APPENDIX A CONNECTION ASSESSMENT

AESO Engineering Connection Assessment

FortisAlberta Provost Reliability

AESO Project Number: 1782

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Note:

The conclusion and recommendations stated in this Report are based on results listed in the Connection Assessment Results report prepared by a third party as part of the AESO's connection process (Attachment A of this report).

The AESO has reviewed the Connection Assessment Results Report, and finds it acceptable for the purpose of assessing potential impacts of the proposed connection on the transmission system.

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1. Introduction

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

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

1.1. Project Overview

FortisAlberta Inc. (FortisAlberta), 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 improve distribution system reliability in the Provost area.

The DFO's request for system access service included a request for transmission development, but did not include any change to its existing Rate DTS, *Demand Transmission Service*, or Rate STS, *Supply Transmission Service*, contract capacities (collectively, the Project).

The scheduled in-service date (ISD) for the Project is May 1, 2020.

2. Assessment Scope

2.1. Objectives

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

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

2.2. Study Area

The Study Area for the Project consists of the AESO planning areas of Lloydminster (Area 13), Wainwright (Area 32), and Provost (Area 37), including the tie lines connecting these three planning areas to the rest of the AIES. All transmission facilities within the Study Area were studied and monitored for violations of the Reliability Criteria (defined in Section 3.1 of Attachment A1).

3. Connection Alternatives

The AESO, in consultation with the legal owner of transmission facilities (TFO) in the Study Area, and the DFO, examined three transmission alternatives to meet the DFO's request for system access service.

3.1. Connection Alternatives Identified

Alternative 1 – Upgrade the Provost 545S and Edgerton 899S substations

This alternative includes the following developments:

- Upgrade the existing Provost 545S substation, including adding one 138/25 kV transformer, three 25 kV circuit breakers and associated equipment.
- Upgrade the existing Edgerton 899S substation, including replacing the existing 138/25 kV transformer with a 138/25 kV transformer of higher capacity, and adding one 25 kV circuit breaker and associated equipment.

Alternative 2 – Add a 138 kV Transmission Line to connect the Hayter 277S substation and the Provost 545S substation

This alternative includes the following developments:

- Add a new 138 kV transmission line, approximately 33 km in length, between the existing Hayter 277S and Provost 545S substations.
- Modify the Hayter 277S substation, including adding two 138 kV circuit breakers, one 25 kV circuit breaker and associated equipment.
- Modify the Provost 545S substation, including adding two 138 kV circuit breakers and associated equipment.
- Modify the existing Killarney Lake 267S substation, including adding one 138 kV circuit breaker and associated equipment.

Alternative 3 – Convert the existing Killarney Lake 267S substation T-tap connection to an in-and-out connection

This alternative includes the following developments:

- Add a new 138 kV circuit, approximately 20 km in length, between the Killarney Lake 267S substation and the 138 kV transmission line 749L (between Metiskow 649S and Edgerton 899S substations) to convert the connection for Killarney Lake 267S substation from a T-tap connection to an in-and-out connection.
- Upgrade the existing Killarney Lake 267S substation, including adding one 138/25 kV transformer and associated equipment.

3.2. Connection Alternative Selected for Further Study

Alternative 2 is considered technically feasible and was selected for further study.

3.3. Connection Alternatives Not Selected for Further Study

Alternative 1 and Alternative 3 were not selected for further study as both alternatives were determined to be not technically feasible by the DFO. Specifically, the DFO advised that Alternative 1 would not meet their load restoration criteria and that Alternative 3 would not meet their requested level of reliability.

4. Assessment Approach

4.1. Standards, Criteria, and Assumptions

A detailed description of the standards, criteria, and assumptions that were used for the connection assessment can be found in Attachment A1 of Attachment A.

4.2. Studies Performed

The scheduled ISD for the Project is May 1, 2020. Therefore, the studies were performed using the 2020 summer light (SL), summer peak (SP), and winter peak (WP) for high generation (HG) scenarios, and SP and WP for low generation (LG) scenarios. The short-circuit studies were also performed using the 2027 WP scenario with all generators in and around the Study Area in service.

Table 4-1 provides a list of the study scenarios.

Table 4-1: List of the Connection Study Scenarios

Scenario	Year/Season Load	Condition	System Generation Dispatch Conditions
1	2020 SL	Pre-Project	High generation (HG)
2	2020 SP	Pre-Project	High generation (HG)
3	2020 SP	Pre-Project	Low generation (LG)
4	2020 WP	Pre-Project	High generation (HG)[a]
5	2020 WP	Pre-Project	Low generation (LG)
6	2020 SL	Post-Project	High generation (HG)
7	2020 SP	Post-Project	High generation (HG)
8	2020 SP	Post-Project	Low generation (LG)
9	2020 WP	Post-Project	High generation (HG)[a]
10	2020 WP	Post-Project	Low generation (LG)
11	2027 WP	Post-Project	All generators in and around the Study Area on

Note: [a] For short circuit studies, all generation in and around the Study Area are assumed in service.

As described in Section 3.3.2 of Attachment A1, two different generation dispatch scenarios were studied, high generation (with existing and planned renewable generation dispatched up to forecast) and low generation (with renewable generation dispatched at 0 MW).

4.2.1. Power Flow Studies

The purpose of the power flow studies is to identify and quantify any thermal and voltage criteria violations in the Study Area.

In addition, power flow studies are also used to identify voltage deviations beyond the limits listed in Table 3-1 of Attachment A1 of Attachment A[1] at point of delivery (POD) low voltage busses.

Power flow studies were performed for the 2020 summer light (SL), summer peak (SP) and winter peak (WP) pre-Project and post-Project scenarios for both generation dispatch scenarios.

4.2.2. Voltage Stability (PV) Studies

The objective of the voltage stability analysis is to determine the ability of the network to maintain voltage stability at all the busses under Category A and Category B system conditions. The purpose of the voltage stability studies is to assess the post-Project load transfer capabilities of the transmission system, based on the maximum established planned load as a reference load level.

Voltage stability studies were performed for the 2020 WP LG post-Project scenario.

4.2.3. Short-Circuit Studies

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

Short-circuit studies were performed for the 2020 WP HG pre-Project scenario and for the 2020 WP HG and 2027 WP HG post-Project scenarios.

4.3. Mitigation Measure Development and Evaluation

As contemplated in Section 5 of Attachment A1, mitigation measures were developed to address the system performance issues that were identified in the post-Project scenarios. The studies that were performed to assess the effectiveness of the mitigation measures are briefly outlined below.

4.3.1. Post-Mitigation Studies

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

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

5. Interpretation of Results

5.1. Results Overview

This section provides an assessment of the impact of the Project on the performance of the AIES. Table 5-1 provides a summary of the observed Reliability Criteria violations and proposed mitigation measures.

An overview of the Reliability Criteria violations observed during the connection assessment studies are provided in the following sections:

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

The detailed study results are provided in Attachment A.

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

Scenario	Details of Violation (Violation Observed On)	Contingency (System Element Lost)	Project Impact	Pre-Project Mitigation Measures	Post-Project Mitigation Measures
2020 SP HG	7L14 (Kitscoty 705S - Hill 751S)	648ST1 (Metiskow 648S 138/25 kV transformer)	Thermal criteria violation is resolved	Real-time operational practices	None
	7L130 (Vermilion 710S - Kitscoty 705S)		Thermal criteria violation is resolved	Real-time operational practices	None
	7L129 (Vermilion 710S - Bauer 918S Tap)		Thermal criteria violation is resolved	Planned RAS 138	None
	7L129 (Buffalo Creek 526S - Bauer 918S Tap)		Thermal criteria violation is resolved	Planned RAS 138	None
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)		Materially reduced existing thermal criteria violation	Planned RAS 138	Planned RAS 138
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	7L14 (Kitscoty 705S - Hill 751S)	No impact on thermal criteria violation	Planned RAS 138	Planned RAS 138
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	7L42 (Hill 751S - Lloydminster 716S)	No impact on thermal criteria violation	Planned RAS 138	Planned RAS 138
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	899S T3 (Edgerton 899S 138/25 kV transformer)	No impact on thermal criteria violation	Planned RAS 138	Planned RAS 138
	7L129 (Buffalo Creek 526S - Bauer 918S Tap)	749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	Marginally reduced existing thermal criteria violation	Planned RAS 138	Planned RAS 138
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)		Marginally reduced existing thermal criteria violation	Planned RAS 138	Planned RAS 138
	7L129 (Vermilion 710S - Bauer 918S Tap)		Marginally reduced existing thermal criteria violation	Planned RAS 138	Planned RAS 138
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	749L/7L749 (Edgerton 899S - Lloydminster 716S)	No impact on thermal criteria violation	Planned RAS 138	Planned RAS 138
	749L (Edgerton 899S - Killarney Lake 267S Tap)	7L50 (Buffalo Creek 526S - Jarrow 252S/Battle River 757S)	Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L749 (Edgerton 899S - Briker 880S Tap)		Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
	749L (Edgerton 899S - Killarney Lake 267S Tap)	526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
	749L (Edgerton 899S - Killarney Lake 267S Tap)	7L129 (Buffalo Creek 526S - Vermilion 710S)	Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
2020 SP LG	Voltage Collapse	648ST1 (Metiskow 648S 138/25 kV transformer)	Voltage criteria violation is resolved	Real-time operational practices	None
2020 WP HG	Voltage Collapse	648ST1 (Metiskow 648S 138/25 kV transformer)	Voltage criteria violation is resolved	Real-time operational practices	None
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	899S T3 (Edgerton 899S 138/25 kV transformer)	No impact on thermal criteria violation	Planned RAS 138	Planned RAS 138
	749L (Edgerton 899S - Killarney Lake 267S Tap)	526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L749 (Edgerton 899S - Briker 880S Tap)		Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	Marginally reduced existing thermal criteria violation	Planned RAS 138	Planned RAS 138
	7L130 (Vermilion 710S - Kitscoty 705S)		No impact on thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	749L/7L749 (Edgerton 899S - Lloydminster 716S)	No impact on thermal criteria violation	Planned RAS 138	Planned RAS 138
	749L (Edgerton 899S - Killarney Lake 267S Tap)	7L50 (Buffalo Creek 526S - Jarrow 252S/Battle River 757S	Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L749 (Edgerton 899S - Briker 880S Tap)		Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
	749L (Edgerton 899S - Killarney Lake 267S Tap)	7L129 (Buffalo Creek 526S - Vermilion 710S)	Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
	7L749 (Edgerton 899S - Briker 880S Tap)		Marginally increased existing thermal criteria violation	Real-time operational practices	Real-time operational practices
2020 WP, LG	Voltage Collapse	648ST1 (Metiskow 648S 138/25 kV transformer)	Voltage criteria violation is resolved	Real-time operational practices	None
	7L130 (Vermilion 710S - Kitscoty 705S)	749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	Marginally reduced existing thermal criteria violation	Real-time operational practices	Real-time operational practices

Notes:

- Marginally increased refers to a thermal criteria violation that existed pre-Project and post-Project, and the percent loading difference (post-Project percent loading minus pre-Project percent loading) is between 0% and +3%
- Marginally reduced refers to a thermal criteria violation that existed pre-Project and post-Project, and the percent loading difference (post-Project percent loading minus pre-Project percent loading) is between 0% and -3%
- Materially reduced refers to a thermal criteria violation that existed pre-Project and post-Project, and the percent loading difference (post-Project percent loading minus pre-Project percent loading) is more than -3%
- RAS 138 is an existing RAS (See Section 1.2.2.2 of Attachment A1). Modifications to existing RAS 138 were proposed for the proposed Sharp Hills Wind Farm Connection in the *Sharp Hills Wind Farm Connection Needs Identification Document (NID),* as originally filed with the Commission in AUC Proceeding 23066 and Application 23066-A001. Further modifications were proposed for the proposed Paintearth Wind Project Connection in the *Paintearth Wind Project Connection NID*, as originally filed with the Commission in AUC Proceeding 23206 and Application 23206-A001. This modified version of RAS 138 is referred to herein as “Planned RAS 138”.

5.2. Pre-Project Studies Results

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

5.2.1. High Generation Scenarios

Category A condition

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

Category B conditions

The pre-Project power flow studies identified a number of thermal criteria violations under Category B conditions (i.e., loss of a single system element). No voltage criteria violations or voltage deviations beyond the limits listed in Table 3-1 of Attachment A1 (hereafter referred to as point of delivery (POD) bus voltage deviations) were observed under Category B conditions. A voltage collapse was observed following the loss of Metiskow 648S substation transformer T1.

5.2.2. Low Generation Scenarios

Category A condition

No Reliability Criteria violations were observed under the Category A condition for any of the pre-Project scenarios.

Category B conditions

A voltage collapse was observed following the loss of Metiskow 648S substation transformer T1 in all scenarios studied. A thermal criteria violation was also identified. No POD bus voltage deviations were observed.

5.3. Post-Project Studies Results

This section describes the results of the post-Project studies.

5.3.1. High Generation Scenarios

Category A condition

No Reliability Criteria violations were observed under the Category A condition for any of the post-Project scenarios. The post-Project short-circuit fault levels were not significantly higher than pre-Project levels. The long term short circuit levels were found to be within the typical capabilities of the nearby facilities.

Category B conditions

The post-Project power flow studies identified a number of thermal criteria violations under Category B conditions. There was no material increase in any of the thermal criteria violations, compared to the pre-Project scenarios. No voltage criteria violations or POD bus voltage

deviations were observed. The voltage collapse that was observed in pre-Project scenarios following the loss of Metiskow 648S substation transformer T1 no longer occurs in post-Project scenarios.

5.3.2. Low Generation Scenarios

Category A condition

No Reliability Criteria violations were observed under the Category A condition for any of the pre-Project scenarios.

Category B conditions

The voltage collapse that was observed in pre-Project scenarios following the loss of Metiskow 648S substation transformer T1 no longer occurs in post-Project scenarios. A thermal criteria violation was also identified. There was no material increase in the thermal criteria violation, compared to the pre-Project scenarios. The results of the voltage stability studies did not indicate any voltage stability concerns, and the system showed acceptable load transfer capabilities under all studied Category B contingencies.

5.4. Mitigation Measures

This section discusses the AESO's proposed mitigation measures to address the system performance issues that were identified in the pre-Project and post-Project scenarios.

5.4.1. Pre-Project

Prior to connection of the Project, some of the thermal criteria violations observed in the pre-Project scenarios can be mitigated by real-time operational practices. Planned RAS 138 can be used to mitigate the remaining thermal criteria violations. Real time operational practices are already in place to manage the voltage collapse following the loss of Metiskow 648S substation transformer T1.

5.4.2. Post-Project

After connection of the Project, no new mitigation measures are required. The thermal criteria violations observed in the post-Project scenarios can continue to be mitigated by real-time operational practices and planned RAS138.

5.5. Post-Mitigation Studies Results

Category B conditions

After planned RAS 138 was applied, all of the observed Reliability Criteria violations requiring RAS were mitigated.

In the event that the existing RAS 138 is not modified as planned, the existing RAS 138 can be used to effectively mitigate all of the pre-Project and post-Project Reliability Criteria violations indicated in Table 5-1.

6. Project Dependencies

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

7. Conclusions and Recommendations

Based on the study results, Alternative 2 is technically viable. The connection assessment identified a number of pre-Project system performance issues that are managed using existing mitigation measures, including planned RAS 138 and real-time operational practices. Fewer system performance issues were identified post-Project, and these system performance issues can continue to be managed using planned RAS 138 and real-time operational practices. With continued implementation of the existing mitigation measures, the connection of the project with the proposed alternative does not adversely affect the performance of the AIES.

It is recommended to proceed with the Project using Alternative 2 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 planned RAS 138 to mitigate the identified system performance issues.

Alternative 2 involves adding a new 138 kV transmission line between the existing Hayter 277S and Provost 545S substations. Alternative 2 also includes modifying the Hayter 277S substation by adding two 138 kV circuit breakers and one 25 kV circuit breaker, modifying the Provost 545S substation by adding two 138 kV circuit breakers and modifying the existing Killarney Lake 267S substation by adding one 138 kV circuit breaker.

The conductor used for the new 138 kV circuit should have a minimum thermal rating equal to the existing 138 kV transmission line 748L.

Attachment A

Engineering Connection Assessment Results

Engineering Connection Assessment Results

Fortis Provost Reliability

Date: January 29, 2018

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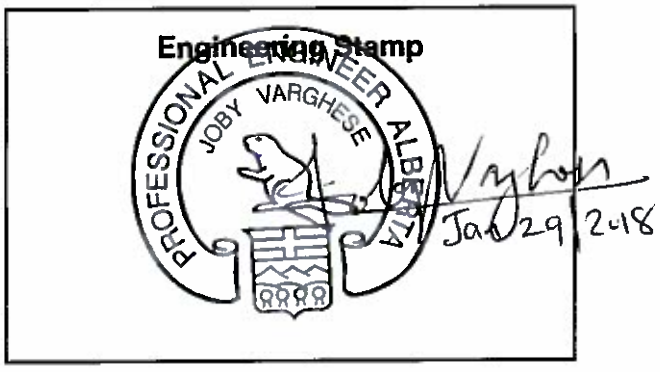
Engineering Stamp



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1. Introduction

This report presents the results of the engineering studies that were completed by AltaLink Management Ltd. (the Studies Consultant) to assess the impact of the Project (as defined in Attachment A1: AESO Engineering Connection Assessment Scope) on the performance of the Alberta Interconnected Electric System (AIES). The studies were performed in accordance with Attachment A1, which was prepared by the Alberta Electric System Operator (AESO). The following sections describe the results of the studies.

The power system network analysis tool that was used for the studies in this connection assessment was PSS/E version 33.

2. Pre-Project Study Results

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

2.1. Power Flow Studies

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

2.1.1. 2020 Summer Light High Generation Pre-Project

Category A condition

No Reliability Criteria (as defined in Section 3.1.1 of Attachment A1) violations were observed under the Category A condition.

Category B conditions

No Reliability Criteria violations were observed under Category B conditions.

2.1.2. 2020 Summer Peak High Generation Pre-Project

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 3-1 of Attachment A1 (hereafter referred to as, point of delivery (POD) bus voltage deviations) were observed. Thermal criteria violations, both above the normal rating and above the emergency rating, were observed under certain Category B conditions, as shown in Table 2-1.

Table 2-1: Thermal Criteria Violations under Category B Conditions for the 2020 SP HG Pre-Project Scenario

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA) [a]	Emergency Rating (MVA)[a]	Pre-Project Results	
				Power Flow (MVA)	% Loading[b]
648ST1 (Metiskow 648S 138/25 kV transformer)	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	81.2	113
	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	84.8	118
	7L129 (Vermilion 710S - Bauer 918S Tap)	109.3	120.2	115.9	106
	7L129 (Buffalo Creek 526S - Bauer 918S Tap)	120.0	132.0	127.2	106
	7L50 (Buffalo Creek 526S – Jarrow 252S Tap)	109.3	120.2	147.6	135
7L14 (Kitscoty 705S - Hill 751S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	110.9	101.5
7L42 (Hill 751S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	129.6	118.6
899S T3 (Edgerton 899S 138/25 kV transformer)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	138.8	127
749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	7L129 (Buffalo Creek 526S - Bauer 918S Tap)	120.0	132.0	121.9	101.6
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	142.1	130
	7L129 (Vermilion 710S - Bauer 918S Tap)	109.3	120.2	110.5	101.1
749L/7L749 (Edgerton 899S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	136.4	124.8
7L50 (Buffalo Creek 526S - Jarrow 252S/Battle River 757S)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	134	104.5	108.9
	7L749 (Edgerton 899S - Briker 880S Tap)	96	134	98.9	103
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	134	99.7	103.9
7L129 (Buffalo Creek 526S - Vermilion 710S)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	134	96.3	100.3

[a] The facility ratings shown in Attachment A1 have been adjusted from a 144 kV voltage base to a 138 kV voltage base, as is used by the power system network analysis tool.

[b] Reported as a percentage of the observed power flow (in MVA) relative to the transmission line's normal rating (also in MVA, as shown in Attachment A1).

2.1.3. 2020 Summer Peak Low Generation Pre-Project

Category A condition

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

Category B conditions

A voltage collapse was observed following the loss of transformer T1 at Metiskow 648S substation. No other Reliability Criteria violations were observed under Category B conditions.

2.1.4. 2020 Winter Peak High Generation Pre-Project

Category A condition

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

Category B conditions

A voltage collapse was observed following the loss of transformer T1 at Metiskow 648S substation. No other voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations above the normal rating were observed under certain Category B conditions, as shown in Table 2-2.

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

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
899S T3 (Edgerton 899S 138/25 kV transformer)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	139	150.5	142.9	102.8
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	143	104.5	111.4
	7L749 (Edgerton 899S - Briker 880S Tap)	96	143	98.9	104.3
749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	139	150.5	146.5	105.4
	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	94.9	87.3	101.2
749L/7L749 (Edgerton 899S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	139	150.5	140.1	100.8
7L50 (Buffalo Creek 526S - Jarrow 252S/Battle River 757S)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	143	112.0	116.7
	7L749 (Edgerton 899S - Briker 880S Tap)	96	143	105.1	109.5
7L129 (Buffalo Creek 526S - Vermilion 710S)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	143	104.0	108.3
	7L749 (Edgerton 899S -	96	143	97.3	101.4

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
	Briker 880S Tap)				

2.1.5. 2020 Winter Peak Low Generation Pre-Project

Category A condition

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

Category B conditions

A voltage collapse was observed following the loss of transformer T1 at Metiskow 648S substation. No other voltage criteria violations or POD bus voltage deviations were observed. Thermal criteria violations above the normal rating were observed under certain Category B conditions, as shown in Table 2-3.

Table 2-3: Thermal Criteria Violations under Category B Conditions for the 2020 WP LG Pre-Project Scenario

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results	
				Power Flow (MVA)	% Loading
749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	94.9	87.8	101.7

3. Post-Project Study Results

This section describes the results of the post-Project power flow studies and transient stability studies. As described in Section 2 of Attachment A1, the post-Project studies were performed using Alternative 2.

3.1. Power Flow Studies

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

3.1.1. 2020 Summer Light High Generation Post-Project

Category A condition

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

Category B conditions

No Reliability Criteria violations were observed under Category B conditions.

3.1.2. 2020 Summer Peak High Generation Post-Project

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. Thermal criteria violations, both above the normal and emergency rating, were observed under certain Category B conditions, as shown in Table 3-1.

Table 3-1: Thermal Criteria Violations under Category B Conditions for the 2020 SP HG 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	
648ST1 (Metiskow	7L14 (Kitscoty 705S - Hill 751S)	71.9	71.9	81.2	113	9.3	13	-100

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	
648S 138/25 kV transformer)	7L130 (Vermilion 710S - Kitscoty 705S)	71.9	71.9	84.8	118	13.7	19	-99
	7L129 (Vermilion 710S - Bauer 918S Tap)	109.3	120.2	115.9	106	83.1	76	-30
	7L129 (Buffalo Creek 526S - Bauer 918S Tap)	120.0	132.0	127.2	106	94.8	79	-27
	7L50 (Buffalo Creek 526S – Jarrow 252S Tap)	109.3	120.2	147.6	135	114.8	105	-30
7L14 (Kitscoty 705S - Hill 751S)	7L50 (Buffalo Creek 526S – Jarrow 252S Tap)	109.3	120.2	110.9	101.5	110.9	101.5	0
7L42 (Hill 751S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	129.6	118.6	129.6	118.6	0
899S T3 (Edgerton 899S 138/25 kV transformer)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	138.8	127	138.8	127.0	0
749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	7L129 (Buffalo Creek 526S - Bauer 918S Tap)	120.0	132.0	121.9	101.6	121.0	100.8	-0.8
	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	142.1	130	141.1	129.1	-0.9
	7L129 (Vermilion 710S - Bauer 918S Tap)	109.3	120.2	110.5	101.1	109.5	100.2	-0.9
749L/7L749 (Edgerton 899S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	136.4	124.8	136.4	124.8	0
7L50 (Buffalo Creek 526S - Jarrow 252S/Battle River 757S)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	134	104.5	108.9	105.5	109.9	1.0
	7L749 (Edgerton 899S - Briker 880S Tap)	96	134	98.9	103	99.8	104.0	1.0
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	134	99.7	103.9	100.6	104.8	0.9
7L129 (Buffalo Creek 526S - Vermilion 710S)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	134	96.3	100.3	97.2	101.2	0.9

3.1.3. 2020 Summer Peak Low Generation Post-Project

Category A condition

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

Category B conditions

No Reliability Criteria violations were observed under Category B conditions. The voltage collapse that occurred in the pre-Project scenario following the loss of transformer T1 at Metiskow 648S substation no longer occurs in the post-Project scenario.

3.1.4. 2020 Winter Peak High Generation Post-Project

Category A condition

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

Category B conditions

Thermal criteria violations above the normal rating were observed under certain Category B conditions, as shown in Table 3-2. The voltage collapse that occurred in the pre-Project scenario following the loss of transformer T1 at Metiskow 648S substation no longer occurs in the post-Project scenario. No voltage criteria violations or POD bus voltage deviations were observed under Category B conditions.

Table 3-2: Thermal Criteria Violations under Category B Conditions for the 2020 WP HG 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	
899S T3 (Edgerton 899S 138/25 kV transformer)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	139	150.5	142.9	102.8	142.9	102.8	0
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	143	104.5	111.4	108.0	112.5	1.1
	7L749 (Edgerton 899S - Briker 880S Tap)	96	143	98.9	104.3	101.2	105.4	1.1
749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	139	150.5	146.5	105.4	145.4	104.6	-0.8
	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	94.9	87.3	101.2	87.3	101.2	0
749L/7L749 (Edgerton 899S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	139	150.5	140.1	100.8	140.1	100.8	0

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	
7L50 (Buffalo Creek 526S - Jarrow 252S/Battle River 757S	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	143	112.0	116.7	113.1	117.8	1.1
	7L749 (Edgerton 899S - Briker 880S Tap)	96	143	105.1	109.5	106.2	110.6	1.1
7L129 (Buffalo Creek 526S - Vermilion 710S)	749L (Edgerton 899S - Killarney Lake 267S Tap)	96	143	104.0	108.3	105.0	109.4	1.1
	7L749 (Edgerton 899S - Briker 880S Tap)	96	143	97.3	101.4	98.3	102.4	1.0

3.1.5. 2020 Winter Peak Low Generation Post-Project

Category A condition

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

Category B conditions

Thermal criteria violations above the normal rating were observed under certain Category B conditions, as shown in Table 3-3. The voltage collapse that occurred following the loss of transformer T1 at Metiskow 648S substation in the pre-Project scenario no longer occurs in the post-Project scenario. No voltage criteria violations or POD bus voltage deviations were observed under Category B conditions.

Table 3-3: Thermal Criteria Violations under Category B Conditions for the 2020 WP LG 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	
749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	7L130 (Vermilion 710S - Kitscoty 705S)	86.3	94.9	87.8	101.7	87.7	101.6	-0.1

3.2. Voltage Stability (PV) Studies

Voltage stability studies were performed for the 2020 WP Low Generation scenario. The reference load level for the study area (AESO planning areas 13, 32 and 37) is 394.6 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 19.7 MW (0.05 x 394.6 MW = 19.7 MW).

Table 3-4 summarizes the voltage stability results for Category A and the worst contingencies for voltage stability transfer margins. Voltage stability diagrams are in Attachment A4.

The voltage stability margin was met for all studied conditions.

Table 3-4: Voltage Stability Results for the 2020 WP LG Post-Project Scenario

Studied Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets 105% transfer criteria
N-0	System Normal		250	Yes
749L	Metiskow 648S	Edgerton 899S/Killarney Lake 267S	90	Yes
7L130	Vermilion 710S	Kitscoty 705S	110	Yes
899S T3	Edgerton 899S 138/25 kV transformer		120	Yes
7L14	Kitscoty 705S	Hill 751S	130	Yes
749L/7L749	Edgerton 899S	Lloydminster 716S	140	Yes

4. Short-Circuit Study Results

4.1. Pre-Project

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

Table 4-1: Short-Circuit Current Levels for the 2020 WP HG 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)
Hansman Lake 650S	138	143.2	8.0	0.016058+ j0.055084	8.3	0.005599+ j0.051734
Hansman Lake 650S	240	256.8	6.2	0.011168+ j0.042423	6.8	0.003869+ j0.032530
Provost 545S	138	141.7	3.9	0.042561+ j0.107883	2.8	0.059800+ j0.244494
Hayter 277S	138	139.4	2.3	0.086218+ j0.174693	1.7	0.126647+ j0.394956
Killarney Lake 267S	138	141.2	3.1	0.063080+ j0.130046	2.2	0.094029+ j0.304747
Edgerton 899S	138	141.8	3.0	0.065813+ j0.133207	2.2	0.083916+ j0.307539
Metiskow 648S	138	143.1	8.0	0.016115+ j0.054952	8.3	0.005674+ j0.051860
Metiskow 648S	240	256.8	6.2	0.011226+ j0.042670	6.7	0.004052+ j0.033583

4.2. Post-Project

Post-Project short-circuit current levels are provided in Table 4-2 and Table 4-3.

Table 4-2: Short-Circuit Current Levels for the 2020 WP HG 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)
Hansman Lake 650S	138	143.2	8.0	0.016180+ j0.055043	8.3	0.005687+ j0.051448

[1] Short-circuit current studies were based on modeling information provided to the AESO by third parties. The authenticity of the modeling information has not been validated. Fault levels could change as a result of system developments, new customer connections, or additional generation in the area. It is recommended that these changes be monitored and fault levels reviewed to ensure that the fault levels are within equipment operating limits. The information provided in this study should not be used as the sole source of information for electrical equipment specifications or for the design of safety-grounding systems.

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)
Hansman Lake 650S	240	256.8	6.2	0.011207+ j0.042393	6.8	0.003891+ j0.032456
Provost 545S	138	141.4	4.4	0.038068+ j0.094303	3.4	0.047669+ j0.192774
Hayter 277S	138	140.8	3.6	0.050257+ j0.114366	2.7	0.066814+ j0.242465
Killarney Lake 267S	138	142.2	3.9	0.047708+ j0.107625	2.8	0.068193+ j0.243742
Edgerton 899S	138	142.3	3.1	0.062415+ j0.129792	2.3	0.080072+ j0.299421
Metiskow 648S	138	143.2	8.0	0.016217+ j0.054950	8.3	0.005758+ j0.051697
Metiskow 648S	240	256.8	6.2	0.011265+ j0.042641	6.7	0.004075+ j0.033508

Table 4-3: Short-Circuit Current Levels for the 2027 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)
Hansman Lake 650S	138	142.6	7.5	0.016629+ j0.055454	8.2	0.004662+ j0.044264
Hansman Lake 650S	240	256.8	5.6	0.012414+ j0.044864	6.6	0.002928+ j0.025891
Provost 545S	138	141.0	3.7	0.043150+ j0.108079	2.7	0.058857+ j0.237012
Hayter 277S	138	136.5	2.2	0.082526+ j0.169656	1.7	0.114021+ j0.363400
Killarney Lake 267S	138	139.1	3.1	0.059234+ j0.125590	2.3	0.079104+ j0.265410
Edgerton 899S	138	140.6	3.3	0.050760+ j0.119581	3.5	0.014353+ j0.111256
Metiskow 648S	138	142.5	7.5	0.016670+ j0.055293	8.2	0.004703+ j0.044249
Metiskow 648S	240	256.8	5.5	0.012469+ j0.045107	6.5	0.003108+ j0.026936

5. Mitigation Measure Development and Evaluation

The Studies Consultant, in consultation with the AESO, developed mitigation measures to address the system performance issues that were identified in the post-Project scenarios for Alternative 2. Existing remedial action schemes (RASs) are described in Section 1.2.2.2 of Attachment A1.

5.1. Pre-Project

Mitigation measures for both high generation and low generation dispatch scenarios are summarized in Table 5-1. The table describes the mitigation measure, when the mitigation measure will be triggered and what transmission facilities will have Reliability Criteria violations mitigated by the corresponding mitigation measure.

Table 5-1: Pre-Project Mitigation Measures

Mitigation Measure	Mitigated Reliability Criteria Violation	
	Reliability Criteria Violation Type	Transmission Facility
Planned RAS 138[a]	Thermal Criteria Violation Above Normal Rating	7L50 (Buffalo Creek 526S – Jarrow 252S Tap)
		7L129 (Buffalo Creek 526S – Bauer 918S Tap)
		7L129 (Vermilion 710S – Bauer 918S Tap)
Real time operational practices	Voltage Criteria Violation (Voltage Collapse)	N/A
	Thermal Criteria Violation Above Normal Rating	7L749 (Edgerton 899S – Briker 880S Tap)
		749L (Edgerton 899S – Killarney Lake 267S Tap)
		7L130 (Vermilion 710S – Kitscoty 705S)

[a] RAS 138 is an existing RAS (See Section 1.2.2.2 of Attachment A1). Modifications to existing RAS 138 were proposed for the proposed Sharp Hills Wind Project Connection in the *Sharp Hills Wind Farm Connection Needs Identification Document (NID)*, as originally filed with the Commission in AUC Proceeding 23066 and Application 23066-A001. Further modifications to RAS 138 were proposed for the proposed Paintearth Wind Project Connection and identified in the *Paintearth Wind Project Connection NID,* as originally filed with the Commission in AUC Proceeding 23206 and Application 23206-A001. This modified version of RAS 138 is referred to herein as "Planned RAS 138

5.2. Post-Project

Mitigation measures for both high generation and low generation dispatch scenarios are summarized in Table 5-2. The table describes the mitigation measure, when the mitigation measure will be triggered and what transmission facilities will have Reliability Criteria violations mitigated by the corresponding mitigation measure.

Table 5-2: Post-Project Mitigation Measures

Mitigation Measure	Mitigated Reliability Criteria Violation	
	Reliability Criteria Violation Type	Transmission Facility
Planned RAS 138	Thermal Criteria Violation Above Normal Rating	7L50 (Buffalo Creek 526S – Jarrow Tap)
		7L129 (Buffalo Creek 526S – Bauer 918S Tap)
		7L129 (Vermilion 710S – Bauer 918S Tap)
Real time operational practices	Thermal Criteria Violation (Above Normal Rating)	7L749 (Edgerton 899S – Briker 880S Tap)
		749L (Edgerton 899S – Killarney Lake 267S Tap)
		7L130 (Vermilion 710S – Kitscoty 705S)

5.3. Mitigation Measure 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 proposed mitigation measures.

The post-mitigation measures studies were performed under Category B conditions for the 2020 SP and WP HG scenarios using Alternative 2 and the RAS described in Sections 5.1 and 5.2.

The post-mitigation power flow diagrams for selected Category B conditions are provided in Attachment A5. The post-mitigation power flow diagrams present only those post-Project contingencies that result in Reliability Criteria violations that require RAS mitigation. The post-Project contingencies that result in Reliability Criteria violations that can be mitigated by real time operational practices were not studied.

5.3.1. 2020 Summer Peak Post-Project High Generation

Category B conditions

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by the RASs described in Section 5.1, as shown in Table 5-3.

Table 5-3: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2020 SP HG 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
749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	141.1	129.1	107.1	98%
	7L129 (Buffalo Creek 526S - Bauer 918S Tap)	120.0	132.0	121.0	100.8	87.6	73%

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
	7L129 (Vermilion 710S - Bauer 918S Tap)	109.3	120.2	109.5	100.2	76.5	70%
648ST1 (Metiskow 648S 138/25 kV transformer)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	114.8	105	100.6	92%
7L14 (Kitscoty 705S - Hill 751S)	7L50 (Buffalo Creek 526S – Jarrow 252S Tap)	109.3	120.2	110.9	101.5	98.4	90%
899S T3 (Edgerton 899S 138/25 kV transformer)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	138.8	127	106.0	97%
7L42 (Hill 751S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	129.6	118.6	104.9	96%
749L/7L749 (Edgerton 899S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	109.3	120.2	136.4	124.8	97.3	95%

5.3.2. 2020 Winter Peak Post-Project High Generation

Category B conditions

The thermal criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by the RASs described in Section 5.1, as shown in Table 5-4. Real-time operational practices are required to alleviate the thermal criteria violation observed on 144 kV transmission line 7L130, as the RAS has no impact on the violations.

Table 5-4: Post-RAS Power Flow Study Results under certain Category B Conditions for the 2020 WP HG 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
749L (Metiskow 648S - Edgerton 899S/Killarney Lake 267S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	139	150.5	145.4	104.6	127.9	92%
	7L130 (Vermilion 710S Kitscoty 705S)	86.3	94.9	87.3	101.2	87.2	101%[a]
899S T3 (Edgerton 899S 138/25 kV transformer)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	139	150.5	142.9	102.8	126.5	91%

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
749L/7L749 (Edgerton 899S - Lloydminster 716S)	7L50 (Buffalo Creek 526S - Jarrow 252S Tap)	139	150.5	140.1	100.8	118.2	85%

[a] Real-time operational practices are required to mitigate the overload on 7L130.

Attachment A1

AESO Engineering Connection Assessment Scope

AESO Engineering Connection Assessment Scope

FortisAlberta Inc.

Fortis Provost Reliability

AESO Project Number: 1782

Company Name	Engineer Name P.Eng.	Date	Engineer Signature
AltaLink Management Ltd.	Joby Varghese, P.Eng.	Jan 18, 2018	Joby Varghese
AESO (Project Studies Engineer)	Maz Mazadi, PhD, P.Eng.	Jan 19, 2018	Mazadi

Company Name	Name	Date	Signature
FortisAlberta Inc.	Zurex Fontanilla, P.Eng	Jan. 18, 2018	Fontanilla

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Contents

Attachments

Attachment A1.1 Transmission Planning Criteria – Basis and Assumptions

Tables

Figures

1. Introduction

This AESO Engineering Connection Assessment Scope provides an overview of the engineering studies to be completed by AltaLink Management Ltd. (the Studies Consultant) to assess the impact of the Project (as defined in Section 1.1) on the performance of the Alberta interconnected electric system (AIES). Technical criteria, assumptions and methods for performing these engineering studies are provided in this document.

1.1. Project

1.1.1. Project Overview

FortisAlberta Inc. (FortisAlberta), 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 improve distribution system reliability in the Provost area.

The DFO's request for system access service included a request for transmission development, but did not include any change to its existing Rate DTS, *Demand Transmission Service*, or Rate STS, *Supply Transmission Service*, contract capacities (collectively, the Project).

The scheduled in-service date (ISD) for the Project is May 1, 2020.

1.1.2. Load Component

There is no load component associated with the Project.

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 studies are as follows:

- Study the impact of the Project on the performance of the AIES.

- Identify any violations of the relevant AESO criteria, standards or requirements, both pre-Project and post-Project.
- Recommend mitigation measures, if required, to reliably connect the Project to the AIES.

1.2.2. Study Area

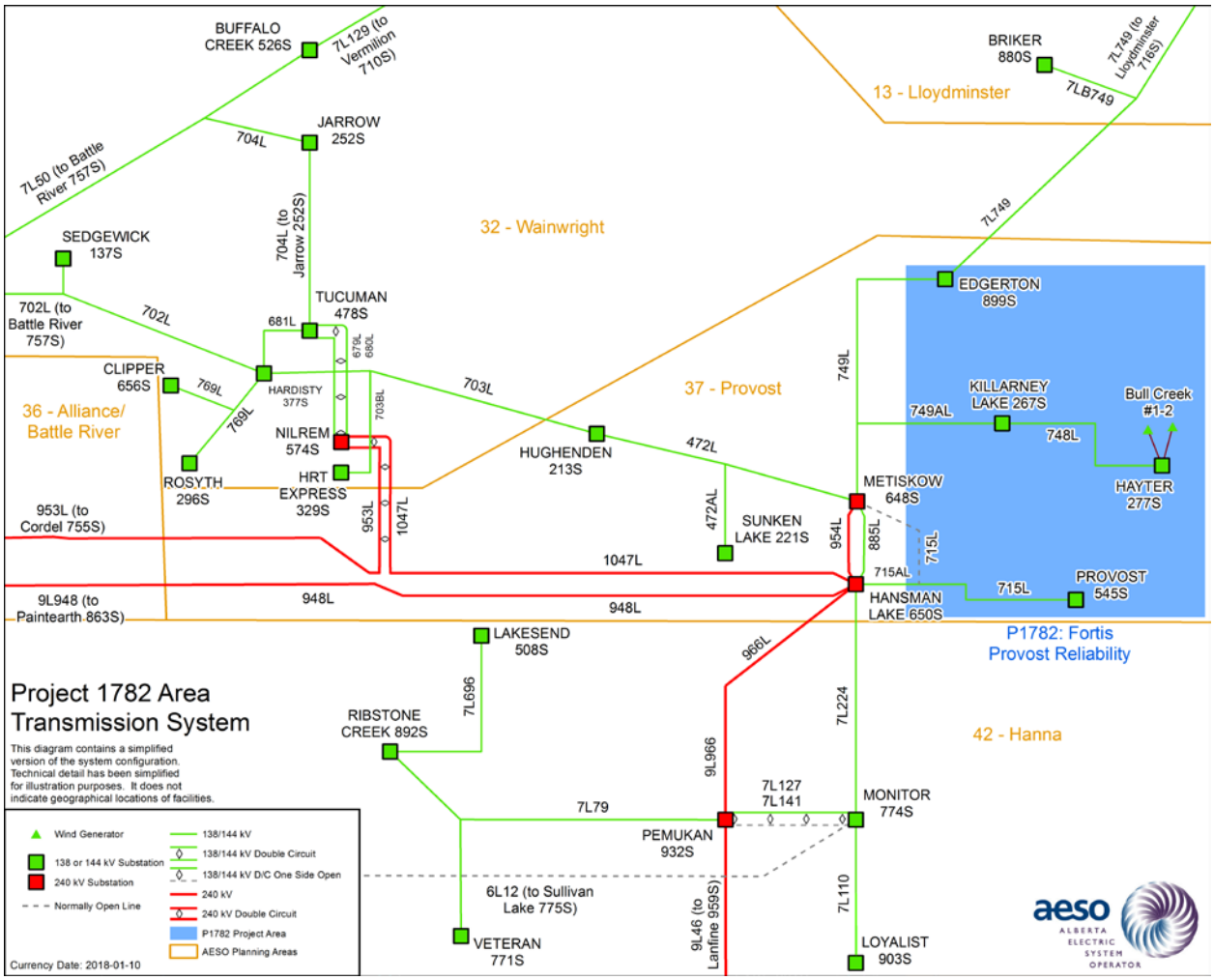
1.2.2.1. Study Area Description

Geographically, the Project is located in the AESO planning area of Provost (Area 37), which is part of the AESO Central Planning Region.

From a transmission perspective, the Provost planning area consists of 138 kV and 240 kV transmission facilities. Two 240 kV substations, Hansman Lake 650S and Metiskow 648S, are key sources for the load in the area. The Provost area is connected to the adjacent planning areas through 138 kV/144 kV lines 749L/7L749, 7L224, and 703L, and 240 kV transmission lines 1047L, 966L/9L966, and 948L/9L948.

The Study Area for the Project consists of the AESO planning areas of Lloydminster (Area 13), Wainwright (Area 32), and Provost (Area 37), including the tie lines connecting these three planning areas to the rest of the AIES. All transmission facilities within the Study Area will be studied and monitored for violations of the Reliability Criteria (as defined in Section 3.1). Figure 1-1 shows the existing transmission system in the Study Area.

Figure 1-1: Existing Study Area Transmission System



1.2.2.2. Existing Constraints

Existing constraints in the Study Area are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management* (TCM Rule). There are a number of existing constraints in the Study Area that are mitigated by remedial action schemes (RASs).

The following RASs/protection schemes are used to manage constraints in the area:

1. RAS 32: Battle River 757s 7L50 and 7L701 thermal protection scheme
2. RAS 138: 7L50 - 526S Buffalo Creek overload mitigation scheme
3. RAS 149: Eastern Alberta Transmission Line (EATL) HVDC

1.2.3. Engineering Studies Required

The following engineering studies are required for the pre-Project scenarios:

- Power flow studies
- Short-circuit studies

The following engineering studies are required for the post-Project scenarios:

- Power flow studies
- Voltage stability studies
- Short-circuit studies

2. Connection Alternative to be Studied

The following alternative will be studied.

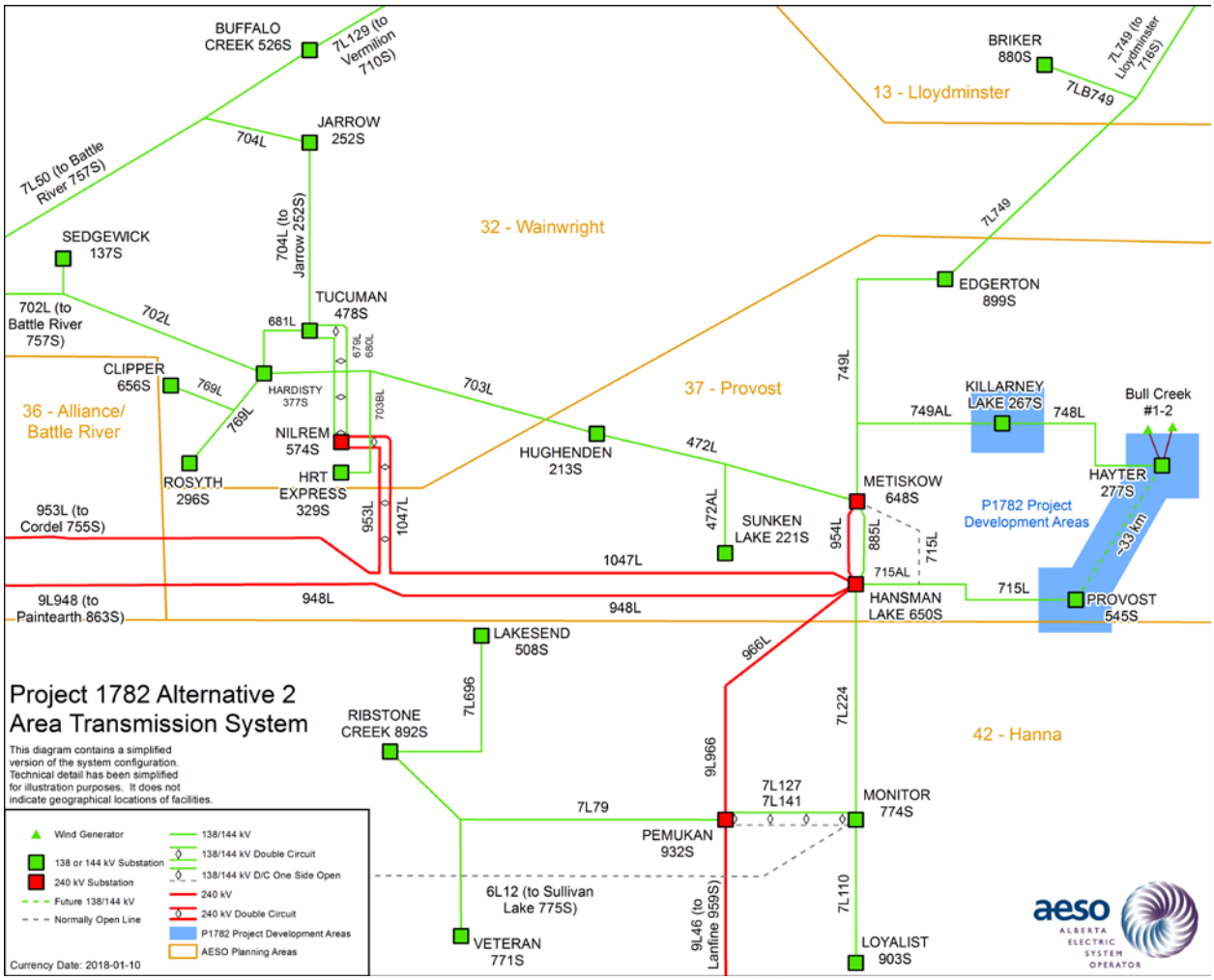
Alternative 2 – Add a 138 kV transmission line to connect the Hayter 277S substation and the Provost 545S substation

This alternative includes the following developments:

- Add a new 138 kV transmission line, approximately 33 km in length, between the existing Hayter 277S and Provost 545S substations.
- Modify the Hayter 277S substation, including adding two 138 kV circuit breakers, one 25 kV circuit breaker and associated equipment;
- Modify the Provost 545S substation, including adding two 138 kV circuit breakers and associated equipment; and,
- Modify the existing Killarney Lake 267S substation, including adding one 138 kV circuit breaker and associated equipment.

The proposed connection configuration is shown in Figure 2-1.

Figure 2-1: Connection Alternative 2



3. Criteria, System Data, and Study Assumptions

3.1. Criteria, Standards, and Requirements

3.1.1. 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* [1] (collectively, the Reliability Criteria) will be applied to evaluate system performance under Category A system conditions (i.e., all elements in-service) and following Category B (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 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.

[1] Please refer to Attachment A1.1

- For Category A conditions: Voltage range under normal operating condition per AESO Information Document ID #2010-007RS, *General Operating Practices – Voltage Control* (ID #2010-007RS). For the busses not listed in ID#2010-007RS, Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions* applies.

- For Category B conditions: The extreme voltage range values per Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions*.

- Desired post-contingency voltage deviation limits for three defined post event timeframes as provided in Table 3-1.

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

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

3.1.2. ISO Rules and IDs

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

The TCM Rule will be followed to set up the study scenarios and assess the impact of the Project. In addition, due regard will be given to the AESO's *Connection Study Requirements* and the AESO's *Generation and Load Interconnection Standard*.

3.2. Study Scenarios

The scheduled ISD of the Project is May 1, 2020. Therefore, the studies will be performed using the 2020 summer light (SL), summer peak (SP), and winter peak (WP) for high generation (HG) scenarios, and SP and WP for low generation (LG) scenarios. The short-circuit studies will also be performed using the 2027 WP scenario with all generators in and around the Study Area dispatched on.

Table 3-2 provides a list of the study scenarios.

Table 3-2: List of the Connection Study Scenarios

Scenario	Scenario Name	Year/Season	Condition	System Generation Dispatch Conditions
1	2020 SL HG Pre-Project	2020 SL	Pre-project	High generation (HG)
2	2020 SP HG Pre-Project	2020 SP	Pre-project	High generation (HG)
3	2020 SP LG Pre-Project	2020 SP	Pre-project	Low generation (LG)

Scenario	Scenario Name	Year/Season	Condition	System Generation Dispatch Conditions
4	2020 WP HG Pre-Project	2020 WP	Pre-project	High generation (HG)[a]
5	2020 WP LG Pre-Project	2020 WP	Pre-project	Low generation (LG)
6	2020 SL HG Post-Project	2020 SL	Post-project	High generation (HG)
7	2020 SP HG Post-Project	2020 SP	Post-project	High generation (HG)
8	2020 SP LG Post-Project	2020 SP	Post-project	Low generation (LG)
9	2020 WP HG Post-Project	2020 WP	Post-project	High generation (HG)[a]
10	2020 WP LG Post-Project	2020 WP	Post-project	Low generation (LG)
11	2027 WP Post-Project	2027 WP	Post-project	All generators in the Study Area on

Note: [a] For short-circuit studies, all generation in and around the Study Area is assumed on.

3.3. Load and Generation Assumptions

3.3.1. Load Assumptions

The AESO Planning Region load forecast used for this connection study is shown in Table 3-3 and is based on the AESO 2017 Long-term Outlook (2017 LTO). For the studies, when loads are modified to align with the load forecast in the 2017 LTO, the active power to reactive power ratio in the base case scenarios will be maintained.

Table 3-3: Forecast Area Load (2017 LTO at Central Planning Region Peak)

AESO Planning Region Name	Season	Forecast Peak Load (MW)
		2020
Central Planning Region*	SP	1,918
	SL	1,421
	WP	2,184

Note: *The Central Region comprises the following AESO planning areas: 56,13,32,37,36,42,35,39,38,30,29,34, and 28.

3.3.2. Generation Assumptions

As there is no Rate STS or Rate DTS change associated with the Project, the generation assumptions for pre-Project scenarios and post-Project scenarios are the same.

The dispatch levels for the existing non-renewable generators in and around the Study Area are listed in Table 3-4, for both the high generation (HG) and low generation (LG) study scenarios.

Table 3-4: Existing Non-Renewable Generation Dispatch Levels

Unit Name	AESO Planning Area	Pmax (MW)	High Generation (HG) Scenarios			Low Generation (LG) Scenarios	
			2020 SL Net Generation (MW)*	2020SP Net Generation (MW)	2020 WP Net Generation (MW)	2020 SP Net Generation (MW)	2020 WP Net Generation (MW)
Sheerness #1	43	400	198.8	379.1	391.3	202.6	268.1
Sheerness #2	43	390	224.4	376.7	369.7	201.2	239.9
Battle River #3	36	149	Retired	Retired	Retired	Retired	Retired
Battle River #4	36	155	152.6	134.2	138.7	60	60
Battle River #5	36	385	185	356.2	378.5	N-G	N-G

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

In addition to the non-renewable generators listed in Table 3-4, the HG study scenarios will include renewable generation. Per the 2017 LTO, the total forecast renewable electricity generation in 2020 is 2,065 MW. This includes existing and planned renewable generation facilities.

To remain consistent with the 2017 LTO's renewable generation forecast of 2,065 MW, the existing and planned renewable generation facilities will be dispatched in order to yield the credible worst-case power flow conditions for the Study Area. The 2020 HG dispatch levels for the existing renewable electricity generation facilities are shown in Table 3-5.

Table 3-5: HG Scenario Dispatch Levels for Existing Renewable Generating Facilities

Renewable Generating Facility Name	AESO Planning Area	Busses	MC (MW)	2020 SP/SL/WP Unit Net Generation (MW)
Ardenville Wind	53	4735, 4740	68	68
Blue Trail Wind	53	66328, 67328	66	66
Castle River #1	53	2234, 3234	39	39
Castle Rock Ridge Wind Farm	53	67221	77	77
Cowley Ridge	53	255, 265, 4264	20	20
Enmax Taber	52	15343, 16343	81	81
Kettles Hill	53	2402, 3402	63	63
McBride Lake Wind farm	53	2901, 3901, 4901	75	75
Soderglen Wind	53	12358, 13358	68	68
Summerview 1	53	2338, 3338	66	66
Summerview 2	53	4339, 5337	66	66
Suncor Chin Chute	54	2389	30	30
Suncor Magrath	53	11002	30	30

Suncor Wintering Hills	43	60789, 60791, 60793, 60846, 60848, 60850	88	88
Black Spring Ridge	49	61736, 61737	300	300
Oldman River	53	61543	47	47
AESO South Planning Region Subtotal			**1,184**	**1,184**
Ghost Pine	42	2621 to 2625	82	82
Halkirk	42	66435, 67435	150	150
Bull Creek DG	37	4222	29.5	29.5
AESO Central Planning Region Subtotal			**261.5**	**261.5**
Total Existing Renewable Generation			**1,445.5**	**1445.5**

For study purposes, planned renewable generation facilities will be dispatched according to the AESO Connection Queue. Table 3-6 depicts the dispatch levels for the planned renewable generation projects in the AESO Central planning regions in the AESO Connection Process, as of January 9, 2018.

Table 3-6: HG Scenario Dispatch Levels for Planned Renewable Generating Facilities

AESO Project Name	AESO Project Number	AESO Planning Area	Pmax (MW)	2020 SP/SL/WP HG Net Generation (MW)
Suncor Hand Hills Wind Energy Project[a]	635	42	80	0
BlueEarth Hand Hills Wind Project[b]	678	42	80	19.5
Irma Wainwright Wind Project[c]	937	32	90	0
E.ON Grizzly Bear Wind Facility[d]	1250	13	120	0
Sharp Hills Wind Farm New Facility Generator Capacity[e]	1567	42	300	300
Paintearth Wind Farm[f]	1704	42	150	150
Capital Power Halkirk 2 Wind	1710	36	150	150
Total Planned Renewable Generation			**970**	**619.5**

[a]The *Suncor Hand Hills Wind Energy Connection* NID, as originally approved by AUC Decision 2482-D01-2015 and Approval 2482-D03-2015.
[b]The *BluEarth Hand Hills Wind Energy Connection* NID, as originally approved by AUC Decision 2482-D01-2015 and Approval 2482-D02-2015.
[c]The *Irma Wind Power Project Connection* NID, as filed with the AUC on August 3, 2017 in Proceeding 22857.
[d]The *Grizzly Bear Creek Wind Power Connection* NID, as originally approved by AUC Decision 21643-D01-2016 and Approval 21643-D02-2016.
[e] The *Sharp Hills Wind Farm Connection* NID, as filed with the AUC on October 27, 2017 in Proceeding 23066.
[f] The *Paintearth Wind Project Connection NID,* as filed with the AUC on December 15, 2017 in Proceeding 23206.

For the LG scenarios, it will be assumed that all renewable generation in and around the Study Area will be offline. Battle River Unit 5 was identified as the critical generator. It will be turned off to represent the N-G study condition in and around the Study Area for all LG scenarios.

3.3.3. Intertie Flow Assumptions

Intertie assumptions are included for the British Columbia-Alberta (BC-AB), Saskatchewan-Alberta (SK-AB), and Montana-Alberta (MATL) interties can be found in Table 3-7 for Scenarios 1 through 10. These export and import assumptions coincide with high export and high import conditions for the AIES. For the 2027 WP scenario, the intertie flows should be as per the published AESO base cases.

Table 3-7: Intertie Flow Assumptions

Scenario Number	Scenario Name	Intertie Flow Conditions	Intertie		
			Import (-) /Export (+) to BC BC-AB (MW)	Import (-) /Export (+) to Saskatchewan SK-AB (MW)	Import (-) /Export (+) to MATL MATL (MW)
1	2020 SL HG Pre-Project	High Export	700	150	300
2	2020 SP HG Pre-Project	High Import	-800	-150	-300
3	2020 SP LG Pre-Project	Zero import	0	0	0
4	2020 WP HG Pre-Project	High Import	-800	-150	-300
5	2020 WP LG Pre-Project	Zero import	0	0	0
6	2020 SL HG Post-Project	High Export	700	150	300
7	2020 SP HG Post-Project	High Import	-800	-150	-300
8	2020 SP LG Post-Project	Zero import	0	0	0
9	2020 WP HG Post-Project	High Import	-800	-150	-300
10	2020 WP LG Post-Project	Zero import	0	0	0

3.3.4. HVDC Power Order

The Western Alberta Transmission Line (WATL) and the Eastern Alberta Transmission Line (EATL) are high-voltage direct current (HVDC) transmission lines. The HVDC power order assumptions for Scenarios 1 through 10 will be set to minimize losses for the pre-Project and post-Project study scenarios, as shown in Table 3-8. For the 2027 WP scenario, the HVDC power order should be as per the published AESO base cases.

Table 3-8: HVDC Power Order by Scenario

Scenario Number	Scenario	WATL (MW)	EATL (MW)
1	2020 SL HG Pre-Project	275 N → S	300 S → N
2	2020 SP HG Pre-Project	525 S → N	875 S → N
3	2020 SP LG Pre-Project	475 N → S	350 N → S
4	2020 WP HG Pre-Project	450 S → N	850 S → N
5	2020 WP LG Pre-Project	475 N → S	300 N → S
6	2020 SL HG Post-Project	275 N → S	300 S → N

Scenario Number	Scenario	WATL (MW)	EATL (MW)
7	2020 SP HG Post-Project	525 S → N	875 S → N
8	2020 SP LG Post-Project	475 N → S	350 N → S
9	2020 WP HG Post-Project	450 S → N	850 S → N
10	2020 WP LG Post-Project	475 N → S	300 N → S

Notes: *N → S: HVDC flow direction is North to South*

S → N: HVDC flow direction is South to North

3.4. System Projects

No planned AESO system transmission project will be considered in the system topology for the study scenarios because planned transmission developments are not expected to be in service before the scheduled Project ISD.

3.5. Connection Projects

Connection projects in and around the Study Area in the AESO Connection Queue as of January 9, 2018 will be modelled in the study scenarios, unless otherwise indicated. Table 3-9 summarizes the connection project assumptions that will be used in the studies. Information in this table is subject to change as projects progress.

Table 3-9: Connection Project Assumptions

AESO Planning Area	Queue Position[a]	Scheduled In-Service Date	AESO Project Name	AESO Project Number	Gen (MW)	Load (MW)	Included/Excluded from Studies
42	7	October 7, 2019	Suncor Hand Hills Wind Energy Project	635	80	0.1	See Table 3-6
42	8	Sept. 1, 2019	BlueEarth Hand Hills Wind Project	678	78.2	0	See Table 3-6
37	10	Nov. 1, 2020	TransCanada Keystone KXL Pumpstation #2-Eyre	851	0	25	Included at 0 MW
37	11	Nov. 1, 2020	TransCanada Keystone KXL Pumpstation #2-Eyre	851	0	0	Included
42	12	Nov. 1, 2020	TransCanada Keystone KXL Pumpstation #3-Current	863	0	25	Included at 0 MW
42	13	Nov. 1, 2020	TransCanada Keystone KXL Pumpstation #4-Armitage	864	0	25	Included at 0 MW
32	16	Jul 1, 2019	Irma Wind Power	937	90	3	See Table 3-6
13	22	Sep 1, 2019	E.ON Grizzly Bear Wind	1250	120	1.5	See Table 3-6

AESO Planning Area	Queue Position[a]	Scheduled In-Service Date	AESO Project Name	AESO Project Number	Gen (MW)	Load (MW)	Included/Excluded from Studies
37	37	Dec 3, 2018	Enbridge Sunken Lake 221S Transformer Change	1516	0	14	Included
32	42	Dec 1, 2018	Enbridge New Hardisty Substation	1558	0	0	Included
32	44	Mar 1, 2018	Fortis Wainwright Enhanced Reliability	1594	0	0	Included
42	45	May 1, 2019	EDPR Sharp Hills Wind Farm New Facility Generator Capacity	1567	300	1	See Table 3-6
42	58	Jul 2, 2019	Paintearth Wind Farm	1704	150	1	See Table 3-6
36	60	Dec. 1, 2019	Capital Power Halkirk 2 Wind[b]	1710	150	1.8	See Table 3-6

Notes: [a] Per the AESO Connection Queue posted in January 2018. The projects in and around the Study Area, if any, that have queue positions after the Project are not listed in this table and will not be modeled in the study scenarios, except as otherwise noted.

[b] P1710 is after the Project in the AESO Connection Queue, but is included in order to yield the credible worst-case power flow conditions in the Study Area, as described in Section 3.3.2.

3.6. Facility Ratings and Shunt Elements

The legal owners of transmission facilities (TFOs) provided the thermal ratings assumptions for the existing transmission lines in the Study Area. Table 3-10 shows the normal ratings and the emergency ratings for the key transmission lines in the Study Area, which will be used to perform the engineering studies.

Table 3-10: Thermal Rating Assumptions for Key Transmission Lines in the Study Area

Line ID	Line Description	Voltage Class (kV)	Normal Rating (MVA)		Emergency Rating (MVA)	
			Summer	Winter	Summer	Winter
9L966	Pemukan 932S - Hansman Lake 650S	240	332CT	332CT	432CT	432CT
9L953	Cordel 755S - Nilrem 574S	240	498CT	498CT	498CT	498CT
9L948	Paintearth 863S - Hansman Lake 650S	240	332CT	332CT	332CT	332CT
1047L	Hansman Lake 650S – Nilrem 574S	240	499	499	680	748
954L	Hansman Lake 650S – Metiskow 648S	240	333	333	499	499
7L129	Vermilion 710S - Bauer 918S Tap	144	114	145	129	149CT
7L129	Buffalo Creek 526S - Bauer 918S Tap	144	114	145	129	149
7L50	Battle River 757S – Jarrow 252S Tap	144	114	145	129	154.4
7L50	Buffalo Creek 526S – Jarrow 252S Tap	144	114	145	129	157
7L53	Irish Creek706S - Lindberg 969S Tap	144	75	90	75	90
7L53	Lindberg 969S Tap - Bonnyville 700S	144	75	90	75	90
7L117	Vermilion 710S - Irish Creek 706S	144	129	157	129	157

Line ID	Line Description	Voltage Class (kV)	Normal Rating (MVA)		Emergency Rating (MVA)	
			Summer	Winter	Summer	Winter
7L65	Vermilion 710S - Vegreville 709S	144	99CT	99CT	99CT	99CT
7L130	Vermilion 710S - Kitscoty 705S	144	75	90	75	90
7L749	Lloydminster 716S – Briker 880S Tap	144	114	145	129	157
7L14	Kitscoty 705S - Hill 751S	144	75	90	75	90
7L42	Hill 751S - Lloydminster 716S	144	99CT	99CT	99CT	99CT
7L224	Hansman Lake 650S - Monitor 774S	144	114	145	129	149CT
7L127	Pemukan 932S - Monitor 774S	144	132CT	132CT	132CT	132CT
749L	Edgerton 899S – Briker 880S Tap	138	96	96	134	140
749L	Edgerton 899S - Killarney Lake 267S Tap	138	96	96	134	140
749L	Metiskow 648S – Killarney Lake 267S Tap	138	121	149	133	164
715L	Hansman Lake 650S – Provost 545S	138	98	132	108	145
748L	Killarney Lake 267S – Hayter 277S	138	119	146	131	161
885L	Hansman Lake 650S – Metiskow 648S	138	287	287	344	373
703L	HRT Express 329S Tap – Hardisty 377S	138	96	96	133	143
703L	Hughenden 213S – HRT Express 329S Tap	138	121	145	133	160
408L[a]	Jarrow 252S – Wainwright 51S	138	75	79	83	87
704L	Wainwright 51S – Tucuman 478S	138	75	79	83	87
472L	Metiskow 648S – Sunken Lake 221S Tap	138	121	150	133	153
472L	Sunken Lake 221S Tap – Hughenden 213S	138	121	150	133	165

Note: "CT" indicates that the transmission line is limited by current transformer.
[a] The segment of 704L from Wainwright 51S to Jarrow 252S was re-numbered to 408L as part of the *Wainwright Transmission Reinforcement* NID, and as originally approved by AUC Decision 21857-D01-2017 and Approval 21857-D02-2017.

The TFOs provided the details of the substation transformers in the Study Area. The key transformers in the Study Area are shown in Table 3-11.

Table 3-11: Summary of Key Transformer Ratings in the Study Area

Substation Name and Number	Transformer ID	Transformer Voltages (kV)	Transformer Rating (MVA)
Metiskow 648S	T1	138/25	25
	T3	240/138	200
Hansman Lake 650S	T1	240/138	200
	T3	240/18	200

The TFOs provided the details of the shunt elements in the Study Area. The key shunt elements in the Study Area are shown in Table 3-12.

Table 3-12: Summary of Key Shunt Elements in the Study Area

Substation Name and Number	Voltage Class (kV)	Capacitors		Reactors	
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)	Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)
Buffalo Creek 526S	138	1 x 15.00 MVAr	15.00	-	-
Sunken Lake 221S	138	1 x 18.00 MVAr	18.00	-	-
Halkirk 615S	34.5	1 x 6.00 MVAr + 3 x 18.00 MVAr	60.00	2 x -14.00 MVAr	-28.00
	0.5	2 x 12.50 MVAr	25.00	2 x -12.50 MVAr	-25.00
Hansman Lake 650S	18.0	1 x 200.0 MVAr	200.0	1 x -100.0 MVAr	-100.0
Hardisty 377S	138	1 x 27.02 MVAr	27.02	-	-
Hill 751S	138	1 x 18.12 MVAr + 1 x 22.96 MVAr	41.08	-	-
Stettler 769S	138	1 x 13.78 MVAr	13.78	-	-
Killarney Lake 267S	138	1 x 9.10 MVAr + 2 x 10.90 MVAr	30.90	-	-
Lloydminster 716S	138	1 x 18.12 MVAr	18.12	-	-
Tucuman 478S	138	1 x 27.17 MVAr	27.17	-	-
Vermilion 710S	138	1 x 22.96 MVAr	22.96	-	-
Lanfine 959S	34.5	1 x 200 MVAr	200	1 x -100 MVAr	-100
	138	2 x 27.55 MVAr	55.10	-	-
Monitor 774S	138	1 x 18.38 MVAr + 1 x 27.55 MVAr	45.93	-	-
Pemukan 932S	138	2 x 27.55 MVAr	55.10	-	-
Battle River 757S	69	1 x 9.19	9.19	-	-

3.7. Voltage Profile Assumption

ID # 2010-007RS will be 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 the AESO ID# 2010-007RS. These voltages will be utilized to set the voltage profile for the study base cases prior to power flow studies.

4. Study Methodology

4.1. Engineering Studies to be Performed

The engineering studies to be performed for this connection assessment are identified in Table 4-1.

Table 4-1: Engineering Studies to be Performed

Scenario No. and Name		System Conditions	Power Flow	Voltage Stability	Short-circuit
1	2020 SL HG Pre-Project	Category A and Category B	X		
2	2020 SP HG Pre-Project	Category A and Category B	X		
3	2020 SP LG Pre-Project	Category A and Category B	X		
4	2020 WP HG Pre-Project	Category A and Category B	X		X[a]
5	2020 WP LG Pre-Project	Category A and Category B	X		
6	2020 SL HG Post-Project	Category A and Category B	X		
7	2020 SP HG Post-Project	Category A and Category B	X		
8	2020 SP LG Post-Project	Category A and Category B	X		
9	2020 WP HG Post-Project	Category A and Category B	X		X[a]
10	2020 WP LG Post-Project	Category A and Category B	X	X	
11	2027 WP Post-Project	Category A			X[a]

Note: [a] Only the Category A condition will be studied for short-circuit studies, with all generators in and around the Study Area on.

4.2. Power Flow Studies

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

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

Voltage deviations at point-of-delivery (POD) low voltage busses will also be assessed for both the pre-Project and post-Project scenarios by first locking all tap changers and area shunt reactive compensating devices to identify any post-transient voltage deviations above 10%.

Second, tap changers will be allowed to move while shunt reactive compensating devices remain locked to determine if any voltage deviations above 7% occur in the area. Third, all the taps and shunt reactive compensating devices will be allowed to adjust, and voltage deviations above 5% will be reported.

The scenarios and cases to be studied are as shown in Table 4-1.

4.2.1. Contingencies to be Studied

Power flow studies will be performed for all Category B contingencies in the Study Area.

4.3. Voltage Stability Studies

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

Voltage stability studies will be performed for the 2020 WP post-Project scenario only. Voltage stability studies for pre-Project scenarios will only be performed if post-Project scenarios show voltage stability criteria violations.

Voltage stability studies will be performed according to the Western Electricity Coordinating Council (WECC) Voltage Stability Assessment Methodology. WECC voltage stability criteria state, for load areas, post-transient voltage stability is required for the area modelled at a minimum of 105% of the reference load level for Category A and for Category B conditions. For this standard, the reference load level is the maximum established planned load.

Typically, voltage stability analysis is carried out assuming the worst case loading scenarios. For the Project's worst case scenario, load will be increased in the Study Area and the corresponding generation will be increased in Wabamun (Area 40).

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

4.3.1. Contingencies to be Studied

Voltage stability studies will be performed for all Category B contingencies in the Study Area.

4.4. Short-circuit Studies

A maximum fault level must be provided for the substations in the vicinity of the Project assuming normal system operation with all transmission elements in service and generation dispatched. Three-phase faults and single line-to-ground faults will be simulated. Polar coordinates and per-unit values will be used for reporting the results.

Winter peak scenarios will be used for the short-circuit studies because winter peak scenarios generally produce higher short-circuit current levels than summer peak scenarios.

Estimated maximum three-phase faults and single line-to-ground short-circuit current levels will be reported for the following substations:

- Hansman Lake 650S,
- Provost 545S,
- Hayter 277S,
- Killarney Lake 267S,
- Edgerton 899S, and
- Metiskow 648S

The scenarios to be studied are as shown in Table 4-1.

5. Mitigation Measures

5.1. Development

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

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

- Collaborate with the AESO to propose changes, if any, to the connection alternatives that could remove the requirement for a RAS.
- Collaborate with the AESO to study modifications to existing and/or planned RASs, proposed by the AESO, to ensure the coordination of existing protection schemes with the addition of any proposed protection schemes.
- Collaborate with the AESO to identify and study new RASs, if any, that may be required to ensure post-Project system reliability is maintained.

The AESO Studies Engineer will work closely with the Studies Consultant and guide the development and/or modifications of the proposed mitigation measures to ensure system reliability, security and compliance with the AESO's system access business practices.

5.2. Evaluation

5.2.1. Post-Mitigation Studies

Studies to evaluate the effectiveness of mitigation measures, if required, will be performed in accordance with the technical criteria, assumptions, and methods provided in this AESO Engineering Connection Assessment Scope and in accordance with further instructions from the AESO.

Attachment A1.1

Transmission Planning Criteria- Basis and Assumptions (Reliability Criteria)

1. Introduction

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

2. Transmission Reliability Standards and Criteria[1]

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

1. **TPL-001-AB-0: System Performance Under Normal Conditions**
   Category A represents a normal system condition with all elements in service (N-0). All equipment must be within its applicable rating, voltages must be within their applicable ratings and the system must be stable with no cascading outages. Under Category A, electric supply to load cannot be interrupted and generating units cannot be removed from service.

2. **TPL-002-AB-0: System Performance Following Loss of a Single BES Element**
   Category B events result in the loss of any single element (N-1) under specified fault conditions with normal clearing. The specified elements are a generating unit, a transmission circuit, a transformer or a single pole of a direct current transmission line. The acceptable impact on the system is the same as Category A with the exception that radial customers or some local network customers, including loads or generating units, are allowed to be disconnected from the system if they are connected through the faulted element. The loss of opportunity load or opportunity interchanges is allowed. No cascading can occur.

3. **TPL-003-AB-0: System Performance Following Loss of Two or More BES Elements**
   Category C events result in the loss of two or more bulk electric system elements (sequential, N-1-1 or concurrent, N-2) under specified fault conditions and include both normal and delayed fault clearing. All of the system limits for Category A and B events apply with the exception that planned and controlled loss of firm load, firm transfers and/or generation is acceptable provided there is no cascading.

4. **TPL-004-AB-0: System Performance Following Extreme BES Events**
   Category D represents a wide variety of extreme, rare and unpredictable events, which may result in the loss of load and generation in widespread areas. The system may not be able to reach a new stable steady state, which means a blackout is a possible outcome. The AESO needs to evaluate these events, at its discretion, for risks and consequences prior to creating mitigation plans.

5. **FAC-014-AB-2: Establishing and Communicating System Operating Limits**
   The AESO is required to establish system operating limits where a contingency is not mitigated through construction of transmission facilities.

[1] A complete description of these standards are given in: AESO. *Alberta Reliability Standards*. Available from http://www.aeso.ca/rulesprocedures/17004.html

2.1 Thermal Loading Criteria

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

2.2 Voltage Range and Voltage Stability Criteria

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

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

Nominal Voltage	Extreme Minimum	Normal Minimum	Normal Maximum	Extreme Maximum
500	475	500	525	550
240	216	234	252	264
260 (Northeast & Northwest)*	234	247	266	275
144	130	137	151	155
138	124	135	145	150
72	65	68.5	75.5	79
69	62	65.5	72.5	76

Table 2-2: Voltage Stability Criteria

Performance Level	Disturbance (1)(2)(3)(4) Initiated by: Fault or No fault DC Disturbance	MW Margin (P-V method) (5)(6)(7)	MVAr Margin (V-Q method) (6)(7)
A	Any element such as: One Generator One Circuit One Transformer One Reactive Power Source One DC Monopole	≥ 5%	Worst Case Scenario(8)
B	Bus Section	≥ 5%	50% of Margin Requirement

Performance Level	Disturbance (1)(2)(3)(4) Initiated by: Fault or No fault DC Disturbance	MW Margin (P-V method) (5)(6)(7)	MVAr Margin (V-Q method) (6)(7)
			in Level A
C	Any combination of two elements such as: A Line and a Generator A Line and a Reactive Power Source Two Generators Two Circuits Two Transformers Two Reactive Power Sources DC Bipole	≥ 2.5%	50% of Margin Requirement in Level A
D	Any combination of three or more elements. i.e.: Three or More Circuits on ROW Entire Substation Entire Plant Including Switchyard	> 0	> 0

2.3 Transient Stability Analysis Assumptions

Standard fault clearing times as shown in Table 2-3 are used for the new facilities or when the actual clearing times are not available for the existing facilities. Double line-to-ground faults are applied for the Category C5 events with normal clearing times. Single line-to-ground faults are applied for Category C6 to C9 events with delayed clearing times as depicted in Table 2-4 and Table 2-5.

Table 2-3: Fault Clearing Times

Nominal	Near End	Far End
kV	Cycles	Cycles
500	4	5
240	5	6
144/138	6	8

with telecommunications		
144/138 without telecommunications	6	30

Table 2-4: Stuck Breaker Clearing Times for Lines

Fault Clearing Time			Fault Clearing Time			Fault Clearing Time		
138/144 kV			240 kV			500 kV		
Near End	Far End	2nd Ckt (for C5 and C7 Only)	Near End	Far End	2nd Ckt (for C5 and C7 Only)	Near End	Far End	2nd Ckt (for C5 and C7 Only)
15	24	24	12	6	14	9	5	11

Table 2-5: Stuck Breaker Clearing Times for Transformers

Fault Clearing Time (Cycles)						Fault Clearing Time (Cycles)					
240/138 kV						500/240 kV					
Fault on 240 kV Side			Fault on 138 kV Side			Fault on 500 kV Side			Fault on 240 kV Side		
240 kV Side	138 kV Side	2nd Ckt (for Breaker Fail)	138 kV Side	240 kV Side	2nd Ckt (for Breaker Fail)	500 kV Side	240 kV Side	2nd Ckt (for Breaker Fail)	240 kV Side	500 kV Side	2nd Ckt (for Breaker Fail)
12	6	14	15	5	24	9	5	11	12	4	14

Attachment A2

Pre-Project Power Flow Diagrams

Table 1: Summary of System Performance (Element Loading) Scenario 1- 2020 SL HG Pre-Project

Contingency	Thermal Overloads	Overload %	Voltage Criteria Violation	Figure in Attachment A2
N-0: Normal Operation	*None*	--	*None*	*A2-1*
648ST1 (Metiskow 648S 138/25 kV transformer)	*None*	--	*None*	*A2-2*
7L14 (Kitscoty 705S to Hill 751S)	*None*	--	*None*	*A2-3*
7L42 (Hill 751S to Lloydminster 716S)	*None*	--	*None*	*A2-4*
899S T3 (Edgerton 899S 138/25 kV transformer)	*None*	--	*None*	*A2-5*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*None*	--	*None*	*A2-6*
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*None*	--	*None*	*A2-7*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*None*	--	*None*	*A2-8*
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*None*	--	*None*	*A2-9*
7L129 (Buffalo Creek 526S to Vermilion 710S)	*None*	--	*None*	*A2-10*

Table 2: Summary of System Performance (Element Loading) Scenario 2- 2020 SP HG Pre-Project

Contingency	Thermal Overloads	Overload %	Voltage Criteria Violation	Figure in Attachment A2
N-0: Normal Operation	*None*	--	*None*	*A2-11*
648ST1 (Metiskow 648S 138/25 kV transformer)	*7L14 (Kitscoty 705S to Hill 751S)*	113.0	*None*	*A2-12*
	7L130 (Vermilion 710S to Kitscoty 705S)	118.0		
	7L129 (Vermilion 710S to Bauer 918S Tap)	106.0		
	7L129 (Buffalo Creek 526S to Bauer 918S Tap)	106.0		
	7L50 (Buffalo Creek 526S to Jarrow Tap)	135.0		
7L14 (Kitscoty 705S to Hill 751S)	*7L50 (Buffalo Creek 526S to Jarrow Tap*	*101.5*	*None*	*A2-13*
7L42 (Hill 751S to Lloydminster 716S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*118.6*	*None*	*A2-14*
899S T3 (Edgerton 899S 138/25 kV transformer)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*127.0*	*None*	*A2-15*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*7L129 (Buffalo Creek 526S to Bauer 918S Tap)*	*101.6*	*None*	*A2-16*
	7L50 (Buffalo Creek 526S to Jarrow 252S Tap)	*130*		
	7L129 (Vermilion 710S to Bauer 918S Tap)	*101.1*		
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*124.8*	*None*	*A2-17*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*108.9*	*None*	*A2-18*
	7L749 (Edgerton 899S to Briker 880S Tap)	*103.0*		
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*103.9*	*None*	*A2-19*
7L129 (Buffalo Creek 526S to Vermilion 710S)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*100.3*	*None*	*A2-20*

Table 3: Summary of System Performance (Element Loading) Scenario 3- 2020 SP LG Pre-Project

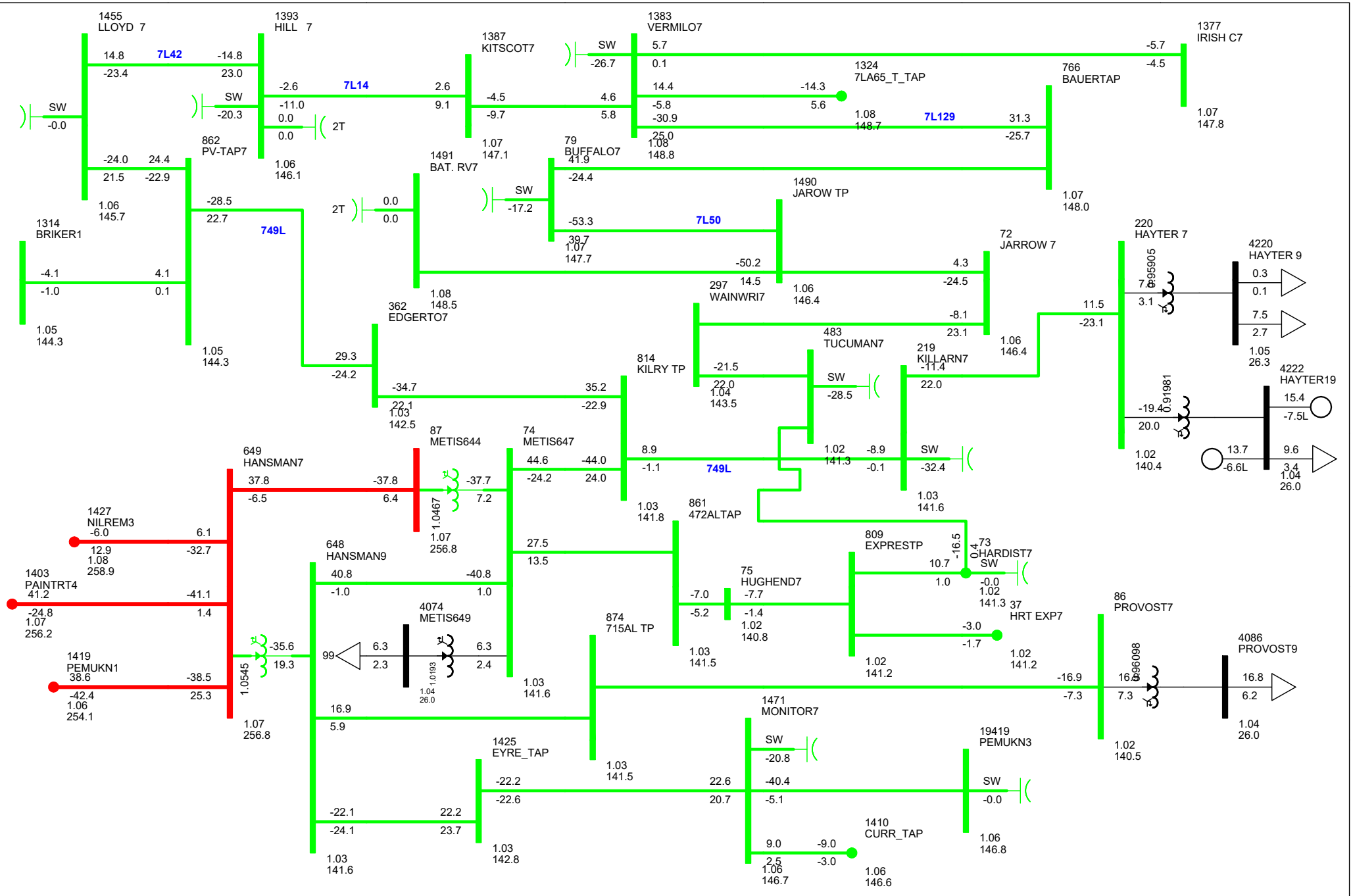
Contingency	Thermal Overloads	Overload %	Voltage Criteria Violation	Figure in Attachment A2
N-0: Normal Operation	*None*	--	*None*	*A2-21*
648ST1 (Metiskow 648S 138/25 kV transformer)	*None*	--	*Voltage Collapse*	*A2-22*
7L14 (Kitscoty 705S to Hill 751S)	*None*	--	*None*	*A2-23*
7L42 (Hill 751S to Lloydminster 716S)	*None*	--	*None*	*A2-24*
899S T3 (Edgerton 899S 138/25 kV transformer)	*None*	--	*None*	*A2-25*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*None*	--	*None*	*A2-26*
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*None*	--	*None*	*A2-27*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*None*	--	*None*	*A2-28*
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*None*	--	*None*	*A2-29*
7L129 (Buffalo Creek 526S to Vermilion 710S)	*None*	--	*None*	*A2-30*

Table 4: Summary of System Performance (Element Loading) Scenario 4- 2020 WP HG Pre-Project

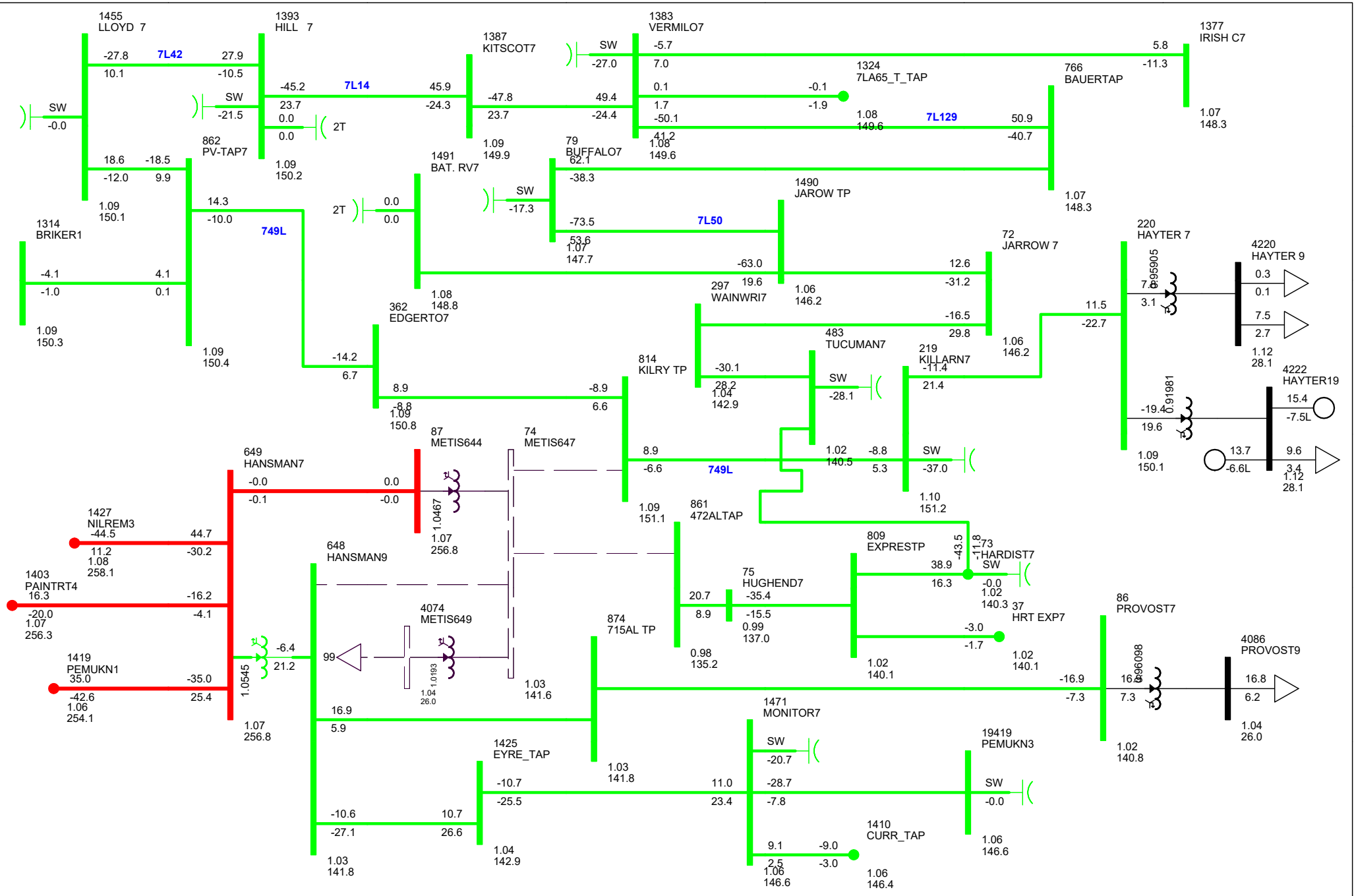
Contingency	Thermal Overloads	Overload %	Voltage Criteria Violation	Figure in Attachment A2
N-0: Normal Operation	*None*	--	*None*	*A2-31*
648ST1 (Metiskow 648S 138/25 kV transformer)	*None*	--	*Voltage Collapse*	*A2-32*
7L14 (Kitscoty 705S to Hill 751S)	*None*	--	*None*	*A2-33*
7L42 (Hill 751S to Lloydminster 716S)	*None*	--	*None*	*A2-34*
899S T3 (Edgerton 899S 138/25 kV transformer)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*102.8*	*None*	*A2-35*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*105.4*	*None*	*A2-36*
	7L130 (Vermilion 710S Kitscoty 705S)	*101.2*		
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*100.8*	*None*	*A2-37*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*116.7*	*None*	*A2-38*
	7L749 (Edgerton 899S to Briker 880S Tap)	*109.5*		
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*111.4*	*None*	*A2-39*
	7L749 (Edgerton 899S to Briker 880S Tap)	*104.3*		
7L129 (Buffalo Creek 526S to Vermilion 710S)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*108.3*	*None*	*A2-40*
	7L749 (Edgerton 899S to Briker 880S Tap)	*101.4*		

Table 5: Summary of System Performance (Element Loading) Scenario 5- 2020 WP LG Pre-Project

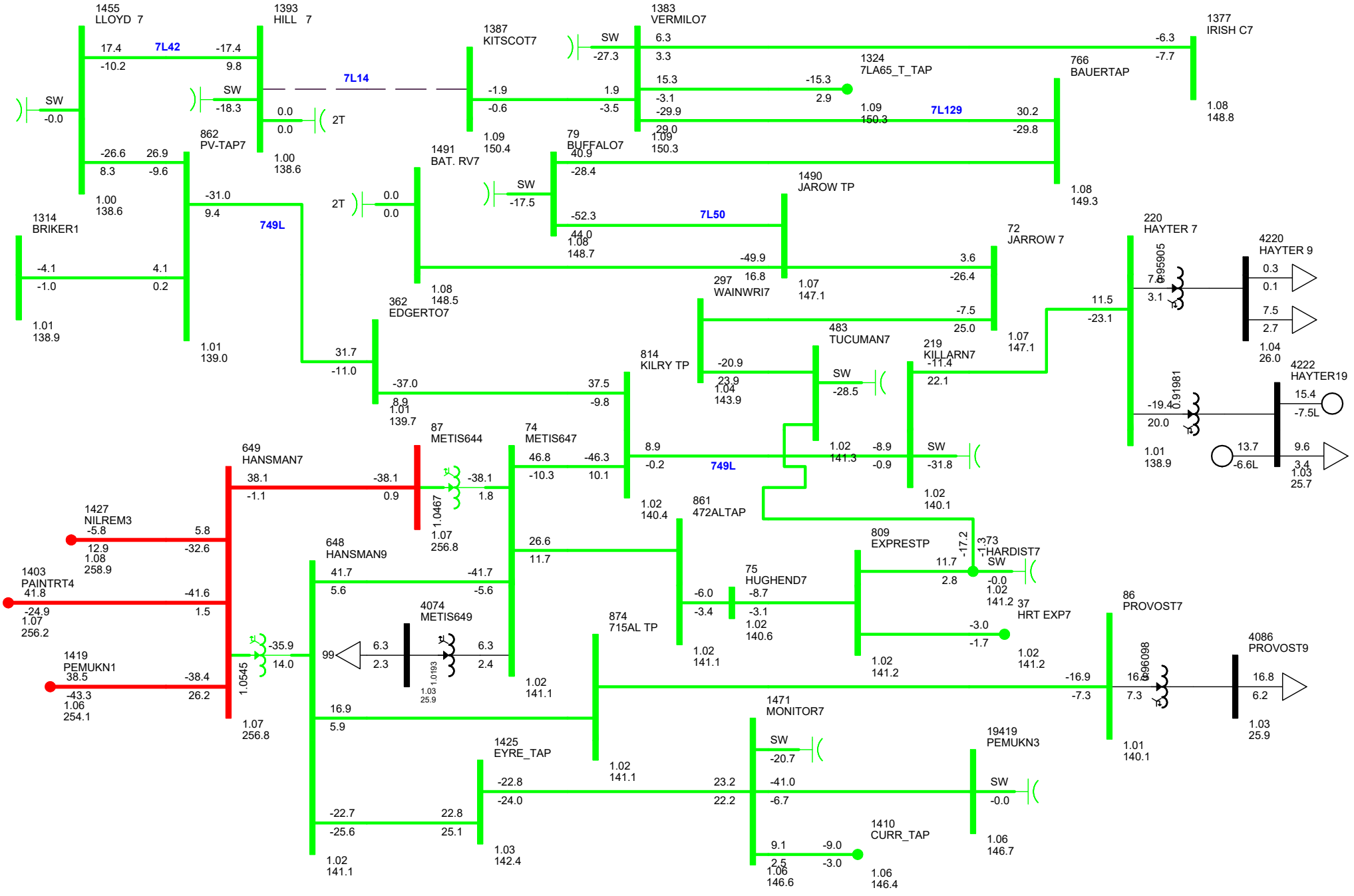
Contingency	Thermal Overloads	Overload %	Voltage Criteria Violation	Figure in Attachment A2
N-0: Normal Operation	*None*	--	*None*	*A2-41*
648ST1 (Metiskow 648S 138/25 kV transformer)	*None*	--	*Voltage Collapse*	*A2-42*
7L14 (Kitscoty 705S to Hill 751S)	*None*	--	*None*	*A2-43*
7L42 (Hill 751S to Lloydminster 716S)	*None*	--	*None*	*A2-44*
899S T3 (Edgerton 899S 138/25 kV transformer)	*None*	--	*None*	*A2-45*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*7L130 (Vermilion 710S Kitscoty 705S)*	*101.7*	*None*	*A2-46*
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*None*	--	*None*	*A2-47*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*None*	--	*None*	*A2-48*
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*None*	--	*None*	*A2-49*
7L129 (Buffalo Creek 526S to Vermilion 710S)	*None*	--	*None*	*A2-50*



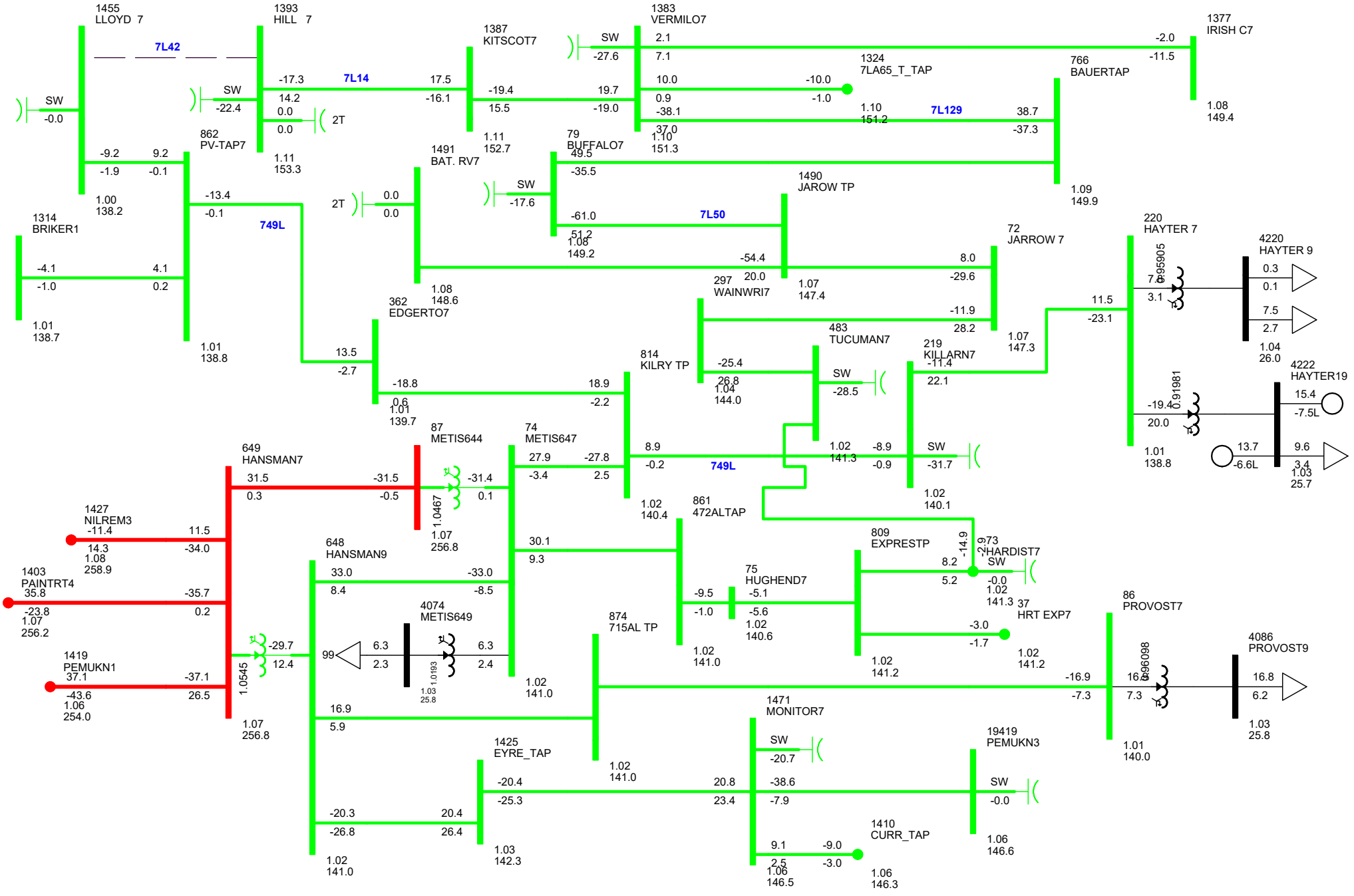
Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A2-1 N-0: NORMAL OPERATION WED, DEC 06 2017 11:14	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



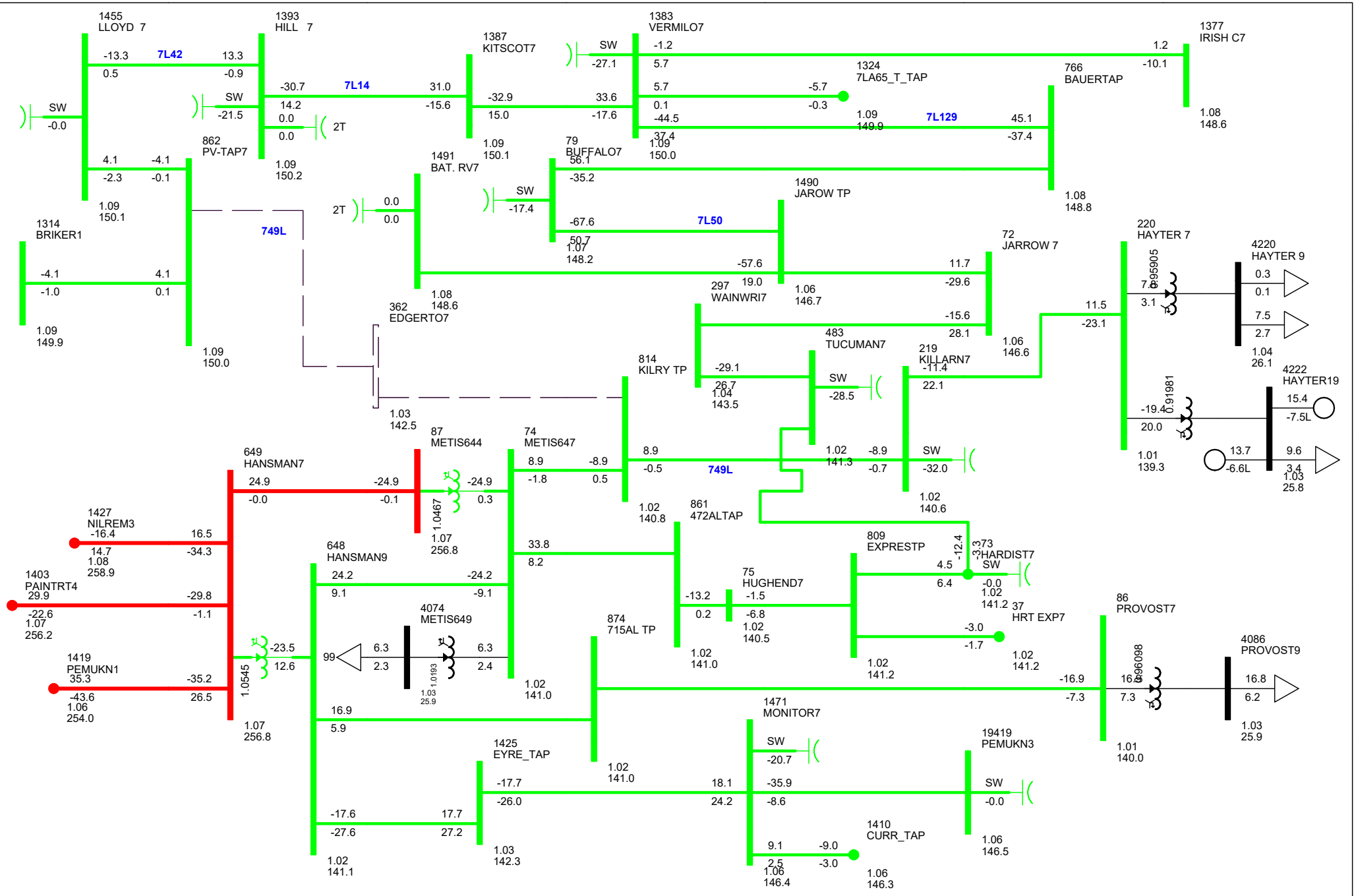
Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A2-2 N-1: METISKOW 648S 138/25 KV TRANSFORMER WED, DEC 06 2017 11:15	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



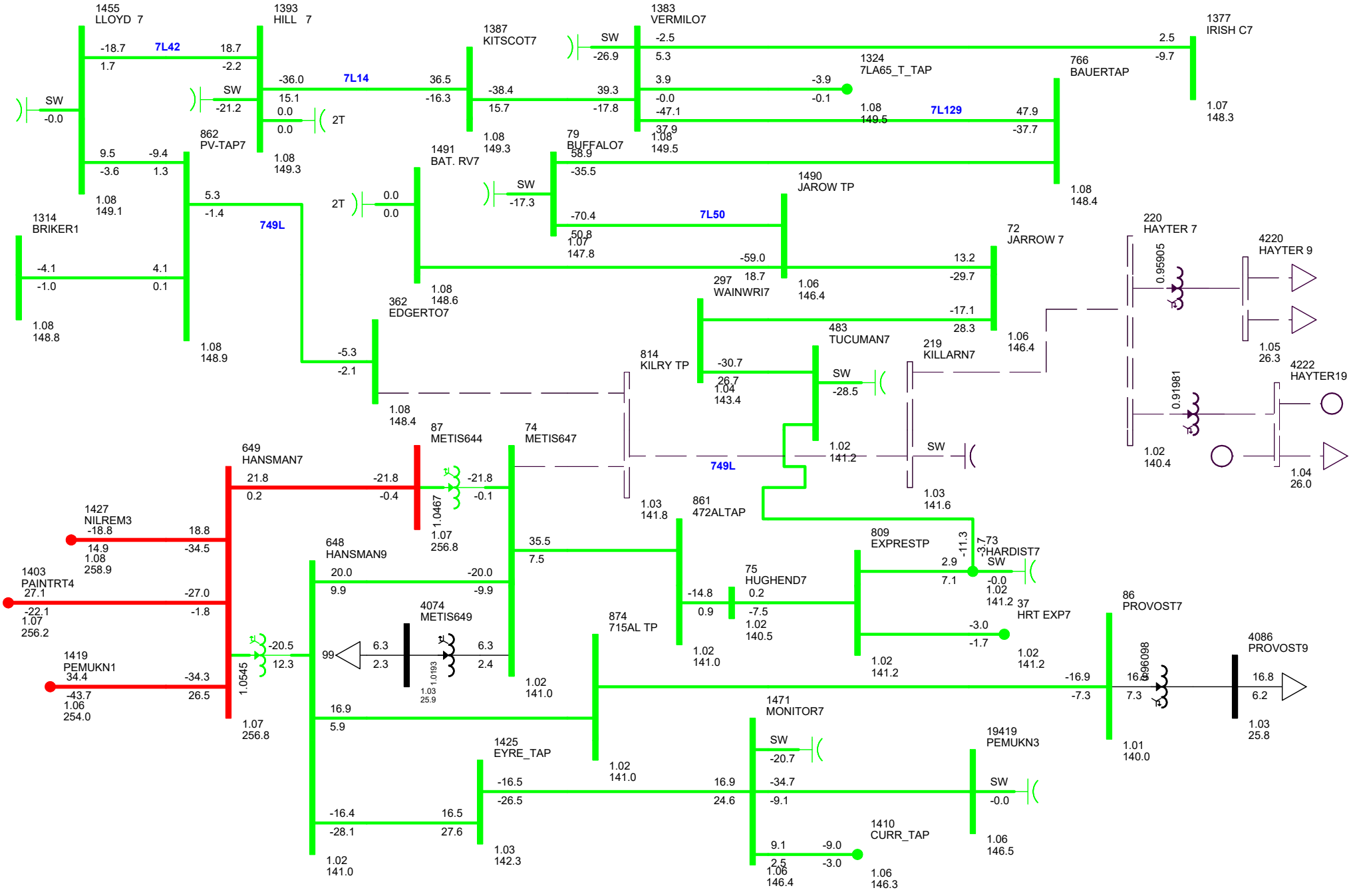
Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A2-3 N-1: 7L14 KITSCOTY 705S TO HILL 751S WED, DEC 06 2017 11:15	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



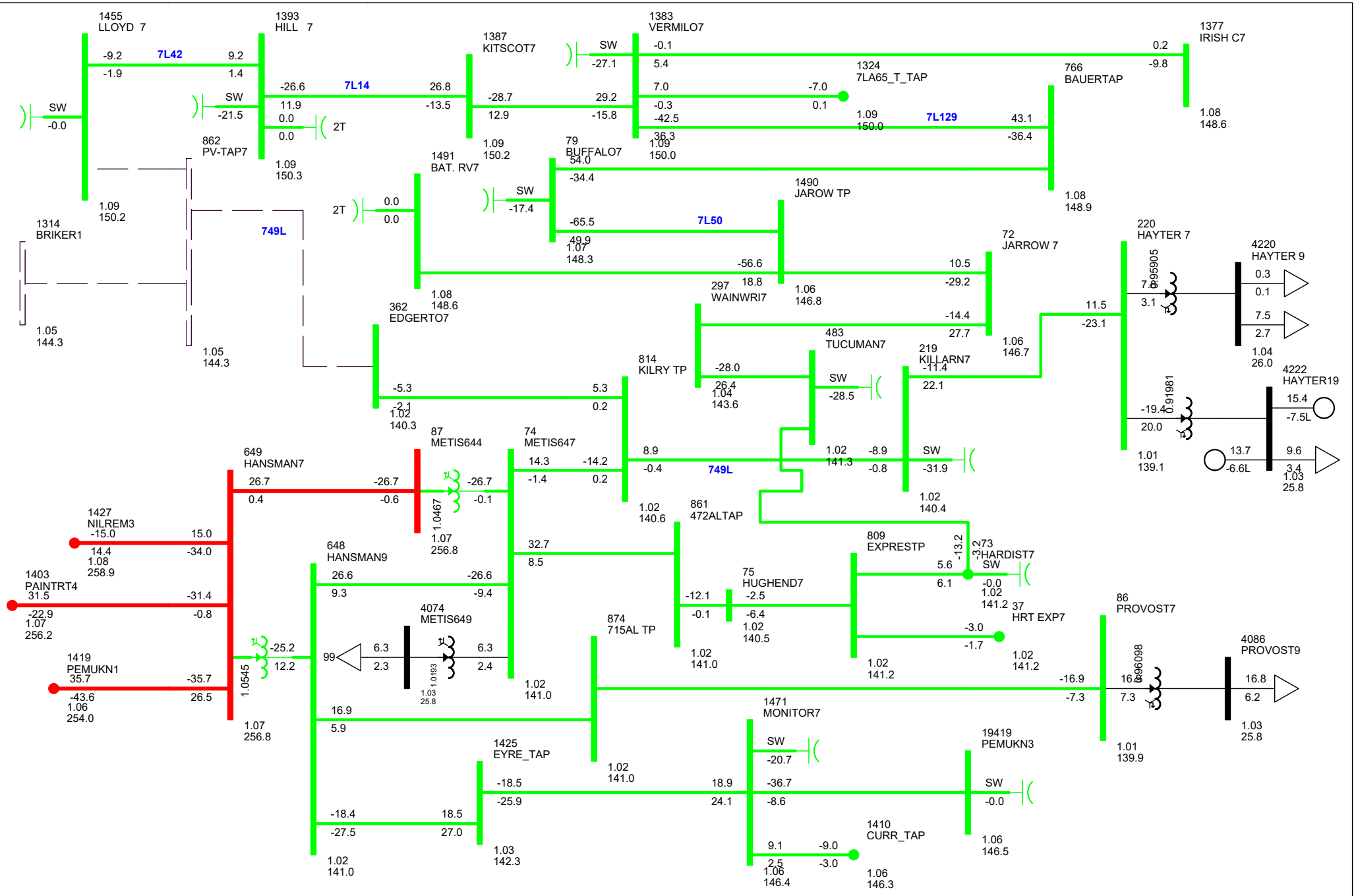
Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A2-4 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S WED, DEC 06 2017 11:15	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



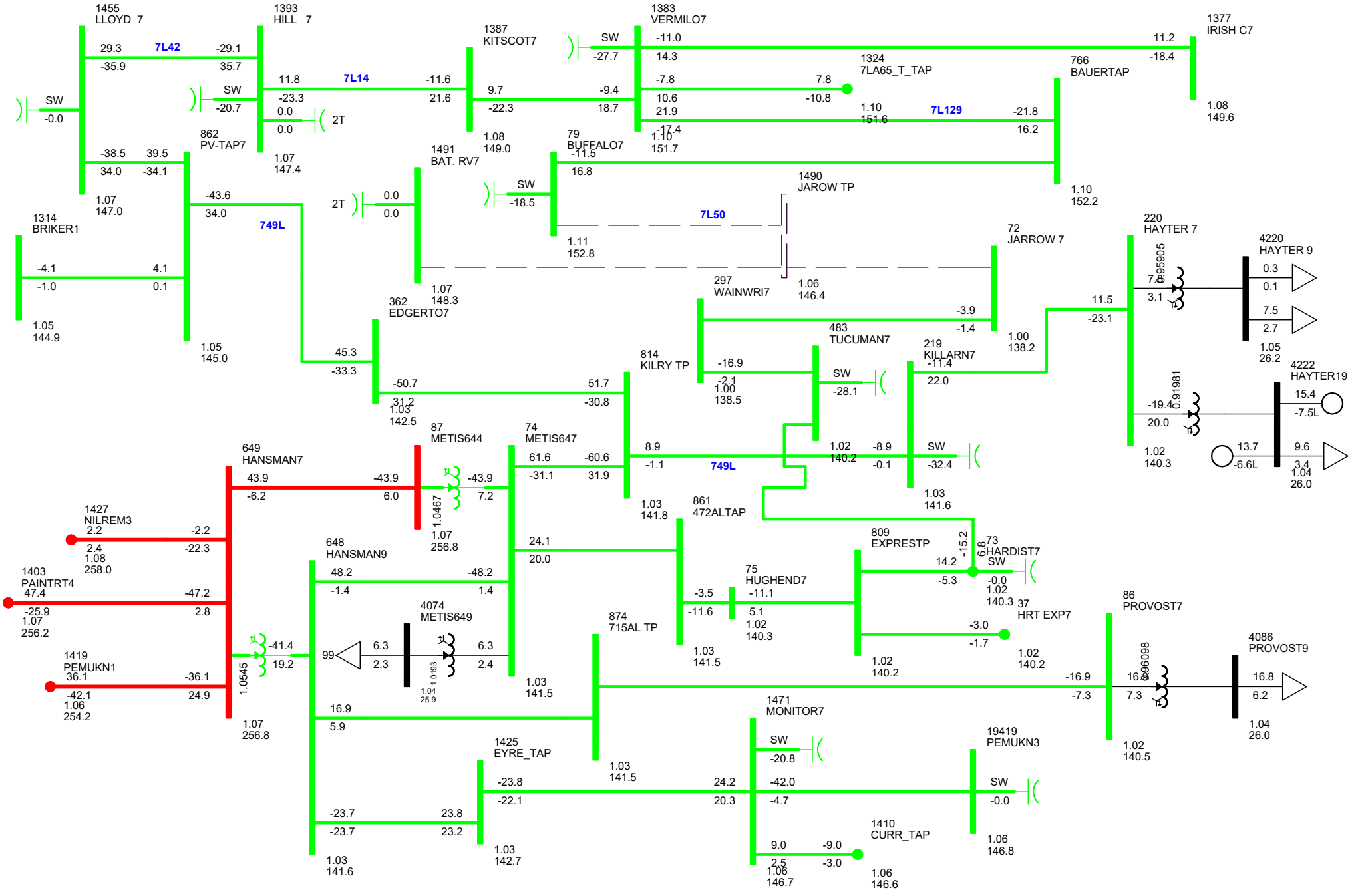
Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A2-5 N-1: EDGERTON 899S 138/25 KV TRANSFORMER WED, DEC 06 2017 11:15	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



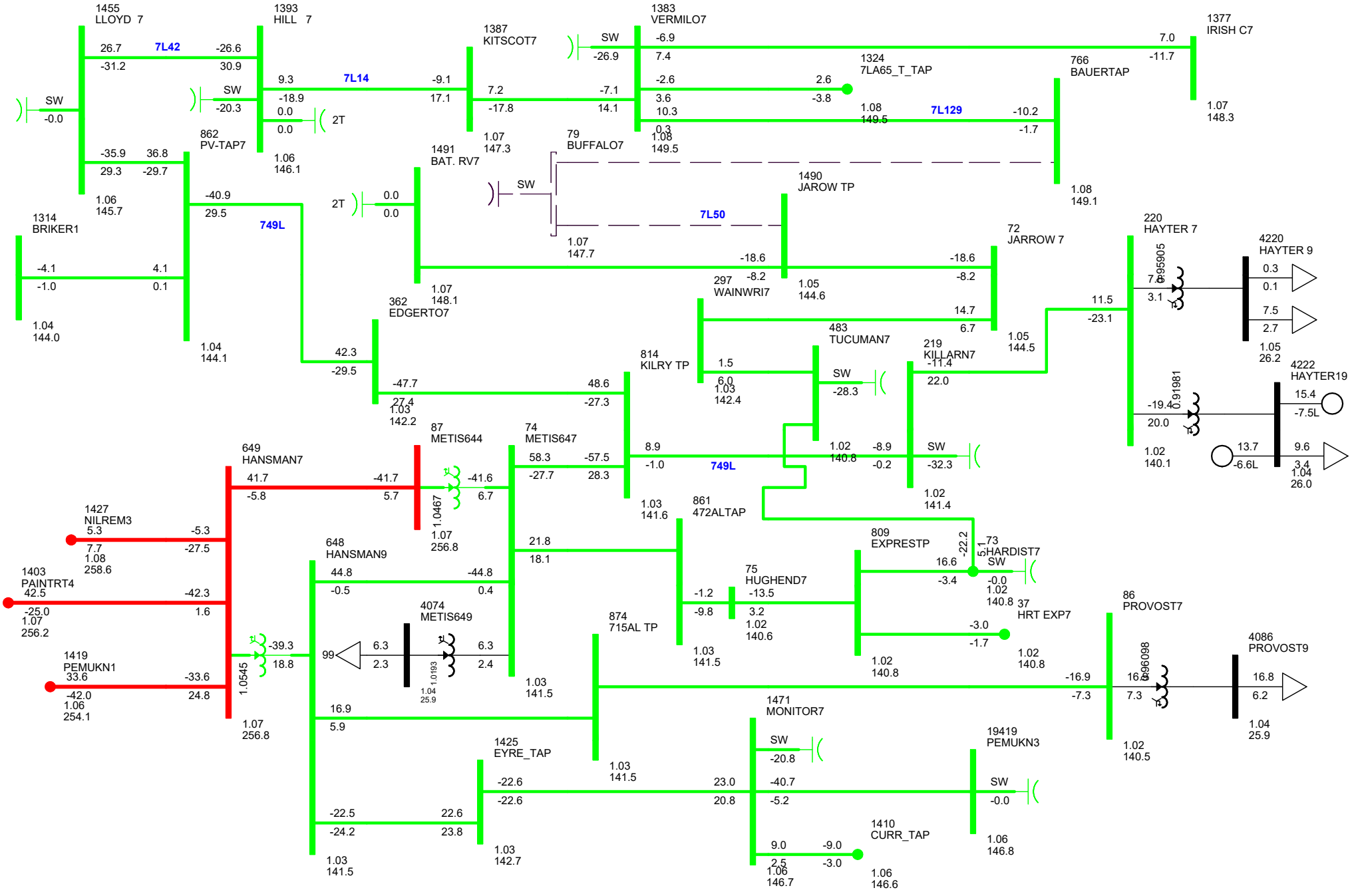
Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A2-6 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S WED, DEC 06 2017 11:15	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A2-7 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S WED, DEC 06 2017 11:15	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A2-8 N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S WED, DEC 06 2017 11:15	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability

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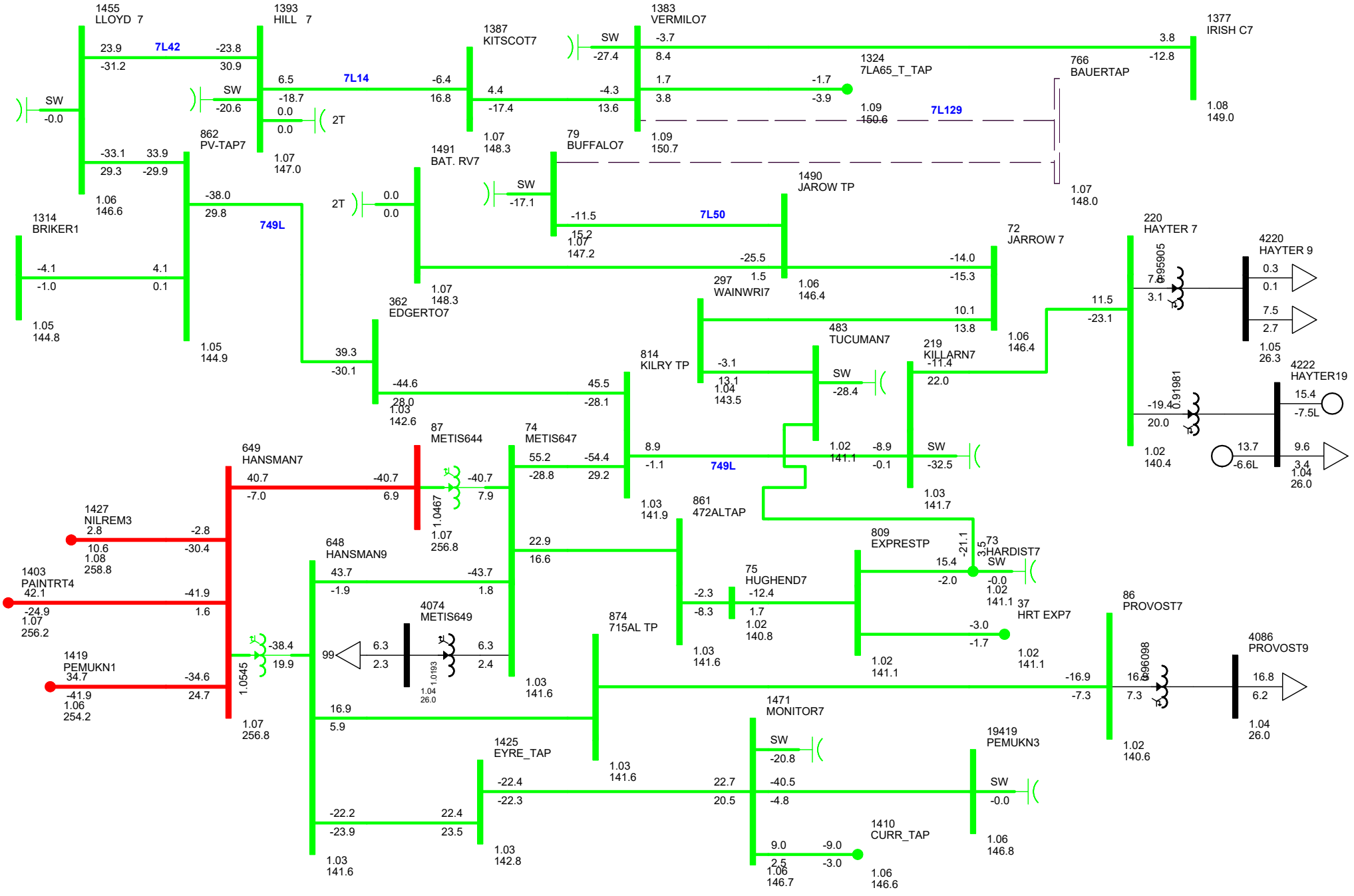
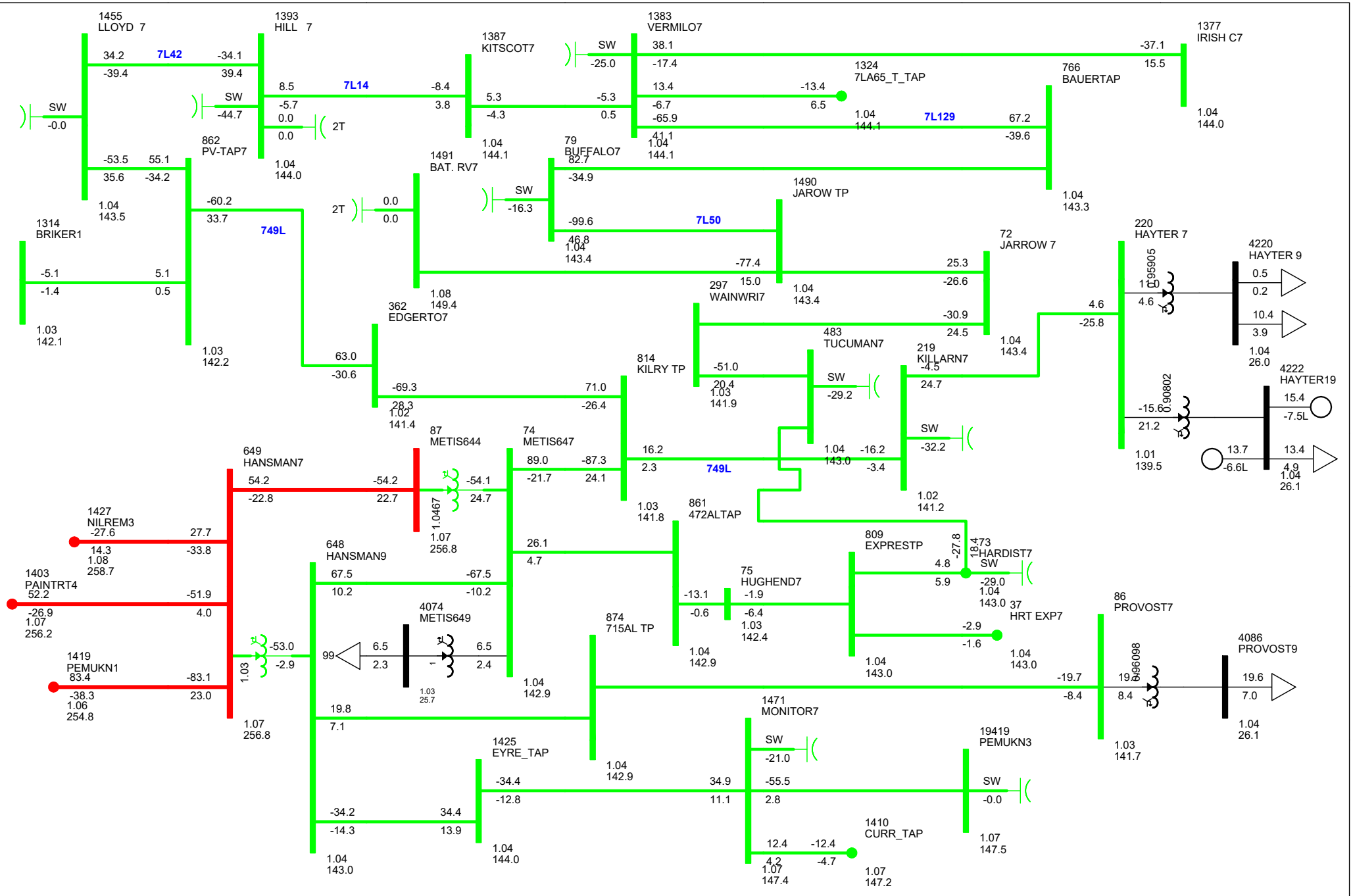
2020 SL

P1782 PRE-CONNECTION - DIAGRAM A2-9
N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER
WED, DEC 06 2017 11:16

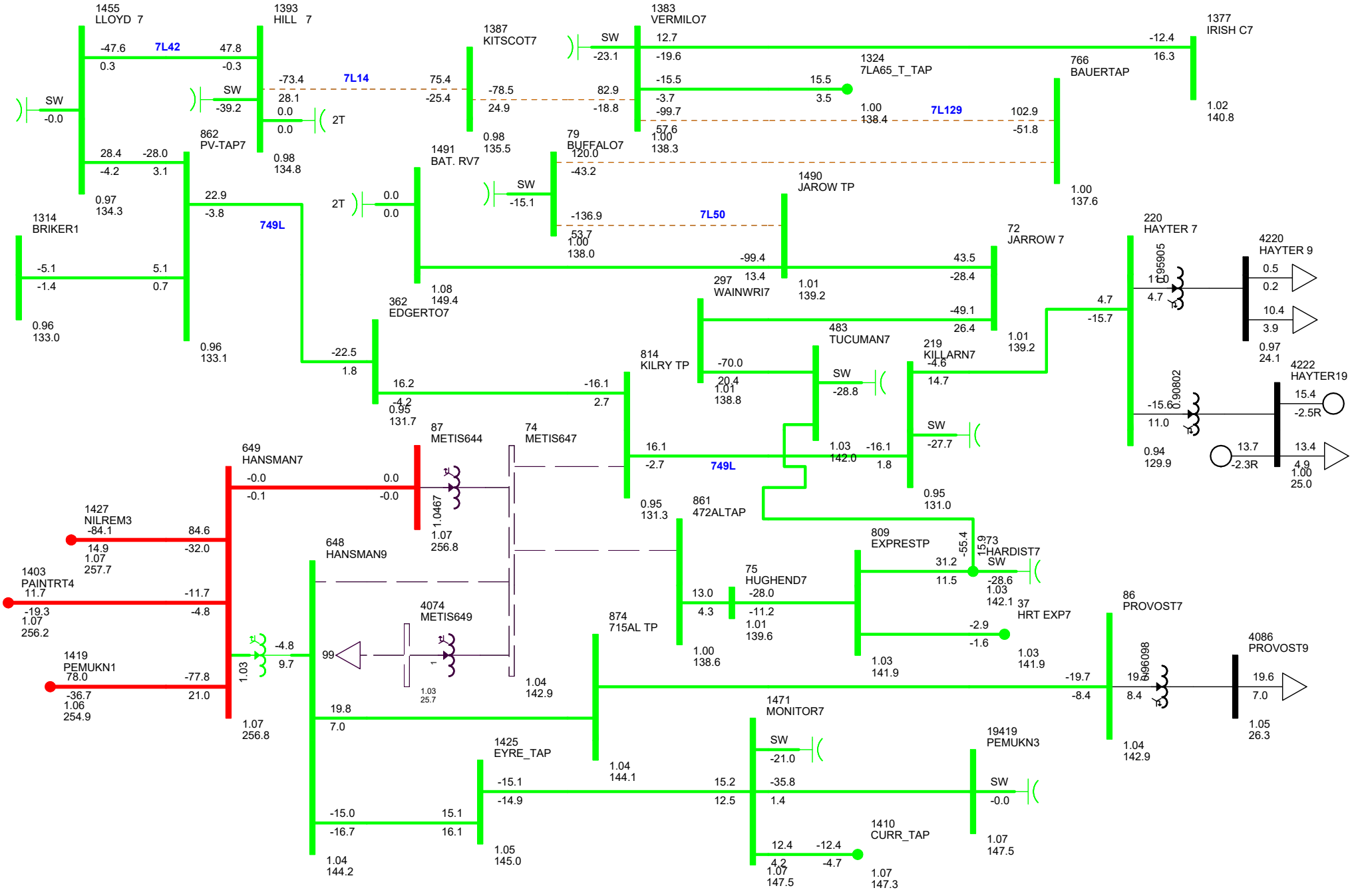
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.125OV 0.899UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



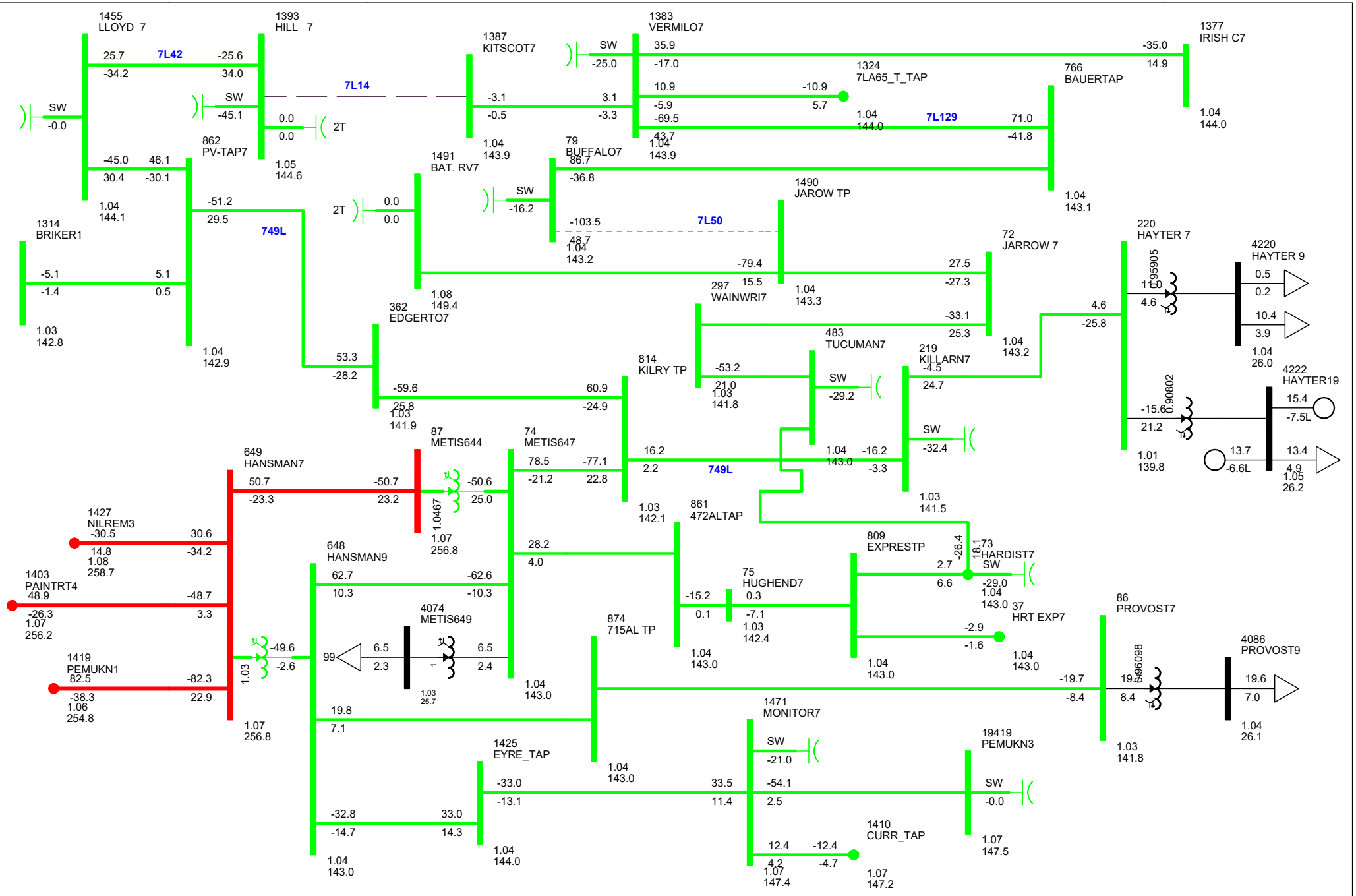
Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A2-10 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S WED, DEC 06 2017 11:16	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



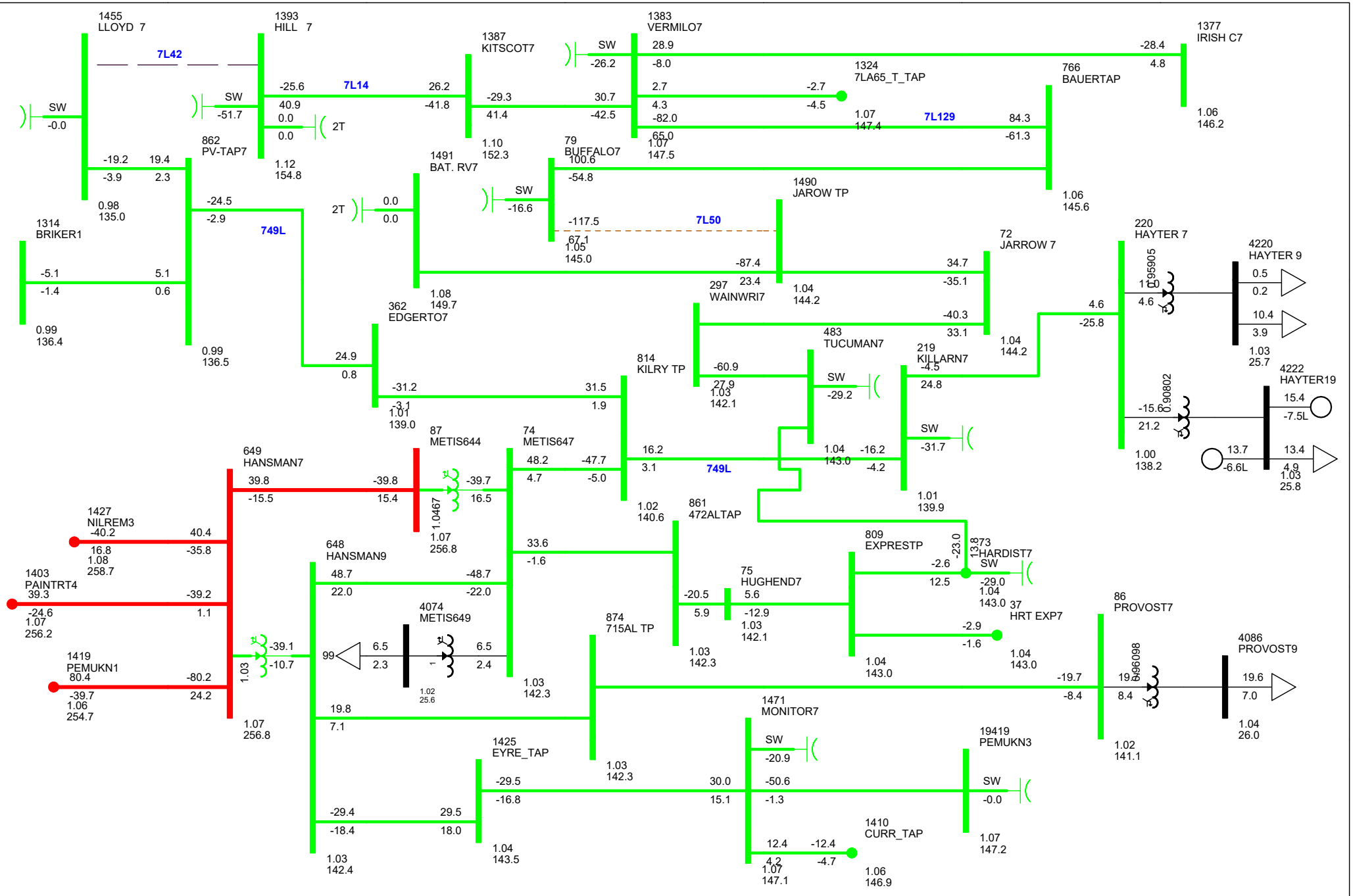
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-11 N-0: NORMAL OPERATION WED, DEC 06 2017 11:37	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-12 N-1: METISKOW 648S 138/25 KV TRANSFORMER WED, DEC 06 2017 11:37	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-13 N-1: 7L14 KITSCOTY 705S TO HILL 751S WED, DEC 06 2017 11:37	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability

Project 1782

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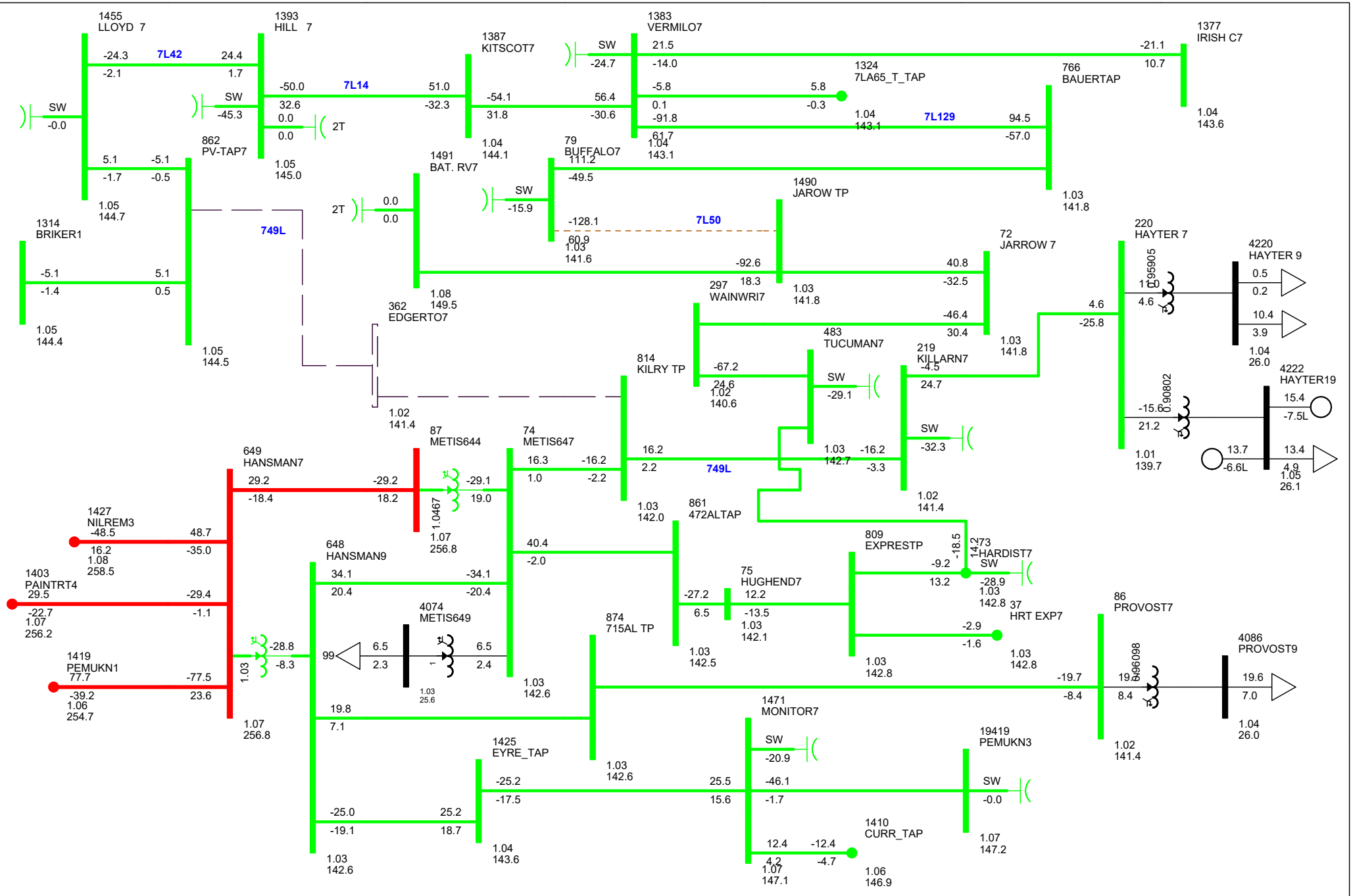
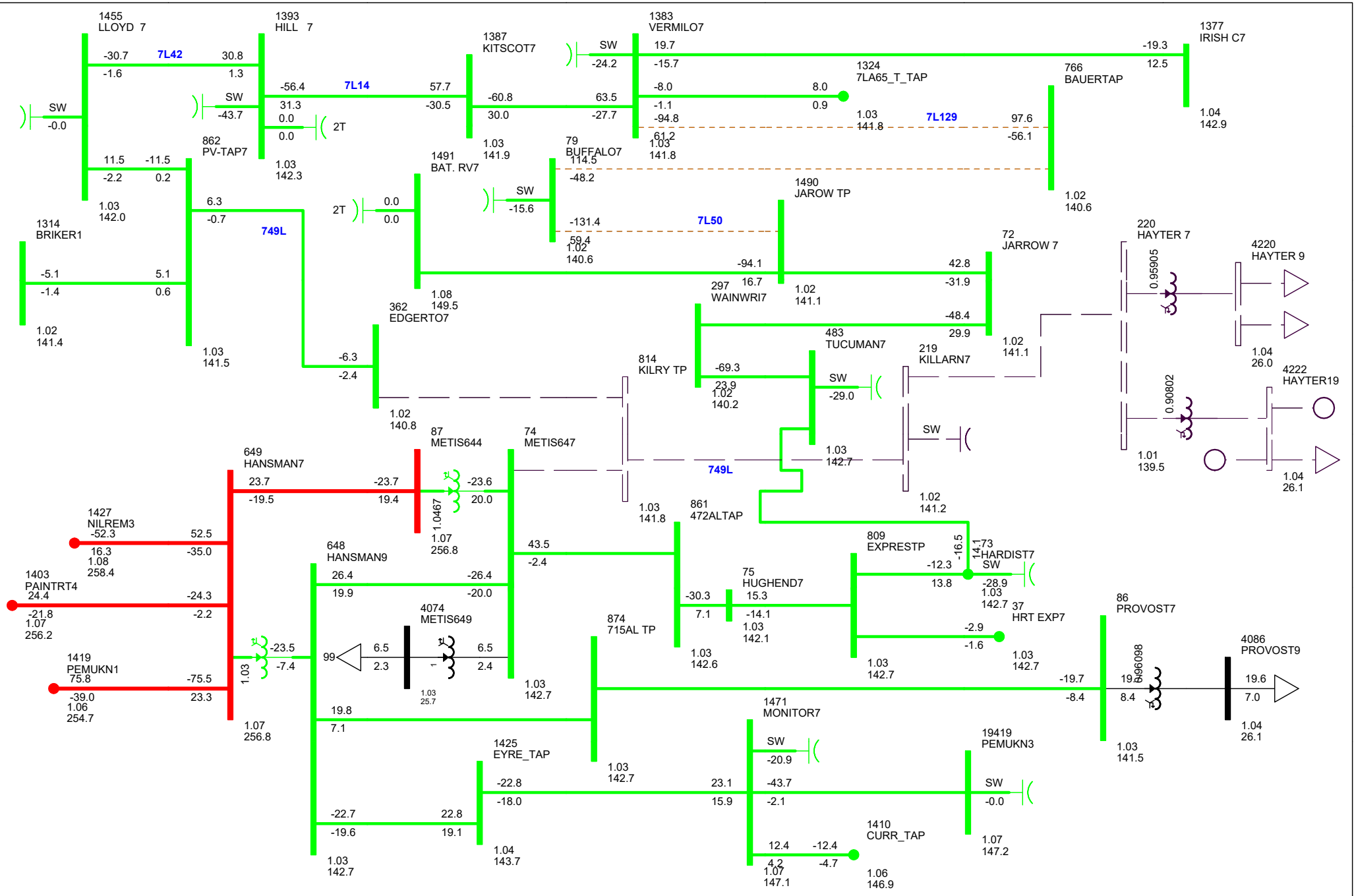
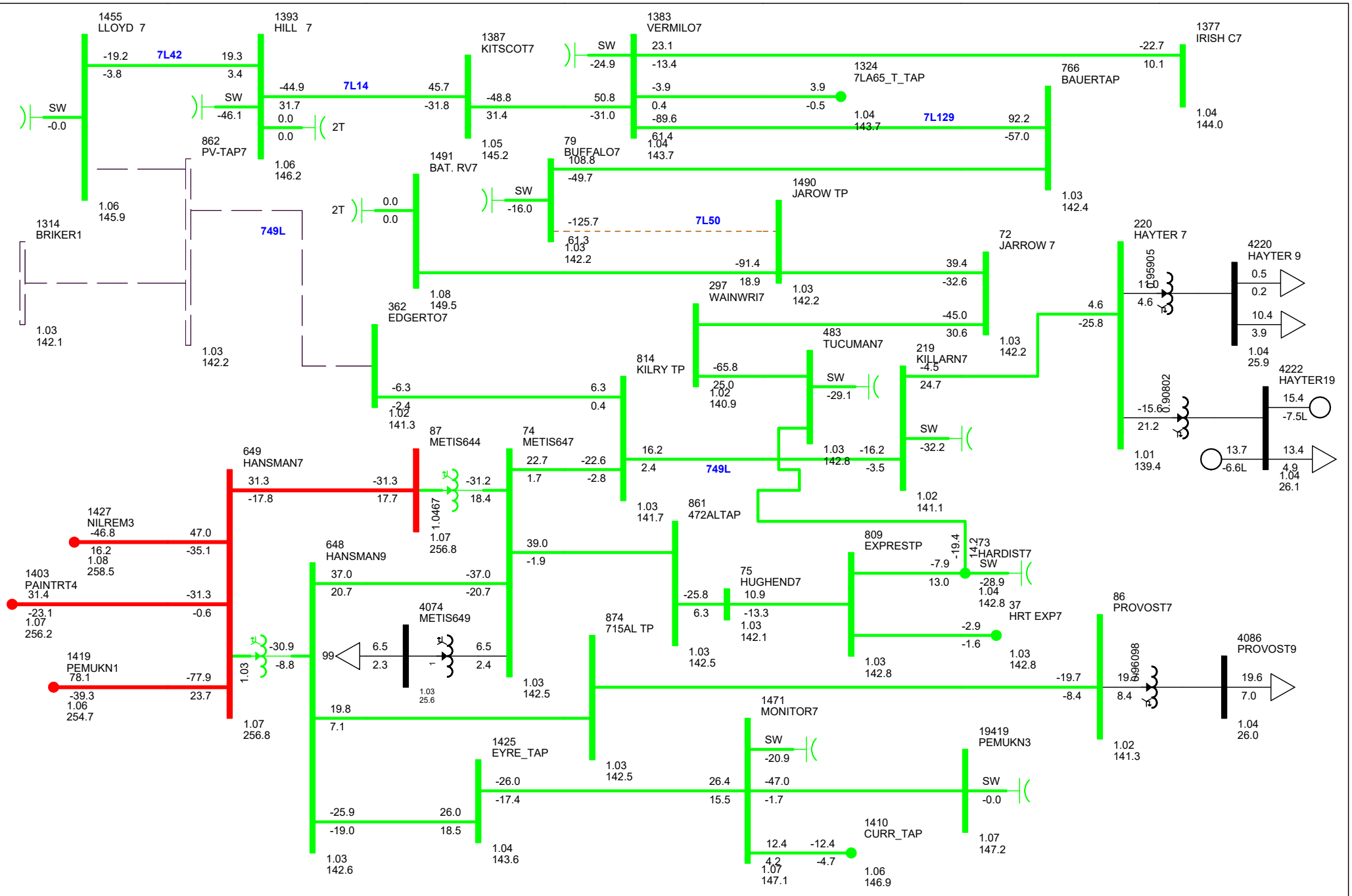
P1782 PRE-CONNECTION - DIAGRAM A2-14
N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S
WED, DEC 06 2017 11:38

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.125OV 0.899UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000


1455 LLOYD 7
1393 HILL 7
1387 KITSCOT7
1383 VERMILO7
1377 IRISH C7
1324 7LA65_T_TAP
766 BAUERTAP
7L42
7L14
7L129
862 PV-TAP7
1491 BAT. RV7
79 BUFFALO7
1490 JAROW TP
7L50
1314 BRIKER1
749L
362 EDGERTO7
72 JARROW 7
220 HAYTER 7
4220 HAYTER 9
4222 HAYTER19
297 WAINWRI7
483 TUCUMAN7
219 KILLARN7
814 KILRY TP
87 METIS644
74 METIS647
649 HANSMAN7
861 472ALTAP
809 EXPRESTP
273 HARDIST7
1427 NILREM3
1403 PAINTRT4
1419 PEMUKN1
648 HANSMAN9
4074 METIS649
75 HUGHEND7
874 715AL TP
37 HRT EXP7
86 PROVOST7
4086 PROVOST9
1471 MONITOR7
19419 PEMUKN3
1425 EYRE_TAP
1410 CURR_TAP
Provost Area Reliability
Project 1782
2020 SP
P1782 PRE-CONNECTION - DIAGRAM A2-15
N-1: EDGERTON 899S 138/25 KV TRANSFORMER
WED, DEC 06 2017 11:38
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.125OV 0.899UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-16 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S WED, DEC 06 2017 11:38	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



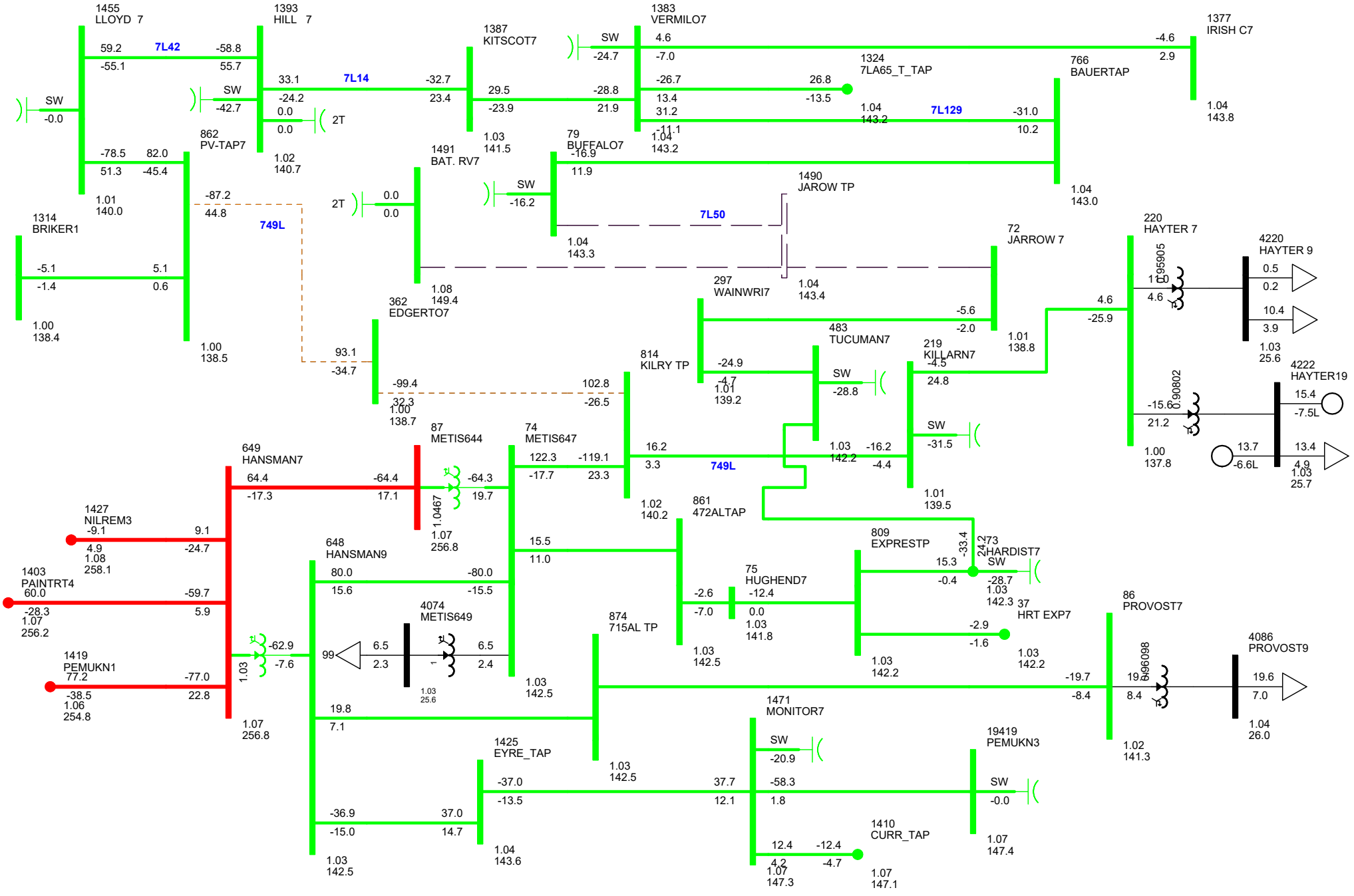
Provost Area Reliability

Project 1782

2020 SP

P1782 PRE-CONNECTION - DIAGRAM A2-17
N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S
WED, DEC 06 2017 11:38

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.125OV 0.899UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



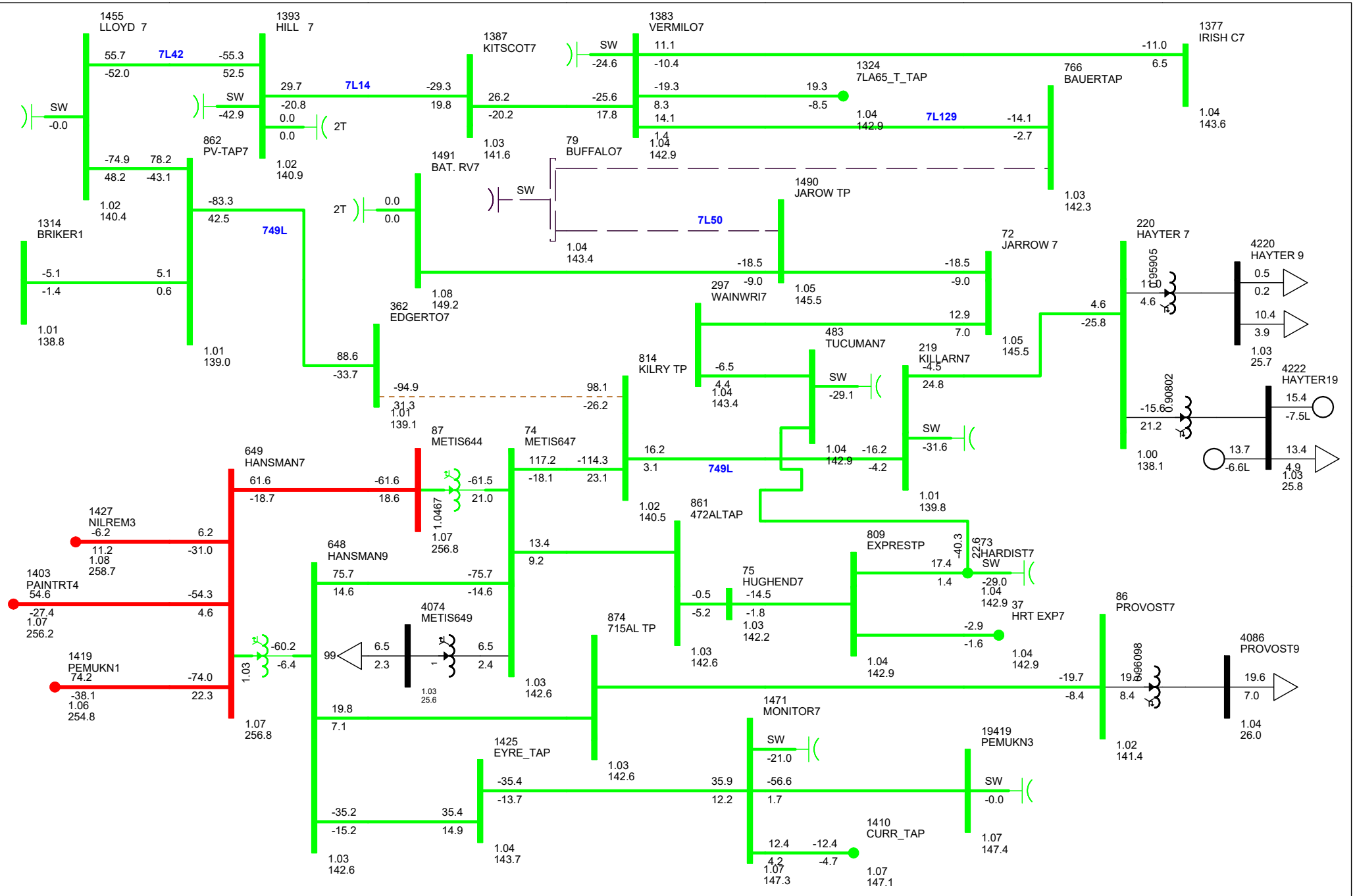
Provost Area Reliability

Project 1782

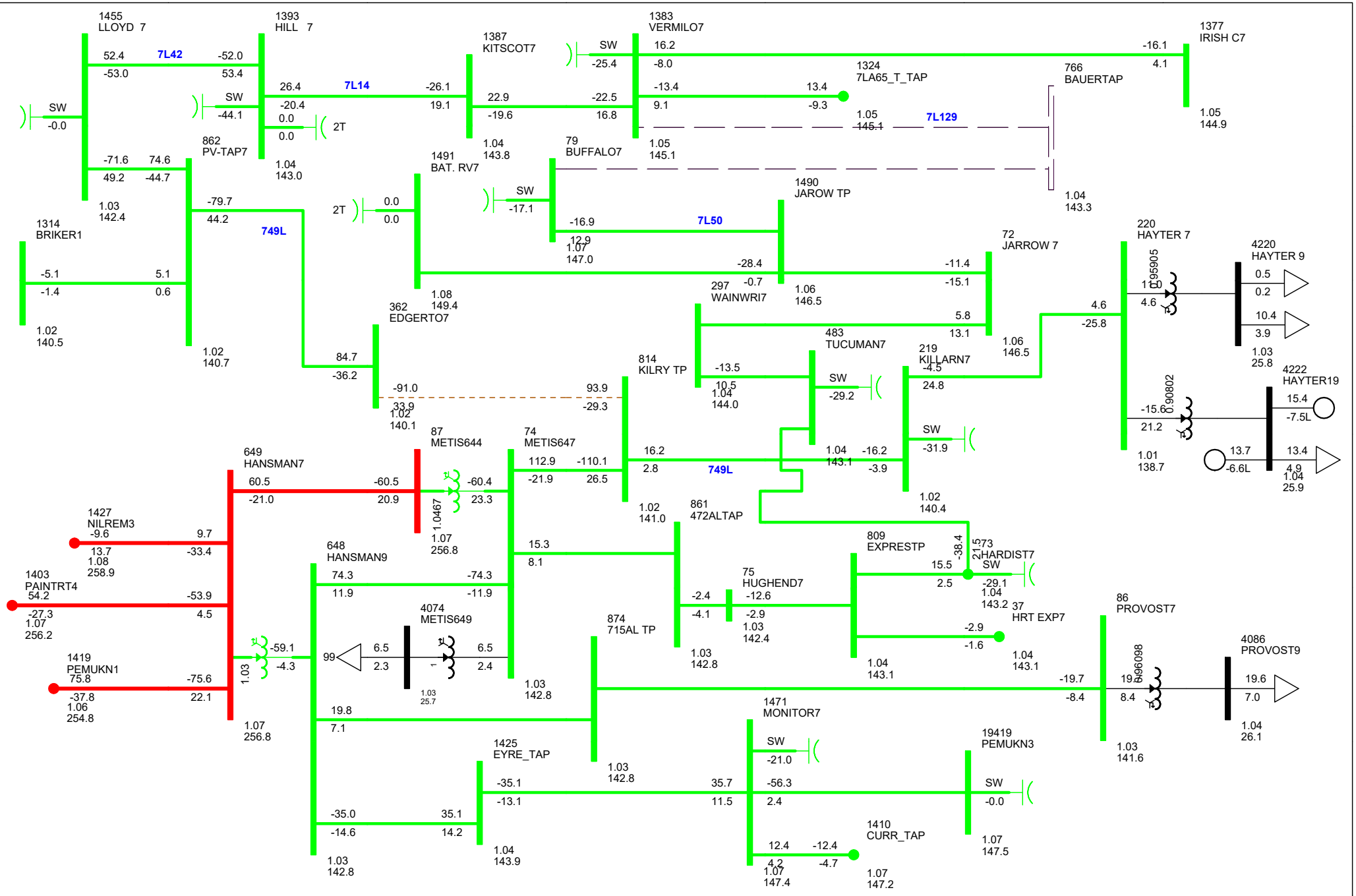
2020 SP

P1782 PRE-CONNECTION - DIAGRAM A2-18
N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S
WED, DEC 06 2017 11:38

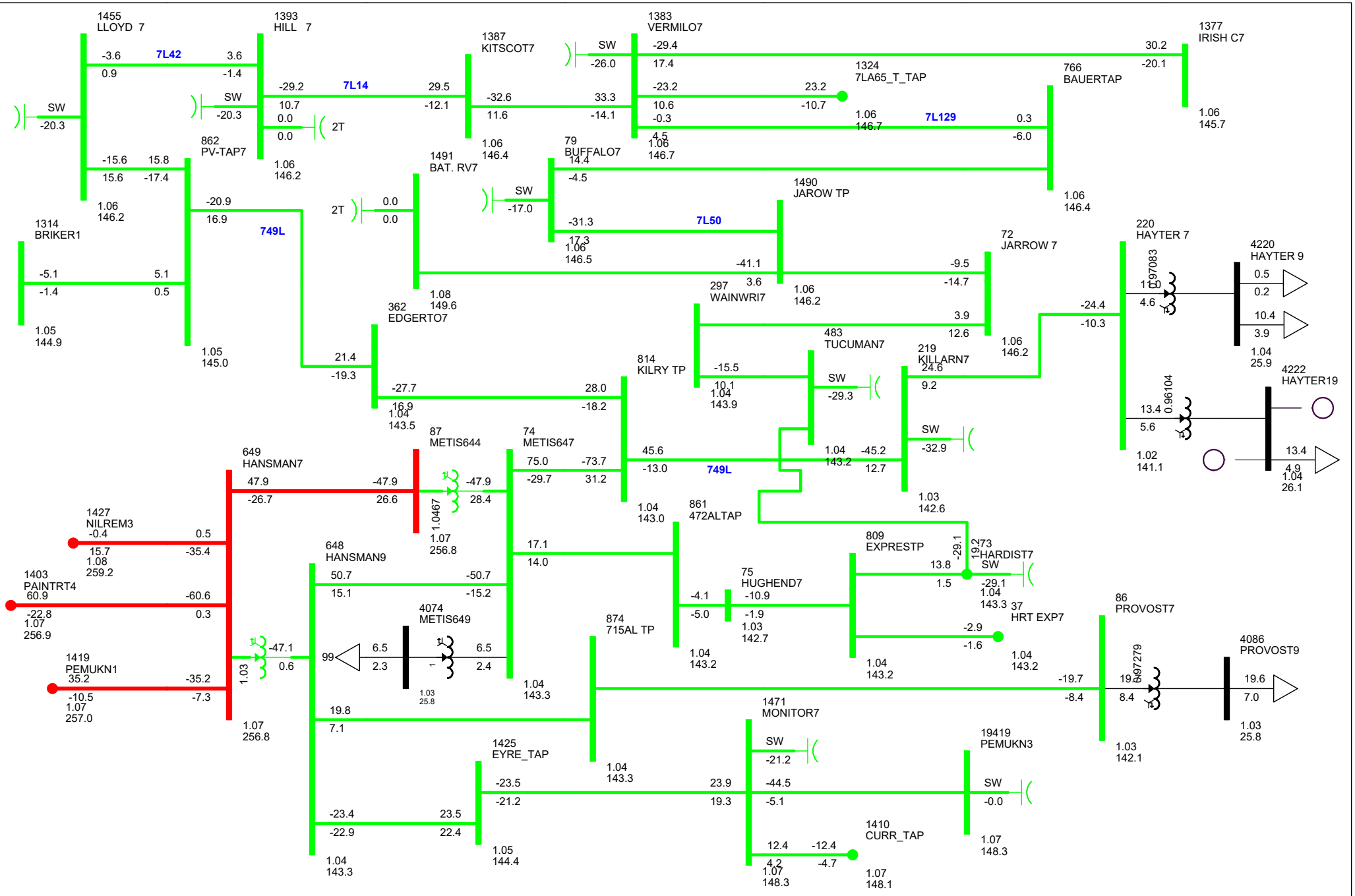
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.125OV 0.899UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



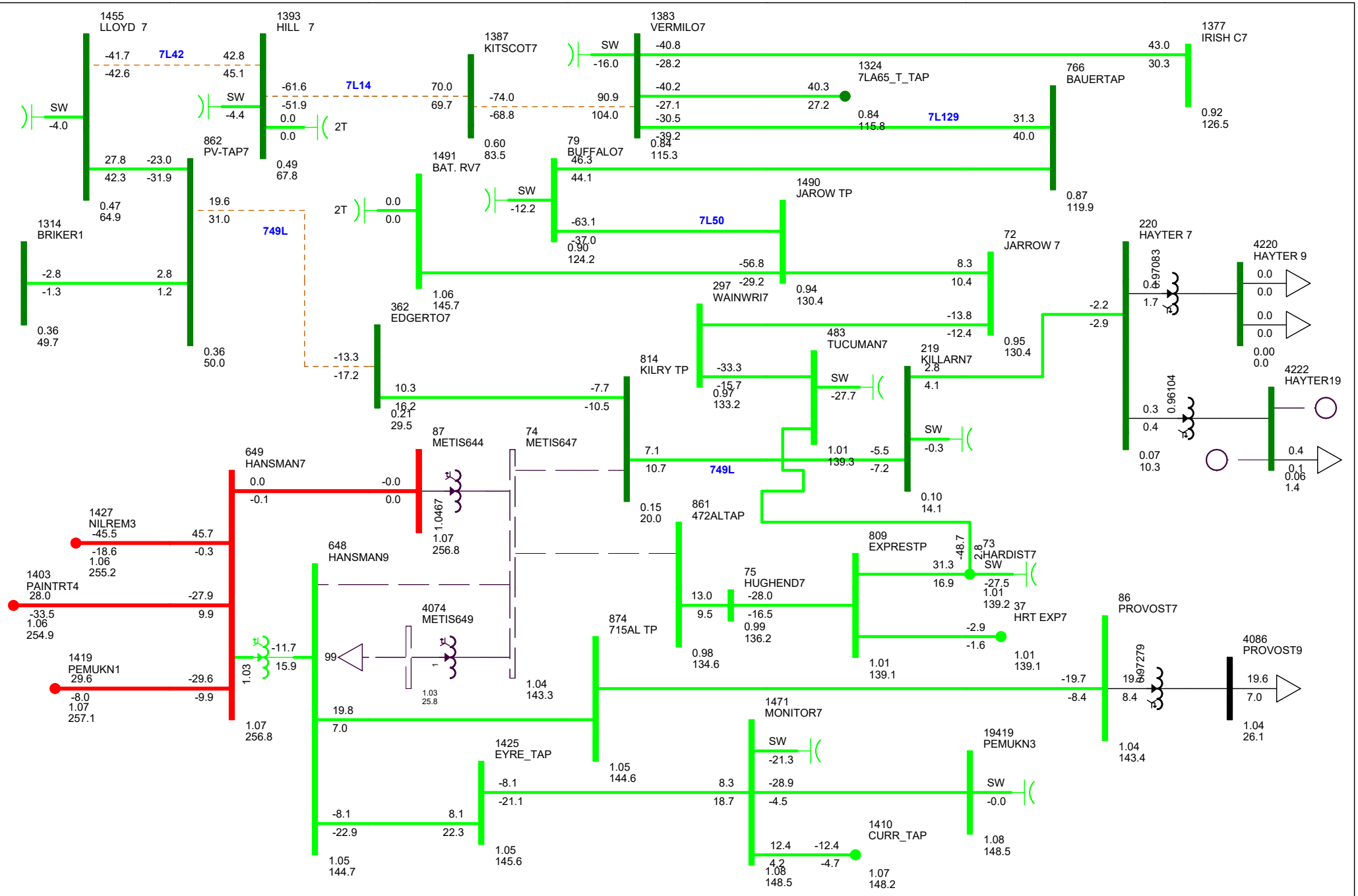
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-19 N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER WED, DEC 06 2017 11:38	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



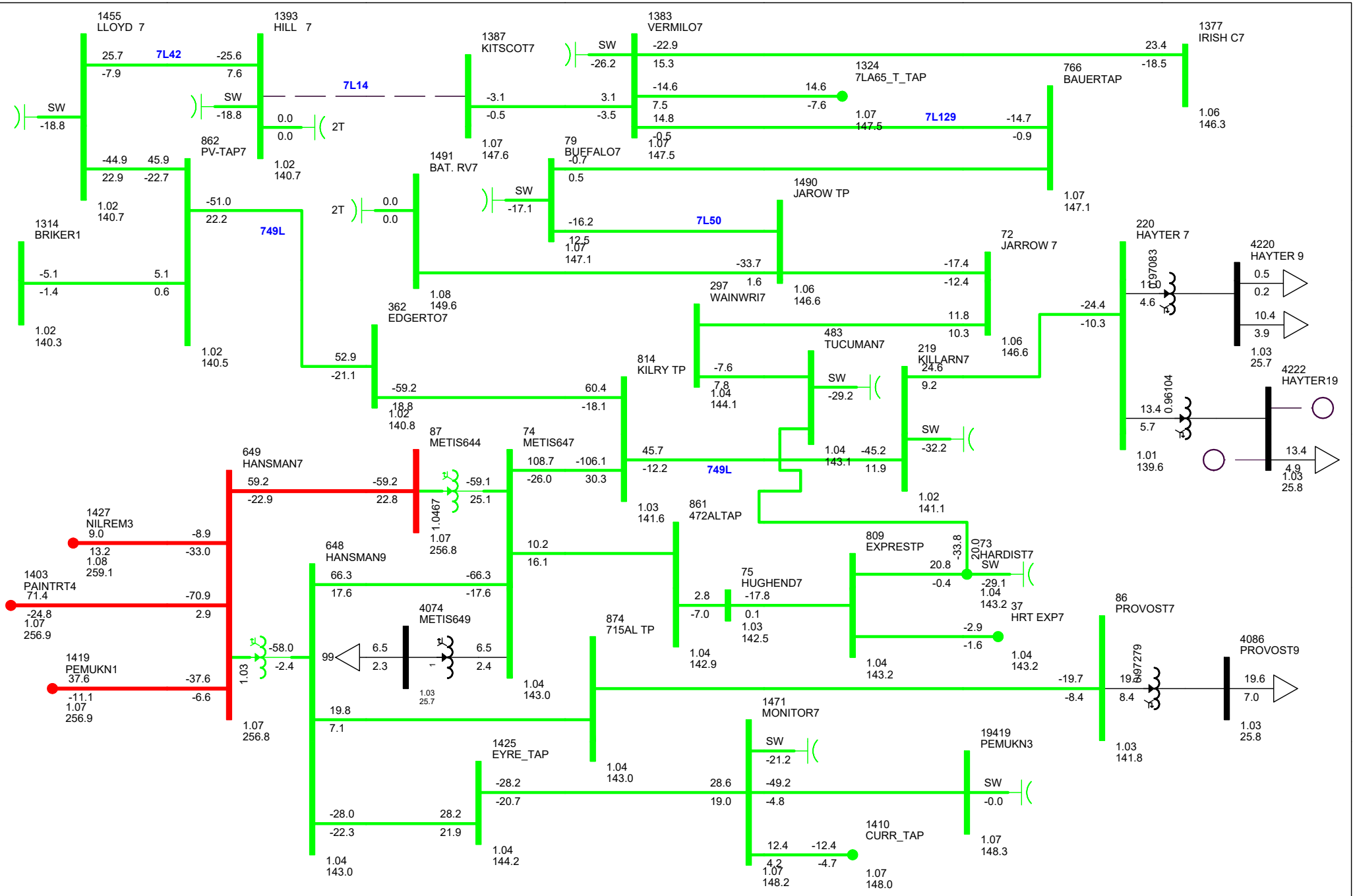
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-20 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S WED, DEC 06 2017 11:39	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



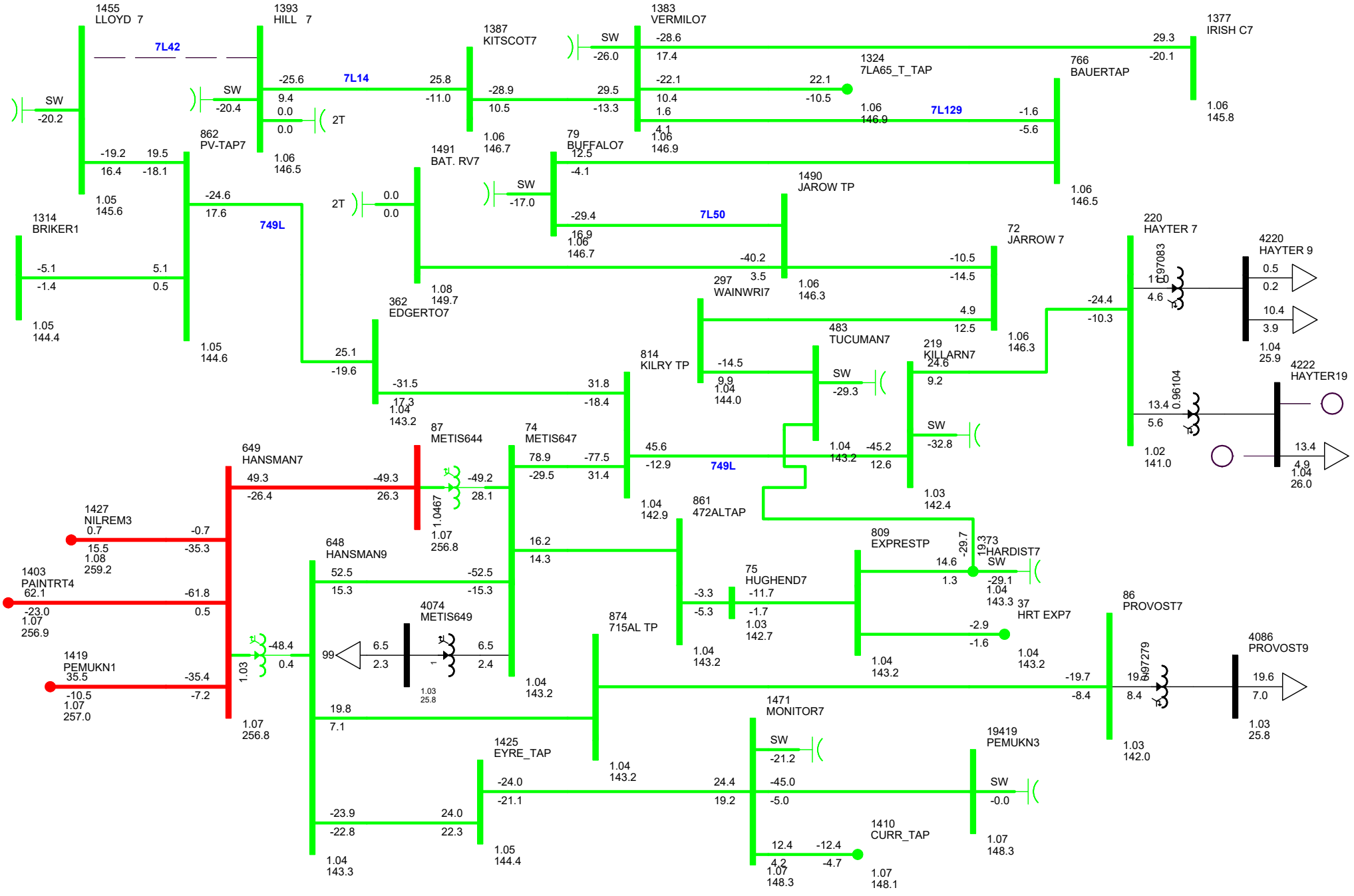
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-21 N-0: NORMAL OPERATION THU, JAN 25 2018 18:05	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



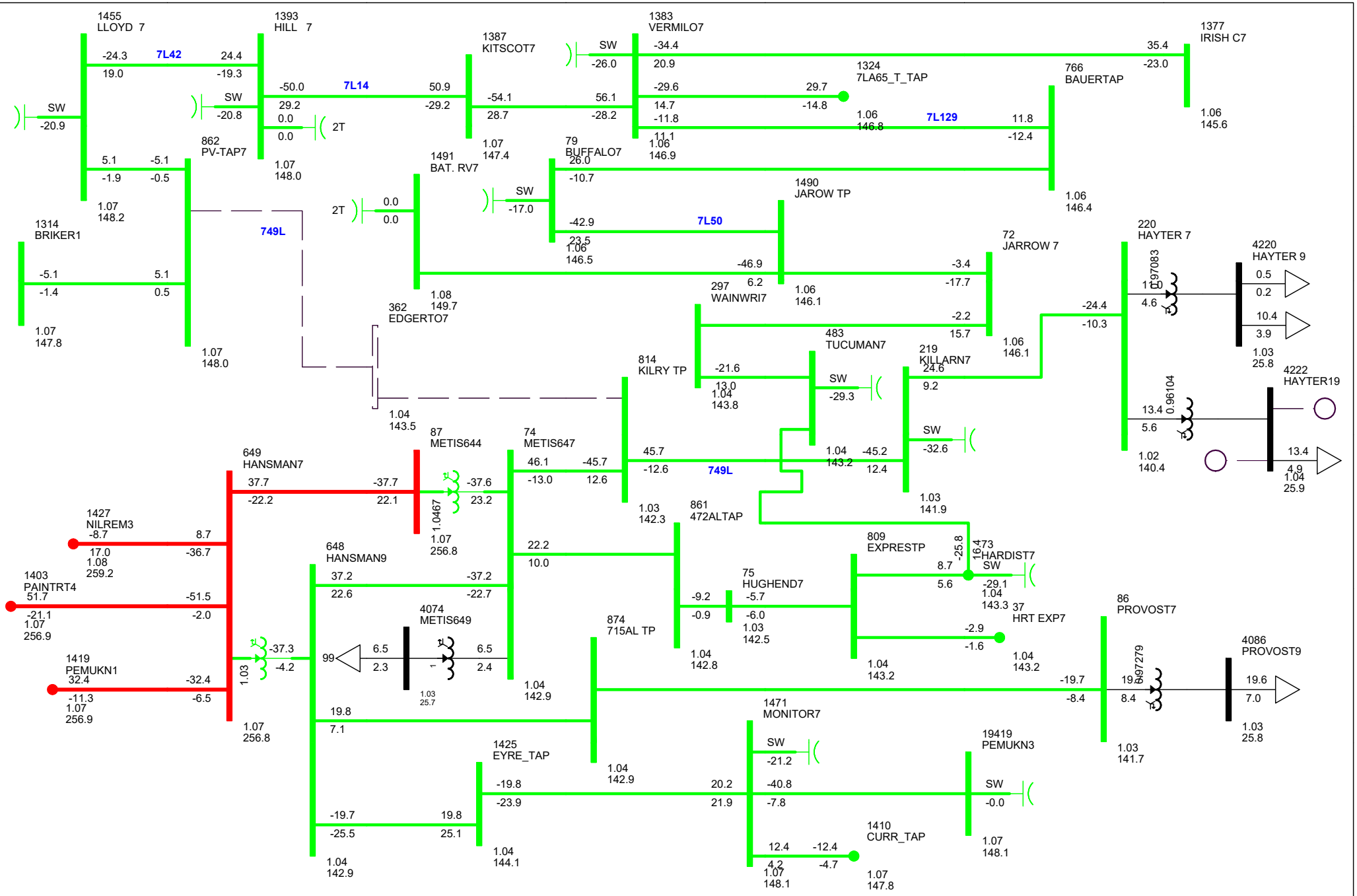
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-22 N-1: METISKOW 648S 138/25 KV TRANSFORMER THU, JAN 25 2018 18:05	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-23 N-1: 7L14 KITSCOTY 705S TO HILL 751S THU, JAN 25 2018 18:05	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-24 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S THU, JAN 25 2018 18:05	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



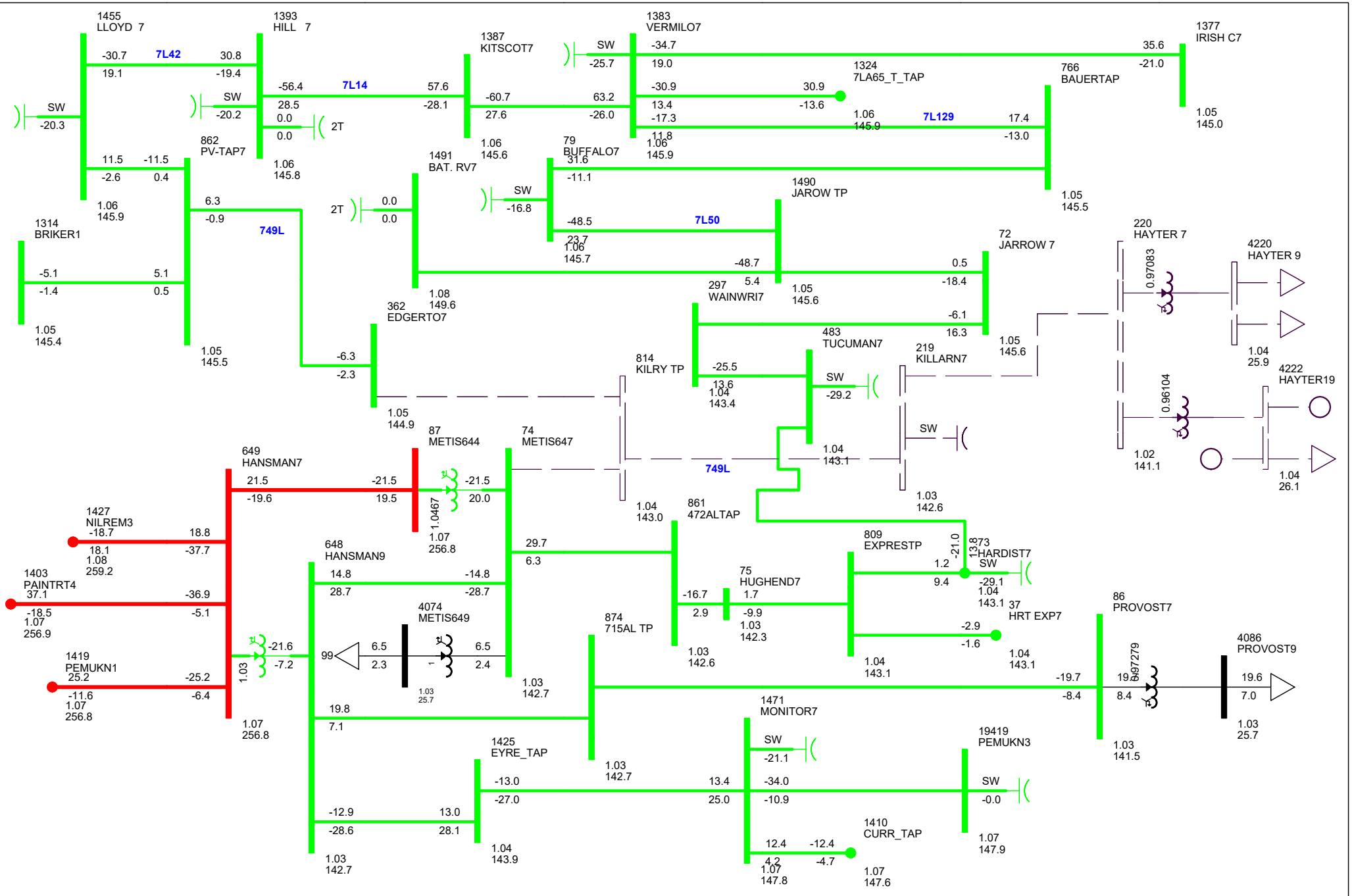
Provost Area Reliability

Project 1782

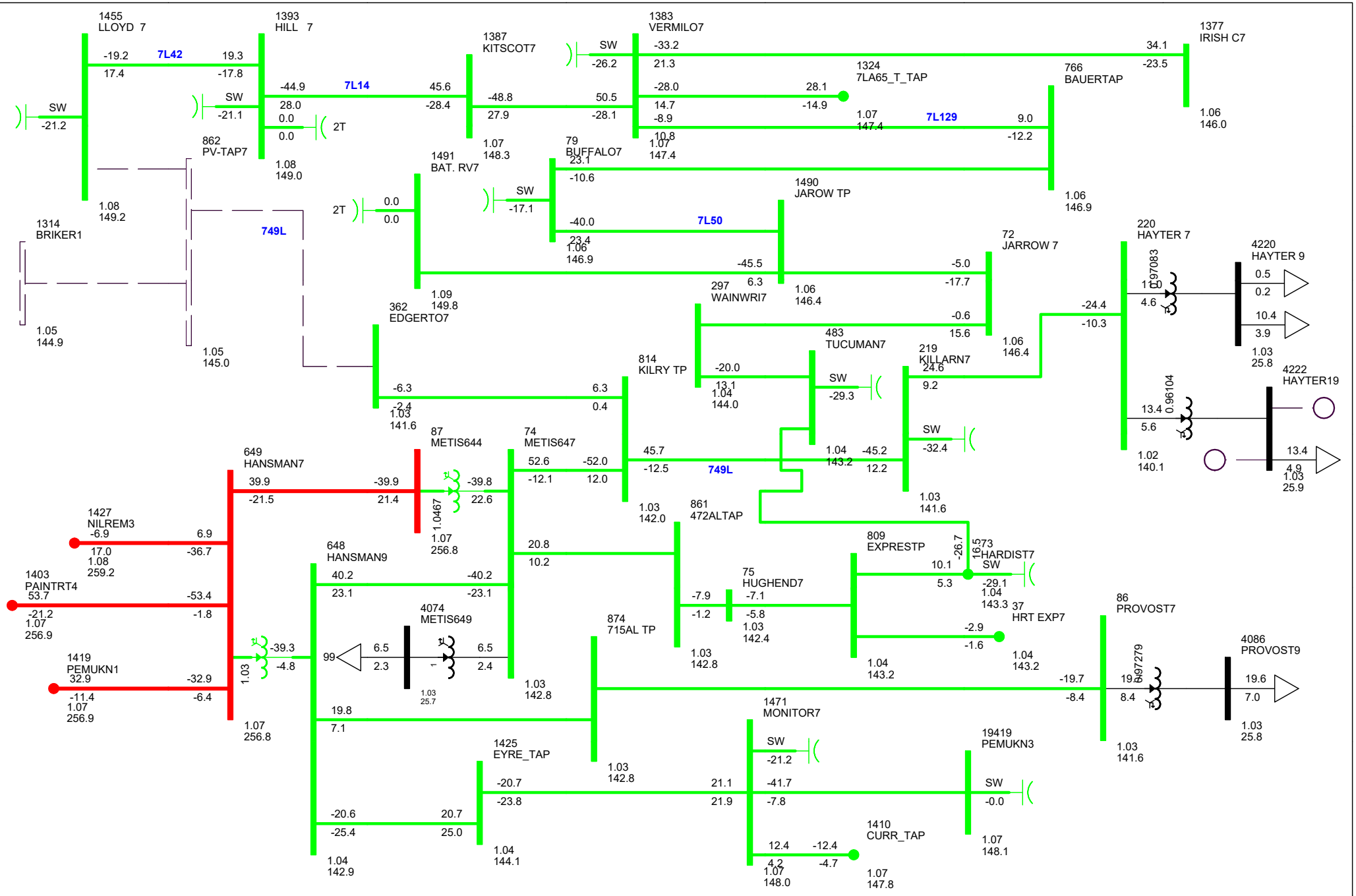
2020 SP

P1782 PRE-CONNECTION - DIAGRAM A2-25
N-1: EDGERTON 899S 138/25 KV TRANSFORMER
THU, JAN 25 2018 18:06

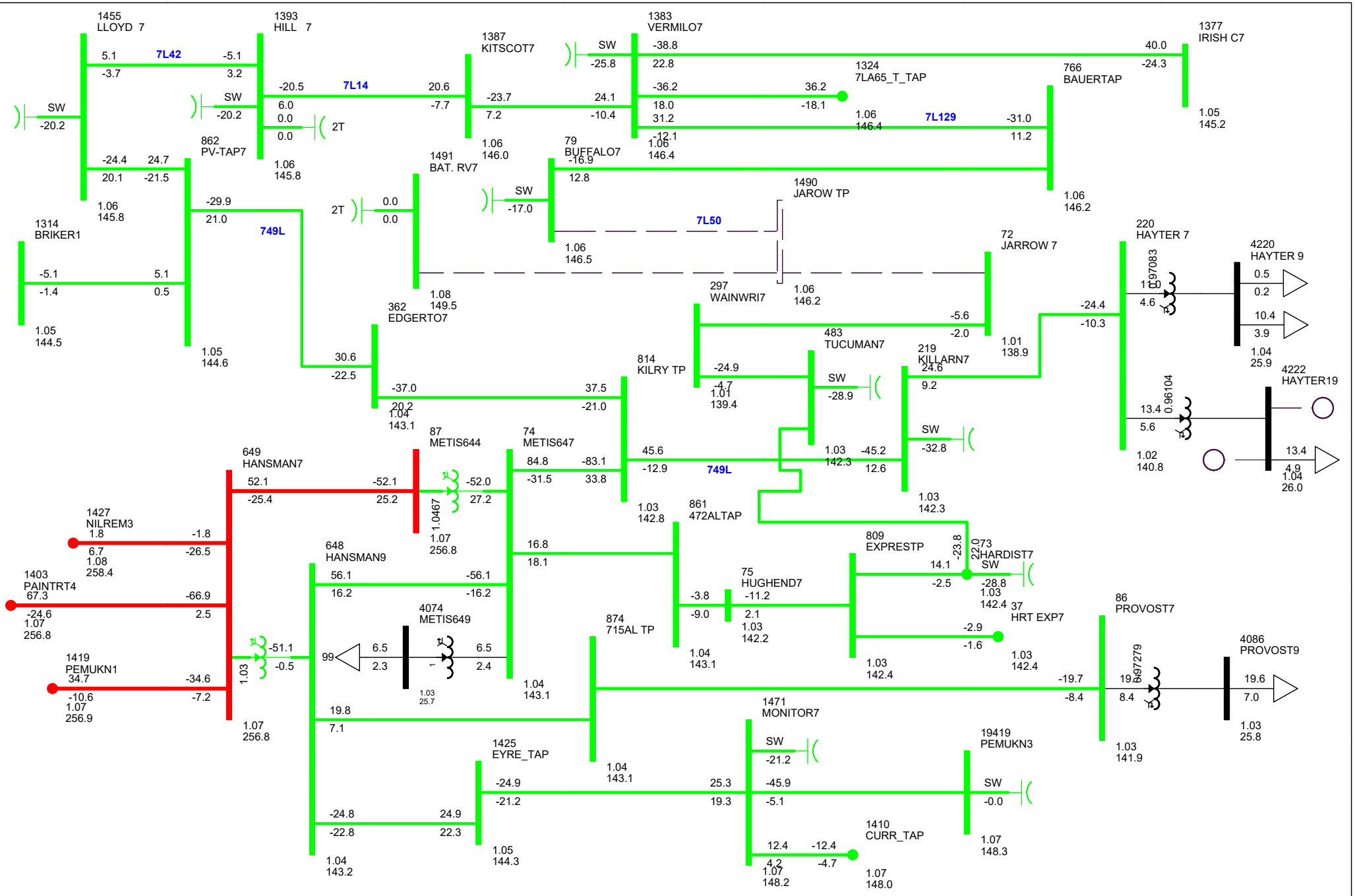
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.125OV 0.899UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



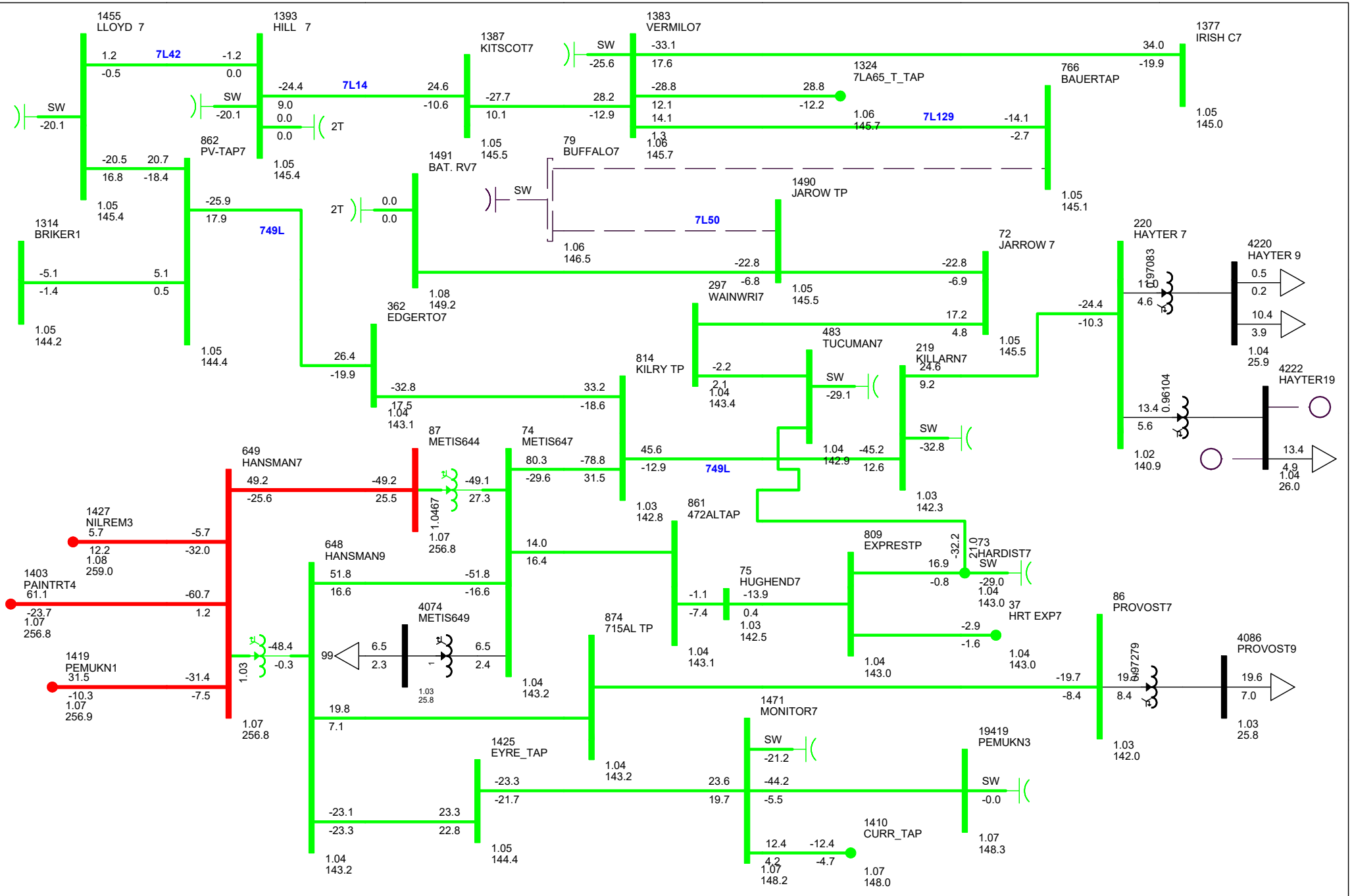
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-26 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S THU, JAN 25 2018 18:06	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-27 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S THU, JAN 25 2018 18:06	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-28 N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S THU, JAN 25 2018 18:06	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



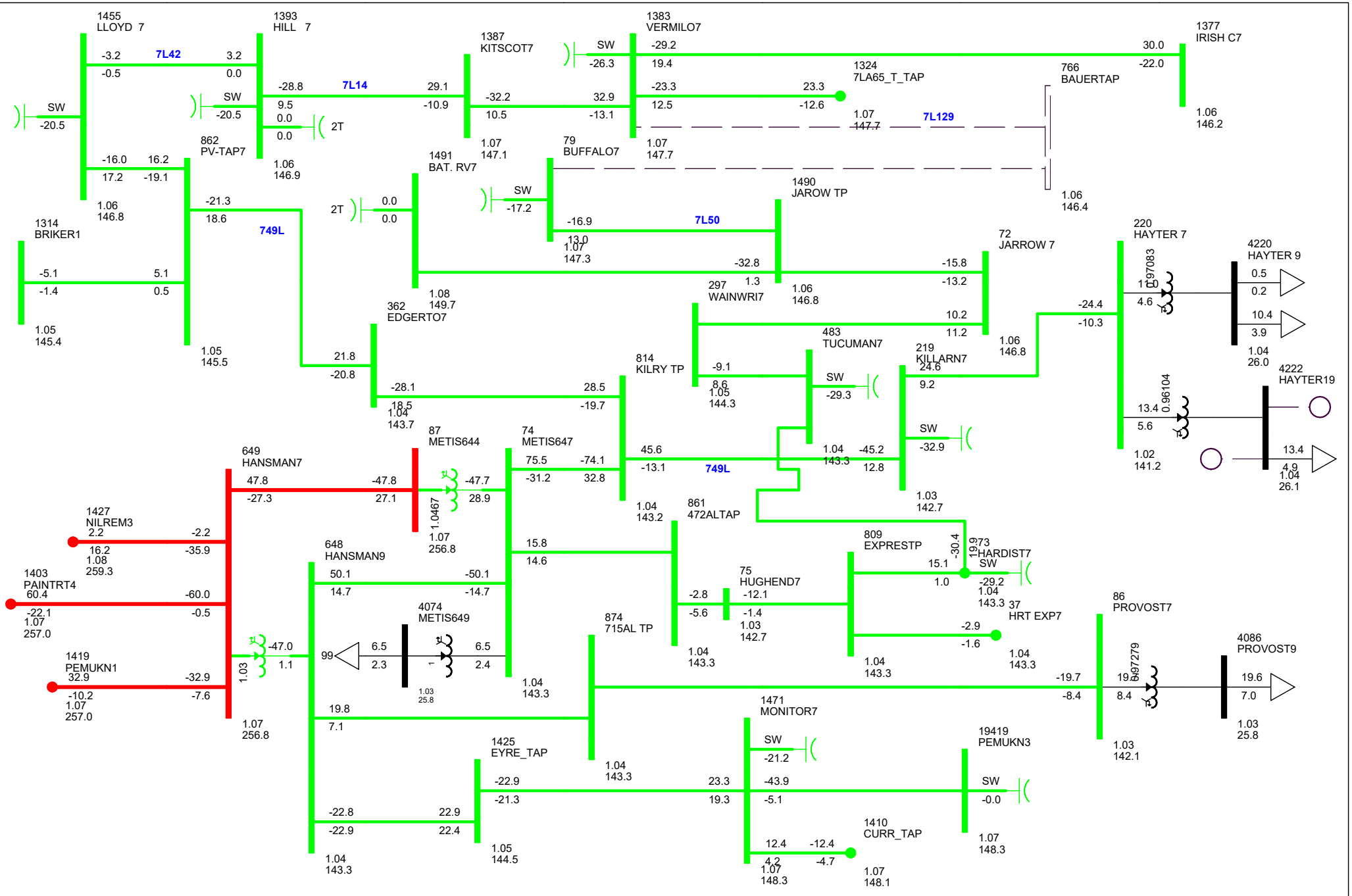
Provost Area Reliability

Project 1782

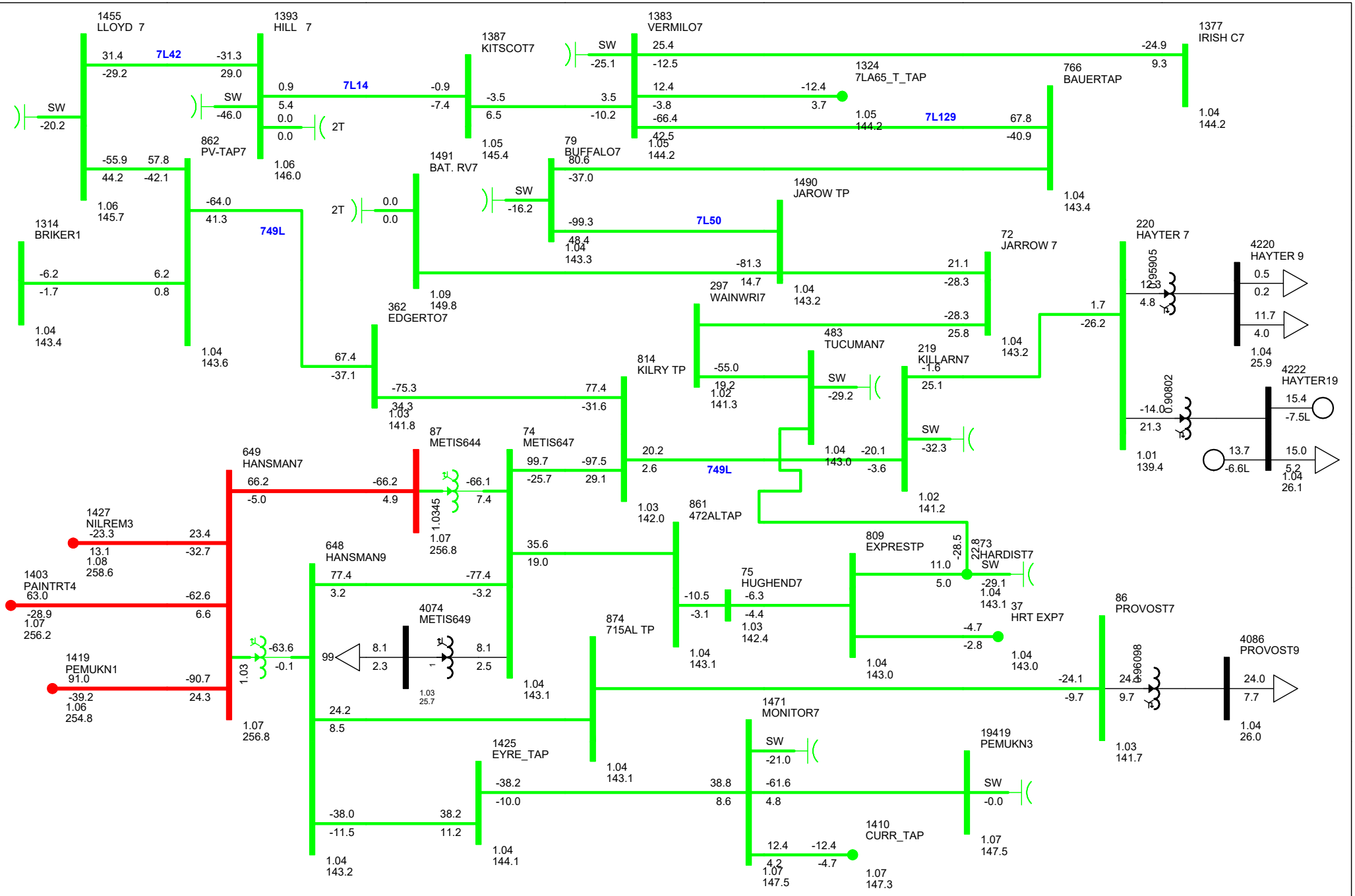
2020 SP

P1782 PRE-CONNECTION - DIAGRAM A2-29
N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER
THU, JAN 25 2018 18:07

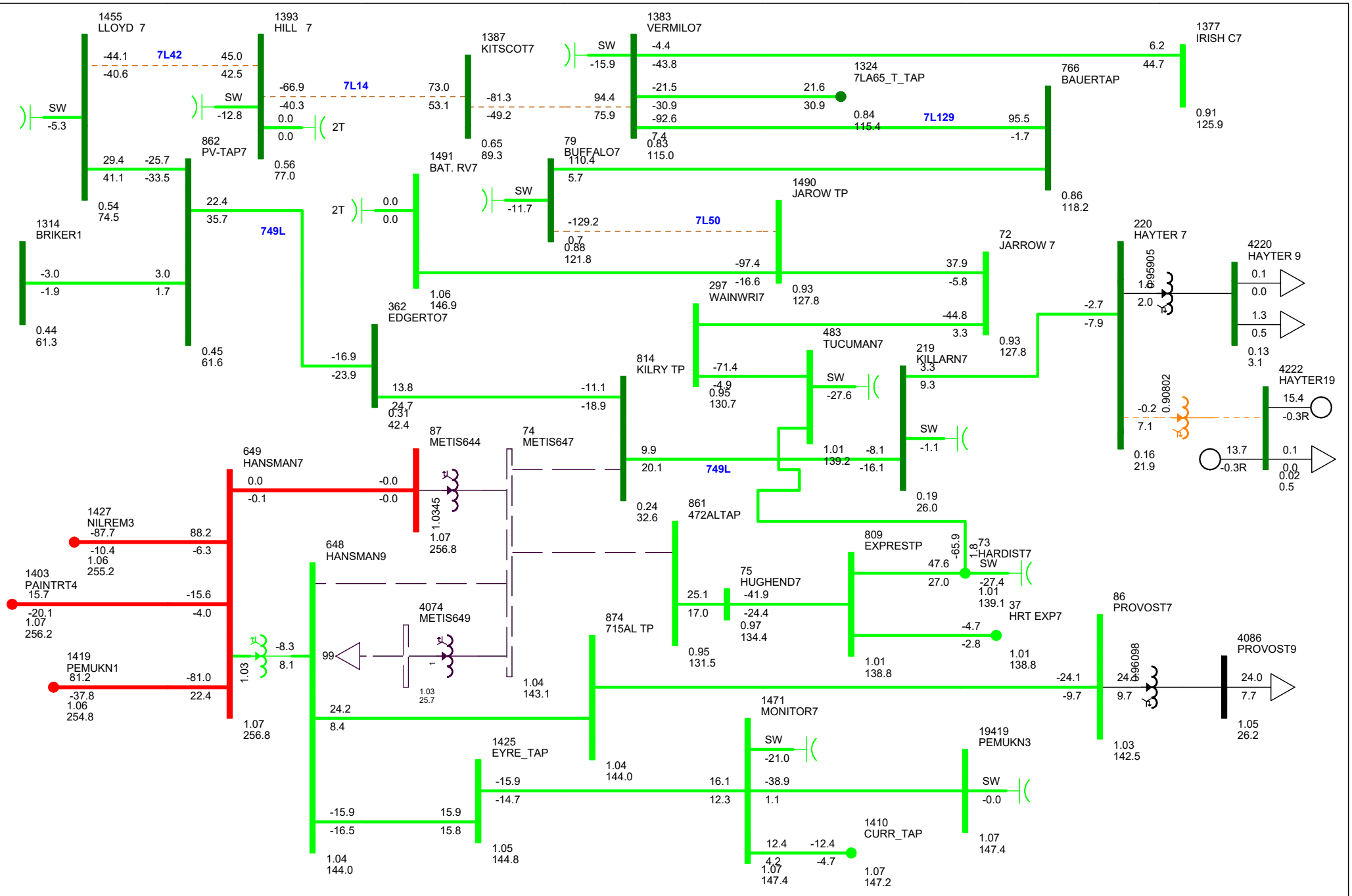
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.125OV 0.899UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



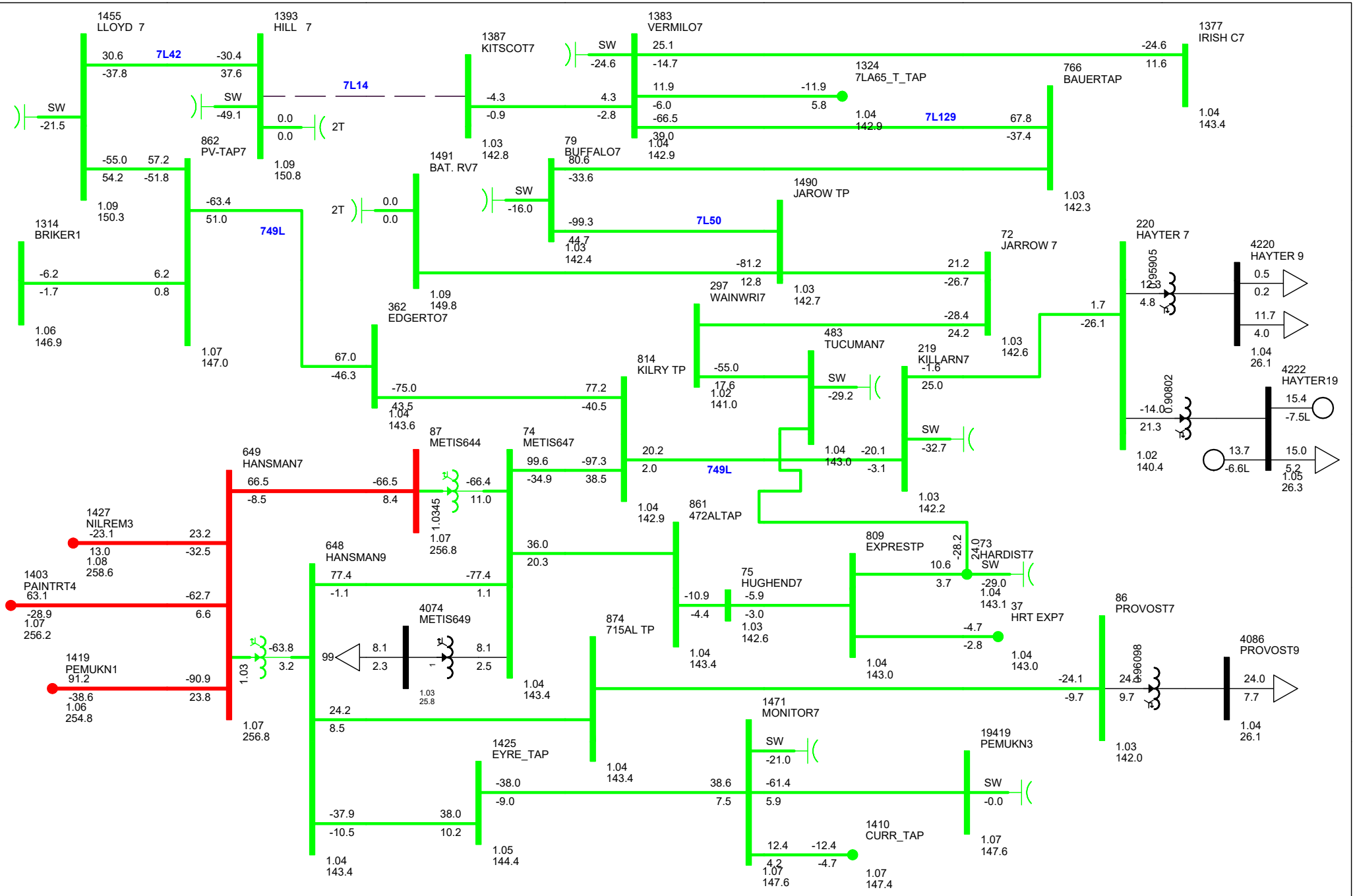
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A2-30 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S THU, JAN 25 2018 18:07	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-31 N-0: NORMAL OPERATION THU, JAN 25 2018 17:58	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-32 N-1: METISKOW 648S 138/25 KV TRANSFORMER THU, JAN 25 2018 17:59	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



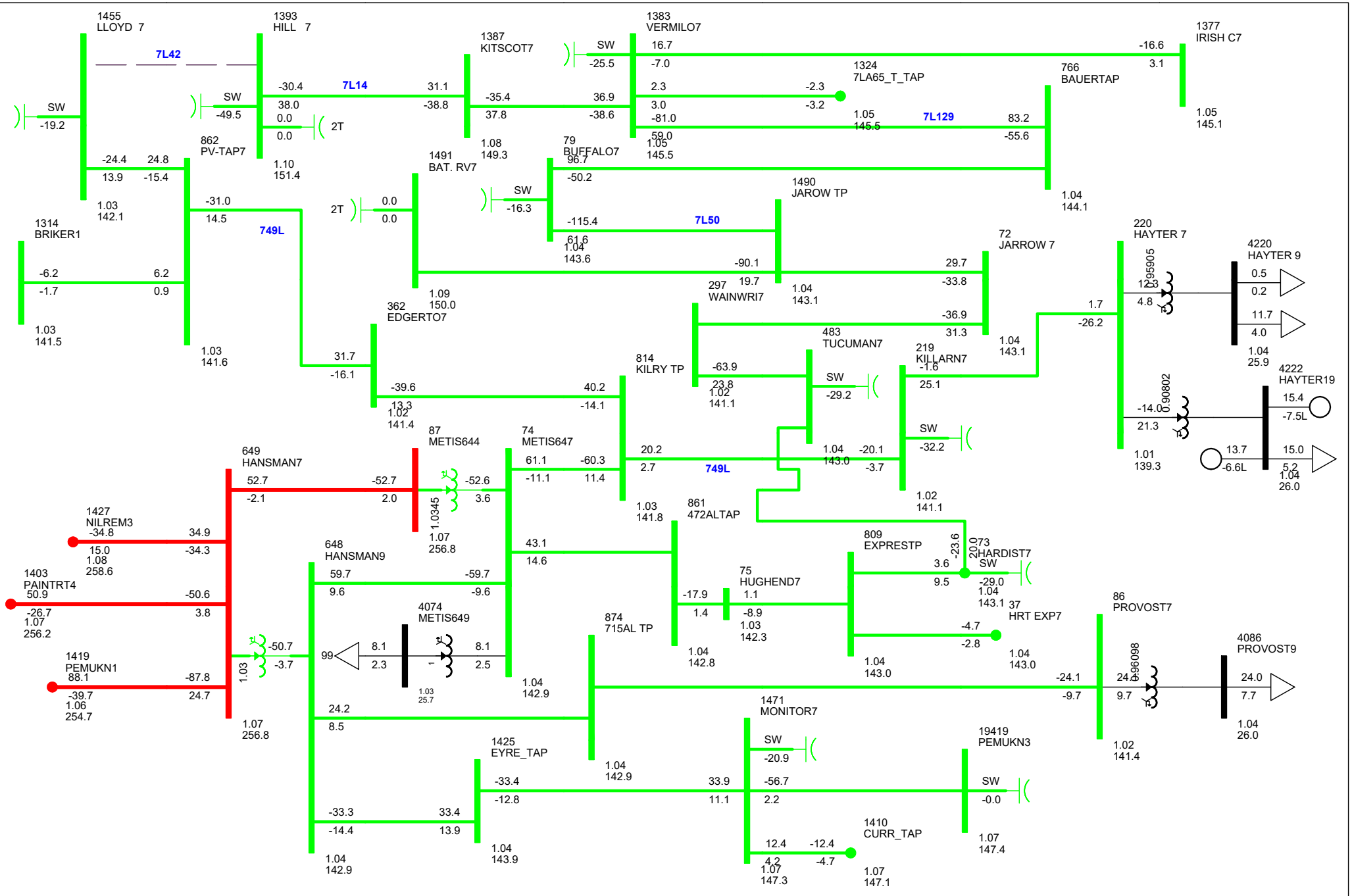
Provost Area Reliability

Project 1782

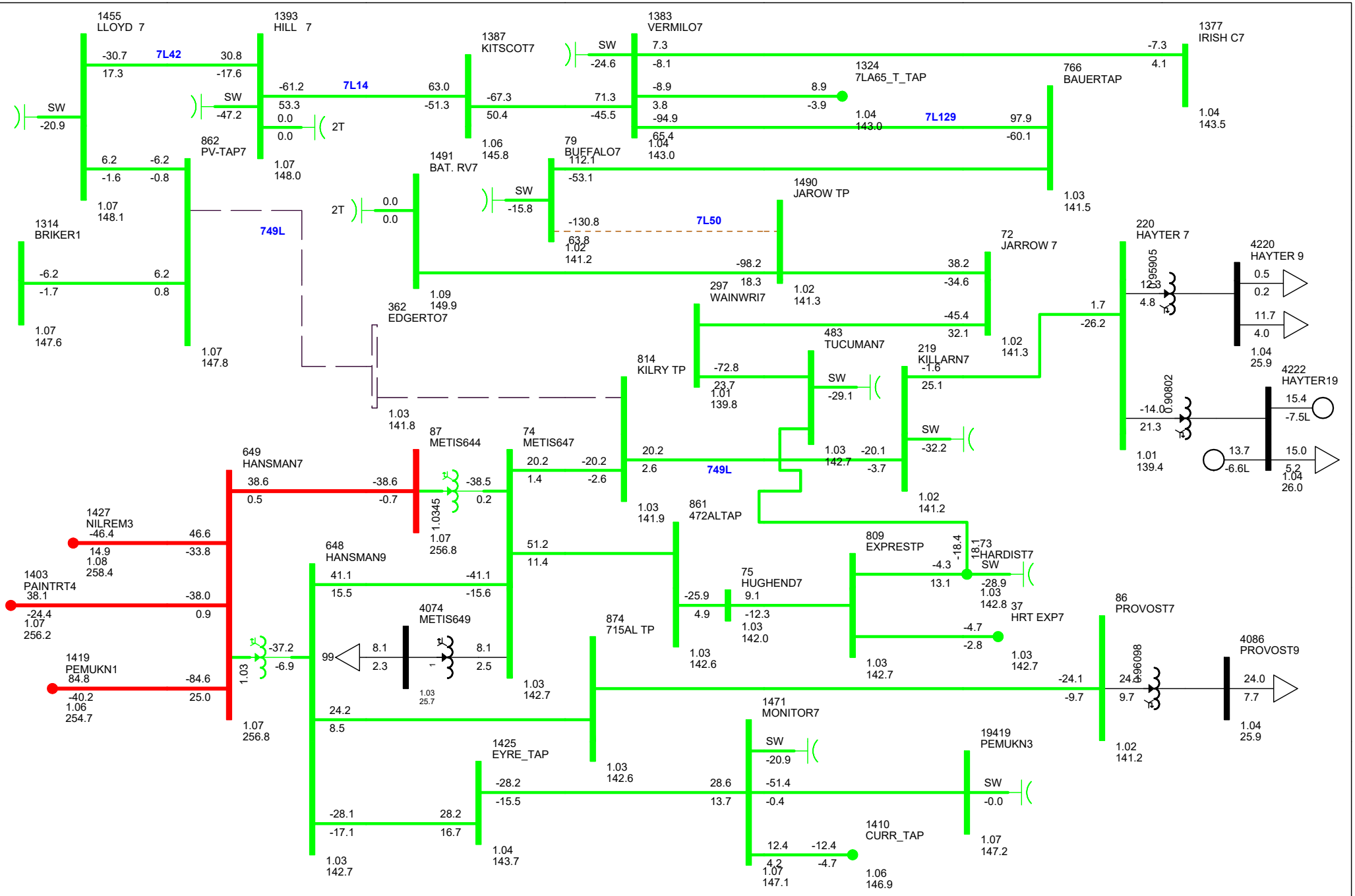
2020 WP

P1782 PRE-CONNECTION - DIAGRAM A2-33
N-1: 7L14 KITSCOTY 705S TO HILL 751S
THU, JAN 25 2018 17:59

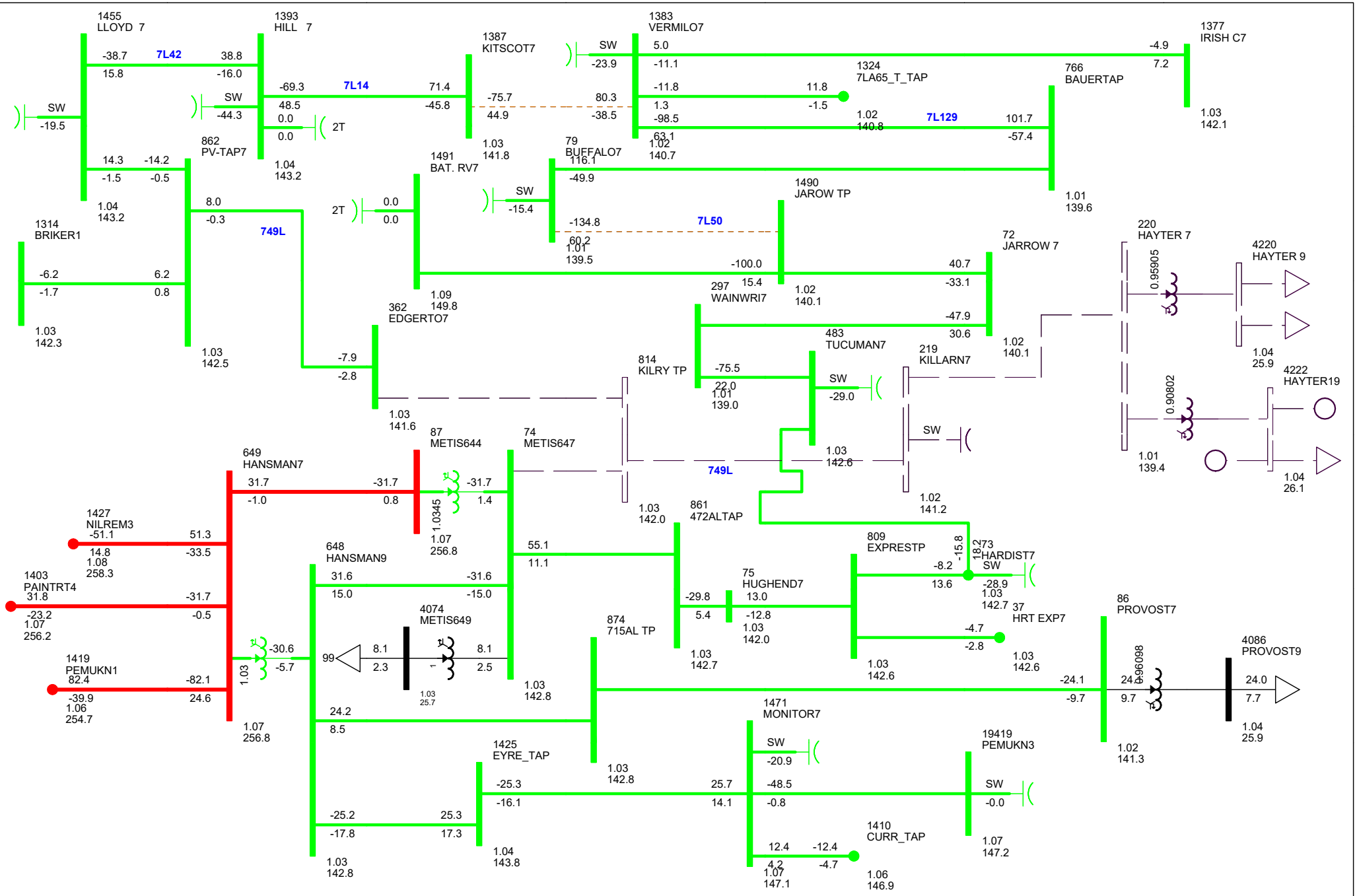
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.125OV 0.899UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



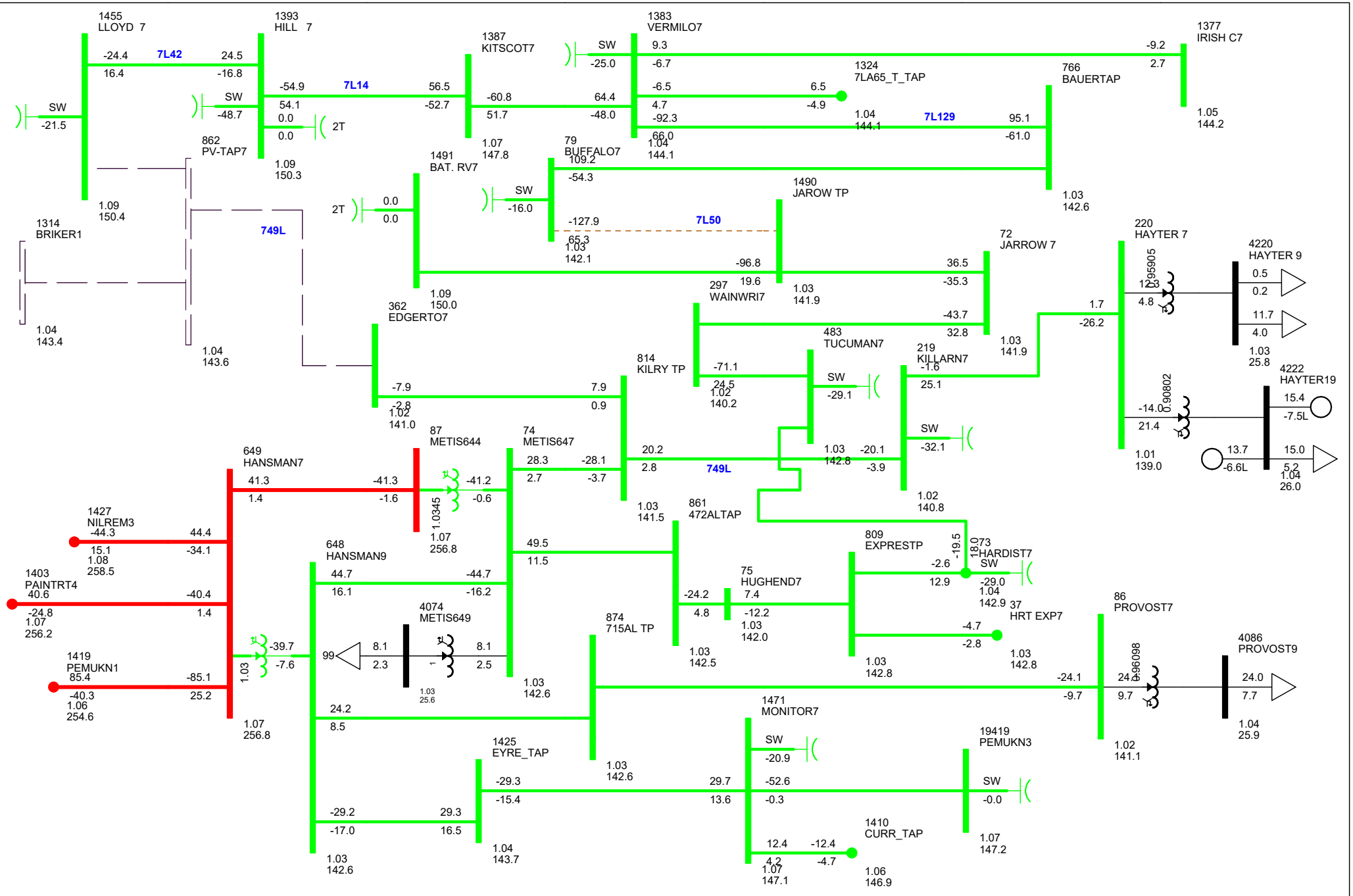
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-34 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S THU, JAN 25 2018 18:00	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



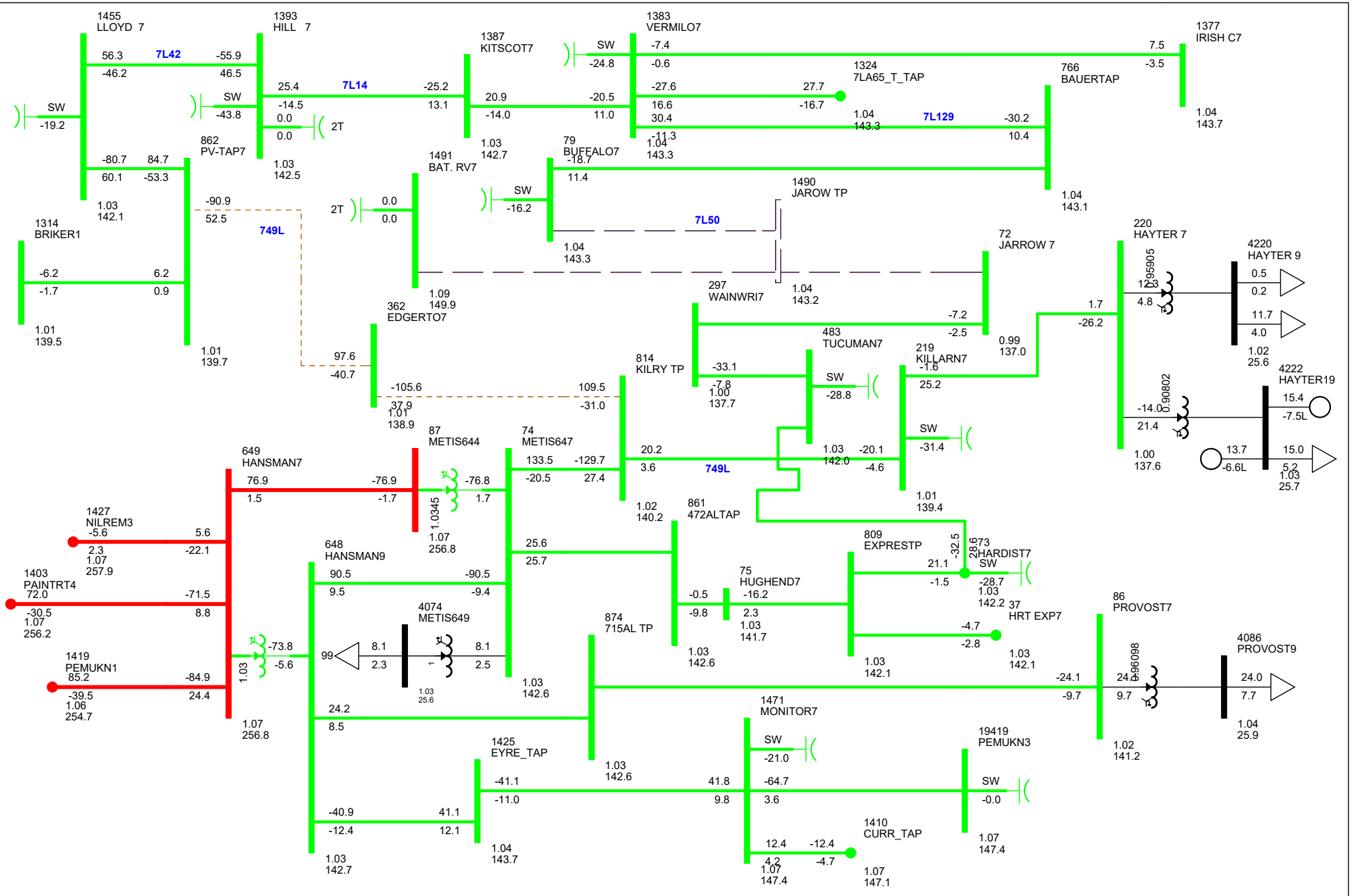
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-35 N-1: EDGERTON 899S 138/25 KV TRANSFORMER THU, JAN 25 2018 18:00	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



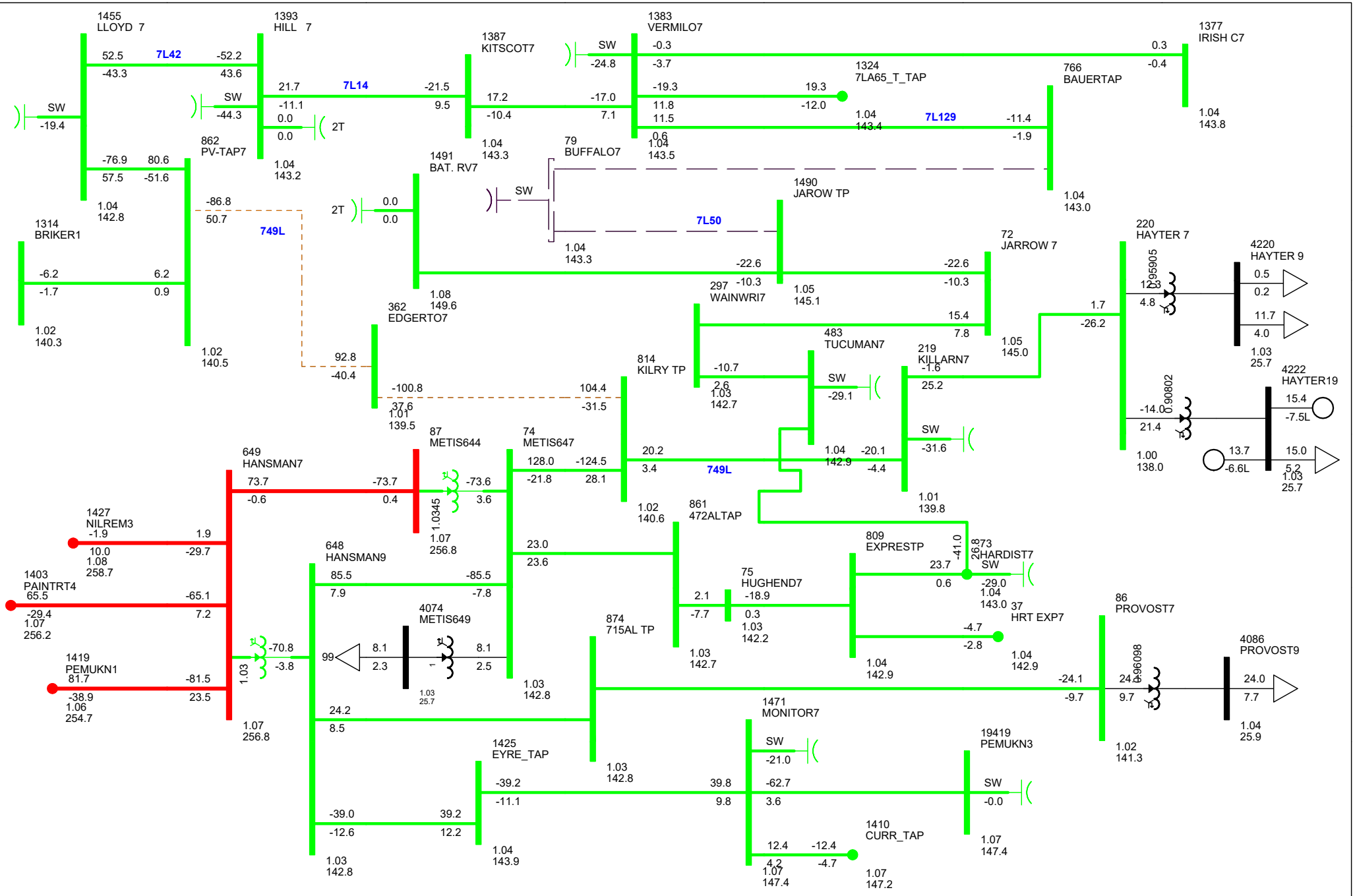
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-36 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S THU, JAN 25 2018 18:00	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-37 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S THU, JAN 25 2018 18:00	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-38 N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S THU, JAN 25 2018 18:01	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



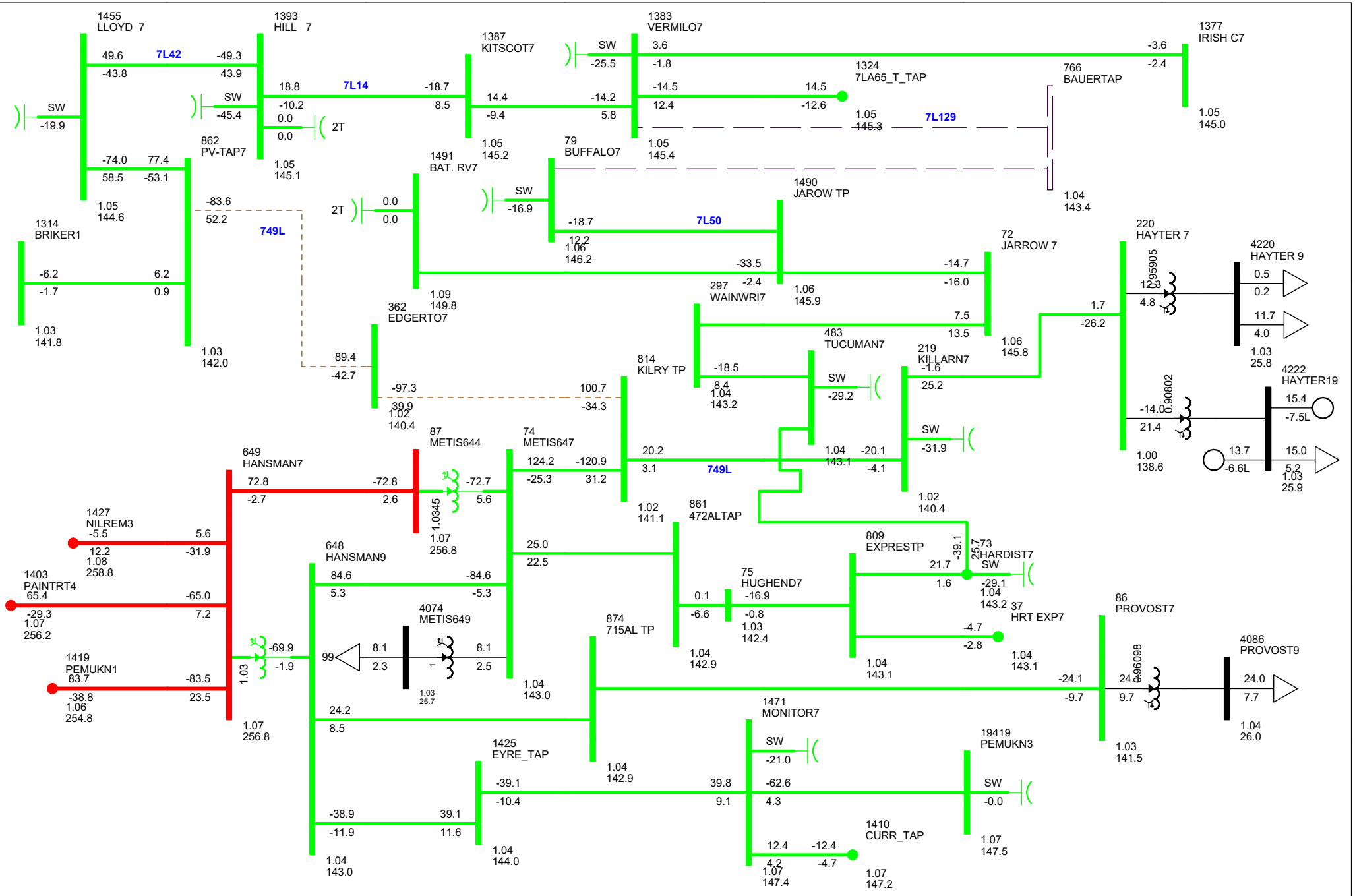
Provost Area Reliability

Project 1782

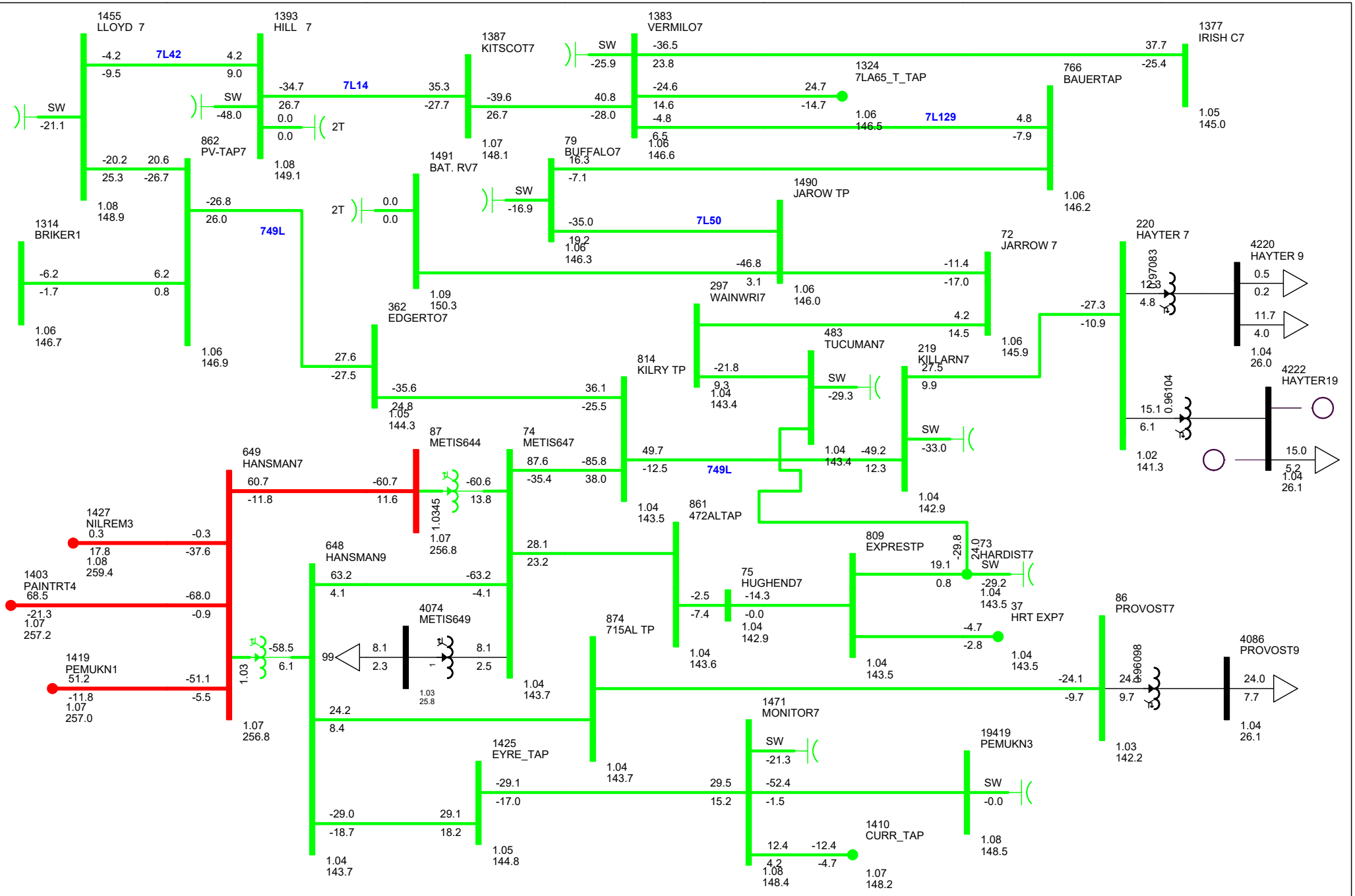
2020 WP

P1782 PRE-CONNECTION - DIAGRAM A2-39
N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER
THU, JAN 25 2018 18:01

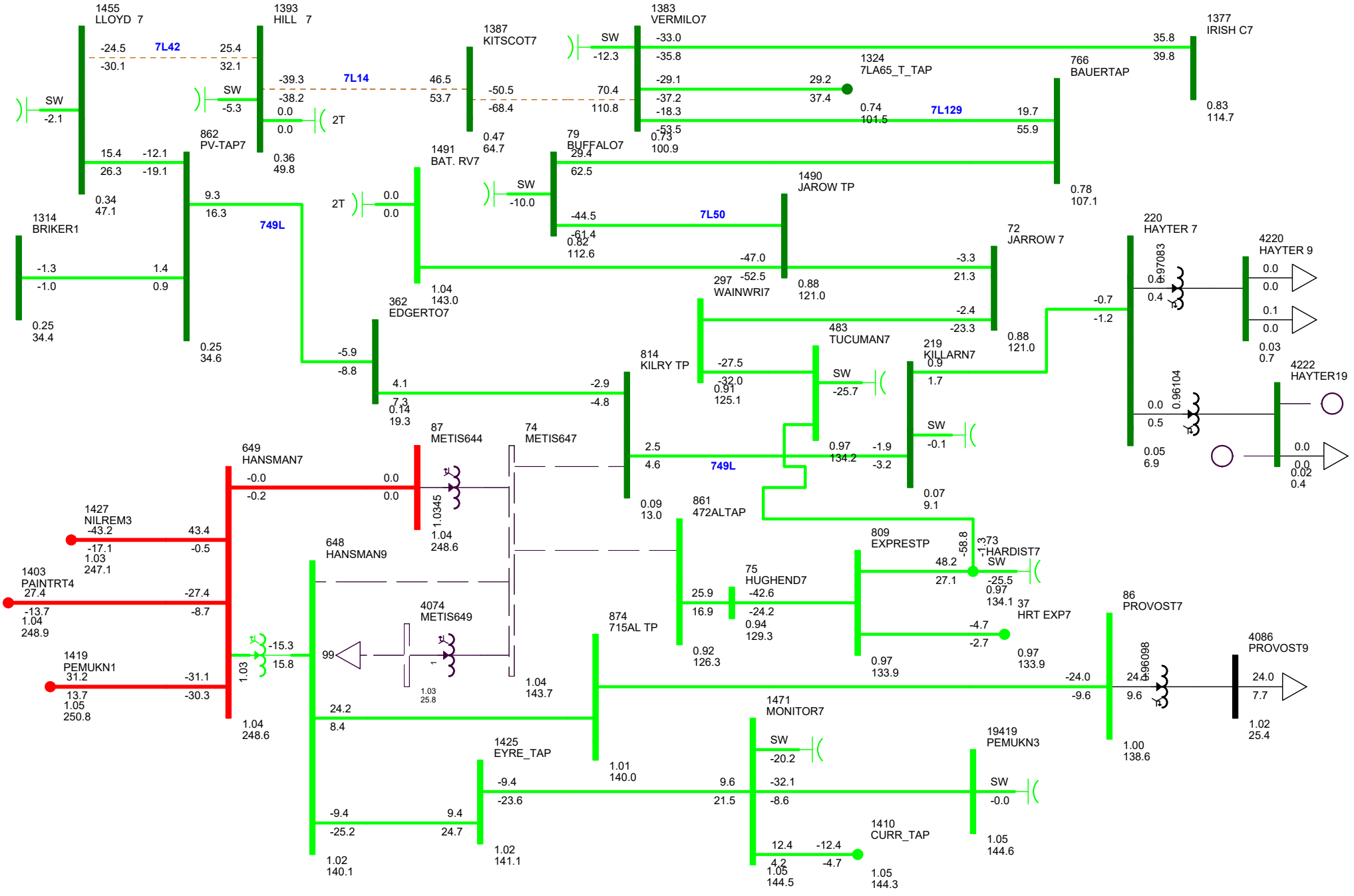
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.125OV 0.899UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



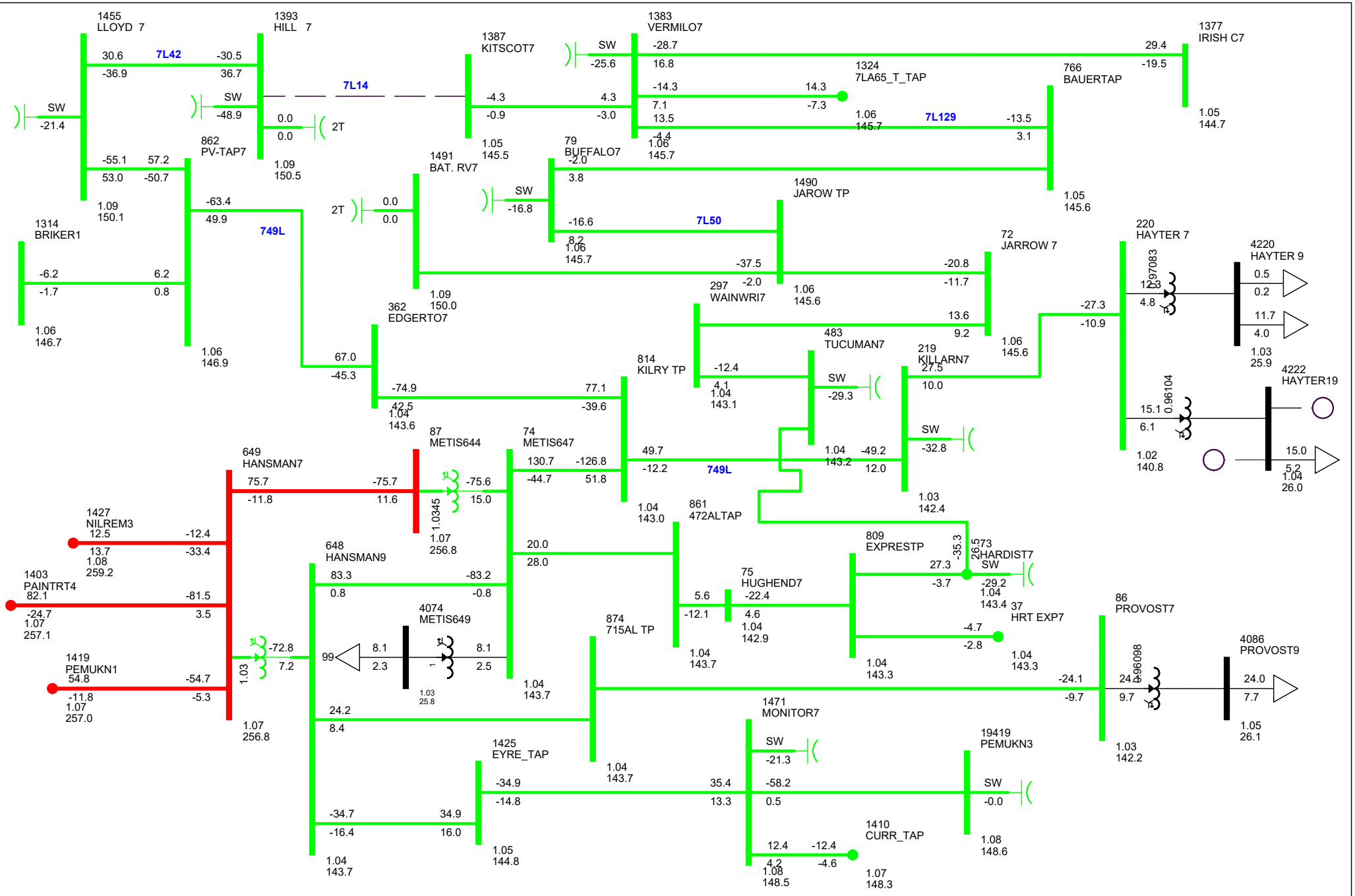
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-40 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S THU, JAN 25 2018 18:01	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



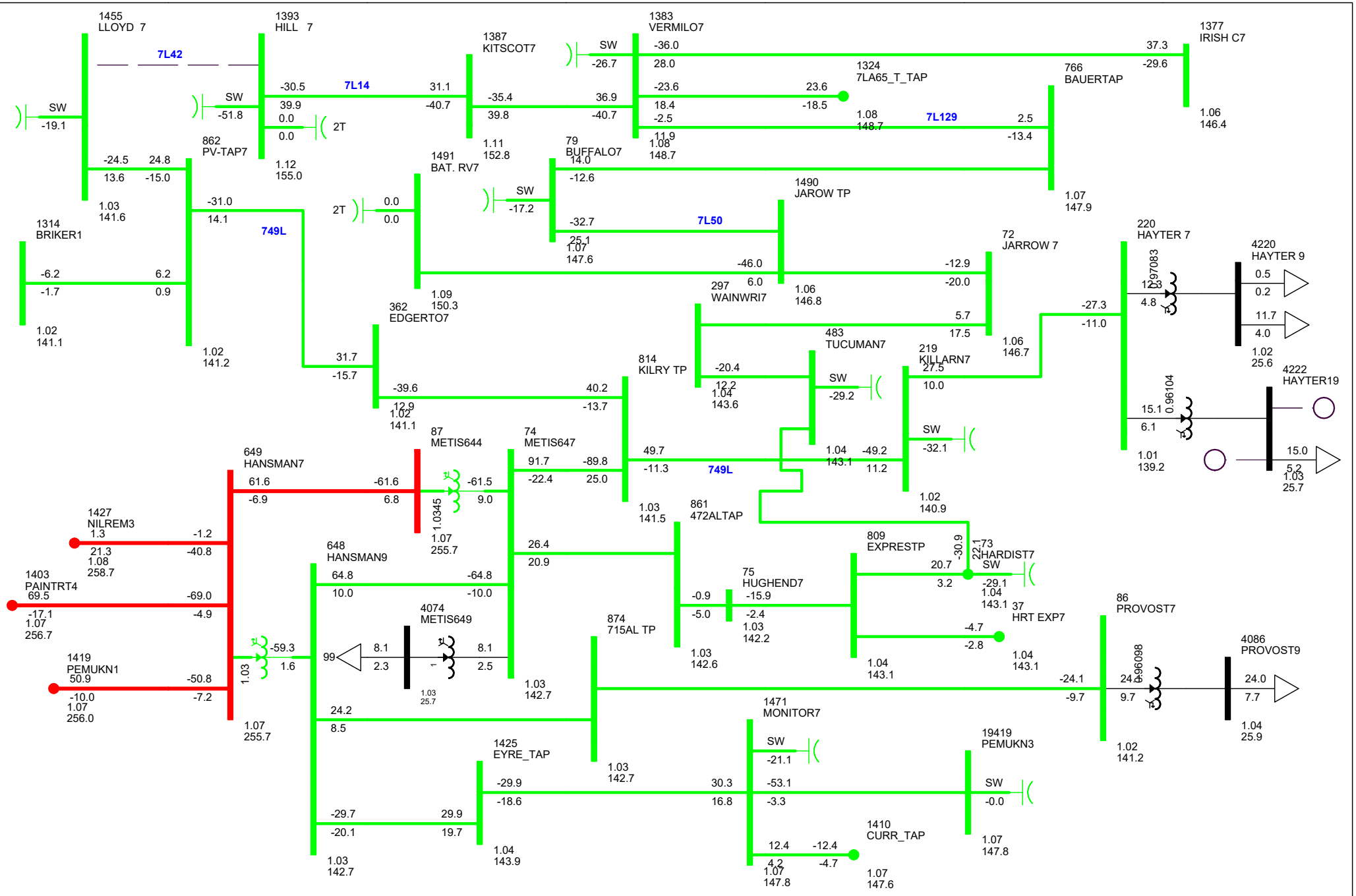
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-41 N-0: NORMAL OPERATION THU, JAN 25 2018 15:55	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



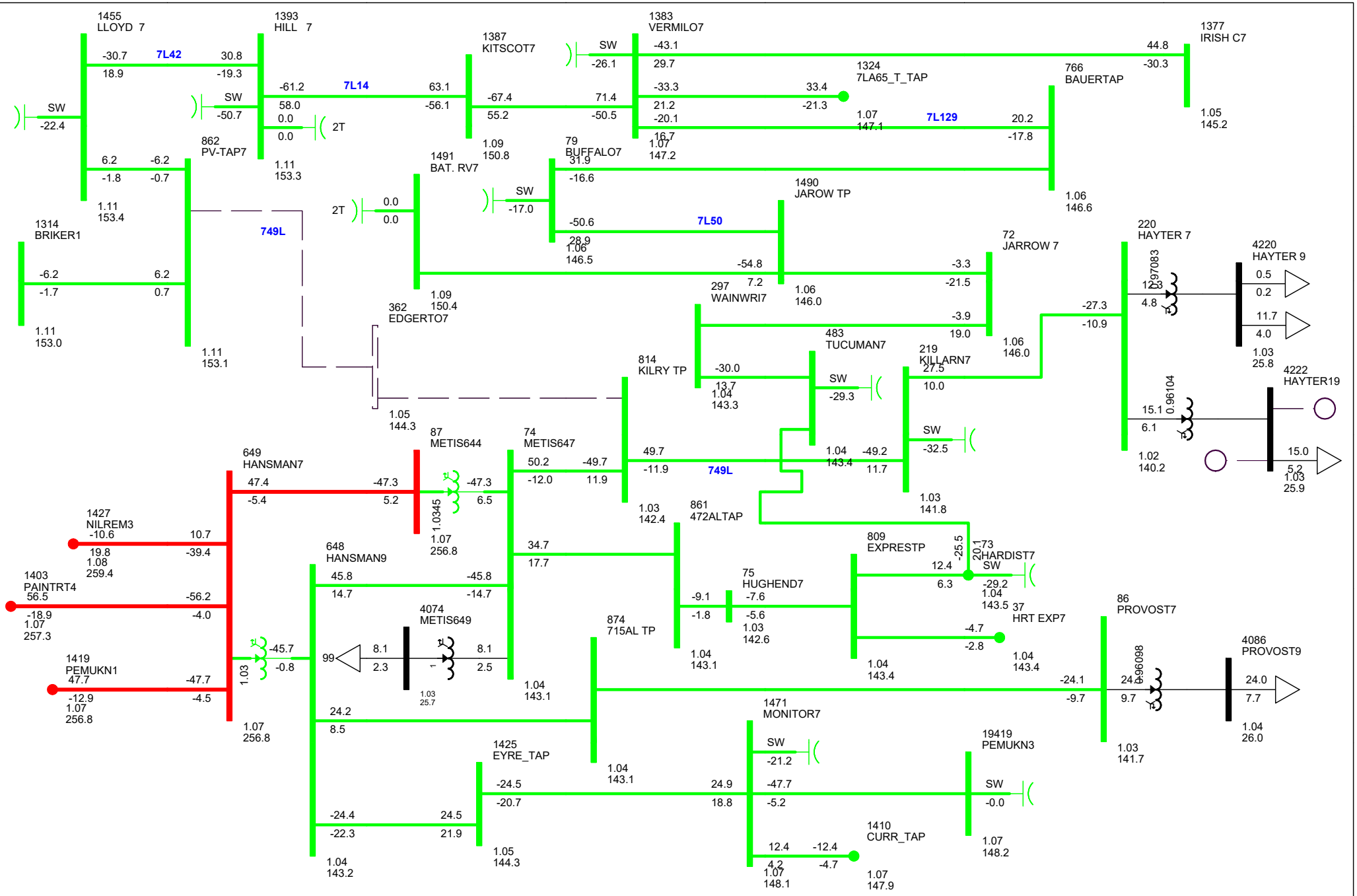
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-42 N-1: METISKOW 648S 138/25 KV TRANSFORMER THU, JAN 25 2018 16:02	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



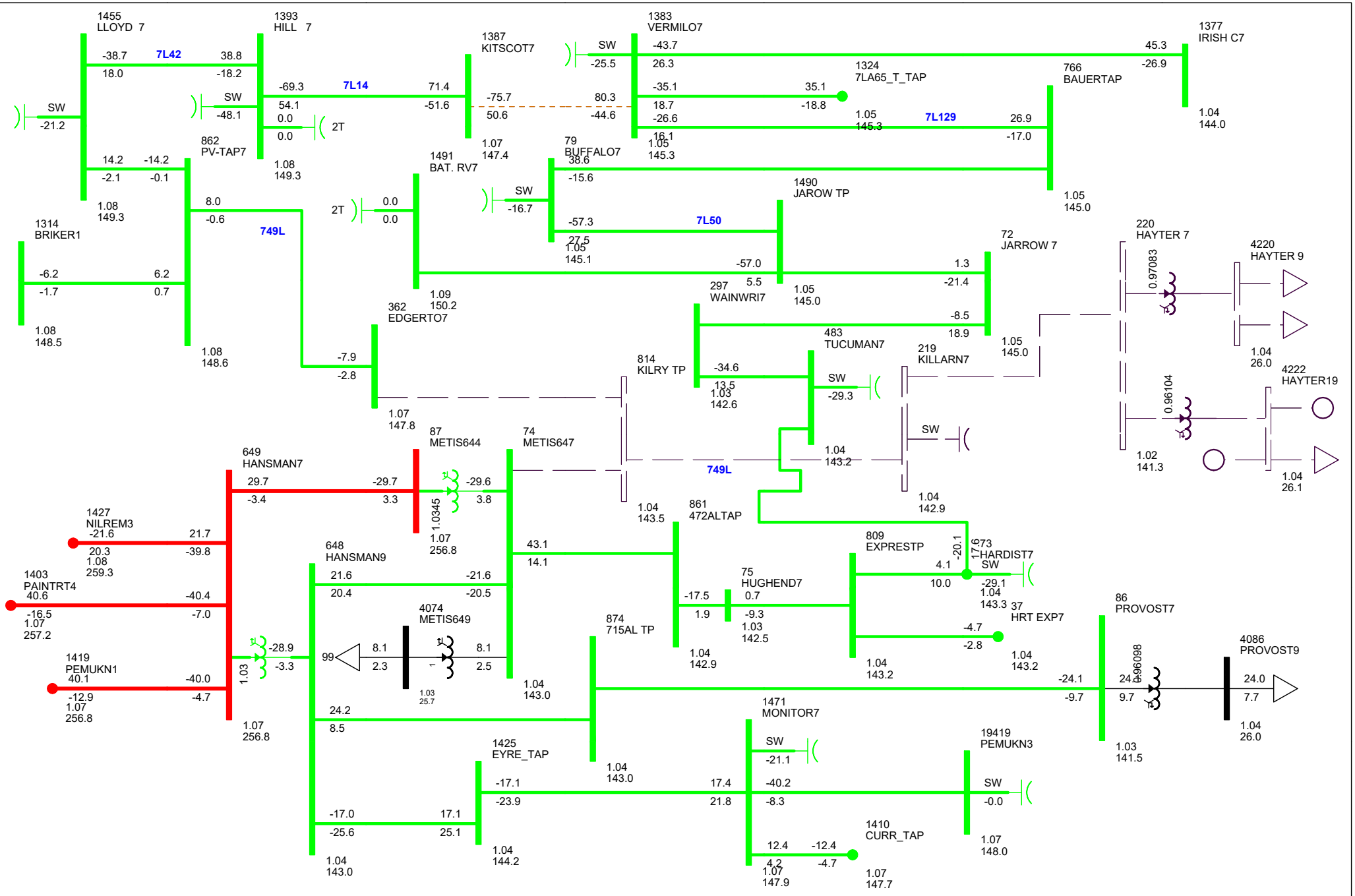
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-43 N-1: 7L14 KITSCOTY 705S TO HILL 751S THU, JAN 25 2018 15:56	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



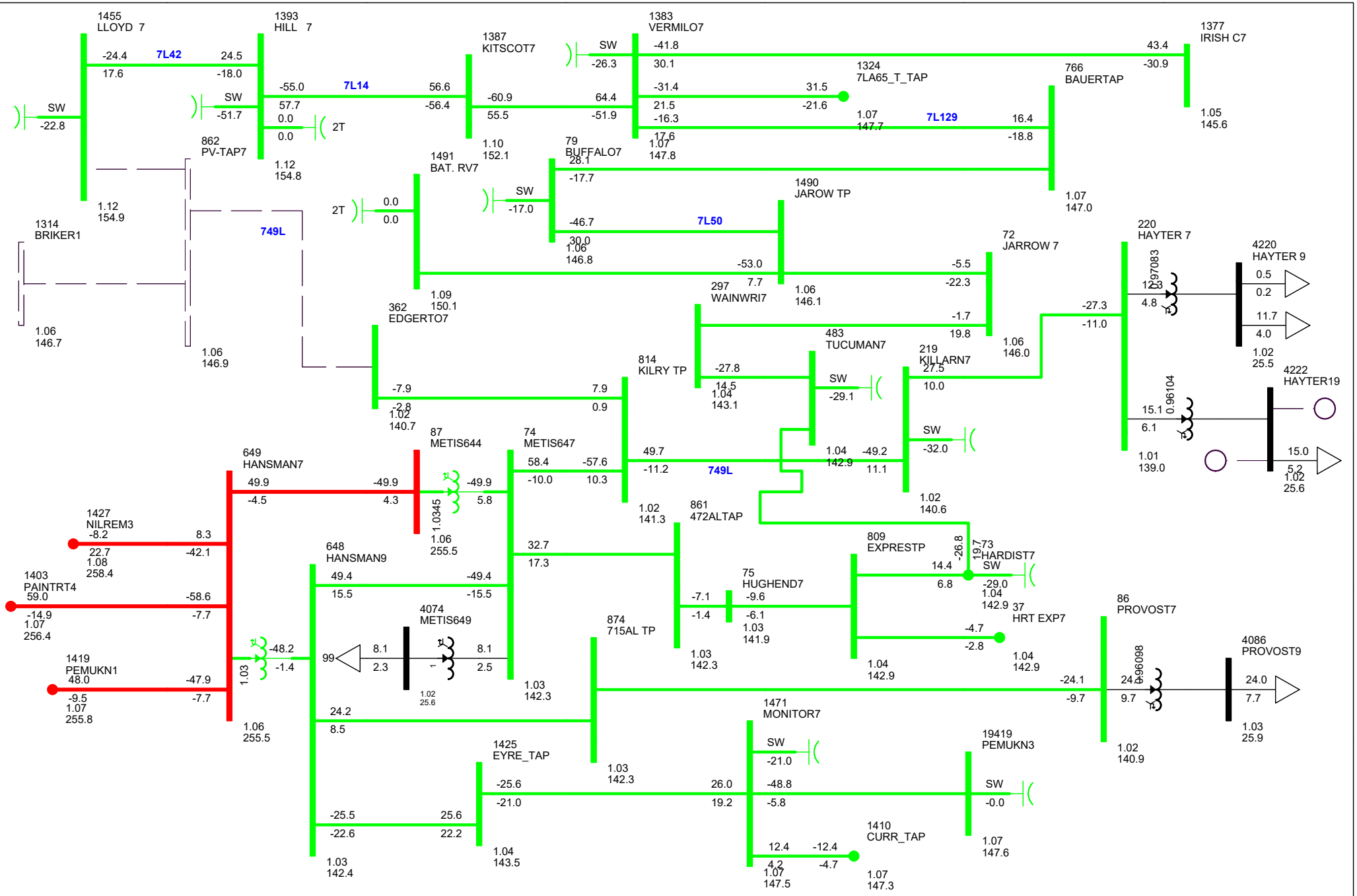
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-44 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S THU, JAN 25 2018 15:56	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



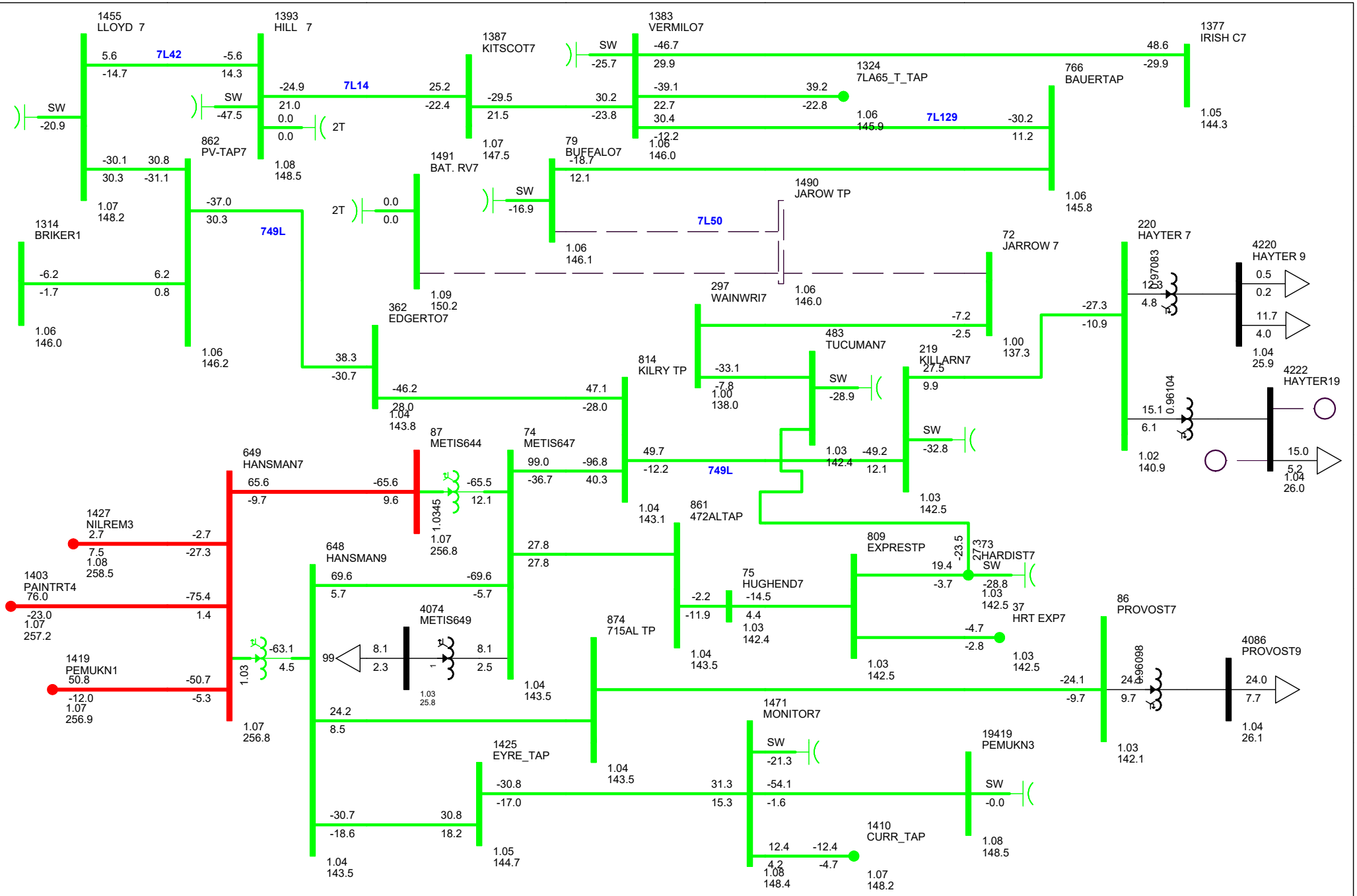
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-45 N-1: EDGERTON 899S 138/25 KV TRANSFORMER THU, JAN 25 2018 15:57	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



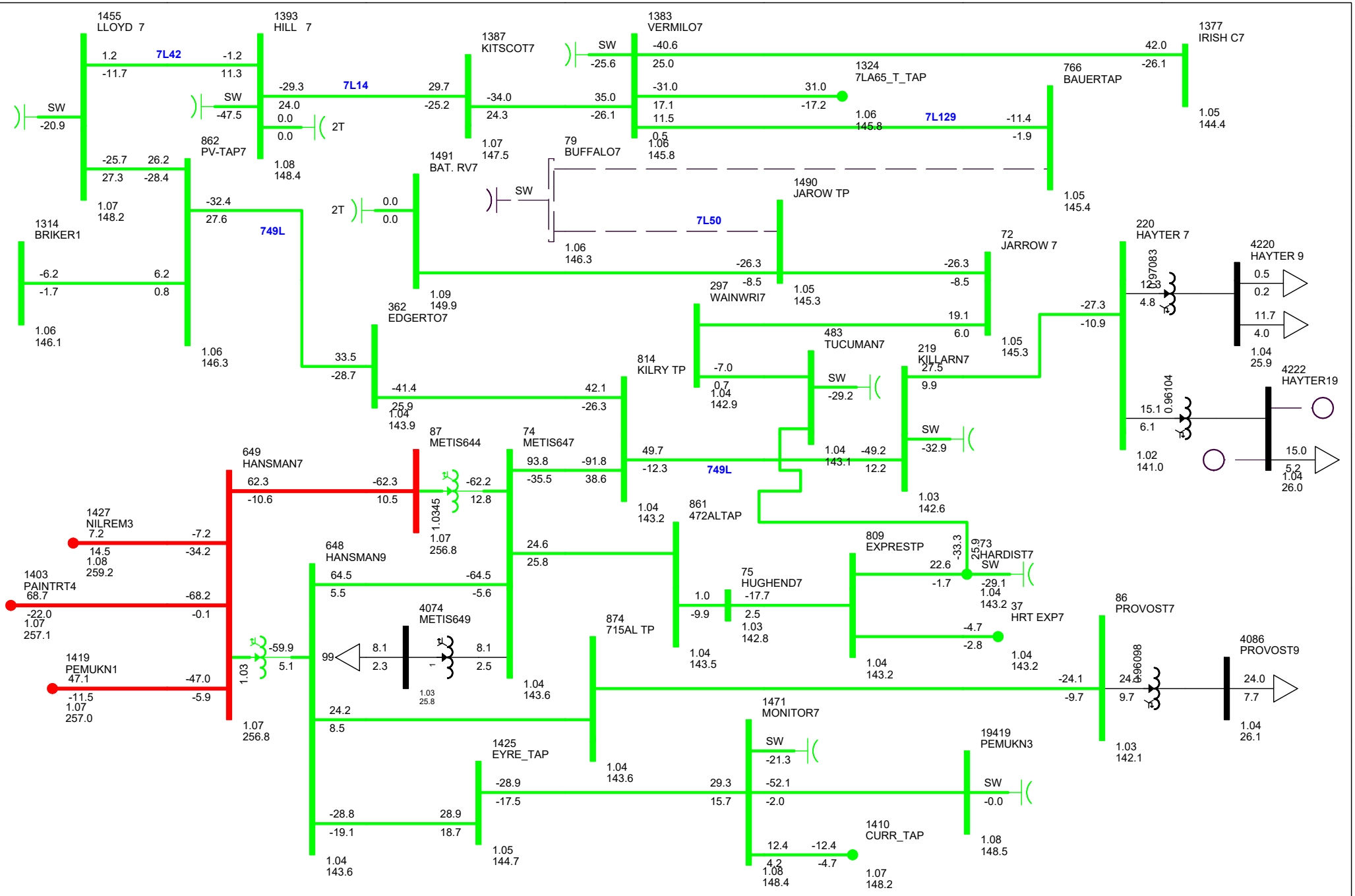
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-46 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S THU, JAN 25 2018 15:57	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



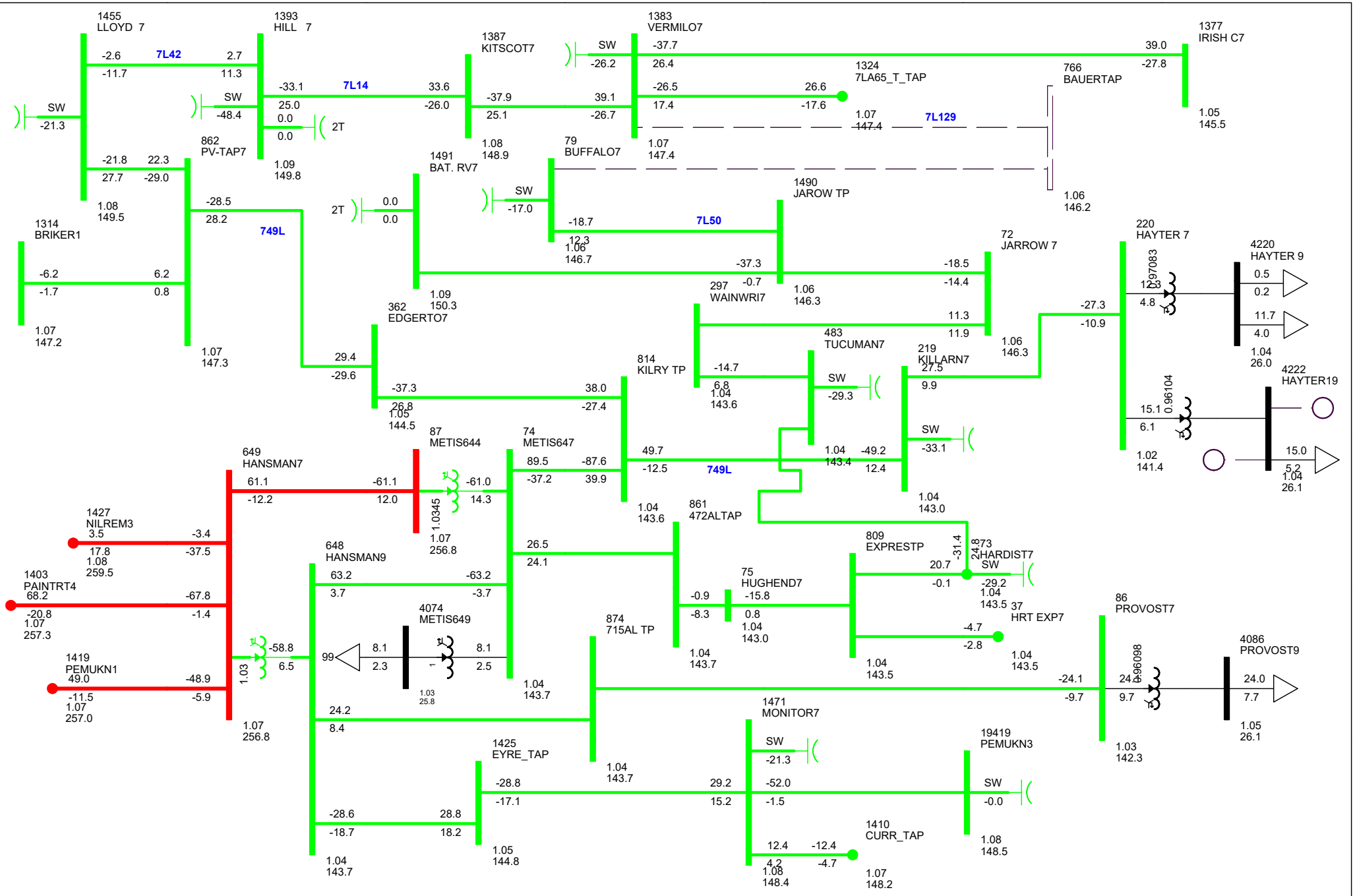
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-47 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S THU, JAN 25 2018 15:57	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-48 N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S THU, JAN 25 2018 15:57	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-49 N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER THU, JAN 25 2018 15:57	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A2-50 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S THU, JAN 25 2018 15:58	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Attachment A3

Post-Project Power Flow Diagrams

Table 1: Summary of System Performance (Element Loading) Scenario 6- 2020 SL HG Post-Project

Contingency	Thermal Overloads	Overload %	Figure in Attachment A3
N-0: Normal Operation	*None*	--	*A3-1*
648ST1 (Metiskow 648S 138/25 kV transformer)	*None*	--	*A3-2*
7L14 (Kitscoty 705S to Hill 751S)	*None*	--	*A3-3*
7L42 (Hill 751S to Lloydminster 716S)	*None*	--	*A3-4*
899S T3 (Edgerton 899S 138/25 kV transformer)	*None*	--	*A3-5*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*None*	--	*A3-6*
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*None*	--	*A3-7*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*None*	--	*A3-8*
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*None*	--	*A3-9*
7L129 (Buffalo Creek 526S to Vermilion 710S)	*None*	--	*A3-10*

Table 2: Summary of System Performance (Element Loading) Scenario 7- 2020 SP HG Post-Project

Contingency	Thermal Overloads	Overload %	Figure in Attachment A3
N-0: Normal Operation	*None*	--	*A3-11*
648ST1 (Metiskow 648S 138/25 kV transformer)	*7L50 (Buffalo Creek 526S to Jarrow Tap*	*105.0*	*A3-12*
7L14 (Kitscoty 705S to Hill 751S)	*7L50 (Buffalo Creek 526S to Jarrow Tap*	*101.5*	*A3-13*
7L42 (Hill 751S to Lloydminster 716S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*118.6*	*A3-14*
899S T3 (Edgerton 899S 138/25 kV transformer)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*127.0*	*A3-15*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*7L129 (Buffalo Creek 526S to Bauer 918S Tap)*	*100.8*	*A3-16*
	7L50 (Buffalo Creek 526S to Jarrow 252S Tap)	*129.1*	
	7L129 (Vermilion 710S to Bauer 918S Tap)	*100.2*	
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*124.8*	*A3-17*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*109.9*	*A3-18*
	7L749 (Edgerton 899S to Briker 880S Tap)	*104.0*	
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*104.8*	*A3-19*
7L129 (Buffalo Creek 526S to Vermilion 710S)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*101.2*	*A3-20*

Table 3: Summary of System Performance (Element Loading) Scenario 8- 2020 SP LG Post-Project

Contingency	Thermal Overloads	Overload %	Figure in Attachment A3
N-0: Normal Operation	*None*	--	*A3-21*
648ST1 (Metiskow 648S 138/25 kV transformer)	*None*	--	*A3-22*
7L14 (Kitscoty 705S to Hill 751S)	*None*	--	*A3-23*
7L42 (Hill 751S to Lloydminster 716S)	*None*	--	*A3-24*
899S T3 (Edgerton 899S 138/25 kV transformer)	*None*	--	*A3-25*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*None*	--	*A3-26*
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*None*	--	*A3-27*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*None*	--	*A3-28*
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*None*	--	*A3-29*
7L129 (Buffalo Creek 526S to Vermilion 710S)	*None*	--	*A3-30*

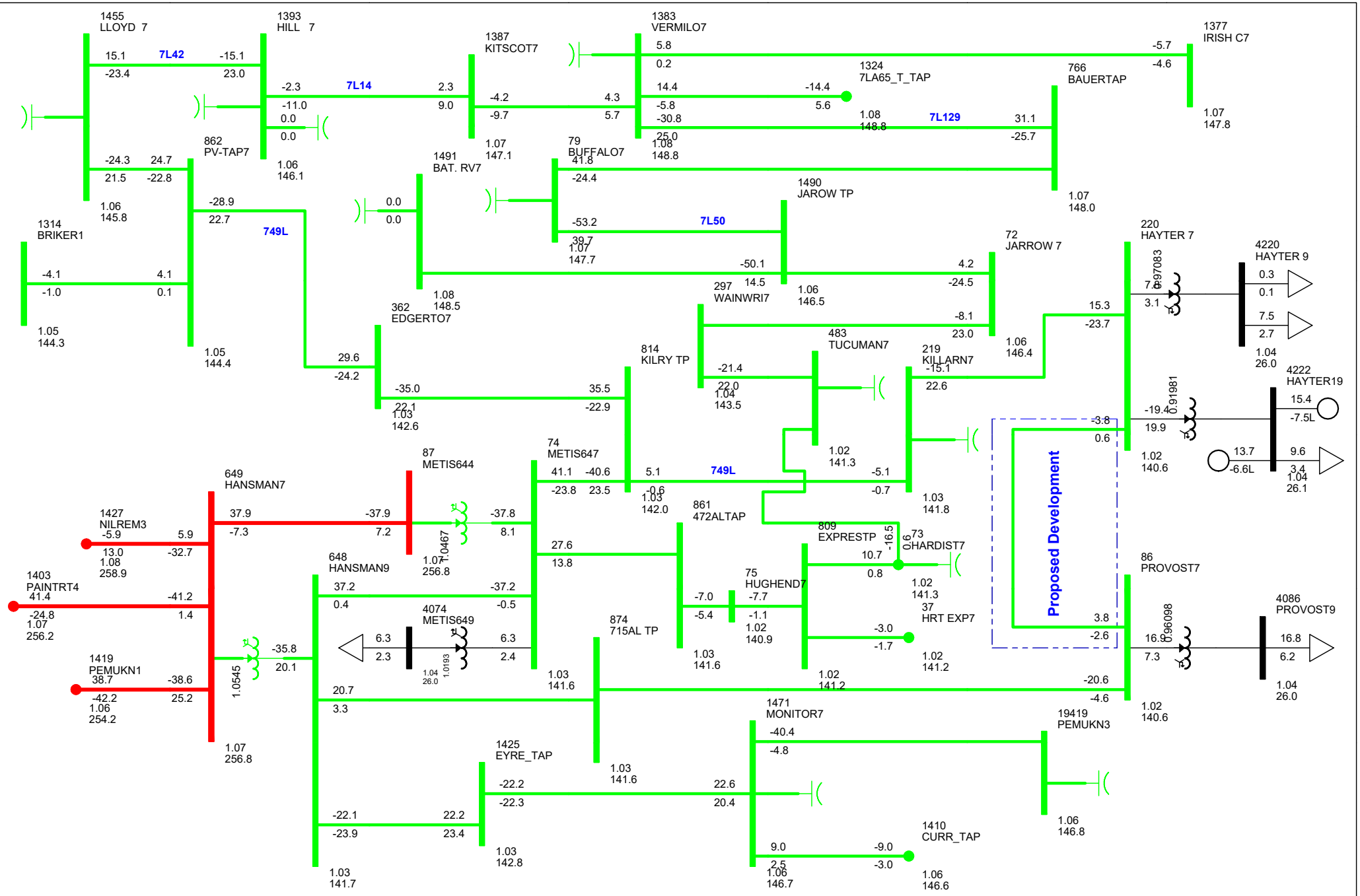
Table 4: Summary of System Performance (Element Loading) Scenario 9- 2020 WP HG Post-Project

Contingency	Thermal Overloads	Overload %	Figure in Attachment A3
N-0: Normal Operation	*None*	--	*A3-31*
648ST1 (Metiskow 648S 138/25 kV transformer)	*None*	--	*A3-32*
7L14 (Kitscoty 705S to Hill 751S)	*None*	--	*A3-33*
7L42 (Hill 751S to Lloydminster 716S)	*None*	--	*A3-34*
899S T3 (Edgerton 899S 138/25 kV transformer)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*102.8*	*A3-35*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*104.6*	*A3-36*
	7L130 (Vermilion 710S Kitscoty 705S)	*101.2*	
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*100.8*	*A3-37*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*117.8*	*A3-38*
	7L749 (Edgerton 899S to Briker 880S Tap)	*110.6*	
	749L (Edgerton 899S to Killarney Lake 267S Tap)	*112.5*	*A3-39*

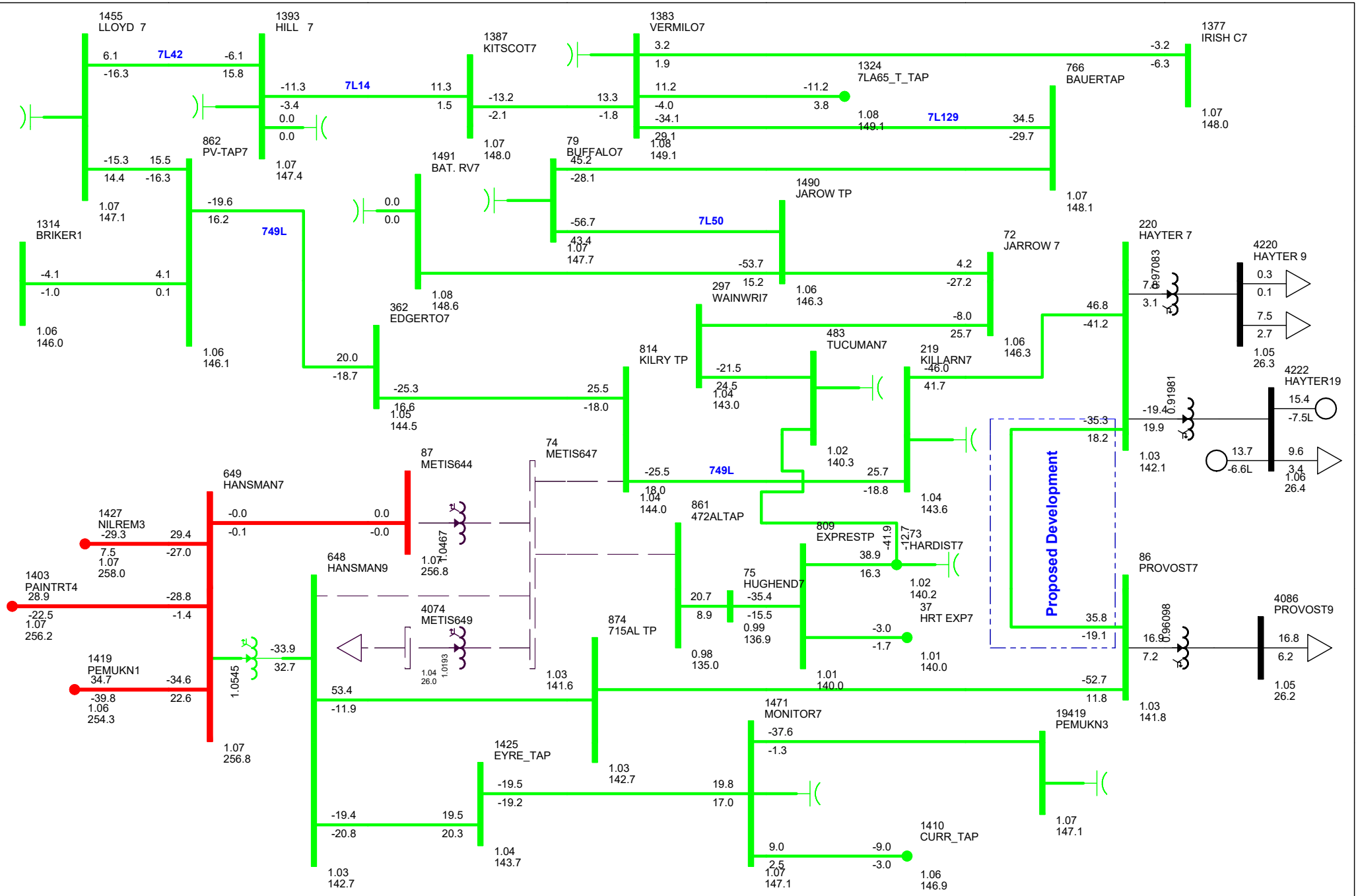
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*7L749 (Edgerton 899S to Briker 880S Tap)*	*105.4*	
7L129 (Buffalo Creek 526S to Vermilion 710S)	*749L (Edgerton 899S to Killarney Lake 267S Tap)*	*109.4*	*A3-40*
	7L749 (Edgerton 899S to Briker 880S Tap)	*102.4*	

Table 5: Summary of System Performance (Element Loading) Scenario 10- 2020 WP LG Post-Project

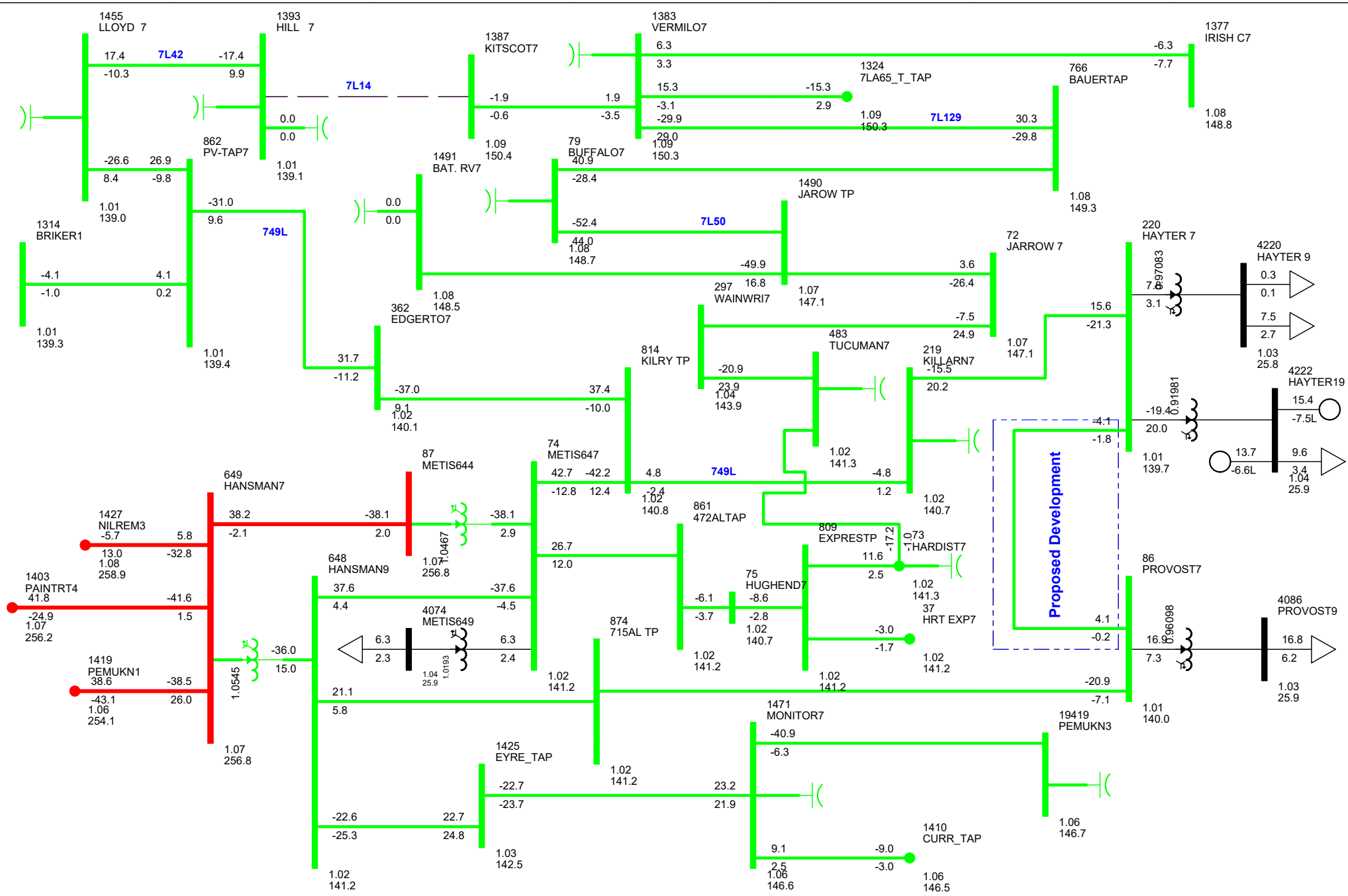
Contingency	Thermal Overloads	Overload %	Figure in Attachment A3
N-0: Normal Operation	*None*	--	*A3-41*
648ST1 (Metiskow 648S 138/25 kV transformer)	*None*	--	*A3-42*
7L14 (Kitscoty 705S to Hill 751S)	*None*	--	*A3-43*
7L42 (Hill 751S to Lloydminster 716S)	*None*	--	*A3-44*
899S T3 (Edgerton 899S 138/25 kV transformer)	*None*	--	*A3-45*
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*7L130 (Vermilion 710S Kitscoty 705S)*	*101.6*	*A3-46*
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*None*	--	*A3-47*
7L50 (Buffalo Creek 526S to Jarrow 252S/Battle River 757S)	*None*	--	*A3-48*
526ST1/T2 (Buffalo Creek 526S 138/25 kV transformers)	*None*	--	*A3-49*
7L129 (Buffalo Creek 526S to Vermilion 710S)	*None*	--	*A3-50*



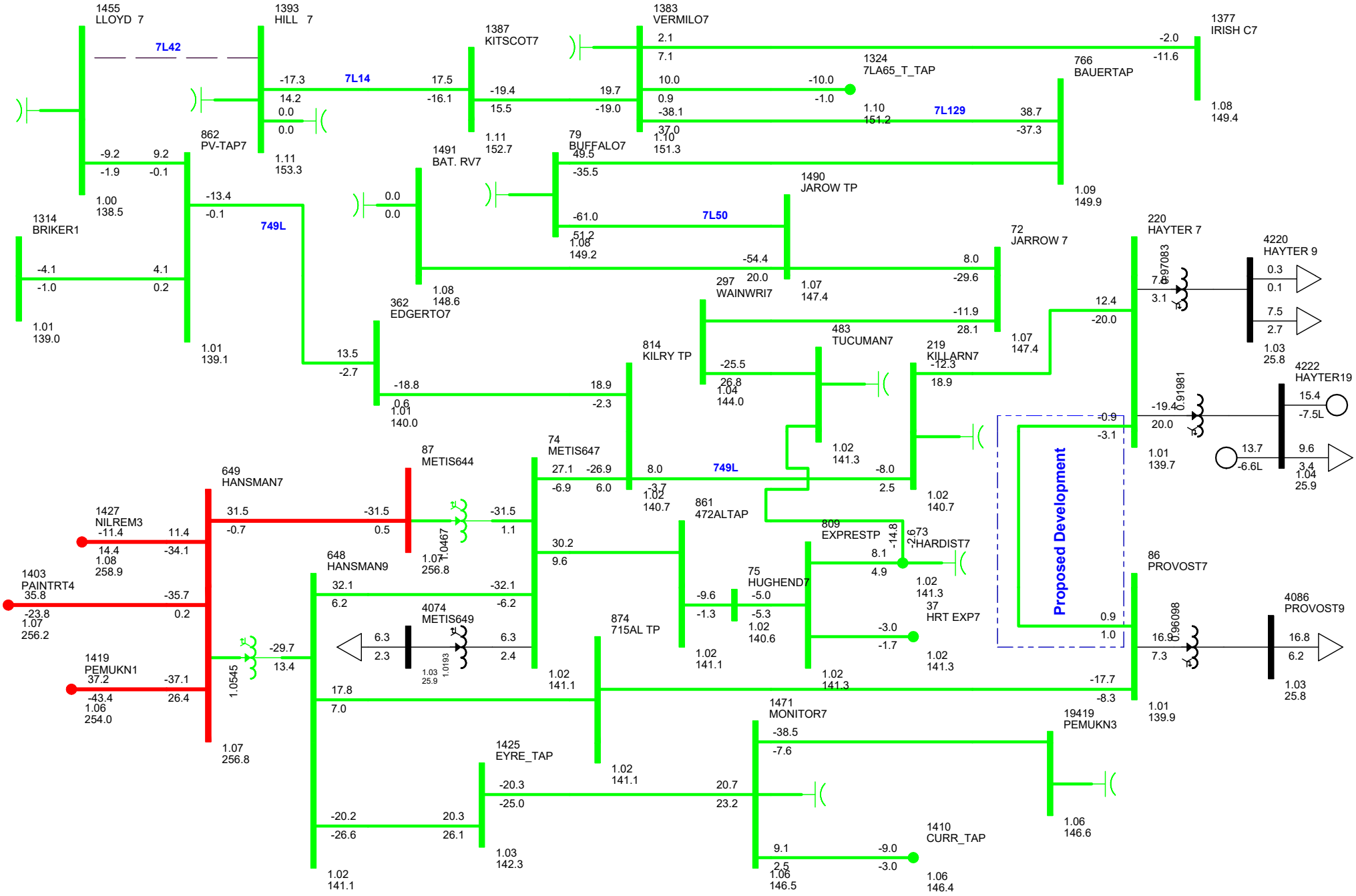
Provost Area Reliability Project 1782 2020 SL	P1782 POST-CONNECTION - DIAGRAM A3-1 N-0: NORMAL OPERATION MON, JAN 22 2018 15:40	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



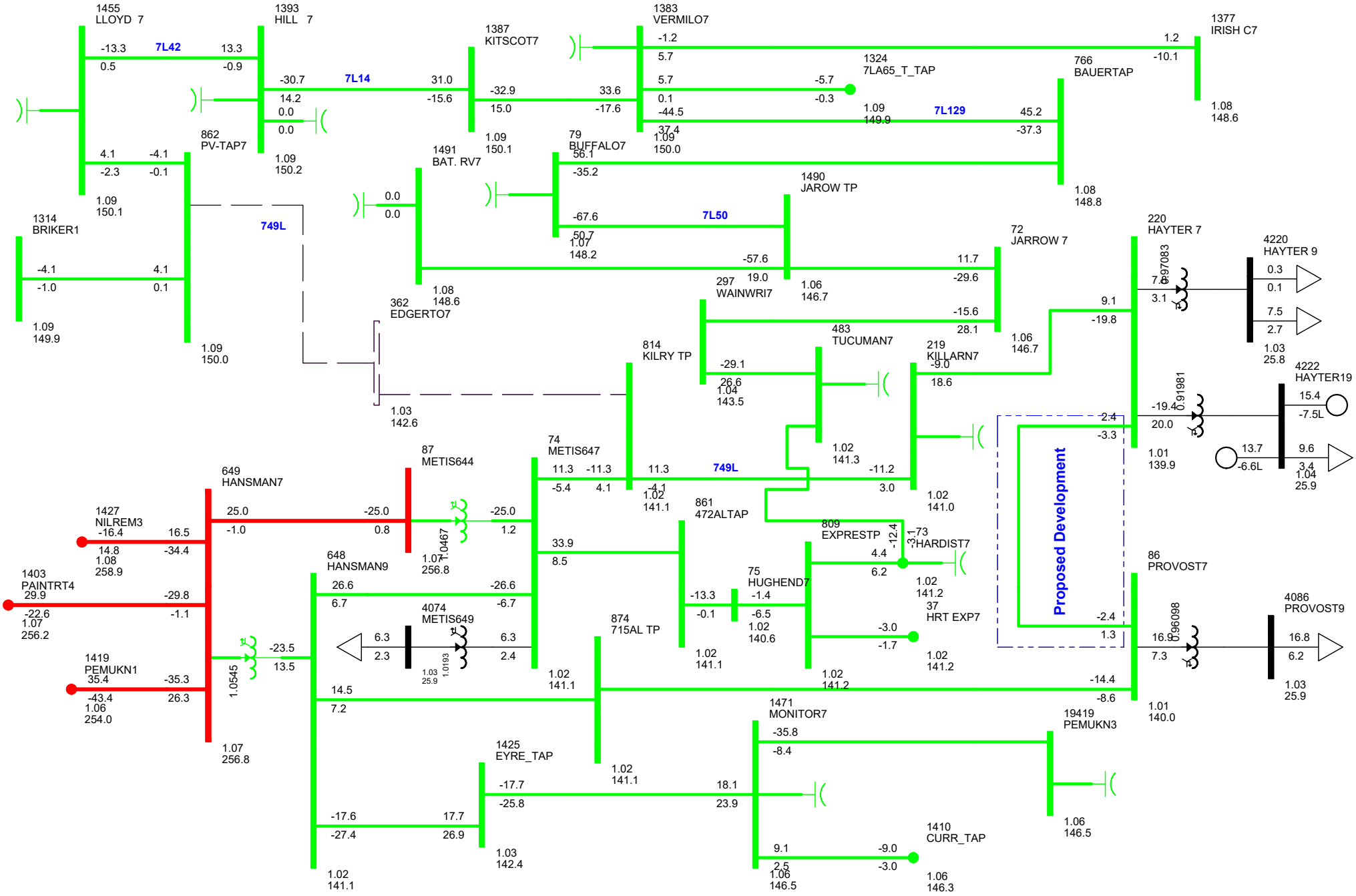
Provost Area Reliability Project 1782 2020 SL	P1782 POST-CONNECTION - DIAGRAM A3-2 N-1: METISKOW 648S 138/25 KV TRANSFORMER MON, JAN 22 2018 15:42	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



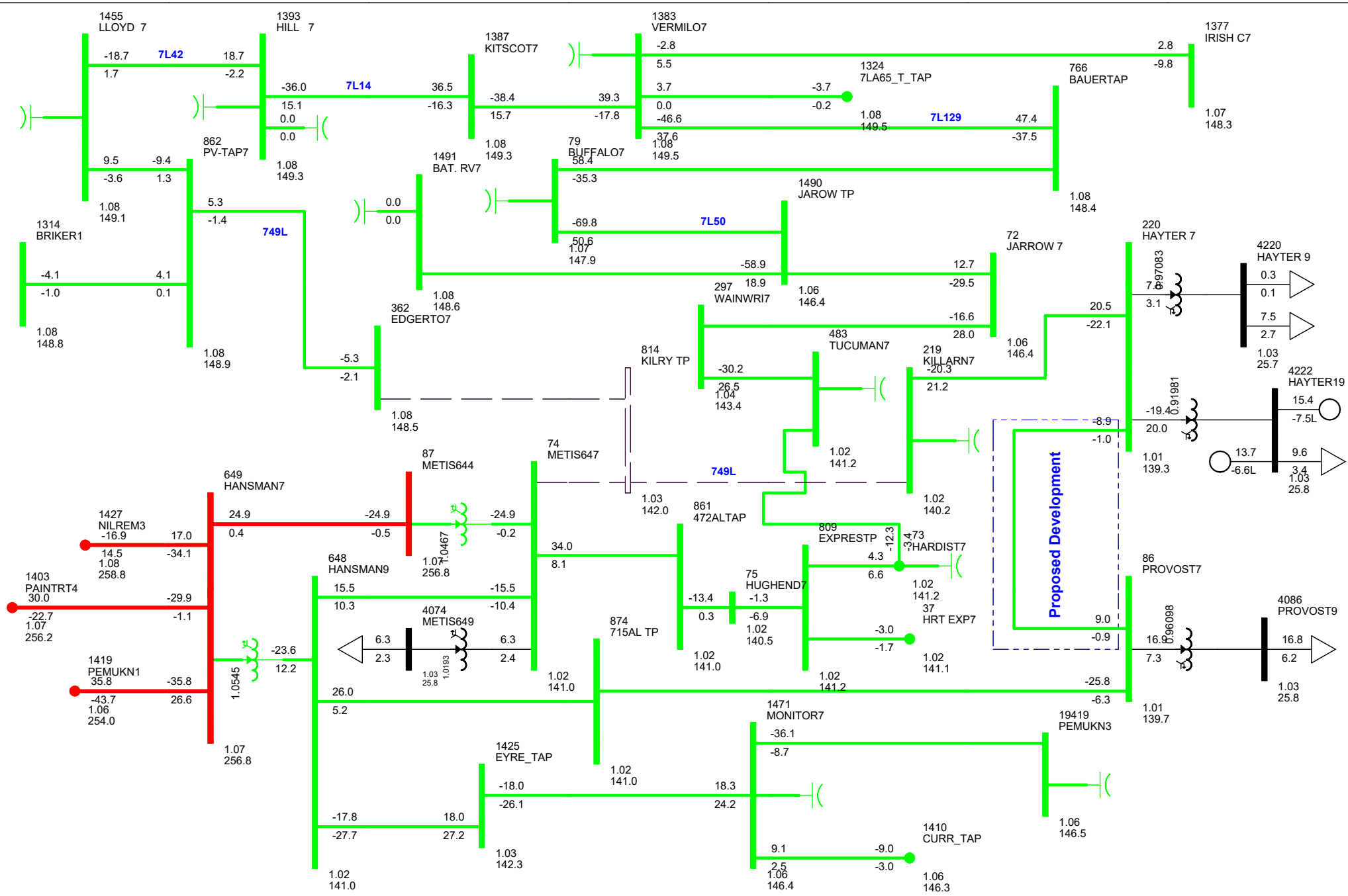
Provost Area Reliability Project 1782 2020 SL	P1782 POST-CONNECTION - DIAGRAM A3-3 N-1: 7L14 KITSCOTY 705S TO HILL 751S MON, JAN 22 2018 15:42	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



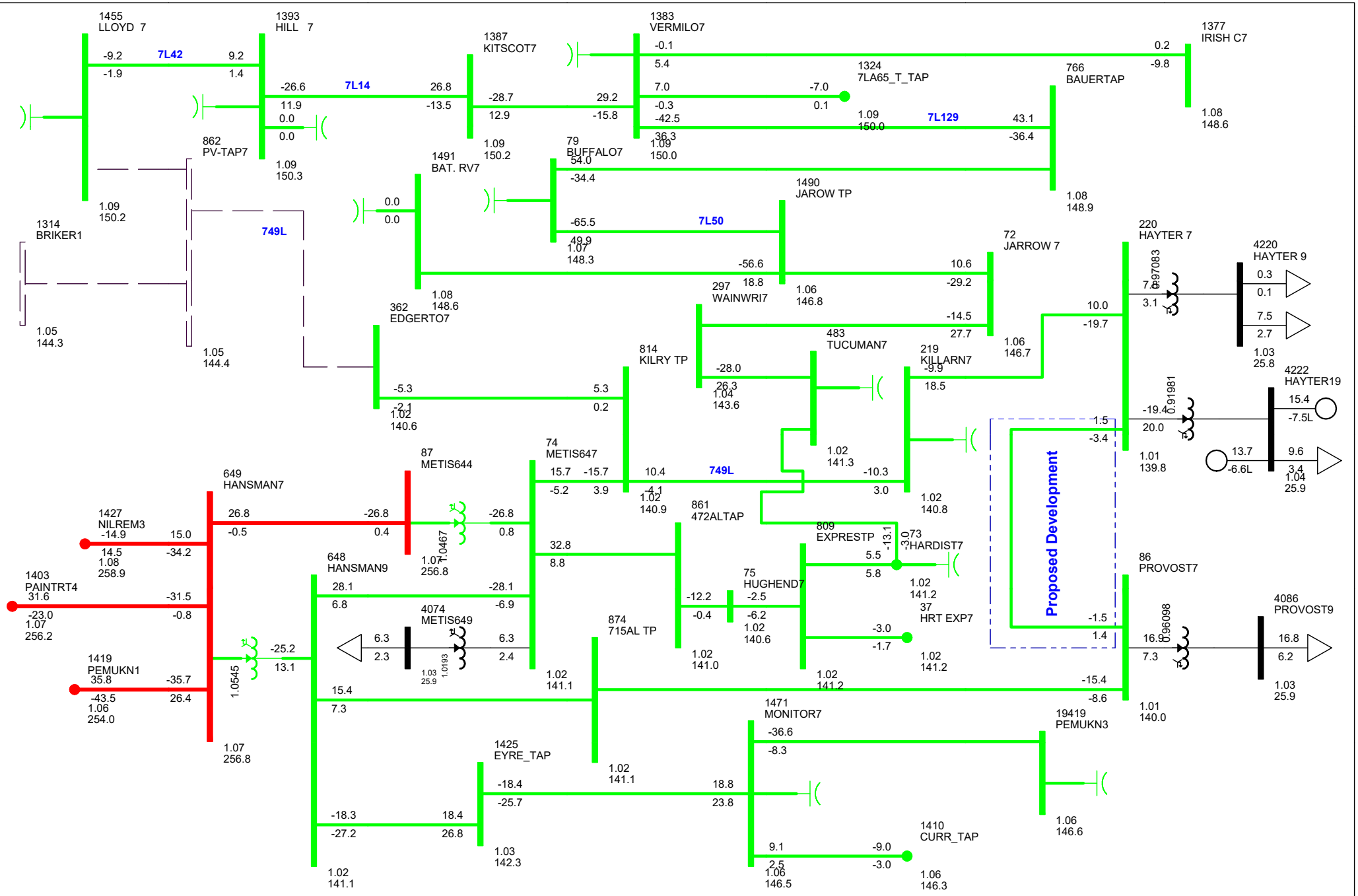
Provost Area Reliability Project 1782 2020 SL	P1782 POST-CONNECTION - DIAGRAM A3-4 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S MON, JAN 22 2018 15:44	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



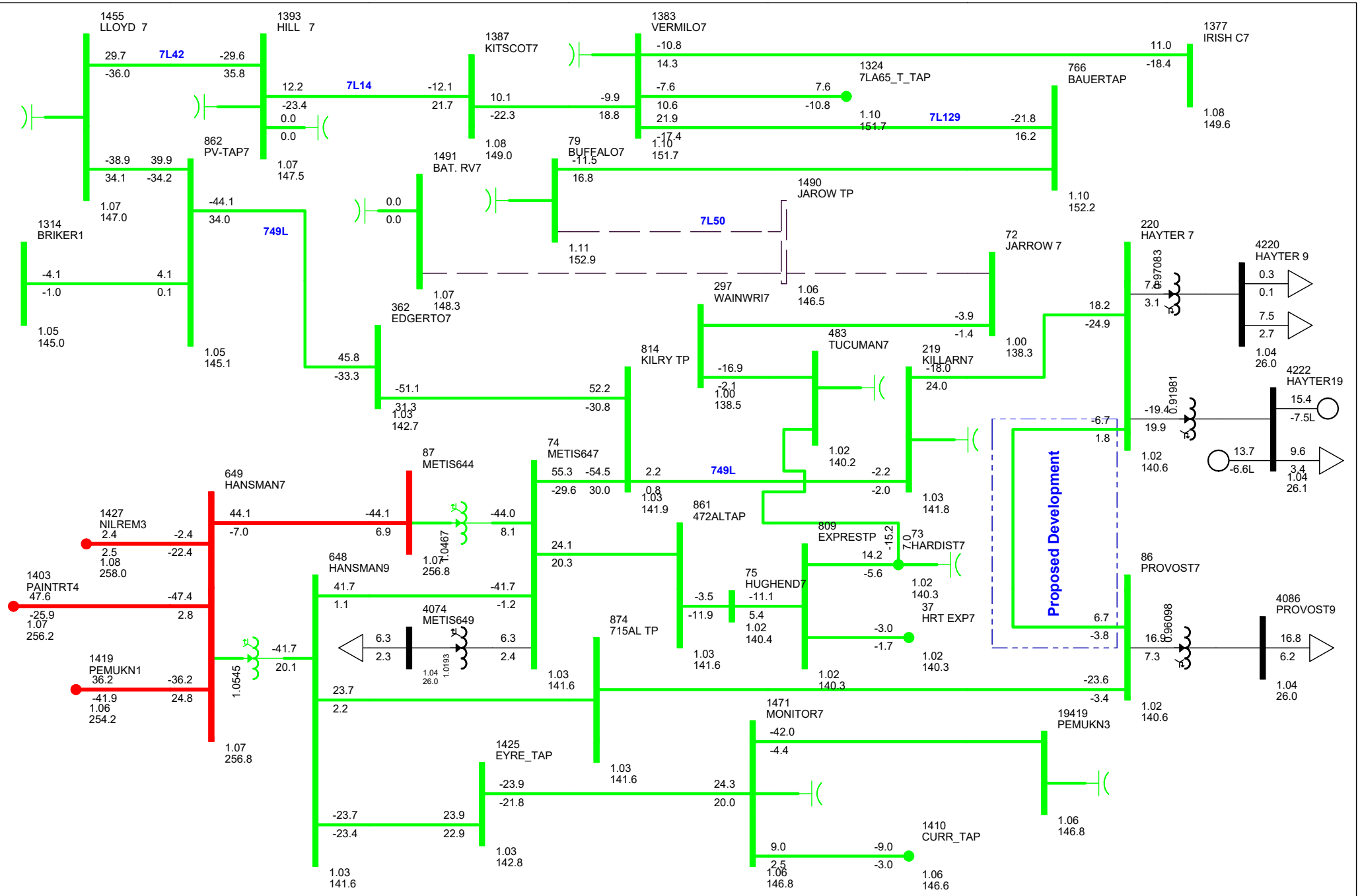
Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A3-5 N-1: EDGERTON 899S 138/25 KV TRANSFORMER MON, JAN 22 2018 15:44	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



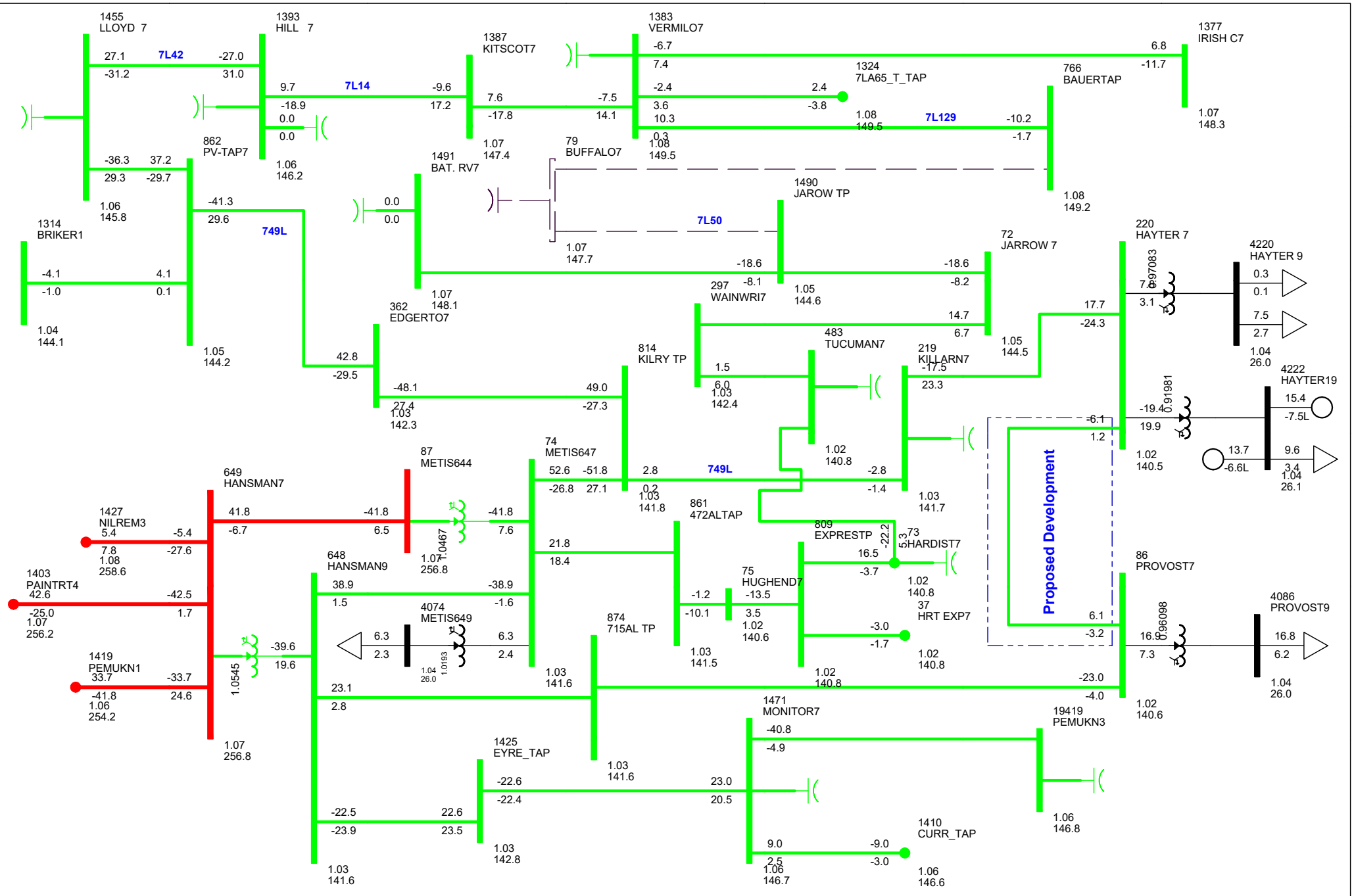
Provost Area Reliability Project 1782 2020 SL	P1782 POST-CONNECTION - DIAGRAM A3-6 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S MON, JAN 22 2018 15:44	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



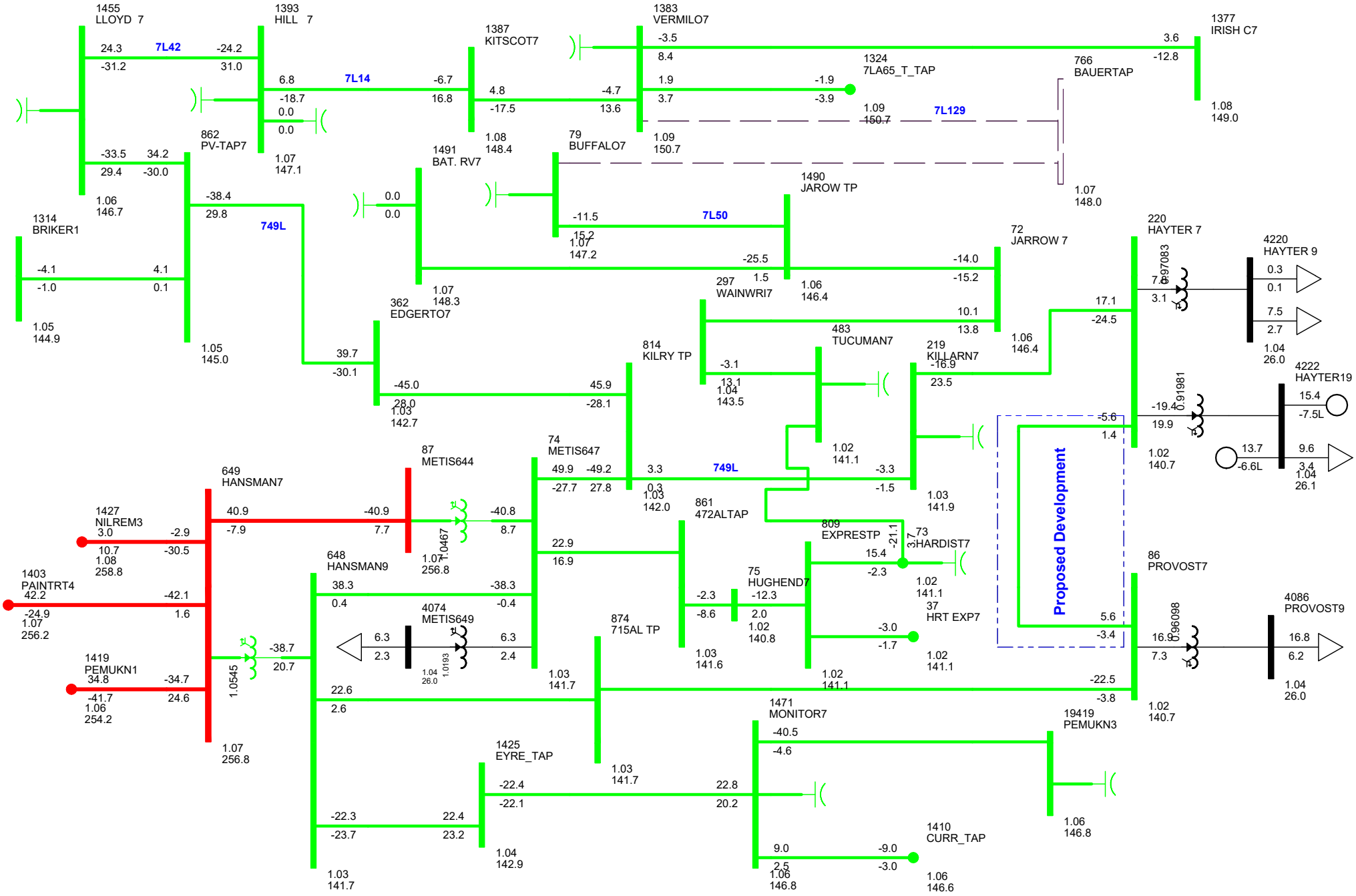
Provost Area Reliability Project 1782 2020 SL	P1782 POST-CONNECTION - DIAGRAM A3-7 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S MON, JAN 22 2018 15:44	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



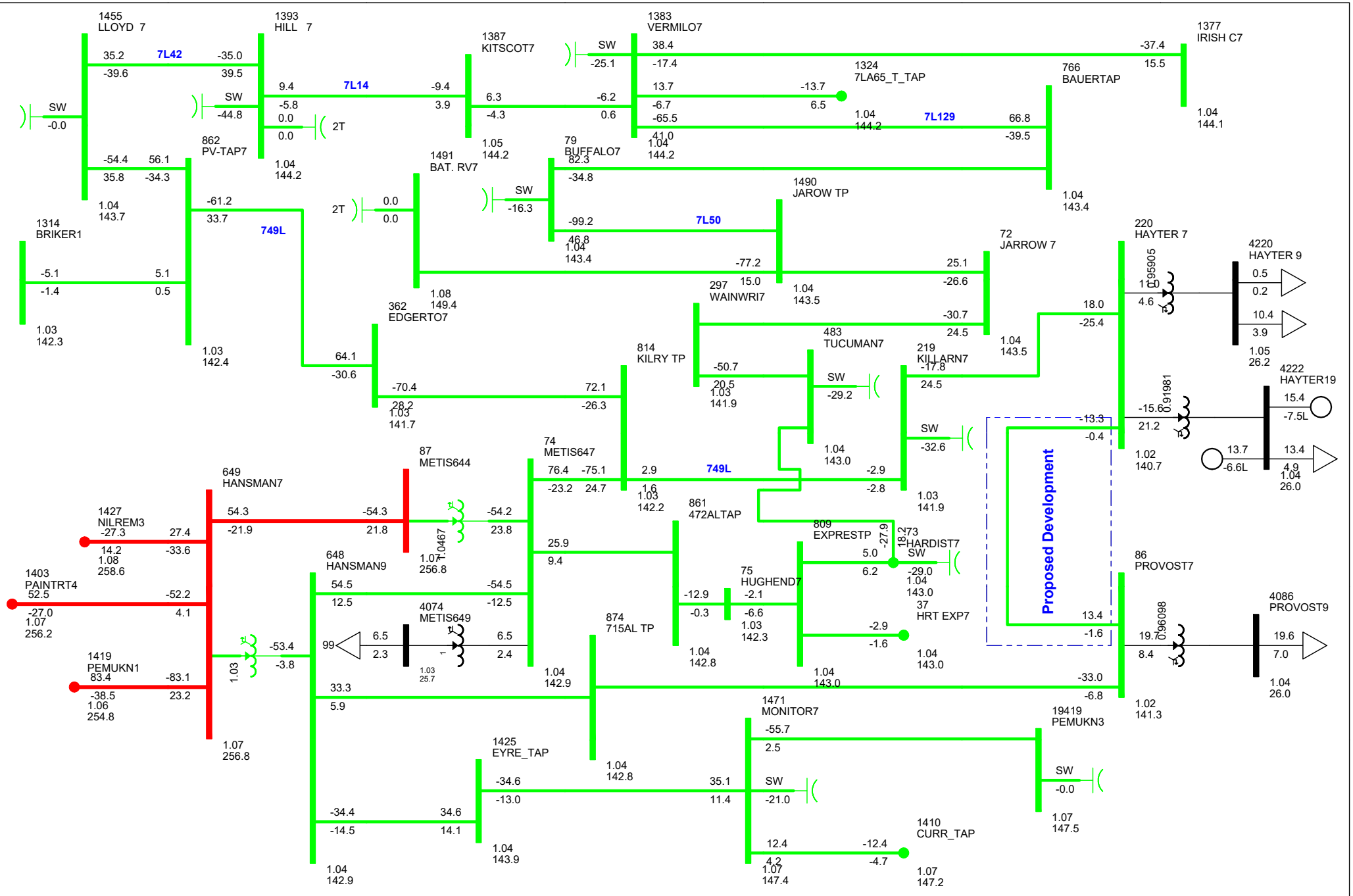
Provost Area Reliability Project 1782 2020 SL	P1782 POST-CONNECTION - DIAGRAM A3-8 N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S MON, JAN 22 2018 15:45	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



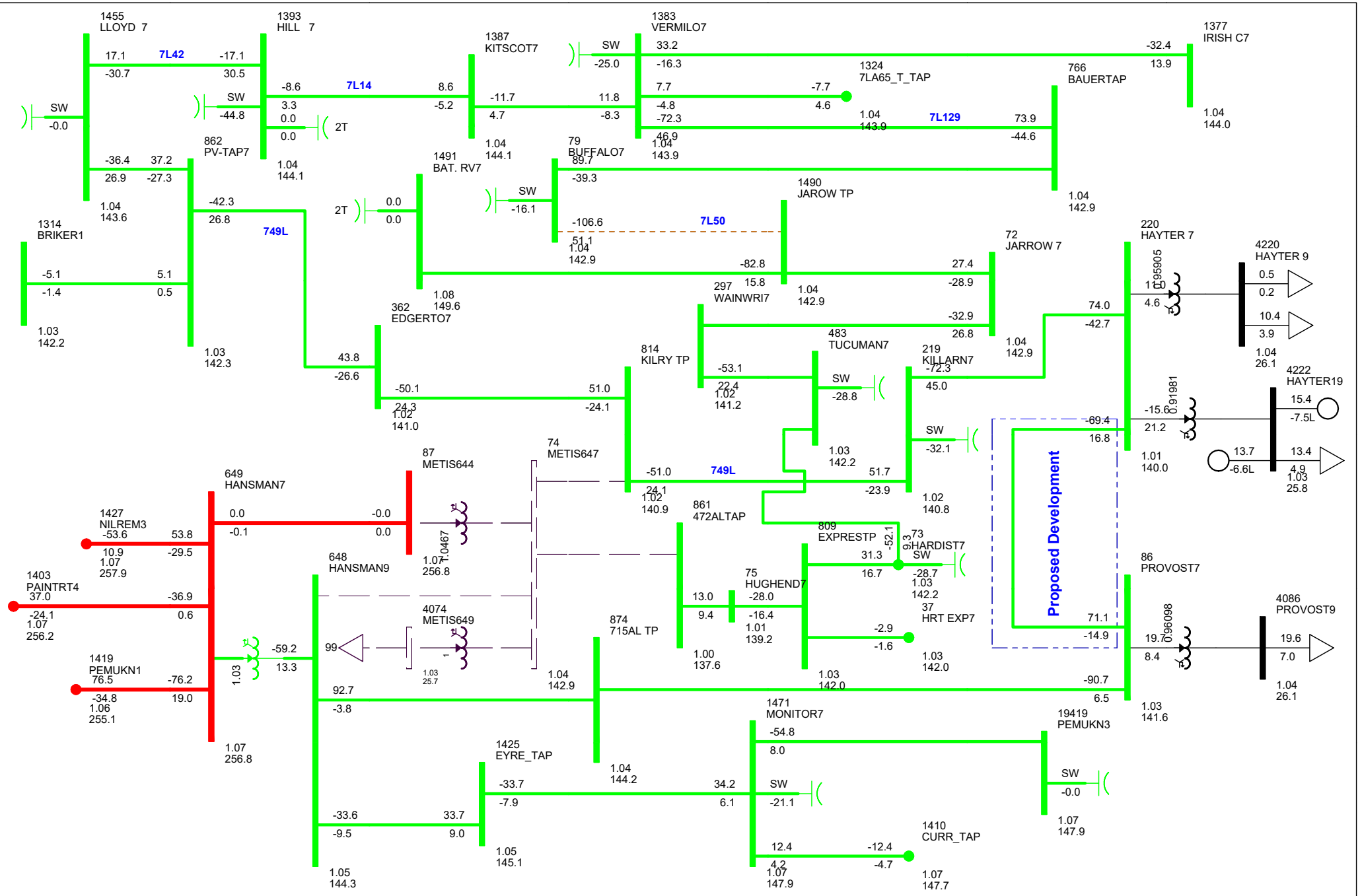
Provost Area Reliability Project 1782 2020 SL	P1782 PRE-CONNECTION - DIAGRAM A3-9 N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER MON, JAN 22 2018 15:45	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



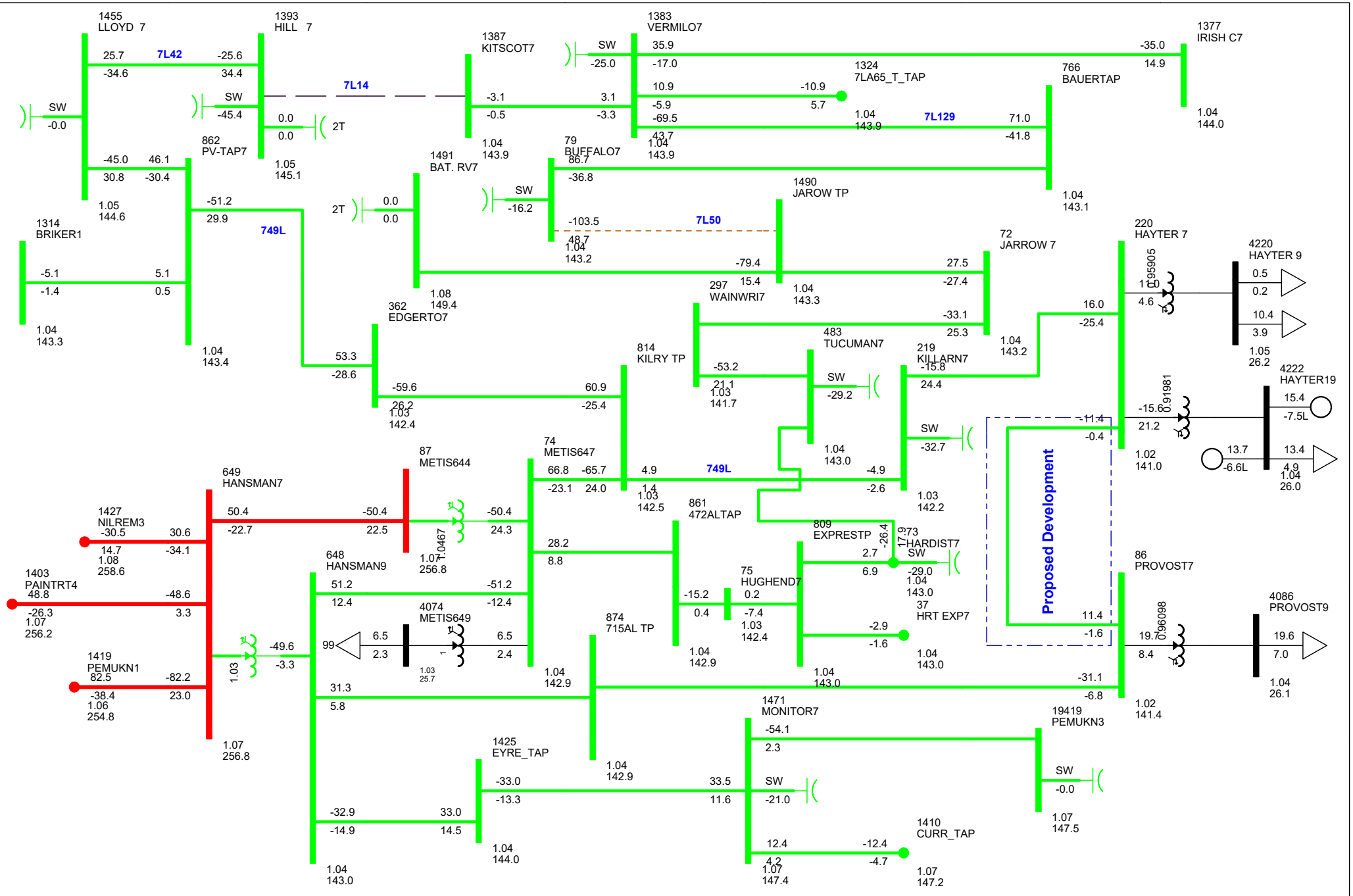
Provost Area Reliability Project 1782 2020 SL	P1782 POST-CONNECTION - DIAGRAM A3-10 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S MON, JAN 22 2018 15:45	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



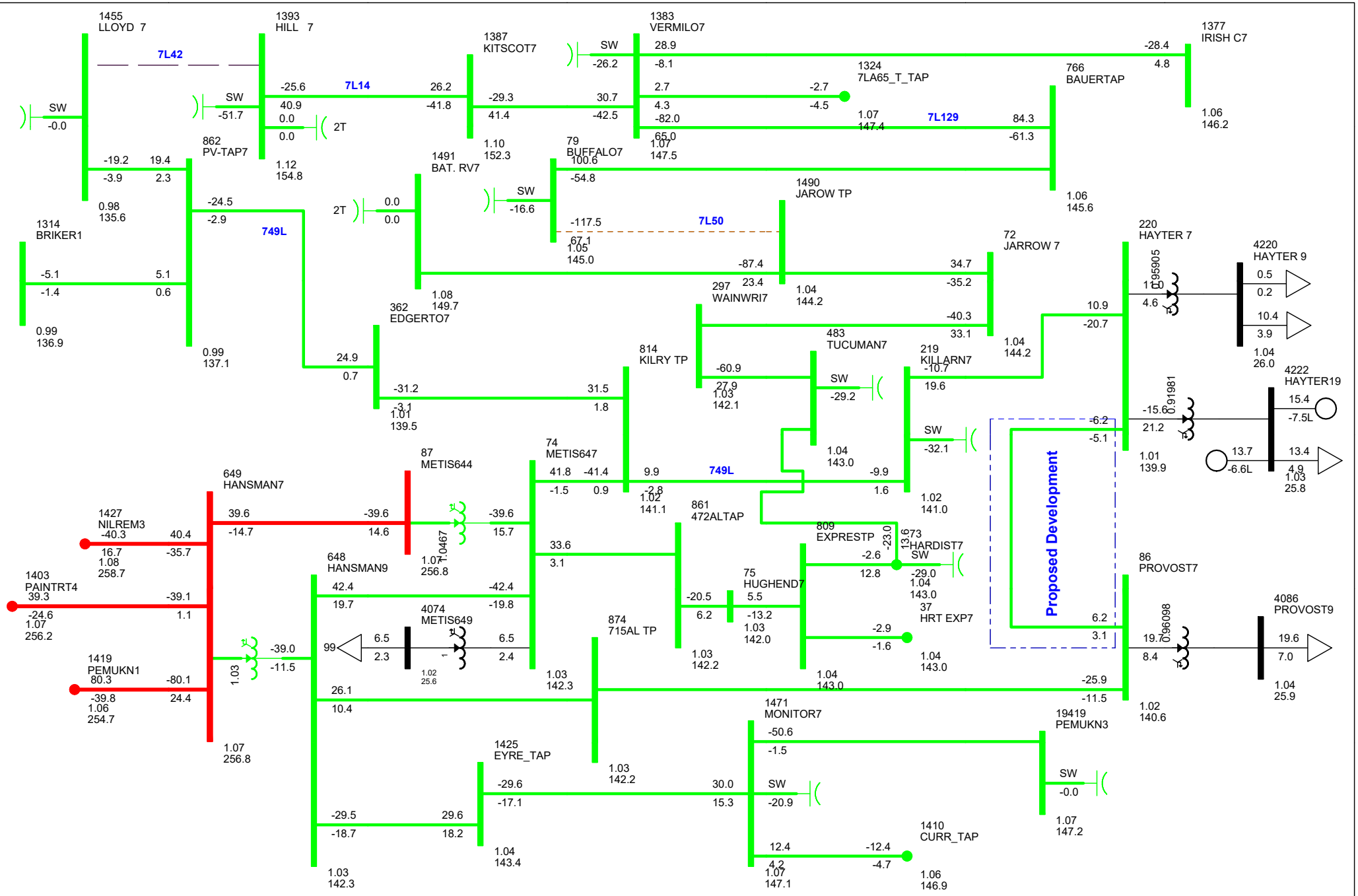
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-11 N-0: NORMAL OPERATION MON, JAN 22 2018 15:48	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



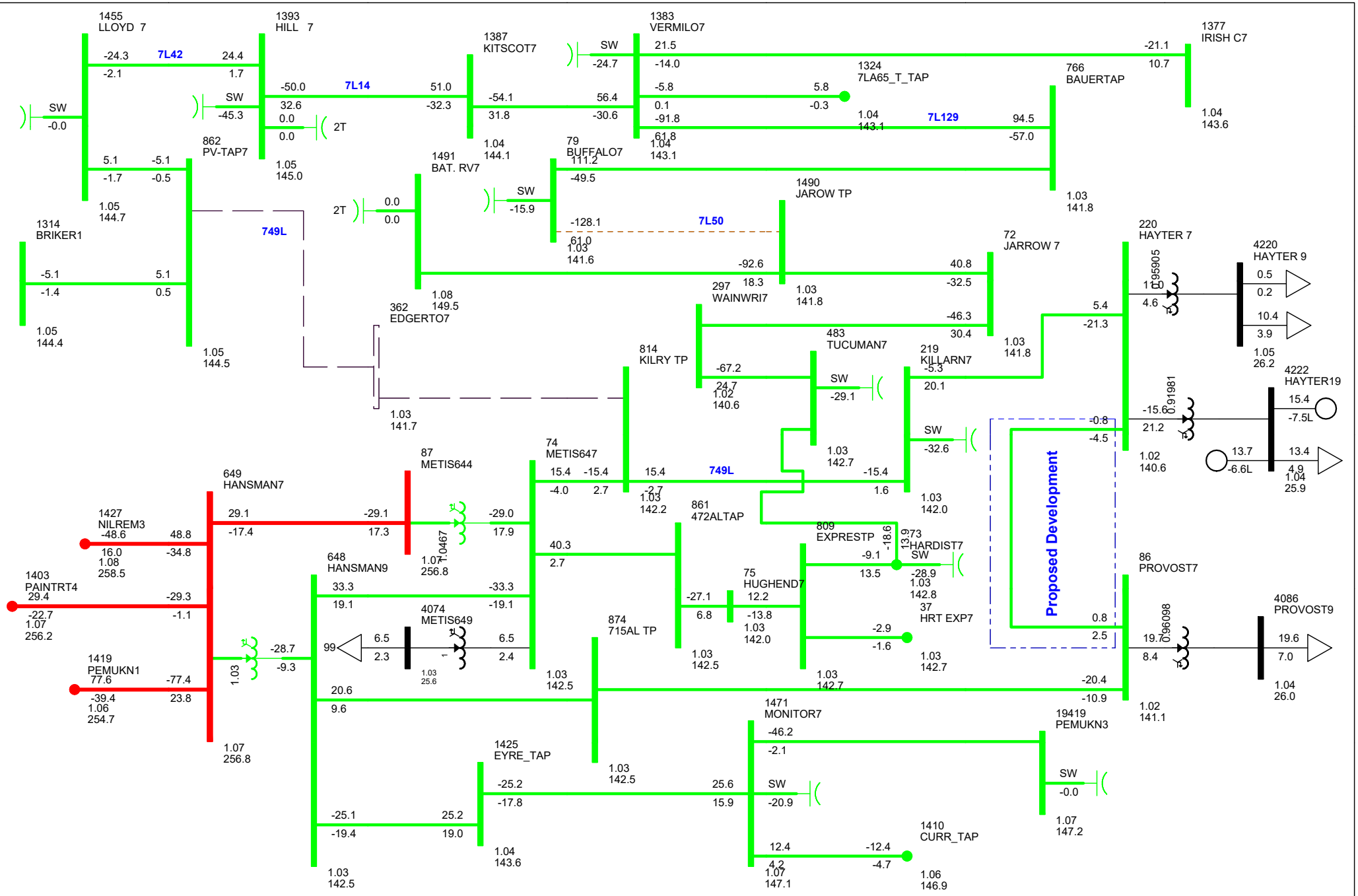
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-12 N-1: METISKOW 648S 138/25 KV TRANSFORMER MON, JAN 22 2018 15:48	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



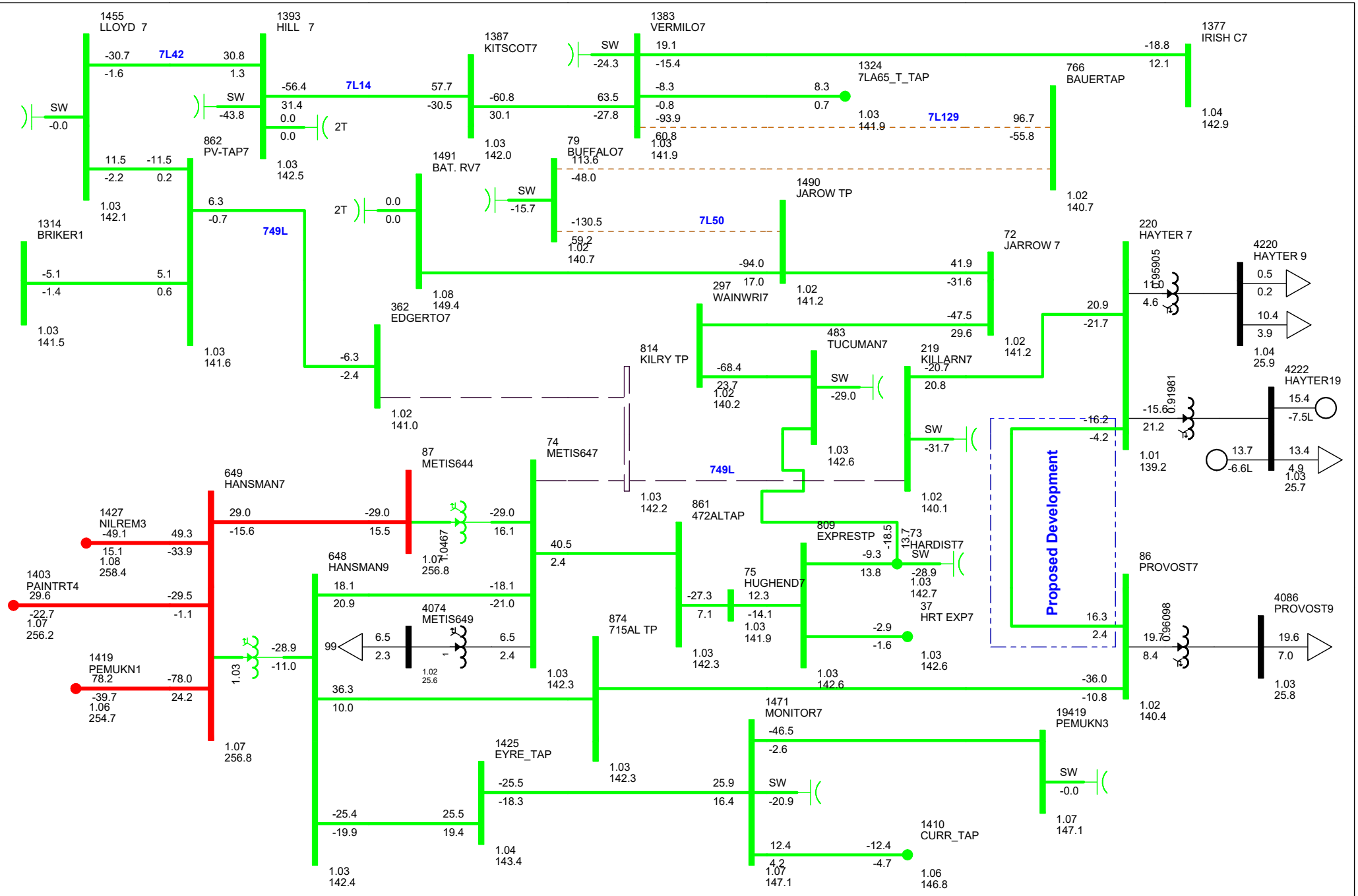
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-13 N-1: 7L14 KITSCOTY 705S TO HILL 751S MON, JAN 22 2018 15:48	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



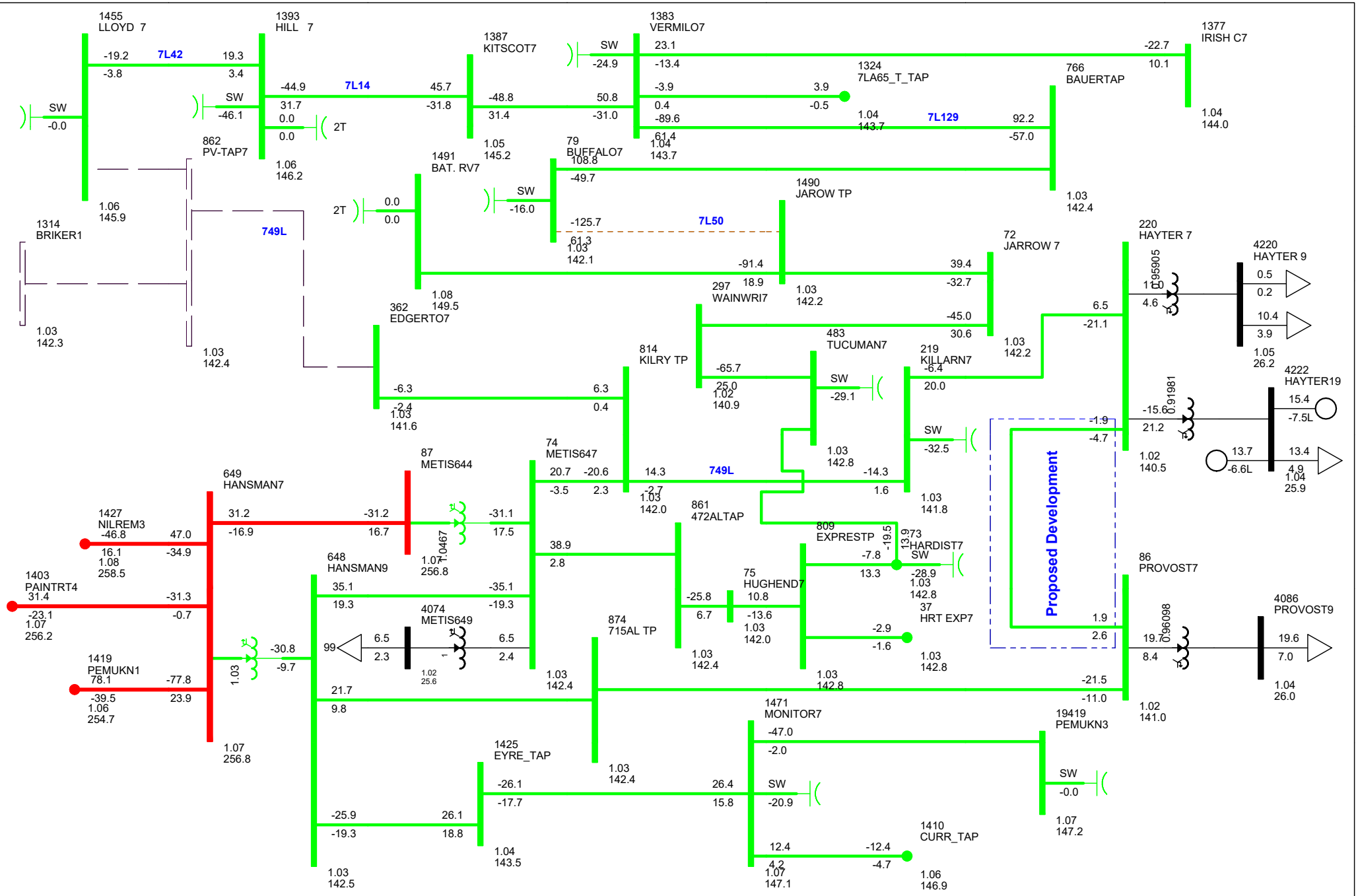
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-14 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S MON, JAN 22 2018 15:49	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



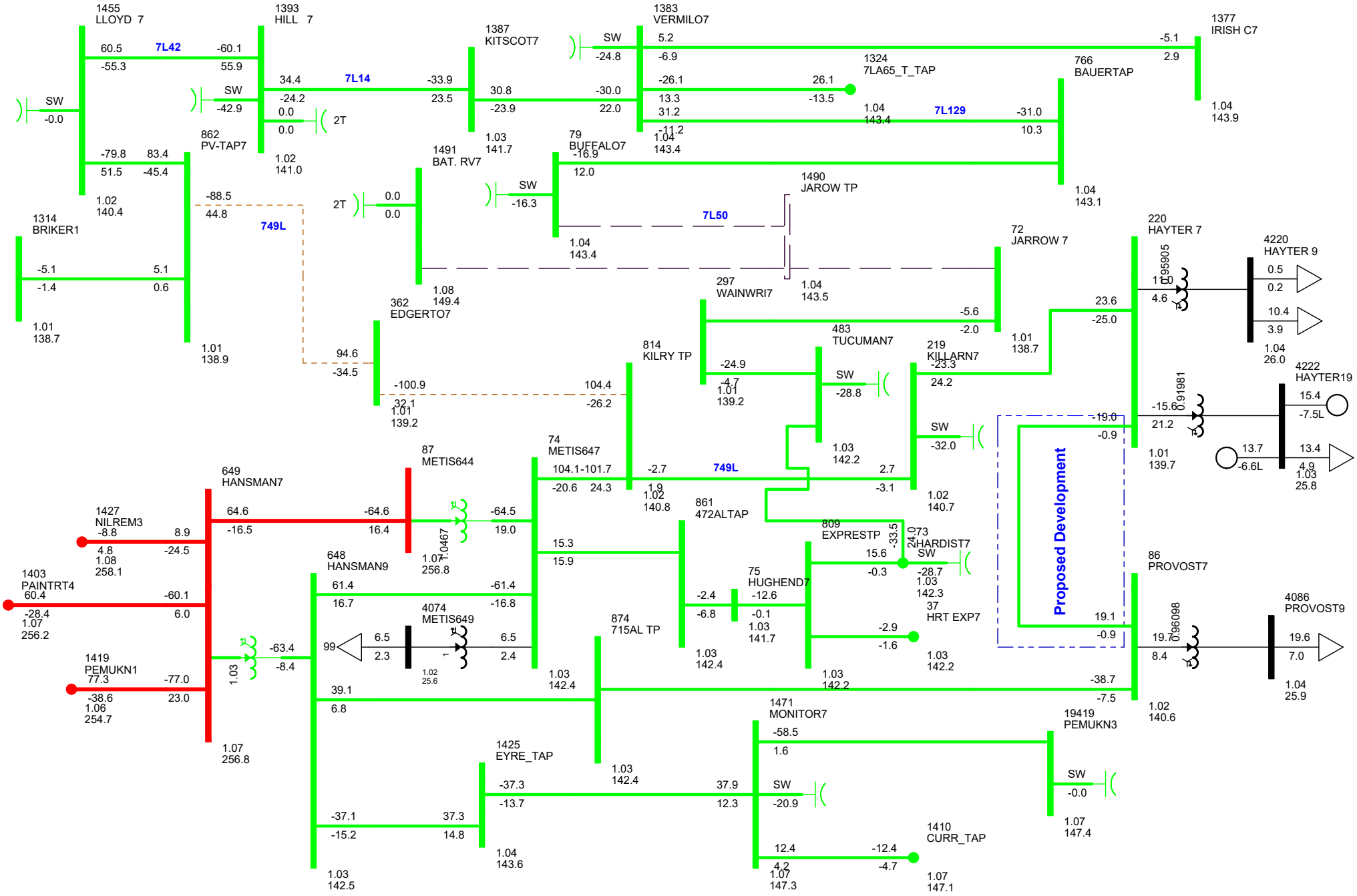
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A3-15 N-1: EDGERTON 899S 138/25 KV TRANSFORMER MON, JAN 22 2018 15:49	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



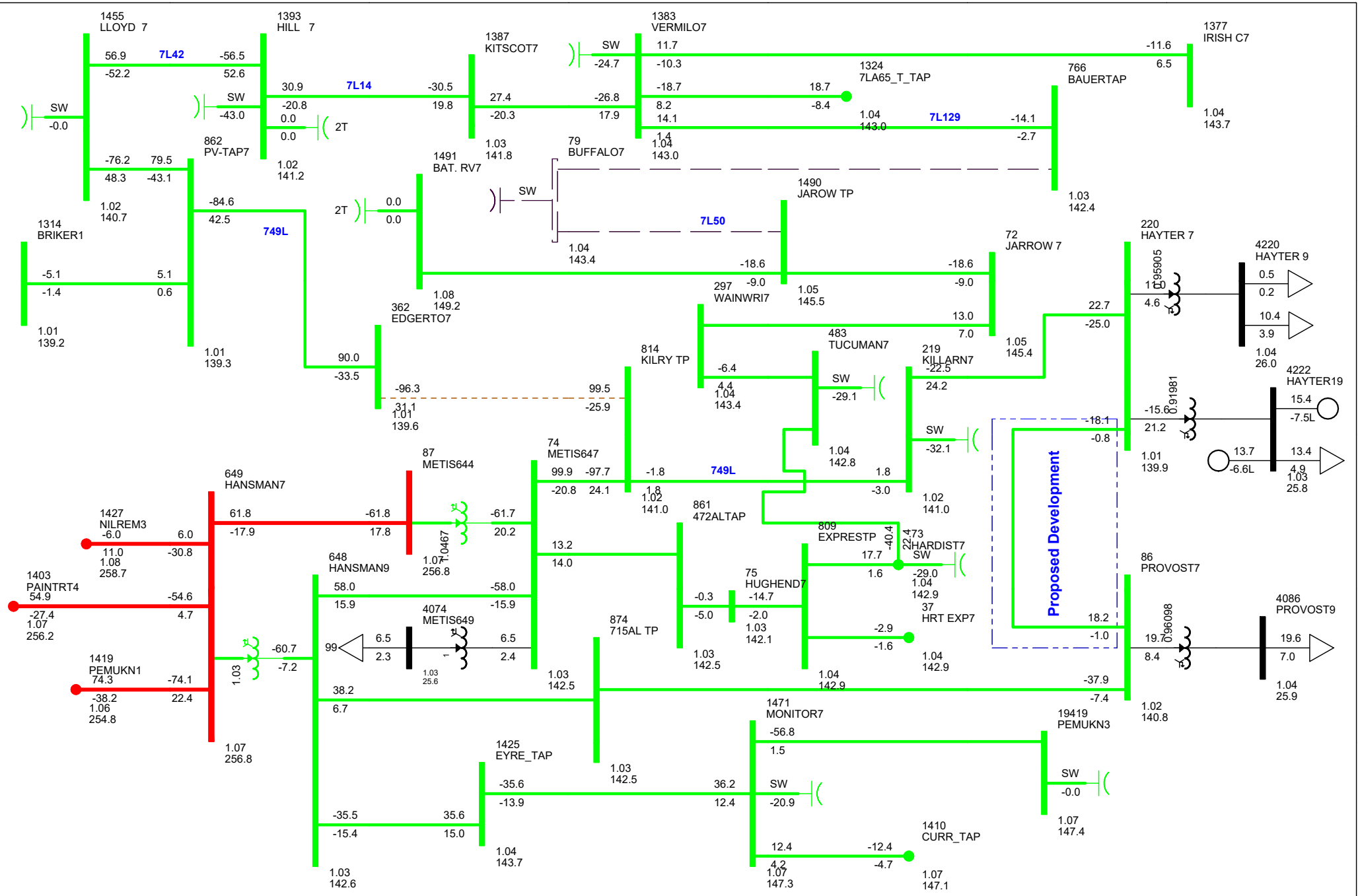
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-16 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S MON, JAN 22 2018 15:50	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



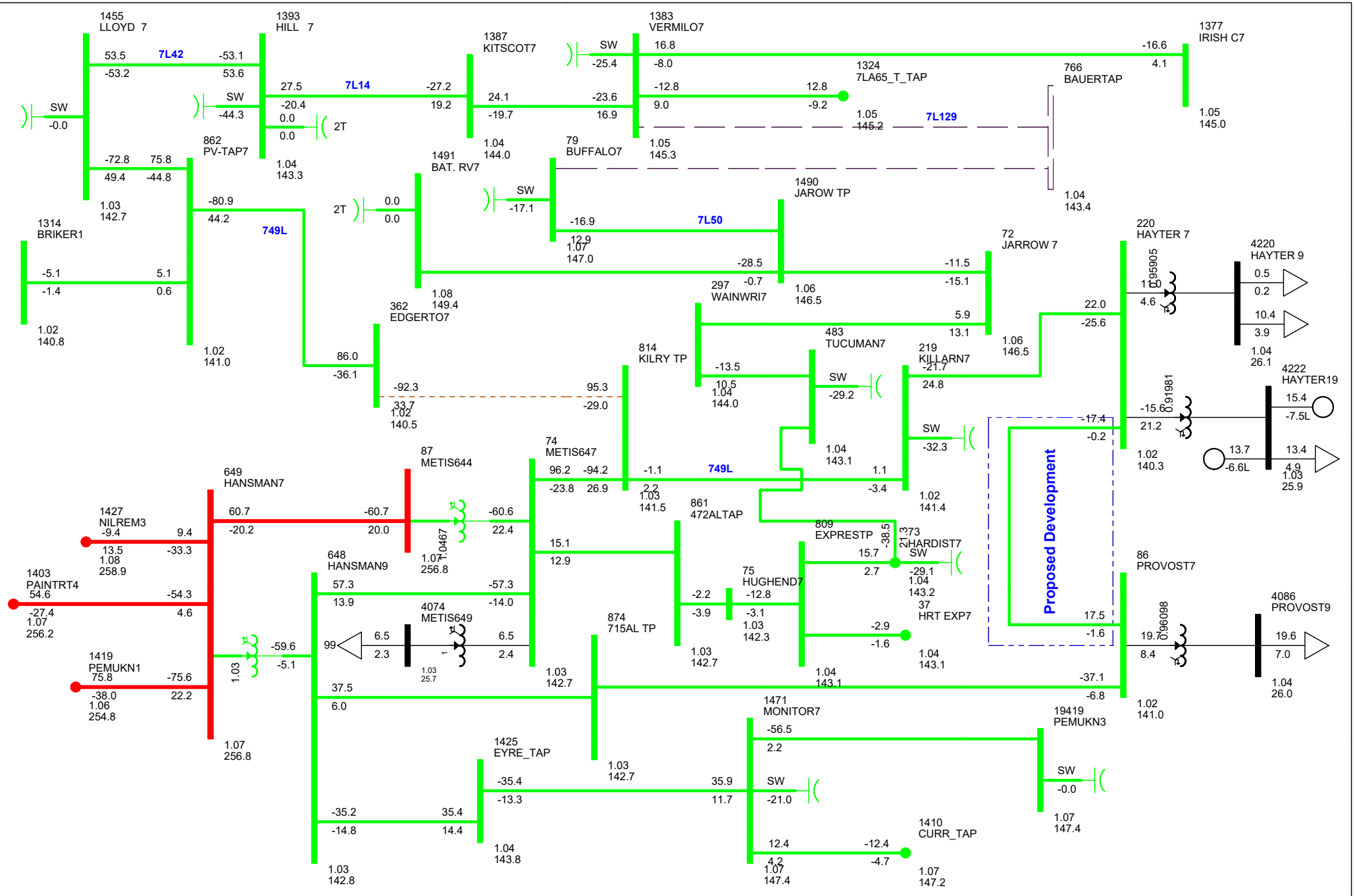
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-17 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S MON, JAN 22 2018 15:51	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



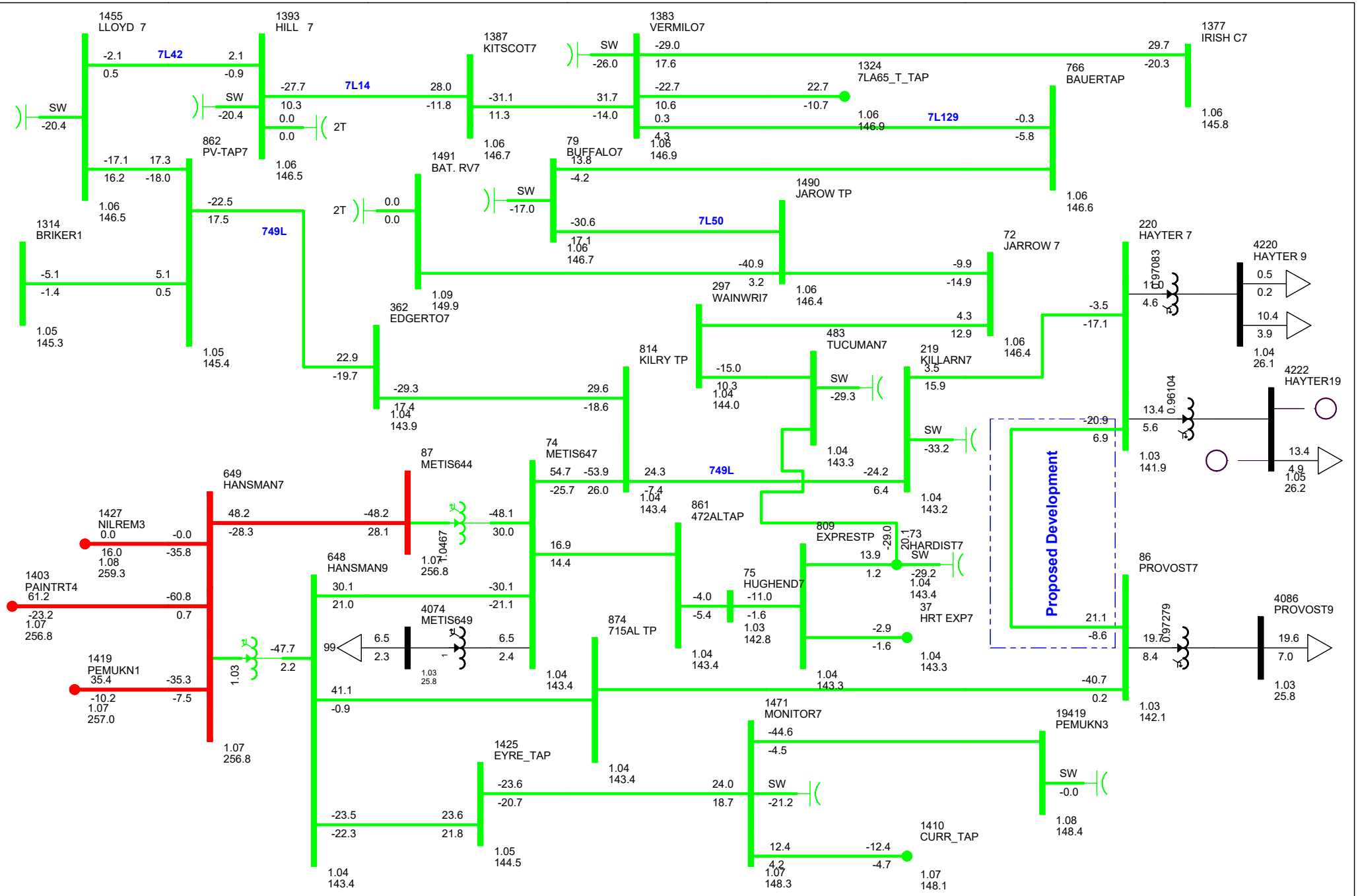
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-18 N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S MON, JAN 22 2018 15:51	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



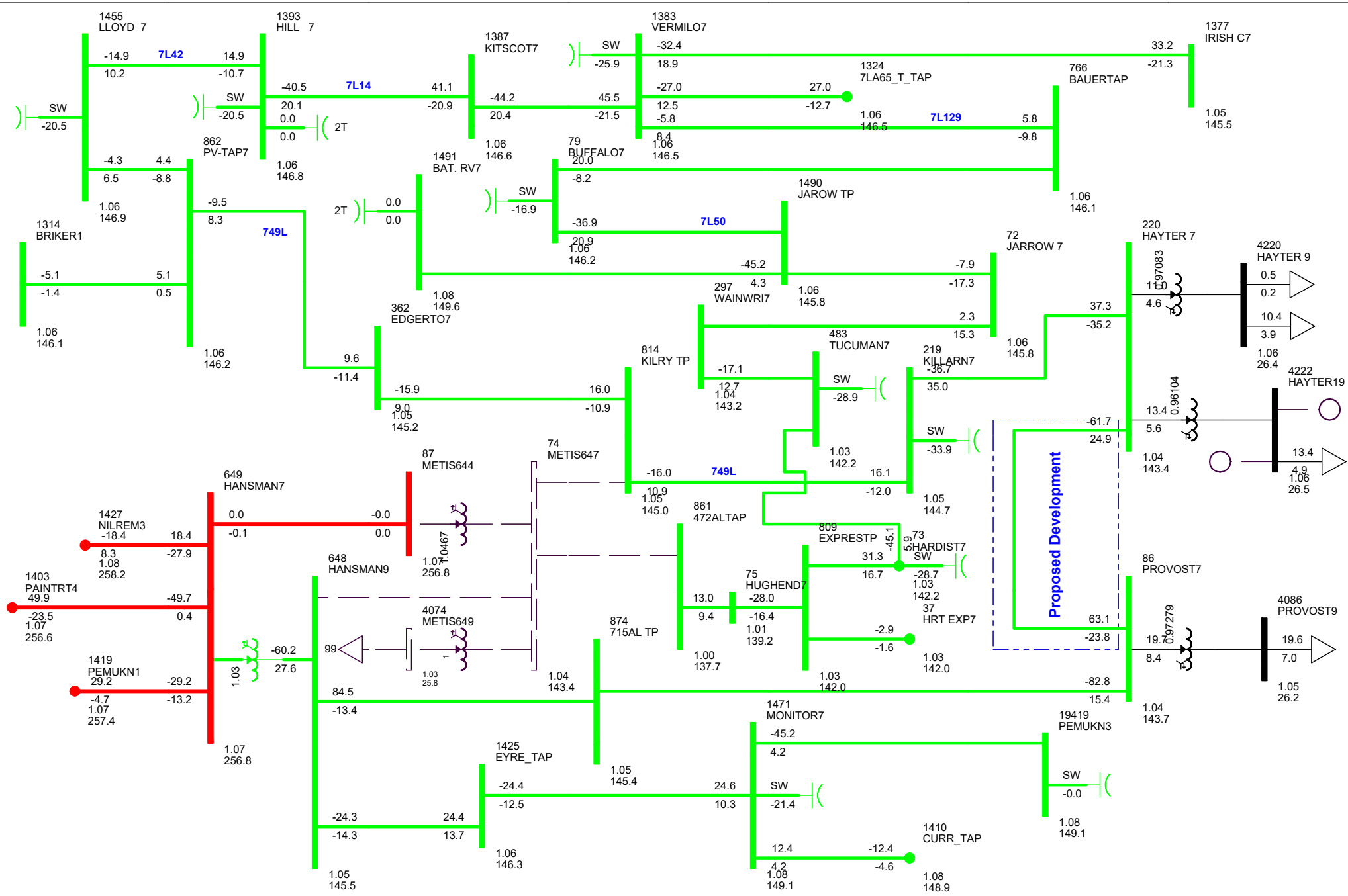
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A3-19 N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER MON, JAN 22 2018 15:51	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



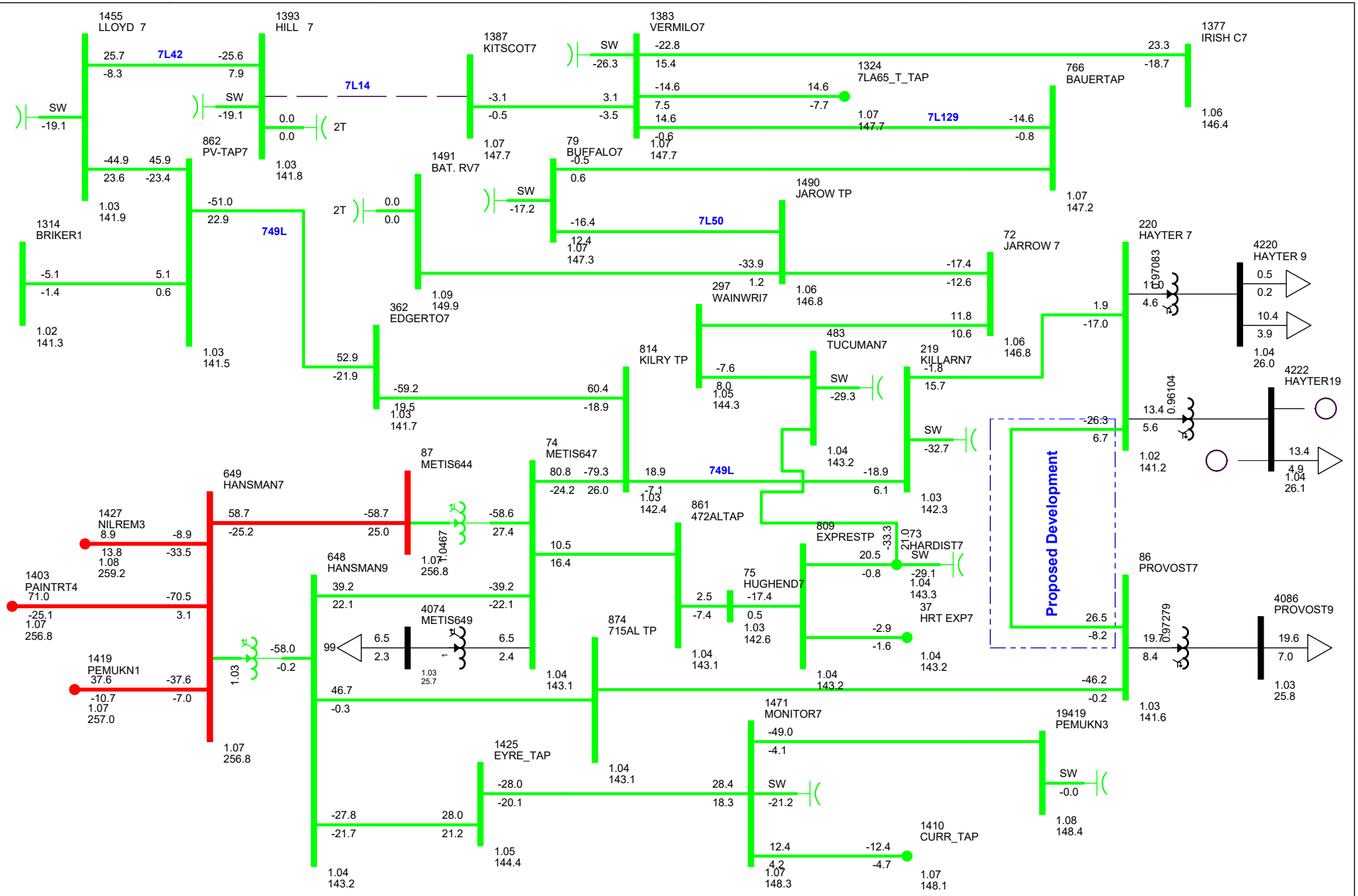
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-20 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S MON, JAN 22 2018 15:52	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



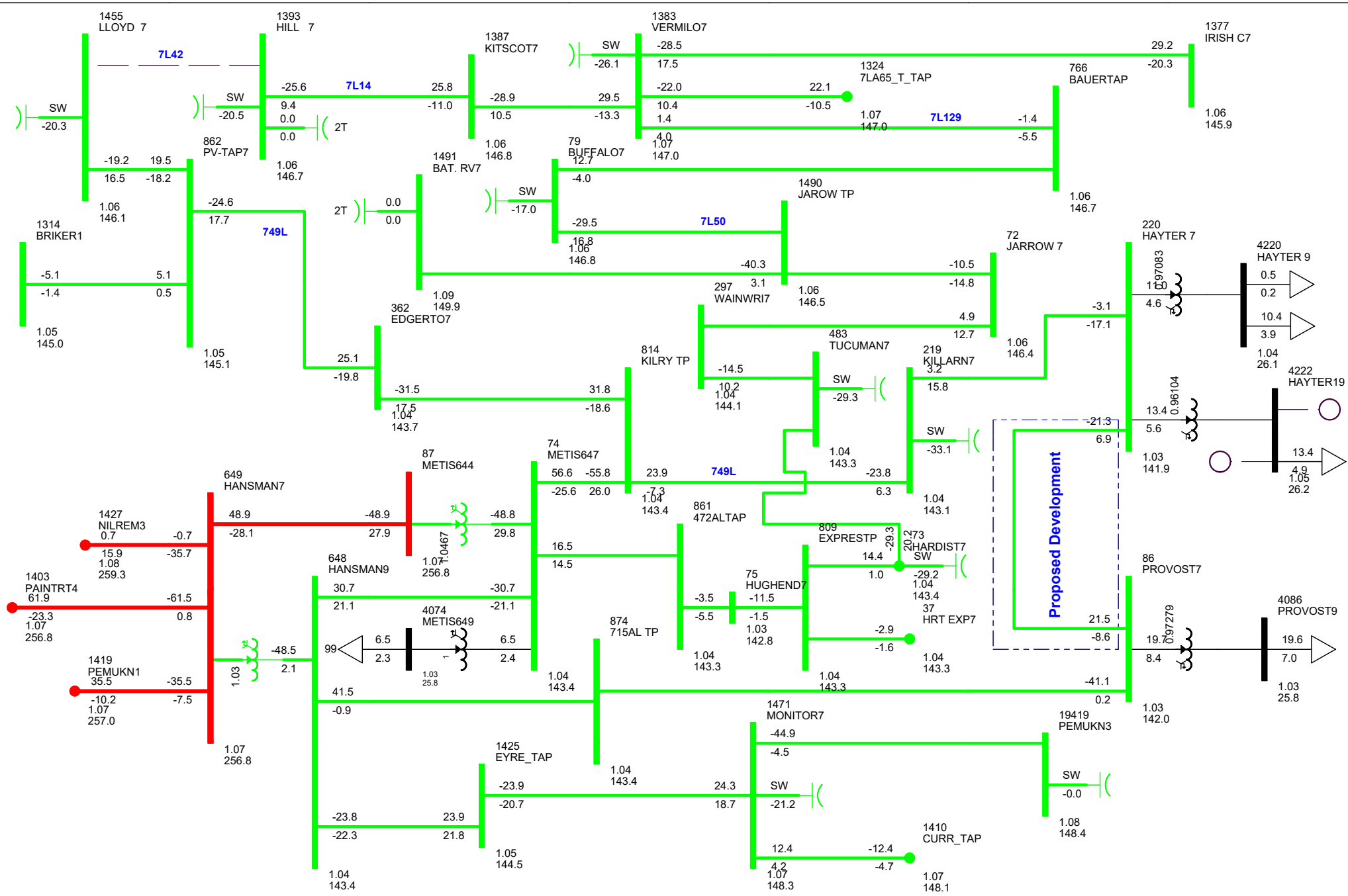
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-21 N-0: NORMAL OPERATION THU, JAN 25 2018 17:50	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



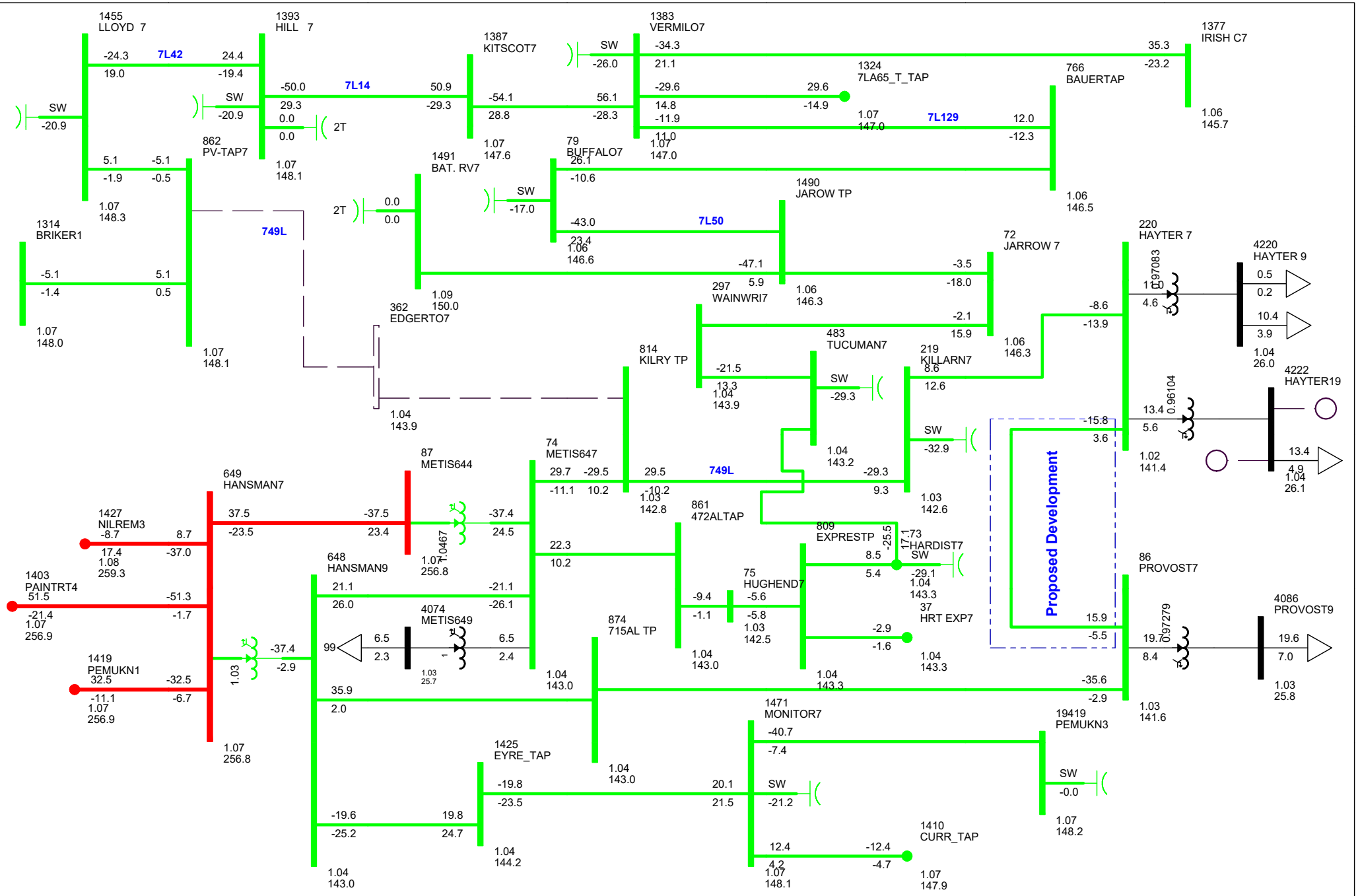
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-22 N-1: METISKOW 648S 138/25 KV TRANSFORMER THU, JAN 25 2018 17:51	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



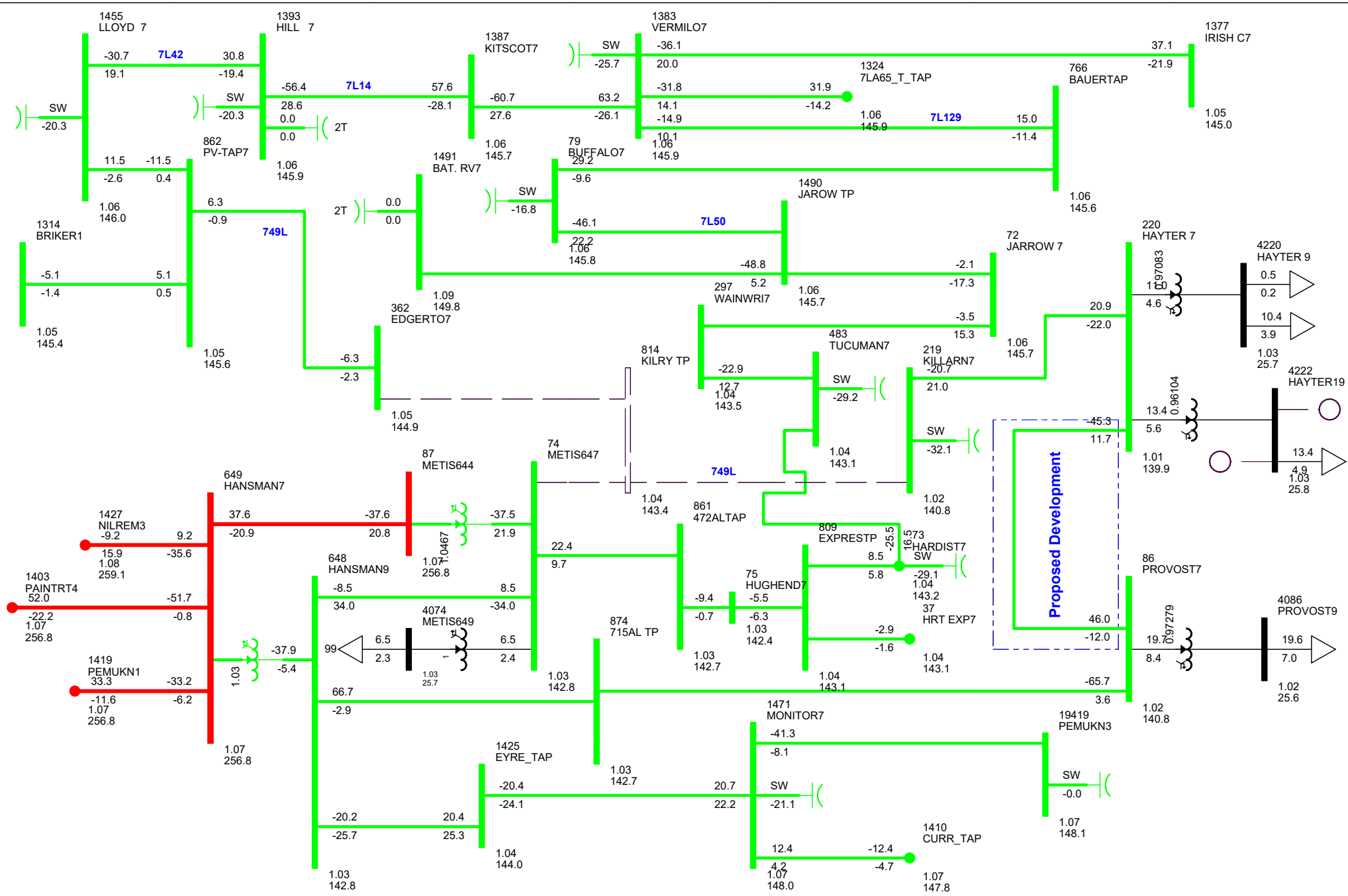
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-23 N-1: 7L14 KITSCOTY 705S TO HILL 751S THU, JAN 25 2018 17:51	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



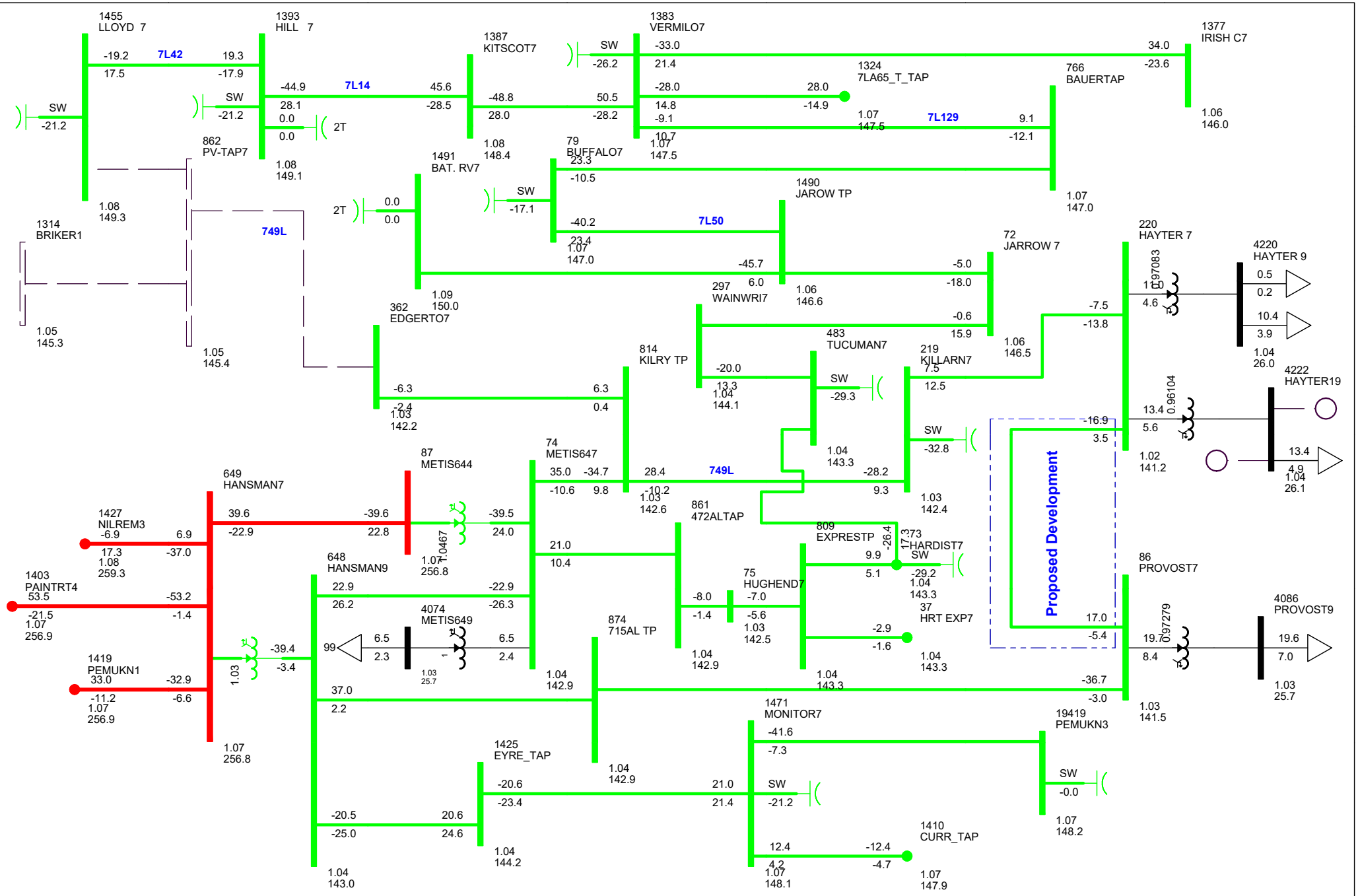
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-24 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S THU, JAN 25 2018 17:51	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



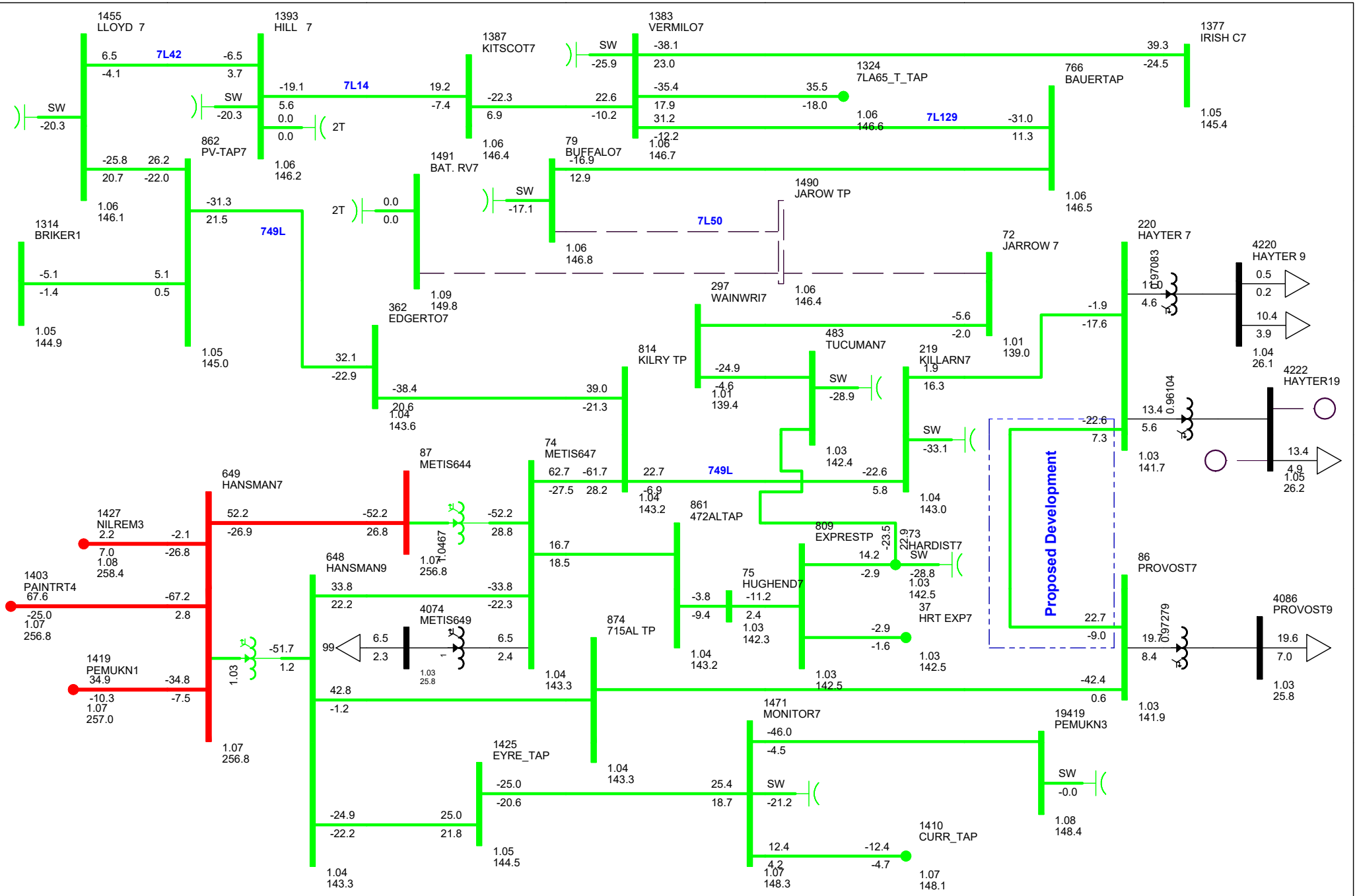
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A3-25 N-1: EDGERTON 899S 138/25 KV TRANSFORMER THU, JAN 25 2018 17:52	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



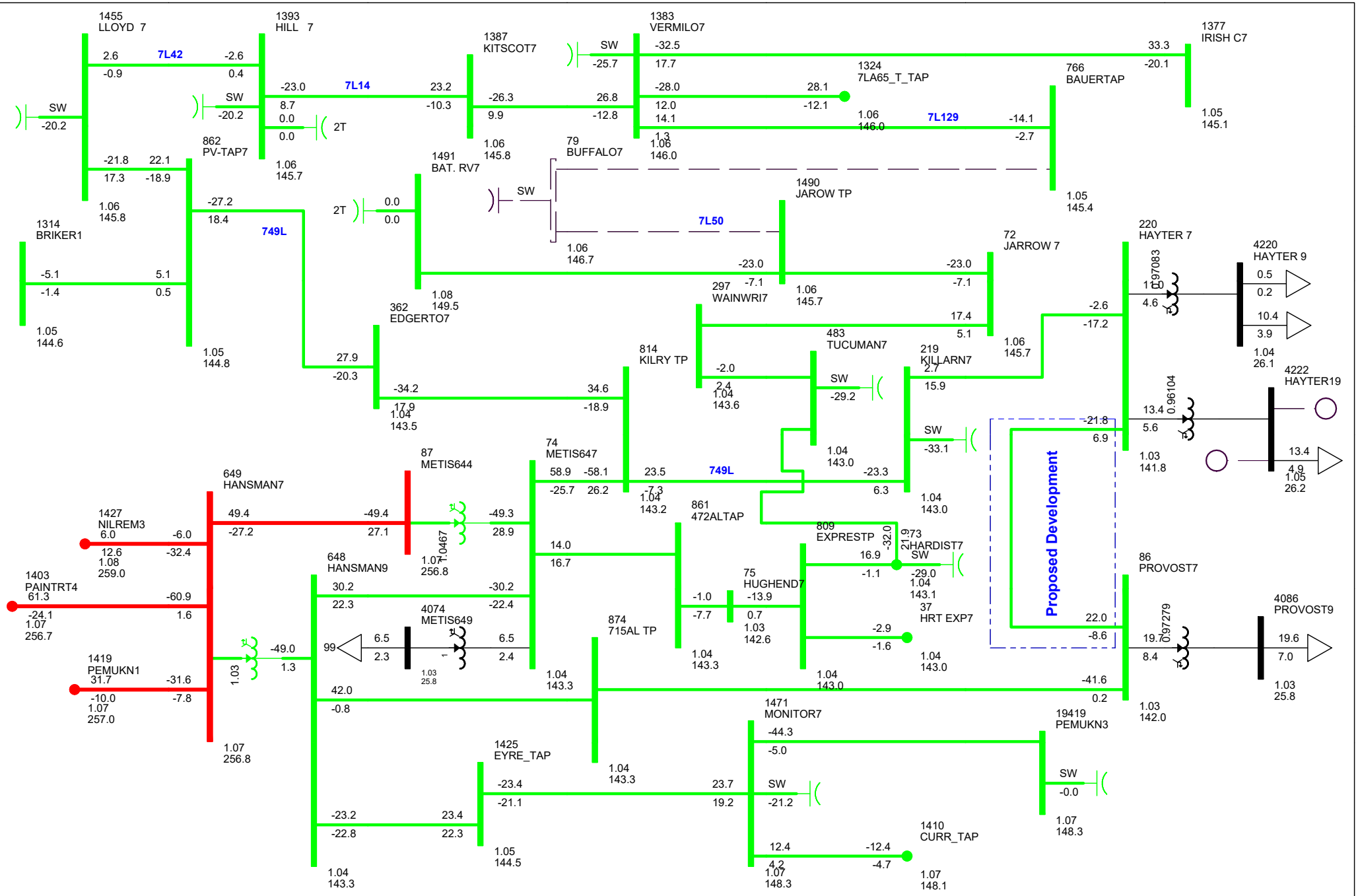
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-26 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S THU, JAN 25 2018 17:52	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



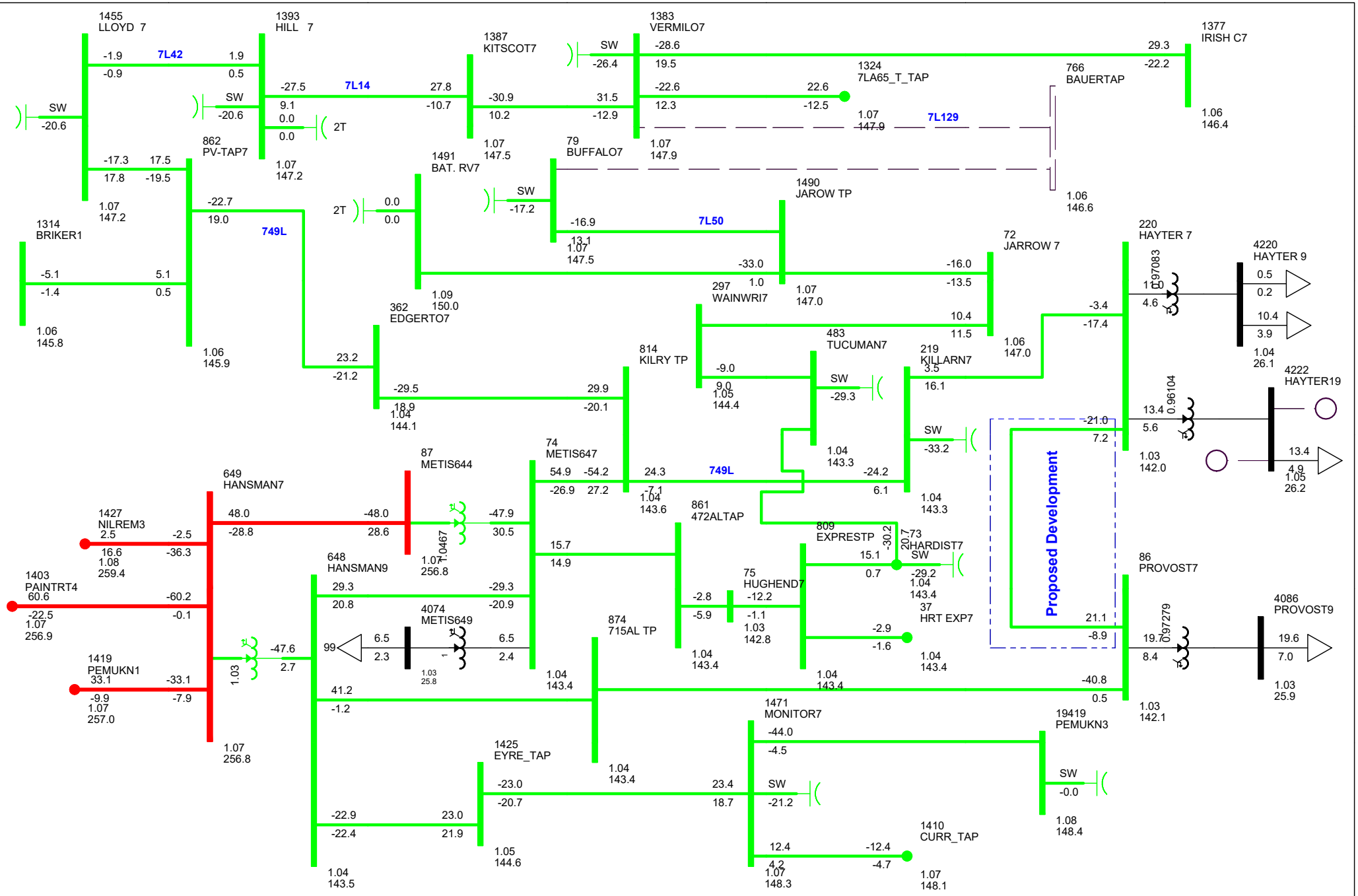
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-27 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S THU, JAN 25 2018 17:52	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



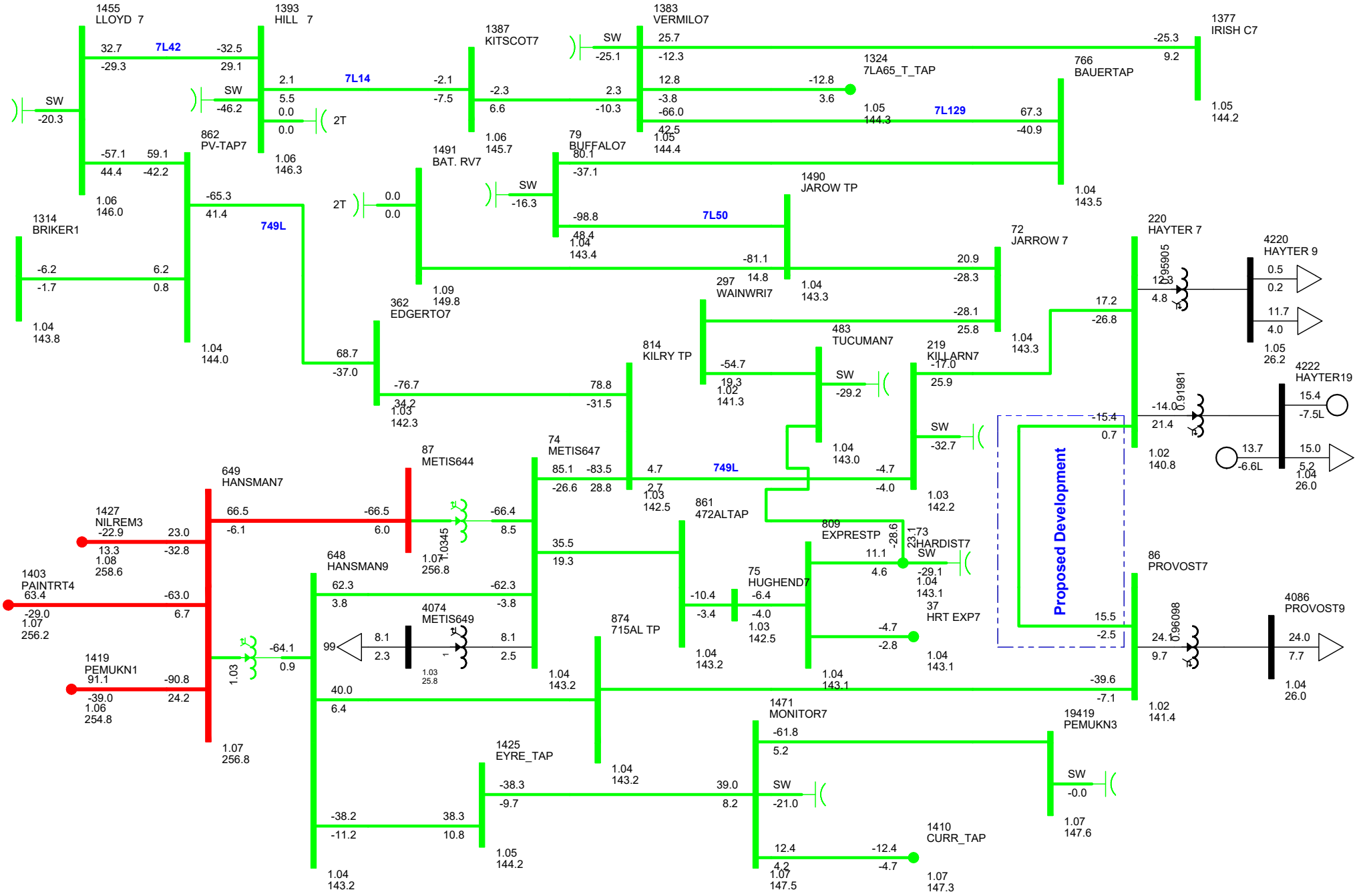
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-28 N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S THU, JAN 25 2018 17:52	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



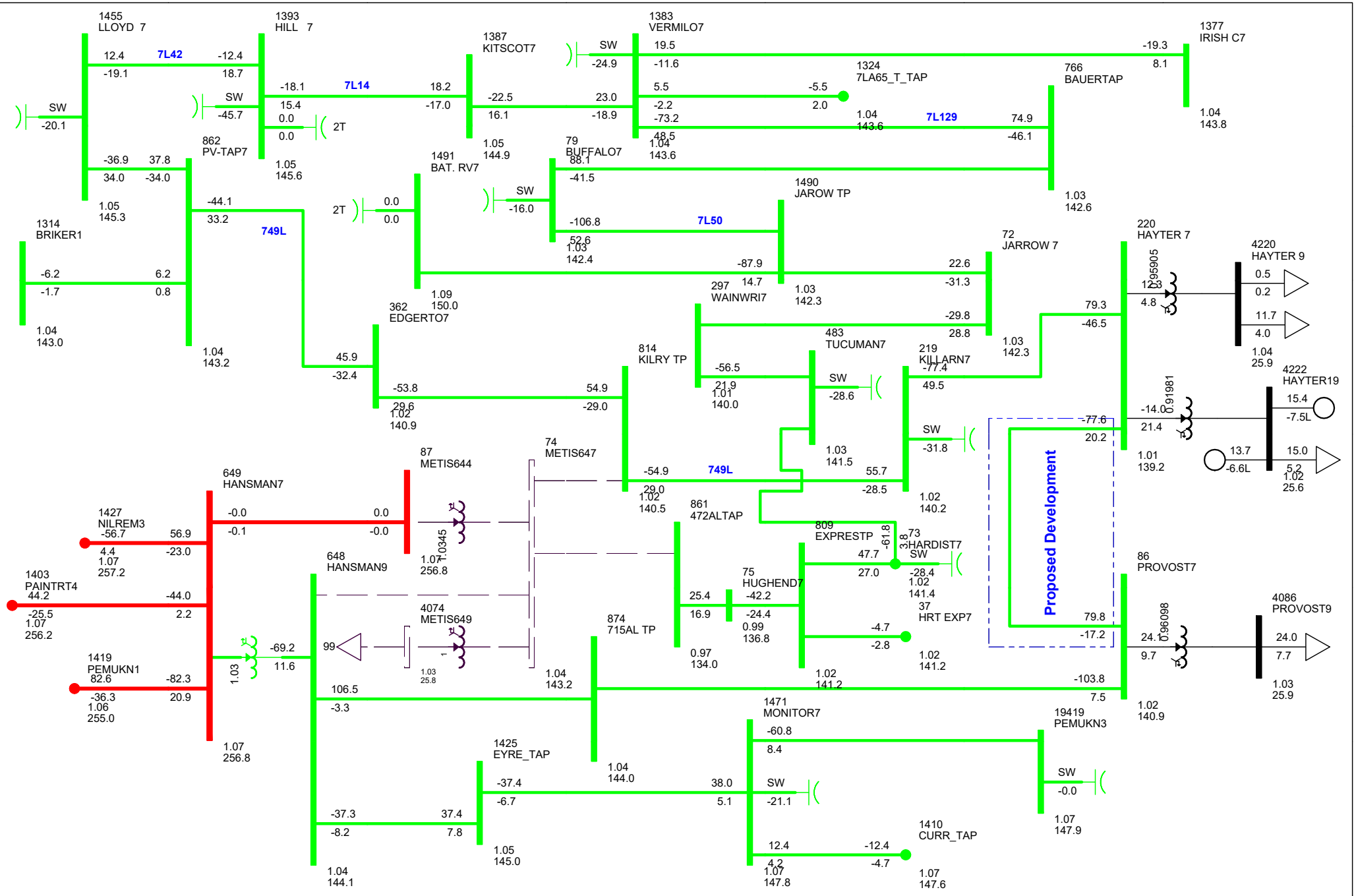
Provost Area Reliability Project 1782 2020 SP	P1782 PRE-CONNECTION - DIAGRAM A3-29 N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER THU, JAN 25 2018 17:52	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



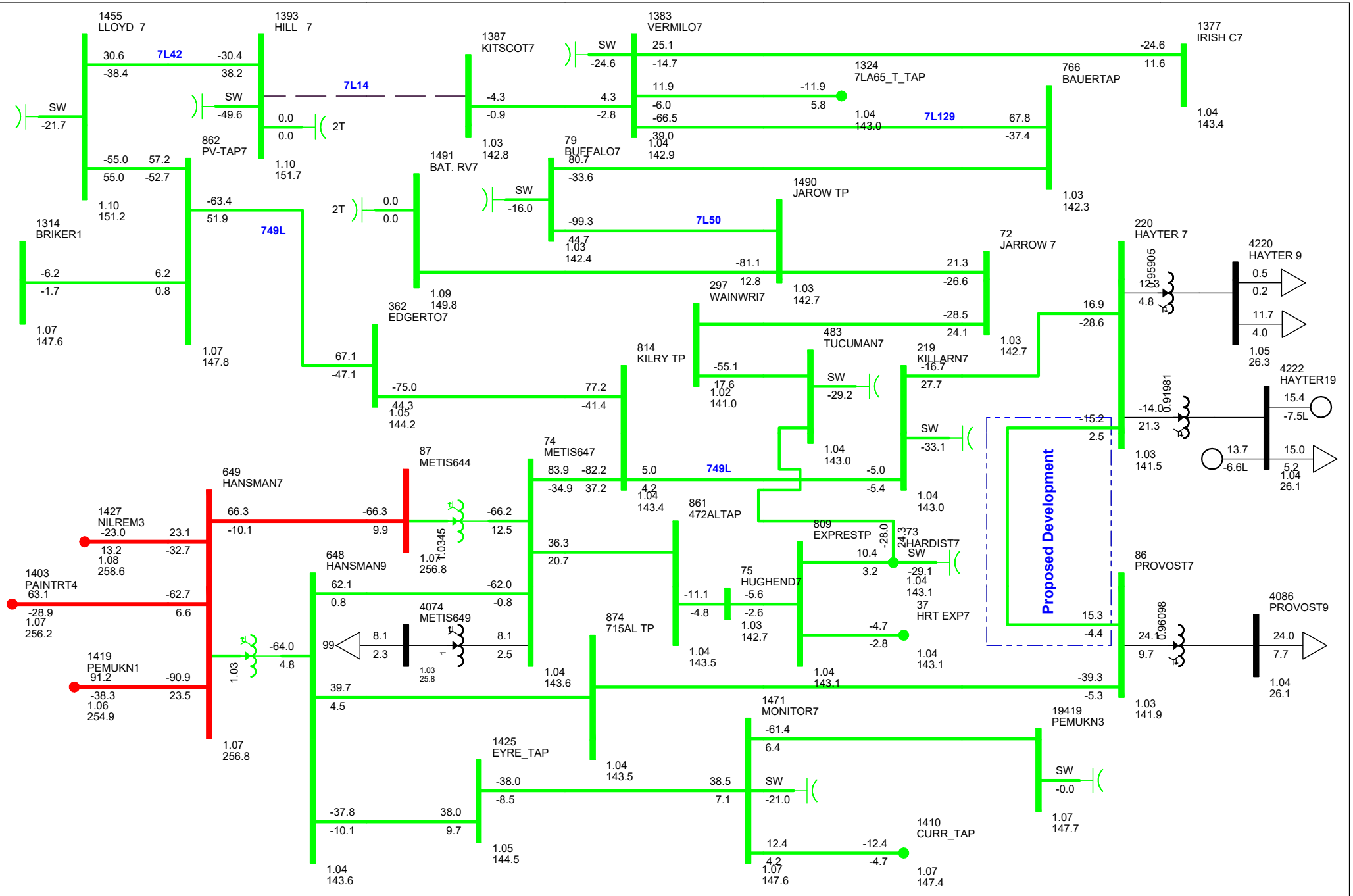
Provost Area Reliability Project 1782 2020 SP	P1782 POST-CONNECTION - DIAGRAM A3-30 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S THU, JAN 25 2018 17:53	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



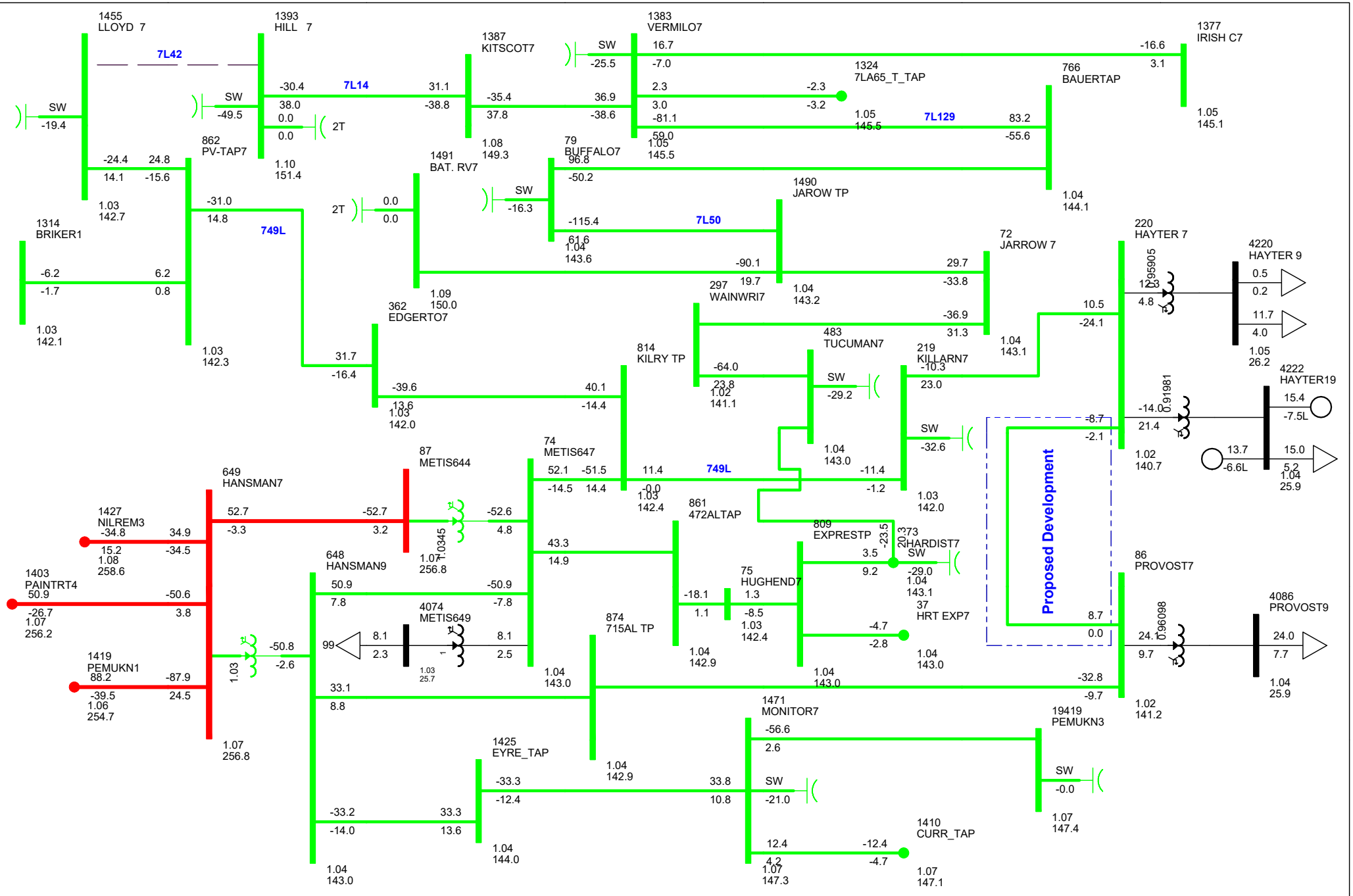
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-31 N-0: NORMAL OPERATION THU, JAN 25 2018 17:43	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



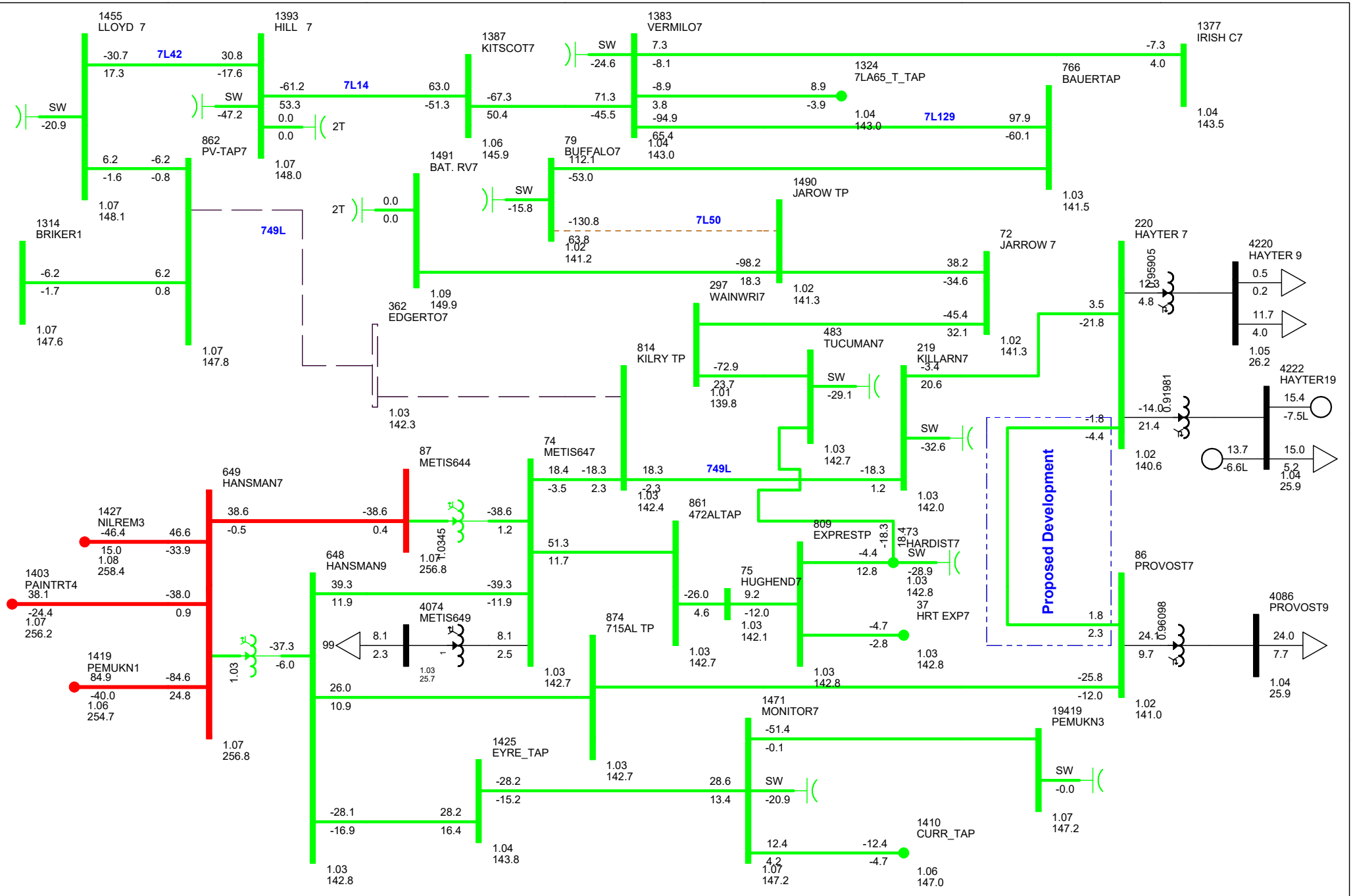
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-32 N-1: METISKOW 648S 138/25 KV TRANSFORMER THU, JAN 25 2018 17:43	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



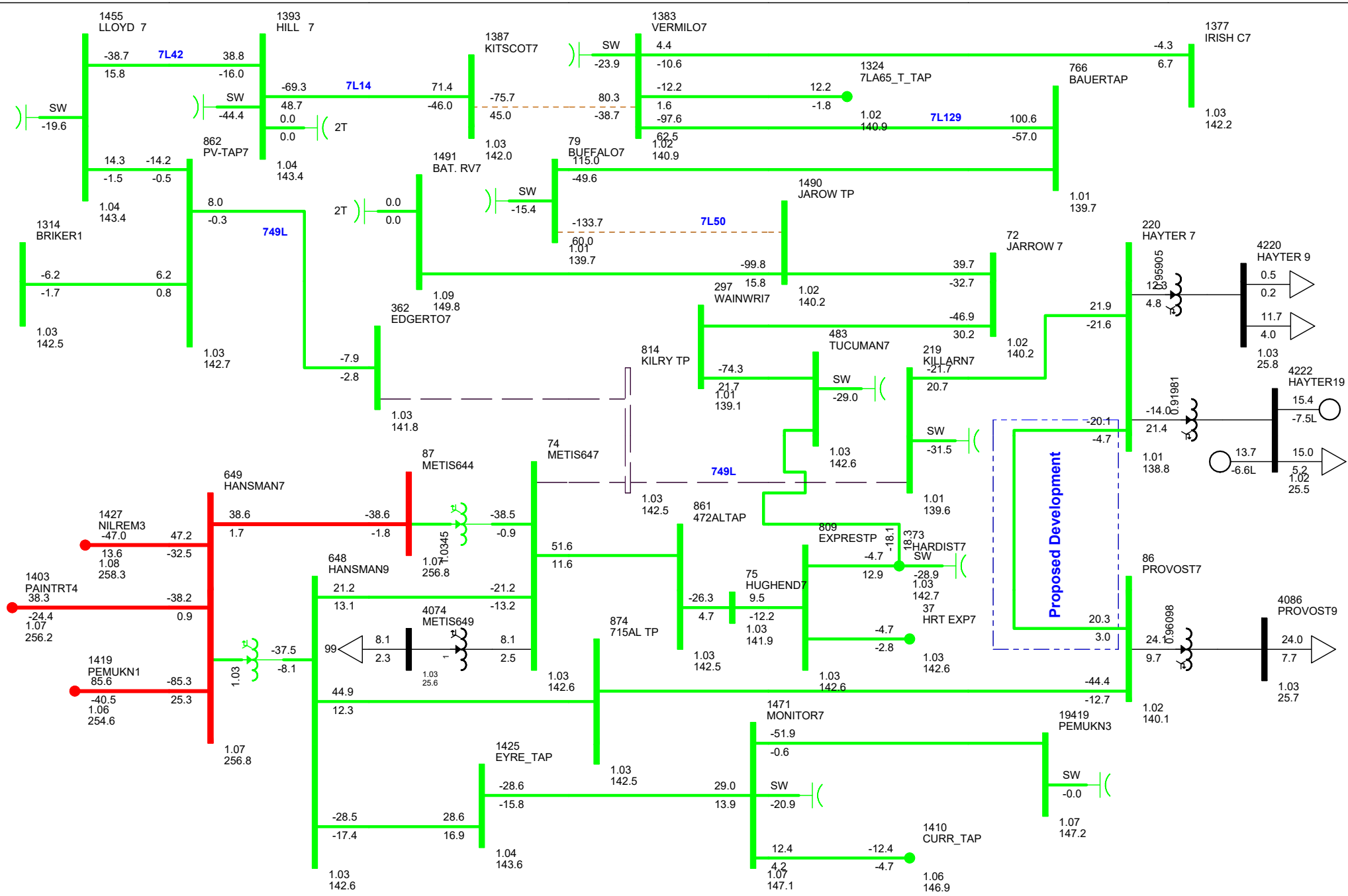
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-33 N-1: 7L14 KITSCOTY 705S TO HILL 751S THU, JAN 25 2018 17:44	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



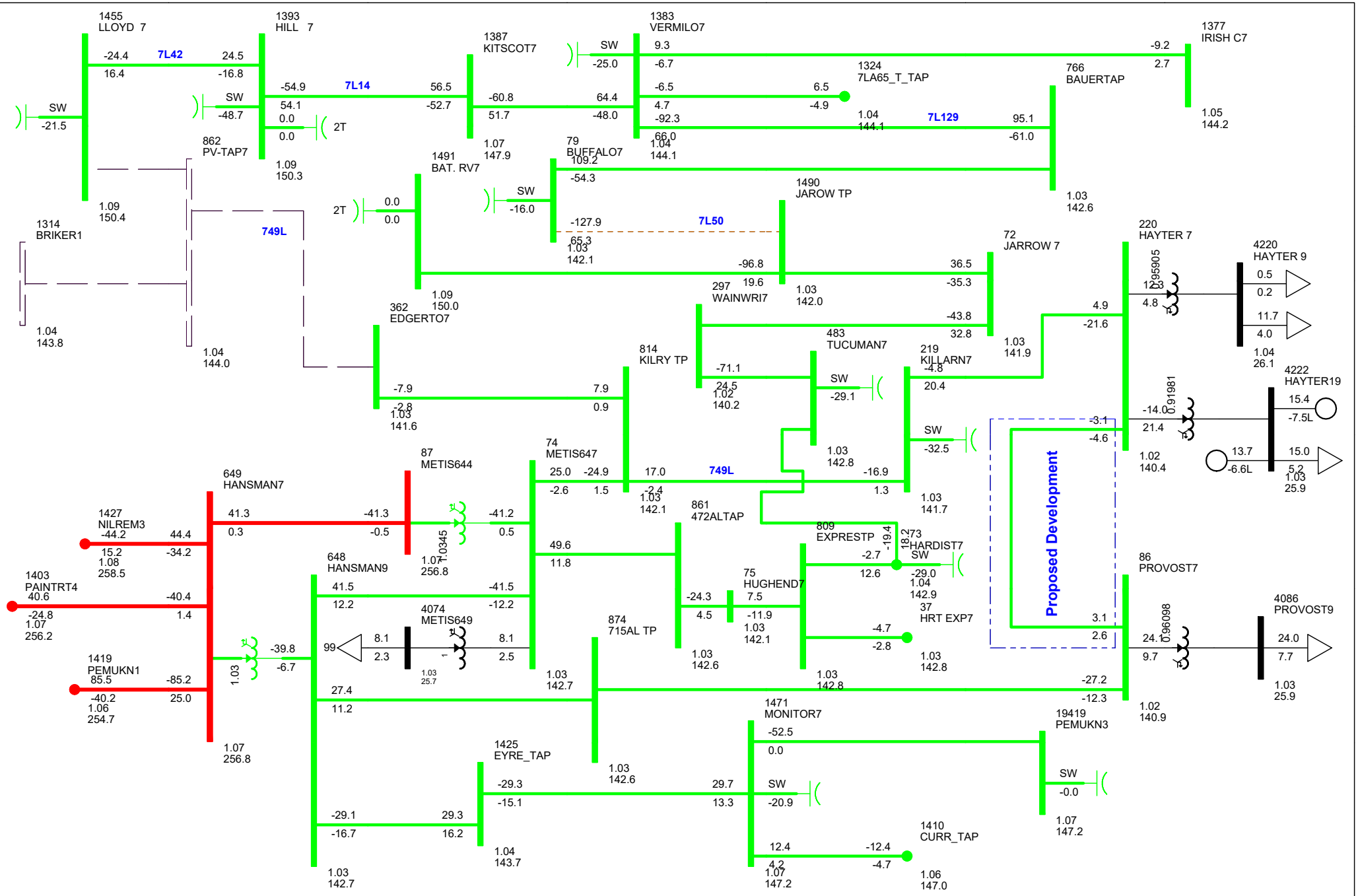
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-34 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S THU, JAN 25 2018 17:44	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



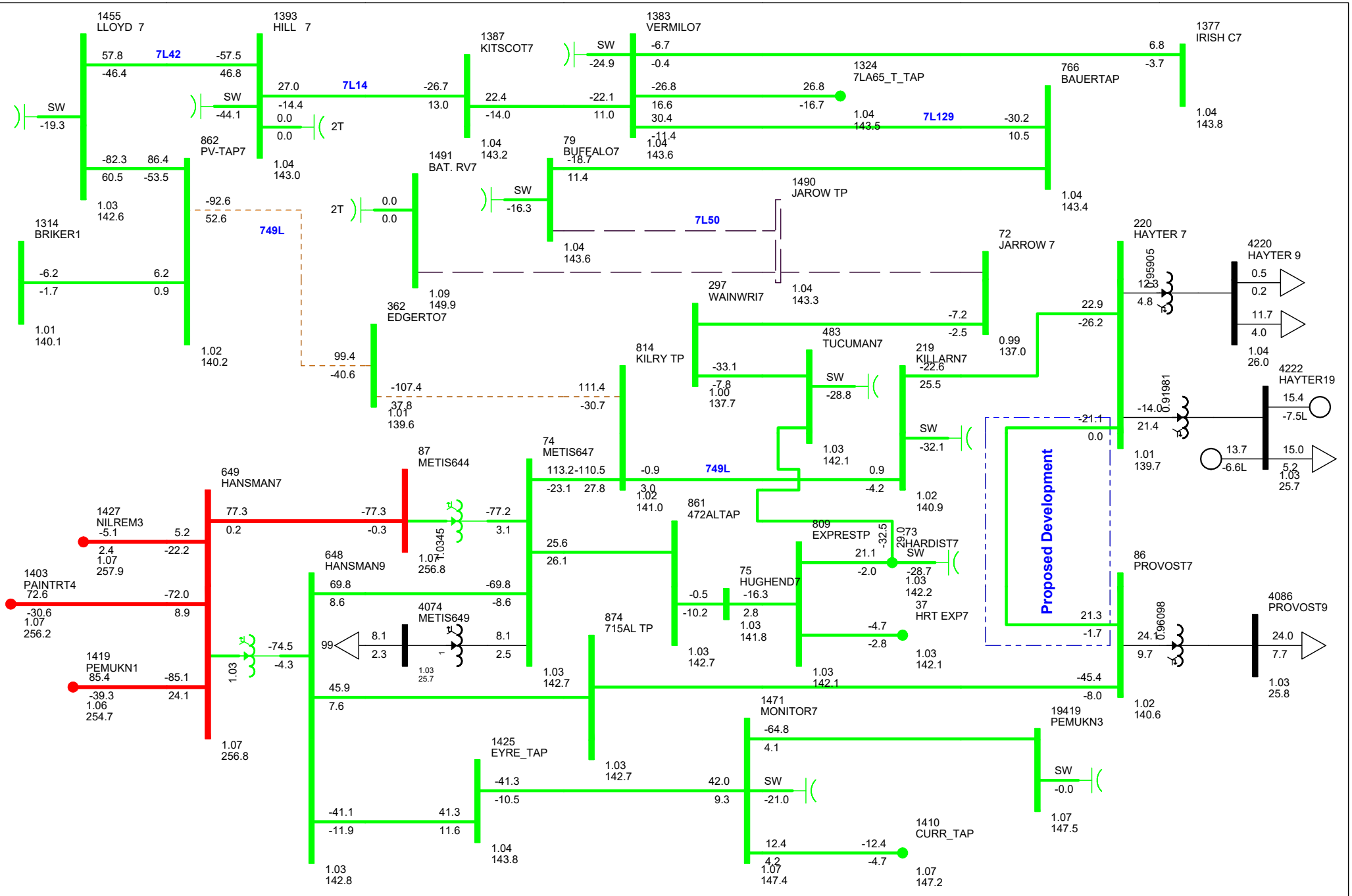
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A3-35 N-1: EDGERTON 899S 138/25 KV TRANSFORMER THU, JAN 25 2018 17:44	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



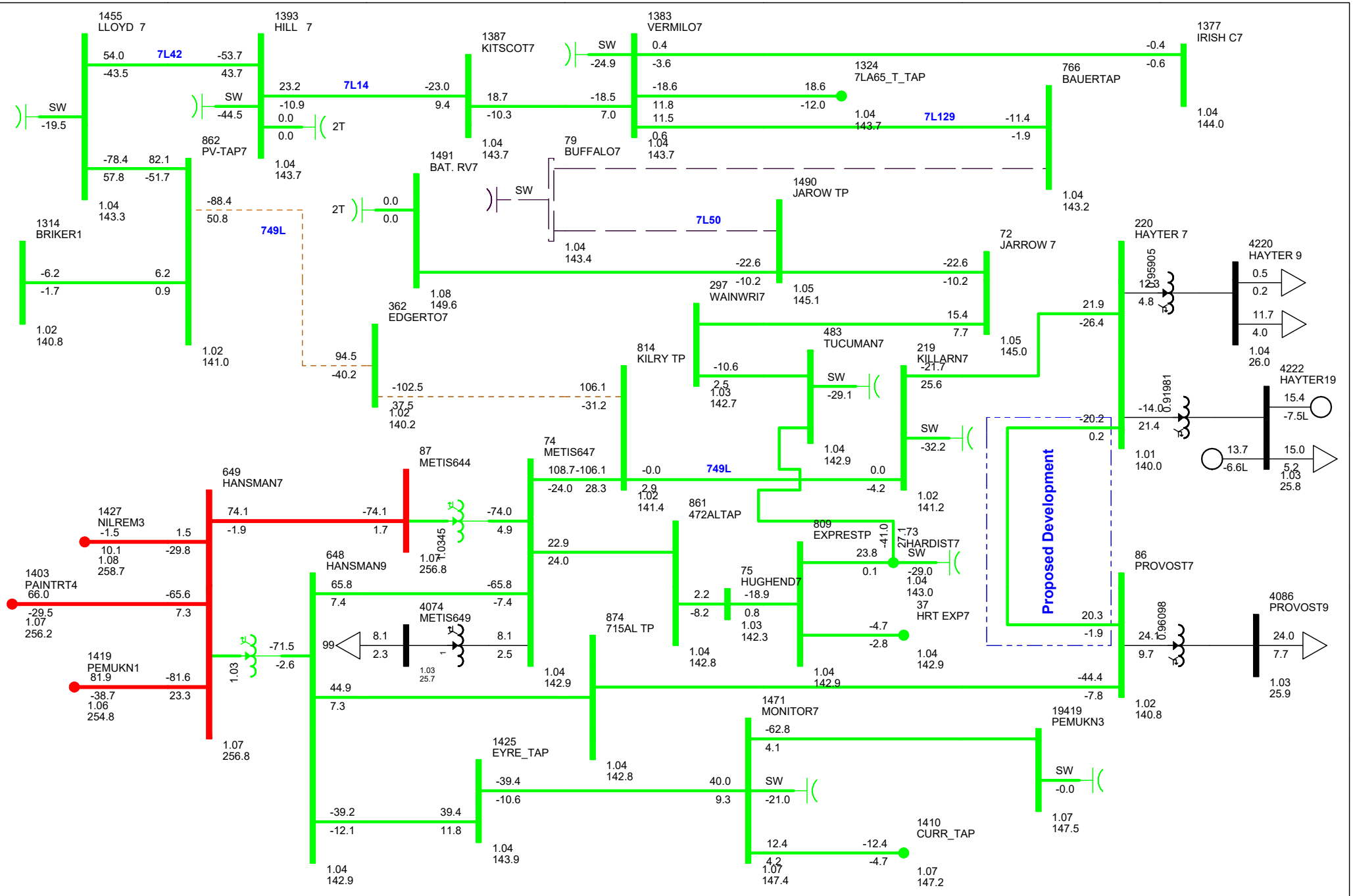
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-36 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S THU, JAN 25 2018 17:45	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



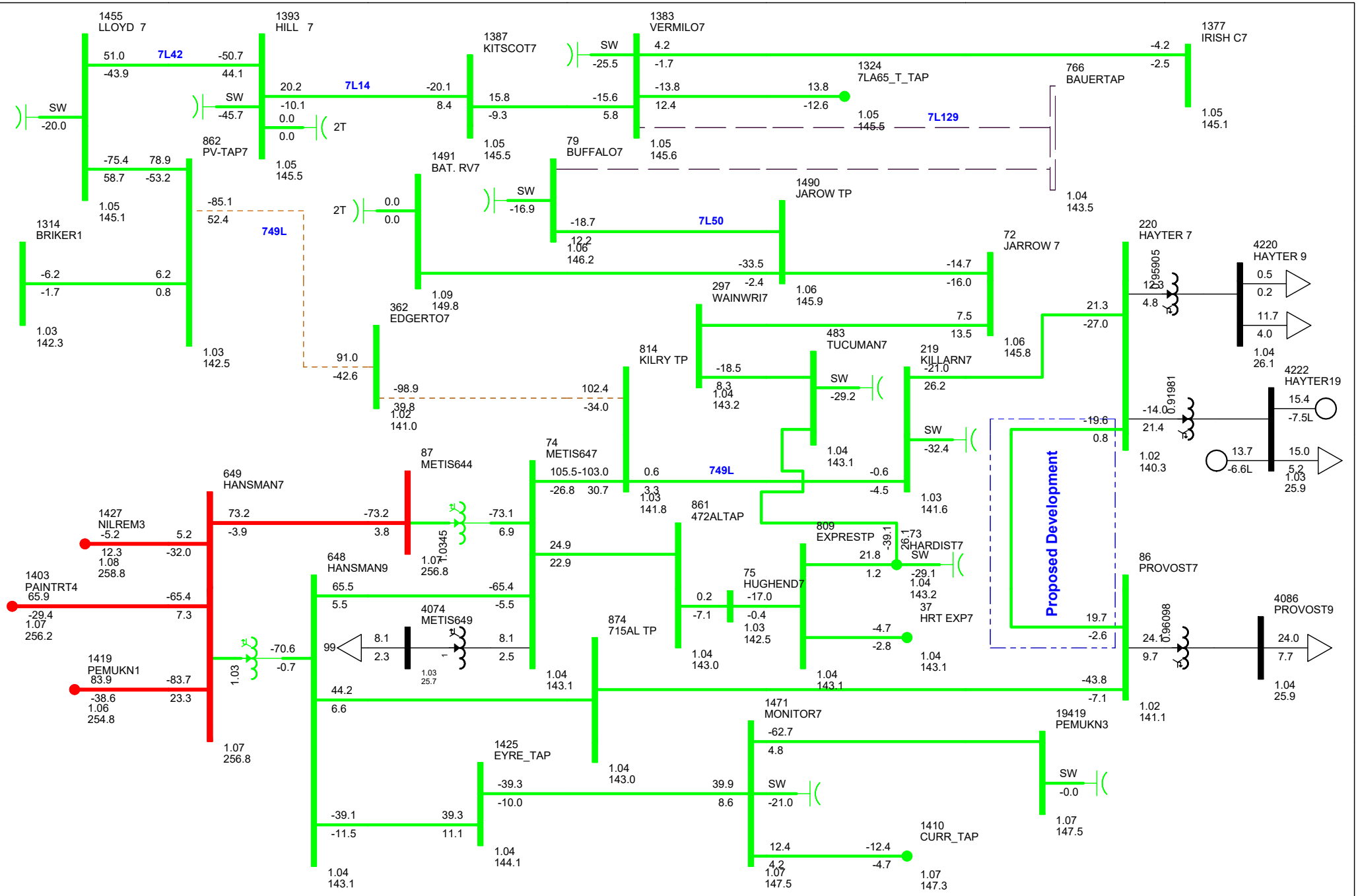
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-37 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S THU, JAN 25 2018 17:45	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



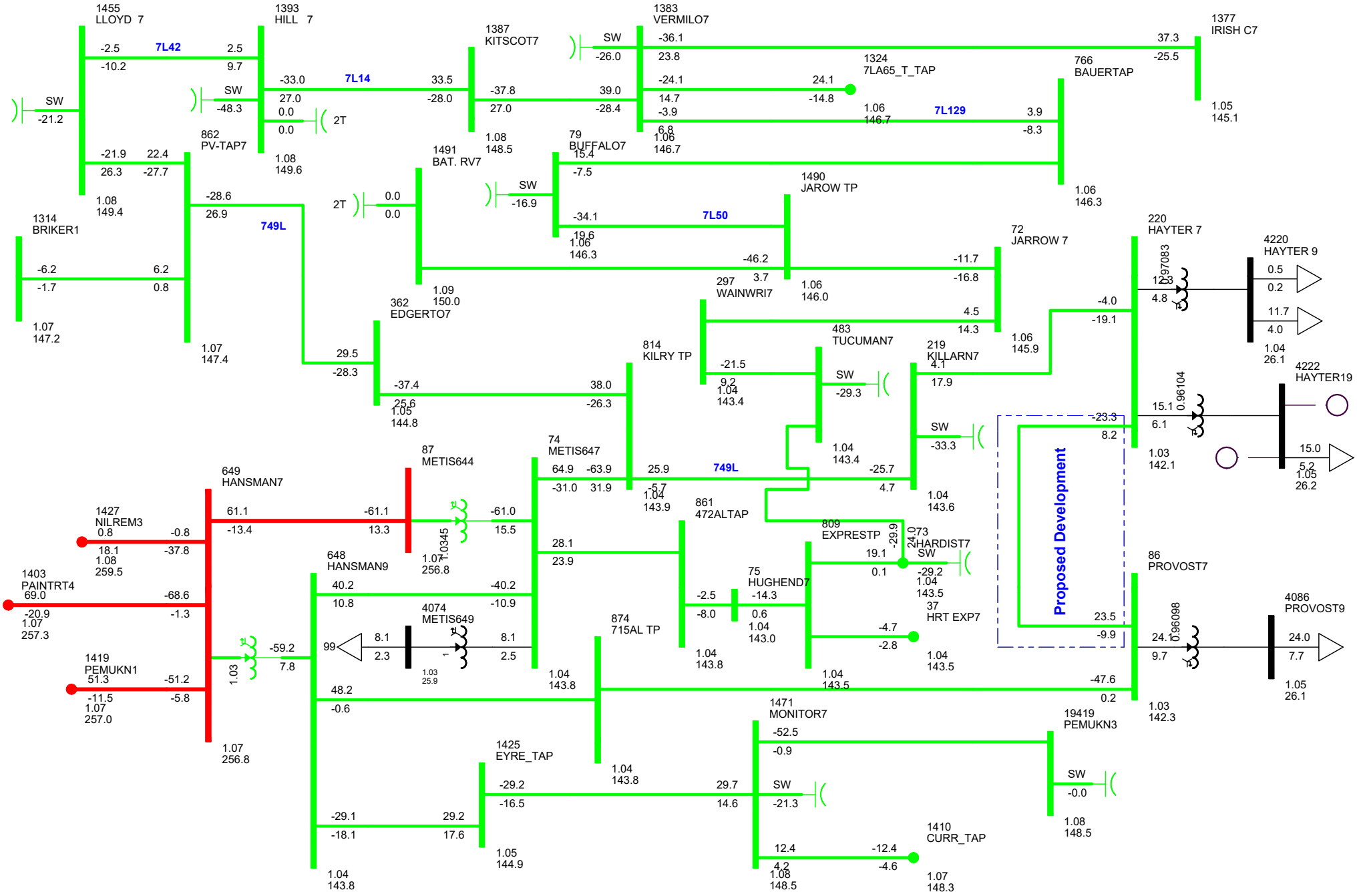
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-38 N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S THU, JAN 25 2018 17:46	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



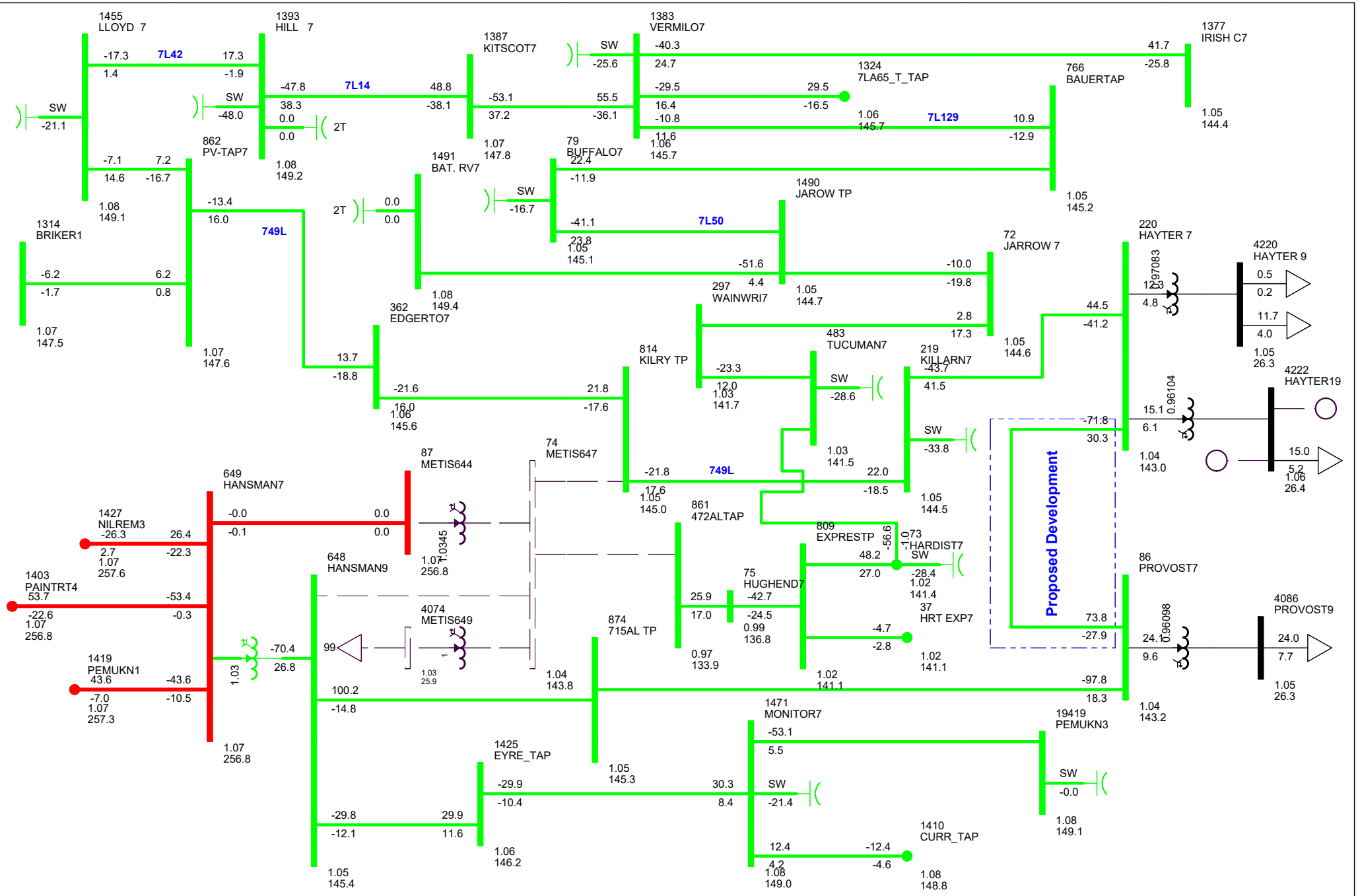
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A3-39 N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER THU, JAN 25 2018 17:46	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



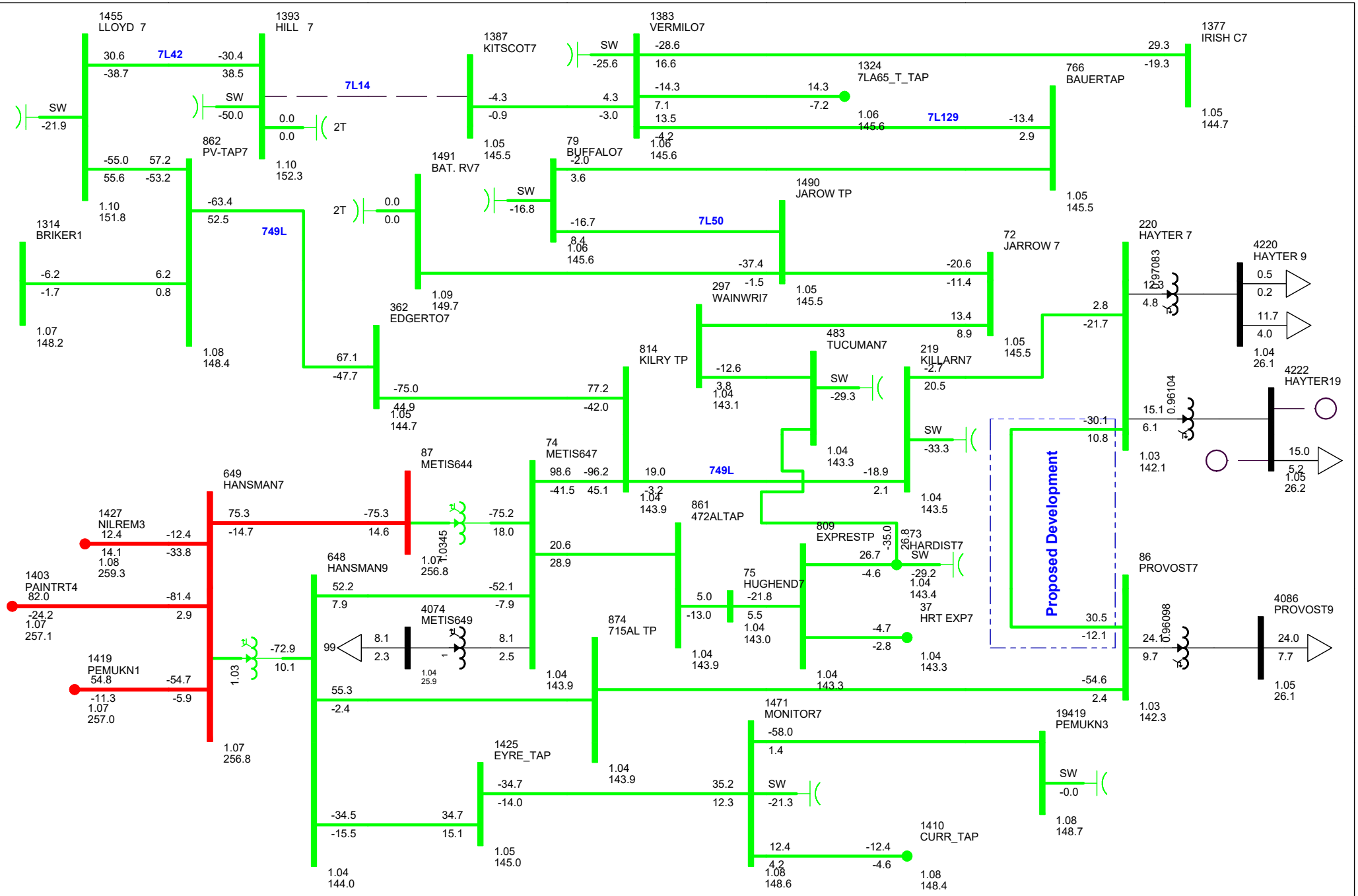
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-40 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S THU, JAN 25 2018 17:46	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



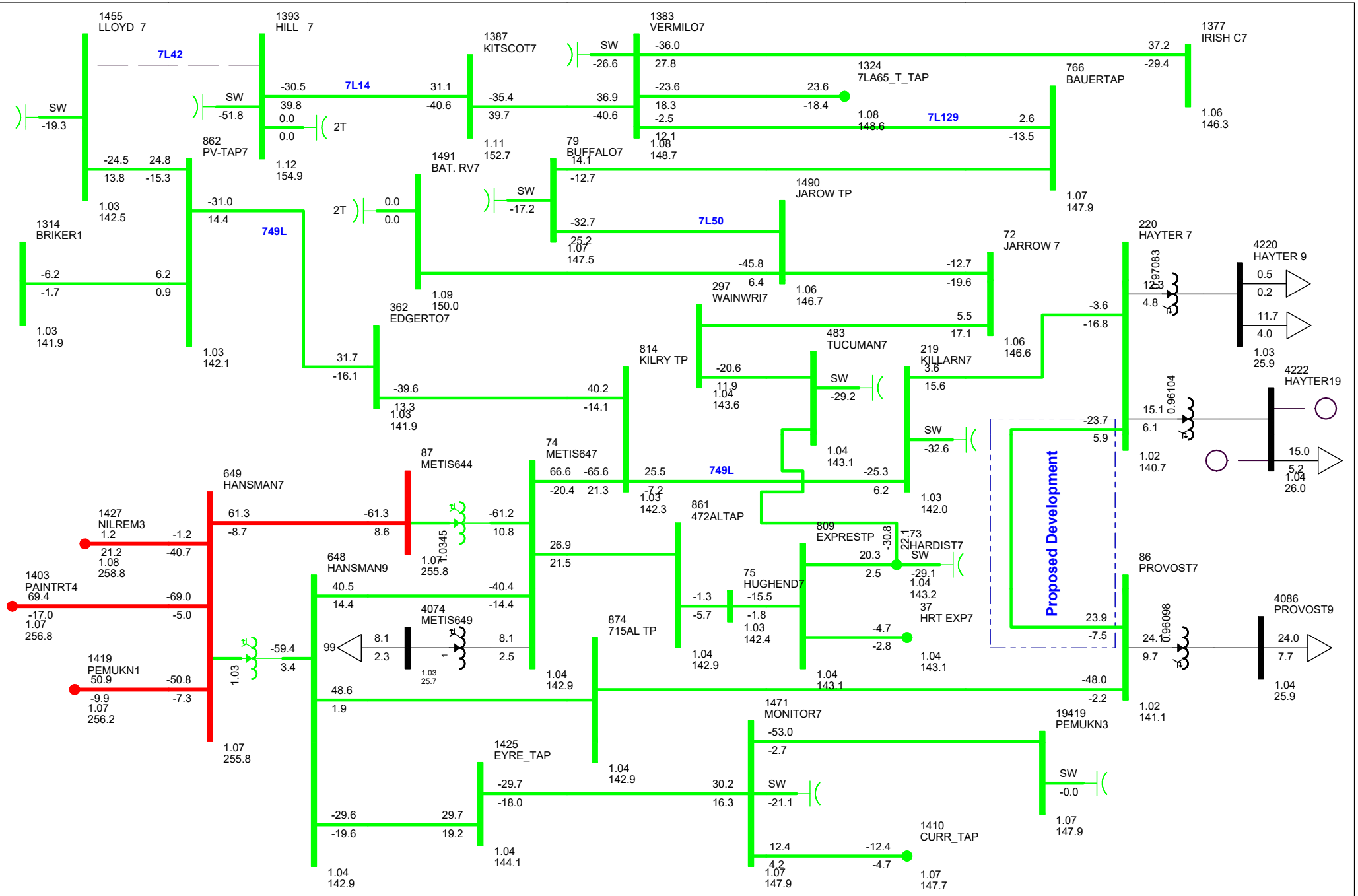
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-41 N-0: NORMAL OPERATION THU, JAN 25 2018 16:20	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



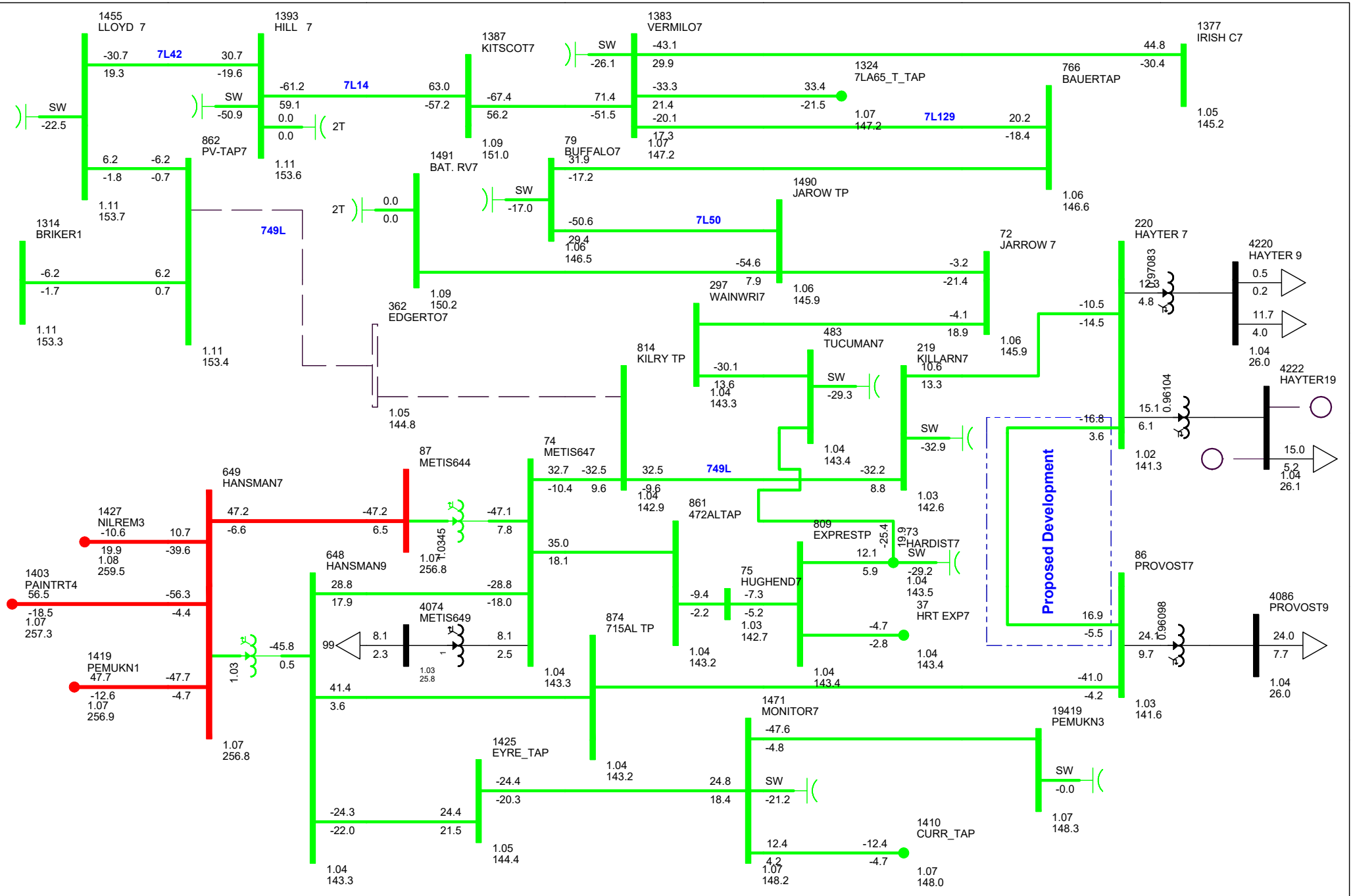
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-42 N-1: METISKOW 648S 138/25 KV TRANSFORMER THU, JAN 25 2018 16:21	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



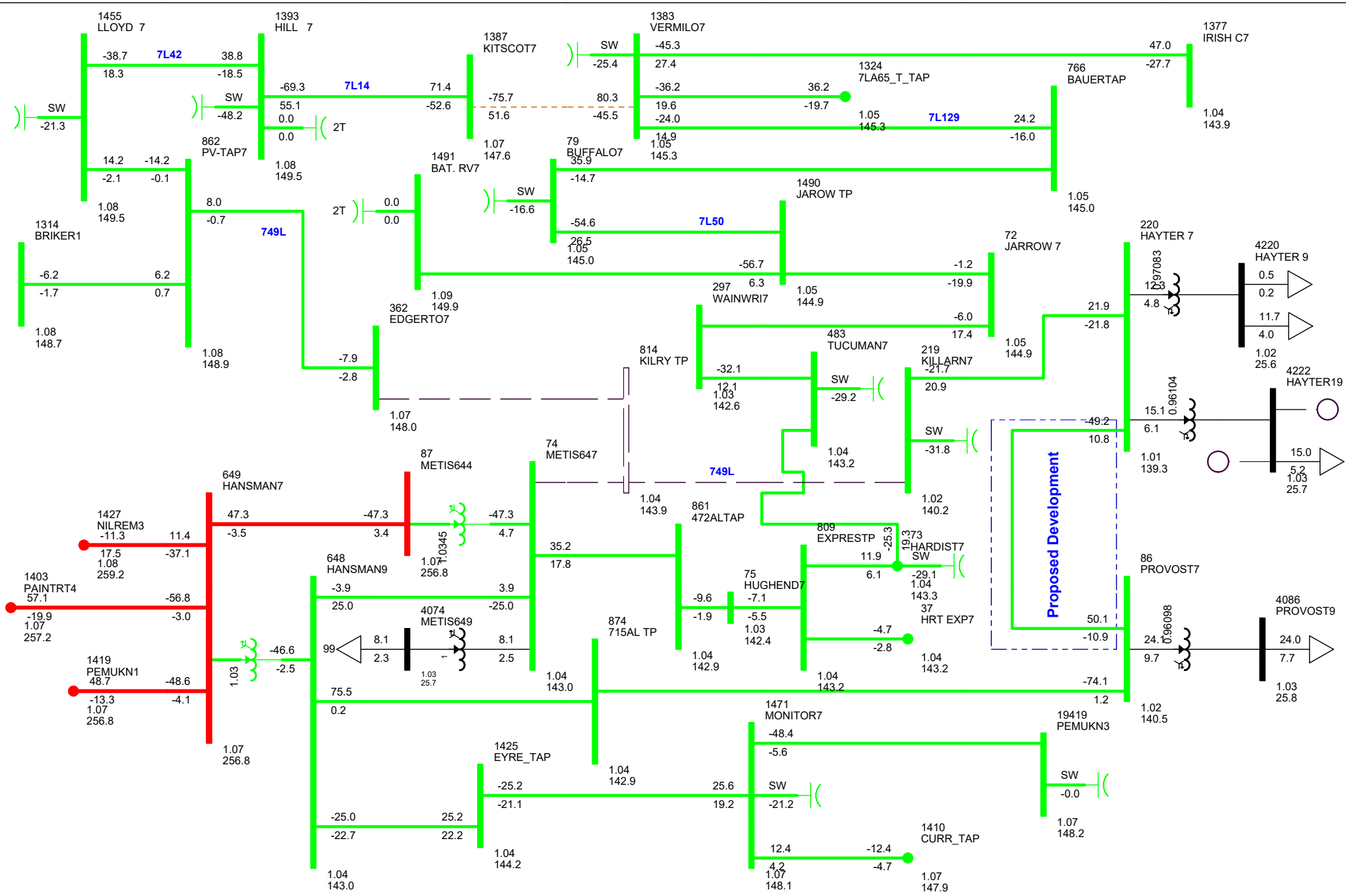
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-43 N-1: 7L14 KITSCOTY 705S TO HILL 751S THU, JAN 25 2018 16:21	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



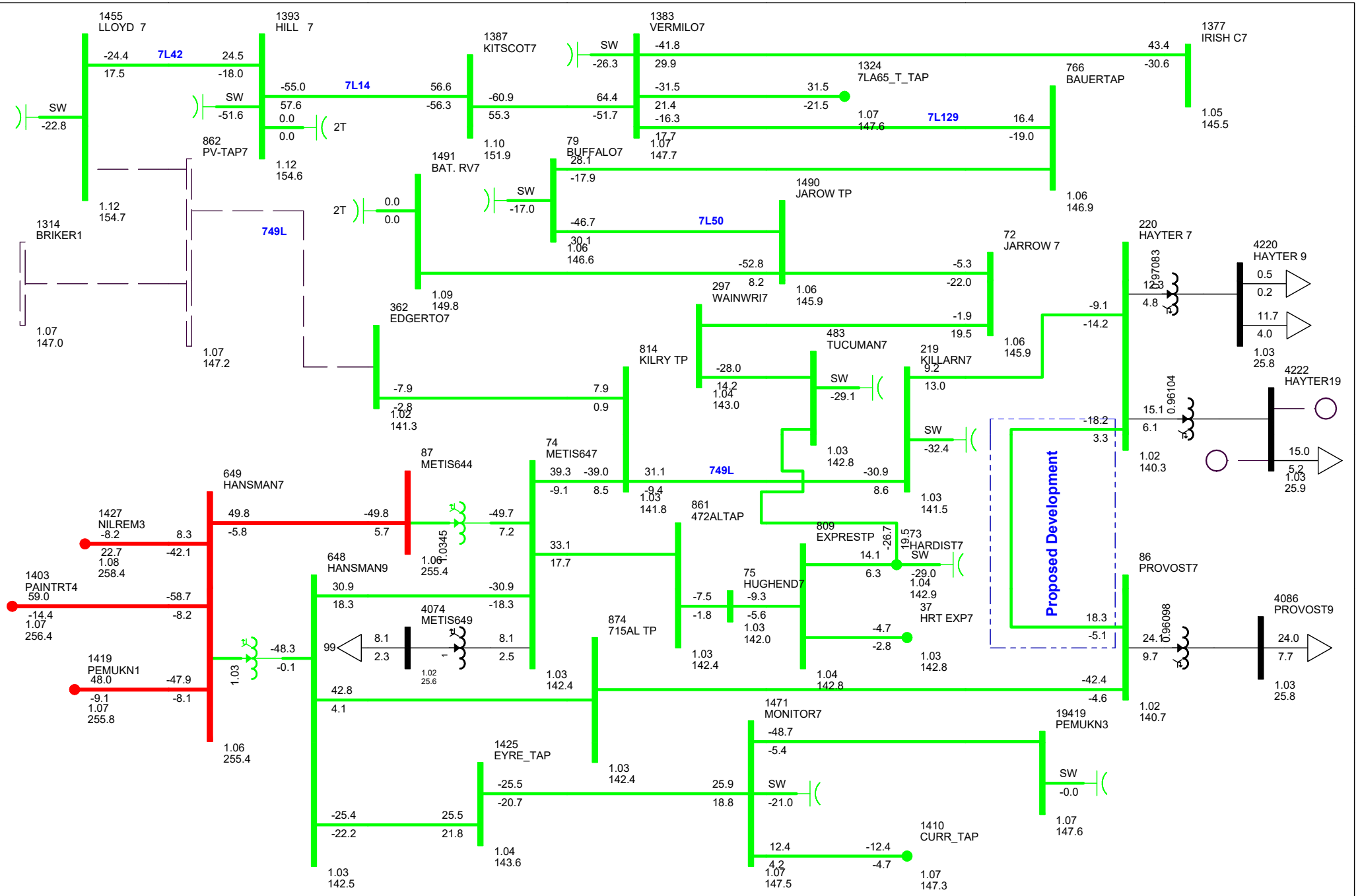
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-44 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S THU, JAN 25 2018 16:21	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



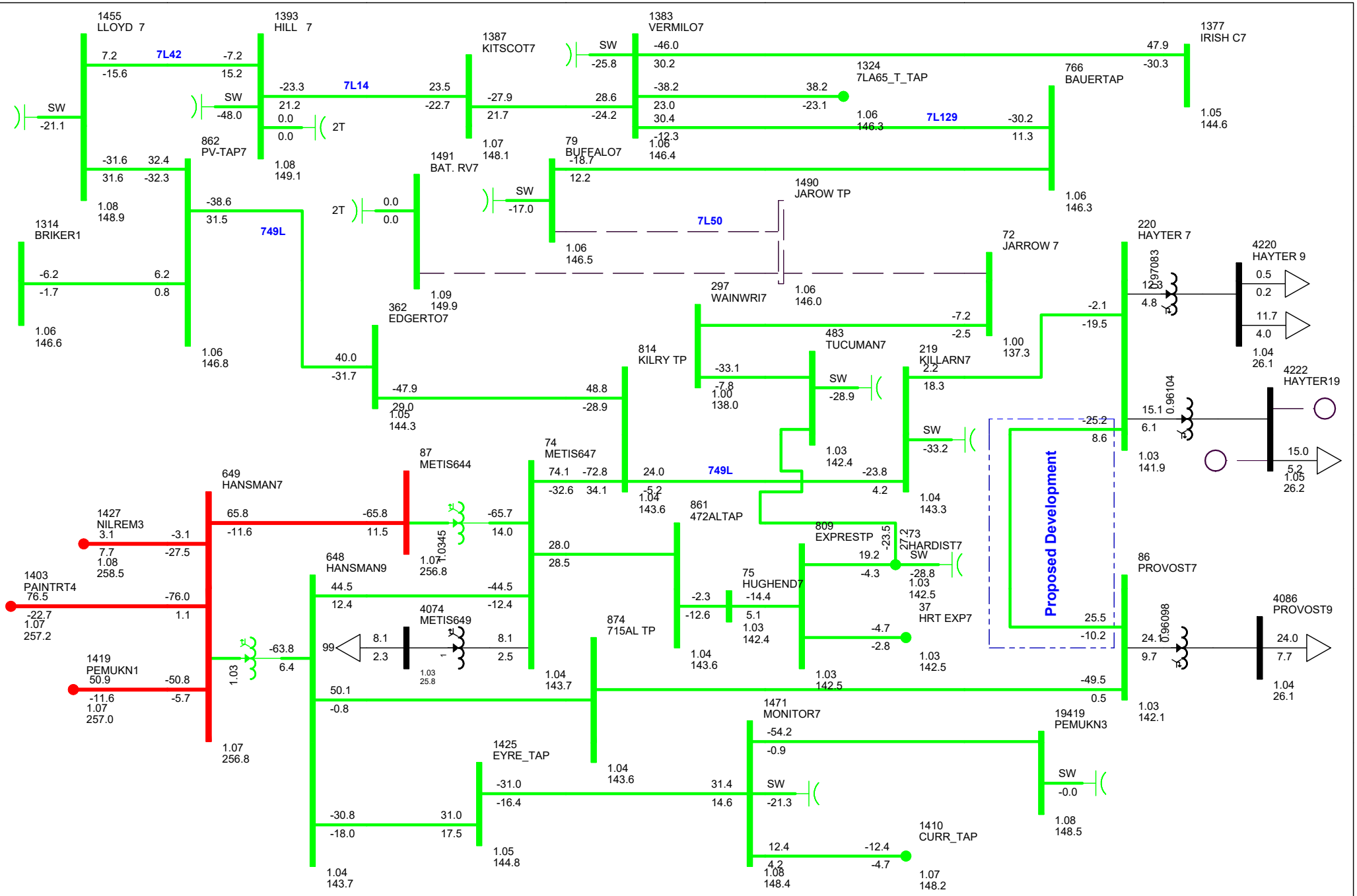
Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A3-45 N-1: EDGERTON 899S 138/25 KV TRANSFORMER THU, JAN 25 2018 16:22	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



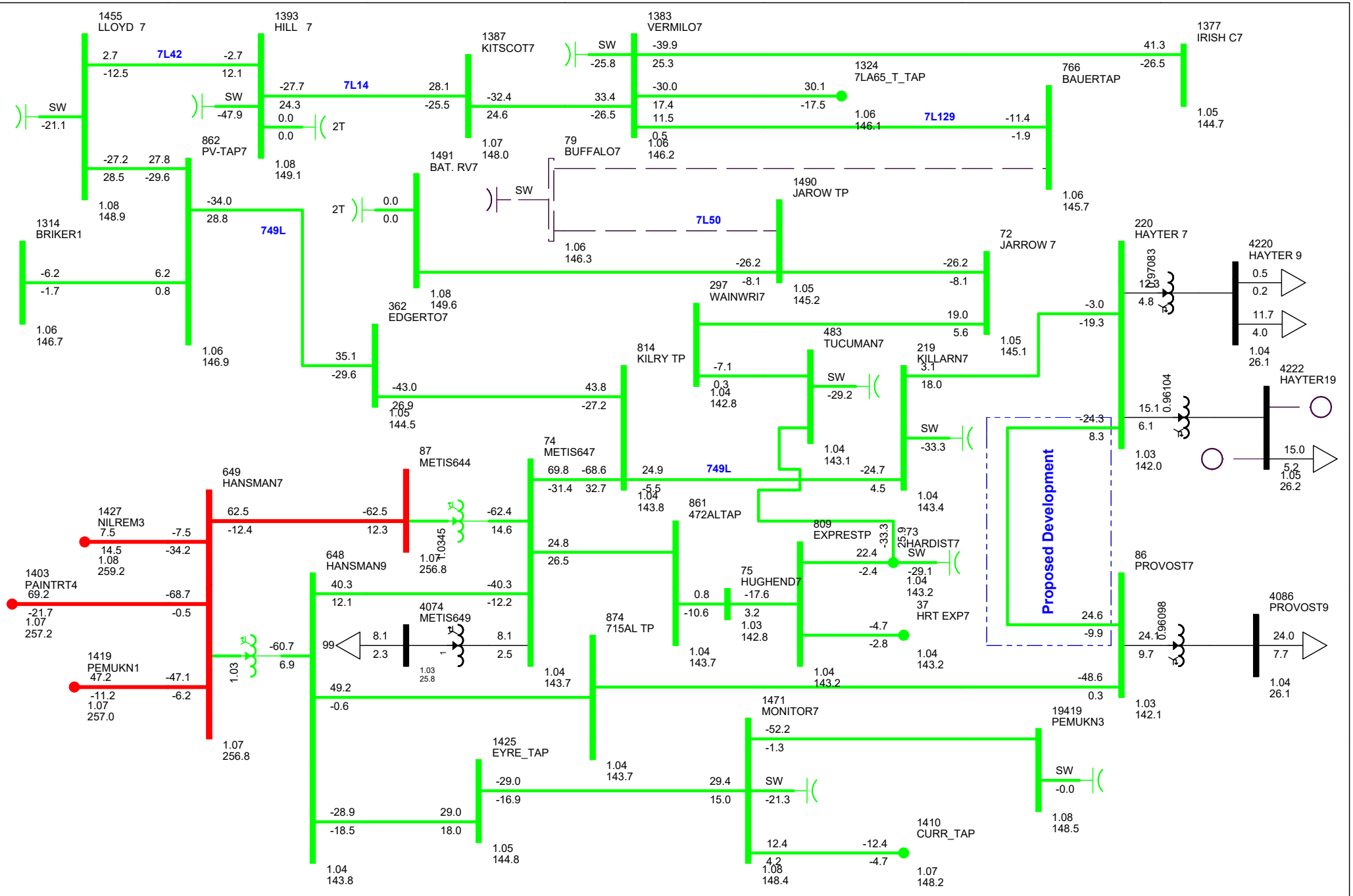
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-46 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S THU, JAN 25 2018 16:22	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



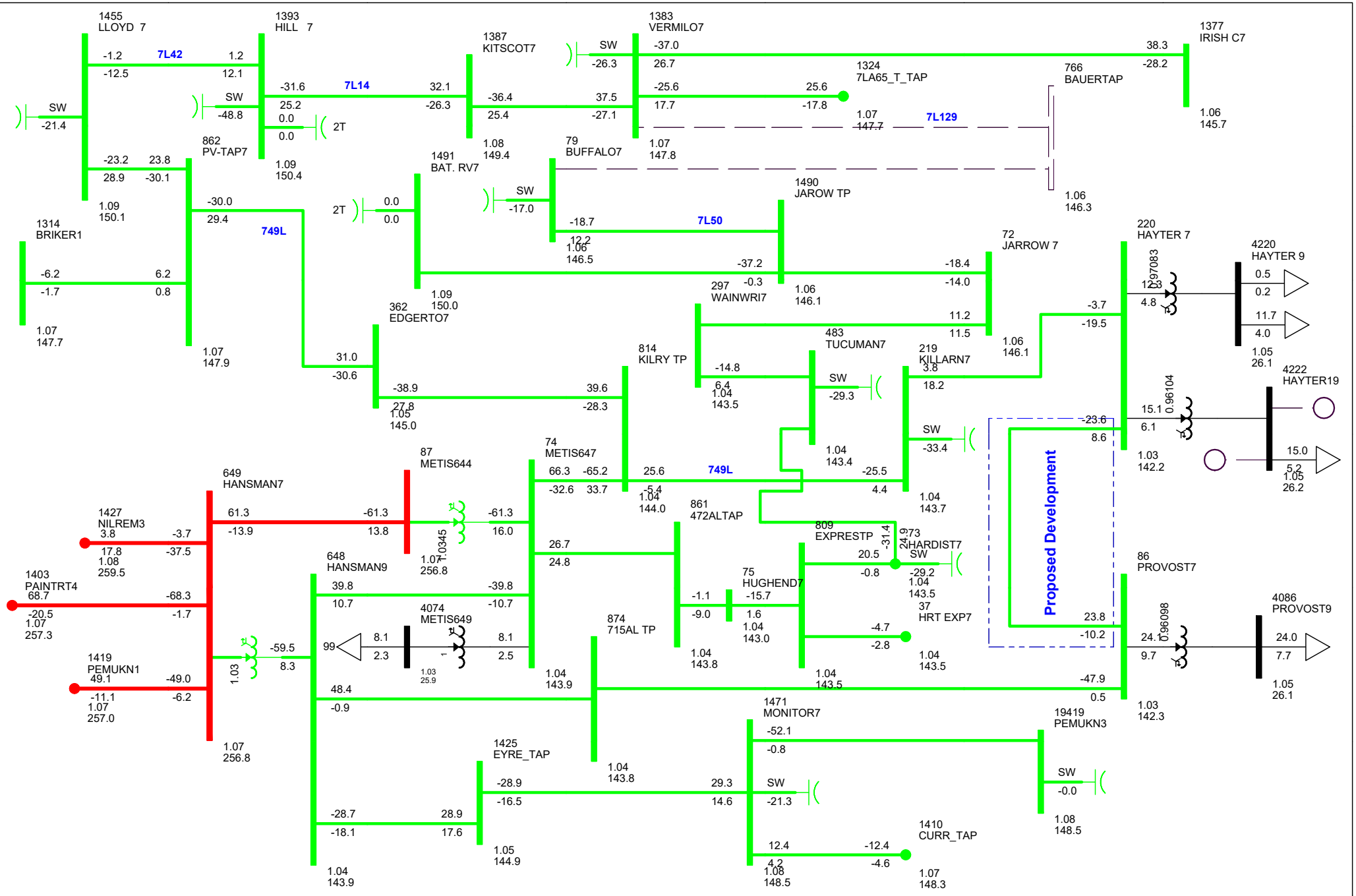
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-47 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S THU, JAN 25 2018 16:22	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-48 N-1: 7L50 BUFFALO CREEK 526S TO BATTLE RIVER 757S THU, JAN 25 2018 16:23	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 PRE-CONNECTION - DIAGRAM A3-49 N-1: BUFFALO CREEK 526S 138/25 KV TRANSFORMER THU, JAN 25 2018 16:23	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



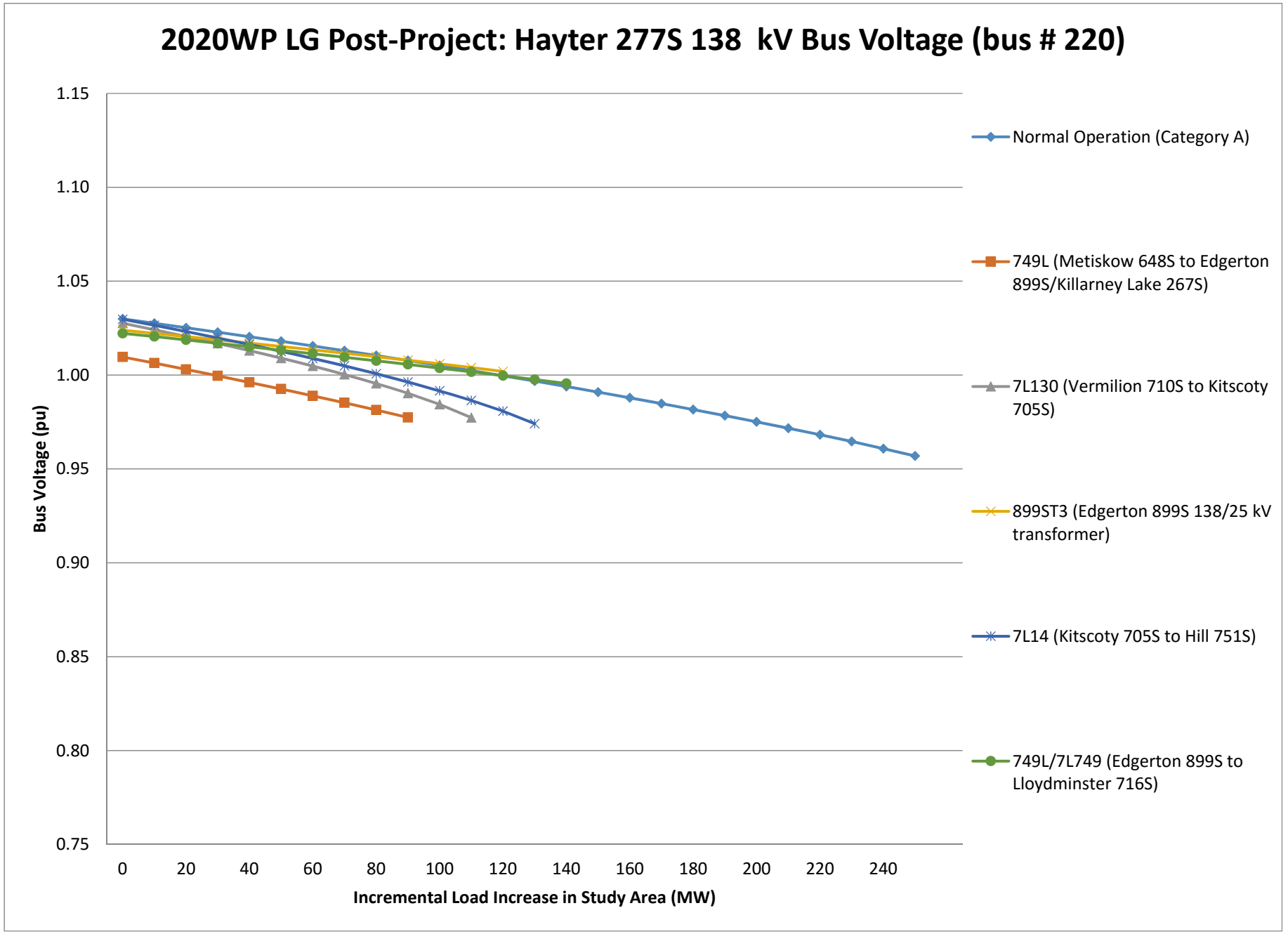
Provost Area Reliability Project 1782 2020 WP	P1782 POST-CONNECTION - DIAGRAM A3-50 N-1: 7L129 BUFFALO CREEK 526S TO VERMILION 710S THU, JAN 25 2018 16:23	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

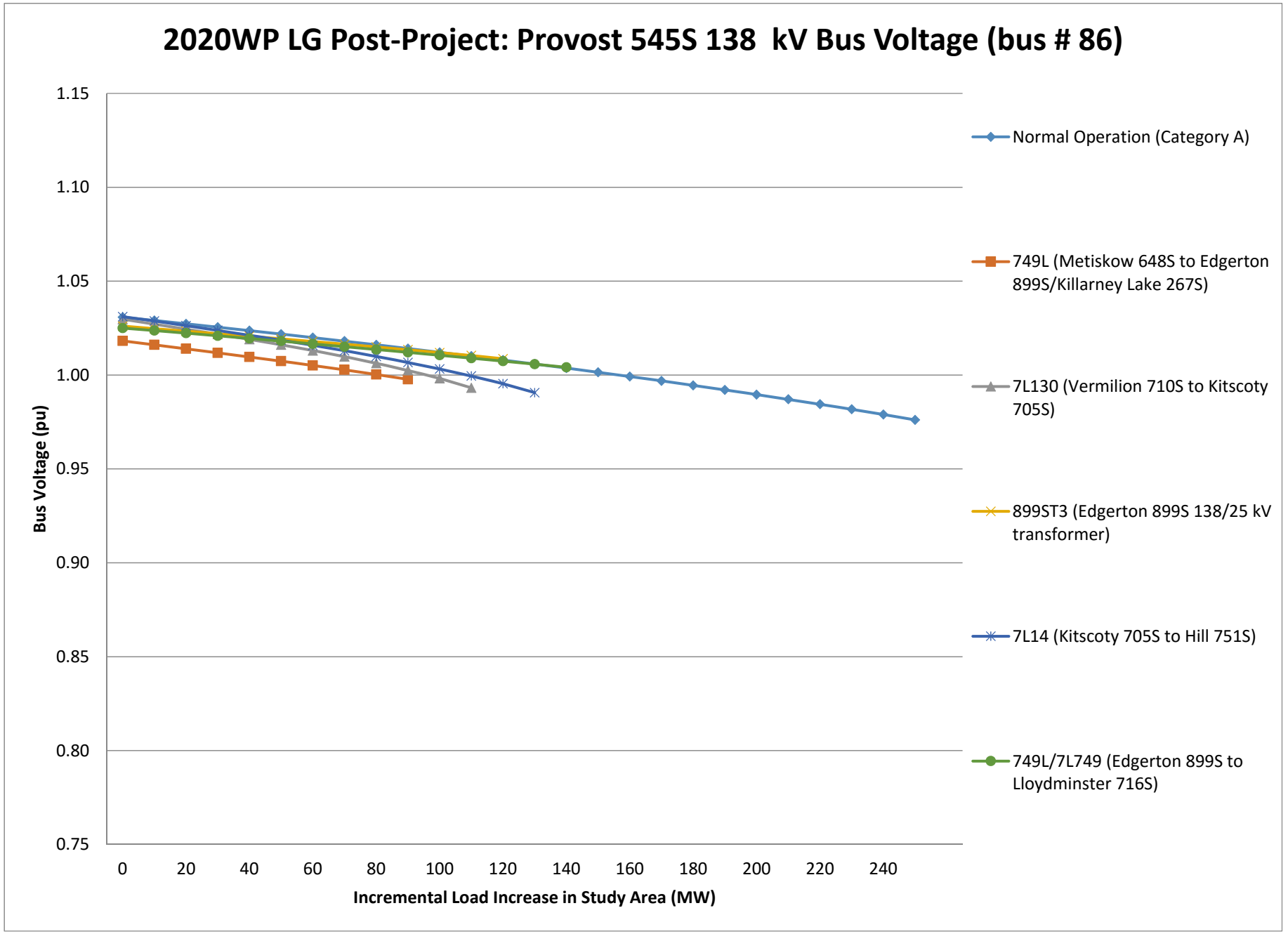
Attachment A4

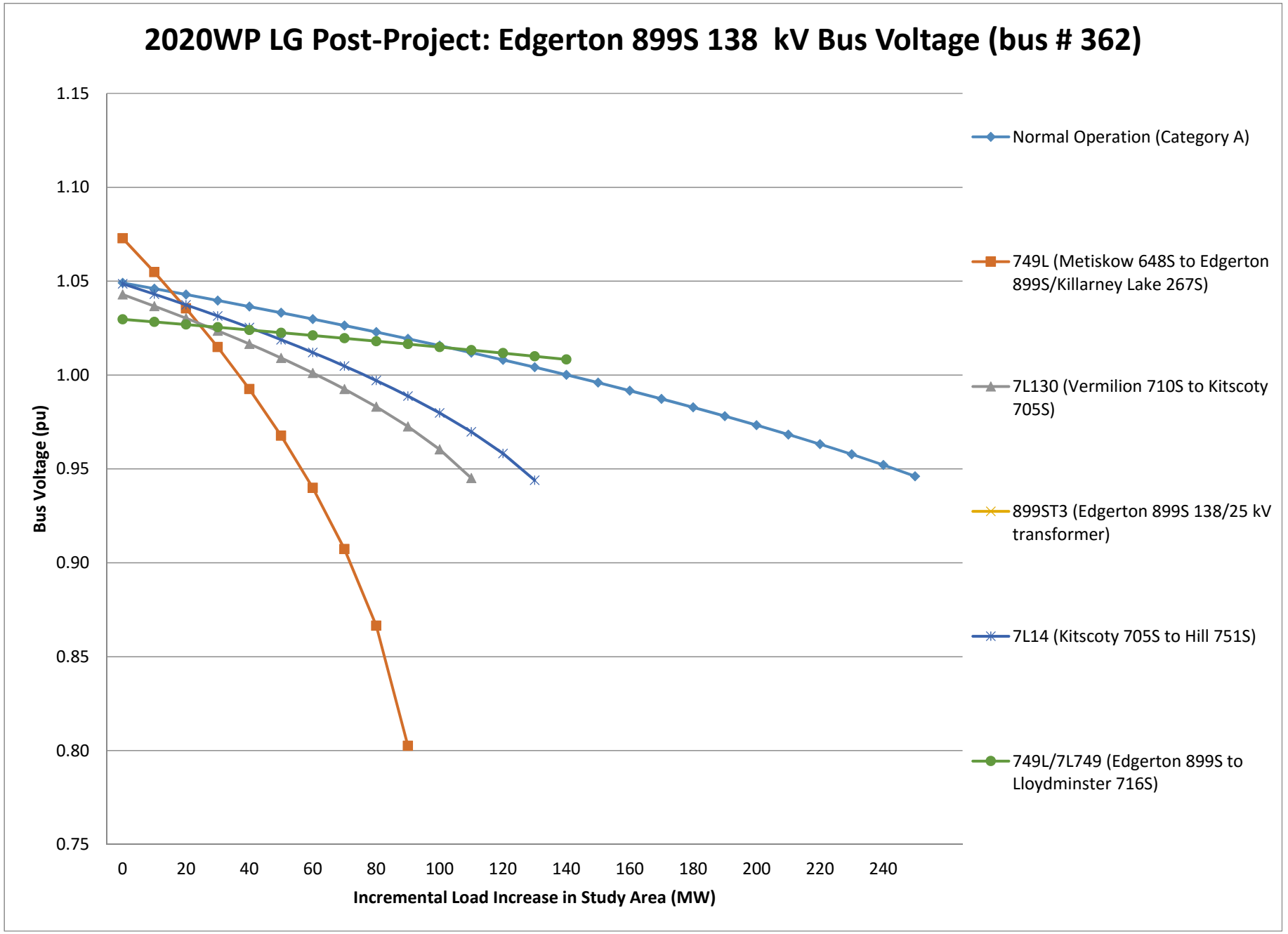
Post-Project Voltage Stability Diagrams

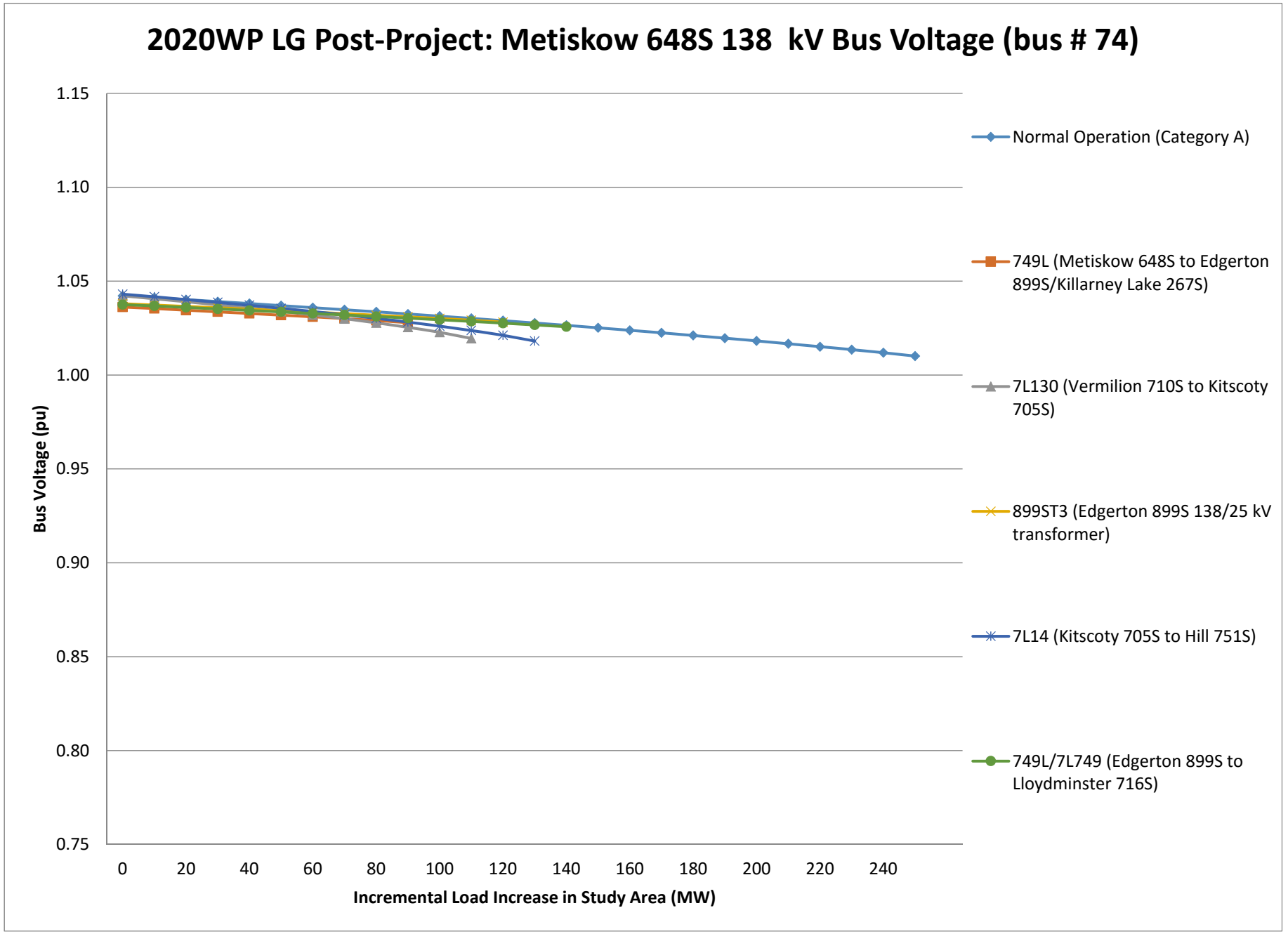
Table 1: P-V Analysis-2020 WP LG Post-Project

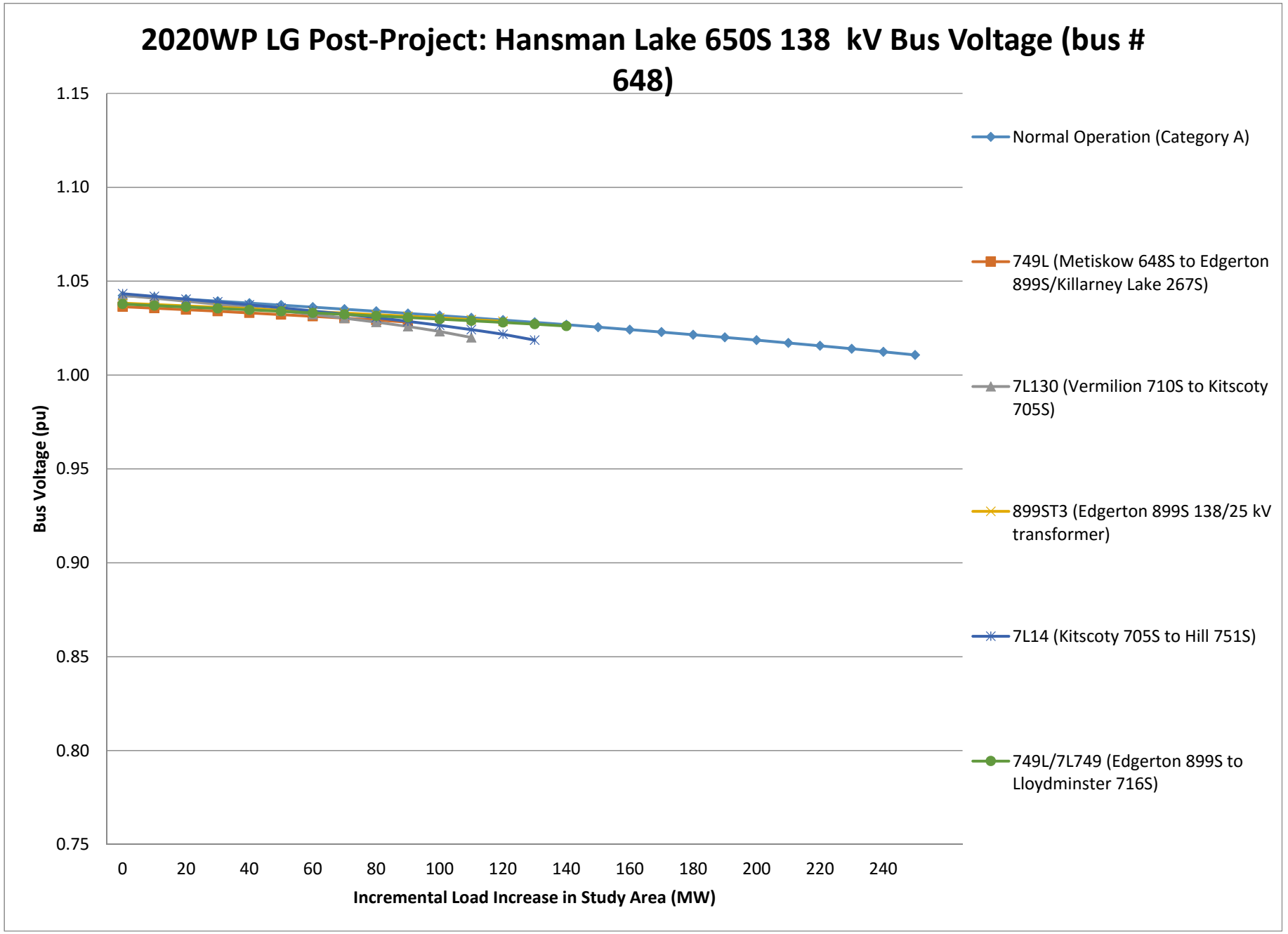
Contingency	From	To	Maximum incremental transfer (MW)	Meets 105% transfer criteria?
N-0	*System Normal*		*250*	*Yes*
749L	*Metiskow 648S*	*Edgerton 899S/Killarney Lake 267S*	*90*	*Yes*
7L130	*Vermilion 710S*	*Kitscoty 705S*	*110*	*Yes*
899S T3	*Edgerton 899S 138/25 kV transformer*		*120*	*Yes*
7L14	*Kitscoty 705S*	*Hill 751S*	*130*	*Yes*
749L/7L749	*Edgerton 899S*	*Lloydminster 716S*	*140*	*Yes*

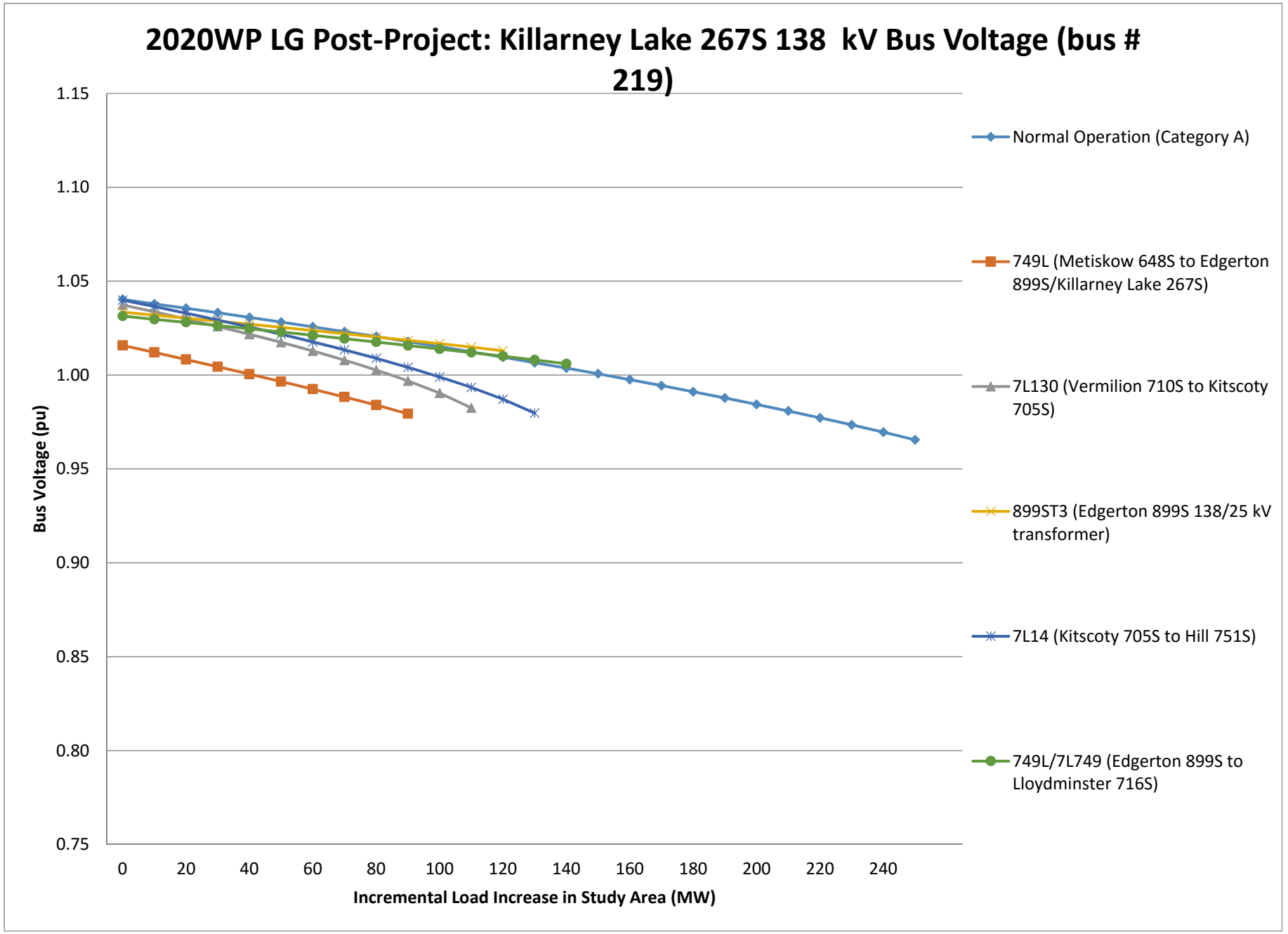

2020WP LG Post-Project: Hayter 277S 138 kV Bus Voltage (bus # 220)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
Bus Voltage (pu)
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)

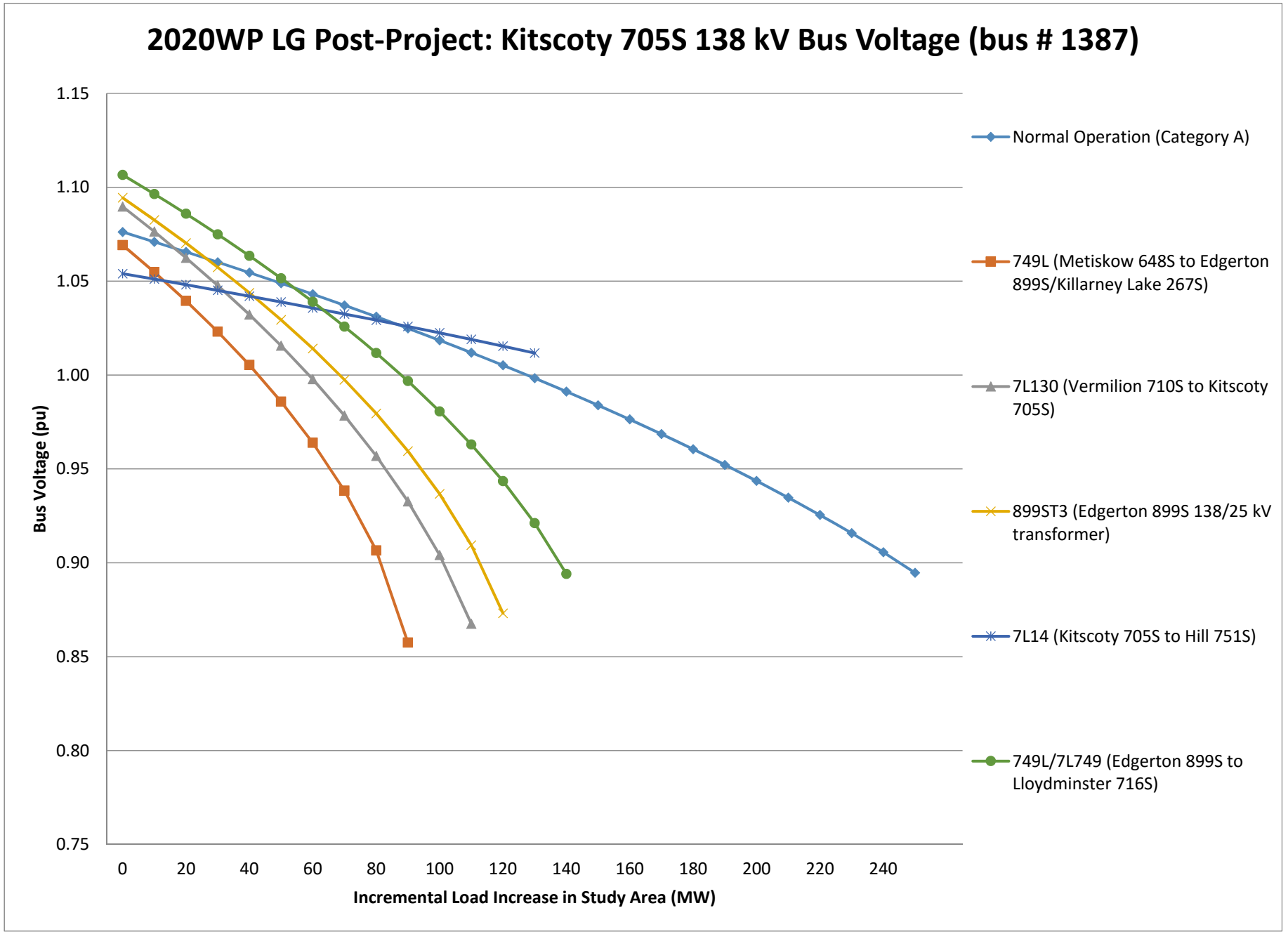

2020WP LG Post-Project: Provost 545S 138 kV Bus Voltage (bus # 86)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
Bus Voltage (pu)
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)

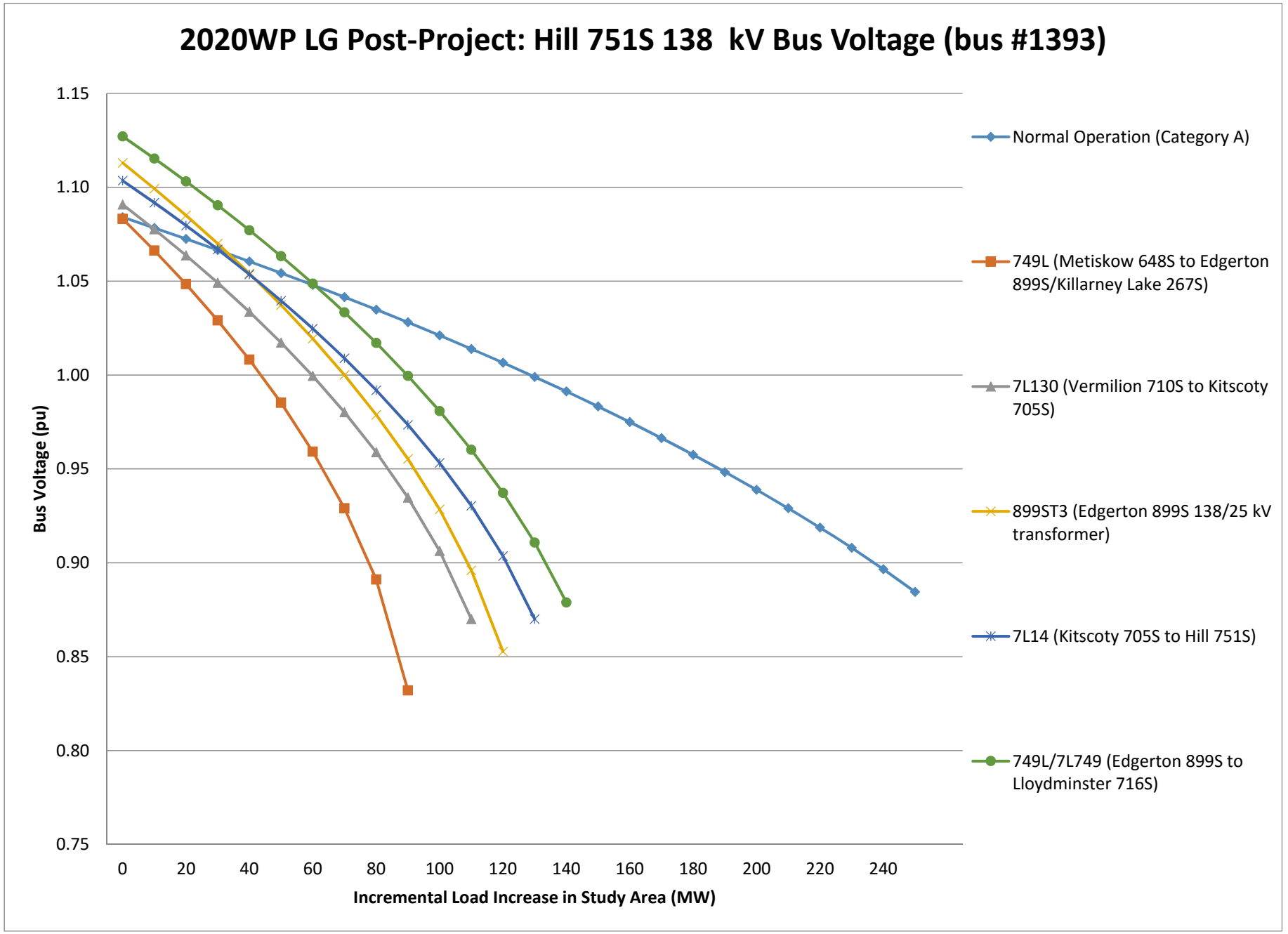

2020WP LG Post-Project: Edgerton 899S 138 kV Bus Voltage (bus # 362)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
Bus Voltage (pu)
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)

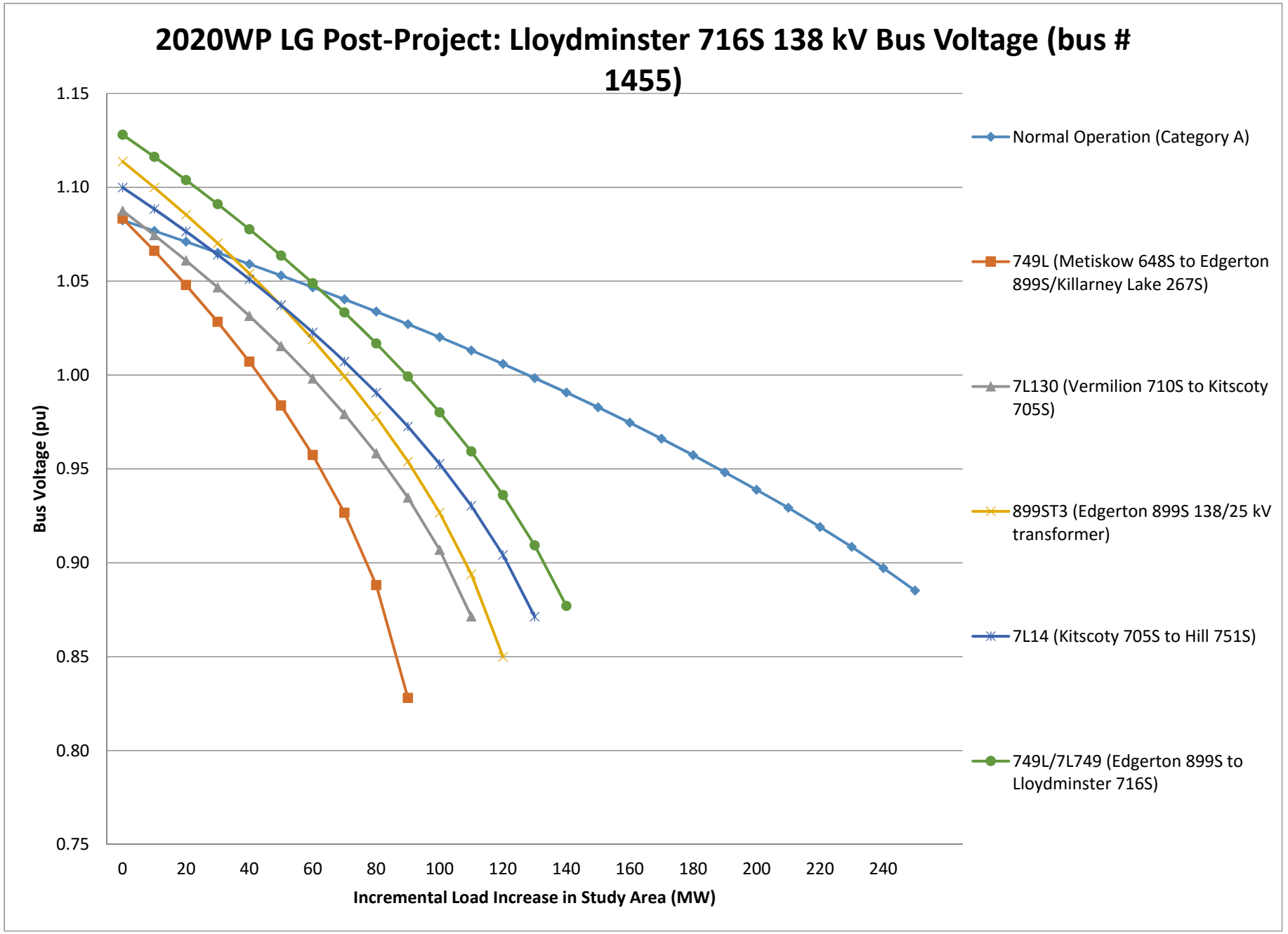

2020WP LG Post-Project: Metiskow 648S 138 kV Bus Voltage (bus # 74)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
Bus Voltage (pu)
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)

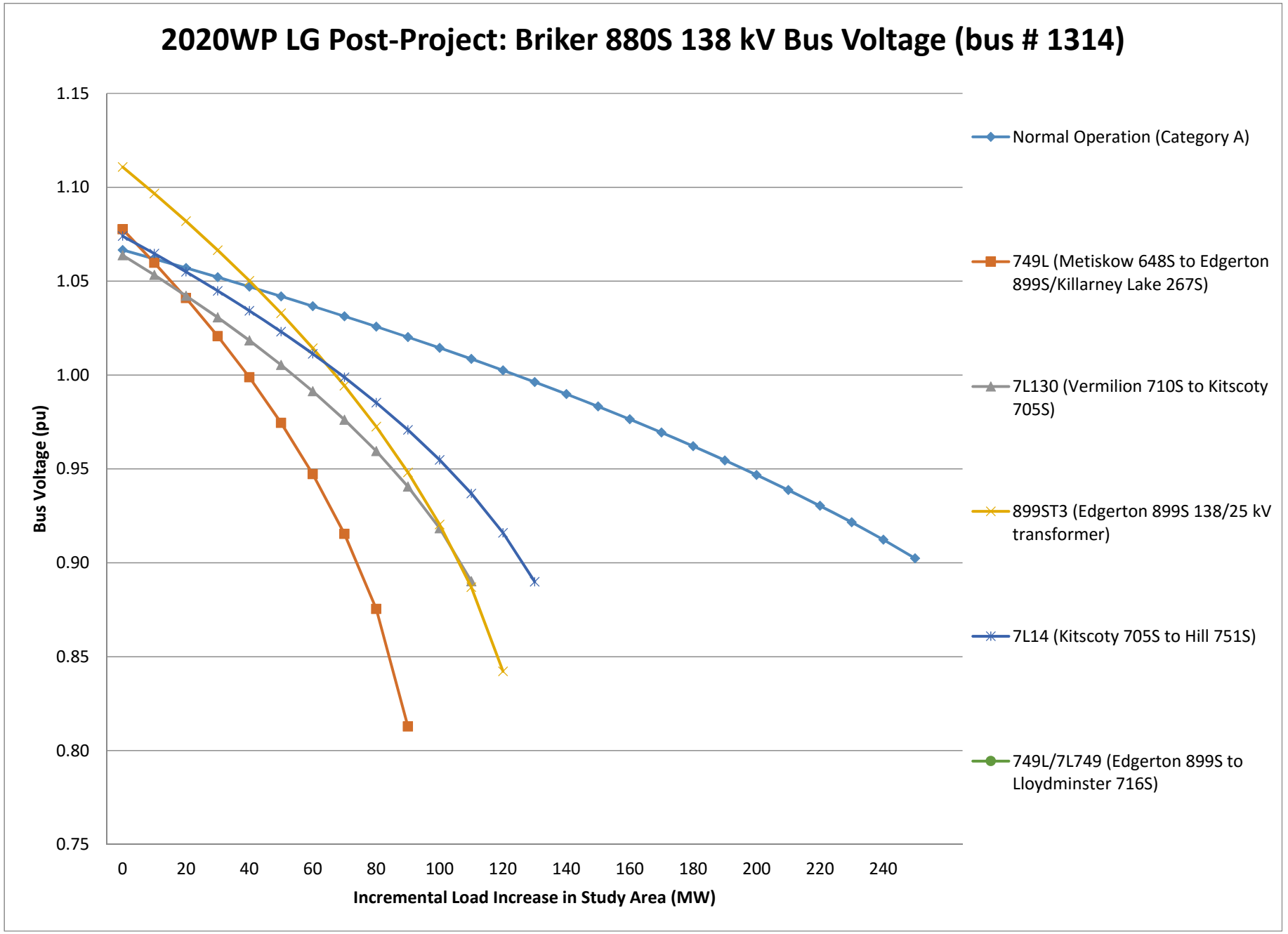

2020WP LG Post-Project: Hansman Lake 650S 138 kV Bus Voltage (bus # 648)
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)


2020WP LG Post-Project: Killarney Lake 267S 138 kV Bus Voltage (bus # 219)
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)


2020WP LG Post-Project: Kitscoty 705S 138 kV Bus Voltage (bus # 1387)
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)


2020WP LG Post-Project: Hill 751S 138 kV Bus Voltage (bus #1393)
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)


2020WP LG Post-Project: Lloydminster 716S 138 kV Bus Voltage (bus # 1455)
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)


2020WP LG Post-Project: Briker 880S 138 kV Bus Voltage (bus # 1314)
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0
20
40
60
80
100
120
140
160
180
200
220
240
Incremental Load Increase in Study Area (MW)
Normal Operation (Category A)
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)
7L130 (Vermilion 710S to Kitscoty 705S)
899ST3 (Edgerton 899S 138/25 kV transformer)
7L14 (Kitscoty 705S to Hill 751S)
749L/7L749 (Edgerton 899S to Lloydminster 716S)

Attachment A5

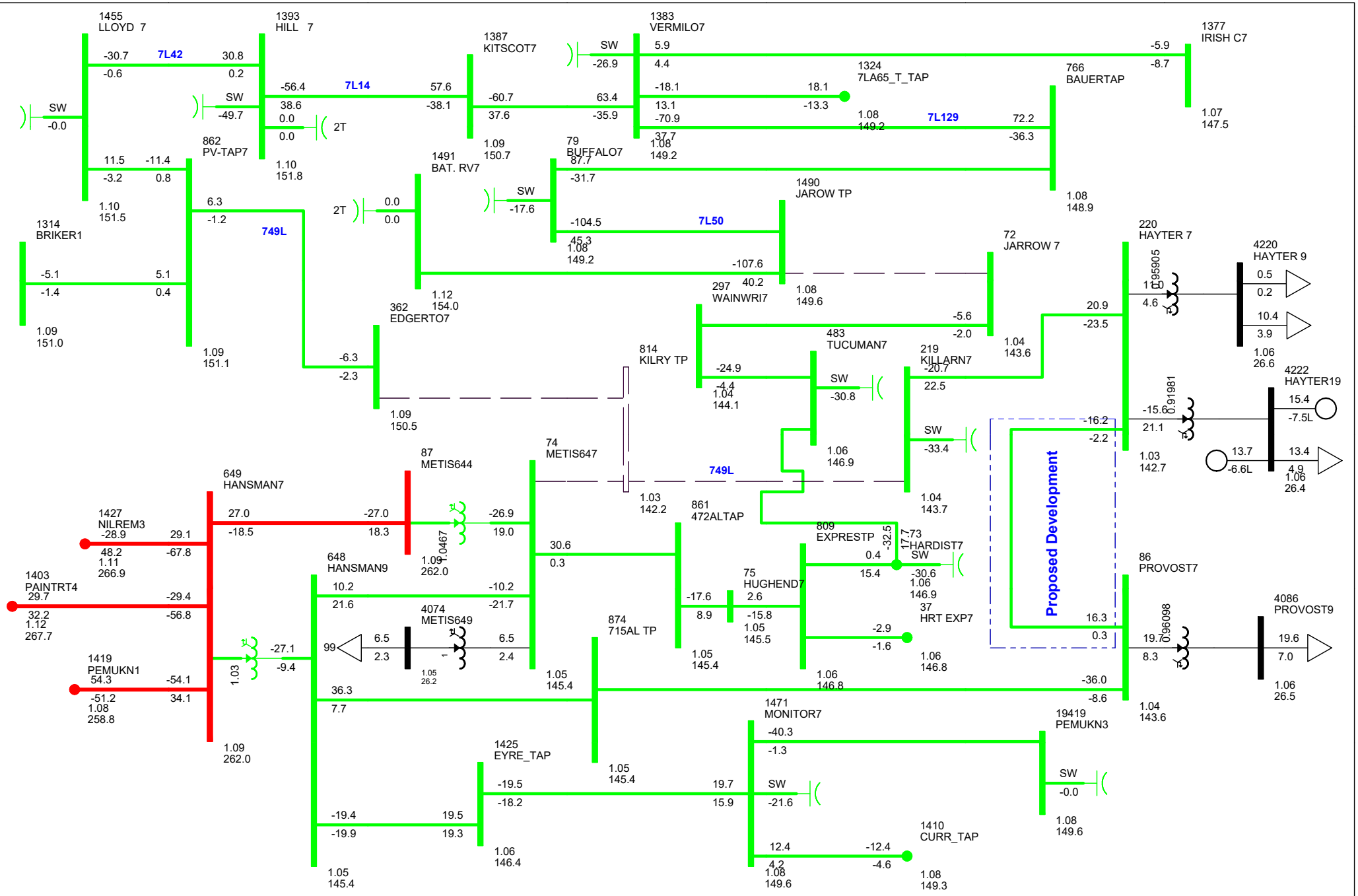
Post-Mitigation Power Flow Diagrams

Table 1: Summary of System Performance (Element Loading) Scenario 7- 2020 SP HG Post-Mitigation

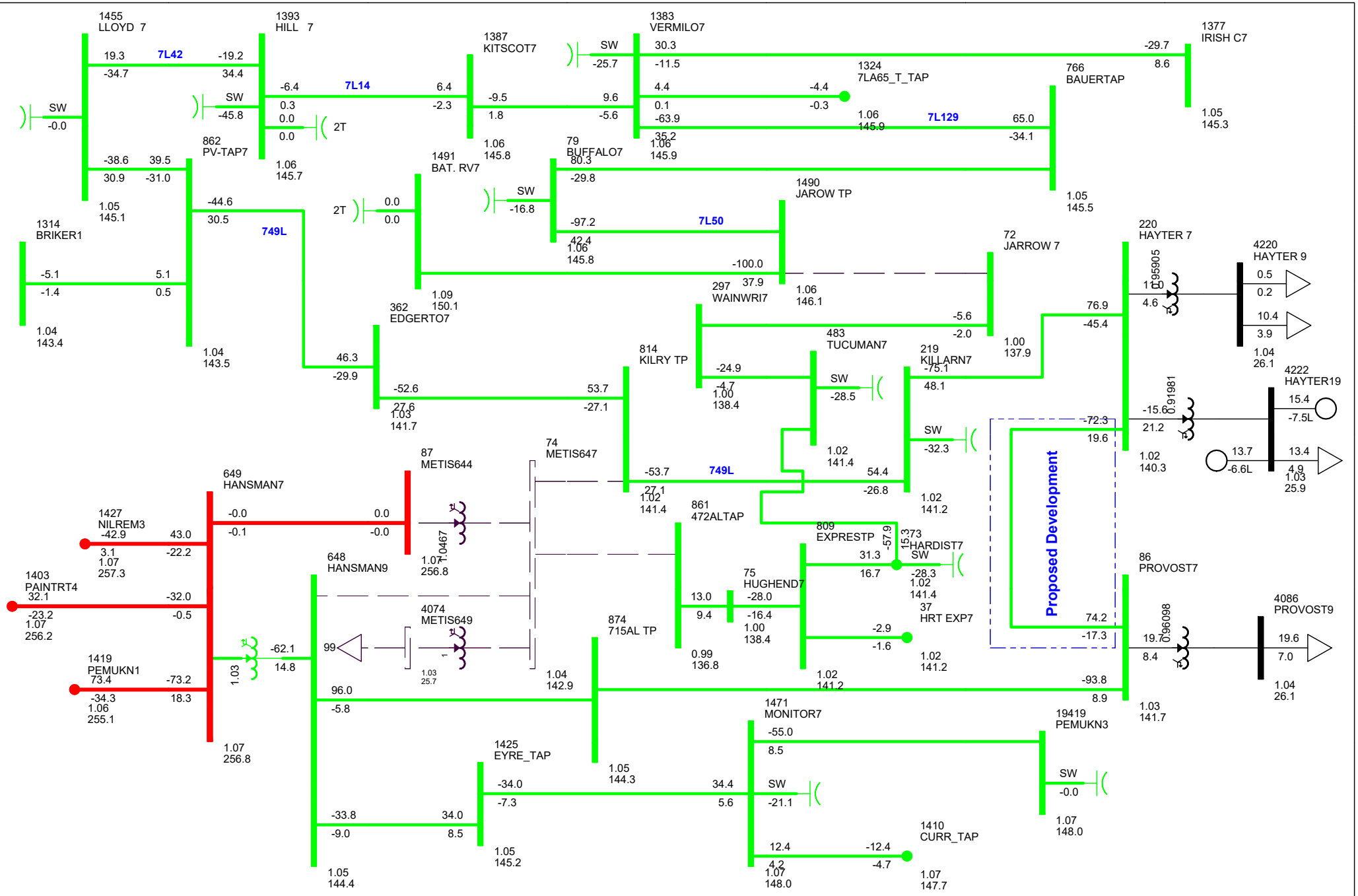
Contingency	Thermal Overloads	Figure in Attachment A3
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*7L129 (Buffalo Creek 526S to Bauer 918S Tap)*	*A5-1*
	7L50 (Buffalo Creek 526S to Jarrow 252S Tap)	
	7L129 (Vermilion 710S to Bauer 918S Tap)	
648ST1 (Metiskow 648S 138/25 kV transformer)	*7L50 (Buffalo Creek 526S to Jarrow Tap*	*A5-2*
7L14 (Kitscoty 705S to Hill 751S)	*7L50 (Buffalo Creek 526S to Jarrow Tap*	*A5-3*
899S T3 (Edgerton 899S 138/25 kV transformer)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*A5-4*
7L42 (Hill 751S to Lloydminster 716S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*A5-5*
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*A5-6*

Table 2: Summary of System Performance (Element Loading) Scenario 8- 2020 WP HG Post-Mitigation

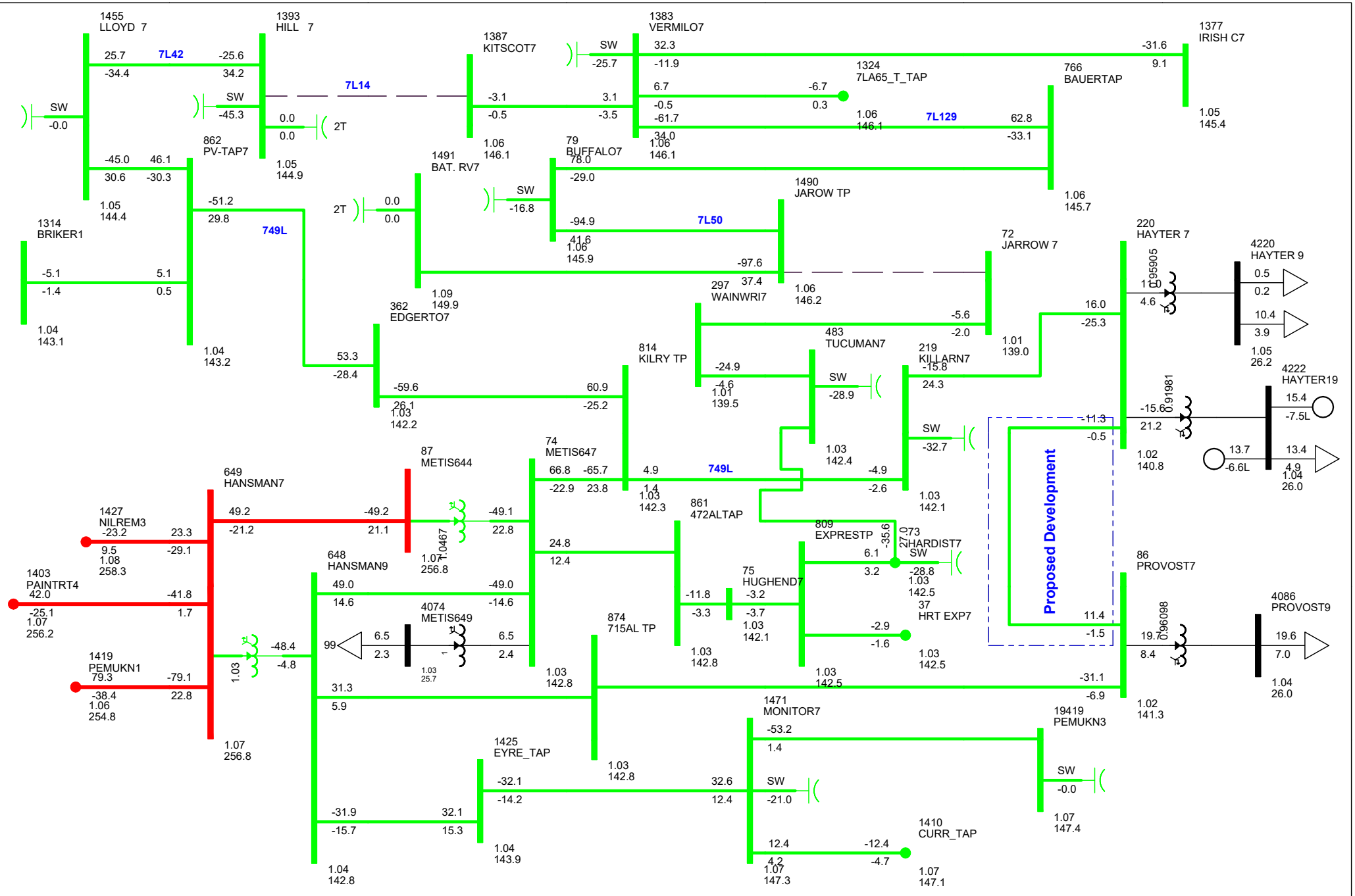
Contingency	Thermal Overloads	Figure in Attachment A3
749L (Metiskow 648S to Edgerton 899S/Killarney Lake 267S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*A5-7*
	704L (Wainright 51S to Tucuman 478S)	
	7L130 (Vermilion 710S Kitscoty 705S)	
899S T3 (Edgerton 899S 138/25 kV transformer)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*A5-8*
749L/7L749 (Edgerton 899S to Lloydminster 716S)	*7L50 (Buffalo Creek 526S to Jarrow 252S Tap)*	*A5-9*



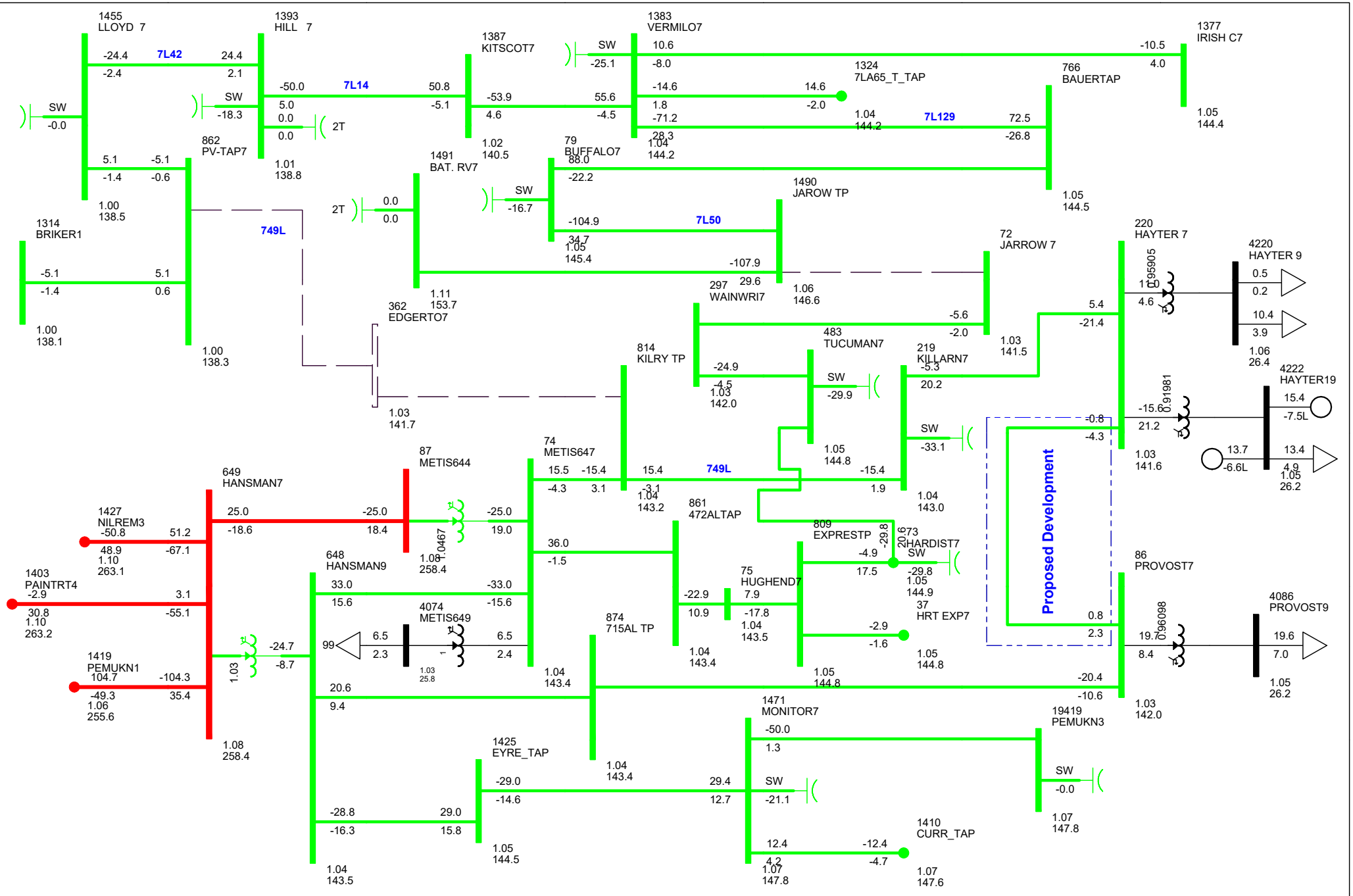
Provost Area Reliability Project 1782 2020 SP	P1782 POST-MITIGATION - DIAGRAM A5-1 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S WED, JAN 24 2018 11:15	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



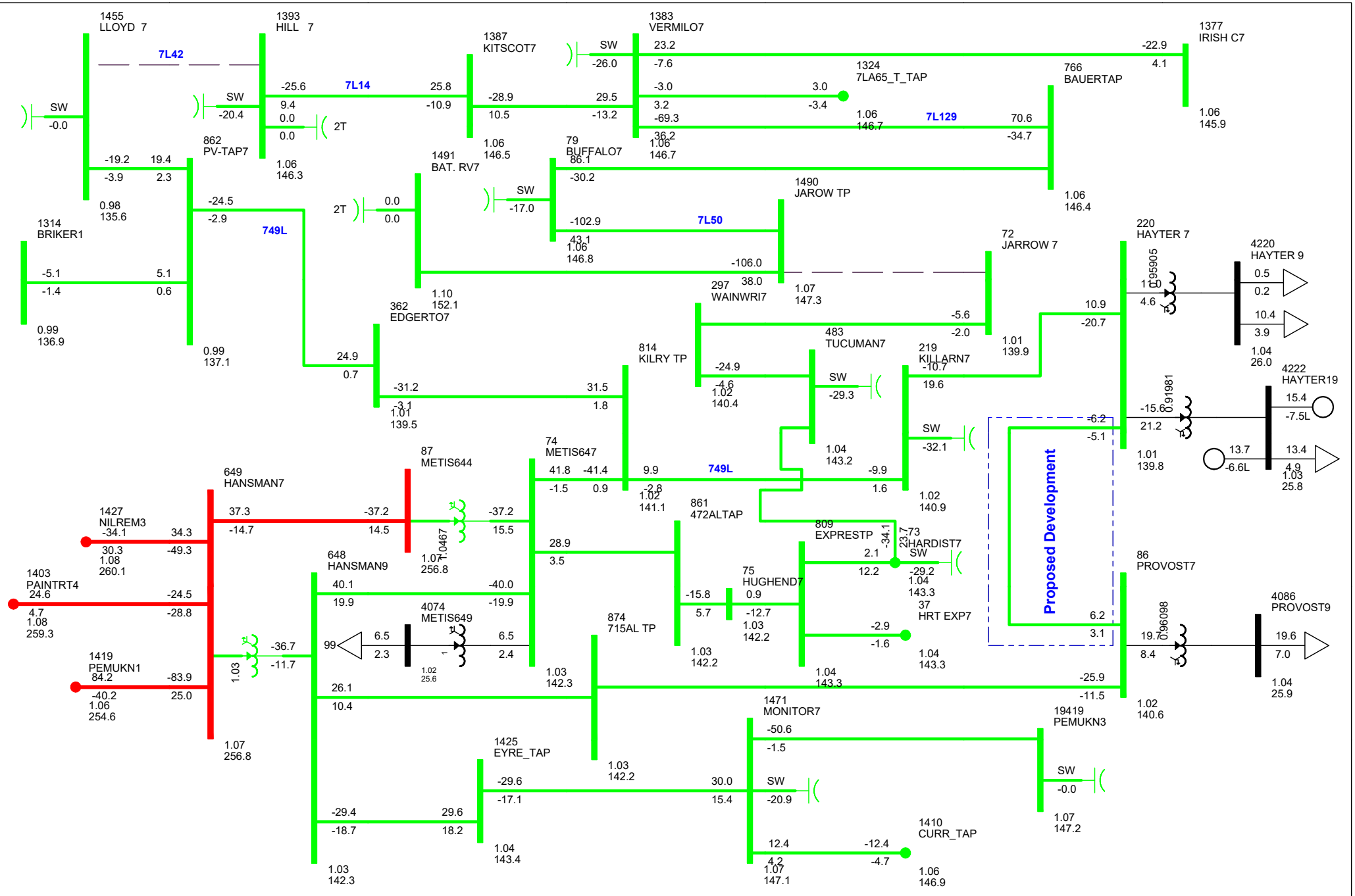
Provost Area Reliability Project 1782 2020 SP	P1782 POST-MITIGATION - DIAGRAM A5-2 N-1: METISKOW 648S 138/25 KV TRANSFORMER WED, JAN 24 2018 11:16	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



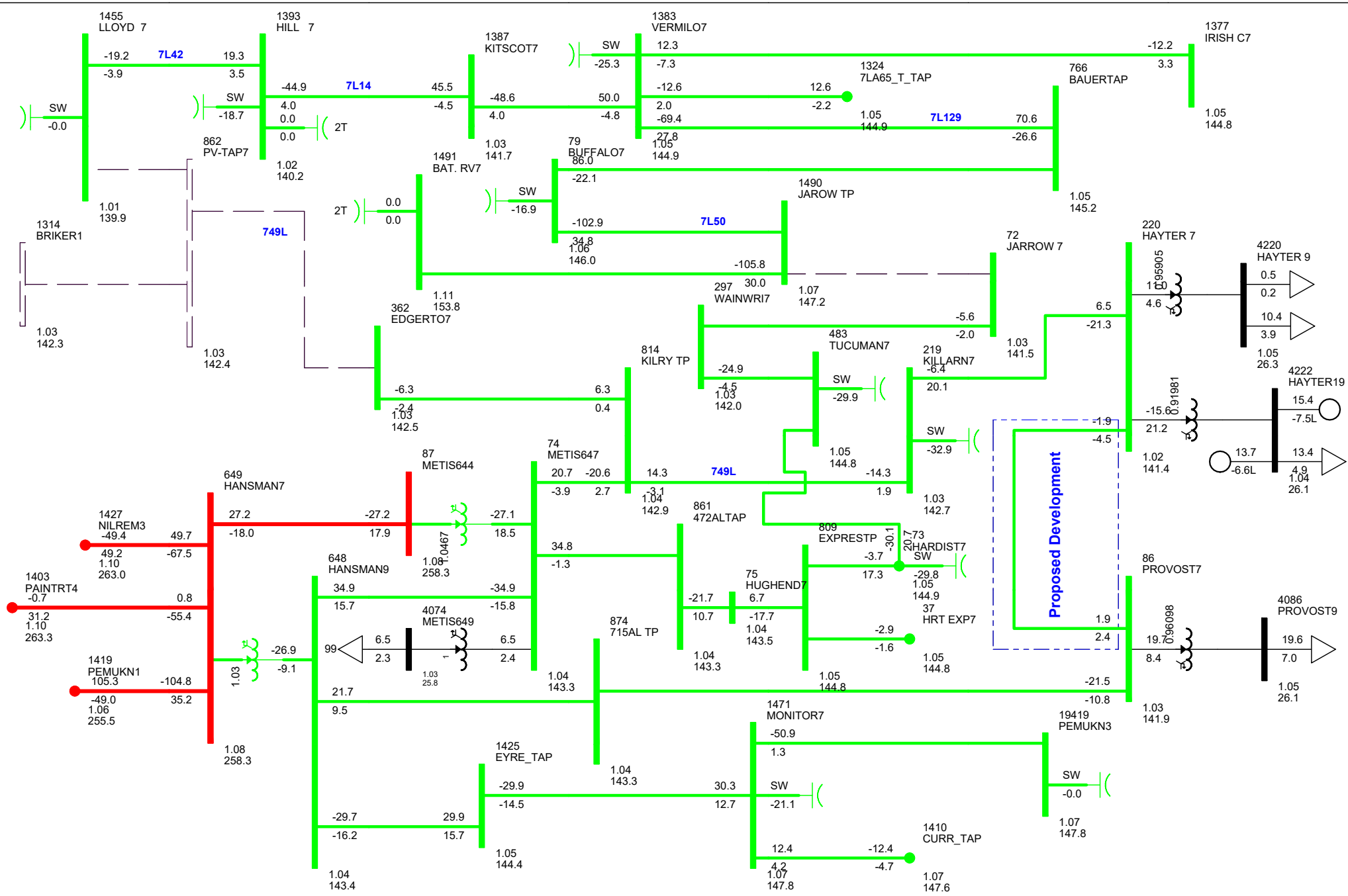
Provost Area Reliability Project 1782 2020 SP	P1782 POST-MITIGATION - DIAGRAM A5-3 N-1: 7L14 KITSCOTY 705S TO HILL 751S WED, JAN 24 2018 11:16	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



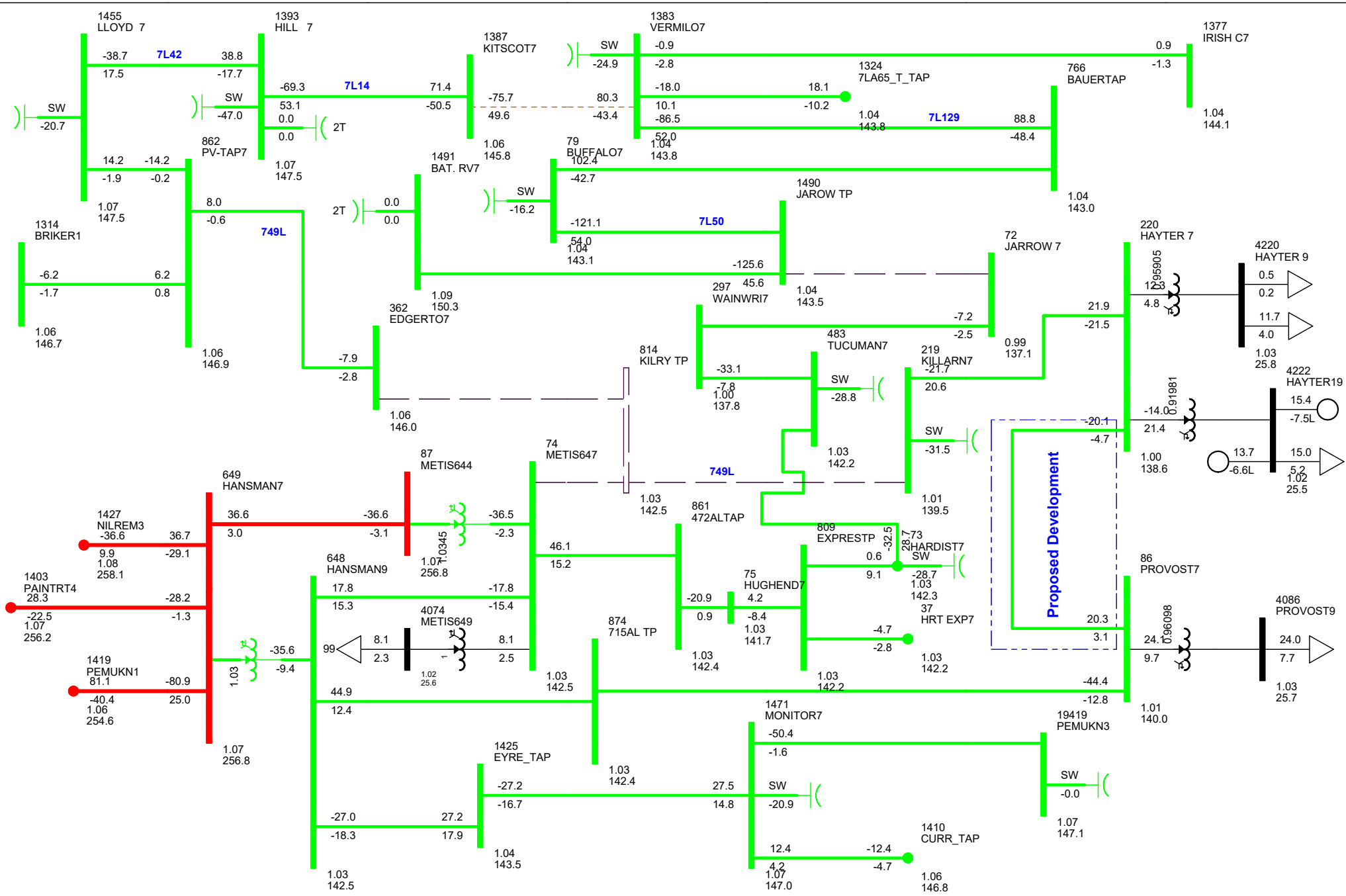
Provost Area Reliability Project 1782 2020 SP	P1782 POST-MITIGATION - DIAGRAM A5-4 N-1: EDGERTON 899S 138/25 KV TRANSFORMER WED, JAN 24 2018 11:17	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



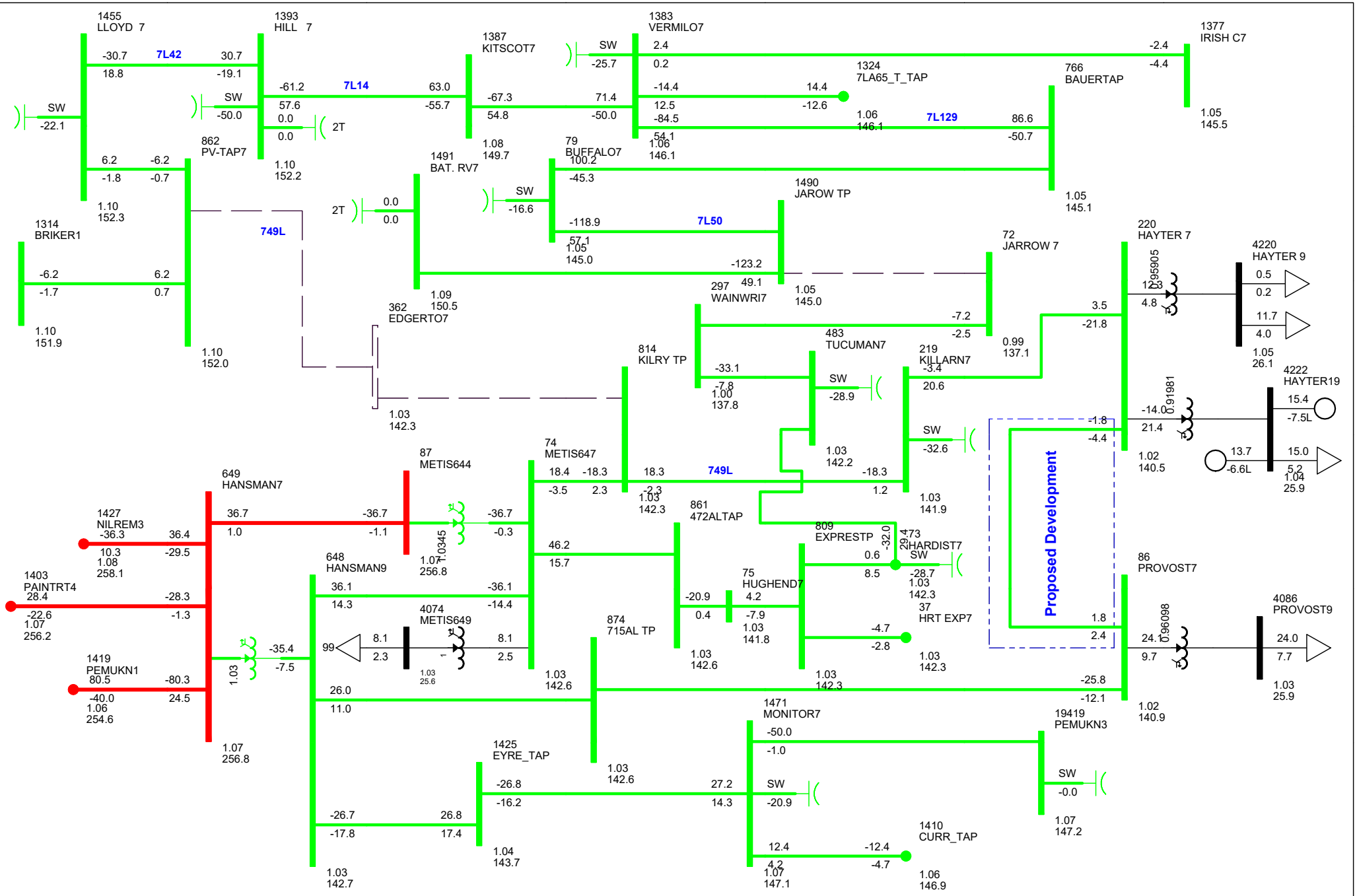
Provost Area Reliability Project 1782 2020 SP	P1782 POST-MITIGATION - DIAGRAM A5-5 N-1: 7L42 HILL 751S TO LLOYDMINSTER 716S WED, JAN 24 2018 11:17	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



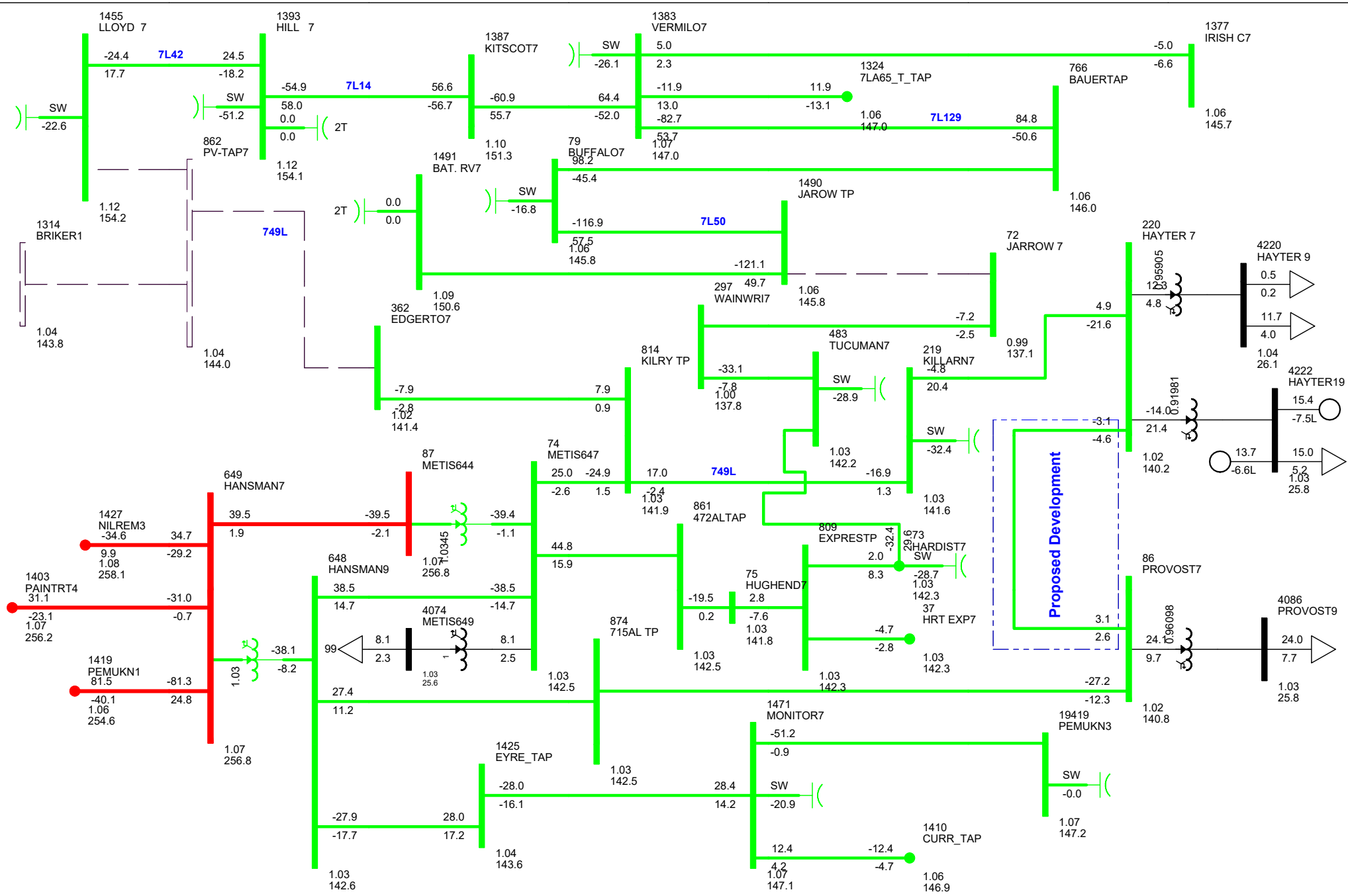
Provost Area Reliability Project 1782 2020 SP	P1782 POST-MITIGATION - DIAGRAM A5-6 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S WED, JAN 24 2018 11:17	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 POST-MITIGATION - DIAGRAM A5-7 N-1: 749L METISKOW 648S TO EDGERTON 899S/KILLARNEY LAKE 267S WED, JAN 24 2018 11:20	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 POST-MITIGATION - DIAGRAM A5-8 N-1: EDGERTON 899S 138/25 KV TRANSFORMER WED, JAN 24 2018 11:20	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Provost Area Reliability Project 1782 2020 WP	P1782 POST-MITIGATION - DIAGRAM A5-9 N-1: 749L/7L749 EDGERTON 899S TO LLOYDMINSTER 716S WED, JAN 24 2018 11:20	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.125OV 0.899UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000