APPENDIX A CONNECTION ASSESSMENT

Anthony Henday 309S Substation
Project Number: 1442

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

Information regarding the AESO Connection Process can be found at: http://www.aeso.ca/8602.html

Date: November 30, 2016

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Engineering Study Report

Anthony Henday 309S Substation

AESO Project No: P1442

Revision: 0

Revision Date: November 25, 2016

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Executive Summary

Overview

FortisAlberta Inc. (FortisAlberta), in its capacity as the legal owner of distribution facilities (DFO), has submitted a system access service request (SASR) to the Alberta Electric System Operator (AESO) to reliably serve industrial load growth in the Sherwood Park area.

The SASR includes a request for a Rate DTS, *Demand Transmission Service* (DTS), contract capacity of 21 MW for a new system access service in the Sherwood Park area and a request for transmission development (collectively, the Project). Specifically, the DFO requested a new point-of-delivery (POD) substation with two 138/25 kV transformers to reliably serve new industrial load at the existing Kinder Morgan Canada Edmonton pump station terminal.

The scheduled in-service date (ISD) for the Project is February 1, 2019.

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

Existing System

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

From a transmission system perspective, Edmonton (Area 60) consists of 69 kV, 138 kV, 240 kV, and 500 kV transmission systems.

The Project is located within one km of four existing substations, East Edmonton 38S substation, Bernese 293S, Broadmoor 420S and Knightsbridge 216S. Three 138 kV transmission lines are located near the Project: 731L and 865L are located on double circuit towers immediately south of the Project site and 215L is located immediately west of the Project site.

Study Summary

<u>Study Area</u>

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

<u>Studies Performed</u>

Studies were conducted using the *AESO 2012 Long-term Outlook Update* (2012 LTOU). Study scenarios were selected to correspond to the originally requested ISD of January 1, 2017, and to test the impact of the South and West Edmonton Area Transmission System Reinforcement[1] on the performance of the AIES before and after connection of the Project. The scheduled in-service date of the South and West Edmonton Area Transmission System Reinforcement was Q1 2018 at the time of study.

Power flow studies were performed for the 2016 winter peak (WP) pre-Project and post-Project scenarios, and for the 2018 summer peak (SP) pre-Project and post-Project scenarios. Voltage stability studies were performed for the 2016 WP and 2018 SP post-Project scenarios.

Results of Pre-Project Studies

No Reliability Criteria violations were observed under Category A conditions or Category B contingency conditions for the pre-Project scenarios.

Connection Alternatives

Five transmission alternatives were examined to meet the DFO's request for system access service.

Alternative 1: Upgrade the Broadmoor 420S substation by adding two 138/25 kV transformers, at least one 138 kV breaker, at least two 25 kV circuit breakers, and associated equipment. Alternative 1 would also involve the addition of two 25 kV distribution circuits, each approximately 2.6 km in length.

Alternative 2: Add a POD substation, to be designated as the Anthony Henday 309S substation, including two 138/25 kV transformers, two 138 kV breakers, and associated equipment. The proposed Anthony Henday 309S substation would be connected to the existing 138 kV transmission line 865L between the East Edmonton 38S and the Knightsbridge 216S substations using a T-tap connection configuration. The 138 kV transmission line 865L is strung in a double-circuit configuration with 138 kV transmission line 731L and a 25 kV distribution underbuild. To create the T-tap connection configuration, Alternative 2 would require the addition of one 138 kV circuit, approximately 75 m long, and rebuilding approximately 420 m of 25 kV distribution circuit.

Alternative 3: Add a POD substation, to be designated as the Anthony Henday 309S substation, including two 138/25 kV transformers, two 138 kV breakers, and associated equipment. The proposed Anthony Henday 309S substation would be connected to the existing 138 kV transmission line 215L between the East Edmonton 38S and the Yasa 286S substations using a T-tap connection configuration. This would require the addition of one 138 kV circuit, approximately 50 m in length.

Alternative 4: Modify the East Edmonton 38S substation by adding two 25 kV circuit breakers and associated equipment. Alternative 4 would also involve adding a 25 kV circuit, approximately 0.5 km in length.

Alternative 5: Upgrade the Knightsbridge 216S substation by adding two 138/25 kV transformers, at least one 138 kV breaker, at least two 25 kV circuit breakers, and

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

associated equipment. Alternative 5 also involves the addition two 25 kV distribution circuits, each approximately 0.8 km in length.

Alternative 6: Upgrade the Baseline 317S substation by adding two 138/25 kV transformers, at least one 138 kV breakers, at least two 25 kV circuit breakers, and associated equipment. Alternative 6 also involves the addition of two 25 kV distribution circuits, each approximately 0.8 km in length.

Alternatives Selected for Further Examination

Alternative 1 and Alternative 3 are technically feasible and were selected for further study.

Alternative 2 involves increased development and hence, increased cost compared to Alternative 3. Therefore, Alternative 2 was not selected for further study.

Alternative 4 was not selected for further study because it was determined to be not technically acceptable by the DFO.

Alternative 5 and Alternative 6 were not selected for further study because both alternatives were determined to be not technically feasible as there is not adequate space to expand the substations to accommodate the required equipment additions.

Results of Post-Project Studies

Alternative 1

No Reliability Criteria violations were observed for the post-Project scenarios, under Category A conditions.

No voltage criteria violations were observed for the post-Project scenarios under Category B contingency conditions. However, the following thermal criteria violations were observed for the 2018 SP post-project scenario:

- Loading above the seasonal continuous line rating, but below the short-term emergency rating of 138 kV transmission line 649L was observed following the loss of the 138 kV transmission line 731L.
- Loading above the seasonal continuous line rating, but below the short-term emergency rating of a segment of 138 kV transmission line 731L was observed following the loss of the 138 kV transmission line 649L.

Alternative 3

No Reliability Criteria violations were observed for the post-Project scenarios, under both Category A conditions and Category B contingency conditions.

Sensitivity Studies

Power flow sensitivity studies were conducted to assess the performance of the AIES before and after connection of the Project based on the updated scheduled ISD (February 1, 2019) and the *AESO 2016 Long-term Outlook* (2016 LTO). The main difference between the main study and the sensitivity study is Edmonton (Area 60) load. Edmonton (Area 60) load is forecast to be higher in 2019 than in 2017. The thermal criteria violations observed in post-Project studies of Alternative 1 were exacerbated as a result of forecast load increases in the Edmonton area evaluated in the power flow sensitivity analysis.

No Reliability Criteria violations were observed for Alternative 3, under both Category A conditions and Category B contingency conditions.

Alternative Selection

Based on the power flow studies results, Alternative 1 was eliminated from consideration because thermal criteria violations were observed in the post-Project scenarios. No Reliability Criteria violations were observed in the Alternative 3 studies. Therefore, Alternative 3 is the AESO's preferred alternative to meet the DFO's request for system access service.

Conclusions and Recommendation

It is recommended to proceed with Alternative 3 as the preferred alternative to respond to the DFO's request for system access service. The connection assessment did not identify any system performance issues before or after connection of Alternative 3. Alternative 3 is technically viable and would not adversely affect the performance of the AIES.

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Attachments

Attachment A: Pre-Project Power Flow Diagrams (Scenarios 1 and 2)
Attachment B: Alternative 1 Post-Project Power Flow Diagrams (Scenarios 3 and 4)
Attachment C: Alternative 3 Post-Project Power Flow Diagrams (Scenarios 3 and 4)
Attachment D: Alternative 1 Post-Project Voltage Stability Diagrams (Scenarios 3 and 4)
Attachment E: Alternative 3 Post-Project Voltage Stability Diagrams (Scenarios 3 and 4)
Attachment F: Alternative 1 Post-Project Sensitivity Power Flow Diagrams (Scenarios 5 and 6)
Attachment G: Alternative 3 Post-Project Sensitivity Power Flow Diagrams (Scenarios 5 and 6)

Figures

Tables

1. Introduction

This report presents the results of the study conducted to assess the impact of the Project (as defined below) on the performance of the Alberta interconnected electric system (AIES).

1.1. Project

1.1.1. Overview

FortisAlberta Inc. (FortisAlberta), in its capacity as the legal owner of distribution facilities (DFO), has submitted a system access service request (SASR) to the Alberta Electric System Operator (AESO) to reliably serve industrial load growth in the Sherwood Park area.

The SASR includes a request for a Rate DTS, Demand Transmission Service (DTS), contract capacity of 21 MW for a new system access service in the Sherwood Park area and a request for transmission development (collectively, the Project). Specifically, the DFO requested a new point-of-delivery (POD) substation with two 138/25 kV transformers to reliably serve new industrial load at the existing Kinder Morgan Canada Edmonton pump station terminal.

The scheduled in-service date (ISD) for the Project is February 1, 2019.

1.1.2. Load Component

- Rate DTS, Demand Transmission Service (DTS), contract capacity of 21 MW for a new system access service in the Sherwood Park area
- Load type: Oil and Gas: 4 x 5000 HP induction motors with variable frequency drives (VFDs) and other pump station load.
- Power Factor (PF): 0.9 pf (lagging) is assumed.
- There is no plan for future expansion.

1.1.3. Generation Component

There is no generation component associated with the Project.

1.2. Study Scope

1.2.1. Study Objectives

The objective of the study is as follows:

- Assess the impact of the Project on the performance of the AIES.
- Identify any violations of the relevant criteria, standards, or requirements of the AESO both pre-Project and post-Project.
- Recommend the preferred Project connection alternative and mitigation measures to address any system performance concerns to enable the reliable integration of the Project into the AIES.

1.2.2. Study Area

Description

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

From a transmission system perspective, Edmonton (Area 60) consists of 69 kV, 138 kV, 240 kV, and 500 kV transmission systems.

The Project is located within one km of four existing substations, East Edmonton 38S substation, Bernese 293S, Broadmoor 420S and Knightsbridge 216S. Three 138 kV transmission lines are located near the Project: 731L and 865L are located on double circuit towers immediately south of the Project site and 215L is located immediately west of the Project site.

The Study Area for the Project is Edmonton (Area 60) and the tie lines connecting Edmonton (Area 60) to the AIES.

Figure 1-1 shows the existing transmission system in the Study Area. Figure 1-2 shows the existing transmission system in the vicinity of the Project.

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

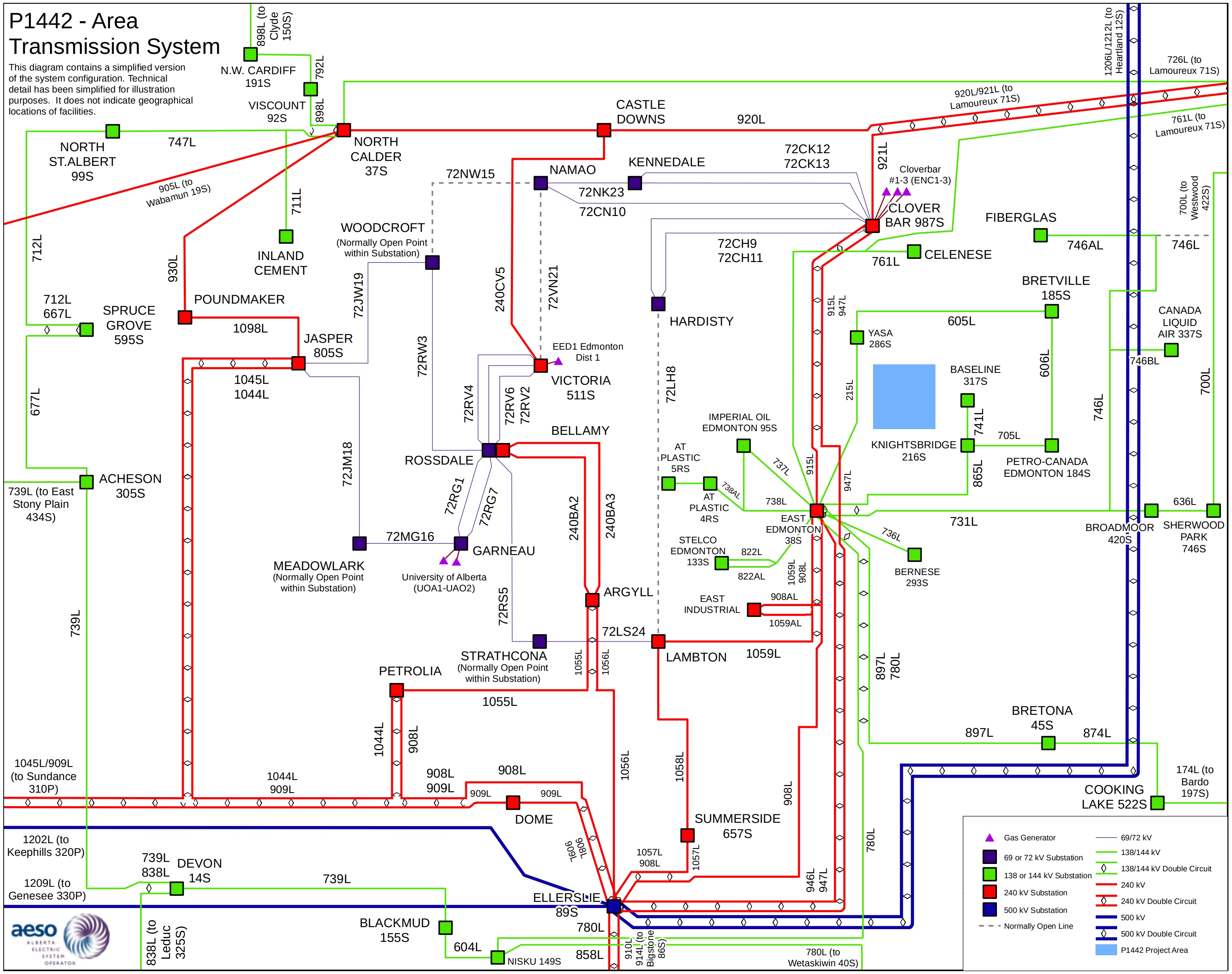
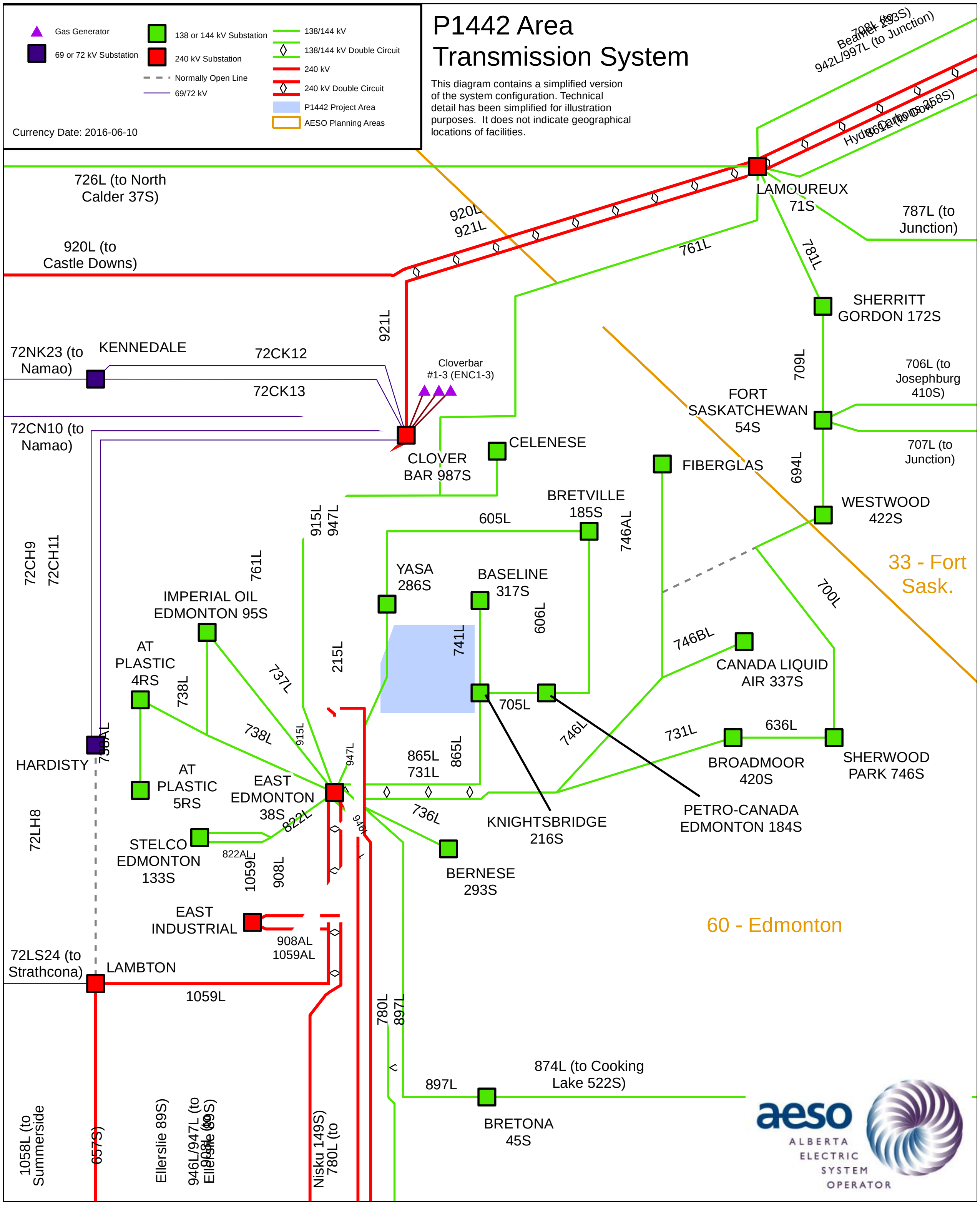


Figure 1-2: Existing Transmission System in vicinity of the Project



Existing Constraints

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

AESO Long-Term Transmission Plans (LTP)

Two system projects, the South and West Edmonton Area Transmission System Reinforcement,[2] and the Edmonton Region 240 kV Transmission System Upgrades,[3] occur in the Study Area, as shown in Table 1.2-1.

Table 1.2-1: Summary of System Projects

AESO Project Number	Project Name	Project Area	Scheduled In-Service Date
850	South and West Edmonton Area Transmission System Reinforcement	60	Q1-2018
786	Edmonton Region 240 kV Transmission System Upgrades	60	In service

The *AESO 2015 Long-term Transmission Plan* (2015 LTP)[4] includes plans for the following system developments in the east of Edmonton sub-region in the near term (by 2020):[5]

- Add a new 240/138 kV substation near the north edge of the Edmonton/Strathcona refinery area.
- Add a new 138 kV transmission line from a new substation to nearby Bretville 185S substation.
- Reconfigure the 138 kV network in the East Edmonton–Sherwood Park area.
- Open the 138 kV network between the Edmonton and Fort Saskatchewan areas.

1.2.3. Studies Performed

The following pre-Project studies were performed:

- Power flow

The following studies post-Project studies were performed:

- Power flow
- Voltage stability

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

[3] The *Edmonton Region 240 kV Transmission System Upgrades Needs Identification Document* was originally approved by the Alberta Utilities Commission on February 24, 2009 in Approval No. U2009-62.

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

[5] The 2015 LTP identifies the near-term transmission developments East of Edmonton sub-region on page 63.

1.3. Report Overview

The Executive Summary provides a high-level summary of the study and its conclusions. Section 1 provides an introduction to the Project and describes the study scope. Section 2 describes the criteria, system data, and other study assumptions used in this study. Section 3 describes the study methodology. Section 4 discusses the pre-Project study results. Section 5 presents the connection alternatives identified. Section 6 provides the post-Project study results for the examined connection alternatives. Section 7 identifies any dependencies the Project may have. Section 8 presents the conclusions and recommendations of this assessment.

2. Criteria, System Data, and Study Assumptions

2.1. Criteria, Standards, and Requirements

2.1.1. Transmission Planning Standards and Reliability Criteria

The Transmission Planning (TPL) Standards, which are included in the Alberta Reliability Standards, and the AESO's *Transmission Planning Criteria – Basis and Assumptions* [6] (collectively, the Reliability Criteria) were applied to evaluate system performance under Category A system conditions (i.e., all elements in-service) and following Category B contingencies (i.e., for a single element outage), prior to and following the studied alternatives. Below is a summary of Category A and Category B contingency conditions.

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

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

The Alberta Reliability Standards include the Transmission Planning (TPL) standards that specify the desired system performance under different contingency categories with respect to the Applicable Ratings. The transmission system performance under various system conditions is defined in Appendix 1 of the TPL standards. For the purpose of applying the TPL standards to this study, the Applicable Ratings shall mean:

- Seasonal continuous thermal ratings of the line's loading limits
- Highest specified loading limits for transformers
- For Category A conditions: Voltage range under normal operating condition should follow the AESO Information Document ID #2010-007RS, which relates to Section 304.4 of the ISO rules, *Maintaining Network Voltage*. For the busses not listed in ID #2010-007RS, Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions* applies.
- For Category B conditions: The extreme voltage range values per Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions*.

[6] Filed under a separate cover

- Desired post-contingency voltage change limits for three defined post event time periods as provided in Table 2.1-1.

Table 2.1-1: Post Contingency Voltage Deviation Guidelines

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

2.1.2. AESO Rules and IDs

The AESO ID #2010-007RS will be applied to establish pre-contingency voltage profiles in the Study Area. The TCM Rule will be followed in setting up the study scenarios and assessment of 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.

2.2. Study Scenarios

The 2016 WP study scenario was selected to correspond to the originally requested ISD of January 1, 2017. The 2018 SP study scenario was selected to test the impact of the South and West Edmonton Area Transmission System Reinforcement on the performance of the AIES before and after connection of the Project. The scheduled in-service date of the South and West Edmonton Area Transmission System Reinforcement was Q1 2018 at the time of study.

Table 2.2-1 provides a list of the study scenarios. A power factor of 0.90 lagging was used for the project load.

Table 2.2-1: Summary of Study Scenario Assumptions

Scenario	Year/Season Load	Condition	Project Load (MW)	Project Generation (MW)
1	2016 WP	Pre-Project	0	0
2	2018 SP	Pre-Project	0	0
3	2016 WP	Post-Project	21	0
4	2018 SP	Post-Project	21	0

2.3. Load and Generation Assumptions

2.3.1. Load Assumptions

The Study Area load forecasts used for this connection study are shown in Table 2.3-1 and are from the *AESO 2012 Long-term Outlook Update* (2012 LTOU). As part of its planning responsibilities, the AESO updates its corporate forecasts routinely to ensure they reflect the latest economic projects, factors and timing.[7] In this study, the active power to reactive power ratio in the base case scenarios were maintained when modifying the planning area loads.

Table 2.3-1: Forecast Area Load (2012 LTOU at Edmonton Planning Region Peak)

Area or Region Name	Season	Forecast Peak Load (MW)
Edmonton (Area 60)	2016 WP	1946.2
	2018 SP	1866.7
Alberta Internal Load w/o Losses	2016 WP	12550.6
	2018 SP	12247.8

2.3.2. Generation Assumptions

The key generation conditions for this connection study are described in Table 2.3-2. Clover Bar generation unit G3 was identified as the critical generator. It was turned off to represent the N-G study condition in the Study Area for all study scenarios.

Table 2.3-2: Key Local Generation (MW) in the Study Area

Existing/Future	Unit Name	Unit ID	Bus Number	AESO Planning Area	Pmax (MW)	2016 WP Unit Net Generation (MW)	2018 SP Unit Net Generation (MW)
Existing	Sundance	1	129	40	300	262.9	262.9
Existing		3	130	40	380	360.8	360.8
Existing		2	338	40	300	262.7	262.7
Existing		4A	342	40	430	406.7	406.7
Existing		5A	345	40	435.4	389.9	389.9
Existing		6A	350	40	425	399.3	399.3
Existing	Keephills	3	403	40	498	468.7	468.7
Existing		1	422	40	415	415	397.4
Existing		2	424	40	415	413.3	395.7
Existing	Genesee	3	490	40	527.4	474.7	474.7
Existing		1	491	40	422	407.5	407.5
Existing		2A	492	40	422	408.8	408.8
Existing	Celanese	4	25401	60	4.4	0	0
Existing		1	25402	60	6.6	0	0
Existing		2	25402	60	6.6	0	0
Existing		3	25402	60	6.6	0	0

[7] The AESO has updated its regional forecasts since the connection studies were performed, the *AESO 2016 Long-term Outlook* (2016 LTO) was used to complete sensitivity studies as described in Section 6.3.

Existing/Future	Unit Name	Unit ID	Bus Number	AESO Planning Area	Pmax (MW)	2016 WP Unit Net Generation (MW)	2018 SP Unit Net Generation (MW)
Existing	Clover Bar	G1	25516	60	43.9	43.9	37.3
Existing		G2	26516	60	100	96	59.8
Existing		G3	27516	60	100.8	OFF	OFF

2.3.3. Intertie Flow Assumptions

The Alberta-British Columbia, Alberta-Montana, and Alberta-Saskatchewan intertie power flows are expected to have no material impact on the connection assessment for the Project. Therefore, the AESO planning base case intertie flow assumptions were used.

2.3.4. High Voltage Direct Current (HVDC) Assumptions

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

2.4. System Projects

Table 2.4-1 provides a list of the system projects that are assumed to be in service for the studies. The near-term system projects identified in the 2015 LTP (see Section 1.2.2.3) were not considered in the study.

Table 2.4-1: System Projects Included in the Study Scenarios

AESO Project Number	Project Name	Project Area	Scheduled In-Service Date
850	South and West Edmonton Area Transmission System Reinforcement	60	Q1-2018
786	Edmonton Region 240 kV Transmission System Upgrades	60	In Service

2.5. Customer Connection Projects

There are no customer connection projects in the Study Area that have AESO Connection Queue positions before the Project and that have passed through Gate 2 of the AESO Connection Process as of October 2016. Therefore, no customer connection projects were included in the studies.

2.6. Facility Ratings and Shunt Elements

The legal owner of transmission facilities (TFO) provided the ratings of the existing transmission lines and the existing transformers in the Study Area. The key transmission line ratings are shown in Table 2.6-1 and the key transformer ratings are shown in Table 2.6-2.

Table 2.6-1: Key Transmission Line Ratings in the vicinity of the Study Area (*MVA on 138 kV Bases*)

Line ID	Line Description	Voltage Class (kV)	Seasonal Continuous Rating (MVA)		Short-term[a] Rating (MVA)	
			Summer	Winter	Summer	Winter
865L	East Edmonton 38S - Knightsbridge 216S	138	119	146	131	161
731L	East Edmonton 38S- JCT. 746L	138	172	212	189	233
731L	JCT.746L - Broadmoor 420S	138	119	146	131	161
215L	East Edmonton 38S - Yasa 286S	138	120	146	132	161
605L	Bretville 185S - Yasa 286S	138	120	146	132	161
606L	Petro-Canada Edmonton 184S - Bretville 185S	138	120	146	132	161
705L	Knightsbridge 216S - Petro-Canada Edmonton 184S	138	119	113	131	124
741L	Knightsbridge 216S - Baseline 317S	138	98	132	108	145
636L	Broadmoor 420S - Sherwood Park 746S	138	119	146	131	161
700L	Westwood 422S - JCT. 746L	138	119	146	131	161
700L	JCT.746L - Sherwood Park 746S	138	119	146	131	161
694L	Fort Saskatchewan 54S - Westwood 422S	138	119	146	131	161
736L	East Edmonton 38S - Bernese 293S	138	121	149	133	164
897L	East Edmonton 38S - Bretona 45S	138	85	90	94	99
780L	East Edmonton 38S - Nisku 149S	138	98	132	108	145
822L	East Edmonton 38S - 822AL Tap Point	138	119	146	131	161
822L	J822AL Tap Point - Stelco Edmonton 133S	138	119	146	131	161
822AL	822AL Tap Point - Stelco Edmonton 133S	138	119	146	131	161
738L	Imperial Oil Edmonton 95S - EP738AL Tap Point	138	111	141	122	155
738L	EP738AL Tap Point - East Edmonton 38S	138	111	141	122	155
761L	East Edmonton 38S - Lamoureux 71S	138	98	132	108	145

Line ID	Line Description	Voltage Class (kV)	Seasonal Continuous Rating (MVA)		Short-term[a] Rating (MVA)	
			Summer	Winter	Summer	Winter
761L	East Edmonton 38S - Lamoureux 71S	138	98	132	108	145
737L	East Edmonton 38S - Imperial Oil Edmonton 95S	138	103	135	113	146

NOTE:

[a] When a line loading under a Category B contingency condition is observed to exceed its seasonal continuous rating and is less than its short-term (emergency) rating, it is assumed that AESO and TFO operating practices can manage the constraint within the time requirements of TFO short-term (emergency) rating.

Table 2.6-2: Key Transformer Ratings in the Study Area

Substation Name and Number	Transformer ID	Transformer Voltages (kV)	MVA Rating
East Edmonton 38S	T1	240/138	337
	T2	240/138	337
	T3	138/25	93.3
	T4	138/25	93.3
Ellerslie 89S	T1	500/240	400
	T2	500/240	400
Broadmoor 420S	T1	138/25	42
Sherwood Park 746S	T1	138/25	42
	T2	138/25	42
Bretona 45S	T1	138/25	42

The details of key shunt elements in the Study Area are given in Table 2.6-3. There are no reactors present within the Study Area.

Table 2.6-3: Key Shunt Elements in the Study Area

Substation Name and Number	Voltage Class (kV)	Capacitors			
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)	Status in Study (on or off)	
				2016 WP	2018 SP
Acheson 305S	138	1	24.46	On	Off
East Edmonton 38S	138	2	97.82	On	On
Nisku 149S	138	1	30.00	On	On
Jasper	240	1	105.32	On	On

Substation Name and Number	Voltage Class (kV)	Capacitors			
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)	Status in Study (on or off)	
				2016 WP	2018 SP
Rossdale	69	2	95.5	On	On
Cloverbar	69	1	31.57	On	On
Stelco Edmonton 133S	34.5	2	46.8	On	On

2.7. Voltage Profile Assumptions

The AESO ID# 2010-007RS was used to establish system normal (i.e., pre-contingency) voltage profiles for key area busses prior to commencing any studies. Table 2-1 of the *Transmission Planning Criteria – Basis and Assumptions* applies for all the busses not included in the ID# 2010-007RS. These voltages were utilized to set the voltage profile for the study base cases prior to power flow analysis. A list of operating voltages for the key busses in the Study Area are shown in Table 2.7-1.

Table 2.7-1: Bus Voltages of Key Substations in the Study Area

Substation Name and Number	System Base (kV)	Minimum Limit (kV)	Desired Range (kV)	Maximum Limit (kV)
East Edmonton 38S	240	240	240 - 253	255
	138	139	139 - 144	145
Ellerslie 89S	500	505	520 - 540	550
	240	243	246 - 254	255
North Calder 37S	240	240	244 - 255	260
	138	137	138 - 144	145
Clover Bar 987S	240	240	245 - 254	255
Bellamy	240	-	-	255
Acheson 305S	138	138	138 - 144	145

3. Study Methodology

All connection studies were completed using PTI PSS/E version 33.

3.1. Connection Studies Carried Out

The studies carried out for this connection study were identified in Table 3.1-1.

Table 3.1-1: Studies Performed

Scenario and Condition		System Conditions Category		Power Flow	Voltage Stability
		A	B		
1	2016 WP pre-Project	✓	✓	✓	-
2	2018 SP pre-Project	✓	✓	✓	-
3	2016 WP post-Project	✓	✓	✓	✓
4	2018 SP post-Project	✓	✓	✓	✓

3.2. Power Flow Analysis

Pre-Project and post-Project power flow analysis was conducted to identify thermal and voltage criteria violations as per the Reliability Criteria, and to identify any deviations from the desired limits in Table 2.1-1. The purpose of the power flow analysis is to quantify any violations in the Study Area both for the pre-Project and post-Project study scenarios. Transformer taps and switched shunt reactive compensation devices such as shunt capacitors and reactors will be locked and continuous shunt devices will be enabled when performing Category B power flow analysis.

POD low voltage bus deviations were assessed by first locking all tap changers and area capacitors to identify any post-transient voltage deviations above 10%. Second, tap changers were allowed to move while capacitors remained locked to determine if any voltage deviations above 7% were found in the area. Third, all taps and capacitor controls were allowed to adjust, and voltage deviations above 5% were reported for both the pre-Project and post-Project scenarios

3.2.1. Contingencies Studied

The Category B contingencies studied included all 138 kV, 240 kV, and 500 kV transmission facilities within the Study Area. All transmission facilities in the Study Area were monitored for Reliability Criteria violations.

3.3. Voltage Stability Analysis

The objective of the voltage stability analysis is to determine the ability of the transmission system to maintain voltage stability at all the busses in the system under Category A and Category B conditions. The power-voltage (PV) curve is a representation of voltage change as a result of increased power transfer between two systems. The reported incremental transfers will be to the collapse point. As per the AESO requirements, no assessment based upon other criteria such as minimum voltage will be made at the PV minimum transfer.

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

Voltage stability (PV) analysis was 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 modeled 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 scenarios in terms of loading. The source system for the voltage stability analysis was formed by the generation in Fort McMurray (Area 25). The sink system included Edmonton (Area 60).

The studies performed assume the following:

- The voltage stability analysis was performed by increasing load in Edmonton (Area 60) and increasing generation in the Fort McMurray (Area 25). P/Q ratio was maintained constant while scaling the area load.
- The analysis was performed initially with discrete switched capacitors and reactors, LTC transformers and phase shifting transformers locked.

Power-voltage (P-V) curves were generated for Category A condition and the top five worst case Category B contingency conditions in the Study Area. The maximum operating load limits were determined to be:

- 5% below the load at the collapse point on the P-V curve for Category A.
- 5% below the pre-contingency load corresponding to the collapse point on the P-V curve for Category B contingency conditions.

3.4. Contingencies Studied

The Category B contingencies studied included all 138 kV, 240 kV, and 500 kV transmission facilities within the Study Area. All transmission facilities in the Study Area were monitored for Reliability Criteria violations.

4. Pre-Project System Assessment

4.1. Pre-Project Power Flow Analysis

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

4.1.1. Scenario 1: 2016 Winter Peak

Category A condition

No Reliability Criteria violations were observed.

Category B contingency conditions

No Reliability Criteria violations or POD bus voltage deviations were observed.

4.1.2. Scenario 2: 2018 Summer Peak

Category A condition

No Reliability Criteria violations were observed.

Category B contingency conditions

No Reliability Criteria violations or POD bus voltage deviations were observed.

5. Connection Alternatives

5.1. Overview

Six alternatives were examined to meet the DFO's request for system access service. Details of these alternatives are described in Section 5.2.

5.2. Connection Alternatives Identified

Below is a description of the developments associated with the transmission alternatives that were examined for the Project.[8]

Alternative 1: Upgrade the Broadmoor 420S substation

Alternative 1 involves the addition of two 138/25 kV transformers, at least one 138 kV circuit breaker, at least two 25 kV circuit breakers and associated equipment at the Broadmoor 420S substation. Alternative 1 would also involve the addition of a two 25 kV distribution circuits, each approximately 2.6 km in length, to connect the industrial load to Broadmoor 420S substation.

Alternative 2: New POD substation connected to the 138 kV transmission line 865L

Alternative 2 involves the addition of a new POD substation, to be designated as Anthony Henday 309S. The Anthony Henday 309S substation would be connected to the existing 138 kV transmission line 865L between the East Edmonton 38S and the Knightsbridge 216S substations using a T-tap connection configuration. The 138 kV transmission line 865L is strung in a double circuit configuration with 138 kV transmission line 731L and includes a 25 kV distribution underbuild. To create the T-tap connection configuration, Alternative 2 would require the addition of one 138 kV circuit, approximately 75 m long, and rebuilding approximately 420 m of 25 kV distribution circuit.

The proposed Anthony Henday 309S substation would include the following equipment:

- Two 138/25 kV, on-load tap changing (LTC) transformers. One of the transformers is an emergency backup transformer for reliability, to minimize the substation downtime when the other transformer offline due to maintenance or malfunction;
- Two 138 kV circuit breakers; and
- Associated equipment.

Alternative 3: New POD substation connected to the 138 kV transmission line 215L

Alternative 3 involves the addition of a new POD substation, to be designated as Anthony Henday 309S. The Anthony Henday 309S substation would be connected to the existing 138 kV transmission line 215L between East Edmonton 38S substation and Yasa 286S substation, using a T-tap connection configuration. This would require the addition of one 138 kV circuit, approximately 50 m in length.

[8] These alternatives reflect more up to date engineering design than the alternatives identified in the FortisAlberta *Need for Development New East Edmonton Area Transmission Facility Upgrades* report, which is filed under a separate cover.

The proposed Anthony Henday 309S substation would include the following equipment:

- Two 138/25 kV, LTC transformers. One of the transformers is an emergency backup transformer for reliability, to minimize the substation downtime when the other transformer offline due to maintenance or malfunction;
- Two 138 kV circuit breakers; and
- Associated equipment.

Alternative 4: Modify the East Edmonton 38S substation

Alternative 4 includes the installation of two new 25 kV circuit breakers and associated equipment at the existing East Edmonton 38S substation. Alternative 4 would also involve adding a 25 kV circuit, approximately 0.5 km in length.

Alternative 5: Upgrade the Knightsbridge 216S substation

Alternative 5 involves upgrading the existing Knightsbridge 216S substation by adding two 138/25 kV transformer, at least one 138 kV breaker, at least two 25 kV circuit breakers, and associated equipment. Alternative 5 also involves the addition two 25 kV distribution circuits, each approximately 0.8 km in length.

Alternative 6: Upgrade the Baseline 317S substation

Alternative 6 involves upgrading the existing Baseline 317S substation by adding two 138/25 kV transformer, at least one 138 kV breaker, at least two 25 kV circuit breakers, and associated equipment. Alternative 6 also involves the addition of two 25 kV distribution circuits, each approximately 0.8 km in length.

5.2.1. Connection Alternatives Selected for Further Studies

Alternative 1 and Alternative 3 are considered technically feasible and were selected for further study.

5.2.2. Connection Alternatives Not Selected for Further Studies

Alternative 2 is considered technically feasible. However, this alternative involves increased development and hence, increased costs compared to Alternative 3. Therefore, Alternative 2 was not selected for further study.

Alternative 4 was not selected for further study because it was determined to be not technically acceptable by the DFO[9].

Alternative 5 and Alternative 6 were not selected for further study because both alternatives were determined to be not technically feasible as there is not adequate space to expand the substations to accommodate the required equipment additions.

[9] As per the FortisAlberta *Need for Development New East Edmonton Area Transmission Facility Upgrades* report, which is filed under a separate cover.

6. Technical Analysis of the Connection Alternatives

This section provides the results of the post-Project power flow, voltage stability and sensitivity studies for Alternative 1 and Alternative 3.

6.1. Power Flow

6.1.1. Alternative 1

The post-Project power flow diagrams for Alternative 1 are provided in Attachment B.

Scenario 3: 2016 Winter Peak

Category A condition

No Reliability Criteria violations were observed.

Category B contingency conditions

No Reliability Criteria violations or POD bus voltage deviations were observed.

Scenario 4: 2018 Summer Peak

Category A condition

No Reliability Criteria violations were observed.

Category B contingency conditions

No voltage criteria violations or POD bus voltage deviations were observed. Two thermal criteria violations were observed, which are also described below, and shown in Table 6.1-1.

- Loading above the seasonal continuous line rating, but below the short-term emergency rating of 138 kV transmission line 694L (between Westwood 422S substation and Fort Saskatchewan 54S substation) was observed following the loss of the 138 kV transmission line 731L (between East Edmonton 38S substation and Broadmoor 420S substation).
- Loading above the seasonal continuous line rating, but below the short-term emergency rating of a segment of 138 kV transmission line 731L (between Broadmoor 420S and the junction with 138 kV transmission line 746L) was observed following the loss of the 138 kV transmission line 694L (between Westwood 422S substation and Fort Saskatchewan 54S substation).

Table 6.1-1: Reliability Criteria Violations for Alternative 1 - 2018 SP Post-Project Scenario

Contingency	Limiting Branch	Seasonal Continuous Rating (MVA)	Short-term Rating (MVA)	Post-Project	
				Power Flow (MVA)	% Loading
138kV line 731L (East Edmonton 38S - Broadmoor 420S)	138kV line 694L (Westwood 422S - Fort Saskatchewan 54S)	119	131	131	109.7
138kV line 694L (Westwood 422S - Fort Saskatchewan 54S)	138kV line 731L (Broadmoor 420S - 746L Tap Point)	119	131	127	105.6

6.1.2. Alternative 3

The post-Project power flow diagrams for Alternative 3 are provided in Attachment C.

Scenario 3: 2016 Winter Peak

Category A condition

No Reliability Criteria violations were observed.

Category B contingency conditions

No Reliability Criteria violations or POD bus voltage deviations were observed.

Scenario 4: 2018 Summer Peak

Category A condition

No Reliability Criteria violations were observed.

Category B contingency conditions

No Reliability Criteria violations or POD bus voltage deviations were observed.

6.2. Voltage Stability

Voltage stability analysis was conducted using the 2016 WP and 2018 SP post-Project scenarios to investigate the system active power margins after the Project is connected to the AIES under the Category A condition and Category B contingency conditions. The reference load level of the Study Area for 2016 WP scenario is 1946 MW and for 2018 SP scenario is 1867 MW. The minimum incremental load transfer for the Category B contingencies is 5.0% of the reference load or 97.3 MW for 2016 WP and 93.4 MW for 2018 SP to meet the voltage stability criteria.

6.2.1. Alternative 1

Table 6.2-1 and Table 6.2-2 summarize the voltage stability results for Category A and for the five worst contingencies under Category B system conditions, for the 2016 WP and 2018 SP post-Project scenarios, respectively.

The voltage stability margin was met in all conditions for both the 2016 WP and 2018 SP post-Project scenarios. The voltage stability plots for Alternative 1 are presented in Attachment D.

Table 6.2-1: Alternative 1 2016 WP– Voltage Stability Analysis Results (min. transfer = 97.3 MW)

Condition	From	To	Incremental Area Load Increase before Collapse (MW)	Margin (%) (Incremental/Base Load* x 100)	Meets 105% transfer criteria?
Category A	System Normal		780	40	Yes
Category B Contingencies					
604L	Nisku 149S	Blackmud 155S	770	39.5	Yes
780L	East Edmonton 38S	Nisku 149S	770	39.5	Yes
T6 240/138 kV transformer	North Calder 37S		770	39.5	Yes
T1 orT4 240/138 kV transformer	East Edmonton 38S		770	39.5	Yes
T1 or T2 240/138 kV transformer	Ellerslie 89S		770	39.5	Yes

*Base load is 1946 MW

Table 6.2-2: Alternative 1 2018 SP– Voltage Stability Analysis Results (min. transfer = 93.4 MW)

Condition	From	To	Incremental Area Load Increase before Collapse (MW)	Margin (%) (Incremental/Base Load* x 100)	Meets 105% transfer criteria?
Category A	System Normal		760	39	Yes
Category B Contingencies					
604L	Nisku 149S	Blackmud 155S	690	35.5	Yes
780L	East Edmonton 38S	Nisku 149S	720	37	Yes
T6 240/138 kV transformer	North Calder 37S		750	38.5	Yes
T1 or T4 240/138 kV transformer	East Edmonton 38S		750	38.5	Yes
T1 or T2 240/138 kV transformer	Ellerslie 89S		750	38.5	Yes

*Base load is 1946 MW

6.2.2. Alternative 3

Table 6.2-3 to Table 6.2-4 summarize the voltage stability results for Category A and for the five worst contingencies under Category B system conditions, for the 2016 WP and 2018 SP post-Project scenarios, respectively.

The voltage stability margin was met in all conditions for both the 2016 WP and 2018 SP post-Project scenarios. The voltage stability in plots for Alternative 3 are presented in Attachment E.

Table 6.2-3: Alternative 3 2016 WP – Voltage Stability Analysis Results (min. transfer = 97.3 MW)

Condition	From	To	Incremental Area Load Increase before Collapse (MW)	Margin (%) (Incremental/Base Load* x 100)	Meets 105% transfer criteria?
Category A	System Normal		770	39.5	Yes
Category B Contingencies					
604L	Nisku 149S	Blackmud 155S	770	39.5	Yes
780L	East Edmonton 38S	Nisku 149S	770	39.5	Yes
T6 240/138 kV transformer	North Calder 37S		770	39.5	Yes
T1 or T4 240/138 kV transformer	East Edmonton 38S		770	39.5	Yes
T1 or T2 240/138 kV transformer	Ellerslie 89S		770	39.5	Yes

*Base load is 1946 MW

Table 6.2-4: Alternative 3 2018 SP– Voltage Stability Analysis Results (min. transfer = 93.4 MW)

Condition	From	To	Incremental Area Load Increase before Collapse (MW)	Margin (%) (Incremental/Base Load* x 100)	Meets 105% transfer criteria?
Category A	System Normal		950	51.0	Yes
Category B Contingencies					
604L	Nisku 149S	Blackmud 155S	810	43.0	Yes
780L	East Edmonton 38S	Nisku 149S	870	46.5	Yes
T6 240/138 kV transformer	North Calder 37S		880	47.0	Yes
T1 or T4 240/138 kV transformer	East Edmonton 38S		890	48.0	Yes
T1 or T2 240/138 kV transformer	Ellerslie 89S		900	48.0	Yes

*Base load is 1946 MW

6.3. Sensitivity Studies

Power flow sensitivity studies were conducted to assess the impact of the Project based on updated ISD (February 1, 2019) and the *AESO 2016 Long-term Outlook* (2016 LTO).

6.3.1. Study Methodology

Table 6.3-1 provides a list of the sensitivity study scenarios. A power factor of 0.90 lagging was used for the project load.

Table 6.3-1: Summary of Sensitivity Study Scenario Assumptions

Scenario	Year/Season Load	Condition	Project Load (MW)	Project Generation (MW)
5	2018 WP	Post Project	21	0
6	2019 SP	Post-Project	21	0

Table 6.3-2 shows the Study Area load forecast based on 2016 LTO at Edmonton Regional Peak.

Table 6.3-2: Study Area Load based on 2016 LTO at Edmonton Regional Peak

Area or Region Name and Season		Forecast Peak Load (MW)
Area 60 (Edmonton)	2018 WP	2018.7
	2019 SP	2109.9
AIL w/o Losses	2018 WP	12213.8
	2019 SP	11575.2

6.3.2. Alternative 1 Results

The post-Project sensitivity study power flow diagrams for Alternative 1 are provided in Attachment F.

Scenario 5: 2018 Winter Peak

Category A condition

No Reliability Criteria violations were observed.

Category B contingency conditions

No Reliability Criteria violations or POD bus voltage deviations were observed.

Scenario 6: 2019 Summer Peak

Category A condition

No Reliability Criteria violations were observed.

Category B contingency conditions

No voltage criteria violations or POD bus voltage deviations were observed. Two thermal criteria violations were observed, which are also described below, and shown in Table 6.3-3.

- Loading above the short-term emergency rating of 138 kV transmission line 694L (between Westwood 422S substation and Fort Saskatchewan 54S substation) was observed following the loss of the 138 kV transmission line 731L (between East Edmonton 38S substation and Broadmoor 420S substation).
- Loading above the short-term emergency rating of a segment of 138 kV transmission line 731L (between Broadmoor 420S and the junction with 138 kV transmission line 746L) was observed following the loss of the 138 kV transmission line 694L (between Westwood 422S substation and Fort Saskatchewan 54S substation).

The thermal criteria violations observed in post-Project studies of Alternative 1 were exacerbated as a result of forecast load increases in the Edmonton area that were studied in the 2019 SP scenario.

Table 6.3-3: Reliability Criteria Violations for Alternative 1 - 2019 SP Post-Project Sensitivity Scenario

Contingency	Limiting Branch	Seasonal Continuous Rating (MVA)	Short-term Rating (MVA)	Post-Project	
				Power Flow (MVA)	% Loading
138kV line 731L (East Edmonton 38S - Broadmoor 420S)	138kV line 694L (Westwood 422S - Fort Saskatchewan 54S)	119	131	143.1	119
138kV line 694L (Westwood 422S - Fort Saskatchewan 54S)	138kV line 731L (Broadmoor 420S - 746L tap point)	119	131	136.4	115

6.3.3. Alternative 3 Results

Category A condition

No Reliability Criteria violations were observed in both of the 2018 WP or 2019 SP scenarios.

Category B contingency conditions

No Reliability Criteria violations or POD bus voltage deviations were observed in both of the 2018 WP or 2019 SP scenarios.

The post-Project sensitivity study power flow diagrams for Alternative 3 are provided in Attachment G.

6.4. Alternative Selection

Based on the power flow study results, Alternative 1 was eliminated from consideration because thermal criteria violations were observed in the post-Project scenarios. No Reliability Criteria violations were observed in the Alternative 3 studies. Therefore, Alternative 3 is the AESO's preferred alternative to meet the DFO's request for system access service.

7. Project Interdependencies

The Project is not dependent on other AESO plans to expand or enhance the transmission system.

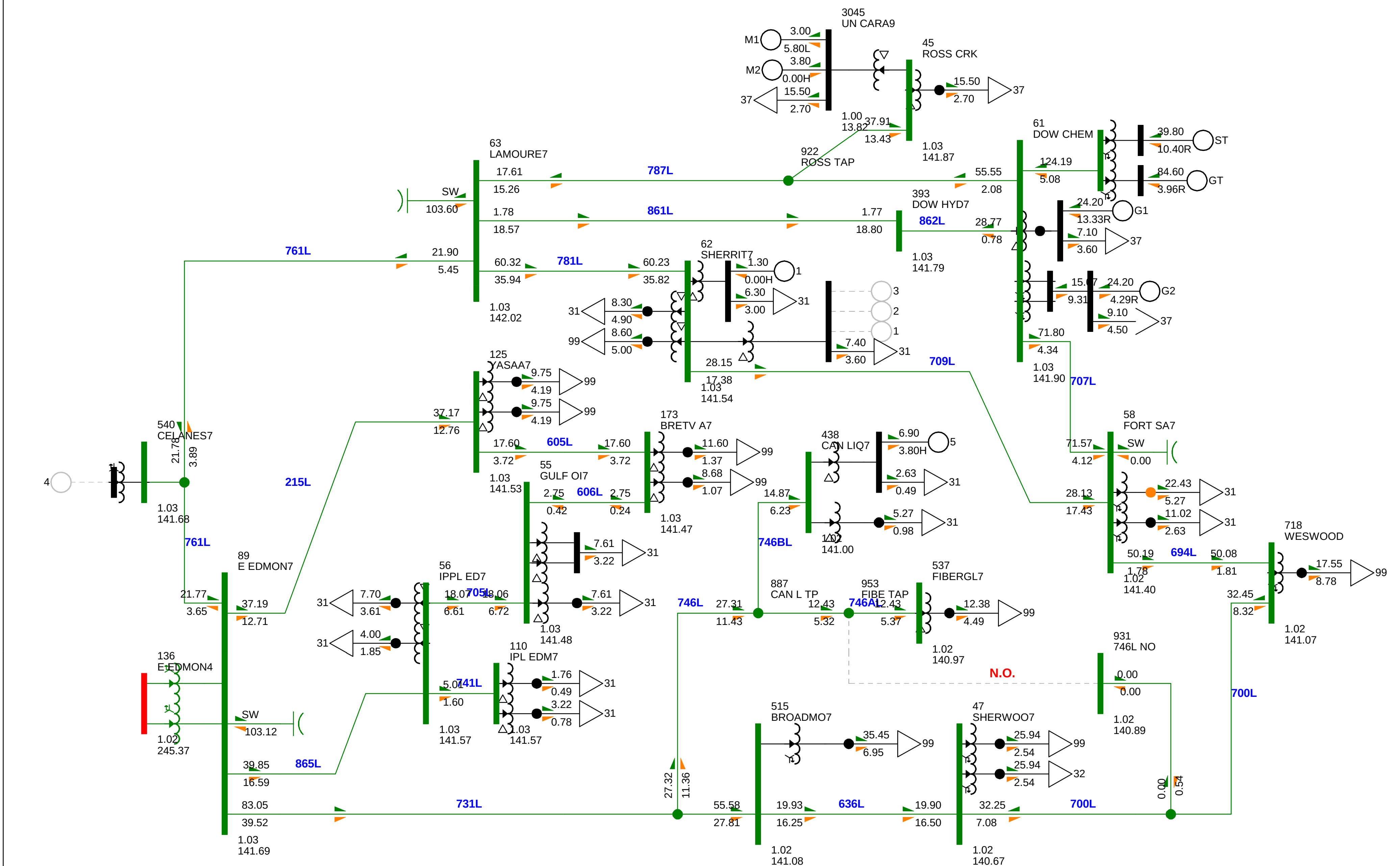
8. Conclusion and Recommendation

It is recommended to proceed with Alternative 3 as the preferred alternative to respond to the DFO's request for system access service. The connection assessment did not identify any system performance issues before or after connection of Alternative 3. Alternative 3 is technically viable and would not adversely affect the performance of the AIES.

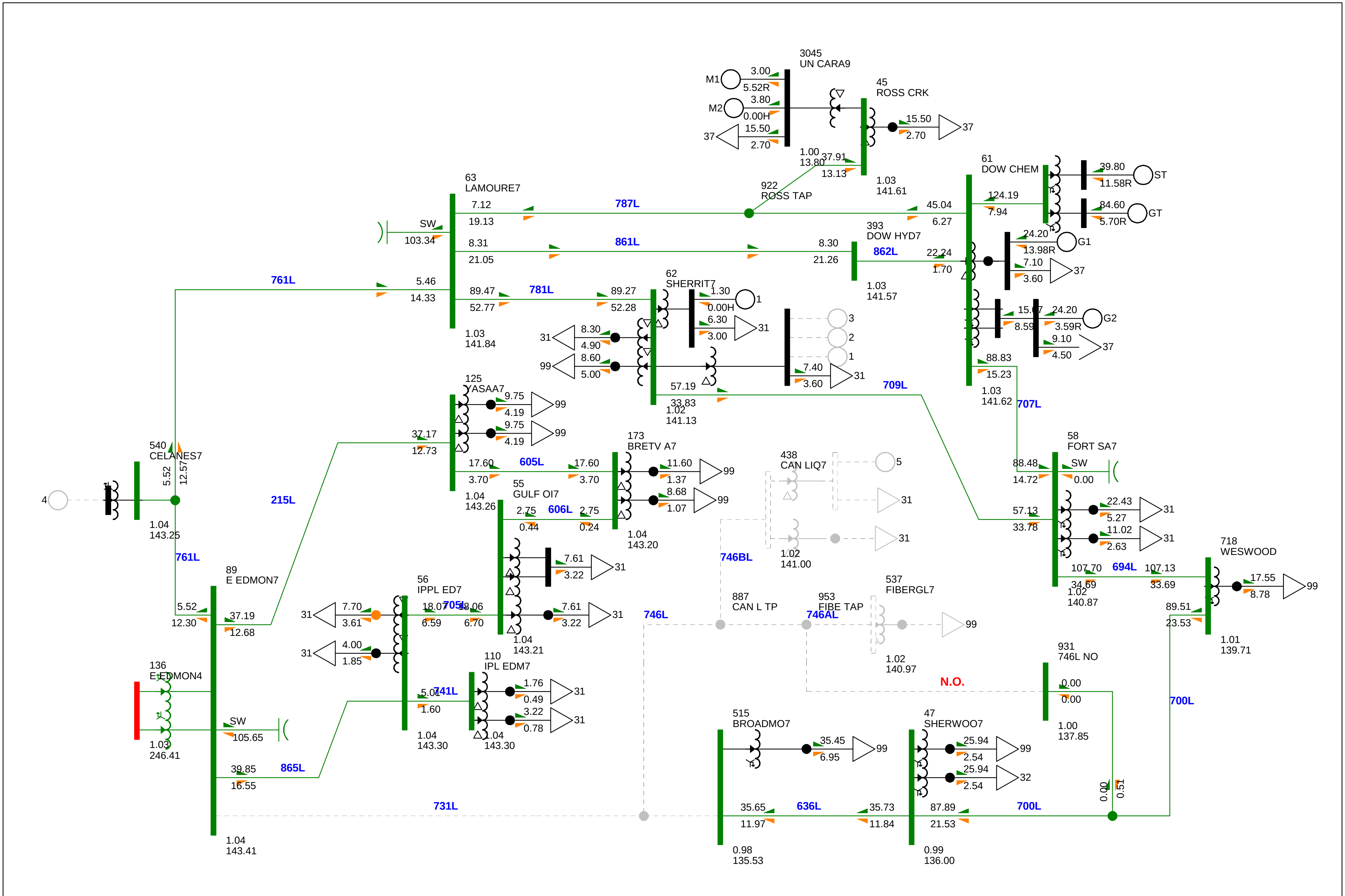
Alternative 3 involves adding a new POD substation, to be named the Anthony Henday 309S substation, with two 138/25 kV LTC transformers, one 138 kV circuit breaker, three 25 kV circuit breakers and associated equipment; and connecting the Anthony Henday 309S substation to the 138 kV transmission line 215L using a 138 kV circuit approximately 50 m in length, to create a T-tap connection configuration. The conductor used for the 138 kV circuit should have a minimum thermal rating similar to the existing 138 kV transmission line 215L. The minimum transformation capacity required for each of the two 138/25 kV transformers at the proposed Anthony Henday 309S substation is 24 MVA.

A maximum capability of 25 MVA is recommended for each of the two 138/25 kV transformers at the proposed Anthony Henday 309S substation, based on good electric industry practice and under advisement from AltaLink, in its capacity as the legal owner of transmission facilities, regarding its asset management and inventory practices.

Attachment A: Pre-Project Power Flow Diagrams (Scenarios 1 and 2)



P1442_Fortis Anthony Henday Sybstation Sept 2013	**FIGURE A1-1-N-0: NORMAL OPERATION** **2016 WINTER PEAK (PRE-CONNECTION)** **PRINTED ON FRIDAY 25. NOVEMBER 2016**	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.050OV 0.950UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

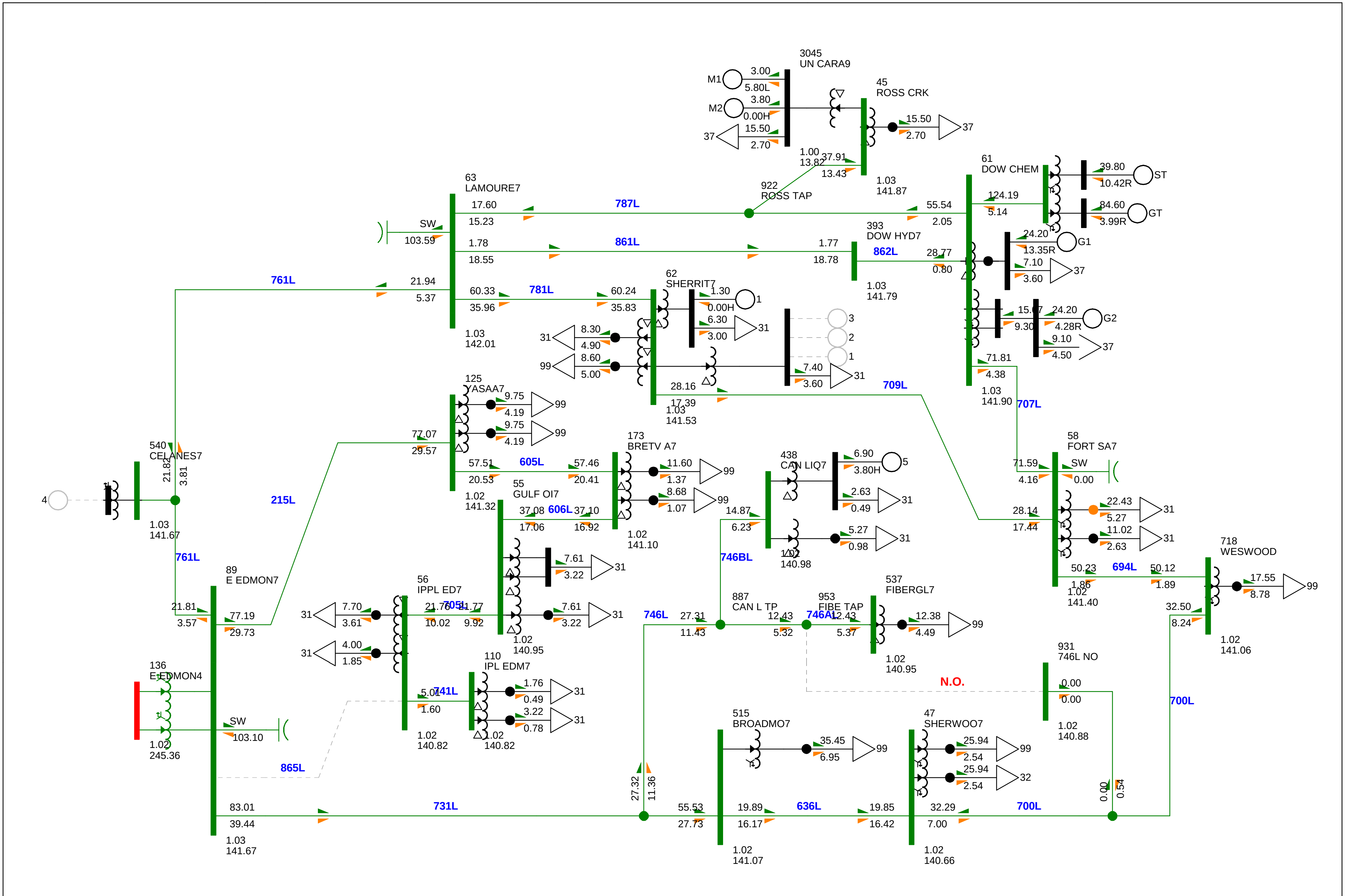


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE A1-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)
2016 WINTER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

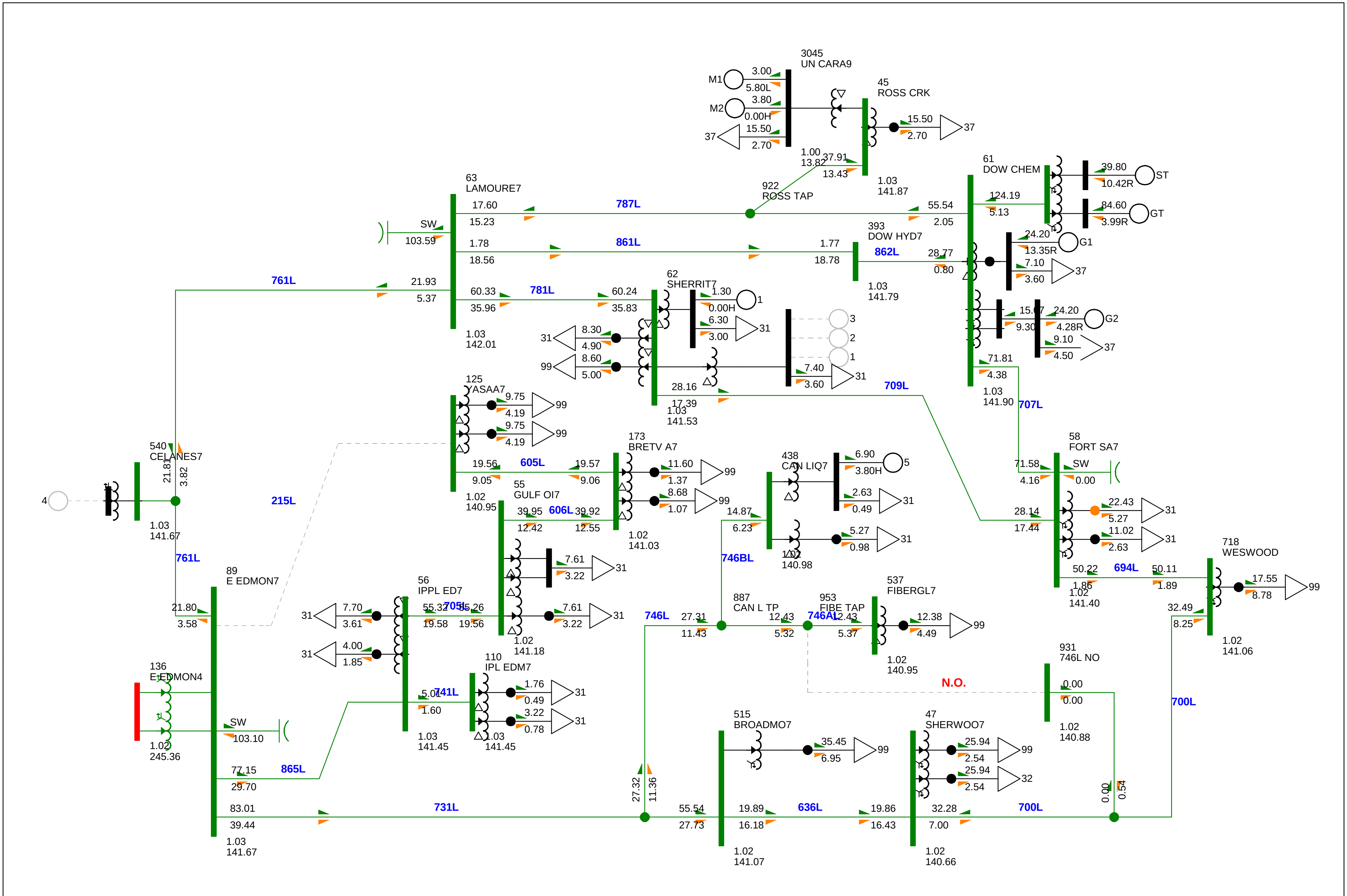


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE A1-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)
2016 WINTER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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Sept 2013

FIGURE A1-4 N-1: 215L (EAST EDMONTON 38S TO YASA 286S)
2016 WINTER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

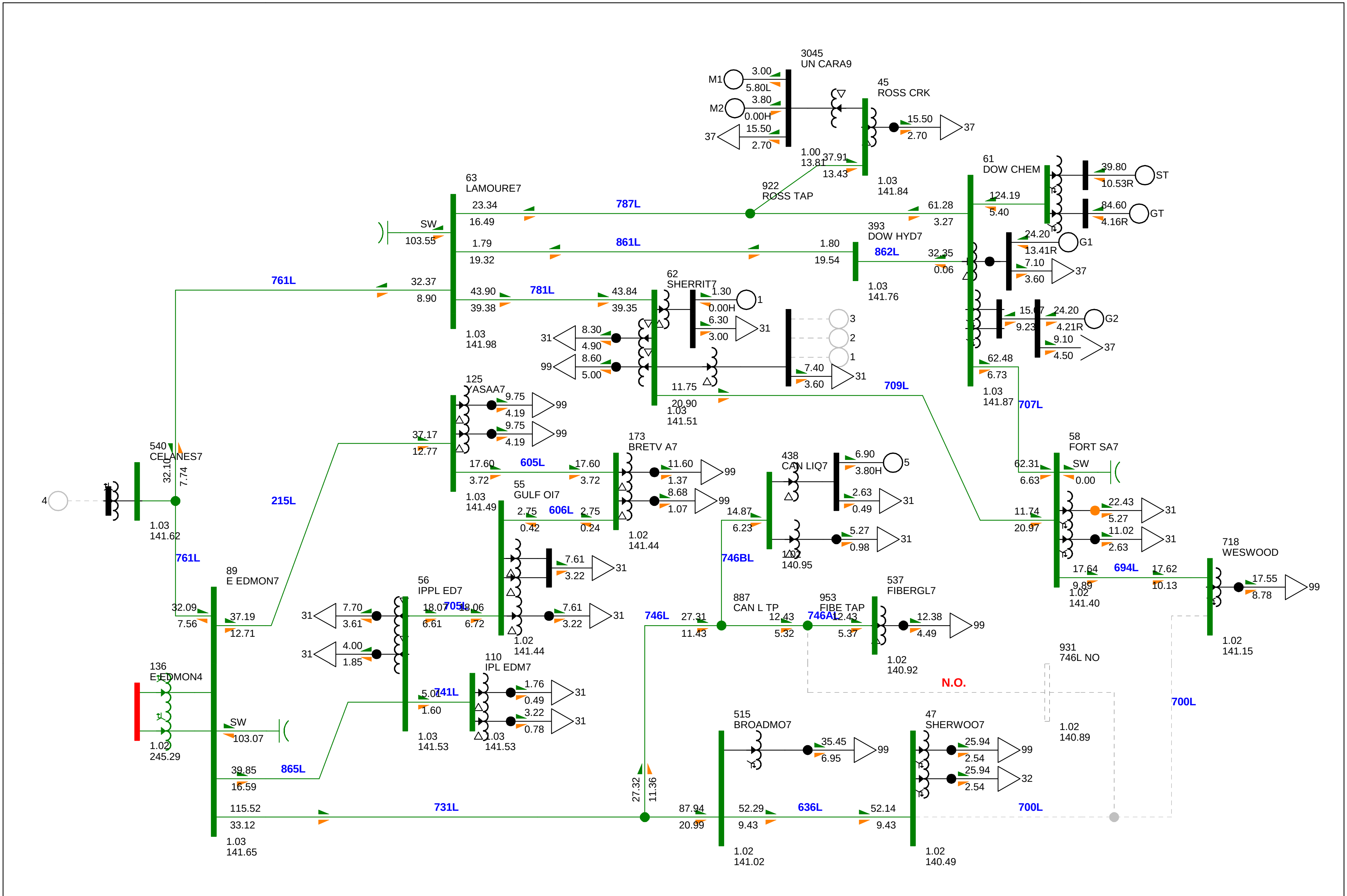

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FIGURE A1-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)
2016 WINTER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

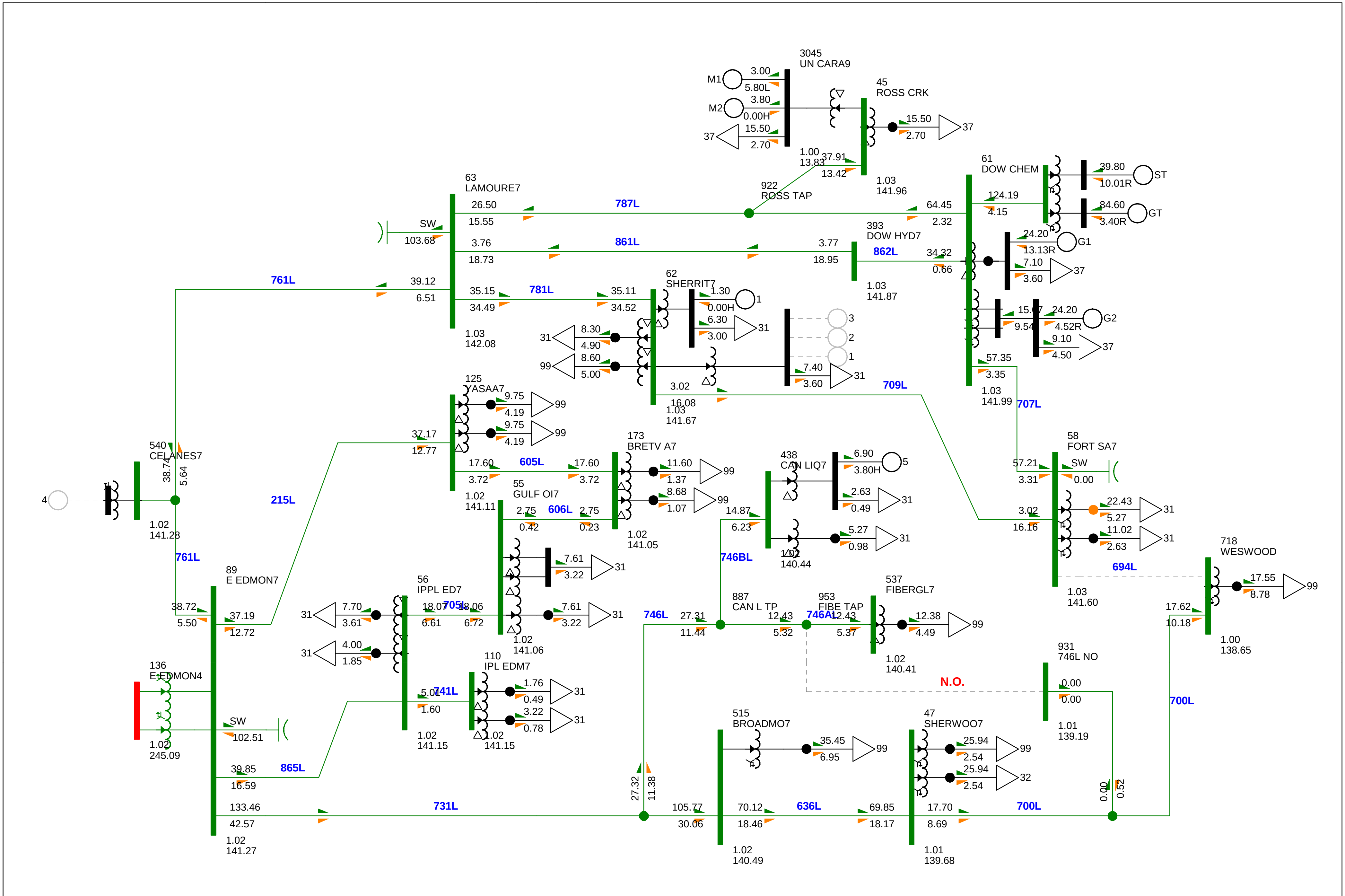

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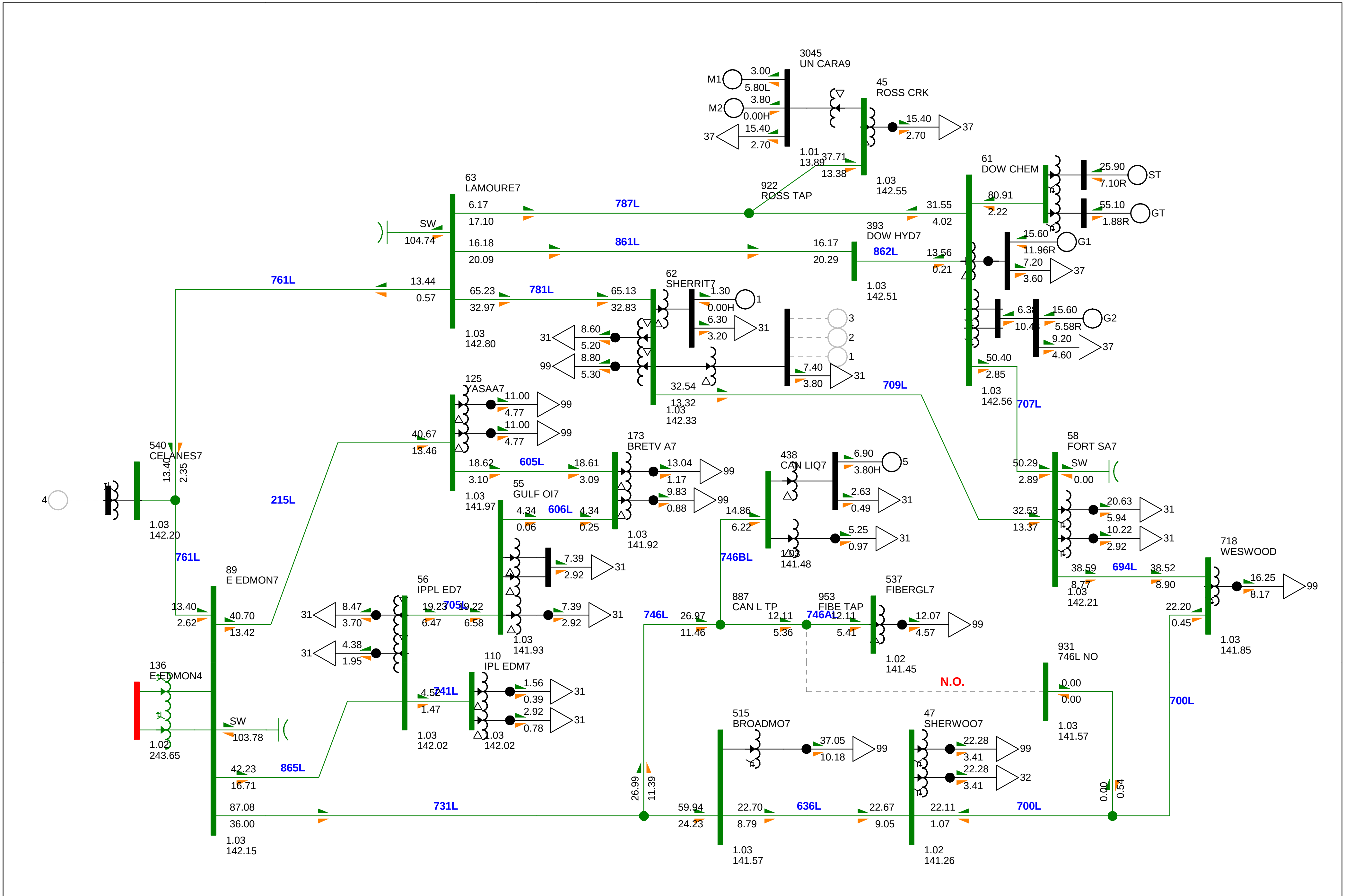
FIGURE A1-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2016 WINTER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

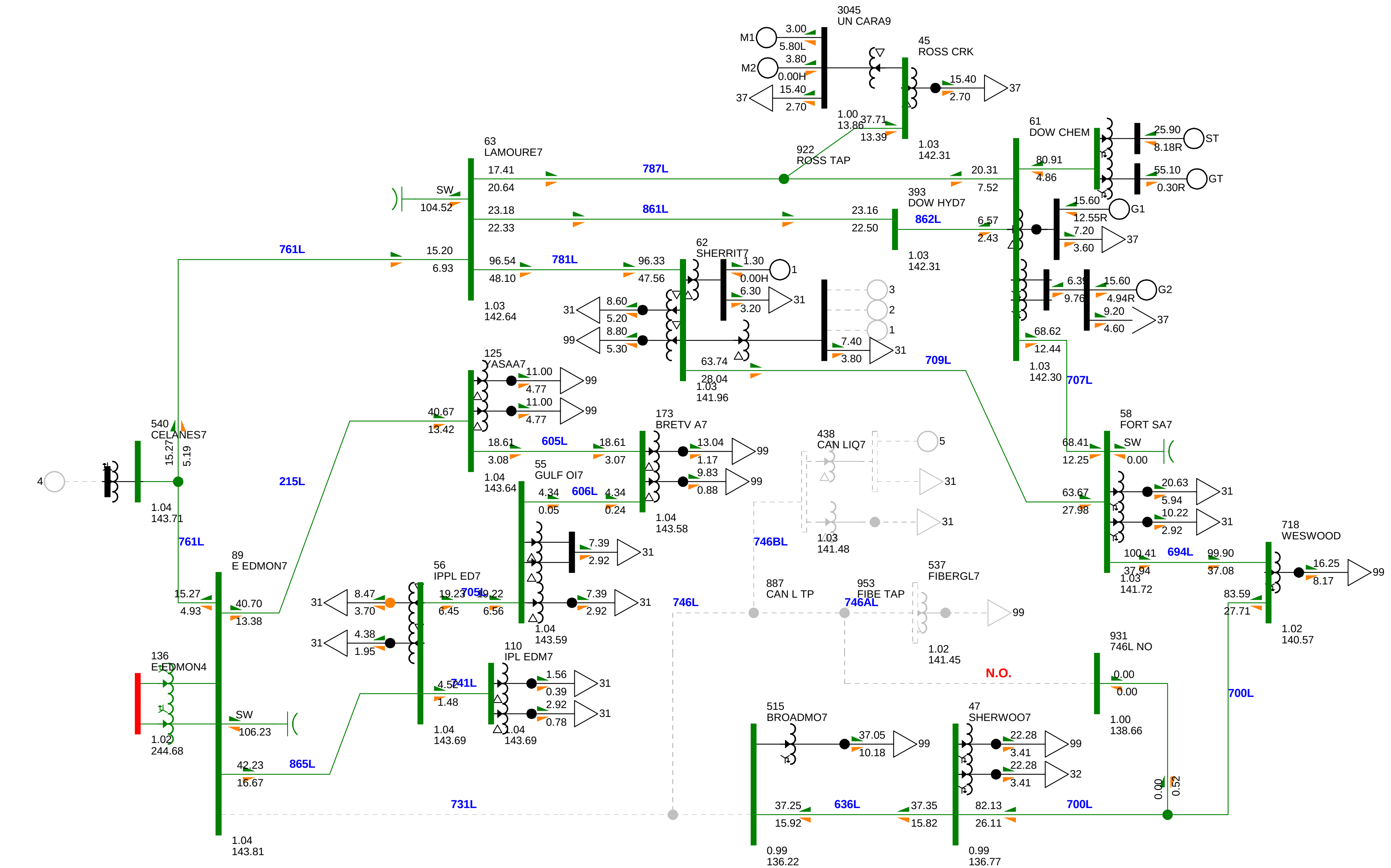


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE A2-1-N-0: NORMAL OPERATION
2018 SUMMER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

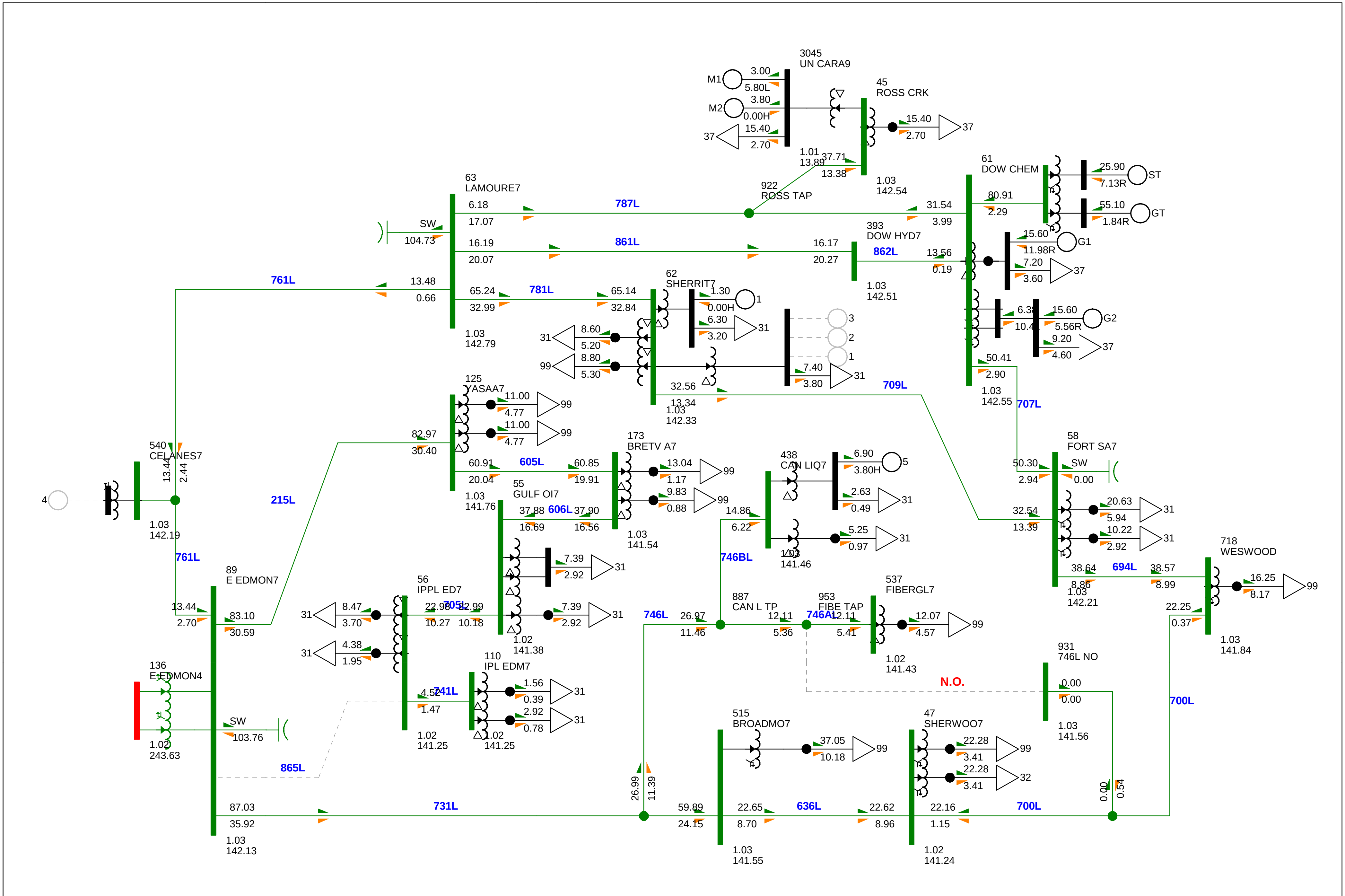


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE A2-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)
2018 SUMMER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

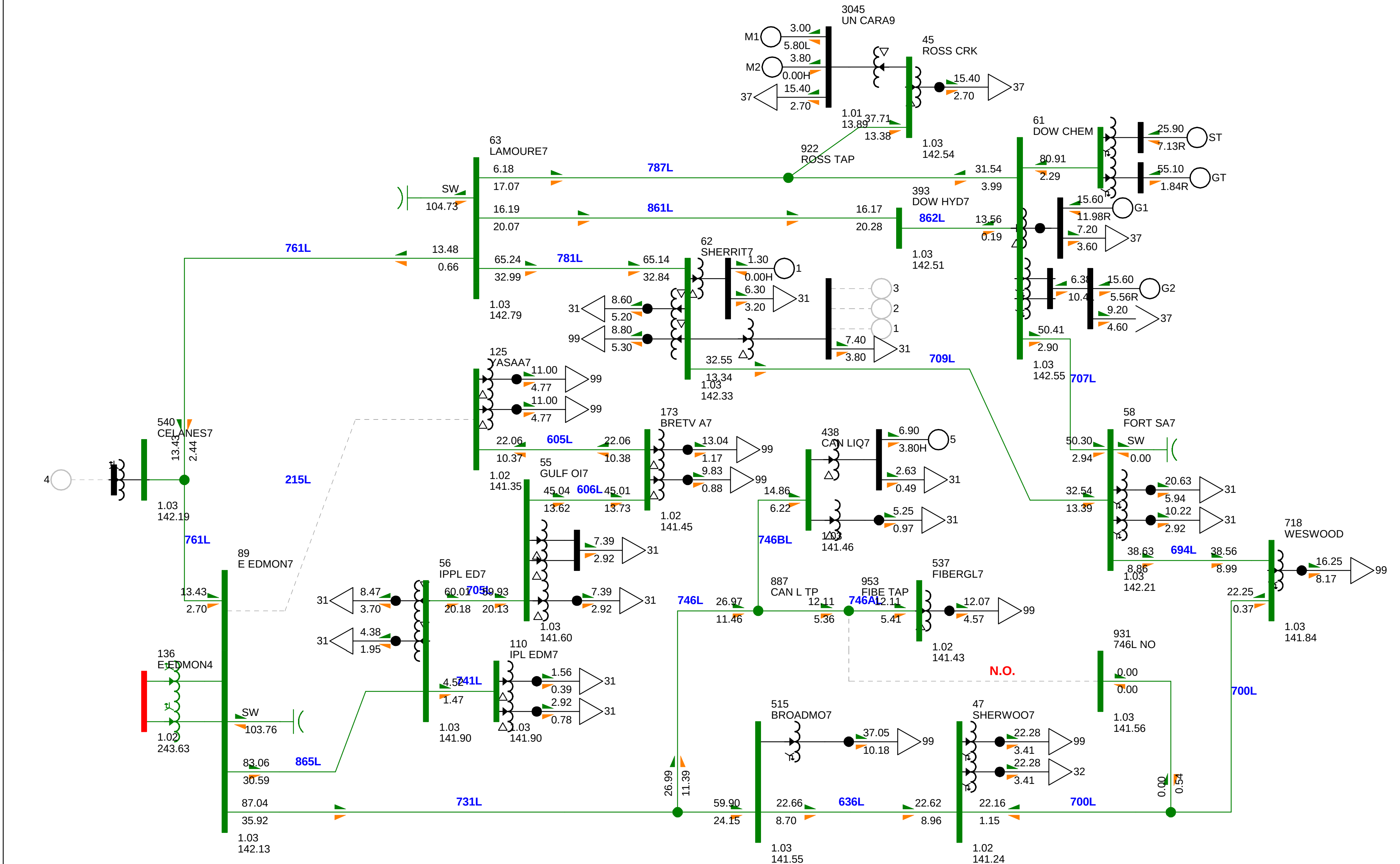


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE A2-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)
2018 SUMMER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

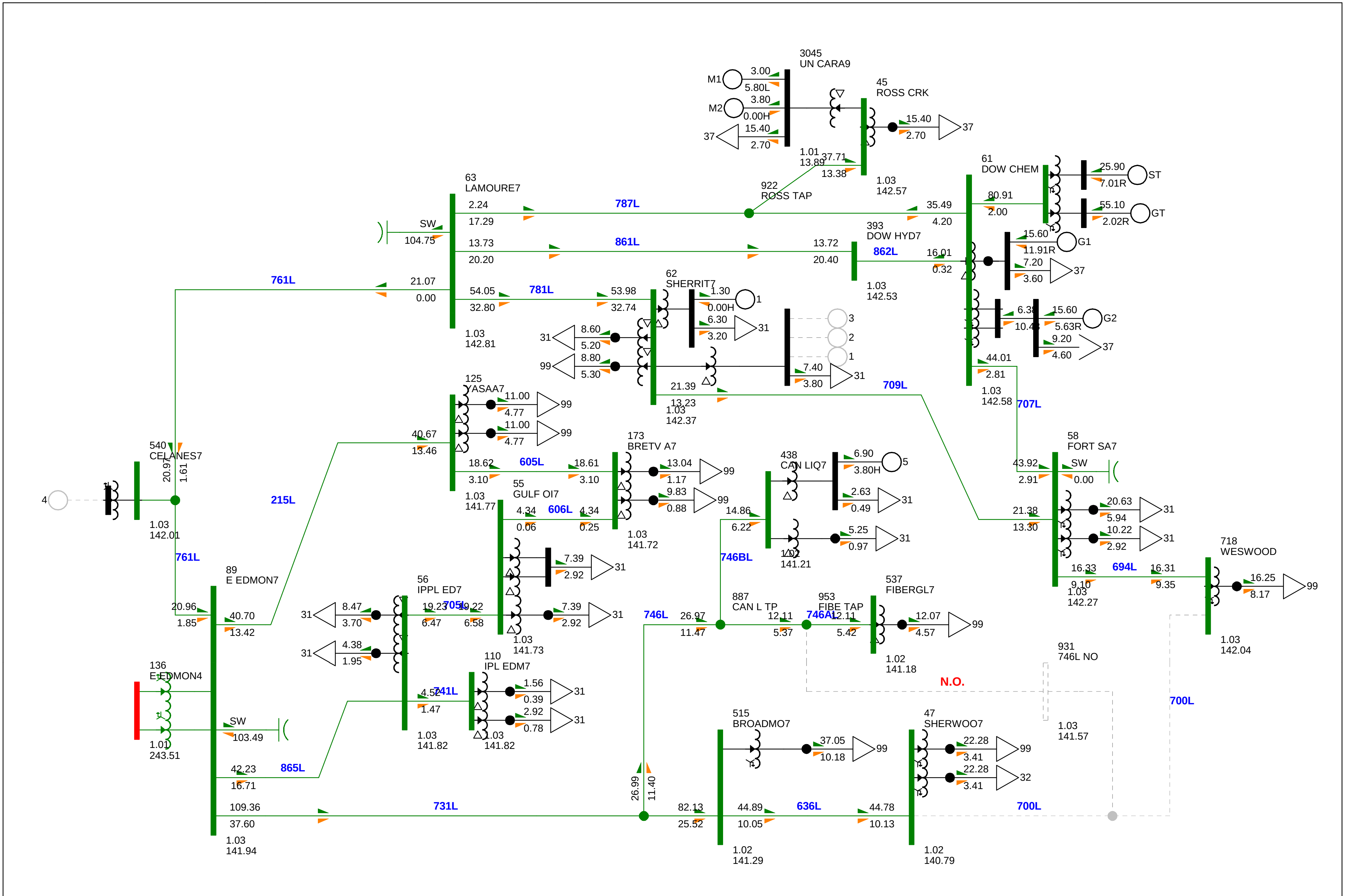


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE A2-4 N-1: 215L (EAST EDMONTON 38S TO YASA 286S)
2018 SUMMER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

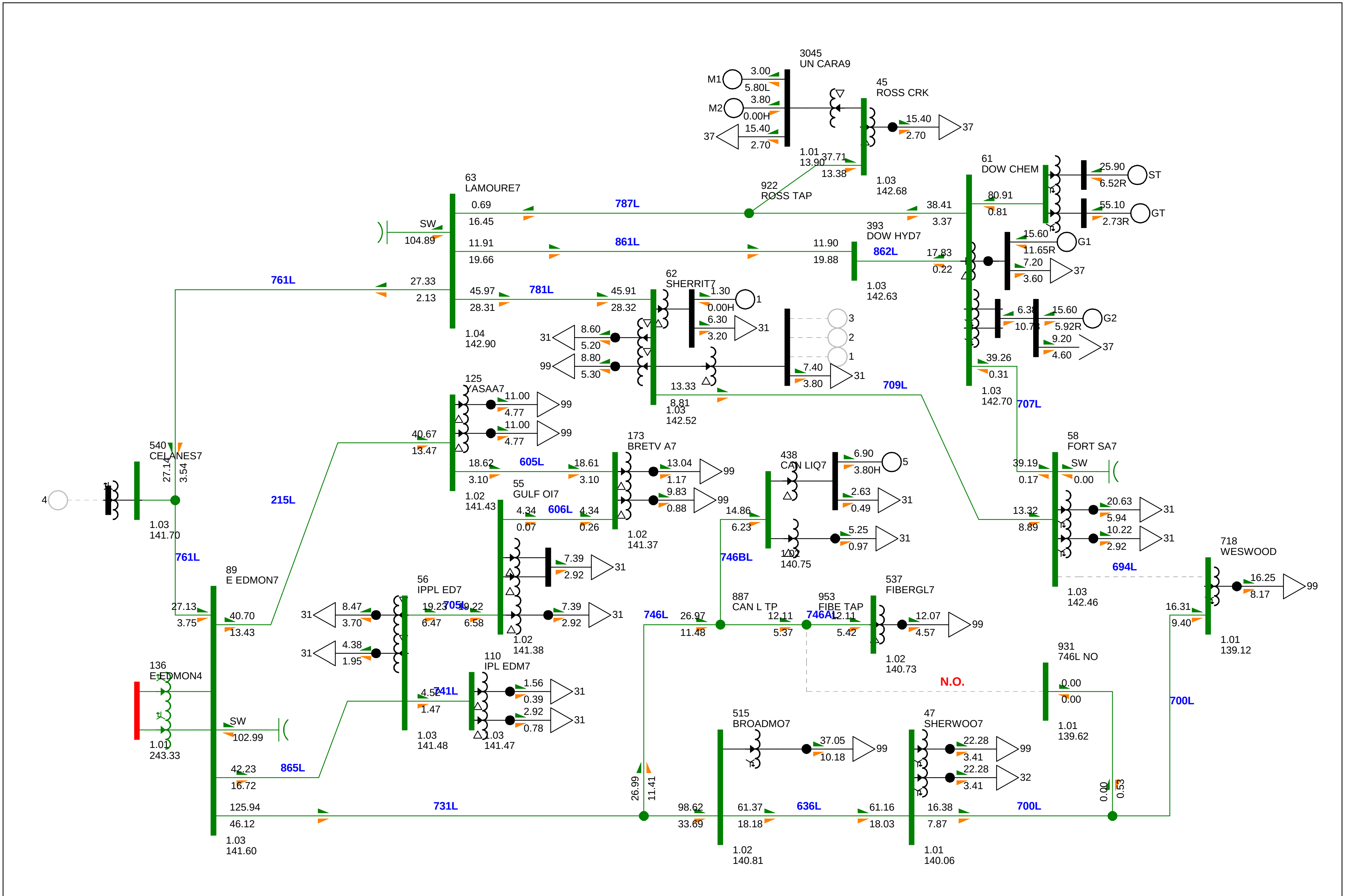


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE A2-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)
2018 SUMMER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



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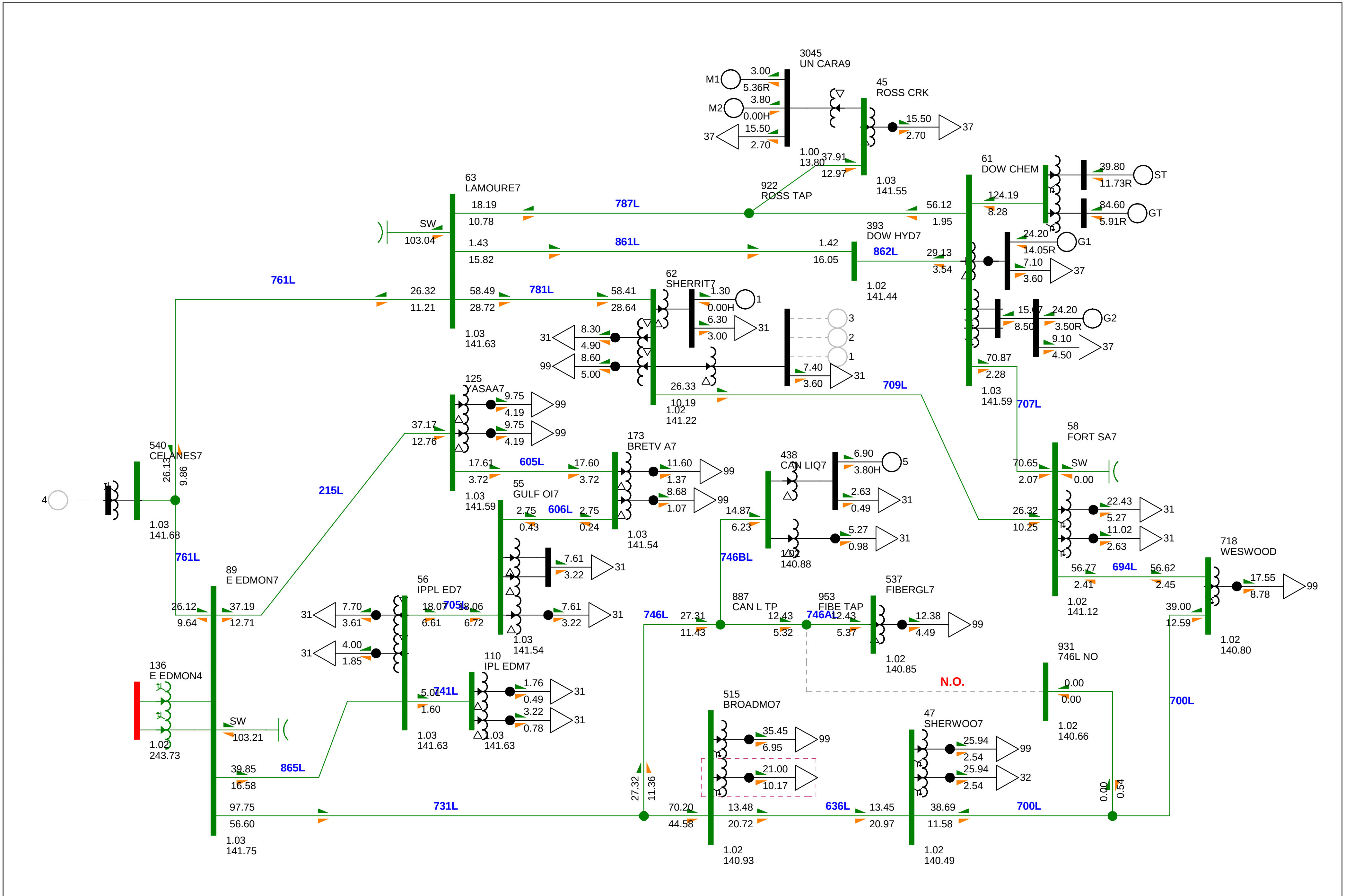
Sept 2013

FIGURE A2-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2018 SUMMER PEAK (PRE-CONNECTION)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Attachment B: Alternative 1 Post-Project Power Flow Diagrams (Scenarios 3 and 4)



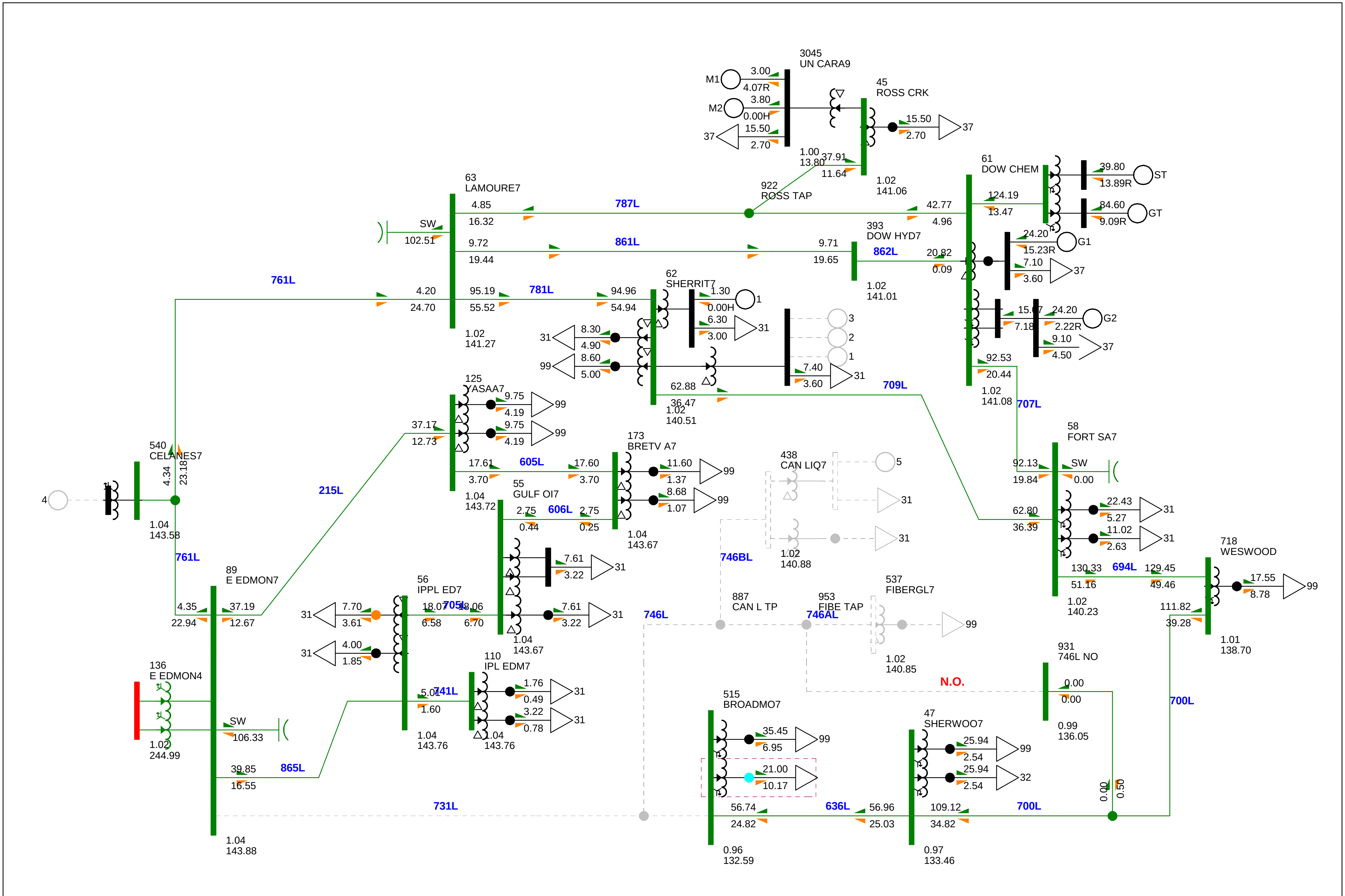
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B1-1-N-0: NORMAL OPERATION
2016 WINTER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



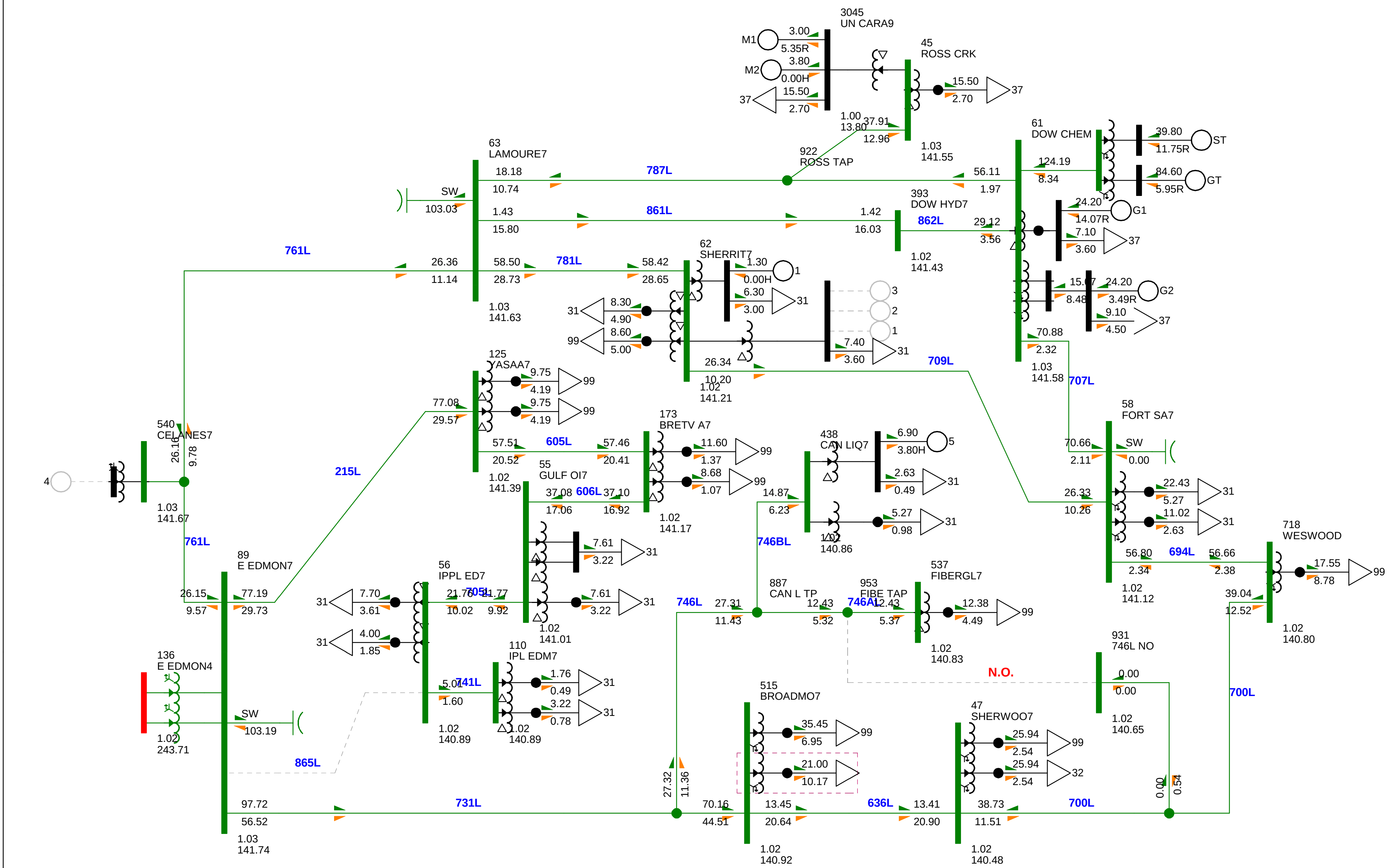
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B1-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)
2016 WINTER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



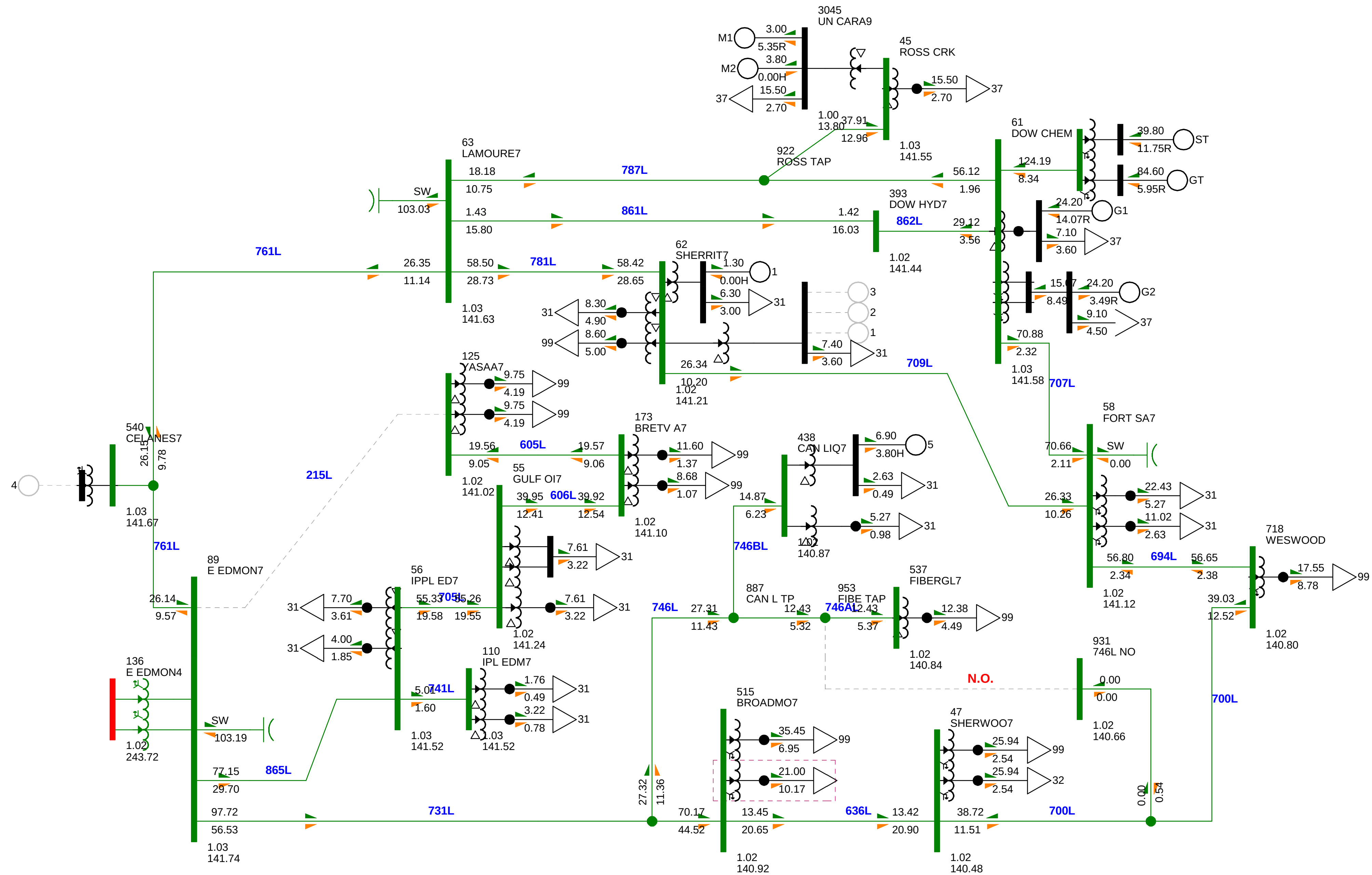
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B1-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)
2016 WINTER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



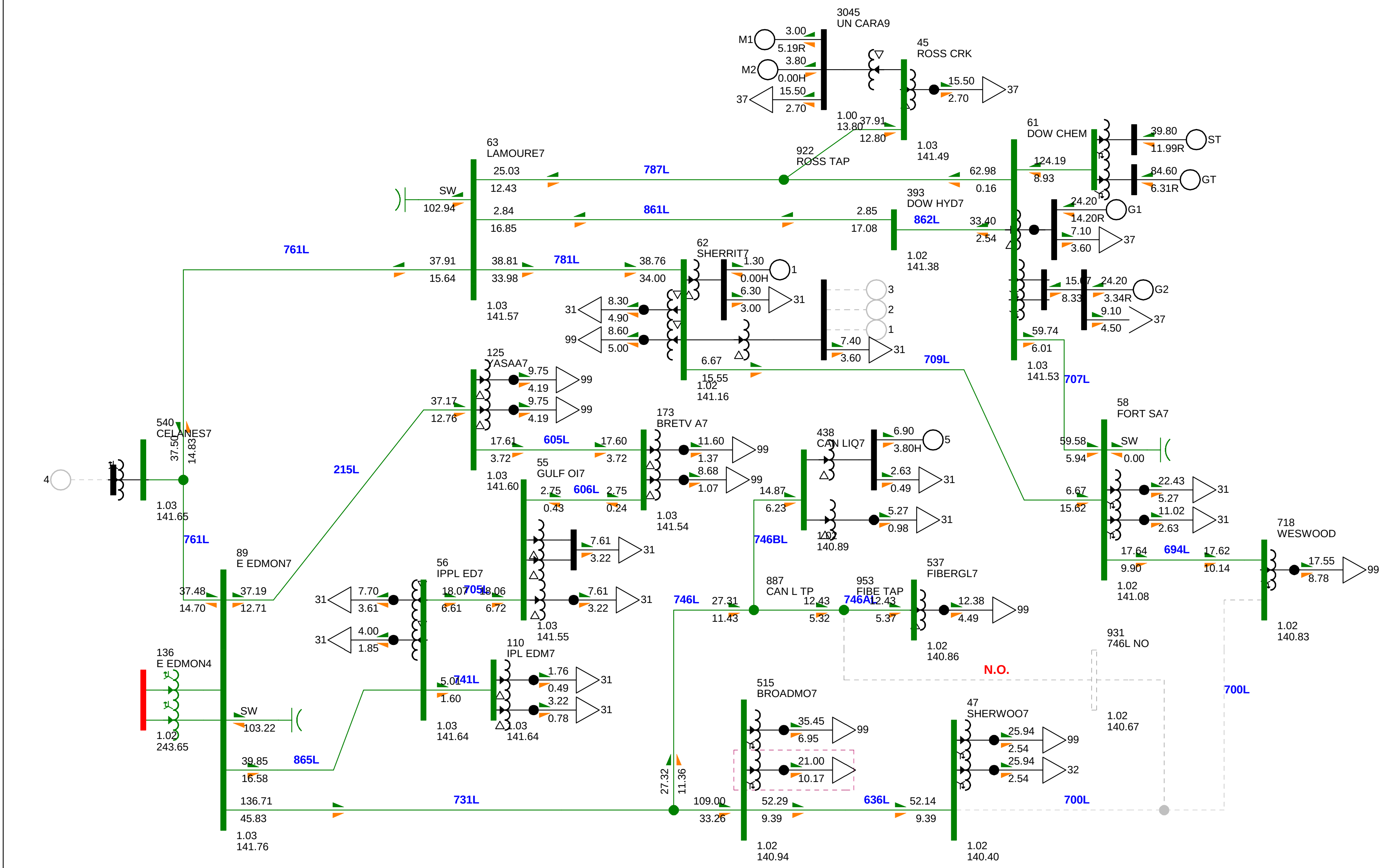
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B1-4 N-1: 215L (EAST EDMONTON 38S TO YASA 286S)
2016 WINTER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



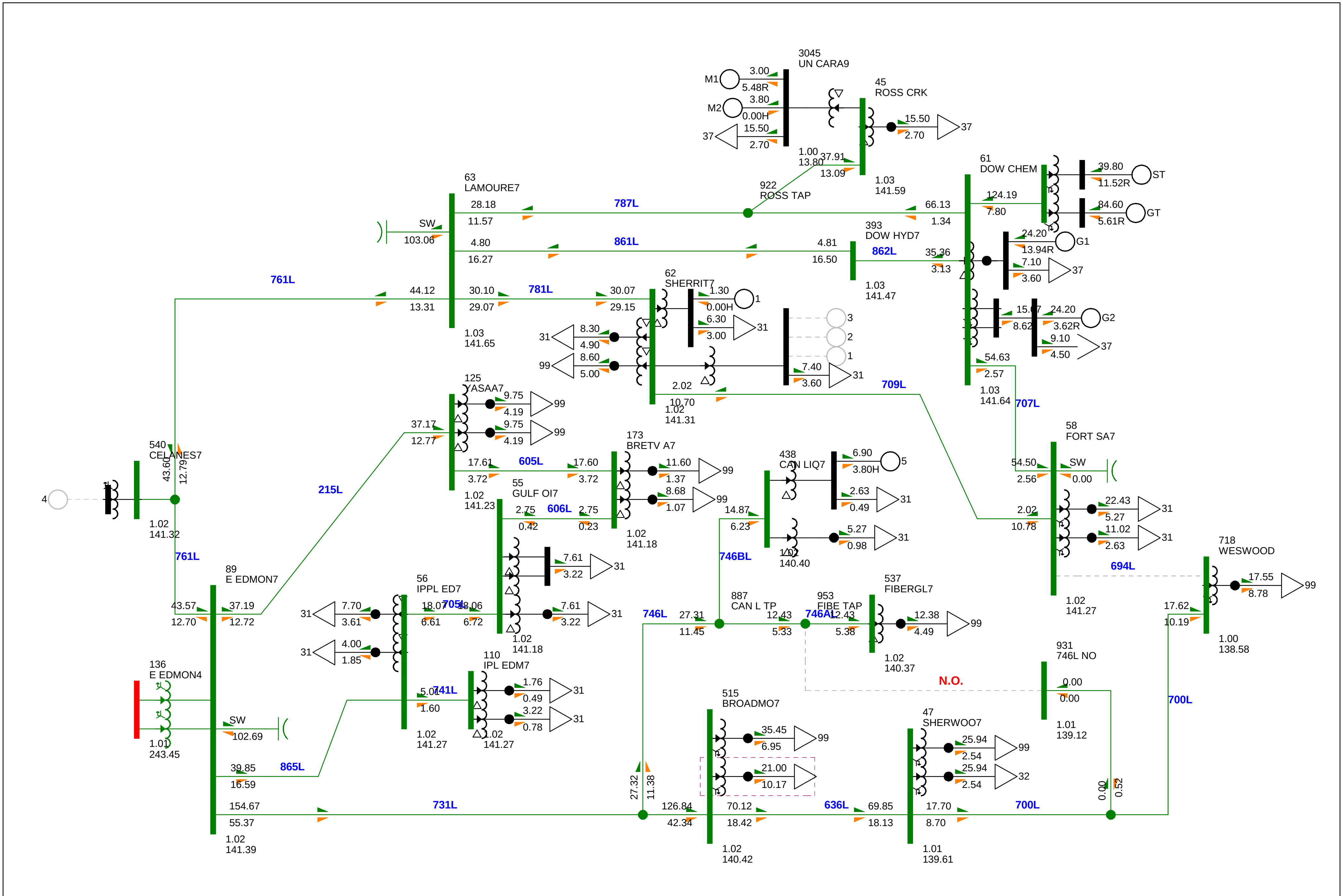
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B1-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)
2016 WINTER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



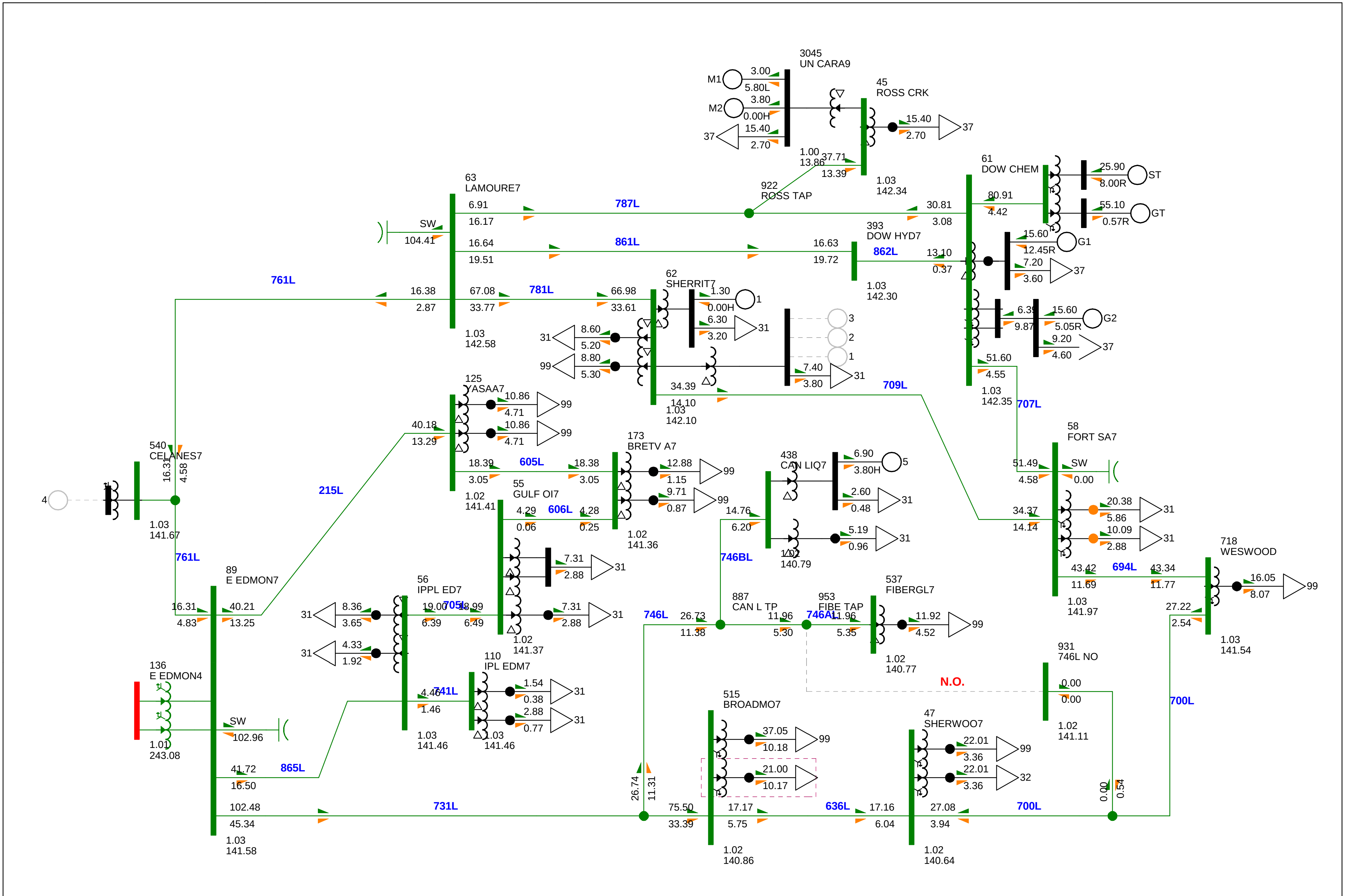
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B1-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2016 WINTER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



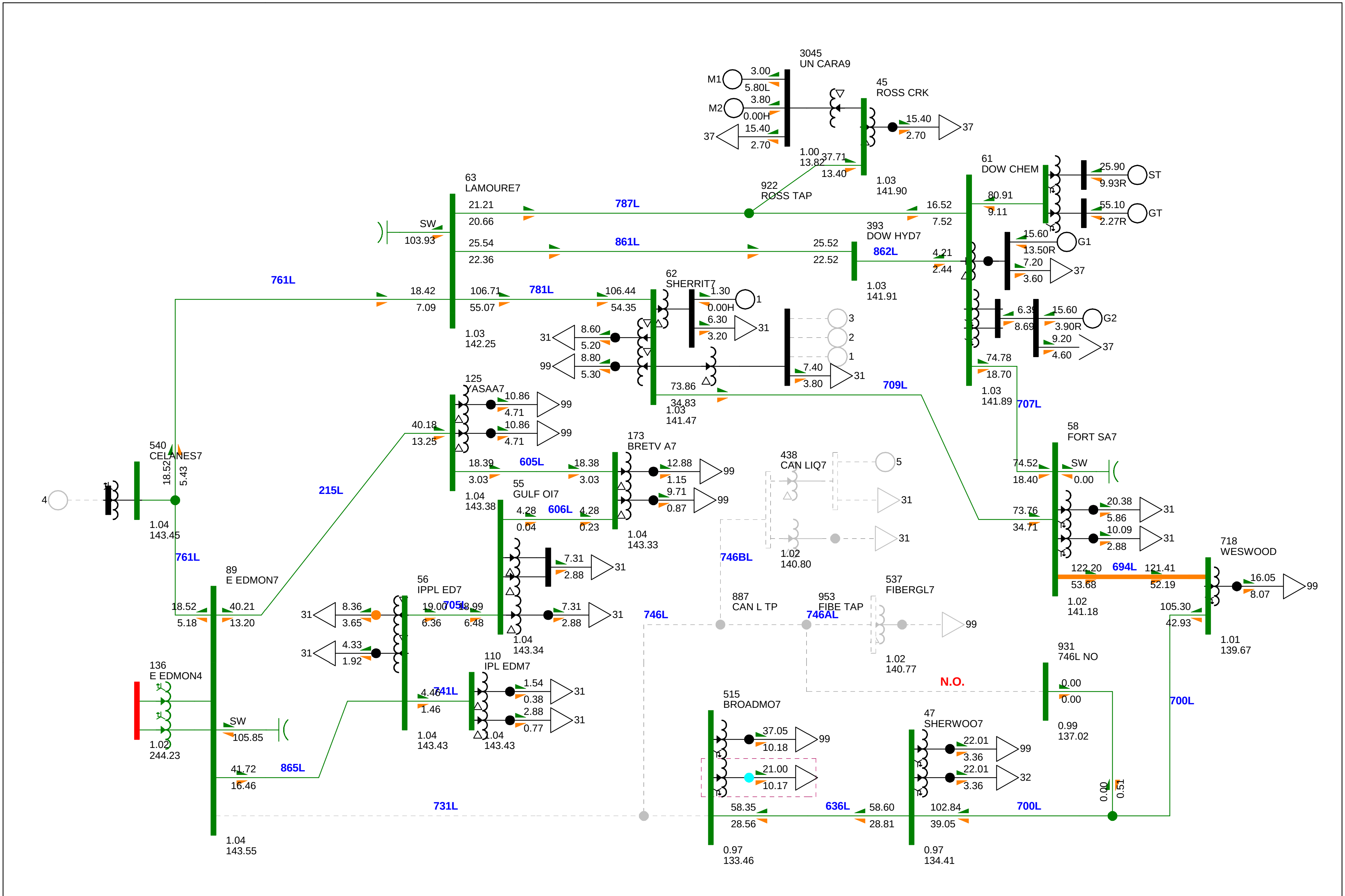
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B2-1-N-0: NORMAL OPERATION
2018 SUMMER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



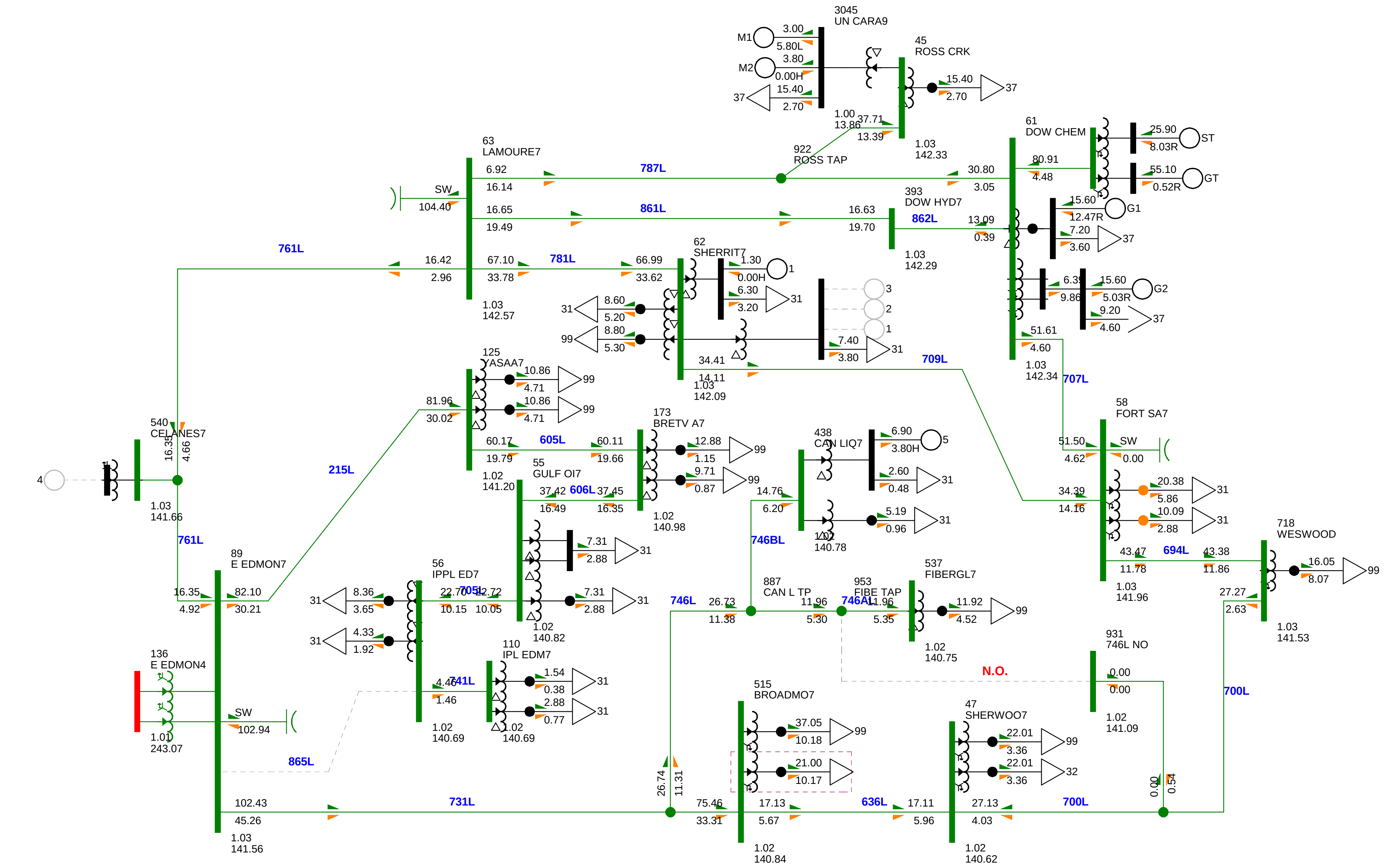
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

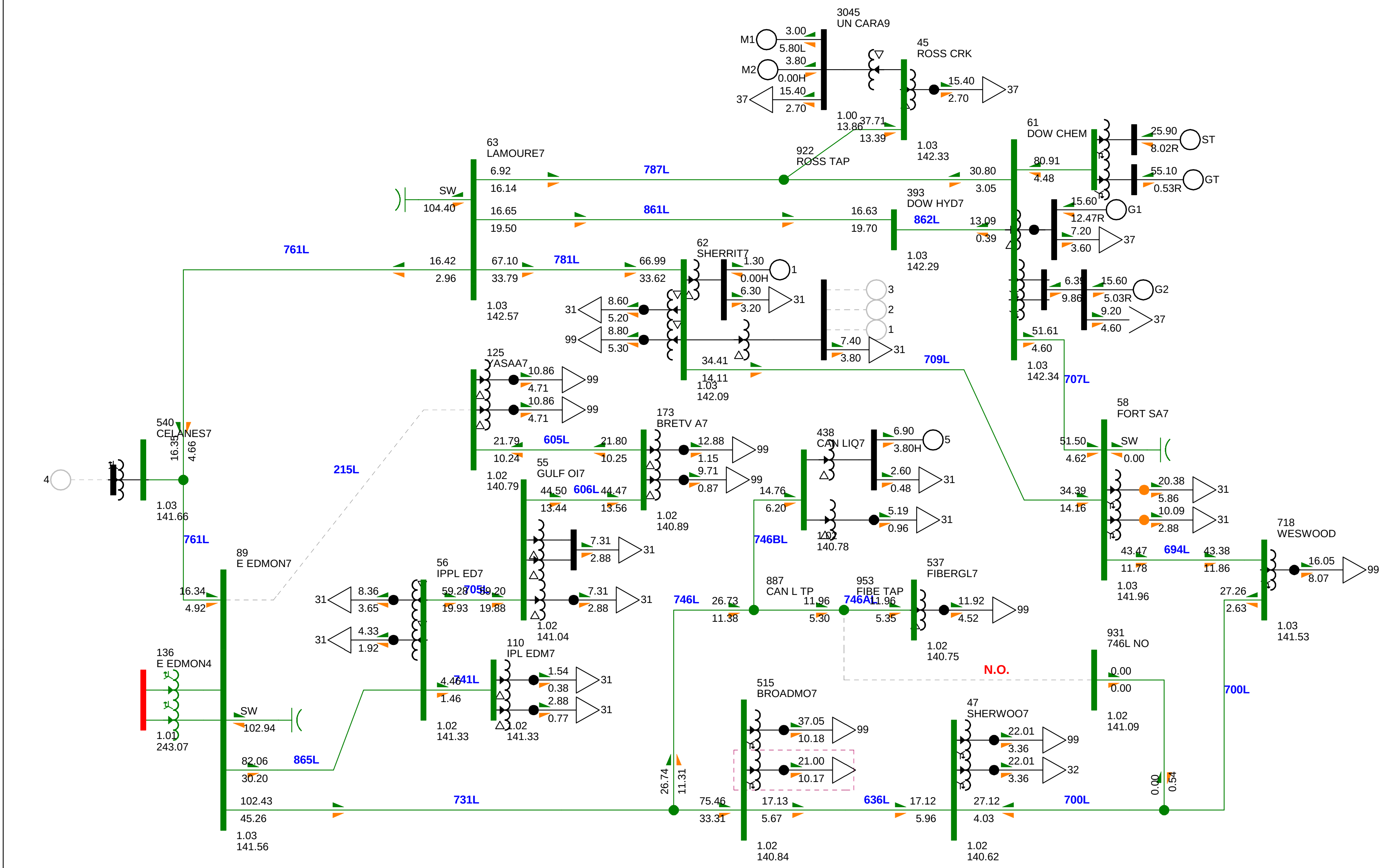
Sept 2013

FIGURE B2-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)
2018 SUMMER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Fortis Anthony Henday **(Alternative 1 - Upgrade Broadmoor)** Sept 2013	**FIGURE B2-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)** **2018 SUMMER PEAK (ALT 1)** **PRINTED ON FRIDAY 25. NOVEMBER 2016**	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate A 1.050OV 0.950UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



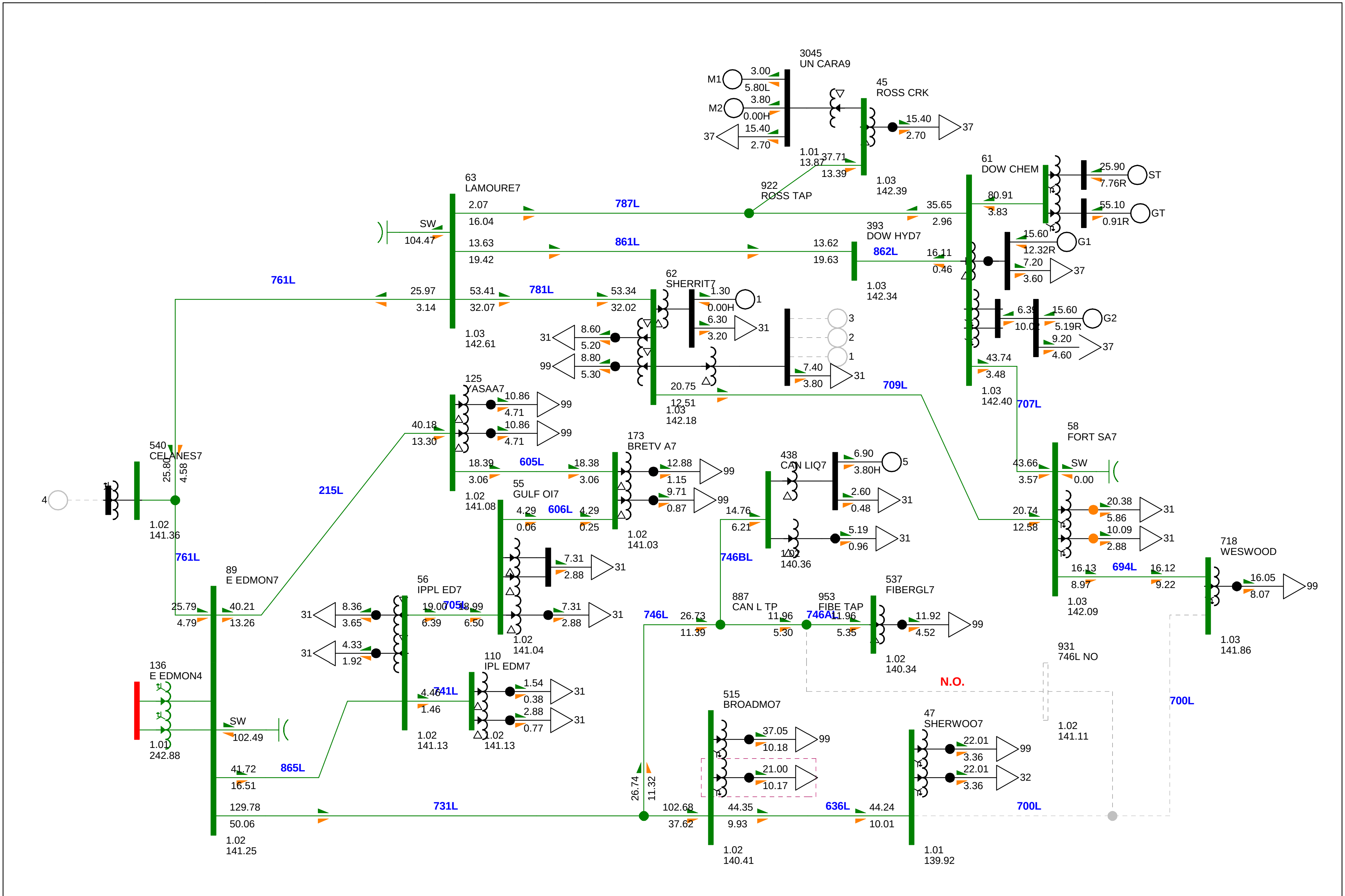
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B2-4 N-1: 215L (EAST EDMONTON 38S TO YASA 286S)
2018 SUMMER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

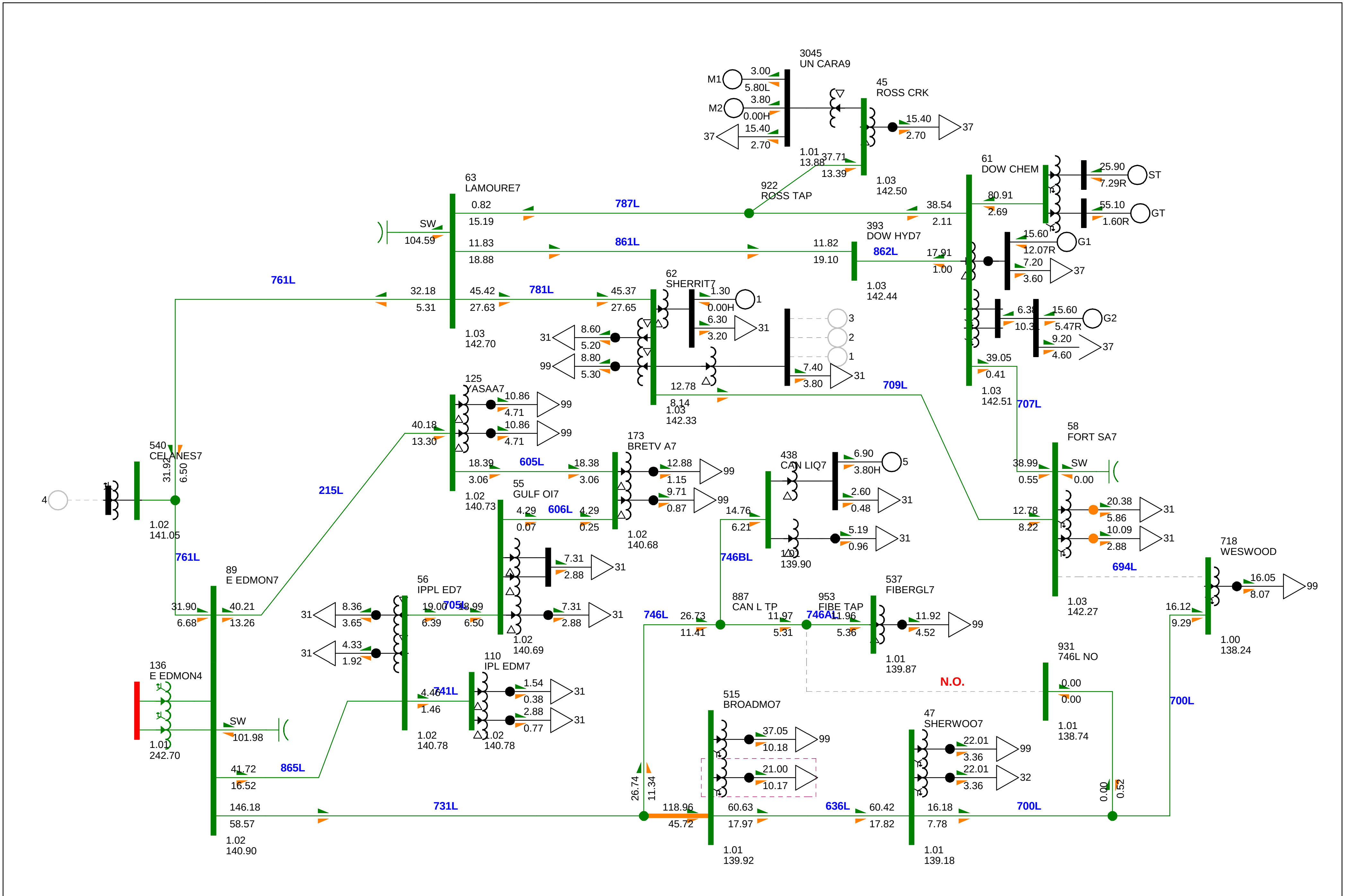


Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B2-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)
2018 SUMMER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016



Fortis Anthony Henday

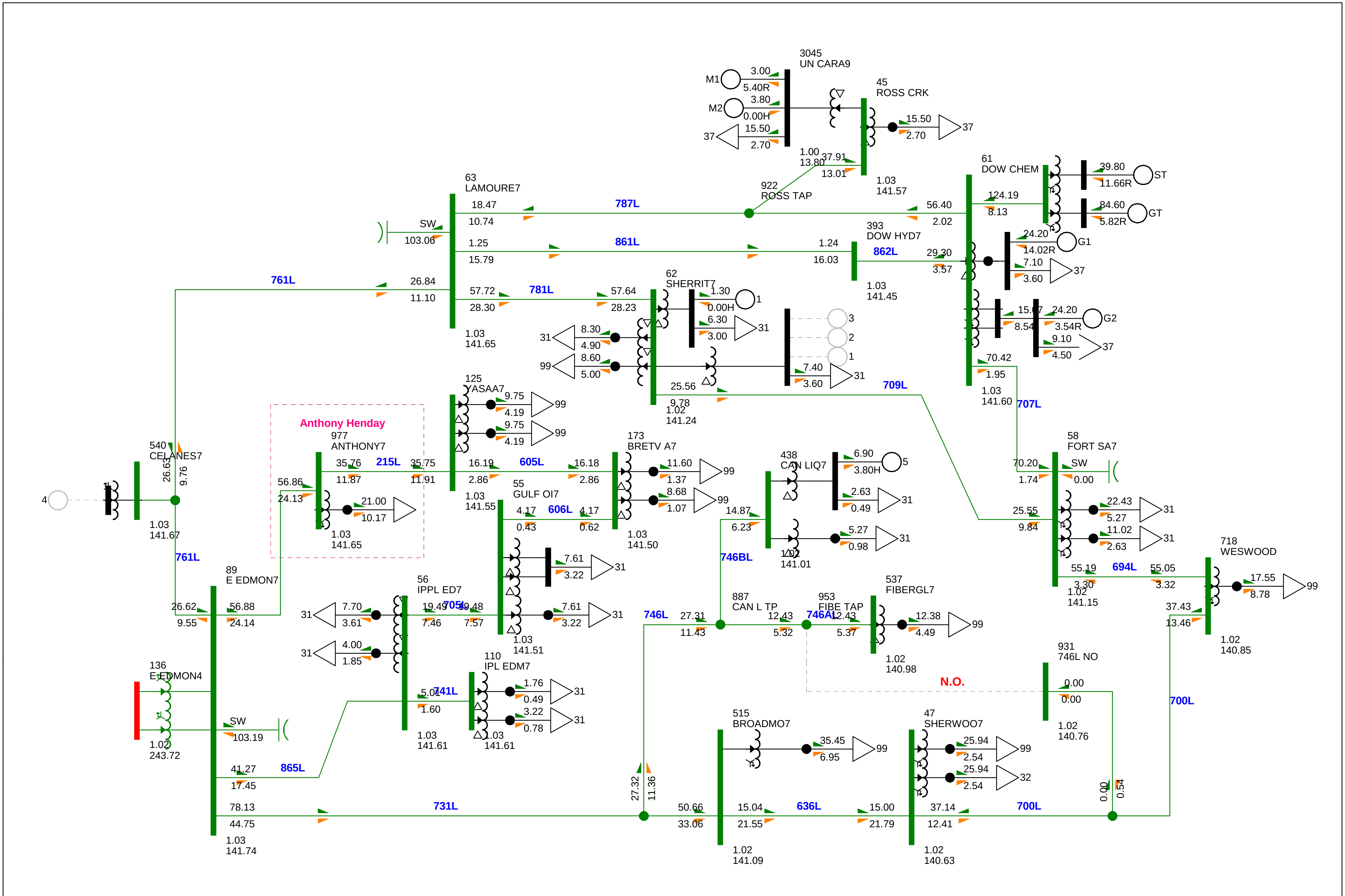
(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE B2-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2018 SUMMER PEAK (ALT 1)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Attachment C: Alternative 3 Post-Project Power Flow Diagrams (Scenarios 3 and 4)



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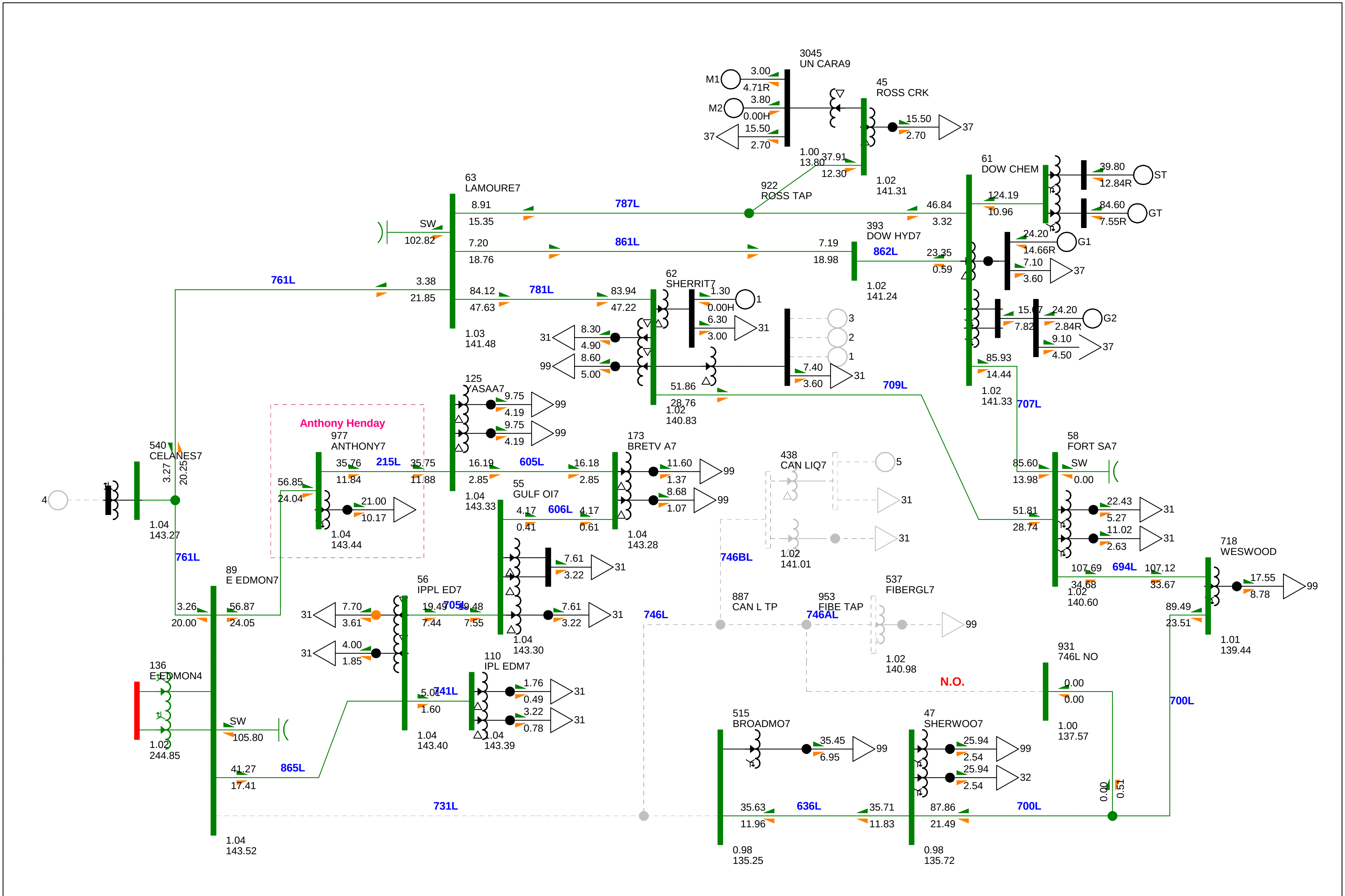
Sept 2013

FIGURE C1-1-N-0: NORMAL OPERATION
2016 WINTER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

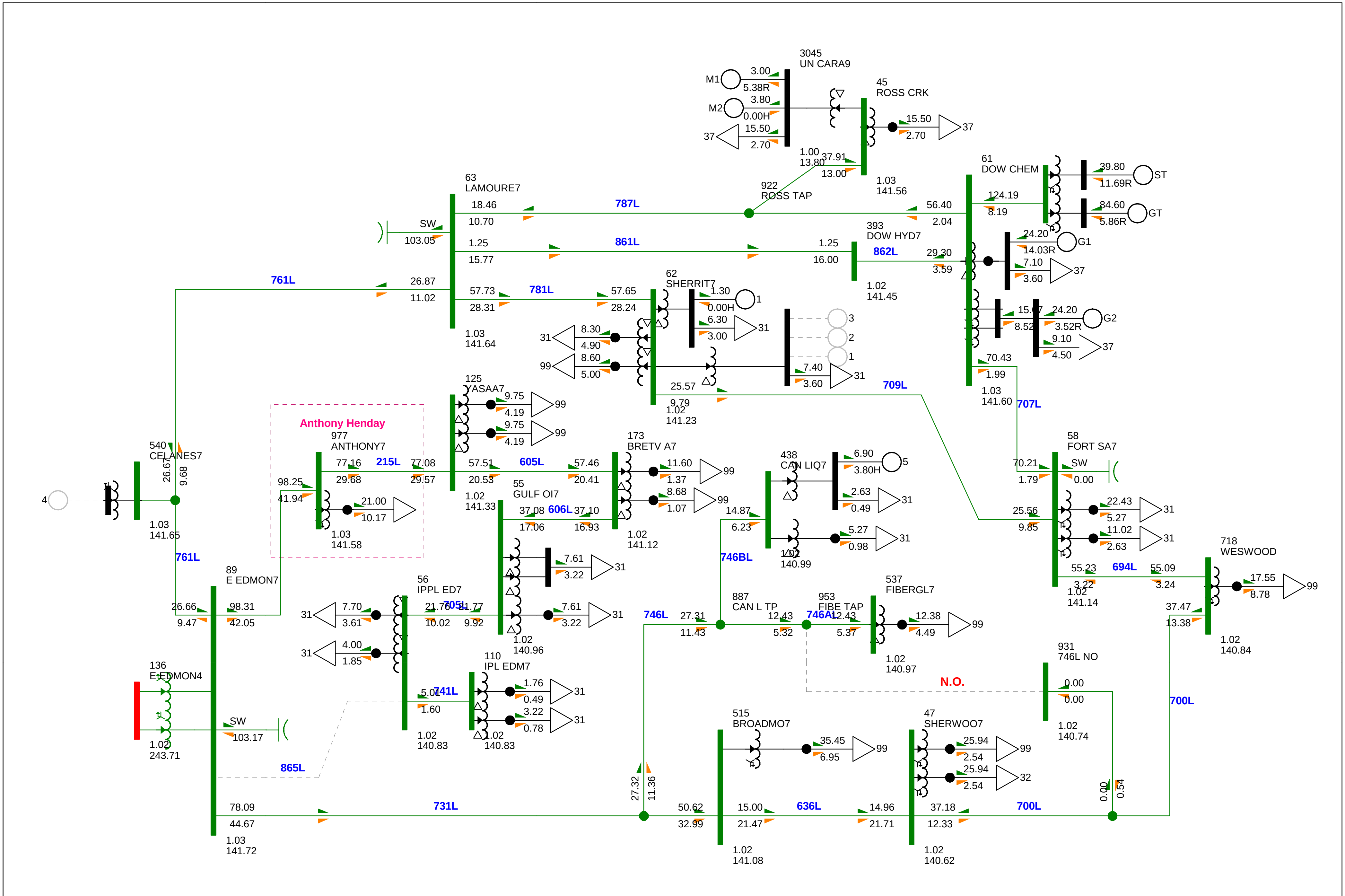


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C1-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)
2016 WINTER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

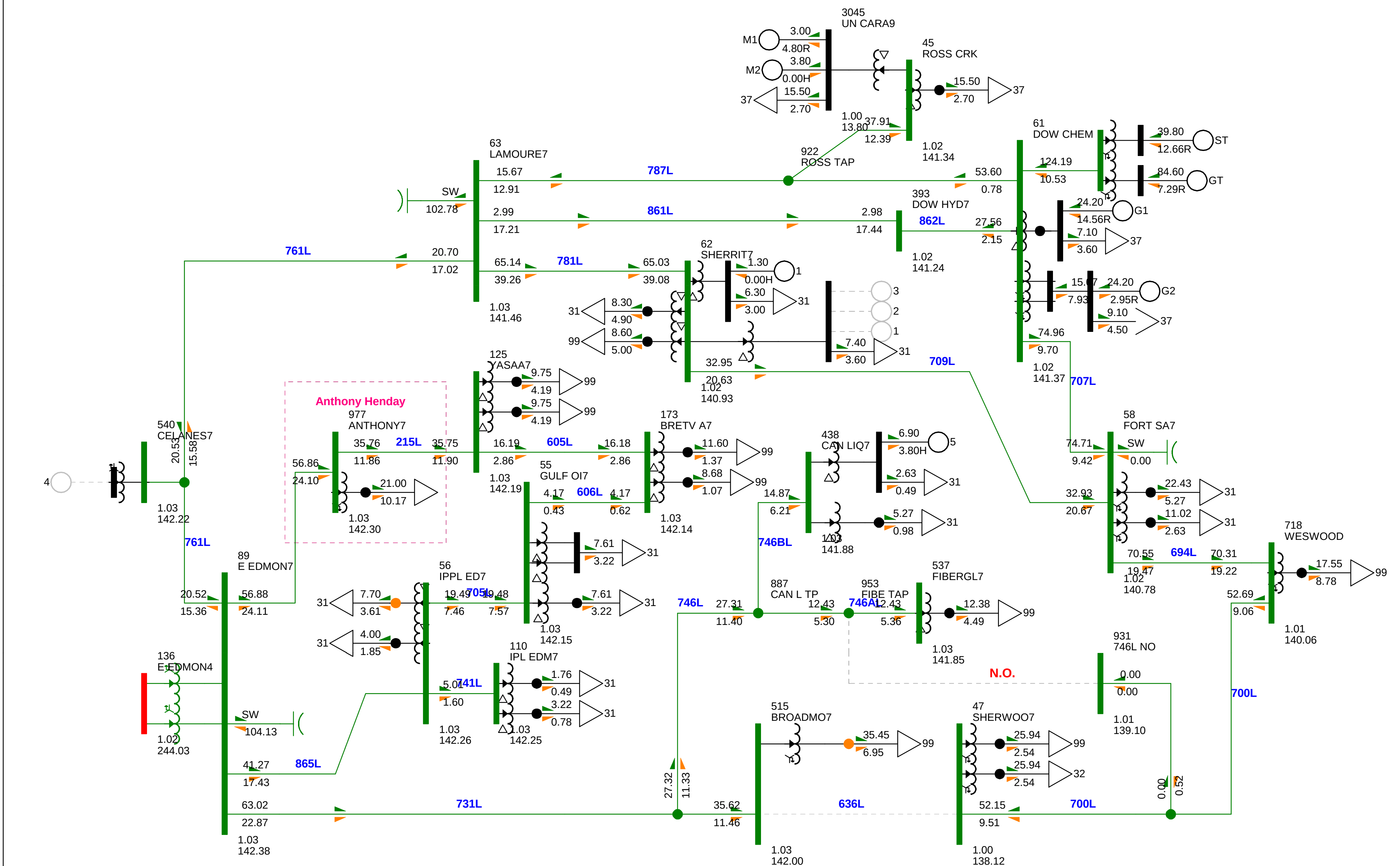


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C1-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)
2016 WINTER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

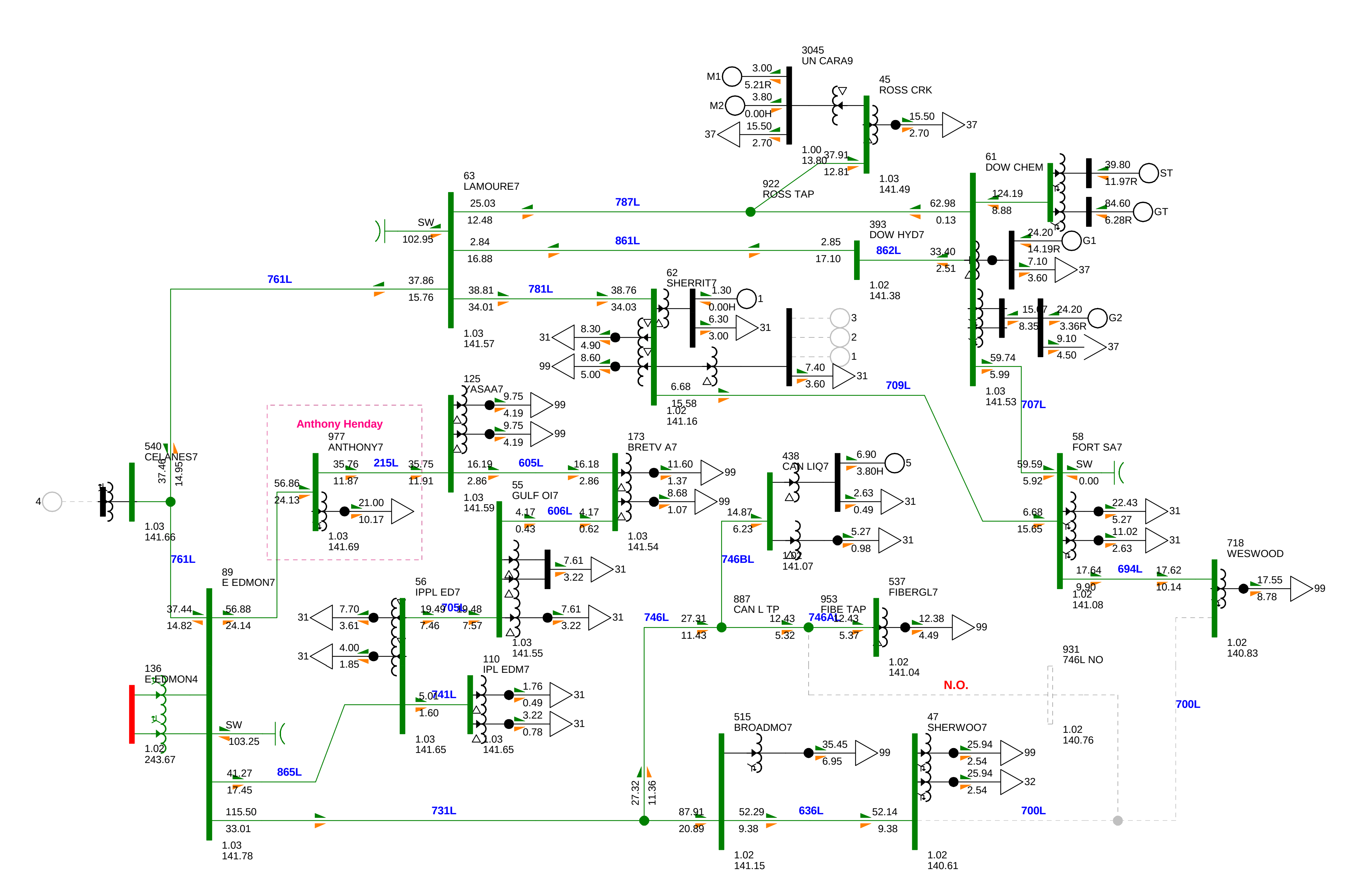


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C1-4 N-1: 636L (BROADMOOR 420S TO SHERWOOD PARK 746S)
2016 WINTER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

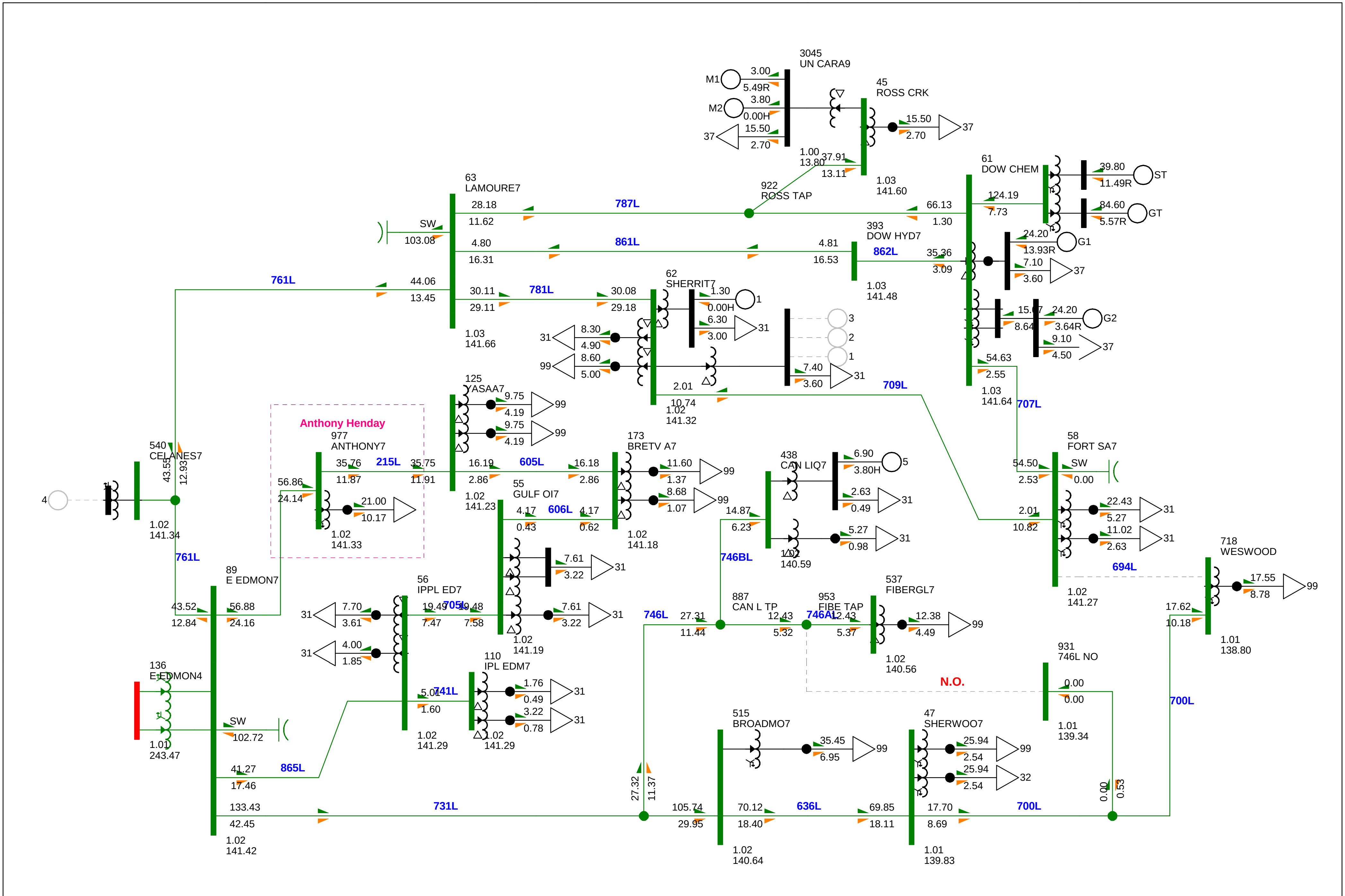


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C1-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)
2016 WINTER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

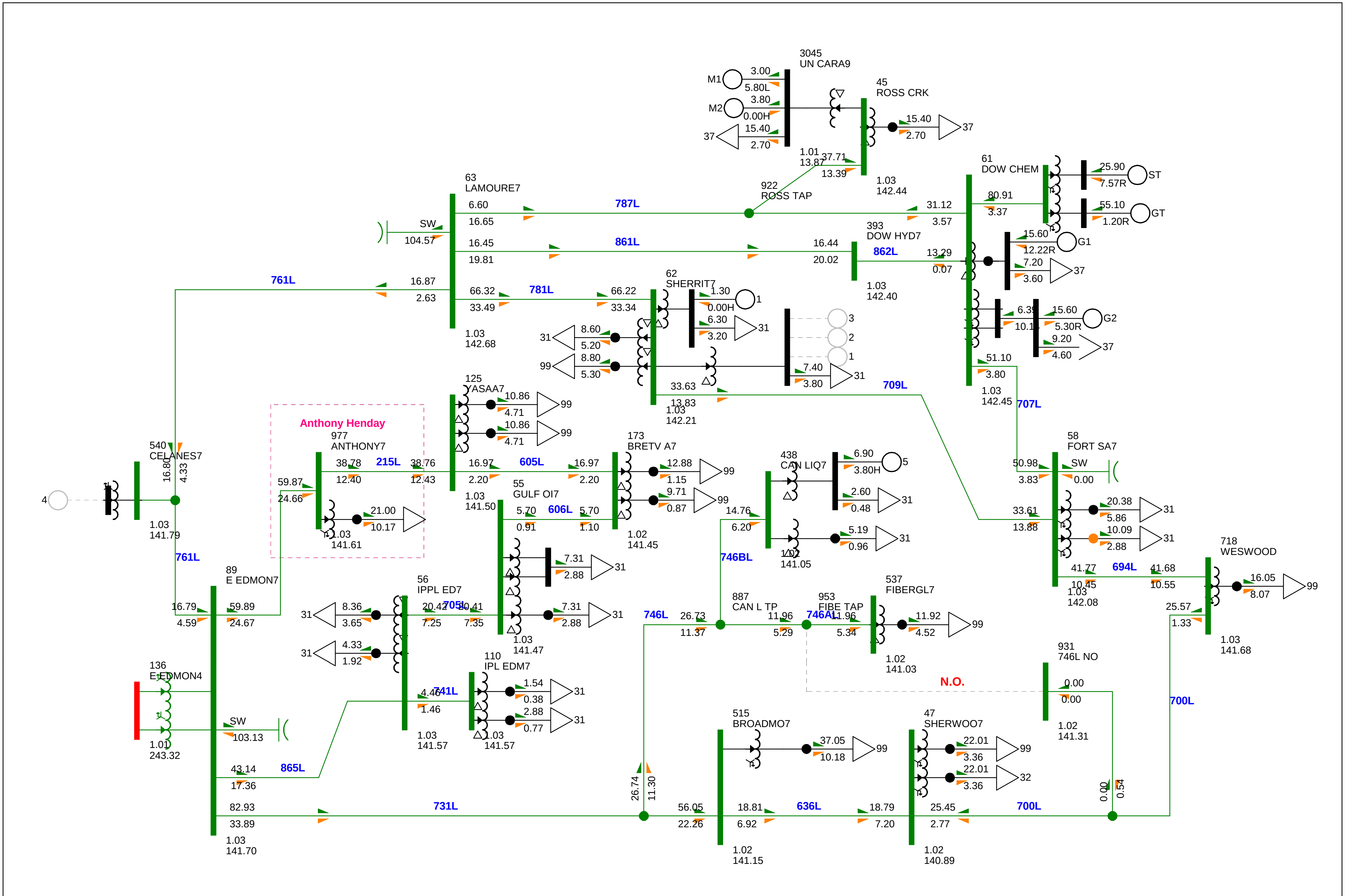


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C1-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2016 WINTER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

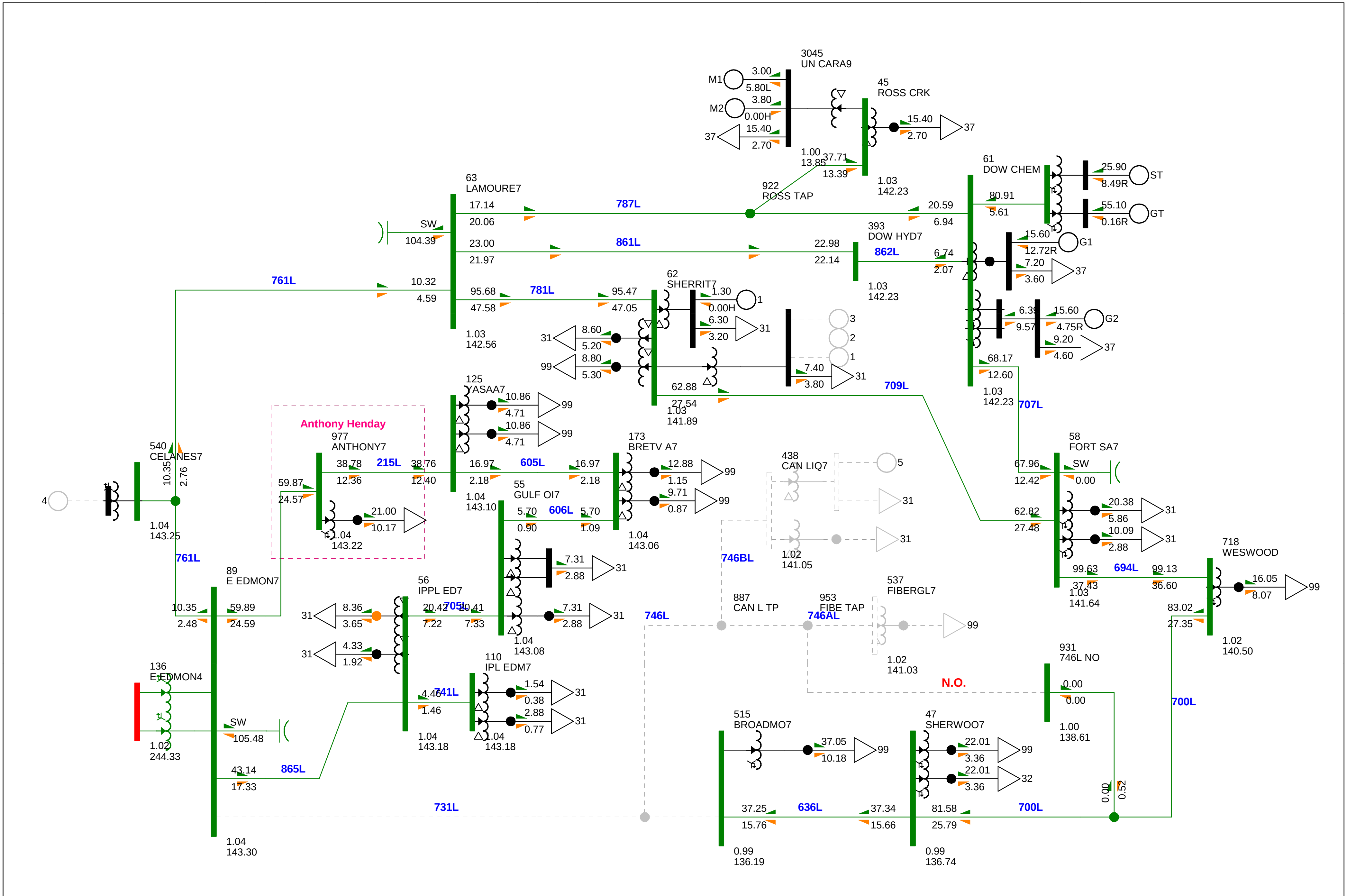
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



P1442_Fortis Anthony Henday Sybstation

Sept 2013

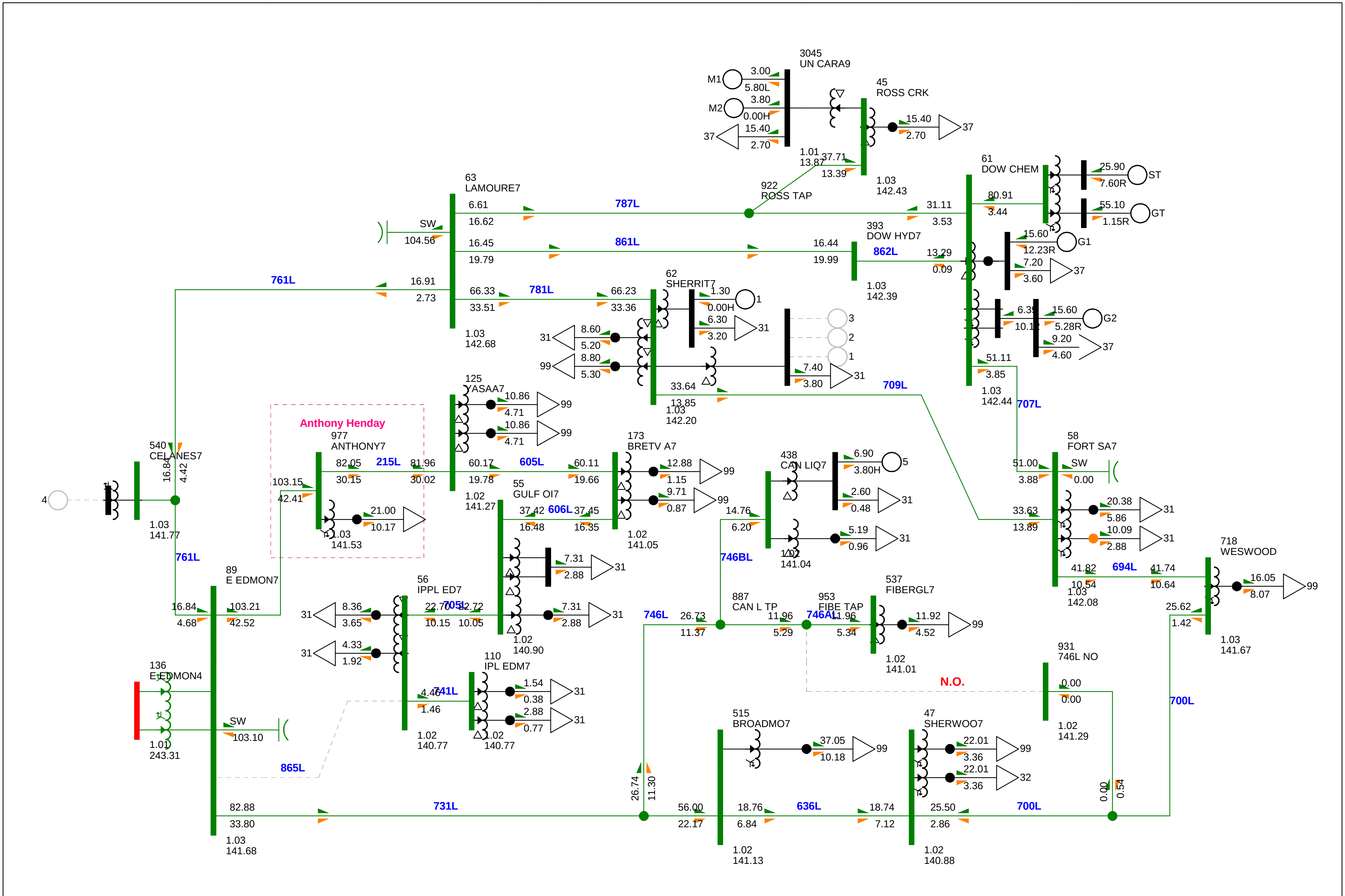
FIGURE C2-1-N-0: NORMAL OPERATION
2018 SUMMER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016



P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C2-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)
2018 SUMMER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

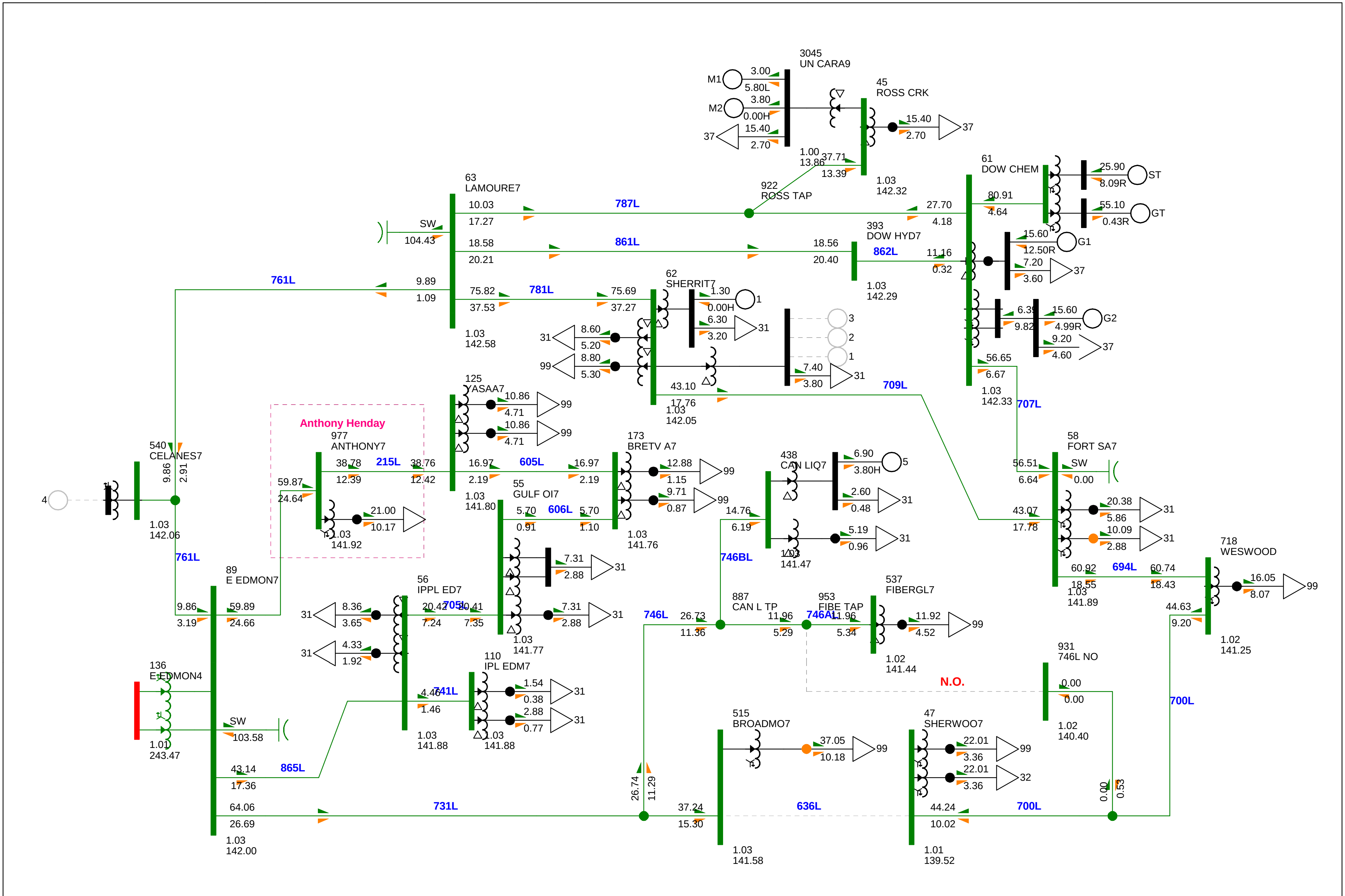


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C2-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)
2018 SUMMER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

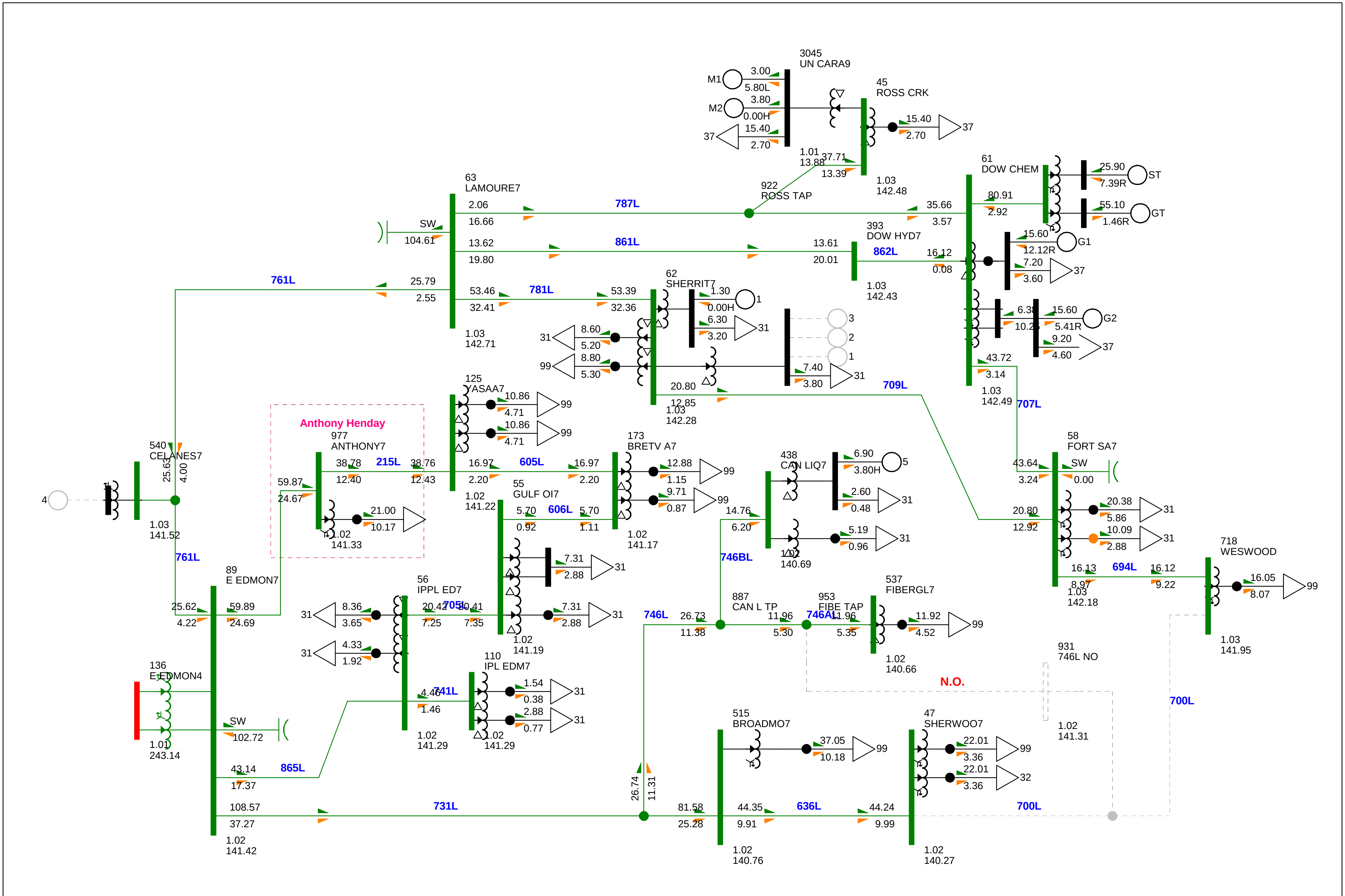


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C2-4 N-1: 636L (BROADMOOR 420S TO SHERWOOD PARK 746S)
2018 SUMMER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

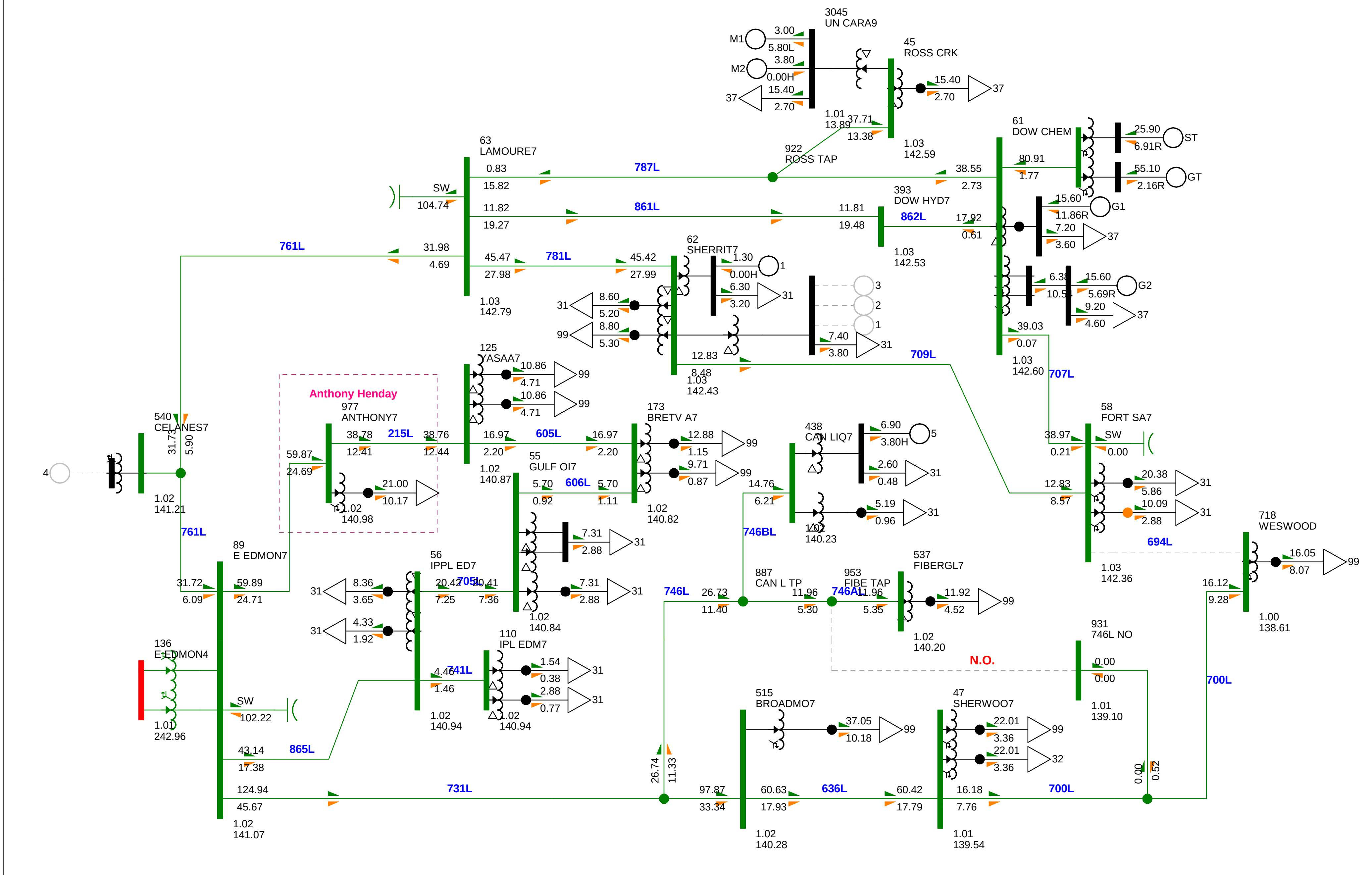


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C2-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)
2018 SUMMER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE C2-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2018 SUMMER PEAK (ALT 3)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Attachment D: Alternative 1 Post-Project Voltage Stability Diagrams (Scenarios 3 and 4)

Figure D- 1: PV Curve for Alternative 1, 2016 WP

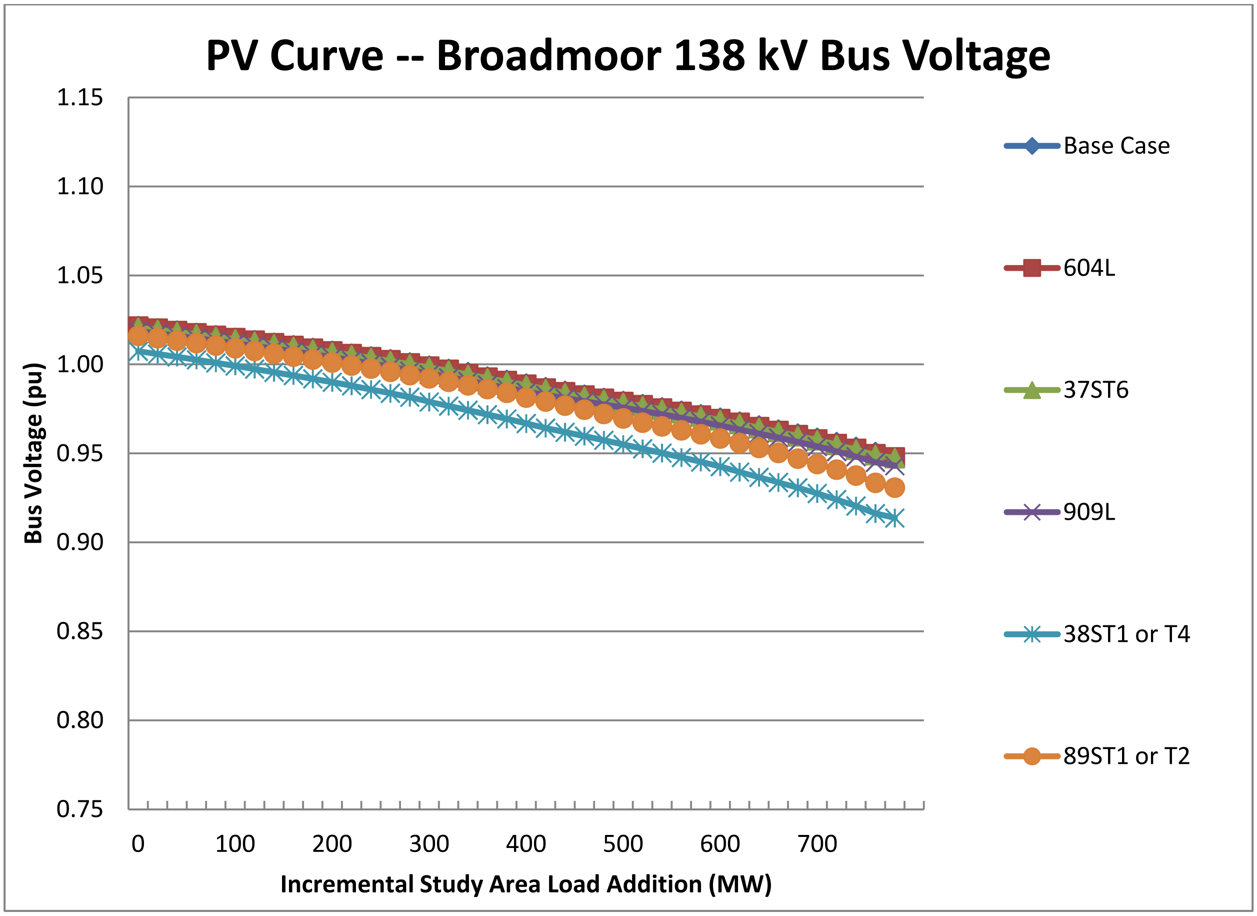
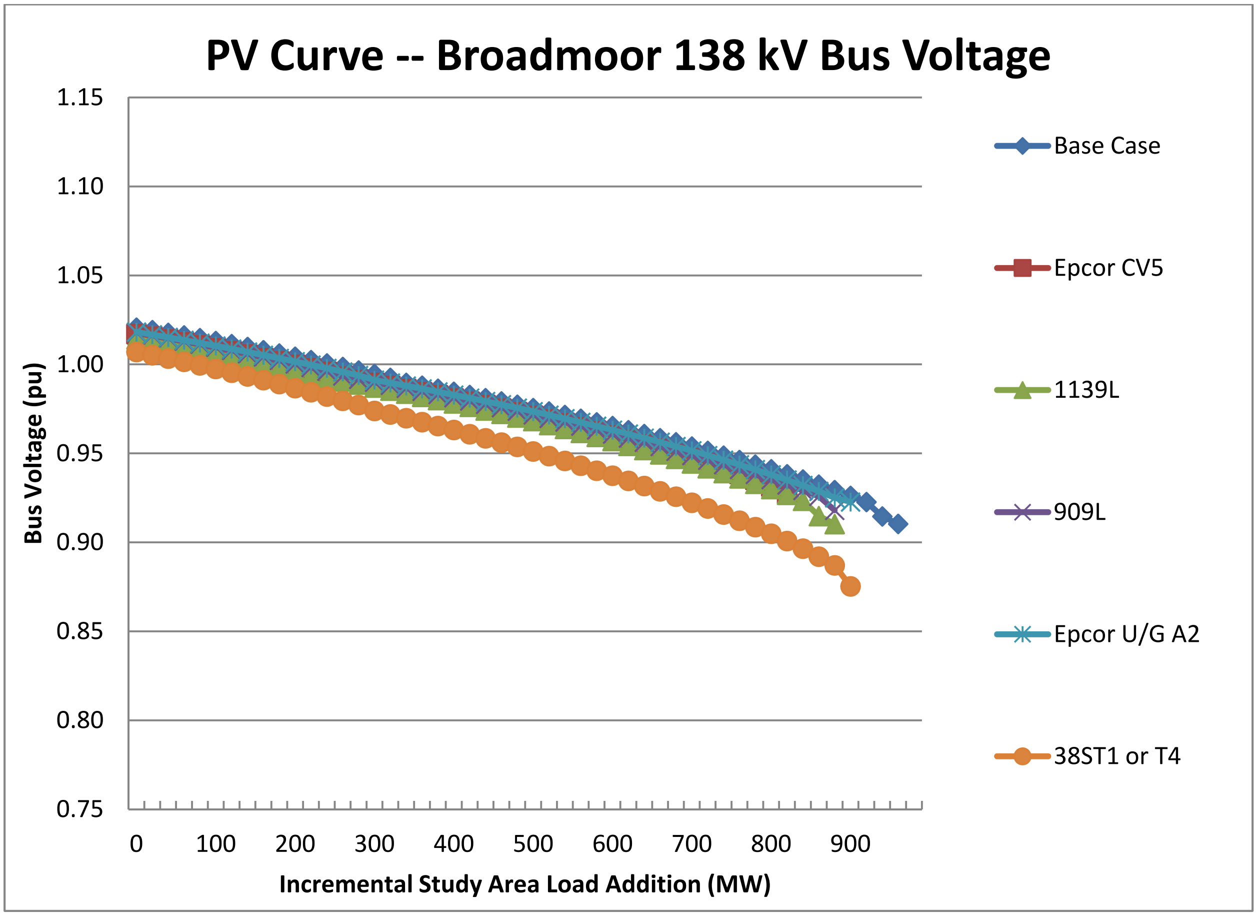


Figure D- 2: PV Curve for Alternative 1, 2018 SP



Attachment E: Alternative 3 Post-Project Voltage Stability Diagrams (Scenarios 3 and 4)

Figure E- 1: PV Curve for Alternative 3, 2016 WP (a)

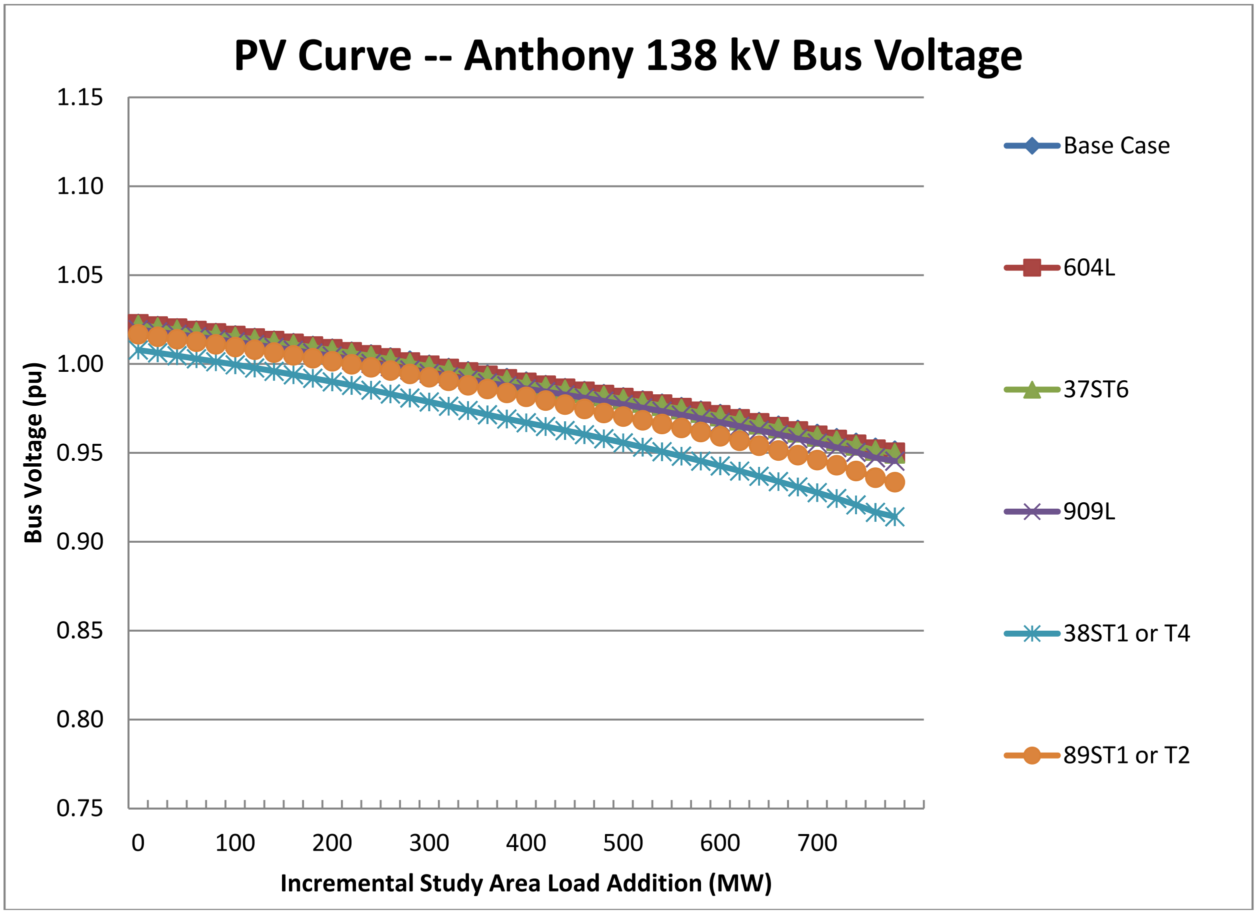


Figure E- 2: PV Curve for Alternative 3, 2016 WP (b)

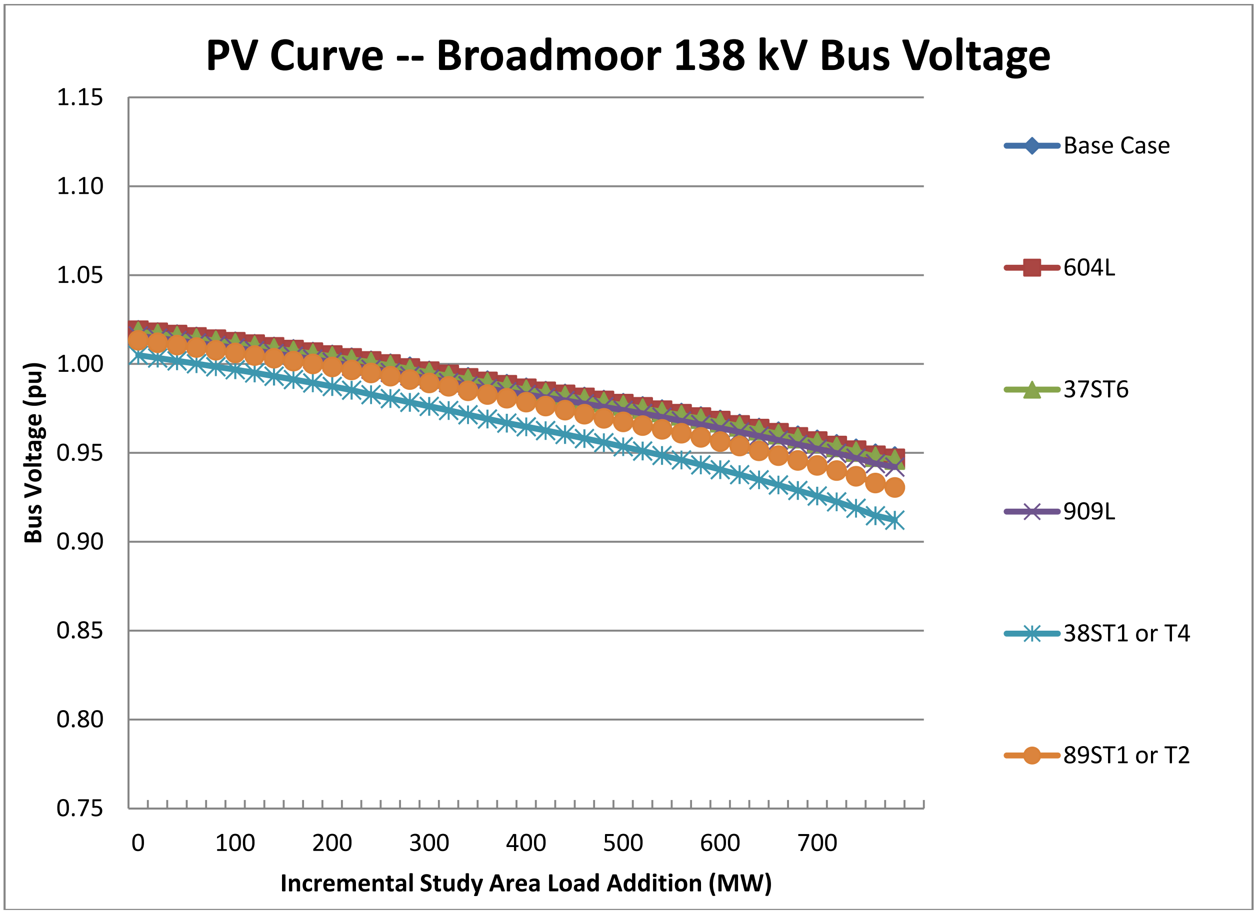


Figure E- 3: PV Curve for Alternative 3, 2018 SP (a)

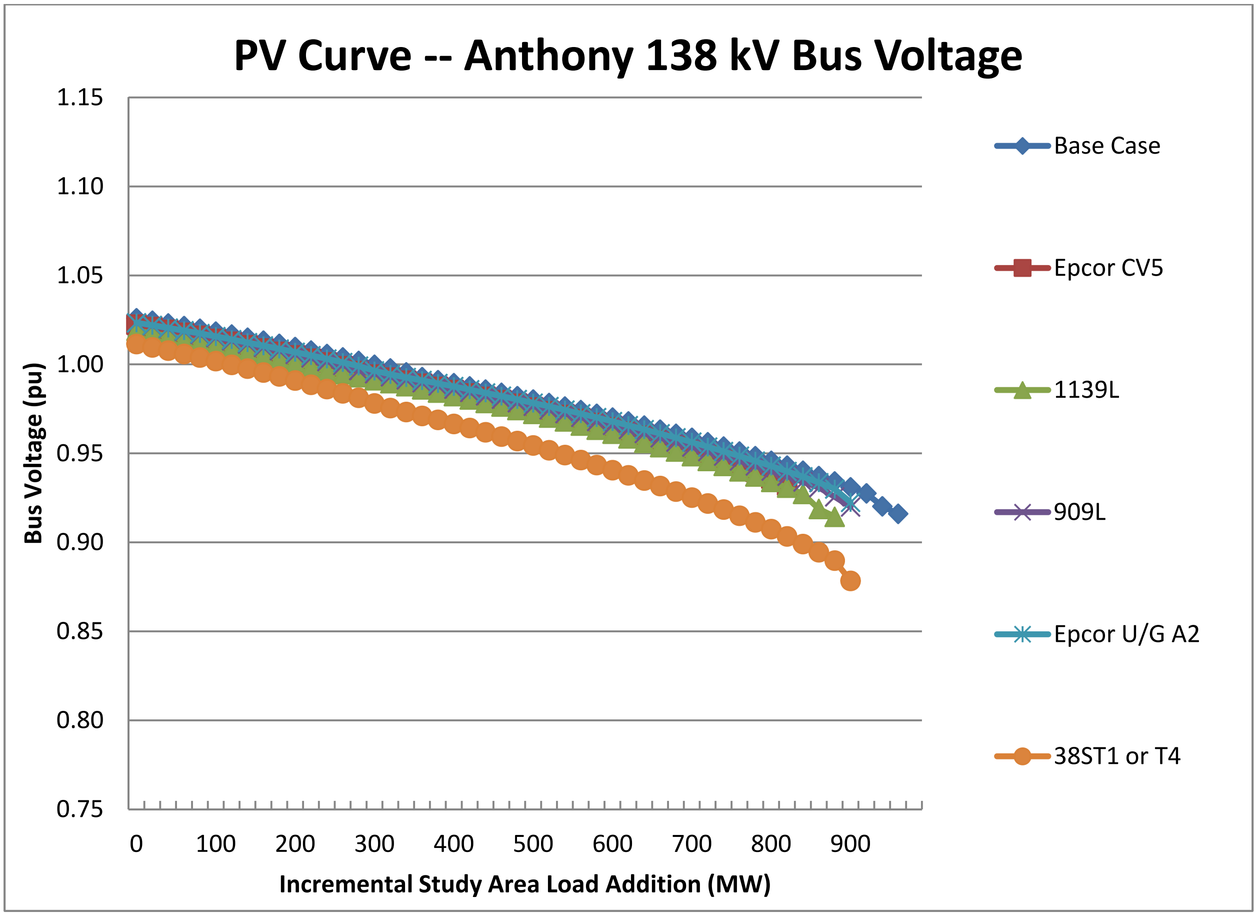
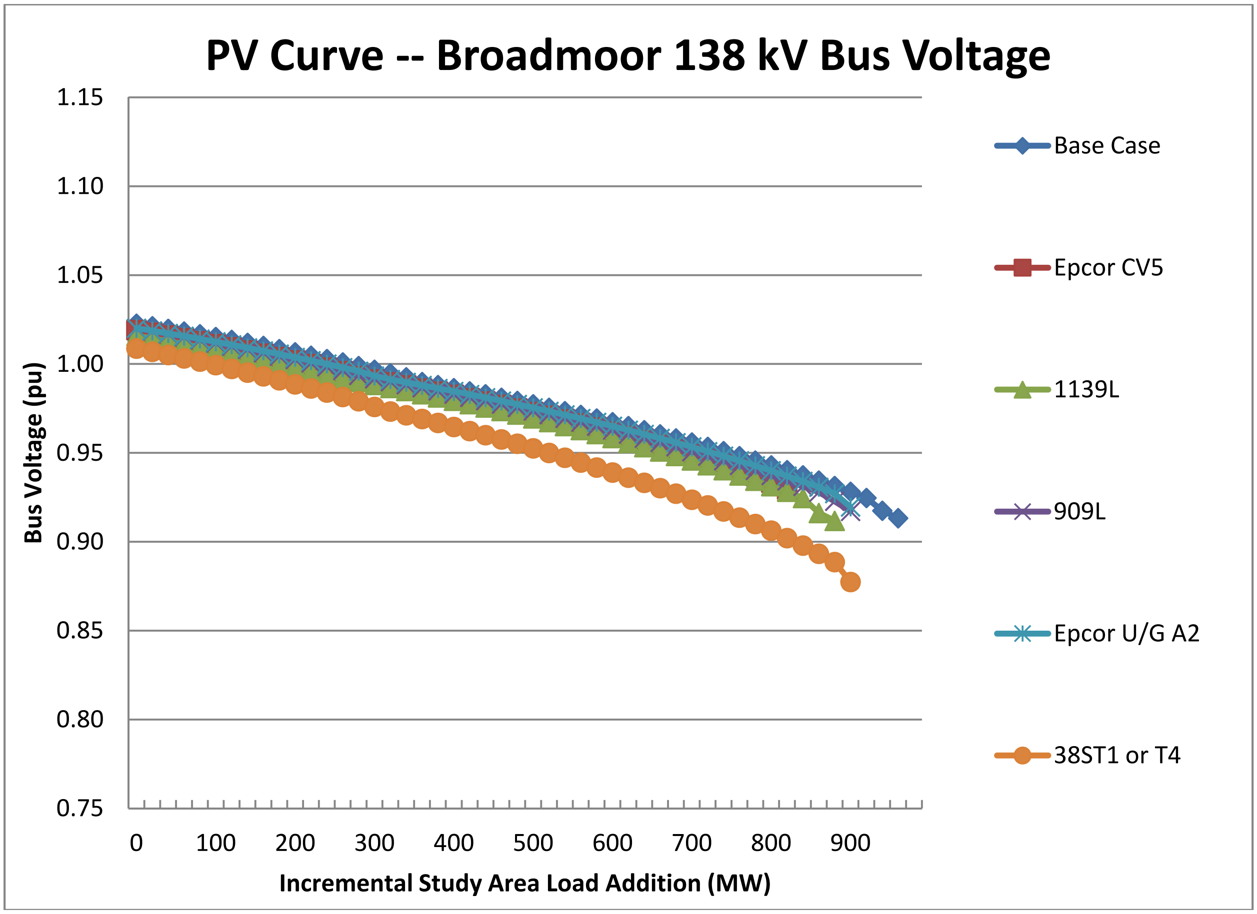
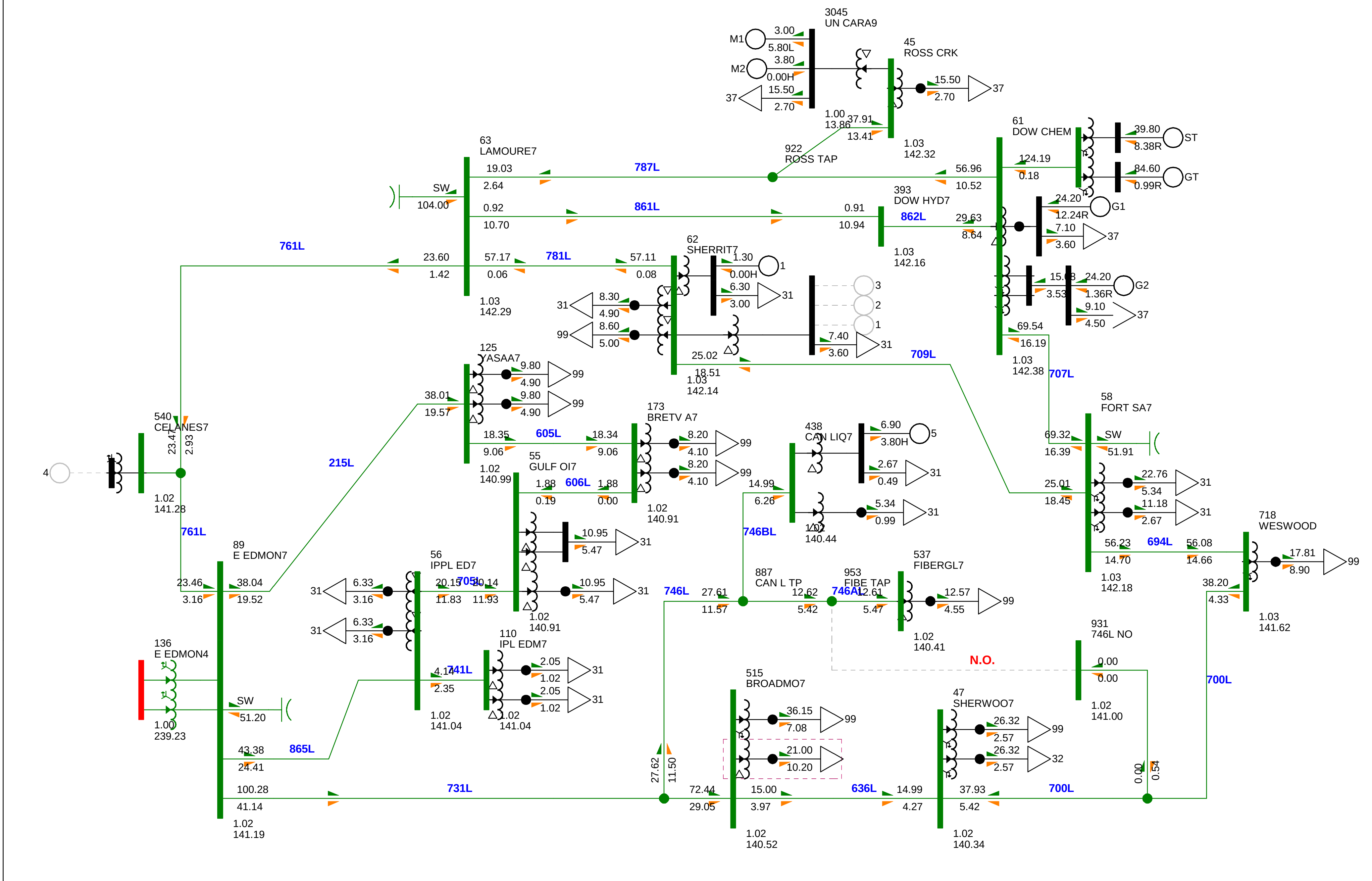


Figure E- 4: PV Curve for Alternative 3, 2018 SP (b)



Attachment F: Alternative 1 Post-Project Sensitivity Power Flow Diagrams (Scenarios 5 and 6)



Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE F1-1-N-0: NORMAL OPERATION
2018 WINTER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

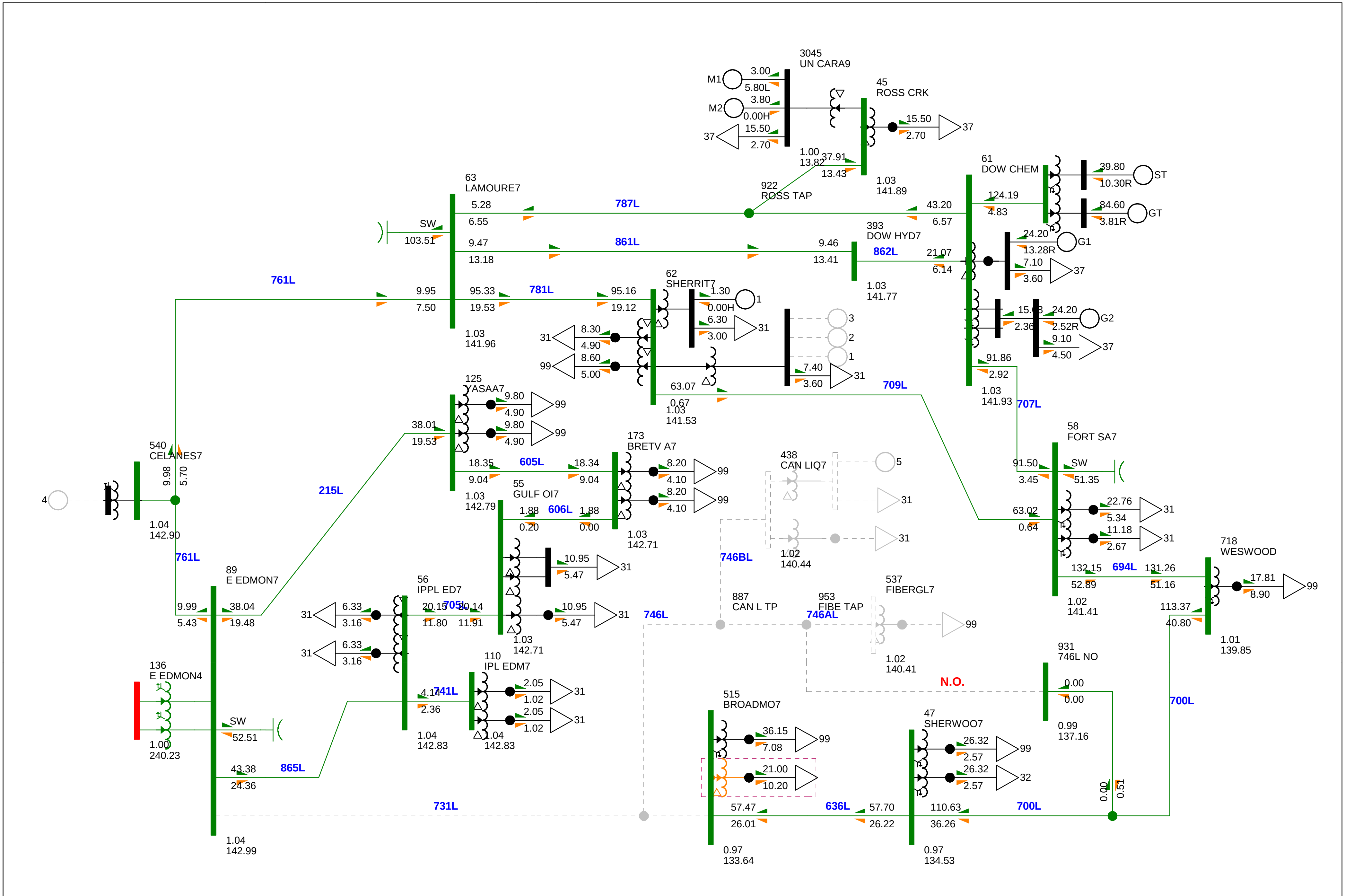


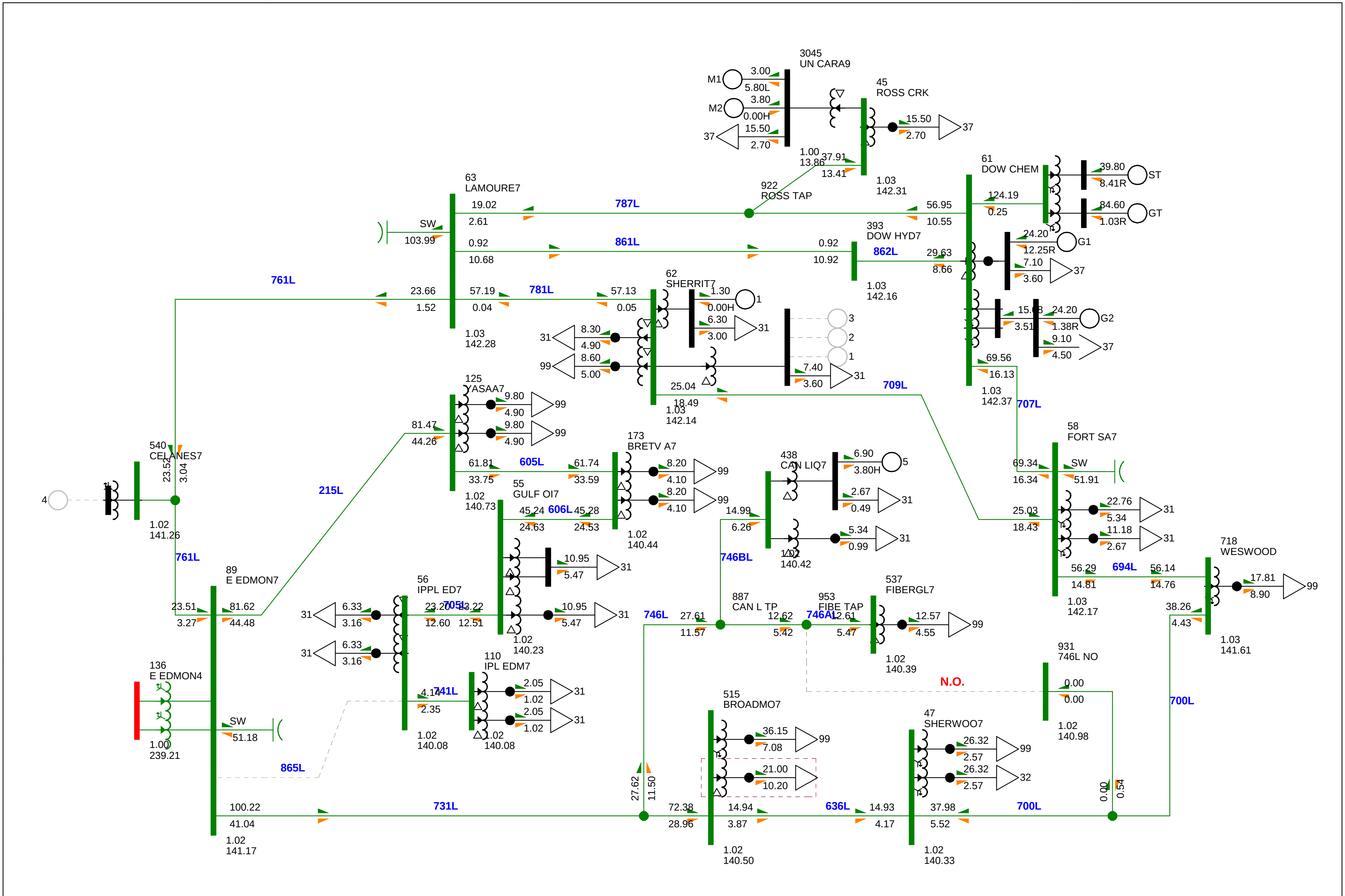
FIGURE F1-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)
2018 WINTER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



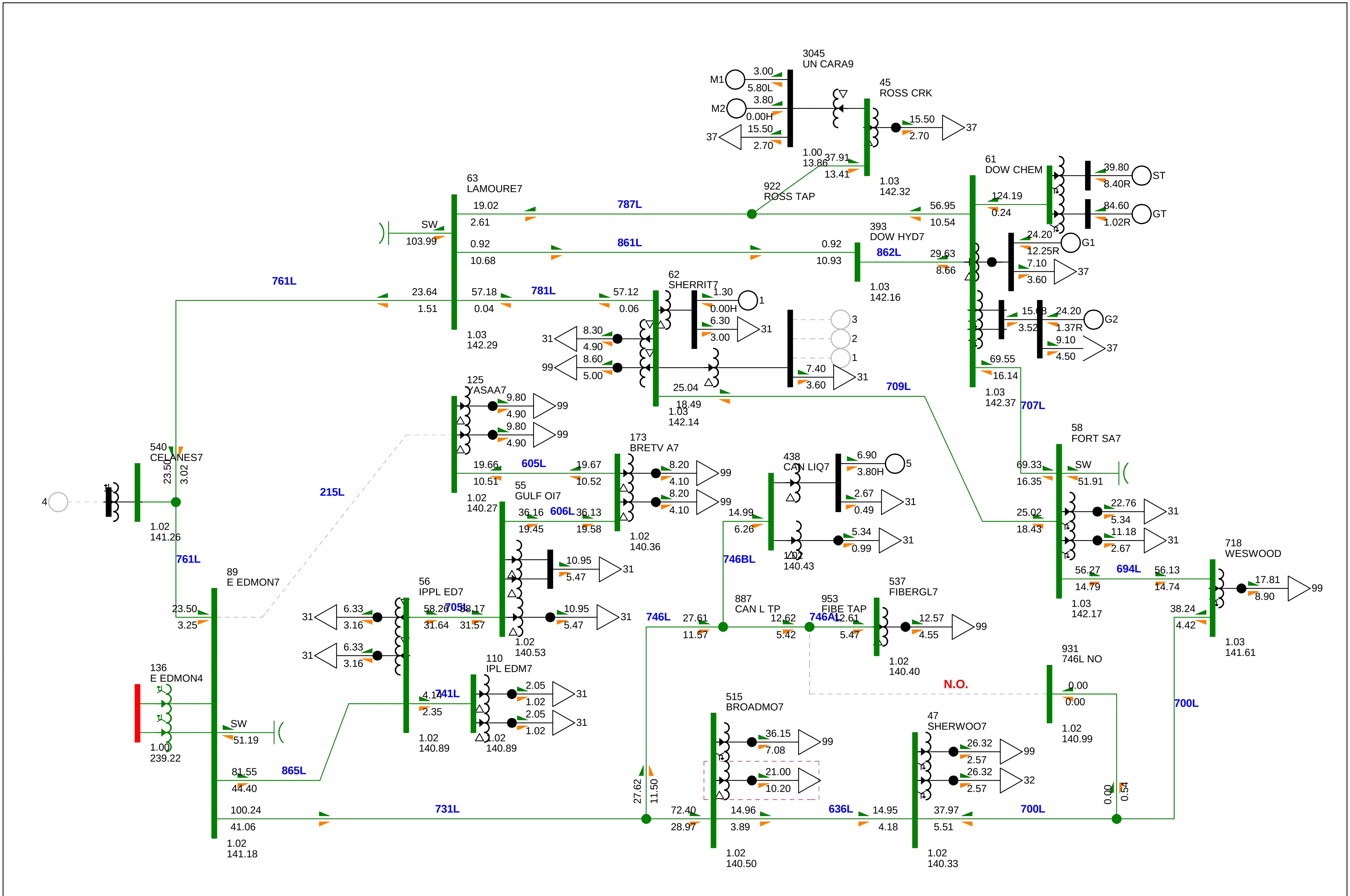
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE F1-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)
2018 WINTER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



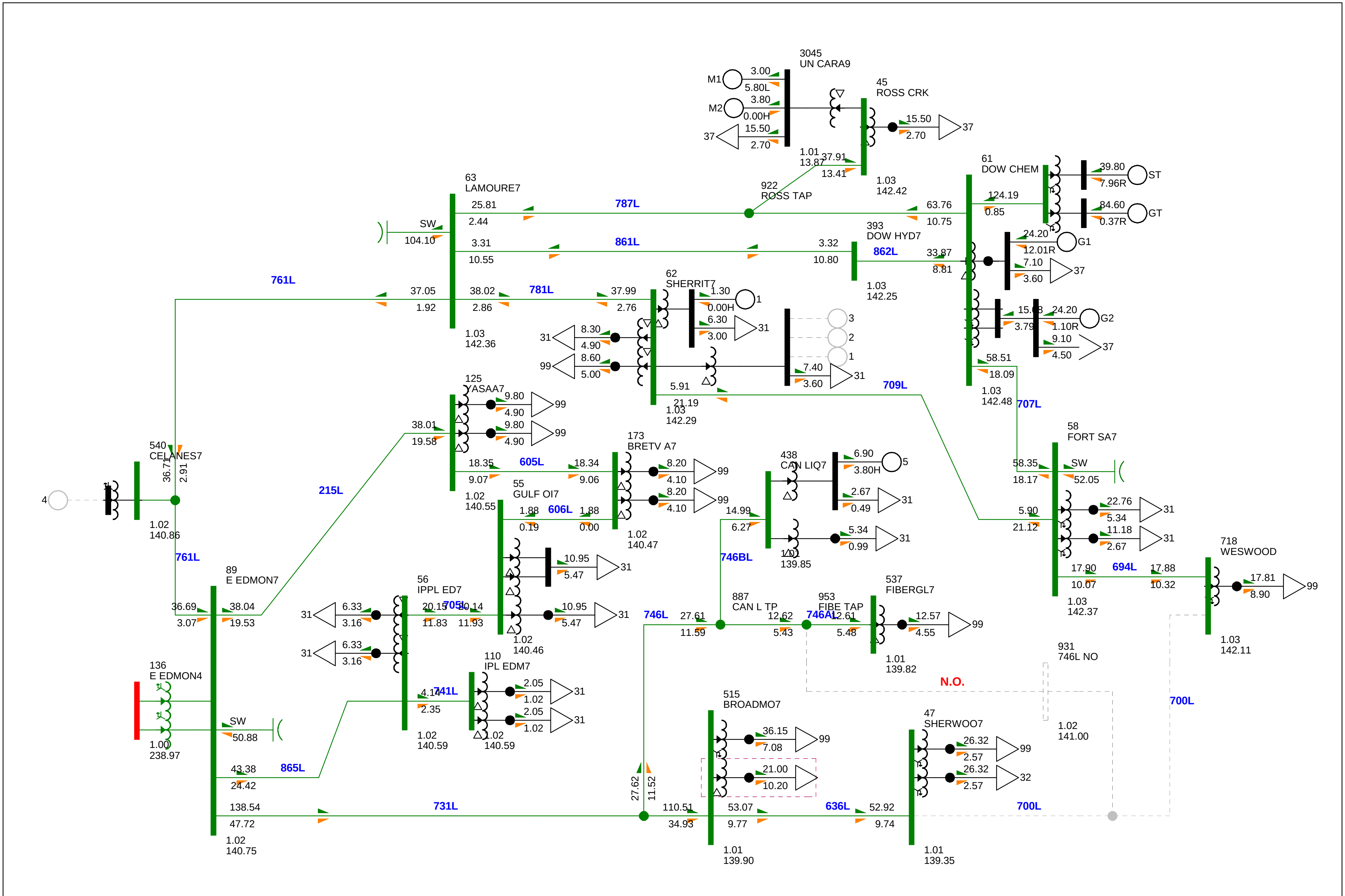
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE F1-4 N-1: 215L (EAST EDMONTON 38S TO YASA 286S)
2018 WINTER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



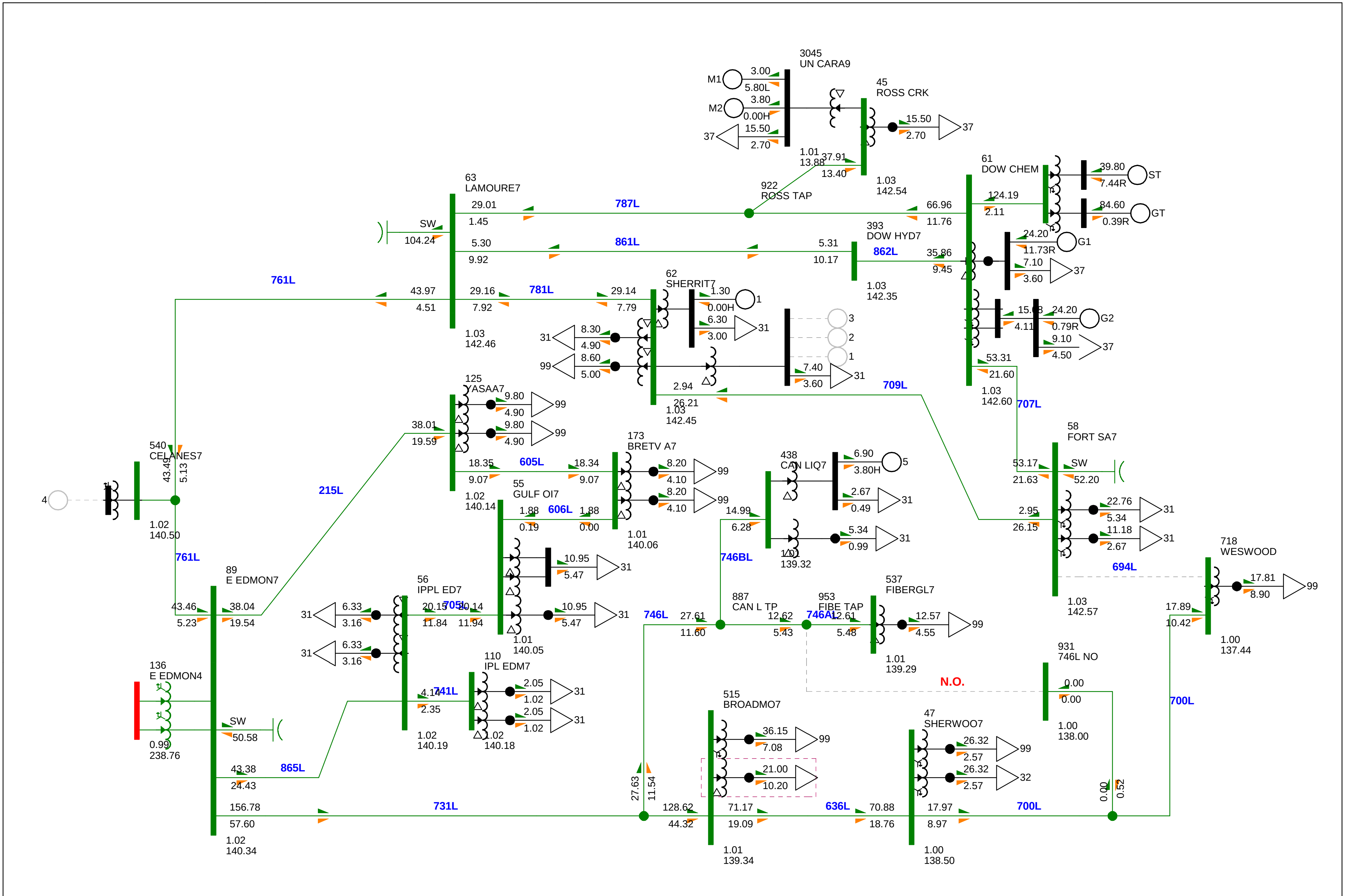
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE F1-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)
2018 WINTER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



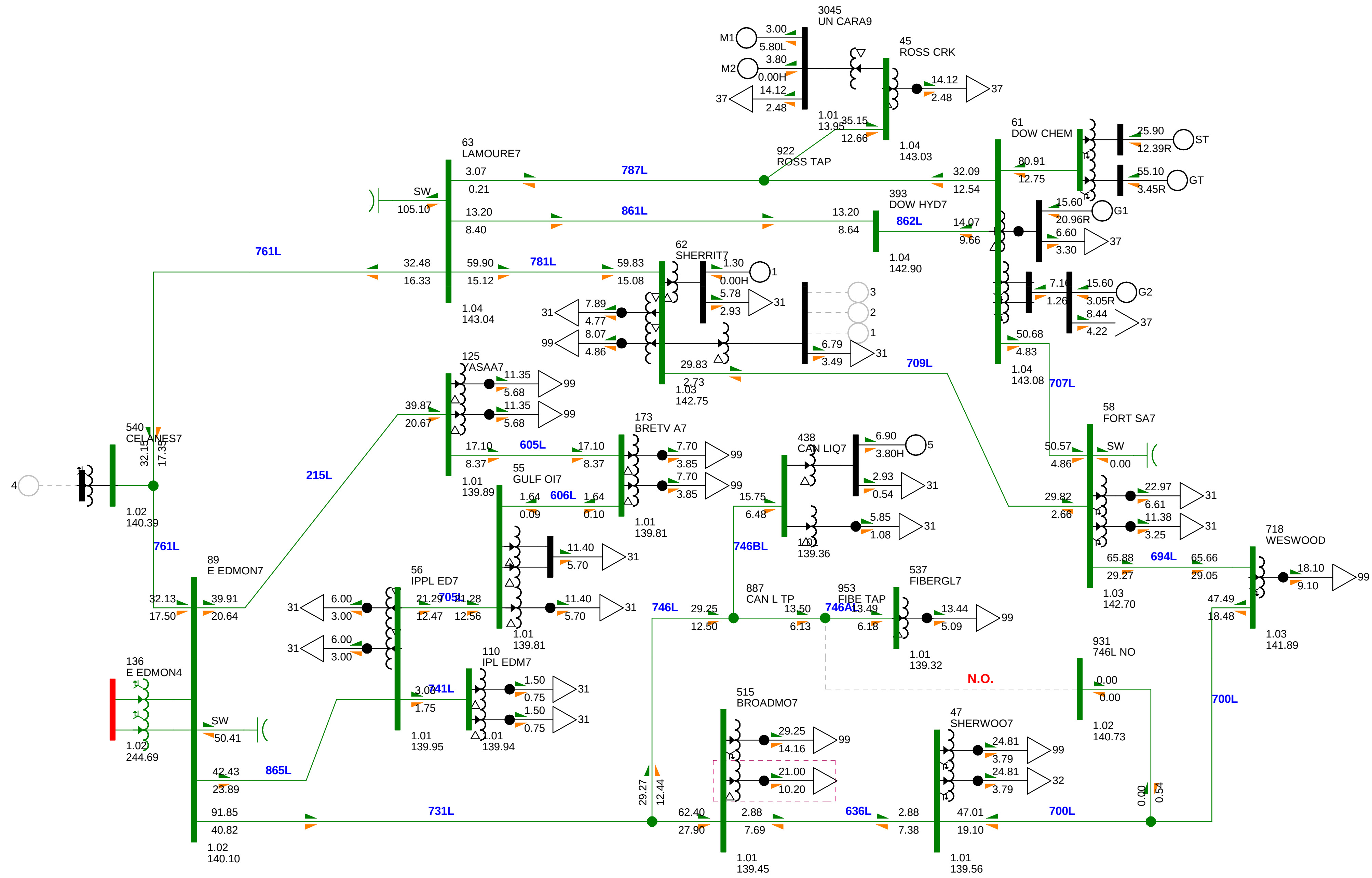
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE F1-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2018 WINTER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



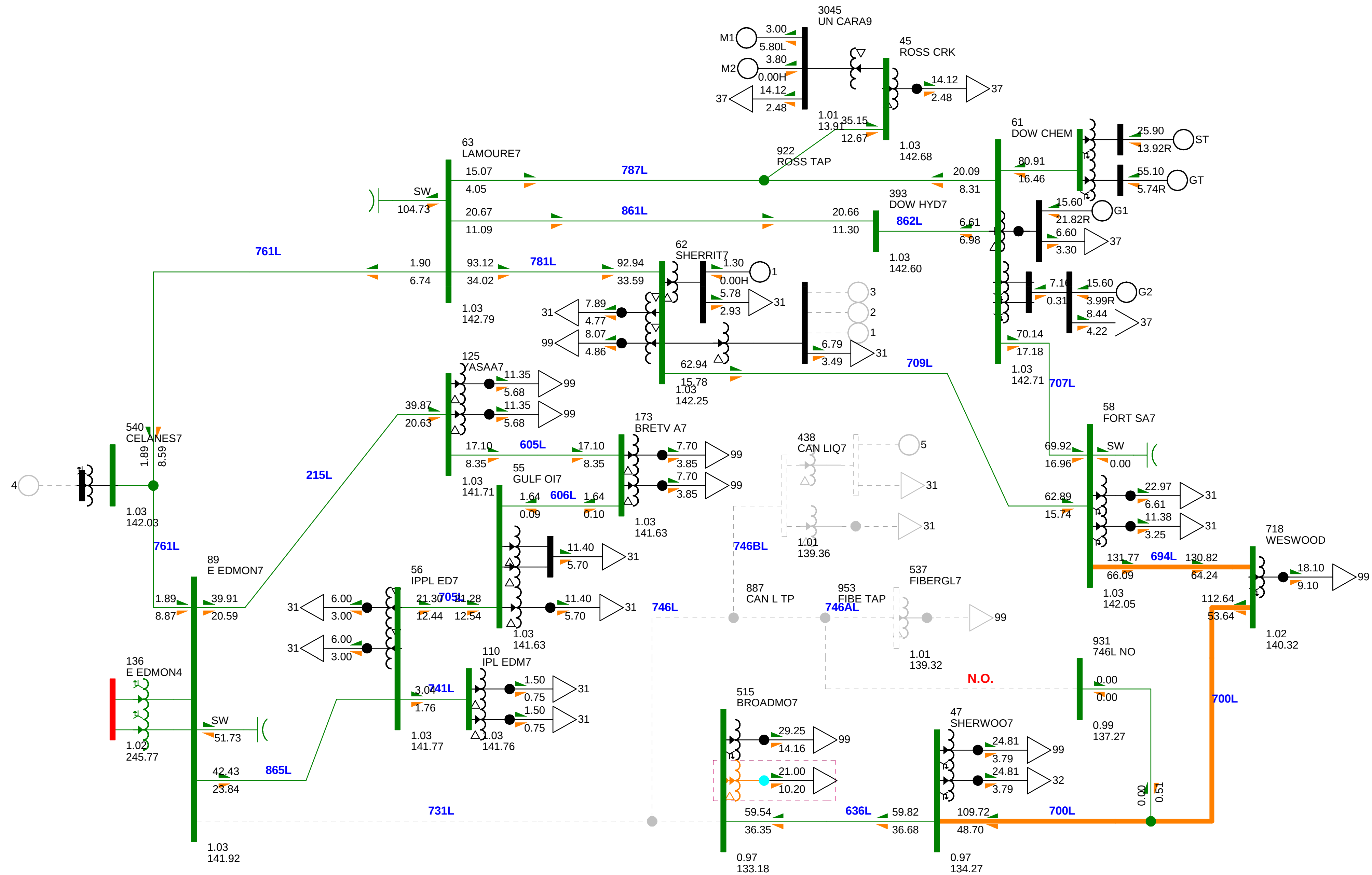
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

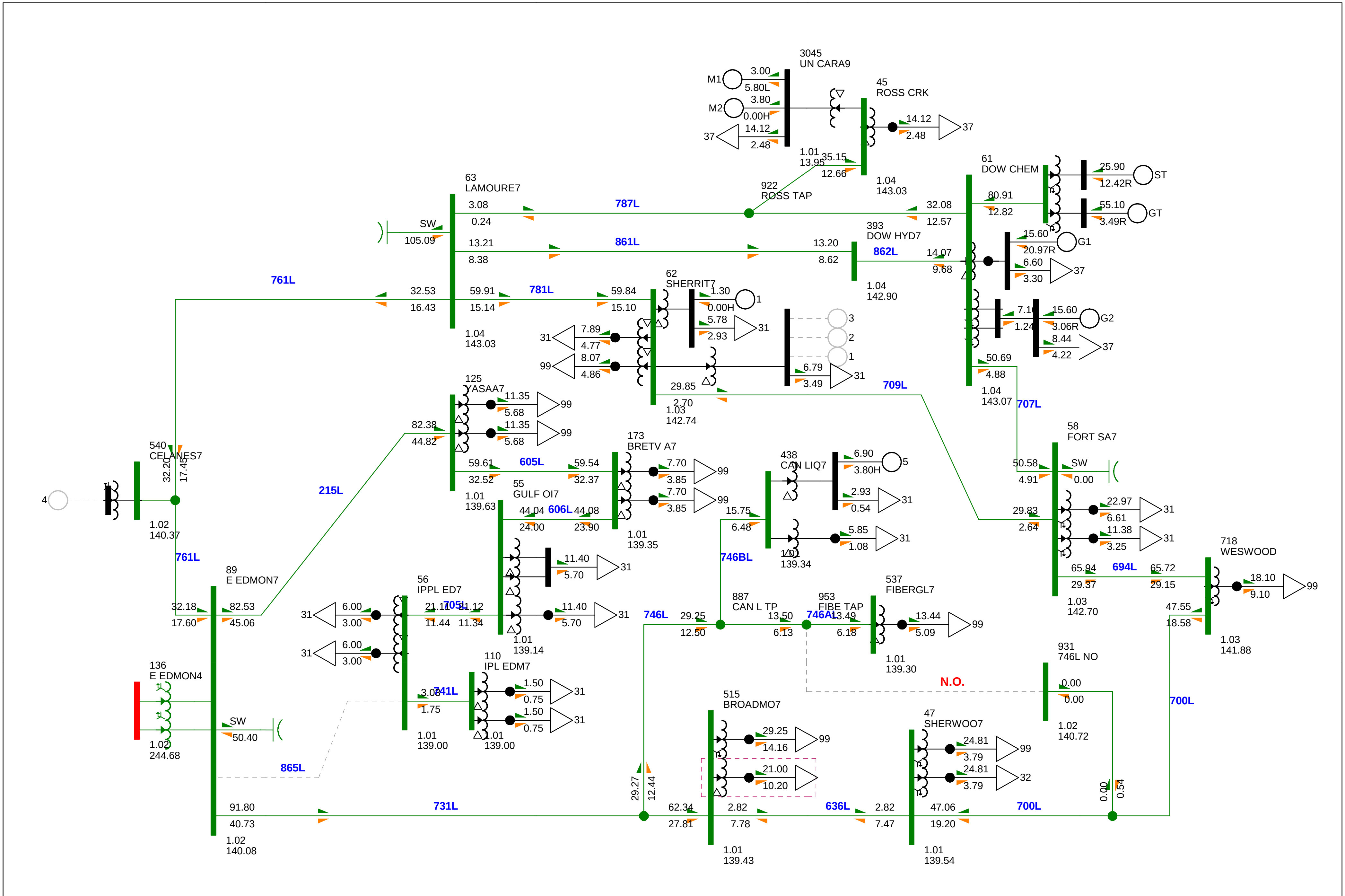
FIGURE F2-1-N-0: NORMAL OPERATION
2019 SUMMER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Fortis Anthony Henday **(Alternative 1 - Upgrade Broadmoor)** Sept 2013	**FIGURE F2-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)** **2019 SUMMER PEAK (ALT 1)** **PRINTED ON MONDAY 28. NOVEMBER 2016**

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

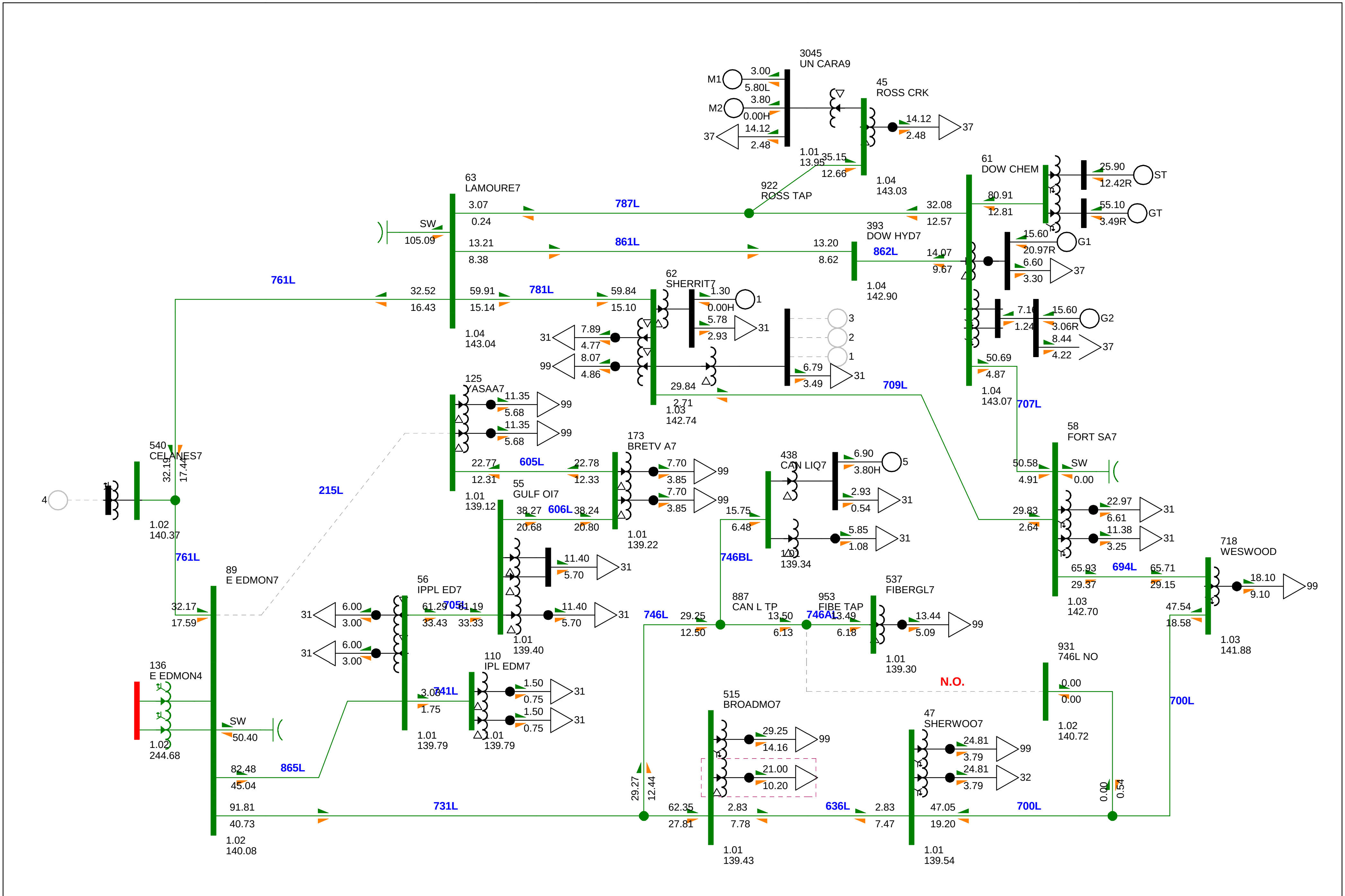


Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE F2-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)
2019 SUMMER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016



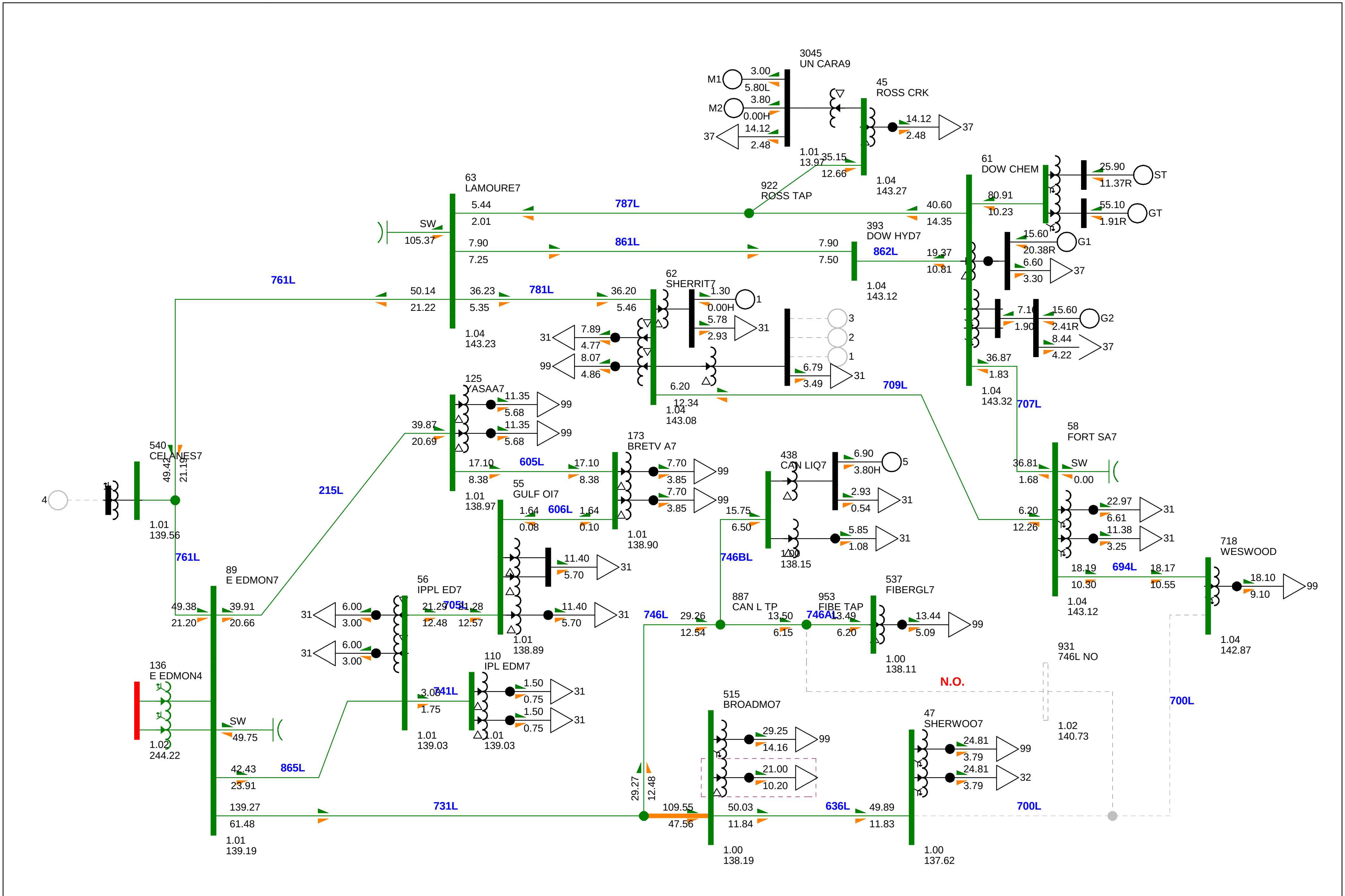
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE F2-4 N-1: 215L (EAST EDMONTON 38S TO YASA 286S)
2019 SUMMER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



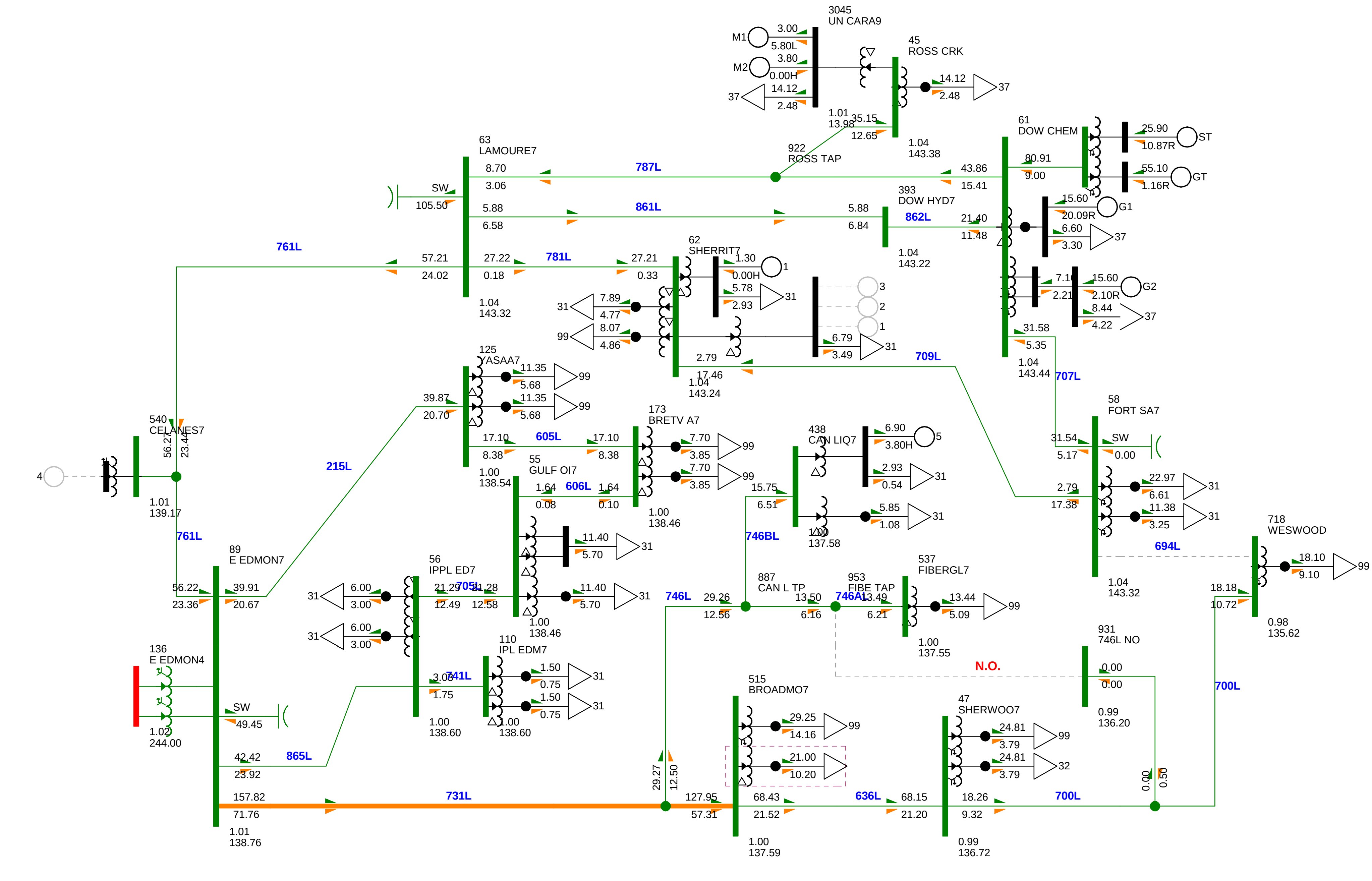
Fortis Anthony Henday

(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE F2-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)
2019 SUMMER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Fortis Anthony Henday

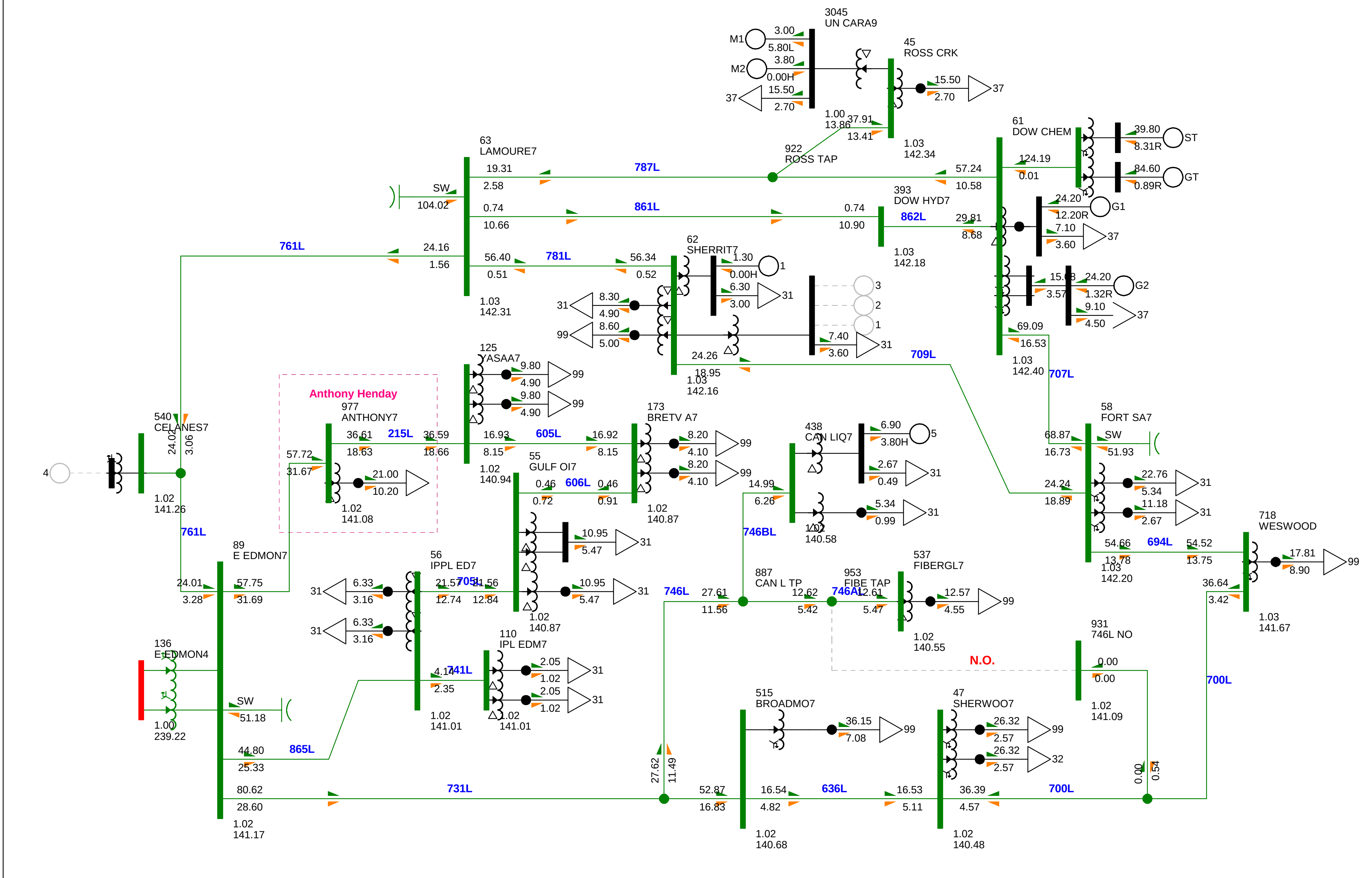
(Alternative 1 - Upgrade Broadmoor)

Sept 2013

FIGURE F2-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2019 SUMMER PEAK (ALT 1)
PRINTED ON MONDAY 28. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Attachment G: Alternative 3 Post-Project Sensitivity Power Flow Diagrams (Scenarios 5 and 6)

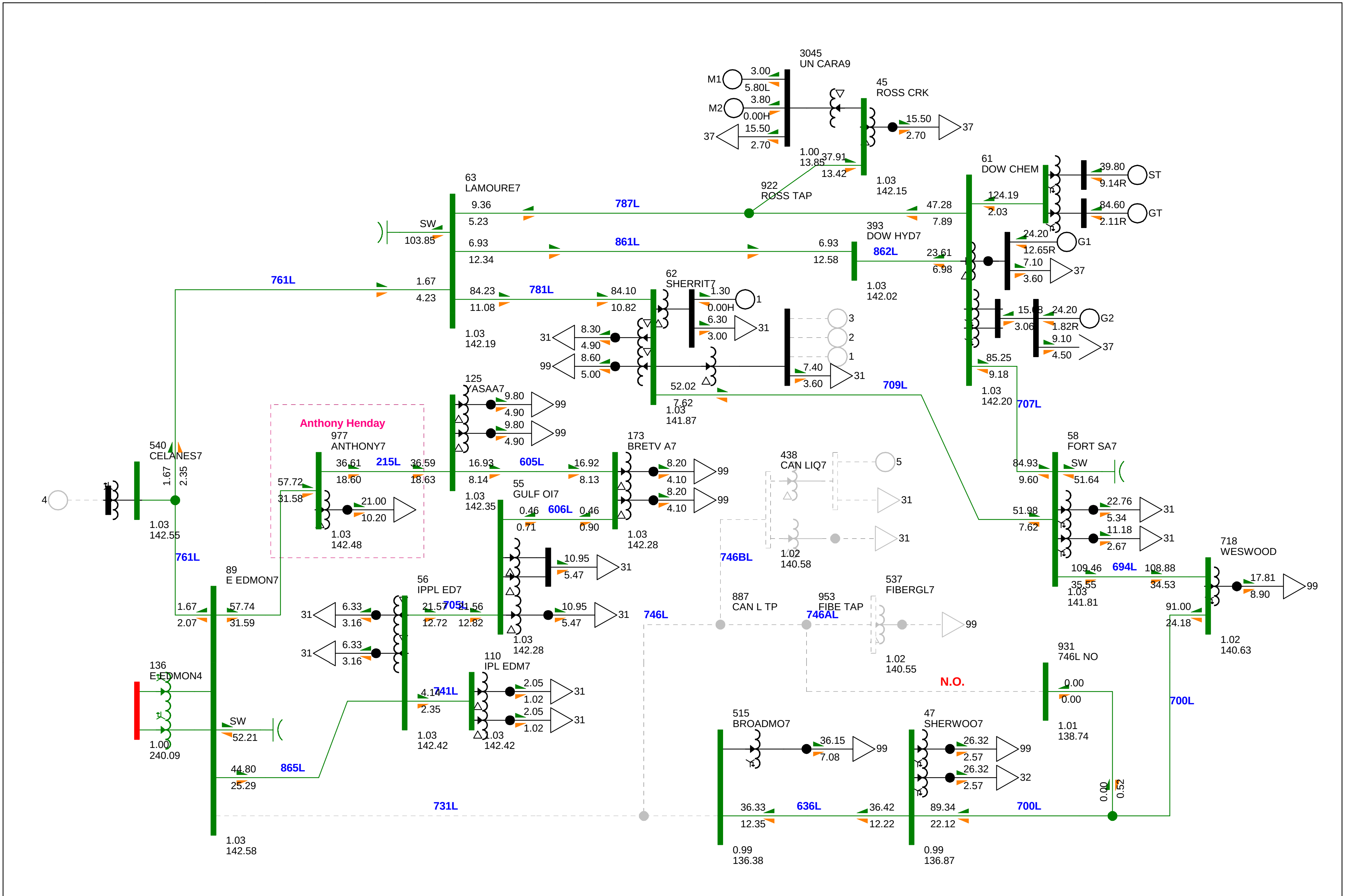


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G1-1-N-0: NORMAL OPERATION
2018 WINTER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

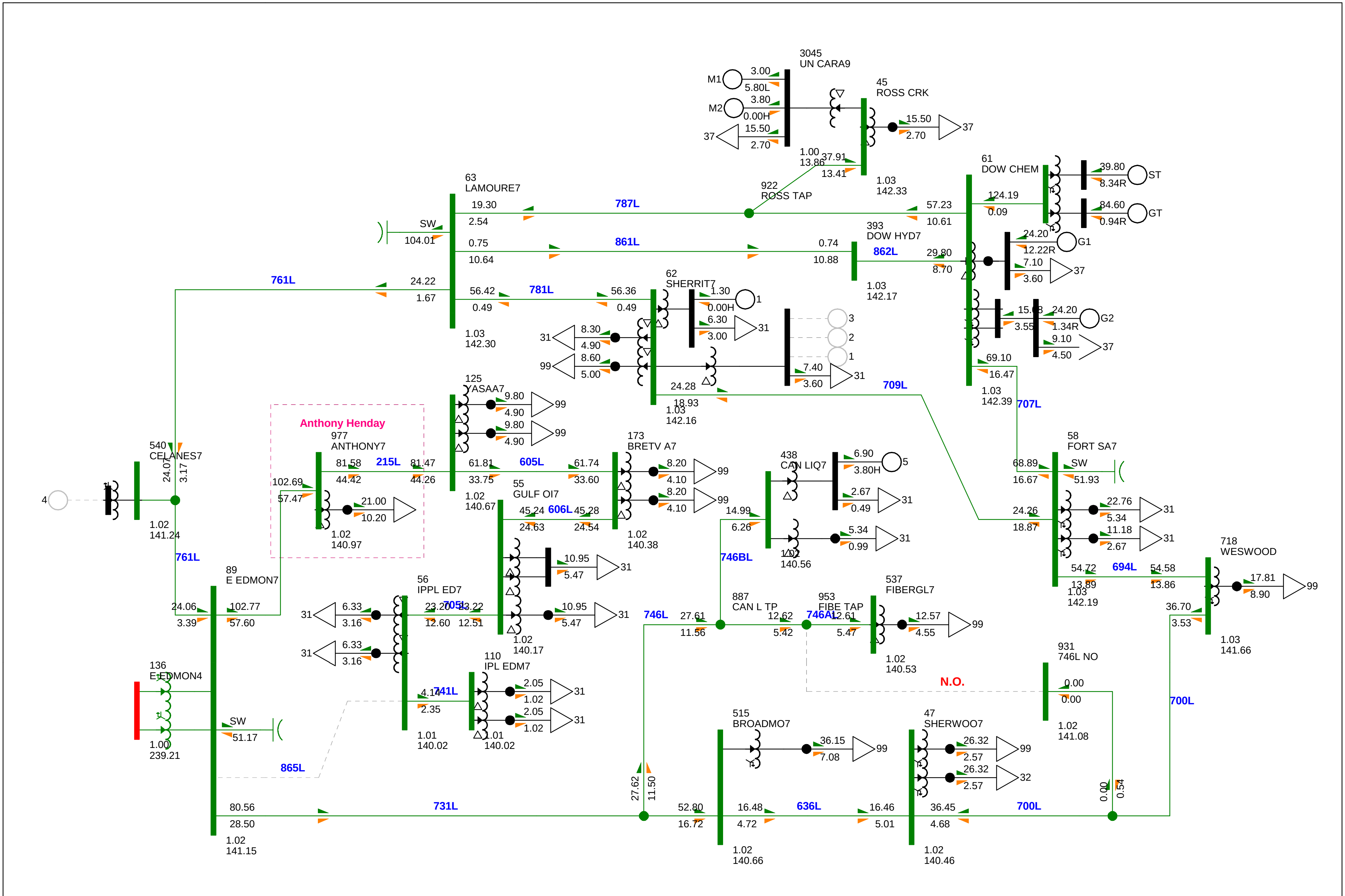


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G1-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)
2018 WINTER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

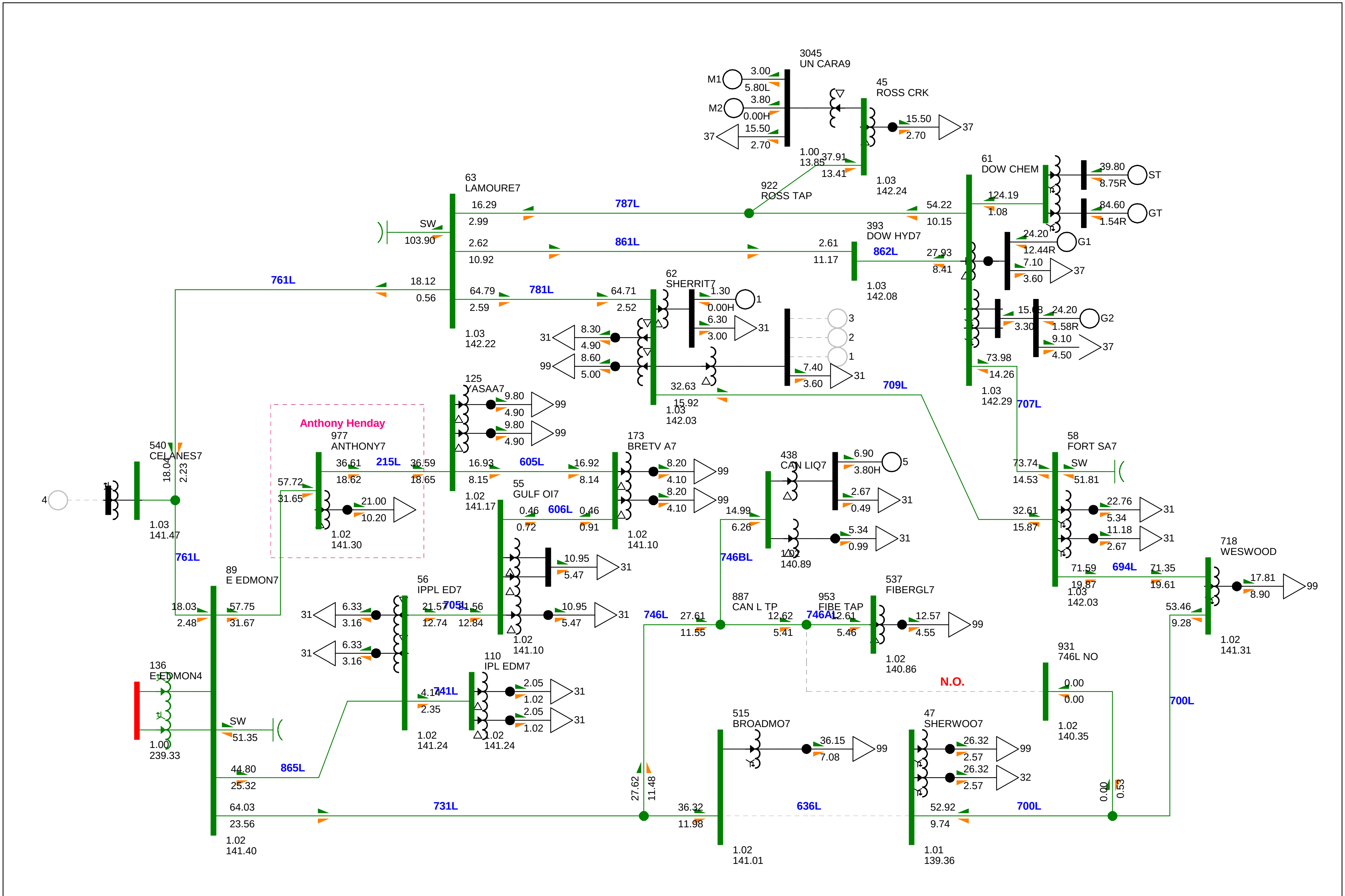


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G1-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)
2018 WINTER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

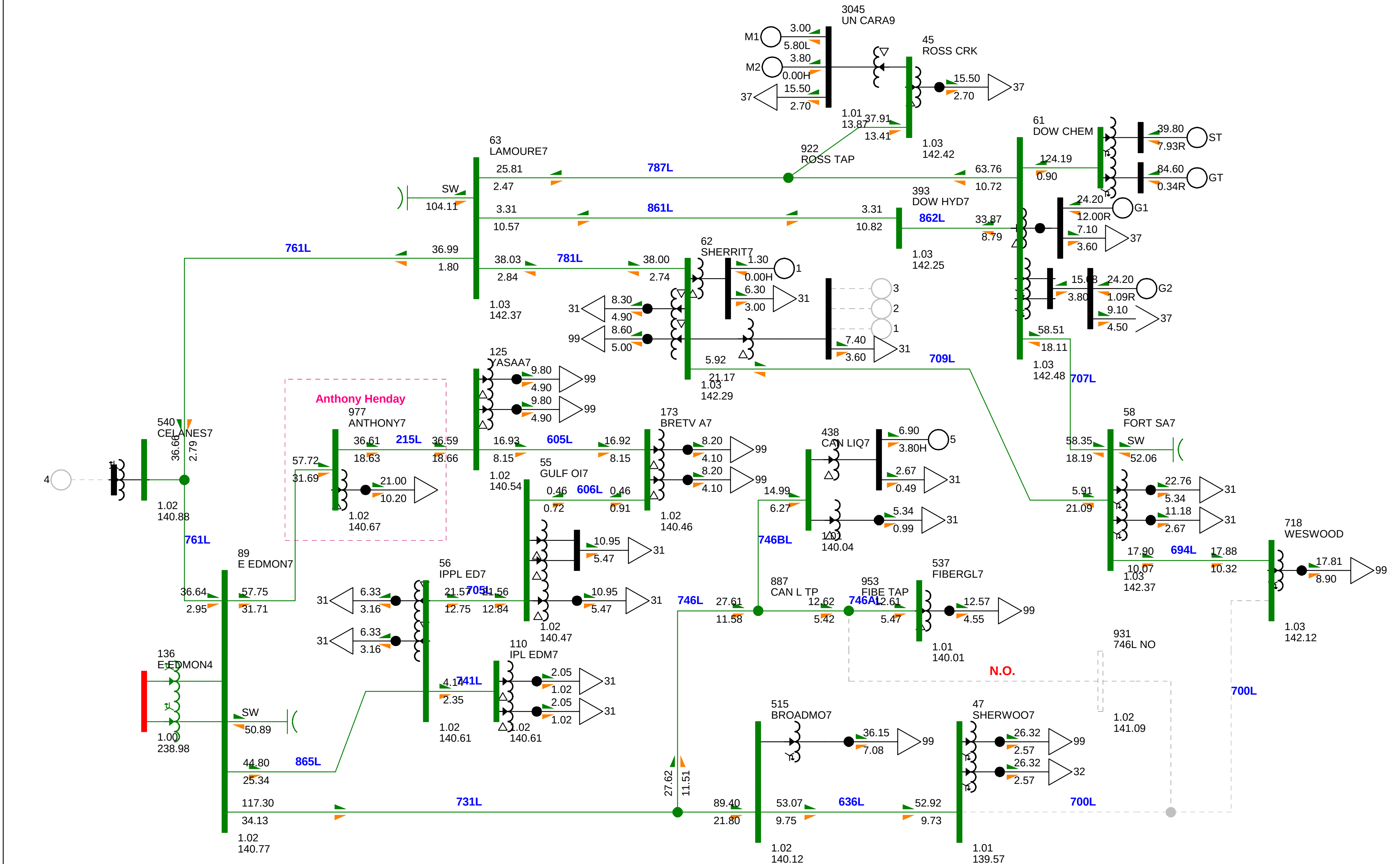


P1442_Fortis Anthony Henday Sybstation

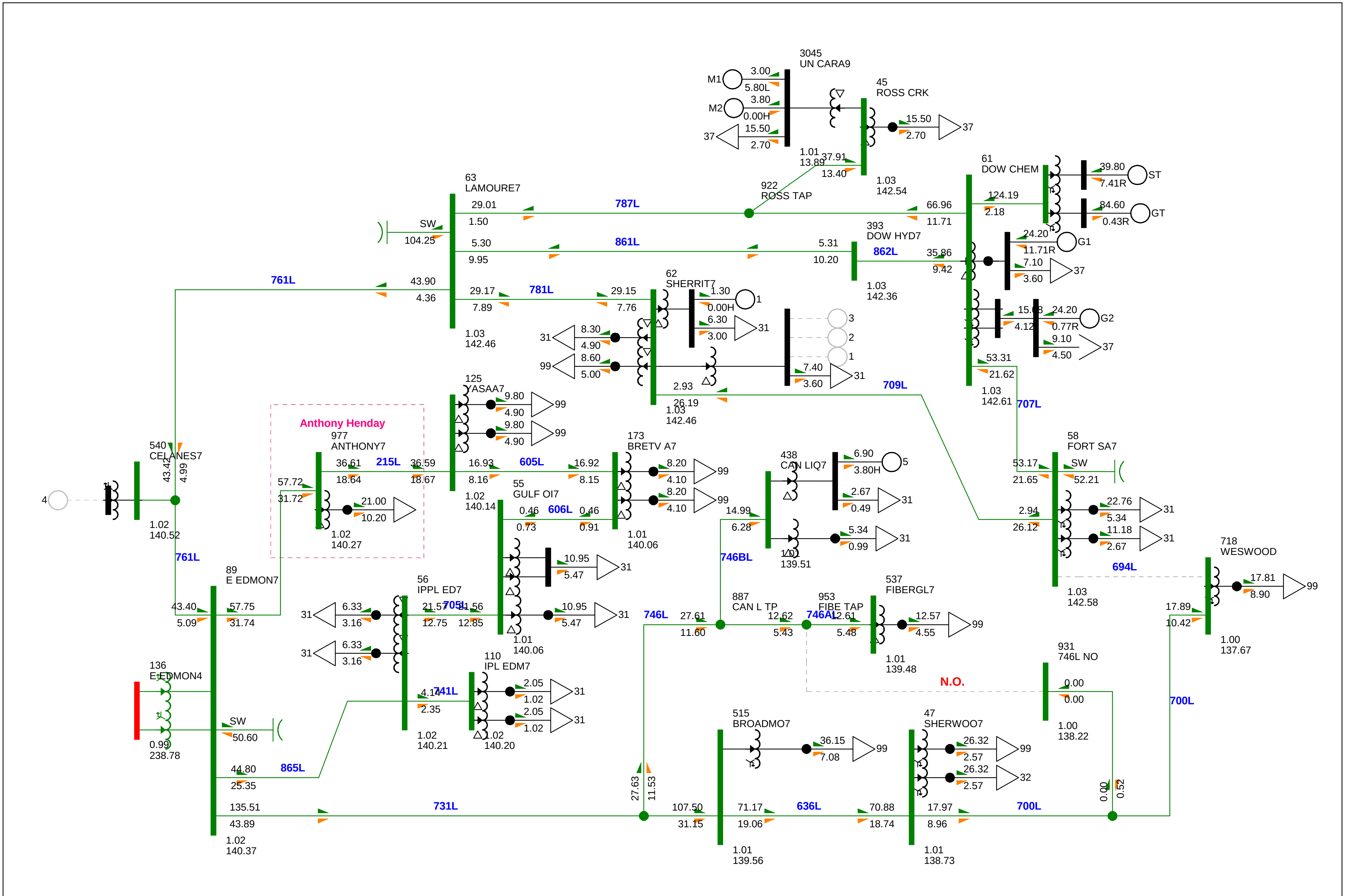
Sept 2013

FIGURE G1-4 N-1: 636L (BROADMOOR 420S TO SHERWOOD PARK 746S)
2018 WINTER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



P1442_Fortis Anthony Henday Sybstation Sept 2013	**FIGURE G1-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)** **2018 WINTER PEAK (ALT 3)** **PRINTED ON FRIDAY 25. NOVEMBER 2016**	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%Rate B 1.050OV 0.950UV kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

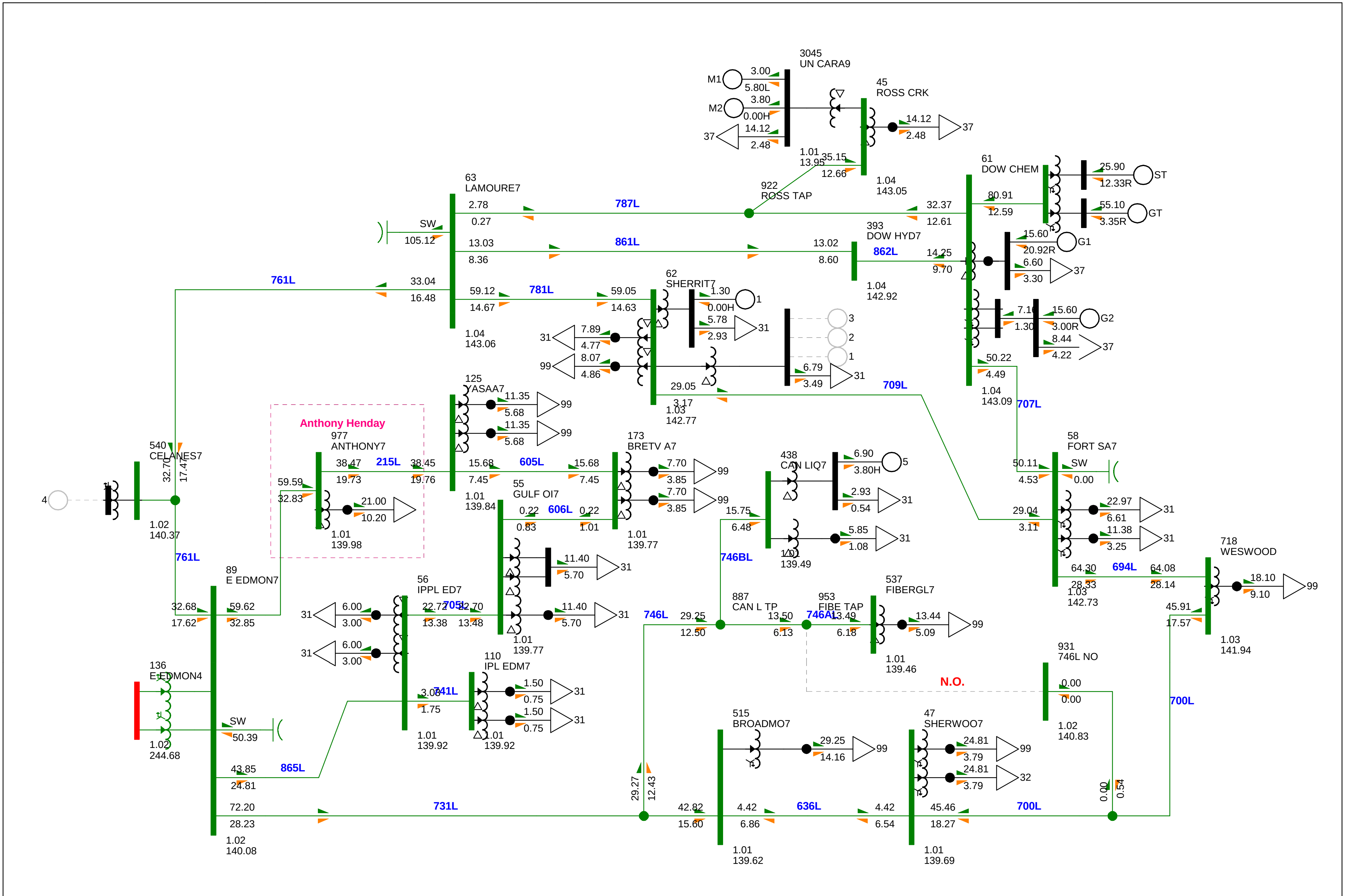


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G1-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2018 WINTER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

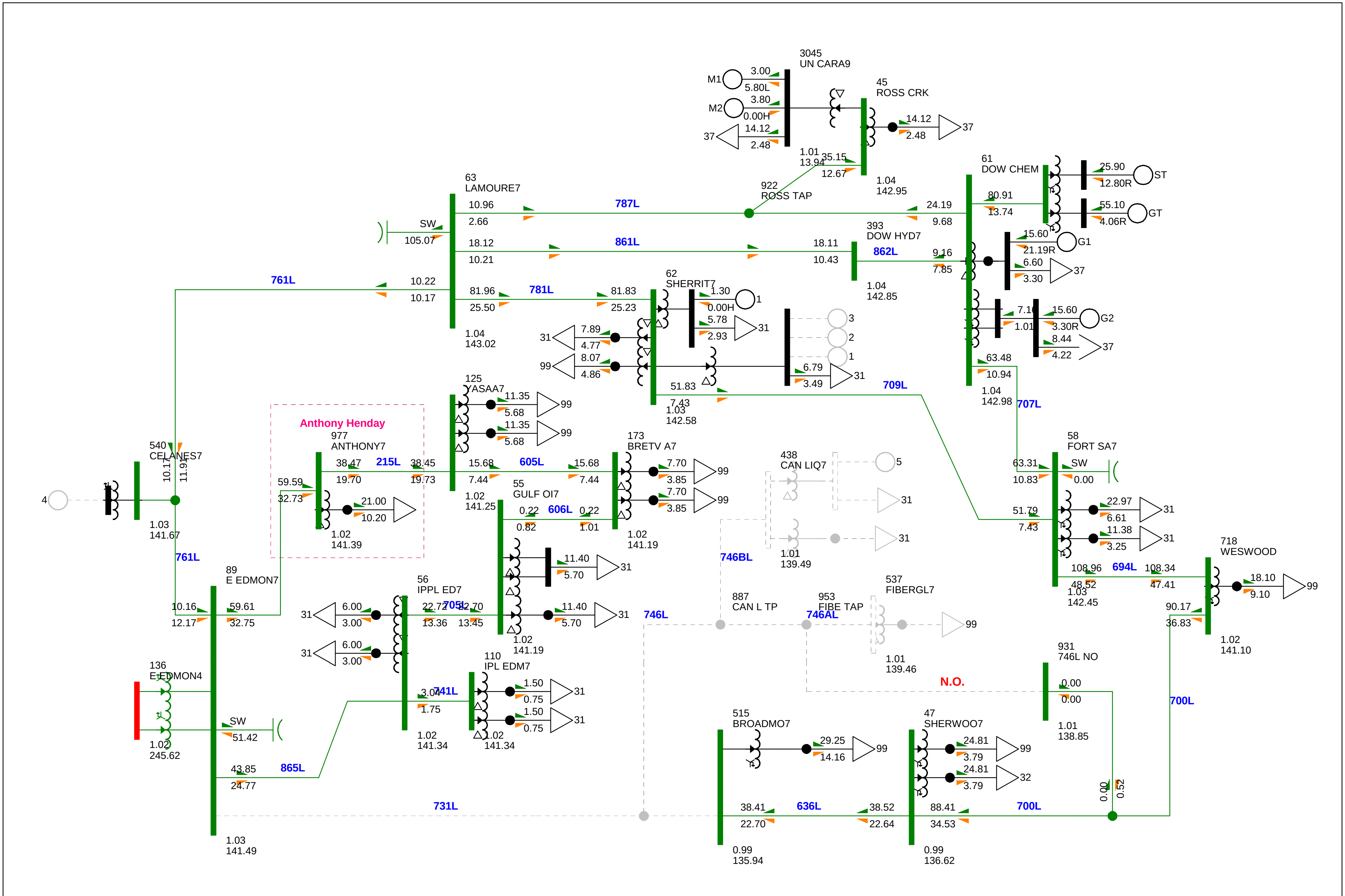


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G2-1-N-0: NORMAL OPERATION
2019 SUMMER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

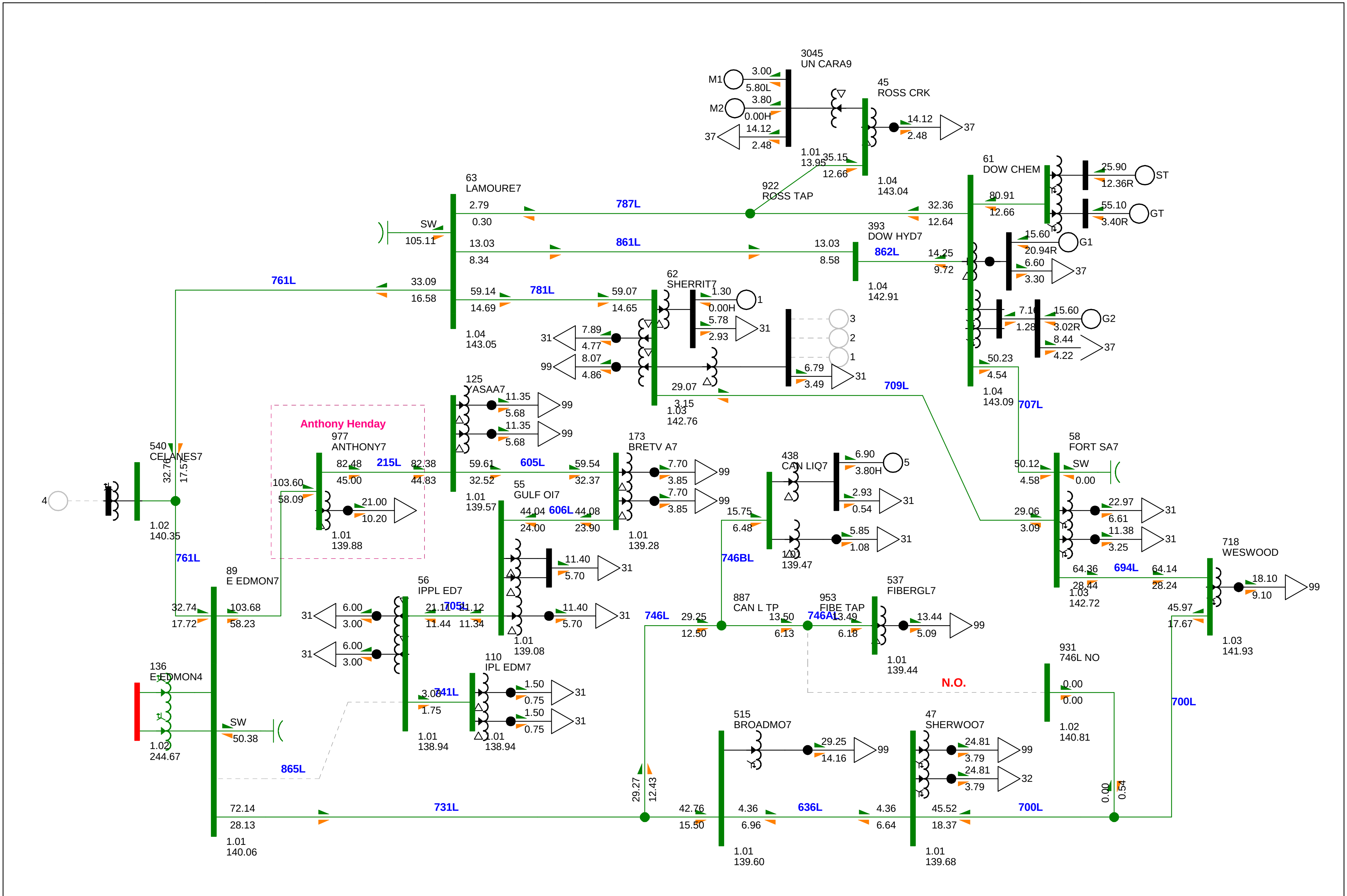


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G2-2 N-1: 731L (EAST EDMONTON 38S TO BROADMOOR 420S)
2019 SUMMER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

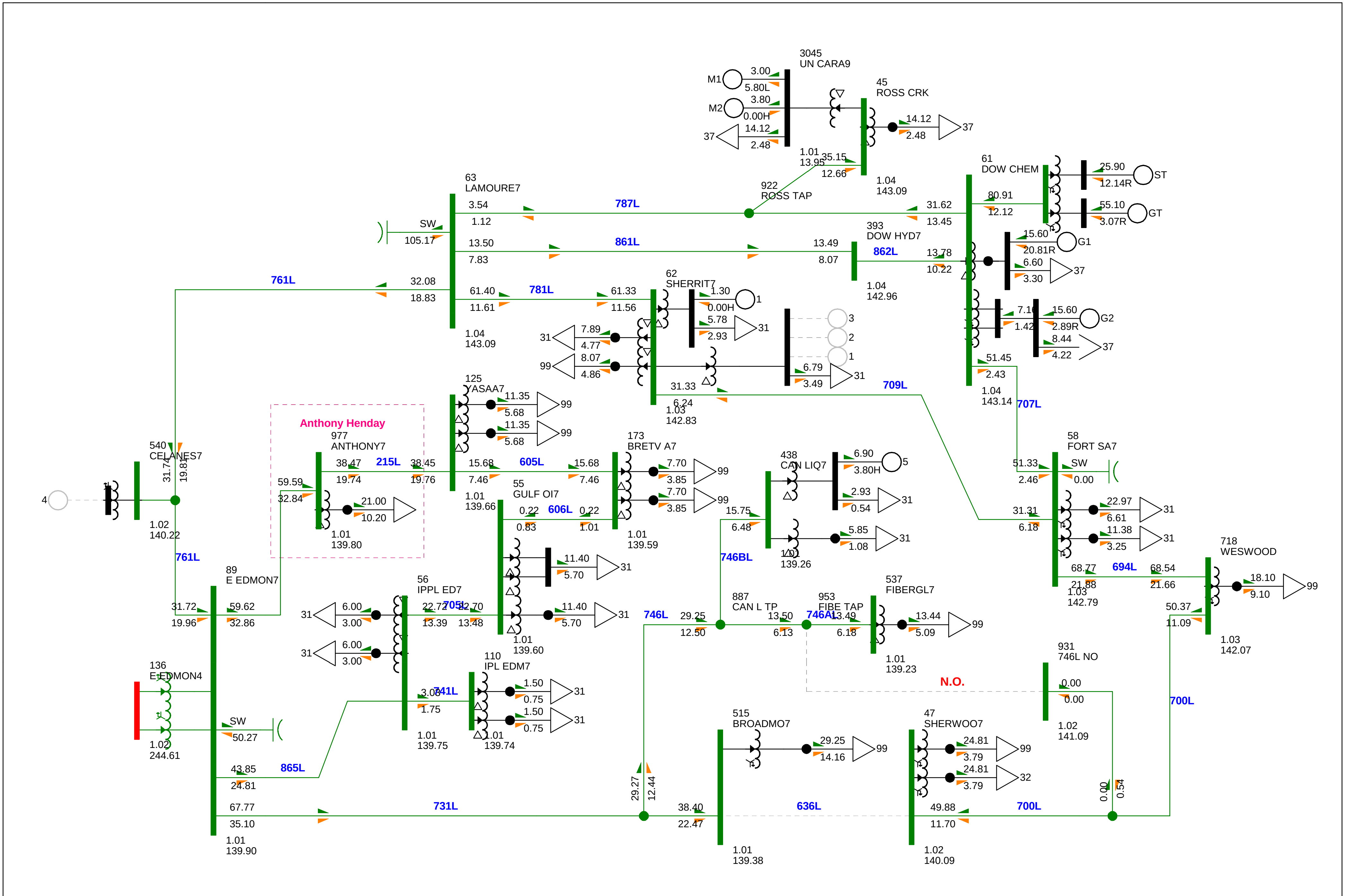


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G2-3 N-1: 865L (EAST EDMONTON 38S TO KNIGHTSBRIDGE 216S)
2019 SUMMER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

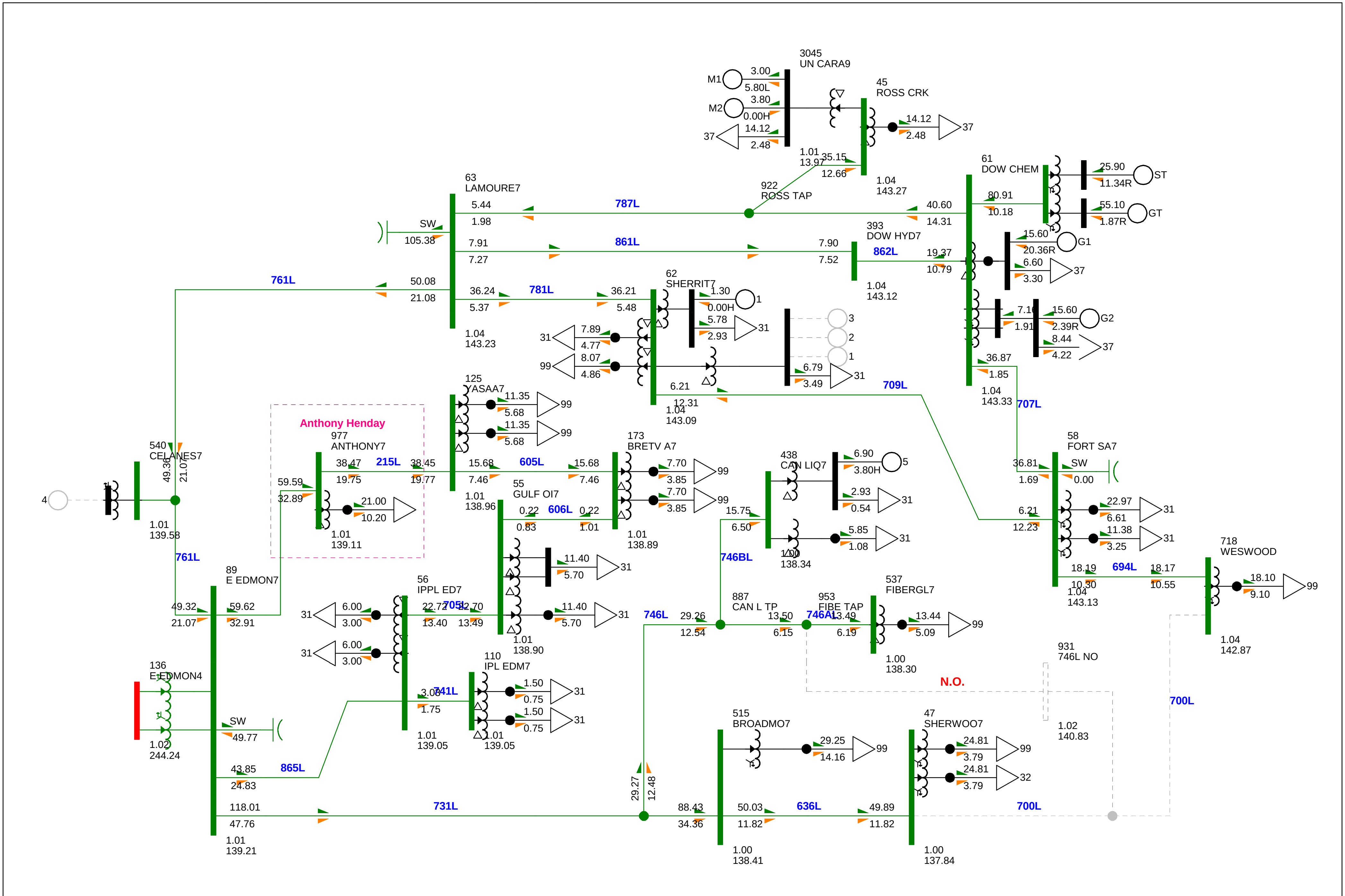


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G2-4 N-1: 636L (BROADMOOR 420S TO SHERWOOD PARK 746S)
2019 SUMMER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

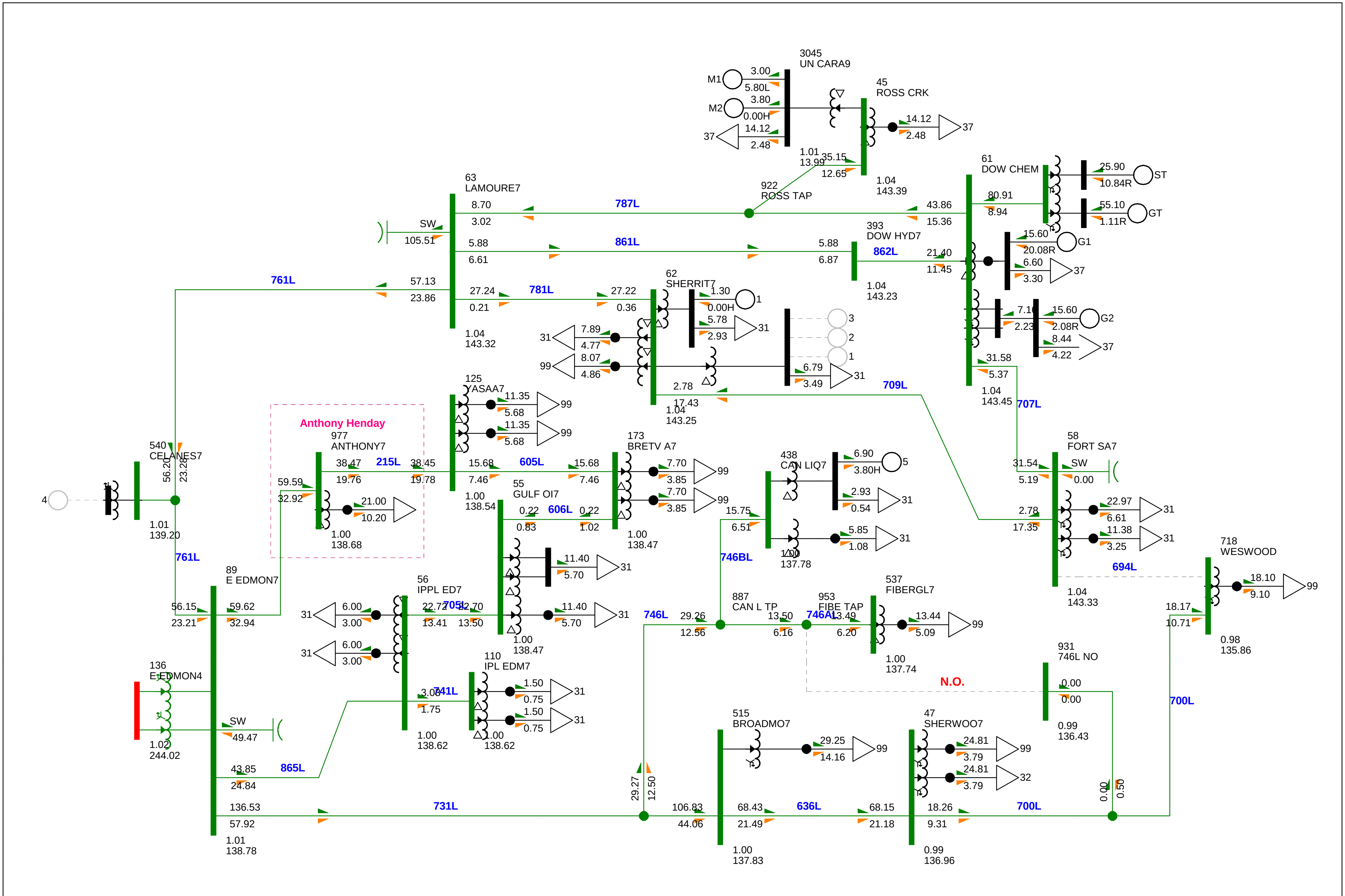


P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G2-5 N-1: 700L (SHERWOOD PARK 746S TO WESTWOOD 422S)
2019 SUMMER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



P1442_Fortis Anthony Henday Sybstation

Sept 2013

FIGURE G2-6 N-1: 694L (WESTWOOD 422S TO FORT SASKATCHEWAN 54S)
2019 SUMMER PEAK (ALT 3)
PRINTED ON FRIDAY 25. NOVEMBER 2016

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.950UV
kV: <=25.000 <=69.000 <=138.000 <=240.000 <=500.000 >500.000