown in Table 2–4.

The University of Alberta Cogen generators are considered to be the critical generating units for the purpose of the studies (N-G), and are assumed to be offline for the power flow and voltage stability analyses. Additionally, the DFO has advised that these generators are not within its control and cannot guarantee generation during peak loading conditions.[6]

Table 2-4: Existing Local Generation (MW) in the Study Area

Unit Name	Bus Number	Area	Pmax (MW)	2020 SP Unit Net Generation[a] (MW)	2020 WP Unit Net Generation[a] (MW)
Sundance #1	129	40	280	Retired	Retired
Sundance #2	130	40	280	Retired	Retired
Sundance #3	338	40	368	322	286
Sundance #4	342	40	406	Mothballed	Mothballed
Sundance #5	345	40	406	348	340
Sundance #6	350	40	401	297	311
Keephills #1	422	40	395	341	348
Keephills #2	424	40	395	353	345
Keephills #3	403	40	463	411	393
Genesee #1	491	40	400	393	375
Genesee #2	492	40	400	389	378

[6] See EDTI-AESO-2019APR09-008 in NID Appendix G.

Unit Name	Bus Number	Area	Pmax (MW)	2020 SP Unit Net Generation[a] (MW)	2020 WP Unit Net Generation[a] (MW)
Genesee #3	490	40	466	451	442
Cloverbar #1	25516	60	48	0	0
Cloverbar #2	26516	60	101	0	0
Cloverbar #3	27516	60	101	0	0
University of Alberta	25352	60	39	N-G[b]	N-G[b]

[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

All the generation dispatch shown as "0" means the generating unit is not in-merit based on forecasted economic merit order. For the sake of the studies, these units are assumed off-line.

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 to have any material impact on the connection assessment for the Project. Therefore, the intertie flows were dispatched the same as in the AESO's base cases.

The Western Alberta Transmission HVDC Line (WATL) and the Eastern Alberta Transmission HVDC Line (EATL) assumptions were expected to have minimal impact for the connection studies. Therefore, HVDC assumptions are kept consistent with that in the AESO planning base cases and not adjusted for this study.

2.4. System Projects

No system projects in the Edmonton planning area from the *AESO 2017 Long-Term Transmission Plan* were included in the study scenarios.

2.5. Connection Projects

Table 2-5 summarizes the customer connection project assumptions that were used in the study scenarios.

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

AESO Planning Area	Planned In-Service Date	Project Name	Project #	Gen Addition (MW)	Load Addition (MW)	Included/Excluded from Studies
60	Nov 1, 2020	Fortis New Anthony Henday Substation	1442	0.0	21.0	Excluded due to ISD
60	Mar 31, 2022	CP Genesee Generating Units 4 & 5 Phase 2	1440	530.0	0.0	Excluded due to ISD
60	Mar 31, 2023	CP Genesee Generating Units 4 & 5 Phase 3	1440	530.0	0.0	Excluded due to ISD
60	Feb 1, 2021	CP Genesee Generating Units 4 & 5 Phase 1	1440	0.0	50.0	Excluded due to ISD

AESO Planning Area	Planned In-Service Date	Project Name	Project #	Gen Addition (MW)	Load Addition (MW)	Included/Excluded from Studies
60	Oct 1, 2019	EPCOR Strathcona Capacity Increase	1659	0.0	14.2	Included, dispatched to requested DTS

2.6. Facility Ratings and Shunt Elements

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

Table 2-6: Thermal Rating Assumptions for Key Transmission Lines in the Study Area

Line ID	Line Description	Voltage Class (kV)[a]	Normal Rating (MVA)		Emergency Rating (MVA)	
			Summer	Winter	Summer	Winter
72RS5	Rossdale-Strathcona	72	25	25	70	73
72RG1	Rossdale-Garneau	72	60	60	140[c]	140[c]
72RG7	Rossdale-Garneau	72	80	80	140[c]	140[c]
72LH8	Lambton-Hardisty	72	90	124	105	135
72LS24	Lambton-Strathcona	72	90	124	105	135
72CH11	Hardisty-Cloverbar	72	40	40	80	80
72CK12	Cloverbar-Kennedale	72	48	56	64	68
72CK13	Cloverbar-Kennedale	72	48	56	64	68
1055L	Petrolia-Argyll	240	419	517	419[b]	517[b]
1056L	Ellerslie-Argyll	240	419	517	419[b]	517[b]
1058L	Summerside-Lambton	240	499	499	499	499
1059L	Lambton-East Edmonton	240	499	499	499	499
240BA2[b]	Argyll-Bellamy	240	400	479	473[b]	540[b]
240BA3[b]	Argyll-Bellamy	240	400	479	473[b]	540[b]

[a] Ratings for 72kV facilities in the study cases have been converted to MVA ratings based on 69 kV.

[b] If one of 240BA2 or 240BA3 is out of service, the continuous rating of the remaining cable increases to 453 MVA in summer and 534 MVA in winter.

[c] 10-minute ratings

Table 2-7: Summary of key transformers 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
Lambton	T3	240/72	80

The TFOs provided the details of the shunt elements in the Study Area, as shown in Table 2-8.

Table 2-8: Summary of shunt elements in the Study Area

Substation Name and Number	Voltage Class (kV)	Capacitors	
		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
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

ID #2010-007RS is used to establish normal system (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 all the busses not included in ID #2010-007RS. These voltages were used to set the voltage profile for the study base cases prior to power flow studies. The key bus voltages for the Study Area for the project are shown in Table 2-9.

Table 2-9: Summary of the Voltage Operating Ranges at Key Nodes 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 803S	240	240	245 – 254	255
East Edmonton 38S	240	240	240 – 253	255
	138	139	139 – 144	145
Jasper Terminal 805S	240	240	245 – 254	255
Petrolia 816S	240	240	245 – 254	255
Clover Bar 987S	240	240	245 – 254	255

3. Study Methodology

The analyses 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

Scenario and Condition		System Conditions	Power Flow	Voltage Stability	Short Circuit
1	2020 SP Pre-Project	Category A and Category B	X	-	-
2	2020 WP Pre-Project	Category A and Category B	X	-	X*
3	2020 SP Post-Project	Category A and Category B	X	-	-
4	2020 WP Post-Project	Category A and Category B	X	X	X*
5	2020 WP Post-Project	Category A	-	-	X

*Short-circuit studies were performed for Category A conditions only

3.2. Power Flow Studies

Pre-Project and post-Project power flow studies were performed to identify thermal and voltage criteria violations as per the Reliability Criteria, and any deviations from the limits listed in Table 2-1. The purpose of the power flow analysis is to quantify any incremental violations in the Study Area after the Project is connected. For the Category B power flow studies, the transformer taps and switched shunt reactive compensating devices such as shunt capacitors and reactors were locked and continuous shunt devices were enabled.

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

3.2.1. Contingencies Studied

The power flow studies were performed for all Category B contingencies (72 kV facilities and above) within the Study Area. All transmission facilities 72 kV and above in the Study Area were monitored for Reliability Criteria violations.

3.3. Voltage Stability (PV) Analysis

The objective of the voltage stability studies is to determine the ability of the network to maintain voltage stability at all the busses in the system under normal and abnormal system conditions. The power-voltage (PV) curve represents voltage change as a result of increased power transfer between two systems. The incremental transfers are reported at the collapse point.

Voltage stability studies were performed for post-Project scenarios. For load connection projects, the load level modelled in post-Project scenarios is the same or higher than in pre-Project 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 modeled at a minimum of 105% of the reference load level for system normal conditions (Category A) and for single contingencies (Category B). For this standard, the reference load level is the maximum established planned load.

Typically, voltage stability analysis is carried out assuming the worst case scenarios in terms of loading. The voltage stability analysis was performed by increasing load in Edmonton area (Area 60) and by increasing the corresponding generation in Fort McMurray (Area 25).

3.3.1. Contingencies Studied

Voltage stability analysis was performed for the Category A condition and all Category B contingencies 72 kV and above in the Study Area for the 2020 WP post-Project scenario.

3.4. Short-Circuit Analysis

Short-circuit analysis was performed for the 2020 WP pre-Project scenario, the 2020 WP post-Project scenario, and the 2028 post-Project scenario to determine the short-circuit levels in the vicinity of the Project. The short-circuit analysis includes three phase and single line to ground faults. Fault levels are provided in the form of currents in kilo amperes and per unit positive and zero sequence impedances.

4. Pre-Project System Assessment

4.1. Power Flow

This section describes 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 - Pre-Project 2020 SP

Category A condition

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

Category B conditions

No voltage criteria violations or voltage deviations beyond the limits listed in Table 2-1 (hereafter referred to as, point of delivery (POD) bus voltage deviations) were observed under Category B conditions.

Thermal criteria violations, both above normal rating and above emergency rating, were observed under Category B conditions as shown in Table 4-1.

Table 4-1: Thermal Criteria Violations under Category B Conditions for the 2020 SP Pre-Project Scenario

Contingency	Limiting Branch	Normal Rating (MVA)	Emergency Rating (MVA)	Power Flow (MVA)	% Loading
72CH9 (Hardisty - Cloverbar)	72CH11 (Hardisty - Cloverbar)	38.3	76.7	66.37	169.52
72CH11 (Hardisty - Cloverbar)	72CH9 (Hardisty - Cloverbar)	38.3	76.7	66.39	169.52
72CK13 (Cloverbar - Kennedale)	72CK12 (Cloverbar - Kennedale)	46	61.3	63.47	133.44
72CK12 (Cloverbar - Kennedale)	72CK13 (Cloverbar - Kennedale)	46	61.3	63.47	133.44
72RG7 (Rossdale - Garneau)	72RG1 (Rossdale - Garneau)	57.5	134.2	81.86	137.19[a]
72RG1 (Rossdale - Garneau)	72RG7 (Rossdale - Garneau)	76.70	134.2	81.90	102.71[a]
72MG16 (Meadowlark - Garneau)	72JM18 (Jasper - Meadowlark)	57.5	57.5	67.63	113.18[b]
72JM18 (Jasper - Meadowlark)/Jasper T1	72MG16 (Meadowlark - Garneau)	57.5	57.5	66.23	112.43[b]
72JM18 (Jasper - Meadowlark) /Jasper T1	72RG1 (Rossdale - Garneau)	57.5	134.2	59.88	100.70[b]

[a]Although the loading on 72RG1 and 72RG7 is below the emergency rating, the emergency rating provided by the TFO is only valid for 10 minutes. The TFO has advised that major equipment failures such as a cable fault, a cable splice failure or a termination

failure would result in extended unavailability of the equipment for a duration of weeks to months (See EDTI-AESO-2019APR09-003 in Appendix G). Therefore, these overloads may not be resolved by real-time operating practices within the 10 minutes provided by the emergency rating without shedding load (See EDTI-AESO-2019APR09-008 in Appendix G).

[b]These overloads are observed if the normally open breaker at Meadowlark is closed to restore load to Meadowlark substation.

4.1.2. Scenario 2 – Pre-Project 2020 WP

Category A condition

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

Category B conditions

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

Thermal criteria violations, both above normal rating and above emergency rating, were observed under Category B conditions as shown in Table 4-2.

Table 4-2: Thermal Criteria Violations under Category B Conditions for the 2020 WP Pre-Project Scenario

Contingency	Limiting Branch	Normal Rating (MVA)	Emergency Rating (MVA)	Power Flow (MVA)	% Loading
72CH9 (Hardisty - Cloverbar)	72CH11 (Hardisty - Cloverbar)	38.3	76.7	65.81	167.57
72CH11 (Hardisty - Cloverbar)	72CH9 (Hardisty - Cloverbar)	38.3	76.7	65.82	167.57
72CK13 (Cloverbar - Kennedale)	72CK12 (Cloverbar - Kennedale)	53.7	65.2	62.46	111.90
72CK12 (Cloverbar - Kennedale)	72CK13 (Cloverbar - Kennedale)	53.7	65.2	62.46	111.90
72RG7 (Rossdale - Garneau)	72RG1 (Rossdale - Garneau)	62.3	134.2	80.82	125.34[a]
72JM18 (Jasper - Meadowlark) /Jasper T1	72MG16 (Meadowlark - Garneau)	62.3	62.3	64.94	101.81[b]

[a]Although the loading on 72RG1 is below the emergency rating, the emergency rating provided by the TFO is only valid for 10 minutes. The TFO has advised that major equipment failures such as a cable fault, a cable splice failure or a termination failure would result in extended unavailability of the equipment for a duration of weeks to months (See EDTI-AESO-2019APR09-003 in NID Appendix G). Therefore, these overloads may not be resolved by real-time operating practices within the 10 minutes provided by the emergency rating without shedding load (See EDTI-AESO-2019APR09-008 in NID Appendix G).

[b]This overload is observed if the normally open breaker at Meadowlark is closed to restore load to Meadowlark substation.

5. Connection Alternatives

5.1. Overview

The AESO, in consultation with the TFO in the Study Area, and the DFO, examined four transmission alternatives to meet the DFO's request for system access service.

5.2. Connection Alternatives Identified

Alternative 1A: Add a 72 kV circuit between the existing Poundmaker and Meadowlark substations and upgrade Garneau substation including adding a transformer

This alternative includes the following developments:

- Add one 72 kV circuit between the existing Poundmaker and Meadowlark substations;
- Modify the Poundmaker substation, including adding one 240/72kV transformer, one 240 kV breaker and one 72 kV breaker;
- Modify the Meadowlark substation, including adding two 72 kV circuit breakers;[7]
- Upgrade the existing Garneau substation, including adding one 72/14.4 kV transformer and adding one 72 kV breaker
- Add or modify associated equipment as required for the above transmission developments.

The TFO has advised that the 72 kV circuit between Poundmaker and Meadowlark substations would be approximately 9 km in length.

Alternative 1B: Add a 72 kV circuit between the existing Poundmaker and Meadowlark substations and upgrade the Garneau substation including replacing the three transformers

This alternative includes the following developments:

- Add one 72 kV circuit between the Poundmaker and Meadowlark substations;
- Modify the Poundmaker substation, including adding one 240/72kV transformer, one 240 kV breaker and one 72 kV breaker;
- Modify the Meadowlark substation, including adding two 72 kV circuit breakers;[8]
- Upgrade the existing Garneau substation, including replacing the three existing 72/14.4 kV transformers with three 72/14.4 kV transformers of higher capacity; and

[7] The proposed 72 kV circuit breaker on 72MG16 (M725) would be operated as normally open.

[8] The proposed 72 kV circuit breaker on 72MG16 (M725) would be operated as normally open.

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

The TFO has advised that the 72 kV circuit between Poundmaker and Meadowlark substations would be approximately 9 km in length.

Alternative 2: Add a 72 kV circuit between the existing Jasper and Meadowlark substations and upgrade the Jasper and Meadowlark substations

This alternative includes the following developments:

- add one 72 kV circuit between the existing Jasper and Meadowlark substations;
- upgrade the existing Jasper substation, including converting the 72 kV bus to a ring bus configuration, adding one 240/72 kV transformer, adding one 240 kV circuit breaker, and adding three 72 kV circuit breakers;
- modify the existing Meadowlark substation by adding three 72 kV breakers; and
- add or modify associated equipment as required for the above developments[9].

The TFO has advised that the 72 kV circuit between Jasper and Meadowlark substations would be approximately 11 km in length. The TFO has further advised that this alternative would require expansion of the Jasper substation fenceline to accommodate the required equipment additions.

Alternative 3: Enhance the connection between the existing Rossdale and Garneau substation

This alternative could be carried out in one of three ways[10]:

3A: Replacing the existing 72 kV underground circuit 72RG1 between Rossdale and Garneau substations with one new 72 kV underground circuit of higher capacity. The DFO has advised that this alternative would require the DFO to implement a load transfer scheme to shift load from the Garneau substation to the Rossdale substation.

3B: Replacing both of the existing 72 kV underground circuits between Rossdale and Garneau substations (72RG1 and 72RG7) with two new 72 kV underground circuit of higher capacity.

3C: Adding one 72 kV circuit between the Rossdale and Garneau substations.

5.2.1. Connection Alternatives Selected for Further Study

Alternative 1B was selected for further study by the AESO as further explained in section 5.2.2. below.

[9] In addition, this alternative would also require the addition of transformation capacity at the Garneau substation as described in Alternatives 1A and 1B.

[10] In addition, this alternative would also require the addition of transformation capacity at the Garneau substation as described in Alternatives 1A and 1B.

5.2.2. Connection Alternatives Not Selected for Further Study

Cost estimates prepared by the TFO indicate that Alternative 1B has a lower estimated total cost than Alternative 1A[11]. Therefore, Alternative 1A was not selected for further study.

The TFO has advised that Alternative 2 is not technically feasible due to space limitations in and around the Jasper substation.

Alternatives 3A, 3B, and 3C were determined to be not technically acceptable by the DFO. The DFO advised that these alternatives would not adequately meet its Distribution Planning Criteria – POD Loading Policy for N-1 load reliability at the Meadowlark substation. Specifically, Alternatives 3A, 3B, and 3C would not resolve the issue of unsupplied load at the Meadowlark substation under N-1 conditions (i.e. loss of Jasper T1, 72JM18, or 72MG16) which would violate the DFO's Distribution Planning Criteria – POD Loading Policy.

[11] Cost estimates for Alternative 1A and Alternative 1B are provided in NID Appendix B.

6. Technical Analysis of the Connection Alternative

This section describes the results of the post-Project power flow studies and voltage stability studies for Alternative 1B.

6.1. Power Flow Study Results

The post-Project power flow diagrams are provided in Attachment B.

6.1.1. Scenario 3- Post-Project 2020 SP

Category A condition

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

Category B conditions

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

Most of the same thermal criteria violations that were observed under Category B contingency conditions in the pre-Project study scenarios were also observed in the post-Project scenarios, as shown in Table 6-1. In addition, two new thermal criteria violations were observed. The thermal criteria violations observed on 72 kV transmission lines 72MG16 and 72JM18 in the pre-Project 2020 SP scenario were not observed in the post-Project 2020 SP scenario.

Table 6-1: Thermal Criteria Violations under Category B Conditions for the 2020 SP Post-Project Scenario

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading	
72CH9 (Hardisty - Cloverbar)	72CH11 (Hardisty - Cloverbar)	38.3	76.7	66.37	169.52	65.81	167.75	-1.68
72CH11 (Hardisty - Cloverbar)	72CH9 (Hardisty - Cloverbar)	38.3	76.7	66.39	169.52	65.82	167.75	-1.68
72CK13 (Cloverbar - Kennedale)	72CK12 (Cloverbar - Kennedale)	46	61.3	63.47	133.44	62.47	130.78	-2.59
72CK12 (Cloverbar - Kennedale)	72CK13 (Cloverbar - Kennedale)	46	61.3	63.47	133.44	62.47	130.78	-2.59
72RG7 (Rossdale - Garneau)	72RG1 (Rossdale - Garneau)	57.5	134.2	81.86	137.19	91.21	154.39	17.2*
72RG1 (Rossdale - Garneau)	72RG7 (Rossdale - Garneau)	76.7	134.2	81.90	102.71	91.23	115.56	12.85*
New 72PM25 (Poundmaker - Meadowlark)	72JM18 (Jasper - Meadowlark)	57.5	57.5	N/A	N/A	64.53	105.7	N/A
New Poundmaker Transformer T4	72JM18 (Jasper - Meadowlark)	57.5	57.5	N/A	N/A	64.14	104.99	N/A

*Although the loading on 72RG1 and 72RG7 is below the emergency rating, the emergency rating provided by the TFO is only valid for 10 minutes. The TFO has advised that major equipment failures such as a cable fault, a cable splice failure or a termination failure would result in extended unavailability of the equipment for a duration of weeks to months (See EDTI-AESO-2019APR09-003 in NID Appendix G). Therefore, these overloads may not be resolved by real-time operating practices within the 10 minutes provided by the emergency rating without shedding load (See EDTI-AESO-2019APR09-008 in NID Appendix G).

6.1.2. Scenario 4- Post-Project 2020 WP

Category A condition

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

Category B conditions

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

Most of the same thermal criteria violations that were observed under Category B contingency conditions in the pre-Project study scenarios were also observed in the post-Project scenarios, as shown in Table 6-2. In addition, one new thermal criteria violation was observed.

Table 6-2: Thermal Criteria Violations under Category B Conditions for the 2020 WP Post-Project Scenario

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Load Flow (MVA)	% Loading	Load Flow (MVA)	% Loading	
72CH9 (Hardisty - Cloverbar)	72CH11 (Hardisty - Cloverbar)	38.3	76.7	65.81	167.57	64.7	164.66	-2.85
72CH11 (Hardisty - Cloverbar)	72CH9 (Hardisty - Cloverbar)	38.3	76.7	65.82	167.57	64.71	164.66	-2.86
72CK13 (Cloverbar - Kennedale)	72CK12 (Cloverbar - Kennedale)	53.7	65.2	62.46	111.90	61.39	109.94	-1.93
72CK12 (Cloverbar - Kennedale)	72CK13 (Cloverbar - Kennedale)	53.7	65.2	62.46	111.90	61.39	109.94	-1.93
72RG7 (Rossdale - Garneau)	72RG1 (Rossdale - Garneau)	62.3	134.2	80.82	125.34	91.15	142.14	16.8*
72RG1 (Rossdale - Garneau)	72RG7 (Rossdale - Garneau)	86.3	134.2	65.81	167.57	91.18	102.46	13.46*

*Although the loading on 72RG1 is below the emergency rating, the emergency rating provided by the TFO is only valid for 10 minutes. The TFO has advised that major equipment failures such as a cable fault, a cable splice failure or a termination failure would result in extended unavailability of the equipment for a duration of weeks to months (See EDTI-AESO-2019APR09-003 in NID Appendix G). Therefore, these overloads may not be resolved by real-time operating practices within the 10 minutes provided by the emergency rating without shedding load (See EDTI-AESO-2019APR09-008 in NID Appendix G).

6.2. Voltage Stability Study Results

Voltage stability analysis was performed for the post-Project 2020 SP scenario. The reference load level for the Study Area is 2350 MW. To meet the voltage stability criteria, the minimum incremental load transfer for the Category B contingencies is 5.0% of the reference load or approximately 117 MW.

Table 6-3 below summarizes the voltage stability results for Category A and the five worst contingencies. Voltage stability diagrams are provided in Attachment C.

The voltage stability margin was met for all studied conditions.

Table 6-3: Voltage Stability Results for the 2020 SP Post-Project Scenario

Contingency	From	To	Maximum incremental transfer (MW)	Meets 105% transfer criteria?
N-G-0	System Normal		1050.00	Yes
240CV5	Castle Downs	Victoria	768.75	Yes
Rossdale T2/T3	Rossdale 72kV	Rossdale 14.4kV	768.75	Yes
Victoria T5	Victoria 240kV	Victoria 72kV	775.00	Yes
Bellamy T1/T2	Bellamy	Rossdale	856.25	Yes
1202L	Ellerslie 89S	Keephills 320P	937.50	Yes

6.3. Short-Circuit Study Results

Short-circuit current levels for the studied alternative are provided below in Table 6-4, Table 6-5 and Table 6-6 below.[12]

Table 6-4: Short-Circuit Results for the 2020 WP Pre-Project Scenario

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)
Jasper 240kV	240	249.64	18.1	0.003+0.013j	15.7	0.003+0.020j
Jasper 72kV	69	74.16	13	0.008+0.069j	16.4	0.001+0.026j
Rossdale 72kV	69	71.99	28.6	0.005+0.030j	37.1	0.001+0.010j
Meadowlark 72kV	69	73.71	10.3	0.021+0.085j	10.6	0.055+0.066j
Garneau 72kV	69	71.87	26.2	0.007+0.033j	30.9	0.009+0.017j
Poundmaker 240kV	240	249.4	17.3	0.003+0.014j	15.3	0.003+0.020j

[12] 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 6-5: Short-Circuit Results for the 2020 WP Post-Project Scenario (With breaker M725 open)

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)
Jasper 240kV	240	249.08	18.1	0.003+0.013j	16.6	0.002+0.018j
Jasper 72kV	69	74	13	0.008+0.069j	16.5	0.001+0.025j
Rossdale 72kV	69	71.95	28.5	0.005+0.030j	37	0.001+0.010j
Meadowlark 72kV	69	73.55	10.2	0.021+0.085j	10.6	0.055+0.065j
Garneau 72kV	69	71.85	26.1	0.007+0.033j	30.8	0.009+0.016j
Poundmaker 240kV	240	248.75	17.3	0.003+0.014j	16.5	0.002+0.017j

Table 6-6: Short-Circuit Results for the 2028 WP Post-Project Scenario

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)
Jasper 240kV	240	250.14	18.6	0.003+0.013j	16.2	0.003+0.020j
Jasper 72kV	69	74.41	12.9	0.007+0.070j	16.4	0.001+0.026j
Rossdale 72kV	69	71.66	30.7	0.004+0.028j	39.6	0.001+0.009j
Meadowlark 72kV	69	73.99	10.2	0.021+0.086j	10.6	0.055+0.066j
Garneau 72kV	69	71.56	28	0.006+0.031j	32.7	0.009+0.016j
Poundmaker 240kV	240	249.82	17.8	0.003+0.014j	16.5	0.002+0.018j

7. Results Analysis and Mitigation Measures

7.1. Results Summary

The Reliability Criteria violations observed during the connection assessment studies and the associated mitigation measures are summarized in Table 7-1. Under certain Category B conditions, thermal criteria violations were observed in the pre-Project and post-Project scenarios.

Table 7-1: Mitigation Measures for Thermal Criteria Violations under Category B Conditions for Pre-Project and Post-Project Scenarios

Identified Reliability Criteria Violations		Year/ Season Load	Pre-Project Thermal Criteria Violation	Pre-Project Mitigation Measures	Post Project Thermal Criteria Violation	Post Project Mitigation Measures	Project Impact [a]
Violation	Contingency						
72RG1 (Rossdale - Garneau)	72RG7(Rossdale - Garneau)	2020SP 2020WP	Above normal rating	Real-time operational practices [b]	Above normal rating	Garneau – Meadowlark Reconfiguration RAS	Materially increased thermal criteria violation, mitigated by the Garneau-Meadowlark Reconfiguration RAS (see Section 7.3)
72RG7 (Rossdale - Garneau)	72RG1(Rossdale - Garneau)	2020SP	Above normal rating	Real-time operational practices [b]	Above normal rating		Materially increased thermal criteria violation, mitigated by the Garneau-Meadowlark Reconfiguration RAS (see Section 7.3)
		2020WP	n/a	n/a	Above normal rating		New thermal criterial violation mitigated by the Garneau-Meadowlark Reconfiguration RAS
72JM18 (Jasper - Meadowlark) /Jasper T1	New 72PM25 (Poundmaker - Meadowlark)	2020SP	n/a	n/a	Above emergency rating		New thermal criterial violation mitigated by the Garneau-Meadowlark Reconfiguration RAS
	New Poundmaker Transformer T4	2020SP	n/a	n/a	Above emergency rating		New thermal criterial violation mitigated by the Garneau-Meadowlark Reconfiguration RAS
	72MG16 (Meadowlark - Garneau)	2020SP	Above emergency rating	Real-time operational practices [b]	n/a	Real-time operational practices [b]	Resolved thermal criteria violation
72CH11 (Clover Bar - Hardisty)	72CH9 (Clover Bar - Hardisty)	2020SP 2020WP	Above normal rating		Above normal rating		Marginally reduced thermal criteria violation
72CH9 (Clover Bar - Hardisty)	72CH11(Clover Bar - Hardisty)	2020SP 2020WP	Above normal rating		Above normal rating		Marginally reduced thermal criteria violation
72CK12 (Clover Bar - Kennedale)	72CK13(Clover Bar - Kennedale)	2020SP	Above emergency rating		Above normal rating		Marginally reduced thermal criteria violation
		2020WP	Above normal rating				
72CK13 (Clover Bar - Kennedale)	72CK12(Clover Bar - Kennedale)	2020SP	Above emergency rating		Above normal rating		Marginally reduced thermal criteria violation
		2020WP	Above normal rating				
72RG1 (Rossdale - Garneau)	72JM18 (Jasper - Meadowlark)	2020SP	Above normal rating		n/a		Resolved thermal criteria violation
72MG16 (Meadowlark - Garneau)	72JM18 (Jasper - Meadowlark)	2020SP 2020WP	Above emergency rating		n/a		Resolved thermal criteria violation

[a]Marginally reduced indicates post-Project loading is less than pre-Project loading by less than 3%; Materially increased indicates post-Project loading is more than pre-Project loading by more than 3%; New indicates pre-Project loading was below the normal rating and post-Project loading was above the normal rating; Resolved indicates a thermal criteria violation that was observed pre-Project was no longer observed post-Project

[b]Real-time operational practices may include load shedding

7.2. Mitigation Measures

7.2.1. Pre-Project

Real-time operational practices are currently being used to manage the observed pre-Project system performance issues. These real time operating practices may result in load shedding.

7.2.2. Post-Project

Most of the post-Project system performance issues can continue to be managed using real-time operational practices (i.e. 72CH9, 72CH11, 72CK12, 72CK13). However, certain post-Project system performance issues cannot be managed by using real-time operational practices. The contingency of 72RG7 or 72RG1 will result in load shedding; therefore, the AESO determined that a reconfiguration remedial action scheme (RAS) is required to mitigate these system performance issues. This RAS also addresses the issue of N-1 load shedding at Meadowlark substation.

7.3. Proposed Garneau – Meadowlark Reconfiguration RAS

Post-Project an automated switching scheme RAS is required to mitigate observed system performance issues, during Category B contingency conditions. This RAS acts to automatically switch 72 kV transmission system elements upon certain contingencies.

This RAS, hereafter referred to as the Garneau-Meadowlark Reconfiguration RAS, has four actions:

- Under loss of 72RG7, reclose 72MG16 and split the Garneau 72kV bus
- Under loss of 72RG1, reclose 72MG16 and split the Garneau 72kV bus
- Under loss of the new 72kV transmission line 72PM25, reclose 72MG16 and split the Meadowlark 72kV bus
- Under loss of the new 240/72kV Poundmaker transformer, reclose 72MG16 and split the Meadowlark 72kV bus

7.4. Garneau – Meadowlark Reconfiguration RAS Evaluation

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 the proposed Garneau – Meadowlark Reconfiguration RAS.

The post-RAS studies were performed under Category B conditions for the 2020 SP and WP scenarios using Alternative 1B and the RAS described in Sections 7.3.

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

7.4.1. Scenario 3- Post-Project 2020 SP with Garneau – Meadowlark Reconfiguration RAS

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by Garneau – Meadowlark Reconfiguration RAS, as shown in Table 7-2.

Table 7-2: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2020 SP Post-Project Scenario

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
72RG7 (Rossdale - Garneau)	72RG1 (Rossdale - Garneau)	57.5	134.2	91.21	154.4	28.6	47.6
72RG1 (Rossdale - Garneau)	72RG7 (Rossdale - Garneau)	76.7	134.2	91.23	115.6	28.5	35.7
New 72PM25 (Poundmaker - Meadowlark)	72JM18 (Jasper - Meadowlark)	57.5	57.5	64.53	105.7	42.4	68.5
New Poundmaker Transformer T4	72JM18 (Jasper - Meadowlark)	57.5	57.5	64.14	105.0	42.4	68.5

7.4.2. Scenario 4- Post-Project 2020 WP with Garneau – Meadowlark Reconfiguration RAS

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by Garneau – Meadowlark Reconfiguration RAS, as shown in Table 7-3.

Table 7-3: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2020 WP Post-Project Scenario

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Load Flow (MVA)	% Loading	Load Flow (MVA)	% Loading
72RG7 (Rossdale - Garneau)	72RG1 (Rossdale - Garneau)	62.3	134.2	91.15	142.14	28.5	43.9
72RG1 (Rossdale - Garneau)	72RG7 (Rossdale - Garneau)	86.3	134.2	91.18	102.46	28.5	31.6

7.5 Transmission System Development Alignment

In pre-Project scenarios, thermal criteria violations are observed on the 72 kV transmission lines 72RG1 and 72RG7 under Category B conditions, as shown in Table 7-1. These thermal criteria violations are presently managed using real-time operational measures which may include load shedding, which would be in violation of the Reliability Criteria.

These thermal criteria violations observed on the 72 kV transmission lines 72RG1 and 72RG7 are consistent with the near term need to upgrade the 72 kV circuits between Garneau and Rossdale substations, as identified in the 2017 LTP (see Table 1-1). However, upgrading the 72 kV circuits between Garneau and Rossdale (as described in Alternative 3B) was determined to be insufficient to address the entirety of the DFO's request for system access service.

As shown in Sections 7.4.1 and 7.4.2, the Garneau – Meadowlark Reconfiguration RAS can reduce power flows below the normal rating of the 72 KV transmission lines 72RG1 and 72RG7 without dropping load, and therefore will meet the requirements of TPL standard TPL-002-AB1-0. Both AESO and EDTI have acknowledged that the Garneau – Meadowlark Reconfiguration RAS is currently acceptable. Therefore, Alternative 1B with the Garneau – Meadowlark Reconfiguration RAS defers the timing of the need to upgrade the 72 kV circuits between Garneau and Rossdale substations identified in the 2017 LTP (see Table 1-1). The future potential need to upgrade the 72 kV circuits between Garneau and Rossdale substations will be reviewed as part of the AESO's LTP planning process.

8. Project Dependencies

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

9. Conclusion and Recommendations

Based on the study results Alternative 1B is technically viable and addresses the distribution deficiencies identified by the DFO. The connection assessment identified pre-Project and post-Project system performance issues. These system performance issues can be mitigated using real-time operational practices and the Garneau-Meadowlark Reconfiguration RAS. With the implementation of these mitigation measures, the connection of the project with Alternative 1B will not adversely affect the performance of the AIES.

It is recommended to proceed with the Project using Alternative 1B as the preferred option to respond to the DFO's request for system access service. It is also recommended to use real-time operational practices and the Garneau-Meadowlark Reconfiguration RAS to mitigate the identified system performance issues (collectively, the Proposed Transmission Development).

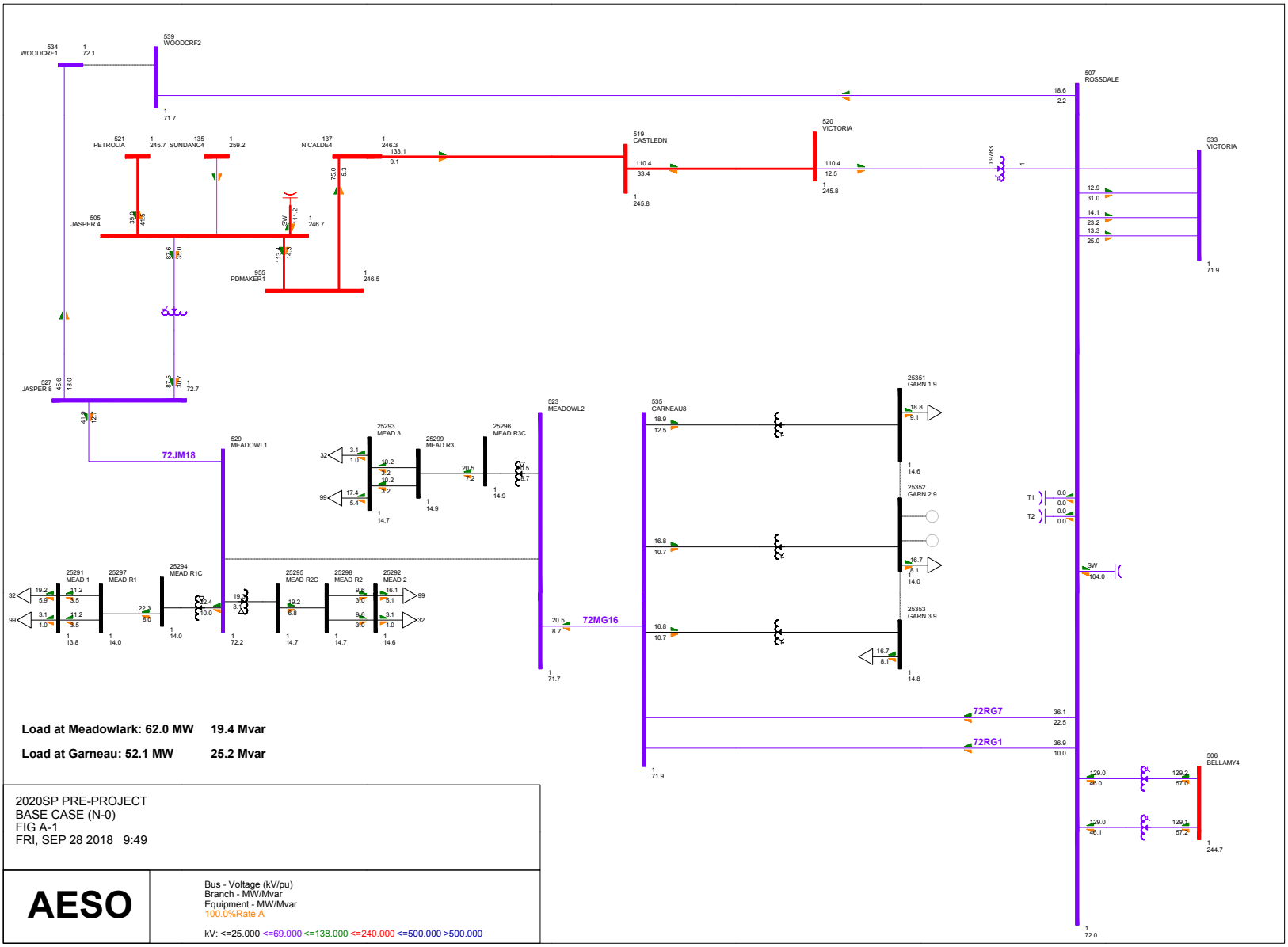
Alternative 1B involves adding one 72 kV circuit between the Poundmaker and Meadowlark substations. Alternative 1B also involves upgrading the Poundmaker substation, including adding one 240/72 kV transformer, one 240 kV circuit breaker and one 72 kV circuit breaker, as well as modifying the Meadowlark substation, including adding two 72 kV circuit breakers. Finally, Alternative 1B involves upgrading the Garneau substation, including replacing the three existing 72/14.4 kV transformers with three 72/14.4 kV transformers of higher capacity.

It is recommended that the 72 kV circuit between Poundmaker and Meadowlark substations has a minimum capacity of 69 MVA and that the 240/72 kV transformer at the Poundmaker substation has a minimum transformation capacity of 69 MVA to meet the existing DTS contract capacity at the Meadowlark substation and the DFO's Distribution Planning Criteria - POD Loading Policy. A minimum transformation capacity of 41 MVA is recommended for each of the transformers at the Garneau substation to meet the requested DTS contract capacity at the Garneau substation and the DFO's Distribution Planning Criteria - POD Loading Policy.

Attachment A

Power Flow Diagrams

2020SP/2020WP Pre-Project



Load at Meadowlark: 62.0 MW 19.4 Mvar

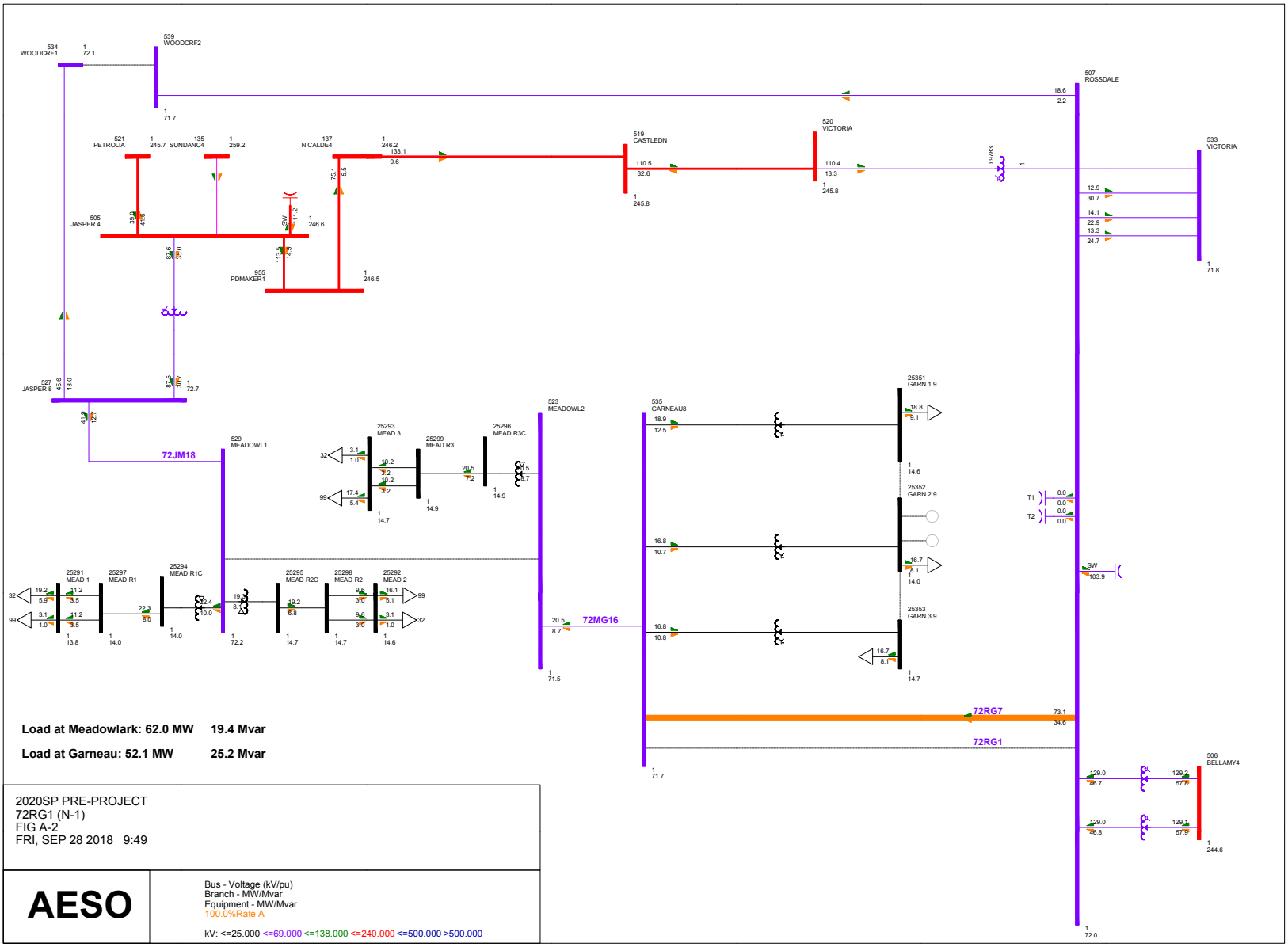
Load at Garneau: 52.1 MW 25.2 Mvar

2020SP PRE-PROJECT
BASE CASE (N-0)
FIG A-1
FRI, SEP 28 2018 9:49

AESO

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

kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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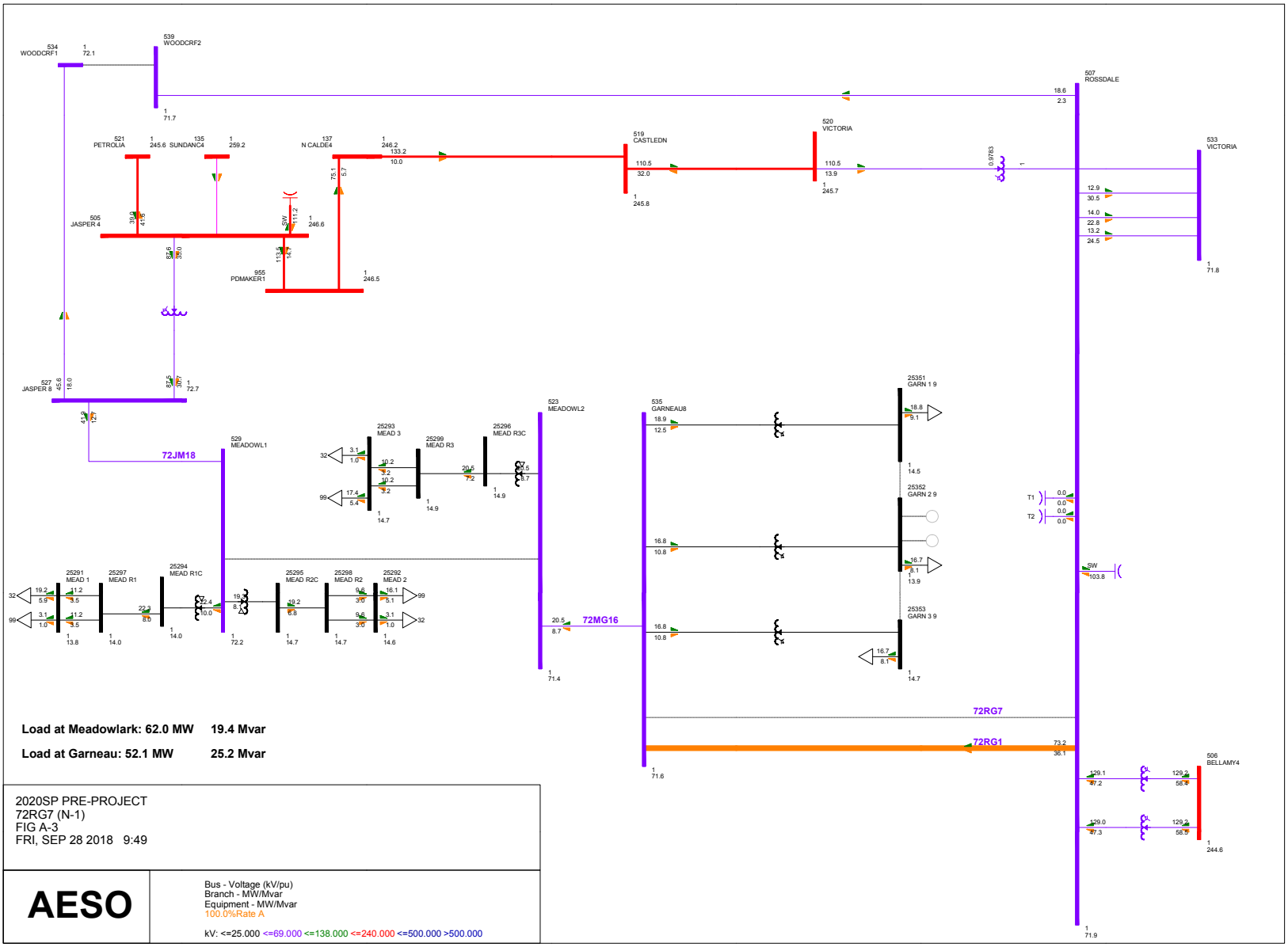
539 WOODCRF2
507 ROSSDALE
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
527 JASPER 8
529 MEADOWL1
72JM18
523 MEADOWL2
535 GARNEAU8
72MG16
72RG7
72RG1
506 BELLAMY4
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
SW
T1
T2
Load at Meadowlark: 62.0 MW 19.4 Mvar
Load at Garneau: 52.1 MW 25.2 Mvar
2020SP PRE-PROJECT
72RG1 (N-1)
FIG A-2
FRI, SEP 28 2018 9:49
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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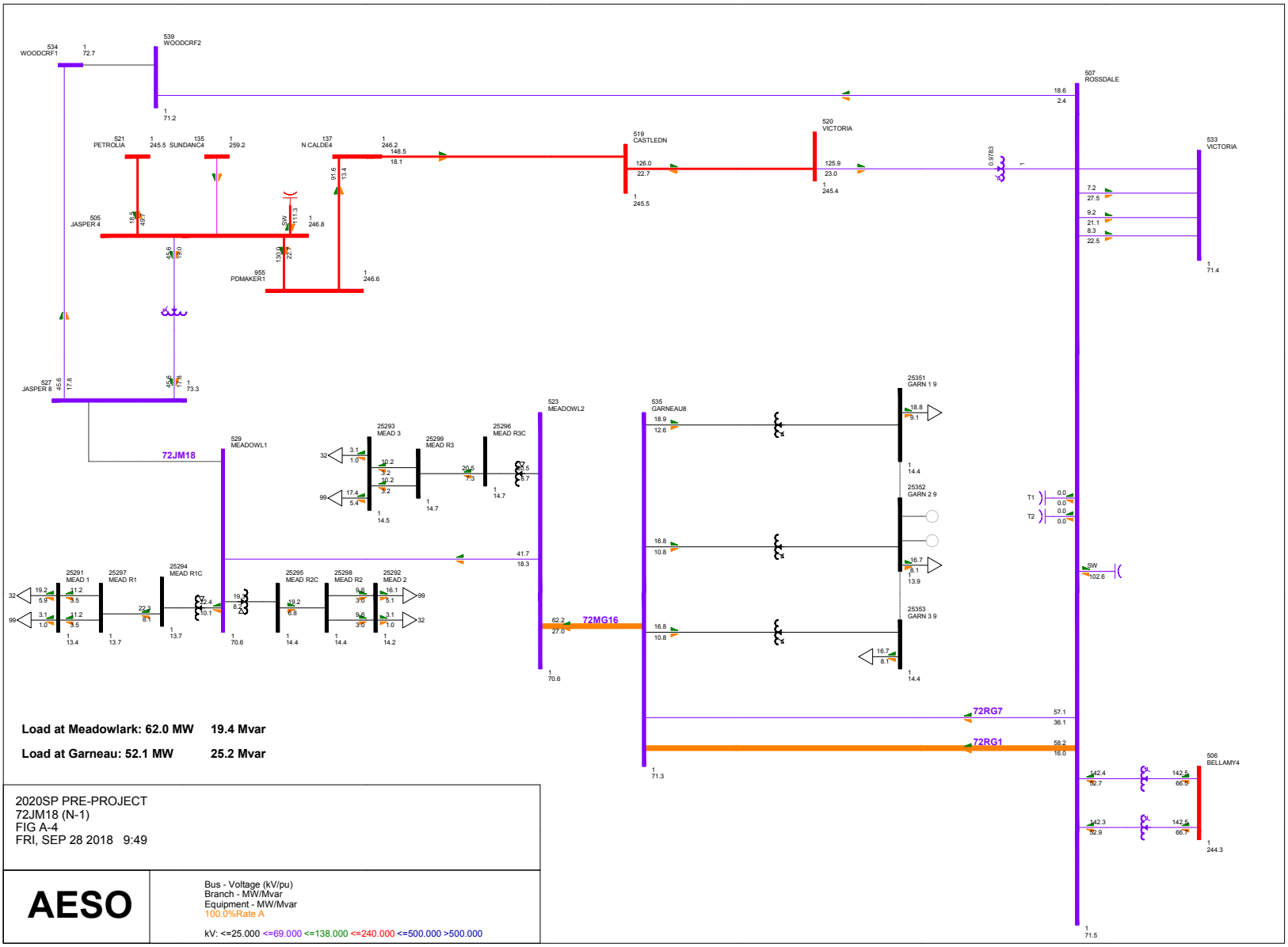
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
527 JASPER 8
529 MEADOWL1
72JM18
523 MEADOWL2
535 GARNEAU8
72MG16
72RG7
72RG1
506 BELLAMY4
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
SW
T1
T2
Load at Meadowlark: 62.0 MW 19.4 Mvar
Load at Garneau: 52.1 MW 25.2 Mvar
2020SP PRE-PROJECT
72RG7 (N-1)
FIG A-3
FRI, SEP 28 2018 9:49
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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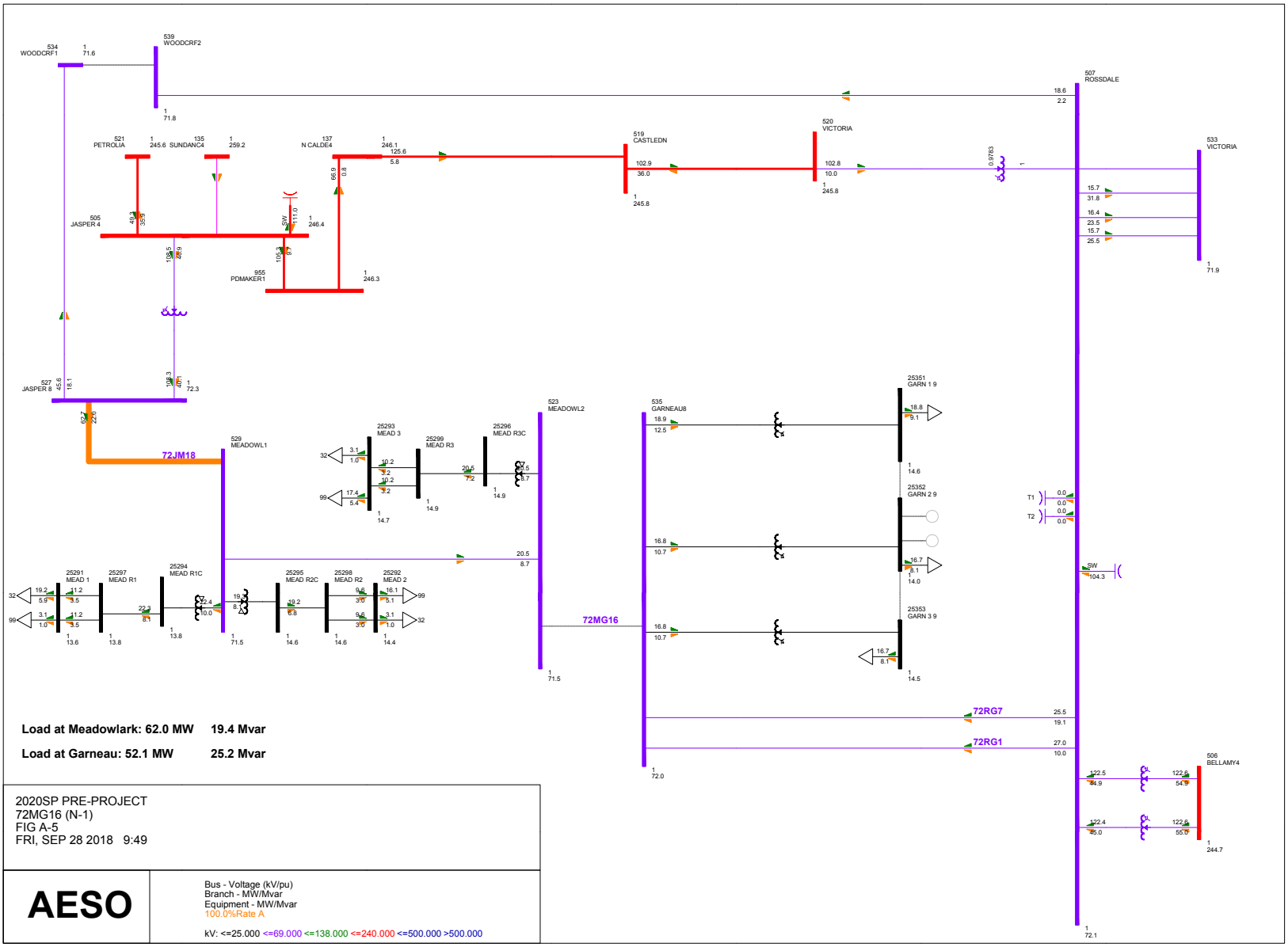
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
527 JASPER 8
529 MEADOWL1
72JM18
523 MEADOWL2
535 GARNEAU8
72MG16
72RG7
72RG1
506 BELLAMY4
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
SW
T1
T2
Load at Meadowlark: 62.0 MW 19.4 Mvar
Load at Garneau: 52.1 MW 25.2 Mvar
2020SP PRE-PROJECT
72JM18 (N-1)
FIG A-4
FRI, SEP 28 2018 9:49
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Load at Meadowlark: 62.0 MW 19.4 Mvar

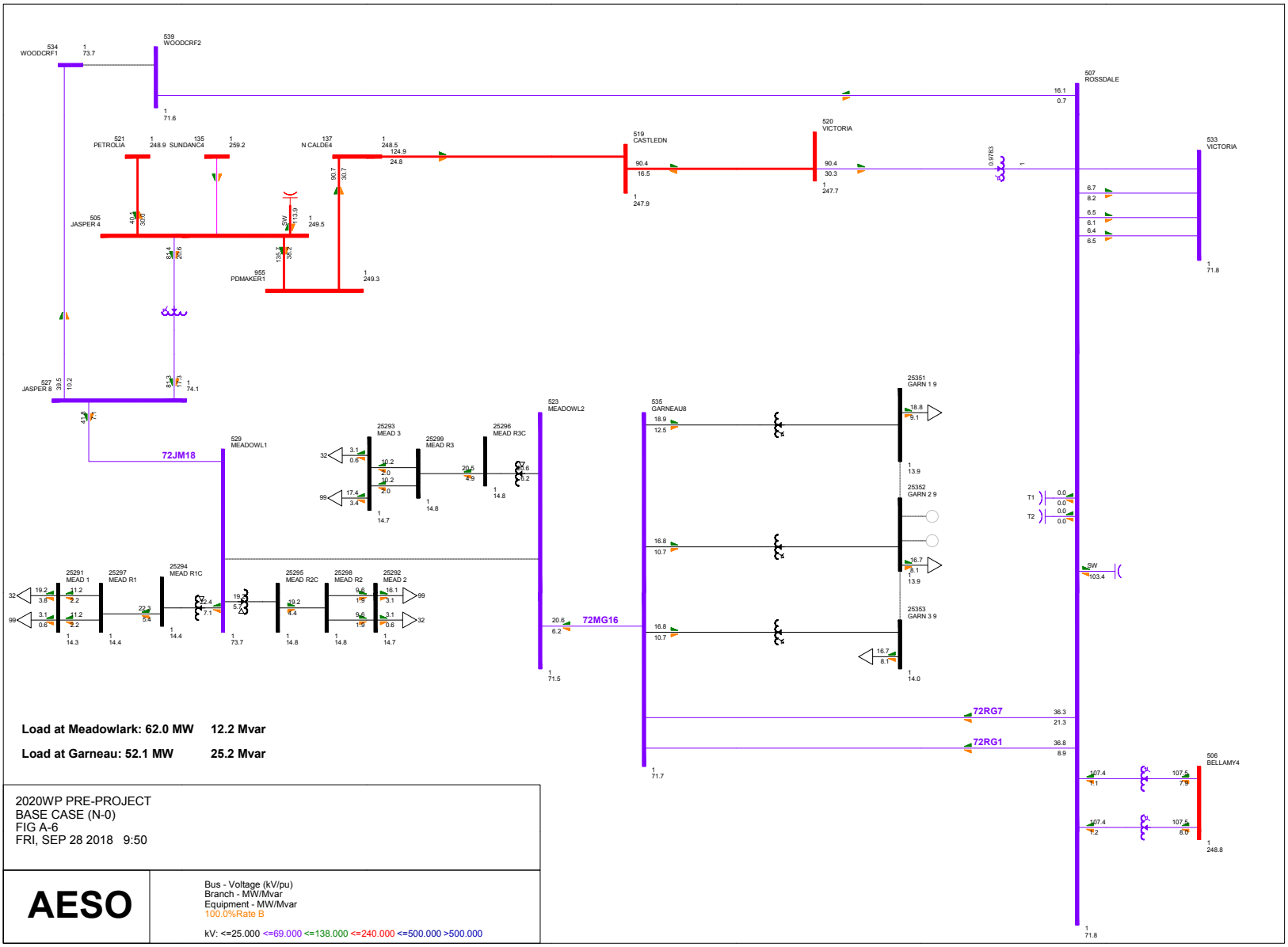
Load at Garneau: 52.1 MW 25.2 Mvar

2020SP PRE-PROJECT
72MG16 (N-1)
FIG A-5
FRI, SEP 28 2018 9:49

AESO

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

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



Load at Meadowlark: 62.0 MW 12.2 Mvar

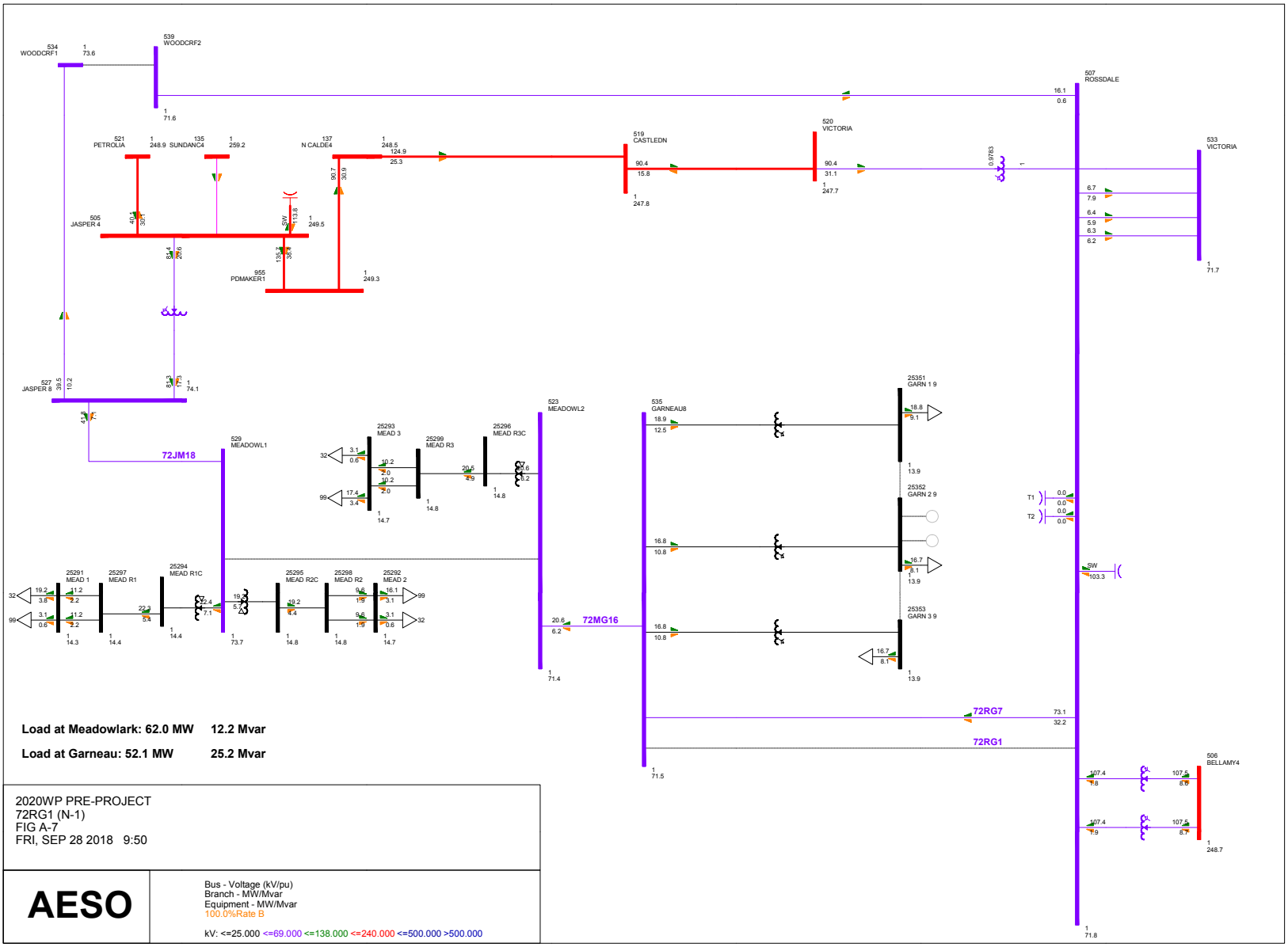
Load at Garneau: 52.1 MW 25.2 Mvar

2020WP PRE-PROJECT
BASE CASE (N-0)
FIG A-6
FRI, SEP 28 2018 9:50

AESO

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

kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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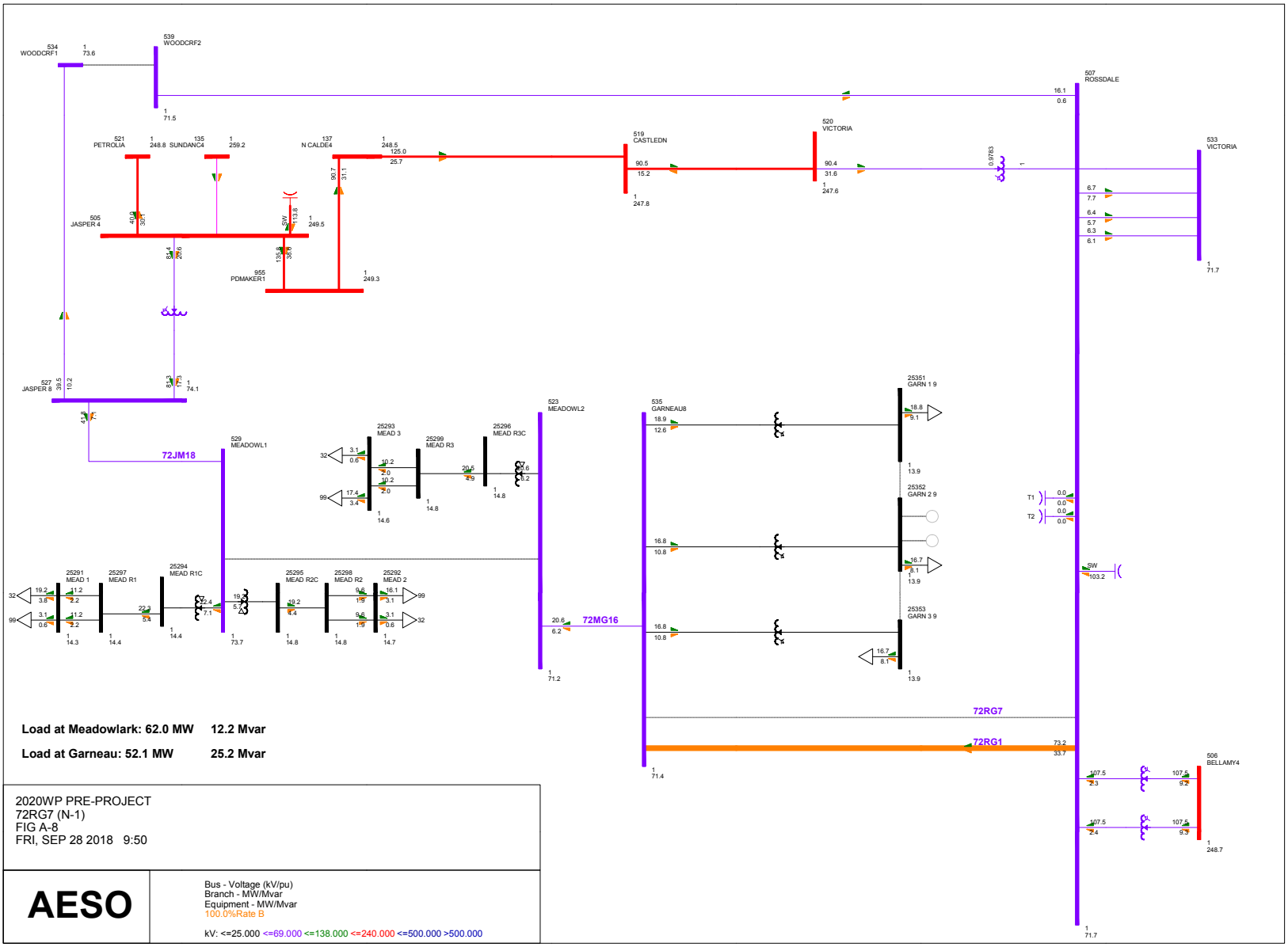
539 WOODCRF2
507 ROSSDALE
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
527 JASPER 8
529 MEADOWL1
72JM18
523 MEADOWL2
535 GARNEAU8
72MG16
72RG7
72RG1
506 BELLAMY4
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
SW
T1
T2
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 52.1 MW 25.2 Mvar
2020WP PRE-PROJECT
72RG1 (N-1)
FIG A-7
FRI, SEP 28 2018 9:50
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

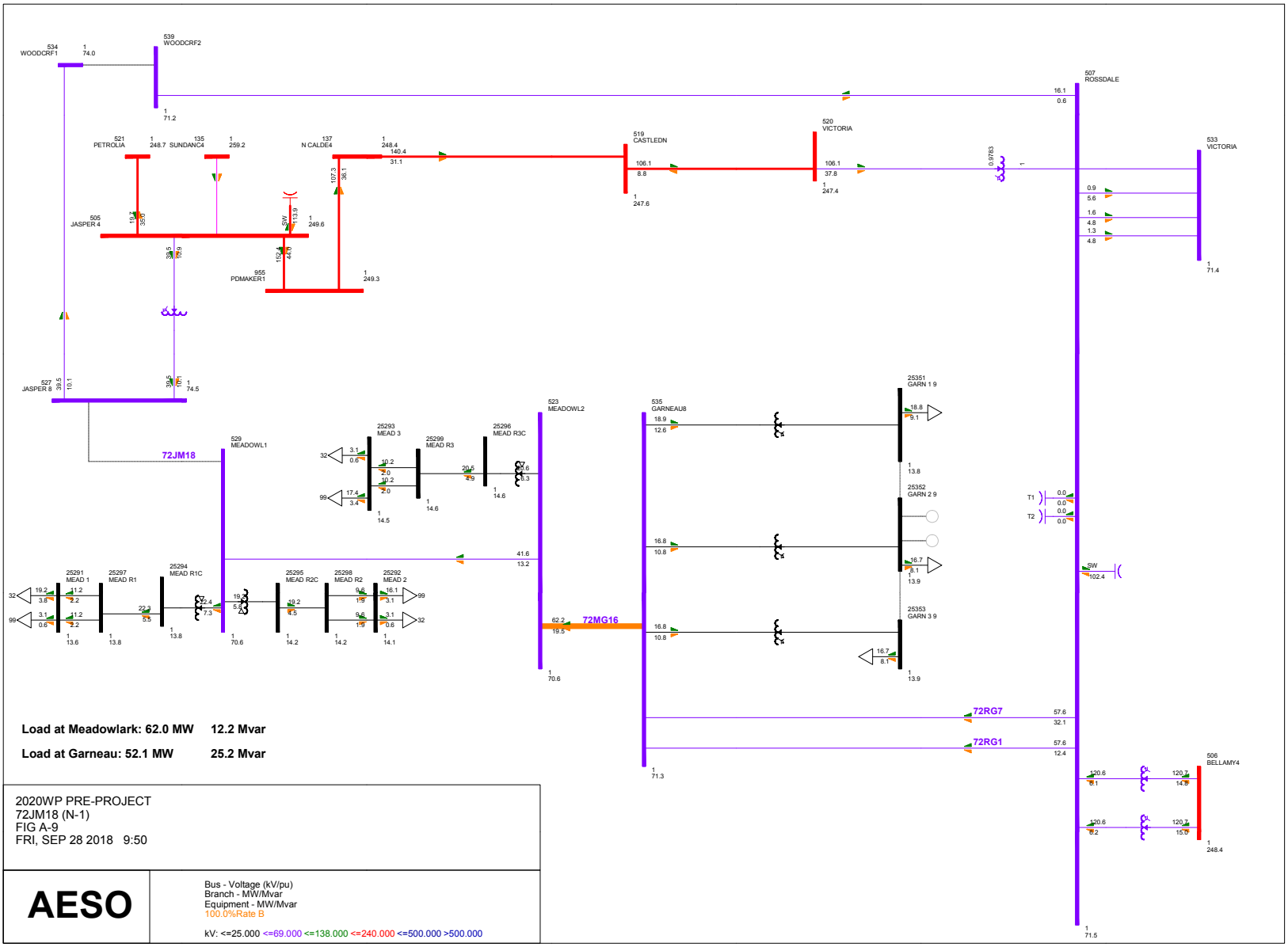


2020WP PRE-PROJECT
72RG7 (N-1)
FIG A-8
FRI, SEP 28 2018 9:50

AESO

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

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



Load at Meadowlark: 62.0 MW 12.2 Mvar

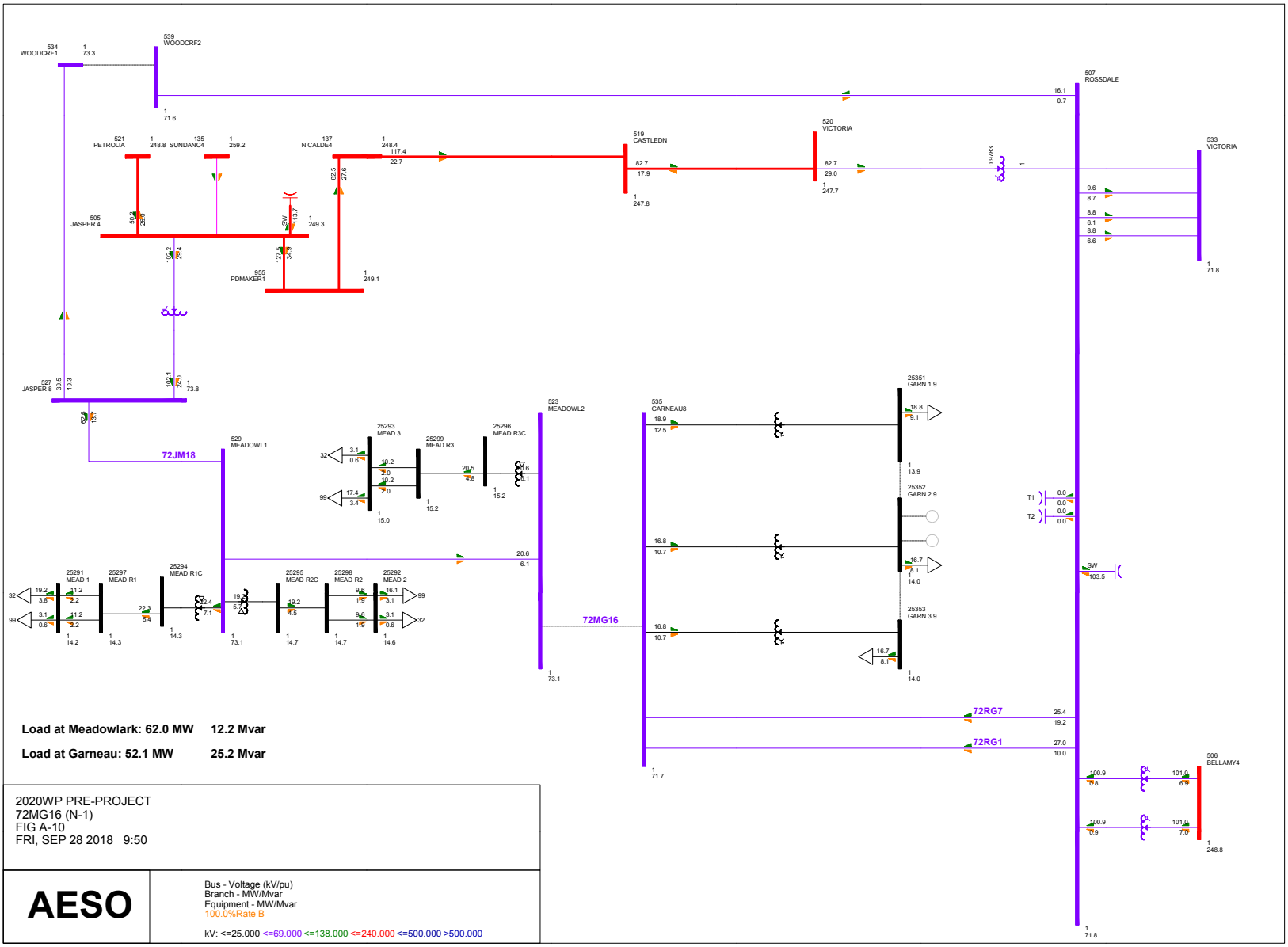
Load at Garneau: 52.1 MW 25.2 Mvar

2020WP PRE-PROJECT
72JM18 (N-1)
FIG A-9
FRI, SEP 28 2018 9:50

AESO

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

kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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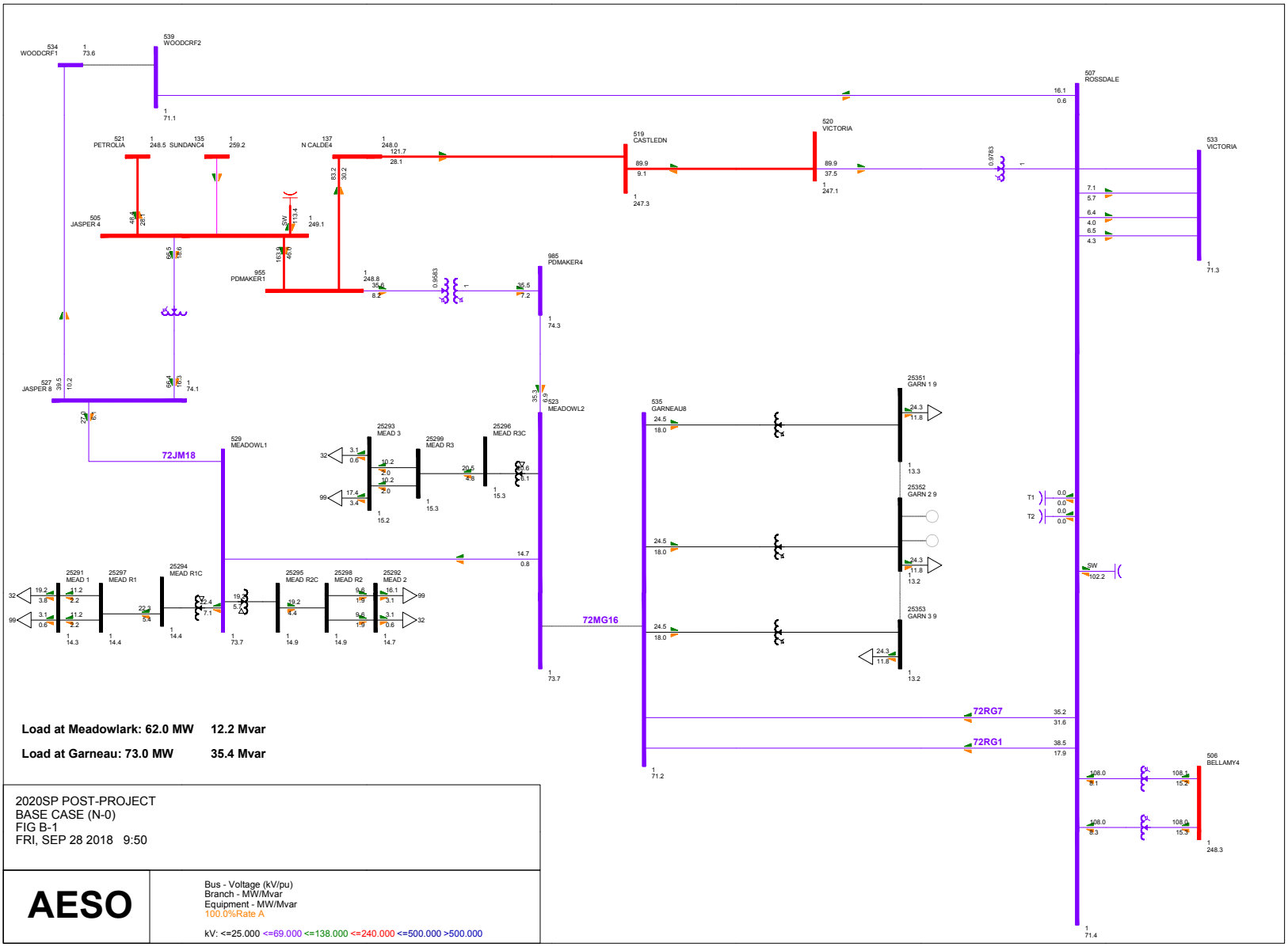
539 WOODCRF2
507 ROSSDALE
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
527 JASPER 8
529 MEADOWL1
523 MEADOWL2
535 GARNEAU8
72JM18
72MG16
72RG7
72RG1
506 BELLAMY4
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
SW
T1
T2
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 52.1 MW 25.2 Mvar
2020WP PRE-PROJECT
72MG16 (N-1)
FIG A-10
FRI, SEP 28 2018 9:50
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Attachment B

Power Flow Diagrams

2020SP/2020WP Post-Project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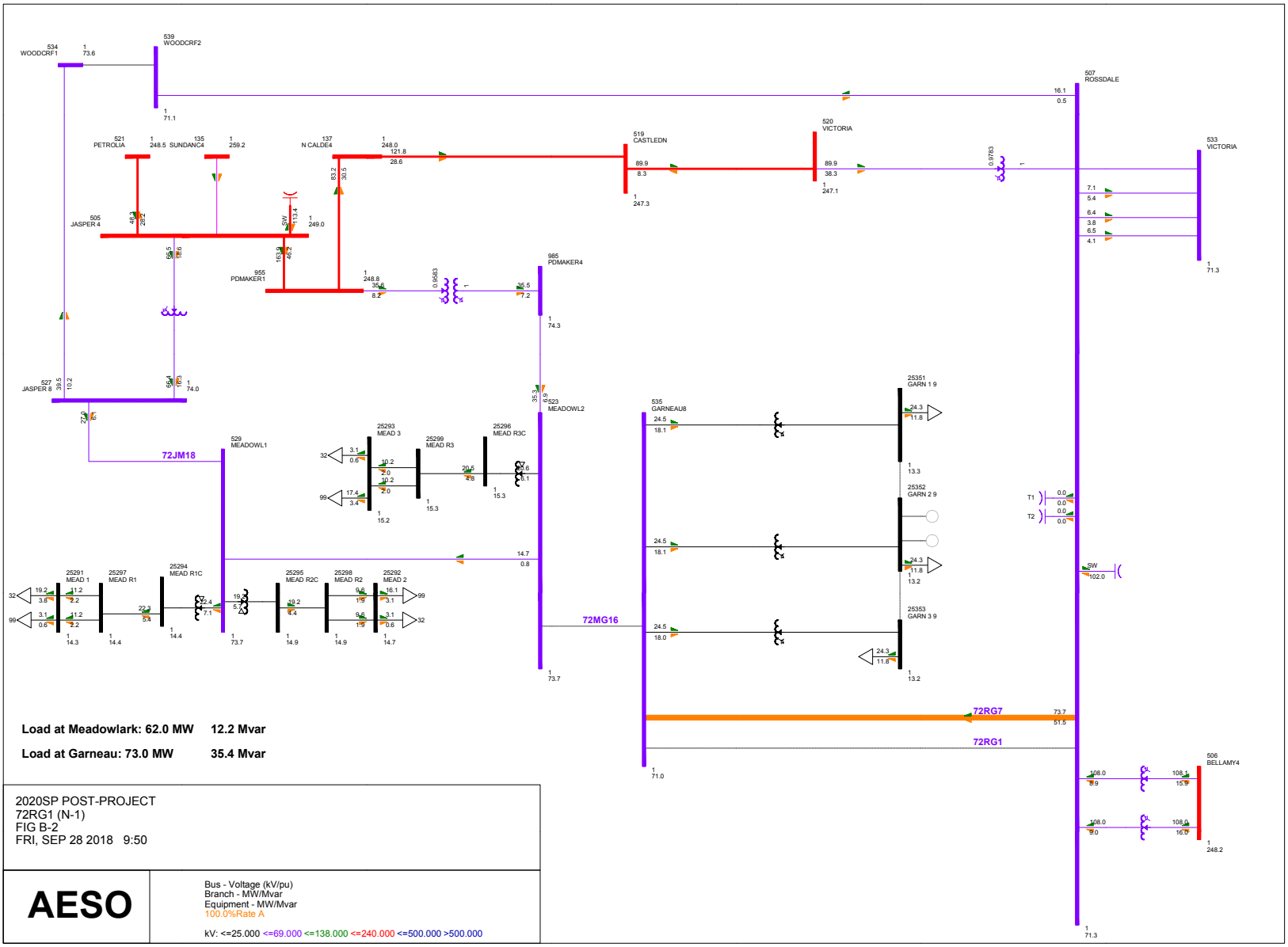
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
529 MEADOWL1
523 MEADOWL2
535 GARNEAU8
72JM18
72MG16
72RG7
72RG1
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
506 BELLAMY4
SW
T1
T2
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020SP POST-PROJECT
BASE CASE (N-0)
FIG B-1
FRI, SEP 28 2018 9:50
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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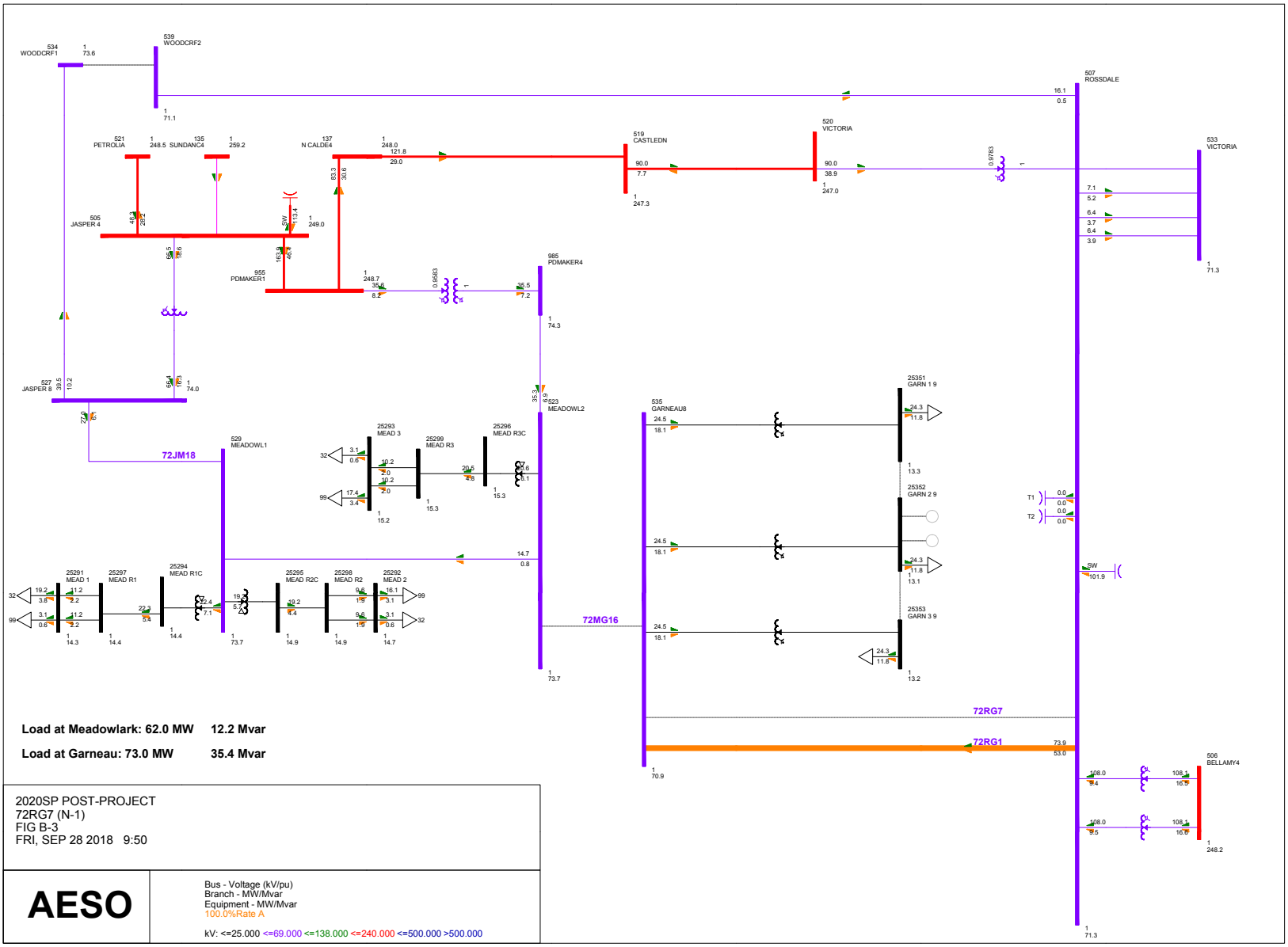
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
529 MEADOWL1
523 MEADOWL2
535 GARNEAU8
72JM18
72MG16
72RG7
72RG1
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
506 BELLAMY4
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020SP POST-PROJECT
72RG1 (N-1)
FIG B-2
FRI, SEP 28 2018 9:50
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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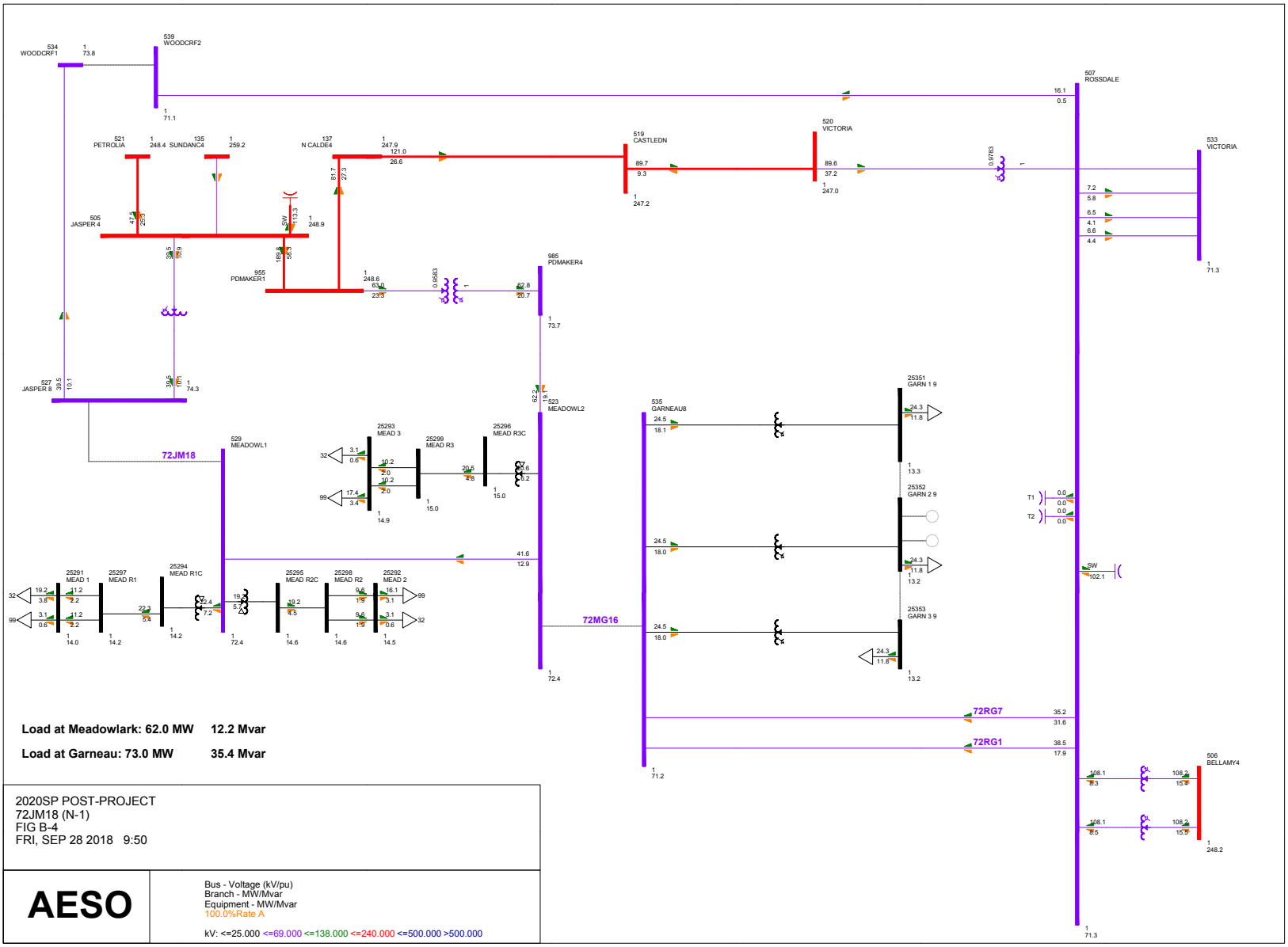
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
523 MEADOWL2
529 MEADOWL1
72JM18
72MG16
72RG7
72RG1
535 GARNEAU8
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
506 BELLAMY4
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020SP POST-PROJECT
72RG7 (N-1)
FIG B-3
FRI, SEP 28 2018 9:50
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Load at Meadowlark: 62.0 MW 12.2 Mvar

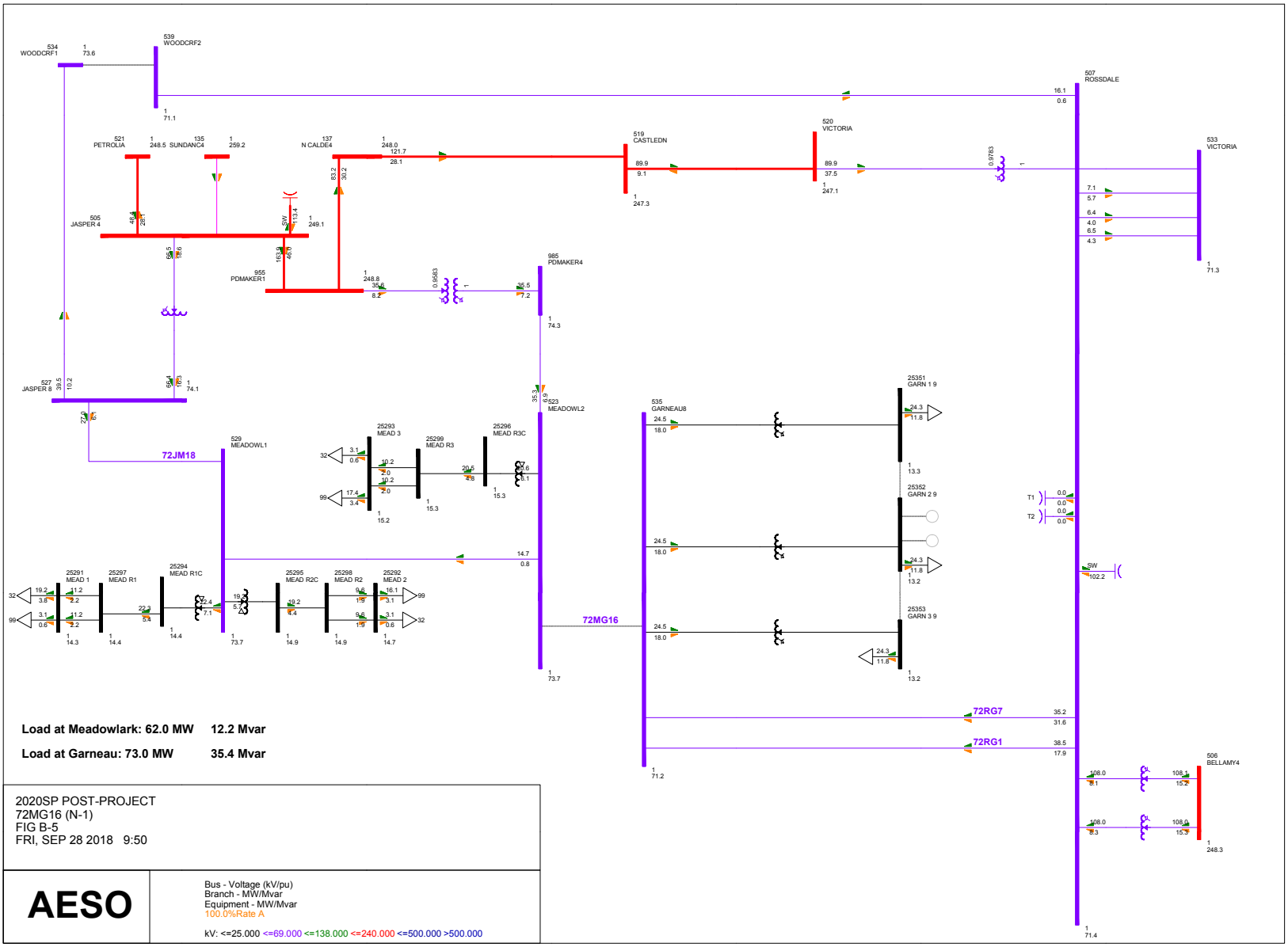
Load at Garneau: 73.0 MW 35.4 Mvar

2020SP POST-PROJECT
72JM18 (N-1)
FIG B-4
FRI, SEP 28 2018 9:50

AESO

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

kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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539 WOODCRF2
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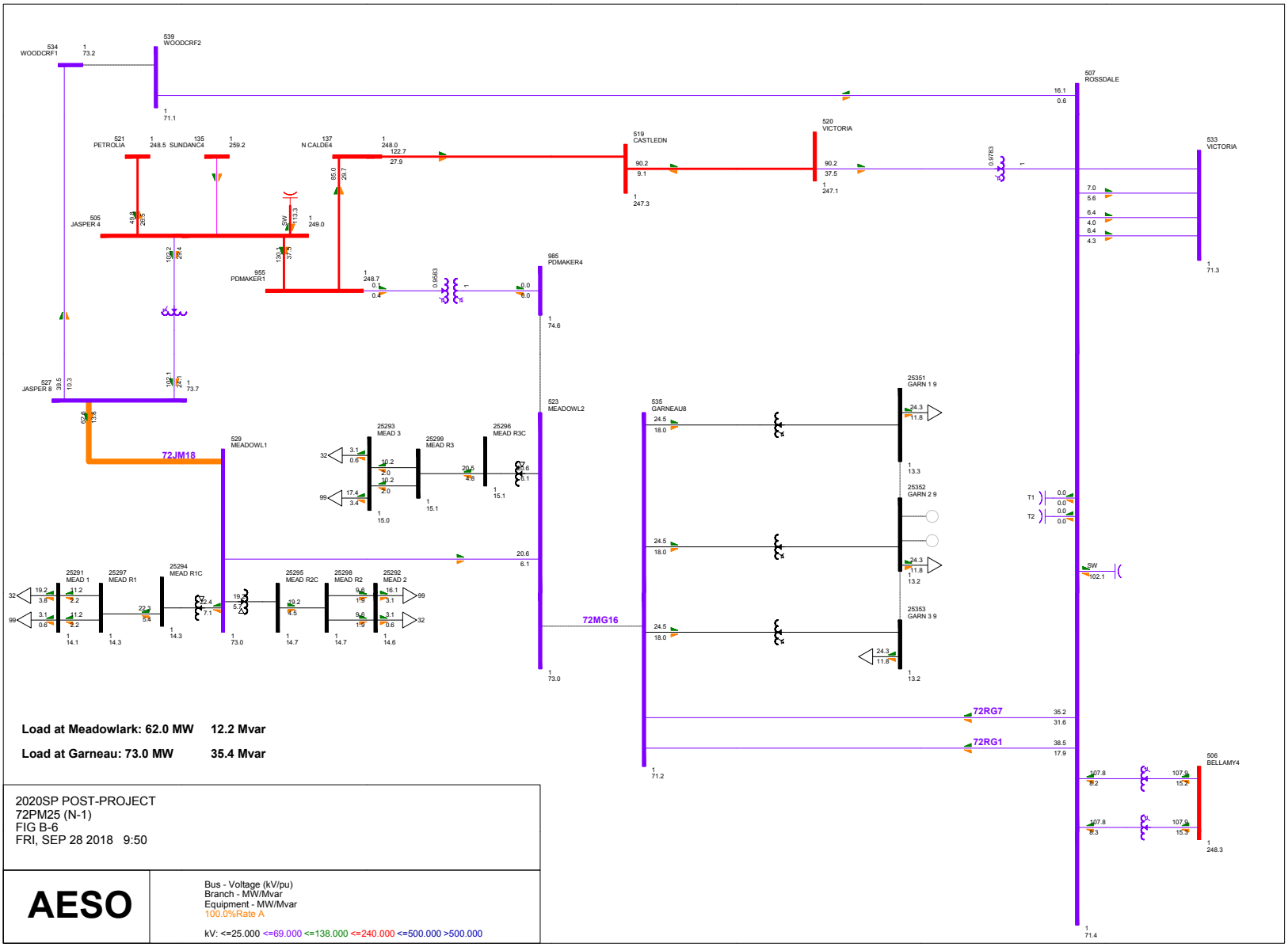
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
529 MEADOWL1
523 MEADOWL2
535 GARNEAU8
72JM18
72MG16
72RG7
72RG1
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
506 BELLAMY4
SW
T1
T2
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020SP POST-PROJECT
72MG16 (N-1)
FIG B-5
FRI, SEP 28 2018 9:50
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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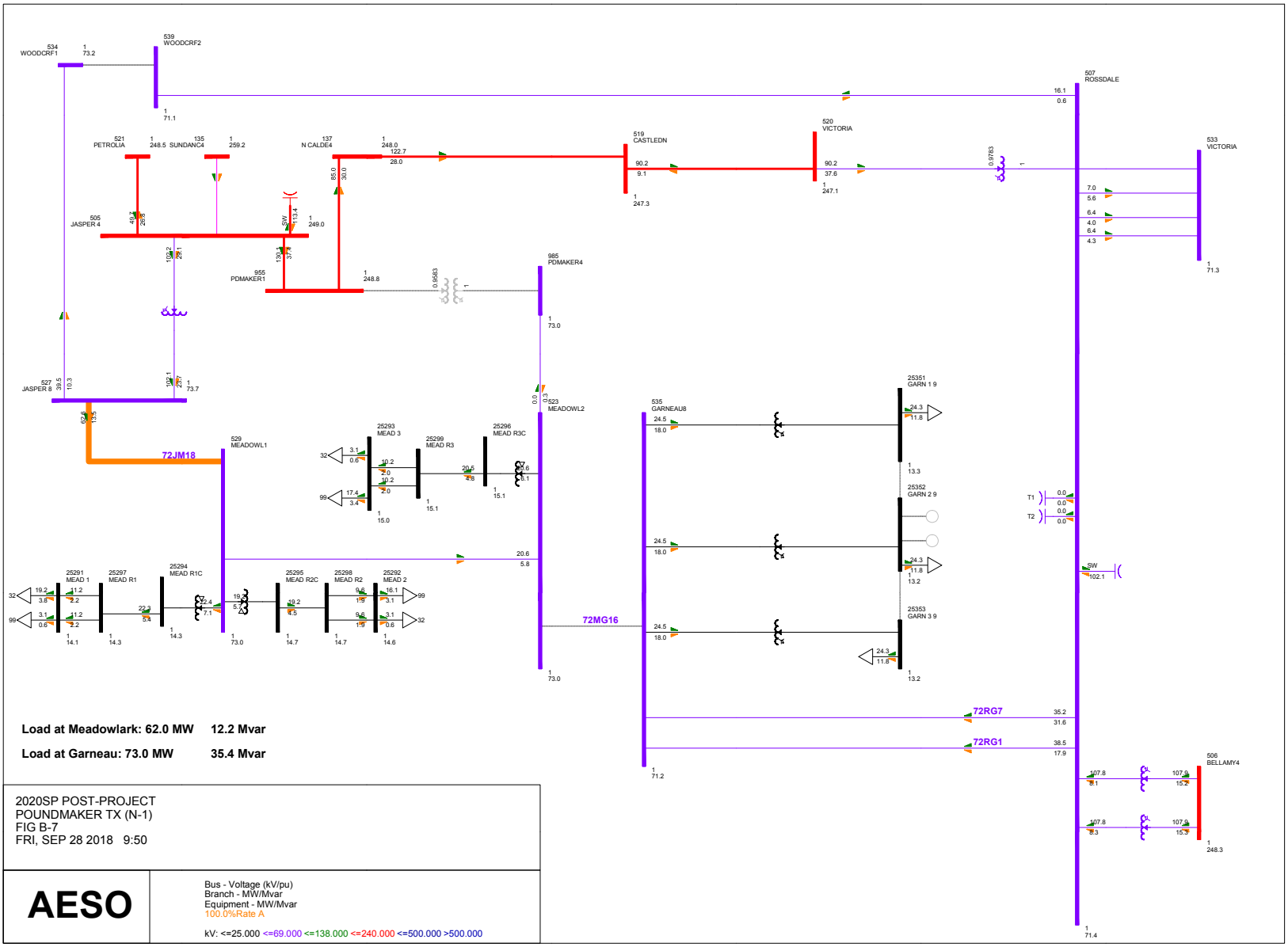
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
72JM18
529 MEADOWL1
523 MEADOWL2
535 GARNEAU8
72MG16
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
72RG7
72RG1
506 BELLAMY4
SW
T1
T2
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020SP POST-PROJECT
72PM25 (N-1)
FIG B-6
FRI, SEP 28 2018 9:50
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Load at Meadowlark: 62.0 MW 12.2 Mvar

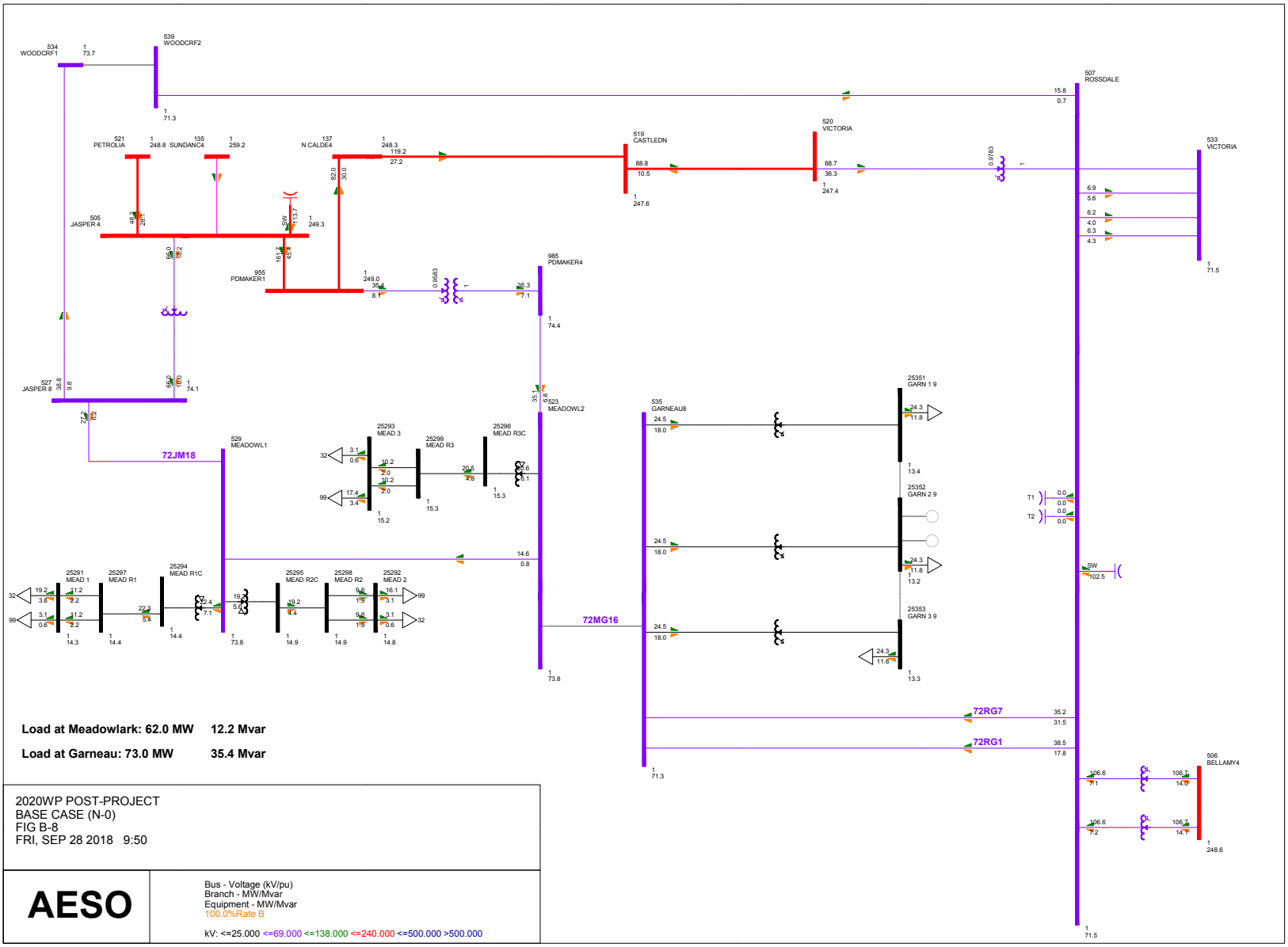
Load at Garneau: 73.0 MW 35.4 Mvar

2020SP POST-PROJECT
POUNDMAKER TX (N-1)
FIG B-7
FRI, SEP 28 2018 9:50

AESO

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

kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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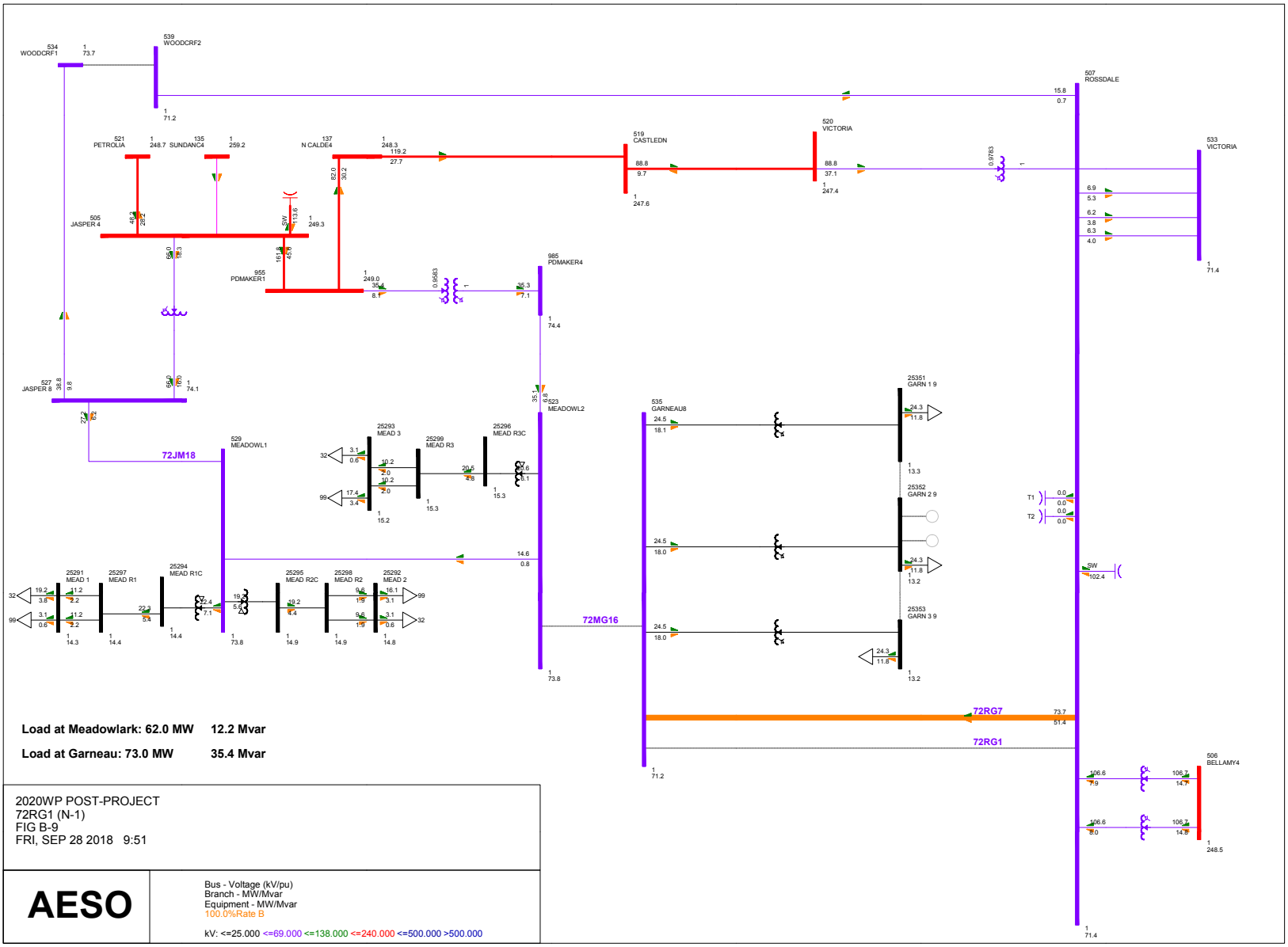
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
529 MEADOWL1
523 MEADOWL2
535 GARNEAU8
72JM18
72MG16
72RG7
72RG1
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
506 BELLAMY4
SW
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020WP POST-PROJECT
BASE CASE (N-0)
FIG B-8
FRI, SEP 28 2018 9:50
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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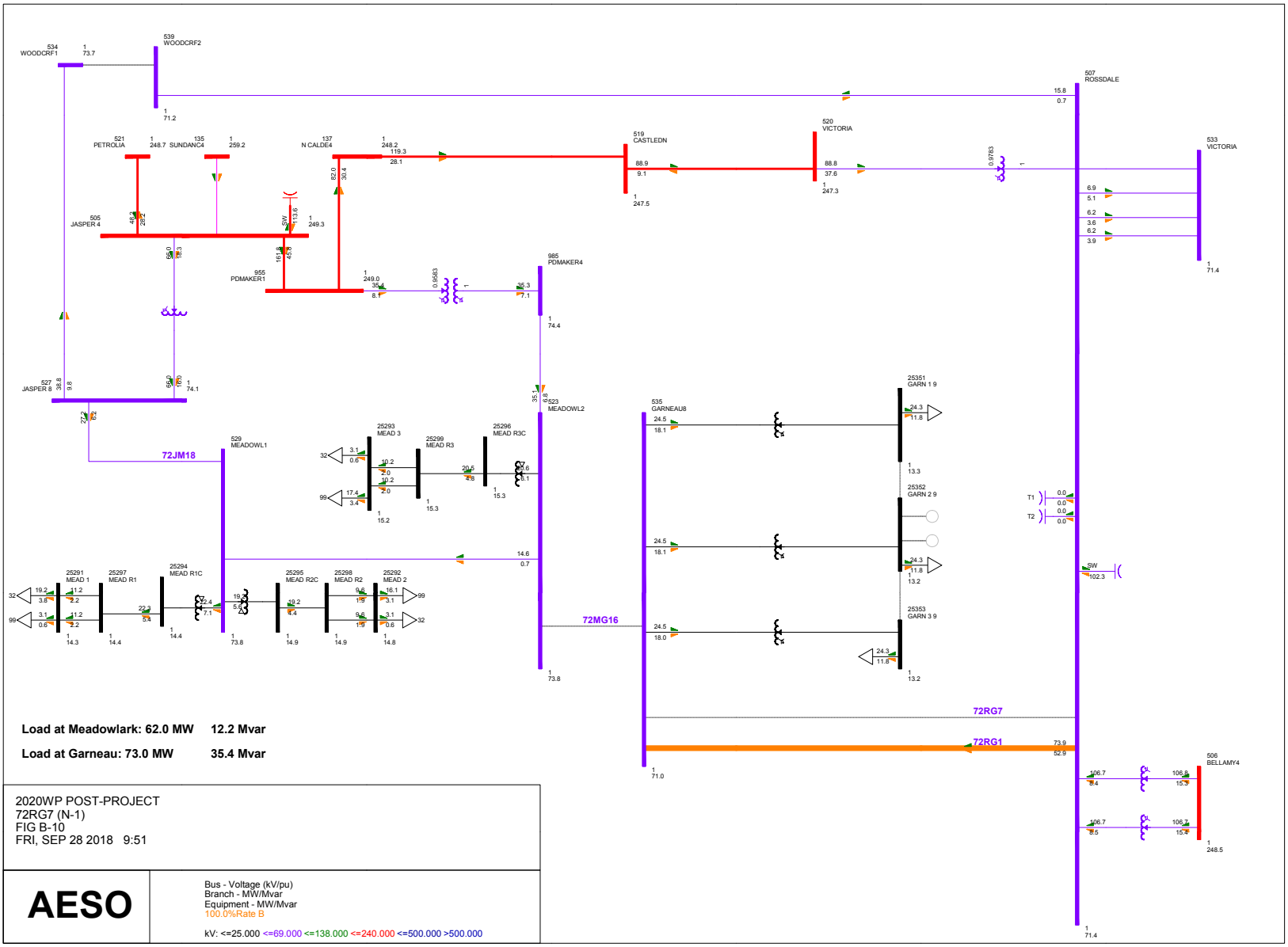
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
529 MEADOWL1
523 MEADOWL2
535 GARNEAU8
72JM18
72MG16
72RG7
72RG1
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
506 BELLAMY4
SW
T1
T2
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020WP POST-PROJECT
72RG1 (N-1)
FIG B-9
FRI, SEP 28 2018 9:51
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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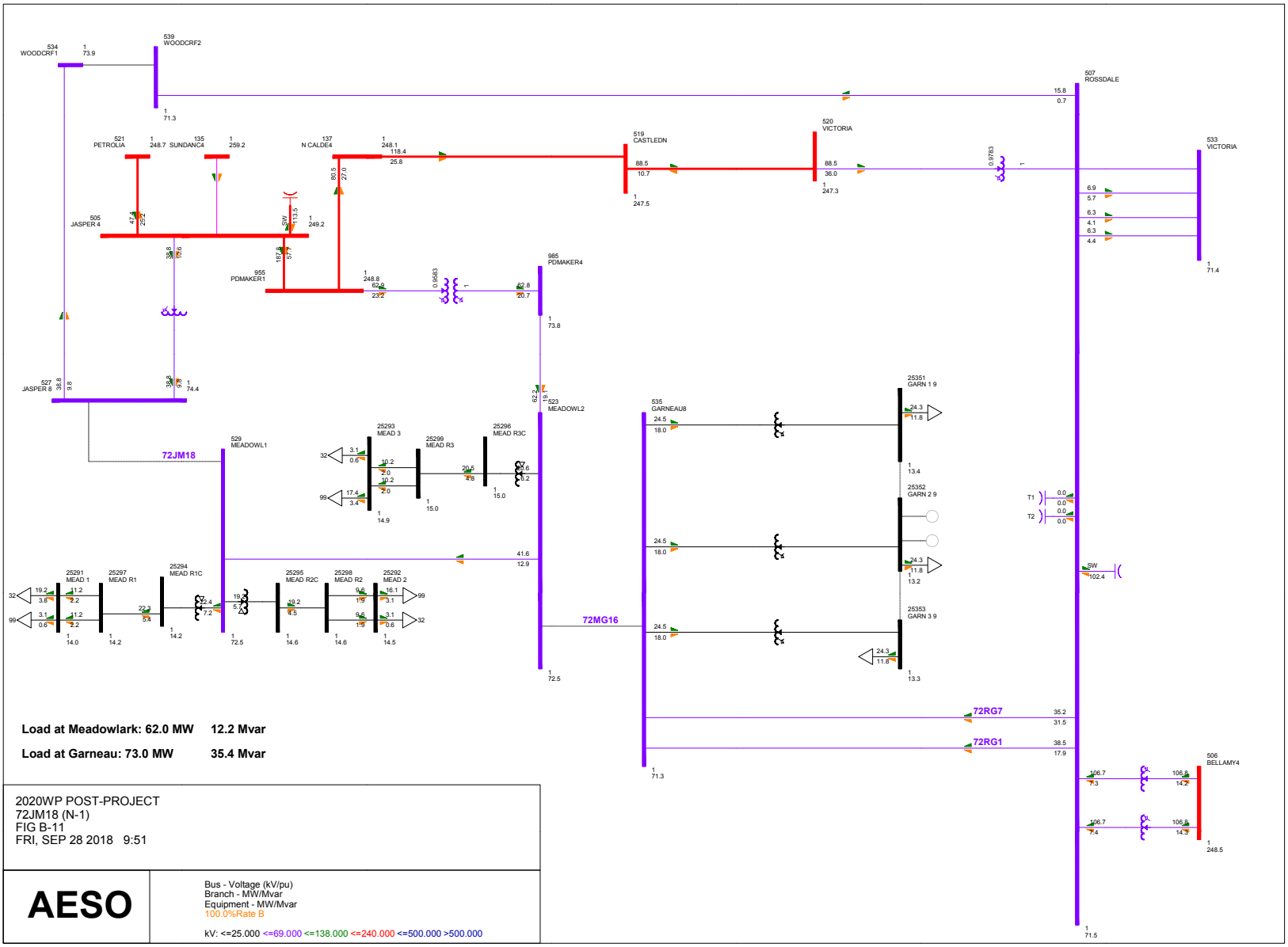
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
529 MEADOWL1
523 MEADOWL2
535 GARNEAU8
72JM18
72MG16
72RG7
72RG1
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
506 BELLAMY4
SW
T1
T2
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020WP POST-PROJECT
72RG7 (N-1)
FIG B-10
FRI, SEP 28 2018 9:51
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Load at Meadowlark: 62.0 MW 12.2 Mvar

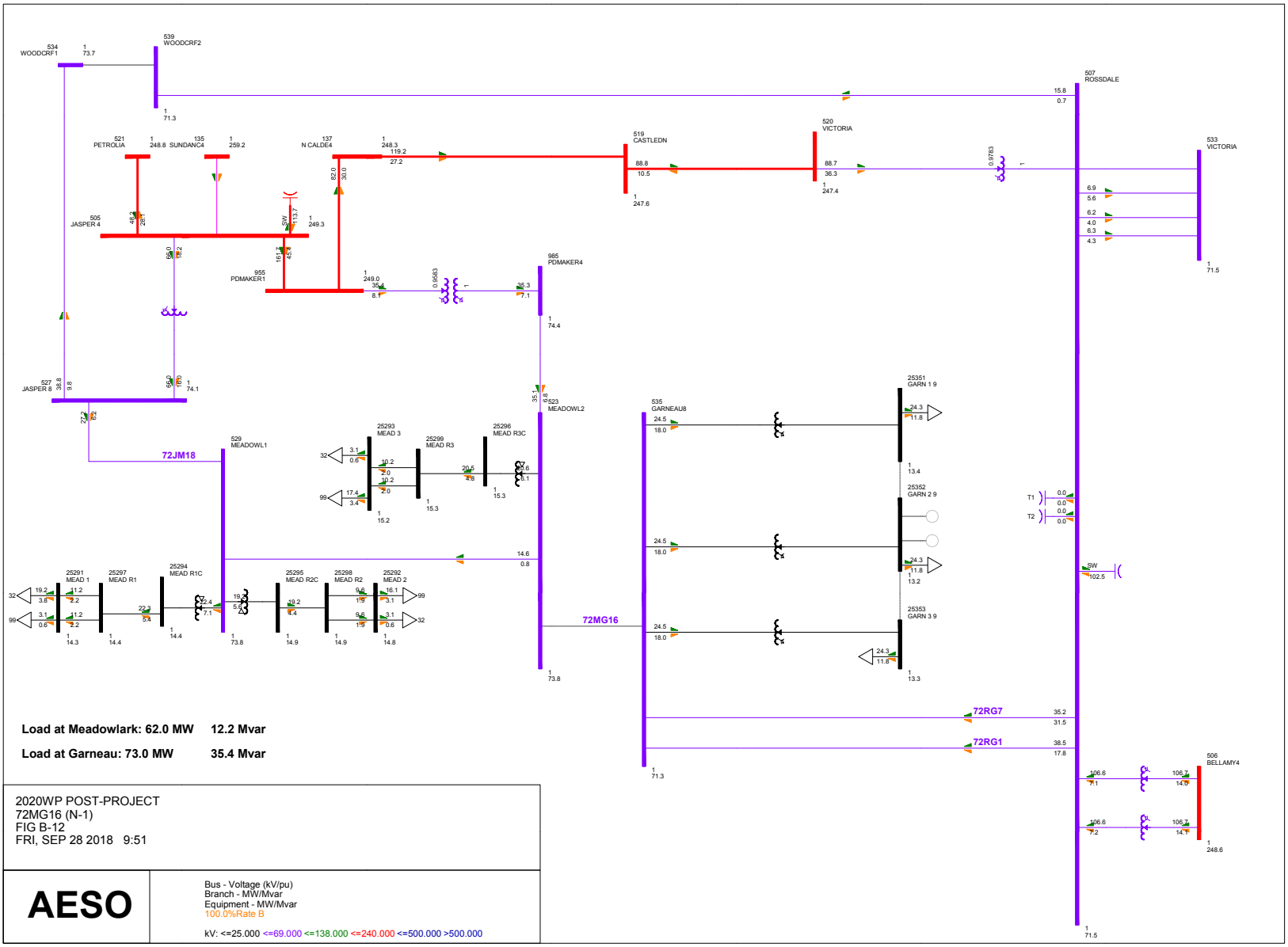
Load at Garneau: 73.0 MW 35.4 Mvar

2020WP POST-PROJECT
72JM18 (N-1)
FIG B-11
FRI, SEP 28 2018 9:51

AESO

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

kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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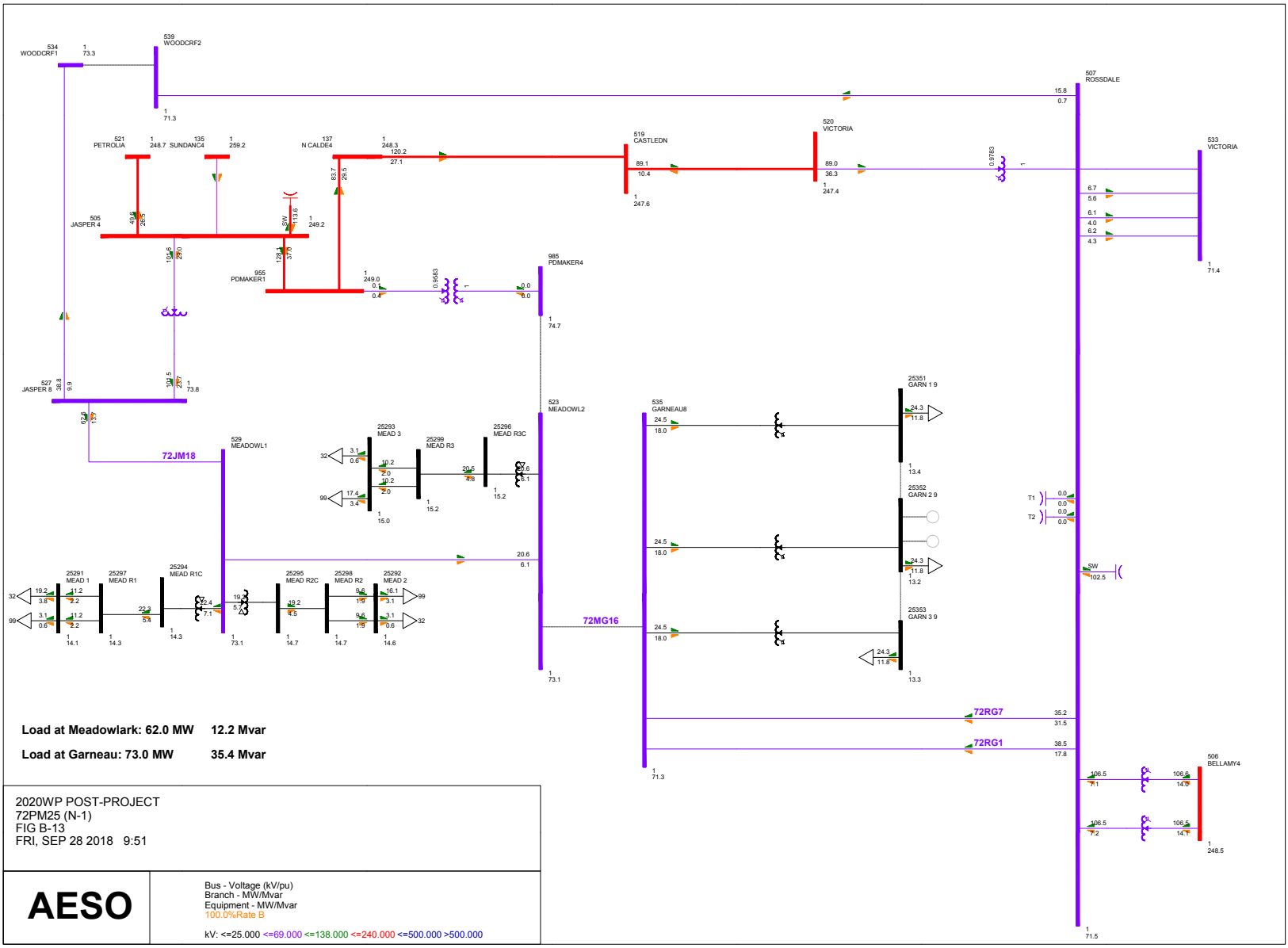
507 ROSSDALE
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
529 MEADOWL1
523 MEADOWL2
535 GARNEAU8
72JM18
72MG16
72RG7
72RG1
25351 GARN 1 9
25352 GARN 2 9
25353 GARN 3 9
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
506 BELLAMY4
SW
T1
T2
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020WP POST-PROJECT
72MG16 (N-1)
FIG B-12
FRI, SEP 28 2018 9:51
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Load at Meadowlark: 62.0 MW 12.2 Mvar

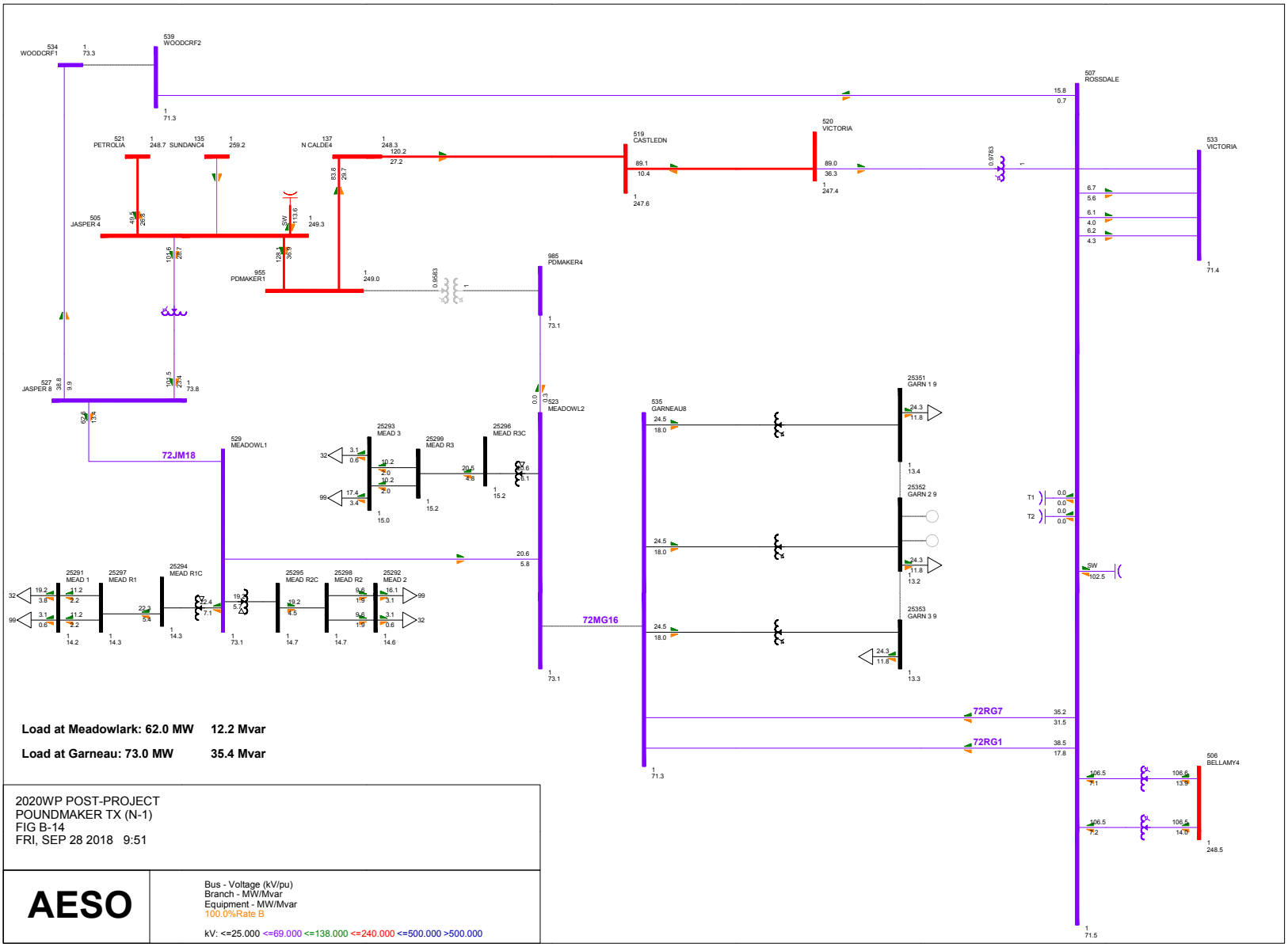
Load at Garneau: 73.0 MW 35.4 Mvar

2020WP POST-PROJECT
72PM25 (N-1)
FIG B-13
FRI, SEP 28 2018 9:51

AESO

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

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



Load at Meadowlark: 62.0 MW 12.2 Mvar

Load at Garneau: 73.0 MW 35.4 Mvar

2020WP POST-PROJECT
POUNDMAKER TX (N-1)
FIG B-14
FRI, SEP 28 2018 9:51

AESO

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

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

Attachment C

Voltage Stability Diagrams

2020SP Post-Project

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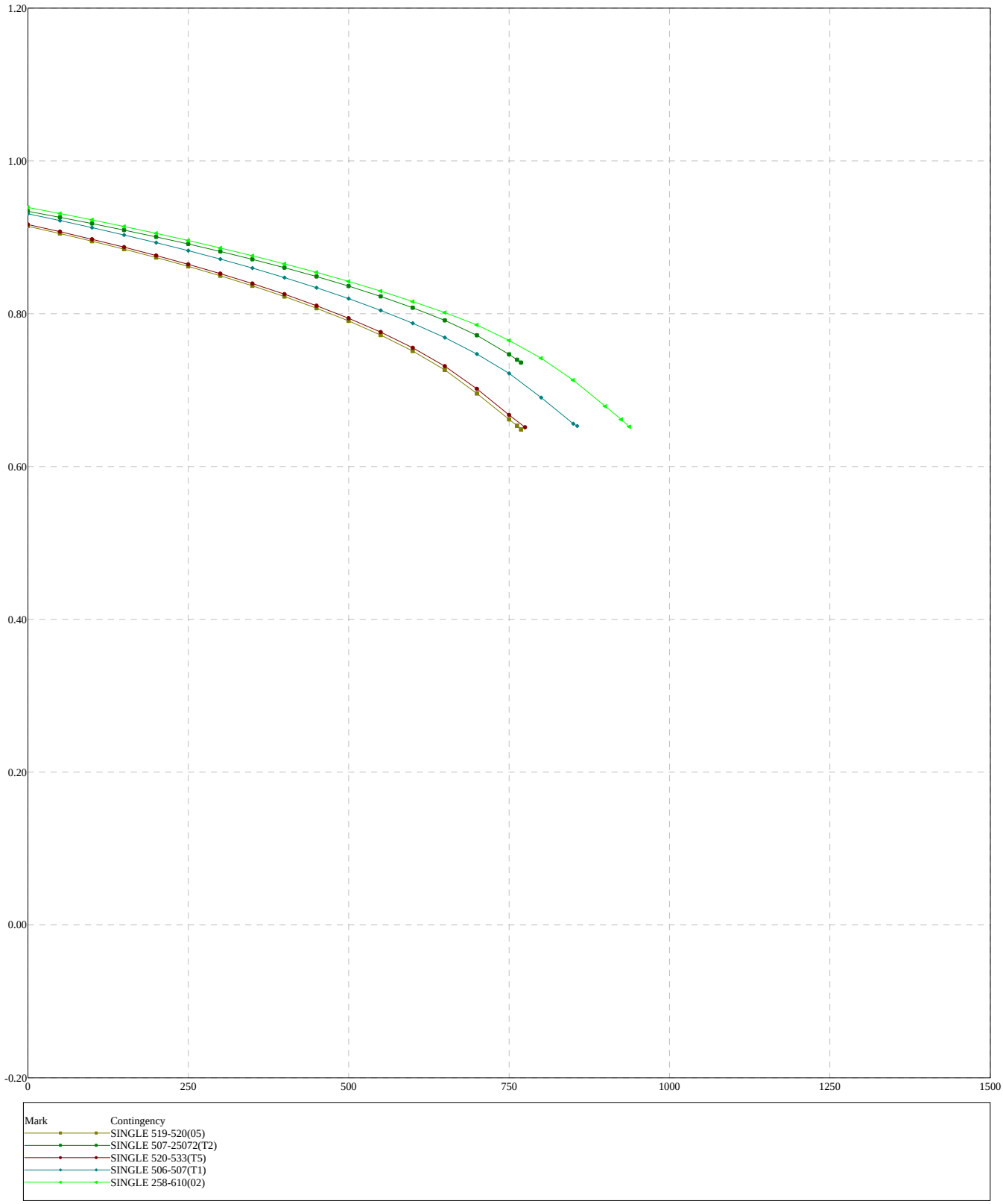
WED, SEP 26 2018 11:24



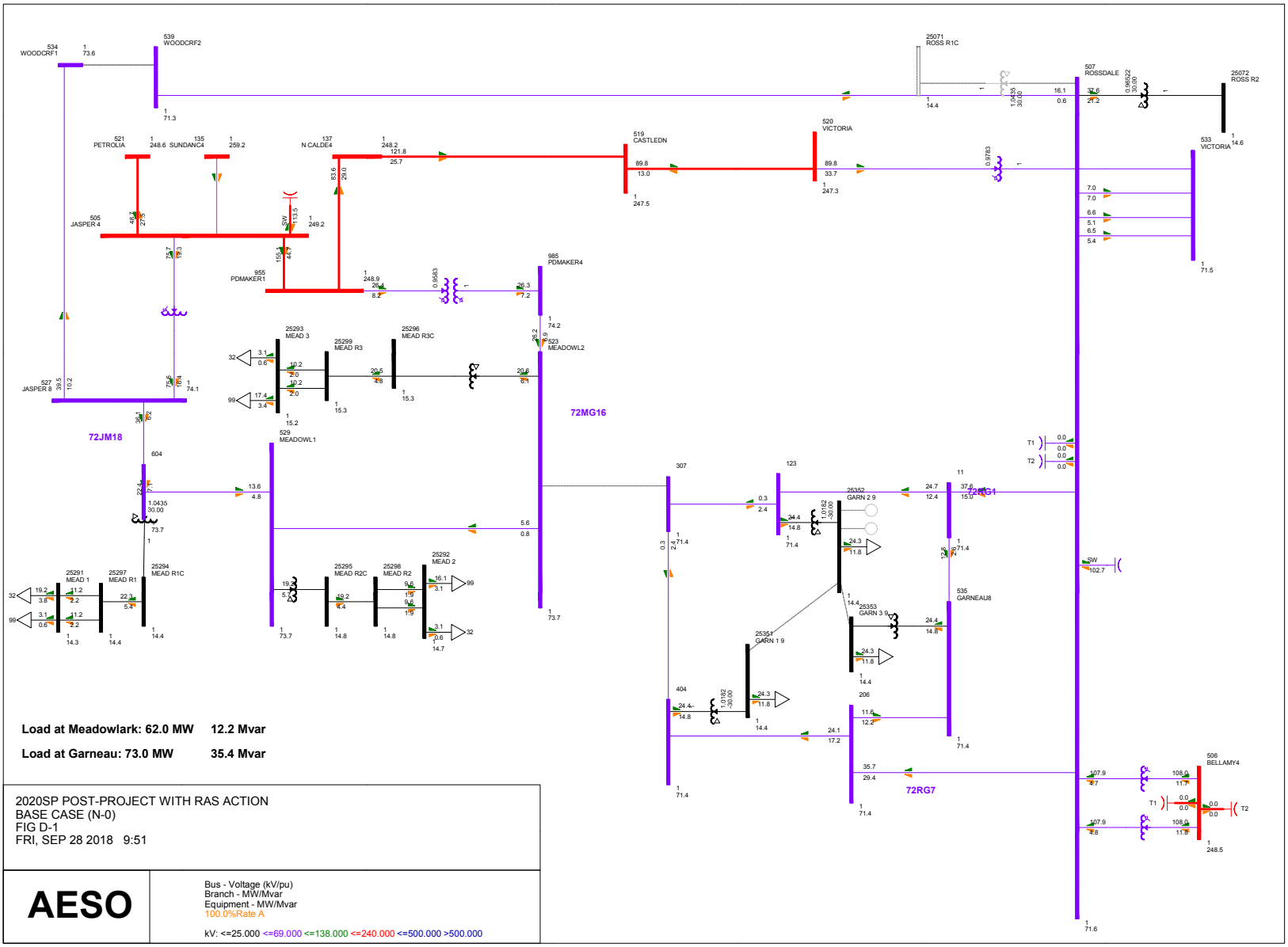
Attachment D

Power Flow Diagrams

2020SP/2020WP Post-Project

With New Garneau-Meadowlark

Reconfiguration RAS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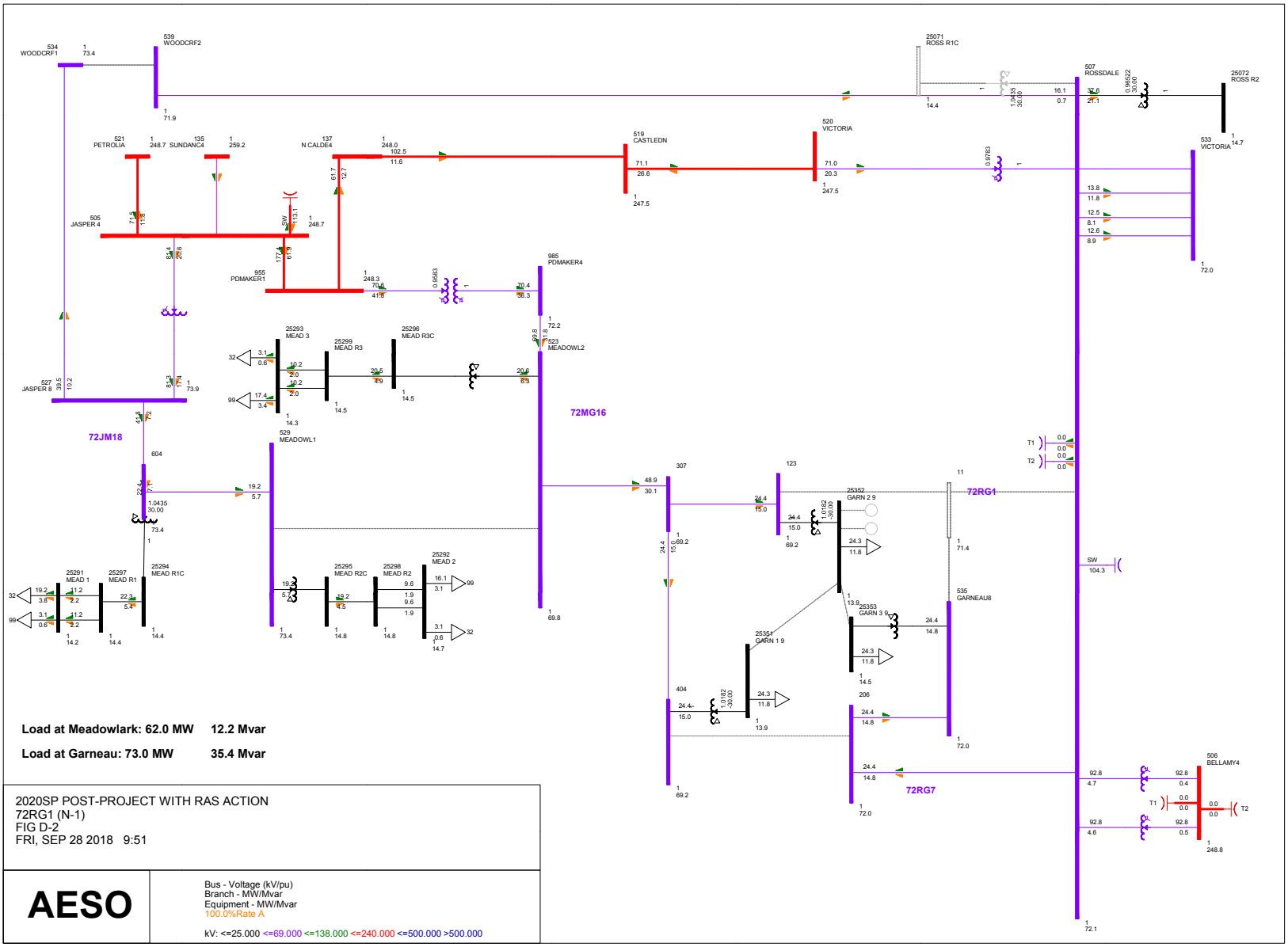
539 WOODCRF2
25071 ROSS R1C
507 ROSSDALE
25072 ROSS R2
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
523 MEADOWL2
72MG16
72JM18
529 MEADOWL1
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25352 GARN 2 9
25353 GARN 3 9
25354 GARN 1 9
535 GARNEAU8
72MG1
72RG7
506 BELLAMY4
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020SP POST-PROJECT WITH RAS ACTION
BASE CASE (N-0)
FIG D-1
FRI, SEP 28 2018 9:51
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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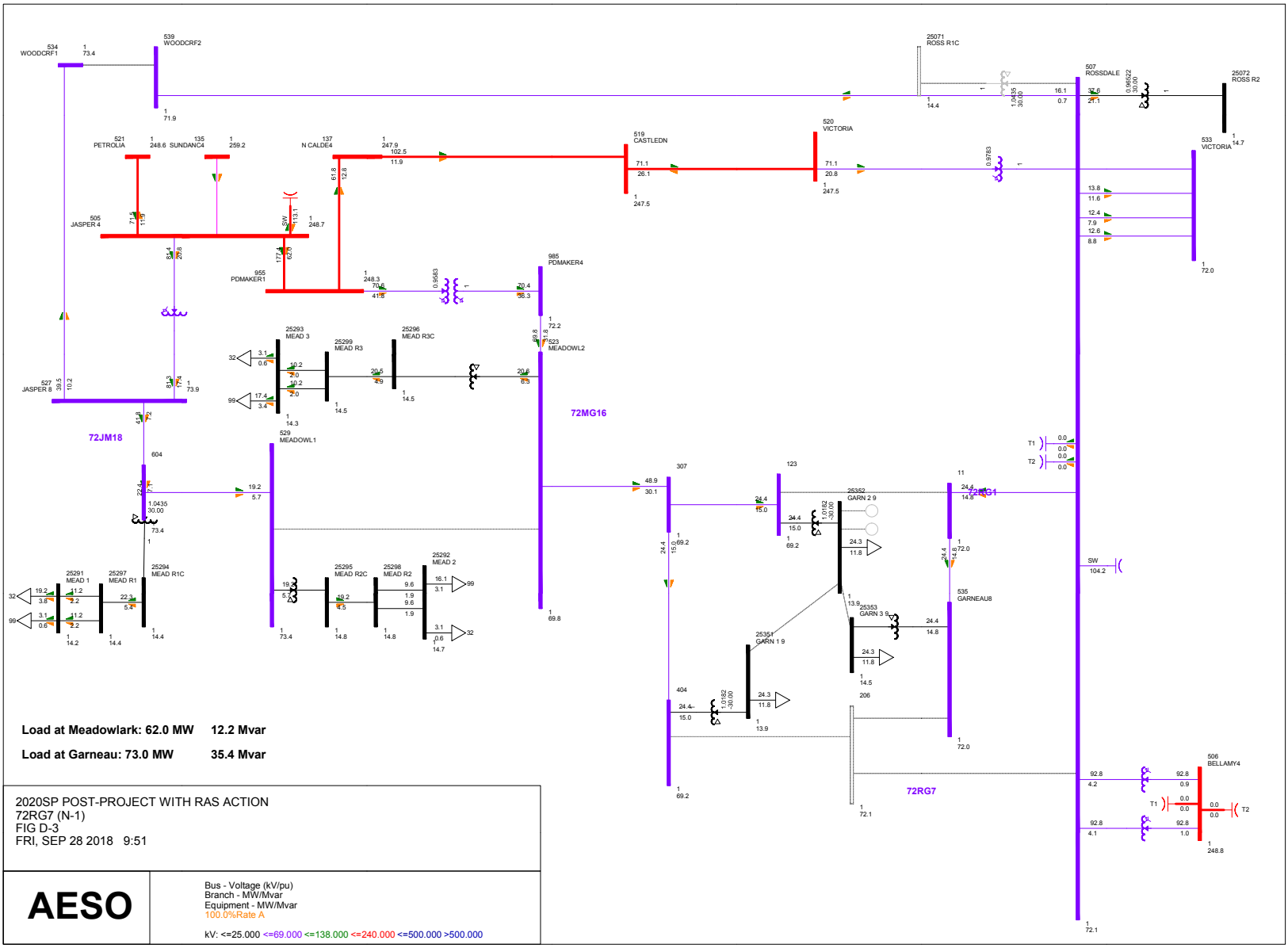
539 WOODCRF2
25071 ROSS R1C
507 ROSSDALE
25072 ROSS R2
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
523 MEADOWL2
527 JASPER 8
72JM18
72MG16
529 MEADOWL1
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25352 GARN 2 9
25353 GARN 3 9
25351 GARN 1 9
72RG1
535 GARNEAU8
72RG7
506 BELLAMY4
SW
T1
T2
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020SP POST-PROJECT WITH RAS ACTION
72RG1 (N-1)
FIG D-2
FRI, SEP 28 2018 9:51
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Load at Meadowlark: 62.0 MW 12.2 Mvar

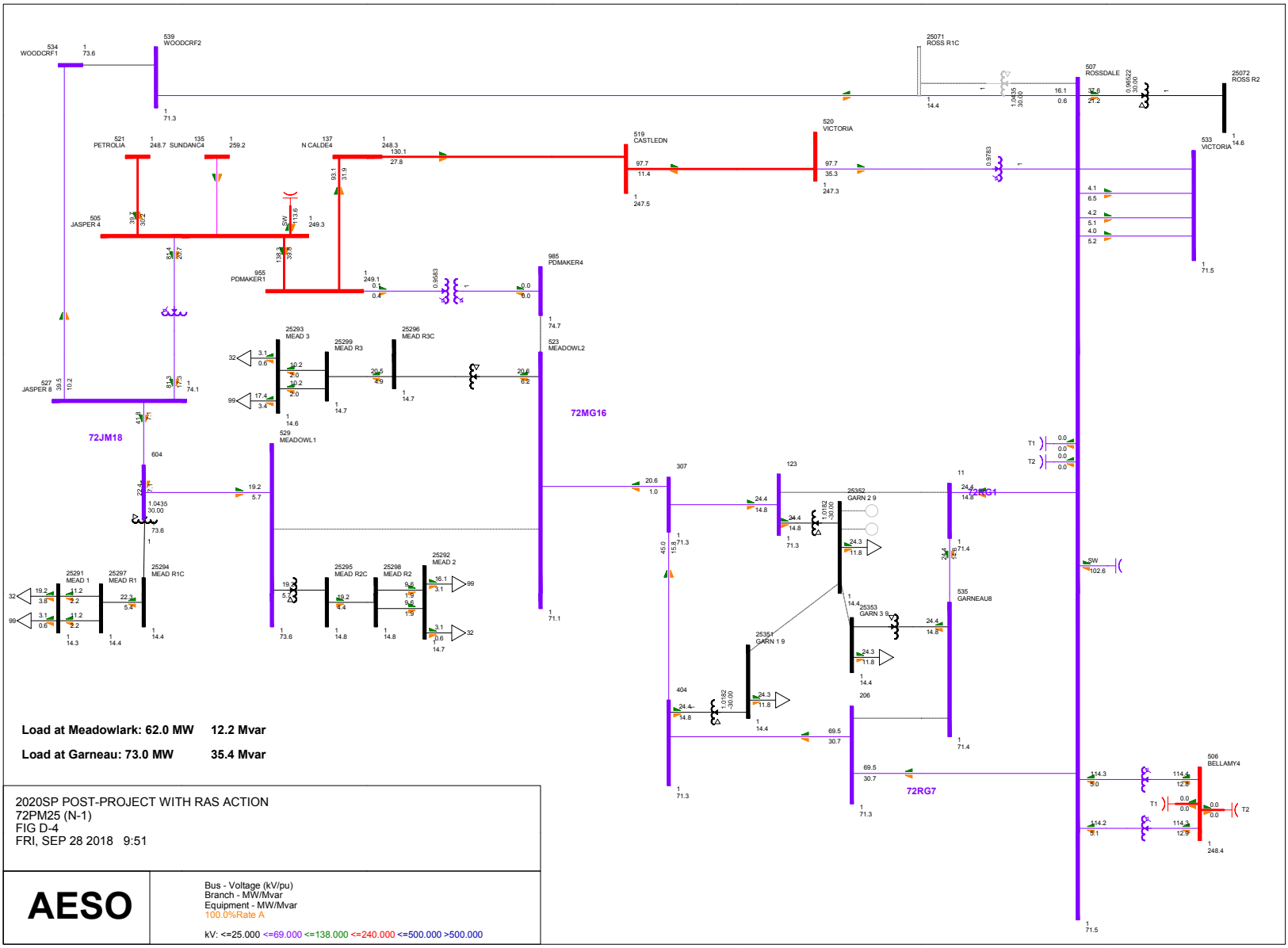
Load at Garneau: 73.0 MW 35.4 Mvar

2020SP POST-PROJECT WITH RAS ACTION
72RG7 (N-1)
FIG D-3
FRI, SEP 28 2018 9:51

AESO

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

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



Load at Meadowlark: 62.0 MW 12.2 Mvar

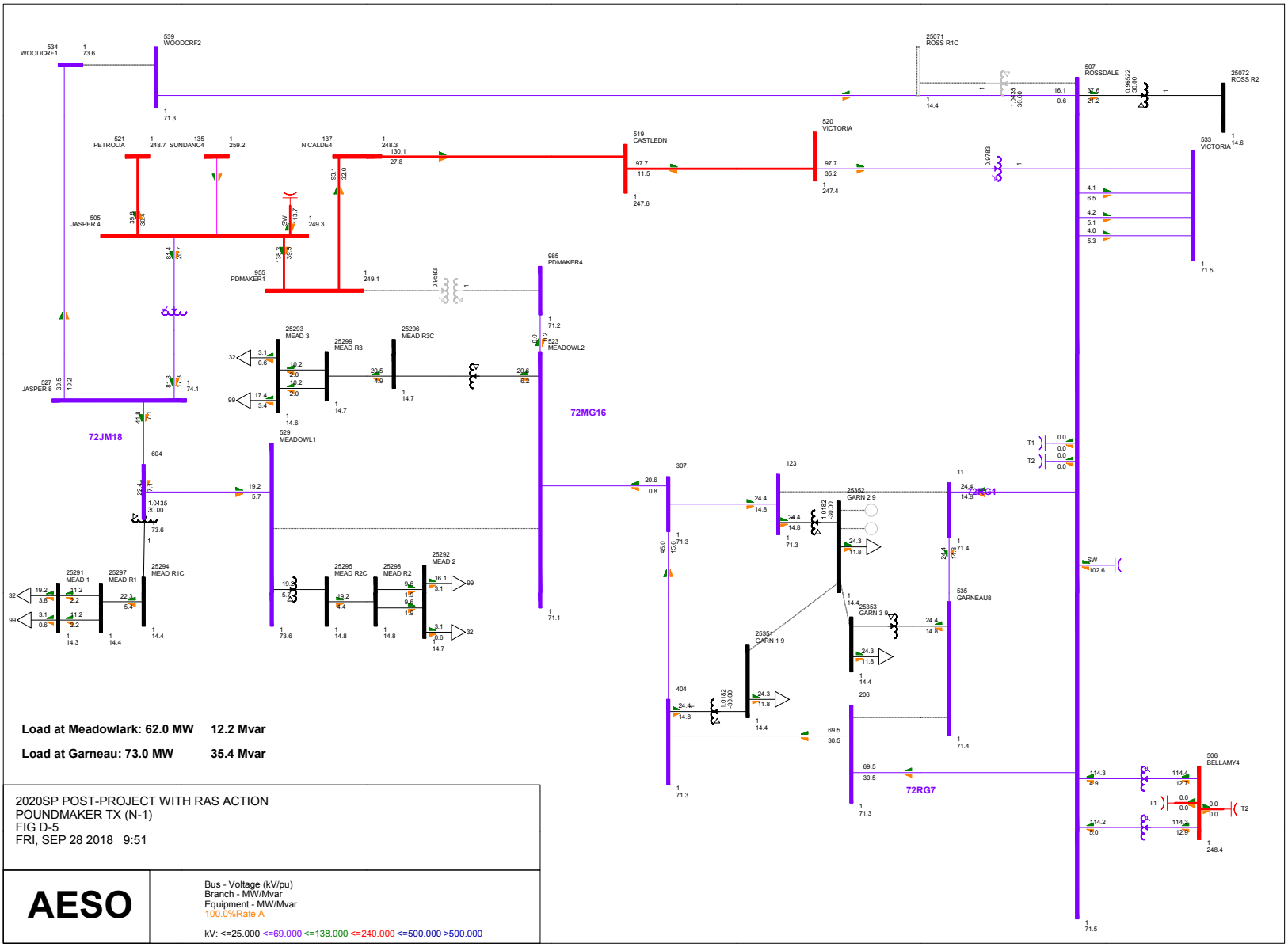
Load at Garneau: 73.0 MW 35.4 Mvar

2020SP POST-PROJECT WITH RAS ACTION
72PM25 (N-1)
FIG D-4
FRI, SEP 28 2018 9:51

AESO

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

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



Load at Meadowlark: 62.0 MW 12.2 Mvar

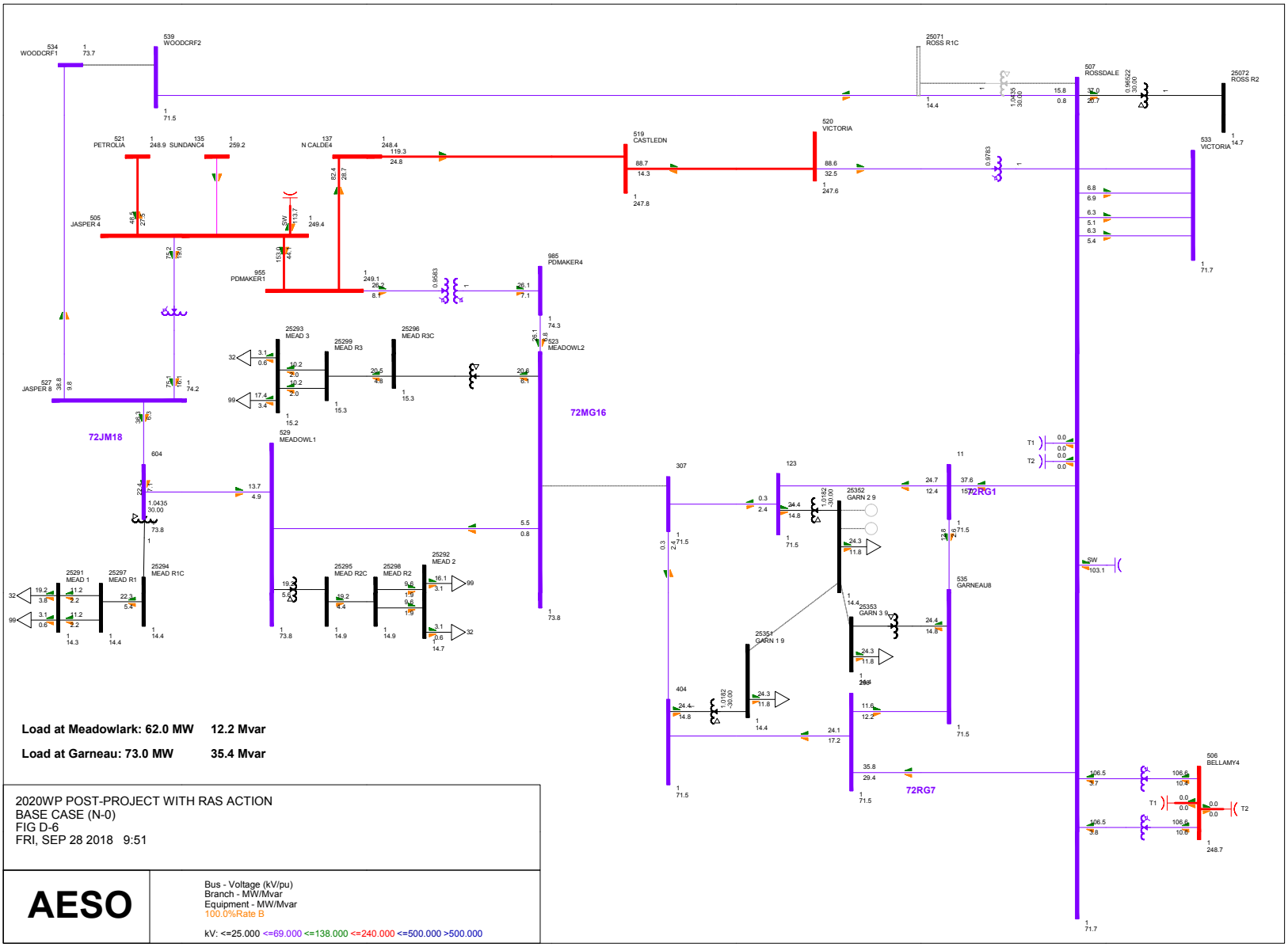
Load at Garneau: 73.0 MW 35.4 Mvar

2020SP POST-PROJECT WITH RAS ACTION
POUNDMAKER TX (N-1)
FIG D-5
FRI, SEP 28 2018 9:51

AESO

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

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



Load at Meadowlark: 62.0 MW 12.2 Mvar

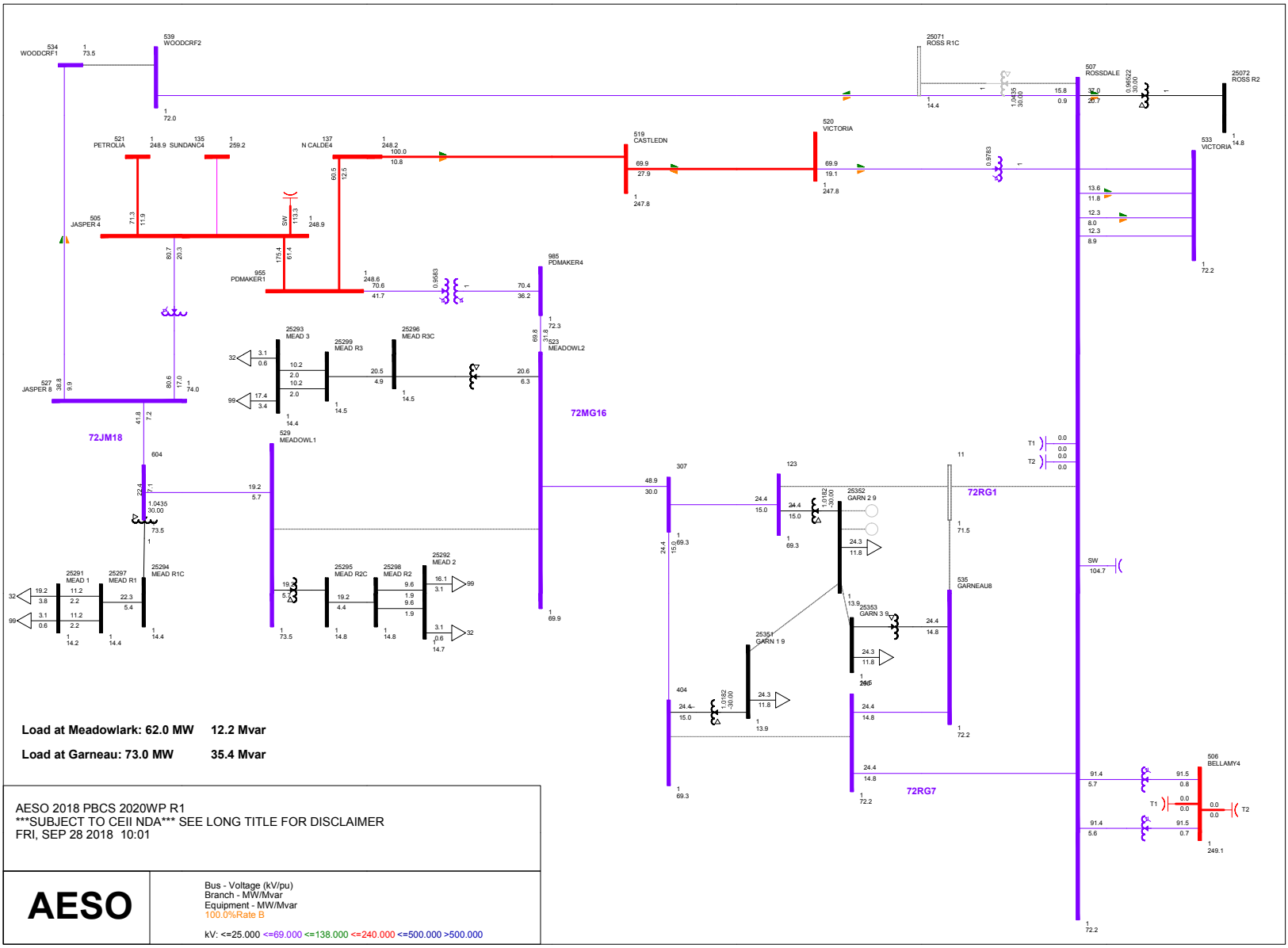
Load at Garneau: 73.0 MW 35.4 Mvar

2020WP POST-PROJECT WITH RAS ACTION
BASE CASE (N-0)
FIG D-6
FRI, SEP 28 2018 9:51

AESO

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

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



Load at Meadowlark: 62.0 MW 12.2 Mvar

Load at Garneau: 73.0 MW 35.4 Mvar

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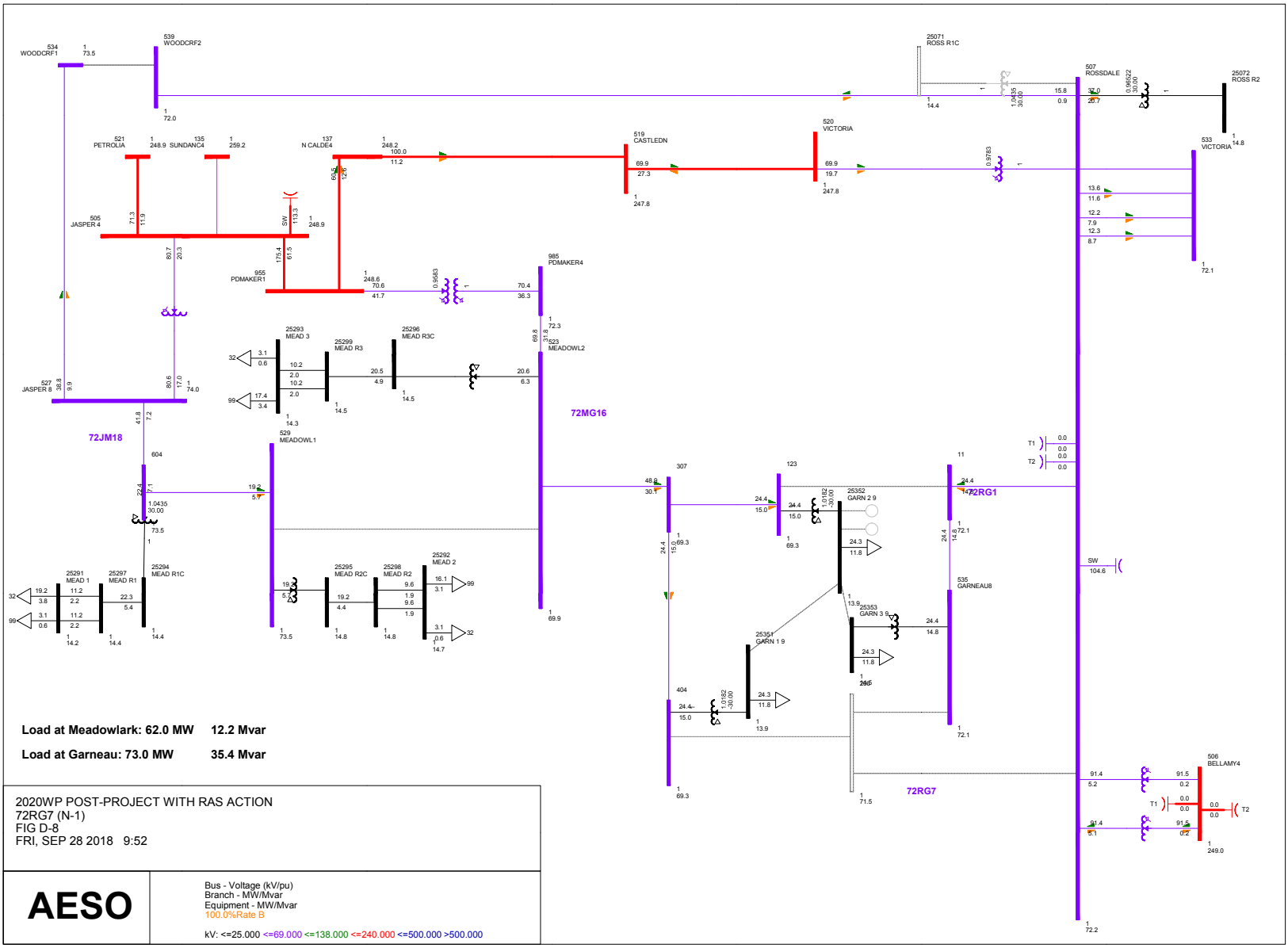
AESO

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

kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000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507 ROSSDALE
25072 ROSS R2
521 PETROLIA
135 SUNDANC4
137 N CALDE4
519 CASTLEDN
520 VICTORIA
533 VICTORIA
505 JASPER 4
955 PDMAKER1
985 PDMAKER4
527 JASPER 8
523 MEADOWL2
529 MEADOWL1
72JM18
72MG16
72RG1
72RG7
25293 MEAD 3
25299 MEAD R3
25296 MEAD R3C
25291 MEAD 1
25297 MEAD R1
25294 MEAD R1C
25295 MEAD R2C
25298 MEAD R2
25292 MEAD 2
25352 GARN 2 9
25353 GARN 3 9
25351 GARN 1 9
535 GARNEAU8
506 BELLAMY4
SW
Load at Meadowlark: 62.0 MW 12.2 Mvar
Load at Garneau: 73.0 MW 35.4 Mvar
2020WP POST-PROJECT WITH RAS ACTION
72RG7 (N-1)
FIG D-8
FRI, SEP 28 2018 9:52
AESO
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000