APPENDIX A CONNECTION ASSESSMENT

Bohn Transformer Addition
Project # 1570

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

Information regarding the AESO's connection process can be found at: http://www.aeso.ca/8602.html

Date: February 10, 2016

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Connection Engineering Study Report for AUC Application

Bohn 931S Transformer Addition

File No. 1570

Revision: 1

Revision Date: 2016-02-09

	Name	Date	Signature
Prepared by:	Mariya Babiy, P. Eng.	February 9, 2016	PROFESSIONAL ENGINEER MARIYA BABIY ALBERTA

APEGA Permit to Practice P0850

Executive Summary

Project Overview

ATCO Electric Ltd., in its capacity as the legal owner of distribution facilities (DFO), has received a request from Enbridge (Athabasca) Pipeline (Enbridge) to expand the electric service to its Enbridge Janvier surface pump station (Facility) in the Janvier South area for its Wood Buffalo Pipeline Extension project. The DFO has submitted a System Access Service Request (SASR) to the Alberta Electric System Operator (AESO), which includes a Rate DTS, *Demand Transmission Service*, contract capacity increase from 12 MW to 19 MW. The existing load at the Facility is served by the Bohn 931S substation. The Bohn 931S substation currently includes one 15/20/25 MVA 144/4.16 kV transformer and one 4.16 kV breaker dedicated to serving the Facility load.

The new load includes three new motor/pump sets that will be used to increase the flowrate of the Enbridge pipeline that runs through the Facility. To meet Enbridge's operational requirements, which stipulate that a maximum of four motor/pump sets be connected to one feeder, at minimum Enbridge needs a dedicated 4.16 kV breaker to serve the new load.

Although the transformer that currently serves the Facility has enough spare capacity available to connect a new dedicated 4.16 kV breaker, Enbridge has asked that the new dedicated breaker be connected to a second transformer to improve the reliability of electrical service to the Facility. The Facility provides pumping support to a key Enbridge pipeline and operates continuously. A second transformer ensures that the Enbridge pipeline will continue to operate should there be an outage to one of the transformers.

The requested in-service date (ISD) for the Project is February 1, 2017.

This report presents the results of the study that assesses the impact of the Project on the Alberta interconnected electric system (AIES).

Existing System

The Facility is located in the Fort McMurray area (AESO planning area 25), which is part of the AESO Northeast region. The Fort McMurray area occupies the northeast corner of Alberta. The transmission system in the Fort McMurray area is comprised of 240 kV, 144 kV and 72 kV. Currently, the Fort McMurray area connects to the AIES through four long 240 kV transmission lines. Two of these 240 kV lines, 9L55 and 9L930, are part of the 240 kV path connecting Fort McMurray Area to the Edmonton area (AESO planning area 60) while the third line, 9L56, is part of the path connecting Fort McMurray area to the High Prairie area (AESO planning area 21) and 9L15 which connects Fort McMurray area with Peace River area (AESO planning area 19).

The existing constraints in the Northeast region are managed in accordance with Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management*.[1]

[1] Available on the AESO website

Study Summary

Study Area for the Project

The Study Area for the Project consists of the south-east portion of the Fort McMurray area (AESO planning area 25).

Studies performed for the Project

Power flow analysis was performed for the 2016 winter peak (2016WP) pre- and post-connection scenarios and the 2017 summer peak (2017SP) post-connection scenario. Voltage stability analysis was completed for the 2016WP post-connection scenario.

The analyses included all Category A and Category B conditions.

All transmission facilities 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).

Results of the pre-connection studies

No Reliability Criteria violations were observed for the pre-connection study scenario.

Connection alternatives examined for the Project

The Project is located close to one point-of-delivery (POD), the Bohn 931S substation. All other PODs in the area are too far away to effectively serve the requested load addition.

Therefore, the only connection alternative considered for the Project included the addition of a second 15/20/25 MVA 144/4.16 kV transformer with a dedicated 4.16 kV breaker to the Bohn 931S substation to supply the requested load addition.

Results of the post-connection studies

Category A (N-G-0) conditions

Under Category A conditions, no Reliability Criteria violations were observed for any of the studied scenarios with the examined alternative.

Category B (N-G-1) contingency conditions

Under Category B contingency conditions, no Reliability Criteria violations were observed for any of the studied scenarios with the examined alternative.

Conclusions and Recommendation

The study confirmed that the AIES is not adversely impacted by upgrading the Bohn 931S substation and increasing its DTS. It also confirmed that this alternative is technically viable and that there are no Reliability Criteria violations. Therefore, it is recommended to proceed with the addition of a second transformer at the Bohn 931S substation.

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1. Introduction

This Engineering Study Report presents the results of the study that assesses the impact of the Project (as defined below) on the AIES.

1.1. Project

1.1.1. Project Overview

ATCO, in its capacity as the DFO in the Janvier South area, has received a request from Enbridge to expand the electric service to its Facility for the Wood Buffalo Pipeline Extension project. The DFO has submitted a SASR to the AESO, which includes a Rate DTS, *Demand Transmission Service*, contract capacity increase from 12 MW to 19 MW. The existing load at the Facility is served by the Bohn 931S substation. The substation currently includes one 15/20/25 MVA 144/4.16 kV transformer and one 4.16 kV breaker dedicated to serving the Facility load.

The new load includes three new motor/pump sets that will be used to increase the pipeline flowrate of the Enbridge pipeline that runs through the Facility. To meet Enbridge's operational requirements, which stipulate that a maximum of four motor/pump sets be connected to one feeder, at minimum Enbridge needs a dedicated 4.16 kV breaker to serve the new load.

Although the transformer that currently serves the Facility has enough spare capacity available to connect a new dedicated 4.16 kV breaker, Enbridge has asked that the new dedicated breaker be connected to a second transformer to improve the reliability of electrical service to the Facility. The Facility provides pumping support to a key Enbridge pipeline and operates continuously. A second transformer ensures that the Enbridge pipeline will continue to operate should there be an outage to one of the transformers.

In this report, connecting the load addition at the Facility will be referred to as the Project. The requested ISD for the Project is February 1, 2017.

1.1.2. Load Component

Existing DTS contract capacity: 12 MW.

Requested DTS contract capacity: 19 MW.

Power Factor Studied: 0.9 lagging.

Load Type: Industrial motor/ pump station.

Existing Number of Motors: 3.

Number of Motors with new load: 6.

Future Allowance for Load Growth: Enbridge does not currently have future expansion plans to increase the load above 19 MW at its Facility.

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 Reliability Criteria, standards or requirements of the AESO both pre- and post-connection of the Project.
- Mitigation measures, if required, to enable the reliable connection of the Project to the AIES.

1.2.2. Study Area

1.2.2.1. Study Area Description

The Project is located within the Fort McMurray area which is part of the Northeast region.

The Study Area for the Project consists of the south-east portion of the Fort McMurray area (AESO planning area 25).

The transmission system in the Fort McMurray Area is comprised of 240 kV, 144 kV and 72 kV. Currently, the Fort McMurray area connects to the AIES through four long 240 kV transmission lines. Two of these 240 kV lines, 9L55 and 9L930, are part of the 240 kV path connecting Fort McMurray Area to the Edmonton area (AESO planning area 60) while the third line, 9L56, is part of the path connecting Fort McMurray area to the Wabamun area (AESO planning area 40) and 9L15 which connects Fort McMurray area with Peace River area (AESO planning area 19).

Figure 1-1 shows transmission network of the Fort McMurray Area. Figure 1-2 shows the transmission network of the Study Area.

Figure 1-1: Fort McMurray Area Transmission Network

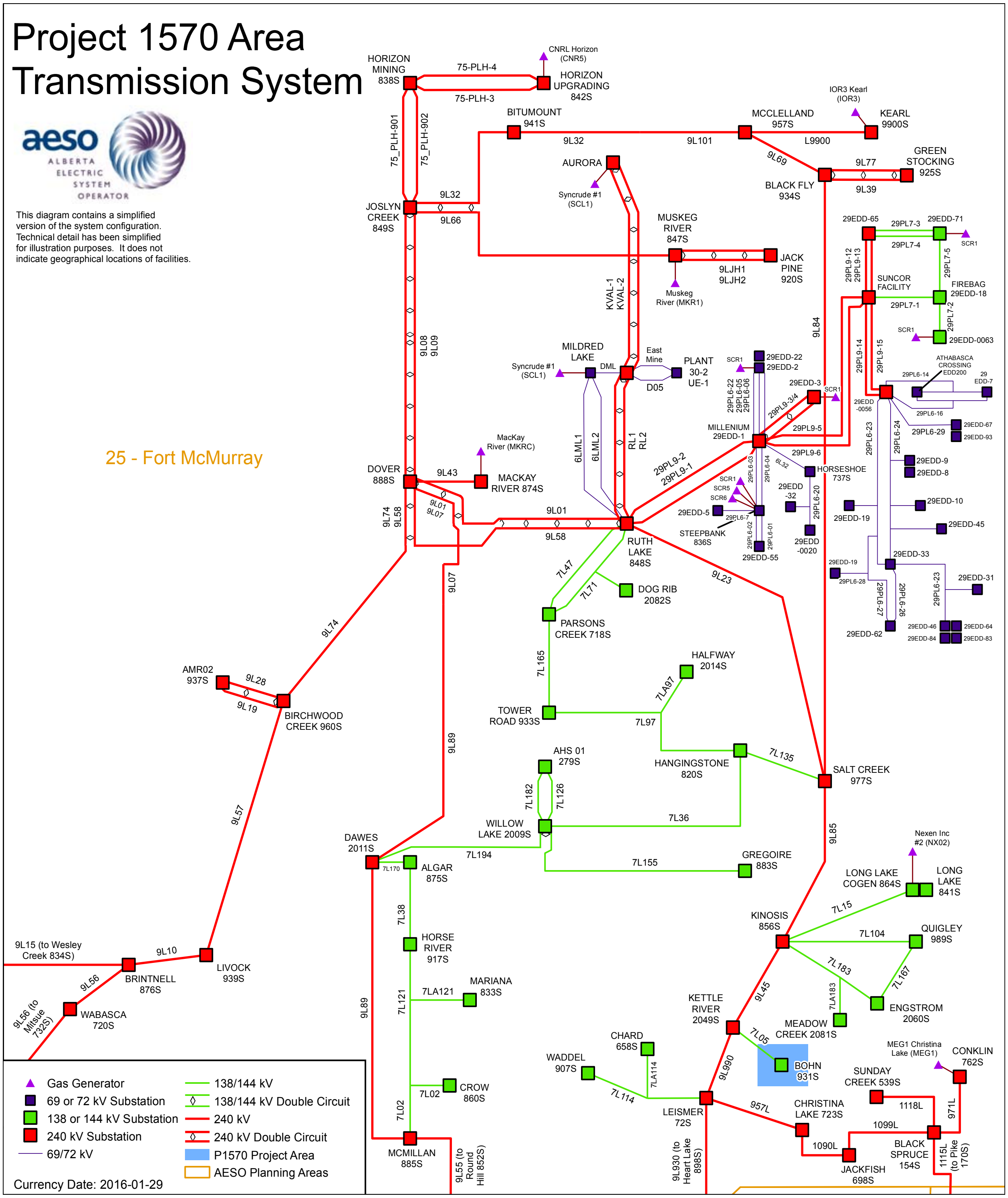
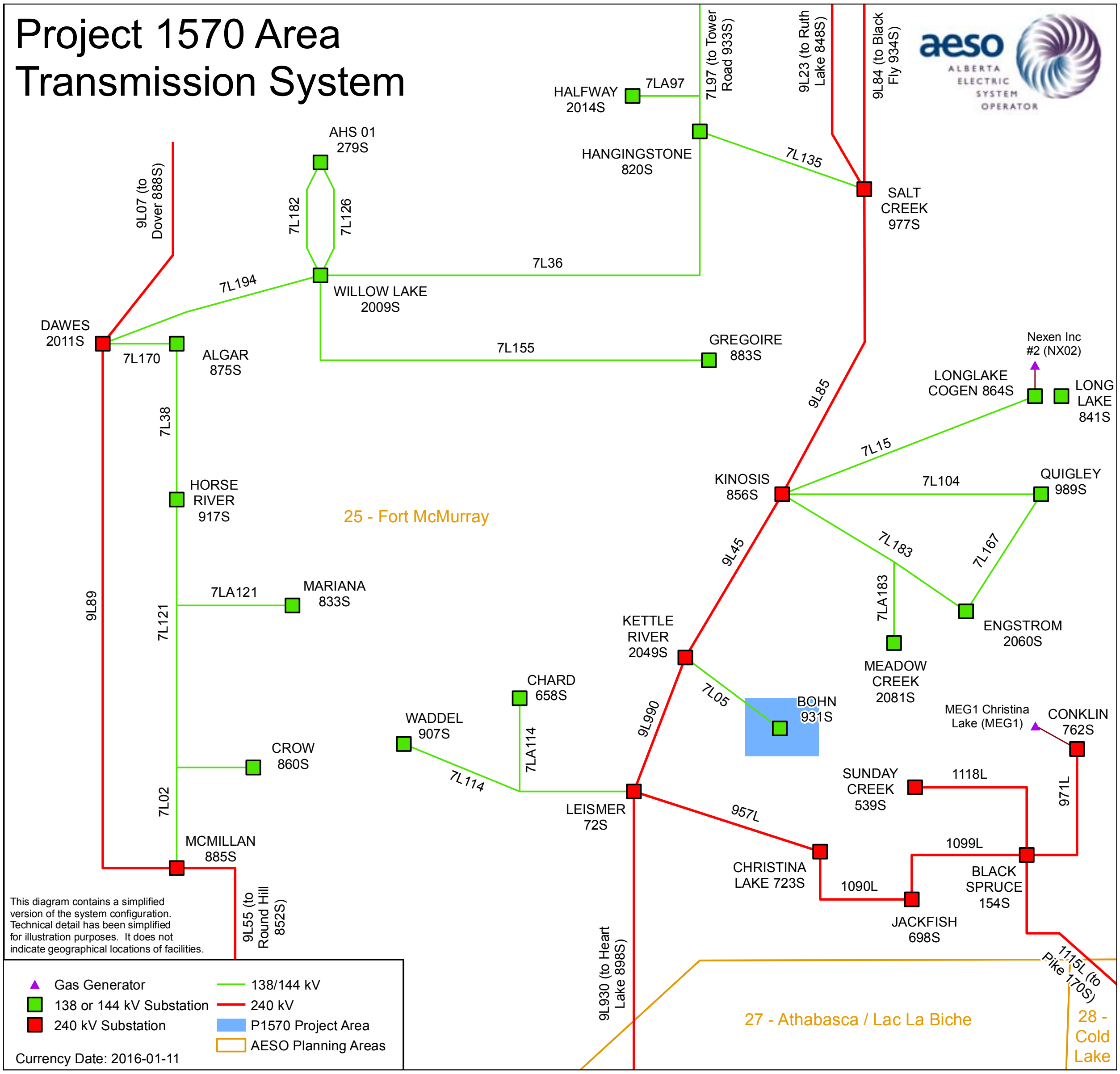


Figure 1-2: The Transmission Network in the Study Area



1.2.2.2. Existing Constraints

The Northeast region is currently managed by the AESO Rule 302.1 Information Document ID#2011-008(R) - *Real Time Transmission Constraint Management* (TCM Rule). This AESO ID specifies the Fort McMurray Export Cutplane Transfer-out-Limits (710 MW) and the Fort McMurray Import Cutplane Transfer-In-Limits (593 MW (Voltage) / 512 MW (Thermal)). These transfer levels are based on the existing transmission network configuration and represent the system normal condition (all transmission elements in service).

1.2.2.3. AESO Long-Term Plans

The AESO published the *AESO 2015 Long Term Plan* (2015 LTP) in November 2015. There are no transmission developments proposed for the Study Area in the near-term.[2] Table 1-1 shows system reinforcements in the Fort McMurray area recently energized.

Table 1-1: Summary of Recently Energized System Projects in the Study Area

Project Name
Whitefish 825S 100 MVAr capacitor bank addition
Dover 888S 100 MVAr capacitor bank addition
Leismer 72S 60 MVAr capacitor bank addition
Winefred 818S 42 MVAR capacitor bank addition
Kettle River 2049S 60 MVAr capacitor bank addition
Kinosis area 60 MVAr capacitor bank addition
Algar Area System Reinforcement Project
Christina Lake Area Transmission Development project

1.2.3. Studies Performed

The following studies were performed for both the pre-connection and post-connection analysis:

- Power flow analysis (Category A and B).

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

- Voltage stability analysis (Category A and B).

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

1.3. Report Overview

The Executive Summary provides a high-level summary of the report and its conclusions. Section 1 provides an introduction of the Project. Section 2 describes the Reliability Criteria, system data, and other study assumptions used in this report. Section 3 describes the study methodology used. Section 4 discusses the pre-connection assessment of the system. Section 5 presents the connection alternatives identified. Section 6 provides a technical analysis of the connection alternative selected for further study. Section 7 discusses project interdependencies. Section 8 presents a conclusions and recommendations of this study.

[2] Refer to: *AESO 2015 Long-term Transmission Plan* available on the AESO website.

2. Criteria, System Data, and Study Assumptions

2.1. Criteria, Standards, and Requirements

2.1.1. Transmission Planning Standards and Criteria

The Transmission Planning (TPL) Standards, which are included in the Alberta Reliability Standards, and the AESO's *Transmission Planning Criteria – Basis and Assumptions*[3] (collectively, the Reliability Criteria) were applied to evaluate system performance under Category A system conditions (i.e., all elements in-service) and following Category B contingencies (i.e., single element outage), prior to and following the studied alternatives. Below is a summary of Category A and Category B system conditions.

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

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

The TPL standards, TPL-001-AB-0 and TPL-002-AB-0 have referenced Applicable Rating 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 Practice – Voltage Control*.
- For Category B conditions: The extreme voltage range as applicable from Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions*.
- Desired post-contingency voltage deviations for three defined post event timeframes as provided in Table 2-1 below.

[3] Filed under a separate cover

The post contingency voltage deviations following Category B events were compared with the guidelines in Table 2-1.

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

Time Period	Post-Transient (Up to 30 sec)	Post-Auto Control (30 sec to 5 min)	Post-manual Control (Steady State)
Voltage Deviation from Steady State at POD Low Voltage Bus	± 10%	± 7%	± 5%

2.1.2. AESO Rules

ISO rules Section 304.4 ID #2010-007RS[4] was used to set the system pre-contingency voltages at critical busses to be within the desired range. The Northeast region constraints are outlined in AESO ID#2011-008R[5].

The AESO Voltage Control Practice ID # 2010-007RS, which relates to Section 304.4 of the ISO Rules, *Maintaining Network Voltage* will be applied to establish pre-contingency voltage profiles in the study region. The TCM Rule will be followed in setting up the study scenarios and assessment of the connection impact. In addition, due regard will be given to the AESO Customer Connection Study Requirements Document and the Generation and Load Interconnection Standard.

2.2. Load and Generation Assumptions

2.2.1. Load Assumptions

The Fort McMurray area load forecast used for this connection study is reflected in Table 2-2 and is based on the AESO *2014 Long-Term Outlook* (LTO).

Table 2-2: Fort McMurray Area Coincident 2014 LTO Peak Load Forecasted

Area Name	2016WP Forecast Peak Load (MW)	2017SP Forecast Peak Load (MW)
Fort McMurray area	2614.9	2363.5
Alberta Internal Load (AIL) without Losses	12154.5	11441

2.2.2. Generation Assumptions

The generation within the Northeast region contains natural gas-fired generation from industrial sites in the Fort Saskatchewan (AESO planning area 33), Fort McMurray and Cold Lake areas, and biomass generation in the Athabasca/Lac La Biche area (AESO planning area 27).

[4] Available on the AESO website
[5] Available on the AESO website

Table 2-3 provides the area generation assumptions used in this engineering study. The MEG-Conklin generator is defined as the Study Area critical generator and its status is off on all analyses.

Table 2-3: Key Generation Facilities by Study Scenarios

Existing/ Future	Plant name	Bus Number	Area	Capacity (MW)	2016WP Unit Net Generation (MW)	2017SP Unit Net Generation (MW)
Existing	LONGLAKE G1	13249	25	80	80	78
Existing	LONGLAKE G2	12249	25	80	80	78
Existing	LONGLAKE G3	11241	25	11.5	11	11
Existing	LONGLAKE G4	11241	25	11.5	11	11
Existing	MEG-Conklin	2405	25	85	Offline	0ffline
Existing	MEG-Conklin 2B	3405	25	85	85	70
Future	Project 1245	23754	25	50	44	38
Future	Project 1245	23755	25	50	44	38
Existing	Mackay	18274	25	185	181	153
Existing	Syncrude G1	19209	25	53	42	37
Existing	Syncrude-UE-1-G11	17233	25	22	18	15
Existing	Syncrude-UE-1-G12	16233	25	86	69	61
Existing	Syncrude G2	18209	25	53	42	37
Existing	Syncrude G20	18206	25	100	80	70
Existing	Syncrude G21	18207	25	100	80	70
Existing	Syncrude G3	17209	25	28.8	23	20
Existing	Syncrude G4	17210	25	53	42	37
Existing	Syncrude G5	18210	25	28.8	23	20
Existing	Syncrude G6	19210	25	67.5	54	48
Existing	Suncor 1	16218	25	34.4	31	27
Existing	Suncor 2	18218	25	34.4	31	27
Existing	Millennium 3	16219	25	68.8	62	54
Existing	Millennium 4	18223	25	81	73	63
Existing	Millennium 5	18208	25	130.5	118	102
Existing	Millennium 6	19208	25	130.5	118	102
Existing	Suncor	3273	25	86.8	79	68
Existing	Firebag 3 G1	19297	25	85	77	66
Existing	Firebag 3 G2	18297	25	85	77	66
Existing	Firebag 4 G1	17297	25	95	86	74
Existing	Firebag 4 G2	16297	25	95	86	74
Future	Project 1404 (Cenovus Narrows Lake)	4733	25	50	0	41

2.2.3. Intertie Flow and High Voltage Direct Current (HVDC) Line Flow Assumptions

The intertie points are deemed to be too far away to have an effect on the assessment of the proposed connection. The flows in the Study Area are not influenced by the AIES HVDC facilities. As a result, the intertie and HVDC assumptions are consistent with that in the AESO planning base cases.

2.3. System Projects

No additional system projects were identified to be included in the study aside from those listed in Table 1-1.

2.4. Customer Connection Projects

Table 2-4 lists the customer connection projects included in all study scenarios unless noted otherwise.

Table 2-4: Summary of Customer Connection Projects Assumptions

AESO Project Number	Project Description	Generation (MW)	Load (MW)	Projected in-service date
1245	Cenovus Sunday Creek BTF	30	50	March 1, 2016
1482	ATCO Grand Rapids MacKay Pumpstation	0	1.5	May 6, 2016
1491	ATCO Wabasca 720S-Breaker Addition	0	8	July 1, 2016
1287	Fortis Alberta CNRL - Edwards Lake Substation	0	50	March 1, 2017
1258	Fortis Alberta Grist Lake (Pike) Substation	0	29.2	March 1, 2017
1404*	Cenovus Narrows Lake Substation (Boreal)	0	35	June 1, 2017
1348*	Fort Hills Switching Station	0	20	June 1, 2017
1104*	AOC Dover West Leduc Insitu Bitumen Extraction Facility	0	120	November 20, 2017

*Projects P1404, P1348 and P1104 are included in 2017SP scenario only.

2.5. Facility Ratings and Shunt Elements

Table 2-5 provide the summer and winter ratings of key transmission lines for the Project in the Study Area.

Table 2-5: Key Transmission Line Ratings in the Study Area (MVA)

Transmission Line	From Substation	To Substation	Nominal Voltage (kV)	Summer Rating (MVA)	Winter Rating (MVA)
971L	Conklin 762S	Black Spruce 154S	240	624	764
1099L	Black Spruce 154S	Jackfish 698S	240	624	764
1090L	Jackfish 698S	Christina Lake 723S	240	594	713

Transmission Line	From Substation	To Substation	Nominal Voltage (kV)	Summer Rating (MVA)	Winter Rating (MVA)
9L930	Leismer 72S	Heart Lake 898S	240	592	713
9L45	Kettle River 2049S	Kinosis 856S	240	332	332
9L990	Kinosis 856S	Leismer 72S	240	332	332
1115L	Black Spruce 154S	Pike 170S	240	931	1117
1116L	Pike 170S	Ipiatik 167S	240	874	1103
1117L	Ipiatik 167S	Heart Lake 898S	240	874	1103

Table 2-6 provides the summary of key shunt elements for the Project in the Study Area.

Table 2-6: Key Shunt Elements in the Study Area

Bus Number	Bus Name	Nominal Bus Voltage (kV)	Block 1 Steps	Block 1 Bstep (Mvar)	Block 2 Steps	Block 2 Bstep (Mvar)	Block 3 Steps	Block 3 Bstep (Mvar)
1402	SALTCR1	240	1	-34.96	0	0	0	0
17218	SUNC_R67	13.8	1	8.17	0	0	0	0
18200	RUTH LA9	14.4	3	-5	0	0	0	0
18224	HANGSTO1	25	2	5	0	0	0	0
19200	RUTH LB9	14.4	1	-20	0	0	0	0
19218	SUNC_R68	13.8	1	8.17	0	0	0	0
19224	HANGSTO9	25	2	5	0	0	0	0
468	LEISMER7	138	2	27.19	0	0	0	0
1242	KINOSIS2	138	2	30	0	0	0	0
17204	MCMILLA9	25	1	-20	0	0	0	0
18291	KR03	138	2	27.55	0	0	0	0
19242	KINOSIS3	25	1	-20	0	0	0	0

2.6. Voltage Profile Assumptions

The voltages at the key Fort McMurray area substations in the study scenarios for the Project are shown in Table 2-7. The desired voltage ranges as provided in the AESO ID# 2010-007RS were utilized to set the study scenarios voltages prior to power flow analysis.

Table 2-7: Summary of Voltages at Key Substations in Fort McMurray Area

Substation	AESO ID# 2010-007RS				Voltage in the Study Scenarios N-G (kV)		
	Nominal Voltage (kV)	Minimum Operating Limit (kV)	Desired Range (kV)	Maximum Operating Limit (kV)	Pre-connection	Post-connection	
					2016WP	2016WP	2017SP
Whitefish 825S	240	253	255-265	275	261.6	261.4	265.2

Substation	AESO ID# 2010-007RS				Voltage in the Study Scenarios N-G (kV)		
	Nominal Voltage (kV)	Minimum Operating Limit (kV)	Desired Range (kV)	Maximum Operating Limit (kV)	Pre-connection	Post-connection	
					2016WP	2016WP	2017SP
Ruth Lake 848S	240	248	263– 269	275	263.4	263.4	263.5
	144	141	144-153	155	149.4	149.6	150.6
Dover 888S	240	263	264-271	275	266.7	266.7	266.2
Heart Lake 898S	240	258	260-269	275	265.5	265.3	267.7
	144	138	140-144	145	143.8	143.7	143.4
Leismer 72S	240	248	262-271	280	265.4	264.8	264.5
	144	138	140-146	150	144.7	144.7	144.8
Salt Creek 977S	240	246	258-269	275	263.9	263.4	262.2
	144	144	147-152	155	150.3	150.6	150.5

3. Study Methodology

All the following analysis was completed using PTI PSS/E version 33.

3.1. 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 Reliability Criteria, standards or requirements of the AESO both pre- and post-connection of the Project.
- Recommend mitigation measures, if required, to enable the reliable connection of the Project into the AIES.

3.2. Study Scenarios

The study was conducted using the 2016WP and 2017SP scenarios. The study scenarios were derived from the published AESO's 2014 Planning Base Case Suite and related auxiliary data files.

Table 3-1 lists the scenarios considered for the project study. A power factor of 0.9 lagging was used for the new Facility load.

Table 3-1: Study Scenarios Analyzed

Study Scenario	Study Scenarios for Alternative Identified	Facility Load (MW)	System Generation Dispatch Conditions
1	2016WP pre-connection	12	Economic
2	2016WP post-connection	19	Economic
3	2017SP post-connection	19	Economic

Note that the critical generator identified for this study was the MEG-Conklin unit. The power flow and voltage stability analyses were performed with this generator out-of-service.

3.3. Connection Studies Carried Out

The following studies were carried out for this connection study:

Table 3-2: Summary of Studies Performed

Study Scenarios	Critical Generator Status	Studies Performed	Conditions Studied
1,2,3	OFF	Power flow	Category A and B
2	OFF	Voltage stability	Category B

3.4. Power flow Analysis

Power flow analysis was completed to identify any thermal or transmission voltage violations as per the Reliability Criteria. The purpose of the power flow analysis is to quantify any incremental violations that are observed following the connection of the Project.

PODs low voltage bus deviations were also assessed by first locking all tap changers and area capacitors to identify any post transient voltage deviations above 10%. Tap changers were then allowed to move while capacitors remained locked to determine if any voltage deviations above 7% were found in the area. Once all taps and capacitor controls were allowed to adjust, voltage deviations above 5% were reported for both the pre-connection and post-connection networks.

3.4.1. Contingencies Studied

The contingencies studied include all lines and transformers in Study Area as well as ties into it. The Study Area was monitored for voltage and thermal violations during contingency analysis.

3.5. Voltage Stability Analysis

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 system normal conditions (Category A) and for single contingencies (Category B)”. For this standard, the reference load level is the maximum established planned load.

The reference load level is the maximum forecasted load for the Fort McMurray area. The Wabamun area (AESO planning area 40) was used as the remote generation source for the voltage stability analysis.

The objective of the Power-Voltage (PV) curve 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 PV curve is a representation of voltage change as a result of increased power transfer between two systems. The reported incremental transfers will be to the collapse point. As per the AESO requirements, no assessment based upon other criteria such as minimum voltage will be made at the PV minimum transfer.

As per the voltage stability criteria, post-transient techniques (all tap changers, all discrete capacitors locked, but SVCs were allowed to adjust) were used in applying the criteria and this information is reflected in all tables and graphs. Also for this analysis, no limits were selected for the generation sources and non-negative active power constant MVA loads was enforced.

3.5.1. Contingencies Studied

Voltage stability analysis was performed for the Category A condition and all Category B contingencies in the study area for the 2016WP post-connection scenario to determine the system voltage stability margin.

4. Pre-Connection System Assessment

4.1. Pre-Connection Power flow Analysis

No Reliability Criteria violation was observed for Category A conditions and Category B contingencies studied in the 2016WP pre-connection scenario within the study area. Please refer to Attachment A for pre-connection power flow plots for the Study Area.

4.1.1. Scenario 1: 2016WP Pre-Connection

No thermal overloads, voltage violations or POD bus voltage deviations were found for the Category A condition or the Category B contingencies analyzed.

5. Connection Alternatives

5.1. Connection Alternative Identified

Bohn 931S substation is supplying the existing Facility load. The requested load addition is at the Facility site.

The new load includes three new motor/pump sets that will be used to increase the flowrate of the Enbridge pipeline that runs through the Facility. To meet Enbridge's operational requirements, which stipulate that a maximum of four motor/pump sets be connected to one feeder, at minimum Enbridge needs a dedicated 4.16 kV breaker to serve the new load.

Although the transformer that currently serves the Facility has enough spare capacity available to connect a new dedicated 4.16 kV breaker, Enbridge has asked that the new dedicated breaker be connected to a second transformer to improve the reliability of electrical service to the Facility. The Facility provides pumping support to a key Enbridge pipeline and operates continuously. A second transformer ensures that the Enbridge pipeline will continue to operate should there be an outage to one of the transformers.

ATCO Electric DFO[6] concluded that there are no other PODs in the vicinity of the customer site technically capable of supplying the proposed load effectively. Therefore, only one alternative was evaluated for this connection project:

[6] Please refer to: ATCO Electric 2016 Distribution Deficiency Report *Bohn 931S Transformer Addition*, which has been filed under a separate cover.

Alternative 1: Install a second 15/20/25 MVA 144/4.16 kV transformer at the Bohn 931S substation with a dedicated 4.16 kV breaker

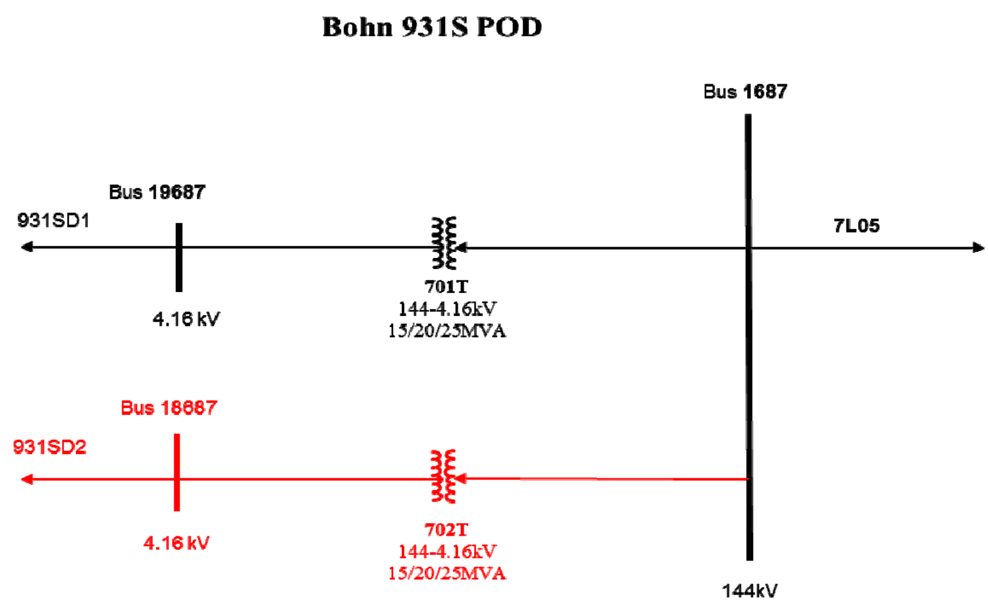
This alternative includes the following work at Bohn 931S:

- Installing 1 (one) 15/20/25 MVA 144/4.16 kV LTC transformer.
- Installing 1 (one) grounding resistor. Size to be defined by Enbridge.
- Installing 1 (one) 144 kV breaker and associated disconnect switch and instrument transformers.
- Installing 1 (one) 4.16 kV breaker and associated disconnect switches.

5.1.1. Connection Alternatives Selected for Further Studies

Only Alternative 1 was evaluated. The red elements in Figure 5-1 show the proposed developments in Bohn 931S substation for the connection alternative evaluated.

Figure 5-1: Alternative 1 - Serve load from the existing Bohn 931S Substation



5.1.2. Connection Alternatives Not Selected for Further Studies

N/A

6. Post-Connection System Assessment

No transmission criteria violation was found for the contingencies studied in the 2016WP and 2017SP post-connection scenarios within the Study Area. Please refer to Attachment B for post-connection power flow plots. Also, no voltage stability margin problems were found in the Study Area for this connection project.

6.1. Post-Connection Power Flow Analysis

6.1.1. Scenario 2: 2016WP Post-Connection

No thermal overloads, voltage violations or POD bus voltage deviations were found for any Category A conditions or Category B contingencies within the Study Area.

6.1.2. Scenario 3: 2017SP Post-Connection

No thermal overloads, voltage violations or POD bus voltage deviations were found for any Category A or B or selected C5 contingencies within the Study Area.

6.2. Post-Connection Voltage Stability Analysis

The voltage stability analysis was conducted for the 2016WP post-connection scenario.

6.2.1. Scenario 2: 2016WP Post-Connection

In the 2016WP post-connection scenario, the reference load level for the Fort McMurray area is 2614.9MW. The minimum incremental load transfer for the Category B contingencies is 5.0% of the reference load or 130.75 MW to meet the voltage stability criteria (0.05 x 2614.9MW = 130.75MW). All contingencies met the minimum criteria.

The five worst contingencies for Categories B contingencies are shown in Table 6-1. The PV curves for the 240 kV transmission line 9L10, the MacKay generator's transformer, the 240 kV transmission line 9L43, the 240 kV transmission line 9L57, and the 240 kV transmission line 9L930 contingencies in the Study Area in the 2016WP post-connection scenario are included in Attachment C.

Table 6-1: Scenario 2 - 2016WP Post-Connection (Voltage Stability Analysis Results)

Contingency	From Substation	To Substation	Maximum incremental transfer (MW)	Meets transfer criteria?
System Normal (N-G)			560	YES
Category B (Min Transfer = 130.75 MW)				
9L10	Brintnell 876S	Livock 939S	410	YES
MacKay Generator's Transformer			430	YES
9L43	Dover 888S	MacKay 874S	440	YES

Contingency	From Substation	To Substation	Maximum incremental transfer (MW)	Meets transfer criteria?
9L57	Livock 939S	Birchwood Creek 960S	460	YES
9L930	Edwards Lake 89S	Heart Lake 898S	470	YES

6.3. Mitigation Measures for Identified Issues

No Reliability Criteria violations were found in the Study Area for the 2016WP pre- and post-connection scenarios and the 2017SP post-connection scenario for the conditions studied. No mitigation measures are, therefore, required.

6.4. Conclusions and Recommendations

There were no Reliability Criteria violations found within the Study Area or on the tie lines that connect it to the AIES for the evaluated connection alternative. Hence, the evaluated connection alternative is recommended to proceed based on the technical assessment presented in Section 6.

7. Project Interdependencies

No project interdependencies were identified.

8. Conclusions and Recommendations

ATCO, in its capacity as DFO, in the Janvier South area, has received a request from Enbridge to expand the electric service to its Facility. The DFO has submitted a SASR to the AESO, which includes a Rate DTS, *Demand Transmission Service*, contract capacity increase from 12 MW to 19 MW. In addition to increased capacity, Enbridge has asked for a second transformer to serve its Facility to improve the reliability of the electricity service to its Facility. The existing load at the Facility is served by the Bohn 931S substation. The ISD requested for the Project is February 1, 2017.

This report presented the results of the study that assesses the impact of the Project on the AIES.

The Project is located within the Fort McMurray area, which is part of the Northeast region. The existing constraints in the Northeast region are managed in accordance Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management*.

Study Area

The Study Area chosen was defined as south-east portion of the Fort McMurray area (AESO planning area 25).

Studies performed for the Project

Power flow analysis was performed for the 2016WP pre- and post-connection scenarios and 2017SP post-connection scenario.

Voltage stability analysis was completed for the 2016WP post-connection scenario.

Results of the pre-connection studies

No Reliability Criteria violations were observed for the pre-connection study scenario.

Connection alternatives examined for the Project

The only alternative considered and evaluated includes adding a second 15/20/25 MVA 144/4.16 kV transformer with a dedicated 4.16 kV breaker at the Bohn 931S substation to supply the additional Enbridge load. All other PODs in the area are too far away to effectively serve the requested load addition.

Results of the post-connection studies

Category A (N-G-0) conditions

Under Category A conditions, no Reliability Criteria violations were observed for any of the studied scenarios with the examined alternative.

Category B (N-G-1) contingency conditions

Under Category B contingency conditions, no Reliability Criteria violations were observed for any of the studied scenarios with the examined alternative.

Recommendations

The study confirmed that the AIES is not adversely impacted by upgrading the Bohn 931S substation and increasing its DTS. It also confirmed that this alternative is technically viable and that there are no Reliability Criteria violations. Therefore, it is recommended to proceed with the addition of a second transformer at the Bohn 931S substation.

ATTACHMENT A
Pre-Connection System Power Flow Plots

A-1 System Power Flow Results

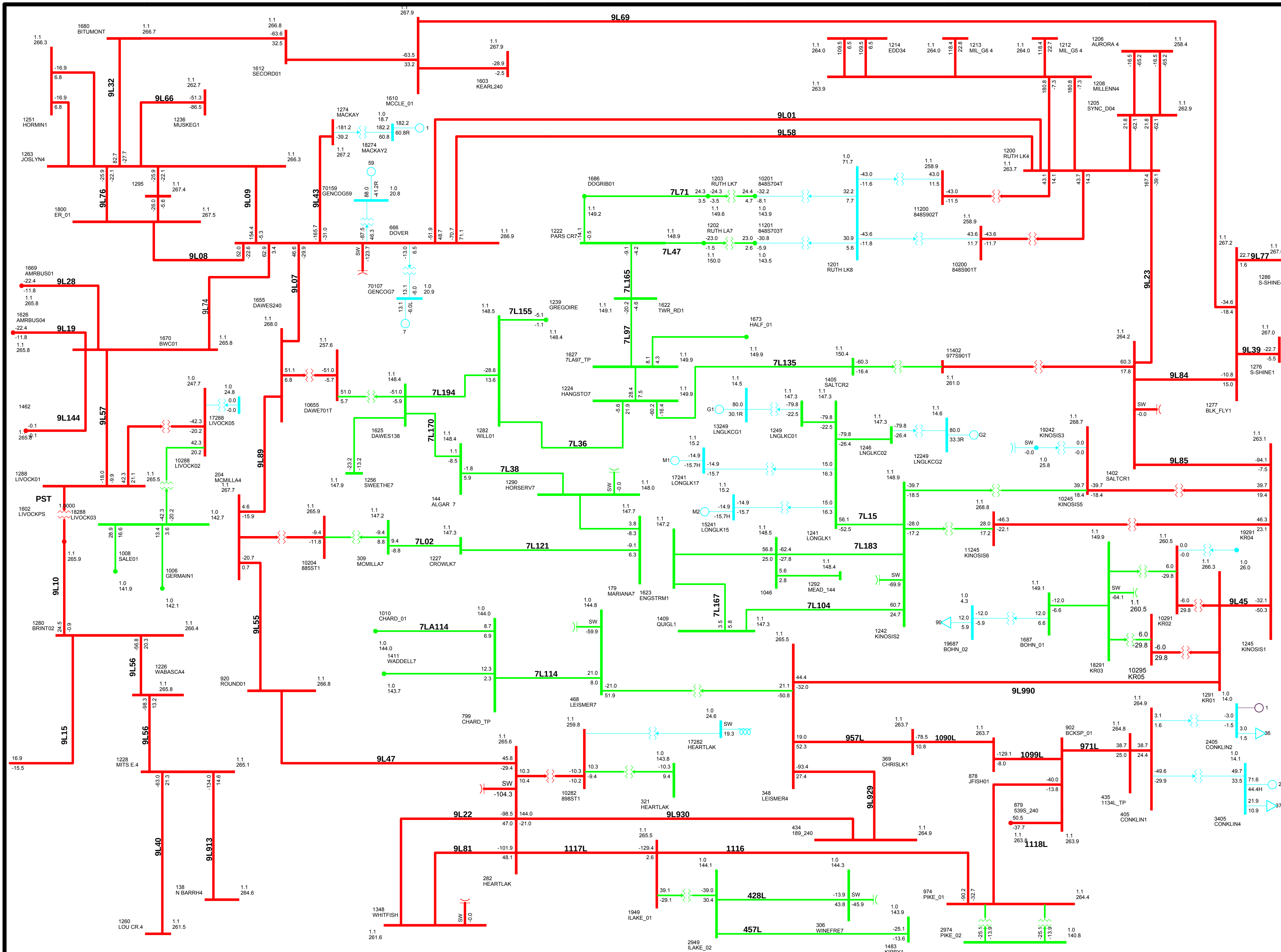
Power Flow Diagrams

The pre-connection power flow diagrams for Categories A and B contingencies are provided in this section. The following table presents the list of the power flow diagrams.

Table A-1: List of Pre-Connection Power Flow Diagrams

Scenario	Power Flow Diagram	Page Number
Scenario 1 (2016WP-Pre Project)	N-G-0, System Normal Condition	A-3
	N-G-1, Loss of 9L45	A-4
	N-G-1, Loss of 9L990	A-5
	N-G-1, Loss of 9L85	A-6
	N-G-1, Loss of 9L47	A-7

NOTES: Other power flow diagrams will be provided upon request.



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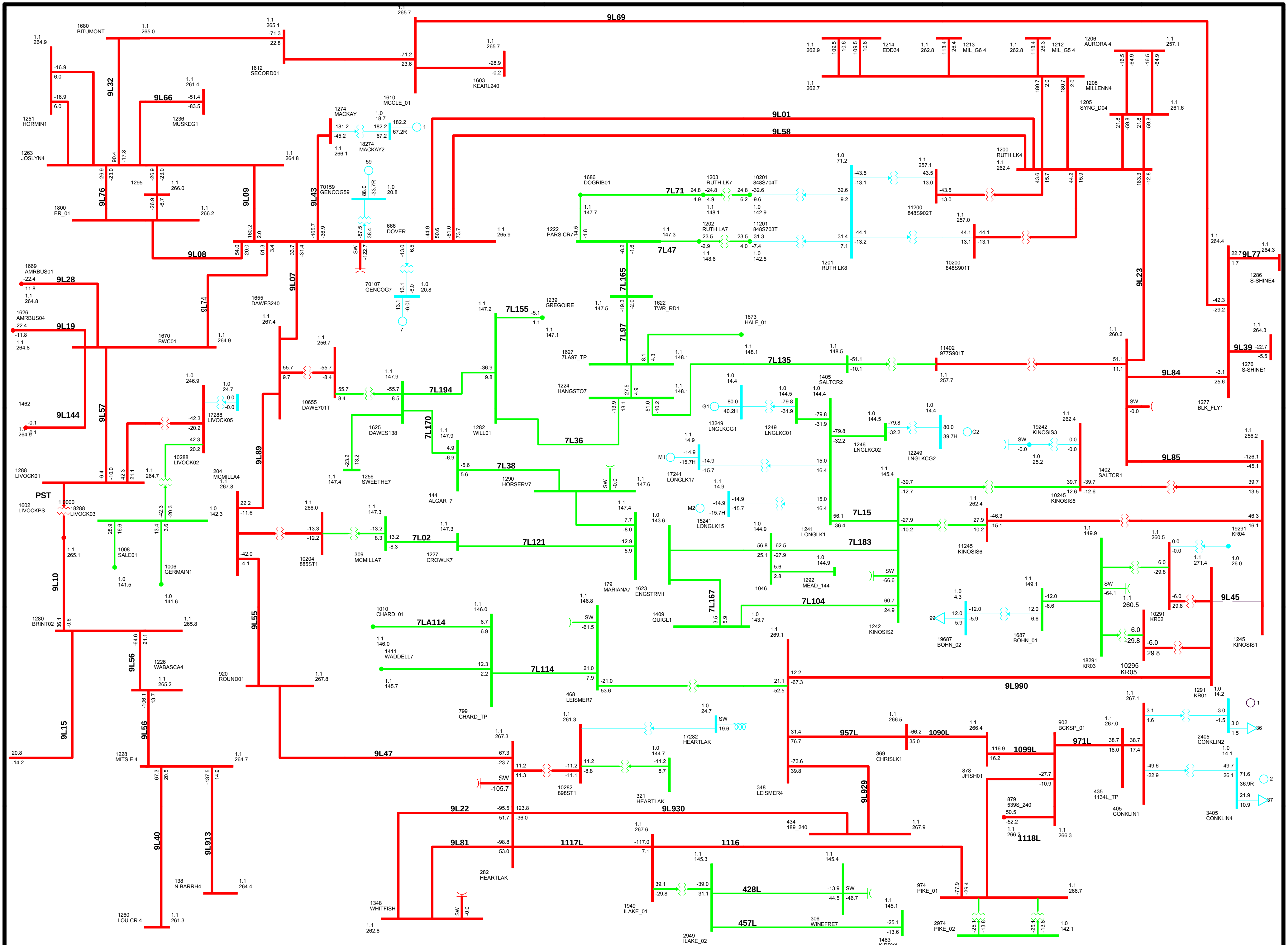
CATEGORY A, N-0
2016WP PRE-CONNECTION
MON, JAN 25 2016 14:45

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



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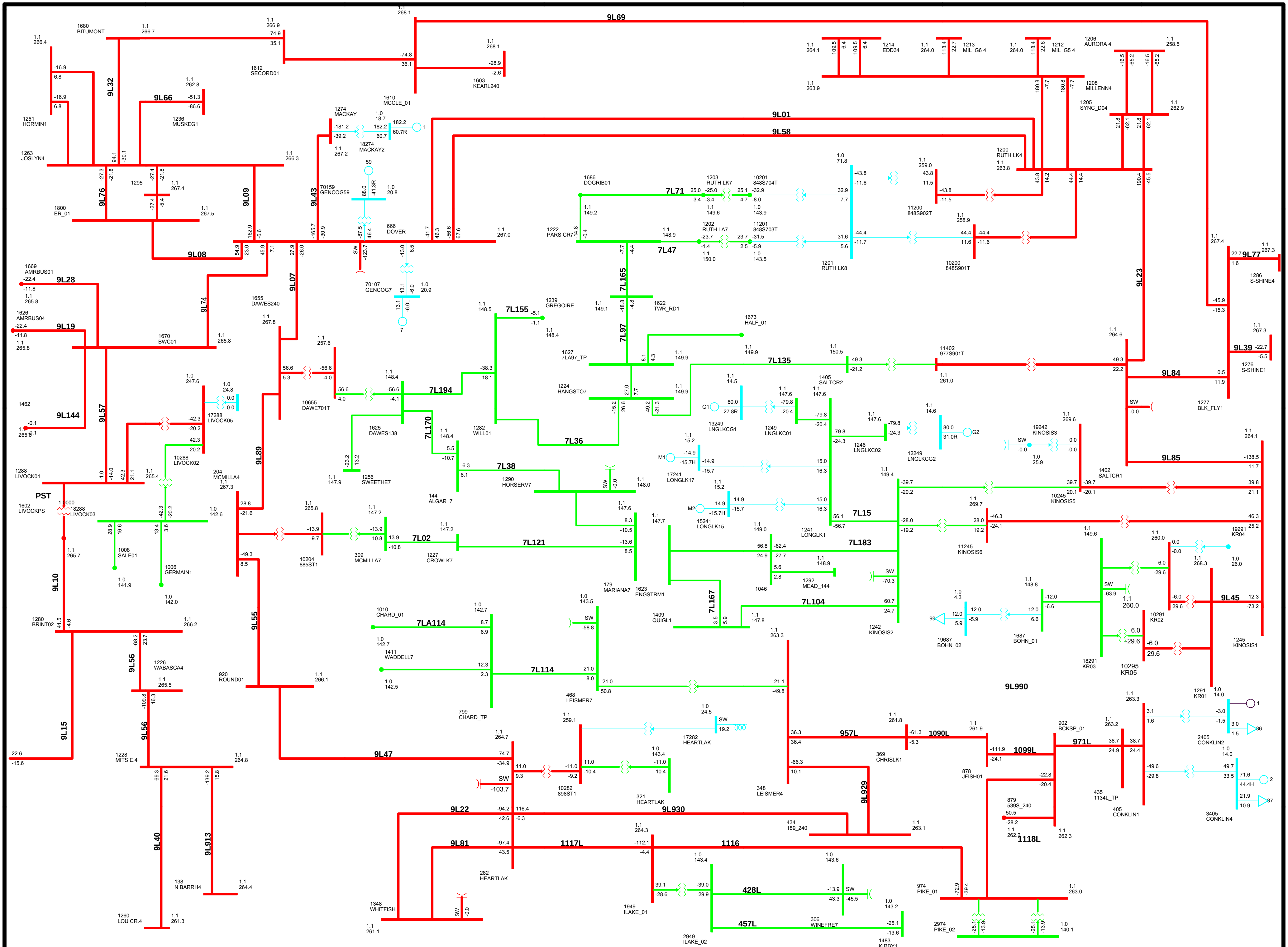
CATEGORY B, LOSS OF 9L45
2016WP PRE-CONNECTION
MON, JAN 25 2016 14:45

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



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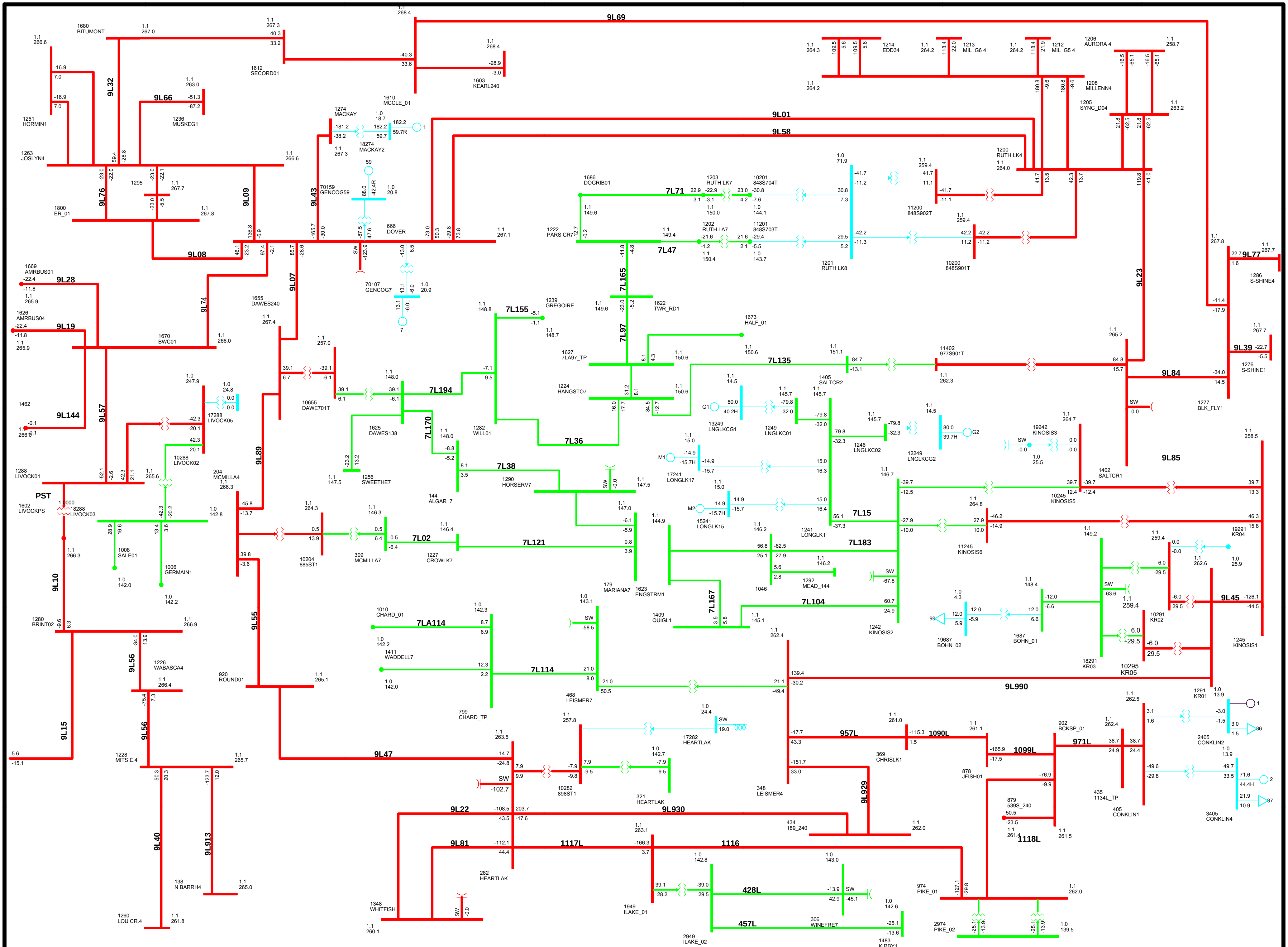
CATEGORY B, LOSS OF 9L990
2016WP PRE-CONNECTION
MON, JAN 25 2016 14:45

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



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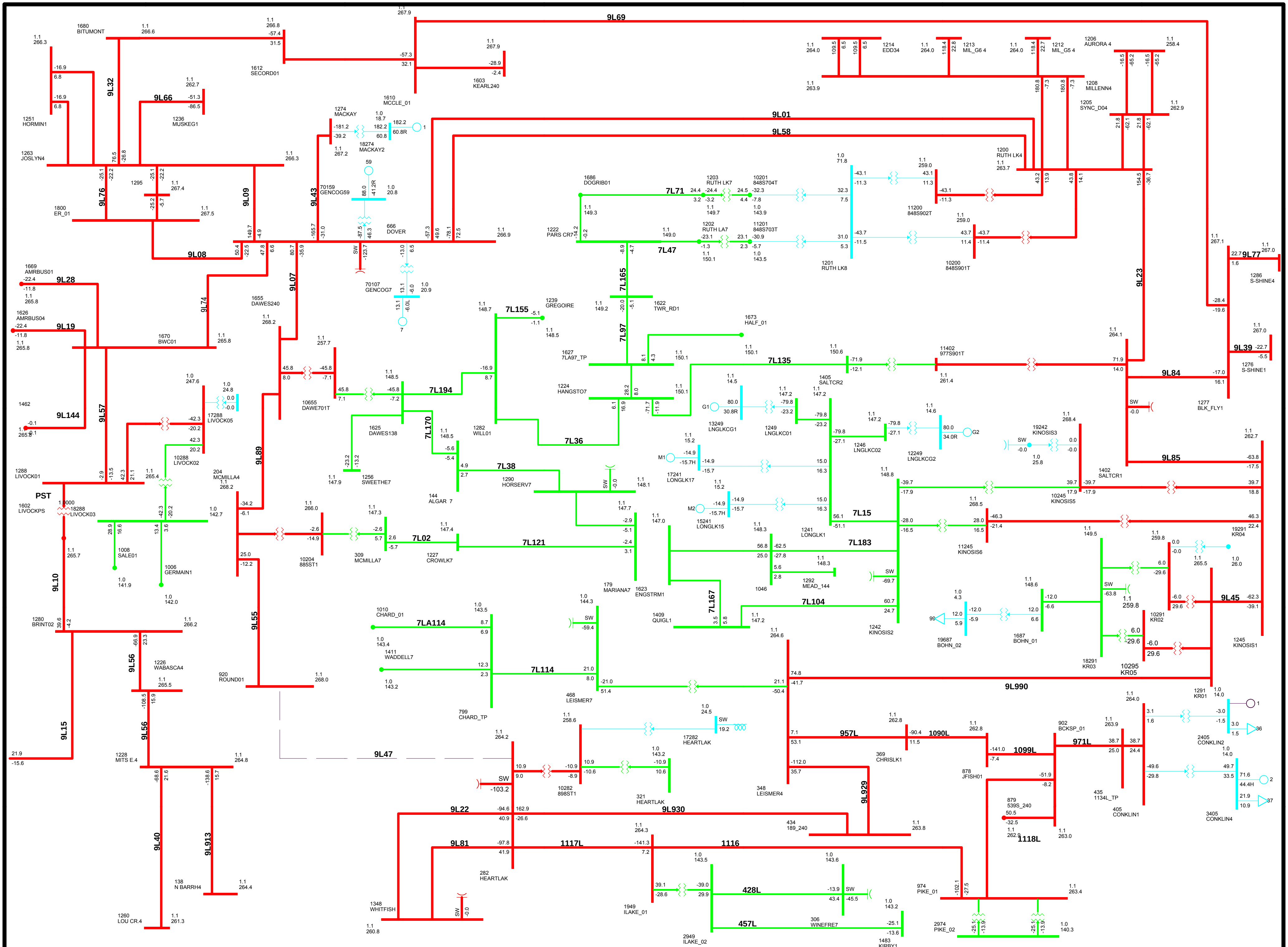
CATEGORY B, LOSS OF 9L85
2016WP PRE-CONNECTION
MON, JAN 25 2016 14:45

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



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CATEGORY B, LOSS OF 9L47
2016WP PRE-CONNECTION
MON, JAN 25 2016 14:45

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

ATTACHMENT B

Post-Connection System Power Flow Plots

B-1 System Power Flow Results

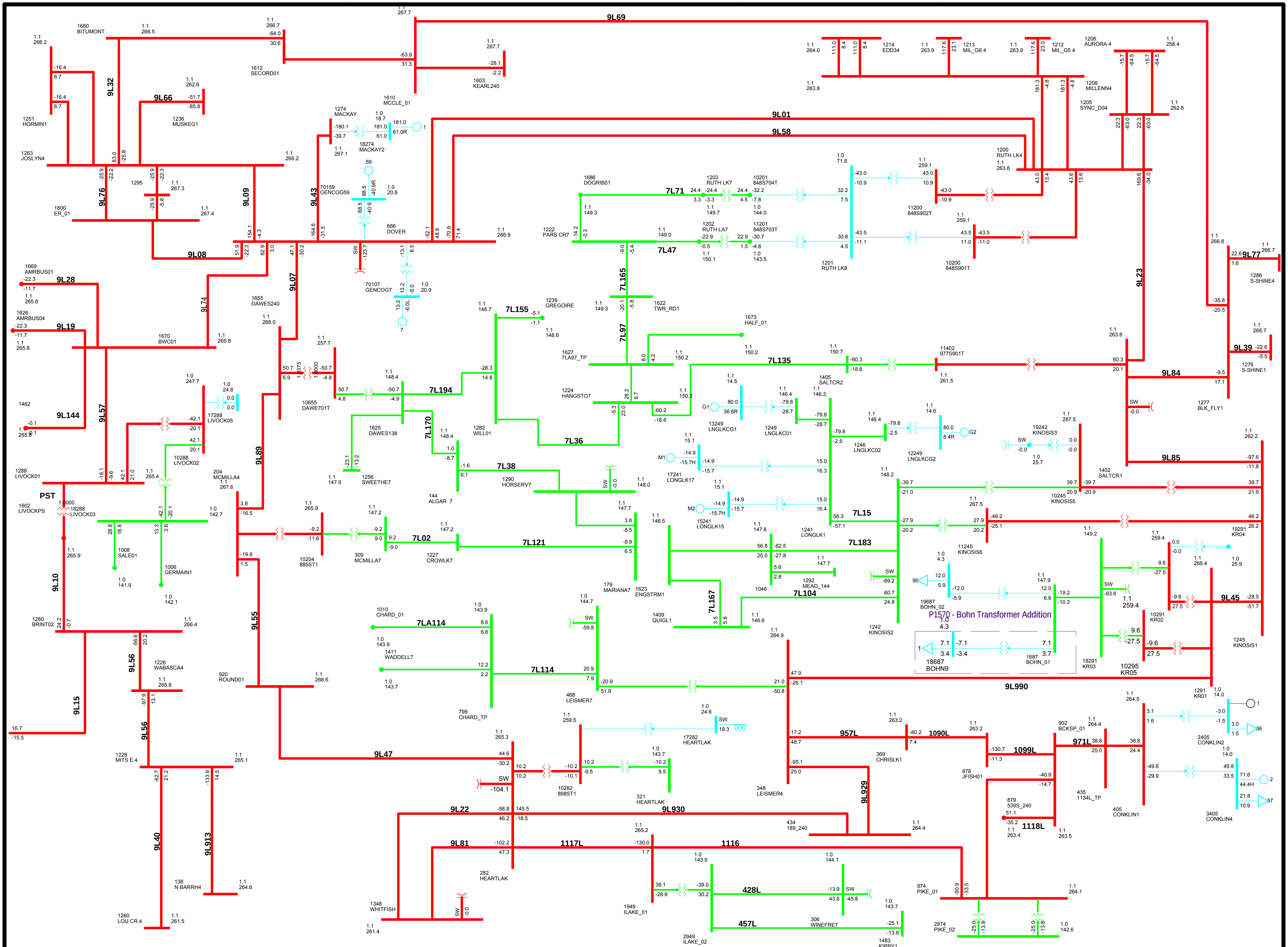
Power Flow Diagrams

The post-connection power flow diagrams for Categories A and B contingencies are provided in this section. The following table presents the list of the power flow diagrams.

Table B-1: List of Post-Connection Power Flow Diagrams

Scenario	Power Flow Diagram	Page Number
Scenario 2 (2016WP-Post Project)	N-G-0, System Normal Condition	B-3
	N-G-1, Loss of 9L45	B-4
	N-G-1, Loss of 9L990	B-5
	N-G-1, Loss of 9L85	B-6
	N-G-1, Loss of 9L47	B-7
Scenario 3 (2017SP-Post Project)	N-G-0, System Normal Condition	B-8
	N-G-1, Loss of 9L45	B-9
	N-G-1, Loss of 9L990	B-10
	N-G-1, Loss of 9L85	B-11
	N-G-1, Loss of 9L47	B-12

NOTES: Other power flow diagrams will be provided upon request.



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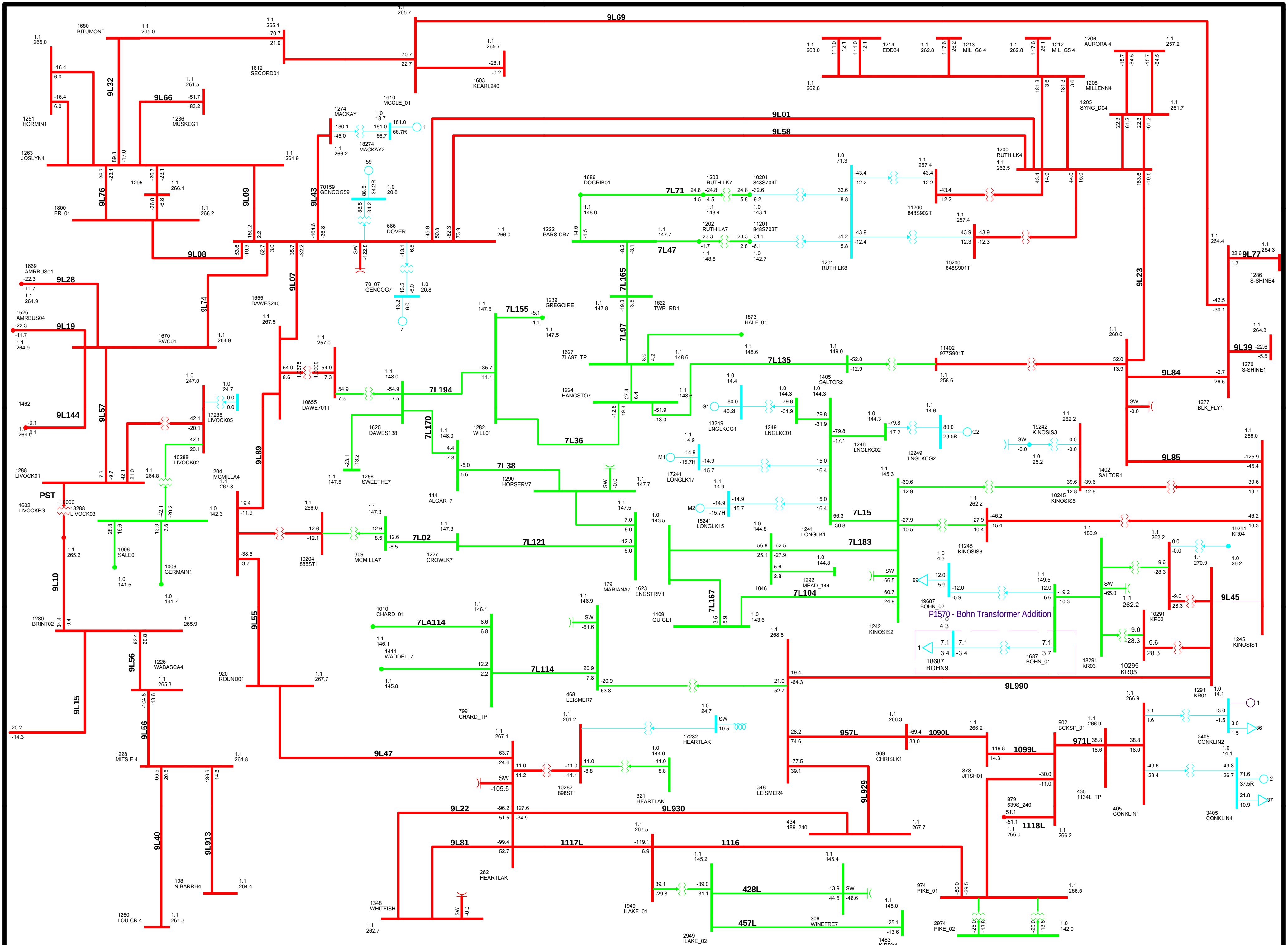
CATEGORY A, N-0
2016WP POST-CONNECTION
MON, JAN 25 2016 14:48

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



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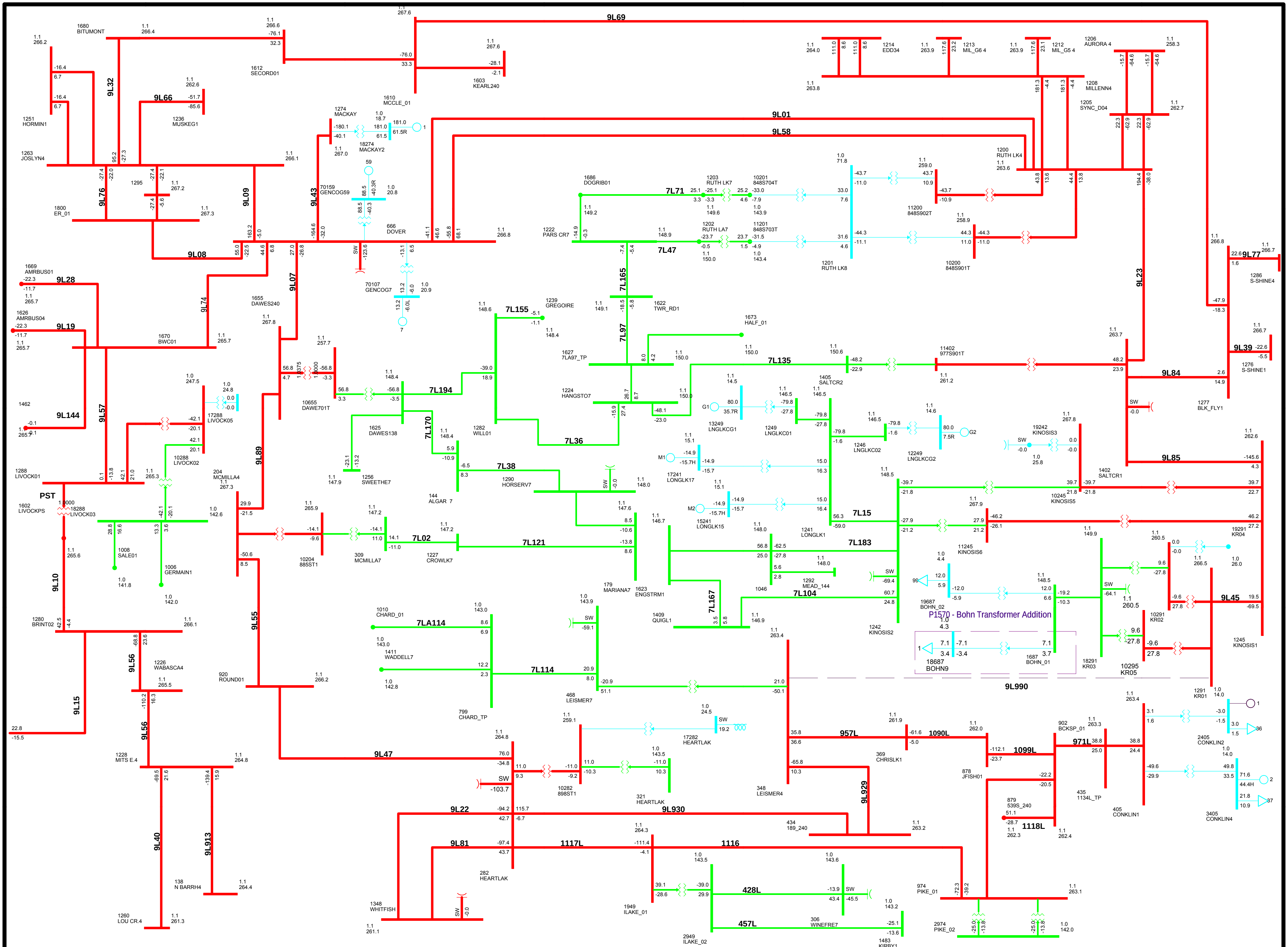
CATEGORY B, LOSS OF 9L45
2016WP POST-CONNECTION
MON, JAN 25 2016 14:48

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



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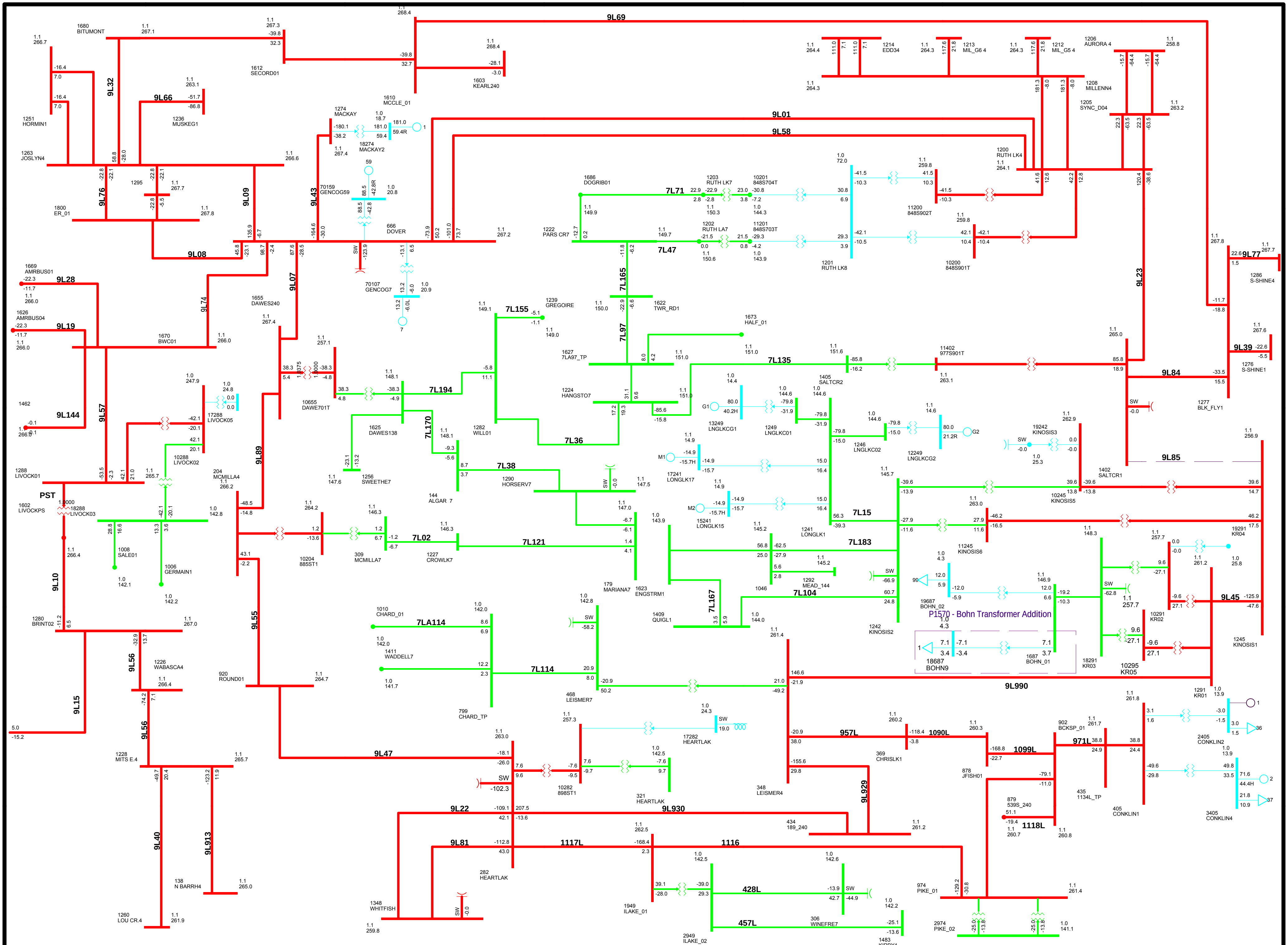
CATEGORY B, LOSS OF 9L990
2016WP POST-CONNECTION
MON, JAN 25 2016 14:48

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



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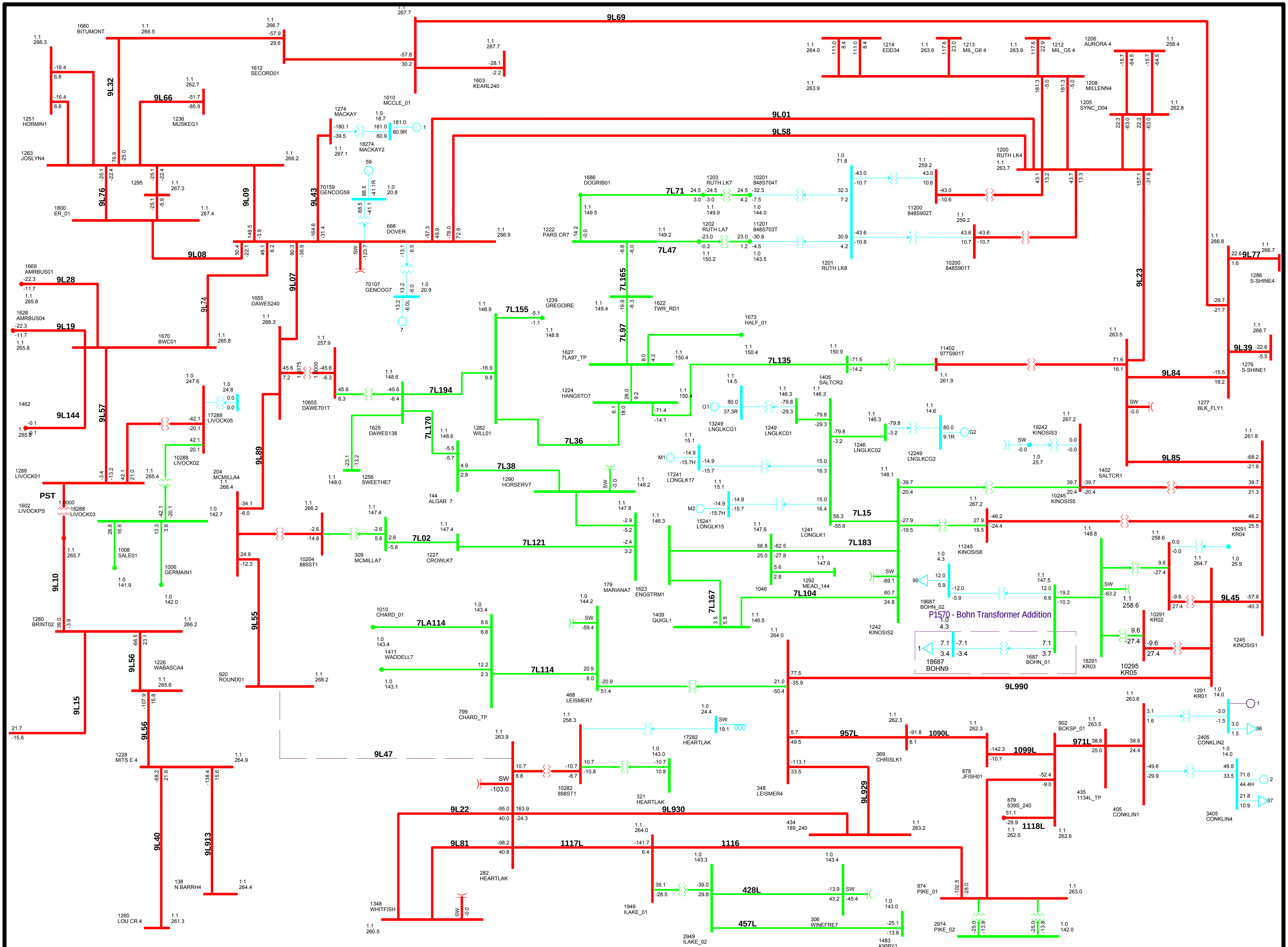
CATEGORY B, LOSS OF 9L85
2016WP POST-CONNECTION
MON, JAN 25 2016 14:49

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



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CATEGORY B, LOSS OF 9L47
2016WP POST-CONNECTION
MON, JAN 25 2016 14:49

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

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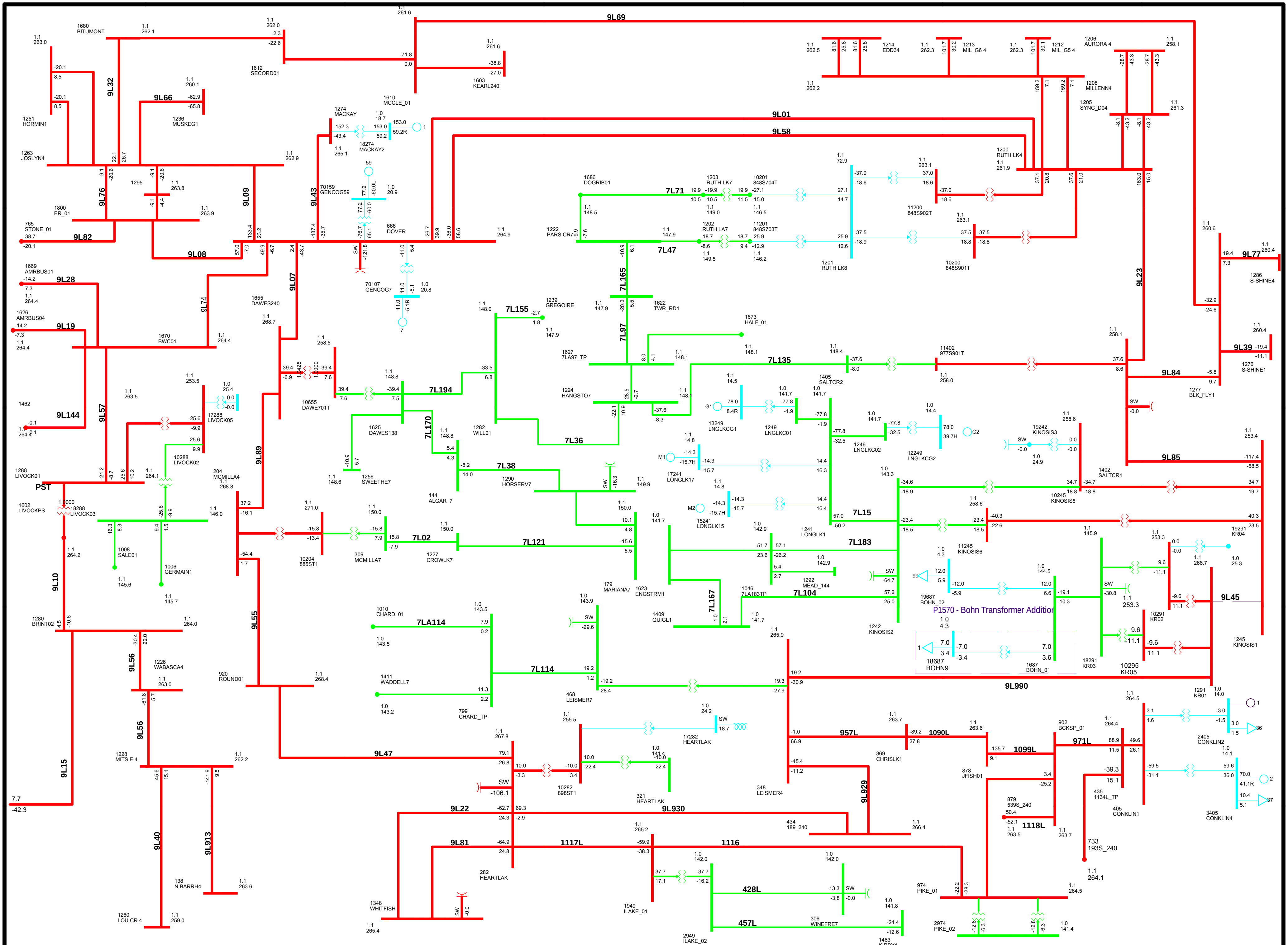
CATEGORY A, N-0
2017SP POST-CONNECTION
MON, JAN 25 2016 14:50

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



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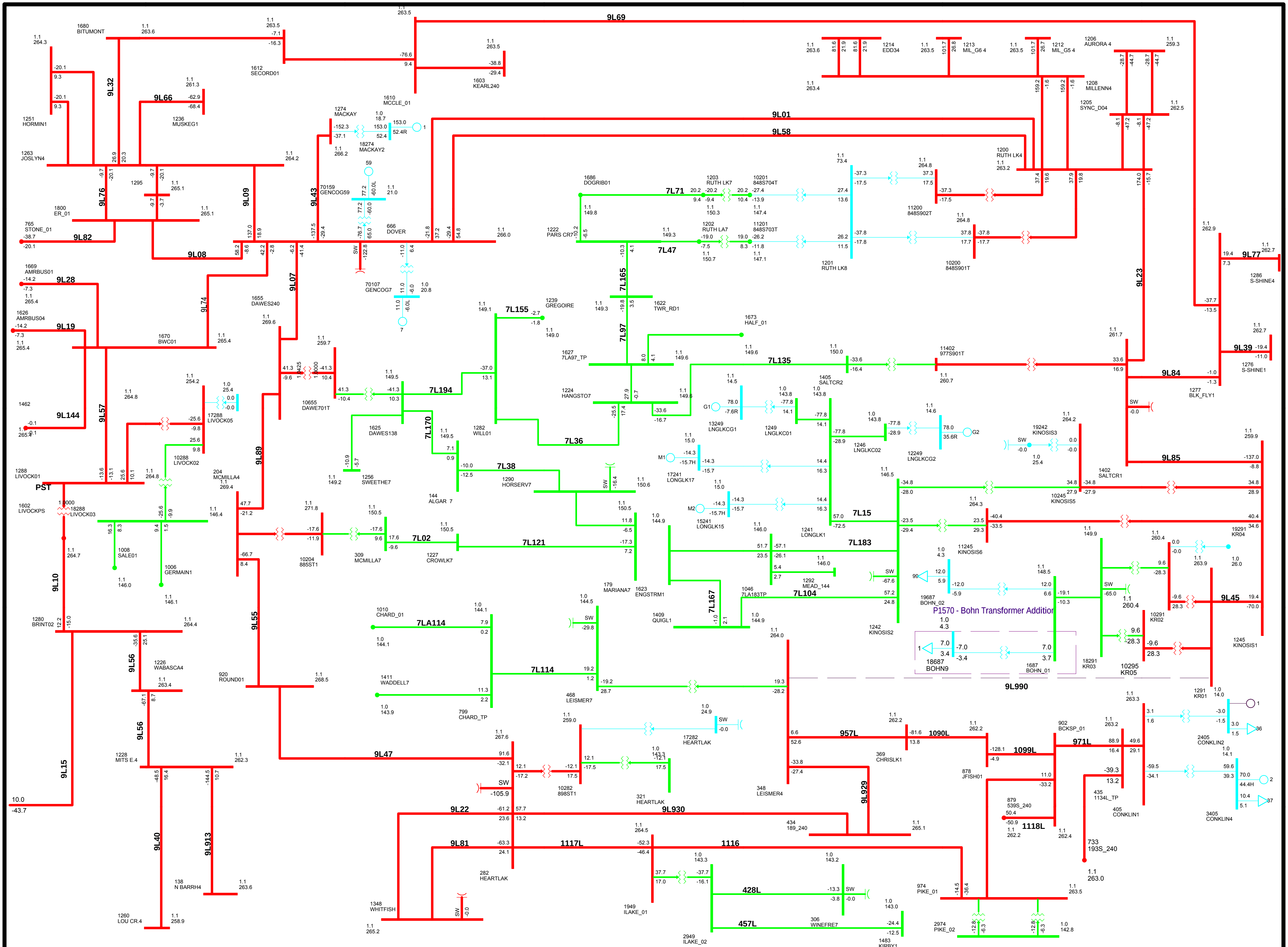
CATEGORY B, LOSS OF 9L45
2017SP POST-CONNECTION
MON, JAN 25 2016 14:50

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



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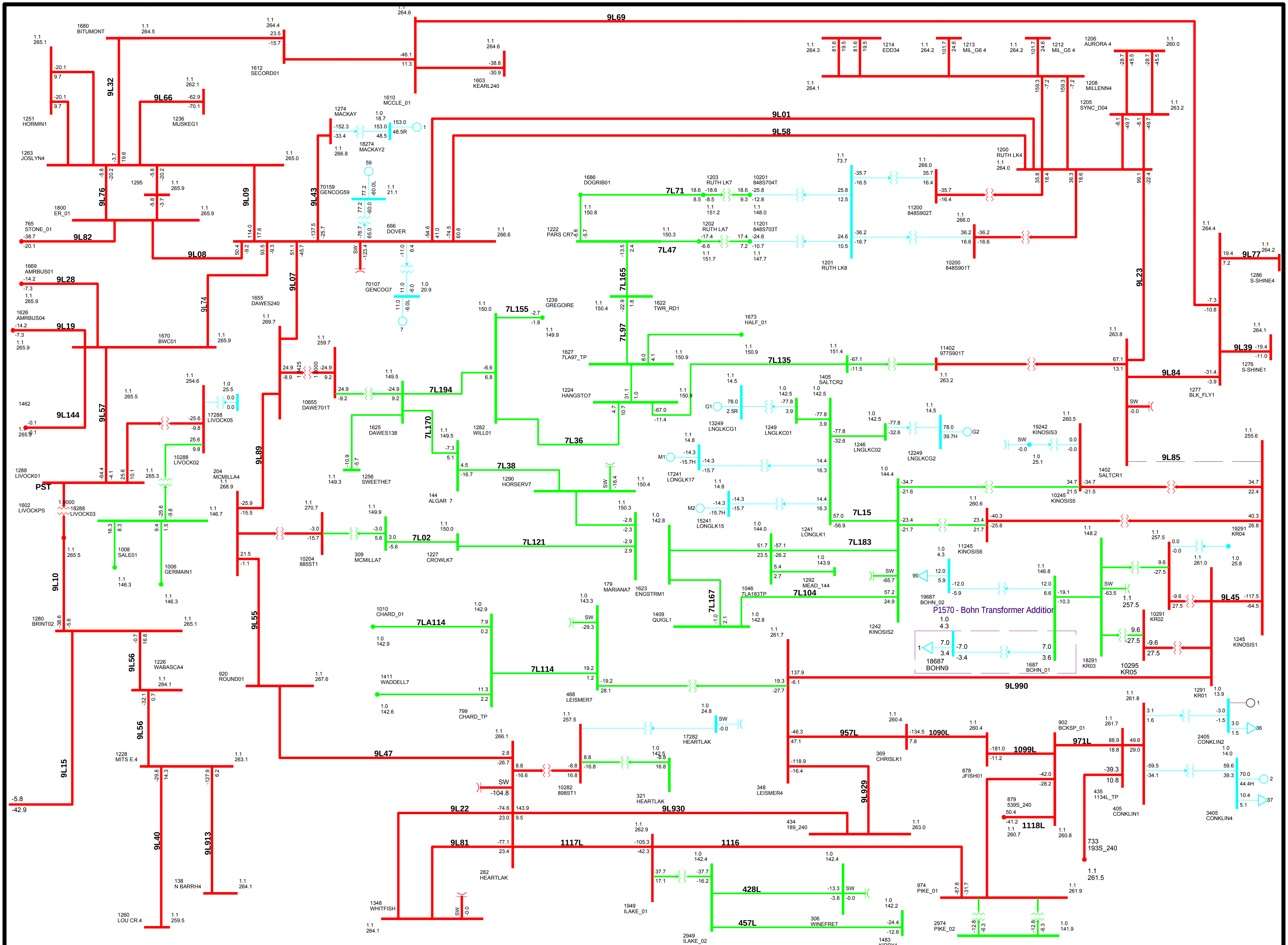
CATEGORY B, LOSS OF 9L990
2017SP POST-CONNECTION
MON, JAN 25 2016 14:50

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



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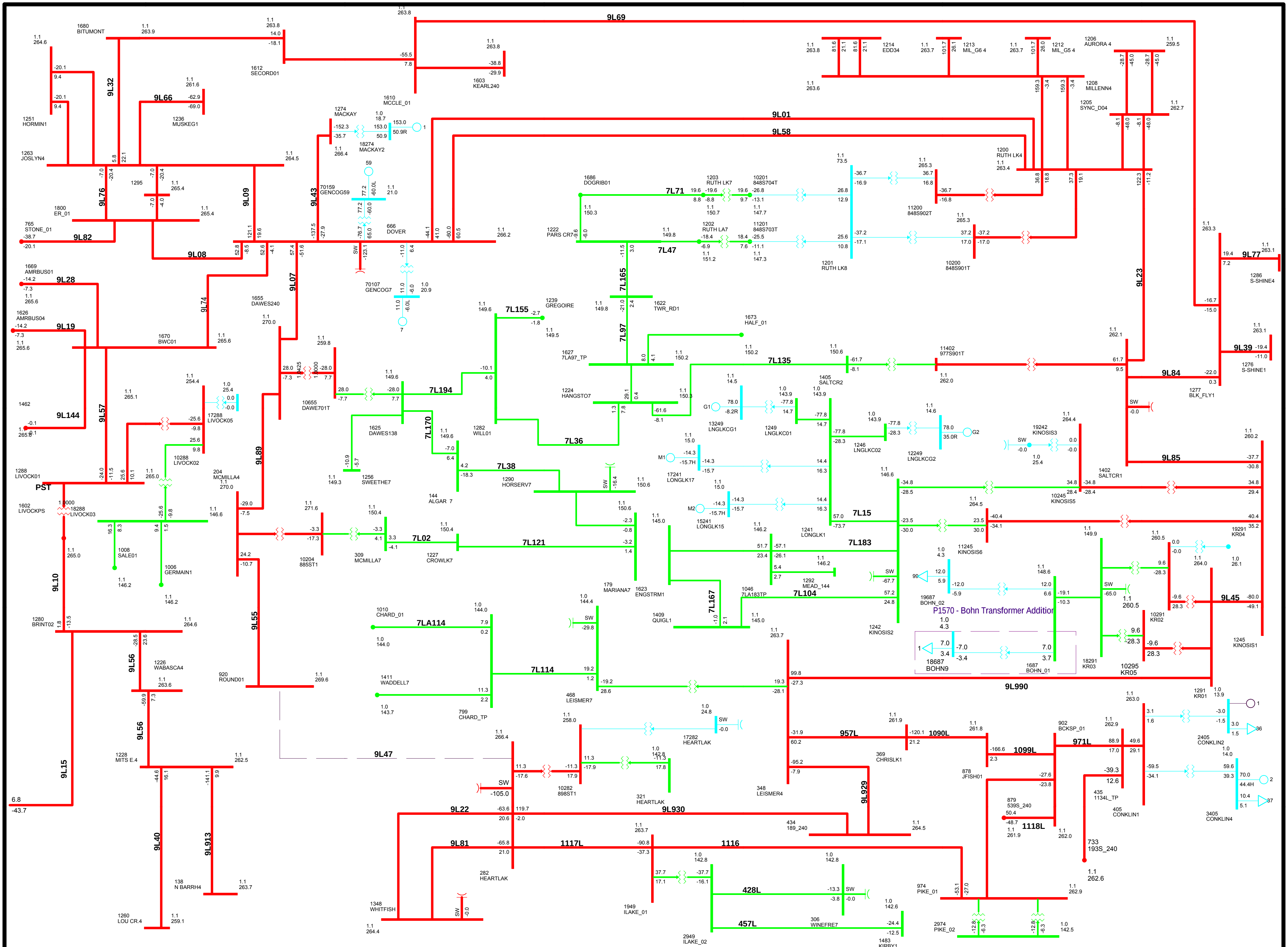
page B-11

CATEGORY B, LOSS OF 9L85
2017SP POST-CONNECTION
MON, JAN 25 2016 14:50

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



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CATEGORY B, LOSS OF 9L47
2017SP POST-CONNECTION
MON, JAN 25 2016 14:50

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

ATTACHMENT C

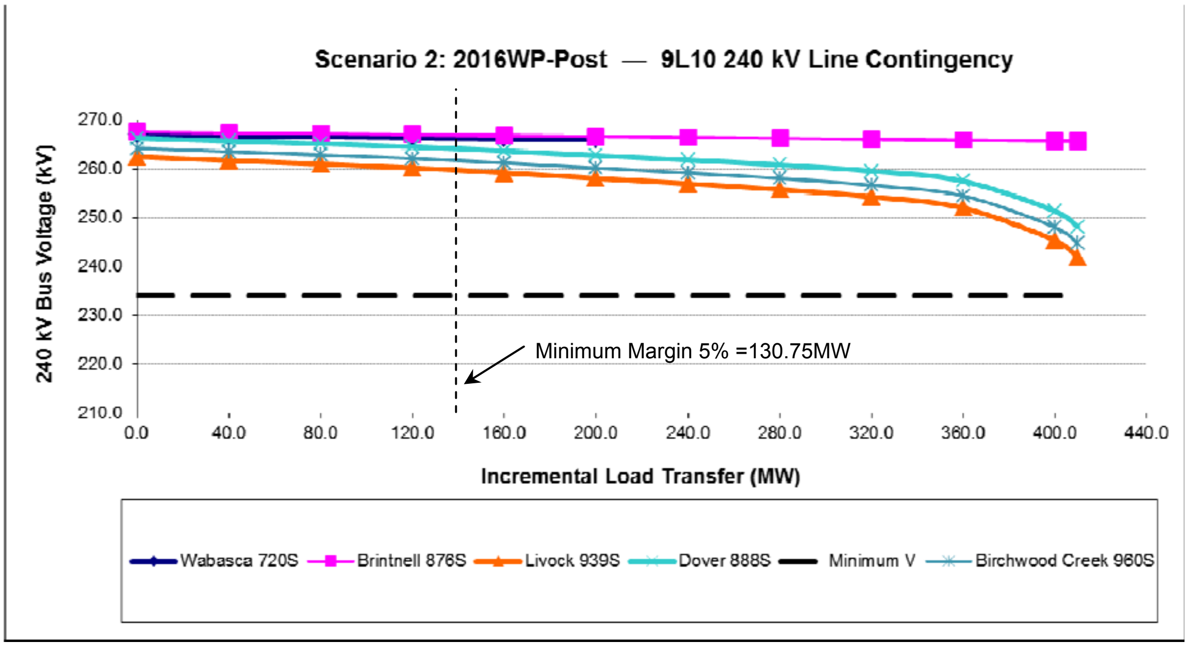
Post-Connection System Voltage Stability Analysis Results

C-1 Post-Connection System Voltage Stability Analysis Results

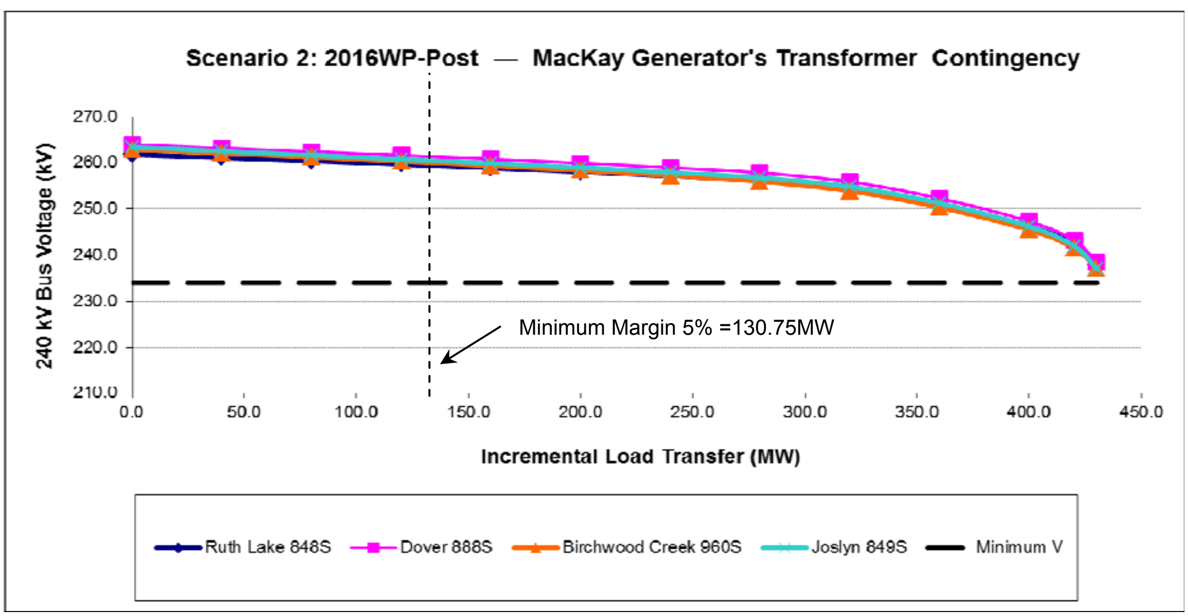
Scenario 2: 2016WP Post-Project

Figure C-1 shows the PV curves for the 240 kV transmission line 9L10, the MacKay generator's transformer, the 240 kV transmission line 9L43, the 240 kV transmission line 9L57, and the 240 kV transmission line 9L930 contingencies in the Study Area in the 2016WP post-connection scenario.

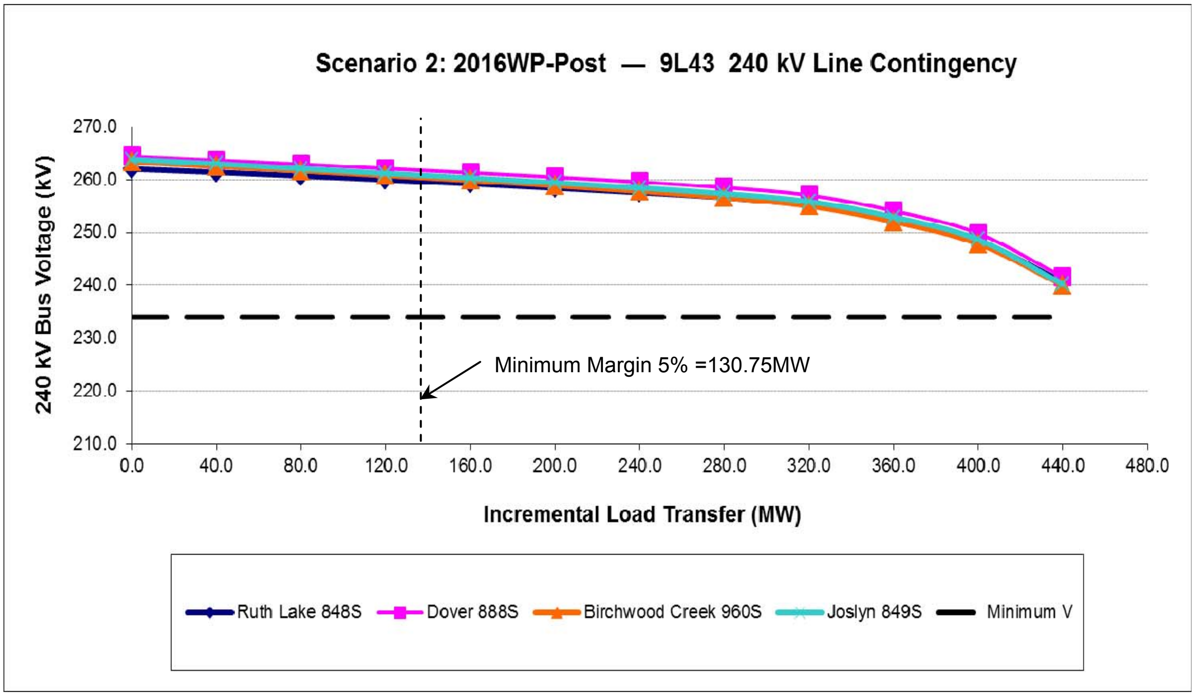
Figure C-1: PV Curves for Scenario 2 – 2016WP Post-Project



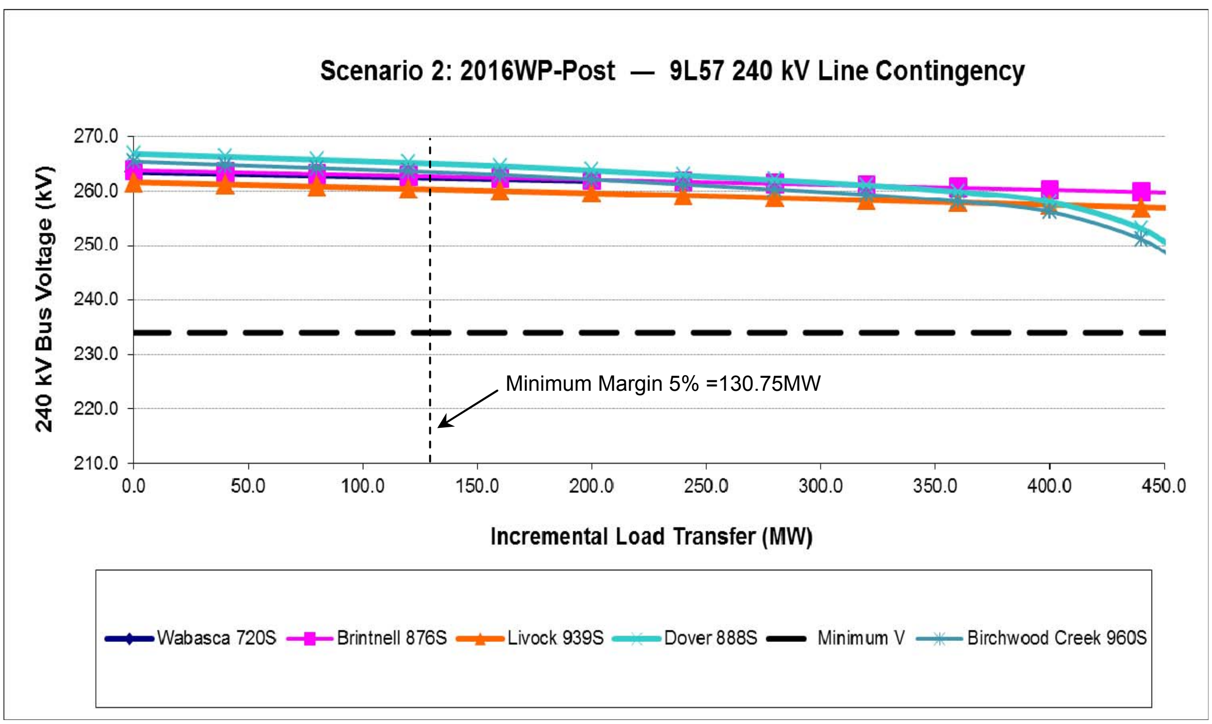
(a) 9L10 Contingency



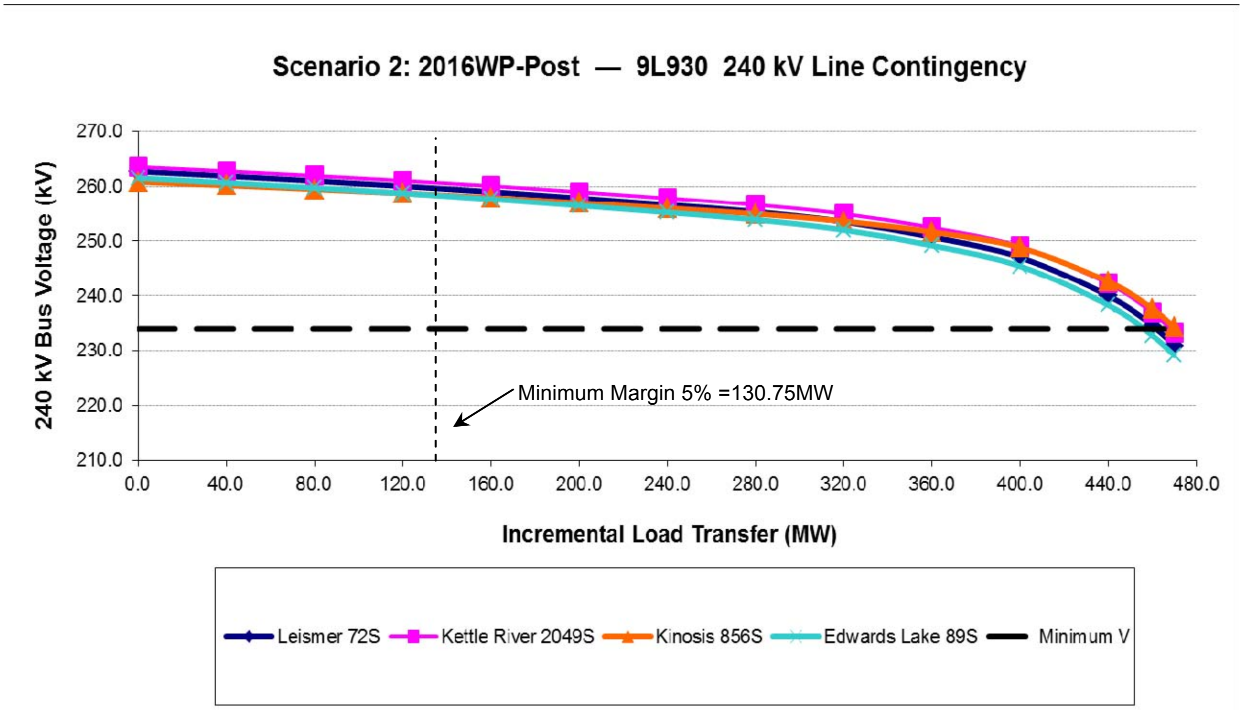
(b) MacKay Generator's Transformer Contingency



(c) 9L43 Contingency



(d) 9L57 Contingency



(e) 9L930 Contingency