August 22, 2014

Attention: Wade Vienneau
Executive Director – Facilities
Alberta Utilities Commission
Fifth Avenue Place
4th Floor, 425 - 1 Street SW
Calgary, AB T2P 3L8

Dear Mr. Vienneau:

Re: Application to the Alberta Utilities Commission (AUC) for approval of the 138 kV Transmission System Reinforcement in South Calgary – Foothills Area Transmission Development Plan Needs Identification Document

---

Please find enclosed the Alberta Electric System Operator (AESO) application for approval of the Needs Identification Document (NID) for the proposed 138 kV Transmission System Reinforcement in South Calgary – Foothills Area Transmission Development Plan Needs Identification Document pursuant to Section 34 of the *Electric Utilities Act*.

The AESO understands that ENMAX Power Corporation will file the related facilities application shortly. The AESO requests that the Commission combine the NID and the facilities application and consider them together pursuant to Section 15.4 of the Hydro and Electric Energy Act.

Please do not hesitate to contact the below if you have questions or concerns regarding the foregoing:

Melissa Mitchell
Senior Regulatory Coordinator
need.applications@aeso.ca
403-539-2948

Sincerely,



Scott Bias, P. Eng.
Senior Regulatory Specialist, Regulatory

Alberta Utilities Commission

In the Matter of the Need for 138 kV Transmission System Reinforcement in South Calgary – Foothills Area Transmission Development Plan

And in the matter of the *Electric Utilities Act*, S.A. 2003, c. E-5.1, the *Alberta Utilities Commission Act*, S.A. 2007, c. A-37.2, the *Hydro and Electric Energy Act*, R.S.A. 2000, c. H-16, the *Transmission Regulation*, AR 86/2007 and Alberta Utilities Commission Rule 007, all as amended

Application of the Alberta Electric System Operator for Approval of the Needs Identification Document for 138 kV Transmission System Reinforcement in the South Calgary – Foothills Area Transmission Development Plan

PART A - APPLICATION

1 Introduction

1.1 Application – Pursuant to section 34 of the *Electric Utilities Act* (Act), and in accordance with the further provisions included in the legislation set out in the title to this application, the Alberta Electric System Operator (AESO) applies to the Alberta Utilities Commission (Commission) for approval of this *138 kV Transmission System Reinforcement in South Calgary – Foothills Area Transmission Development Plan Needs Identification Document*. For ease of reference, the AESO will refer to this document as the 'Application' and the area addressed by the Application as the 'South Calgary Area'.[1]

1.2 Application Overview – This Application seeks approval of the AESO determined need for 138 kV transmission system reinforcement (the 'Proposed Transmission Developments') – needed in the 2016 timeframe to resolve identified constraints and to contribute to the long-term reliable operation of the 138 kV transmission system in the South Calgary Area.[2,3]

As described in Section 2 below, the AESO's 2009 Long-term Transmission System Plan identified transmission reliability constraints in the South Calgary Area that would arise within the 2014 to 2019 timeframe.[4] In 2011, the AESO established a transmission

[1] In this Application, the South Calgary Area refers to the area encompassing the existing ENMAX No. 65, No. 26, No. 54, No. 41, No. 40, and No. 32 substations.

[2] For information purposes, some of the legislative provisions relating to the AESO's planning duties and duty for forecast need are referenced in note i of Part C of this Application.

[3] Note iii of Part C of this Application describes the Application scope in more detail.

[4] 2009 Long-term Transmission System Plan, Section 4.7.

plan[5], referred to in this Application as the 2011 FATD Plan, which included the Proposed Transmission Developments. In 2012, the AESO undertook two sets of sensitivity studies to supplement the 2011 FATD Plan, which also confirm the Proposed Transmission Developments continue to be needed as originally planned. These sensitivity studies are collectively referred to as the '2012 FATD Sensitivities'.[6] The AESO Long-term Transmission Plan, filed in June 2012 also refers to the need for the transmission developments included in the 2011 FATD Plan.[7] The studies undertaken in support of the AESO's 2013 Long-term Transmission Plan assume the Proposed Transmission Developments are in service.[8]

The Proposed Transmission Developments, described in more detail in Sections 3.1 are a subset of the transmission system developments identified as needed in the 2011 FATD Plan, and confirmed in the 2012 Sensitivity Studies. Substantial components of the AESO's FATD Plan have been approved and are under construction. Previous approvals of the FATD Plan components are found in Commission approvals U2012-500 (East Calgary NID) and U2013-459 (FATD East NID).[9] The Proposed Transmission Developments are incremental to those previously approved in U2012-500 and U2013-459, and there is no duplication or overlap of the Proposed Transmission Developments with these previous approvals. Furthermore, as described in Section 3.4, 2012 FATD Sensitivities in Appendix D indicate that local 138 kV transmission system constraints in the South Calgary Area are alleviated following the implementation of the Proposed Transmission Developments when considered in combination with the developments previously approved under U2012-500 and U2013-459, and that no new constraints

[5] The AESO's 2011 FATD Plan, including supporting transmission planning studies, is described in the 'Foothills Area Transmission Development – Engineering Report', included as Appendix B to this Application.

[6] Included as Appendices C and D respectively.

[7] AESO Long-term Transmission Plan, filed June 2012, Sections 4.4.3.5 and 4.4.3.6.

[8] AESO 2013 Long-term Transmission Plan, Figure 7.3.3-2.

arise in the study period. Therefore, it is appropriate that the Proposed Transmission Developments be considered subsequent to the previously approved applications, and separate from other FATD Plan developments to be applied for at a later date. Appendix A includes a breakdown of the FATD Plan components by application/approval.

The 2011 FATD Plan also identified the need for additional transmission system developments for which the AESO anticipates filing needs identification document applications at a later date. These additional developments may be subject to additional AESO study and planning refinement, and while included as part of the AESO's 2011 FATD Plan, these developments are physically separate from the Proposed Transmission Developments.

1.3 AESO Directions – In the process of determining the need for the Proposed Transmission Developments and preparing this Application, the AESO issued various directions to ENMAX Power Corporation (ENMAX), the legal owner of transmission facilities (TFO) in the area, pursuant to section 39 of the Act and section 14 of the *Transmission Regulation*, including directions to assist the AESO in preparing this Application and, pursuant to section 35 of the Act, directions to file a facility proposal (Facility Proposal) to meet the identified need.[10]

[9] Issued November 1, 2012 and October 28, 2013 respectively.

[10] A Facility Proposal is also referred to as facility application, or FA, under Commission Rule 007.

2 Determination of Need for Transmission System Developments

2.1 AESO Load Forecasts and Generation Assumptions – Pursuant to its responsibilities under section 33 of the Act and section 8 of the *Transmission Regulation*, the AESO has forecast load growth in the Calgary and its adjacent areas. The AESO has also made assumptions regarding the timing and location of future generation sources to be integrated into the transmission system. Since the AESO prepared its 2011 FATD Plan, the AESO has updated its load and generation forecasts. The forecasts used to develop the 2011 FATD Plan were updated in 2012. Subsequently, 2012 FATD Sensitivity Studies were performed, which confirmed the 2011 FATD Plan using the 2012 Long-term Outlook (2012 LTO). While the forecasts used to develop and confirm the FATD Plan included load and generation forecasts for Calgary and rural areas to the south, this Application focuses on the 138 kV transmission system reinforcements in the Calgary area and is relatively unaffected by the load forecasts in the neighboring areas.

The AESO has recently developed its 2014 Long-term Outlook, or 2014 LTO. The forecast summer peak load is 1,709 MW in 2016 (the earliest in-service date for the proposed transmission development) in the Calgary area. This load level is slightly higher than the 2012 LTO forecast for 2014 summer peak load in the Calgary area (1,695 MW was studied in the 2012 FATD Sensitivities).

The AESO is currently forecasting 1,820 MW of summer peak load in the Calgary area by 2019 which is approximately 150 MW, or a 9% increase in load from the recorded 2013 summer peak load. Therefore, the forecast average annual growth rate is 1.5%.[11]

[11] The AESO's load growth forecasts and generation assumptions are derived from its corporate forecasts. The AESO's forecasts used in the 2011 FATD Plan are contained in *Future Demand and Energy Outlook (2009-2029*) and the *2009 AESO Long-Term Transmission System Plan.* Appendix E to this Application contains further information on the AESO's 2009 forecasts and Appendix F includes a summary of the AESO's corporate forecasts referred to as 2012 Long-term Outlook, or 2012 LTO. Appendix G includes a summary of the AESO's more recently developed corporate forecasts referred to as 2014 Long-term Outlook or 2014 LTO. The South Calgary Area is contained within the AESO's Calgary Planning Area.

In addition to forecast load growth, various generation scenarios were considered in the 2011 FATD Plan and 2012 FATD Sensitivity Studies. Both wind and gas-fired generation comprise the existing and forecast generation mix in the South Region and the combined level of actual/forecast generation for the 2014-2019 study period has not materially changed from the 2012 LTO to the 2014 LTO. Specifically, ENMAX's new combined-cycle plant, the Shepard Energy Centre (851 MW), forecast in the 2012 LTO, is being commissioned for commercial operation in early 2015. In addition to Shepard generating station, the AESO continues to forecast additional gas-fired generation additions in the South Region in the order of 500 to 600 MW by 2022. The AESO continues to regularly receive system access service requests for new gas-fired generation connections in the South Region, which are consistent with its generation forecast.

The existing installed wind generation in Alberta is 1,435 MW, which is approximately 190 MW higher than the 2012 LTO forecast for 2014 (1,247 MW was studied in the 2012 FATD Sensitivities). The existing wind capacity in Alberta is forecast to continue to increase by approximately 100 - 580 MW, to a total capacity of approximately 1,550 – 2,000 MW, by 2019.

Therefore, it can be concluded that the combined wind generation forecast for Alberta and gas-fired generation forecast for the area south of Calgary (including south Calgary) has not changed materially in the 2014-2019 planning horizon, from the 2012 LTO to the 2014 LTO.

2.2 Existing Transmission System Adequacy – The AESO has studied the transmission system under forecast loading and under various generation dispatch assumptions and transmission contingencies.[12] Specifically, the AESO's 2012

[12] Transmission contingency is defined in ISO Rules as an event occurring on the Alberta Transmission System resulting in the loss of one or more system elements. Appendix 1 in each one of the Alberta Transmission Planning (TPL) standards explains the contingency conditions through categories of events and their expected performance requirements. AESO Transmission Reliability Criteria is referenced in note ii of Part C of this Application.

Sensitivity Studies isolate the Proposed Transmission Developments by studying the performance of the transmission system following completion of the developments approved in U2012-500 and U2013-459, but without the Proposed Transmission Developments. These studies utilize the AESO's 2012 LTO forecasts, which were the AESO's corporate forecast at the time. The studies clearly demonstrate that with the developments approved in U2012-500 and U2013-459 in service, the existing 138 kV system in the South Calgary area is prone to overloading under certain N-1 contingencies, as early as 2014. In particular, the 2012 FATD Sensitivities indicate that the 138 kV transmission system constraints in the vicinity of the ENMAX No. 65 Substation remain in the South Calgary Area prior to completion of the Proposed Transmission Developments. The 2012 FATD Sensitivities further indicate that these transmission constraints in the South Calgary Area are alleviated following implementation of the Proposed Transmission Developments.[13] Therefore, these studies confirmed that the need and timing for the Proposed Transmission Developments, as originally identified in the FATD Plan, persist under the 2012 LTO forecast. The studies also confirm that load growth is a primary driver of the observed constraints, and that while different generation assumptions studied in the different scenarios have an impact of the severity of these 138 kV system constraints, the constraints nevertheless arise under various forecasted levels of generation and generation scenarios.

As described in Section 2.1, the AESO has recently completed its 2014 LTO forecast cycle. Current Calgary Area summer peak load forecast is 1,709 MW in 2016, which is the earliest possible in-service year for the Proposed Transmission Developments. This forecast load slightly exceeds the forecast load in year 2014 in the 2012 LTO (1,695 MW was studied in the 2012 FATD Sensitivities). Furthermore, there are no material changes to the base forecast generation levels in, and south of Calgary in the near-term, or in the 2014-2019 planning horizon, compared to the 2012 LTO, which were

[13] The constraint on 9.80L from SS-31 to SS-9 will be resolved by the TFO removing existing CT limits, and does not form part of this application.

studied in the 2012 FATD Sensitivities. Therefore, the AESO can confirm that generation forecasts and scenarios studied in the 2012 FATD Sensitivities remain applicable today. Consequently, the AESO can further confirm that there is a need for the Proposed Transmission Developments in order to resolve transmission constraints arising under N-1 contingency conditions in the 2016 timeframe.

3 Proposed Transmission Developments

This section describes the Proposed Transmission Developments included in this Application to meet the need identified in Section 2 above.

3.1 Proposed Transmission System Developments – Figure 1 illustrates the existing transmission system in the South Calgary Area (following completion of the developments approved in U2012-500 and U2013-459). Figure 2 illustrates the transmission system in the South Calgary Area after implementation of the Proposed Transmission Developments.[14] The Proposed Transmission Developments include the following major elements:

1. Build a new 138 kV transmission circuit between the existing ENMAX No. 65 and ENMAX No. 41 substations, with an in-and-out connection to the existing ENMAX No. 54 Substation.[15]

2. Reconfigure the existing 138 kV transmission lines 32.82L and 26.81L to form a direct connection between the existing ENMAX No. 32 and ENMAX No. 26 substations.

3. Modify, alter, add or remove equipment, including switchgear, and any operational, protections, control and telecommunication devices required to undertake the work as planned and ensure reliable integration of the Proposed Transmission Developments with the transmission system.

[14] Details and configuration of equipment required for the Proposed Transmission Development, including substation single line diagrams are more specifically described in the AESO's Functional Specification included in the TFO's transmission facility proposal. Also, further details will be determined as detailed engineering progresses. Routing and/or siting of transmission facilities, including tower design do not form part of this Application and are addressed in the TFO's facility proposal.

[15] Studied transmission circuit ratings have been approximated to the accuracy level required by the AESO for transmission planning purposes. Minimum circuit ratings to be specified by the AESO will be consistent with ratings of those existing circuits to which circuits will be connected. Actual ratings of constructed facilities may vary.

Figure 1: Existing Transmission System in the South Calgary Area

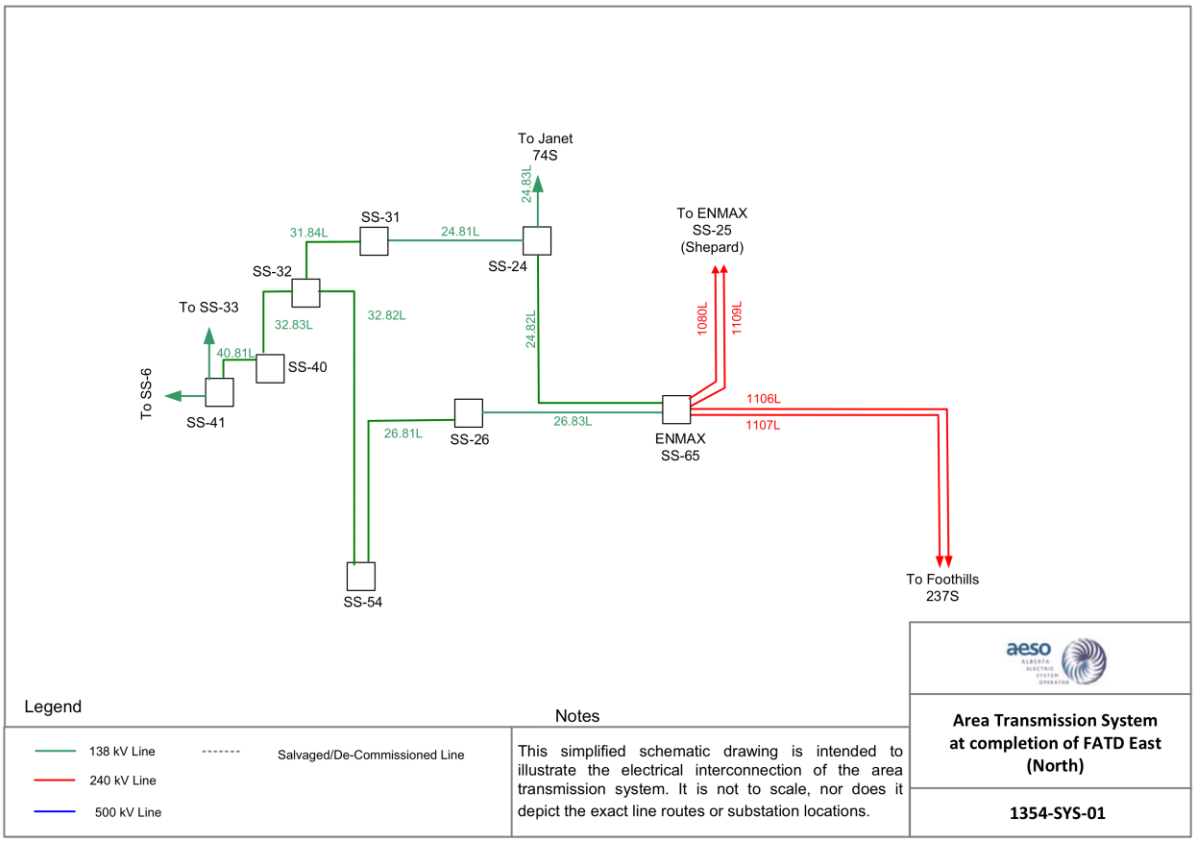
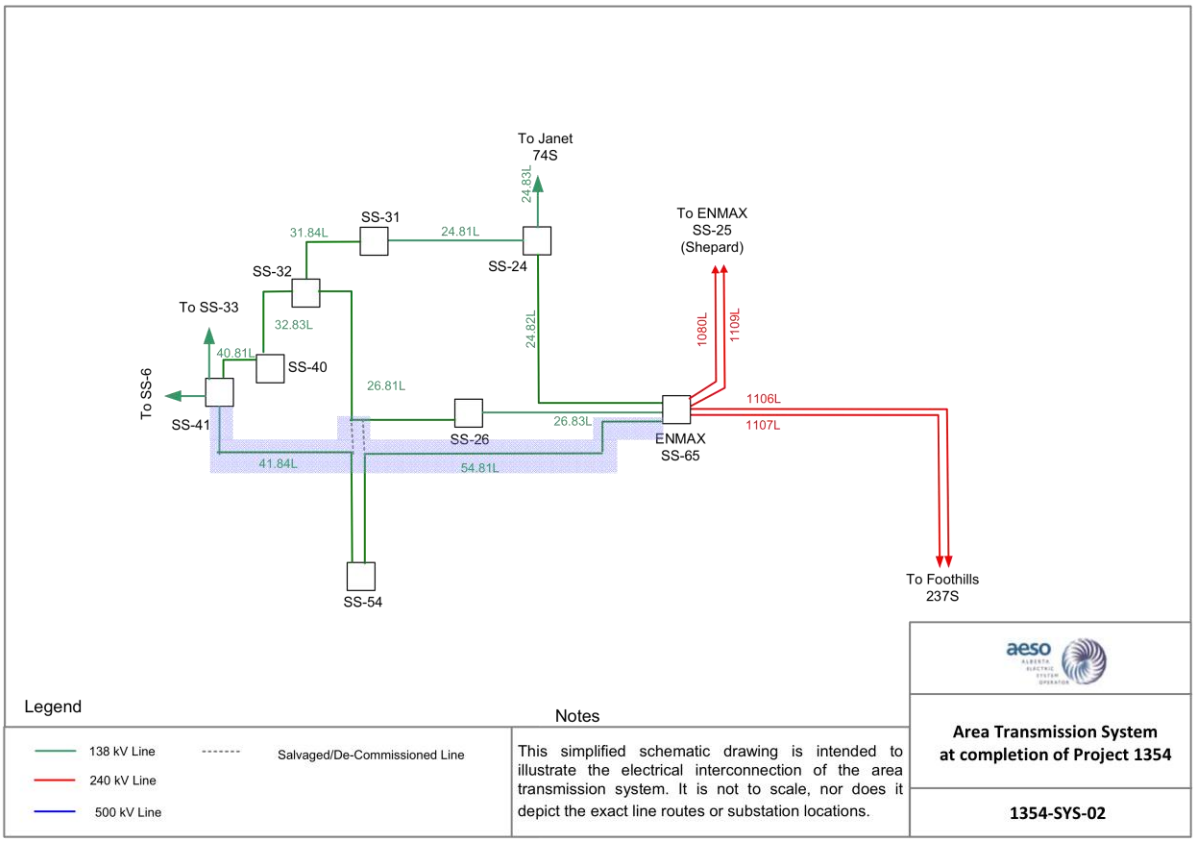


Figure 2: Transmission System in the South Calgary Area Following the Proposed Transmission Developments



3.2 Transmission Development Alternatives – Based on the assessment of the existing transmission system performed to develop the 2011 FATD Plan, the AESO determined that 138 kV transmission developments were required in the South Calgary Area. The AESO employed an incremental approach to identify reliability violations – mainly thermal overloads on the existing transmission lines in the larger FATD area – and determined appropriate transmission developments to address the identified needs by satisfying the performance requirements of the Transmission Planning (TPL) Standards in Alberta under various system conditions (TPL-001-AB-0, TPL-002-AB-0 and specified contingencies associated with TPL-003-AB-0) in the long-term. The AESO's approach to determining transmission developments to meet the need considered the requirement to serve local load in the South Calgary Area during the

construction of any new transmission developments, and maximizing use of the existing transmission system, including reconfiguring the system where possible to minimize new developments. As the circuits exhibiting overloads are already high capacity circuits, rebuilding these circuits to even higher capacity was not considered appropriate and was therefore not studied in detail.

Further, ENMAX No. 65 substation was approved and developed to provide a strong local source of supply for the South Calgary 138 kV transmission system, and to serve the needs of the area for the long term. This substation is currently connected to two existing 138 kV transmission lines with limited capacity. Under certain system conditions, either line will experience significant thermal overload. Therefore, the AESO's Proposed Transmission Developments to meet the identified need utilize the capacity of the ENMAX No. 65 Substation to reinforce service to local load, consistent with its intended purpose. Consequently, the AESO did not study alternatives to the Proposed Transmission Developments in detail.

3.3 Proposed System Development Costs – The total capital cost of the Proposed Transmission Developments to meet the minimum requirements as outlined in the AESO Functional Specification is estimated to be in the order of $22 million (+20%/-10%, $2016).[16] The AESO understands that the TFO's Facility Proposal will include cost estimates totaling $2 million greater, because of the inclusion of incremental costs for expandable steel towers proposed along portions of the TFO's preferred route. The expandable towers exceed the requirements of the Functional Specification issued by the AESO and the AESO has therefore excluded these costs from its Application. There are no market participant related costs associated with these developments.

3.4 Summary of AESO System Study Results – The 2011 FATD Plan alleviates identified system constraints in the study period, including the specific constraints

[16] See Appendix H for details. Also, note iv of Part C of this Application describes the AESO's responsibilities with respect to transmission cost estimates and reporting.

identified on the local 138 kV transmission system in the South Calgary Area. The 2012 FATD Sensitivities isolate the Proposed Transmission Developments from the remainder of the 2011 FATD Plan by assessing system performance prior to and following completion of the Proposed Transmission Developments.[17] As described in Section 2.1, the 2012 FATD Sensitivities identify localized 138 kV transmission system constraints in the vicinity of the ENMAX No. 65 Substation and further indicate that these transmission constraints in the South Calgary Area are alleviated following implementation of the Proposed Transmission Developments. Therefore, the AESO confirms that the results of the 2012 FATD Sensitivities remain applicable under the latest AESO forecasts and that the need for transmission development is consistent with the proposed 2016 in-service date for the Proposed Transmission Developments. The AESO will apply for any remaining developments in the FATD Plan at an appropriate time, following additional planning refinement and review.[18]

3.5 Transmission Development Interdependencies – The 2011 FATD Plan also identified the need for additional 240 kV transmission circuits from the Foothills 237S substation to the Sarcee 42S substation. The Proposed Transmission Developments do not rely on these additional developments to effectively alleviate local 138 kV transmission system constraints in the South Calgary Area within the 2014 to 2019 planning horizon. The remaining components of the FATD Plan may be subject to additional AESO study and planning refinement, and while included as part of the AESO's 2011 FATD Plan to provide overall planning context, the Proposed Transmission Developments will resolve the identified need independent of these additional developments within the FATD Plan.

[17] The FATD-East configuration studied in the 2012 FATD Sensitivities, provided in Appendix D, includes all of the developments previously approved in U2012-500 and U2013-459. The FATD-East + 3rd Circuit configuration adds the Proposed Transmission Development.

[18] 2013 AESO Long-trem Transmission Plan, Table 7.3.3-8 reference to 240 kV transmission line capacity between Foothills and Sarcee, identified as needed in the medium-term planning horizon.

3.6 Planning Uncertainty and Risk of In-Service Date Delays – While the FATD Sensitivity Studies indicate that the Proposed Transmission Developments are needed in 2014, the earliest in-service date is currently anticipated to be Q3, 2016. In-service dates are dependent on a number of variables, including the regulatory process, impact of seasonal construction, and the availability of transmission outages to accommodate construction and commissioning activities.

To mitigate the risk of in-service delays, and as further discussed in Section 4 below, the AESO has chosen to file this Application in combination with the associated TFO's Facility Proposal. It is anticipated that the combined review of this Application and the associated TFO's Facility Proposal will also result in process efficiencies and contribute to the development of required transmission system expansions in a timely manner.

Should operational constraints arise prior to the in-service of the Proposed Transmission Developments it may be necessary for the AESO to impose operational measures in the South Calgary Area until the developments have been completed. Such operational matters are beyond the scope of this Application and will be addressed via operational studies as required

3.7 Participant Involvement Program – The AESO directed the TFO to assist the AESO in conducting a Participant Involvement Program (PIP), in accordance with NID14 and Appendix A of Commission Rule 007. Between February 2014 and August 2014, the TFO and the AESO utilized various methods to notify occupants, residents and landowners of the need for the Proposed Transmission Developments in the area where transmission facilities could be installed to address the identified need. Ten joint AESO-TFO open houses were held between April 1 and April 9, 2014. The AESO believes that all comments and questions regarding the need for the Proposed Transmission Developments have been appropriately addressed. The AESO is not aware of any outstanding concerns regarding the need for the Proposed Transmission Developments. Further information regarding the AESO's PIP for this Application is included at Appendix I.

3.8 Information In Regards to Rule 007, Section 6.1 - NID13 – The AESO has been advised that the TFO's Facility Proposal addresses the 'major aspects' listed in Commission Rule 007, Section 6.1 – NID 13. In consideration of that fact, and as the filing of the Application is combined with the TFO's Facility Proposal, the AESO has not included a separate assessment of the sort contemplated in Commission Rule 007, Section 6.1 – NID13 in this Application.[19]

3.9 Approval is in the Public Interest – Having regard to the following:

- the transmission planning duties of the AESO as described in Sections 29, 33 and 34 of the Act;
- the AESO's Planning studies;
- the AESO's Long Term Outlook;
- information obtained from the AESO PIP Activities; and
- the AESO's long-term transmission system plans;

the AESO has identified and confirmed the need for the Proposed Transmission Developments. As a result of the AESO's consideration of these factors, the AESO submits that approval of this Application is in the public interest.

[19] As per Appendix J of this Application, the AESO has been advised that the TFO's facility proposal will contain information in respect of Commission Rule 007, Section 6.1 – NID13.

4 Request to Combine this Application with Respective Facility Proposals for Consideration in a Single Process

4.1 Pursuant to Subsection 35(1) of the Act, the AESO has directed the TFO to prepare a Facility Proposal to meet the need identified. The AESO understands that the TFO's Facility Proposal will be filed shortly.[20] The AESO requests, and expects the TFO will request, that this Application be combined with the Facility Proposal for consideration by the Commission in a single process. This request is consistent with Section 15.4 of the *Hydro and Electric Energy Act* and Section 6 of Commission Rule 007.

4.2 While it is believed that this Application and the Facility Proposal will be materially consistent, the AESO respectfully requests that in its consideration of both, the Commission be mindful of the fact that the documents have been prepared separately and for different purposes. The purpose of this Application is to obtain approval of the need for the identified transmission system developments and provide a preliminary description of the manner proposed to meet that need. In contrast, the Facility Proposal will contain more detailed engineering and designs for the Proposed Transmission Developments and seek approval for the construction and operation of specific facilities. In this regard, the AESO notes that ENMAX and the AESO's cost estimates for the Proposed Transmission Developments are expected to differ as described previously in Section 3.3.

[20] The AESO understands that the TFO intends to file a Facility Proposal relating to this Application to be titled *Foothills Area Transmission Development – South Calgary*.

5 Relief requested

5.1 Having regard to the factors set out in section 38 of the *Transmission Regulation*, and in particular, subsection 38(d) and (e), the AESO submits that:

a) Its assessment of the need for 138 kV transmission system reinforcement in the South Calgary Area is technically complete;

b) That the assessed need is in the public interest; and

c) The Proposed Transmission Developments meet the assessed need, satisfy Alberta Reliability Standards, and are consistent with the AESO long-term forecasts and transmission system plans.

As such, the AESO also submits that approval of the Application is in the public interest.

5.2 For the reasons set out herein, and pursuant to section 34 of the Act, the AESO requests that the Commission approve this Application, including issuing an approval of the need for 138 kV transmission system reinforcement in the South Calgary Area, and, which shall be comprised of the following transmission developments with a target in-service date of 2016:

1. Add a new 138 kV transmission circuit between the existing ENMAX No. 65 and No. 41 substations, with an in-and-out connection to the existing ENMAX No. 54 substation.

2. Reconfigure the existing 138 kV transmission lines 32.82L and 26.81L to form a direct connection between the existing ENMAX No. 32 and No. 26 substations.

3. Modify, alter, add or remove equipment, including switchgear, and any operational, protections, control and telecommunication devices required to undertake the work as planned and ensure reliable integration of the Proposed Transmission Developments with the transmission system.

All of which is respectfully submitted this 22nd day of August 2014.

Alberta Electric System Operator

Doyle Sullivan, P. Eng.
Director, Regulatory

PART B – APPLICATION APPENDICES

The following appended documents support the Application (Part A). The appendices include work undertaken by the AESO in the execution of its duties to plan the transmission system and in the preparation of this Application.

APPENDIX A **FATD Plan Components by NID Application –** Appendix A contains a list of the transmission components of the FATD Plan relative to the previous NID approvals or NID application.

APPENDIX B **AESO 2011 FATD Planning Studies –** Appendix B contains the AESO 2011 *Foothills Area Transmission Development Engineering Report,* or 2011 FATD Plan, which describes the need for transmission system expansion in south Calgary and the High River Planning Area. By way of presenting relevant transmission planning studies undertaken to simulate the future performance of the system under forecasted loading and generation levels and various contingencies, the AESO identified the elements of the system that are subject to reliability violations. The 2011 FATD Plan describes the process used to determine the Proposed Transmission Developments that will alleviate the identified constraints. The FATD Plan also describes in detail, the study scope and study limitations and for reference, includes the AESO's planning assumptions and planned future transmission system developments in planning horizon.

APPENDIX C **AESO 2012 Supplement to 2011 Planning Studies – 69 kV Upgrade Sensitivity –** Appendix C contains a copy of the AESO planning study report entitled *Foothills Area Transmission Development – Supplementary Report: South Calgary 69kV Transmission System Sensitivity Studies*. The report documents sensitivity studies undertaken by the AESO to confirm that amendments to the AESO's South Calgary 69 kV Transmission System Upgrade Needs Identification Document, subsequently approved by the Commission in U2012-343, do not change the need for, or configuration of, the 2011 FATD Plan.

APPENDIX D **AESO 2012 Supplement to 2011 Planning Studies – Confirmation of Need –** Appendix D contains a copy of the AESO report entitled *Foothills Area Transmission Development – Supplementary Report; 2012 Long Term Outlook and HVDC Dispatch Sensitivity Studies*. The report documents sensitivity studies performed by the AESO to determine whether consideration of 2012 Long Term Outlook, the AESO's 2012 corporate forecasts, or a wider range of HVDC dispatch assumptions would affect the conclusions reached in the 2011 FATD Plan.

APPENDIX E **AESO Load and Generation Forecast –** Appendix E contains the AESO's *Foothills Area Transmission Development – Load and Generation Forecast* used in the 2011 FATD Plan contained in Appendix B and sensitivity studies included in Appendix C.

APPENDIX F **AESO 2012 Supplement to Load and Generation Forecast –** Appendix F contains details of the 2012 Long Term Outlook (2012 LTO) used in the 2012 Supplemental Planning studies contained in Appendix D. Also included is a comparison of 2012 LTO forecast to the forecast provided in Appendix E.

APPENDIX G **AESO 2014 Long-term Outlook –** Appendix G contains details of the 2014 Long-term Outlook (2014 LTO), including comparison to the 2012 LTO contained in Appendix F.

APPENDIX H **TFO Capital Cost Estimates –** Appendix H contains the TFO-prepared capital cost estimates referred to in this Application. The estimates have been prepared by the TFO according to the AESO direction. The AESO has modified the estimates to include an additional line item for the incremental costs of the expandable towers proposed by ENMAX. The AESO has revised the estimate total cost accordingly to correspond with the estimates discussed in Section 3.3 of this Application. The estimates are prepared to an approximate accuracy level of (+20%/-10%), which exceeds the accuracy requirement of Commission Rule 007, NID11.

APPENDIX I **AESO PIP –** Appendix I provides a summary of the PIP activities conducted regarding the need for the Proposed Transmission Developments described in this Application. The AESO and TFO coordinated various PIP activities as activities undertaken in preparation of the Application were combined with the Facility Proposal application. Copies of the relevant materials distributed during the PIP are included.

APPENDIX J **TFO confirmation that Commission Rule 007 NID 13 aspects are being addressed in TFO Facility Proposal** – Appendix J contains a letter provided by the TFO confirming that the seven major aspects of Commission Rule 007, NID 13 are addressed throughout their facility proposal.

APPENDIX K **AESO Transmission Planning Criteria – Basis and Assumptions** – Recently the AESO has revised the Transmission Reliability Criteria, Part II System Planning, Version 0, dated March 11, 2005 to mainly remove all criteria that are now included in the Transmission Planning (TPL) Standards[21]. Appendix K contains the Transmission Planning Criteria – Basis and Assumptions, Version 1, which includes the applicable thermal and voltage limits in support of the TPL standards. Planning studies that are included in this Application meet all the performance requirements of the specified TPL Standards (TPL-001-AB-0, TPL-002-AB-0 and specified contingencies associated with TPL-003-AB-0).

[21] TPL Standards are included in the current Alberta Reliability Standards.

PART C – REFERENCES

i. **AESO Planning Duties and Responsibilities and Duty to Forecast Need –** Certain aspects of the AESO's duties and responsibilities with respect to planning the transmission system are described in the Act. For example, section 17, subsections (g), (h), (i), and (j), states the general planning duties of the AESO[22]. Section 33 of the Act states that the AESO "must forecast the needs of Alberta and develop plans for the transmission system to provide efficient, reliable, and non-discriminatory system access service and the timely implementation of required transmission system expansions and enhancements". As stated in subsection 34(1) of the Act, when the AESO determines that an expansion or enhancement of the capability of the transmission system is or may be required to meet to the needs of Alberta and is in the public interest, the AESO must prepare and submit to the Commission for approval a needs identification document that describes the constraint or condition affecting the operation or performance of the system and indicates the means by which or the manner in which the constraint or condition could be alleviated. Where, as in this case, the AESO has identified a need to reinforce the transmission system to relieve anticipated reliability criteria violations, it has set about to determine a reasonable solution to meet the identified need. In determining the means by which, or the manner in which, the constraint or condition affecting the operation or performance of the transmission system could be alleviated, the AESO has applied engineering judgments and made assumptions as necessary; such judgments and assumptions being required and permitted by its prescribed responsibilities and authorities under the Act. In accordance with section 11 of the *Transmission Regulation*, the AESO has considered technical, economic, environmental and other factors as necessary in determining its preferred option for system expansion.

ii. **AESO Planning Criteria** – The AESO is required to plan a transmission system that satisfies applicable reliability standards. Transmission Planning (TPL) standards are included in the Alberta Reliability Standards and are described at:
http://www.aeso.ca/rulesprocedures/17006.html[23]

[22] The legislation and regulations refer to the Independent System Operator or ISO. "AESO" and "Alberta Electric System Operator" are the registered trade names of the Independent System Operator.

[23] This link is provided for ease of reference and does not form part of this Application.

iii. **Application for Approval of the Need for Expansion or Enhancement of the Capability of the Transmission System –** This Application is directed solely to the question of the need for expansion or enhancement of the capability of the transmission system as more fully described in the Act and the Transmission Regulation. This Application does not seek approval of those aspects of transmission development that are managed and executed separately from the needs identification document approval process. Other aspects of the AESO's responsibilities regarding transmission development are managed under the appropriate processes, including the ISO Rules, Alberta Reliability Standards and the ISO Tariff, which are also subject to specific regulatory approvals. While the Application or its supporting appendices may refer to such other processes or information from time to time, the inclusion of such information is for context and reference only**.**

Furthermore, this Application is directed solely to the question of the need for expansion or enhancement of the capability of the transmission system. Any reference within the Application to market participants or other parties and/or the facilities they may own and operate or may wish to own and operate is not intended to constitute an application for approval of such facilities, and the responsibility for seeking such regulatory or other approval remains the responsibility of such market participants or other parties.

iv. **Capital Cost Estimates** – Capital costs estimates provided in the Application are used by the AESO for the sole purpose of comparing transmission development alternatives. Where only a single transmission development alternative has been studied, capital cost estimates are provided for context. Project costs will be determined by the TFO as part of its facilty proposal. The AESO's responsibilities with respect to project cost reporting are described in the *Transmission Regulation*, including section 25, and AESO Rule 9.1.

APPENDIX A FATD PLAN COMPONENTS BY NID APPLICATION

SUMMARY OF FOOTHILLS AREA TRANSMISSION DEVELOPMENTS

For reference, Table 8-1 from the 2011 FATD Plan has been reproduced here.[1] Four columns have been added. The first column indicates the transmission system developments that have been previously approved in U2012-500. The second column indicates the transmission system developments that have been approved in U2013-459. The third column addresses the Proposed Transmission Developments included in the FATD-South Calgary NID. The fourth column addresses transmission developments to be applied for by the AESO at a later date.

2011 FATD Plan – Scope Summary

Description of the Required Developments	Scope approved in U2012-500	Scope approved in U2013-459	Scope of FATD South Calgary NID	Scope to be included in subsequent NID filings
A new 240 kV double circuit line from Langdon 102S to Janet 74S with a minimum summer rating of 800 MVA for each circuit. The lines are designated 1064L and 1065L.	No	Yes	--	--
A 240 kV double circuit line from Langdon 102S to East Calgary 5S. This path will be created using the existing lines (936L, 937L, 917, 23.80L, and 2.80L). As per the TFO's data submission, the summer rating of each circuit is 489 MVA. The lines are designated 936L and 937L.	Partial	Development completed by U2013-459.	--	--
Replace the existing 240/138 kV 336 MVA transformer at East Calgary 5S substation with two new 400 MVA transformers.	Yes	--	--	--
A new 240 kV substation designated Foothills 237S that includes two new 240/138 kV transformers, each with a minimum rating of 400 MVA.	No	Yes	--	modifications for new line terminations
A new 240 kV double circuit line from Foothills 237S substation to ENMAX No. 65 substation with a minimum summer rating of 600 MVA for each circuit. The lines will be designated 1106L and 1107L.	No	Yes	--	--

[1] Development descriptions provided in Table 8-1 and the descriptions of the Proposed Transmission Developments included in this document or the FATD South Calgary NID are materially consistent. Any variances between Table 8-1 prepared in 2011 and this recently prepared material are the result of simplifications made for readability and presentation purposes.

Description of the Required Developments	Scope approved in U2012-500	Scope approved in U2013-459	Scope of FATD South Calgary NID	Scope to be included in subsequent NID filings
A 240 kV double circuit line from ENMAX No. 65 substation to ENMAX No. 25 substation. This path will be created using sections of the existing lines (911L, and 850L energized at 240 kV). As per the TFO's data submission, the summer rating of each circuit is 489 MVA. The lines are designated 1080L and 1109L.	Partial	Development completed with U2013-459	--	--
A new 240 kV double circuit line from ENMAX No. 25 substation to Janet 74S substation with a minimum summer rating of 920 MVA for each circuit. The lines are designated 985L and 1003L.	Partial	Development completed with U2013-459	--	--
A new 240 kV double circuit line from Foothills 237S to Sarcee 42S with a minimum summer rating of 600 MVA for each circuit. The lines are designated 1066L and 1067L.	No	No	--	Yes
A new 138 kV single circuit line from Janet 74S substation to ENMAX No. 23 substation with a minimum summer rating of 260 MVA. The line is designated 23.80L.	Yes	No	--	--
A new 138 kV single circuit line from ENMAX No. 2 substation to ENMAX No. 23 substation with a minimum rating of 260 MVA. The line is designated 2.80L.	Yes	No	--	--
A new 138 kV single circuit line from ENMAX No. 65 to ENMAX No. 41 with in and out connection at ENMAX No. 54 substation. The minimum rating of this new line is 260 MVA. The line is designated 54.81L from ENMAX No. 65 to ENMAX No. 54 substation and 41.84L from ENMAX No. 54 to ENMAX No. 41 substation.	No	No	Yes	--
A new 138 kV single circuit line from Foothills 237S to Okotoks 678S with a minimum summer rating of 260 MVA. The line is designated 646L. *	No	Yes	--	--
A new 138 kV single circuit line from Foothills 237S to High River 65S with a minimum summer rating of 260 MVA. The line is designated 434L.*	No	Yes	--	--
A 138 kV single circuit line from Okotoks 678S to Carseland 525S. This path will be created using sections of the existing 138 kV lines 727L and 850L.* As per the TFO's data submission the summer rating of the line is 89 MVA. The line is designated 850L.	No	Yes	--	--

Description of the Required Developments	Scope approved in U2012-500	Scope approved in U2013-459	Scope of FATD South Calgary NID	Scope to be included in subsequent NID filings
De-energize sections of the 911L line from Janet 74S to ENMAX No. 25 substation and from south of ENMAX No. 65 substation to Foothills 237S.*	Partial	De-energize Completed with U2013-459	--	--
De-energize sections of the 727L line from Janet 74S to where 850L turns east toward Carseland.*	No	Yes	--	--
De-energize sections of the 850L line from Janet 74S substation to ENMAX No. 25 substation.	No	Yes	--	--

* The existing 911L in the High River Planning Area will be discontinued from transmission use upon completion of the SATR project. Therefore, the potential to utilize sections of this line exists to create the required 646L or 434L or the circuit from Okotoks 678S to Carseland 525S, where suitable. 911L will then be re-energized at 138 kV.

APPENDIX B AESO 2011 FATD PLANNING STUDIES

Foothills Area Transmission Development

Engineering Report

File No. RP-05-736

R1

April 29, 2011

	Name	Signature	Date
Prepared/ Reviewed	Steve Heidt, P.Eng.		April 27, 2011
Approved	Steve Kanerva, P.Eng.		April 28, 2011

APEGGA Permit to Practice P-8200

PROFESSIONAL ENGINEER ALBERTA STEPHEN HEIDT

April 27/2011

The following engineers have contributed to the preparation and reviewing of the Foothills Area Transmission Development Engineering Report:

	Name	Signature	Date
Prepared/ Reviewed	Aaron Krush, P.Eng.		2011-04-28
Prepared/ Reviewed	Dawn Chen, E.I.T.		2011-04-28
Prepared/ Reviewed	Ebrahim Rahimi, P.Eng.	E. Rahimi	2011-04-28
Prepared/ Reviewed	Isabel Pana, P.Eng.		2011-04-28
Prepared/ Reviewed	Niraj Kshatriya, P.Eng. (member of PEO)		2011-04-28

EXECUTIVE SUMMARY

The Foothills Area Transmission Development is a plan proposed to resolve transmission system constraints in south Calgary and the High River planning area (Area 46). The electrical system in this area will not have sufficient capacity to supply steady load growth, connect projected generation to the system, and enable the transmission of power from southern Alberta without a number of system developments.

This engineering report presents the system analyses conducted to ensure there is a reliable transmission system in south Calgary and the High River planning area. It discusses the results of these analyses in detail and provides recommendations for system developments that will ensure electrical system performance in the area will meet the AESO Transmission Reliability Criteria.

Historically, the Calgary area load has been supplied primarily by the 240 kV transmission system between Edmonton and Calgary. Calgary area load has also been supplied, to a lesser extent, by imports from British Columbia when dispatched and generation supply in southern Alberta.

Recently, a significant number of wind power facilities have been proposed for connection in southern Alberta. The Southern Alberta Transmission Reinforcement project enables connection of the wind power facilities to the southern Alberta transmission system, as detailed in its NID application. The project was approved by the Alberta Utilities Commission (AUC) in Q3, 2009. The Foothills Area Transmission Development proposes to facilitate the transmission of power generated in southern Alberta to the load centres in Calgary and the surrounding area.

The AESO has also received applications to connect approximately 1,300 MW of gas-fired generation in the study area. The 240 kV and 138 kV transmission lines in the study area are approaching their maximum thermal loading limits due to the annual load growth. The existing transmission system capacity creates significant constraints on the output power of the proposed local generators connecting to the grid.

The need assessment studies have identified transmission system constraints in the study area and demonstrated the need for developments in Q2, 2014 to alleviate the identified constraints and to ensure system performance is compliant with the AESO Transmission Reliability Criteria. The study results confirm severe thermal overloads on the 240 kV and 138 kV transmission elements in the area as well as voltage violations. According to the need assessment studies, a number of transmission system developments will be needed:

- 240 kV connections between Langdon 102S substation, Janet 74S substation, and East Calgary 5S substation
- 240 kV connections between Janet 74S substation and the new Foothills 237S substation
- 138 kV transmission system around ENMAX No. 65 substation
- 138 kV transmission lines supplying the electrical demand in the High River planning area

The AESO recommends the proposed Foothills Area Transmission Development plan to resolve the identified system constraints in the study area. The Foothills Area Transmission Development plan is required to be in service in Q2, 2014 to ensure system reliability.

A detailed list of the proposed transmission system developments is provided below.

FATD Scope Summary

Description of the Required Developments
A new 240 kV double circuit line from Langdon 102S to Janet 74S with a minimum summer rating of 800 MVA for each circuit. The lines are designated 1064L and 1065L.
A 240 kV double circuit line from Langdon 102S to East Calgary 5S. This path will be created using the existing lines (936L, 937L, 917, 23.80L, and 2.80L). As per the TFO's data submission, the summer rating of each circuit is 489 MVA. The lines are designated 936L and 937L.
Replace the existing 240/138 kV 336 MVA transformer at East Calgary 5S substation with two new 400 MVA transformers.
A new 240 kV substation designated Foothills 237S that includes two new 240/138 kV transformers, each with a minimum rating of 400 MVA.
A new 240 kV double circuit line from Foothills 237S substation to ENMAX No. 65 substation with a minimum summer rating of 600 MVA for each circuit. The lines will be designated 1106L and 1107L.
A 240 kV double circuit line from ENMAX No. 65 substation to ENMAX No. 25 substation. This path will be created using sections of the existing lines (911L, 850L energized at 240 kV). As per the TFO's data submission, the summer rating of each circuit is 489 MVA. The lines are designated 1080L and 1109L.
A new 240 kV double circuit line from ENMAX No. 25 substation to Janet 74S substation with a minimum summer rating of 920 MVA for each circuit. The lines are designated 985L and 1003L.
A new 240 kV double circuit line from Foothills 237S to Sarcee 42S with a minimum summer rating of 600 MVA for each circuit. The lines are designated 1066L and 1067L.
A new 138 kV single circuit line from Janet 74S substation to ENMAX No. 23 substation with a minimum summer rating of 260 MVA. The line is designated 23.80L.
A new 138 kV single circuit line from ENMAX No. 2 substation to ENMAX No. 23 substation with a minimum rating of 260 MVA. The line is designated 2.80L.
A new 138 kV single circuit line from ENMAX No. 65 to ENMAX No. 41 with in and out connection at ENMAX No. 54 substation. The minimum rating of this new line is 260 MVA. The line is designated 54.81L from ENMAX No. 65 to ENMAX No. 54 substation and 41.84L from ENMAX No. 54 to ENMAX No. 41 substation[2].
A new 138 kV single circuit line from Foothills 237S to Okotoks 678S with a minimum summer rating of 260 MVA. The line is designated 646L[1].
A new 138 kV single circuit line from Foothills 237S to High River 65S with a minimum summer rating of 260 MVA. The line is designated 434L[1].
A 138 kV single circuit line from Okotoks 678S to Carseland 525S. This path will be created using sections of the existing 138 kV lines 727L and 850L. As per the TFO's data submission the summer rating of the line is 89 MVA. The line is designated 850L.
De-energize sections of the 911L line from Janet 74S to ENMAX No. 25 substation and from south of ENMAX No. 65 substation to Foothills 237S[1].
De-energize sections of the 727L line from Janet 74S to where 850L turns east toward Carseland.
De-energize sections of the 850L line from Janet 74S substation to ENMAX No. 25 substation.

[1] The existing 911L in the High River planning area will be de-energized upon completion of the SATR project. Therefore, there is the potential to utilize sections of this line where suitable to create the required 646L or 434L. 911L will then be re-energized at 138 kV.

[2] FATD proposes to restore the current connectivity between ENMAX No. 26 and ENMAX No. 32 substation through 26.81L. The ENMAX No. 54 substation will be initially connected in and out to 26.81L in ENMAX No. 54 connection project, i.e. 26.81L (ENMAX No. 26 to ENMAX No. 54) and 32.82L (ENMAX No. 54 to ENMAX No. 32).

TABLE OF CONTENTS

EXECUTIVE SUMMARY 3
1. INTRODUCTION 8
1.1 Study Scope 10
2. CRITERIA, SYSTEM DATA, AND STUDY ASSUMPTIONS 13
2.1 AESO Transmission Reliability Criteria 13
2.2 Load and Generation Assumptions 14
2.2.1 Load Assumptions 14
2.2.2 Generation Assumptions 14
2.3 System Projects 14
2.3.1 South Calgary 69 kV Conversion and Calgary Downtown Cable Replacement Projects 15
2.3.2 Southern Alberta Transmission Reinforcement (SATR) Project 16
2.3.3 Critical Transmission Infrastructure (CTI) Projects 17
2.3.4 Hanna Region Transmission Development Project 17
2.4 Customer Connection Projects in the Study Area 17
2.5 Facility Ratings and Shunt Elements 18
2.6 Dynamic Data and Assumptions 20
2.7 Protection Fault Clearing Time 20
2.8 Voltage Profile Assumptions 20
2.9 Applicable Operating Policies and Procedures 20
3. STUDY METHODOLOGY 22
3.1 Study Cases 22
3.1.1 Scenarios 24
3.2 Power Flow Analysis 26
3.3 Voltage Stability (PV) Analysis 26
3.4 Short-Circuit Analysis 27
3.5 Transient Stability Analysis 27
4. EXISTING SYSTEM ASSESSMENT 28
4.1 Power Flow Analysis 30
4.1.1 Scenario 1 31
4.1.2 Scenario 2 32
4.1.3 Scenario 3 34
4.1.4 Scenario 4 37
4.1.5 Scenario 5 41
4.1.6 Scenario 6 42
4.2 Existing System Analysis for All Scenarios – Near Term (2014) 44
4.3 Existing System Analysis for All Scenarios – Long Term (2019) 46
4.4 Summary and Conclusions of the Need Assessment Studies 48
5. SYSTEM DEVELOPMENTS TO ADDRESS THE NEED 50
5.1 Transmission Technologies 50
5.2 Methodology to Plan a Transmission Alternative 51
5.3 Step 1: Reinforcement of the 240 kV Transmission Path from Langdon 102S to Janet 74S to East Calgary 5S 52
5.4 Step 2: Reinforcement of the 240 kV Transmission Path from Janet 74S to Foothills 237S 53
5.5 Step 3: 138 kV Development in the High River Planning Area 57
5.6 Step 4: Creation of a Second Path between Foothills and Calgary 60
5.7 Summary and Conclusions 61
6. TRANSMISSION DEVELOPMENT PLAN – NEAR-TERM ASSESSMENT 63
6.1 Study Assumptions and Methodology 63
6.2 Impact of Each Step of the Transmission Plan in 2014 – Branch Loading 64

6.3 Impact of each Step of the Transmission Plan in 2014 – Voltage Considerations 66
6.4 Summary and Conclusion 67
7. TRANSMISSION DEVELOPMENT PLAN – LONG-TERM ASSESSMENT 68
7.1 Study Assumptions and Methodology 68
7.2 Impact of each Step of the Transmission Plan in 2019 68
7.3 Summary and Conclusion 71
8. RECOMMENDED TRANSMISSION DEVELOPMENT 72
8.1 Voltage Stability (PV) Analysis 75
8.2 Dynamic Stability Analysis 76
8.3 Shepard Connection Impact 76
8.4 Short-Circuit Analysis 76
8.5 Updated Generation Forecast 79
8.6 Summary and Conclusion 81
9. PROJECT INTERDEPENDANCIES 82
10. SUMMARY AND CONCLUSIONS 85

List of Figures

Figure 1-1: Study Area for the FATD Plan 11
Figure 1-2: Simplified South Calgary and the High River Planning Area Transmission System 12
Figure 4-1: Existing System in the Study Area in 2014 – Simplified System Configuration 29
Figure 5-1: Existing 240 kV Transmission Path Langdon 102S to Janet 74S to East Calgary 5S 52
Figure 5-2: Step 1 - 240 kV Path Langdon 102S to Janet 74S to East Calgary 5S 53
Figure 5-3: Simplified System Configuration after Step 1 55
Figure 5-4: Simplified System Configuration after Step 2 56
Figure 5-5: Existing System High River Planning Area (Area 46) in 2014 57
Figure 5-6: Diagrams of 138 kV Transmission Alternatives in the High River Planning Area 59
Figure 5-7: 138 kV Transmission Lines in High River Area after Connecting 727L and 850L (Alternatives 1 to 3 are presented in the above figure) 59
Figure 5-8: Step 4 of Developing the FATD Plan 61
Figure 8-1: Proposed Foothills Area Transmission Development 73

List of Tables

Table 2-1: Specific Area Load Forecast 14
Table 2-2: Summary of System Projects Included in the FATD Studies 15
Table 2-3: Customer Connection Projects in the Study Area 18
Table 2-4: Facility Ratings in the Study Area and Vicinity – Key 240 kV Transmission Lines 18
Table 2-5: Summer/Winter Ratings for each Section of 911L 18
Table 2-6: Facility Ratings in the Study Area and Vicinity – Key 138 kV Transmission Lines 19
Table 2-7: Facility Ratings in the Study Area and Vicinity – Key Transformers 19
Table 2-8: Capacitor Banks in the Study Area 19
Table 2-9: Assumptions for Clearing Times of Facilities 20
Table 3-1: Local Area Generators in the Study Case(s) 23
Table 3-2: Study Cases and Considered Scenarios 26
Table 4-1: Study Scenarios 30
Table 4-2: Voltage Collapse (VC) in 2019 (prior to any transmission developments) 31
Table 4-3: Scenario 1, Study Results 32
Table 4-4: Scenario 2, Study Results 33
Table 4-5: Scenario 3, Study Results 36
Table 4-6: Scenario 4, Study Results 38

Table 4-7: Scenario 5, Study Results 42
Table 4-8: Scenario 6, Contingency Analysis Results 43
Table 4-9: Study Scenarios 44
Table 4-10: 2014 All Scenarios, Study Results 45
Table 4-11: Voltage Collapse in the High River Planning Area 46
Table 4-12: 2019 All Scenarios, Contingency Analysis Results 47
Table 5-1: Viable Alternatives to Reinforce the High River Planning Area 58
Table 6-1: Study Scenarios 63
Table 6-2: Loading on Critical Lines in the Study Area for 2014 65
Table 6-3: Major Overloads Resolved at each Step of the FATD Plan in 2014 66
Table 6-4: Low Voltage in the High River Planning Area in 2014 67
Table 7-1: Loading on Critical Lines in the Study Area for 2019 69
Table 7-2: Severe Overloads Resolved at each Step of the FATD Plan in 2019 70
Table 8-1: FATD Scope Summary 74
Table 8-2: PV Stability Results for the Recommended FATD Alternative in 2019 75
Table 8-3: Critical Buses for Short-Circuit Calculations 77
Table 8-4: Short-Circuit Levels for the Existing System – 2014 Pre-FATD 78
Table 8-5: Short-Circuit Levels in 2014 – Post FATD 78
Table 8-6: Short-Circuit Levels in 2019 – Post FATD 79
Table 8-7: Comparison of the Generation Forecast Information 80
Table 8-8: Applying Updated Forecast for 2014 80
Table 9-1: Wind Connection Projects – NID Applications Filed with the AUC 82
Table 9-2: Wind Connection Projects – NID Applications being Prepared[4] 83

List of Attachments

Attachment A: Need Assessment – 2014, Scenario 1 to 6 89
Attachment B: Need Assessment – 2019, Scenario 1 to 6 149
Attachment C: Transmission Development Plan – Step 1, 2014 209
Attachment D: Transmission Development Plan – Step 2, 2014 227
Attachment E: Transmission Development Plan – Step 3, 2014 241
Attachment F: Transmission Development Plan – Step 4, 2014 253
Attachment G: Transmission Development Plan – Step 1, 2019 257
Attachment H: Transmission Development Plan – Step 2, 2019 279
Attachment I: Transmission Development Plan – Step 3, 2019 299
Attachment J: Transmission Development Plan – Step 4, 2019 317
Attachment K: Proposed Alternative, Power-Voltage Studies – 2019 329
Attachment L: Proposed Alternative, Transient Stability Analysis – 2014 433
Attachment M: Proposed Alternative, Transient Stability Analysis – 2019 521
Attachment N: Power Flow Studies using Updated Forecast – 2014 609

1. INTRODUCTION

The Alberta Interconnected Electric System (AIES) is planned, designed, and operated to deliver electric energy to Alberta customers reliably and efficiently under a wide variety of system conditions. The AESO uses forecast information to perform system studies that assess the ability of the transmission system to accommodate existing and future generation supply and existing and future customer demand.

The system studies detailed in this engineering report were performed under the Foothills Area Transmission Development (FATD) plan. The focus of the studies was the transmission system in south Calgary and the High River planning area (Area 46). The High River planning area includes the towns of Black Diamond, Turner valley, High River, Okotoks, and the areas between these towns.

This report presents the system studies conducted to ensure that the transmission system in south Calgary and the High River planning area is reliable. It discusses the study results in detail and provides recommendations for system developments that ensure system compliance with the AESO Transmission Reliability Criteria.

Historically, the Calgary area load has been mainly supplied by the generation sources located in northern Alberta. Power has been transmitted via the 240 kV north-south transmission system between Edmonton and Calgary, which is known as the South of Keephills-Ellerslie-Genesee (SOK-240 kV) cut-plane. Other supplies to the Calgary area include imports from British Columbia (BC) when dispatched, and generation in southern Alberta.

Recently, there has been significant interest in developing wind generation in southern Alberta. The Southern Alberta Transmission Reinforcement (SATR) project, approved by the Alberta Utilities Commission (AUC) in Q3 2009, identified transmission system constraints in southern Alberta that could significantly limit the integration of wind generation into the southern system. The SATR project proposed transmission system reinforcements to facilitate reliable generation additions in the southern Alberta electric system. One of the main system assumptions in the SATR project was that the system would have sufficient developments in south Calgary and the surrounding areas to facilitate the transmission of surplus generation from southern Alberta.

The transmission system in south Calgary and its surrounding areas is reaching its capacity to reliably supply firm load in the near future. Transmission line loadings are approaching maximum thermal limits, and the time windows when system conditions allow maintenance outages or unconstrained operation are decreasing. Due to the stress on the existing transmission system in the area, new local generators cannot be connected to the AIES without constraints on their output power.

The existing transmission system performance in south Calgary and the High River planning area was assessed under a variety of system conditions. The Foothills Area Transmission System Development plan identifies the transmission developments that will address the identified system needs in the area by facilitating the transfer of wind generation, integrating local gas generation, and supplying electrical load customers.

The goal of the FATD plan is to address three need drivers in south Calgary and the High River planning area:

- **Increasing demand for electricity**

  Steady load growth in the Calgary area has resulted in operational constraints in recent years, particularly during transmission outages. The Calgary area annual load growth has been approximately 50 MW on average for the past 5 years and is projected to continue at that rate for the next 10 years. The electrical demand in the High River planning area is increasing. The transmission system in south Calgary and the High River planning area will not be sufficient to withstand critical contingencies during the forecasted peak load in 2014. The peak demand for power in the Calgary and High River planning areas is currently about 1,600 MW and is expected to reach approximately 2,200 MW by 2019.

- **Facilitate transmission of power from southern Alberta to the system**

  It has been proposed that a significant number of Wind Power Facilities (WPFs) to be connected in southern Alberta. The forecasted amount of generation in the area is considerably higher than the load in the area. This surplus power is to be collected at the key 240 kV substations in southern Alberta (the approved SATR project) for transmission to the load centres. Therefore, transmission developments in south Calgary and the High River planning area are required to ensure reliable power transmission to the system.

- **Increasing interest in generating power in south Calgary and the High River planning area**

  Interest in developing gas-fired generation in south Calgary and surrounding areas is growing. ENMAX's Shepard Energy Centre (~850 MW) and TransCanada Energy's Saddlebrook (~350 MW) are two examples of such interest. Applications for connection of approximately 1,300 MW of gas generated power in the area have been filed with the AESO.

AESO initiated the FATD engineering study, which consisted of a full assessment of the south Calgary and the High River planning area transmission system. The study was intended to achieve the following objectives:

a) Identify the existing transmission system constraints and any violations of the AESO's Reliability Criteria

b) Plan a reliable transmission system for the area that addresses near-term and long-term system needs for the next ten years and beyond

This report, which discusses the FATD study, is structured as follows:

Section 1 provides an introduction to the FATD and the engineering study scope.

Section 2 discusses the Reliability Criteria, system data, and assumptions that were used.

Section 3 presents the study methodology for the power flow, dynamic stability, and voltage stability studies performed, as well as the methodology for other related studies.

Section 4 discusses analysis of the existing system prior to transmission developments in the study area in order to identify system constraints and the need for system developments.

Section 5 proposes a comprehensive method for developing an appropriate transmission alternative to address the identified system constraints.

Section 6 evaluates the performance of the proposed system developments in the near term.

Section 7 evaluates the performance of the proposed system developments in the long term.

Section 8 provides the results of comprehensive steady state and dynamic studies for the recommended alternative and reconciles any differences with the updated forecast.

Section 9 discusses project interdependencies in detail and shows the impact of the FATD plan on system and customer projects.

Section 10 provides a summary of, and a conclusion regarding, the assessment of the system prior to any transmission developments and following implementation of the recommended transmission developments.

1.1 Study Scope

The scope of the studies outlined in this report was limited to:

- Identifying the need for transmission system reinforcement in south Calgary and the High River planning area (the study area).
- Determining a viable transmission plan that would address the identified need for system developments in the study area, and ensuring the effectiveness of the proposed developments for the next 10 years.

The study area comprised south Calgary and the High River planning area. It included the substations shown in Figure 1-1 and all the transmission lines in the area with voltages of 69 kV and above. Figure 1-2 provides a simplified representation of the system configuration in south Calgary and the High River planning area including the new ENMAX No. 65 substation and an assumed termination point for the 240 kV double circuit lines from the south. This double circuit line is included in the SATR project. Figure 1-2 is not to scale and does not indicate geographical locations of facilities.

Power flow studies were performed for the need assessment and the analysis of the proposed transmission development plan. The objective of the power flow studies was to identify the thermal overload and voltage criteria violation issues under Category A, Category B, and selected Category C contingencies.

Upon completion of the need assessment studies, a transmission plan was proposed to address the system constraints. The following studies were performed for the

recommended alternative under Category A, Category B, and selected Category C contingencies:

a) Power flow analysis for the thermal loading and voltage deviation assessment

b) Power Voltage (PV) stability analysis to evaluate the voltage stability margin

c) Transient stability analysis to assess the transient response of the system during a fault and after a fault has been cleared

d) Short-circuit analysis to calculate the maximum short-circuit levels at the critical buses before and after the recommended system developments

e) Sensitivity studies to evaluate the impact that variations in particular study assumptions would have on the recommendations for reinforcements

The study scope does not include analysis of system constraints beyond the study area and does not include recommendations for the alleviation of such constraints. The recommended transmission developments in this engineering report resolve system constraints in the study area for the next 10 years. The scope of the studies presented in this report does not include transmission system assessment beyond the next 10 years.

The following section discusses the criteria, system data, and study assumptions applied during the FATD studies.

Figure 1-1: Study Area for the FATD Plan

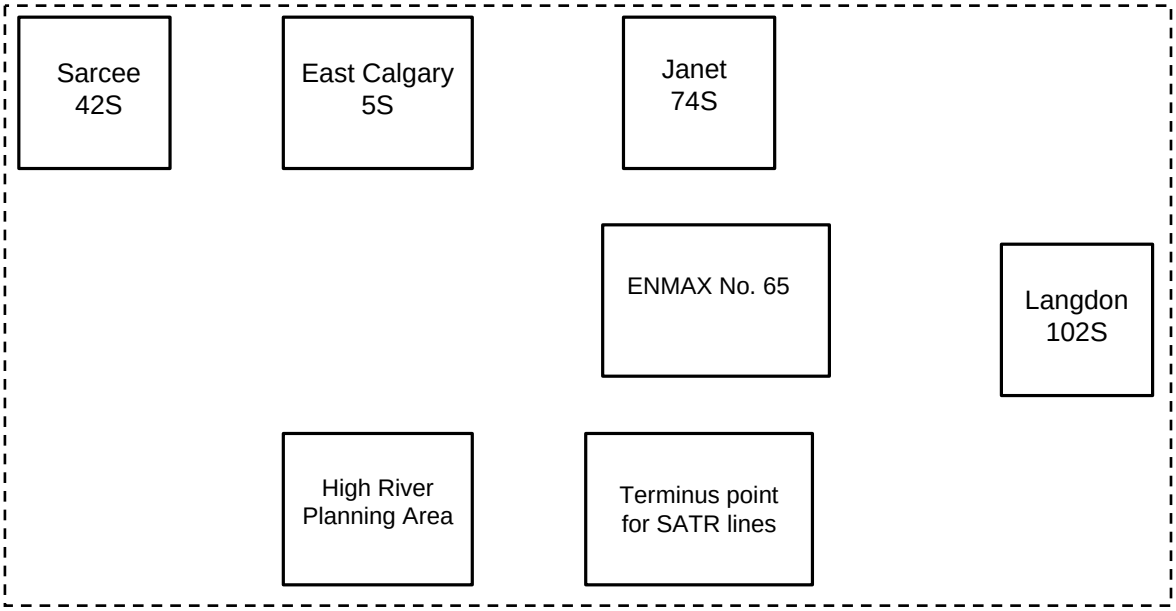
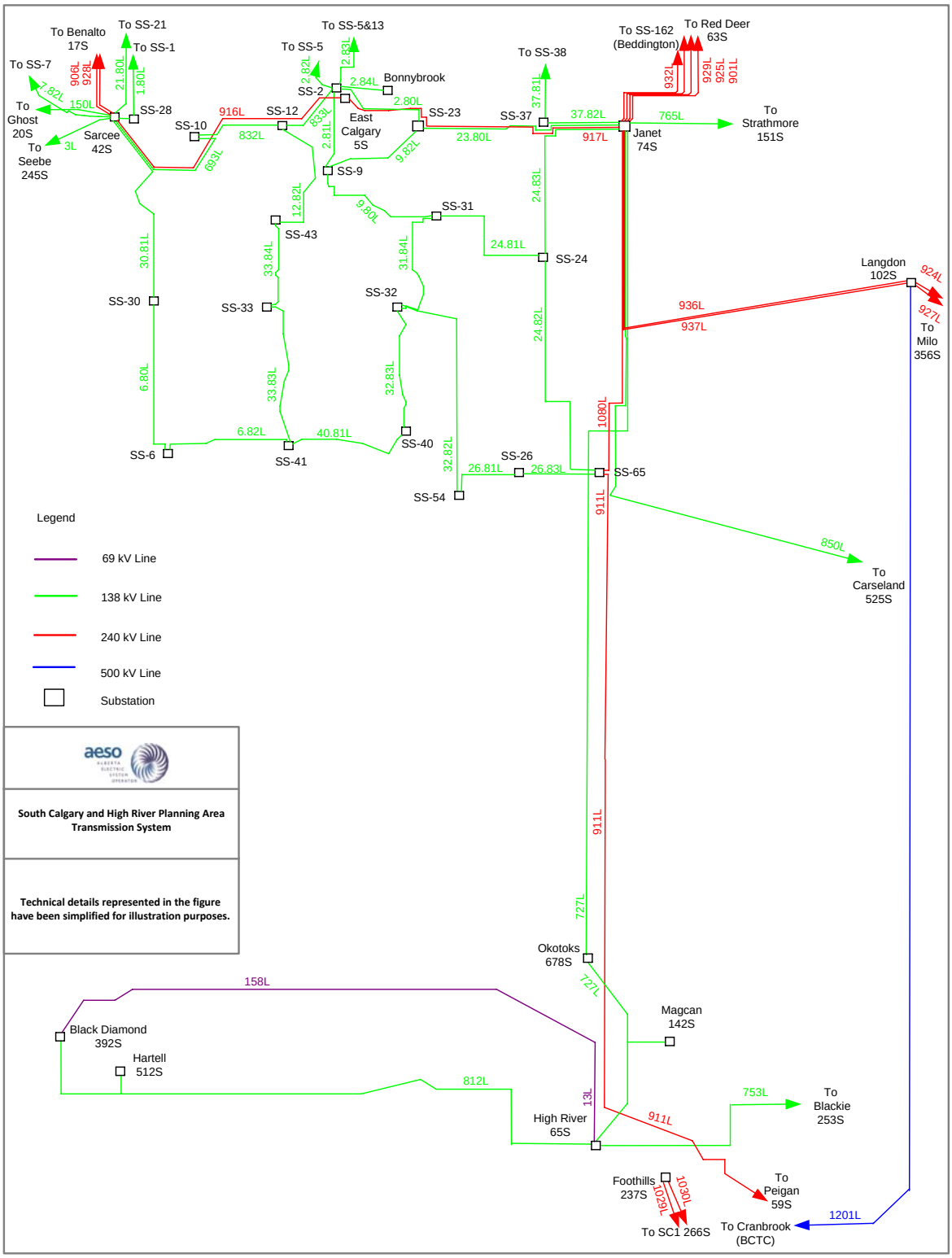


Figure 1-2: Simplified South Calgary and the High River Planning Area Transmission System



2. CRITERIA, SYSTEM DATA, AND STUDY ASSUMPTIONS

The study assumptions and system data reflect the best information available when the studies were conducted. The AESO has taken reasonable steps to verify the assumptions and system data, where possible. The bulk transmission system configuration is consistent with the AESO's *2009 Long-Term Transmission Plan* and the more recent *2011 Long-Term Transmission Plan*, which is expected to be published in Q2, 2011.

This section discusses the applicable criteria, system data, and specific study assumptions applied in the FATD assessment.

The system studies were conducted using PTI version 31 and DSA tools version 10.

2.1 AESO Transmission Reliability Criteria

The AESO Transmission Reliability Criteria was applied during the FATD studies to assess system reliability under various system conditions. Category A (all transmission elements in-service), Category B (a single transmission element out-of-service), and selected Category C (two or more transmission elements out-of-service) conditions were examined. The AESO Transmission Reliability Criteria can be found at http://www.aeso.ca/rulesprocedures/8677.html.

The following is a general explanation of the AESO Transmission Reliability Criteria (the Reliability Criteria) applied throughout this study:

- Under Category A or Category B conditions the system must be able to supply all firm loads and firm transfers to other areas. All equipment must operate within its applicable rating, voltages must be within their applicable ranges, and the system must be stable.
- Equipment loadings are monitored to record any violations based on 100% static applicable seasonal rating. AESO Reliability Criteria requires all transmission elements to operate within their ratings with no thermal overloads. Therefore, all violations were recorded for the identification of the transmission system deficiencies.
- Voltage Deviation and Voltage Stability Criteria were applied for Category A and B contingency analysis.
- Cascading outages or unplanned loss of load/generation following a single contingency is not acceptable. All single contingencies that resulted in cascading outages, or unplanned loss of load/generation were recorded as transmission system deficiencies.

2.2 Load and Generation Assumptions

2.2.1 Load Assumptions

The studies were conducted using the most recent AESO Corporate Load Forecast currently available (2009). The specific area load values are shown in Table 2-1.

Table 2-1: Specific Area Load Forecast

Year	Loading	Area 6 (MW) †	Area 45 (MW) †	Area 46 (MW) †	AIL (MW) *
2014	SP	1,741	117	113	11,548
2014	WP	1,730	129	134	12,162
2014	SL	819	64	60	8,179
2019	SP	2,060	136	143	13,974
2019	WP	2,040	148	166	14,759
2019	SL	968	74	76	9,885

† Maximum and minimum forecasted load by area.

* Alberta Interconnected Load (AIL) at time of all three areas combined maximum or minimum load.

More detail regarding the AESO load forecast is presented in the NID Appendix "Foothills System Planning Study Load and Generation Forecasts".

2.2.2 Generation Assumptions

Generation forecast information was used for the FATD studies to create reasonable system stressed conditions. Two generation scenarios from the *2009 Long-Term Transmission System Plan* were used for the FATD study: high northern generation development (Scenario A1) and high southern generation development (Scenario B5). Particularly, Scenario B5 appropriately stresses the system in the study area to facilitate the identification of transmission issues regarding connecting local gas generation and transferring wind generation from southern Alberta to the load centers.

Currently, there is no generation in the study area. The AESO has, as of March 2011, received applications to connect 1,315 MW of gas-fired generation within the study area, which aligns with the generation assumptions in Scenario B5.

Wind generation in southern and central Alberta is an important component of the FATD studies. Wind capacity values of 2,388 MW by 2014 and 4,488 MW by 2019 are forecasted for these regions, in accordance with Scenario B5.

Details regarding the forecast information can be found in the NID Appendix "Foothills System Planning Study Load and Generation Forecasts."

2.3 System Projects

It was assumed that the projects listed in Table 2-2 will be part of the AIES at their anticipated in-service dates. In the study cases, the status of the transmission system

projects in Table 2-2 depended on the projected facility in-service date. Critical Transmission Infrastructure projects are designated CTI. These projects are in the Electric Statutes Amendment Act, introduced on June 1, 2009. The remaining projects have been filed with the AUC and received approval for implementation. A description of each project and its significance to the FATD studies follows Table 2-2.

Table 2-2: Summary of System Projects Included in the FATD Studies

Project Name	Projected In-Service Date	2014 Base Case (Status)	2019 Base Case (Status)
South Calgary 69 kV Conversion	2012	In Service	In Service
Calgary Downtown Cable Replacement	2012	In Service	In Service
Southern Alberta Transmission Reinforcement (SATR) - Phase 1	2013	In Service	In Service
Southern Alberta Transmission Reinforcement (SATR) - Phase 2 [1]	2014	In Service	In Service
ENMAX No. 65 CTI Project (TUC Substation)	2013	In Service	In Service
Heartland CTI Project Phase 1	2013	In Service	In Service
Heartland CTI Project Phase 2	2015	Not Implemented	In Service
Hanna Region Transmission Development Stage I	2012	In Service	In Service
Hanna Region Transmission Development Stage II	2017	Not Implemented	In Service
East HVDC	2014	In Service	In Service
West HVDC	2014	In Service	In Service

[1] The 240 kV double circuit transmission line from Journault 260S to Whitla 251S is not implemented in the 2014 base cases as the in-service date is 2015. The transmission development is in service in 2019 cases.

2.3.1 South Calgary 69 kV Conversion and Calgary Downtown Cable Replacement Projects

The south Calgary 69 kV conversion project provides an additional 138 kV feed to the south part of the city by converting ENMAX No. 10 substation from 69 kV to 138 kV and by converting two of the existing 69 kV lines to 138 kV. This system project will assist in increasing supply capability and the ability to do maintenance work in the south Calgary transmission system.

The AESO has planned to replace the existing four transmission cables and the terminal equipment serving the central business district with four new 300 MVA cross-linked polyethylene (XLPE) underground power cables. As shown in Table 2-2, this project will be completed by 2012.

Both the 69 kV and the central business district cable projects were modeled in the FATD study cases to determine what other developments will be required to remove all transmission reliability violations in the study area.

2.3.2 Southern Alberta Transmission Reinforcement (SATR) Project

The development of the SATR project was an important transmission system assumption in the FATD study cases. The existing 240 kV transmission line 911L from Peigan 59S to Janet 74S is a significant limiting factor in the capability of the system to transfer wind generation from the Pincher Creek area towards the study area. The SATR project originally aimed at increasing transmission capacity in southern Alberta to allow new wind generation connections and enable transmission of surplus generation to major load centres in southern Alberta (Calgary). Preliminary system studies showed the need for a double circuit 240 kV transmission line from Peigan 59S to Janet 74S. However, these studies indicated a significant number of transmission constraints in and around the Calgary area that were outside the scope of work for the SATR project. A separate project, the Foothills Area Transmission Development (FATD), was initiated to properly address these system constraints in south Calgary and allow the transmission of wind generation from southern Alberta.

The SATR project has two stages: SATR Stage I and SATR Stage II. The milestones for both stages have been met and the proposed transmission developments are advanced into the construction phase upon approval of the necessary facility applications. FATD studies modeled the SATR transmission developments according to their projected in-service dates. The following projects are included in SATR Stage I and Stage II:

- A double circuit 240 kV transmission line from Peigan 59S substation to the new Dewinton substation, currently re-named to Foothills 237S substation. The existing 240 kV transmission line 911L is from Peigan 59S to Janet 74S. Sections of the line from Peigan 59S to the new Foothills 237S substation will be de-energized by this development (2014).
- 240 kV Milo Junction Substation (2011).
- Russell 632S substation with a phase-shifting transformer (2011).
- 240 kV Cassils 324S and 240/138 kV Bowmanton 244S substations and a 240 kV double circuit line between these two substations (2014).
- 240 kV Whitla 251S substation and the double circuit 240 kV transmission connection between Whitla 251S and Bowmanton 244S (2014).
- 138 kV transmission system developments in the Medicine Hat area (2014).
- 500/240 kV Chapel Rock 491S (Crowsnest) substation and its double circuit 240 kV transmission line to Fidler 312S substation (2014).

- 240 kV Journault 260S substation and a 240 kV single circuit line to Picture Butte 120S substation (2014).
- 240 kV transmission line from Goose Lake 103S to Journault 260S (2016).
- 240 kV double circuit transmission line from Journault 260S to Whitla 251S (2014).
- Blackie area transmission system modifications (2014).
- SVC addition at Cypress 562S substation (2013).
- Modifications to the exiting 933L transmission line (Anderson 801S to West Brooks 28S); this line is currently by-passing Ware Junction 132S. Through the SATR project, 933L will be in and out at Ware Junction 132S, maintaining its terminal points at Anderson 801S and West Brooks 28S (2012).

2.3.3 Critical Transmission Infrastructure (CTI) Projects

The CTI projects given in Table 2-2 were modeled in the FATD study cases according to their in-service dates.

2.3.4 Hanna Region Transmission Development Project

The Hanna Region Transmission Development (HRTD) project was designed to reliably supply projected peak load and accommodate connection of new wind projects in the region by 2017, as specified in the approved NID application[1]. A significant portion of surplus generation from the Hanna region (from all sources) will be transferred to southern Alberta and the balance will be transferred to the Red Deer area via the 240 kV transmission system.

2.4 Customer Connection Projects in the Study Area

The customer connection projects listed in Table 2-3 were modeled in the FATD study cases. The status of each project in the study cases depended on the scenario being tested. The study scenarios are explained in detail in Section 3.1.

The FATD studies assumed a 240 kV double circuit connection from the Saddlebrook generation facility to the AIES to model generation injection into the grid. These studies determined the system's capability to absorb Saddlebrook's generation injection into the grid. As part of the Saddlebrook generation application, a separate customer connection study will be needed to determine the configuration of the Saddlebrook connection and its impact on the AIES.

As shown in Table 2-3, the in-service date for Shepard connection is 2013; this includes the ENMAX No. 25 substation, and its associated load. The requested commercial in-service date for the generation operation is 2015. ENMAX Shepard Inc. has requested to be able to operate their generators in 2014 for testing purposes.

[1] Filed on August 14, 2009 and received AUC's approval on April, 2010. Application number is 1605359.

Table 2-3: Customer Connection Projects in the Study Area

Facility Name	Requested In-Service Date	Generation Size (MW)	2014 Base Case (Status)	2019 Base Case (Status)
Shepard Generator	2013 for station construction load; 2015 for generation connection	~ 850	Installed	Installed
Saddlebrook Generator	Within the next 5 years	~ 350	Installed	Installed
Bonnybrook Generator	2012	~ 170	Installed	Installed

2.5 Facility Ratings and Shunt Elements

Table 2-4 to Table 2-7 summarize the ratings of the key transmission elements in the study area and its vicinity:

Table 2-4: Facility Ratings in the Study Area and Vicinity – Key 240 kV Transmission Lines

Transmission Line	From Substation	To Substation	Summer (MVA)	Winter (MVA)
936L	Langdon 102S	Janet 74S	489	606
937L	Langdon 102S	Janet 74S	489	606
917L	East Calgary 5S	Janet 74S	481	499
916L	East Calgary 5S	Sarcee 42S	408	494

As documented in Section 2.3, the existing 240 kV transmission line 911L (Peigan 59S to Janet 74S) will be reconfigured by the SATR project. Also, ENMAX No.65 substation and the Shepard generation (ENAMX No. 25 substation) will be connected to this line in other projects. Different sections of the line will have different ratings. Table 2-5 gives the new line number and rating of each section of the line. Note that the section of the line from Peigan 59S to Foothills 237S will be de-energized by the SATR project.

Table 2-5: Summer/Winter Ratings for each Section of 911L

Transmission Line	From Substation	To Substation	Summer (MVA)	Winter (MVA)
911L	Foothills 237S	ENMAX No. 65	337	407
1080L [1]	ENMAX No. 65	ENMAX No. 25	489	606
1003L [1]	ENMAX No. 25	Janet 74S	638	788

[1] These lines have been renamed from sections of 911L.

Table 2-6: Facility Ratings in the Study Area and Vicinity – Key 138 kV Transmission Lines

Transmission Line	From Substation	To Substation	Summer (MVA)	Winter (MVA)
23.80L	Janet 74S	ENMAX No. 23	260	321
24.83L	Janet 74S	ENMAX No. 24	318	392
727L	Janet 74S	Okotoks 678S	119	146
850L	Janet 74S	Carseland 525S	89	109
765L	Janet 74S	Strathmore 151S	85	90
24.82L	ENMAX No. 65	ENMAX No. 24	260	321
26.83L	ENMAX No. 65	ENMAX No. 26	260	321
24.81L	ENMAX No. 24	ENMAX No. 31	287	287
9.80L	ENMAX No. 9	ENMAX No. 31	191	191
9.82L	ENMAX No. 9	ENMAX No. 23	260	321
26.81L	ENMAX No. 26	ENMAX No. 54	260	321

Table 2-7: Facility Ratings in the Study Area and Vicinity – Key Transformers

Station Name and Number	Transformer	MVA Rating
Janet 74S	T1 and T2	400
Sarcee 42S	T1 and T2	400
East Calgary 5S	T1	336
ENMAX No. 65	T1 and T2	400
Beddington (ENMAX No. 162)	T1 and T2	400

Capacitor banks in the study area are shown in Table 2-8.

Table 2-8: Capacitor Banks in the Study Area

Substation Name and Number	Nominal Bus Voltage (kV)	Number of Blocks	Total at Nominal Voltage (MVAr)
JANET 74S	240	2	269
JANET 74S	138	2	162
SARCEE 42S	240	2	200
SARCEE 42S	138	1	54
ENMAX No. 2	138	2	170
ENMAX No. 21	138	1	49
ENMAX No. 14	138	1	49
ENMAX No. 38	138	1	48
ENMAX No. 31	138	1	48
ENMAX No. 41	138	1	54

2.6 Dynamic Data and Assumptions

Validated dynamic data was used for existing equipment in the AIES such as generators, WPFs, motor loads, and Static VAR Compensators (SVCs) when such data was available. Generic dynamic models were adopted for existing equipment if validated data was not available and for facilities planned to be in service within the timeline of the FATD studies.

2.7 Protection Fault Clearing Time

For the existing and proposed transmission lines, the fault clearing times in Table 2-9 were assumed based on their voltage class.

Table 2-9: Assumptions for Clearing Times of Facilities

Nominal Voltage (kV)	Fast End (Cycles)	Slow End (Cycles)
500	5	6
240	6	7
138	7	8

2.8 Voltage Profile Assumptions

Voltages in the study area under normal operating conditions were assumed to be at or above 1.0 per unit (pu).

The reactive power rating of the SVC at Langdon 102S substation is ±250 MVAr. The SVC assists with controlling the voltage of the 240 kV bus at Langdon 102S substation at 252 kV (1.05 pu). Current operating practices indicate that the SVC should be operating in the +40/-80 MVAr range in steady state. Therefore, for the steady state analysis, the operating range of the SVC was monitored and maintained at the +40/-80 MVAr range where possible.

2.9 Applicable Operating Policies and Procedures

The applicable Operating Policies and Procedures (OPPs) when this report was written were:

- Alberta-BC Interconnection Transfer Limits (OPP-304)
  http://www.aeso.ca/downloads/OPP_304.pdf
- SOK-240 Operation (OPP-521)
  http://www.aeso.ca/downloads/OPP_521.pdf
- Voltage Control (OPP-702)
  http://www.aeso.ca/downloads/OPP_702.pdf

These OPPs were considered when setting up the study cases and performing the need assessment studies in order to ensure the established system limits and/or acceptable voltage ranges were respected.

The existing Calgary Area Operation (OPP-510) will be revised in accordance with the AESO's operational studies following completion of the proposed FATD plan.

3. STUDY METHODOLOGY

This section provides a comprehensive review of the methodology applied to achieve the study objectives. The system studies were performed in accordance with the Reliability Criteria.

The study objectives were:

- Identify constraints in the study area that can impact reliable system performance
- Design and propose a transmission system alternative that can resolve all identified system constraints in the study area and allow flexibility for any required future development

To achieve these objectives the following system studies were performed:

- Power flow studies for Category A, Category B, and selected Category C contingencies
- PV stability analysis for Category A, Category B, and selected Category C contingencies
- Transient stability analysis for Category A, Category B, and selected Category C contingencies
- Short-circuit fault current studies

Power flow studies were performed to provide information regarding system performance during various system conditions. These studies identified equipment thermal overloads and voltage performance that would violate the Reliability Criteria.

PV analysis was performed to ensure that sufficient PV stability margin exists according to the Reliability Criteria.

Transient stability analysis was performed to ensure a satisfactory response following a system disturbance according to the Reliability Criteria. Various contingencies were studied.

Short-circuit fault currents were calculated to provide appropriate guidance to Transmission Facility Owners (TFOs) for their facility designs.

The selected study years, system conditions, and methodology used for each study are described in the following sub-sections.

3.1 Study Cases

The summer peak (SP) load condition was used because of the lower transmission line thermal rating and the higher reactive power demand by the load under that condition. System light (SL) load levels were examined to ensure overvoltage and/or transmission of generation will not be an issue during light load conditions.

The year 2014 was selected for near-term analysis because all components of the SATR project (Stage I and II) are currently anticipated to be in-service by 2014, with the exception

of the 240 kV double circuit line from Journault 260S to Goose Lake 103S, as documented in Section 2.3. The SATR project will allow the integration of additional wind generation in southern Alberta. The new double circuit 240 kV transmission lines from Peigan 59S substation to the terminating substation (the new Foothills 237S) will allow power flow from southern Alberta to the load centre. Another reason for selecting year 2014 was the steady annual load growth; it is expected that without any transmission development reliable load supply will become increasingly critical in the study area by 2014.

The system conditions for 2019 were assessed to ensure that the proposed transmission development will be sufficient for reliable system performance in the longer term.

In summary, the system performance was evaluated for the following years and load conditions:

- Near Term – SP 2014 and SL 2014
- Long Term – SP 2014 and SL 2019

Wind generation was modeled as several lumped generators in southern and central Alberta in a manner consistent with the approved SATR project.

The Shepard and Saddlebrook generators are expected to be on the same transmission path used to transfer wind generation from southern Alberta to the study area. Therefore, the dispatch of these generators at maximum power output was considered to analyze the worst case system conditions based on the scenario being studied. All the remaining Calgary generators were assumed to be offline as their generation output will not cause any material stress to the existing south Calgary transmission system. Table 3-1 shows generation assumptions for the Calgary area used for the FATD studies.

Table 3-1: Local Area Generators in the Study Case(s)

Generation Name	Approximate Total Capacity (MW)	Status in the Study Case
Shepard Generators	850	On/Off (depending on the study case)
Saddlebrook Generators	350	On/Off (depending on the study case)
Bonnybrook Generators	170	Off
Balzac	120	Off
Cavalier	120	Off
Calgary Energy Centre (CEC)	300	Off
Crossfield	132	Off

Shepard and Saddlebrook generators could be online at their maximum capacity depending on the system conditions studied. Saddlebrook generation is forecasted to be available by 2014. Shepard generation is assumed to be online in 2014 to facilitate the

ENMAX Shepard Inc. request for testing the generators in 2014 to prepare for the commissioning, as explained in Section 2.4.

Depending on the study case, the following interchange flows with British Columbia were assumed:

- Negligible interchange (~0 MW)
- Maximum import from British Columbia into Alberta (~780 MW)

These intertie flows represent system conditions that could cause stress on the transmission system in the study area.

3.1.1 Scenarios

The following scenarios were simulated for the FATD studies using the forecasted load and generation for 2014 and 2019. These scenarios represent a range of potential operating conditions and assumed different loading conditions and generation dispatch in order to analyze the transmission system performance in the study area. The given scenarios were assumed to be worst case conditions to ensure system reliability is maintained according to the Reliability Criteria.

Scenario 1:

- SP load conditions
- ~780 MW import from BC
- All wind generation is offline
- All local gas generators in the study area are offline
- Economic dispatch of all other generators in the AIES

Scenario 2:

- SP load conditions
- ~0 MW interchange between Alberta and BC
- All wind generation dispatched at full power
- All local gas generators are offline
- Economic dispatch of all other generators in the AIES

Scenario 3:

- SP load conditions
- ~0 MW interchange between Alberta and BC
- All wind generation dispatched at full power
- All local gas generators are offline except the Saddlebrook generation (dispatched at 350 MW)
- Economic dispatch of all other generators in the AIES

Scenario 4:

- SP load conditions
- ~0 MW interchange between Alberta and BC
- All wind generation dispatched at full power
- All local gas generators are off line except the Shepard and Saddlebrook generators (Shepard dispatched at ~850 MW and Saddlebrook dispatched at 350 MW)
- Economic dispatch of all other generators in the AIES

Scenario 5:

- SP load conditions
- ~780 MW import from BC
- All wind generation is off line
- All local gas generators are offline except the Shepard and Saddlebrook generators (Shepard dispatched at ~850 MW and Saddlebrook dispatched at 350 MW)
- Economic dispatch of all other generators in the AIES

Scenario 6:

- System light load condition
- ~0 MW interchange between Alberta and BC
- All wind generation dispatched at full power
- All local gas generation is offline
- Economic dispatch of all other generators in the AIES

These scenarios create a set of different system conditions, which could serve as the bookends for the complete analysis of the study area. Table 3-2 provides a summary of all the study cases created based on the above system scenarios.

Table 3-2: Study Cases and Considered Scenarios

Year	Scenario	Load Condition	Import from BC (MW)	Shepard Generation (MW)	Saddlebrook Generation (MW)	Wind Generation Dispatch (MW)
2014	1	Summer Peak	780	0	0	0
	2	Summer Peak	0	0	0	2388
	3	Summer Peak	0	0	350	2388
	4	Summer Peak	0	~850	350	2388
	5	Summer Peak	780	~850	350	0
	6	System Light	0	0	0	2388
2019	1	Summer Peak	780	0	0	0
	2	Summer Peak	0	0	0	4488
	3	Summer Peak	0	0	350	4488
	4	Summer Peak	0	~850	350	4488
	5	Summer Peak	780	~850	350	0
	6	System Light	0	0	0	3400

In Scenario 1, northern generation was assumed to be the source, in addition to the import from BC to supply peak load in Calgary and southern Alberta. In the remaining scenarios the source is assumed to be wind generation in Alberta and/or local gas-fired generators in the study area.

3.2 Power Flow Analysis

For the power flow analysis, Category A, Category B, and selected Category C contingencies were simulated. The system in the study area and its vicinity was monitored to identify any violation of the Reliability Criteria, including thermal overload and voltage issues.

The contingencies considered for the power flow studies include the outage of transmission elements rated at 138 kV and above in the study area and its vicinity.

The area that was monitored to record any violation of the Reliability Criteria includes all the components at 69 kV and above in the study area and its vicinity.

3.3 Voltage Stability (PV) Analysis

In the FATD studies, the PV analysis was performed on the scenarios and critical contingencies identified in the power flow analysis. The methodology used for the PV analysis was to incrementally increase the load in the study area (the sink) to identify the point of voltage instability (the nose point) under normal and contingency conditions. This allowed the voltage stability margin to be calculated to ensure a sufficient stability margin exists under the various system scenarios discussed previously.

Due to the location of the Calgary area load, the primary supply (the source) paths are:

- Northern Alberta
- Southern Alberta

In the PV analysis, the sink was considered as the electrical load in the study area. The source that can respond to the specified sink was determined based on the following study scenario:

- Generation in the Wabamun and Fort McMurray planning areas (Areas 40 and 25)
- Wind generation in southern Alberta

Without wind generation, the primary source of supply to the sink is generation in northern Alberta, particularly the Wabamun area, and export from the Fort McMurray area.

These assumptions created the most stressed conditions for the PV analysis in the study area.

3.4 Short-Circuit Analysis

For the short-circuit analysis, all the generators in and around the study area were switched on to evaluate the maximum fault current under three-phase-to-ground faults and single-line-to-ground faults. Three-phase faults typically create the maximum fault current. Single-line-to-ground faults were calculated because under certain circumstances they may exceed the three-phase fault currents. The calculated fault currents under three-phase-to-ground faults and single-line-to-ground faults should be considered by the TFOs when specifying substation equipment.

3.5 Transient Stability Analysis

In the transient stability analysis, a three-phase–to-ground fault was applied to critical 138 kV and higher voltage class transmission lines in the study area to assess system stability with the proposed transmission developments in service. The fault was cleared by opening the near-end and far-end breakers of the line according to the time delay given in Table 2-9.

A system dynamic response is considered acceptable if the following conditions are met after a disturbance:

- All the generators remain stable and connected to the AIES
- The BC intertie does not trip
- The post-contingency voltage does not differ from the pre-fault voltage by more than 10%
- All oscillations in the system are damped successfully within approximately 20 seconds following a contingency

4. EXISTING SYSTEM ASSESSMENT

This section assesses the capability of the existing transmission system in the study area to:

- Supply the load
- Transmit power generated in southern Alberta
- Integrate new local generation

The Reliability Criteria was applied to benchmark system performance under different scenarios and contingencies. As discussed in Section 3, the year 2014 was selected for the assessment of the existing system performance. The assumption was that approved transmission developments with in-service dates before the end of 2014 have been implemented, including ENMAX No. 65 substation and the SATR project. The Shepard and Saddlebrook generators were also modeled in the studies. The complete list of the system and customer projects modeled is given in Section 2. Figure 4-1 is a schematic diagram of the existing system in 2014 that provides a simplified representation of the system configuration. The technical details were simplified for illustration purposes and the geographic location of facilities is not indicated.

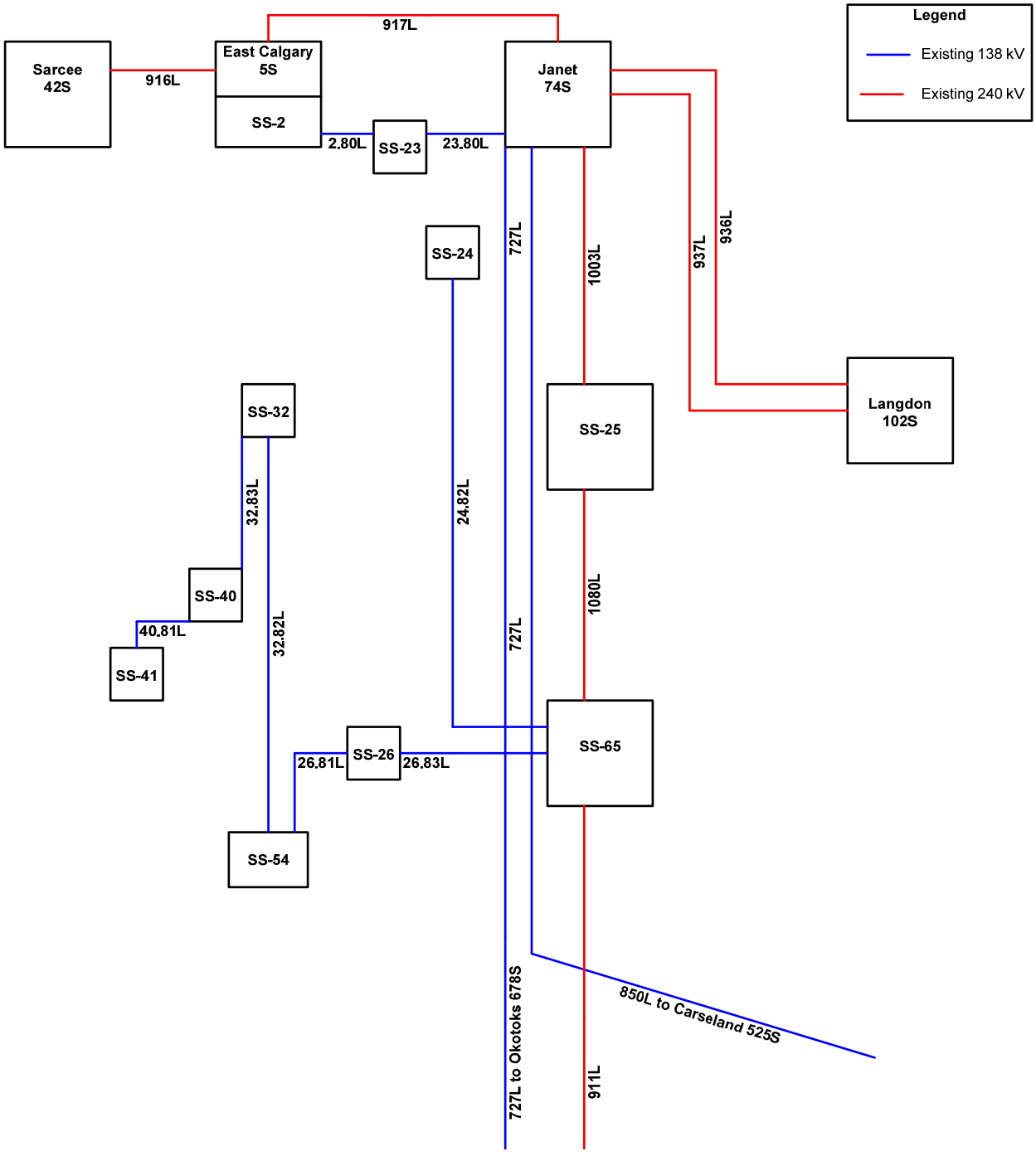
System performance in 2019 was studied to identify the transmission capacity needed in the long term. It should be noted that, due to significant system deficiencies, in 2019 in certain scenarios studied voltage collapse occurred following a single contingency (N-1). Therefore, to enable the continuation of the system studies and to identify thermal overload issues in the study area provisional SVCs were added to the simulation at three critical buses in the study area and its vicinity. These reactive supports were used only for modeling purposes to allow the completion of the need assessment and were removed from the model when developing a suitable transmission plan to address the identified system constraints. Further details regarding the provisional SVCs are provided in Section 4.1.

The load flow studies were performed for all the scenarios in Table 3-2. The results of the need assessment study showed the areas of the system that can experience severe thermal overload under system normal and/or contingency conditions. The transmission system capacity needed to remove system constraints such as thermal line ratings was determined taking the long term need assessment study results into consideration.

This section is structured as follows:

- Section 4.1 provides a power flow analysis of the existing system performance considering each scenario for 2014 and 2019 individually
- Section 4.2 provides a comparison of the existing system performance under different scenarios in the near term (2014)
- Section 4.3 provides a comparison of the existing system performance under different scenarios in the long term (2019)
- Section 4.4 provides a summary of, and conclusions regarding, the need assessment studies

Figure 4-1: Existing System in the Study Area in 2014 – Simplified System Configuration



4.1 Power Flow Analysis

The following load flow studies were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 conditions)

The study results for the existing system are discussed in the following subsections. A brief description of the studied scenarios is provided in Table 4-1.

Table 4-1: Study Scenarios

Scenario	Load Condition
1	SP, no wind generation, no local generation, ~780 MW import from BC
2	SP, full wind generation, no local generation, ~0 MW import from BC
3	SP, full wind generation, Saddlebrook generation online, ~0 MW import from BC
4	SP, full wind generation, Saddlebrook and Shepard generation online, ~0 MW import from BC
5	SP, no wind generation, Saddlebrook and Shepard generation online, ~780 MW import from BC
6	System Light (SL), full wind generation, no local generation, ~0 MW import from BC

An outage of the 138 kV line 765L from Janet 74S substation to Strathmore 151S substation may cause voltage collapse in the Strathmore/Blackie Planning Area (Area 45) under peak loading conditions in 2014. In the FATD studies, a provisional SVC was modeled at Namaka 428S substation to facilitate system assessment in the study area. The AESO is currently assessing the transmission system deficiencies in the Strathmore/Blackie planning area and will address the need in a separate NID application.

The 2019 system conditions that resulted in voltage collapse (VC) in the study area are presented in Table 4-2.

Table 4-2: Voltage Collapse (VC) in 2019 (prior to any transmission developments)

Contingency	SC1	SC2	SC3	SC4	SC5	SC6
Open 936L 240kV line (Langdon 102S to Janet 74S)	VC	VC	VC	VC	√	√
Open 937L 240kV line (Langdon 102S to Janet 74S)	VC	VC	VC	VC	√	√
Open 917L 240kV line (Janet 74S to East Calgary 5S)	VC	VC	VC	VC	√	√
Open 911L 240kV line (Janet 74S to ENMAX No. 25)	√	√	√	VC	√	√
Open 727L 138kV line (Janet 74S to Okotoks 678S)	VC	VC	VC	VC	VC	√
Open 765L 138kV line (Janet 74S to Strathmore 151S)	VC	VC	VC	VC	VC	√
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	VC	VC	VC	VC	√	√
Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	√	√	√	VC	√	√
Open 1201L 500kV line	VC	VC	VC	VC	√	√
Open 929L or 925L 240 kV line (Janet 74S to Red Deer 63S)	VC	√	√	√	√	√
Open 906L or 928L 240 kV line (Sarcee 42S to Benalto 17S)	VC	√	√	√	√	√
Open 918L 240 kV line (Beddington to Benalto 17S)	VC	√	√	√	√	√
Open 911L 240 kV line (Foothills 237S to Peigan 59S)	√	VC	√	√	√	√
Langdon SVC outage	VC	VC	VC	VC	√	√

For the 2019 study cases, three variable size SVCs were added to these locations due to voltage collapse following a single contingency:

- Okotoks 678S substation
- Namaka 428S substation
- Beddington substation (ENMAX No. 162)

The injection of reactive power into the system helped to prevent voltage collapse following a single contingency when simulating the 2019 loading condition. Further studies were performed to measure thermal overloads on the transmission lines in the study area. This information was used to plan appropriate transmission developments as discussed in Section 5. Following the system developments in the study area, the modeled SVCs were removed from the study cases.

In the need assessment studies, Foothills 237S substation was modeled as the terminating point for the 240 kV double circuit transmission lines from Peigan 59S substation. This assumption was required to evaluate the system constraints in the study area following the SATR project implementation. The injection of the Shepard and Saddlebrook plants into the grid was modeled to assess the capability of the existing system to absorb power output from these generators.

4.1.1 Scenario 1

Scenario 1 was used to assess the capability of the existing system to reliably supply the load in the study area in 2014 and 2019. The assumptions were that there is no wind generation in the AIES, no local gas generation, and the maximum import on the BC intertie (780 MW).

A summary of the contingency analysis results for Scenario 1 is given in Table 4-3. The power flow diagrams of the system with all elements in service (N-0) and following a critical single contingency (N-1) are given in Attachments A and B.

Table 4-3: Scenario 1, Study Results

Contingency	Overloaded Branch	2014	2019
Base Case (N-0)	727L 138kV line (Janet 74S to Okotoks 678S)	√	117% 142MVA
Base Case (N-0)	765L 138kV line (Janet 74S to Strathmore 151S)	103% 92MVA	138% 120MVA
Open 240/138 kV transformer (Sarcee 42S)	240/138 kV transformer (East Calgary 5S)	√	110% 370MVA
Open 765L 138kV line (Janet 74S to Strathmore 151S)	727L 138kV line (Janet 74S to Okotoks 678S)	115% 144MVA	174% 212MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	850L 138kV line (Janet 74S to Carseland 525S)	√	145% 131MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	148% 133MVA	199% 172MVA
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	√	106% 281MVA

The study results show that the 138 kV transmission line 727L (Janet 74S to Okotoks 678S) will experience thermal overload under the contingency of 765L (Janet 74S to Strathmore 151S) in 2014. Therefore, transmission development is needed for reliable load supply in the High River planning area in 2014.

4.1.2 Scenario 2

Scenario 2 was analyzed to assess the capability of the existing system to reliably supply the forecasted load in the study area and to transfer wind generation to the load centre in 2014 and 2019. The assumptions were that all wind generation is online in southern and central Alberta, local gas generators are offline, and there is ~0 MW transfer on the BC intertie.

In this scenario, the outage of the 500 kV line 1201L could cause a voltage collapse in 2019. An additional SVC was modeled at Foothills 237S substation to enable the continuation of the need assessment studies and to identify thermal overload issues in the study area.

A summary of the contingency analysis results for this scenario is given in Table 4-4. The power flow diagrams of the system for Category A and critical Category B conditions are given in Attachments A and B.

Table 4-4: Scenario 2, Study Results

Contingency	Overloaded Branch	2014	2019
Base Case (N-0)	936L 240kV line (Langdon 102S to Janet 74S)	√	152% 778MVA
Base Case (N-0)	937L 240kV line (Langdon 102S to Janet 74S)	√	152% 778MVA
Base Case (N-0)	917L 240kV line (Janet 74S to East Calgary 5S)	√	130% 647MVA
Base Case (N-0)	727L 138kV line (Janet 74S to Okotoks 678S)	√	109% 134MVA
Base Case (N-0)	765L 138kV line (Janet 74S to Strathmore 151S)	√	132% 116MVA
Base Case (N-0)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	√	128% 343MVA
Base Case (N-0)	911L 240kV line (Foothills 237S to ENMAX No. 65)	168% 595MVA	294% 1019MVA
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	500/240 kV transformer (Langdon 102S)	√	114% 1373MVA
Open 937L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to Janet 74S)	157% 805MVA	279% 1430MVA
Open 936L 240kV line (Langdon 102S to Janet 74S)	937L 240kV line (Langdon 102S to Janet 74S)	157% 805MVA	279% 1430MVA
Open 240/138 kV transformer (Janet 74S)	917L 240kV line (Janet 74S to East Calgary 5S)	√	147% 729MVA
Open 500/240 kV transformer (Langdon 102S)	1003L 240kV line (Janet 74S to ENMAX No. 25)	√	134% 872MVA
Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	√	117% 469MVA
Open 240/138 kV transformer (East Calgary 5S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	√	115% 491MVA
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	√	125% 420MVA
Open 500/240 kV transformer (Langdon 102S)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	√	174% 865MVA
Open 765L 138kV line (Janet 74S to Strathmore 151S)	727L 138kV line (Janet 74S to Okotoks 678S)	111% 143MVA	166% 204MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	850L 138kV line (Janet 74S to Carseland 525S)	√	140% 128MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	139% 128MVA	192% 168MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	√	109% 307MVA
Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	√	124% 330MVA
Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	123% 344MVA	212% 558MVA
Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	240/138 kV transformers (T1&T2) (ENMAX No. 65)	√	105% 418MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	111% 228MVA	168% 326MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	√	144% 421MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	√	109% 175MVA
Open 500/240 kV transformer (Langdon 102S)	911L 240kV line (Foothills 237S to ENMAX No. 65)	236% 821MVA	426% 1479MVA

The study results show the following 240 kV transmission lines will experience thermal overloads in 2014:

- 911L from Foothills 237S substation to ENMAX No. 65 substation; ~ 68% overload under N-0, which becomes significantly worse under N-1 conditions.

- 936L and 937L lines from Janet 74S substation to Langdon 102S substation; ~ 57% overload under N-1 conditions.

The study results show that the following 138 kV transmission lines will experience thermal overloads under N-1 conditions in 2014:

- 24.82L from ENMAX No. 65 substation to ENMAX No. 24 substation; ~23% overload.
- 727L from Janet 74S substation to Okotoks 678S substation; ~11% overload.
- 9.80L from ENMAX No. 9 substation to ENMAX No. 31 substation; ~ 11% overload.

The number of thermal overload violations under Category A and Category B system conditions is considerably higher in 2019, as presented in Table 4-4. The study results demonstrate that the following 240 kV and 138 kV transmission lines will experience severe thermal overloads with all transmission elements in service (N-0):

- 911L from Foothills 237S substation to ENMAX No. 65 substation; ~ 1000 MVA loading on a 337 MVA line.
- 936L and 937L lines from Janet 74S substation to Langdon 102S substation; ~52% overload.
- 917L from Janet 74S substation to East Calgary 5S substation; ~ 30% overload.
- 24.82L from ENMAX No. 65 substation to ENMAX No. 24 substation; ~ 28% overload.
- 727L from Janet 74S substation to Okotoks 678S substation; ~ 9% overload.

Analysis of Scenario 2 (full wind, no local gas generation) shows the need for transmission developments in the following areas in 2014:

- The 240 kV path between Langdon 102S substation and Janet 74S substation
- The 240 kV path between Foothills 237S substation and ENMAX No. 65 substation
- The 138 kV transmission system supplying the High River planning area
- The 138 kV transmission system around ENMAX No. 65 substation

4.1.3 Scenario 3

Scenario 3 was used to assess the capability of the existing system to supply the load in the study area, transfer generation from southern Alberta to the system, and integrate Saddlebrook gas generation into the study area. The assumptions were that all wind generation is online at full power output, Saddlebrook generation is online at its maximum output, and there is ~0 MW transfer on the BC intertie.

A summary of the contingency analysis results for this scenario is given in Table 4-5. The power flow diagrams of the system for N-0 and critical N-1 contingencies are given in Attachments A and B.

The study results show that the following 240 kV transmission lines will experience thermal overloads in 2014:

- 911L from Foothills 237S substation to ENMAX No. 65 substation; ~ 136% overload under the N-0 condition, which becomes significantly worse under N-1 conditions.
- 936L and 937L from Langdon 102S substation to Janet 74S substation; ~ 64% overload under N-1 conditions.
- 1080L from ENMAX No. 25 substation to ENMAX No. 65 substation; ~ 25% overload under N-1 conditions.
- 917L from Janet 74S substation to East Calgary 5S substation; ~ 7% overload under N-1 conditions.

The study results show that the following 138 kV transmission lines will experience thermal overloads in 2014:

- 24.82L from ENMAX No. 65 substation to ENMAX No. 24 substation; ~ 3% overload under the N-0 condition, which becomes significantly worse under N-1 conditions.
- 9.80L from ENMAX No. 9 substation to ENMAX No. 31 substation; ~ 29% overload under N-1 conditions.
- 727L from Janet 74S substation to Okotoks 678S substation; ~ 14% overload under N-1 conditions.
- 24.81L from ENMAX No. 31 substation to ENMAX No. 24 substation; ~ 13% overload under N-1 conditions.

Table 4-5: Scenario 3, Study Results

Contingency	Overloaded Branch	2014	2019
Base Case (N-0)	936L 240kV line (Langdon 102S to Janet 74S)	√	159% 810MVA
Base Case (N-0)	937L 240kV line (Langdon 102S to Janet 74S)	√	159% 810MVA
Base Case (N-0)	917L 240kV line (Janet 74S to East Calgary 5S)	√	141% 698MVA
Base Case (N-0)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	√	135% 676MVA
Base Case (N-0)	727L 138kV line (Janet 74S to Okotoks 678S)	√	107% 132MVA
Base Case (N-0)	765L 138kV line (Janet 74S to Strathmore 151S)	103% 93MVA	130% 115MVA
Base Case (N-0)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	103% 281MVA	142% 381MVA
Base Case (N-0)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	√	112% 219MVA
Base Case (N-0)	911L 240kV line (Foothills 237S to ENMAX No. 65)	236% 832MVA	363% 1258MVA
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	500/240 kV transformer (Langdon 102S)	√	137% 1649MVA
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	936L 240kV line (Langdon 102S to Janet 74S)	164% 831MVA	325% 1367MVA
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	937L 240kV line (Langdon 102S to Janet 74S)	164% 831MVA	325% 1367MVA
Open 240/138 kV transformer (Janet 74S)	917L 240kV line (Janet 74S to East Calgary 5S)	107% 539MVA	158% 781MVA
Open 500/240 kV transformer (Langdon 102S)	1003L 240kV line (Janet 74S to ENMAX No. 25)	√	170% 1087MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	240/138 kV transformers (T1&T2) (Janet 74S)	√	122% 487MVA
Open 240/138 kV transformer (East Calgary 5S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	√	128% 543MVA
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	√	128% 431MVA
Open 500/240 kV transformer (Langdon 102S)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	125% 637MVA	220% 1076MVA
Open 765L 138kV line (Janet 74S to Strathmore 151S)	727L 138kV line (Janet 74S to Okotoks 678S)	114% 144MVA	163% 201MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	850L 138kV line (Janet 74S to Carseland 525S)	√	139% 128MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	148% 133MVA	190% 167MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	√	124% 328MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	√	112% 325MVA
Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	√	134% 359MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	173% 465MVA	260% 679MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformers (T1&T2) (ENMAX No. 65)	√	125% 500MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	129% 257MVA	185% 360MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	113% 339MVA	154% 453MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	√	119% 192MVA
Open 500/240 kV transformer (Langdon 102S)	911L 240kV line (Foothills 237S to ENMAX No. 65)	314% 1093MVA	511% 1774MVA

The number of thermal overload violations under Category A and Category B system conditions is considerably higher in 2019, as presented in Table 4-5. The study results demonstrate that the following 240 kV and 138 kV transmission lines will experience severe thermal overloads with all transmission elements in service (N-0):

- 911L from Foothills 237S substation to ENMAX No. 65 substation; ~ 1260 MVA loading on a 337 MVA line.
- 936L and 937L lines from Janet 74S substation to Langdon 102S substation; ~59% overload.
- 917L from Janet 74S substation to East Calgary 5S substation; ~ 41% overload.
- 1080L from ENMAX No. 25 substation to ENMAX No. 65 substation; ~ 35% overload under N-1 conditions.
- 24.82L from ENMAX No. 65 substation to ENMAX No. 24 substation; ~ 42% overload.
- 9.80L from ENMAX No. 9 substation to ENMAX No. 31 substation; ~ 12% overload under N-1 conditions.
- 727L from Janet 74S substation to Okotoks 678S substation; ~ 7% overload.

Analysis of Scenario 3 (full wind generation, Saddlebrook generation online) demonstrates the need for transmission developments in the following areas in 2014:

- The 240 kV path between Langdon 102S, Janet 74S, and East Calgary 5S substations
- The 240 kV path between Foothills 237S substation and ENMAX No. 25 substation
- The 138 kV transmission system that is supplying the High River planning area
- The 138 kV transmission system around ENMAX No. 65 substation

4.1.4 Scenario 4

Scenario 4 was used to assess the capability of the existing system to supply the load in the study area, transfer wind generation from southern Alberta to the system, and integrate Saddlebrook and Shepard generation into the study area. The assumptions were that all wind generation is online at full power output, the Saddlebrook and Shepard generators are online at their maximum power output, and there is ~0 MW transfer on the BC intertie.

A summary of the contingency analysis results for this scenario is given in Table 4-6. The power flow diagrams of the system for N-0 and critical N-1 contingencies are given in Attachments A and B.

Table 4-6: Scenario 4, Study Results

Contingency	Overloaded Branch	2014	2019
Base Case (N-0)	936L 240kV line (Langdon 102S to Janet 74S)	√	151% 775MVA
Base Case (N-0)	937L 240kV line (Langdon 102S to Janet 74S)	√	151% 775MVA
Base Case (N-0)	917L 240kV line (Janet 74S to East Calgary 5S)	131% 656MVA	176% 876MVA
Base Case (N-0)	1003L 240kV line (Janet 74S to ENMAX No. 25)	171% 1147MVA	205% 1362MVA
Base Case (N-0)	916L 240kV line (Sarcee 42S to East Calgary 5S)	√	141% 592MVA
Base Case (N-0)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	√	121% 614MVA
Base Case (N-0)	727L 138kV line (Janet 74S to Okotoks 678S)	√	123% 148MVA
Base Case (N-0)	765L 138kV line (Janet 74S to Strathmore 151S)	114% 101MVA	142% 123MVA
Base Case (N-0)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	122% 326MVA	157% 411MVA
Base Case (N-0)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	101% 199MVA	129% 247MVA
Base Case (N-0)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	√	115% 331MVA
Base Case (N-0)	911L 240kV line (Foothills 237S to ENMAX No. 65)	228% 795MVA	346% 1200MVA
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	500/240 kV transformer (Langdon 102S)	√	131% 1573MVA
Open 937L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to Janet 74S)	164% 842MVA	278% 1428MVA
Open 936L 240kV line (Langdon 102S to Janet 74S)	937L 240kV line (Langdon 102S to Janet 74S)	164% 842MVA	278% 1428MVA
Open 932L 240kV line (Janet 74S to Beddington SS-162)	917L 240kV line (Janet 74S to East Calgary 5S)	152% 760MVA	209% 1031MVA
Open 240/138 kV transformer (Janet 74S)	917L 240kV line (Janet 74S to East Calgary 5S)	145% 727MVA	195% 967MVA
Open 500/240 kV transformer (Langdon 102S)	1003L 240kV line (Janet 74S to ENMAX No. 25)	208% 1375MVA	269% 1765MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	240/138 kV transformers (T1&T2) (Janet 74S)	107% 426MVA	136% 545MVA
Open 240/138 kV transformer (East Calgary 5S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	120% 517MVA	168% 713MVA
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	117% 393MVA	149% 499MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	173% 857MVA	187% 911MVA
Open 500/240 kV transformer (Langdon 102S)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	113% 571MVA	205% 1019MVA
Open 765L 138kV line (Janet 74S to Strathmore 151S)	727L 138kV line (Janet 74S to Okotoks 678S)	118% 145MVA	182% 219MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	850L 138kV line (Janet 74S to Carseland 525S)	√	149% 133MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	160% 140MVA	206% 176MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	108% 303MVA	140% 381MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.83L 138kV line (Janet 74S to ENMAX No. 24)	134% 424MVA	178% 537MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	2.80L 138kV line (ENMAX No. 2 to ENMAX No. 23)	√	120% 308MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	117% 336MVA	151% 412MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	142% 365MVA	186% 458MVA

Contingency	Overloaded Branch	2014	2019
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	333% 858MVA	431% 1060MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformers (T1&T2) (ENMAX No. 65)	153% 611MVA	195% 781MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	218% 416MVA	281% 507MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	142% 414MVA	182% 516MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	140% 221MVA	177% 265MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	129% 205MVA	164% 245MVA
Open 500/240 kV transformer (Langdon 102S)	911L 240kV line (Foothills 237S to ENMAX No. 65)	312% 1072MVA	491% 1705MVA

The study results show that the following 240 kV transmission elements will experience thermal overloads in 2014:

- 911L from Foothills 237S substation to ENMAX No. 65 substation; ~ 128% overload under the N-0 condition, which becomes significantly worse under N-1 conditions.
- 1003L from Janet 74S substation to ENMAX No. 25 substation; ~ 71% overload under the N-0 condition, which becomes significantly worse under N-1 conditions.
- 917L from Janet 74S substation to East Calgary 5S substation; ~ 31% overload under the N-0 condition, which becomes significantly worse under N-1 conditions.
- 1080L from ENMAX No. 25 substation to ENMAX No. 65 substation; ~ 73% overload under N-1 conditions in 2014.
- 936L and 937L from Langdon 102S substation to Janet 74S substation; ~ 64% overload under N-1 conditions.
- 240/138 kV transformer T1 at ENMAX No. 65 substation; ~ 53% overload under N-1 conditions in 2014.
- 916L from Sarcee 42S substation to East Calgary 5S substation; ~ 20% overload under N-1 conditions.
- 240/138 kV transformer T1 at East Calgary 5S substation; ~ 17% overload under N-1 conditions.
- 240/138 kV transformers T1 and T2 at Janet 74S substation; ~ 7% overload under N-1 conditions.

The study results indicate that the following 138 kV transmission lines will experience thermal overload in 2014:

- 24.82L from ENMAX No. 65 substation to ENMAX No. 24 substation; ~ 22% overload under the N-0 condition, which becomes significantly worse under specific N-1 conditions.
- 9.80L from ENMAX No. 9 substation to ENMAX No. 31 substation; ~ 1% overload under N-0 conditions, which becomes significantly worse under specific N-1 conditions.

- 26.83L from ENMAX No. 65 substation to ENMAX No. 26 substation; ~ 42% overload under N-1 conditions.
- 24.81L from ENMAX No. 31 substation to ENMAX No. 24 substation; ~ 42% overload under N-1 conditions.
- 32.83L from ENMAX No. 32 substation to ENMAX No. 40 substation; ~ 40% overload under N-1 conditions.
- 24.83L from Janet 74S substation to ENMAX No. 24 substation; ~ 34% overload under N-1 conditions.
- 40.81L from ENMAX No. 40 substation to ENMAX No. 41 substation; ~ 29% overload under N-1 conditions.
- 727L from Janet 74S substation to Okotoks 678S substation; ~ 18% overload under N-1 conditions.
- 2.81L from ENMAX No. 2 substation to ENMAX No. 9 substation; ~ 17% overload under N-1 conditions.
- 23.80L from Janet 74S substation to ENMAX No. 23 substation; ~ 8% overload under N-1 conditions in 2014.

System studies for 2019 show very poor system performance even with all elements in service, as presented in Table 4-6. The study results demonstrate that the following 240 kV and 138 kV transmission lines will experience severe thermal overloads with all transmission elements in service (N-0):

- 911L from Foothills 237S substation to ENMAX No. 65 substation; ~ 1200 MVA loading on a 337 MVA line.
- 1003L from Janet 74S substation to ENMAX No. 25 substation; ~ 105% overload.
- 917L from Janet 74S substation to East Calgary 5S substation; ~ 76% overload.
- 936L and 937L from Langdon 102S substation to Janet 74S substation; ~ 51% overload.
- 916L from Sarcee 42S substation to East Calgary 5S substation; ~ 41% overload.
- 1080L from ENMAX No. 25 substation to ENMAX No. 65 substation; ~ 21% overload.
- 24.82L from ENMAX No. 65 substation to ENMAX No. 24 substation; ~ 57% overload.
- 9.80L from ENMAX No. 9 substation to ENMAX No. 31 substation; ~ 29% overload.
- 727L from Janet 74S substation to Okotoks 678S substation; ~ 23% overload.
- 24.81L from ENMAX No. 31 substation to ENMAX No. 24 substation; ~ 15% overload.

Analysis of Scenario 4 (Full wind generation, Saddlebrook/Shepard generation online) demonstrates the need for transmission developments in the following areas in 2014:

- The 240 kV path between Langdon 102S, Janet 74S, and East Calgary 5S substations
- The 240 kV path between Foothills 237S substation and Janet 74S substation
- The 138 kV transmission system around ENMAX No. 65 substation
- The 138 kV transmission system that is supplying the High River planning area

4.1.5 Scenario 5

Scenario 5 was used to assess the capability of the existing system to supply load in the study area and to assess the integration of the Shepard and Saddlebrook generators into the system. No wind generation was considered in this scenario. There was approximately a 780 MW import from BC.

A summary of the results of the contingency analysis for this scenario is given in Table 4-7. The power flow diagrams of the system for N-0 as well as critical N-1 contingencies are given in Attachments A and B.

The study results show that the following 240 kV transmission elements will experience thermal overloads in 2014:

- 1003L from Janet 74S substation to ENMAX No. 25 substation; ~ 18% overload under the N-0 condition, which becomes significantly worse under N-1 conditions.
- 1080L from ENMAX No. 25 substation to ENMAX No. 65 substation; ~ 66% overload under N-1 conditions.
- 911L from Foothills 237S substation to ENMAX No. 65 substation; ~ 65% overload under N-1 conditions.
- 240/138 kV transformer T1 or T2 at ENMAX No. 65 substation; ~ 13% overload under N-1 conditions.

The study results demonstrate that the following 138 kV transmission lines will experience thermal overload under N-1 conditions in 2014:

- 24.82L from ENMAX No. 65 substation to ENMAX No. 24 substation; ~ 136% overload.
- 9.80L from ENMAX No. 9 substation to ENMAX No. 31 substation; ~ 54% overload.
- 727L from Janet 74S substation to Okotoks 678S substation; ~ 18% overload.
- 26.83L from ENMAX No. 65 substation to ENMAX No. 26 substation; ~ 6% overload.
- 24.81L from ENMAX No. 31 substation to ENMAX No. 24 substation; ~ 6% overload.

Table 4-7: Scenario 5, Study Results

Contingency	Overloaded Branch	2014	2019
Base Case (N-0)	1003L 240kV line (Janet 74S to ENMAX No. 25)	118% 803MVA	113% 758MVA
Base Case (N-0)	727L 138kV line (Janet 74S to Okotoks 678S)	√	112% 137MVA
Base Case (N-0)	765L 138kV line (Janet 74S to Strathmore 151S)	114% 100MVA	134% 118MVA
Open 500/240 kV transformer (Langdon 102S)	1003L 240kV line (Janet 74S to ENMAX No. 25)	149% 1006MVA	142% 951MVA
Open 240/138 kV transformer (Janet 74S)	240/138 kV transformers (T1&T2) (Janet 74S)	√	109% 437MVA
Open 240/138 kV transformer (Sarcee 42S)	240/138 kV transformer (East Calgary 5S)	√	107% 361MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	166% 852MVA	169% 853MVA
Open 765L 138kV line (Janet 74S to Strathmore 151S)	727L 138kV line (Janet 74S to Okotoks 678S)	118% 145MVA	169% 207MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	850L 138kV line (Janet 74S to Carseland 525S)	√	142% 129MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	160% 140MVA	195% 170MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	106% 281MVA	113% 297MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	236% 622MVA	236% 621MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformers (T1&T2) (ENMAX No. 65)	113% 451MVA	115% 459MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	154% 298MVA	148% 286MVA
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	106% 313MVA	116% 339MVA
Open 500/240 kV transformer (Langdon 102S)	911L 240kV line (Foothills 237S to ENMAX No. 65)	165% 587MVA	164% 569MVA

Thermal overloads under Category A and Category B system conditions are considerably worse in 2019, as shown in Table 4-7. The study results demonstrate that the following 240 kV and 138 kV transmission lines will experience thermal overloads with all transmission elements in service (N-0):

- 1003L from Janet 74S substation to ENMAX No. 25 substation; ~ 13% overload.
- 727L from Janet 74S substation to Okotoks 678S substation; ~ 12% overload.

Analysis of Scenario 5 (no wind generation, Saddlebrook and Shepard generation online) demonstrates the need for developments in the following areas in 2014:

- The 240 kV path between Foothills 237S substation and Janet 74S substation
- The 138 kV transmission system around ENMAX No. 65 substation
- The 138 kV transmission system that is supplying the High River planning area

4.1.6 Scenario 6

Scenario 6 was used to determine system performance under light load conditions and the capability of the system to transfer power from southern Alberta to the system. The

assumptions were that all wind generation is online at full power output and there is no local generation.

A summary of the contingency analysis results for this scenario is given in Table 4-8. The power flow diagrams of the system for N-0 and critical N-1 contingencies are presented in Attachments A and B.

Table 4-8: Scenario 6, Contingency Analysis Results

Contingency	Overloaded Branch	2014	2019
Base Case (N-0)	936L 240kV line (Langdon 102S to Janet 74S)	√	117% 598MVA
Base Case (N-0)	937L 240kV line (Langdon 102S to Janet 74S)	√	117% 598MVA
Base Case (N-0)	911L 240kV line (Foothills 237S to ENMAX No. 65)	167% 612MVA	227% 788MVA
Open 937L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to Janet 74S)	150% 791MVA	213% 1092MVA
Open 936L 240kV line (Langdon 102S to Janet 74S)	937L 240kV line (Langdon 102S to Janet 74S)	150% 791MVA	213% 1092MVA
Open 932L 240kV line (Janet 74S to Beddington SS-162)	917L 240kV line (Janet 74S to East Calgary 5S)	√	114% 570MVA
Open 240/138 kV transformer (Janet 74S)	917L 240kV line (Janet 74S to East Calgary 5S)	√	107% 534MVA
Open 500/240 kV transformer (Langdon 102S)	1003L 240kV line (Janet 74S to ENMAX No. 25)	√	117% 777MVA
Open 500/240 kV transformer (Langdon 102S)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	110% 570MVA	152% 772MVA
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	√	117% 101MVA
Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	121% 330MVA	163% 426MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	√	122% 235MVA
Open 500/240 kV transformer (Langdon 102S)	911L 240kV line (Foothills 237S to ENMAX No. 65)	243% 869MVA	327% 1134MVA

The study results show that the following 240 kV transmission lines will experience thermal overloads in 2014:

- 911L from Foothills 237S substation to ENMAX No. 65 substation; ~ 67% overload under the N-0 condition, which becomes significantly worse under N-1 conditions.
- 936L and 937L from Langdon 102S substation to Janet 74S substation; ~ 50% under N-1 conditions.
- 1080L from ENMAX No. 25 substation to ENMAX No. 65 substation; ~ 10% overload under N-1 conditions.

The study results indicate that the following 138 kV transmission lines will experience severe thermal overloads in 2014 under N-1 conditions:

- 24.82L from ENMAX No. 65 substation to ENMAX No. 24 substation; ~ 21% overload.

The number of thermal overload violations under Category A and Category B system conditions is considerably higher in 2019, as presented in Table 4-8. The study results

demonstrate that the following 240 kV transmission lines will experience thermal overloads with all transmission elements in service (N-0):

- 911L from Foothills 237S substation to ENMAX No. 65 substation; ~ 127% overload.
- 936L and 937L from Langdon 102S substation to Janet 74S substation; ~ 17% under N-1 conditions.

Analysis of Scenario 6 (system light load condition, full wind, and no local generation online) demonstrates the need for transmission developments in the following areas in 2014:

- The 240 kV path between Langdon 102S substation and Janet 74S substation
- The 240 kV path between Foothills 237S substation and ENMAX No.25 substation
- The 138 kV transmission system around ENMAX No. 65 substation

4.2 Existing System Analysis for All Scenarios – Near Term (2014)

As shown previously, analysis of the existing system under Scenarios 1 to 6 with different load/generation conditions demonstrates that under Category A and/or Category B the Reliability Criteria is not met in 2014 with no transmission developments in the study area. In this section, a summary of the thermal overloads and voltage criteria violations that occur in the study area under the six load/generation scenarios in 2014 is presented.

For convenience, Table 4-1, which contains the descriptions of the study scenarios, is reproduced as Table 4-9.

Table 4-9: Study Scenarios

Scenario	Load Condition
1	SP, no wind generation, no local generation, ~780 MW import from BC
2	SP, full wind generation, no local generation, ~0 MW import from BC
3	SP, full wind generation, Saddlebrook generation online, ~0 MW import from BC
4	SP, full wind generation, Saddlebrook and Shepard generation online, ~0 MW import from BC
5	SP, no wind generation, Saddlebrook and Shepard generation online, ~780 MW import from BC
6	System Light (SL), full wind generation, no local generation, ~0 MW import from BC

Table 4-10: 2014 All Scenarios, Study Results

Contingency	Overloaded Branch	SC1	SC2	SC3	SC4	SC5	SC6
Base Case (N-0)	917L 240kV line (Janet 74S to East Calgary 5S)	√	√	√	131% 656MVA	√	√
Base Case (N-0)	1003L 240kV line (Janet 74S to ENMAX No. 25)	√	√	√	171% 1147MVA	118% 803MVA	√
Base Case (N-0)	765L 138kV line (Janet 74S to Strathmore 151S)	103% 92MVA	√	103% 93MVA	114% 101MVA	114% 100MVA	√
Base Case (N-0)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	√	√	103% 281MVA	122% 326MVA	√	√
Base Case (N-0)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	√	√	√	101% 199MVA	√	√
Base Case (N-0)	911L 240kV line (Foothills 237S to ENMAX No. 65)	√	168% 595MVA	236% 832MVA	228% 795MVA	√	167% 612MVA
Open 937L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to Janet 74S)	√	157% 805MVA	169% 868MVA	164% 842MVA	√	150% 791MVA
Open 936L 240kV line (Langdon 102S to Janet 74S)	937L 240kV line (Langdon 102S to Janet 74S)	√	157% 805MVA	169% 868MVA	164% 842MVA	√	150% 791MVA
Open 932L 240kV line (Janet 74S to Beddington SS-162)	917L 240kV line (Janet 74S to East Calgary 5S)	√	√	108% 544MVA	152% 760MVA	104% 524MVA	√
Open 240/138 kV transformer (Janet 74S)	917L 240kV line (Janet 74S to East Calgary 5S)	√	√	107% 539MVA	145% 727MVA	103% 518MVA	√
Open 500/240 kV transformer (Langdon 102S)	1003L 240kV line (Janet 74S to ENMAX No. 25)	√	√	√	208% 1375MVA	149% 1006MVA	√
Open 917L 240kV line (Janet 74S to East Calgary 5S)	240/138 kV transformer (Janet 74S)	√	√	√	106% 425MVA	√	√
Open 917L 240kV line (Janet 74S to East Calgary 5S)	240/138 kV transformer (Janet 74S)	√	√	√	107% 426MVA	√	√
Open 240/138 kV transformer (East Calgary 5S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	√	√	√	120% 517MVA	√	√
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	√	√	√	117% 393MVA	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	√	√	√	173% 857MVA	166% 852MVA	√
Open 500/240 kV transformer (Langdon 102S)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	√	√	125% 637MVA	113% 571MVA	√	110% 570MVA
Open 765L 138kV line (Janet 74S to Strathmore 151S)	727L 138kV line (Janet 74S to Okotoks 678S)	115% 144MVA	111% 143MVA	114% 144MVA	118% 145MVA	118% 145MVA	√
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	148% 133MVA	139% 128MVA	148% 133MVA	160% 140MVA	160% 140MVA	√
Open 917L 240kV line (Janet 74S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	√	√	√	114% 303MVA	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.83L 138kV line (Janet 74S to ENMAX No. 24)	√	√	√	134% 424MVA	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	√	√	√	117% 336MVA	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	√	√	√	142% 365MVA	106% 281MVA	√
Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	√	123% 344MVA	173% 465MVA	333% 858MVA	236% 622MVA	121% 330MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformer (ENMAX No. 65)	√	√	√	153% 611MVA	113% 451MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformer (ENMAX No. 65)	√	√	√	153% 611MVA	113% 451MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	√	√	117% 233MVA	218% 416MVA	154% 298MVA	√
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	√	102% 315MVA	110% 333MVA	129% 381MVA	106% 313MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	√	√	√	140% 221MVA	101% 162MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	√	√	√	129% 205MVA	√	√
Open 500/240 kV transformer (Langdon 102S)	911L 240kV line (Foothills 237S to ENMAX No. 65)	101% 361MVA	236% 821MVA	315% 1093MVA	312% 1072MVA	165% 587MVA	243% 869MVA

To summarize, based on the need assessment study results, the following transmission paths in the study area will experience severe thermal overloads under Category B conditions in 2014:

- The 240 kV transmission path from Langdon 102S to Janet 74S to East Calgary 5S will not have sufficient capacity to supply load, accommodate additional local generation, and accommodate power transfer from southern Alberta.
- The 240 kV path from Foothills 237S to Janet 74S will not have sufficient capacity to supply load, accommodate additional local generation, and accommodate power transfer from southern Alberta. The Foothills 237S substation is assumed to be the terminating point for the approved double circuit 240 kV transmission line from Peigan 59S substation in southern Alberta. The 240 kV path from Foothills 237S to Janet 74S may still experience overloads with no wind generation in southern Alberta, depending on the system conditions.
- The 138 kV transmission system around ENMAX No. 65 substation will experience thermal overload.
- The 138 kV transmission system feeding the High River planning area will experience thermal overload.

Appropriate transmission developments to resolve these overload issues are discussed in Section 5.

The need assessment studies for 2014 also show that there are severe voltage problems in the High River planning area under the peak loading level. The area could experience voltage collapse following a single contingency, as shown in Table 4-11.

Table 4-11: Voltage Collapse in the High River Planning Area

Contingency	SC1	SC2	SC3	SC4	SC5	SC6
Open 765L 138kV line (Janet 74S to Strathmore 151S)	Voltage Collapse	Voltage Collapse	Voltage Collapse	Voltage Collapse	Voltage Collapse	√
Open 727L 138kV line (Janet 74S to Okotoks 678S)	Voltage Collapse	Voltage Collapse	Voltage Collapse	Voltage Collapse	Voltage Collapse	√

Reliability Criteria violations were also observed in north Calgary and the Strathmore/Blackie planning area. Those violations are not documented in this engineering report. The AESO is currently assessing the transmission system deficiencies in north Calgary and will address the need in a separate NID application. As documented in Section 4.1, a separate NID application will address system constraints in the Strathmore/Blackie planning area.

4.3 Existing System Analysis for All Scenarios – Long Term (2019)

In this section, a summary of all the thermal overloads and voltage violations that occur in the study area in 2019 is presented.

Table 4-12 provides a summary of all the thermal overloads under the six load/generation scenarios. The need assessment studies show the severity of thermal overloads in the long

term if the system is not appropriately reinforced. These study results were considered when determining the thermal ratings of the required transmission elements during the development of an appropriate plan to address system constraints.

As demonstrated through the FATD studies, transmission system developments will be required to meet the Reliability Criteria in 2019. The developments will allow the system to supply the load in the study area, transfer generation from southern Alberta, and integrate new local generation.

Table 4-12: 2019 All Scenarios, Contingency Analysis Results

Contingency	Overloaded Branch	SC1	SC2	SC3	SC4	SC5	SC6
Base Case (N-0)	936L 240kV line (Langdon 102S to Janet 74S)	√	152% 778MVA	159% 810MVA	151% 775MVA	√	117% 598MVA
Base Case (N-0)	937L 240kV line (Langdon 102S to Janet 74S)	√	152% 778MVA	159% 810MVA	151% 775MVA	√	117% 598MVA
Base Case (N-0)	917L 240kV line (Janet 74S to East Calgary 5S)	√	130% 647MVA	141% 698MVA	176% 876MVA	√	√
Base Case (N-0)	1003L 240kV line (Janet 74S to ENMAX No. 25)	√	√	104% 681MVA	205% 1362MVA	113% 758MVA	√
Base Case (N-0)	916L 240kV line (Sarcee 42S to East Calgary 5S)	√	√	103% 433MVA	141% 592MVA	√	√
Base Case (N-0)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	√	√	135% 676MVA	121% 614MVA	√	√
Base Case (N-0)	727L 138kV line (Janet 74S to Okotoks 678S)	117% 142MVA	109% 134MVA	107% 132MVA	123% 148MVA	112% 137MVA	√
Base Case (N-0)	765L 138kV line (Janet 74S to Strathmore 151S)	138% 120MVA	132% 116MVA	130% 115MVA	142% 123MVA	134% 118MVA	√
Base Case (N-0)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	√	128% 343MVA	142% 381MVA	157% 411MVA	102% 273MVA	√
Base Case (N-0)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	√	101% 197MVA	112% 219MVA	129% 247MVA	√	√
Base Case (N-0)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	√	√	102% 303MVA	115% 331MVA	√	√
Base Case (N-0)	911L 240kV line (Foothills 237S to ENMAX No. 65)	√	294% 1019MVA	363% 1258MVA	346% 1200MVA	101% 351MVA	227% 788MVA
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	500/240 kV transformer (Langdon 102S)	√	114% 1373 MVA	137% 1649 MVA	131% 1573 MVA	√	√
Open 937L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to Janet 74S)	√	279% 1430MVA	293% 1490MVA	278% 1428MVA	√	213% 1092MVA
Open 936L 240kV line (Langdon 102S to Janet 74S)	937L 240kV line (Langdon 102S to Janet 74S)	√	279% 1430MVA	293% 1490MVA	278% 1428MVA	√	213% 1092MVA
Open 932L 240kV line (Janet 74S to Beddington SS-162)	917L 240kV line (Janet 74S to East Calgary 5S)	√	153% 756MVA	166% 818MVA	209% 1031MVA	105% 522MVA	114% 570MVA
Open 240/138 kV transformer (Janet 74S)	917L 240kV line (Janet 74S to East Calgary 5S)	√	147% 729MVA	158% 781MVA	195% 967MVA	105% 524MVA	107% 534MVA
Open 500/240 kV transformer (Langdon 102S)	1003L 240kV line (Janet 74S to ENMAX No. 25)	√	134% 872MVA	170% 1087MVA	269% 1765MVA	142% 951MVA	117% 777MVA
Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	101% 403MVA	117% 469MVA	120% 481MVA	128% 511MVA	109% 437MVA	√
Open 240/138 kV transformer (East Calgary 5S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	√	115% 491MVA	128% 543MVA	168% 713MVA	√	√
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	√	125% 420MVA	128% 431MVA	149% 499MVA	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	√	√	√	√	169% 853MVA	√
Open 500/240 kV transformer (Langdon 102S)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	√	174% 865MVA	220% 1076MVA	205% 1019MVA	√	152% 772MVA
Open 765L 138kV line (Janet 74S to Strathmore 151S)	727L 138kV line (Janet 74S to Okotoks 678S)	174% 212MVA	166% 204MVA	163% 201MVA	182% 219MVA	169% 207MVA	√
Open 727L 138kV line (Janet 74S to Okotoks 678S)	850L 138kV line (Janet 74S to Carseland 525S)	145% 131MVA	140% 128MVA	139% 128MVA	149% 133MVA	142% 129MVA	√
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	199% 172MVA	192% 168MVA	190% 167MVA	206% 176MVA	195% 170MVA	117% 101MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	√	116% 307MVA	124% 328MVA	149% 381MVA	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.83L 138kV line (Janet 74S to ENMAX No. 24)	√	√	√	178% 537MVA	√	√
Open 917L 240kV line (Janet 74S to East Calgary 5S)	2.80L 138kV line (ENMAX No. 2 to ENMAX No. 23)	√	√	√	120% 308MVA	√	√

Contingency	Overloaded Branch	SC1	SC2	SC3	SC4	SC5	SC6
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	833L 138kV line (ENMAX No. 2 to ENMAX No. 12)	√	√	√	108% 205MVA	√	√
Open 917L 240kV line (Janet 74S to East Calgary 5S)	2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	√	100% 292MVA	112% 325MVA	139% 391MVA	√	√
Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	√	124% 330MVA	134% 359MVA	146% 382MVA	103% 276MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	√	212% 558MVA	260% 679MVA	431% 1060MVA	236% 621MVA	163% 426MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformer (ENMAX No. 65)	√	105% 418MVA	125% 500MVA	195% 781MVA	115% 459MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformer (ENMAX No. 65)	√	105% 418MVA	125% 500MVA	195% 781MVA	115% 459MVA	√
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	31.84L 138kV line (ENMAX No. 31 to ENMAX No. 32)	√	101% 162MVA	105% 170MVA	114% 180MVA	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	√	146% 283MVA	175% 339MVA	281% 507MVA	148% 286MVA	116% 235MVA
Open 917L 240kV line (Janet 74S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	√	144% 421MVA	154% 453MVA	182% 516MVA	114% 330MVA	√
Open 917L 240kV line (Janet 74S to East Calgary 5S)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	√	109% 175MVA	119% 192MVA	142% 222MVA	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	√	√	√	164% 245MVA	√	√
Open 500/240 kV transformer (Langdon 102S)	911L 240kV line (Foothills 237S to ENMAX No. 65)	101% 351MVA	426% 1479MVA	511% 1775MVA	491% 1705MVA	164% 569MVA	327% 1134MVA

A comparison of the 2019 study results shown in Table 4-12 with the 2014 study results shown in Table 4-10 indicates that the severity of the thermal overloads in 2019 is significantly higher than the severity of the thermal overloads in 2014. This is due to the forecasted load growth in the study area and the increased transmission of power from southern Alberta.

The 240 kV paths that will experience thermal overloads in 2014 will experience severe thermal overloads in 2019. Also, the 138 kV system around ENMAX No. 65 substation and the feeders to the High River planning area will be severely overloaded.

Part of the system will experience voltage collapse under several critical N-1 contingencies in 2019. When a voltage collapse occurs in an area there is no steady state operating point. Therefore, it is not possible to analyze the system further to identify the needed system capacity. As described in Section 4.1, provisional SVCs were modeled at several critical locations in the system to prevent voltage collapse and facilitate the assessment of the overload issues in the study area.

4.4 Summary and Conclusions of the Need Assessment Studies

Based on the presented need assessment study results, the study area will experience several thermal overloads under Category A and Category B system conditions in 2014. The identified thermal overloads are due to one or more of the following factors in the study area, depending on the system condition being studied:

- Steady load growth
- Insufficient transmission capacity to allow power flow from southern Alberta to the load centres
- Insufficient transmission capacity to integrate new local generation

Consequently, the following 240 kV and 138 kV transmission paths will need to be reinforced in 2014 to ensure system reliability. The systems identified below are severely overloaded under Category B conditions, and in some cases overloads are experienced under Category A conditions:

- The 240 kV transmission path from Langdon 102S to Janet 74S to East Calgary 5S
- The 240 kV transmission path from Foothills 237S to Janet 74S
- The 138 kV transmission system around ENMAX No. 65 substation
- The 138 kV transmission system supplying the High River planning area

During the summer peak loading condition there is a risk of voltage collapse in the High River planning area following a single contingency. The voltage issue is due to the forecasted load growth in the area and an inadequate transmission supply connecting this area to the AIES.

The need assessment studies demonstrate that both thermal overload and voltage violations are significantly increased by 2019. Therefore, to facilitate assessment of the system constraints considering thermal overload violations only, provisional SVCs were modeled at a number of locations in the system.

5. SYSTEM DEVELOPMENTS TO ADDRESS THE NEED

In the previous section, the need assessment study results were presented and discussed, and the need for system developments in the study area was established. In this section, an overview of the planning process used for the FATD plan is provided and transmission developments to resolve system constraints are identified.

The following four phases provide a general view of the planning process used for the FATD:

1. Examine transmission technologies and their suitability for implementation in the study area.
2. Formulate a suitable transmission alternative in steps that will address the identified system needs using selected transmission technologies from Phase 1.
3. Study the formulated transmission developments in each step to ensure the proposed transmission developments are the minimum developments required to completely address system needs up to 2019.
4. Perform a detailed analysis of the proposed alternative to show that it resolves all identified constraints up to 2019 and meets the Reliability Criteria.

Section 5 discusses Phase 1 and Phase 2 of the planning process in detail. Phase 3 is discussed in Section 6 (near-term assessment) and Section 7 (long-term assessment). Phase 4 is discussed in Section 8.

5.1 Transmission Technologies

A number of transmission technologies were considered for the development of the system in the study area. The following options were considered suitable to resolve system deficiencies in the study area and comply with the Reliability Criteria in the near term (2014) and the long term (2019):

- New Alternating Current (AC) transmission lines
- Transmission line reconfigurations, upgrades, and/or re-builds
- Voltage up-rating, such as conversion of existing 138 kV transmission to 240 kV
- New transformer substations and/or substation upgrades
- Reactive power support, such as capacitor banks and/or SVCs

Various factors were considered when selecting transmission technologies, including:

- Consistency with the AESO's long-term plans
- Flexibility for future expansion
- Compatibility with the existing transmission systems in the area and in the neighboring areas as well as compatibility with developments approved for the neighboring areas

- Applicability of technology
- Construction and maintenance

AC transmission lines are among the most viable options to solve thermal overload and voltage problems. In Alberta, 240 kV and 500 kV transmission lines are used in the AIES backbone system. However, the existing 240 kV backbone system that connects the study area to southern Alberta is insufficient, as has been determined in the approved SATR application. The results in Section 4 support the SATR assessment. The transmission system in the study area consists of 138 kV and 240 kV transmission lines. Therefore, 138 kV and 240 kV voltage classes are prudent choices where new transmission lines are needed in the area. Single circuit and double circuit transmission lines were considered based on the need.

Reconfiguring, upgrading and/or rebuilding the existing transmission lines were considered when planning transmission developments in the area. These options were considered based on their feasibility and on discussions with the TFOs in the study area.

Voltage up-rating from 138 kV to 240 kV can increase the capacity of a transmission line by the ratio of the two voltages. This option is relatively convenient, particularly for existing lines built using 240 kV standards that can be easily re-energized at 240 kV. The existing line re-energized at 240 kV must be terminated at 240 kV substations at both ends.

New substations will add additional capacity to the transmission system and serve as strong sources to support the transmission system. New substations can be configured as hubs to facilitate power flow diversity that will alleviate congestion from already stressed transmission paths, and as a consequence, improve the system voltage profile. Additional local reactive power support may be required to further support the voltage and to meet the Reliability Criteria.

5.2 Methodology to Plan a Transmission Alternative

The proposed transmission developments in the study area are were planned in four steps. Each step deals with a constrained transmission path. As presented in Section 4 the following 240 kV and 138 kV transmission system in the study area are constrained under Category A and/or Category B conditions:

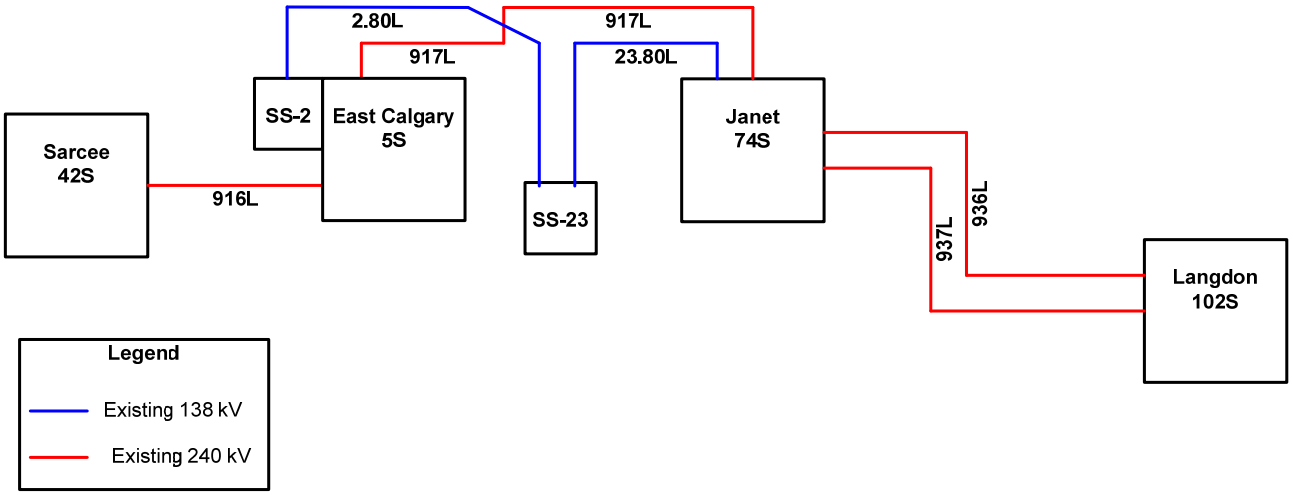
- The 240 kV transmission path from Langdon 102S to Janet 74S to East Calgary 5S
- The 240 kV transmission path from Foothills 237S to Janet 74S
- The 138 kV system that connects the High River planning area to the AIES
- The 138 kV transmission system around ENMAX No. 65 substation

The developments proposed at each step aim to alleviate the congestion on a specific path. Sections 5.2 to 5.5 explain each step of the development plan. The figures used to illustrate each step of the transmission development plan are only intended to show simplified electrical connections; they are not to scale, nor do they depict the line routes or substation locations. The performance of each step of the transmission development plan is discussed in Sections 6 and 7.

5.3 Step 1: Reinforcement of the 240 kV Transmission Path from Langdon 102S to Janet 74S to East Calgary 5S

Figure 5-1 shows a diagram of the existing 240 kV transmission path from Langdon 102S to Janet 74S to East Calgary 5S. The ratings of the existing lines are given in Section 2.5.

Figure 5-1: Existing 240 kV Transmission Path Langdon 102S to Janet 74S to East Calgary 5S



The need assessment study demonstrated that the existing path from Langdon 102S to Janet 74S to East Calgary 5S will be severely constrained under Category B conditions. The following transmission developments are proposed to address the system needs considering the selected transmission technologies from Phase 1 and discussions with the TFOs.

Figure 5-2 shows the transmission developments in Step 1.

- Re-energize the existing 2.80L (ENMAX No. 2 substation to ENMAX No. 23 substation) and 23.80L (ENMAX No. 23 substation to Janet 74S substation) at 240 kV. These lines were built using the 240 kV standards. To free these lines for re-energization at 240 kV it is proposed to build new 138 kV lines from ENMAX No. 2 substation to ENMAX No. 23 substation (designated 2.80L) and from ENMAX No. 23 substation to Janet 74S substation (designated 23.80L).
- Build two 240 kV connections from East Calgary 5S to Langdon 102S designated 936L and 937L by using the following existing lines:
    i. Connect 2.80L energized at 240 kV to sections of 917L and 936L to form a transmission line from East Calgary 5S to Langdon 102S called 936L.
    ii. Connect the remaining sections of 917L to 23.80L (energized at 240 kV) and 937L to form a transmission line from East Calgary 5S to Langdon 102S called 937L.
- Build a new 240 kV double circuit line from Langdon 102S to Janet 74S designated 1064L and 1065L.

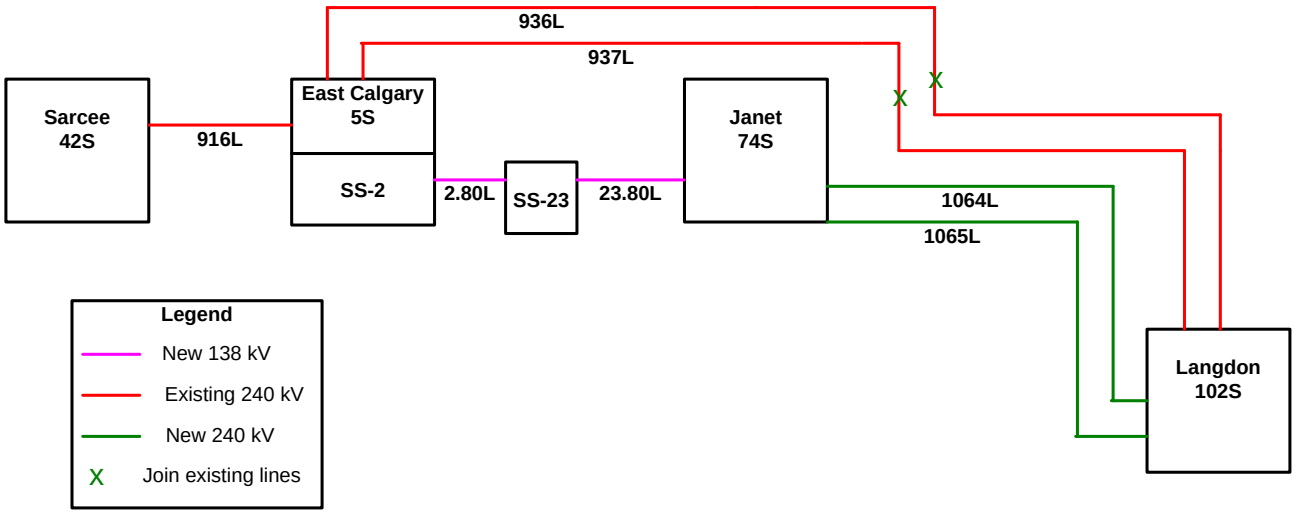
- Replace the existing 240/138 kV 336 MVA transformer at East Calgary 5S with two new 400 MVA transformers.
- Expand the existing ENMAX No. 2 substation to connect to the new 400 MVA transformer at East Calgary 5S substation.

The required minimum ratings of the lines are presented in Section 8, where the detailed studies performed on the proposed alternative are discussed.

The described development helps reduce the system dependency on the Janet 74S substation to supply Calgary's load. This is achieved by providing an alternate path to direct power from Langdon 102S to East Calgary 5S.

The results of the power flow analysis that considered the transmission developments in Step 1 are given in Section 6 for the near term (2014) and Section 7 for the long term (2019).

Figure 5-2: Step 1 - 240 kV Path Langdon 102S to Janet 74S to East Calgary 5S



5.4 Step 2: Reinforcement of the 240 kV Transmission Path from Janet 74S to Foothills 237S

The simplified system configuration following Step 1 is shown in Figure 5-3. In Step 1, transmission developments to improve the system transfer capability from Langdon 102S to Janet 74S and East Calgary 5S were proposed. However, further system developments are needed to resolve overload issues on the 240 kV path from Foothills 237S to Janet 74S.

In Step 2, it is proposed to reinforce the 240 kV path between Janet 74S and Foothills 237S. This development is expected to address the system need considering selected transmission technologies from Phase 1 and discussions with the TFOs. As part of this development, construction of the Foothills 237S substation is required. Figure 5-4 shows the proposed transmission developments in Step 2. This diagram contains a simplified representation of the system. It is not to scale.

- Build two new 240 kV double circuit transmission lines from Janet 74S to ENMAX No. 25 (Shepard Energy Centre plant) substation designated 985L and 1003L.
- Use sections of the existing 240 kV transmission line 911L to connect ENMAX No. 25 substation to ENMAX No. 65 substation. The new line number is 1080L. The remaining portions of the existing 911L on the north side (from Janet 74 substation) will be de-energized or salvaged as determined prudent by the TFO.
- Build an additional 240 kV transmission line from ENMAX No. 25 substation to ENMAX No. 65 substation. This new line is designated 1109L.
- Build a new 240/138 kV substation in the Municipal District (MD) of Foothills designated Foothills 237S substation. This new substation is initially needed to terminate the 240 kV double circuit lines from Peigan 59S as part of the SATR project. The substation will be used in Step 3 of the transmission plan to resolve system issues in the High River planning area and utilized in Step 4 to branch out the power flow and alleviate transmission constraints. Foothills 237S substation will improve system voltage performance by serving as a strong source in the area to reliably supply load and divert power flow from the stressed paths. This substation is configured to be used in the future as a hub to connect new generation plants and new transmission lines to the AIES. The substation will include two 240/138 kV 400 MVA transformers.
- Build a new 240 kV double circuit line from ENMAX No. 65 substation to Foothills 237S substation designated 1106L and 1107L.

The required minimum ratings for the proposed new lines are given in Section 8. Results of the power flow analysis with Step 2 of the development modeled are provided in Section 6 for the near term (2014) and Section 7 for the long term (2019).

Figure 5-3: Simplified System Configuration after Step 1

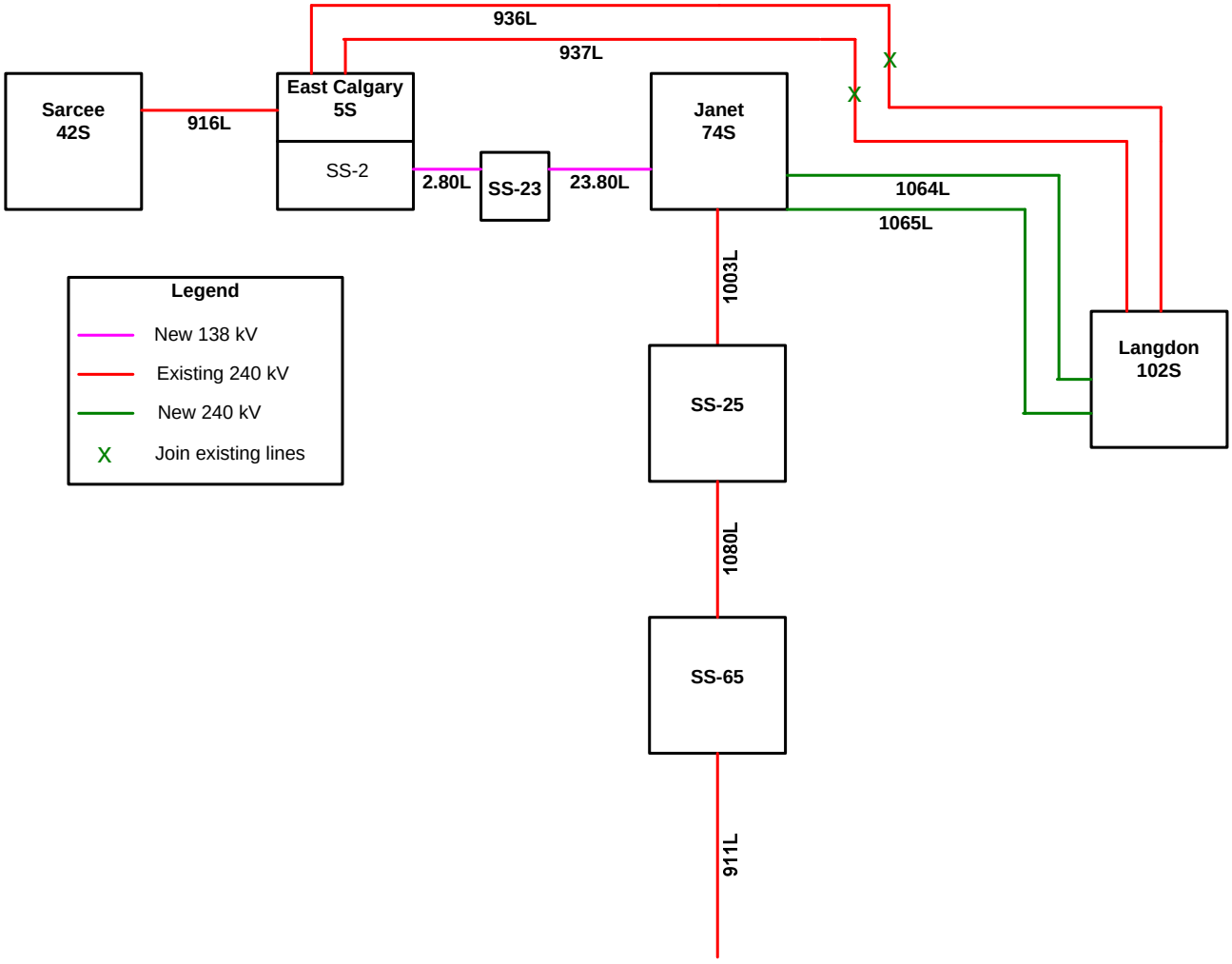
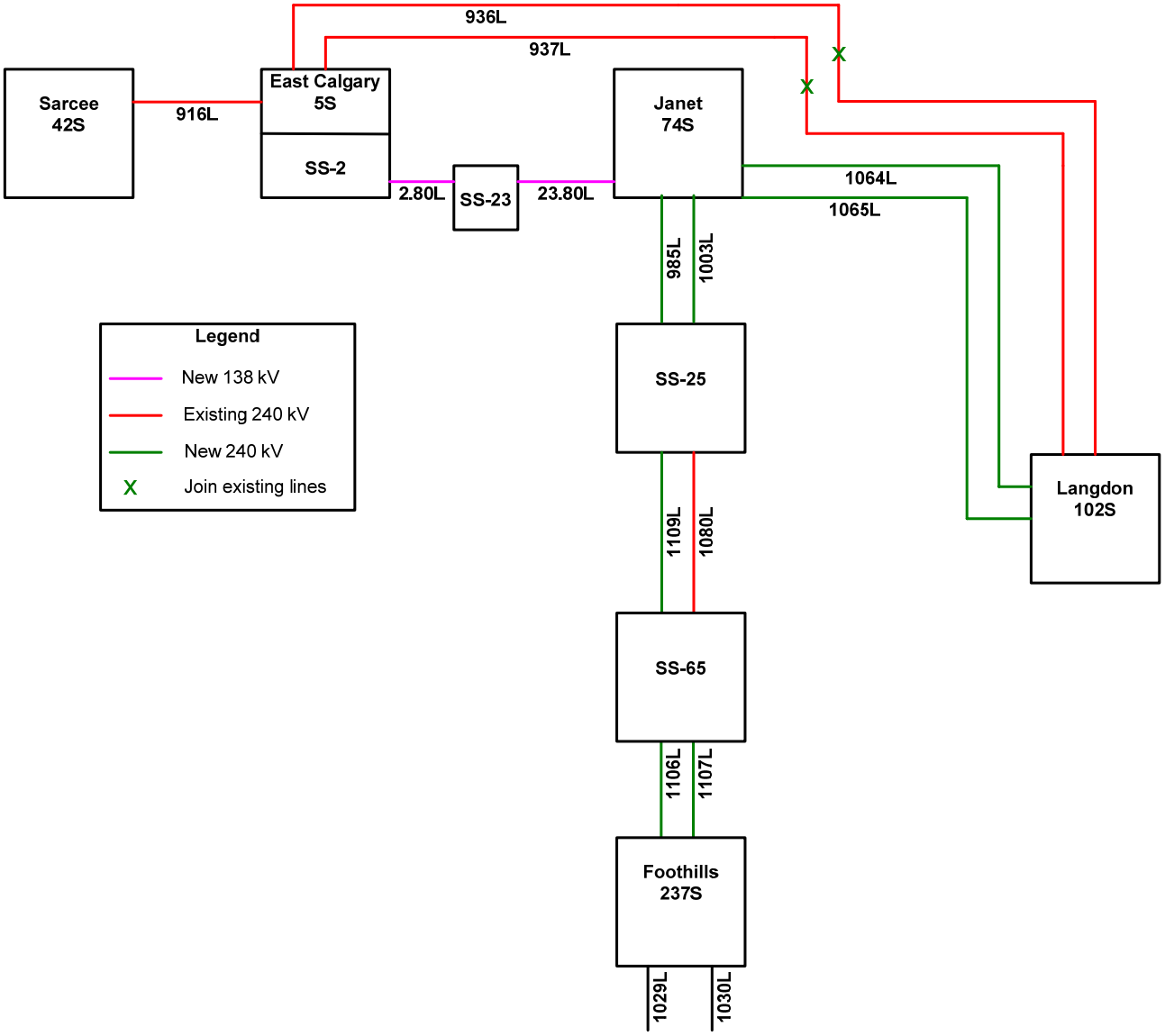


Figure 5-4: Simplified System Configuration after Step 2

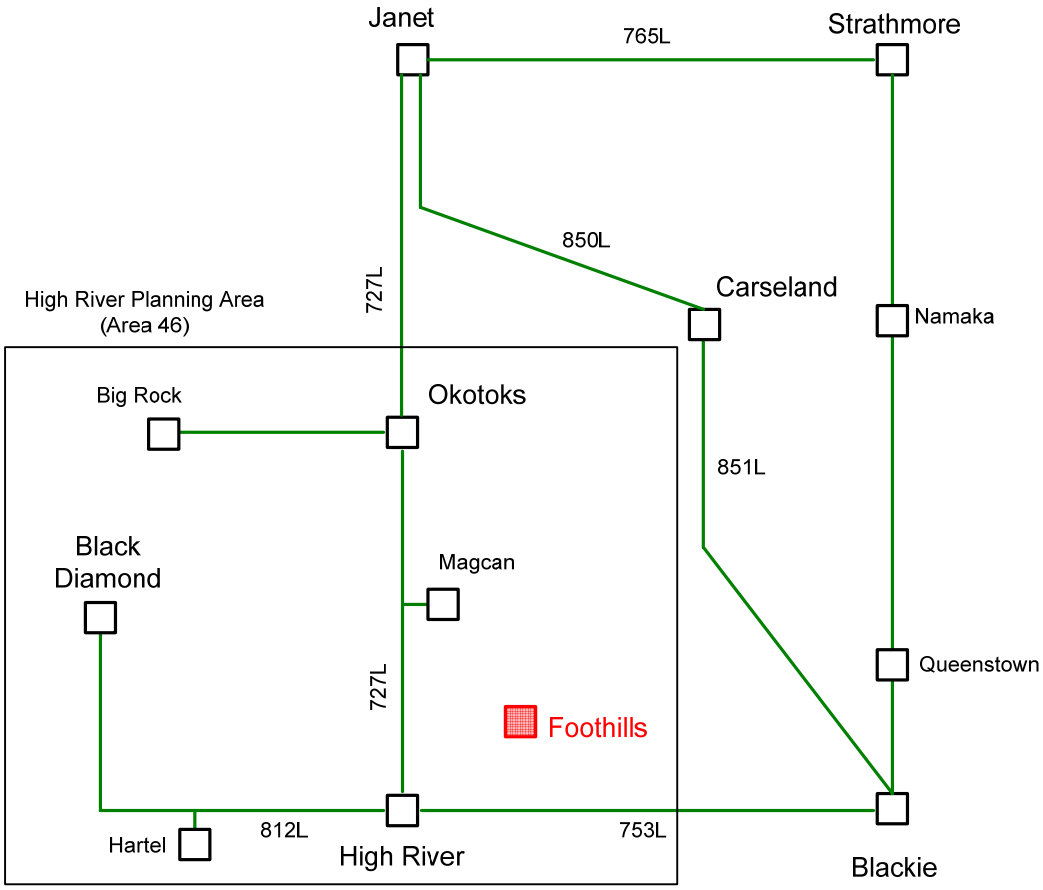


5.5 Step 3: 138 kV Development in the High River Planning Area

Step 3 of the transmission plan focuses on resolving the thermal overload and voltage problems in the High River planning area. Figure 5-5 shows a simplified diagram of the existing 138 kV transmission system in the area and the 138 kV transmission lines supplying the area load. In the existing system the area is supplied by two 138 kV lines: 727L and 753L.

Figure 5-5 contains a simplified representation of the system configuration. It is not to scale.

Figure 5-5: Existing System High River Planning Area (Area 46) in 2014



As demonstrated in the need assessment studies, load in the High River planning area cannot be supplied reliably in 2014 due to the insufficient 138 kV transmission system connecting this area to the AIES. For the need assessment studies in 2019, provisional SVCs were modeled to prevent voltage collapse following the outage of 727L from Janet 74S to Okotoks 678S or the outage of 765L from Janet 74S to Strathmore 151S.

In this step, several potential transmission system developments were considered. Preliminary study results showed that the Foothills 237S substation will serve the area load reliably, primarily due to its location and proposed connectivity to the AIES. Among all the

tested potential solutions, only three transmission alternatives met the Reliability Criteria and were determined to be viable (Table 5-1). Diagrams of the proposed 138 kV alternatives are shown in Figure 5-6 (additional 138 kV lines are only shown).

Table 5-1: Viable Alternatives to Reinforce the High River Planning Area

Alternative	Description
1	Two single circuit 138 kV transmission lines: One from Foothills 237S to Okotoks 678S and one from Foothills 237S to High River 65S.
2	A double circuit 138 kV line from Foothills 237S to High River 65S; and, a new single circuit 138 kV line from Okotoks 678S to High River 65S.
3	A double circuit 138 kV line from Foothills 237S to Okotoks 678S; and, a new single circuit 138 kV from Okotoks 678S to High River 65S.

The developments proposed in Step 3 are expected to address the system need considering the selected transmission technologies and discussions with the TFOs. The following transmission developments are proposed in Step 3.

- Connect the existing 138 kV transmission line 727L to sections of the existing 850L approximately where 850L turns east (south of ENMAX No. 65 substation) to connect Okotoks 678S to Carseland 525S, as shown in Figure 5-7. This line is designated 850L. The northern sections of the existing 727L will be de-energized or salvaged as determined by the TFO.
- Re-energize sections of the existing 850L (Janet 74S to Carseland 525S) at 240 kV to connect ENMAX No. 25 substation to ENMAX No. 65 substation (designated 1109L). Sections of the existing 850L were built using the 240 kV standards. Therefore, these sections of the existing 850L line could serve as the new line between ENMAX No. 25 substation and ENMAX No. 65 substation as described in Item 3 of Step 2 in the transmission development plan.
- De-energize or salvage the remaining portion of the existing 850L to the north side (from Janet 74S substation) as determined prudent by the TFO.
- The 138 kV transmission lines connecting Foothills 237S to Okotoks 678S and High River 65S are designated 646L and 434L, respectively.
- The new 138 kV transmission line connecting Okotoks 678S to High River 65S is designated 431L.

The existing 911L in this area will be de-energized upon completion of the SATR project. Therefore, sections of this line could, where suitable, be used to achieve the connectivity described in Table 5-1.

The required minimum ratings for the proposed new lines are given in Section 8. Results of the power flow analysis with Step 3 of the development modeled are provided in Section 6 for the near term (2014) and in Section 7 for the long term (2019).

Figure 5-6: Diagrams of 138 kV Transmission Alternatives in the High River Planning Area

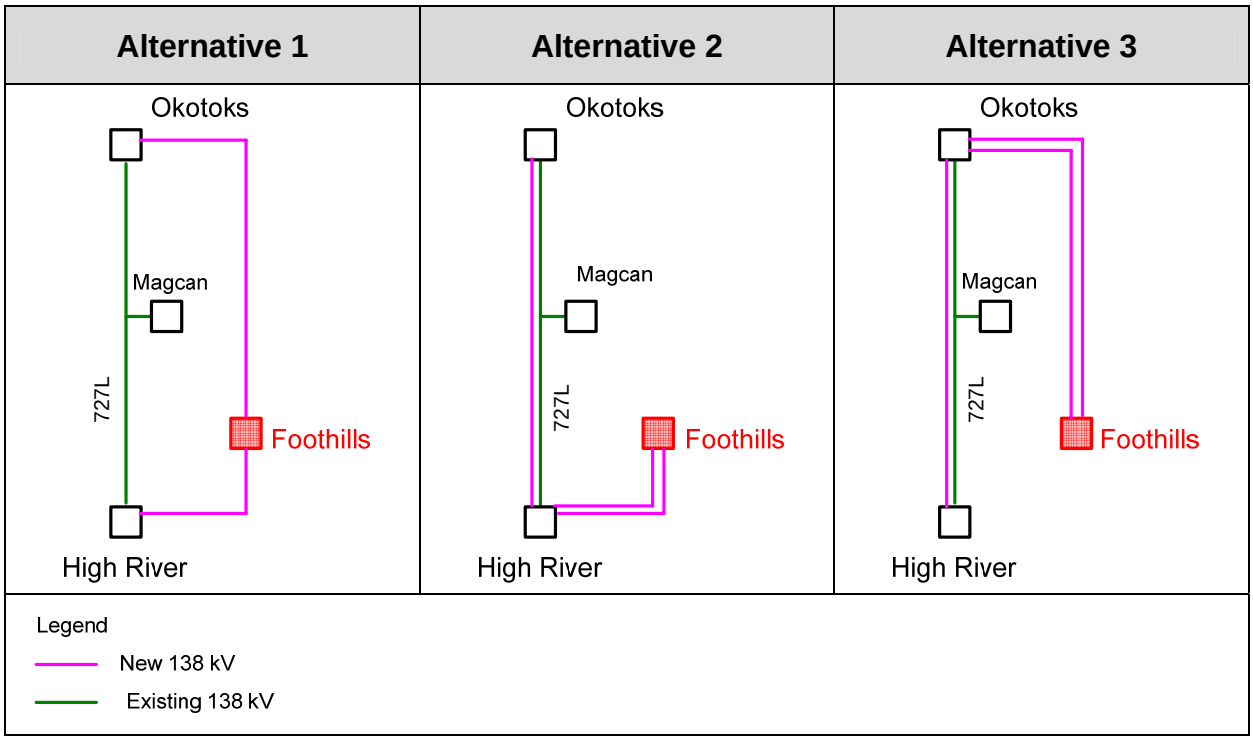
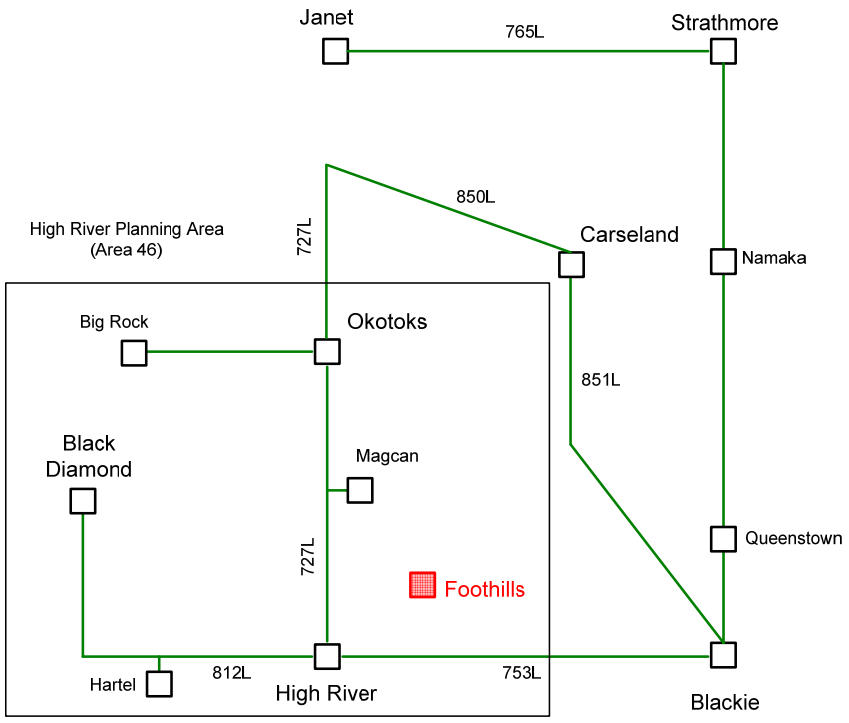


Figure 5-7: 138 kV Transmission Lines in High River Area after Connecting 727L and 850L (Alternatives 1 to 3 are presented in the above figure)



5.6 Step 4: Creation of a Second Path between Foothills and Calgary

Based on the need assessment study results, it is anticipated that one double circuit 240 kV transmission line out of Foothills substation will not be sufficient to resolve all identified system constraints. Therefore, in Step 4 a second 240 kV transmission path from Foothills 237S substation is proposed to alleviate congestion from the 240 kV Foothills 237S substation to the Janet 74S substation following a Category B contingency. There are two potential paths to branch out power flow at Foothills 237S substation:

(a) A new 240 kV double circuit transmission line from Foothills 237S to Sarcee 42S

(b) A new 240 kV double circuit transmission line from Foothills 237S to Langdon 102S

Preliminary study results showed that since there are no loads at Langdon, the power flow from Foothills 237S substation to Langdon 102S substation will be transferred to the Janet 74S substation and the East Calgary 5S substation. Consequently, the injected power at Langdon 102S will cause increased stress on that path and thermal overloads on the lines under a Category B system condition. Therefore, only Option (a) was proposed for further analysis.

In this step, transmission developments are proposed to remove the 138 kV system congestion around ENMAX No. 65 substation. This is because some of the power being carried on the 240 kV transmission system is injected to the nearby 138 kV system at ENMAX No. 65 substation. To resolve the 138 kV overloads around ENMAX No. 65 substation, a new 138 kV line is required from ENMAX No. 65 substation to ENMAX No. 41 substation with an in and out configuration at ENMAX No. 54 substation. The new line is designated 54.81L between ENMAX No. 65 substation and ENMAX No. 54 substation and designated 41.84L between ENMAX No. 54 substation and ENMAX No. 41 substation.

In summary, the following transmission developments are proposed in Step 4:

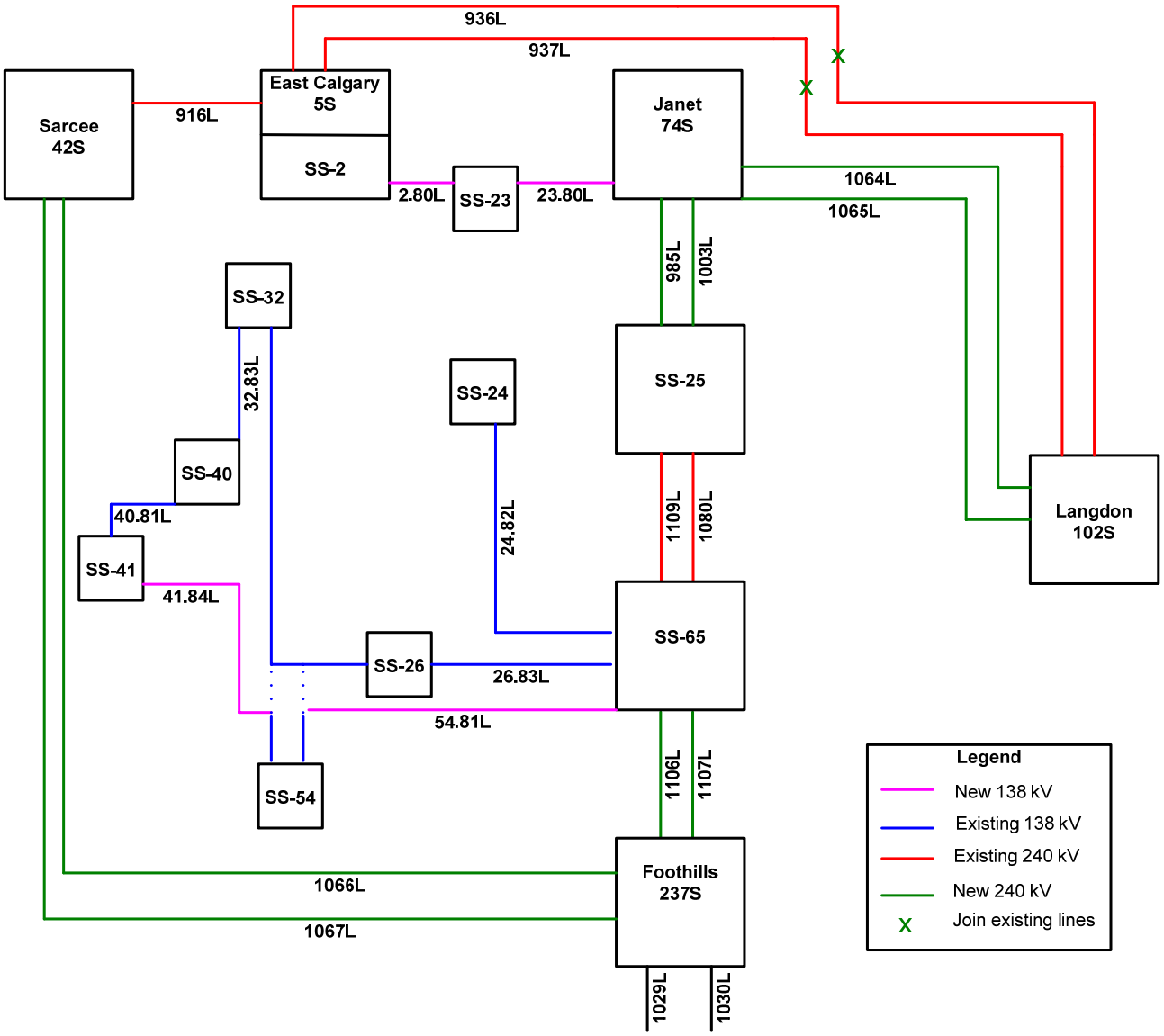
- Build a new 240 kV double circuit transmission line from Foothills 237S to Sarcee 42S designated 1066L and 1067L.
- Build a new 138 kV transmission line from ENMAX No. 65 substation to ENMAX No. 54 substation and from ENMAX No. 54 substation to ENMAX No. 41 substation designated 54.81L and 41.84L, respectively.
- Reconnect ENMAX No. 26 substation to ENMAX No. 32 substation. Currently, these two substations are connected through the existing 26.81L 138 kV line. The ENMAX No. 54 substation project connects the substation in and out of line 26.81L. Step 4 of the transmission plan proposes to restore the original connectivity between ENMAX No. 26 substation and ENMAX No. 32 substation.

Figure 5-8 shows the system configuration after the addition of Step 4 of the transmission plan. The 138 kV transmission developments in the High River area are not shown. Figure 5-8 contains a simplified representation of the system configuration. Technical details are simplified for illustration purposes. It does not indicate geographical locations of facilities.

Power flow study results are provided in Section 6 for the near term (2014) and Section 7 for the long term (2019).

Section 8 shows that the Reliability Criteria will be met when the proposed FATD plan (Step 1 to Step 4) is implemented.

Figure 5-8: Step 4 of Developing the FATD Plan



5.7 Summary and Conclusions

Implementing Steps 1 to 4 of the transmission plan provides a robust solution with the following characteristics:

- Optimize utilization of the existing transmission system capacity
- Balance flows on the 240/138 kV transformers at the Janet 74S, East Calgary 5S, Sarcee 42S, and ENMAX No. 65 substations
- Provide additional capacity to the system to maintain system reliability

- Achieve acceptable system performance under Category A, and Category B conditions
- Facilitate future development in the area when it is required

The described development helps reduce the system dependency on the Janet 74S substation to supply the Calgary load. This is achieved by providing an alternate path to direct power from Langdon 102S substation to East Calgary 5S substation.

The Calgary area load is mainly supplied by the Janet 74S, East Calgary 5S, Sarcee 42S, and ENMAX No. 65 substations in 2014 and beyond. The proposed FATD transmission plan will create a 240 kV transmission loop that securely connects these source substations. This configuration will facilitate balancing the power flow on the transformers supplying the Calgary load.

The FATD plan also provides a strong supply to the High River planning area.

6. TRANSMISSION DEVELOPMENT PLAN – NEAR-TERM ASSESSMENT

As discussed in Section 5, a transmission plan to address the identified system constraints has been developed. Each step of the transmission plan is expected to resolve the congestion of a main path in the study area. The complete transmission plan (Steps 1 to 4) is meant to alleviate all the Reliability Criteria violations in the study area, which were identified in the need assessment.

In this section, system performance following incremental transmission developments at each step is analyzed for the near term assessment (2014). The improvement in system performance at each step of the proposed FATD plan is demonstrated by comparing the results following each step with the identified overloads in the existing system prior to the transmission developments.

A summary of the study results for the critical system constraints is presented. Attachments C to F provide power flow diagrams for the reported critical contingencies in 2014 at each step of the transmission plan. It is demonstrated that all identified constraints in the study area are alleviated following Step 4 of the proposed transmission plan.

6.1 Study Assumptions and Methodology

The following load flow studies were performed for the study area at each step of the FATD transmission plan:

- All transmission elements in service (Category A or N-0 conditions)
- One transmission element out of service (Category B or N-1 conditions)

A brief description of the study scenarios is provided in Table 6-1 for reference. These are the same scenarios studied for the need assessment.

Table 6-1: Study Scenarios

Scenario	Load Condition
1	SP, no wind generation, no local generation, ~780 MW import from BC
2	SP, full wind generation, no local generation, ~0 MW import from BC
3	SP, full wind generation, Saddlebrook generation online, ~0 MW import from BC
4	SP, full wind generation, Saddlebrook and Shepard generation online, ~0 MW import from BC
5	SP, no wind generation, Saddlebrook and Shepard generation online, ~780 MW import from BC
6	SL, full wind generation, no local generation, ~0 MW import from BC

As explained in Section 5, the Foothills 237S substation is modeled as a terminus point of the double circuit lines from Peigan 59S in Step 1 of the transmission plan.

The thermal line ratings and the size of the new transformers at East Calgary 5S and Foothills 237S substations were assumed based on the 2019 need assessment results. The required ratings were determined upon completion of the near term and long term assessment of the FATD plan and are shown in Section 8.

6.2 Impact of Each Step of the Transmission Plan in 2014 – Branch Loading

Table 6-2 provides the thermal loading results of the existing system and the system performance following each step of the transmission plan in 2014. Based on the need assessment results, the scenarios that caused the maximum flow on critical circuits in the study area were selected for the table. Power flow diagrams are shown in Attachments C to F.

The results provided in Step 3 of the transmission plan are applicable for all 138 kV transmission alternatives in the High River planning area.

As expected, system performance improves progressively as system developments are implemented at every step of the transmission plan. The study results show that it is only at Step 4 that all the identified thermal overload violations in the study area are resolved.

The terminology in Table 6-2 is as follows:

- Contingency: the outage that causes the maximum loading on a critical circuit in the existing system (2014 prior to any system developments in the study area).
- Critical Circuit: the circuit (line or transformer) that experiences the maximum flow in the existing system (need assessment).
- Scenario: the scenario that causes the maximum flow.
- Need: the need assessment study results.
- Step 1 to Step 4: the loading that is applicable (based on the step of development). An “N/A” entry means that a specific circuit or contingency does not exist in that configuration.
- Check mark: indicates loading of less than 80% in this table.
- New line numbers were used as specified in Section 5.

Table 6-2: Loading on Critical Lines in the Study Area for 2014

Contingency	Critical Circuit	Scenario	Need	Step 1	Step 2	Step 3	Step 4
Open 937L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to Janet 74S)	SC3	169% 868MVA	N/A	N/A	N/A	N/A
Open 936L 240kV line (Langdon 102S to Janet 74S)	937L 240kV line (Langdon 102S to Janet 74S)	SC3	169% 868MVA	N/A	N/A	N/A	N/A
Open 240/138 kV transformer (Janet 74S)	917L 240kV line (Janet 74S to East Calgary 5S)	SC4	145% 727MVA	N/A	N/A	N/A	N/A
Open 500/240 kV transformer (Langdon 102S)	1003L 240kV line (Janet 74S to ENMAX No. 25)	SC4	208% 1375MVA	205% 1361MVA	√	√	√
Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	103% 410MVA	98% 392MVA	102% 406MVA	89% 355MVA	√
Open 240/138 kV transformer (East Calgary 5S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	SC4	120% 517MVA	99% 426MVA	99% 426MVA	97% 417MVA	√
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	117% 393MVA	87% 293MVA	88% 294MVA	84% 283MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	SC4	173% 857MVA	171% 855MVA	√	√	√
Open 765L 138kV line (Janet 74S to Strathmore 151S)	727L 138kV line (Janet 74S to Okotoks 678S)	SC4	118% 145MVA	118% 145MVA	117% 145MVA	N/A	N/A
Open 765L 138kV line (Janet 74S to Strathmore 151S)	850L 138kV line (Janet 74S to Carseland 525S)	SC4	97% 89MVA	95% 88MVA	95% 88MVA	N/A	N/A
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	SC4	160% 140MVA	158% 139MVA	157% 138MVA	N/A	N/A
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.83L 138kV line (Janet 74S to ENMAX No. 24)	SC4	134% 424MVA	132% 425MVA	√	√	√
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	833L 138kV line (ENMAX No. 2 to ENMAX No. 12)	SC4	√	90% 178MVA	91% 180MVA	92% 183MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	117% 336MVA	103% 299MVA	√	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	142% 365MVA	135% 351MVA	√	√	√
Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	111% 298MVA	106% 284MVA	98% 262MVA	92% 246MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	333% 858MVA	318% 828MVA	√	√	√
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	164% 439MVA	156% 417MVA	143% 383MVA	130% 349MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformer (ENMAX No. 65)	SC4	153% 611MVA	147% 589MVA	√	√	√
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	31.84L 138kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	87% 142MVA	87% 142MVA	85% 140MVA	87% 142MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	218% 416MVA	197% 380MVA	√	√	√
Open 23.80L 138kV line (Janet 74S to ENMAX No. 23)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	138% 270MVA	119% 235MVA	116% 228MVA	122% 240MVA	80% 156MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	144% 412MVA	130% 378MVA	√	√	√
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	129% 381MVA	120% 356MVA	117% 346MVA	119% 353MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	140% 221MVA	132% 211MVA	√	√	√
Open 9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	106% 173MVA	100% 163MVA	95% 157MVA	96% 158MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	129% 205MVA	121% 194MVA	√	√	√
Open 500/240 kV transformer (Langdon 102S)	911L 240kV line (Foothills 237S to ENMAX No. 65)	SC3	315% 1093MVA	308% 1064MVA	√	√	√
Open 937L 240kV line (Langdon 102S to East Calgary 5S)	936L 240kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	109% 559MVA	109% 559MVA	105% 541MVA	√
Open 936L 240kV line (Langdon 102S to East Calgary 5S)	937L 240kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	109% 559MVA	109% 559MVA	105% 541MVA	√
Open 985L 240kV line (Janet 74S to ENMAX No. 25)	1003L 240kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	N/A	115% 1186MVA	107% 1099MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	985L 240kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	N/A	115% 1186MVA	107% 1099MVA	√

Table 6-3 provides a summary of the critical lines that are overloaded and the step in the development plan that resolves the constraint.

Table 6-3: Major Overloads Resolved at each Step of the FATD Plan in 2014

Overloaded Path	Issue in the Existing System	Development Plan
Langdon 102S to Janet 74S, 240 kV	Overloaded up to ~ 69% for N-1 contingency	Step 1
Janet 74S to East Calgary 5S, 240 kV	Overloaded up to ~ 31% under N-0	Step 1
East Calgary, 240/138 kV Transformer	Overloaded up to ~ 17% for N-1 contingency	Step 1
ENMAX No. 65, 240/138 kV Transformer	Overloaded up to ~ 53% for N-1 contingency	Step 1
East Calgary 5S to Sarcee 42S	Overloaded up to ~ 20% for N-1 contingency	Step 1
ENMAX No. 25 to ENMAX No. 65 substation, 240 kV	Overloaded up to ~ 73 MVA for N-1 contingency	Step 2
Foothills 237S to ENMAX No. 65 substation, 240 kV	Loading of up to ~ 832 MVA on a 337 MVA line under N-0	Step 2
Janet 74S to ENMAX No. 24 substation, 138 kV	Overloaded up to ~ 34% for N-1 contingency	Step 2
ENMAX No. 65 substation to ENMAX No. 26 substation, 138kV	Overloaded up to ~ 42% for N-1 contingency	Step 2
ENMAX No. 32 substation to ENMAX No. 40 substation 138 kV	Overloaded up to ~ 40% for N-1 contingency	Step 2
Janet 74S, 240/138 kV Transformer	Overloaded up to ~ 6% for N-1 contingency	Step 3
Janet 74S to Okotoks 678S, 138 kV	Overloaded up to ~ 18% for N-1 contingency	Step 3
Langdon 102S to East Calgary 5S, 240 kV	New connection added to the system at Step 1 of transmission development; it uses the existing transmission lines and will be overloaded ~ 9% under N-1.	Step 4
Janet 74S to ENMAX No. 25, 240 kV	Overloaded up to ~ 71 MVA under N-0	Step 4
ENMAX No. 65 substation to ENMAX No. 24 substation, 138 kV	Overloaded up to ~ 22% under N-0	Step 4
ENMAX No. 31 substation to ENMAX No. 9 substation 138 kV	Loading of up to ~ 416 MVA on a 191MVA line for N-1 contingency	Step 4
ENMAX No. 31 substation to ENMAX No. 24 substation 138 kV	Overloaded up to ~ 29% for N-1 contingency	Step 4

6.3 Impact of each Step of the Transmission Plan in 2014 – Voltage Considerations

Currently, there is approximately 1100 MVAr of switched capacitor banks installed in the Calgary area. This level of reactive power support is sufficient to provide an acceptable voltage profile in south Calgary under normal and contingency conditions in 2014.

In the High River planning area, the most critical contingency in the existing system is the outage of the 138 kV transmission line 727L from Janet 74S to Okotoks 678S. This outage causes low voltage on the 138 kV buses at the Okotoks 678S and High River 65S substations. Table 6-4 shows low-voltage issues following the outage of the 727L transmission line for the existing system and for each step of the transmission plan. The low voltage is removed at Step 3, in which transmission developments in the High River planning area occur.

Step 3 of the development plan provides a strong source to the High River planning area through the connection to the Foothills 237S substation. Also, sections of the existing transmission line 727L will be tied to sections of the existing transmission line 850L to form a 138 kV connection from Okotoks 678S substation to Carseland 525S substation. The north section of 727L from Janet 74S will be de-energized or salvaged as determined prudent by the TFO. The results obtained in Step 3 of the transmission plan are applicable for all 138 kV alternatives in the High River planning area.

Table 6-4: Low Voltage in the High River Planning Area in 2014

Contingency	Critical Bus	Scenario	Need	Step 1	Step 2	Step 3	Step 4
Open 727L 138kV line (Janet 74S to Okotoks 678S)	Okotoks 138 kV	SC1	0.925[1]	0.932	0.932	N/A[2]	N/A
	Okotoks 138 kV	SC2	0.930	0.936	0.940		
	Okotoks 138 kV	SC3	0.947	0.949	0.950		
	Okotoks 138 kV	SC4	0.930	0.934	0.938		
	Okotoks 138 kV	SC5	0.930	0.933	0.935		
	High River 138 kV	SC1	0.935	0.942	0.942		
	High River 138 kV	SC2	0.940	0.946	0.950		
	High River 138 kV	SC3	0.956	0.958	0.960		
	High River 138 kV	SC4	0.941	0.944	0.948		
	High River 138 kV	SC5	0.940	0.944	0.945		

[1] All voltages are given in per-unit

[2] In this step, transmission line 727L is reconfigured to connect Okotoks 678S to Carseland 525S. Therefore, the existing connection from Janet 74S to Okotoks 678S will no longer exist. Study results indicate acceptable voltage performance under Category B conditions following implementation of system developments in the area.

6.4 Summary and Conclusion

The near-term assessment of the system performance at each step of the transmission development plan shows that all the proposed system developments in all steps will be required to fully resolve the identified transmission constraints in 2014. Following the implementation of all the proposed developments in Steps 1 to 4, the thermal overloads and voltage violations are resolved in the study area for 2014.

7. TRANSMISSION DEVELOPMENT PLAN – LONG-TERM ASSESSMENT

As discussed in Section 5, each step of the FATD plan resolves parts of the identified system constraints. Section 6 shows that all the proposed transmission developments (Step 1 to Step 4) will be required to meet the Reliability Criteria in 2014.

In this section, system performance is analyzed for each step of the transmission development plan in 2019 assuming Scenarios 1 to 6 and Category B contingencies. A summary of the study results is provided and compared with the identified system constraints in 2019 (Section 4, need assessment studies) to show the improvement in system performance following each step of the transmission developments. Detailed study results are shown in Attachments G to J, where power flow diagrams for the reported critical contingencies are presented.

7.1 Study Assumptions and Methodology

The same assumptions and methodology described in Section 6.1 were applied to the long-term assessment.

The provisional SVCs modeled in the need assessment studies were removed following system developments, as they were no longer required:

- SVC at Okotoks 678S substation was removed at Step 3.
- SVC at Beddington (ENMAX No. 162) substation was removed at Step 1.

The provisional SVC connected at the Foothills 237S substation was included in Scenario 2 only as described in the Section 4 need assessment studies. This SVC was removed from the model at Step 1 of the transmission development plan since it was no longer required.

The provisional SVC connected at Namaka was still modeled after Step 4 due to the reactive power deficiencies in the Strathmore/Blackie planning area. The AESO will address the system constraints in the Blackie planning area in a separate NID application.

Thermal ratings for the proposed transmission developments were assumed based on the 2019 need assessment results. The required ratings were determined upon completion of the near-term and long-term assessments of the FATD plan and are shown in Section 8.

7.2 Impact of each Step of the Transmission Plan in 2019

Table 7-1 provides the thermal loading results of the existing system and the system performance following each step of the transmission plan in 2019. The table is set up in a manner similar to Table 6-2 in Section 6.

System performance improves progressively as system developments are implemented at every step of the transmission plan. It is only at Step 4 that all the identified thermal overload violations in the study area are resolved.

The results obtained in Step 3 of the transmission plan are applicable for all 138 kV alternatives in the High River planning area.

Table 7-1: Loading on Critical Lines in the Study Area for 2019

Contingency	Critical Circuit	Scenario	Need	Step 1	Step 2	Step 3	Step 4
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	500/240 kV transformer (Langdon 102S)	SC3	137% 1649MVA	135% 1615MVA	N/A	N/A	N/A
Open 937L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to Janet 74S)	SC3	325% 1367MVA	N/A	N/A	N/A	N/A
Open 936L 240kV line (Langdon 102S to Janet 74S)	937L 240kV line (Langdon 102S to Janet 74S)	SC3	325% 1367MVA	N/A	N/A	N/A	N/A
Open 240/138 kV transformer (Janet 74S)	917L 240kV line (Janet 74S to East Calgary 5S)	SC4	195% 967MVA	N/A	N/A	N/A	N/A
Open 500/240 kV transformer (Langdon 102S)	1003L 240kV line (Janet 74S to ENMAX No. 25)	SC4	269% 1765MVA	265% 1745MVA	√	√	√
Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	128% 511MVA	120% 479MVA	125% 499MVA	108% 433MVA	91% 365MVA
Open 240/138 kV transformer (East Calgary 5S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	SC4	168% 713MVA	148% 625MVA	147% 624MVA	145% 612MVA	√
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	149% 499MVA	96% 385MVA	97% 387MVA	92% 368MVA	√
Open 240/138 kV transformer (East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	N/A	84% 335MVA	84% 337MVA	√	86% 345MVA
Open 500/240 kV transformer (Langdon 102S)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	SC3	220% 1076MVA	218% 1069MVA	128% 609MVA	√	√
Open 1109L 240kV line (ENMAX No. 25 to ENMAX No. 65)	1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	SC3	N/A	N/A	140% 714MVA	122% 601MVA	√
Open 765L 138kV line (Janet 74S to Strathmore 151S)	727L 138kV line (Janet 74S to Okotoks 678S)	SC4	182% 219MVA	176% 213MVA	174% 212MVA	N/A	N/A
Open 727L 138kV line (Janet 74S to Okotoks 678S)	850L 138kV line (Janet 74S to Carseland 525S)	SC4	149% 133MVA	146% 132MVA	145% 131MVA	N/A	N/A
Open 727L 138kV line (Janet 74S to Okotoks 678S)	765L 138kV line (Janet 74S to Strathmore 151S)	SC4	206% 176MVA	201% 173MVA	199% 172MVA	N/A	N/A
Open 917L 240kV line (Janet 74S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	SC4	140% 381MVA	N/A	N/A	N/A	N/A
Open 24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	SC4	117% 322MVA	100% 278MVA	101% 282MVA	114% 319MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.83L 138kV line (Janet 74S to ENMAX No. 24)	SC4	178% 537MVA	173% 532MVA	√	√	√
Open 917L 240kV line (Janet 74S to East Calgary 5S)	2.80L 138kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	120% 308MVA	N/A	N/A	N/A	N/A
Open 2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	2.80L 138kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	√	√	√	89% 234MVA	√
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	833L 138kV line (ENMAX No. 2 to ENMAX No. 12)	SC4	108% 205MVA	128% 247MVA	129% 249MVA	132% 252MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	151% 412MVA	129% 357MVA	√	√	√
Open 916L 240kV line (Sarcee 42S to East Calgary 5S)	832L 138kV line (ENMAX No. 10 to ENMAX No. 12)	SC4	82% 155MVA	92% 178MVA	92% 177MVA	94% 181MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	186% 458MVA	174% 436MVA	√	√	√
Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	146% 382MVA	137% 359MVA	126% 332MVA	118% 312MVA	82% 217MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	431% 1060MVA	404% 1013MVA	√	√	√
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	213% 557MVA	198% 522MVA	181% 480MVA	166% 438MVA	93% 247MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformer (ENMAX No. 65)	SC4	195% 781MVA	185% 739MVA	√	√	√
Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	√	√	105% 421MVA	97% 387MVA	85% 341MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	240/138 kV transformer (ENMAX No. 65)	SC4	195% 781MVA	185% 739MVA	√	√	√
Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	122% 488MVA	115% 458MVA	105% 421MVA	97% 387MVA	85% 341MVA
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	31.84L 138kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	114% 180MVA	112% 177MVA	110% 176MVA	113% 180MVA	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	281% 507MVA	246% 454MVA	√	√	√
Open 23.80L 138kV line (Janet 74S to ENMAX No. 23)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	174% 332MVA	145% 279MVA	141% 272MVA	151% 291MVA	94% 180MVA
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	163% 469MVA	148% 428MVA	143% 417MVA	148% 430MVA	85% 248MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	177% 265MVA	163% 248MVA	√	√	√
Open 9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	133% 211MVA	121% 194MVA	116% 187MVA	118% 190MVA	√

Contingency	Critical Circuit	Scenario	Need	Step 1	Step 2	Step 3	Step 4
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	164% 245MVA	150% 229MVA	√	√	√
Open 9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	119% 189MVA	108% 173MVA	103% 165MVA	105% 168MVA	√
Open 500/240 kV transformer (Langdon 102S)	911L 240kV line (Foothills 237S to ENMAX No. 65)	SC3	511% 1775MVA	499% 1731MVA	N/A	N/A	N/A
Open 937L 240kV line (Langdon 102S to East Calgary 5S)	936L 240kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	152% 763MVA	152% 764MVA	147% 744MVA	95% 477MVA
Open 936L 240kV line (Langdon 102S to East Calgary 5S)	937L 240kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	152% 763MVA	152% 764MVA	147% 744MVA	95% 477MVA
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	1064L 240kV line (Langdon 102S to Janet 74S)	SC3	N/A	92% 878MVA	√	√	√
Open 911L 240kV line (Foothills 237S to ENMAX No. 65)	1065L 240kV line (Langdon 102S to Janet 74S)	SC3	N/A	92% 878MVA	√	√	√
Open 985L 240kV line (Janet 74S to ENMAX No. 25)	1003L 240kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	N/A	140% 1440MVA	130% 1336MVA	91% 931MVA
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	985L 240kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	N/A	140% 1440MVA	130% 1336MVA	91% 931MVA
Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	1109L 240kV line (ENMAX No. 25 to ENMAX No. 65)	SC3	N/A	N/A	141% 714MVA	122% 601MVA	√
Open 1107L 240kV line (Foothills 237S to ENMAX No. 65)	1106L 240kV line (Foothills 237S to ENMAX No. 65)	SC3	N/A	N/A	109% 1090MVA	96% 949MVA	√
Open 1106L 240kV line (Foothills 237S to ENMAX No. 65)	1107L 240kV line (Foothills 237S to ENMAX No. 65)	SC3	N/A	N/A	109% 1090MVA	96% 949MVA	√

Table 7-2 provides a summary of the critical lines being overloaded and the development plan that resolves the constraint.

Table 7-2: Severe Overloads Resolved at each Step of the FATD Plan in 2019

Overloaded Path	Issue in the Existing System	Development Plan
Langdon 102S to Janet 74S, 240 kV	Overload up to ~59% under N-0	Step 1
Janet 74S to East Calgary 5S, 240 kV	Overload up to ~76% under N-0	Step 1
East Calgary 5S, 240/138 kV Transformer	Overload up to ~ 49% for N-1 contingency	Step 1
Langdon 102S, 500/240 kV Transformer	Overload up to ~37% for N-1 contingency	Step 2
ENMAX No. 65, 240/138 kV Transformer	Overload up to ~ 95% for N-1 contingency	Step 2
Janet 74S substation to ENMAX No. 24 substation, 138 kV	Overload up to ~78% for N-1 contingency	Step 2
Foothills 237S to ENMAX No. 65 substation, 240 kV	Loading of up to ~1258 MVA on a 337 MVA line under N-0 condition	Step 3
Janet 74S to Okotoks 678S, 138 kV	Overload up to ~23% under N-0	Step 3
East Calgary 5S to Sarcee 42S, 240 kV	Overload up to ~41% under N-0	Step 4
Janet 74S, 240/138 kV Transformer	Overload up to ~ 28% for N-1 contingency	Step 4
ENMAX No. 25 to ENMAX No. 65 substation, 240 kV	Overload up to ~35% under N-0	Step 4
Langdon 102S to East Calgary 5S, 240 kV	This connection is proposed at Step 1 of the transmission development plan.	Step 4
Janet 74S to ENMAX No. 25, 240 kV	Loading of up to ~1,362 MVA on a 638 MVA line under N-0	Step 4
ENMAX No. 65 substation to ENMAX No. 24 substation, 138 kV	Overload up to ~57% under N-0	Step 4
ENMAX No. 65 substation to ENMAX No. 26 substation, 138 kV	Overload up to ~46% for N-1 contingency	Step 4
ENMAX No. 31 substation to ENMAX No. 9 substation, 138 kV	Overload up to ~29% under N-0	Step 4
ENMAX No. 31 substation to ENMAX No. 24 substation, 138 kV	Overload up to ~15% under N-0	Step 4
Janet 74S substation to ENMAX No. 23 substation, 138 kV	Overload up to ~49% for N-1 contingency	Step 4

As discussed in Section 4, the existing system will experience voltage collapse in 2019 following several contingencies. Voltage problems are resolved in the study area following the proposed transmission developments in Steps 1 to 4 of the transmission plan.

7.3 Summary and Conclusion

The long-term assessment of the system performance at each step of the transmission development shows that all of the proposed system developments at each step are required to fully resolve the identified transmission constraints in 2019.

Following implementation of all the proposed developments from Steps 1 to 4, thermal overloads and voltage violations are resolved for 2019 in the study area.

The proposed FATD solution comprises Steps 1 to 4 of the transmission development plan. Section 8 provides a detailed technical analysis considering voltage stability margin and transient stability with the proposed FATD alternative in place to ensure the Reliability Criteria is met.

8. RECOMMENDED TRANSMISSION DEVELOPMENT

The results of the comprehensive study of the FATD plan are discussed in this section to ensure the proposed FATD plan is fully in compliance with the Reliability Criteria. Power flow studies are presented in Section 6 and Section 7. This section presents study results for the PV stability, dynamic stability, and short-circuit analysis assuming the FATD plan is implemented. The study methodology is discussed in Section 3.

Based on the study results in Sections 6 and 7, the proposed plan for the FATD is Steps 1 to 4 of the transmission development plan. Sensitivity studies are performed in Section 8.3 to assess the impact of the Shepard generation connection on the proposed transmission developments.

The FATD plan is tested against the most up-to-date generation forecast to assess any impact of the updated generation assumptions on the proposed developments. The study results are shown in Section 8.5.

The configuration of the FATD is given in Figure 8-1 to show the electrical connections. The schematic diagram contains a simplified representation of the system configuration. It is not to scale, nor does it depict line routes or substation locations. The FATD requirements are provided in Table 8-1. In the table, the required ratings of the lines are based on the maximum loadings for the FATD configuration observed in 2019. Alternative 1 in the High River planning area is shown in Figure 8-1 and Table 8-1. Alternatives 2 and 3 produce very similar results.

Figure 8-1: Proposed Foothills Area Transmission Development

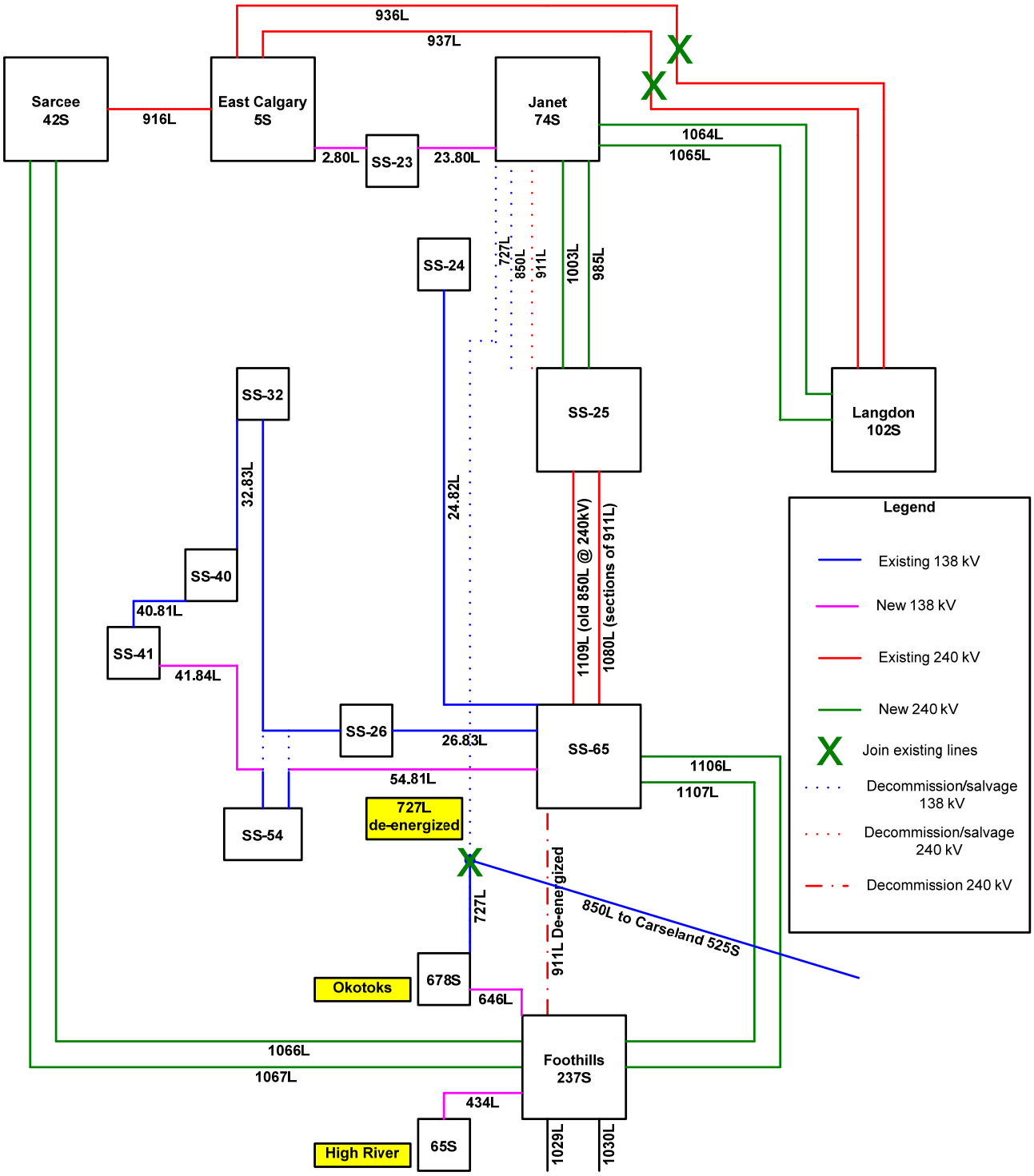


Table 8-1: FATD Scope Summary

Description of the Required Developments
A new 240 kV double circuit line from Langdon 102S to Janet 74S with a minimum summer rating of 800 MVA for each circuit. The lines are designated 1064L and 1065L.
A 240 kV double circuit line from Langdon 102S to East Calgary 5S. This path will be created using the existing lines (936L, 937L, 917, 23.80L, and 2.80L). As per the TFO's data submission, the summer rating of each circuit is 489 MVA. The lines are designated 936L and 937L.
Replace the existing 240/138 kV 336 MVA transformer at East Calgary 5S substation with two new 400 MVA transformers.
A new 240 kV substation designated Foothills 237S that includes two new 240/138 kV transformers, each with a minimum rating of 400 MVA.
A new 240 kV double circuit line from Foothills 237S substation to ENMAX No. 65 substation with a minimum summer rating of 600 MVA for each circuit. The lines will be designated 1106L and 1107L.
A 240 kV double circuit line from ENMAX No. 65 substation to ENMAX No. 25 substation. This path will be created using sections of the existing lines (911L, 850L energized at 240 kV). As per the TFO's data submission, the summer rating of each circuit is 489 MVA. The lines are designated 1080L and 1109L.
A new 240 kV double circuit line from ENMAX No. 25 substation to Janet 74S substation with a minimum summer rating of 920 MVA for each circuit. The lines are designated 985L and 1003L.
A new 240 kV double circuit line from Foothills 237S to Sarcee 42S with a minimum summer rating of 600 MVA for each circuit. The lines are designated 1066L and 1067L.
A new 138 kV single circuit line from Janet 74S substation to ENMAX No. 23 substation with a minimum summer rating of 260 MVA. The line is designated 23.80L.
A new 138 kV single circuit line from ENMAX No. 2 substation to ENMAX No. 23 substation with a minimum rating of 260 MVA. The line is designated 2.80L.
A new 138 kV single circuit line from ENMAX No. 65 to ENMAX No. 41 with in and out connection at ENMAX No. 54 substation. The minimum rating of this new line is 260 MVA. The line is designated 54.81L from ENMAX No. 65 to ENMAX No. 54 substation and 41.84L from ENMAX No. 54 to ENMAX No. 41 substation[2].
A new 138 kV single circuit line from Foothills 237S to Okotoks 678S with a minimum summer rating of 260 MVA. The line is designated 646L[1].
A new 138 kV single circuit line from Foothills 237S to High River 65S with a minimum summer rating of 260 MVA. The line is designated 434L[1].
A 138 kV single circuit line from Okotoks 678S to Carseland 525S. This path will be created using sections of the existing 138 kV lines 727L and 850L. As per the TFO's data submission the summer rating of the line is 89 MVA. The line is designated 850L.
De-energize sections of the 911L line from Janet 74S to ENMAX No. 25 substation and from south of ENMAX No. 65 substation to Foothills 237S[1].
De-energize sections of the 727L line from Janet 74S to where 850L turns east toward Carseland.
De-energize sections of the 850L line from Janet 74S substation to ENMAX No. 25 substation.

[1] The existing 911L in the High River planning area will be de-energized upon completion of the SATR project. Therefore, there is the potential to utilize sections of this line where suitable to create the required 646L or 434L. 911L will then be re-energized at 138 kV.

[2] FATD proposes to restore the current connectivity between ENMAX No. 26 and ENMAX No. 32 substation through 26.81L. The ENMAX No. 54 substation will be initially connected in and out to 26.81L in ENMAX No. 54 connection project, i.e. 26.81L (ENMAX No. 26 to ENMAX No. 54) and 32.82L (ENMAX No. 54 to ENMAX No. 32).

8.1 Voltage Stability (PV) Analysis

The PV analysis was completed on the proposed FATD plan in 2019. The PV stability results for N-0, N-1, and selected N-2 contingencies are given in Table 8-2. The results confirm that after implementation of the FATD plan the system meets the voltage stability criteria.

The load is lower in the 2014 studies, which results in a higher voltage stability margin. Voltage stability curves for 2019 at critical system buses in the study area are given in Attachment K.

Table 8-2: PV Stability Results for the Recommended FATD Alternative in 2019

Contingency List	PV Results in 2019					
	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6
Peigan to Foothills 237S (N-2) [1]	Voltage stability criteria is met					
Janet 74S to Red Deer (N-2)						
Benalto 74S to Sarcee 42S (N-2)						
Langdon 102S to Janet 74S (N-2)						
Langdon 102S to East Calgary 5S (N-2)						
Janet 74S to ENMAX No. 25 (N-2)						
Sarcee 42S to Foothills 237S (N-2)						
ENMAX No. 25 to ENMAX No. 65 (N-2)						
Langdon 102S to Crowsnest 999S (N-1)						
Janet 74S to Beddington SS-162 (N-1)						
Sarcee 42S to East Calgary 5S (N-1)						
Peigan 59S to Foothills 237S (N-1)						
Janet 74S to ENMAX No. 23 (N-1)						
Janet 74S to ENMAX No. 24 (N-1)						
ENMAX No. 2S to ENMAX No. 9 (N-1)						
Okotoks 678S to Carseland 525S (N-1)						
Okotoks 678S to Foothills 237S (N-1)						
High River 65S to Foothills 237S (N-1)						
ENMAX No. 54 to ENMAX No. 65 (N-1)						
ENMAX No. 65 to ENMAX No. 26 (N-1)						
ENMAX No. 65 to ENMAX No. 24 (N-1)						
Janet 74S Transformer (N-1)						
Sarcee 42S Transformer (N-1)						
East Calgary 5S Transformer (N-1)						
ENMAX Sub-65 Transformer (N-1)						
Foothills 237S Transformer (N-1)						
Sheerness 1 unit trip (N-G)						

[1] For this contingency the voltage stability margin is 0.4% without any Remedial Action Schemes (RASes). Planned load curtailment is acceptable under the Category C contingency; under Voltage Load Shedding (UVLS) in the Calgary area is documented in OPP 510. Sufficient reliability margin exists following UVLS and the Reliably Criteria is met in the study area.

8.2 Dynamic Stability Analysis

A comprehensive dynamic stability study was performed on the 2014 and 2019 cases. Bus voltages, bus frequencies, line flows, and generator angles were monitored. The results confirm that the system remains stable for Category B and Category C5 contingencies in the study area. Study results of the stability analysis for critical contingencies are given in Attachment L.

8.3 Shepard Connection Impact

Sensitivity studies were performed to evaluate the system developments required to accommodate the Shepard generation connection.

The required transmission system developments were evaluated with and without Shepard generation injection into the grid. The study results show that without the Shepard generation the existing transmission lines 911L and 850L energized at 240 kV from ENMAX No. 65 substation to Janet 74S substation will be sufficient up to 2019. The rating of each circuit is 489 MVA as per the TFO's data submission.

With Shepard generation injection into the Alberta grid the proposed FATD plan requires system reinforcements between ENMAX No. 25 substation and Janet 74S substation to accommodate Shepard generation connection to the AIES according to the study results shown in Sections 6 and 7. A 240 kV double circuit transmission line is required with a minimum summer rating of each circuit at 920 MVA, as shown in Table 8-1.

8.4 Short-Circuit Analysis

A short-circuit analysis was performed on the existing system (2014) and on the system with the proposed FATD (2014 and 2019). The short-circuit levels at critical buses were calculated. The list of critical buses is given in Table 8-3. The results[2] of the short-circuit studies are given in Table 8-4 to Table 8-6.

[2] Short circuit estimation is subject to change as the system configuration and/or modeling information changes. The information provided in this study is not intended to be used as the sole source of information for electrical equipment specification or the design of public or worker safety-grounding systems.

Table 8-3: Critical Buses for Short-Circuit Calculations

Substation	Voltage Base (kV)	Bus #
Carseland 525S	138	252
East Calgary 5S	240	162
ENMAX No. 2	138	208
ENMAX No. 24	138	590
ENMAX No. 25	240	182
ENMAX No. 26	138	589
ENMAX No. 41	138	592
ENMAX No. 54	138	562
ENMAX No. 65	240	602
ENMAX No. 65	138	570
Foothills 237S	240	598
Foothills 237S	138	600
High River 65S	138	242
Janet 74S	240	160
Janet 74S	138	207
Langdon 102S	240	159
Okotoks 678S	138	239
Peigan 59S	240	165
Peigan 59S	138	166
Sarcee 42S	240	161
Sarcee 42S	138	202

Table 8-4: Short-Circuit Levels for the Existing System – 2014 Pre-FATD

2014 Existing System – Pre FATD						
Substation	**Base Voltage (kV)**	**Pre-Fault Voltage (pu)**	**Three-Phase Fault (kA)**	**Positive Sequence Impedance (R+jX) (pu)***	**Single-Phase Fault (kA)**	**Zero Sequence Impedance (R+jX) (pu)***
Carseland 525S	138	1.044	6.96	0.013867+j0.061179	6.97	0.008644+j0.064303
East Calgary 5S	240	1.046	22.28	0.002498+j0.011014	20.12	0.001985+j0.014986
ENMAX No. 2	138	1.023	34.67	0.003515+j0.011838	33.82	0.001631+j0.013414
ENMAX No. 24	138	1.025	27.56	0.003876+j0.015069	20.07	0.005486+j0.032726
ENMAX No. 25	240	1.044	26.90	0.001828+j0.009157	25.49	0.001251+j0.011040
ENMAX No. 26	138	1.019	18.73	0.004633+j0.022292	13.20	0.009682+j0.050593
ENMAX No. 41	138	1.022	17.60	0.006773+j0.023320	11.44	0.011852+j0.062646
ENMAX No. 54	138	1.018	15.03	0.006791+j0.027497	9.35	0.015111+j0.078680
ENMAX No. 65	240	1.030	20.58	0.002196+j0.011846	15.80	0.004311+j0.022732
ENMAX No. 65	138	1.020	23.97	0.003389+j0.017477	19.35	0.004481+j0.030395
High River 65S	138	1.022	4.72	0.040684+j0.080935	3.50	0.039168+j0.184533
Janet 74S	240	1.051	28.09	0.001951+j0.008786	26.24	0.001637+j0.010944
Janet 74S	138	1.034	32.09	0.003219+j0.013094	28.21	0.002456+j0.019118
Langdon 102S	240	1.050	20.41	0.002038+j0.012207	19.84	0.001554+j0.013484
Okotoks 678S	138	1.022	5.46	0.034450+j0.070399	3.71	0.045890+j0.185979
Peigan 59S	240	1.035	16.07	0.001922+j0.015378	16.54	0.002193+j0.013962
Peigan 59S	138	1.002	8.81	0.006458+j0.047144	8.09	0.003978+j0.060106
Sarcee 42S	240	1.055	17.05	0.003255+j0.014521	14.21	0.003487+j0.023717
Sarcee 42S	138	1.031	29.31	0.004026+j0.014158	26.76	0.002703+j0.018939

* Base MVA=100 MVA

Table 8-5: Short-Circuit Levels in 2014 – Post FATD

2014 Post FATD (Assuming Alternative 1 in the High River Planning Area)						
Substation	**Base Voltage (kV)**	**Pre-Fault Voltage (pu)**	**Three-Phase Fault (kA)**	**Positive Sequence Impedance (R+jX) (pu)***	**Single-Phase Fault (kA)**	**Zero Sequence Impedance (R+jX) (pu)***
Carseland 525S	138	1.045	5.62	0.01749+j0.07579	5.87	0.008798+j0.070715
East Calgary 5S	240	1.047	19.14	0.00274+j0.01287	17.22	0.002241+j0.017557
ENMAX No. 2	138	1.022	34.61	0.00346+j0.01186	33.65	0.001705+j0.013500
ENMAX No. 24	138	1.025	27.33	0.00387+j0.01521	20.37	0.005147+j0.031532
ENMAX No. 25	240	1.060	27.19	0.00187+j0.00919	25.93	0.001302+j0.010883
ENMAX No. 26	138	1.022	20.54	0.00427+j0.02037	15.60	0.006924+j0.040127
ENMAX No. 41	138	1.022	20.62	0.00543+j0.02001	14.32	0.008988+j0.047432
ENMAX No. 54	138	1.022	16.90	0.00545+j0.02470	11.52	0.012534+j0.059604
ENMAX No. 65	240	1.058	23.57	0.00208+j0.01060	22.98	0.001532+j0.011716
ENMAX No. 65	138	1.023	26.37	0.00327+j0.01590	23.80	0.002118+j0.021607
Foothills 237S	240	1.049	18.35	0.00237+j0.01355	12.96	0.006697+j0.030304
Foothills 237S	138	1.030	16.22	0.00330+j0.02635	13.52	0.006778+j0.042220
High River 65S	138	1.036	9.41	0.00948+j0.04504	6.17	0.026363+j0.116192
Janet 74S	240	1.059	27.78	0.00191+j0.00897	26.04	0.001631+j0.011073
Janet 74S	138	1.032	31.26	0.00320+j0.01344	27.23	0.002437+j0.020005
Langdon 102S	240	1.050	24.04	0.00205+j0.01030	23.41	0.001422+j0.011417
Okotoks 678S	138	1.035	8.51	0.01106+j0.04967	5.64	0.028914+j0.125815
Peigan 59S	240	1.040	16.83	0.00198+j0.01474	17.23	0.002168+j0.013664
Peigan 59S	138	1.002	8.90	0.006475+j0.046678	8.15	0.003949+j0.059912
Sarcee 42S	240	1.056	18.76	0.00288+j0.01324	15.70	0.003224+j0.021355
Sarcee 42S	138	1.028	30.21	0.00377+j0.01372	27.96	0.002462+j0.017655

* Base MVA=100 MVA

Table 8-6: Short-Circuit Levels in 2019 – Post FATD

2019 Full (Assuming Alternative 1 in the High River Planning area)						
Substation	**Base Voltage (kV)**	**Pre-Fault Voltage (pu)**	**Three-Phase Fault (kA)**	**Positive Sequence Impedance (R+jX) (pu)***	**Single-Phase Fault (kA)**	**Zero Sequence Impedance (R+jX) (pu)***
Carseland 525S	138	1.035	5.66	0.017437+j0.074514	5.87	0.00878+j0.070741
East Calgary 5S	240	1.031	20.21	0.002455+j0.012025	17.74	0.002193+j0.017361
ENMAX No. 2	138	1.017	35.72	0.003343+j0.011436	34.10	0.001733+j0.013684
ENMAX No. 24	138	1.018	28.32	0.003694+j0.014581	20.61	0.005172+j0.031669
ENMAX No. 25	240	1.053	29.26	0.001648+j0.008503	26.85	0.001356+j0.011075
ENMAX No. 26	138	1.018	21.12	0.004111+j0.019738	15.73	0.006984+j0.040396
ENMAX No. 41	138	1.016	21.13	0.005265+j0.019418	14.41	0.009011+j0.047569
ENMAX No. 54	138	1.017	17.26	0.005294+j0.024075	11.57	0.012581+j0.059814
ENMAX No. 65	240	1.049	25.59	0.001802+j0.009693	23.97	0.001582+j0.011894
ENMAX No. 65	138	1.020	27.38	0.003093+j0.015279	24.15	0.002195+j0.021923
Foothills 237S	240	1.036	22.80	0.001710+j0.010800	14.12	0.006813+j0.03046
Foothills 237S	138	1.036	17.29	0.002883+j0.024890	13.71	0.007257+j0.044334
High River 65S	138	1.037	9.73	0.009276+j0.043622	6.08	0.028817+j0.121839
Janet 74S	240	1.052	29.89	0.001696+j0.008292	27.00	0.001665+j0.011203
Janet 74S	138	1.024	32.66	0.002997+j0.012769	27.82	0.002442+j0.01998
Langdon 102S	240	1.044	26.06	0.001782+j0.009473	24.56	0.001424+j0.011431
Okotoks 678S	138	1.036	8.75	0.011206+j0.048227	5.54	0.031837+j0.132262
Peigan 59S	240	1.050	21.51	0.001595+j0.011633	20.73	0.00203+j0.012908
Peigan 59S	138	1.029	14.26	0.003324+j0.030016	12.12	0.003606+j0.046007
Sarcee 42S	240	1.043	19.94	0.002565+j0.012317	16.14	0.003222+j0.021321
Sarcee 42S	138	1.019	31.34	0.003569+j0.013130	28.49	0.002457+j0.017664

* Base MVA=100 MVA

8.5 Updated Generation Forecast

As documented in Section 2.2.2, generation forecast information provided in the 2009 *Long-Term Transmission System Plan* was the forecast available. Since the inception of the FATD studies, the AESO has updated its generation forecast. The Greenest scenario in the updated forecast is compared to scenario B5 in the 2009 *Long-Term Transmission System Plan*. Table 8-7 shows the differences between the forecast information considering wind generation additions in Alberta for the year 2014 and 2019. This section presents FATD sensitivity studies applying the updated AESO generation forecast. Power flow diagrams for Category A and critical Category B conditions are presented in Attachment N.

Table 8-7: Comparison of the Generation Forecast Information

Wind Generation	Year	B5 Total Capacity (MW)	Greenest Total Capacity (MW)
Southern Alberta	2014	2,026	1,436
	2019	3,526	2,542
Central Alberta	2014	362	538
	2019	962	1,059
Total in Alberta	2014	2,388	1,974
	2019	4,488	3,600

The study results for Scenarios 1 to 6 applying the updated forecast values of wind generation (Greenest) are provided in Table 8-8. In these studies only Steps 1 to 3 of the developed transmission plan are modeled to evaluate sufficiency of the transmission system developments considering Category A and Category B conditions.

Table 8-8: Applying Updated Forecast for 2014

Contingency	Overloaded Branch	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6
Open 937L 240kV line (Langdon 102S to East Calgary 5S)	936L 240kV line (Langdon 102S to East Calgary 5S)	√	√	√	92% 477MVA	√	√
Open 936L 240kV line (Langdon 102S to East Calgary 5S)	937L 240kV line (Langdon 102S to East Calgary 5S)	√	√	√	92% 477MVA	√	√
Open 985L 240kV line (Janet 74S to ENMAX No. 25)	1003L 240kV line (Janet 74S to ENMAX No. 25)	√	√	√	96% 995MVA	√	√
Open 1003L 240kV line (Janet 74S to ENMAX No. 25)	985L 240kV line (Janet 74S to ENMAX No. 25)	√	√	√	96% 995MVA	√	√
Open 24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	√	√	√	93% 248MVA	83% 220MVA	√
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	√	89% 235MVA	98% 262MVA	120% 320MVA	102% 270MVA	√
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	31.84L 138kV line (ENMAX No. 31 to ENMAX No. 32)	√	√	√	83% 136MVA	√	√
Open 23.80L 138kV line (Janet 74S to ENMAX No. 23)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	√	√	82% 161MVA	111% 218MVA	94% 182MVA	√
Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	√	85% 250MVA	93% 274MVA	112% 331MVA	100% 292MVA	√

Thermal overloads may be experienced by 138 kV transmission lines in the study area following a Category B contingency in 2014, as shown in Table 8-8. The loading on many 240 kV transmission lines in the study area is above 90% of the line rating.

System studies were repeated assuming Steps 1 to 3 of the transmission plan as well as the new 138 kV circuit from ENMAX No. 65 substation to ENMAX No. 41 substation with an in and out configuration at ENMAX No. 54 substation implemented for 2014. The study results show that the 138 kV transmission line 9.80L (from ENMAX No. 31 substation to ENMAX No. 9 substation) will be overloaded following the outage of 23.80L (from Janet 74S to ENMAX No. 23 substation). Wind generation in southern Alberta must be limited to approximately 1,150 MW in 2014 to meet the Reliability Criteria under Category B conditions, which is lower than the forecasted Greenest scenario as well as the baseline scenario in southern Alberta. Baseline scenario is presented in the NID Appendix titled

Foothills System Planning Study Load and Generation Forecasts. According to the study results, using the updated forecast values, the proposed FATD alternative (Steps 1 to 4) is required to facilitate reliable transmission of power from southern Alberta in Q2, 2014.

8.6 Summary and Conclusion

Detailed studies were performed on the proposed FATD plan for 2014 and 2019. Voltage stability, dynamic stability, and short-circuit analysis were performed for Category A, Category B, and selected Category C conditions to ensure compliance with the Reliability Criteria.

The impact of the most up-to-date generation forecast assumptions on the proposed FATD plan was studied. The study results indicated that the proposed FATD plan (Table 8-1) is required in Q2, 2014.

Detailed study results confirm that following implementation of the FATD plan the system meets the Reliability Criteria; accordingly, the FATD plan is the AESO's recommend alternative to ensure system reliability in the study area.

9. PROJECT INTERDEPENDANCIES

In recent years, there has been a considerable amount of interest in wind generation in the central and southern part of Alberta. The AUC has approved transmission system developments to accommodate the connection of new wind generation to the AIES as detailed in the Hanna Region Transmission Development (HRTD) and Southern Alberta Transmission Reinforcement (SATR) NID applications.

The HRTD project is planned to facilitate the transfer of a significant portion of the generation additions from the Hanna region to southern Alberta, and the SATR project is planned to facilitate the transfer of generation from southern Alberta to supply load centers in Calgary and surrounding areas. These projects depend on the FATD plan to alleviate system constraints in south Calgary and the High River planning area to enable power flow.

Prior to FATD completion, wind generation in southern and/or central Alberta may be subject to curtailment to maintain reliable system performance, depending on the system conditions. The existing amount of total wind generation in Alberta is 777 MW (695 MW in southern Alberta and 82 MW in the Hanna region). The AESO has filed six NID applications for the connection of additional ~800 MW of wind generation to the system, as shown in Table 9-1. These customer connection projects will depend on the completion of the FATD (and on completion of the SATR and/or the HRTD) for reliable operation.

Table 9-1: Wind Connection Projects – NID Applications Filed with the AUC[3]

Project	Generation (MW)	Requested ISD
Enel Alberta Castle Rock Wind Farm	115	Q2, 2012
Naturener Wild Rose Wind Farm	200	Q1, 2013
Alberta Wind Energy Old Man River Wind Farm	47	Q4, 2011
Suncor Wintering Hills Wind Energy	88	Q4, 2011
Naturener Wild Rose Wind Farm Phase 2	200	Q2, 2013
Greengate Halkirk Wind	150	Q2, 2012

The AESO is in the process of preparing separate NID applications for the wind connection projects listed in Table 9-2, which are planned to be in service by the end of 2014. Some of the NID filings are anticipated in 2011, and the remaining NID applications will be filled in 2012. The generation from these potential sources may need to be constrained until the FATD[4] is completely implemented.

[3] The information provided is according to the project list posting on the AESO website: http://www.aeso.ca/downloads/Final_April_Project_List.xls

[4] FATD studies assume that SATR and HRTD projects are in service.

Table 9-2: Wind Connection Projects – NID Applications being Prepared[4]

Project	Generation (MW)	Requested ISD
Pteragen Peace Butte Wind Farm	116	Q4, 2011
ENEL Alberta HWY 785 Wind Farm	235	Q4, 2014
ENEL Alberta Riverview Wind Farm	115	Q4, 2014
Shell Wild Steer Butte Wind Farm	75	Q1, 2014
Windy Point Wind Farm	61	Q4, 2012
Vindt Willowridge Wind Farm	100	Q4, 2012
GlenRidge Wind Farm Phase 1	100	Q4, 2012
Suncor Hand Hills Wind Energy	80	Q4, 2013
Nexen Hand Hills Wind	80	Q2, 2013
Acciona New Dayton Wind Energy	99	Q4, 2013
Greengate Blackspring Ridge I Wind	300	Q2, 2013
Shell Wild Steer Butte Wind	700	Q1, 2014
Sequoia Oyen Wind	100	Q3, 2013

As demonstrated in this engineering report, local generation connections in south Calgary and the High River planning area are dependent on the FATD plan. The output power from the Shepard and Saddlebrook generation plants will be curtailed until the FATD completion, depending on the system conditions. The AESO will file separate NID applications for each of these generation connections.

The transmission system in south Calgary and the High River planning area will not be sufficient to increase the existing Demand Transmission Service (DTS) contracts in these areas until the proposed FATD plan is in service.

In the FATD studies it was assumed that transmission system constraints in north Calgary and the Strathmore/Blackie planning area will be alleviated through separate projects, as explained in Section 4.2.

The proposed FATD plan is in alignment with the AESO's *2009 Long-Term Transmission System Plan* and the more recent *2011 Long-Term Transmission System Plan* which is expected to be published in Q2, 2011.

The AESO has decided to file several NID applications for the overall FATD plan to facilitate timely construction of the following:

- East Calgary reinforcement, which is combined with the Shepard Energy Centre generator connection
- Foothills 237S substation
- Transmission system developments south east of Calgary and the High River planning area
- Transmission system development south west of Calgary as well as the new 138 kV circuit from ENMAX No. 65 substation to ENMAX No. 41 substation with in and out at ENMAX No. 54 substation.

All the components of the FATD plan are required to be implemented to remove system constraints from the study area and to meet the Reliability Criteria in the area as demonstrated in this engineering report.

10. SUMMARY AND CONCLUSIONS

The reliability of the transmission system in south Calgary and the High River planning area (the study area) was assessed up to 2019. The High River planning area includes the towns of Black Diamond, Turner Valley, High River, and Okotoks, and the areas between these towns. The overall assessment was completed under the Foothills Area Transmission Development (FATD) plan and recommendations were made accordingly.

Historically, the electrical demand (the load) in the study area has been supplied mainly by the 240 kV transmission path from Edmonton to Calgary. Other supplies to the area have been imports from British Columbia when dispatched and/or power transmission from southern Alberta.

Recently, there has been a significant amount of new wind generation projects in southern Alberta. The Southern Alberta Transmission Reinforcement (SATR) project, which was approved by the Alberta Utilities Commission (AUC) in Q1 2009, replaces the existing 240 kV transmission line 911L (Peigan 59S to Janet 74S) with a high-capacity 240 kV double circuit line. However, the existing system in south Calgary does not have sufficient capacity to allow unconstrained power transmission from southern Alberta. The AESO has received applications to connect approximately 1,315 MW of gas-fired generation within the study area, which further contributes to thermal overloads on the existing transmission lines. To prevent violations of the Reliability Criteria, additional generation connections into the study area and/or the transmission of generation from southern Alberta will require significant restrictions prior to system developments.

Load growth in the Calgary and High River planning areas is another cause of stress on the transmission system in the study area. The forecasted load in the Calgary and High River planning areas is approximately 1,860 MW in 2014, and will increase to ~2,200 MW by 2019. System studies confirm that the existing system in the study area will not be capable of reliably supplying the load in 2014.

Taking into consideration the above key drivers, the AESO performed a technical assessment to ensure system reliability is maintained by addressing the following needs:

- Supply load growth in the study area
- Facilitate integration of local generation to the system
- Facilitate transmission of power from southern Alberta to the system

System studies were performed for 2014 (near-term assessment) and 2019 (long-term assessment) to ensure compliance with the Reliability Criteria. System development projects and relevant customer connection projects with in-service dates within the given timeframe were modeled in the study cases. Various system conditions were analyzed, including the following:

- Summer peak loading conditions
- System light loading conditions
- No transmission of power from southern Alberta (~ 0 MW wind generation in the AIES)

- Maximum transmission of power from southern Alberta (wind generation at full output)
- No local gas generation in the study area
- Saddlebrook generation online at its full output
- Saddlebrook and Shepard generation online at their full output
- No import from British Columbia (BC)
- Maximum import from BC

Combinations of the above were tested to determine worst case conditions.

Need assessment studies for 2014 show that thermal overloads are a major concern in the area. Severe thermal overloads were observed on the following 240 kV and 138 kV transmission paths under Category B contingencies:

- From Langdon 102S to Janet 74S to East Calgary 5S (240 kV)
- From Foothills 237S to Janet 74S (240 kV)
- The 138 kV transmission system around ENMAX No. 65 substation
- The 138 kV transmission lines supplying the High River planning area.

The need assessment study results demonstrate that the High River planning area can experience voltage collapse during summer peak loading conditions following the outage of the 138 kV transmission line 727L (Janet 74S to Okotoks 678S) or the 138 kV transmission line 765L (Janet 74S to Strathmore 151S). The voltage problem in the High River planning area is due to load growth and an inadequate transmission system supplying the area load.

Need assessment studies for 2019 show that the number of contingencies that cause voltage collapse increases significantly from 2014 to 2019. The thermal overloads are also considerably higher in the 2019 need assessment than in the 2014 need assessment.

In conclusion, in 2014, assuming various system conditions, the existing system will not have reliable performance. A transmission plan implemented in steps is proposed to resolve the identified system constraints in 2014. Each step of the transmission plan was also tested against the 2019 conditions to examine its performance in the long term. This method addressed the identified needs by utilizing the minimum developments required to resolve all the constraints.

The proposed FATD plan will create a 240 kV transmission loop around the study area that facilitates balancing the power flow among the key substations in Calgary (Janet 74S, East Calgary 5S, Sarcee 42S, and ENMAX No. 65 substation). The proposed plan creates alternate paths from the key substations Langdon 102S and Foothills 237S into Calgary to ensure reliable system performance:

- Two double circuit paths from Langdon 102S
- Two double circuit paths from Foothills 237S

Transmission system developments are proposed in the High River planning area as well.

Detailed studies were performed on the proposed FATD plan including transient stability analysis, power-voltage stability analysis, and short-circuit studies. The study results further

confirmed that the Reliability Criteria will be met by removing all of the identified constraints from the study area.

The recommended FATD plan depicted in Table 8-1tified constraints from the study area.

The recommended FATD plan depicted in Table 8-1 provides a technical solution that resolves the transmission constraints in south Calgary and the High River planning area. The recommended developments are required in Q2, 2014 to ensure system reliability.

ATTACHMENT A

Need Assessment – 2014, Scenario 1 to 6

Table A-1 Scenario 1

Figure Name	Contingency
Figure A-2014-NEED-Sc1-1	Base Case (N-0)
Figure A-2014-NEED-Sc1-2	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure A-2014-NEED-Sc1-3	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure A-2014-NEED-Sc1-4	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure A-2014-NEED-Sc1-5	Open 240/138 kV transformer (Sarcee 42S)

Table A-2 Scenario 2

Figure Name	Contingency
Figure A-2014-NEED-Sc2-1	Base Case (N-0)
Figure A-2014-NEED-Sc2-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure A-2014-NEED-Sc2-3	Open 917L 240kV line (Janet 74S to East Calgary 5S)
Figure A-2014-NEED-Sc2-4	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure A-2014-NEED-Sc2-5	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure A-2014-NEED-Sc2-6	Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)
Figure A-2014-NEED-Sc2-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure A-2014-NEED-Sc2-8	Open 911L 240kV line (Foothills 237S to ENMAX No. 65)
Figure A-2014-NEED-Sc2-9	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure A-2014-NEED-Sc2-10	Open 240/138 kV transformer (Janet 74S)
Figure A-2014-NEED-Sc2-11	Open 240/138 kV transformer (East Calgary 5S)
Figure A-2014-NEED-Sc2-12	Open 500/240 kV transformer (Langdon 102S)

Table A-3 Scenario 3

Figure Name	Contingency
Figure A-2014-NEED-Sc3-1	Base Case (N-0)
Figure A-2014-NEED-Sc3-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure A-2014-NEED-Sc3-3	Open 917L 240kV line (Janet 74S to East Calgary 5S)
Figure A-2014-NEED-Sc3-4	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure A-2014-NEED-Sc3-5	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure A-2014-NEED-Sc3-6	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure A-2014-NEED-Sc3-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure A-2014-NEED-Sc3-8	Open 911L 240kV line (Foothills 237S to ENMAX No. 65)
Figure A-2014-NEED-Sc3-9	Open 240/138 kV transformer (Janet 74S)
Figure A-2014-NEED-Sc3-10	Open 240/138 kV transformer (East Calgary 5S)
Figure A-2014-NEED-Sc3-11	Open 500/240 kV transformer (Langdon 102S)

Table A-4 Scenario 4

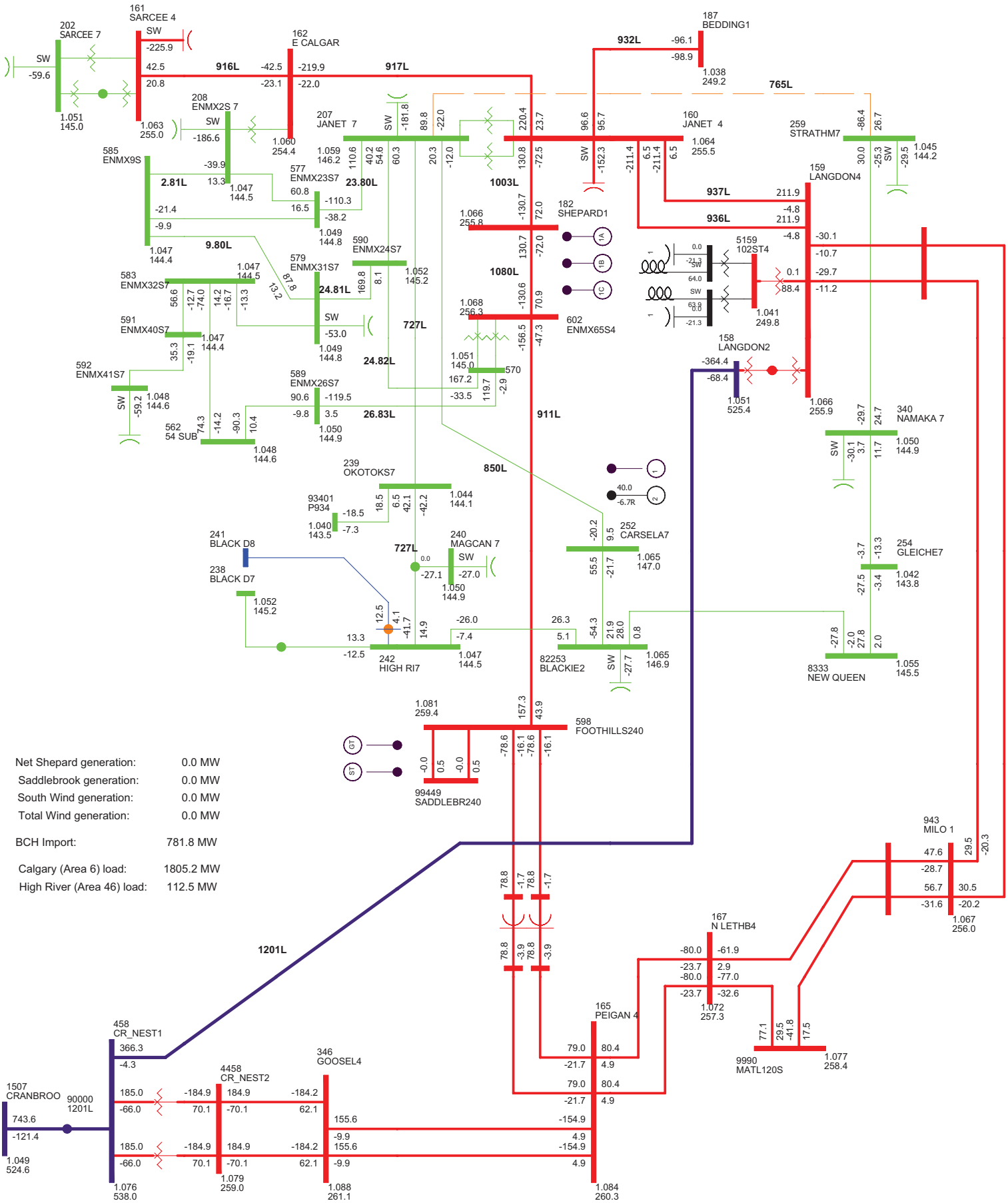
Figure Name	Contingency
Figure A-2014-NEED-Sc4-1	Base Case (N-0)
Figure A-2014-NEED-Sc4-2	Open 932L 240kV line (Janet 74S to Beddington SS-162)
Figure A-2014-NEED-Sc4-3	Open 917L 240kV line (Janet 74S to East Calgary 5S)
Figure A-2014-NEED-Sc4-4	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure A-2014-NEED-Sc4-5	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure A-2014-NEED-Sc4-6	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure A-2014-NEED-Sc4-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure A-2014-NEED-Sc4-8	Open 911L 240kV line (Foothills 237S to ENMAX No. 65)
Figure A-2014-NEED-Sc4-9	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure A-2014-NEED-Sc4-10	Open 240/138 kV transformer (East Calgary 5S)
Figure A-2014-NEED-Sc4-11	Open 500/240 kV transformer (Langdon 102S)

Table A-5 Scenario 5

Figure Name	Contingency
Figure A-2014-NEED-Sc5-1	Base Case (N-0)
Figure A-2014-NEED-Sc5-2	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure A-2014-NEED-Sc5-3	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure A-2014-NEED-Sc5-4	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure A-2014-NEED-Sc5-5	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure A-2014-NEED-Sc5-6	Open 240/138 kV transformer (Janet 74S)
Figure A-2014-NEED-Sc5-7	Open 240/138 kV transformer (Sarcee 42S)
Figure A-2014-NEED-Sc5-8	Open 500/240 kV transformer (Langdon 102S)

Table A-6 Scenario 6

Figure Name	Contingency
Figure A-2014-NEED-Sc6-1	Base Case (N-0)
Figure A-2014-NEED-Sc6-2	Open 932L 240kV line (Janet 74S to Beddington SS-162)
Figure A-2014-NEED-Sc6-3	Open 917L 240kV line (Janet 74S to East Calgary 5S)
Figure A-2014-NEED-Sc6-4	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure A-2014-NEED-Sc6-5	Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)
Figure A-2014-NEED-Sc6-6	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure A-2014-NEED-Sc6-7	Open 240/138 kV transformer (Janet 74S)
Figure A-2014-NEED-Sc6-8	Open 500/240 kV transformer (Langdon 102S)

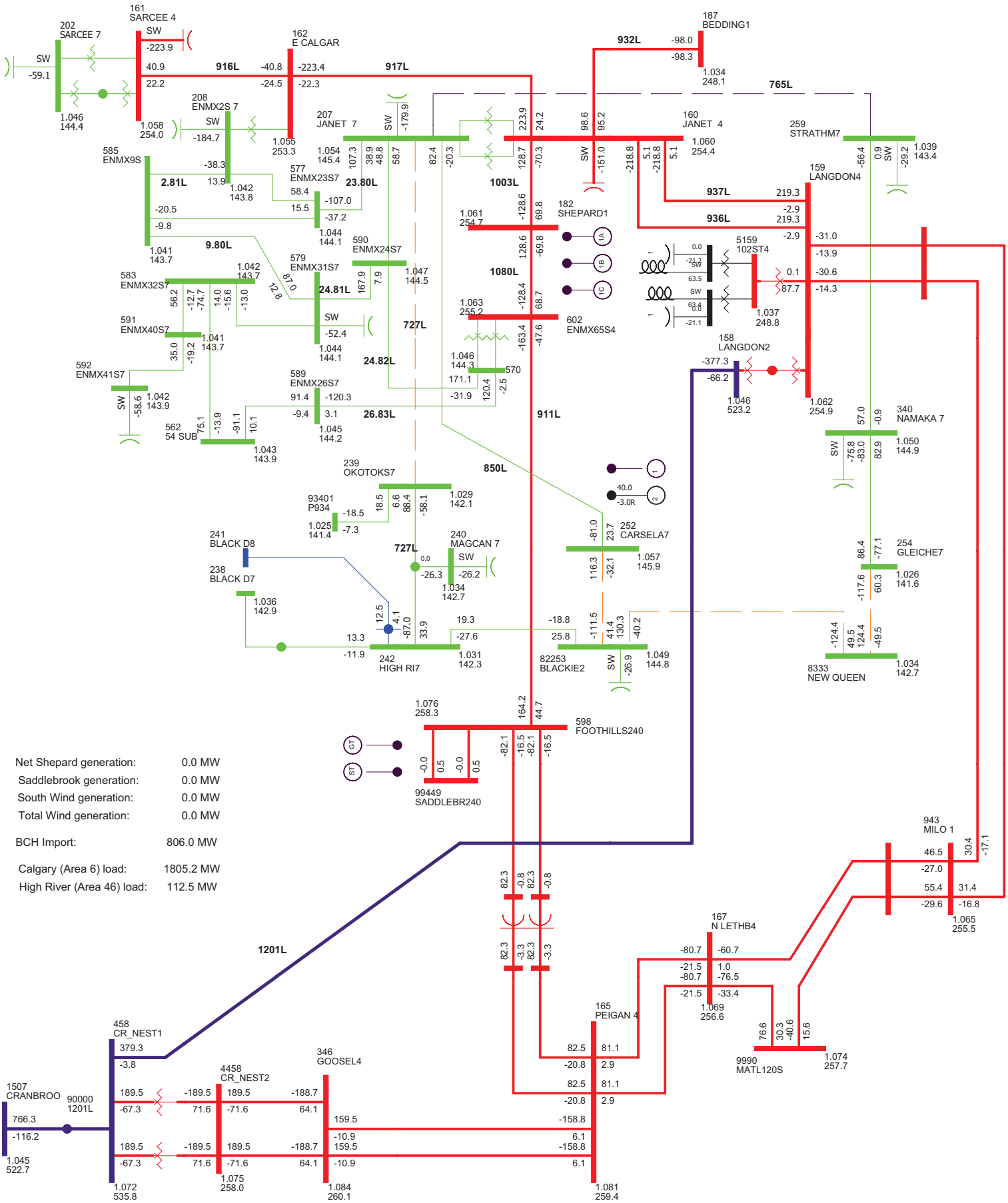


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc1-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:40



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc1-2

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 17:41

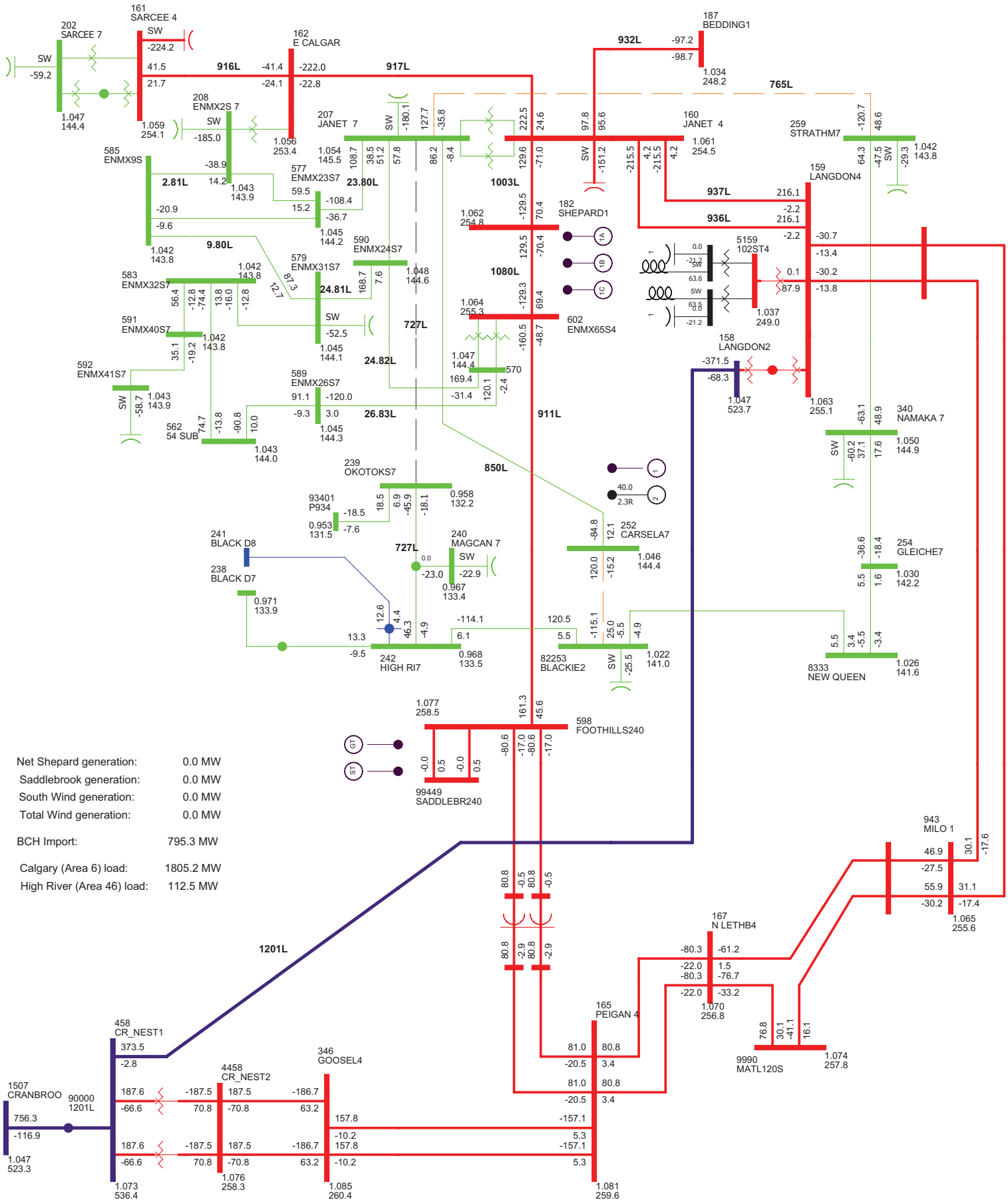
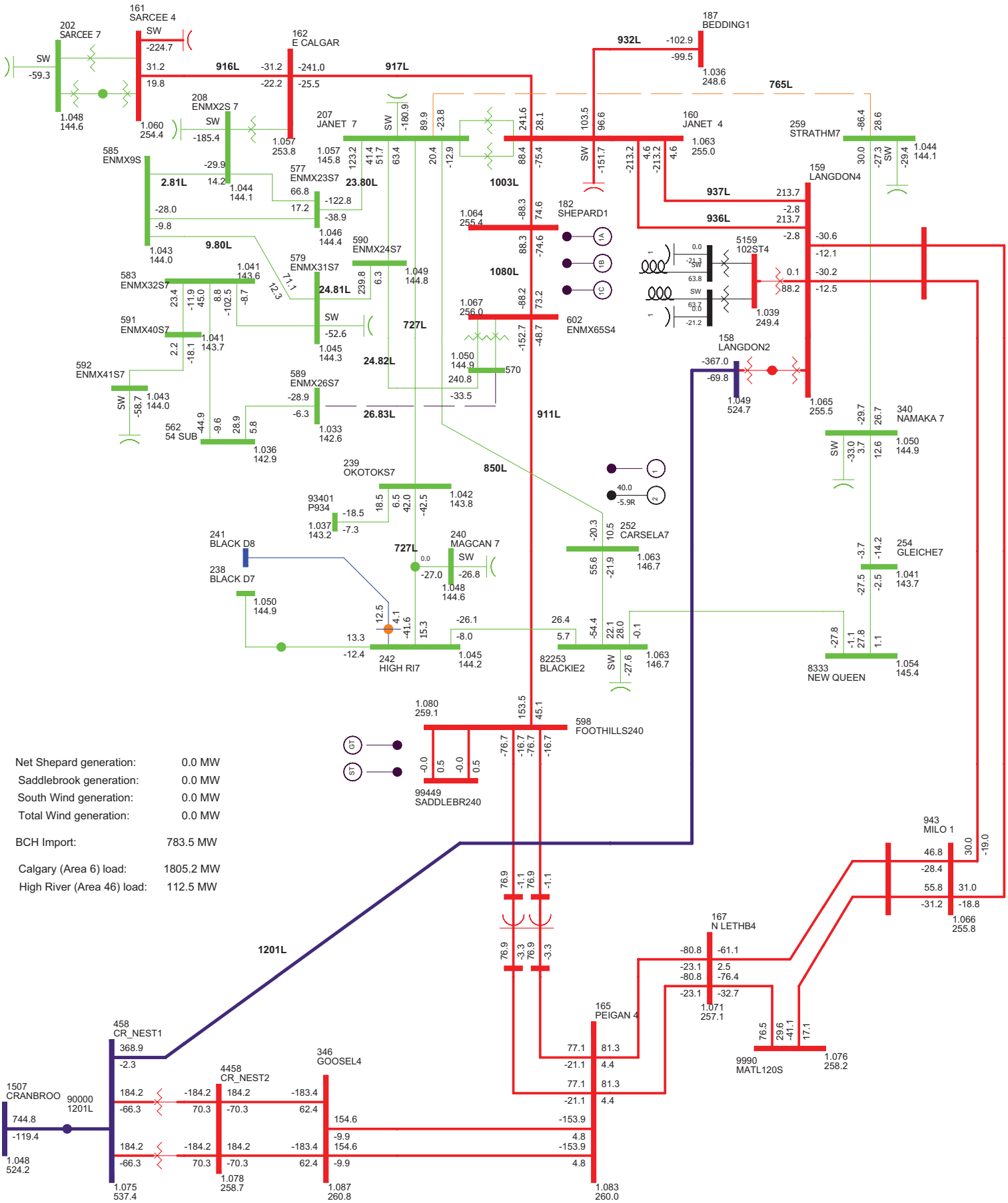


Figure A-2014-NEED-Sc1-3

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:41

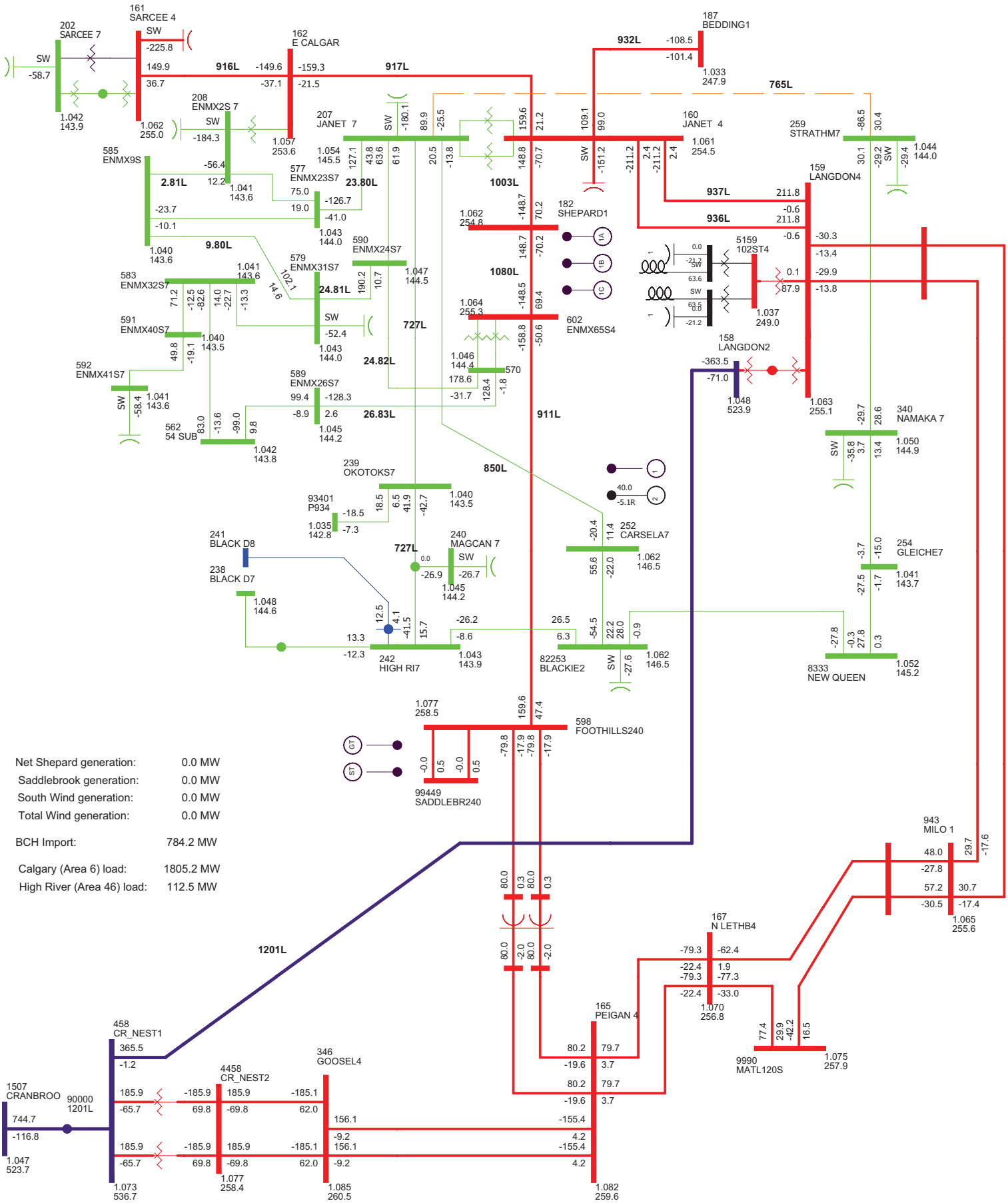


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc1-4

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 20 2011 17:41

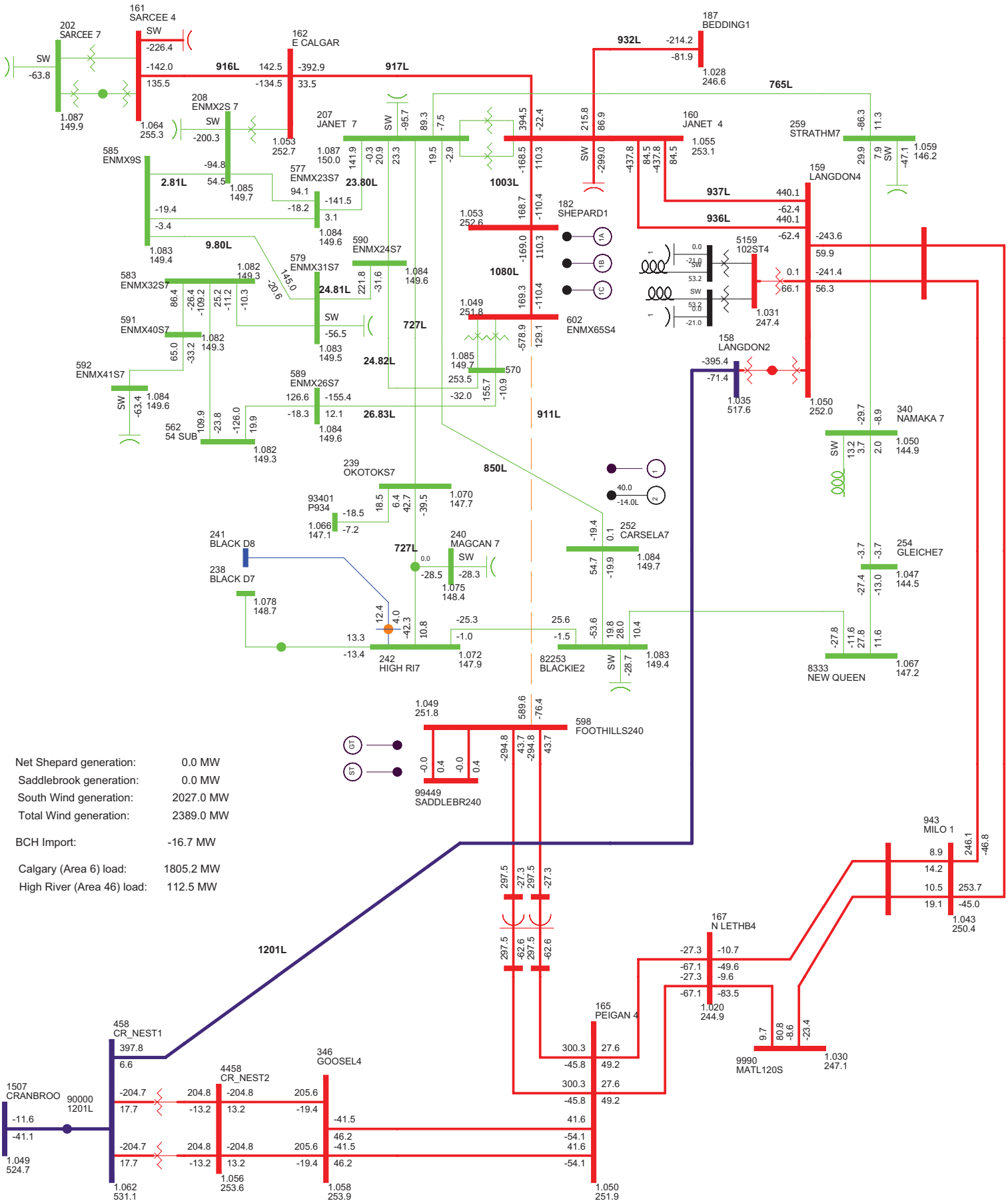


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc1-5

240/138 KV TRANSFORMER (SARCEE 42S)

WED, APR 20 2011 17:42

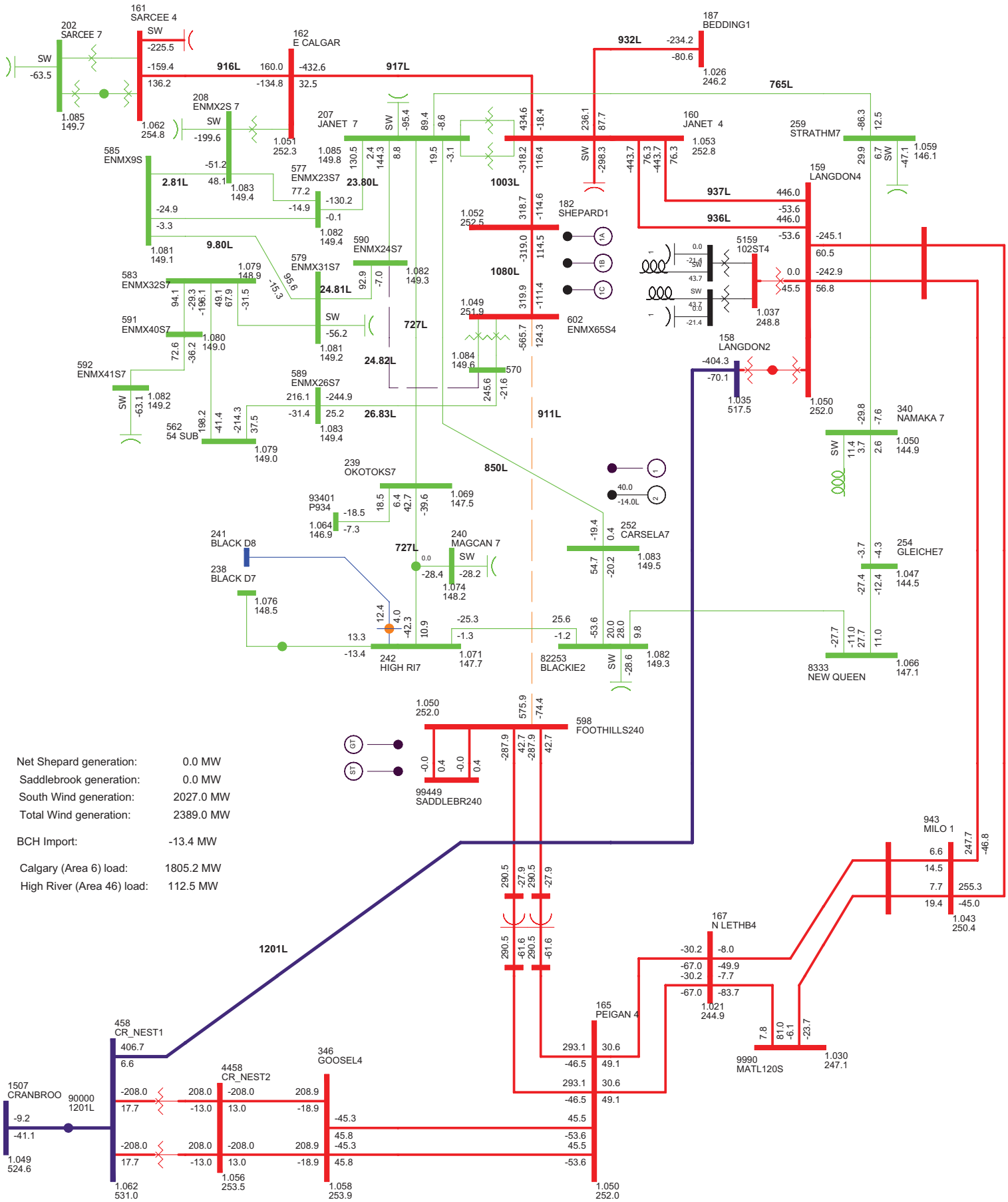


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:44

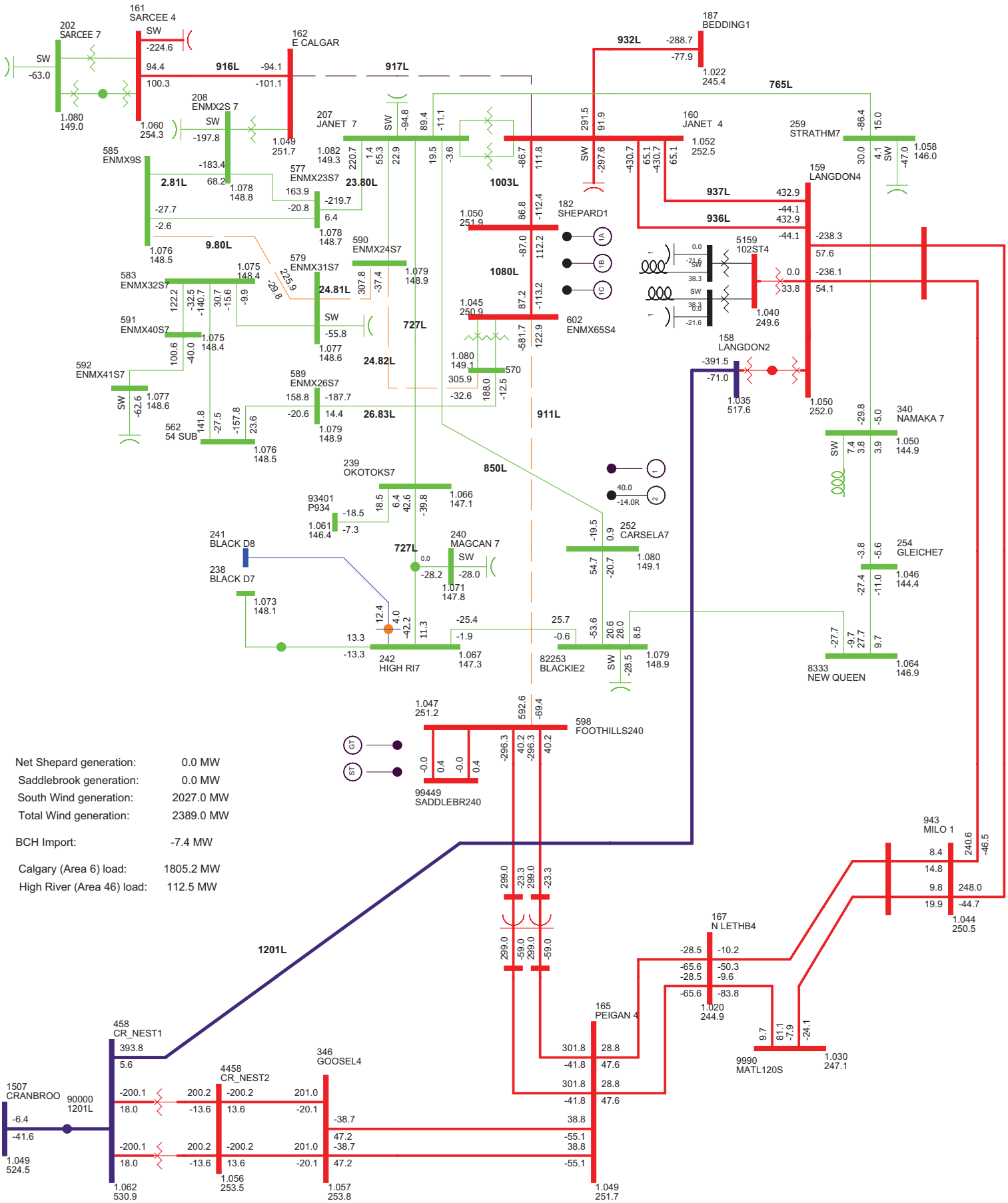


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

WED, APR 20 2011 17:44

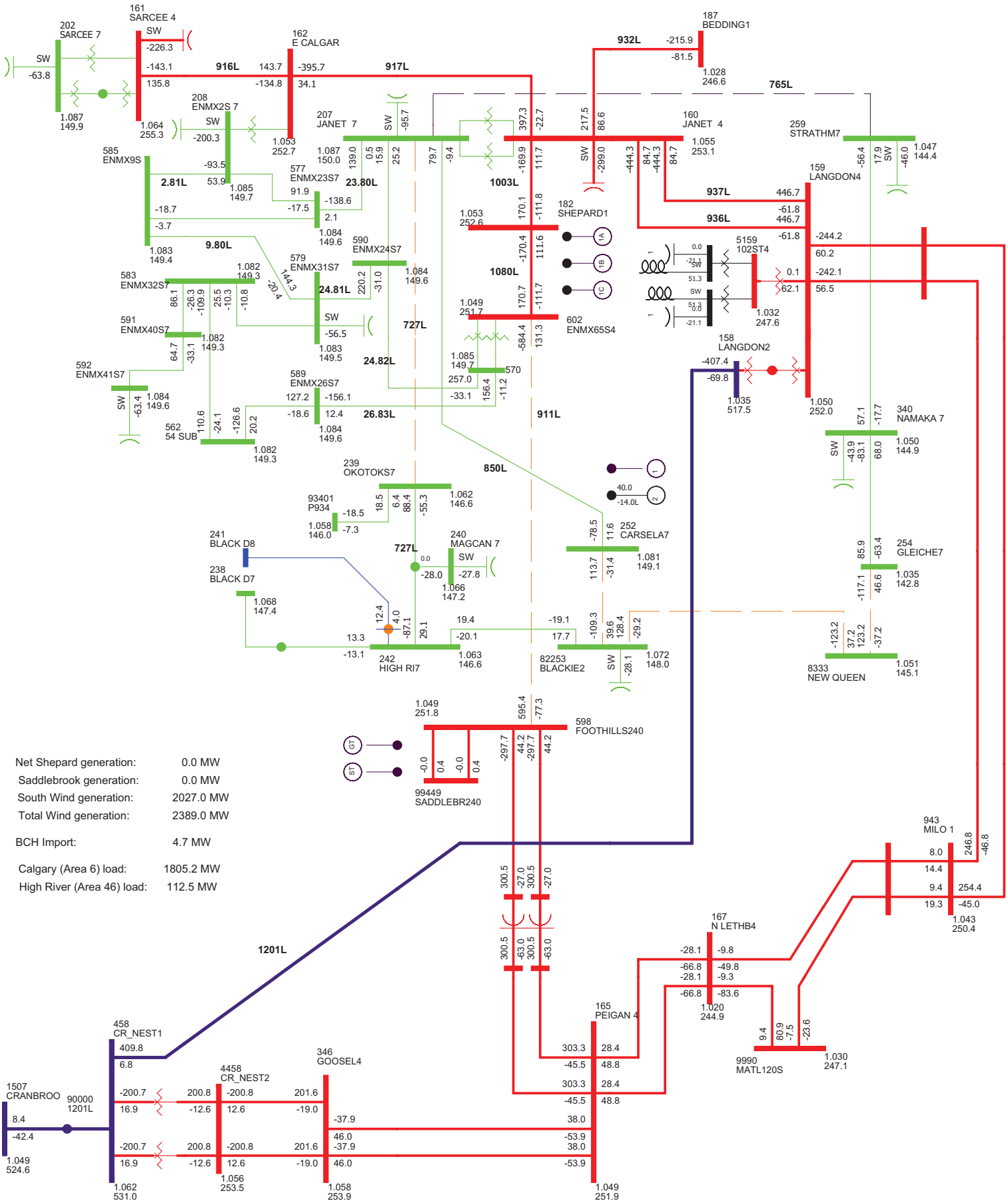


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-3

917L (JANET 74S TO EAST CALGARY 5S)

WED, APR 20 2011 17:44

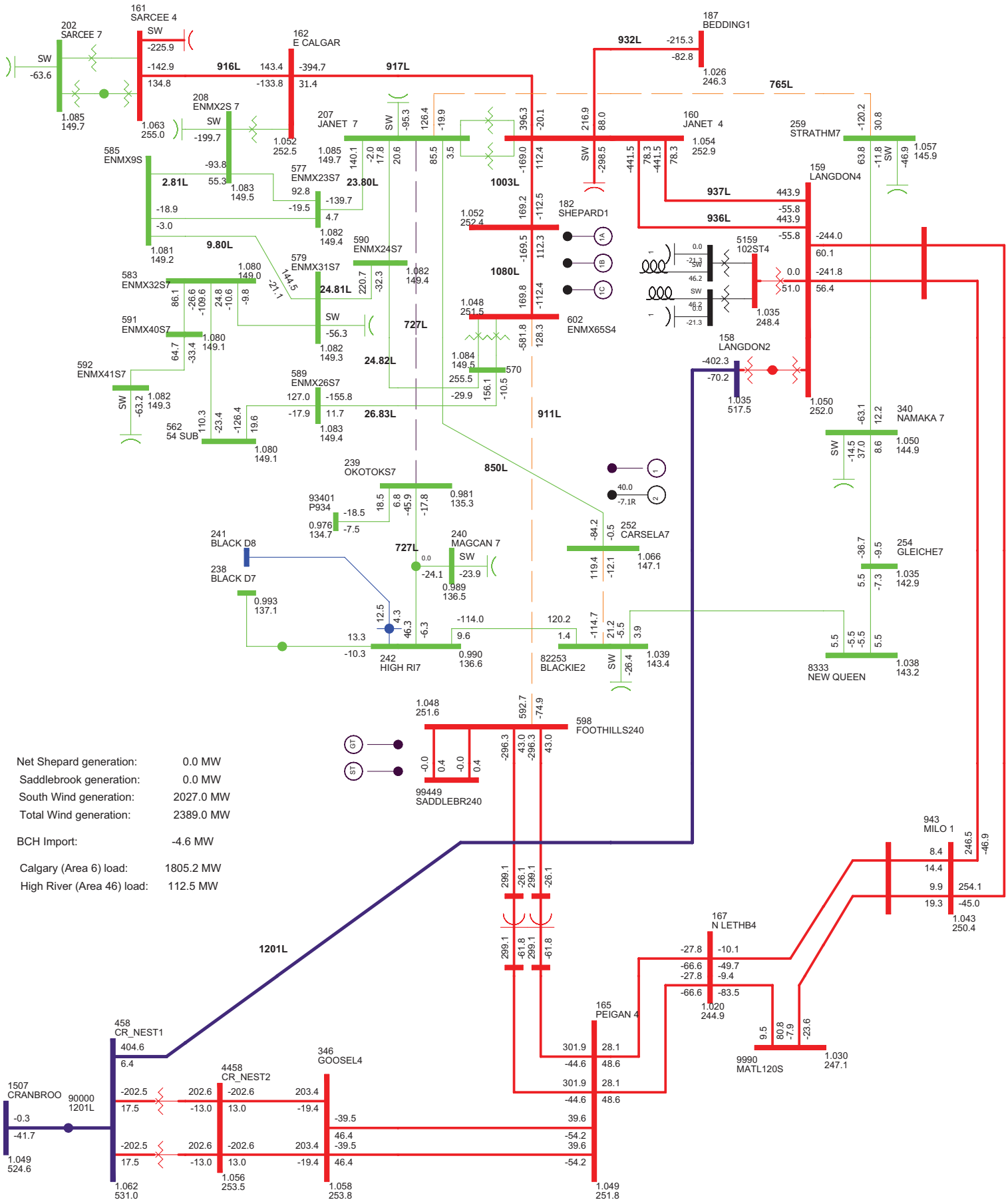


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-4

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 17:44

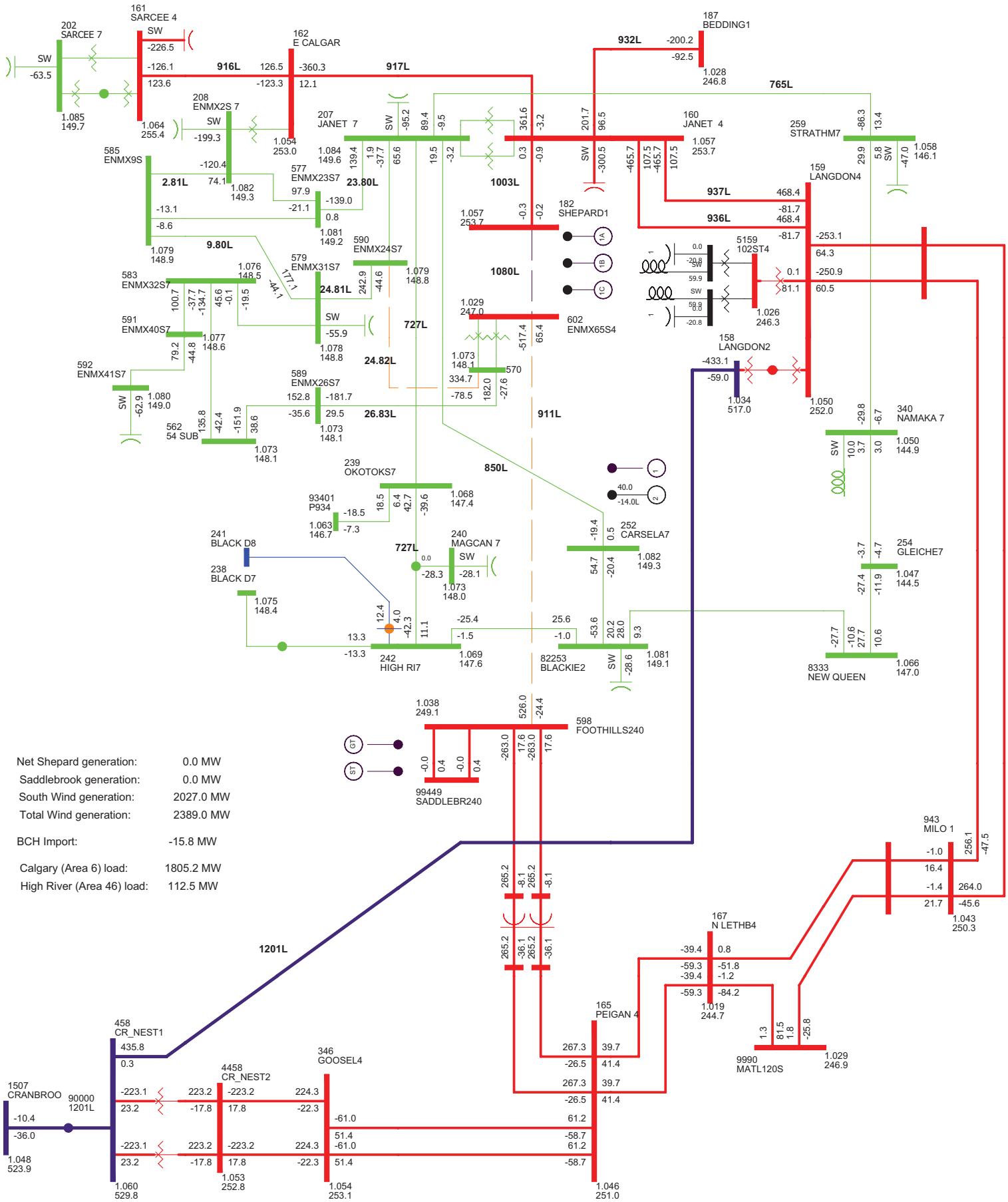


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-5

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:44

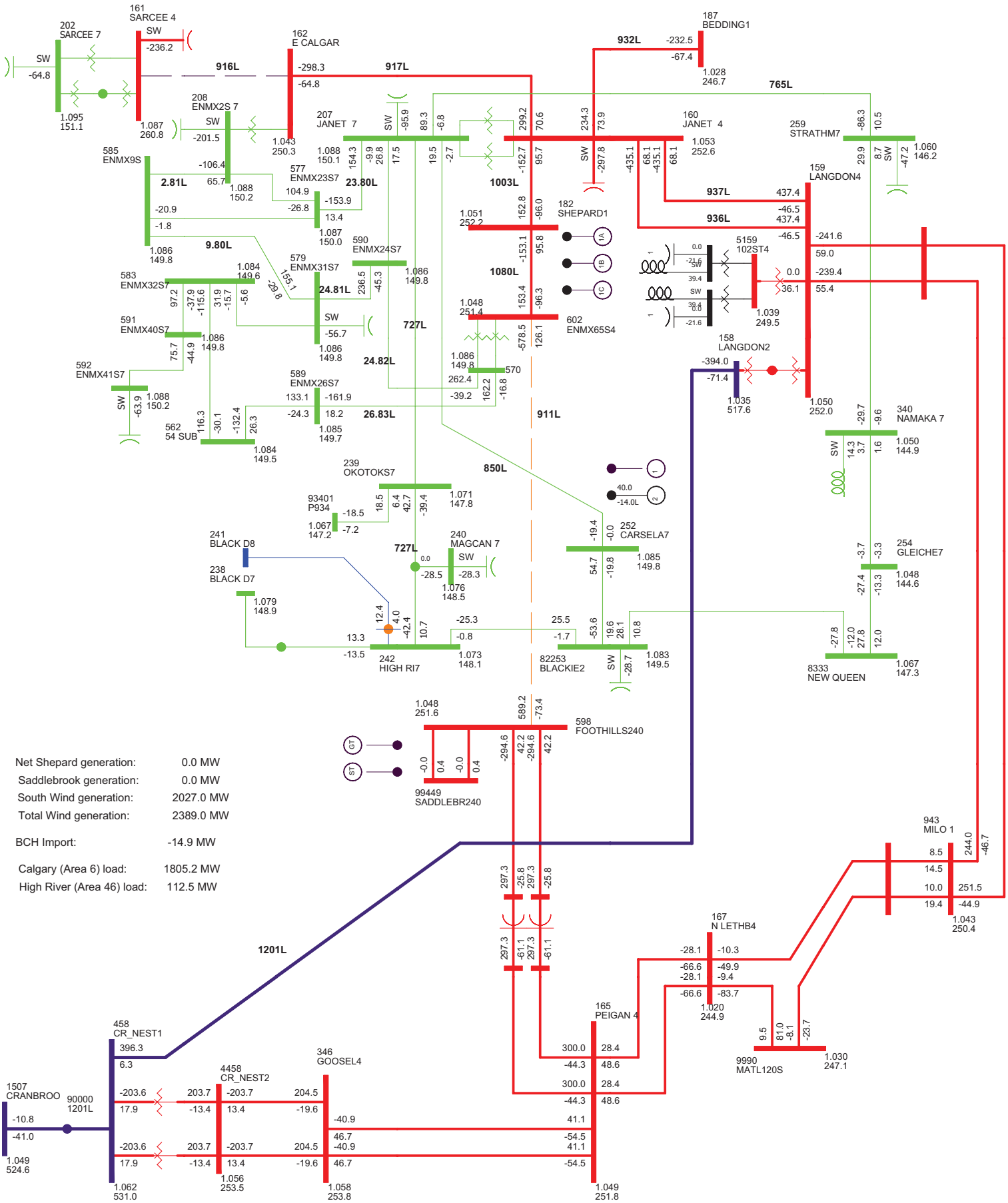


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-6

1080L (ENMAX NO. 25 TO ENMAX NO. 65)

WED, APR 20 2011 17:44



Net Shepard generation: 0.0 MW
Saddlebrook generation: 0.0 MW
South Wind generation: 2027.0 MW
Total Wind generation: 2389.0 MW

BCH Import: -14.9 MW

Calgary (Area 6) load: 1805.2 MW
High River (Area 46) load: 112.5 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-7

916L (SARCEE 42S TO EAST CALGARY 5S)

WED, APR 20 2011 17:45

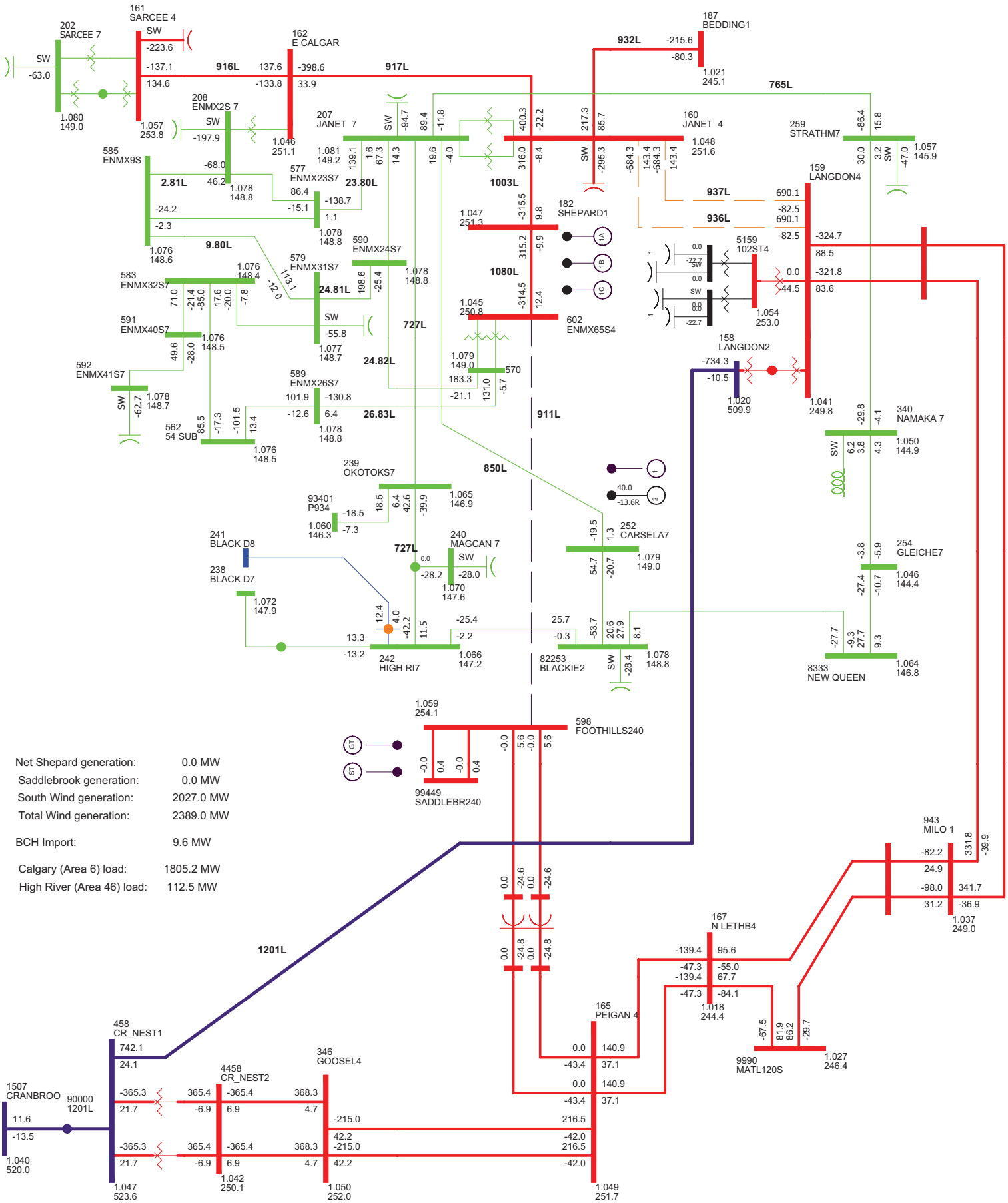
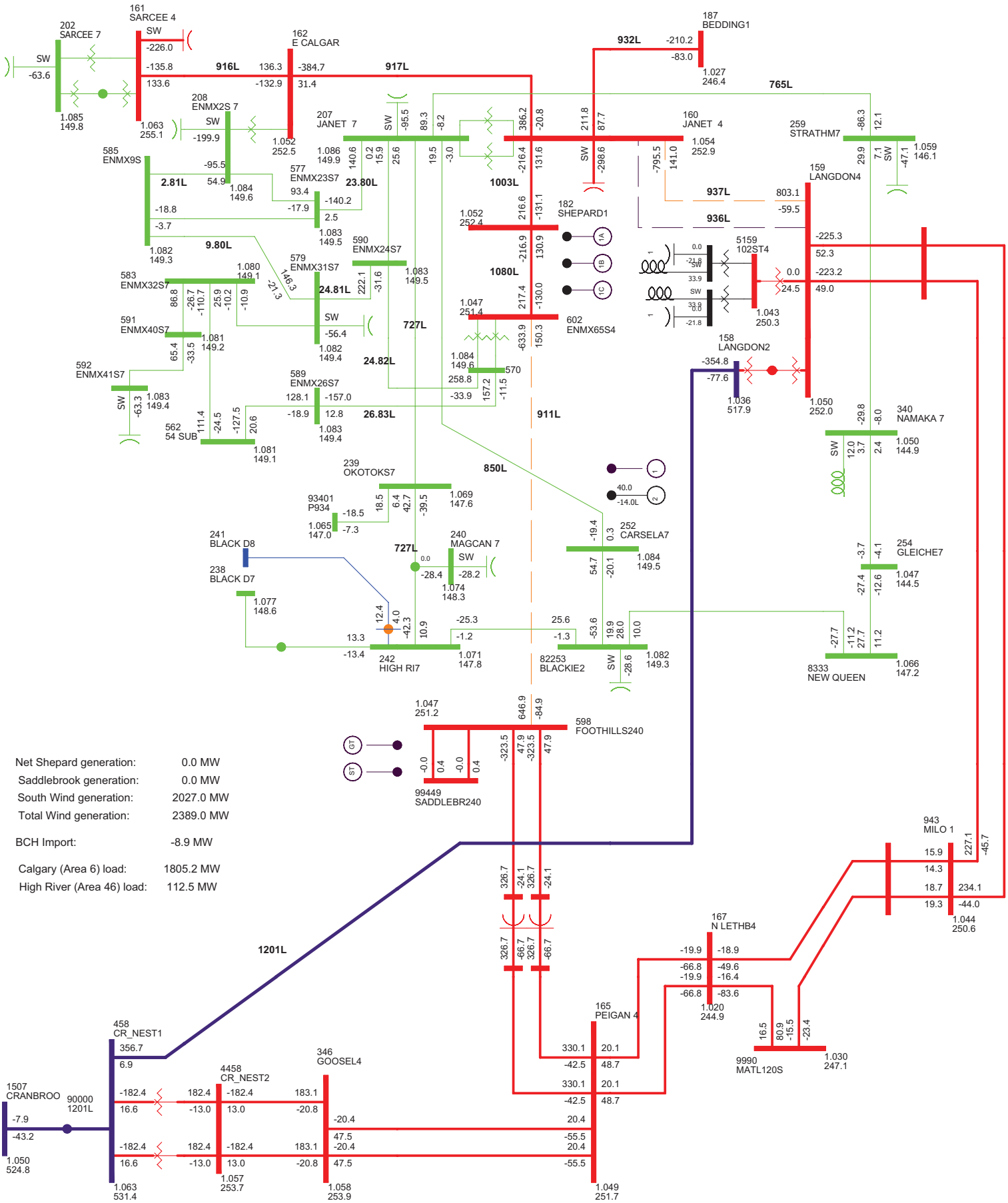


Figure A-2014-NEED-Sc2-8

911L (FOOTHILLS 237S TO ENMAX NO. 65)

WED, APR 20 2011 17:45

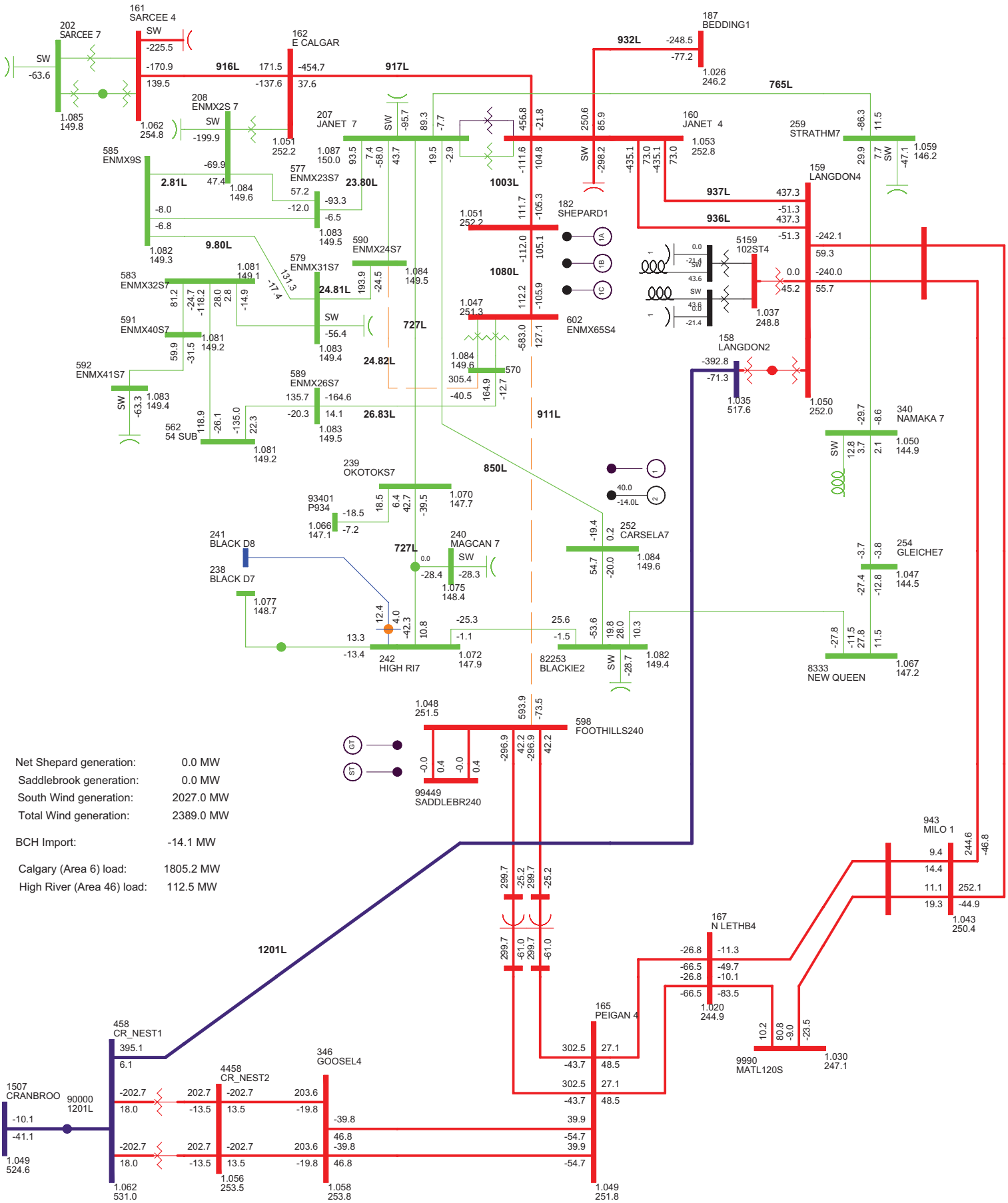


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-9

936L (LANGDON 102S TO JANET 74S)

WED, APR 20 2011 17:45

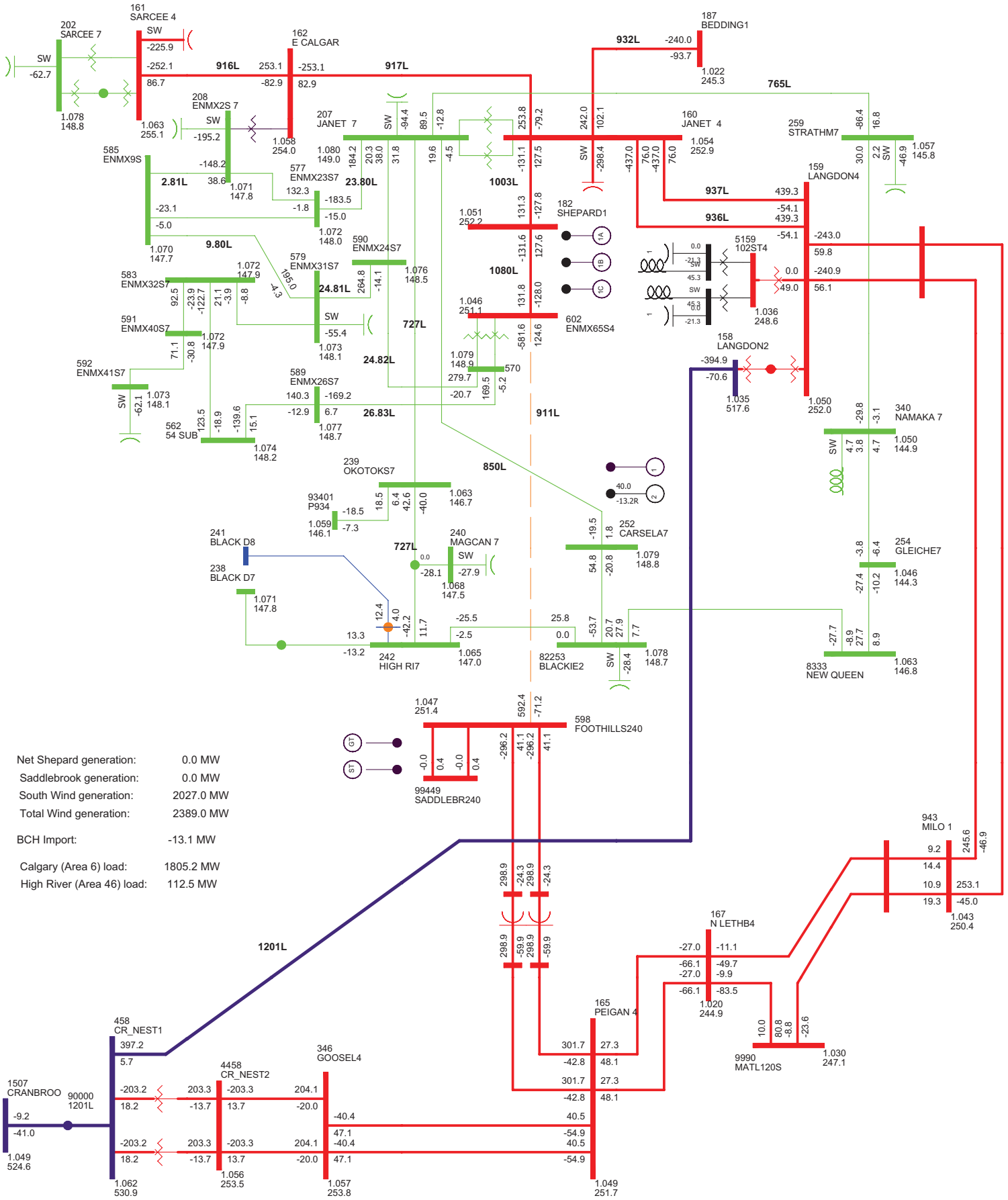


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-10

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 17:45

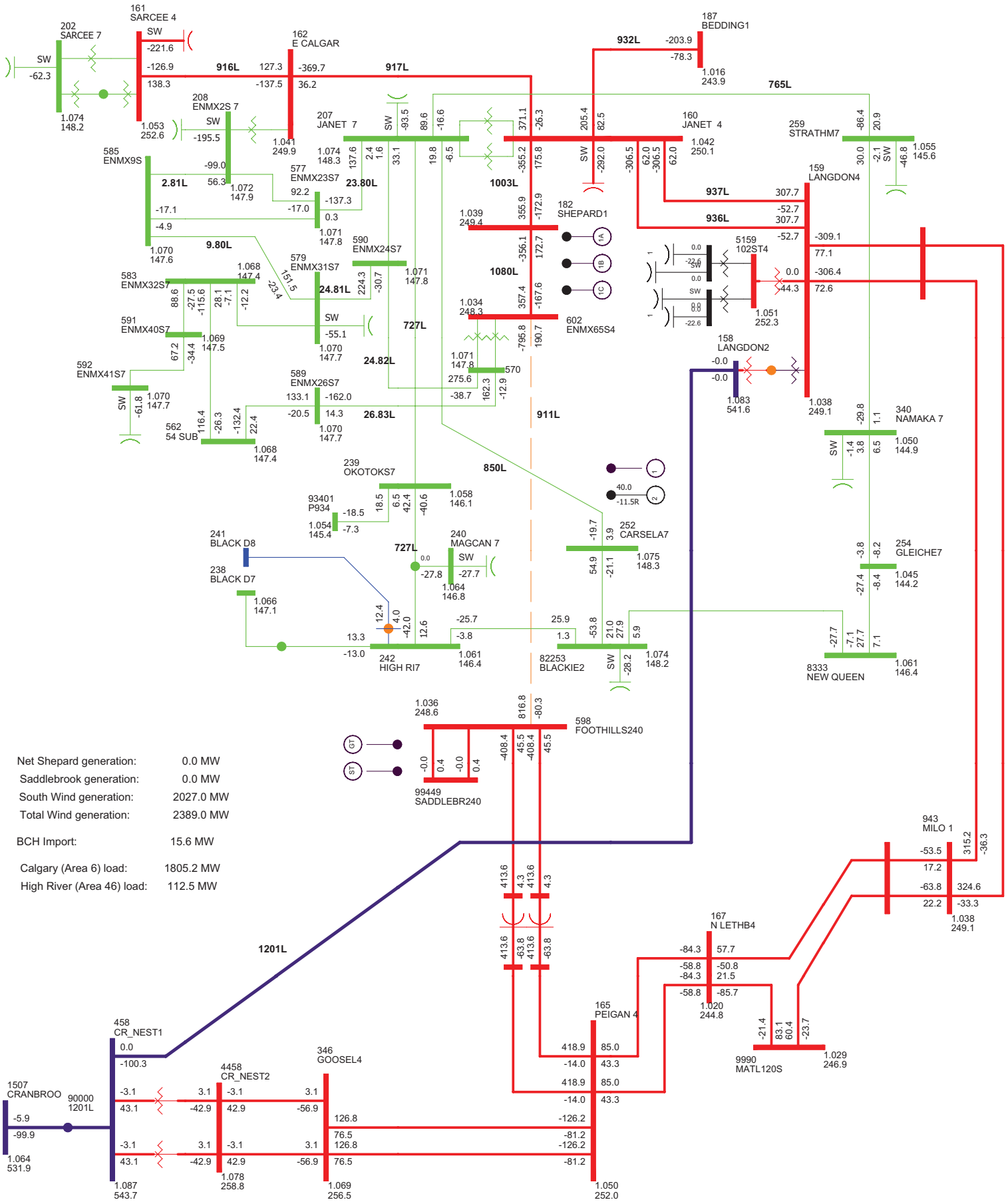


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-11

240/138 KV TRANSFORMER (EAST CALGARY 5S)

WED, APR 20 2011 17:45

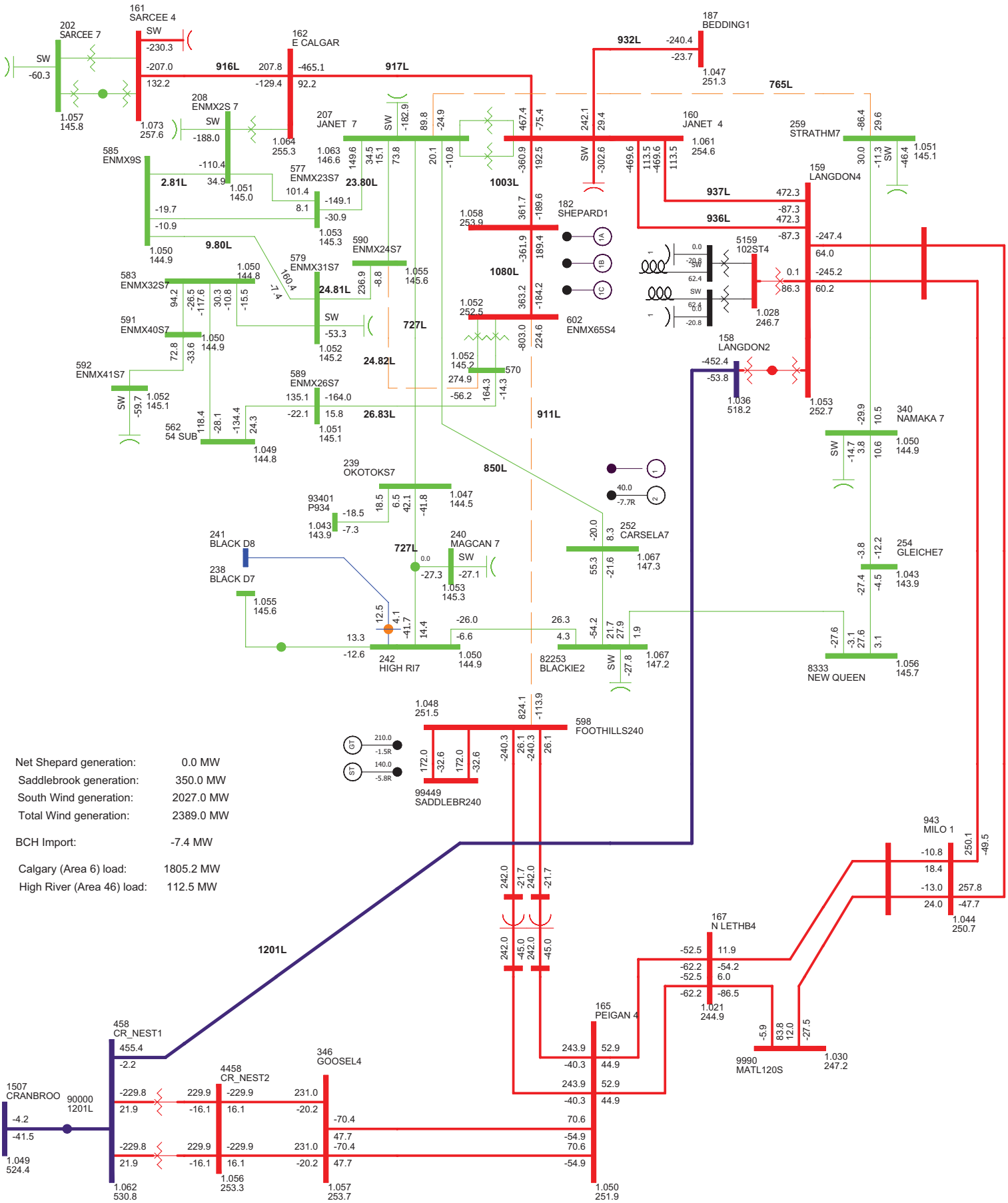


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc2-12

500/240 KV TRANSFORMER (LANGDON 102S)

WED, APR 20 2011 17:46

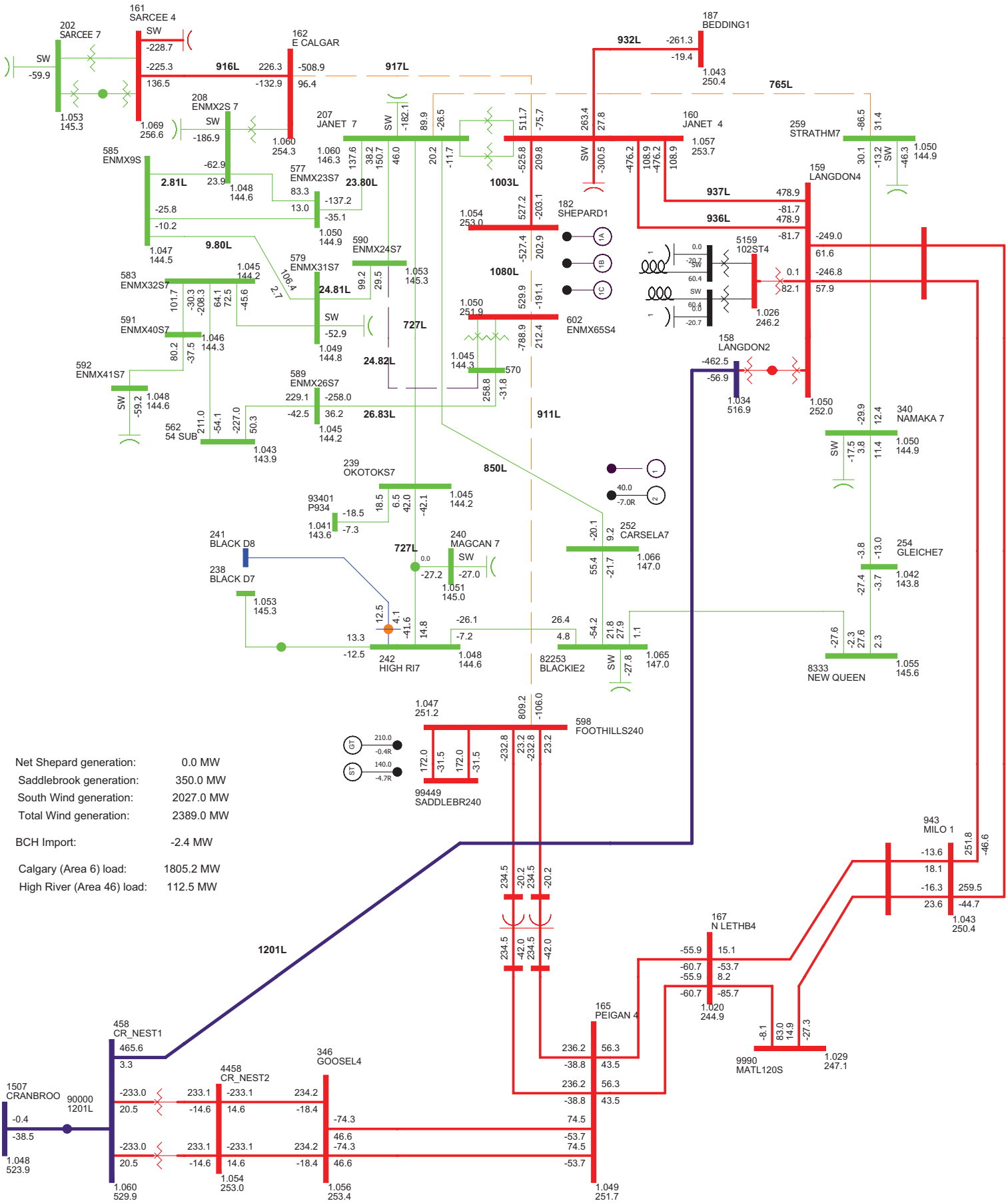


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:47

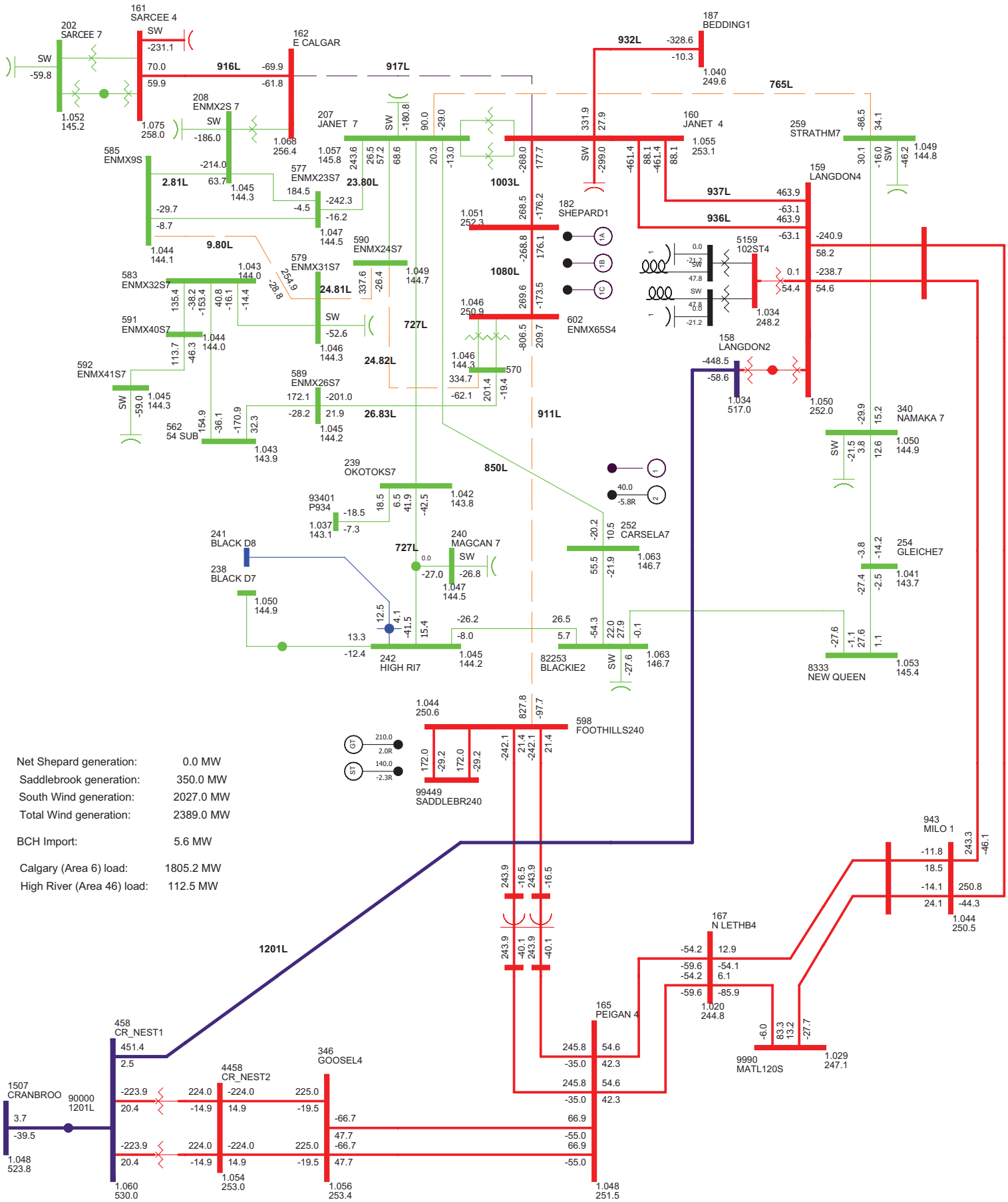


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

WED, APR 20 2011 17:48

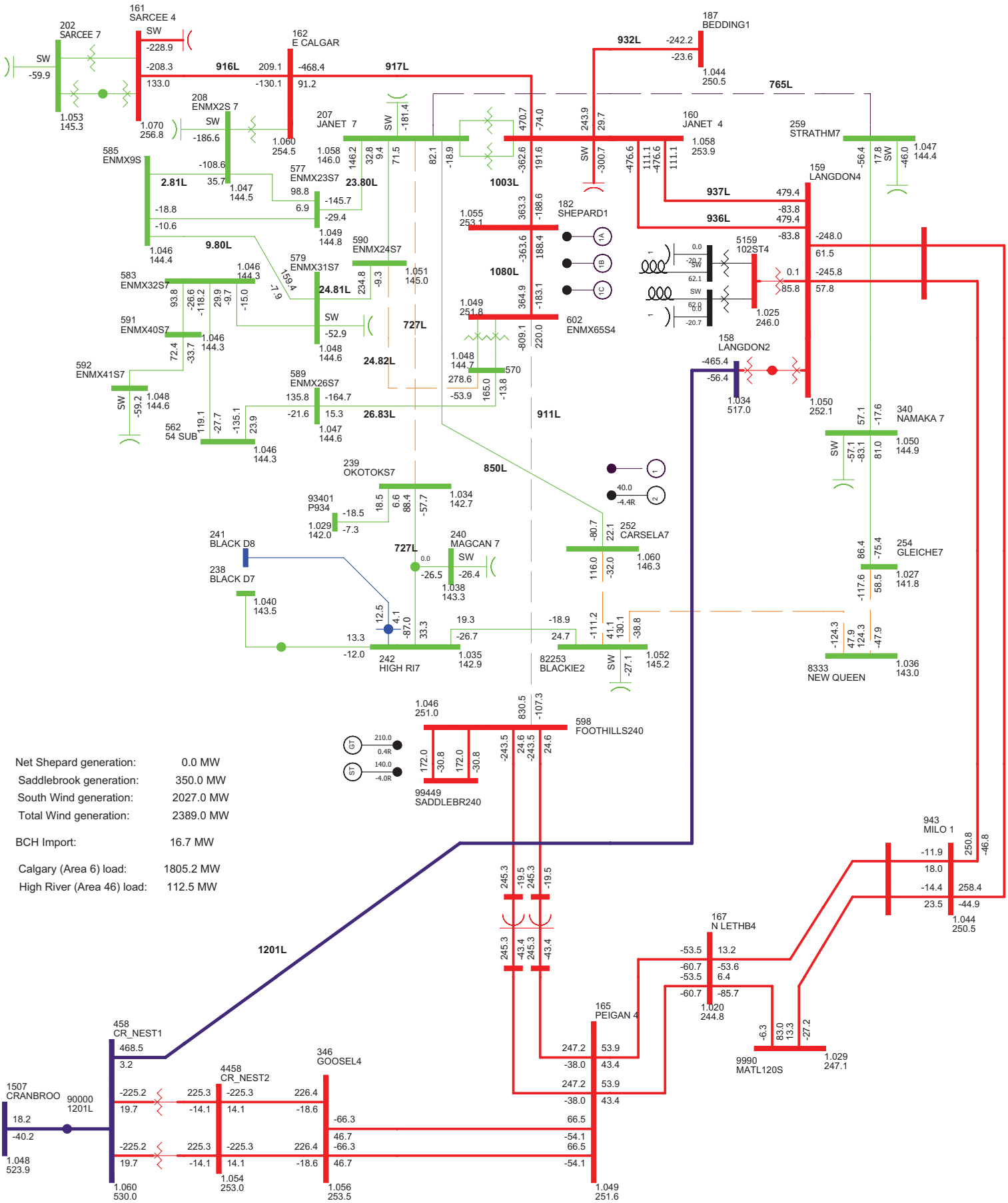


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-3

917L (JANET 74S TO EAST CALGARY 5S)

WED, APR 20 2011 17:48

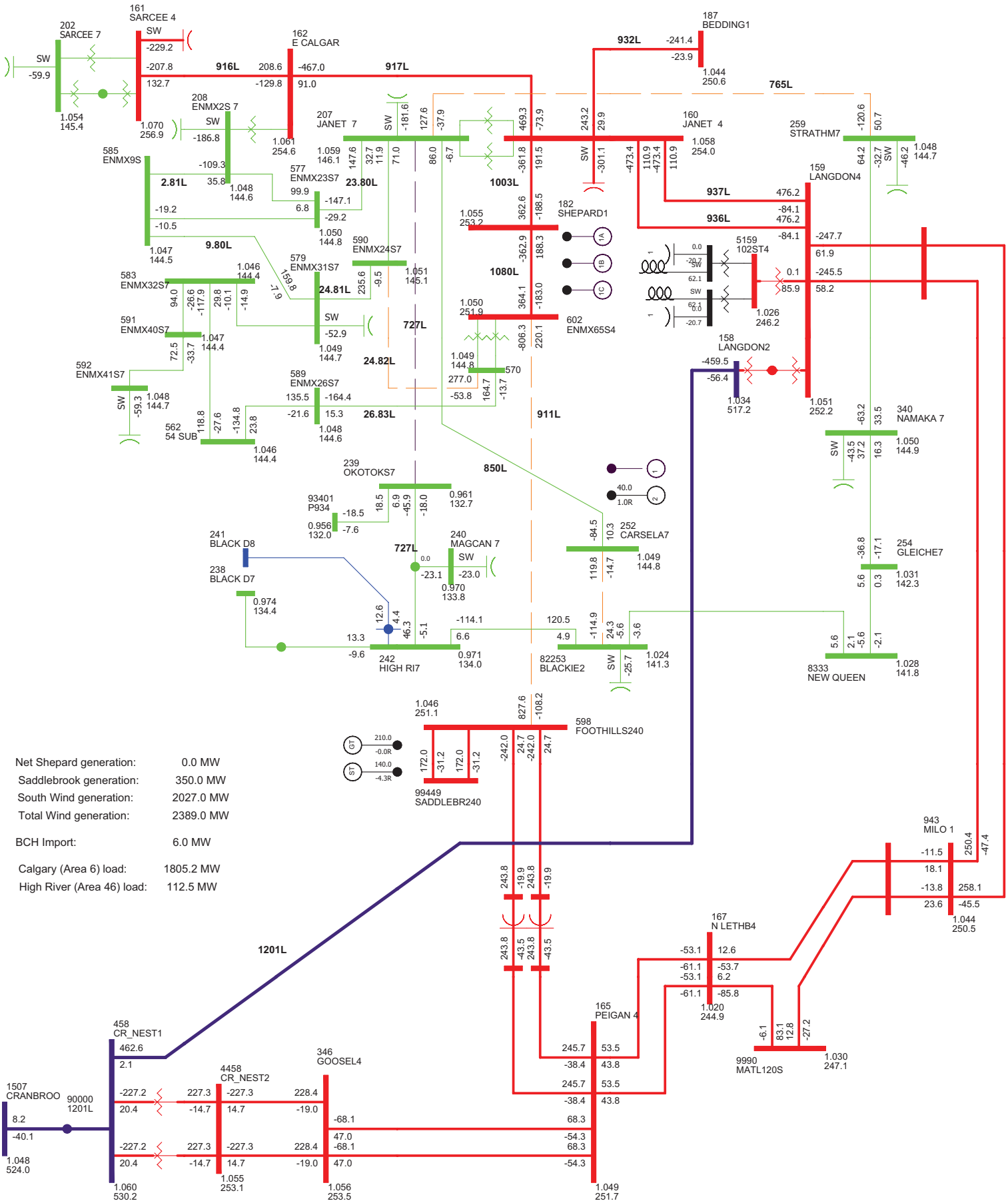


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-4

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 17:48

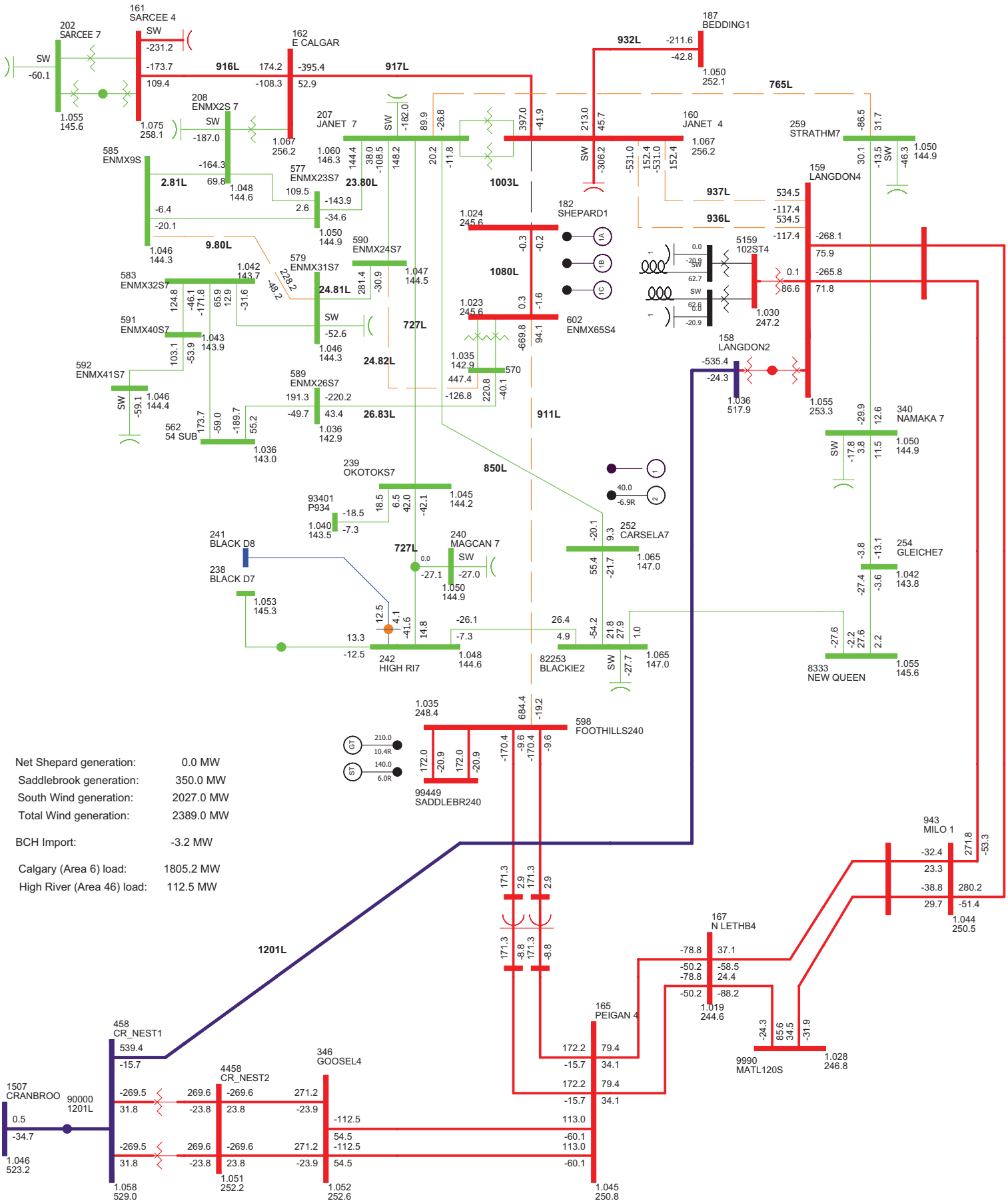


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-5

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:48

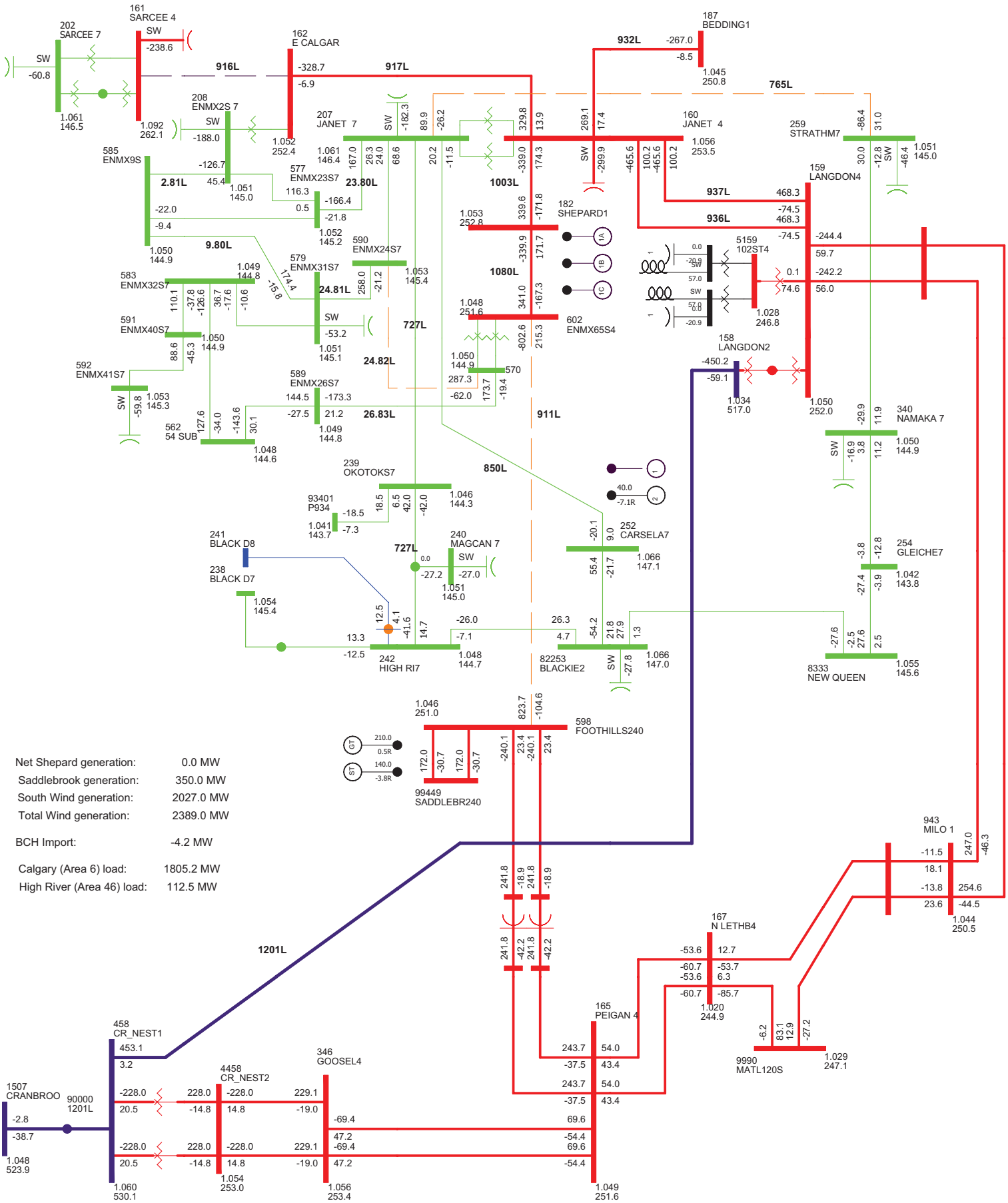


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-6

1003L (JANET 74S TO ENMAX NO. 25)

WED, APR 20 2011 17:48

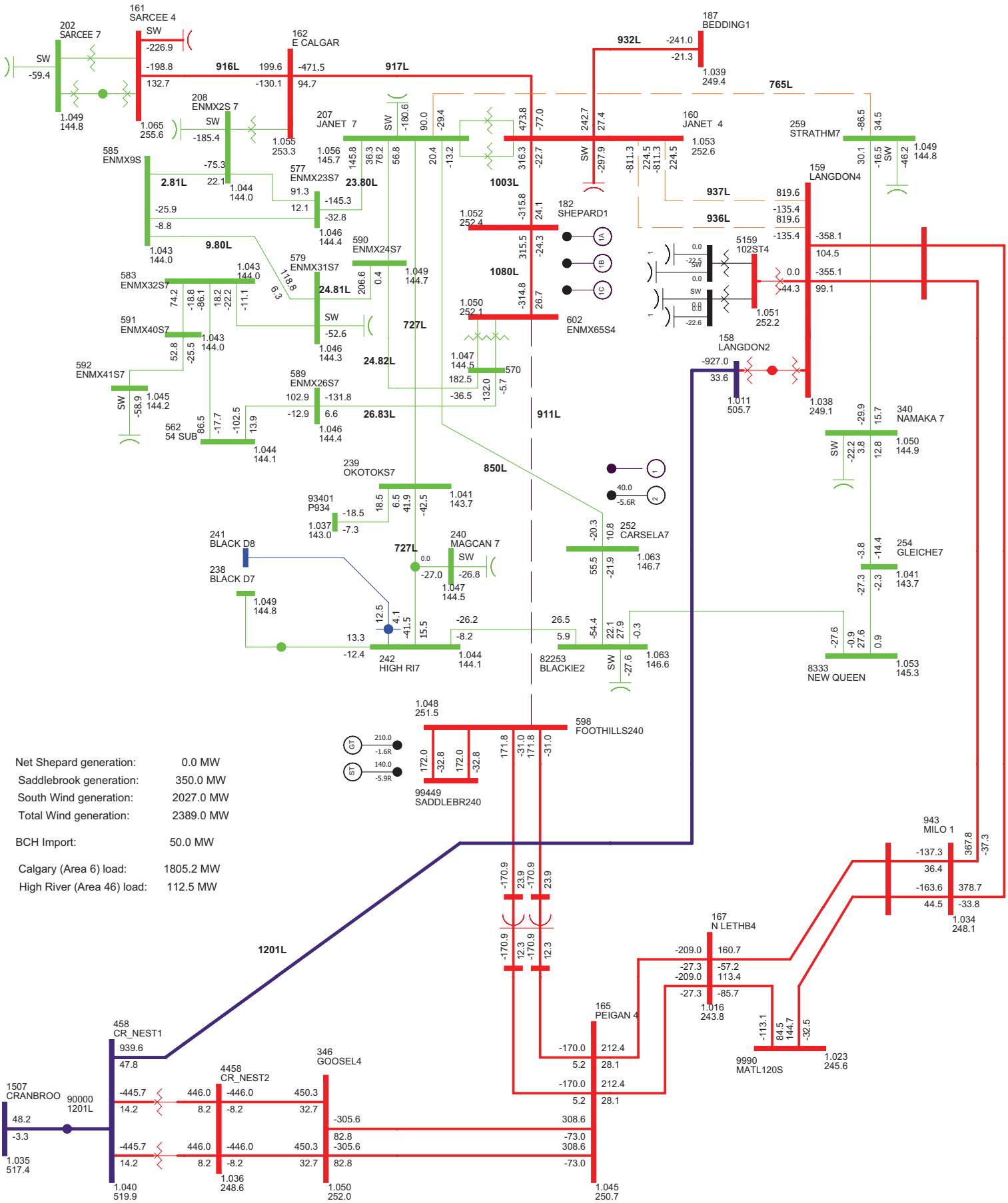


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-7

916L (SARCEE 42S TO EAST CALGARY 5S)

WED, APR 20 2011 17:48

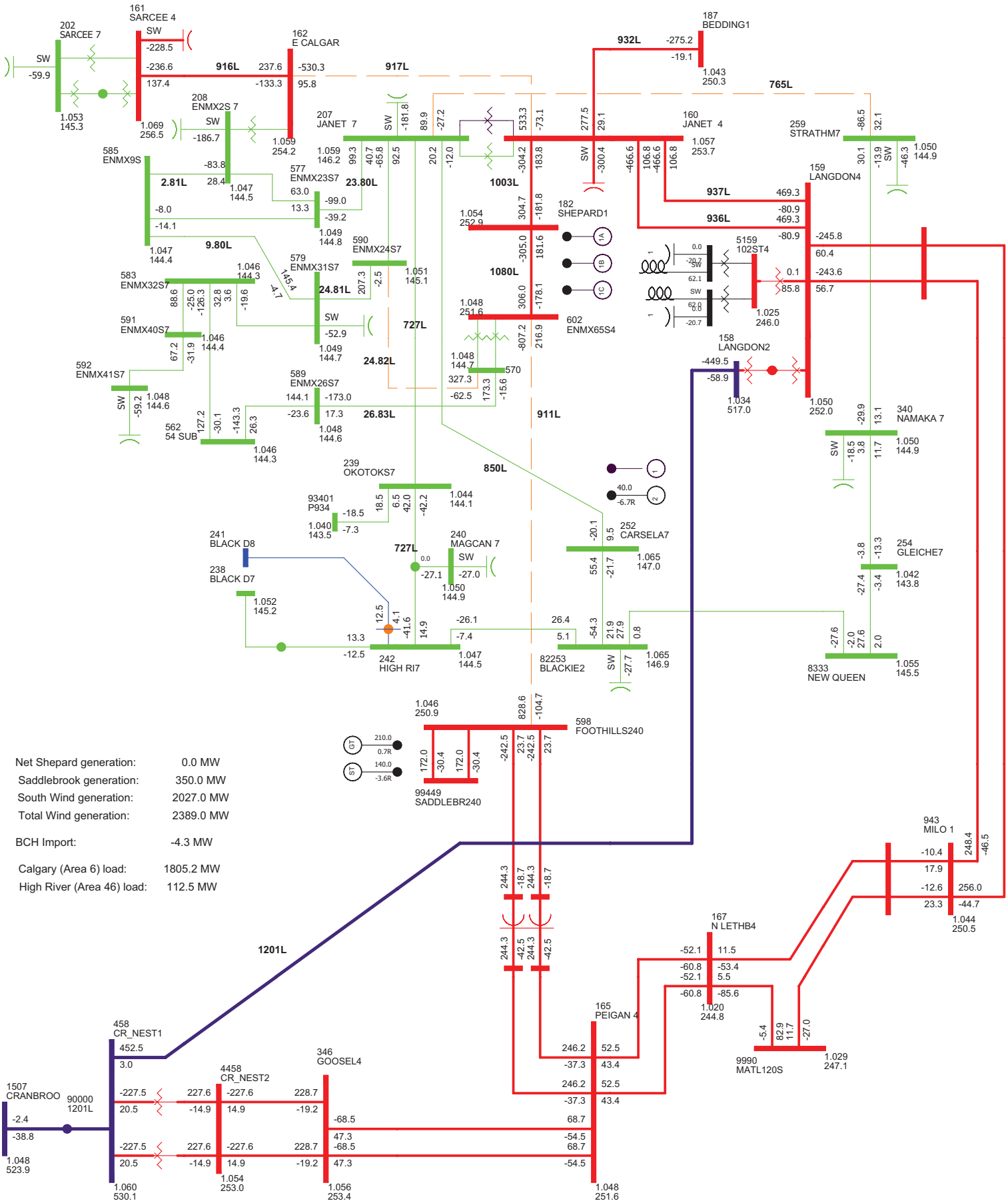


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-8

911L (FOOTHILLS 237S TO ENMAX NO. 65)

WED, APR 20 2011 17:48

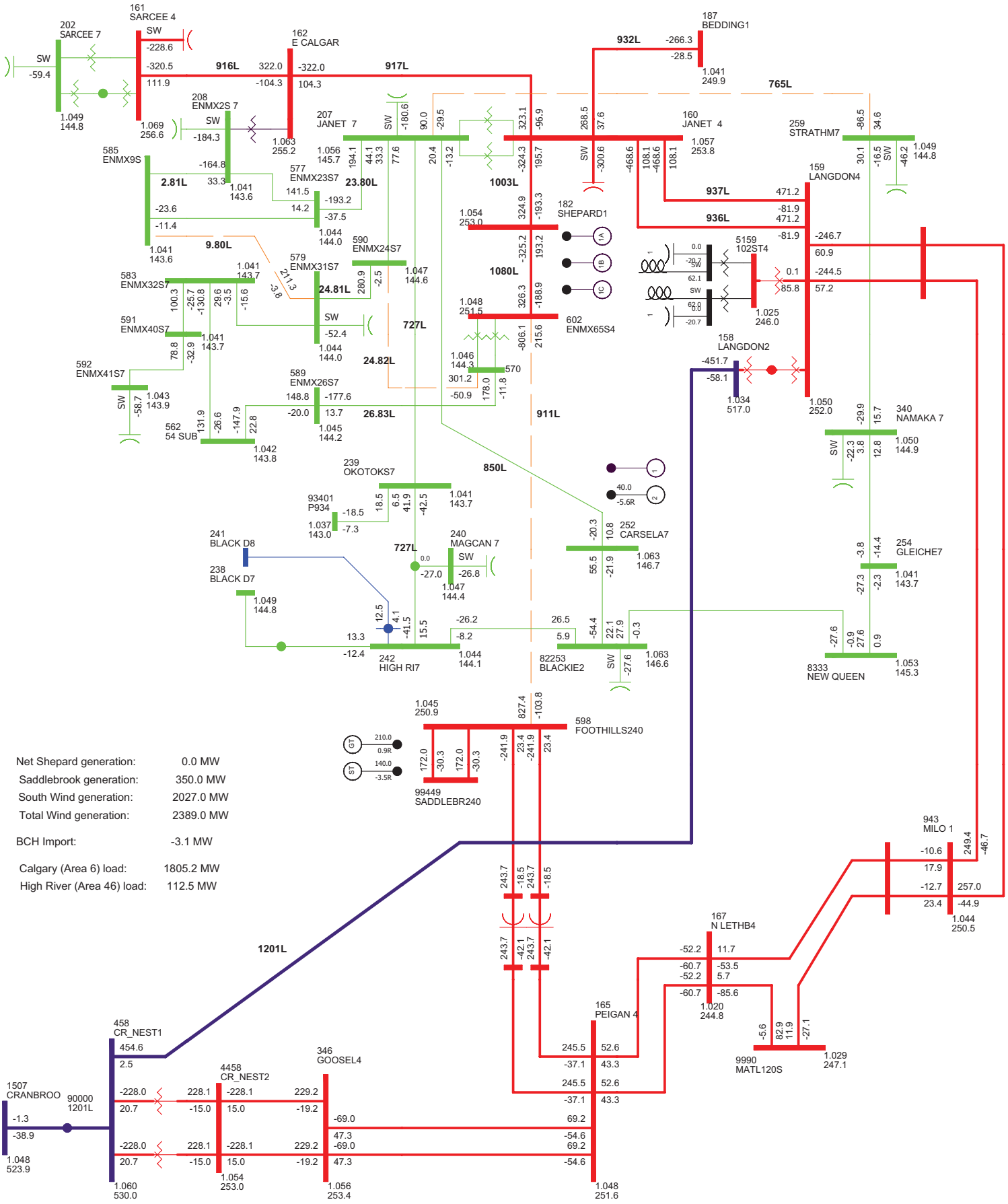


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-9

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 17:49

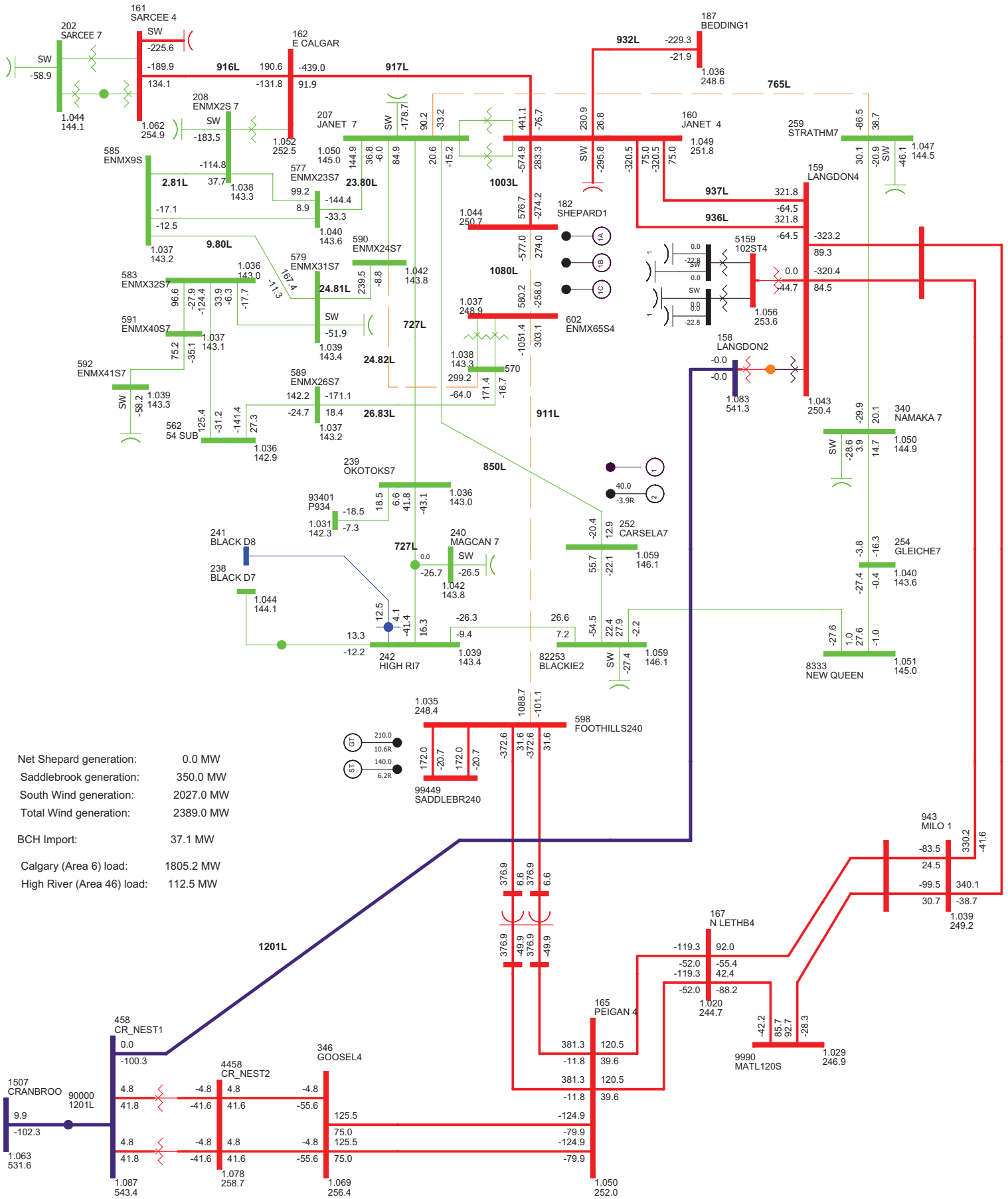


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-10

240/138 KV TRANSFORMER (EAST CALGARY 5S)

WED, APR 20 2011 17:49

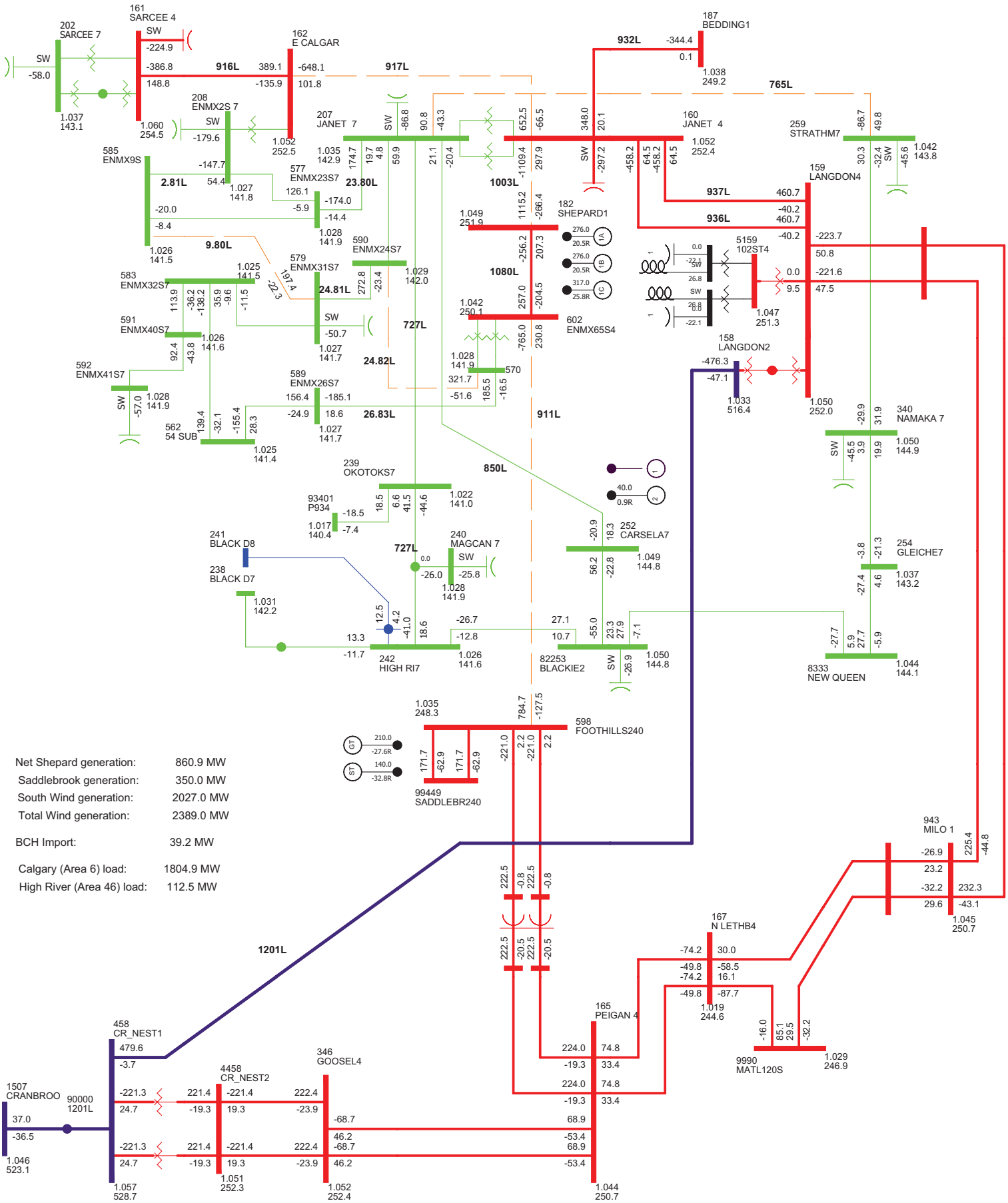


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc3-11

500/240 KV TRANSFORMER (LANGDON 102S)

WED, APR 20 2011 17:49

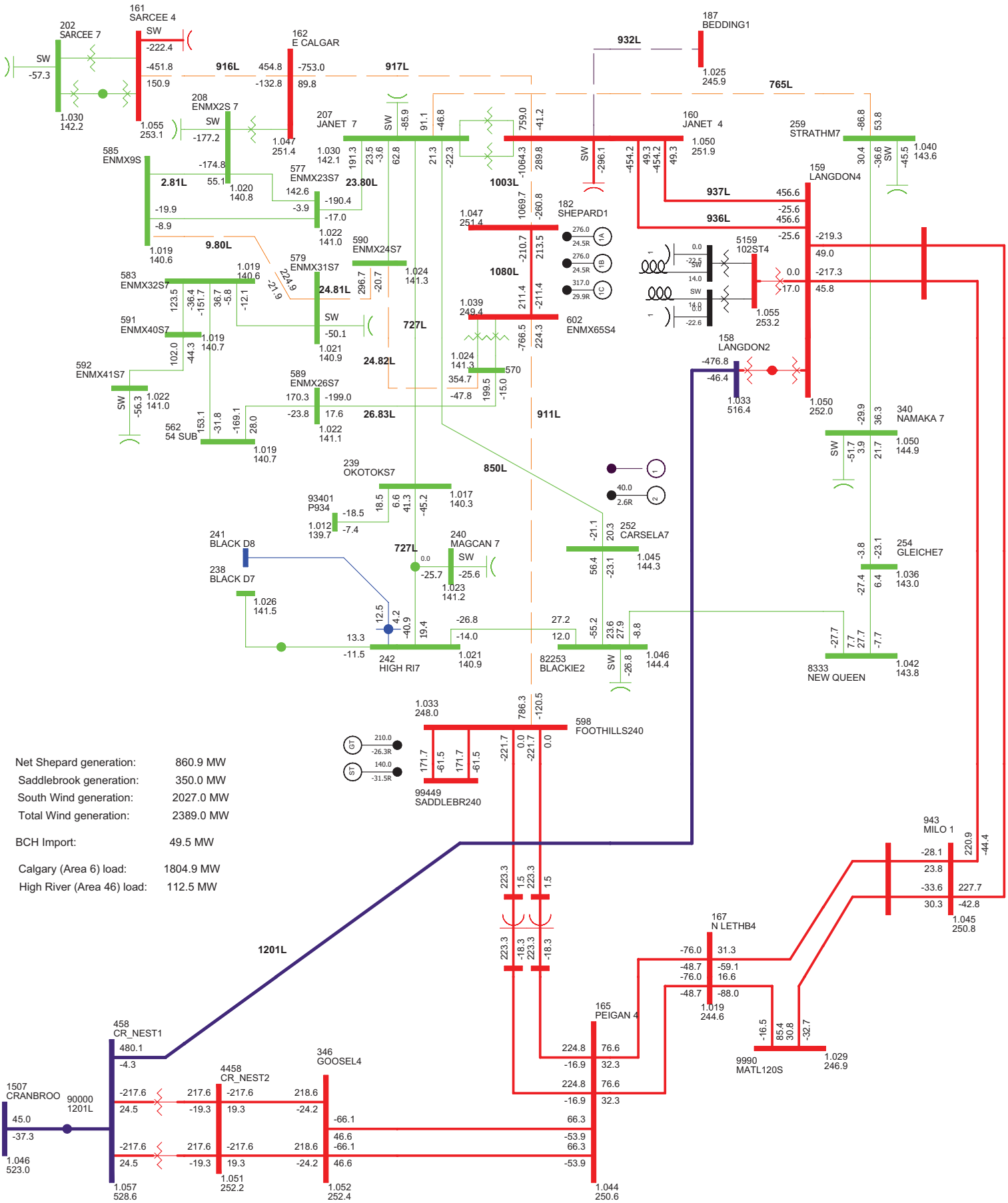


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:51

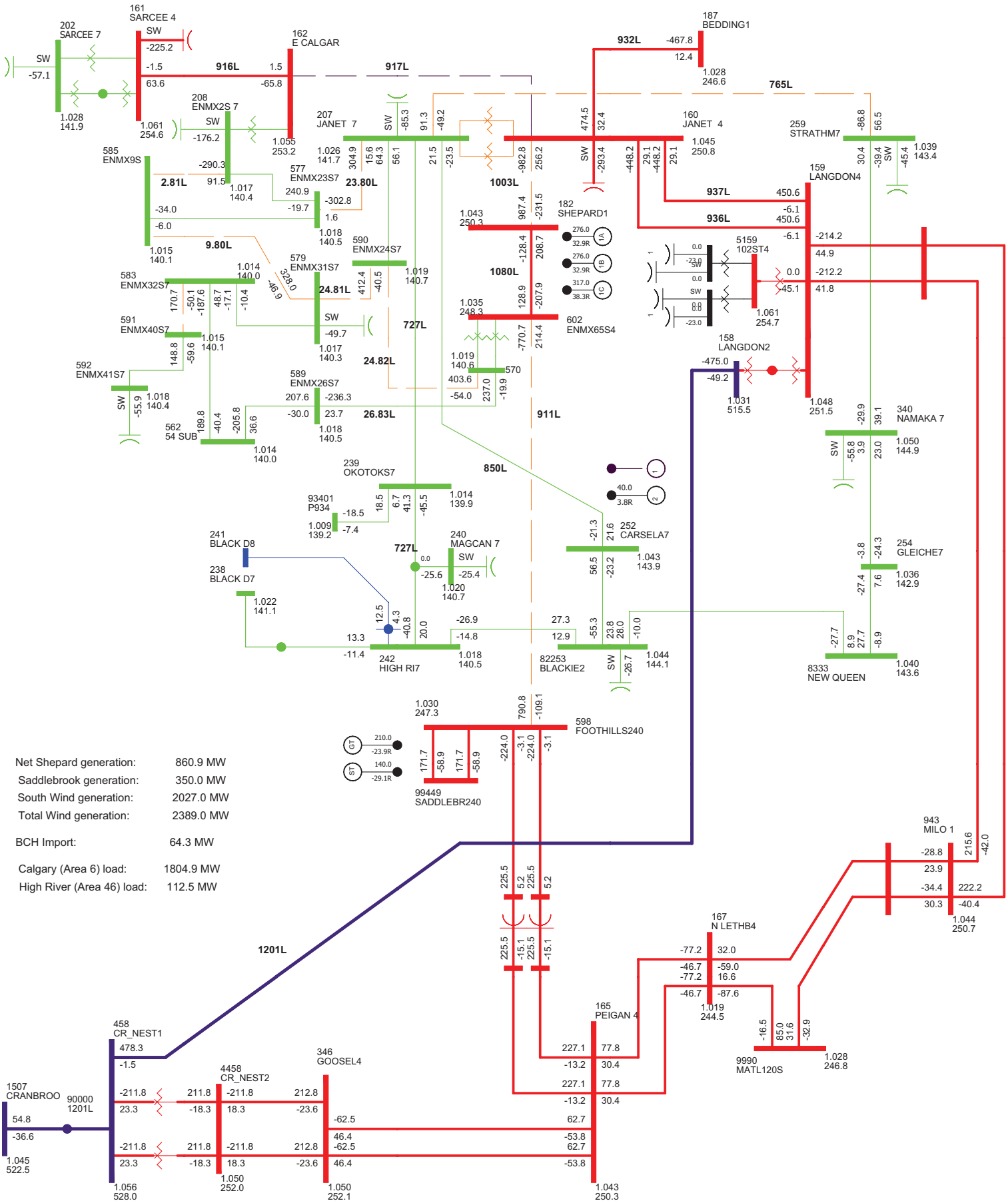


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-2

932L (JANET 74S TO BEDDINGTON NO. 162)

WED, APR 20 2011 17:51

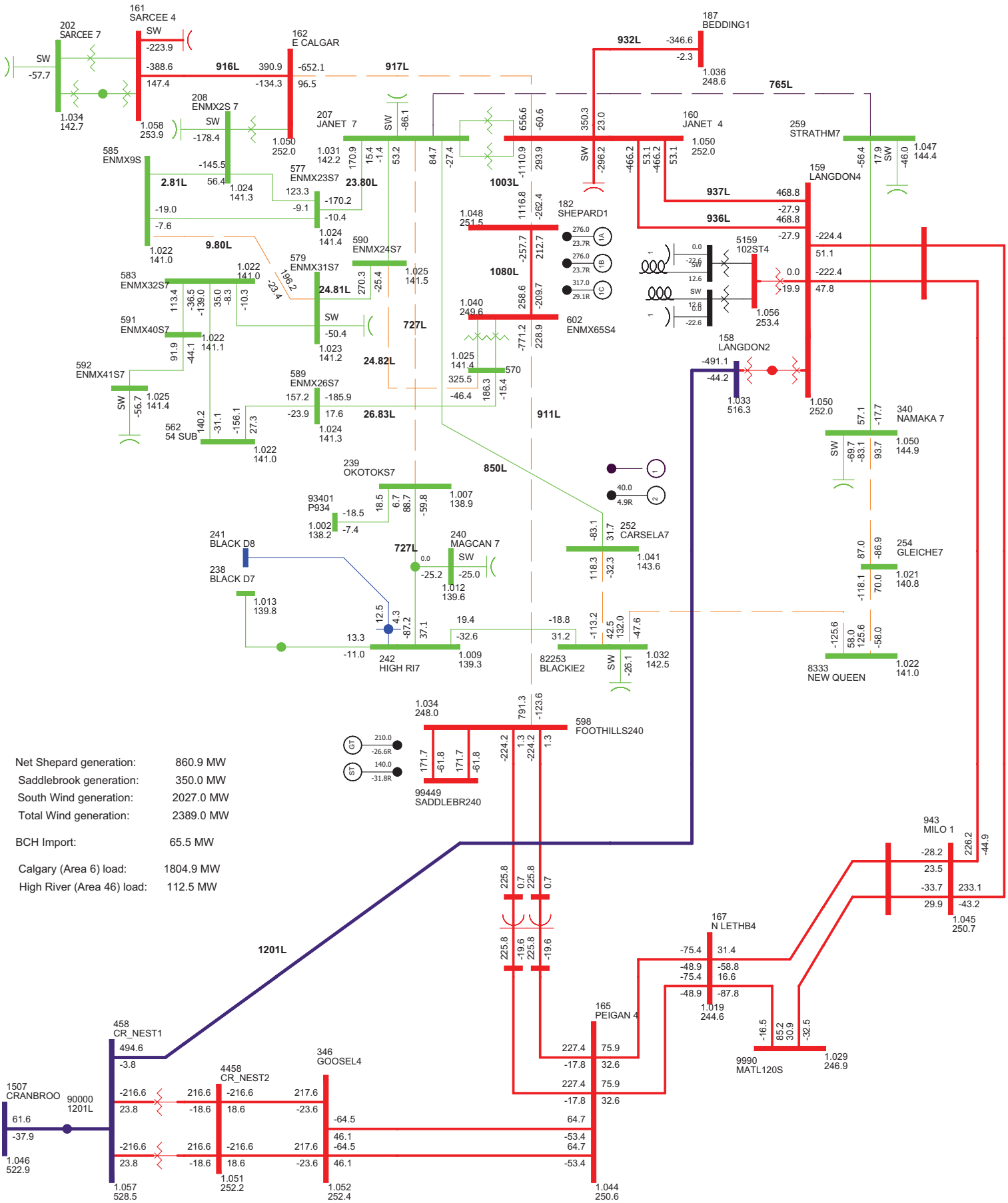


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-3

917L (JANET 74S TO EAST CALGARY 5S)

WED, APR 20 2011 17:51



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-4

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 17:51

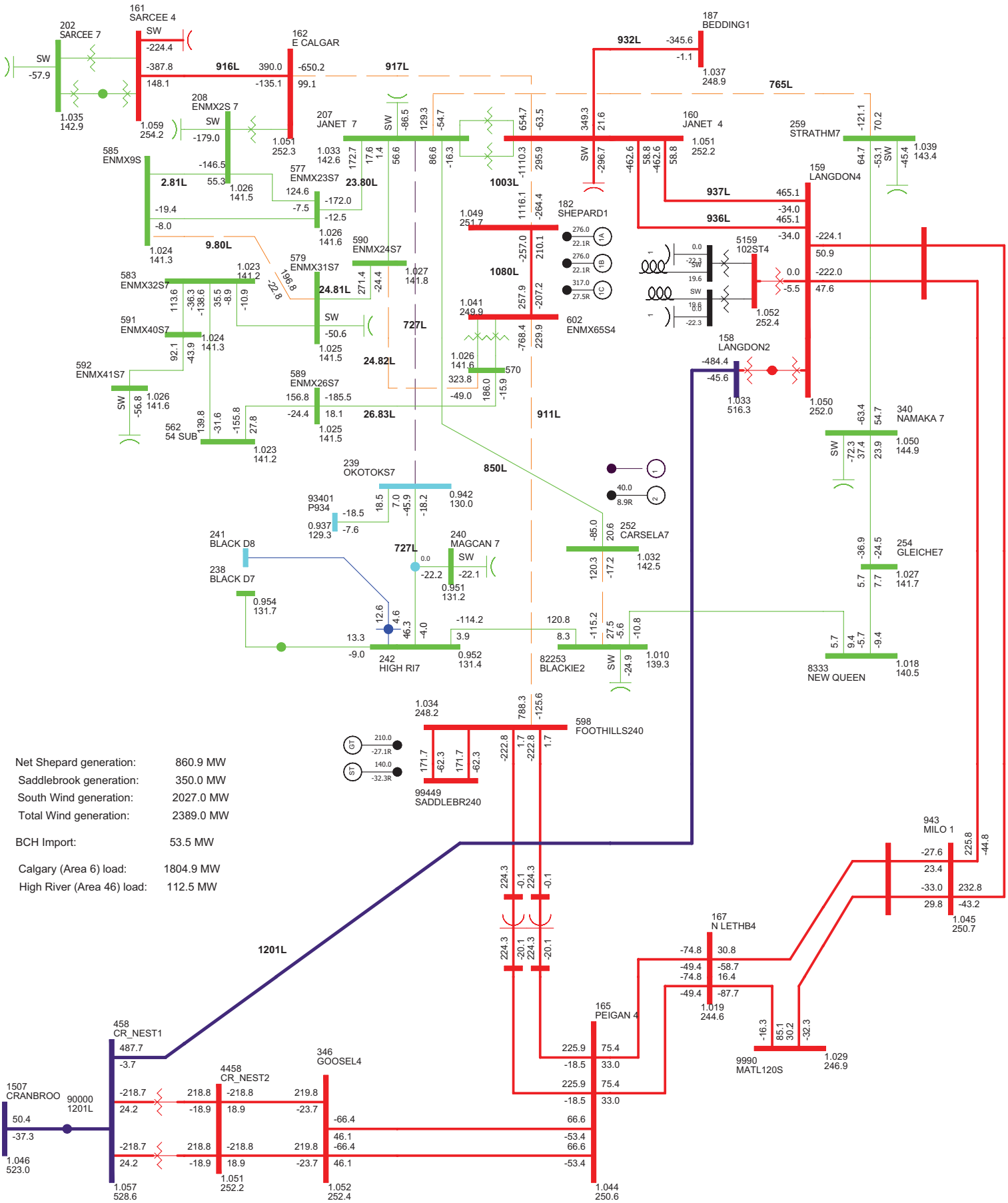
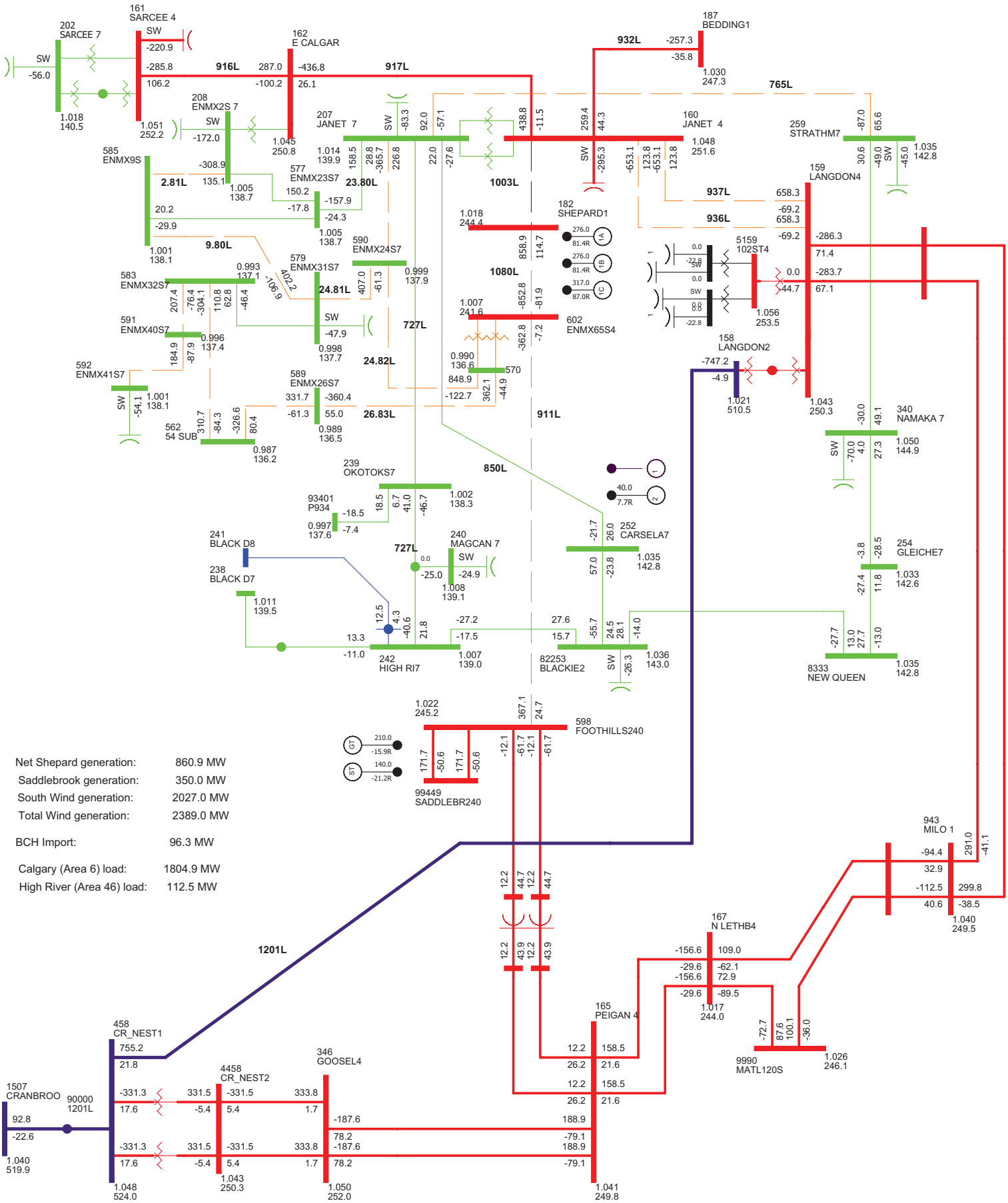


Figure A-2014-NEED-Sc4-5

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:51

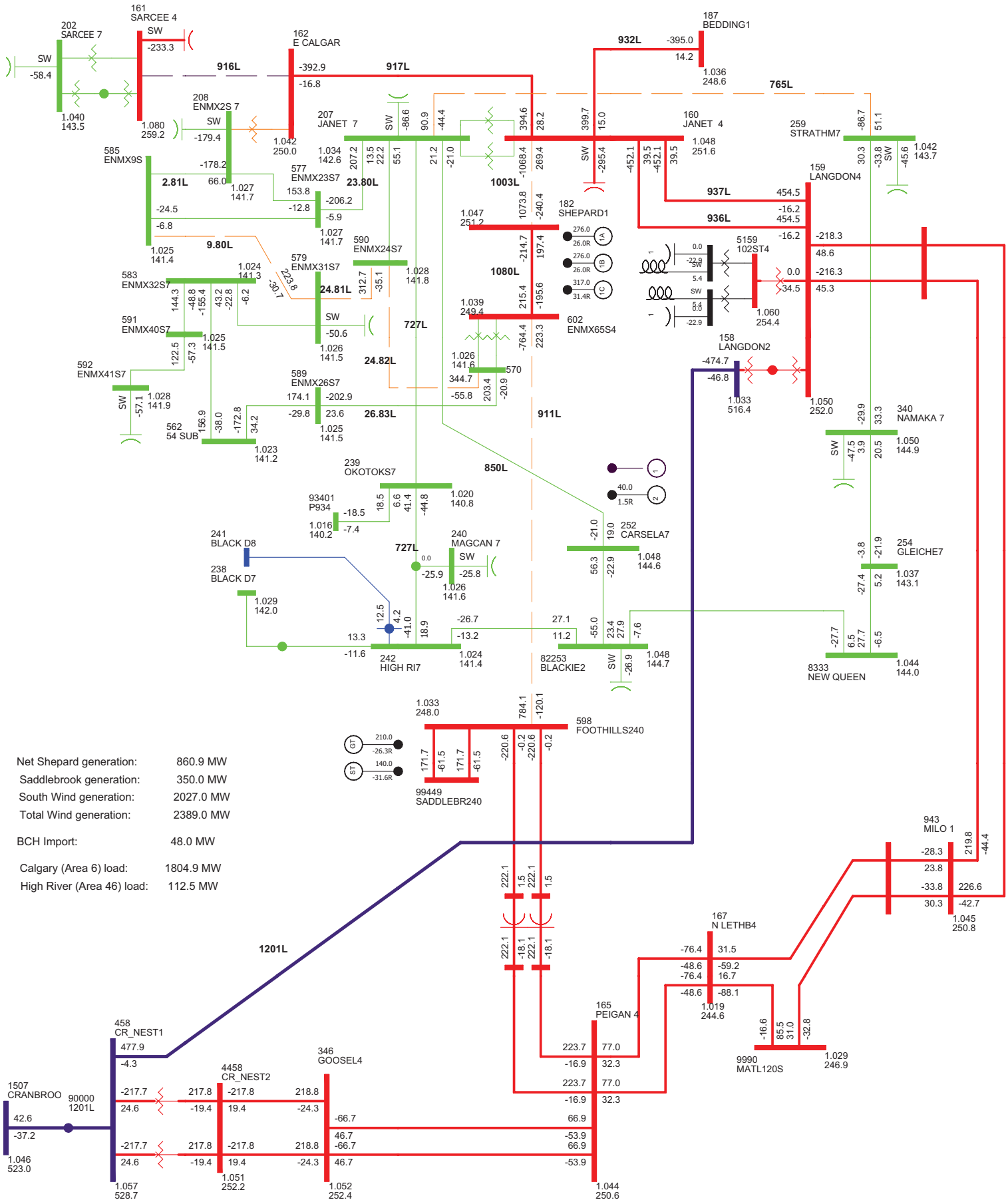


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-6

1003L (JANET 74S TO ENMAX NO. 25)

WED, APR 20 2011 17:52

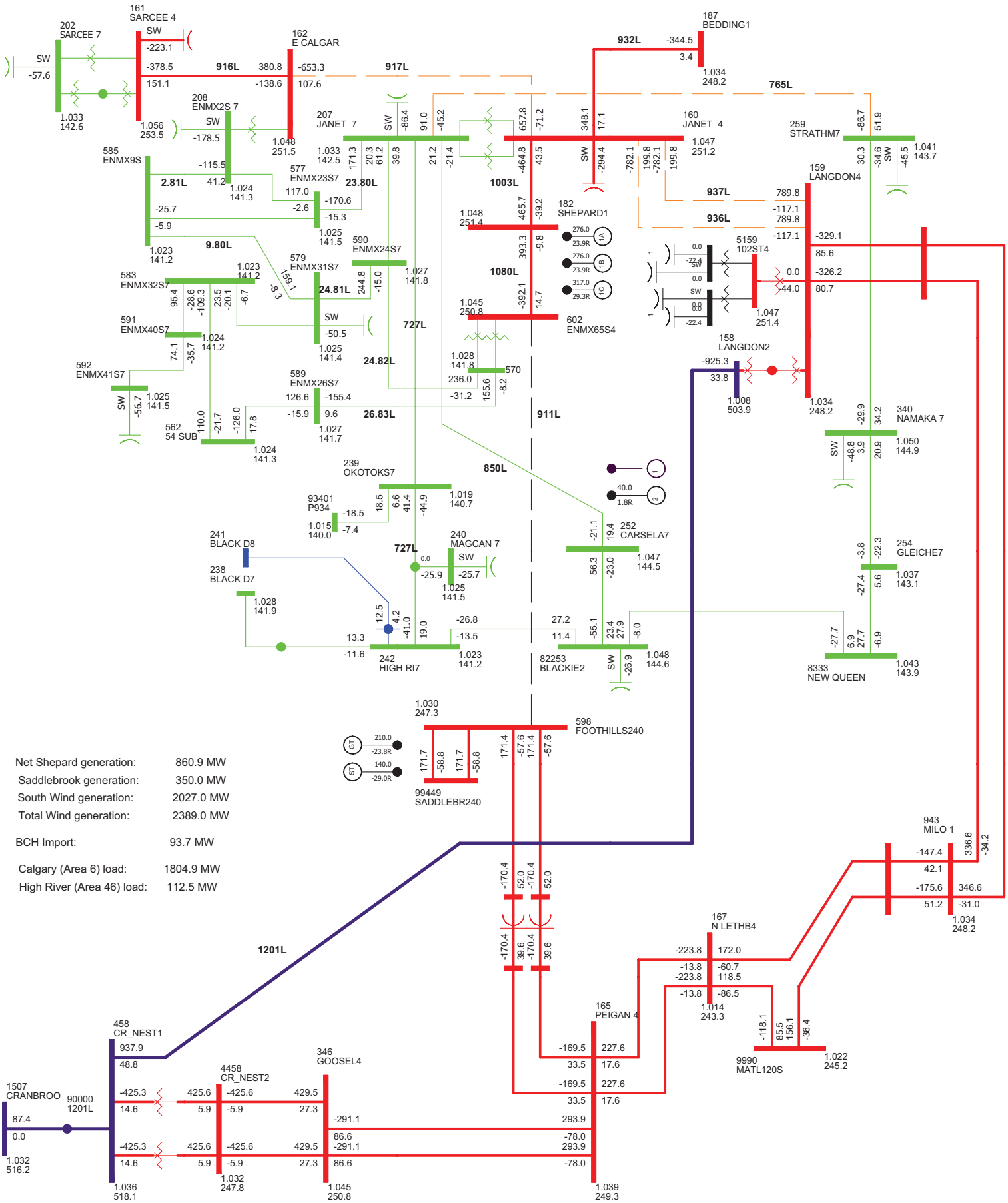


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-7

916L (SARCEE 42S TO EAST CALGARY 5S)

WED, APR 20 2011 17:52

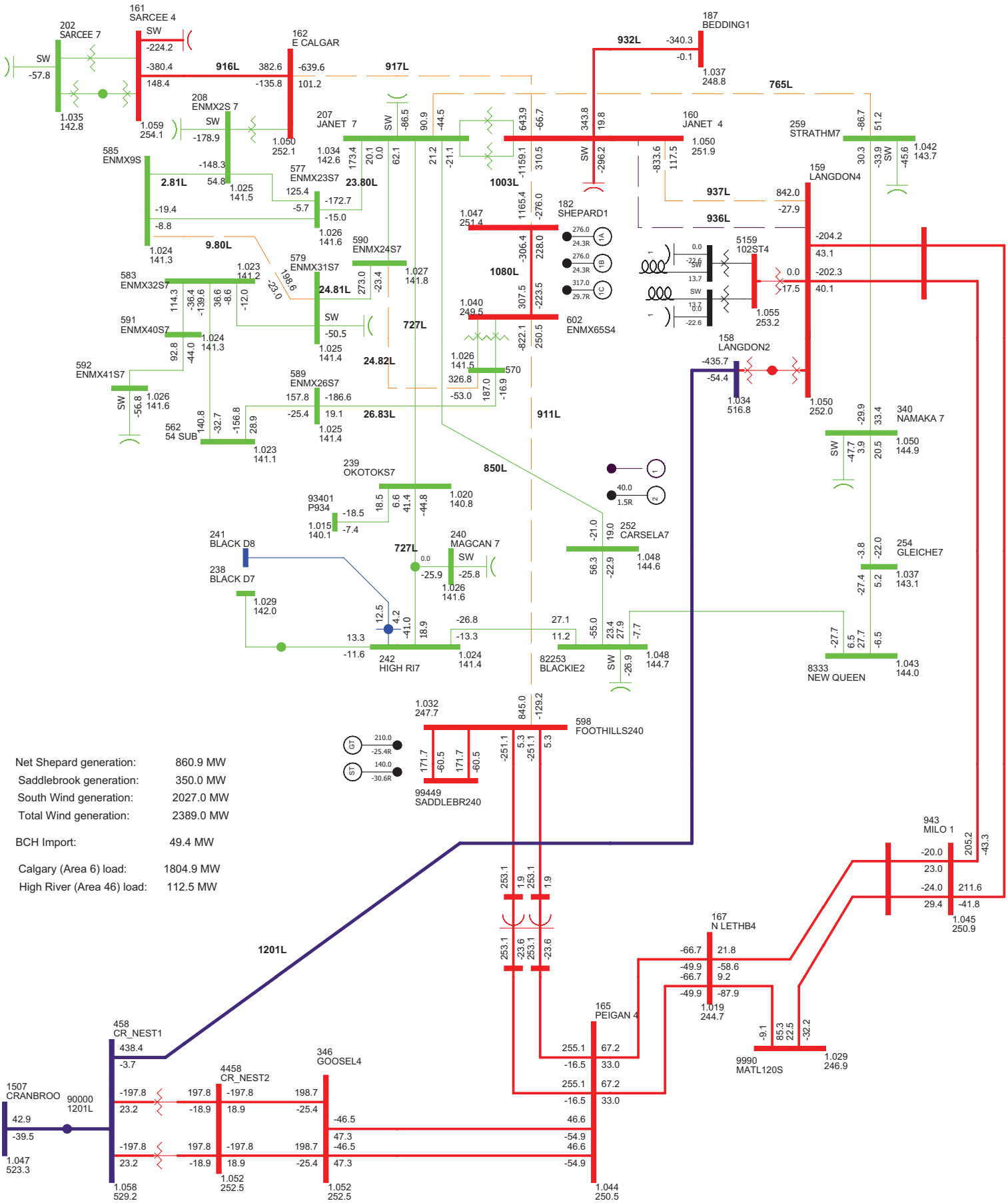


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-8

911L (FOOTHILLS 237S TO ENMAX NO. 65)

WED, APR 20 2011 17:52

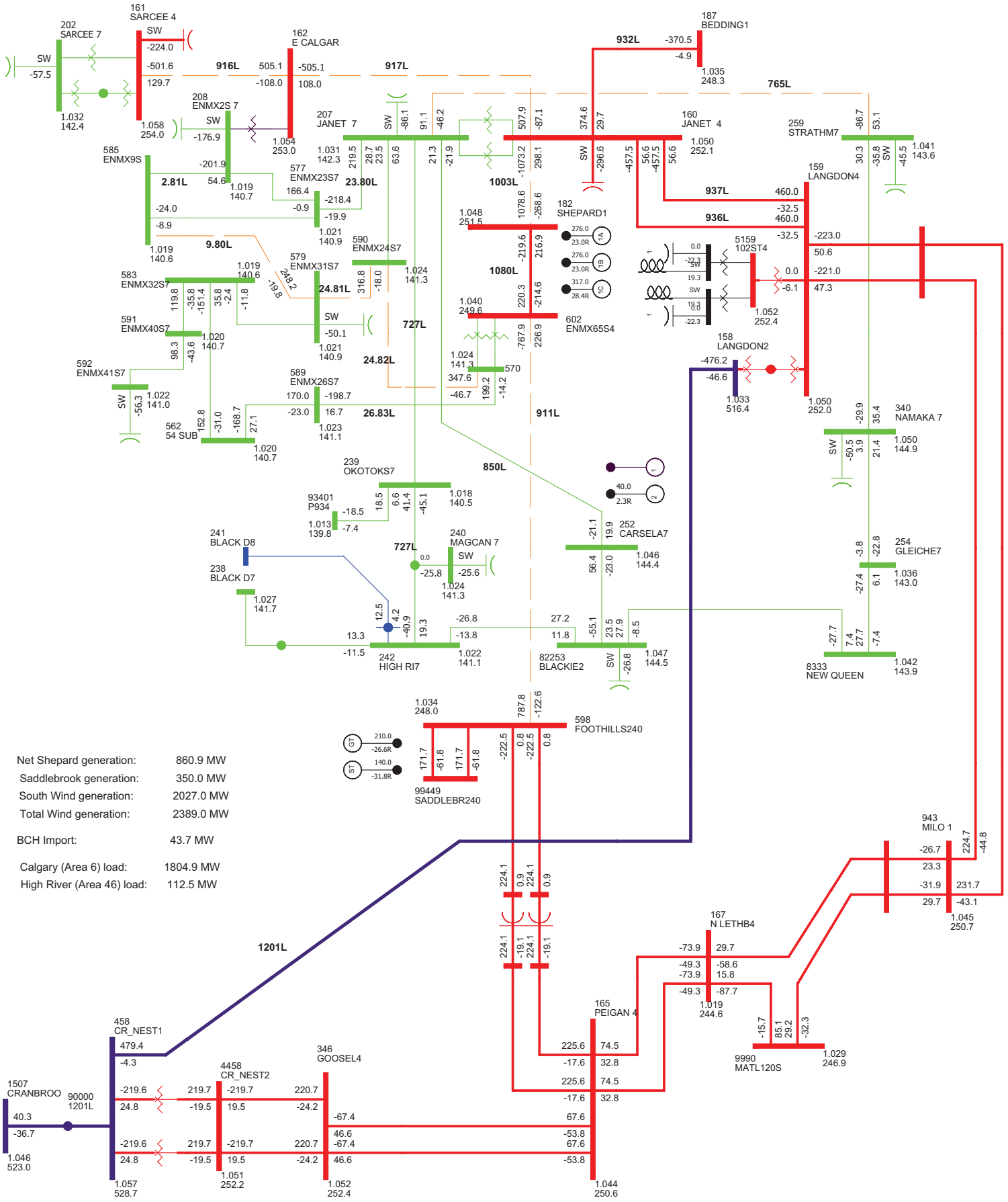


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-9

936L (LANGDON 102S TO JANET 74S)

WED, APR 20 2011 17:52

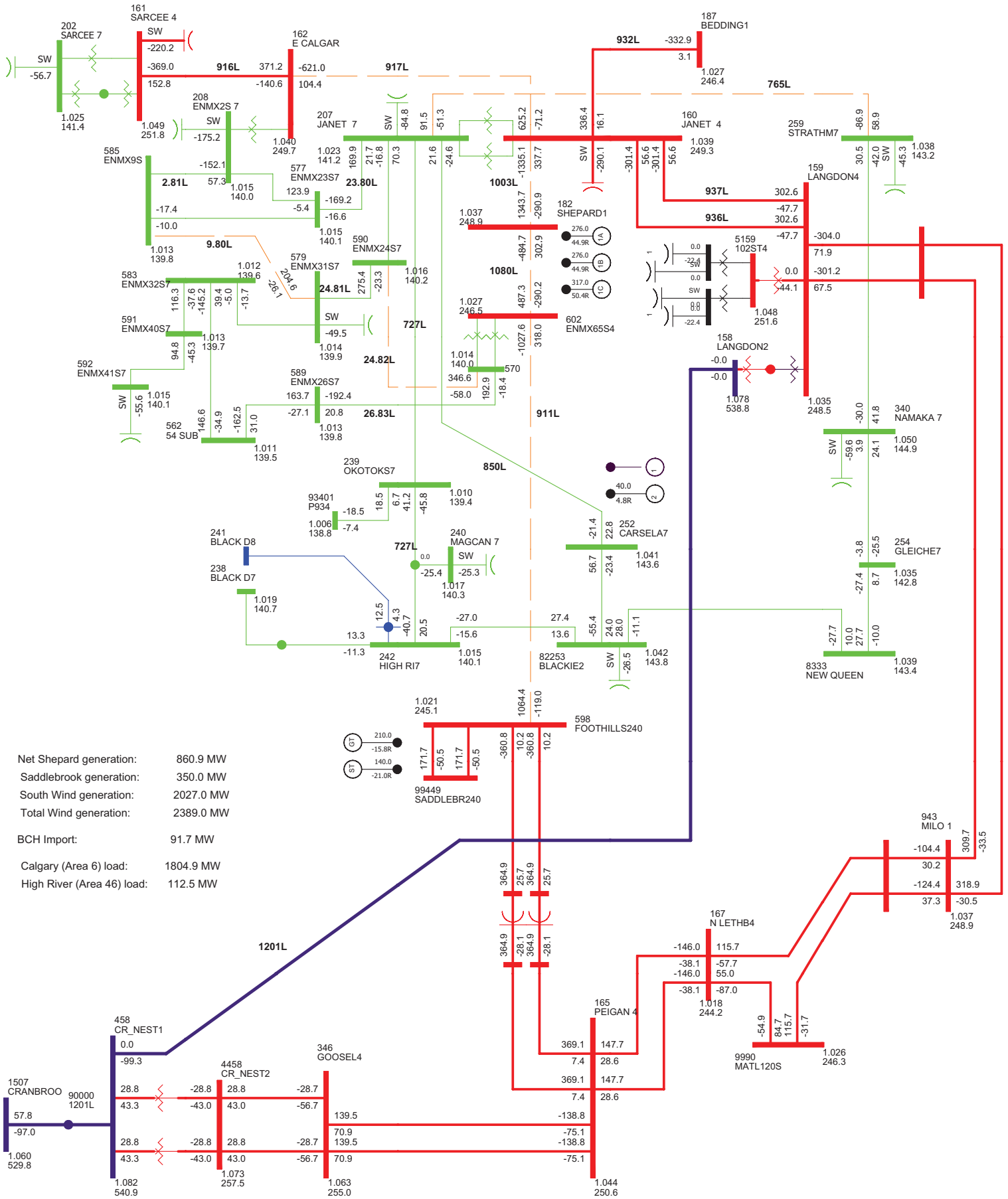


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-10

240/138 KV TRANSFORMER (EAST CALGARY 5S)

WED, APR 20 2011 17:52

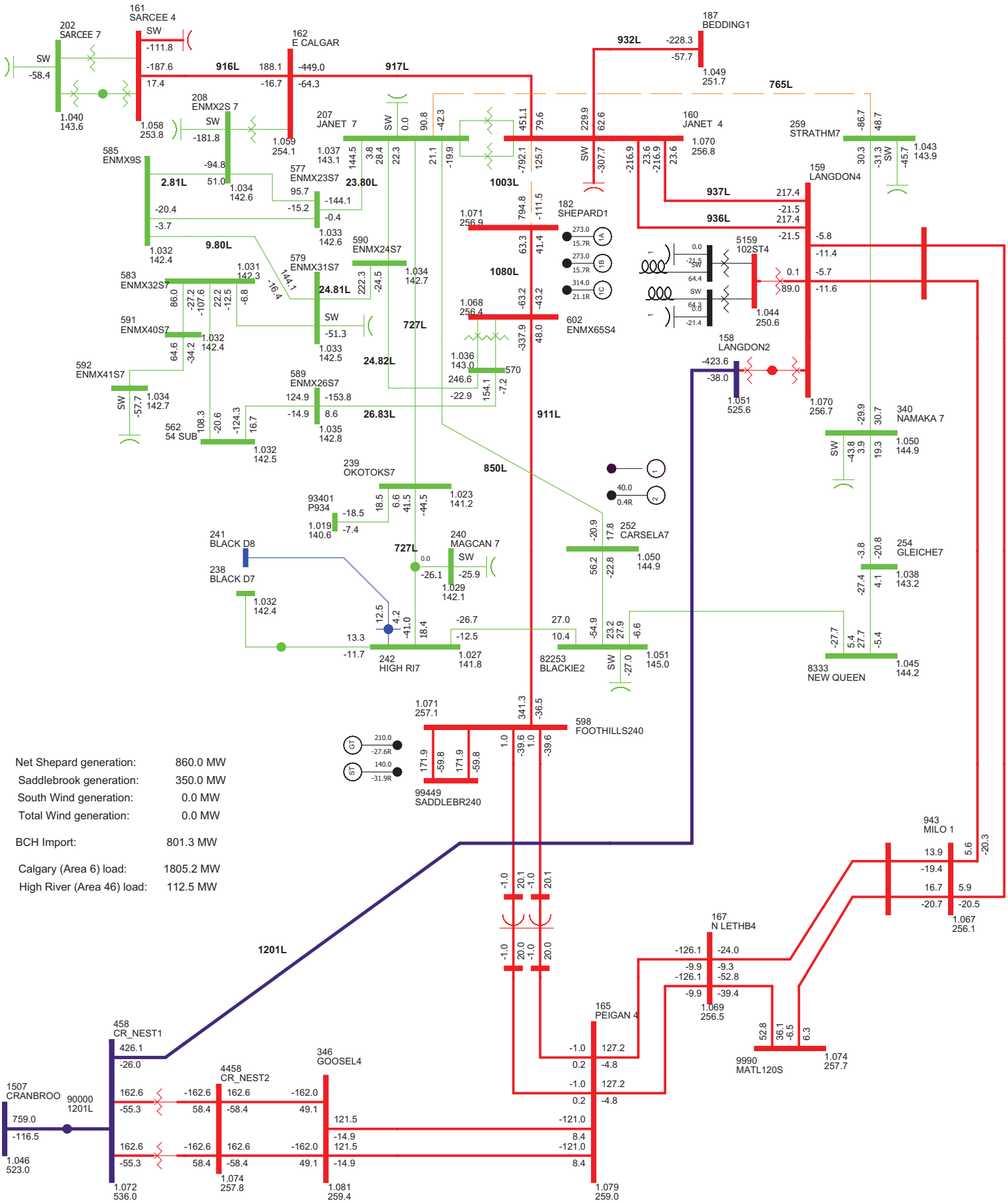


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc4-11

500/240 KV TRANSFORMER (LANGDON 102S)

WED, APR 20 2011 17:53



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc5-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:54

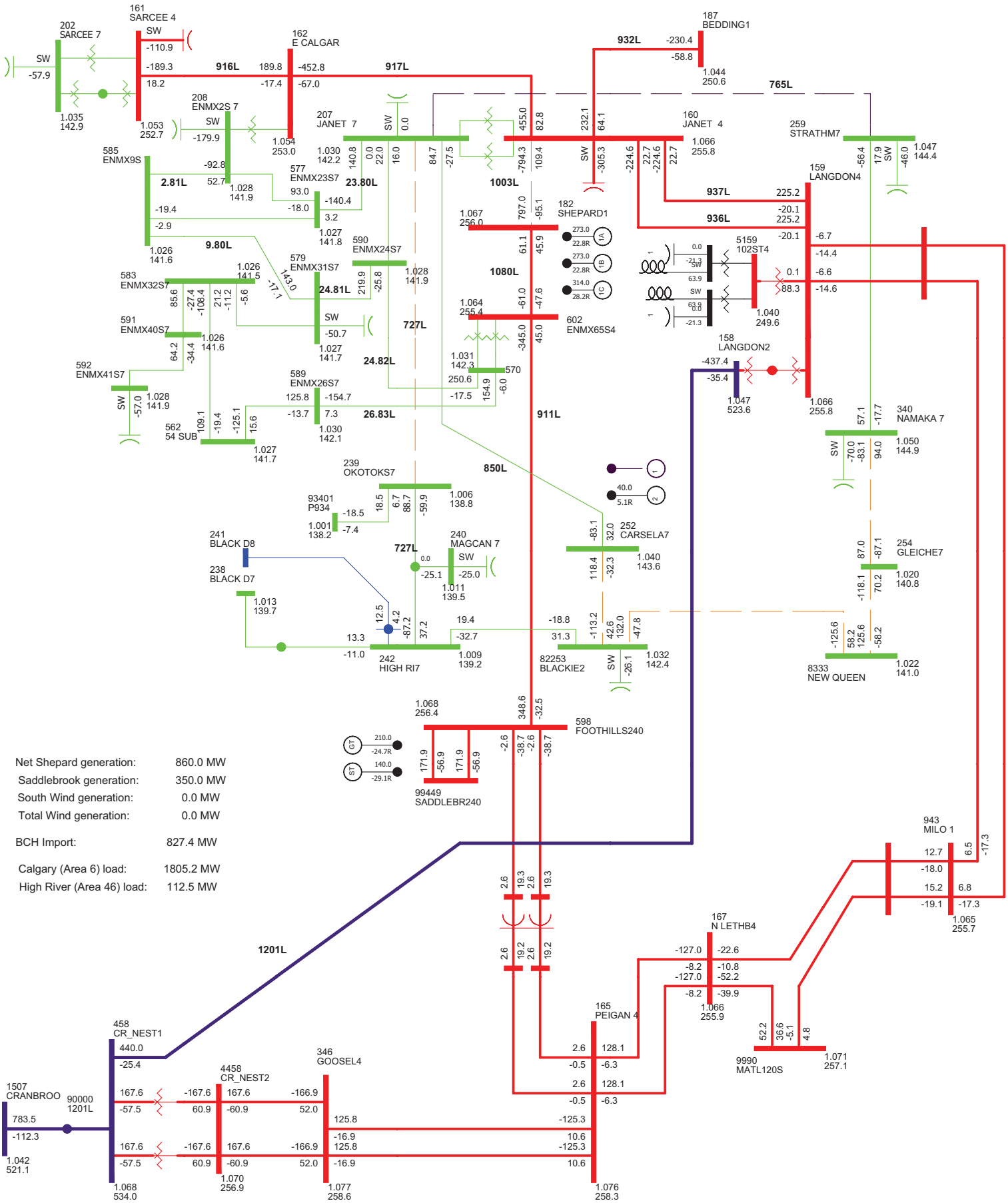
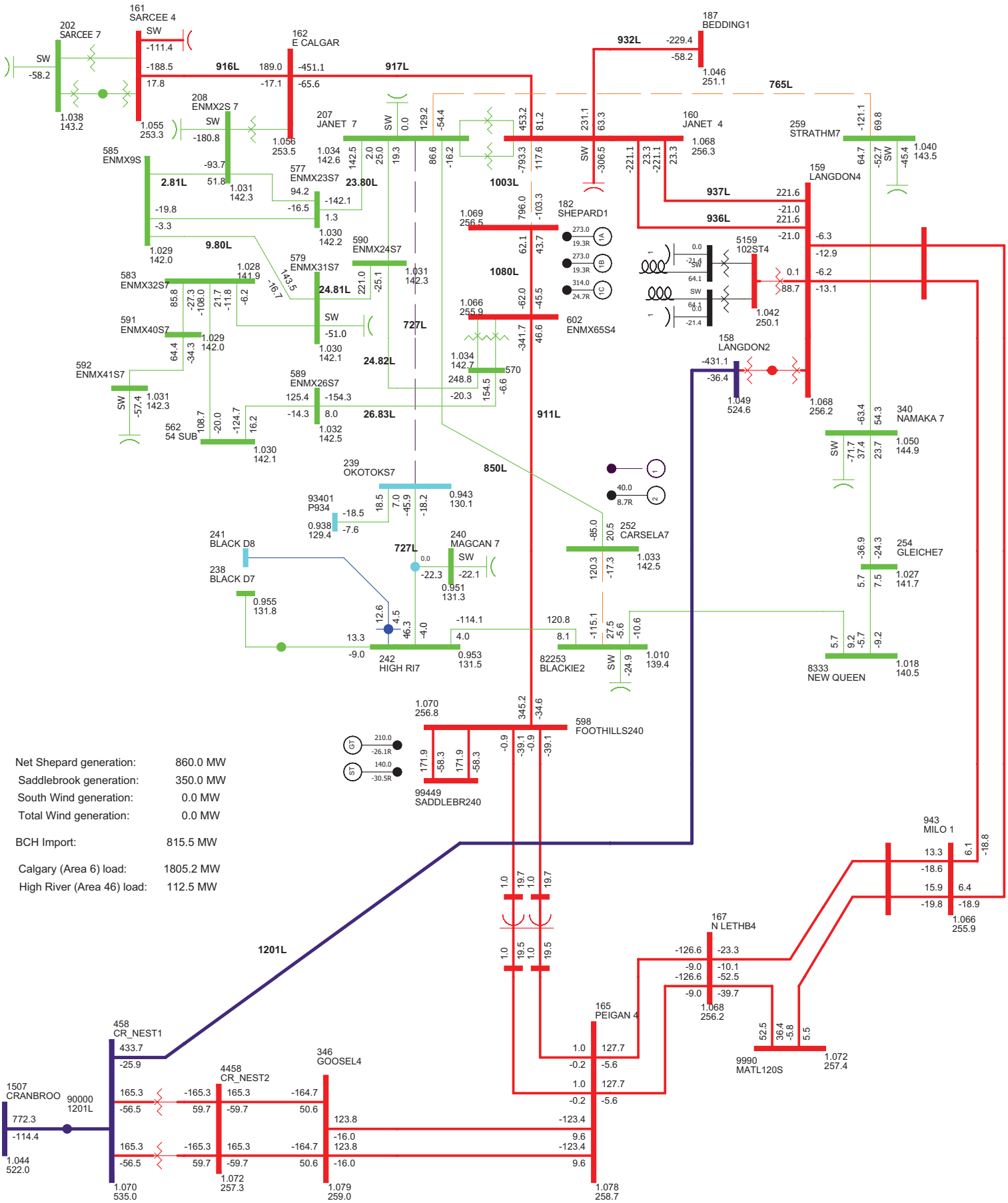


Figure A-2014-NEED-Sc5-2

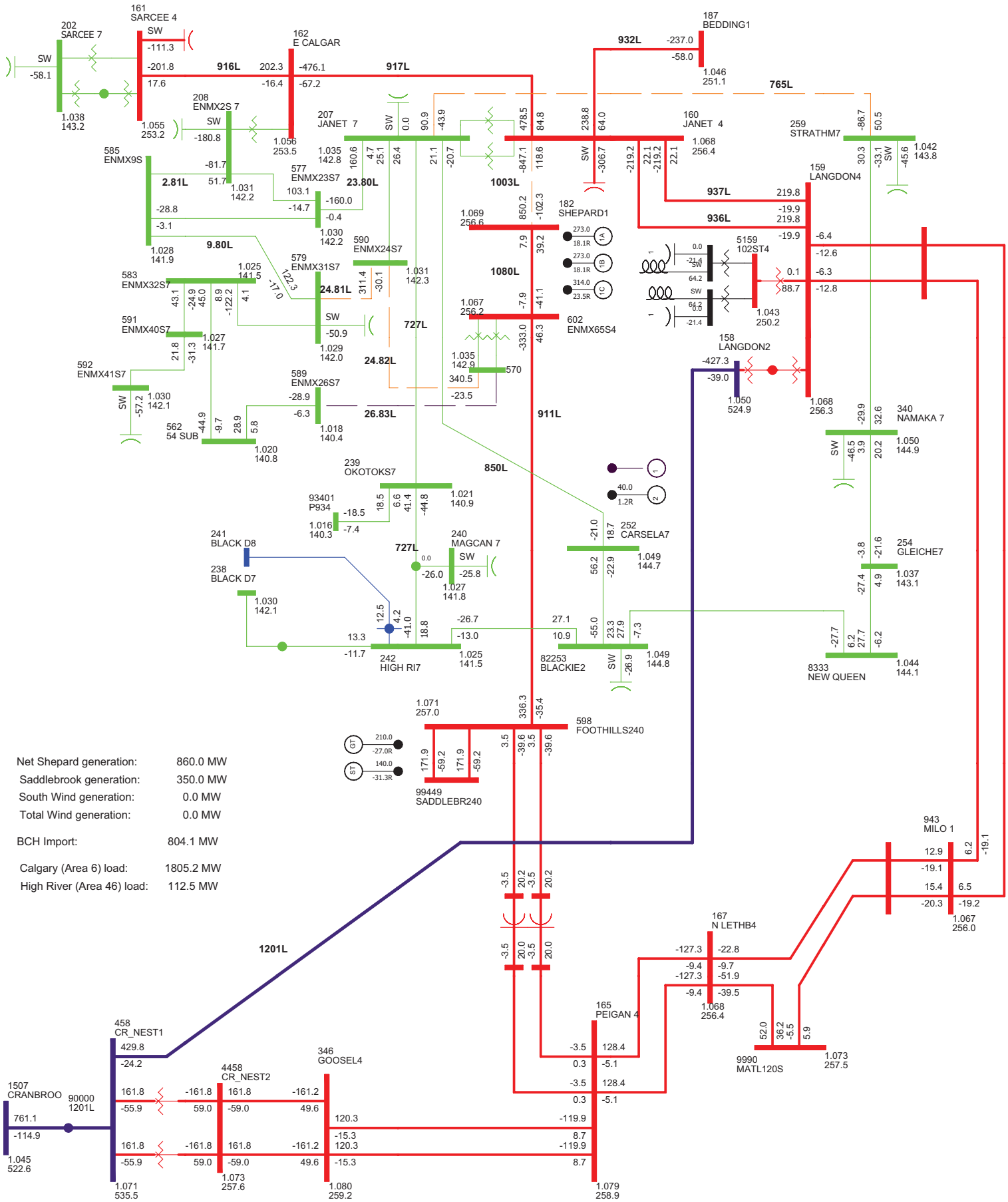


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc5-3

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:54

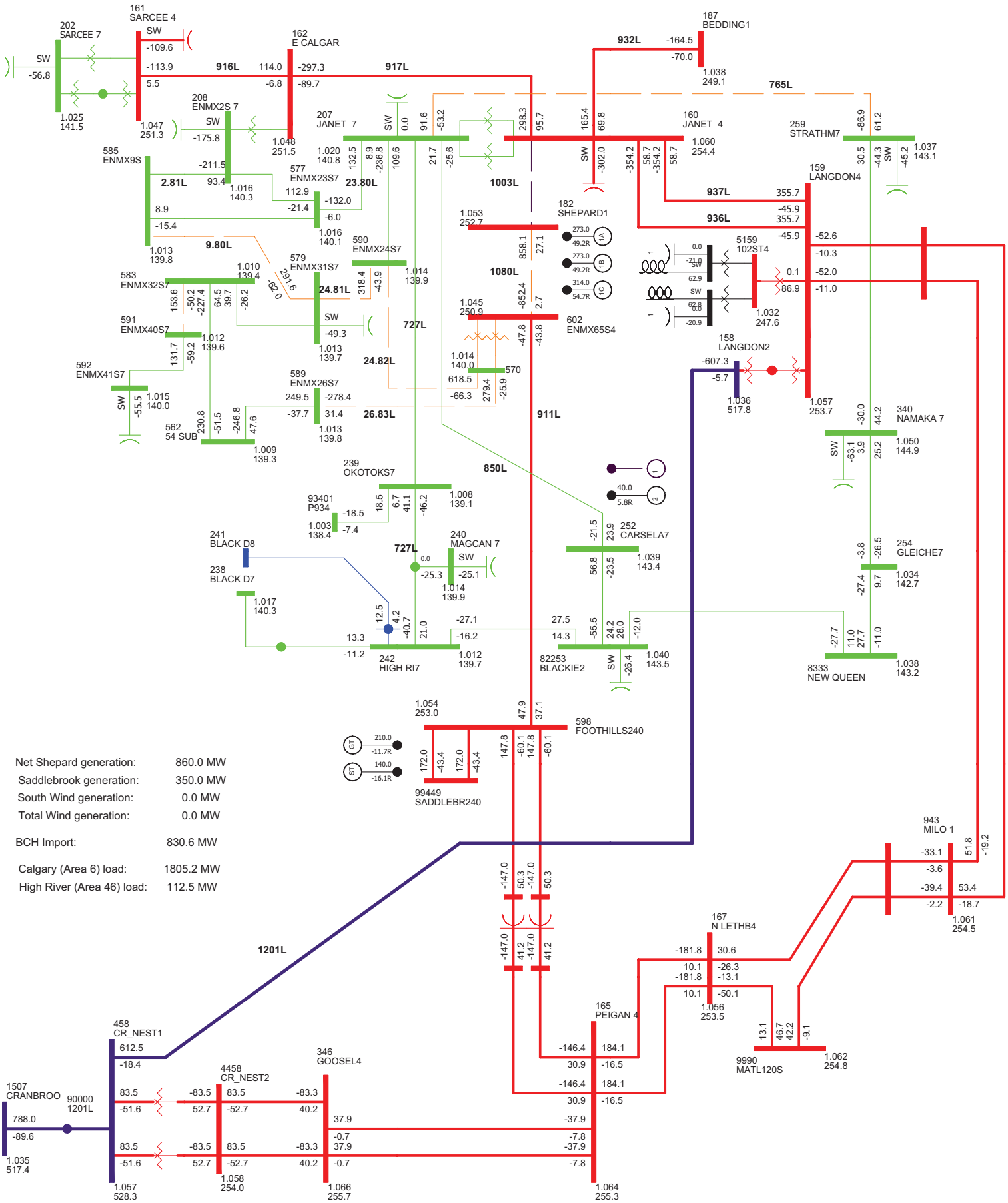


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc5-4

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 20 2011 17:54

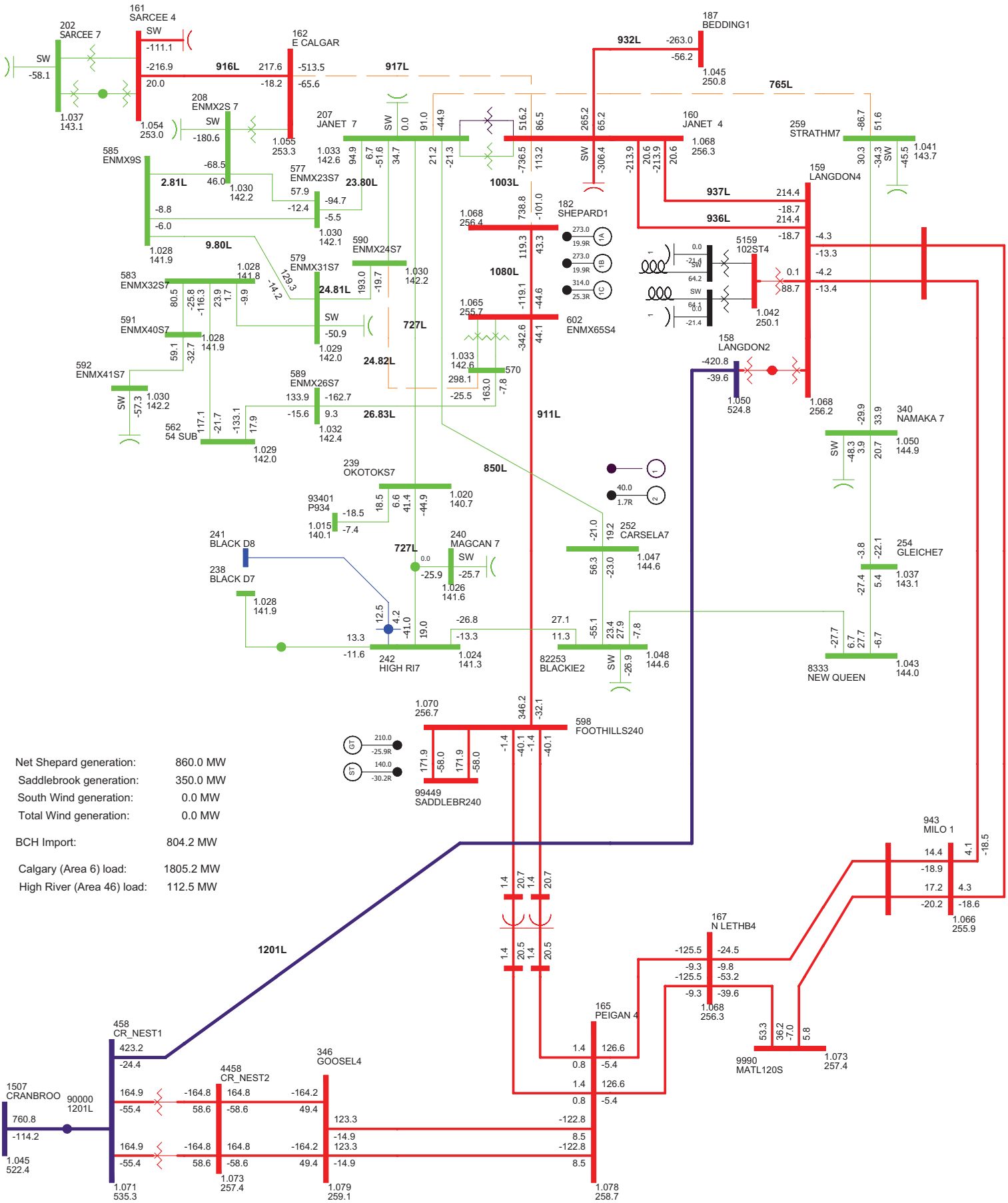


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc5-5

1003L (JANET 74S TO ENMAX NO. 25)

WED, APR 20 2011 17:55

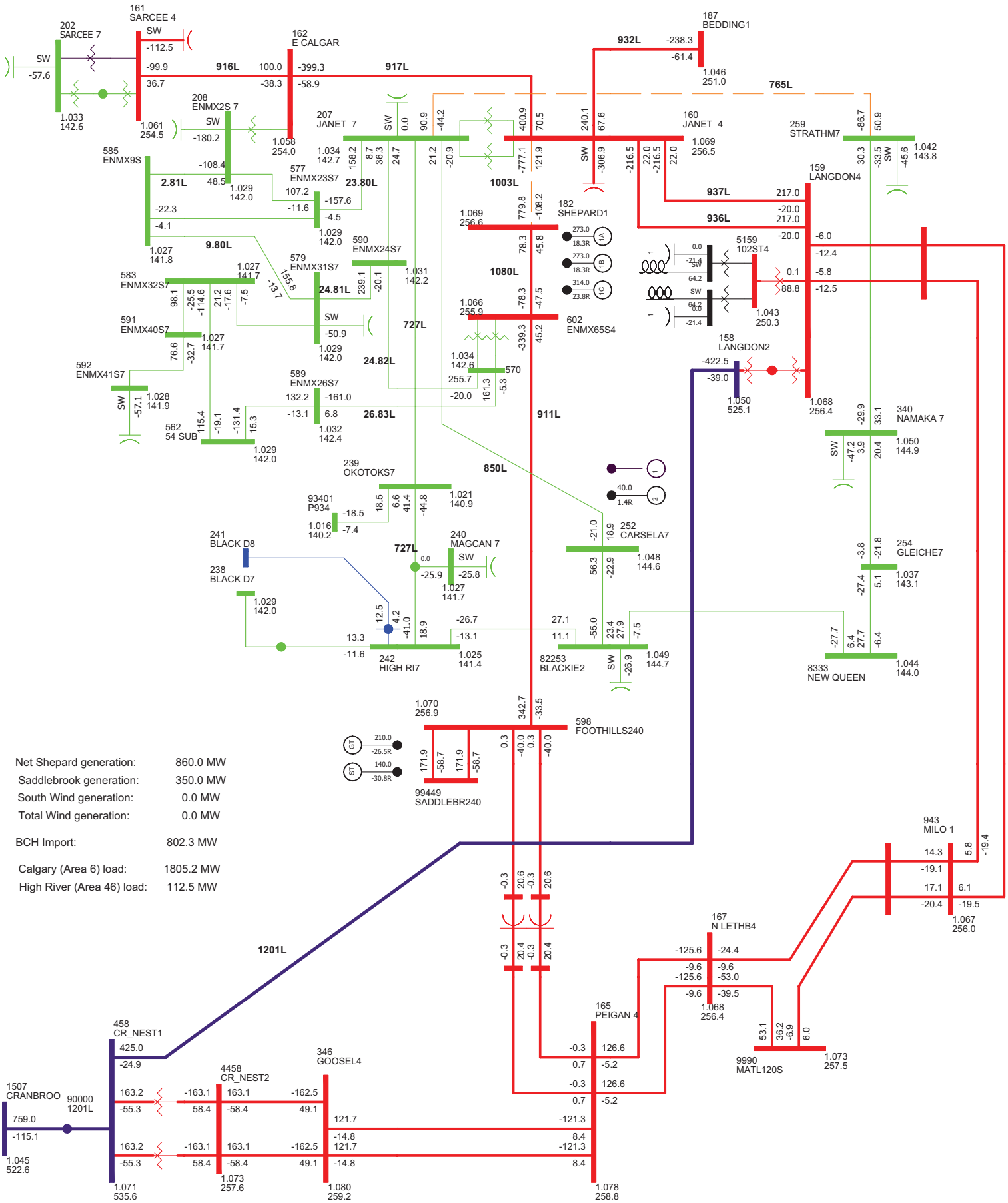


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc5-6

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 17:55

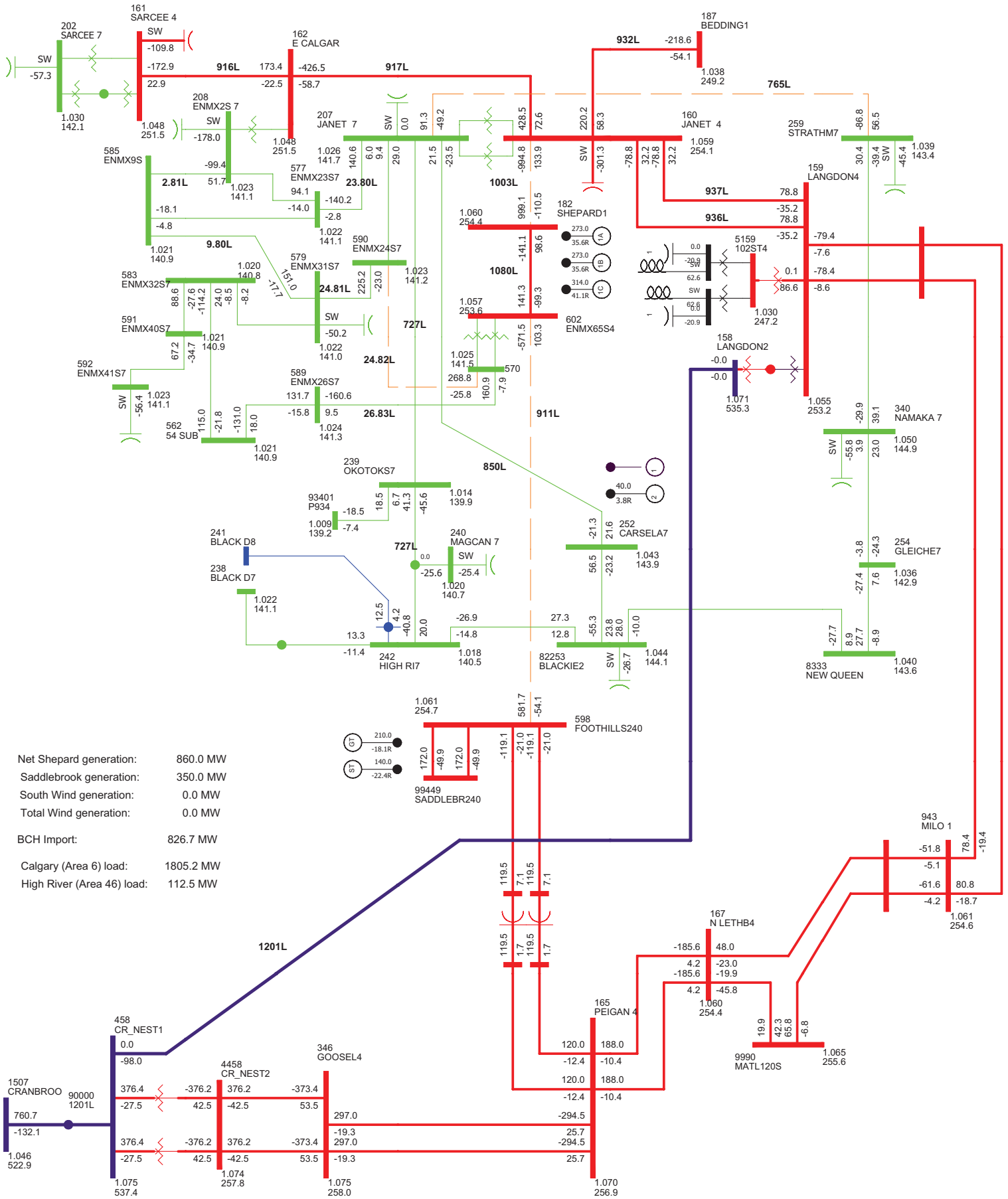


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc5-7

240/138 KV TRANSFORMER (SARCEE 42S)

WED, APR 20 2011 17:55

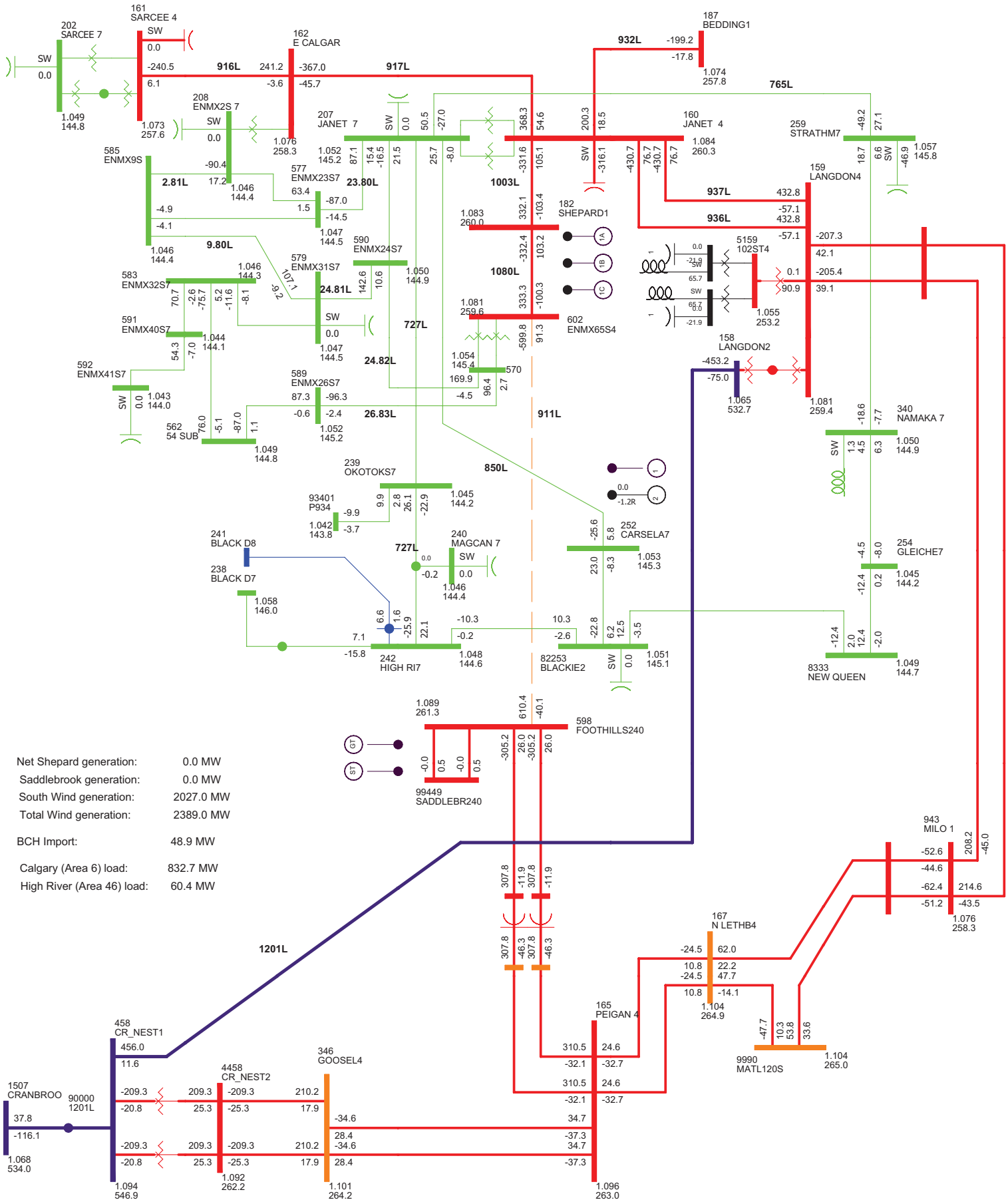


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc5-8

500/240 KV TRANSFORMER (LANGDON 102S)

WED, APR 20 2011 17:56

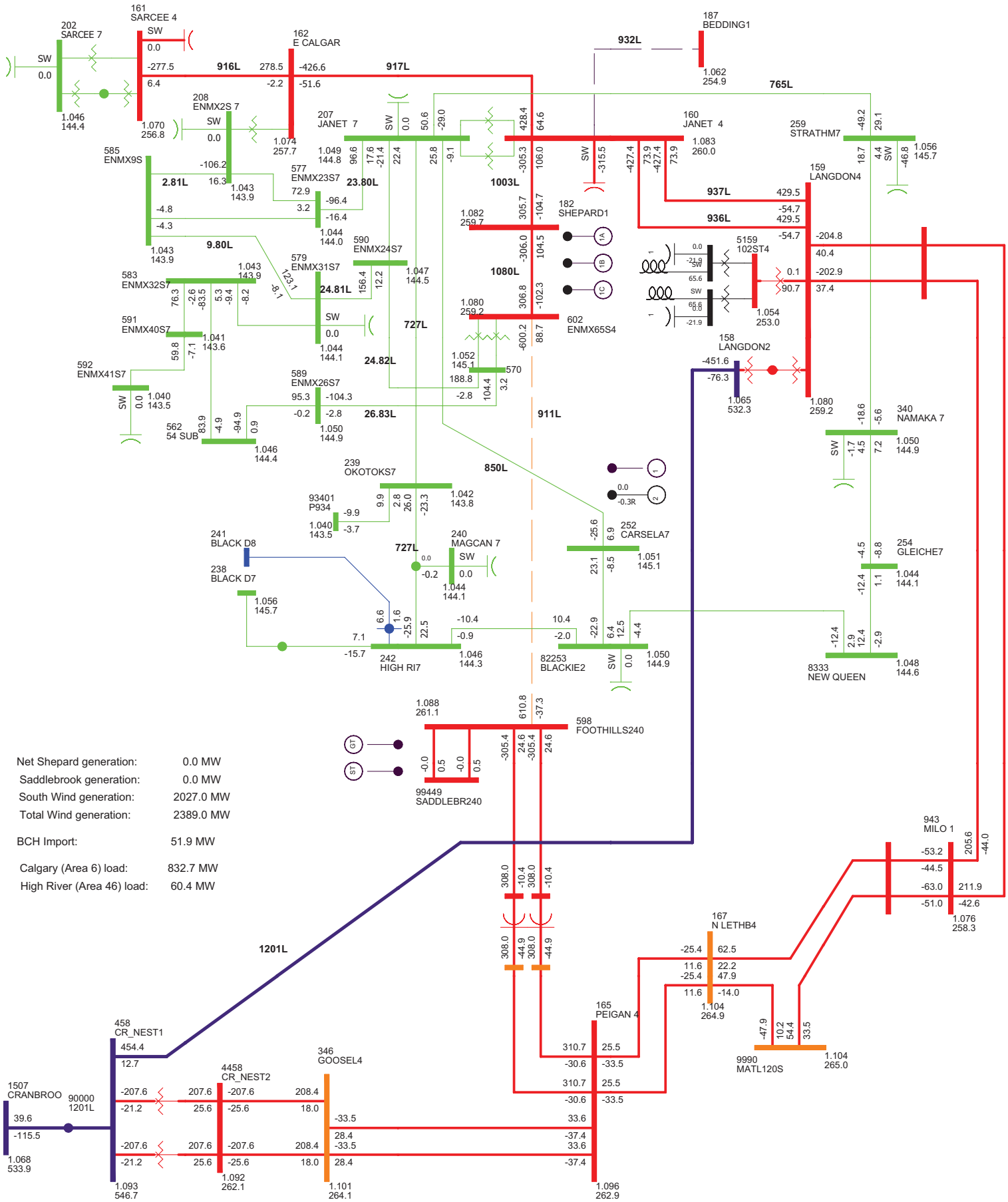


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc6-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:56



Net Shepard generation: 0.0 MW
Saddlebrook generation: 0.0 MW
South Wind generation: 2027.0 MW
Total Wind generation: 2389.0 MW

BCH Import: 51.9 MW

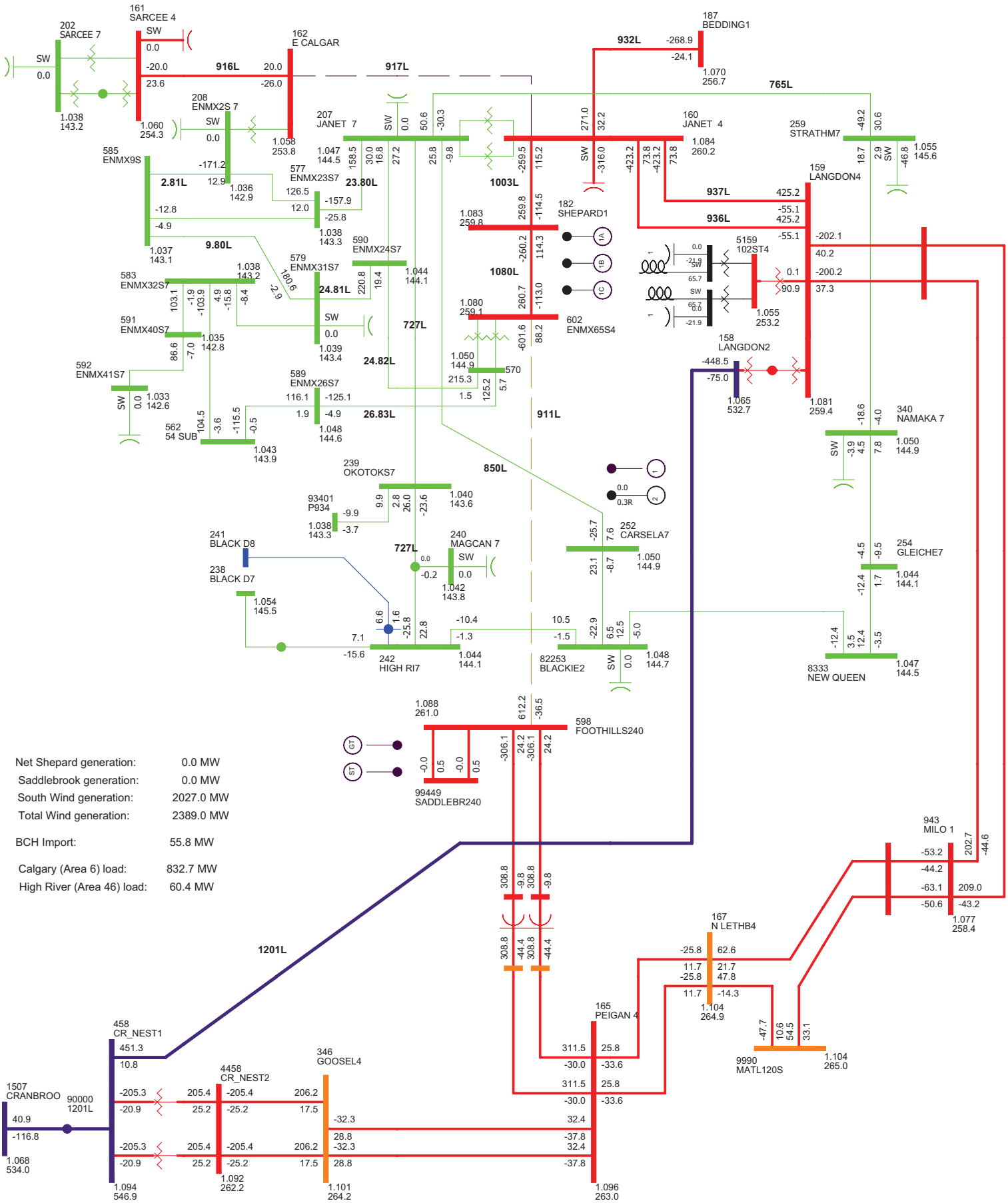
Calgary (Area 6) load: 832.7 MW
High River (Area 46) load: 60.4 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc6-2

932L (JANET 74S TO BEDDINGTON NO. 162)

WED, APR 20 2011 17:57

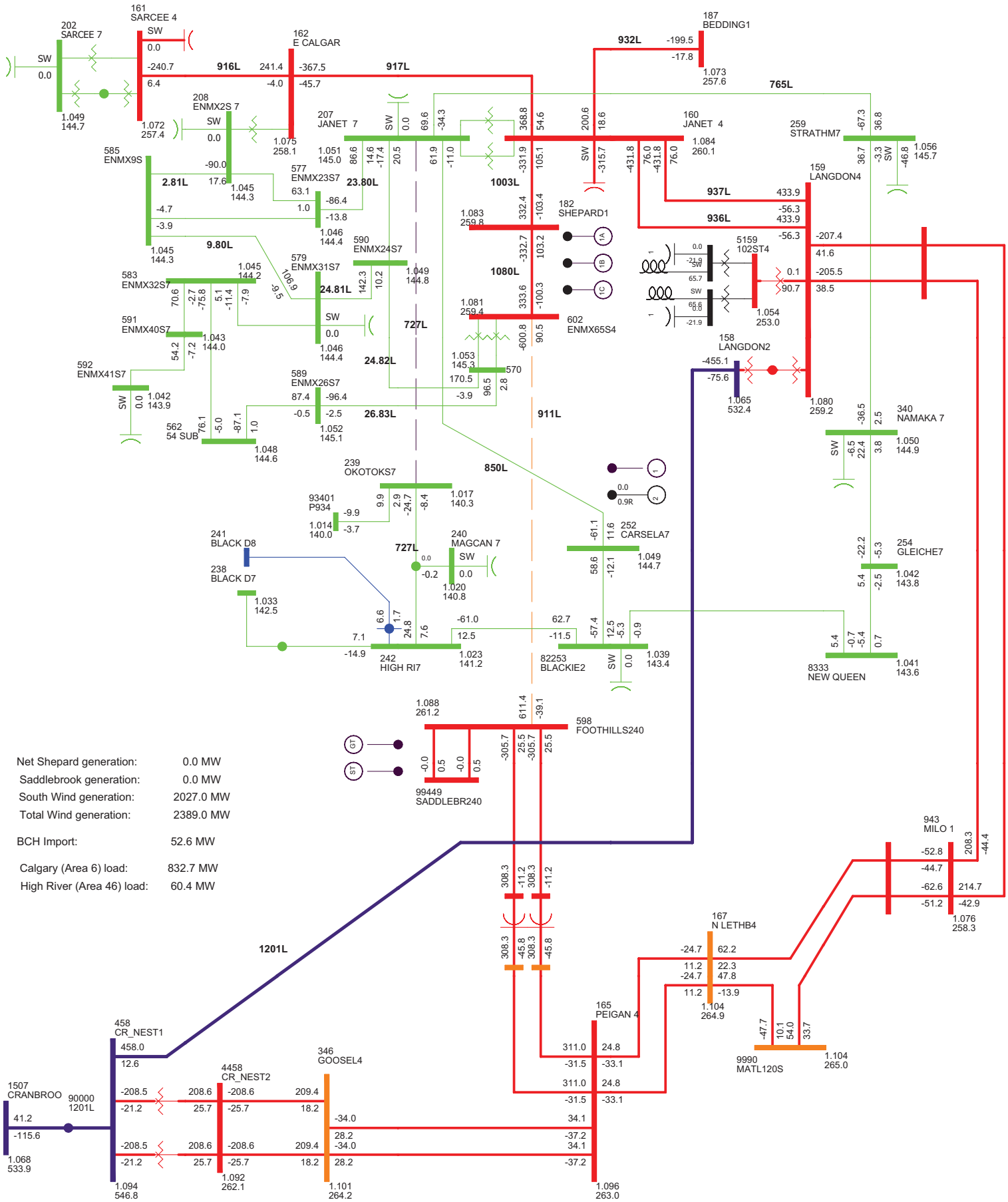


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc6-3

917L (JANET 74S TO EAST CALGARY 5S)

WED, APR 20 2011 17:57

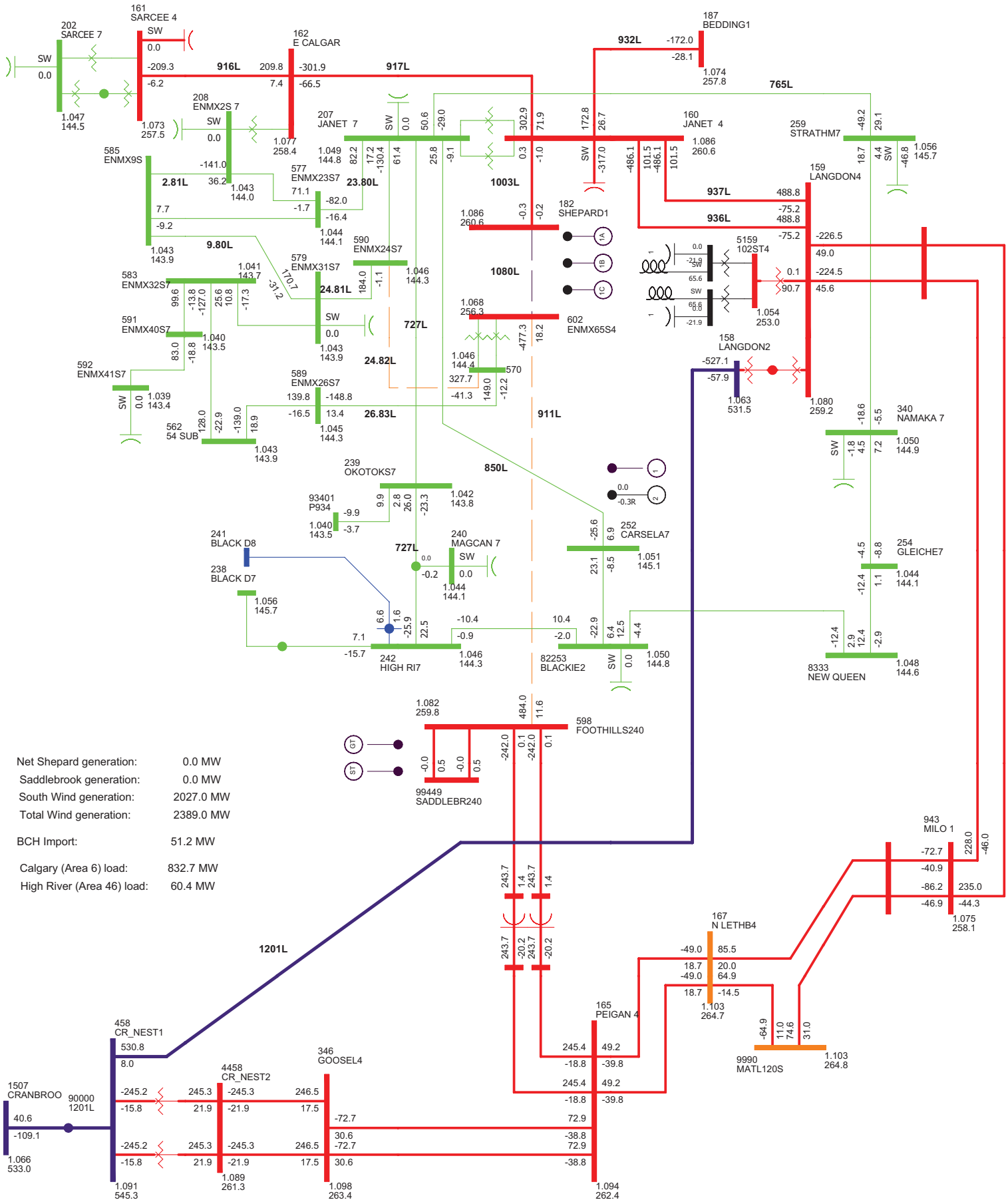


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc6-4

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:57

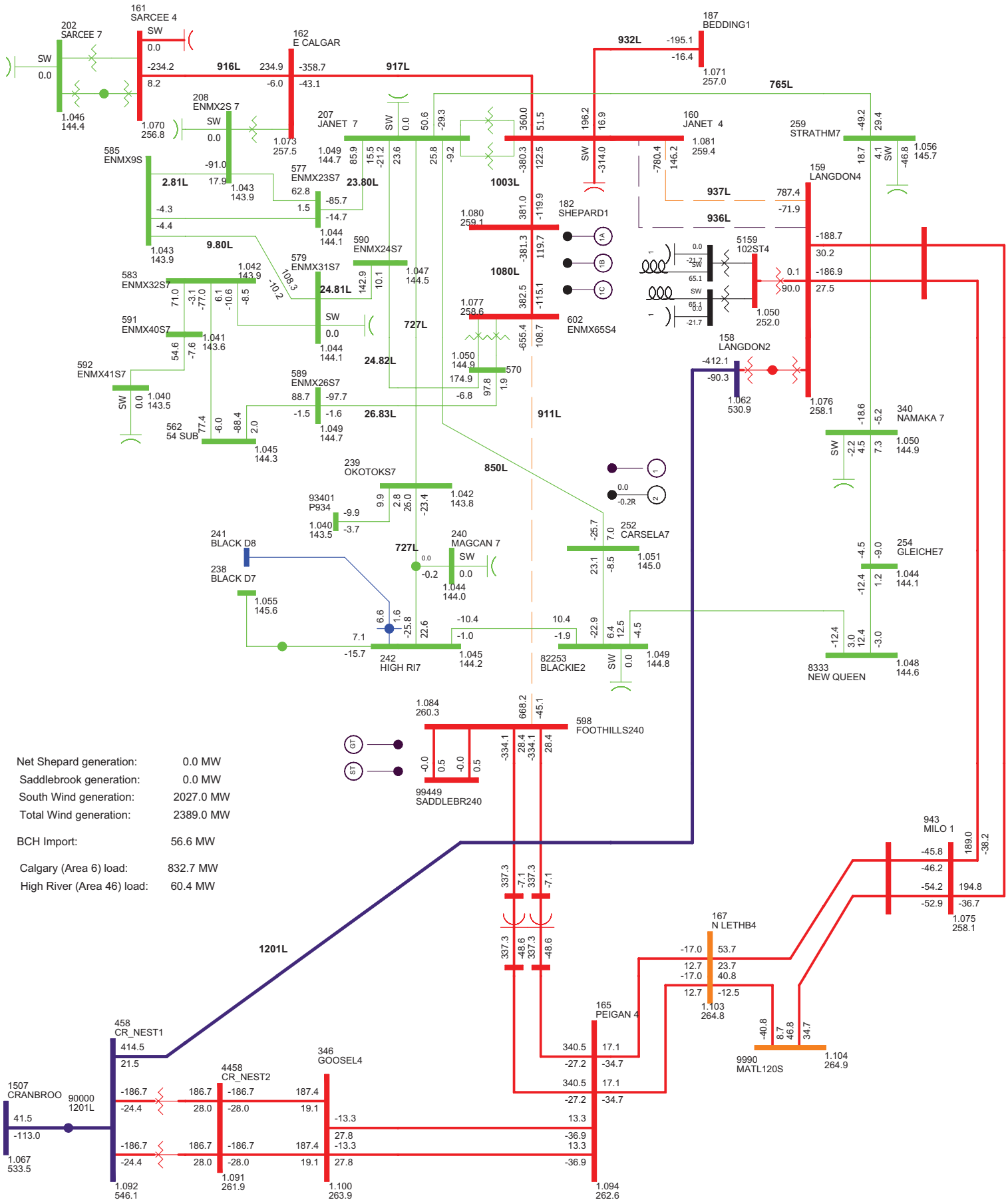


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc6-5

1080L (ENMAX NO. 25 TO ENMAX NO. 65)

WED, APR 20 2011 17:57

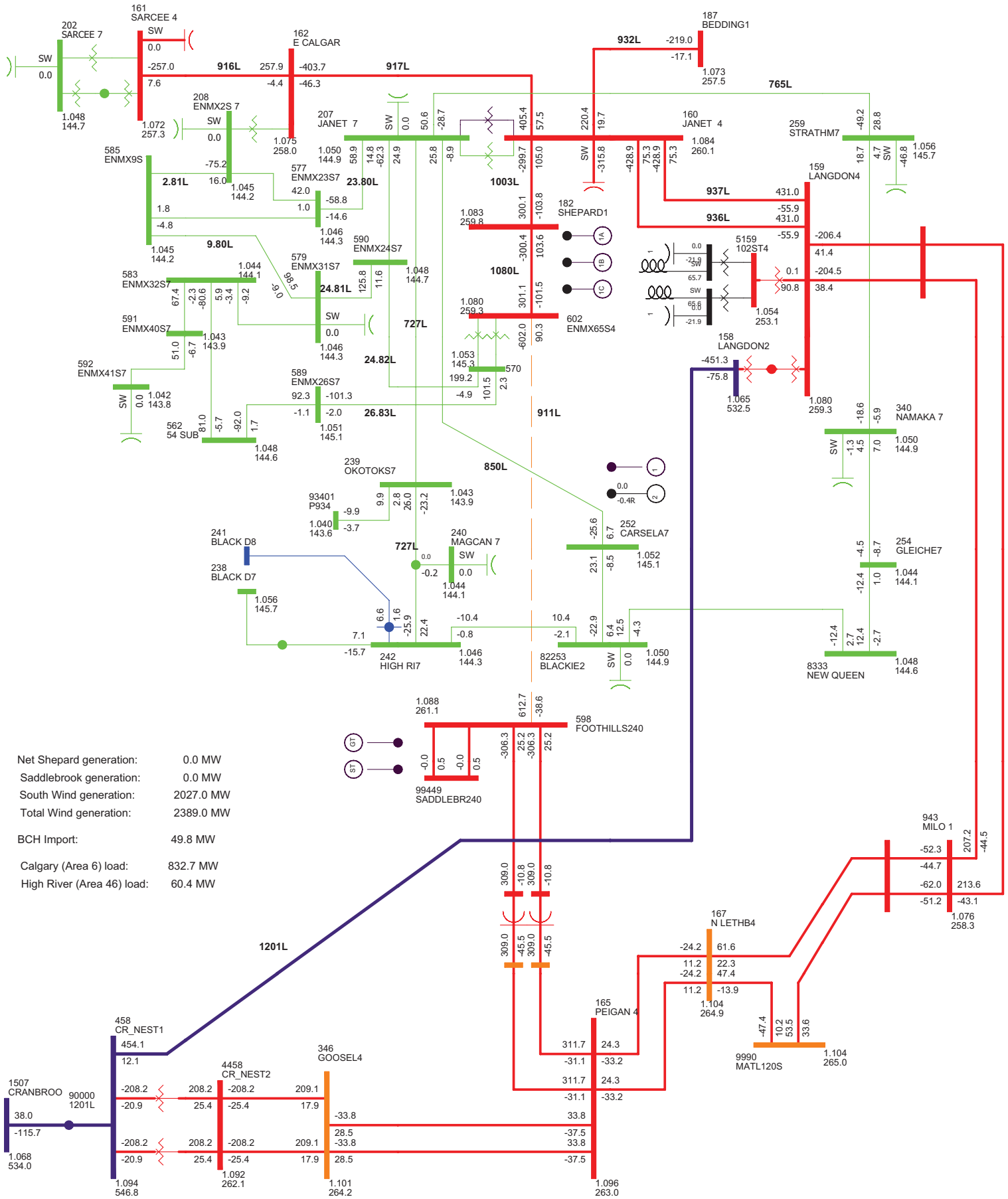


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc6-6

936L (LANGDON 102S TO JANET 74S)

WED, APR 20 2011 17:57

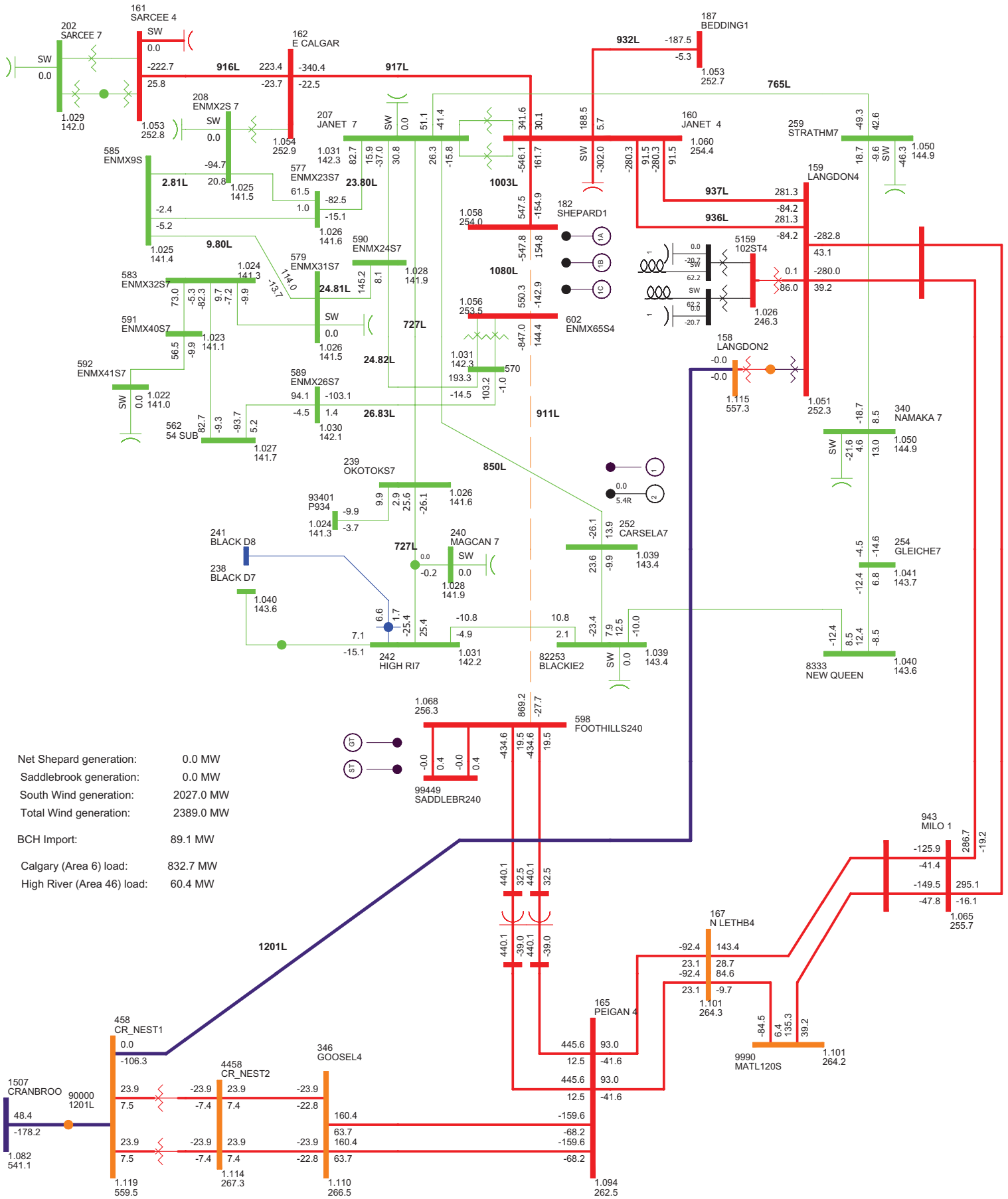


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc6-7

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 17:58



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure A-2014-NEED-Sc6-8

500/240 KV TRANSFORMER (LANGDON 102S)

WED, APR 20 2011 17:58

ATTACHMENT B

Need Assessment – 2019, Scenario 1 to 6

Table B-1 Scenario 1

Figure Name	Contingency
Figure B-2019-NEED-Sc1-1	Base Case (N-0)
Figure B-2019-NEED-Sc1-2	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure B-2019-NEED-Sc1-3	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure B-2019-NEED-Sc1-4	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure B-2019-NEED-Sc1-5	Open 240/138 kV transformer (Sarcee 42S)

Table B-2 Scenario 2

Figure Name	Contingency
Figure B-2019-NEED-Sc2-1	Base Case (N-0)
Figure B-2019-NEED-Sc2-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure B-2019-NEED-Sc2-3	Open 917L 240kV line (Janet 74S to East Calgary 5S)
Figure B-2019-NEED-Sc2-4	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure B-2019-NEED-Sc2-5	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure B-2019-NEED-Sc2-6	Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)
Figure B-2019-NEED-Sc2-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure B-2019-NEED-Sc2-8	Open 911L 240kV line (Foothills 237S to ENMAX No. 65)
Figure B-2019-NEED-Sc2-9	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure B-2019-NEED-Sc2-10	Open 240/138 kV transformer (Janet 74S)
Figure B-2019-NEED-Sc2-11	Open 240/138 kV transformer (East Calgary 5S)
Figure B-2019-NEED-Sc2-12	Open 500/240 kV transformer (Langdon 102S)

Table B-3 Scenario 3

Figure Name	Contingency
Figure B-2019-NEED-Sc3-1	Base Case (N-0)
Figure B-2019-NEED-Sc3-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure B-2019-NEED-Sc3-3	Open 917L 240kV line (Janet 74S to East Calgary 5S)
Figure B-2019-NEED-Sc3-4	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure B-2019-NEED-Sc3-5	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure B-2019-NEED-Sc3-6	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure B-2019-NEED-Sc3-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure B-2019-NEED-Sc3-8	Open 911L 240kV line (Foothills 237S to ENMAX No. 65)
Figure B-2019-NEED-Sc3-9	Open 240/138 kV transformer (Janet 74S)
Figure B-2019-NEED-Sc3-10	Open 240/138 kV transformer (East Calgary 5S)
Figure B-2019-NEED-Sc3-11	Open 500/240 kV transformer (Langdon 102S)

Table B-4 Scenario 4

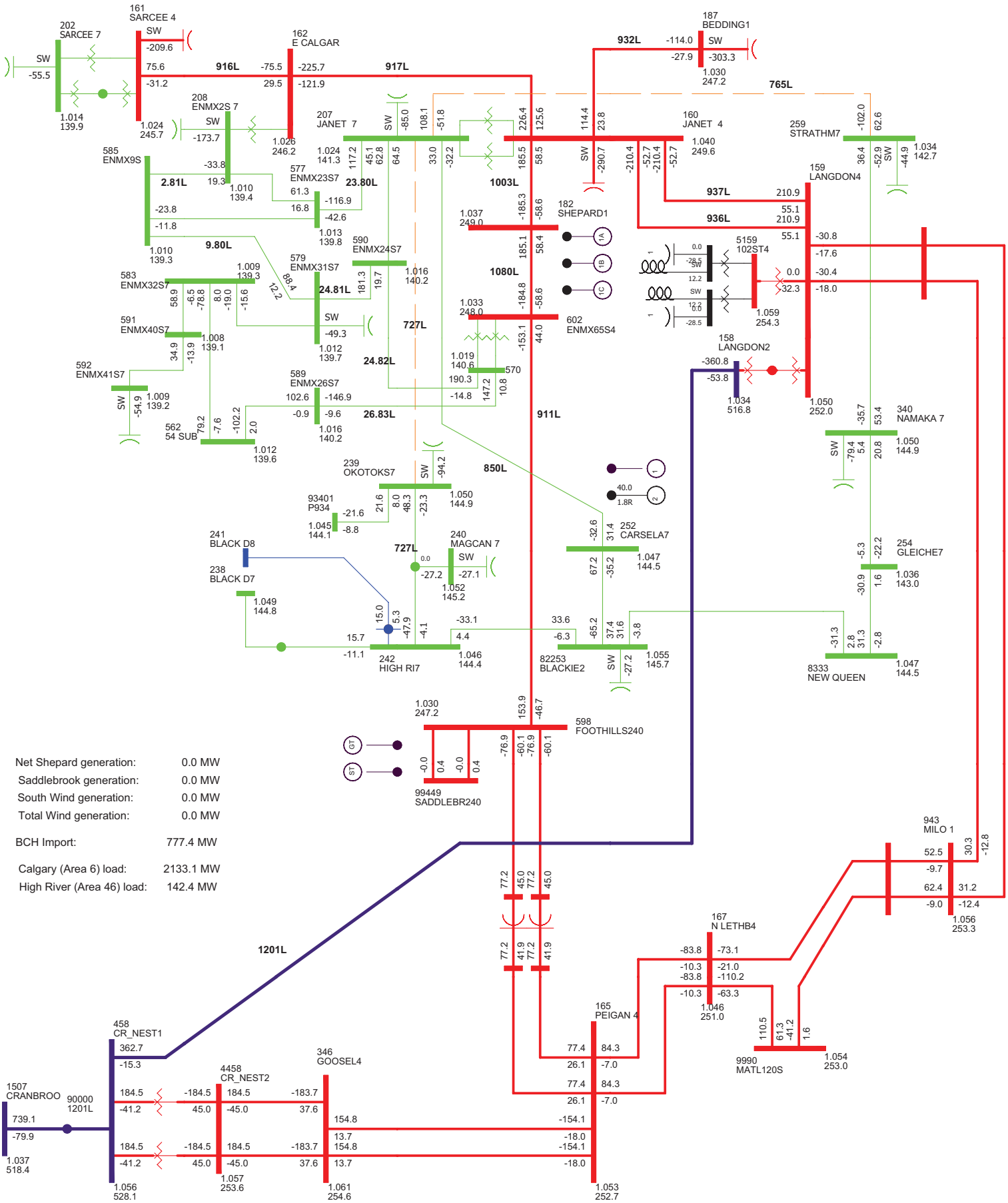
Figure Name	Contingency
Figure B-2019-NEED-Sc4-1	Base Case (N-0)
Figure B-2019-NEED-Sc4-2	Open 932L 240kV line (Janet 74S to Beddington SS-162)
Figure B-2019-NEED-Sc4-3	Open 917L 240kV line (Janet 74S to East Calgary 5S)
Figure B-2019-NEED-Sc4-4	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure B-2019-NEED-Sc4-5	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure B-2019-NEED-Sc4-6	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure B-2019-NEED-Sc4-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure B-2019-NEED-Sc4-8	Open 911L 240kV line (Foothills 237S to ENMAX No. 65)
Figure B-2019-NEED-Sc4-9	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure B-2019-NEED-Sc4-10	Open 240/138 kV transformer (East Calgary 5S)
Figure B-2019-NEED-Sc4-11	Open 500/240 kV transformer (Langdon 102S)

Table B-5 Scenario 5

Figure Name	Contingency
Figure B-2019-NEED-Sc5-1	Base Case (N-0)
Figure B-2019-NEED-Sc5-2	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure B-2019-NEED-Sc5-3	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure B-2019-NEED-Sc5-4	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure B-2019-NEED-Sc5-5	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure B-2019-NEED-Sc5-6	Open 240/138 kV transformer (Janet 74S)
Figure B-2019-NEED-Sc5-7	Open 240/138 kV transformer (Sarcee 42S)
Figure B-2019-NEED-Sc5-8	Open 500/240 kV transformer (Langdon 102S)

Table B-6 Scenario 6

Figure Name	Contingency
Figure B-2019-NEED-Sc6-1	Base Case (N-0)
Figure B-2019-NEED-Sc6-2	Open 932L 240kV line (Janet 74S to Beddington SS-162)
Figure B-2019-NEED-Sc6-3	Open 917L 240kV line (Janet 74S to East Calgary 5S)
Figure B-2019-NEED-Sc6-4	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure B-2019-NEED-Sc6-5	Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)
Figure B-2019-NEED-Sc6-6	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure B-2019-NEED-Sc6-7	Open 240/138 kV transformer (Janet 74S)
Figure B-2019-NEED-Sc6-8	Open 500/240 kV transformer (Langdon 102S)

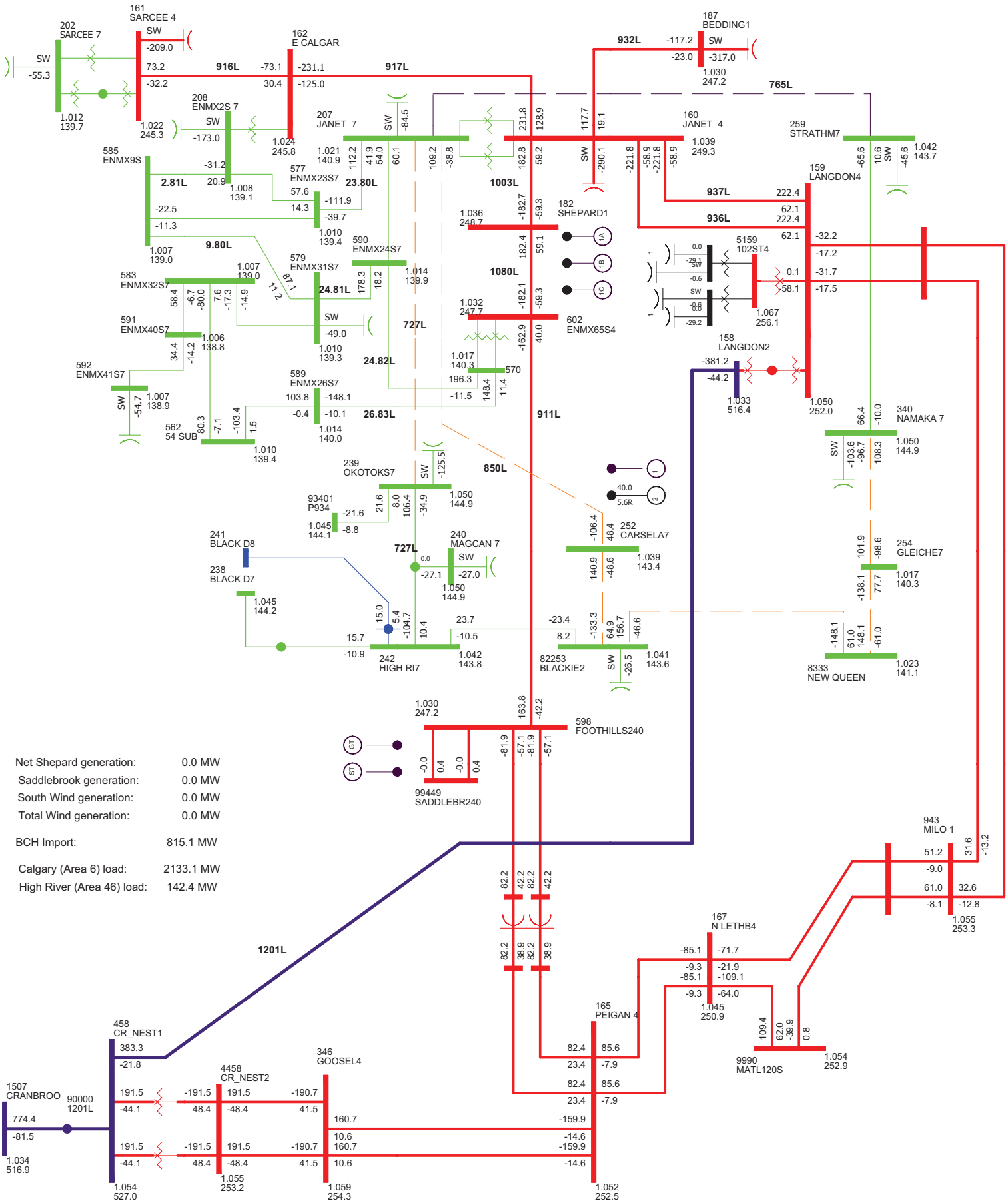


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc1-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 16:49

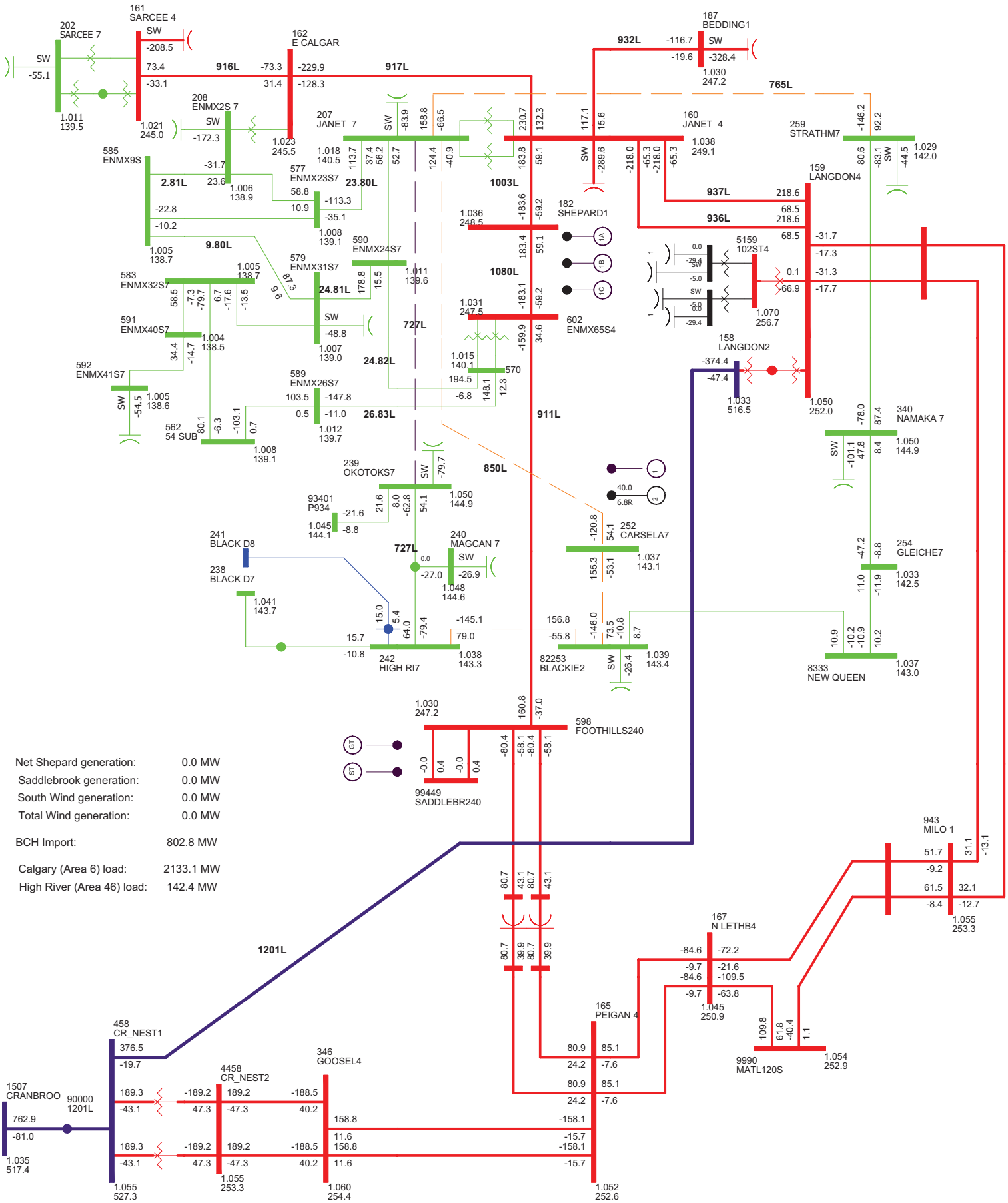


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc1-2

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 16:49

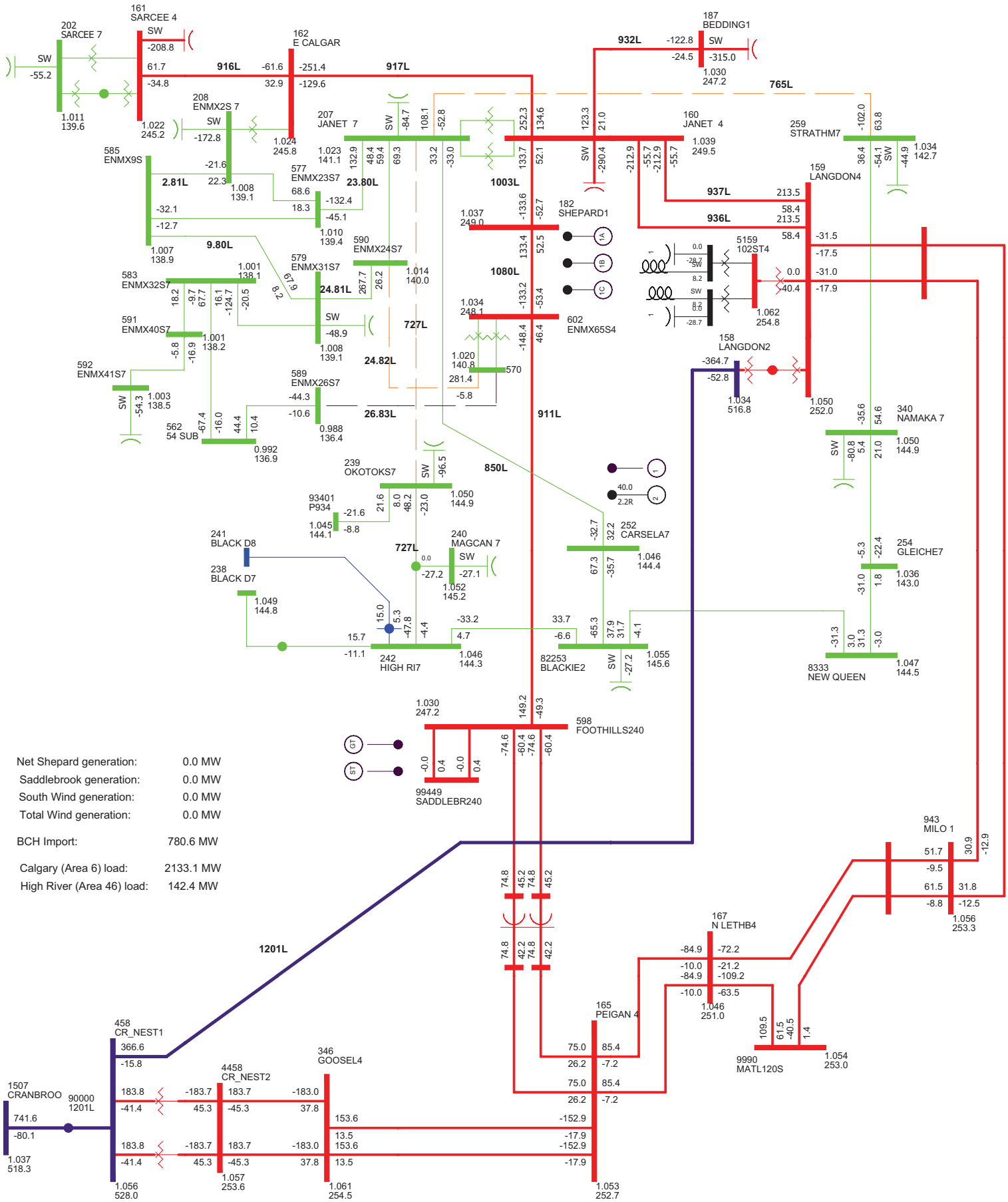


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc1-3

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 16:49

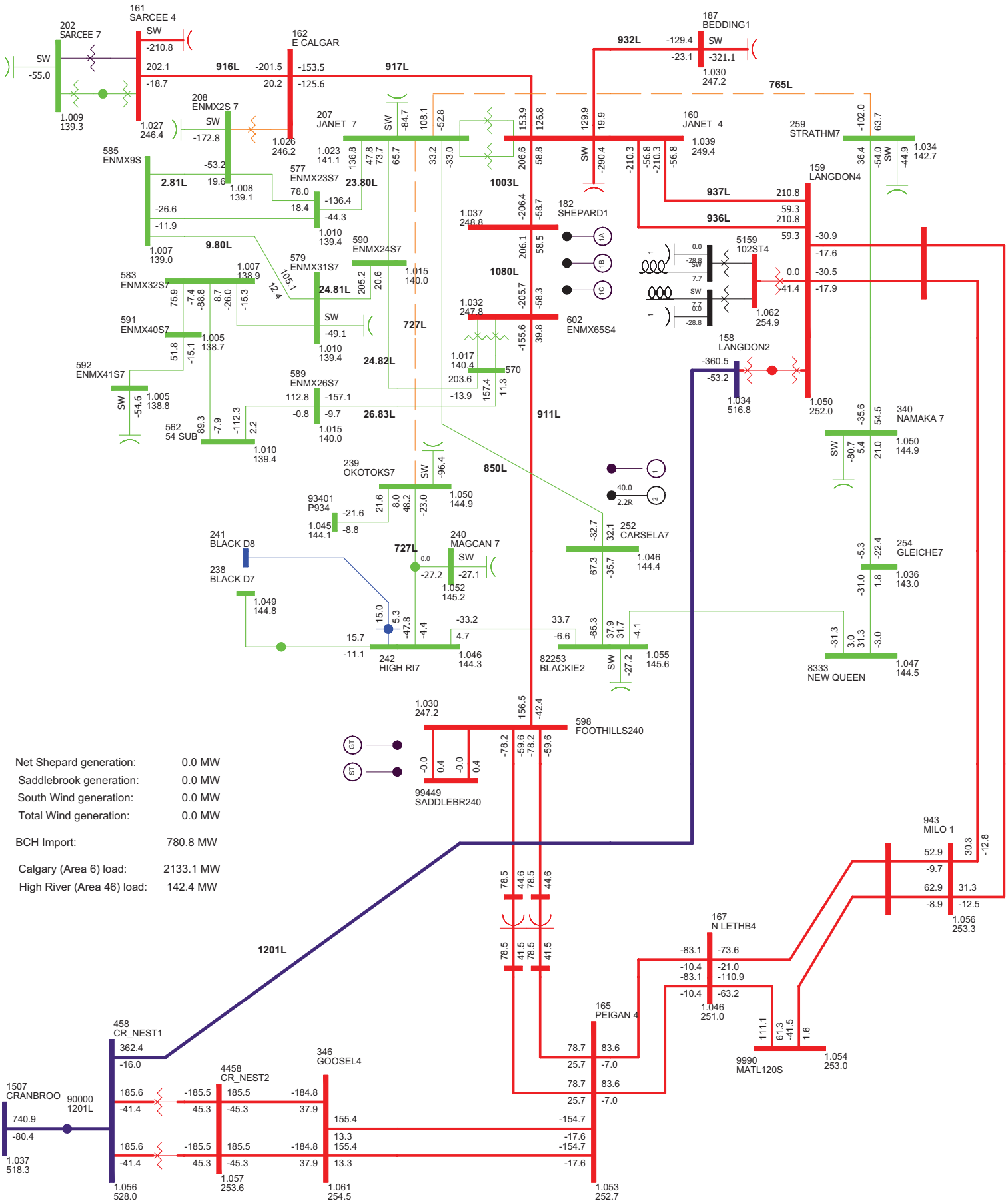


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc1-4

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 20 2011 16:49

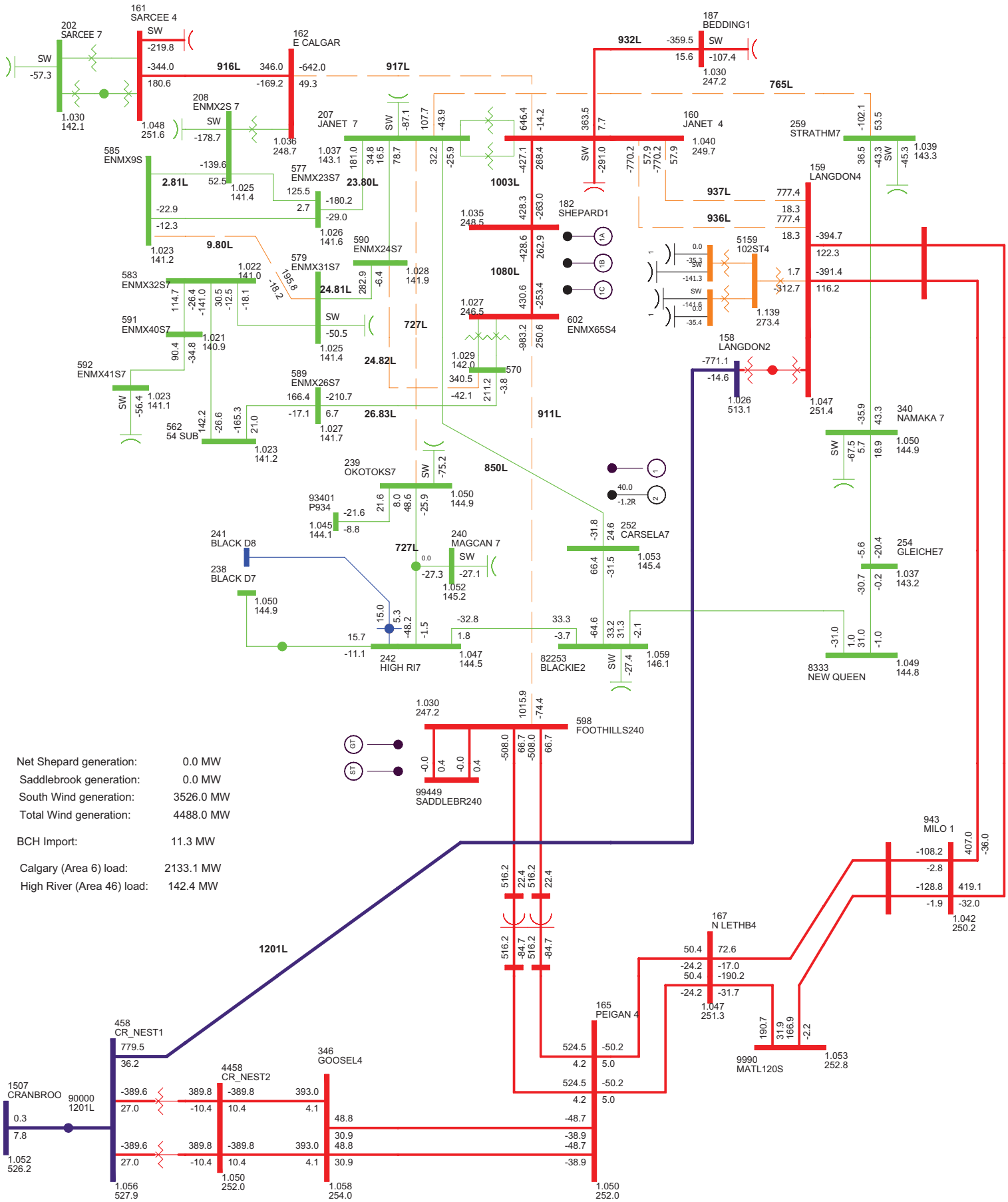


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc1-5

240/138 KV TRANSFORMER (SARCEE 42S)

WED, APR 20 2011 16:50

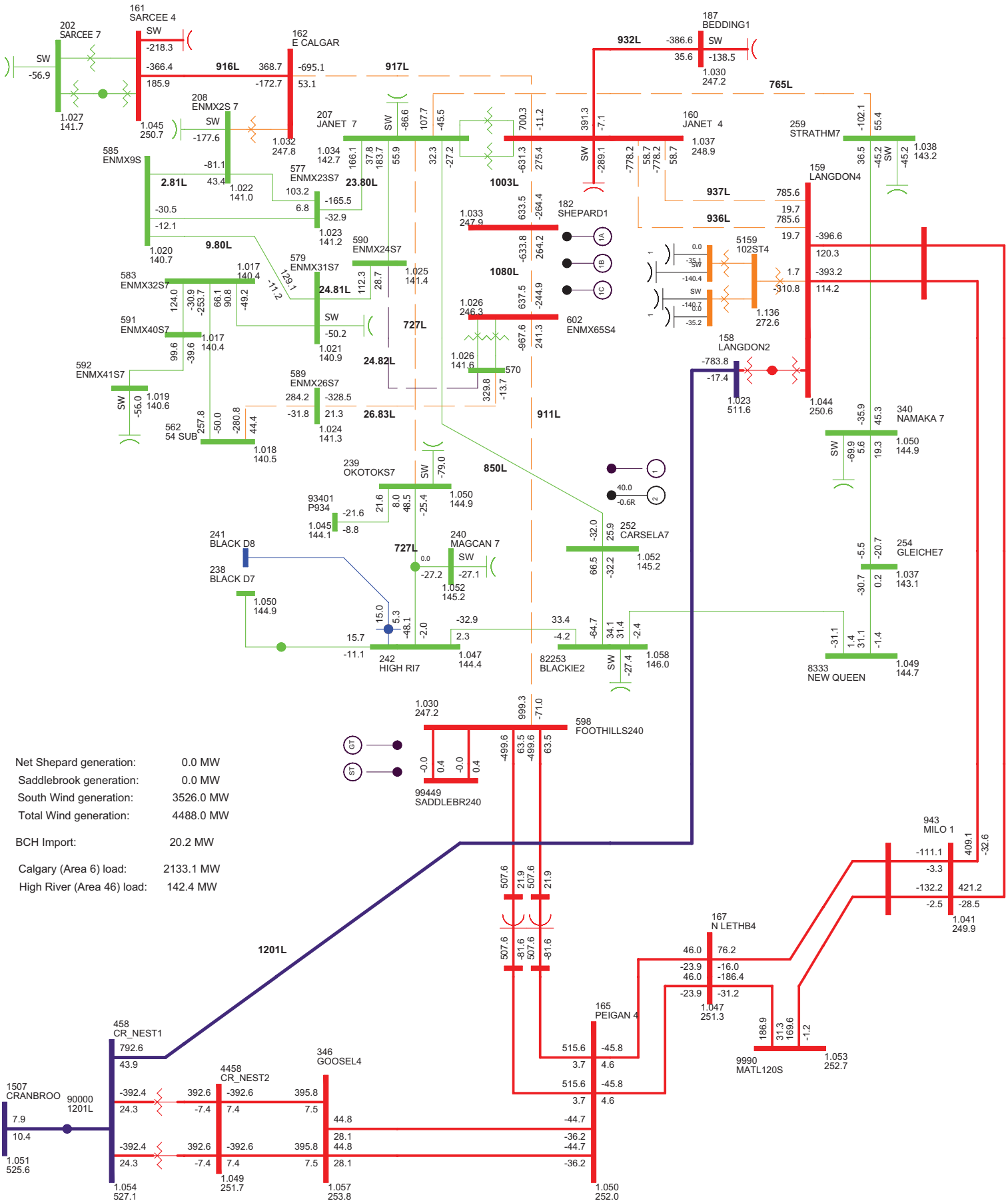


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc2-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:24

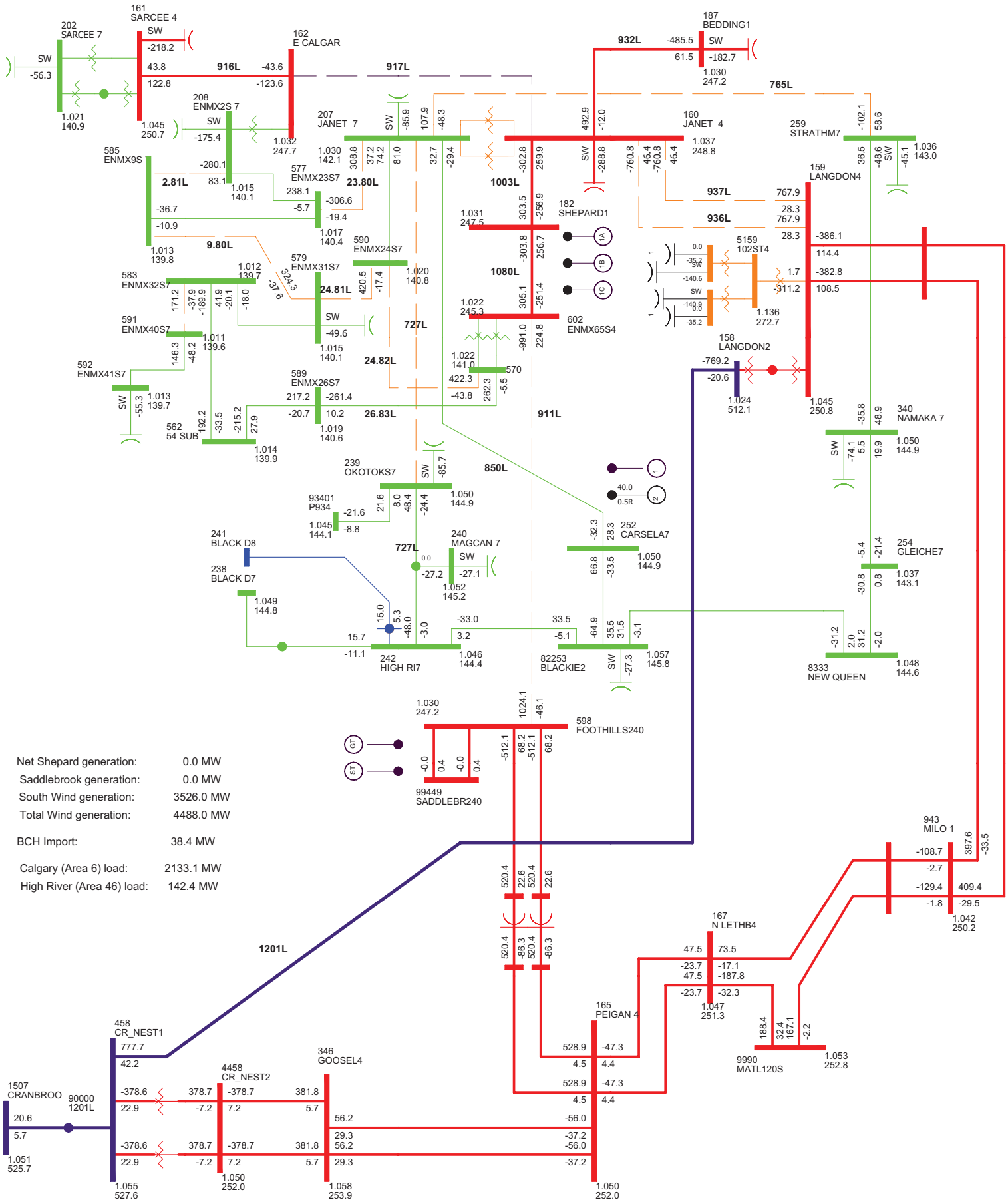


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc2-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

WED, APR 20 2011 17:24



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc2-3

917L (JANET 74S TO EAST CALGARY 5S)

WED, APR 20 2011 17:24

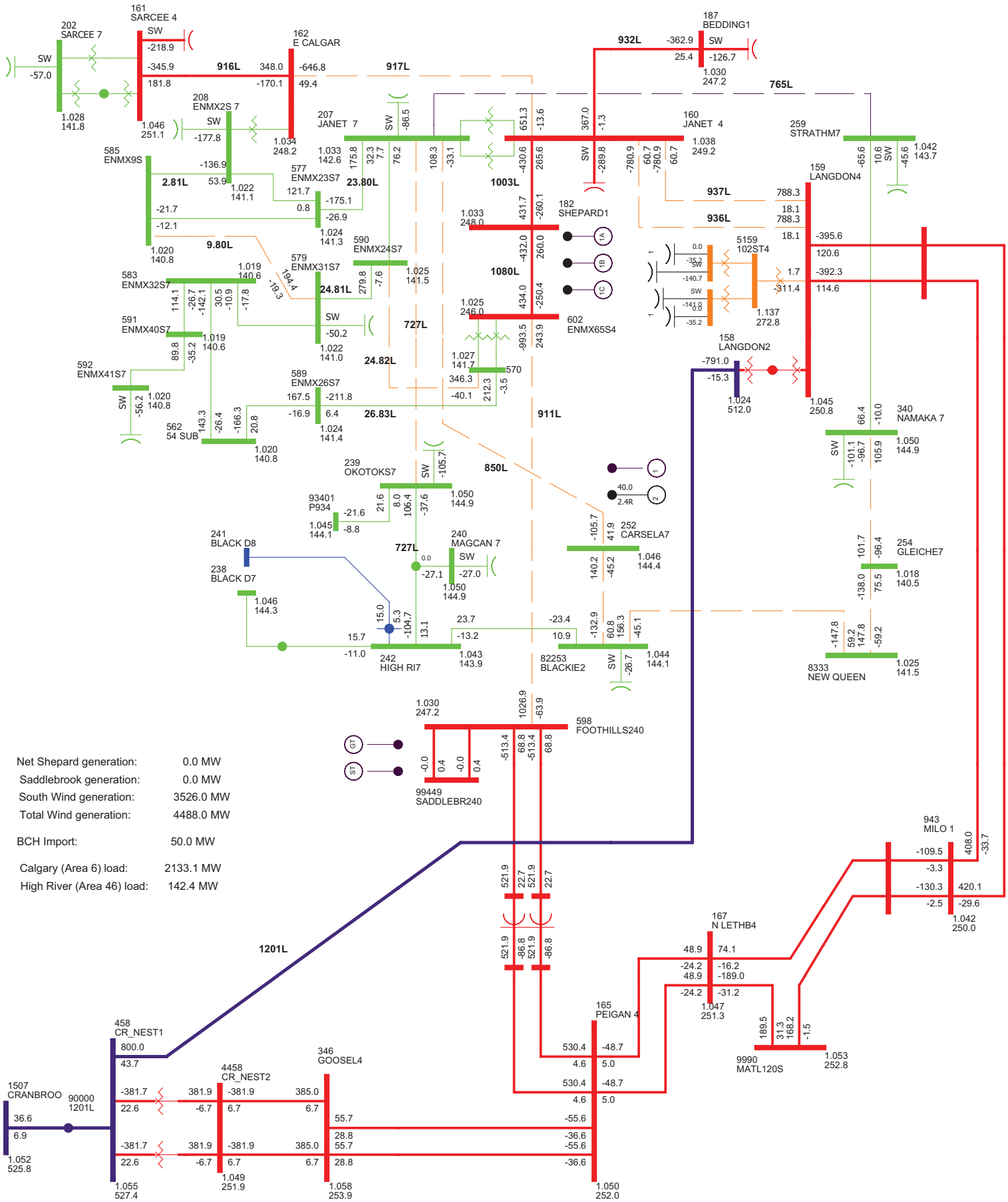
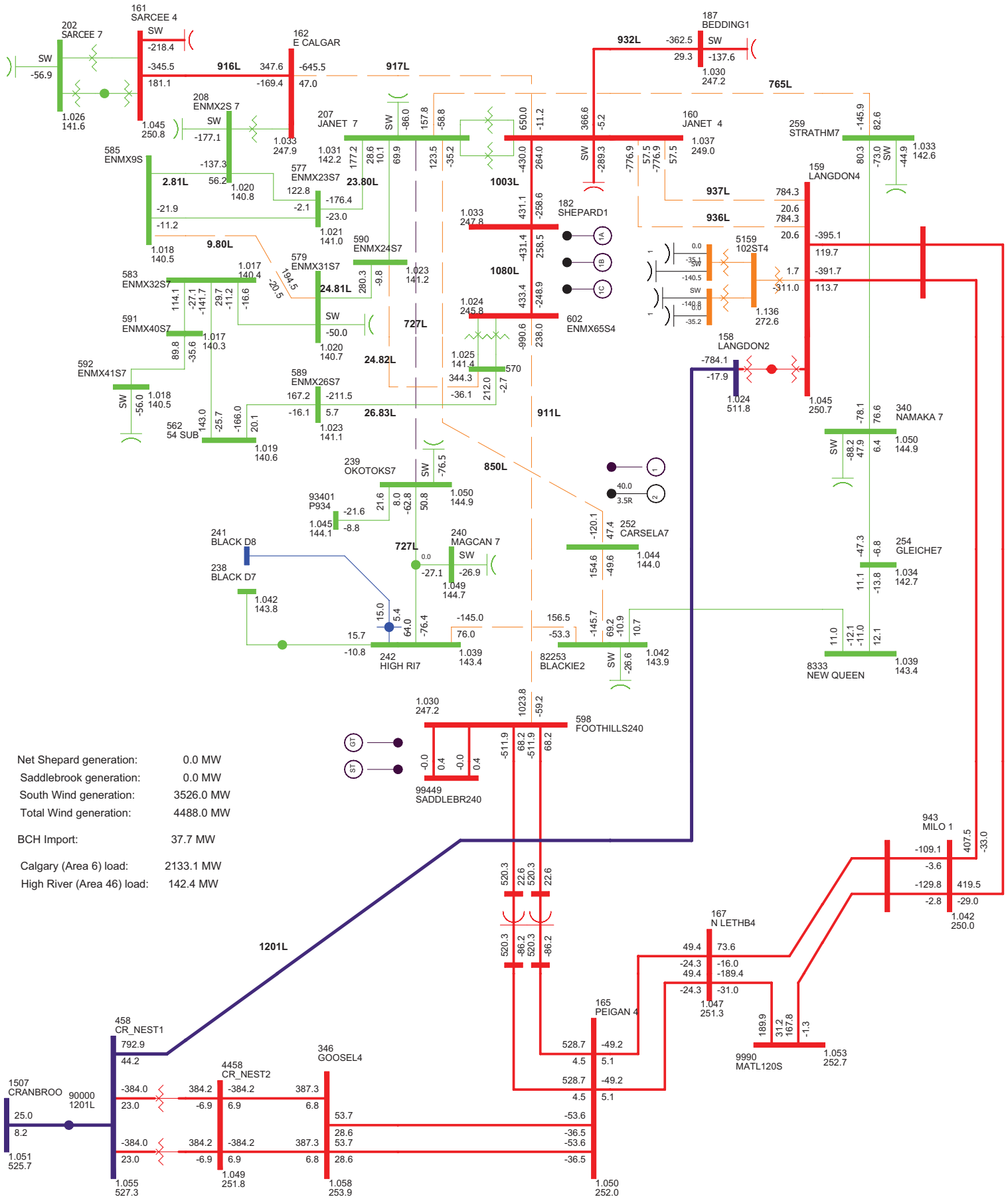


Figure B-2019-NEED-Sc2-4

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 17:24



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc2-5

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:24

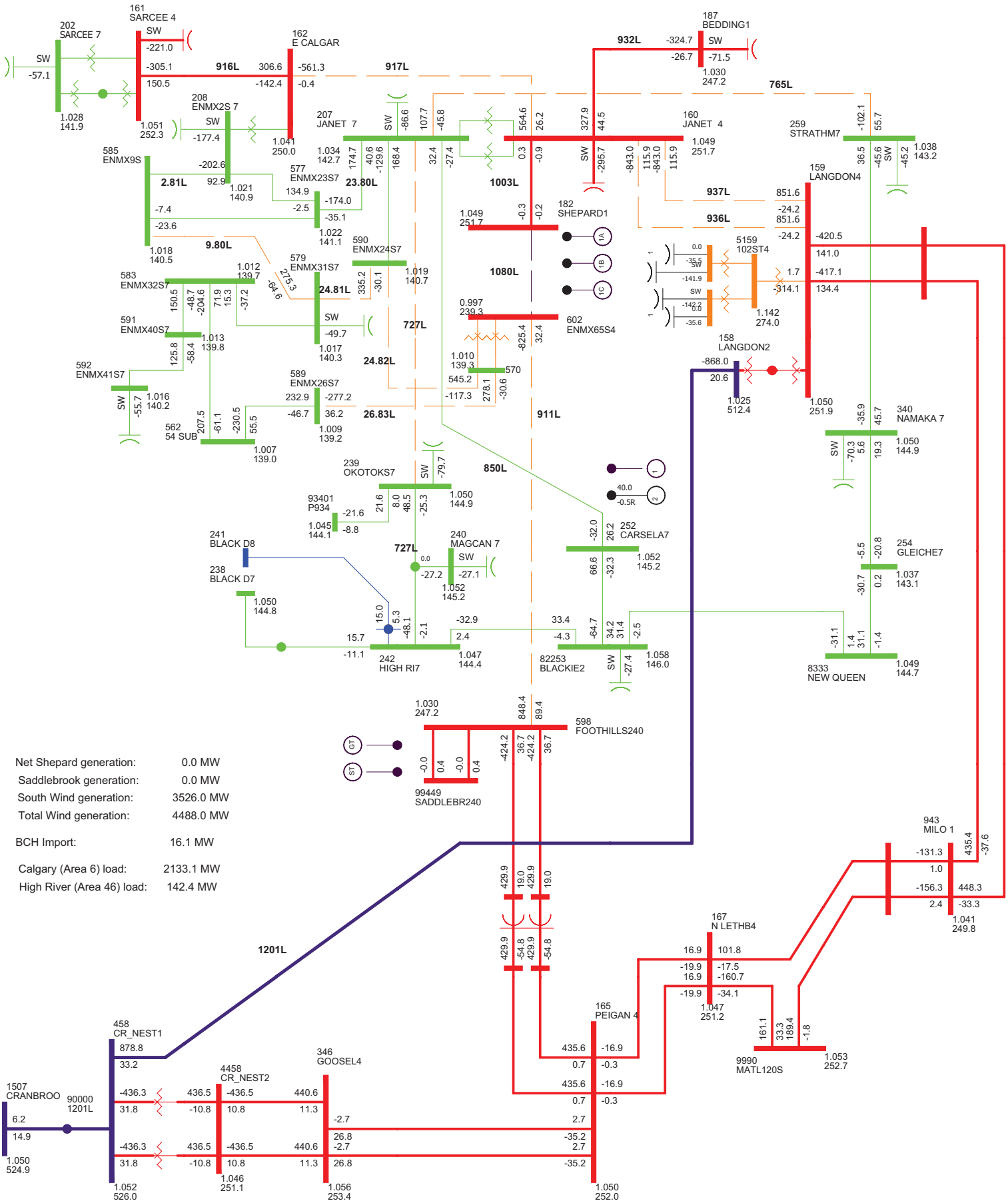


Figure B-2019-NEED-Sc2-6

1080L (ENMAX NO. 25 TO ENMAX NO. 65)

WED, APR 20 2011 17:25

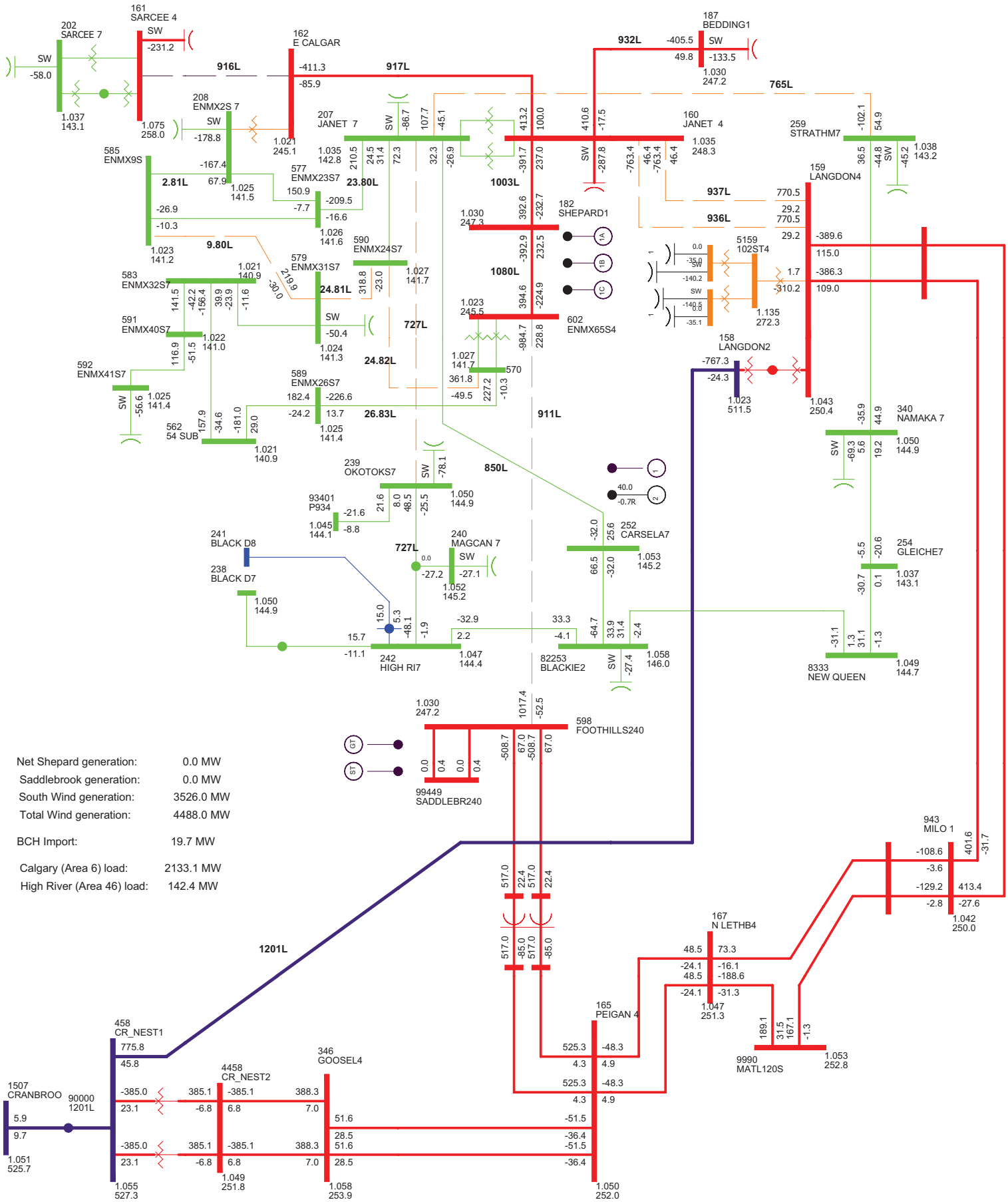
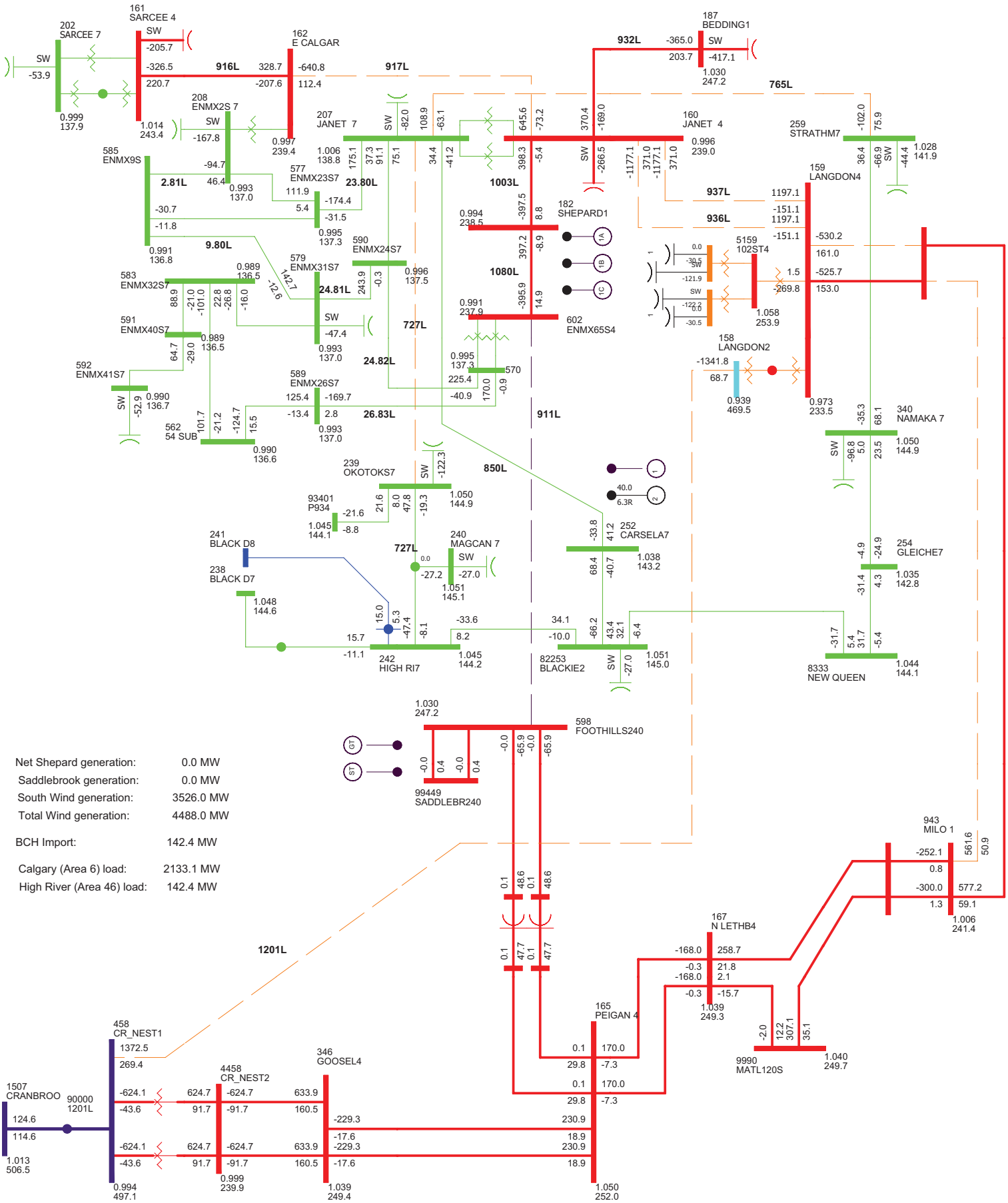


Figure B-2019-NEED-Sc2-7

916L (SARCEE 42S TO EAST CALGARY 5S)

WED, APR 20 2011 17:25

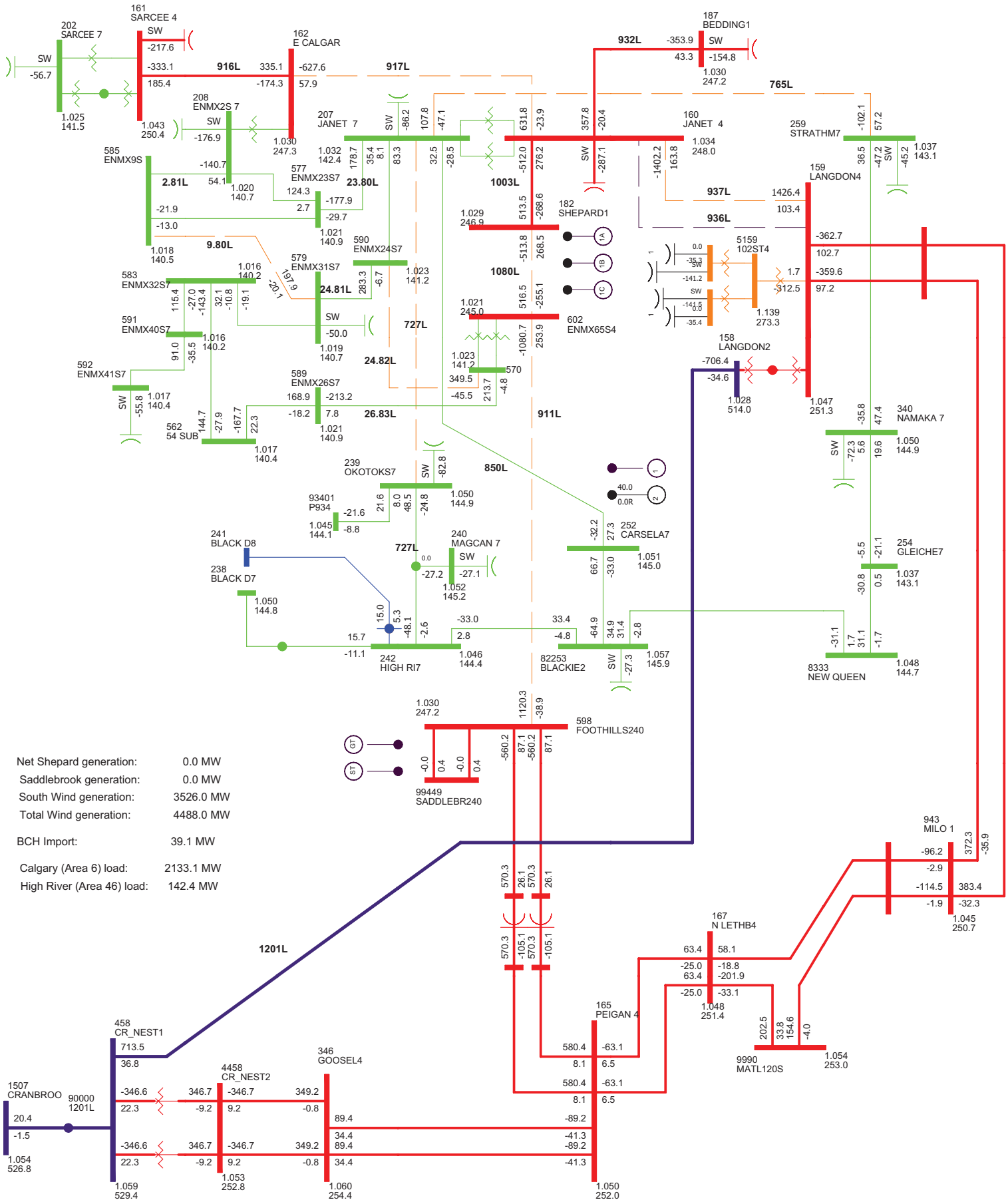


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc2-8

911L (FOOTHILLS 237S TO ENMAX NO. 65)

WED, APR 20 2011 17:25

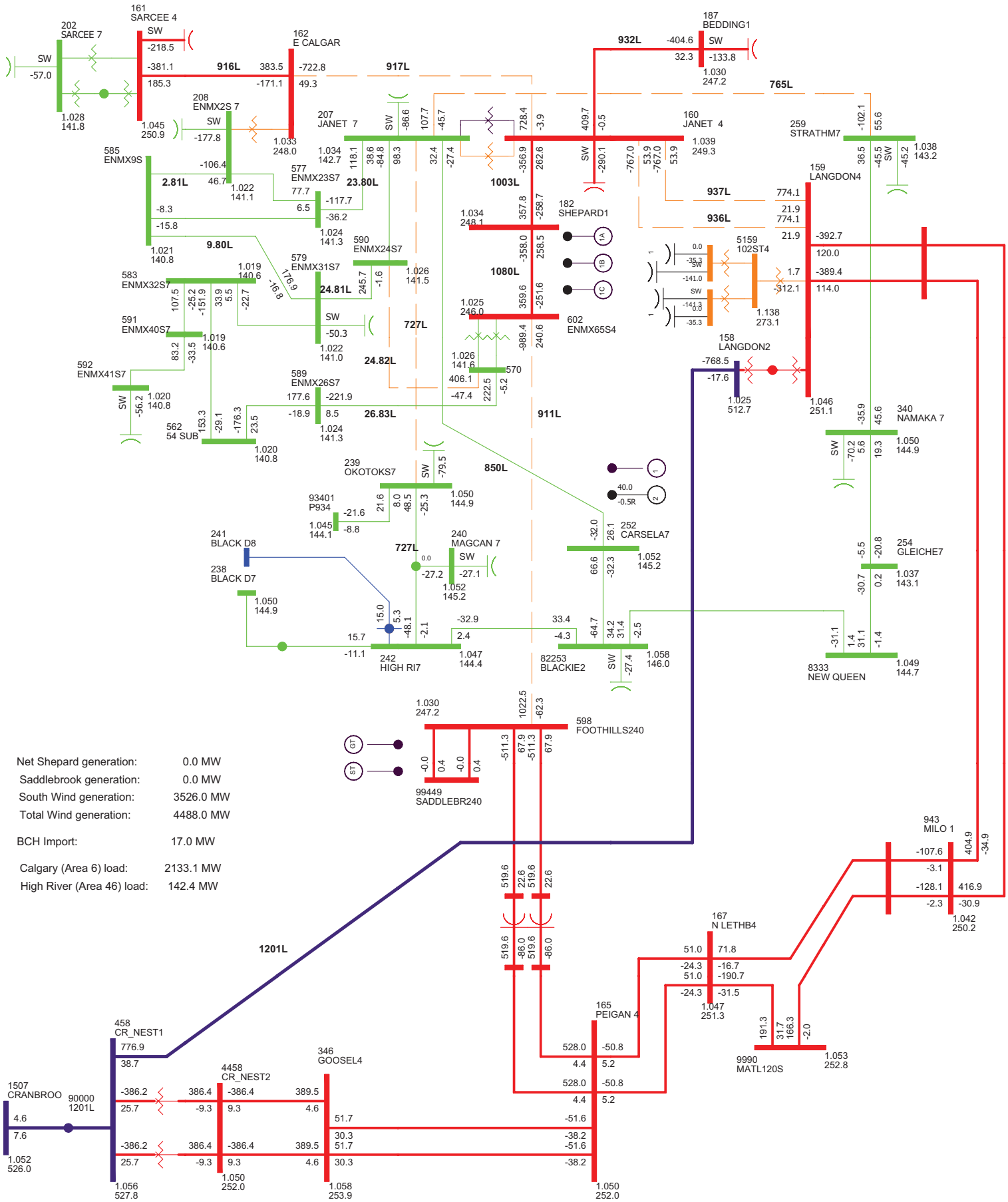


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc2-9

936L (LANGDON 102S TO JANET 74S)

WED, APR 20 2011 17:26

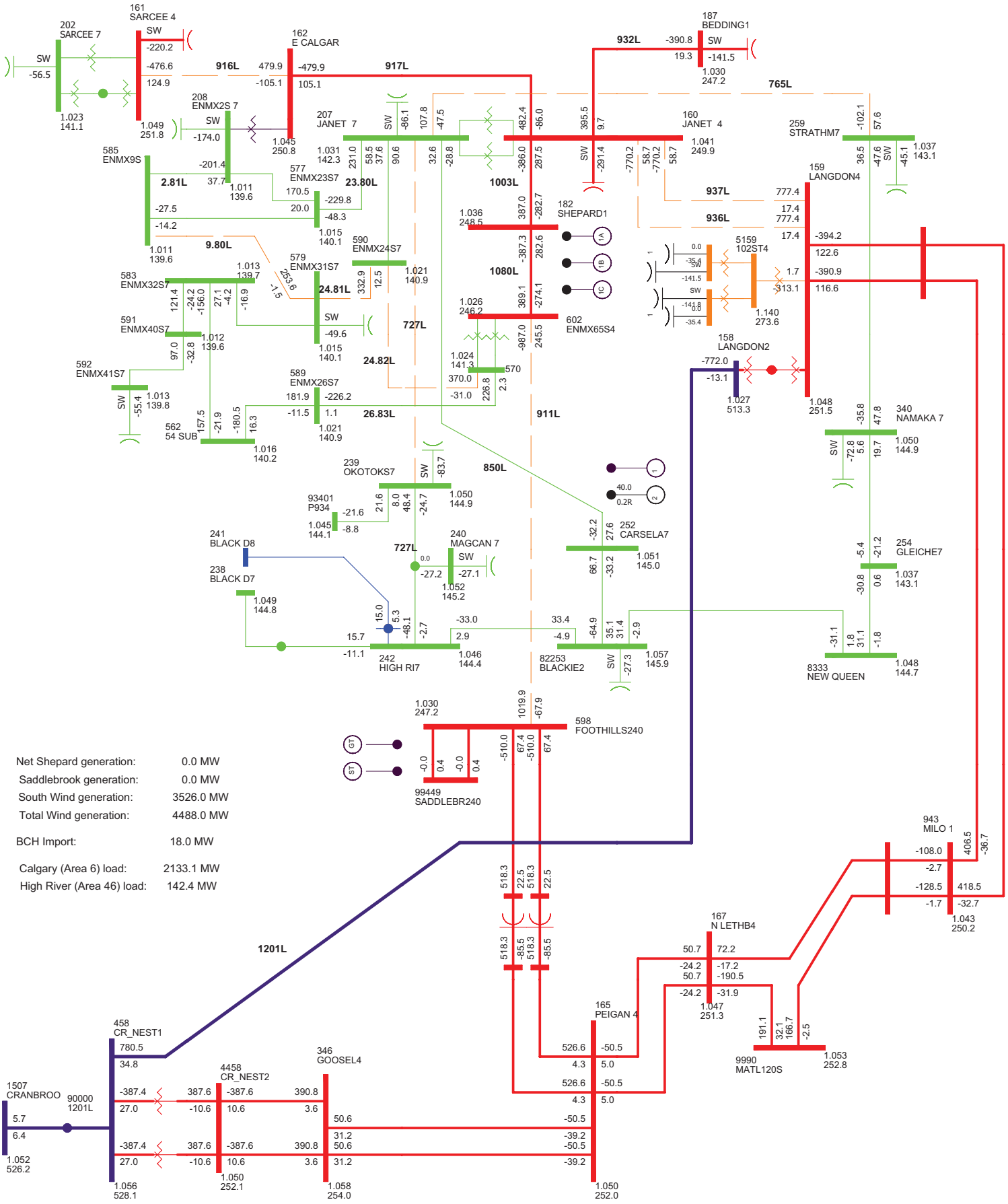


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc2-10

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 17:26

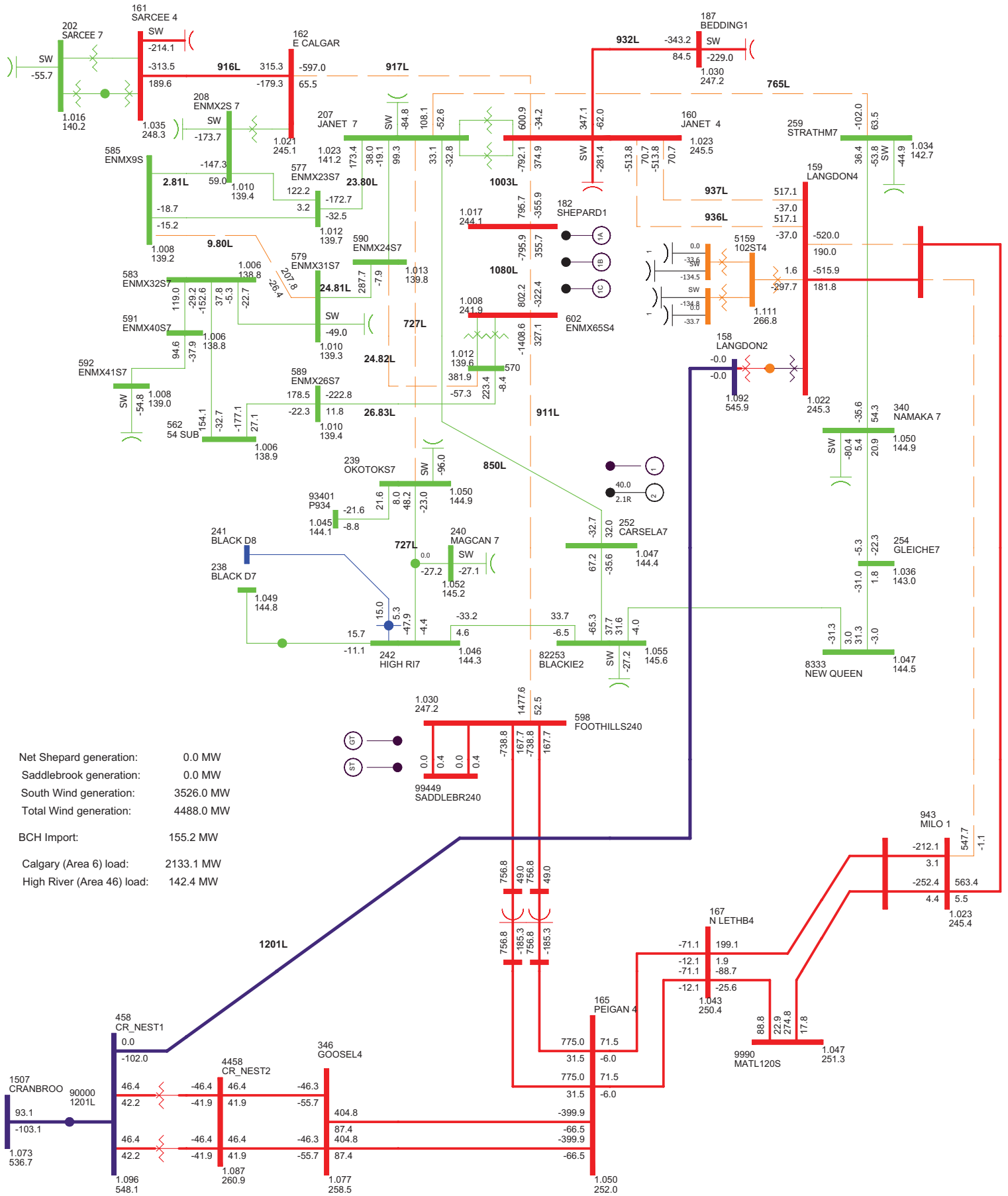


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc2-11

240/138 KV TRANSFORMER (EAST CALGARY 5S)

WED, APR 20 2011 17:26

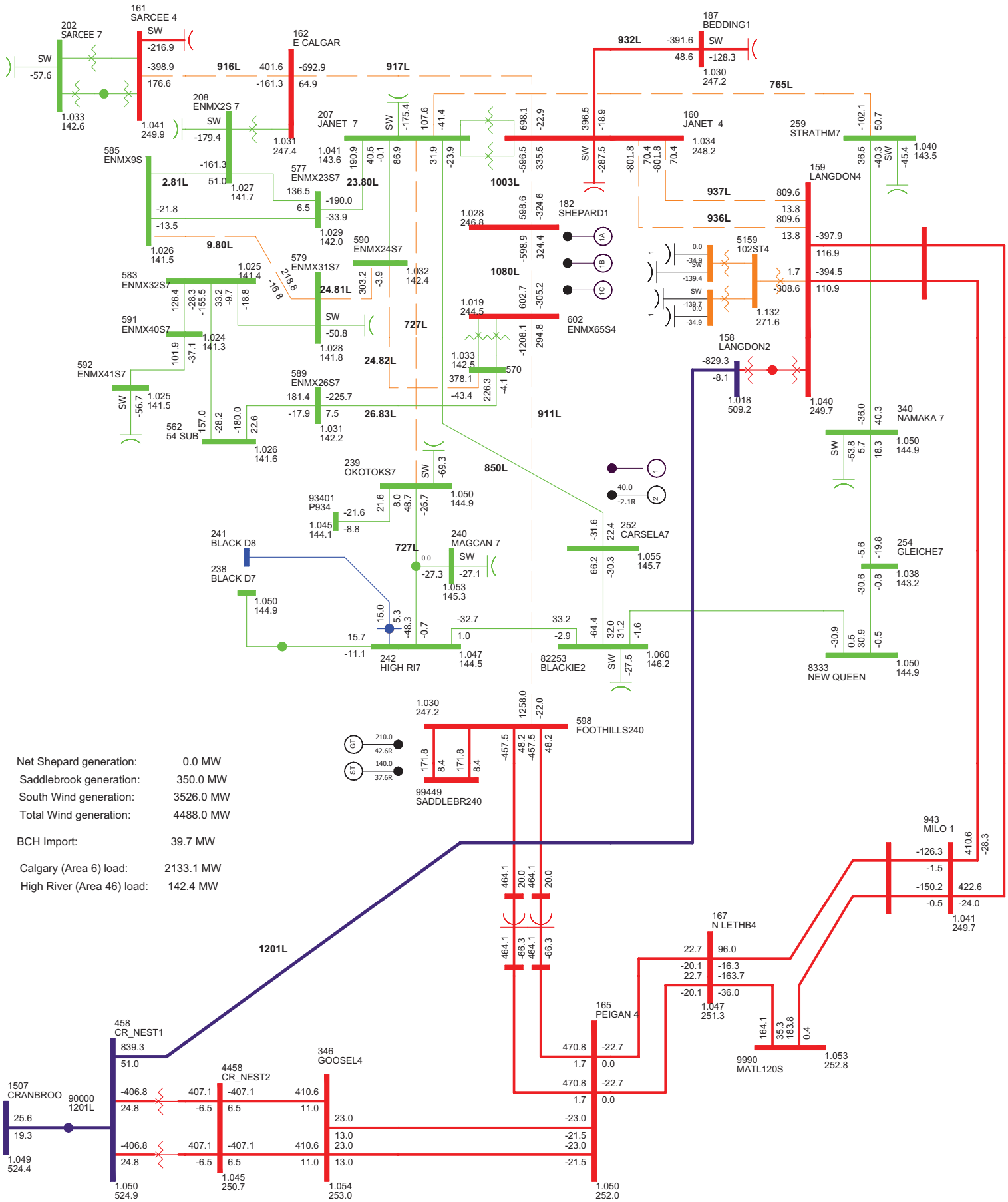


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc2-12

500/240 KV TRANSFORMER (LANGDON 102S)

WED, APR 20 2011 17:26

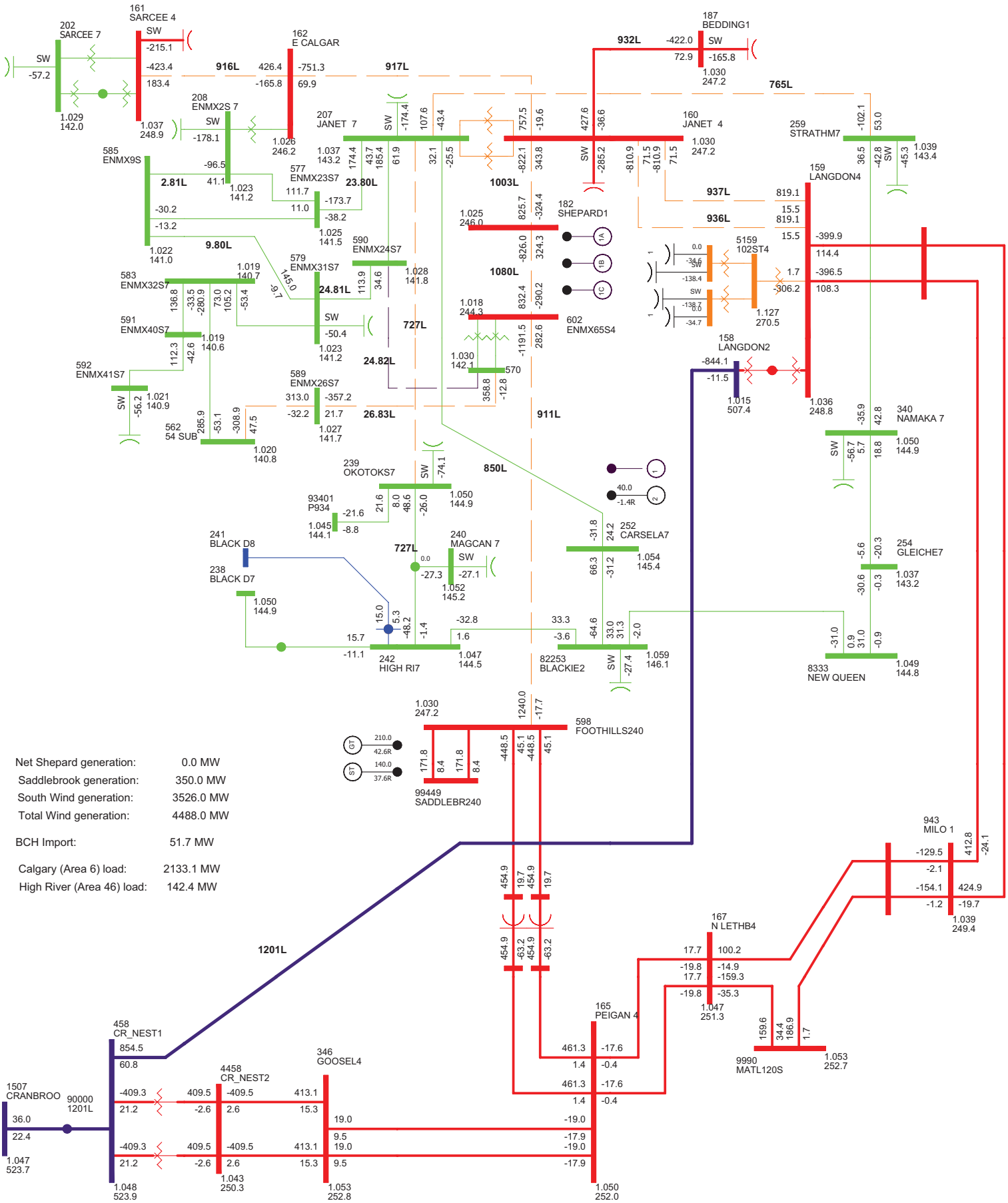


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc3-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:28

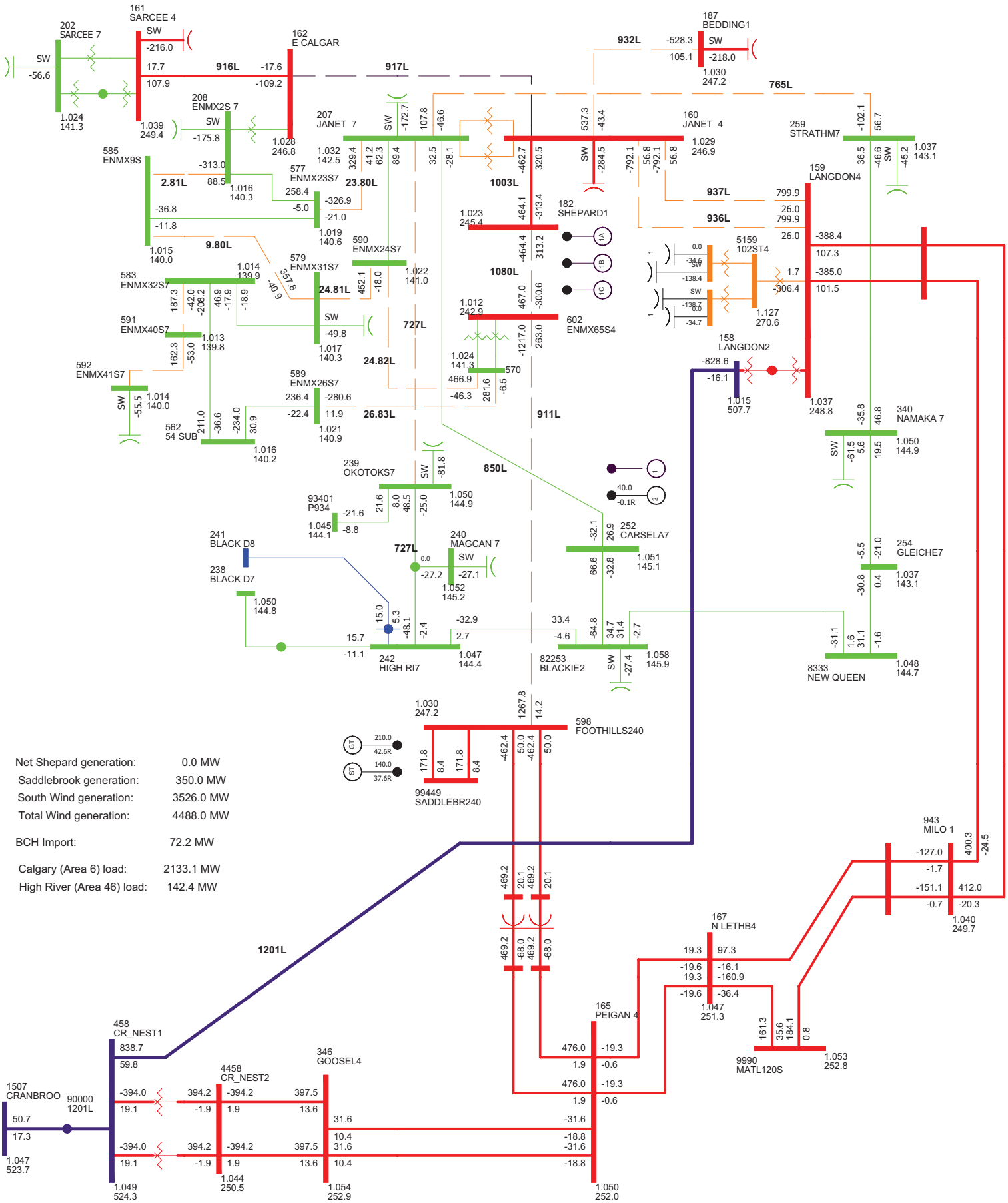


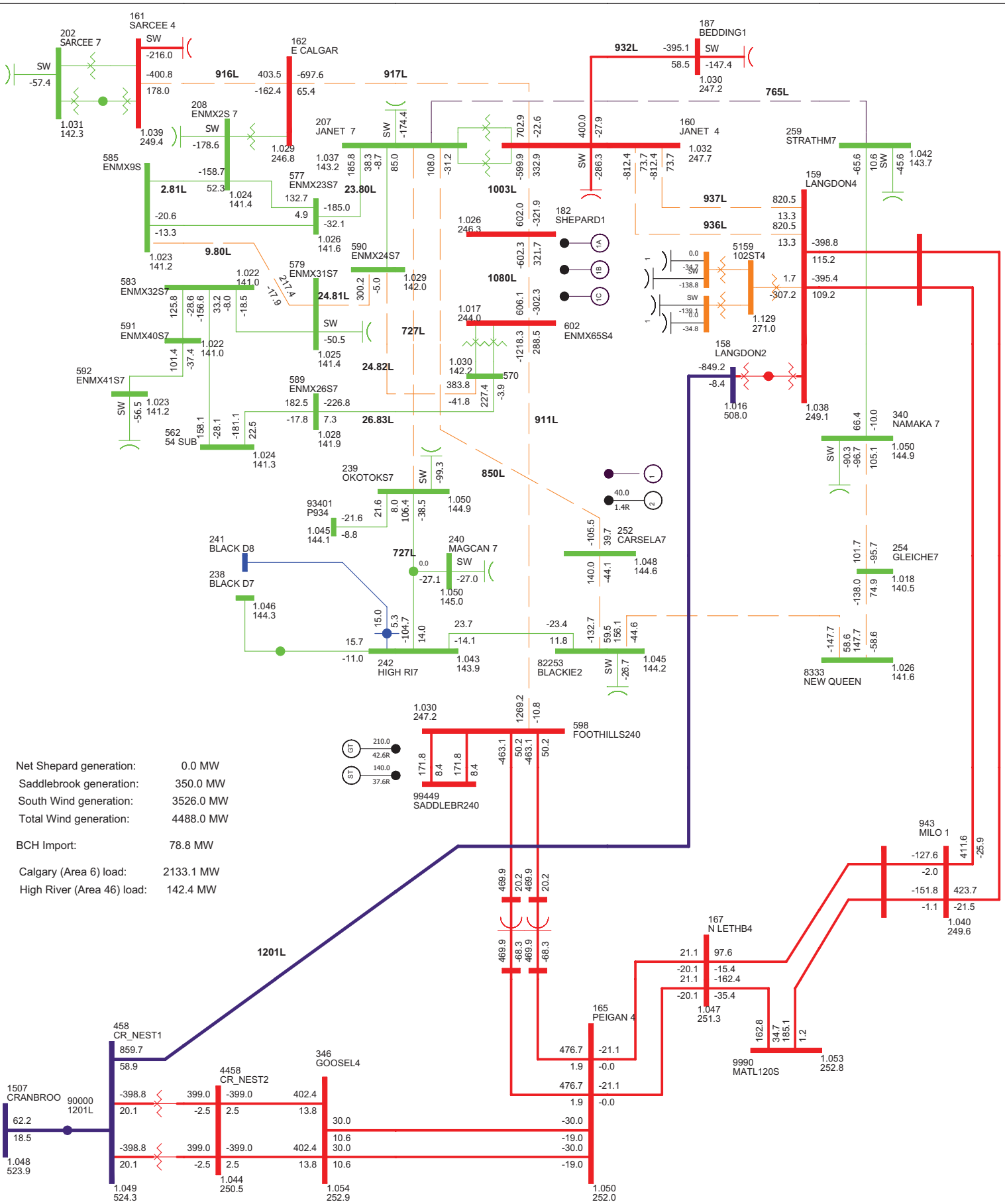
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc3-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

WED, APR 20 2011 17:29


Net Shepard generation: 0.0 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 3526.0 MW
Total Wind generation: 4488.0 MW
BCH Import: 72.2 MW
Calgary (Area 6) load: 2133.1 MW
High River (Area 46) load: 142.4 MW
916L
917L
932L
765L
1003L
1080L
937L
936L
727L
24.81L
24.82L
26.83L
911L
850L
2.81L
9.80L
23.80L
1201L
202 SARCEE 7
161 SARCEE 4
162 E CALGAR
208 ENMX2S 7
207 JANET 7
160 JANET 4
187 BEDDING1
259 STRATHM7
159 LANGDON4
158 LANGDON2
585 ENMX9S
577 ENMX23S7
590 ENMX24S7
579 ENMX31S7
583 ENMX32S7
591 ENMX40S7
592 ENMX41S7
589 ENMX26S7
562 54 SUB
182 SHEPARD1
602 ENMX65S4
5159 102ST4
239 OKOTOKS7
93401 P934
241 BLACK D8
238 BLACK D7
240 MAGCAN 7
252 CARSELA7
254 GLEICHE7
340 NAMAKA 7
242 HIGH RI7
82253 BLACKIE2
8333 NEW QUEEN
598 FOOTHILLS240
99449 SADDLEBR240
943 MILO 1
167 N LETHB4
165 PEIGAN 4
9990 MATL120S
458 CR_NEST1
4458 CR_NEST2
346 GOOSEL4
1507 CRANBROO
90000 1201L
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure B-2019-NEED-Sc3-3
917L (JANET 74S TO EAST CALGARY 5S)
WED, APR 20 2011 17:29

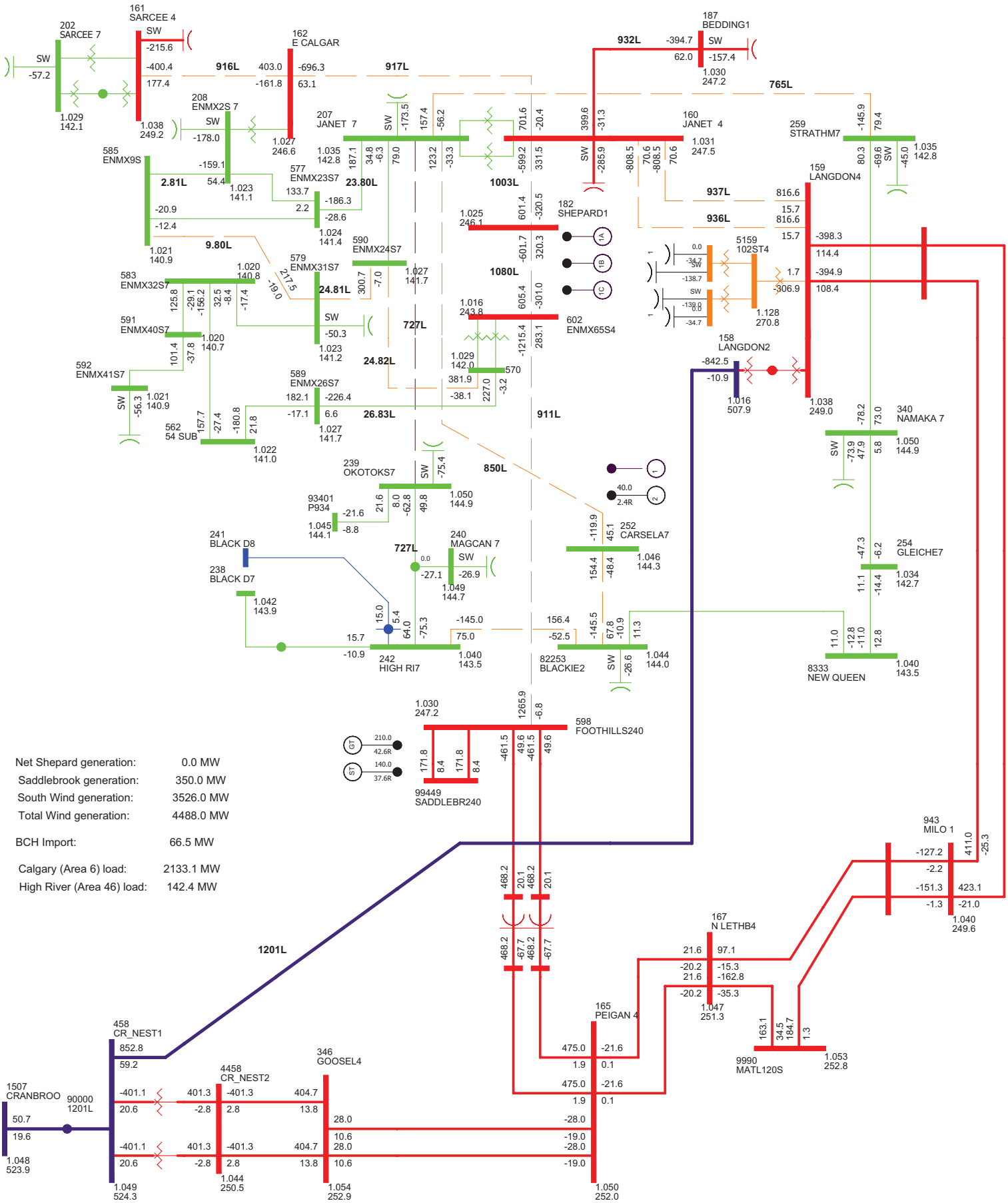


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc3-4

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 17:29



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc3-5

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:29

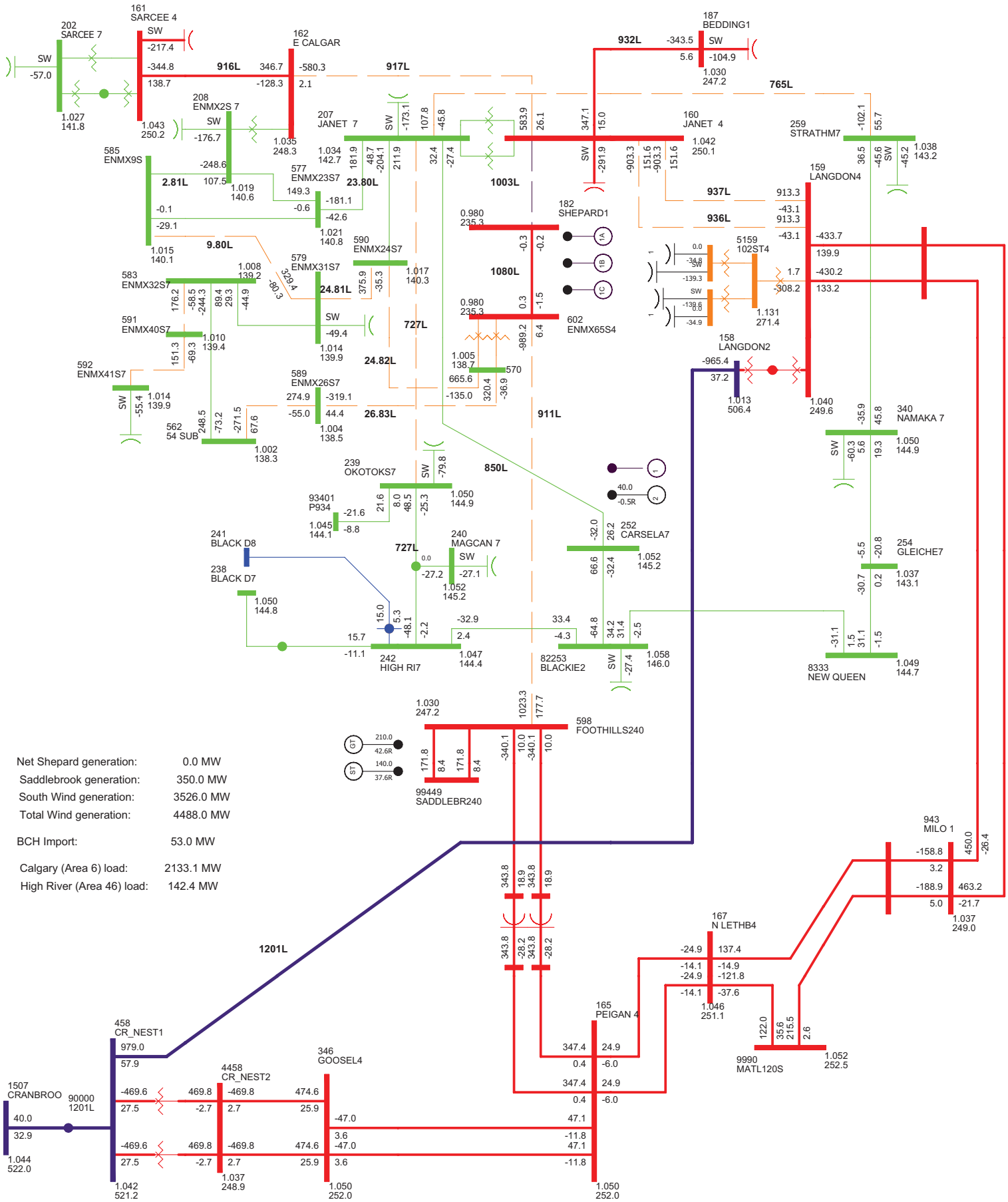
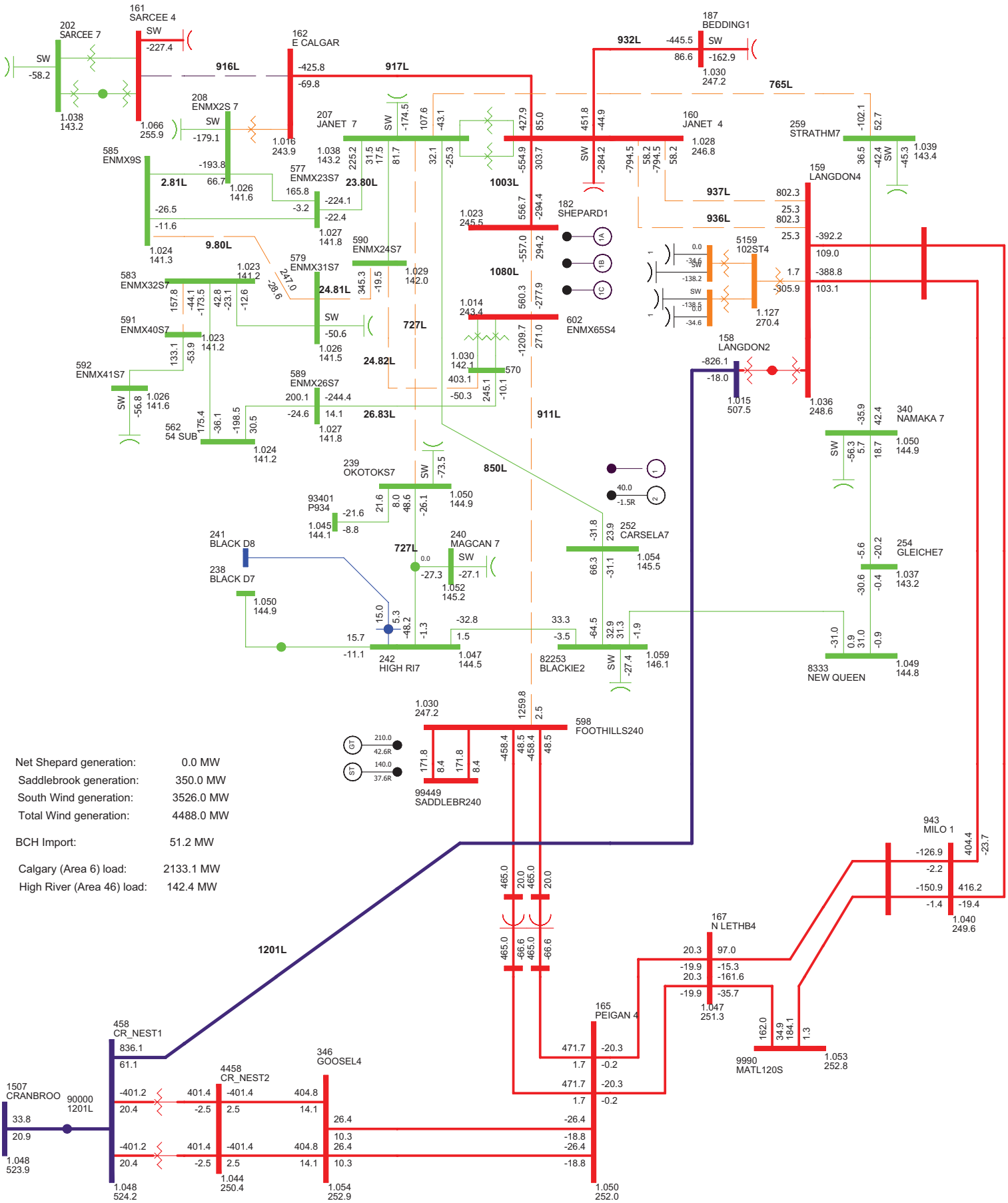


Figure B-2019-NEED-Sc3-6

1003L (JANET 74S TO ENMAX NO. 25)

WED, APR 20 2011 17:29

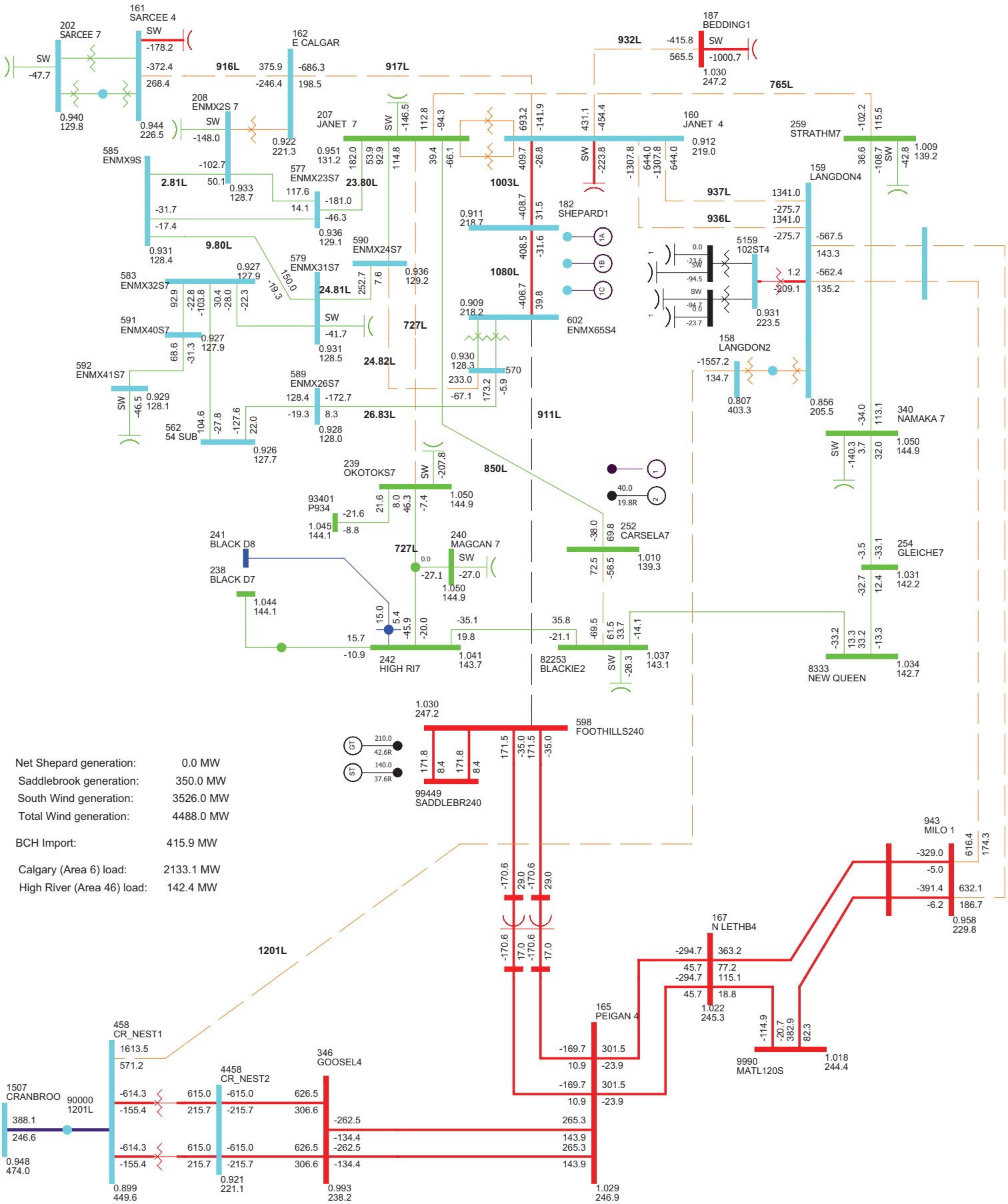


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc3-7

916L (SARCEE 42S TO EAST CALGARY 5S)

WED, APR 20 2011 17:29

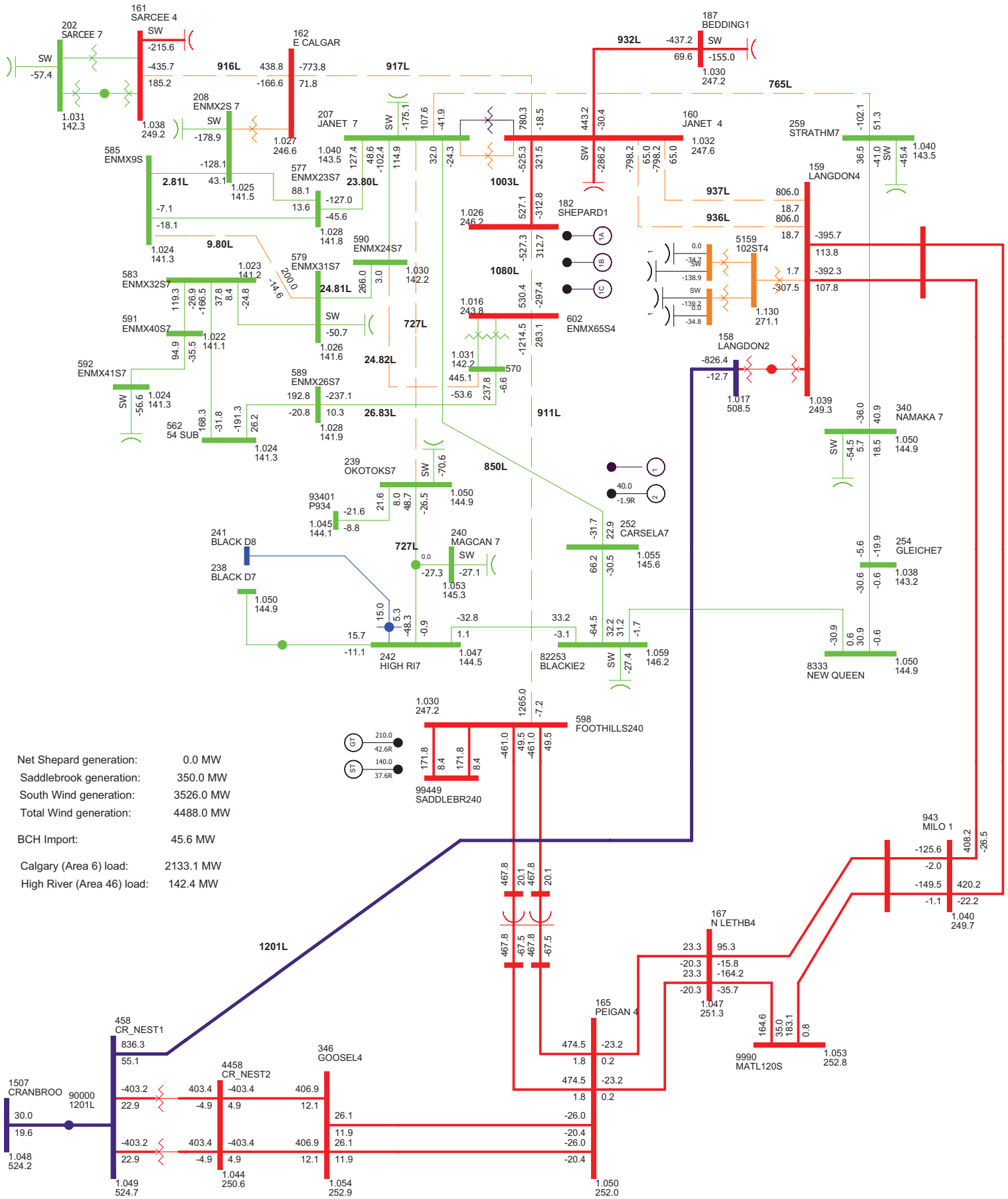


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc3-8

911L (FOOTHILLS 237S TO ENMAX NO. 65)

WED, APR 20 2011 17:30



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc3-9

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 17:30

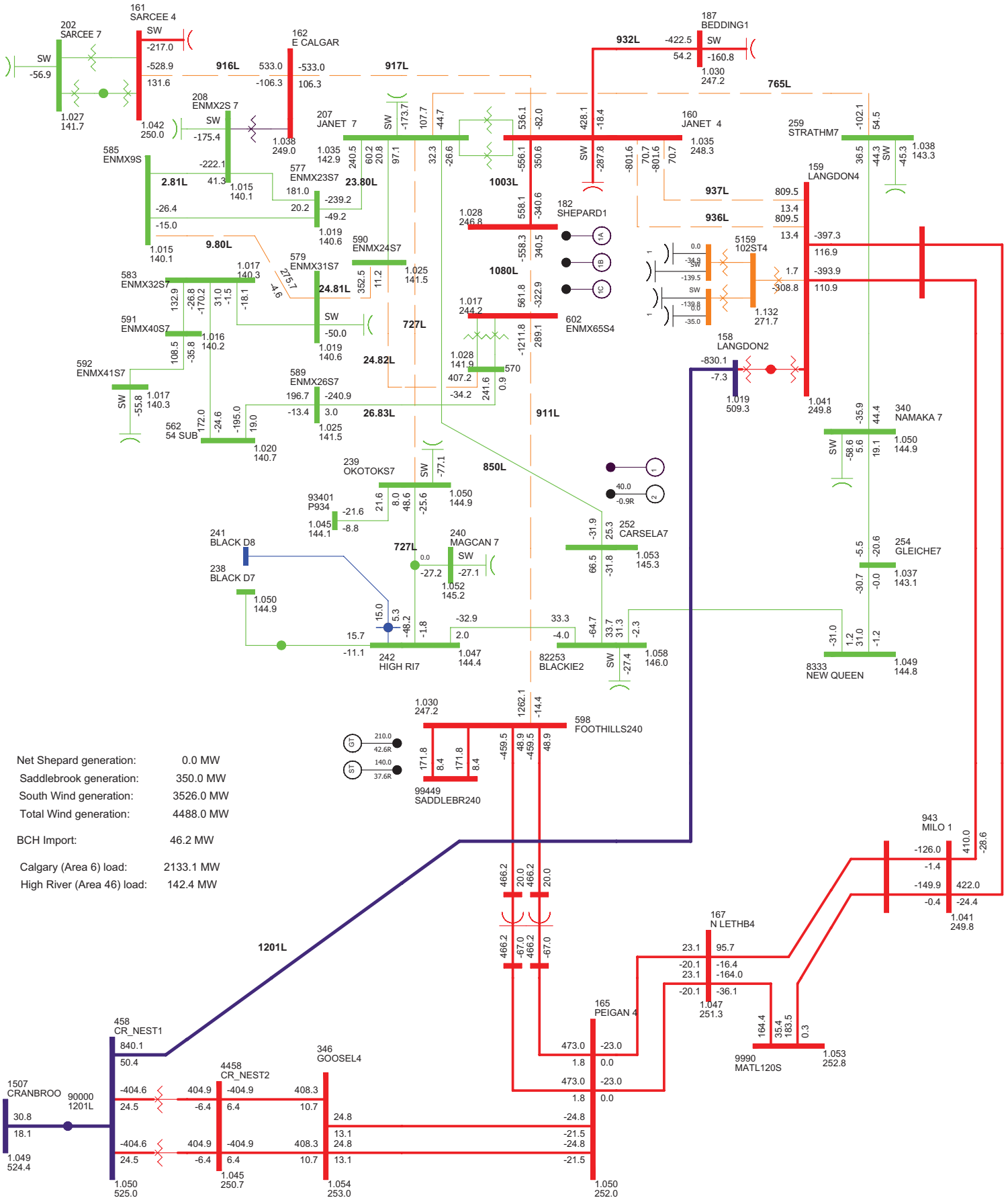
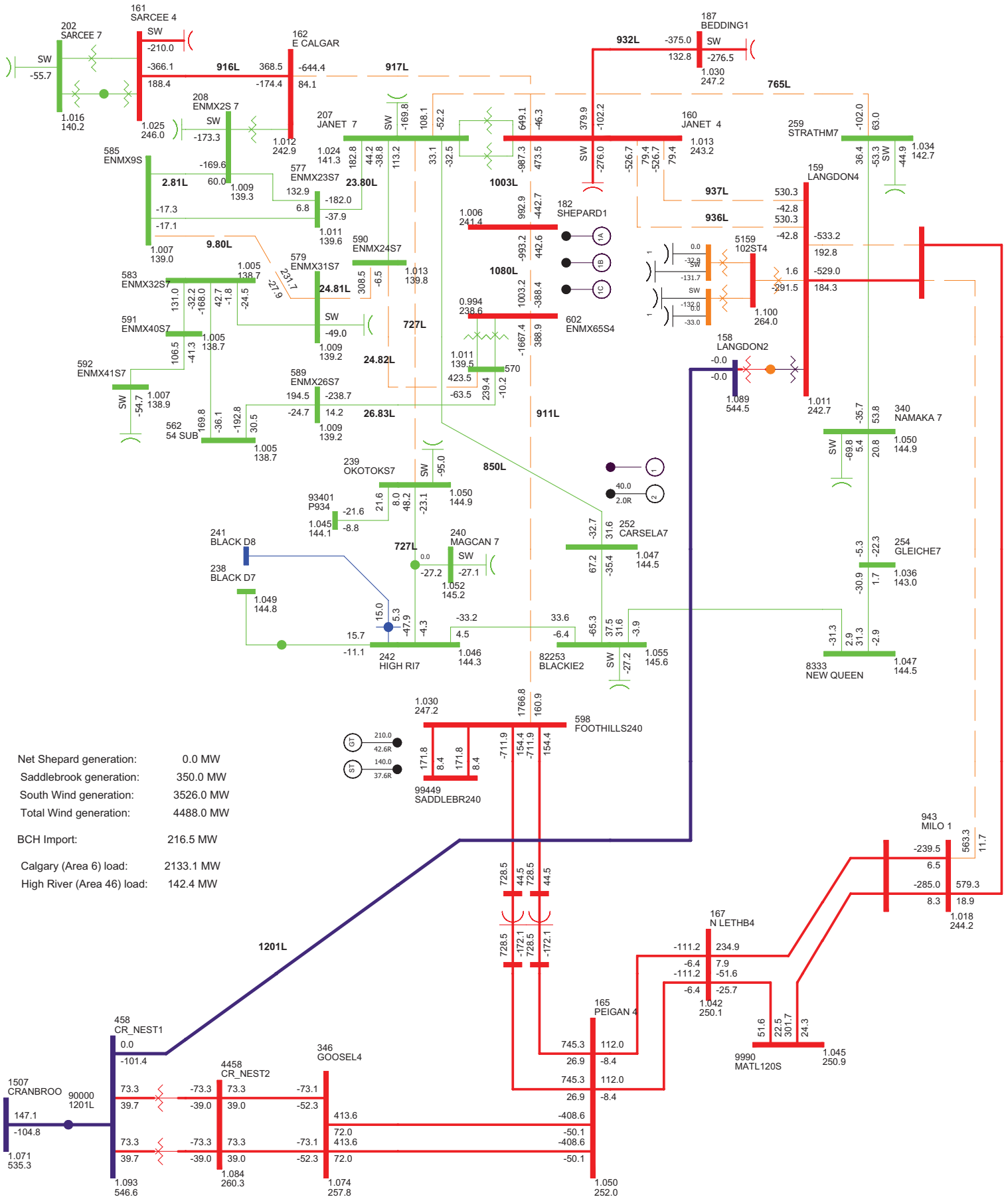


Figure B-2019-NEED-Sc3-10

240/138 KV TRANSFORMER (EAST CALGARY 5S)

WED, APR 20 2011 17:30

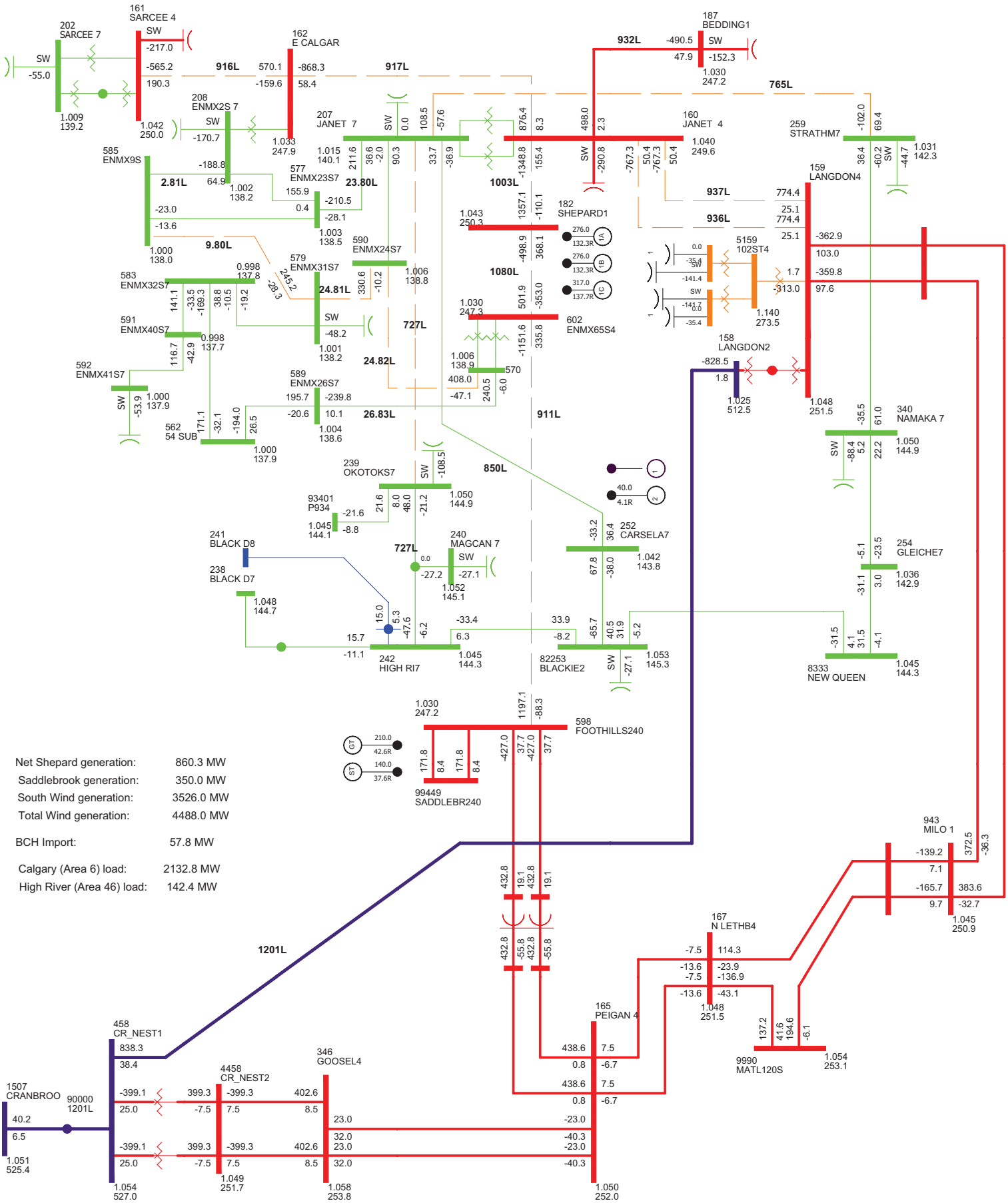


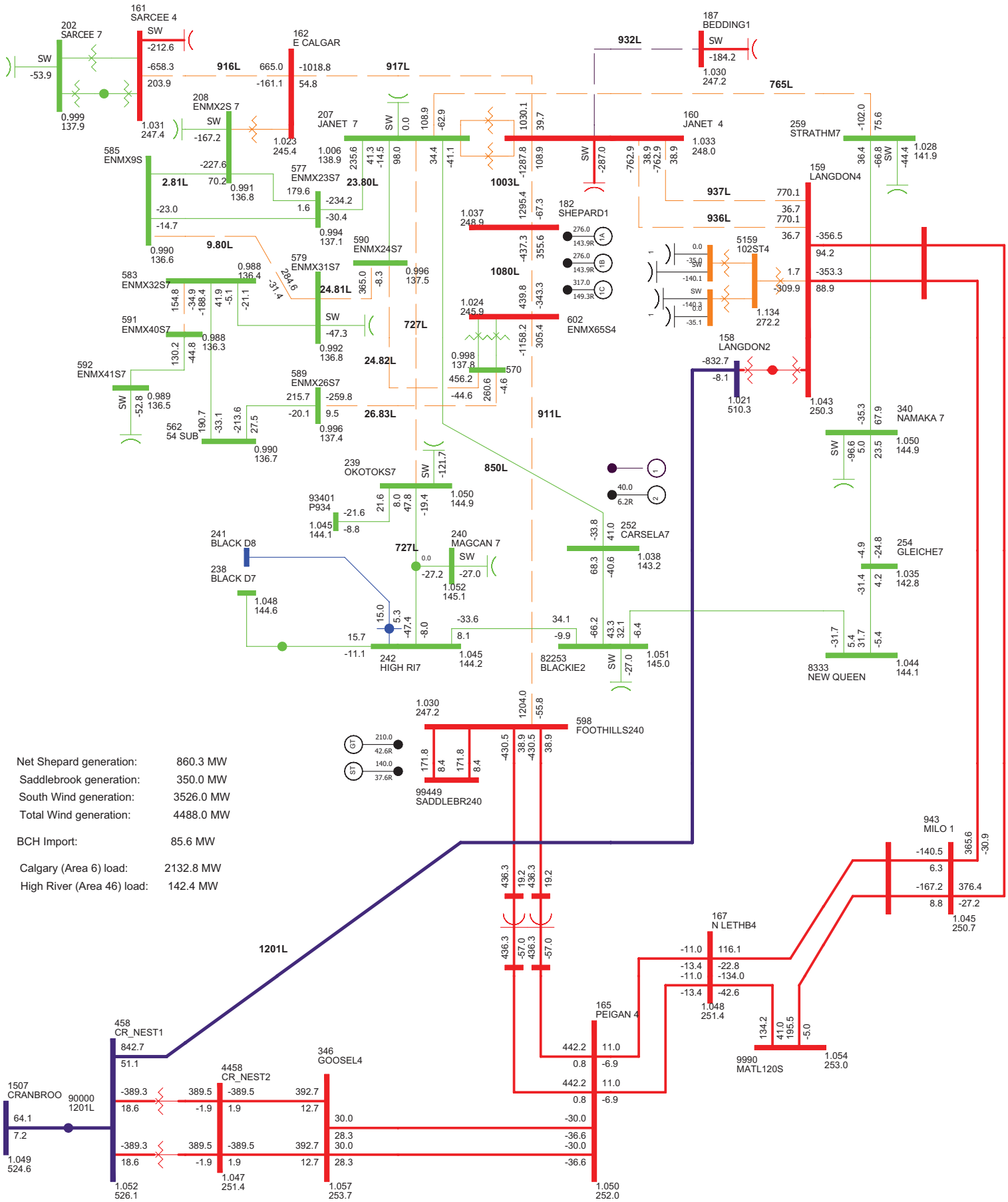
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc3-11

500/240 KV TRANSFORMER (LANGDON 102S)

WED, APR 20 2011 17:31


Net Shepard generation: 860.3 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 3526.0 MW
Total Wind generation: 4488.0 MW
BCH Import: 57.8 MW
Calgary (Area 6) load: 2132.8 MW
High River (Area 46) load: 142.4 MW
916L
917L
932L
765L
1003L
937L
936L
1080L
727L
911L
850L
1201L
23.80L
24.81L
24.82L
26.83L
2.81L
9.80L
202 SARCEE 7
161 SARCEE 4
162 E CALGAR
208 ENMX2S 7
207 JANET 7
160 JANET 4
187 BEDDING1
259 STRATHM7
159 LANGDON4
158 LANGDON2
585 ENMX9S
577 ENMX23S7
579 ENMX31S7
583 ENMX32S7
591 ENMX40S7
592 ENMX41S7
562 54 SUB
589 ENMX26S7
590 ENMX24S7
182 SHEPARD1
602 ENMX65S4
5159 102ST4
239 OKOTOKS7
93401 P934
241 BLACK D8
238 BLACK D7
240 MAGCAN 7
252 CARSELA7
254 GLEICHE7
340 NAMAKA 7
242 HIGH RI7
82253 BLACKIE2
8333 NEW QUEEN
598 FOOTHILLS240
99449 SADDLEBR240
943 MILO 1
167 N LETHB4
165 PEIGAN 4
9990 MATL120S
458 CR_NEST1
4458 CR_NEST2
346 GOOSEL4
1507 CRANBROO
90000 1201L
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure B-2019-NEED-Sc4-1
BASE CASE (ALL ELEMENTS IN SERVICE)
WED, APR 20 2011 17:31

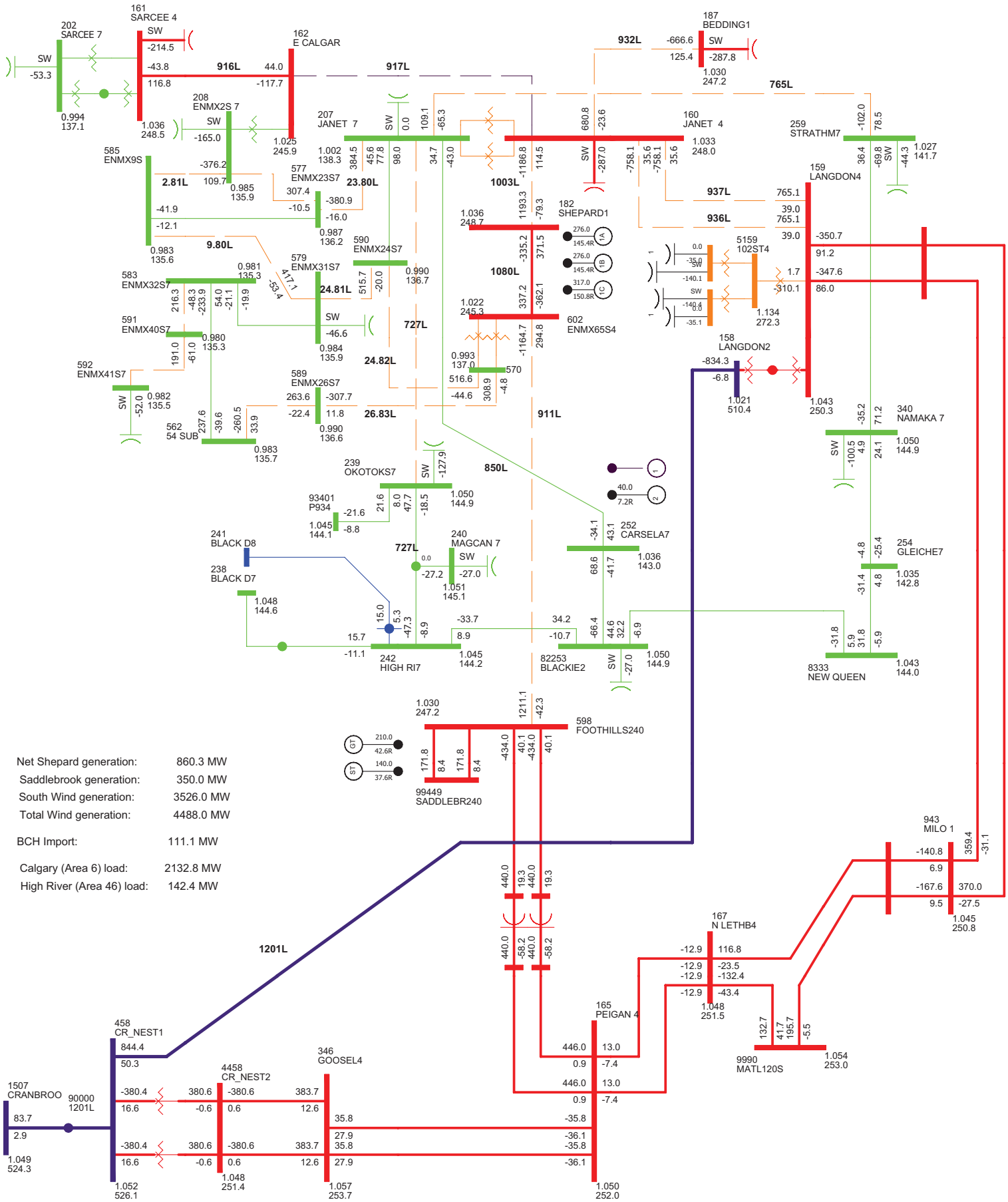


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc4-2

932L (JANET 74S TO BEDDINGTON NO. 162)

WED, APR 20 2011 17:32

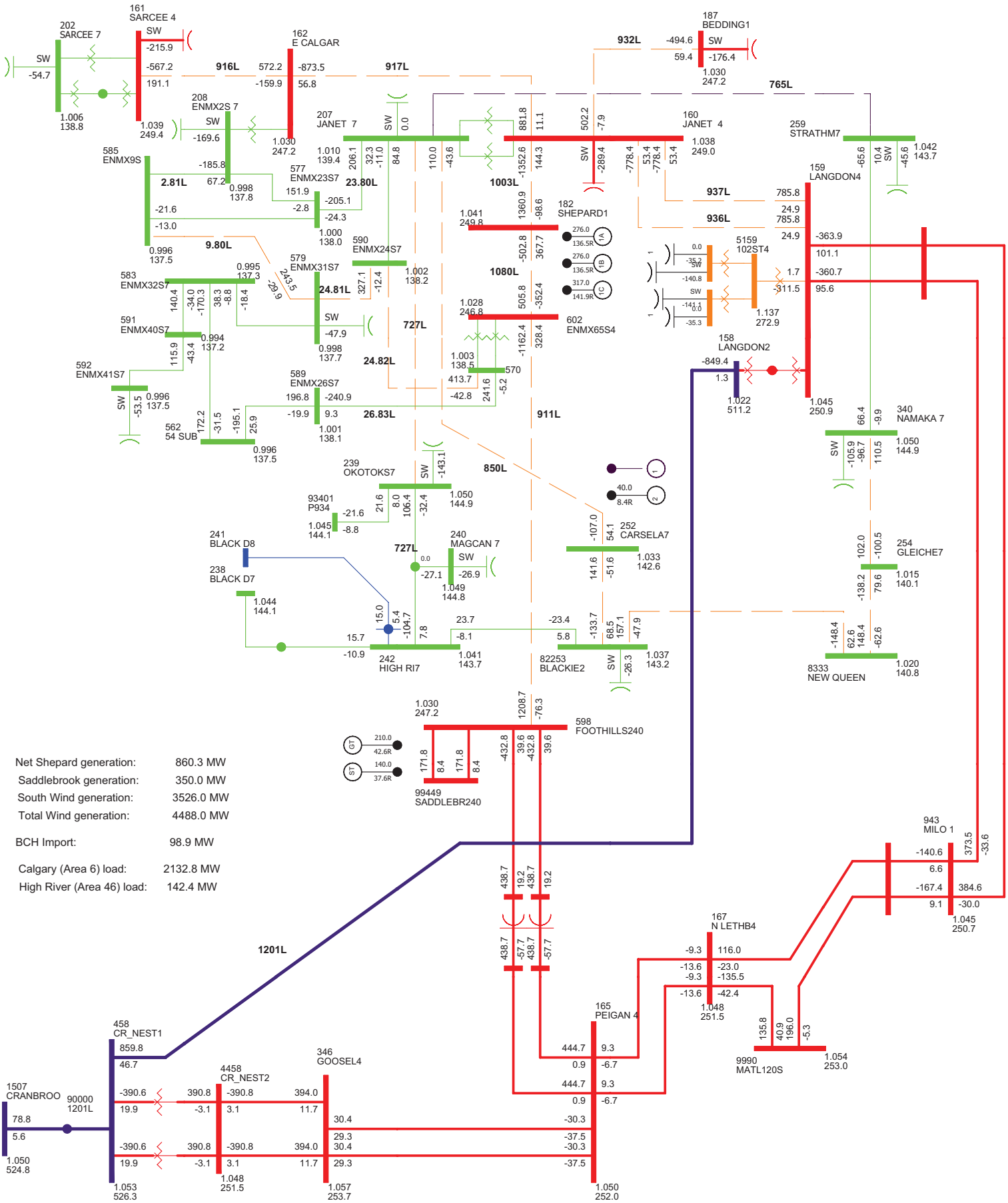


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc4-3

917L (JANET 74S TO EAST CALGARY 5S)

WED, APR 20 2011 17:32

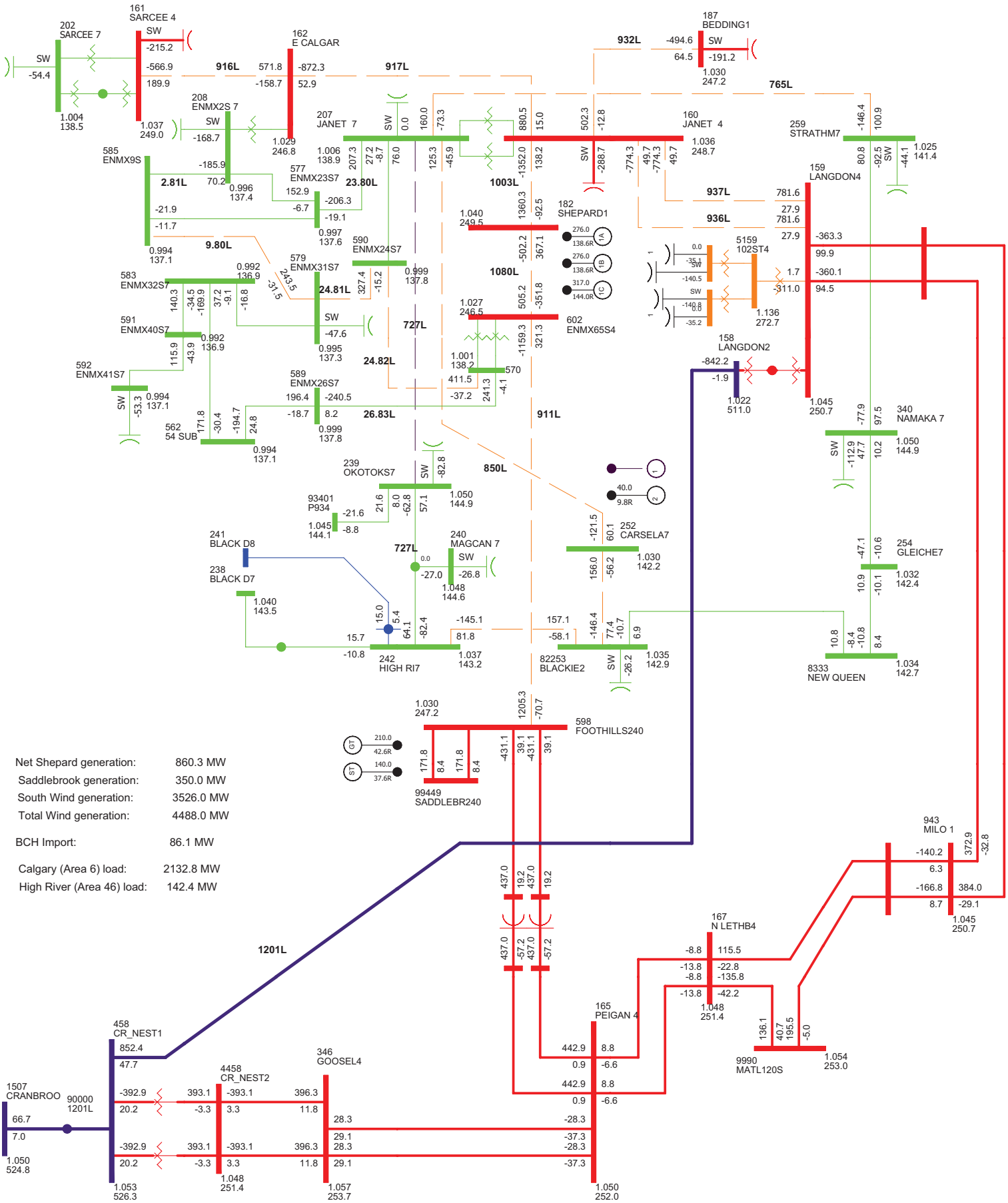


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc4-4

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 17:32



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc4-5

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:32

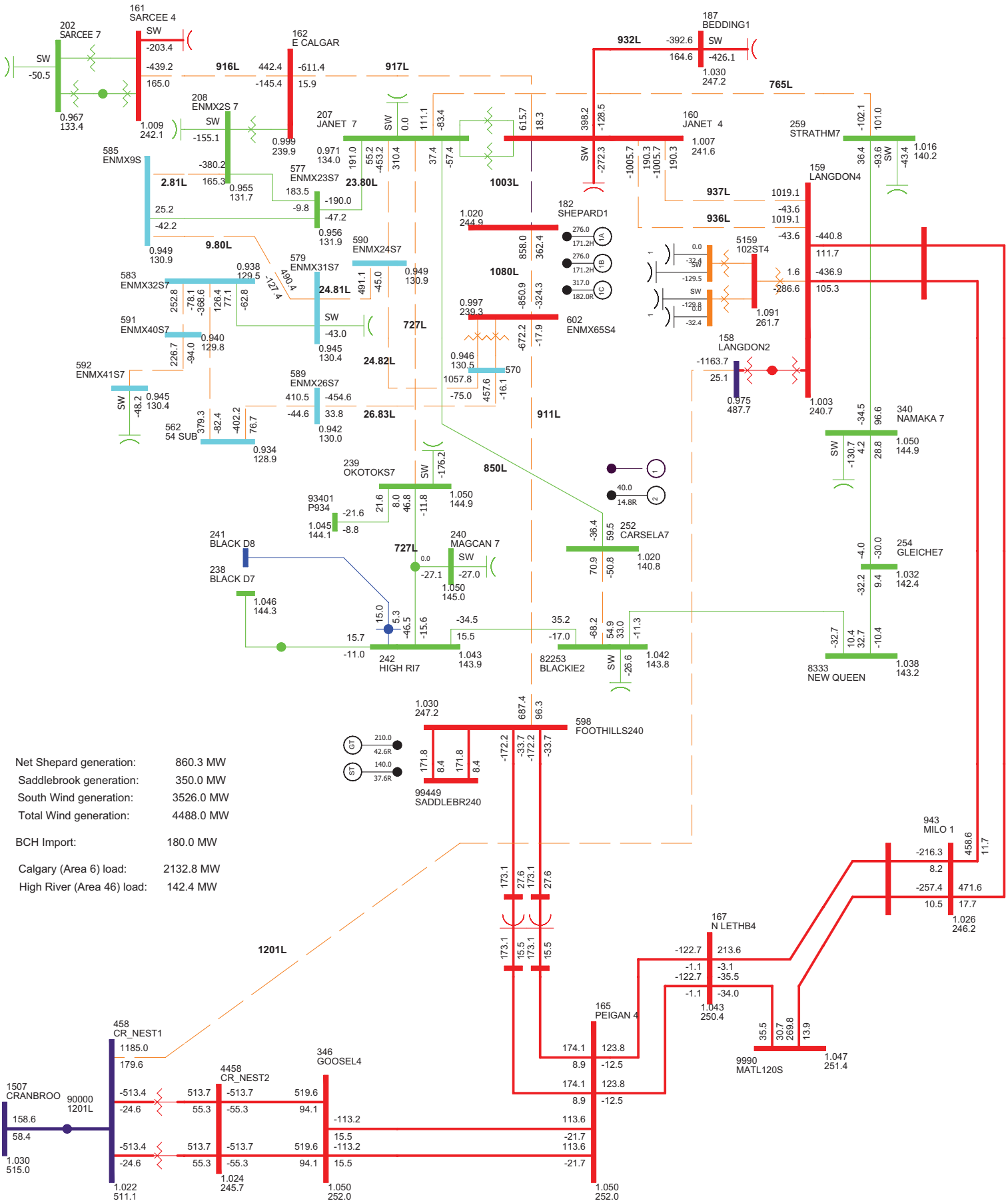
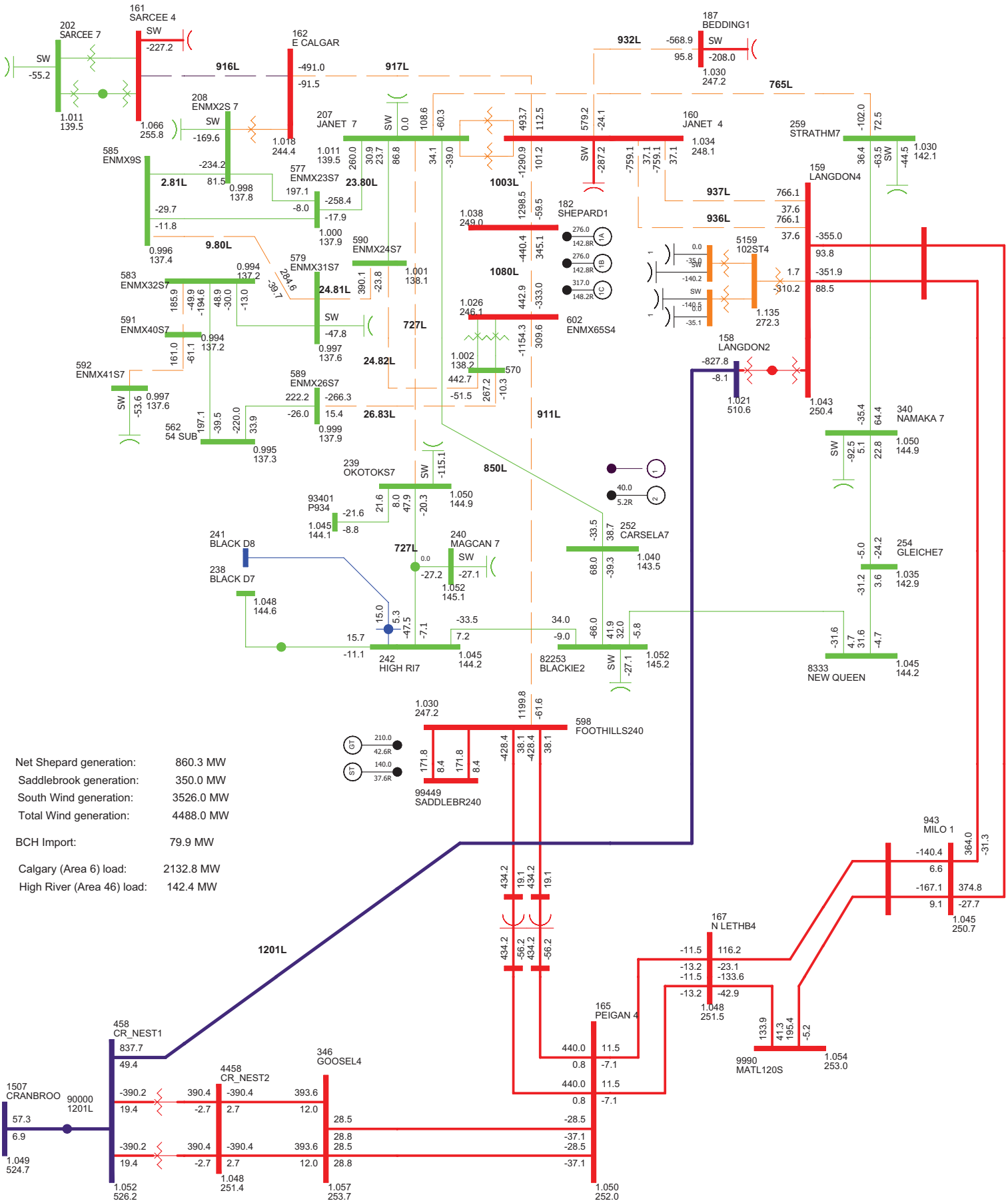


Figure B-2019-NEED-Sc4-6

1003L (JANET 74S TO ENMAX NO. 25)

WED, APR 20 2011 17:32



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc4-7

916L (SARCEE 42S TO EAST CALGARY 5S)

WED, APR 20 2011 17:32

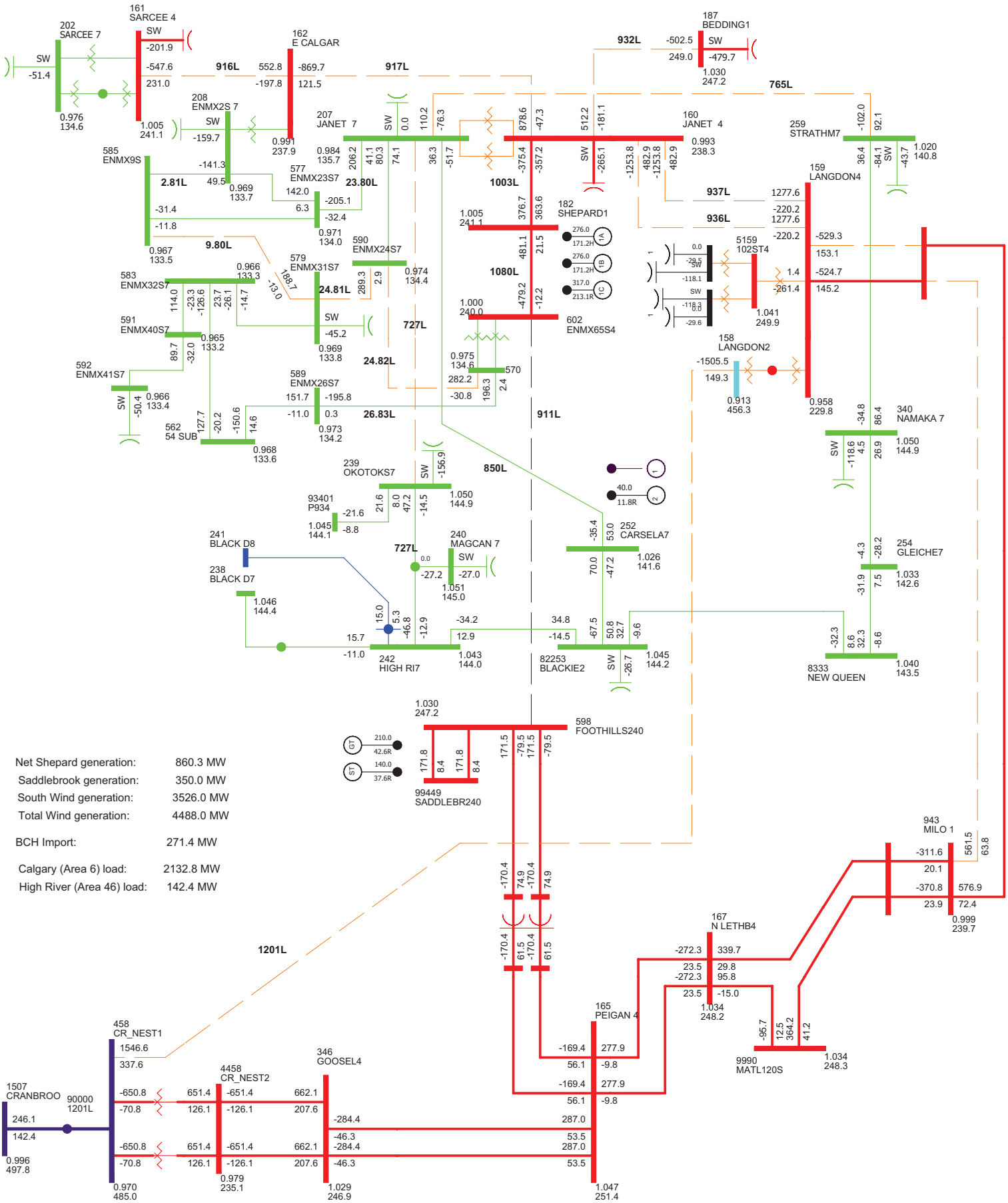
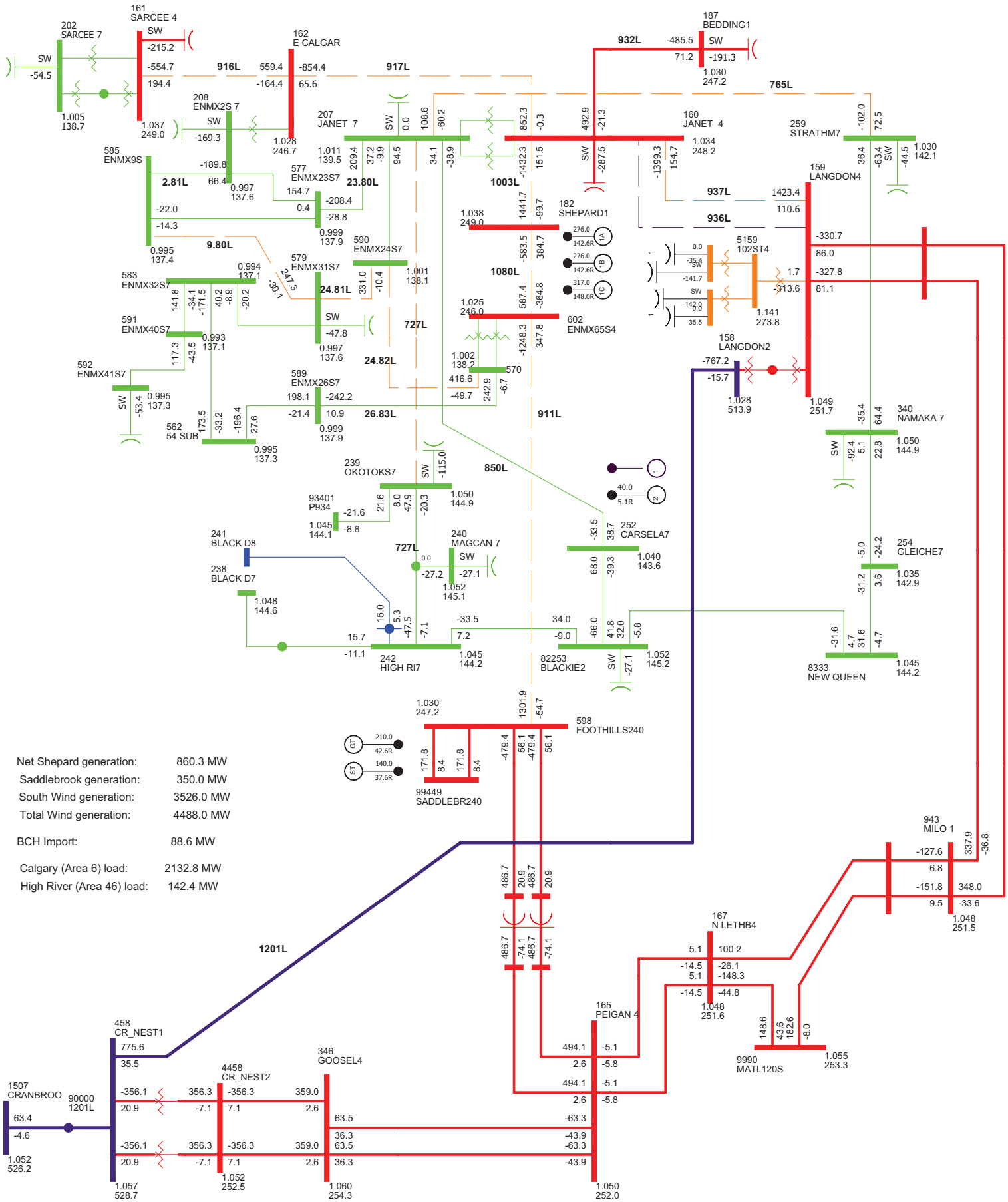


Figure B-2019-NEED-Sc4-8

911L (FOOTHILLS 237S TO ENMAX NO. 65)

WED, APR 20 2011 17:32

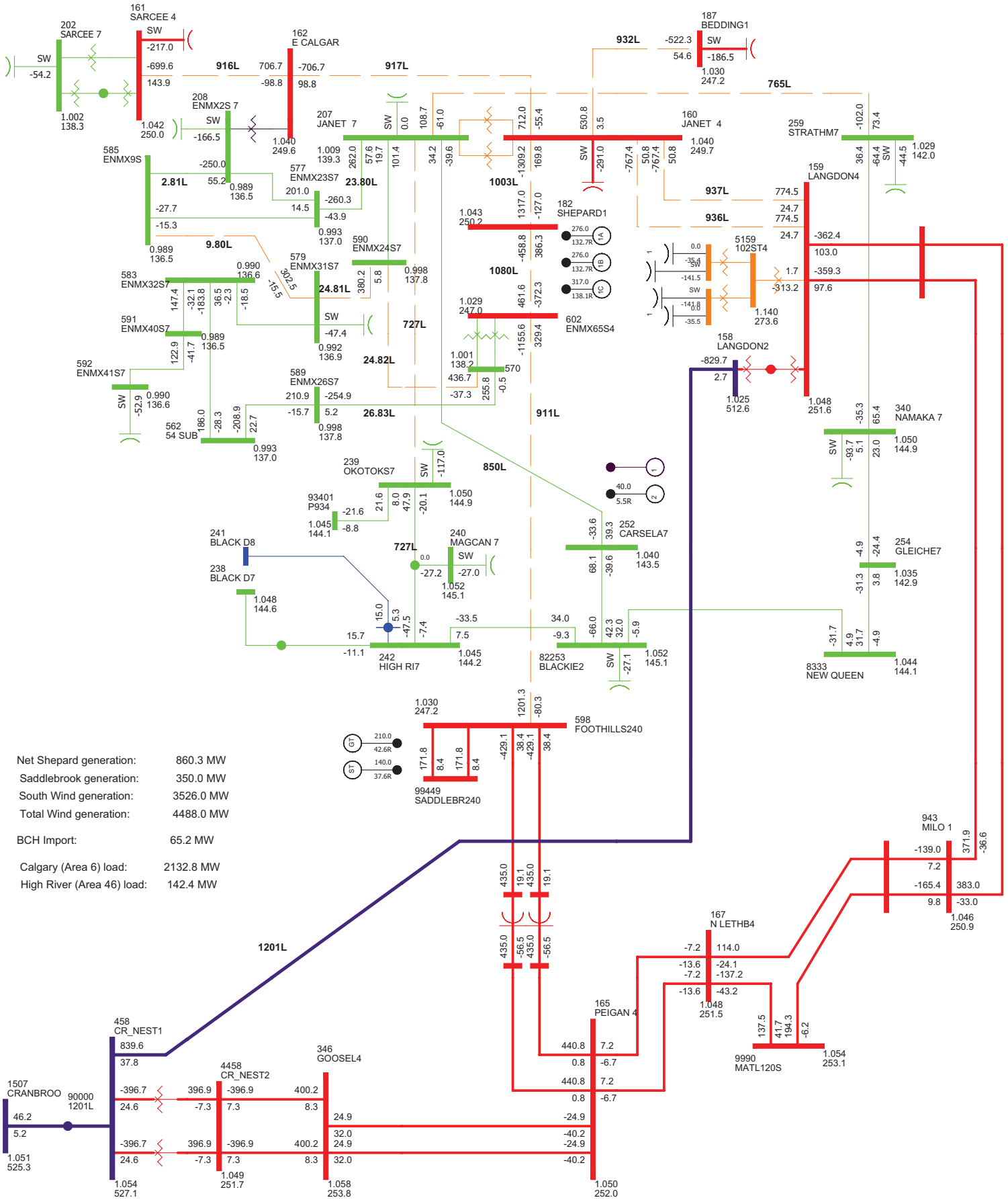


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc4-9

936L (LANGDON 102S TO JANET 74S)

WED, APR 20 2011 17:32

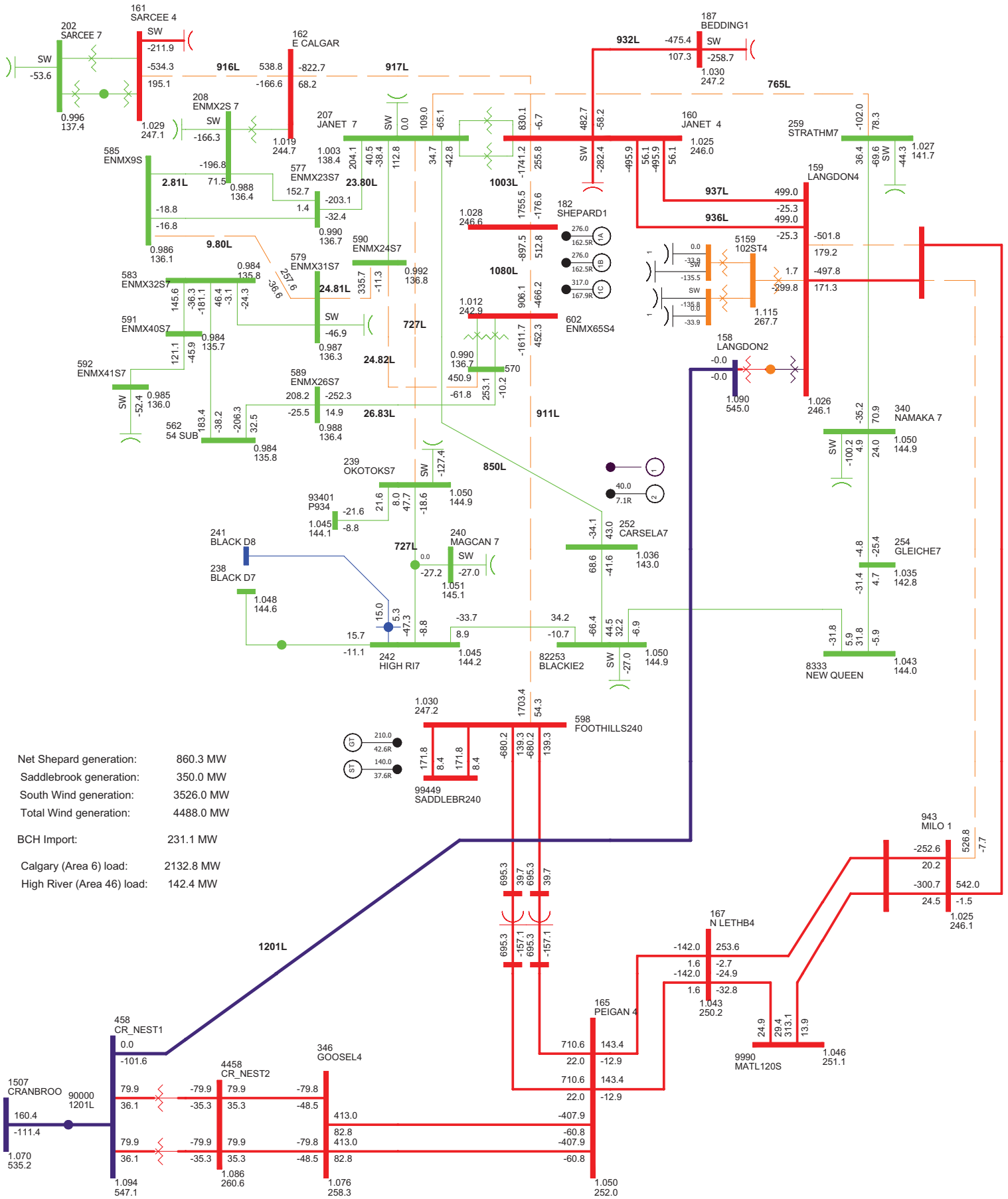


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc4-10

240/138 KV TRANSFORMER (EAST CALGARY 5S)

WED, APR 20 2011 17:33

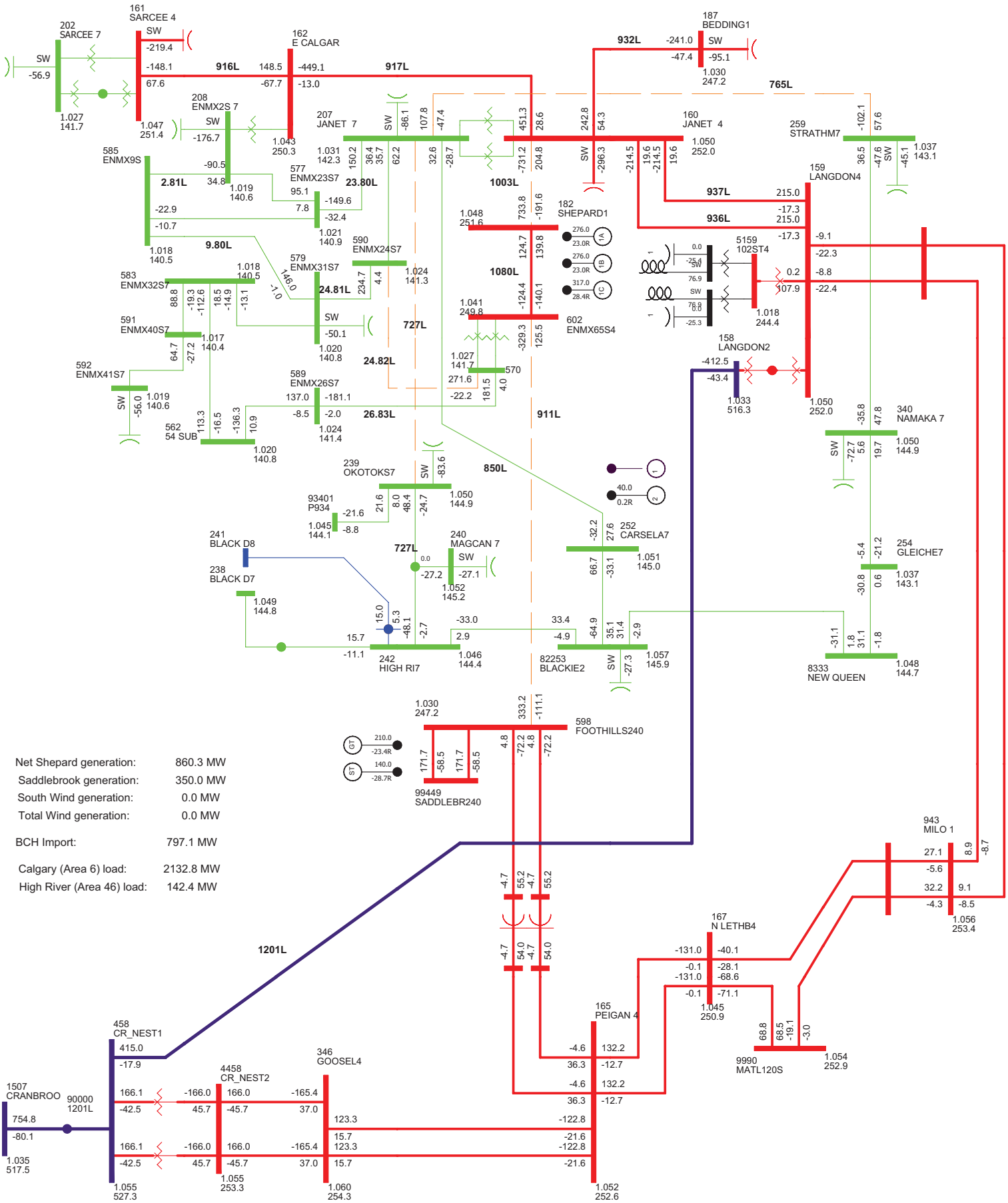


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc4-11

500/240 KV TRANSFORMER (LANGDON 102S)

WED, APR 20 2011 17:33

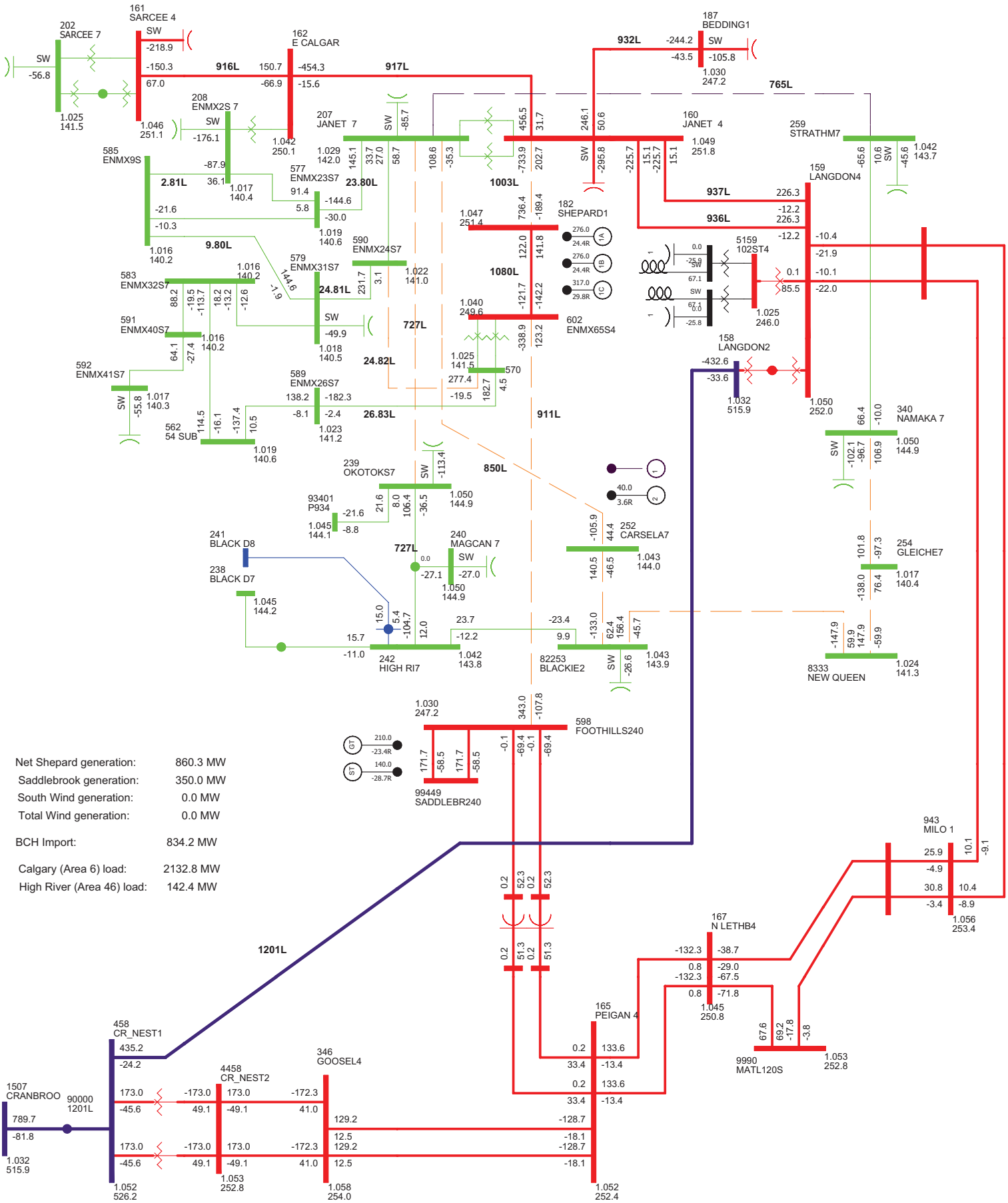


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc5-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:35

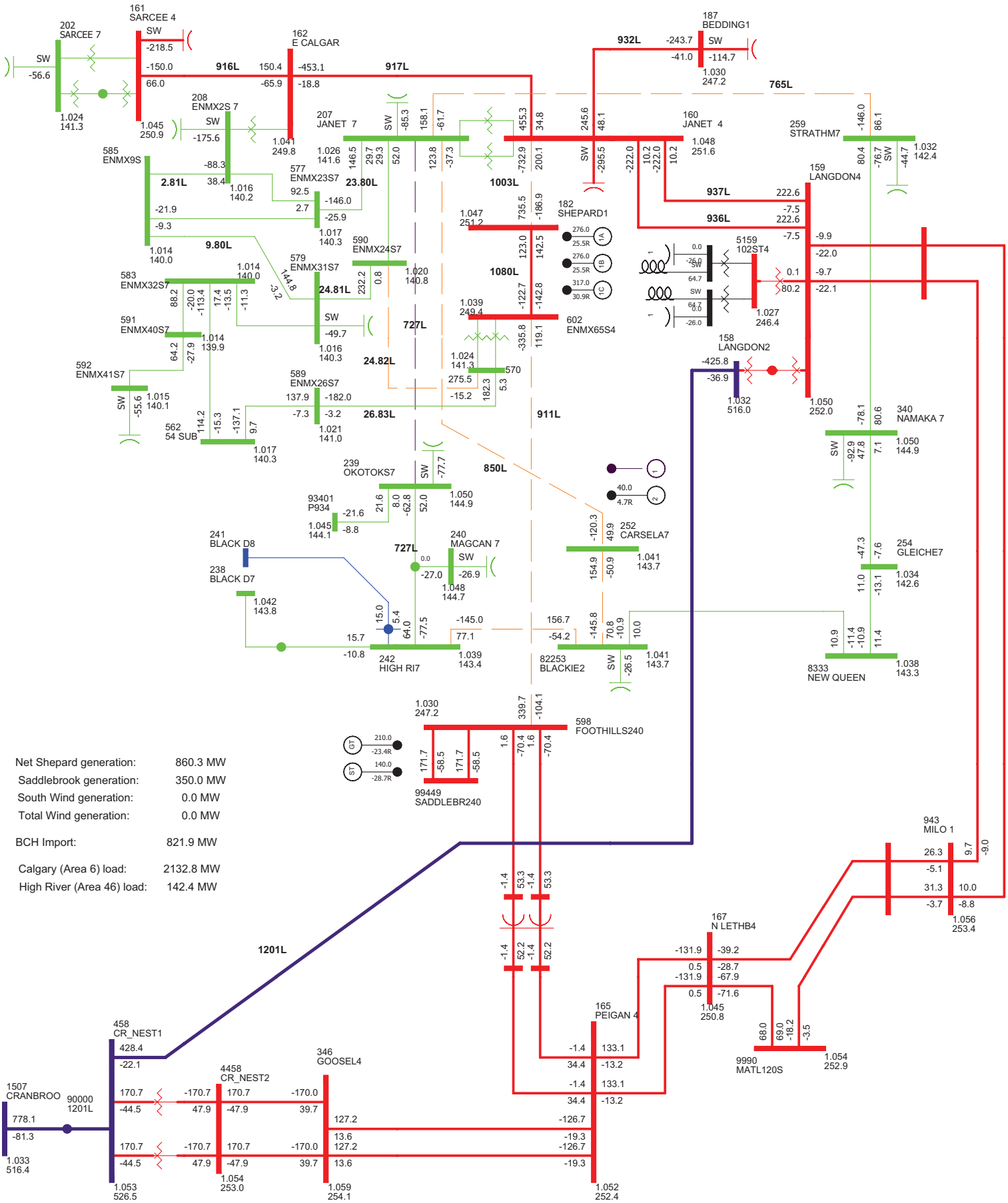


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc5-2

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 17:35

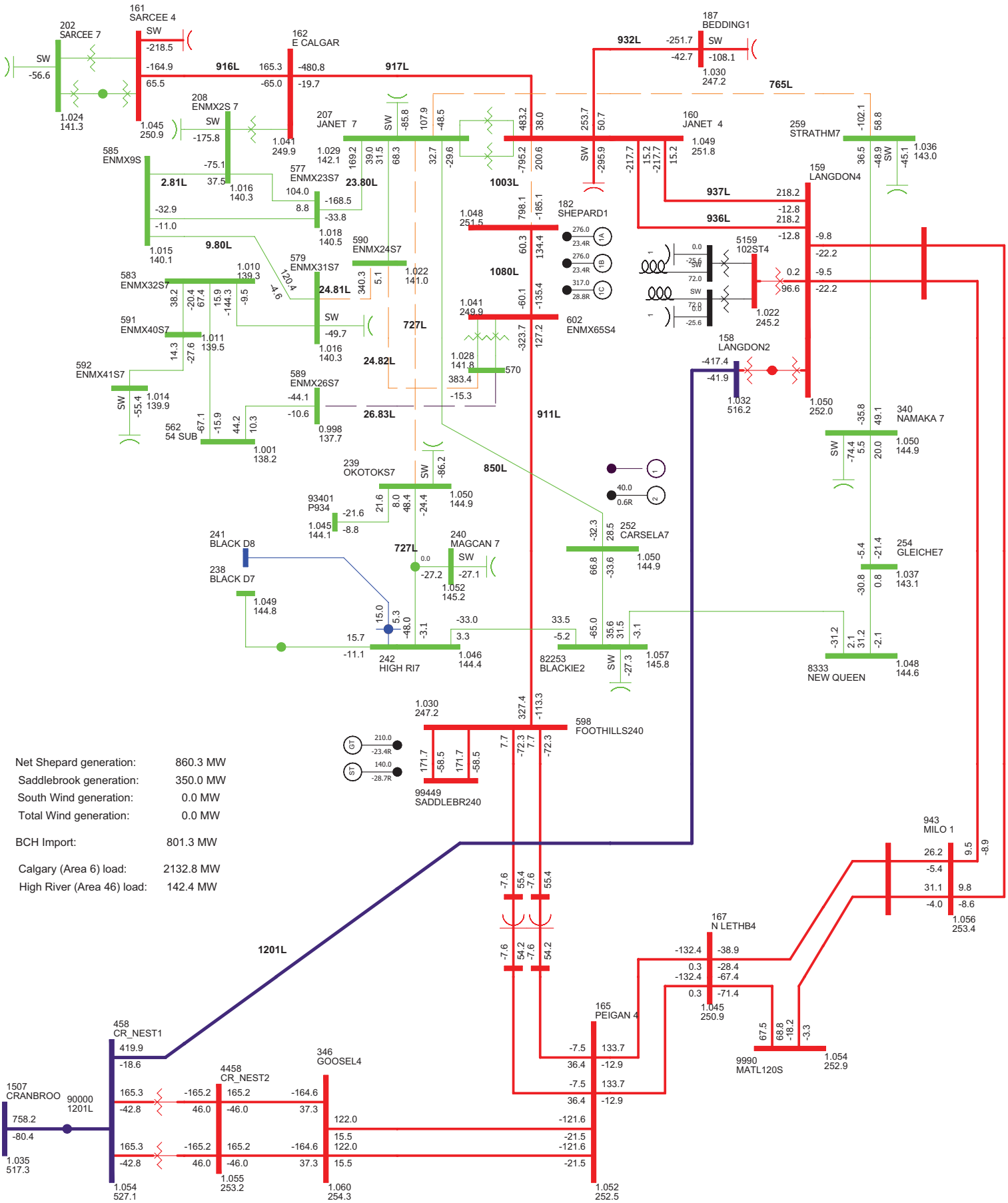


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc5-3

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:35



Net Shepard generation: 860.3 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 0.0 MW
Total Wind generation: 0.0 MW

BCH Import: 801.3 MW

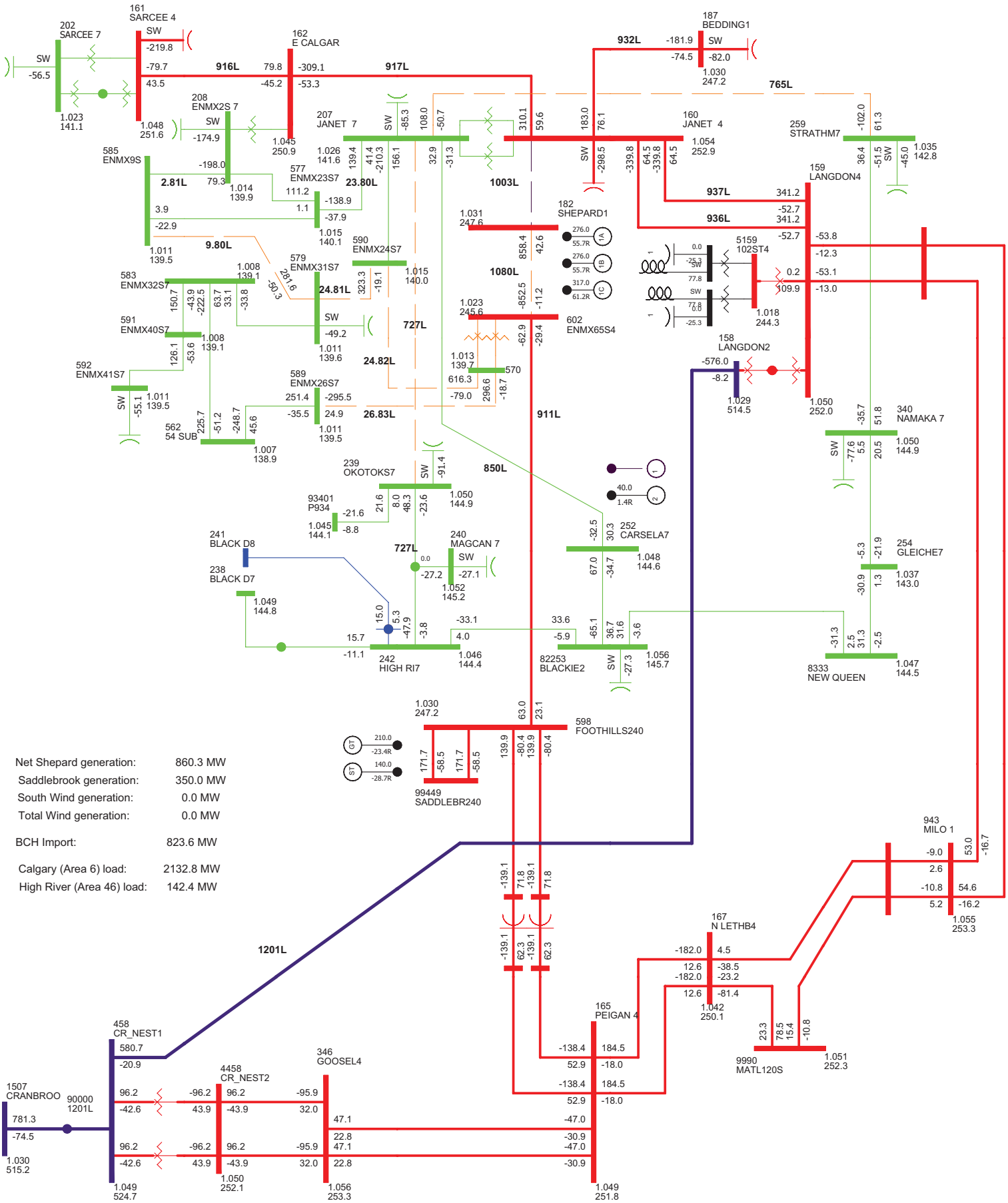
Calgary (Area 6) load: 2132.8 MW
High River (Area 46) load: 142.4 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc5-4

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 20 2011 17:36



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc5-5

1003L (JANET 74S TO ENMAX NO. 25)

WED, APR 20 2011 17:36

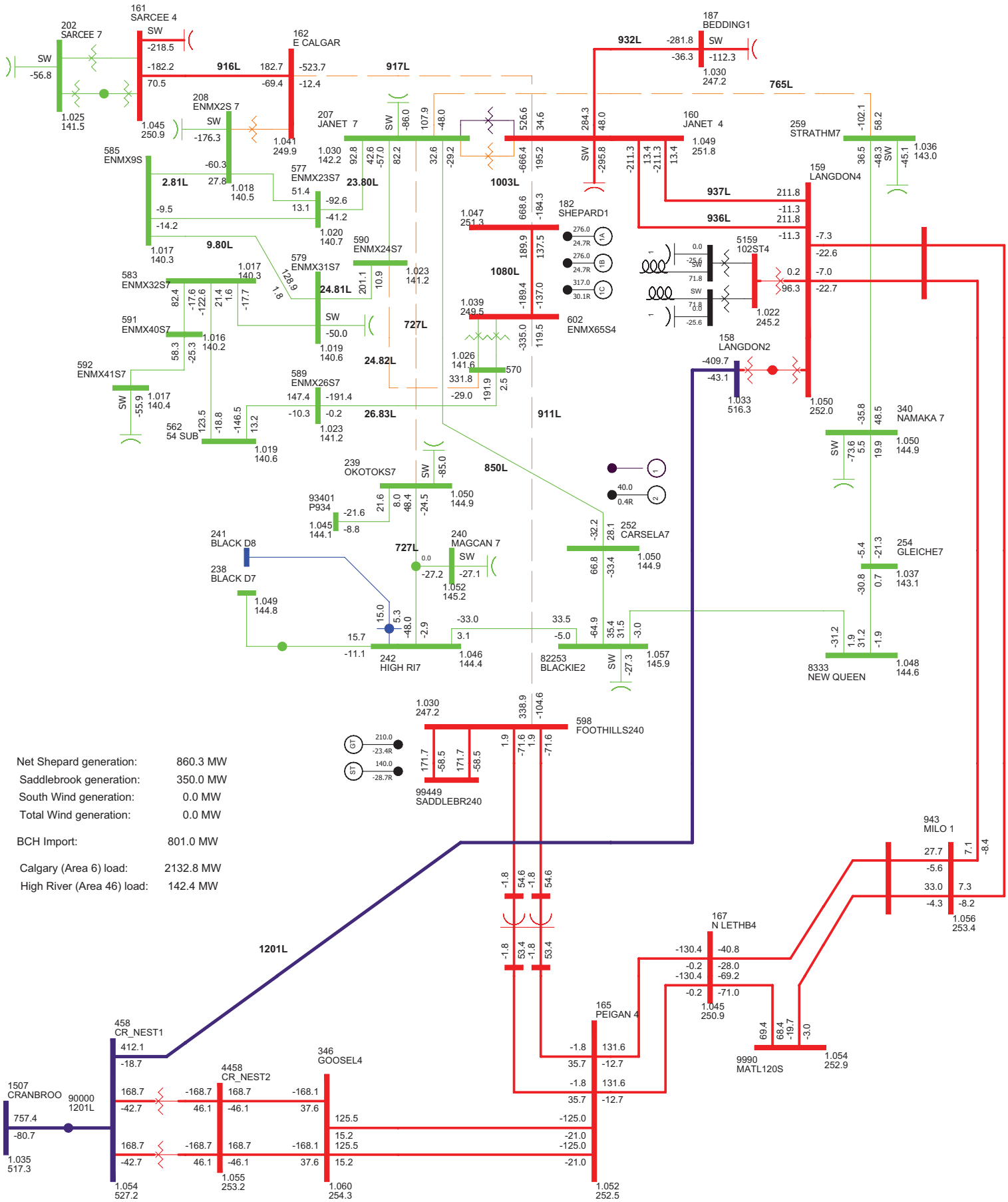
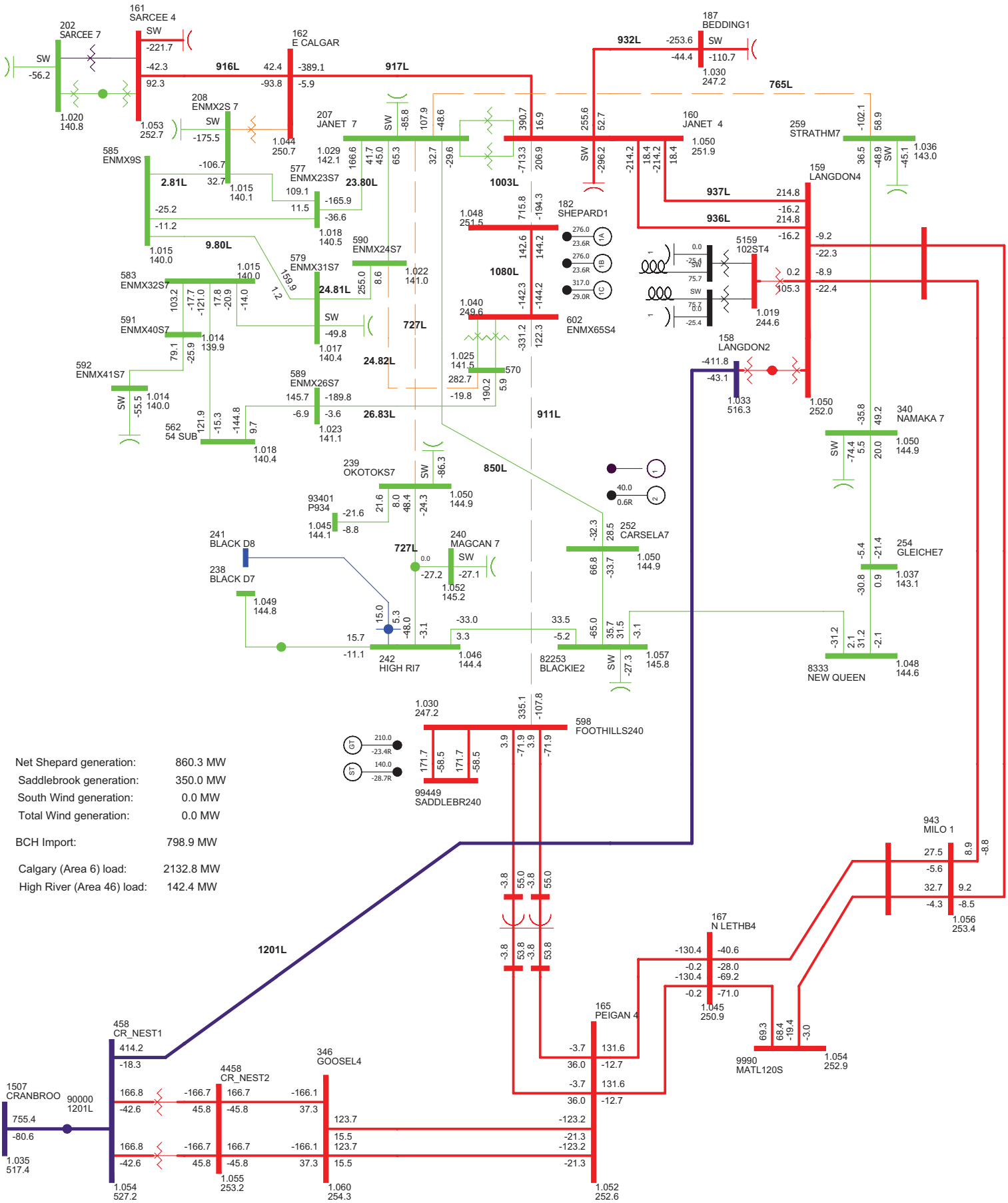


Figure B-2019-NEED-Sc5-6

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 17:36



Net Shepard generation: 860.3 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 0.0 MW
Total Wind generation: 0.0 MW

BCH Import: 798.9 MW

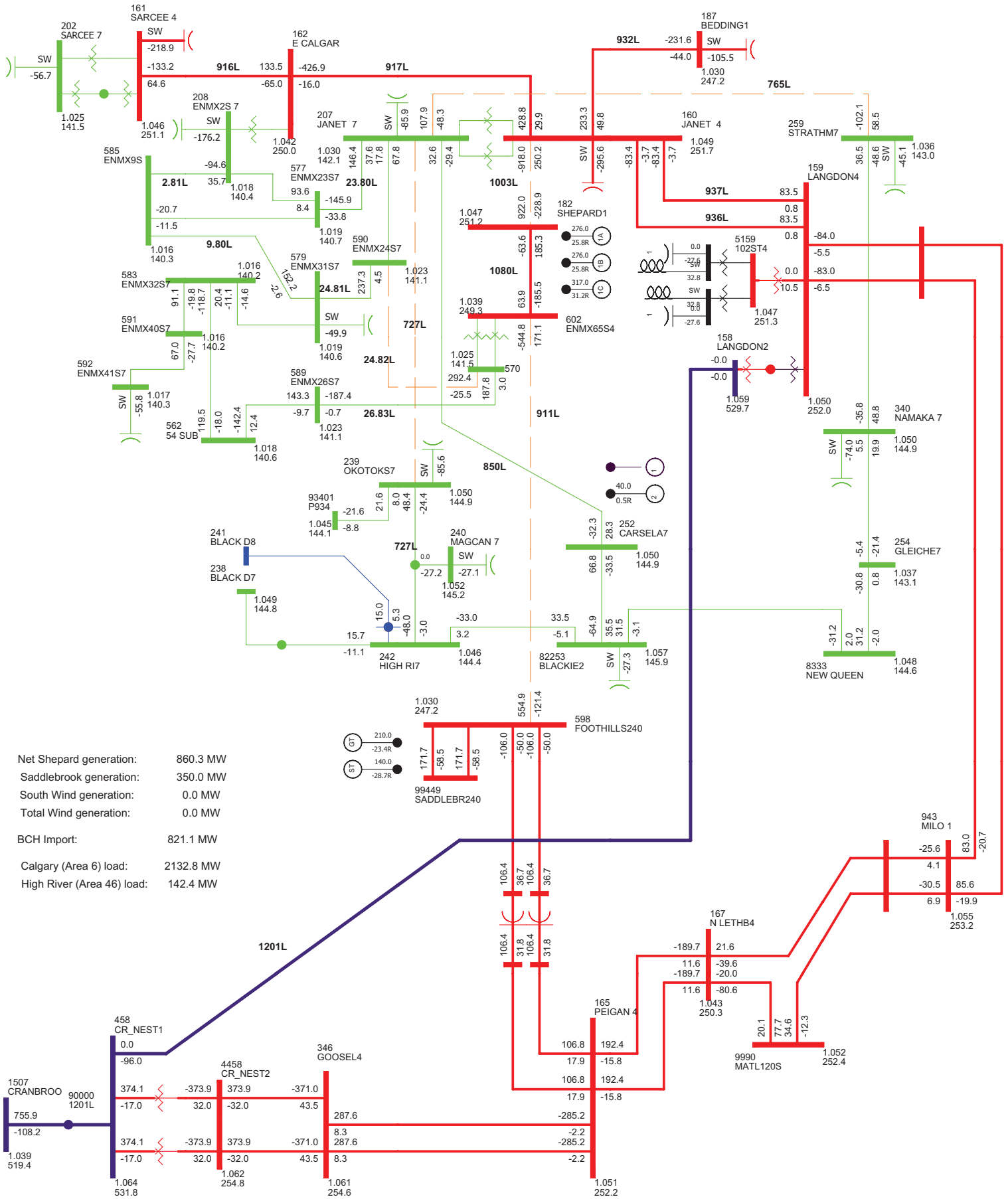
Calgary (Area 6) load: 2132.8 MW
High River (Area 46) load: 142.4 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc5-7

240/138 KV TRANSFORMER (SARCEE 42S)

WED, APR 20 2011 17:36

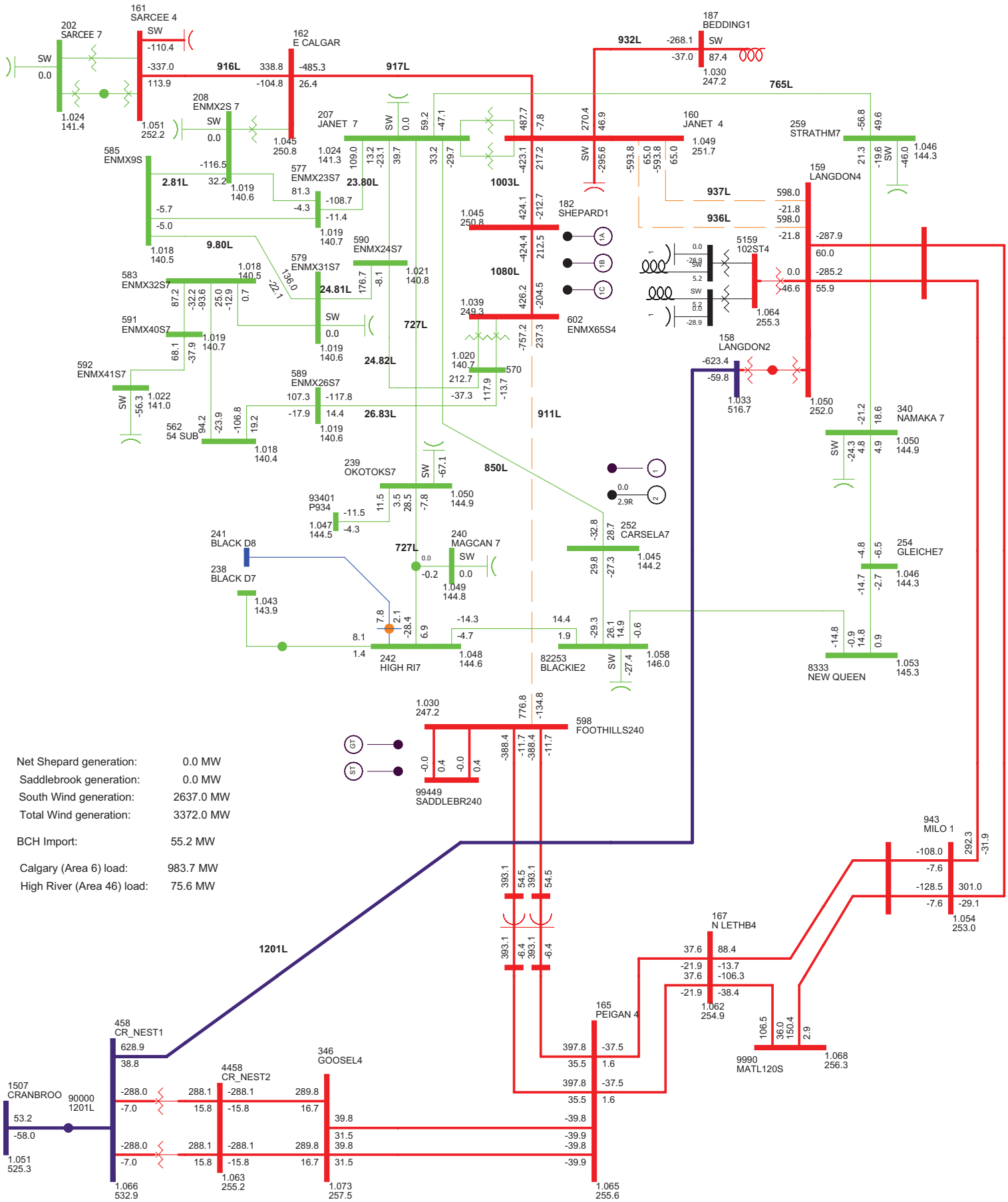


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc5-8

500/240 KV TRANSFORMER (LANGDON 102S)

WED, APR 20 2011 17:37

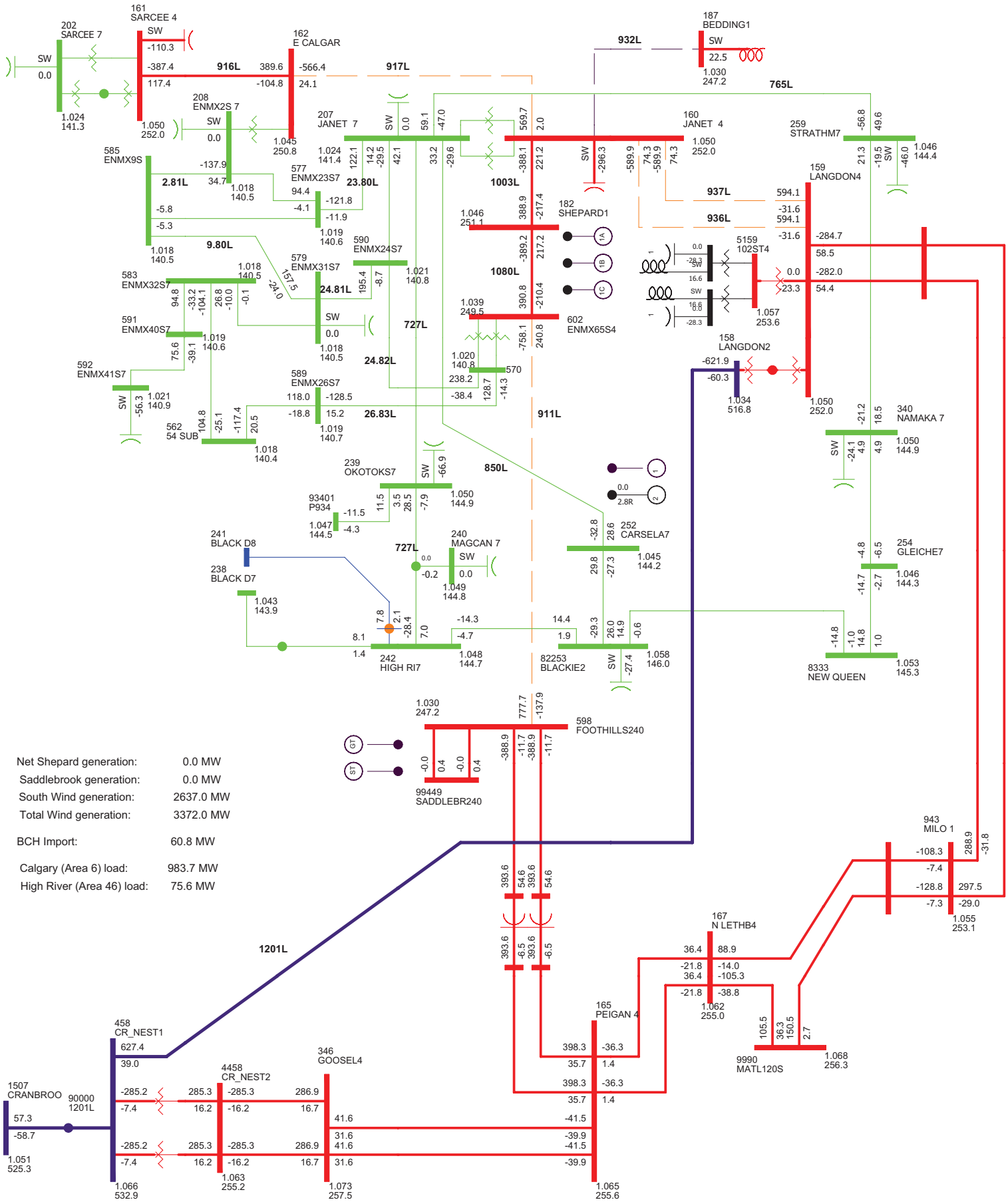


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc6-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 17:37

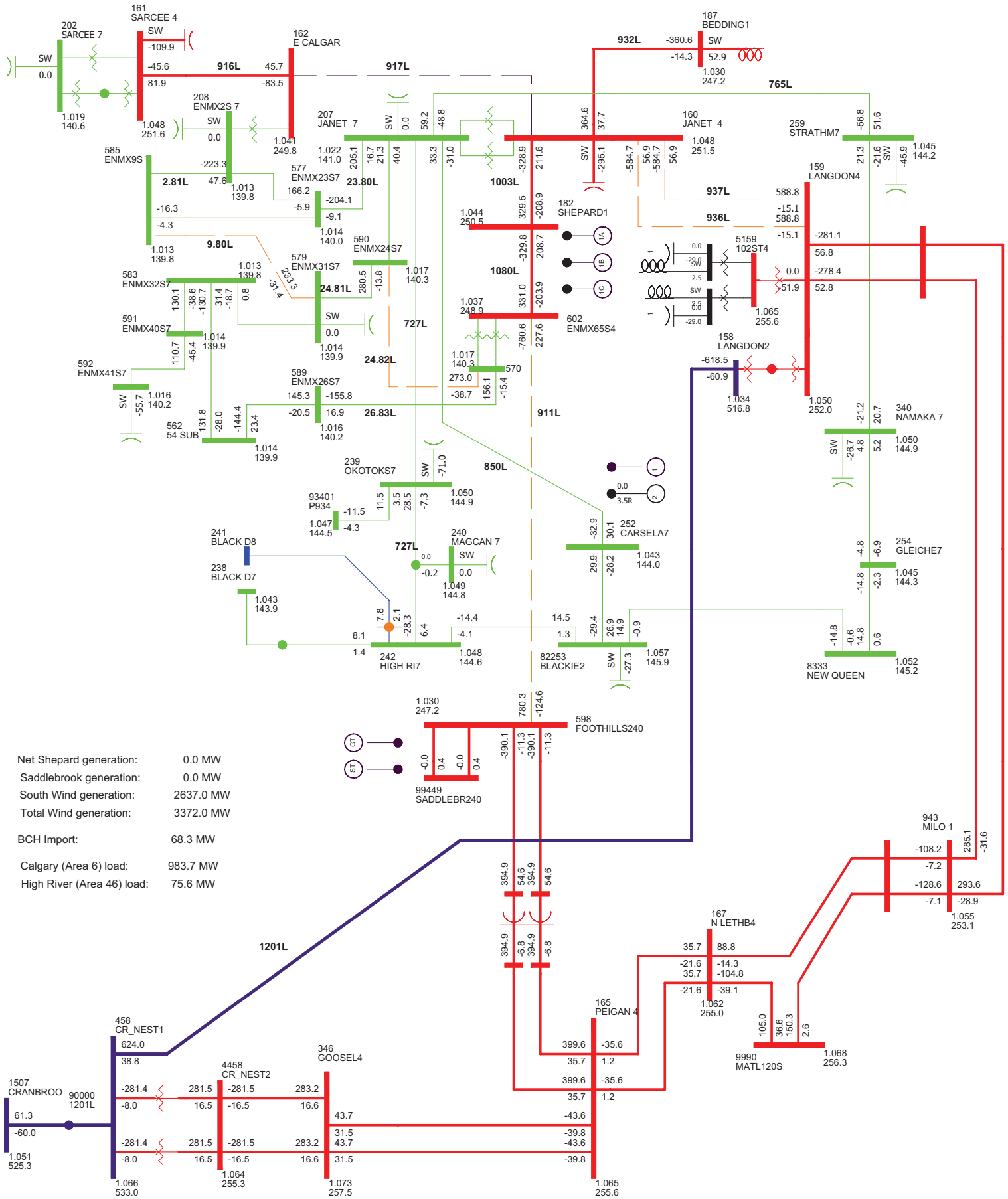


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc6-2

932L (JANET 74S TO BEDDINGTON NO. 162)

WED, APR 20 2011 17:37

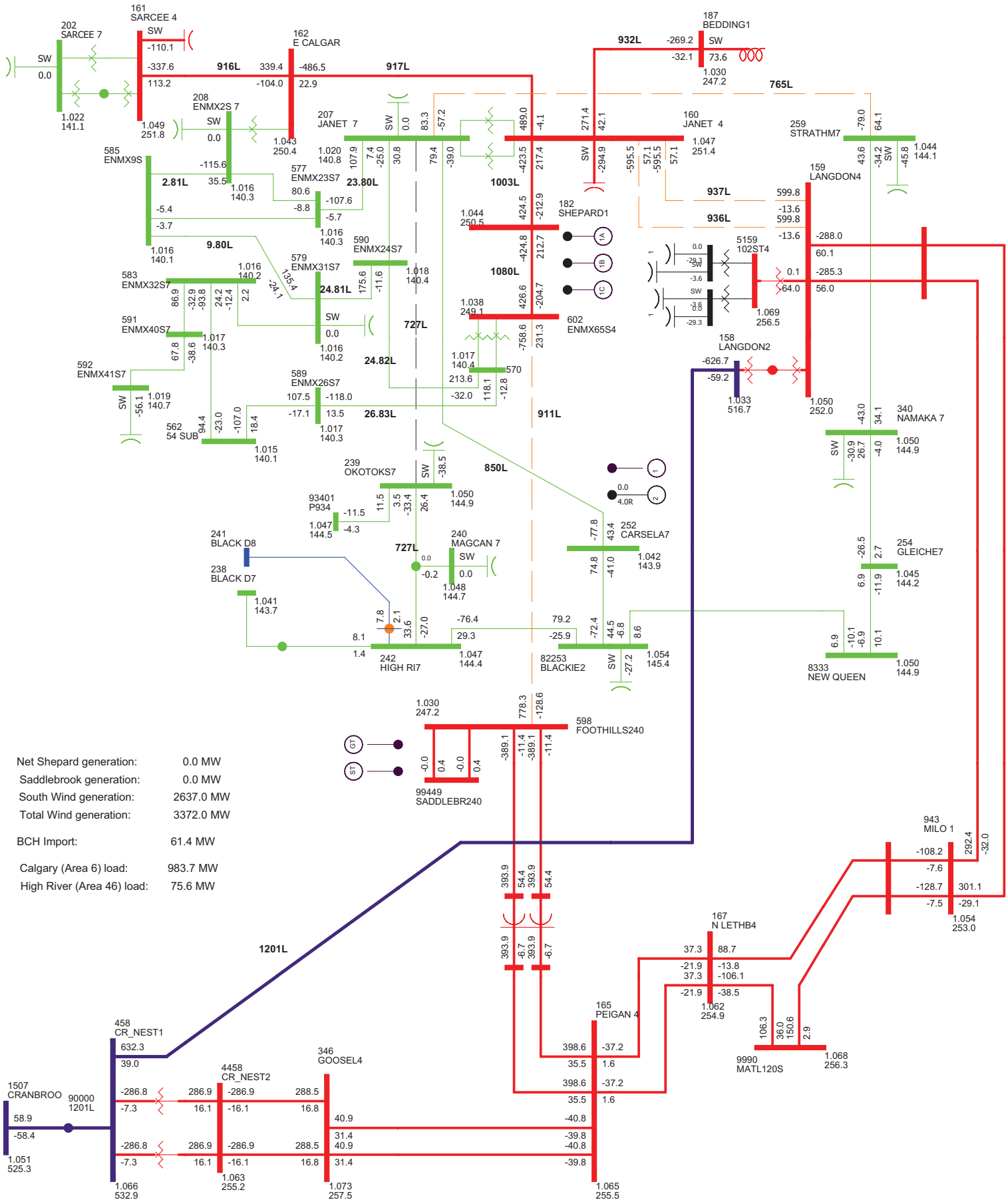


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc6-3

917L (JANET 74S TO EAST CALGARY 5S)

WED, APR 20 2011 17:37

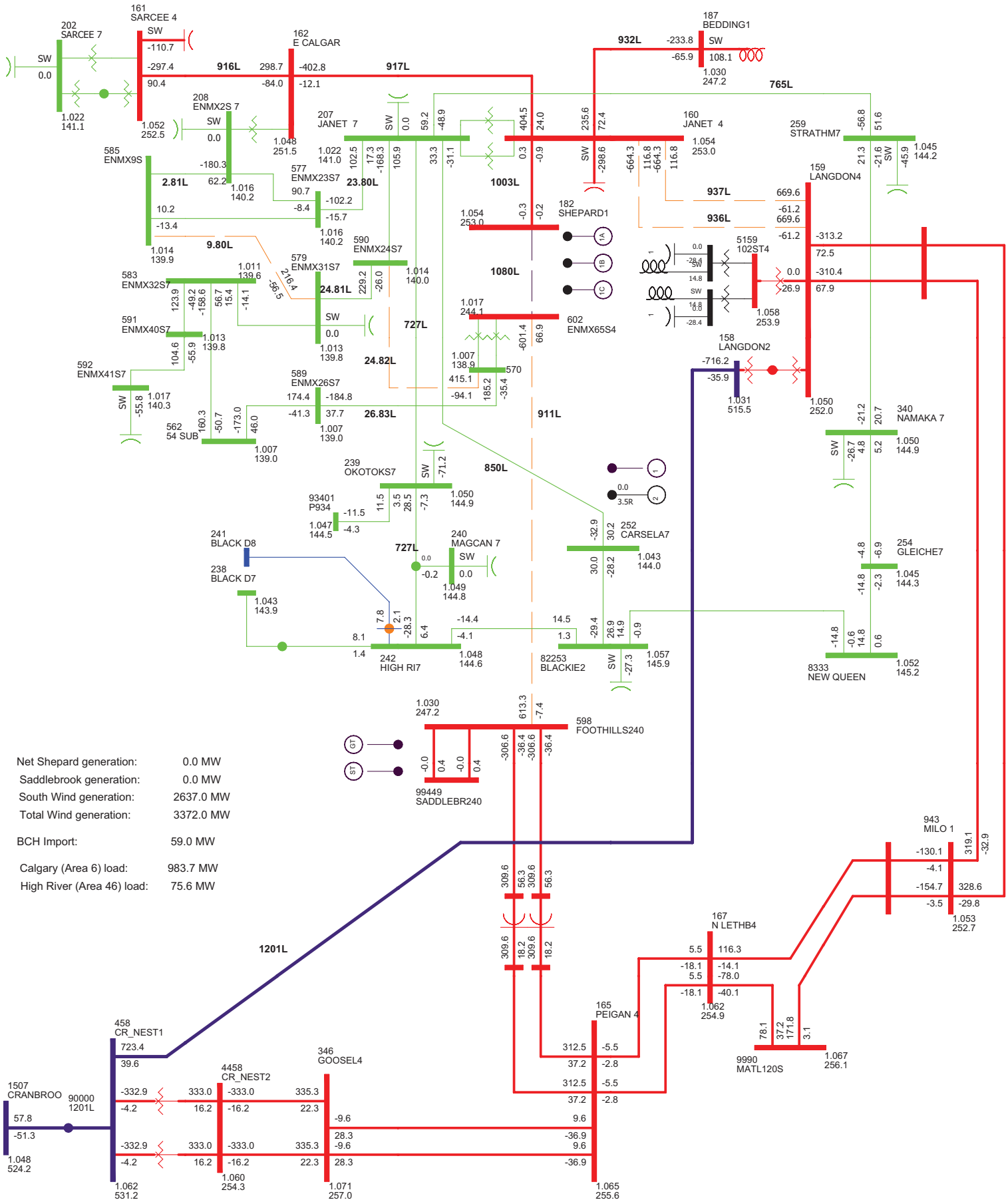


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc6-4

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 17:38

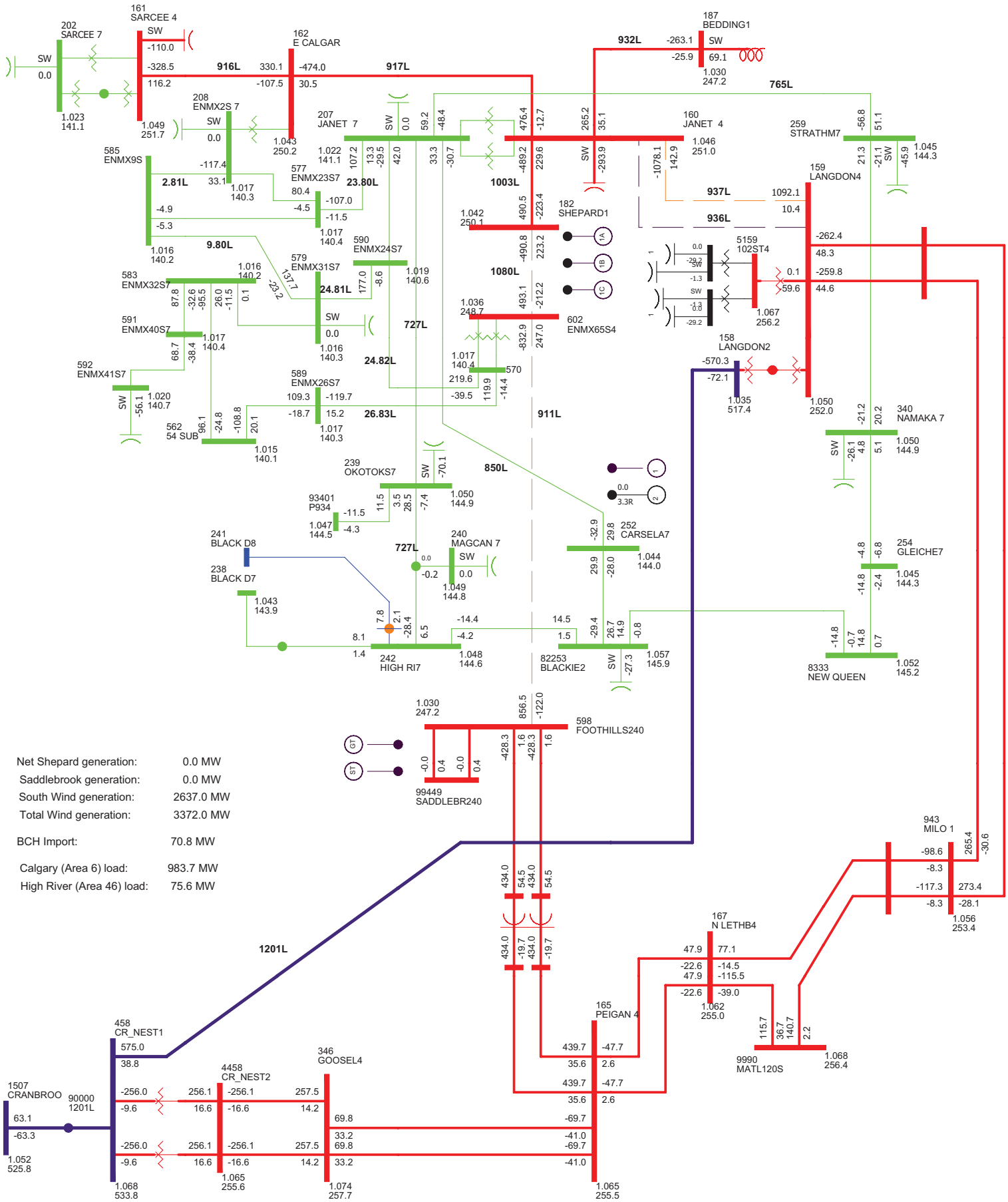


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc6-5

1080L (ENMAX NO. 25 TO ENMAX NO. 65)

WED, APR 20 2011 17:38

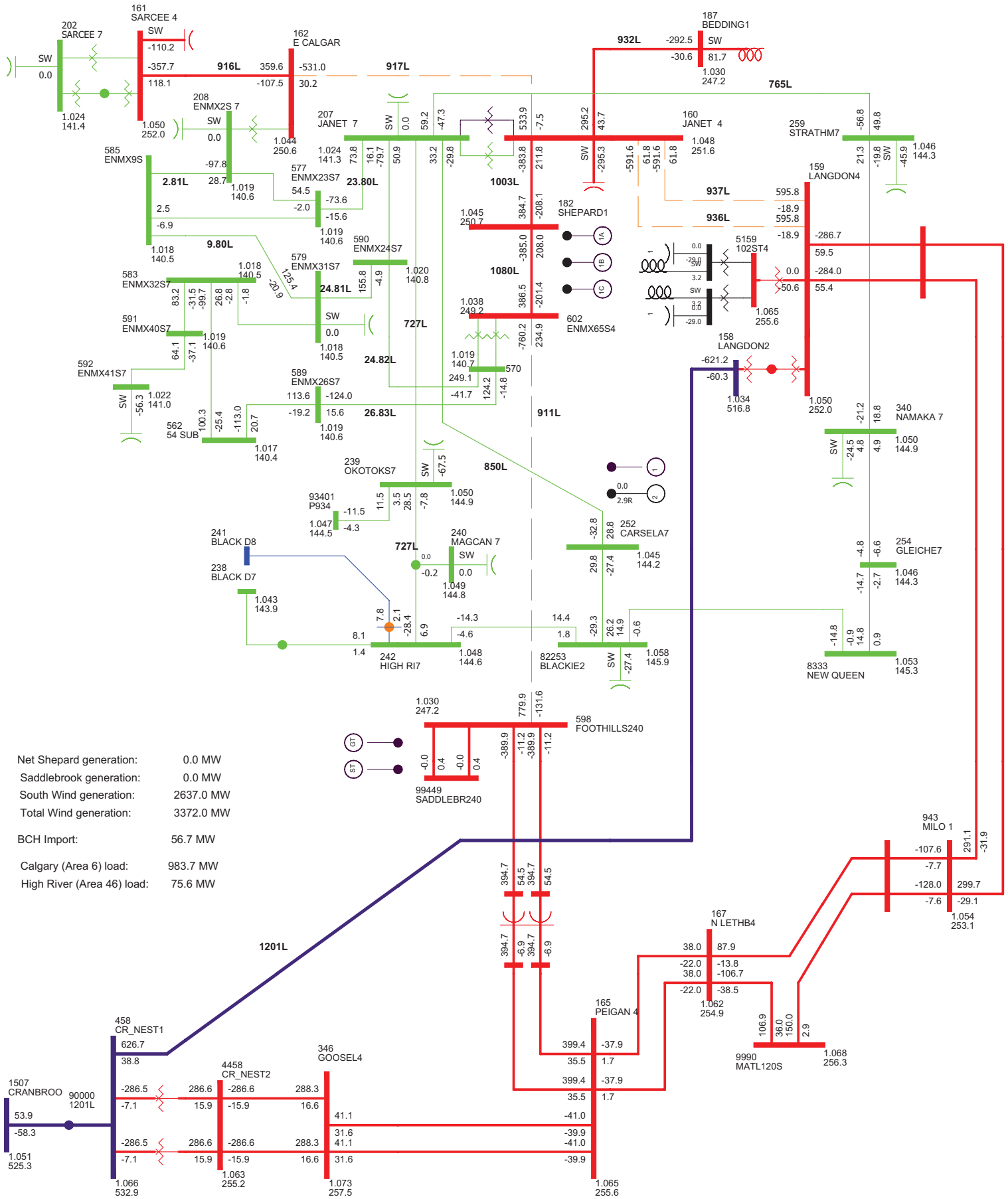


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc6-6

936L (LANGDON 102S TO JANET 74S)

WED, APR 20 2011 17:38

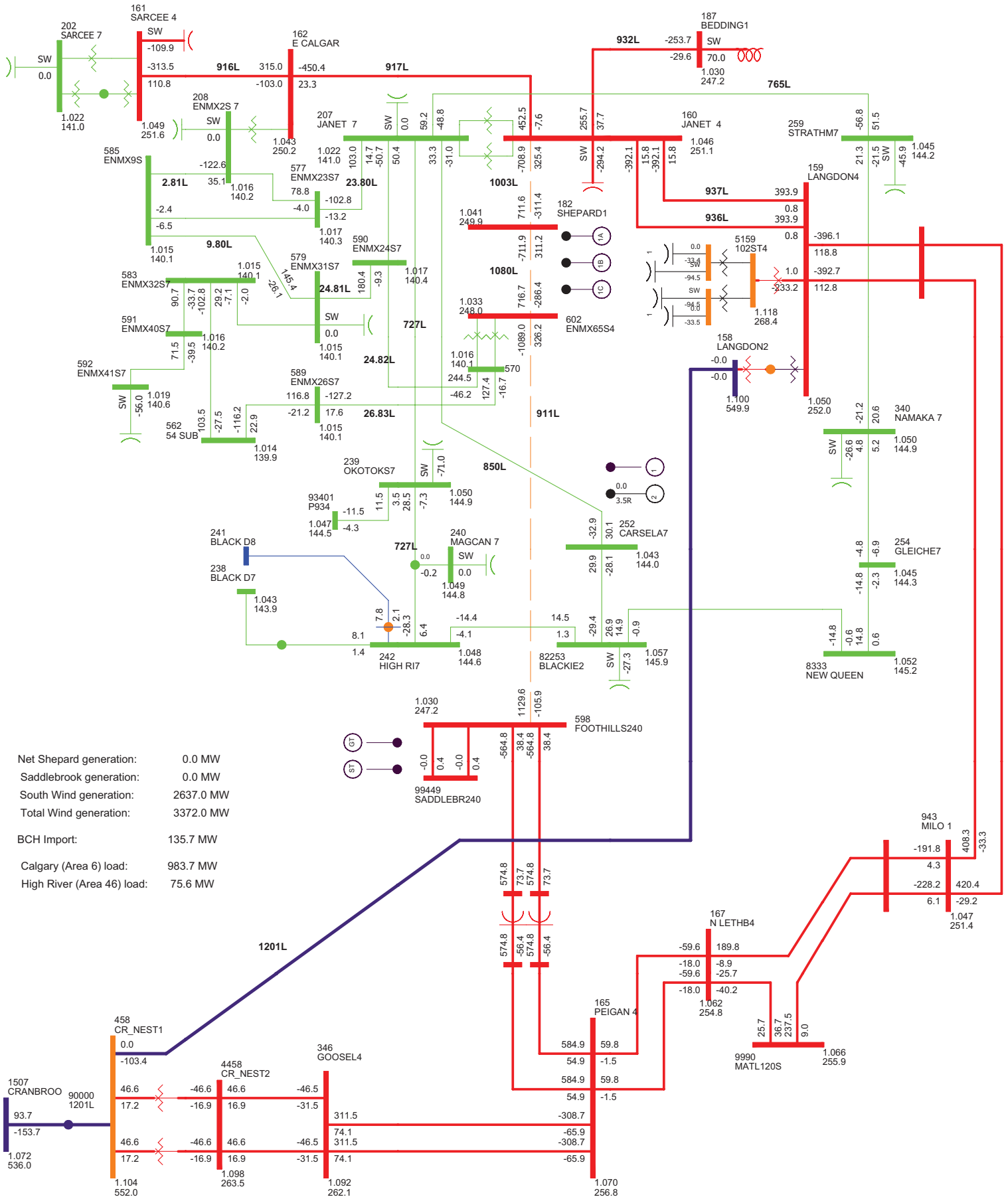


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc6-7

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 17:38



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure B-2019-NEED-Sc6-8

500/240 KV TRANSFORMER (LANGDON 102S)

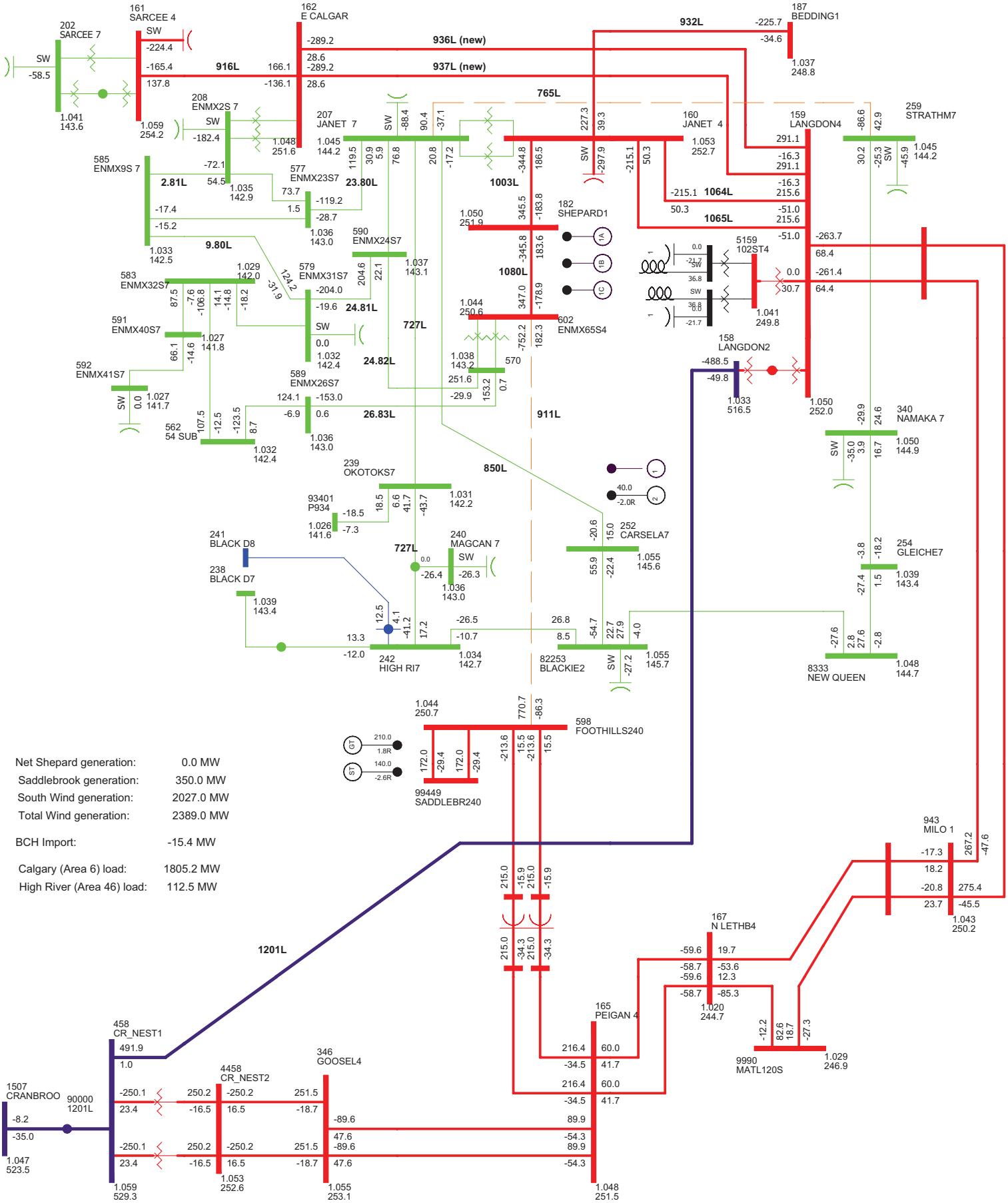
WED, APR 20 2011 17:39

ATTACHMENT C

Transmission Development Plan – Step 1, 2014

Table C-1

Figure Name	Contingency
Figure C-2014-Step1-Sc3-1	Base Case (N-0)
Figure C-2014-Step1-Sc3-2	Open 500/240 kV transformer (Langdon 102S)
Figure C-2014-Step1-Sc4-1	Base Case (N-0)
Figure C-2014-Step1-Sc4-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure C-2014-Step1-Sc4-3	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure C-2014-Step1-Sc4-4	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure C-2014-Step1-Sc4-5	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure C-2014-Step1-Sc4-6	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure C-2014-Step1-Sc4-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure C-2014-Step1-Sc4-8	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure C-2014-Step1-Sc4-9	Open 240/138 kV transformer (Janet 74S)
Figure C-2014-Step1-Sc4-10	Open 240/138 kV transformer (East Calgary 5S)
Figure C-2014-Step1-Sc4-11	Open 500/240 kV transformer (Langdon 102S)
Figure C-2014-Step1-Sc4-12	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)
Figure C-2014-Step1-Sc4-13	Open 9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)
Figure C-2014-Step1-Sc4-14	Open 24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)



Net Shepard generation: 0.0 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 2027.0 MW
Total Wind generation: 2389.0 MW

BCH Import: -15.4 MW

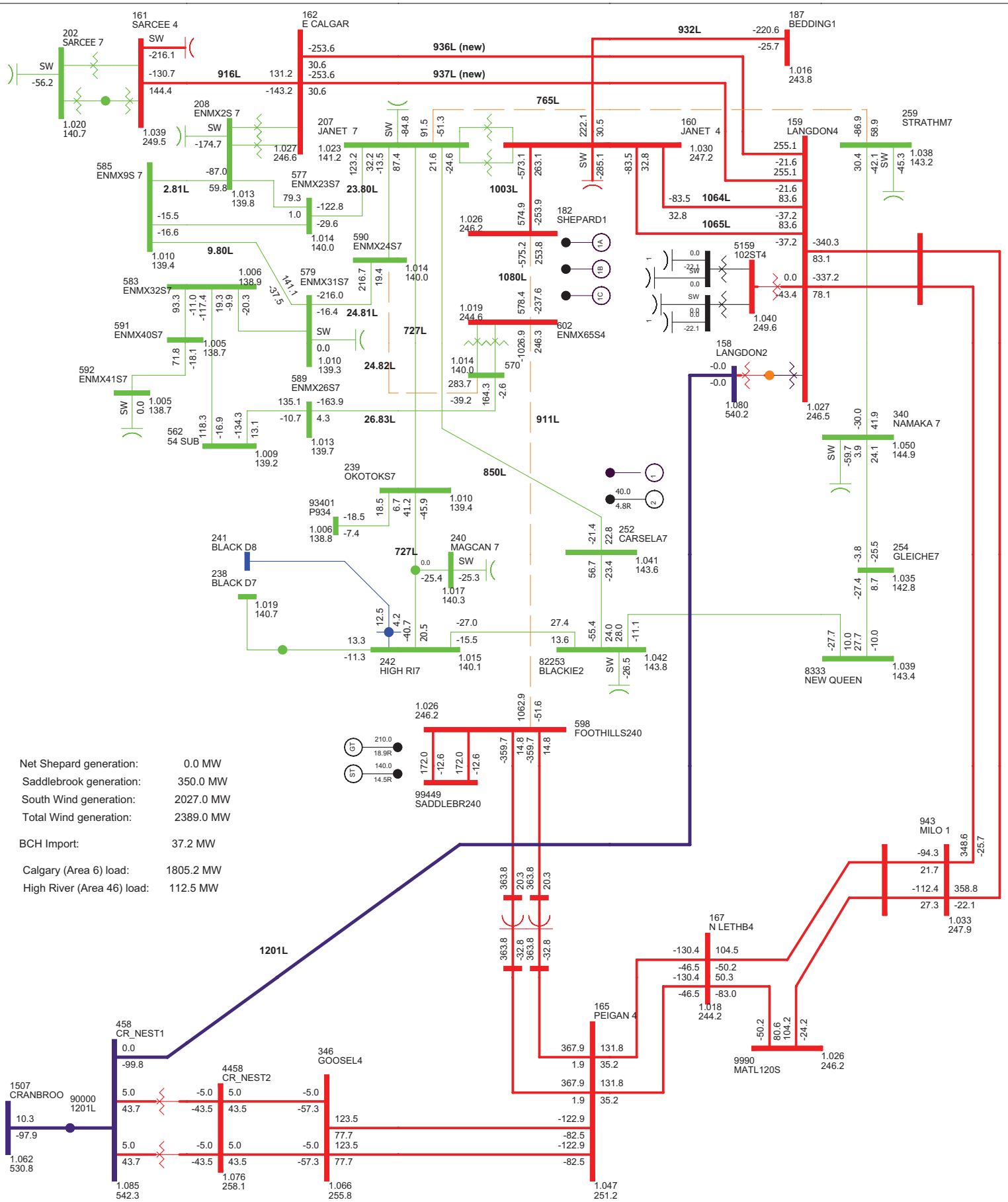
Calgary (Area 6) load: 1805.2 MW
High River (Area 46) load: 112.5 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc3-1

BASE CASE (ALL ELEMENTS IN SERVICE)

TUE, APR 26 2011 14:18

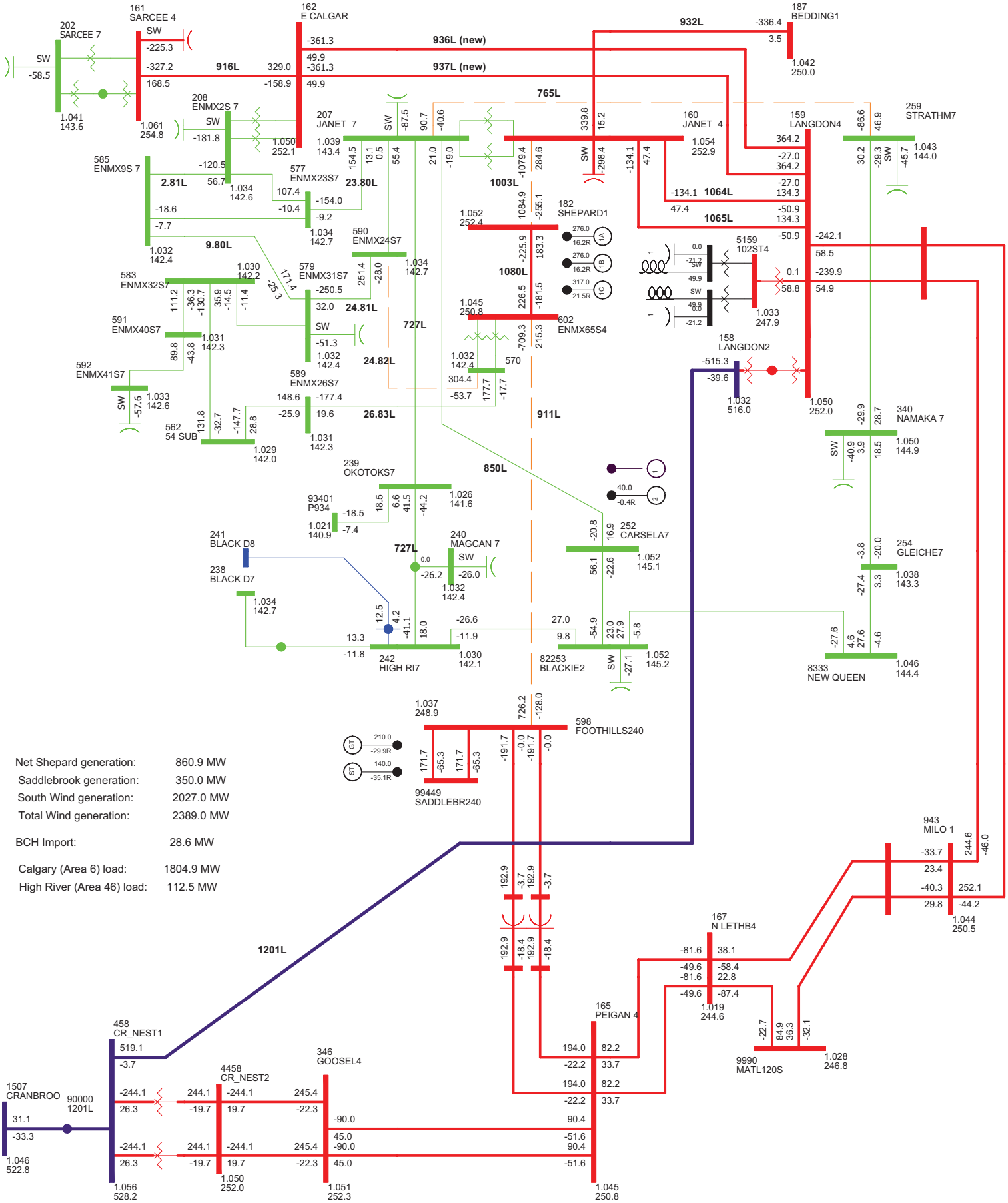


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc3-2

500/240 KV TRANSFORMER (LANGDON 102S)

TUE, APR 26 2011 14:18

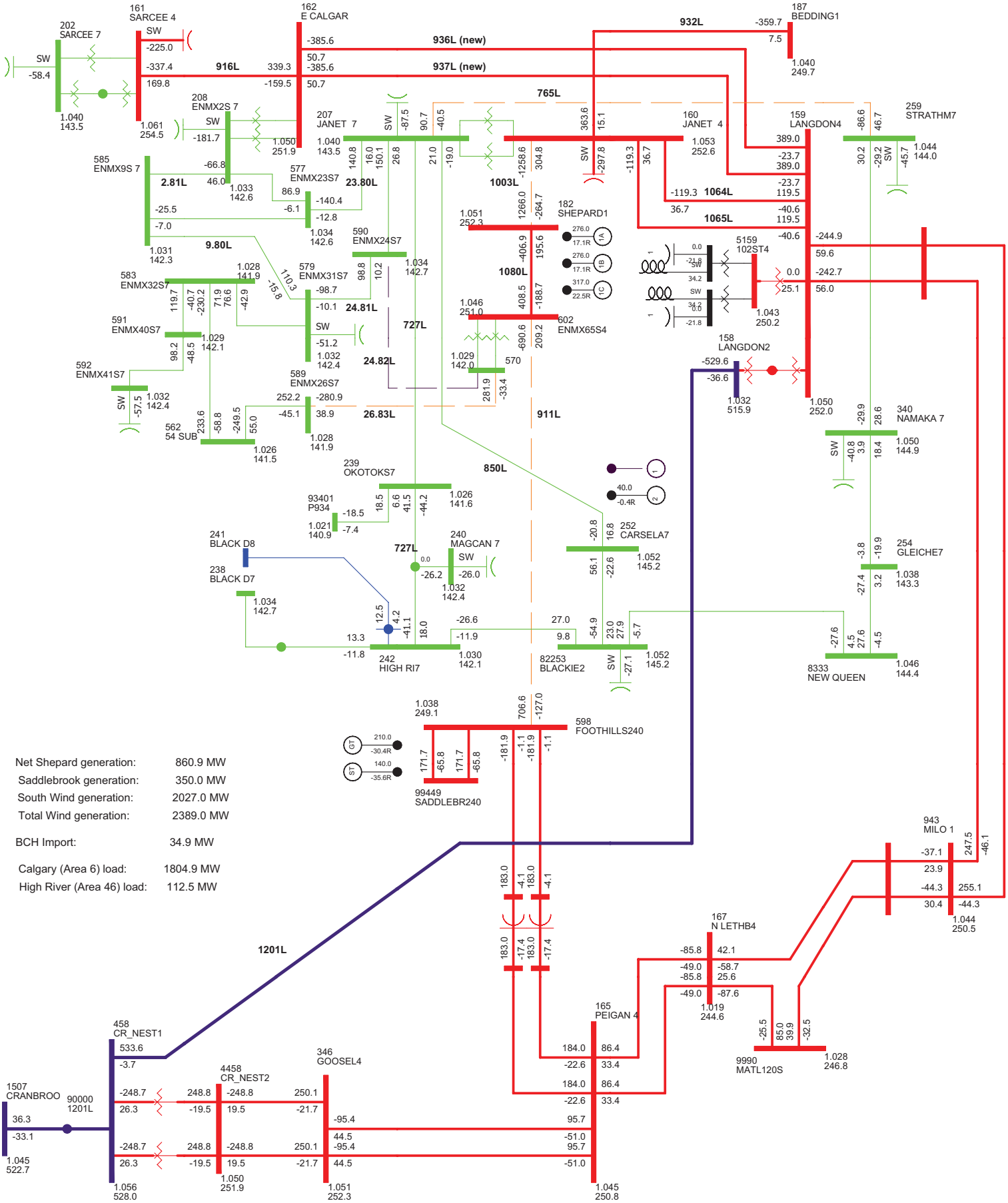


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

TUE, APR 26 2011 14:19

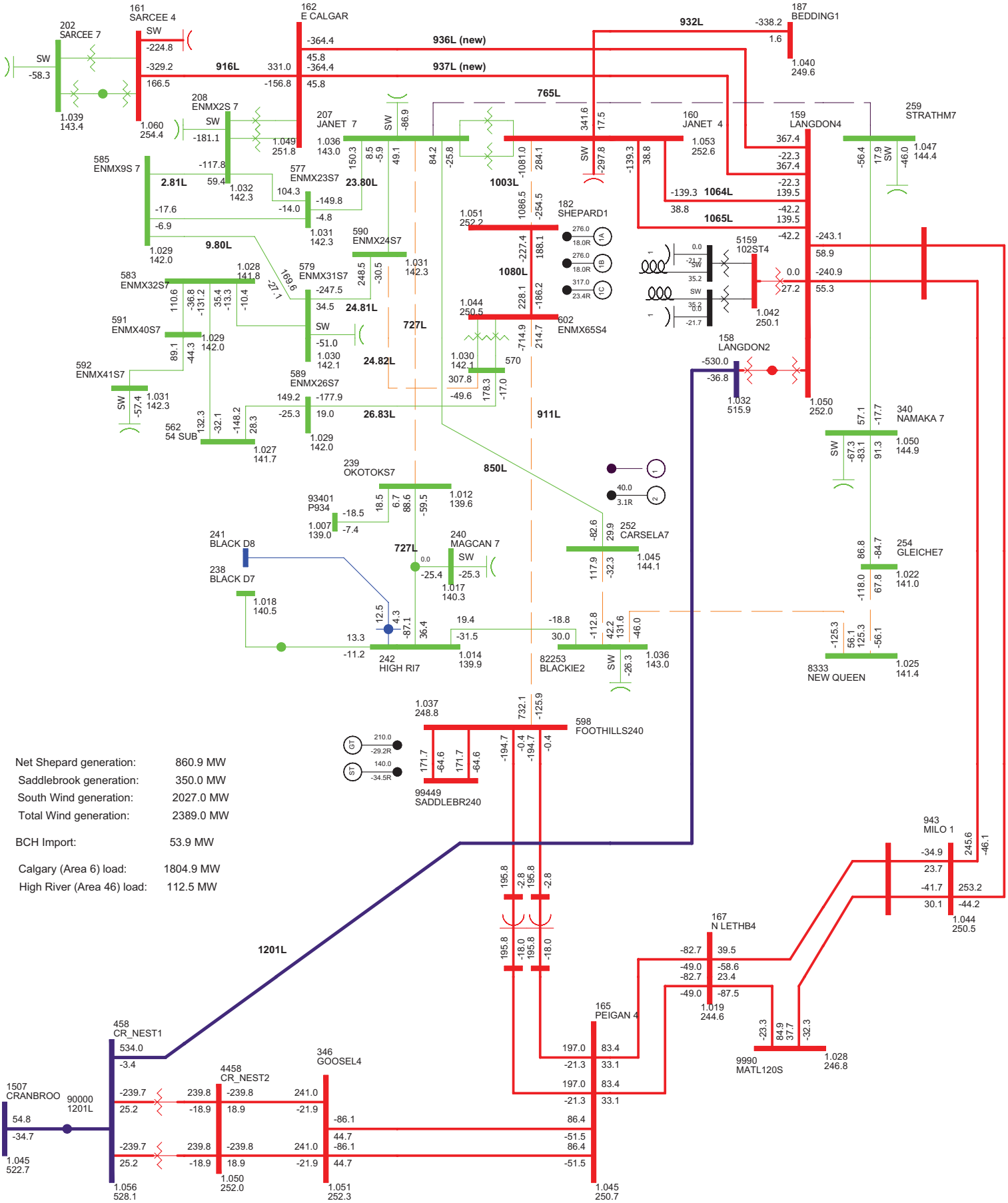


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

TUE, APR 26 2011 14:20

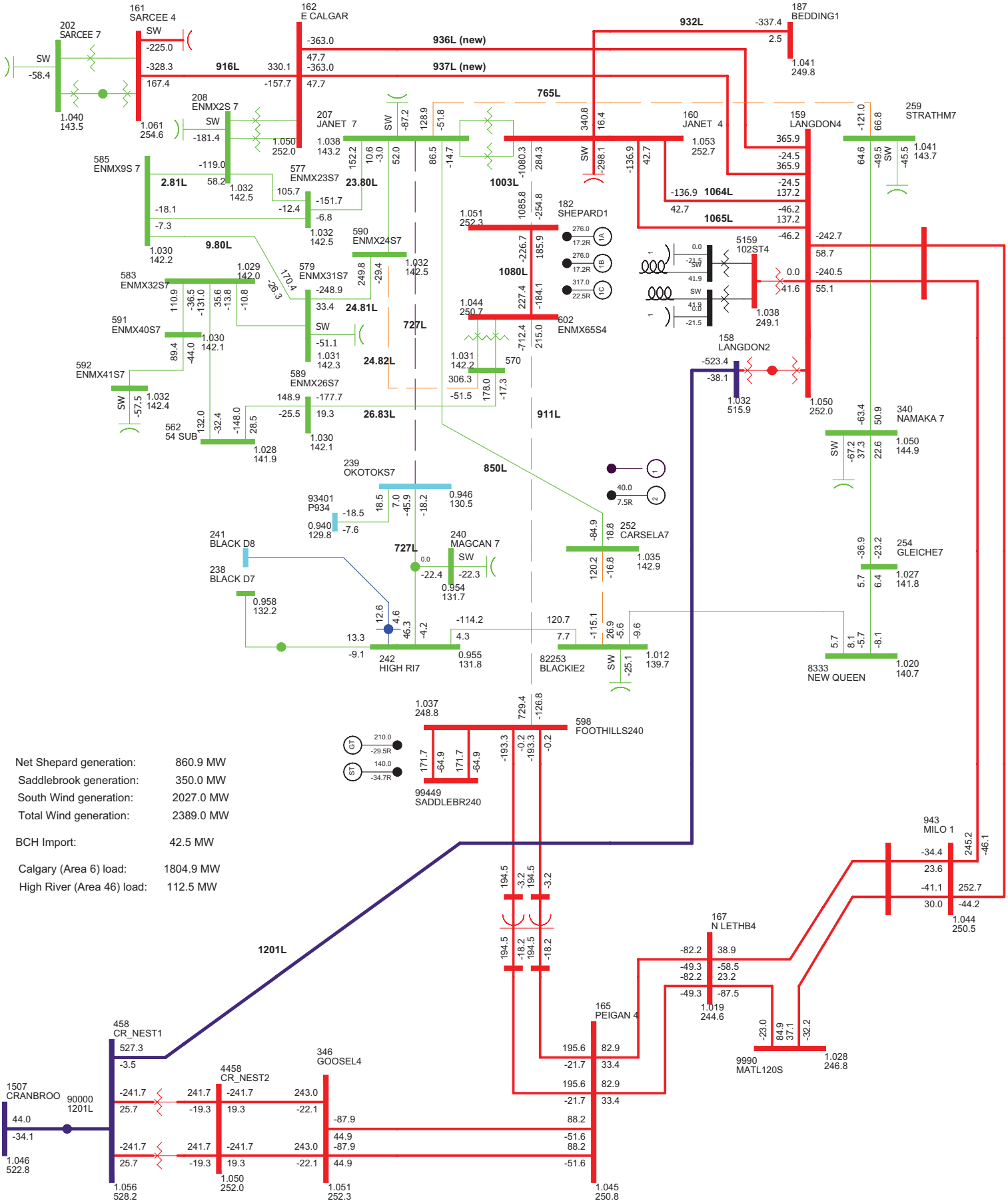


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-3

765L (JANET 74S TO STRATHMORE 151S)

TUE, APR 26 2011 14:20



Net Shepard generation: 860.9 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 2027.0 MW
Total Wind generation: 2389.0 MW

BCH Import: 42.5 MW

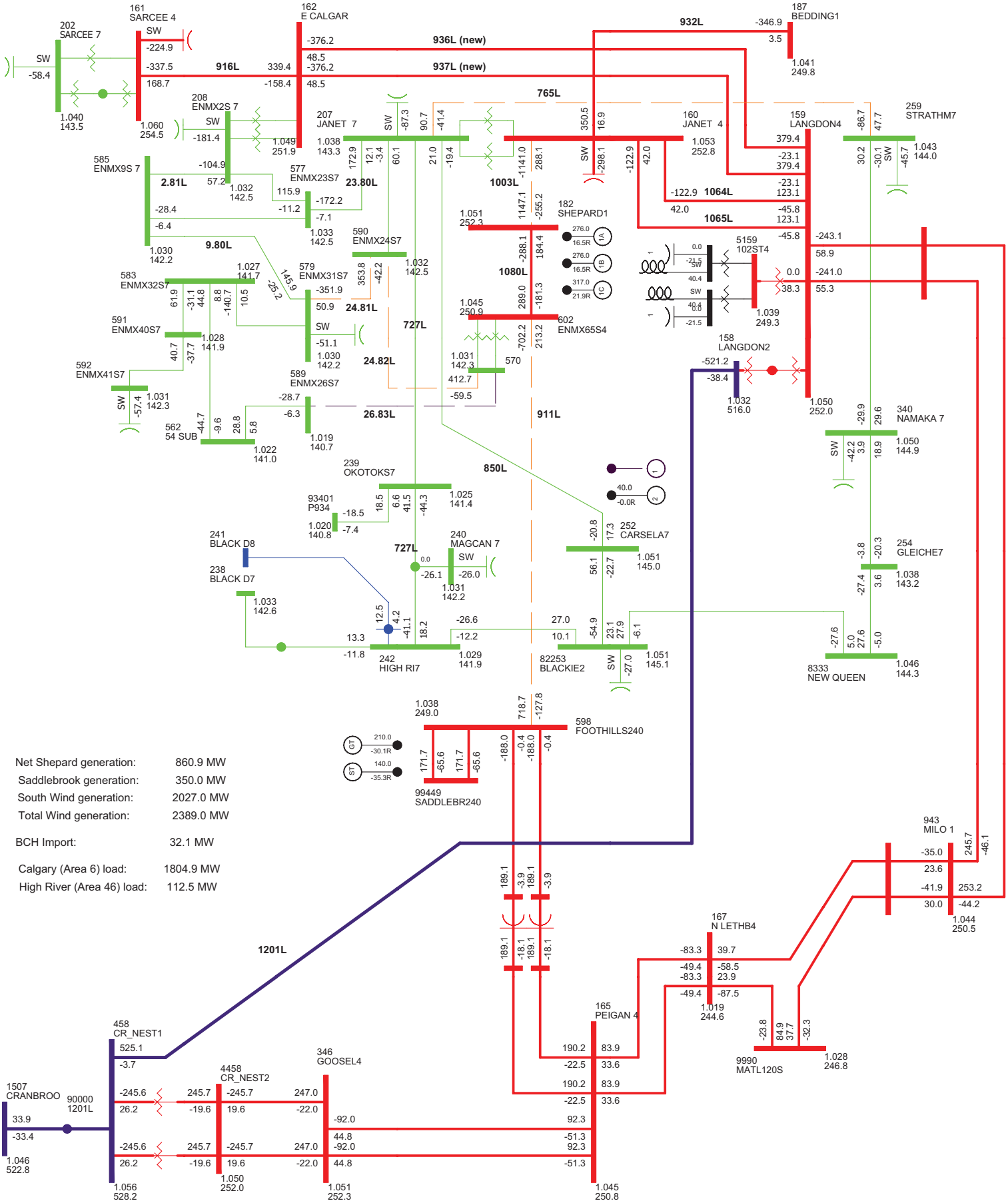
Calgary (Area 6) load: 1804.9 MW
High River (Area 46) load: 112.5 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-4

727L (JANET 74S TO OKOTOKS 678S)

TUE, APR 26 2011 14:20



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-5

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

TUE, APR 26 2011 14:20

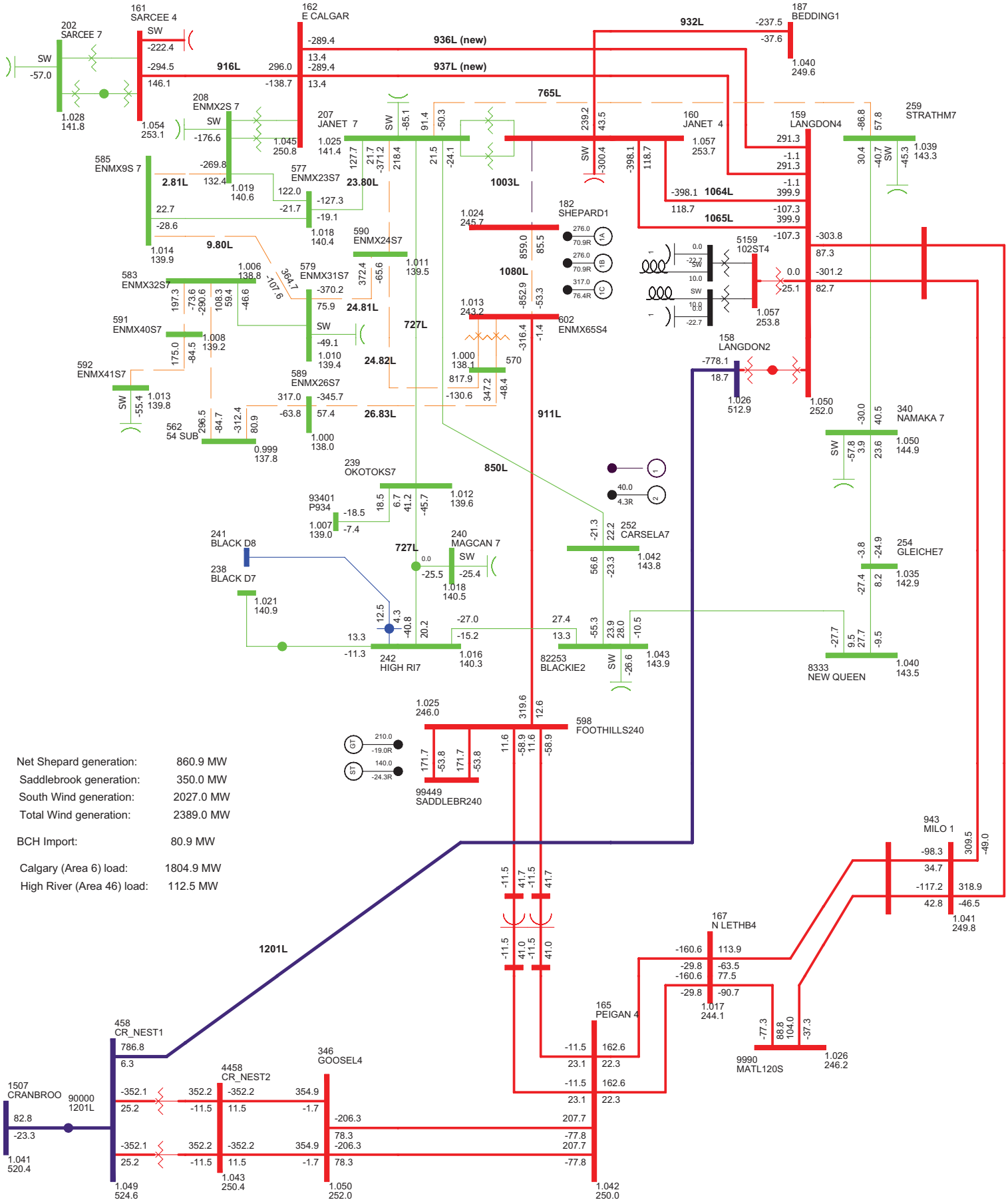
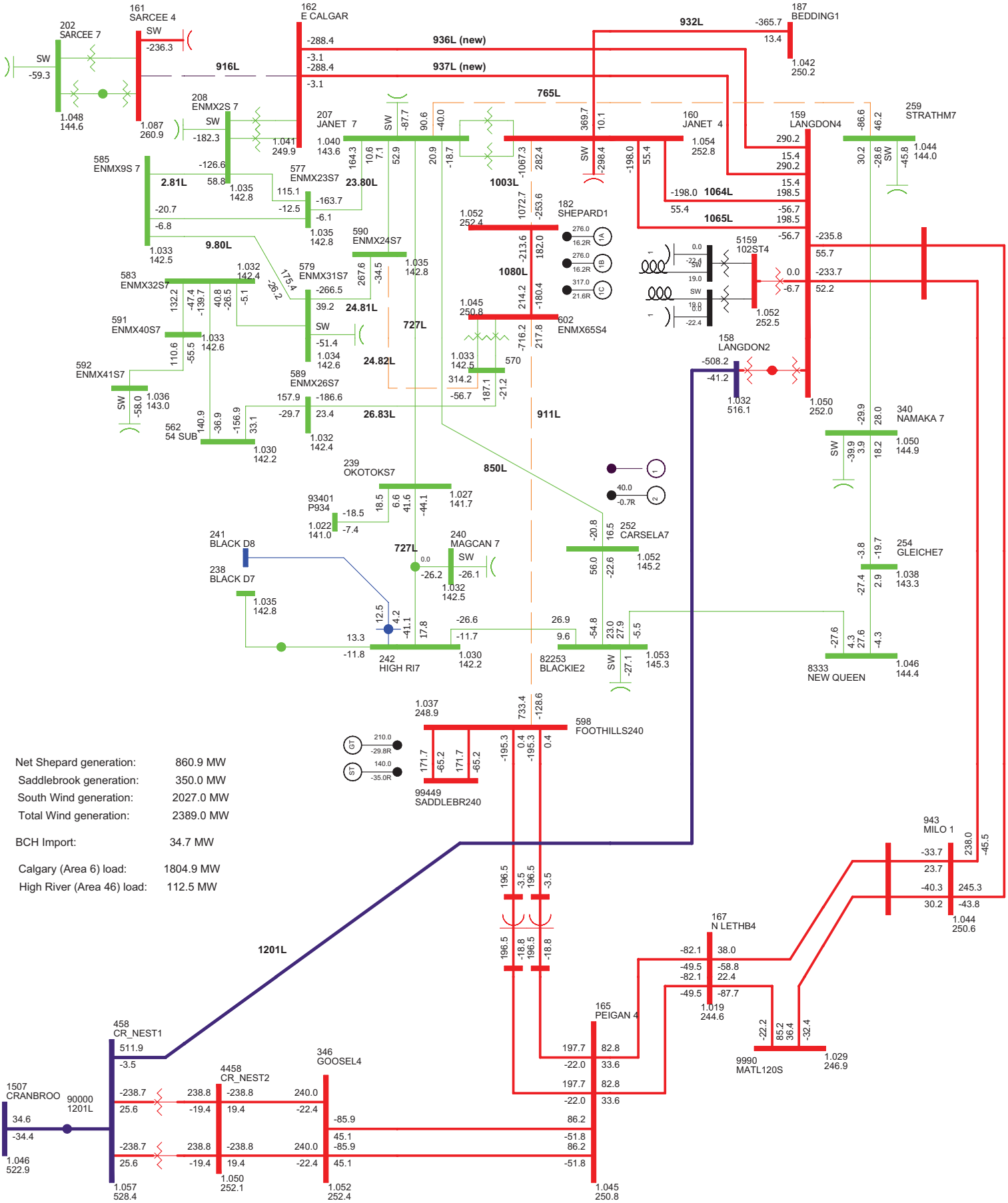


Figure C-2014-Step1-Sc4-6

1003L (JANET 74S TO ENMAX NO. 25)

TUE, APR 26 2011 14:20

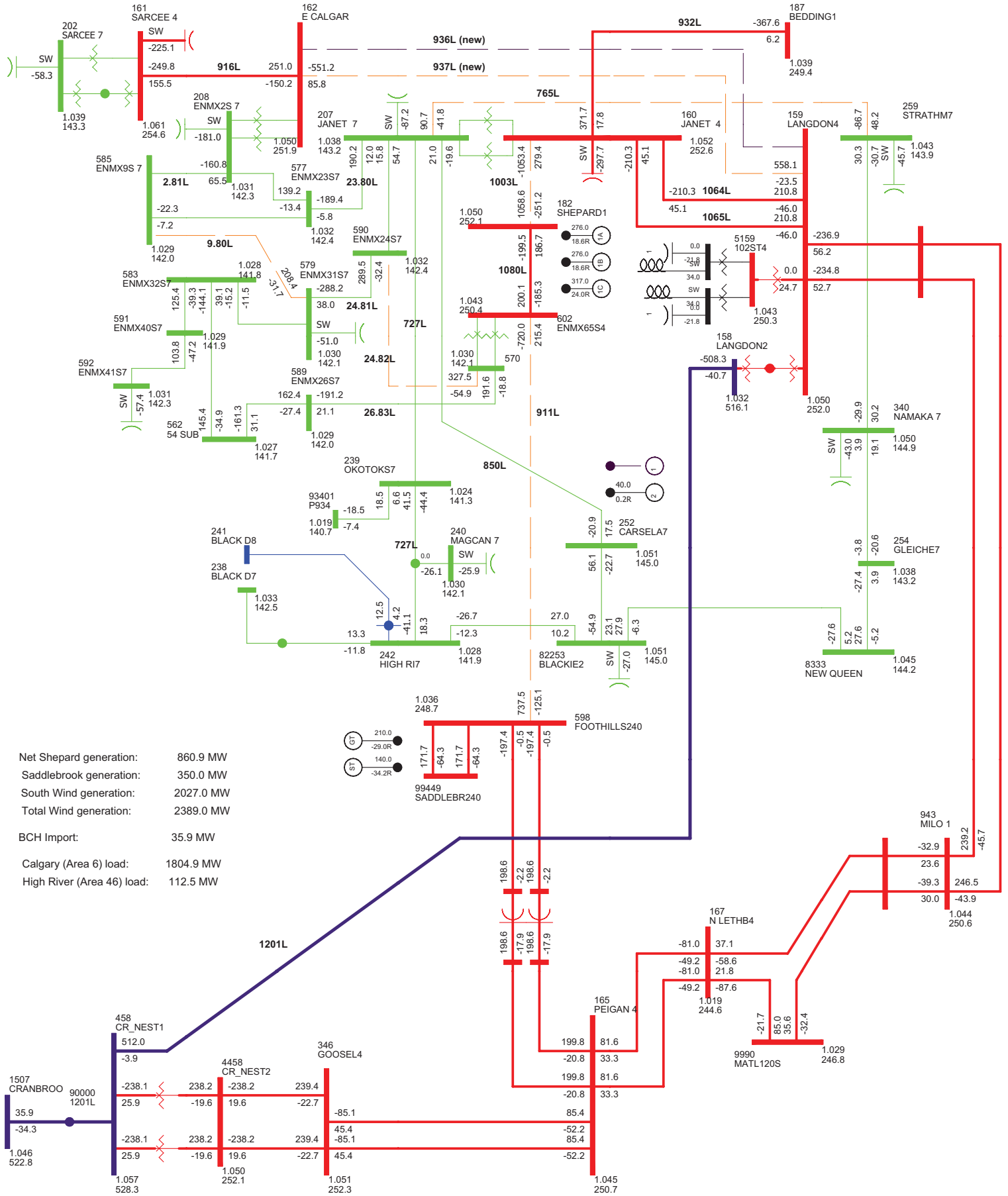


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-7

916L (SARCEE 42S TO EAST CALGARY 5S)

TUE, APR 26 2011 14:20

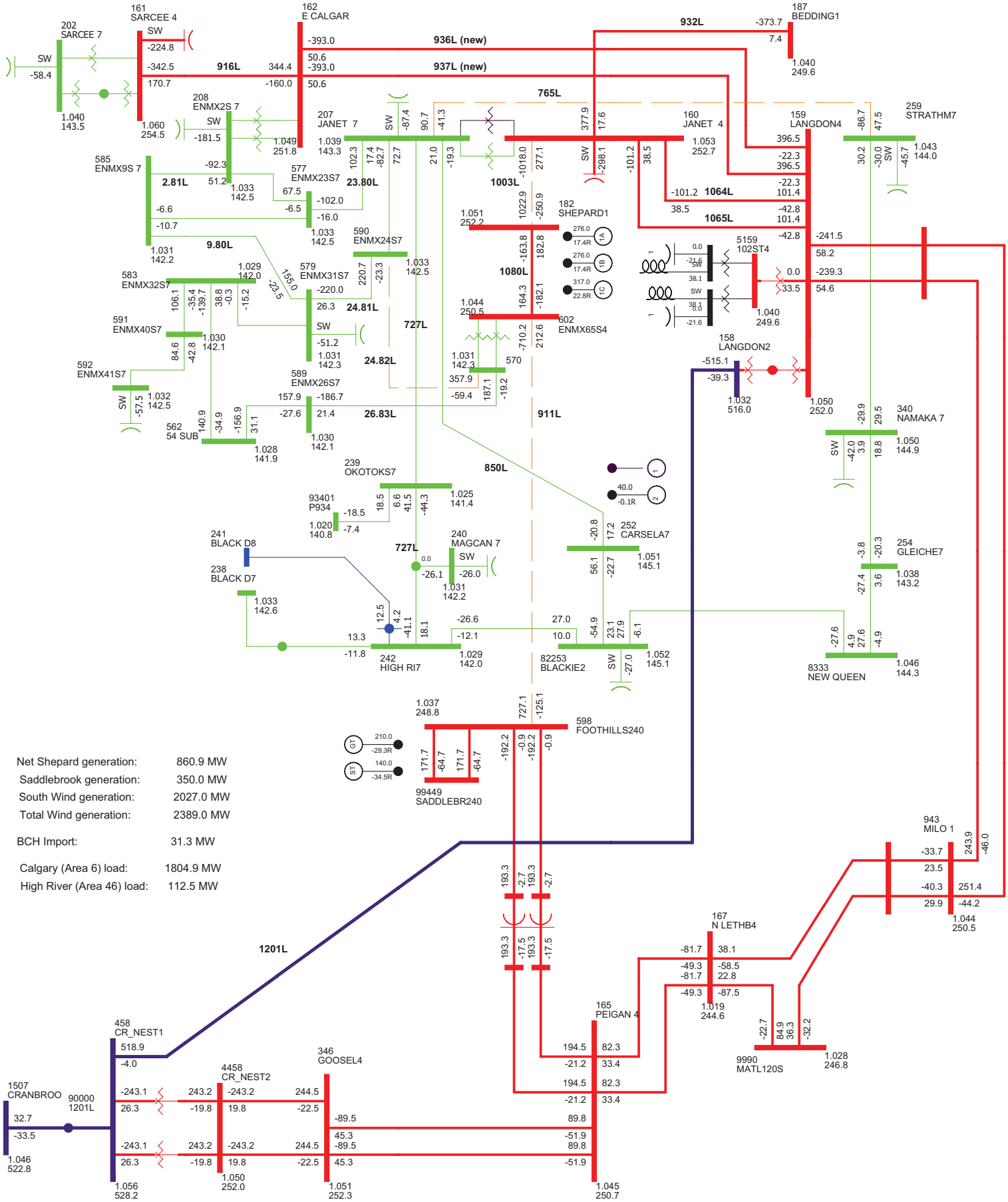


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-8

936L (LANGDON 102S TO EAST CALGARY 5S)

TUE, APR 26 2011 14:21

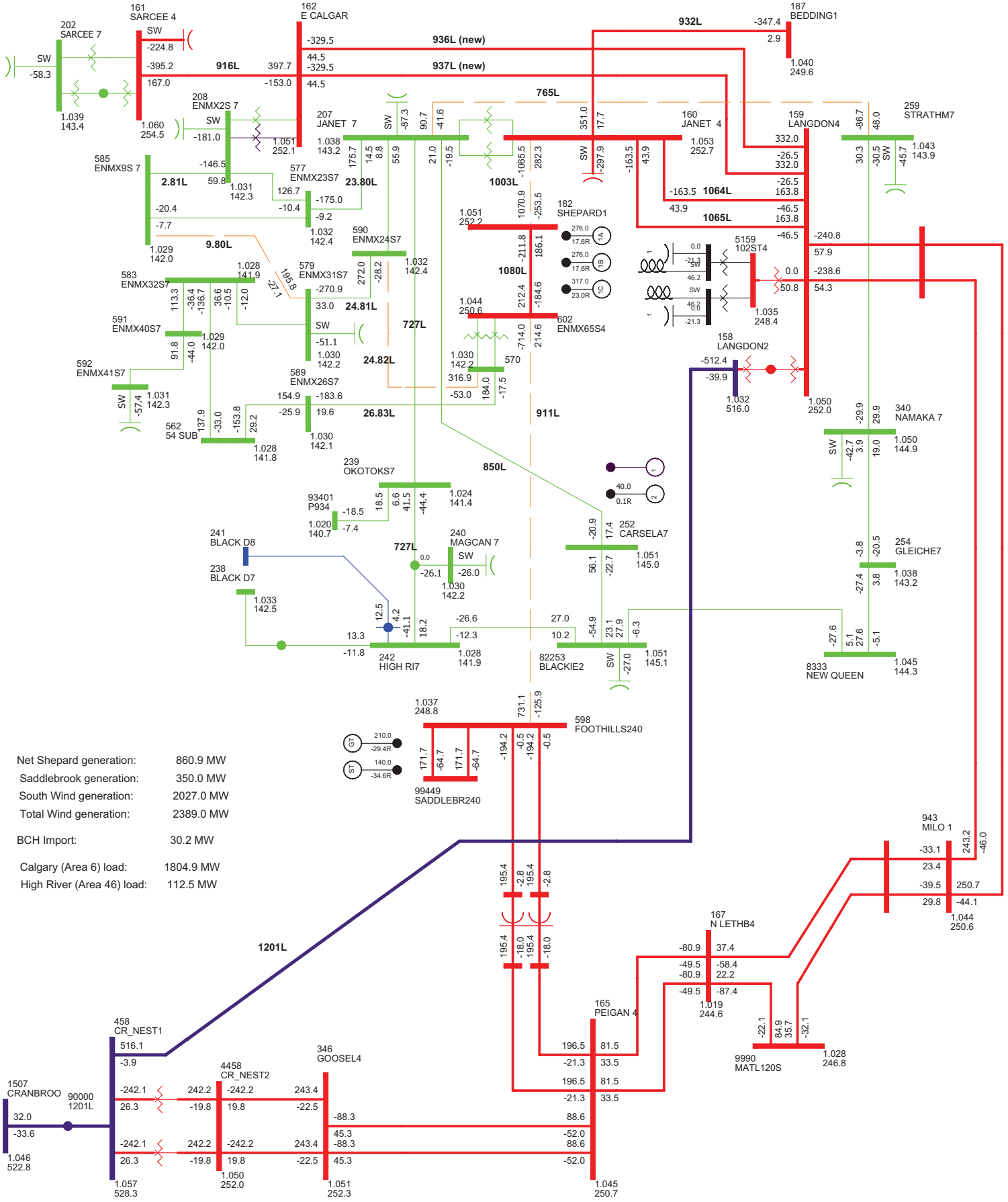


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-9

240/138 KV TRANSFORMER (JANET 74S)

TUE, APR 26 2011 14:21

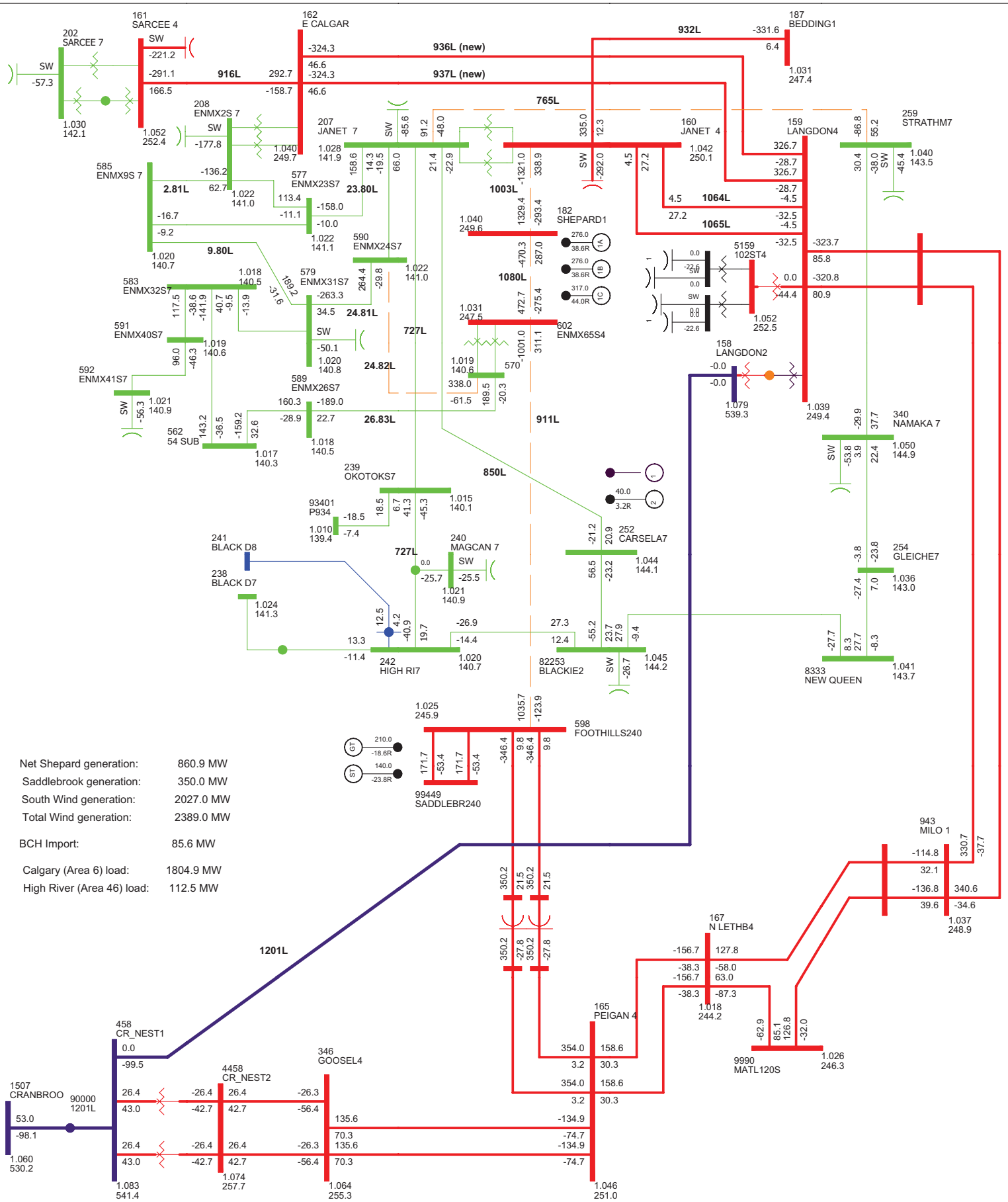


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-10

240/138 KV TRANSFORMER (EAST CALGARY 5S)

TUE, APR 26 2011 14:21

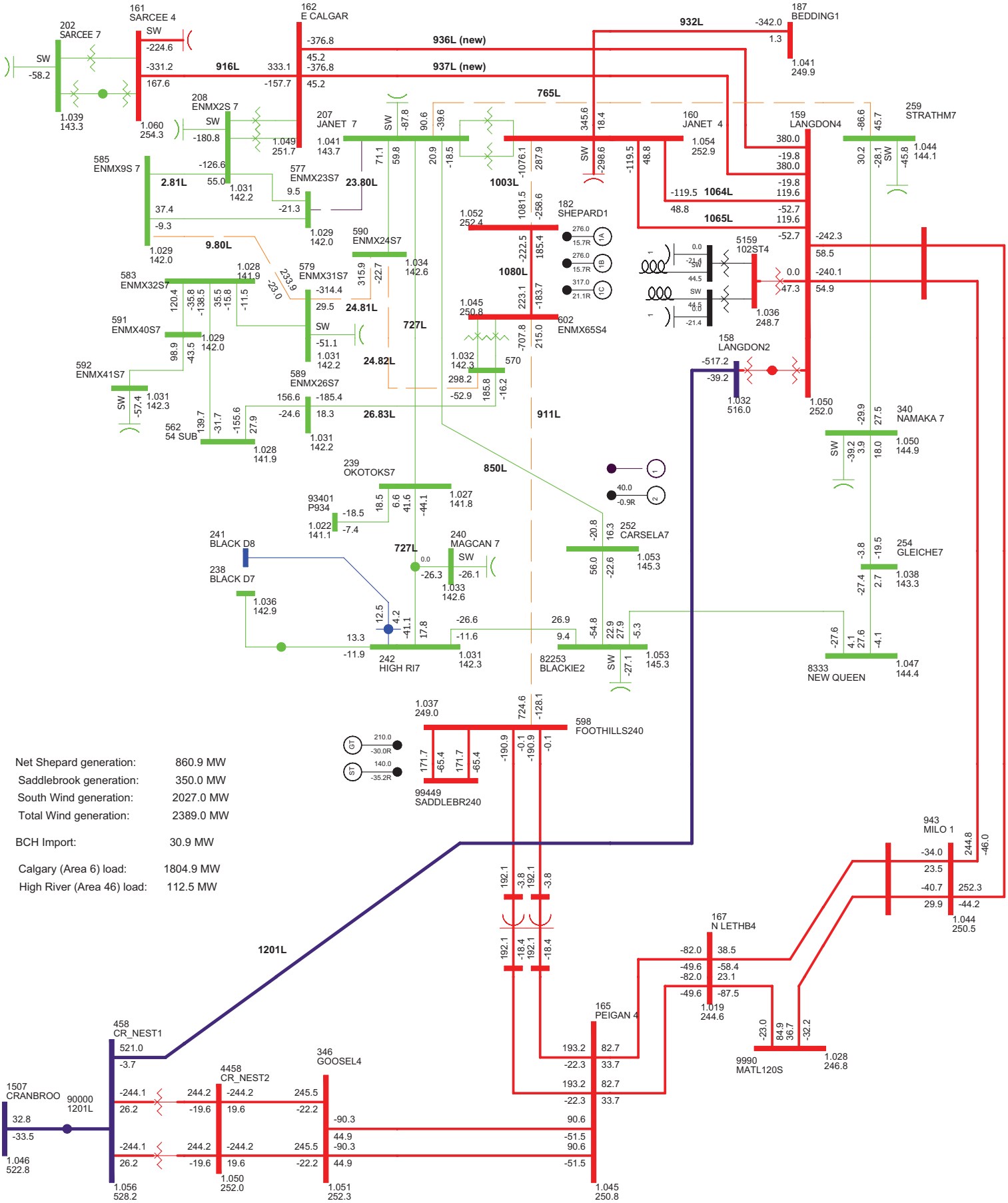


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-11

500/240 KV TRANSFORMER (LANGDON 102S)

TUE, APR 26 2011 14:21

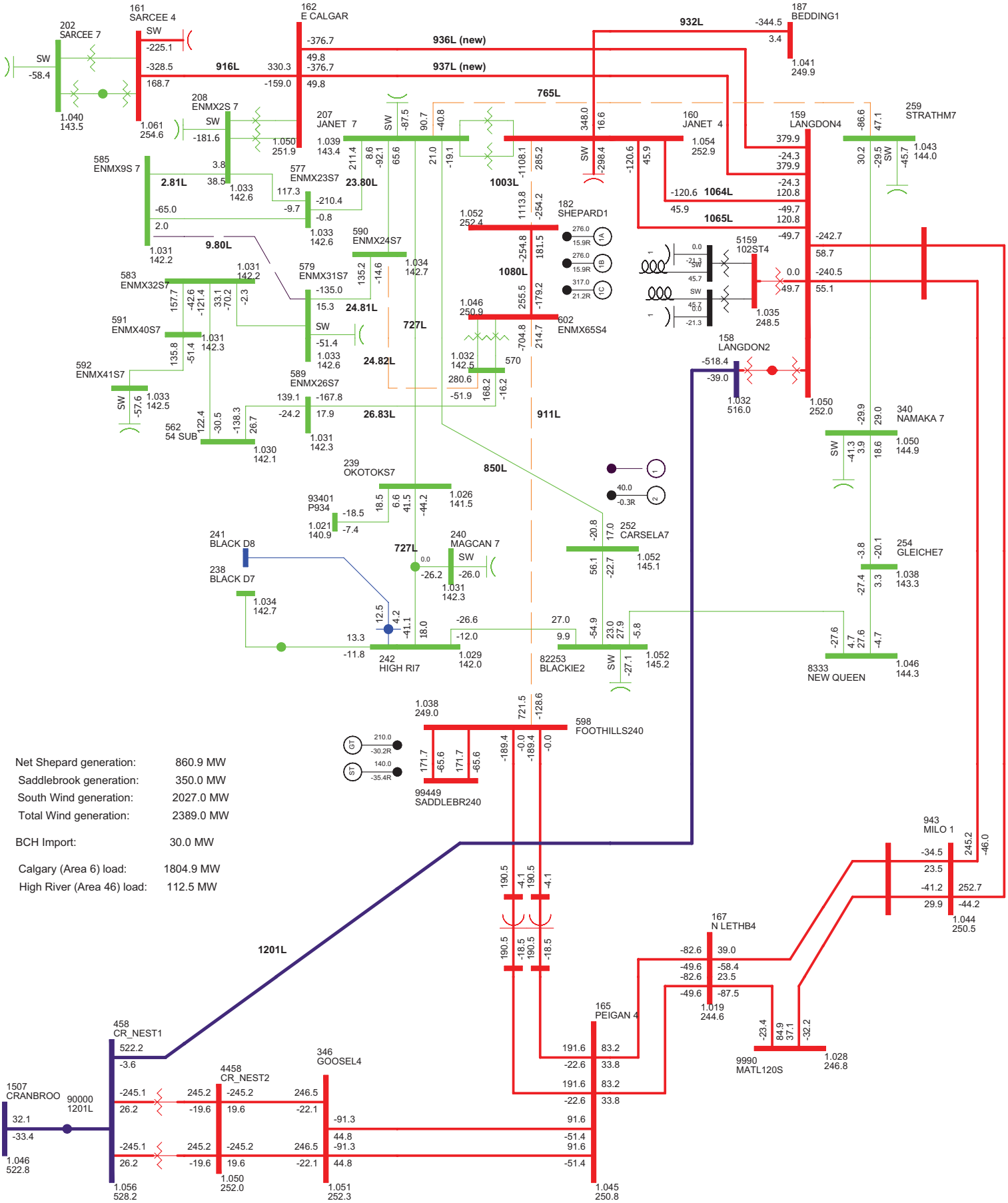


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-12

23.80L (JANET 74S TO ENMAX NO. 23)

TUE, APR 26 2011 14:21



Net Shepard generation: 860.9 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 2027.0 MW
Total Wind generation: 2389.0 MW

BCH Import: 30.0 MW

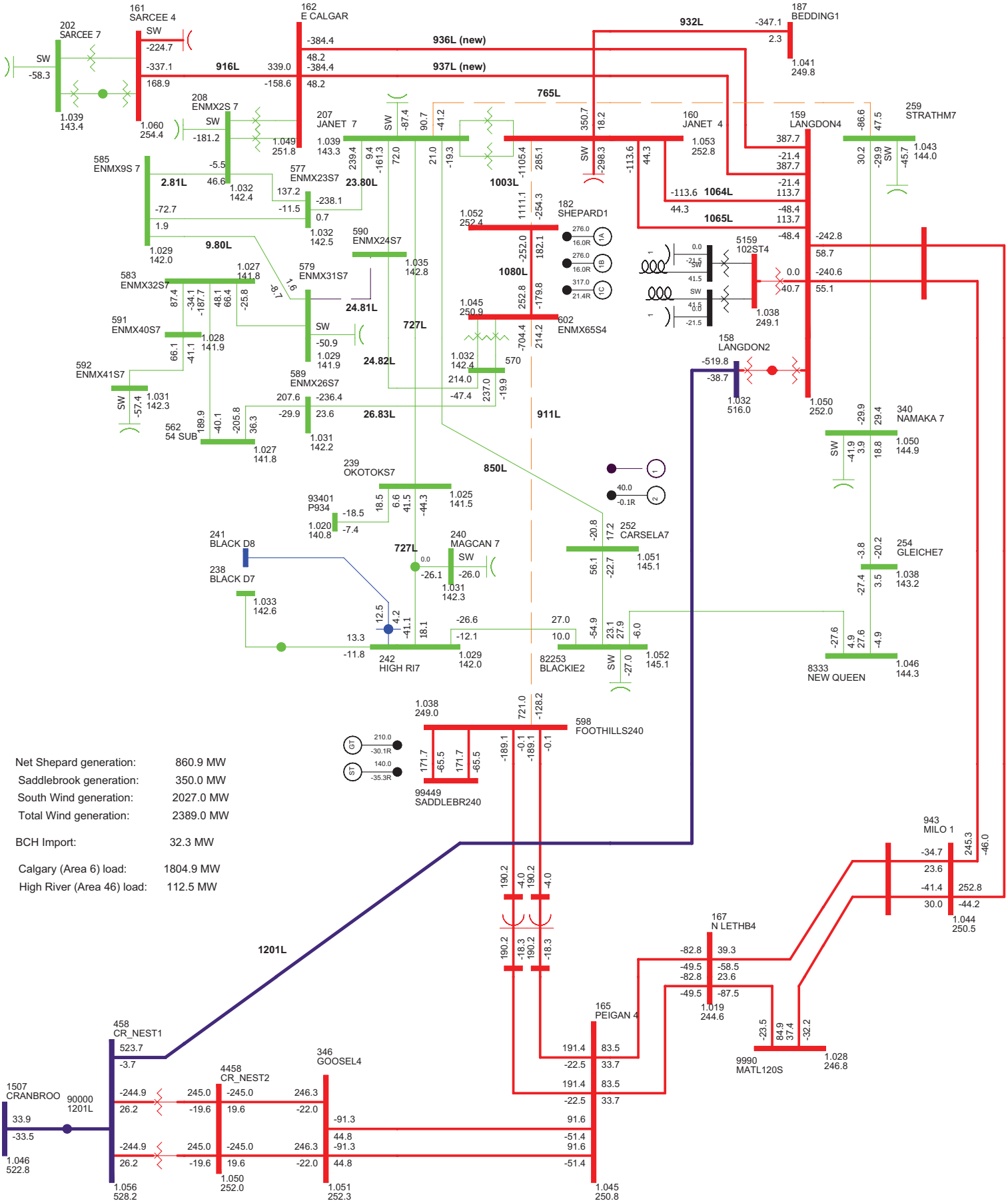
Calgary (Area 6) load: 1804.9 MW
High River (Area 46) load: 112.5 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-13

9.80L (ENMAX NO. 31 TO ENMAX NO. 9)

TUE, APR 26 2011 14:21



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure C-2014-Step1-Sc4-14

24.81L (ENMAX NO. 31 TO ENMAX NO. 24)

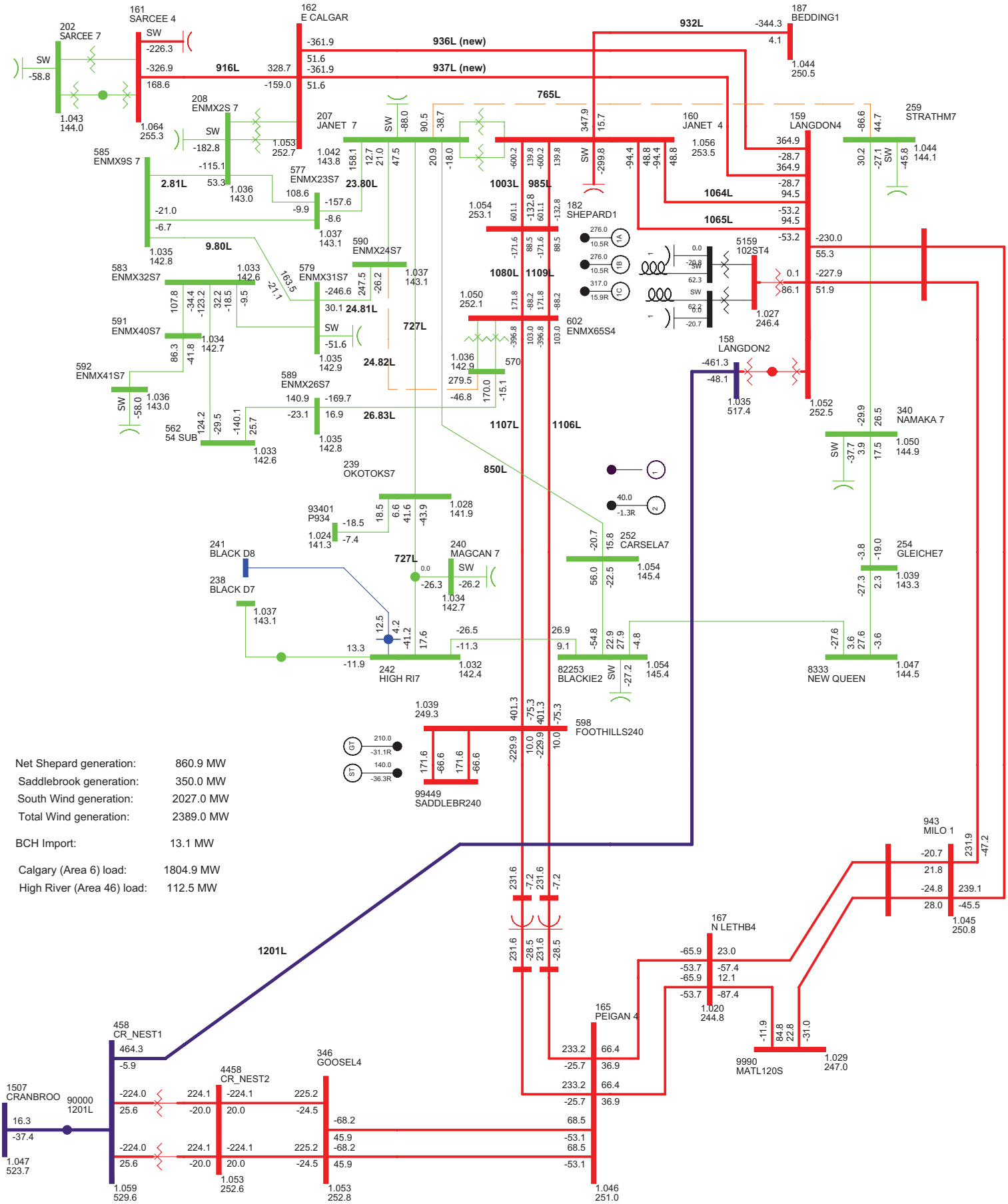
TUE, APR 26 2011 14:21

ATTACHMENT D

Transmission Development Plan – Step 2, 2014

Table D-1

Figure Name	Contingency
Figure D-2014-Step2-Sc4-1	Base Case (N-0)
Figure D-2014-Step2-Sc4-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure D-2014-Step2-Sc4-3	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure D-2014-Step2-Sc4-4	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure D-2014-Step2-Sc4-5	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure D-2014-Step2-Sc4-6	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure D-2014-Step2-Sc4-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure D-2014-Step2-Sc4-8	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure D-2014-Step2-Sc4-9	Open 240/138 kV transformer (Janet 74S)
Figure D-2014-Step2-Sc4-10	Open 240/138 kV transformer (East Calgary 5S)
Figure D-2014-Step2-Sc4-11	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)
Figure D-2014-Step2-Sc4-12	Open 9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)

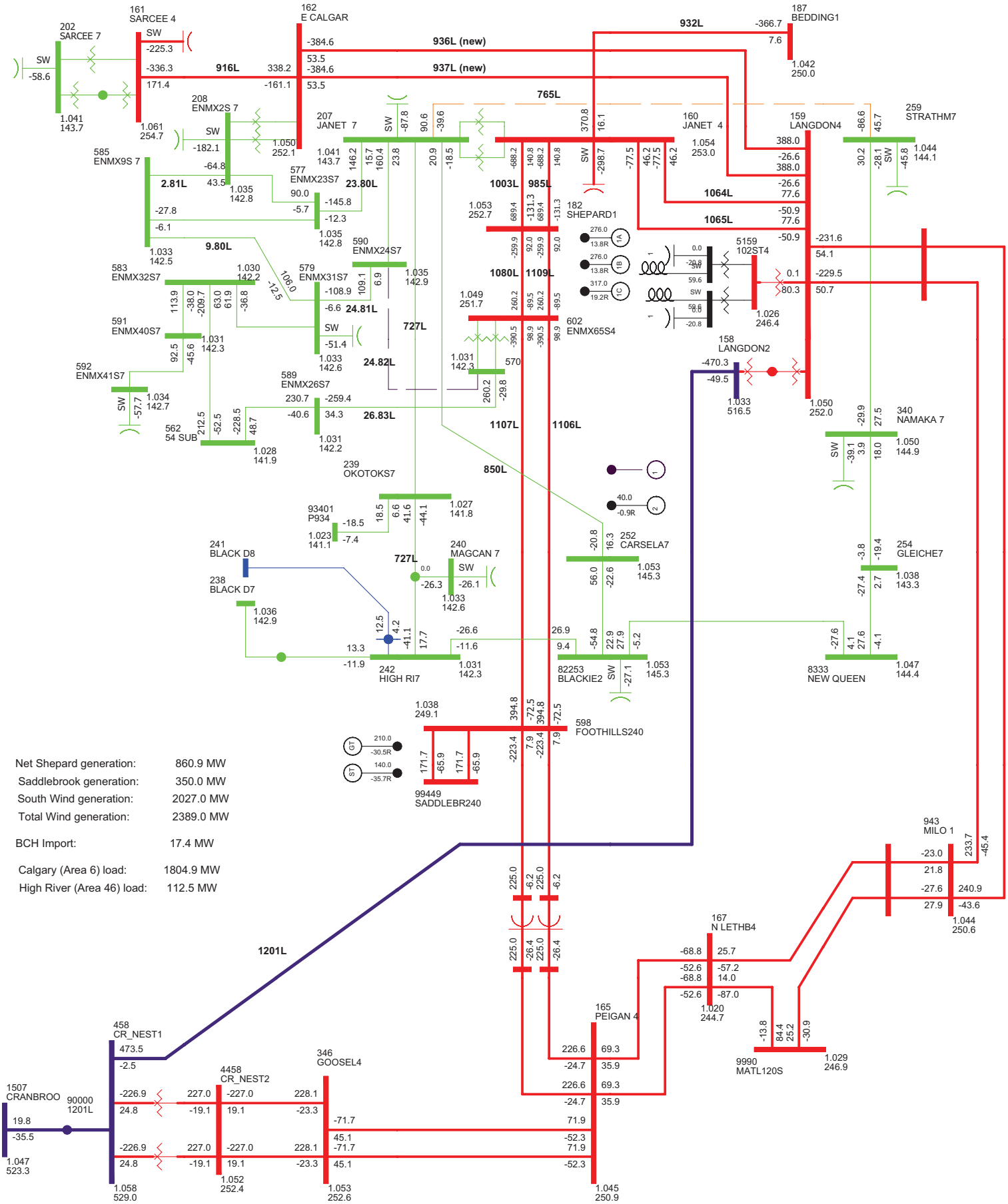


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 14:55



Net Shepard generation: 860.9 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 2027.0 MW
Total Wind generation: 2389.0 MW

BCH Import: 17.4 MW

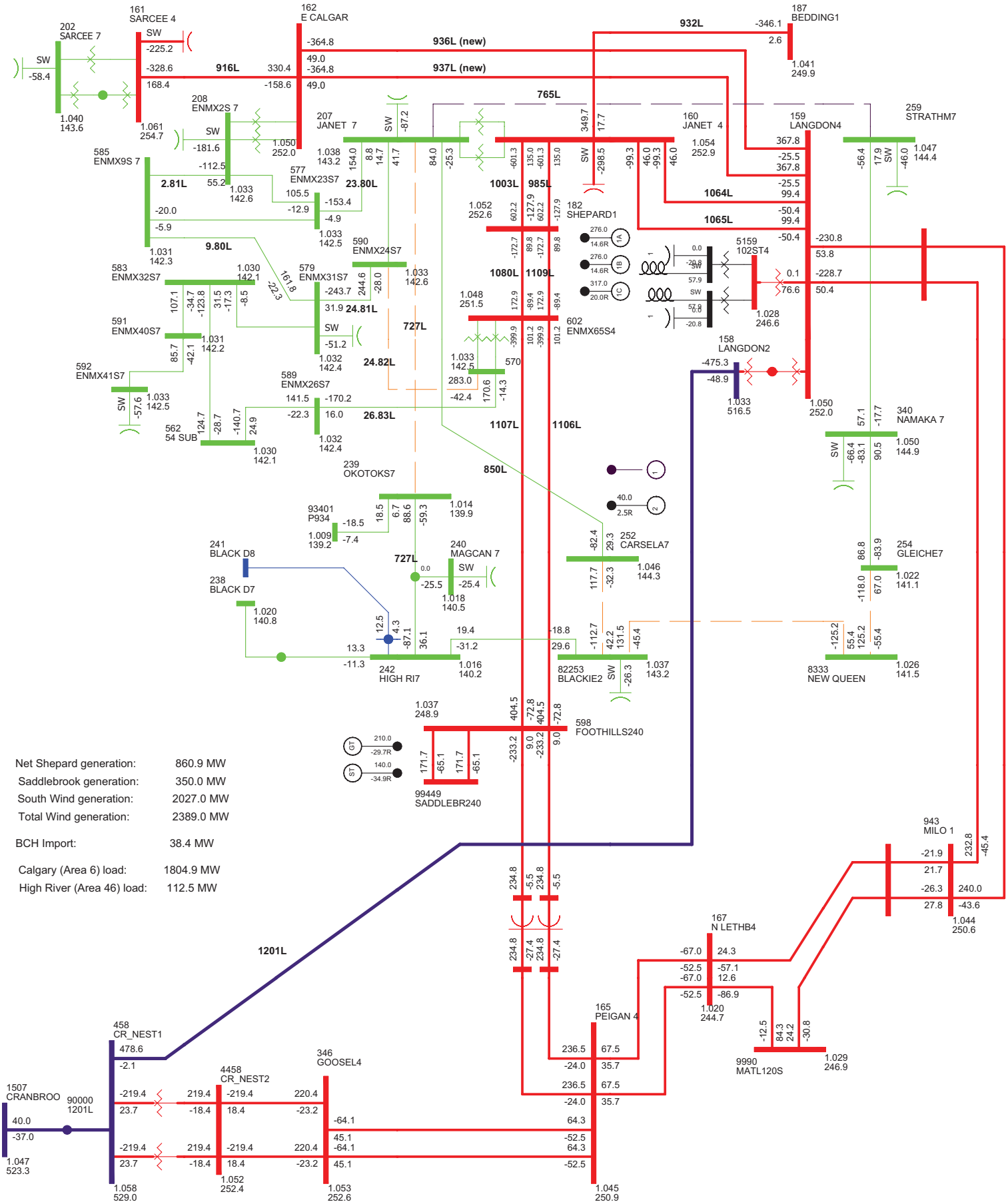
Calgary (Area 6) load: 1804.9 MW
High River (Area 46) load: 112.5 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

WED, APR 20 2011 14:56

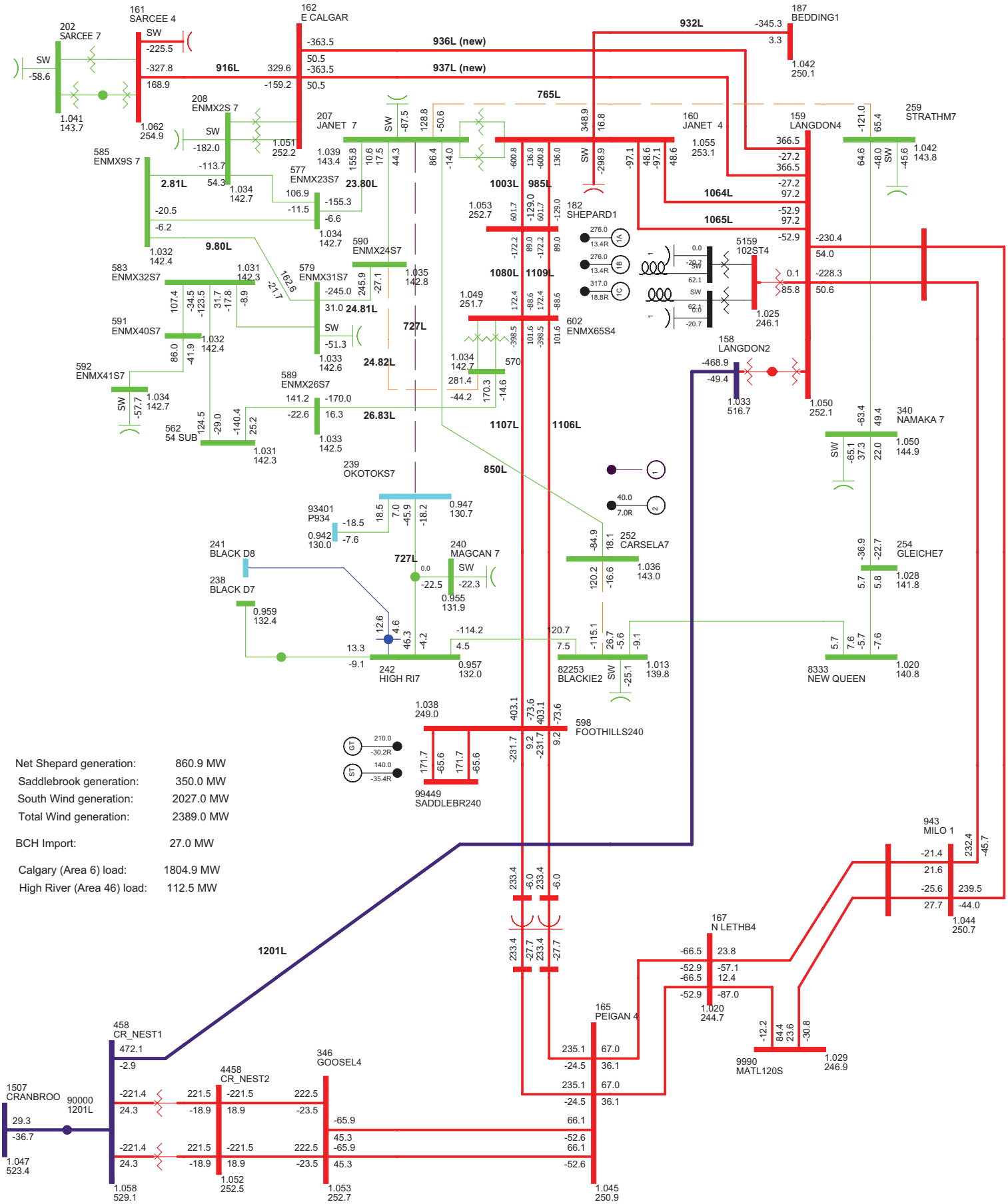


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-3

765L (JANET 74S TO STRATHMORE 151S)

WED, APR 20 2011 14:56

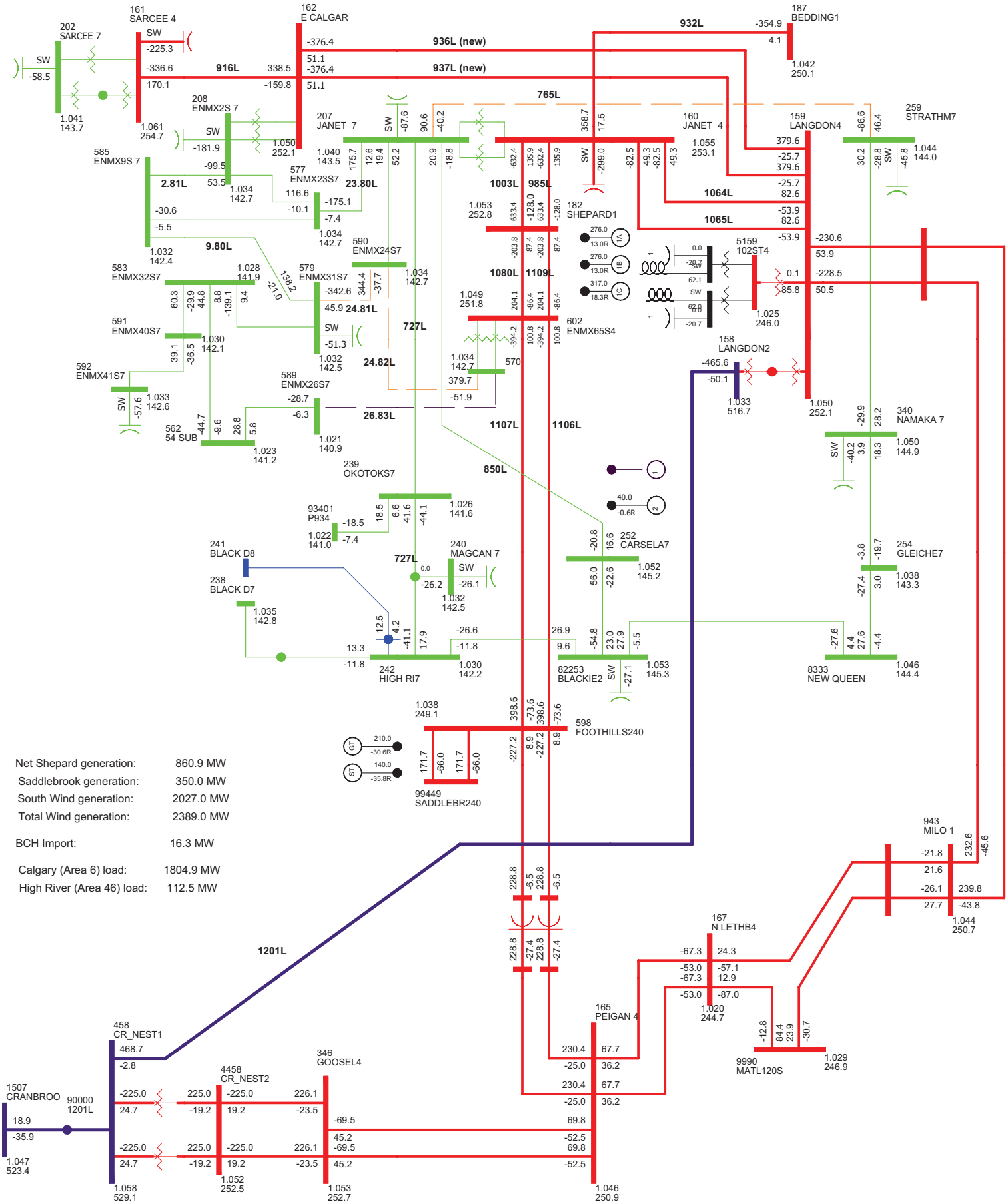


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-4

727L (JANET 74S TO OKOTOKS 678S)

WED, APR 20 2011 14:56

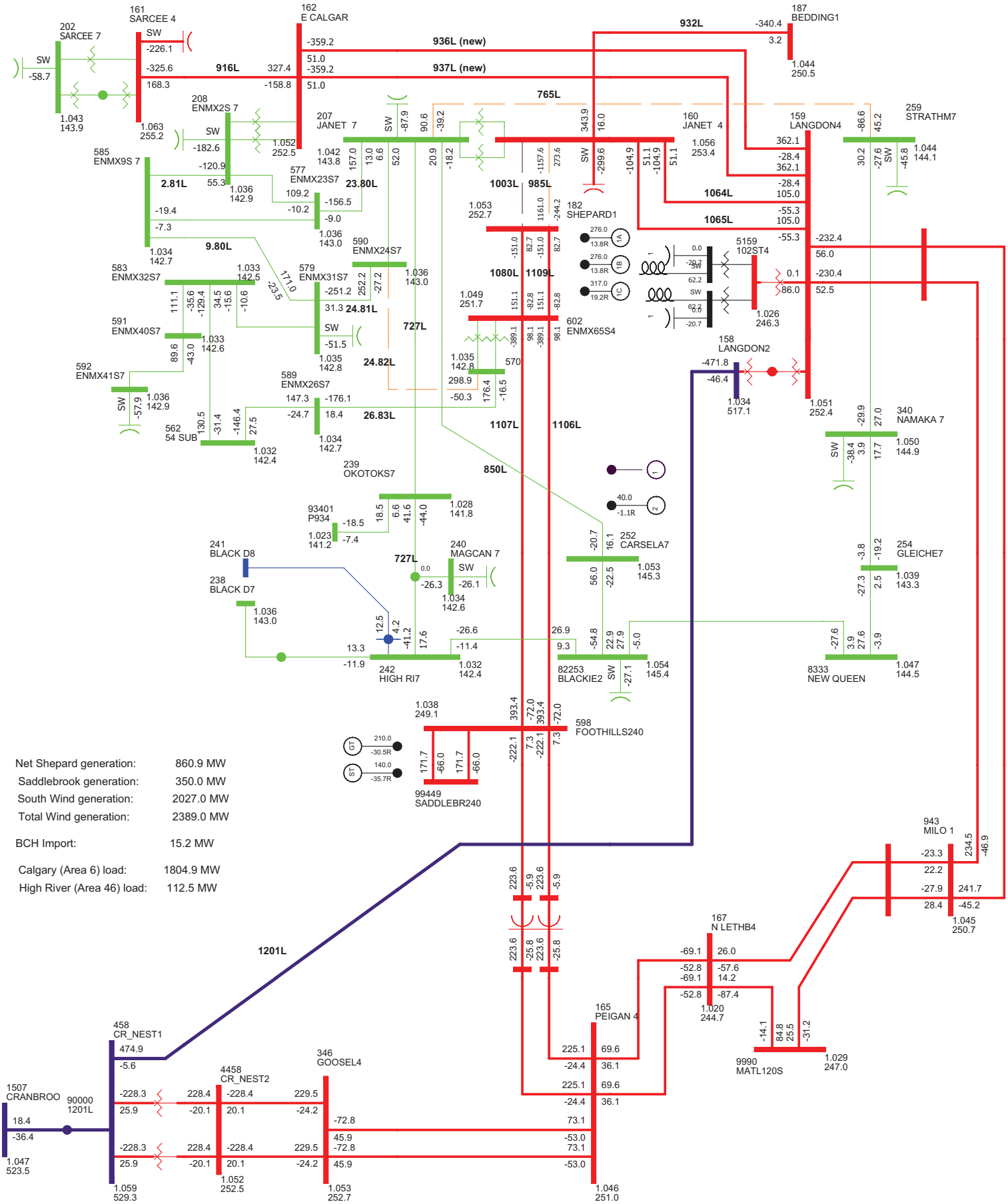


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-5

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 20 2011 14:56

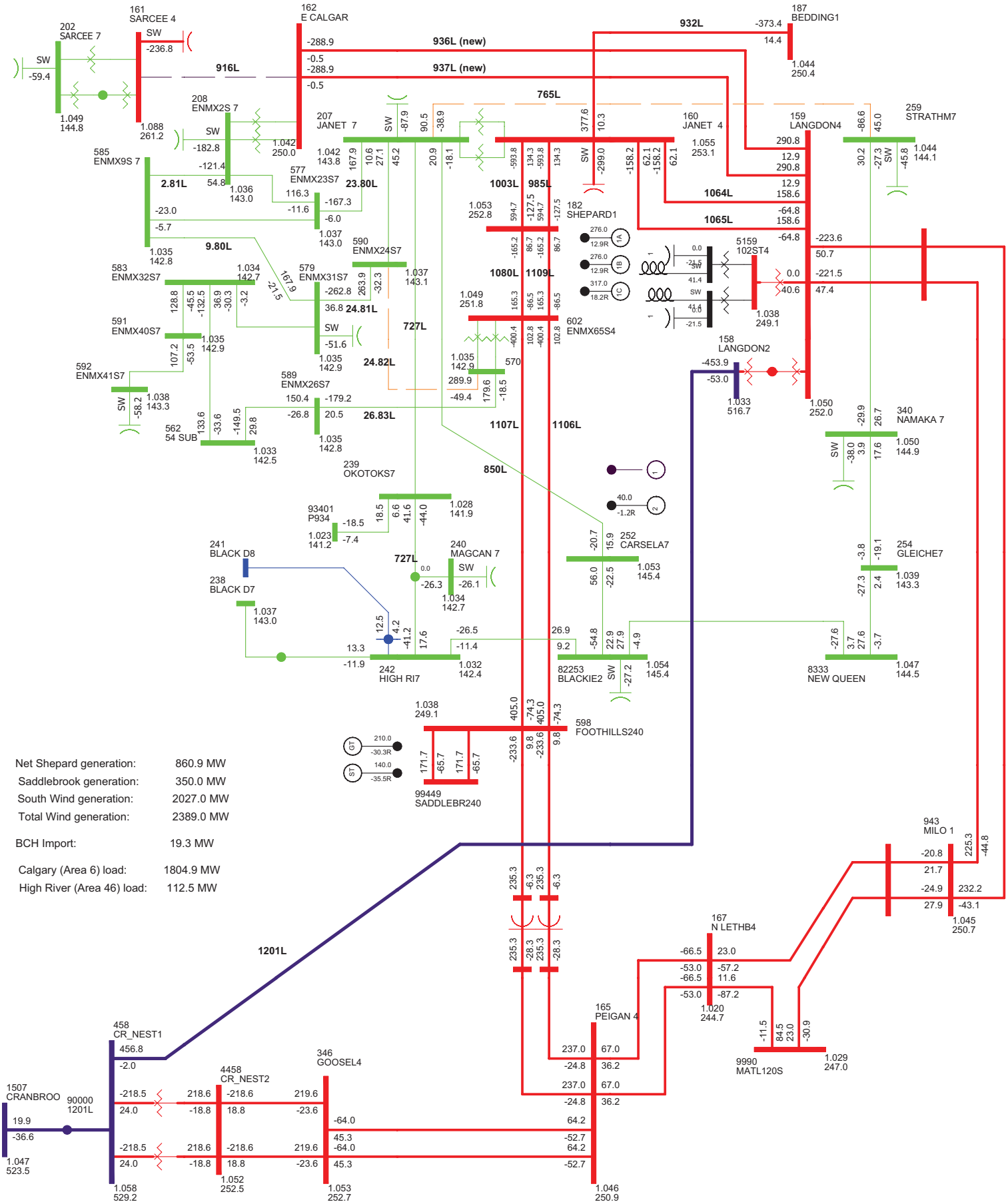


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-6

1003L (JANET 74S TO ENMAX NO. 25)

WED, APR 20 2011 14:56

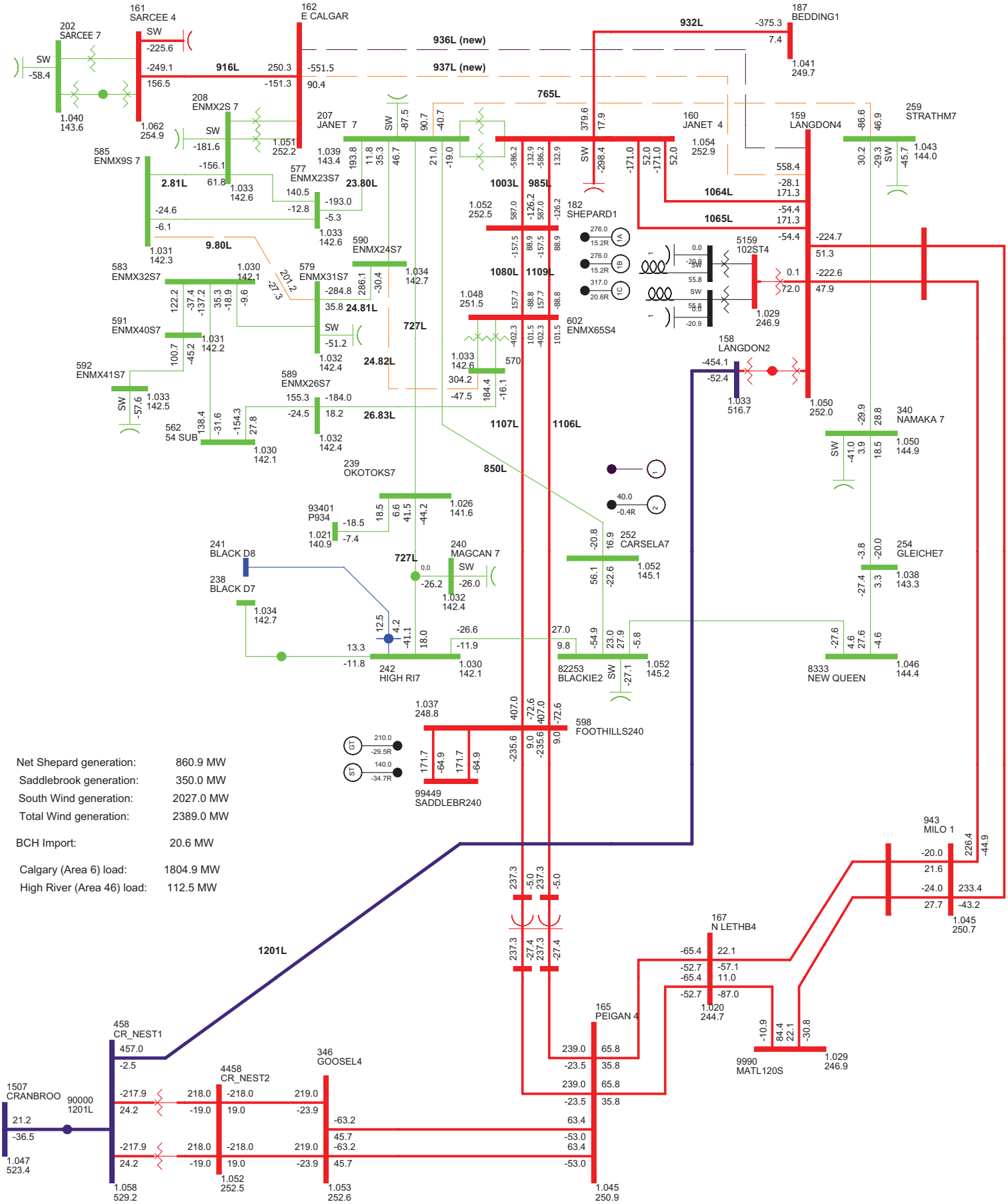


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-7

916L (SARCEE 42S TO EAST CALGARY 5S)

WED, APR 20 2011 14:57

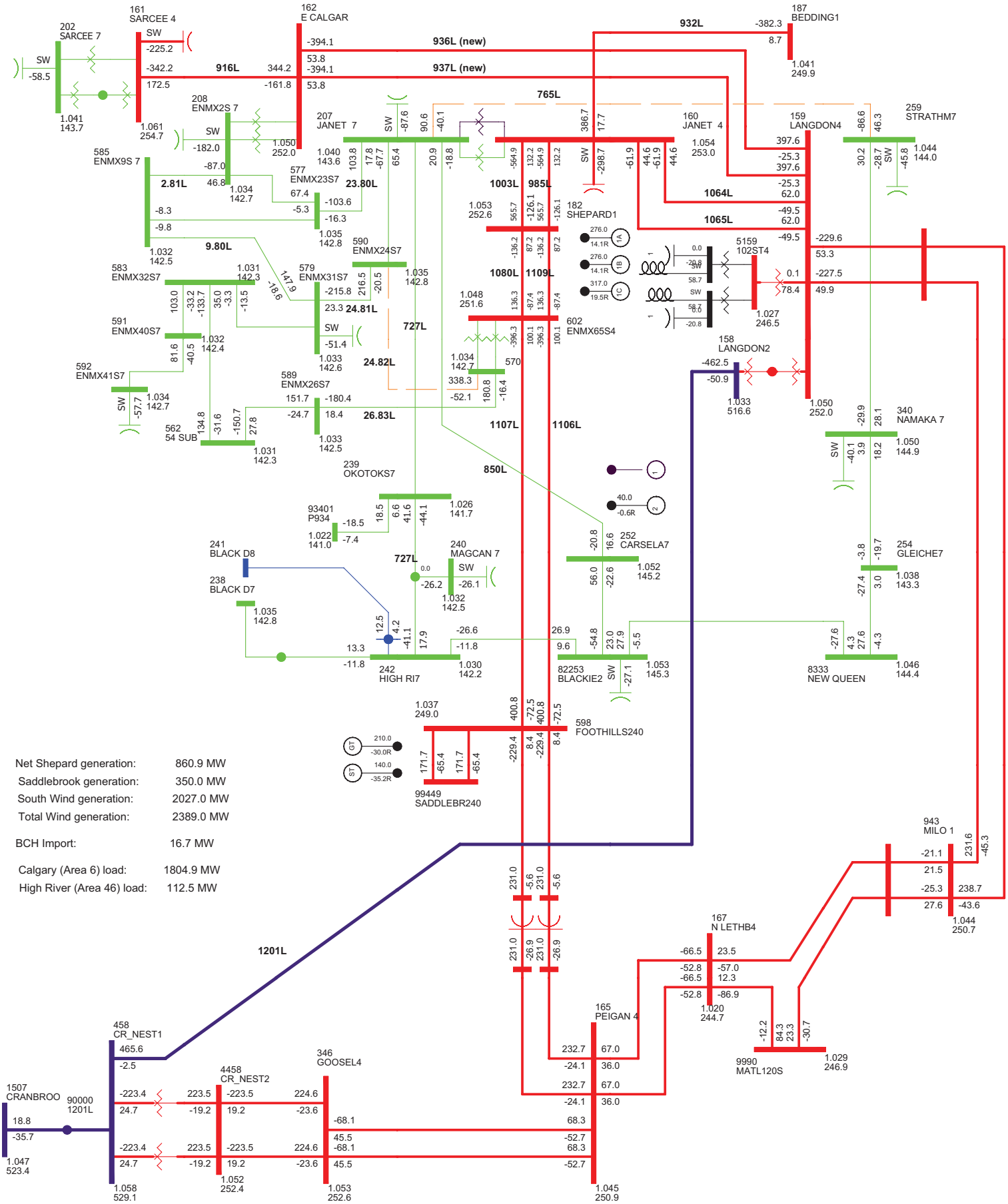


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-8

936L (LANGDON 102S TO EAST CALGARY 5S)

WED, APR 20 2011 14:57



Net Shepard generation: 860.9 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 2027.0 MW
Total Wind generation: 2389.0 MW

BCH Import: 16.7 MW

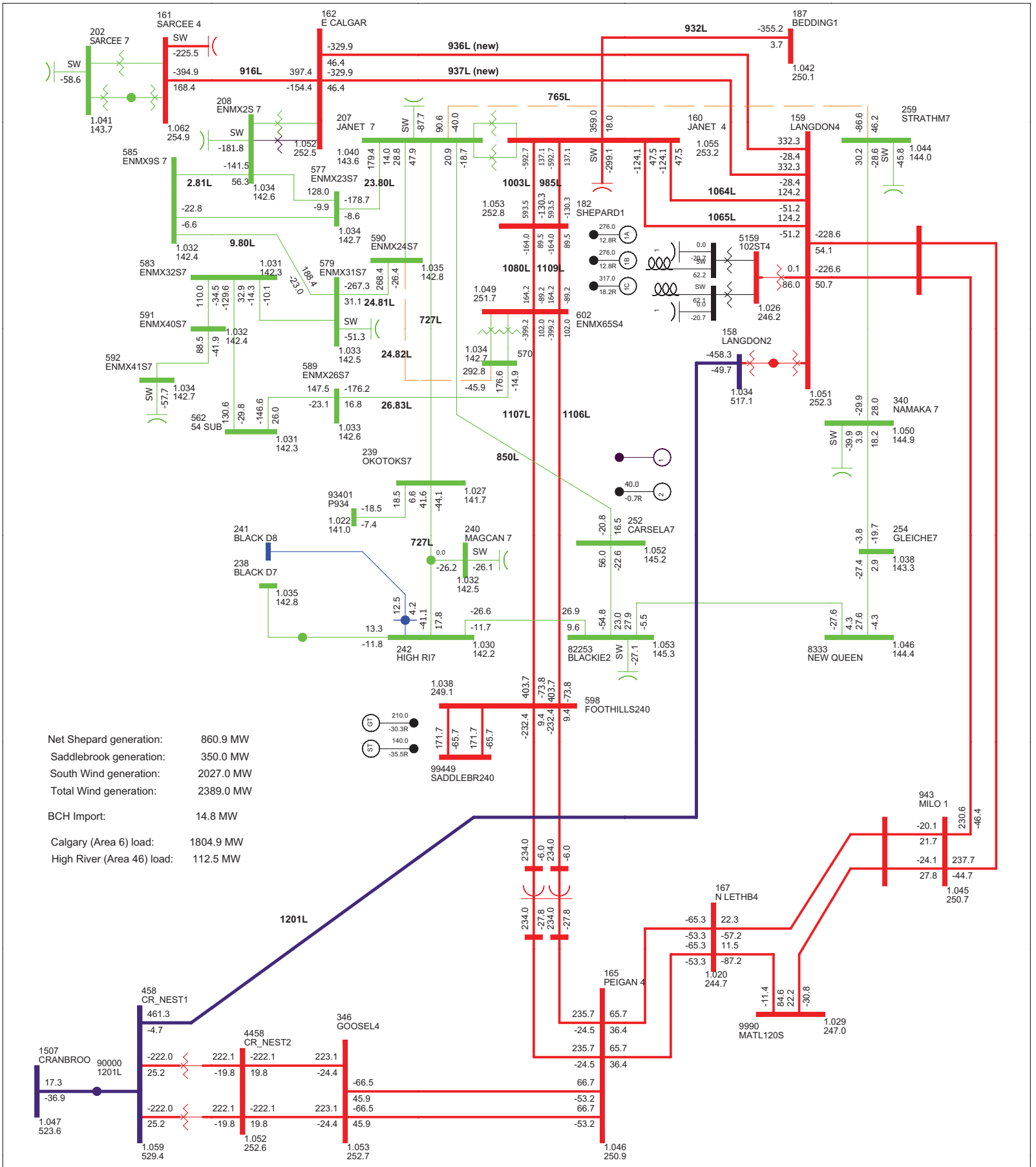
Calgary (Area 6) load: 1804.9 MW
High River (Area 46) load: 112.5 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-9

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 14:57

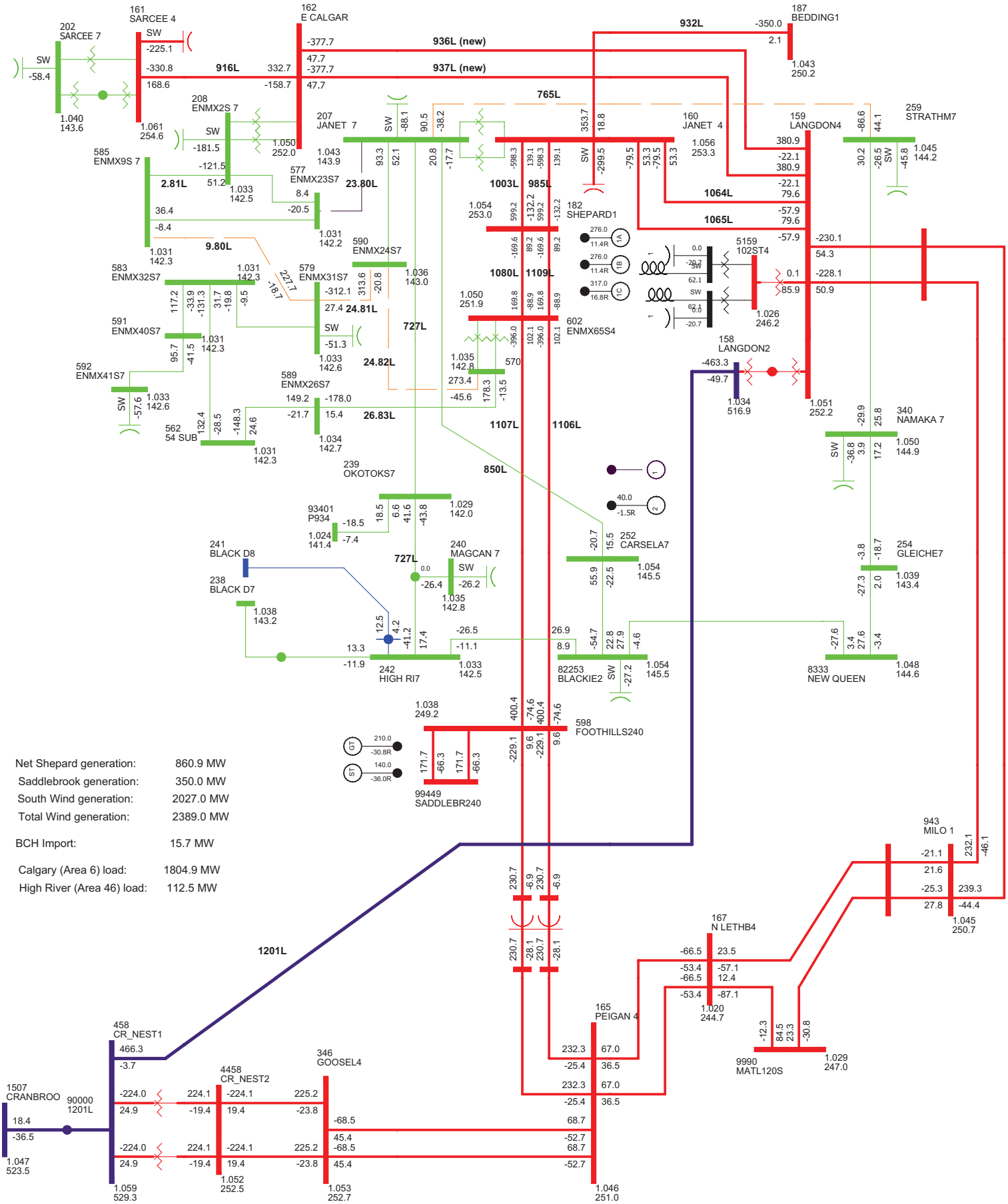


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-10

240/138 KV TRANSFORMER (EAST CALGARY 5S)

WED, APR 20 2011 14:57

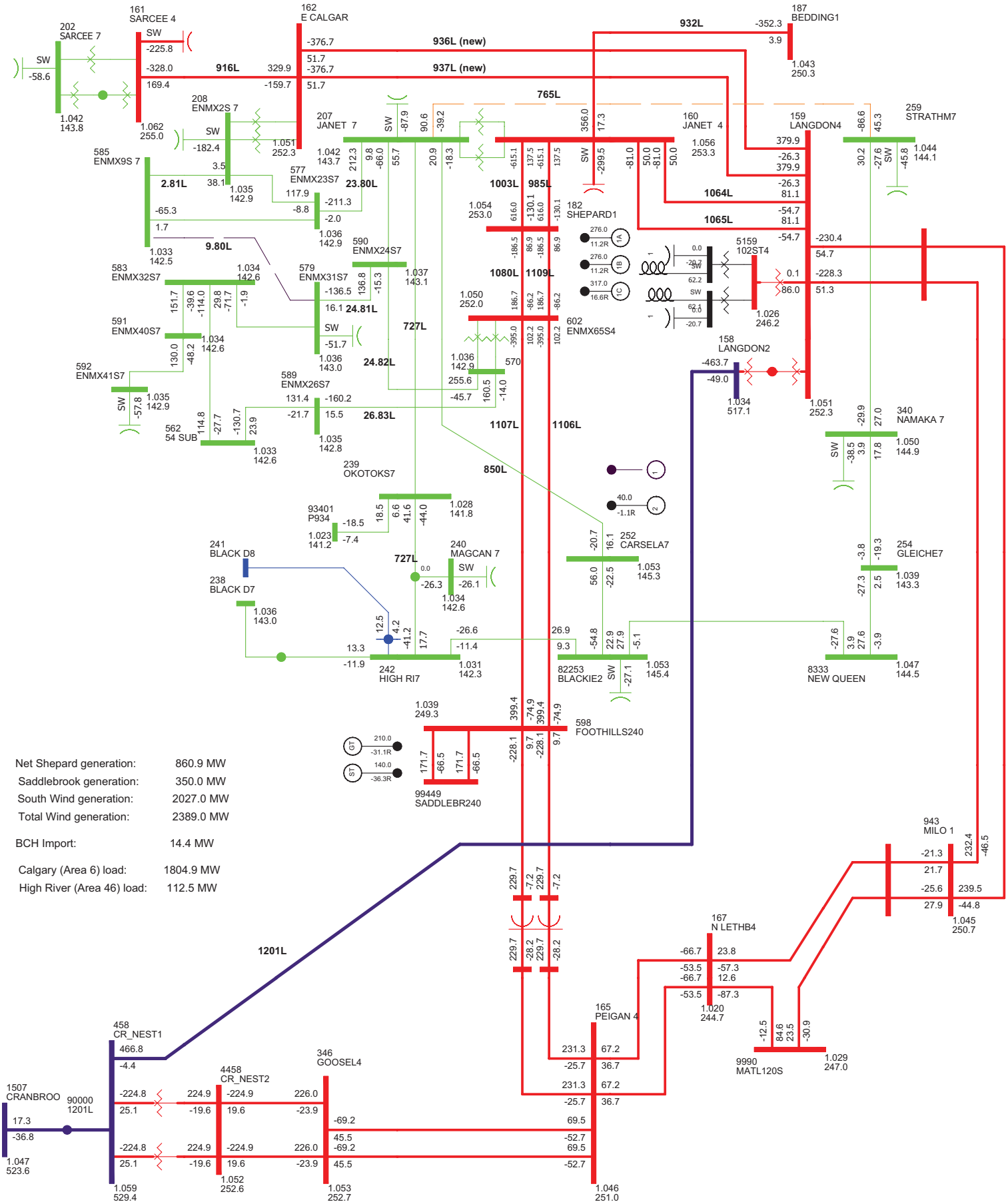


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-11

23.80L (JANET 74S TO ENMAX NO. 23)

WED, APR 20 2011 14:58



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure D-2014-Step2-Sc4-12

9.80L (ENMAX NO. 31 TO ENMAX NO. 9)

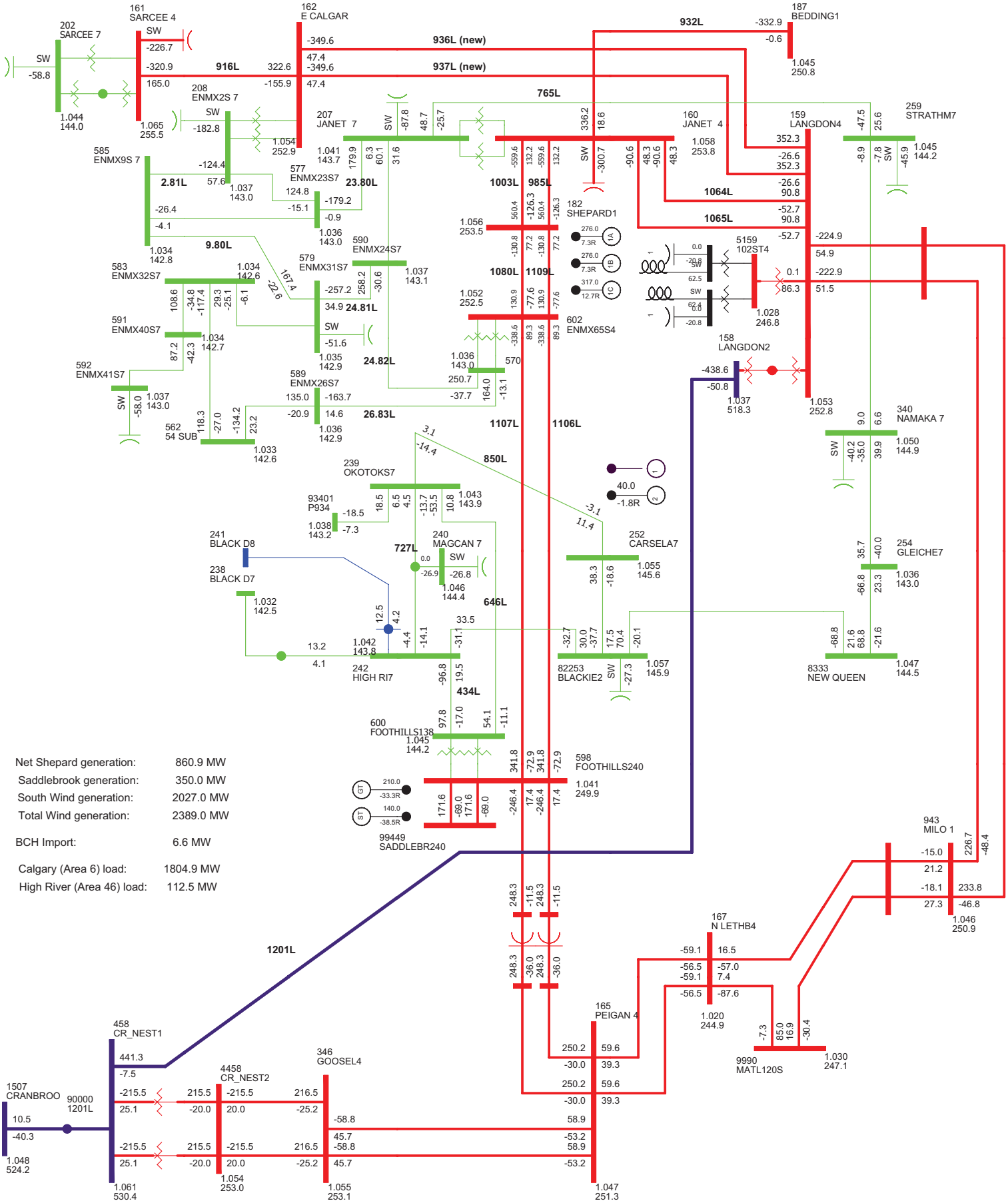
WED, APR 20 2011 14:58

ATTACHMENT E

Transmission Development Plan – Step 3, 2014

Table E-1

Figure Name	Contingency
Figure E-2014-Step3-Sc4-1	Base Case (N-0)
Figure E-2014-Step3-Sc4-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure E-2014-Step3-Sc4-3	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure E-2014-Step3-Sc4-4	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure E-2014-Step3-Sc4-5	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure E-2014-Step3-Sc4-6	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure E-2014-Step3-Sc4-7	Open 240/138 kV transformer (Janet 74S)
Figure E-2014-Step3-Sc4-8	Open 240/138 kV transformer (East Calgary 5S)
Figure E-2014-Step3-Sc4-9	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)
Figure E-2014-Step3-Sc4-10	Open 9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)

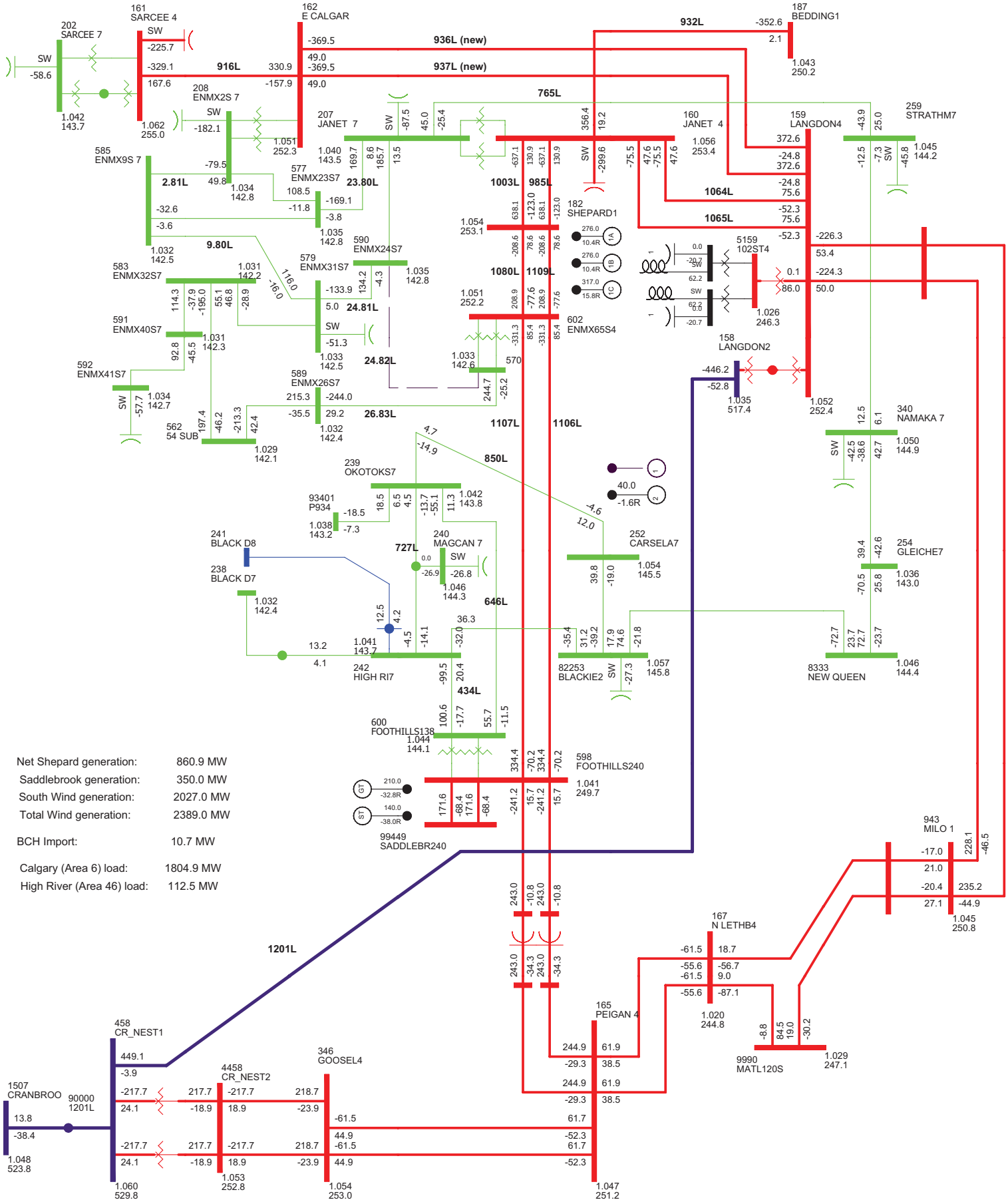


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 15:11

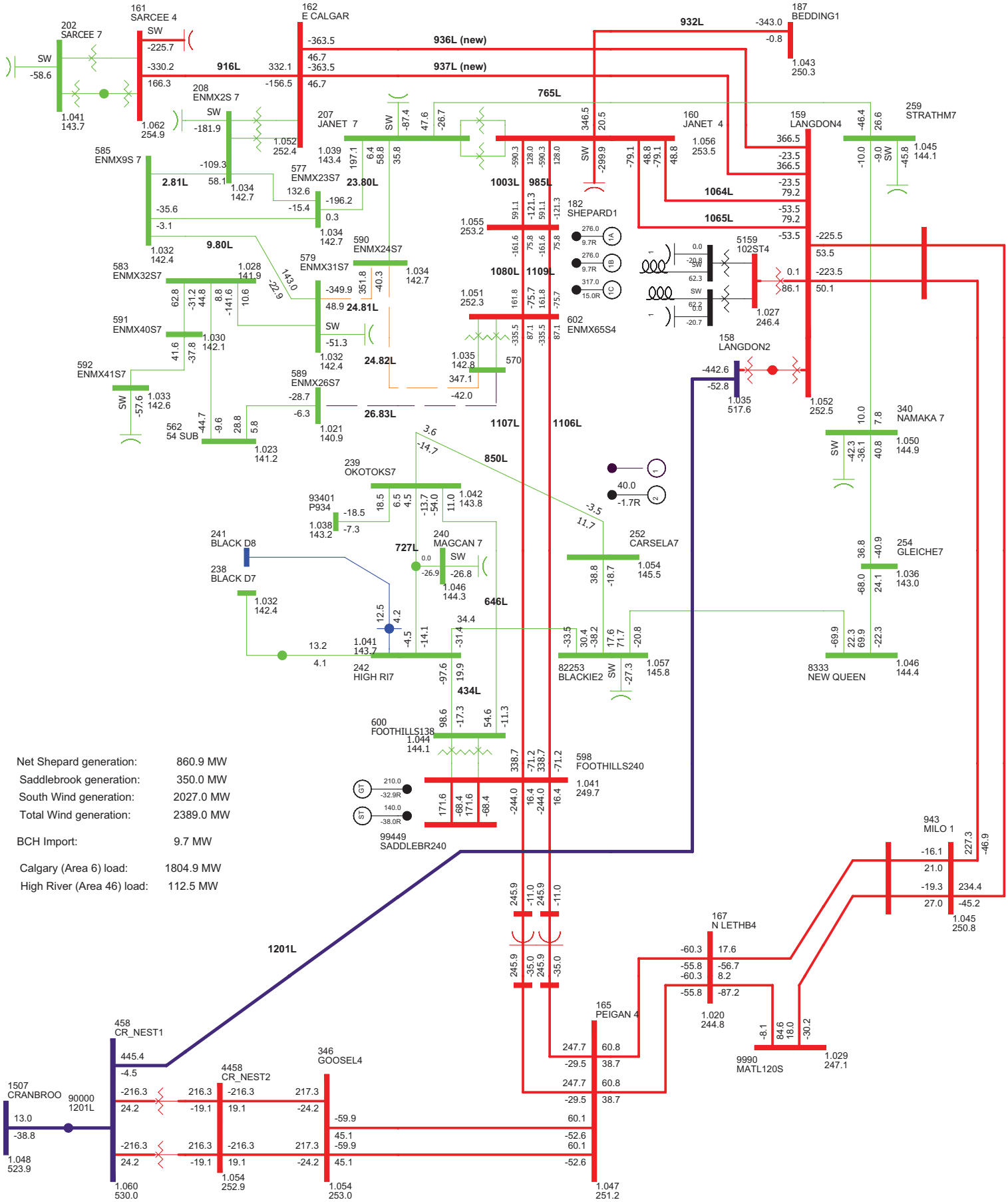


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

WED, APR 20 2011 15:11

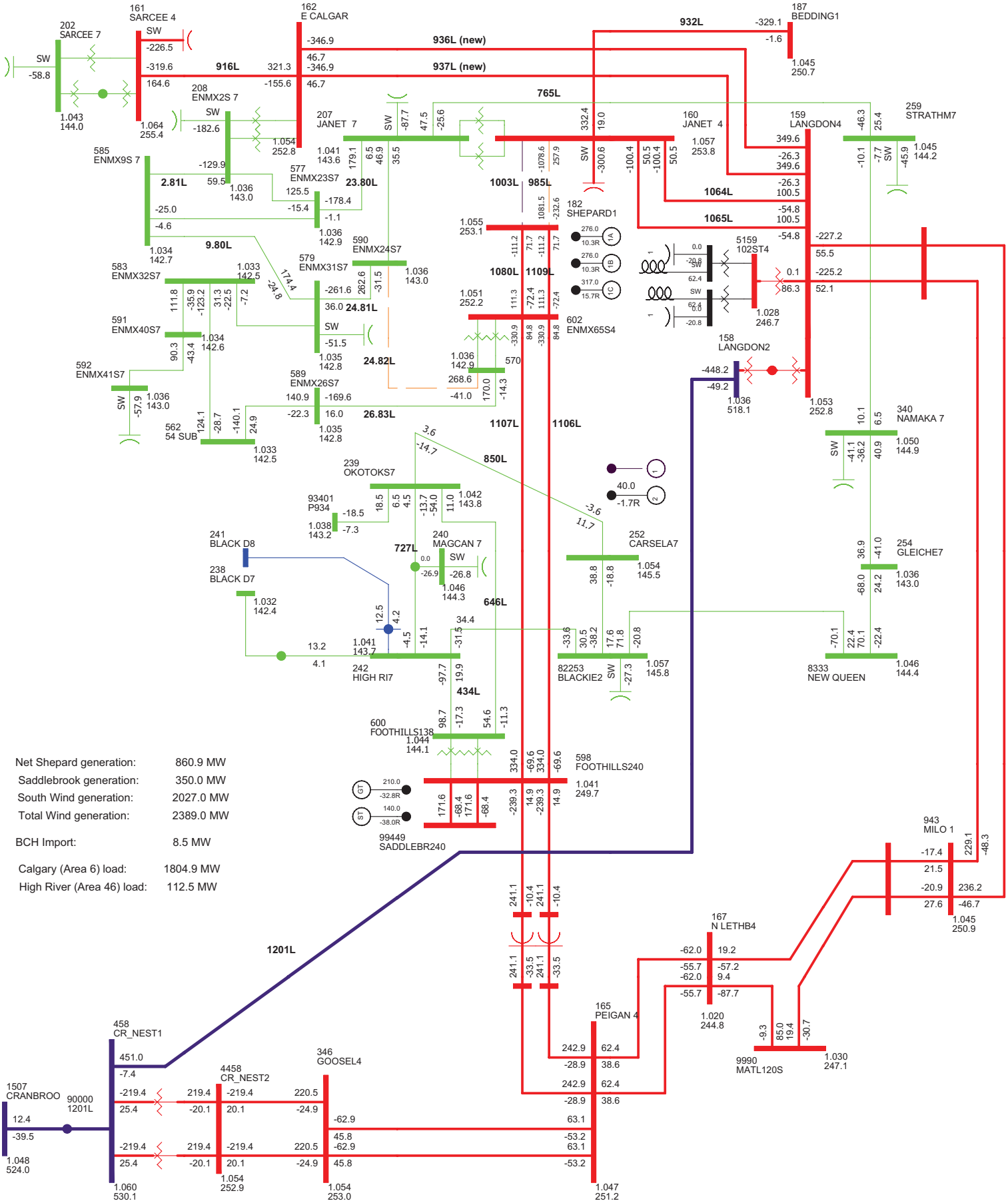


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-3

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 20 2011 15:11

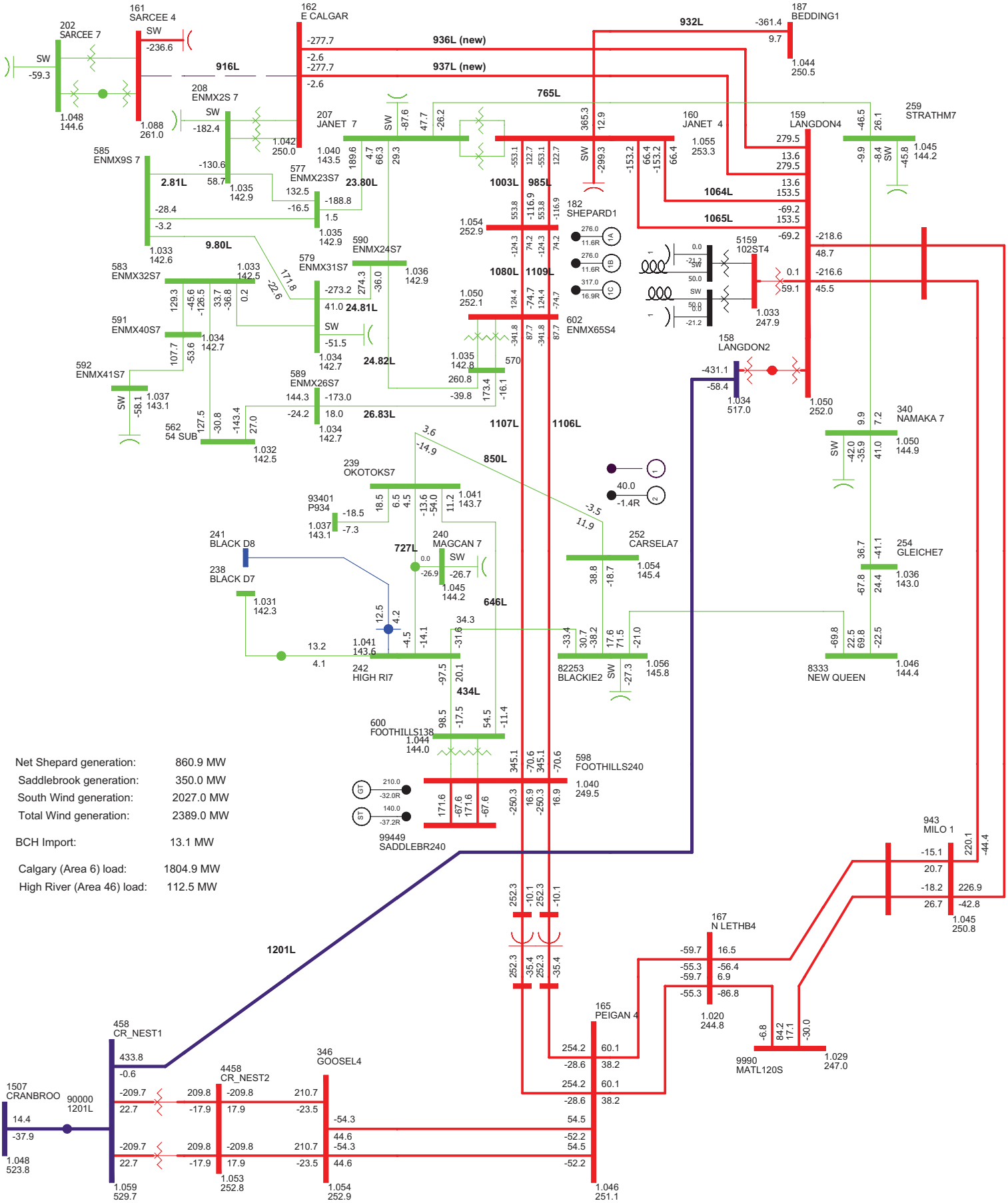


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-4

1003L (JANET 74S TO ENMAX NO. 25)

WED, APR 20 2011 15:11

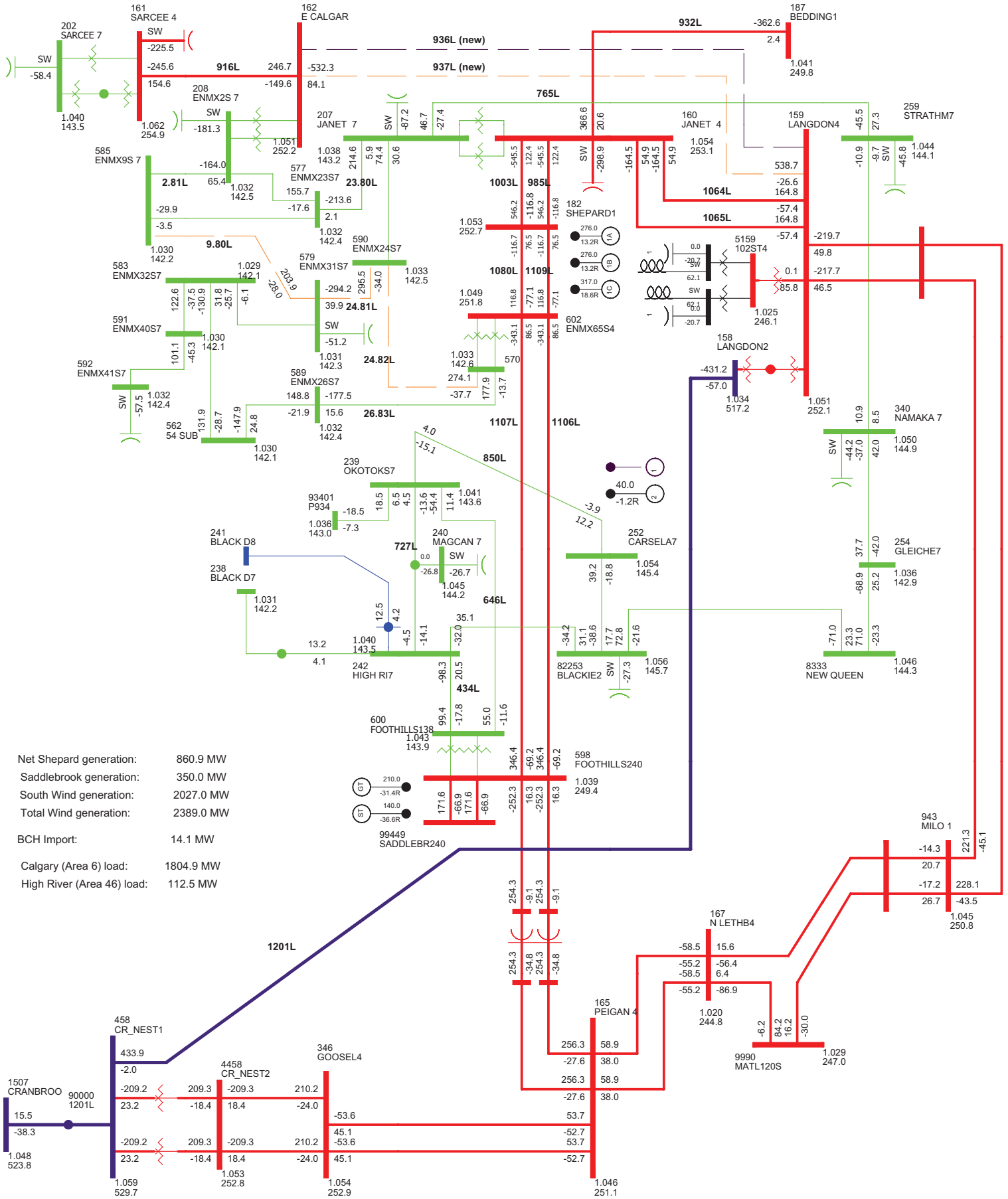


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-5

916L (SARCEE 42S TO EAST CALGARY 5S)

WED, APR 20 2011 15:12

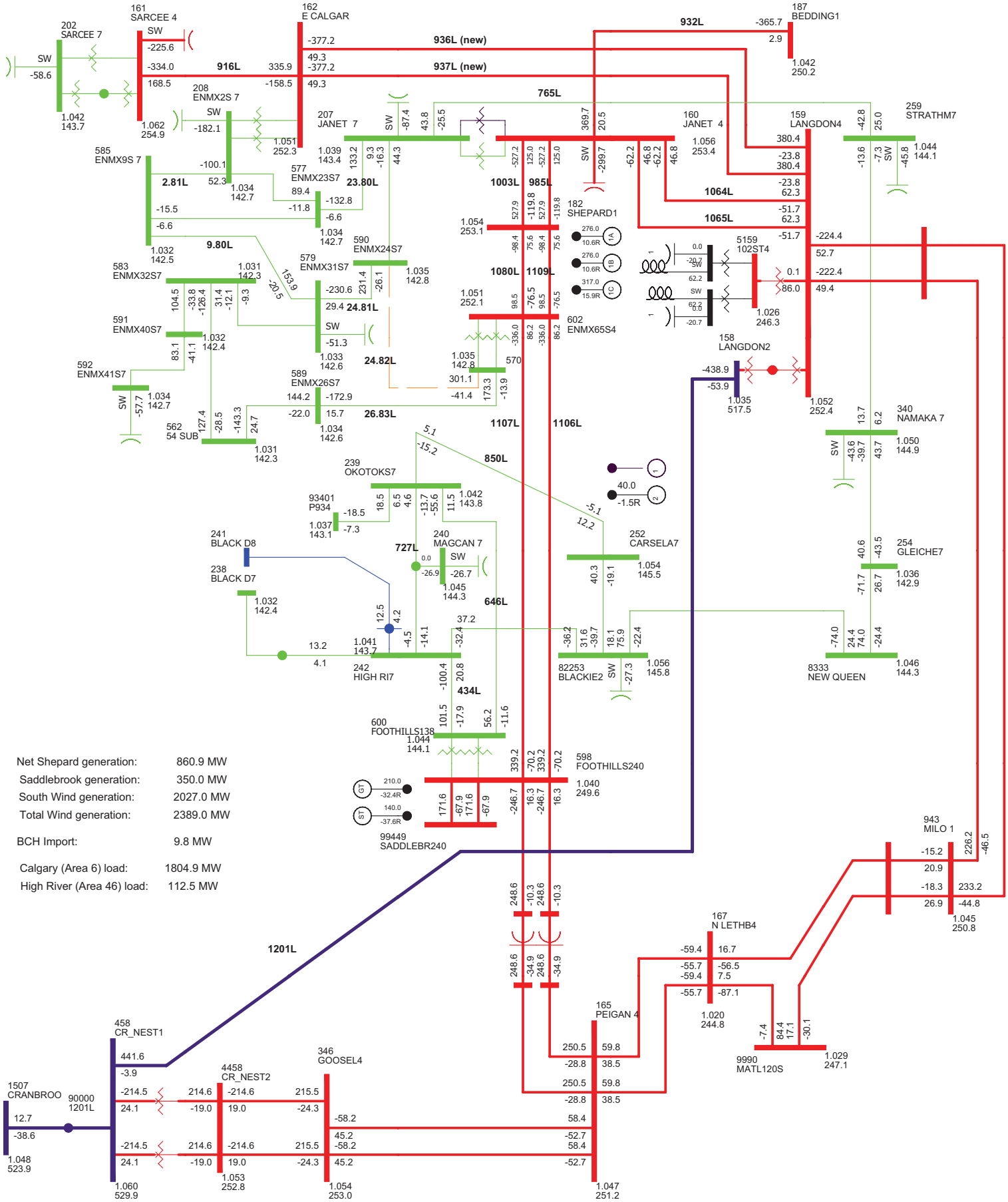


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-6

936L (LANGDON 102S TO EAST CALGARY 5S)

WED, APR 20 2011 15:12

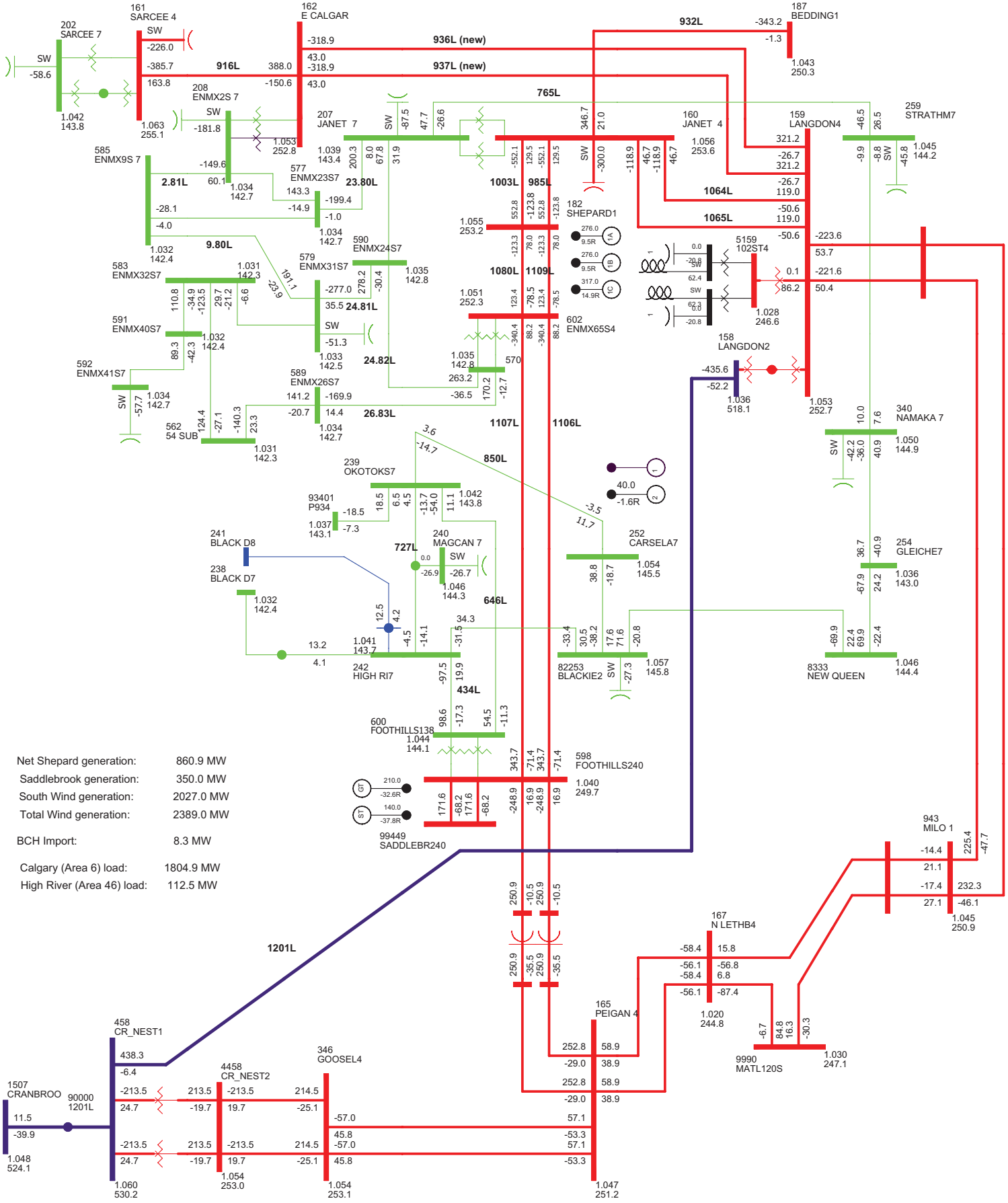


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-7

240/138 KV TRANSFORMER (JANET 74S)

WED, APR 20 2011 15:12

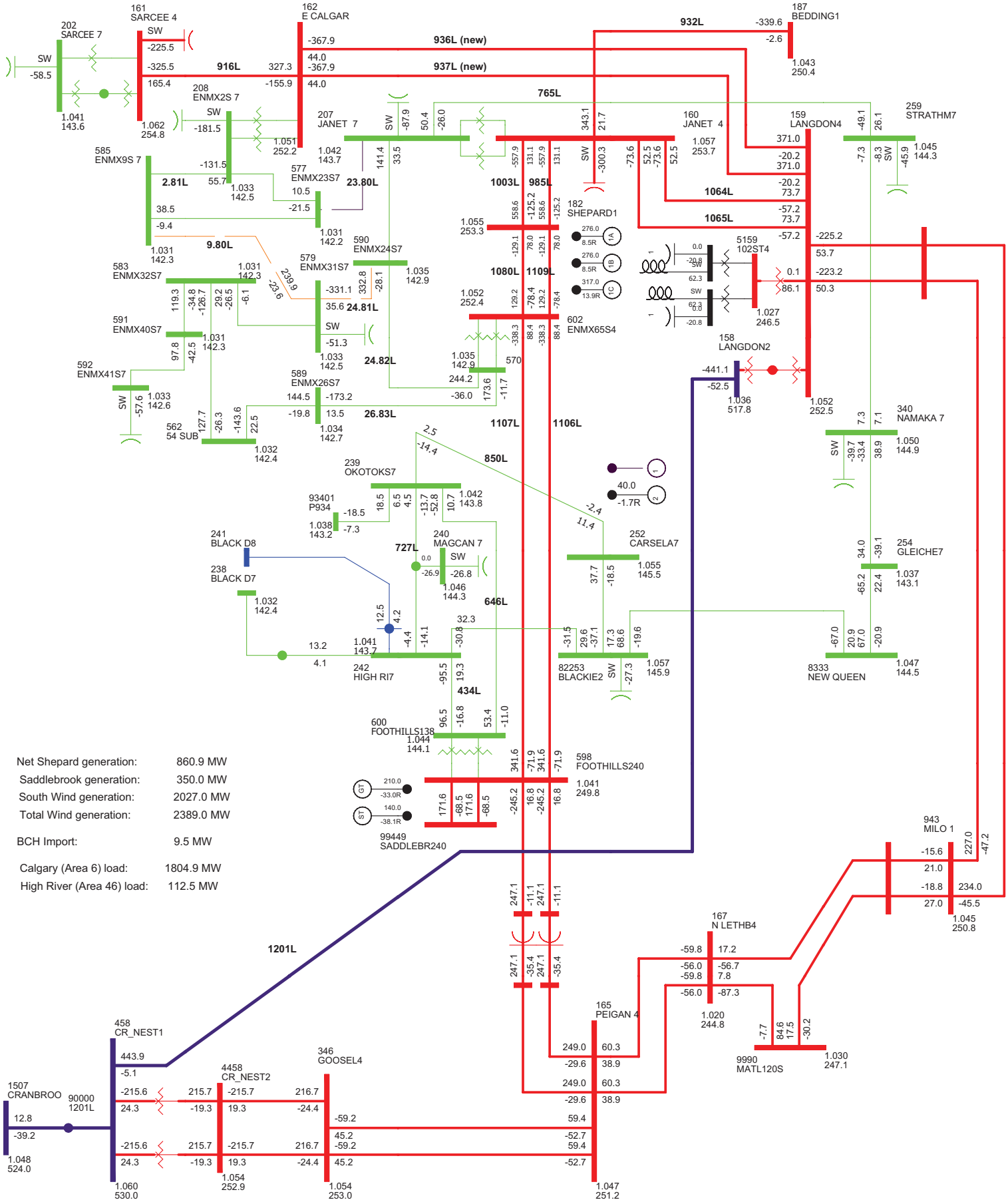


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-8

240/138 KV TRANSFORMER (EAST CALGARY 5S)

WED, APR 20 2011 15:12

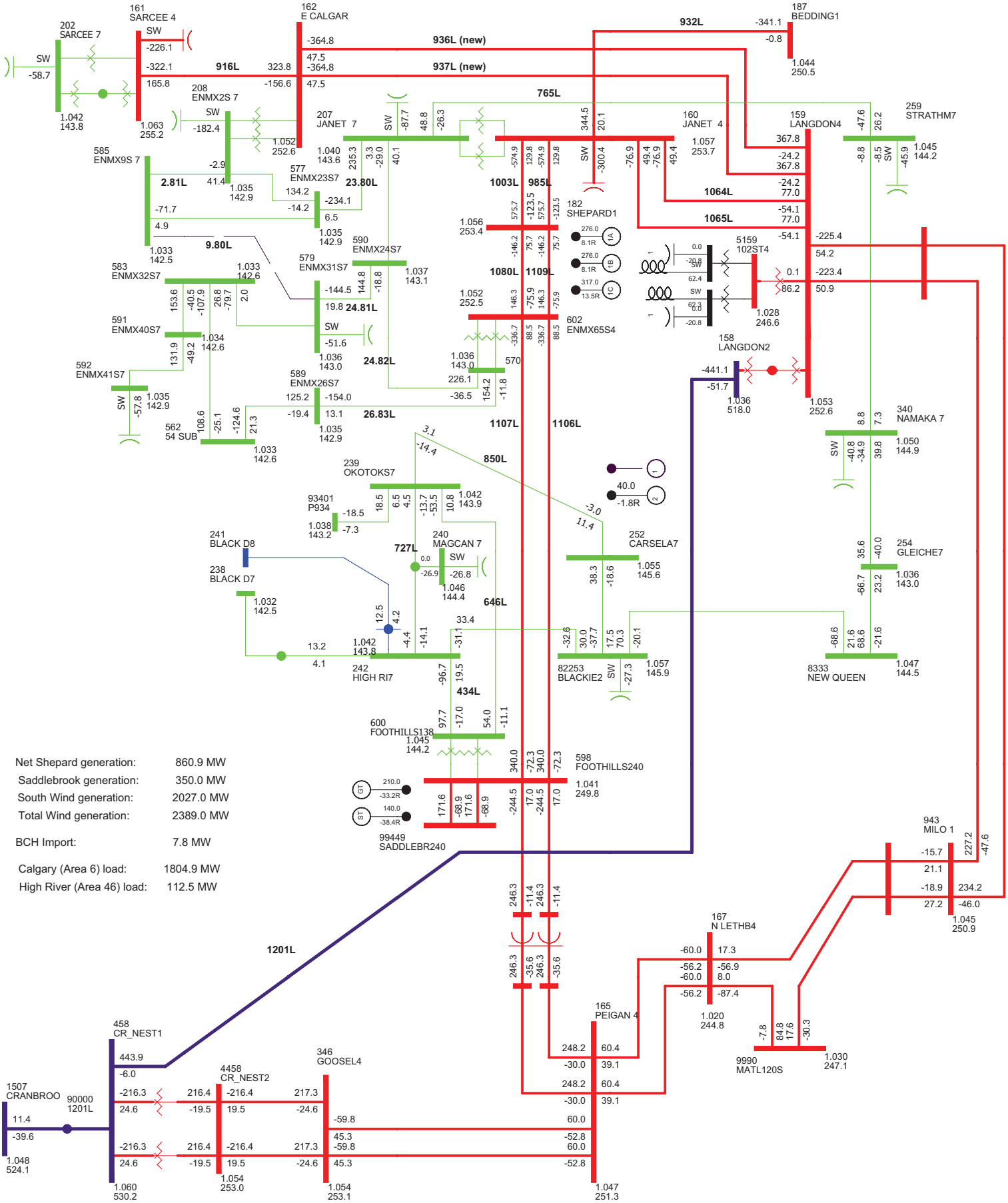


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-9

23.80L (JANET 74S TO ENMAX NO. 23)

WED, APR 20 2011 15:13



Net Shepard generation: 860.9 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 2027.0 MW
Total Wind generation: 2389.0 MW

BCH Import: 7.8 MW

Calgary (Area 6) load: 1804.9 MW
High River (Area 46) load: 112.5 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure E-2014-Step3-Sc4-10

9.80L (ENMAX NO. 31 TO ENMAX NO. 9)

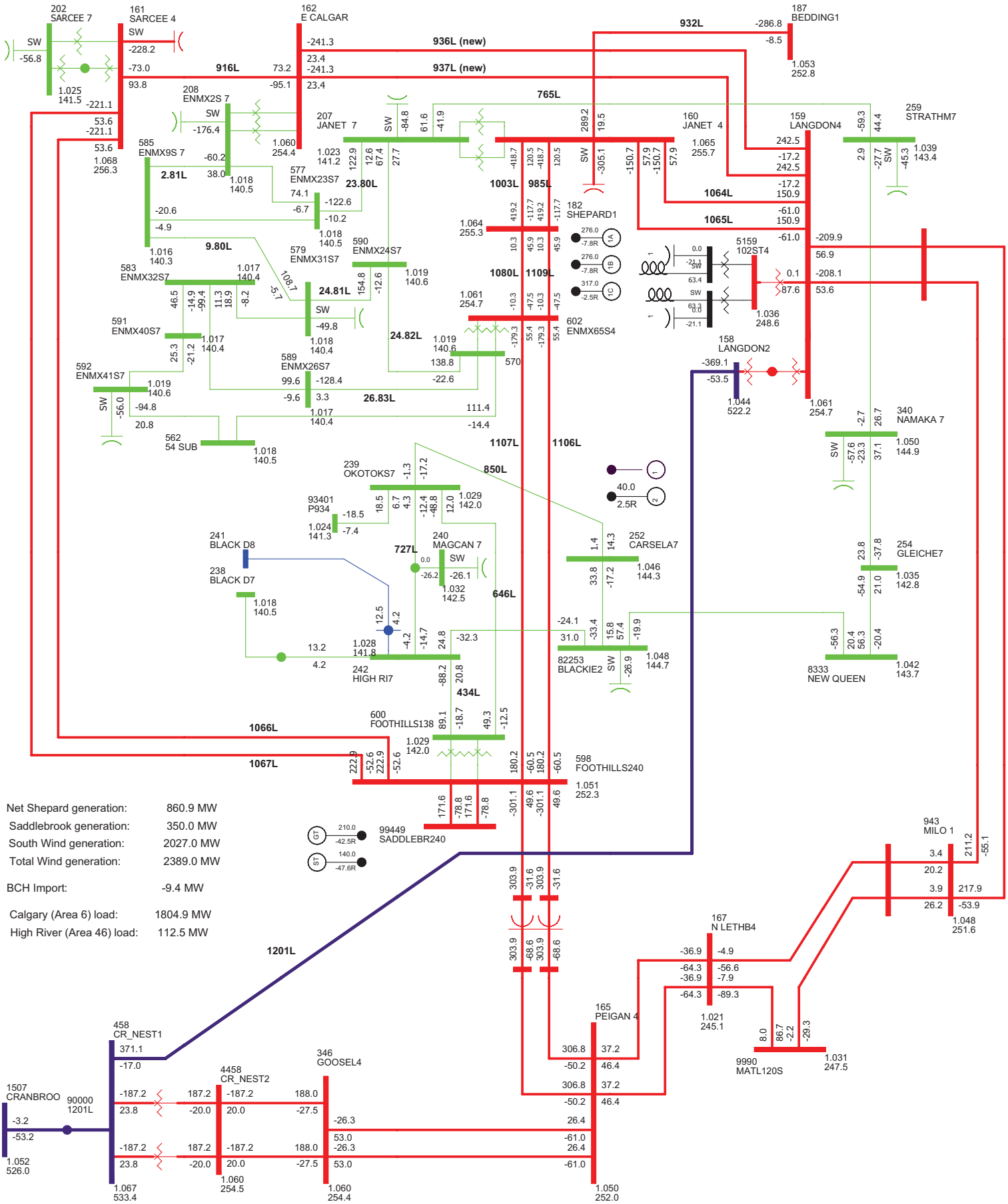
WED, APR 20 2011 15:13

ATTACHMENT F

Transmission Development Plan – Step 4, 2014

Table F-1

Figure Name	Contingency
Figure F-2014-Step4-Sc4-1	Base Case (N-0)
Figure F-2014-Step4-Sc4-2	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)

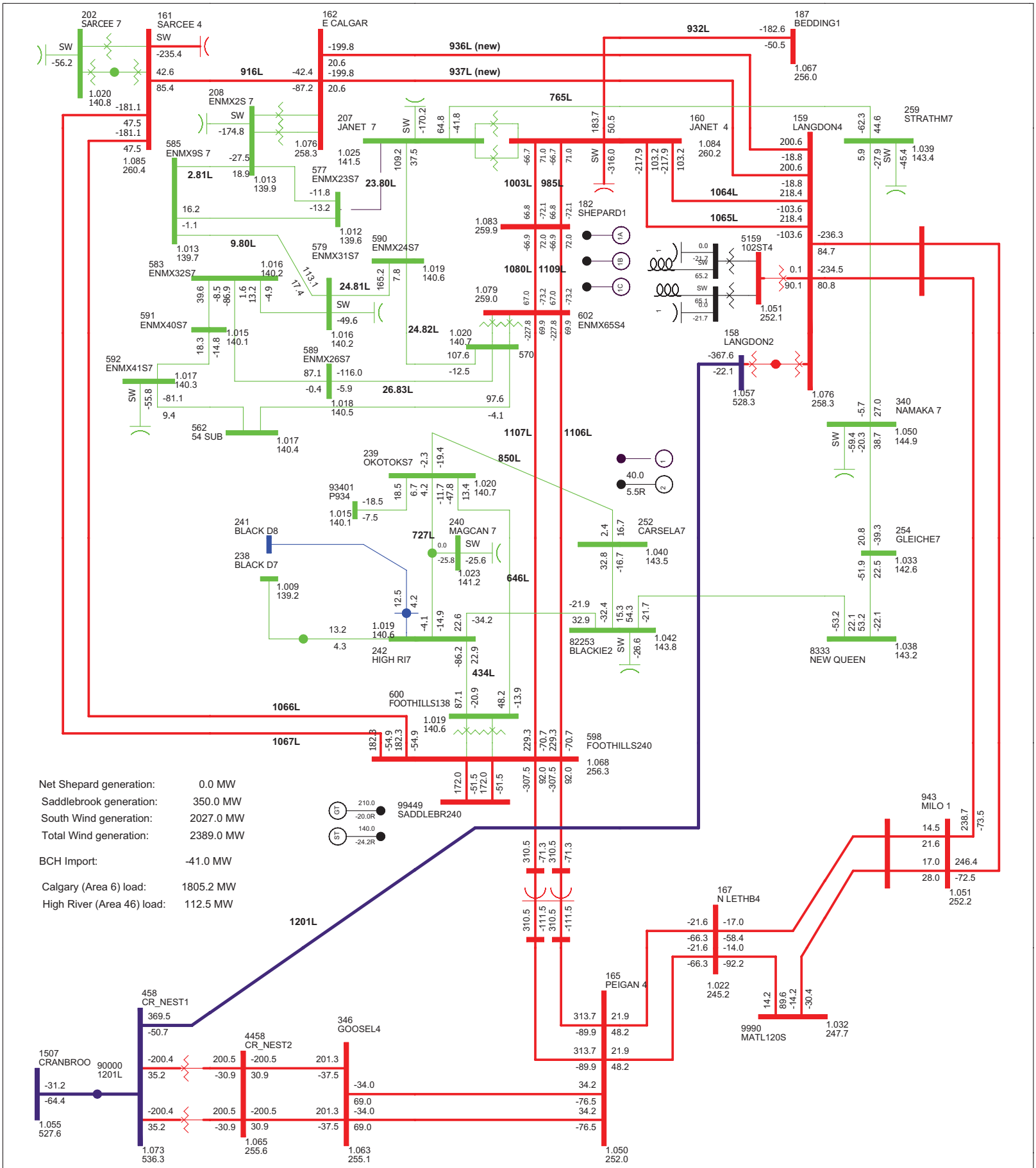


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure F-2014-Step4-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 20 2011 15:15



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure F-2014-Step4-Sc4-2

23.80L (JANET 74S TO ENMAX NO. 23)

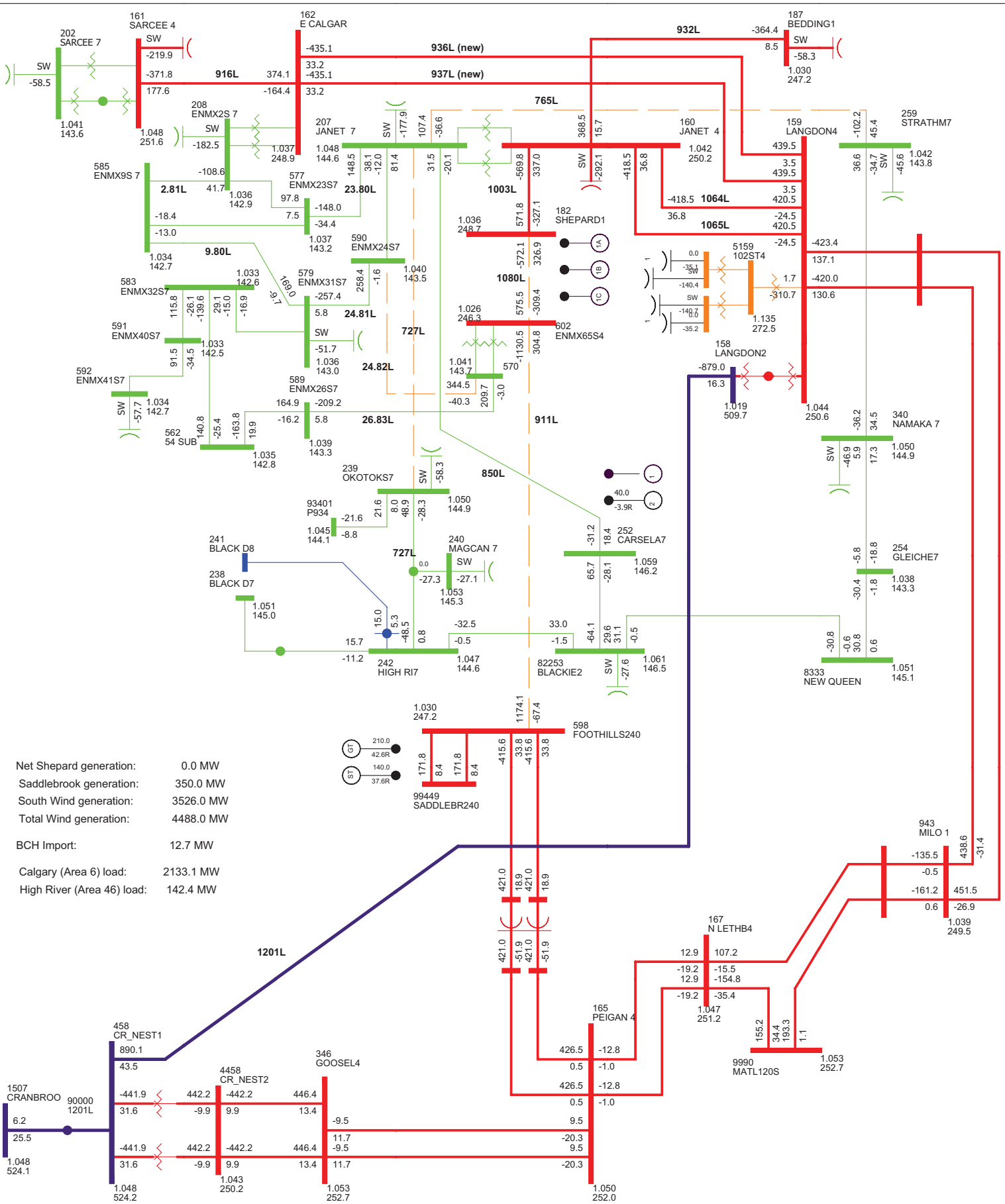
WED, APR 20 2011 15:15

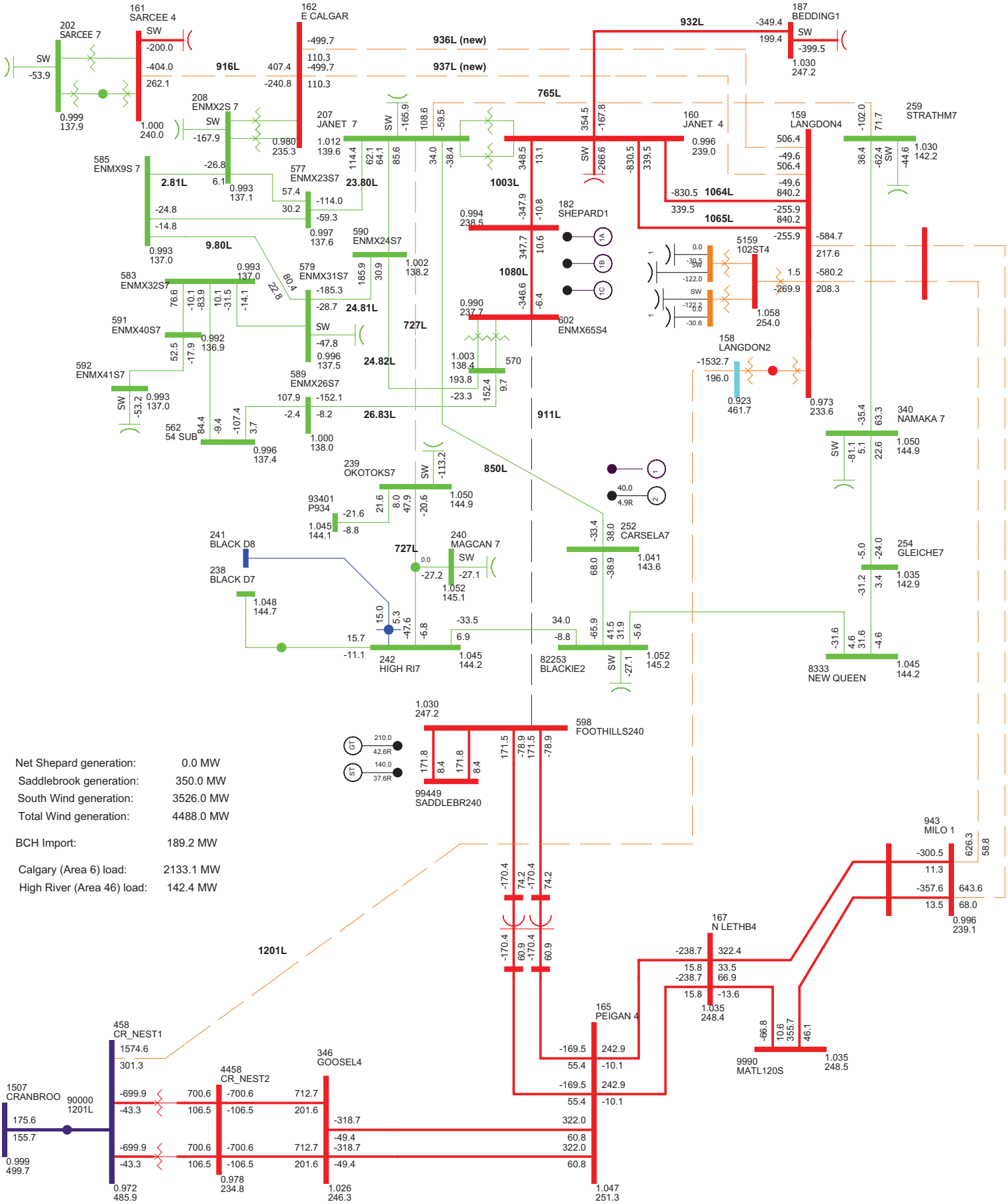
ATTACHMENT G

Transmission Development Plan – Step 1, 2019

Table G-1

Figure Name	Contingency
Figure G-2019-Step1-Sc3-1	Base Case (N-0)
Figure G-2019-Step1-Sc3-2	Open 1106L 240kV line (Foothills 237S to ENMAX No. 65)
Figure G-2019-Step1-Sc3-3	Open 500/240 kV transformer (Langdon 102S)
Figure G-2019-Step1-Sc4-1	Base Case (N-0)
Figure G-2019-Step1-Sc4-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure G-2019-Step1-Sc4-3	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure G-2019-Step1-Sc4-4	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure G-2019-Step1-Sc4-5	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure G-2019-Step1-Sc4-6	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure G-2019-Step1-Sc4-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure G-2019-Step1-Sc4-8	Open 1106L 240kV line (Foothills 237S to ENMAX No. 65)
Figure G-2019-Step1-Sc4-9	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure G-2019-Step1-Sc4-10	Open 240/138 kV transformer (Janet 74S)
Figure G-2019-Step1-Sc4-11	Open 240/138 kV transformer (East Calgary 5S)
Figure G-2019-Step1-Sc4-12	Open 500/240 kV transformer (Langdon 102S)
Figure G-2019-Step1-Sc4-13	Open 240/138 kV transformer (ENMAX No. 65)
Figure G-2019-Step1-Sc4-14	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)
Figure G-2019-Step1-Sc4-15	Open 9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)
Figure G-2019-Step1-Sc4-16	Open 24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)


Net Shepard generation: 0.0 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 3526.0 MW
Total Wind generation: 4488.0 MW
BCH Import: 12.7 MW
Calgary (Area 6) load: 2133.1 MW
High River (Area 46) load: 142.4 MW
161 SARCEE 4
162 E CALGAR
202 SARCEE 7
916L
936L (new)
937L (new)
932L
765L
187 BEDDING1
207 JANET 7
160 JANET 4
159 LANGDON4
259 STRATHM7
208 ENMX2S 7
585 ENMX9S 7
577 ENMX23S7
23.80L
1003L
1064L
1065L
182 SHEPARD1
5159 102ST4
590 ENMX24S7
579 ENMX31S7
1080L
583 ENMX32S7
24.81L
727L
591 ENMX40S7
602 ENMX65S4
158 LANGDON2
592 ENMX41S7
589 ENMX26S7
26.83L
911L
562 54 SUB
340 NAMAKA 7
239 OKOTOKS7
850L
93401 P934
241 BLACK D8
240 MAGCAN 7
252 CARSELA7
238 BLACK D7
254 GLEICHE7
242 HIGH RI7
82253 BLACKIE2
8333 NEW QUEEN
598 FOOTHILLS240
99449 SADDLEBR240
943 MILO 1
1201L
167 N LETHB4
165 PEIGAN 4
458 CR_NEST1
4458 CR_NEST2
346 GOOSEL4
1507 CRANBROO
90000 1201L
9990 MATL120S
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure G-2019-Step1-Sc3-1
BASE CASE (ALL ELEMENTS IN SERVICE)
TUE, APR 26 2011 14:24

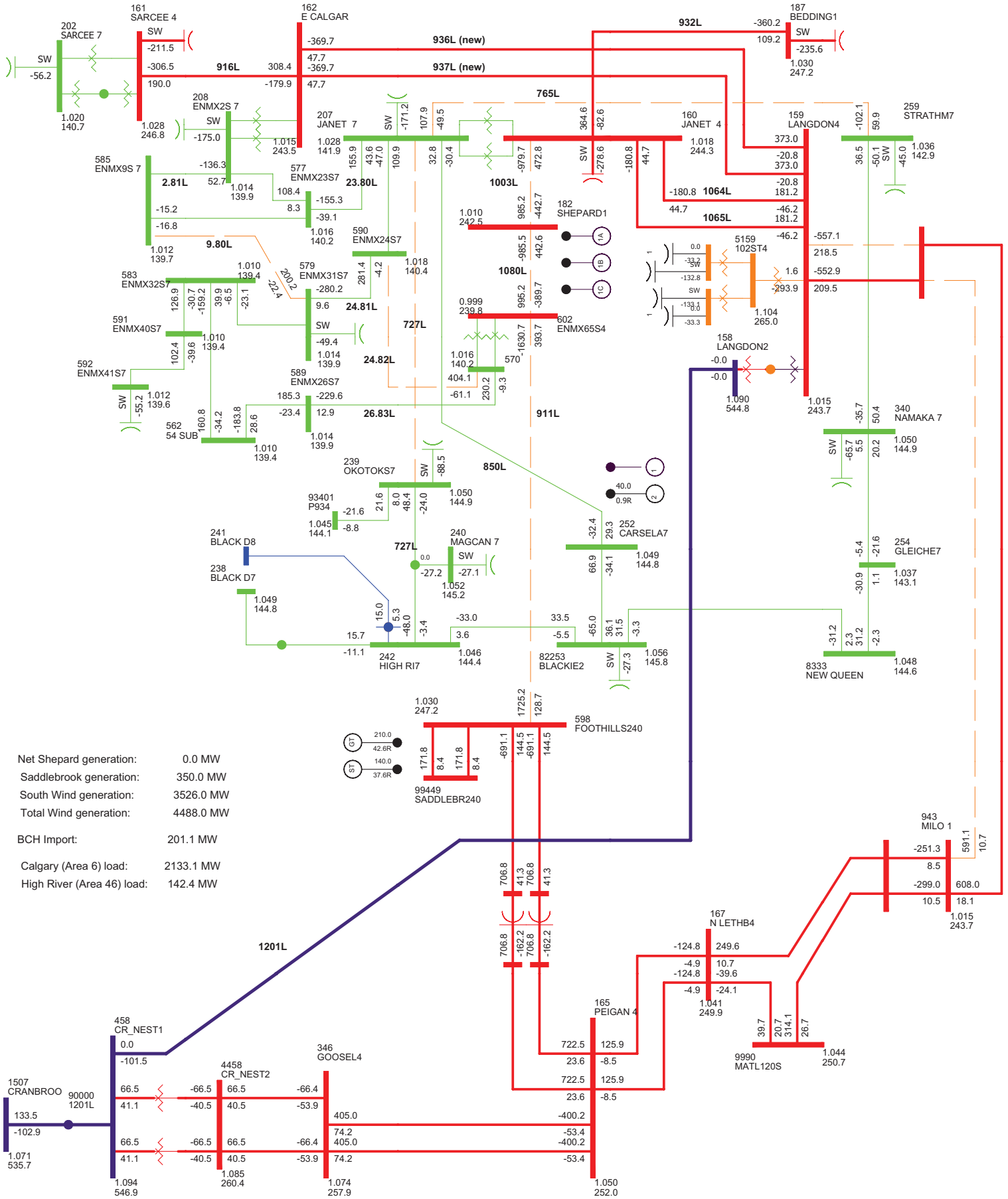


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc3-2

1106L (FOOTHILLS 237S TO ENMAX NO. 65)

TUE, APR 26 2011 14:24

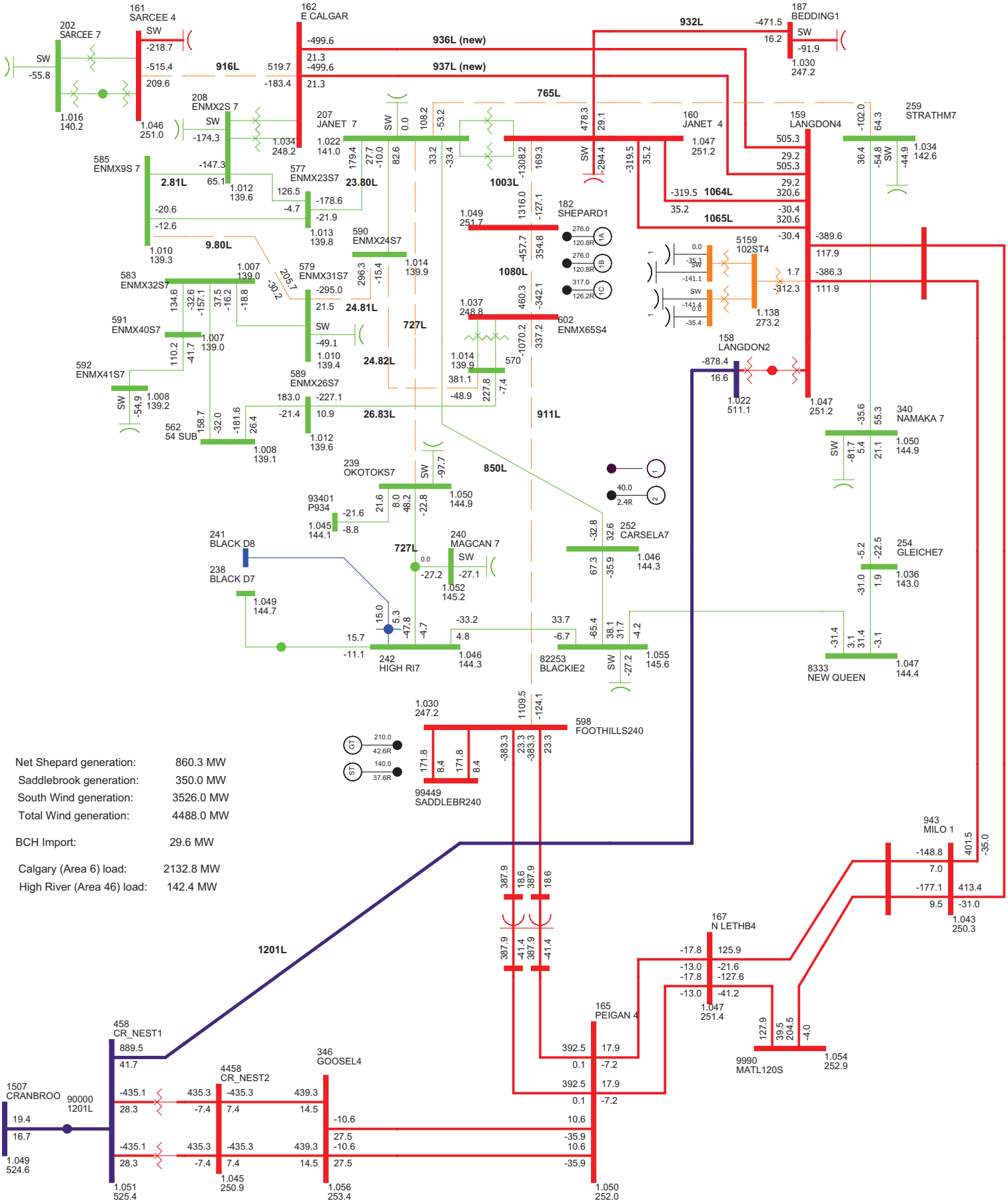


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc3-3

500/240 KV TRANSFORMER (LANGDON 102S)

TUE, APR 26 2011 14:24

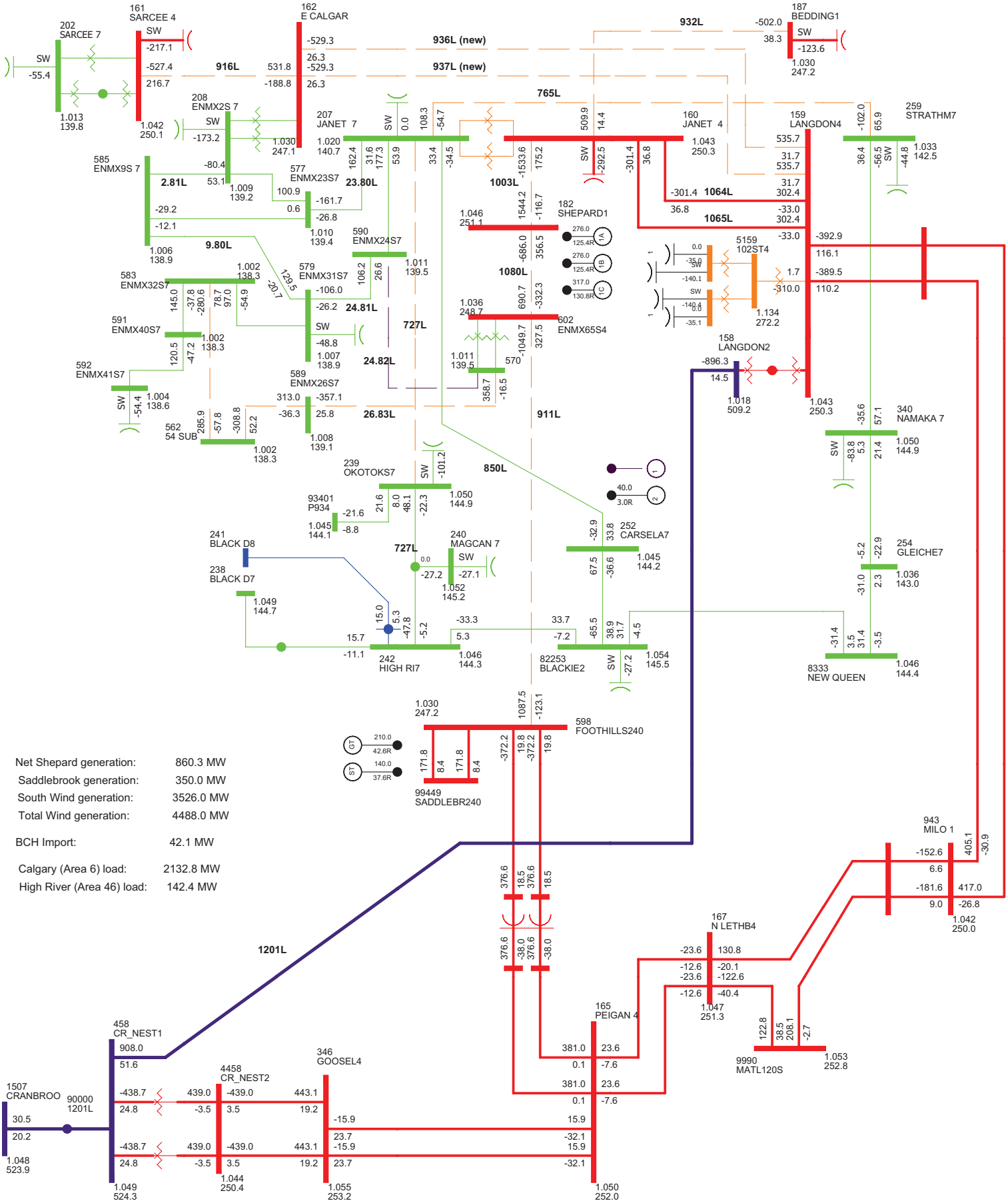


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

TUE, APR 26 2011 14:24



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

TUE, APR 26 2011 14:25

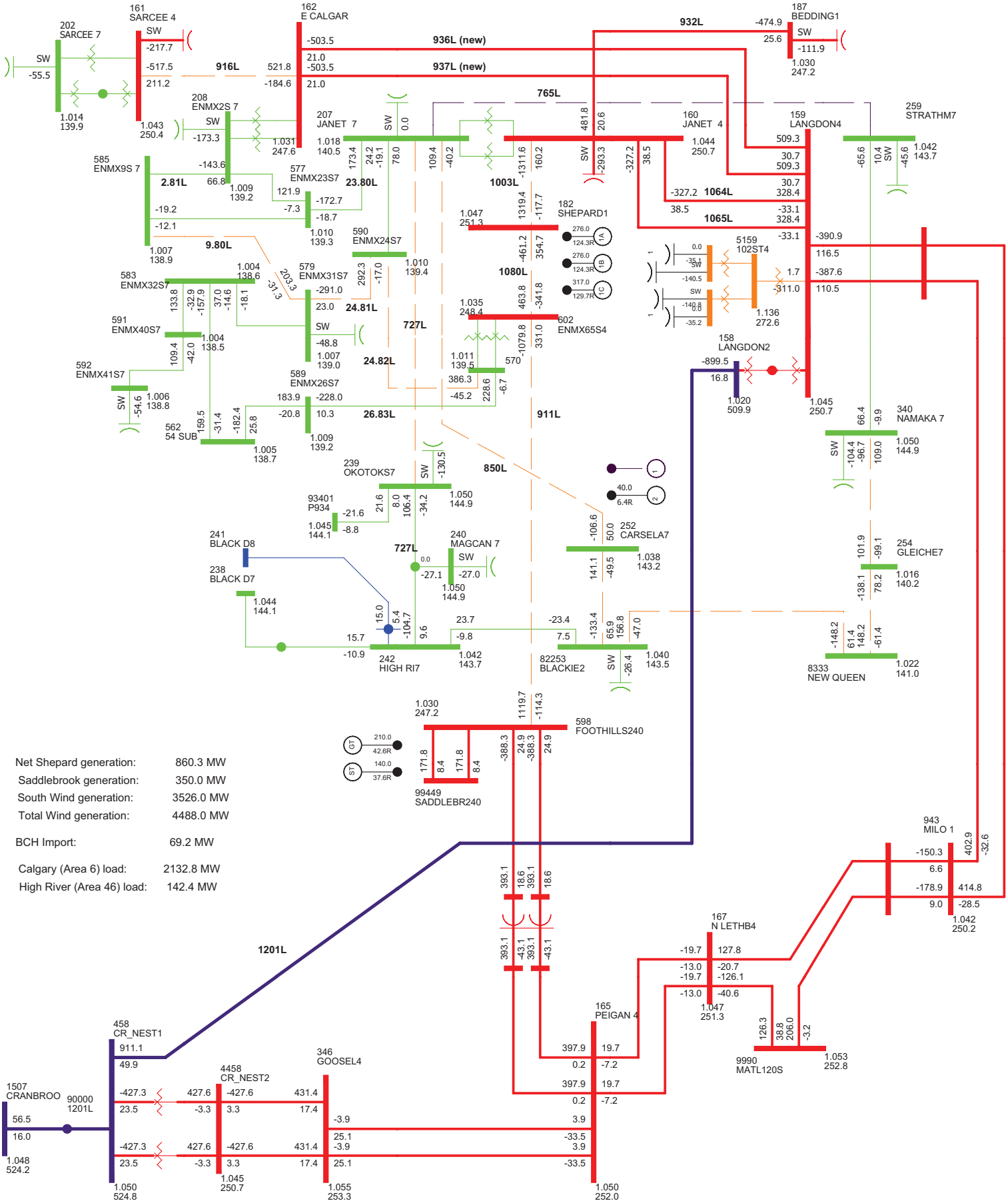
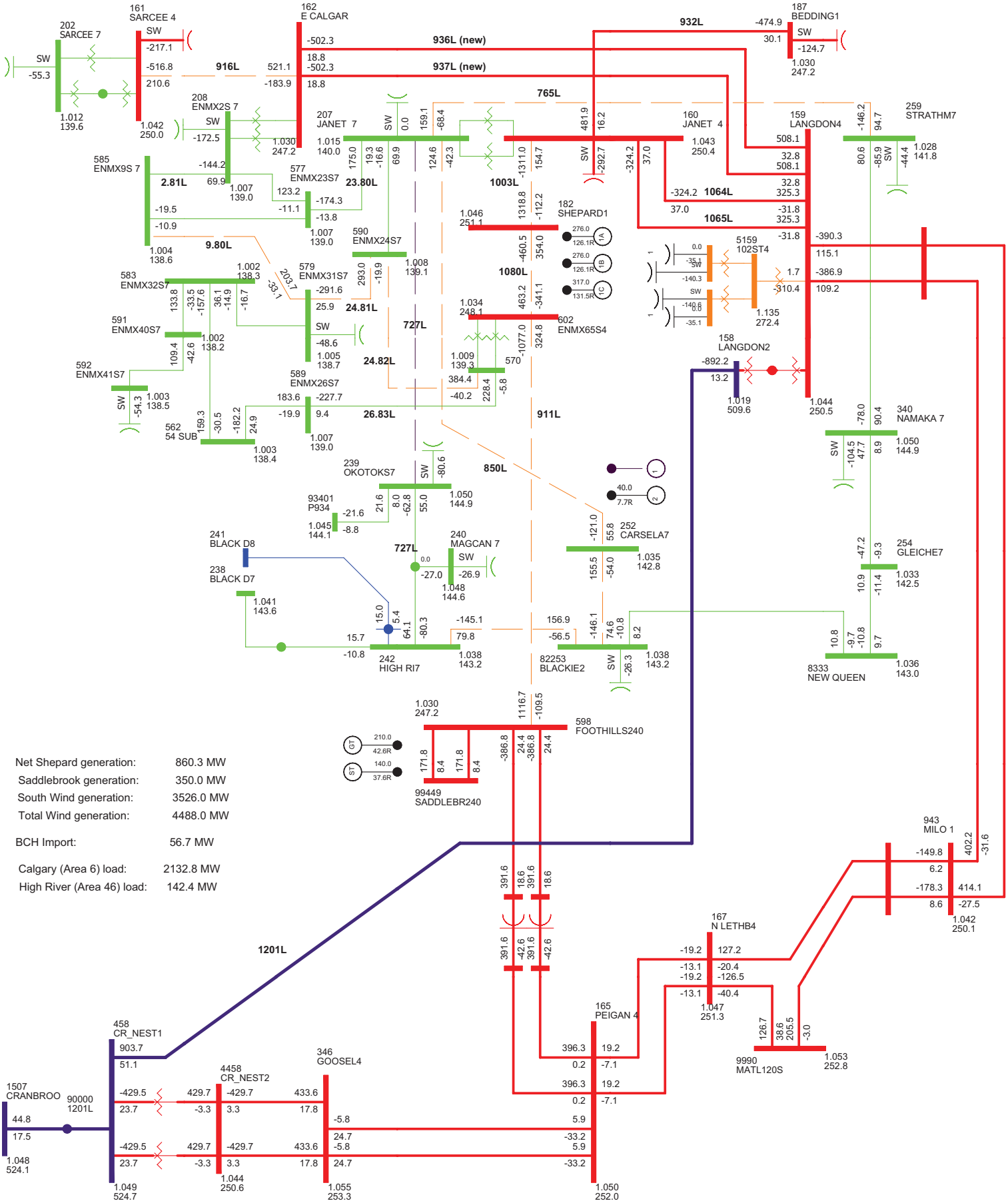


Figure G-2019-Step1-Sc4-3

765L (JANET 74S TO STRATHMORE 151S)

TUE, APR 26 2011 14:25

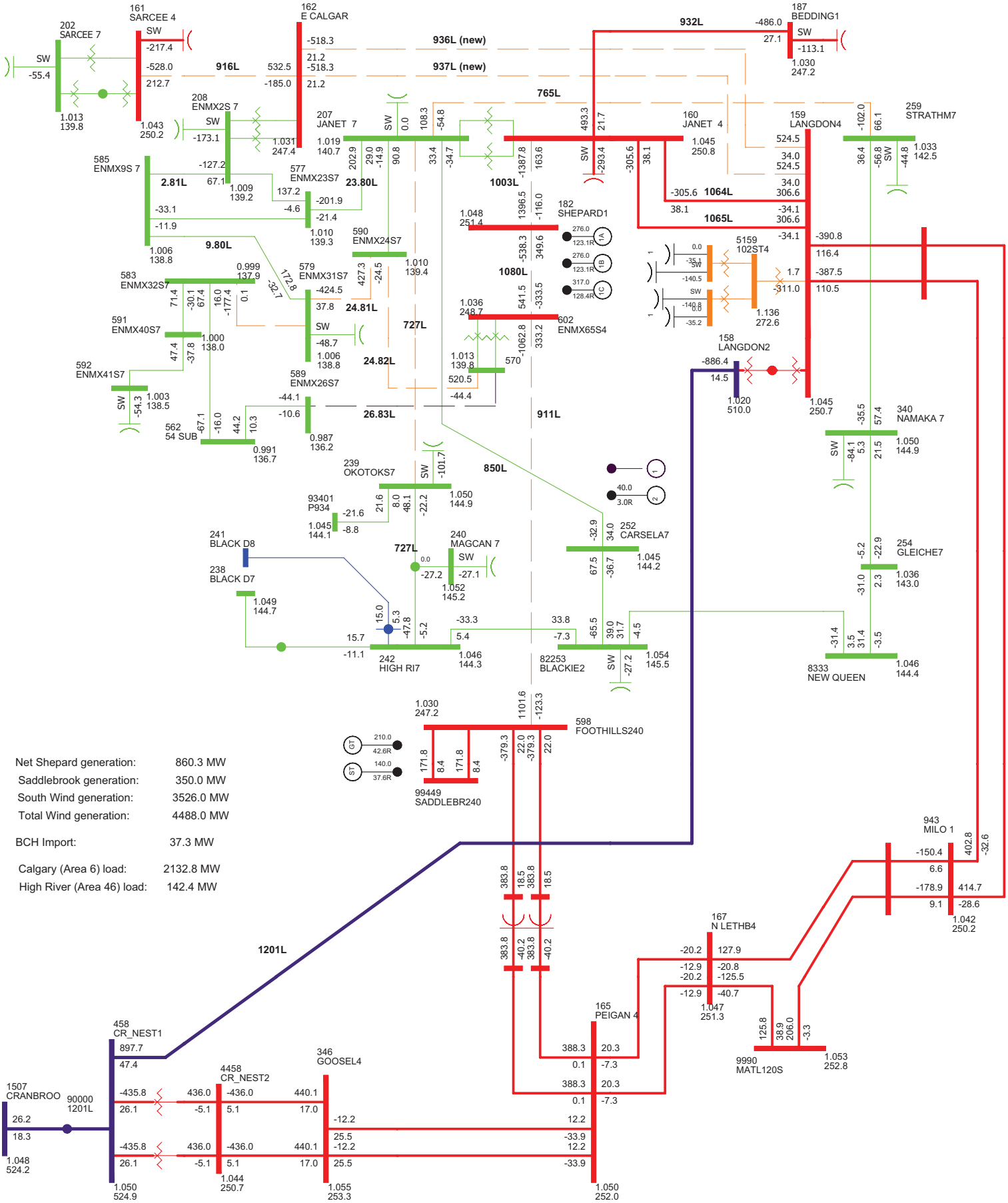


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-4

727L (JANET 74S TO OKOTOKS 678S)

TUE, APR 26 2011 14:25



Net Shepard generation: 860.3 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 3526.0 MW
Total Wind generation: 4488.0 MW

BCH Import: 37.3 MW

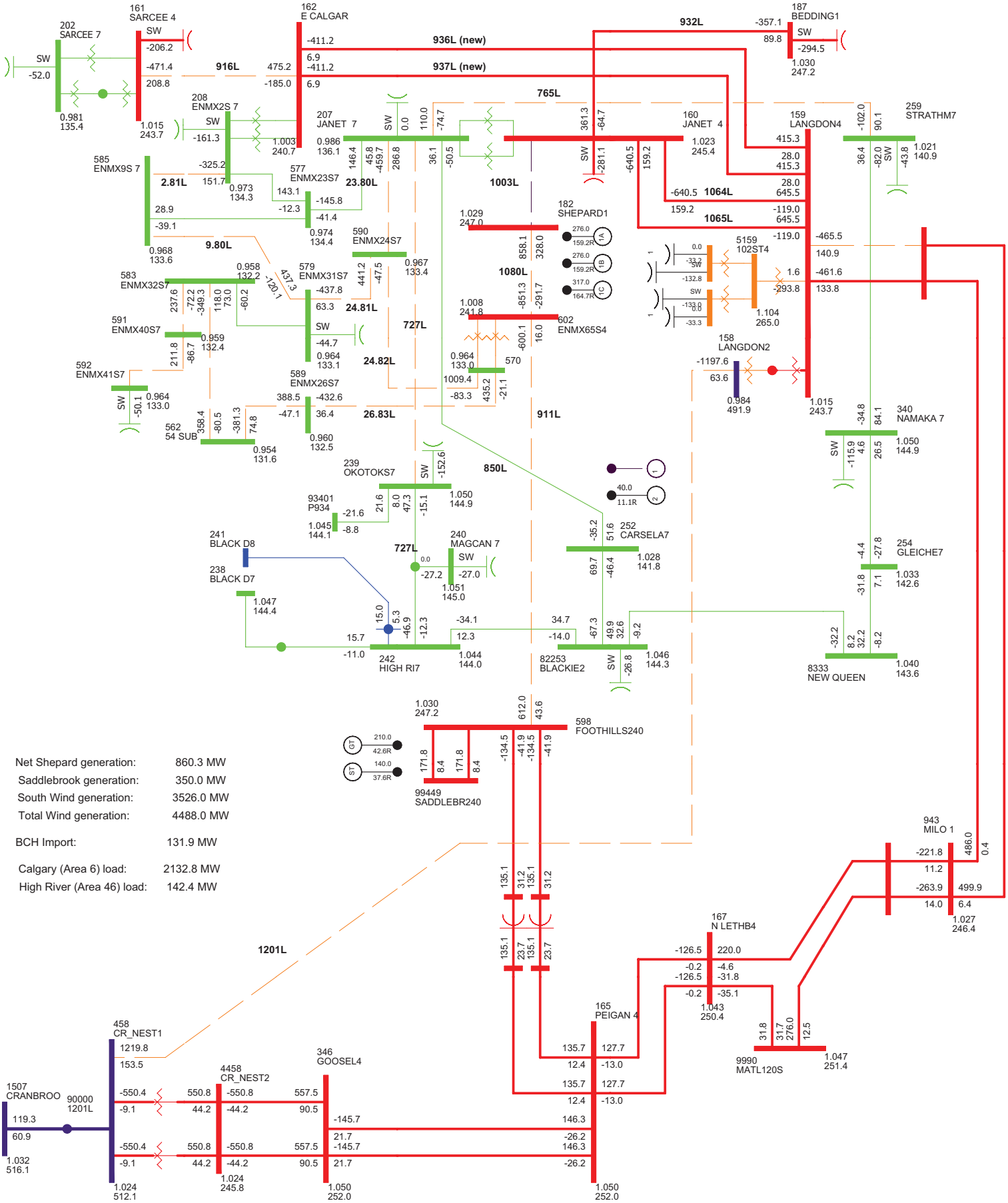
Calgary (Area 6) load: 2132.8 MW
High River (Area 46) load: 142.4 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-5

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

TUE, APR 26 2011 14:25



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-6

1003L (JANET 74S TO ENMAX NO. 25)

TUE, APR 26 2011 14:25

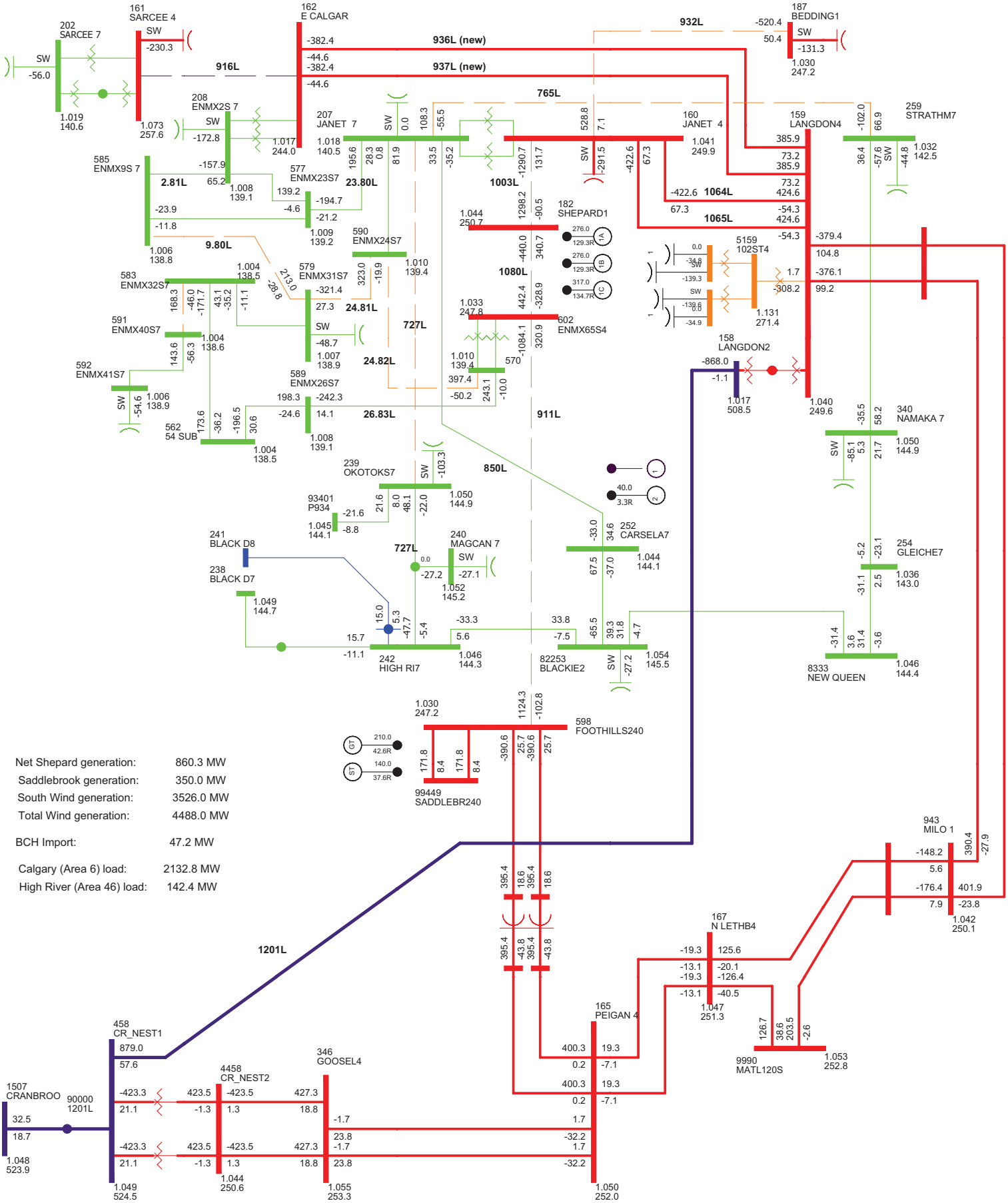


Figure G-2019-Step1-Sc4-7

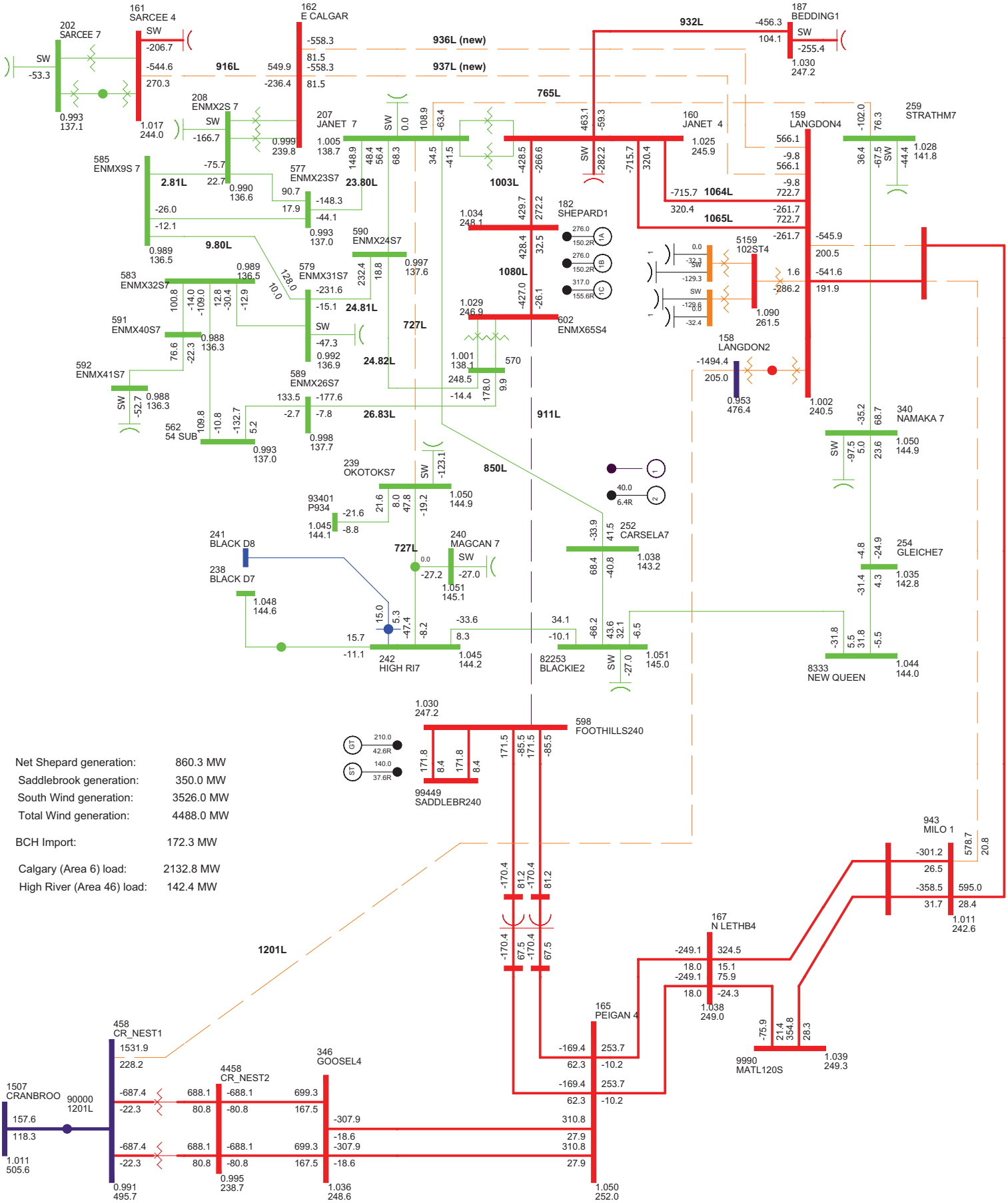
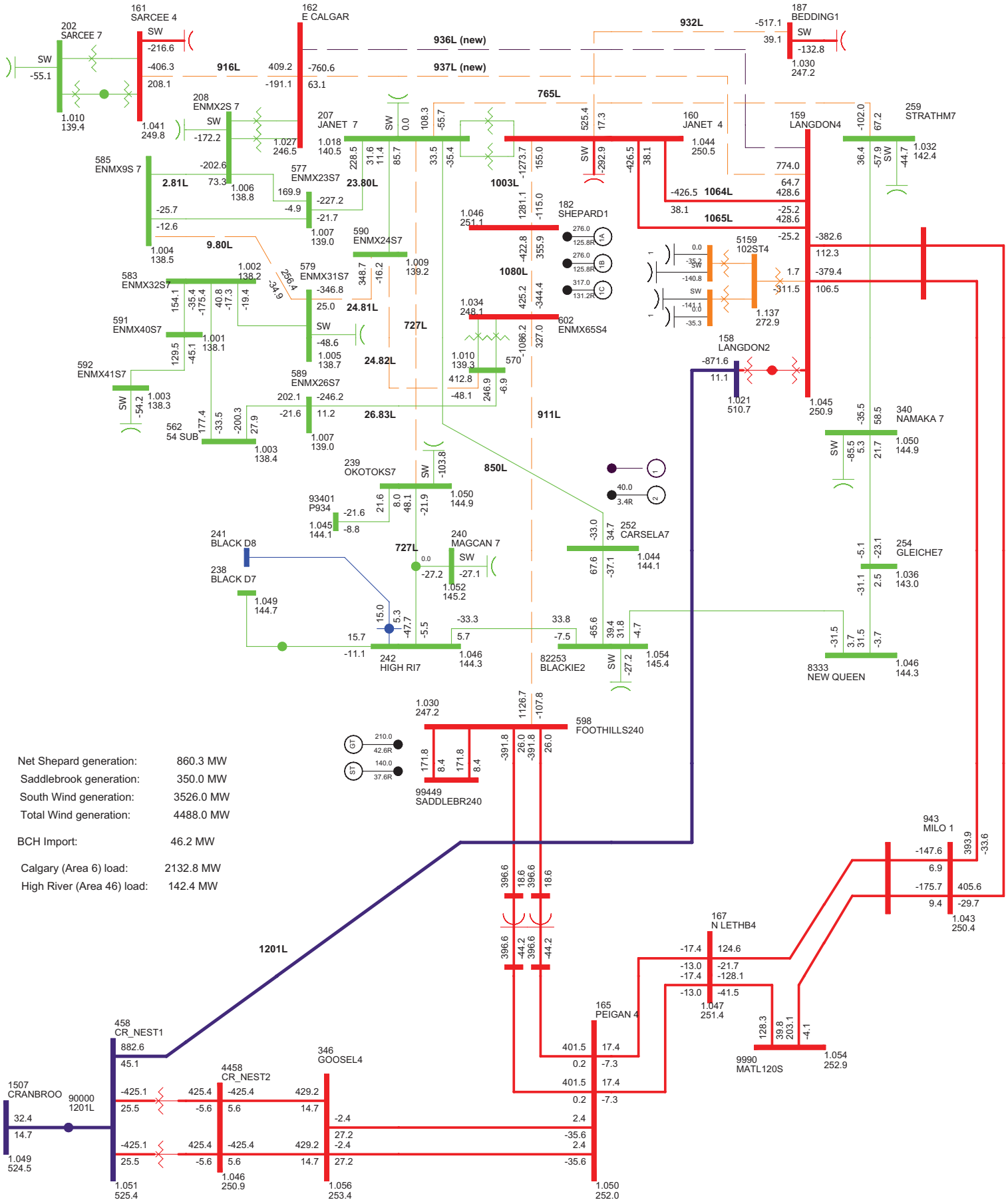


Figure G-2019-Step1-Sc4-8

1106L (FOOTHILLS 237S TO ENMAX NO. 65)

TUE, APR 26 2011 14:25

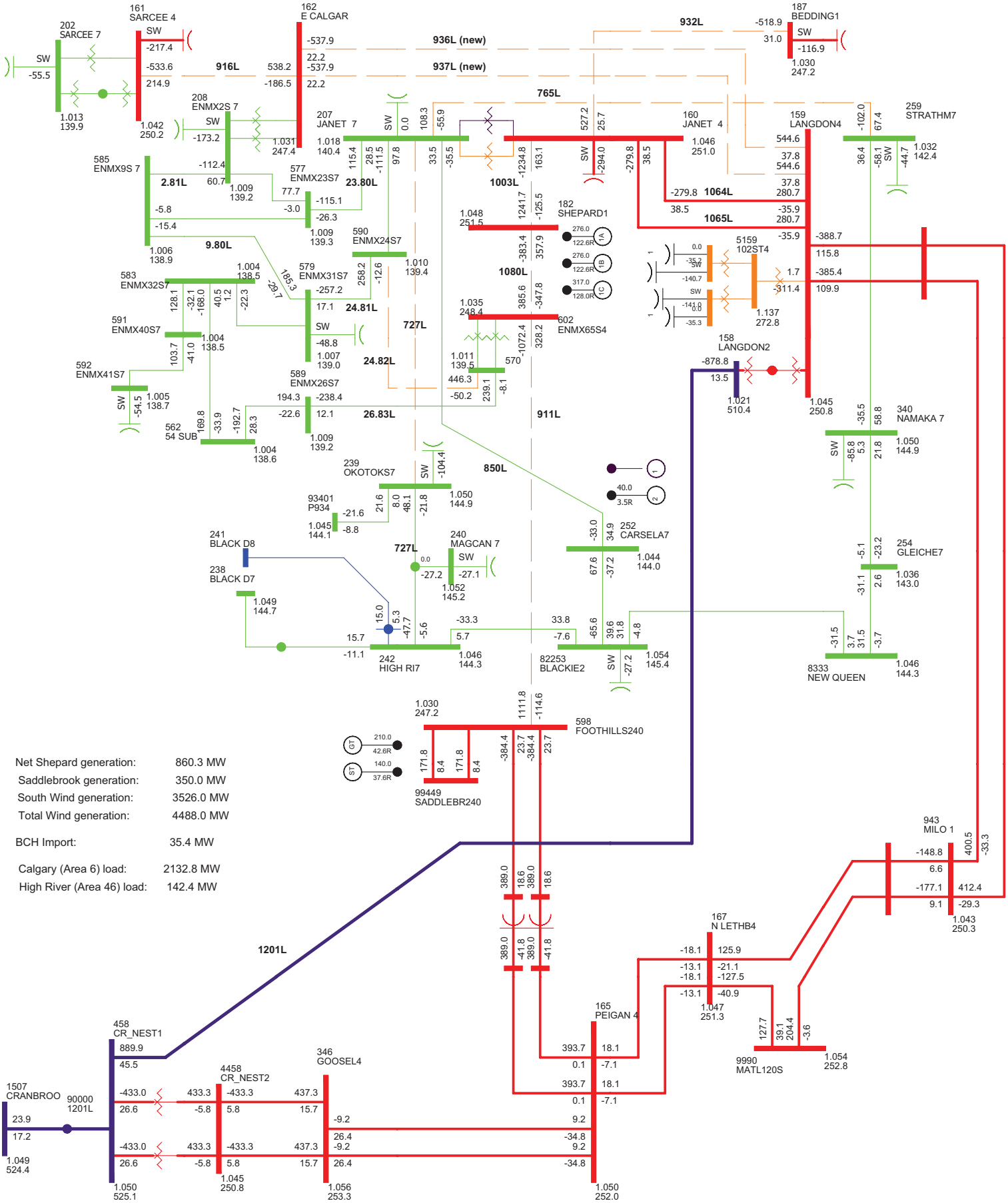


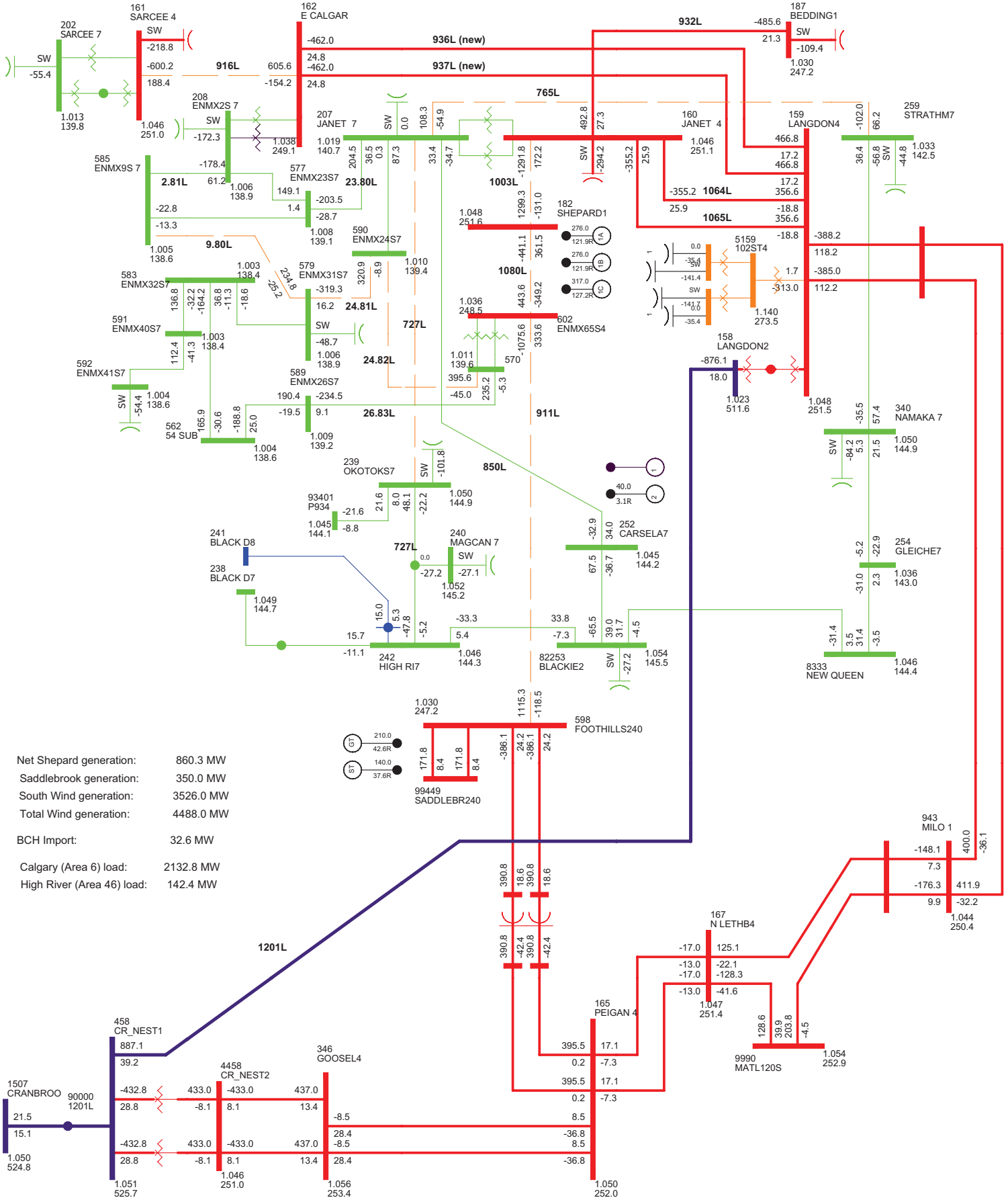
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-9

936L (LANGDON 102S TO EAST CALGARY 5S)

TUE, APR 26 2011 14:26


Net Shepard generation: 860.3 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 3526.0 MW
Total Wind generation: 4488.0 MW
BCH Import: 35.4 MW
Calgary (Area 6) load: 2132.8 MW
High River (Area 46) load: 142.4 MW
161 SARCEE 4
202 SARCEE 7
162 E CALGAR
916L
936L (new)
937L (new)
932L
187 BEDDING1
765L
207 JANET 7
160 JANET 4
159 LANGDON4
259 STRATHM7
208 ENMX2S 7
585 ENMX9S 7
577 ENMX23S7
23.80L
1003L
1064L
1065L
182 SHEPARD1
5159 102ST4
590 ENMX24S7
579 ENMX31S7
24.81L
1080L
583 ENMX32S7
591 ENMX40S7
592 ENMX41S7
602 ENMX65S4
727L
158 LANGDON2
589 ENMX26S7
24.82L
911L
562 54 SUB
340 NAMAKA 7
239 OKOTOKS7
850L
93401 P934
241 BLACK D8
238 BLACK D7
240 MAGCAN 7
252 CARSELA7
254 GLEICHE7
242 HIGH RI7
82253 BLACKIE2
8333 NEW QUEEN
598 FOOTHILLS240
99449 SADDLEBR240
943 MILO 1
1201L
167 N LETHB4
165 PEIGAN 4
9990 MATL120S
458 CR_NEST1
4458 CR_NEST2
346 GOOSEL4
1507 CRANBROO
90000 1201L
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure G-2019-Step1-Sc4-10
240/138 KV TRANSFORMER (JANET 74S)
TUE, APR 26 2011 14:26

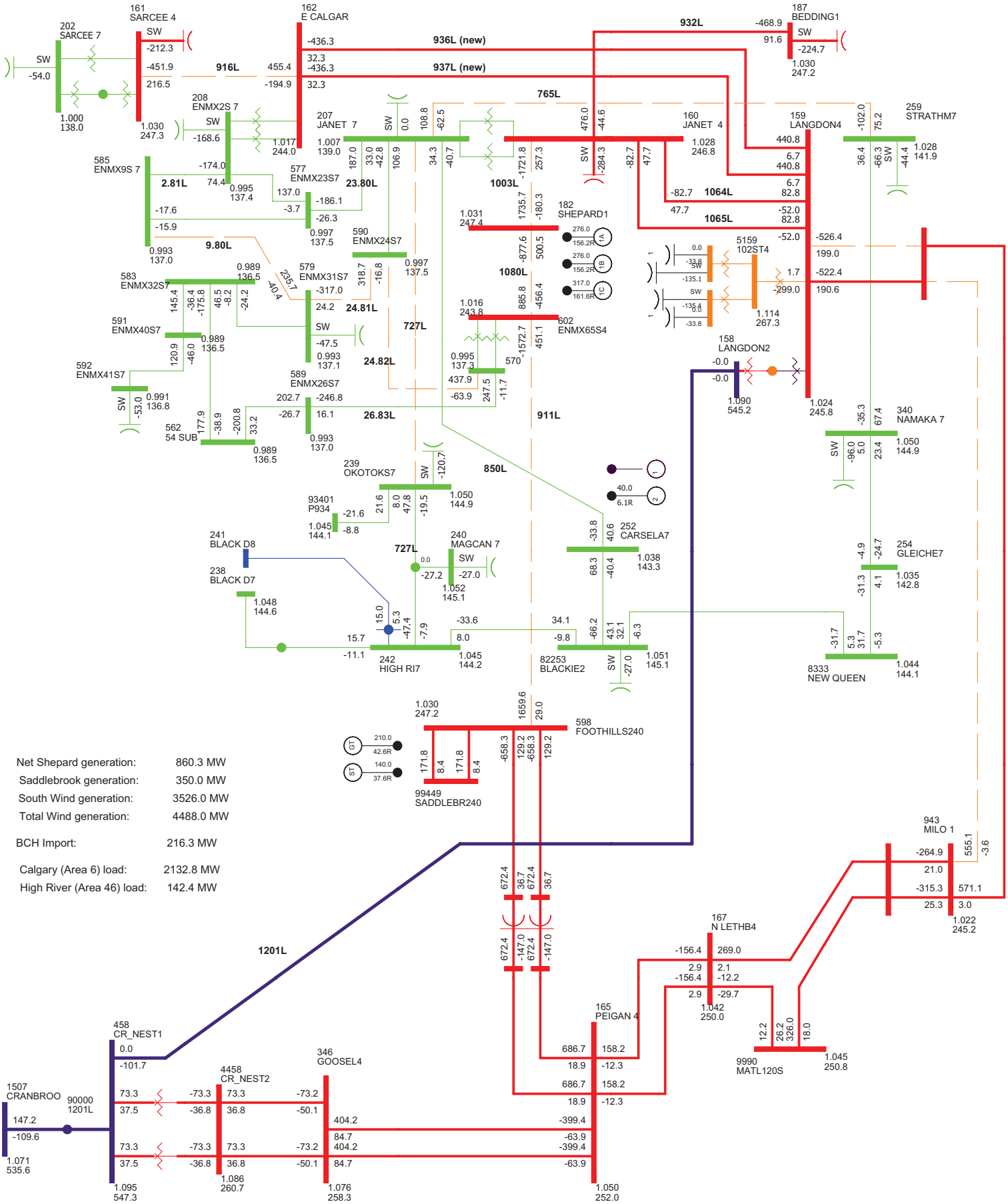


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-11

240/138 KV TRANSFORMER (EAST CALGARY 5S)

TUE, APR 26 2011 14:26

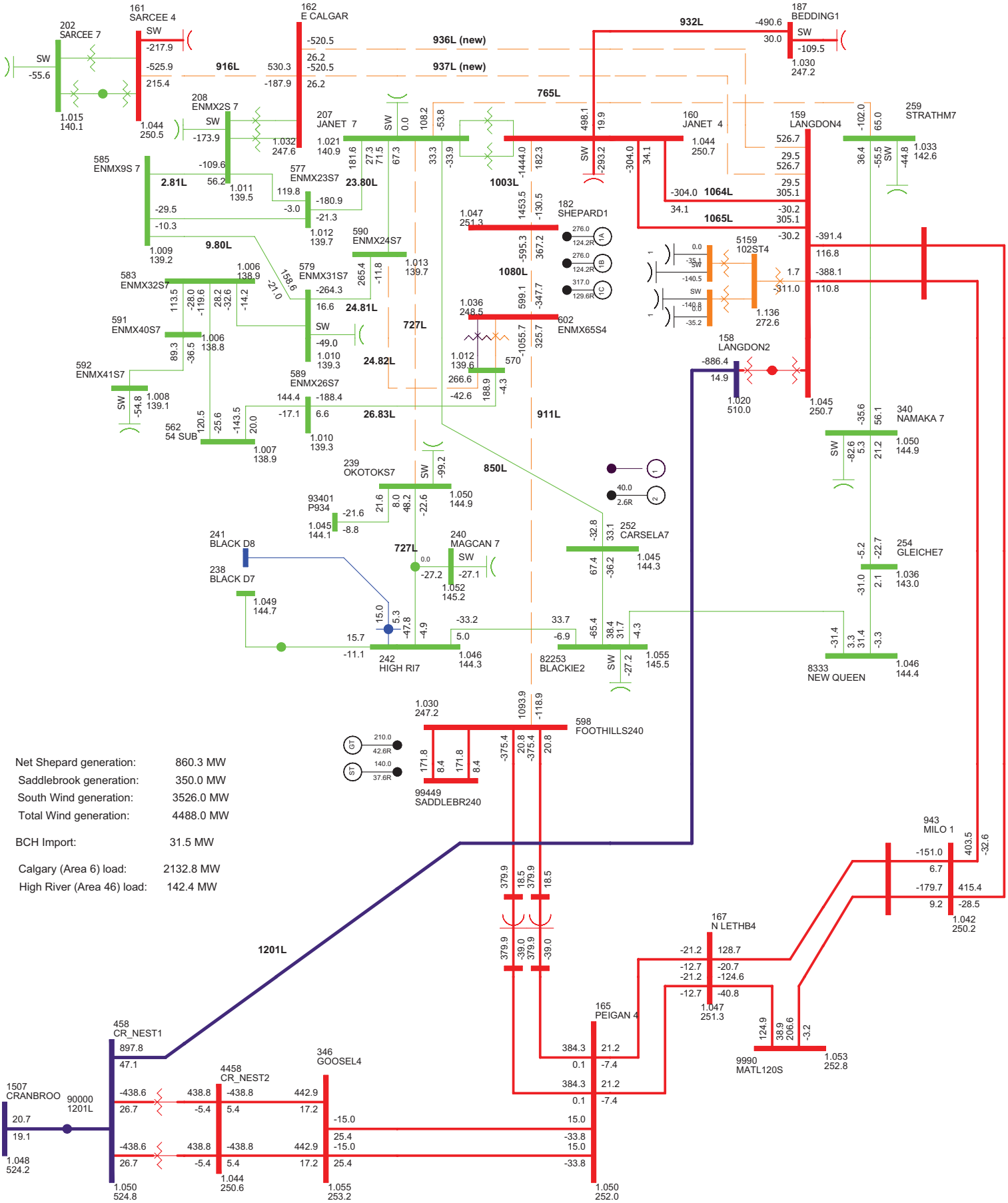


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-12

500/240 KV TRANSFORMER (LANGDON 102S)

TUE, APR 26 2011 14:26



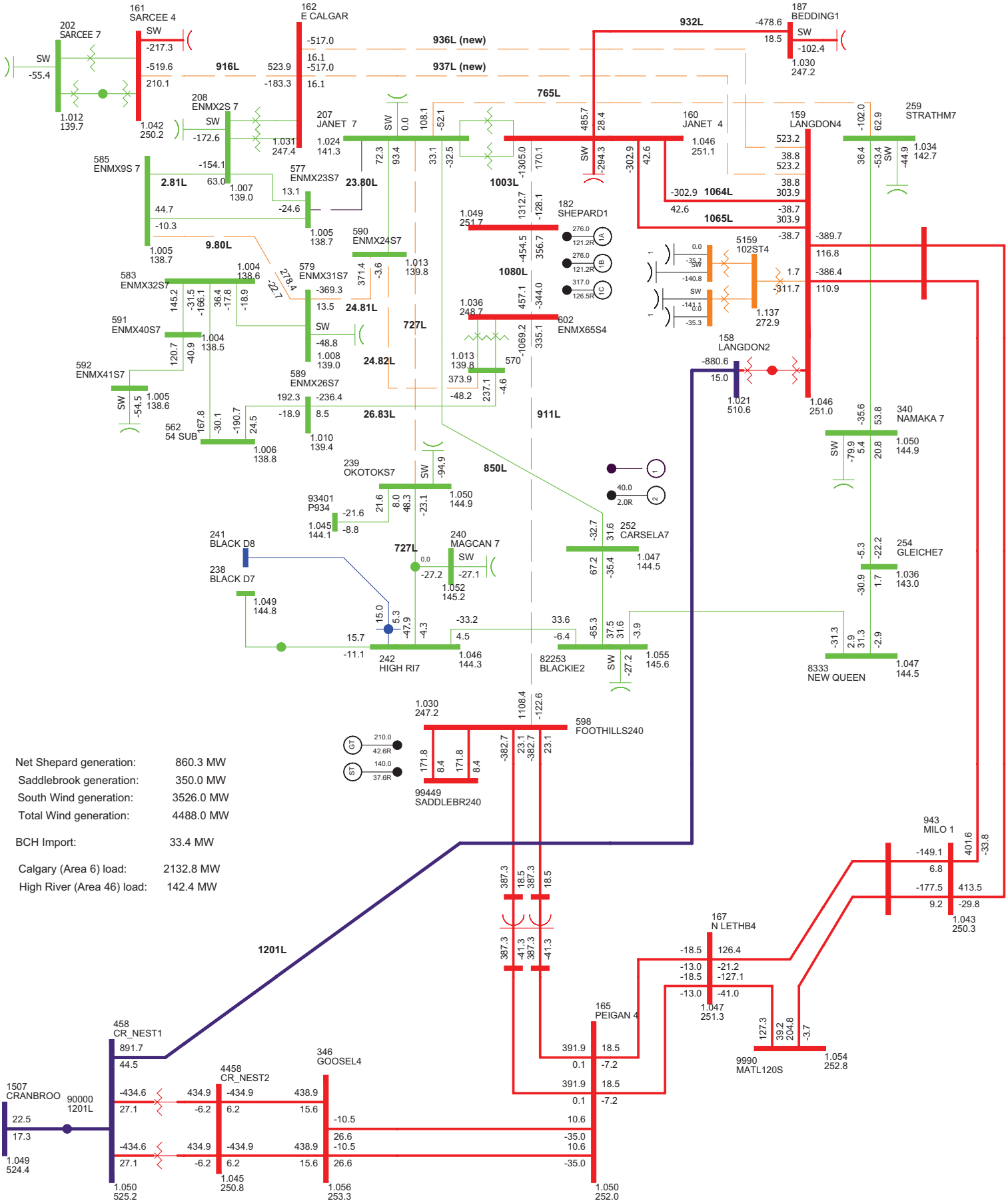
Net Shepard generation:	860.3 MW
Saddlebrook generation:	350.0 MW
South Wind generation:	3526.0 MW
Total Wind generation:	4488.0 MW
BCH Import:	31.5 MW
Calgary (Area 6) load:	2132.8 MW
High River (Area 46) load:	142.4 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-13

240/138 KV TRANSFORMER (ENMAX NO. 65)

TUE, APR 26 2011 14:26



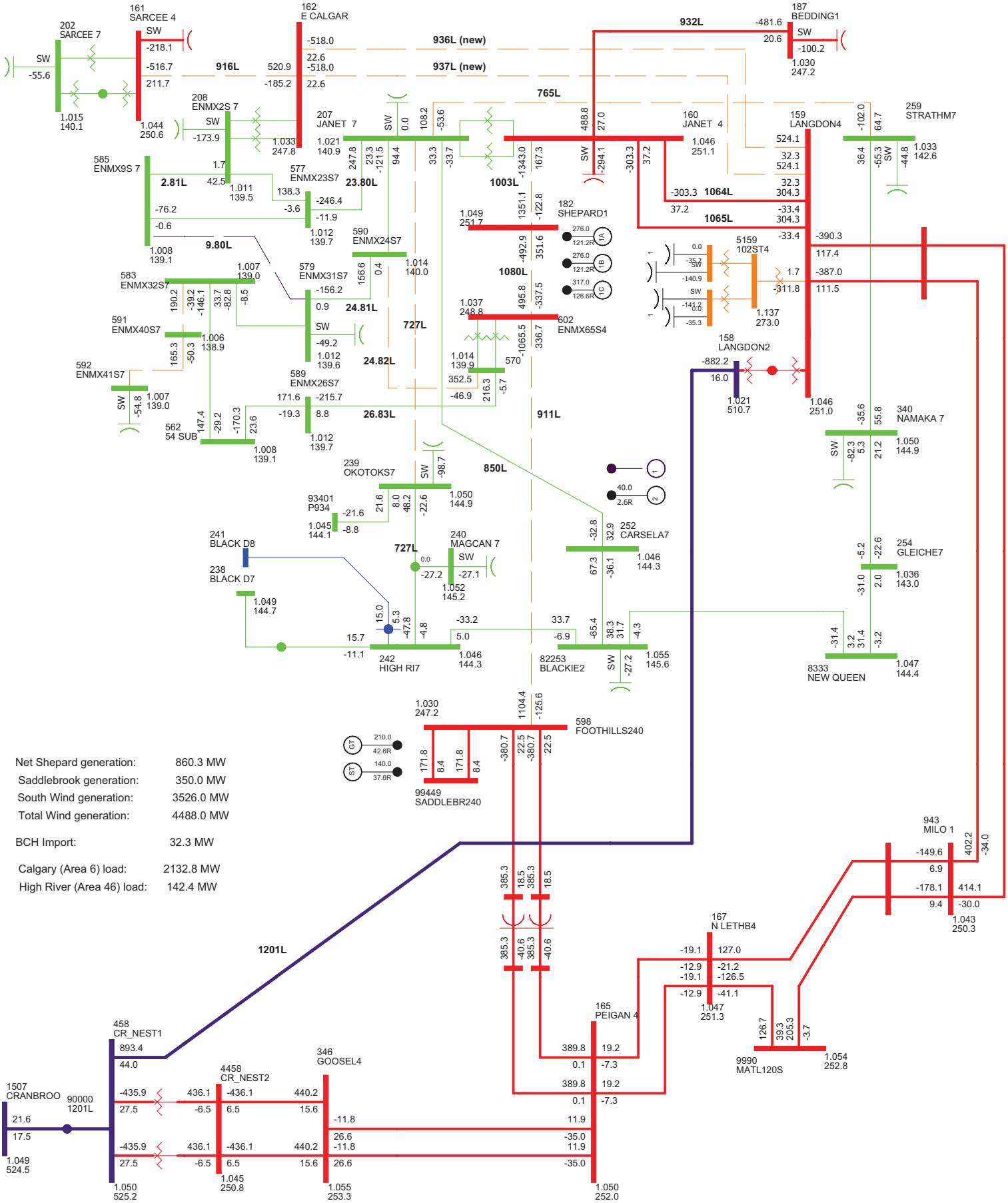
Net Shepard generation:	860.3 MW
Saddlebrook generation:	350.0 MW
South Wind generation:	3526.0 MW
Total Wind generation:	4488.0 MW
BCH Import:	33.4 MW
Calgary (Area 6) load:	2132.8 MW
High River (Area 46) load:	142.4 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-14

23.80L (JANET 74S TO ENMAX NO. 23)

TUE, APR 26 2011 14:26

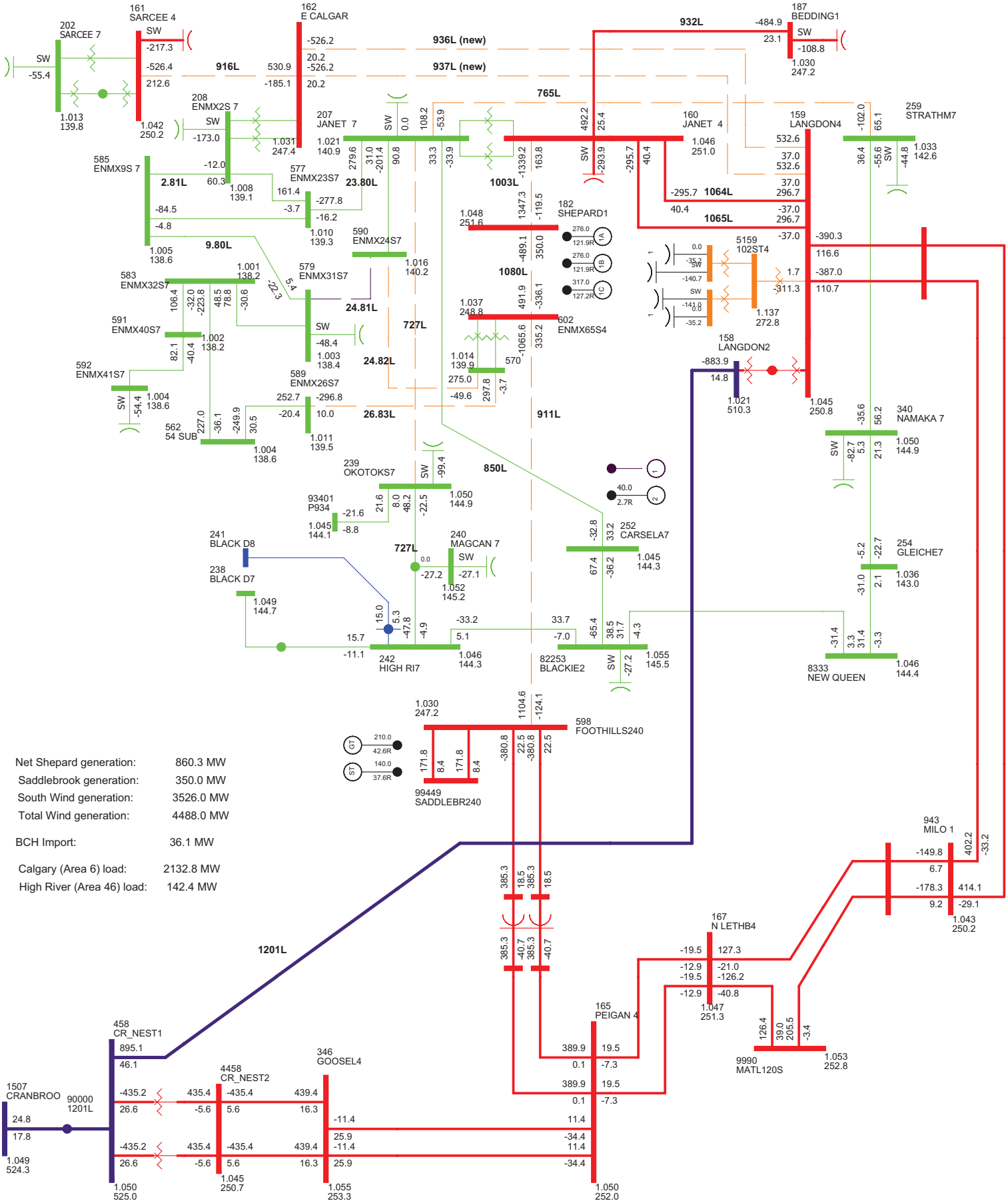


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-15

9.80L (ENMAX NO. 31 TO ENMAX NO. 9)

TUE, APR 26 2011 14:26



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure G-2019-Step1-Sc4-16

24.81L (ENMAX NO. 31 TO ENMAX NO. 24)

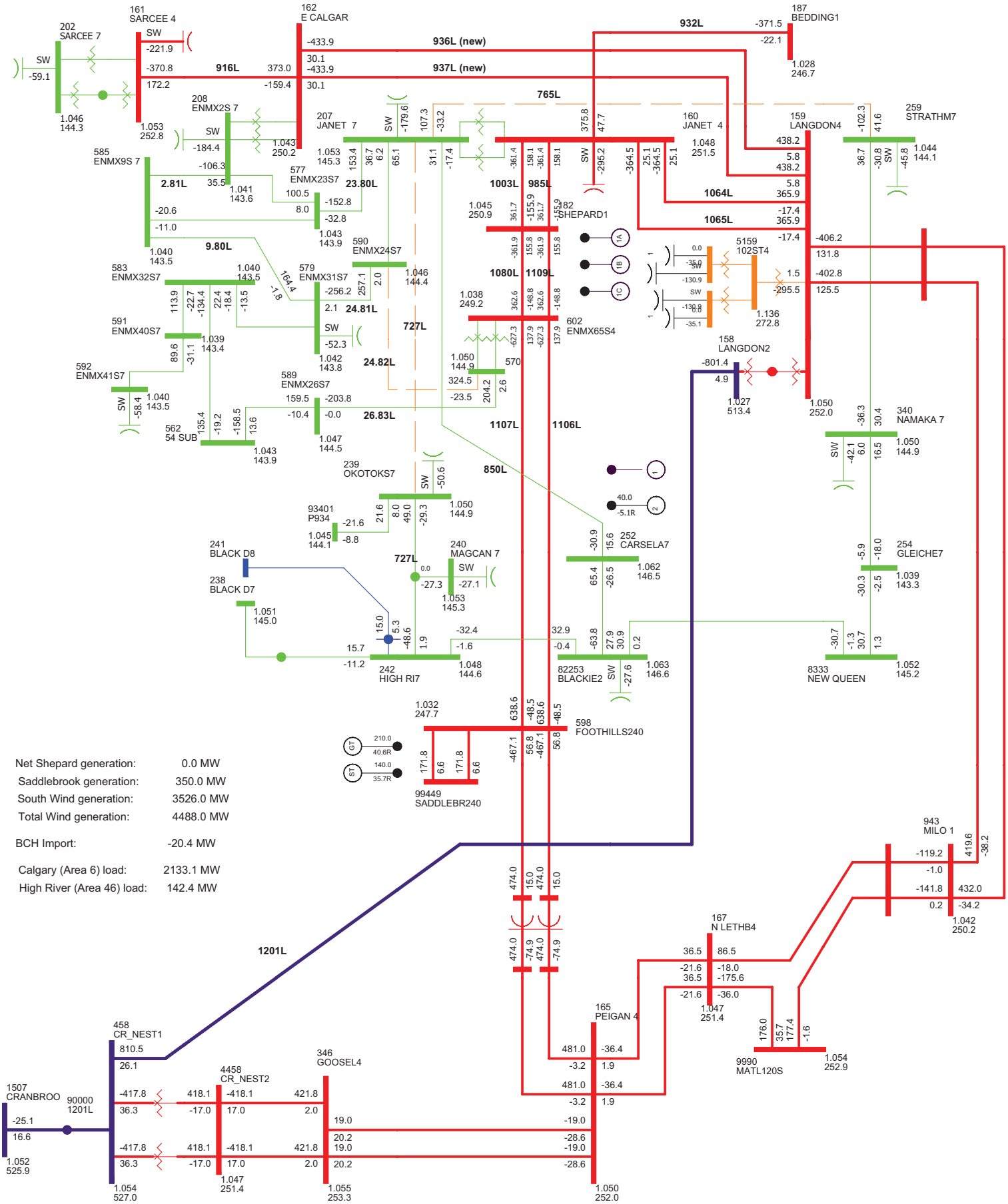
TUE, APR 26 2011 14:26

ATTACHMENT H

Transmission Development Plan – Step 2, 2019

Table H-1

Figure Name	Contingency
Figure H-2019-Step2-Sc3-1	Base Case (N-0)
Figure H-2019-Step2-Sc3-2	Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)
Figure H-2019-Step2-Sc3-3	Open 500/240 kV transformer (Langdon 102S)
Figure H-2019-Step2-Sc4-1	Base Case (N-0)
Figure H-2019-Step2-Sc4-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure H-2019-Step2-Sc4-3	Open 765L 138kV line (Janet 74S to Strathmore 151S)
Figure H-2019-Step2-Sc4-4	Open 727L 138kV line (Janet 74S to Okotoks 678S)
Figure H-2019-Step2-Sc4-5	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure H-2019-Step2-Sc4-6	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure H-2019-Step2-Sc4-7	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure H-2019-Step2-Sc4-8	Open 1106L 240kV line (Foothills 237S to ENMAX No. 65)
Figure H-2019-Step2-Sc4-9	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure H-2019-Step2-Sc4-10	Open 240/138 kV transformer (Janet 74S)
Figure H-2019-Step2-Sc4-11	Open 240/138 kV transformer (East Calgary 5S)
Figure H-2019-Step2-Sc4-12	Open 240/138 kV transformer (ENMAX No. 65)
Figure H-2019-Step2-Sc4-13	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)
Figure H-2019-Step2-Sc4-14	Open 9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)
Figure H-2019-Step2-Sc4-15	Open 24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)

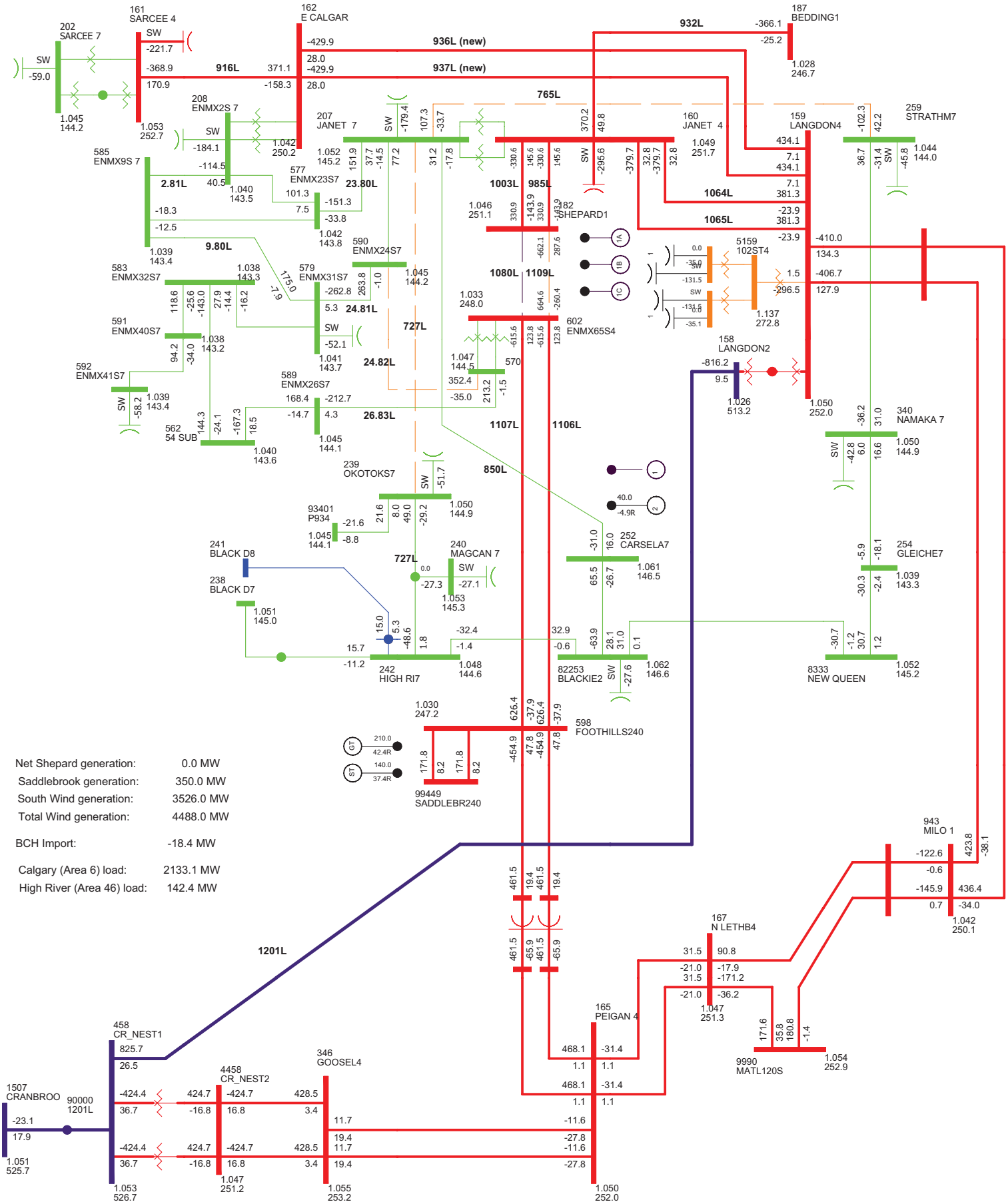


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc3-1

BASE CASE (ALL ELEMENTS IN SERVICE)

TUE, APR 19 2011 21:54

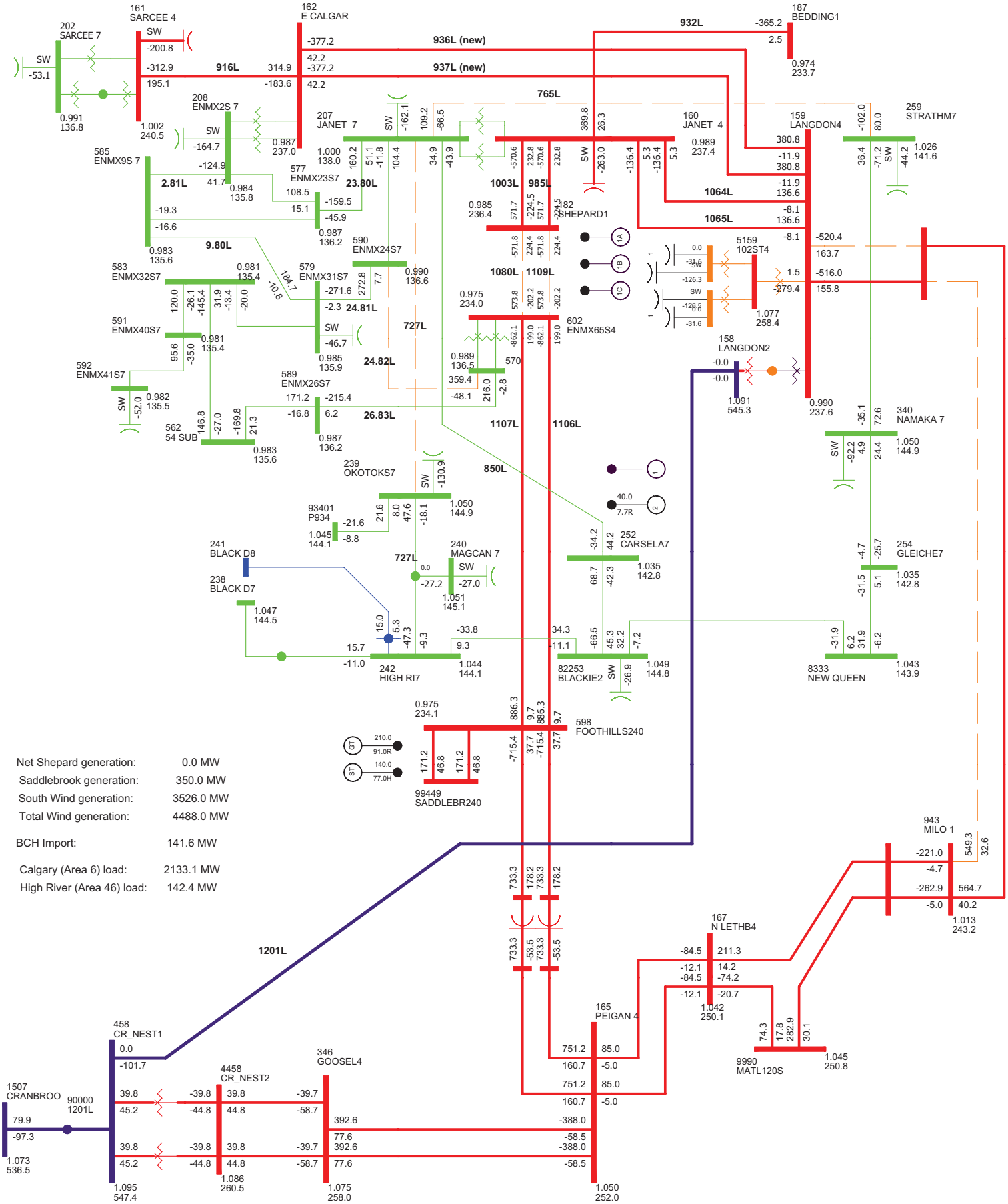


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc3-2

1080L (ENMAX NO. 25 TO ENMAX NO. 65)

TUE, APR 19 2011 21:54

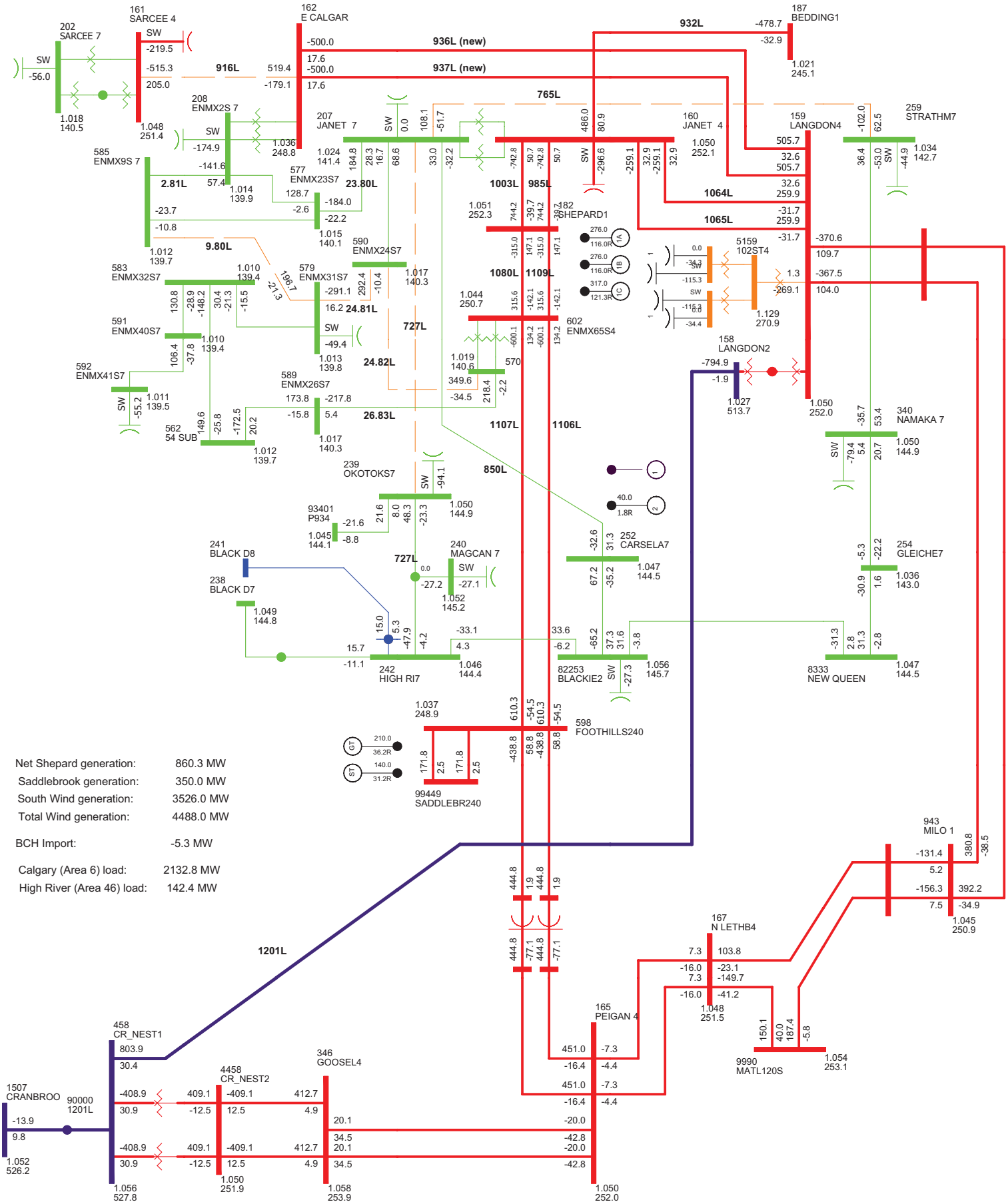


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc3-3

500/240 KV TRANSFORMER (LANGDON 102S)

TUE, APR 19 2011 21:55

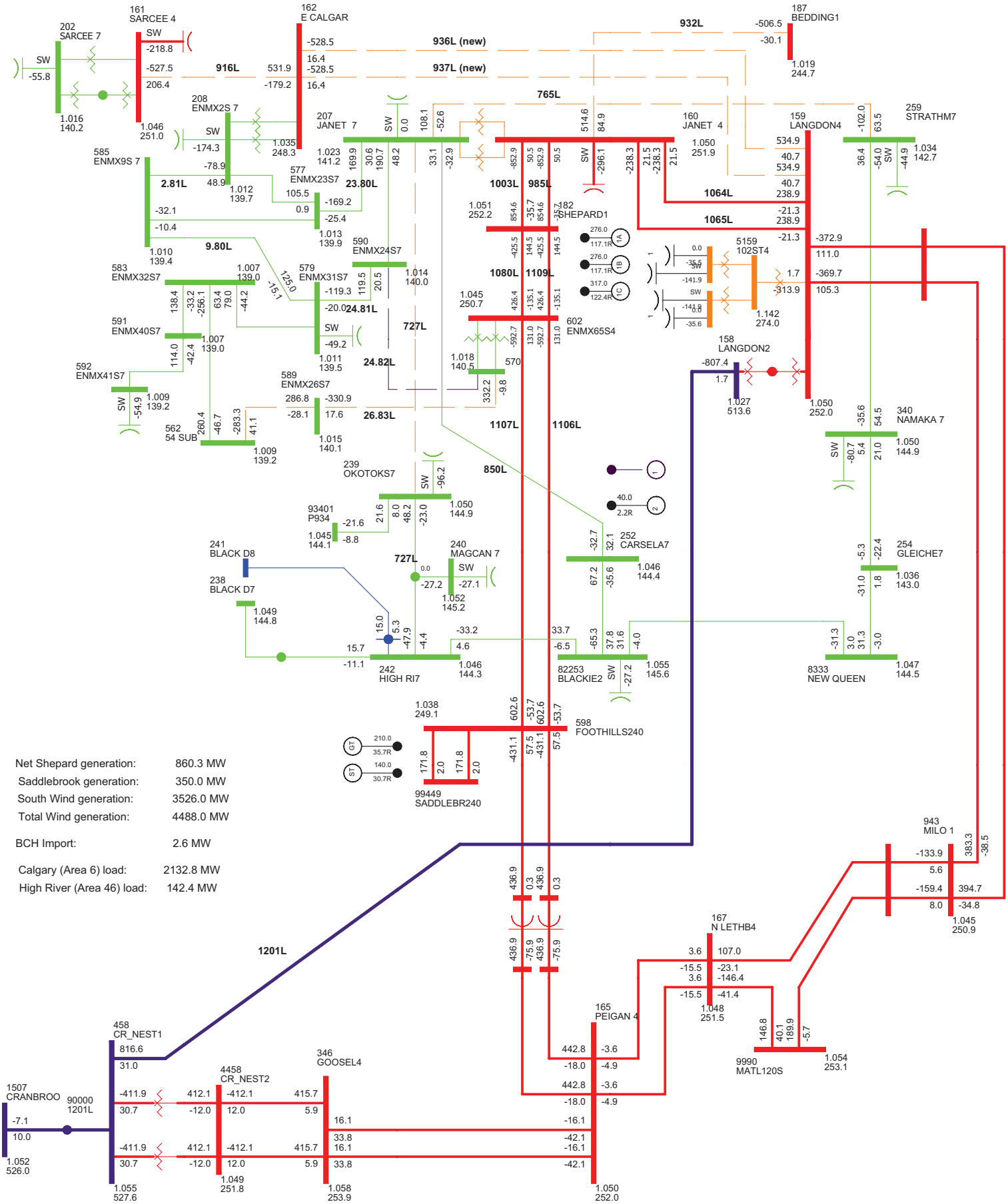


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

TUE, APR 19 2011 21:55

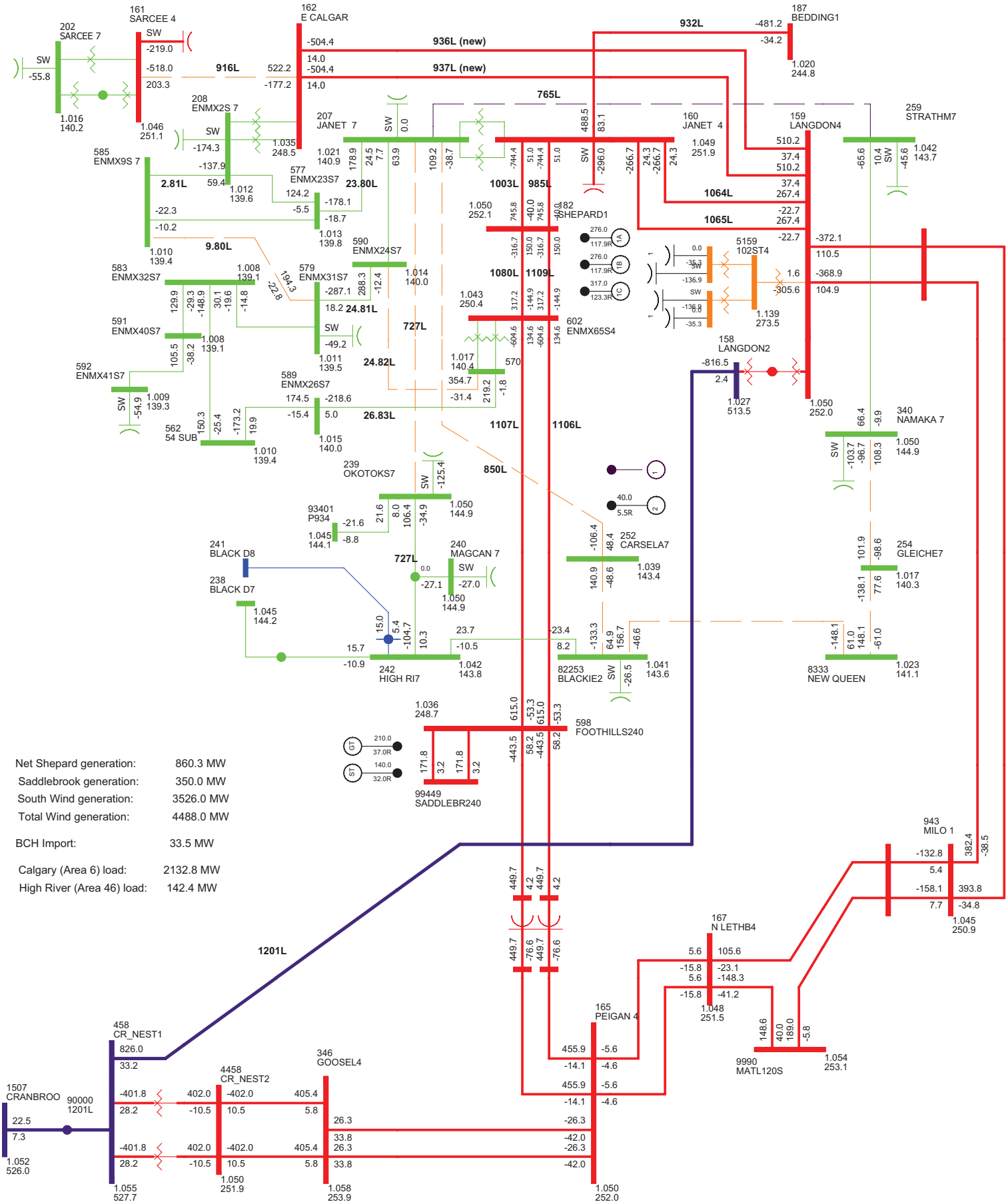


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

TUE, APR 19 2011 21:56

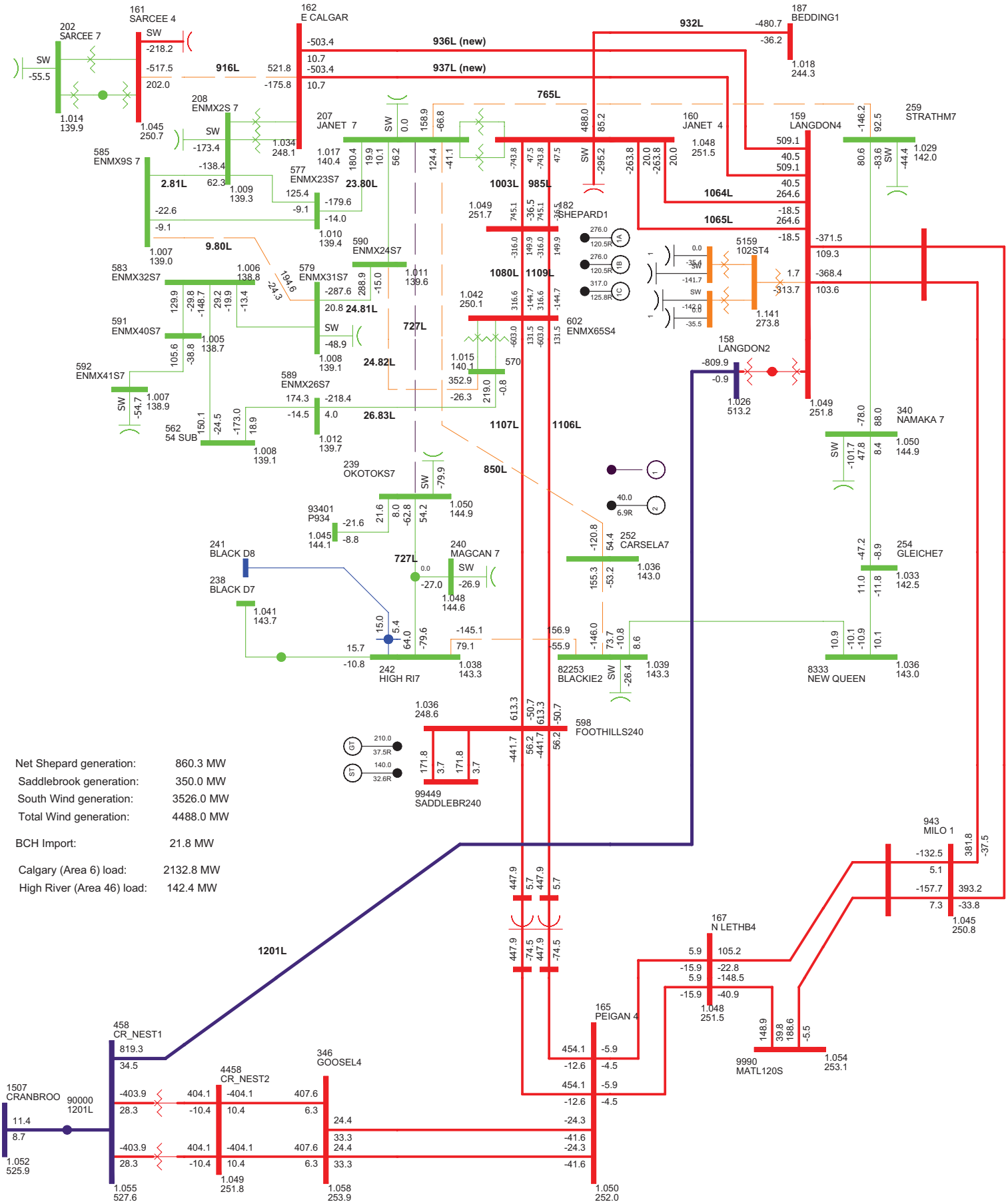


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-3

765L (JANET 74S TO STRATHMORE 151S)

TUE, APR 19 2011 21:56

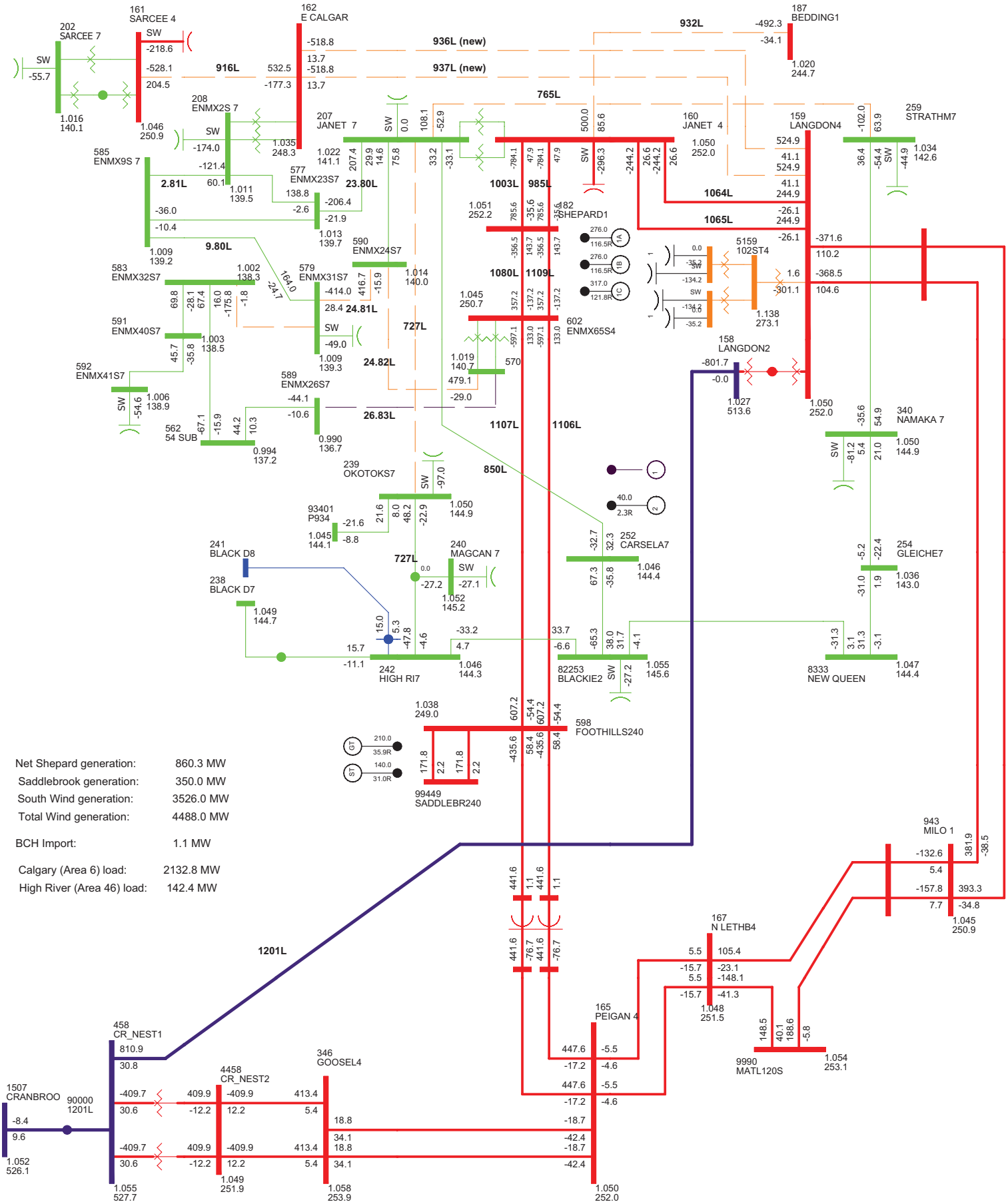


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-4

727L (JANET 74S TO OKOTOKS 678S)

TUE, APR 19 2011 21:56

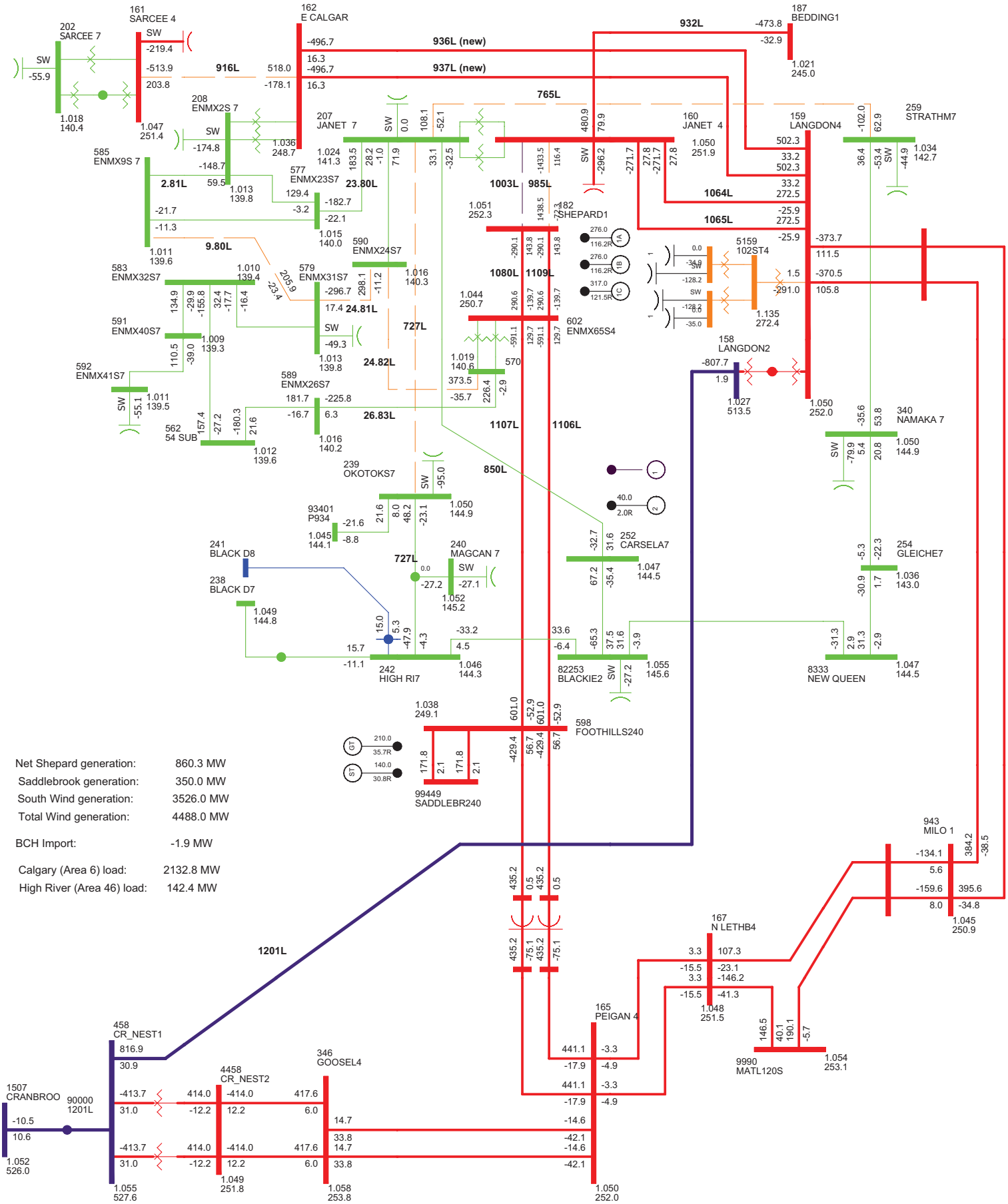


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-5

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

TUE, APR 19 2011 21:56

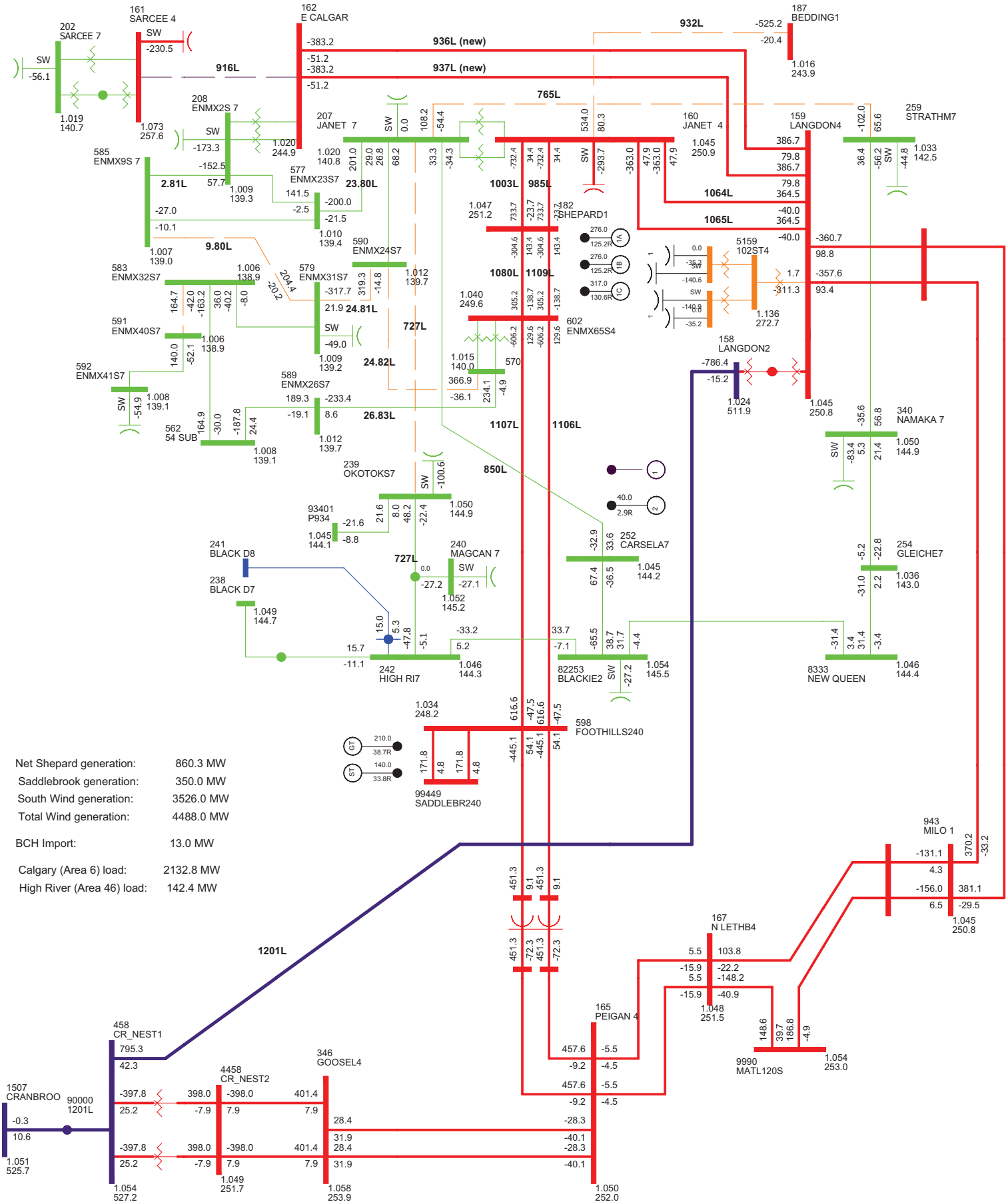


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-6

1003L (JANET 74S TO ENMAX NO. 25)

TUE, APR 19 2011 21:56



Net Shepard generation: 860.3 MW
Saddlebrook generation: 350.0 MW
South Wind generation: 3526.0 MW
Total Wind generation: 4488.0 MW

BCH Import: 13.0 MW

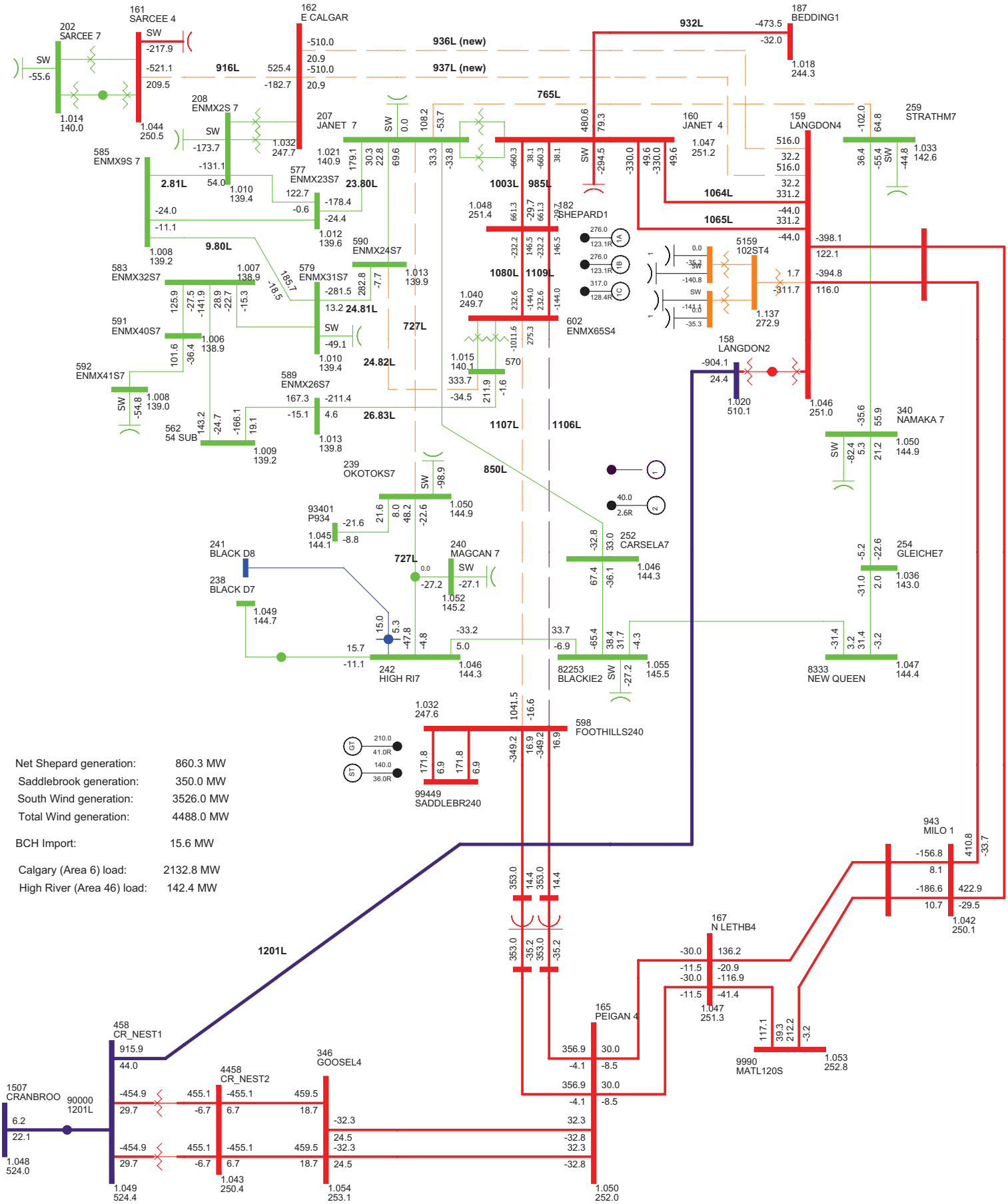
Calgary (Area 6) load: 2132.8 MW
High River (Area 46) load: 142.4 MW

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-7

916L (SARCEE 42S TO EAST CALGARY 5S)

TUE, APR 19 2011 21:57

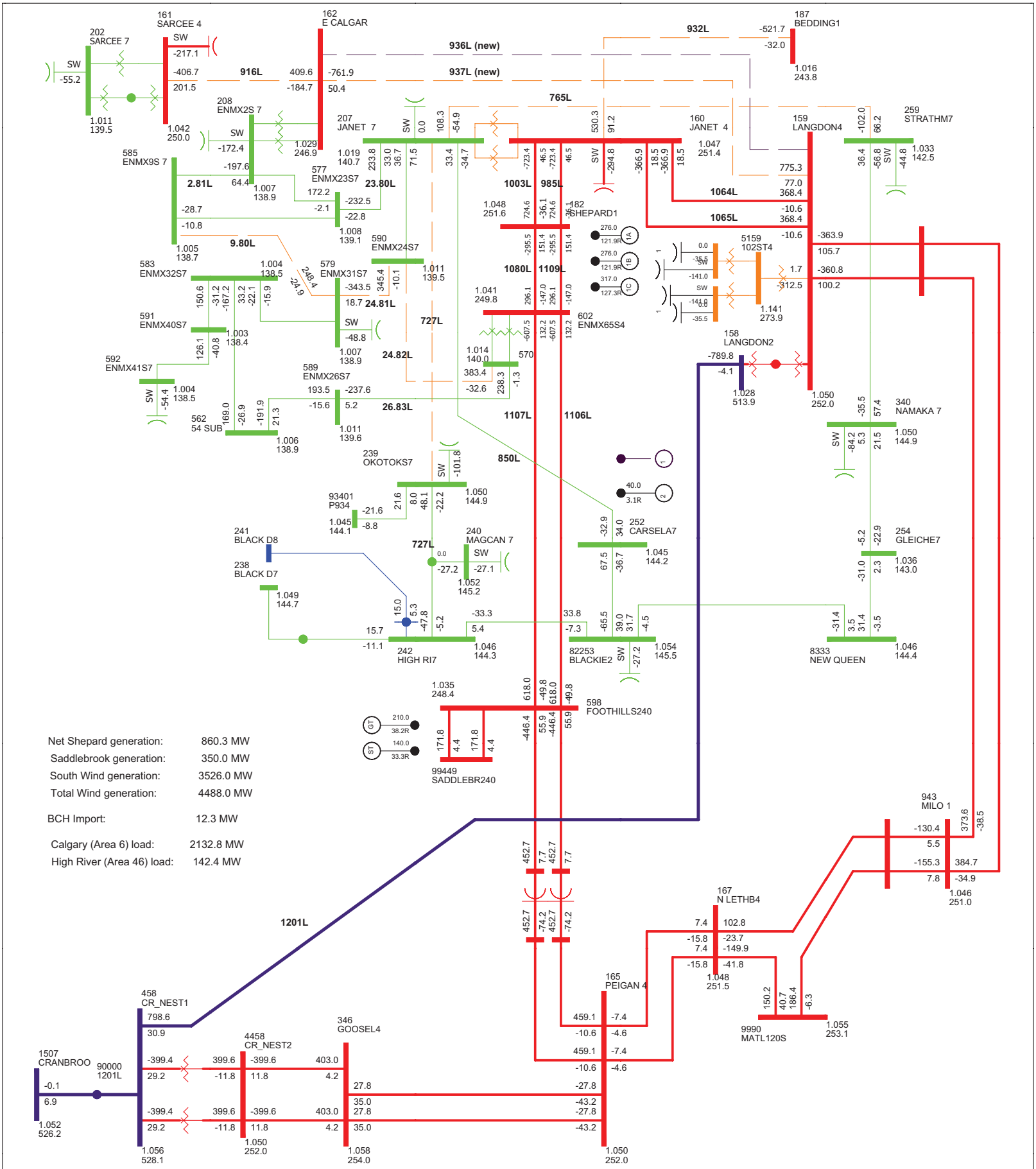


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-8

1106L (FOOTHILLS 237S TO ENMAX NO. 65)

TUE, APR 19 2011 21:57

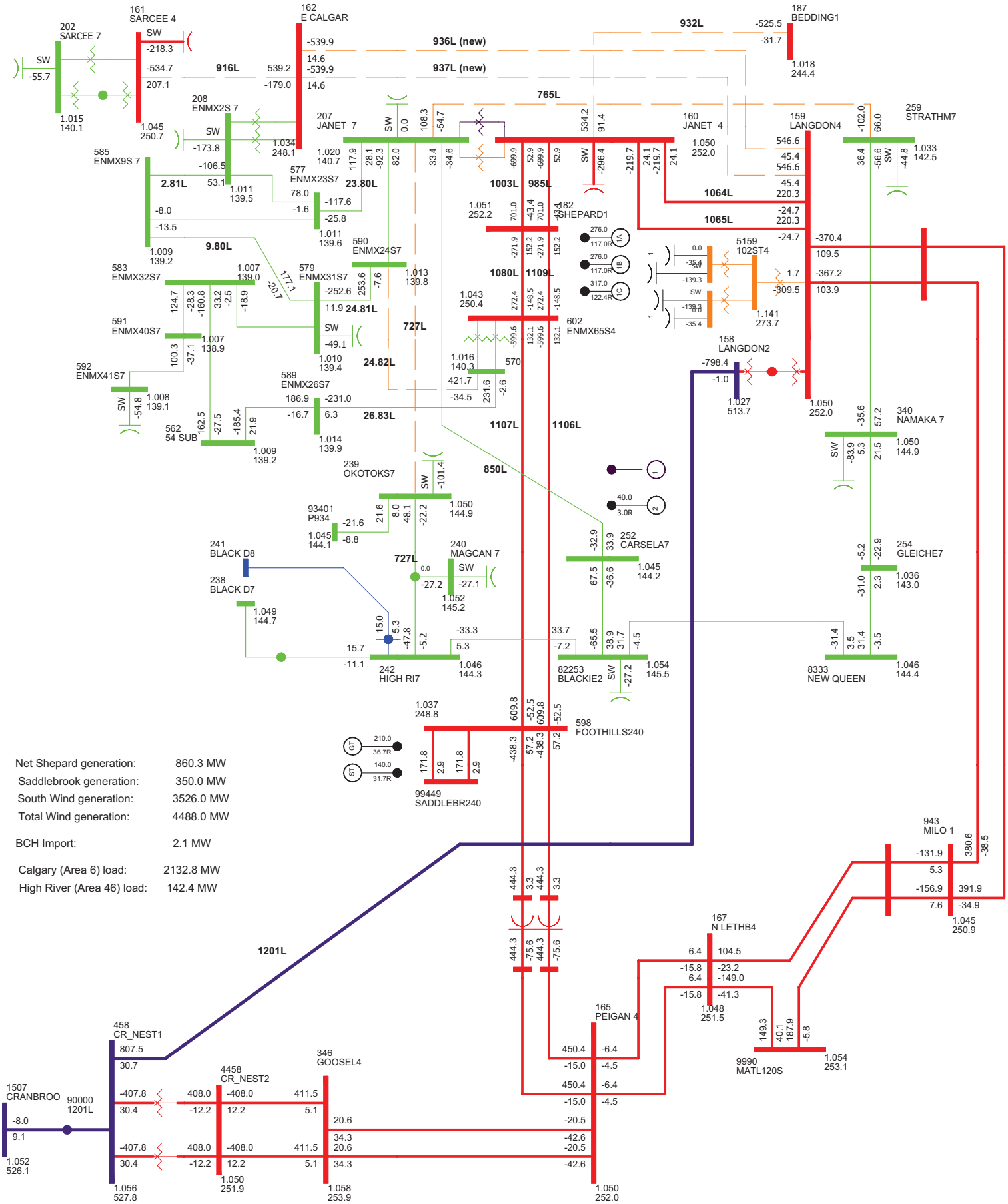


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-9

936L (LANGDON 102S TO EAST CALGARY 5S)

TUE, APR 19 2011 21:57

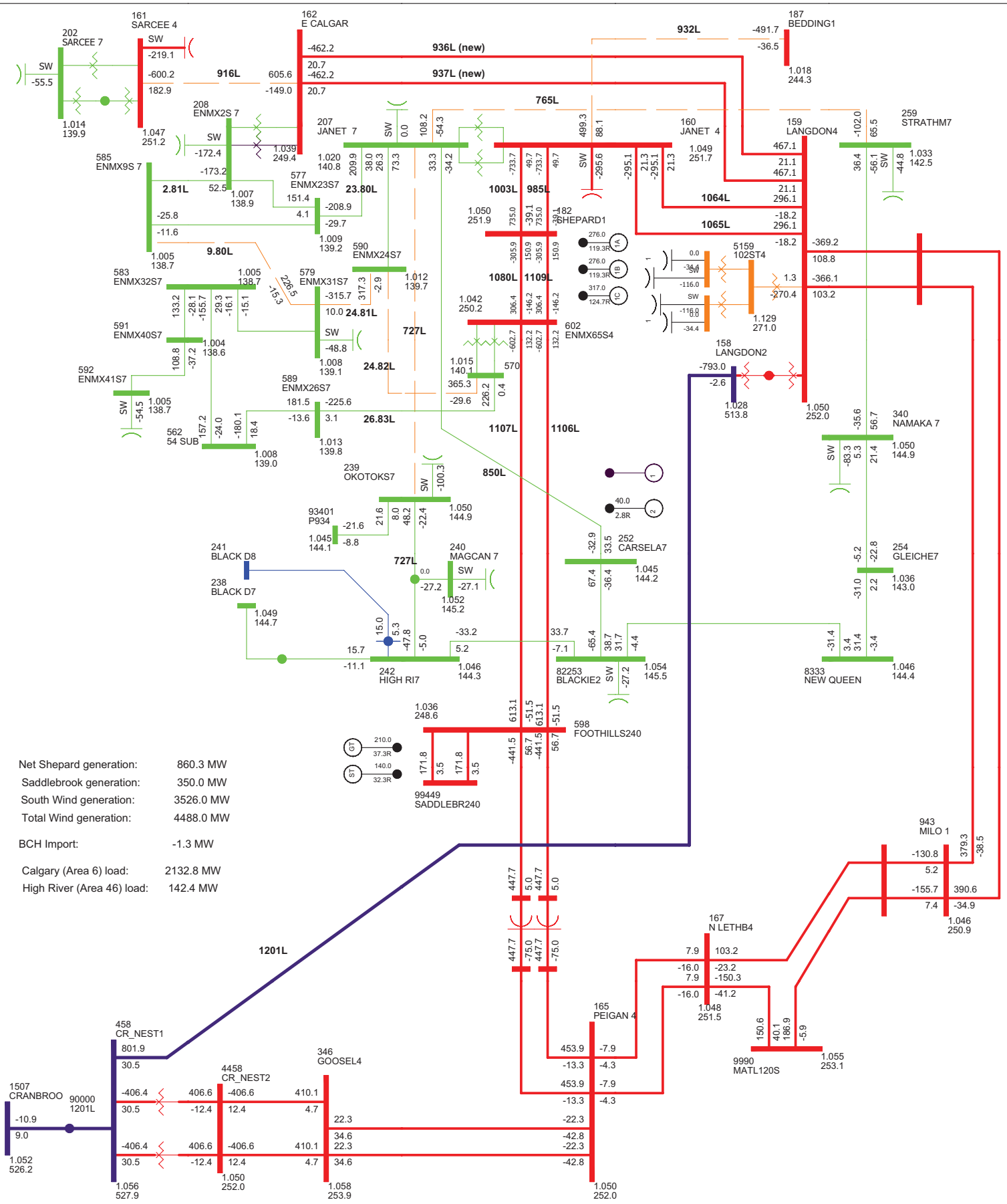


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-10

240/138 KV TRANSFORMER (JANET 74S)

TUE, APR 19 2011 21:57

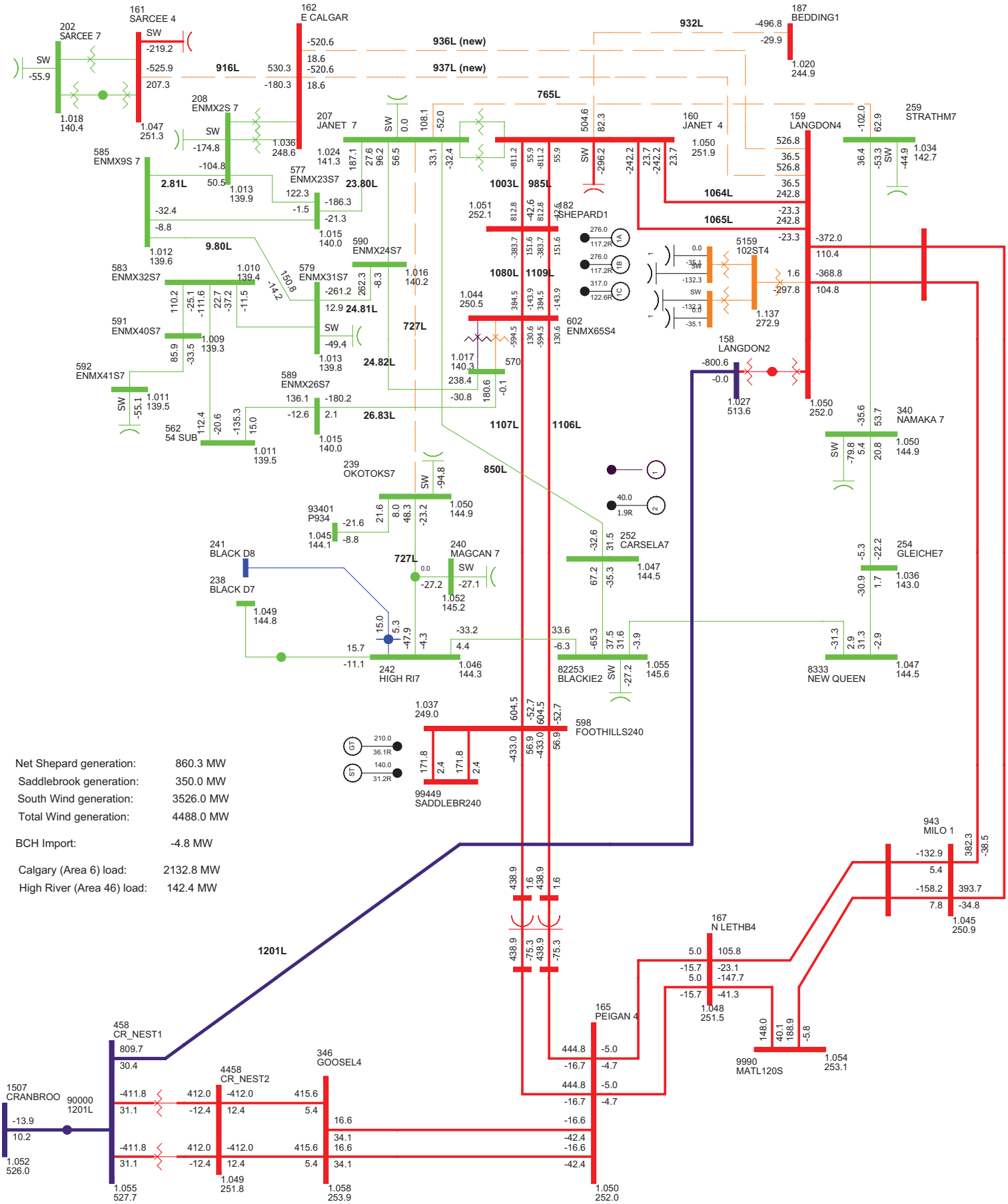


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000<=500.000 >500.000

Figure H-2019-Step2-Sc4-11

240/138 KV TRANSFORMER (EAST CALGARY 5S)

TUE, APR 19 2011 21:57

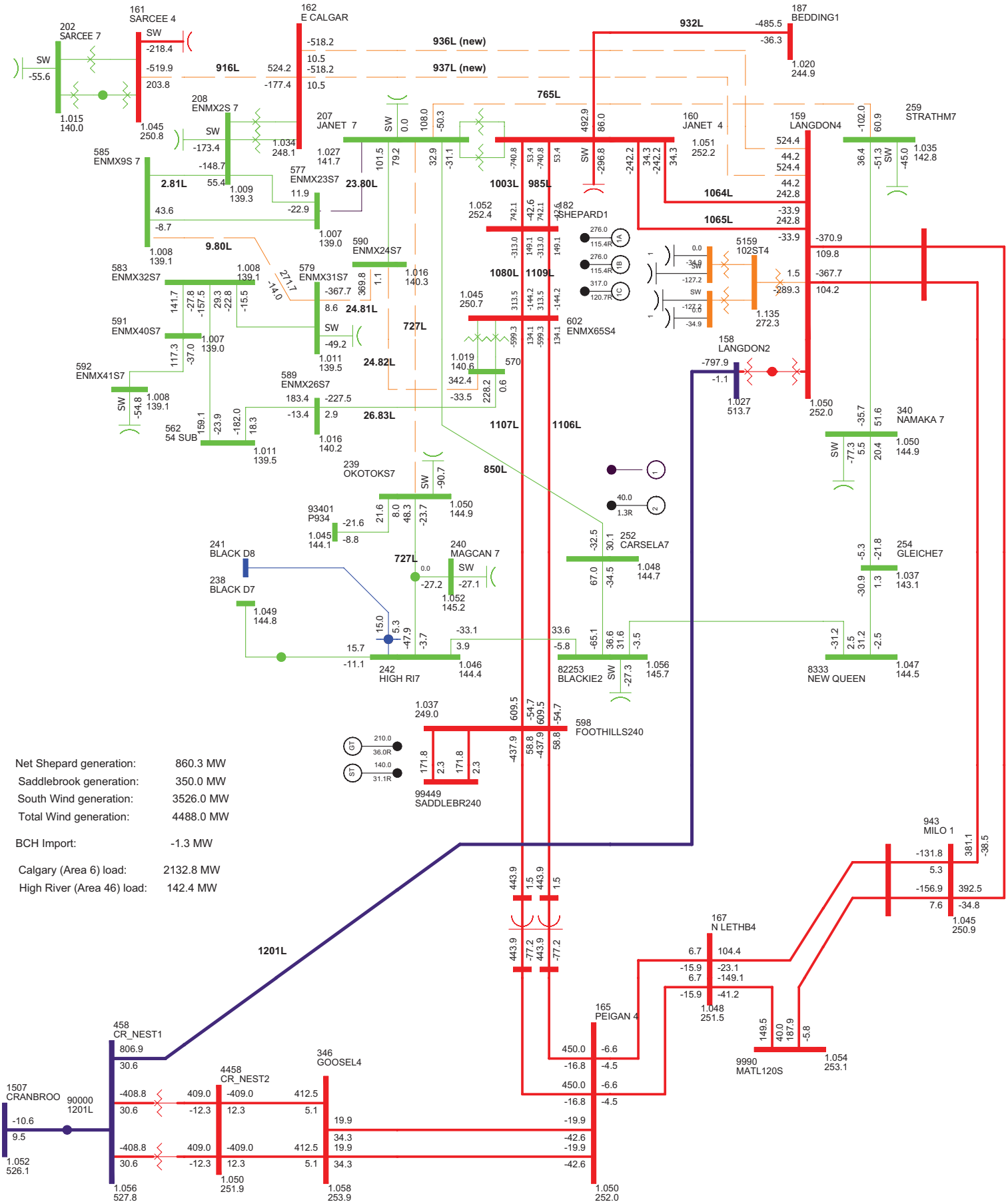


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure H-2019-Step2-Sc4-12

240/138 KV TRANSFORMER (ENMAX NO. 65)

TUE, APR 19 2011 22:20

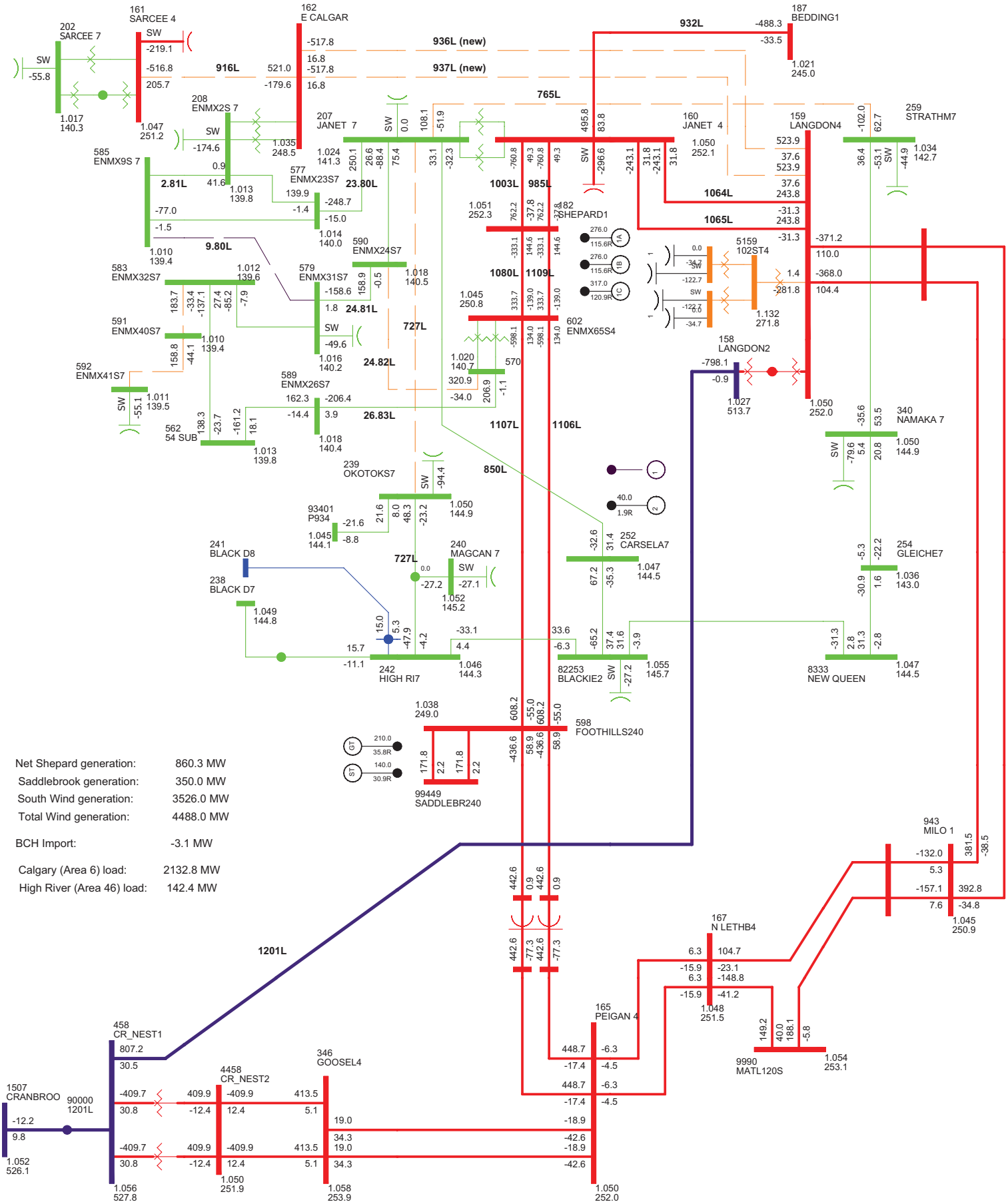


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure H-2019-Step2-Sc4-13

23.80L (JANET 74S TO ENMAX NO. 23)

TUE, APR 19 2011 22:20

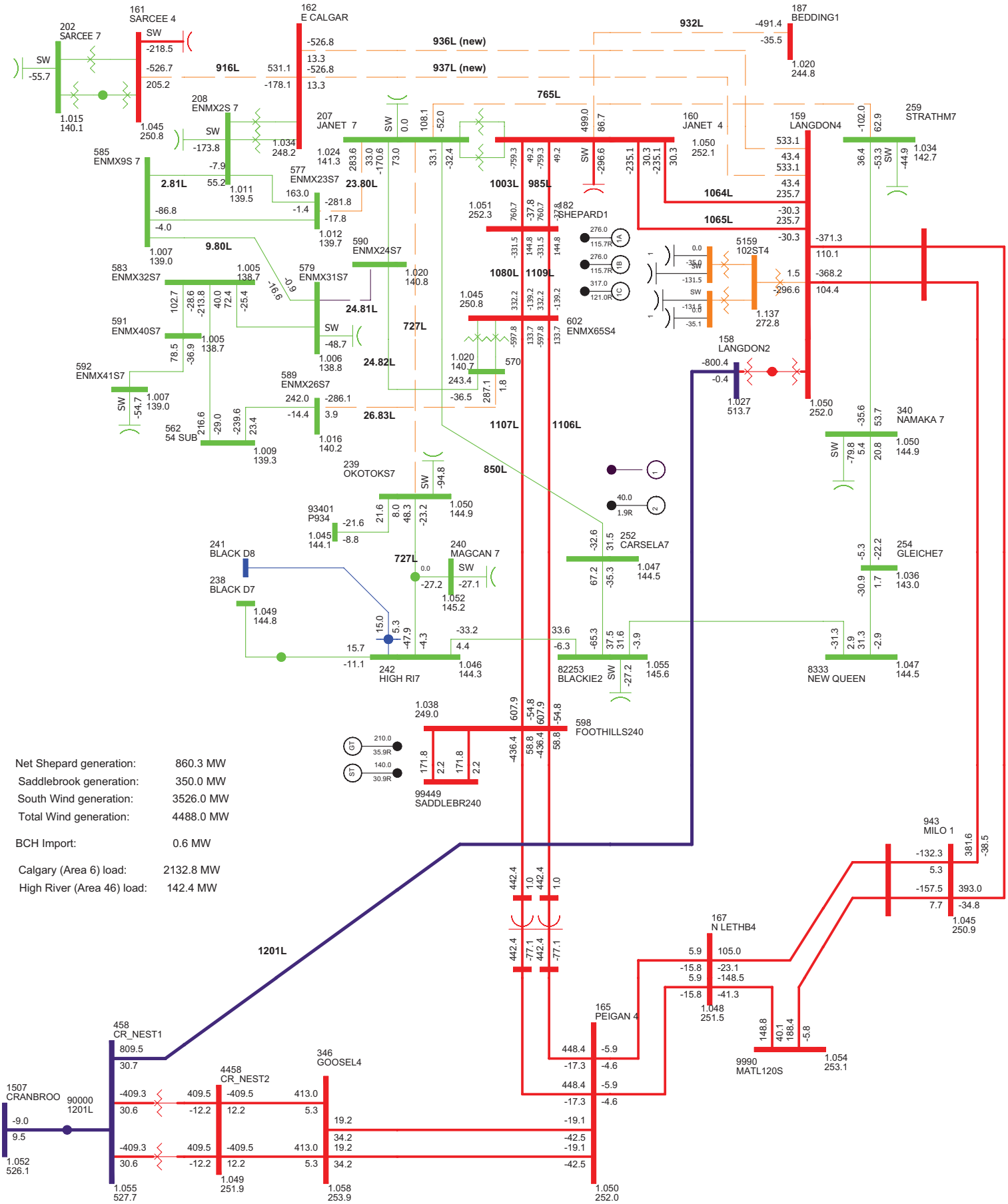


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure H-2019-Step2-Sc4-14

9.80L (ENMAX NO. 31 TO ENMAX NO. 9)

TUE, APR 19 2011 22:20



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure H-2019-Step2-Sc4-15

24.81L (ENMAX NO. 31 TO ENMAX NO. 24)

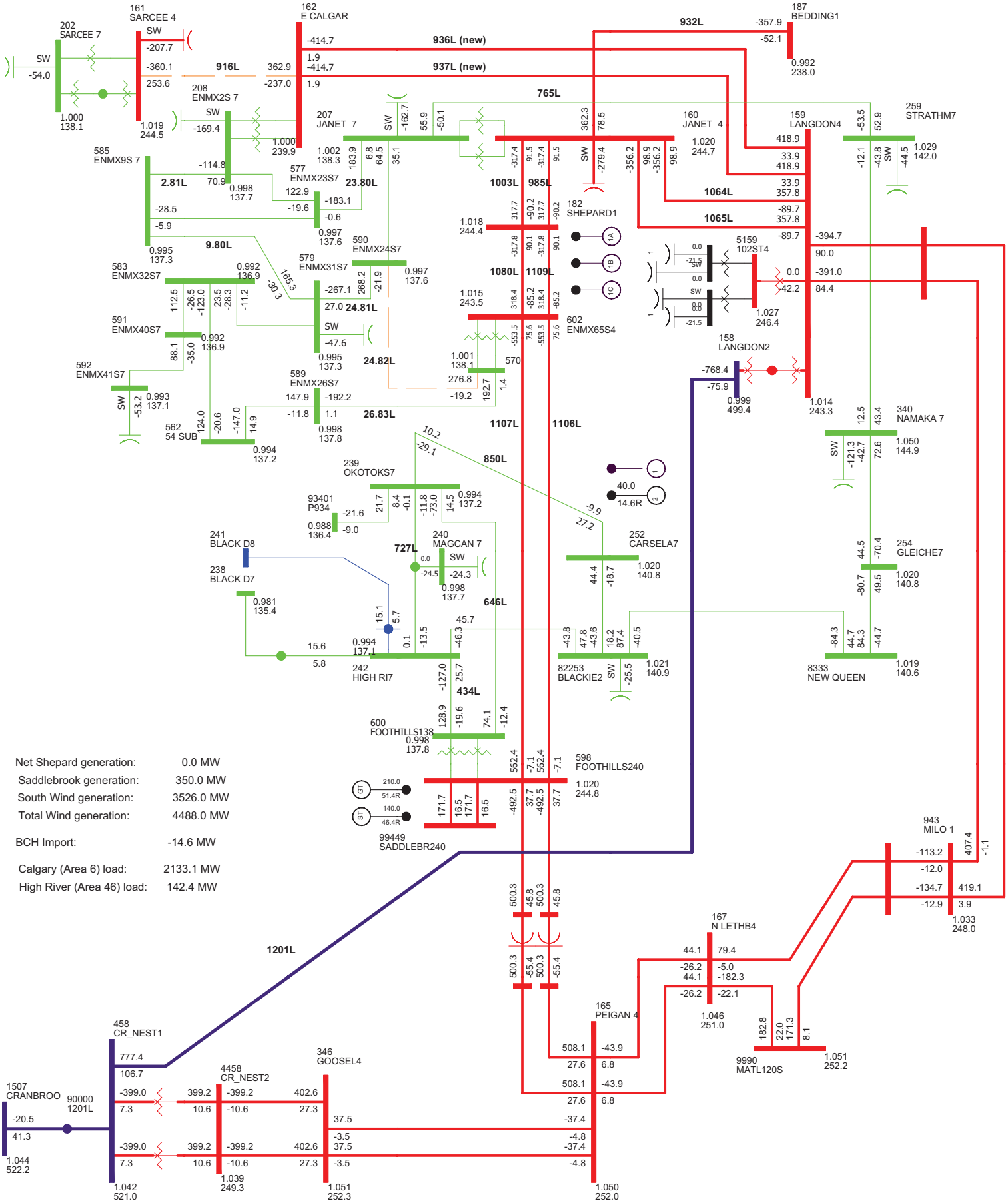
TUE, APR 19 2011 22:21

ATTACHMENT I

Transmission Development Plan – Step 3, 2019

Table I-1

Figure Name	Contingency
Figure I-2019-Step3-Sc3-1	Base Case (N-0)
Figure I-2019-Step3-Sc3-2	Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)
Figure I-2019-Step3-Sc3-3	Open 1106L 240kV line (Foothills 237S to ENMAX No. 65)
Figure I-2019-Step3-Sc4-1	Base Case (N-0)
Figure I-2019-Step3-Sc4-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure I-2019-Step3-Sc4-3	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure I-2019-Step3-Sc4-4	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure I-2019-Step3-Sc4-5	Open 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure I-2019-Step3-Sc4-6	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure I-2019-Step3-Sc4-7	Open 240/138 kV transformer (Janet 74S)
Figure I-2019-Step3-Sc4-8	Open 240/138 kV transformer (East Calgary 5S)
Figure I-2019-Step3-Sc4-9	Open 240/138 kV transformer (ENMAX No. 65)
Figure I-2019-Step3-Sc4-10	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)
Figure I-2019-Step3-Sc4-11	Open 9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)
Figure I-2019-Step3-Sc4-12	Open 24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)
Figure I-2019-Step3-Sc4-13	Open 2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)

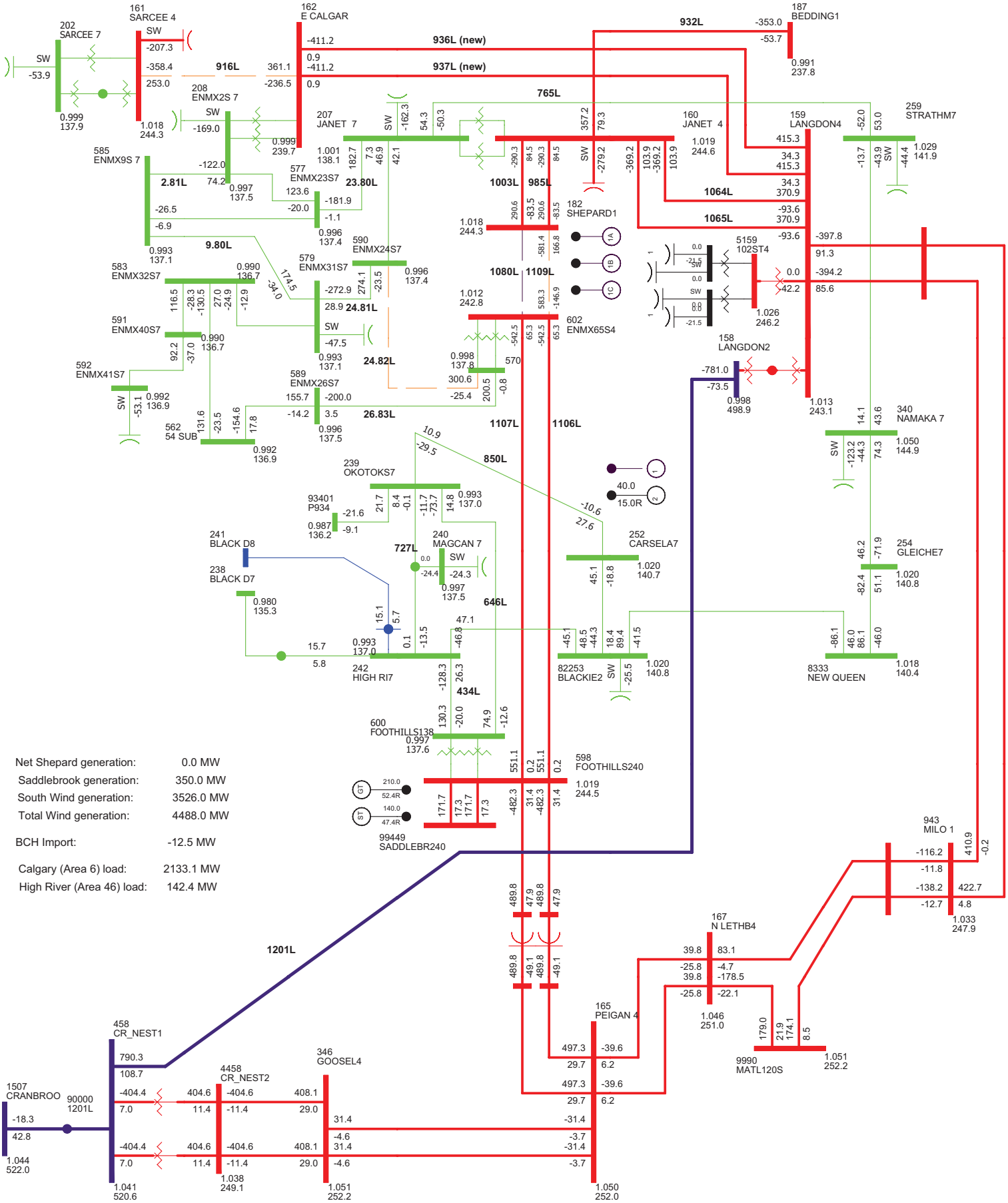


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc3-1

BASE CASE (ALL ELEMENTS IN SERVICE)

TUE, APR 19 2011 22:23

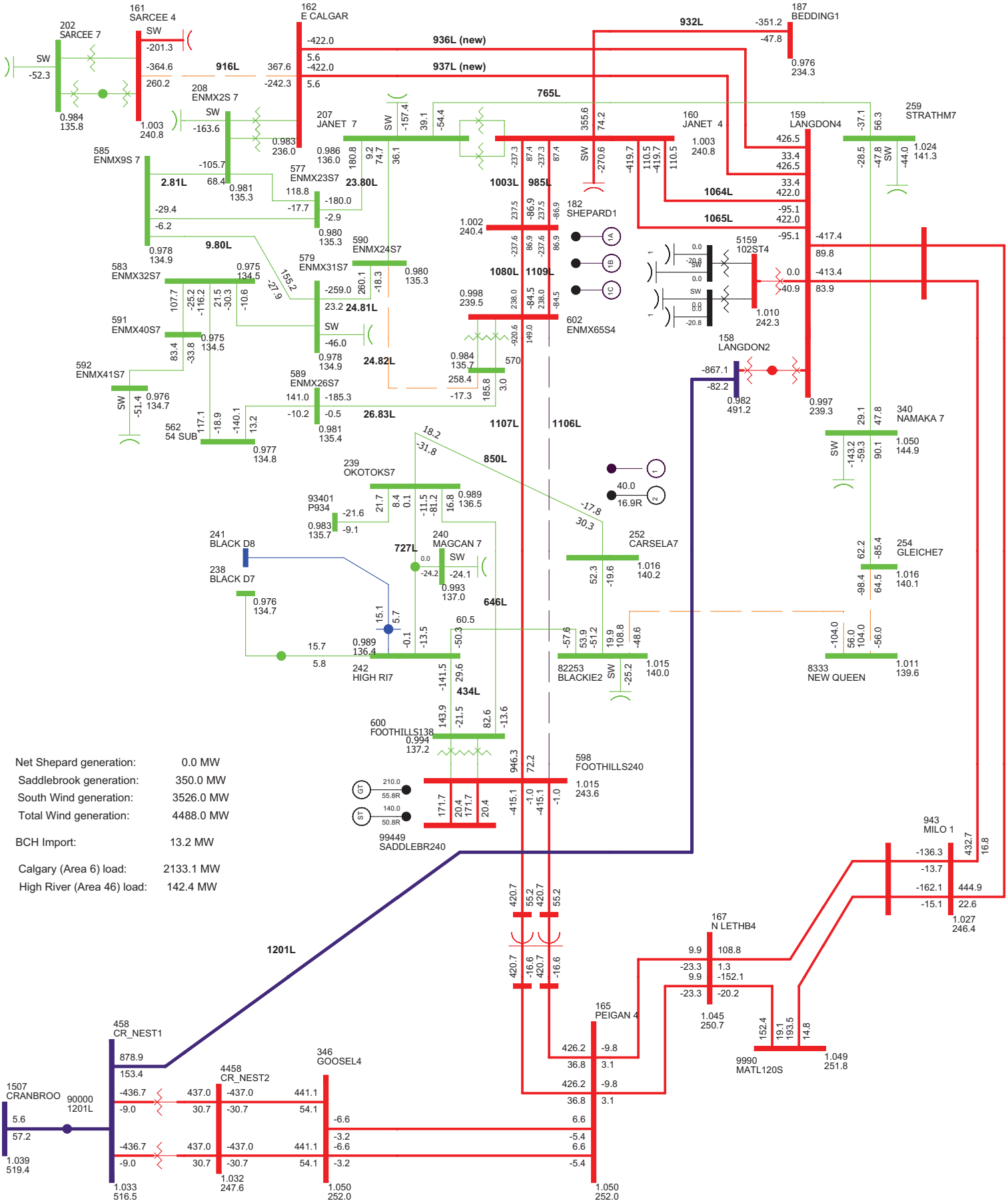


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc3-2

1080L (ENMAX NO. 25 TO ENMAX NO. 65)

TUE, APR 19 2011 22:24

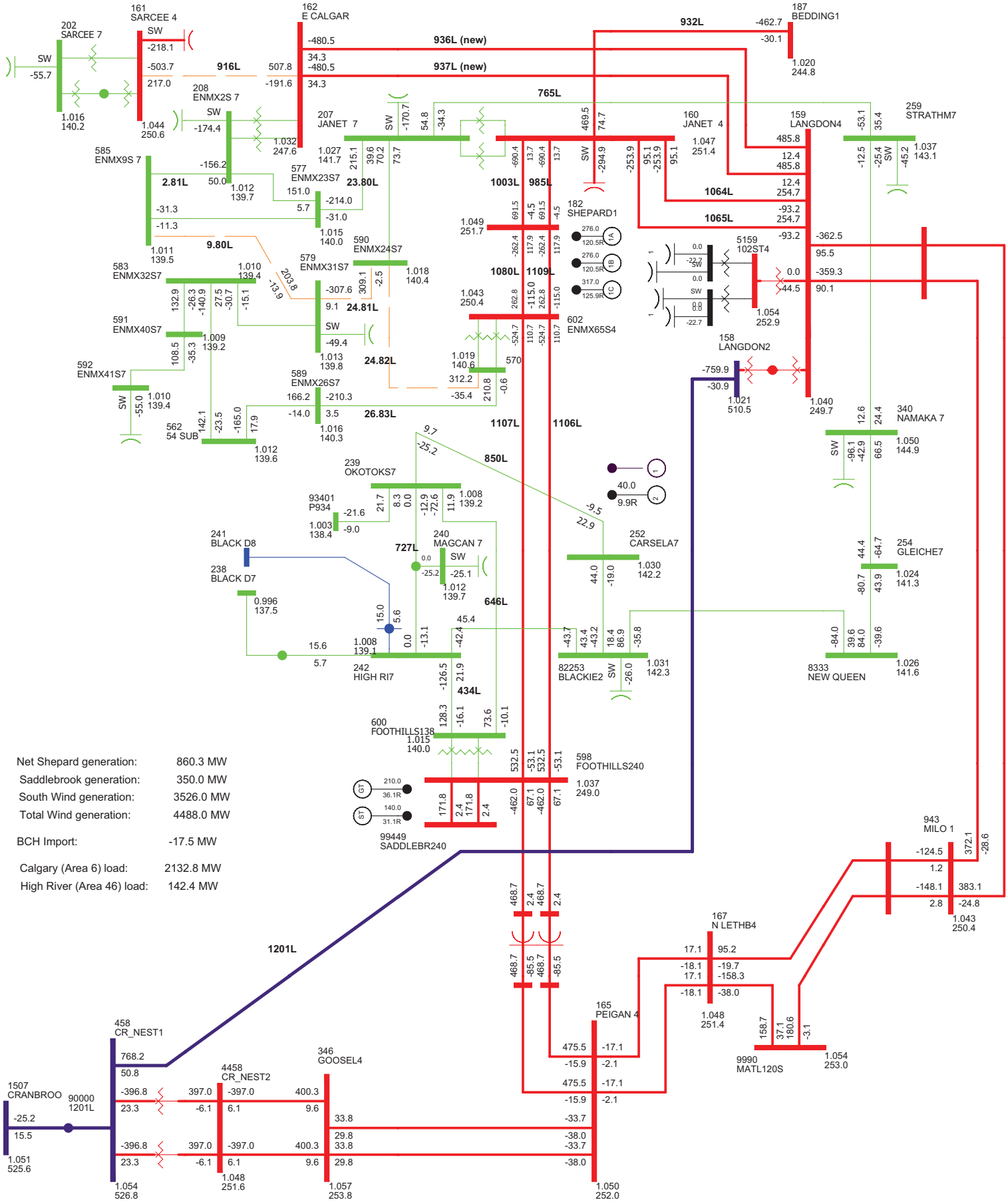


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc3-3

1106L (FOOTHILLS 237S TO ENMAX NO. 65)

TUE, APR 19 2011 22:24

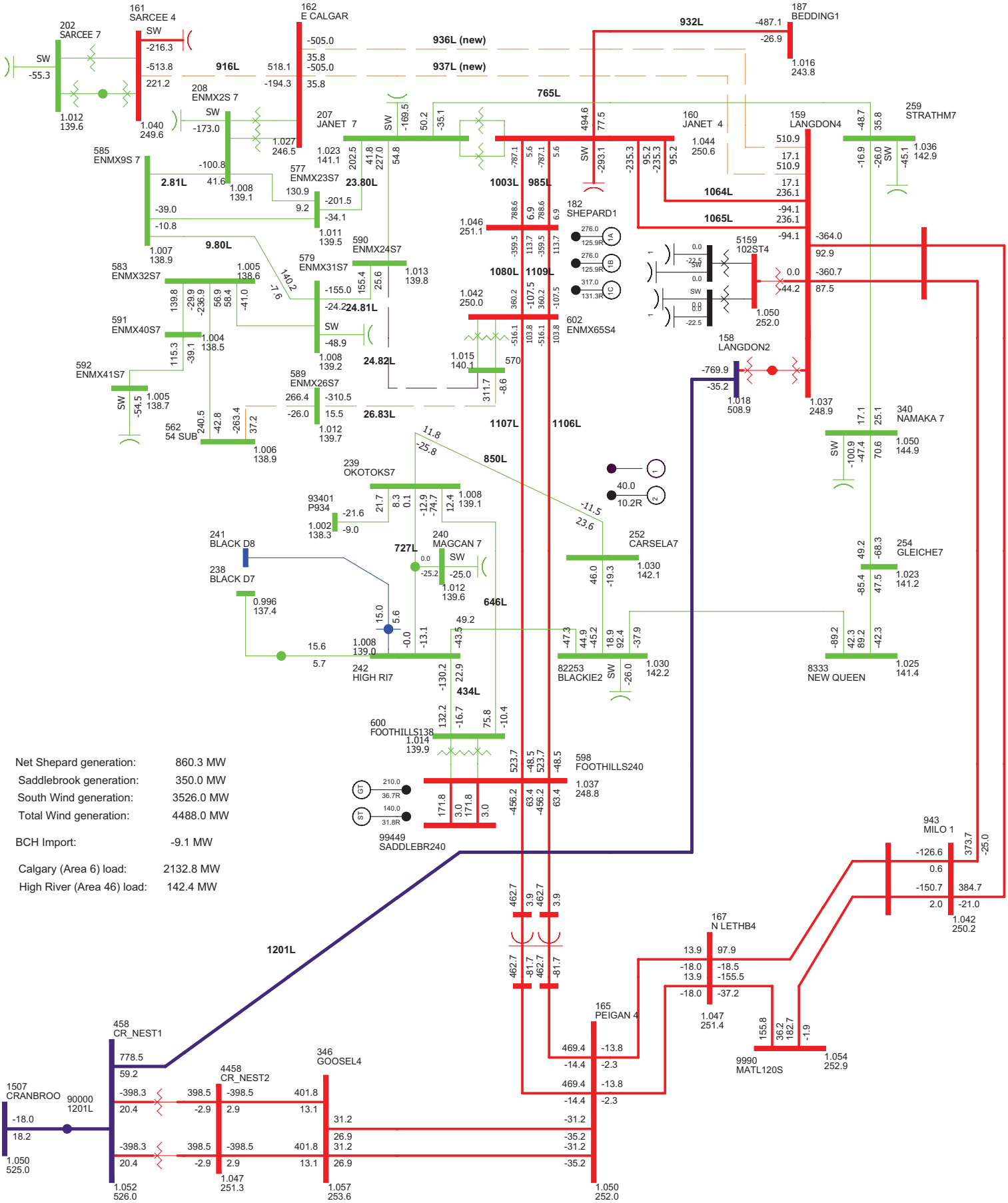


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

TUE, APR 19 2011 22:26

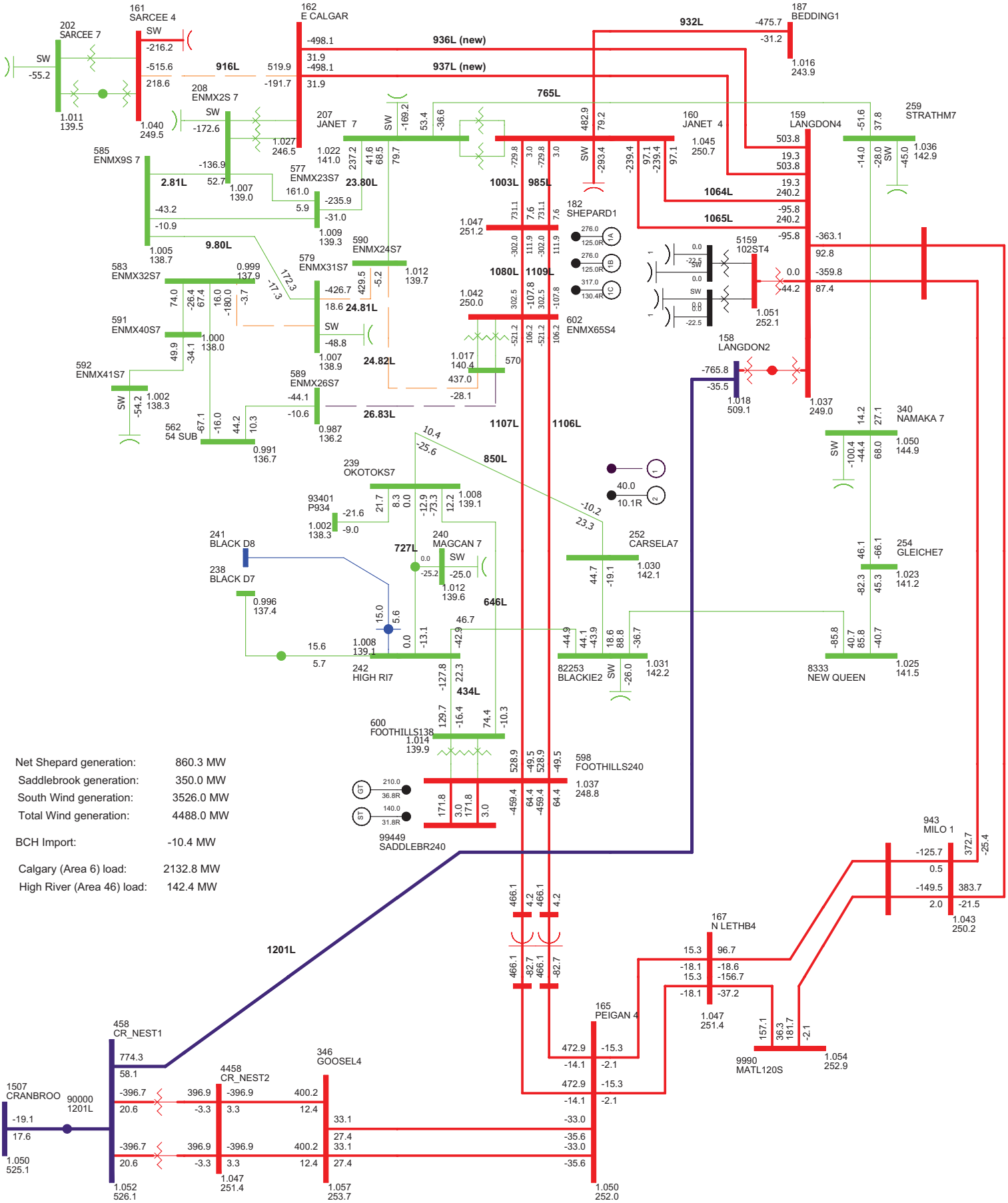


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

TUE, APR 19 2011 22:27

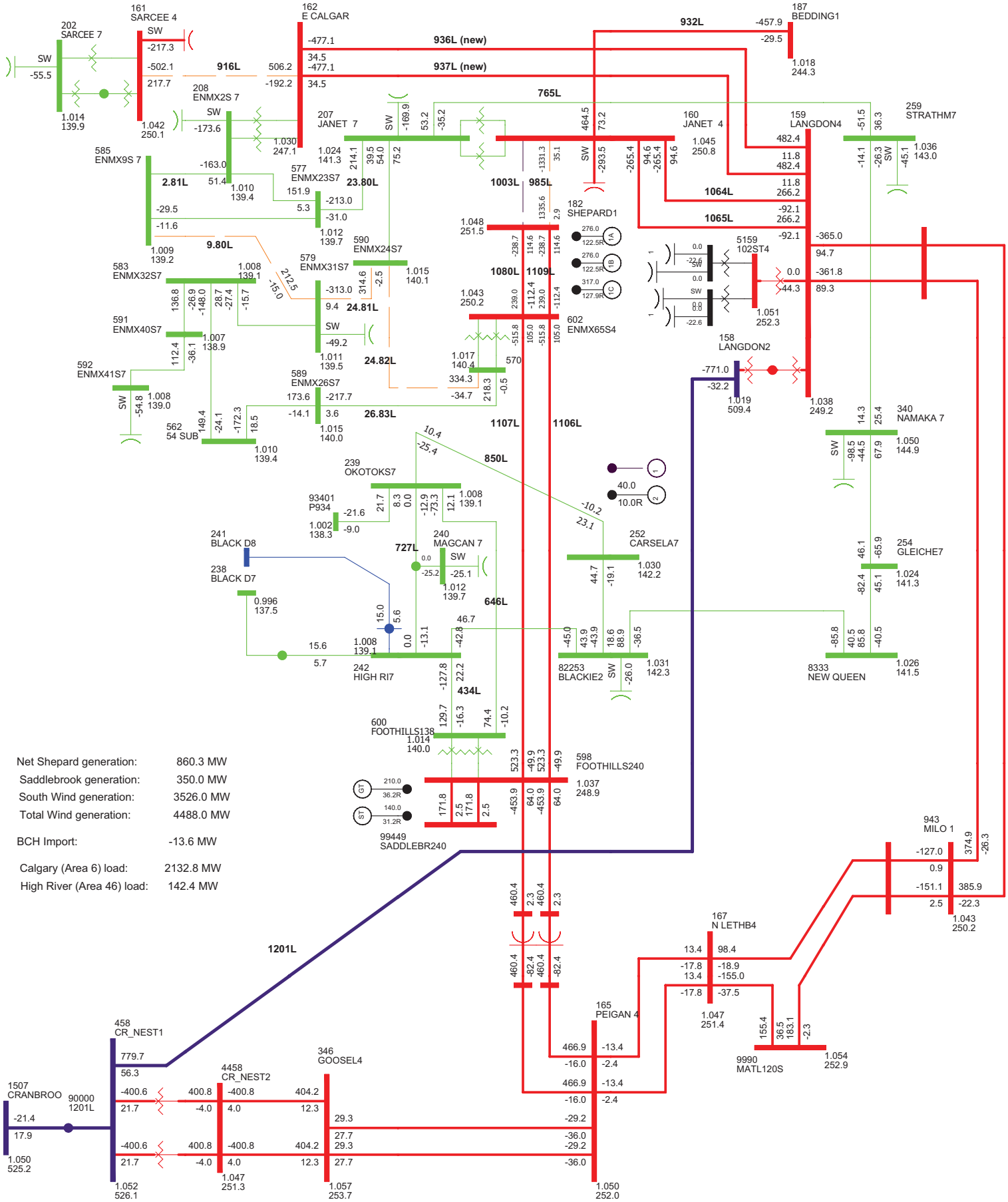


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-3

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

TUE, APR 19 2011 22:27

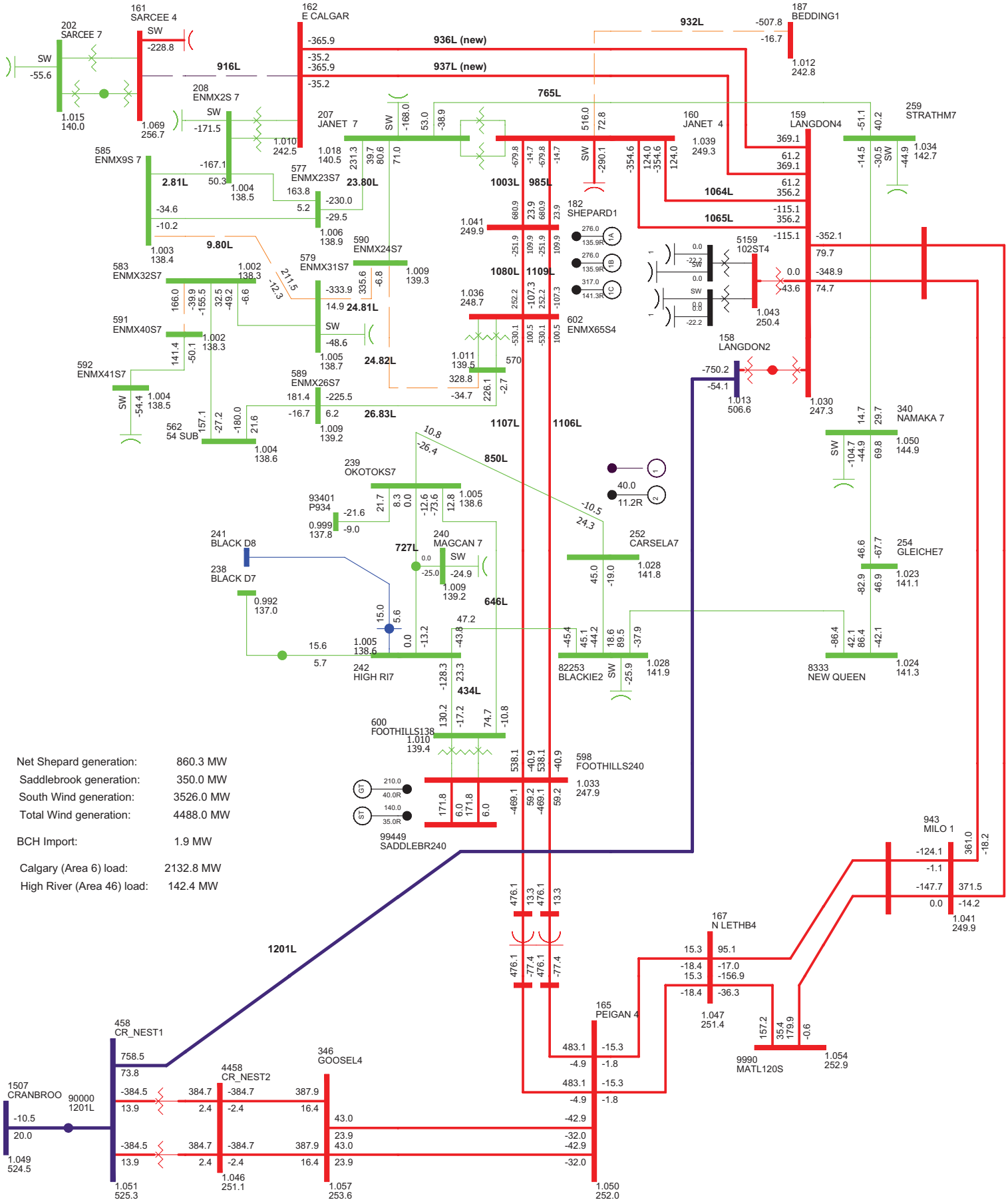


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-4

1003L (JANET 74S TO ENMAX NO. 25)

TUE, APR 19 2011 22:28



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-5

916L (SARCEE 42S TO EAST CALGARY 5S)

TUE, APR 19 2011 22:28

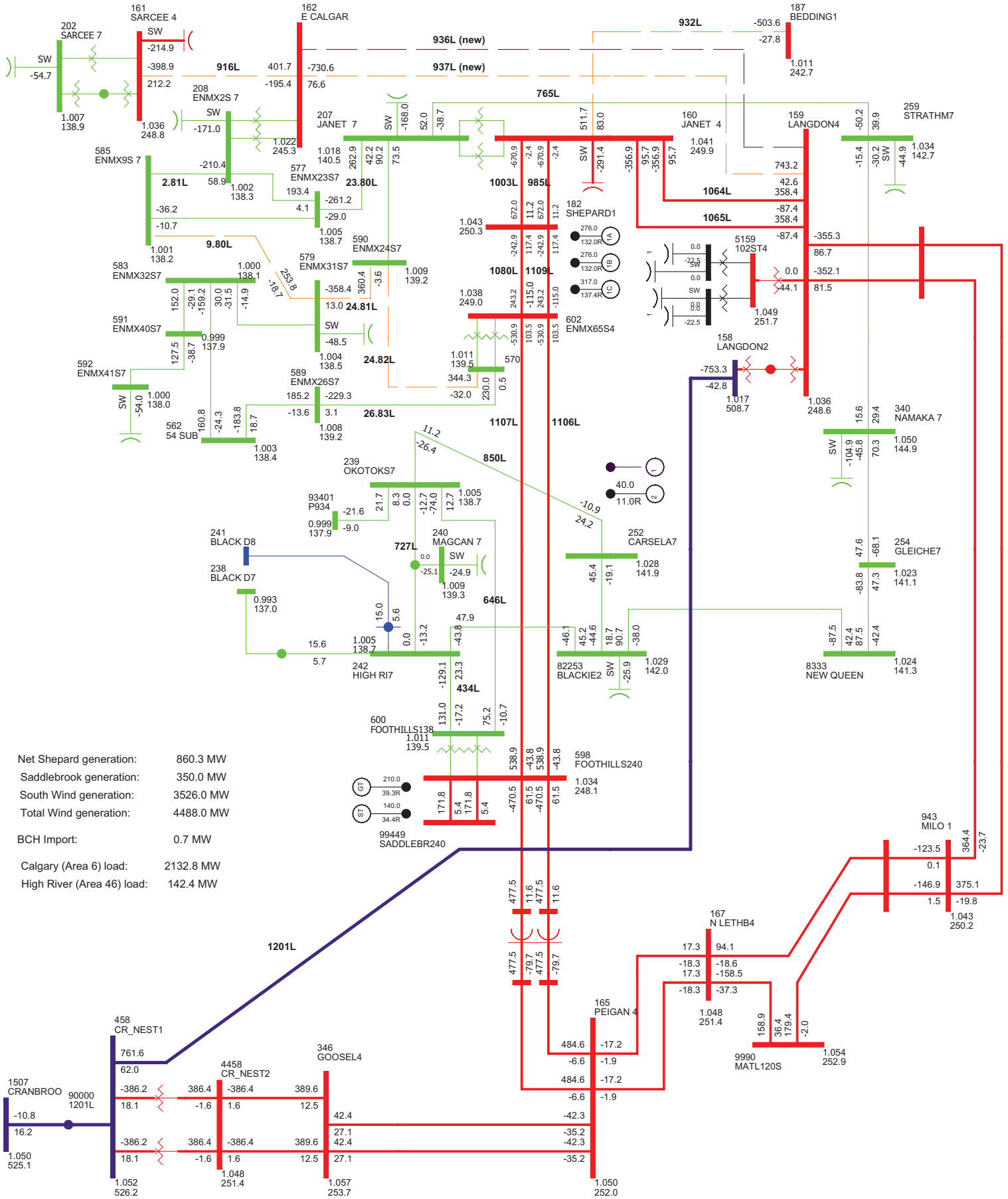
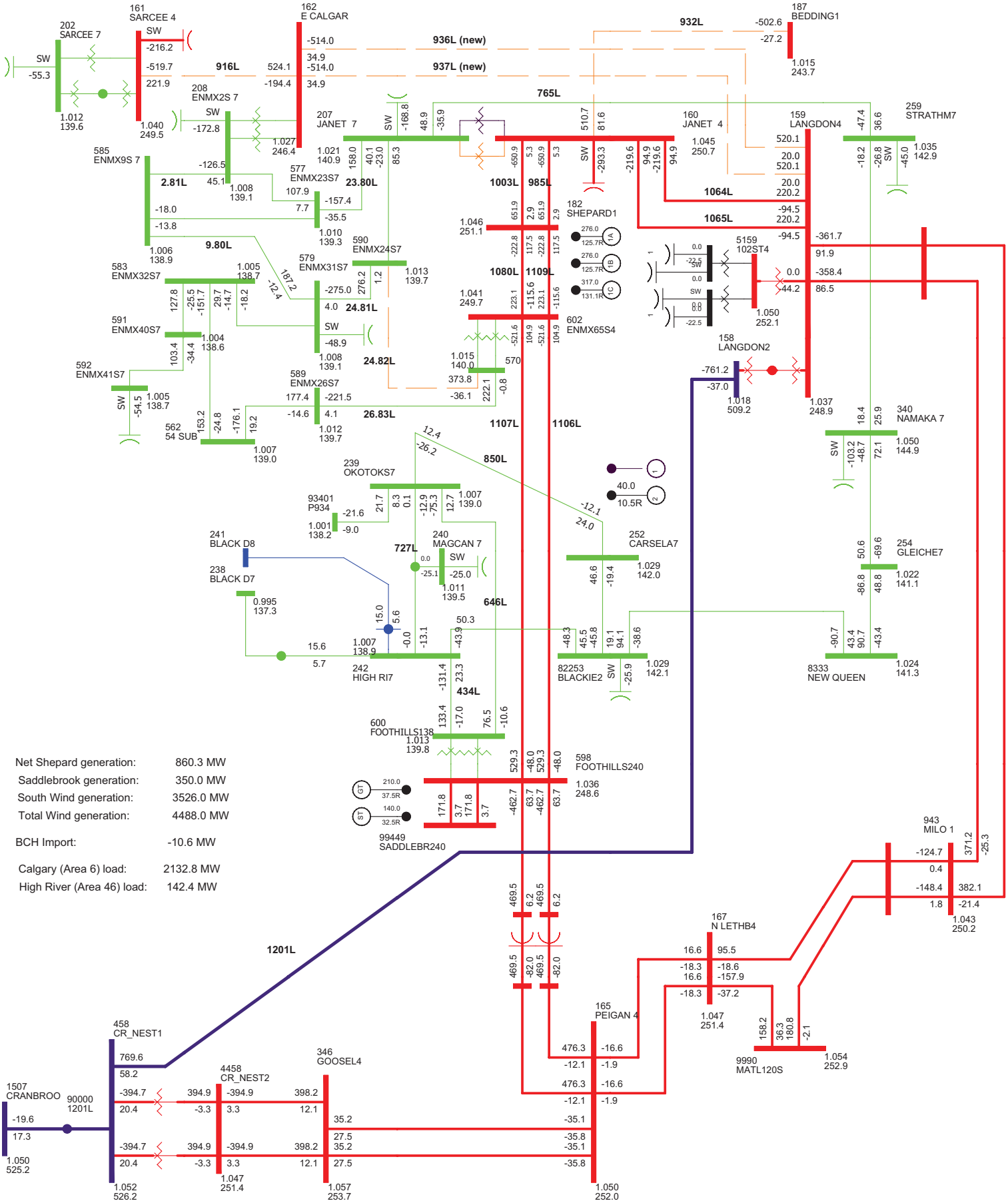


Figure I-2019-Step3-Sc4-6

936L (LANGDON 102S TO EAST CALGARY 5S)

TUE, APR 19 2011 22:28



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-7

240/138 KV TRANSFORMER (JANET 74S)

TUE, APR 19 2011 22:28

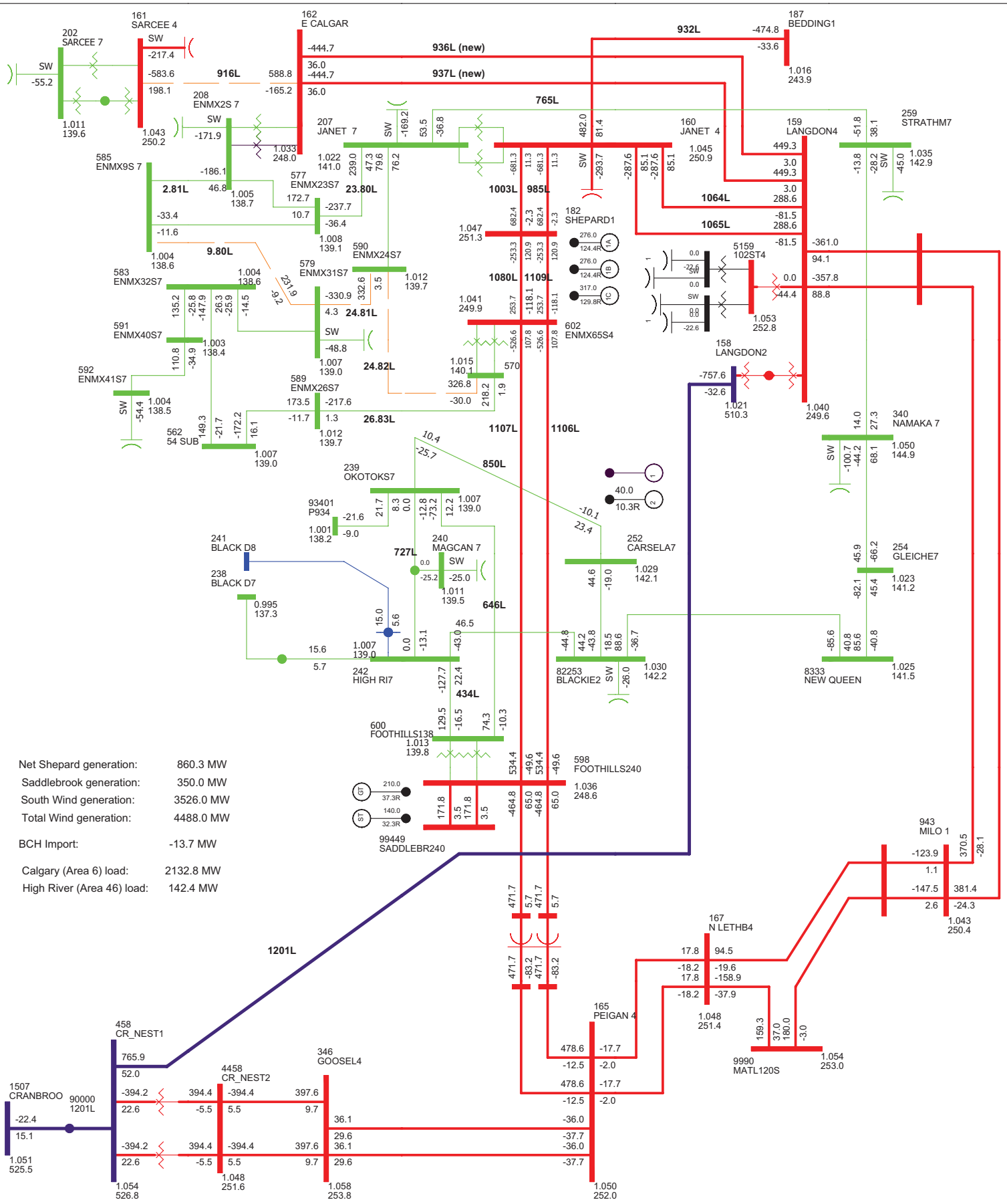
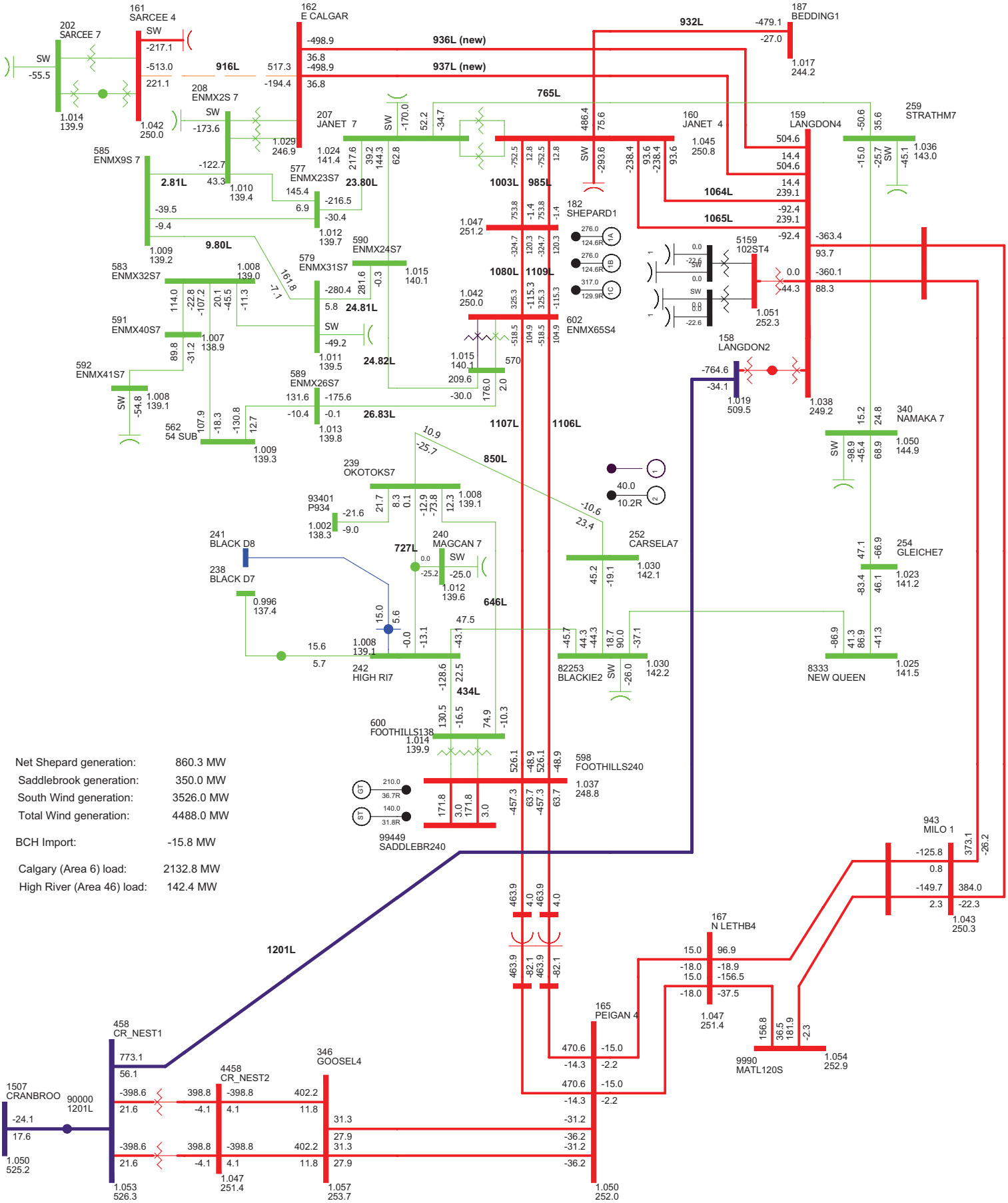


Figure I-2019-Step3-Sc4-8

Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

240/138 KV TRANSFORMER (EAST CALGARY 5S)

TUE, APR 19 2011 22:29

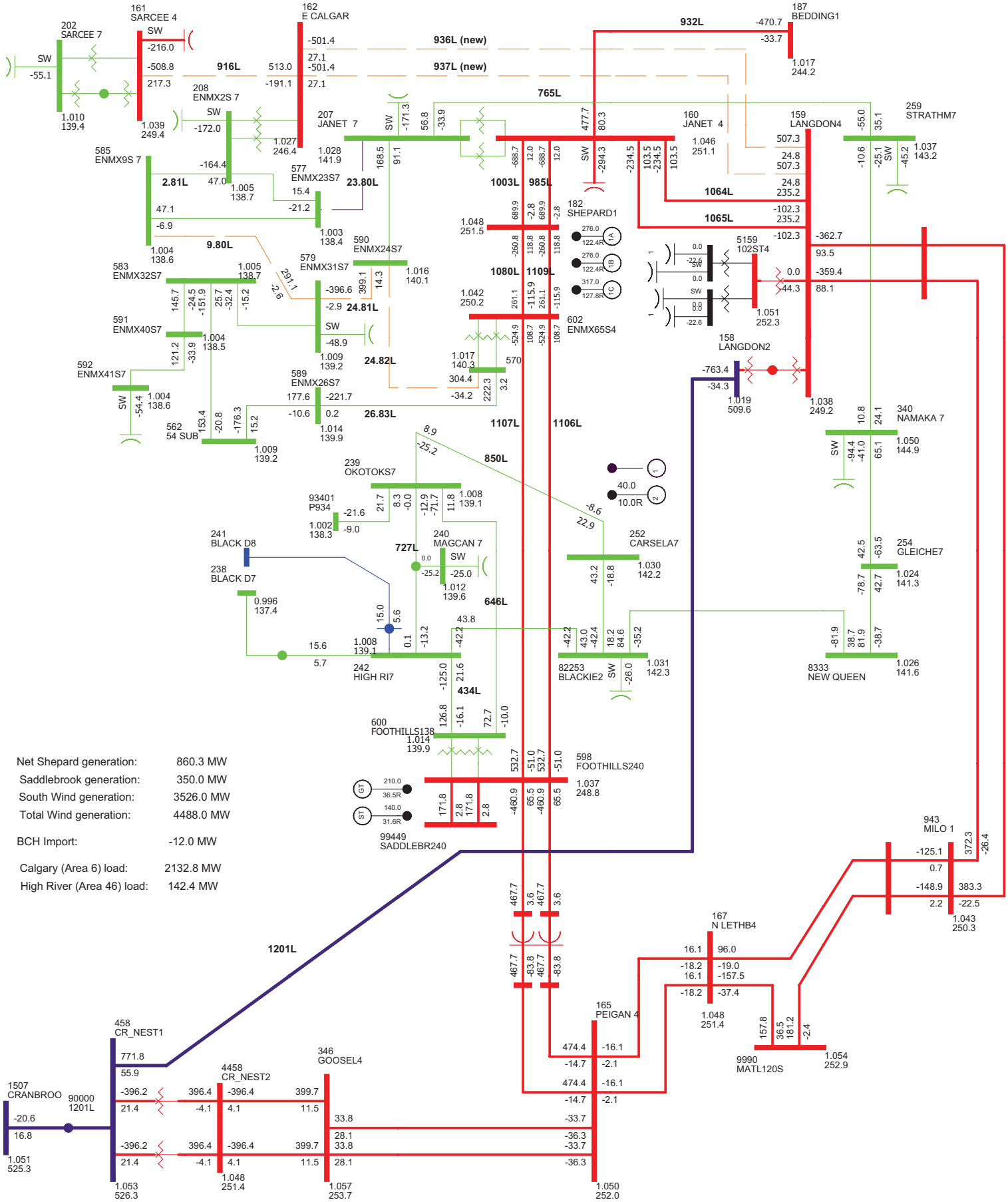


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-9

240/138 KV TRANSFORMER (ENMAX NO. 65)

TUE, APR 19 2011 22:29

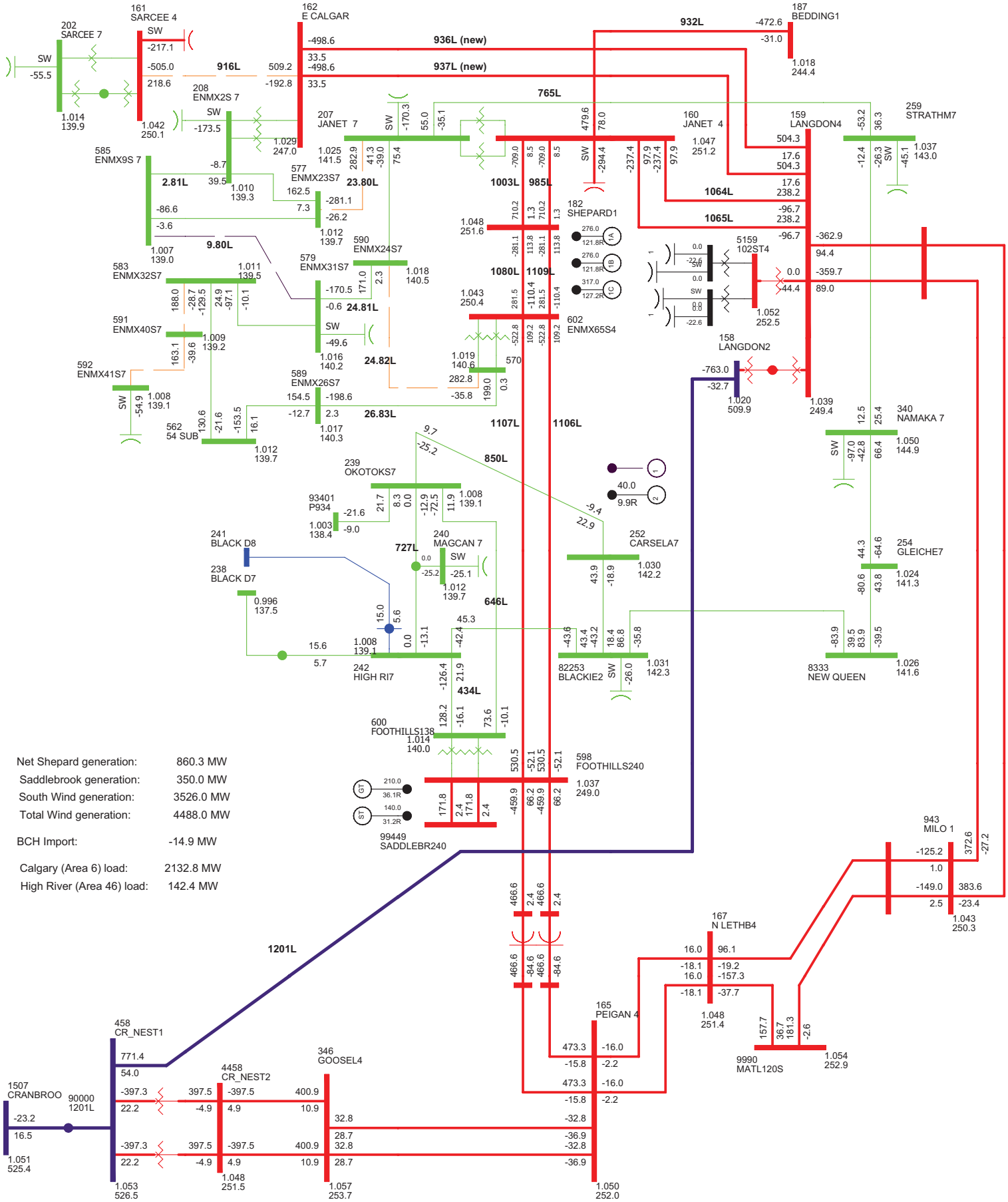


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-10

23.80L (JANET 74S TO ENMAX NO. 23)

TUE, APR 19 2011 22:29

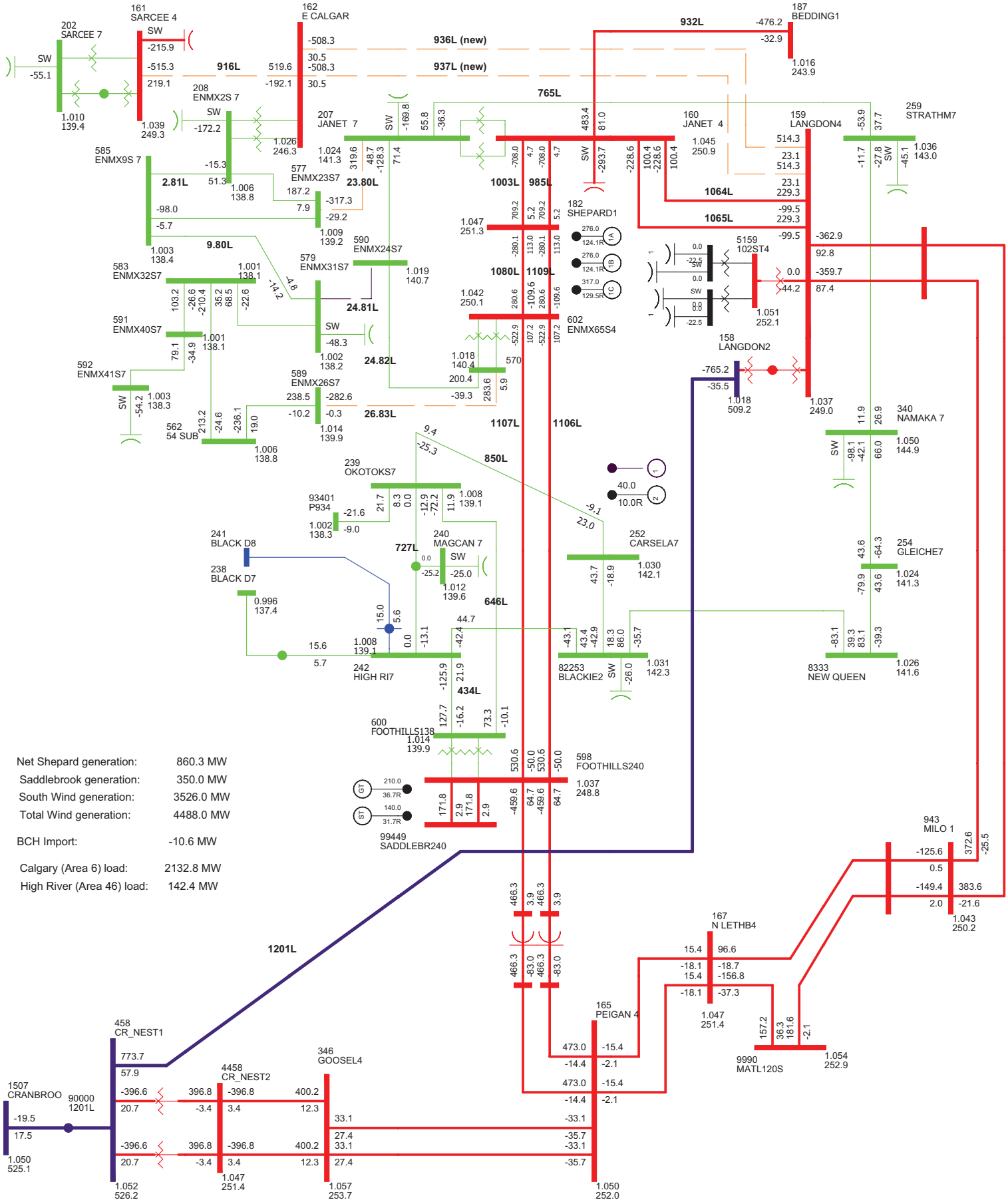


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-11

9.80L (ENMAX NO. 31 TO ENMAX NO. 9)

TUE, APR 19 2011 22:29

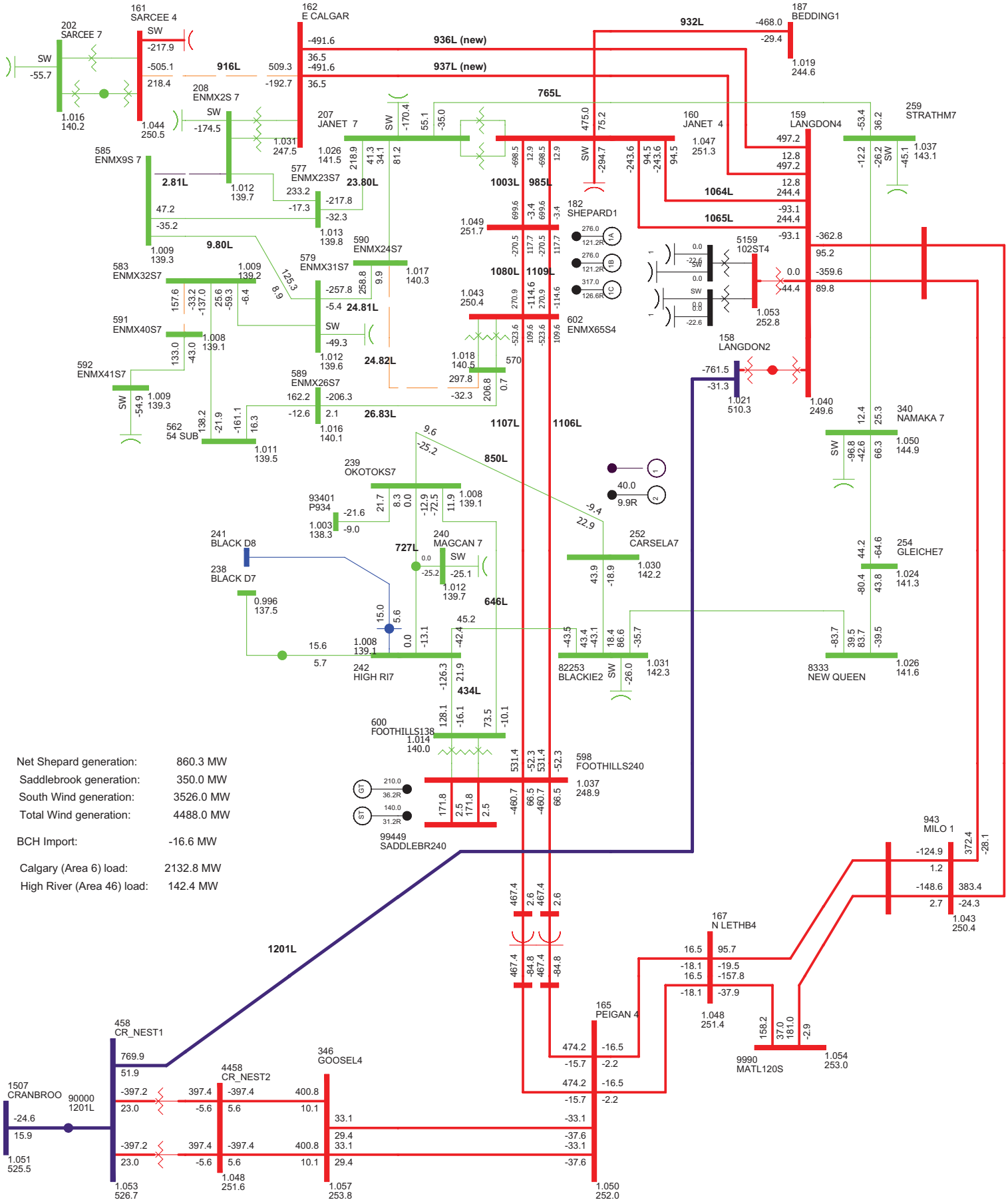


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-12

24.81L (ENMAX NO. 31 TO ENMAX NO. 24)

TUE, APR 19 2011 22:29



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure I-2019-Step3-Sc4-13

2.81L (ENMAX NO. 2 TO ENMAX NO. 9)

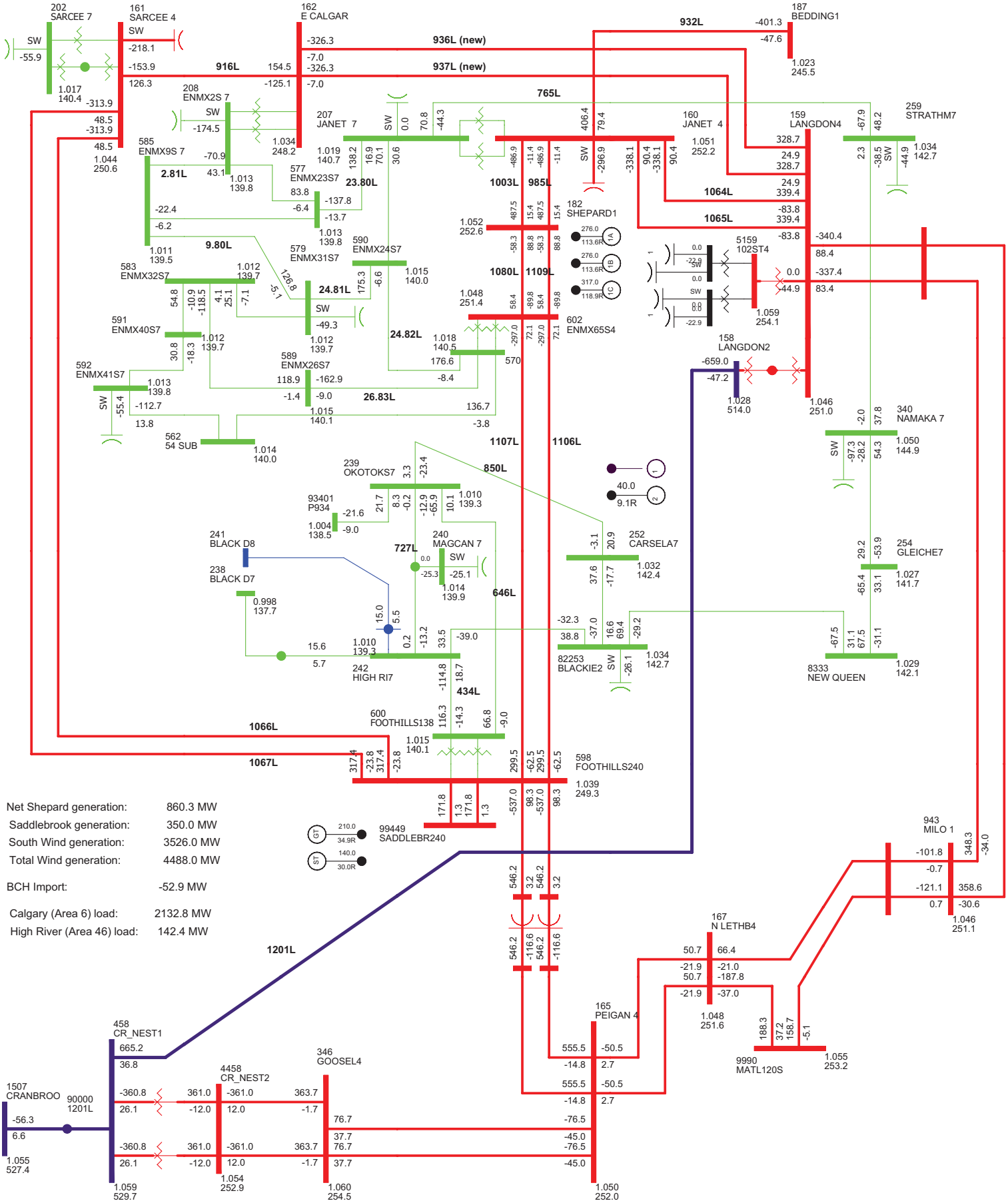
TUE, APR 19 2011 22:29

ATTACHMENT J

Transmission Development Plan – Step 4, 2019

Table J-1

Figure Name	Contingency
Figure J-2019-Step4-Sc4-1	Base Case (N-0)
Figure J-2019-Step4-Sc4-2	Open 24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)
Figure J-2019-Step4-Sc4-3	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure J-2019-Step4-Sc4-4	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure J-2019-Step4-Sc4-5	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure J-2019-Step4-Sc4-6	Open 240/138 kV transformer (Janet 74S)
Figure J-2019-Step4-Sc4-7	Open 240/138 kV transformer (East Calgary 5S)
Figure J-2019-Step4-Sc4-8	Open 240/138 kV transformer (ENMAX No. 65)
Figure J-2019-Step4-Sc4-9	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)

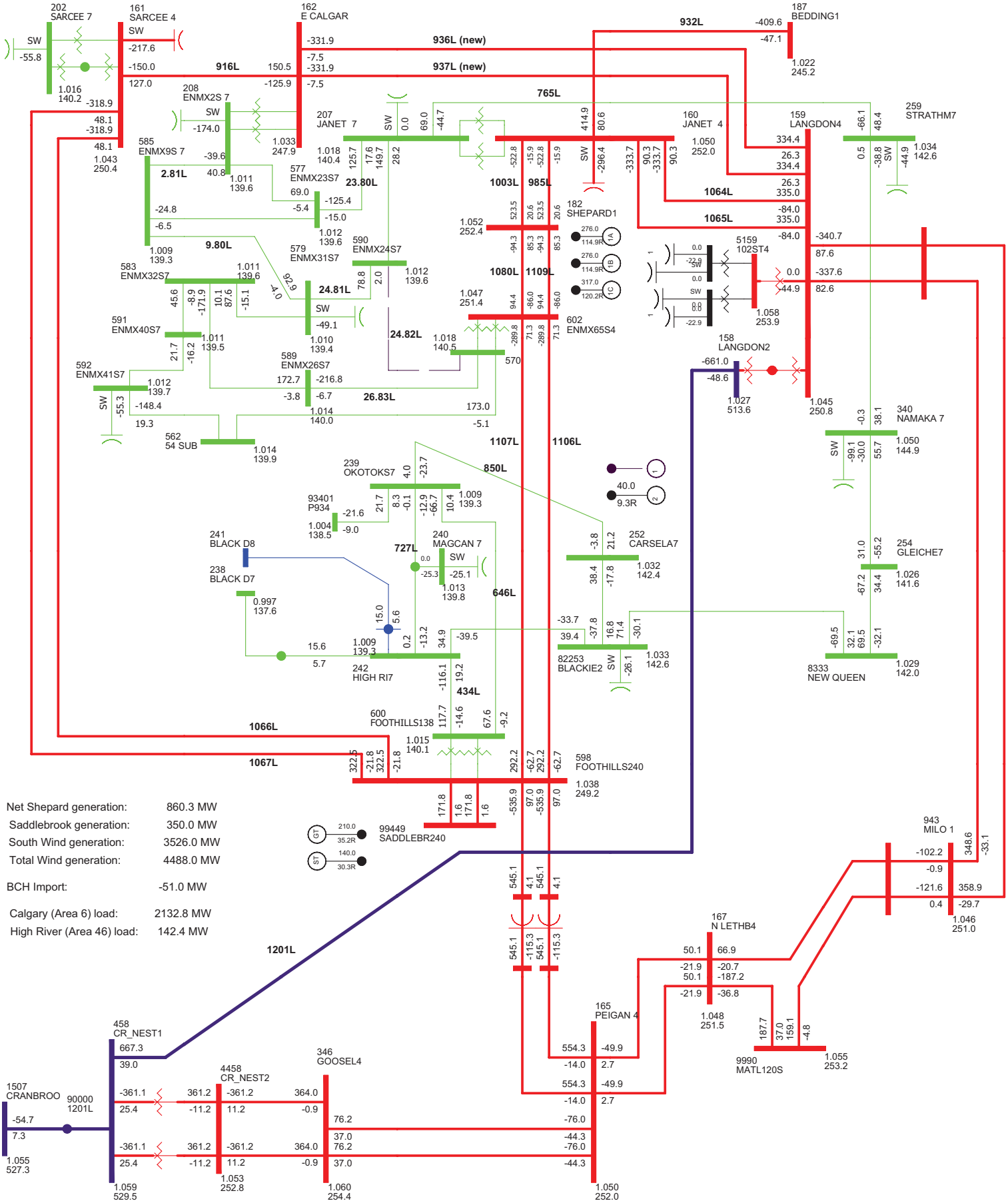


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure J-2019-Step4-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

TUE, APR 19 2011 22:34

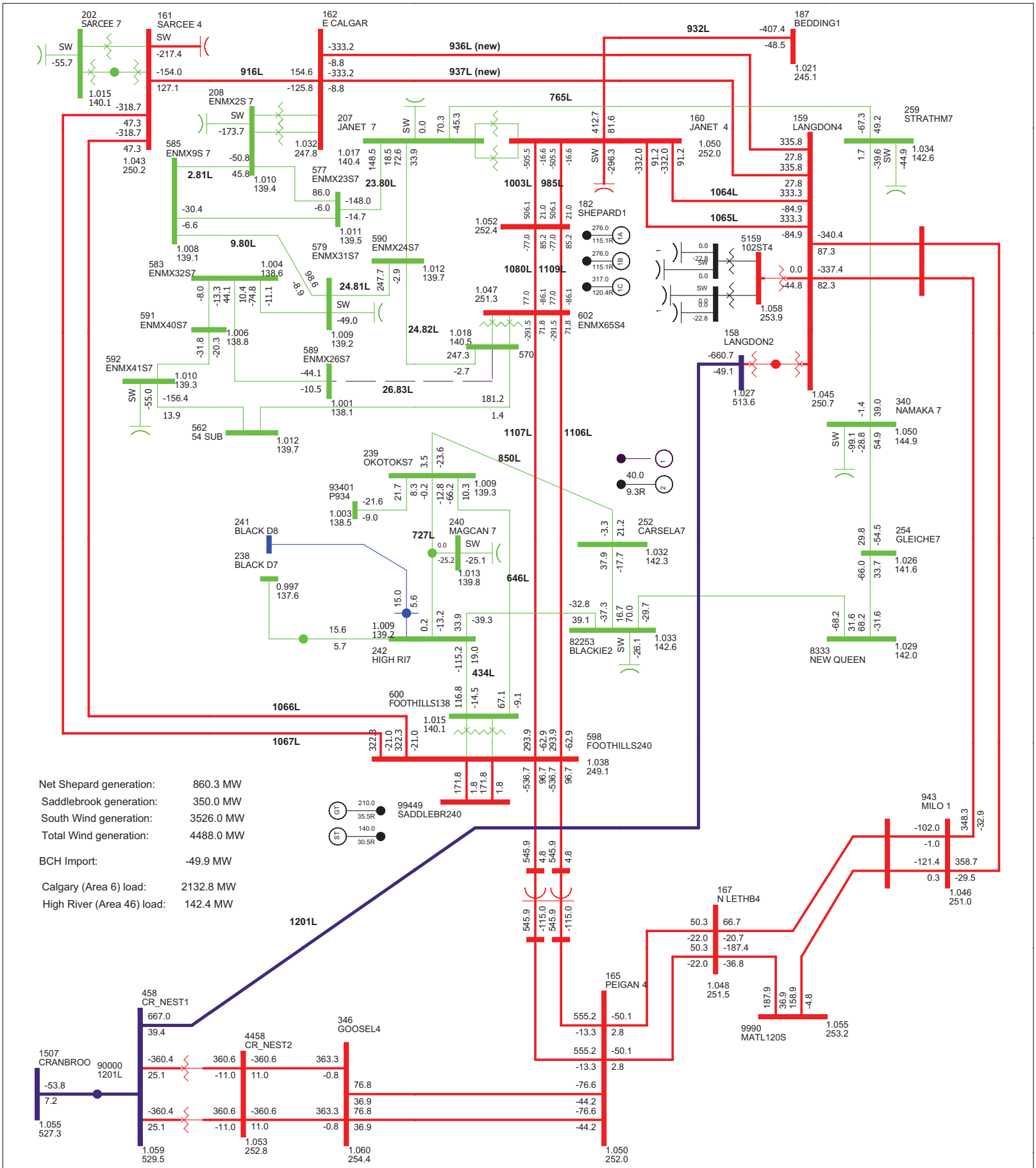


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure J-2019-Step4-Sc4-2

24.82L (ENMAX NO. 65 TO ENMAX NO. 24)

TUE, APR 19 2011 22:34

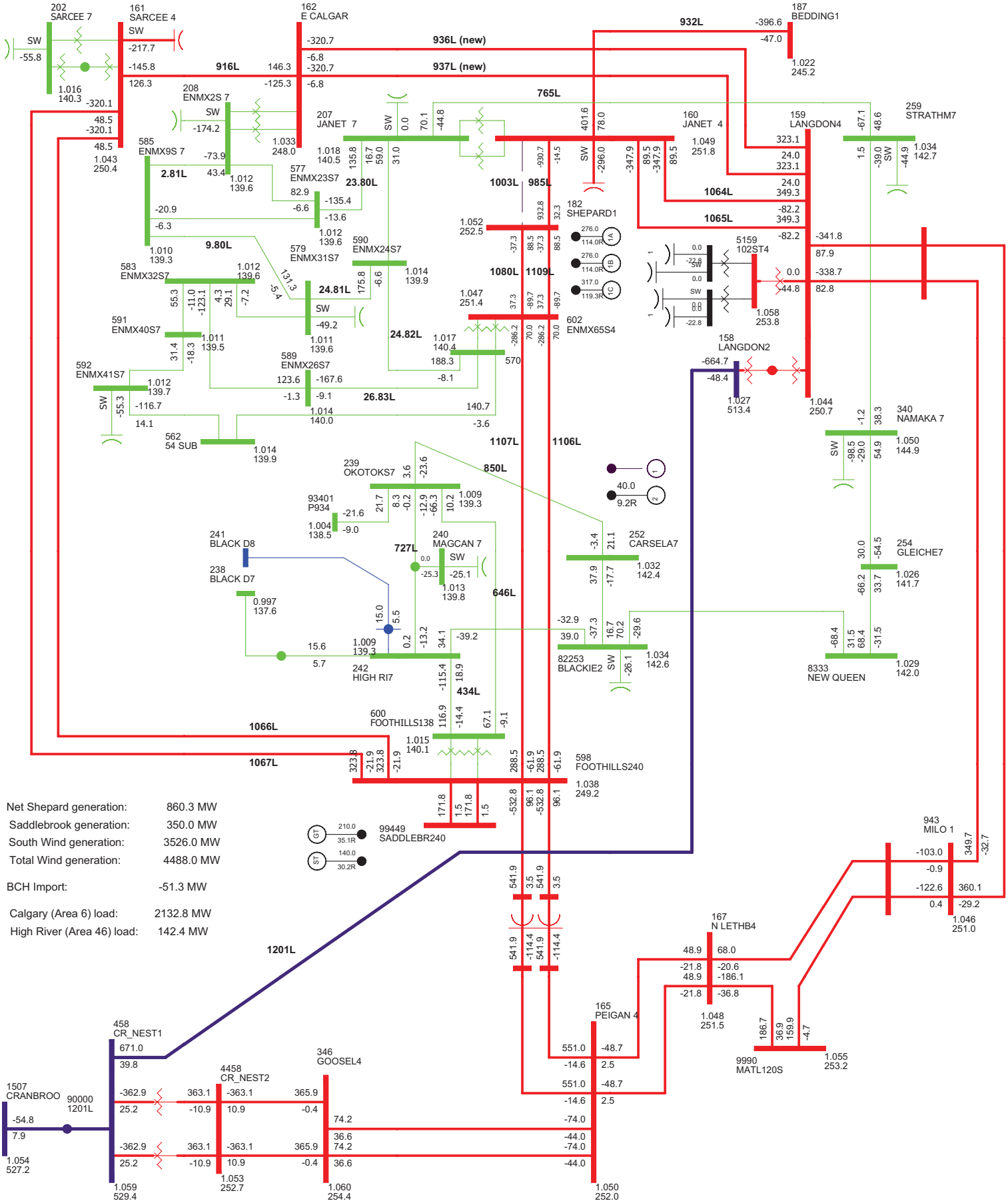


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure J-2019-Step4-Sc4-3

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

TUE, APR 19 2011 22:35

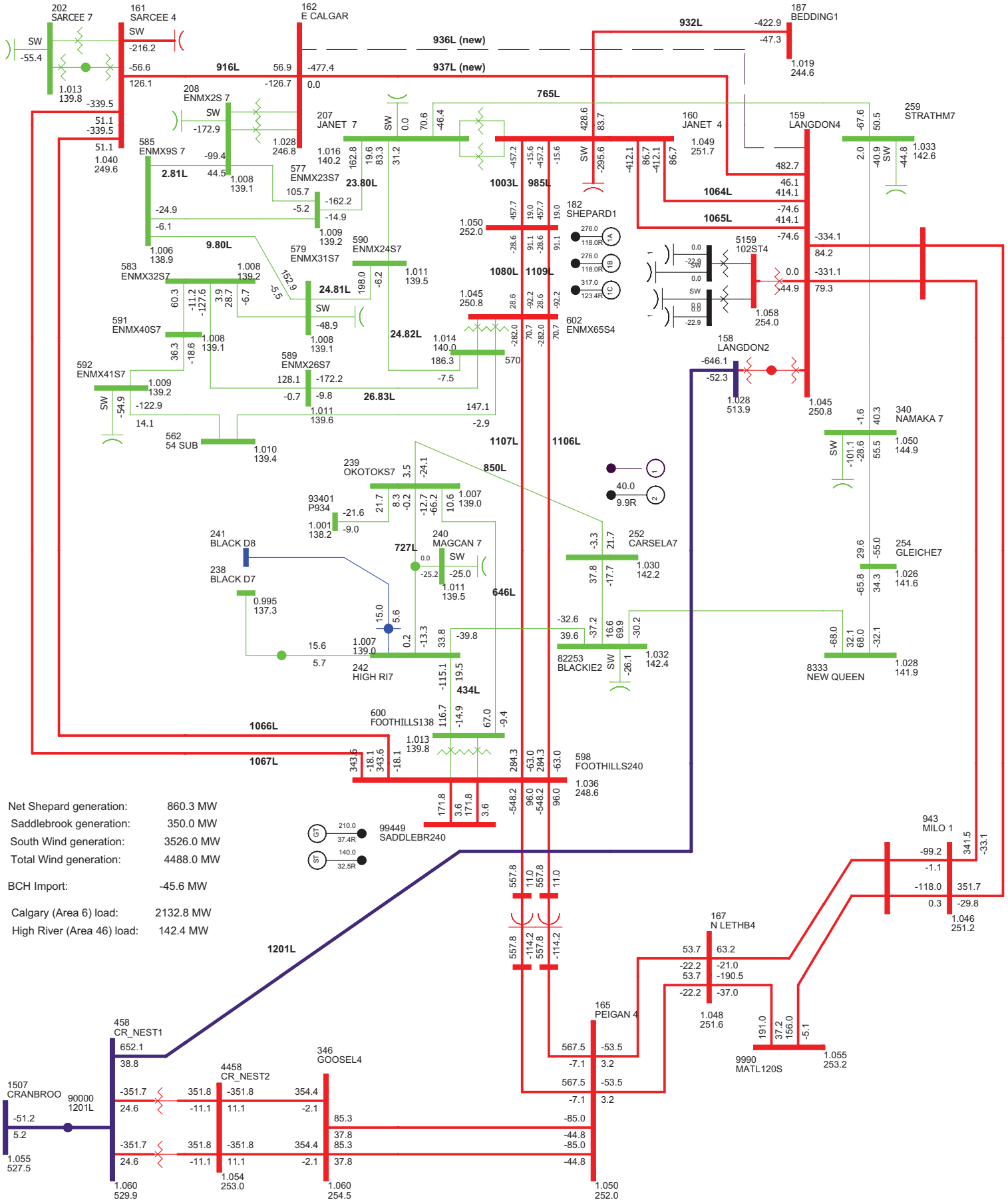


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure J-2019-Step4-Sc4-4

1003L (JANET 74S TO ENMAX NO. 25)

TUE, APR 19 2011 22:35

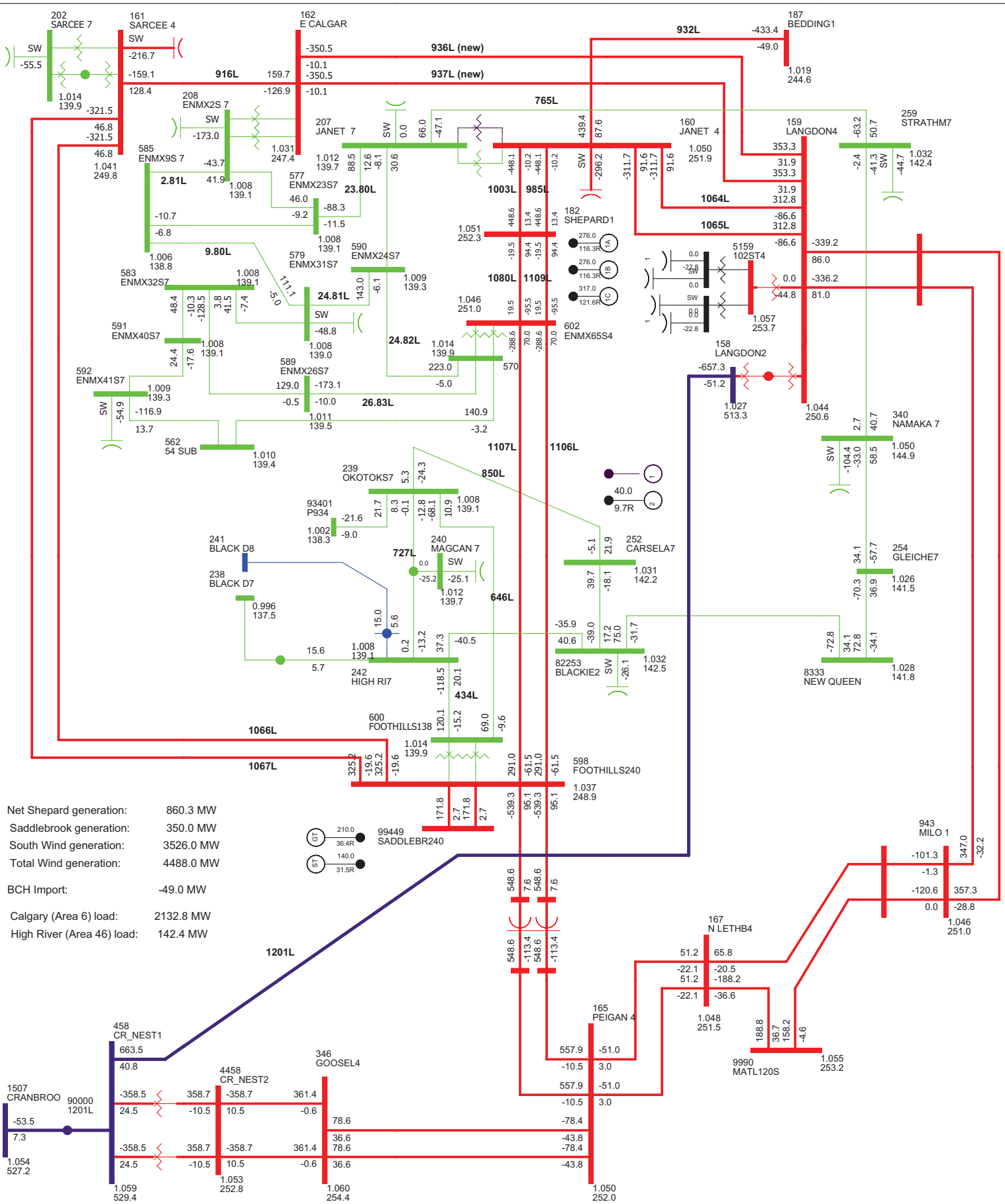


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure J-2019-Step4-Sc4-5

936L (LANGDON 102S TO EAST CALGARY 5S)

TUE, APR 19 2011 22:35

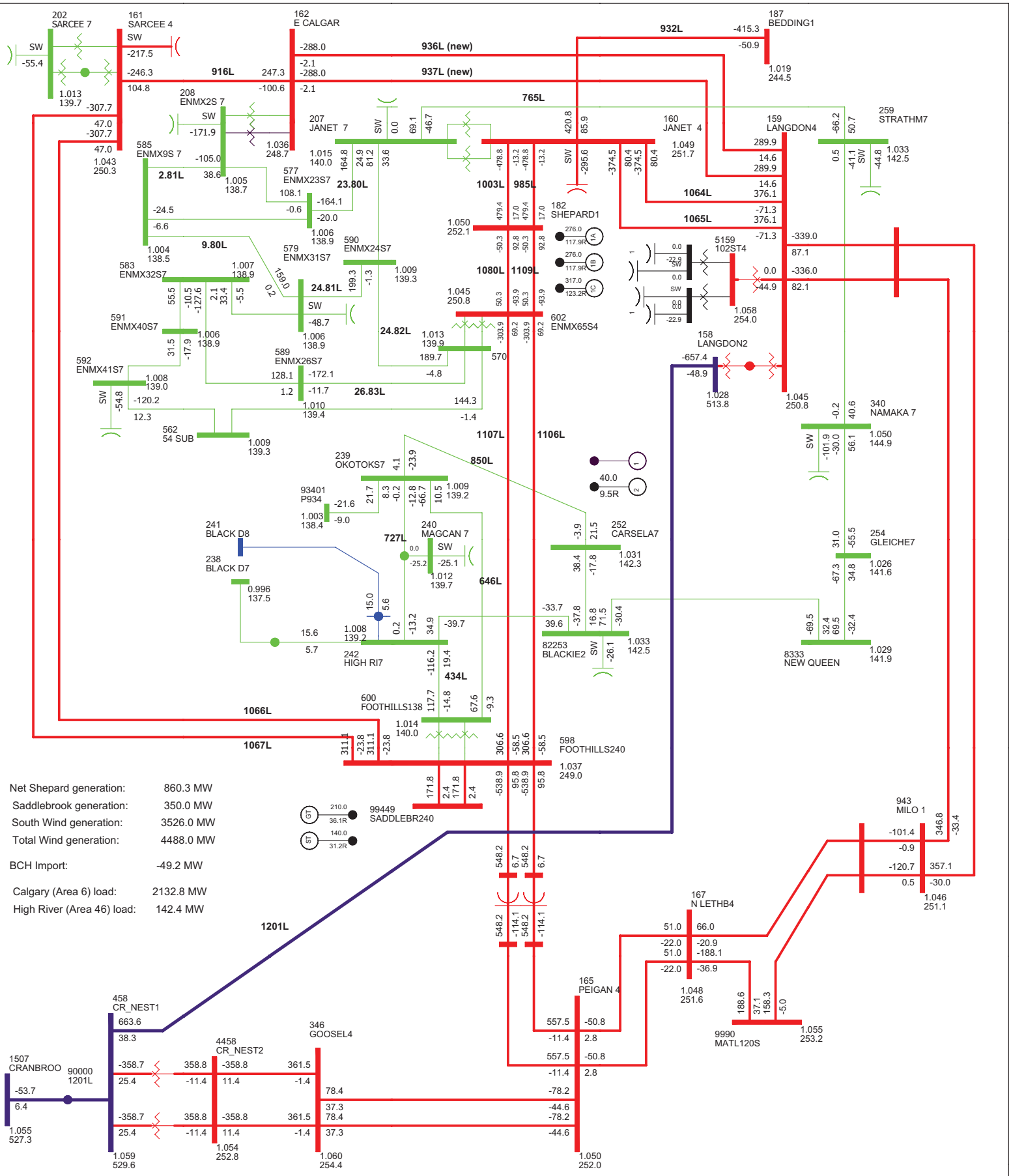


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure J-2019-Step4-Sc4-6

240/138 KV TRANSFORMER (JANET 74S)

TUE, APR 19 2011 22:36

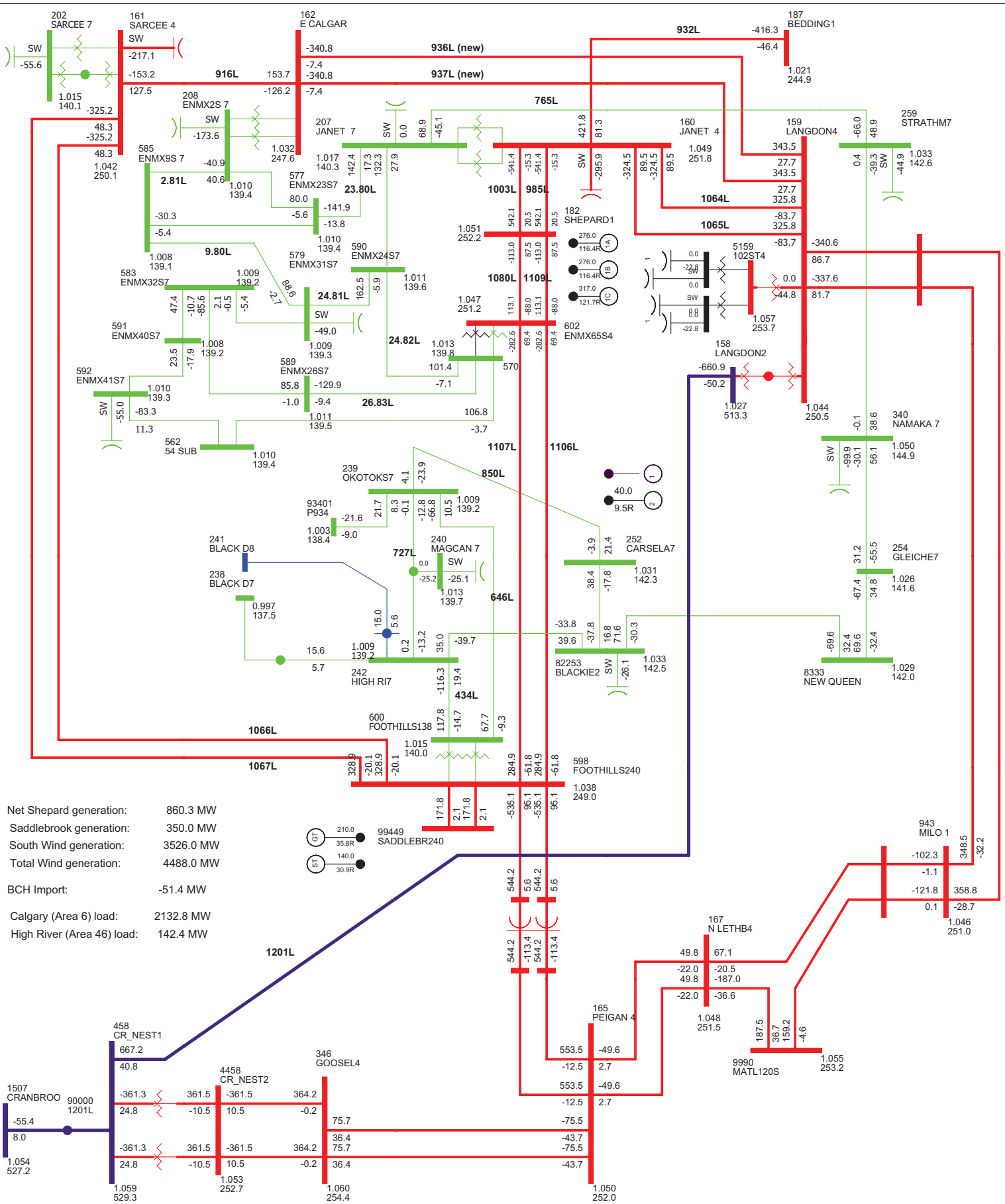


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure J-2019-Step4-Sc4-7

240/138 KV TRANSFORMER (EAST CALGARY 5S)

TUE, APR 19 2011 22:36

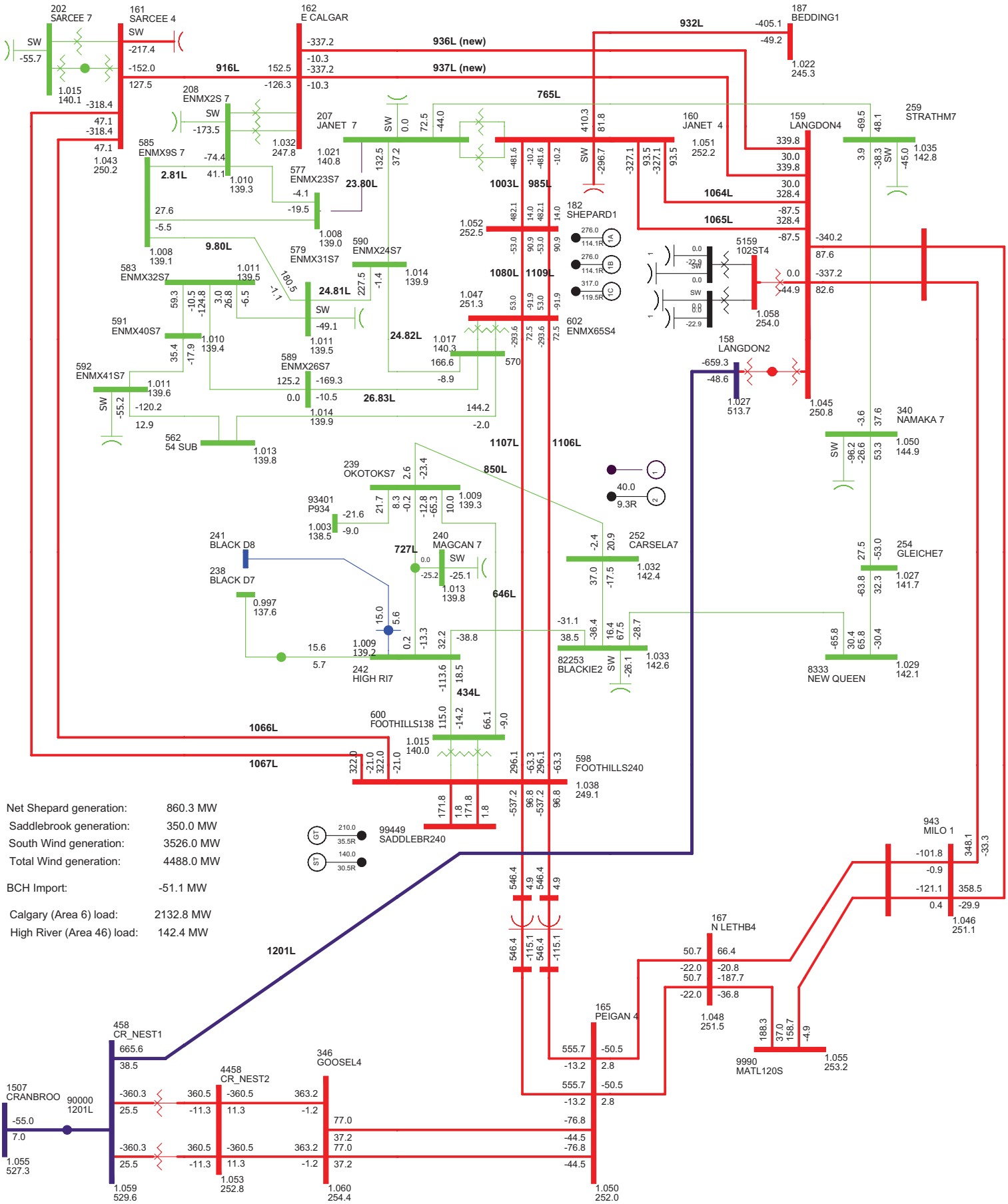


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure J-2019-Step4-Sc4-8

240/138 KV TRANSFORMER (ENMAX NO. 65)

TUE, APR 19 2011 22:36



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure J-2019-Step4-Sc4-9

23.80L (JANET 74S TO ENMAX NO. 23)

TUE, APR 19 2011 22:36

ATTACHMENT K

Power – Voltage (PV) Plots

Table K-1

Figure Name	Monitored Bus	Bus Voltage
Figure K-240-SC1-1	Janet 74S	240 kV
Figure K-240-SC1-2	Sarcee 42S	240 kV
Figure K-240-SC1-3	East Calgary 5S	240 kV
Figure K-240-SC1-4	Langdon 102S	240 kV
Figure K-240-SC1-5	ENMAX No. 65	240 kV
Figure K-240-SC1-6	Foothills 237S	240 kV
Figure K-138-SC1-1	ENMAX No. 65	138 kV
Figure K-138-SC1-2	Janet 74S	138 kV
Figure K-138-SC1-3	Okotoks 678S	138 kV
Figure K-138-SC1-4	High River 65S	138 kV
Figure K-138-SC1-5	Foothills 237S	138 kV
Figure K-138-SC1-6	ENMAX No. 2	138 kV
Figure K-138-SC1-7	ENMAX No. 23	138 kV
Figure K-138-SC1-8	Sarcee 42S	138 kV

Table K-2

Figure Name	Monitored Bus	Bus Voltage
Figure K-240-SC2-1	Janet 74S	240 kV
Figure K-240-SC2-2	Sarcee 42S	240 kV
Figure K-240-SC2-3	East Calgary 5S	240 kV
Figure K-240-SC2-4	Langdon 102S	240 kV
Figure K-240-SC2-5	ENMAX No. 65	240 kV
Figure K-240-SC2-6	Foothills 237S	240 kV
Figure K-138-SC2-1	ENMAX No. 65	138 kV
Figure K-138-SC2-2	Janet 74S	138 kV
Figure K-138-SC2-3	Okotoks 678S	138 kV
Figure K-138-SC2-4	High River 65S	138 kV
Figure K-138-SC2-5	Foothills 237S	138 kV
Figure K-138-SC2-6	ENMAX No. 2	138 kV
Figure K-138-SC2-7	ENMAX No. 23	138 kV
Figure K-138-SC2-8	Sarcee 42S	138 kV

Table K-3

Figure Name	Monitored Bus	Bus Voltage
Figure K-240-SC3-1	Janet 74S	240 kV
Figure K-240-SC3-2	Sarcee 42S	240 kV
Figure K-240-SC3-3	East Calgary 5S	240 kV
Figure K-240-SC3-4	Langdon 102S	240 kV
Figure K-240-SC3-5	ENMAX No. 65	240 kV
Figure K-240-SC3-6	Foothills 237S	240 kV
Figure K-138-SC3-1	ENMAX No. 65	138 kV
Figure K-138-SC3-2	Janet 74S	138 kV
Figure K-138-SC3-3	Okotoks 678S	138 kV
Figure K-138-SC3-4	High River 65S	138 kV
Figure K-138-SC3-5	Foothills 237S	138 kV
Figure K-138-SC3-6	ENMAX No. 2	138 kV
Figure K-138-SC3-7	ENMAX No. 23	138 kV
Figure K-138-SC3-8	Sarcee 42S	138 kV

Table K-4

Figure Name	Monitored Bus	Bus Voltage
Figure K-240-SC4-1	Janet 74S	240 kV
Figure K-240-SC4-2	Sarcee 42S	240 kV
Figure K-240-SC4-3	East Calgary 5S	240 kV
Figure K-240-SC4-4	Langdon 102S	240 kV
Figure K-240-SC4-5	ENMAX No. 65	240 kV
Figure K-240-SC4-6	Foothills 237S	240 kV
Figure K-138-SC4-1	ENMAX No. 65	138 kV
Figure K-138-SC4-2	Janet 74S	138 kV
Figure K-138-SC4-3	Okotoks 678S	138 kV
Figure K-138-SC4-4	High River 65S	138 kV
Figure K-138-SC4-5	Foothills 237S	138 kV
Figure K-138-SC4-6	ENMAX No. 2	138 kV
Figure K-138-SC4-7	ENMAX No. 23	138 kV
Figure K-138-SC4-8	Sarcee 42S	138 kV

Table K-5

Figure Name	Monitored Bus	Bus Voltage
Figure K-240-SC5-1	Janet 74S	240 kV
Figure K-240-SC5-2	Sarcee 42S	240 kV
Figure K-240-SC5-3	East Calgary 5S	240 kV
Figure K-240-SC5-4	Langdon 102S	240 kV
Figure K-240-SC5-5	ENMAX No. 65	240 kV
Figure K-240-SC5-6	Foothills 237S	240 kV
Figure K-138-SC5-1	ENMAX No. 65	138 kV
Figure K-138-SC5-2	Janet 74S	138 kV
Figure K-138-SC5-3	Okotoks 678S	138 kV
Figure K-138-SC5-4	High River 65S	138 kV
Figure K-138-SC5-5	Foothills 237S	138 kV
Figure K-138-SC5-6	ENMAX No. 2	138 kV
Figure K-138-SC5-7	ENMAX No. 23	138 kV
Figure K-138-SC5-8	Sarcee 42S	138 kV

Table K-6

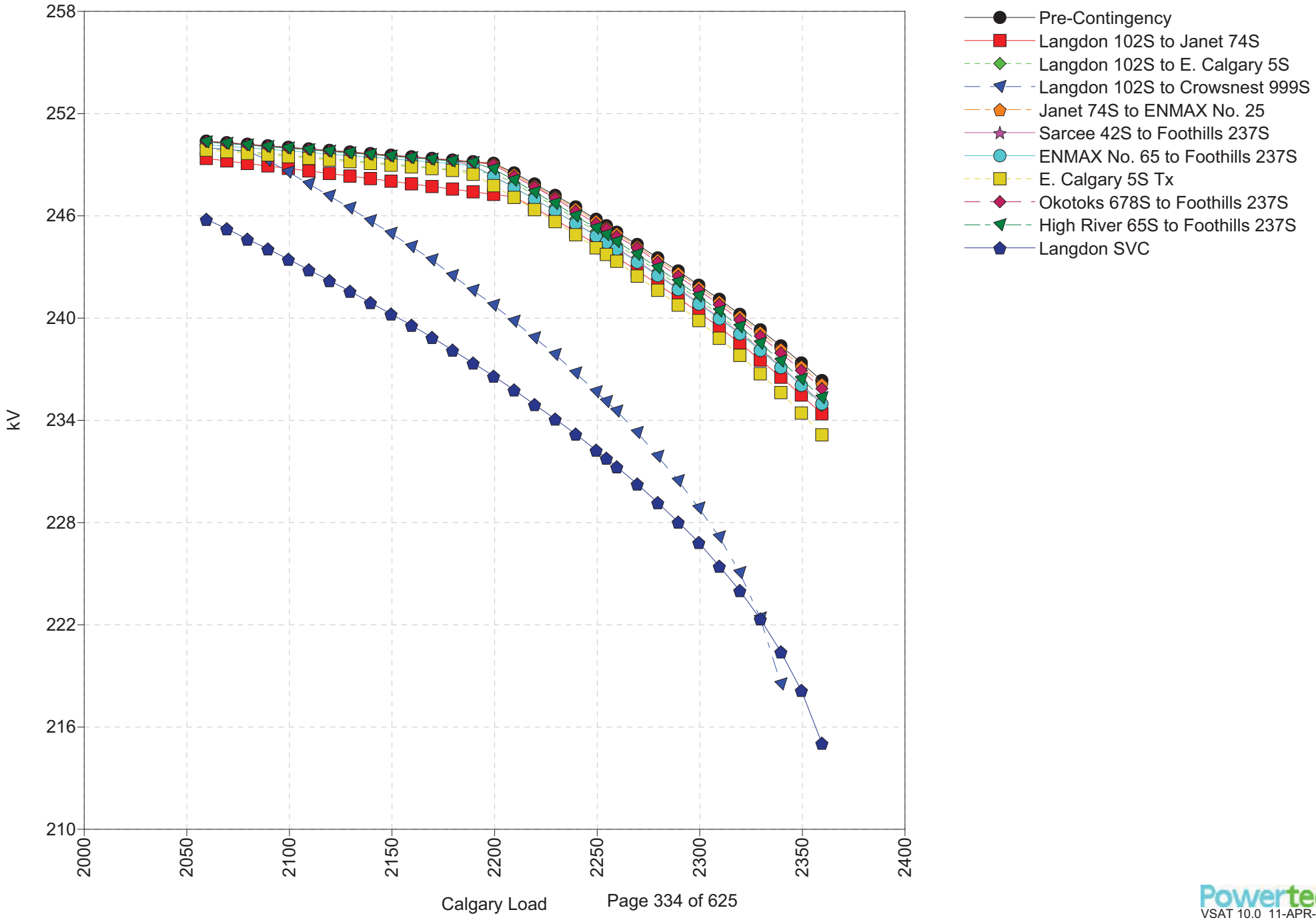
Figure Name	Monitored Bus	Bus Voltage
Figure K-240-SC6-1	Janet 74S	240 kV
Figure K-240-SC6-2	Sarcee 42S	240 kV
Figure K-240-SC6-3	East Calgary 5S	240 kV
Figure K-240-SC6-4	Langdon 102S	240 kV
Figure K-240-SC6-5	ENMAX No. 65	240 kV
Figure K-240-SC6-6	Foothills 237S	240 kV
Figure K-138-SC6-1	ENMAX No. 65	138 kV
Figure K-138-SC6-2	Janet 74S	138 kV
Figure K-138-SC6-3	Okotoks 678S	138 kV
Figure K-138-SC6-4	High River 65S	138 kV
Figure K-138-SC6-5	Foothills 237S	138 kV
Figure K-138-SC6-6	ENMAX No. 2	138 kV
Figure K-138-SC6-7	ENMAX No. 23	138 kV
Figure K-138-SC6-8	Sarcee 42S	138 kV

Table K-7

Figure Name	Monitored Bus	Bus Voltage
Figure K-240-SC1-HR-1	Janet 74S	240 kV
Figure K-240-SC1-HR-2	Sarcee 42S	240 kV
Figure K-240-SC1-HR-3	East Calgary 5S	240 kV
Figure K-240-SC1-HR-4	Langdon 102S	240 kV
Figure K-240-SC1-HR-5	ENMAX No. 65	240 kV
Figure K-240-SC1-HR-6	Foothills 237S	240 kV
Figure K-138-SC1-HR-1	ENMAX No. 65	138 kV
Figure K-138-SC1-HR-2	Janet 74S	138 kV
Figure K-138-SC1-HR-3	Okotoks 678S	138 kV
Figure K-138-SC1-HR-4	High River 65S	138 kV
Figure K-138-SC1-HR-5	Foothills 237S	138 kV
Figure K-138-SC1-HR-6	ENMAX No. 2	138 kV
Figure K-138-SC1-HR-7	ENMAX No. 23	138 kV
Figure K-138-SC1-HR-8	Sarcee 42S	138 kV

Figure K-240-SC1-1

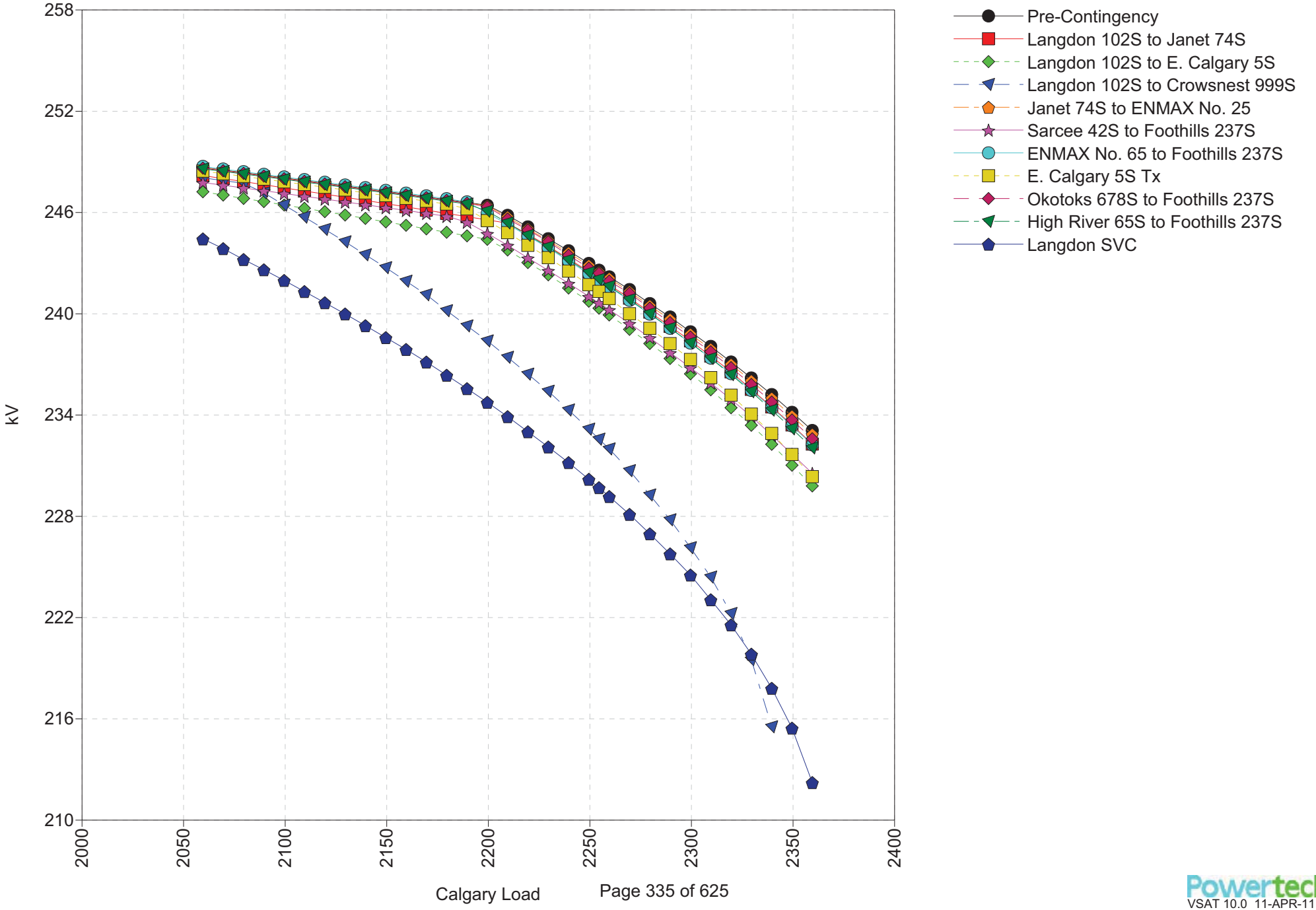
FATD 2019 SP ST4 SC1
Increase Calgary Load
240 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-240-SC1-2

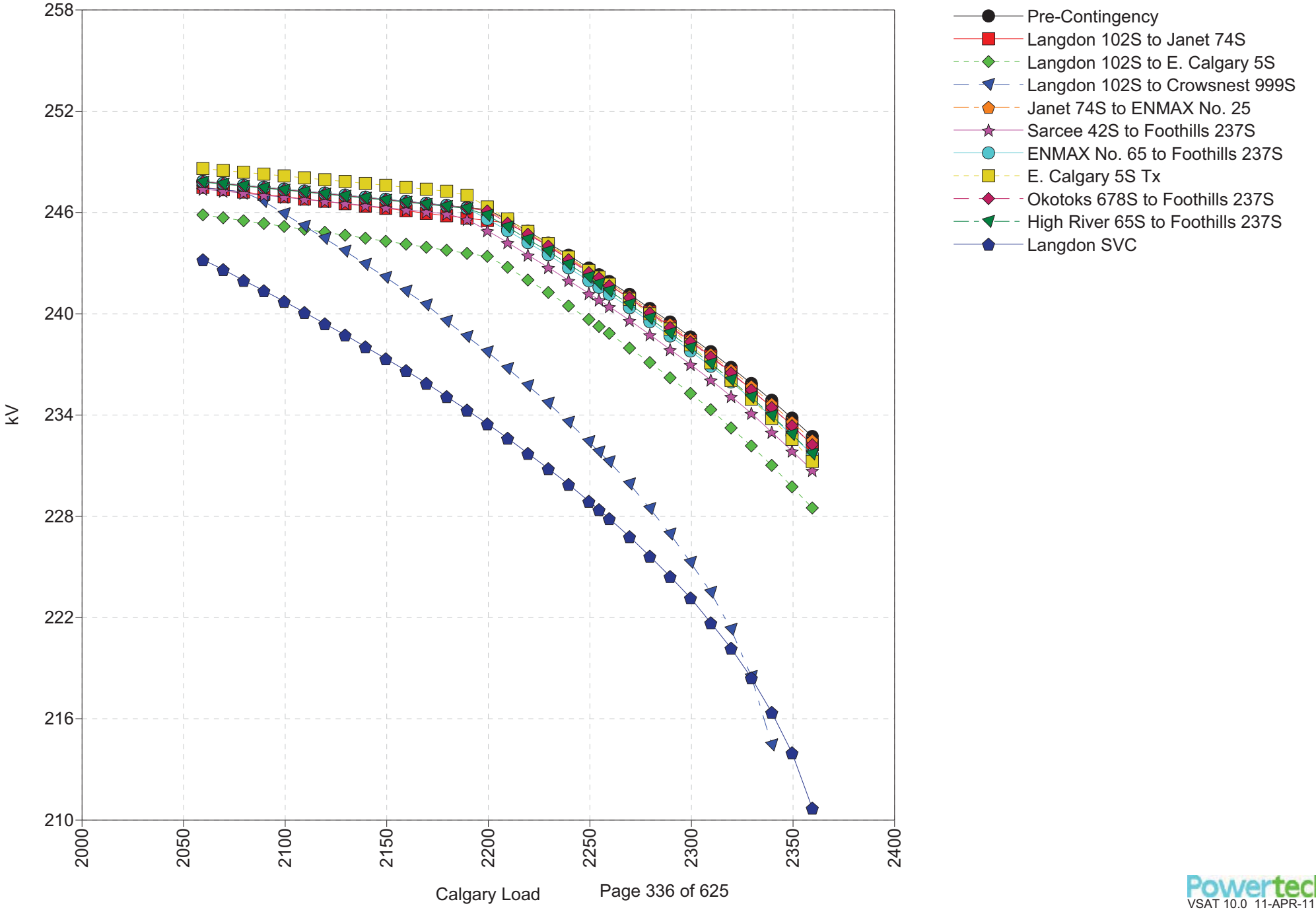
FATD 2019 SP ST4 SC1
Increase Calgary Load
240 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-240-SC1-3

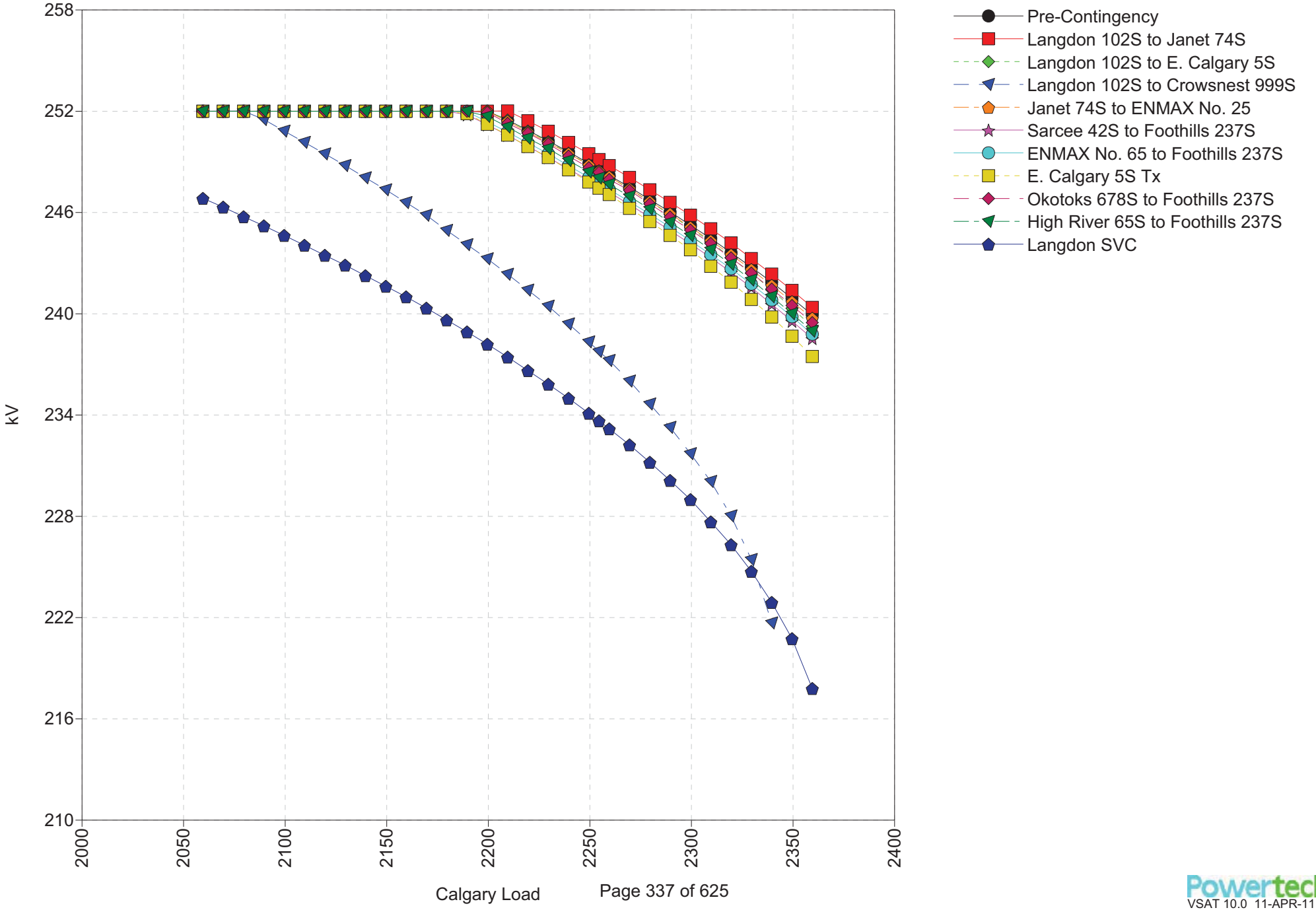
FATD 2019 SP ST4 SC1
Increase Calgary Load
240 E CALGARY 5S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:05

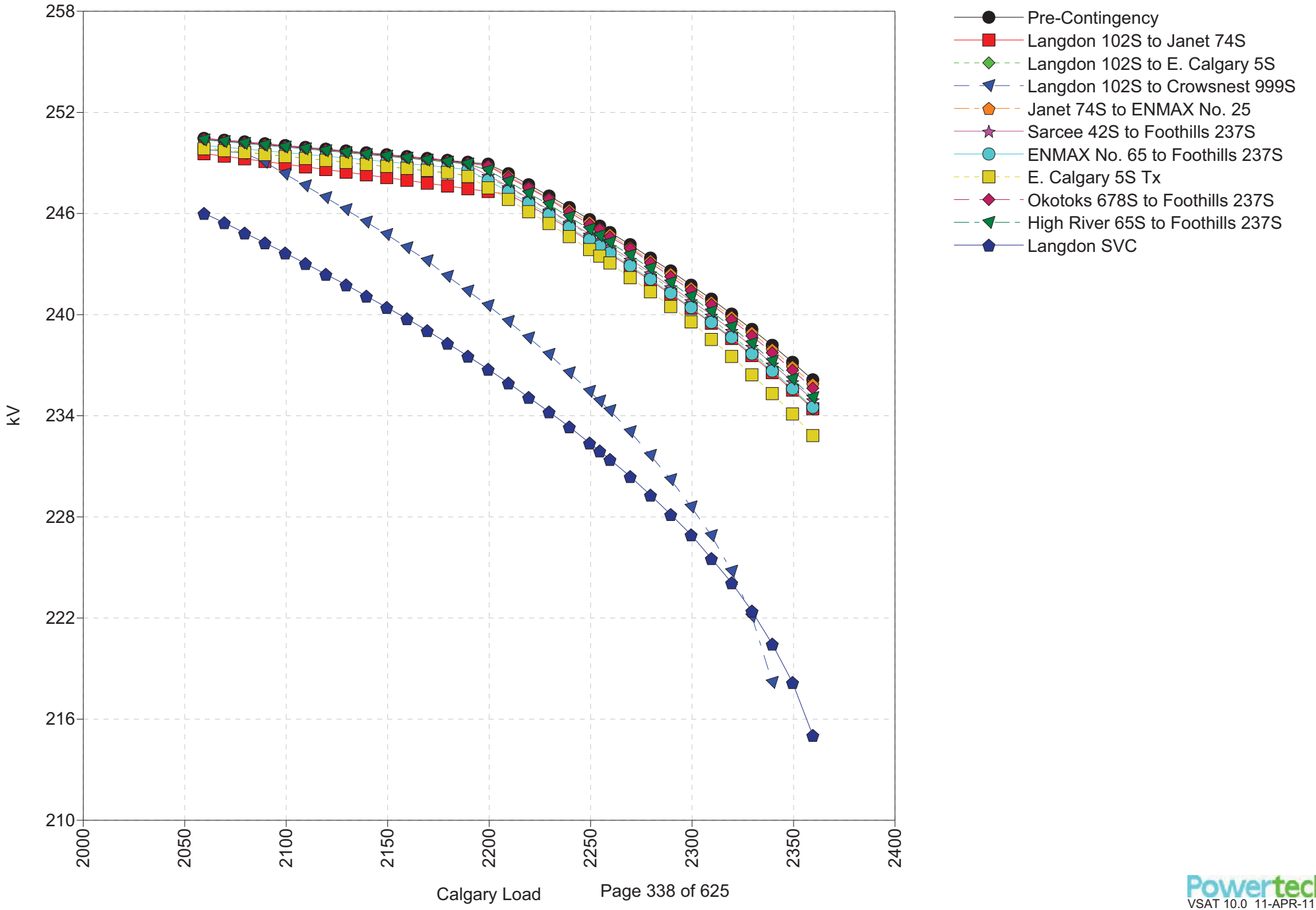
Figure K-240-SC1-4

FATD 2019 SP ST4 SC1
Increase Calgary Load
240 LANGDON 102S Bus Voltage (kV)



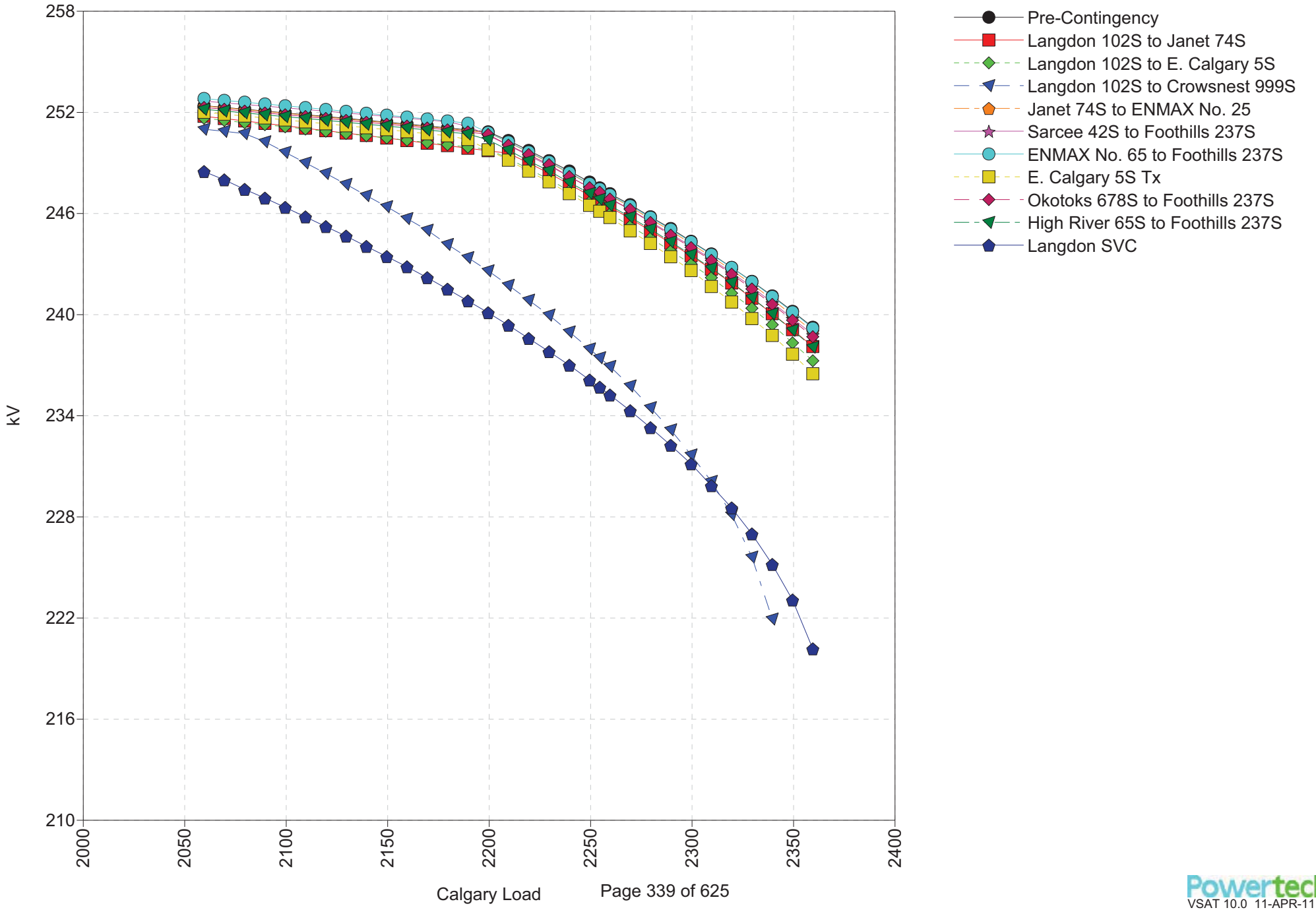
Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-240-SC1-5
FATD 2019 SP ST4 SC1
Increase Calgary Load
240 ENMAX No. 65 Bus Voltage (kV)



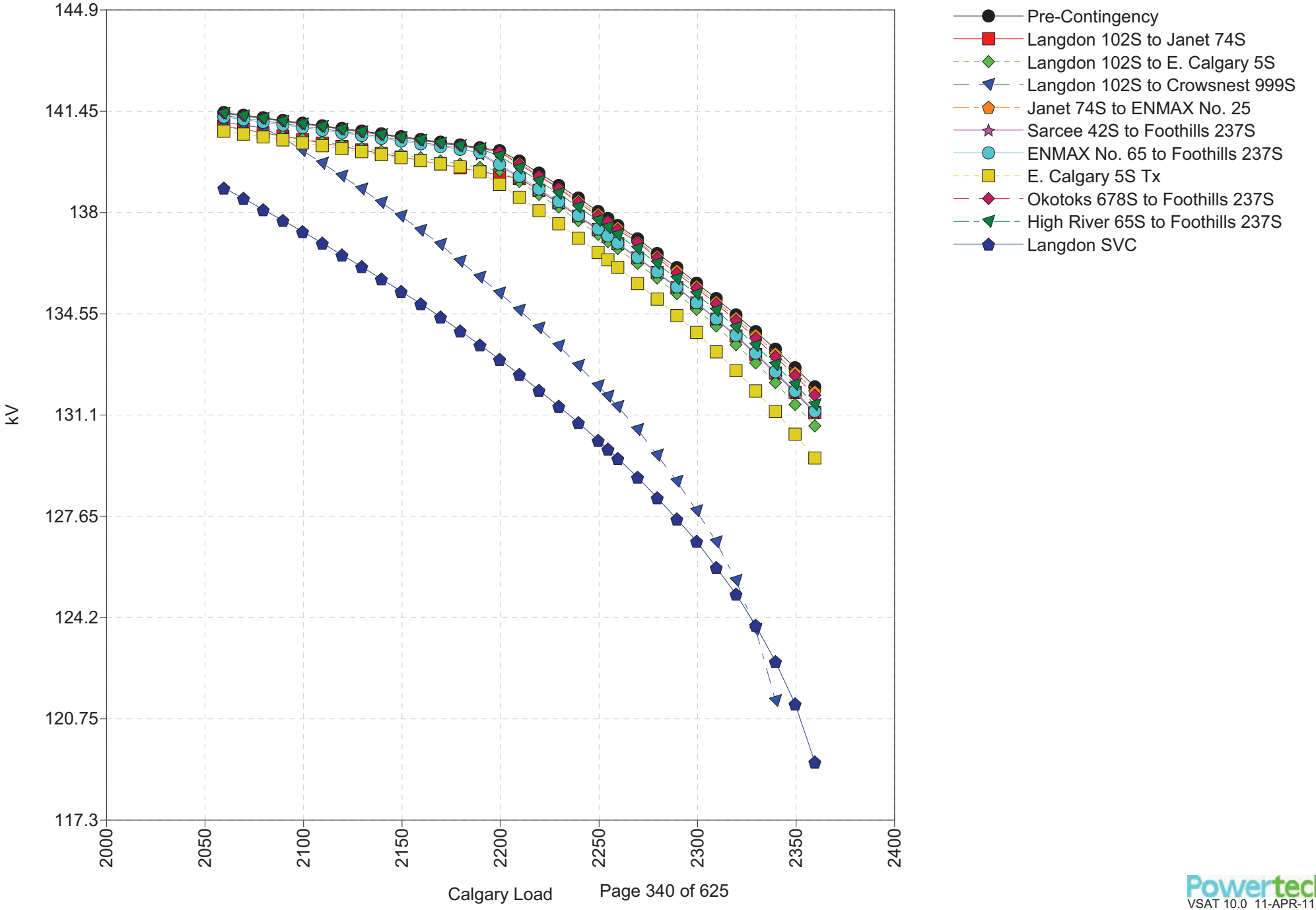
Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-240-SC1-6
FATD 2019 SP ST4 SC1
Increase Calgary Load
240 FOOTHILLS 237S Bus Voltage (kV)



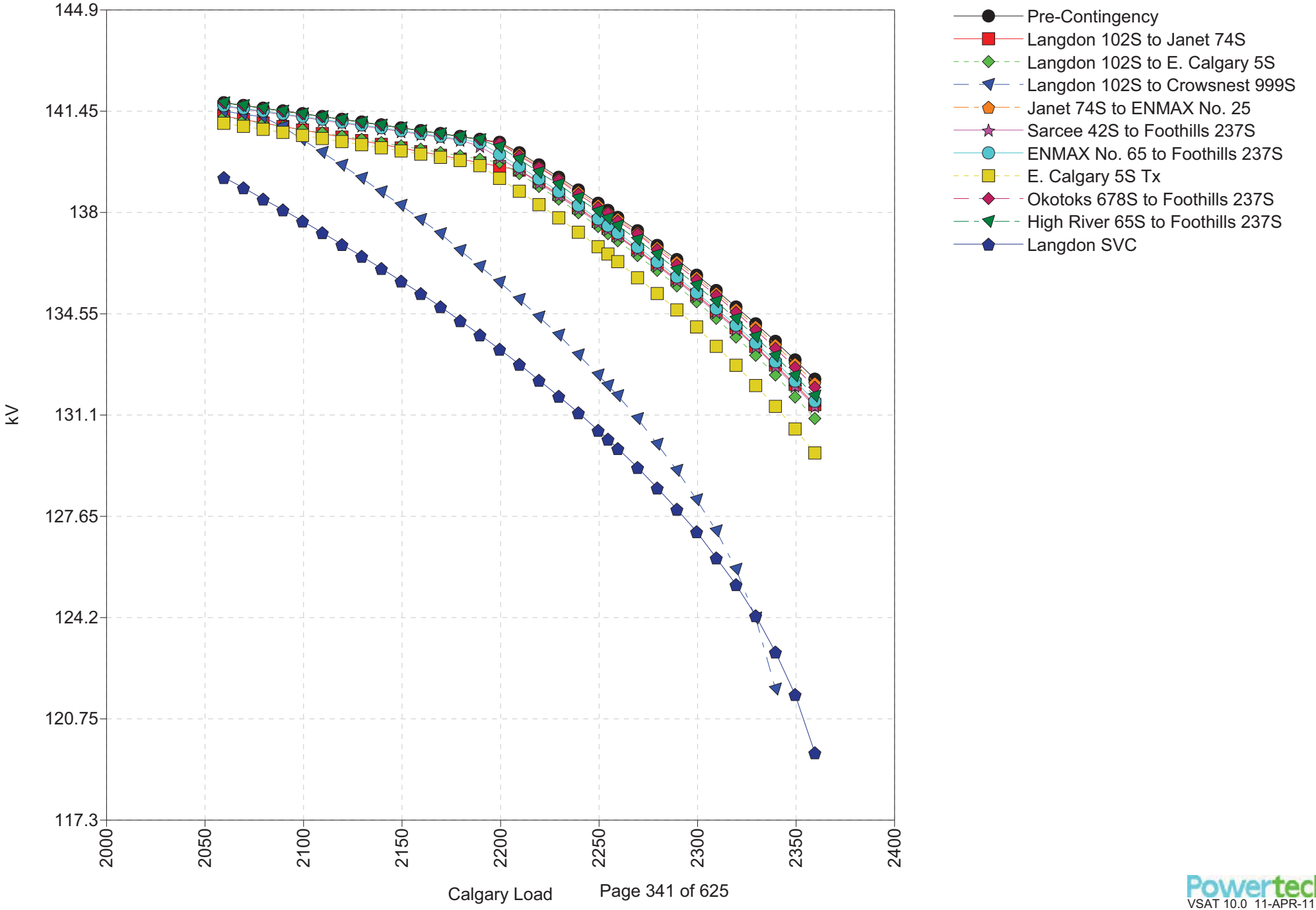
Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-138-SC1-1
FATD 2019 SP ST4 SC1
Increase Calgary Load
138 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:05

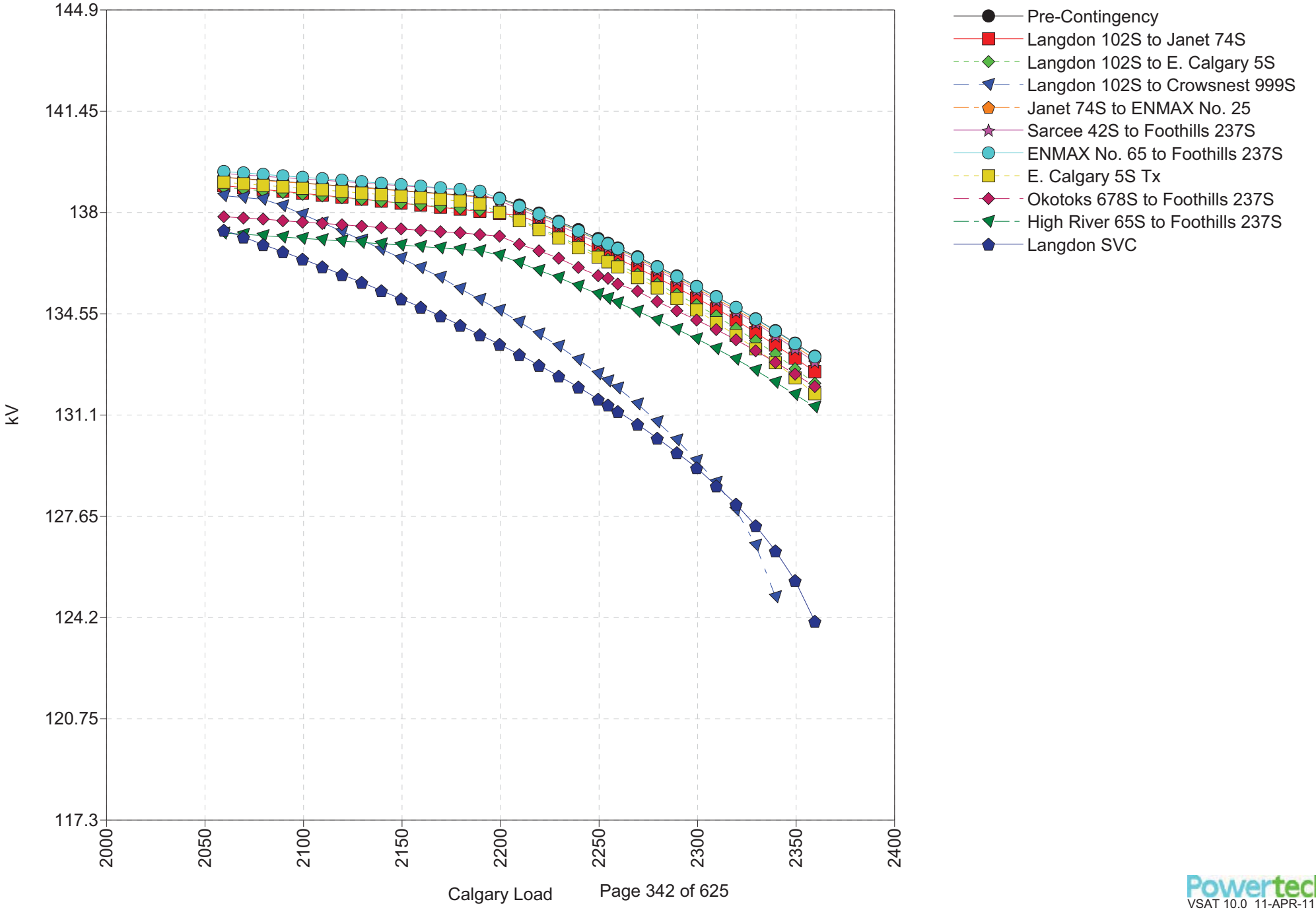
Figure K-138-SC1-2
FATD 2019 SP ST4 SC1
Increase Calgary Load
138 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-138-SC1-3

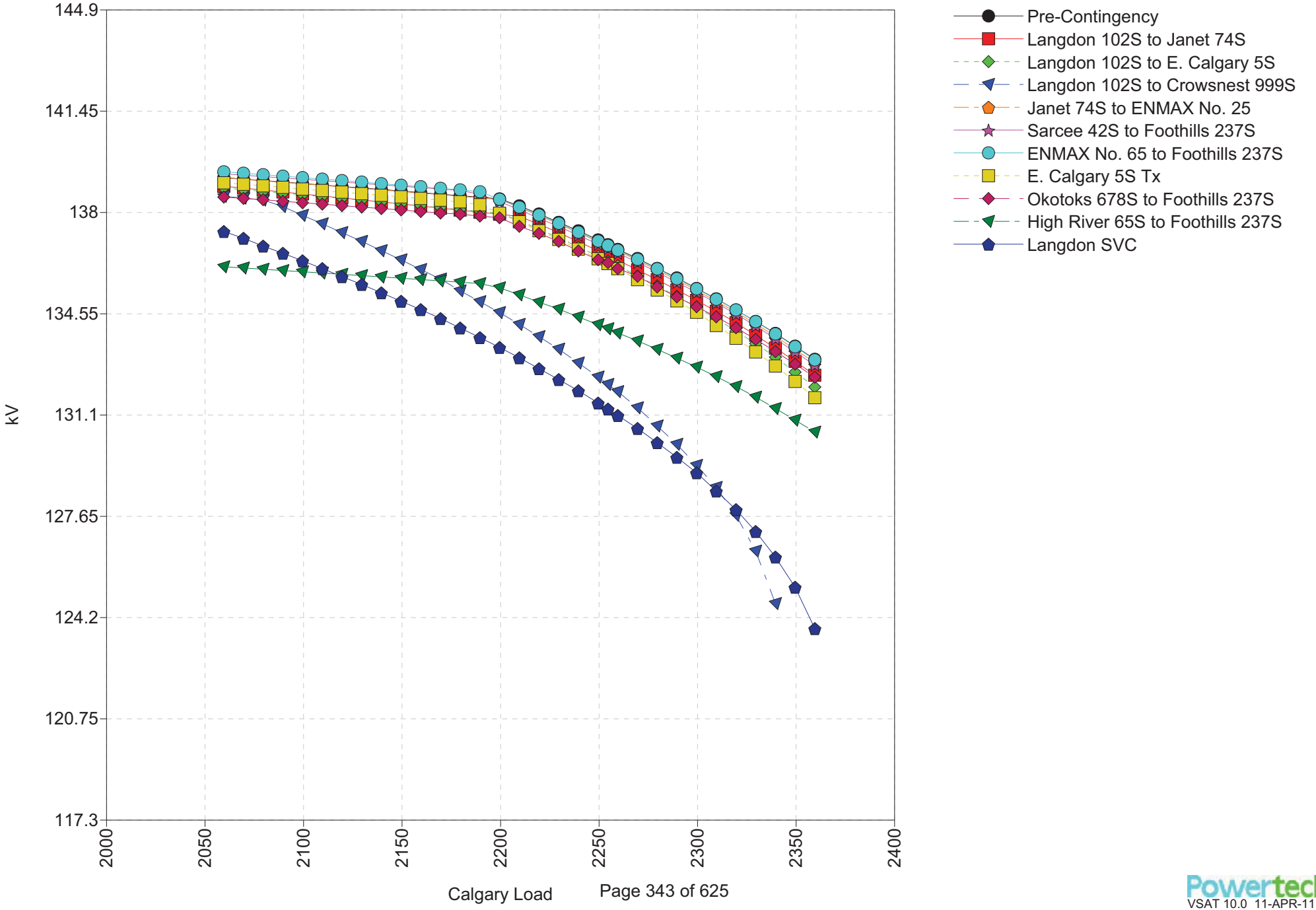
FATD 2019 SP ST4 SC1
Increase Calgary Load
138 OKOTOKS 678S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-138-SC1-4

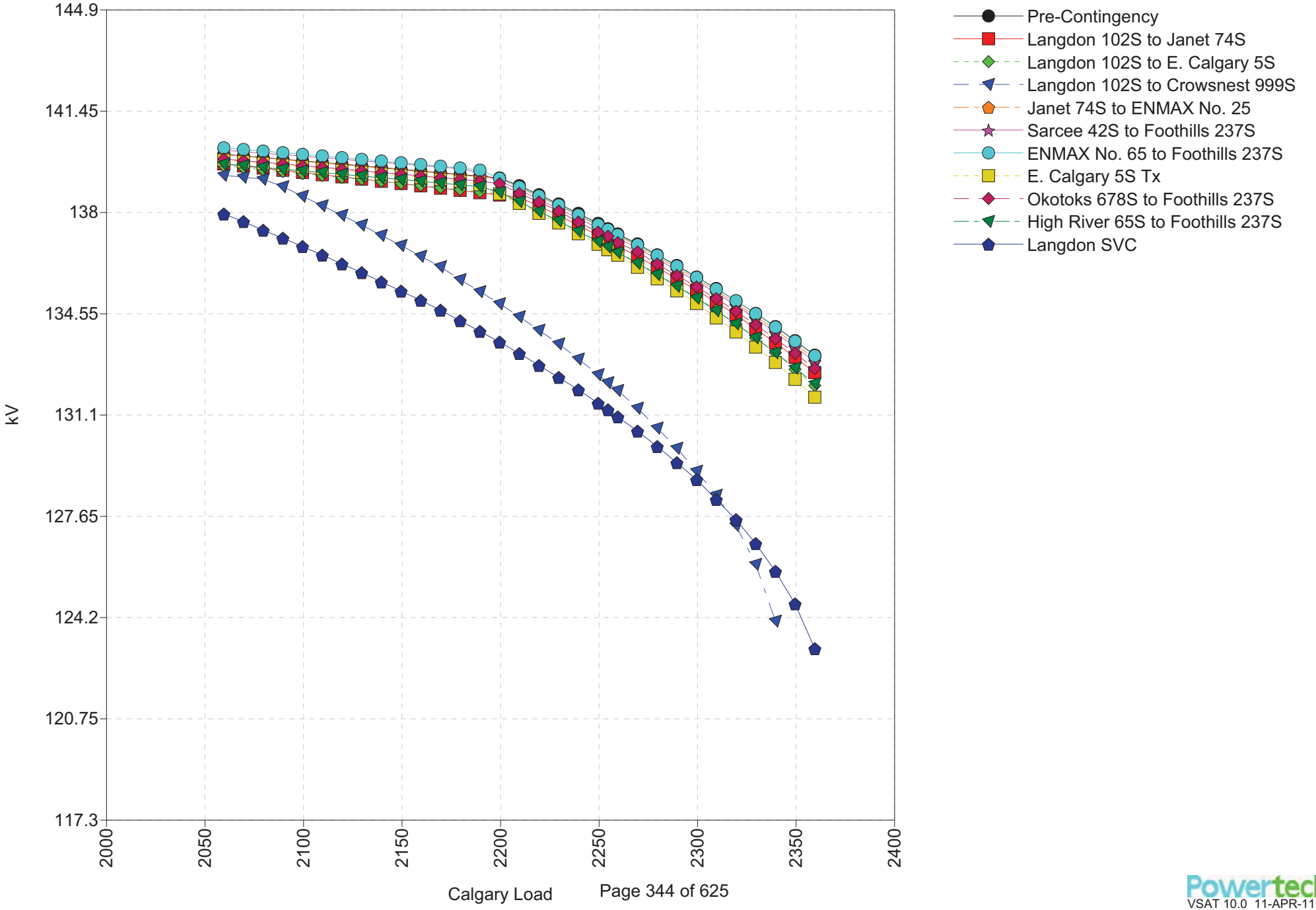
FATD 2019 SP ST4 SC1
Increase Calgary Load
138 HIGH RIVER 65S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:05

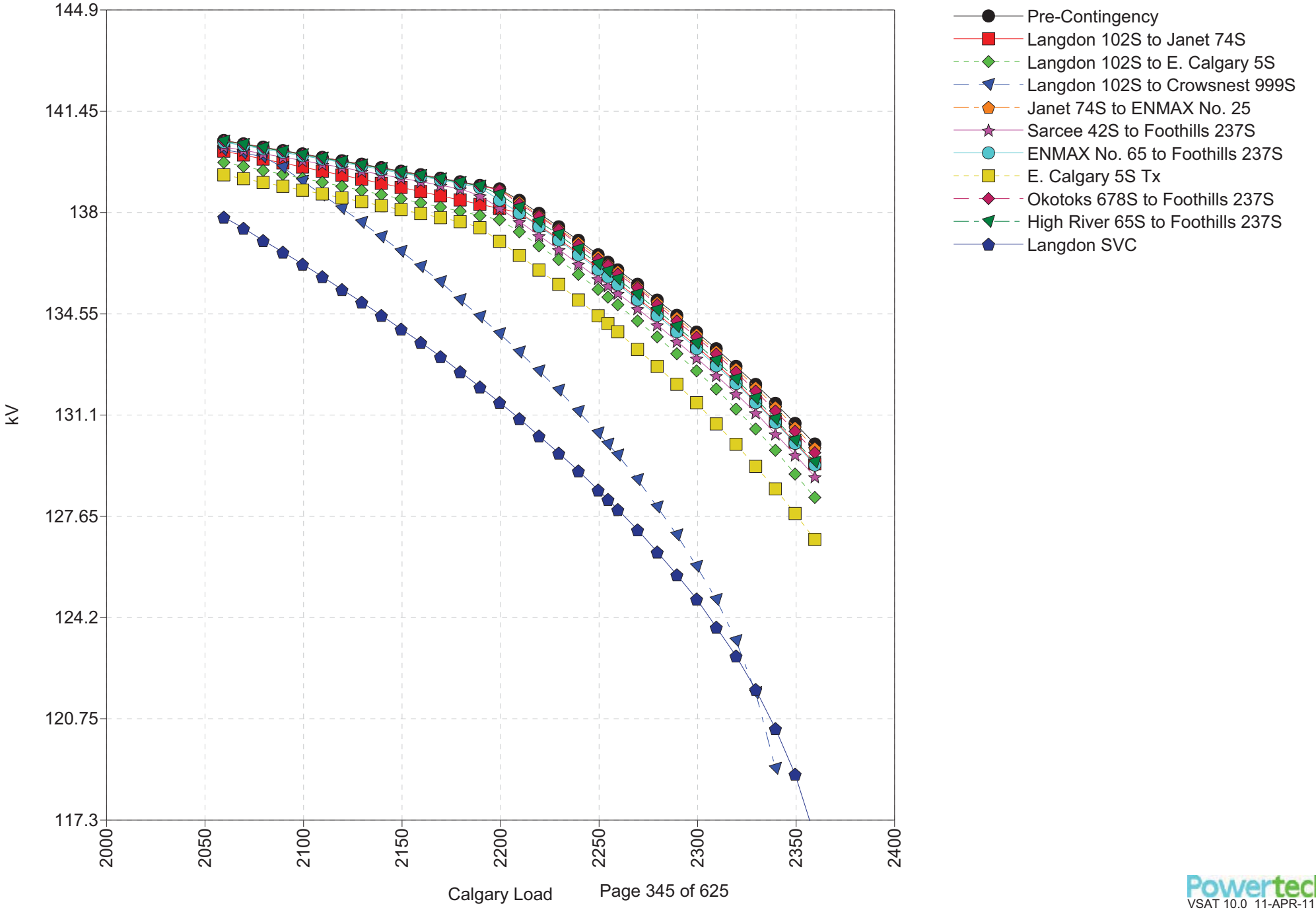
Figure K-138-SC1-5

FATD 2019 SP ST4 SC1
Increase Calgary Load
138 FOOTHILLS 237S Bus Voltage (kV)



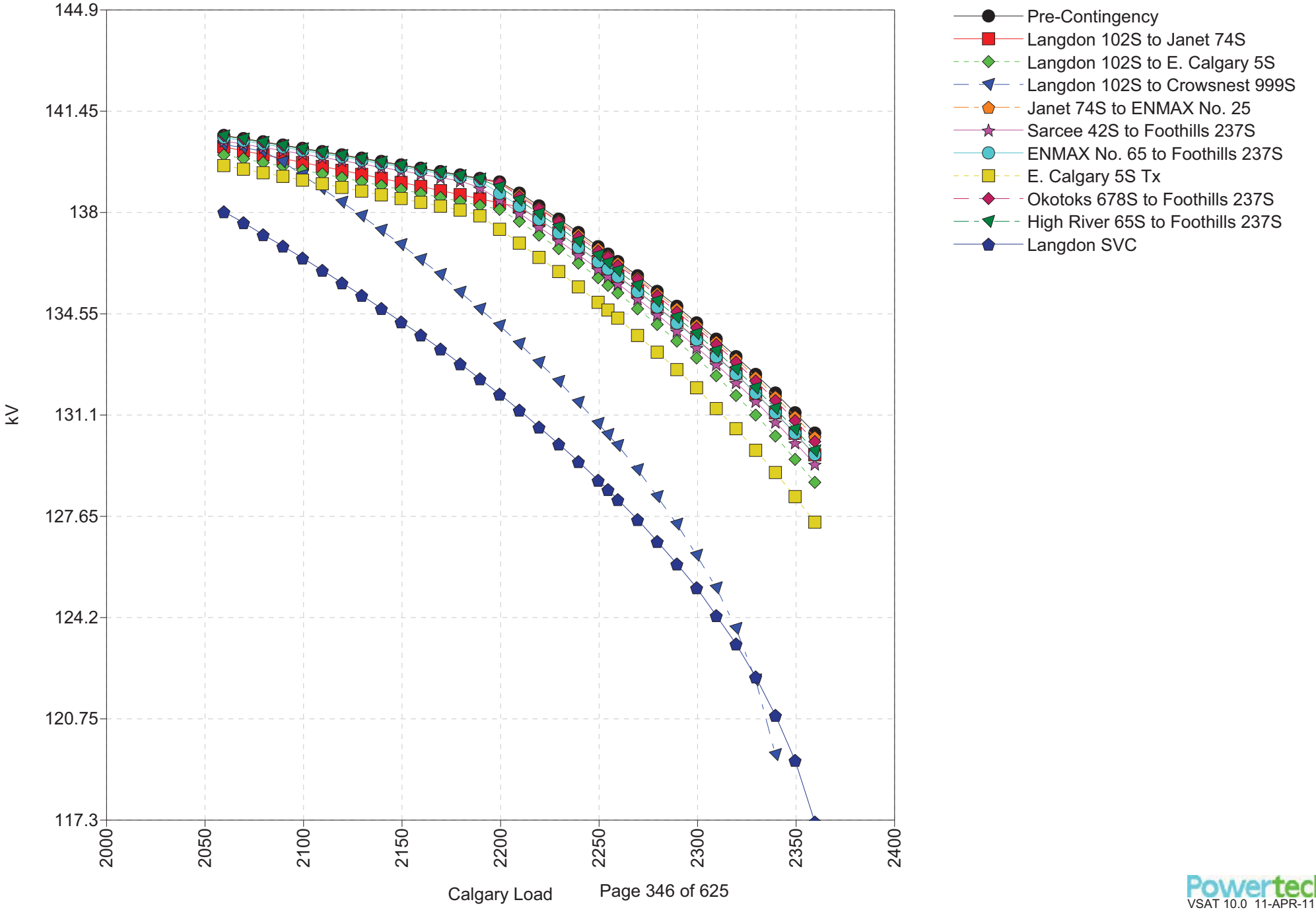
Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-138-SC1-6
FATD 2019 SP ST4 SC1
Increase Calgary Load
138 ENMAX No. 2 Bus Voltage (kV)



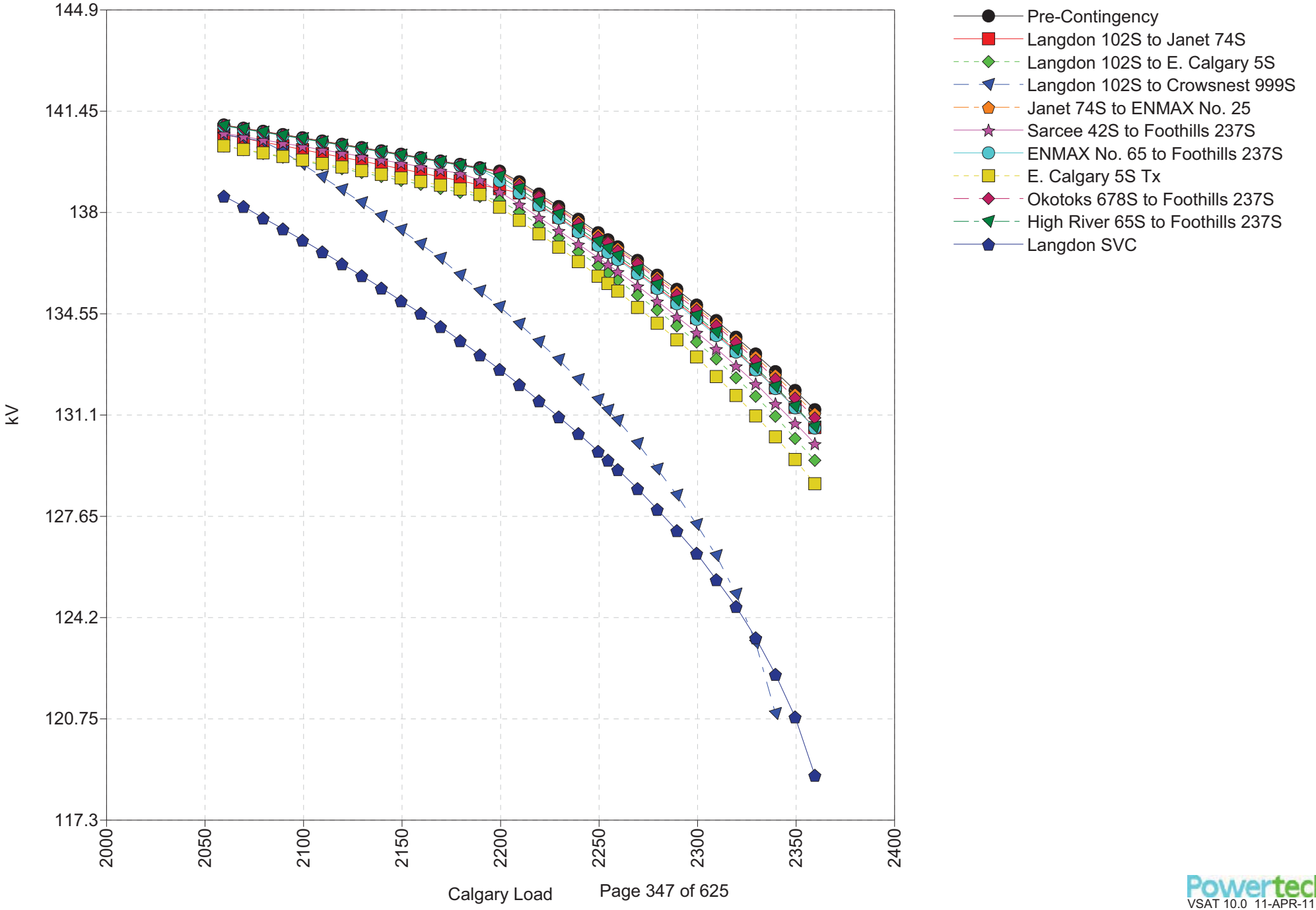
Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-138-SC1-7
FATD 2019 SP ST4 SC1
Increase Calgary Load
138 ENMAX No. 23 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:05

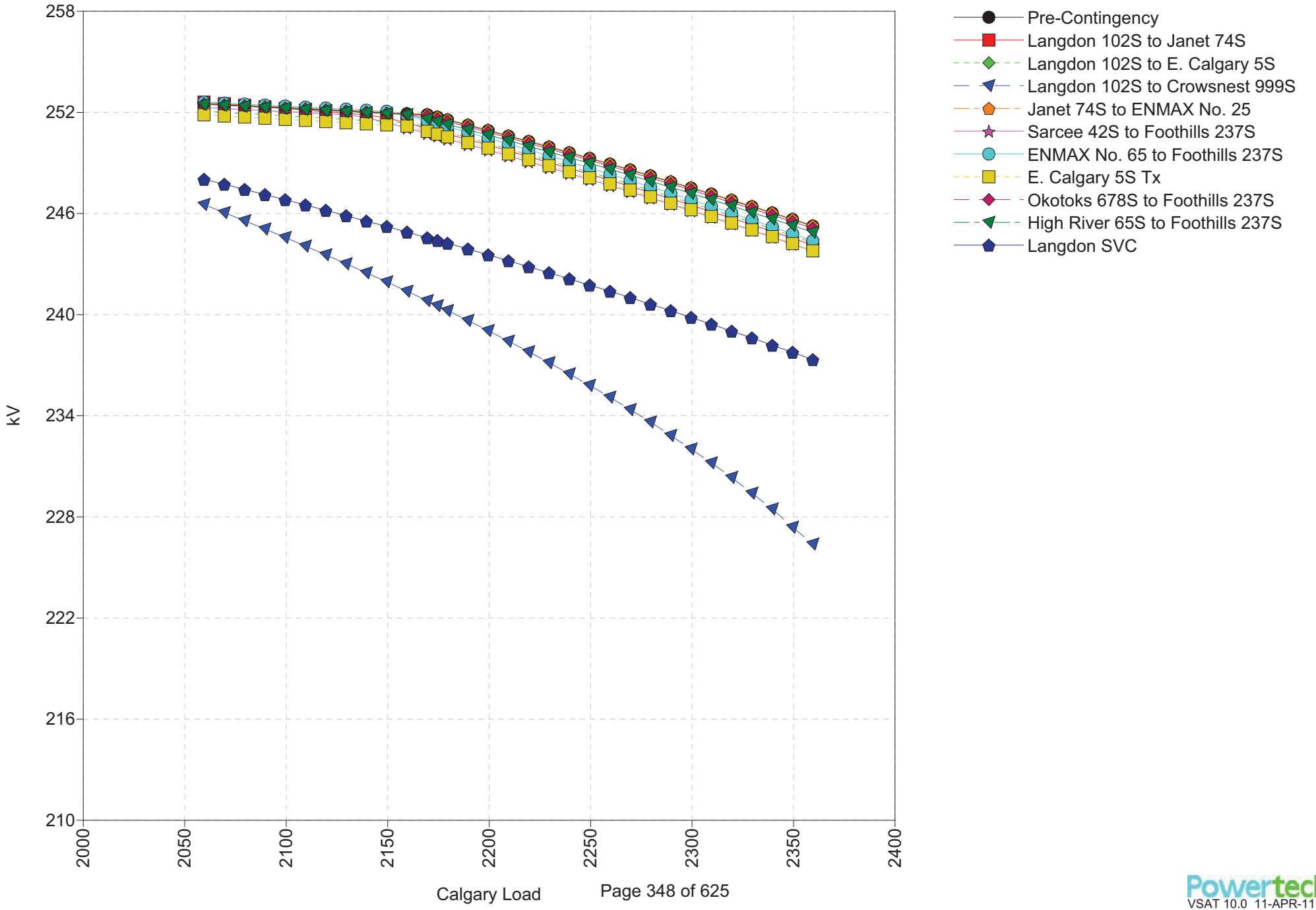
Figure K-138-SC1-8
FATD 2019 SP ST4 SC1
Increase Calgary Load
138 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:05

Figure K-240-SC2-1

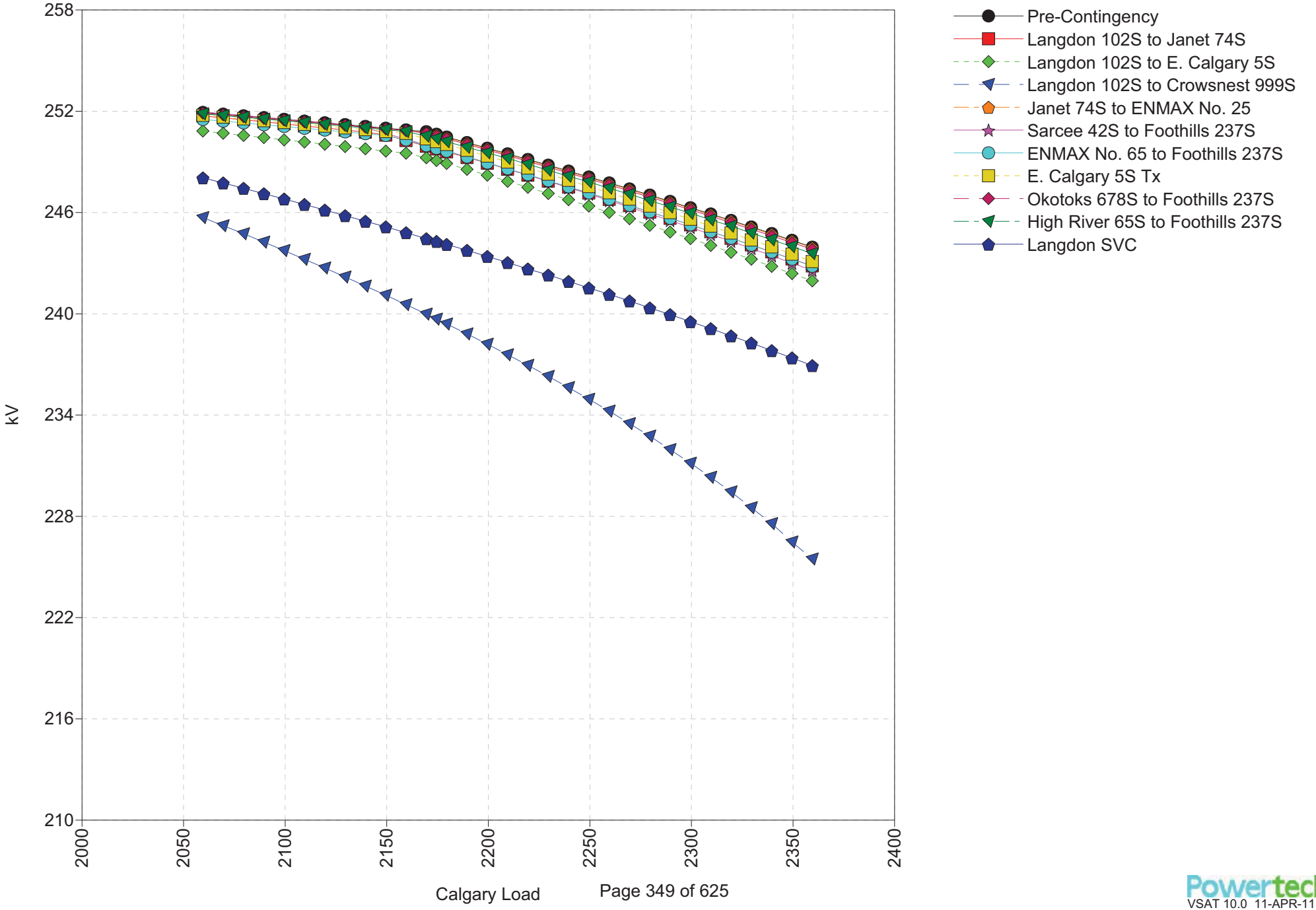
FATD 2019 SP ST4 SC2
Increase Calgary Load
240 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

Figure K-240-SC2-2

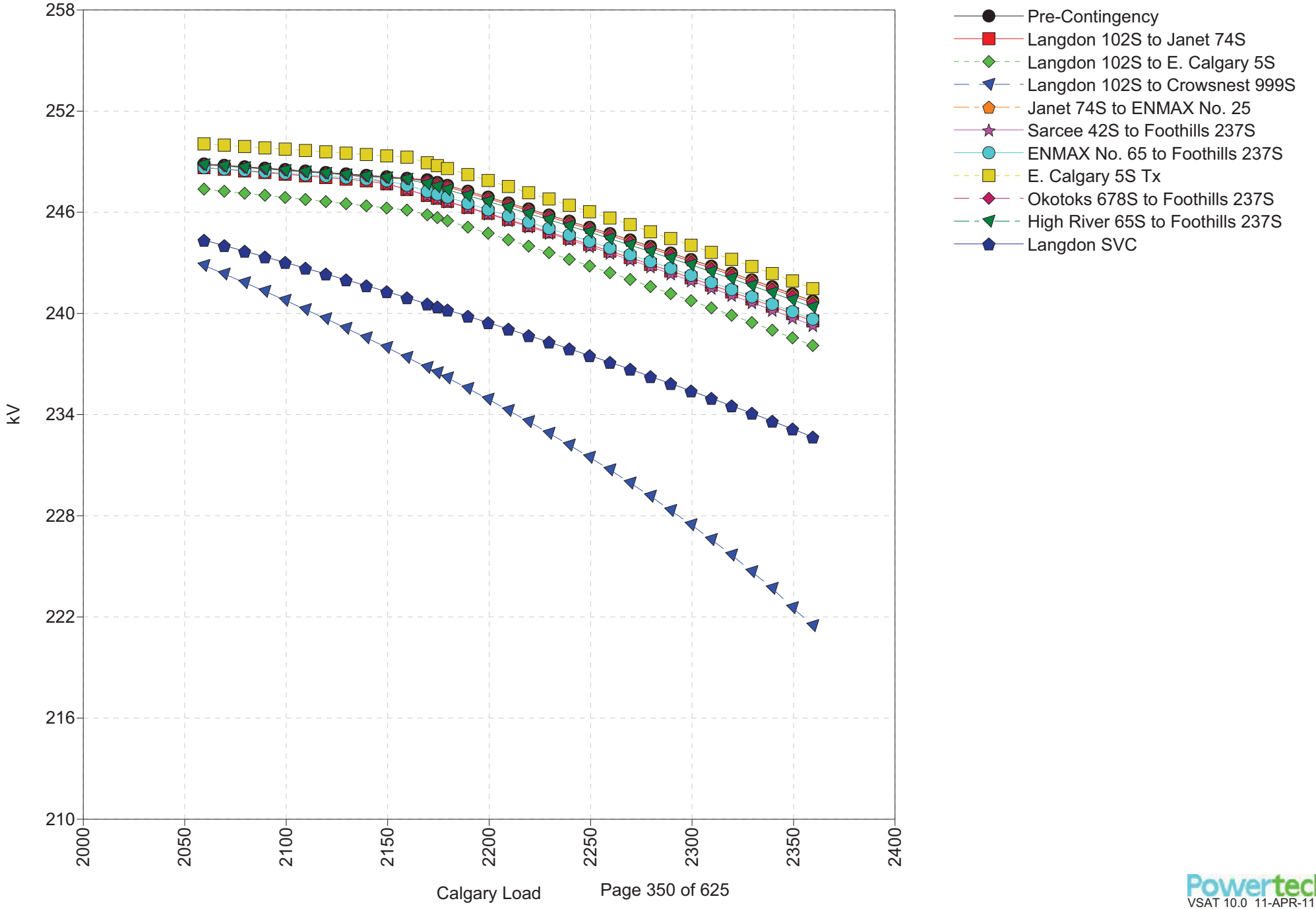
FATD 2019 SP ST4 SC2
Increase Calgary Load
240 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

Figure K-240-SC2-3

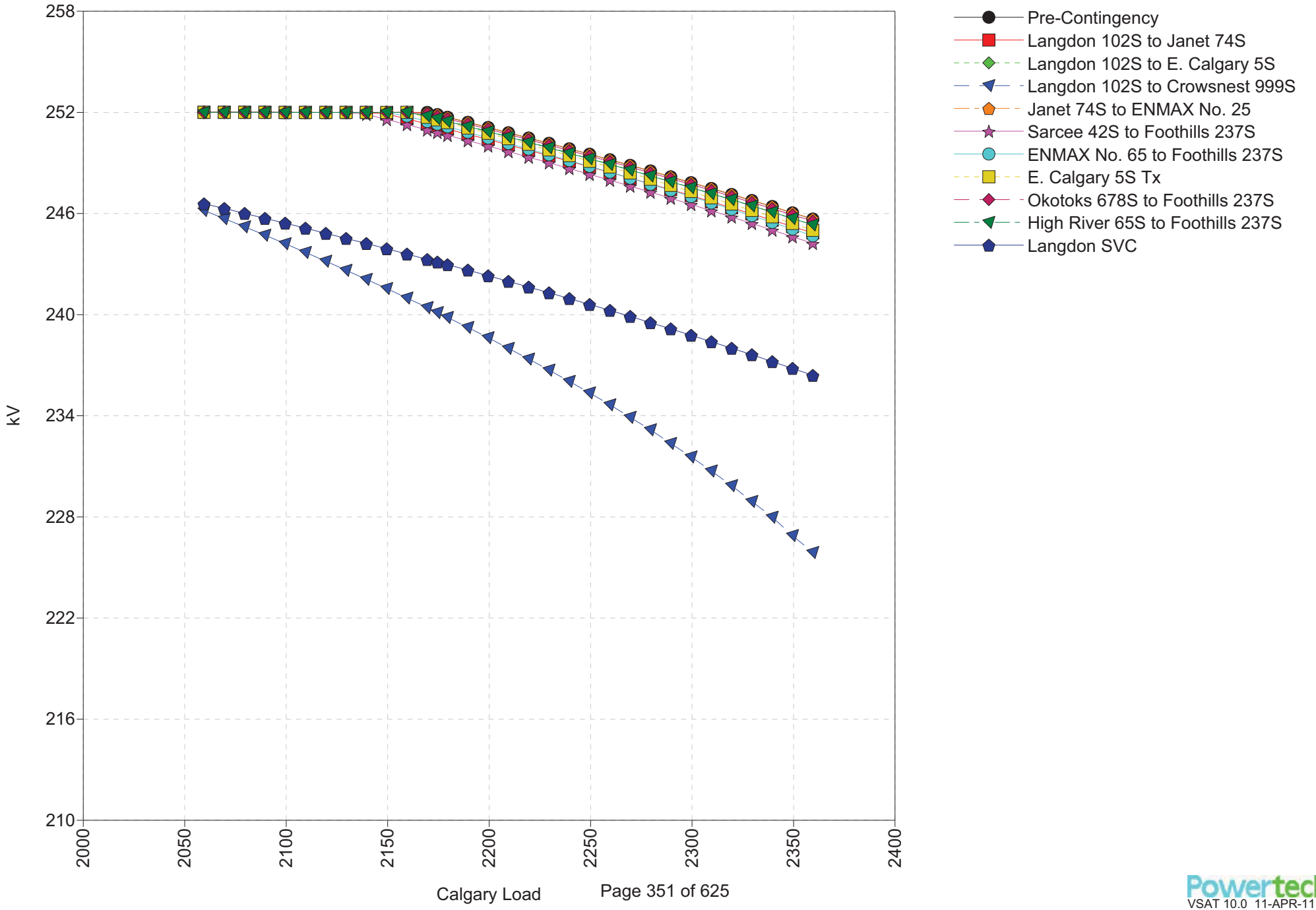
FATD 2019 SP ST4 SC2
Increase Calgary Load
240 E CALGARY 5S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

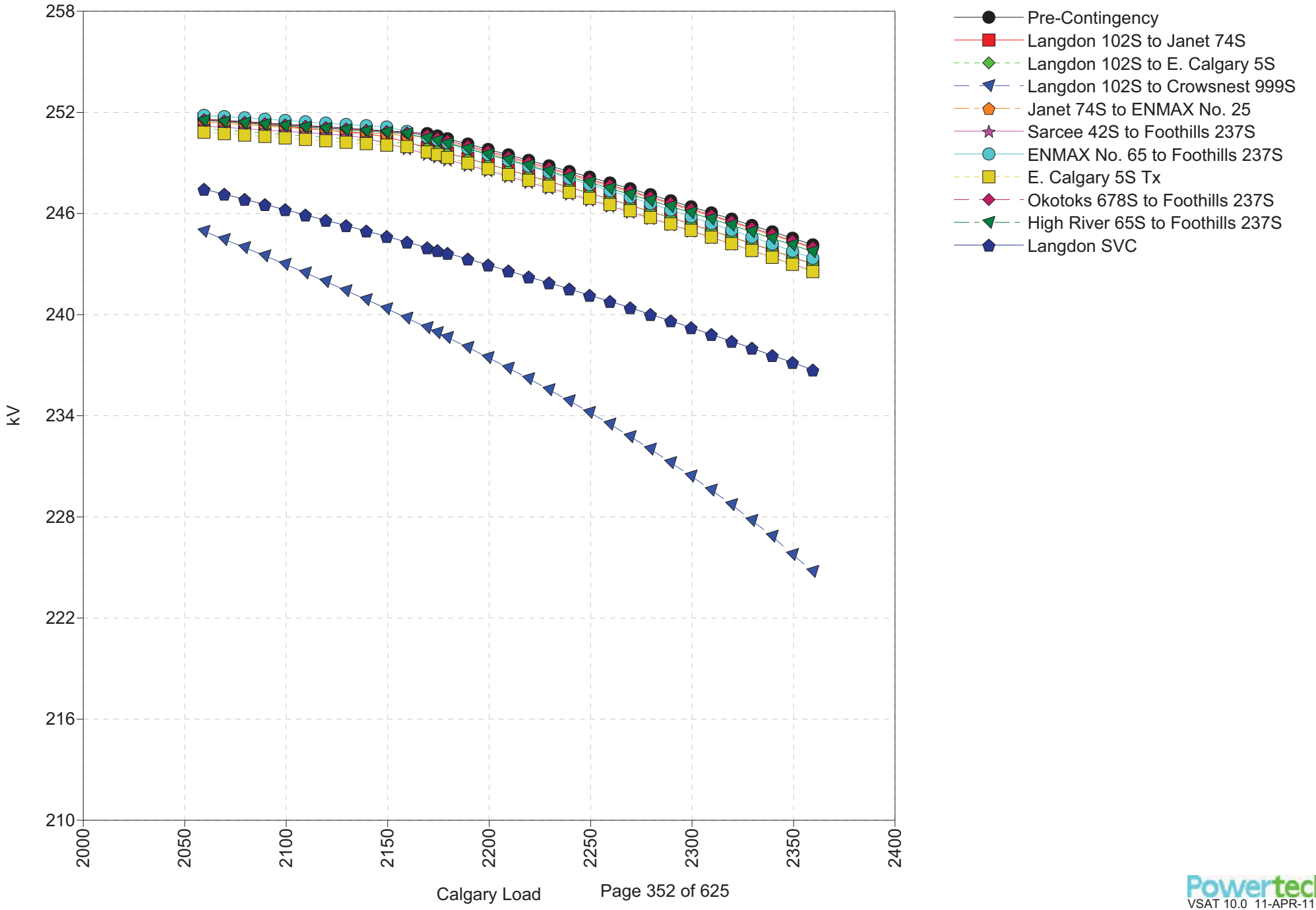
Figure K-240-SC2-4

FATD 2019 SP ST4 SC2
Increase Calgary Load
240 LANGDON 102S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

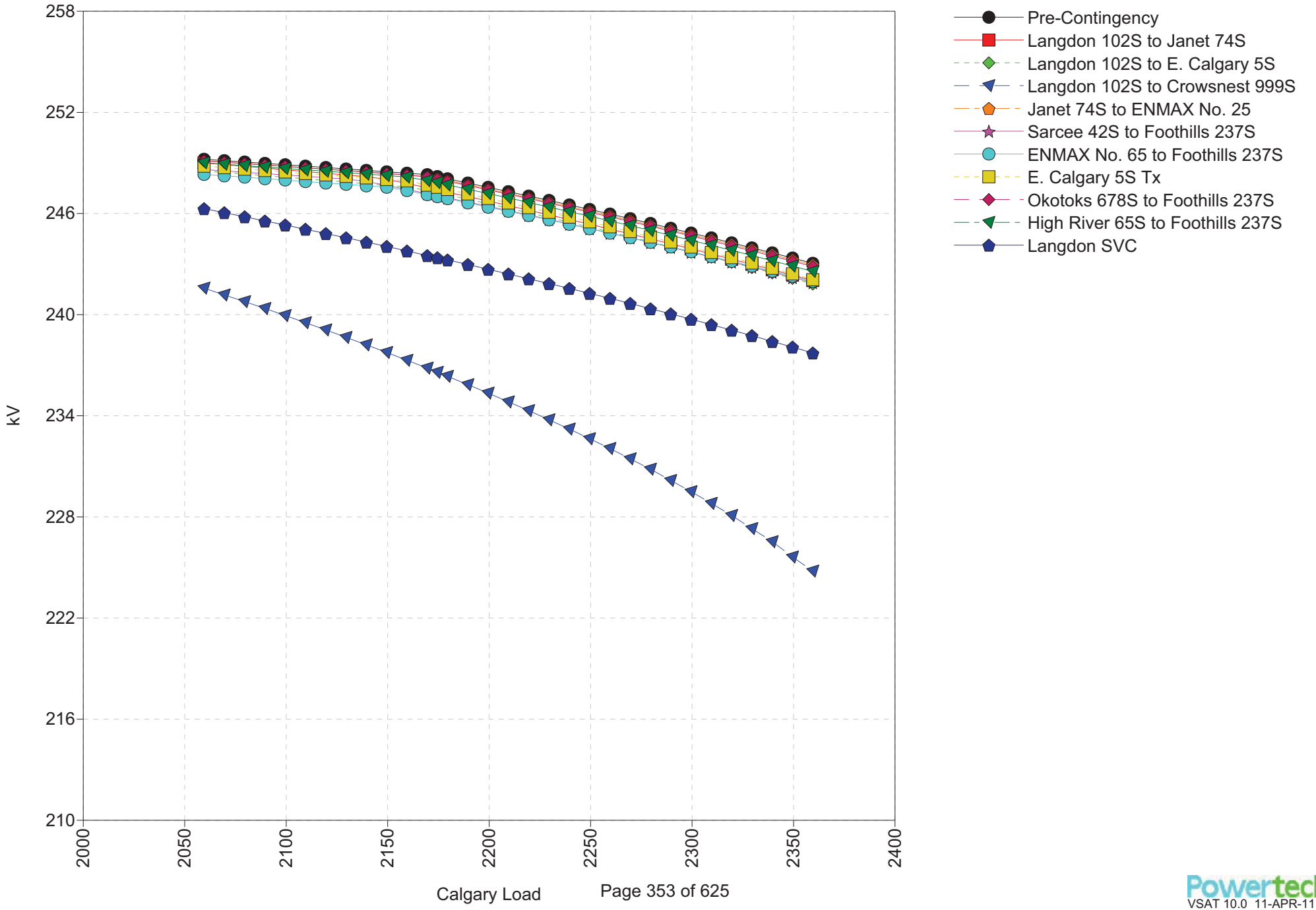
Figure K-240-SC2-5
FATD 2019 SP ST4 SC2
Increase Calgary Load
240 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

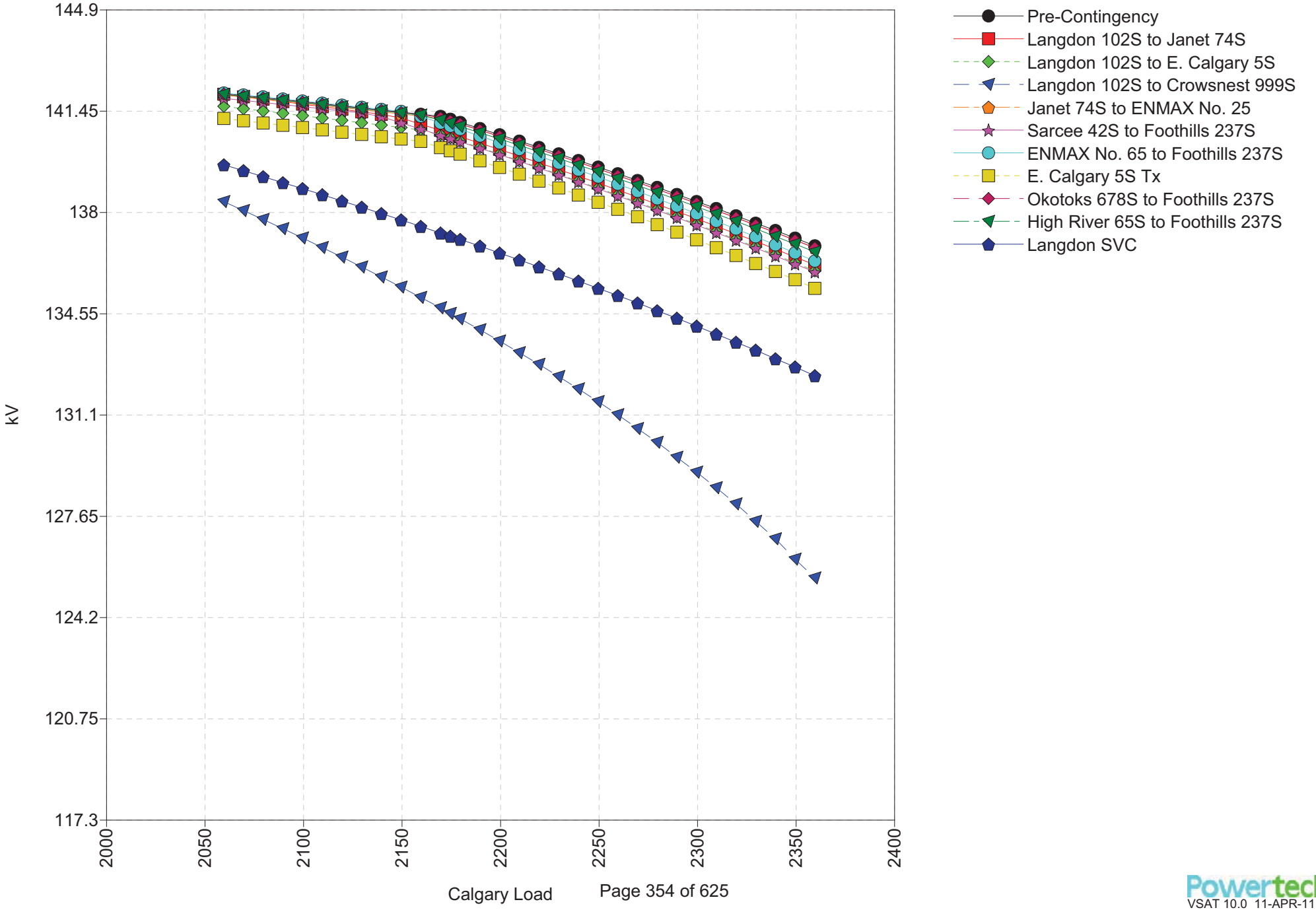
Figure K-240-SC2-6

FATD 2019 SP ST4 SC2
Increase Calgary Load
240 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

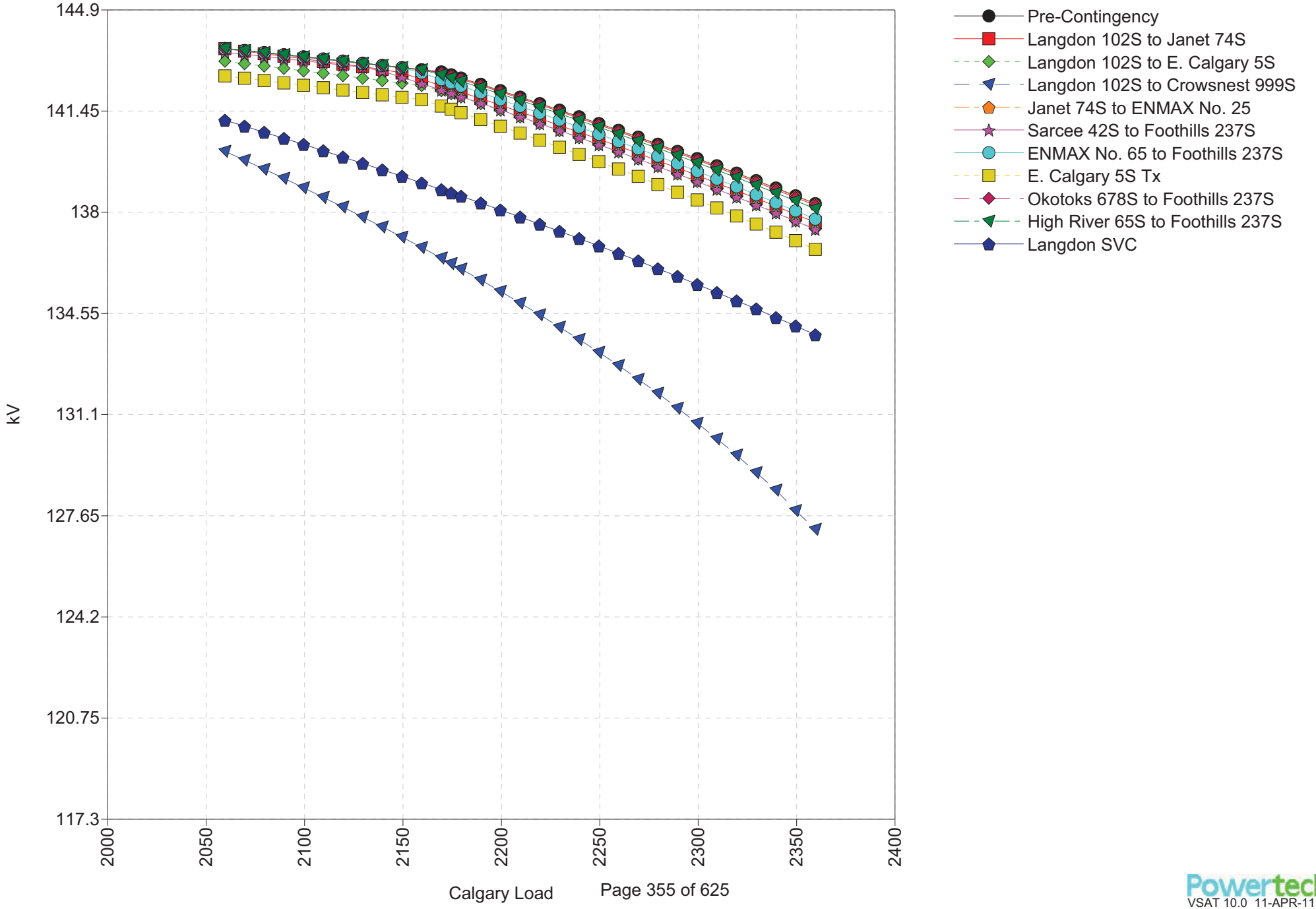
Figure K-138-SC2-1
FATD 2019 SP ST4 SC2
Increase Calgary Load
138 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

Figure K-138-SC2-2

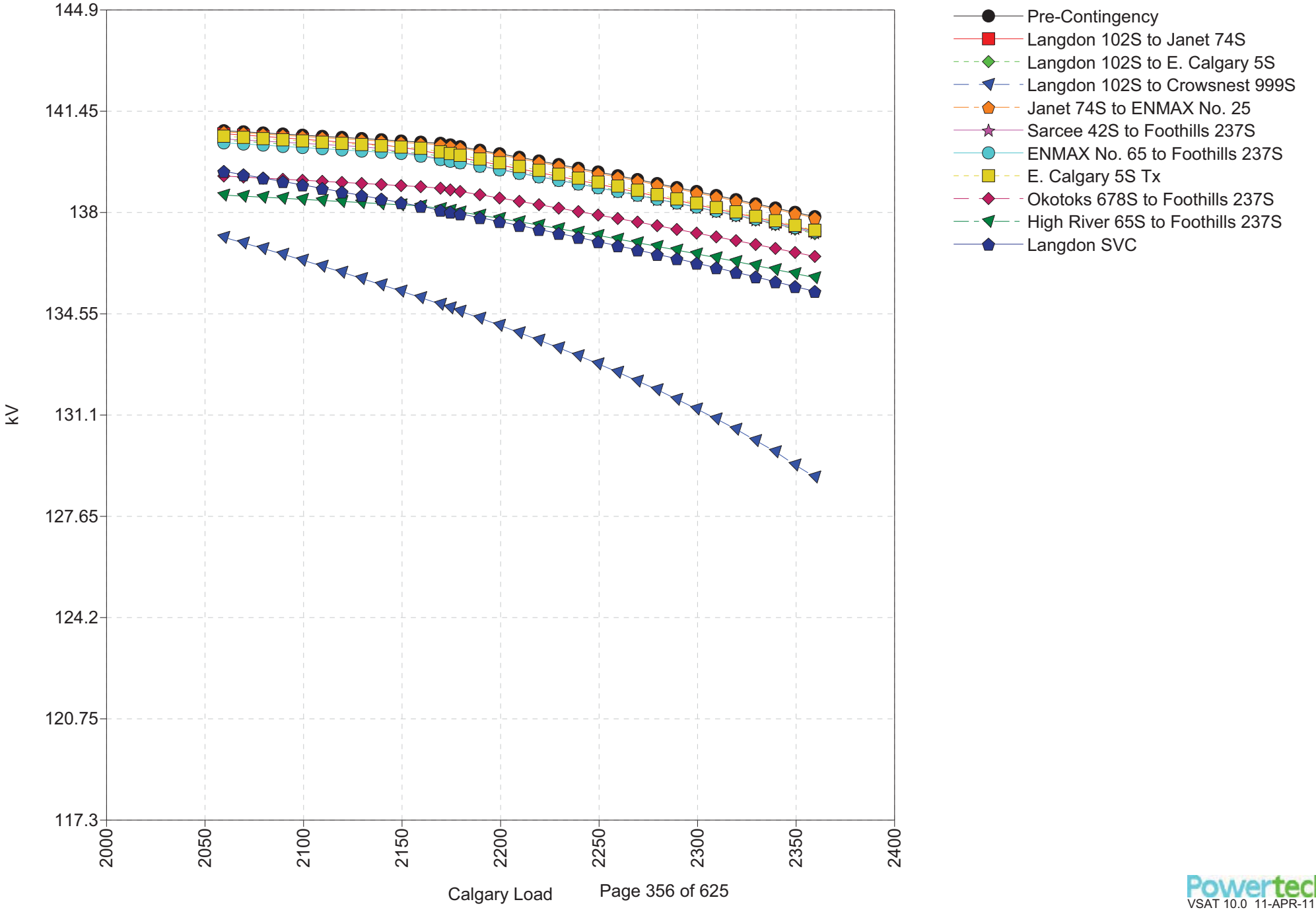
FATD 2019 SP ST4 SC2
Increase Calgary Load
138 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

Figure K-138-SC2-3

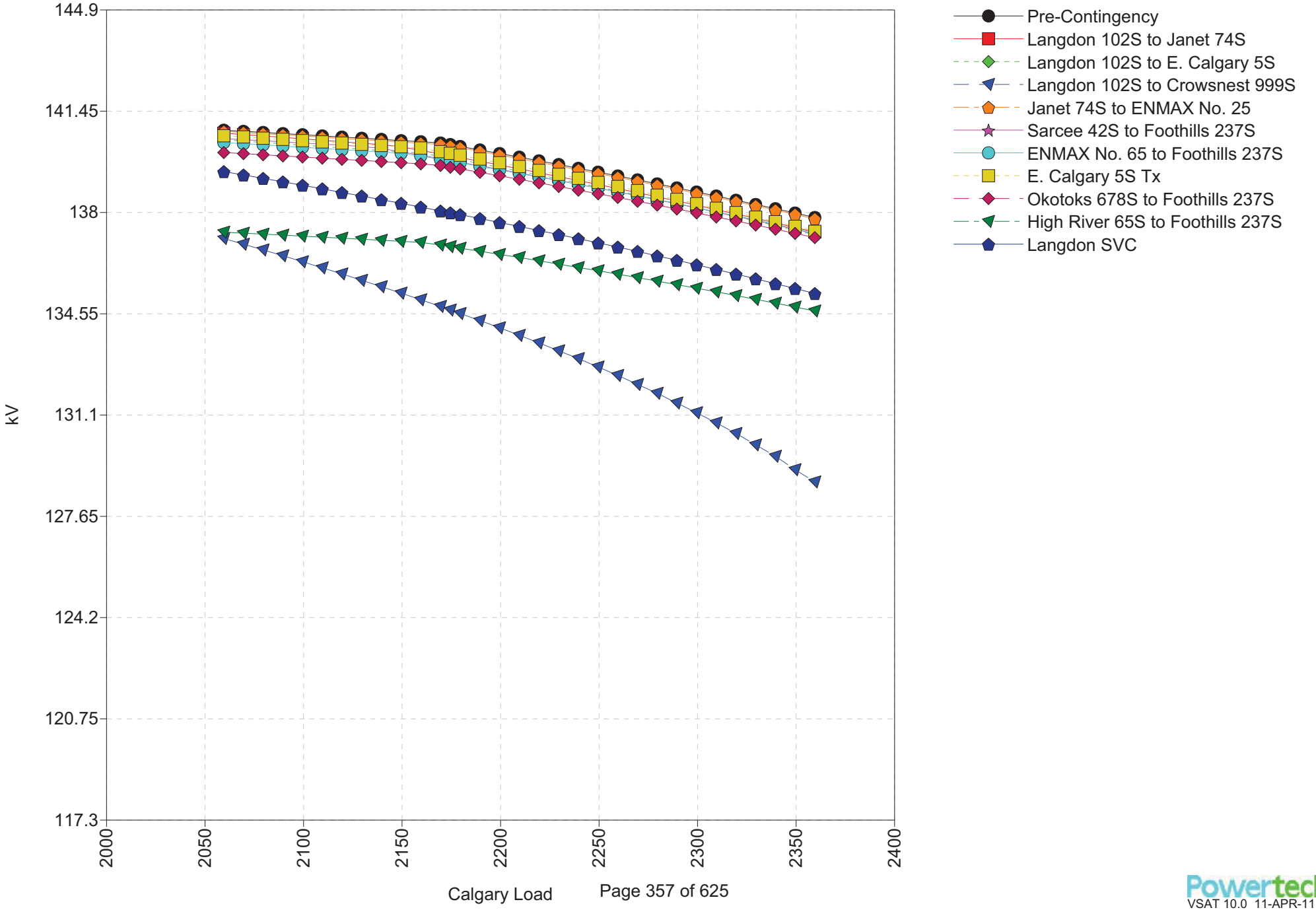
FATD 2019 SP ST4 SC2
Increase Calgary Load
138 OKOTOKS 678S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

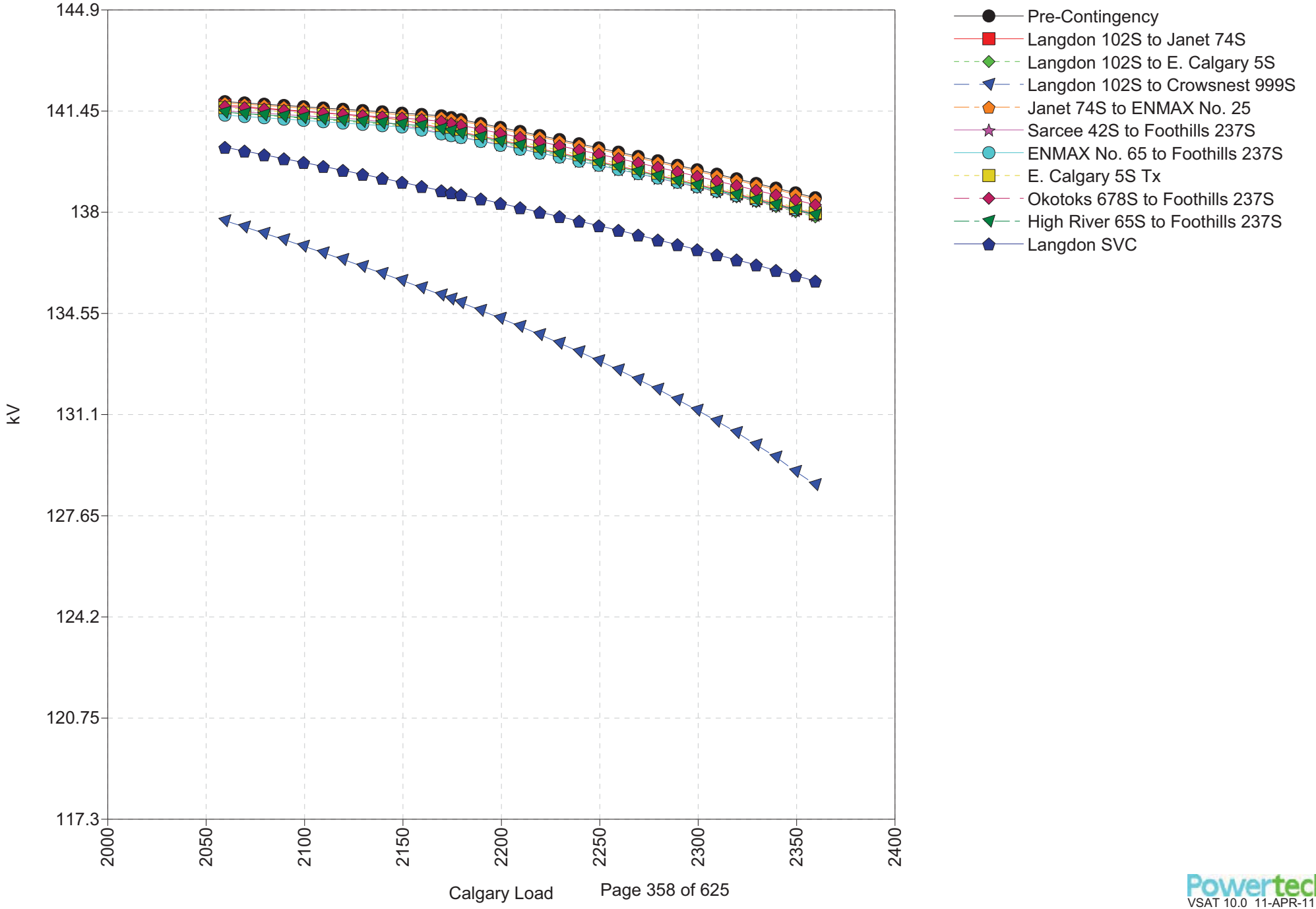
Figure K-138-SC2-4

FATD 2019 SP ST4 SC2
Increase Calgary Load
138 HIGH RIVER 65S Bus Voltage (kV)



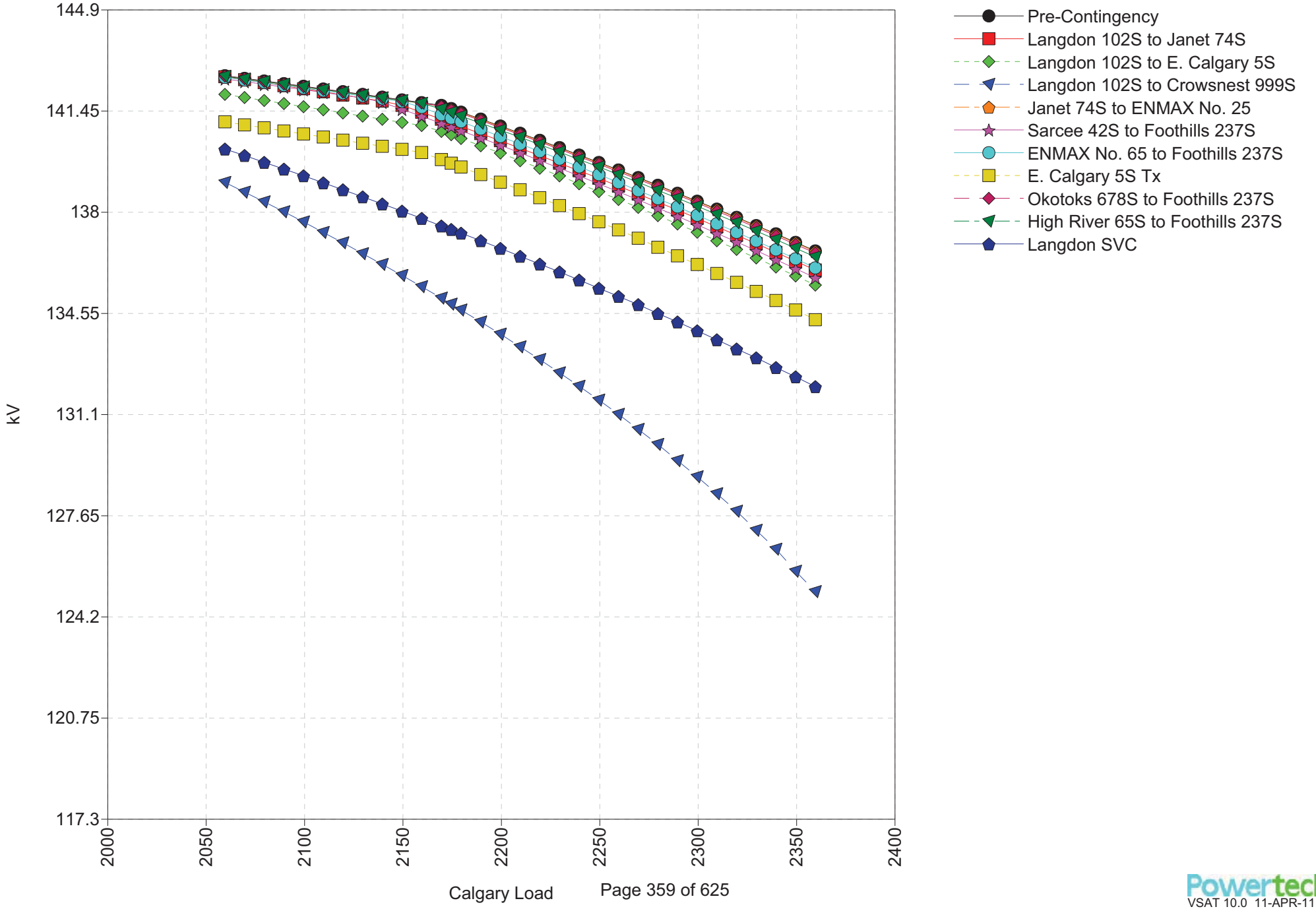
Powertech
VSAT 10.0 11-APR-11 13:06

Figure K-138-SC2-5
FATD 2019 SP ST4 SC2
Increase Calgary Load
138 FOOTHILLS 237S Bus Voltage (kV)



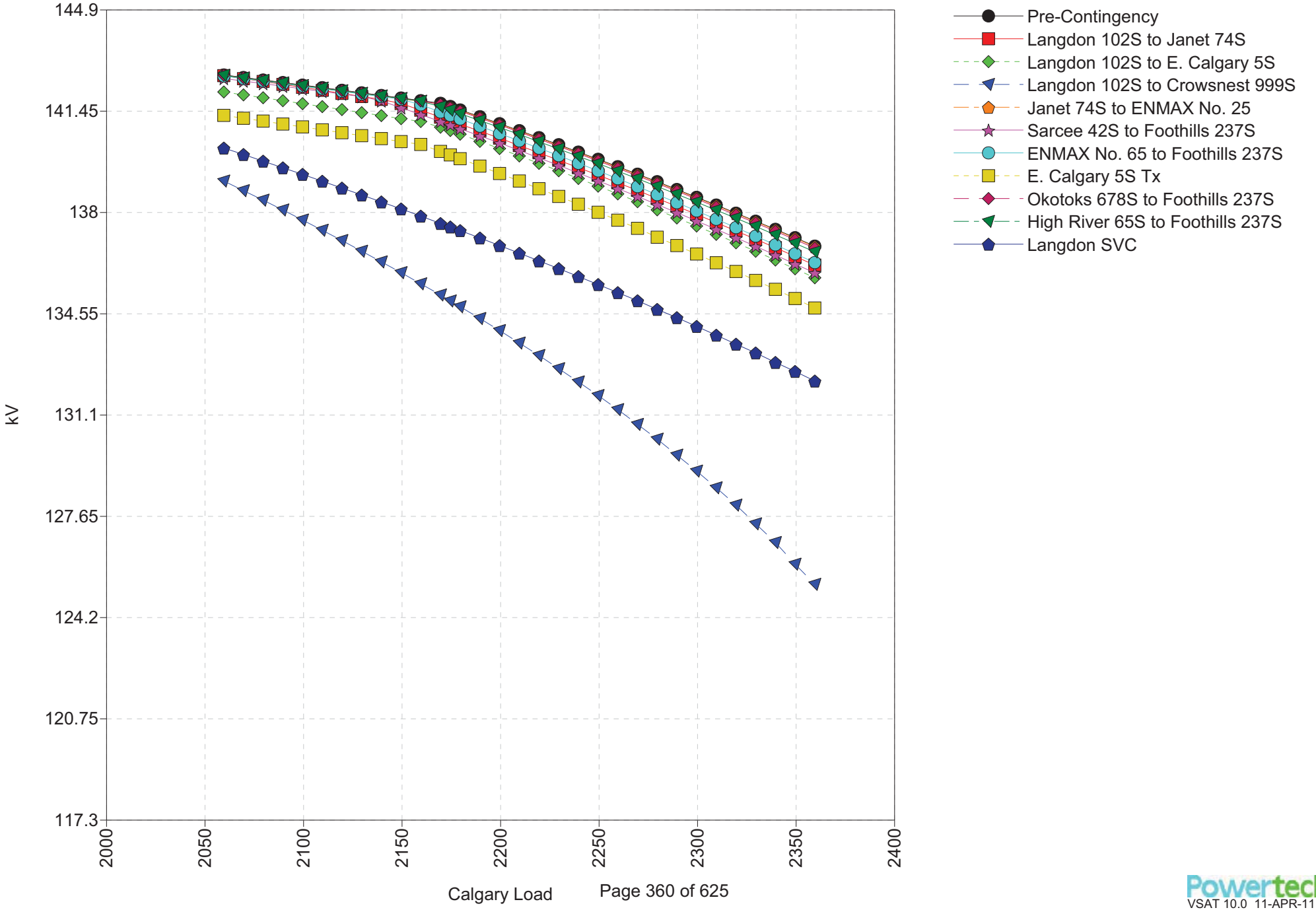
Powertech
VSAT 10.0 11-APR-11 13:06

Figure K-138-SC2-6
FATD 2019 SP ST4 SC2
Increase Calgary Load
138 ENMAX No. 2 Bus Voltage (kV)



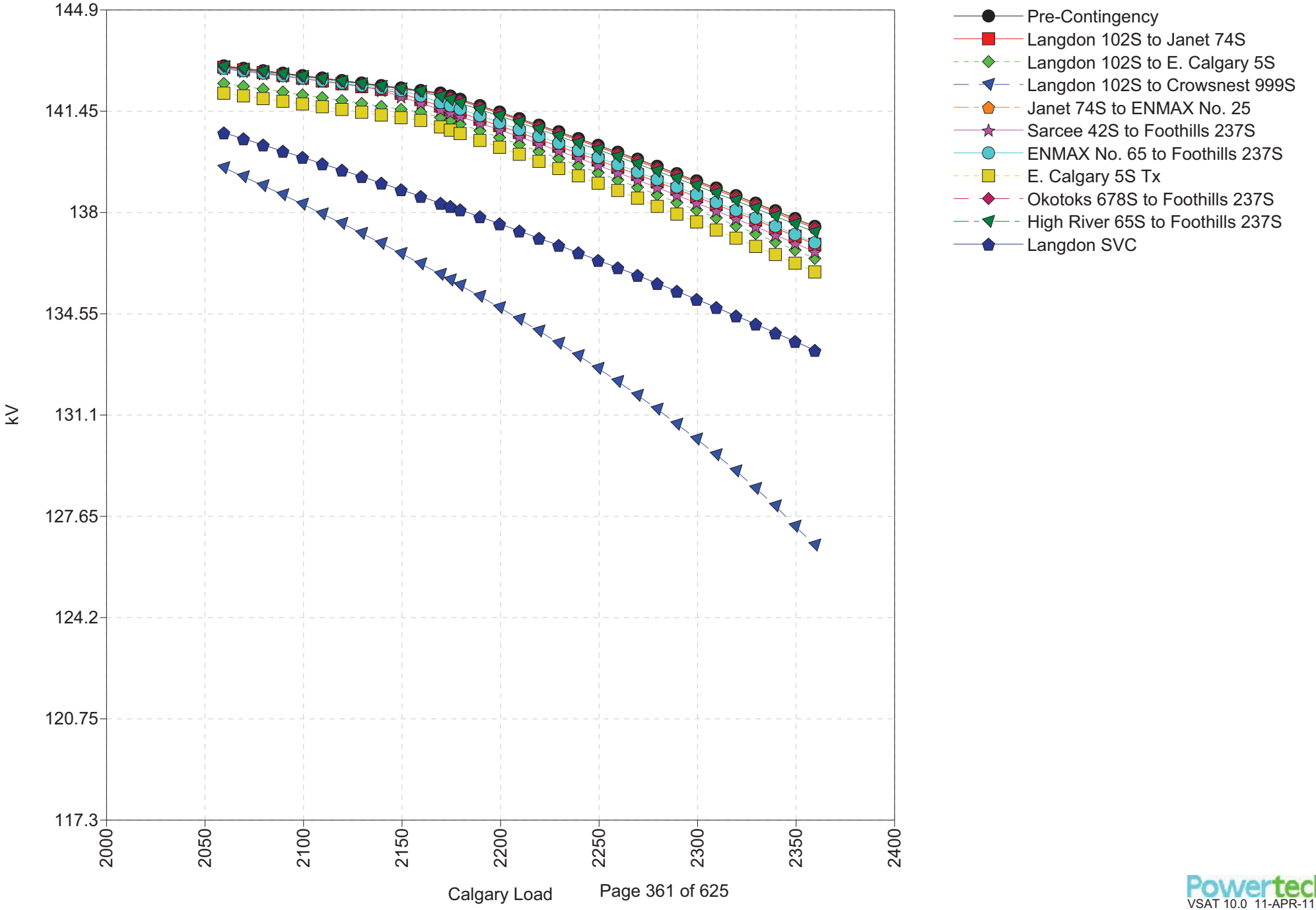
Powertech
VSAT 10.0 11-APR-11 13:06

Figure K-138-SC2-7
FATD 2019 SP ST4 SC2
Increase Calgary Load
138 ENMAX No. 23 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

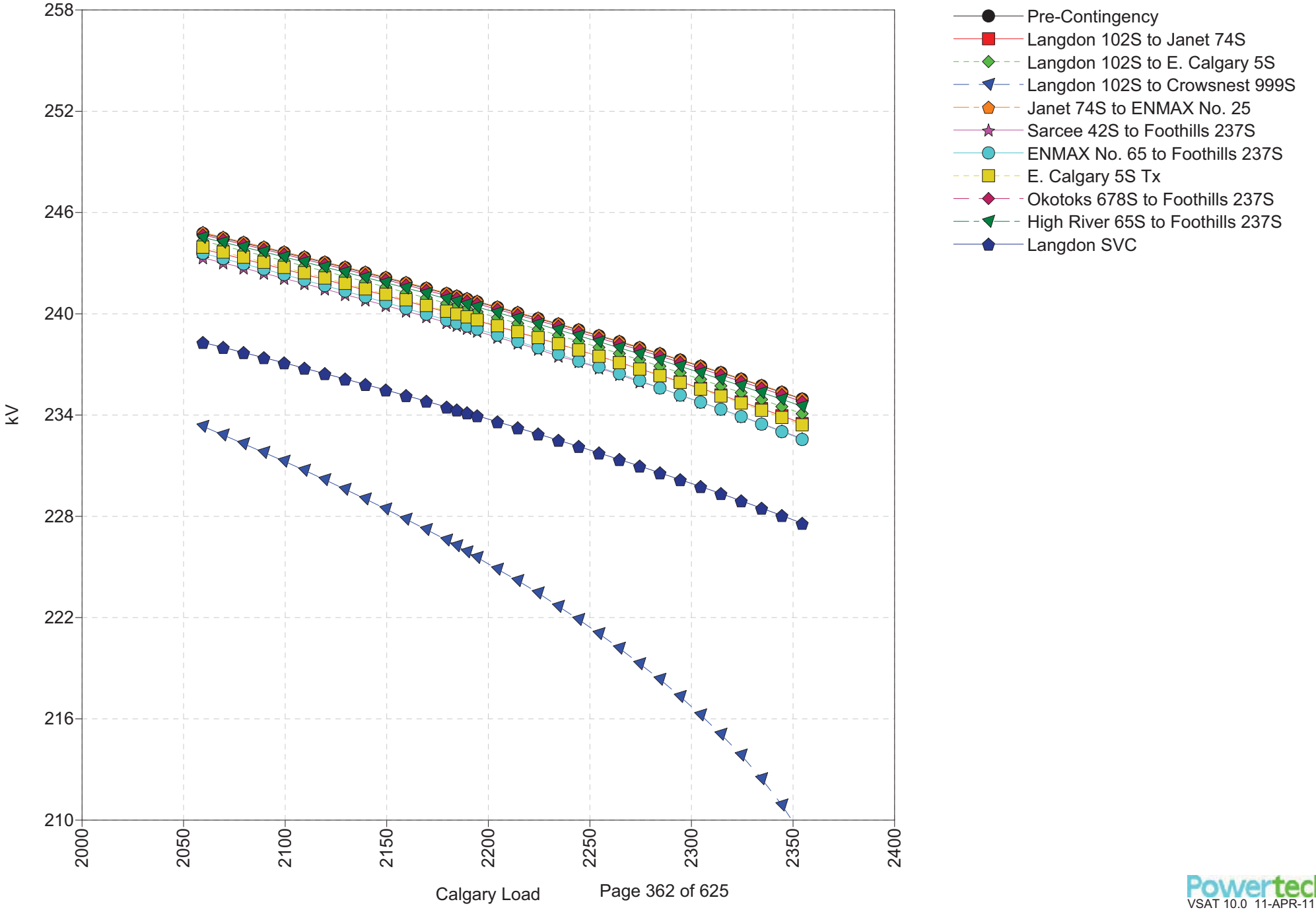
Figure K-138-SC2-8
FATD 2019 SP ST4 SC2
Increase Calgary Load
138 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:06

Figure K-240-SC3-1

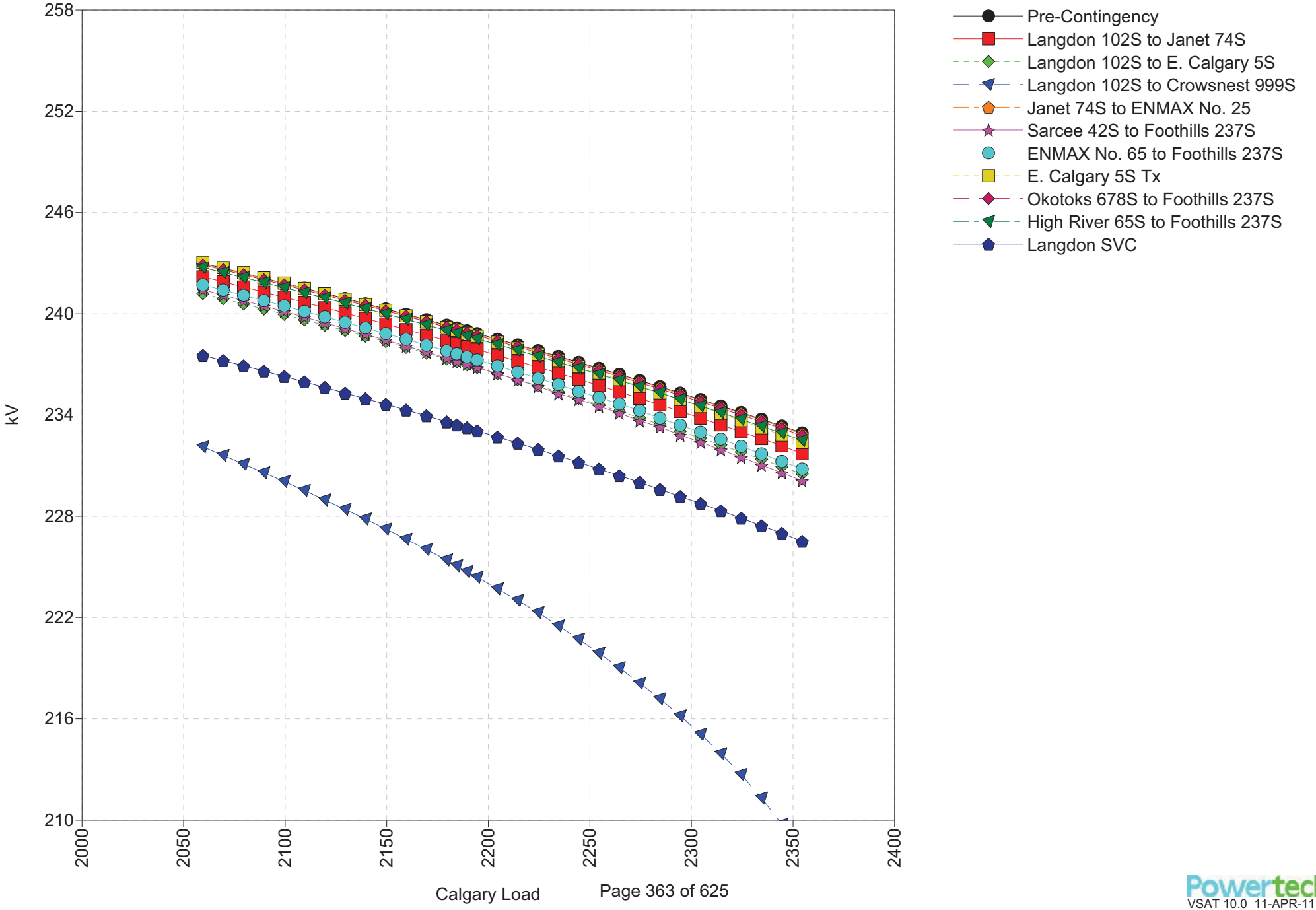
FATD 2019 SP ST4 SC3
Increase Calgary Load
240 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

Figure K-240-SC3-2

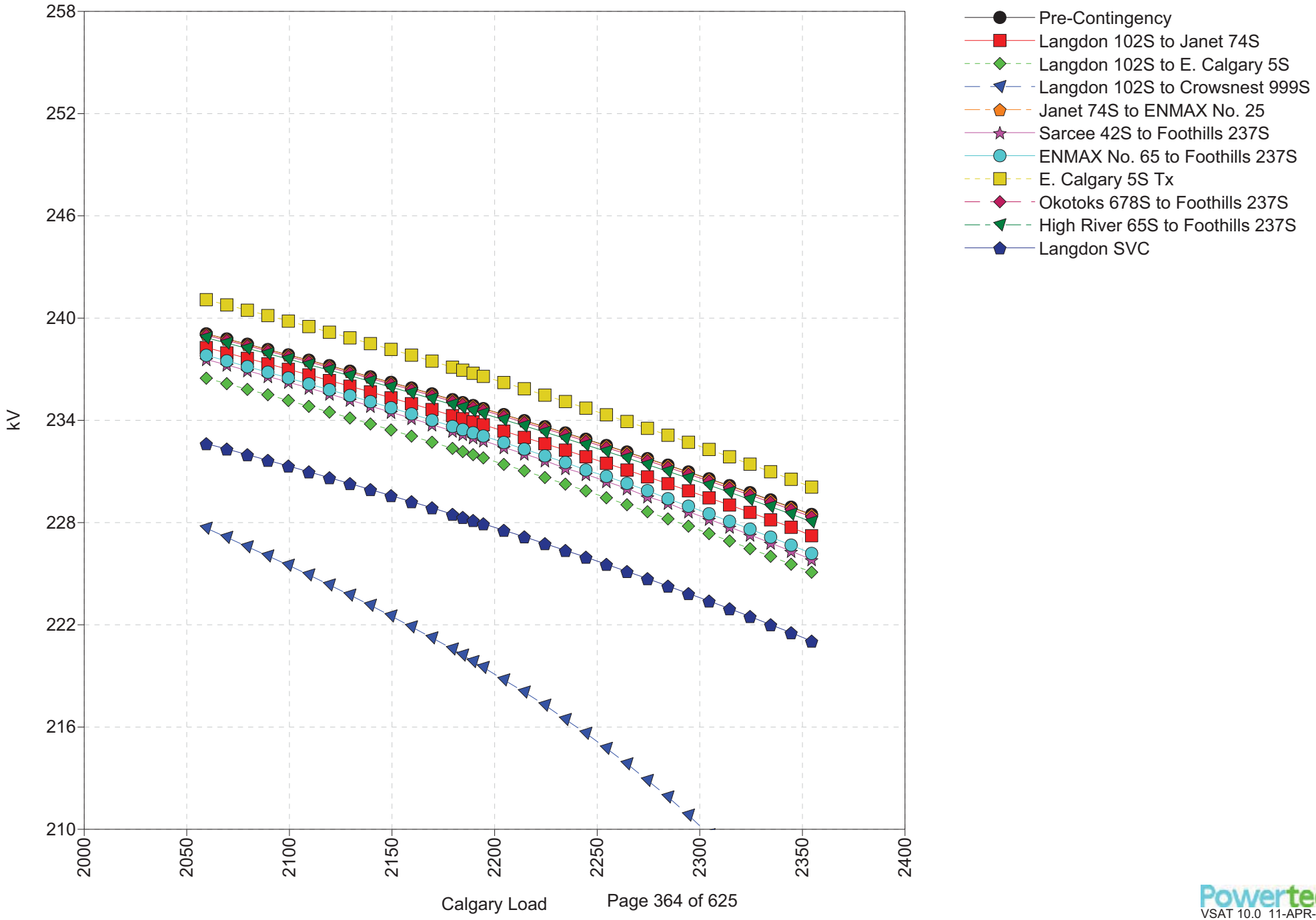
FATD 2019 SP ST4 SC3
Increase Calgary Load
240 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

Figure K-240-SC3-3

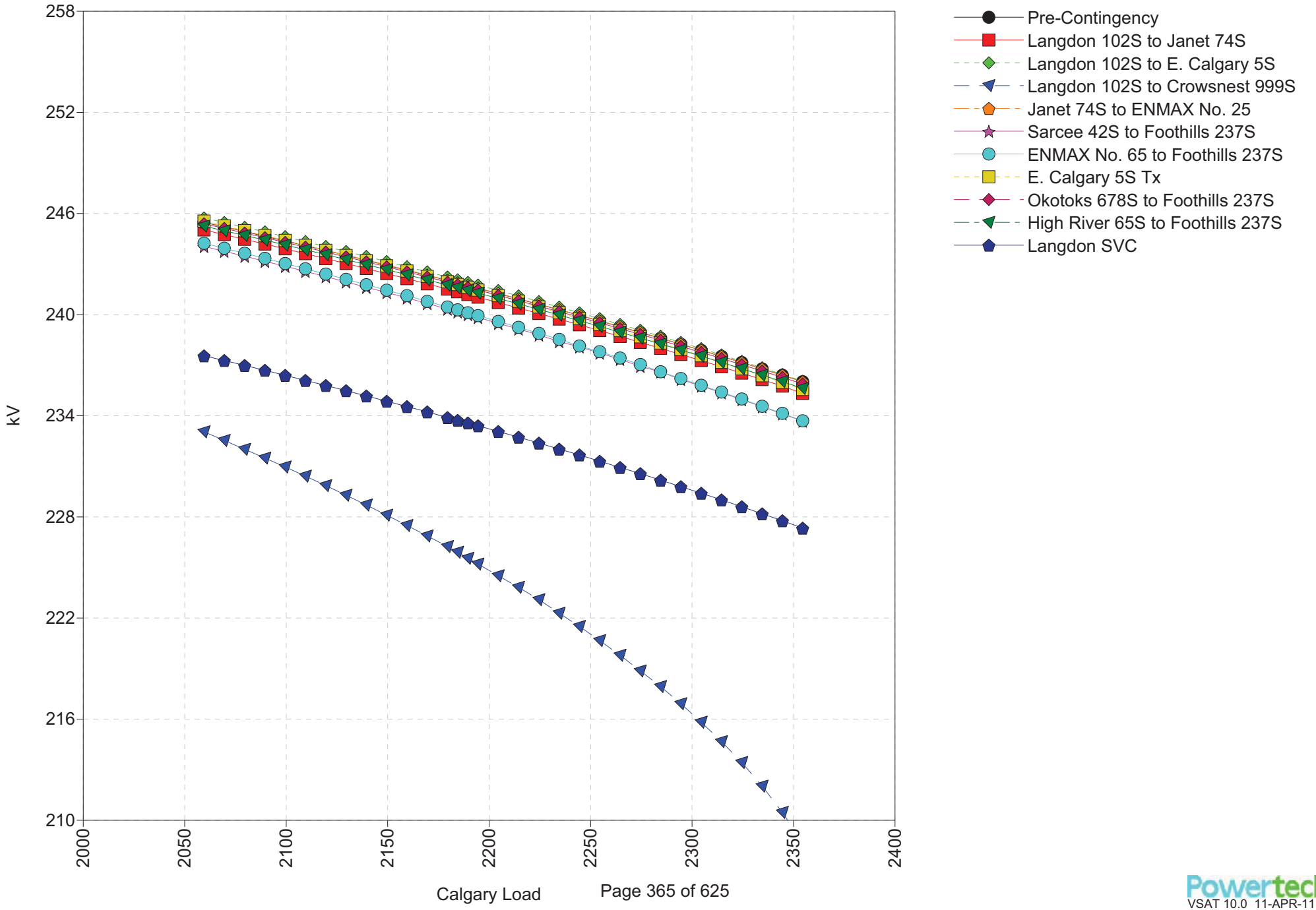
FATD 2019 SP ST4 SC3
Increase Calgary Load
240 E CALGARY 5S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

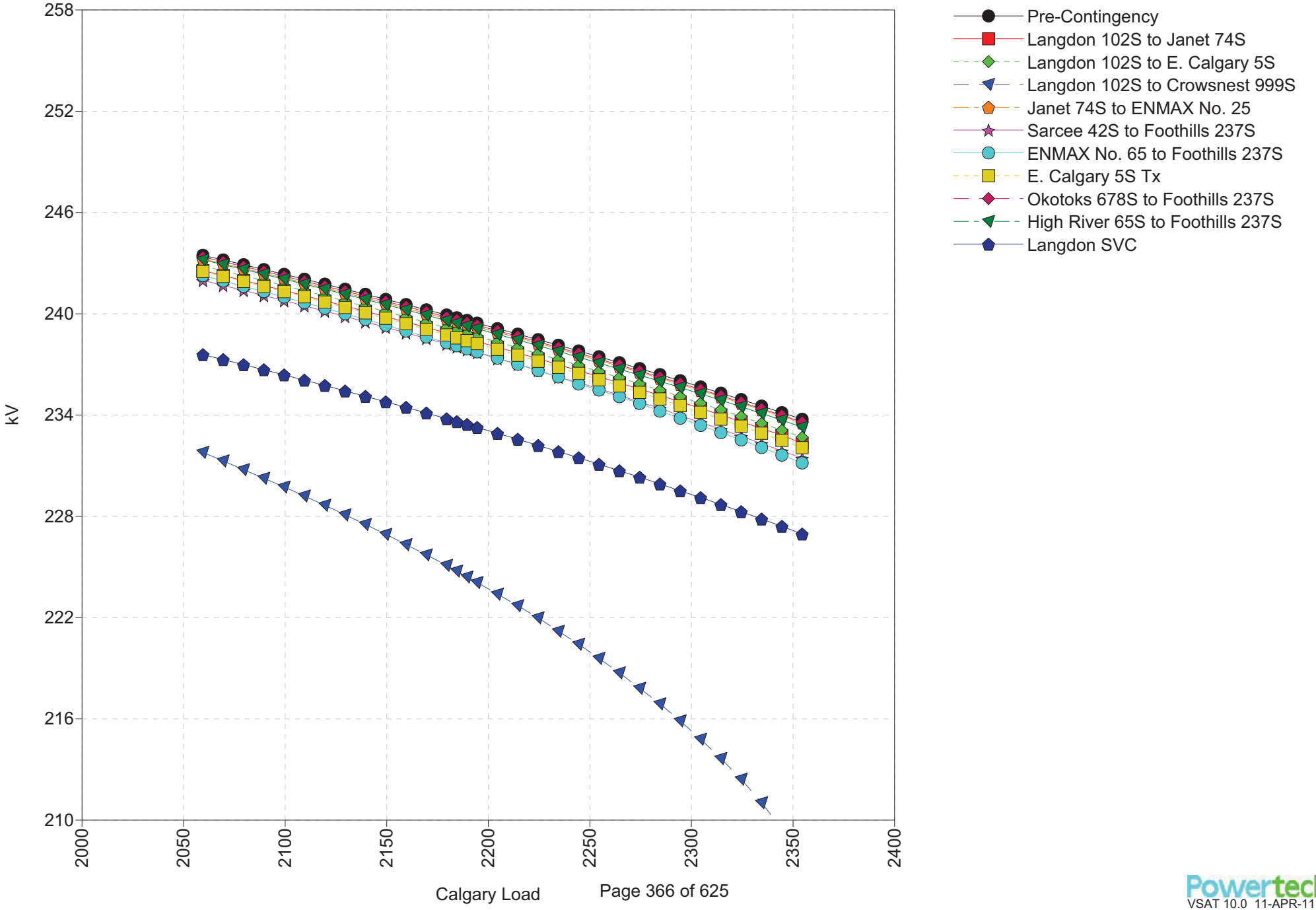
Figure K-240-SC3-4

FATD 2019 SP ST4 SC3
Increase Calgary Load
240 LANGDON 102S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

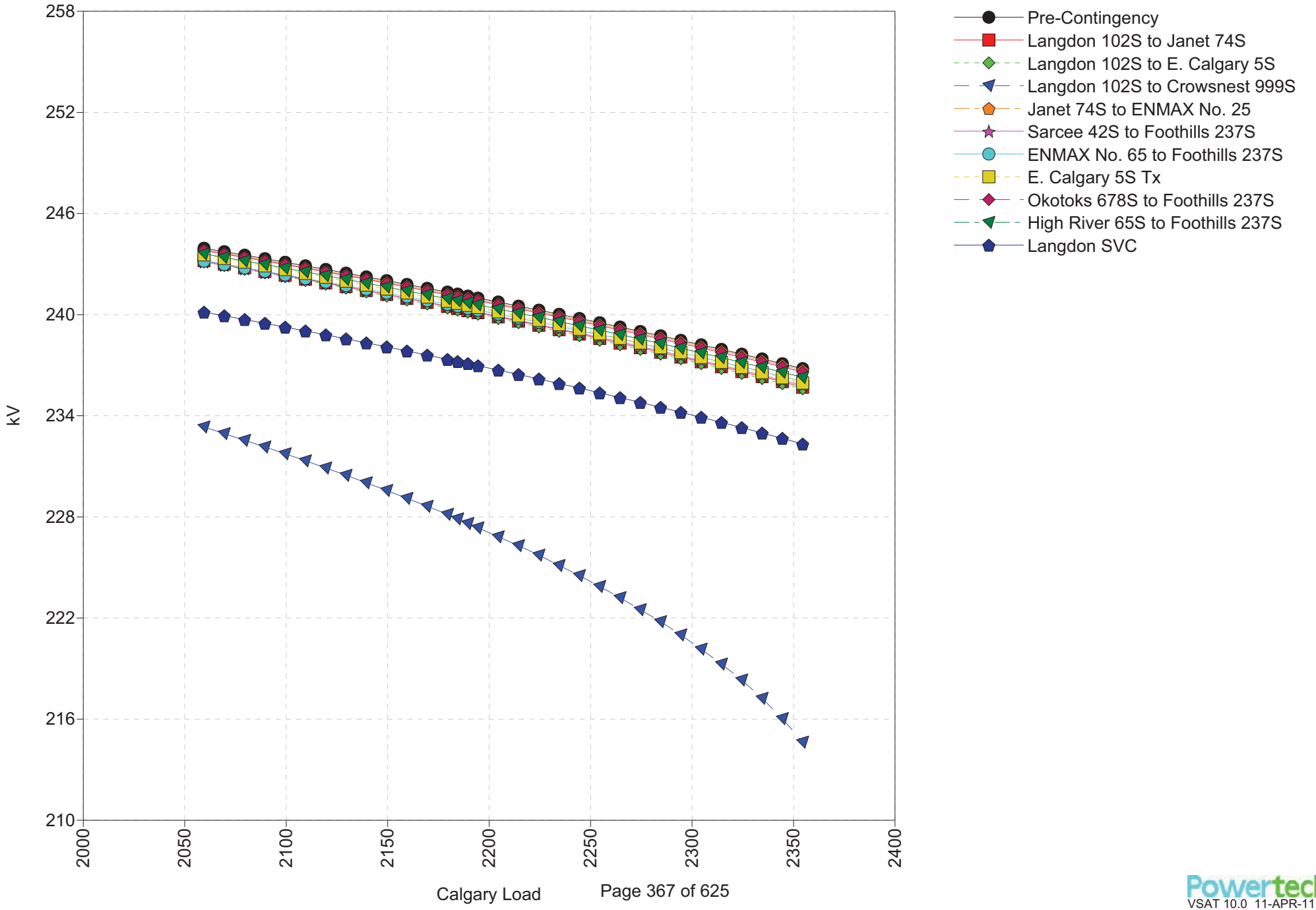
Figure K-240-SC3-5
FATD 2019 SP ST4 SC3
Increase Calgary Load
240 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

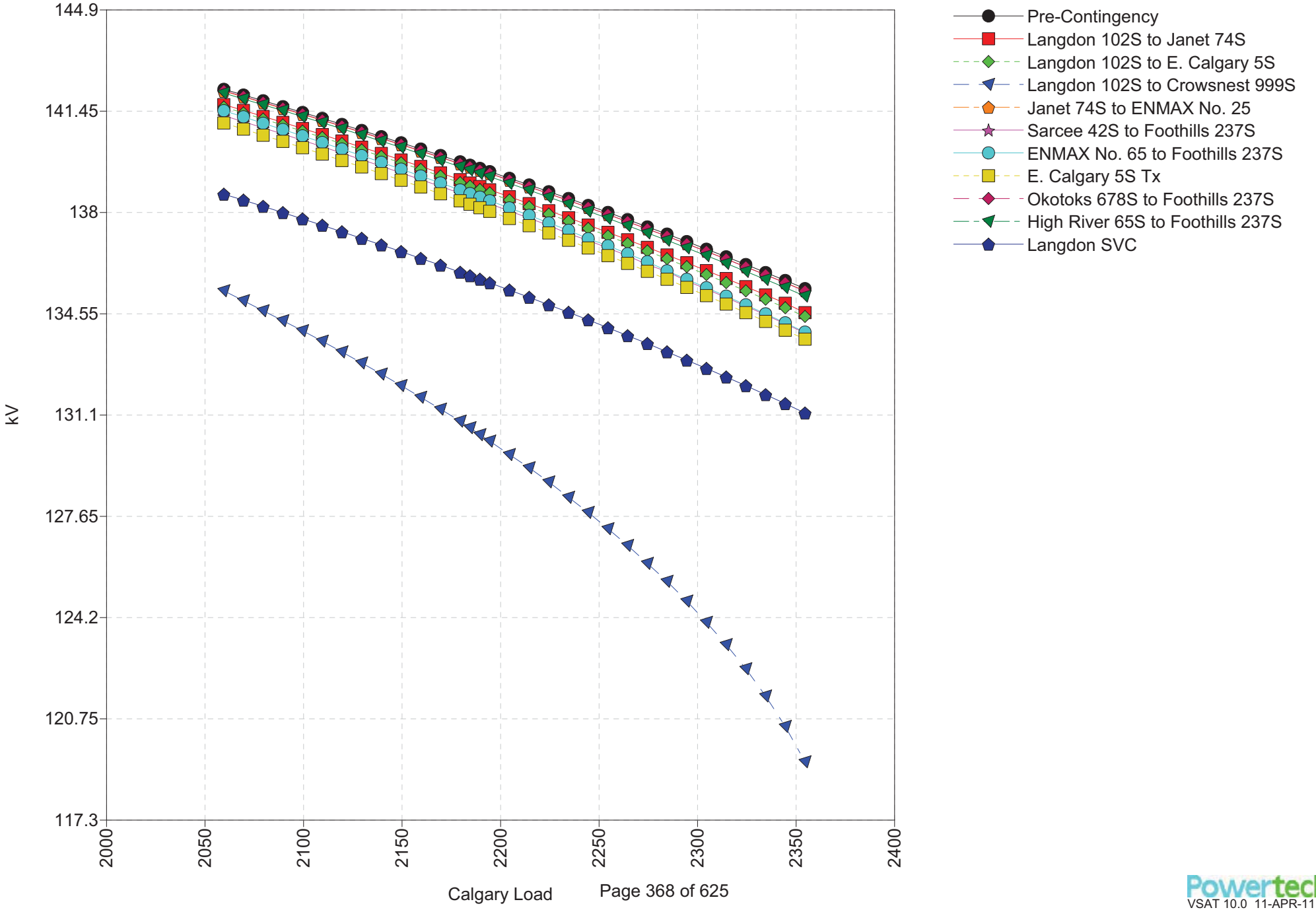
Figure K-240-SC3-6

FATD 2019 SP ST4 SC3
Increase Calgary Load
240 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

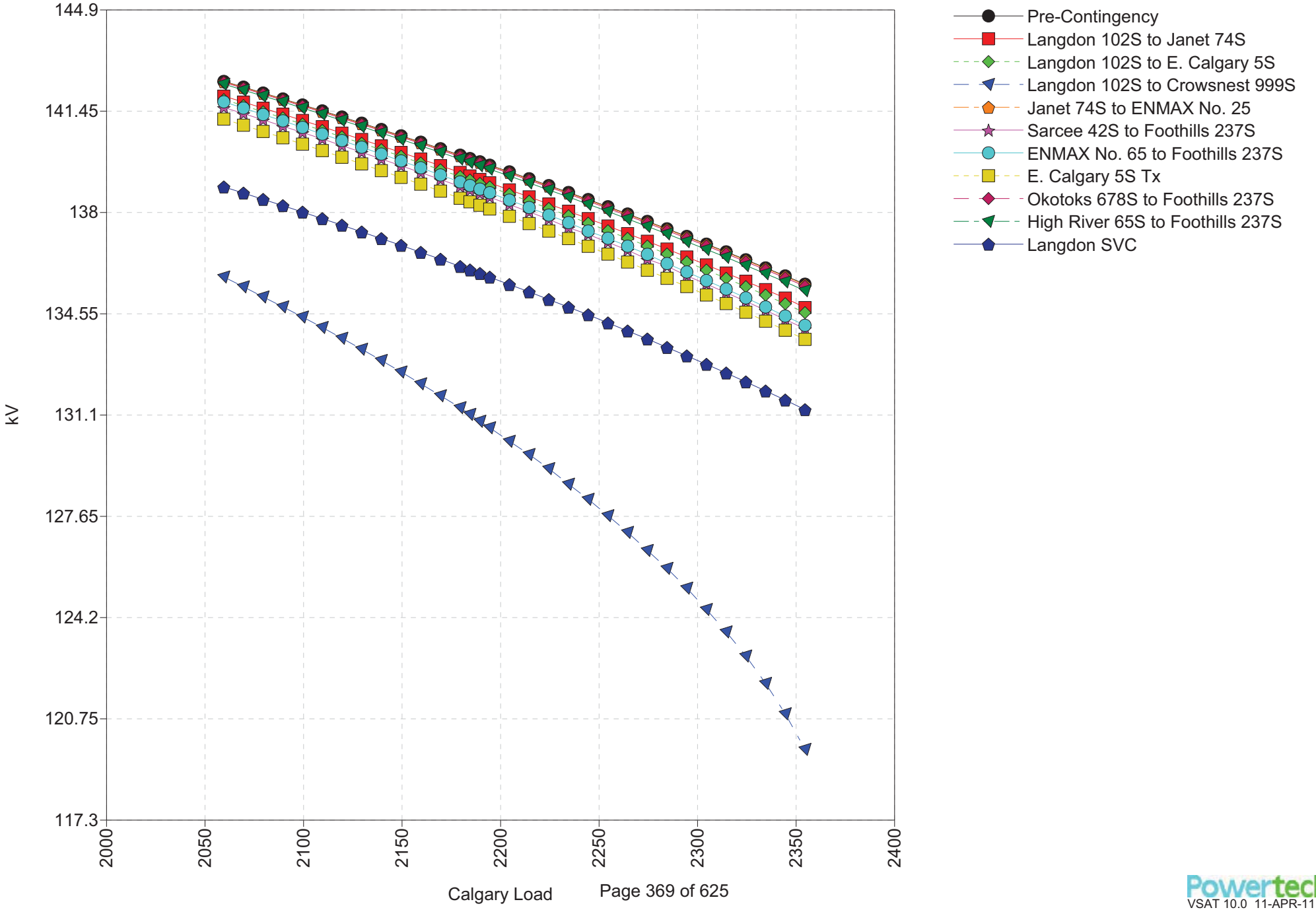
Figure K-138-SC3-1
FATD 2019 SP ST4 SC3
Increase Calgary Load
138 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

Figure K-138-SC3-2

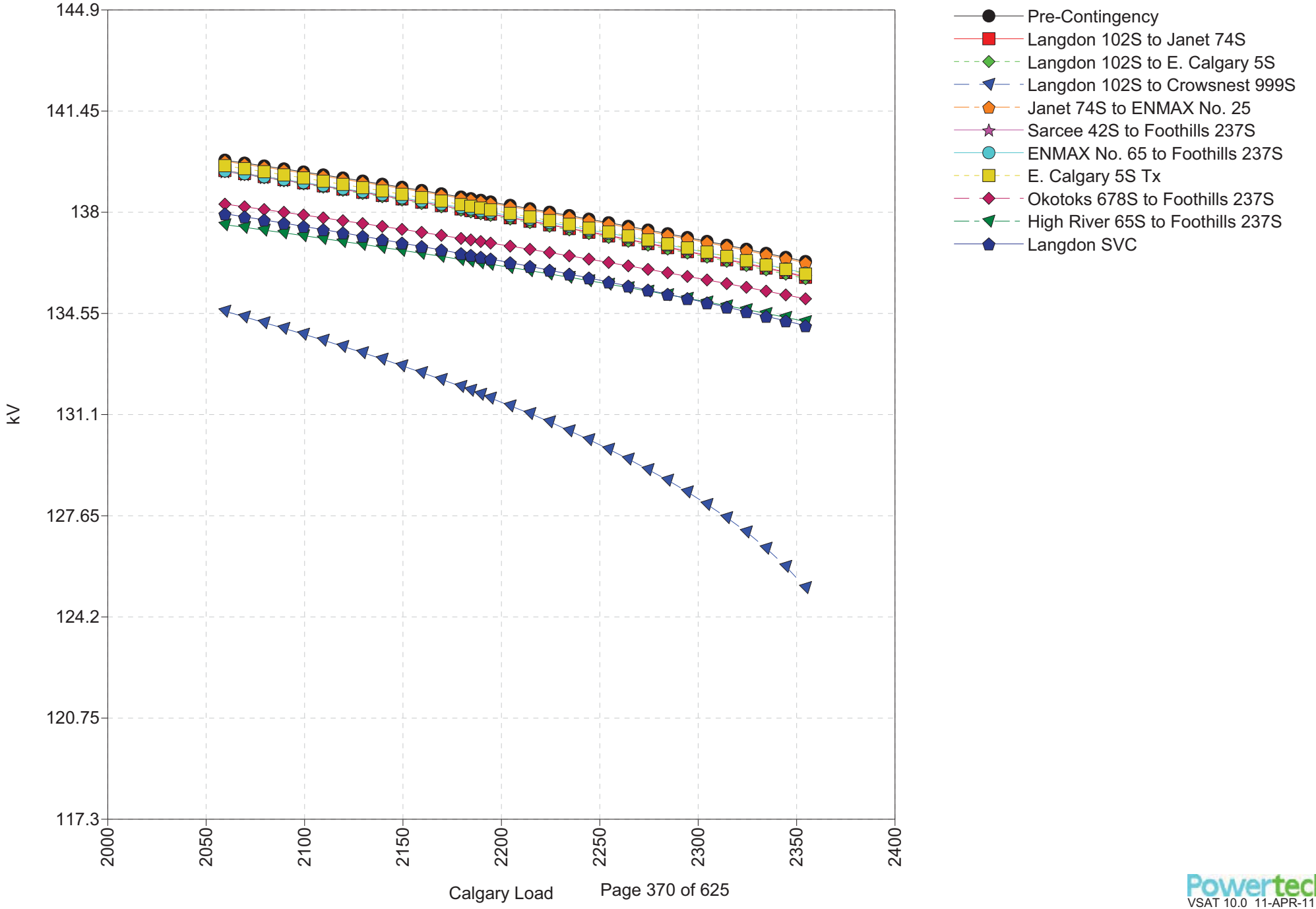
FATD 2019 SP ST4 SC3
Increase Calgary Load
138 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

Figure K-138-SC3-3

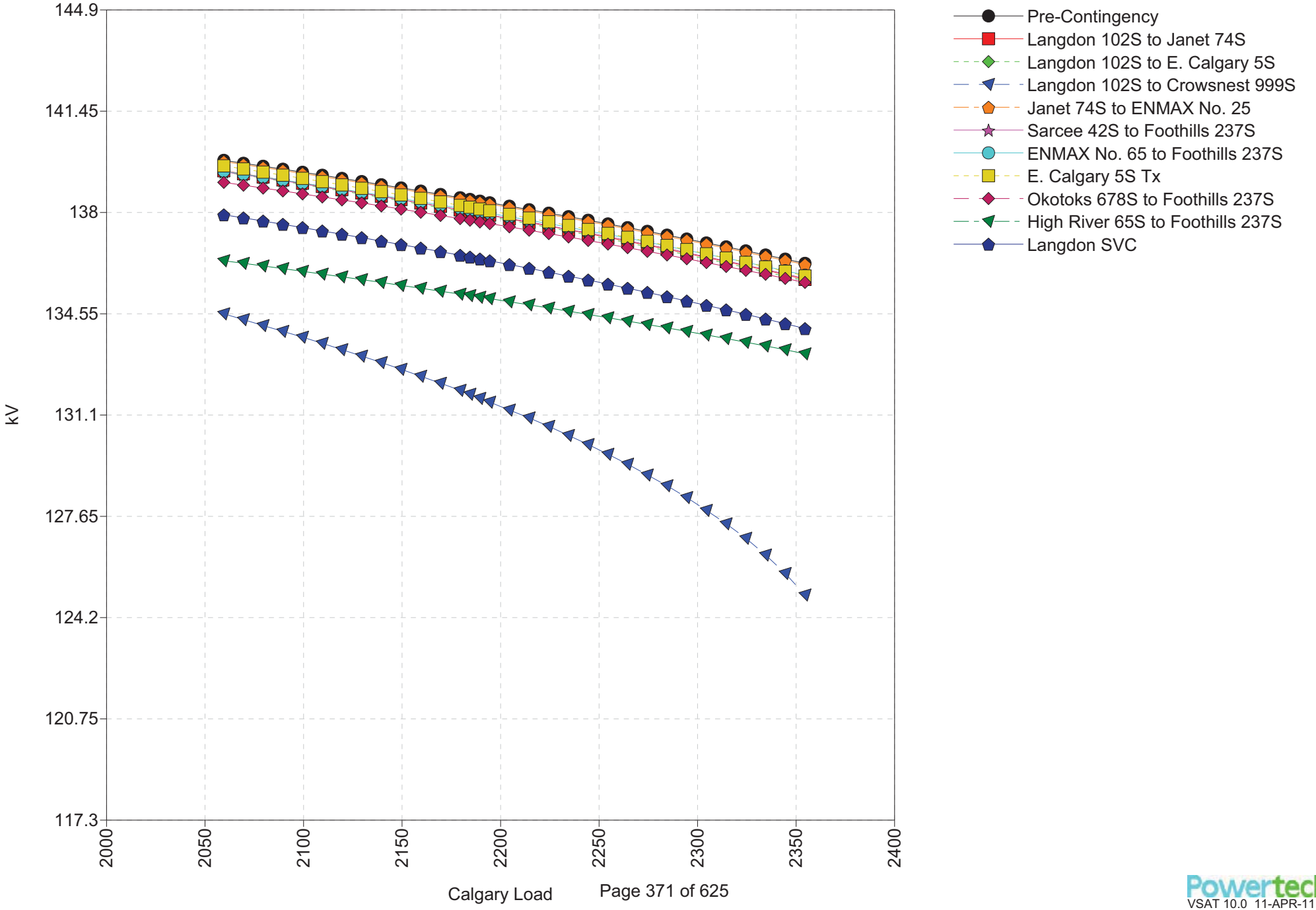
FATD 2019 SP ST4 SC3
Increase Calgary Load
138 OKOTOKS 678S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

Figure K-138-SC3-4

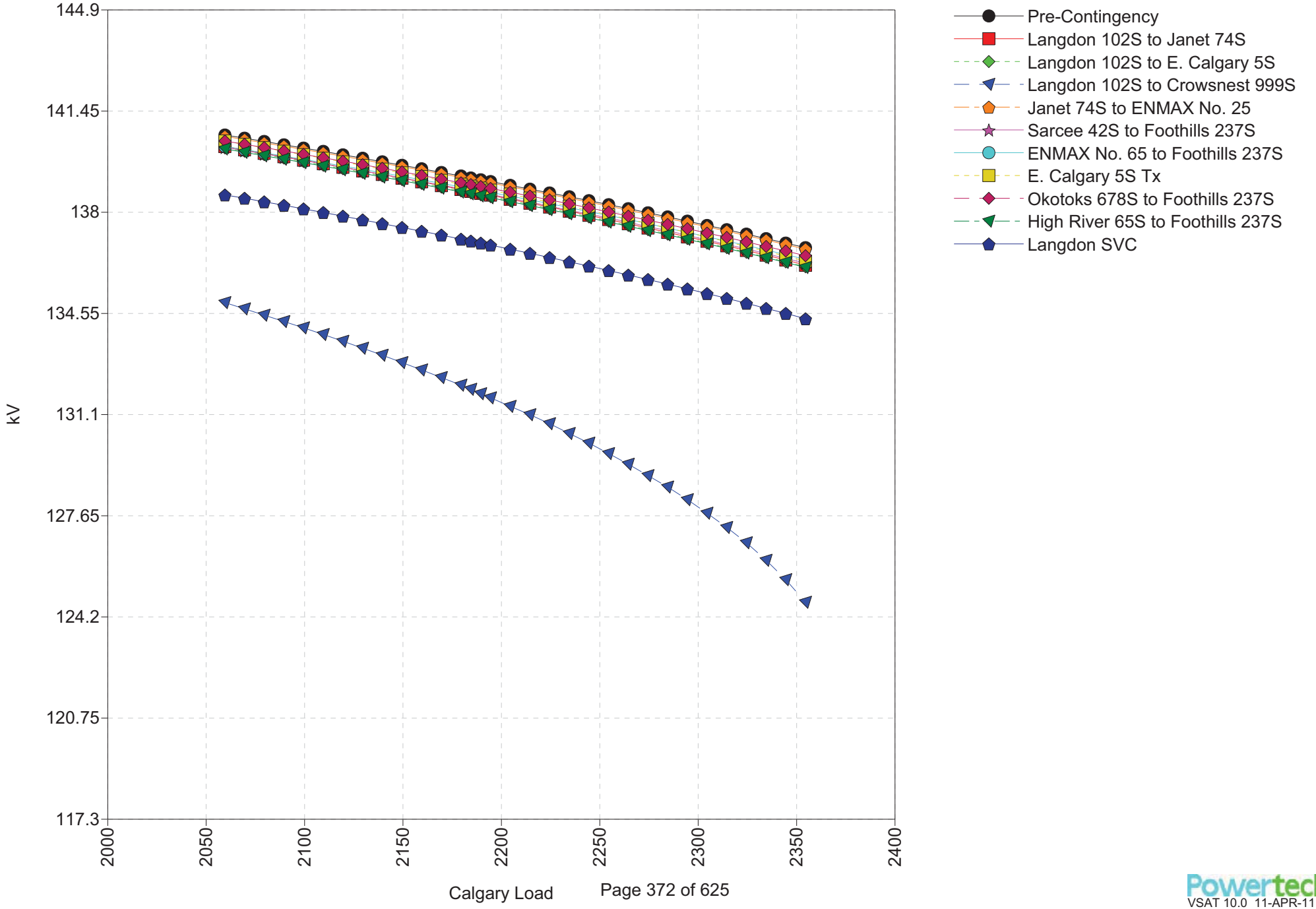
FATD 2019 SP ST4 SC3
Increase Calgary Load
138 HIGH RIVER 65S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

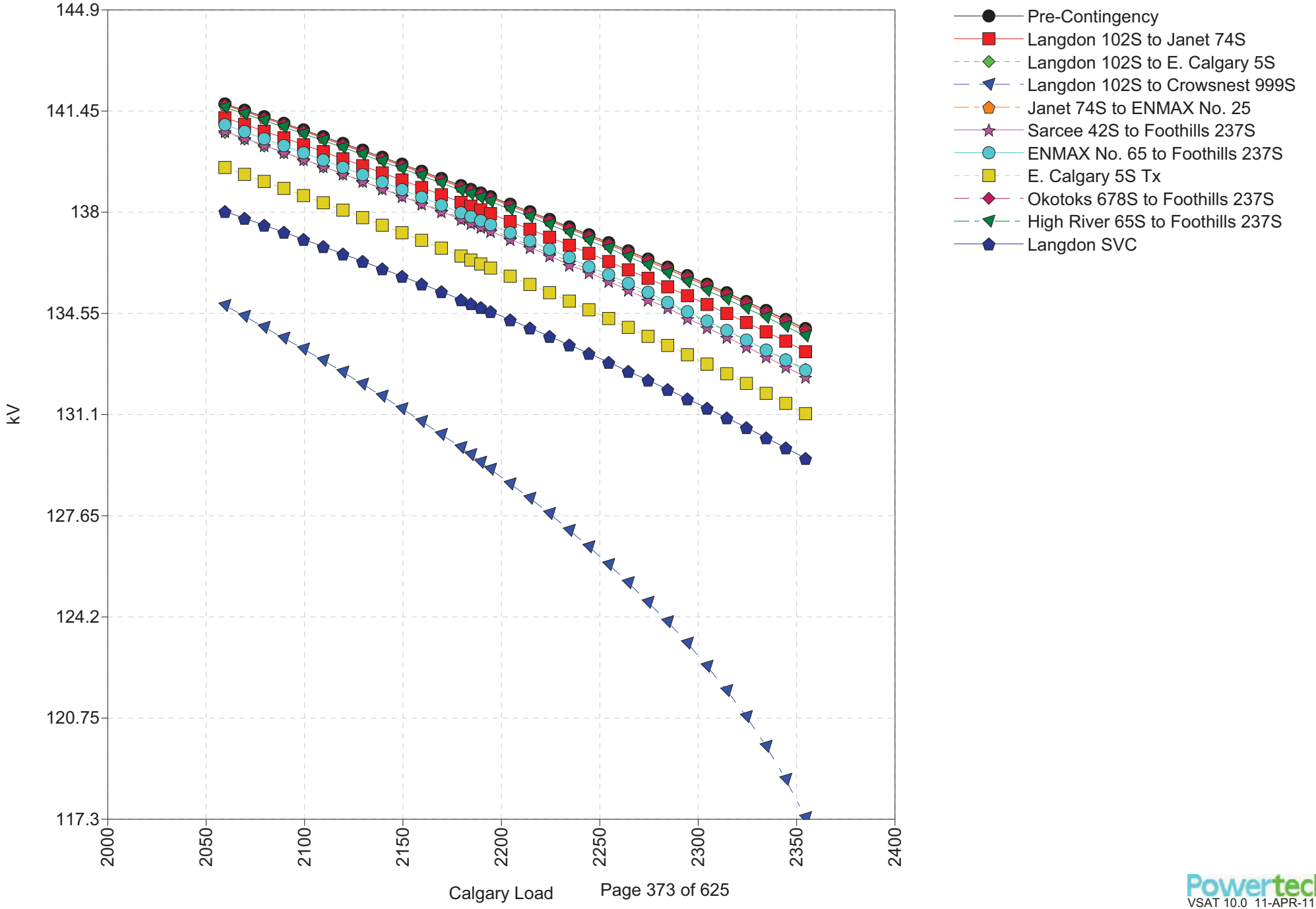
Figure K-138-SC3-5

FATD 2019 SP ST4 SC3
Increase Calgary Load
138 FOOTHILLS 237S Bus Voltage (kV)



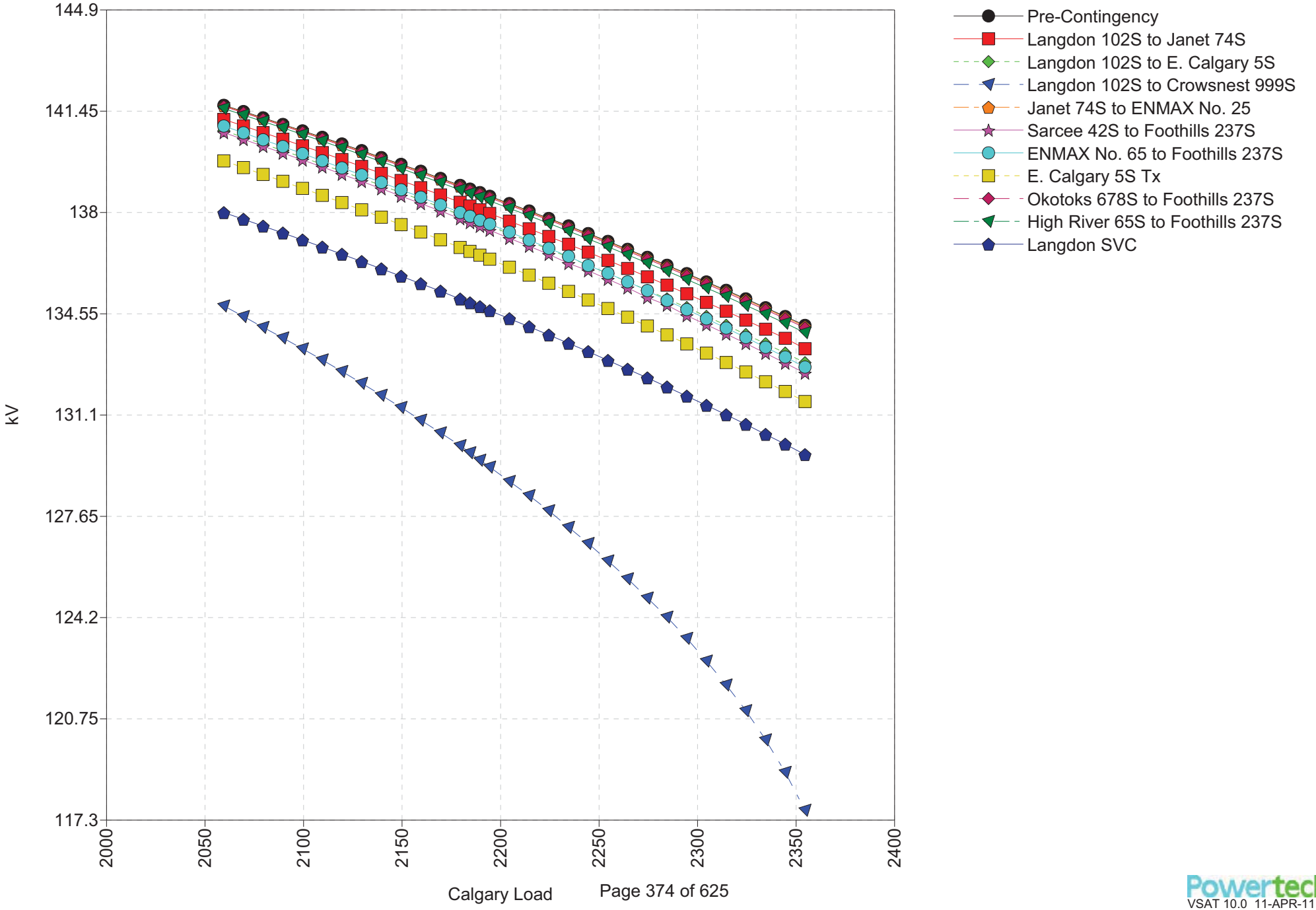
Powertech
VSAT 10.0 11-APR-11 13:07

Figure K-138-SC3-6
FATD 2019 SP ST4 SC3
Increase Calgary Load
138 ENMAX No. 2 Bus Voltage (kV)



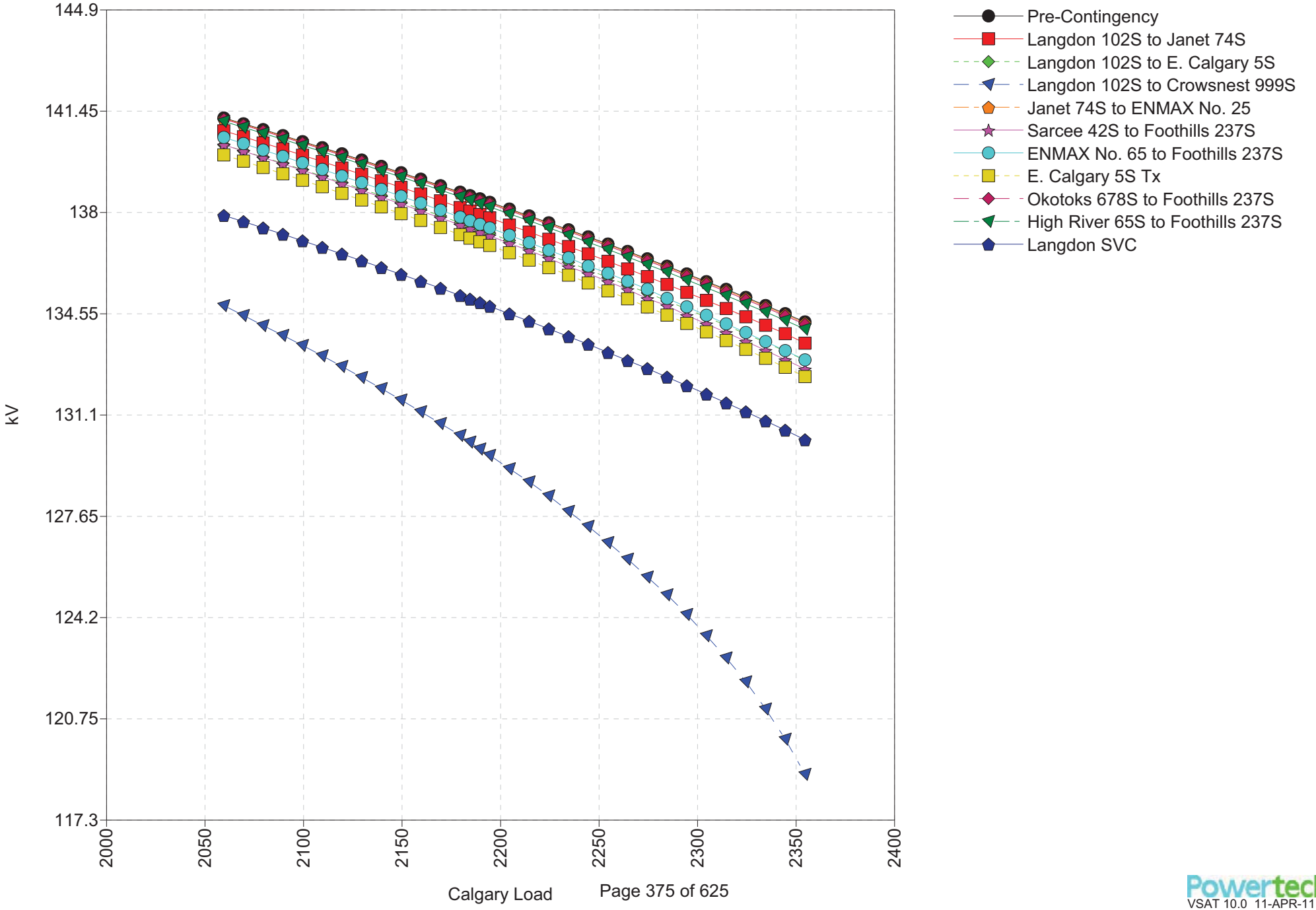
Powertech
VSAT 10.0 11-APR-11 13:07

Figure K-138-SC3-7
FATD 2019 SP ST4 SC3
Increase Calgary Load
138 ENMAX No. 23 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

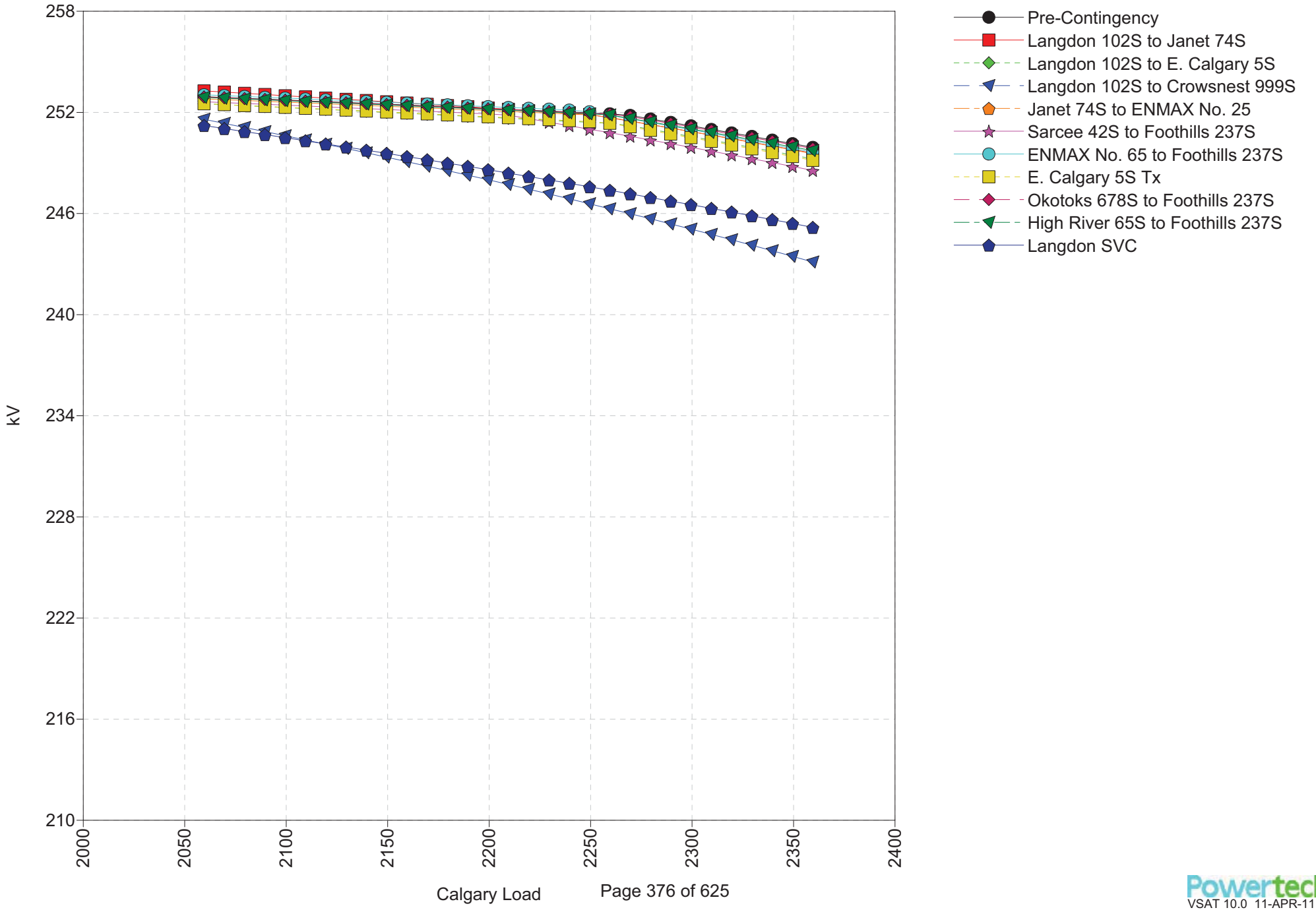
Figure K-138-SC3-8
FATD 2019 SP ST4 SC3
Increase Calgary Load
138 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:07

Figure K-240-SC4-1

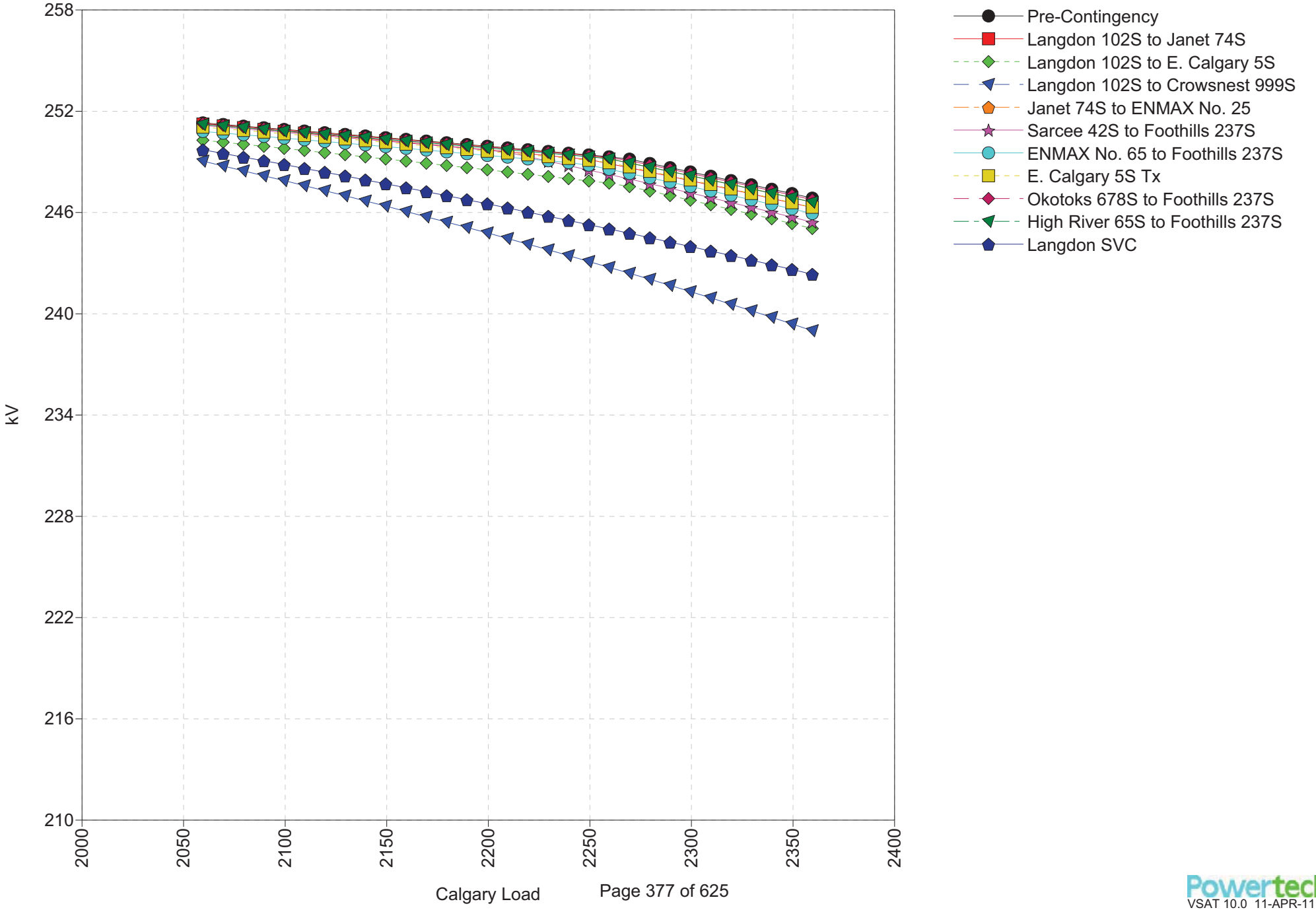
FATD 2019 SP ST4 SC4
Increase Calgary Load
240 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC4-2

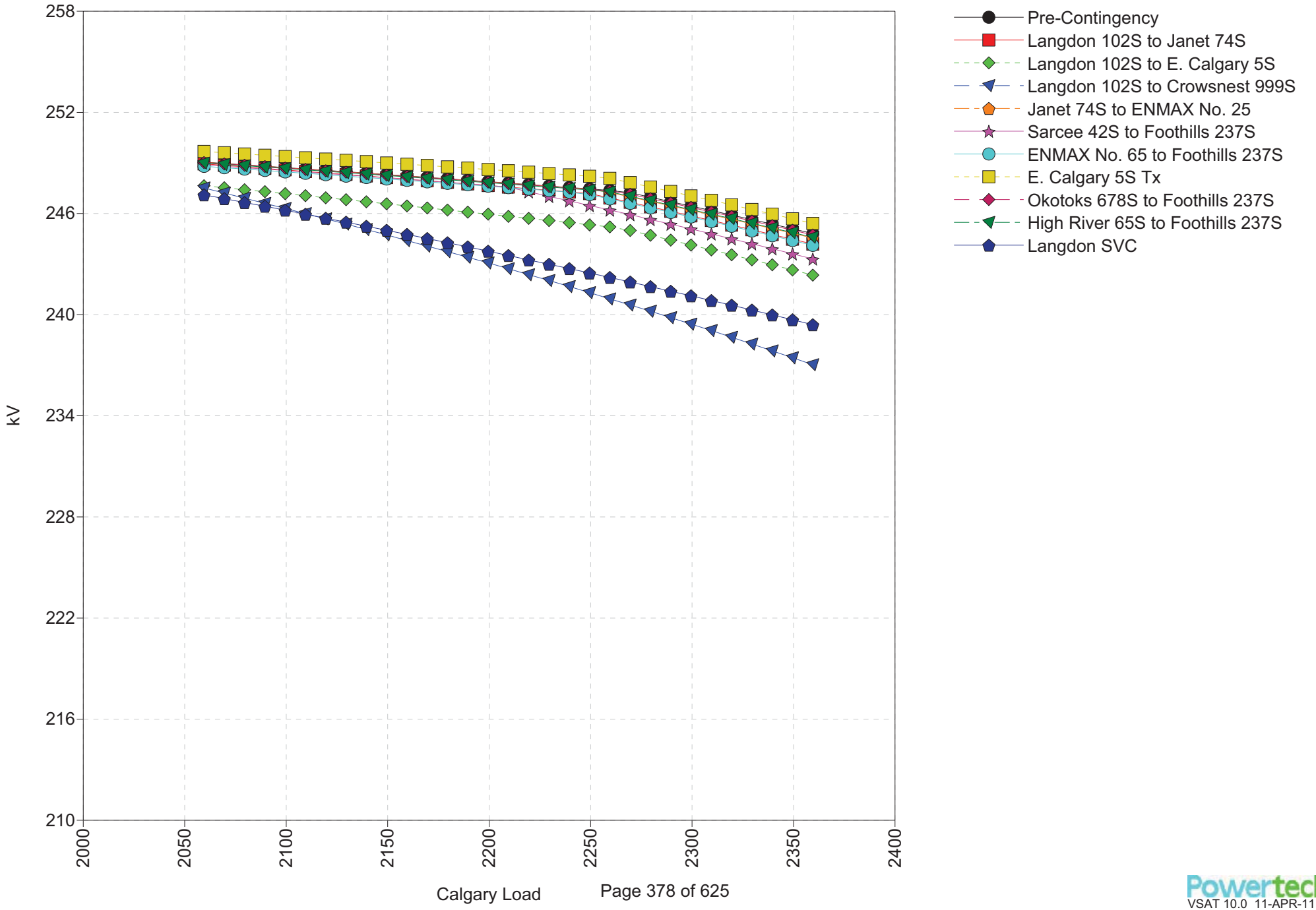
FATD 2019 SP ST4 SC4
Increase Calgary Load
240 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC4-3

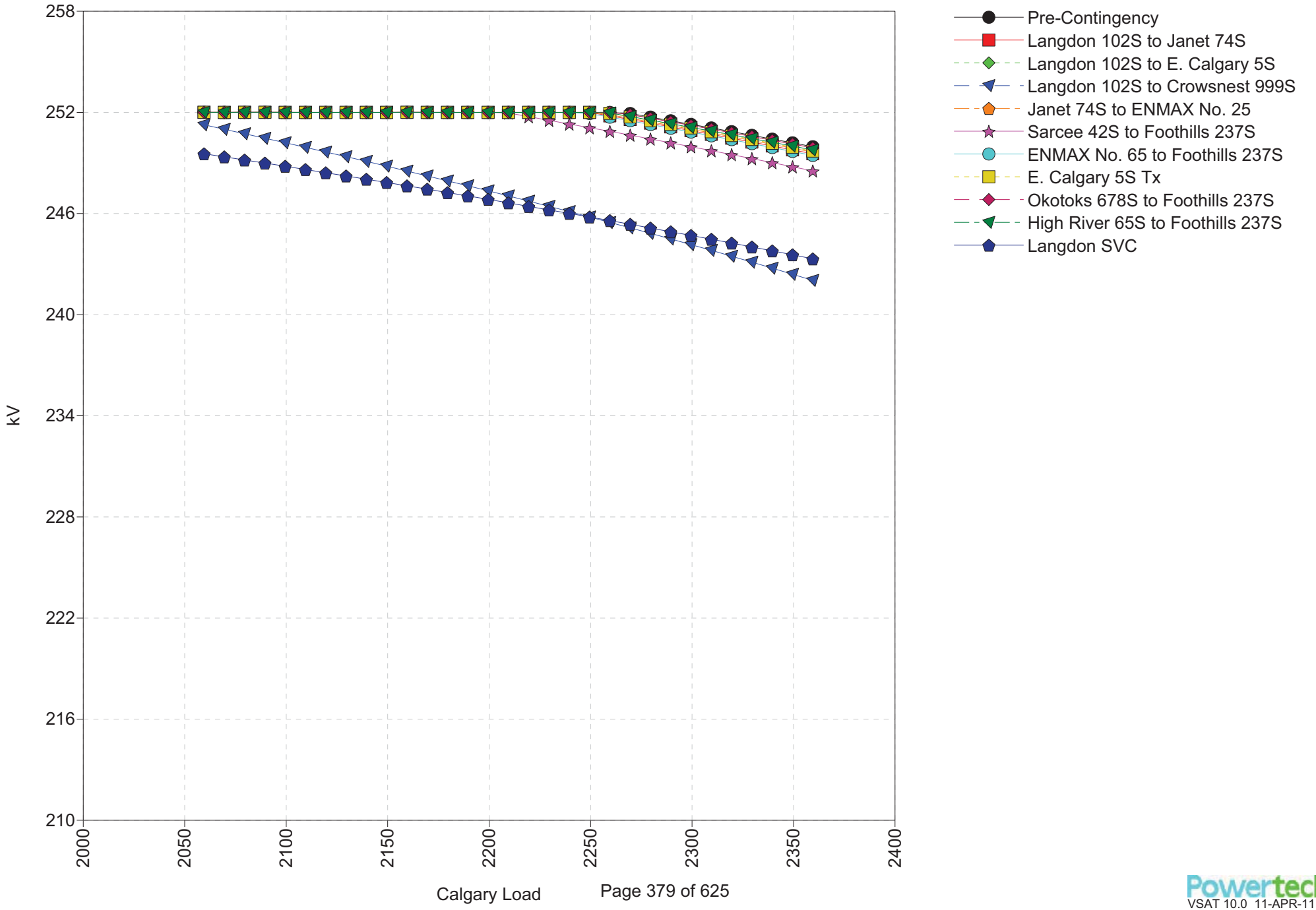
FATD 2019 SP ST4 SC4
Increase Calgary Load
240 E CALGARY 5S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC4-4

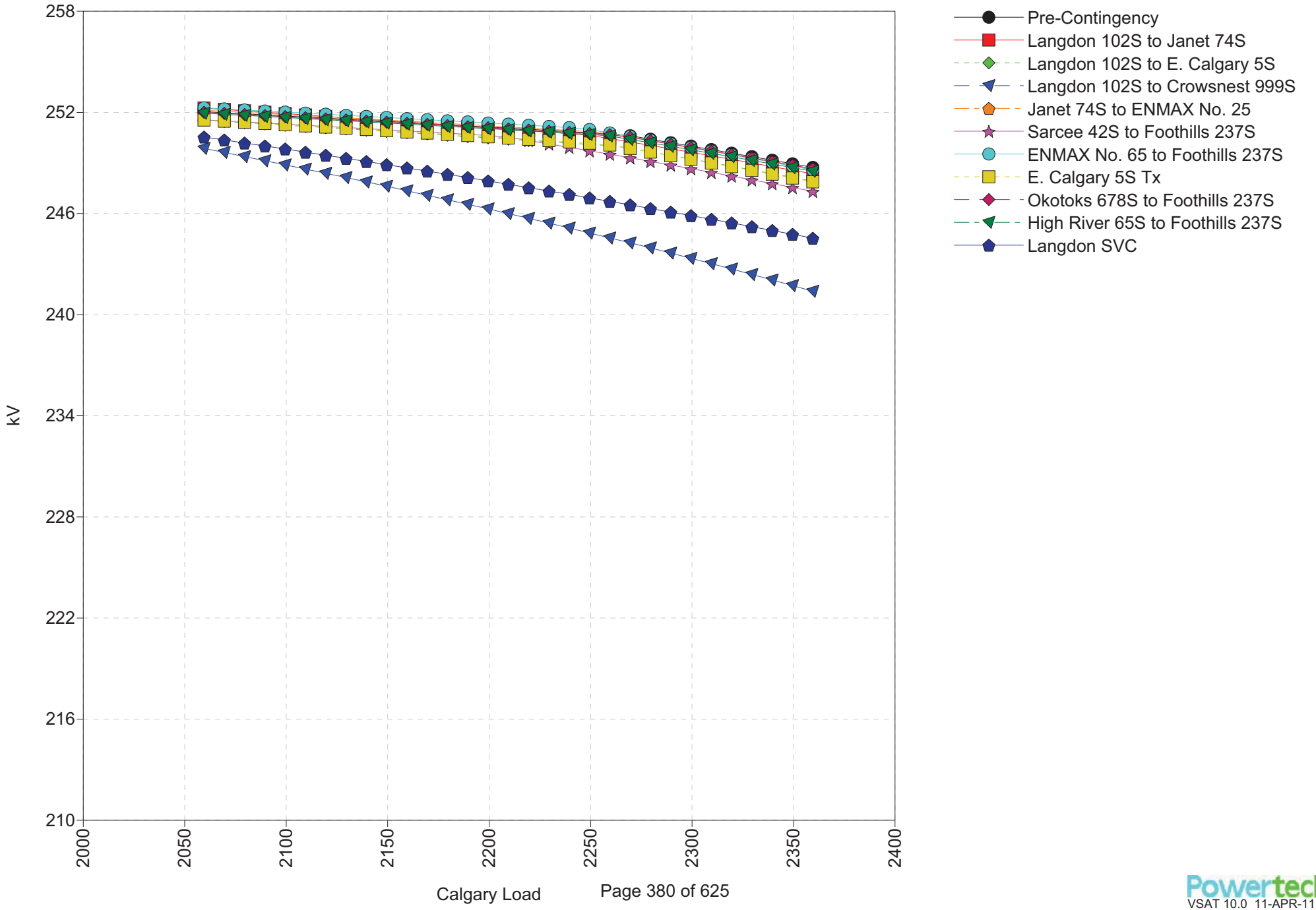
FATD 2019 SP ST4 SC4
Increase Calgary Load
240 LANGDON 102S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC4-5

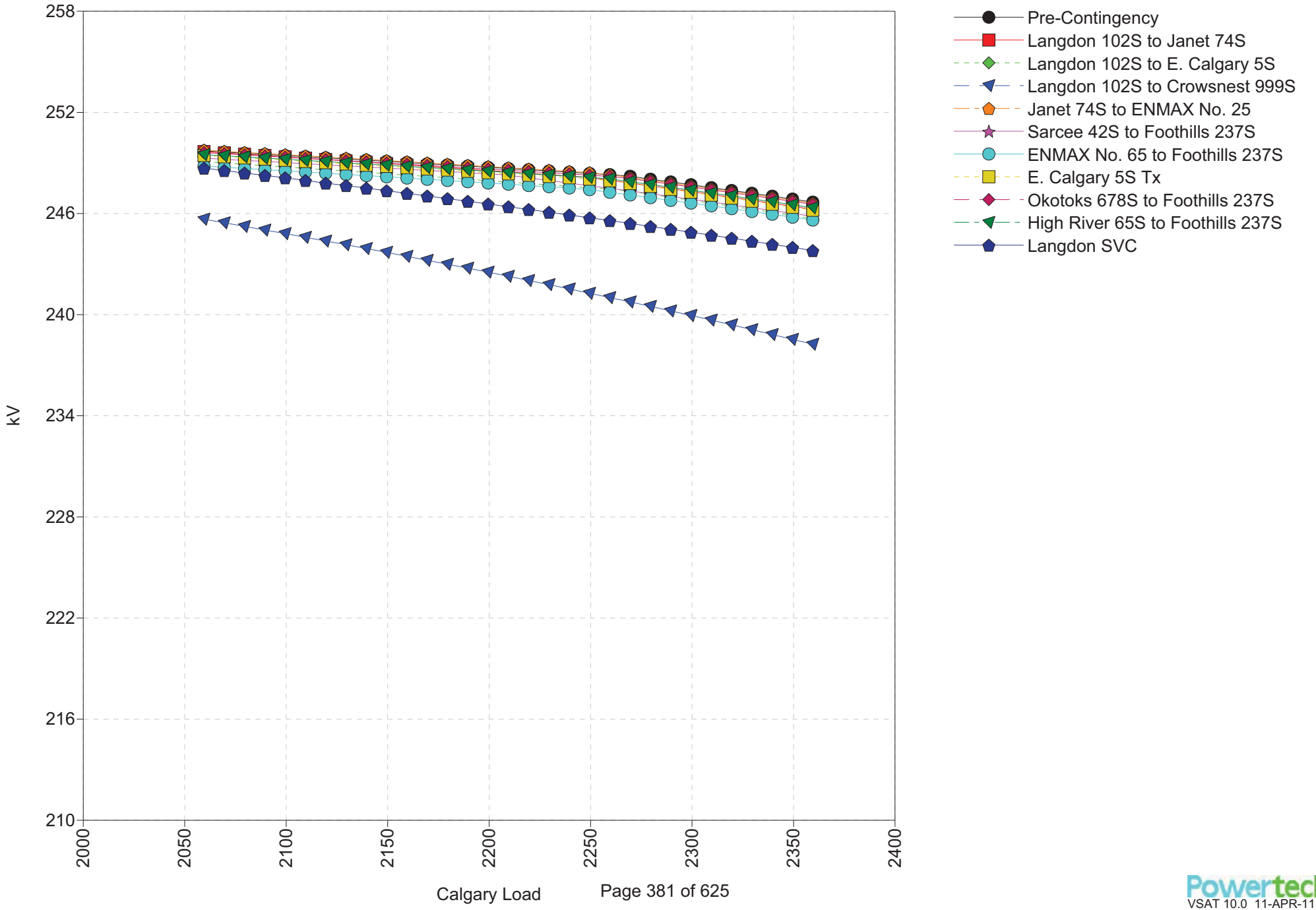
FATD 2019 SP ST4 SC4
Increase Calgary Load
240 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC4-6

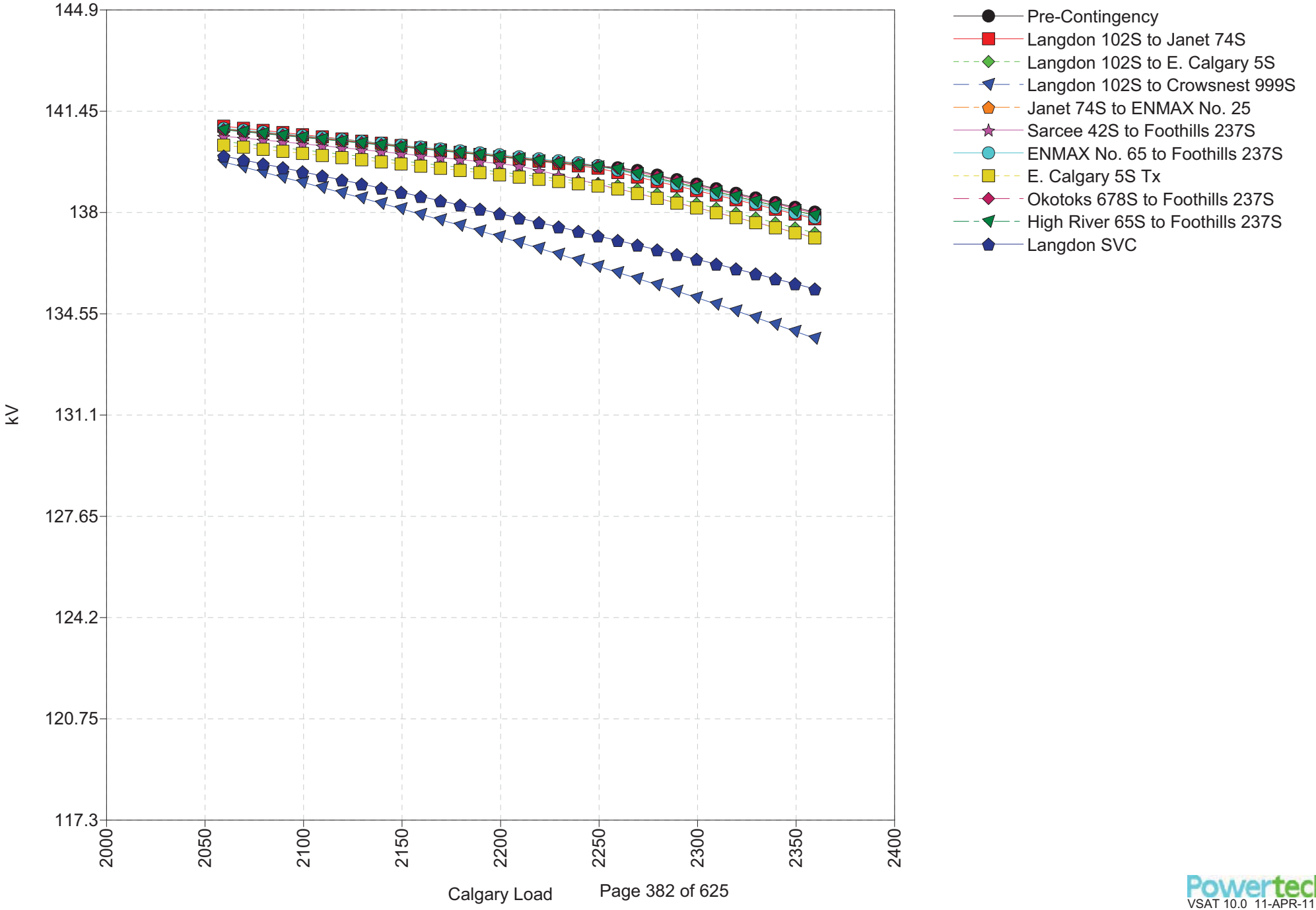
FATD 2019 SP ST4 SC4
Increase Calgary Load
240 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC4-1

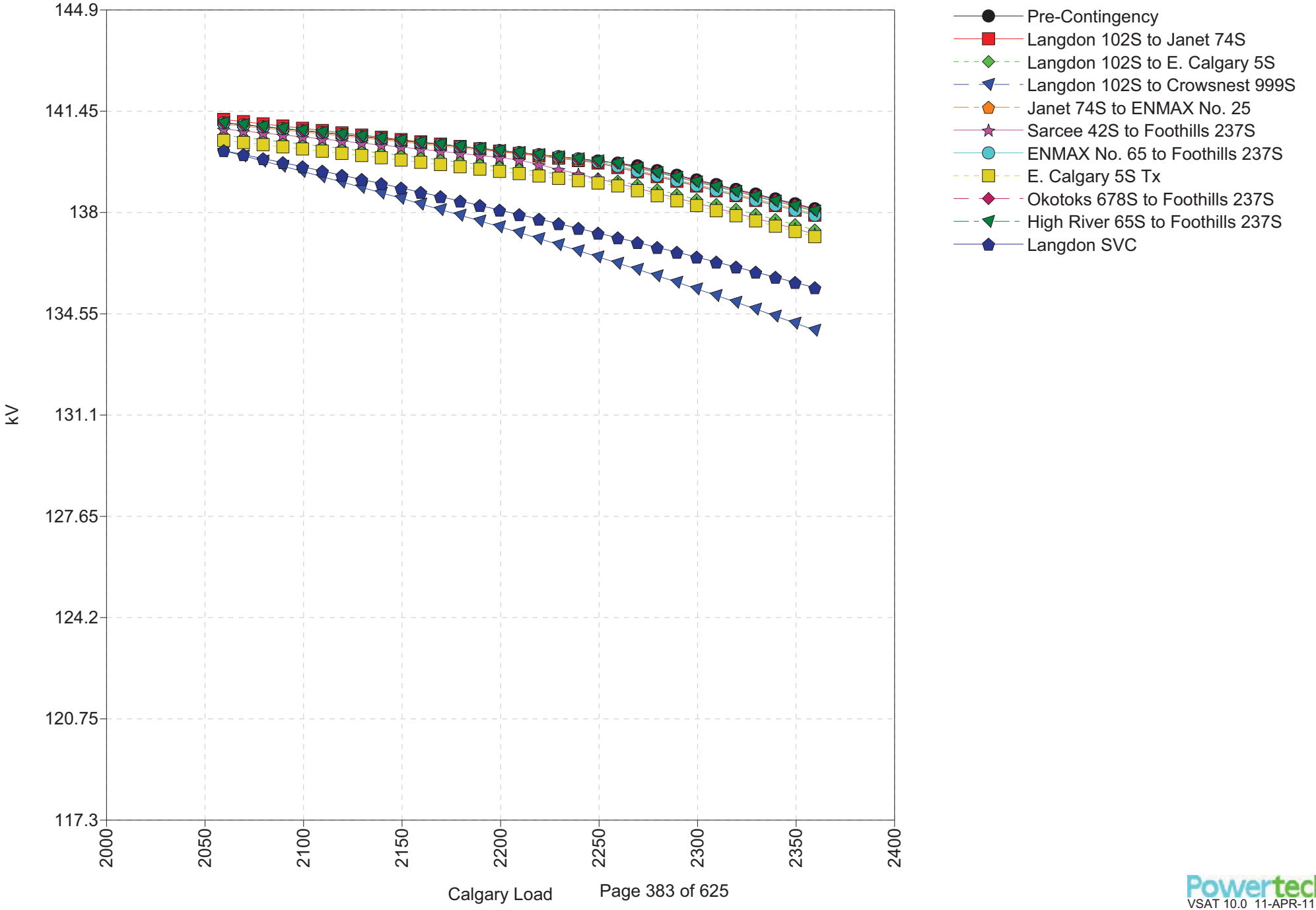
FATD 2019 SP ST4 SC4
Increase Calgary Load
138 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC4-2

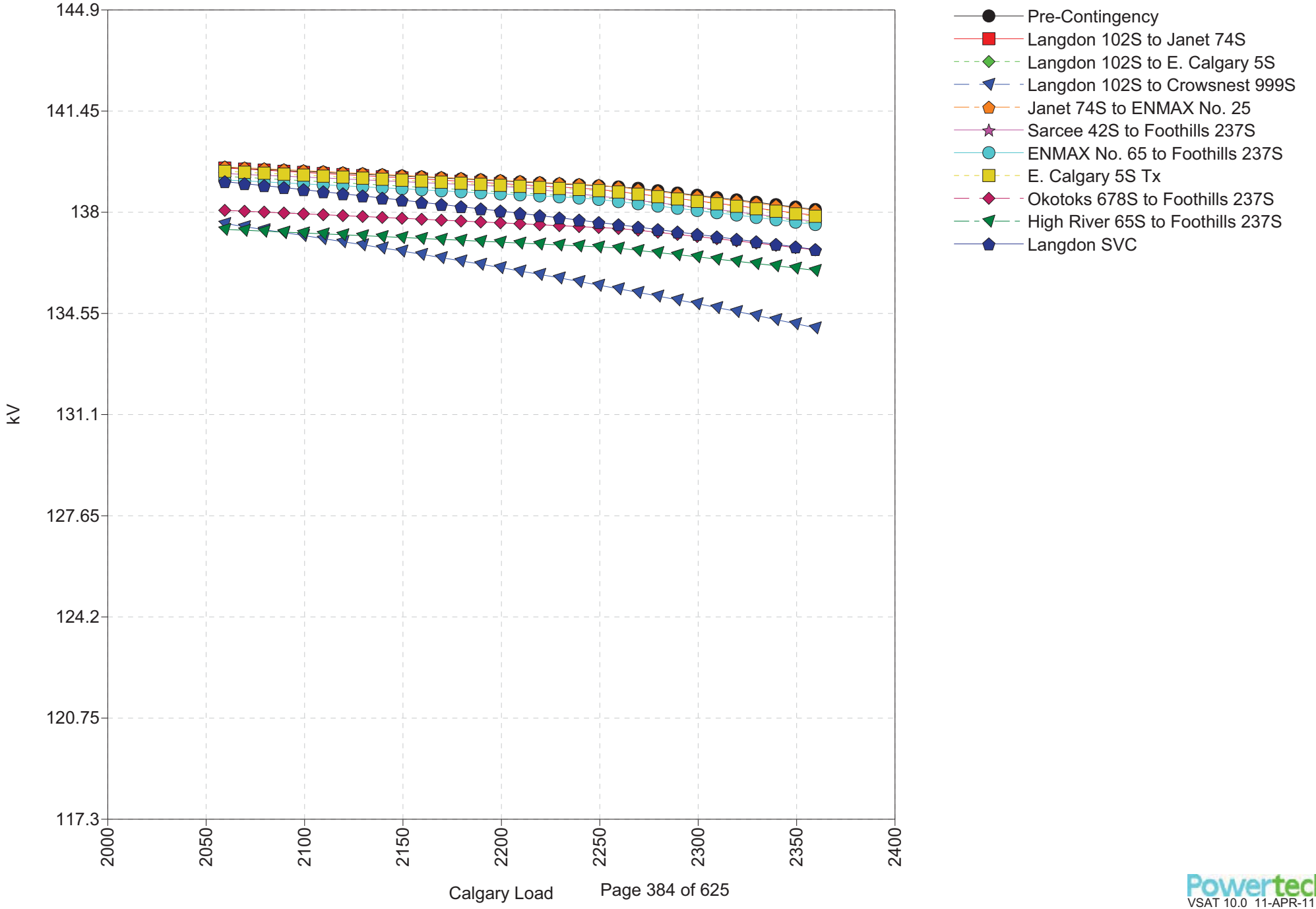
FATD 2019 SP ST4 SC4
Increase Calgary Load
138 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC4-3

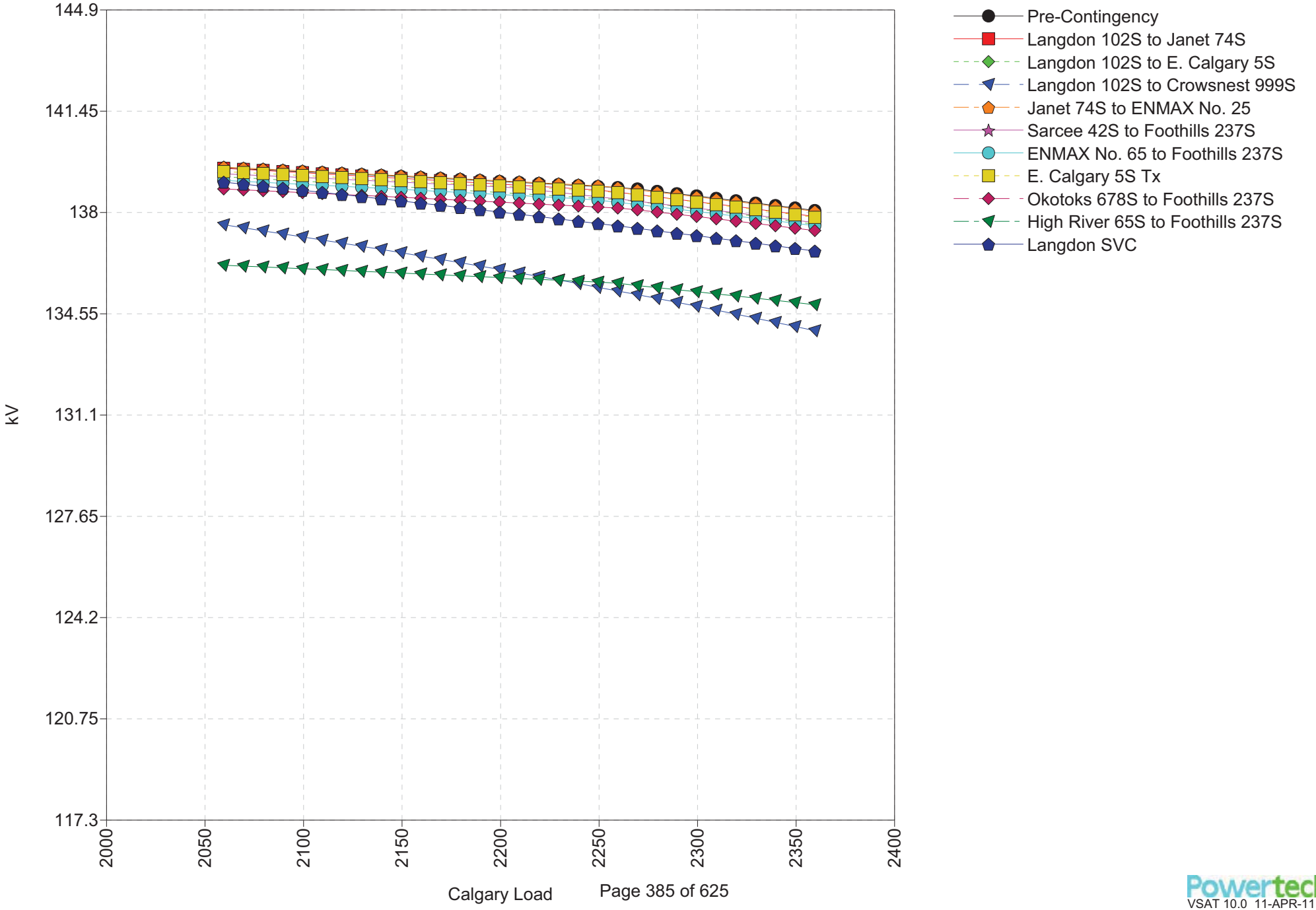
FATD 2019 SP ST4 SC4
Increase Calgary Load
138 OKOTOKS 678S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC4-4

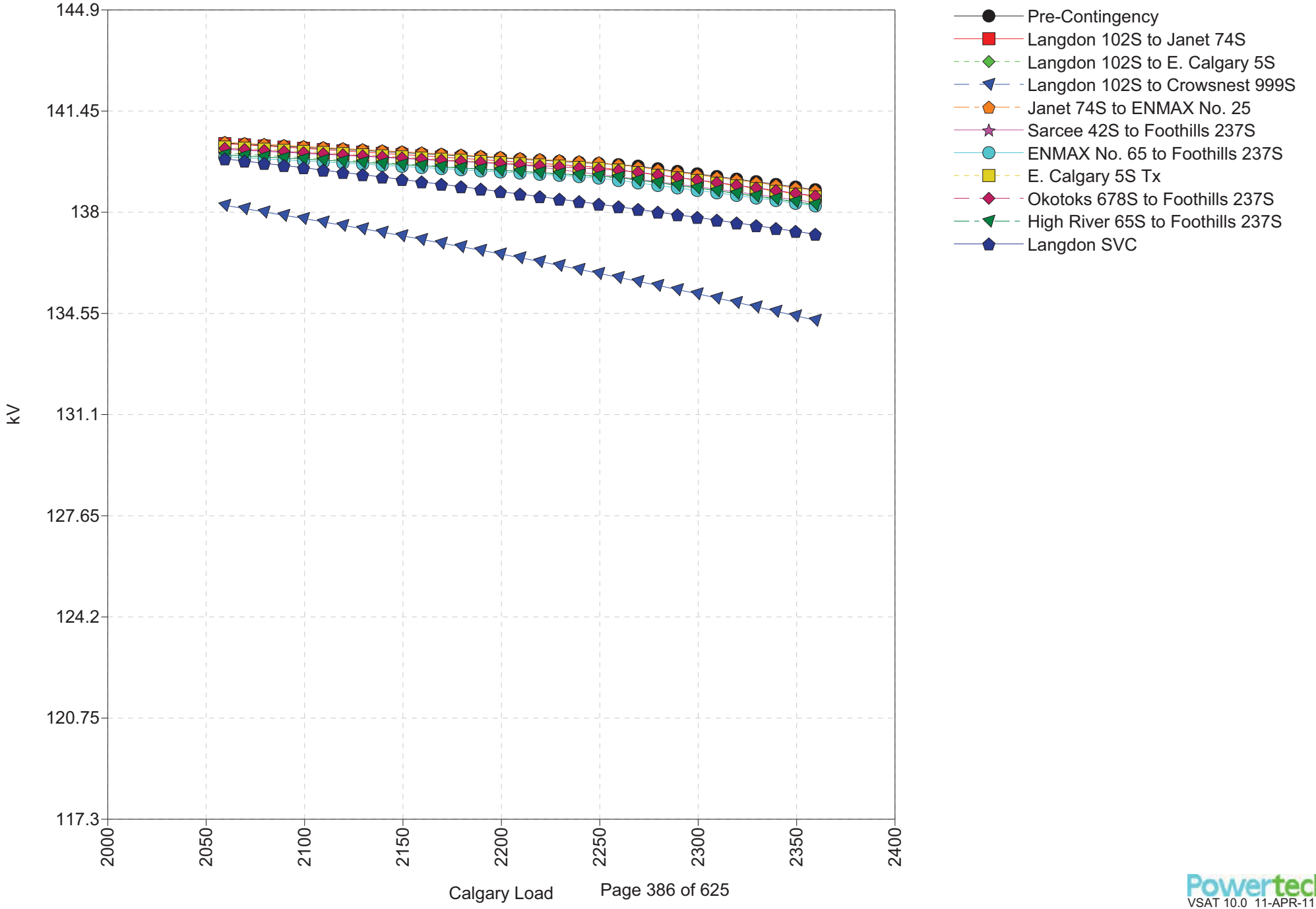
FATD 2019 SP ST4 SC4
Increase Calgary Load
138 HIGH RIVER 65S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC4-5

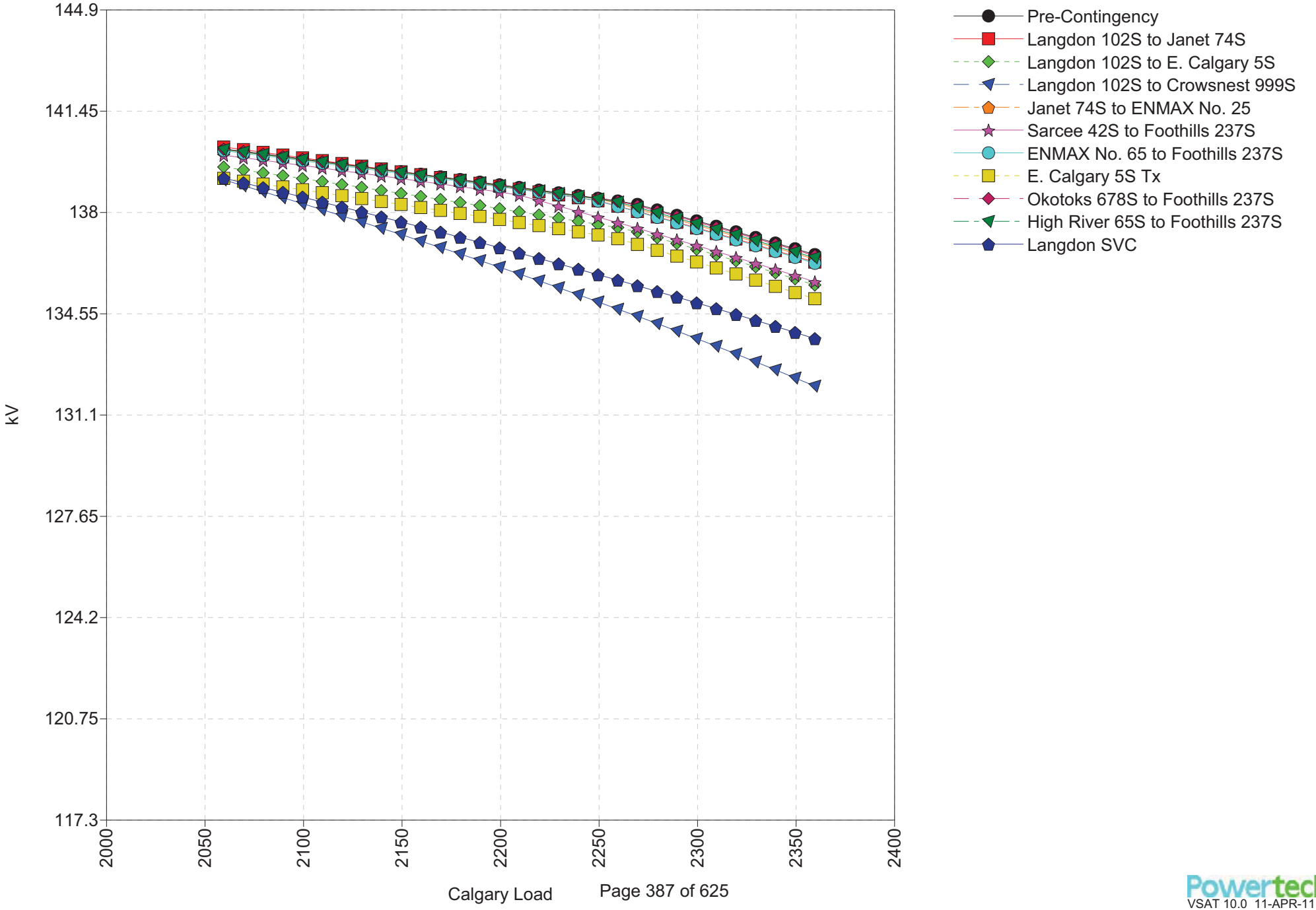
FATD 2019 SP ST4 SC4
Increase Calgary Load
138 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC4-6

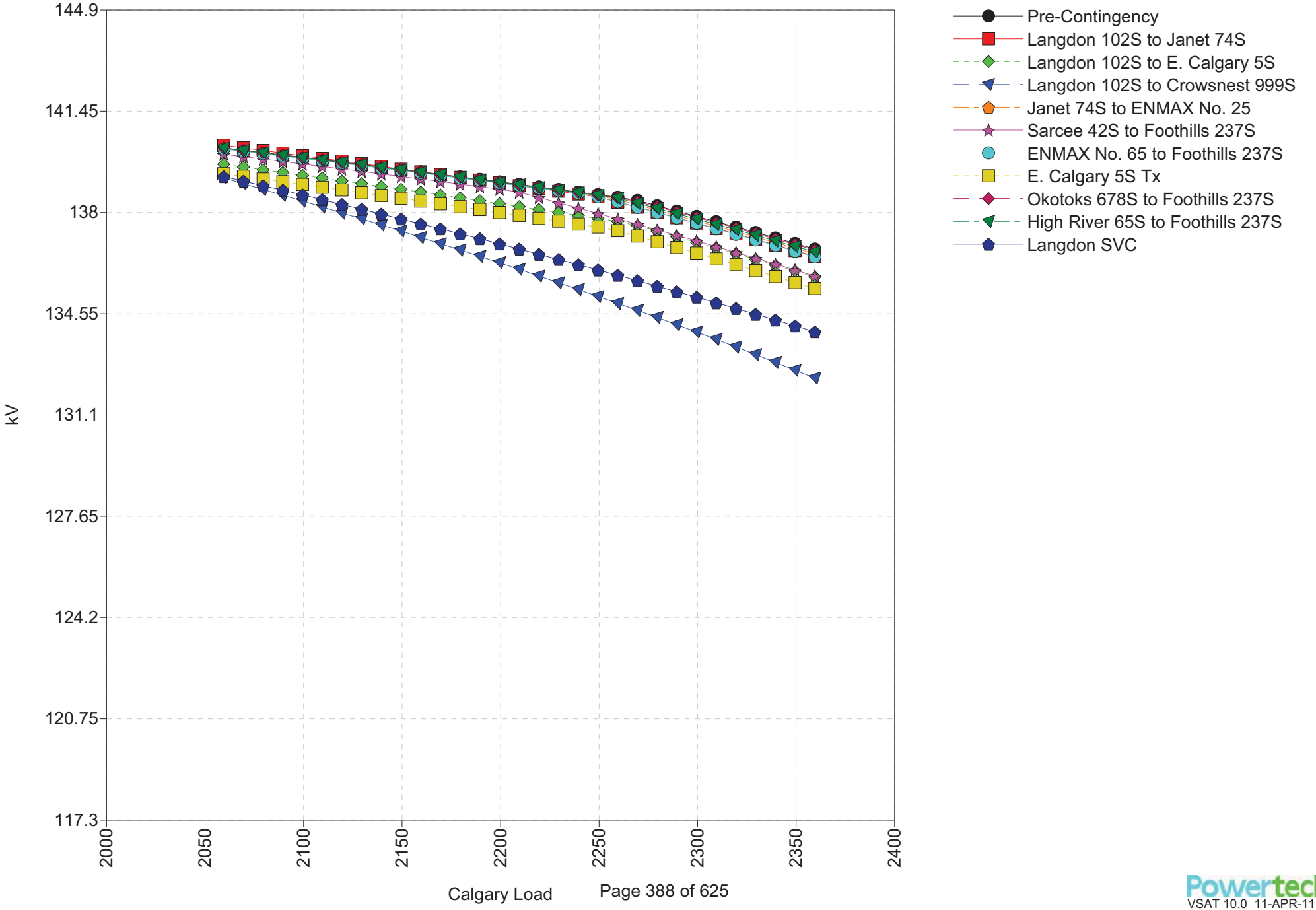
FATD 2019 SP ST4 SC4
Increase Calgary Load
138 ENMAX No. 2 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC4-7

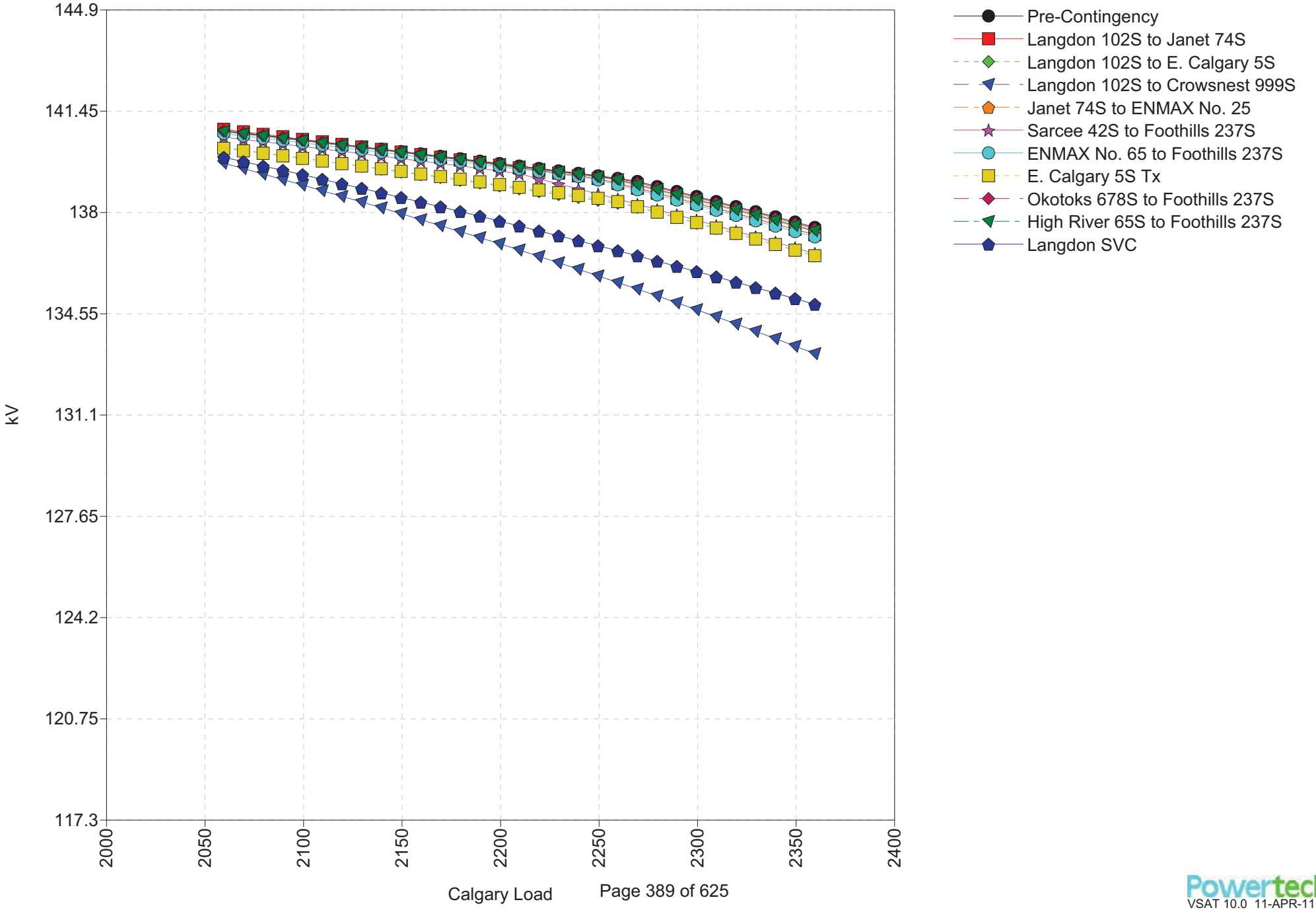
FATD 2019 SP ST4 SC4
Increase Calgary Load
138 ENMAX No. 23 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC4-8

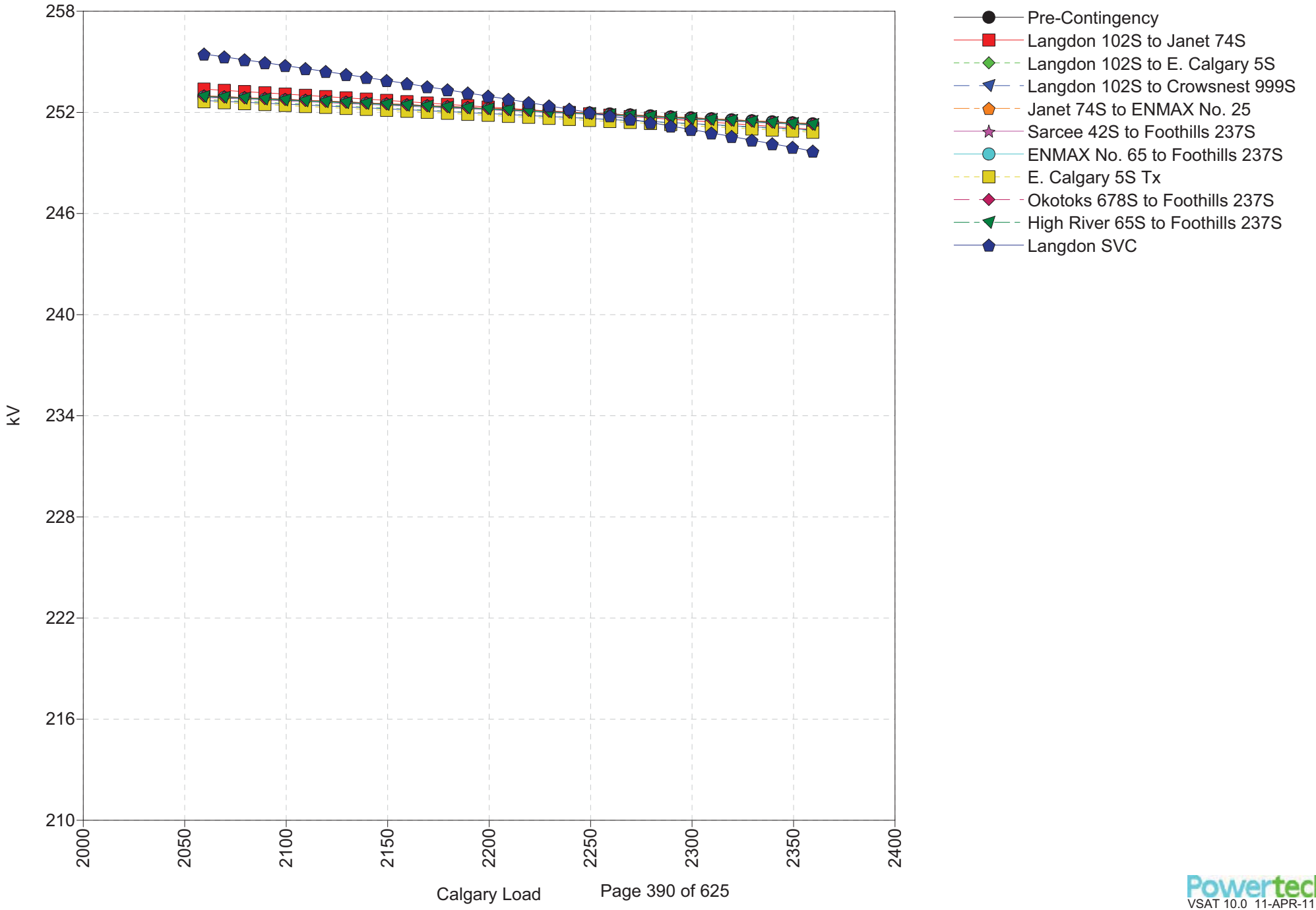
FATD 2019 SP ST4 SC4
Increase Calgary Load
138 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC5-1

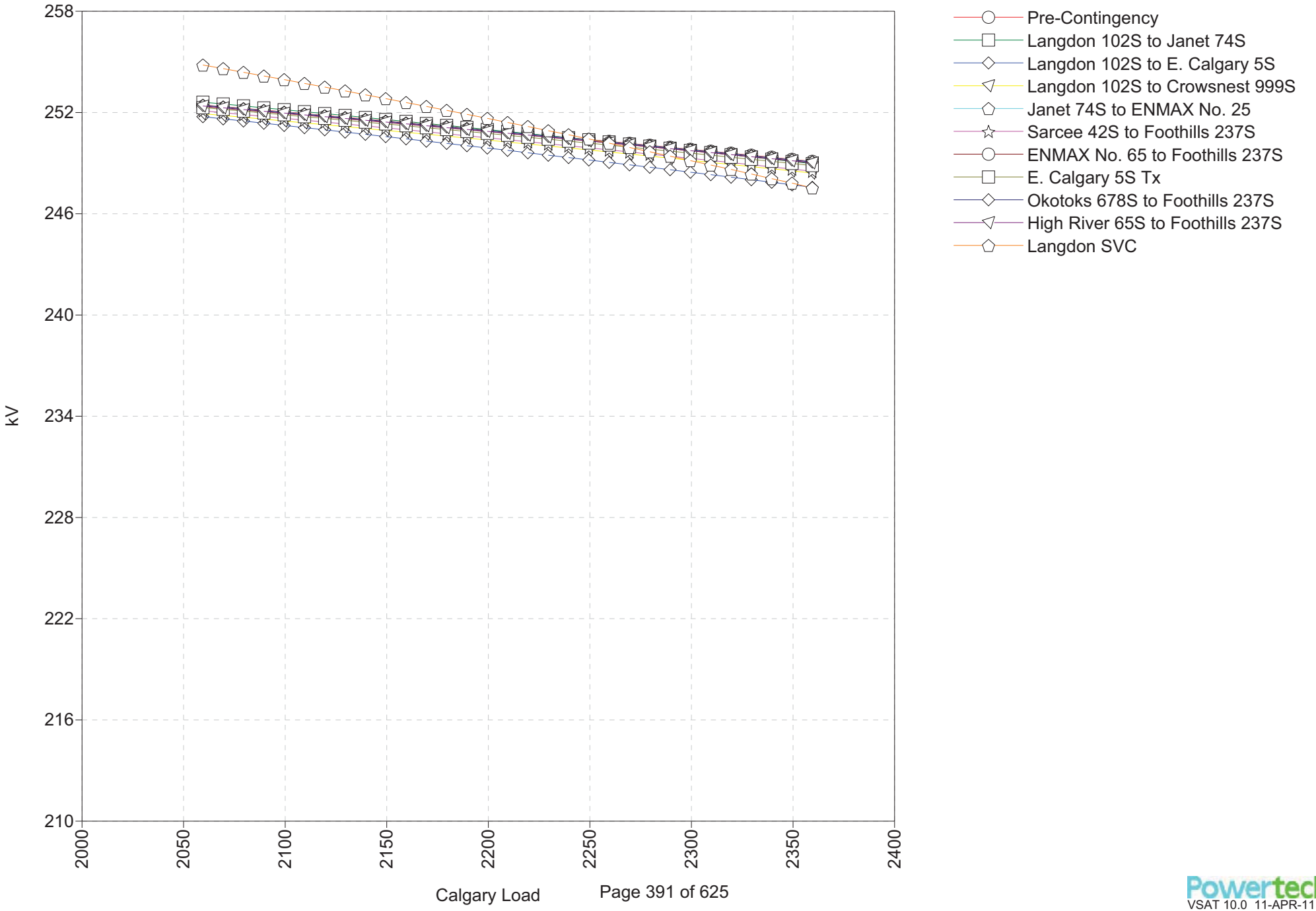
FATD 2019 SP ST4 SC5
Increase Calgary Load
240 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC5-2

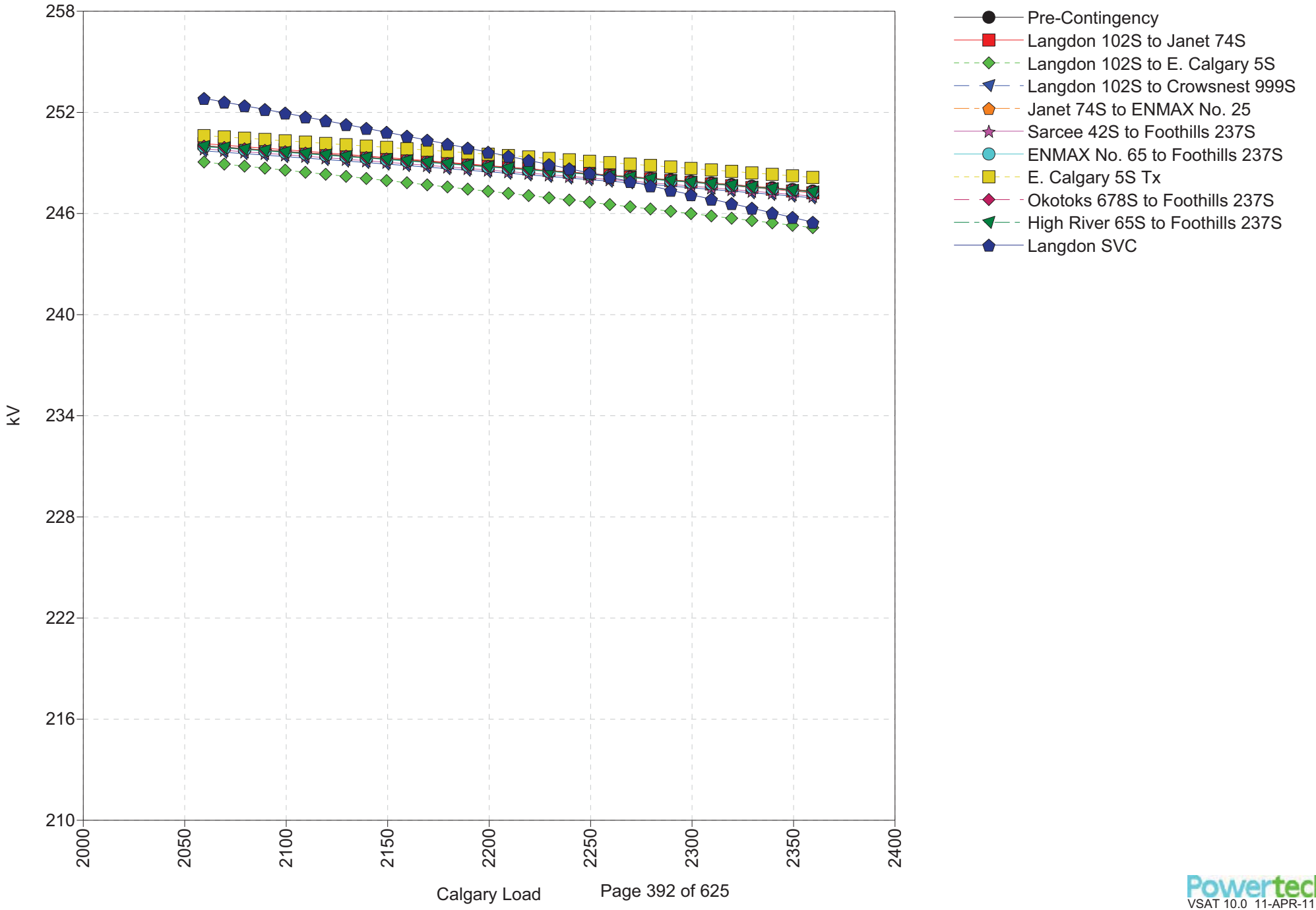
FATD 2019 SP ST4 SC5
Increase Calgary Load
240 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC5-3

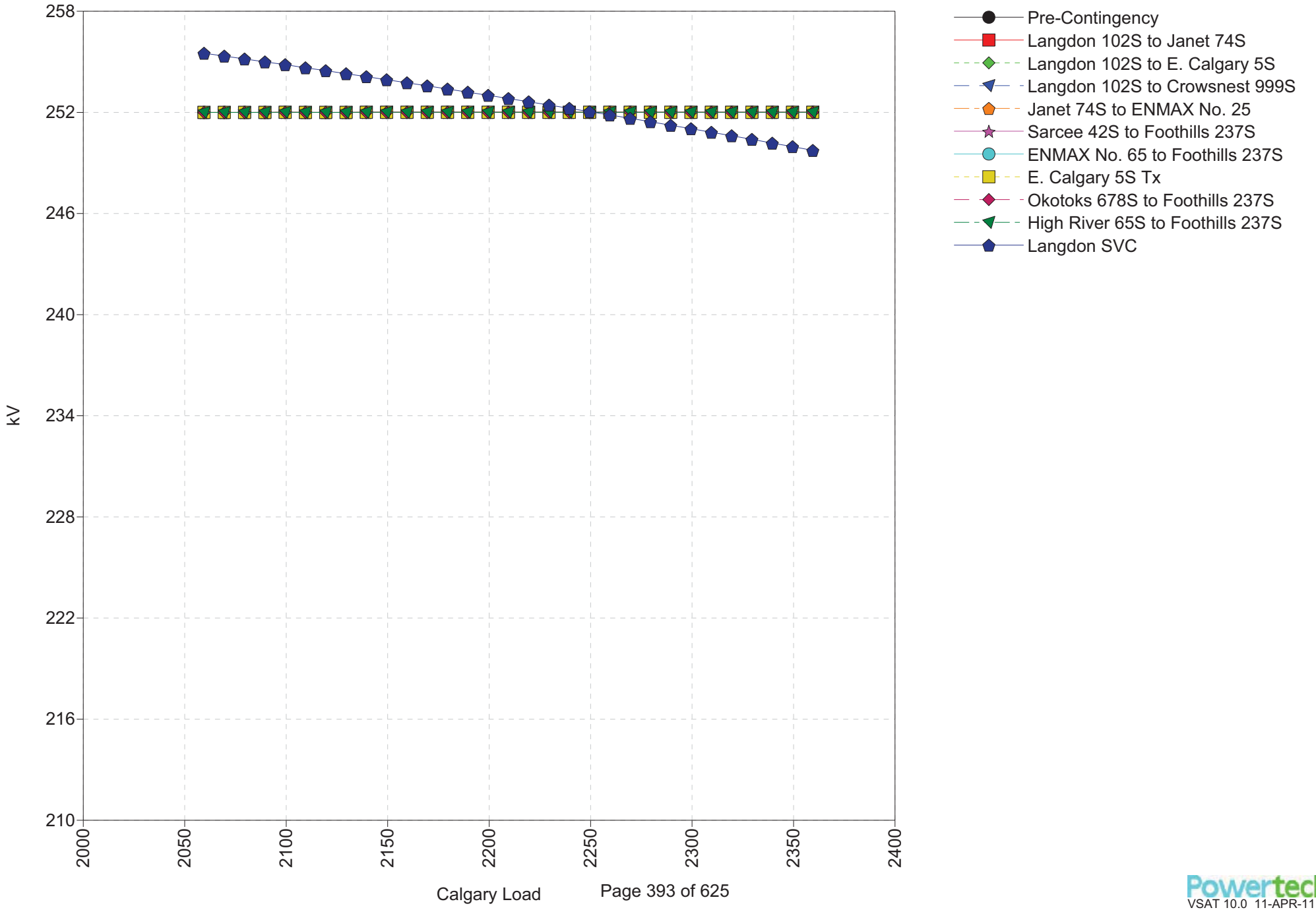
FATD 2019 SP ST4 SC5
Increase Calgary Load
240 E CALGARY 5S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC5-4

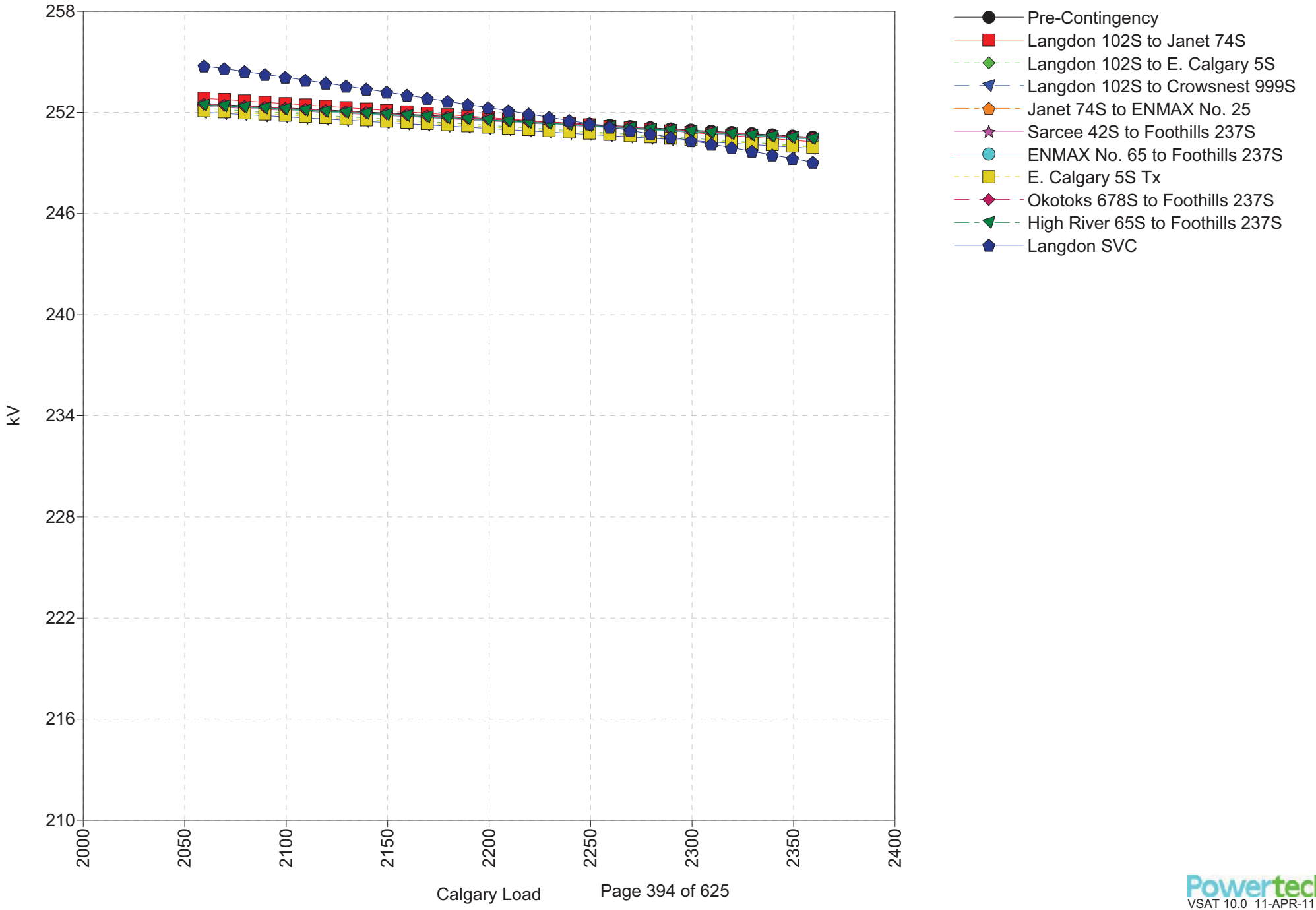
FATD 2019 SP ST4 SC5
Increase Calgary Load
240 LANGDON 102S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC5-5

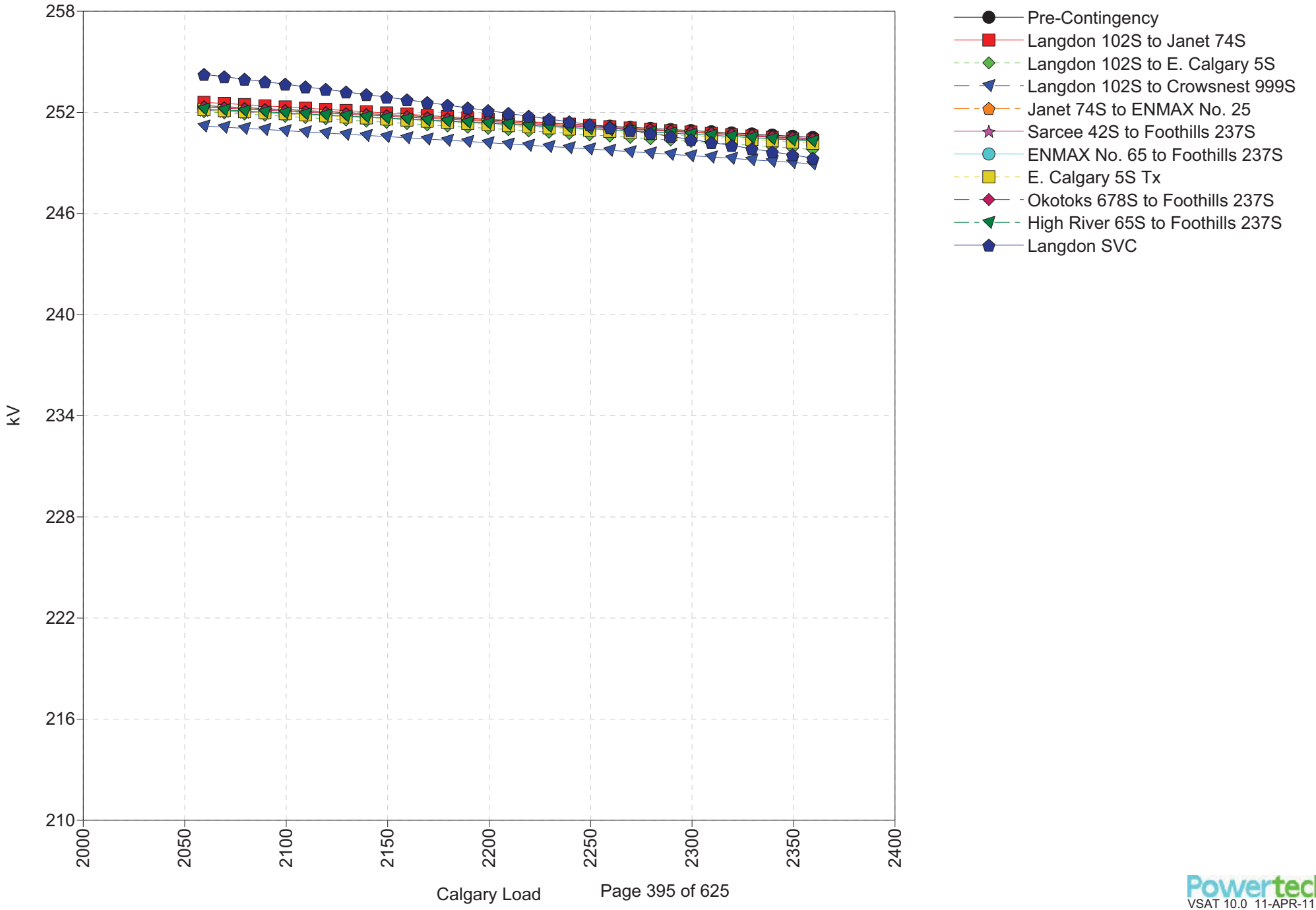
FATD 2019 SP ST4 SC5
Increase Calgary Load
240 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC5-6

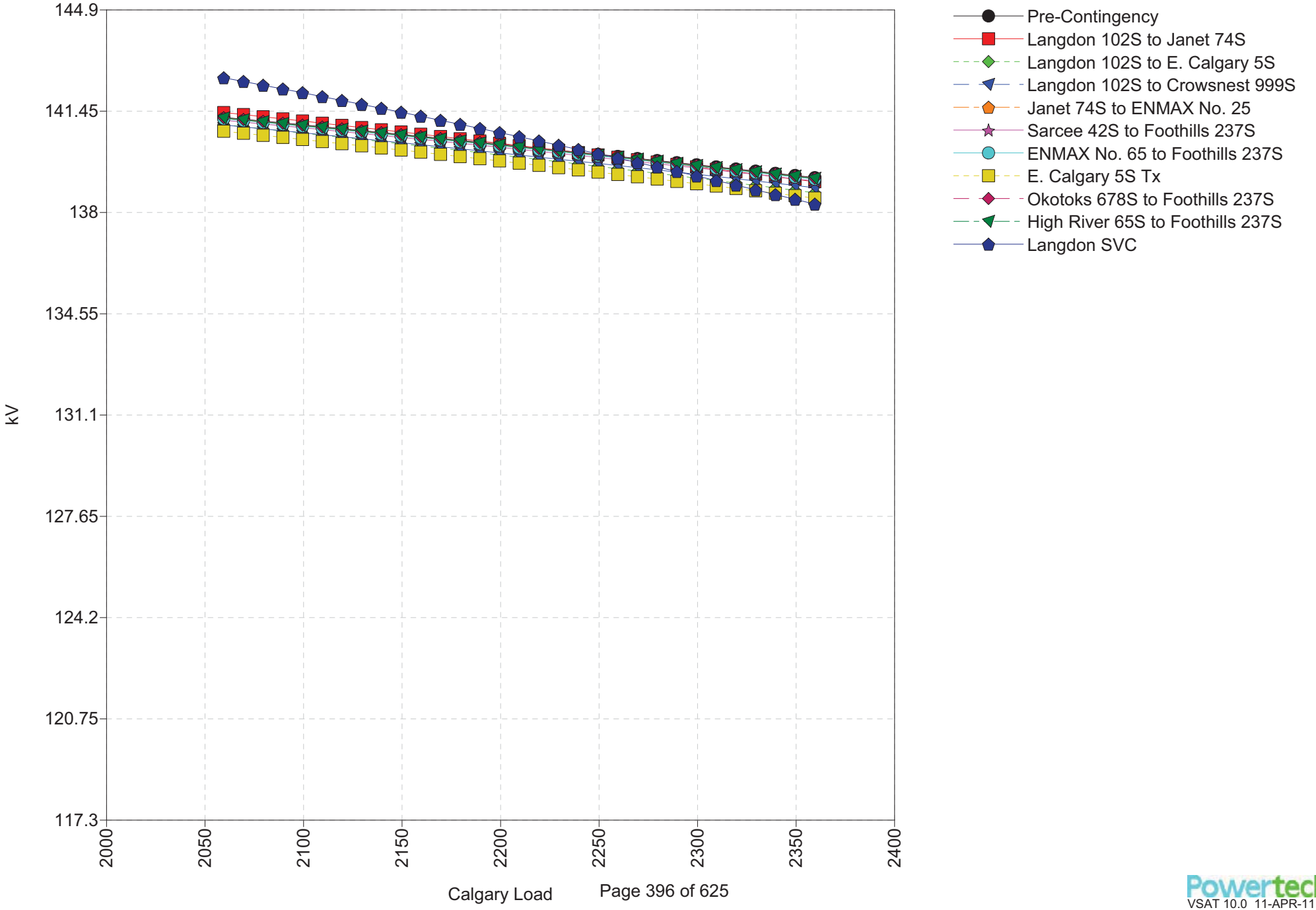
FATD 2019 SP ST4 SC5
Increase Calgary Load
240 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC5-1

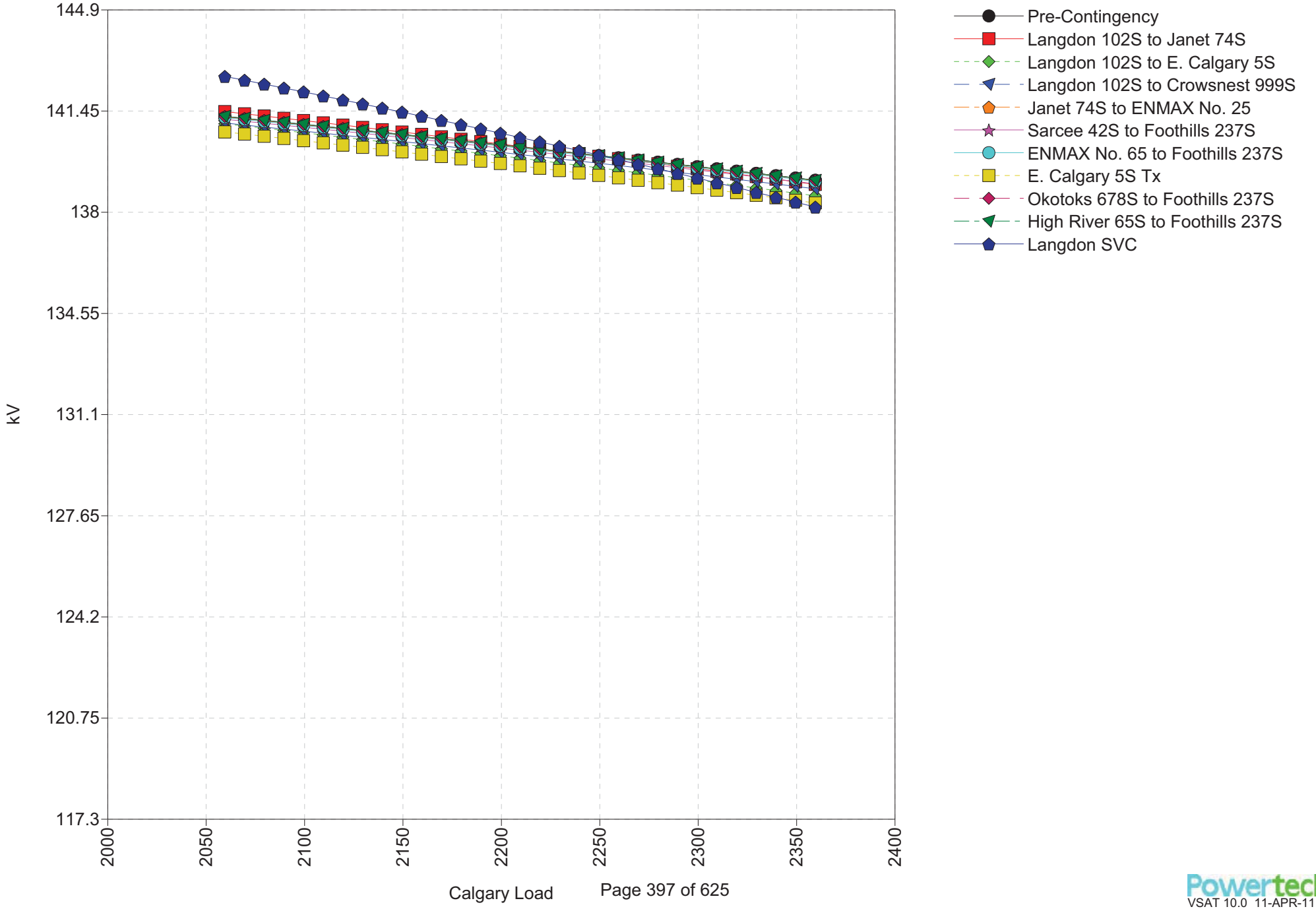
FATD 2019 SP ST4 SC5
Increase Calgary Load
138 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC5-2

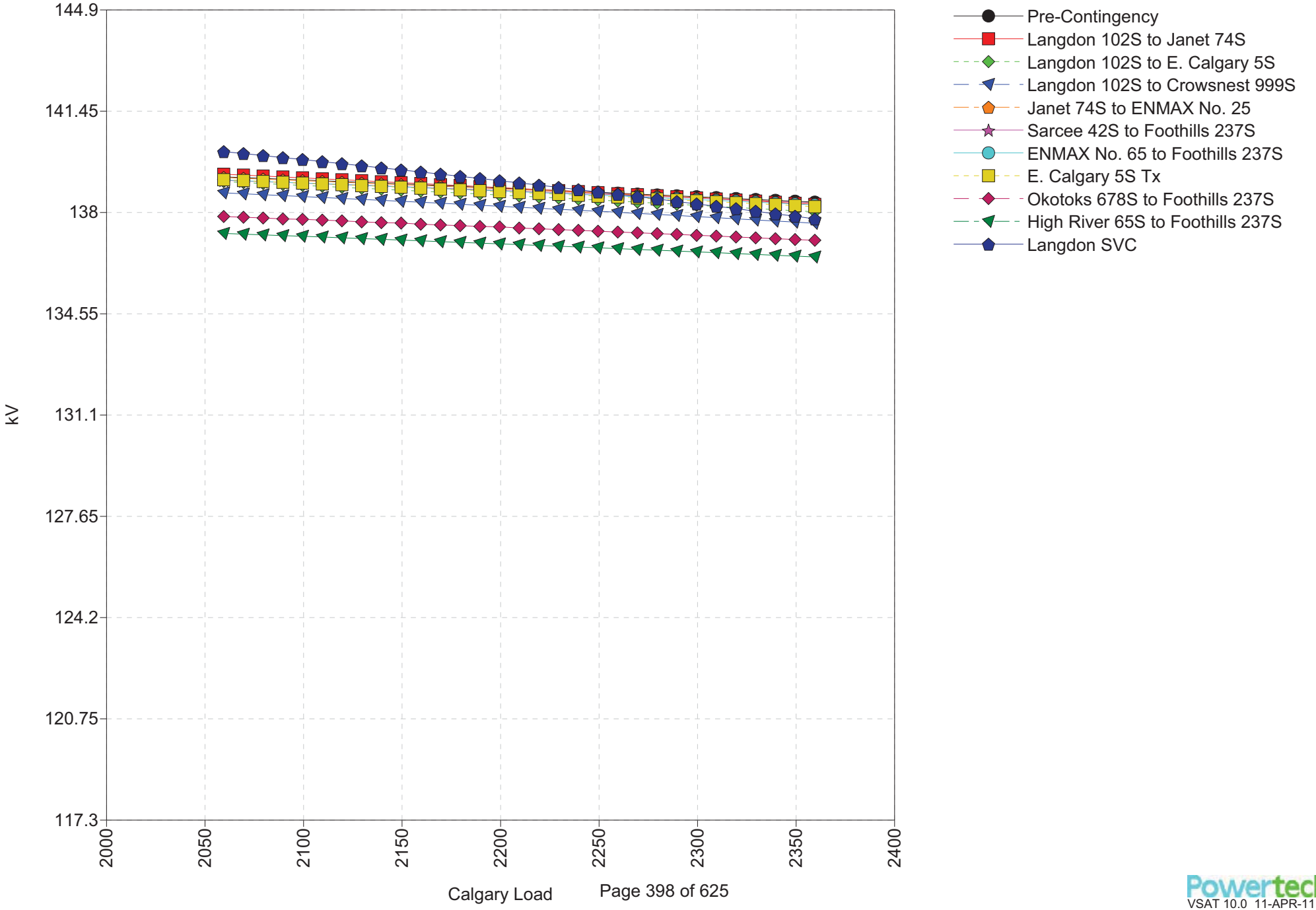
FATD 2019 SP ST4 SC5
Increase Calgary Load
138 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC5-3

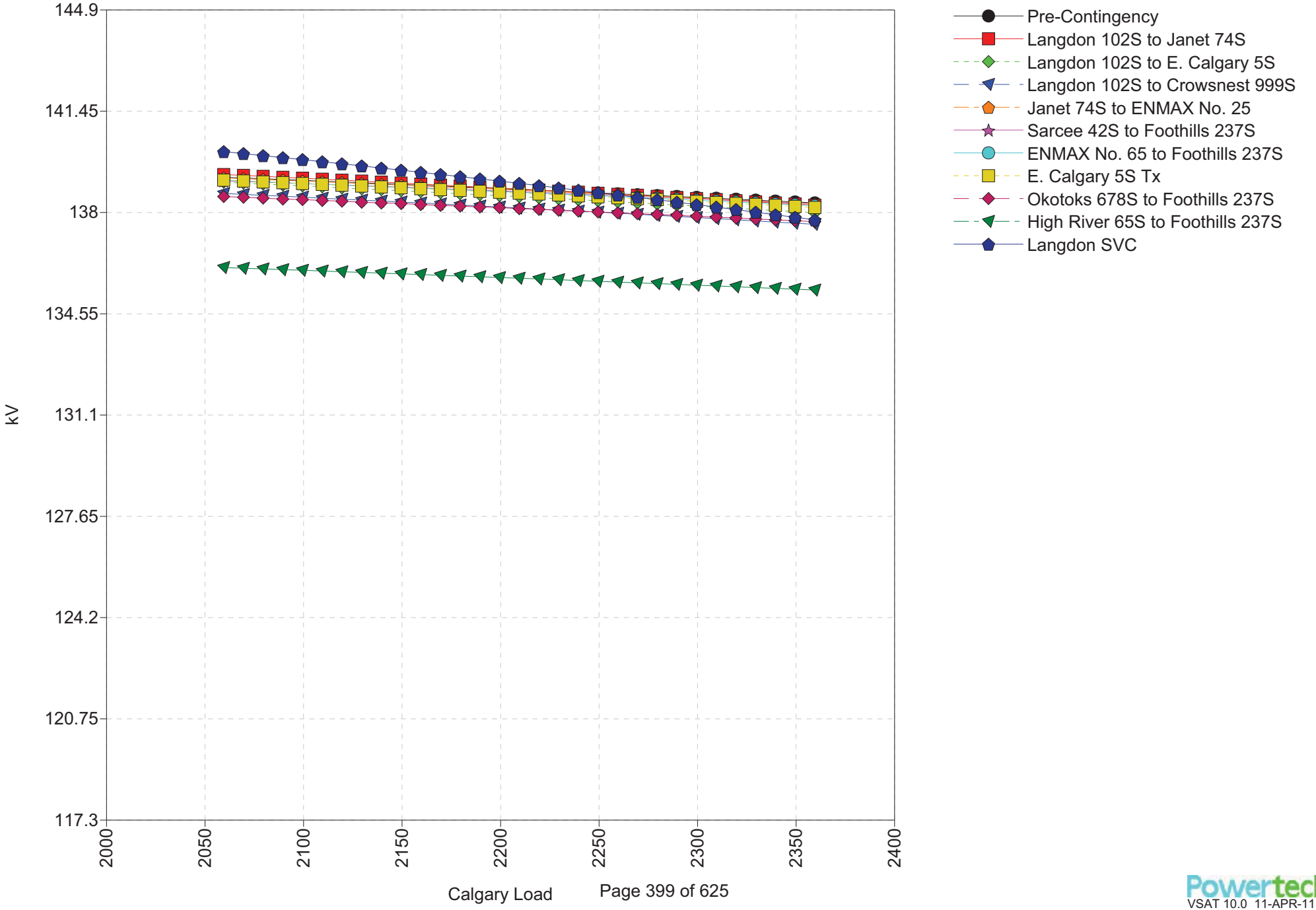
FATD 2019 SP ST4 SC5
Increase Calgary Load
138 OKOTOKS 678S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC5-4

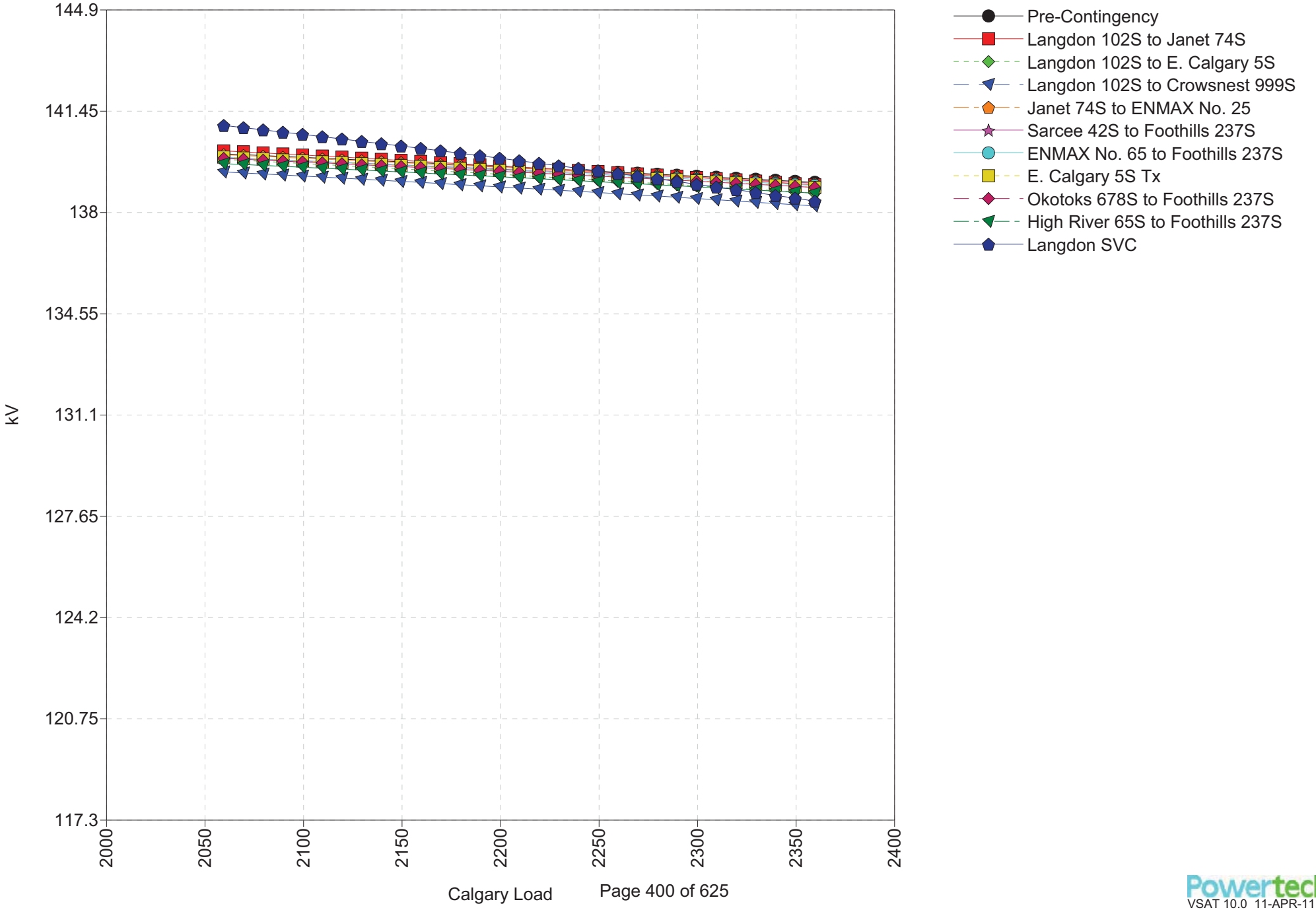
FATD 2019 SP ST4 SC5
Increase Calgary Load
138 HIGH RIVER 65S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC5-5

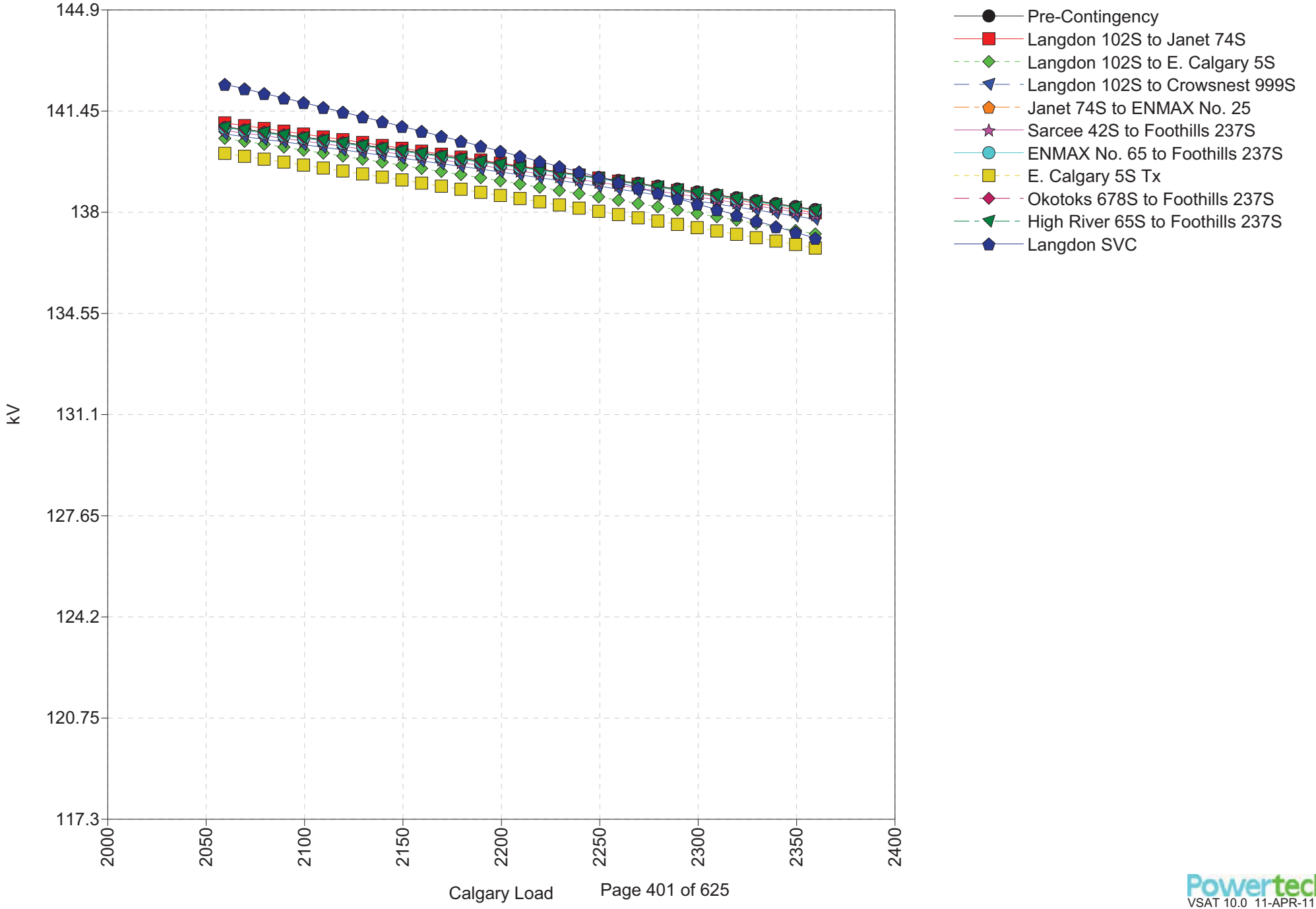
FATD 2019 SP ST4 SC5
Increase Calgary Load
138 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC5-6

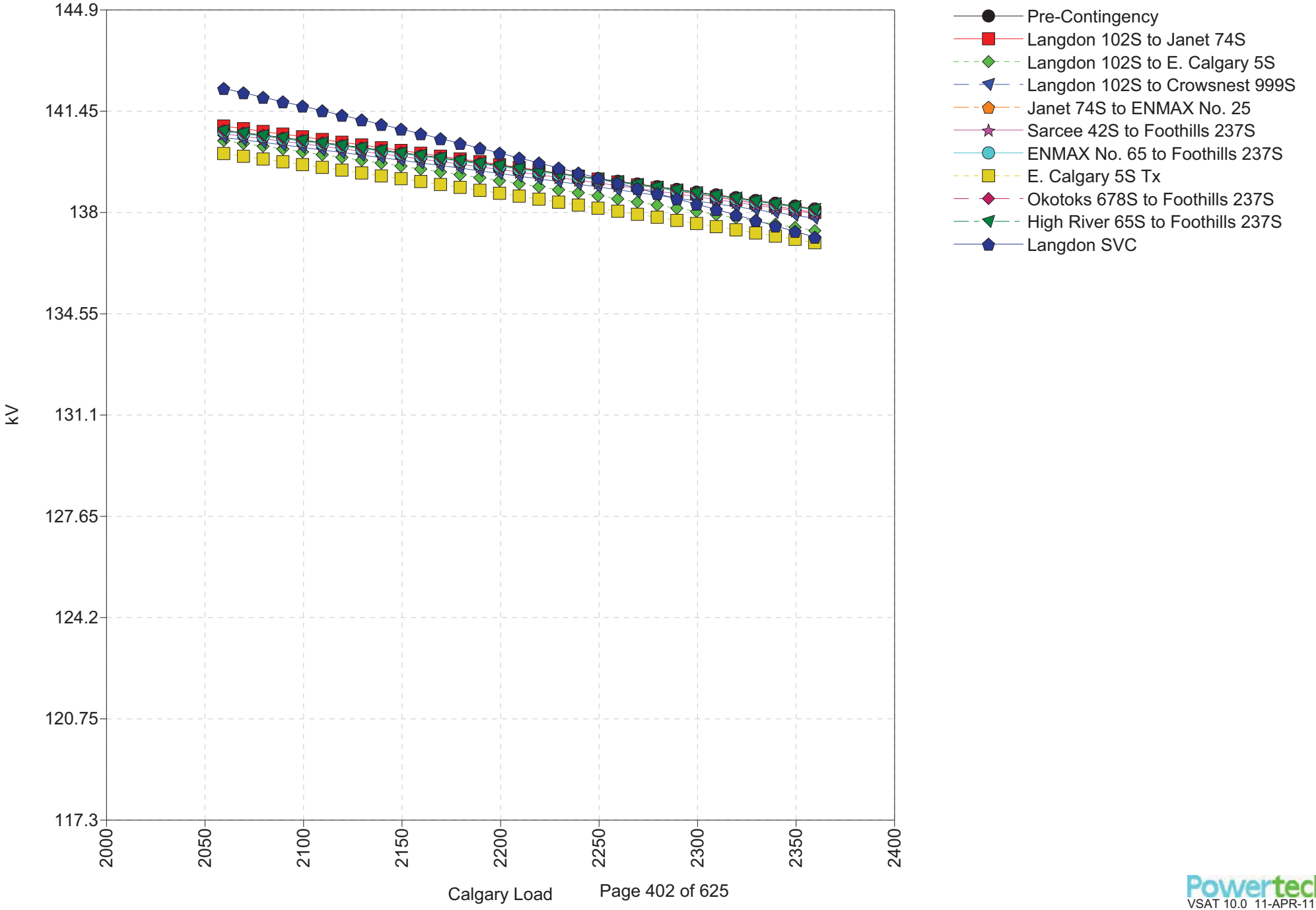
FATD 2019 SP ST4 SC5
Increase Calgary Load
138 ENMAX No. 2 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC5-7

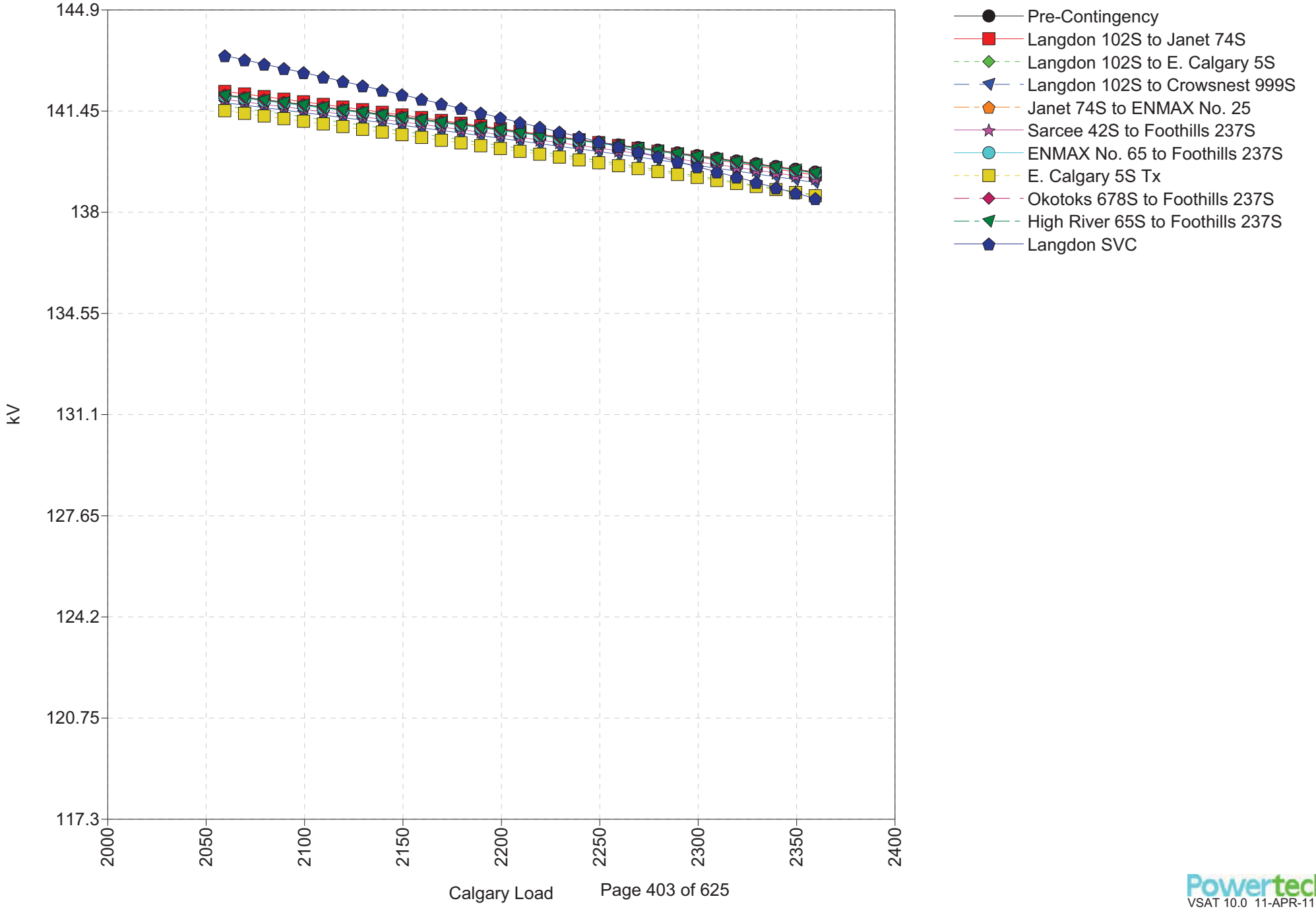
FATD 2019 SP ST4 SC5
Increase Calgary Load
138 ENMAX No. 23 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-138-SC5-8

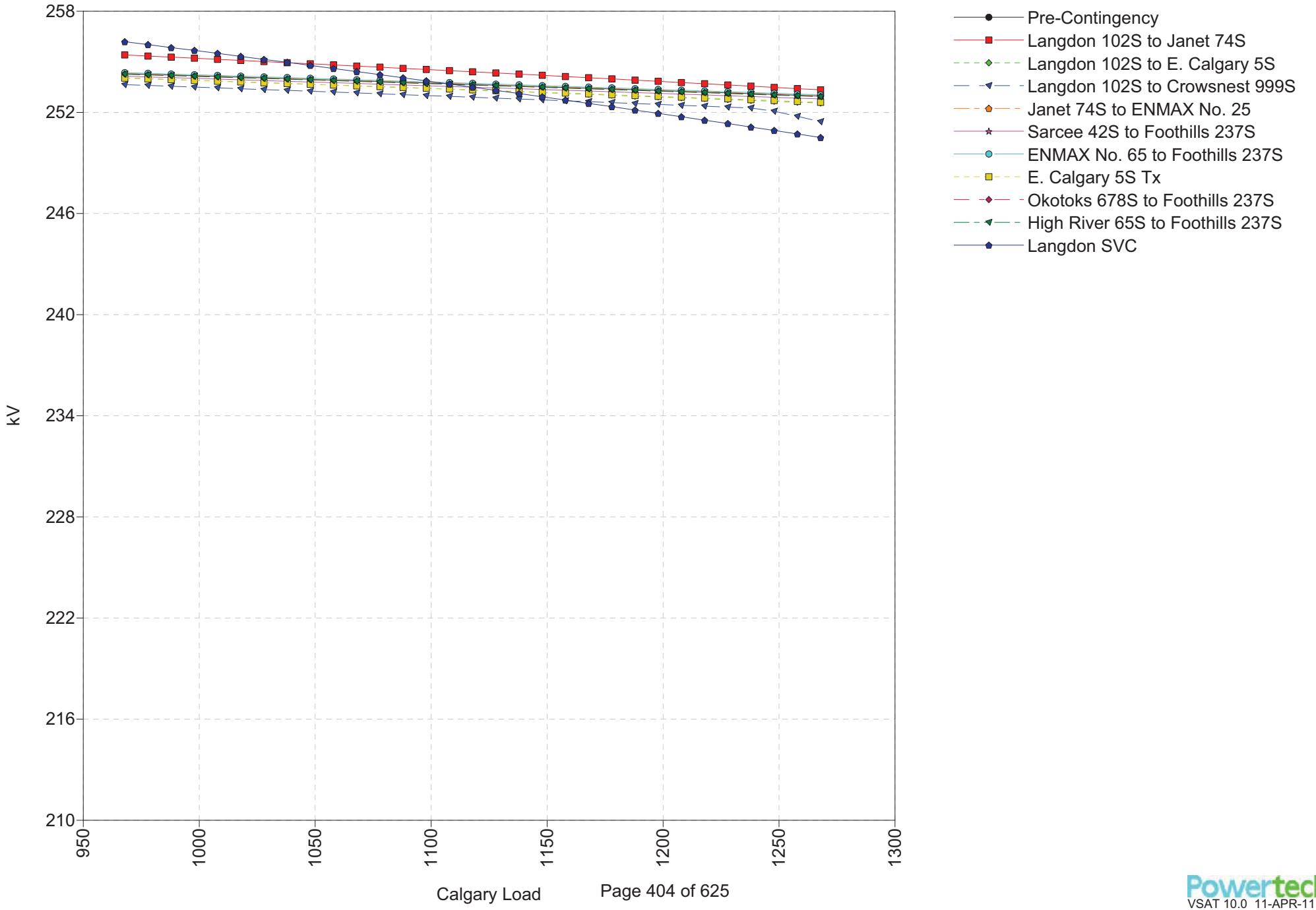
FATD 2019 SP ST4 SC5
Increase Calgary Load
138 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:08

Figure K-240-SC6-1

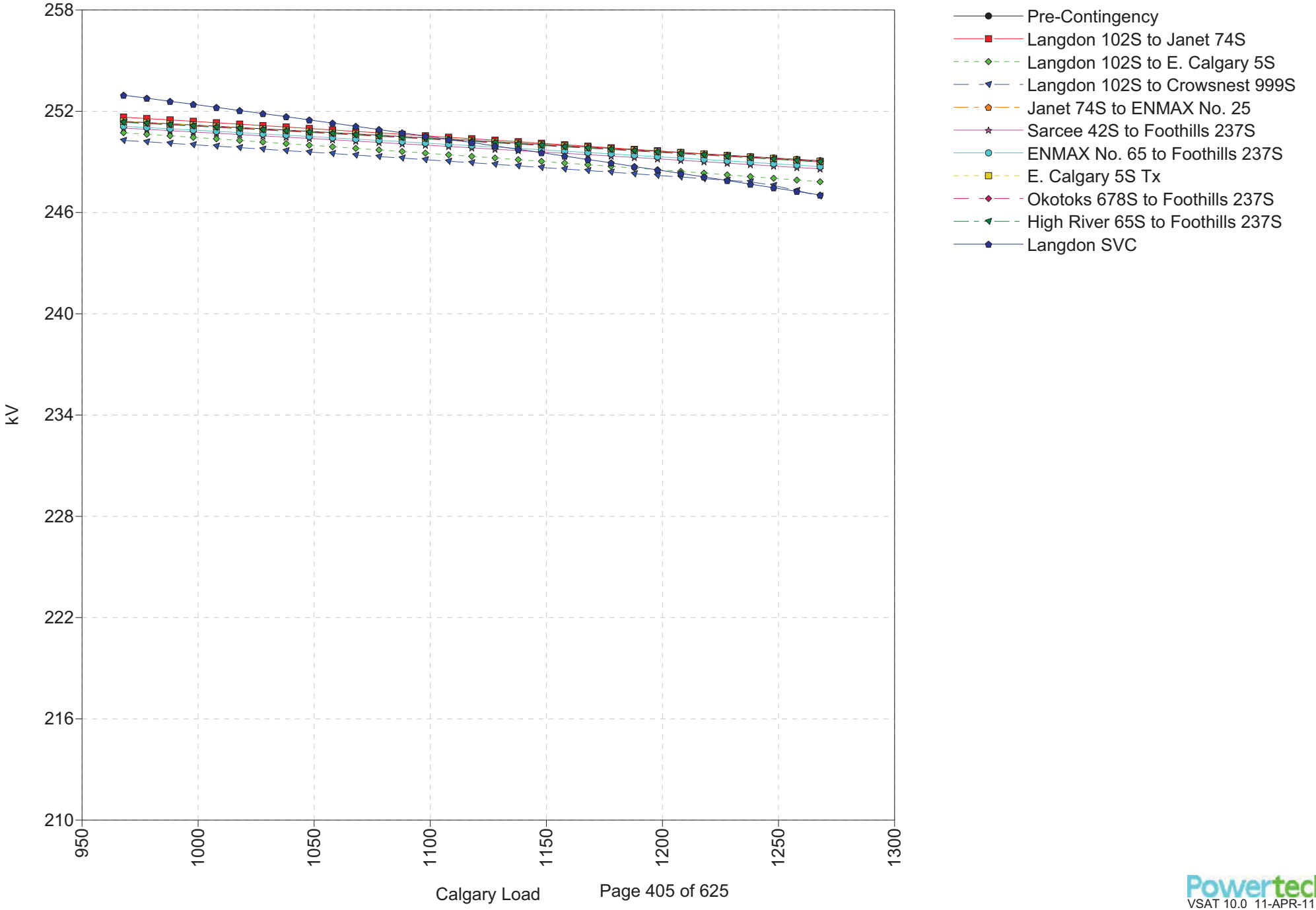
FATD 2019 SL ST4 SC6
Increase Calgary Load
240 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-240-SC6-2

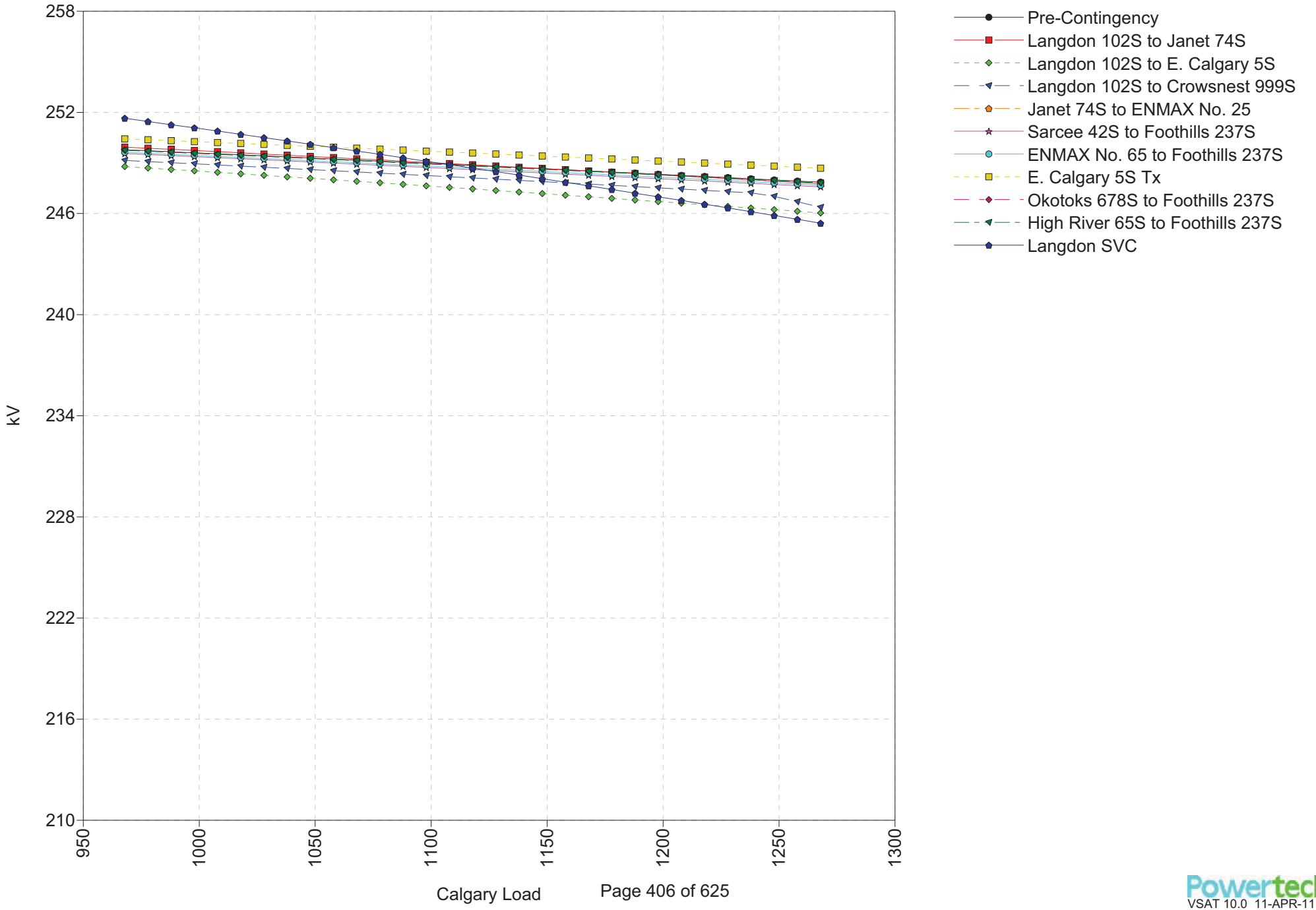
FATD 2019 SL ST4 SC6
Increase Calgary Load
240 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-240-SC6-3

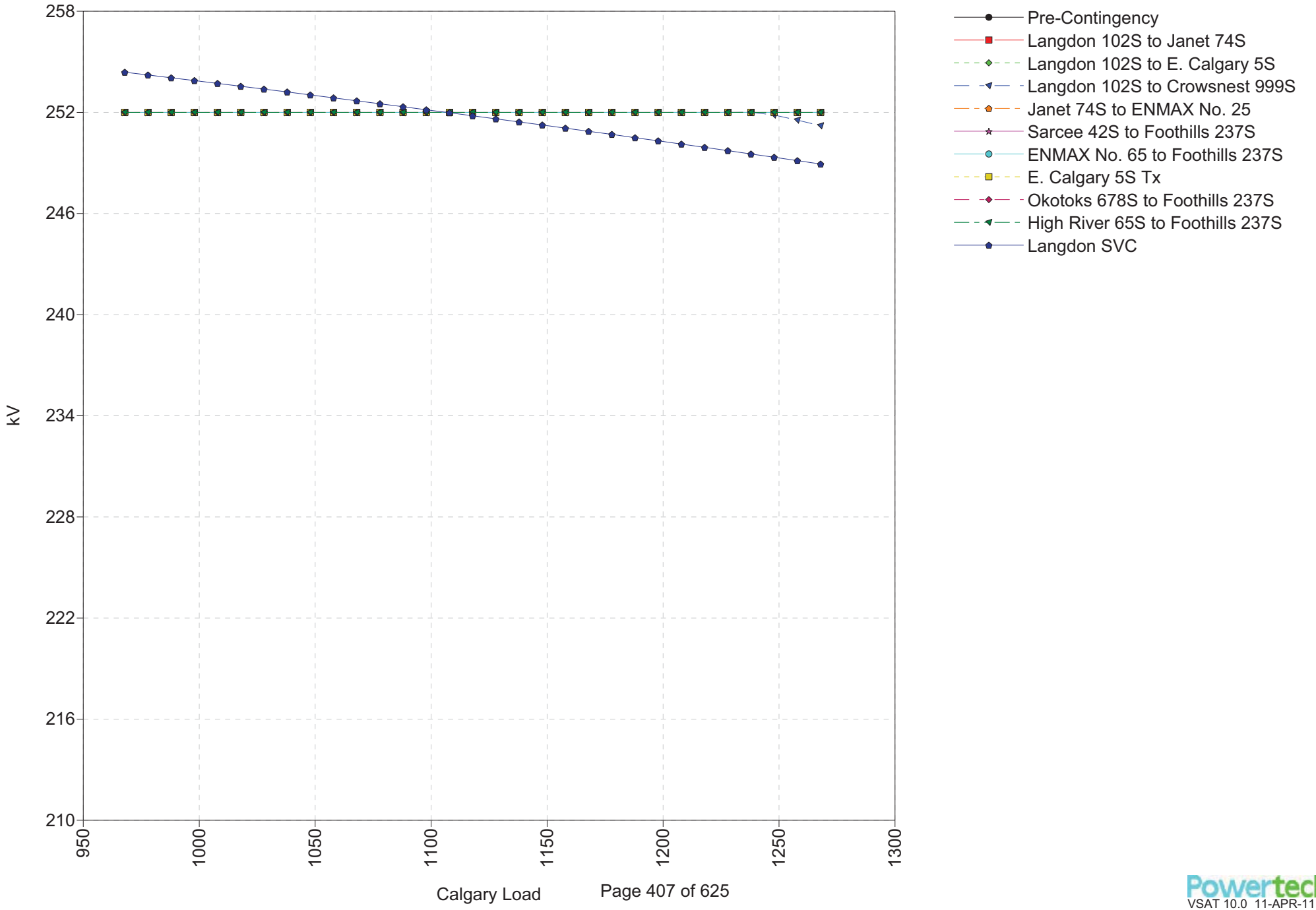
FATD 2019 SL ST4 SC6
Increase Calgary Load
240 E CALGARY 5S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-240-SC6-4

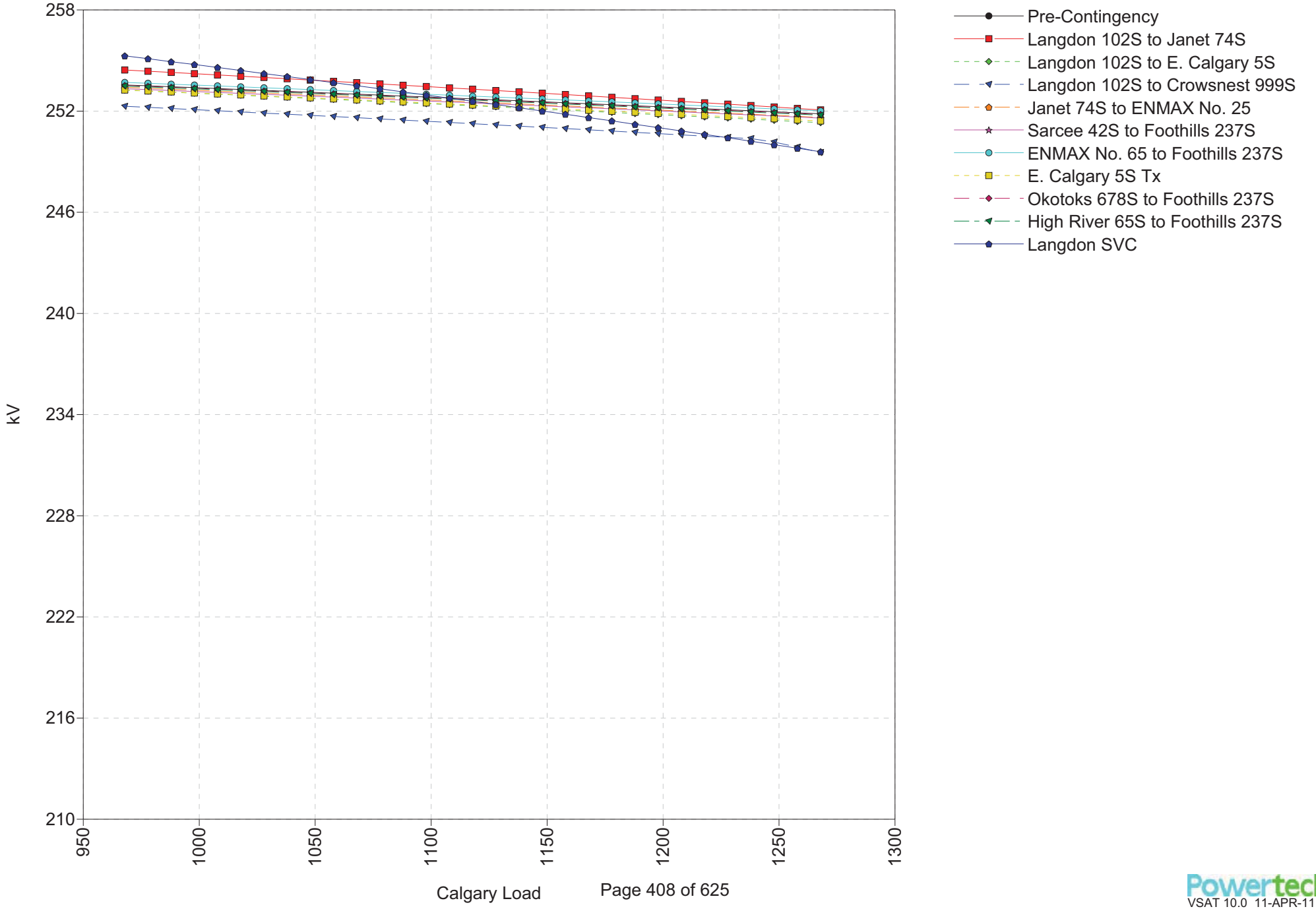
FATD 2019 SL ST4 SC6
Increase Calgary Load
240 LANGDON 102S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-240-SC6-5

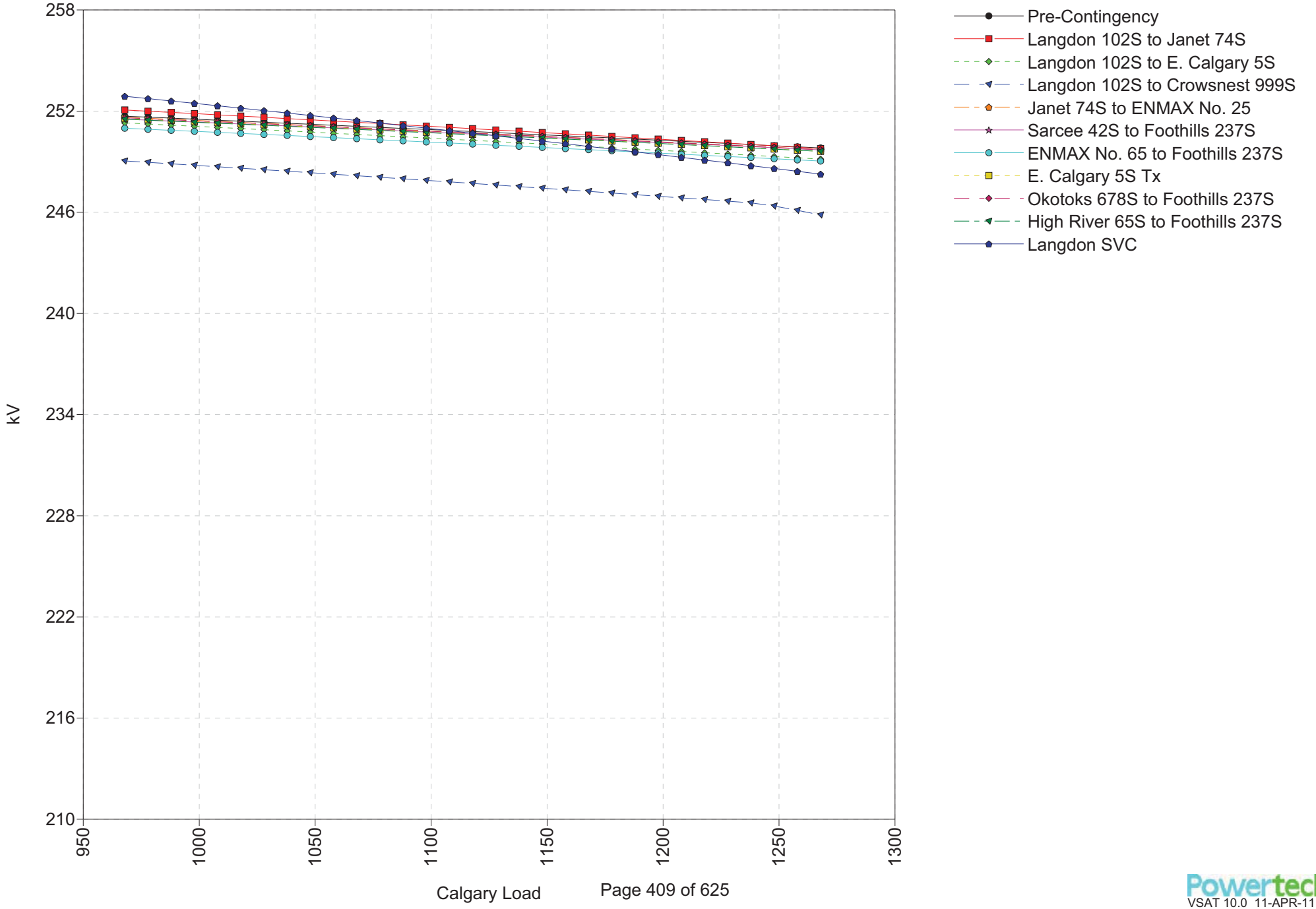
FATD 2019 SL ST4 SC6
Increase Calgary Load
240 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-240-SC6-6

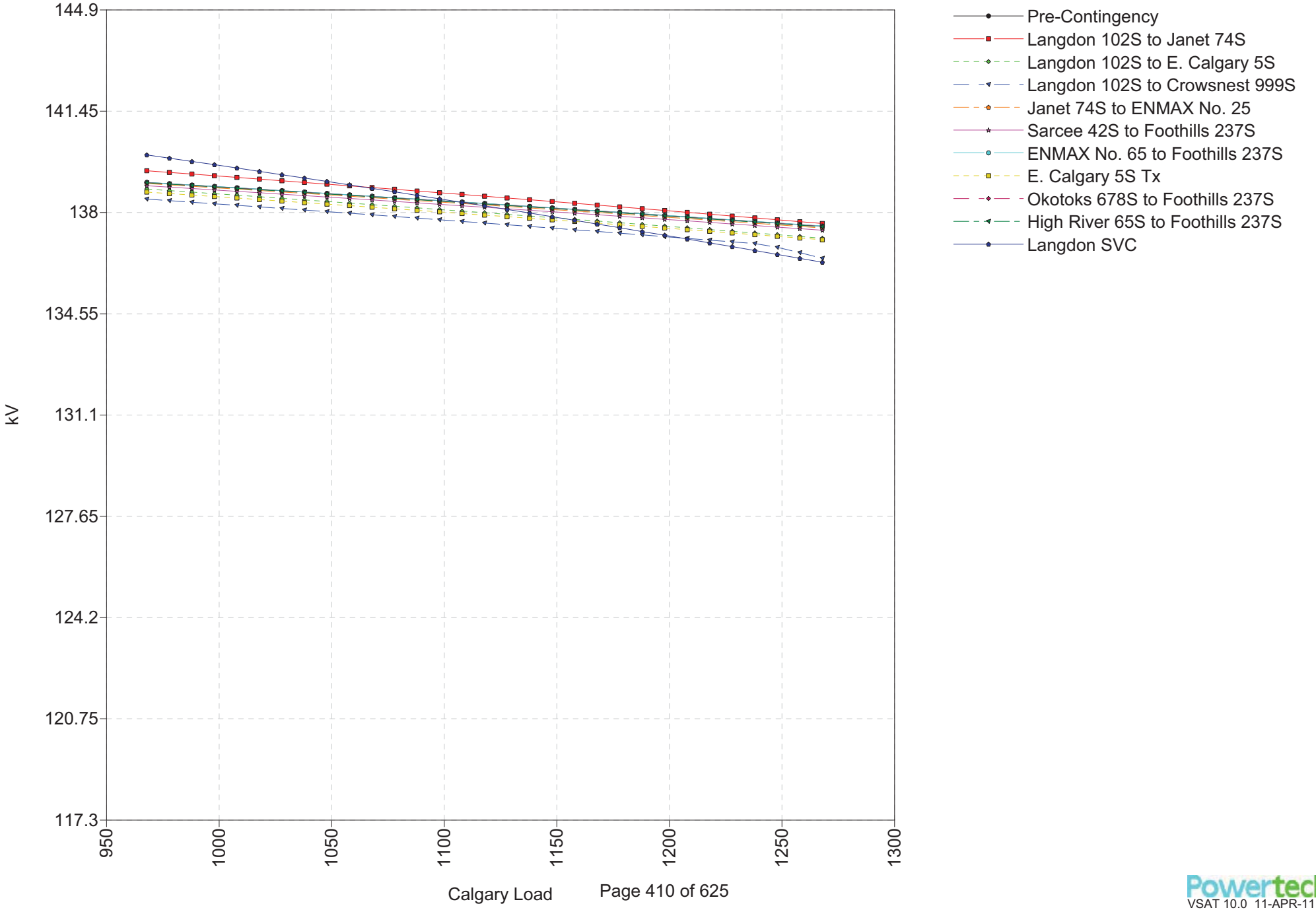
FATD 2019 SL ST4 SC6
Increase Calgary Load
240 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-138-SC6-1

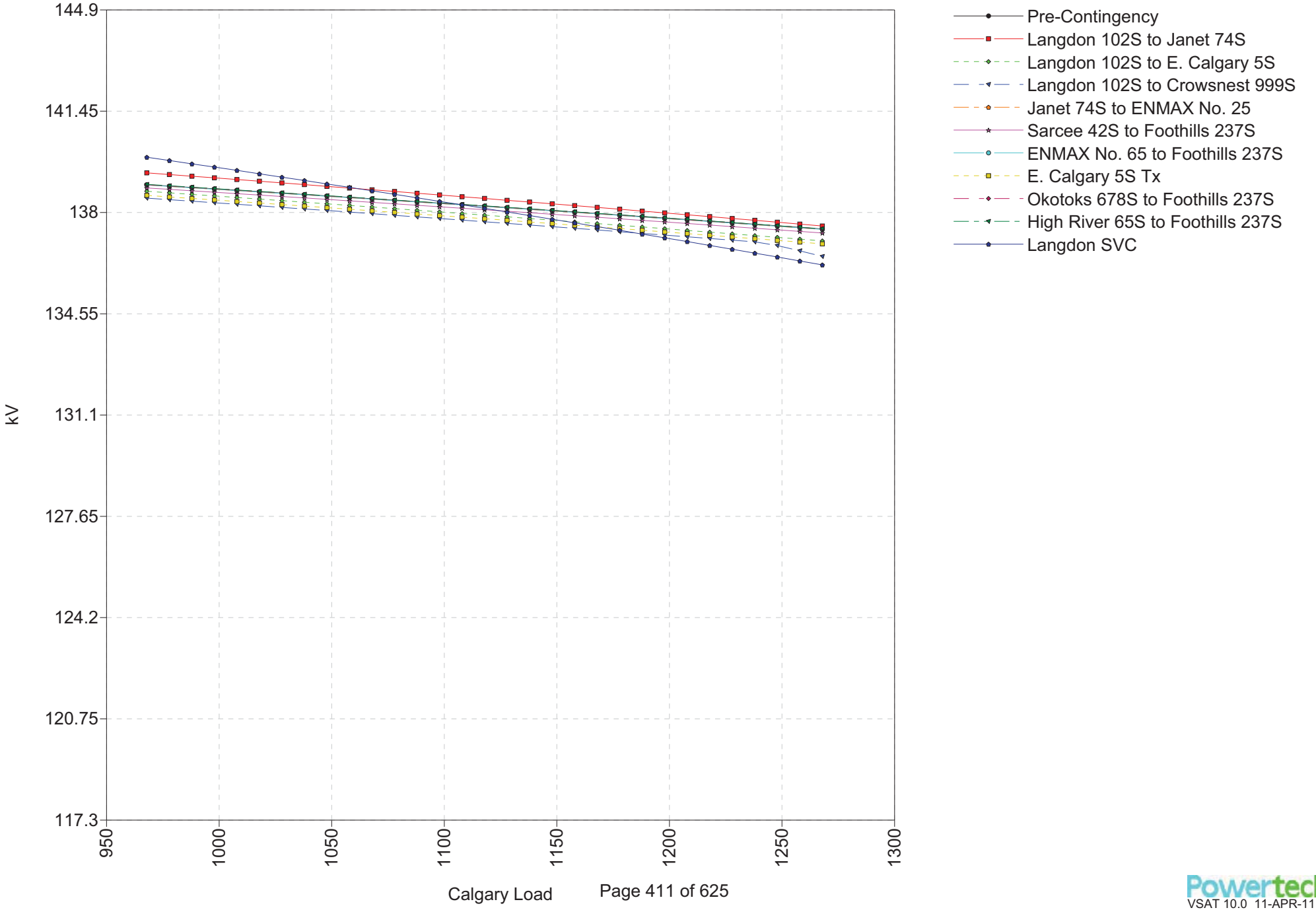
FATD 2019 SL ST4 SC6
Increase Calgary Load
138 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-138-SC6-2

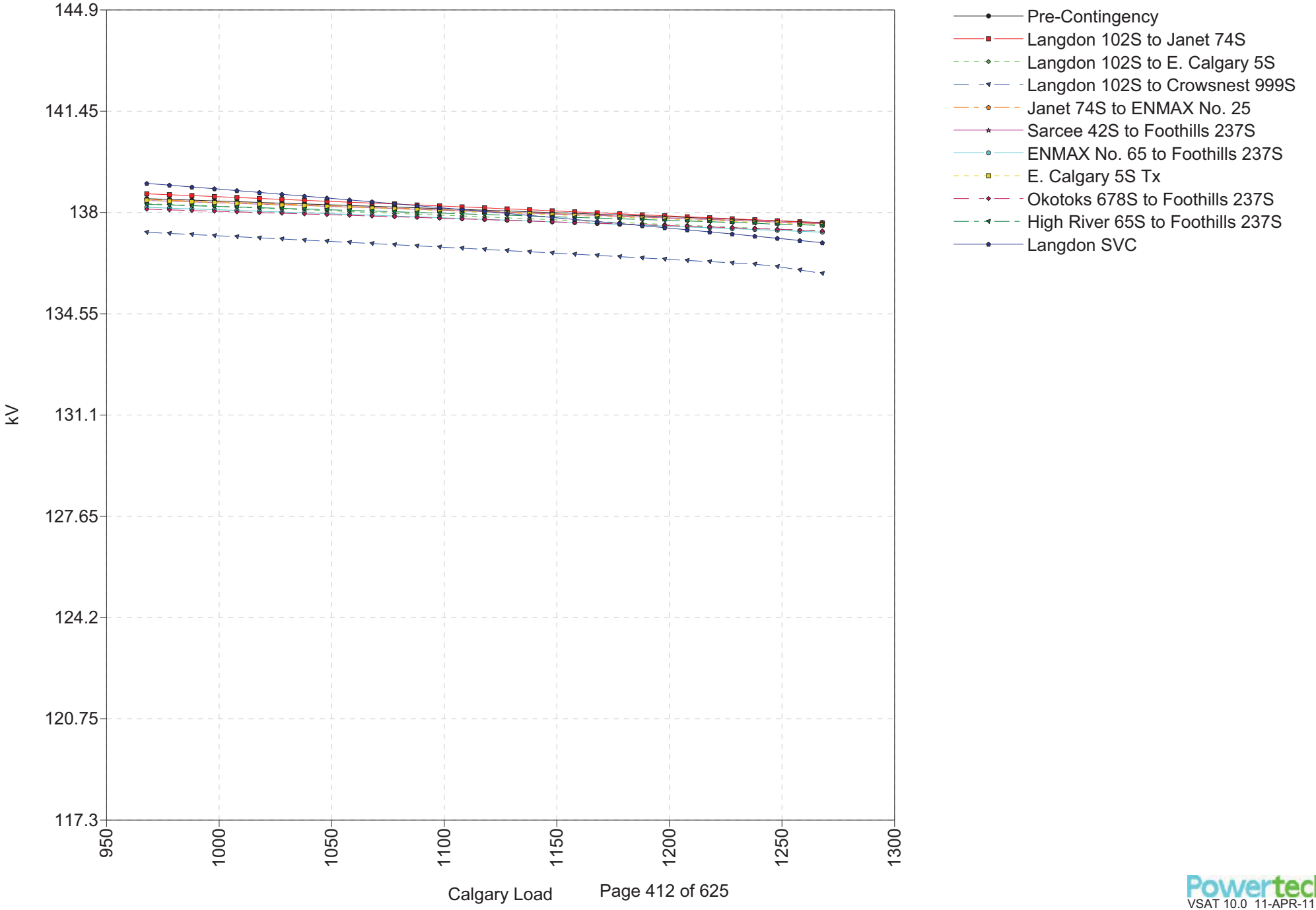
FATD 2019 SL ST4 SC6
Increase Calgary Load
138 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-138-SC6-3

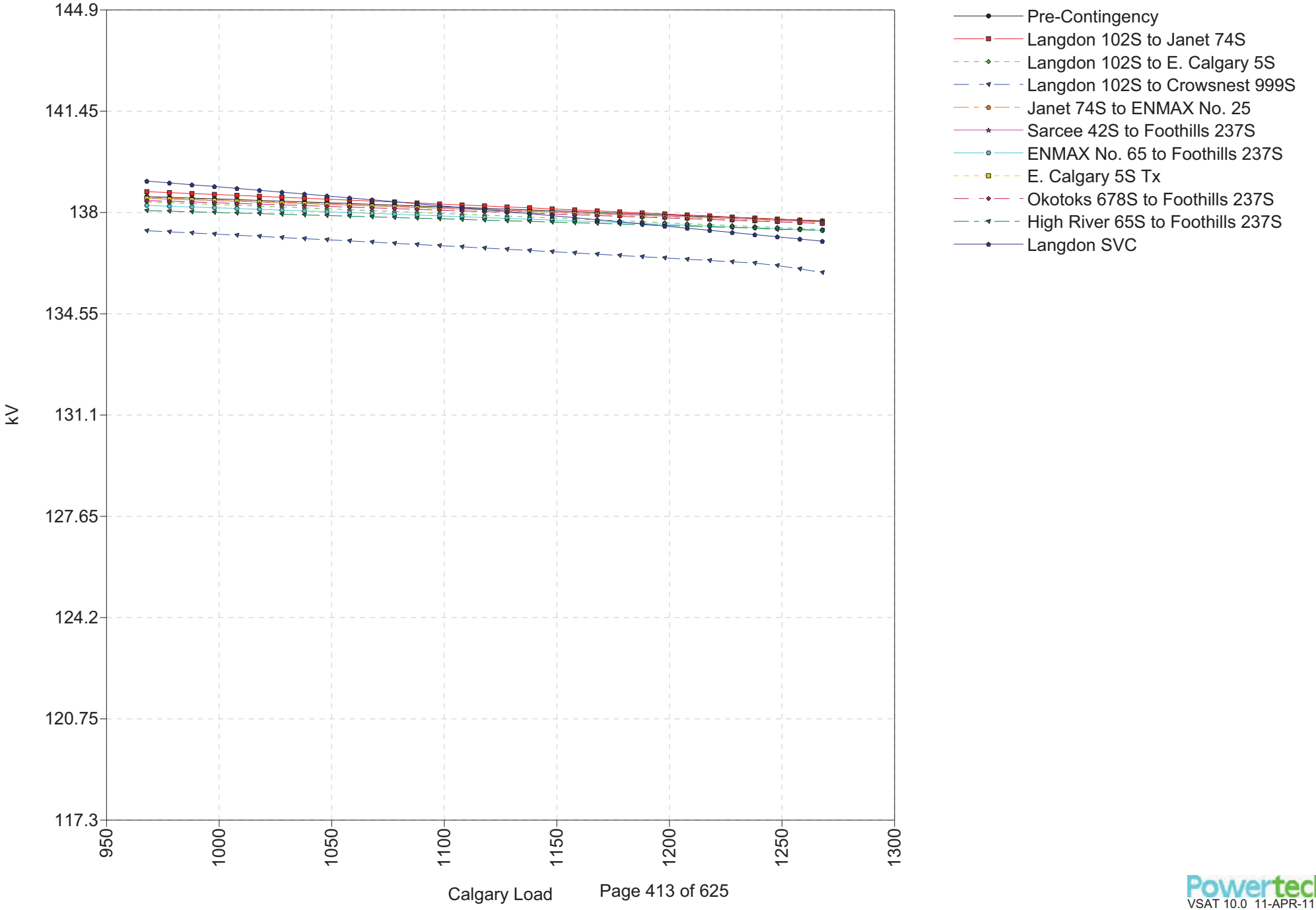
FATD 2019 SL ST4 SC6
Increase Calgary Load
138 OKOTOKS 678S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-138-SC6-4

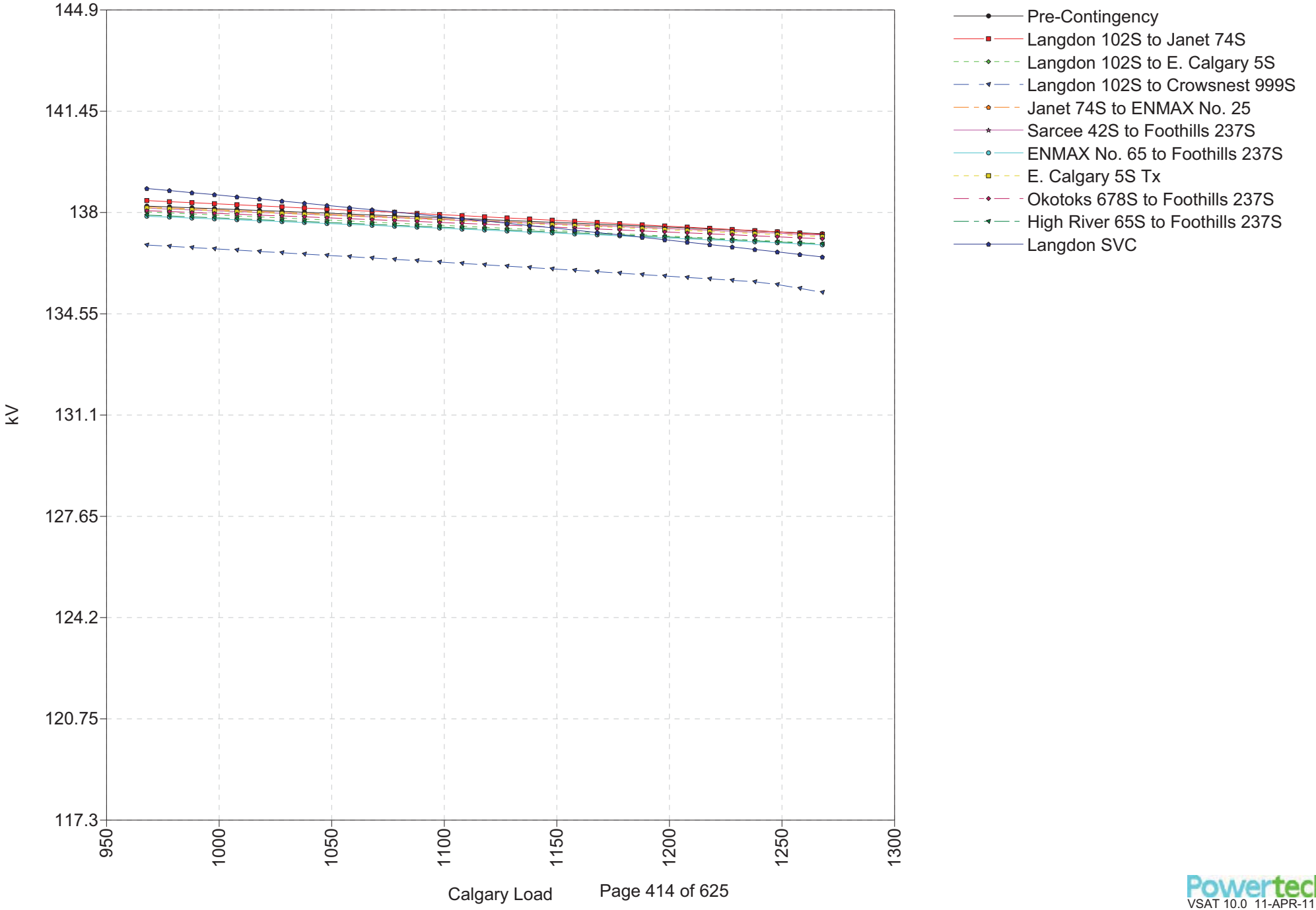
FATD 2019 SL ST4 SC6
Increase Calgary Load
138 HIGH RIVER 65S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-138-SC6-5

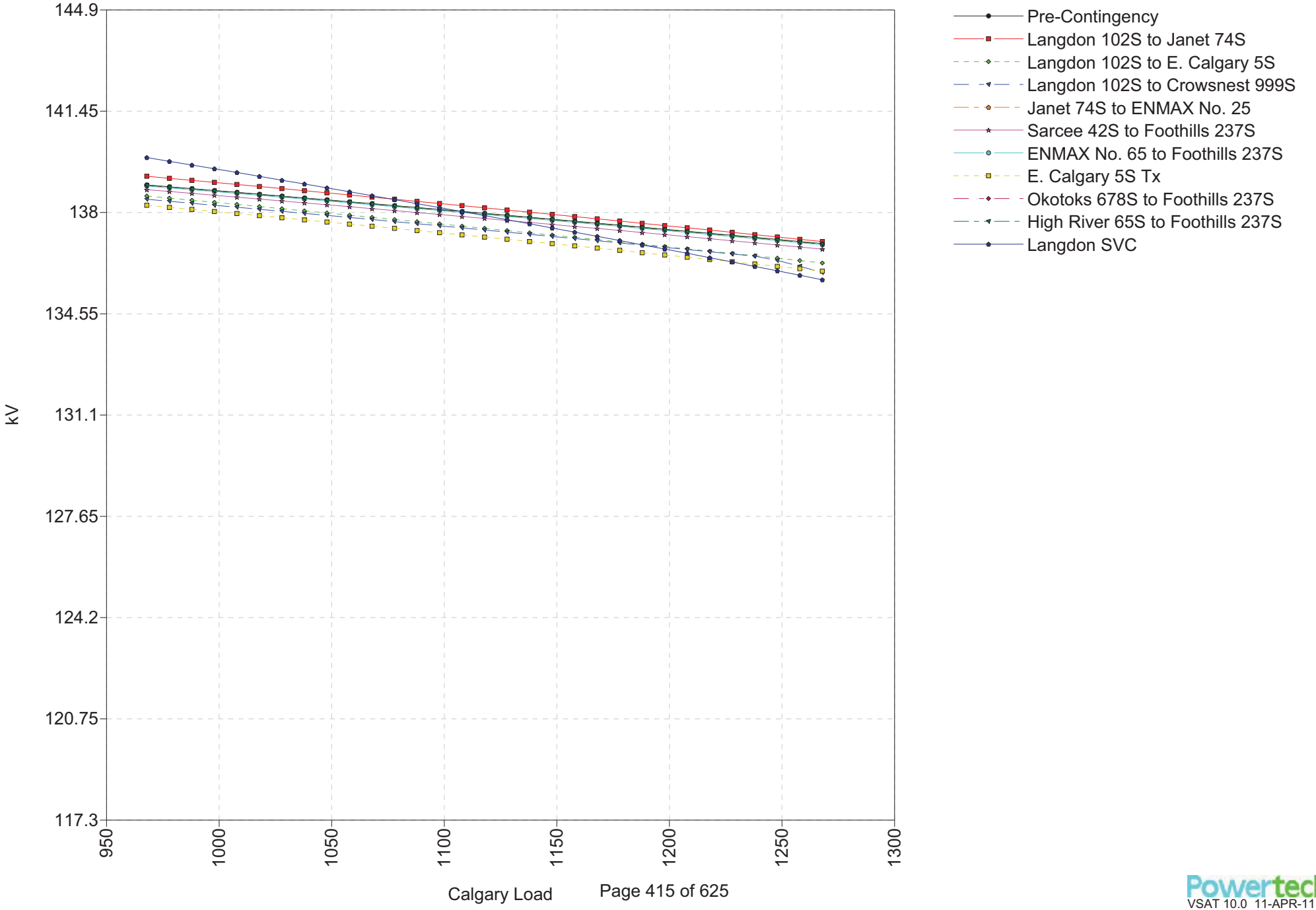
FATD 2019 SL ST4 SC6
Increase Calgary Load
138 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-138-SC6-6

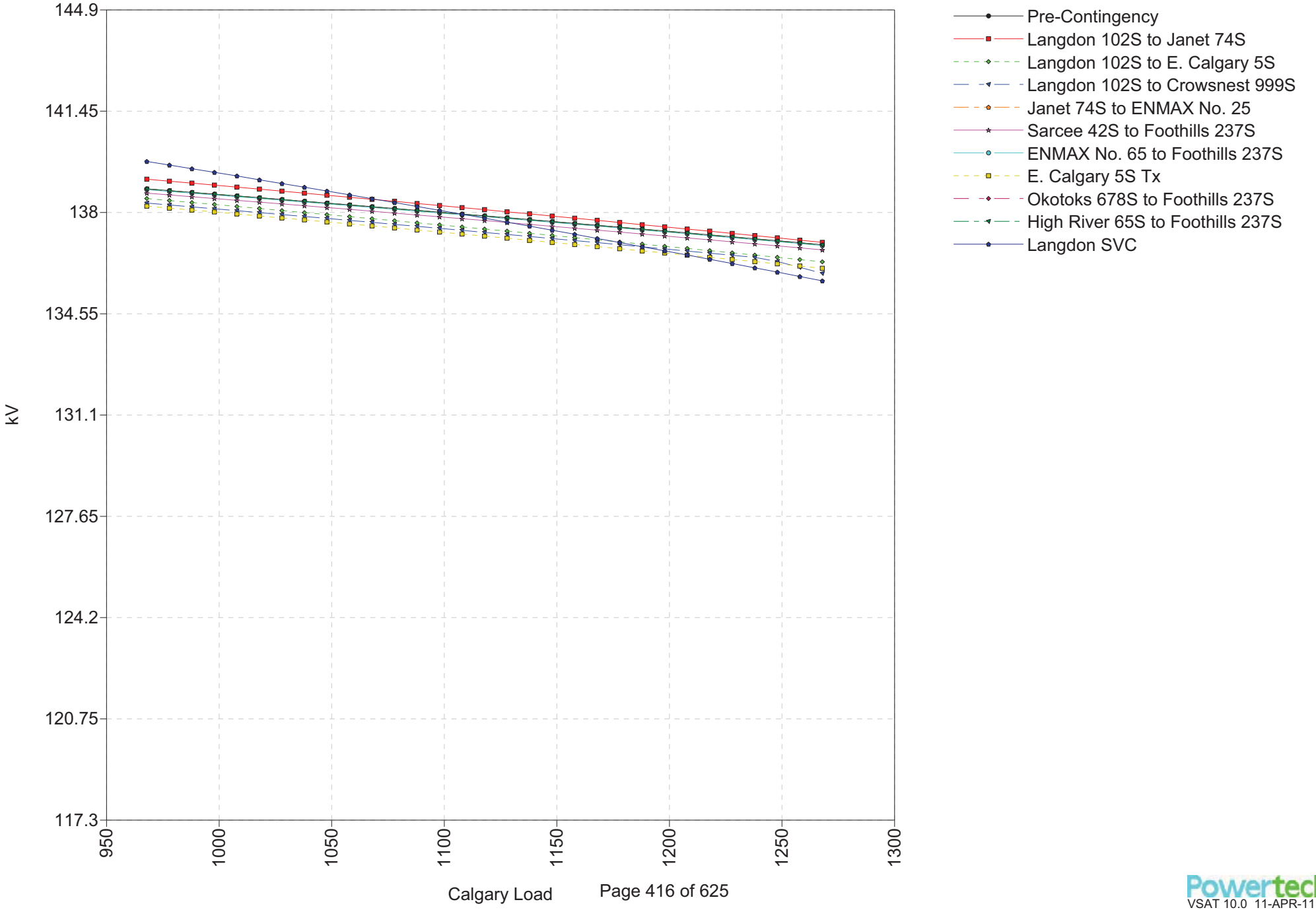
FATD 2019 SL ST4 SC6
Increase Calgary Load
138 ENMAX No. 2 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-138-SC6-7

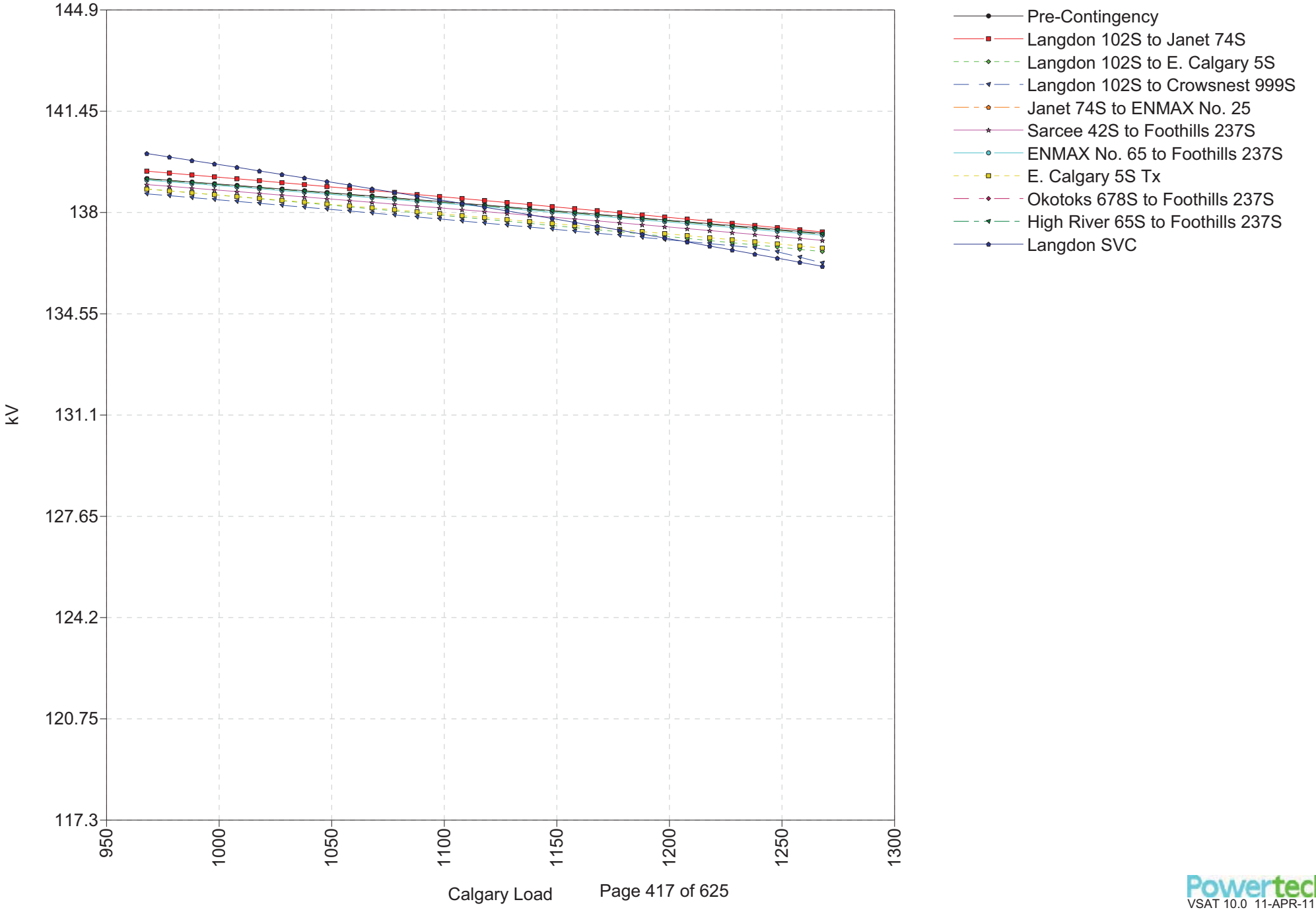
FATD 2019 SL ST4 SC6
Increase Calgary Load
138 ENMAX No. 23 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-138-SC6-8

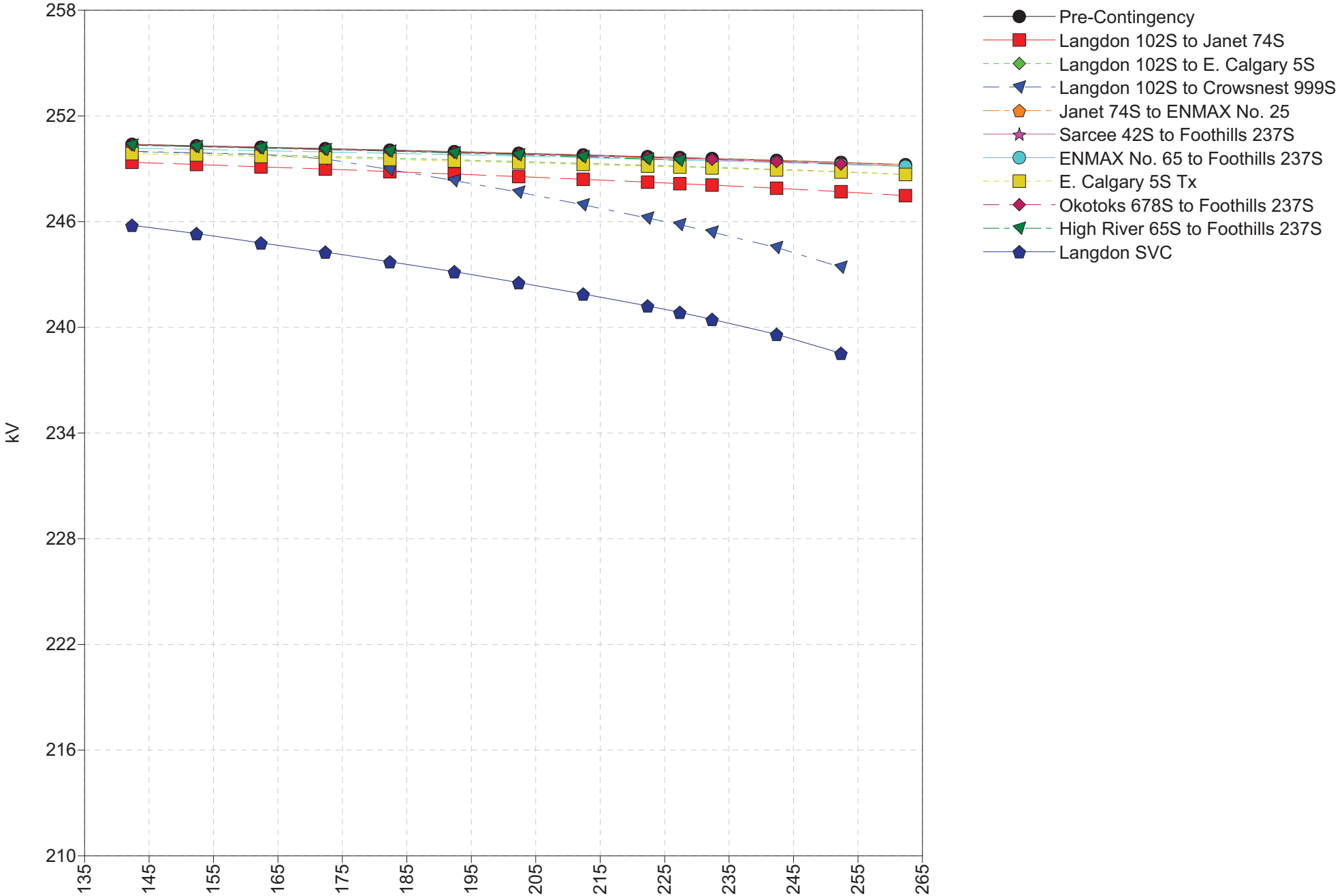
FATD 2019 SL ST4 SC6
Increase Calgary Load
138 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:09

Figure K-240-SC1-HR-1

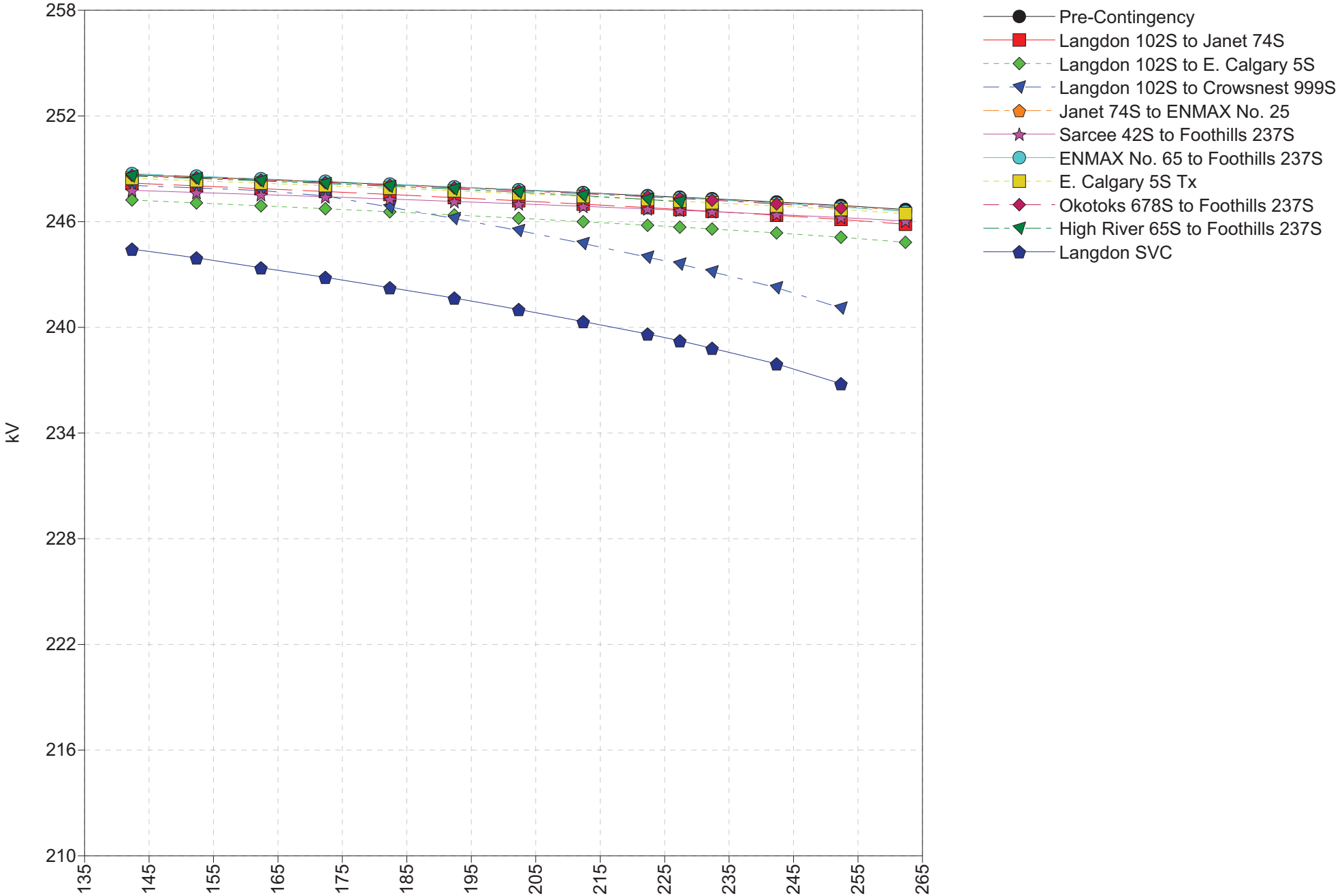
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
240 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-240-SC1-HR-2

FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
240 SARCEE 42S Bus Voltage (kV)

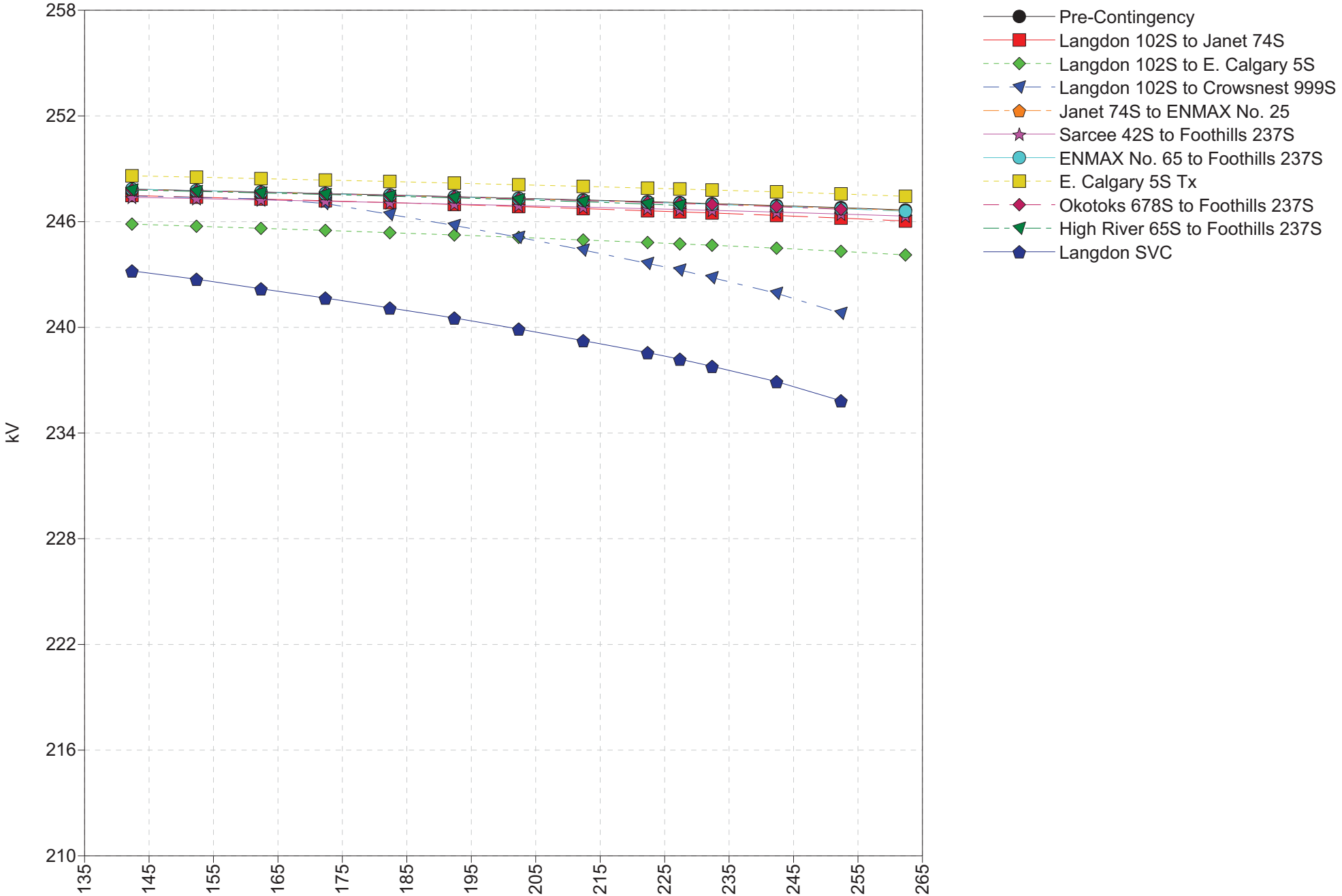


High River Planning Area

Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-240-SC1-HR-3

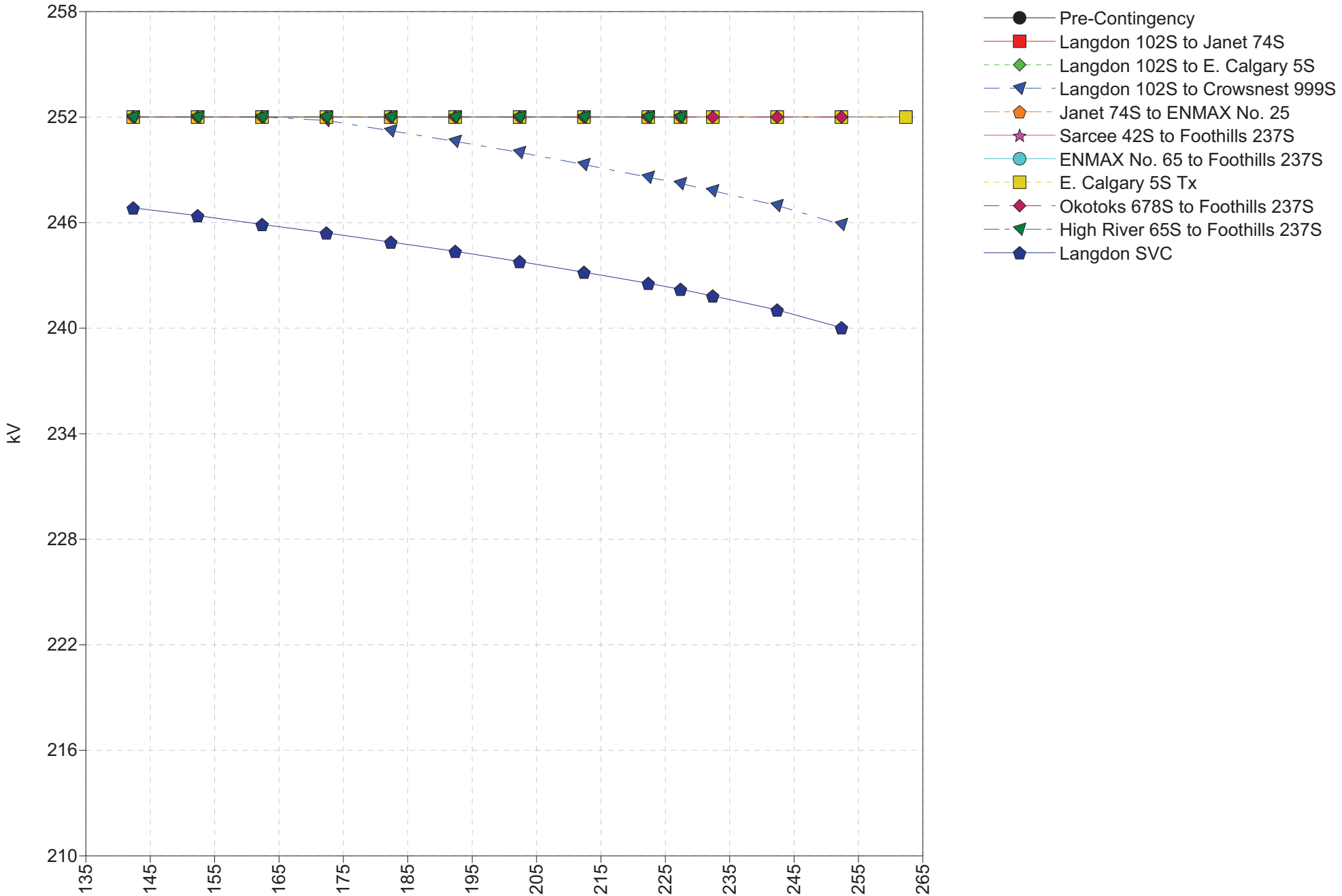
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
240 E CALGARY 5S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-240-SC1-HR-4

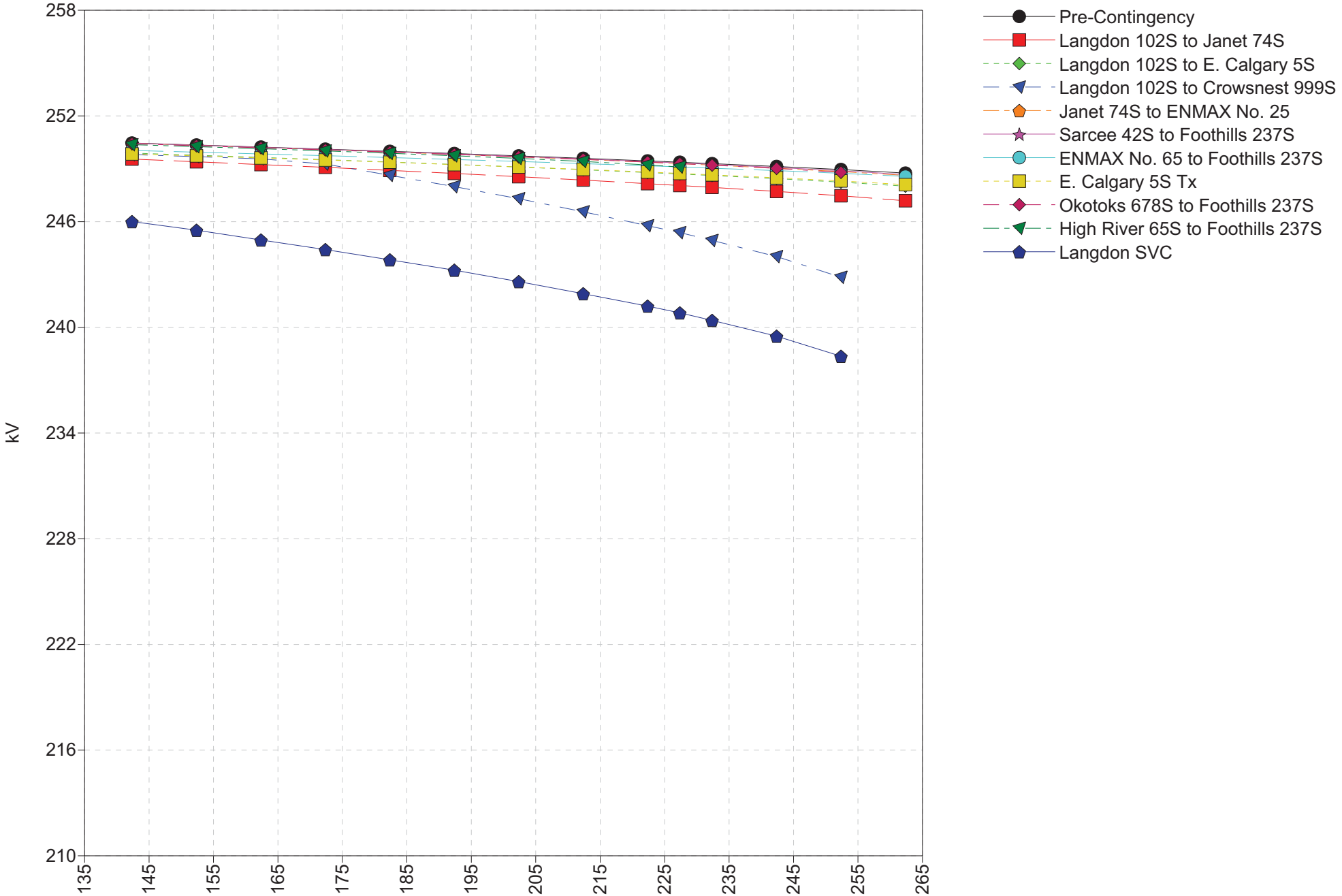
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
240 LANGDON 102S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-240-SC1-HR-5

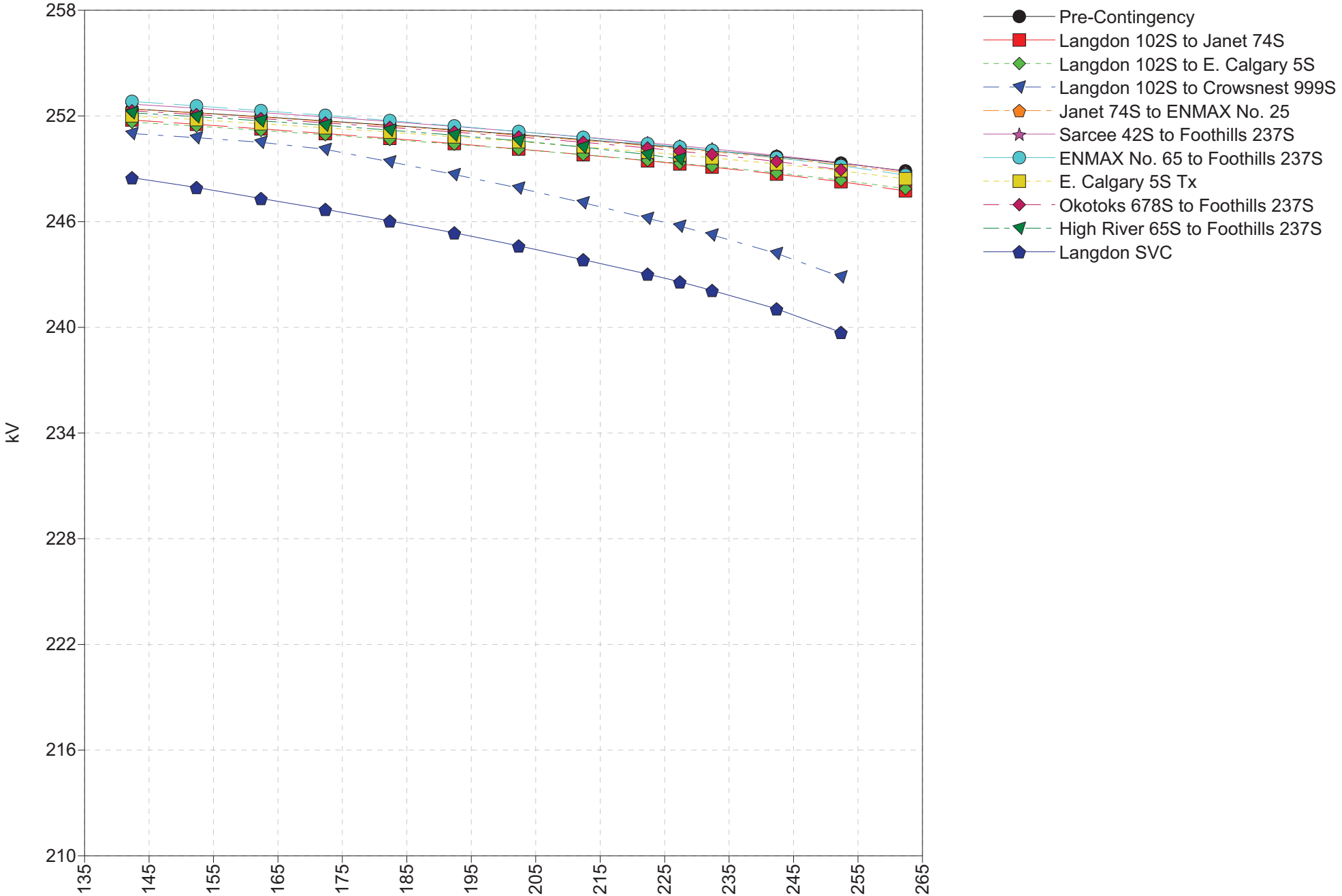
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
240 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-240-SC1-HR-6

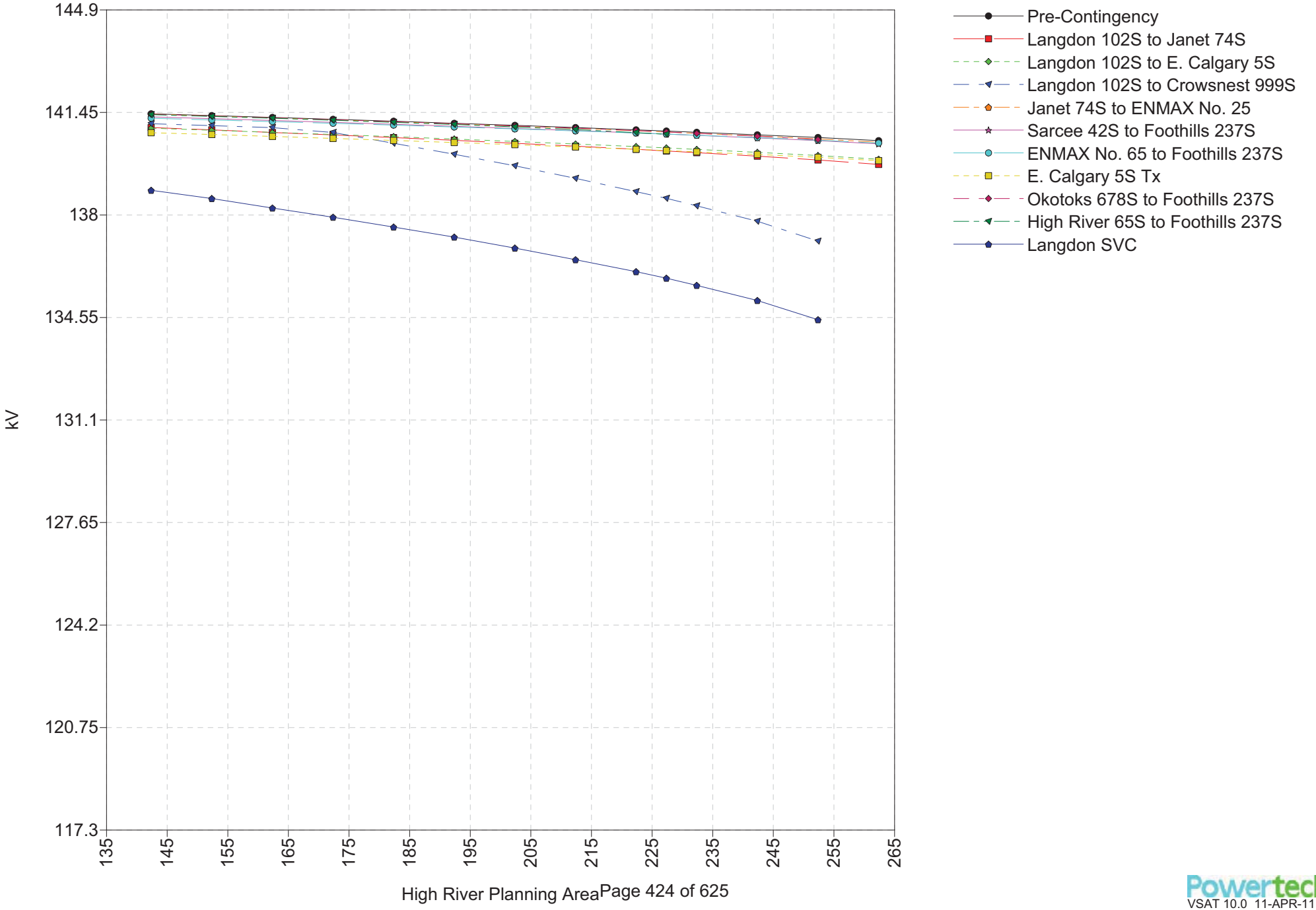
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
240 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-138-SC1-HR-1

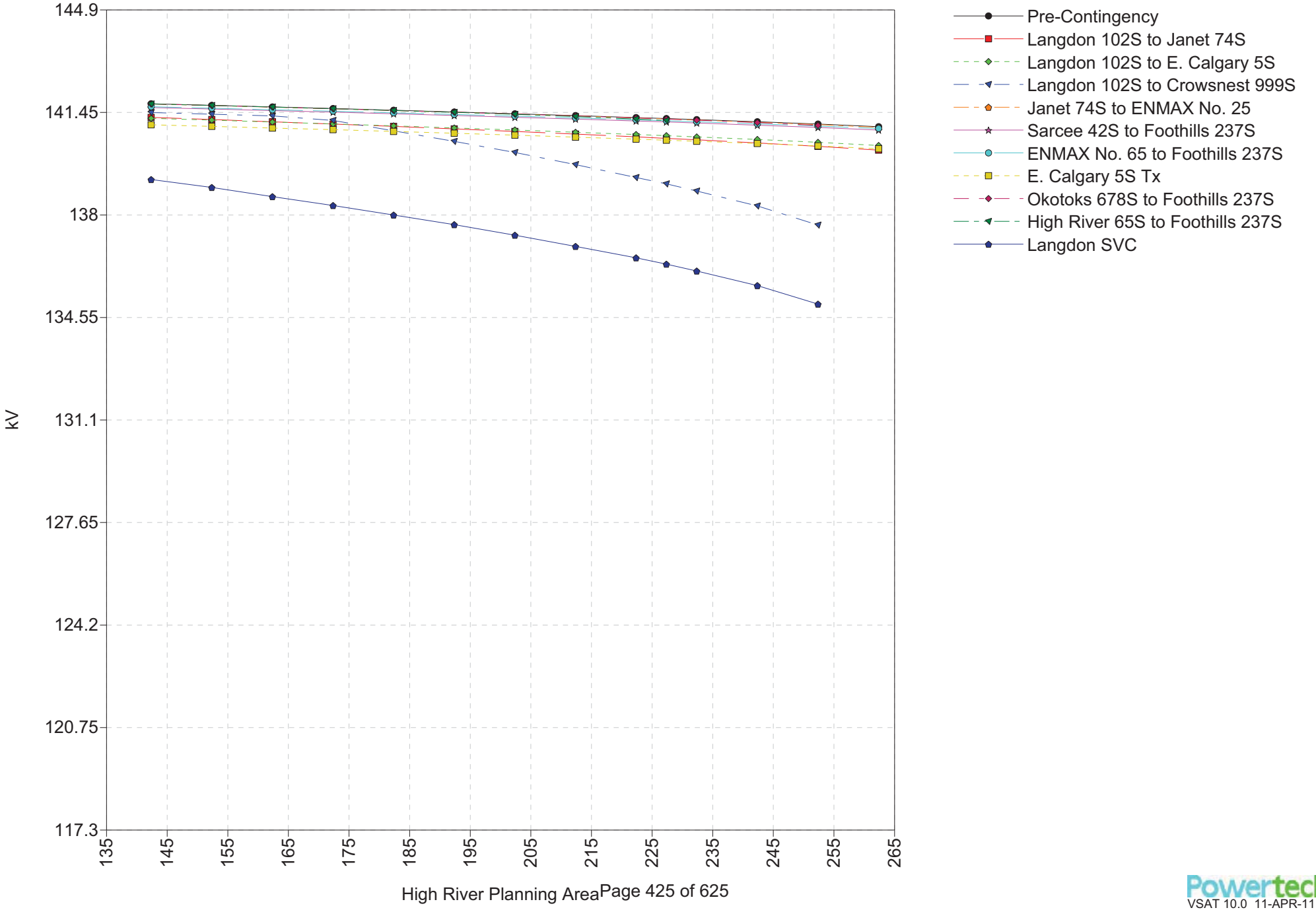
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
138 ENMAX No. 65 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-138-SC1-HR-2

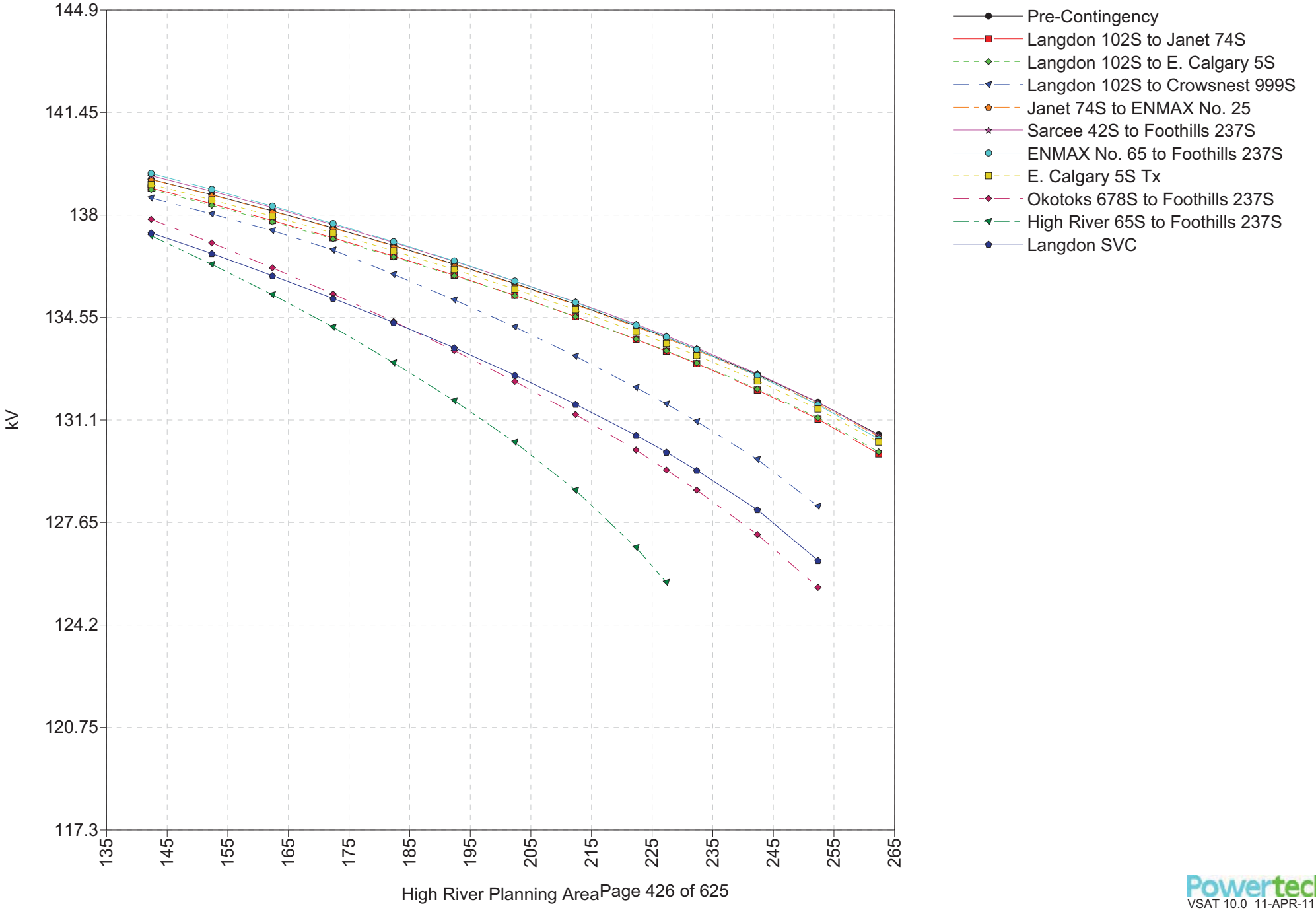
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
138 JANET 74S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-138-SC1-HR-3

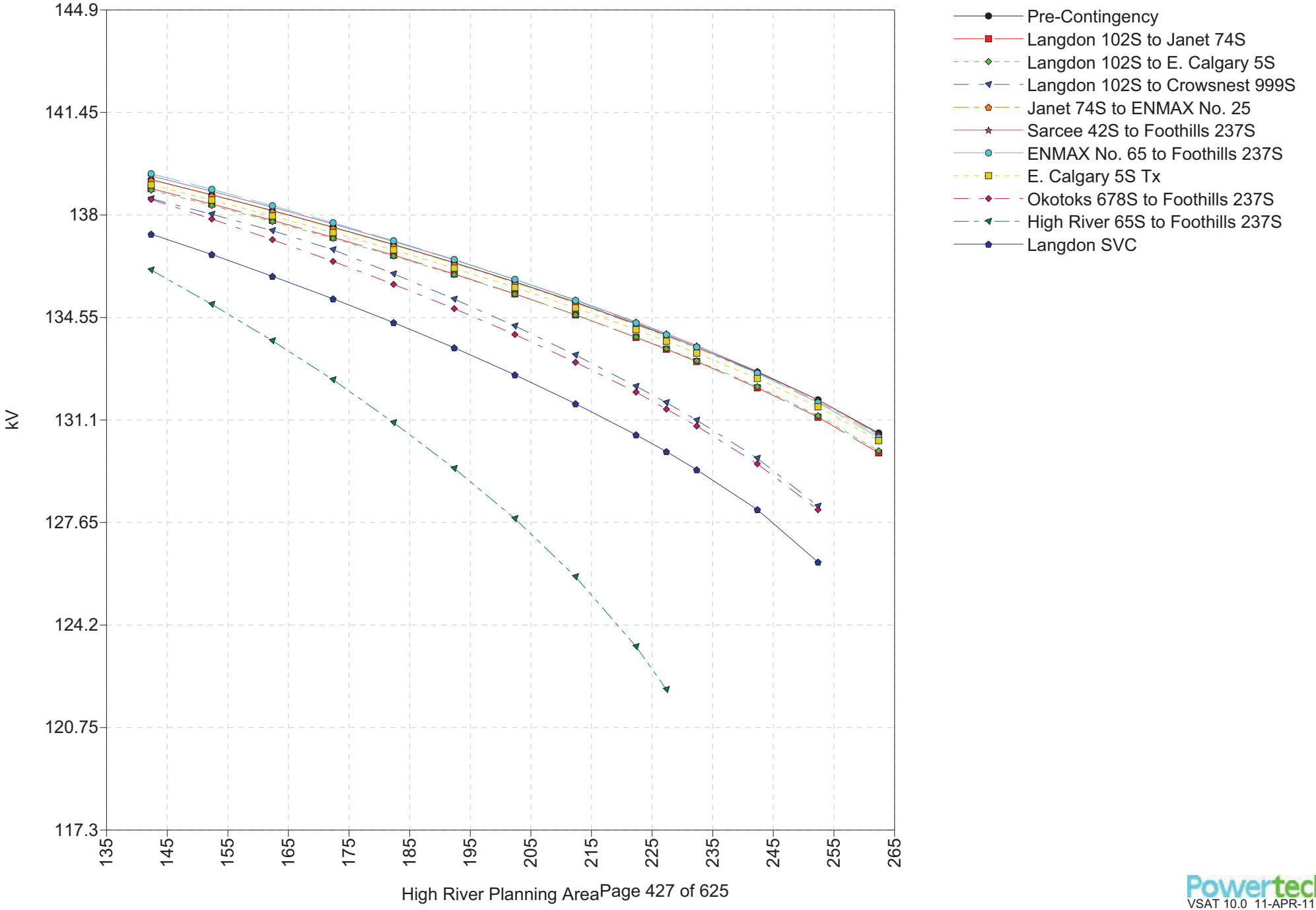
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
138 OKOTOKS 678S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-138-SC1-HR-4

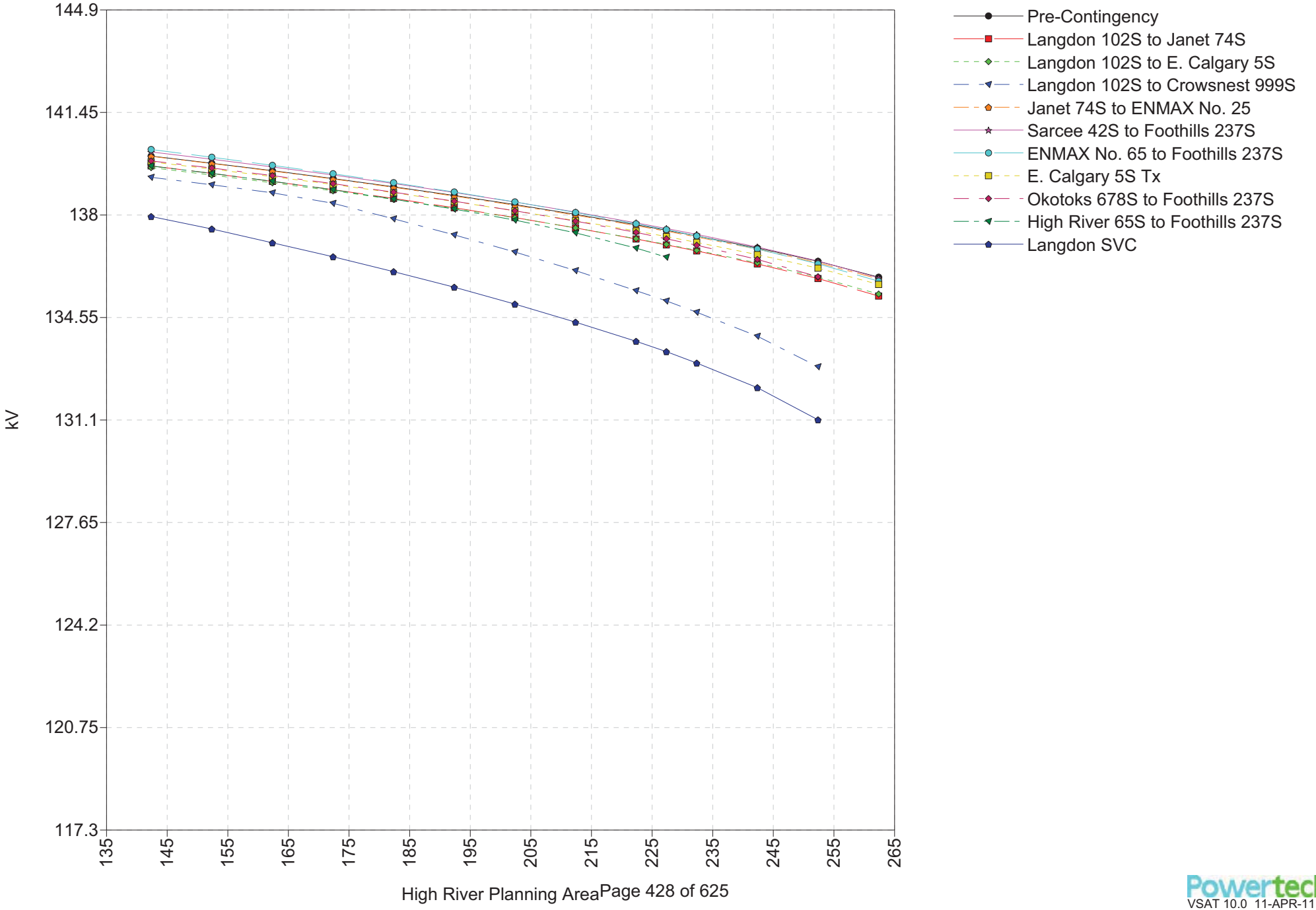
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
138 HIGH RIVER 65S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-138-SC1-HR-5

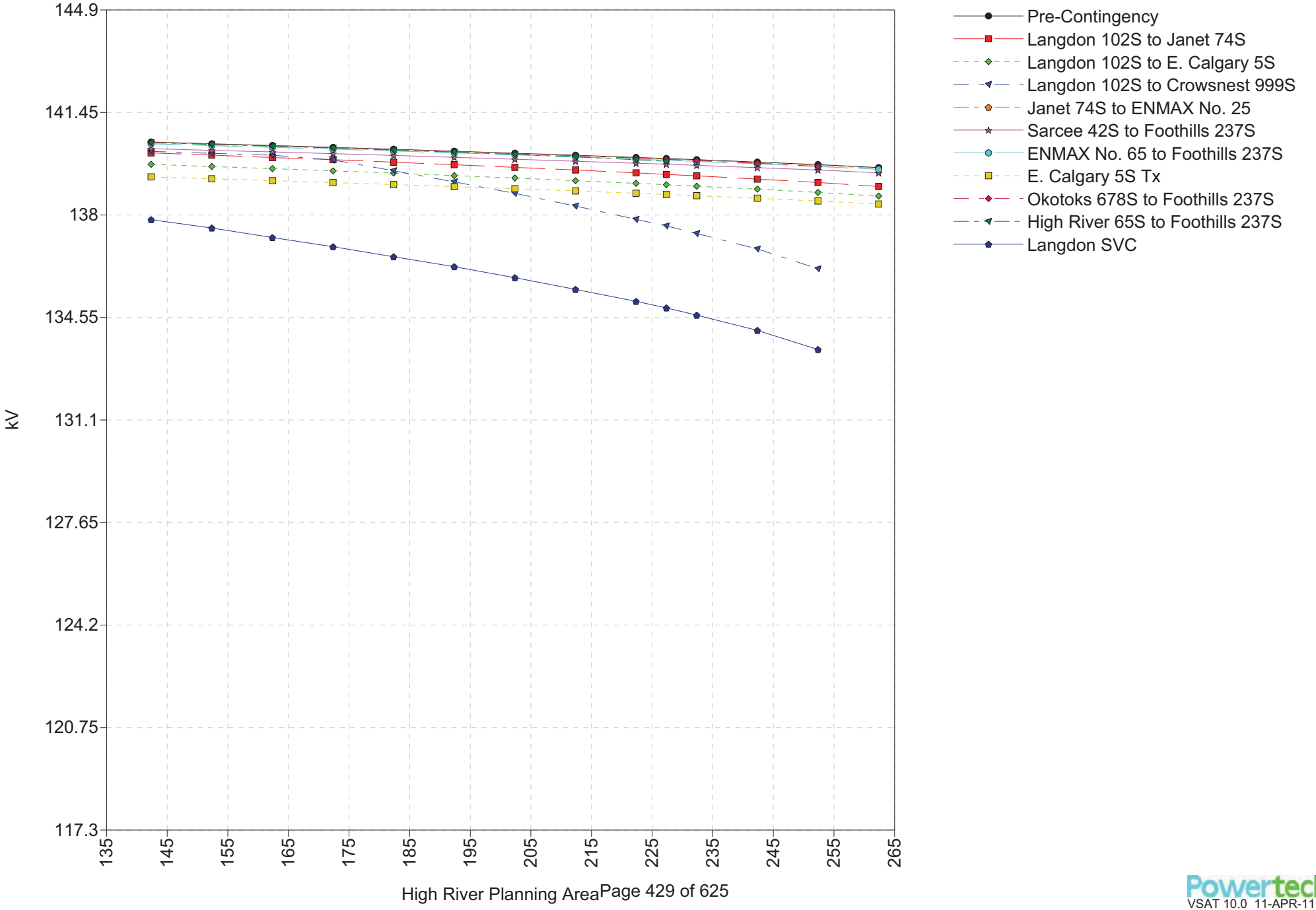
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
138 FOOTHILLS 237S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-138-SC1-HR-6

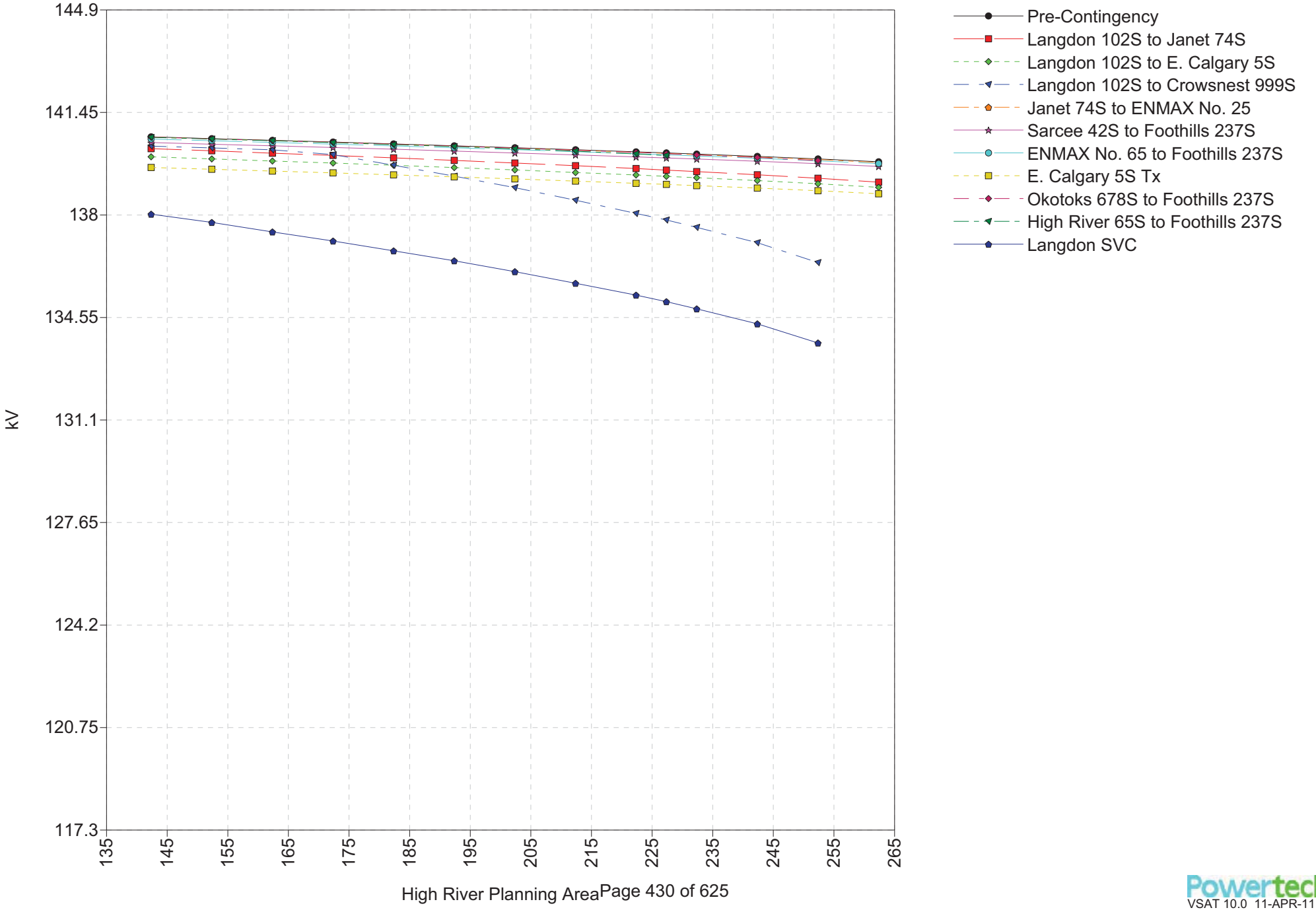
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
138 ENMAX No. 2 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-138-SC1-HR-7

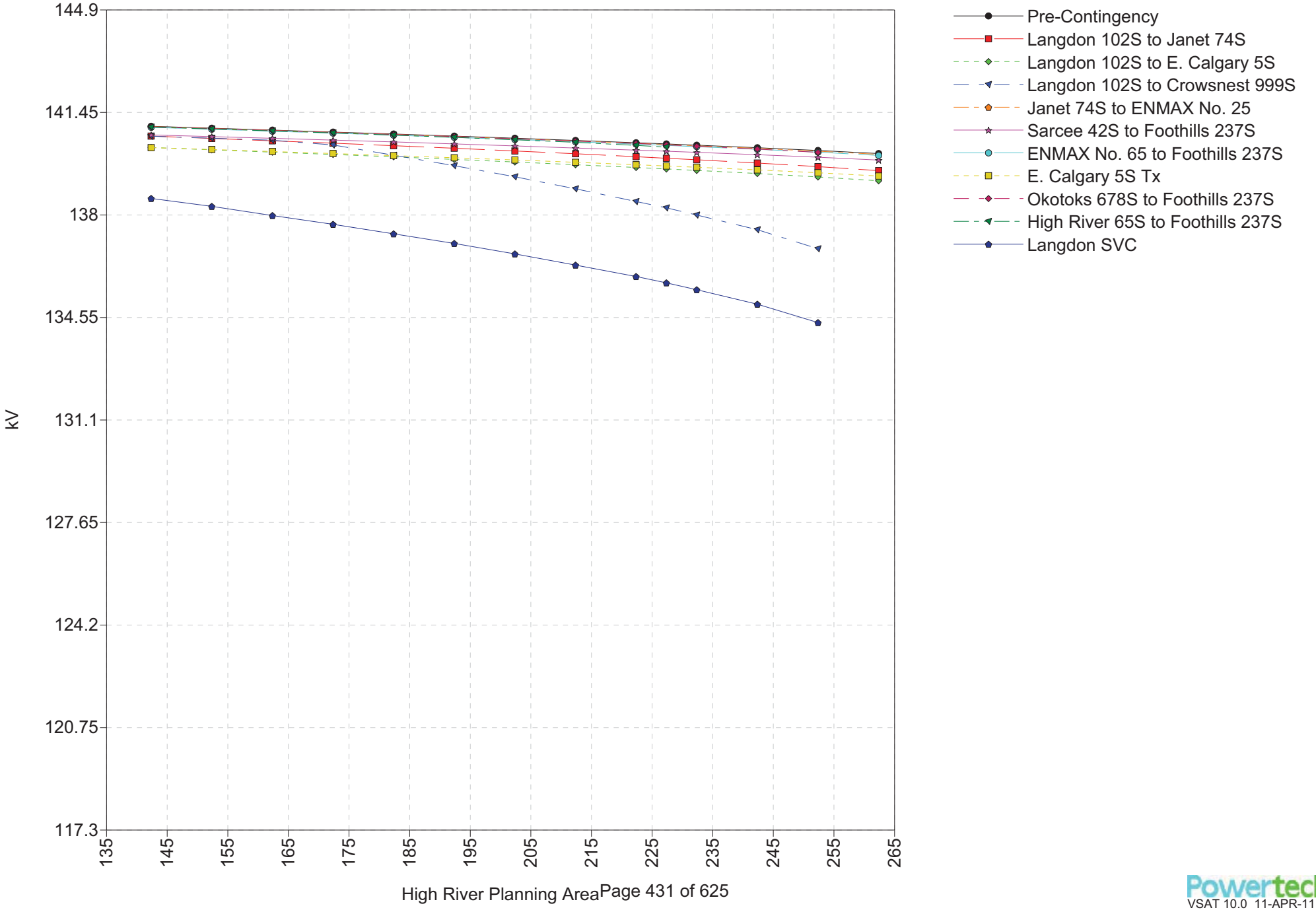
FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
138 ENMAX No. 23 Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

Figure K-138-SC1-HR-8

FATD 2019 SP ST4 SC1 HR
Increase High River Area Load
138 SARCEE 42S Bus Voltage (kV)



Powertech
VSAT 10.0 11-APR-11 13:10

ATTACHMENT L

Proposed Alternative

Transient Stability Analysis

2014

Table L-1

Figure Name	Contingency
Figure L-2014-Step4-Scx[1] -1	Fault on 925L 240kV line (Red Deer 63S to Janet 74S)
Figure L-2014-Step4-Scx-2	Fault on 1064L 240kV line (Langdon 102S to Janet 74S)
Figure L-2014-Step4-Scx-3	Fault on 936L 240kV line (Langdon 102S to East Calgary 5S)
Figure L-2014-Step4-Scx-4	Fault on 927L 240kV line (Langdon 102S to Sub G)
Figure L-2014-Step4-Scx-5	Fault on 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure L-2014-Step4-Scx-6	Fault on 932L 240kV line (Janet 74S to Beddington SS-162)
Figure L-2014-Step4-Scx-7	Fault on 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure L-2014-Step4-Scx-8	Fault on 1066L 240kV line (Sarcee 42S to Foothills 237S)
Figure L-2014-Step4-Scx-9	Fault on 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)
Figure L-2014-Step4-Scx-10	Fault on 1106L 240kV line (ENMAX No. 65 to Foothills 237S)
Figure L-2014-Step4-Scx-11	Fault on 765L 138kV line (Janet 74S to Strathmore 151S)
Figure L-2014-Step4-Scx-12	Fault on 23.80L 138kV line (Janet 74S to ENMAX No. 23)
Figure L-2014-Step4-Scx-13	Fault on 24.83L 138kV line (Janet 74S to ENMAX No. 24)
Figure L-2014-Step4-Scx-14	Fault on 2.80L 138kV line (Enmax 2 to ENMAX No. 23)
Figure L-2014-Step4-Scx-15	Fault on 850L 138 kV line (Okotoks 678S to Carseland 525S)
Figure L-2014-Step4-Scx-16	Fault on 646L 138 kV line (Okotoks 678S to Foothills 237S)
Figure L-2014-Step4-Scx-17	Fault on 434L 138 kV line (High River 65S to Foothills 237S)

[1] "Scx" represents a load/generation scenario. In the corresponding figure "Scx" is replaced by one of the Sc1, Sc2, Sc3, Sc4, or Sc6 scenarios. Definitions of the scenarios are given in the following table:

Scenario	Load Condition
Sc1	Summer Peak (SP), no wind generation, no local generation, ~780 MW import from BC
Sc2	SP, full wind generation, no local generation, ~0 MW import from BC
Sc3	SP, full wind generation, Saddlebrook generation online, ~0 MW import from BC
Sc4	SP, full wind generation, Saddlebrook and Shepard generation online, ~0 MW import from BC
Sc6	System Light (SL), full wind generation, no local generation, ~0 MW import from BC

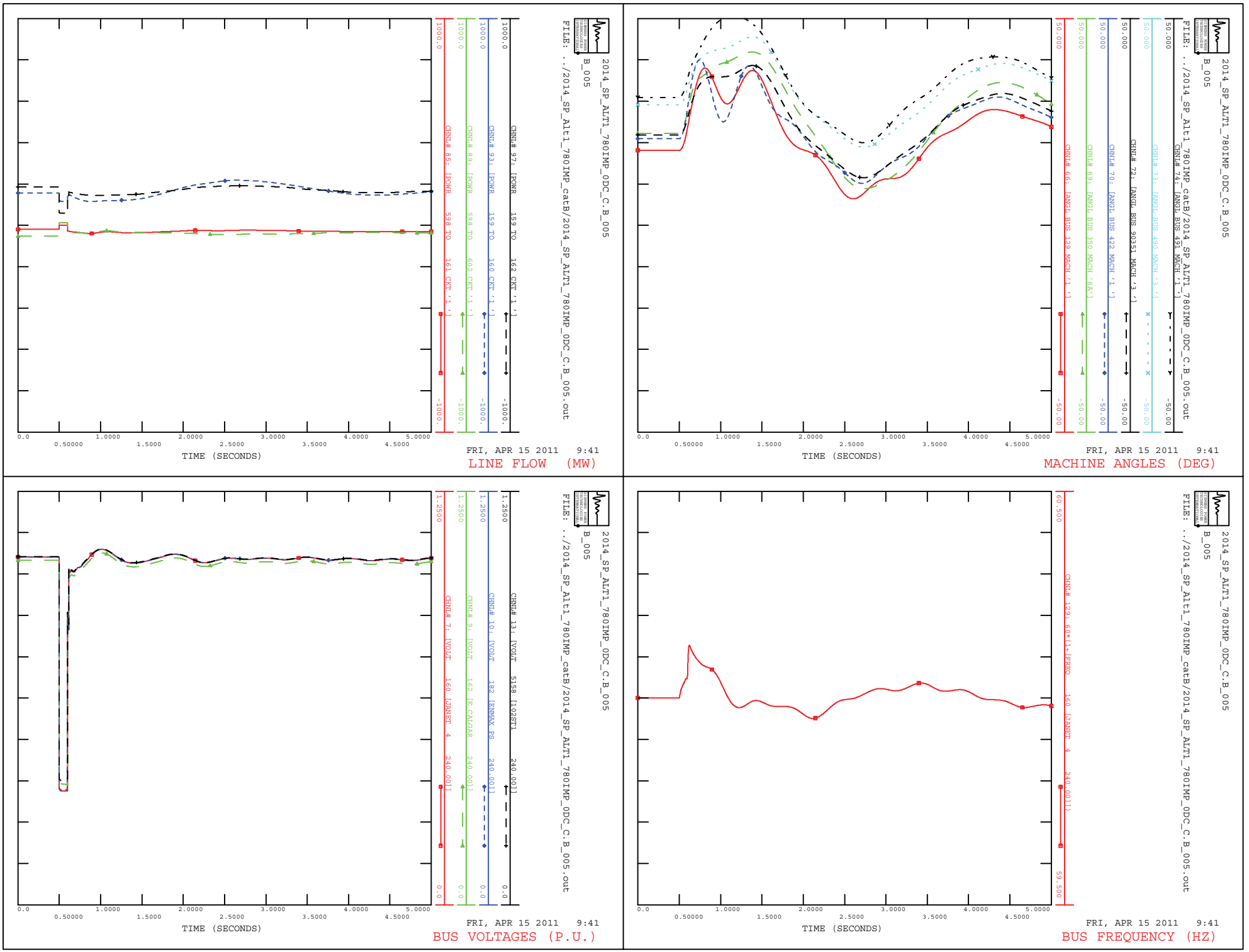


Figure L-2014-Step4-Sc1-1

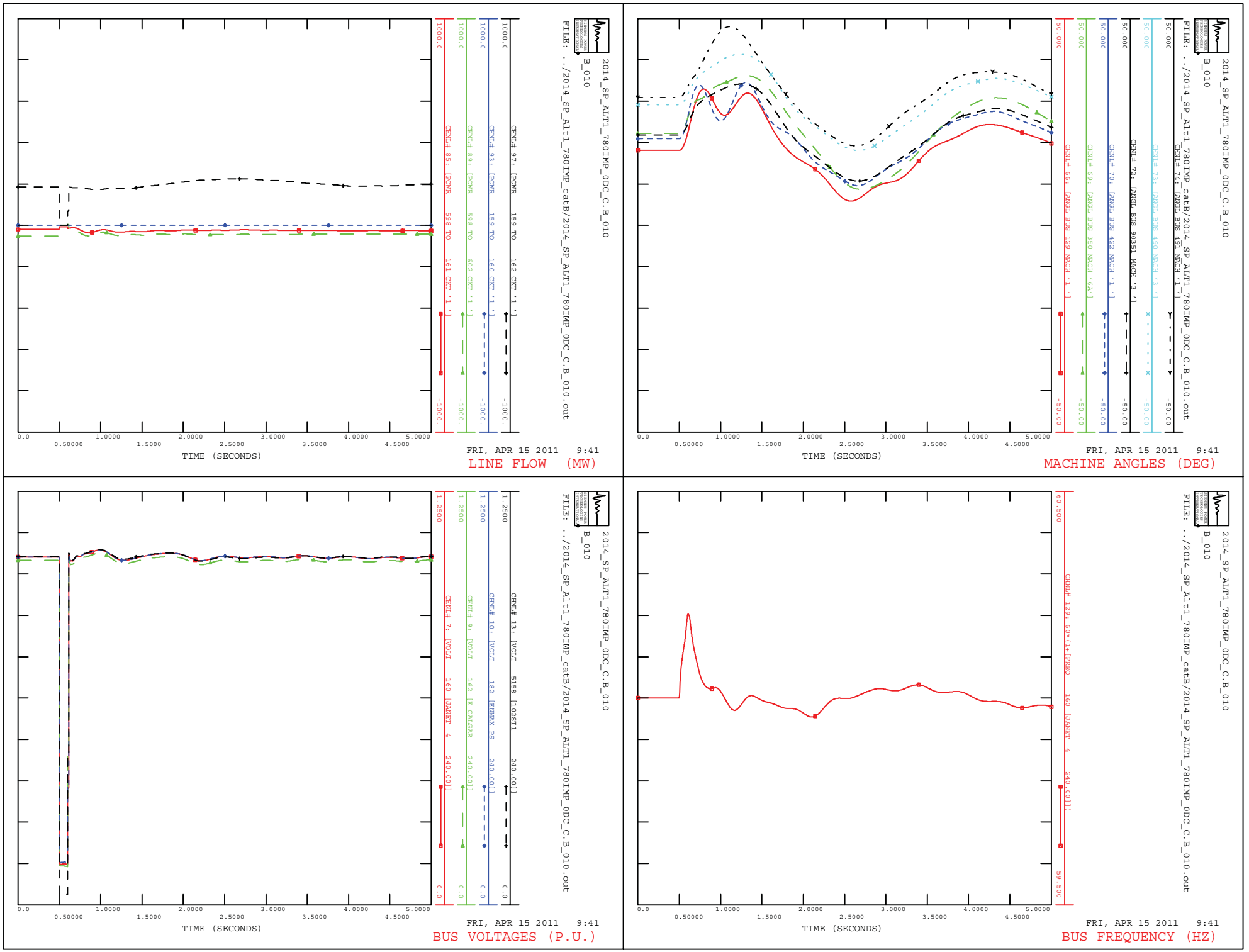


Figure L-2014-Step4-Sc1-2

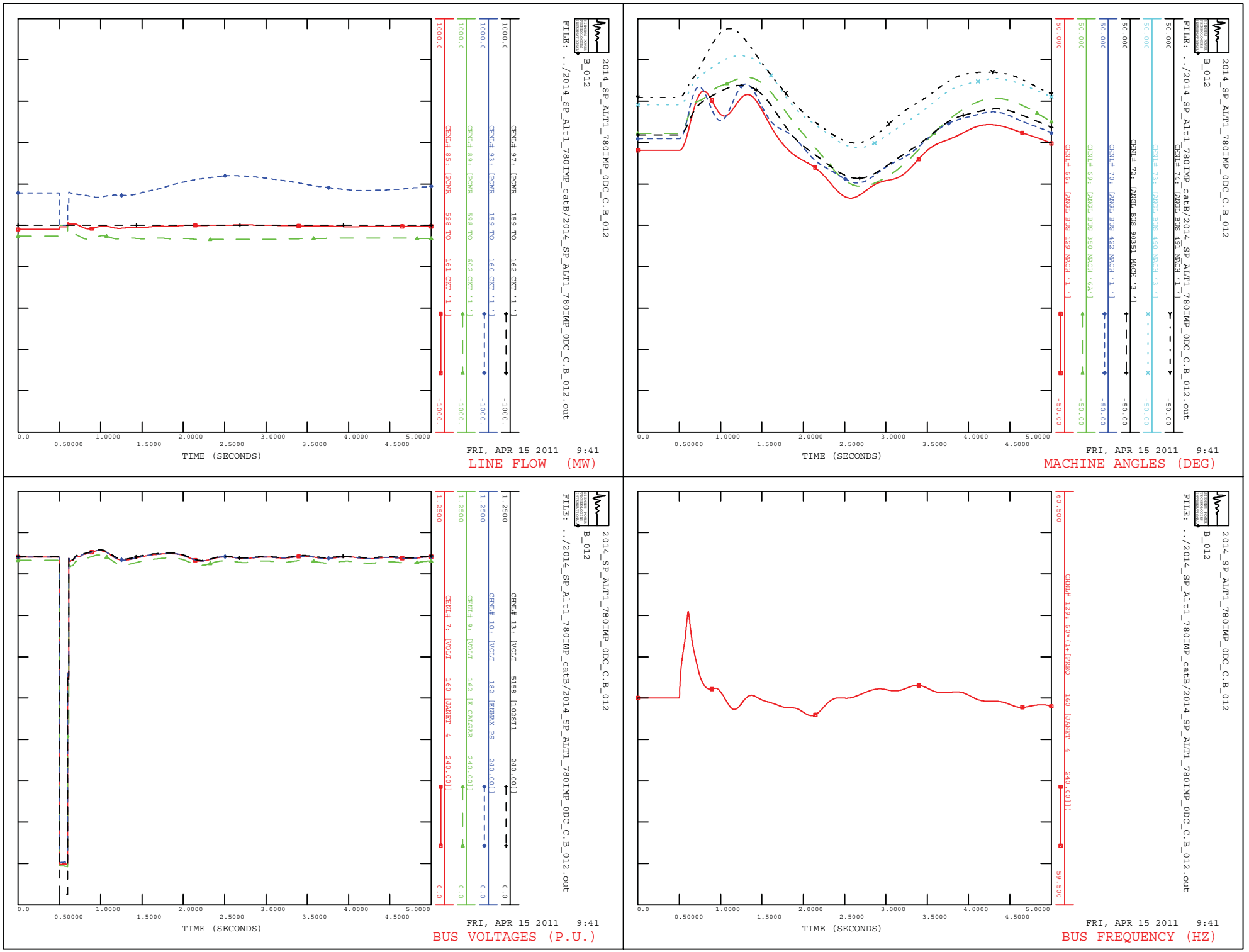


Figure L-2014-Step4-Sc1-3

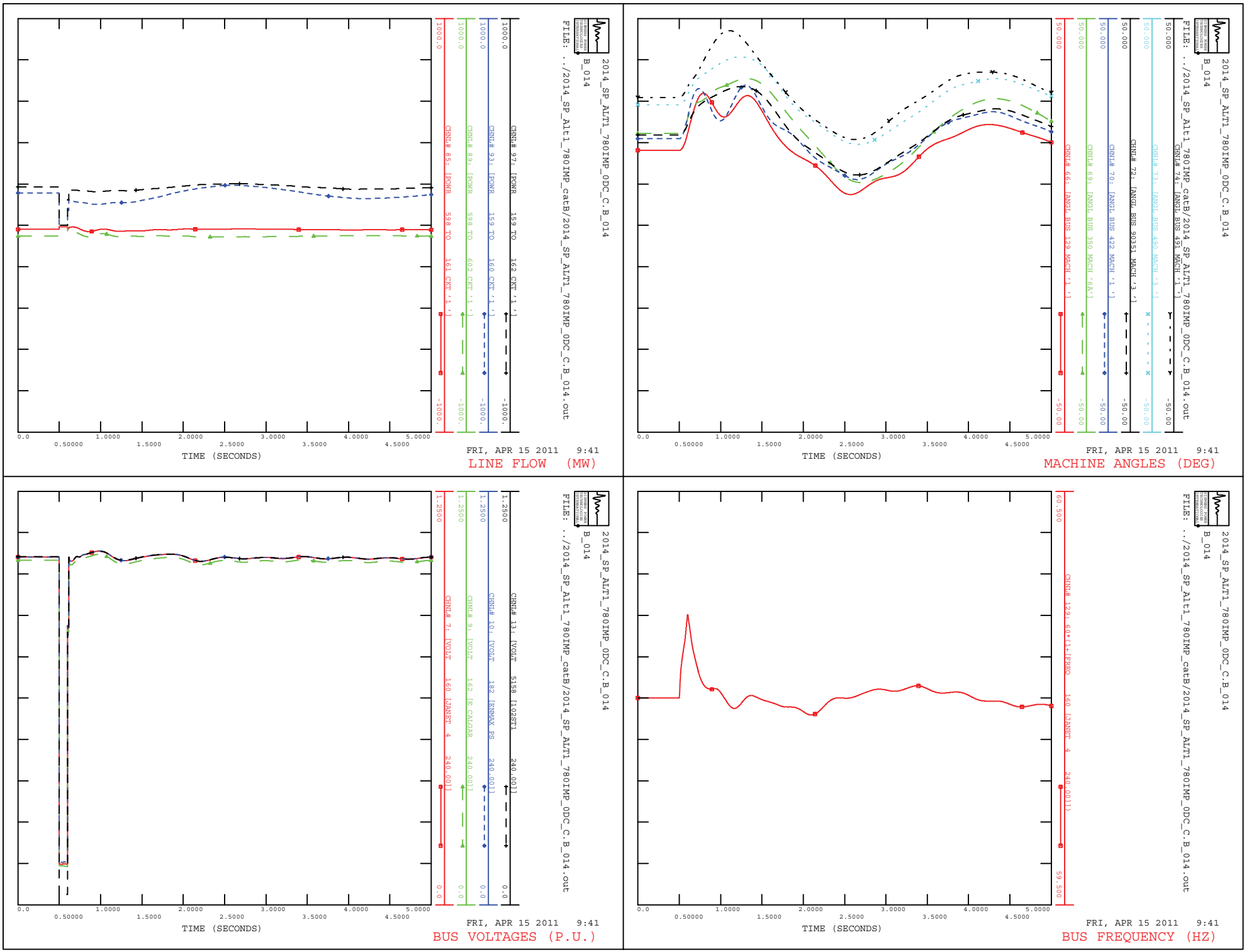


Figure L-2014-Step4-Sc1-4

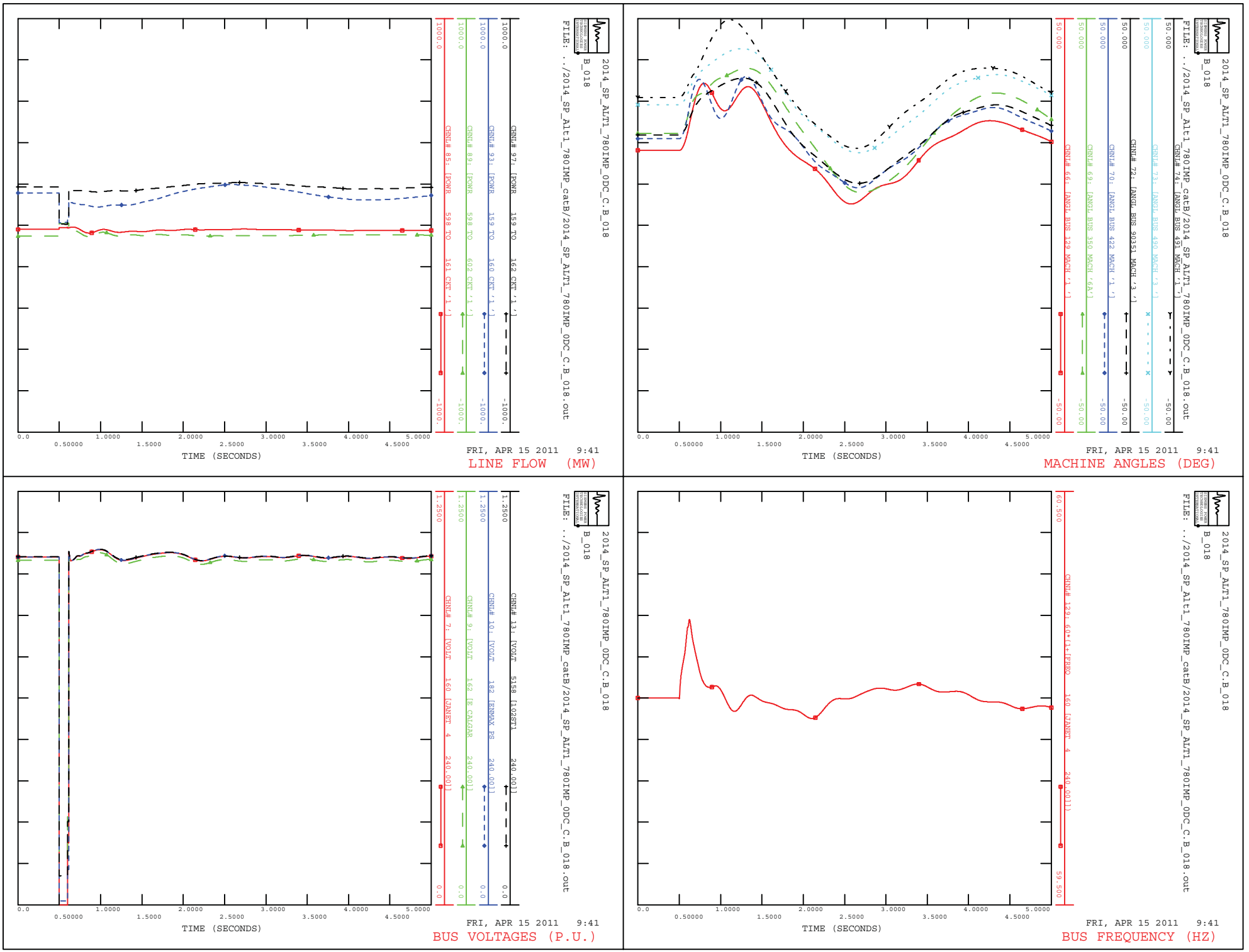


Figure L-2014-Step4-Sc1-5

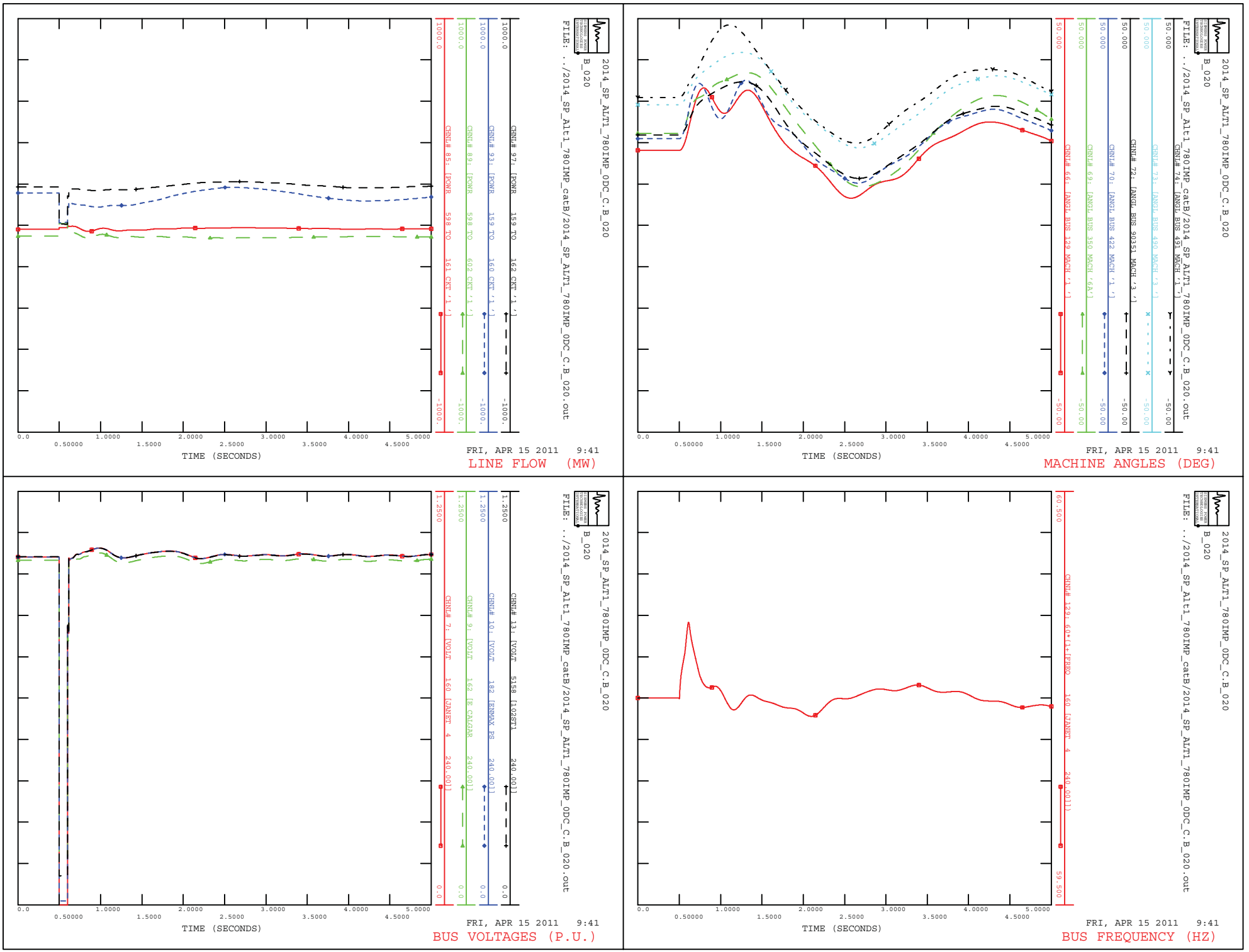


Figure L-2014-Step4-Sc1-6

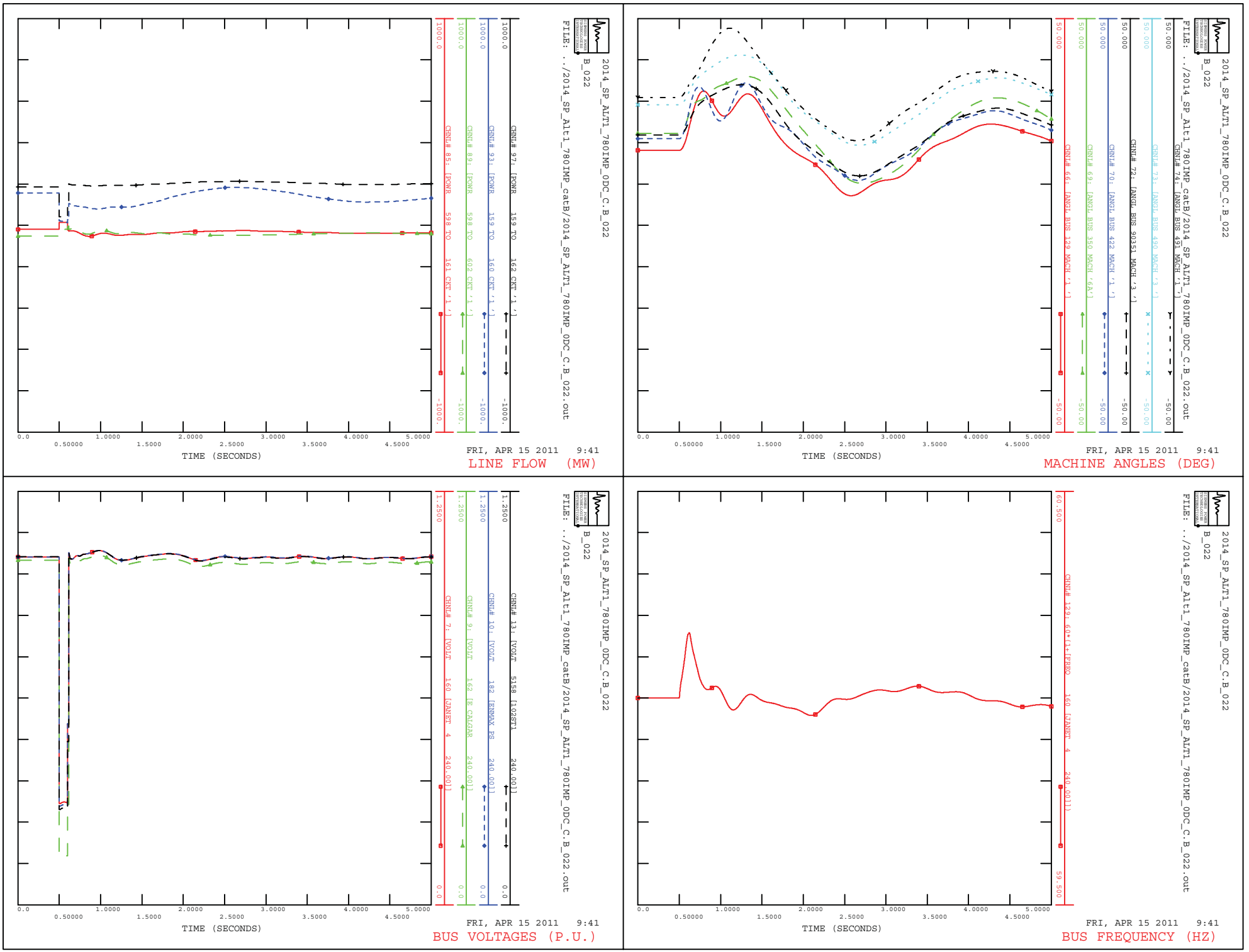


Figure L-2014-Step4-Sc1-7

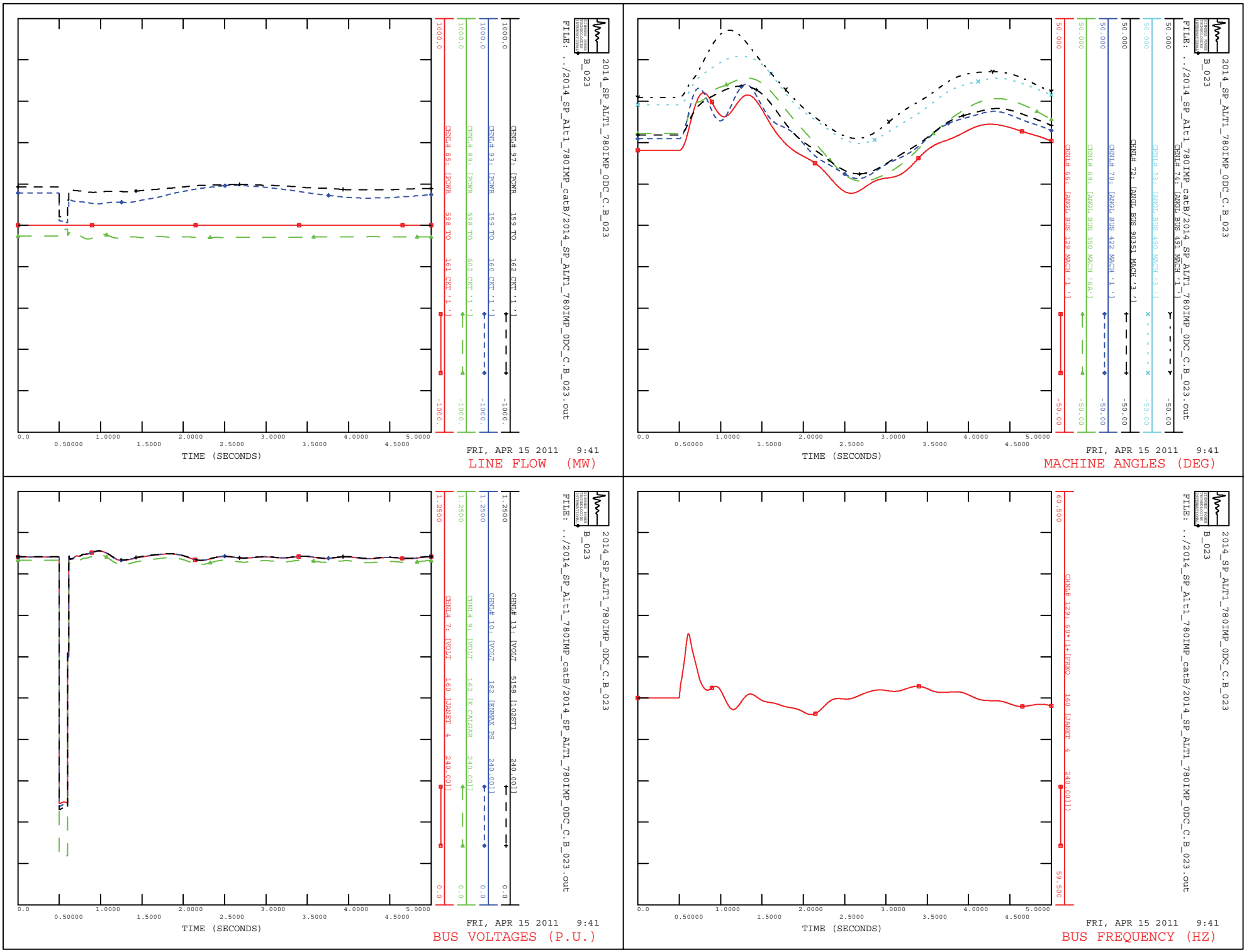


Figure L-2014-Step4-Sc1-8

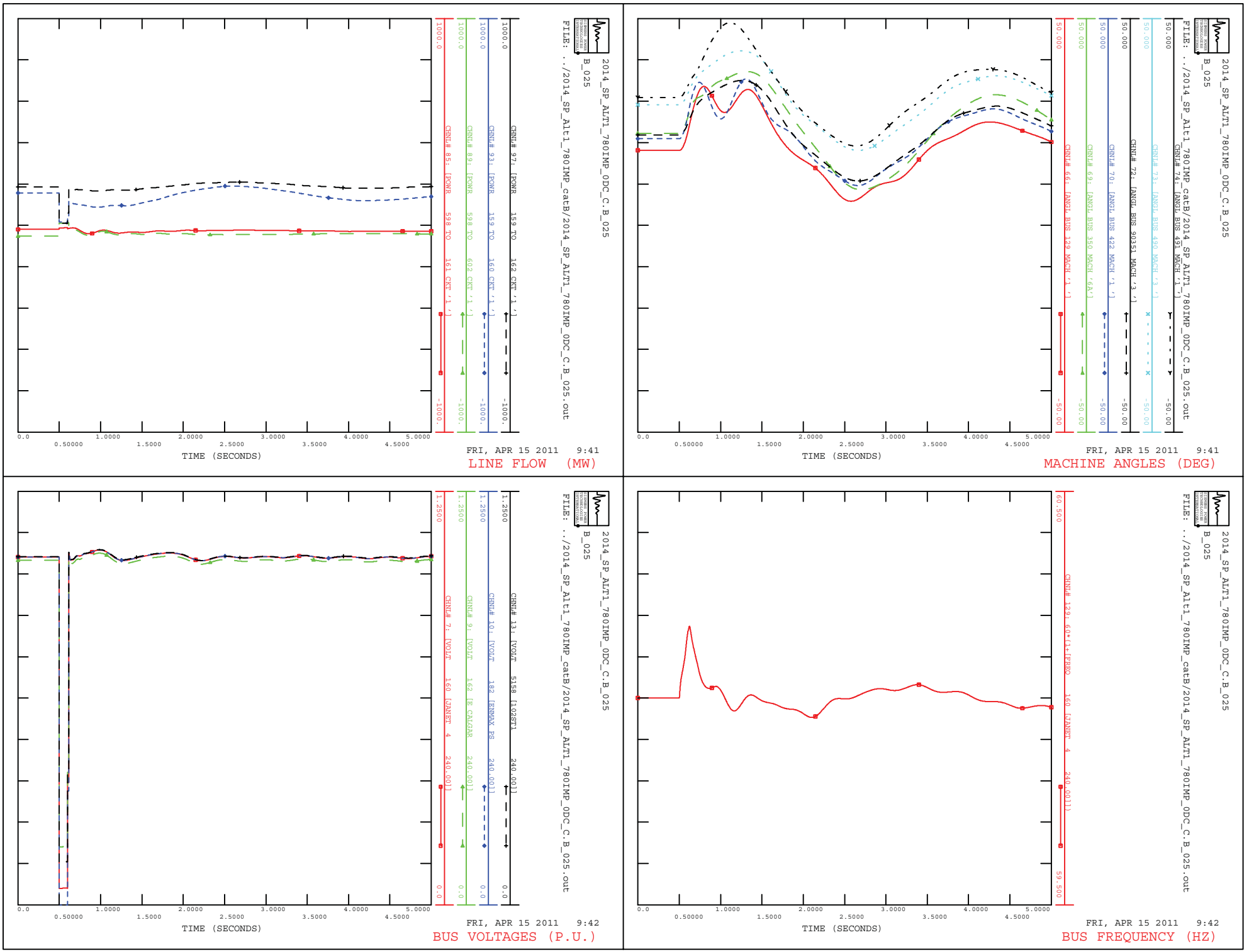


Figure L-2014-Step4-Sc1-9

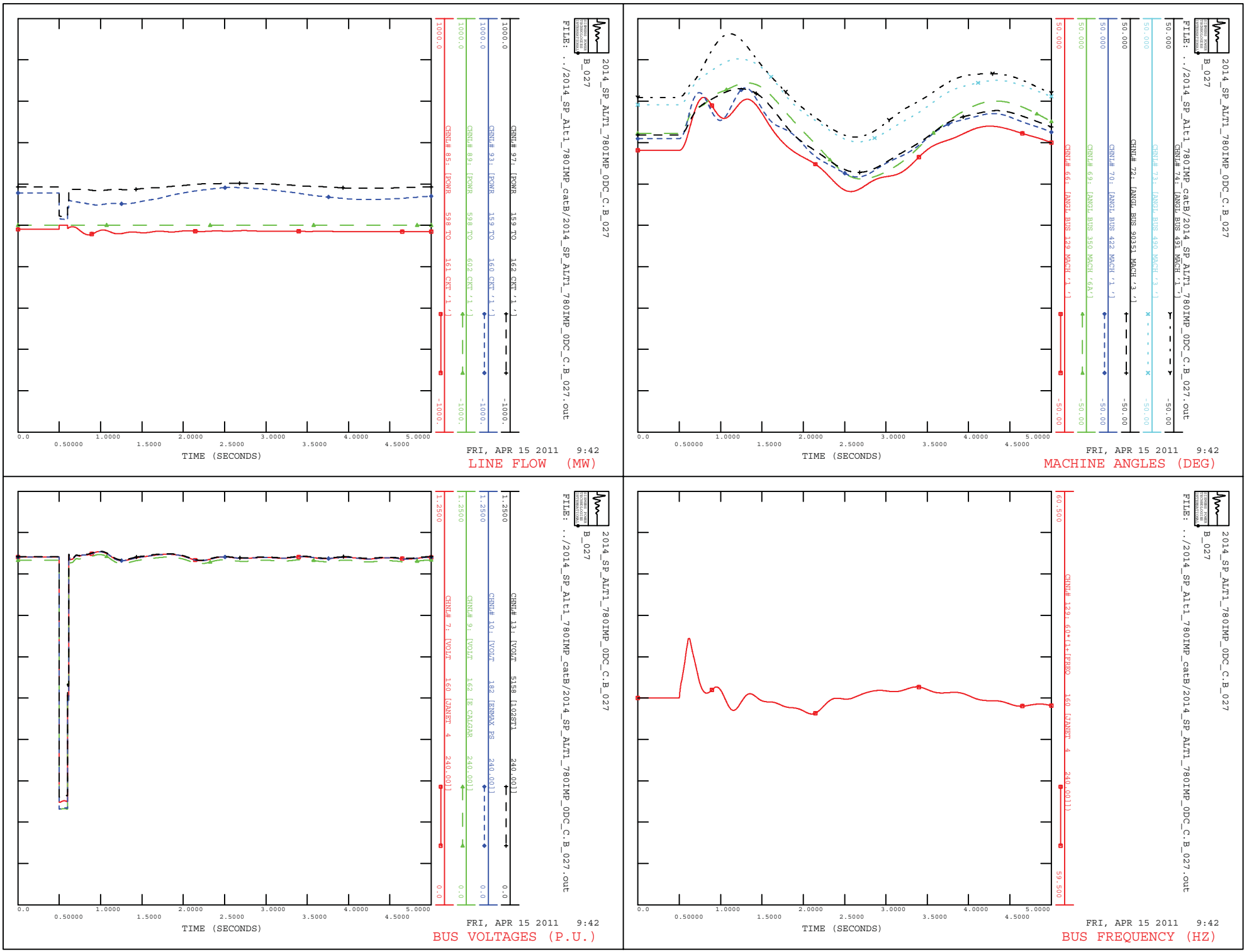


Figure L-2014-Step4-Sc1-10

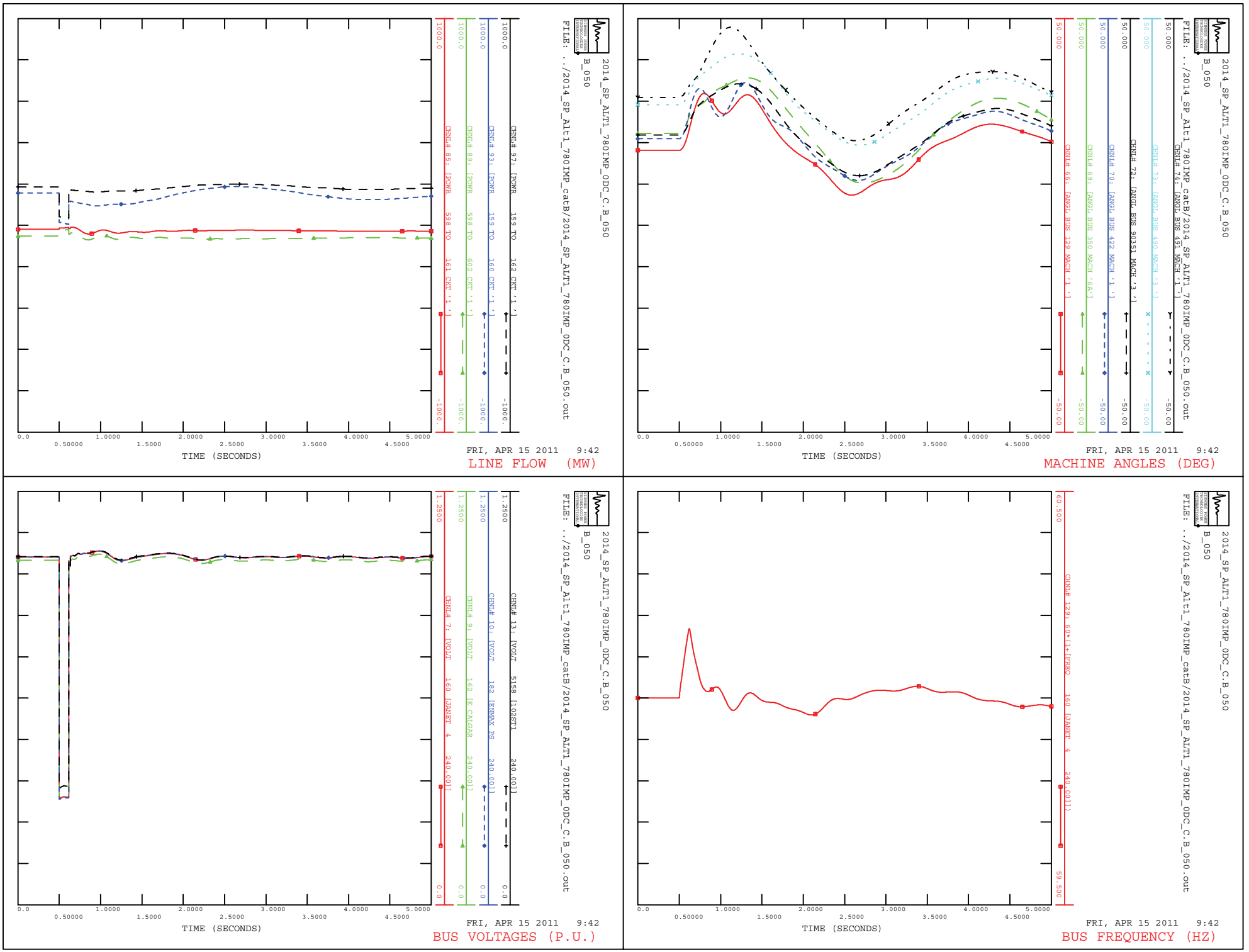


Figure L-2014-Step4-Sc1-11

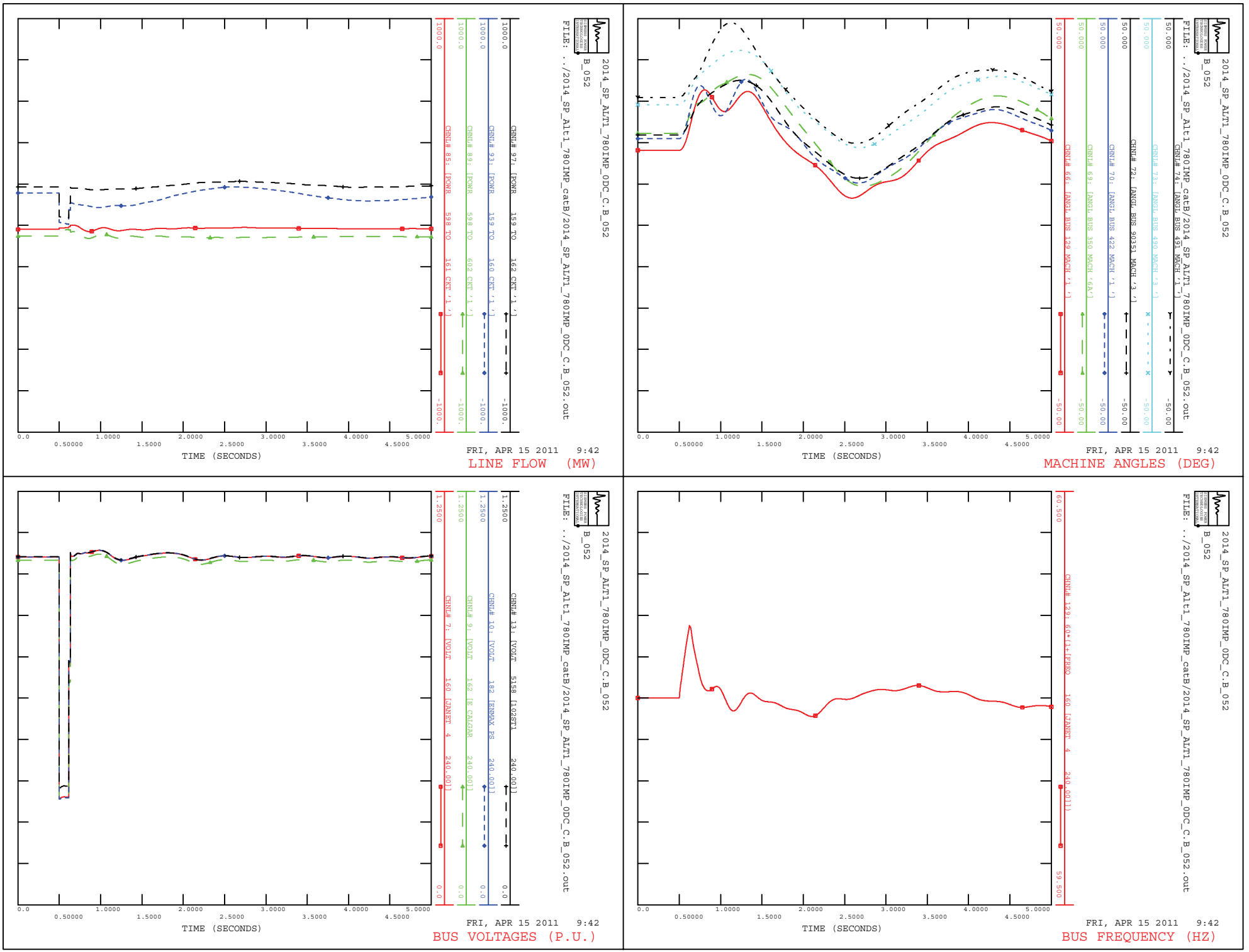


Figure L-2014-Step4-Sc1-12

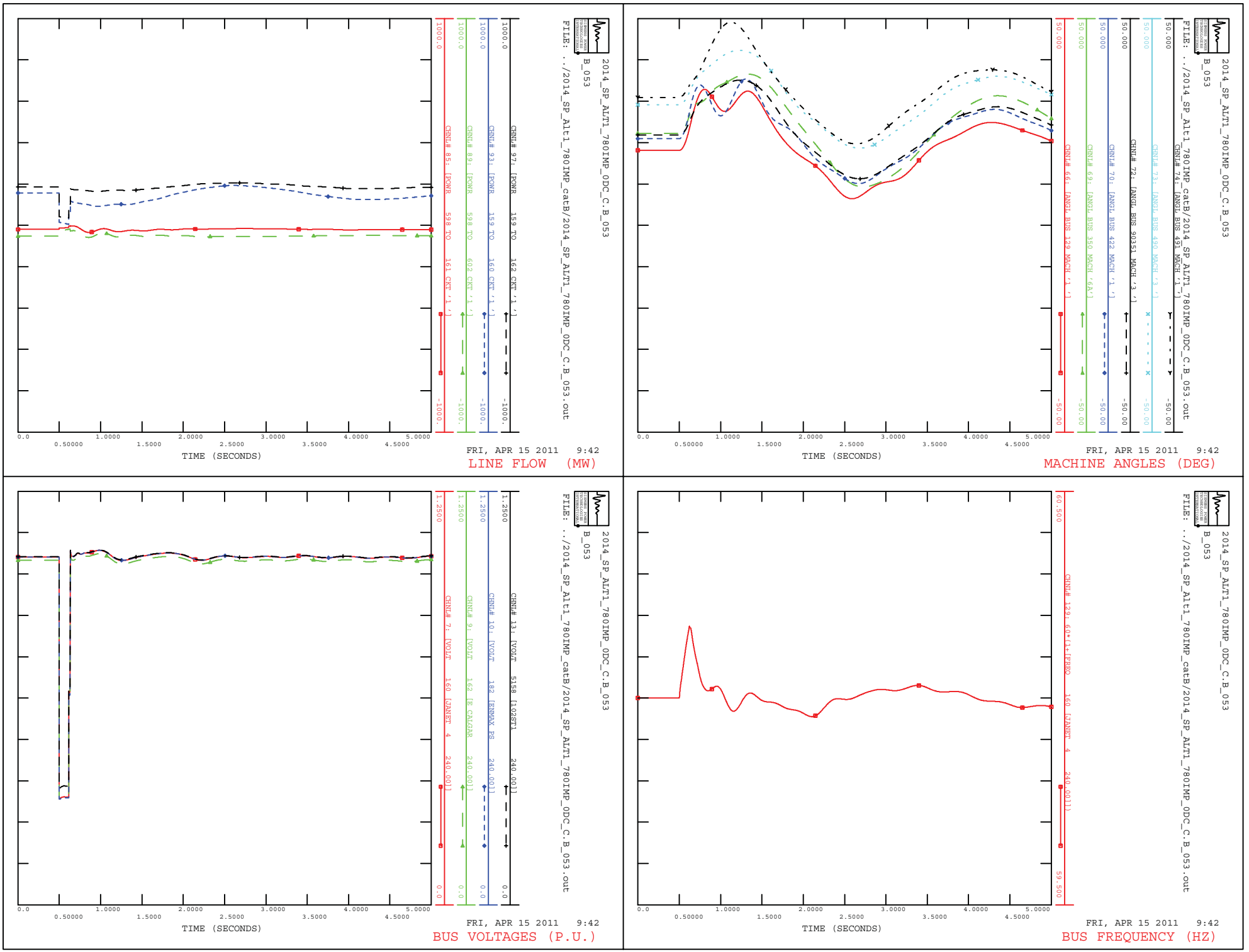


Figure L-2014-Step4-Sc1-13

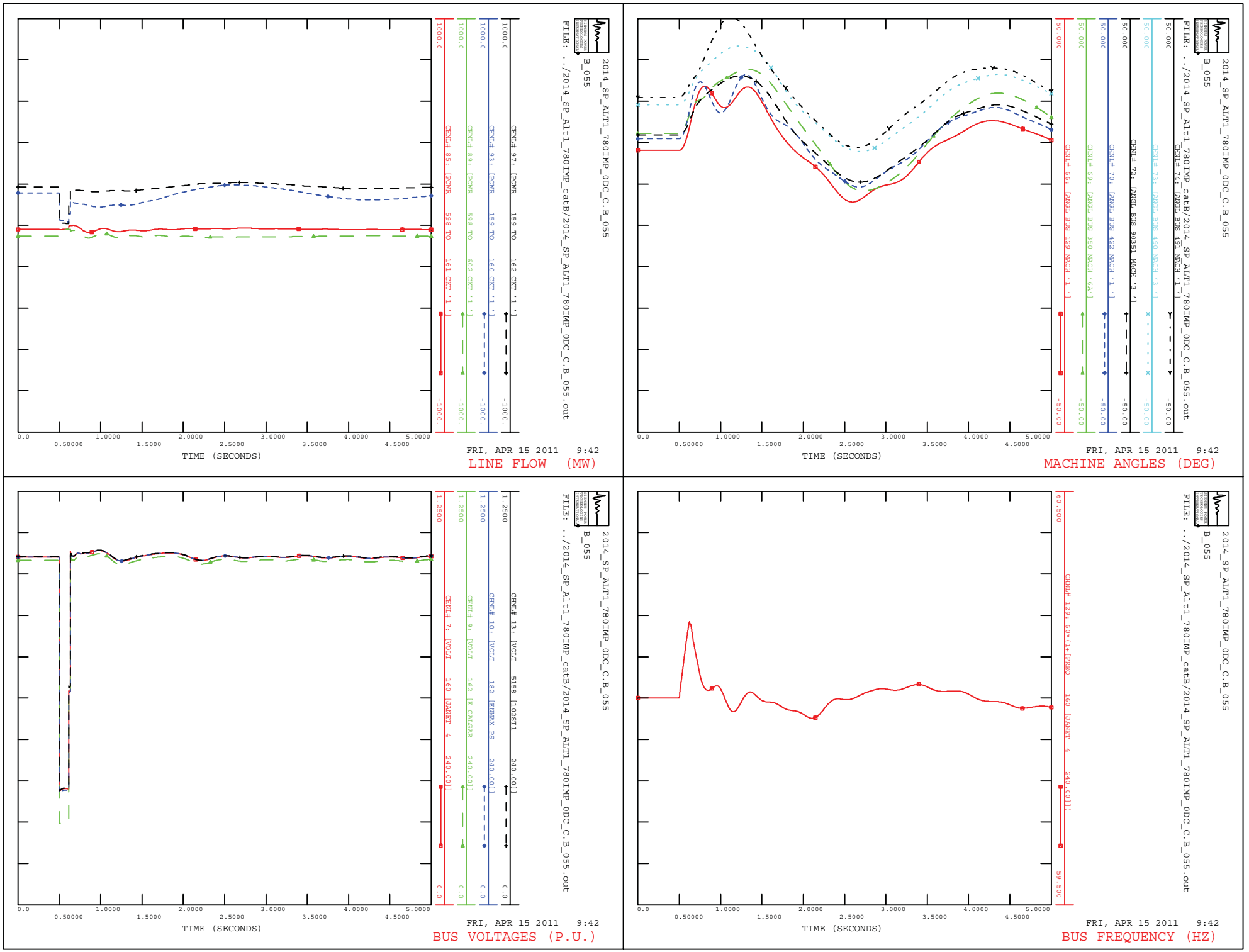


Figure L-2014-Step4-Sc1-14

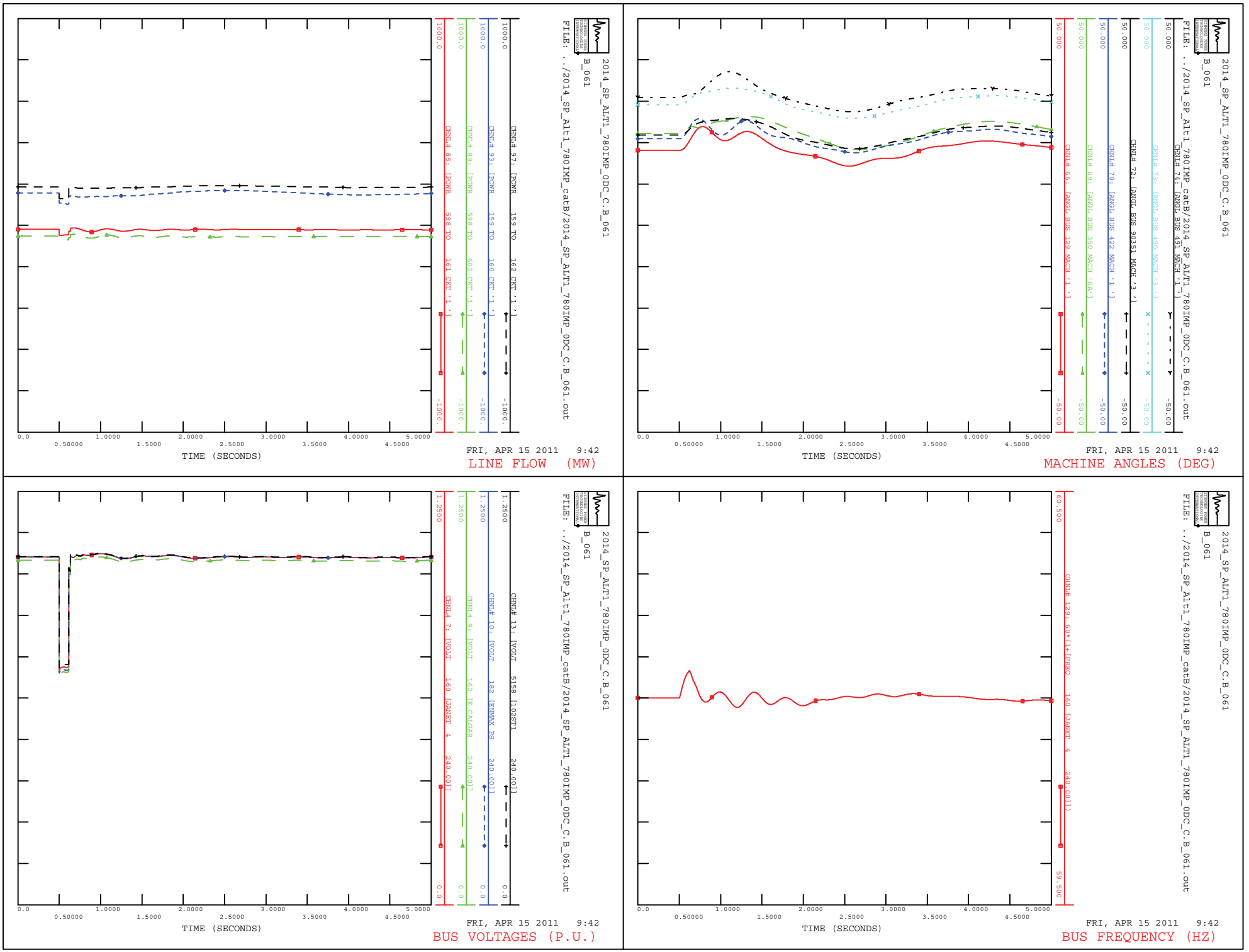


Figure L-2014-Step4-Sc1-15

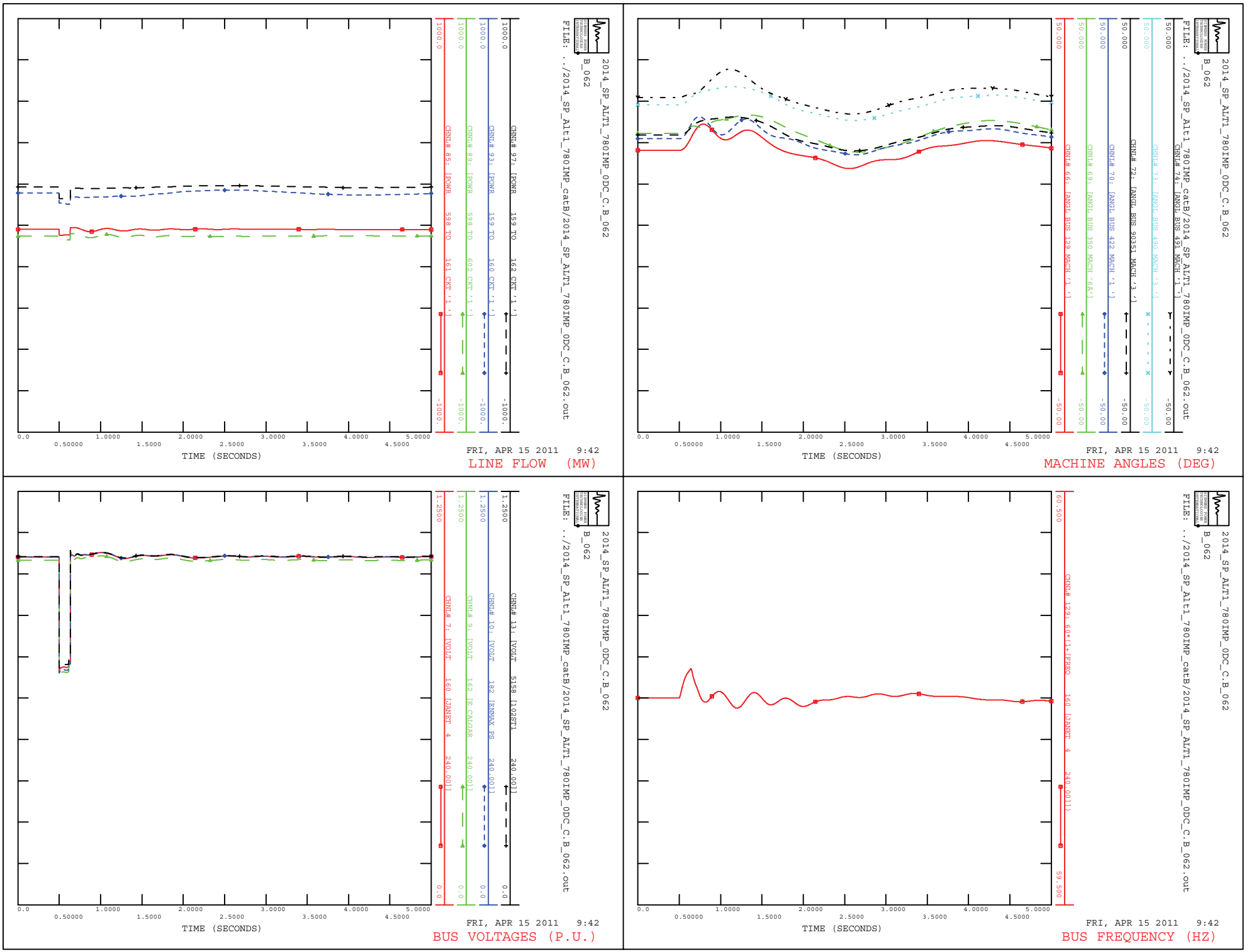


Figure L-2014-Step4-Sc1-16

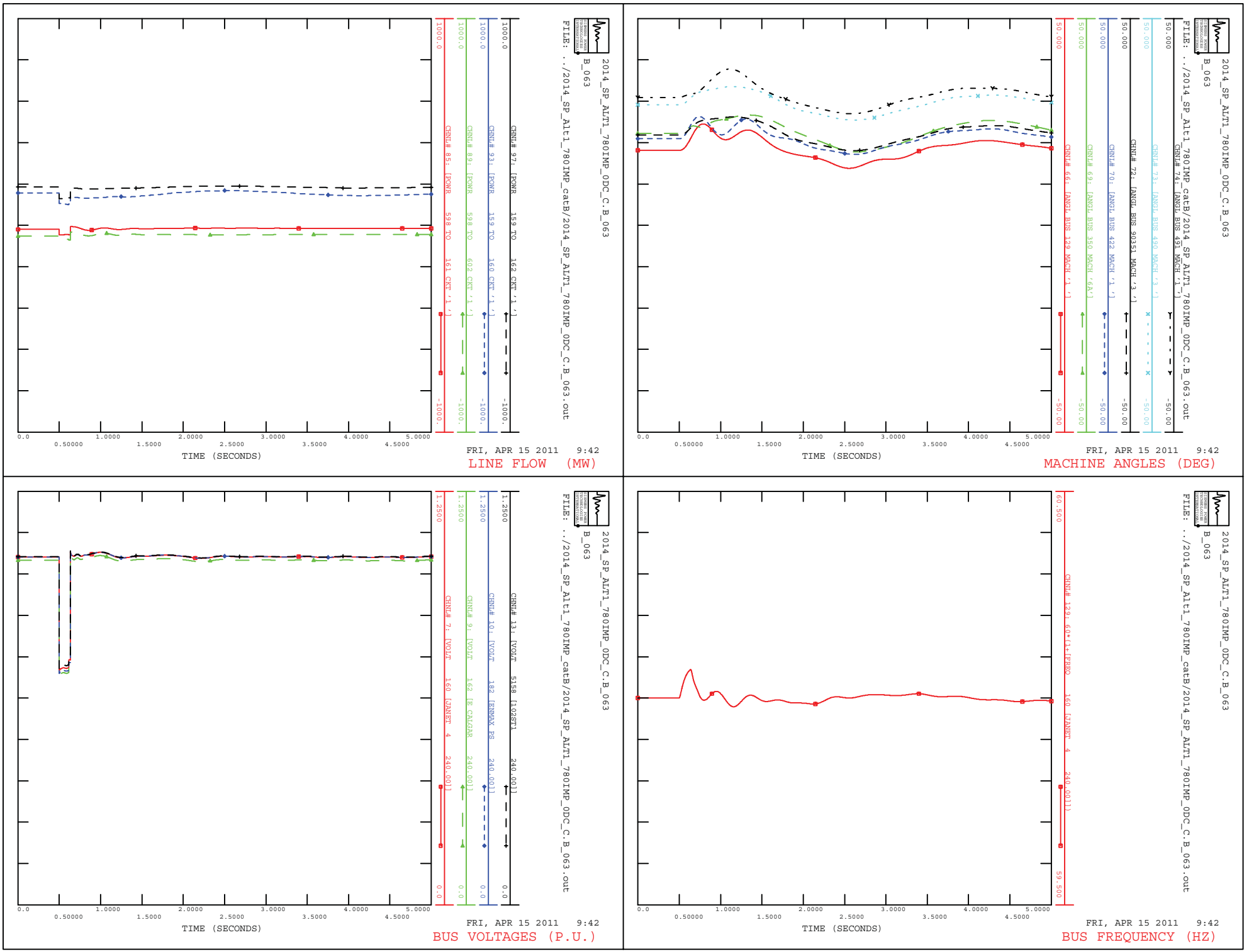


Figure L-2014-Step4-Sc1-17

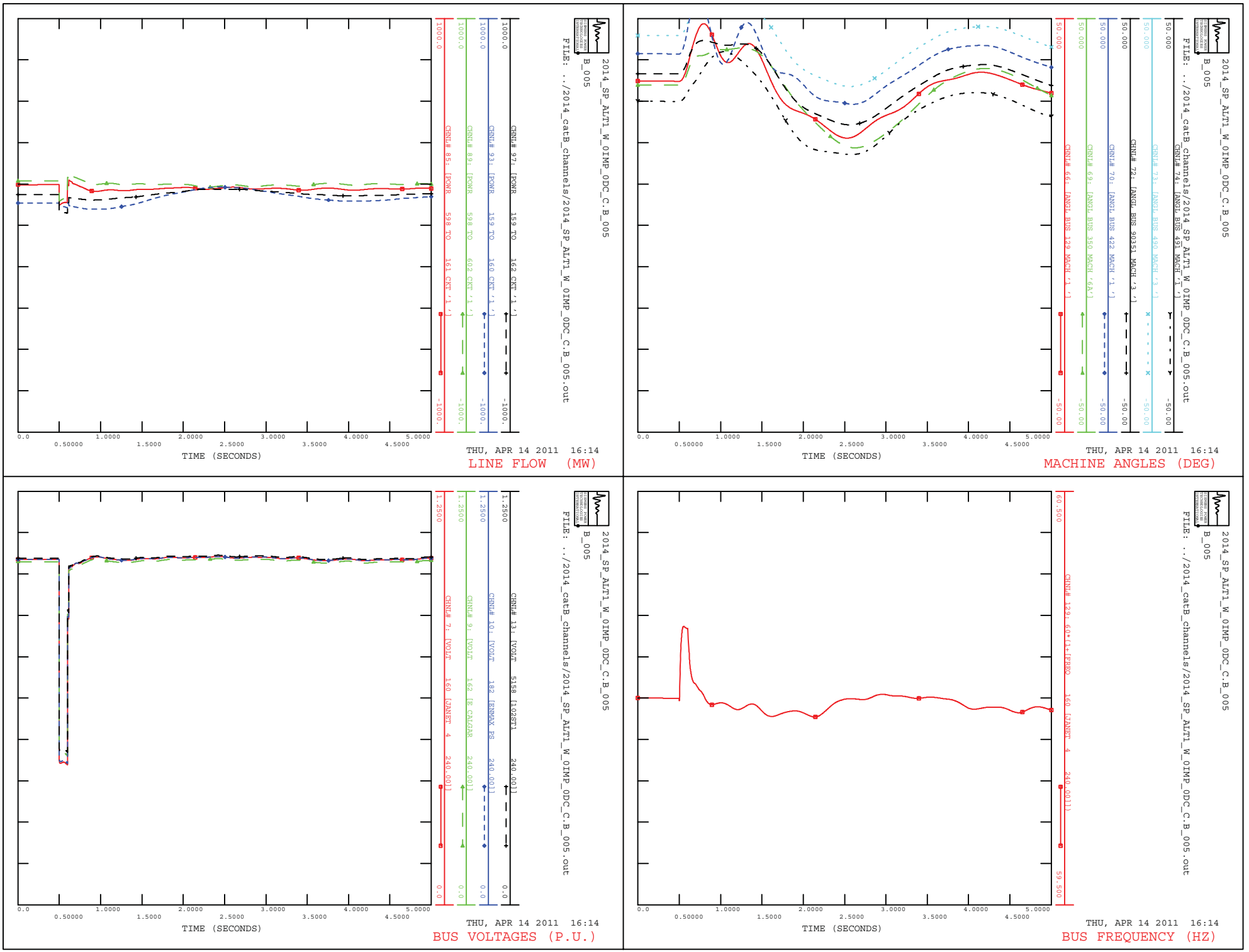


Figure L-2014-Step4-Sc2-1

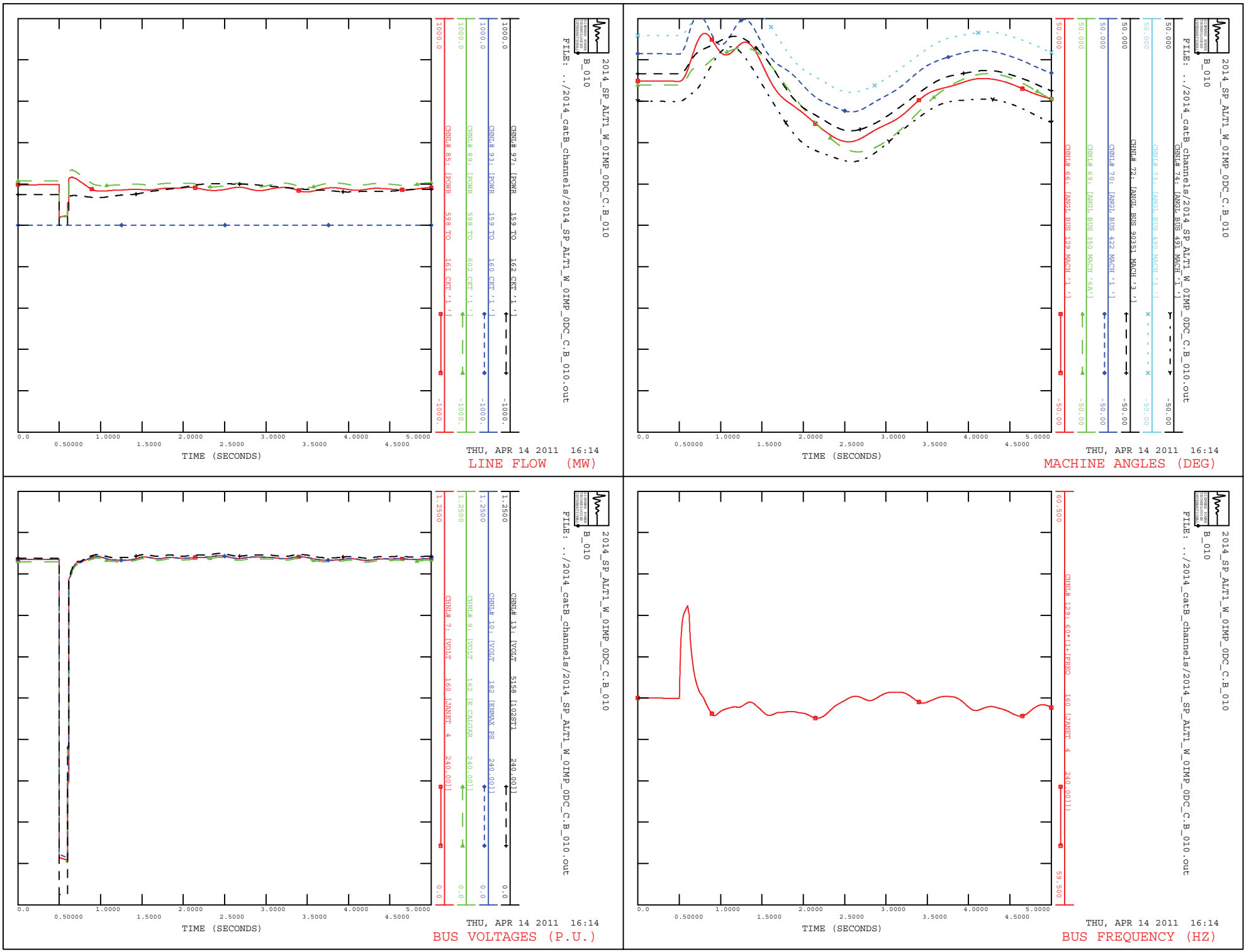


Figure L-2014-Step4-Sc2-2

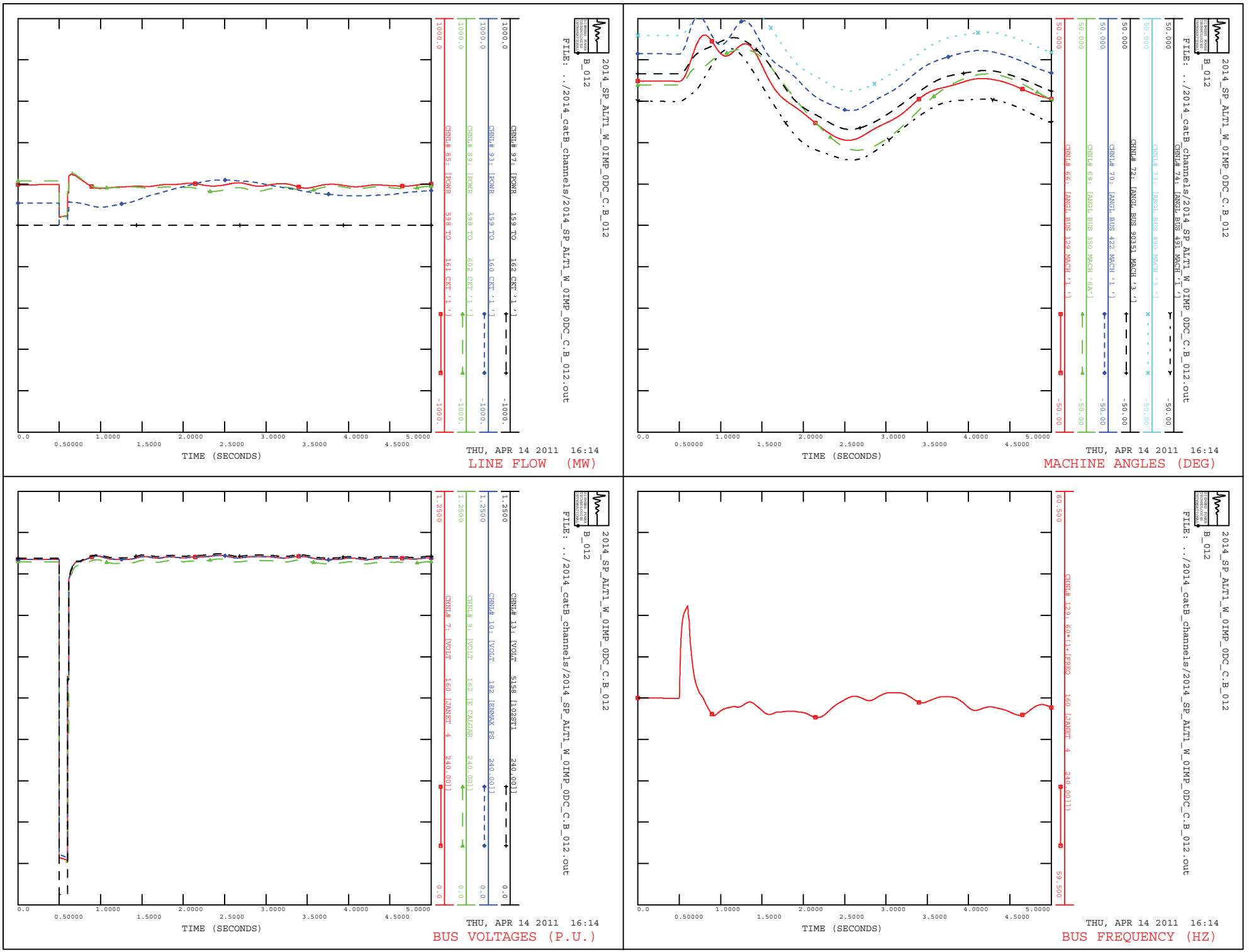
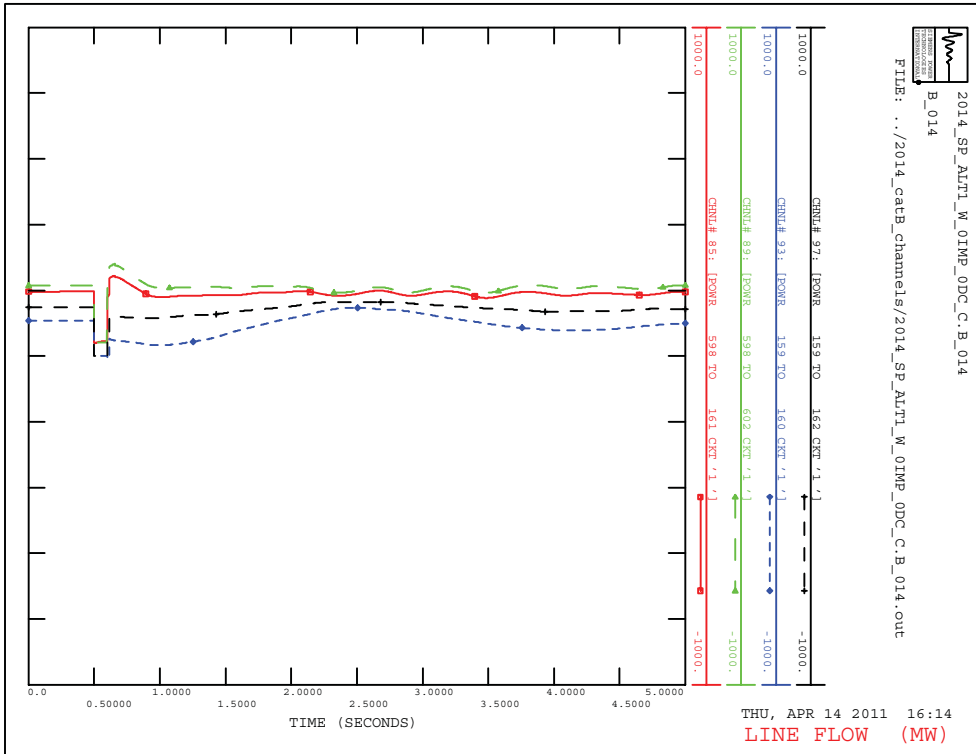
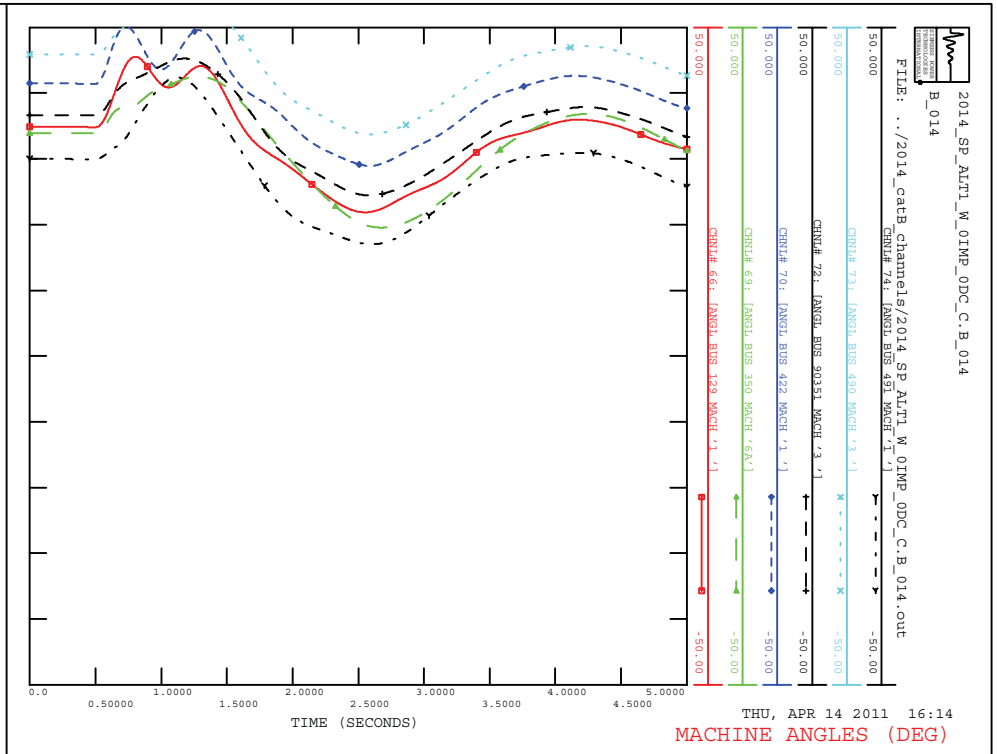
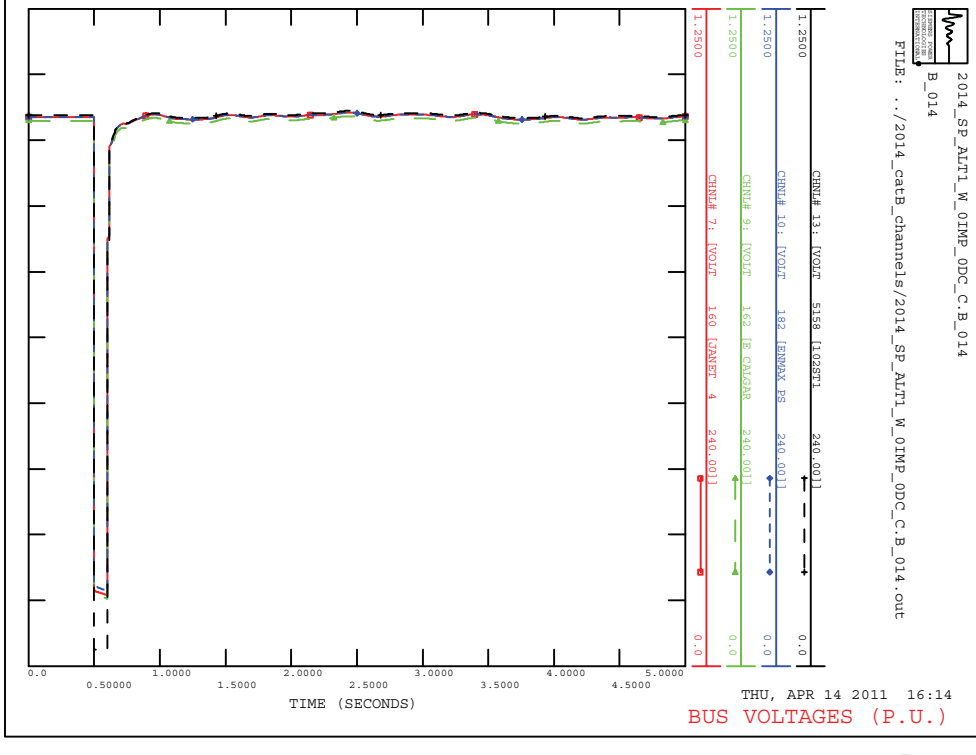


Figure L-2014-Step4-Sc2-3







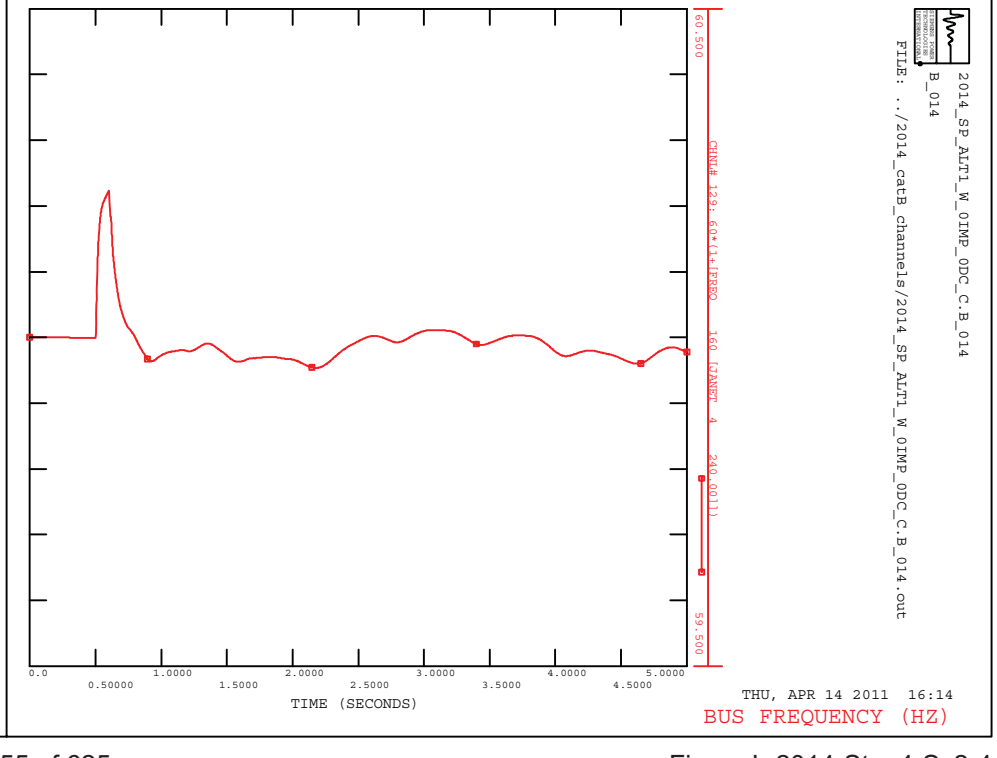


Figure L-2014-Step4-Sc2-4

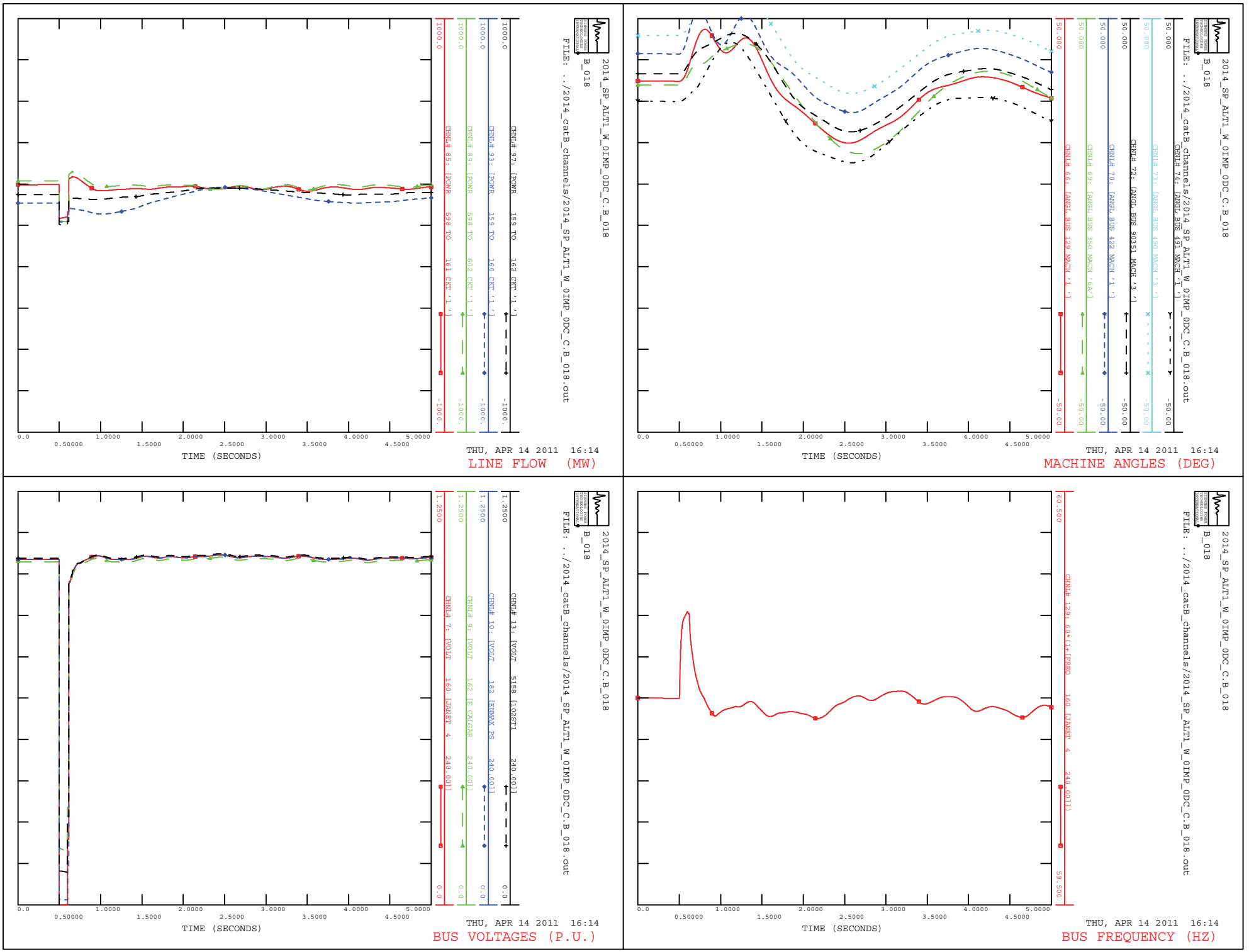


Figure L-2014-Step4-Sc2-5

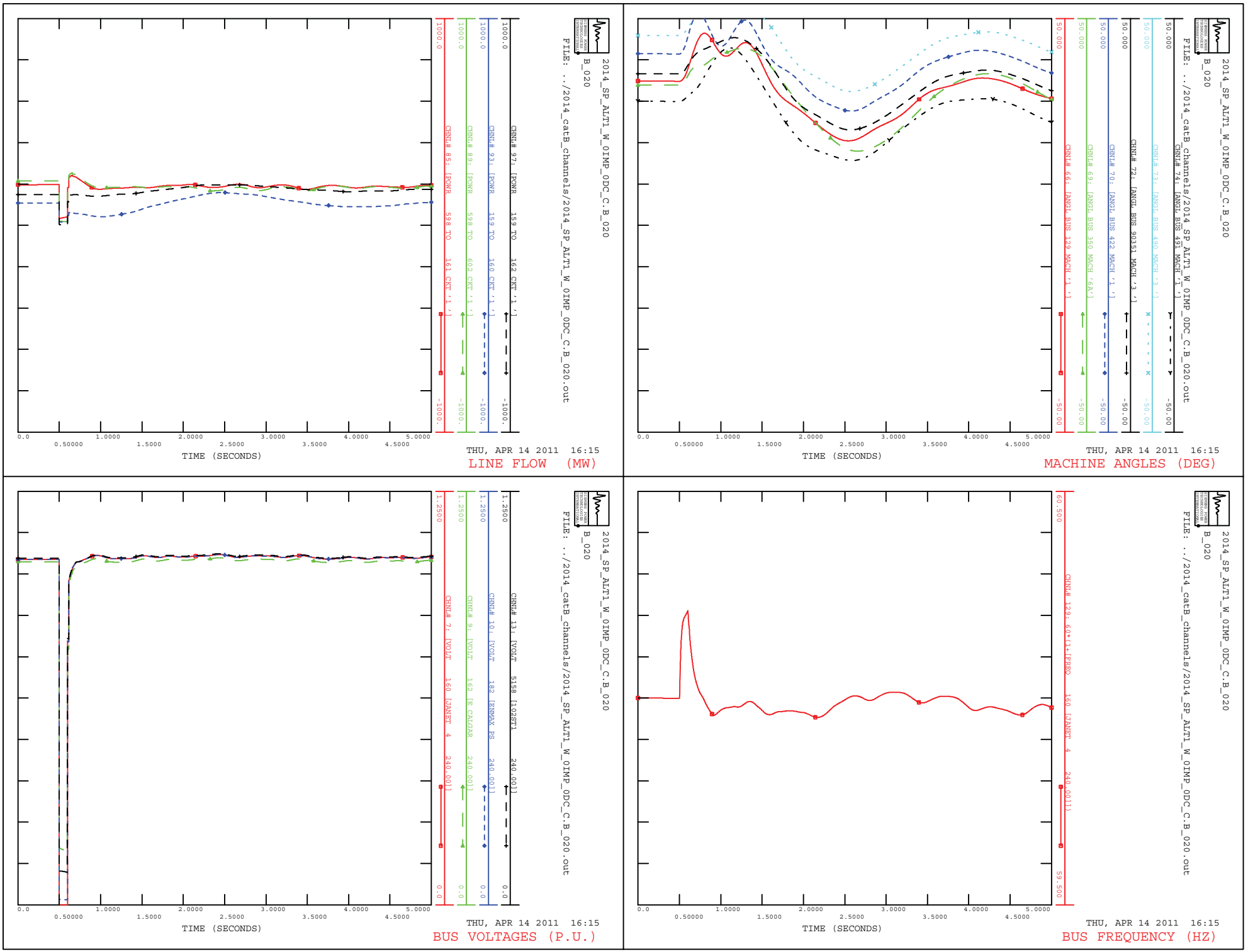


Figure L-2014-Step4-Sc2-6

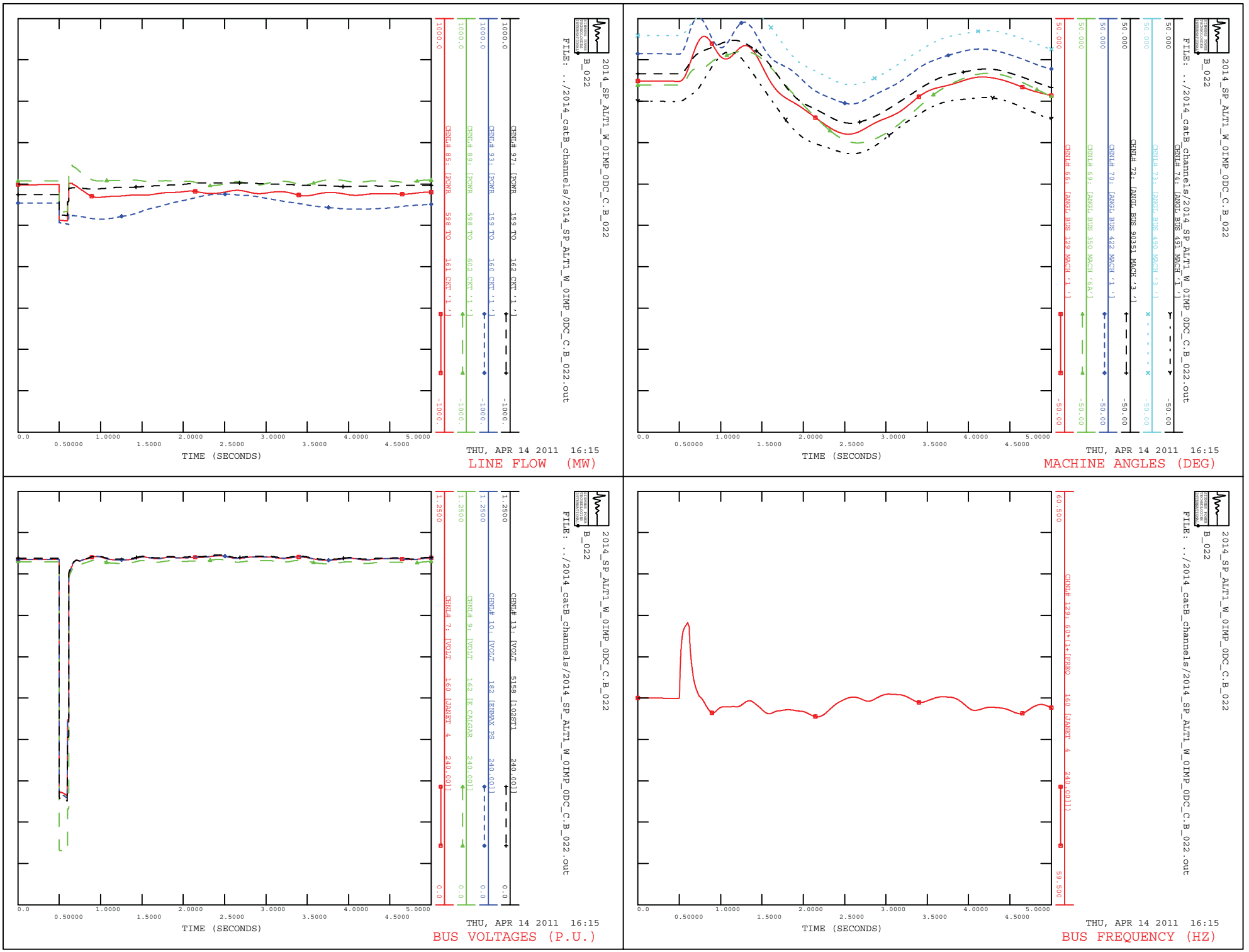


Figure L-2014-Step4-Sc2-7

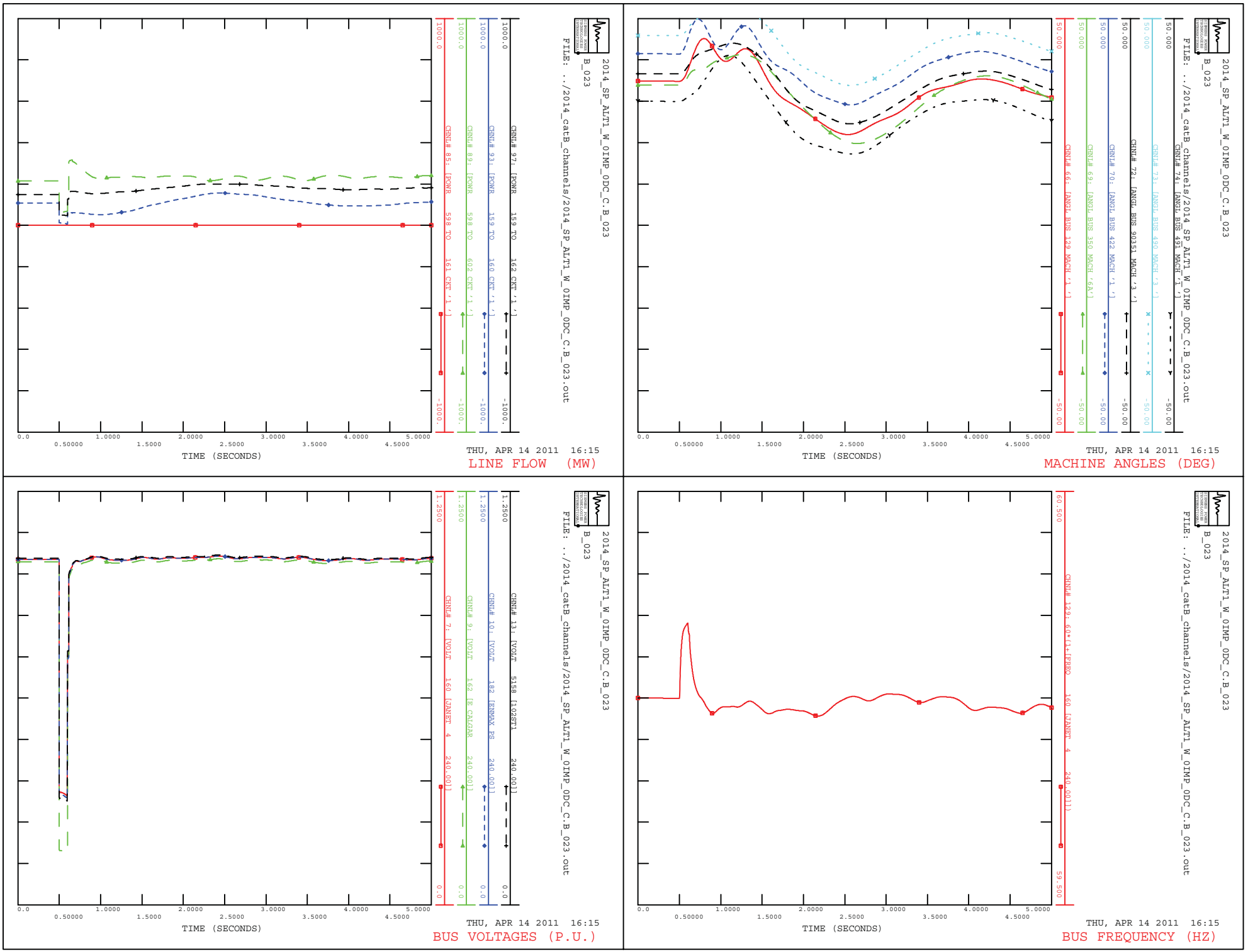


Figure L-2014-Step4-Sc2-8

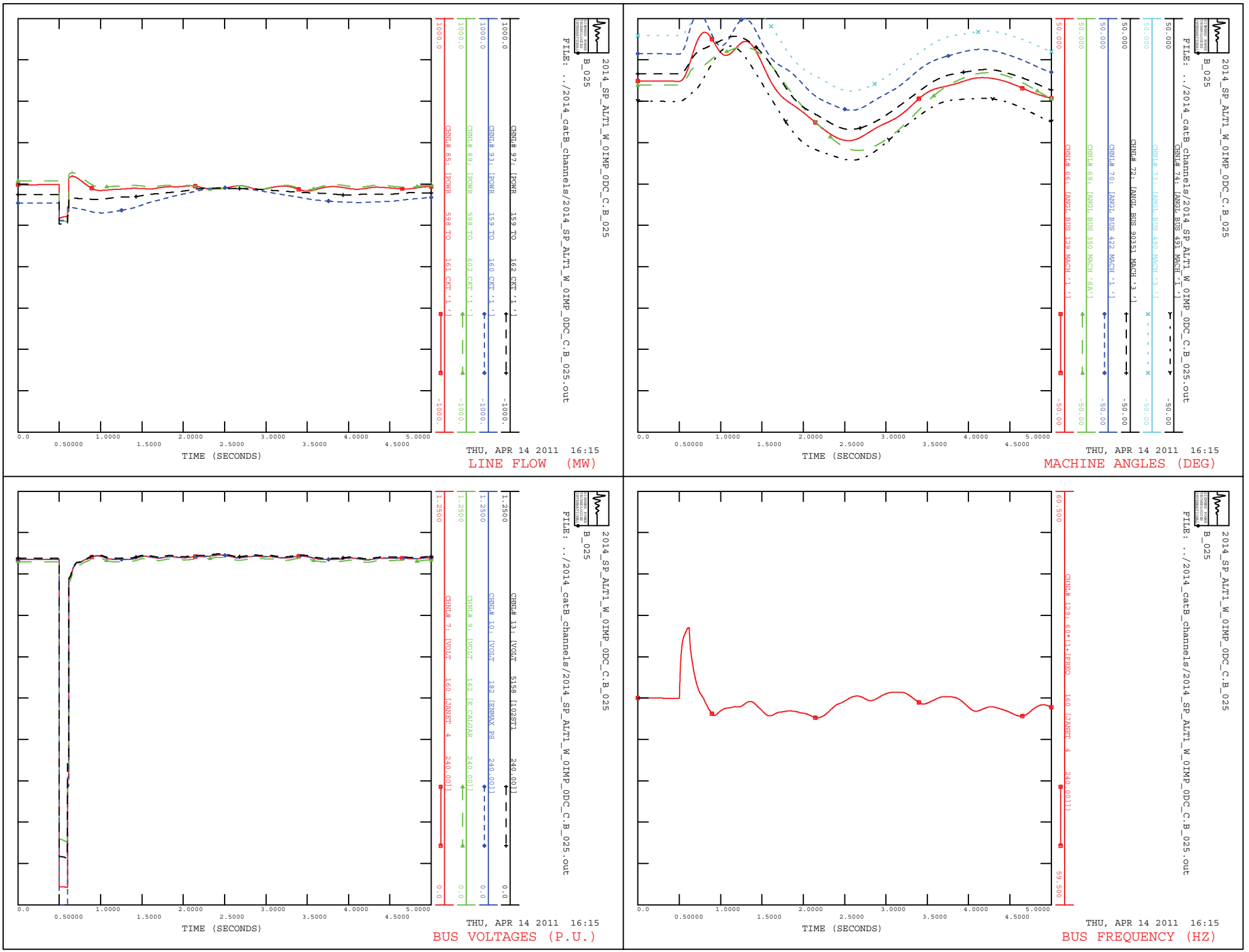


Figure L-2014-Step4-Sc2-9

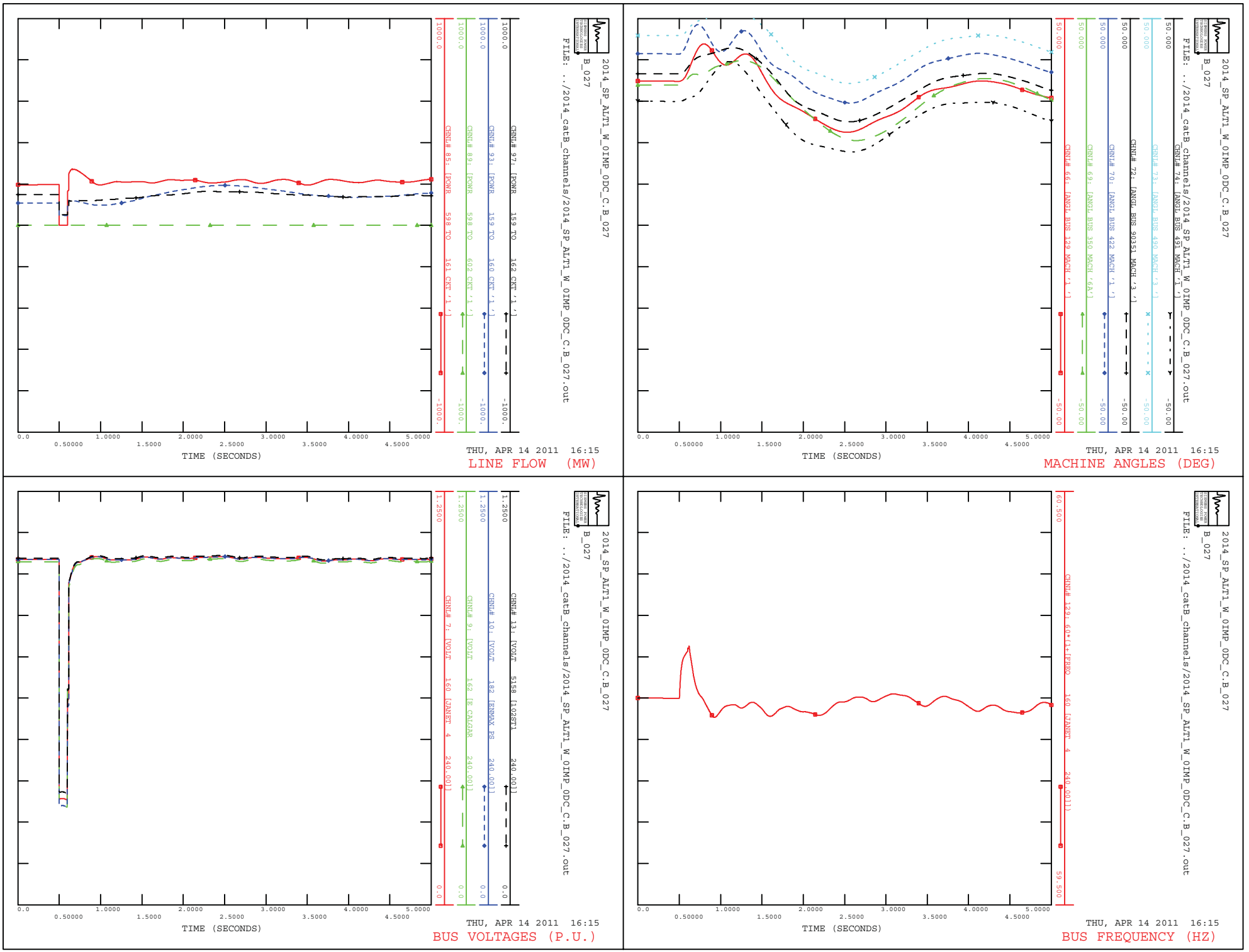


Figure L-2014-Step4-Sc2-10

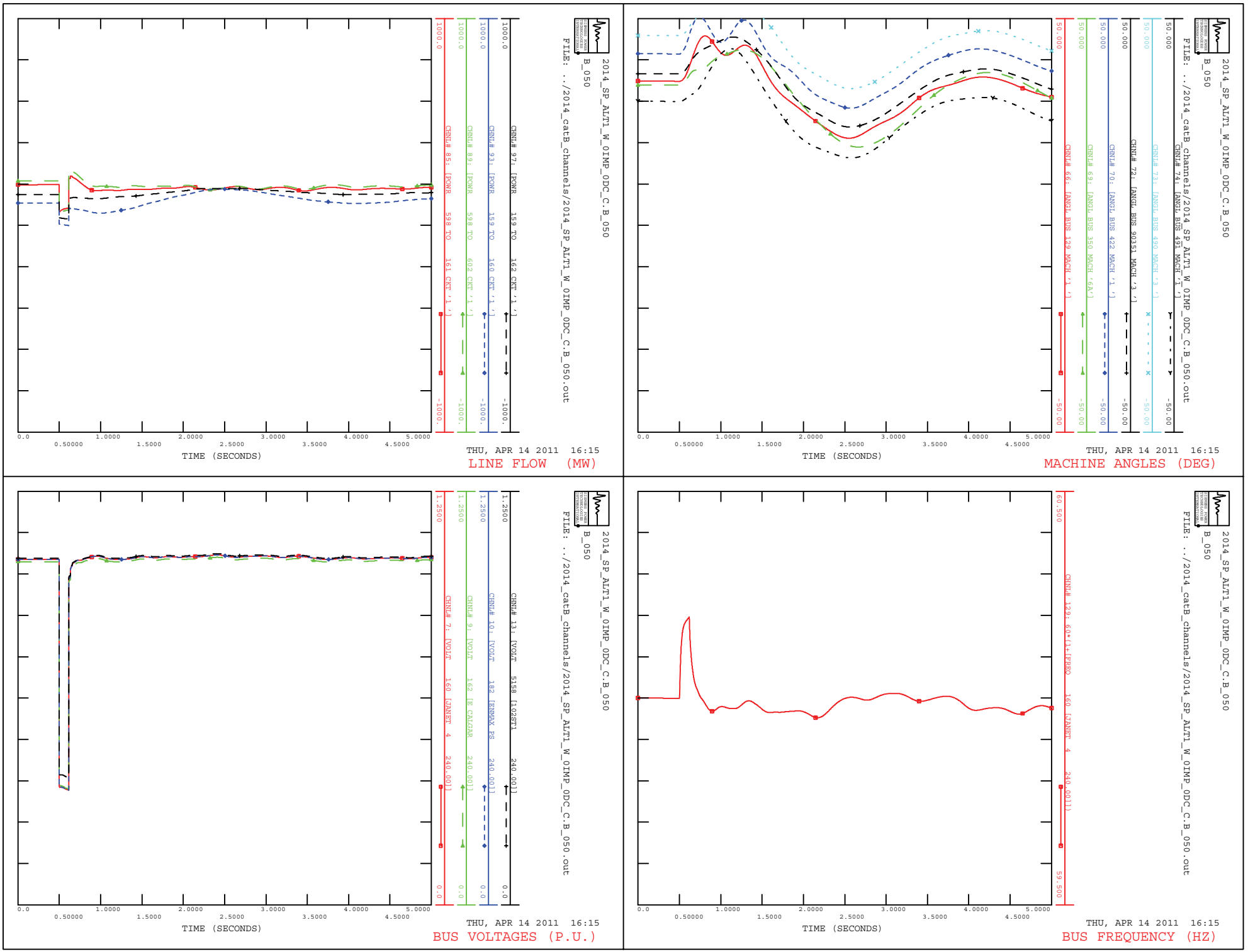


Figure L-2014-Step4-Sc2-11

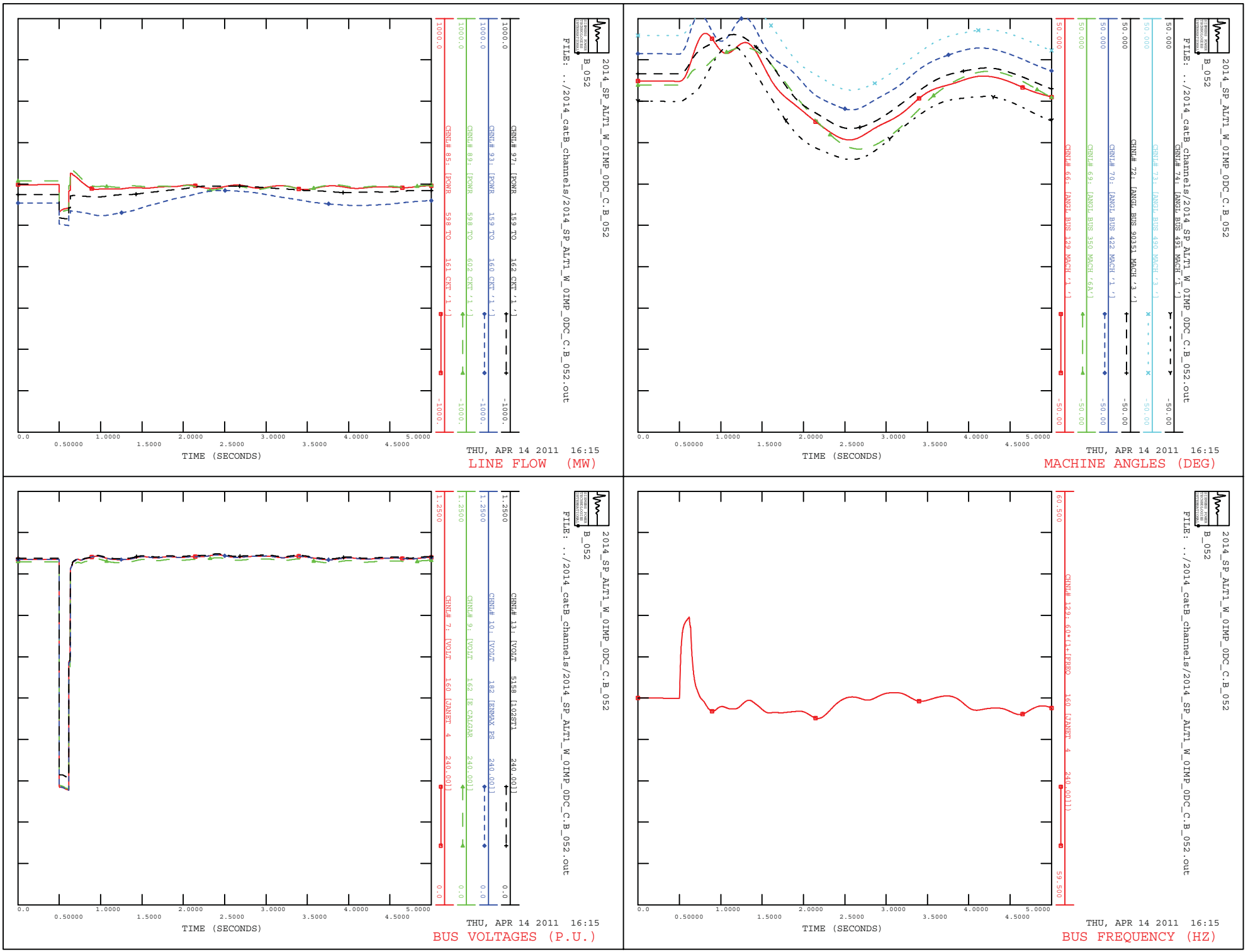


Figure L-2014-Step4-Sc2-12

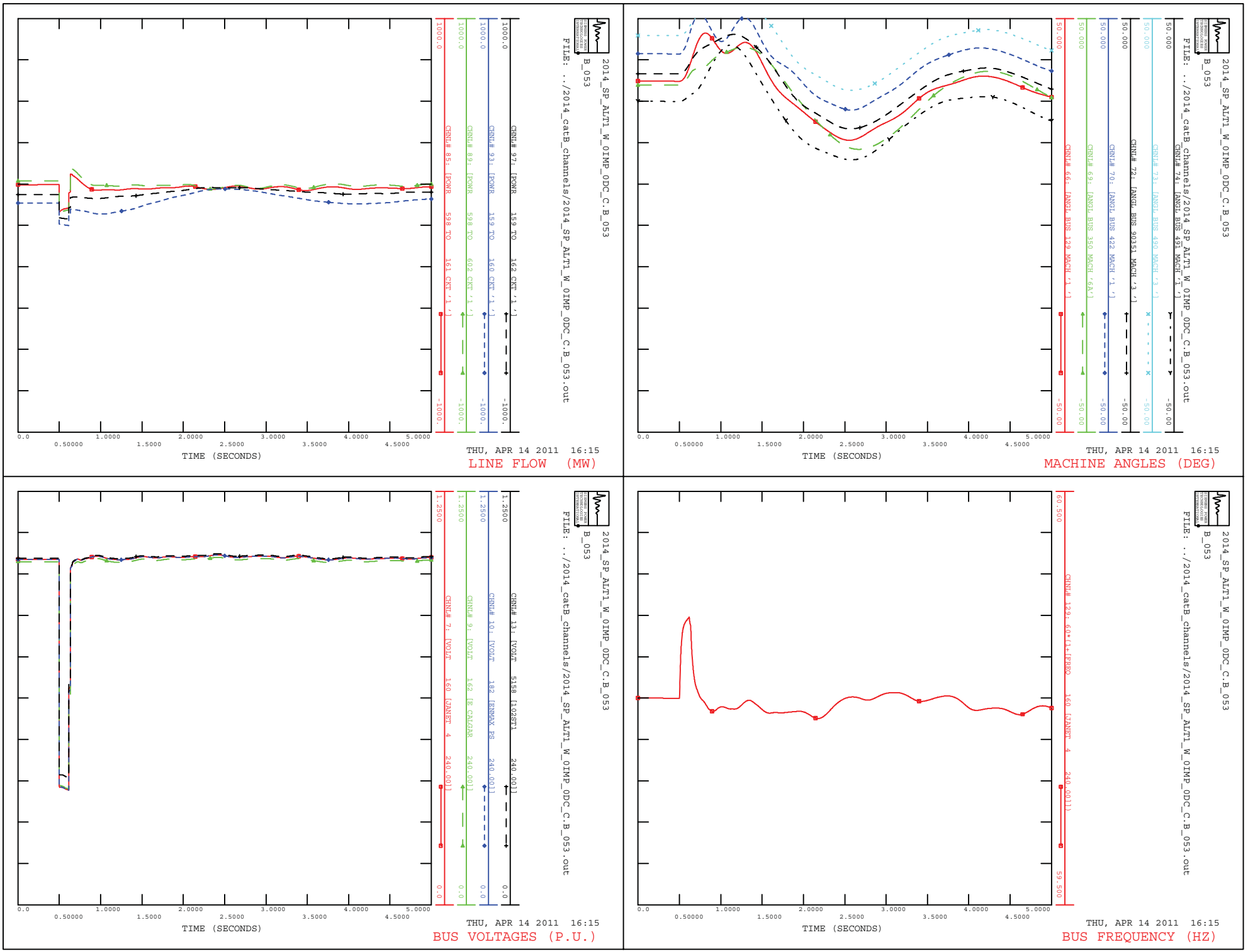


Figure L-2014-Step4-Sc2-13

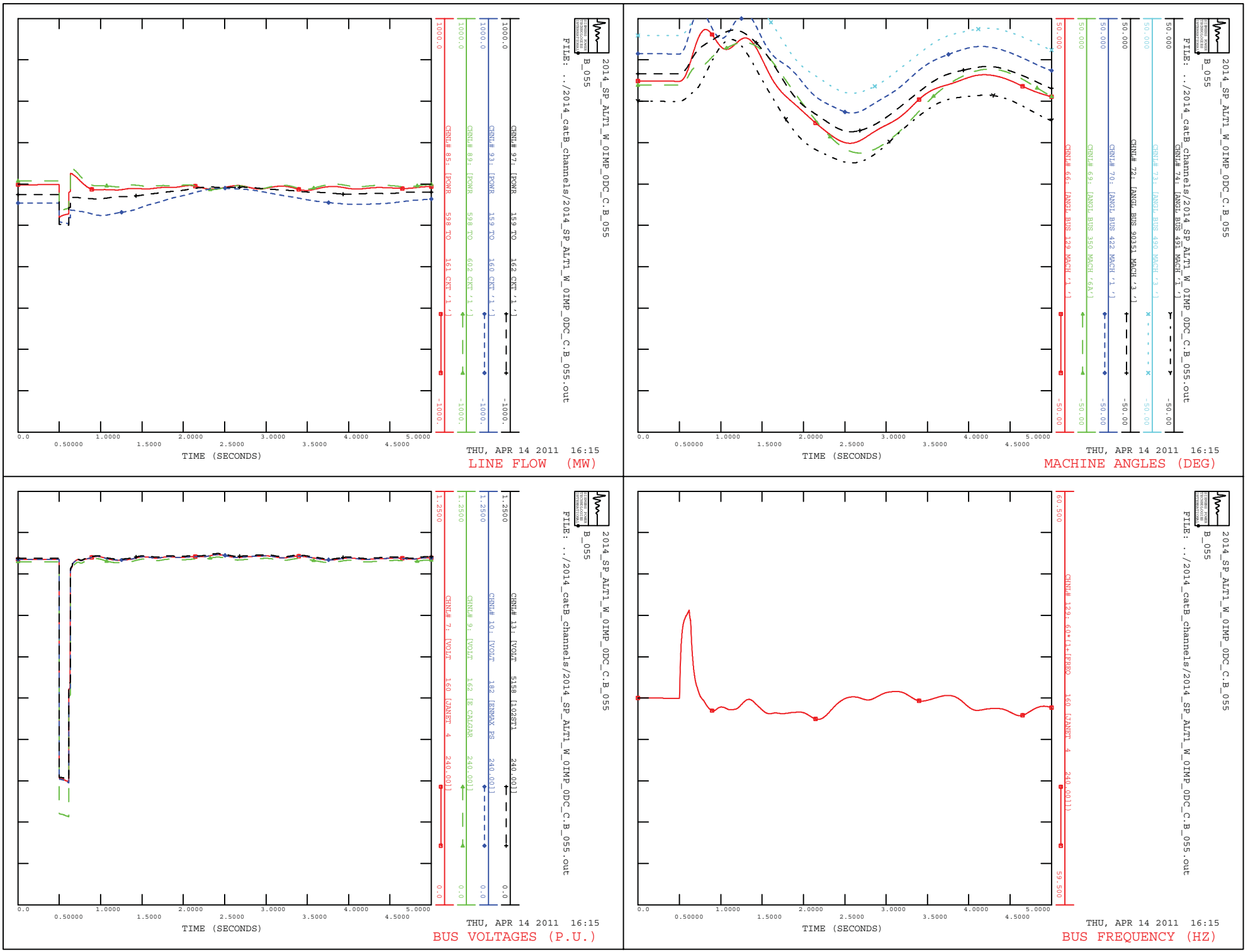


Figure L-2014-Step4-Sc2-14

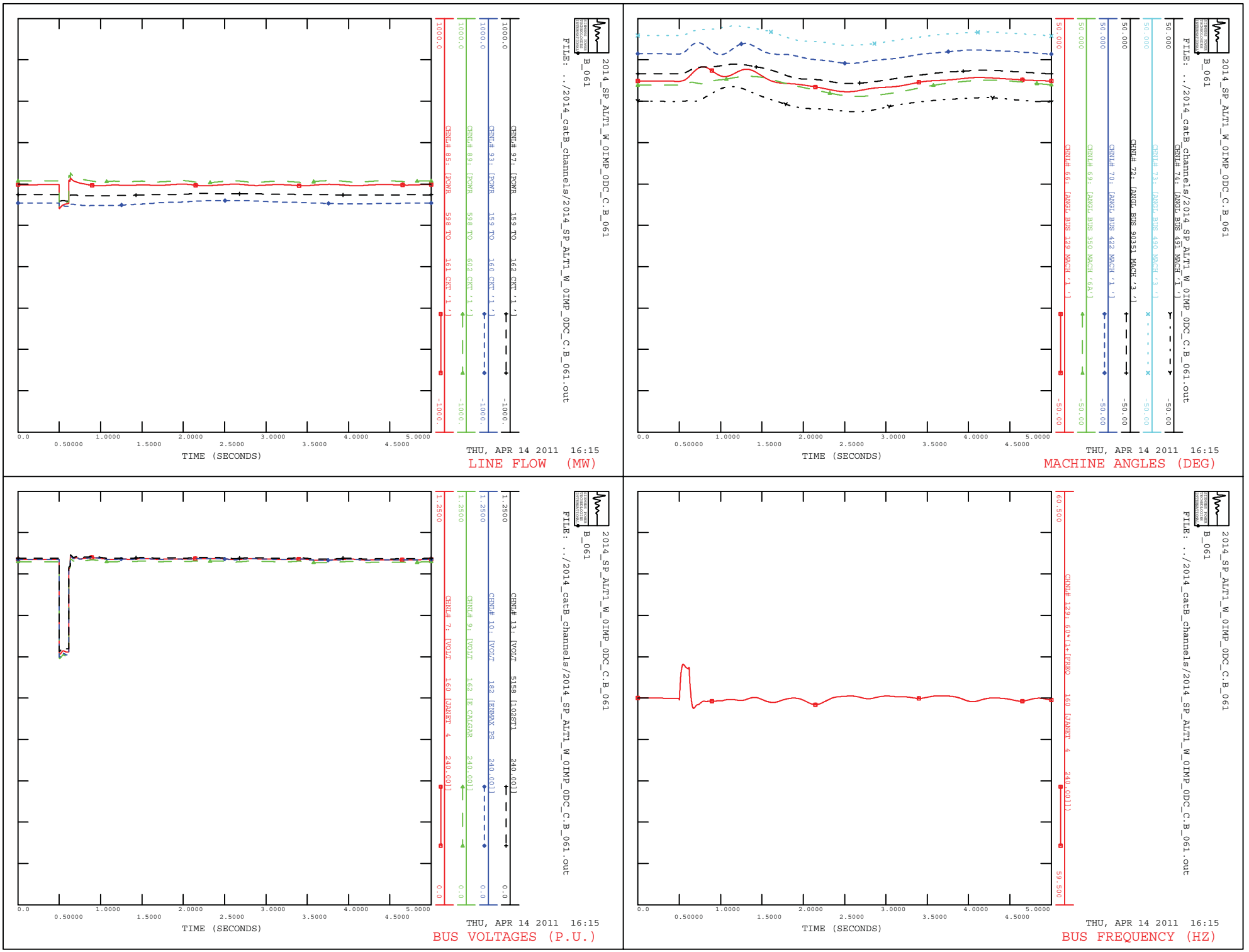


Figure L-2014-Step4-Sc2-15

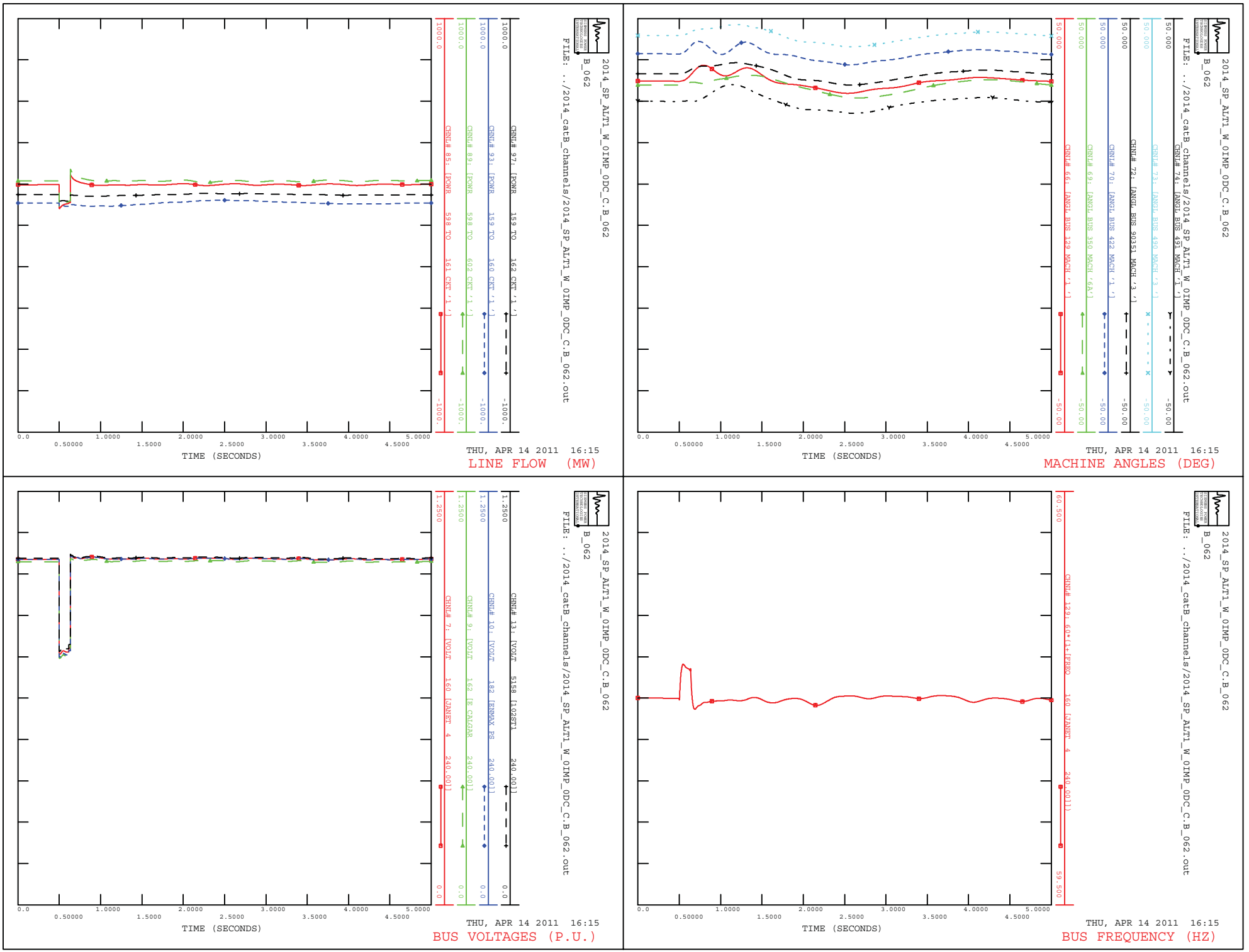


Figure L-2014-Step4-Sc2-16

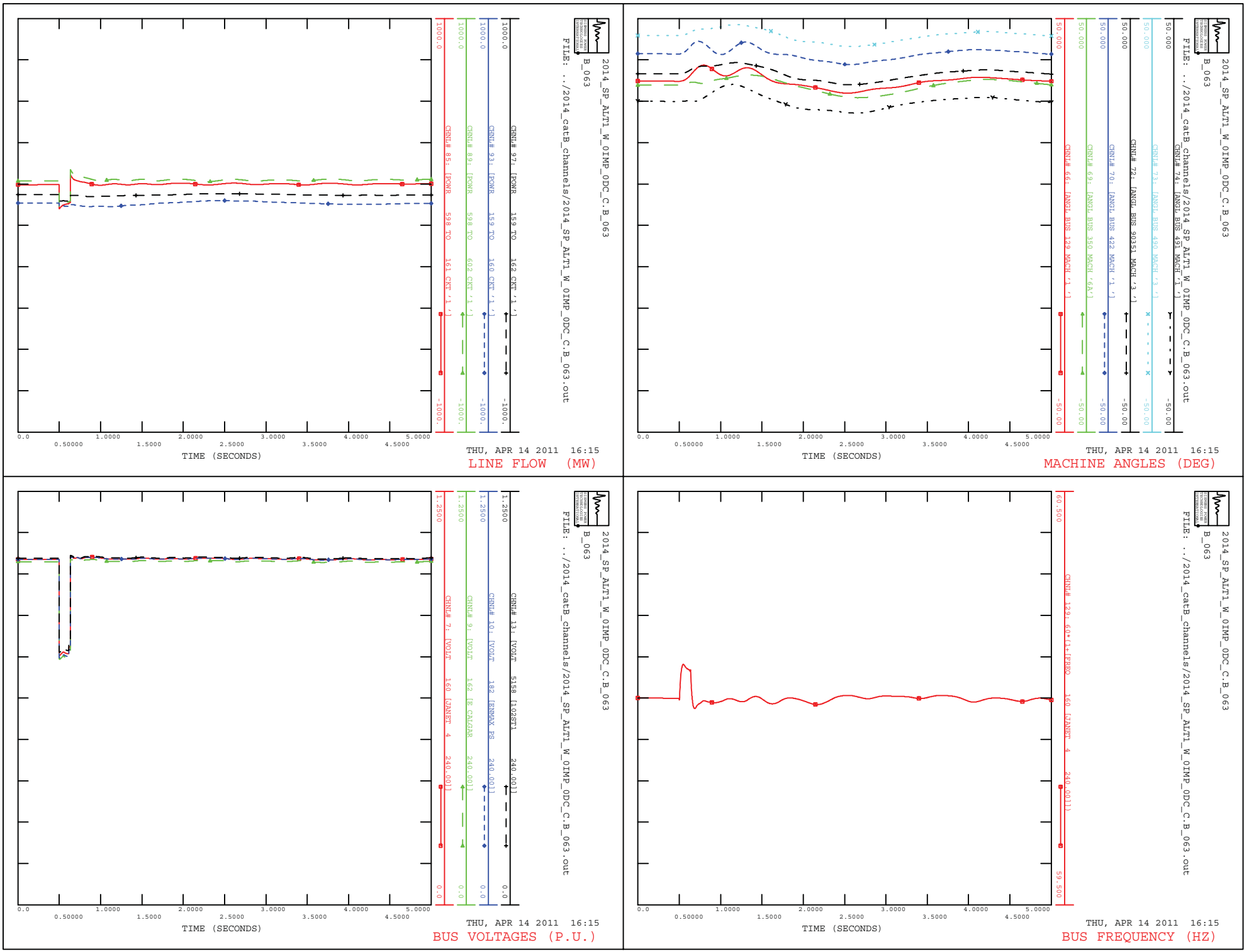


Figure L-2014-Step4-Sc2-17

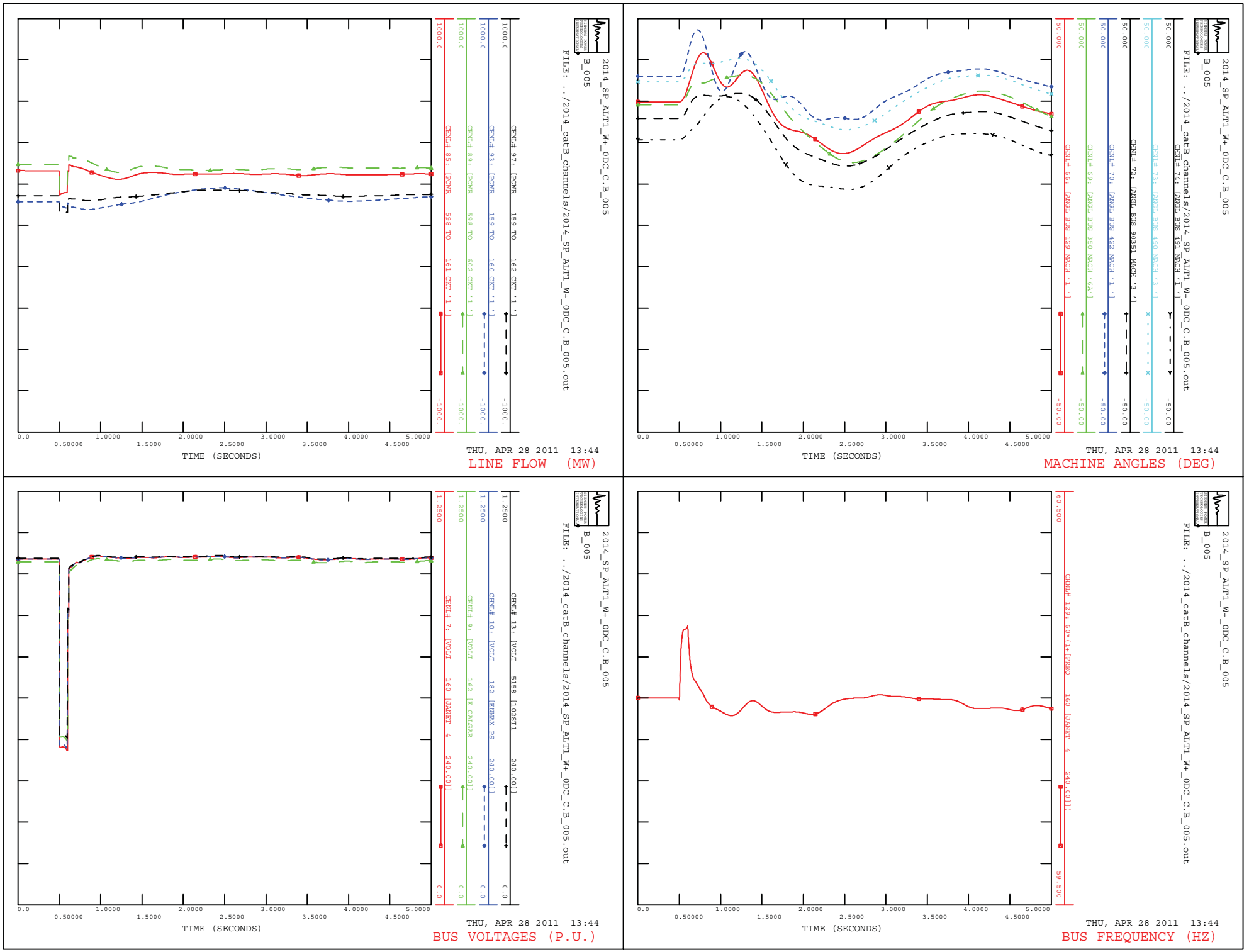


Figure L-2014-Step4-Sc3-1

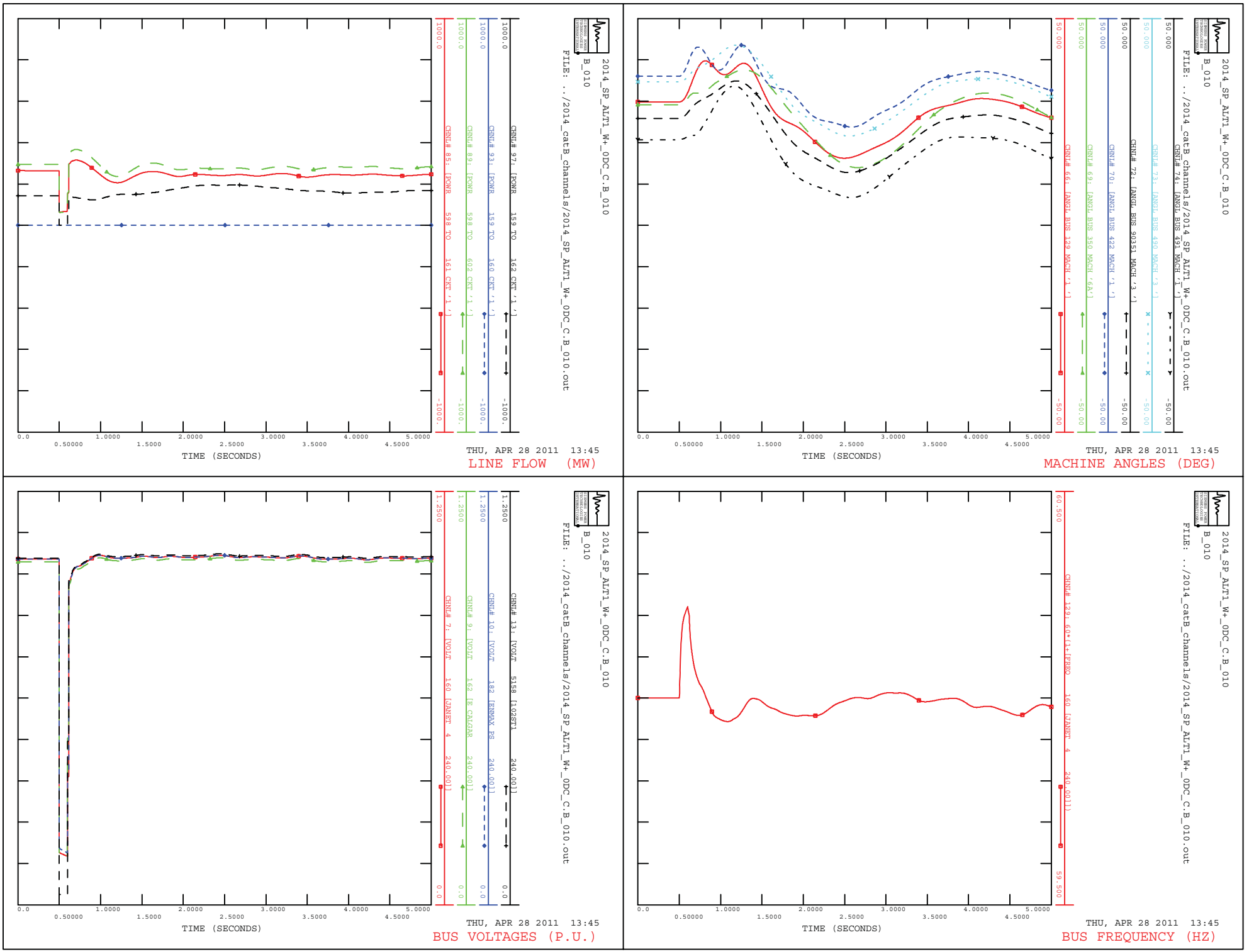


Figure L-2014-Step4-Sc3-2

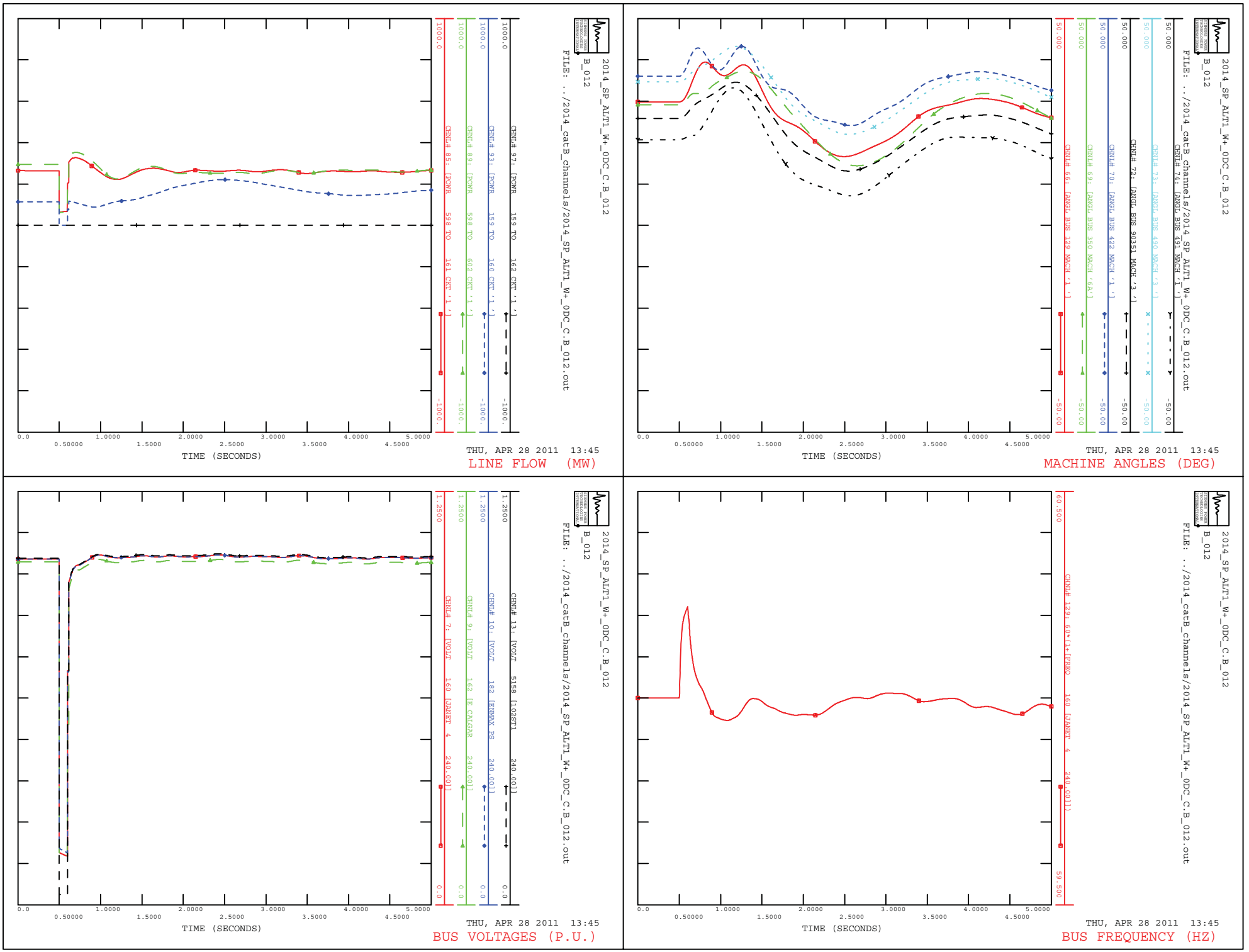


Figure L-2014-Step4-Sc3-3

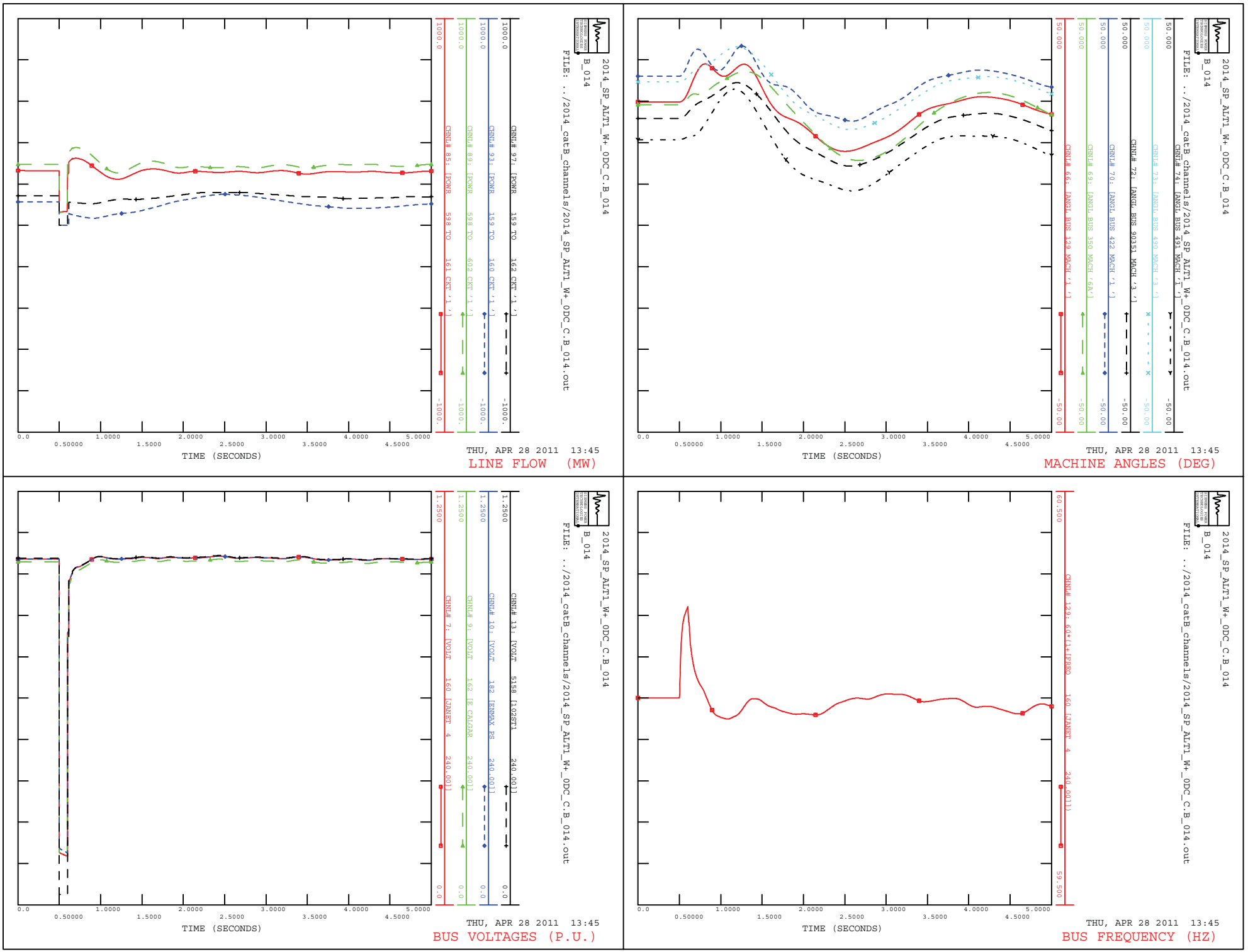


Figure L-2014-Step4-Sc3-4

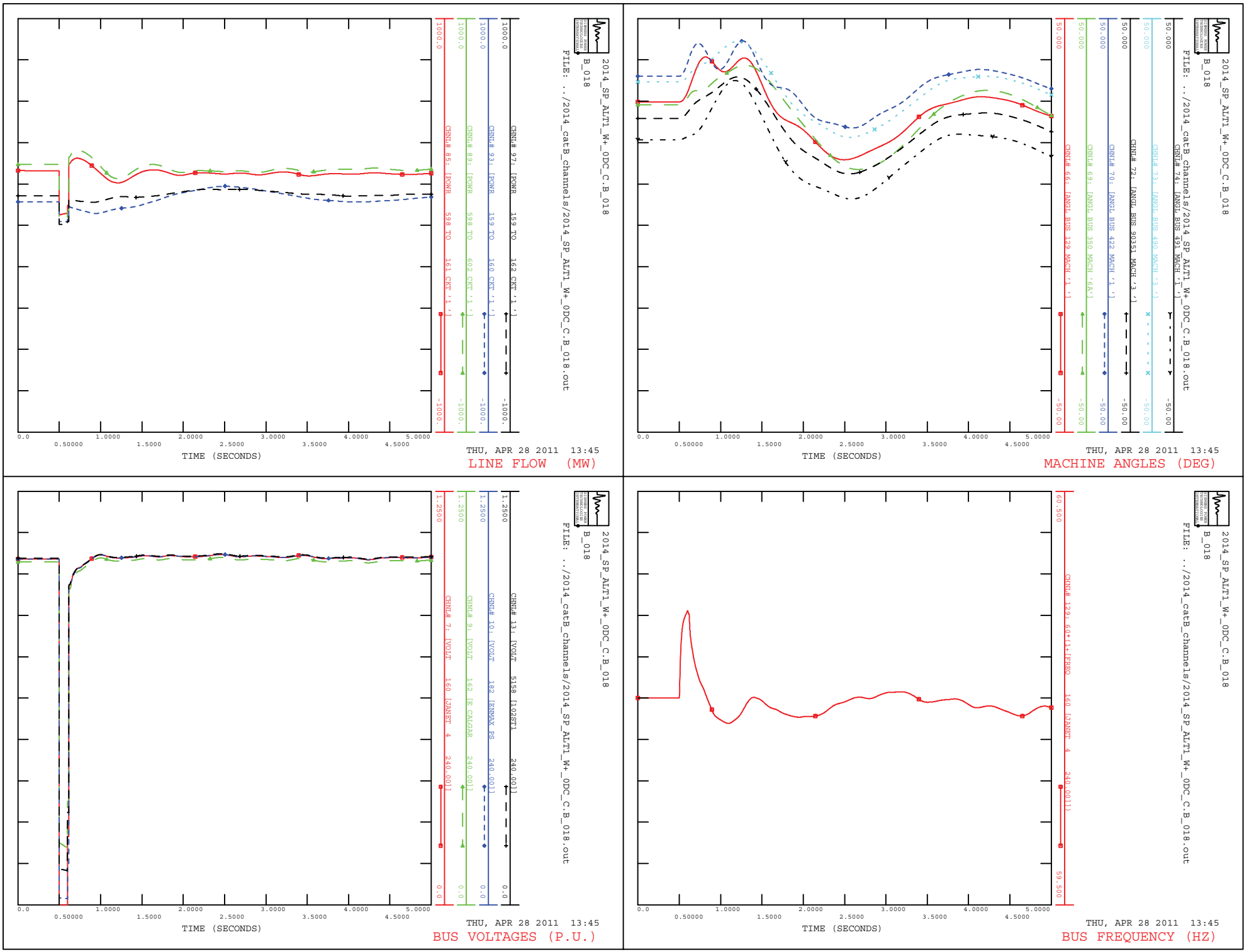


Figure L-2014-Step4-Sc3-5

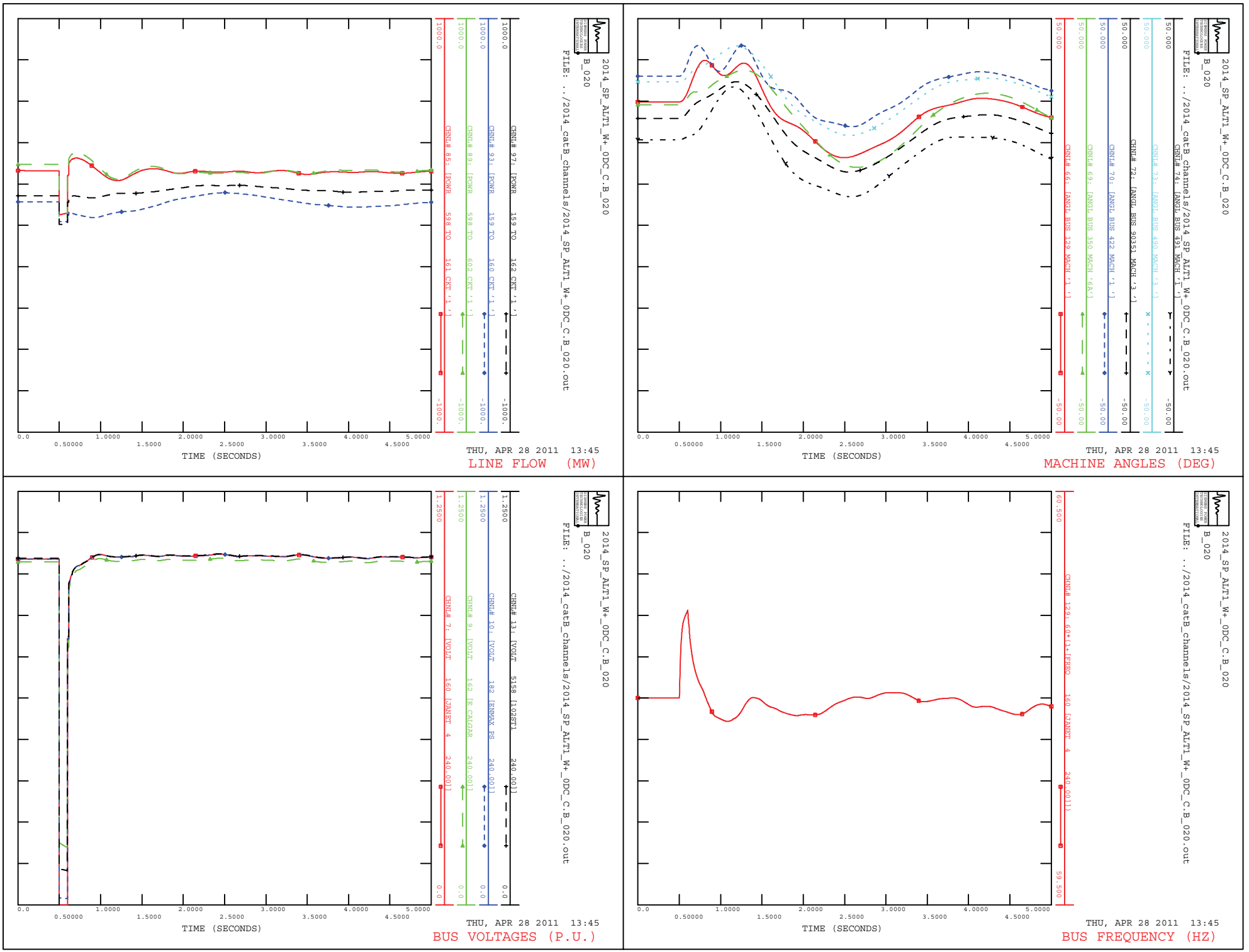


Figure L-2014-Step4-Sc3-6

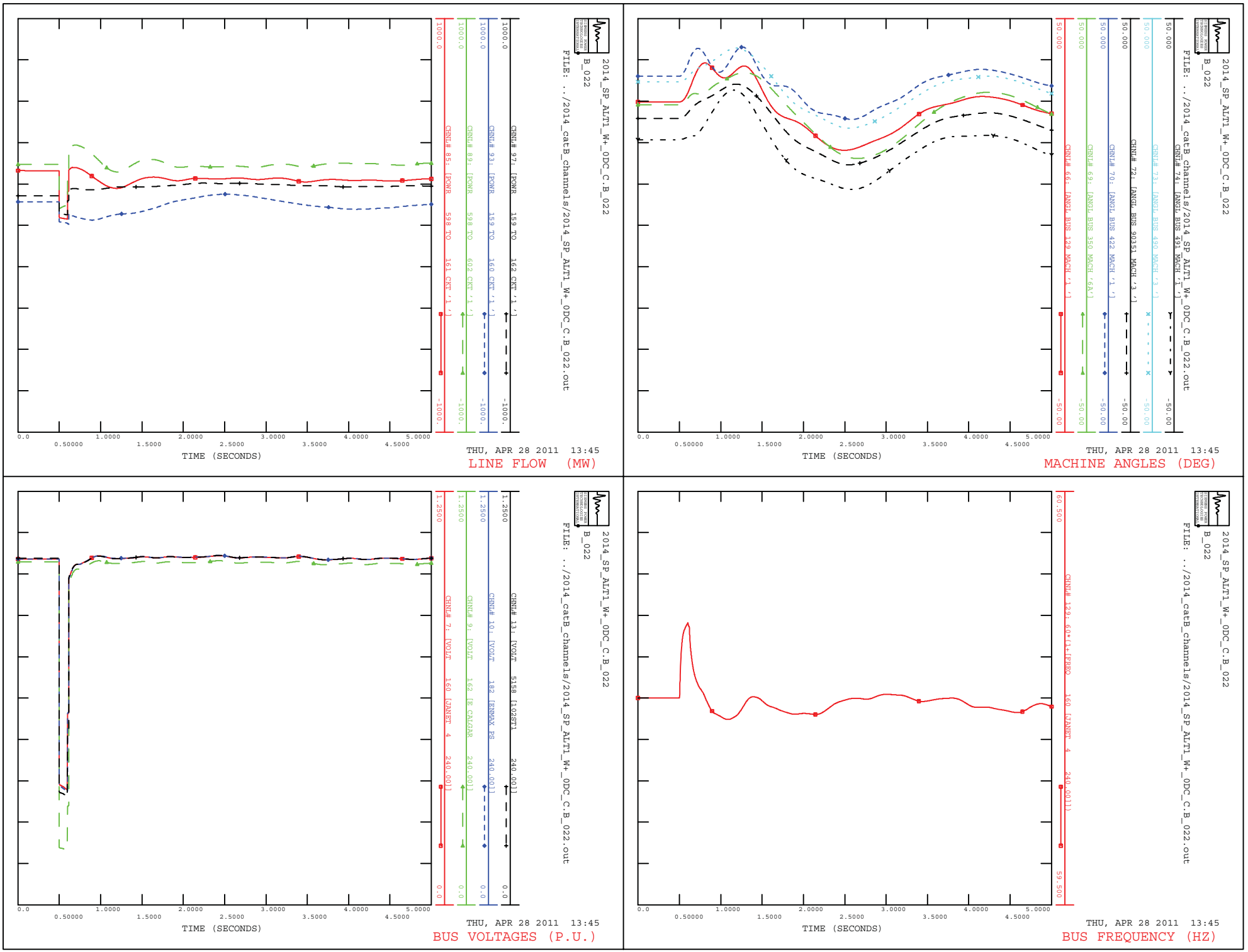


Figure L-2014-Step4-Sc3-7

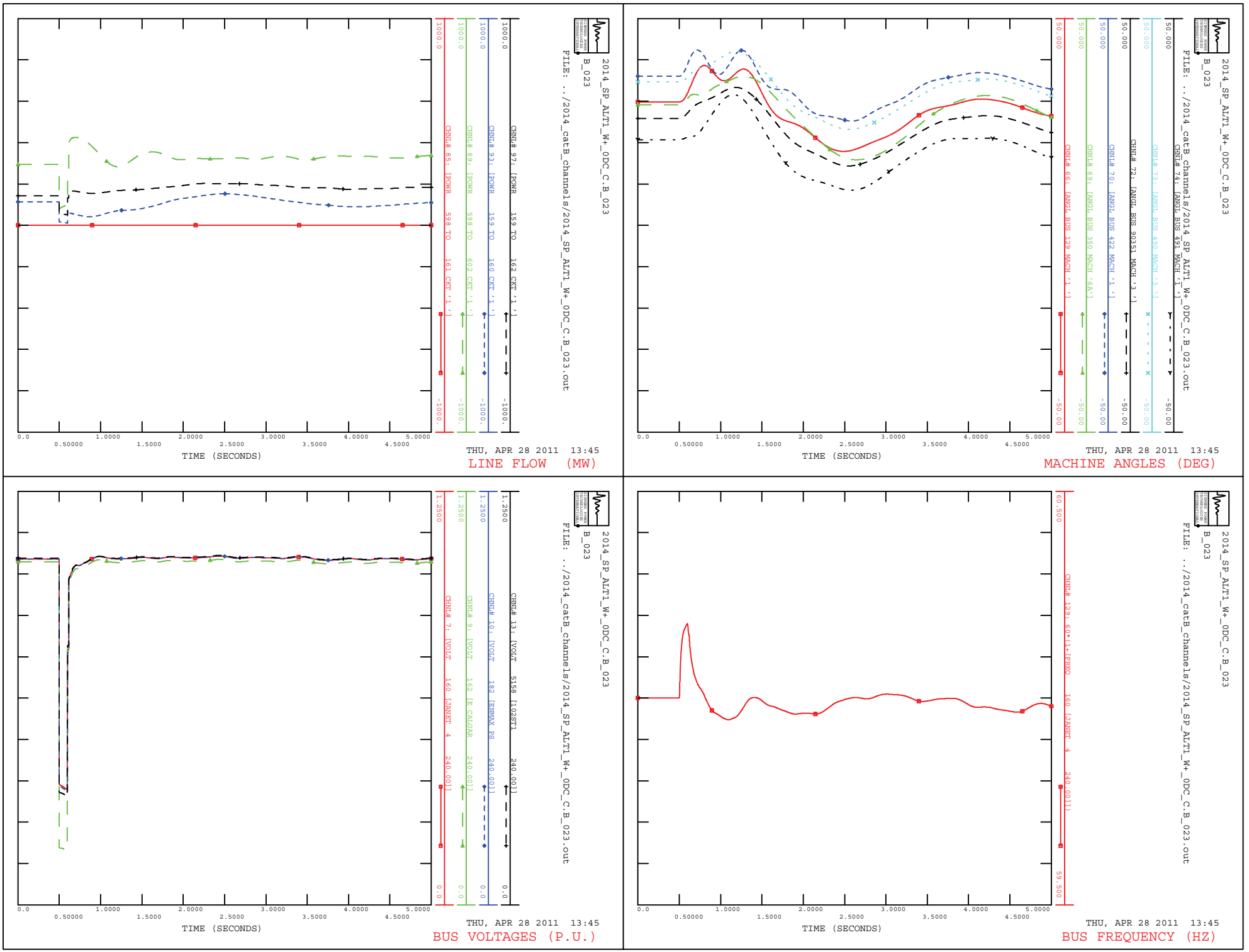


Figure L-2014-Step4-Sc3-8

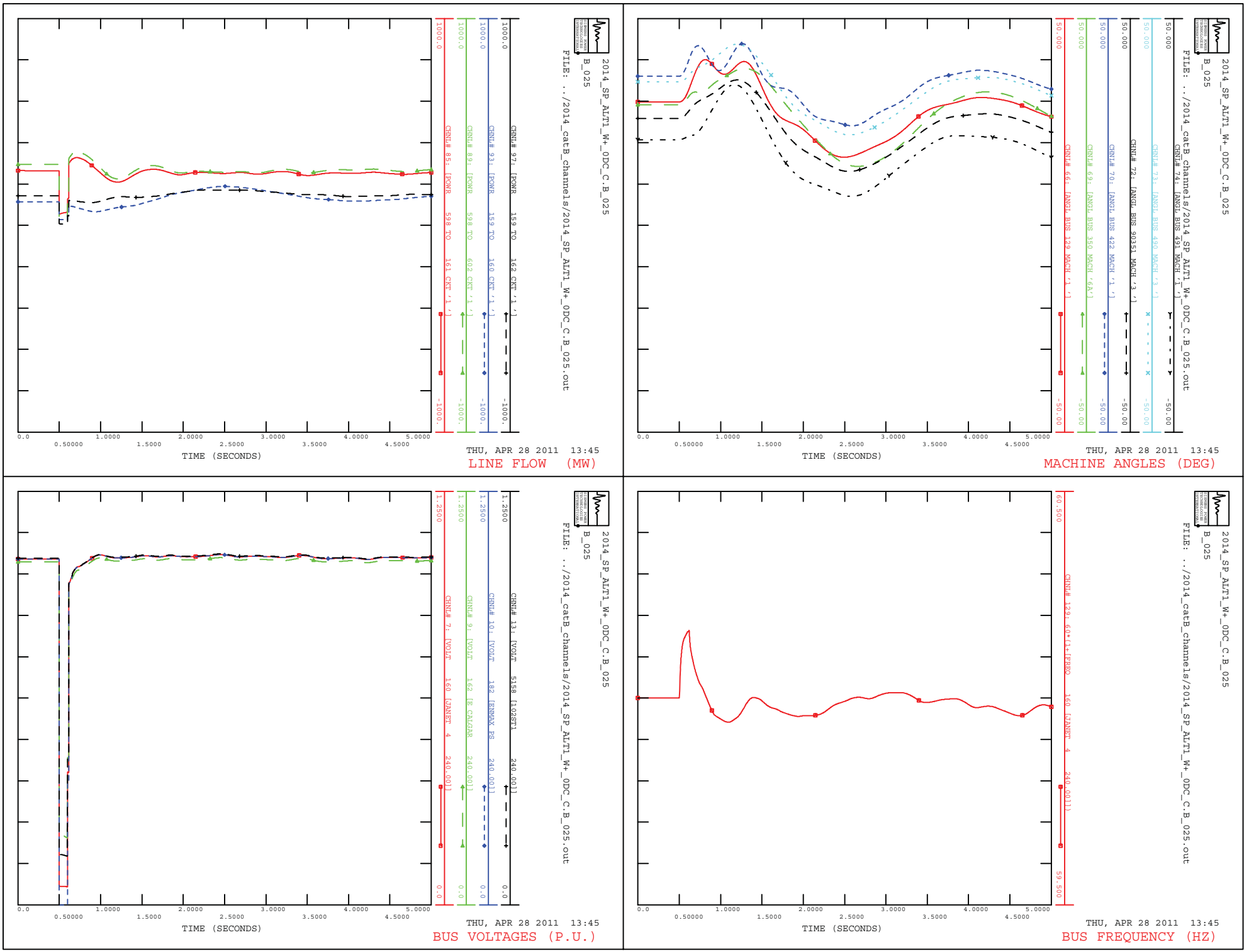


Figure L-2014-Step4-Sc3-9

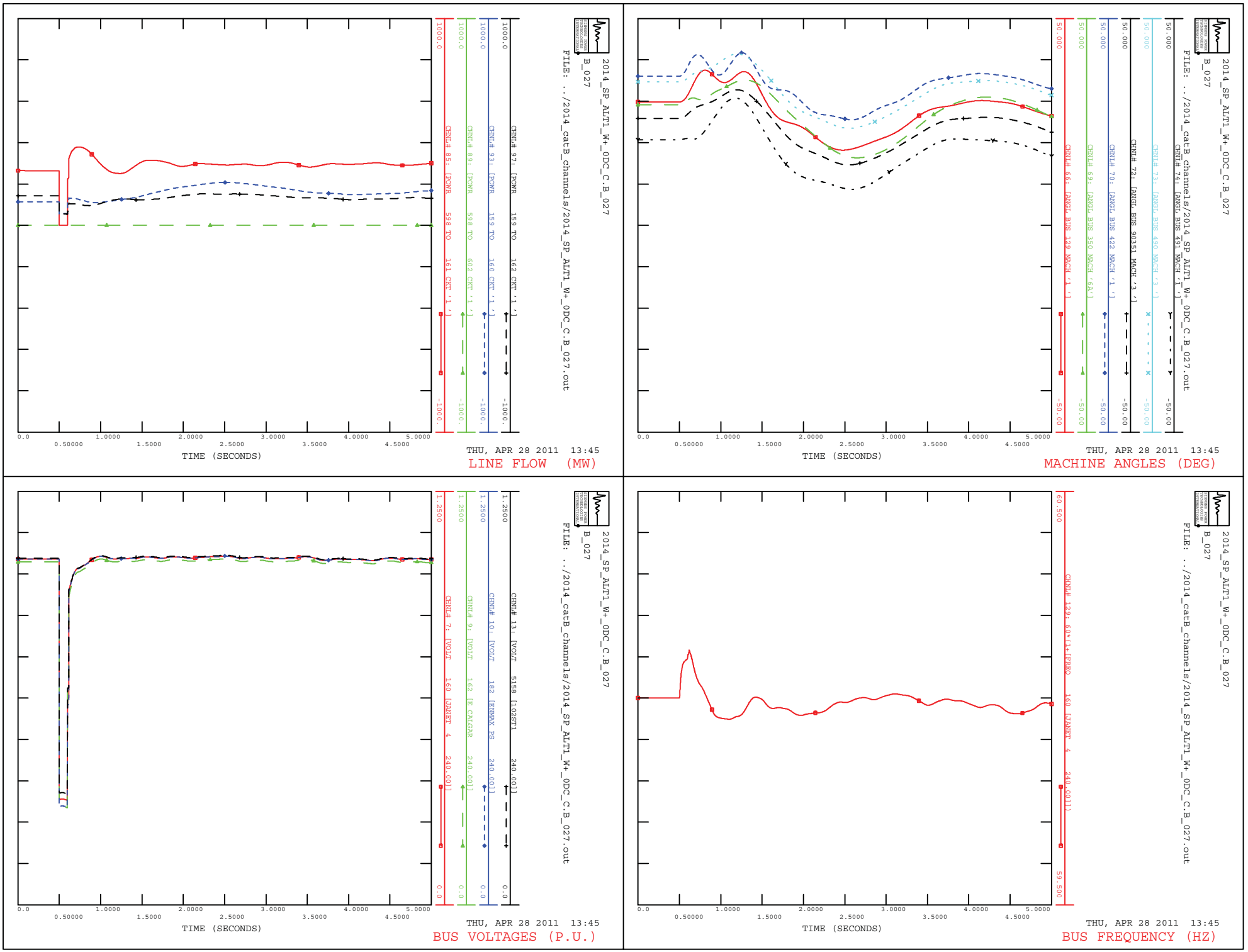


Figure L-2014-Step4-Sc3-10

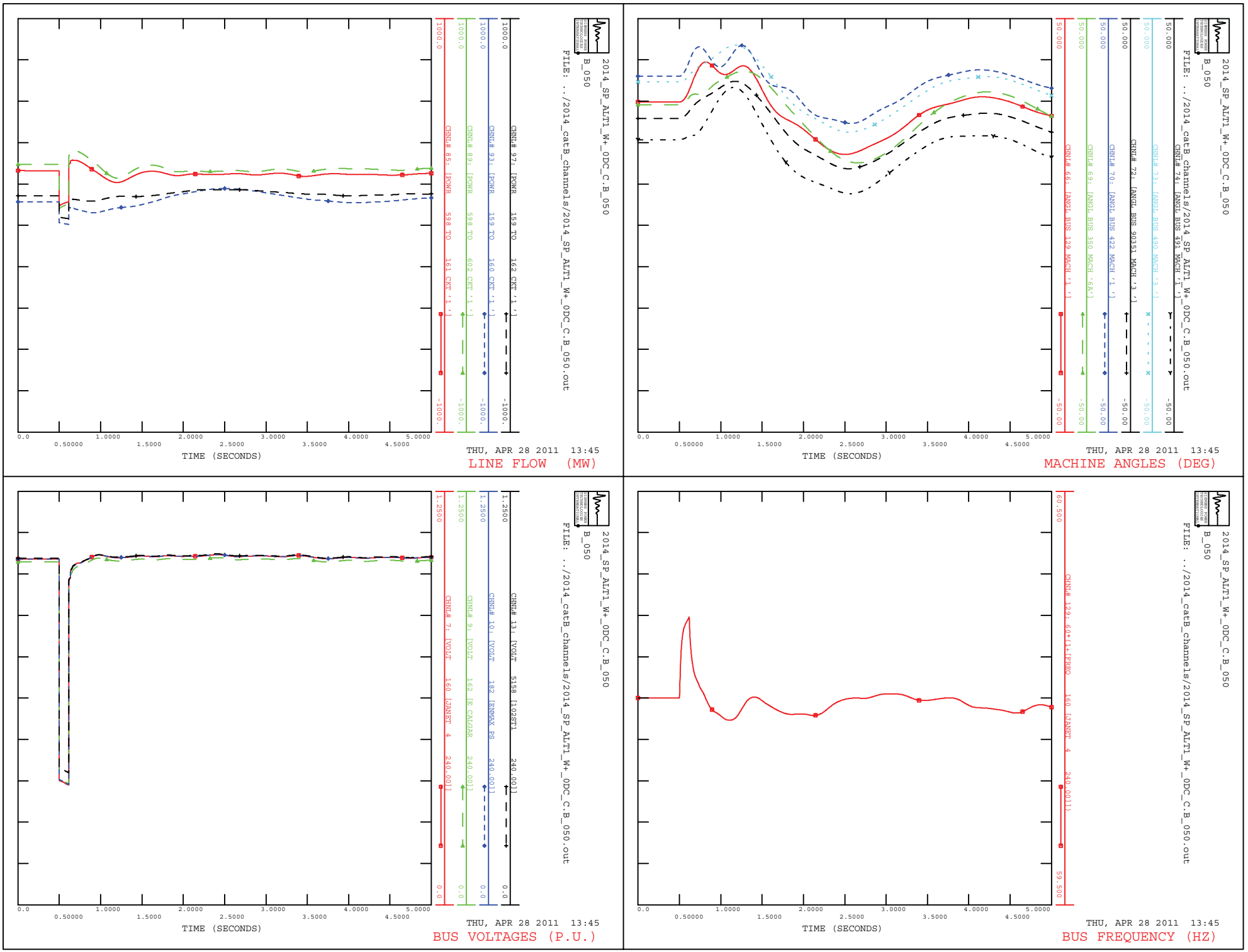


Figure L-2014-Step4-Sc3-11

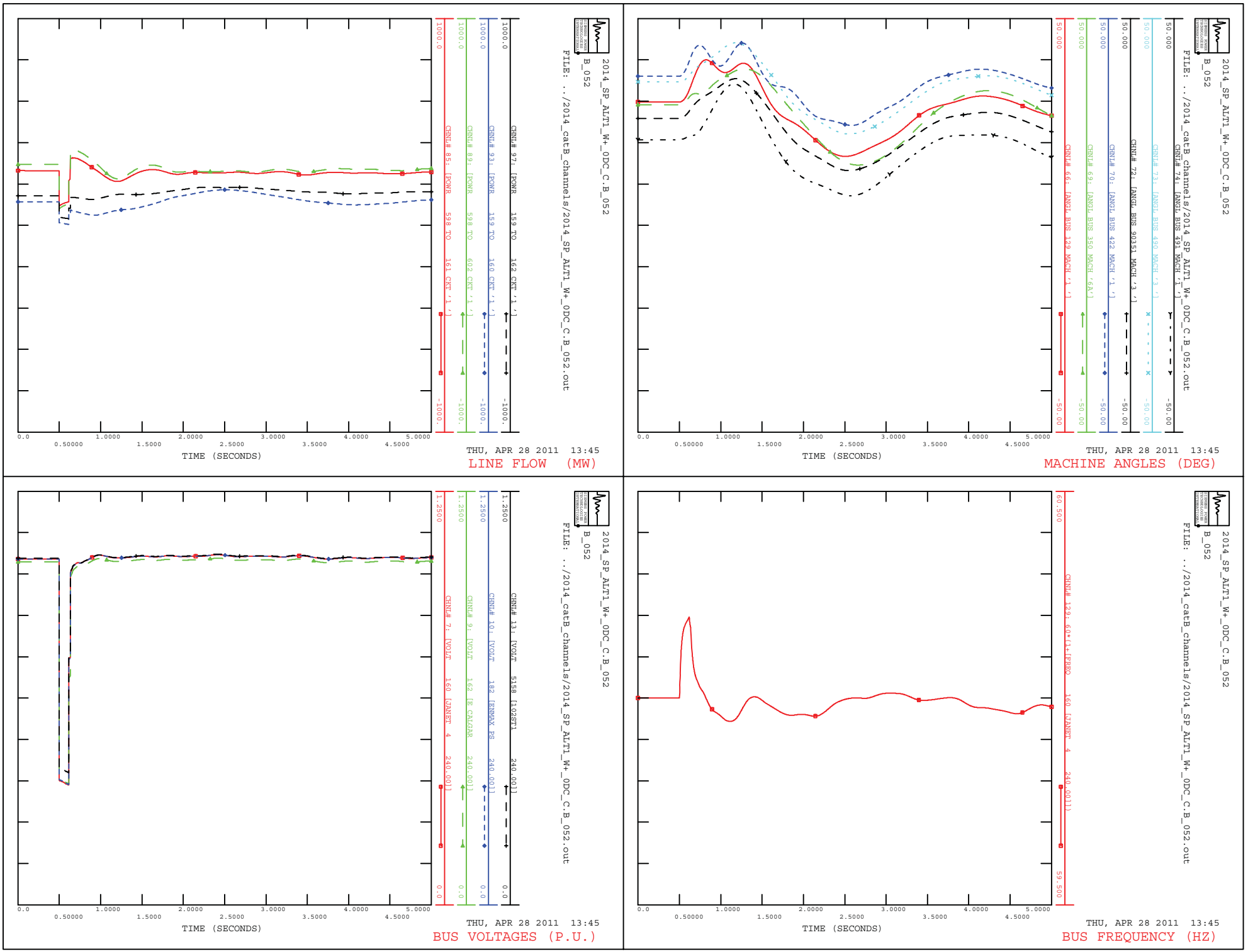


Figure L-2014-Step4-Sc3-12

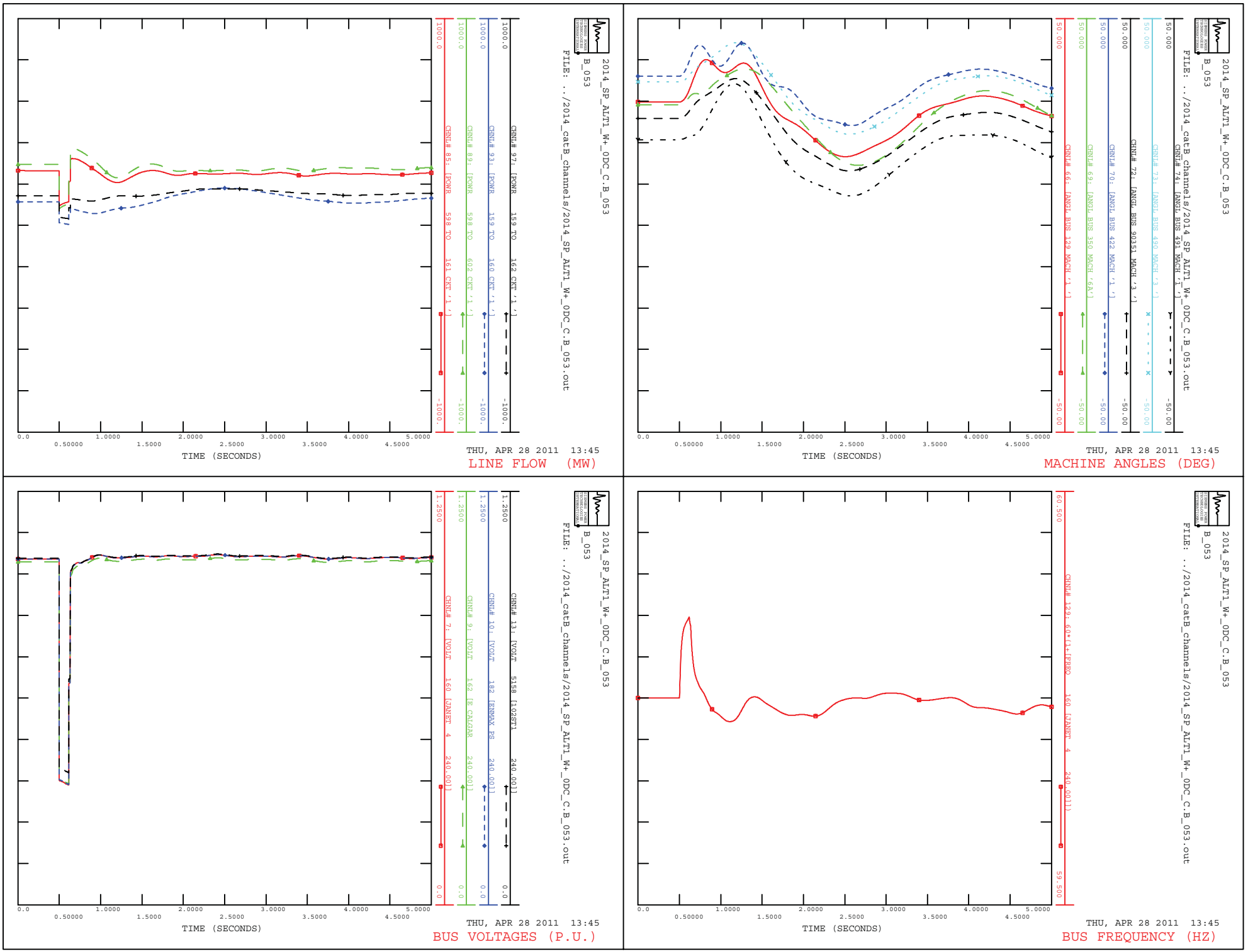


Figure L-2014-Step4-Sc3-13

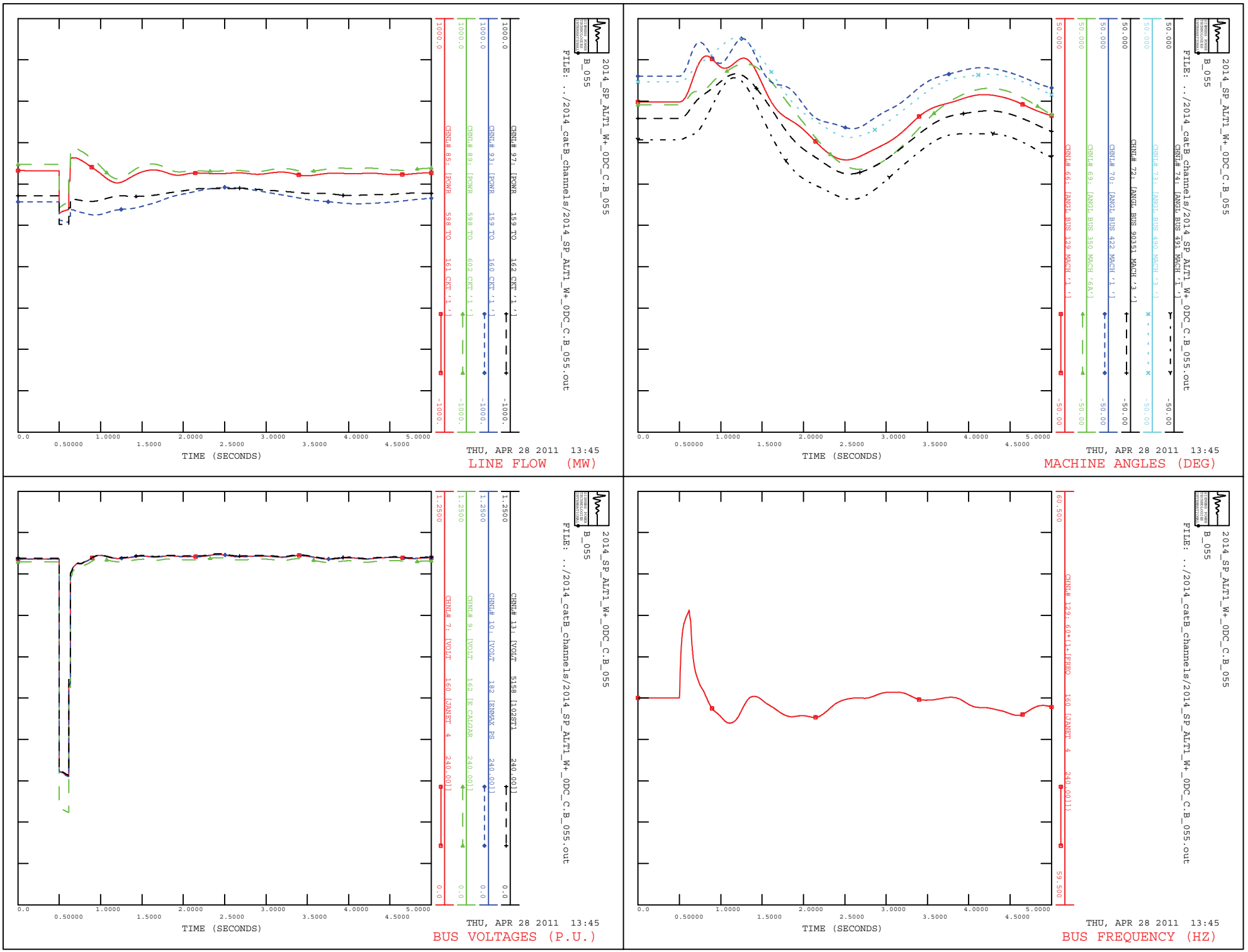


Figure L-2014-Step4-Sc3-14

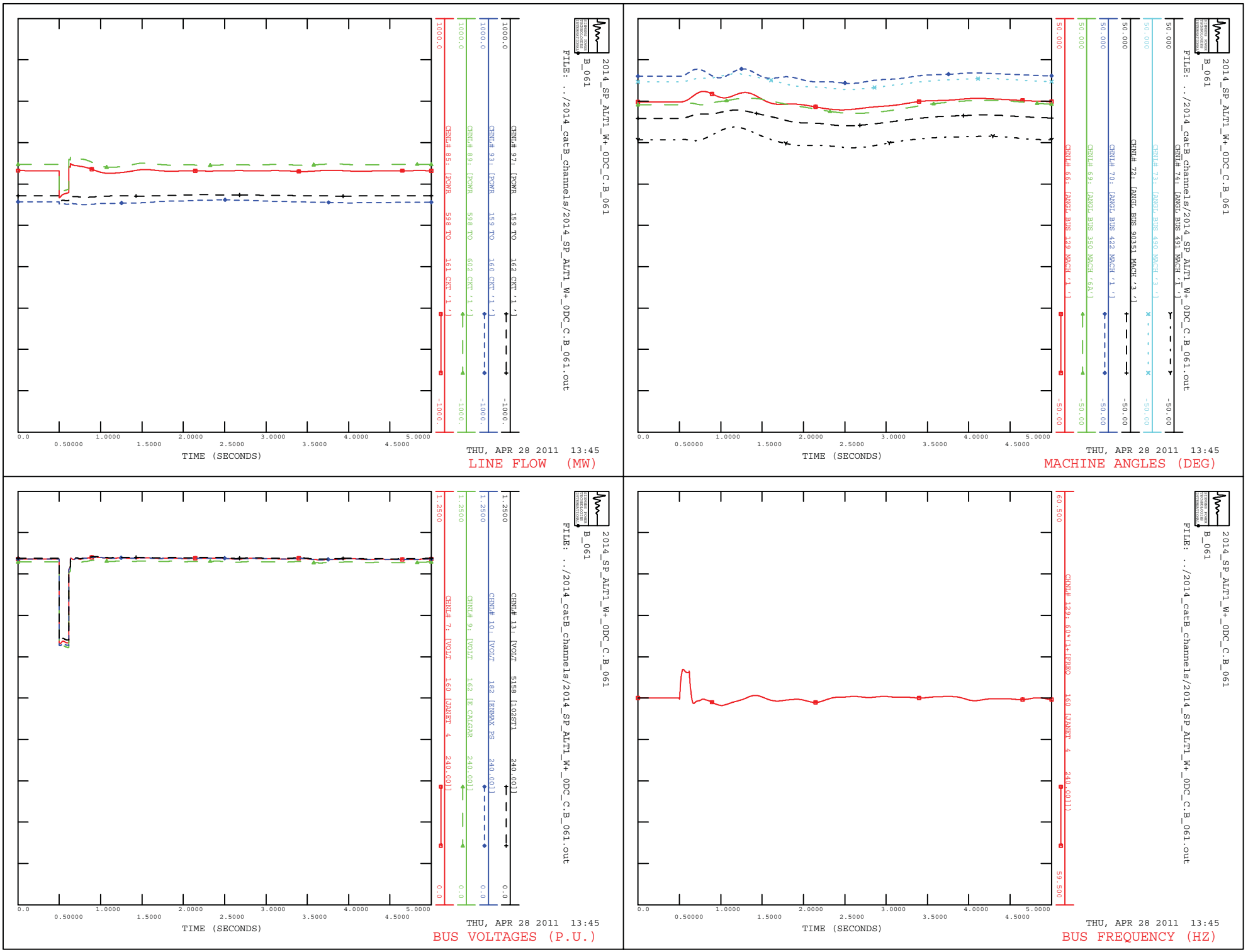


Figure L-2014-Step4-Sc3-15

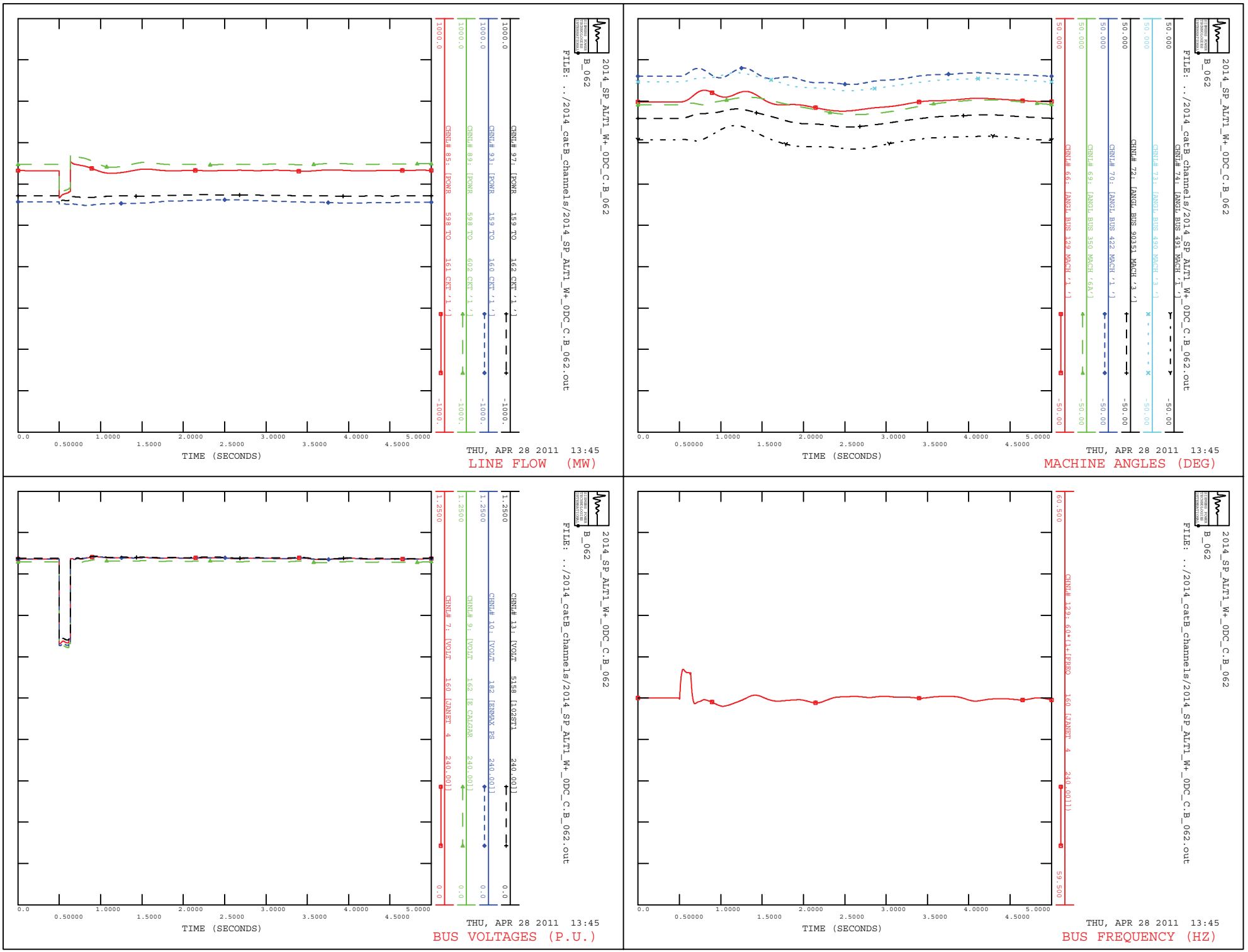


Figure L-2014-Step4-Sc3-16

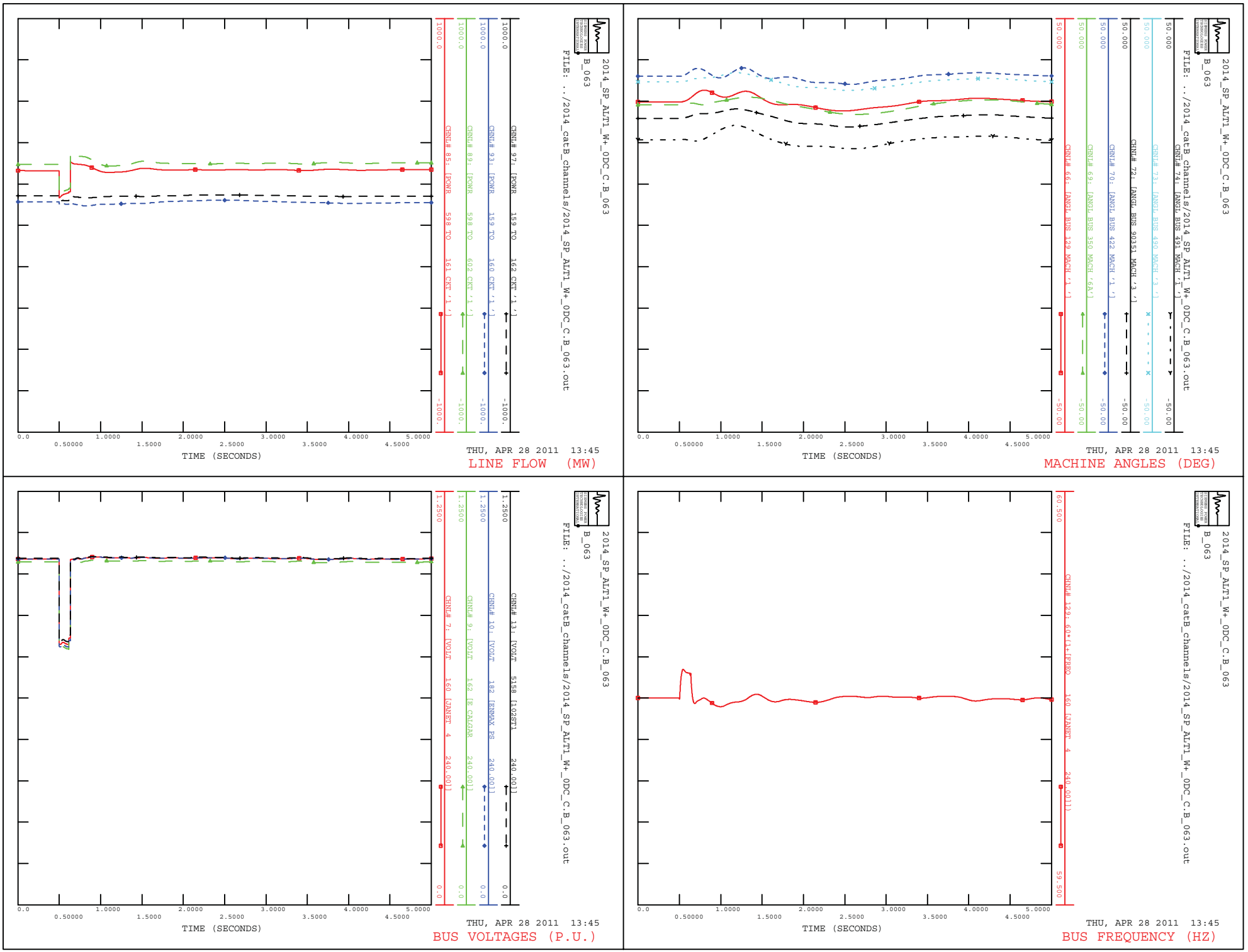


Figure L-2014-Step4-Sc3-17

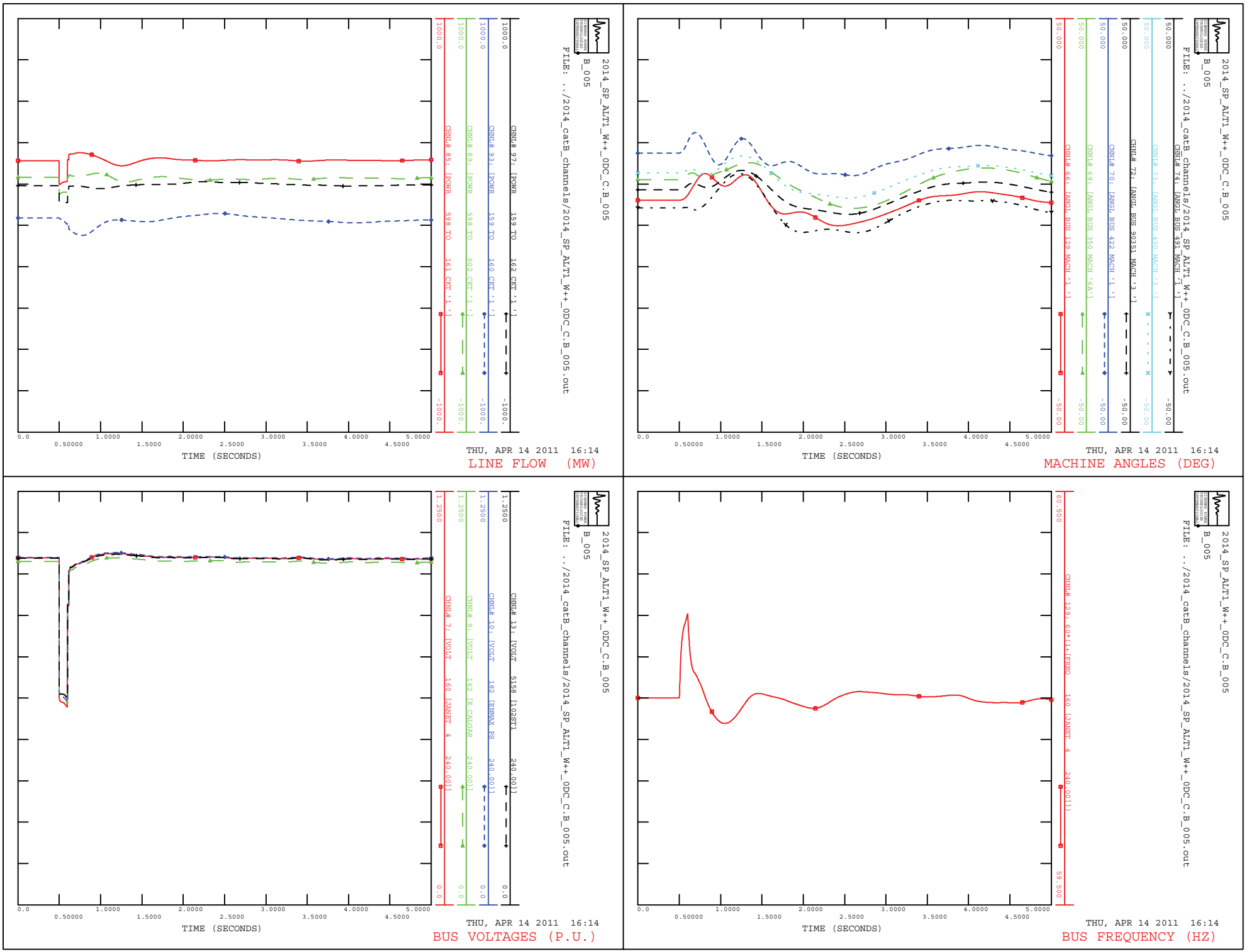


Figure L-2014-Step4-Sc4-1

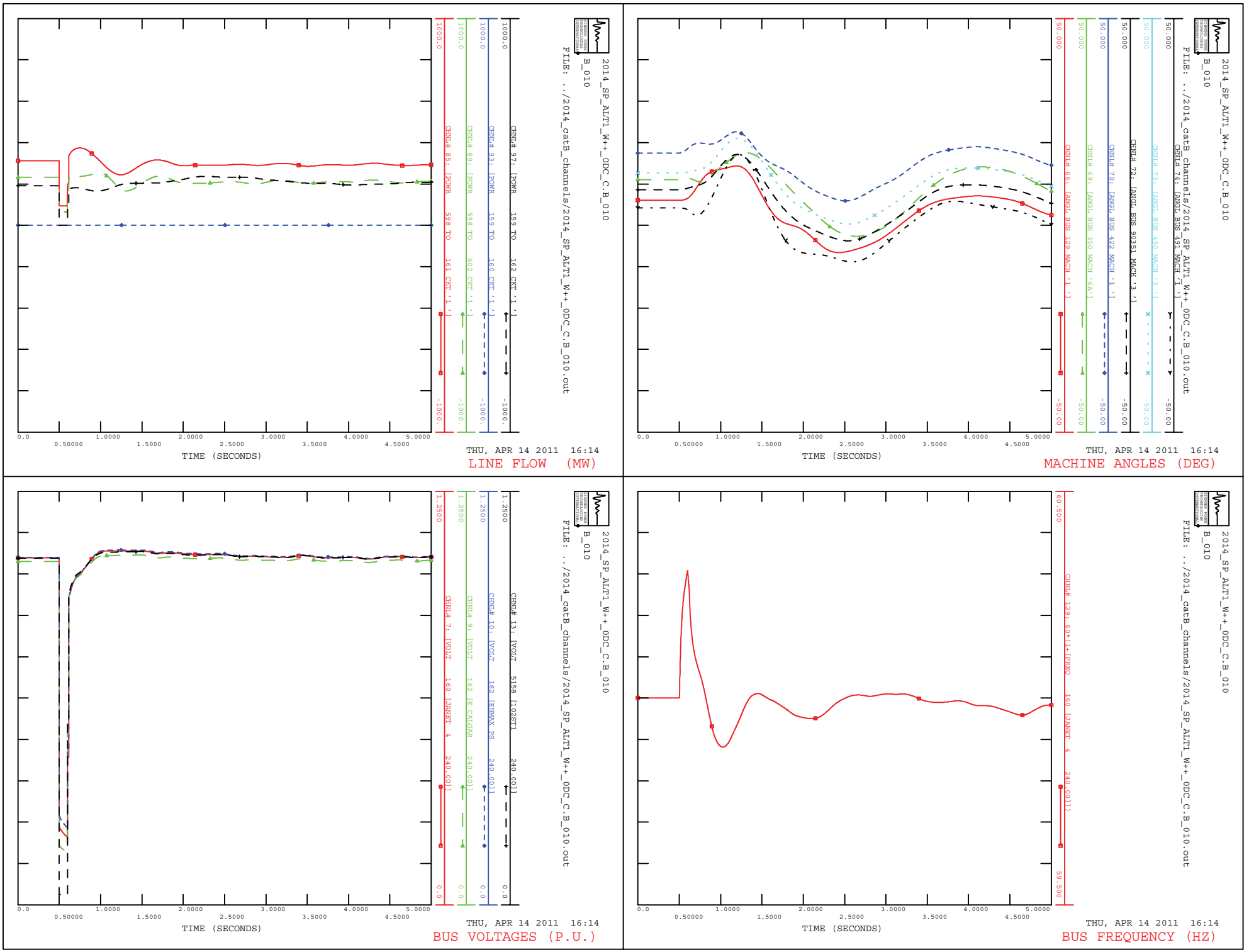


Figure L-2014-Step4-Sc4-2

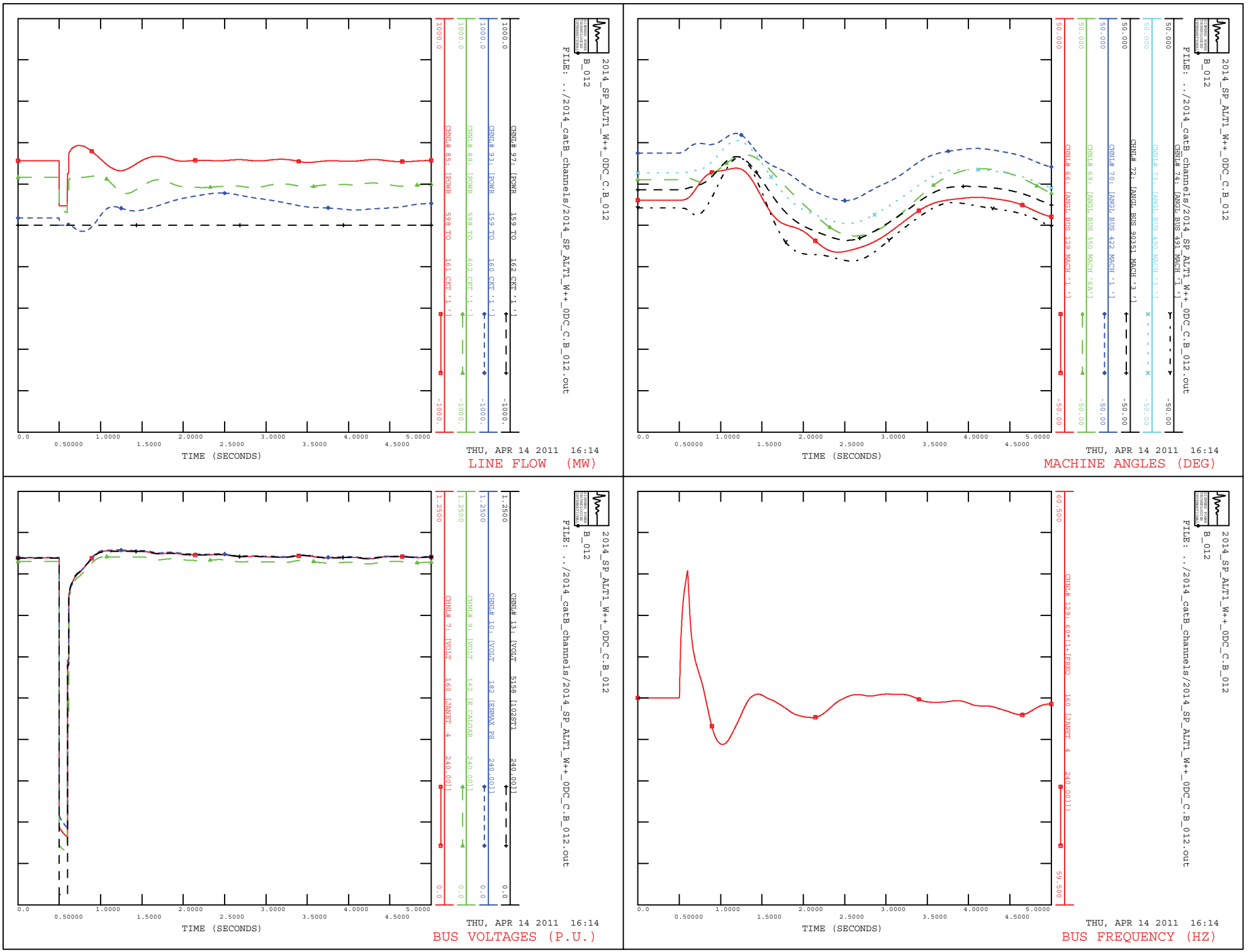


Figure L-2014-Step4-Sc4-3

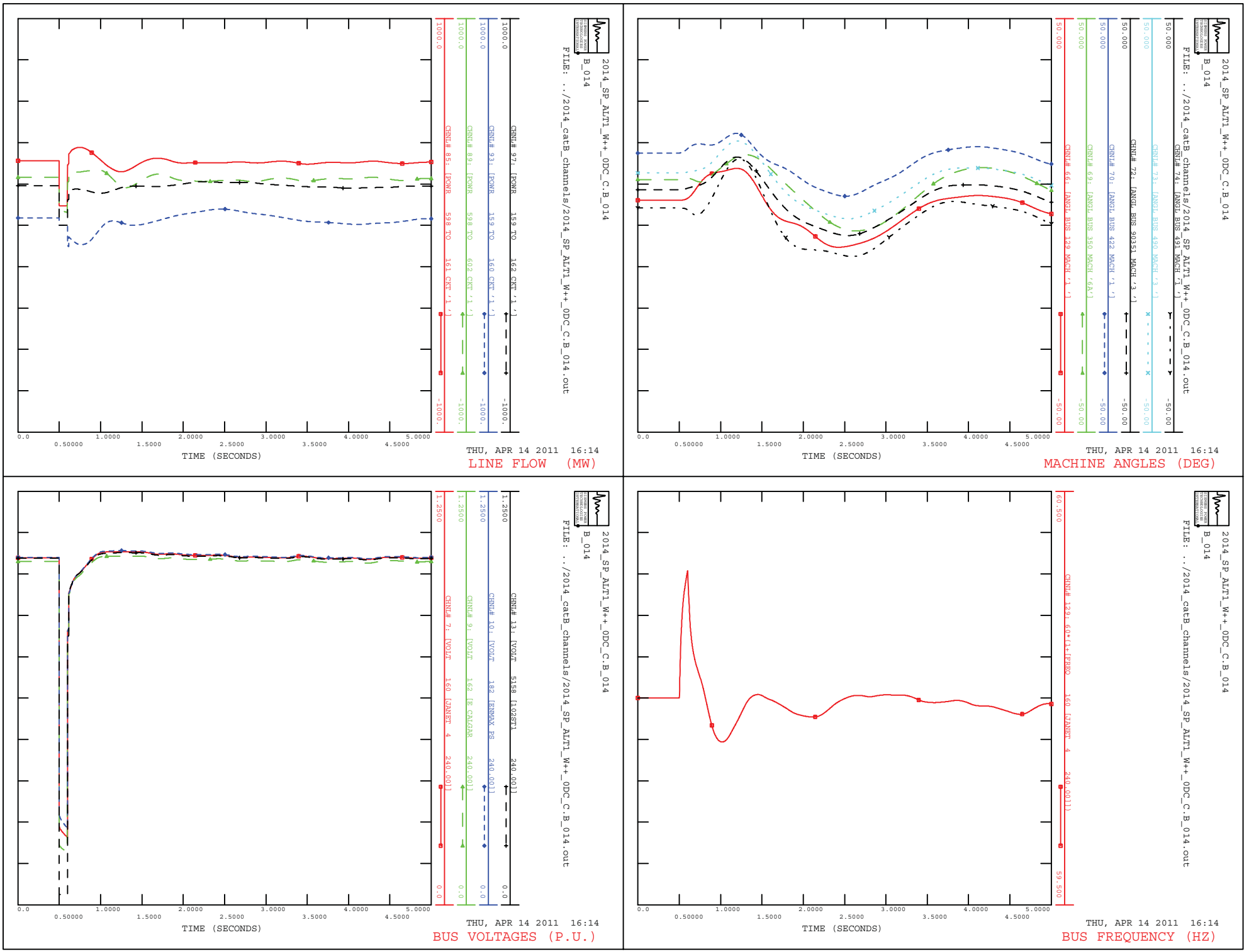


Figure L-2014-Step4-Sc4-4

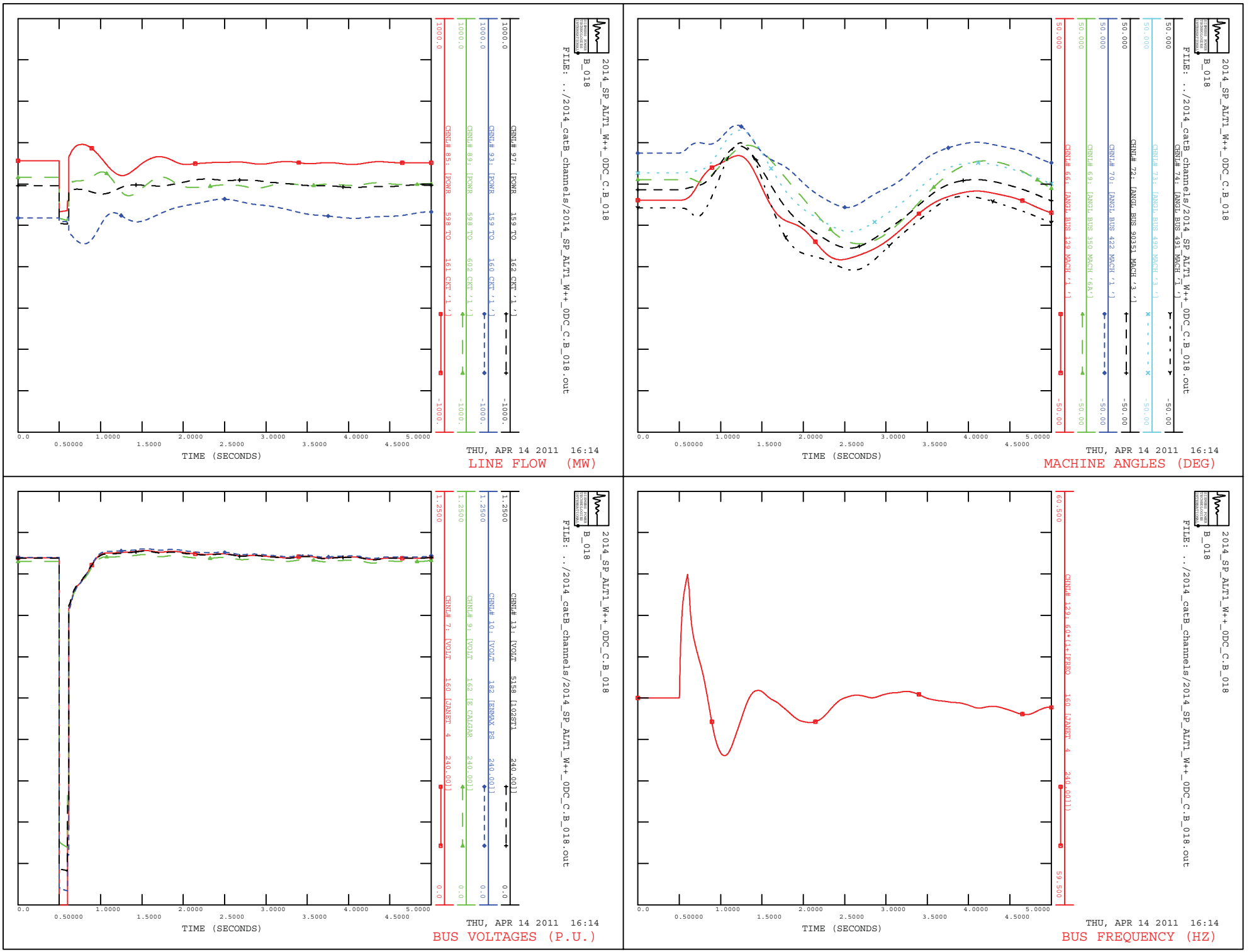


Figure L-2014-Step4-Sc4-5

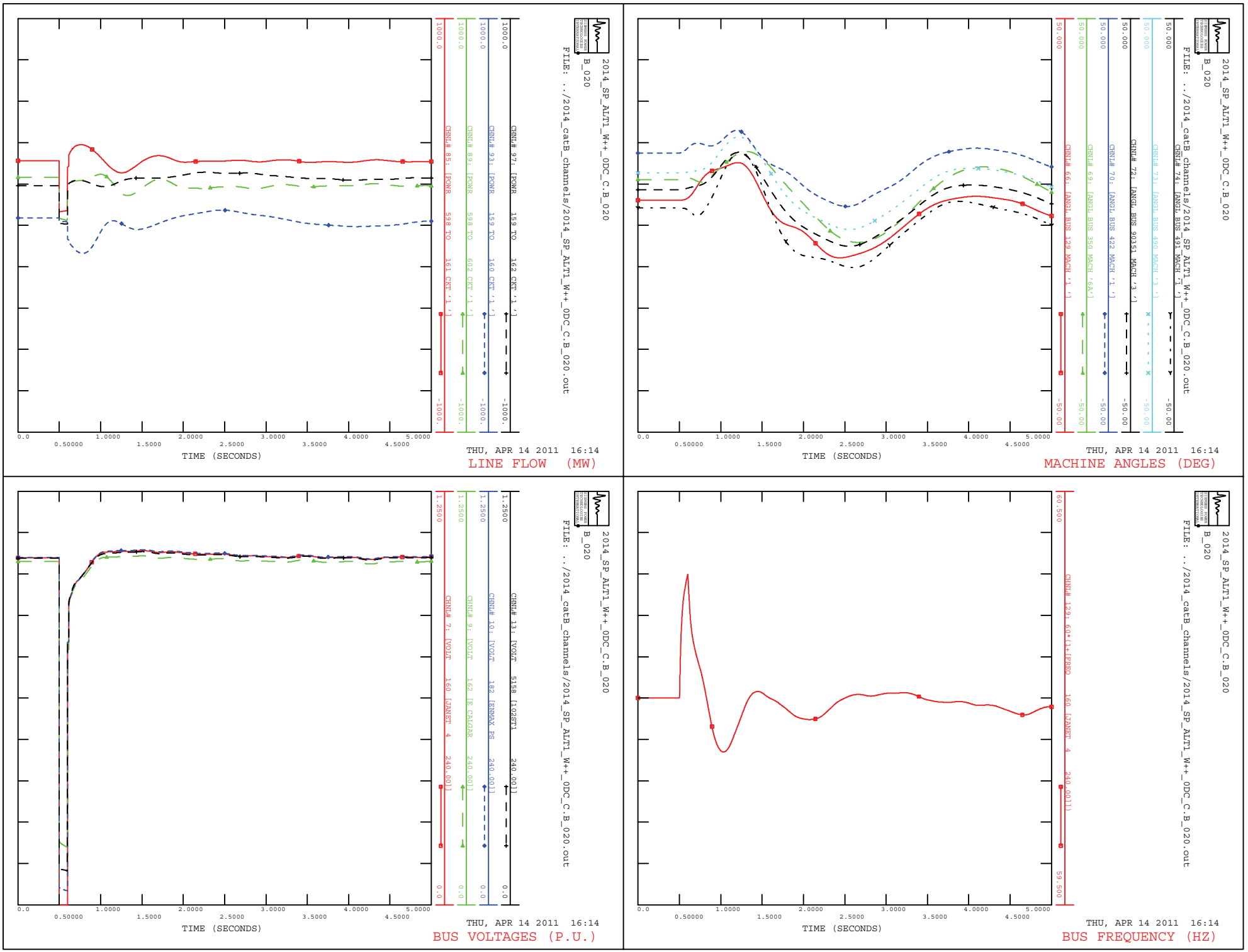


Figure L-2014-Step4-Sc4-6

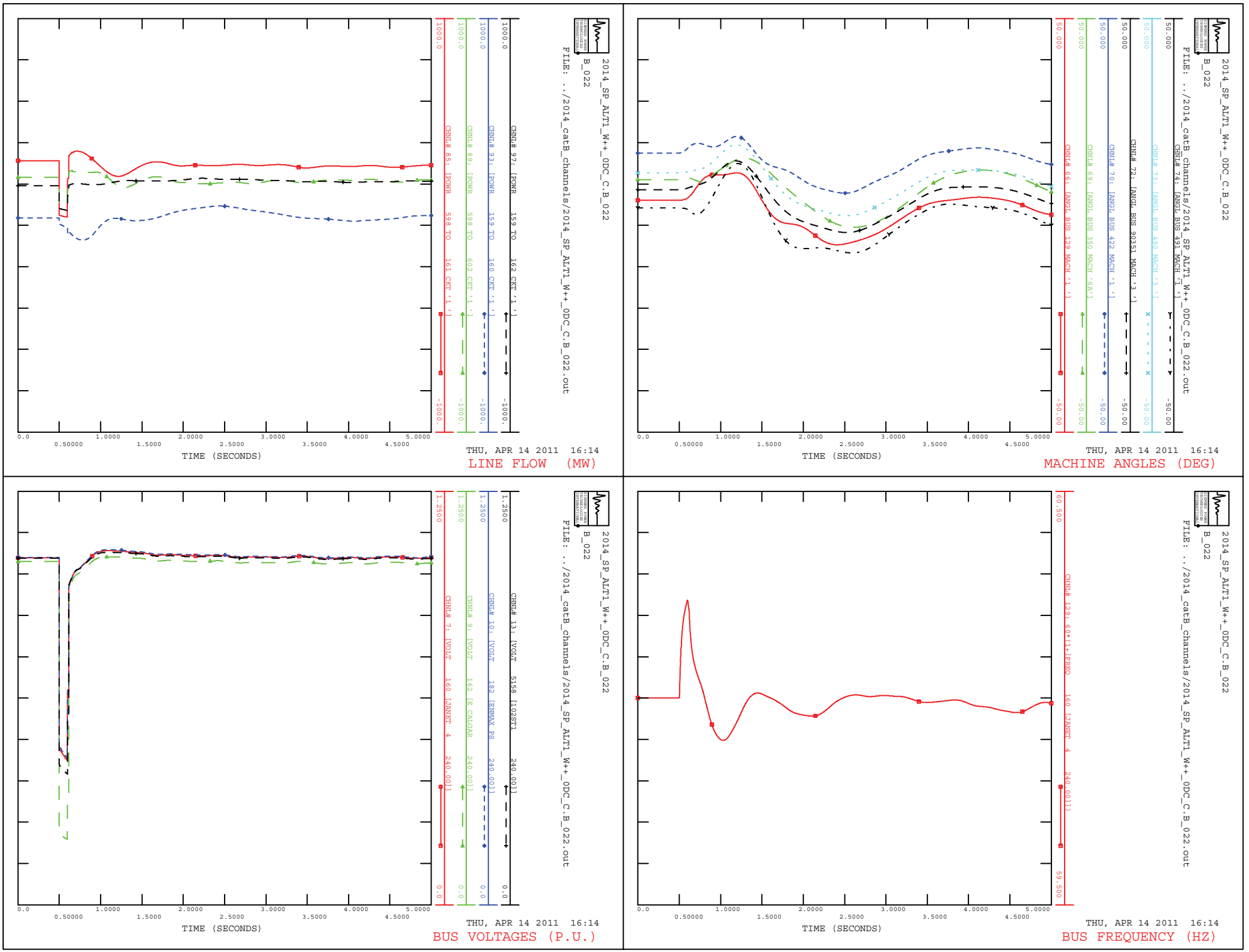


Figure L-2014-Step4-Sc4-7

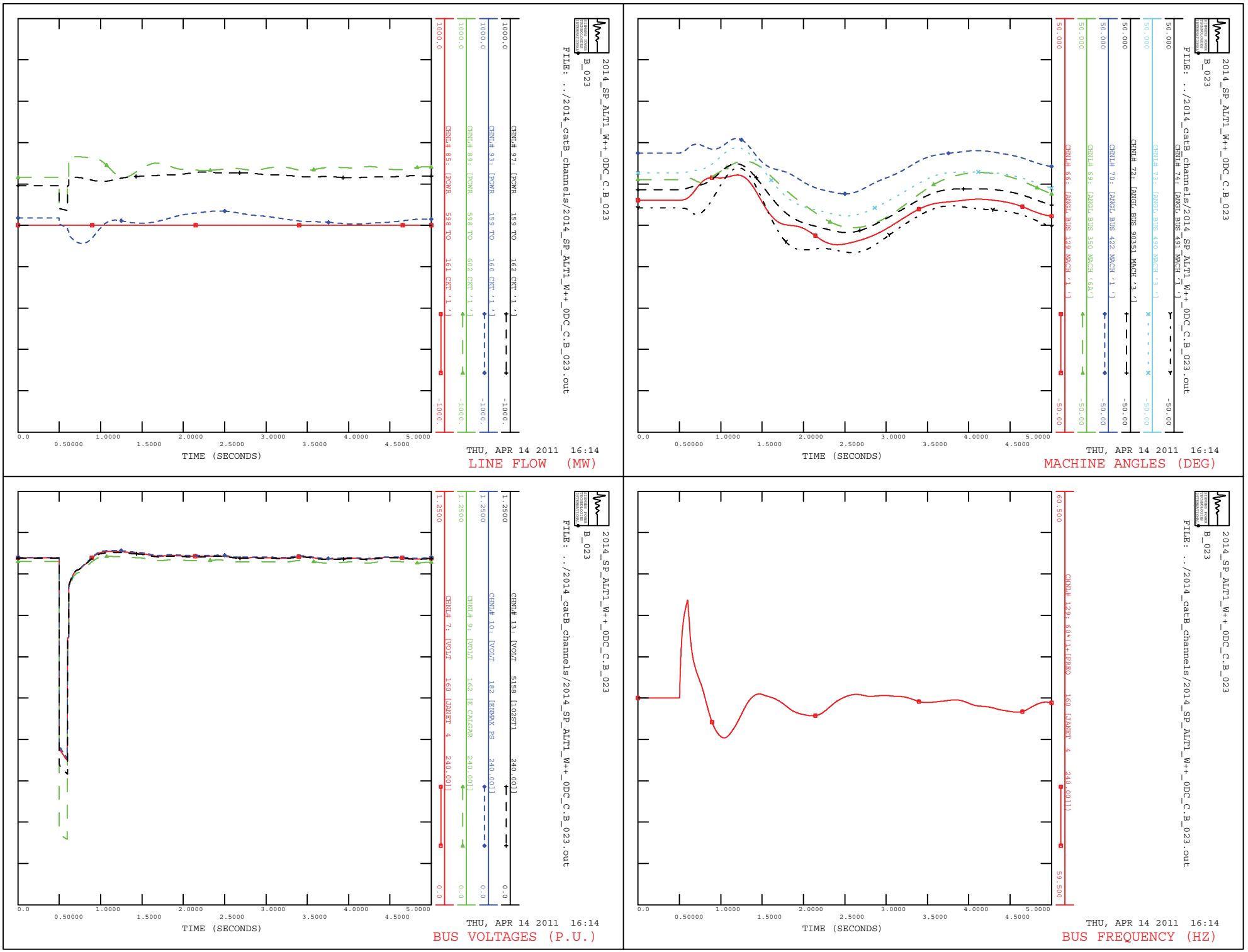


Figure L-2014-Step4-Sc4-8

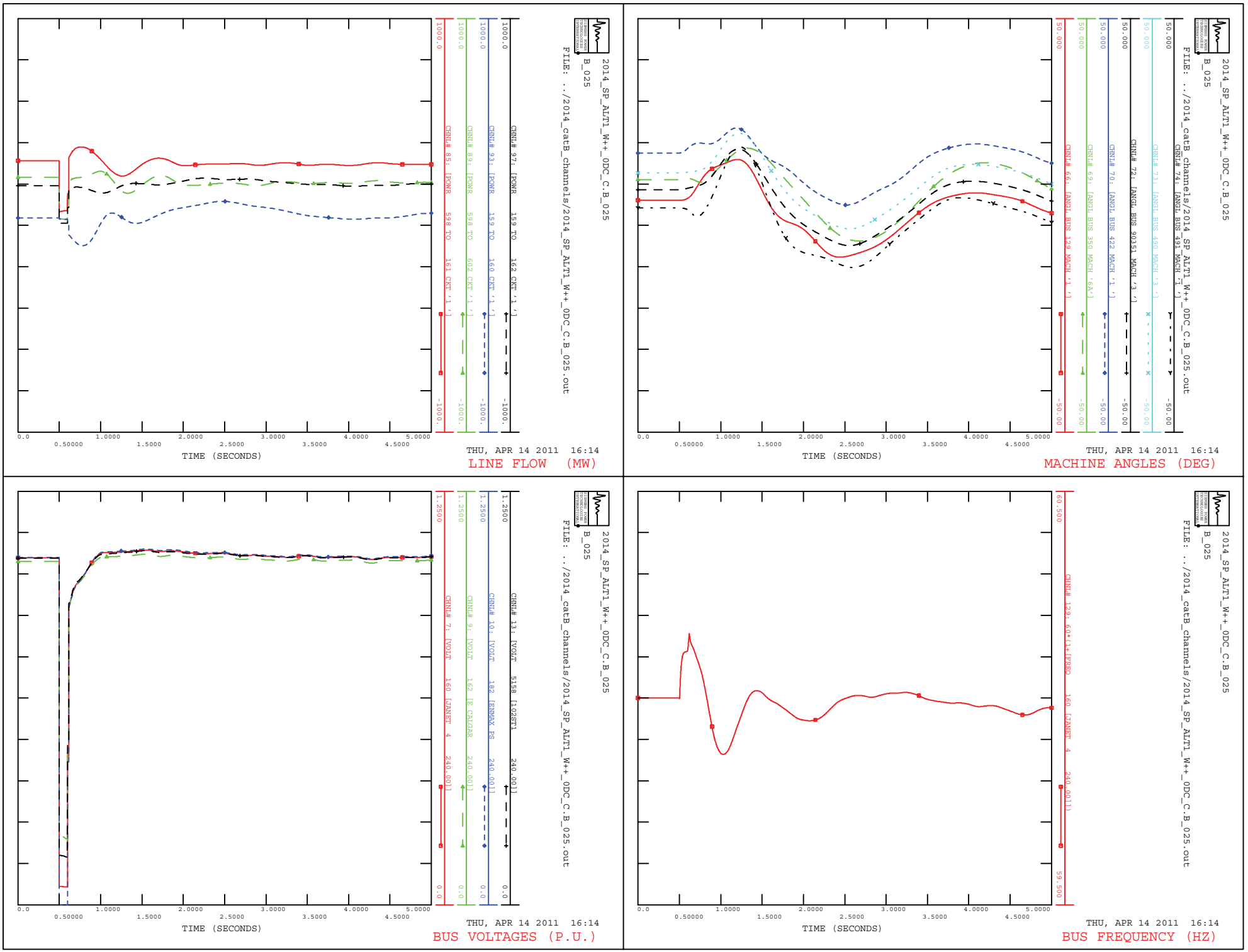


Figure L-2014-Step4-Sc4-9

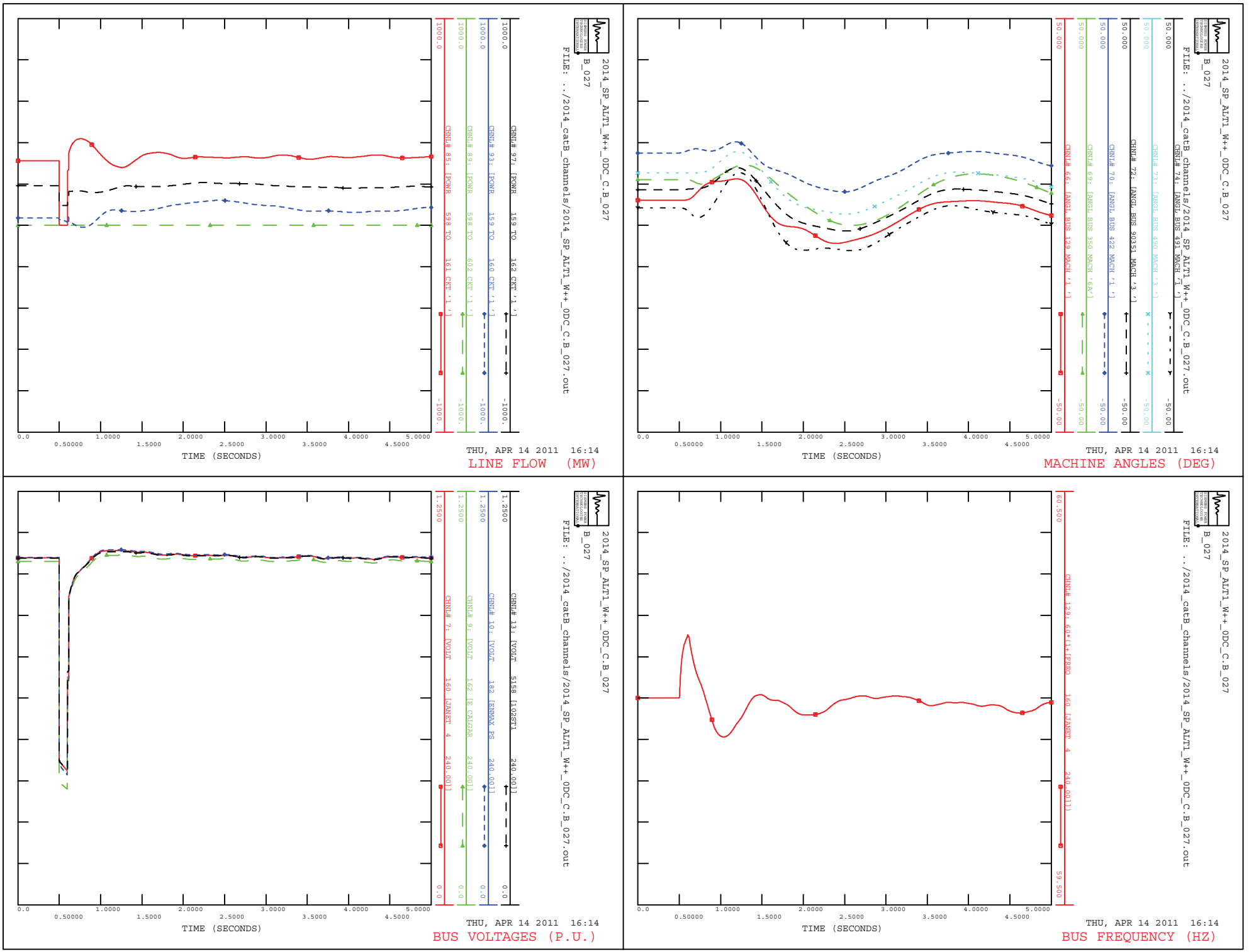


Figure L-2014-Step4-Sc4-10

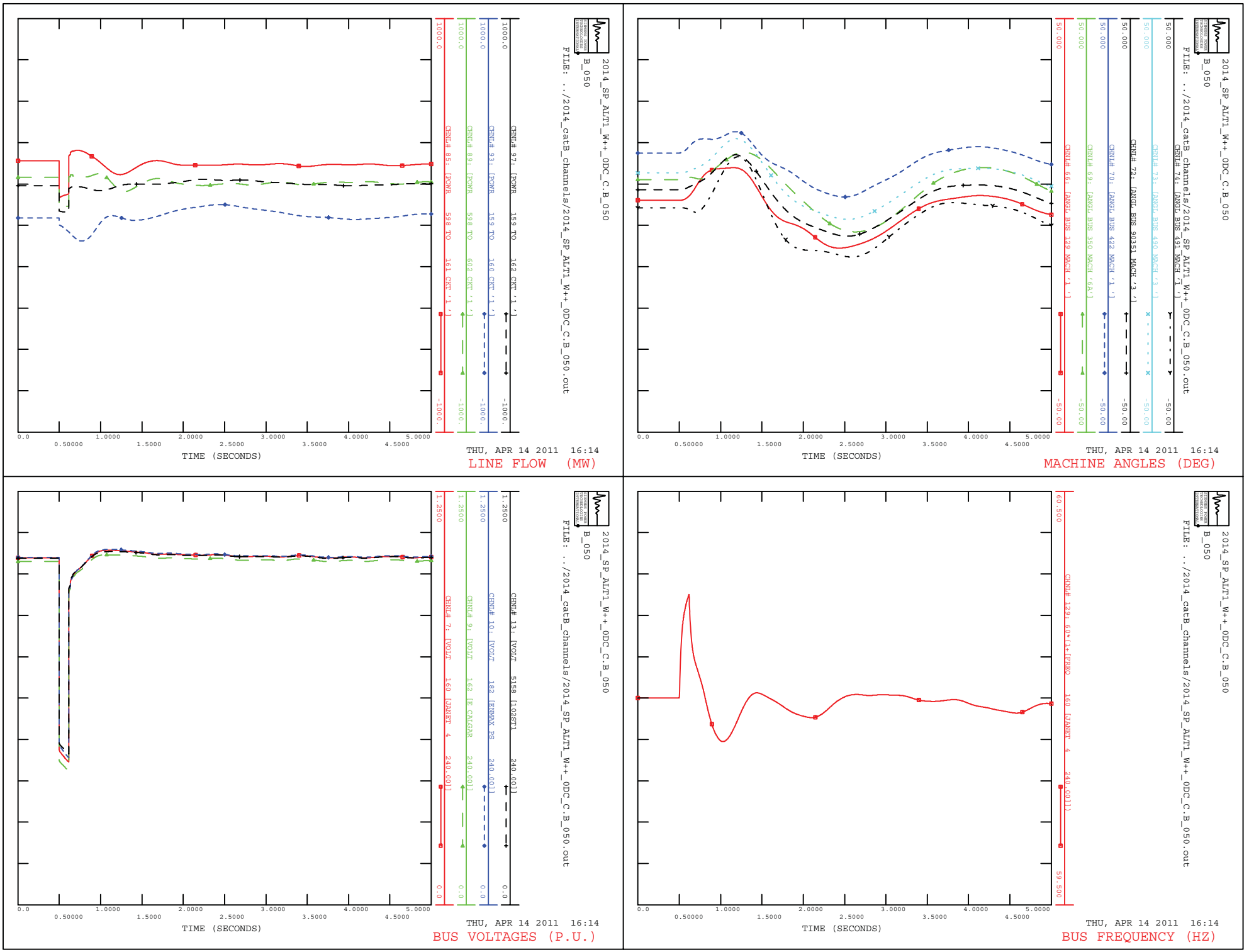


Figure L-2014-Step4-Sc4-11

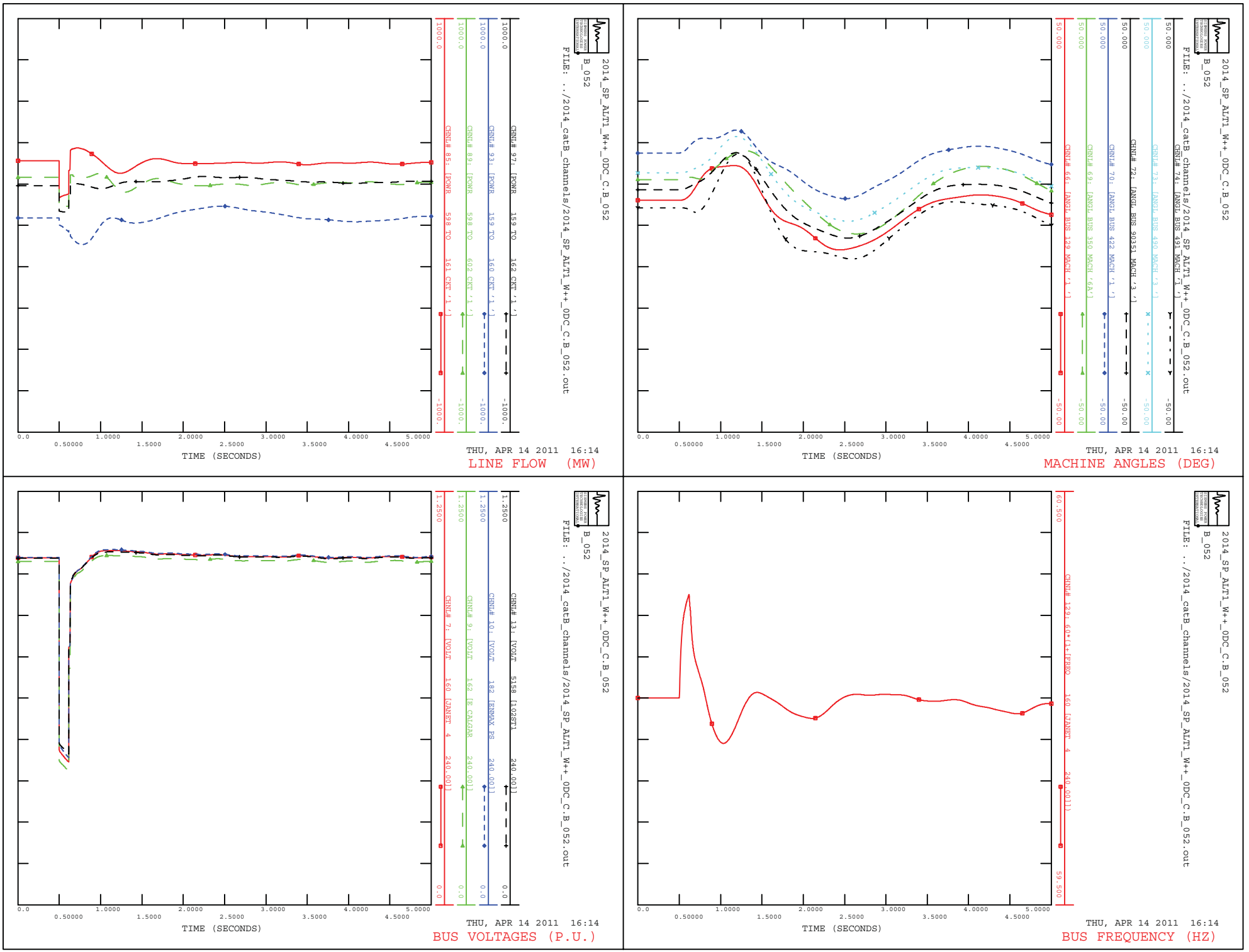


Figure L-2014-Step4-Sc4-12

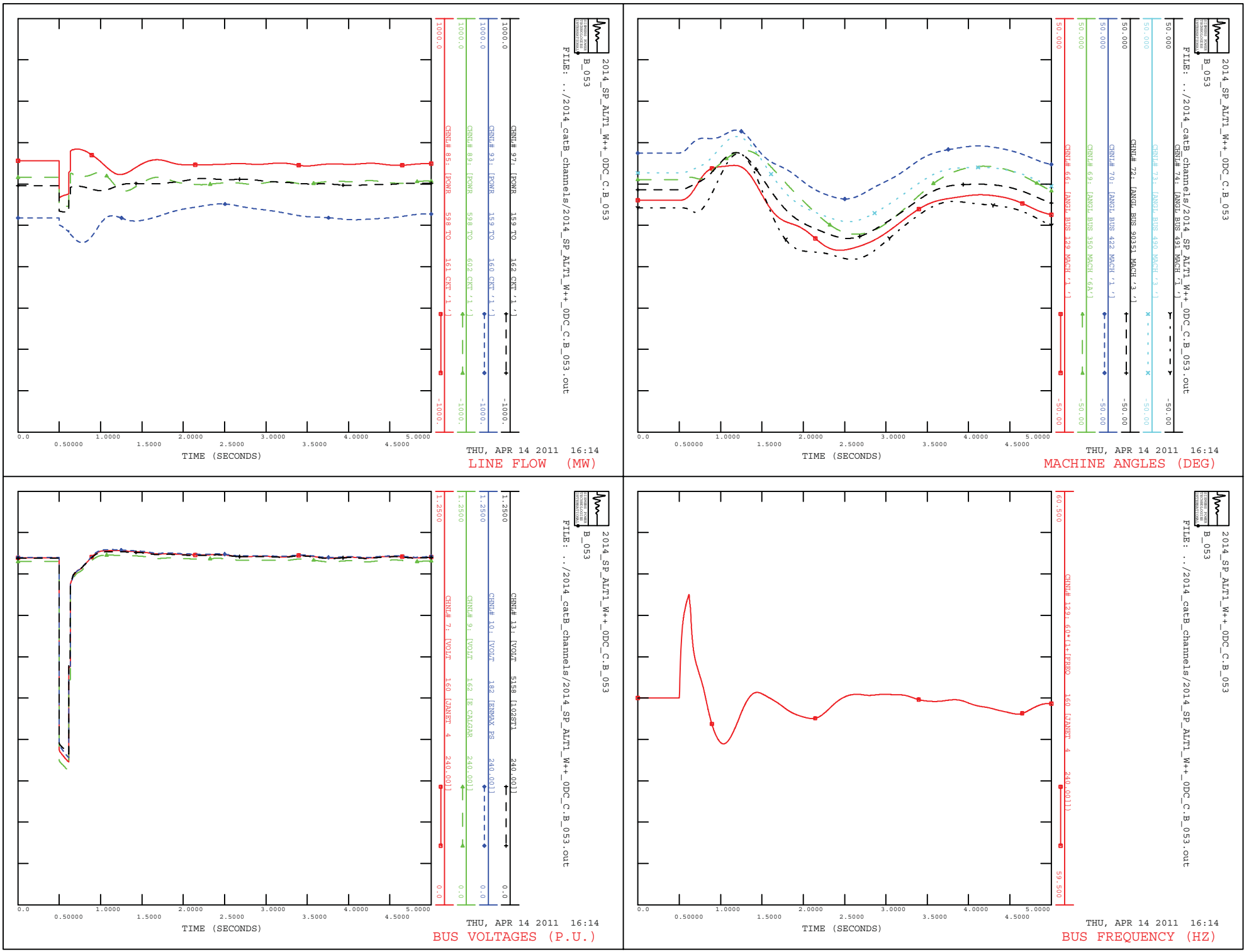


Figure L-2014-Step4-Sc4-13

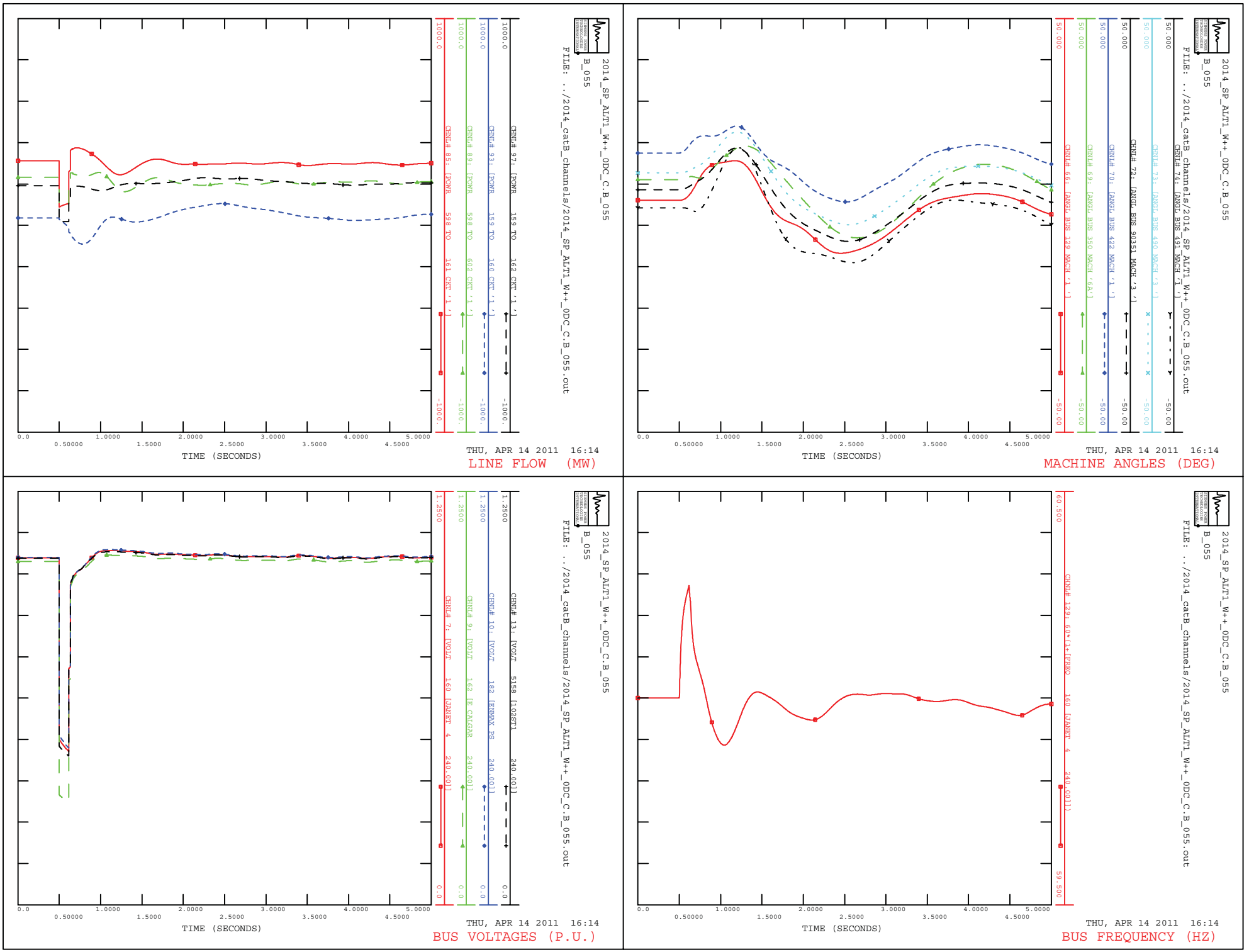


Figure L-2014-Step4-Sc4-14

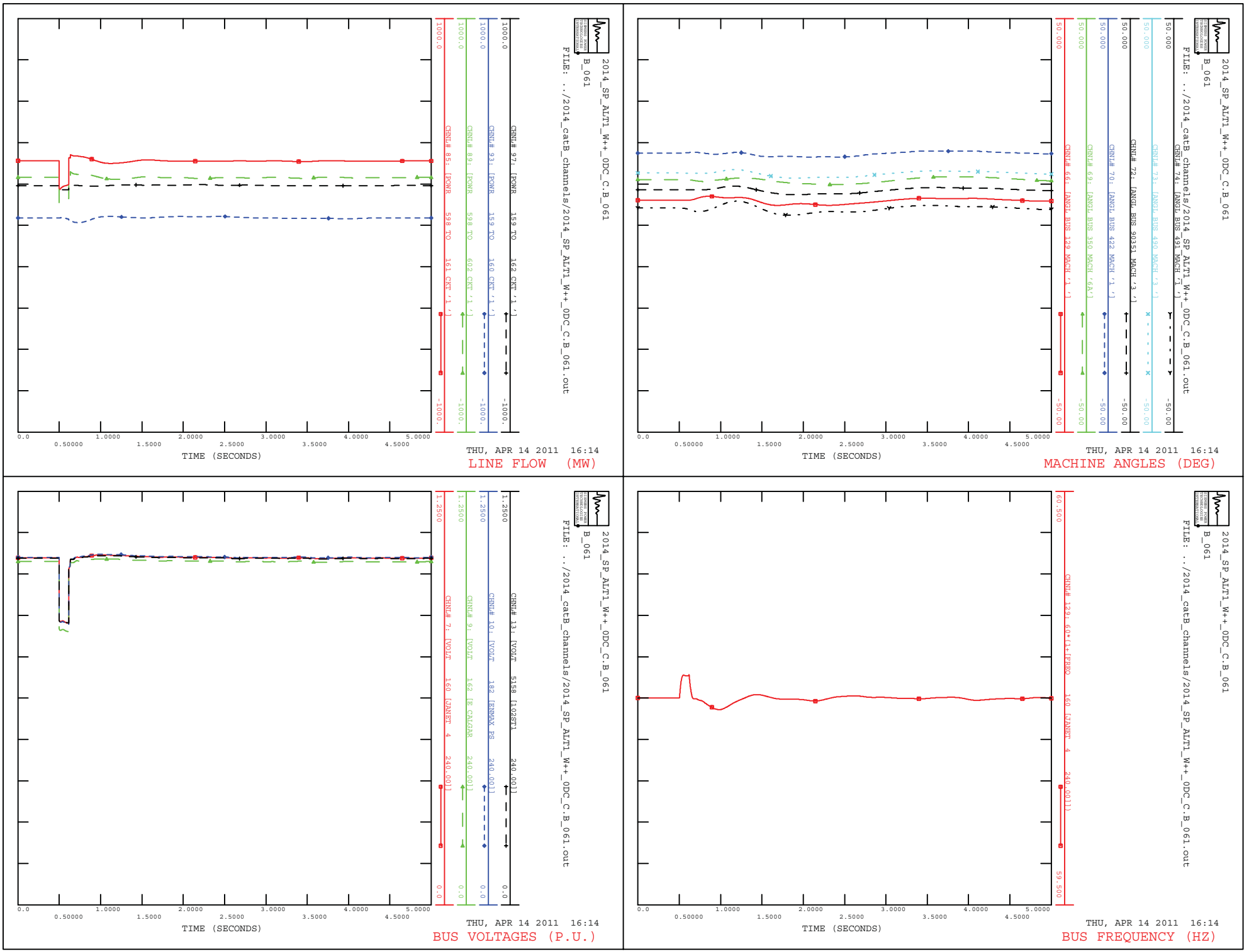


Figure L-2014-Step4-Sc4-15

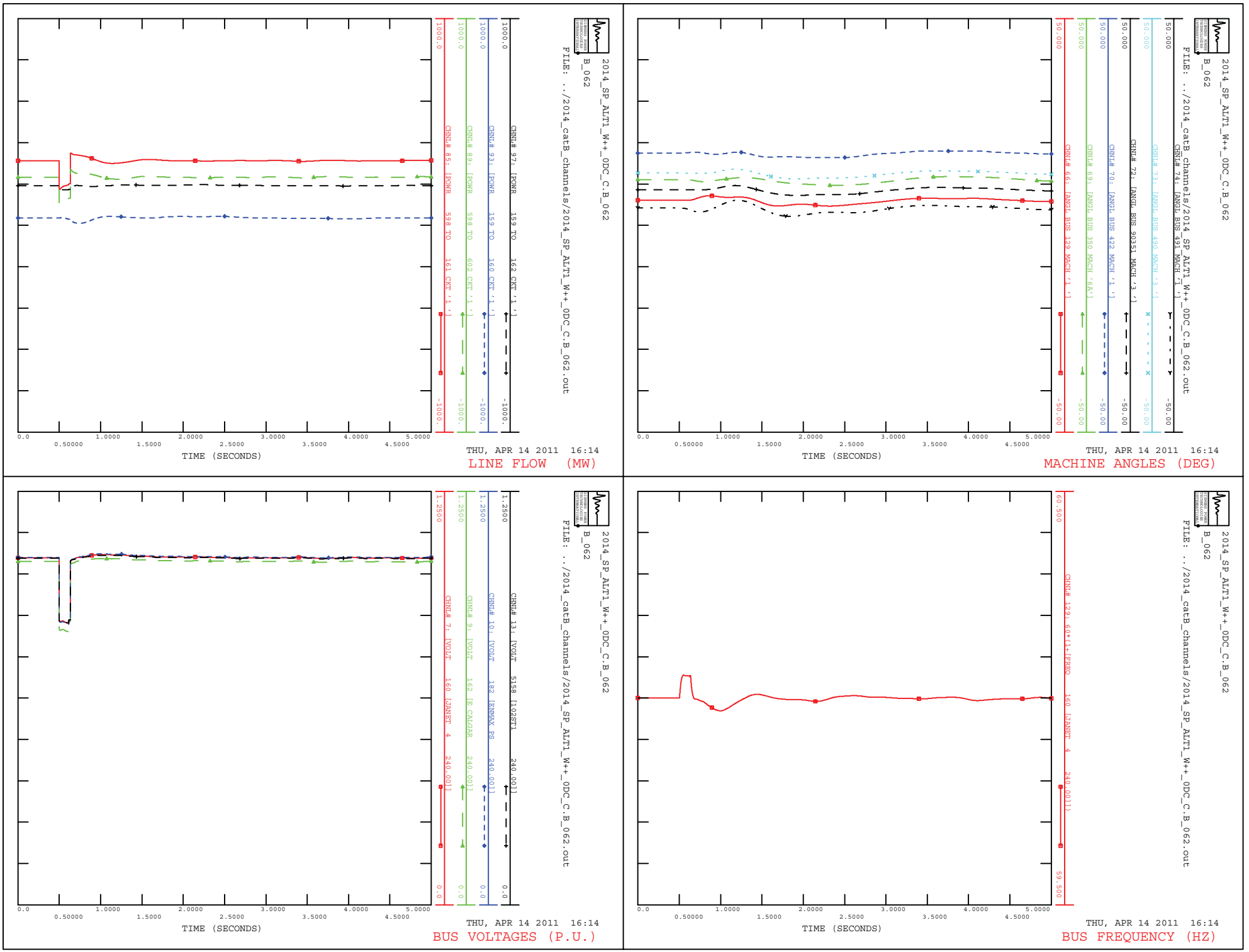


Figure L-2014-Step4-Sc4-16

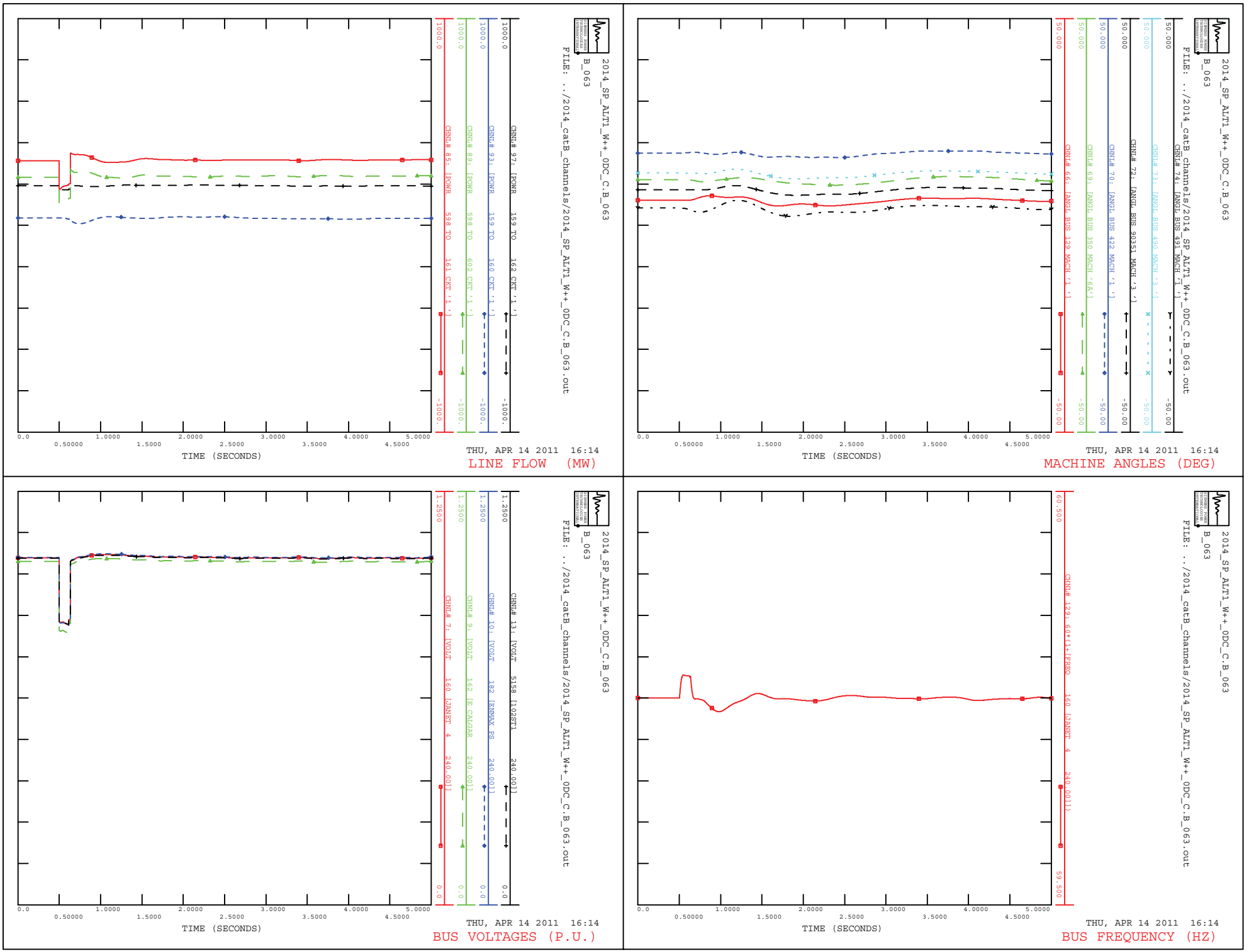


Figure L-2014-Step4-Sc4-17

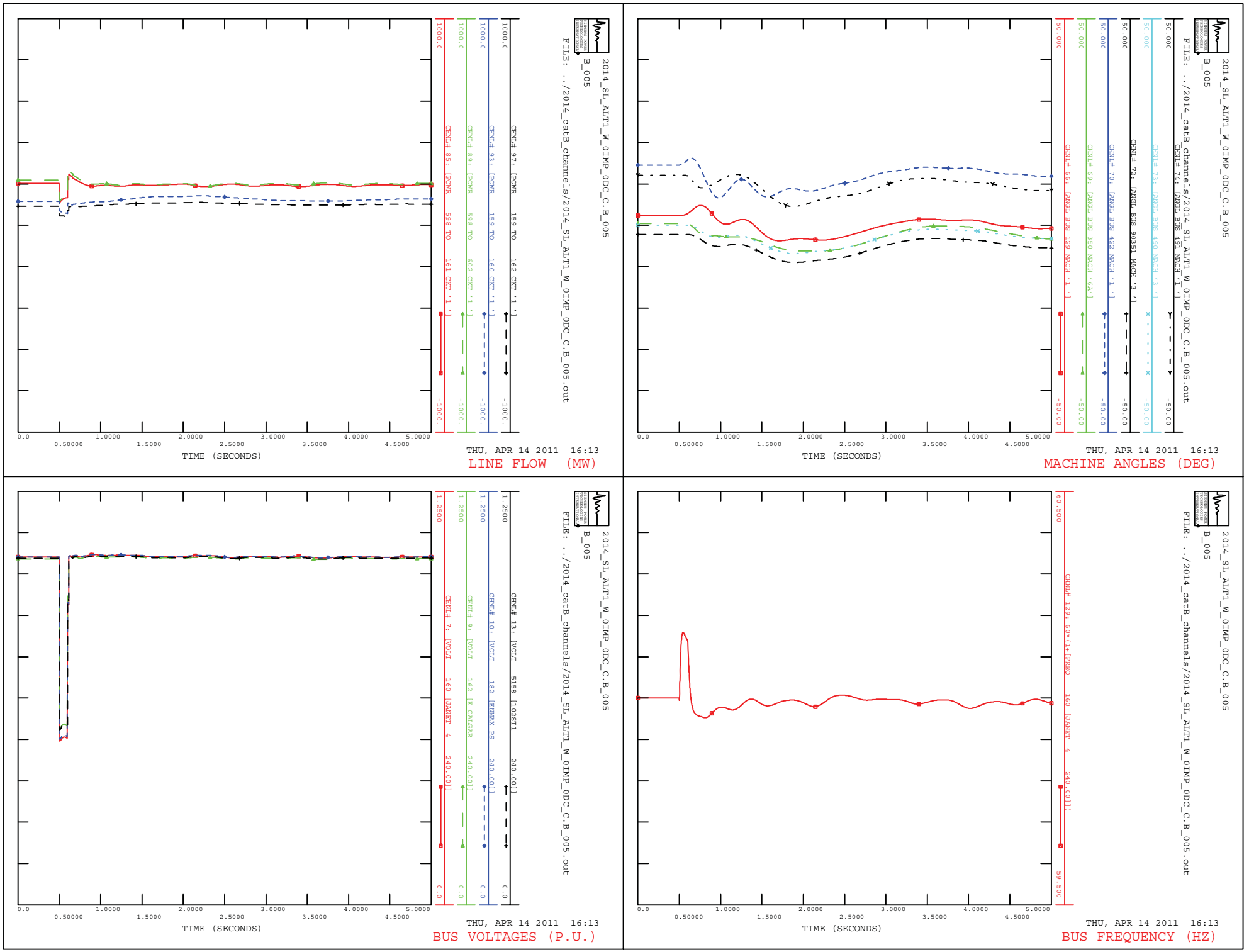


Figure L-2014-Step4-Sc6-1

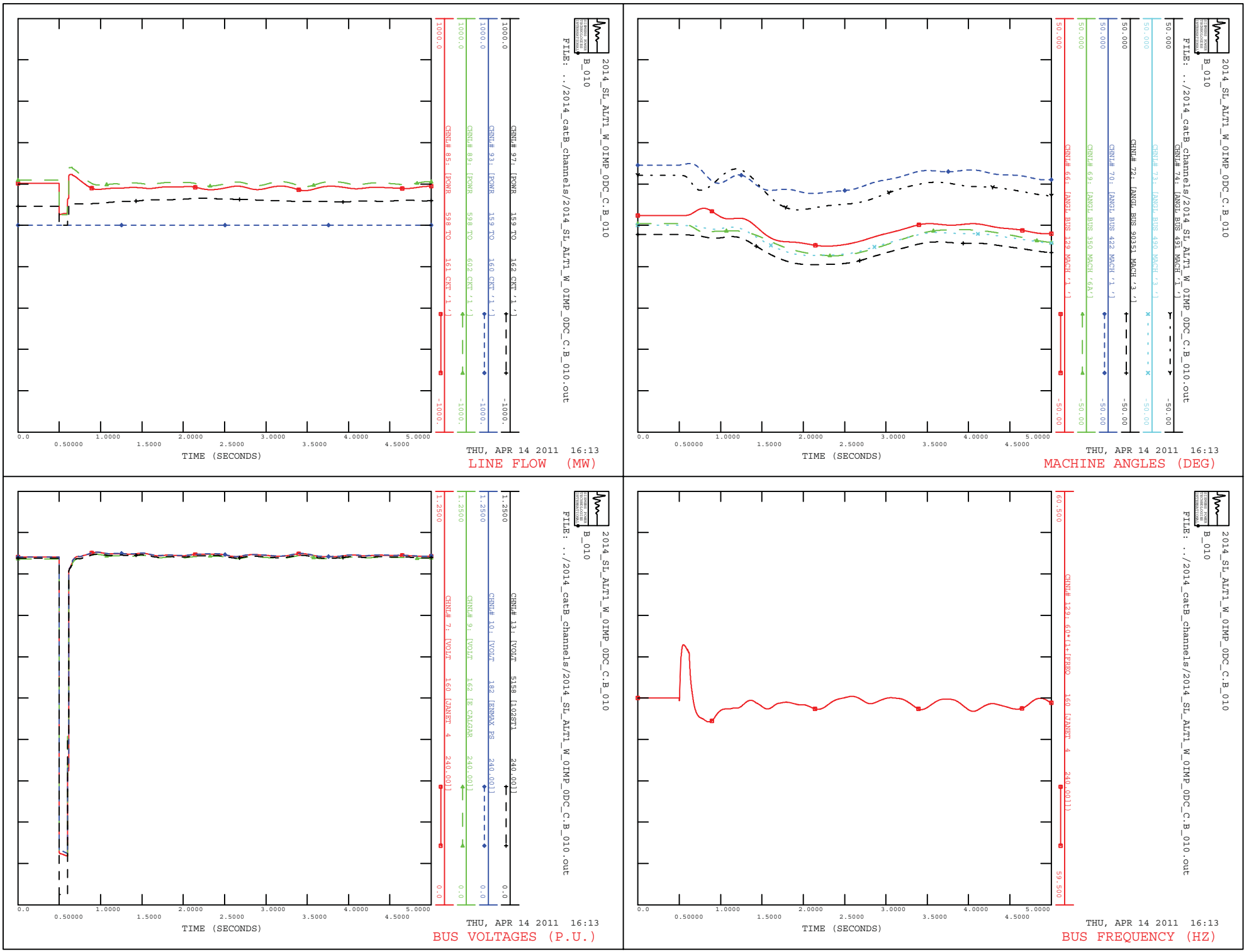


Figure L-2014-Step4-Sc6-2

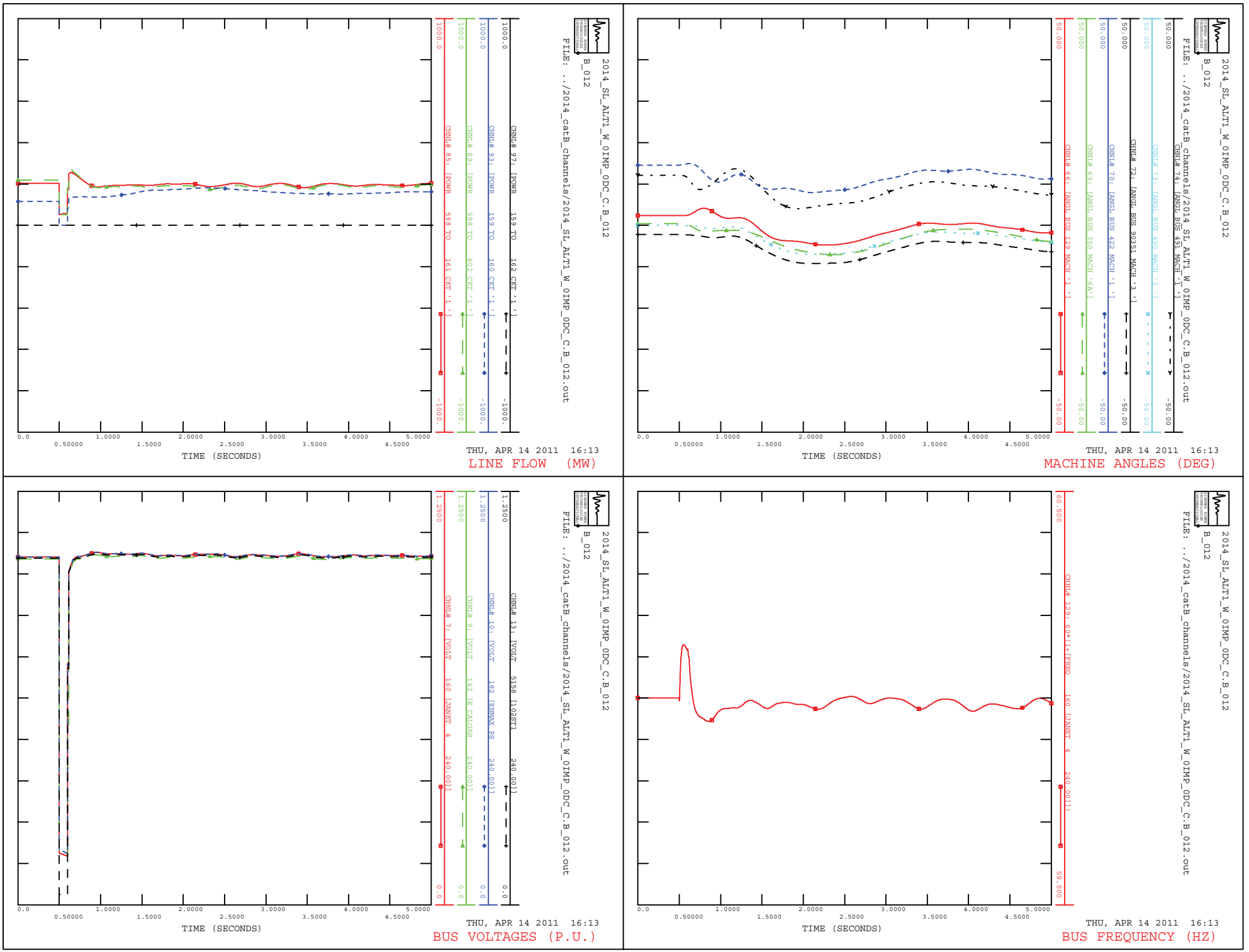


Figure L-2014-Step4-Sc6-3

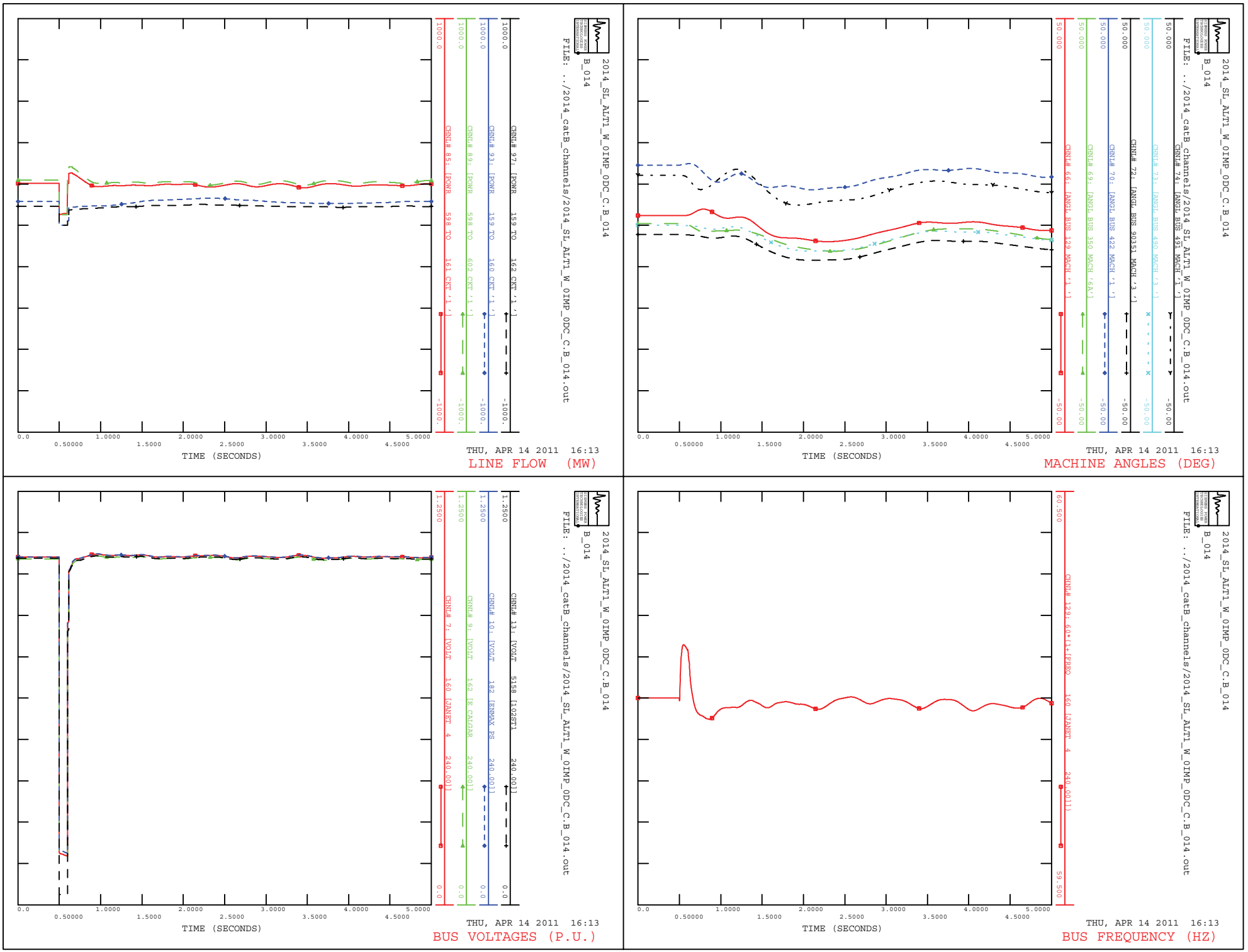


Figure L-2014-Step4-Sc6-4

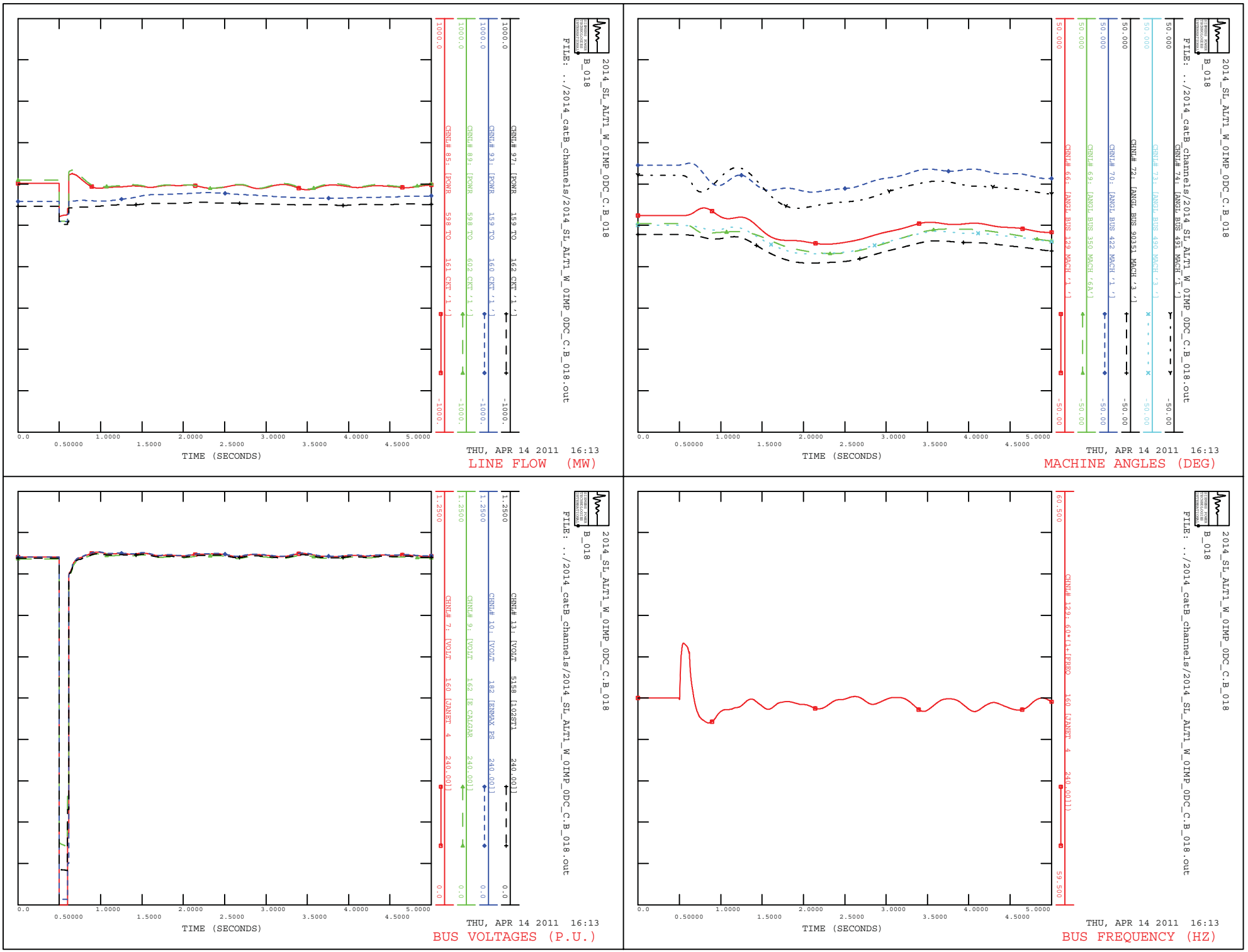


Figure L-2014-Step4-Sc6-5

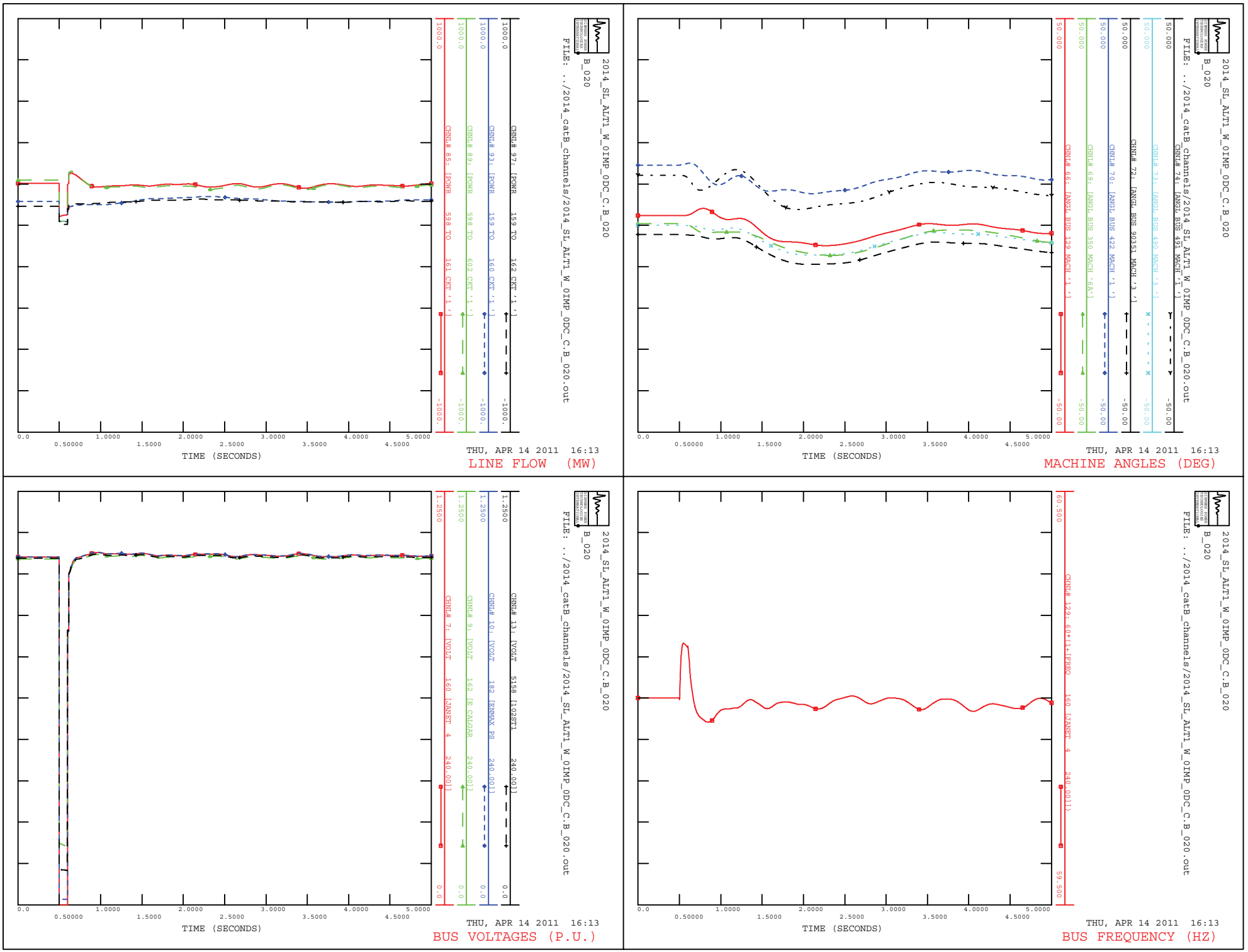


Figure L-2014-Step4-Sc6-6

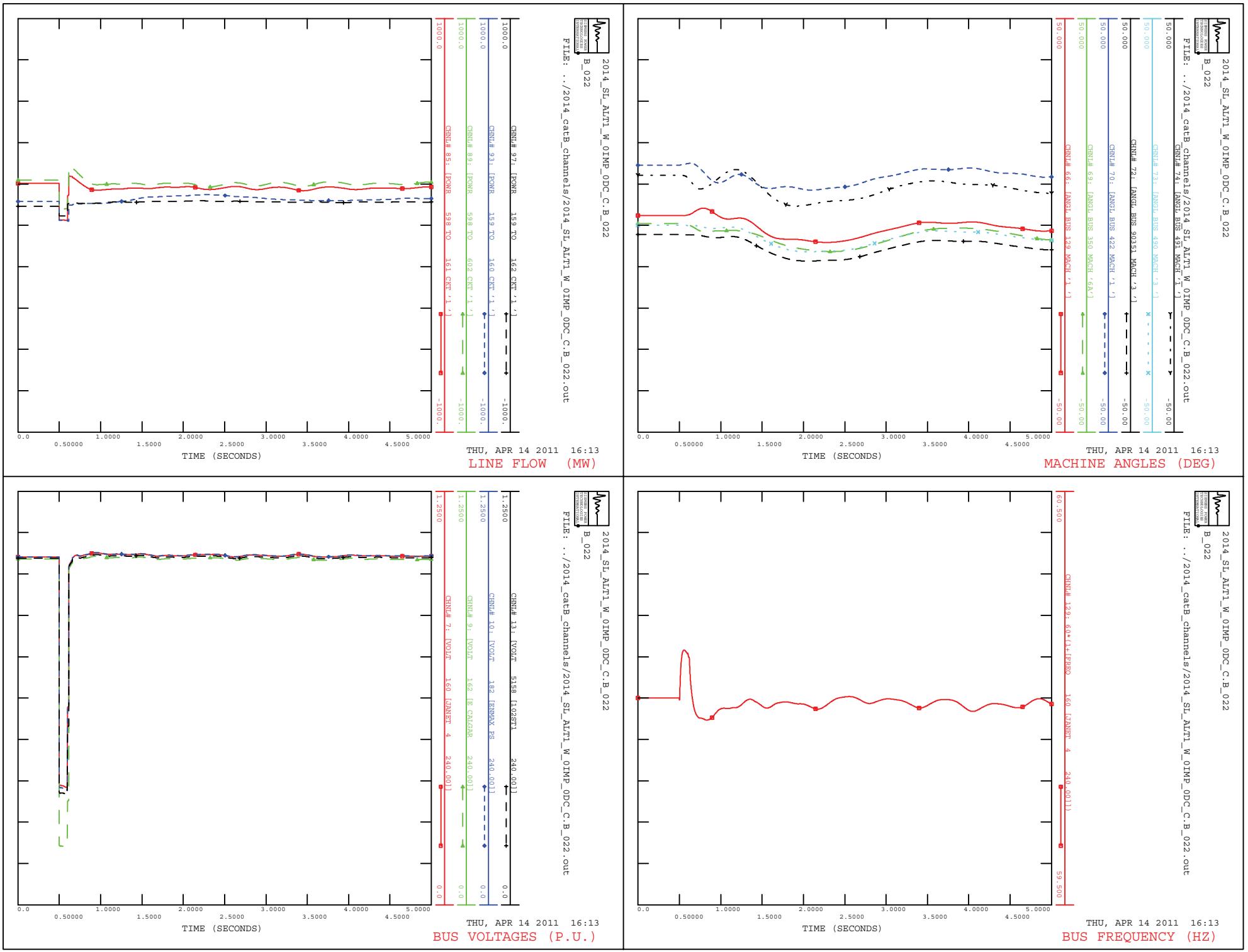


Figure L-2014-Step4-Sc6-7

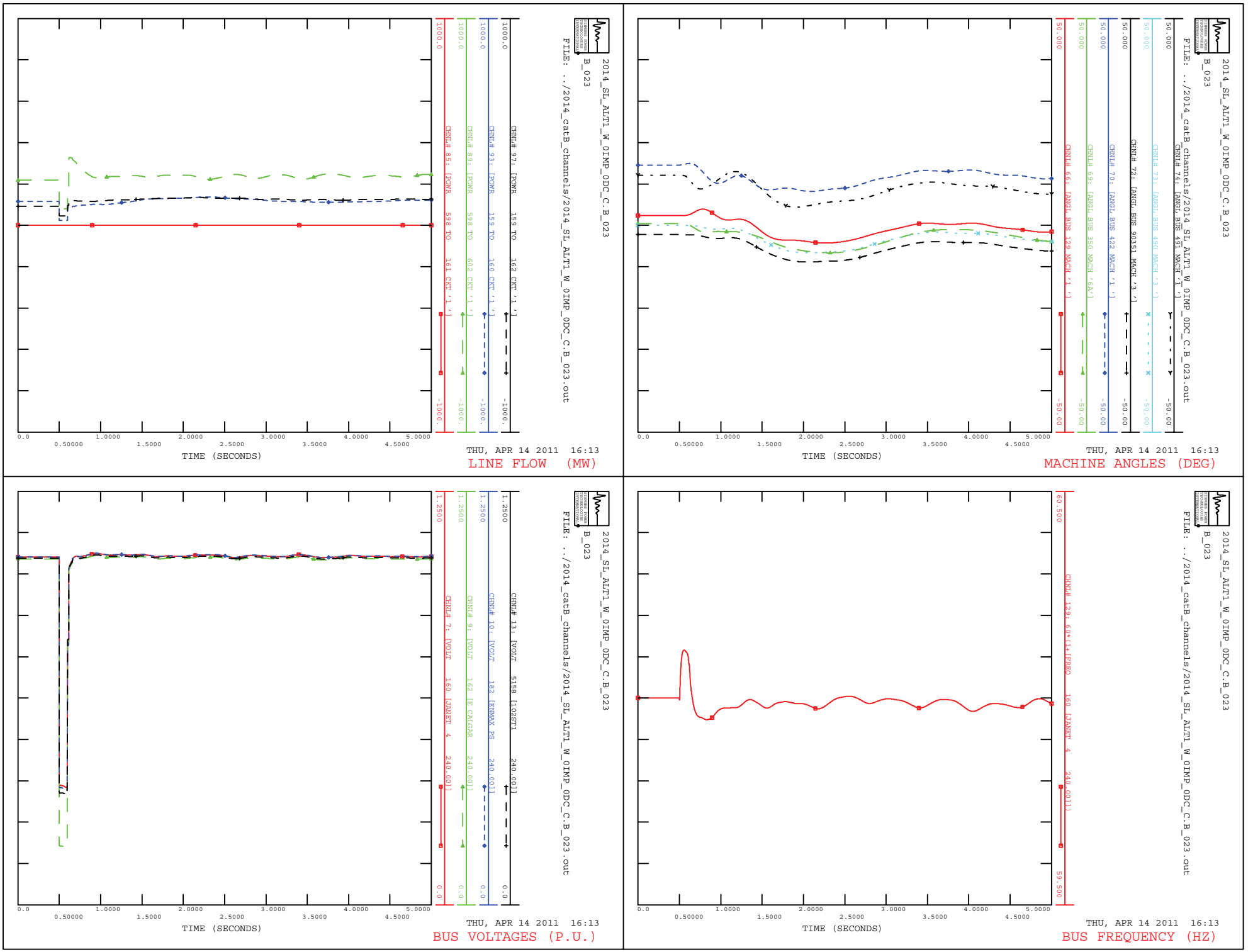


Figure L-2014-Step4-Sc6-8

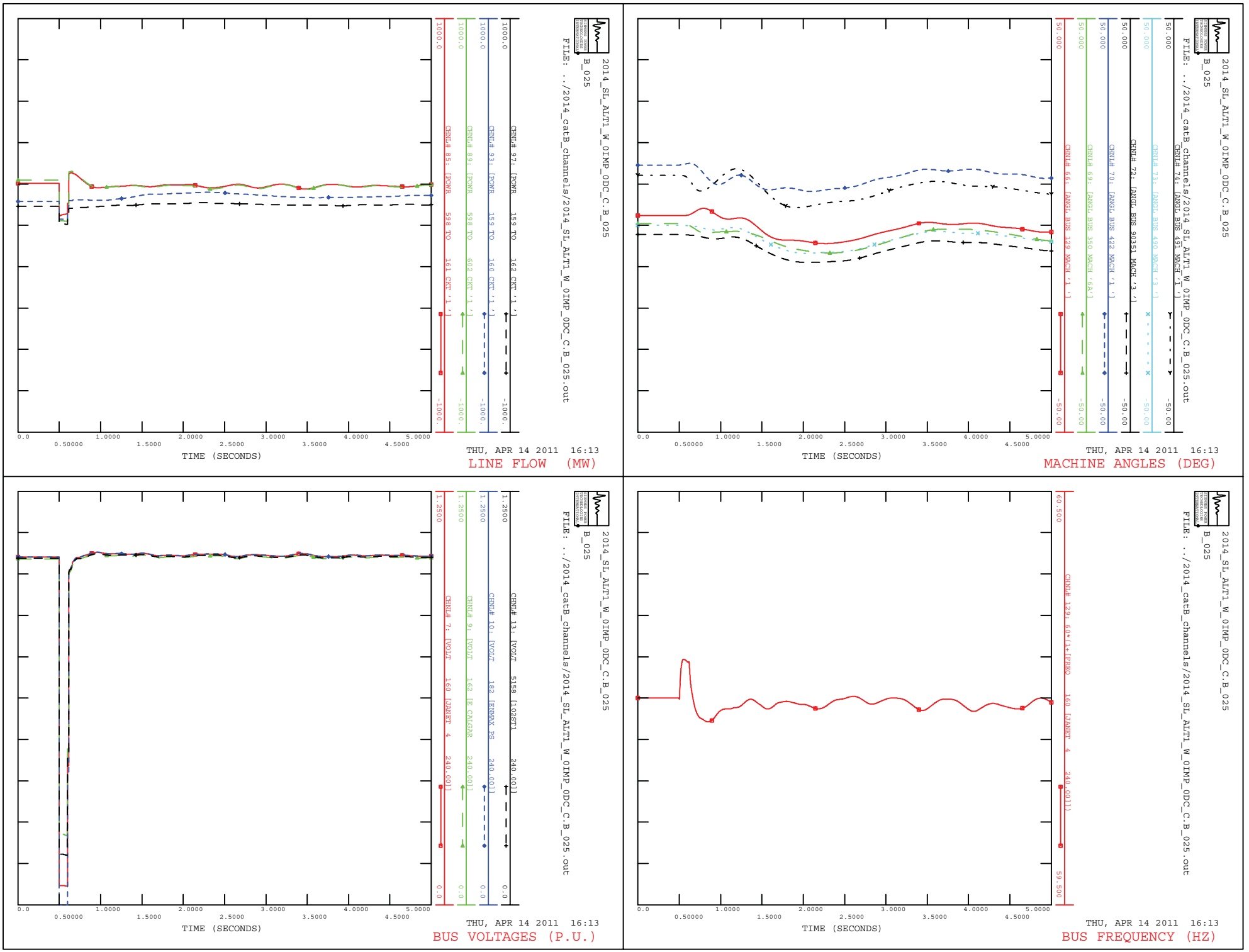


Figure L-2014-Step4-Sc6-9

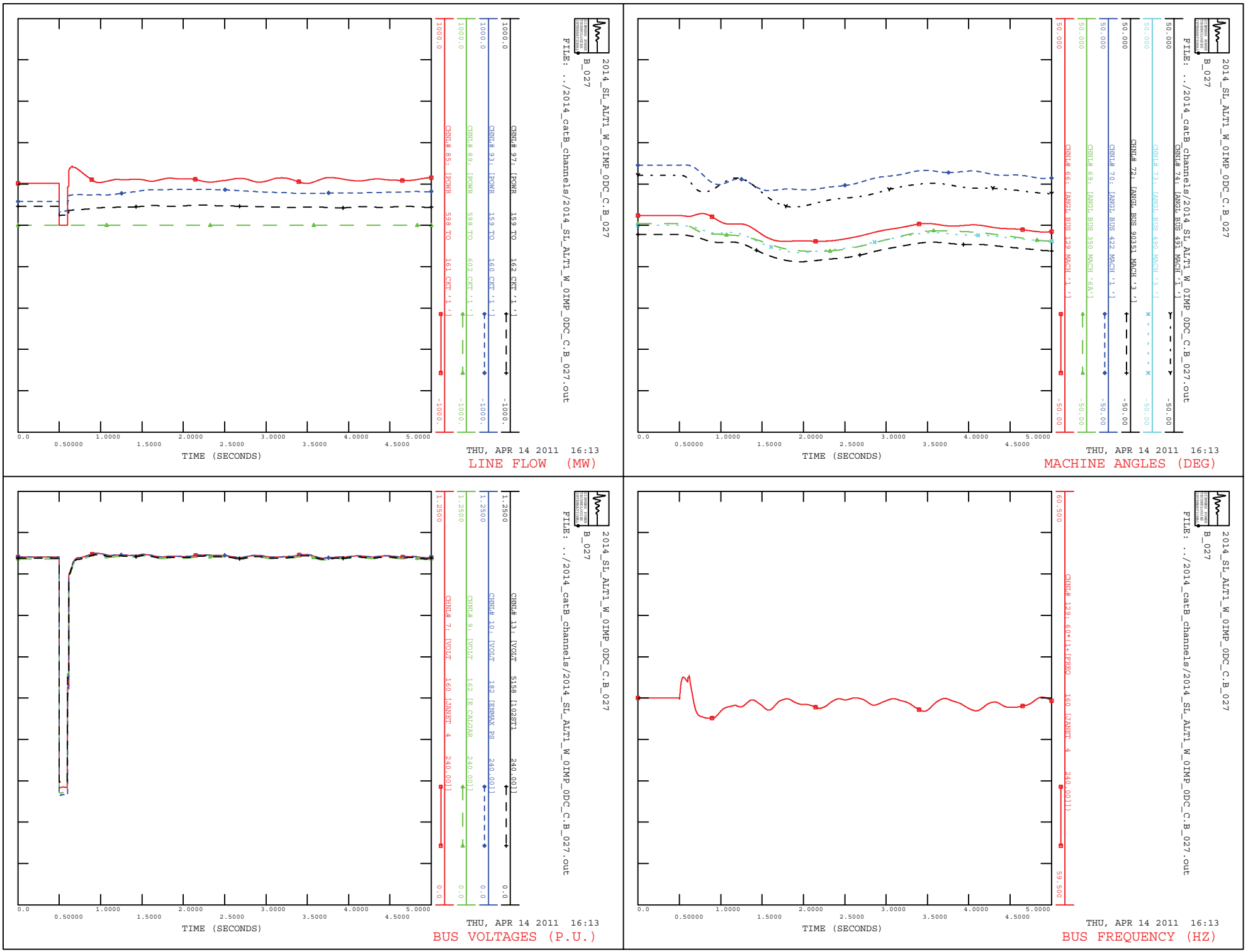


Figure L-2014-Step4-Sc6-10

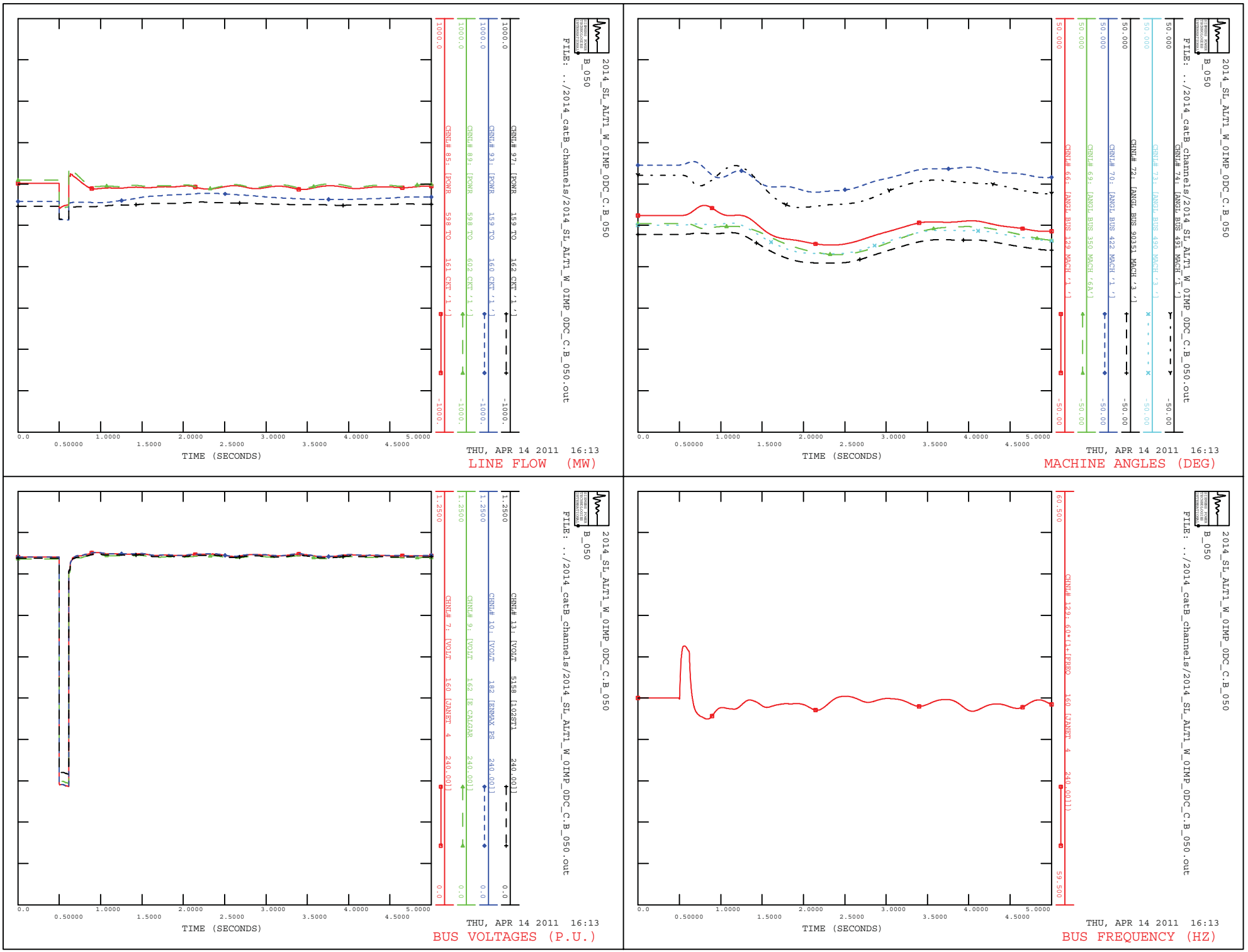


Figure L-2014-Step4-Sc6-11

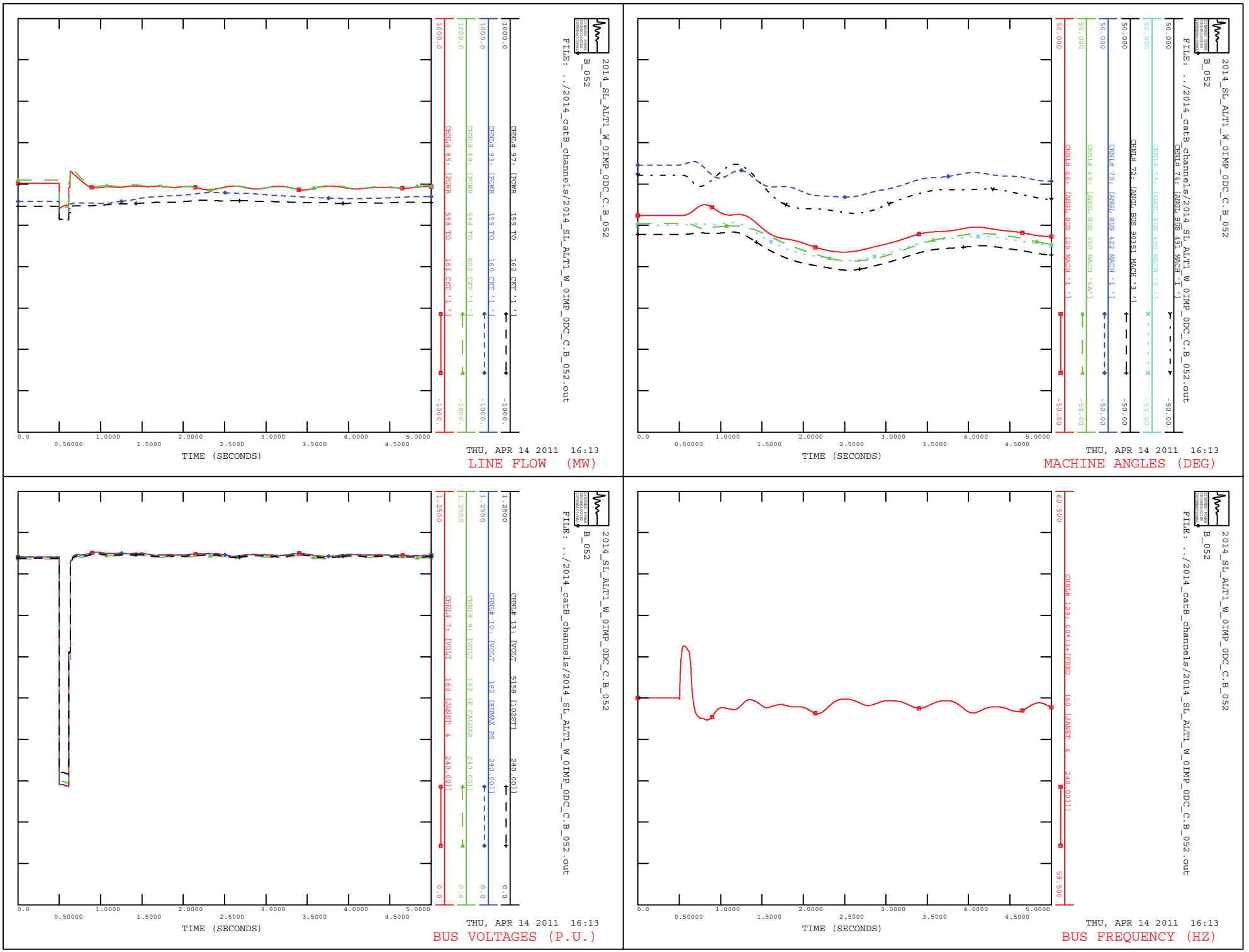


Figure L-2014-Step4-Sc6-12

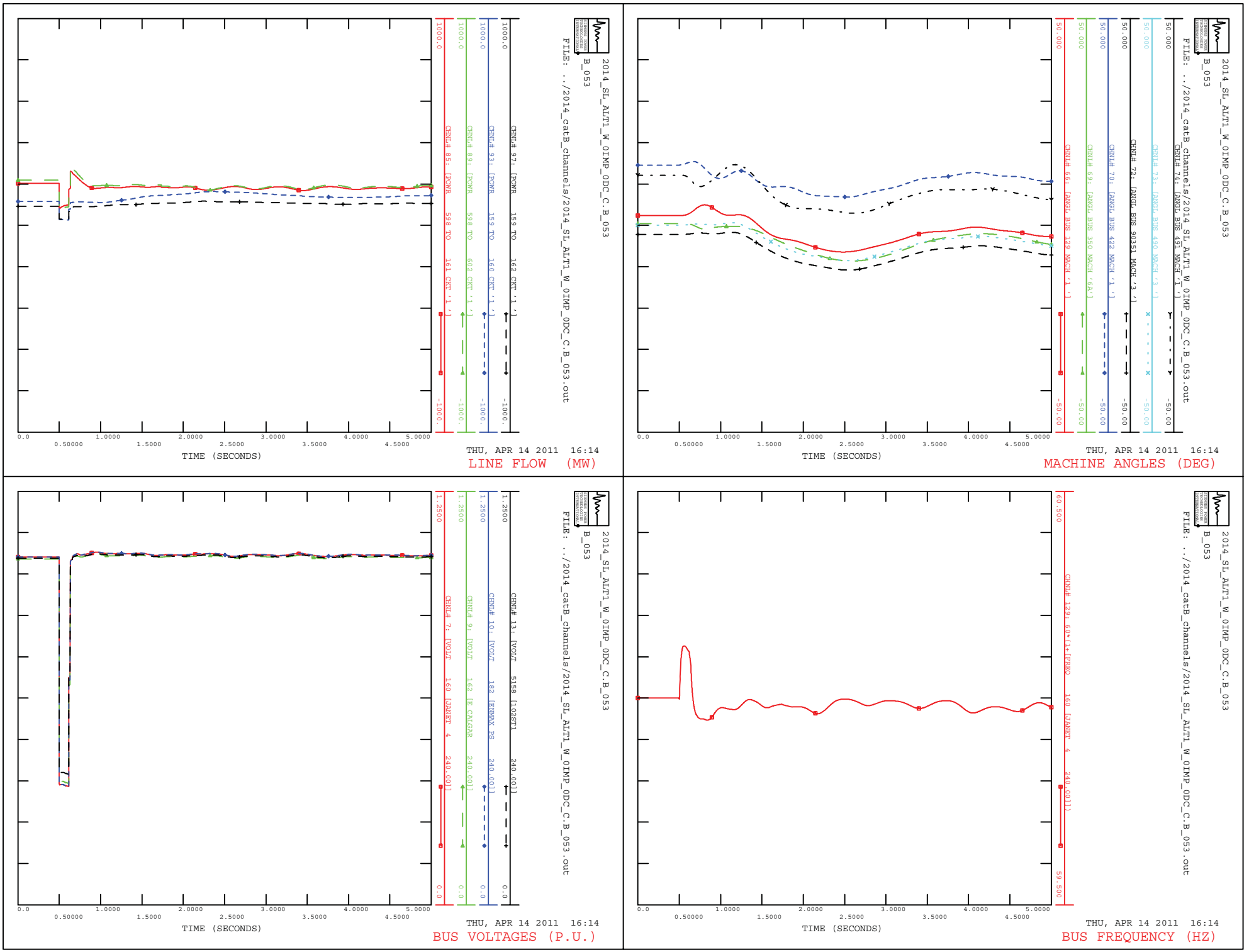


Figure L-2014-Step4-Sc6-13

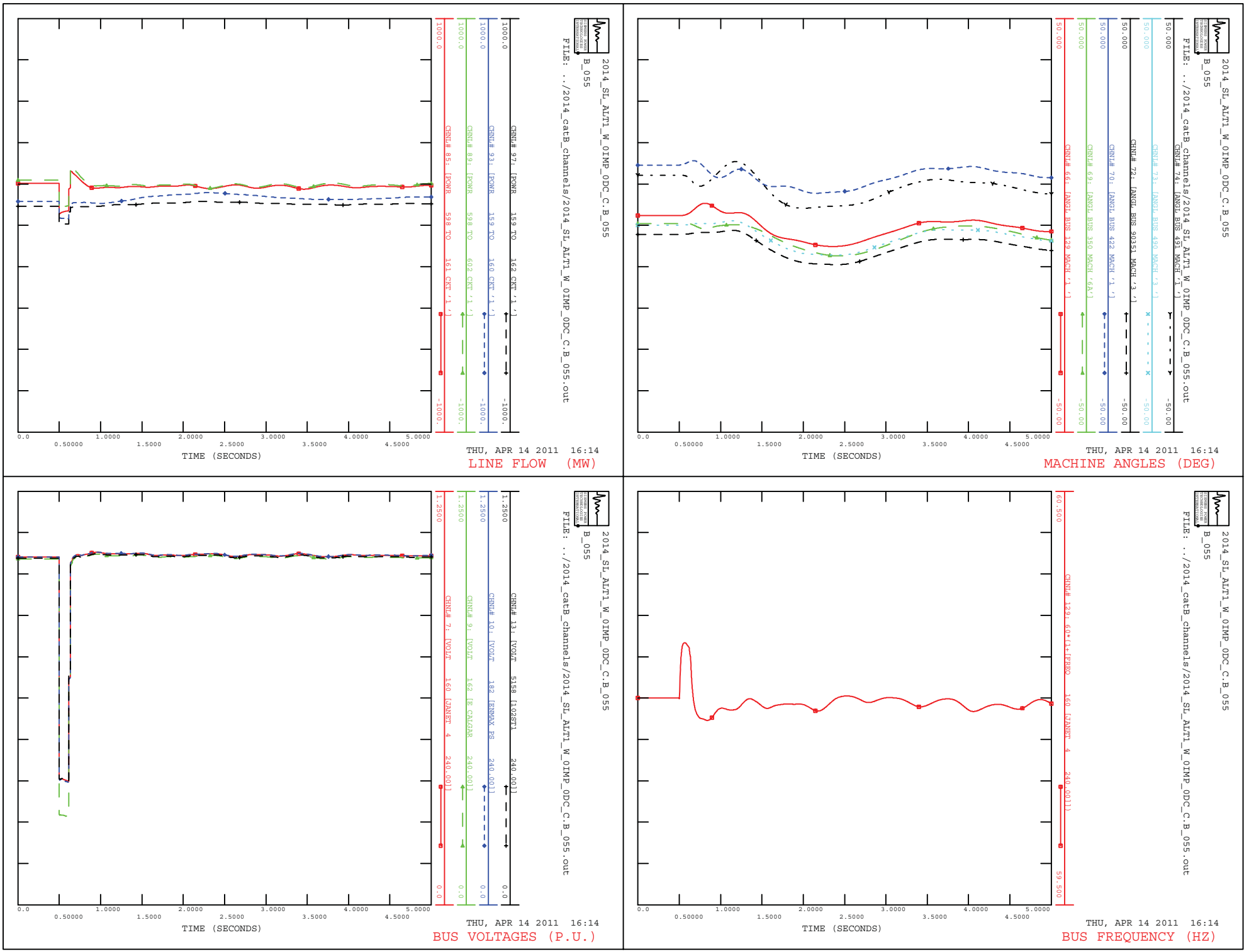


Figure L-2014-Step4-Sc6-14

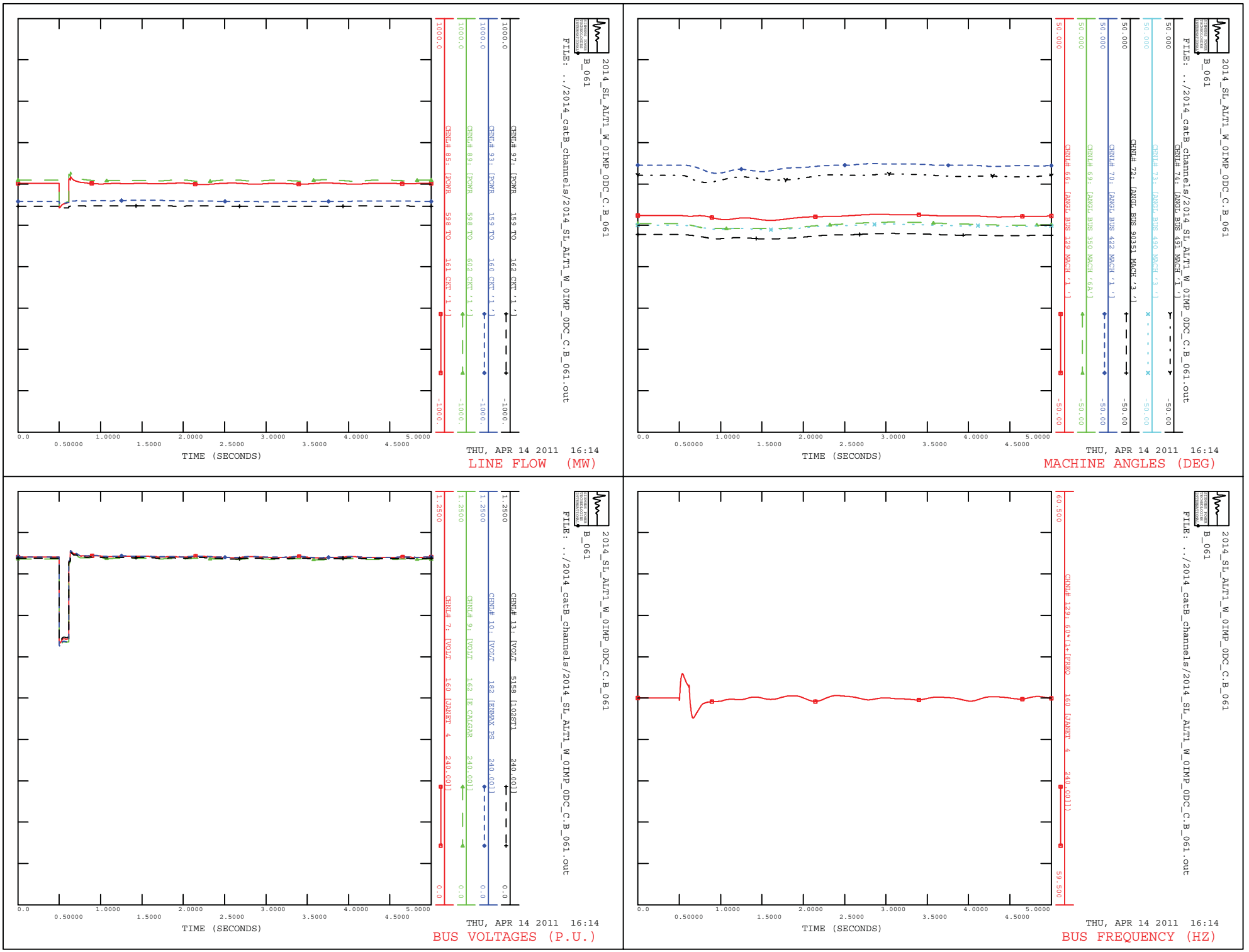


Figure L-2014-Step4-Sc6-15

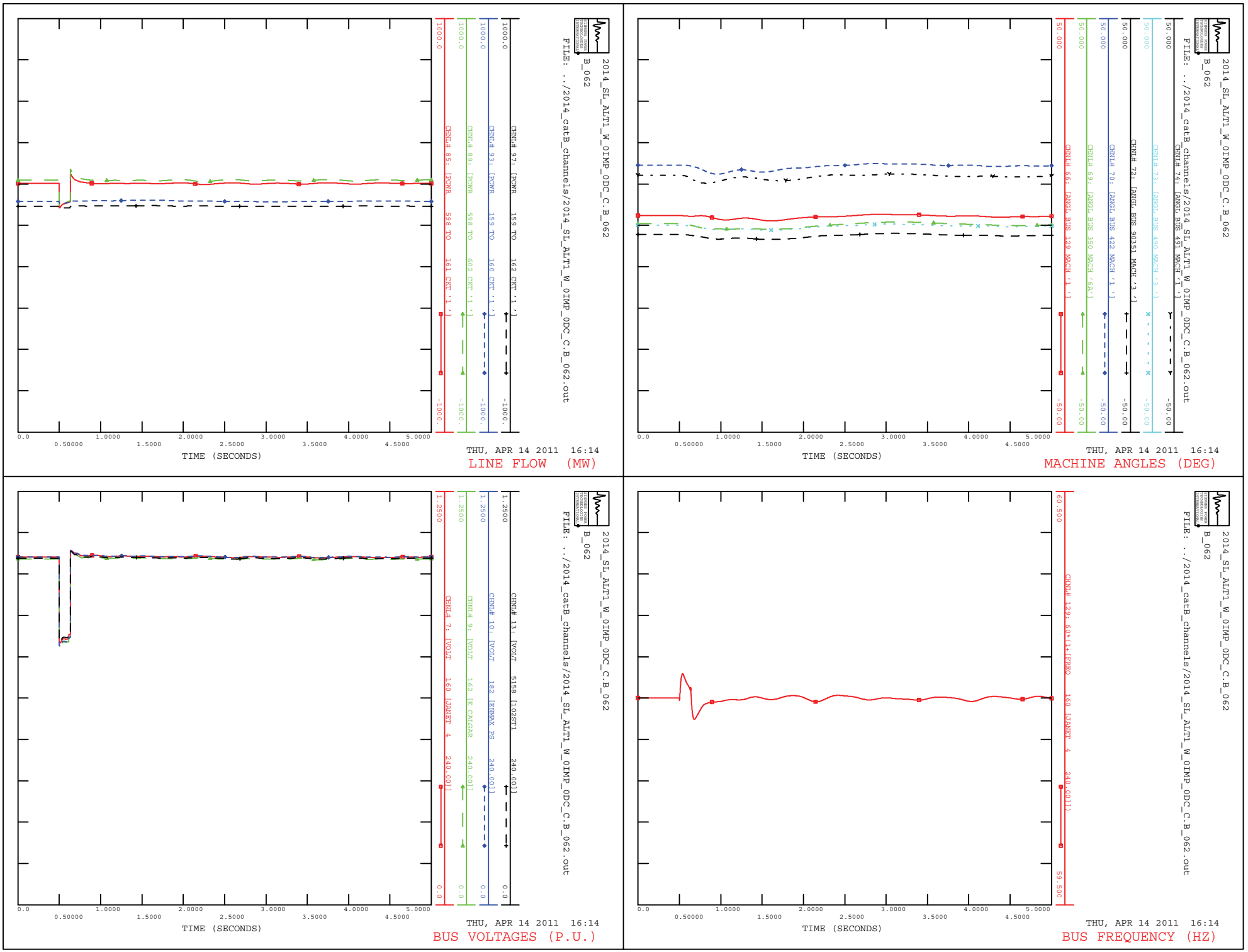


Figure L-2014-Step4-Sc6-16

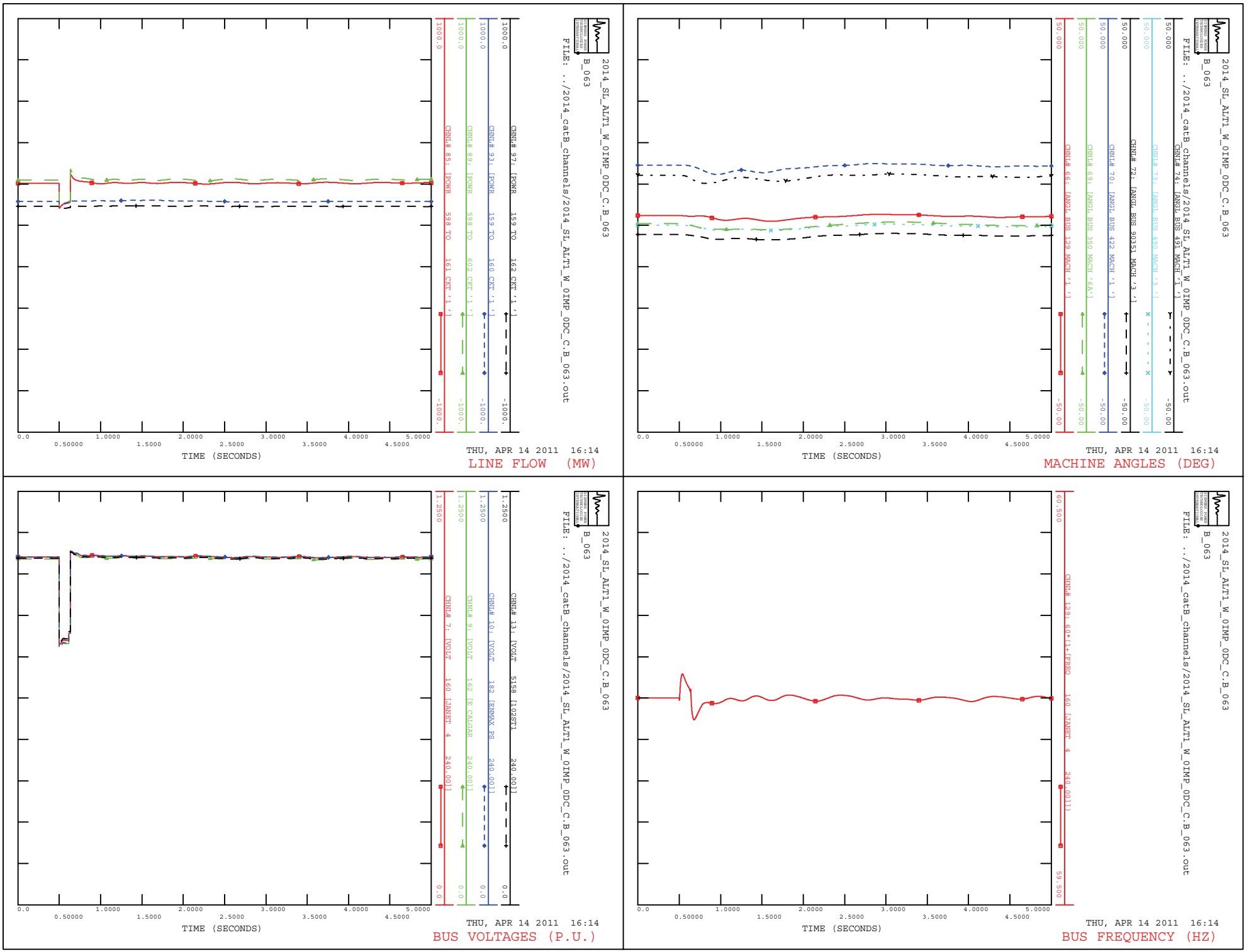


Figure L-2014-Step4-Sc6-17

ATTACHMENT M

Proposed Alternative

Transient Stability Analysis

2019

Table M-1

Figure Name	Contingency
Figure M-2019-Step4-Scx[1] -1	Fault on 925L 240kV line (Red Deer 63S to Janet 74S)
Figure M-2019-Step4-Scx-2	Fault on 1064L 240kV line (Langdon 102S to Janet 74S)
Figure M-2019-Step4-Scx-3	Fault on 936L 240kV line (Langdon 102S to East Calgary 5S)
Figure M-2019-Step4-Scx-4	Fault on 927L 240kV line (Langdon 102S to Sub G)
Figure M-2019-Step4-Scx-5	Fault on 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure M-2019-Step4-Scx-6	Fault on 932L 240kV line (Janet 74S to Beddington SS-162)
Figure M-2019-Step4-Scx-7	Fault on 916L 240kV line (Sarcee 42S to East Calgary 5S)
Figure M-2019-Step4-Scx-8	Fault on 1066L 240kV line (Sarcee 42S to Foothills 237S)
Figure M-2019-Step4-Scx-9	Fault on 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)
Figure M-2019-Step4-Scx-10	Fault on 1106L 240kV line (ENMAX No. 65 to Foothills 237S)
Figure M-2019-Step4-Scx-11	Fault on 765L 138kV line (Janet 74S to Strathmore 151S)
Figure M-2019-Step4-Scx-12	Fault on 23.80L 138kV line (Janet 74S to ENMAX No. 23)
Figure M-2019-Step4-Scx-13	Fault on 24.83L 138kV line (Janet 74S to ENMAX No. 24)
Figure M-2019-Step4-Scx-14	Fault on 2.80L 138kV line (Enmax 2 to ENMAX No. 23)
Figure M-2019-Step4-Scx-15	Fault on 850L 138 kV line (Okotoks 678S to Carseland 525S)
Figure M-2019-Step4-Scx-16	Fault on 646L 138 kV line (Okotoks 678S to Foothills 237S)
Figure M-2019-Step4-Scx-17	Fault on 434L 138 kV line (High River 65S to Foothills 237S)

[1] "Scx" represents a load/generation scenario. In the corresponding figure "Scx" is replaced by one of the Sc1, Sc2, Sc3, Sc4, or Sc6 scenarios. Definitions of the scenarios are given in the following table:

Scenario	Load Condition
Sc1	Summer Peak (SP), no wind generation, no local generation, ~780 MW import from BC
Sc2	SP, full wind generation, no local generation, ~0 MW import from BC
Sc3	SP, full wind generation, Saddlebrook generation online, ~0 MW import from BC
Sc4	SP, full wind generation, Saddlebrook and Shepard generation online, ~0 MW import from BC
Sc6	System Light (SL), full wind generation, no local generation, ~0 MW import from BC

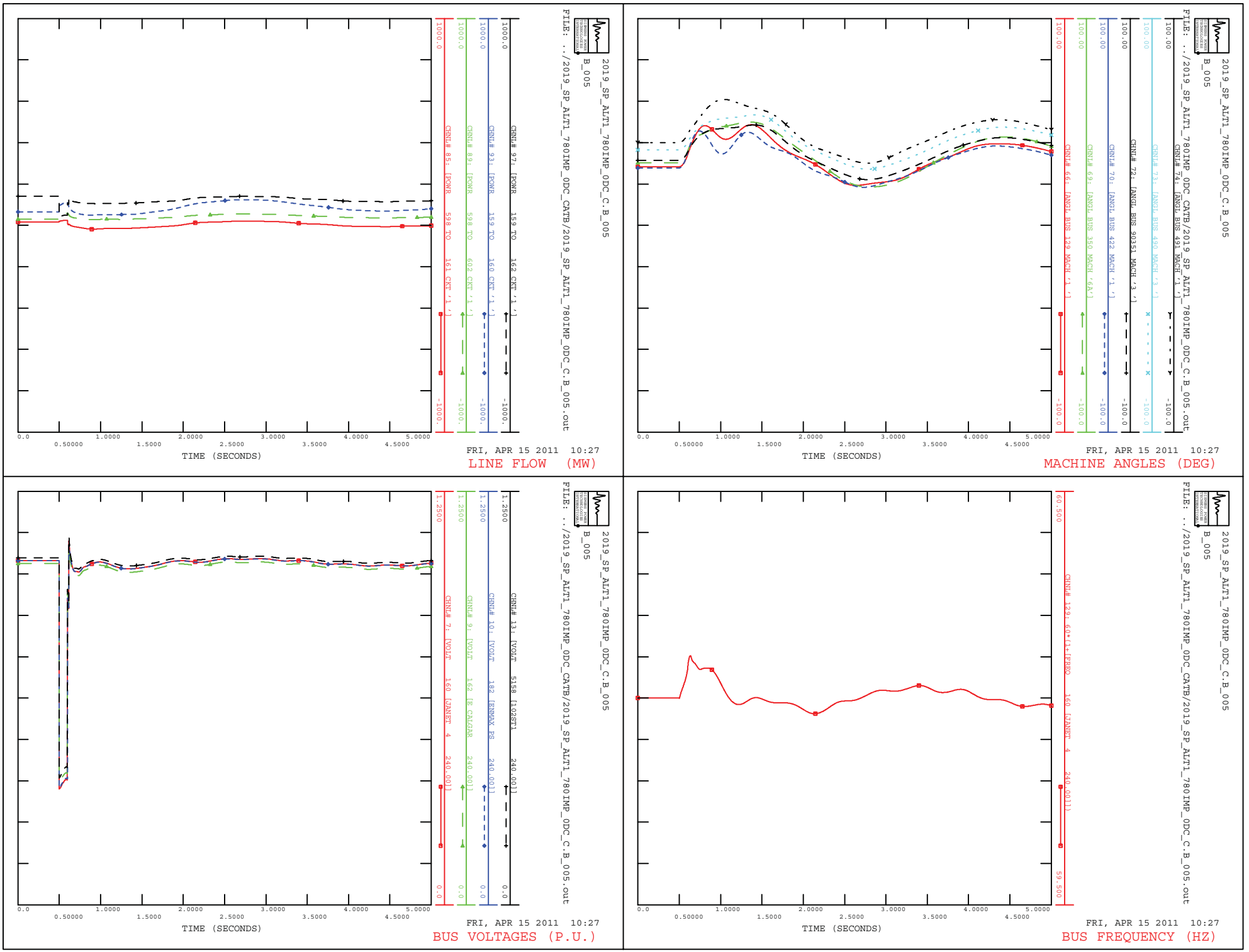


Figure M-2019-Step4-Sc1-1

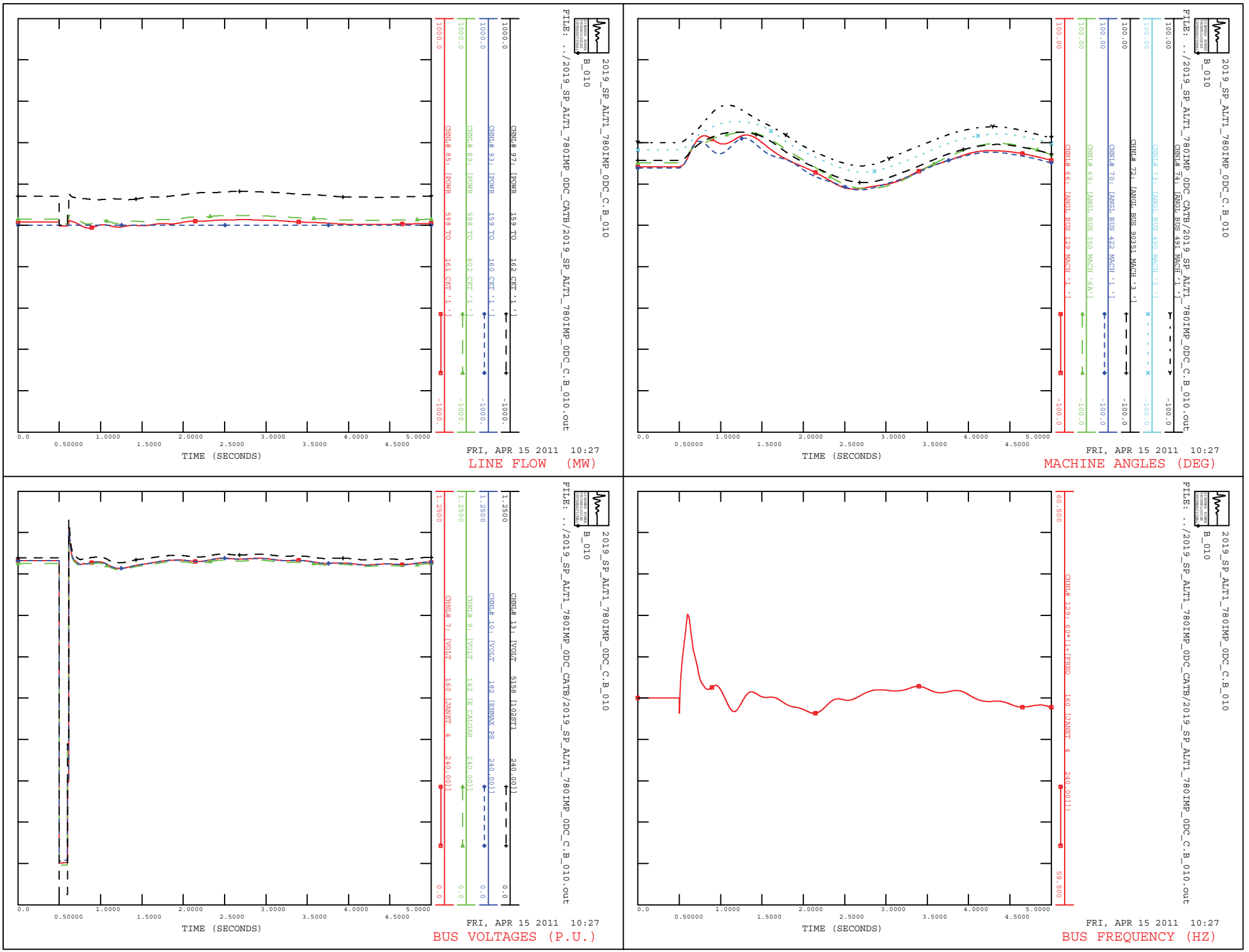


Figure M-2019-Step4-Sc1-2

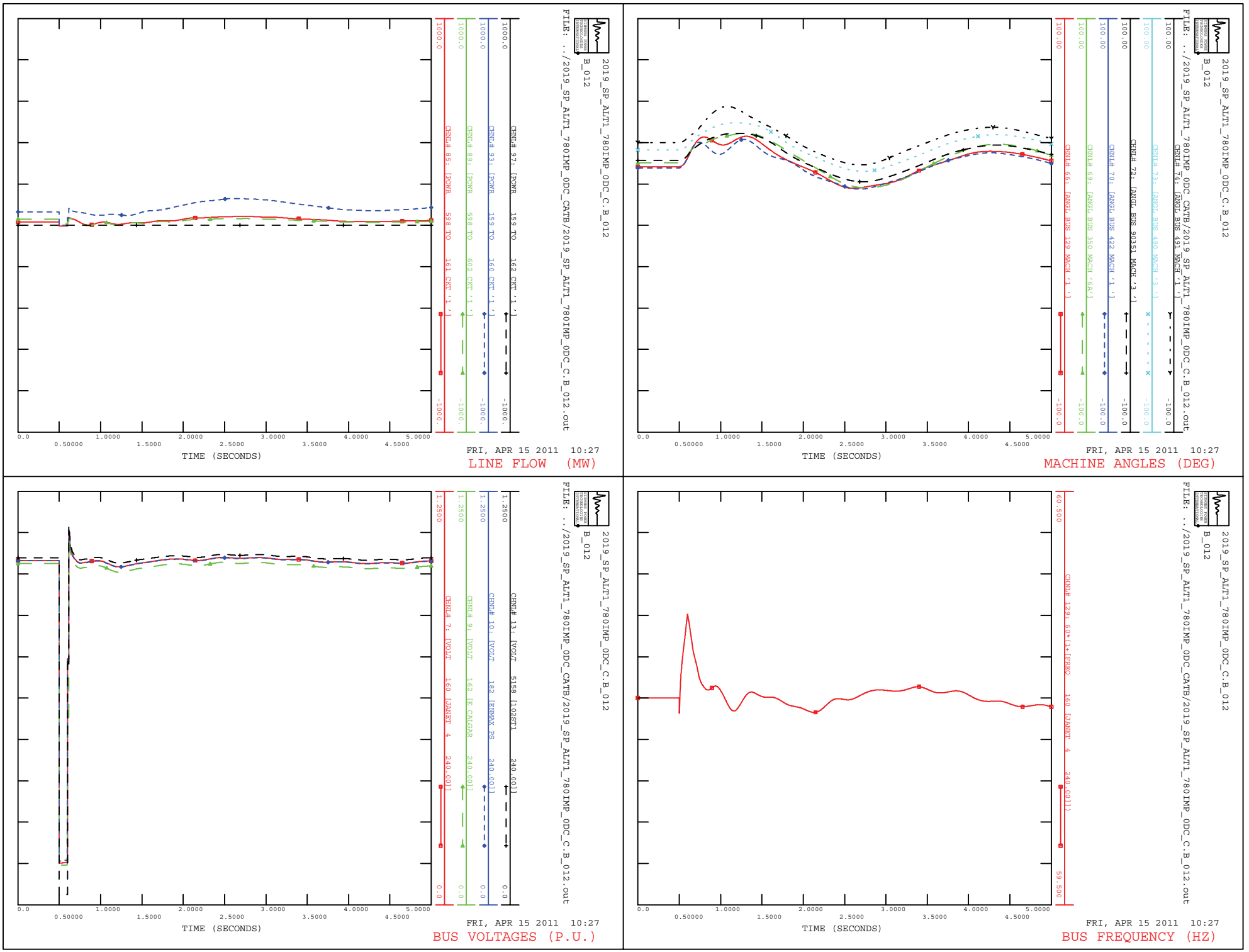


Figure M-2019-Step4-Sc1-3

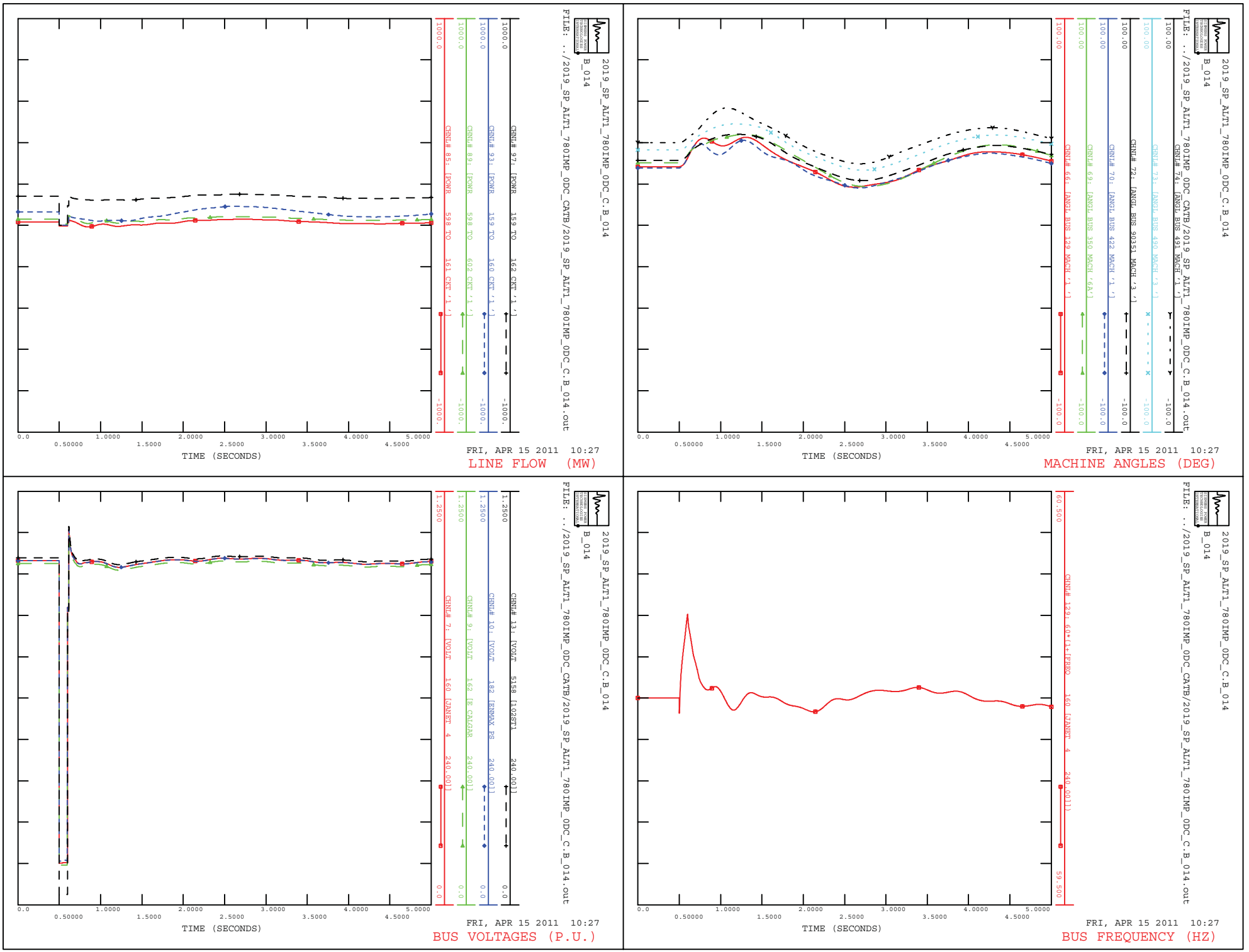


Figure M-2019-Step4-Sc1-4

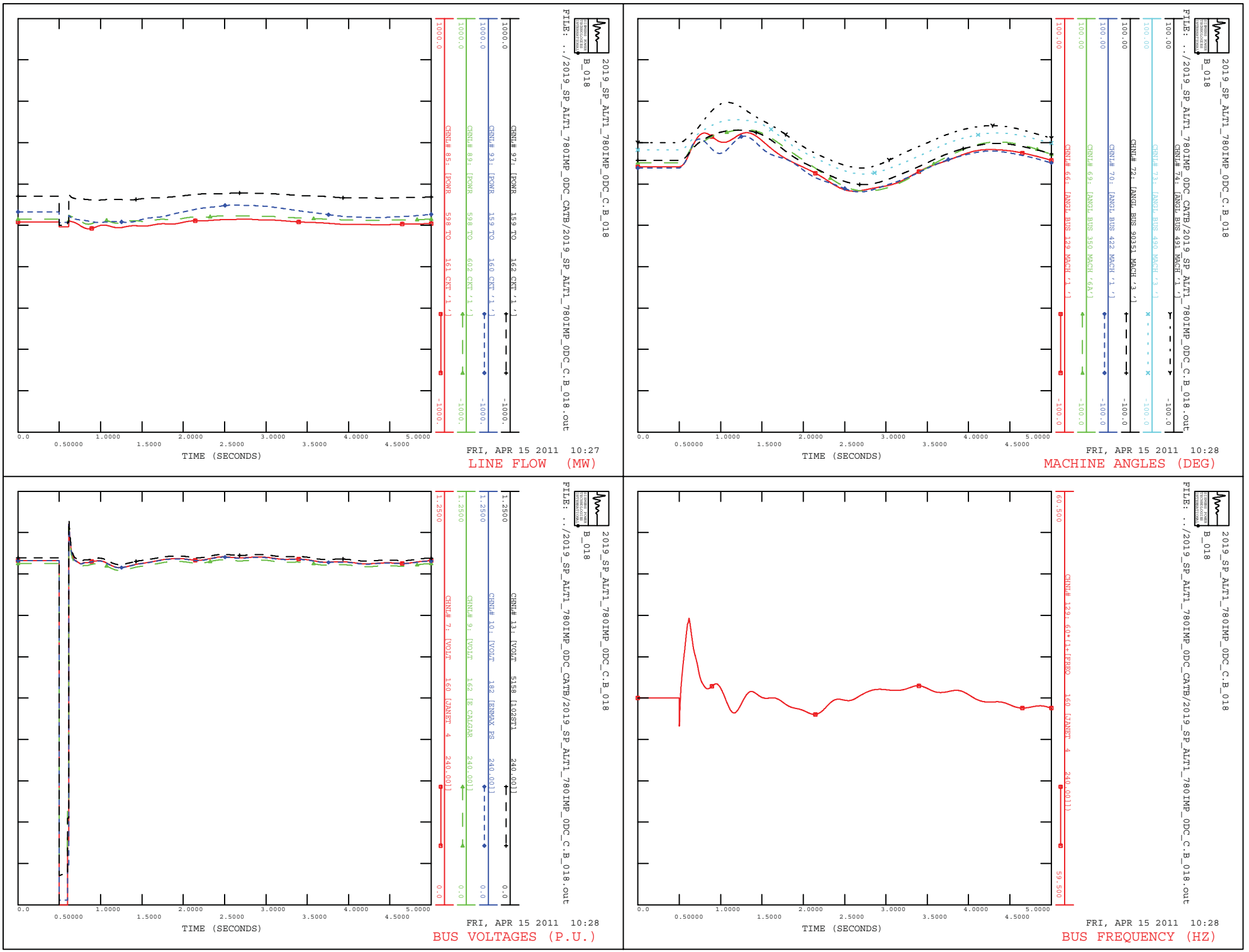


Figure M-2019-Step4-Sc1-5

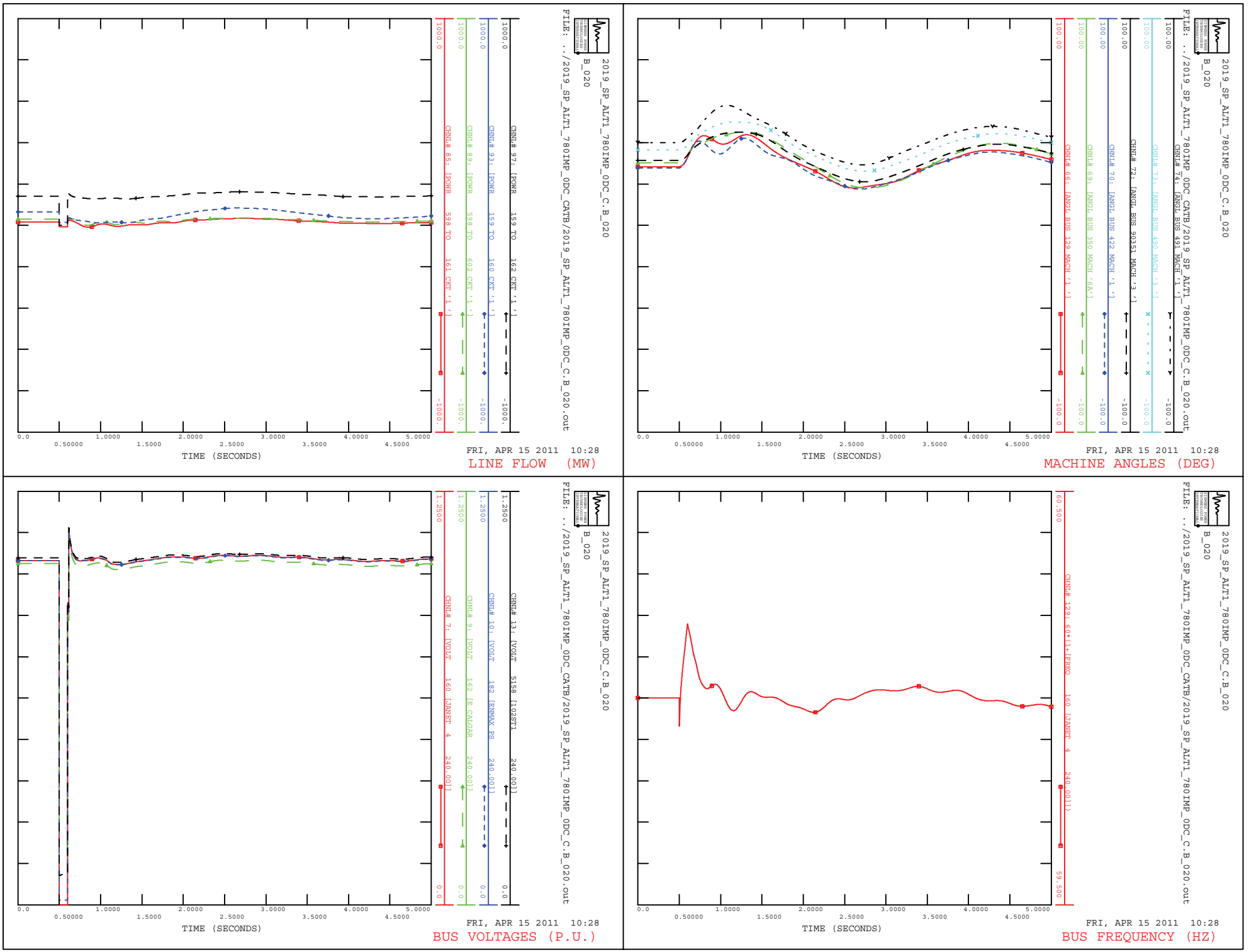


Figure M-2019-Step4-Sc1-6

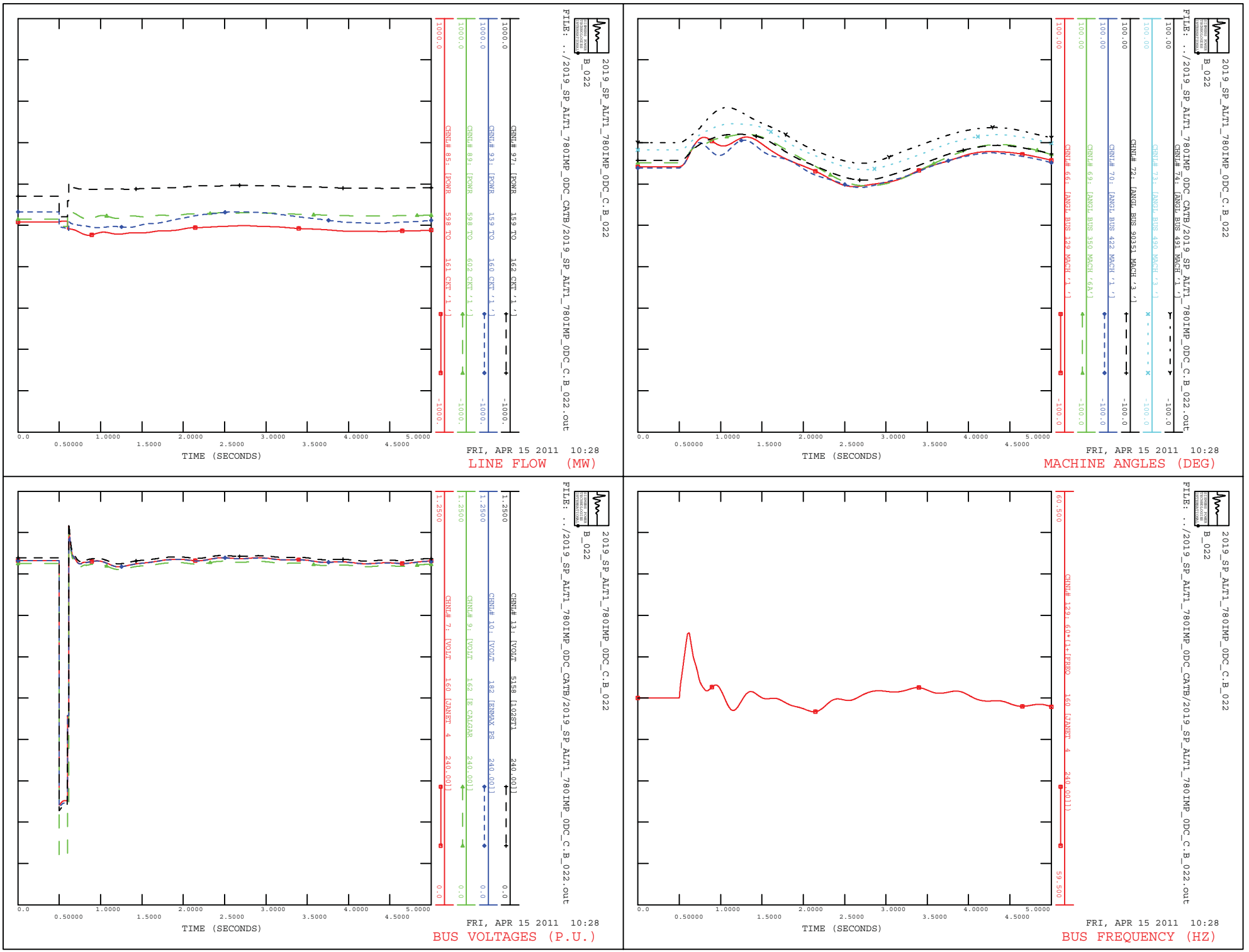


Figure M-2019-Step4-Sc1-7

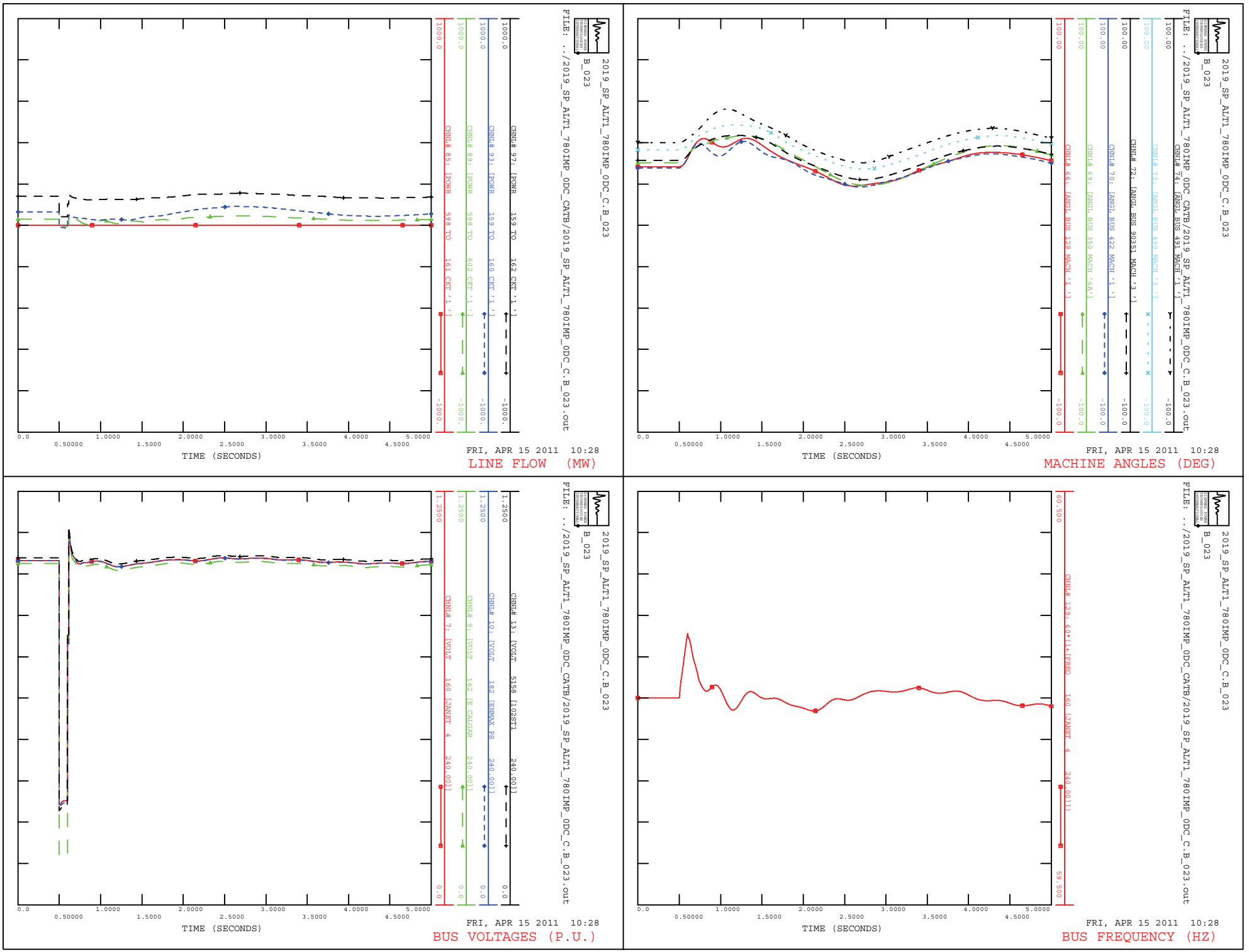


Figure M-2019-Step4-Sc1-8

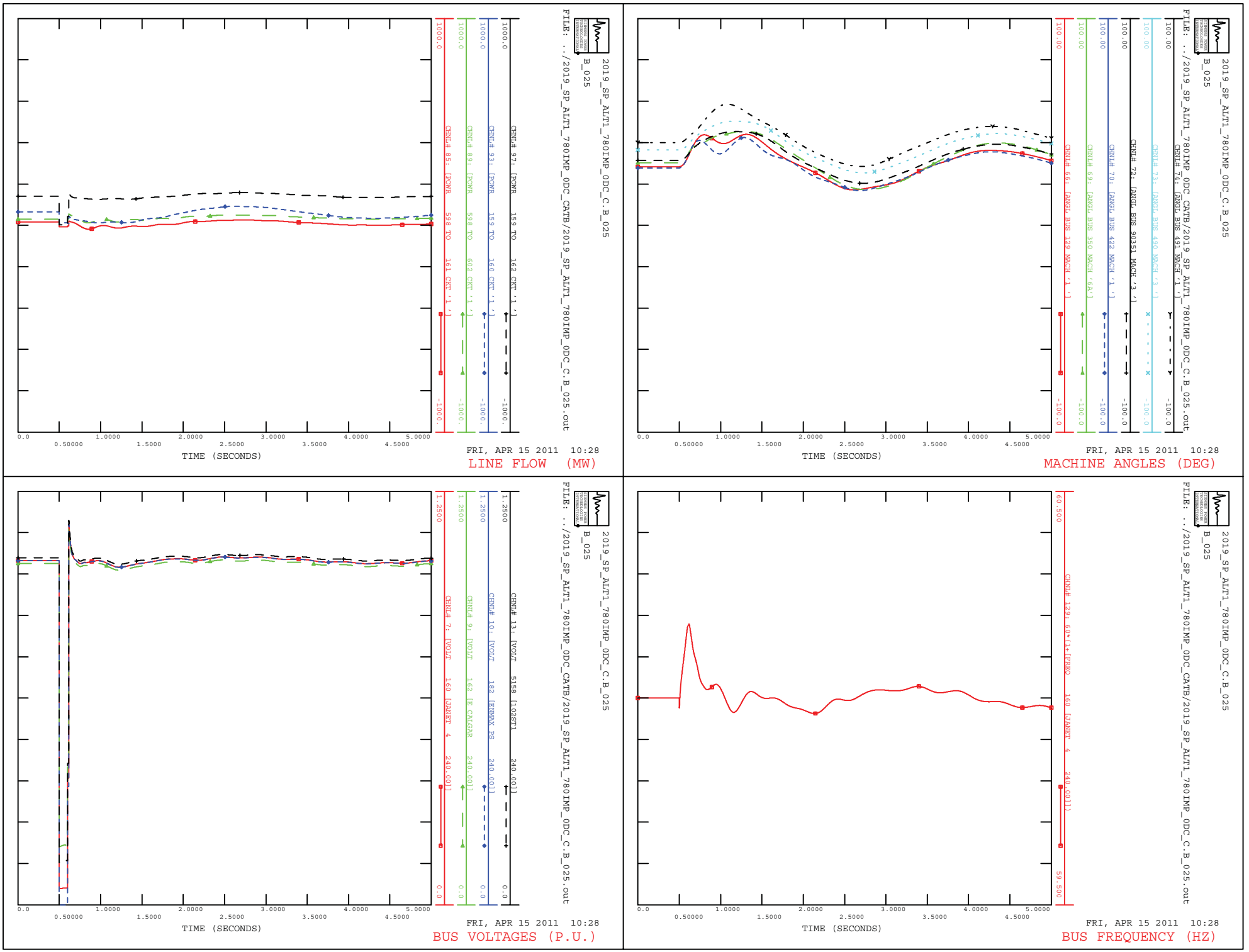


Figure M-2019-Step4-Sc1-9

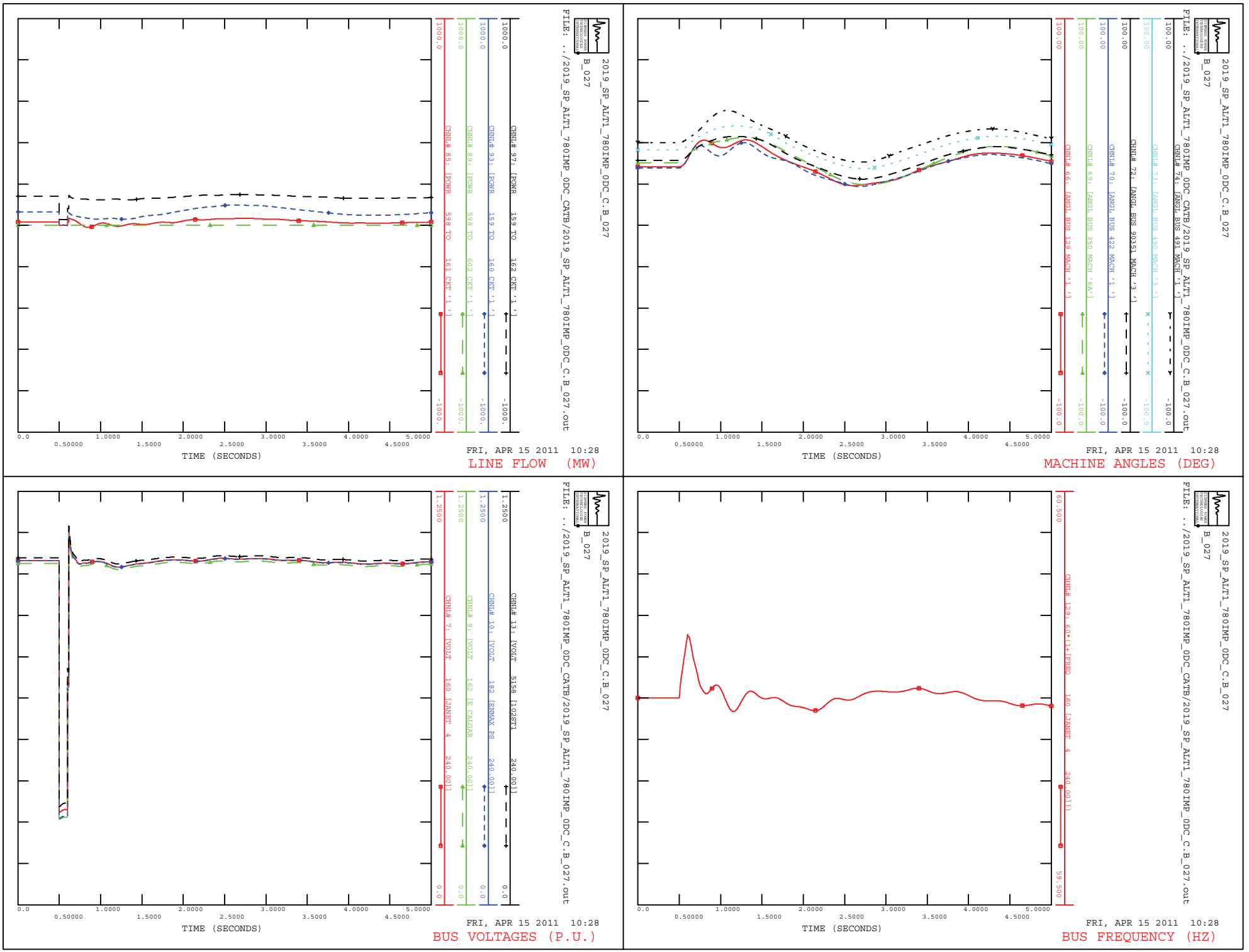


Figure M-2019-Step4-Sc1-10

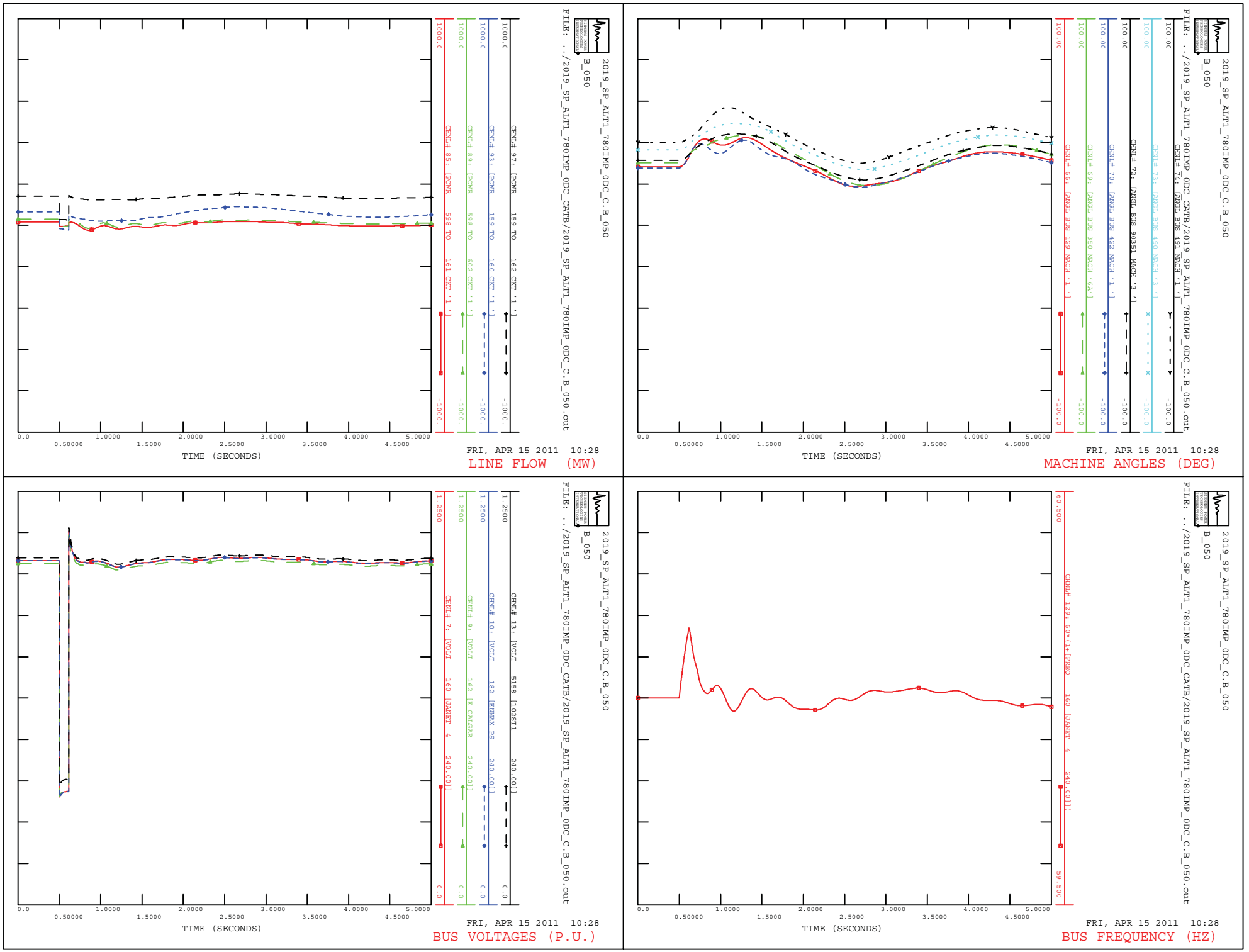


Figure M-2019-Step4-Sc1-11

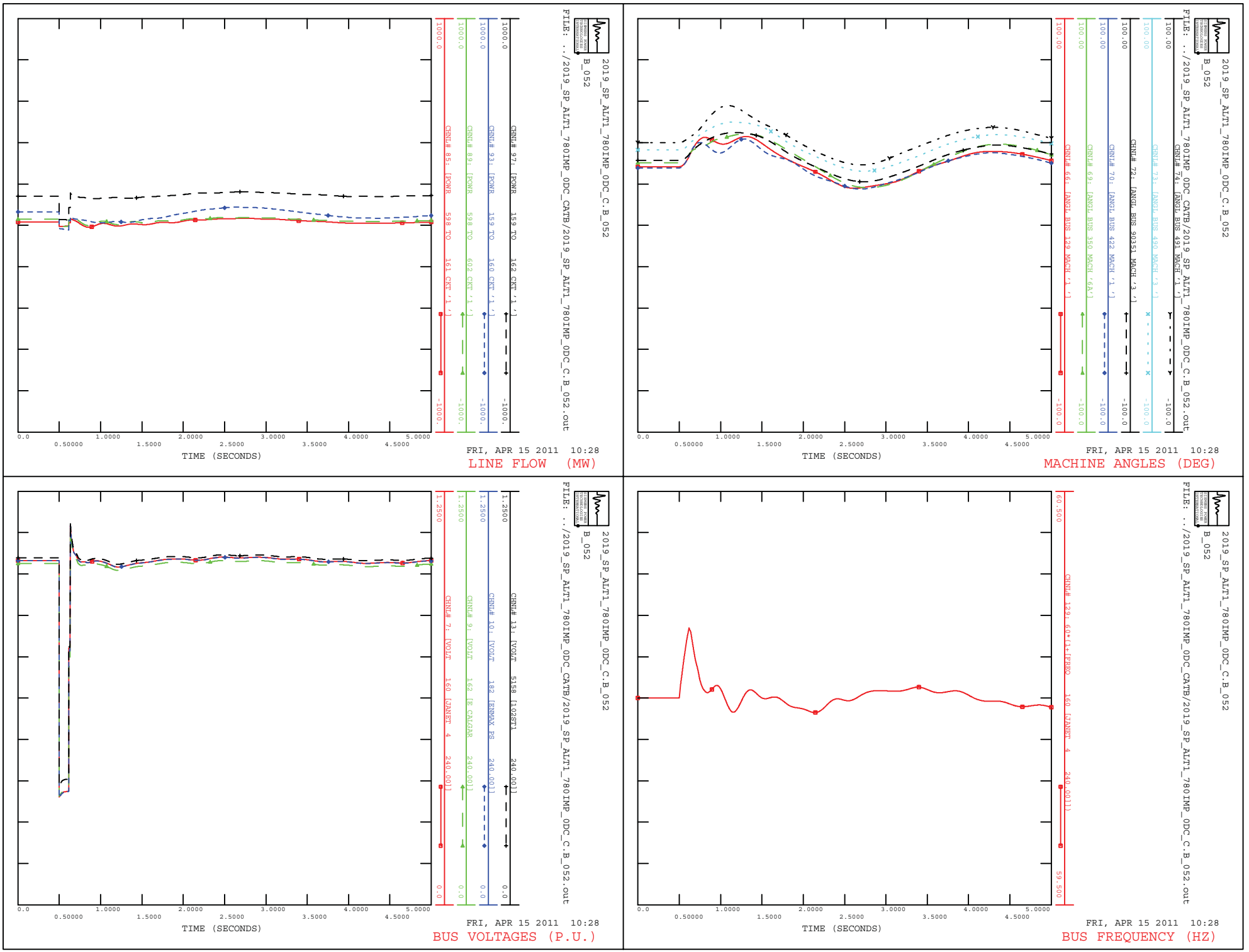


Figure M-2019-Step4-Sc1-12

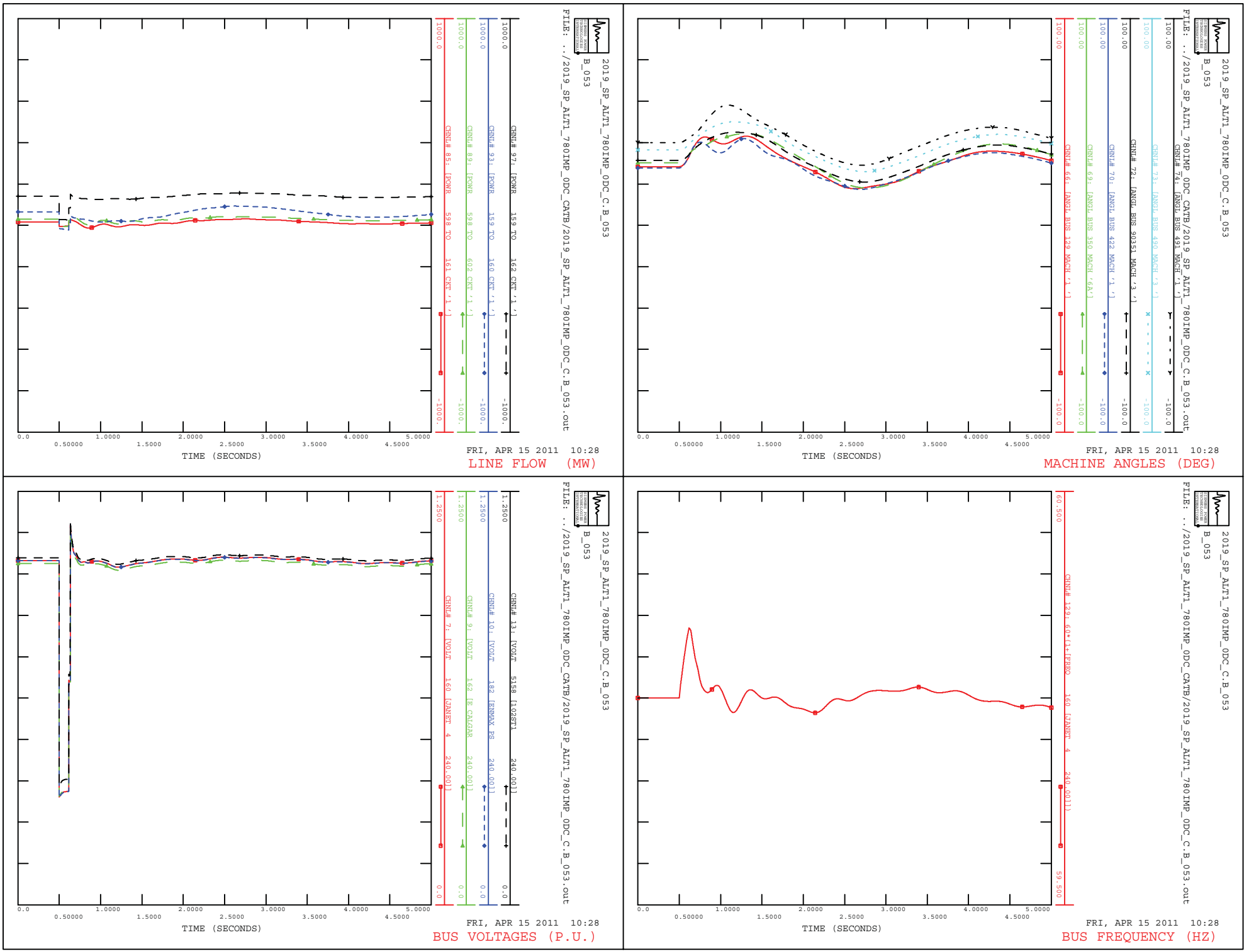


Figure M-2019-Step4-Sc1-13

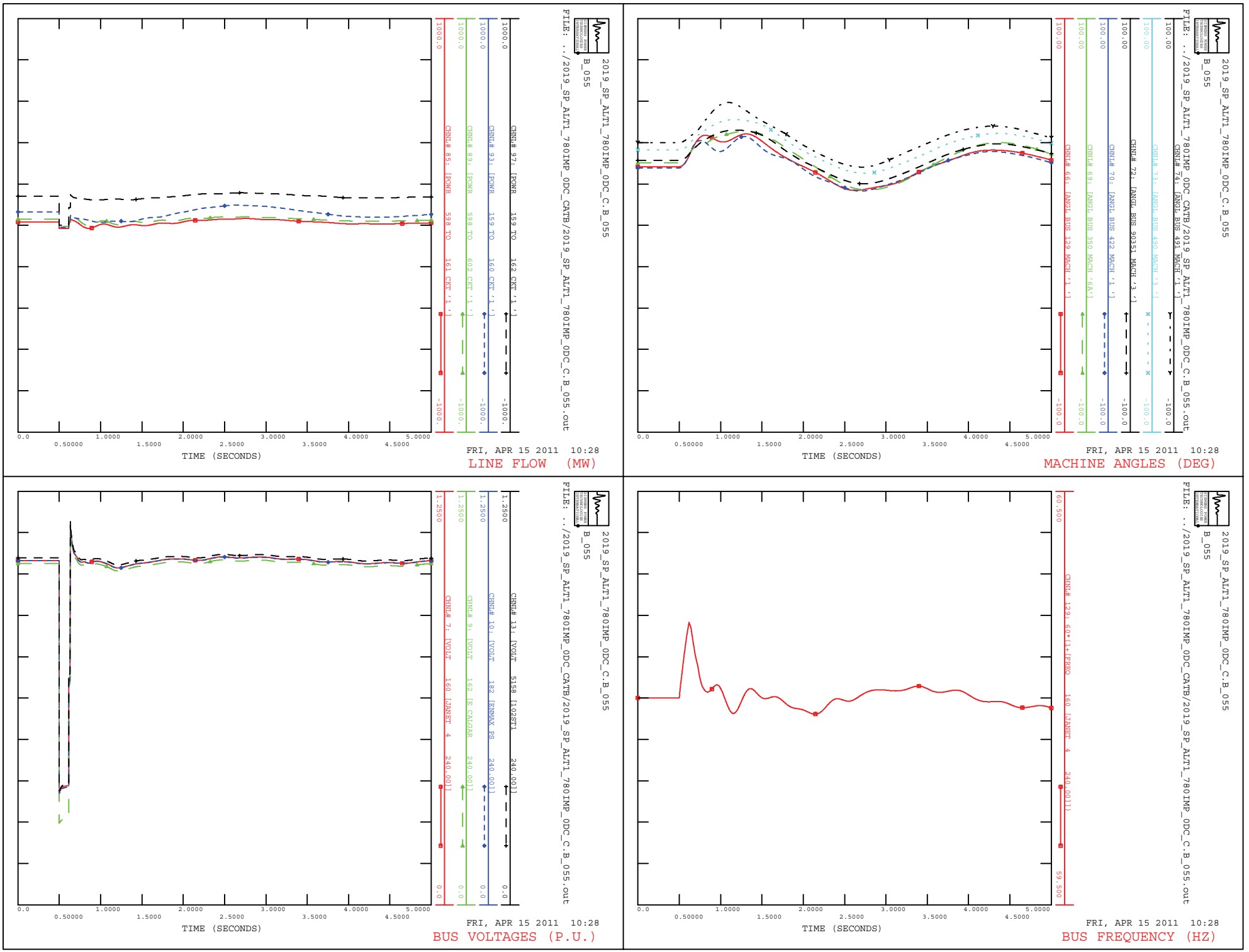


Figure M-2019-Step4-Sc1-14

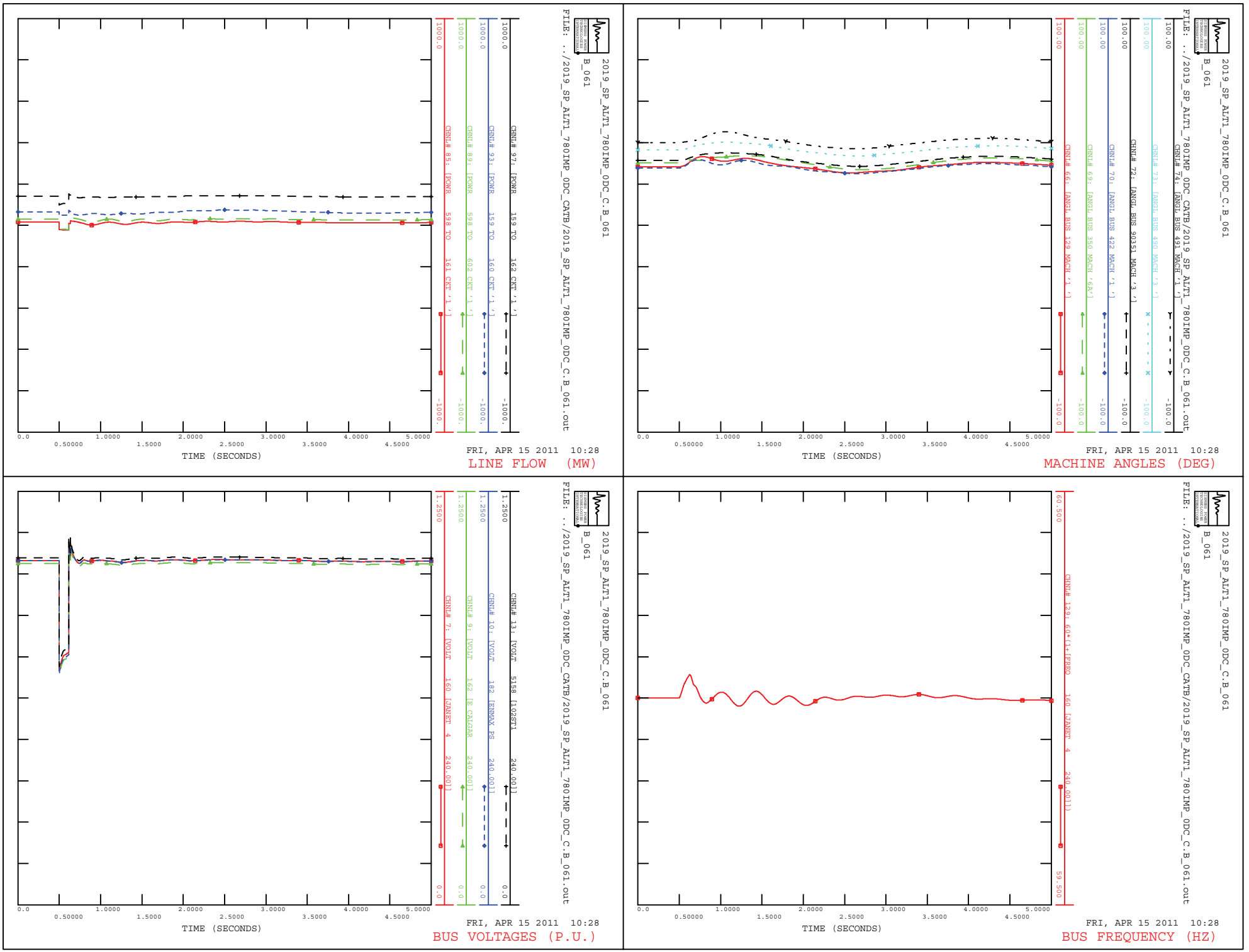


Figure M-2019-Step4-Sc1-15

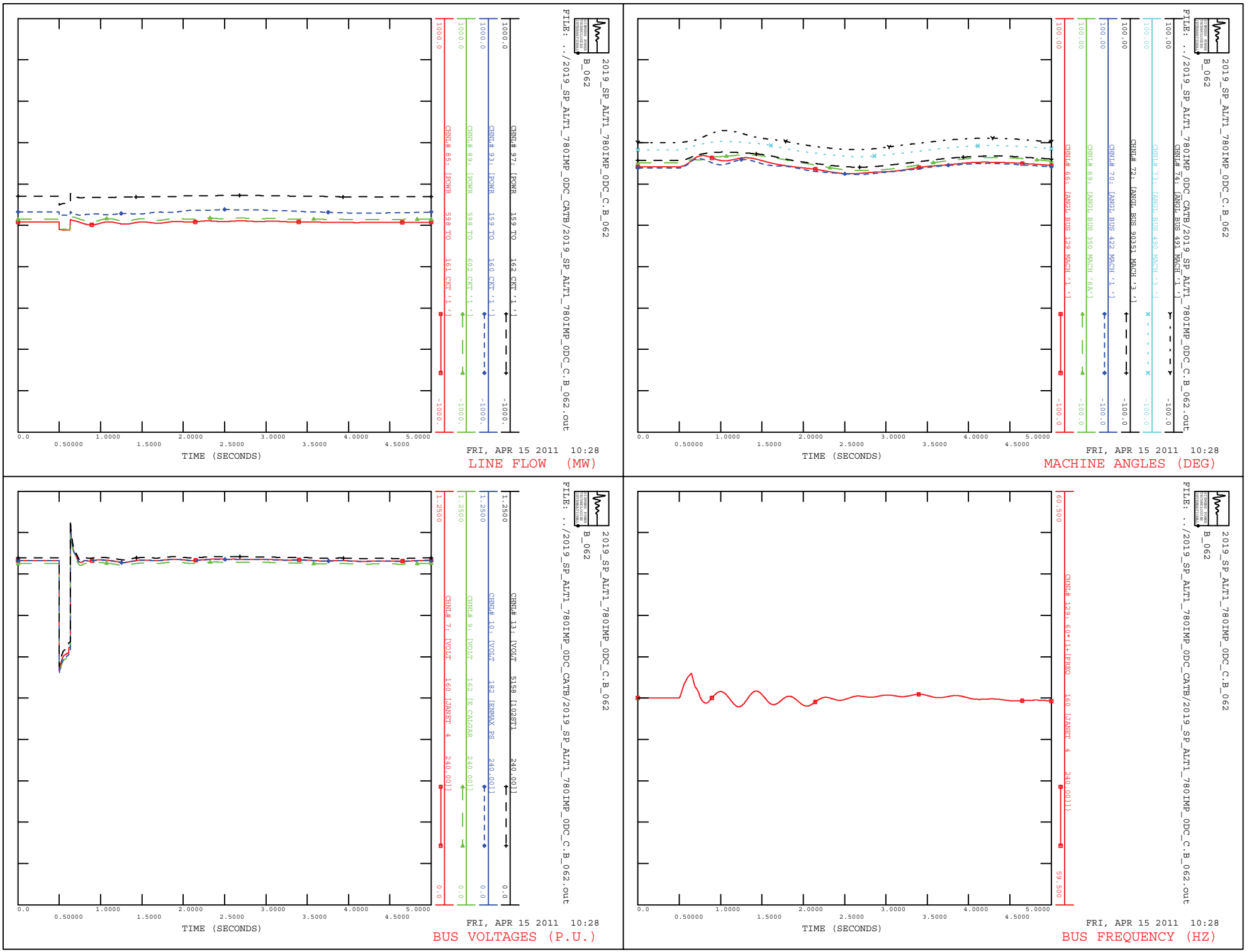


Figure M-2019-Step4-Sc1-16

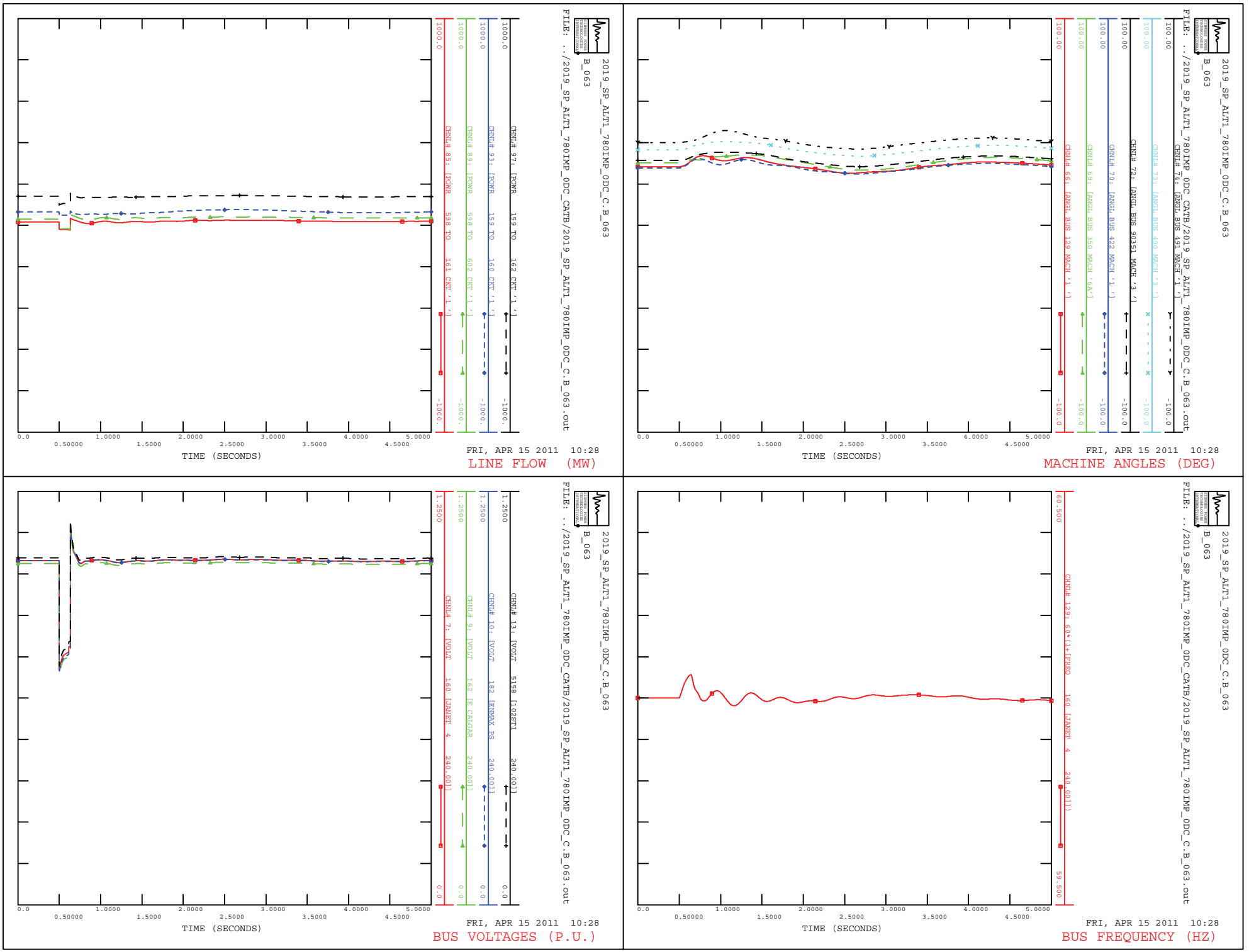


Figure M-2019-Step4-Sc1-17

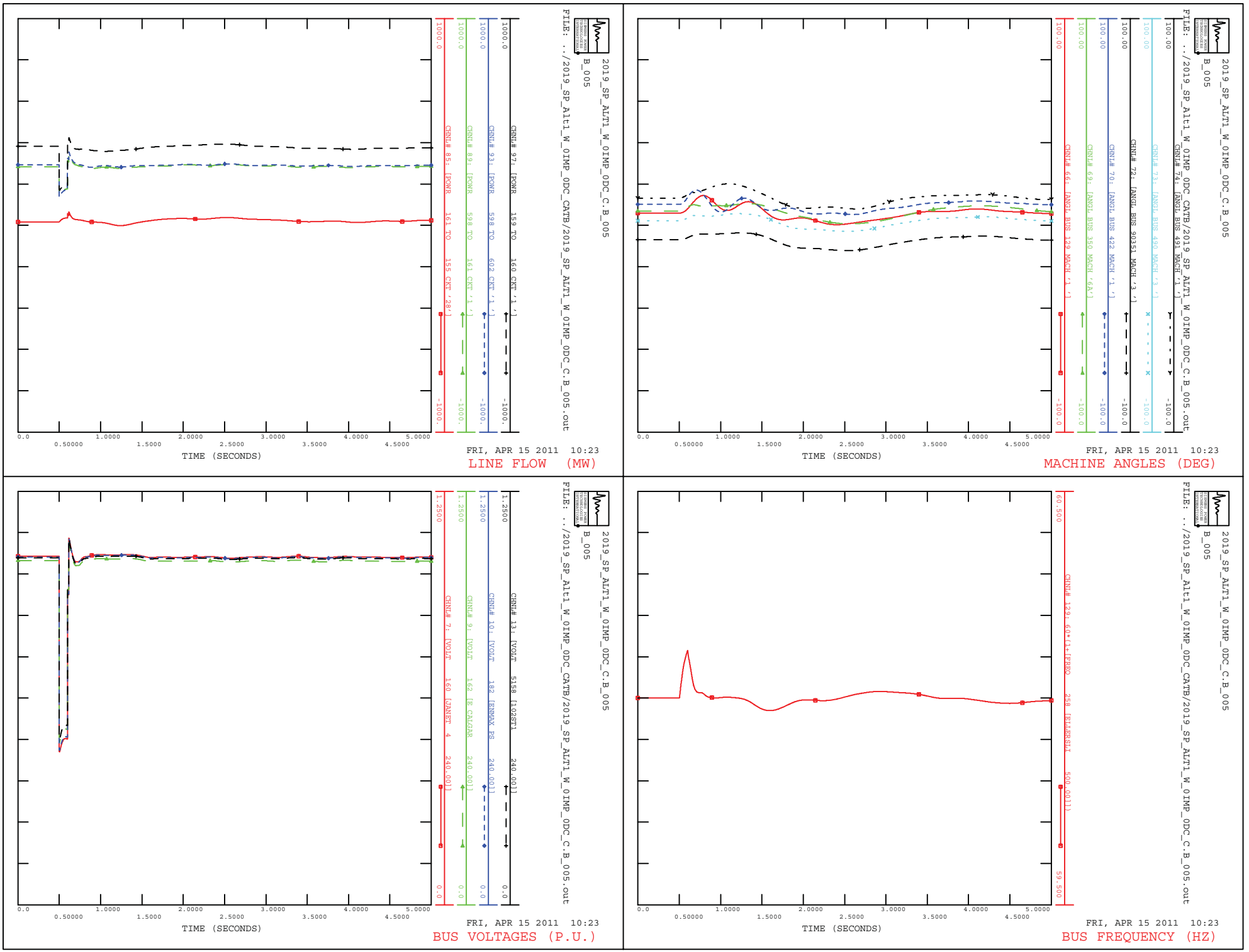


Figure M-2019-Step4-Sc2-1

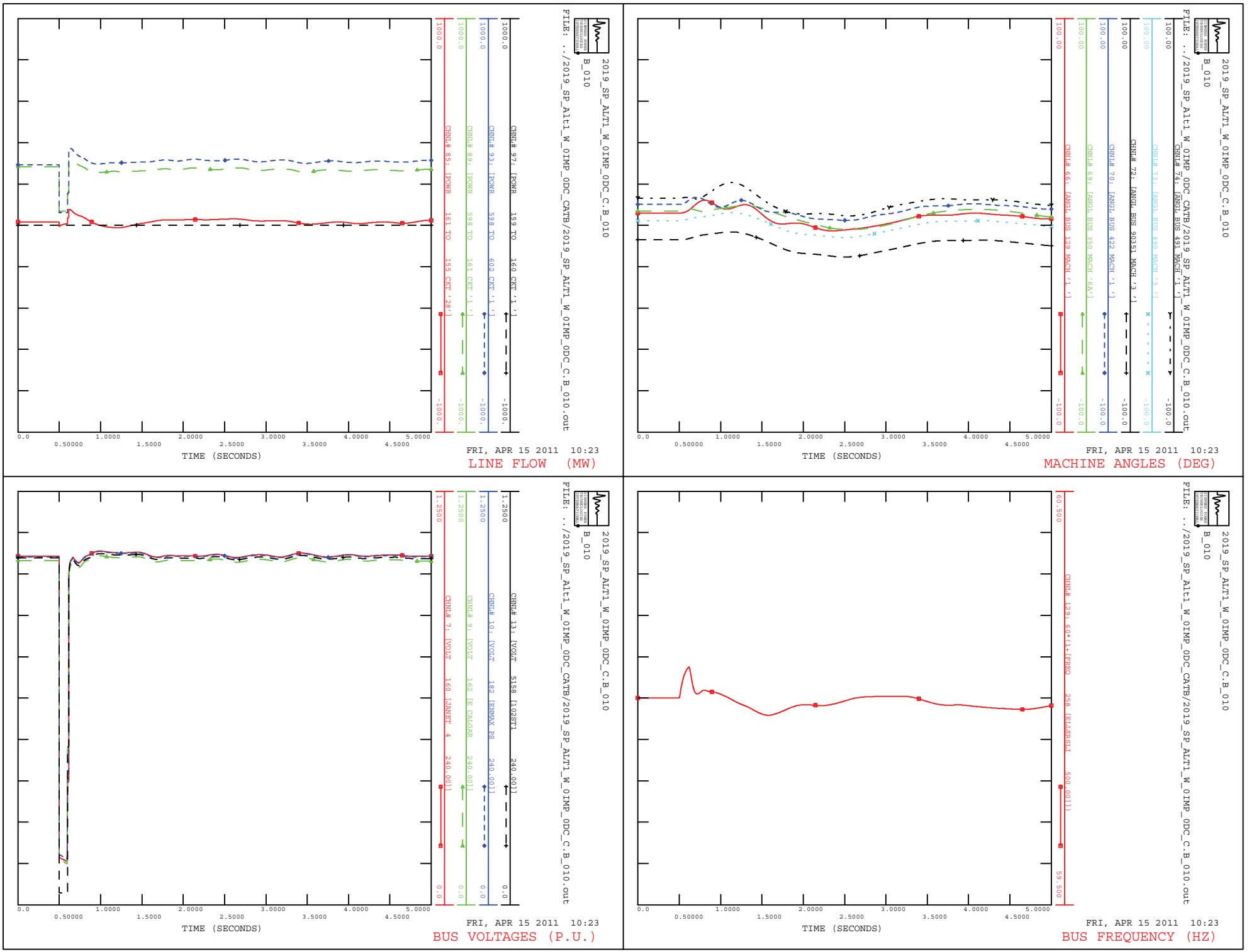


Figure M-2019-Step4-Sc2-2

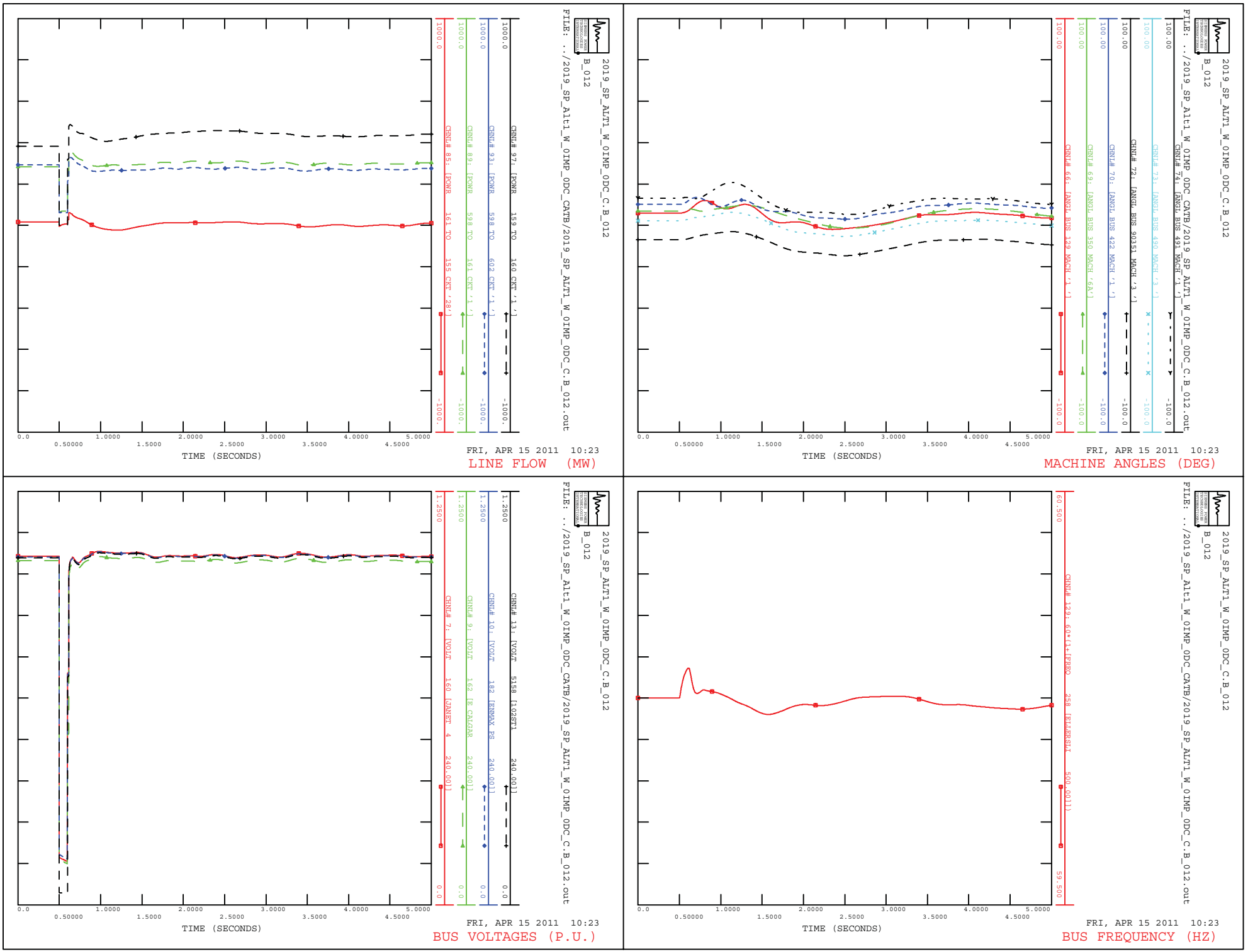


Figure M-2019-Step4-Sc2-3

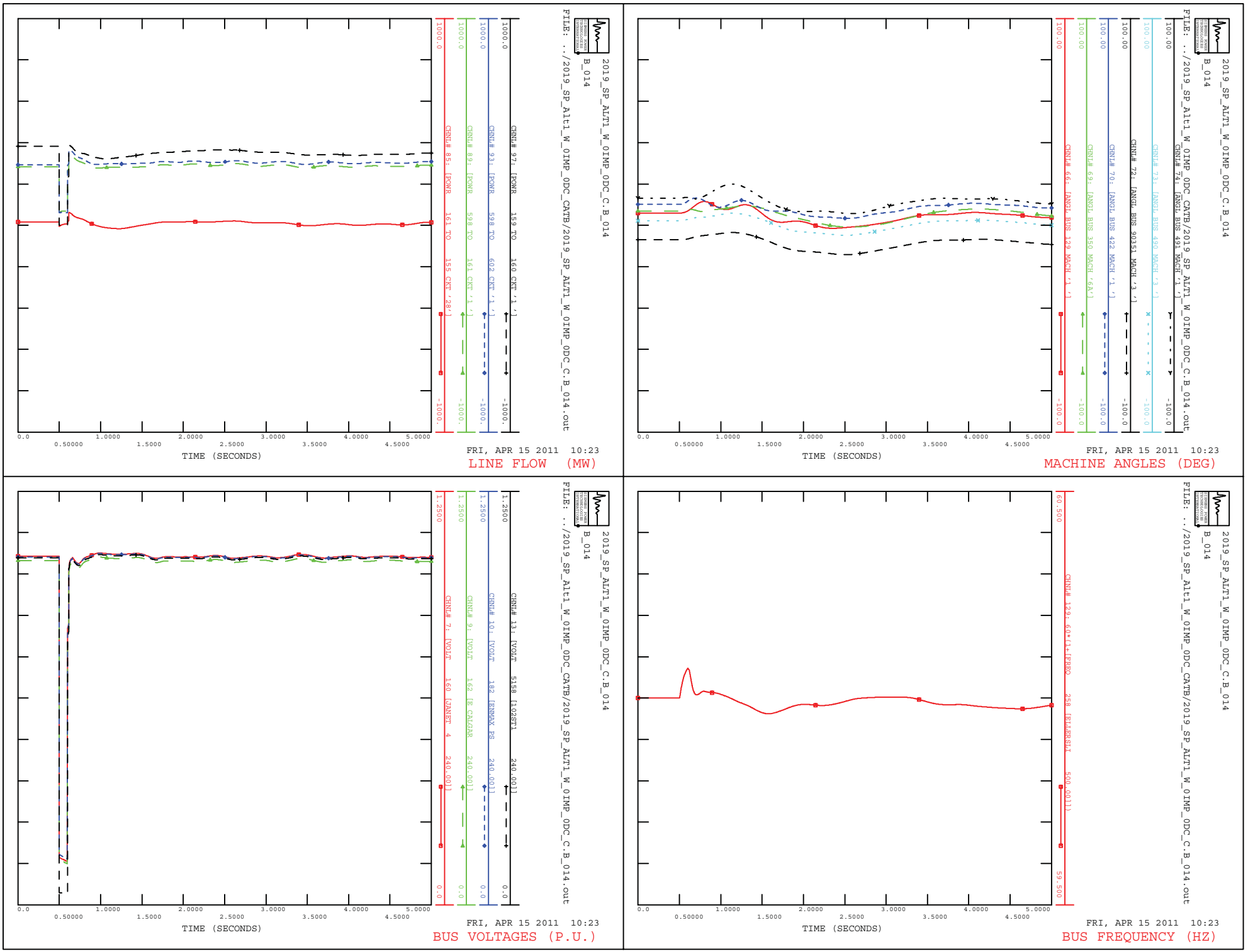


Figure M-2019-Step4-Sc2-4

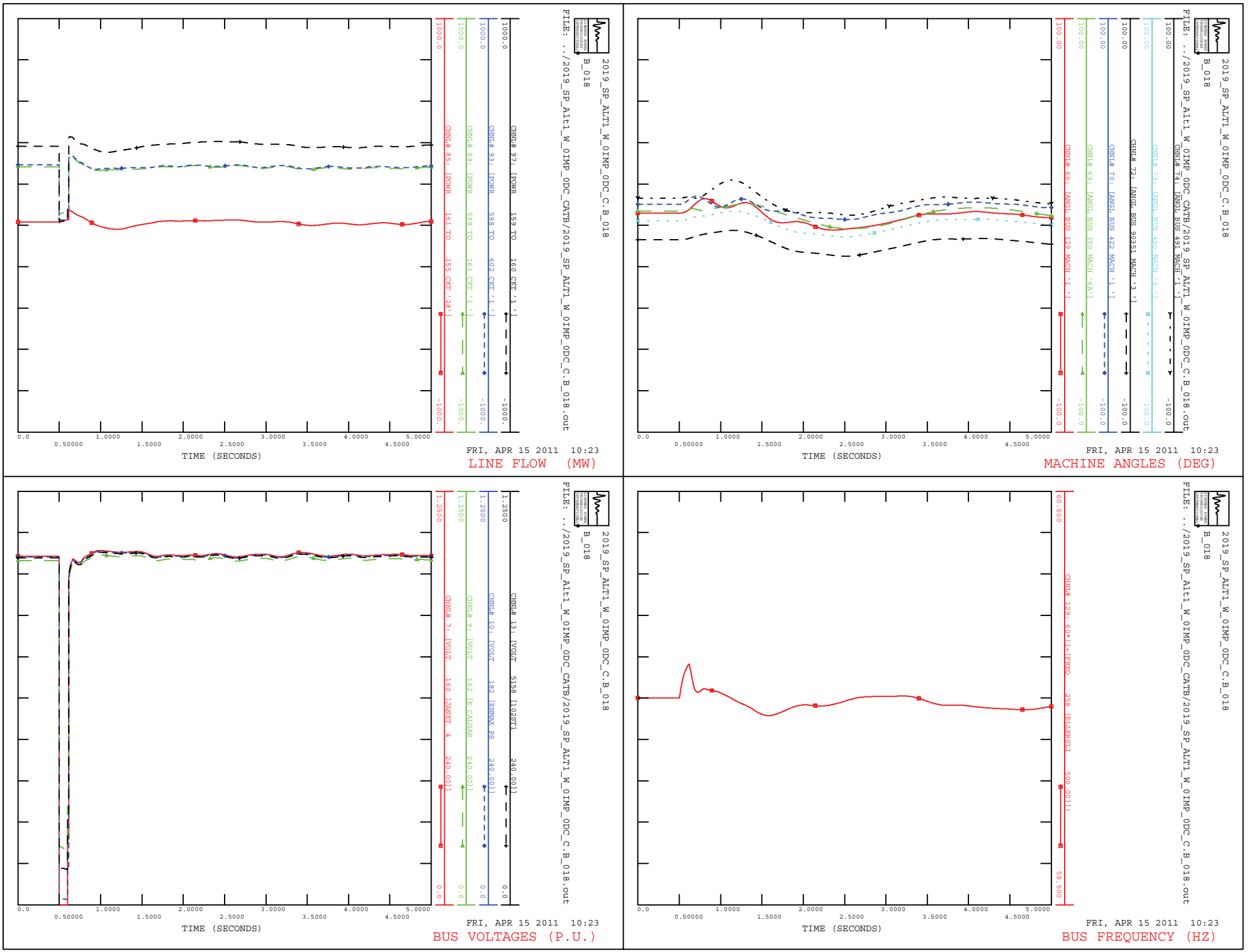


Figure M-2019-Step4-Sc2-5

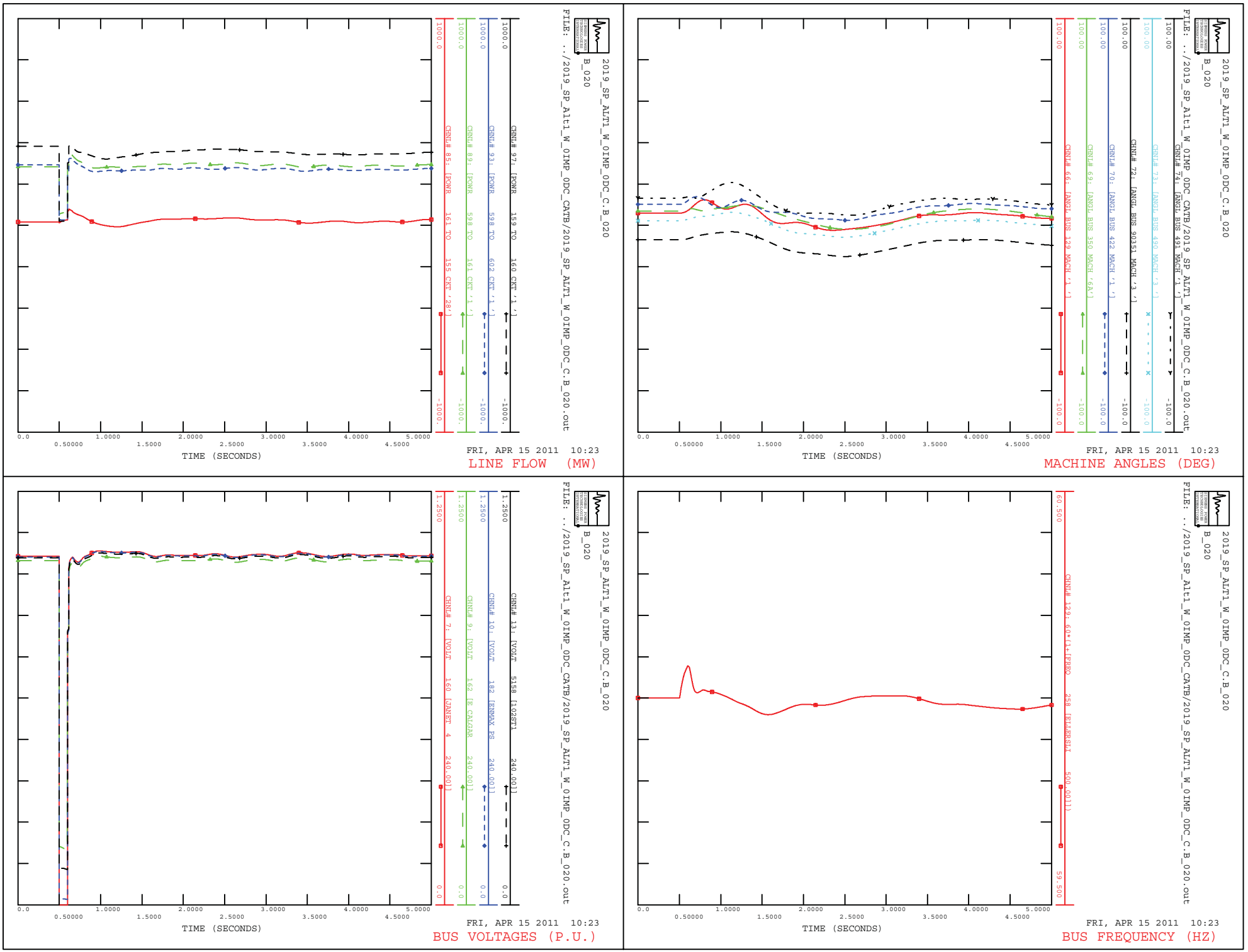


Figure M-2019-Step4-Sc2-6

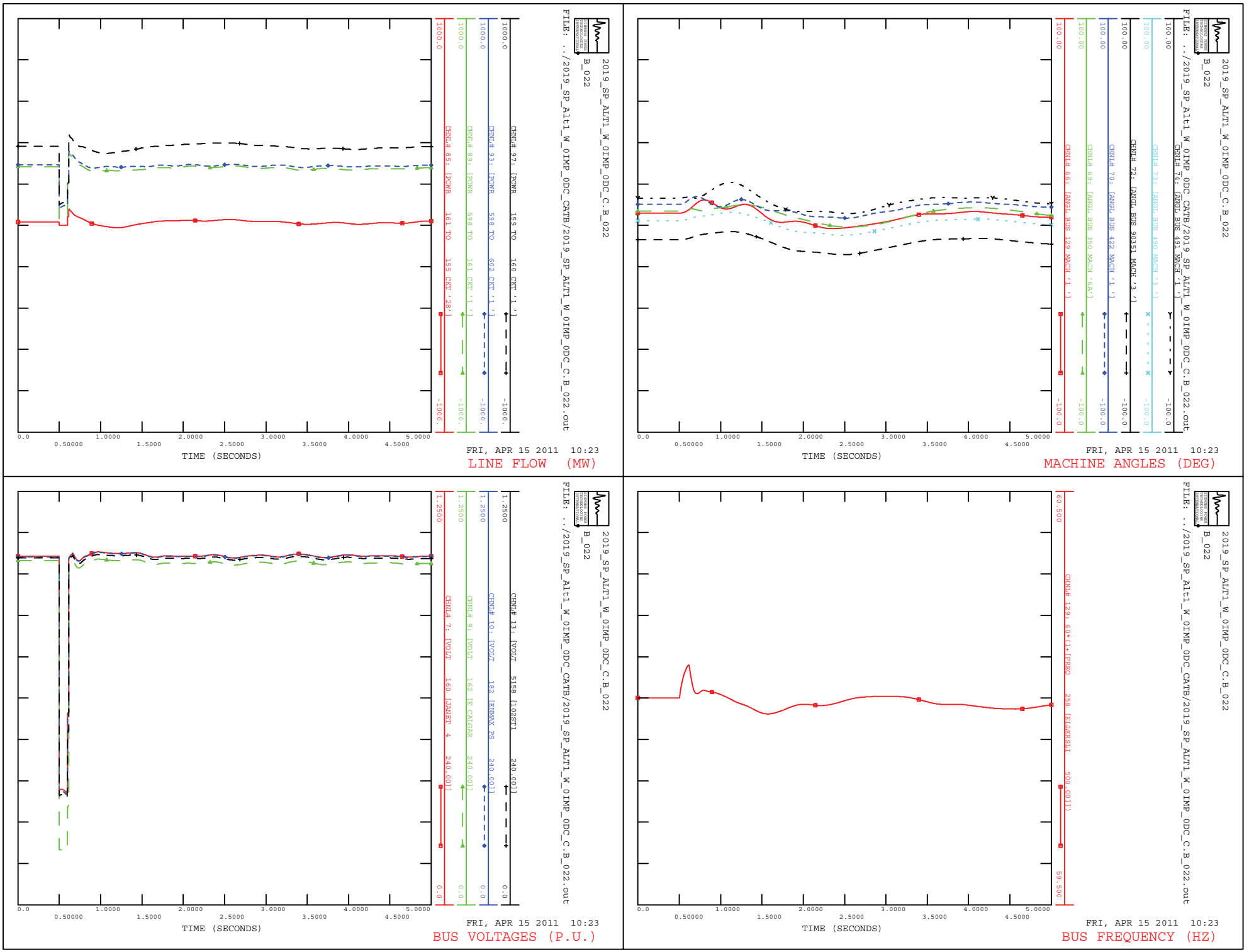


Figure M-2019-Step4-Sc2-7

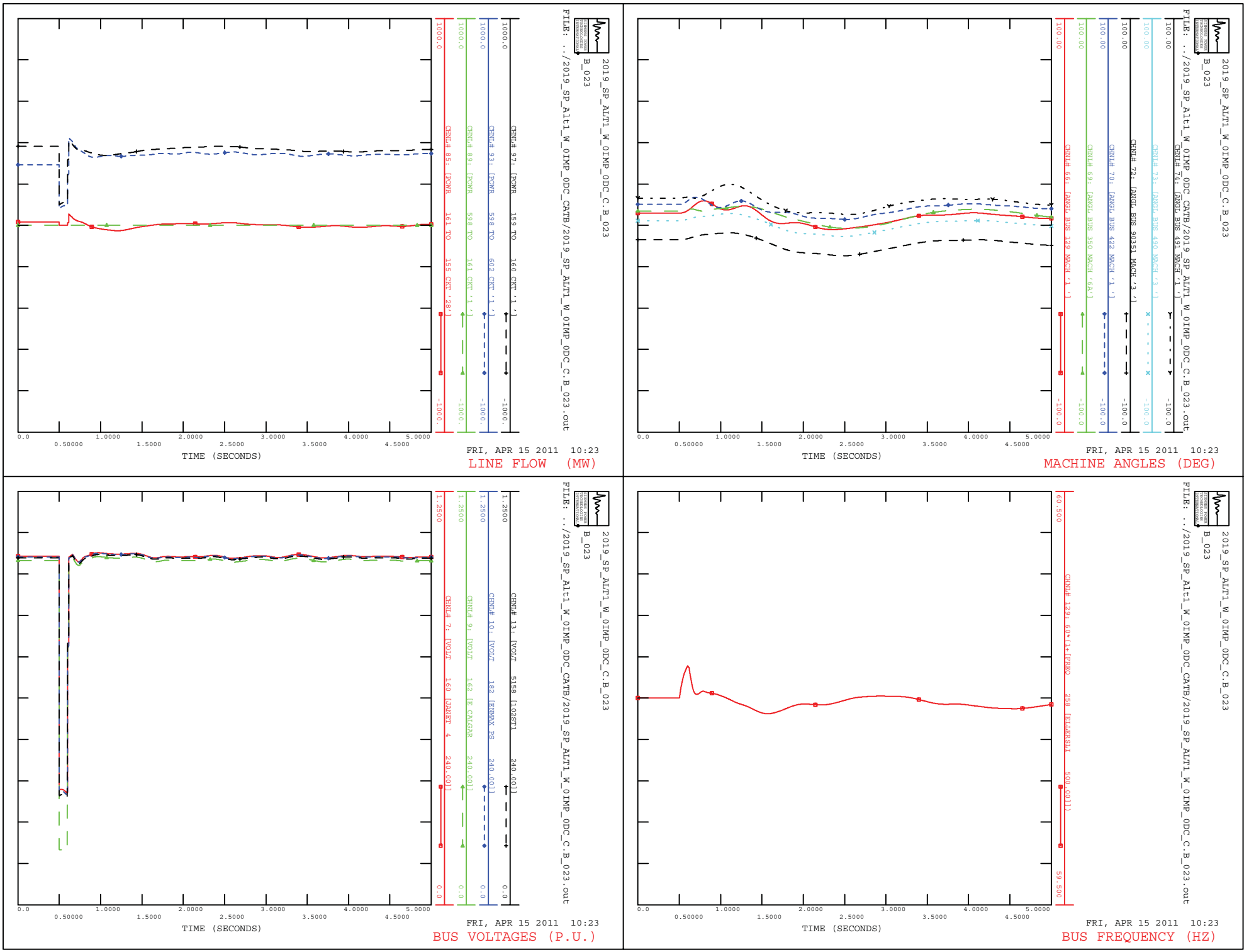


Figure M-2019-Step4-Sc2-8

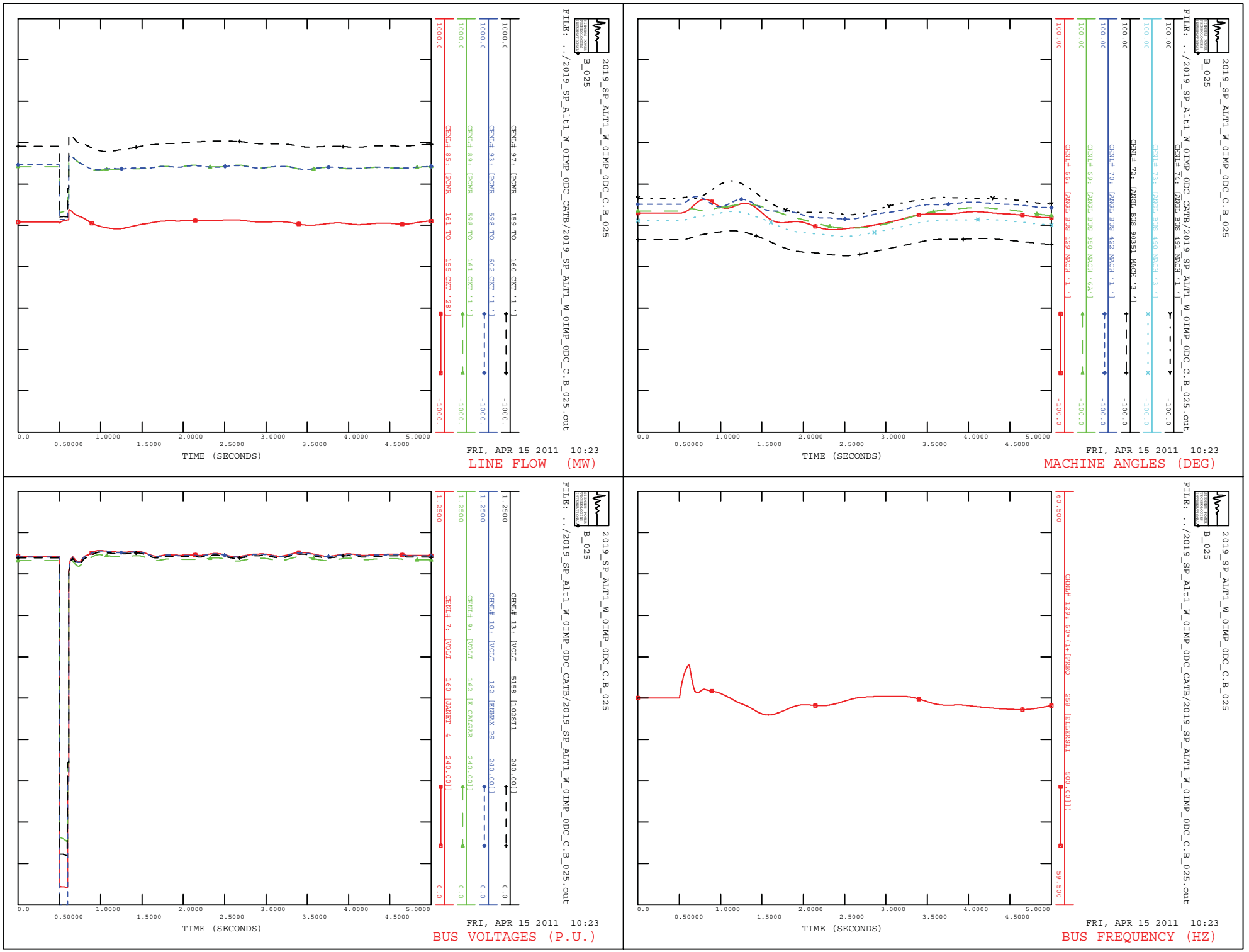


Figure M-2019-Step4-Sc2-9

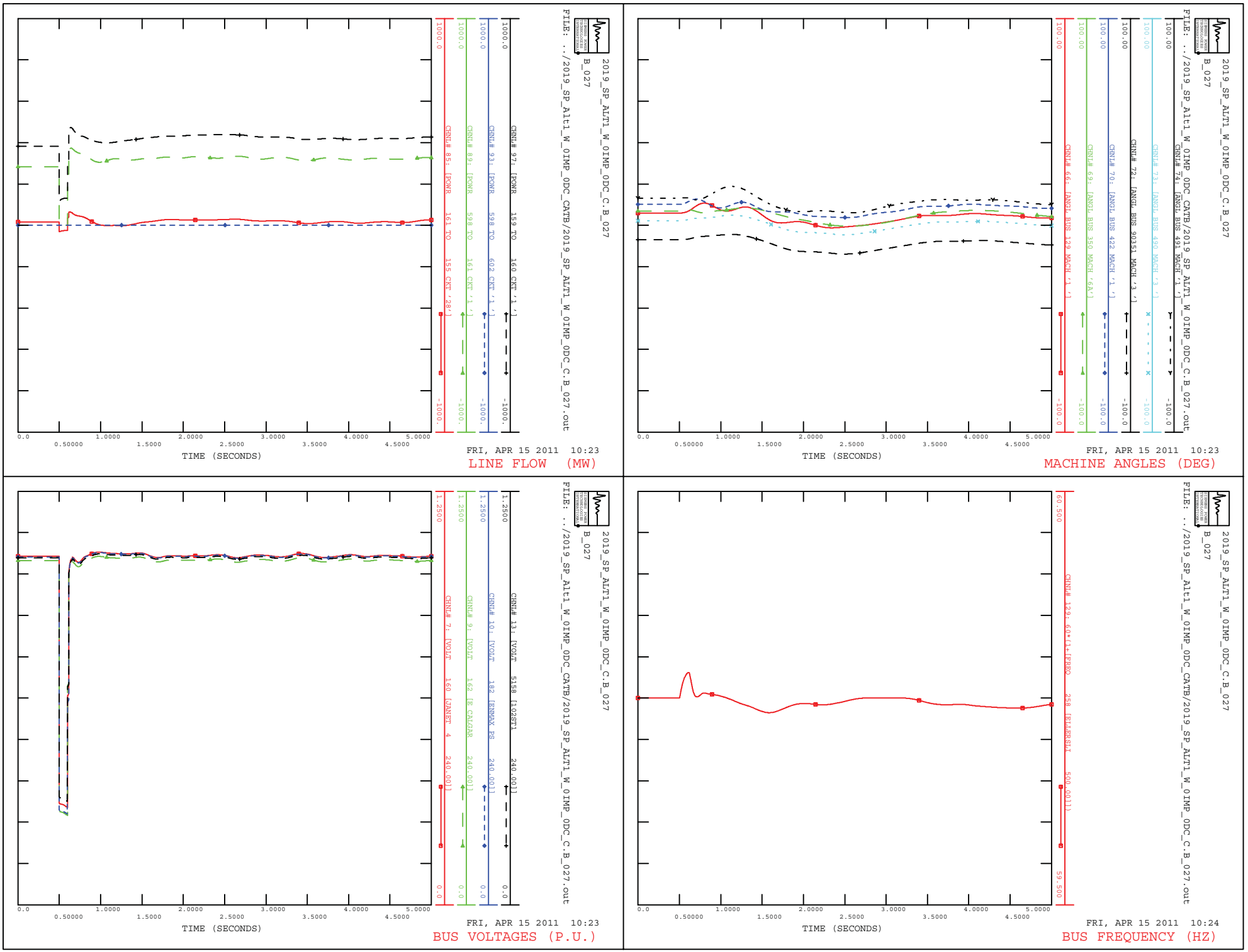


Figure M-2019-Step4-Sc2-10

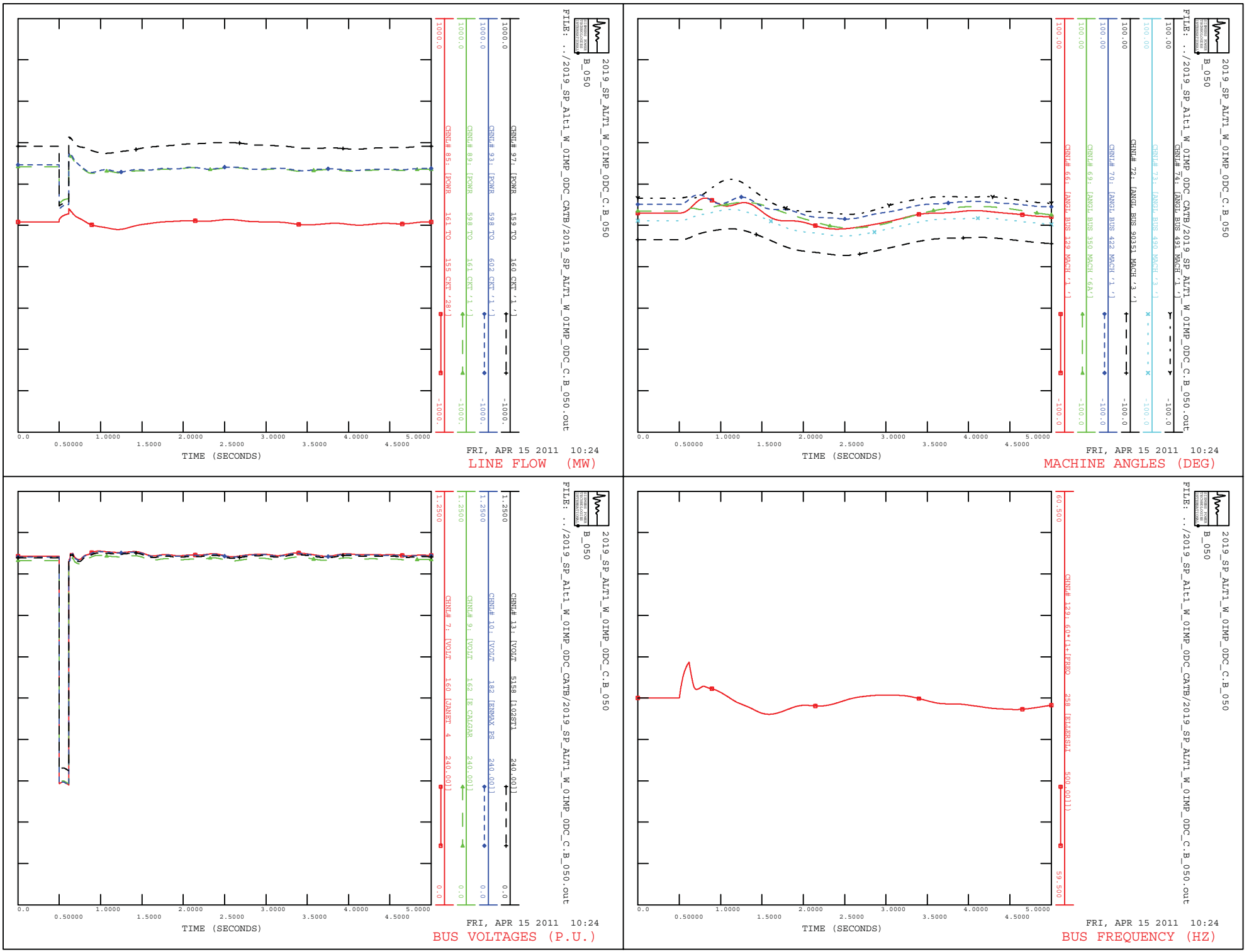


Figure M-2019-Step4-Sc2-11

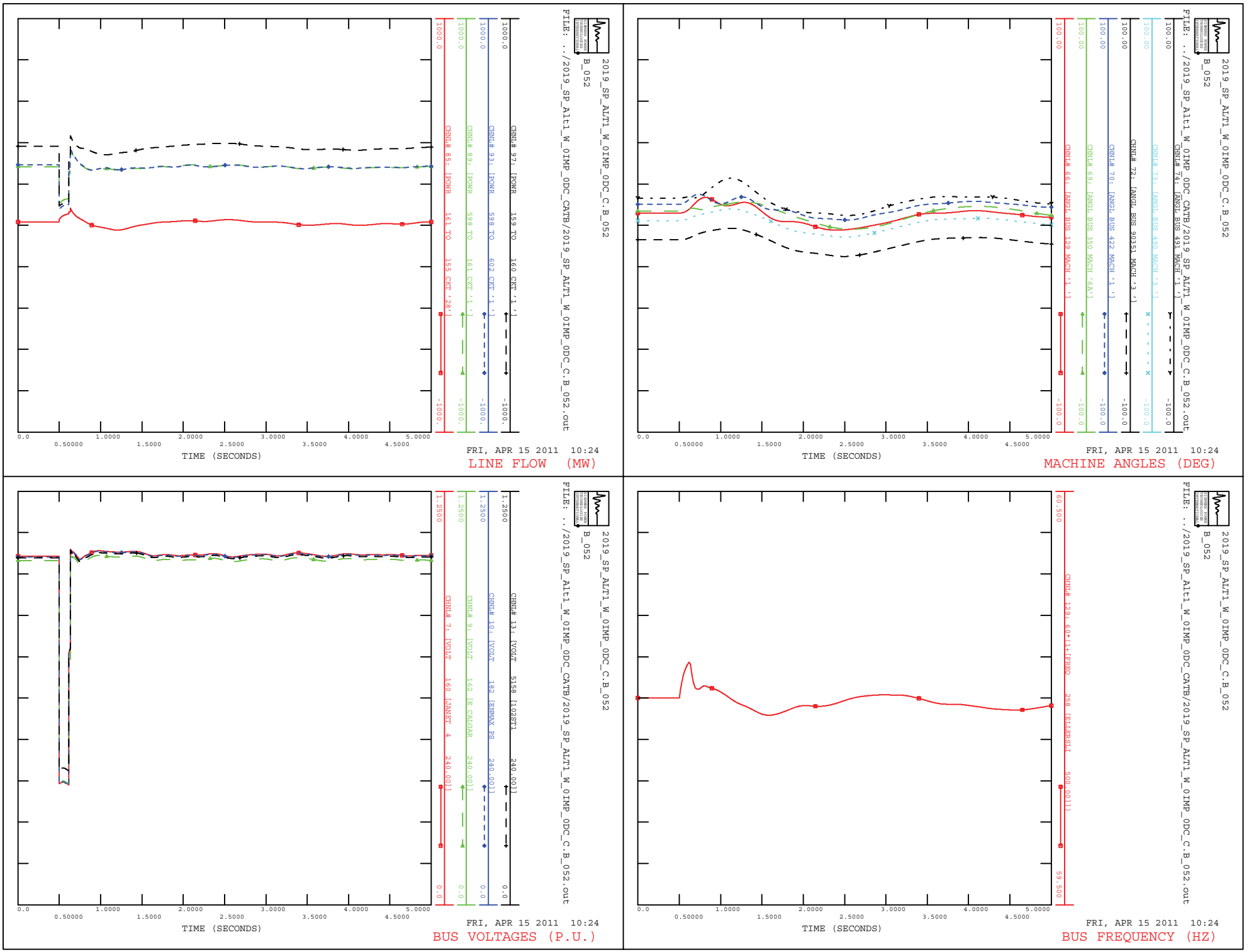


Figure M-2019-Step4-Sc2-12

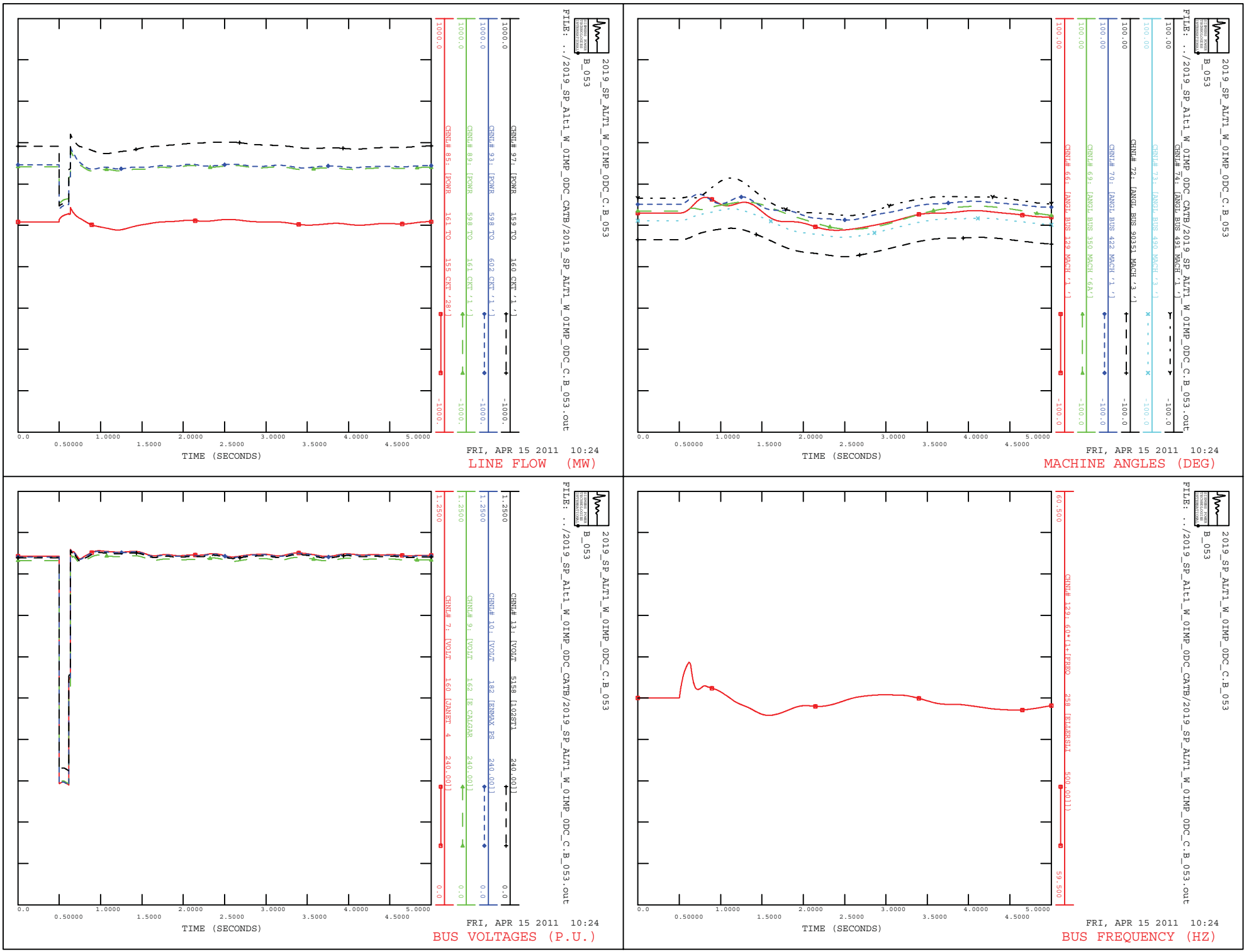


Figure M-2019-Step4-Sc2-13

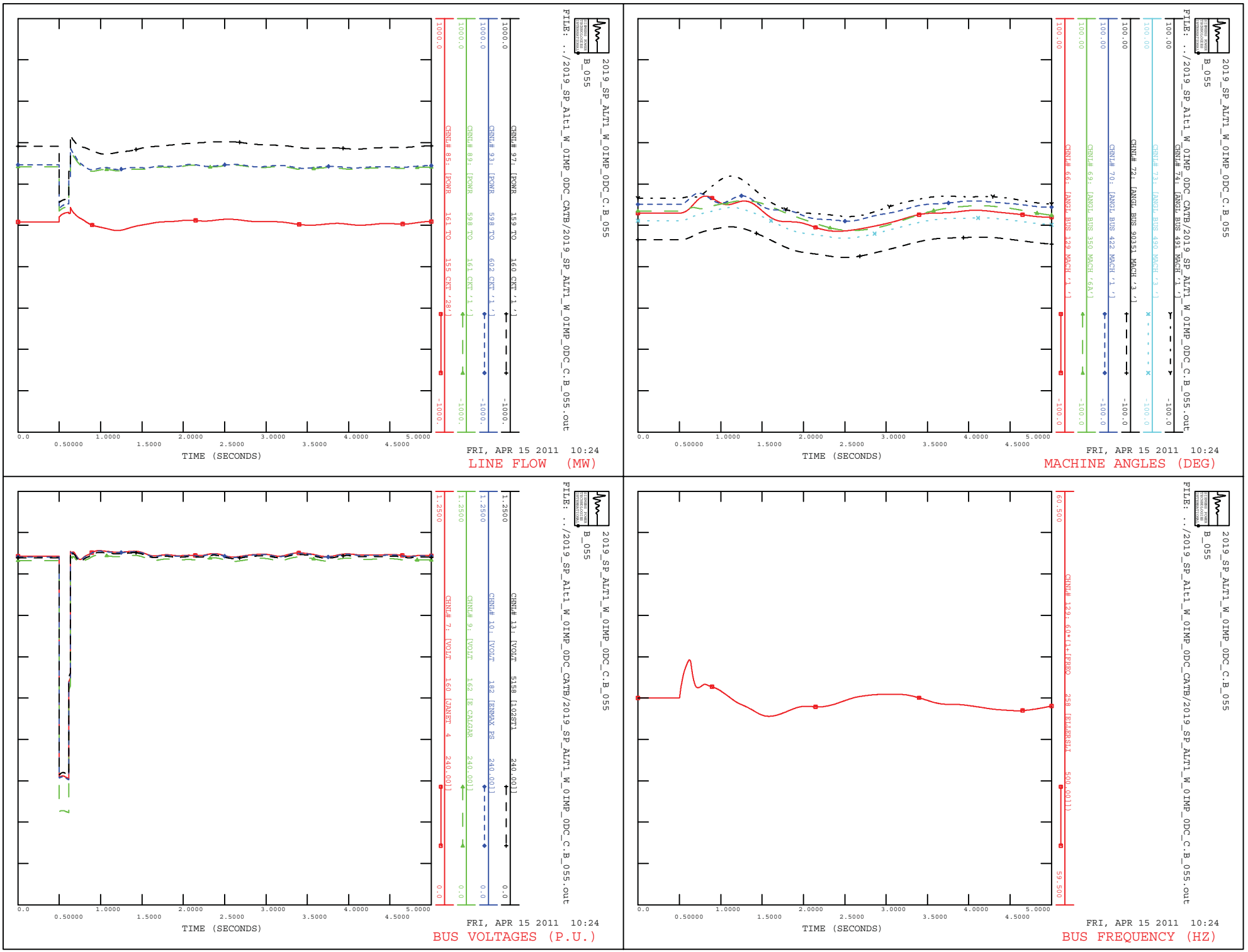


Figure M-2019-Step4-Sc2-14

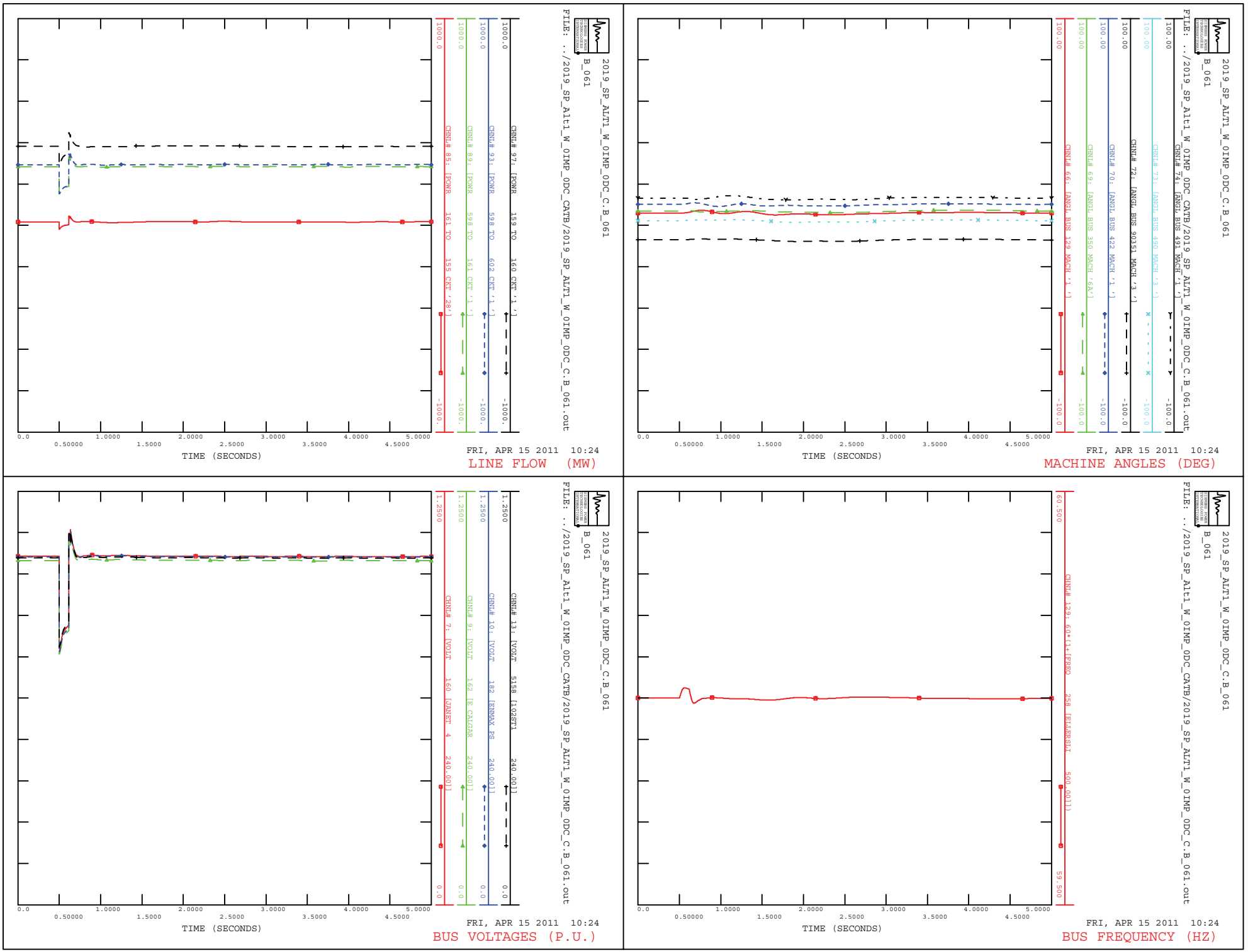


Figure M-2019-Step4-Sc2-15

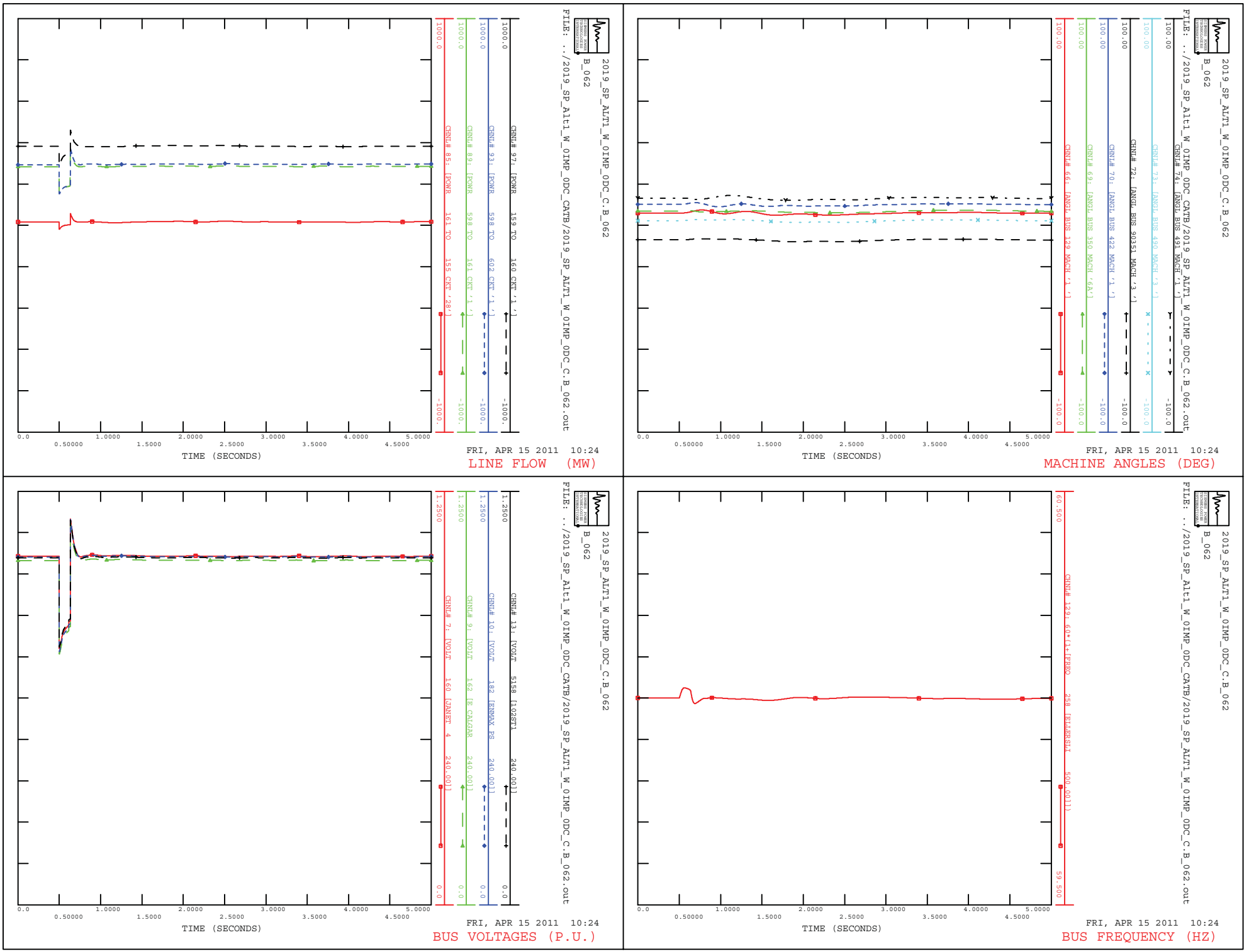


Figure M-2019-Step4-Sc2-16

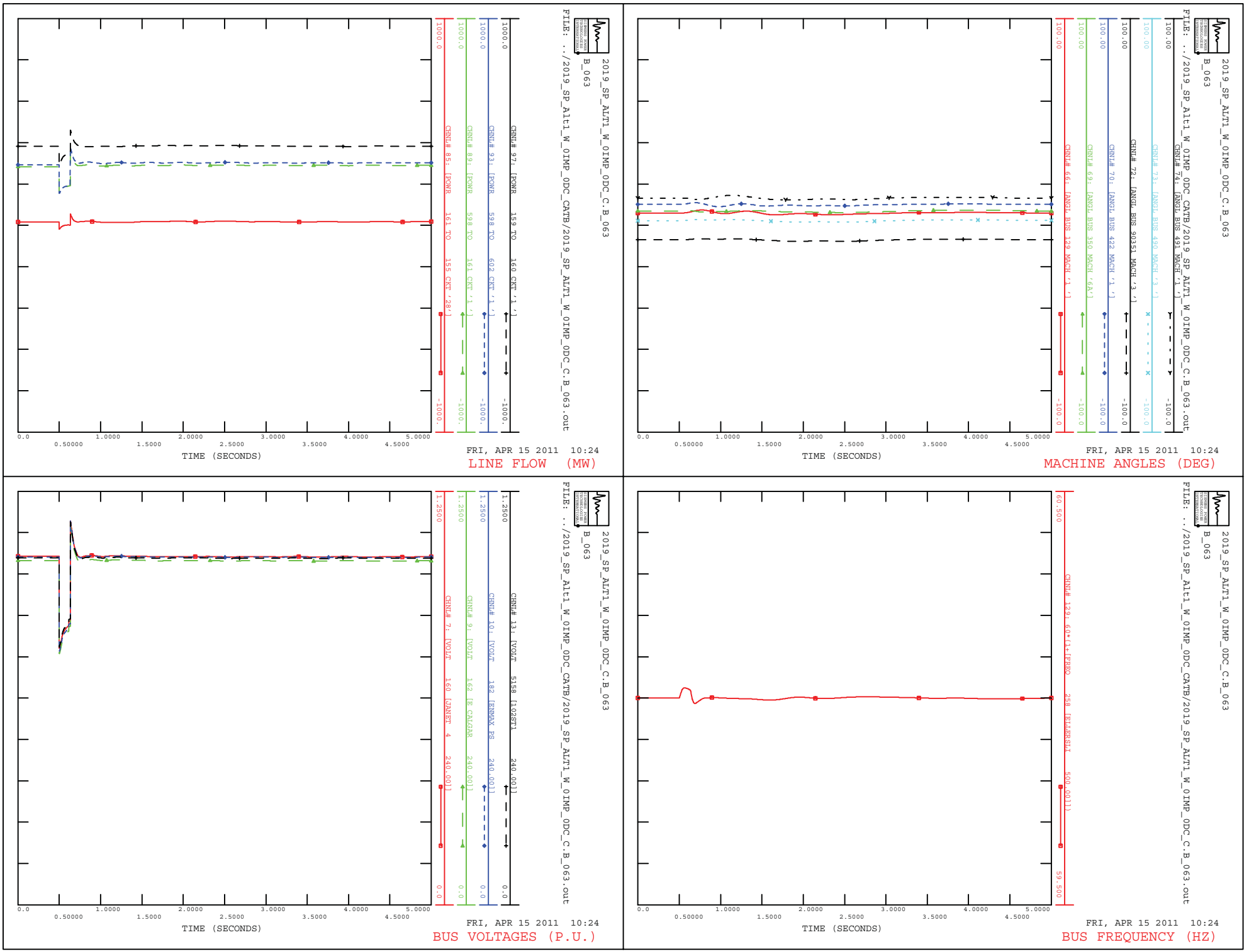


Figure M-2019-Step4-Sc2-17

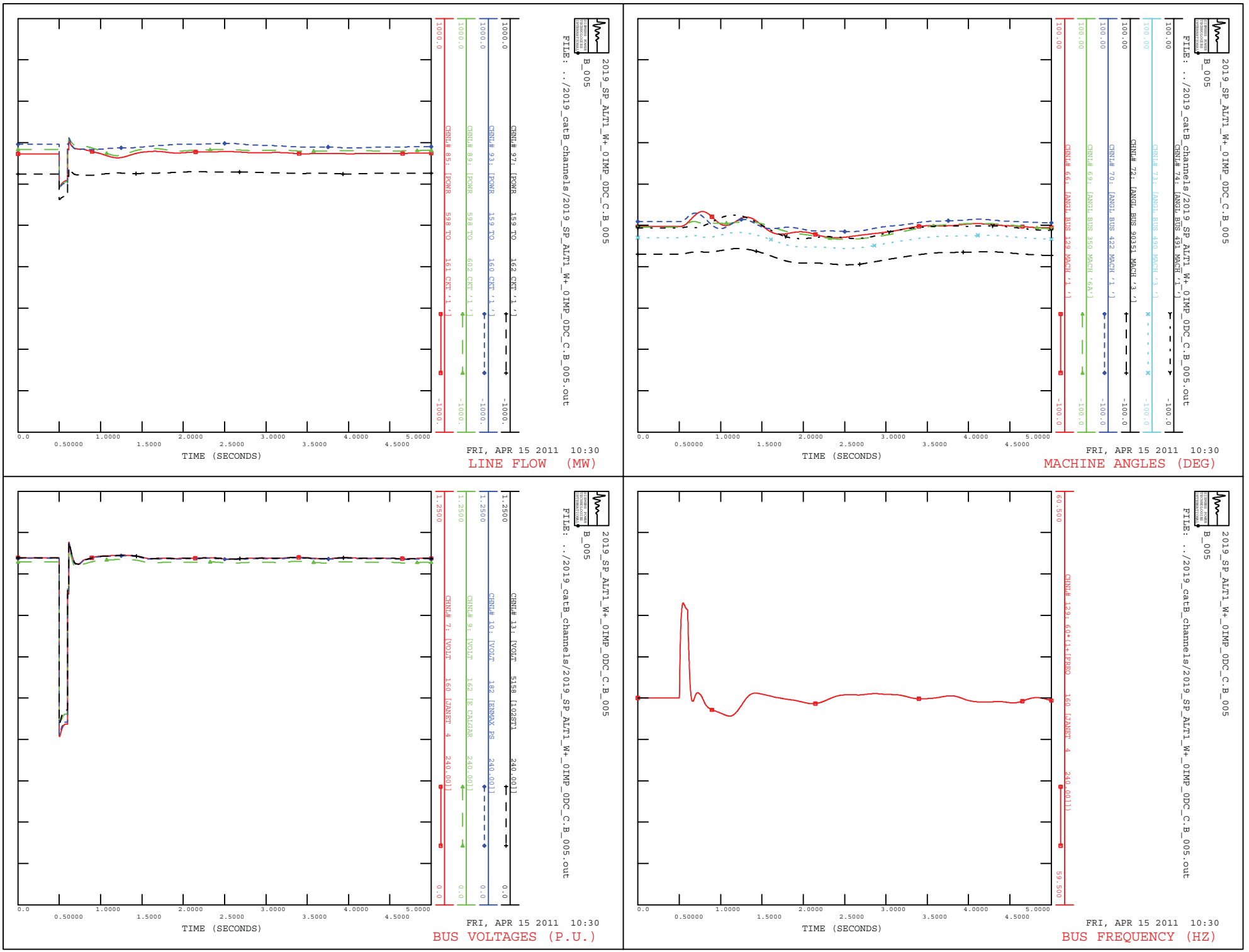


Figure M-2019-Step4-Sc3-1

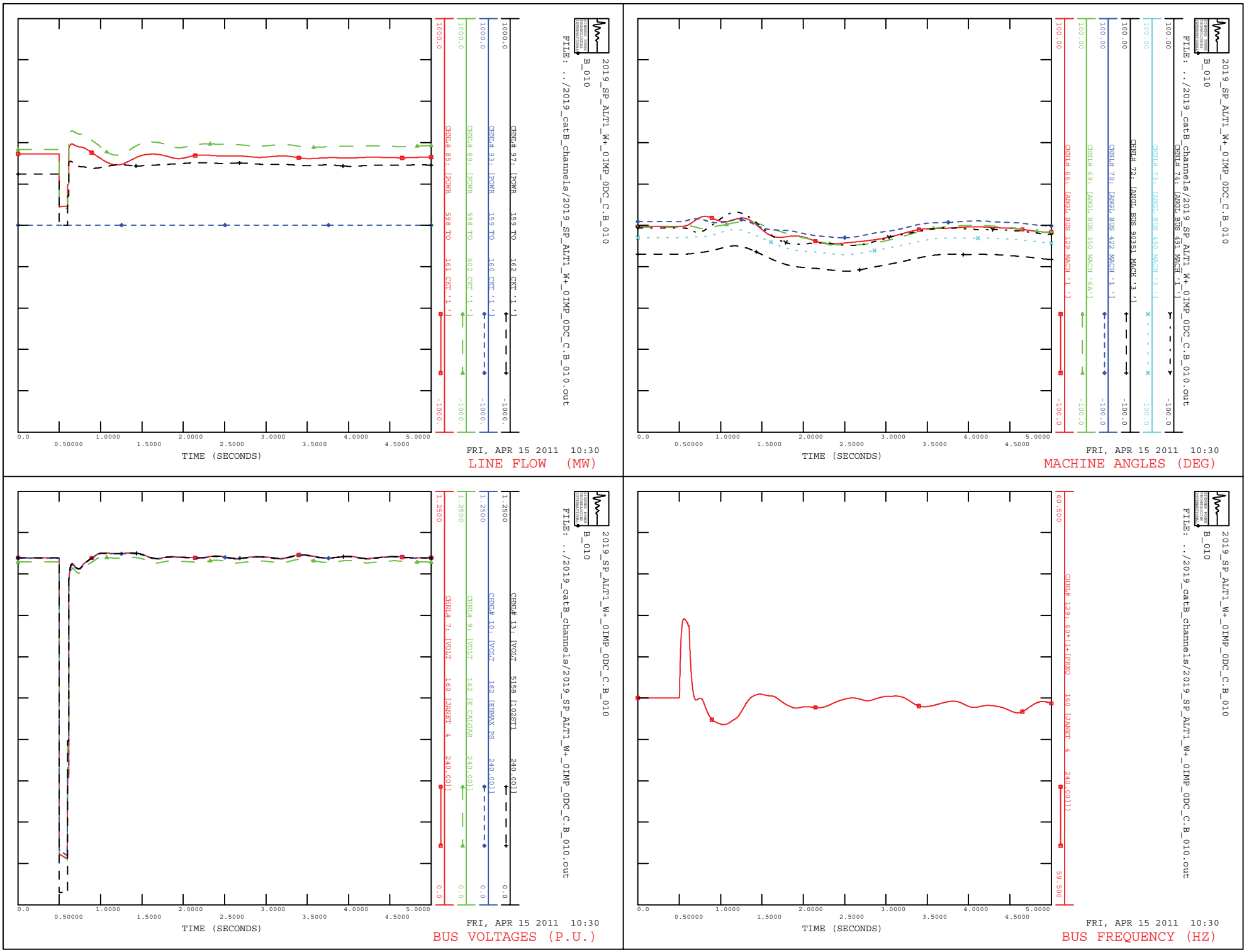


Figure M-2019-Step4-Sc3-2

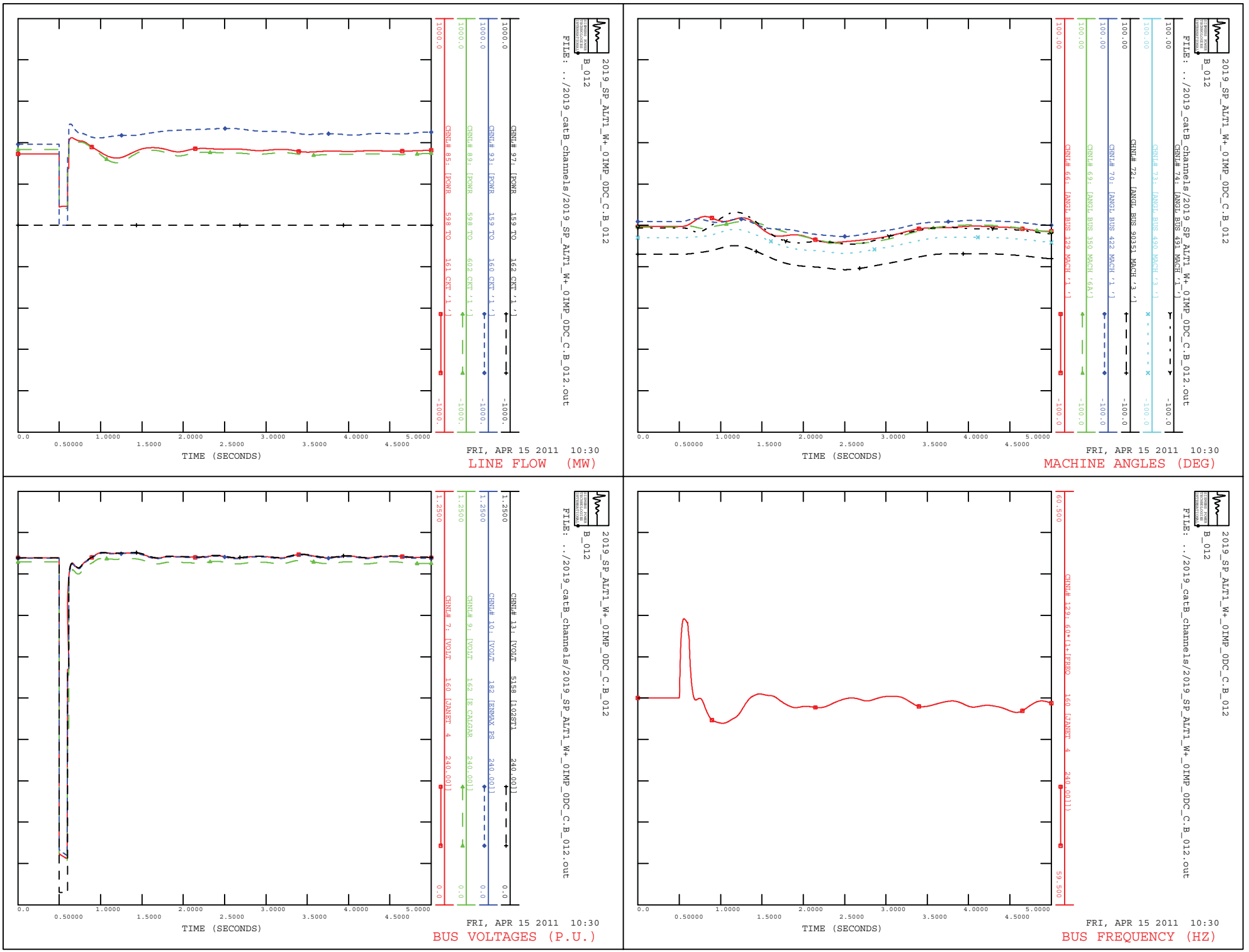


Figure M-2019-Step4-Sc3-3

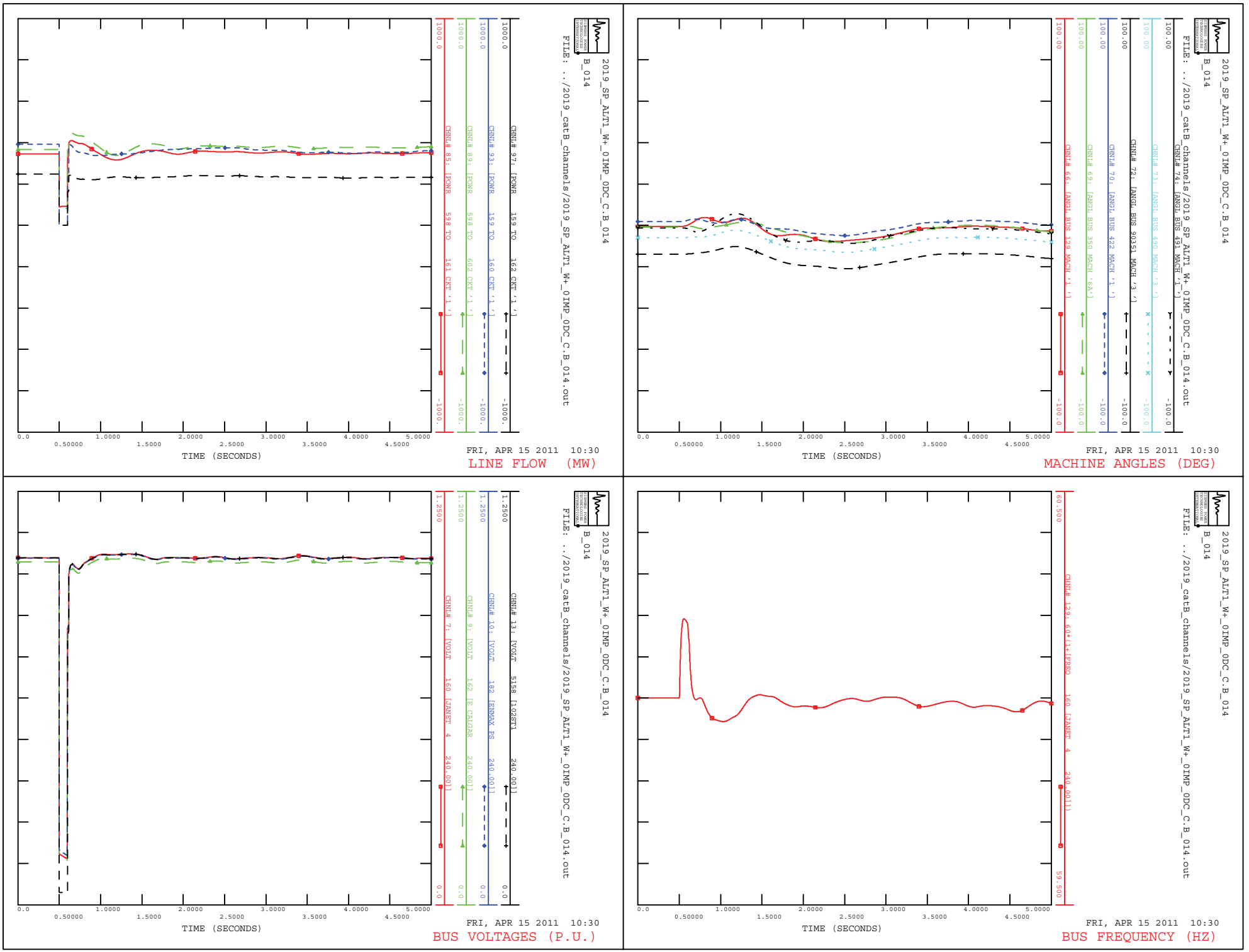


Figure M-2019-Step4-Sc3-4

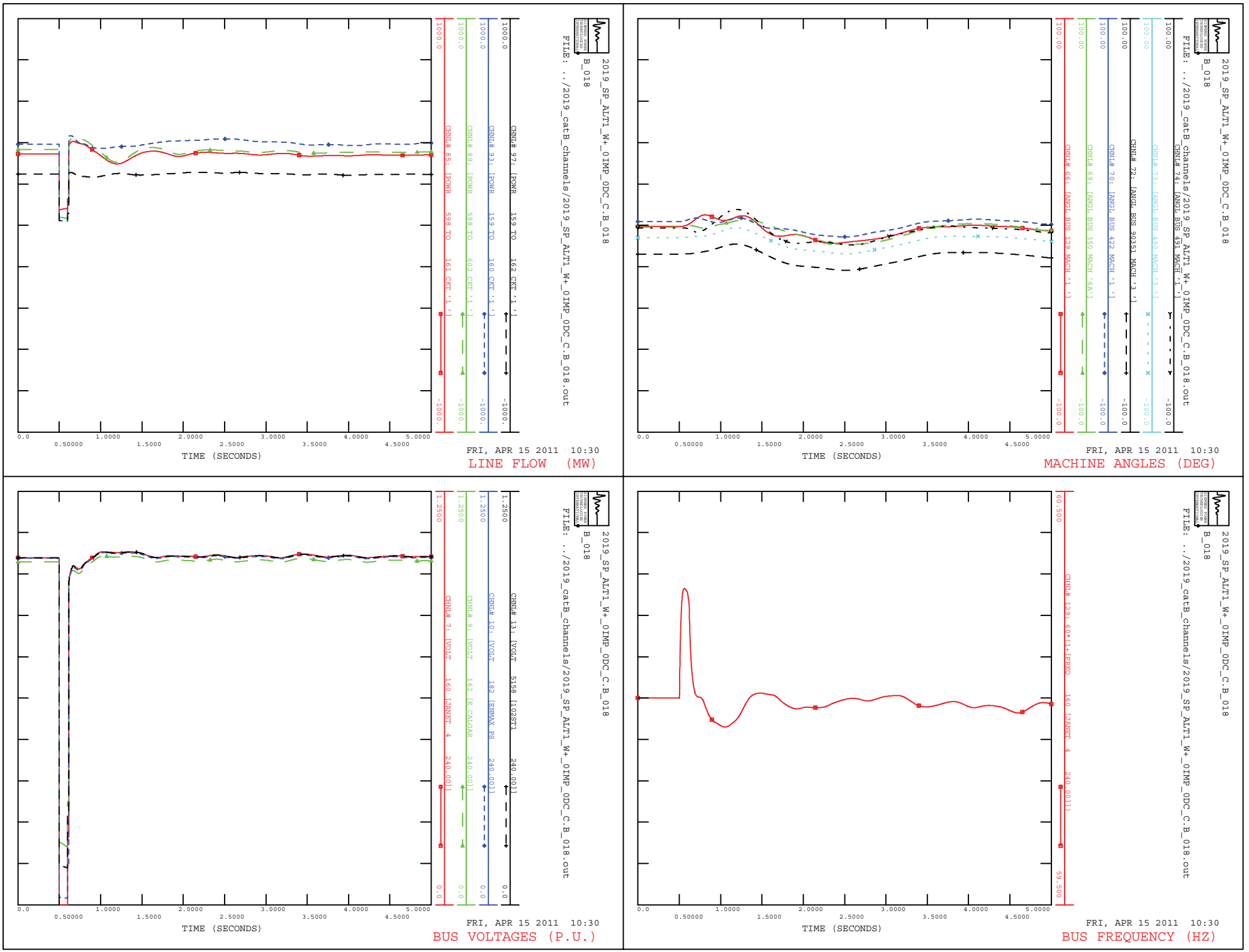


Figure M-2019-Step4-Sc3-5

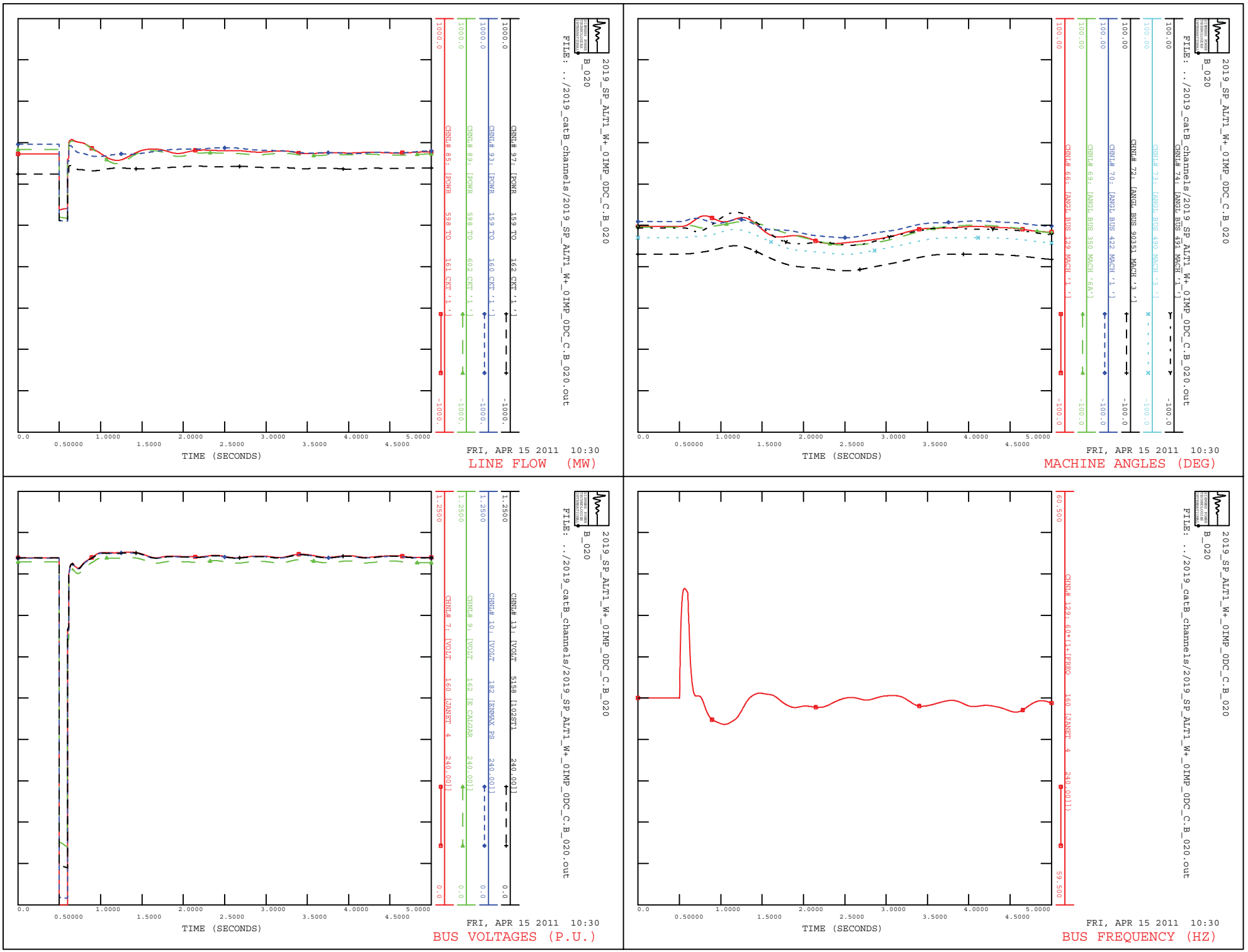


Figure M-2019-Step4-Sc3-6

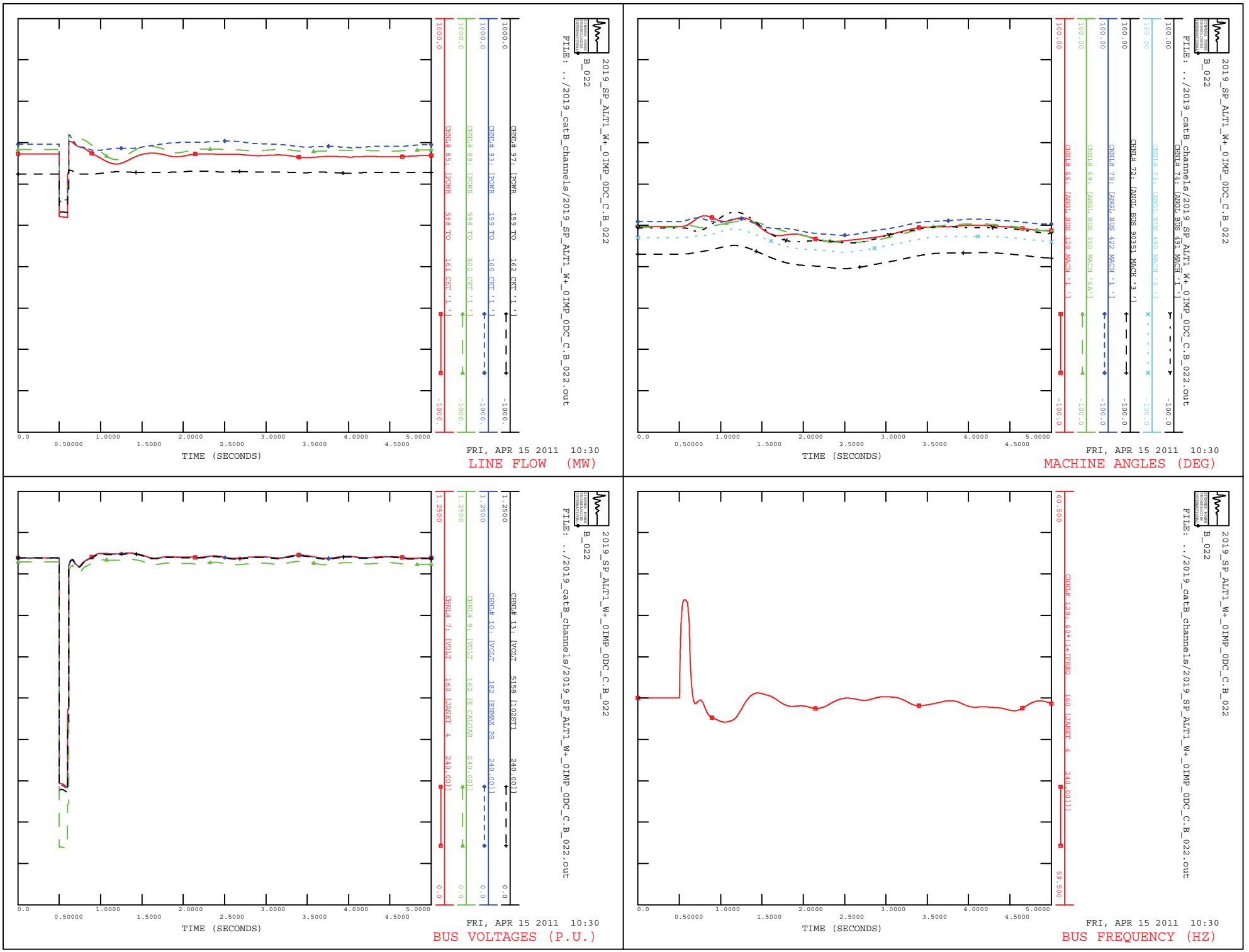


Figure M-2019-Step4-Sc3-7

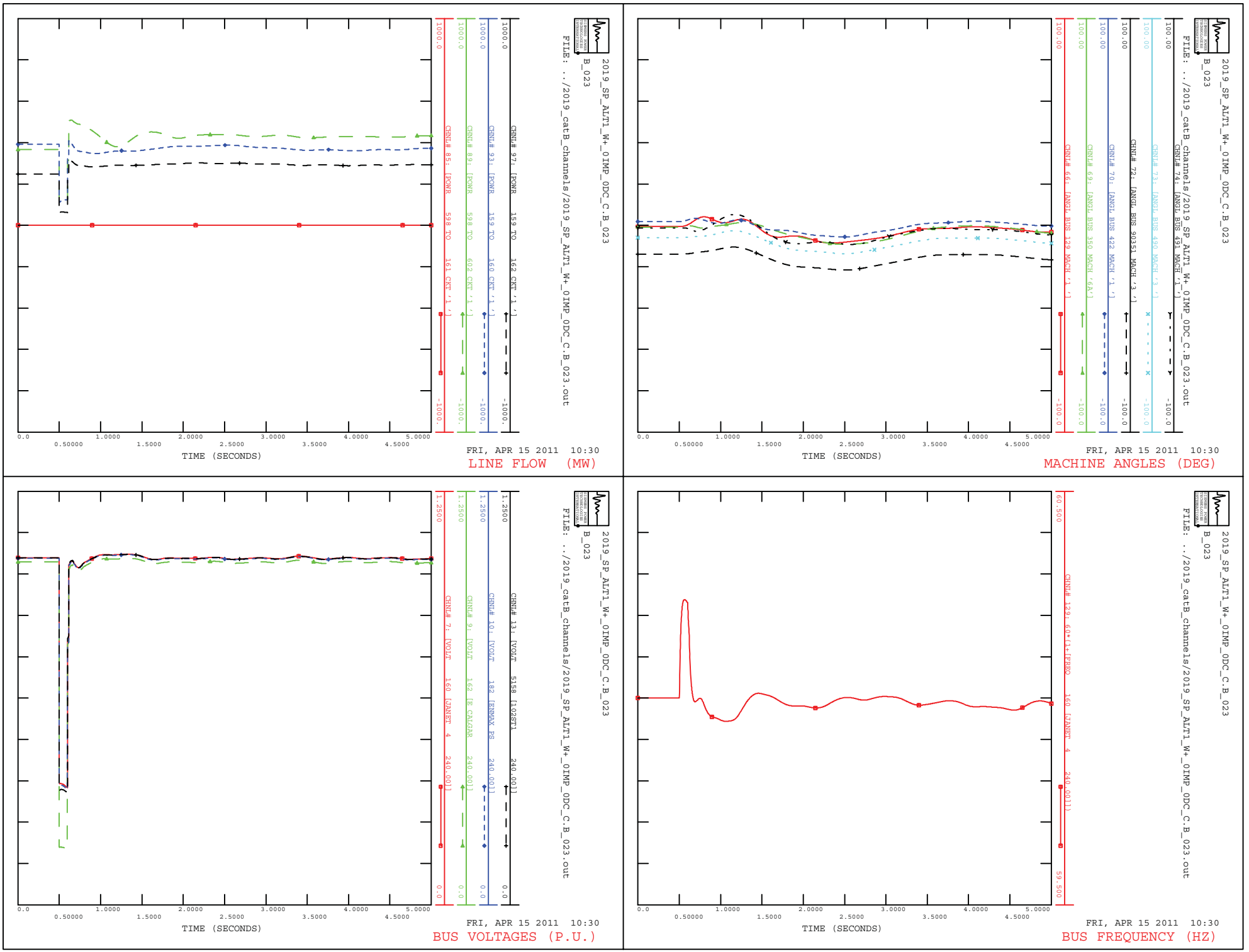


Figure M-2019-Step4-Sc3-8

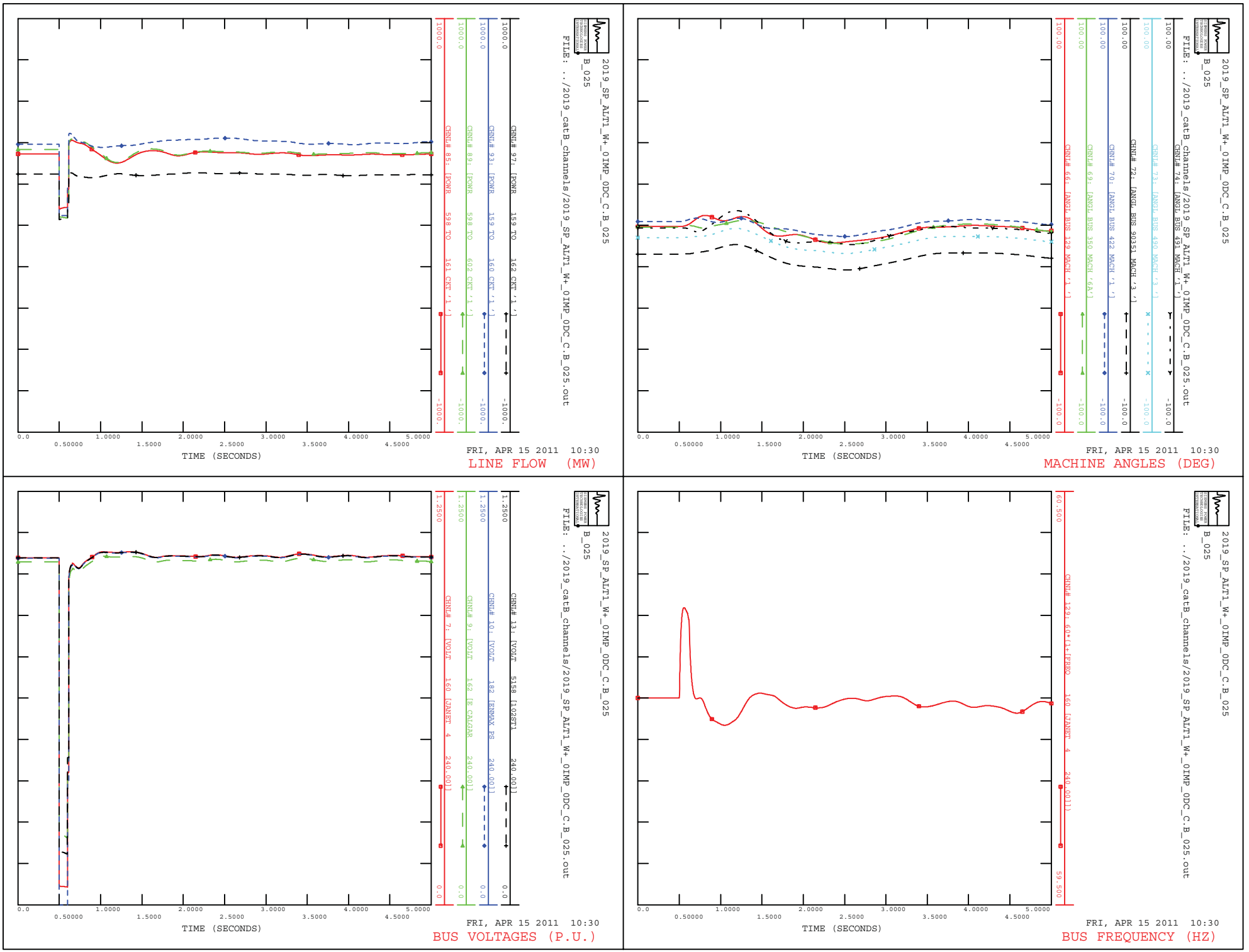


Figure M-2019-Step4-Sc3-9

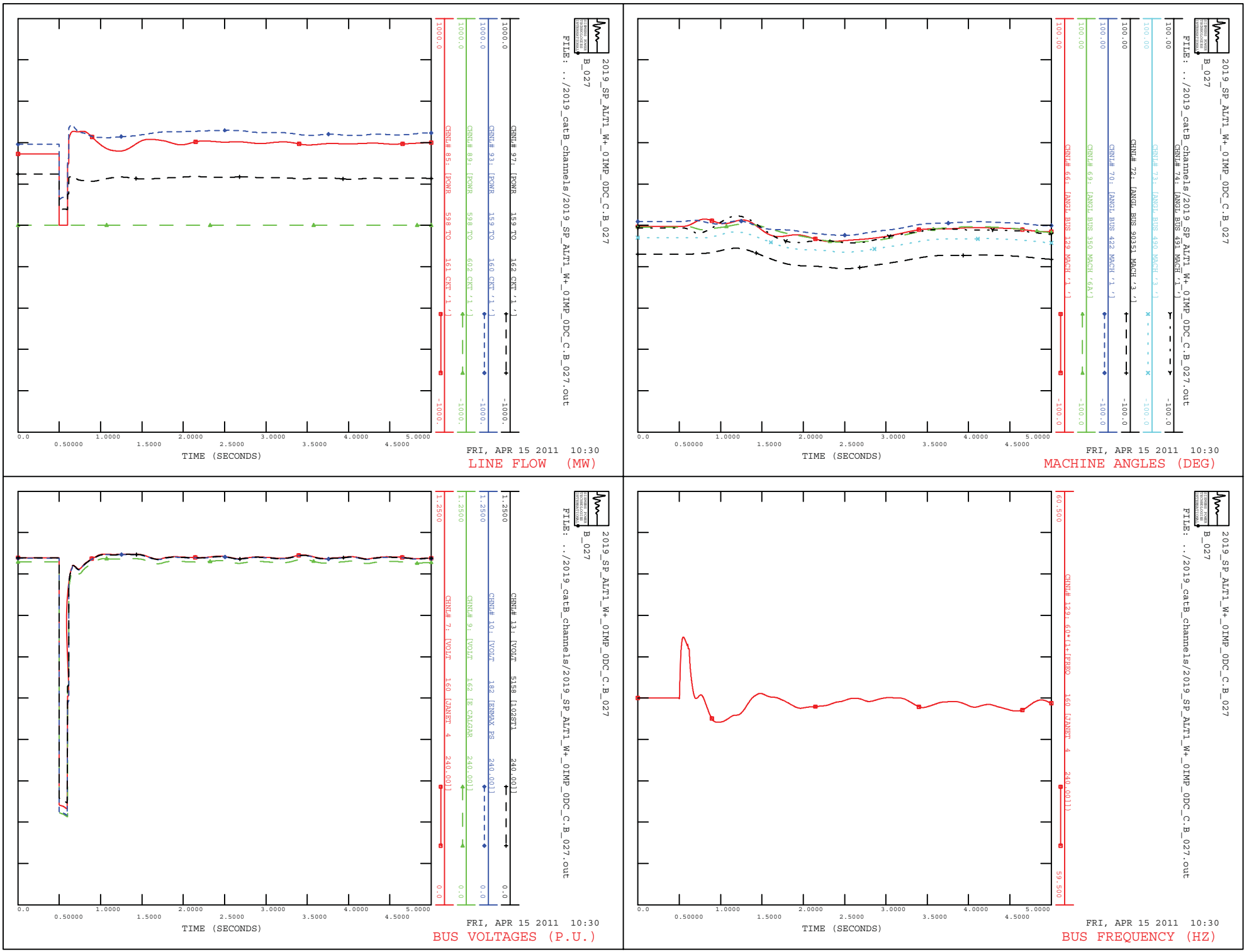


Figure M-2019-Step4-Sc3-10

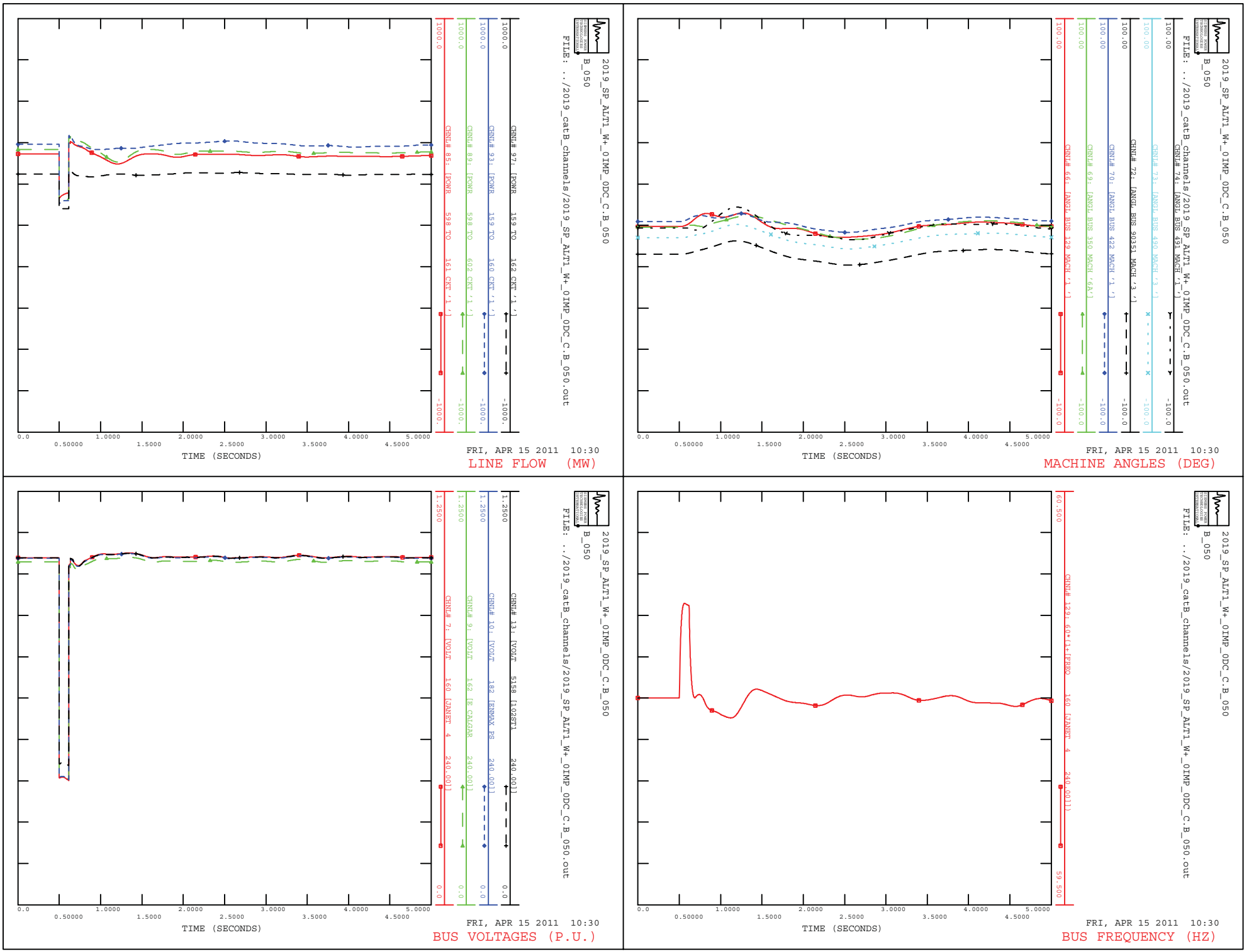


Figure M-2019-Step4-Sc3-11

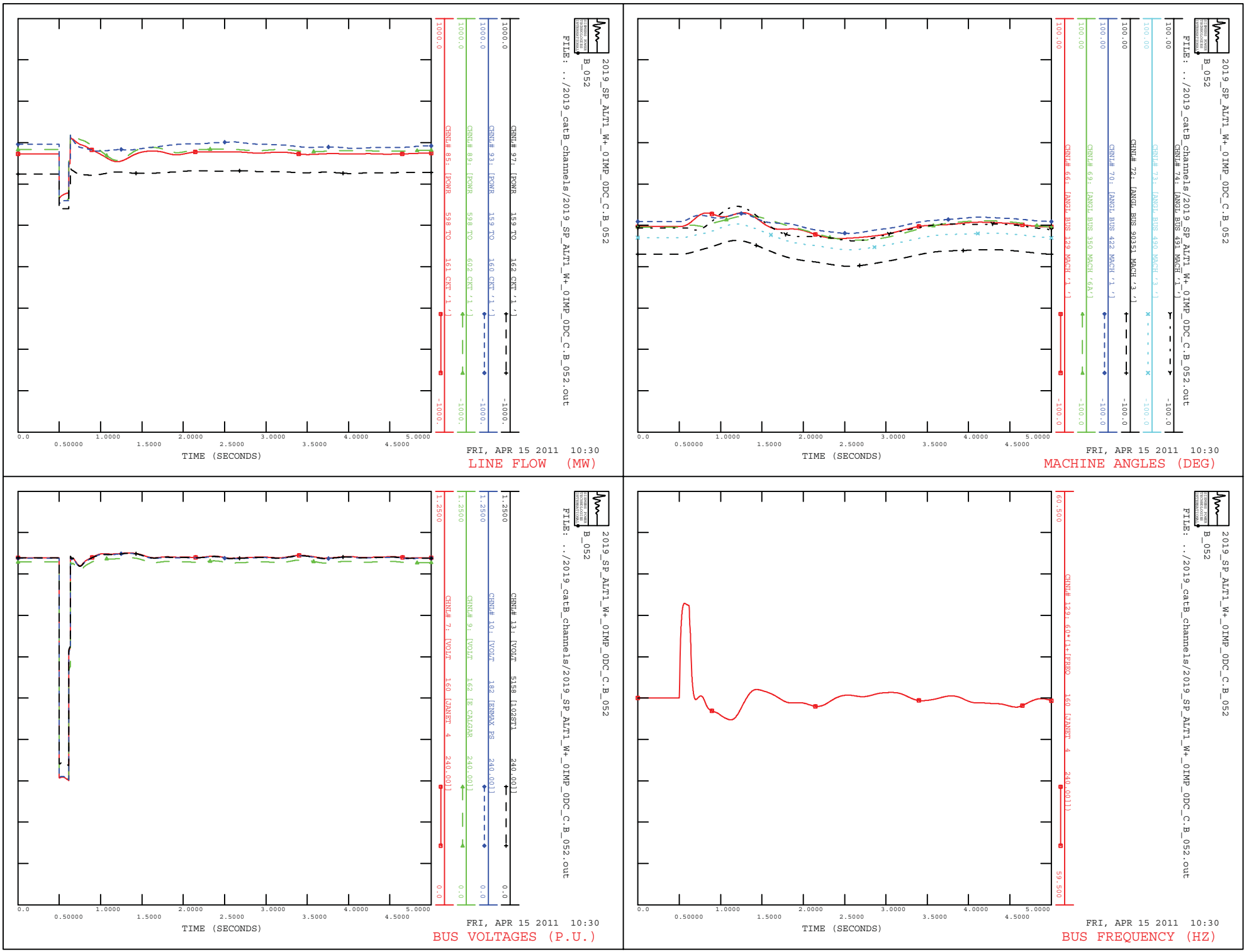


Figure M-2019-Step4-Sc3-12

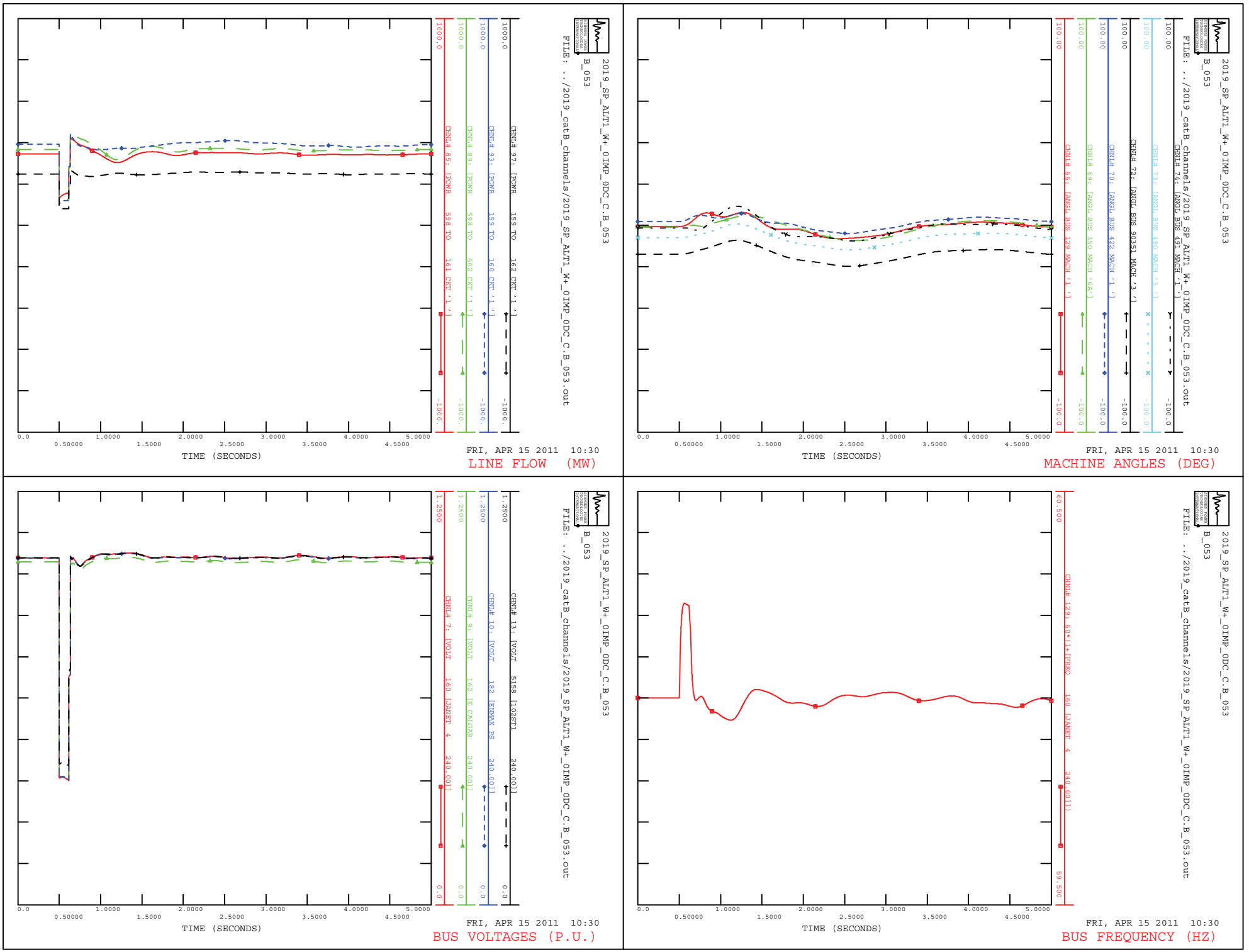


Figure M-2019-Step4-Sc3-13

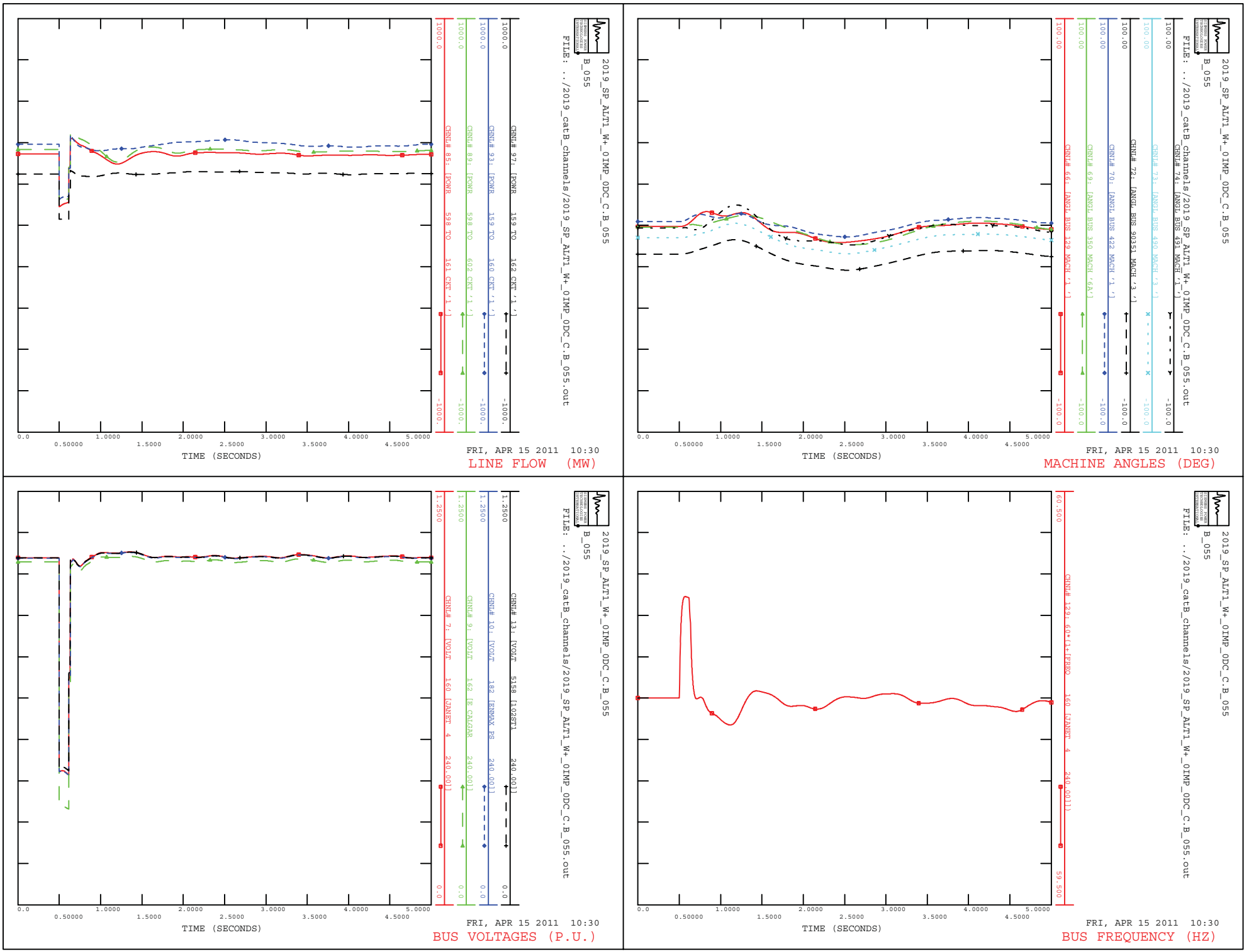


Figure M-2019-Step4-Sc3-14

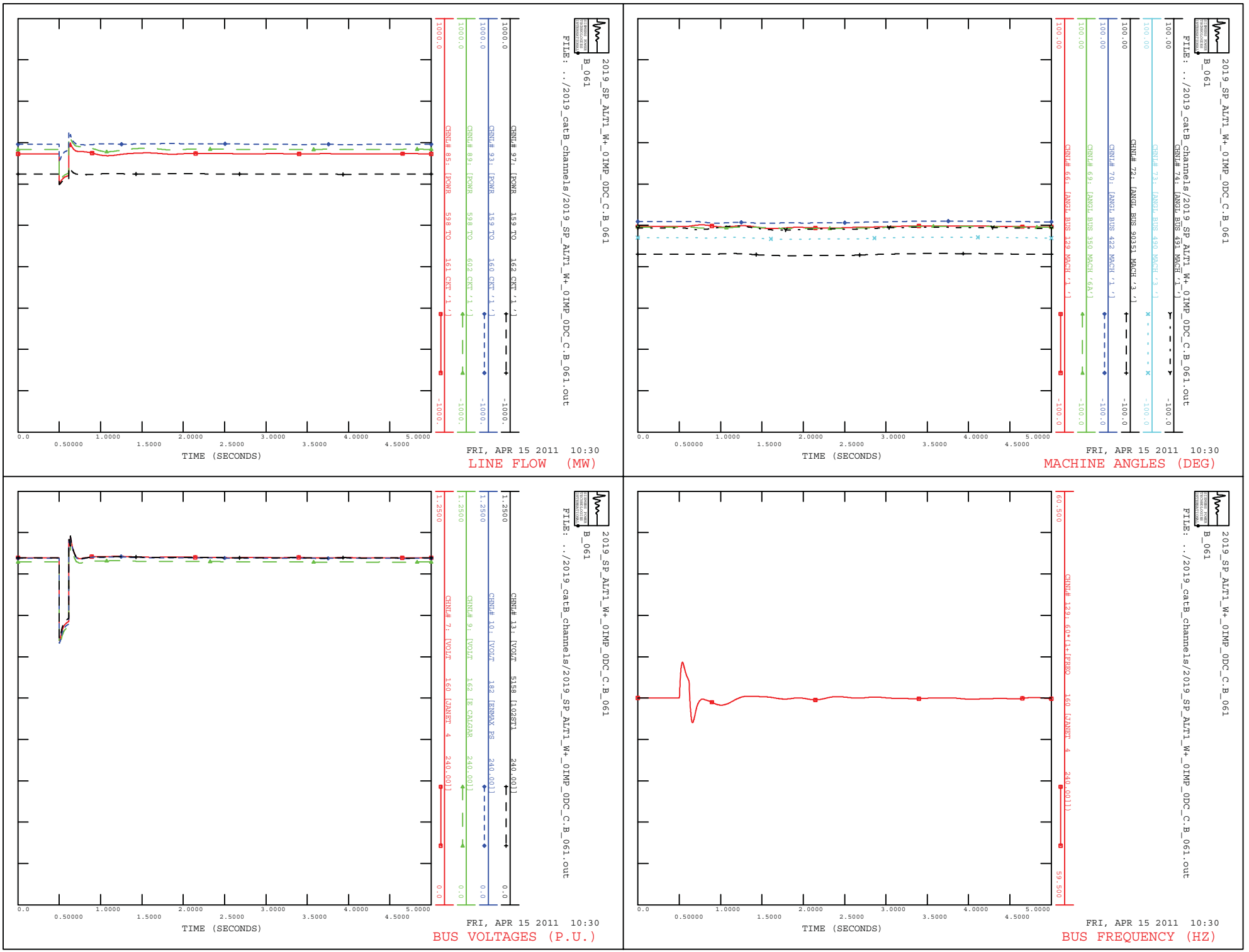


Figure M-2019-Step4-Sc3-15

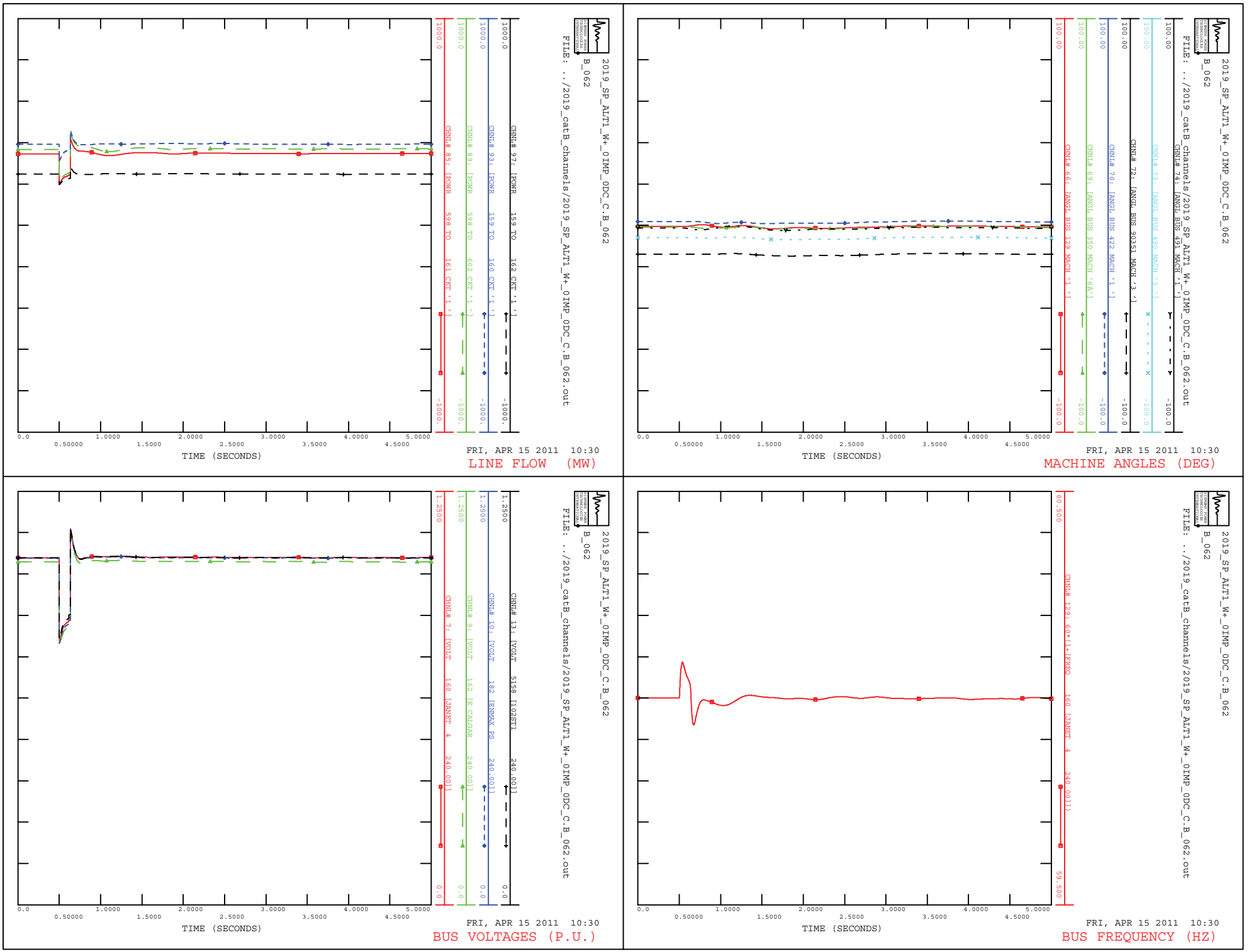


Figure M-2019-Step4-Sc3-16

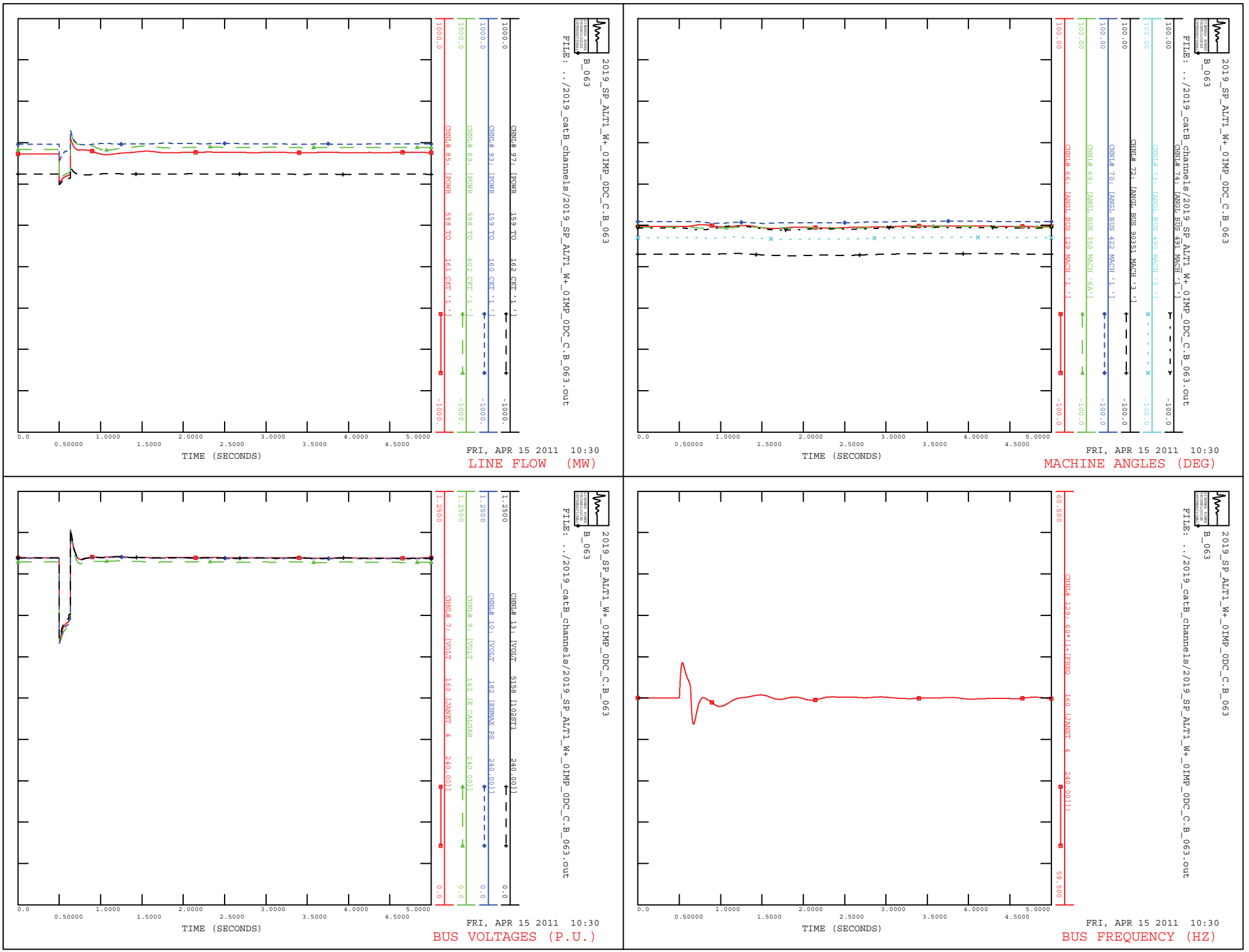


Figure M-2019-Step4-Sc3-17

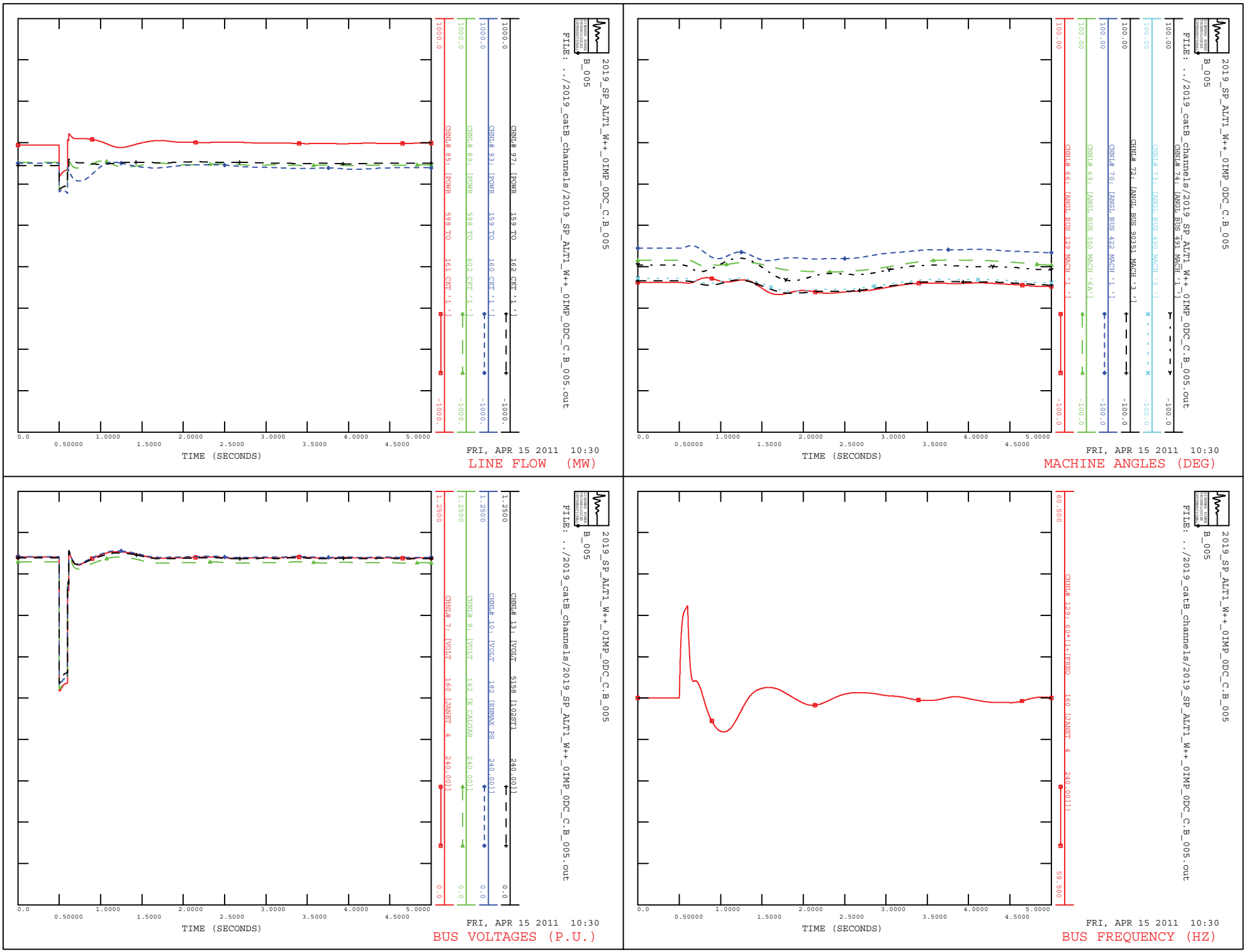


Figure M-2019-Step4-Sc4-1

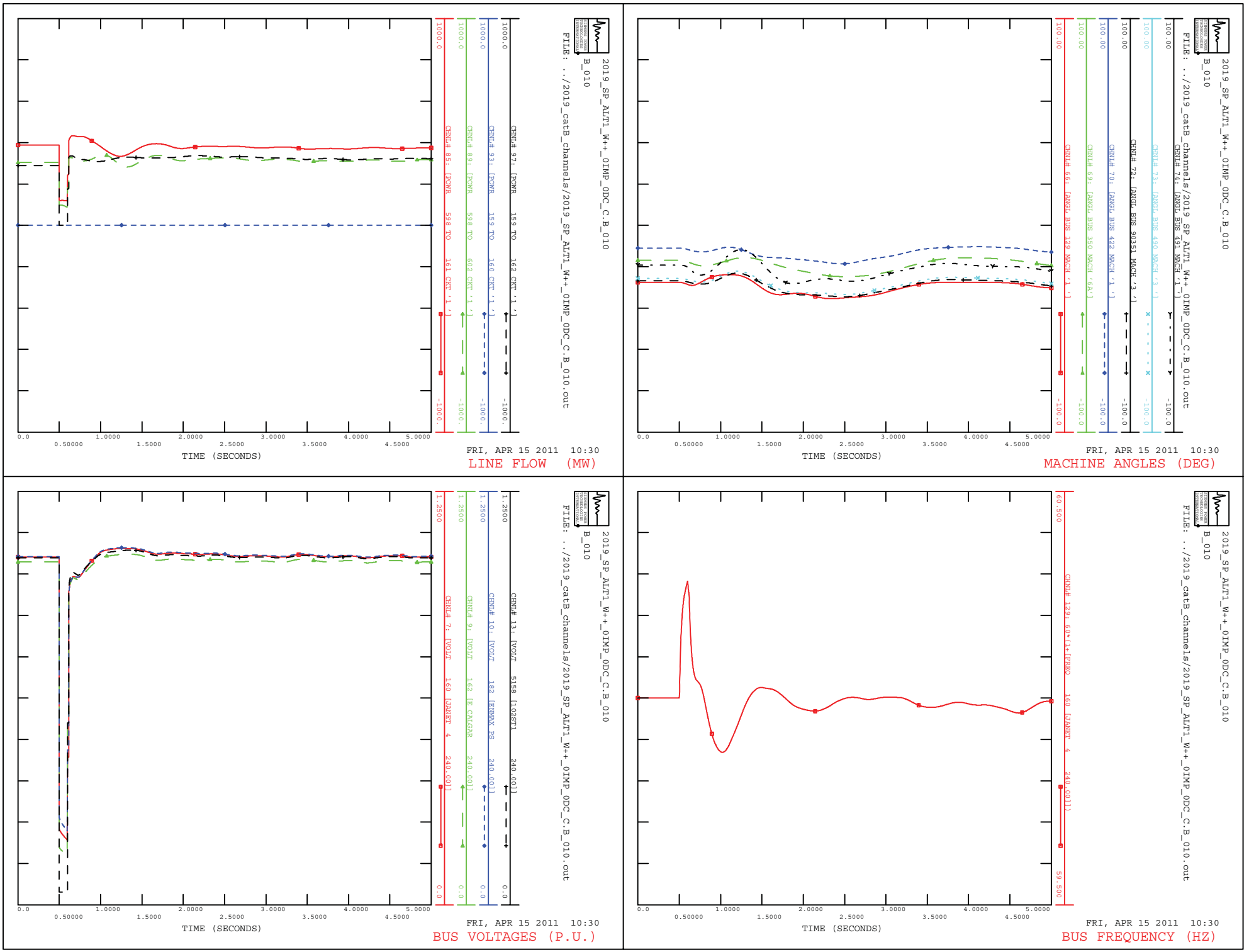


Figure M-2019-Step4-Sc4-2

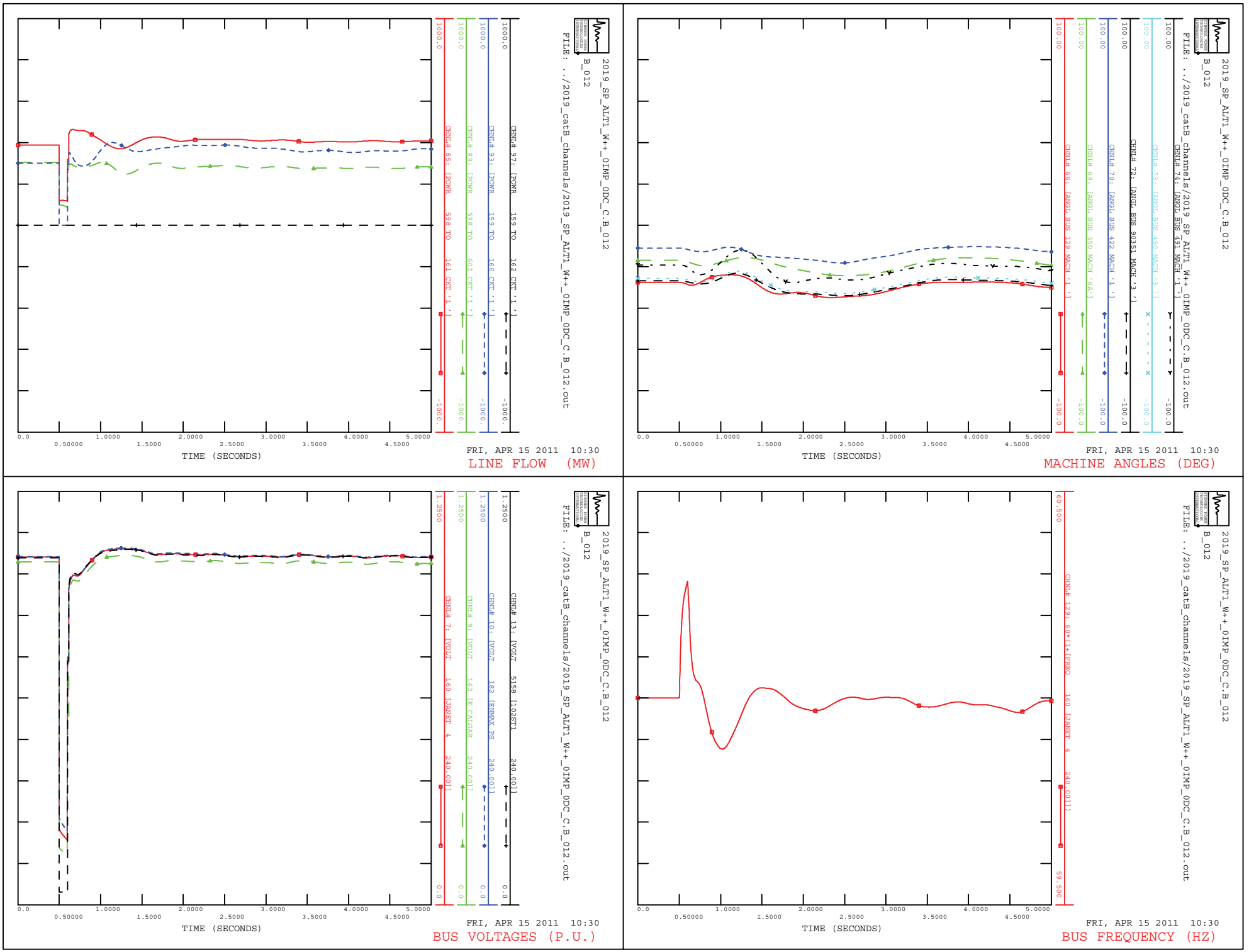


Figure M-2019-Step4-Sc4-3

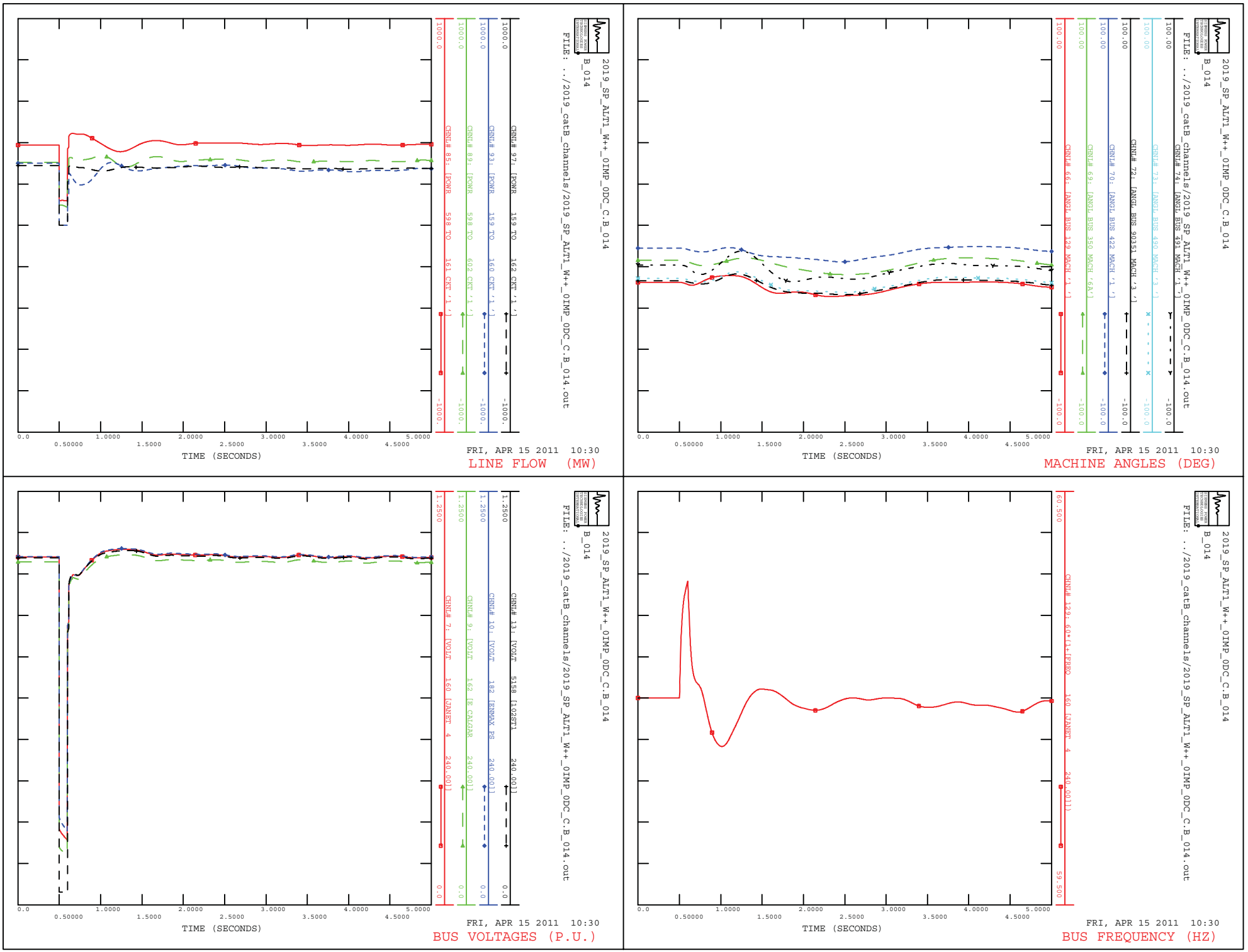


Figure M-2019-Step4-Sc4-4

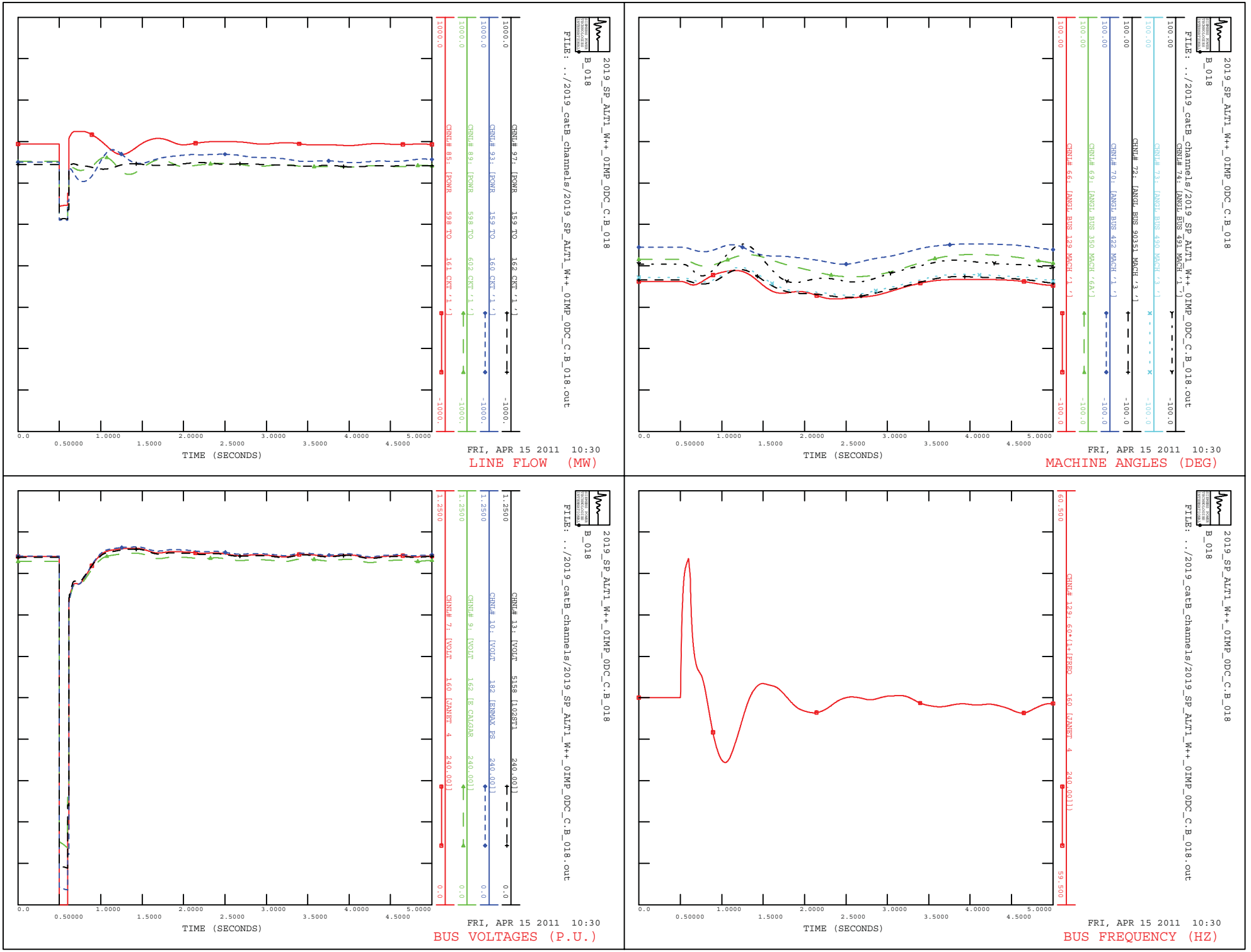


Figure M-2019-Step4-Sc4-5

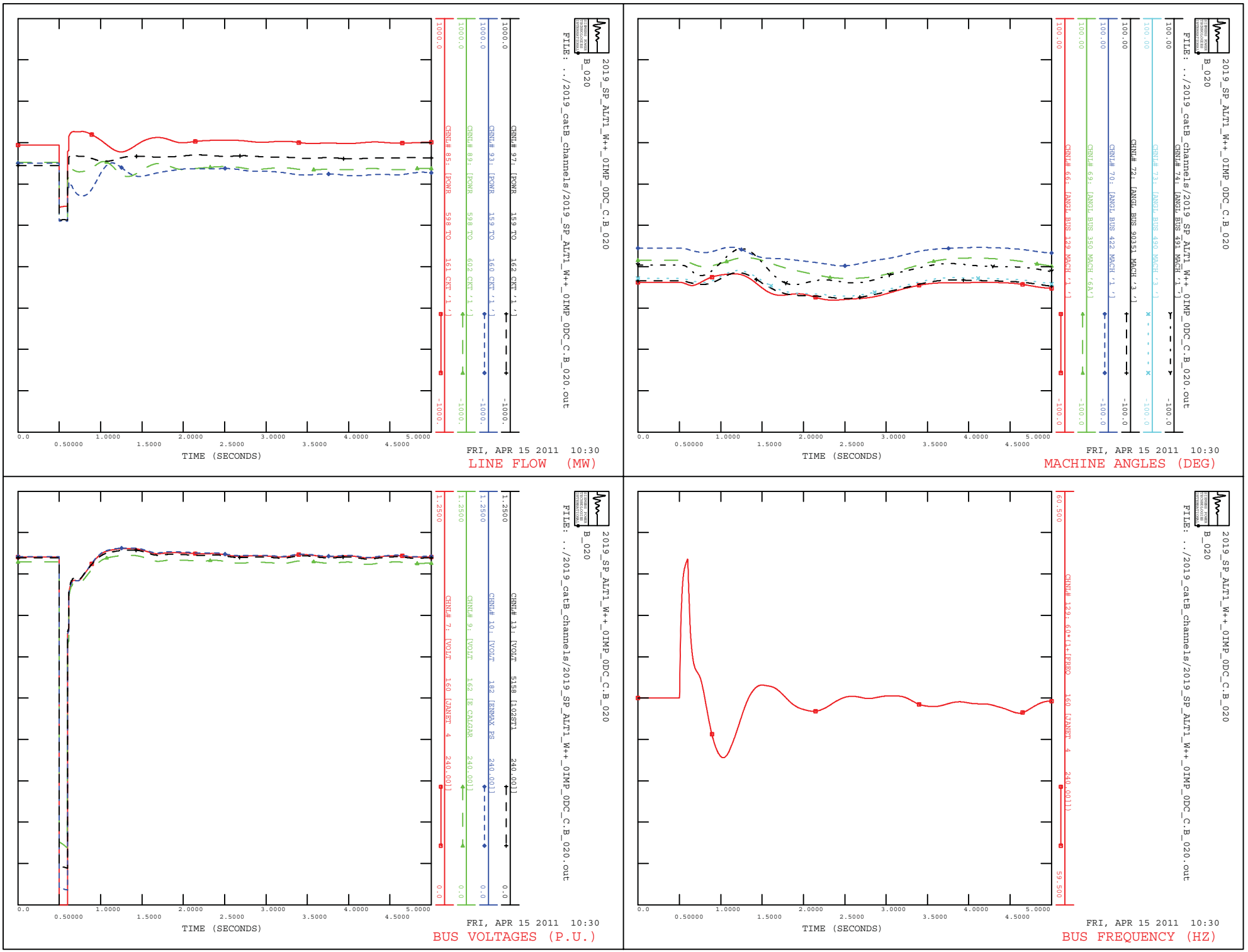


Figure M-2019-Step4-Sc4-6

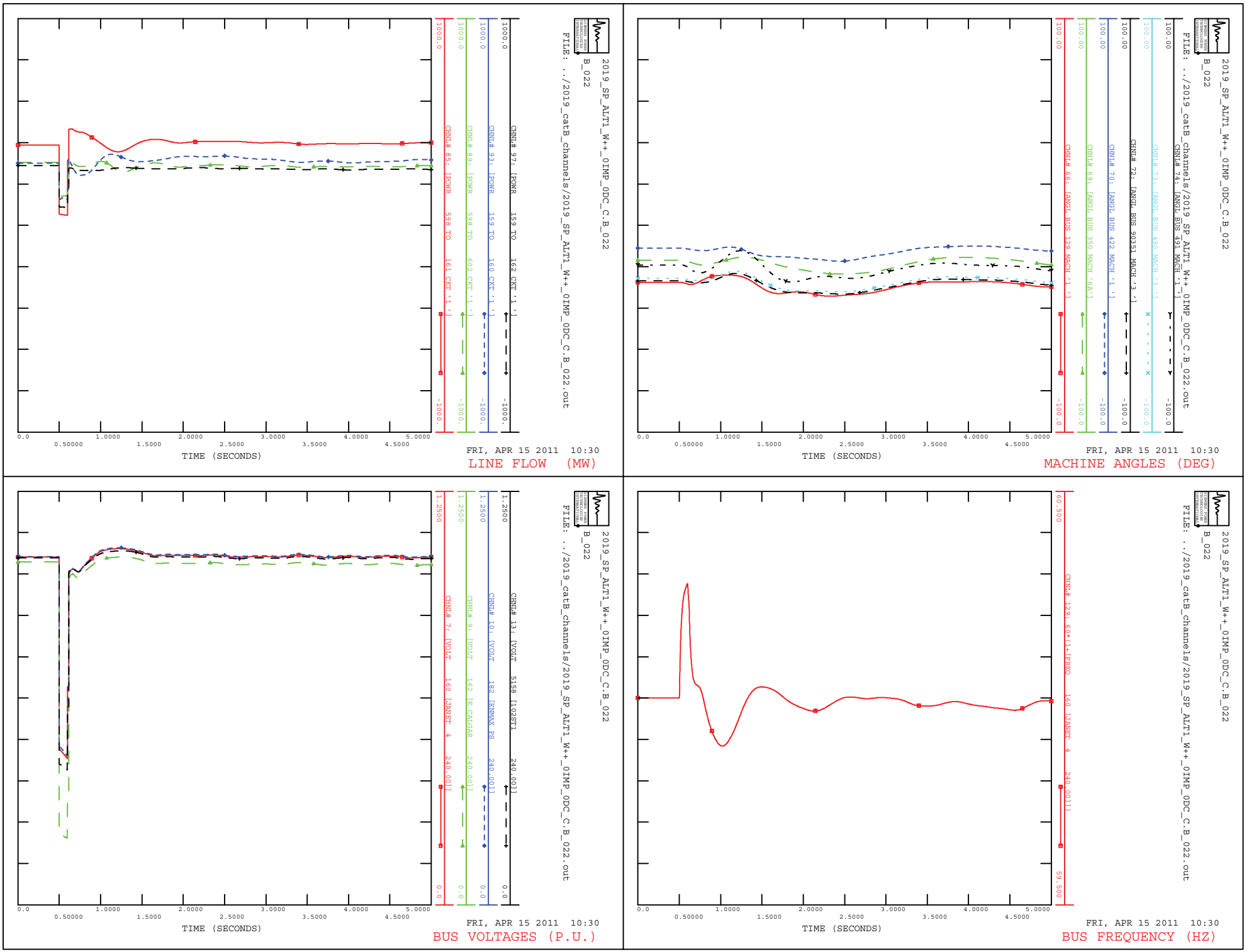


Figure M-2019-Step4-Sc4-7

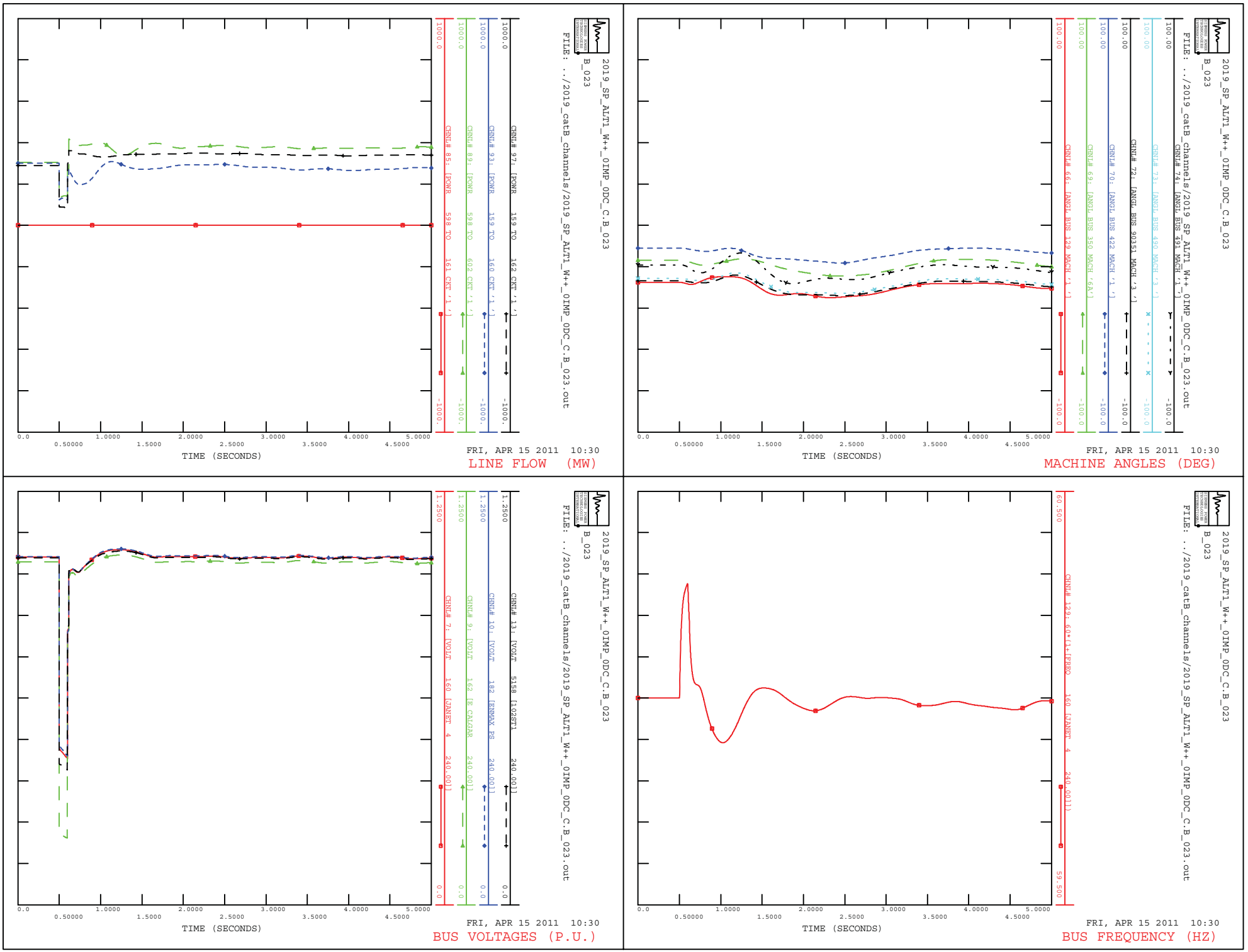


Figure M-2019-Step4-Sc4-8

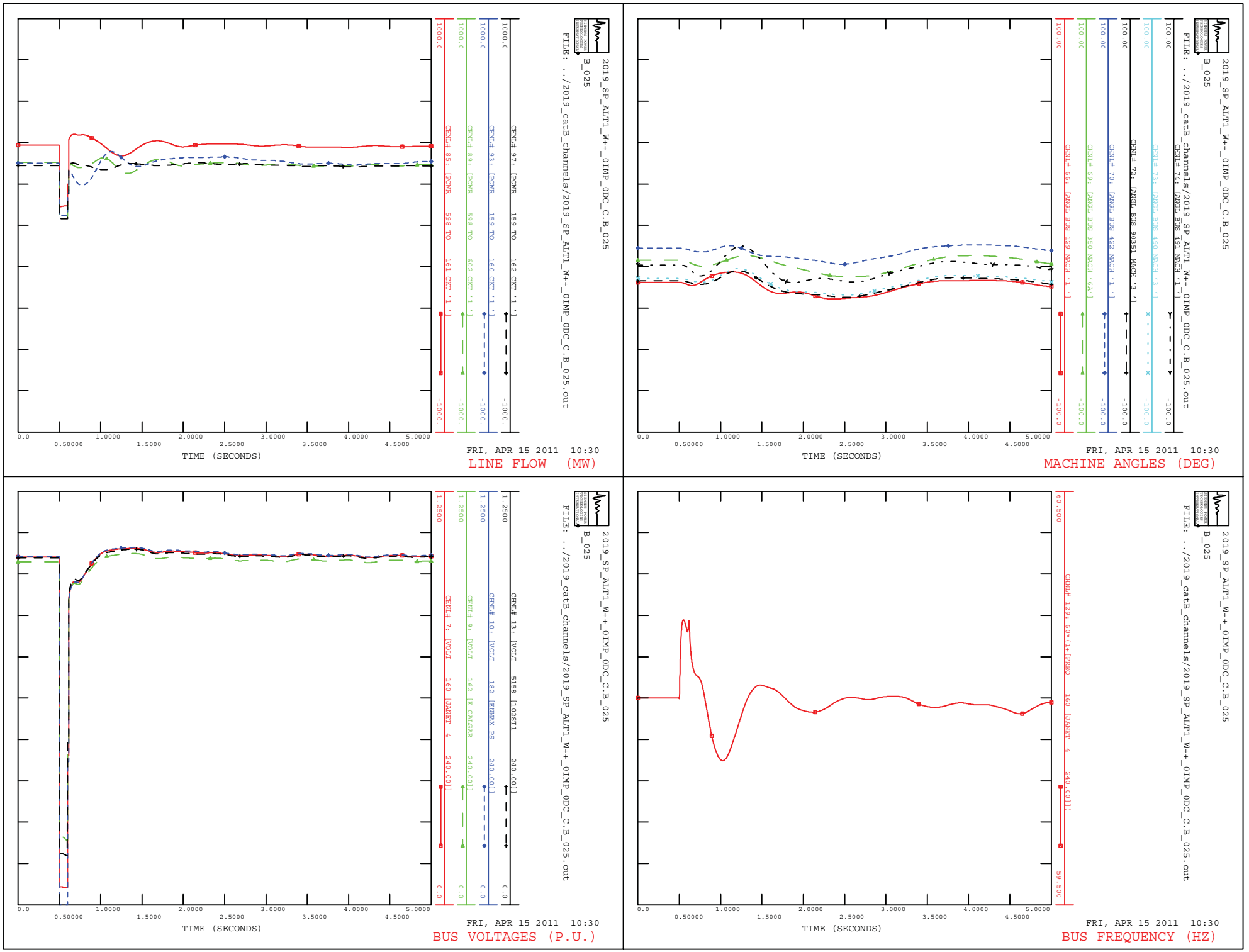


Figure M-2019-Step4-Sc4-9

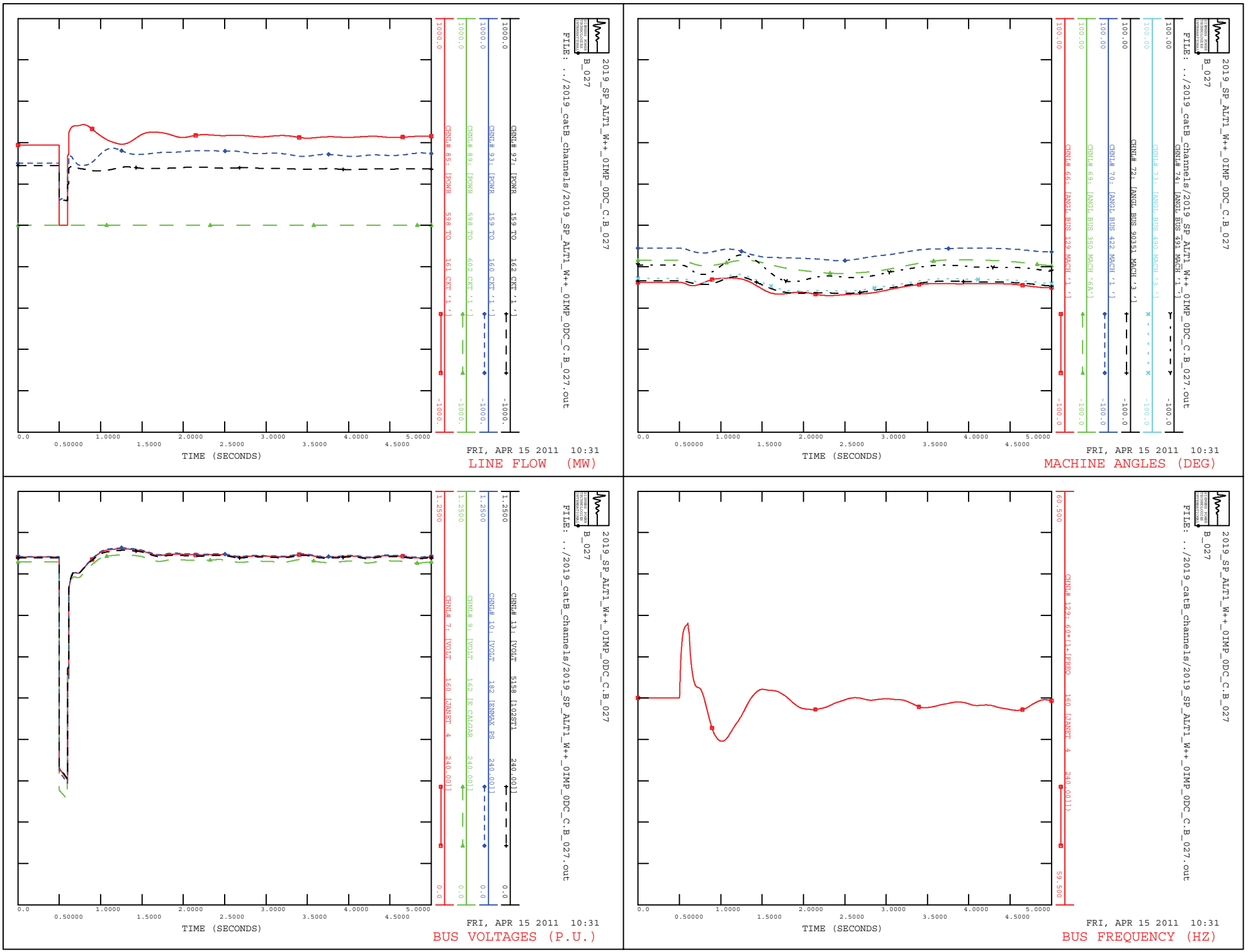


Figure M-2019-Step4-Sc4-10

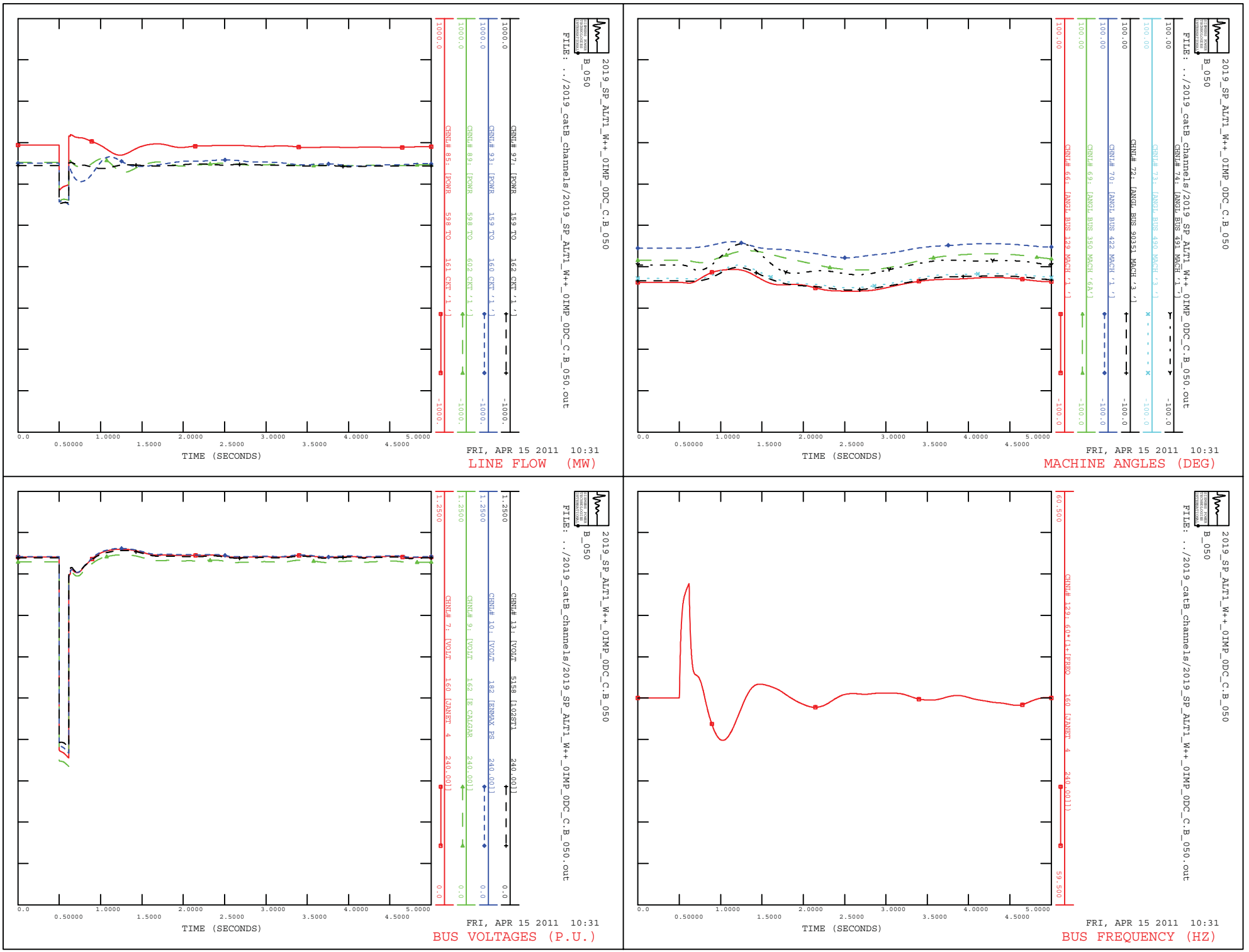


Figure M-2019-Step4-Sc4-11

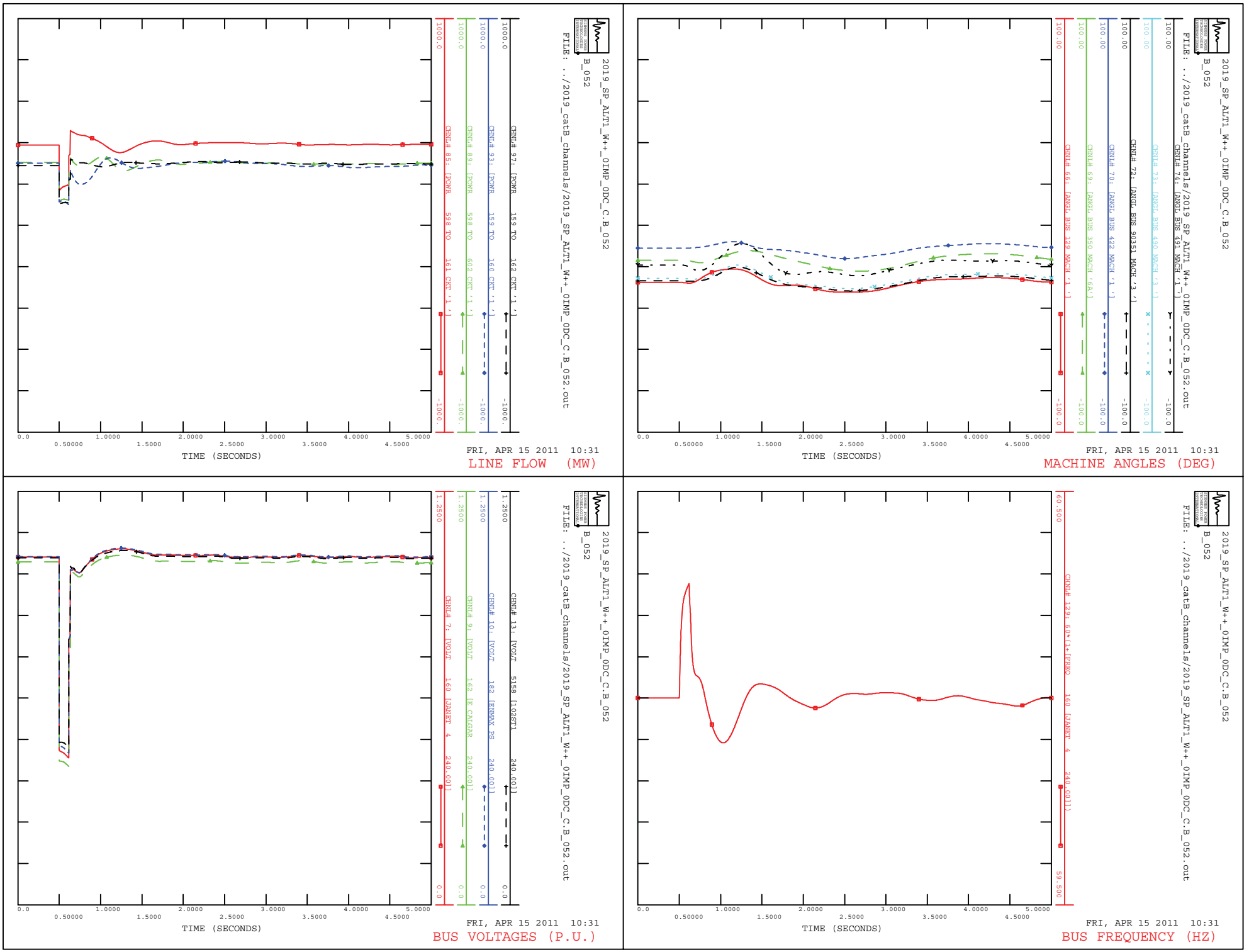


Figure M-2019-Step4-Sc4-12

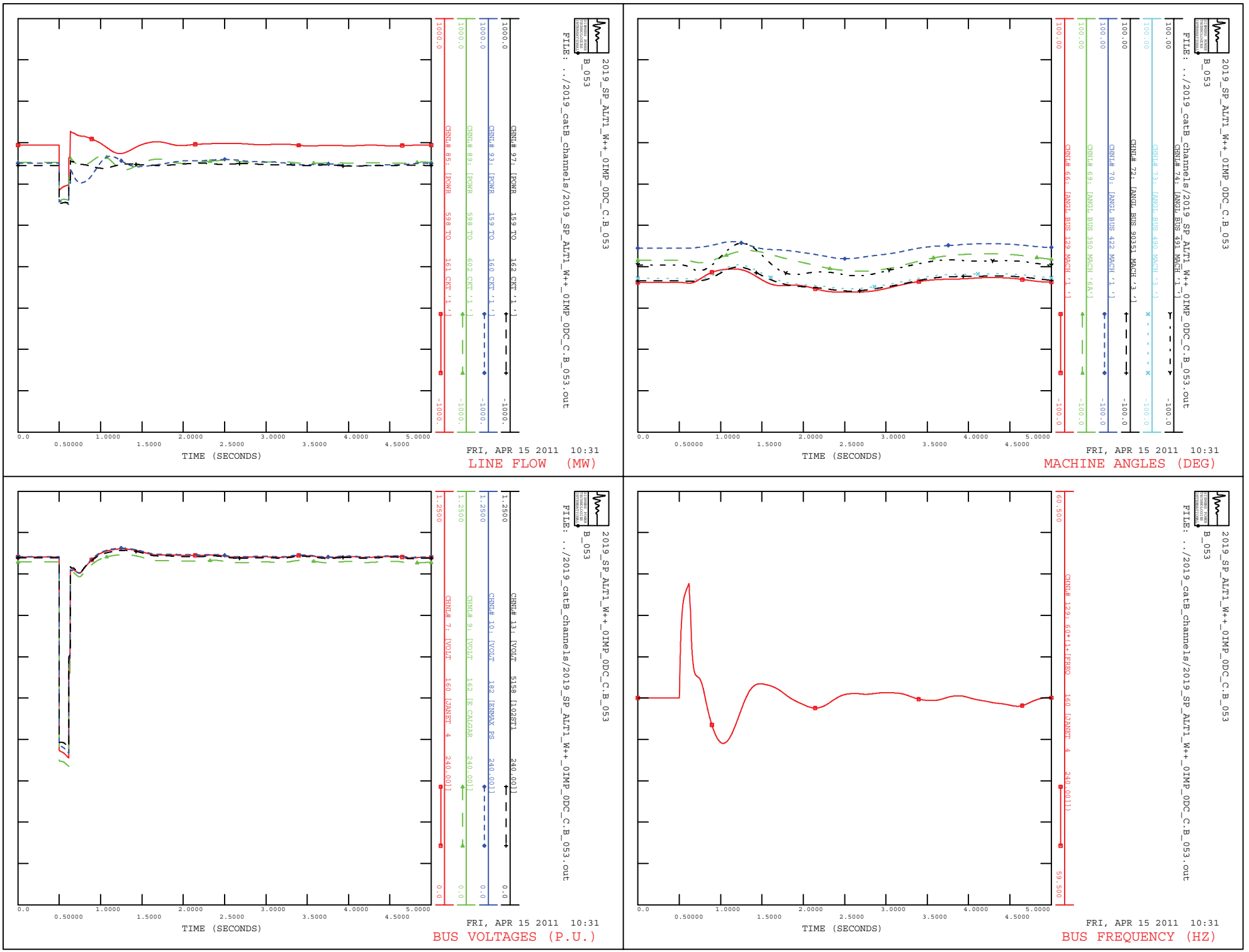


Figure M-2019-Step4-Sc4-13

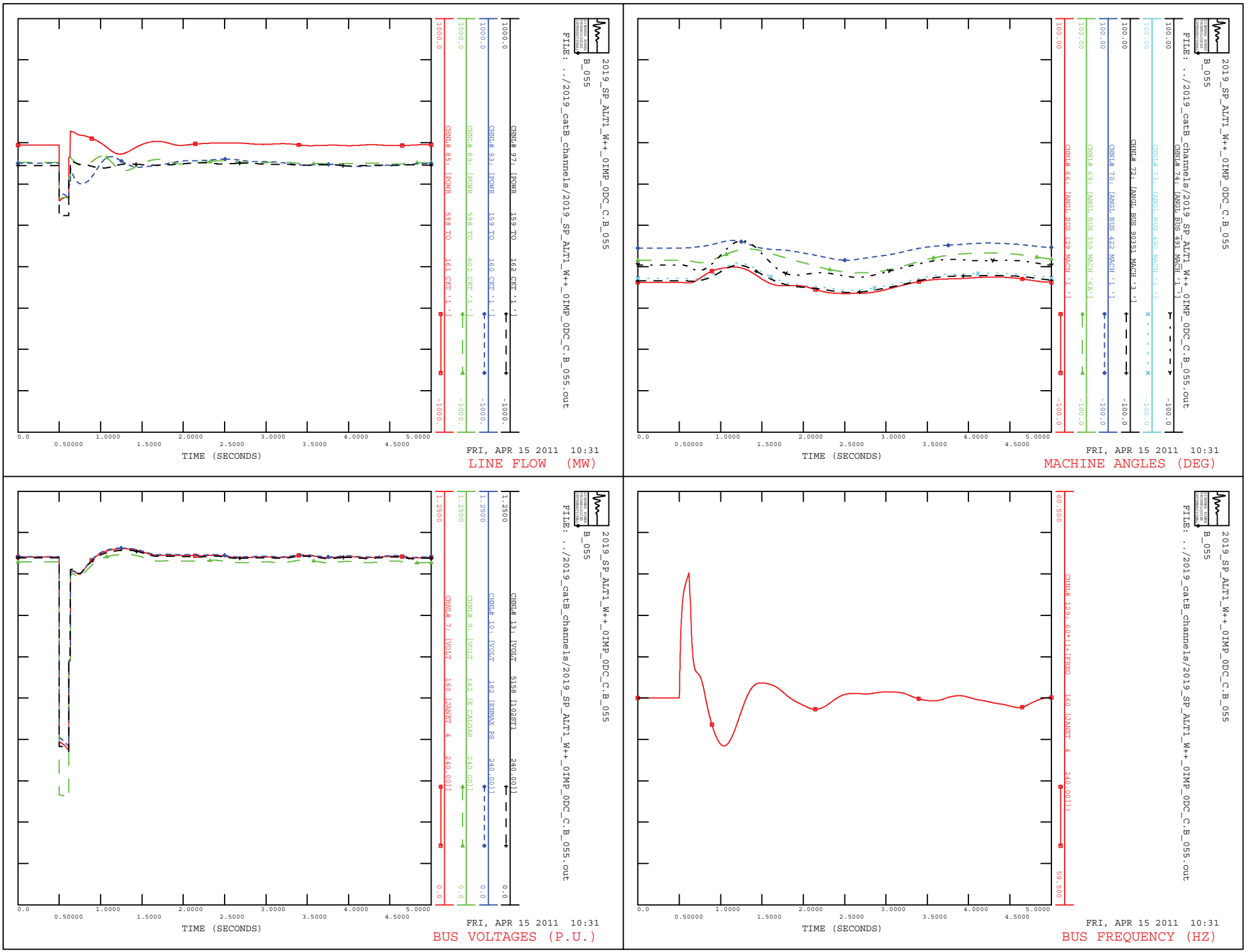


Figure M-2019-Step4-Sc4-14

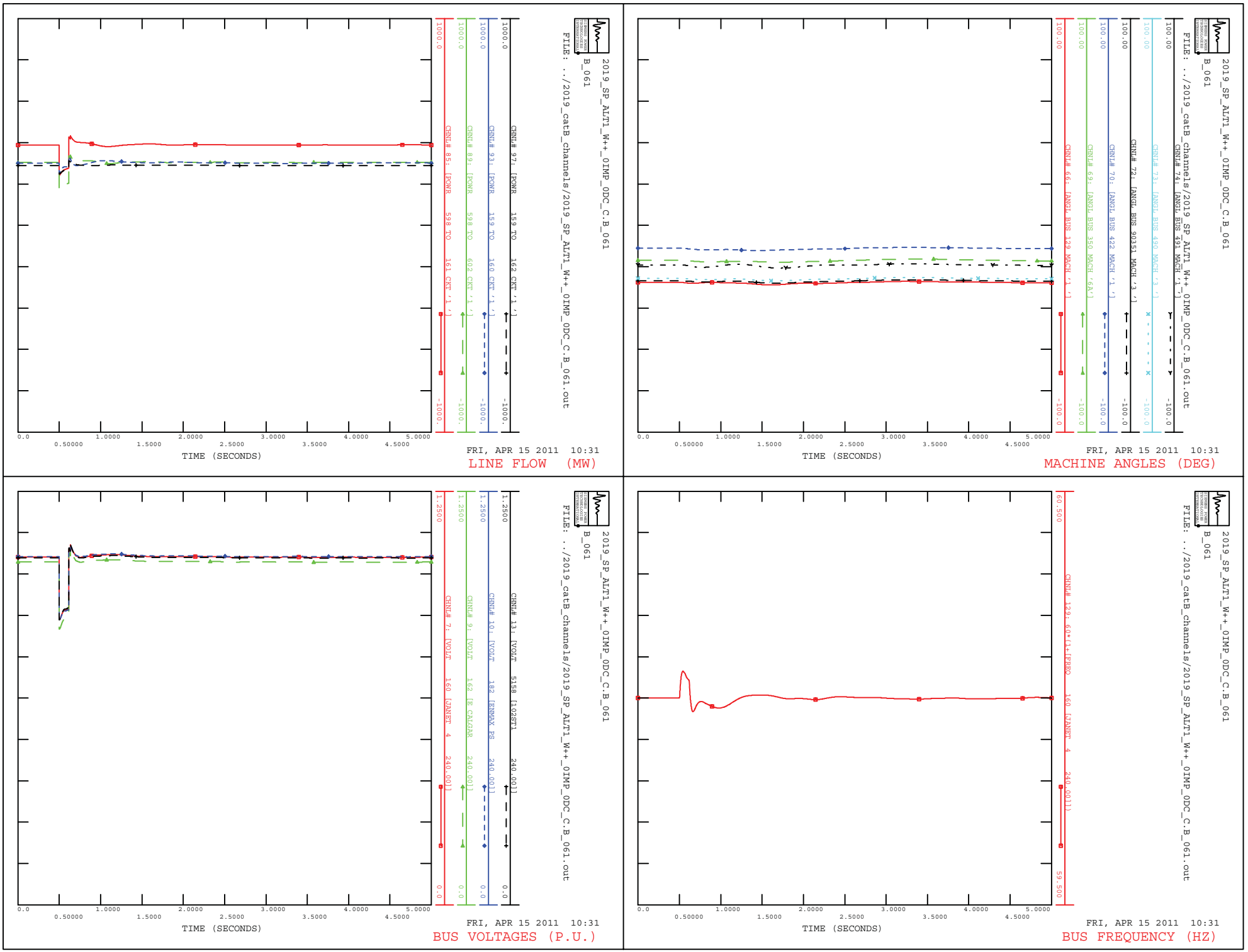


Figure M-2019-Step4-Sc4-15

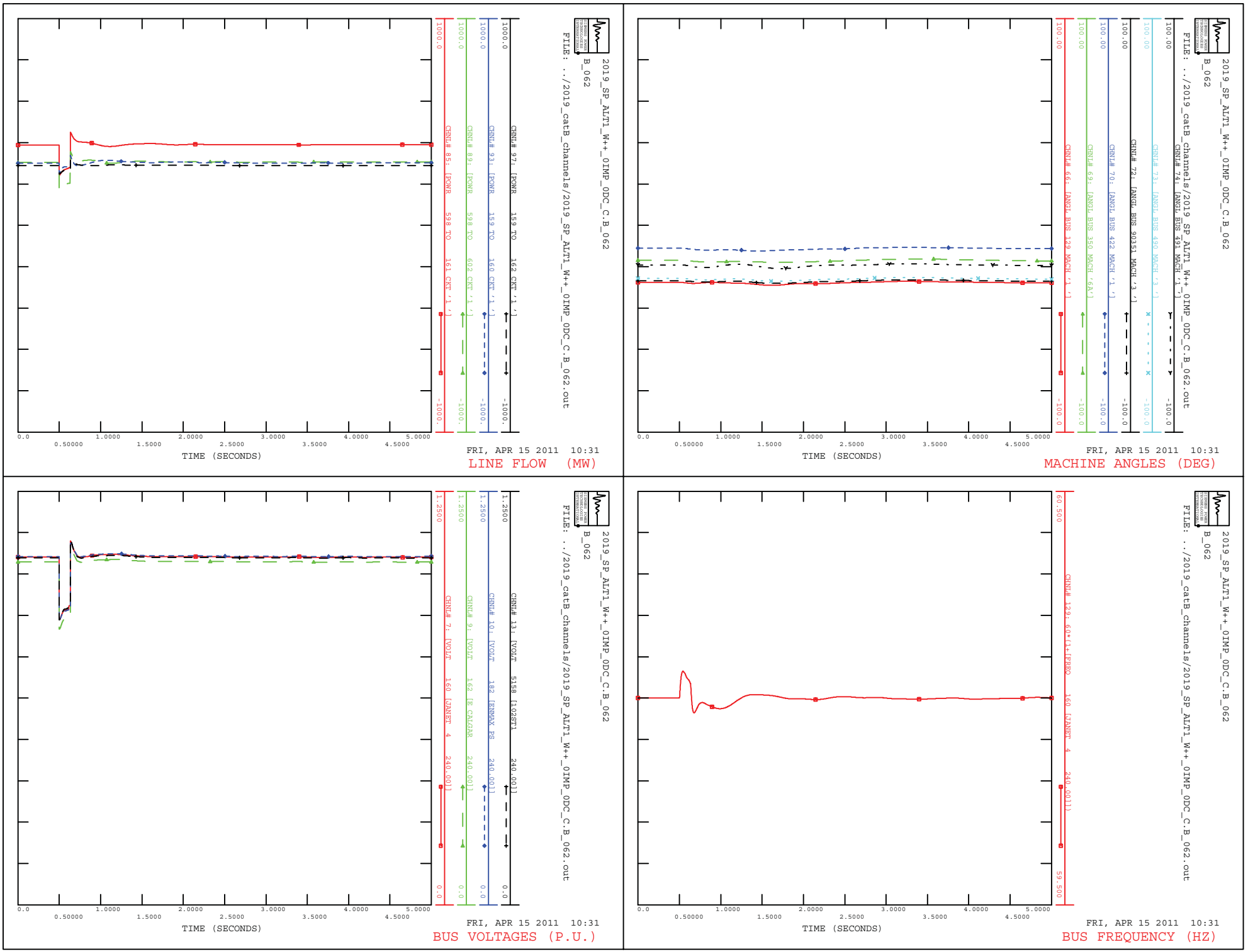


Figure M-2019-Step4-Sc4-16

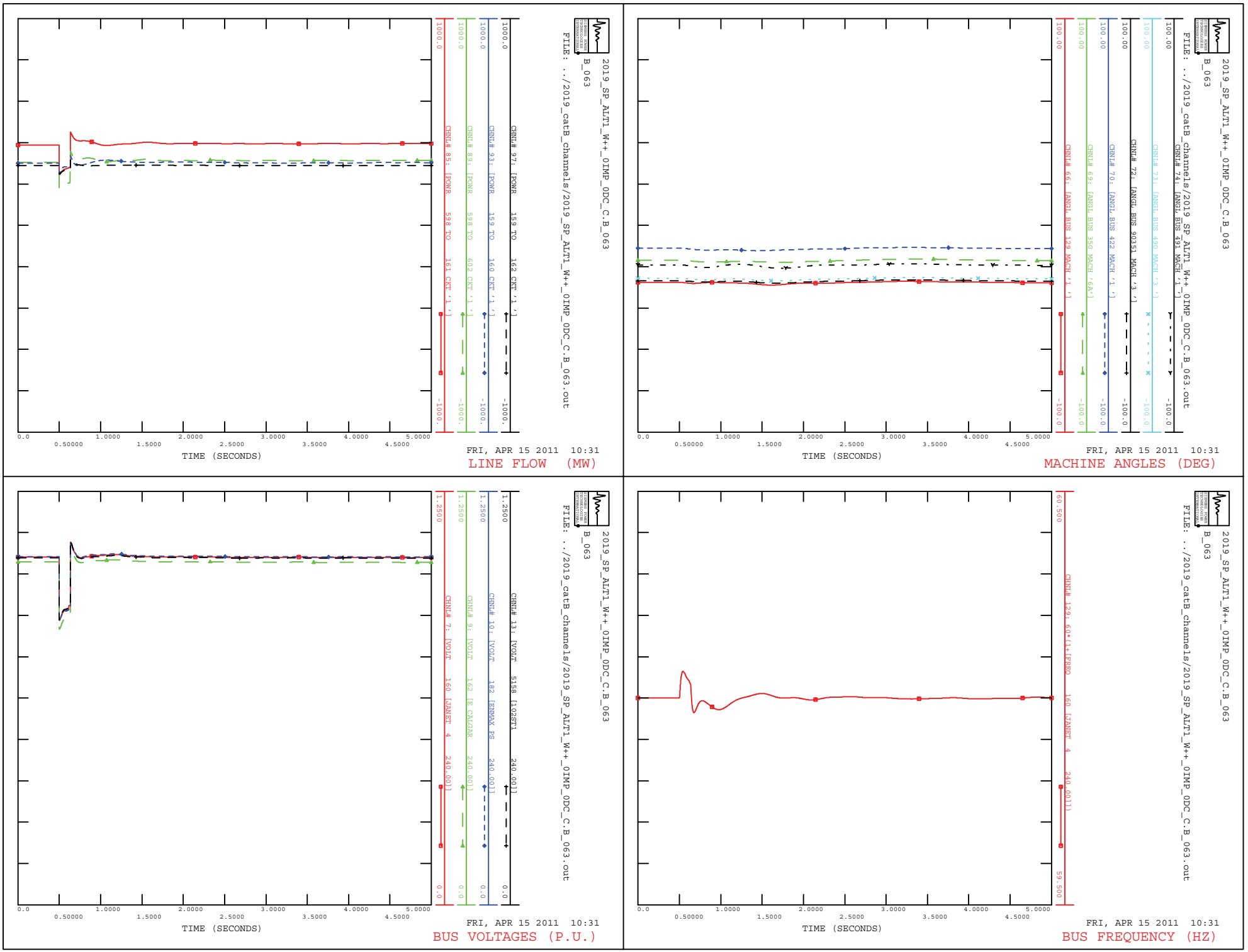


Figure M-2019-Step4-Sc4-17

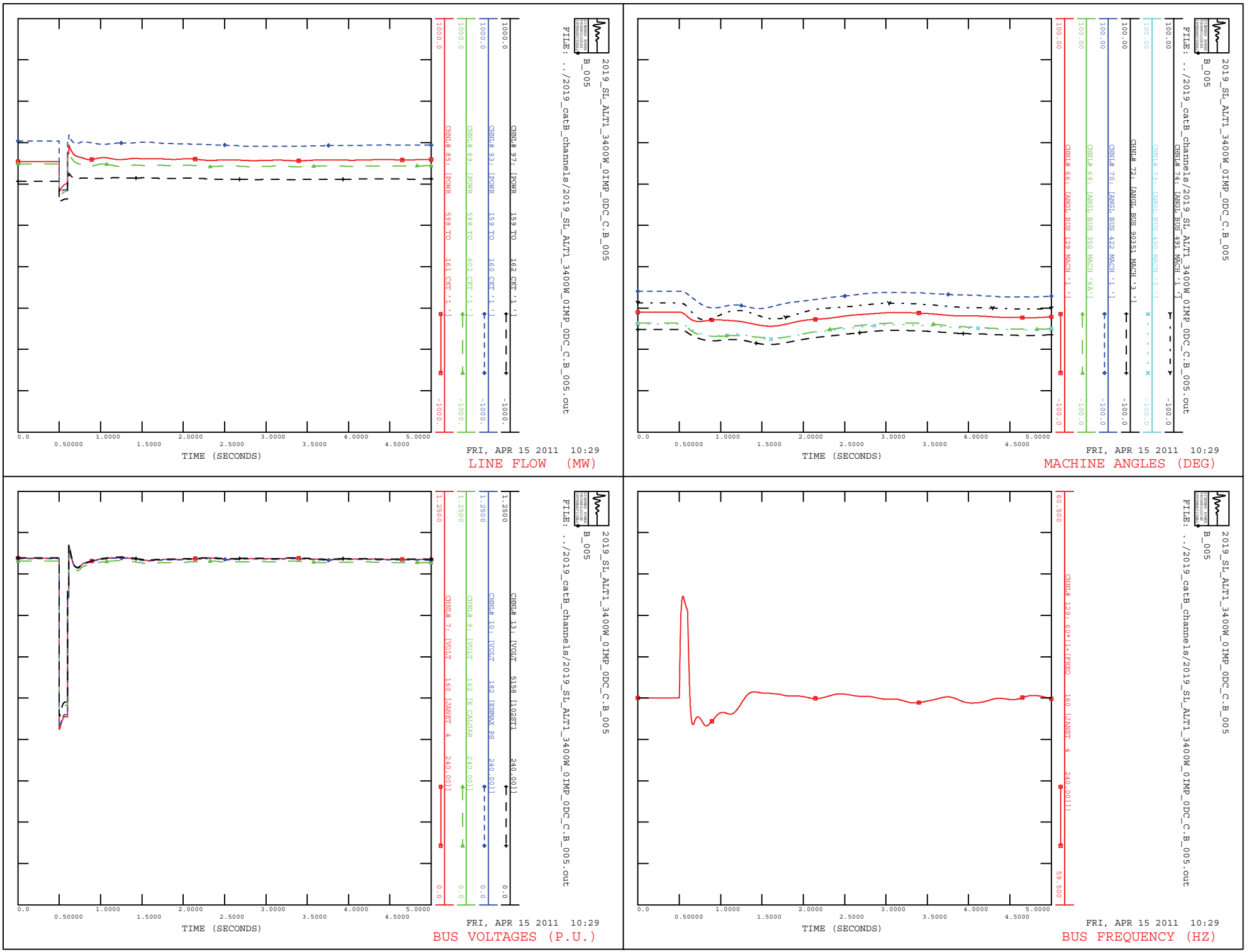


Figure M-2019-Step4-Sc6-1

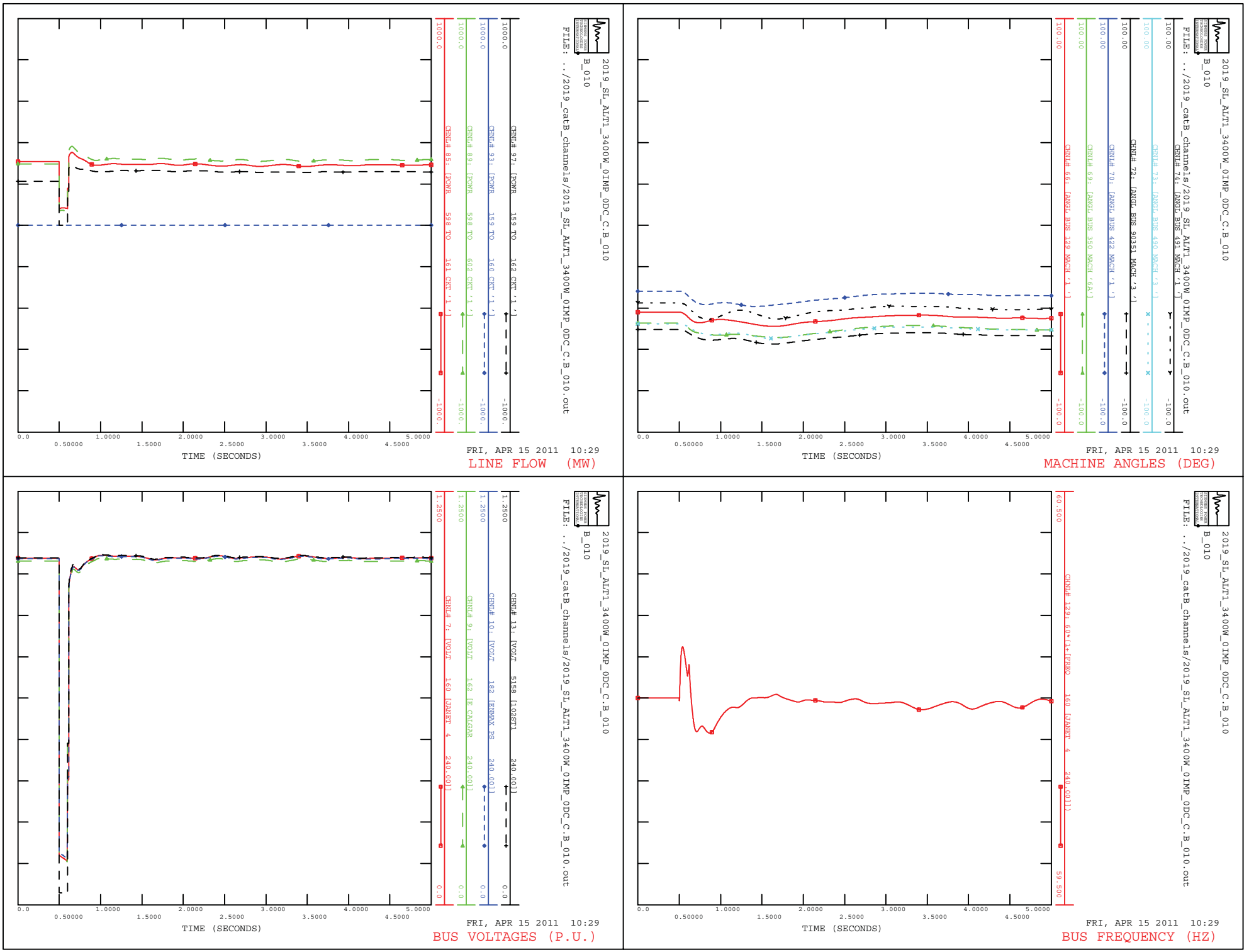


Figure M-2019-Step4-Sc6-2

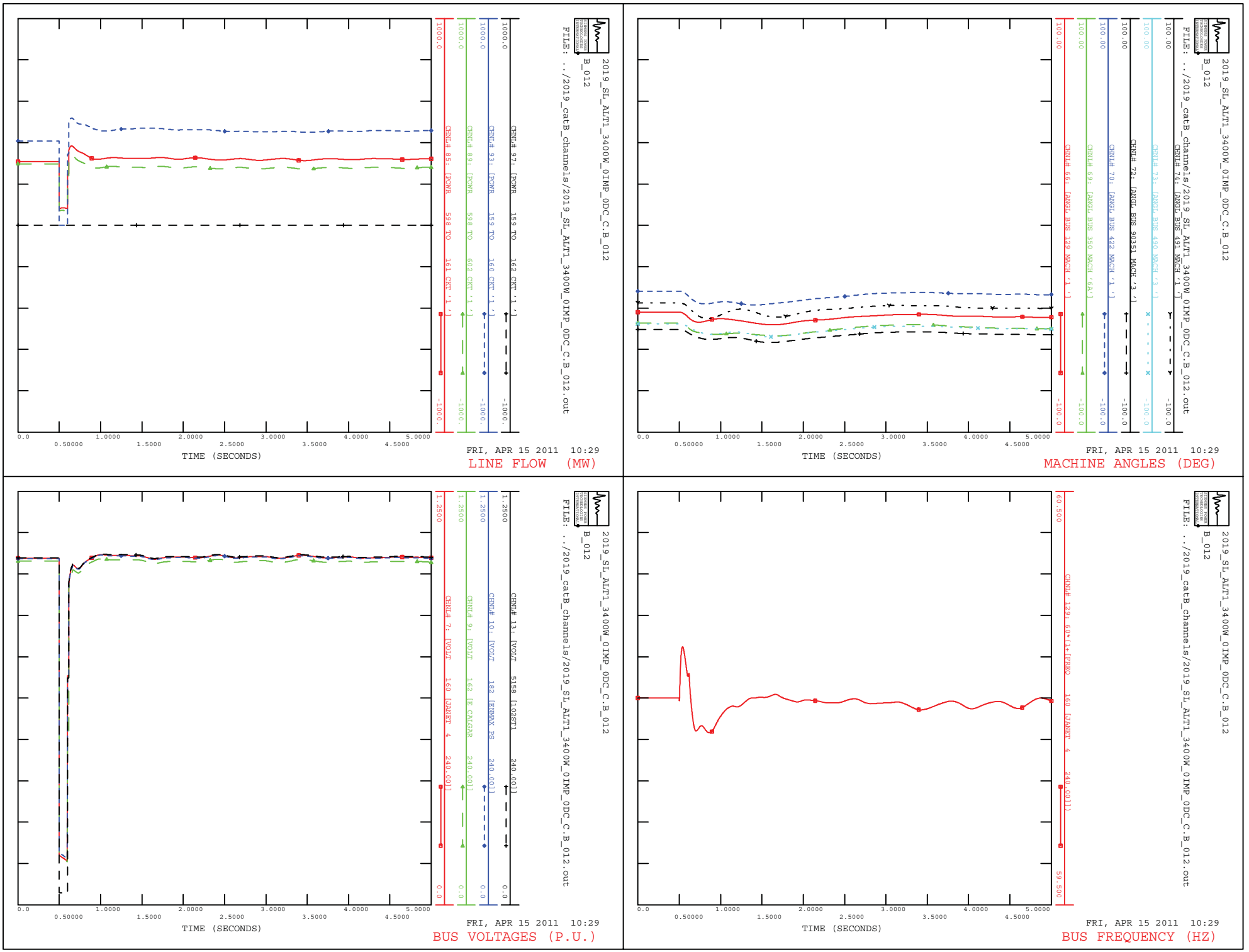


Figure M-2019-Step4-Sc6-3

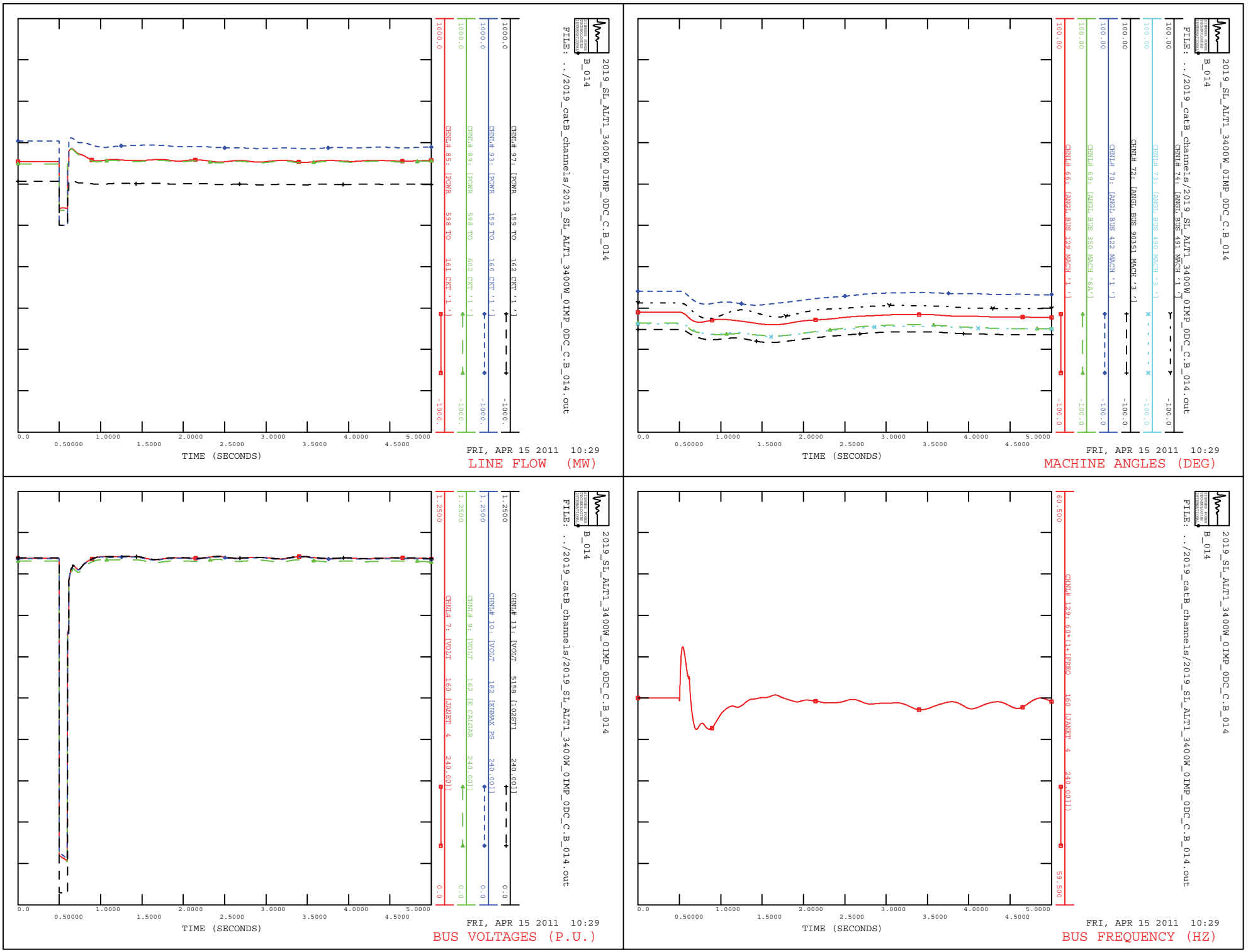


Figure M-2019-Step4-Sc6-4

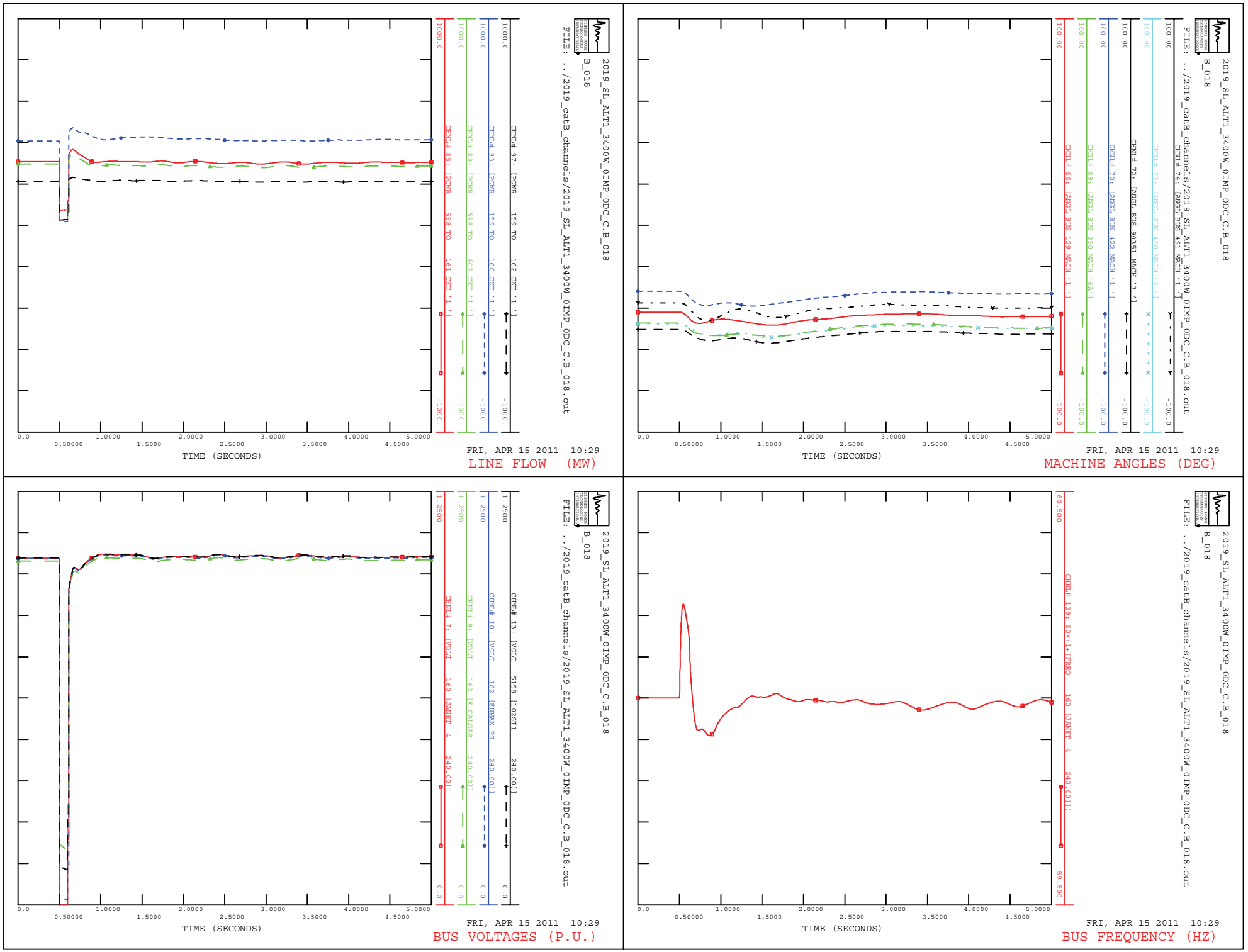


Figure M-2019-Step4-Sc6-5

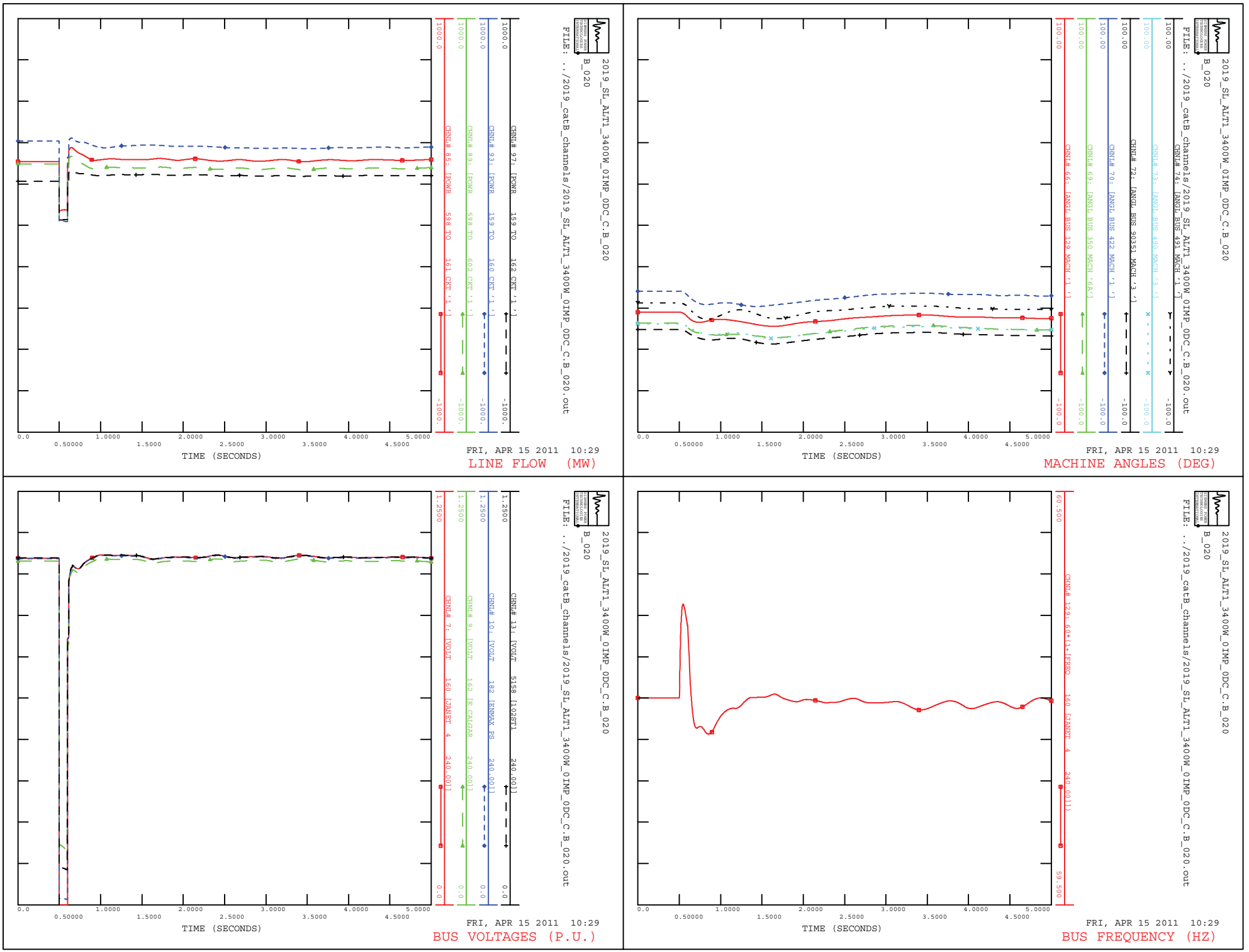


Figure M-2019-Step4-Sc6-6

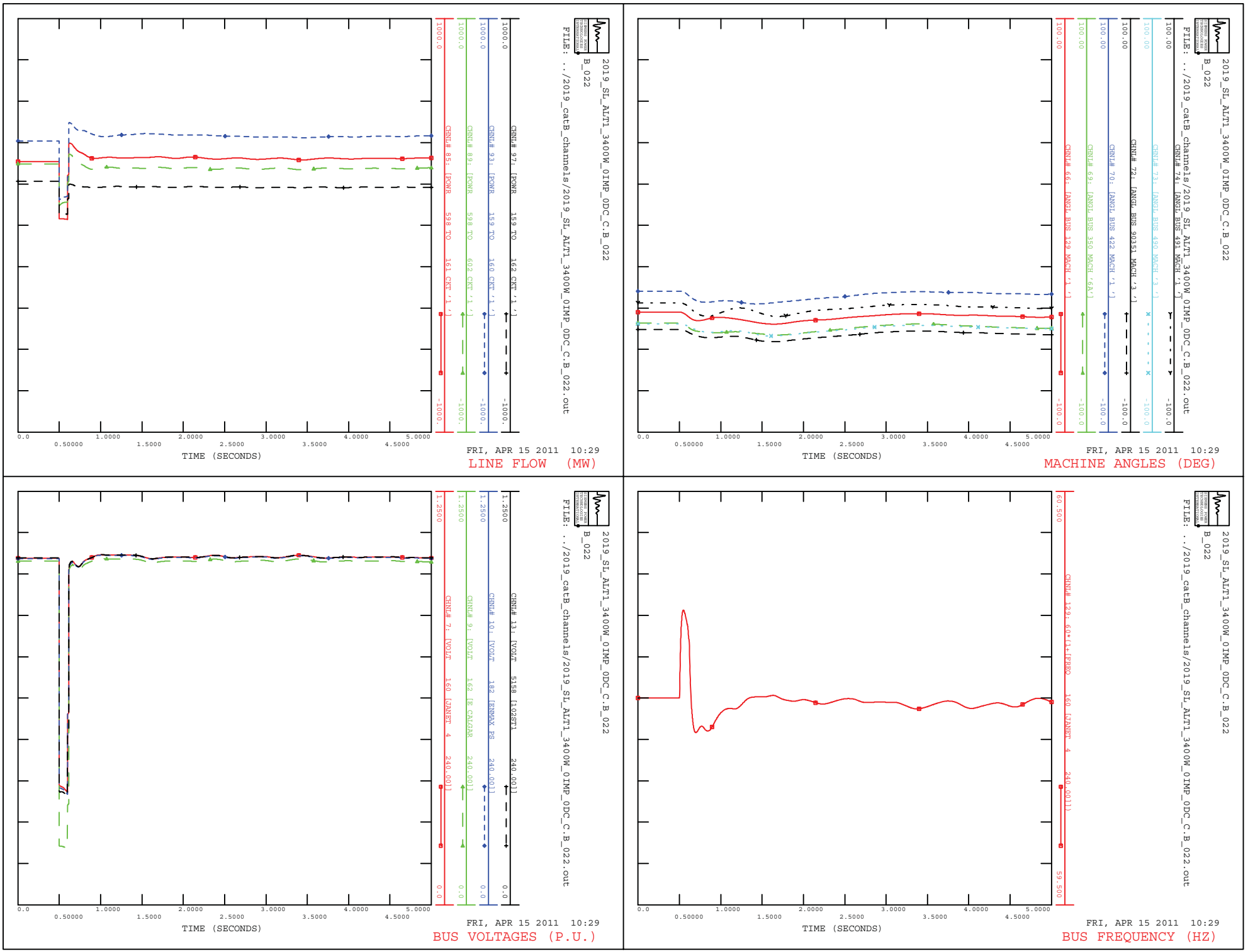


Figure M-2019-Step4-Sc6-7

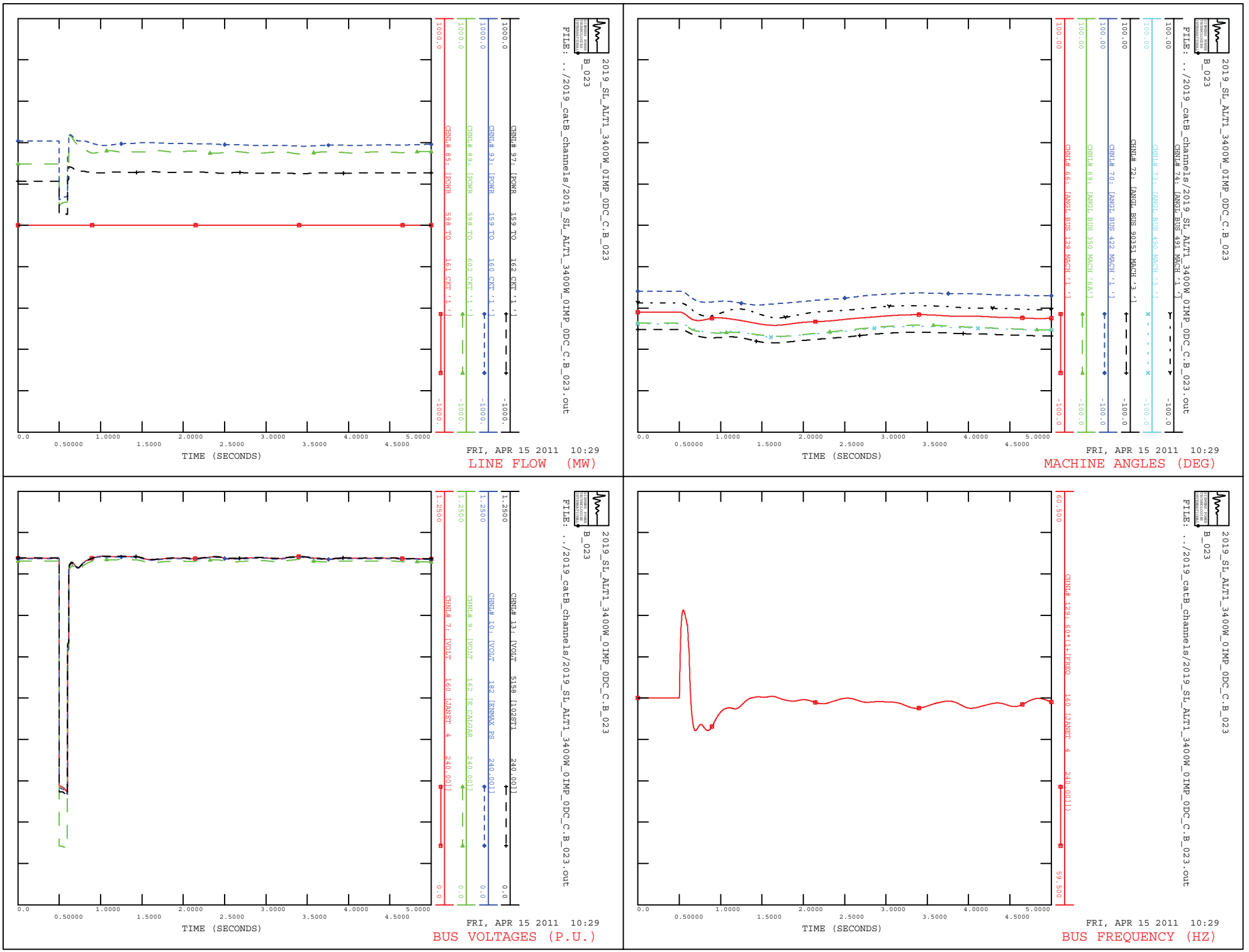


Figure M-2019-Step4-Sc6-8

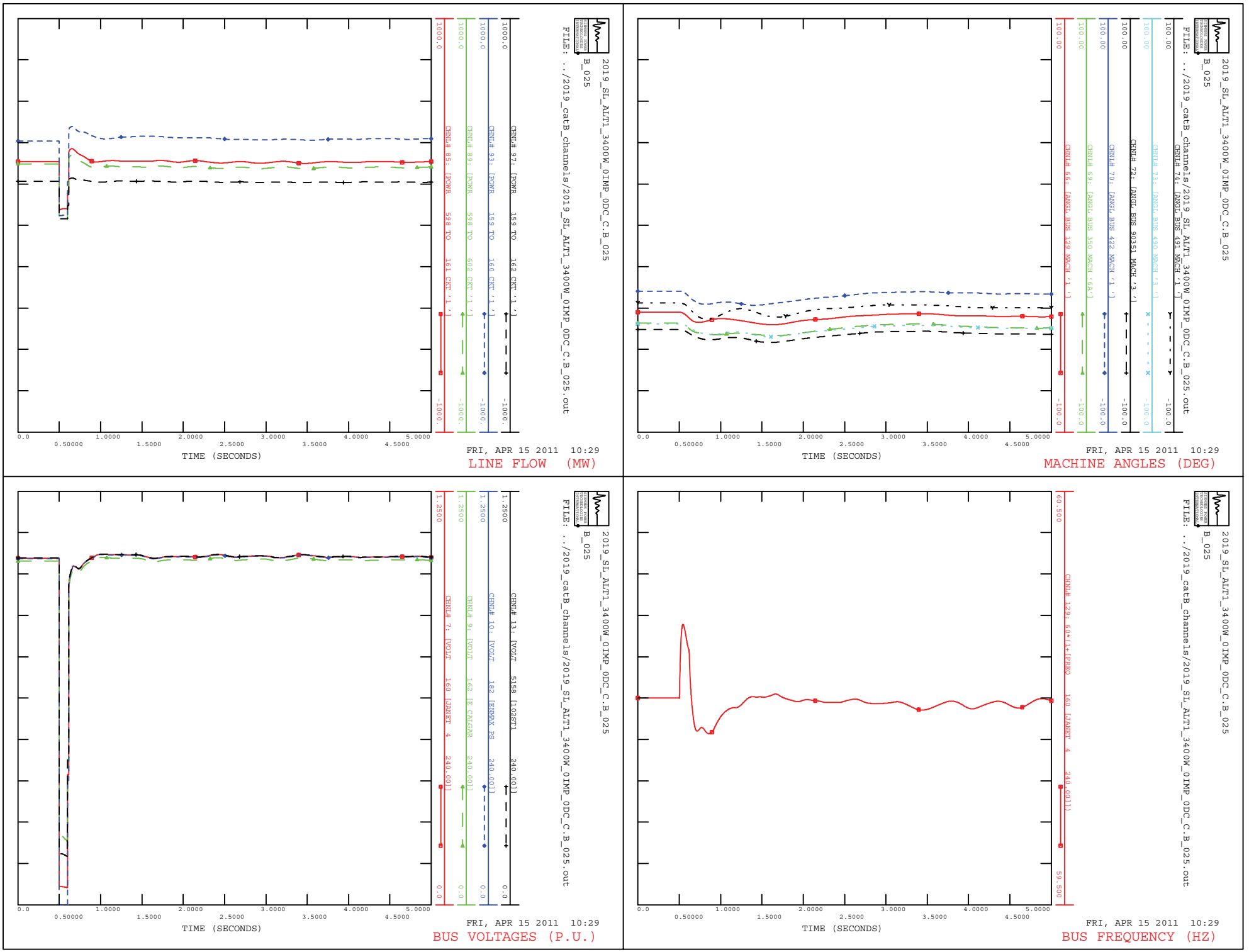


Figure M-2019-Step4-Sc6-9

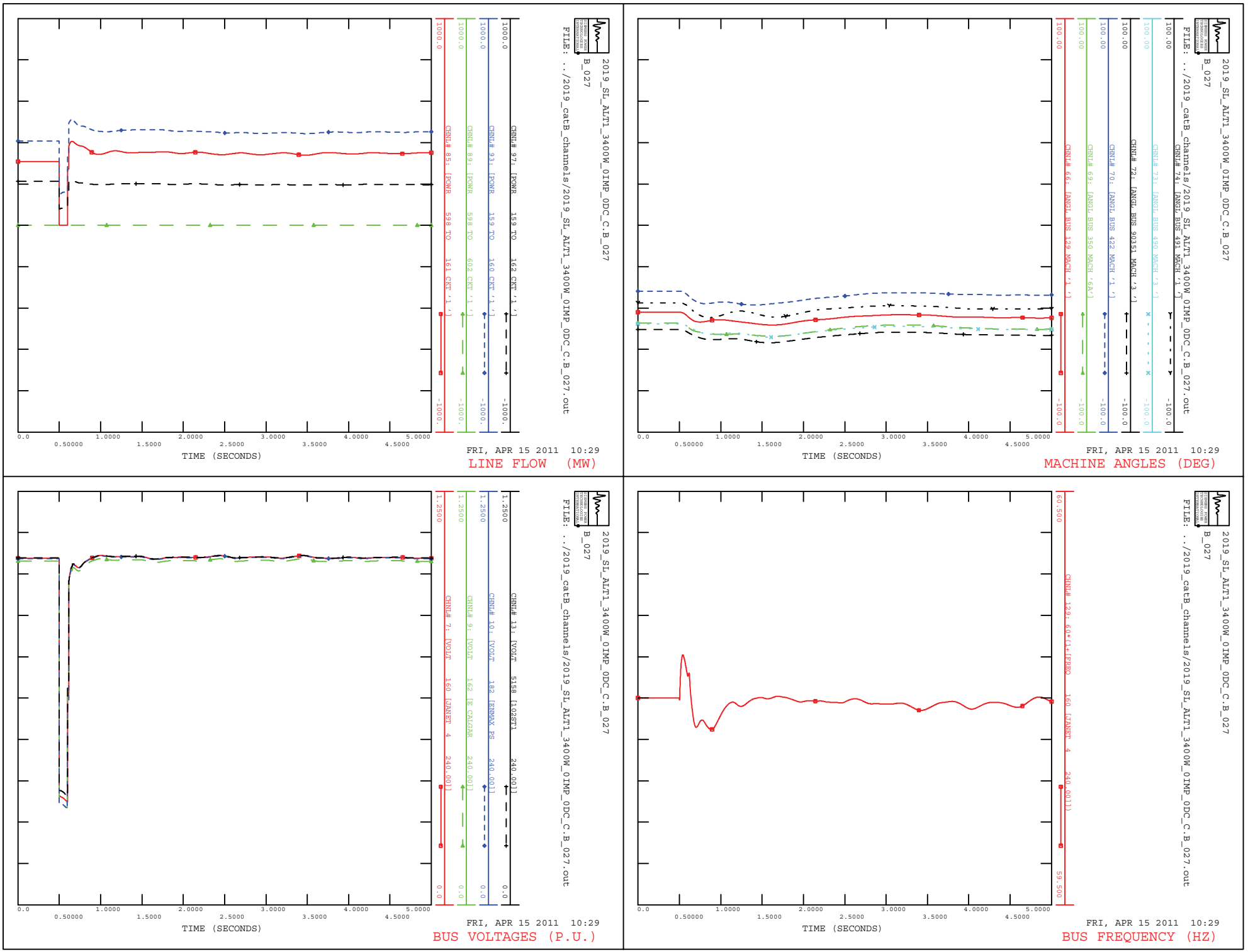


Figure M-2019-Step4-Sc6-10

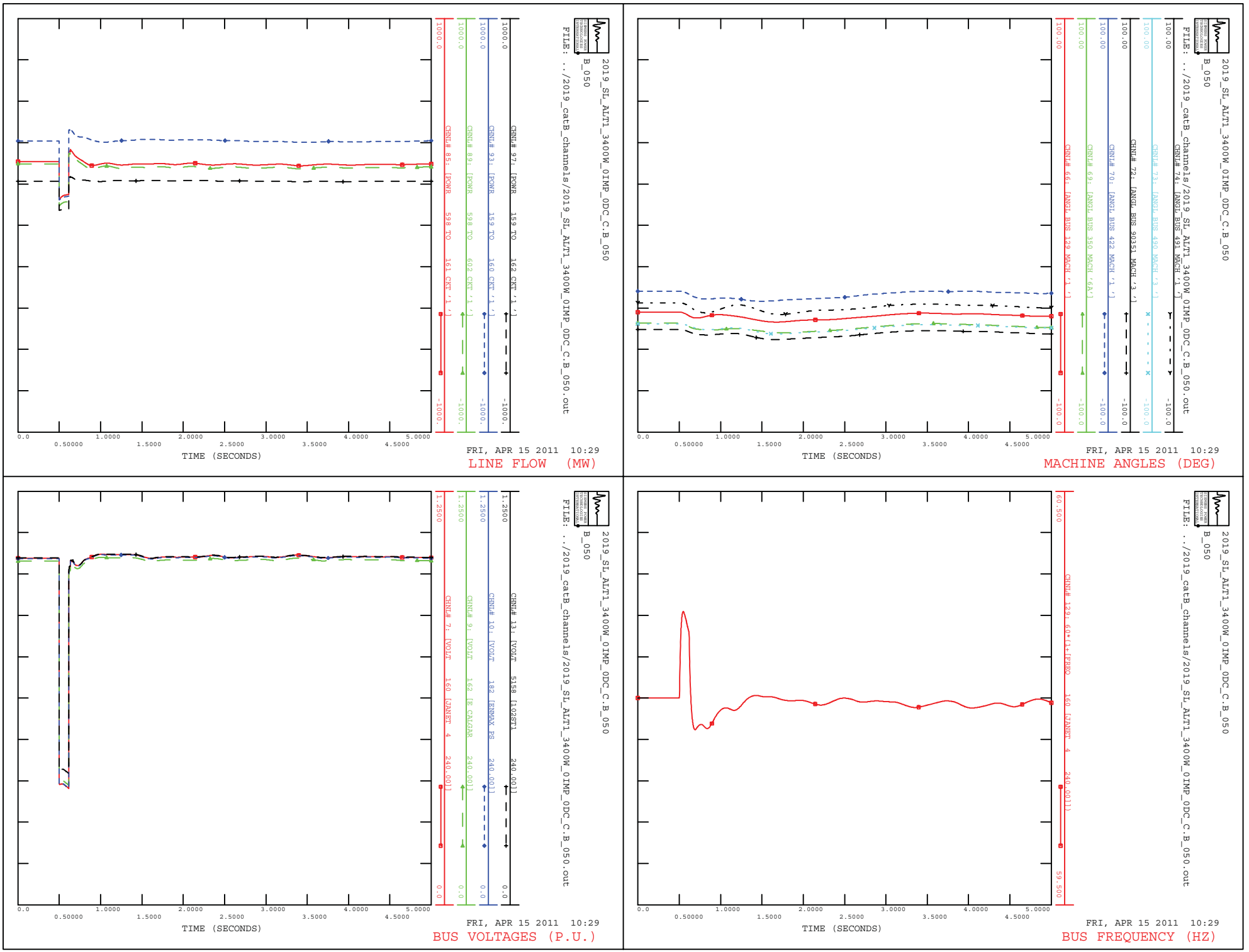


Figure M-2019-Step4-Sc6-11

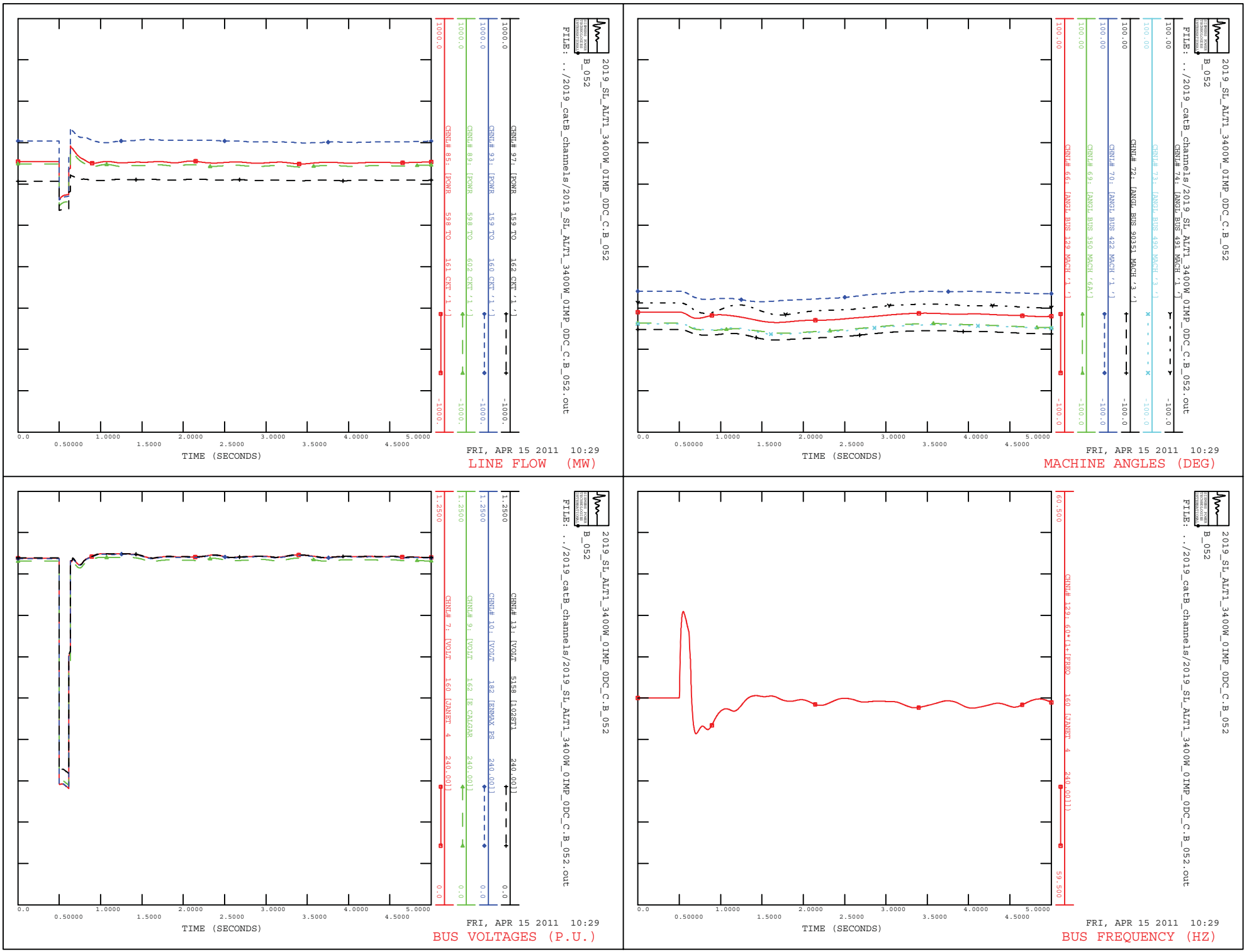


Figure M-2019-Step4-Sc6-12

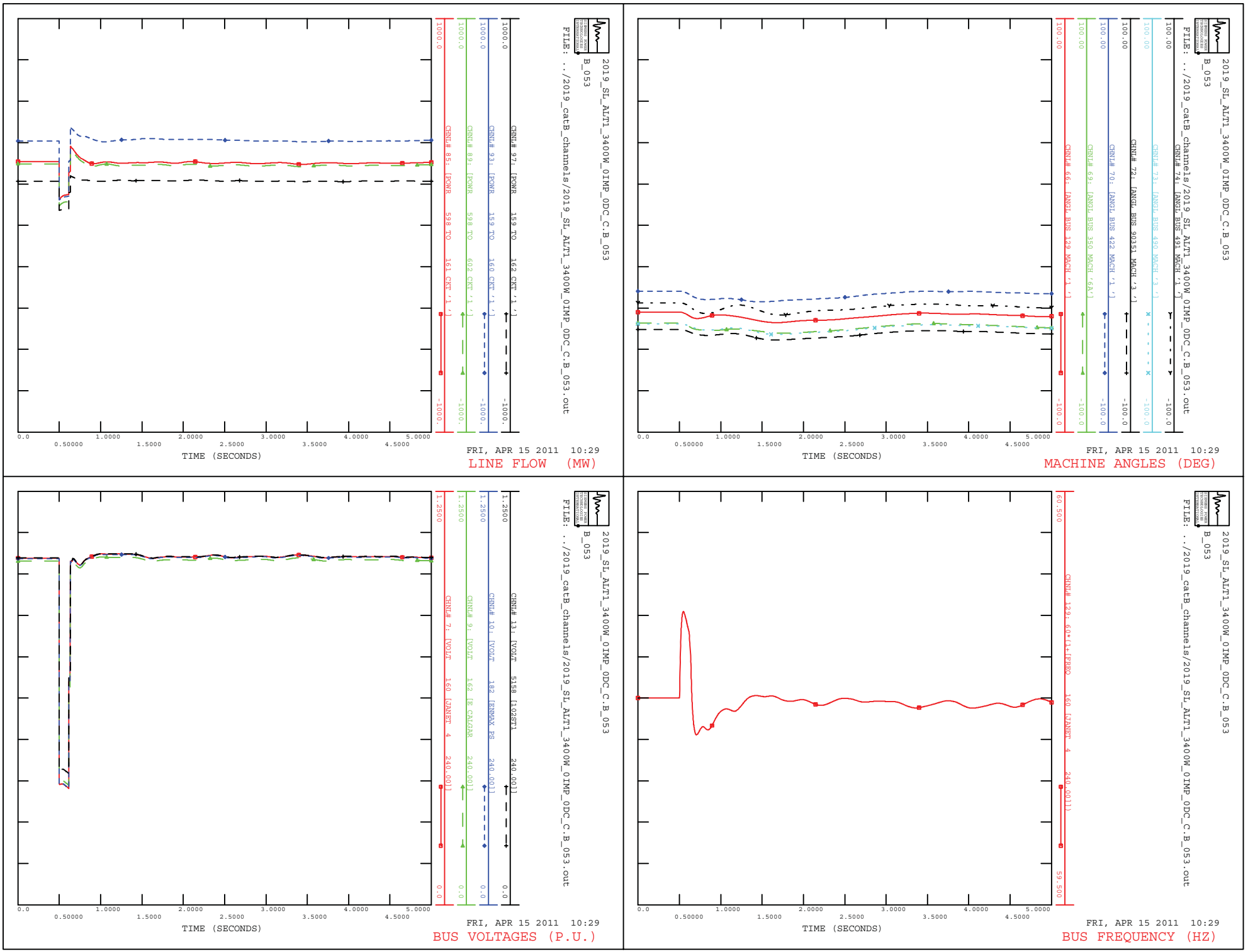


Figure M-2019-Step4-Sc6-13

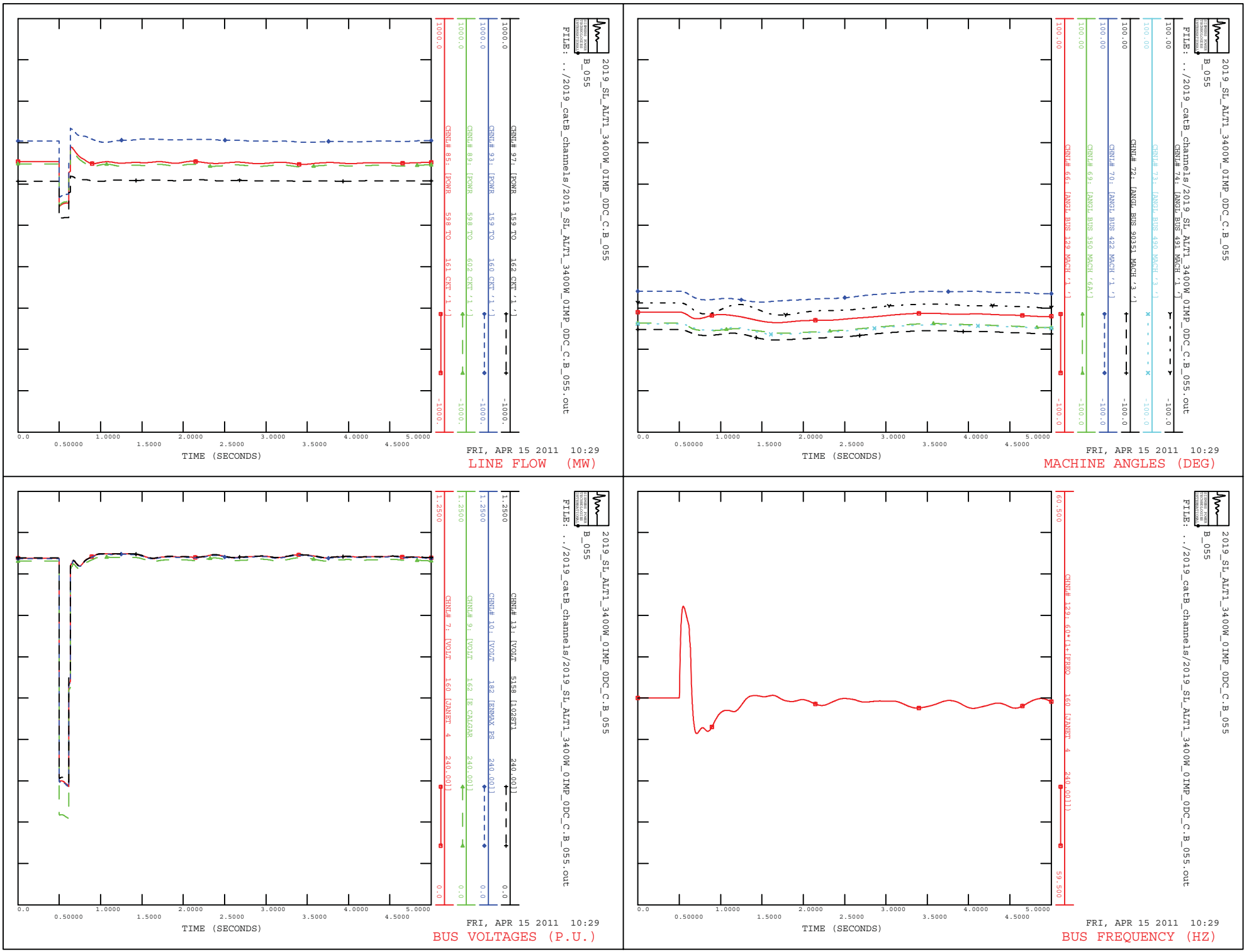


Figure M-2019-Step4-Sc6-14

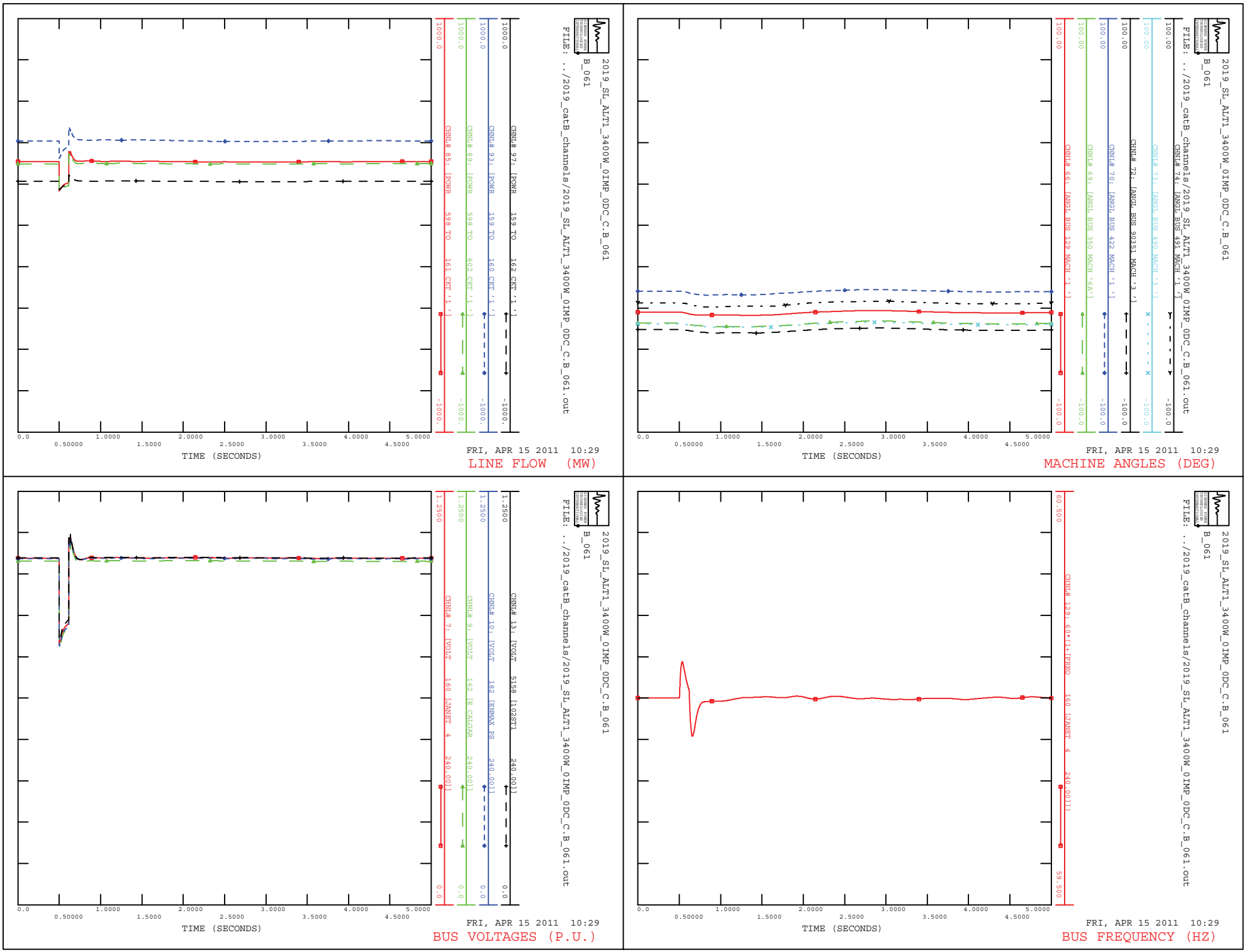


Figure M-2019-Step4-Sc6-15

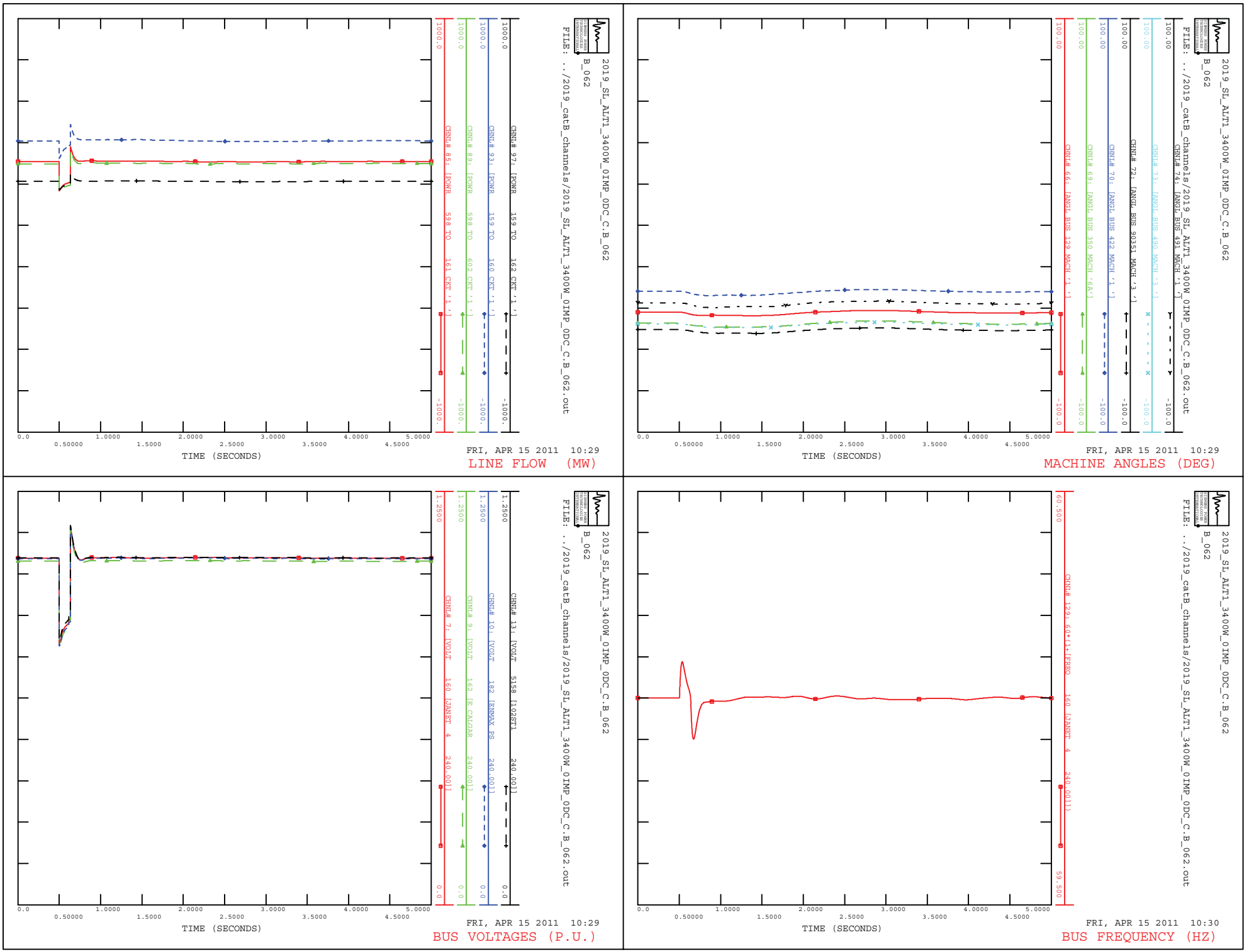


Figure M-2019-Step4-Sc6-16

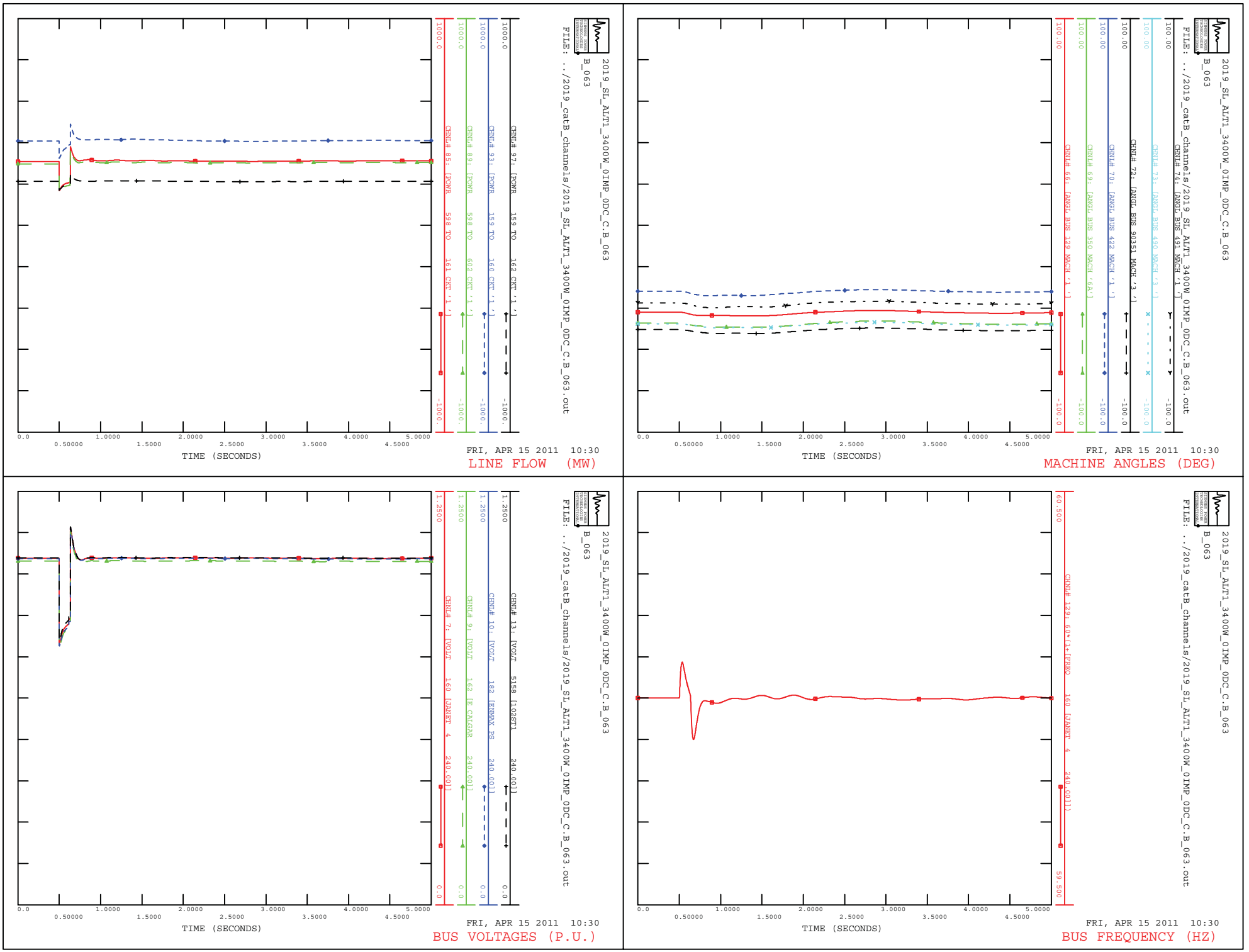


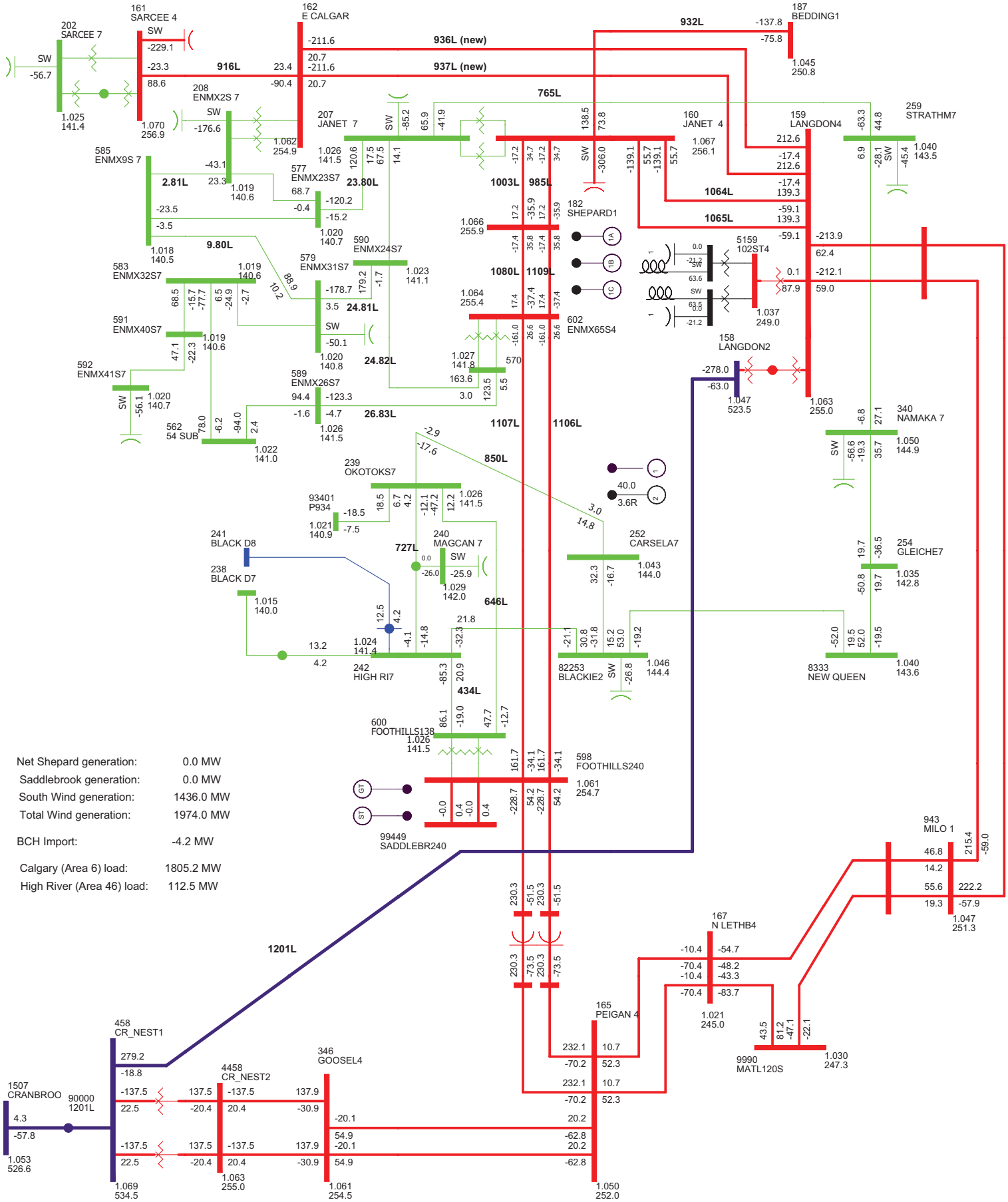
Figure M-2019-Step4-Sc6-17

ATTACHMENT N

Power Flow Studies Using Updated Forecast – 2014

Table N-1

Figure Name	Contingency
Figure N-2014-Step3-Sen-Sc2-1	Base Case (N-0)
Figure N-2014-Step3-Sen-Sc2-2	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure N-2014-Step3-Sen-Sc3-1	Base Case (N-0)
Figure N-2014-Step3-Sen-Sc3-2	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure N-2014-Step3-Sen-Sc3-3	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)
Figure N-2014-Step3-Sen-Sc4-1	Base Case (N-0)
Figure N-2014-Step3-Sen-Sc4-2	Open 936L 240kV line (Langdon 102S to Janet 74S)
Figure N-2014-Step3-Sen-Sc4-3	Open 1003L 240kV line (Janet 74S to ENMAX No. 25)
Figure N-2014-Step3-Sen-Sc4-4	Open 24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)
Figure N-2014-Step3-Sen-Sc4-5	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure N-2014-Step3-Sen-Sc4-6	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)
Figure N-2014-Step3-Sen-Sc5-1	Base Case (N-0)
Figure N-2014-Step3-Sen-Sc5-2	Open 24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)
Figure N-2014-Step3-Sen-Sc5-3	Open 26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)
Figure N-2014-Step3-Sen-Sc5-4	Open 23.80L 138kV line (Janet 74S to ENMAX No.23)

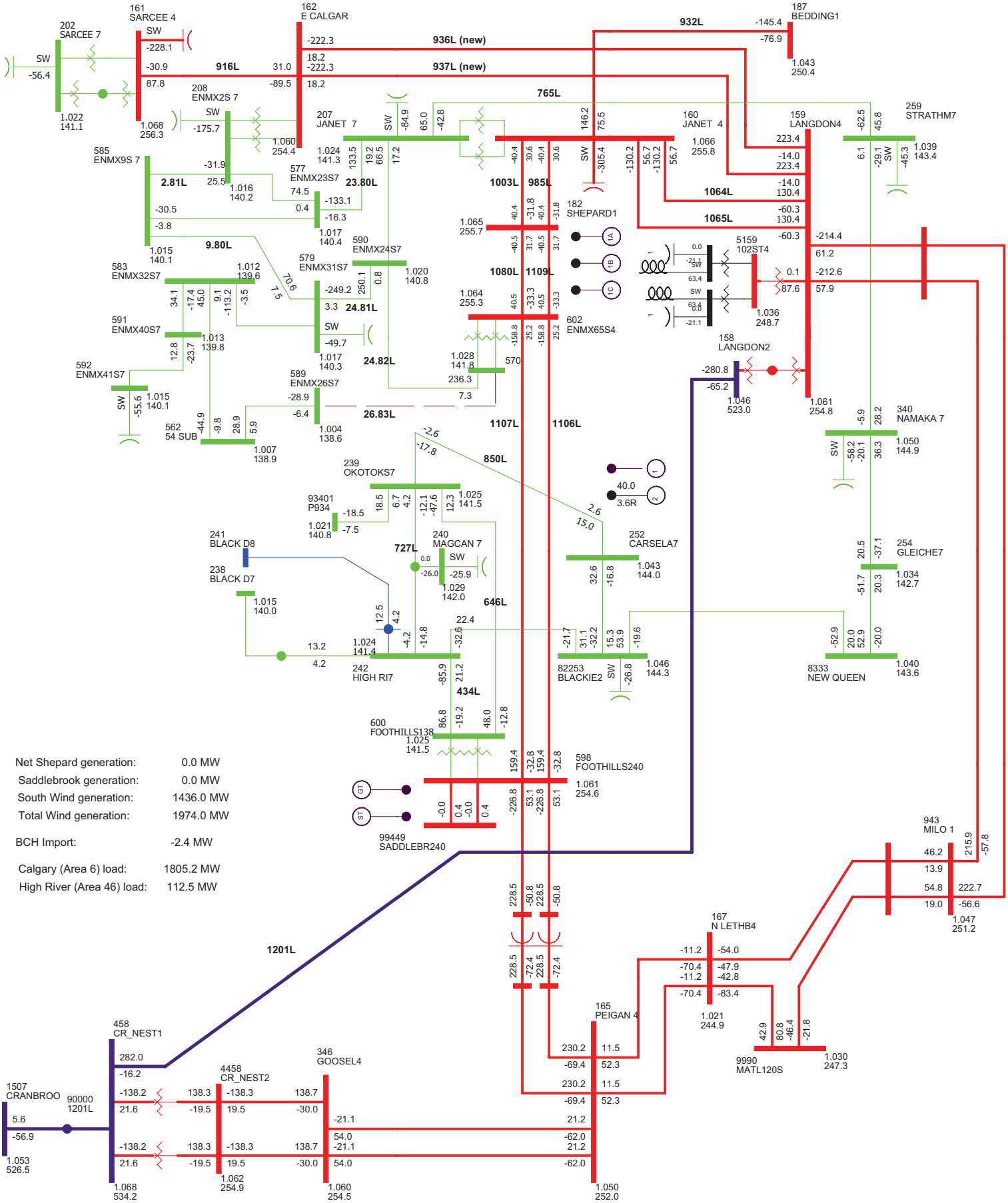


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc2-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 27 2011 17:19

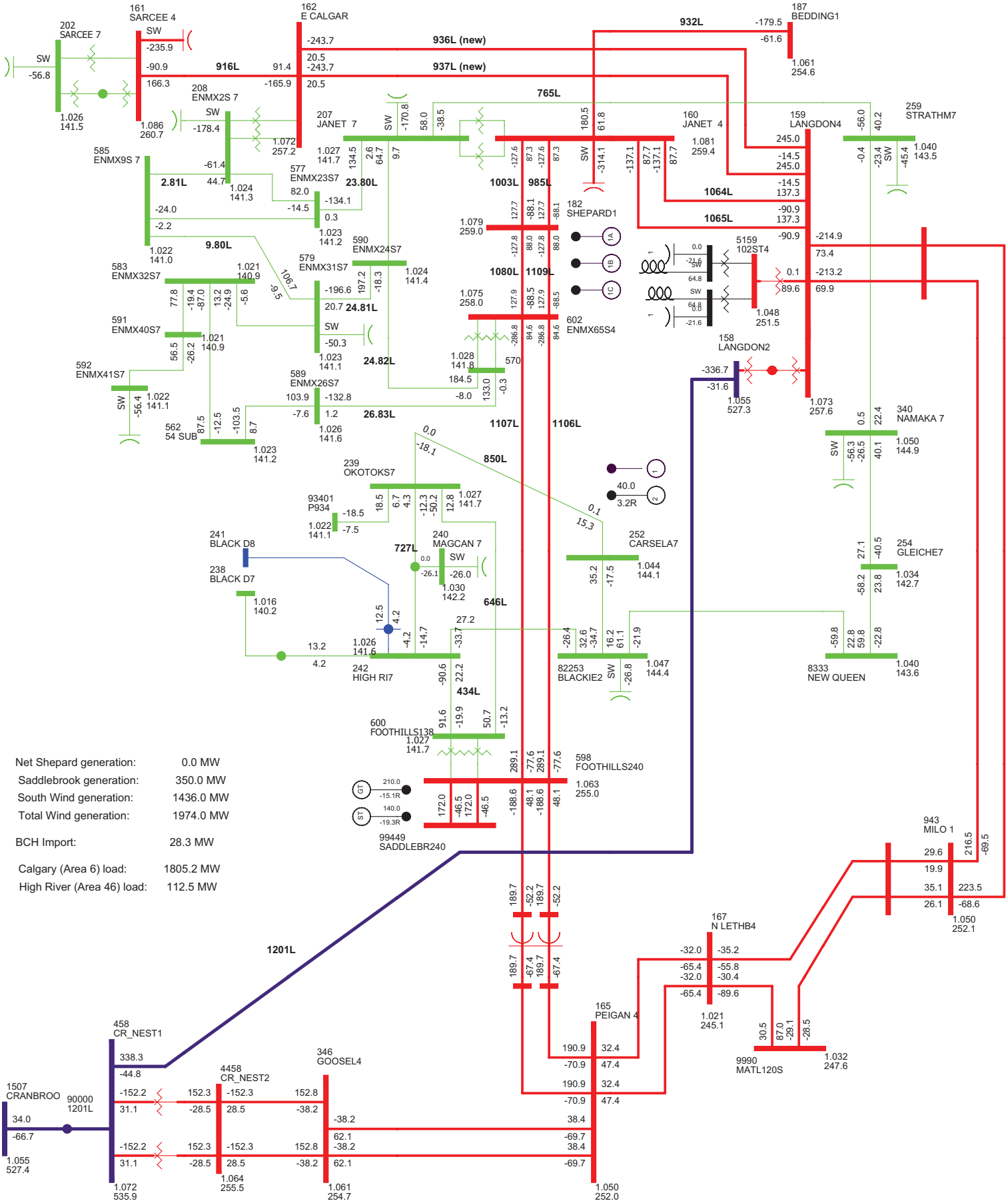


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc2-2

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 27 2011 17:19

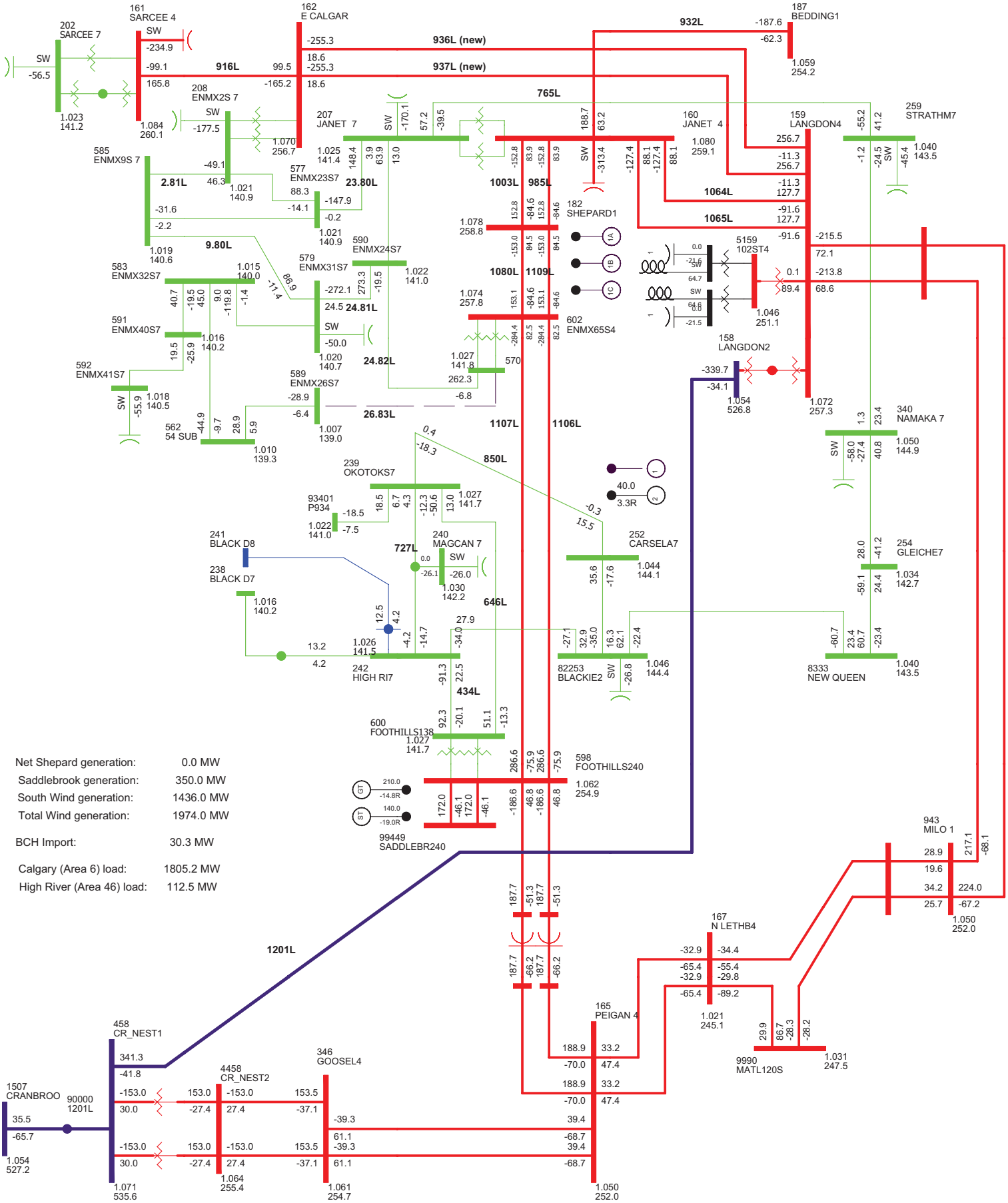


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc3-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 27 2011 17:19

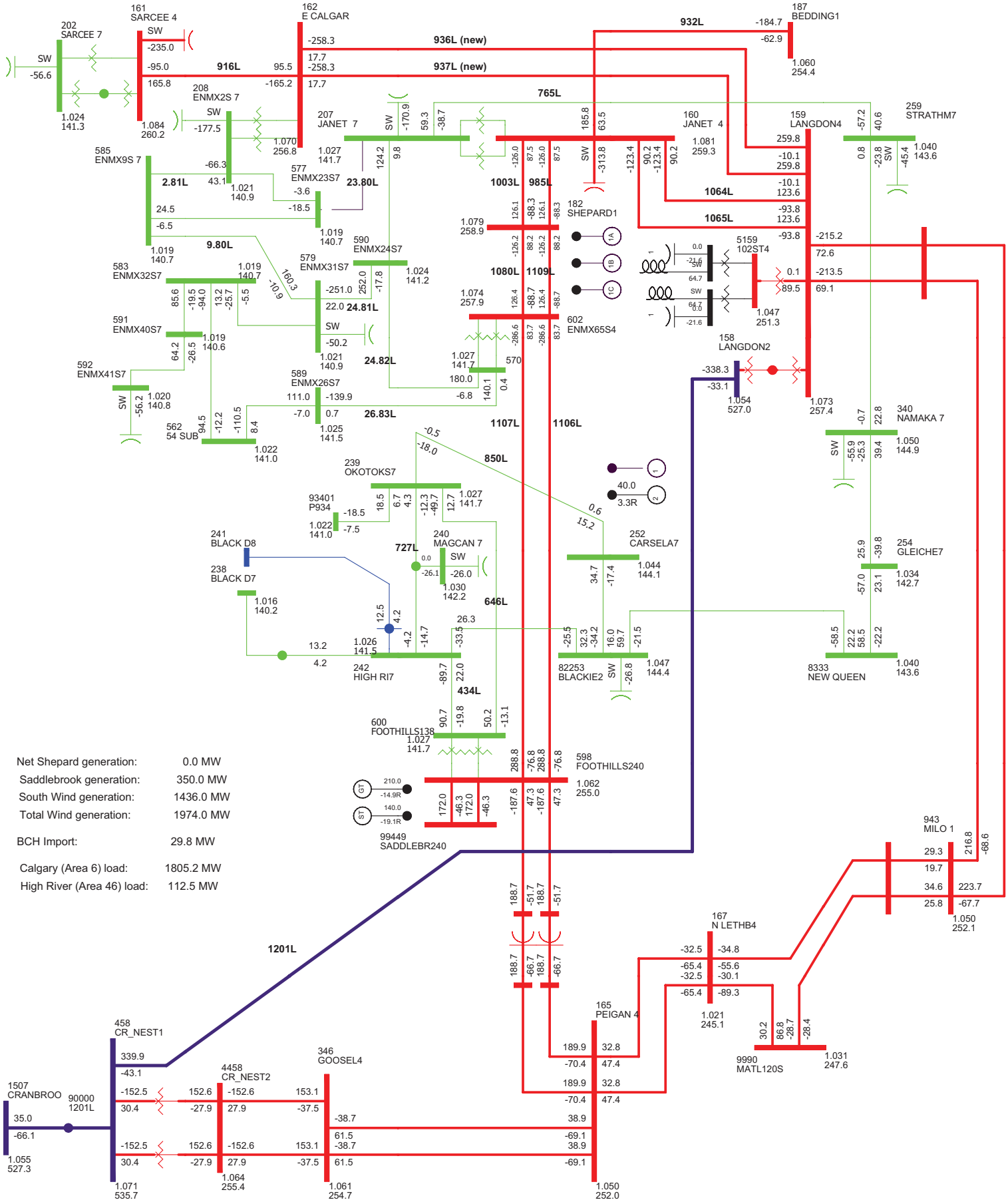


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc3-2

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 27 2011 17:19

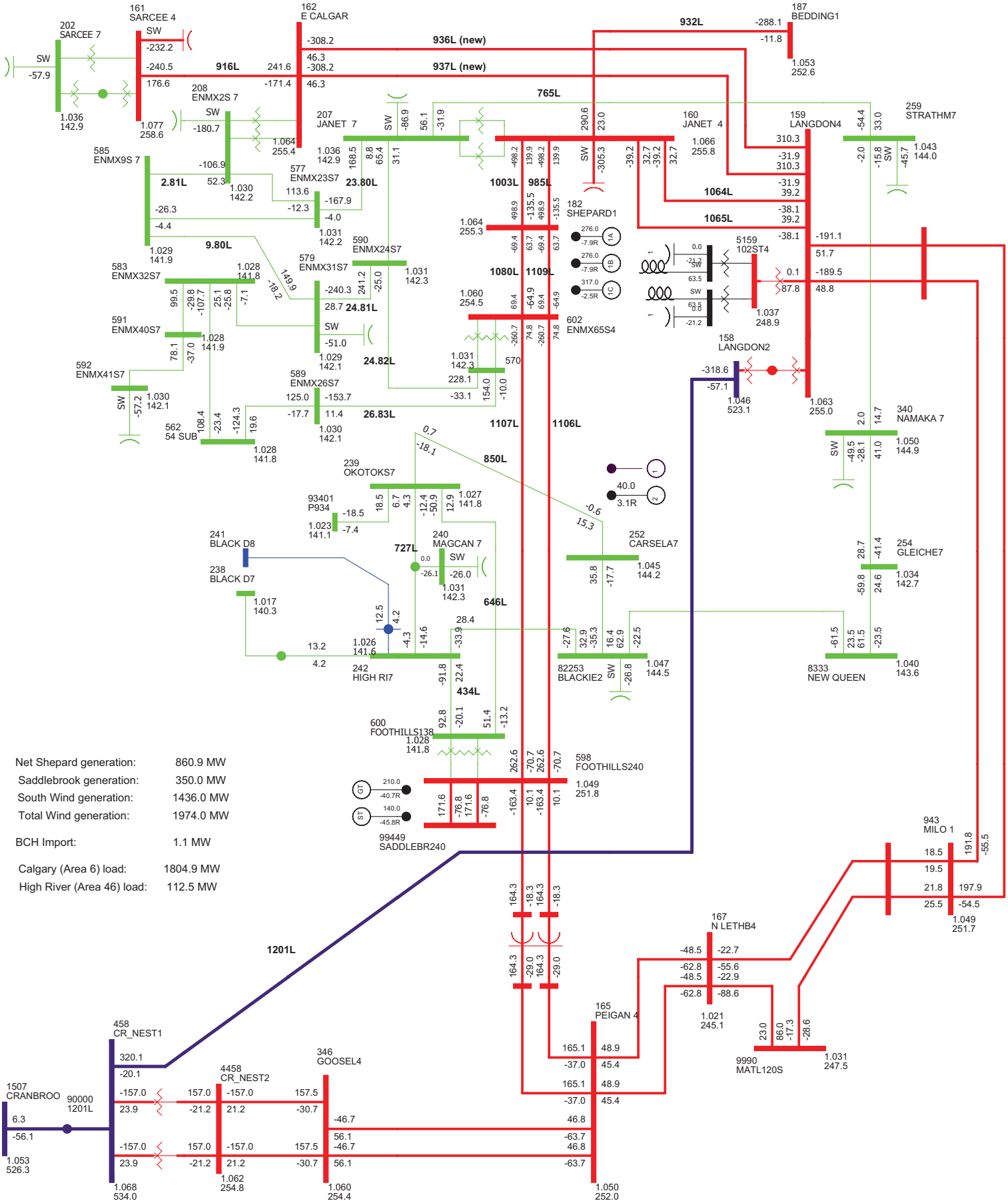


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc3-3

23.80L (JANET 74S TO ENMAX NO. 23)

WED, APR 27 2011 17:19

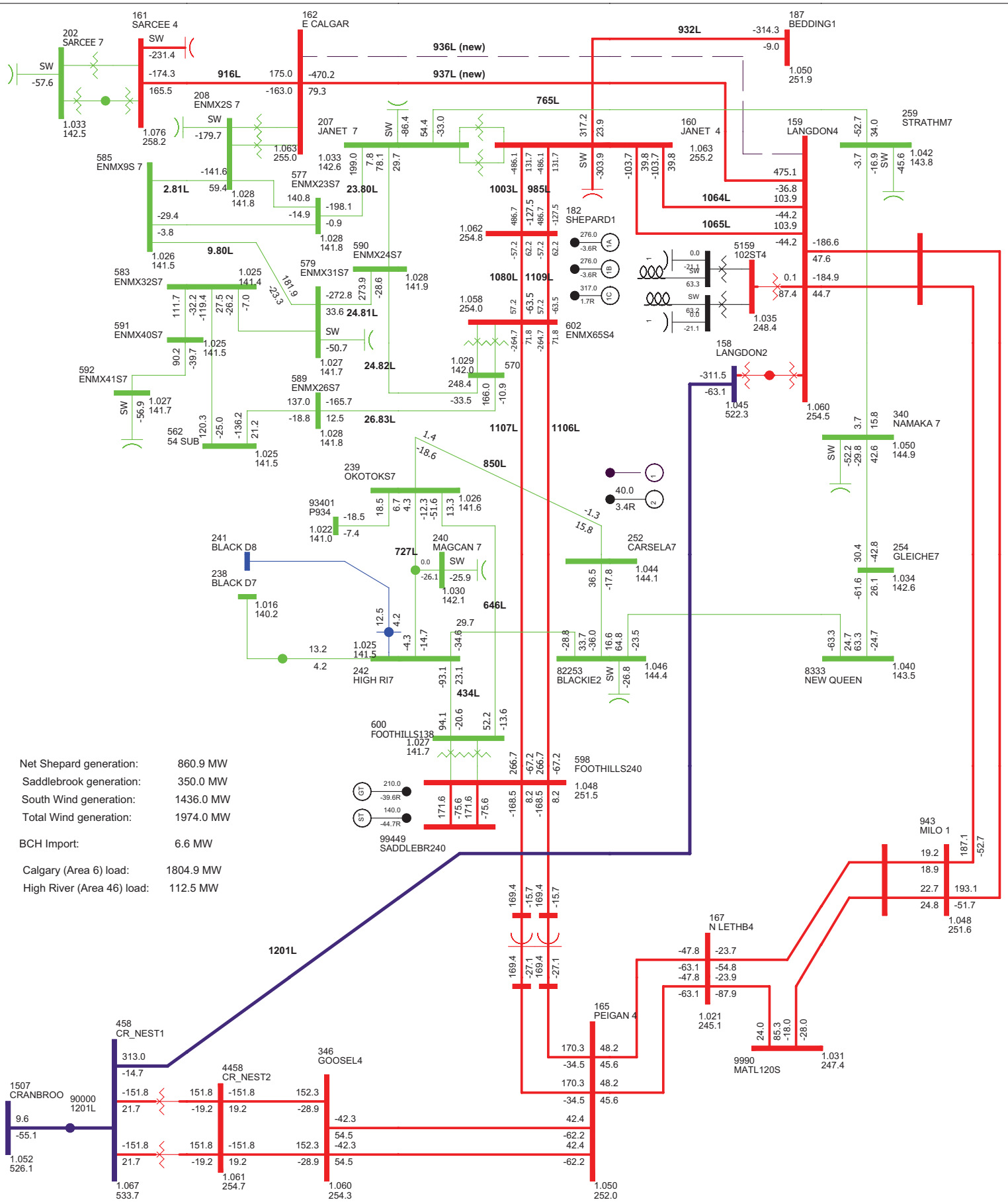


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc4-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 27 2011 17:19

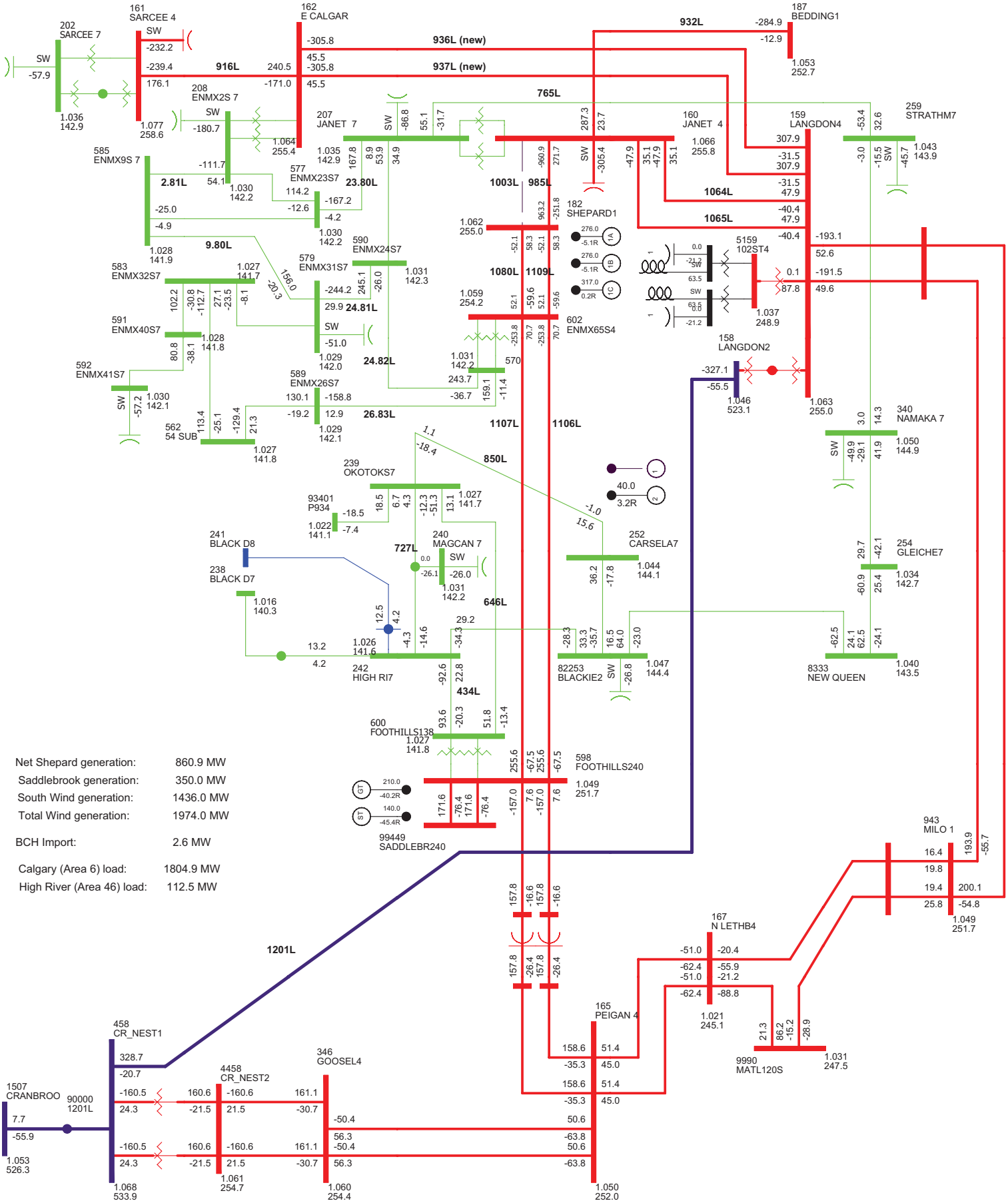


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc4-2

936L (LANGDON 102S TO EAST CALGARY 5S)

WED, APR 27 2011 17:19

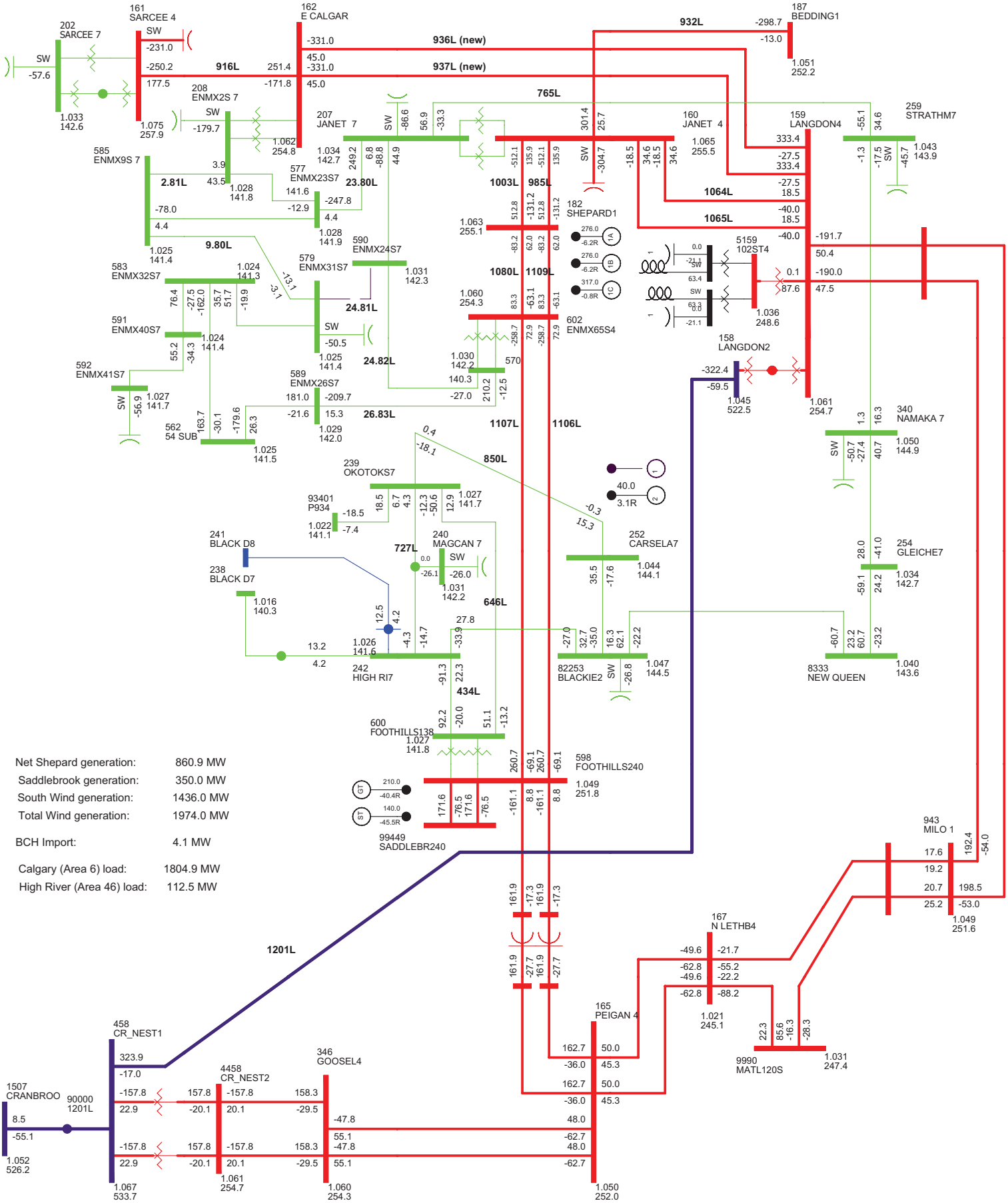


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc4-3

1003L (JANET 74S TO ENMAX NO. 25)

WED, APR 27 2011 17:19

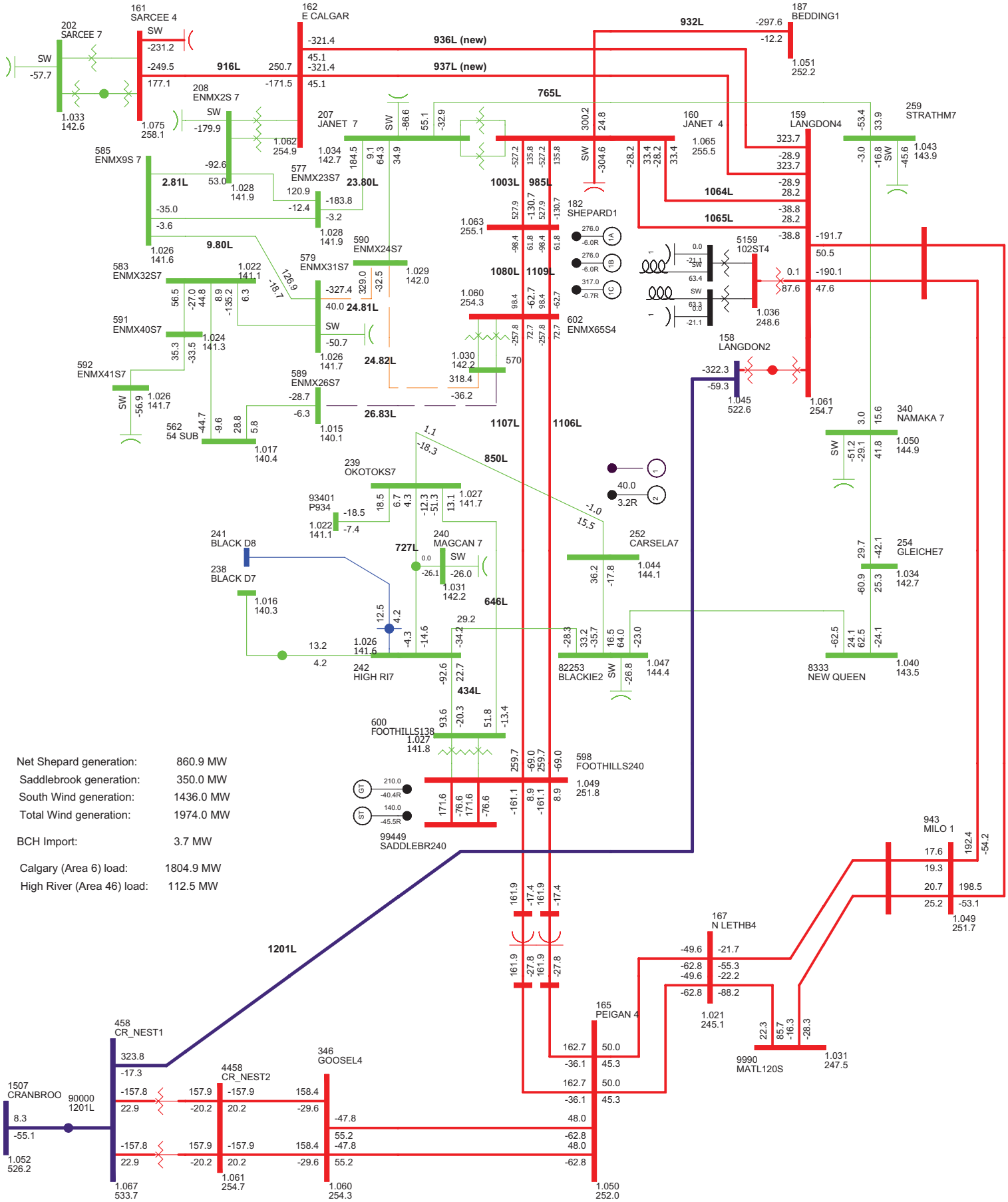


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc4-4

24.81L (ENMAX NO. 31 TO ENMAX NO. 24)

WED, APR 27 2011 17:19

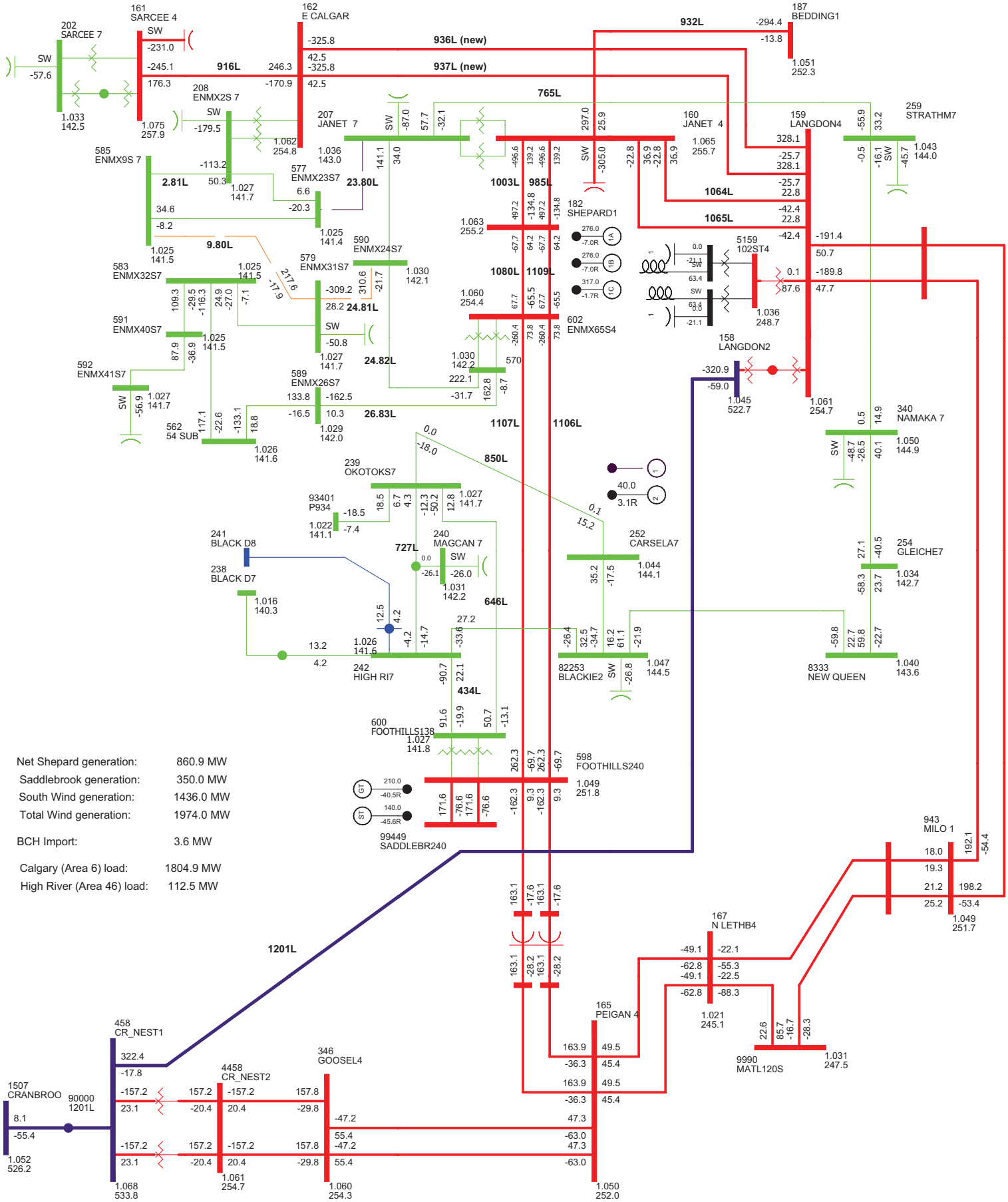


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc4-5

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 27 2011 17:19

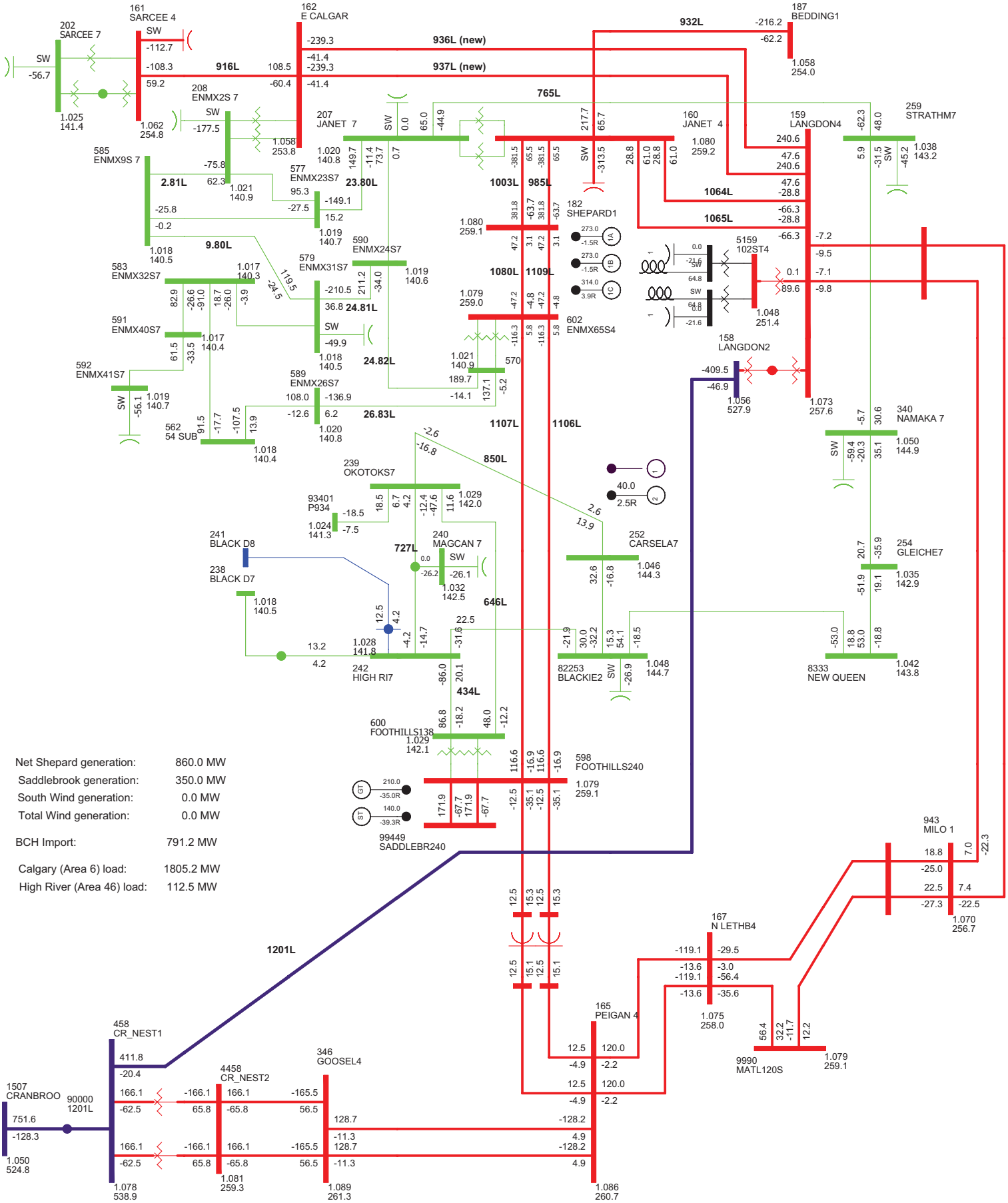


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc4-6

23.80L (JANET 74S TO ENMAX NO. 23)

WED, APR 27 2011 17:19

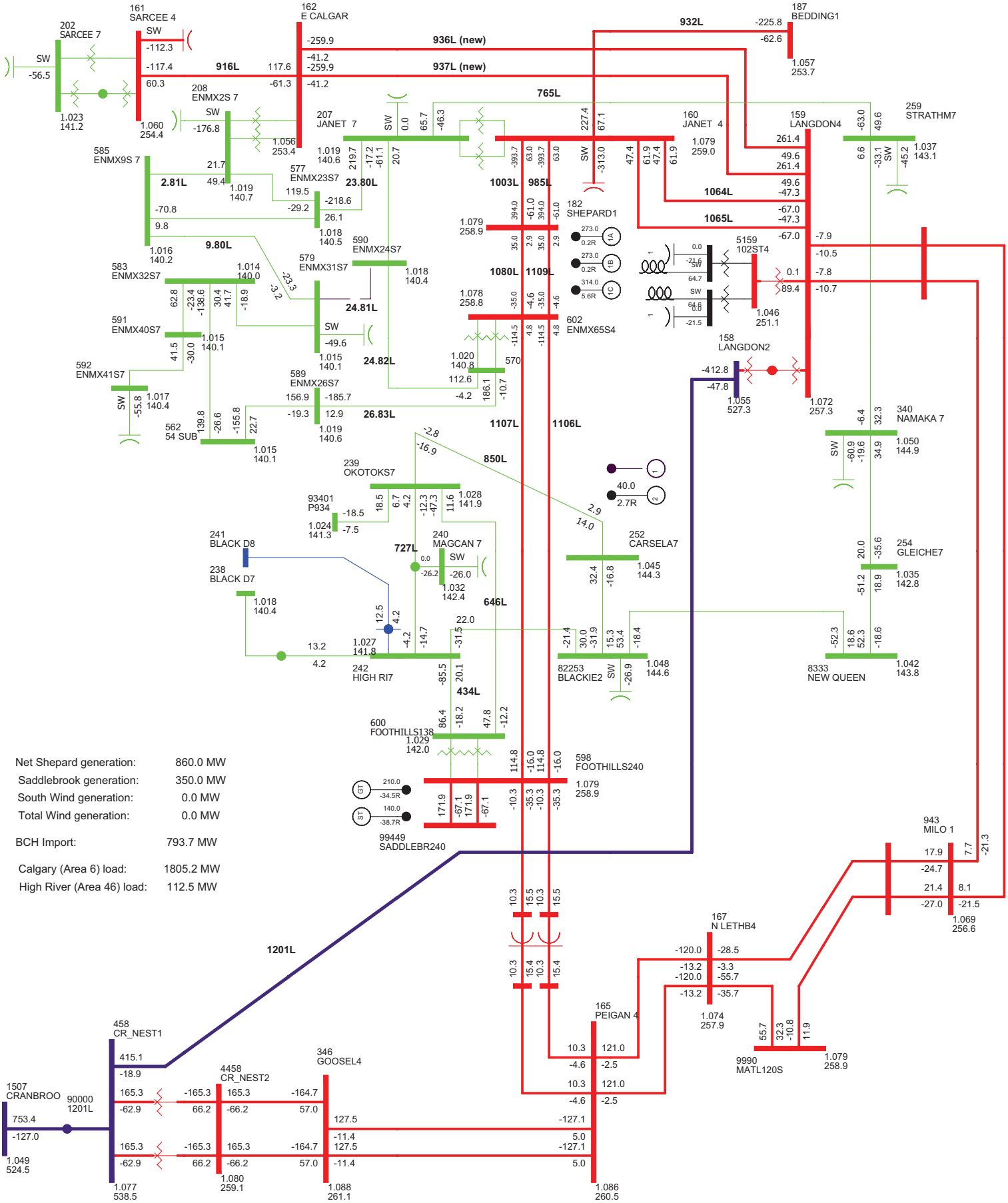


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV/0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc5-1

BASE CASE (ALL ELEMENTS IN SERVICE)

WED, APR 27 2011 17:20

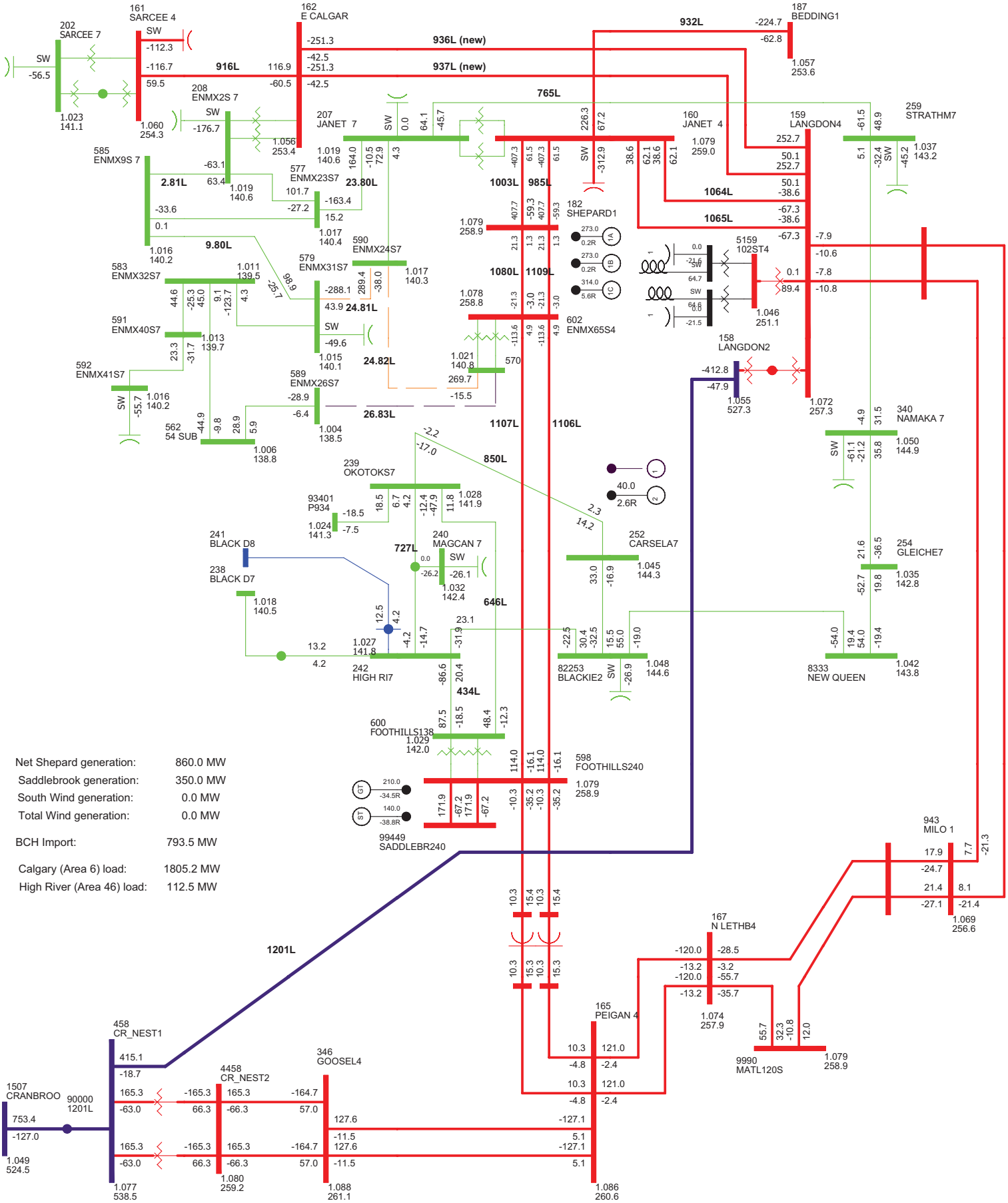


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc5-2

24.81L (ENMAX NO. 31 TO ENMAX NO. 24)

WED, APR 27 2011 17:20

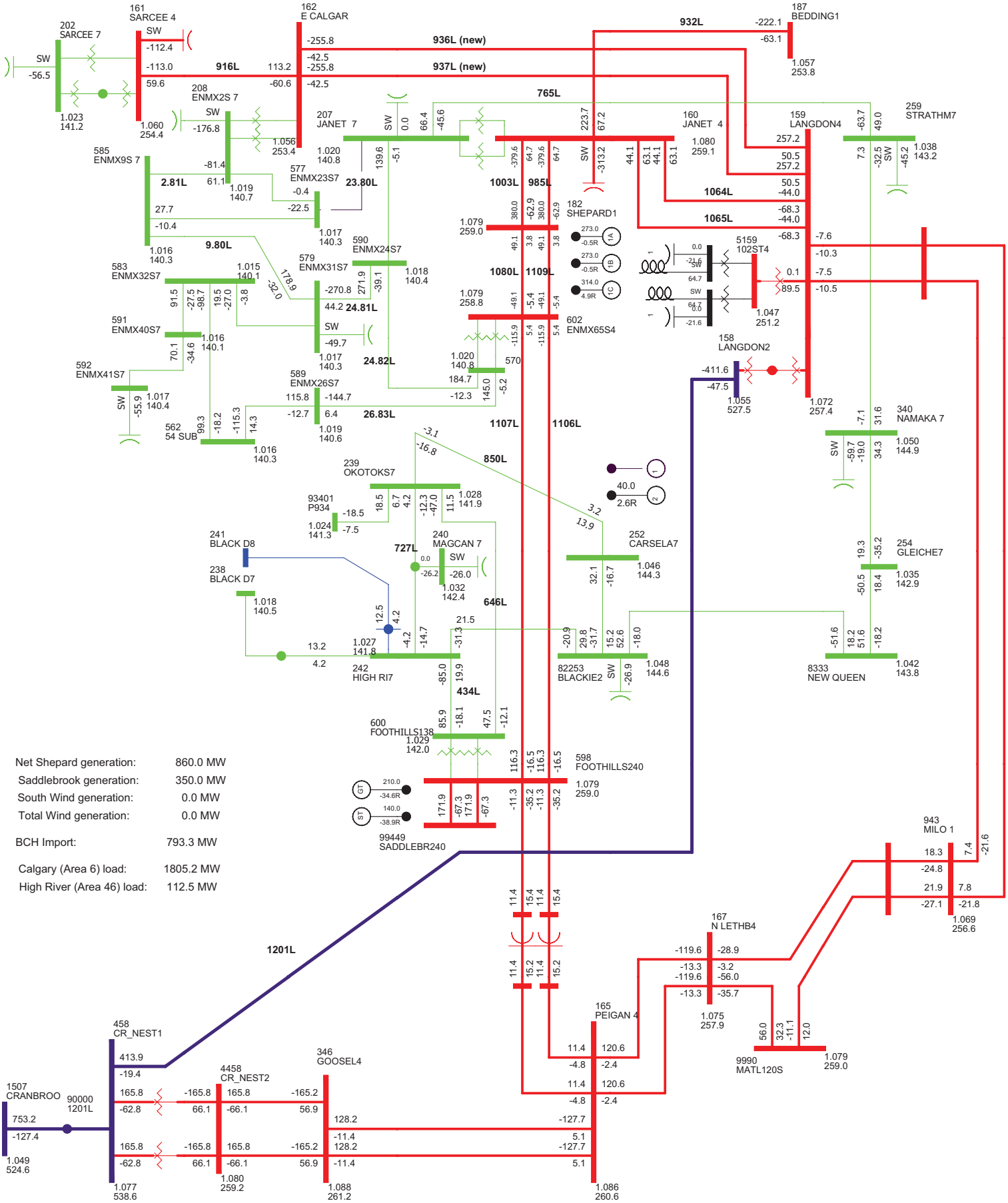


Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc5-3

26.83L (ENMAX NO. 65 TO ENMAX NO. 26)

WED, APR 27 2011 17:20



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

Figure N-2014-Step3-Sen-Sc5-4

23.80L (JANET 74S TO ENMAX NO. 23)

WED, APR 27 2011 17:20

APPENDIX C AESO 2012 SUPPLEMENT TO 2011 PLANNING STUDIES – 69 KV UPGRADE SENSITIVITY

Foothills Area Transmission Development

Supplementary Report: South Calgary 69 kV Transmission System Sensitivity Studies

R1

April 25, 2012



	Name	Signature	Date
Prepared/ Reviewed	Bryce Hughes, E.I.T	Bryce Hughes	Apr. 26, 2012
Prepared/ Reviewed	Ebrahim Rahimi, P.Eng.	E. Rahimi	April 26, 2012
Prepared/ Reviewed	Isabel Pana, P.Eng.		April 26, 2012
Reviewed/Approved	Steve Heidt, P.Eng.		April 26/2012

APEGGA Permit to Practice P-8200

EXECUTIVE SUMMARY

On April 3, 2012, the Alberta Electric System Operator (AESO) advised the Alberta Utilities Commission (AUC) of its intent to amend the South Calgary 69 kV Transmission Upgrade Needs Identification Document[1] (South Calgary NID).

When the Foothills Area Transmission Development (FATD) planning studies were carried out, the transmission developments proposed in the South Calgary NID were modelled because it was assumed these developments would be completed by 2014.

To determine whether 69 kV transmission system upgrades in south Calgary would affect the conclusions and recommendations in the FATD Engineering Report, AESO carried out sensitivity studies in which the existing 69 kV transmission system in south Calgary was modelled without any upgrades. The results of these studies were compared to the results of the FATD planning studies.

Except for the exclusion of the South Calgary 69 kV Transmission Project, all study scenarios, assumptions, system data, and applied criteria were consistent with those used in the FATD Engineering Report dated April 29, 2011.

Power flow studies were performed for 2014 without the FATD Plan in service to determine if topology changes would have any impact on the need assessment conclusion of the FATD planning studies, and power flow studies were performed for 2019 with the FATD Plan in service to determine if there would be any impact on the proposed alternative.

A comparison of the results of these sensitivity studies with the results of the FATD planning studies showed that the 2014 need assessment conclusions in the FATD Engineering Report are not materially impacted if the south Calgary 69 kV transmission upgrade is not built. Moreover, it was found that the proposed transmission developments in the FATD Plan are not materially impacted if the 69 kV transmission upgrade is not built.

Therefore, all conclusions reported in the FATD Engineering Report would remain applicable without any south Calgary 69 kV transmission upgrades. No changes to the identified need or to the proposed FATD Plan would be required.

Based on the sensitivity studies performed, it can be concluded that if no changes to the FATD Plan are required in the extreme case of no upgrades to the south Calgary 69 kV system, then no changes to the FATD Plan would be required if some, but not all, of the South Calgary NID upgrades are implemented.

[1] Application No. 1604960, Proceeding ID No. 234

TABLE OF CONTENTS

EXECUTIVE SUMMARY 2
1. INTRODUCTION 4
2. SENSITIVITY STUDY METHODOLOGY 6
3. SOUTH 69 KV TRANSMISSION SYSTEM IMPACT 7
3.1 2014 Need Assessment 7
3.1.1 Summary for the 2014 Need Assessment 10
3.2 2019 - Foothills Area Transmission Development Plan 10
3.2.1 Steps 1 to 3 of the FATD Plan 10
3.2.2 Steps 1 to 4 of the FATD Plan 14
3.2.3 Summary of the 2019 FATD Results (Steps 1 to 3 and Steps 1 to 4) 15
4. SUMMARY AND CONCLUSIONS 15

List of Figures

Figure 1: Simplified Existing South Calgary 69 kV Transmission System (Without any Transmission Upgrades) 5
Figure 2: Simplified South Calgary Transmission System with the Proposed Upgrades in the South Calgary NID 6

List of Tables

Table 1: Study Scenarios 8
Table 2: Sensitivity Study Results Compared to FATD 2014 Need Assessment Results 8
Table 3: Scenario 2, Highest Difference Thermal Overload with and without the South 69 kV Upgrades – 2014 Need Assessment 9
Table 4: Scenario 3, Highest Difference Thermal Overload with and without the South 69 kV Upgrades – 2014 Need Assessment 9
Table 5: Scenario 4, Highest Difference Thermal Overload with and without the South 69 kV Upgrades – 2014 Need Assessment 9
Table 6: Scenario 5, Highest Difference Thermal Overload with and without the South 69 kV Upgrades – 2014 Need Assessment 10
Table 7: Steps 1 to 3 of the FATD Transmission Development Plan 11
Table 8: Sensitivity Study Results Compared to the FATD 2019 Planning Study Results (Steps 1 to 3 of the Proposed Developments Modelled) 12
Table 9: Scenario 2, Thermal Overloads with and without the South 69 kV Upgrades – 2019 (Steps 1 to 3 of the FATD Development Modelled) 13
Table 10: Scenario 3, Thermal Overload with and without the South 69 kV Upgrades – 2019 (Steps 1 to 3 of the FATD Development Modelled) 13
Table 11: Scenario 4, Thermal Overload with and without the South 69 kV Upgrades – 2019 (Steps 1 to 3 of the FATD Development Modelled) 13
Table 12: Scenario 5, Thermal Overload with and without the South 69 kV Upgrades – 2019 (Steps 1 to 3 of the FATD Development Modelled) 14
Table 13: Transmission Elements Included in Step 4 of the FATD Plan 14

List of Attachments

Attachment A: Need Assessment – 2014 17
Attachment B: FATD East Assessment – 2019 32
Attachment C: FATD Full – 2019 51

1. INTRODUCTION

When the Foothills Area Transmission Development (FATD) planning studies were carried out, the transmission developments proposed in the South Calgary 69 kV Transmission Upgrade Needs Identification Document[2] (South Calgary NID) were modelled. It was assumed these developments would be completed by 2014.

On April 3, 2012, the Alberta Electric System Operator (AESO) advised the Alberta Utilities Commission (AUC) of its intent to amend the South Calgary NID.

To determine whether 69 kV transmission system upgrades in south Calgary would affect the conclusions and recommendations in the FATD Engineering Report, AESO carried out sensitivity studies in which the existing 69 kV transmission system in south Calgary was modelled without any upgrades proposed in the South Calgary NID.

This supplementary report to the FATD Engineering Report provides a summary of the results of those sensitivity studies and discusses their effect on the conclusions in the FATD Engineering Report.

Figure 1 shows the existing 69 kV transmission system in south Calgary. This 69 kV system configuration is modelled in the sensitivity studies. Figure 2 shows the transmission system in south Calgary with the transmission upgrades proposed in the South Calgary NID. These proposed upgrades were assumed to be in service in the FATD planning studies. Figure 1 and Figure 2 are not to scale and do not indicate the geographical locations of facilities.

This supplementary report to the FATD Engineering Report is structured as follows:

Section 1 provides an introduction to the assumptions used in the sensitivity studies and how these assumptions are different than the assumptions used in the FATD planning studies.

Section 2 discusses methodology of the sensitivity studies.

Section 3 discusses the results of the sensitivity studies and comparison between the sensitivity study results and the FATD planning studies.

Section 4 provides a summary of the sensitivity study results and conclusions.

[2] Application No. 1604960, Proceeding ID No. 234

Figure 1: Simplified Existing South Calgary 69 kV Transmission System (Without any Transmission Upgrades)

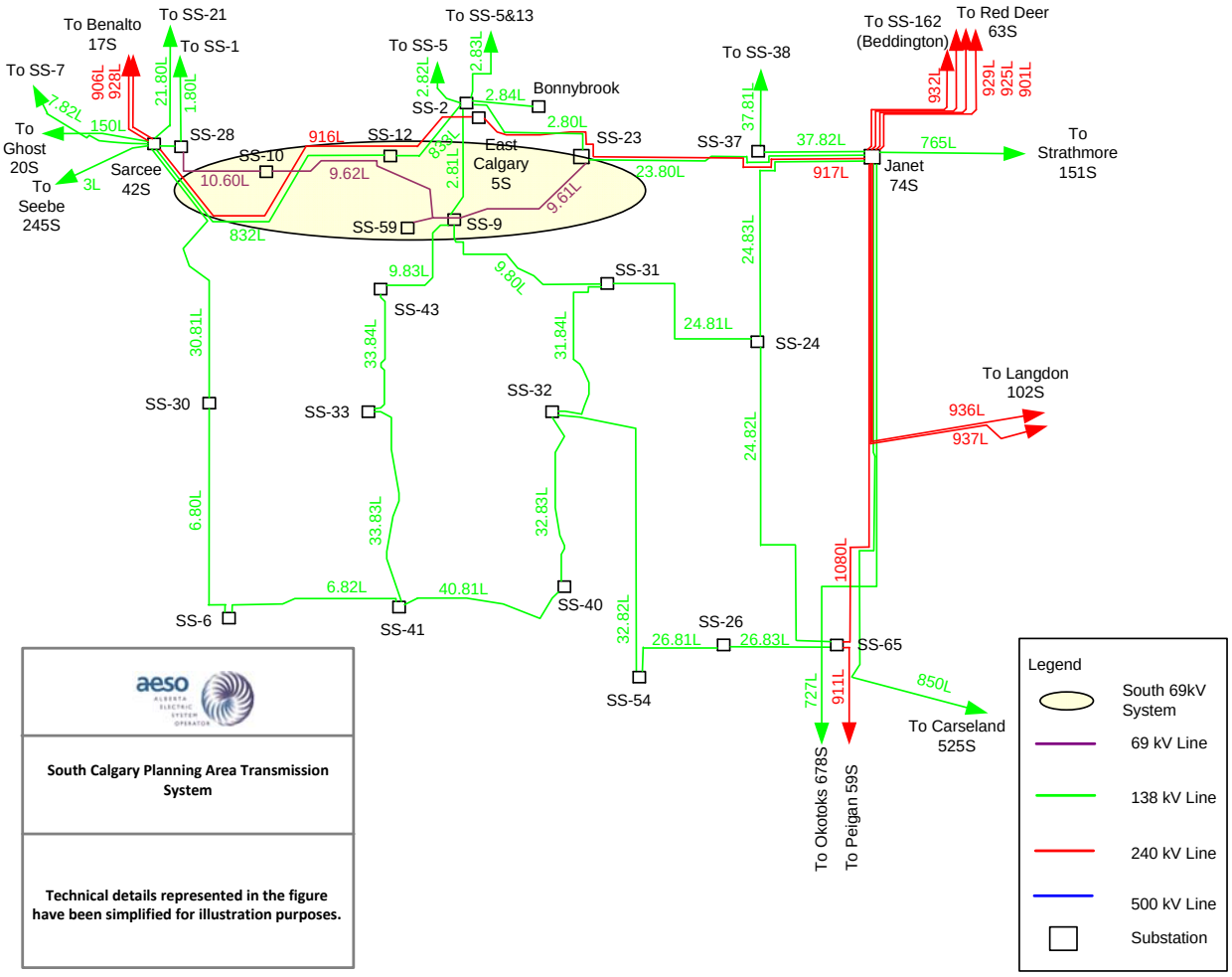
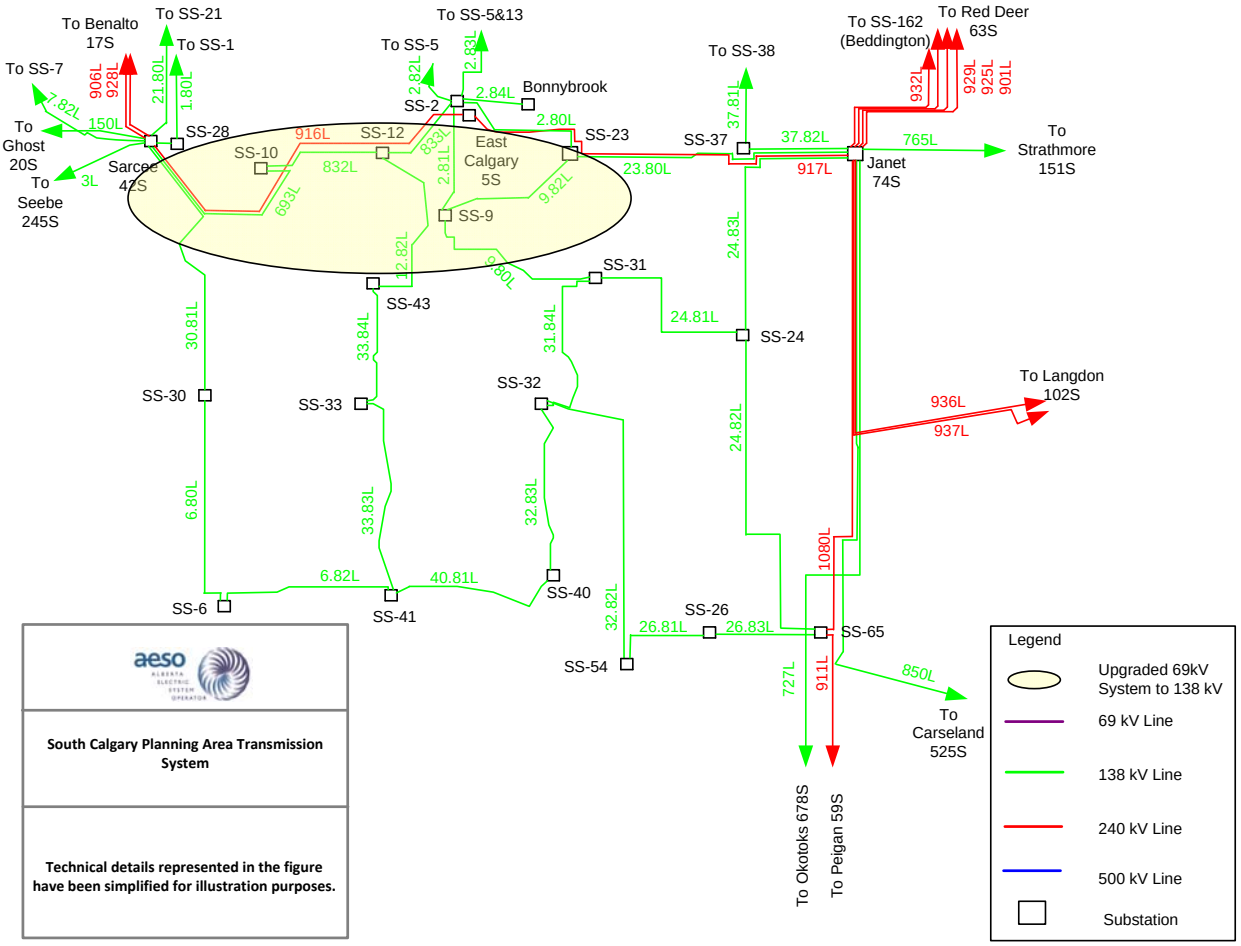


Figure 2: Simplified South Calgary Transmission System with the Proposed Upgrades in the South Calgary NID



2. SENSITIVITY STUDY METHODOLOGY

The objective of the sensitivity studies was to determine whether there would be any effect on the conclusions and recommendations in the FATD Engineering Report if the upgrades proposed in South Calgary NID are not implemented. To accomplish this objective, the existing 69 kV transmission system in south Calgary was modelled in the sensitivity studies.

The system studies were conducted using PTI version 32.

The following sensitivity studies were performed assuming the existing 69 kV transmission system in south Calgary:

- 2014 Need Assessment
- 2019 FATD Plan Analysis – Assuming only Steps 1 to 3 of the FATD Plan

- 2019 FATD Plan Analysis – Assuming the complete FATD Plan (Steps 1 to 4)

The sensitivity studies performed for the 2014 Need Assessment were conducted to determine if there are any material impacts on the established need in the FATD Engineering Report if the proposed 69 kV transmission system upgrades are not built.

The sensitivity studies performed for the Steps 1 to 3 of the FATD Plan and for the complete FATD Plan (Steps 1 to 4) were conducted to determine if removing all 69 kV transmission upgrades in south Calgary would have any material impacts on the developments proposed in the FATD Plan[3,4].

The existing south Calgary 69 kV transmission system was modelled to remove all assumptions regarding upgrades to the 69 kV system. The results of the sensitivity studies were compared with the results of the FATD planning studies to determine if having no 69 kV transmission upgrades in south Calgary would have any impact on the need assessment conclusions and proposed transmission developments in the FATD Engineering Report.

The following power flow studies were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)

Except for the exclusion of the South Calgary 69 kV Transmission Project, all study scenarios, assumptions, system data, and applied criteria were consistent with those used in the FATD Engineering Report dated April 29, 2011.

3. SOUTH 69 KV TRANSMISSION SYSTEM IMPACT

This section discusses the results of the sensitivity studies described in Section 2.

3.1 2014 Need Assessment

The 2014 study cases used for the existing system assessment in Section 4 of the FATD Engineering Report were modified to exclude all south Calgary 69 kV transmission upgrades. The sensitivity study scenarios were the same as those in Section 4 of the FATD report. They are shown in Table 1.

[3] AESO is planning to file FATD-East NID which includes Steps 1 to 3 of the proposed FATD Plan.

[4] Steps 1 to 3 of the FATD Plan are provided in Table 7 of this document. Proposed developments included in Step 4 of the FATD Plan are shown in Table 13.

Table 1: Study Scenarios

Scenario	Load Condition
1	SP, no wind generation, no local generation, ~780 MW import from BC
2	SP, full wind generation, no local generation, ~0 MW import from BC
3	SP, full wind generation, Saddlebrook generation online, ~0 MW import from BC
4	SP, full wind generation, Saddlebrook and Shepard generation online, ~0 MW import from BC
5	SP, no wind generation, Saddlebrook and Shepard generation online, ~780 MW import from BC
6	System Light (SL), full wind generation, no local generation, ~0 MW import from BC

The following power flow studies were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)

For each scenario the sensitivity studies results were very similar to those reported in Section 4 of the FATD Engineering Report. The contingencies that resulted in maximum thermal overload with 3% or higher difference, as compared to the FATD planning studies, are shown in Table 2. Thermal overload differences less than 3% are not included.

Table 2: Sensitivity Study Results Compared to FATD 2014 Need Assessment Results

		Difference as Compared to FATD Engineering Report [1]					
Contingency	**Critical Line**	**SC1**	**SC2**	**SC3**	**SC4**	**SC5**	**SC6**
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)				-13.5%		
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)				-13.6%	-9.9%[3]	
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)				4.9%	5.7%	
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)				8.7%		
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	24.83L 138kV line (Janet 74S to ENMAX No. 24)				3.9%		
917L 240kV line outage. (Janet 74S to East Calgary 5S)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)		11.4%	12.6%	15.2%[2]	12.8%[2]	
917L 240kV line outage. (Janet 74S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)					3.2%[4]	
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)		4.0%[3]				

[1] A negative percentage represents a lower thermal loading as compared to the results in the FATD Engineering Report.

[2] In Table 4-6 and Table 4-7 of the FATD Engineering Report the worst overload on 9.80L is due to an outage of 240 kV transmission line 1003L. However, this table records the highest change where sensitivity study results are compared with the FATD planning study results.

[3] Thermal overload on this line is recorded in Table 4-10 of the FATD Engineering Report.

[4] Table 4-7 of the FATD Engineering Report shows the thermal overload on 138 kV transmission line 24.81L in 2014 and 2019 for an outage of 26.83L, which causes the worst overload on 24.81L in 2019 assuming Scenario 5. Under this Scenario in 2014, the worst line loading occurs following an outage of 240 kV transmission line 917L.

Table 2 does not include a thermal overload on the existing 69 kV transmission line 10.60L from ENMAX No. 28 to ENMAX No. 10 due to an outage of the 138/69 kV auto transformer at ENMAX No. 23. This existing constraint will be resolved by the South Calgary 69 kV Transmission Upgrade project[5].

The actual thermal overloads for each of the differences in the above table are provided in Table 3 to Table 6. The power flow diagrams are presented in Attachment A.

Table 3: Scenario 2, Highest Difference Thermal Overload with and without the South 69 kV Upgrades – 2014 Need Assessment

Contingency	Critical Branch	With 69 kV Upgrades	Without 69 kV Upgrades
917L 240kV line outage. (Janet 74S to East Calgary 5S)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	111% 228MVA	122% 251MVA
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	102% 315MVA	106% 327MVA

Table 4: Scenario 3, Highest Difference Thermal Overload with and without the South 69 kV Upgrades – 2014 Need Assessment

Contingency	Critical Branch	With 69 kV Upgrades	Without 69 kV Conversion
917L 240kV line outage. (Janet 74S to East Calgary 5S)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	129% 257MVA	141% 282MVA

Table 5: Scenario 4, Highest Difference Thermal Overload with and without the South 69 kV Upgrades – 2014 Need Assessment

Contingency	Critical Branch	With 69 kV Upgrades	Without 69 kV Conversion
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	129% 205MVA	116% 183MVA
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	140% 221MVA	126% 199MVA
1003L 240kV line outage.	9.80L 138kV line	218%	223%

[5] The AESO filed an amendment to the South Calgary 69 kV Transmission Upgrade NID on April 26, 2012.

Contingency	Critical Branch	With 69 kV Upgrades	Without 69 kV Conversion
(Janet 74S to ENMAX No. 25)	(ENMAX No. 31 to ENMAX No. 9)	416MVA	425MVA
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	117% 336MVA	126% 360MVA
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	24.83L 138kV line (Janet 74S to ENMAX No. 24)	134% 424MVA	138% 436MVA
917L 240kV line outage. (Janet 74S to East Calgary 5S)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	171% 331MVA	186% 361MVA

Table 6: Scenario 5, Highest Difference Thermal Overload with and without the South 69 kV Upgrades – 2014 Need Assessment

Contingency	Critical Branch	With 69 kV Upgrades	Without 69 kV Conversion
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	101% 162MVA	91% 146MVA
1003L 240kV line outage. (Janet 74S to ENMAX No. 25)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	154% 298MVA	160% 309MVA
917L 240kV line outage. (Janet 74S to East Calgary 5S)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	120.9% 235MVA	133.7% 260MVA
917L 240kV line outage. (Janet 74S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	109% 320MVA	112% 329MVA

3.1.1 Summary for the 2014 Need Assessment

The results of the sensitivity studies demonstrate that if the south Calgary 69 kV transmission upgrade is not built there are no material changes to the 2014 need assessment study results and conclusions in the FATD Engineering Report.

3.2 2019 - Foothills Area Transmission Development Plan

3.2.1 Steps 1 to 3 of the FATD Plan

The 2019 study cases used for the studies with Steps 1 to 3 of the FATD development plan modelled were modified to exclude all south Calgary 69 kV transmission upgrades. Steps 1 to 3 of the FATD development plan are summarized in Table 7.

The study scenarios are provided in Table 1. The 2019 summer peak loading level is assumed for Scenarios 1 to 5 and the 2019 system light loading condition is assumed for Scenario 6.

Except for the exclusion of the south Calgary 69 kV transmission upgrades all study assumptions, system data, and applied criteria were consistent with those in the FATD Engineering Report (Section 2). The existing 69 kV transmission system was modelled for the sensitivity studies.

Table 7: Steps 1 to 3 of the FATD Transmission Development Plan

Steps 1 to 3 of the FATD Required Developments
A new 240 kV double circuit line from Langdon 102S to Janet 74S with a minimum summer rating of 800 MVA for each circuit. The lines are designated 1064L and 1065L.
A 240 kV double circuit line from Langdon 102S to East Calgary 5S. This path will be created using the existing lines (936L, 937L, 917, 23.80L, and 2.80L). As per the TFO's data submission, the summer rating of each circuit is 489 MVA. The lines are designated 936L and 937L.
Replace the existing 240/138 kV 336 MVA transformer at East Calgary 5S substation with two new 400 MVA transformers.
A new 240 kV substation designated Foothills 237S that includes two new 240/138 kV transformers, each with a minimum rating of 400 MVA.
A new 240 kV double circuit line from Foothills 237S substation to ENMAX No. 65 substation with a minimum summer rating of 600 MVA for each circuit. The lines will be designated 1106L and 1107L.
A 240 kV double circuit line from ENMAX No. 65 substation to ENMAX No. 25 substation. This path will be created using sections of the existing lines (911L, 850L energized at 240 kV). As per the TFO's data submission, the summer rating of each circuit is 489 MVA. The lines are designated 1080L and 1109L.
A new 240 kV double circuit line from ENMAX No. 25 substation to Janet 74S substation with a minimum summer rating of 920 MVA for each circuit. The lines are designated 985L and 1003L.
A new 138 kV single circuit line from Janet 74S substation to ENMAX No. 23 substation with a minimum summer rating of 260 MVA. The line is designated 23.80L.
A new 138 kV single circuit line from ENMAX No. 2 substation to ENMAX No. 23 substation with a minimum rating of 260 MVA. The line is designated 2.80L.
A new 138 kV single circuit line from Foothills 237S to Okotoks 678S with a minimum summer rating of 260 MVA. The line is designated 646L[1].
A new 138 kV single circuit line from Foothills 237S to High River 65S with a minimum summer rating of 260 MVA. The line is designated 434L[1].
A 138 kV single circuit line from Okotoks 678S to Carseland 525S. This path will be created using sections of the existing 138 kV lines 727L[2] and 850L. As per the TFO's data submission the summer rating of the line is 89 MVA. The line is designated 850L.
De-energize sections of the 911L line from Janet 74S to ENMAX No. 25 substation and from south of ENMAX No. 65 substation to Foothills 237S[1 and 2].
De-energize sections of the 727L line from Janet 74S to where 850L turns east toward Carseland.
De-energize sections of the 850L line from Janet 74S substation to ENMAX No. 25 substation.

[1] The existing 911L in the High River planning area will be de-energized upon completion of the SATR project. Therefore, there is the potential to utilize sections of this line where suitable to create the required 646L or 434L. 911L will then be re-energized at 138 kV.

[2] Sections of the existing 911L transmission line re-energized at 138 kV can be used along with the existing 138 kV transmission line 850L to create the connection from Okotoks 678S to Carseland 525S.

The following power flow studies were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)

The sensitivity study results are very similar to those in the FATD planning studies. The contingencies that resulted in maximum thermal overload with 3% or higher difference in the study area, as compared to the FATD planning studies,

are shown in Table 8. Thermal overload differences less than 3% are not included.

Table 8: Sensitivity Study Results Compared to the FATD 2019 Planning Study Results (Steps 1 to 3 of the Proposed Developments Modelled)

Contingency	Critical Line	Difference as Compared to FATD Planning Studies [1]					
		SC1	SC2	SC3	SC4	SC5	SC6
24.81L 138kV line outage. (ENMAX No. 31 to ENMAX No. 24)	23.80L 138kV line (Janet 74S to ENMAX No. 23)			-8%	-7%		
916L 240kV line outage. (Sarcee 42S to East Calgary 5S)	833L 138kV line (ENMAX No. 2 to ENMAX No. 12)			-41%	-47%		
9.80L 138kV line outage. (ENMAX No. 31 to ENMAX No. 9)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)				3%		
32.83L 138kV line outage. (ENMAX No. 32 to ENMAX No. 40)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)		13%	14%	15%		
23.80L 138kV line outage. (Janet 74S to ENMAX No. 23)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)		6%[2]	6%[2]	7%[2]	6%	
9.80L 138kV line outage. (ENMAX No. 31 to ENMAX No. 9)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)			3%	3%		
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	31.84L 138kV line (ENMAX No. 31 to ENMAX No. 32)			-14%	-15%		
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)		6%	6%	6%	6%	

[1] Negative percentage represents a lower thermal loading as compared to the FATD planning studies.

[2] The greatest difference occurs for an outage of 138 kV transmission line 32.83L for Scenarios 2, 3, and 4. For Scenario 5 the greatest difference occurs due to the outage of the 138 kV transmission line 23.80L. Under an outage of 23.80L the differences are recorded for Scenarios 2, 3, and 4 because the difference is still higher than 3%.

Though some of the differences recorded in Table 8 are large, there are no material impacts on the FATD planning study conclusions and recommendations. The actual thermal overloads for each of the differences in the above table are provided in Table 9 to Table 12. Power flow diagrams of the scenarios that resulted in a thermal overload and a difference of 3% or higher as compared to the FATD, are shown in Attachment B.

Table 9: Scenario 2, Thermal Overloads with and without the South 69 kV Upgrades – 2019 (Steps 1 to 3 of the FATD Development Modelled)

Contingency	Critical Branch	With 69 kV Upgrades	Without 69 kV Upgrades
23.80L 138kV line outage. (Janet 74S to ENMAX No. 23)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	113% 221MVA	120% 234MVA
32.83L 138kV line outage. (ENMAX No. 32 to ENMAX No. 40)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	109% 213MVA	121% 238MVA
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	122% 359MVA	128% 376MVA

Table 10: Scenario 3, Thermal Overload with and without the South 69 kV Upgrades – 2019 (Steps 1 to 3 of the FATD Development Modelled)

Contingency	Critical Branch	With 69 kV Upgrades	Without 69 kV Upgrades
24.81L 138kV line outage. (ENMAX No. 31 to ENMAX No. 24)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	115% 272MVA	107% 279MVA
916L 240kV line outage. (Sarcee 42S to East Calgary 5S)	833L 138kV line (ENMAX No. 2 to ENMAX No. 12)	104% 181MVA	63% 120MVA
32.83L 138kV line outage. (ENMAX No. 32 to ENMAX No. 40)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	131% 229MVA	144% 253MVA
23.80L 138kV line outage. (Janet 74S to ENMAX No. 23)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	137% 238MVA	143% 249MVA
9.80L 138kV line outage. (ENMAX No. 31 to ENMAX No. 9)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	107% 155MVA	110% 159MVA
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	31.84L 138kV line (ENMAX No. 31 to ENMAX No. 32)	117% 166MVA	104% 147MVA
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	145% 376MVA	151% 392MVA

Table 11: Scenario 4, Thermal Overload with and without the South 69 kV Upgrades – 2019 (Steps 1 to 3 of the FATD Development Modelled)

Contingency	Critical Branch	With 69 kV Upgrades	Without 69 kV Upgrades
24.81L 138kV line outage. (ENMAX No. 31 to ENMAX No. 24)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	115% 314MVA	108% 294MVA
916L 240kV line outage. (Sarcee 42S to East Calgary 5S)	833L 138kV line (ENMAX No. 2 to ENMAX No. 12)	134% 252MVA	87% 163MVA
9.80L 138kV line outage. (ENMAX No. 31 to ENMAX No. 9)	40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	106% 167MVA	109% 172MVA
32.83L 138kV line outage. (ENMAX No. 32 to ENMAX No. 40)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	147% 279MVA	162% 306MVA
23.80L 138kV line outage. (Janet 74S to ENMAX No. 23)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	153% 289MVA	160% 301MVA
9.80L 138kV line outage. (ENMAX No. 31 to ENMAX No. 9)	32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	120% 189MVA	123% 194MVA
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	31.84L 138kV line (ENMAX No. 31 to ENMAX No. 32)	115% 179MVA	100% 156MVA
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	150% 427MVA	156% 443MVA

Table 12: Scenario 5, Thermal Overload with and without the South 69 kV Upgrades – 2019 (Steps 1 to 3 of the FATD Development Modelled)

Contingency	Critical Branch	Original FATD	Without 69 kV Conversion
23.80L 138kV line outage. (Janet 74S to ENMAX No. 23)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	96% 185MVA	102% 197MVA
26.83L 138kV line outage. (ENMAX No. 65 to ENMAX No. 26)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	110% 319MVA	116% 336MVA

3.2.2 Steps 1 to 4 of the FATD Plan

The 2019 study cases used for the studies with the proposed FATD Plan (Steps 1 to 4) modelled were modified to exclude all the south Calgary 69 kV transmission upgrades. The transmission elements included in Step 4 are shown in Table 13. The proposed FATD Plan (Steps 1 to 4) consists of all transmission elements in Table 7 and Table 13.

Table 13: Transmission Elements Included in Step 4 of the FATD Plan

Steps 1 to 4 of the FATD Required Developments
A new 240 kV double circuit line from Foothills 237S to Sarcee 42S with a minimum summer rating of 600 MVA for each circuit. The lines are designated 1066L and 1067L.
A new 138 kV single circuit line from ENMAX No. 65 to ENMAX No. 41 with in and out connection at ENMAX No. 54 substation. The minimum rating of this new line is 260 MVA. The line is designated 54.81L from ENMAX No. 65 to ENMAX No. 54 substation and 41.84L from ENMAX No. 54 to ENMAX No. 41 substation[1].

[1] FATD proposes to restore the current connectivity between ENMAX No. 26 and ENMAX No. 32 substations through 26.81L. The ENMAX No. 54 substation will be initially connected in and out to 26.81L in the ENMAX No. 54 connection project, i.e., 26.81L (ENMAX No. 26 to ENMAX No. 54) and 32.82L (ENMAX No. 54 to ENMAX No. 32).

The study scenarios are provided in Table 1. The 2019 summer peak loading level was assumed for Scenarios 1 to 5, and the 2019 system light loading condition was assumed for Scenario 6.

Except for the exclusion of all the south Calgary 69 kV transmission upgrades, all study assumptions, system data, and applied criteria were consistent with those in the FATD Engineering Report (Section 2). The existing 69 kV transmission system was modelled for the sensitivity studies.

The following power flow studies were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)

In summary, sensitivity study results showed no thermal overloads within the FATD scope of planning which is consistent with the FATD planning study results with the complete FATD Plan implemented. The power flow diagram for the scenario that resulted in the greatest change is shown in Attachment C (no thermal overload was experienced as a result of an outage).

The sensitivity study results did not indicate the need for any changes to the FATD Plan.

3.2.3 Summary of the 2019 FATD Results (Steps 1 to 3 and Steps 1 to 4)

The sensitivity study results demonstrate that exclusion of all the south Calgary 69 kV transmission upgrades has no material impacts on the 2019 FATD planning study results with Steps 1 to 3 of the FATD plan in place or with the complete FATD Plan (Steps 1 to 4) in place. Therefore, no changes to the proposed FATD Plan are required.

4. SUMMARY AND CONCLUSIONS

To determine whether 69 kV transmission system upgrades in south Calgary would affect the conclusions and recommendations in the FATD Engineering Report, AESO carried out sensitivity studies in which the existing 69 kV transmission system in south Calgary was modelled without any upgrades. The results of these studies were compared to the results of the FATD planning studies.

Except for the exclusion of the South Calgary 69 kV Transmission Project, all study scenarios, assumptions, system data, and applied criteria were consistent with those used in the FATD Engineering Report dated April 29, 2011.

The following sensitivity studies were performed assuming the existing 69 kV transmission system in south Calgary:

- 2014 Need Assessment
- 2019 FATD Plan Analysis – Assuming only Steps 1 to 3 of the FATD Plan
- 2019 FATD Plan Analysis – Assuming the complete FATD Plan (Steps 1 to 4)

The following power flow studies were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)

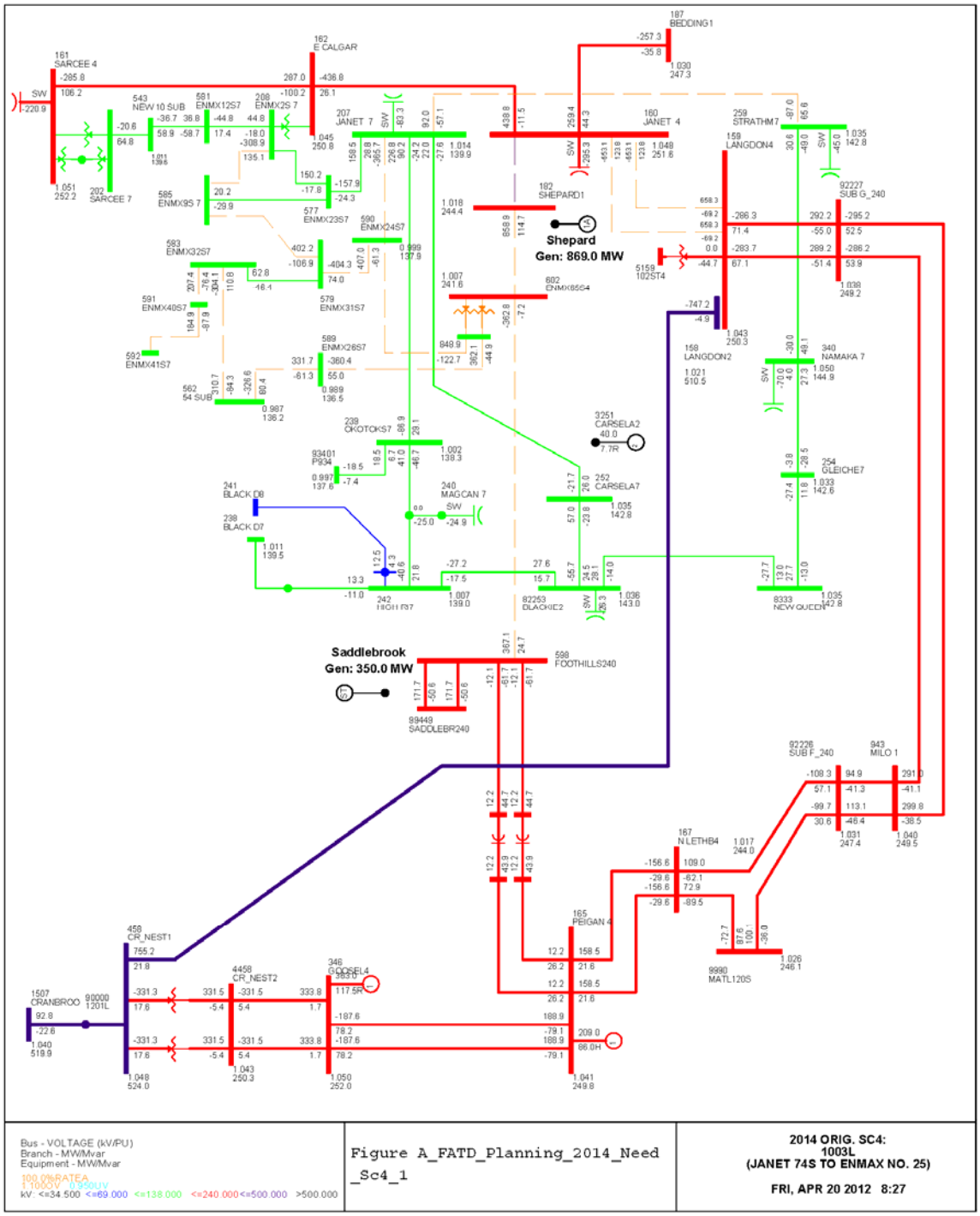
A comparison of the results of the sensitivity studies with the results of the FATD planning studies showed that the 2014 Need Assessment conclusions in the FATD Engineering Report are not materially impacted if the south Calgary 69 kV transmission upgrade is not implemented. Moreover, it was found that the proposed transmission developments in the FATD Plan are not materially impacted if the 69 kV transmission upgrade is not implemented.

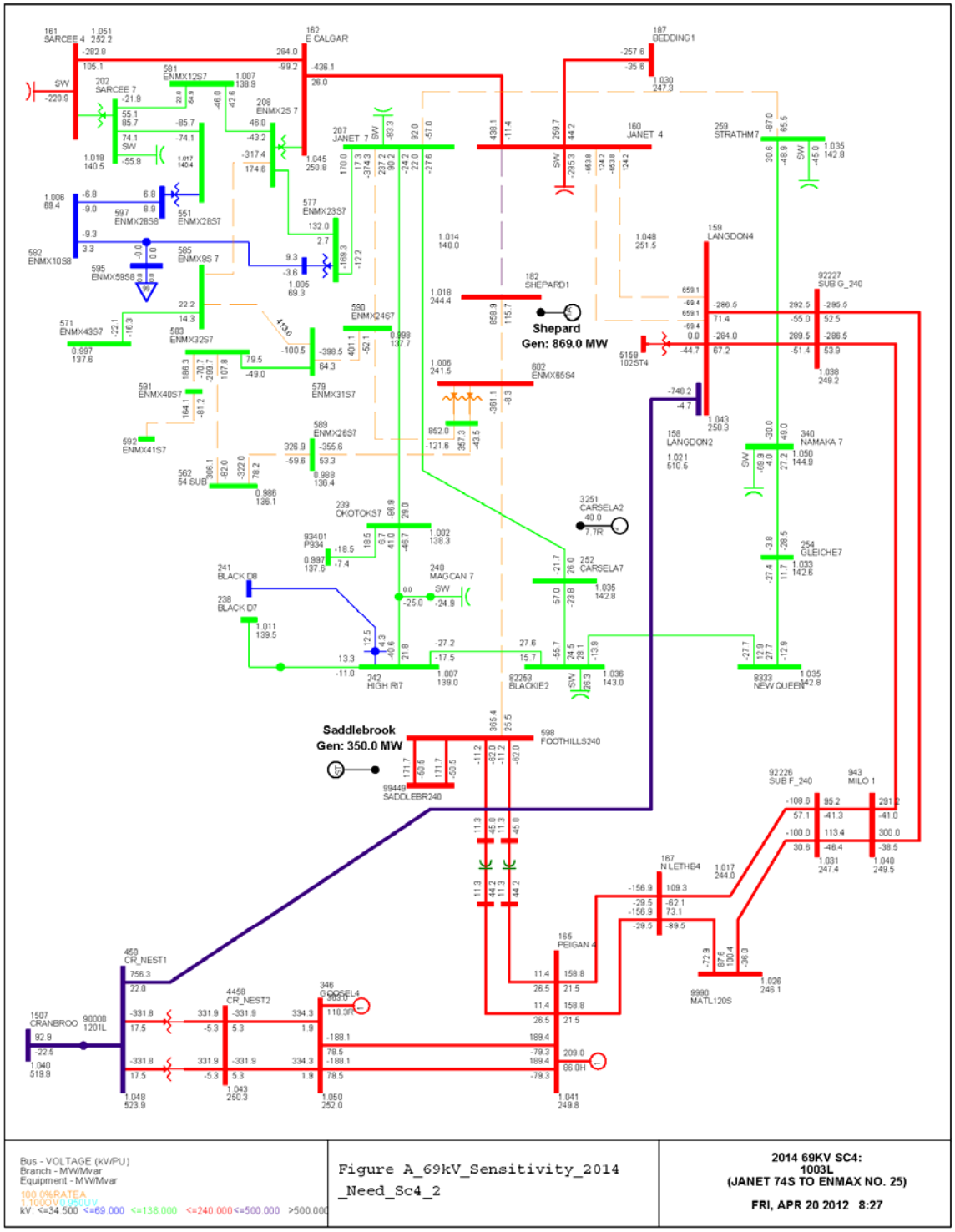
Therefore, all conclusions reported in the FATD Engineering Report would remain applicable without any south Calgary 69 kV transmission upgrades. No changes to the identified need or to the proposed transmission system developments in the FATD Plan are required.

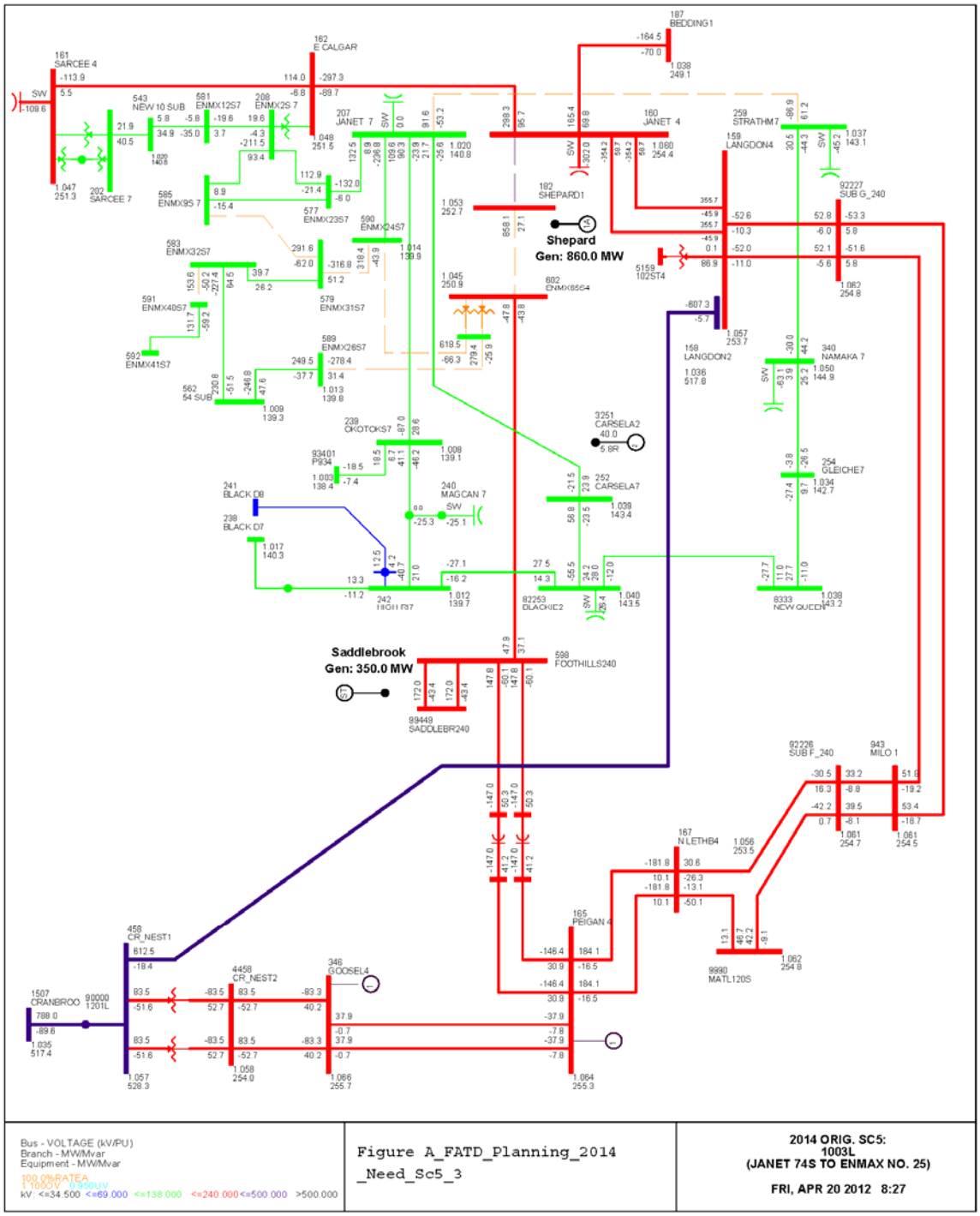
Based on the sensitivity studies performed, it can be concluded that if no changes to the FATD Plan are required in the extreme case of no upgrades to the south Calgary 69 kV system, then no changes to the FATD Plan would be required if some, but not all, of the South Calgary NID upgrades are implemented.

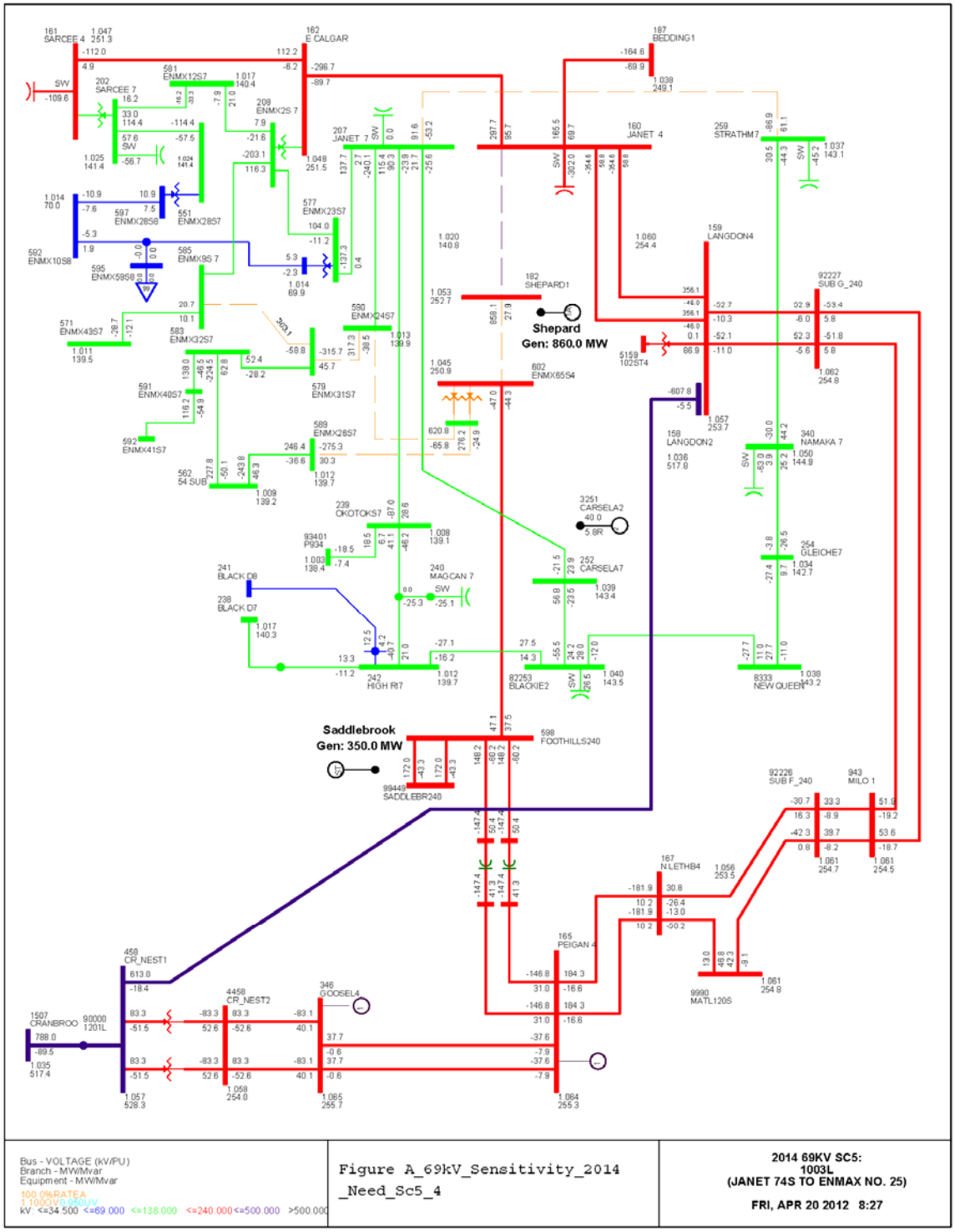
ATTACHMENT A: NEED ASSESSMENT – 2014

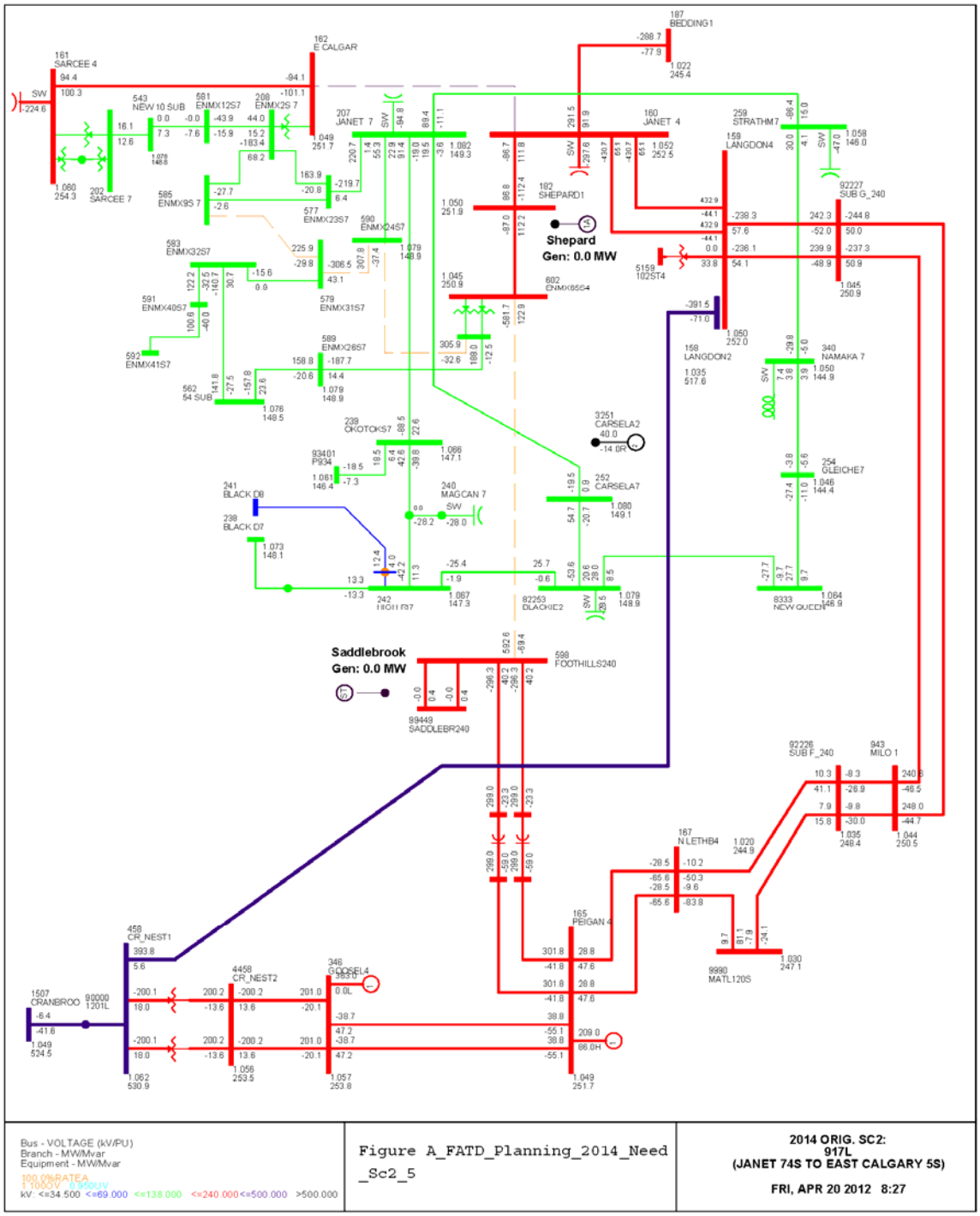
Table A-1	
Figure Name	**Contingency**
Figure A_FATD_Planning_2014_Need_Sc4_1	Open 1003L (Janet 74S to Enmax No. 25)
Figure A_69kV_Sensitivity_2014_Need_Sc4_2	Open 1003L (Janet 74S to Enmax No. 25)
Figure A_FATD_Planning_2014_Need_Sc5_3	Open 1003L (Janet 74S to Enmax No. 25)
Figure A_69kV_Sensitivity_2014_Need_Sc5_4	Open 1003L (Janet 74S to Enmax No. 25)
Figure A_FATD_Planning_2014_Need_Sc2_5	Open 917L (Janet 74S to East Calgary 5S)
Figure A_69kV_Sensitivity_2014_Need_Sc2_6	Open 917L (Janet 74S to East Calgary 5S)
Figure A_FATD_Planning_2014_Need_Sc3_7	Open 917L (Janet 74S to East Calgary 5S)
Figure A_69kV_Sensitivity_2014_Need_Sc3_8	Open 917L (Janet 74S to East Calgary 5S)
Figure A_FATD_Planning_2014_Need_Sc4_9	Open 917L (Janet 74S to East Calgary 5S)
Figure A_69kV_Sensitivity_2014_Need_Sc4_10	Open 917L (Janet 74S to East Calgary 5S)
Figure A_FATD_Planning_2014_Need_Sc5_11	Open 917L (Janet 74S to East Calgary 5S)
Figure A_69kV_Sensitivity_2014_Need_Sc5_12	Open 917L (Janet 74S to East Calgary 5S)
Figure A_FATD_Planning_2014_Need_Sc2_13	Open 26.83L (SS-65 to SS-26)
Figure A_69kV_Sensitivity_2014_Need_Sc2_14	Open 26.83L (SS-65 to SS-26)

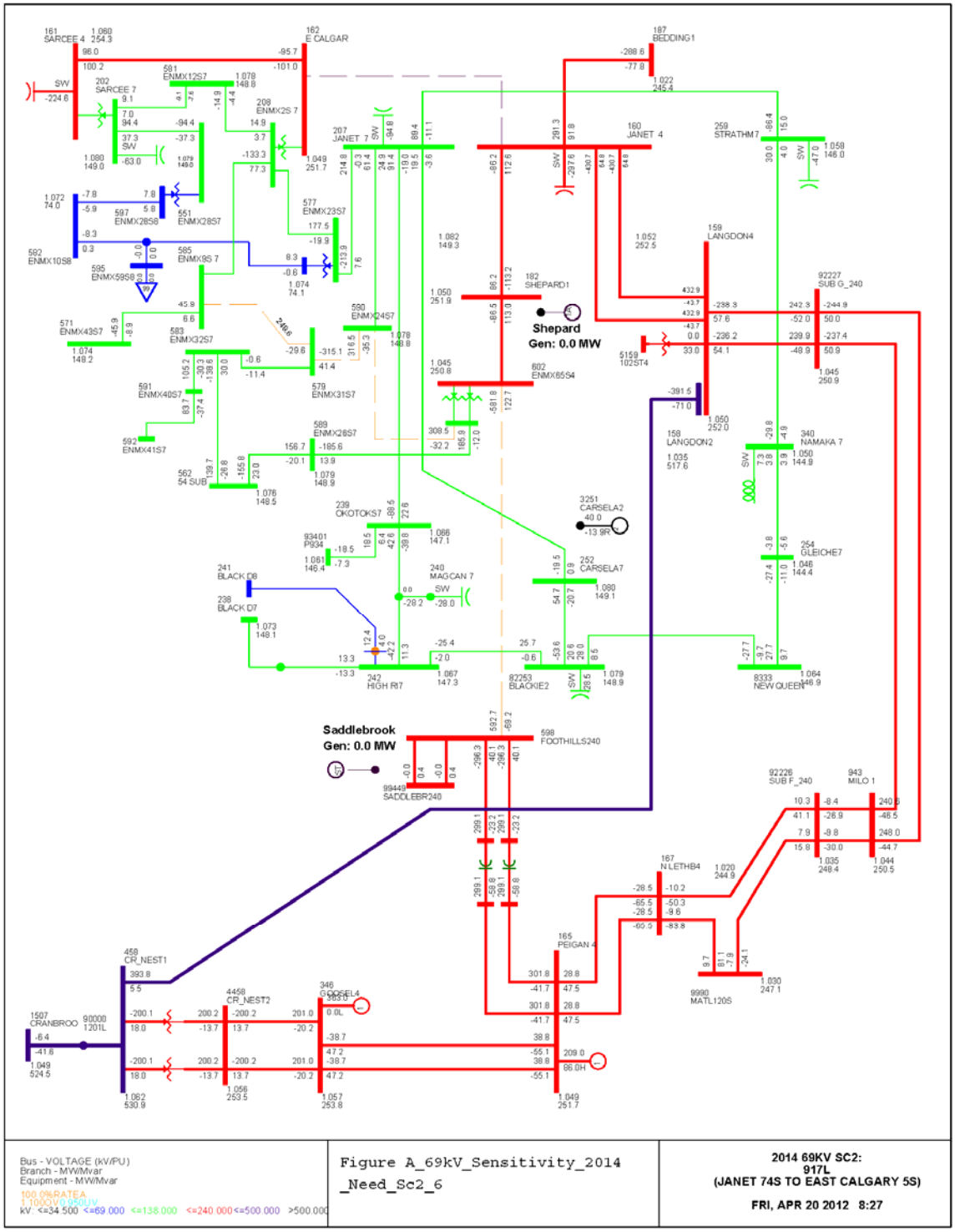

Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_FATD_Planning_2014_Need_Sc4_1
2014 ORIG. SC4:
1003L
(JANET 74S TO ENMAX NO. 25)
FRI, APR 20 2012 8:27

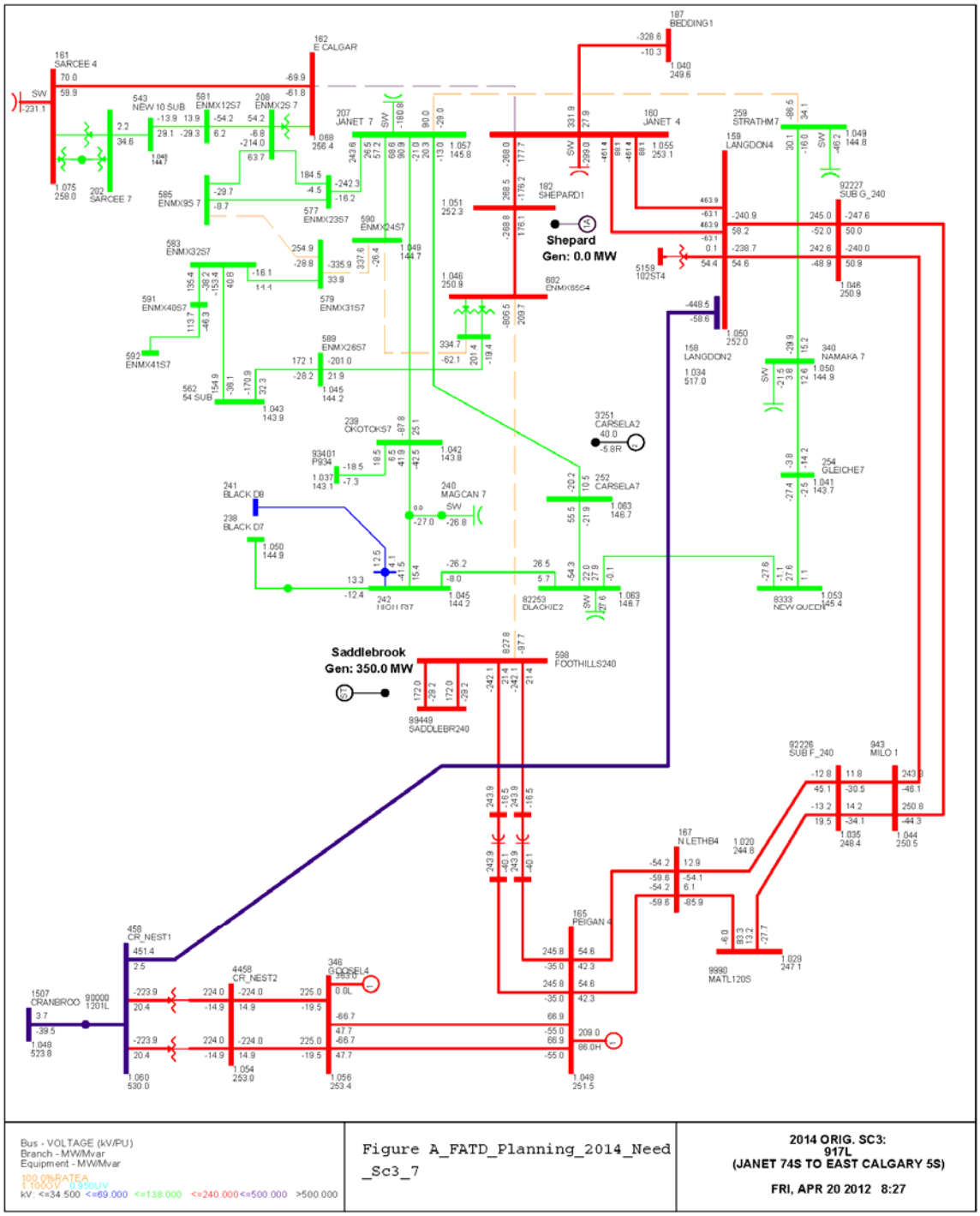

Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_69kV_Sensitivity_2014_Need_Sc4_2
2014 69KV SC4:
1003L
(JANET 74S TO ENMAX NO. 25)
FRI, APR 20 2012 8:27

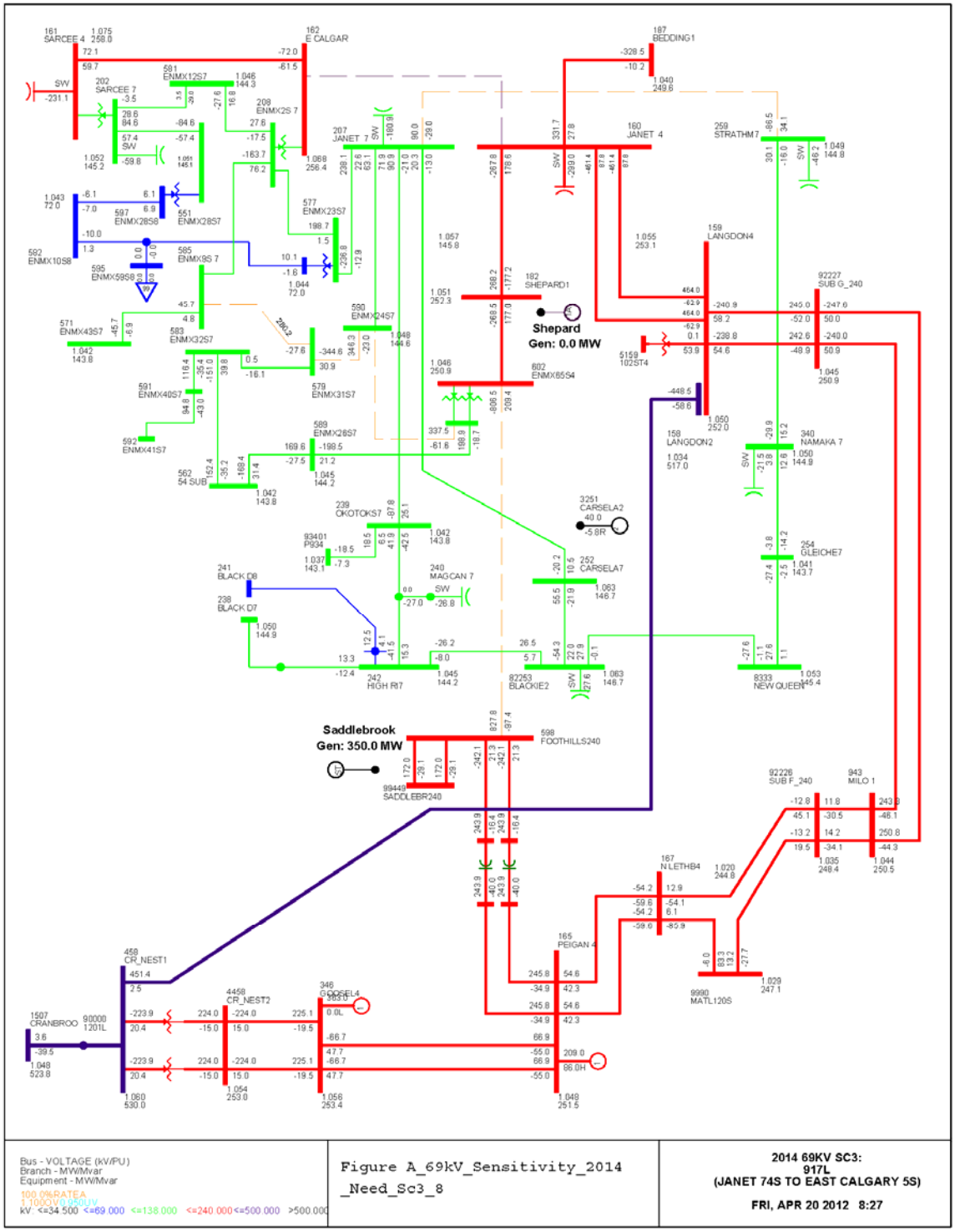

Shepard
Gen: 860.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_FATD_Planning_2014_Need_Sc5_3
2014 ORIG. SC5:
1003L
(JANET 74S TO ENMAX NO. 25)
FRI, APR 20 2012 8:27

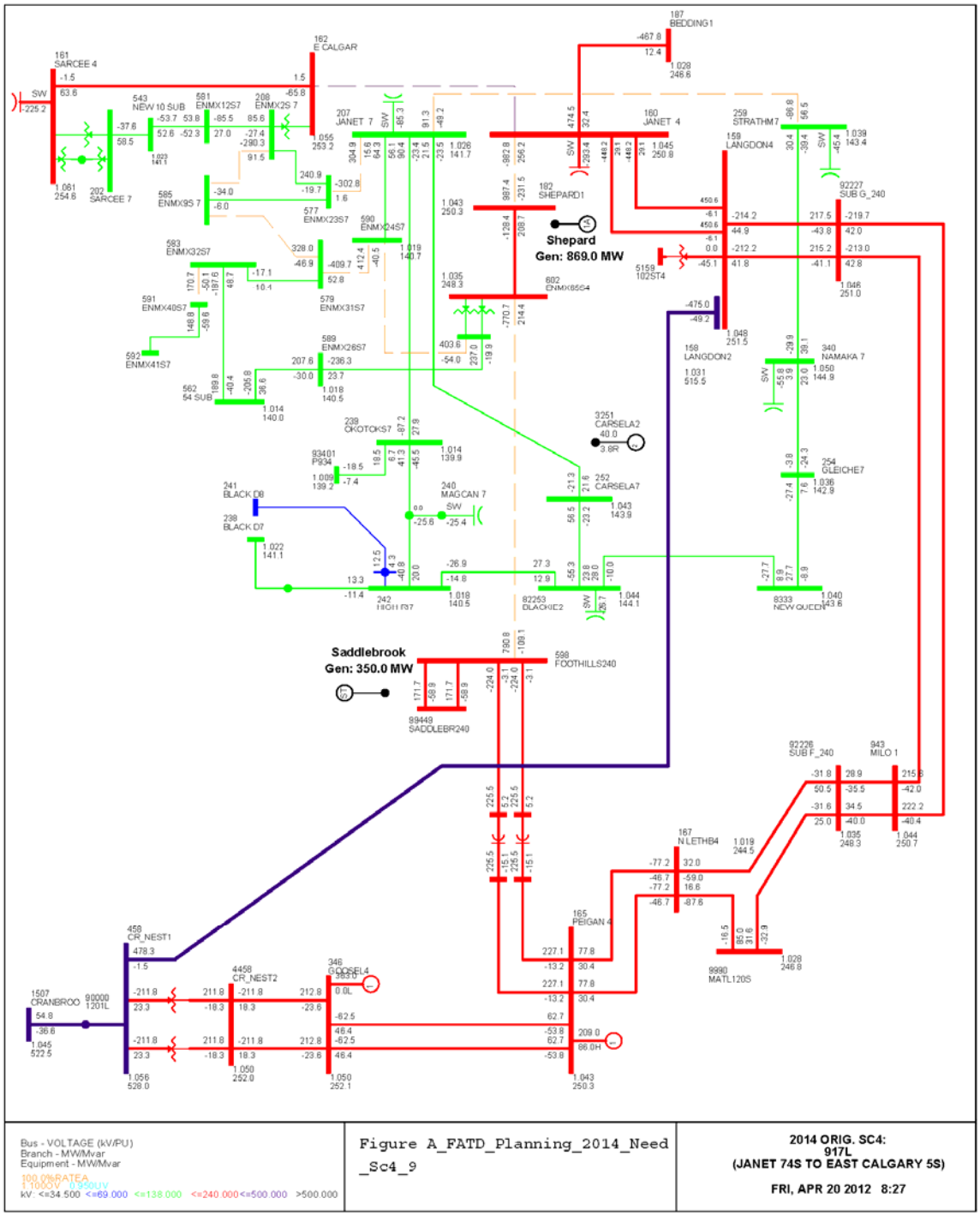

Shepard
Gen: 860.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_69kV_Sensitivity_2014_Need_Sc5_4
2014 69KV SC5:
1003L
(JANET 74S TO ENMAX NO. 25)
FRI, APR 20 2012 8:27

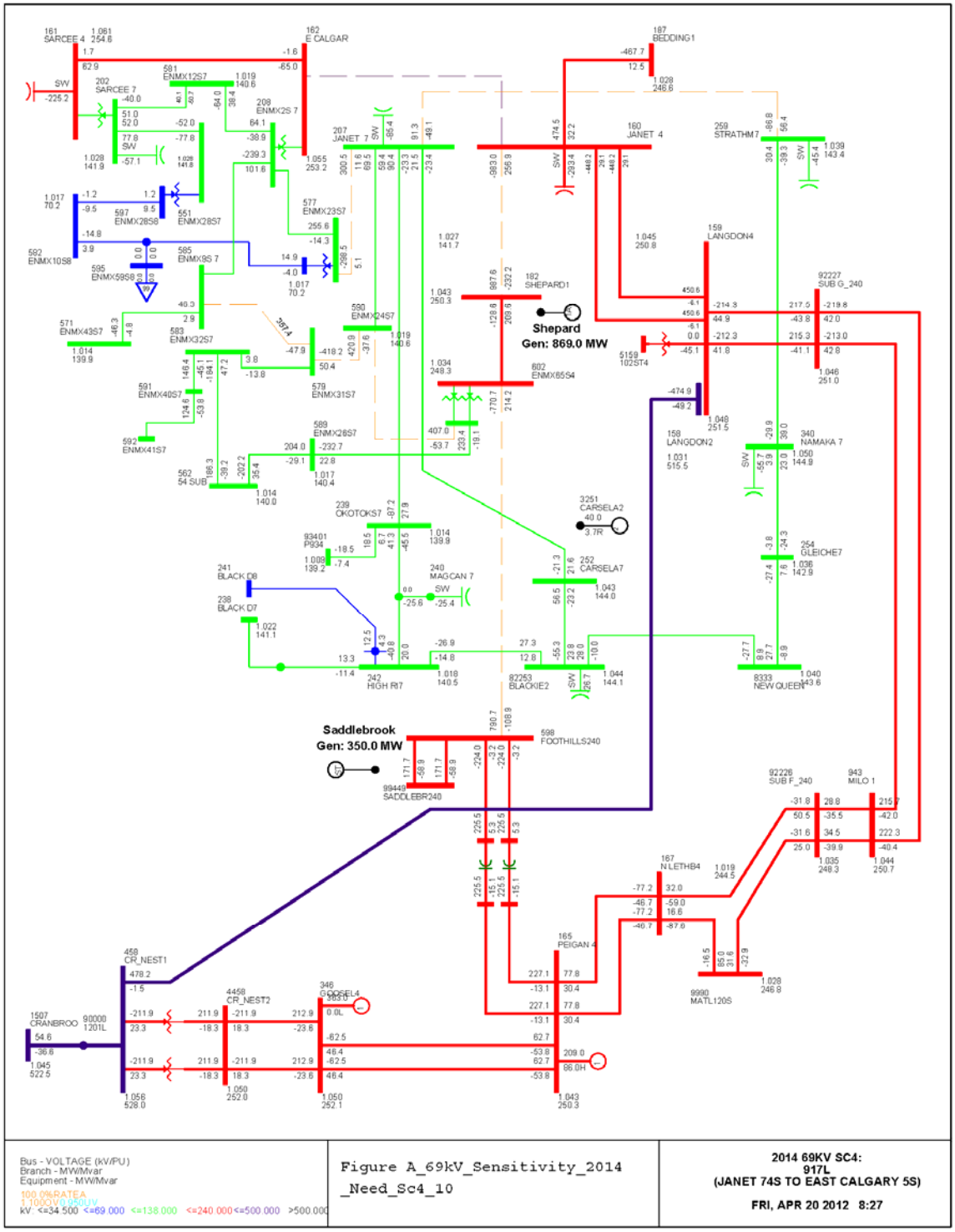

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_FATD_Planning_2014_Need_Sc2_5
2014 ORIG. SC2:
917L
(JANET 74S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:27

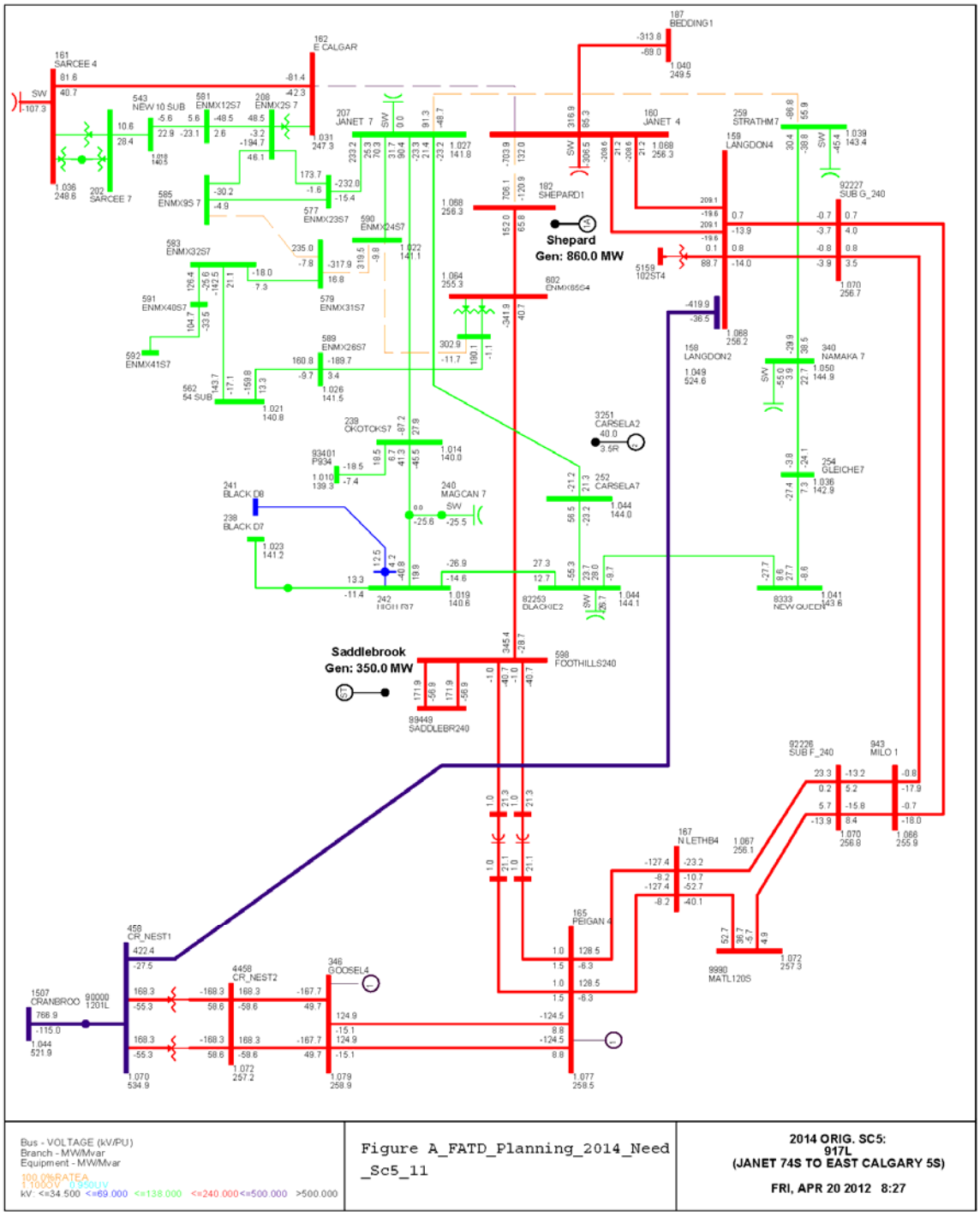

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_69kV_Sensitivity_2014_Need_Sc2_6
2014 69KV SC2:
917L
(JANET 74S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:27

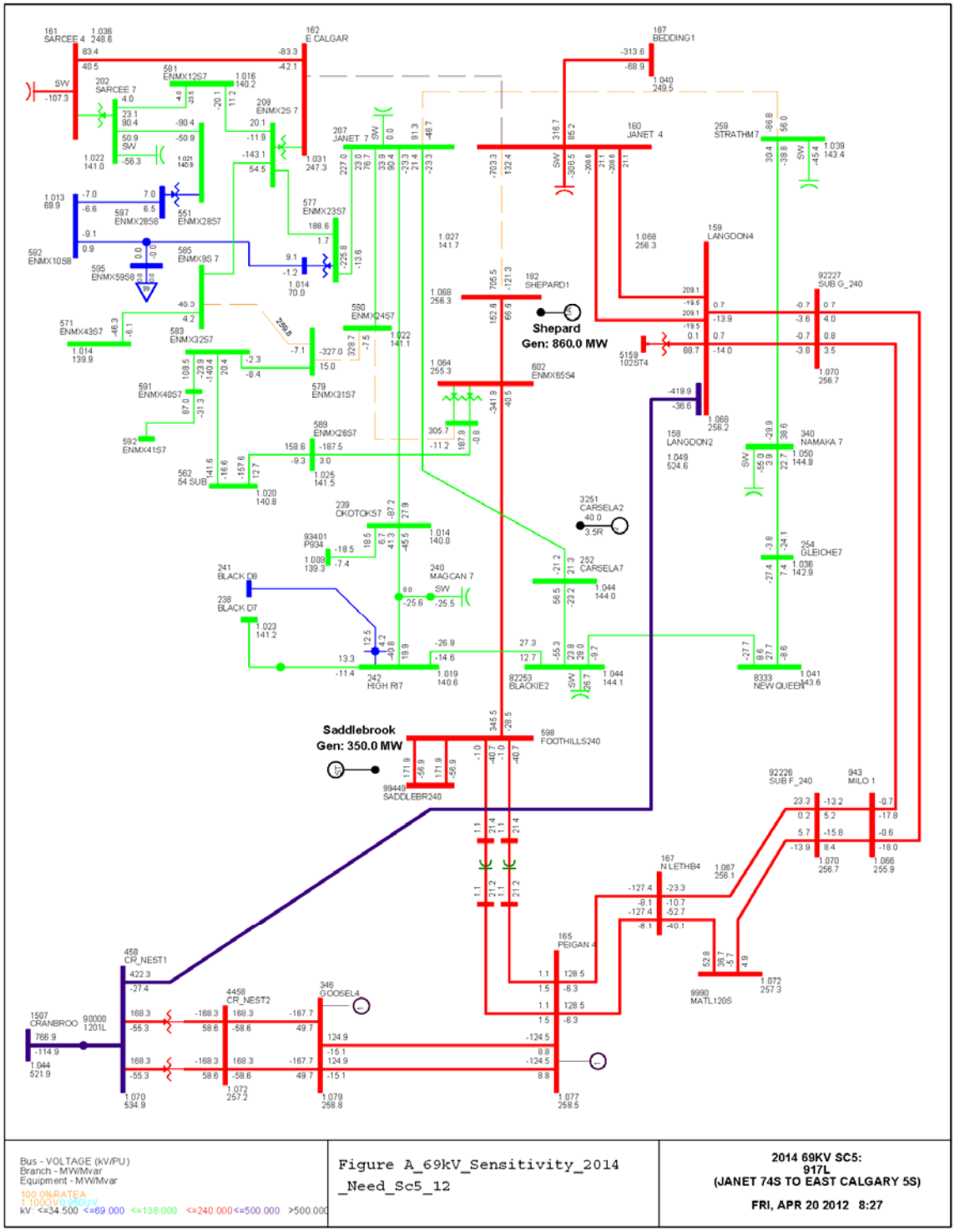

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
Figure A_FATD_Planning_2014_Need_Sc3_7
2014 ORIG. SC3:
917L
(JANET 74S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:27

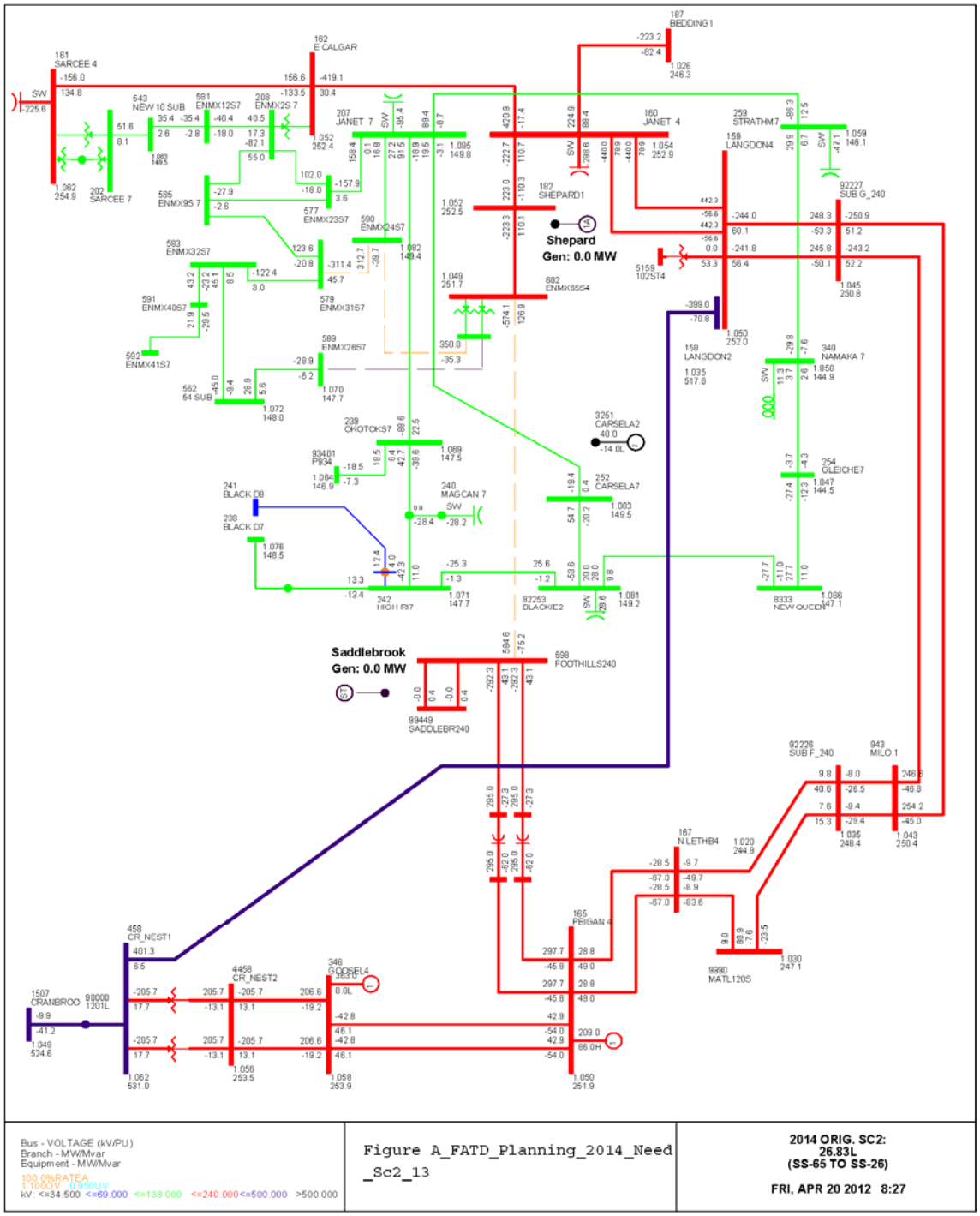

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_69kV_Sensitivity_2014_Need_Sc3_8
2014 69KV SC3:
917L
(JANET 74S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:27

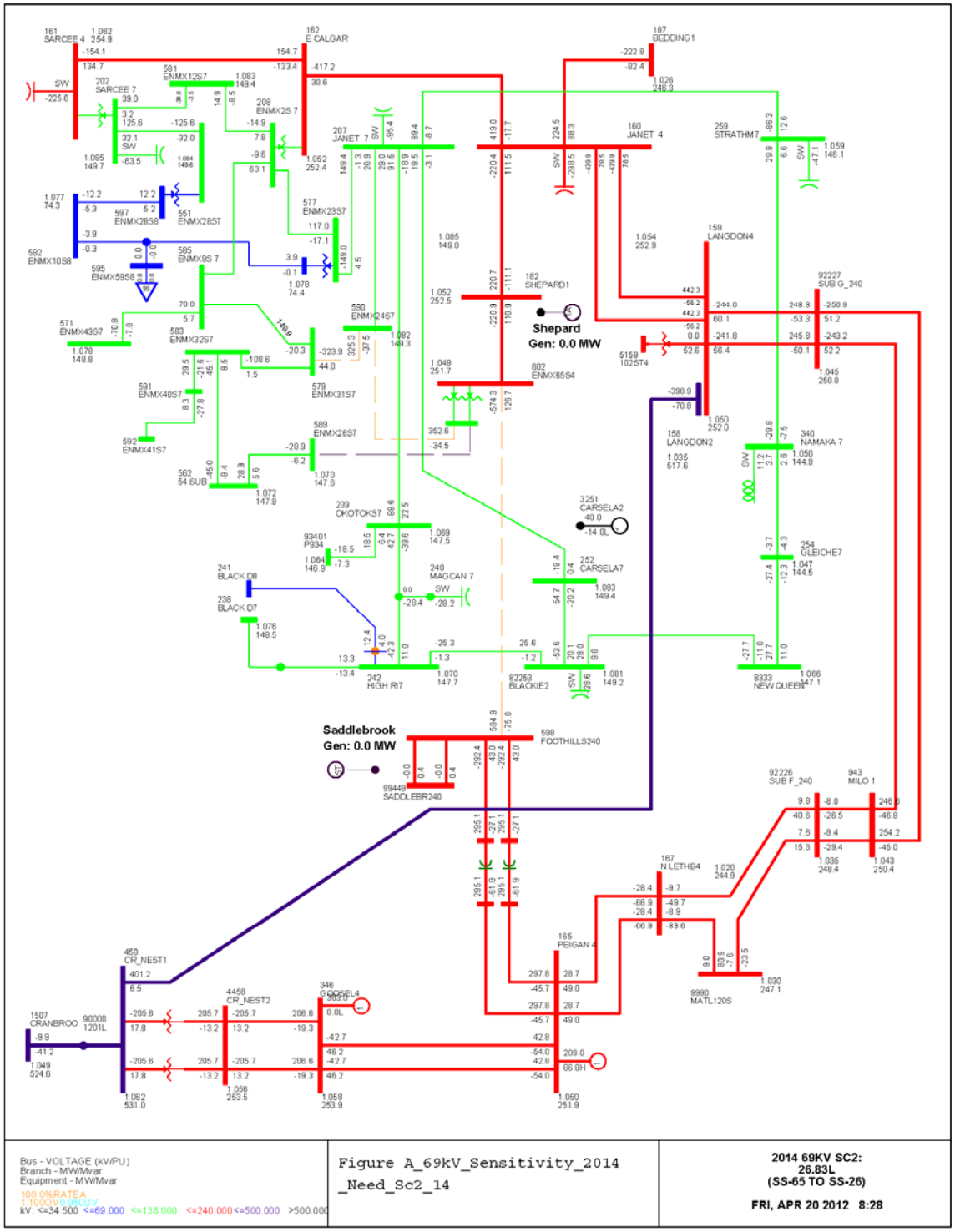

Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_FATD_Planning_2014_Need_Sc4_9
2014 ORIG. SC4:
917L
(JANET 74S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:27


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_69kV_Sensitivity_2014_Need_Sc4_10
2014 69KV SC4:
917L
(JANET 74S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:27


Shepard
Gen: 860.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_FATD_Planning_2014_Need_Sc5_11
2014 ORIG. SC5:
917L
(JANET 74S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:27

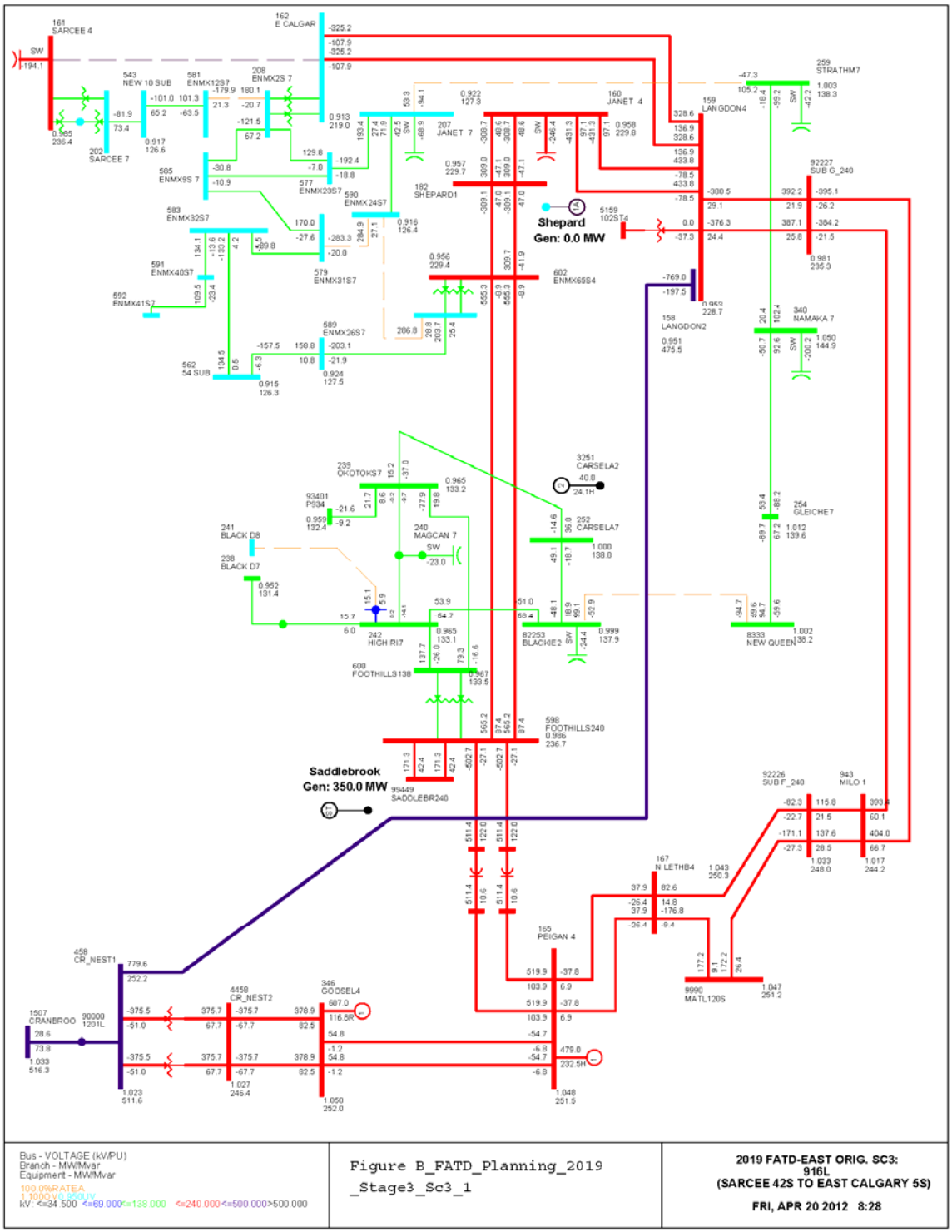

Shepard
Gen: 860.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_69kV_Sensitivity_2014_Need_Sc5_12
2014 69KV SC5:
917L
(JANET 74S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:27

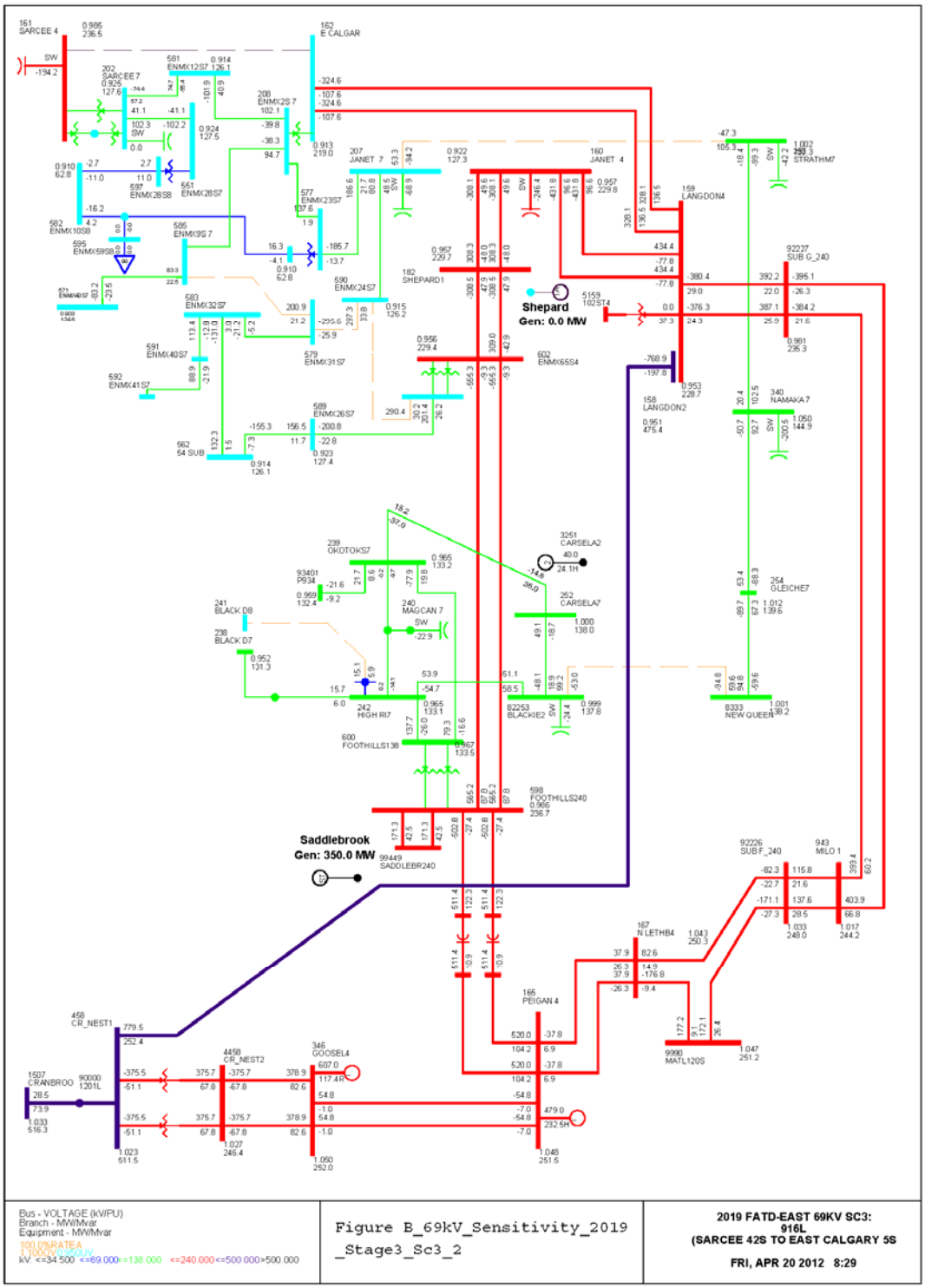

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_FATD_Planning_2014_Need_Sc2_13
2014 ORIG. SC2:
26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:27

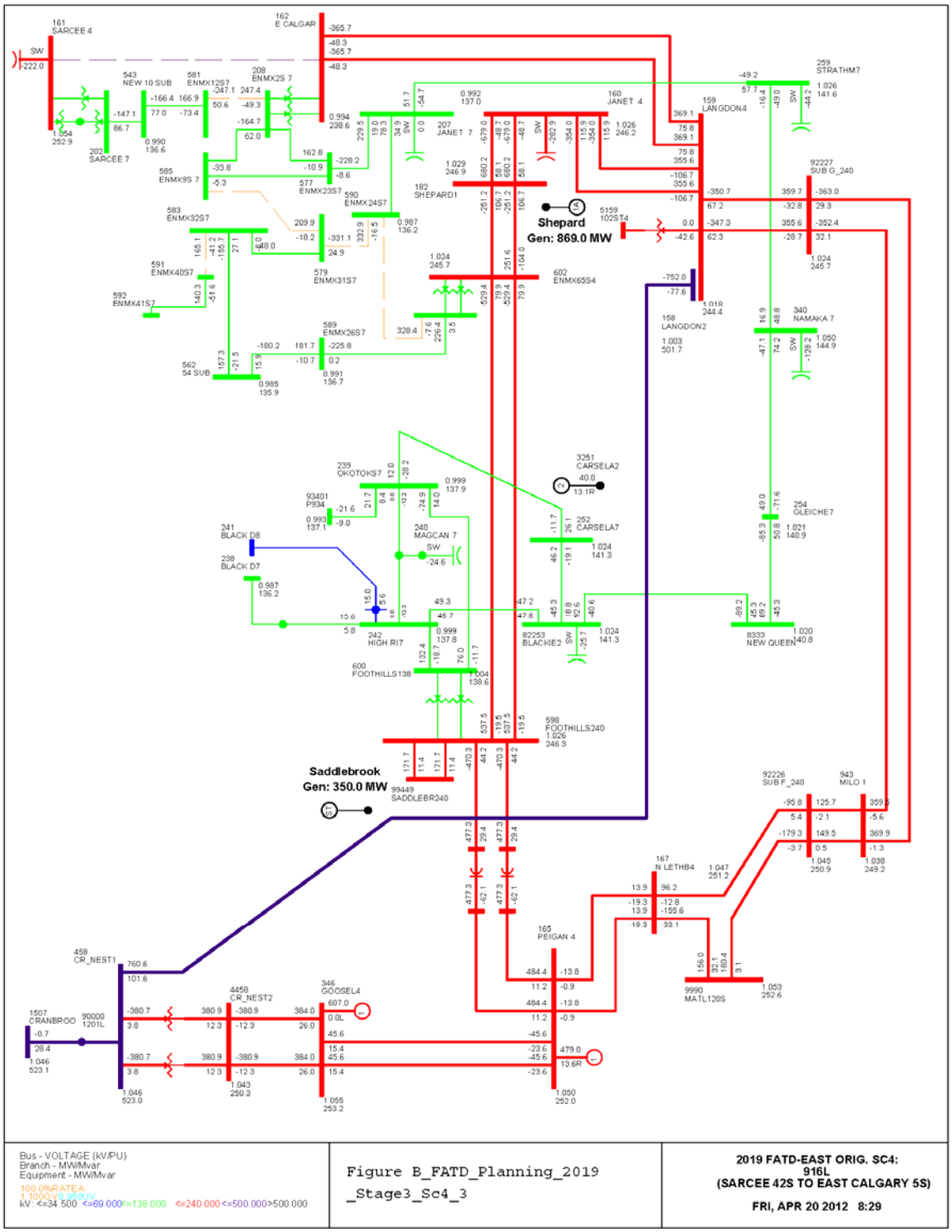

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure A_69kV_Sensitivity_2014_Need_Sc2_14
2014 69KV SC2:
26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:28

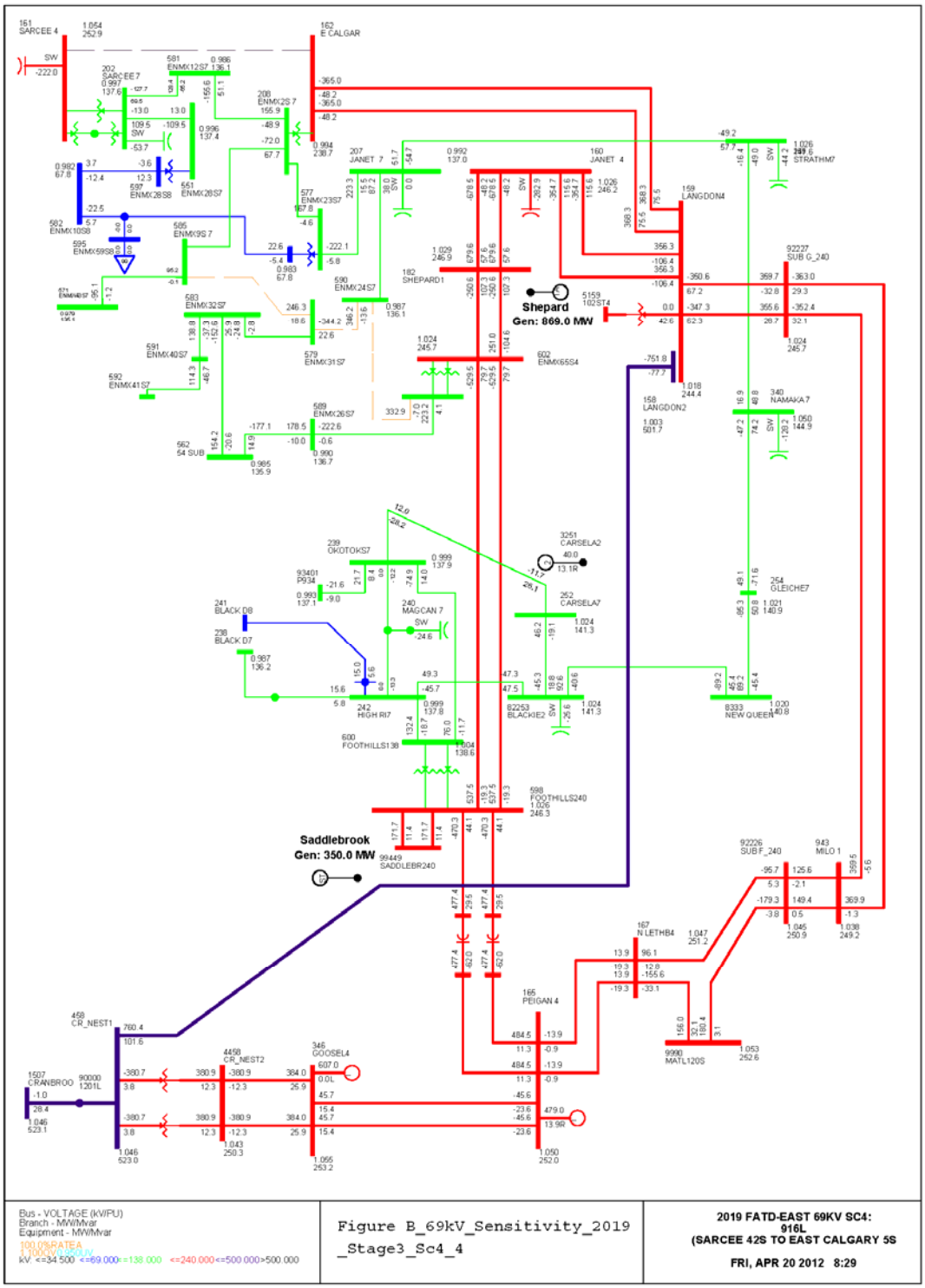
ATTACHMENT B: FATD EAST ASSESSMENT – 2019

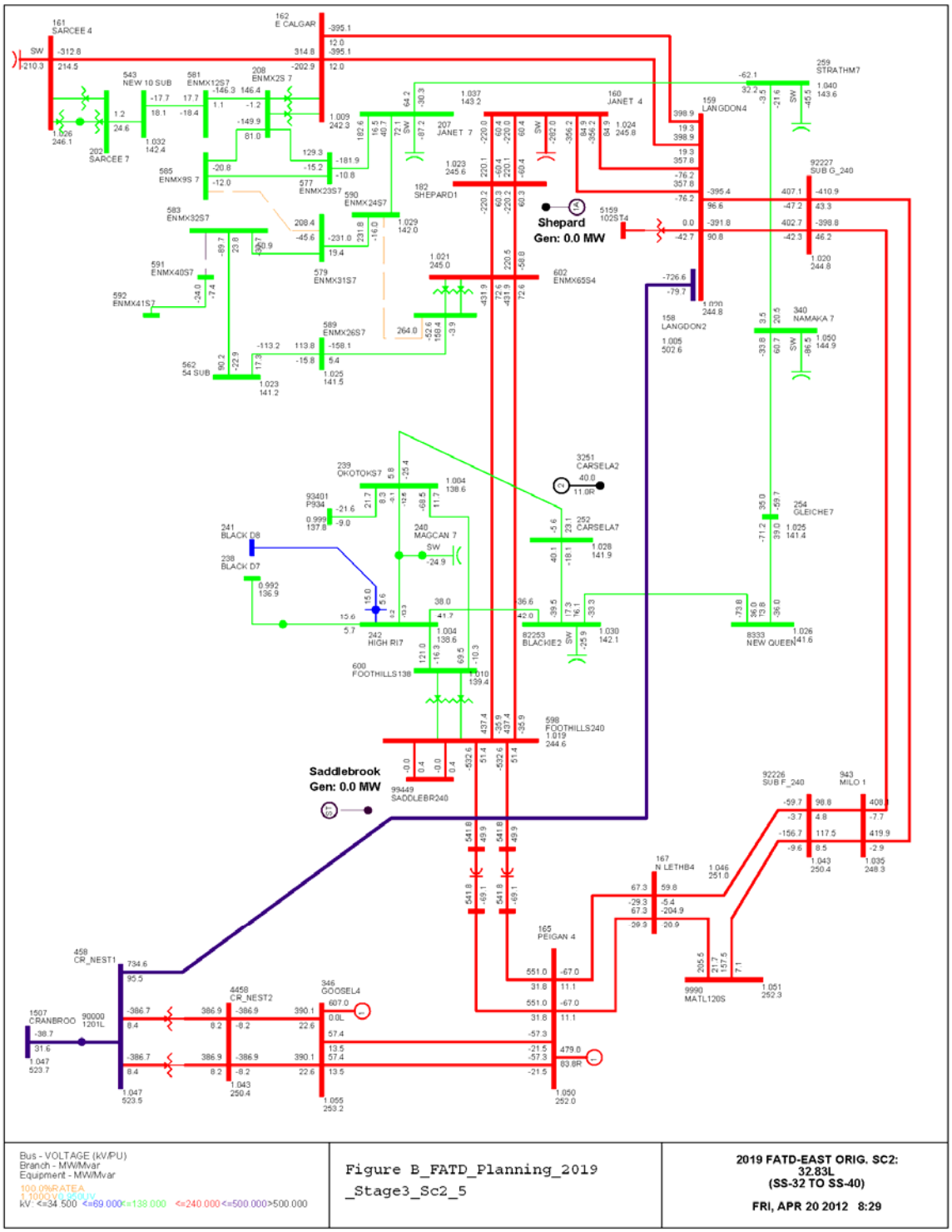
Table B-1	
Figure Name	**Contingency**
Figure B_FATD_Planning_2019_Stage3_Sc3_1	Open 916L (Sarcee 42S to East Calgary 5S)
Figure B_69kV_Sensitivity_2019_Stage3_Sc3_2	Open 916L (Sarcee 42S to East Calgary 5S)
Figure B_FATD_Planning_2019_Stage3_Sc4_3	Open 916L (Sarcee 42S to East Calgary 5S)
Figure B_69kV_Sensitivity_2019_Stage3_Sc4_4	Open 916L (Sarcee 42S to East Calgary 5S)
Figure B_FATD_Planning_2019_Stage3_Sc2_5	Open 32.83L (SS-32 to SS-40)
Figure B_69kV_Sensitivity_2019_Stage3_Sc2_6	Open 32.83L (SS-32 to SS-40)
Figure B_FATD_Planning_2019_Stage3_Sc3_7	Open 32.83L (SS-32 to SS-40)
Figure B_69kV_Sensitivity_2019_Stage3_Sc3_8	Open 32.83L (SS-32 to SS-40)
Figure B_FATD_Planning_2019_Stage3_Sc4_9	Open 32.83L (SS-32 to SS-40)
Figure B_69kV_Sensitivity_2019_Stage3_Sc4_10	Open 32.83L (SS-32 to SS-40)
Figure B_FATD_Planning_2019_Stage3_Sc2_11	Open 26.83L (SS-65 to SS-26)
Figure B_69kV_Sensitivity_2019_Stage3_Sc2_12	Open 26.83L (SS-65 to SS-26)
Figure B_FATD_Planning_2019_Stage3_Sc3_13	Open 26.83L (SS-65 to SS-26)
Figure B_69kV_Sensitivity_2019_Stage3_Sc3_14	Open 26.83L (SS-65 to SS-26)
Figure B_FATD_Planning_2019_Stage3_Sc4_15	Open 26.83L (SS-65 to SS-26)
Figure B_69kV_Sensitivity_2019_Stage3_Sc4_16	Open 26.83L (SS-65 to SS-26)
Figure B_FATD_Planning_2019_Stage3_Sc5_17	Open 26.83L (SS-65 to SS-26)
Figure B_69kV_Sensitivity_2019_Stage3_Sc5_18	Open 26.83L (SS-65 to SS-26)

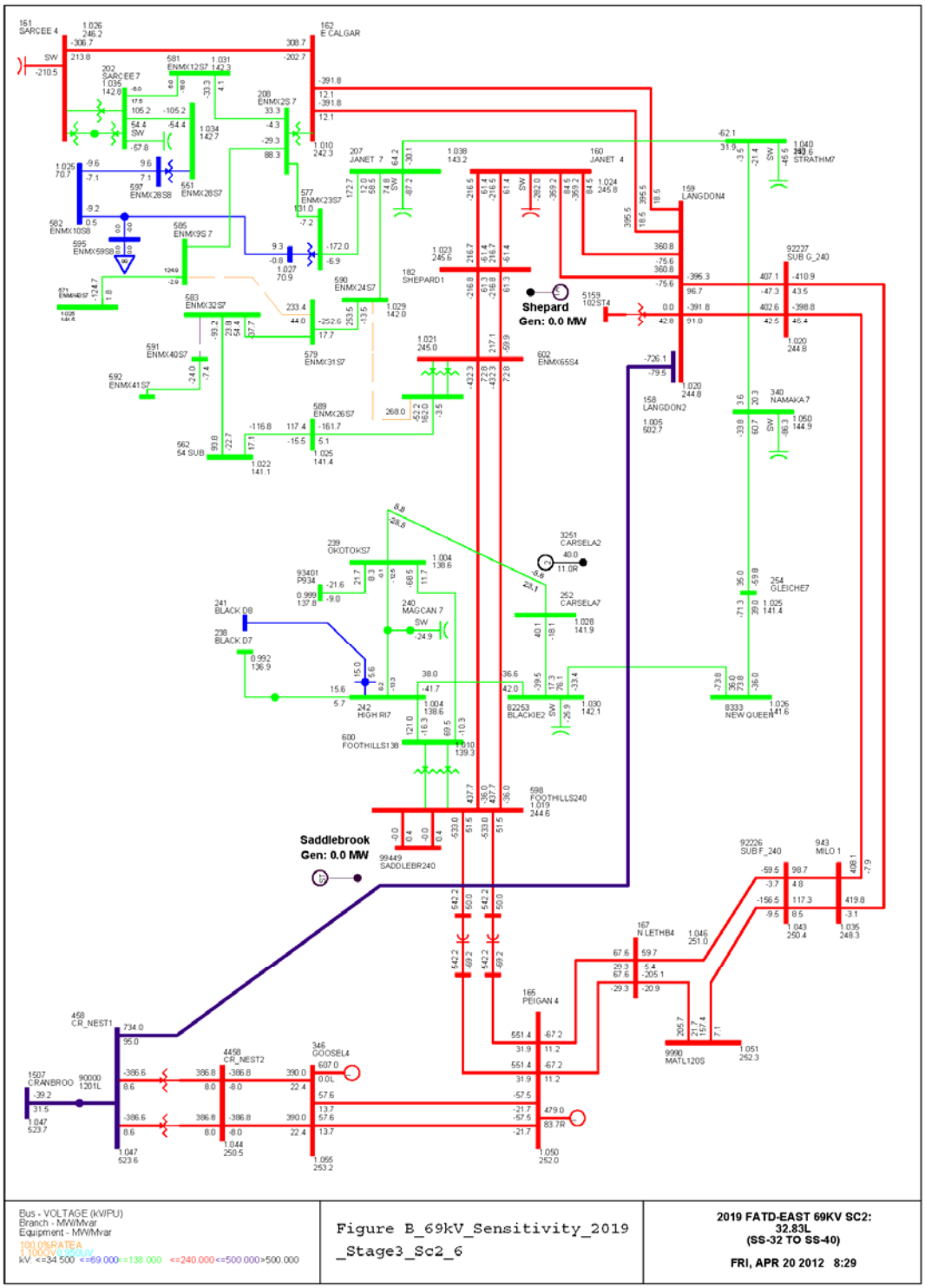

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/MVar
Equipment - MW/MVar
100.0%RATE A
1.100pu/0.950pu
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_FATD_Planning_2019_Stage3_Sc3_1
2019 FATD-EAST ORIG. SC3:
916L
(SARCEE 42S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:28

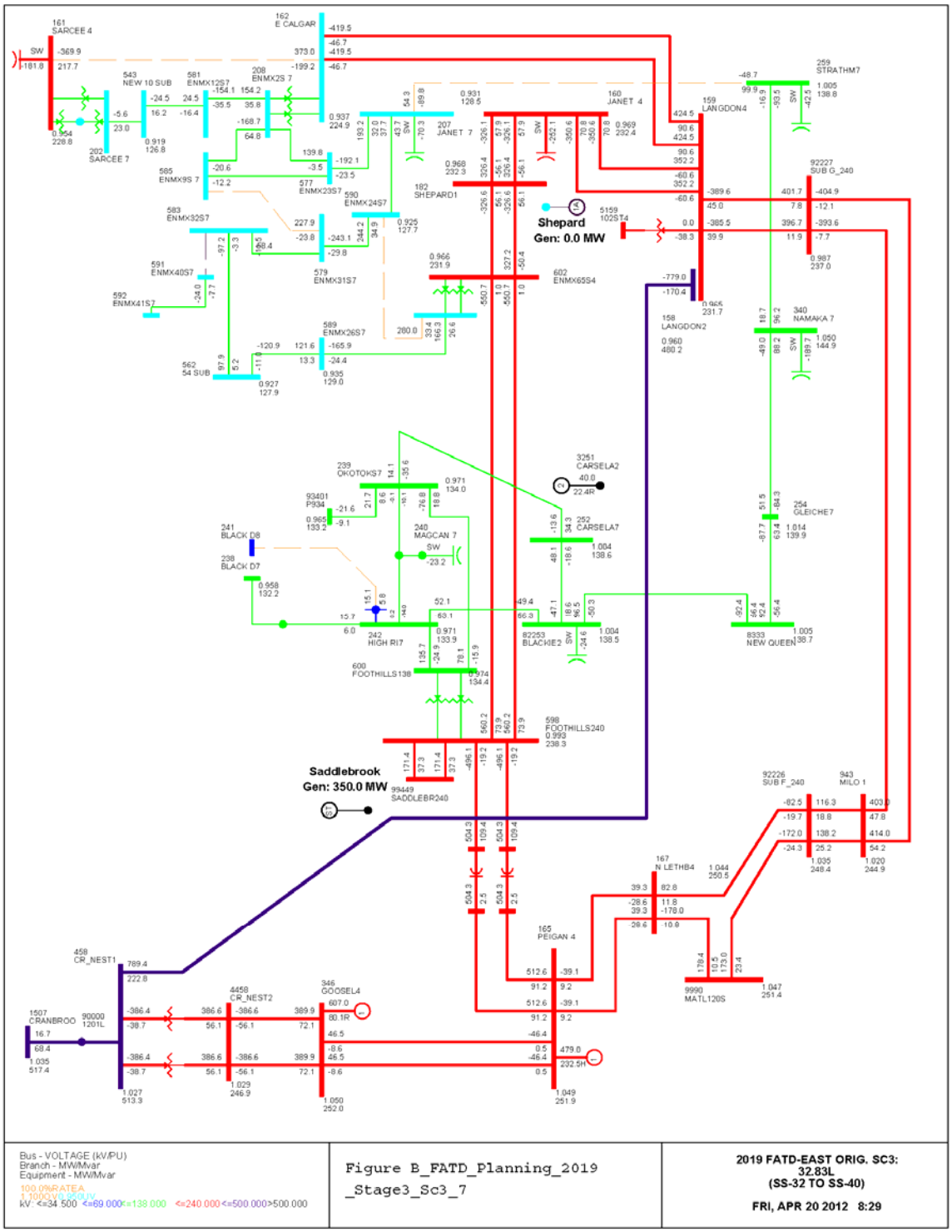

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_69kV_Sensitivity_2019_Stage3_Sc3_2
2019 FATD-EAST 69KV SC3:
916L
(SARCEE 42S TO EAST CALGARY 5S
FRI, APR 20 2012 8:29

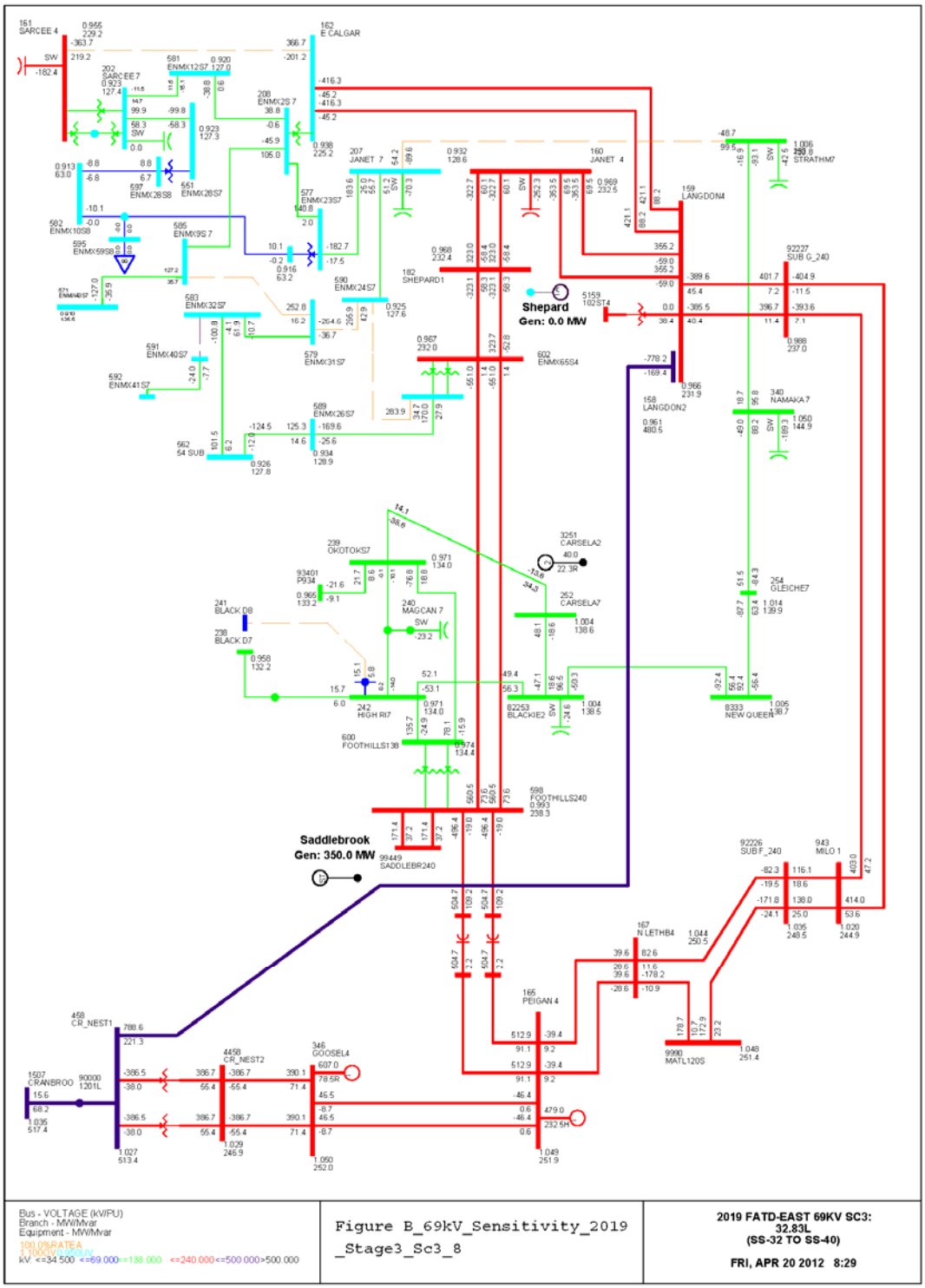

Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/MVar
Equipment - MW/MVar
100.0%RATEA
1.100(U)/0.950(UV
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_FATD_Planning_2019_Stage3_Sc4_3
2019 FATD-EAST ORIG. SC4:
916L
(SARCEE 42S TO EAST CALGARY 5S)
FRI, APR 20 2012 8:29

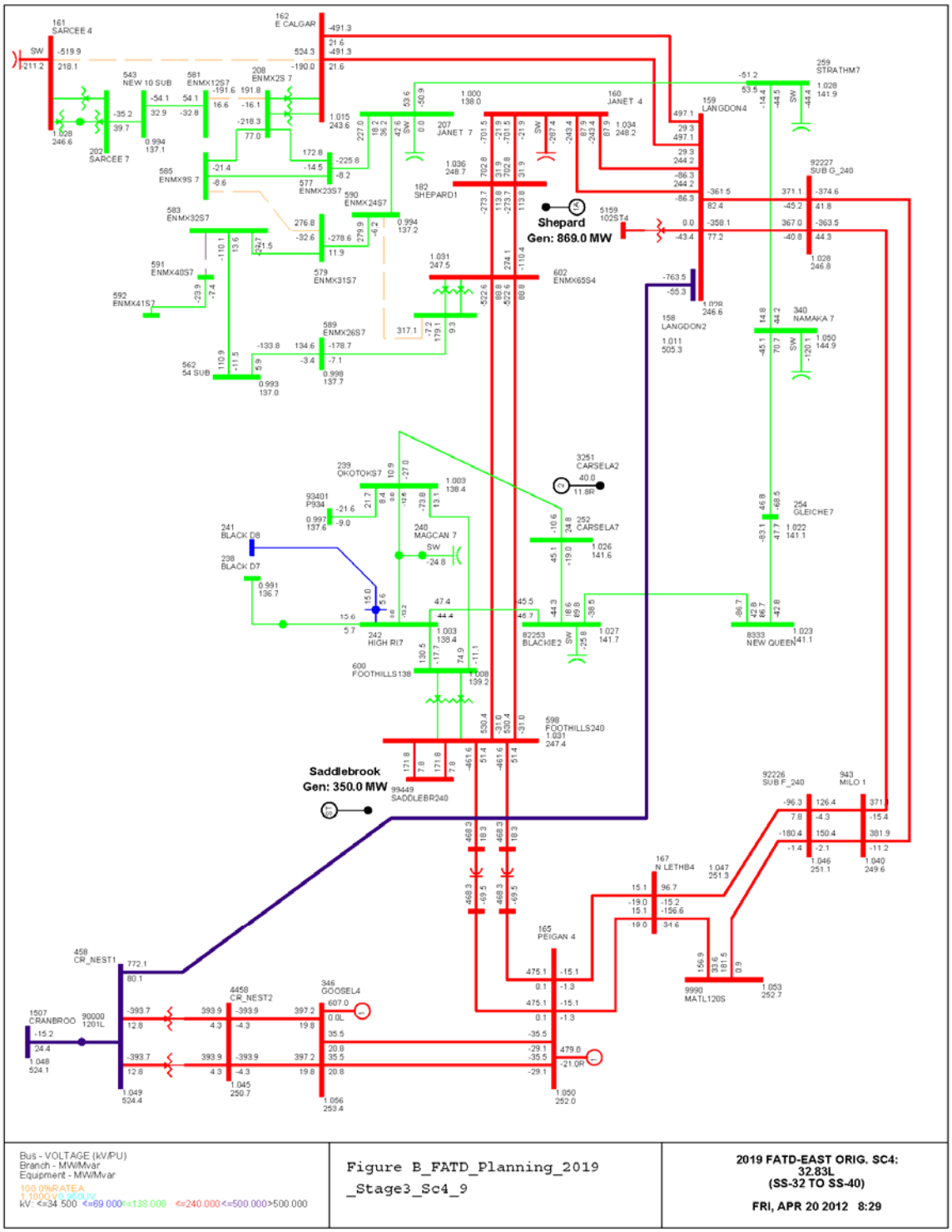

Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_69kV_Sensitivity_2019_Stage3_Sc4_4
2019 FATD-EAST 69KV SC4:
916L
(SARCEE 42S TO EAST CALGARY 5S
FRI, APR 20 2012 8:29

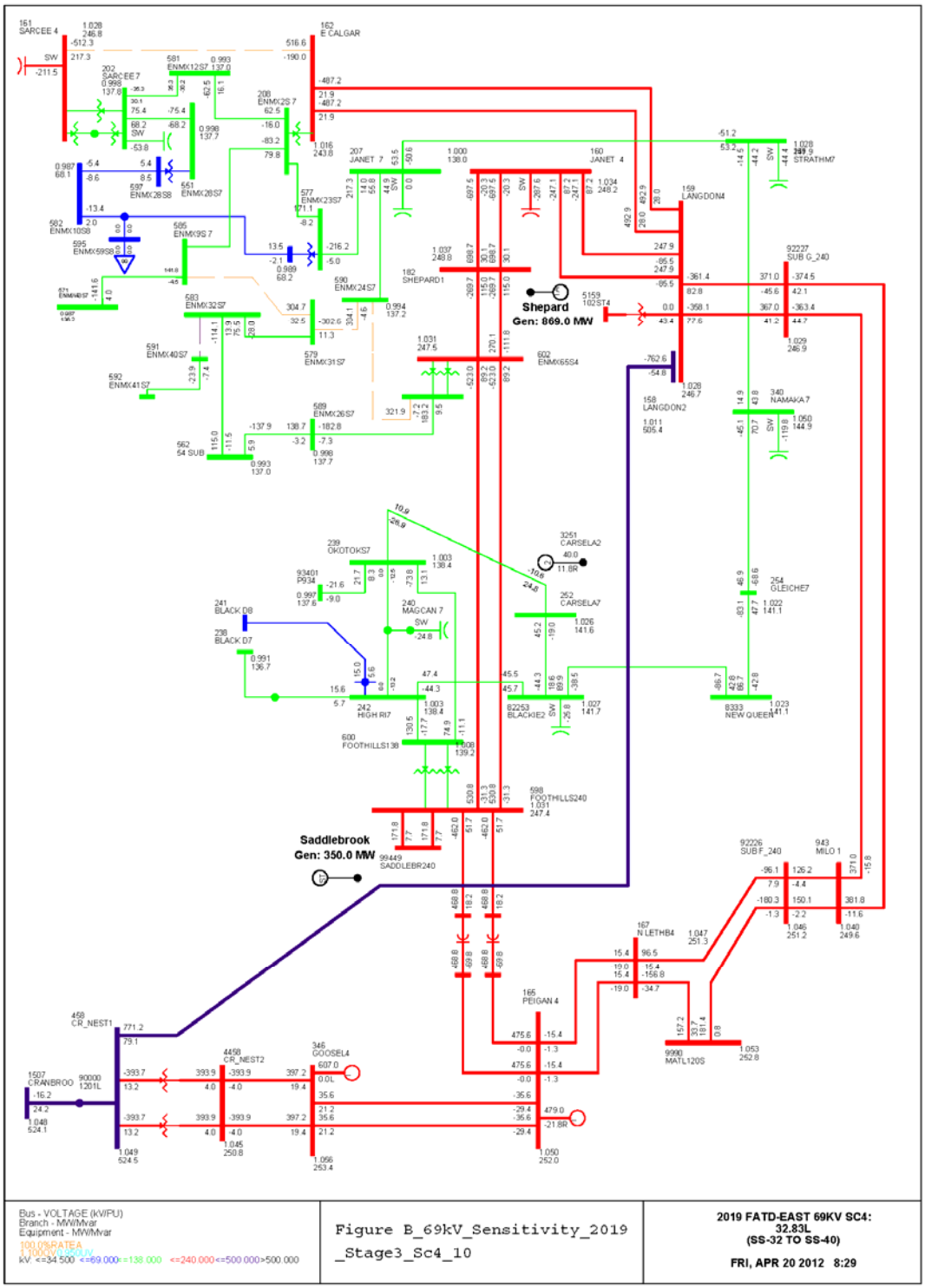

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/MVar
Equipment - MW/MVar
100.0%RATE A
1.100(V)/0.950(V)
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_FATD_Planning_2019_Stage3_Sc2_5
2019 FATD-EAST ORIG. SC2:
32.83L
(SS-32 TO SS-40)
FRI, APR 20 2012 8:29

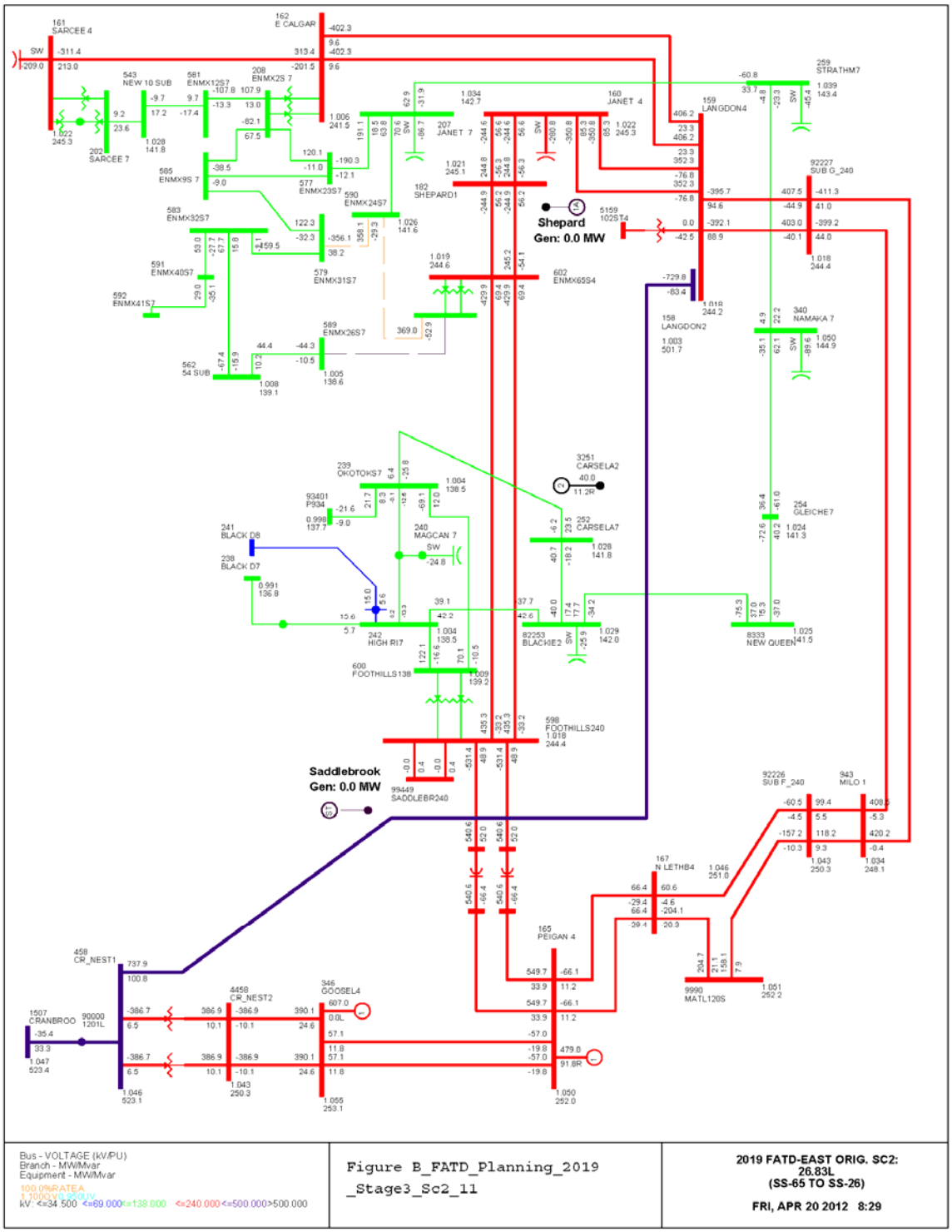

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_69kV_Sensitivity_2019_Stage3_Sc2_6
2019 FATD-EAST 69KV SC2:
32.83L
(SS-32 TO SS-40)
FRI, APR 20 2012 8:29

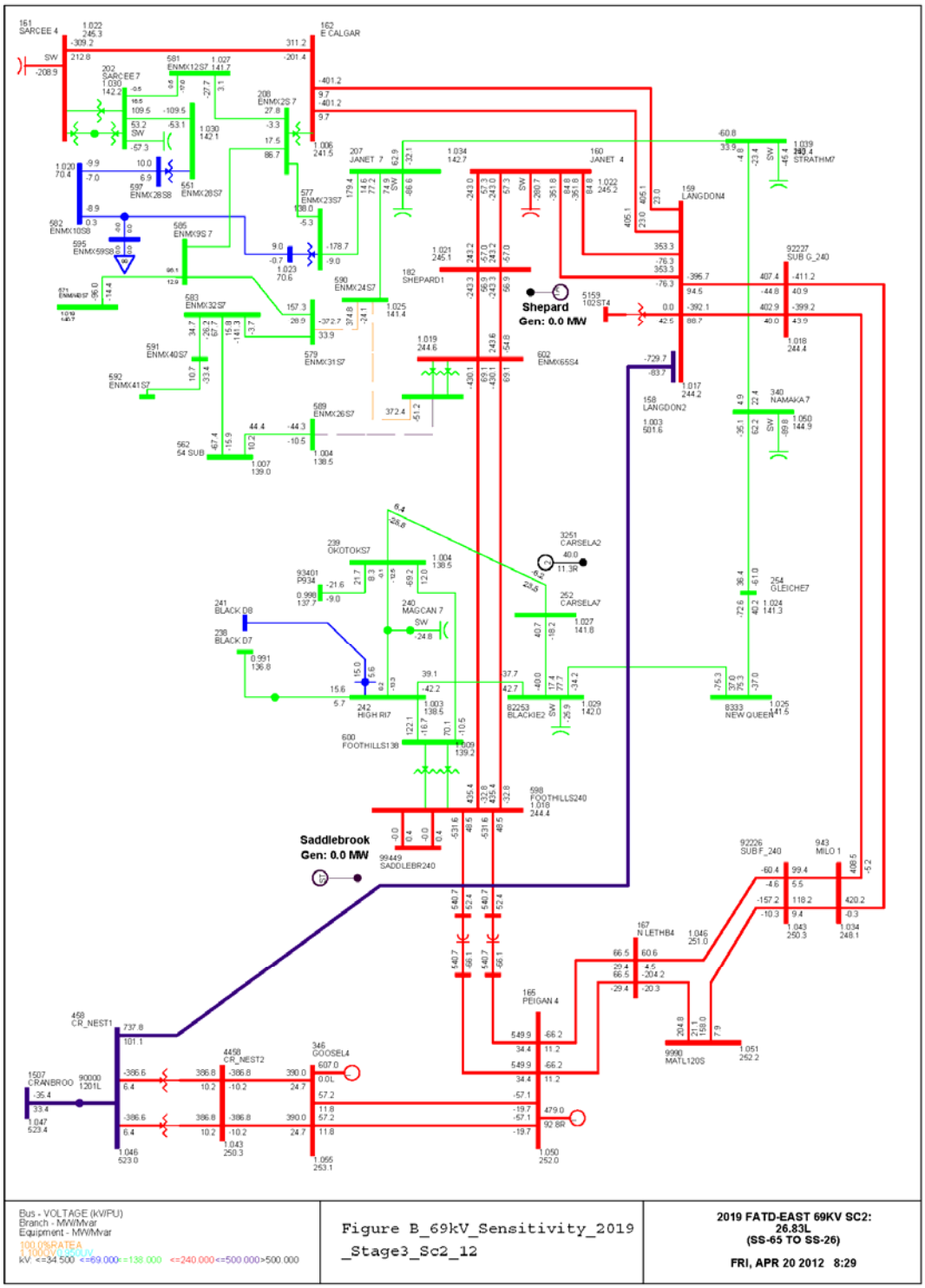

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/MVar
Equipment - MW/MVar
100.0%RATE A
1.1000pu/0.9500pu
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_FATD_Planning_2019_Stage3_Sc3_7
2019 FATD-EAST ORIG. SC3:
32.83L
(SS-32 TO SS-40)
FRI, APR 20 2012 8:29

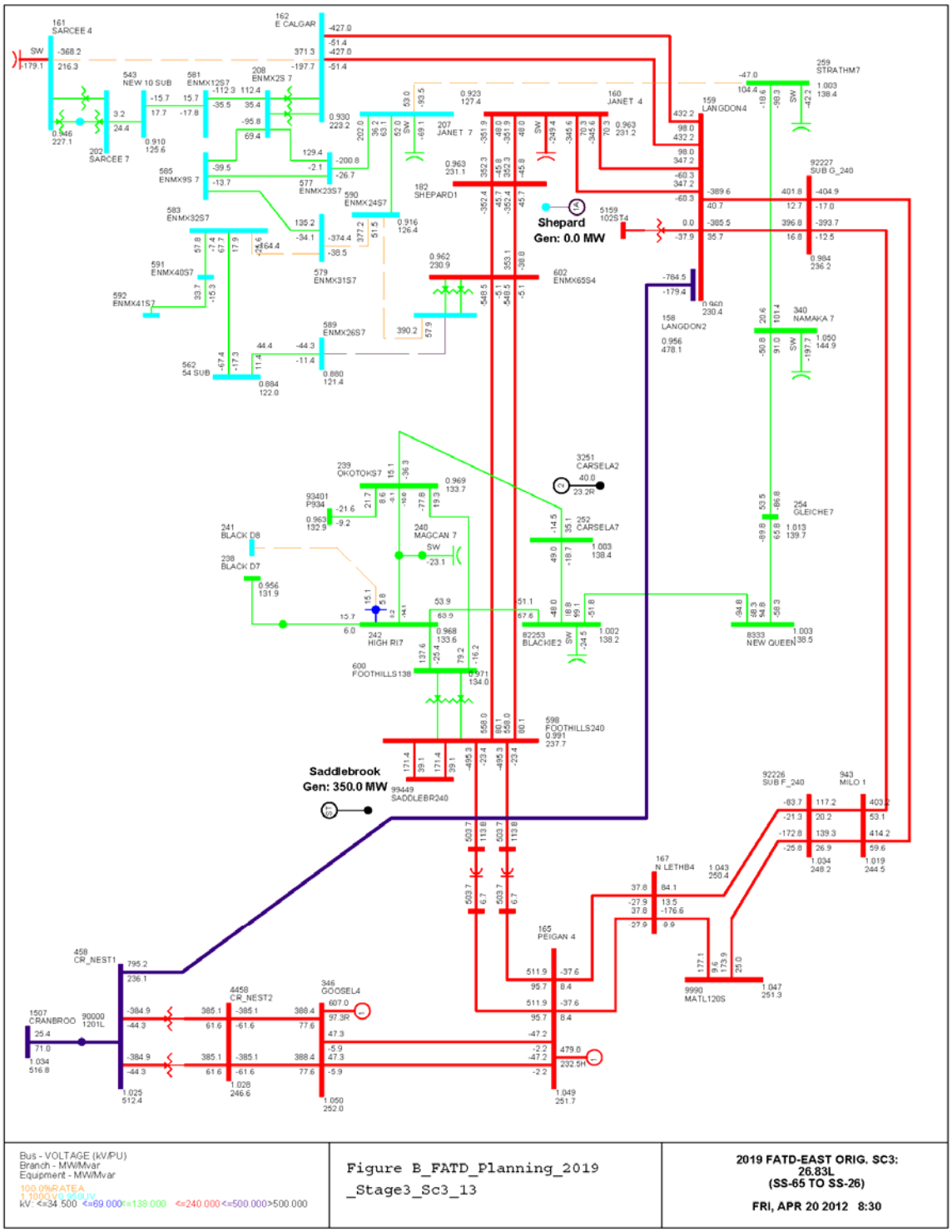

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_69kV_Sensitivity_2019_Stage3_Sc3_8
2019 FATD-EAST 69KV SC3:
32.83L
(SS-32 TO SS-40)
FRI, APR 20 2012 8:29

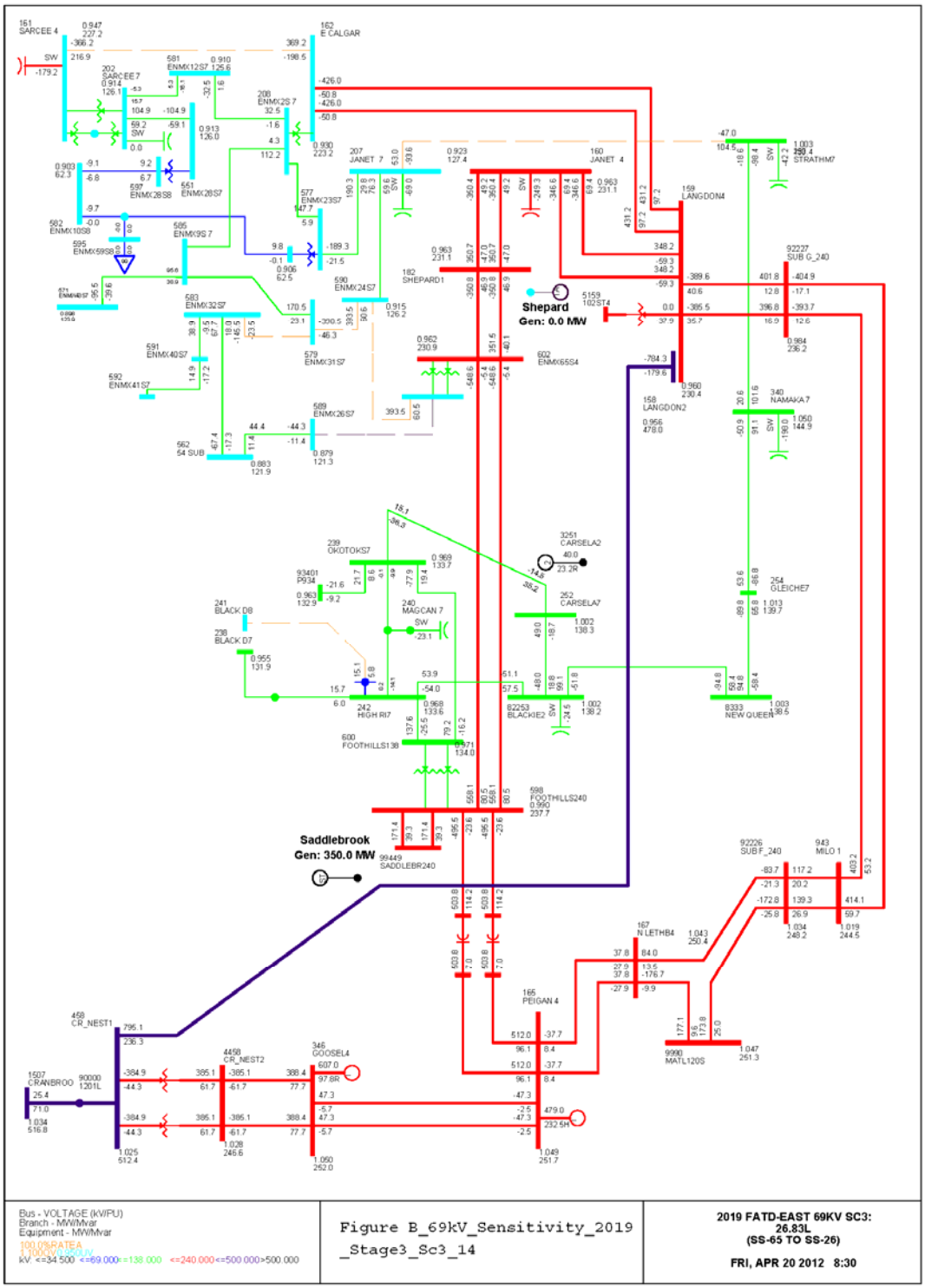

Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/MVar
Equipment - MW/MVar
Figure B_FATD_Planning_2019_Stage3_Sc4_9
2019 FATD-EAST ORIG. SC4:
32.83L
(SS-32 TO SS-40)
FRI, APR 20 2012 8:29

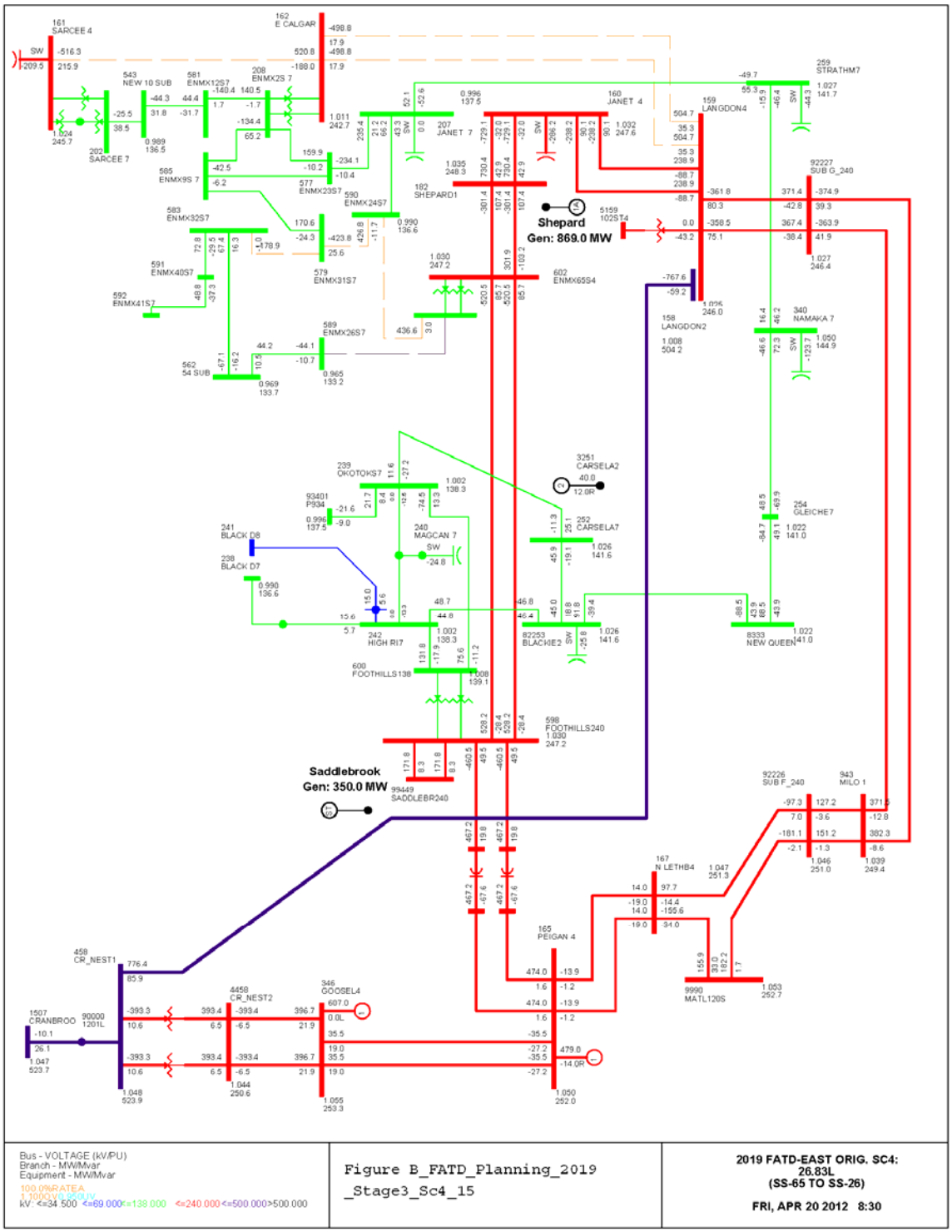

Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure B_69kV_Sensitivity_2019_Stage3_Sc4_10
2019 FATD-EAST 69KV SC4:
32.83L
(SS-32 TO SS-40)
FRI, APR 20 2012 8:29

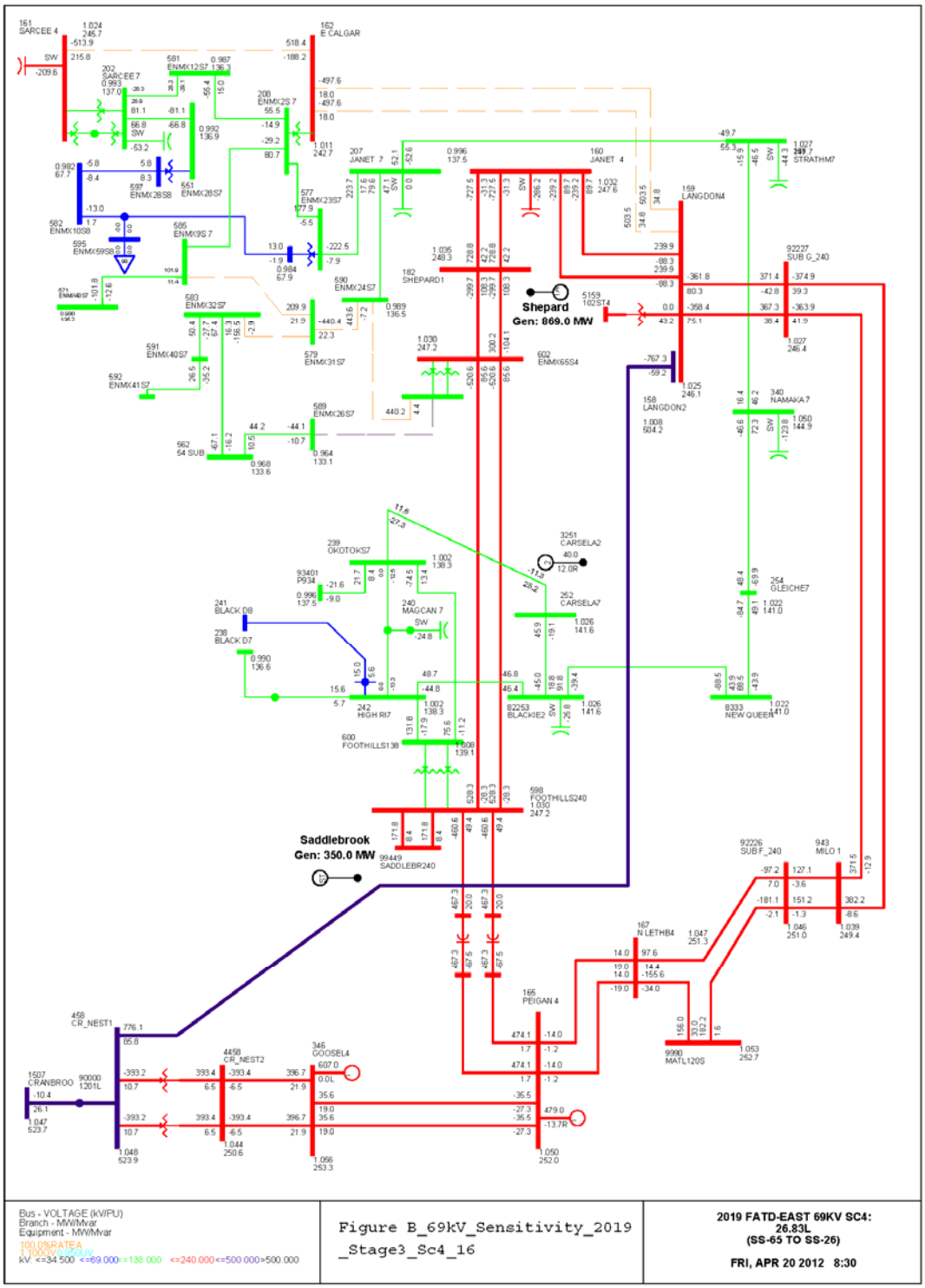

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/MVar
Equipment - MW/MVar
100.0%RATE A
1.100(U)/0.950(U)V
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_FATD_Planning_2019_Stage3_Sc2_11
2019 FATD-EAST ORIG. SC2:
26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:29

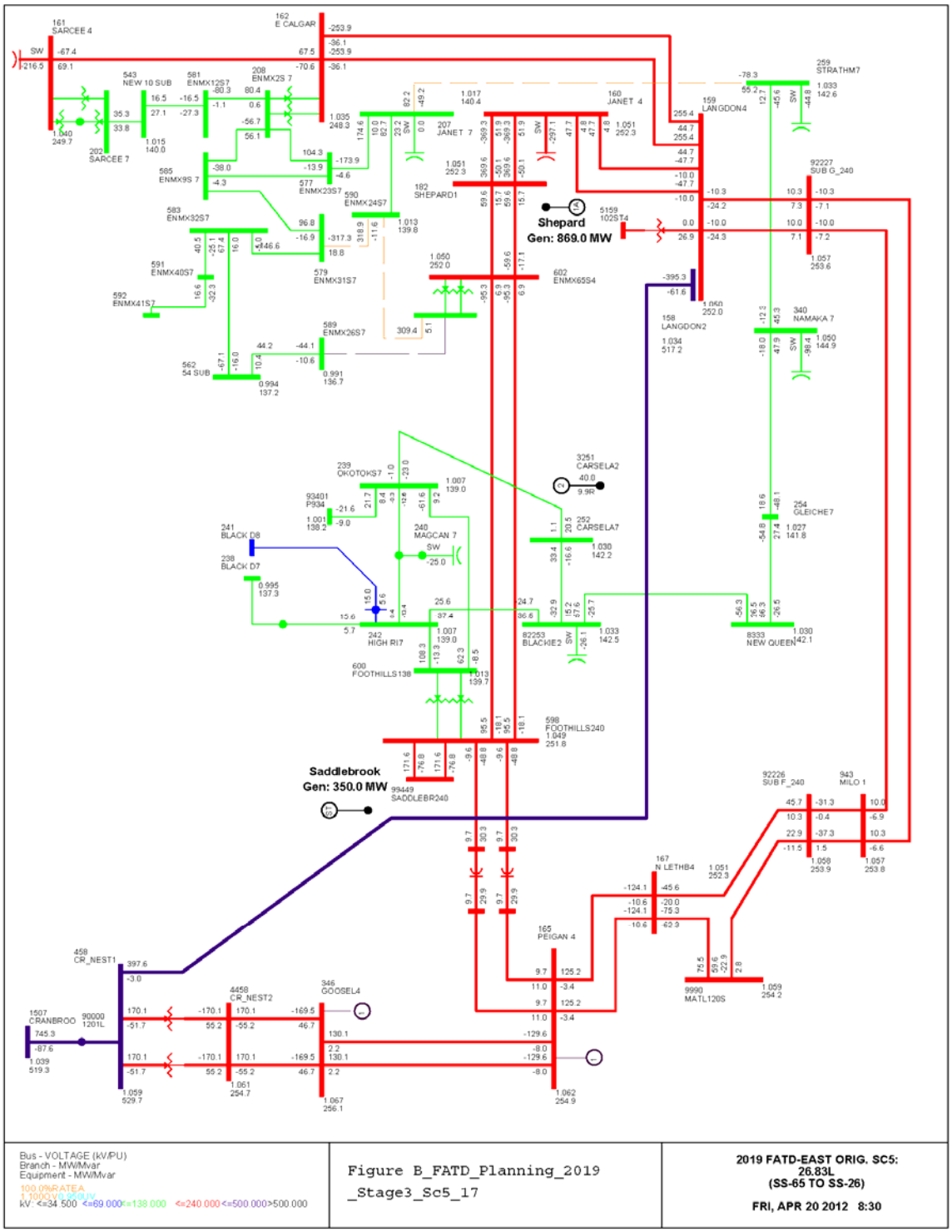

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_69kV_Sensitivity_2019_Stage3_Sc2_12
2019 FATD-EAST 69KV SC2:
26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:29

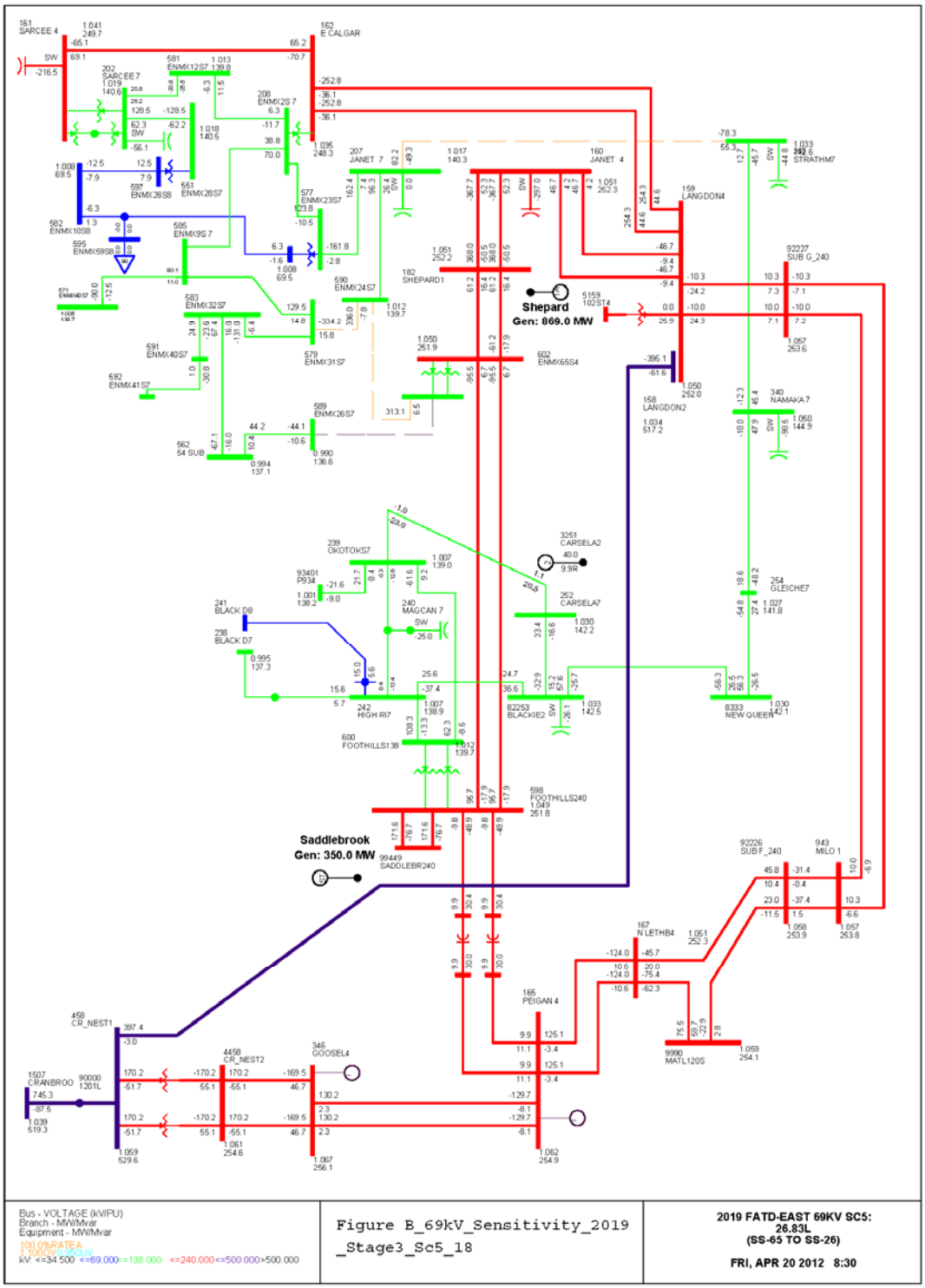

Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/MVar
Equipment - MW/MVar
Figure B_FATD_Planning_2019_Stage3_Sc3_13
2019 FATD-EAST ORIG. SC3:
26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:30


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_69kV_Sensitivity_2019_Stage3_Sc3_14
2019 FATD-EAST 69KV SC3:
26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:30


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/MVar
Equipment - MW/MVar
Figure B_FATD_Planning_2019_Stage3_Sc4_15
2019 FATD-EAST ORIG. SC4:
26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:30


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_69kV_Sensitivity_2019_Stage3_Sc4_16
2019 FATD-EAST 69KV SC4:
26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:30


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100(V)/0.950(V)
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_FATD_Planning_2019_Stage3_Sc5_17
2019 FATD-EAST ORIG. SC5: 26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:30

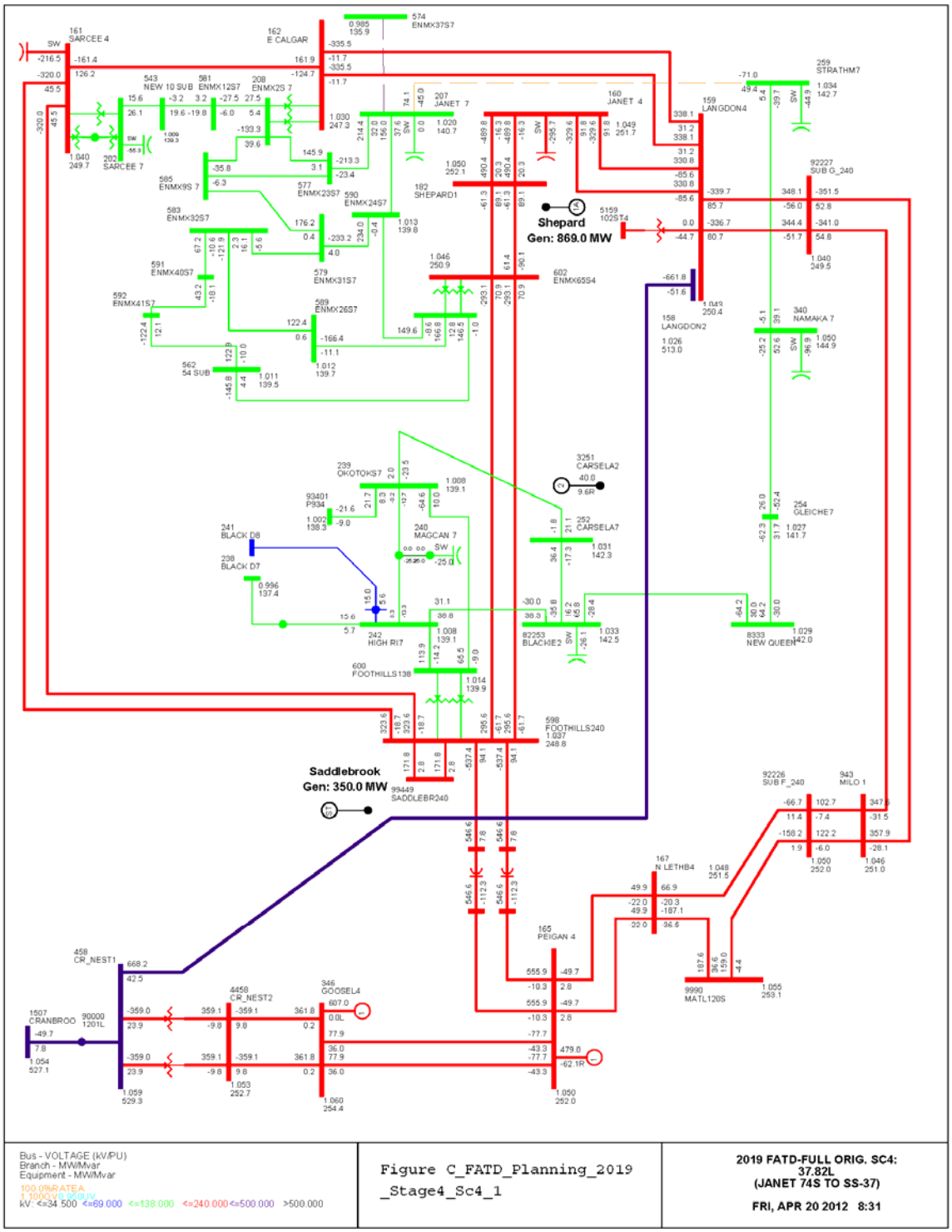

Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV: <=34.500 <=69.000<=138.000 <=240.000<=500.000>500.000
Figure B_69kV_Sensitivity_2019_Stage3_Sc5_18
2019 FATD-EAST 69KV SC5:
26.83L
(SS-65 TO SS-26)
FRI, APR 20 2012 8:30

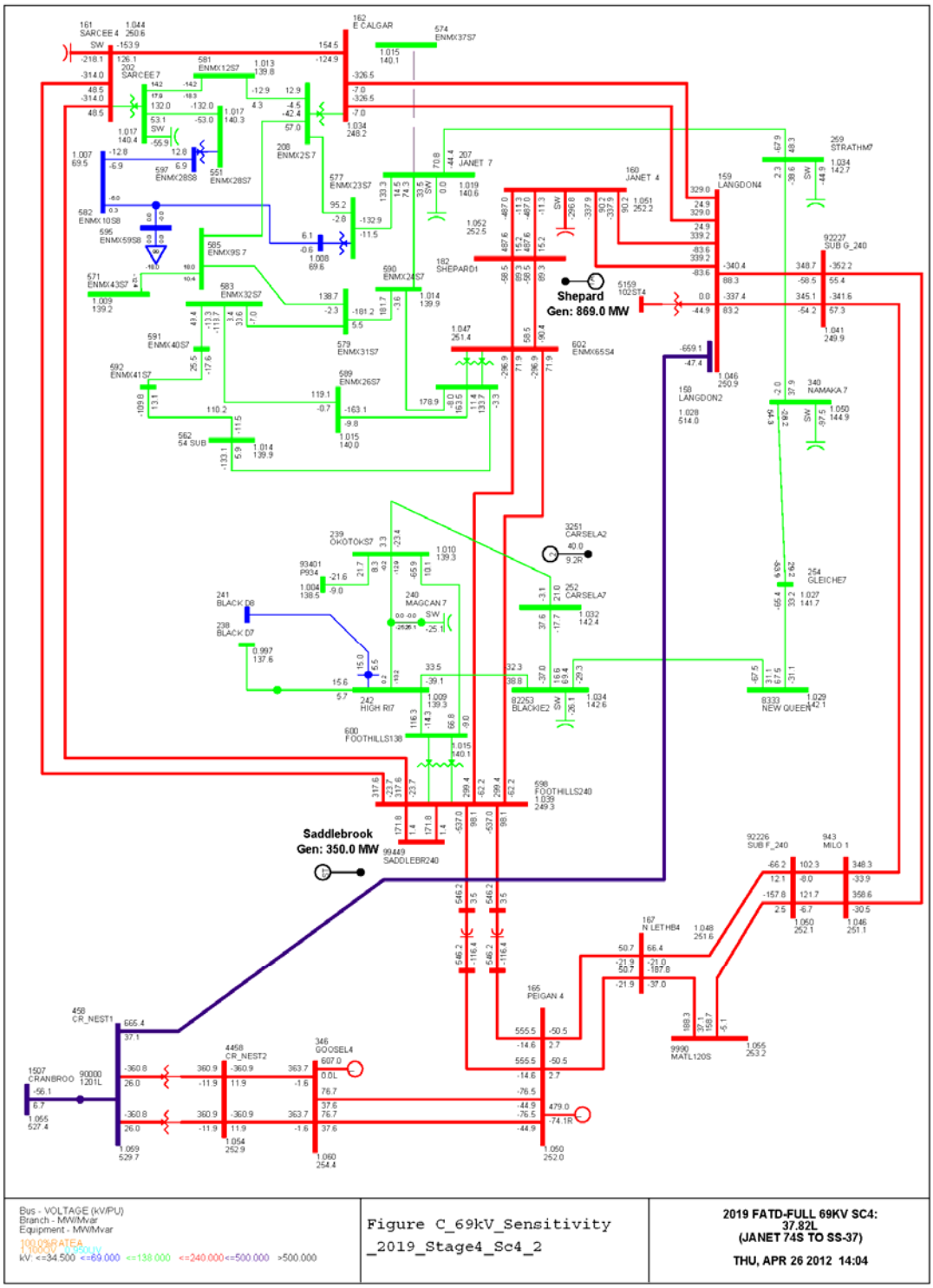
ATTACHMENT C: FATD FULL – 2019

Table C-1	
Figure Name	**Contingency**
Figure C_FATD_Planning_2019_Stage4_Sc4_1	37.82L (Janet 74S to SS-37)
Figure C_69kV_Sensitivity_2019_Stage4_Sc4_2	37.82L (Janet 74S to SS-37)

For the following diagrams, the greatest change in loading occurs on 9.80L between Enmax No. 31 and Enmax No. 9 as shown in Table C-2.

Table C-2			
Contingency	**Critical Branch**	**With 69 kV Upgrades**	**Without 69 kV Upgrades**
37.82L 138kV line outage.	9.80L 138kV line	91%	100%
(Janet 74S to ENMAX No. 37)	(ENMAX No. 31 to ENMAX No. 9)	176MVA	192MVA


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/MVar
Equipment - MW/MVar
100.0%RATEA
1.100(V)/0.950(V)
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure C_FATD_Planning_2019_Stage4_Sc4_1
2019 FATD-FULL ORIG. SC4:
37.82L
(JANET 74S TO SS-37)
FRI, APR 20 2012 8:31


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
kV <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
Figure C_69kV_Sensitivity_2019_Stage4_Sc4_2
2019 FATD-FULL 69KV SC4:
37.82L
(JANET 74S TO SS-37)
THU, APR 26 2012 14:04

APPENDIX D AESO 2012 SUPPLEMENT TO 2011 PLANNING STUDIES - CONRIMATION OF NEED

Foothills Area Transmission Development

Supplementary Report: 2012 Long Term Outlook and HVDC Dispatch Sensitivity Studies

June 14, 2012

PROFESSIONAL ENGINEER ALBERTA GALEN LAM

June 14, 2012

	Name	Signature	Date
Prepared	Olu Fagbemiro, P.Eng.		June 14, 2012
Prepared/ Reviewed	Galen Lam, P.Eng.		June 14, 2012
Prepared/ Reviewed	Ata Rehman, P.Eng.		June 14, 2012
Reviewed/Approved	Jason Doering, P.Eng.		June 14, 2012

APEGA Permit to Practice P8200

EXECUTIVE SUMMARY

This supplementary report was prepared to determine whether the 2012LTO and the 2012LTO combined with various WATL and EATL HVDC line dispatch assumptions affect the conclusions and recommendations made in the FATD Engineering Report dated April 29, 2011. The following sensitivity studies were completed for the FATD planned facilities:

1. 2012LTO Sensitivity
    a. 2012LTO Need Assessment for 2014
    b. 2012LTO Need Assessment for 2019
    c. 2012LTO with FATD Assessment for 2019
2. 2012LTO with the WATL and EATL HVDC Lines Sensitivity
    a. 2012LTO+HVDC Need Assessment for 2014
    b. 2012LTO+HVDC with FATD Assessment for 2019

The study scenarios and applied criteria were consistent with those used in the FATD Engineering Report. The following FATD configurations were tested with the 2012LTO sensitivity study and the 2012LTO combined with WATL/EATL HVDC line dispatch sensitivity study.

- FATD East configuration
- FATD East plus 3rd Circuit configuration (138 kV, SS-65 to SS-54 to SS-41)
- FATD Full configuration

The details of the FATD configurations are discussed in Section 2.6 of this supplementary report. The following power flow contingency studies were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)

In addition, selected Category C events were investigated including Category C3, C5 and C7 contingencies.

The results of the sensitivity studies confirm the need assessment study results in the FATD Engineering Report. Substantial system overloads in the study area were again observed in the need assessments under the 2012LTO both without and with the WATL and EATL HVDC lines dispatched, indicating a need for significant system improvements in the 2014 timeframe. The 2012LTO+HVDC Need Assessment scenario results showed an increased trend for the identified overloads as compared to those of the 2012LTO Need Assessment scenarios.

The FATD-East configuration results for the 2012LTO and 2012LTO+HVDC sensitivities indicated that overloads under Category B contingency conditions will persist in the system by 2019 unless the 138 kV third circuit from ENMAX 65

substation (i.e., 54.81L ENMAX 65 to ENMAX 54 and 41.84L ENMAX 54 to ENMAX 41) is also constructed.

The FATD-East+3rdCkt configuration as studied in this supplementary report mitigated the identified overloads in 2019, with the exceptions of 9.80L (ENMAX 31 – ENMAX 9) and 765L (Janet to Strathmore). The AESO intends to uprate 9.80L line to 287 MVA by resolving the line end CT limitation. 765L is not part of the FATD plan scope and is being addressed by the AESO as part of its ongoing south regional planning evaluations.

The FATD-Full configuration as studied in this supplementary report fully mitigated the identified Category B overloads in the study area through the 2019 timeframe for the 2012LTO and 2012LTO+HVDC sensitivities.

Since the FATD-East+3rdCkt configuration with the 9.80L capacity uprate addresses all Category B concerns in the 2012LTO and 2012LTO+HVDC, the timing for the need of the FATD-Full development will be confirmed by subsequent system studies. However, there were a number of highly loaded (>80%) facilities remaining under the FATD-East+3rdCkt configuration which had reduced loading under the FATD-Full configuration. Additional load and generation growth in the study area beyond the 2019 horizon may begin to introduce overloads under Category B contingencies, which may require additional transmission reinforcement in the area.

Curtailment options were successfully identified with the FATD Plan which could mitigate overloads observed under Category C outage conditions.

TABLE OF CONTENTS

EXECUTIVE SUMMARY E-1
1. INTRODUCTION 1
2. CRITERIA, METHODOLOGY AND ASSUMPTIONS 3
2.1 AESO Transmission Reliability Criteria 3
2.2 Study Area and Critical System 4
2.3 2012LTO Load and Generation Forecast 4
2.4 Mitigation Plans for Category C5 Contingencies 5
2.5 Need Assessment Study Scenarios 5
2.6 FATD Plan Configurations 6
2.7 HVDC Dispatch Assumptions 7
3. 2012 LONG TERM OUTLOOK SYSTEM IMPACT ASSESSMENT 8
3.1 2012LTO Need Assessment Sensitivity Methodology 8
3.2 2012LTO Need Assessment Results - 2014 and 2019 Scenarios 8
3.2.1 Summary for the 2012LTO Need Assessment 20
3.3 2012LTO with FATD Plan Assessment – 2019 Scenarios 21
3.3.1 Summary for the 2012LTO FATD Assessment – Category A & B 21
3.3.2 Category C5 Results for 2012LTO FATD Assessment 24
3.3.3 Category C5 Mitigation Requirements for 2012LTO FATD Assessment 25
4. 2012LTO WITH HVDC DISPATCH SYSTEM IMPACT ASSESSMENT 27
4.1 2012LTO with HVDC Dispatch Sensitivity Methodology 27
4.2 20120LTO+HVDC Need Assessment - 2014 Scenarios 27
4.2.1 Summary for the 2012LTO with HVDC Need Assessment 34
4.3 2012LTO+HVDC with FATD Plan Assessment – 2019 Scenarios 35
4.3.1 Summary for the 2012LTO+HVDC FATD Assessment – Category A & B 36
4.3.2 Category C Results for the 2012LTO+HVDC with FATD Assessment 39
4.3.3 Category C5 Mitigation Requirements for 2012LTO+HVDC with FATD 40
5. SUMMARY AND CONCLUSIONS 43

List of Figures

Figure 1-1: Simplified FATD Plan and Existing System 2

List of Tables

Table 2-1: Study Area 4
Table 2-2: 2012LTO Environmental Scenario Installed Wind Generation Forecast 4
Table 2-3: 2012LTO Study Area Load Forecast 4
Table 3-1: 2012LTO Need Assessment 2014 Study Scenarios 8
Table 3-2: 2012LTO Need Assessment 2019 Study Scenarios 8
Table 3-3: 2012LTO Loading Violations - 2014 9
Table 3-4: 2012LTO UnderVoltage Violations - 2014 13
Table 3-5: 2012LTO Loading Violations - 2019 14
Table 3-6: Comparison of Need Assessment to FATD Configurations (2019 Cat B) 22
Table 3-7: Category C5 results for FATD Configurations - 2019 24
Table 3-8: 2012LTO FATD-East Category C5 Mitigations 26
Table 3-9: 2012LTO FATD-East+3rdCkt Category C5 Mitigations 26
Table 4-1: 2012LTO+HVDC Need Assessment Study Scenarios - 2014 27
Table 4-2: 2012LTO+HVDC Need Assessment Loading Violations – 2014 28
Table 4-3: Comparison of 2012LTO to the 2012LTO+HVDC Need Assessments 35
Table 4-4: 2012LTO+HVDC FATD Assessment Study Scenarios - 2019 36
Table 4-5: Comparison of 2014 Need Assessment to FATD Configurations + HVDC (2019 Cat B) 37
Table 4-6: Category C5 Results for FATD Configurations – LTO2012+HVDC (2019) 39
Table 4-7: 2012LTO FATD-East Cat 5 Curtailment Plan 41
Table 4-8: 2012LTO FATD-East+3rdCkt Cat 5 Curtailment Plan 41
Table 4-9: 2012LTO FATD-Full Cat 5 Curtailment Plan 42

List of Attachments

Attachment A: List of Critical System Elements
Attachment B: Category B 2012LTO Results & Plots
Attachment C: Category B 2012LTO+HVDC Results and Plots
Attachment D: Category C5 2012LTO Results & Plots
Attachment E: Category C5 2012LTO+HVDC Results and Plots

1. INTRODUCTION

The AESO identified the need for the Foothills Area Transmission Development (FATD) plan in the FATD Engineering Report dated April 29, 2011. The FATD Engineering Report was based on certain assumptions regarding the future loading and generation in the Calgary area and greater Alberta region. Subsequent to the issuance of the FATD Engineering Report, the AESO developed the 2012 Long-Term Outlook Load and Generation forecast (2012LTO), which updates some of the forecast assumptions used to develop the FATD Plan.

Additionally, the AESO continues to plan for the integrated operations of two high voltage direct current (HVDC) lines between Edmonton and Calgary, referred to as the Western Alberta Transmission Line (WATL) and Eastern Alberta Transmission Line (EATL). The FATD Engineering Report only considered a single dispatch assumption for the WATL and EATL HVDC lines.

The objective of this supplementary report was to determine whether the 2012LTO assumptions and a broader range of WATL and EATL HVDC line dispatch assumptions affect the conclusions and recommendations made in the FATD Engineering Report. This FATD supplementary report provides the results of the sensitivity studies and discusses whether there is any material effect on the conclusions in the FATD Engineering Report.

Figure 1-1 shows the simplified one line diagram for the FATD Plan and nearby transmission system as proposed in the FATD Engineering Report. Refer to the FATD Engineering Report for the details of the proposed system improvements and reconfigurations. Figure 1-1 is not to scale and does not indicate the geographical locations of facilities. This supplementary report to the FATD Engineering Report includes five Sections:

1. Section 1 provides an introduction to the supplementary report.

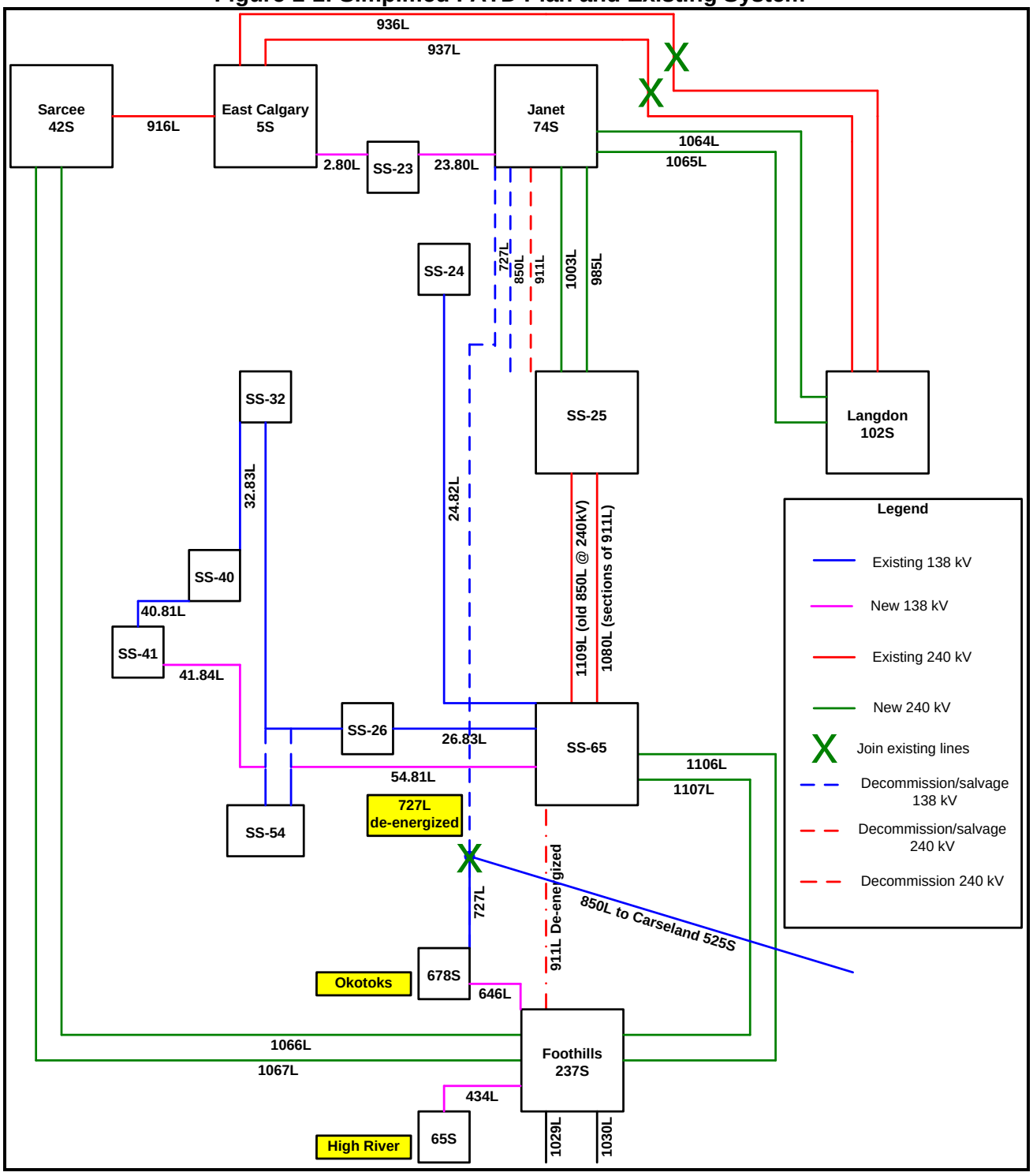
2. Section 2 discusses the assumptions used in this supplementary report and specifically with regards to any differences between the assumptions used in the FATD Engineering Report and supplementary report.

3. Section 3 discusses the results of the 2012LTO sensitivity study on the proposed FATD plan.

4. Section 4 discusses the results of the 2012LTO combined with the WATL/EATL HVDC line dispatch sensitivity study on the proposed FATD plan.

5. Section 5 provides a summary of the conclusions and recommendations.

Figure 1-1: Simplified FATD Plan and Existing System[1]



[1] Figure 1-1 is a simplified representation of the study area and the proposed FATD plan. Some existing substations and circuits are not shown.

2. CRITERIA, METHODOLOGY AND ASSUMPTIONS

The objective of this supplementary report was to determine whether the results of the 2012LTO and the WATL and EATL HVDC line dispatch sensitivity studies affect the conclusions and recommendations made in the FATD Engineering Report dated April 29, 2011. To meet the objective, the following sensitivity studies were completed for the FATD planned facilities:

1. The 2012LTO assumptions
2. The 2012LTO and WATL/EATL HVDC line dispatch assumptions

The impact of the 2012LTO assumption was first analyzed independently by setting the WATL and EATL HVDC line dispatch to zero. Then the 2012LTO was analyzed in combination with various non-zero dispatch assumptions for the WATL/EATL HVDC lines.

The need assessment completed in the FATD Engineering Report was repeated using the 2012LTO assumptions and also for the 2012LTO in combination with the sensitivity of WATL/EATL HVDC line dispatch assumptions. Similarly, the FATD plan configuration as proposed in the FATD Engineering Report was analyzed using the 2012LTO assumptions and also with the 2012LTO in combination with the sensitivity of WATL/EATL HVDC line dispatch assumptions to determine whether any changes result to the FATD plan conclusions and recommendations.

The studies in this report were conducted using PTI version 32. The following sections discuss the details of the criteria, methodology and assumptions used for this FATD supplemental report.

2.1 AESO Transmission Reliability Criteria

The applicable Alberta Reliability Standards (ARS - TPL-001-AB-0, TPL-002-AB-0 and TPL-003-AB-0) were applied to assess system reliability under various system conditions. Category A (all transmission elements in-service), Category B (a single transmission element out-of-service), and selected Category C (multiple transmission elements out-of-service) conditions were examined. The following is a general explanation of the Reliability Criteria applied throughout this study. These are based on the AESO Transmission Reliability Criteria

- Under Category A or Category B conditions, the system must be able to supply all firm loads and firm transfers on interties. All equipment must operate within its applicable rating, voltages must be within their applicable ranges and the system must be stable.
- Equipment loadings are monitored to record any violations based on their 100% static applicable seasonal rating. The Reliability Criteria requires all transmission elements to operate within their ratings with no thermal

overloads. Therefore, all violations were recorded for the identification of the transmission system deficiencies.

2.2 Study Area and Critical System

The FATD sensitivity study areas are summarized in Table 2-1 below. Category B contingencies at 138 kV or higher were simulated in the study area along with ties to the study area. System elements at 69 kV or higher were monitored in the study area. Only overloads on critical system elements were reported in the FATD sensitivity study as other system issues in the study area are being addressed by the AESO's south regional plan. The list of critical system elements are provided in Attachment A. Attachment A also shows the applicable ratings for each of the critical system elements.

Table 2-1: Study Area

Area	Area #	Monitored Elements	Contingencies
6	Calgary	69 kV and above	138 kV and above
45	Strathmore	69 kV and above	138 kV and above
46	High River	69 kV and above	138 kV and above

2.3 2012LTO Load and Generation Forecast

The 2012LTO forecast was the basis for the analysis completed in this supplementary report. While gas-fired generation assumptions in the study area remain unchanged from the assumptions used in the FATD Engineering Study Report, Table 2-2 below provides the 2012LTO forecast of installed wind generation for the 2014 and 2019 timeframes. Table 2-3 below provides the 2012LTO forecast of load for the FATD study areas. Further details of the 2012LTO can be found in the "Foothills Area Transmission Development - Supplemental Information: 2012 LTO Summary", prepared under separate cover.

Table 2-2: 2012LTO Environmental Scenario Installed Wind Generation Forecast

Year	Total Alberta (MW)
2014	**1,247**
2019	**2,544**

Table 2-3: 2012LTO Study Area Load Forecast

Load Forecast	2014		2019	
	Summer Light	Summer Peak	Summer Light	Summer Peak
Area 6 Load (MW) – Calgary	800	1,695	898	1,900
Area 45 Load (MW) - Strathmore	59	110	63	117
Area 46 Load (MW) – High River	50	92	57	105
Total Areas 6,45,46 (MW)	909	1,897	1,018	2,123
Alberta Internal Load (AIL) (MW)	7,907	10,621	9,537	12,500

2.4 Mitigation Plans for Category C5 Contingencies

The study approach for examining the FATD Plan under various stages of completion, as described in Section 2.6, required that potential mitigation options be considered for Category C5 contingencies that caused equipment overloads with loading over 100% of static applicable seasonal ratings. These mitigation options are theoretical and were developed to demonstrate that loading on the overloaded system elements could be reduced to within 95% of their seasonal rating. [2]

The generation curtailment or load shedding requirement for each Category C5 contingency was based on the following methodology and priority order:

1. **HVDC Redispatch**: Adjust the WATL (Genesee to Langdon) HVDC line dispatch to alleviate system overloads attributed to high HVDC dispatches, because it has the most significant impact to the study area.
2. **Generation Curtailment**: Curtail generation as required in the study area.
3. **Calgary Load Curtailment**: Curtail load from specific Calgary substations up to approximately 300 MW.
4. **System Configuration:** Reconfigure system topology only when other mitigations are not effective. [3]

2.5 Need Assessment Study Scenarios

The need assessment completed in the FATD Engineering Report was repeated using the 2012LTO assumptions and also for the 2012LTO in combination with WATL/EATL HVDC line dispatch assumptions. Any differences between the need assessment found in the FATD Engineering Report and this supplemental report were identified and reported.

The need assessment using the 2012LTO assumptions was accomplished by evaluating the performance of the 2014 and 2019 system with the 2012LTO load and generation without the FATD Plan. The 2012LTO base cases were only assessed under Category A system conditions and Category B contingencies. The specific study scenarios are described in more detail in Section 3.1.

The need assessment using the 2012LTO in combination with the WATL/EATL HVDC line dispatch assumptions was accomplished by evaluating the

[2] Actual category C5 mitigation requirements would be sensitive to the specific timing of load and generation connections to the system, as well as the sequence in which the transmission developments proposed under FATD become energized. Detailed Category C5 mitigation studies are beyond the scope of this report.

[3] It is beyond the scope of this report to examine potential system configuration changes for category C5 mitigation purposes. Therefore, C5 mitigation studies in this report assume the proposed FATD configuration is developed and system configuration changes considered are limited to a simple variation on the proposed FATD configuration.

performance of the 2014 system with the 2012LTO load and generation and the WATL and EATL HVDC lines dispatched accordingly without the FATD Plan. The 2012LTO with HVDC dispatch base cases were only assessed under Category A system conditions and Category B contingencies. The specific study scenarios are described in more detail in Section 4.1.

2.6 FATD Plan Configurations

This FATD supplemental report analyzed the FATD Plan as proposed in the FATD Engineering Report. The proposed FATD Plan was tested in three different incremental configurations to determine the system benefit contributed by each major part of the FATD Plan. The following three incremental configurations of the FATD Plan were studied. Each of the three configurations corresponds to the FATD Plan steps as described in the FATD Engineering Report.

1. **FATD-East**: Included steps 1 to 3 of the FATD Plan described in the FATD Engineering Report, which includes the transmission system development applied for by the AESO in its East Calgary/Shepard Needs Identification Document (NID)[4].
2. **FATD-East+3rdCkt**: Included steps 1 to 3 of the FATD Plan as well as the new 138 kV circuits designated 54.81L and 41.84L which will connect ENMAX 65 to ENMAX 54 to ENMAX 41 substations.
3. **FATD-Full**: Included all steps of the complete FATD Plan proposed in the FATD Engineering Report.

The details of the FATD configuration steps can be found in Section 5 of the FATD Engineering Report. The three FATD configurations listed above were each analyzed in the 2019 timeframe for their ability to resolve planning criteria violations under the 2012LTO assumptions and the 2012LTO in combination with the WATL/EATL line dispatch assumptions. The specific study scenarios are described in more detail in Sections 3.1 and 4.1 below.

The South Calgary 69 kV system modeled in this sensitivity study is as it exists today and does not include the system upgrades recommended for this system. However, as demonstrated in the AESO's April 25, 2012 report entitled: "Foothills Area Transmission Development – Supplementary Report: South Calgary 69kV Transmission System Sensitivity Studies", this has no material effect on the conclusions reached in this supplementary report.[5]

[4] East Calgary 240 kV and 138 kV Transmission System Upgrades and the Shepard Energy Center Connection Needs Identification Document, filed May 10, 2011. Commission application number 1607312. Proceeding ID No. 1229.

[5] Filed with the Commission May 4, 2012 under Proceeding ID. No. 1229.

2.7 HVDC Dispatch Assumptions

The WATL and EATL HVDC line dispatch assumptions used in this FATD supplement report were based on the dispatch assumptions associated with the AESO's ongoing HVDC integration studies. The WATL and EATL HVDC line dispatches in each of the HVDC study scenarios are presented in Section 4.1.

3. 2012 LONG TERM OUTLOOK SYSTEM IMPACT ASSESSMENT

This section discusses the methodology and results of the 2012LTO study for the FATD Plan.

3.1 2012LTO Need Assessment Sensitivity Methodology

Studies were performed for the 2014 and 2019 need assessment using the 2012LTO assumptions to identify any impacts on the need established in the FATD Engineering Report. Table 3-1 and Table 3-2 show the study scenarios examined for the 2012LTO Need Assessment for 2014 and 2019, respectively. The study scenarios are consistent with those scenarios studied in the FATD Engineering Report.

Table 3-1: 2012LTO Need Assessment 2014 Study Scenarios

Scenario	Load Condition	Import from BC (MW)	Shepard Generation (MW)	Saddlebrook Generation (MW)	Wind Generation Dispatch (MW)
SC1	Summer Peak	780	0	0	0
SC2	Summer Peak	0	0	0	1,250
SC3	Summer Peak	0	0	350	1,250
SC4	Summer Peak	0	860	350	1,250
SC4B*	Winter Peak	0	860	350	1,250
SC5	Summer Peak	780	860	350	0
SC6	System Light	0	0	0	1,250

*This scenario is in addition to those studied in the 2011 FATD Study

Table 3-2: 2012LTO Need Assessment 2019 Study Scenarios

Scenario	Load Condition	Import from BC (MW)	Shepard Generation (MW)	Saddlebrook Generation (MW)	Wind Generation Dispatch (MW)
SC1	Summer Peak	780	0	0	0
SC2	Summer Peak	0	0	0	2,540
SC3	Summer Peak	0	0	350	2,540
SC4	Summer Peak	0	860	350	2,540
SC5	Summer Peak	780	860	350	0
SC6	System Light	0	0	0	2,540

3.2 2012LTO Need Assessment Results - 2014 and 2019 Scenarios

In the 2012LTO Need Assessment sensitivity study, the following power flow simulations were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)

Table 3-3 below shows thermal overloads identified in the 2014 horizon for the 2012LTO Need Assessment sensitivity. The highlighted value indicates the highest observed loading for each branch across the various scenarios. The detailed results and one-line diagrams for the 2012LTO Need Assessment are contained in Attachment B.

Table 3-3: 2012LTO Loading Violations - 2014

Contingency	Overloaded Branch	Scenario						
		SC1	SC2	SC3	SC4	SC4B	SC5	SC6
BASE CASE	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**140% 949MVA**	108% 900MVA	119% 817MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**101% 274MVA**			
	911L 240 kV line (Foothills 237S to ENMAX No. 65)			**154% 549MVA**	143% 505MVA	111% 473MVA		
Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)				**169% 852MVA**	138% 852MVA	166% 852MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**116% 342MVA**	116% 338MVA	109% 318MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			115% 315MVA	**269% 712MVA**	212% 686MVA	239% 630MVA	
	24.83L 138 kV line (Janet 74S to ENMAX No. 24)				**103% 336MVA**			
	240/138 kV transformer (ENMAX No. 65)				**127% 509MVA**	125% 499MVA	114% 454MVA	
	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)				**105% 278MVA**			
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)				**116% 306MVA**		106% 279MVA	
	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)				**101% 164MVA**			
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**173% 340MVA**	167% 323MVA	157% 304MVA	
Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)						**126% 863MVA**	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			**115% 315MVA**	114% 306MVA			
	911L 240 kV line (Foothills 237S to ENMAX No. 65)						**103% 372MVA**	

Table 3-3 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1	SC2	SC3	SC4	SC4B	SC5	SC6
Open 1201L 500kV line (Langdon 102S to Chapel Rock 491S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**157% 1056MVA**	121% 1003MVA	151% 1019MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**107% 287MVA**		102% 272MVA	
	911L 240 kV line (Foothills 237S to ENMAX No. 65)	107% 383MVA	118% 419MVA	**194% 685MVA**	182% 640MVA	141% 598MVA	168% 598MVA	110% 404MVA
Open 2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**101% 200MVA**			
	917L 240 kV line (Janet 74S to East Calgary 5S)				**100% 511MVA**			
Open 2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**142% 963MVA**	109% 911MVA	121% 828MVA	
Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**111% 220MVA**	107% 211MVA	104% 205MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**103% 524MVA**			
Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**143% 971MVA**	111% 922MVA	123% 841MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**106% 538MVA**		101% 510MVA	
Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**163% 1103MVA**	127% 1052MVA	141% 961MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**105% 534MVA**			
Open 24.83L 138 kV line (Janet 74S to ENMAX No. 24)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**104% 281MVA**			
Open 240/138 kV transformer (East Calgary 5S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**111% 299MVA**		102% 274MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**110% 217MVA**	108% 212MVA	104% 203MVA	
Open 240/138 kV transformer (ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**154% 1044MVA**	120% 999MVA	133% 907MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**102% 521MVA**			

Table 3-3 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1	SC2	SC3	SC4	SC4B	SC5	SC6
Open 240/138 kV transformer (Janet 74S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**120% 325MVA**		111% 300MVA	
	911L 240 kV line (Foothills 237S to ENMAX No. 65)			**155% 552MVA**				
	917L 240 kV line (Janet 74S to East Calgary 5S)				**109% 554MVA**	101% 534MVA	104% 526MVA	
Open 240/138 kV transformer (Sarcee 42S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**104% 282MVA**			
Open 26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**147% 994MVA**	114% 947MVA	126% 862MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				107% 321MVA	**110% 324MVA**	103% 304MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			108% 300MVA	**132% 357MVA**	107% 354MVA	121% 327MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**101% 513MVA**			
Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**148% 1004MVA**	115% 960MVA	128% 873MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				114% 339MVA	**118% 349MVA**	109% 322MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		100% 282MVA	114% 315MVA	139% 376MVA	114% 379MVA	128% 346MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**102% 517MVA**			
Open 32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**142% 960MVA**	109% 912MVA	121% 827MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**103% 279MVA**			
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**112% 222MVA**	110% 217MVA	104% 205MVA	
Open 40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**141% 958MVA**	109% 908MVA	121% 825MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**103% 278MVA**			
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**105% 209MVA**	101% 199MVA		

Table 3-3 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1	SC2	SC3	SC4	SC4B	SC5	SC6
Open 500/240 kV transformer (Langdon 102S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**157% 1055MVA**	121% 1003MVA	150% 1018MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**107% 287MVA**		102% 272MVA	
	911L 240 kV line (Foothills 237S to ENMAX No. 65)	106% 379MVA	118% 418MVA	**193% 684MVA**	182% 640MVA	141% 598MVA	166% 596MVA	110% 405MVA
Open 727L 138 kV line (Janet 74S to Okotoks 678S)	765L 138 kV line (Janet 74S to Strathmore 151S)	104% 95MVA		102% 93MVA	111% 99MVA	**119% 111MVA**	116% 102MVA	
Open 727L 138 kV line (Okotoks 678SS to Magcan 142S to High River 65S)	765L 138 kV line (Janet 74S to Strathmore 151S)					100% 94MVA	101% 89MVA	
Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**144% 975MVA**	111% 925MVA	123% 843MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**102% 522MVA**			
Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**107% 289MVA**			
Open 917L 240 kV line (Janet 74S to East Calgary 5S)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**116% 345MVA**	116% 342MVA	111% 326MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**125% 336MVA**		115% 307MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**139% 274MVA**	134% 261MVA	129% 252MVA	
Open 932L 240 kV line (Janet 74S to Beddington SS-162)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**110% 297MVA**		101% 271MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**111% 563MVA**	102% 537MVA	106% 534MVA	
Open 936L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**144% 976MVA**	111% 922MVA	123% 843MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**102% 277MVA**			
	911L 240 kV line (Foothills 237S to ENMAX No. 65)			**164% 584MVA**	152% 536MVA	118% 500MVA	107% 386MVA	

Table 3-3 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1	SC2	SC3	SC4	SC4B	SC5	SC6
Open 937L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**144% 976MVA**	111% 922MVA	123% 843MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**102% 277MVA**			
	911L 240 kV line (Foothills 237S to ENMAX No. 65)			**164% 584MVA**	152% 536MVA	118% 500MVA	107% 386MVA	

Table 3-4 below shows undervoltage violations identified in the 2014 horizon for the 2012LTO Need Assessment. The results show that voltage violations exist in the High River area under the outage of the Janet to Okotoks 138 kV line 727L.

Table 3-4: 2012LTO UnderVoltage Violations - 2014

Contingency	Monitored Bus	SC4B
Open 727L 138kV line (Janet 74S to Okotoks 678S)	238 BLACK D7 138.00	Vinit = 1 pu Vcont = 0.88 pu
Open 727L 138kV line (Janet 74S to Okotoks 678S)	239 OKOTOKS7 138.00	Vinit = 1.01 pu Vcont = 0.88 pu
Open 727L 138kV line (Janet 74S to Okotoks 678S)	240 MAGCAN 7 138.00	Vinit = 1.01 pu Vcont = 0.89 pu
Open 727L 138kV line (Janet 74S to Okotoks 678S)	241 BLACK D8 69.000	Vinit = 1 pu Vcont = 0.88 pu
Open 727L 138kV line (Janet 74S to Okotoks 678S)	242 HIGH RI7 138.00	Vinit = 1 pu Vcont = 0.89 pu
Open 727L 138kV line (Janet 74S to Okotoks 678S)	243 HARTELL7 138.00	Vinit = 1 pu Vcont = 0.88 pu
Open 727L 138kV line (Janet 74S to Okotoks 678S)	886 MAG TAP7 138.00	Vinit = 1.01 pu Vcont = 0.89 pu
Open 727L 138kV line (Janet 74S to Okotoks 678S)	93401 P934 138.00	Vinit = 1.01 pu Vcont = 0.88 pu
Open 727L 138kV line (Janet 74S to Okotoks 678S)	960 HART TAP 138.00	Vinit = 1 pu Vcont = 0.88 pu

Table 3-5 below shows thermal overloads identified in the 2019 horizon for the 2012LTO Need Assessment. The highlighted value indicates the highest observed loading for each branch across the various scenarios.

Table 3-5: 2012LTO Loading Violations - 2019

Contingency	Overloaded Branch	Scenario					
		SC1	SC2	SC3	SC4	SC5	SC6
BASE CASE	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**157% 1059MVA**	118% 794MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			105% 288MVA	**121% 322MVA**		
	911L 240 kV line (Foothills 237S to ENMAX No. 65)		168% 583MVA	**233% 810MVA**	218% 757MVA	108% 375MVA	171% 593MVA
	917L 240 kV line (Janet 74S to East Calgary 5S)				**120% 607MVA**		
Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)				**172% 875MVA**	169% 852MVA	
	2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)				**111% 321MVA**		
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**134% 385MVA**	109% 319MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		121% 325MVA	165% 443MVA	**316% 822MVA**	239% 631MVA	121% 318MVA
	24.83L 138 kV line (Janet 74S to ENMAX No. 24)				**120% 382MVA**		
	240/138 kV transformer (ENMAX No. 65)				**149% 596MVA**	116% 463MVA	
	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)				**125% 323MVA**		
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)				**140% 365MVA**	112% 297MVA	
	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)				**115% 182MVA**		
	40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)				**104% 165MVA**		
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			110% 219MVA	**201% 385MVA**	151% 293MVA	
	936L 240 kV line (Langdon 102S to Janet 74S)			100% 514MVA	**116% 597MVA**		
	937L 240 kV line (Langdon 102S to Janet 74S)			100% 514MVA	**116% 597MVA**		

Table 3-5 Continued.

Contingency	Overloaded Branch	Scenario					
		SC1	SC2	SC3	SC4	SC5	SC6
Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**128% 863MVA**	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		121% 325MVA	**165% 444MVA**	163% 424MVA		121% 318MVA
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			110% 219MVA	**119% 230MVA**		
	911L 240 kV line (Foothills 237S to ENMAX No. 65)					**111% 386MVA**	
	936L 240 kV line (Langdon 102S to Janet 74S)			**100% 514MVA**			
	937L 240 kV line (Langdon 102S to Janet 74S)			**100% 514MVA**			
Open 1201L 500kV line (Langdon 102S to Chapel Rock 491S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**189% 1275MVA**	148% 988MVA	
	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)			**119% 603MVA**	103% 528MVA		106% 545MVA
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		102% 275MVA	115% 312MVA	**130% 345MVA**	108% 288MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**101% 197MVA**		
	911L 240 kV line (Foothills 237S to ENMAX No. 65)	112% 388MVA	234% 814MVA	**307% 1067MVA**	290% 1005MVA	171% 594MVA	240% 834MVA
Open 2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**104% 306MVA**		
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**117% 227MVA**		
	917L 240 kV line (Janet 74S to East Calgary 5S)				**125% 631MVA**		
Open 2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**160% 1076MVA**	120% 804MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**124% 624MVA**		

Table 3-5 Continued.

Contingency	Overloaded Branch	Scenario					
		SC1	SC2	SC3	SC4	SC5	SC6
Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**113% 331MVA**		
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			106% 211MVA	**128% 249MVA**	103% 202MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**128% 647MVA**		
Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**161% 1087MVA**	122% 816MVA	
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)				**101% 269MVA**		
	917L 240 kV line (Janet 74S to East Calgary 5S)				**131% 662MVA**	102% 514MVA	
Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**185% 1250MVA**	141% 946MVA	
	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)			**105% 534MVA**			
	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)				**101% 269MVA**		
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)			105% 286MVA	**117% 311MVA**	101% 270MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**131% 659MVA**	101% 509MVA	
Open 24.83L 138 kV line (Janet 74S to ENMAX No. 24)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			110% 297MVA	**124% 329MVA**	106% 282MVA	
Open 240/138 kV transformer (East Calgary 5S)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**107% 313MVA**		
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		104% 279MVA	116% 314MVA	**131% 348MVA**	110% 294MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			107% 212MVA	**125% 242MVA**	105% 205MVA	
	916L 240 kV line (Sarcee 42S to East Calgary 5S)				**107% 461MVA**		

Table 3-5 Continued.

Contingency	Overloaded Branch	Scenario					
		SC1	SC2	SC3	SC4	SC5	SC6
Open 240/138 kV transformer (ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**175% 1177MVA**	133% 892MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**128% 645MVA**		
Open 240/138 kV transformer (Janet 74S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		114% 307MVA	126% 344MVA	**143% 380MVA**	120% 323MVA	
	240/138 kV transformer (Janet 74S)				**107% 428MVA**	102% 409MVA	
	911L 240 kV line (Foothills 237S to ENMAX No. 65)		169% 587MVA	**234% 814MVA**			
	917L 240 kV line (Janet 74S to East Calgary 5S)			101% 507MVA	**135% 682MVA**	107% 537MVA	
Open 240/138 kV transformer (Sarcee 42S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			109% 298MVA	**124% 330MVA**	103% 276MVA	
	240/138 kV transformer (East Calgary 5S)	**101% 339MVA**	**101% 339MVA**				
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**105% 203MVA**		
Open 26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**165% 1115MVA**	125% 839MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)		101% 299MVA	109% 326MVA	**124% 364MVA**	107% 316MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		123% 332MVA	138% 376MVA	**157% 419MVA**	131% 350MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**126% 634MVA**		
Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**167% 1129MVA**	127% 852MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)		109% 325MVA	117% 352MVA	**133% 389MVA**	116% 342MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	102% 273MVA	132% 358MVA	147% 402MVA	**167% 445MVA**	140% 376MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**127% 641MVA**		

Table 3-5 Continued.

Contingency	Overloaded Branch	Scenario					
		SC1	SC2	SC3	SC4	SC5	SC6
Open 31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**100% 195MVA**		
Open 32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**159% 1072MVA**	120% 804MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			107% 293MVA	**123% 328MVA**	101% 271MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			105% 209MVA	**129% 250MVA**	102% 199MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				**123% 619MVA**		
Open 33.83L 138 kV line (ENMAX No. 41 to ENMAX No. 33)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**101% 197MVA**		
Open 40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**159% 1070MVA**	120% 801MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			107% 291MVA	**123% 326MVA**	101% 270MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**122% 237MVA**		
	917L 240 kV line (Janet 74S to East Calgary 5S)				**122% 616MVA**		
Open 500/240 kV transformer (Langdon 102S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**189% 1274MVA**	147% 987MVA	
	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)			**119% 603MVA**	103% 527MVA		107% 545MVA
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		102% 274MVA	115% 312MVA	**130% 345MVA**	108% 288MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**101% 197MVA**		
	911L 240 kV line (Foothills 237S to ENMAX No. 65)	112% 388MVA	234% 813MVA	**307% 1067MVA**	289% 1004MVA	171% 594MVA	240% 834MVA
Open 727L 138 kV line (Janet 74S to Okotoks 678S)	765L 138 kV line (Janet 74S to Strathmore 151S)	129% 113MVA	123% 109MVA	119% 106MVA	**131% 114MVA**	128% 112MVA	
	850L 138 kV line (Janet 74S to Carseland 525S)	112% 102MVA	109% 101MVA	106% 100MVA	**113% 103MVA**	111% 102MVA	

Table 3-5 Continued.

Contingency	Overloaded Branch	Scenario					
		SC1	SC2	SC3	SC4	SC5	SC6
Open 765L 138 kV line (Janet 74S to Strathmore 151S)	727L 138 kV line (Janet 74S to Okotoks 678S)	115% 141MVA	107% 133MVA	102% 128MVA	**117% 142MVA**	113% 139MVA	
Open 850L 138 kV line (Janet 74S to Carseland 525S)	727L 138 kV line (Janet 74S to Okotoks 678S)	103% 126MVA			**105% 128MVA**	101% 124MVA	
	765L 138 kV line (Janet 74S to Strathmore 151S)	106% 93MVA			**107% 94MVA**	104% 92MVA	
Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**162% 1091MVA**	122% 818MVA	
Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	917L 240 kV line (Janet 74S to East Calgary 5S)				**128% 643MVA**		
Open 911L 240 kV line (Foothills 237S to ENMAX No. 65)	936L 240 kV line (Langdon 102S to Janet 74S)		131% 670MVA	**154% 791MVA**	141% 723MVA		130% 669MVA
	937L 240 kV line (Langdon 102S to Janet 74S)		131% 670MVA	**154% 791MVA**	141% 723MVA		130% 669MVA
Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**104% 304MVA**		
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			109% 299MVA	**129% 343MVA**	104% 278MVA	
	240/138 kV transformer (East Calgary 5S)				**117% 392MVA**	102% 343MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**113% 220MVA**		
Open 917L 240 kV line (Janet 74S to East Calgary 5S)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)				**102% 287MVA**		
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)		103% 305MVA	112% 334MVA	**136% 398MVA**	114% 334MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		112% 302MVA	127% 344MVA	**150% 398MVA**	122% 326MVA	
	240/138 kV transformer (Janet 74S)				**108% 430MVA**		
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)		112% 221MVA	128% 254MVA	**165% 320MVA**	129% 252MVA	

Table 3-5 Continued.

Contingency	Overloaded Branch	Scenario					
		SC1	SC2	SC3	SC4	SC5	SC6
Open 932L 240 kV line (Janet 74S to Beddington SS-162)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		101% 272MVA	114% 311MVA	**133% 353MVA**	108% 290MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**111% 217MVA**		
	917L 240 kV line (Janet 74S to East Calgary 5S)			101% 508MVA	**140% 705MVA**	107% 540MVA	
Open 936L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**164% 1106MVA**	123% 822MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			108% 293MVA	**123% 327MVA**	101% 269MVA	
	911L 240 kV line (Foothills 237S to ENMAX No. 65)		184% 638MVA	**250% 868MVA**	234% 810MVA	117% 406MVA	186% 647MVA
	937L 240 kV line (Langdon 102S to Janet 74S)		152% 782MVA	**162% 831MVA**	146% 751MVA		151% 774MVA
Open 937L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**164% 1106MVA**	123% 822MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			108% 293MVA	**123% 327MVA**	101% 269MVA	
	911L 240 kV line (Foothills 237S to ENMAX No. 65)		184% 638MVA	**250% 868MVA**	234% 810MVA	117% 406MVA	186% 647MVA
	936L 240 kV line (Langdon 102S to Janet 74S)		152% 782MVA	**162% 831MVA**	146% 751MVA		151% 774MVA
Open 727L 138 kV line (Okotoks 678SS to Magcan 142S to High River 65S)	765L 138 kV line (Janet 74S to Strathmore 151S)	112% 98MVA	106% 94MVA	102% 91MVA	**114% 99MVA**	111% 97MVA	

3.2.1 Summary for the 2012LTO Need Assessment

The results of the 2012LTO Need Assessment confirm the need assessment study results and conclusions in the FATD Engineering Report. As expected, circuit loadings under the 2012LTO assumptions are consistently, albeit marginally, lower than what was observed in the FATD Engineering Report. A trend of increasing system overloads from 2014 to 2019 was observed in the 2012LTO Need Assessment results.

In comparing the results observed in the FATD Engineering Report and the results observed in the 2012LTO Need Assessment, there are relatively few differences in planning criteria violations. Some branches which had been

reported with overloads (>100%) in the 2014 study year in the FATD Engineering Report were instead only observed as overloaded in the 2019 study year under the 2012LTO Need Assessment meaning that these overloads will occur after 2014 based on the 2012 LTO assumptions.

Some branches which had been reported as overloads (>100%) in the FATD Engineering Report were not reported as overloads in the 2012LTO Need Assessment for either 2014 or 2019.

Although a few overload conditions were deferred or not observed in the 2012LTO Need Assessment, the need for the transmission system expansion in the study area was confirmed due to persistent severe overloads reported on numerous branches for the 2012LTO Need Assessment as shown in the results of Section 3.2. The following sections examine the system performance following the implementation of the FATD Plan according to the three FATD configuration described in Section 2.6.

3.3 2012LTO with FATD Plan Assessment – 2019 Scenarios

The FATD Plan configurations described in Section 2.6 were simulated for all 2019 scenarios under the 2012LTO assumptions. The following power flow simulations were performed for the study area with the FATD Plan:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)
- Multiple transmission elements out of service (Category C5 or N-2 condition)

3.3.1 Summary for the 2012LTO FATD Assessment – Category A & B

There were no thermal overloads or voltage violations observed under normal system conditions (Category A) for all the FATD scenarios studied.

Table 3-6 below shows thermal overloads identified in the 2019 horizon for the FATD Plan under the 2012LTO assumptions for Category B contingency events. The detailed results and one-line diagrams for the 2012LTO FATD Assessment are contained in Attachment B. The highlight values in the table indicate where overloads (>100%) were identified. Any branch loadings above 80 percent were also reported in the results to indicate the robustness of the FATD Plan to reduce the study area system loading.

For the FATD-East configuration, the results show three remaining overloaded branches reported under Category B contingencies. The highest reported overload was 132 percent on 24.82L (ENMAX 65 – ENMAX 24). Based on these results, the FATD-East configuration alone does not satisfy the Alberta Transmission Reliability Criteria in the 2019 horizon under the 2012LTO assumptions.

For the East+3rdCkt configuration, the results show one marginal overload of 100 percent was reported on 9.80L (ENMAX 31 – ENMAX 9) line with the outage of 23.80L (Janet to ENMAX 23) line. The AESO intends to uprate 9.80L to 287 MVA by adjusting a CT tap ratio. Considering the 9.80L rating of 287 MVA, the FATD-East+3rdCkt configuration meets planning criteria in the 2019 horizon under the 2012LTO assumptions.

For the FATD-Full configuration, the results show that no overloads (>100%) were observed for Category B contingencies. The maximum loading under Category B contingencies on any branch was at 91 percent, which was the only branch loading reported above 80 percent. Based on the results, the FATD-Full configuration meets planning criteria in the 2019 horizon under the 2012LTO assumptions.

Table 3-6: Comparison of Need Assessment to FATD Configurations (2019 Cat B)

Contingency	Overloaded Branch	Scenario	System Configuration			
			NEED	FATD East	FATD East+3rdCkt	FATD Full
			√ indicates loading below 80% N/A indicates the circuit does not exist			
Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	SC4	**172% 875MVA**	√	√	√
	2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	**111% 321MVA**	√	√	√
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	**316% 822MVA**	99% 271MVA	√	√
	24.83L 138 kV line (Janet 74S to ENMAX No. 24)	SC4	**120% 382MVA**	√	√	√
	240/138 kV transformer (ENMAX No. 65)	SC4	**149% 596MVA**	√	√	√
	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	**125% 323MVA**	√	√	√
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	**140% 365MVA**	√	√	√
	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	**115% 182MVA**	√	√	√
	40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	**104% 165MVA**	√	√	√
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	**201% 385MVA**	87% 174MVA	√	√
	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	97% 1028MVA	92% 979MVA	√
Open 1201L 500kV line (Langdon 102S to Chapel Rock 491S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	**189% 1275MVA**	√	√	√
	911L 240 kV line (Foothills 237S to ENMAX No. 65)	SC3	**307% 1067MVA**	N/A	N/A	N/A
Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	**128% 249MVA**	**113% 227MVA**	100% 200MVA	√
Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	87% 245MVA	85% 247MVA	√	√

Table 3-6 Continued.

Contingency	Overloaded Branch	Scenario	System Configuration			
			NEED	FATD East	FATD East+3rdCkt	FATD Full
			√ indicates loading below 80% N/A indicates the circuit does not exist			
Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	**101% 269MVA**	81% 221MVA	√	√
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	**117% 311MVA**	96% 263MVA	82% 223MVA	√
Open 240/138 kV transformer T1 (East Calgary 5S)	240/138 kV transformer T2 (East Calgary 5S)	SC3	N/A	87% 349MVA	85% 341MVA	91% 362MVA
	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	**107% 461MVA**	82% 359MVA	√	√
Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	98% 391MVA	80% 321MVA	88% 353MVA	√
Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	**107% 428MVA**	92% 367MVA	89% 357MVA	80% 322MVA
Open 240/138 kV transformer (Sarcee 42S)	240/138 kV transformer (Sarcee 42S)	SC1	92% 369MVA	√	√	√
Open 434L 138kV line (High River 65S to Foothills 237S)	765L 138kV line (Janet 74S to Strathmore 151S)	SC1	N/A	86% 76MVA	86% 76MVA	82% 74MVA
	765L 138kV line (Janet 74S to Strathmore 151S)	SC5	N/A	81% 71MVA	82% 72MVA	83% 73MVA
Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	**133% 389MVA**	**122% 368MVA**	90% 271MVA	√
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	**167% 445MVA**	**132% 361MVA**	93% 255MVA	√
	31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	90% 145MVA	88% 146MVA	√	√
Open 500/240 kV transformer (Langdon 102S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)	SC3	**307% 1067MVA**	N/A	N/A	N/A
Open 727L 138 kV line (Janet 74S to Okotoks 678S)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC4	**131% 114MVA**	N/A	N/A	N/A
	850L 138 kV line (Janet 74S to Carseland 525S)	SC4	**113% 103MVA**	N/A	N/A	N/A
Open 765L 138 kV line (Janet 74S to Strathmore 151S)	727L 138 kV line (Janet 74S to Okotoks 678S)	SC4	**117% 142MVA**	N/A	N/A	N/A
Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	97% 156MVA	87% 145MVA	√	√
Open 911L 240 kV line (Foothills 237S to ENMAX No. 65)	1201L 500kV line (Langdon 102S to Chapel Rock 491S)	SC3	86% 914MVA	N/A	N/A	N/A
Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	**117% 392MVA**	√	√	√
Open 917L 240 kV line (Janet 74S to East Calgary 5S)	2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	84% 222MVA	N/A	N/A	N/A
	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	**102% 287MVA**	N/A	N/A	N/A
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	**136% 398MVA**	N/A	N/A	N/A
	240/138 kV transformer (Janet 74S)	SC4	**108% 430MVA**	N/A	N/A	N/A
	932L 240 kV line (Janet 74S to Beddington SS-162)	SC4	88% 438MVA	N/A	N/A	N/A

Table 3-6 Continued.

Contingency	Overloaded Branch	Scenario	System Configuration			
			NEED	FATD East	FATD East+3rdCkt	FATD Full
			√ indicates loading below 80% N/A indicates the circuit does not exist			
Open 932L 240 kV line (Janet 74S to Beddington SS-162)	917L 240 kV line (Janet 74S to East Calgary 5S)	SC4	**140% 705MVA**	N/A	N/A	N/A
Open 936L 240 kV line (Langdon 102S to East Calgary 5S)	937L 240 kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	96% 507MVA	92% 486MVA	√
Open 936L 240 kV line (Langdon 102S to Janet 74S)	937L 240 kV line (Langdon 102S to Janet 74S)	SC3	**162% 831MVA**	N/A	N/A	N/A
Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	96% 507MVA	92% 486MVA	√
Open 937L 240 kV line (Langdon 102S to Janet 74S)	936L 240 kV line (Langdon 102S to Janet 74S)	SC3	**162% 831MVA**	N/A	N/A	N/A
Open 985L 240 kV line (Janet 74S to ENMAX No. 25)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	97% 1028MVA	92% 979MVA	√

3.3.2 Category C5 Results for 2012LTO FATD Assessment

Selected Category C5 contingency events were simulated for each of the FATD configurations in the 2019 horizon and the results are summarized below. Only Scenarios SC1, SC3 and SC4 were tested with Category C5 events since these were the scenarios which reported the highest loadings for Category B contingencies. Table 3-7 below shows thermal overloads identified in the 2019 horizon for the FATD Plan under the 2012LTO assumptions for Category C5 contingency events. The red highlight values in the table indicate where loadings (>100%) were identified. The detailed Category C5 results and one-line diagrams for the 2012LTO FATD Assessment are contained in Attachment D.

Table 3-7: Category C5 results for FATD Configurations - 2019

Contingency	Overloaded Branch	Scenario	System Configuration		
			FATD East	FATD East+3rdCkt	FATD Full
			√ indicates loading below 80% N/A indicates the circuit does not exist		
Open 985L 240 kV line (Janet 74S to ENMAX No. 25) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	98% 1042MVA	94% 992MVA	√
Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	91% 244MVA	81% 218MVA	√
	2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	√	84% 249MVA	√
	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	**108% 311MVA**	98% 283MVA	√
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	**137% 407MVA**	**103% 306MVA**	√
Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	**135% 355MVA**	95% 249MVA	√

Table 3-7 Continued.

Contingency	Overloaded Branch	Scenario	System Configuration		
			FATD East	FATD East+3rdCkt	FATD Full
			√ indicates loading below 80% N/A indicates the circuit does not exist		
Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	240/138 kV transformer (East Calgary 5S)	SC3	√	√	84% 337MVA
Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	240/138 kV transformer (ENMAX No. 65)	SC4	√	82% 327MVA	√
	240/138 kV transformer (Janet 74S)	SC4	99% 396MVA	95% 379MVA	√
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	87% 234MVA	81% 217MVA	√
	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	83% 135MVA	√	√
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	**162% 319MVA**	**143% 282MVA**	86% 172MVA
	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC3	√	√	85% 344MVA
Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	81% 353MVA	81% 351MVA	√
Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	932L 240 kV line (Janet 74S to Beddington SS-162)	SC4	87% 435MVA	83% 417MVA	√
Open 1003L 240 kV line (Janet 74S to ENMAX No. 25) Open 1064L 240 kV line (Langdon 102S to Janet 74S)	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	98% 1042MVA	94% 992MVA	√

3.3.3 Category C5 Mitigation Requirements for 2012LTO FATD Assessment

While detailed mitigation planning is beyond the scope of this sensitivity study, mitigation options for Category C5 contingency events were developed according to the procedure and priority discussed in Section 2.4 above. Table 3-8 and Table 3-9 below show the mitigation options identified for FATD-East and FATD-East+3rdCkt configurations, respectively. These mitigation options illustrate that the Category C5 events can be relieved using appropriate operational measures in the planning horizon, albeit the mitigation measures required following the 3rd Ckt addition are significantly simplified. However, other mitigation options may exist for the same Category C5 events and detailed operational studies should be completed as FATD facilities get constructed to specify any required operating procedures. Such detailed operational studies are beyond the scope of this report and would be executed outside of the needs approval process.

Table 3-8: 2012LTO FATD-East Category C5 Mitigations

Contingency	Critical Circuit	Scenario	FATD East	Mitigation Option
Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	135% 355MVA	Shed 2x42 @ Enmax 24 and 2x23.5 @ Enmax 31 = **Total 131 MW Load Shed + 350 MW Saddlebrook Generation Shed**
Open 936L 240kV line (Langdon 102S to East Calgary 5S) Open 937L 240kV line (Langdon 102S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	SC4	108% 311MVA	Shed 23.7 MW @ Enmax 23, 4x12.7 MW @ Enmax 2, 3x23.5 MW @ Enmax 31, 2x17.6 MW @ Enmax 33, 3x7.9 MW @ Enmax 43, 3x20.7 MW @ Enmax 9, 2x = 15.9MW @ Enmax 41 **Total 297 MW + Open 1 x Enmax 65 240/138 kV transformer** **(24.81L reduced to 96% Loading)**
	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	137% 407MVA	
	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)*	SC4	162% 319MVA	

*9.80L (SS-9 to SS-31) line rating can be increased to 287 MVA by adjusting the CT limit ratio to 1200 A. The amount of load shedding was based on this increased rating.

Table 3-9: 2012LTO FATD-East+3rdCkt Category C5 Mitigations

Contingency	Critical Circuit	Scenario	FATD East+3rdCkt	Mitigation Option
Open 936L 240kV line (Langdon 102S to East Calgary 5S) Open 937L 240kV line (Langdon 102S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	103% 306MVA	Shed 23.5 MW @ Enmax 31 and 2x20.7 MW @ Enmax 9 = **Total of 64.9 MW**
	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)*	SC4	143% 282MVA	

*9.80L (SS-9 to SS-31) line rating can be increased to 287 MVA by adjusting the CT limit ratio to 1200 A. The amount of load shedding is based on this increased rating. The load shed was required for 24.81L. 9.80L line uprate to 287 MVA reduces the loading to 95%.

4. 2012LTO WITH HVDC DISPATCH SYSTEM IMPACT ASSESSMENT

This section discusses the methodology and results of the 2012LTO combined with the WATL/EATL HVDC line dispatch sensitivity study for the FATD Plan.

4.1 2012LTO with HVDC Dispatch Sensitivity Methodology

Sensitivity studies were performed for the 2014 need assessment using the 2012LTO assumptions combined with the WATL/EATL HVDC line dispatch assumptions (2012LTO+HVDC Need Assessment) to identify any impacts on the need established in the FATD Engineering Report. Table 4-1 shows the study scenarios examined for the 2012LTO+HVDC Need Assessment sensitivity for 2014. The WATL and EATL HVDC line dispatch assumptions were based on the dispatch assumptions associated with the AESO's ongoing HVDC integration studies as described in Section 2.7.

Table 4-1: 2012LTO+HVDC Need Assessment Study Scenarios - 2014

Scenario	Load Condition	Import from BC (MW)	Shepard Generation (MW)	Saddlebrook Generation (MW)	Wind Generation Dispatch (MW)	WATL HVDC Dispatch (MW)*	EATL HVDC Dispatch (MW)**
SC1A	Summer Peak	780	0	0	0	1,000	0
SC1B	Summer Peak	780	0	0	0	500	500
SC2	Summer Peak	0	0	0	1,250	600	300
SC3	Summer Peak	0	0	350	1,250	500	250
SC4	Summer Peak	0	860	350	1,250	150	100
SC5	Summer Peak	780	860	350	0	100	100
SC6	System Light	0	0	0	1,250	250	150

* Positive values indicate the power flows from Genesee to Langdon, i.e. north to south
** Positive values indicate the power flows from Heathfield to Newell, i.e. north to south

The following sections outline the results of the 2012LTO+HVDC Need Assessment sensitivity and the 2012LTO+HVDC with FATD Assessment sensitivity respectively.

4.2 20120LTO+HVDC Need Assessment - 2014 Scenarios

In the 2012LTO+HVDC Need Assessment sensitivity, the following power flow simulations were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)

Table 4-2 below shows thermal overloads identified in the 2014 horizon for the 2012LTO+HVDC Need Assessment sensitivity. The highlighted value indicates the highest observed loading for each branch across the various scenarios. The

detailed results and one-line diagrams for the 2012LTO+HVDC Need Assessment are contained in Attachment C.

Table 4-2: 2012LTO+HVDC Need Assessment Loading Violations – 2014

Contingency	Overloaded Branch	Scenario						
		SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
BASE CASE	911L 240 kV line (Foothills 237S to ENMAX No. 65)			110% 377MVA	**171% 599MVA**	148% 515MVA	106% 374MVA	
	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**139% 923MVA**	123% 817MVA	
	936L 240 kV line (Langdon 102S to Janet 74S)	**120% 611MVA**	104% 536MVA	107% 535MVA	102% 515MVA			
	937L 240 kV line (Langdon 102S to Janet 74S)	**120% 611MVA**	104% 536MVA	107% 535MVA	102% 515MVA			
	917L 240 kV line (Janet 74S to East Calgary 5S)					**106% 522MVA**	101% 498MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**106% 279MVA**		
Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)						**129% 860MVA**	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**129% 340MVA**	119% 310MVA		
	911L 240 kV line (Foothills 237S to ENMAX No. 65)						**111% 388MVA**	
	936L 240 kV line (Langdon 102S to Janet 74S)				**108% 546MVA**			
	937L 240 kV line (Langdon 102S to Janet 74S)				**108% 546MVA**			
	917L 240 kV line (Janet 74S to East Calgary 5S)						**103% 506MVA**	
Open 1201L 500kV line (Langdon 102S to Chapel Rock 491S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)	110% 383MVA	136% 486MVA	140% 471MVA	**211% 730MVA**	188% 651MVA	174% 616MVA	122% 435MVA
	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**158% 1034MVA**	154% 1021MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**112% 292MVA**	107% 278MVA	
	765L 138 kV line (Janet 74S to Strathmore 151S)					101% 86MVA	**105% 89MVA**	

Table 4-2 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				129% 340MVA	**278% 711MVA**	247% 636MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**181% 339MVA**	164% 306MVA	
	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)					**172% 854MVA**	168% 853MVA	
	240/138 kV transformer (ENMAX No. 65)					**128% 512MVA**	116% 465MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)					**122% 345MVA**	114% 322MVA	
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)					**120% 308MVA**	110% 283MVA	
	765L 138 kV line (Janet 74S to Strathmore 151S)					109% 92MVA	**113% 95MVA**	
	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)					**109% 279MVA**		
	936L 240 kV line (Langdon 102S to Janet 74S)				**108% 546MVA**			
	937L 240 kV line (Langdon 102S to Janet 74S)				**108% 546MVA**			
	24.83L 138 kV line (Janet 74S to ENMAX No. 24)					**104% 325MVA**		
	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)					**104% 162MVA**		
Open 2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	917L 240 kV line (Janet 74S to East Calgary 5S)					**111% 544MVA**	106% 518MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**108% 208MVA**		
Open 2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**142% 936MVA**	125% 828MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)					**109% 536MVA**	103% 508MVA	

Table 4-2 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				107% 205MVA	**120% 229MVA**	111% 212MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)					**114% 558MVA**	109% 534MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)					**106% 304MVA**	100% 289MVA	
Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**143% 948MVA**	127% 842MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)					**117% 572MVA**	111% 546MVA	
Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**164% 1086MVA**	146% 968MVA	
	936L 240 kV line (Langdon 102S to Janet 74S)	**121% 615MVA**	105% 540MVA	108% 539MVA				
	937L 240 kV line (Langdon 102S to Janet 74S)	**121% 615MVA**	105% 540MVA	108% 539MVA				
	917L 240 kV line (Janet 74S to East Calgary 5S)					**116% 565MVA**	110% 538MVA	
	765L 138 kV line (Janet 74S to Strathmore 151S)						**101% 87MVA**	
Open 24.83L 138 kV line (Janet 74S to ENMAX No. 24)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**110% 287MVA**	103% 271MVA	
Open 240/138 kV transformer (East Calgary 5S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)			111% 381MVA	**172% 602MVA**		107% 378MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				106% 203MVA	**118% 224MVA**	110% 209MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				104% 274MVA	**116% 304MVA**	108% 281MVA	
	765L 138 kV line (Janet 74S to Strathmore 151S)						**103% 88MVA**	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)					**100% 288MVA**		
Open 240/138 kV transformer (ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**155% 1022MVA**	137% 910MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)					**113% 553MVA**	107% 527MVA	

Table 4-2 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
Open 240/138 kV transformer (Janet 74S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)					**149% 519MVA**	108% 379MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			103% 279MVA	113% 298MVA	**126% 332MVA**	117% 307MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)				102% 498MVA	**120% 587MVA**	115% 562MVA	
	765L 138 kV line (Janet 74S to Strathmore 151S)						**102% 87MVA**	
Open 240/138 kV transformer (Sarcee 42S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**109% 287MVA**	101% 264MVA	
Open 240 kV line (Langdon 102S to HVDC_P1)	765L 138 kV line (Janet 74S to Strathmore 151S)	**105% 89MVA**						
Open 26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**147% 971MVA**	130% 862MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	100% 266MVA	100% 271MVA	112% 304MVA	122% 325MVA	**138% 363MVA**	127% 334MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				103% 301MVA	**113% 327MVA**	108% 311MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)					**111% 544MVA**	106% 519MVA	
Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**148% 981MVA**	131% 872MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	107% 285MVA	106% 287MVA	118% 321MVA	129% 344MVA	**145% 382MVA**	134% 352MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)			103% 307MVA	110% 319MVA	**120% 345MVA**	114% 329MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)					**112% 549MVA**	107% 525MVA	
Open 32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**141% 934MVA**	125% 828MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				103% 200MVA	**120% 230MVA**	110% 211MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)					**109% 532MVA**	103% 508MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**108% 285MVA**		

Table 4-2 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
Open 40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**141% 932MVA**	124% 826MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**112% 215MVA**	103% 197MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)					**108% 530MVA**	103% 505MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**108% 283MVA**		
Open 500/240 kV transformer (Langdon 102S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)	110% 386MVA	136% 480MVA	140% 472MVA	**210% 730MVA**	187% 650MVA	173% 614MVA	122% 437MVA
	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**158% 1035MVA**	153% 1020MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**112% 292MVA**	106% 277MVA	
	765L 138 kV line (Janet 74S to Strathmore 151S)					101% 86MVA	**102% 87MVA**	
Open 727L 138 kV line (Janet 74S to Okotoks 678S)	765L 138 kV line (Janet 74S to Strathmore 151S)	126% 109MVA	111% 99MVA	112% 99MVA	121% 105MVA	129% 111MVA	**135% 116MVA**	
Open 727L 138 kV line (Okotoks 678SS to Magcan 142S to High River 65S)	765L 138 kV line (Janet 74S to Strathmore 151S)	113% 98MVA			106% 92MVA	114% 98MVA	**118% 101MVA**	
Open 765L 138 kV line (Janet 74S to Strathmore 151S)	936L 240 kV line (Langdon 102S to Janet 74S)	**121% 614MVA**						
	937L 240 kV line (Langdon 102S to Janet 74S)	**121% 614MVA**						
Open 850L 138 kV line (Janet 74S to Carseland 525S)	765L 138 kV line (Janet 74S to Strathmore 151S)	105% 91MVA				108% 93MVA	**115% 99MVA**	
Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**144% 952MVA**	127% 845MVA	
	917L 240 kV line (Janet 74S to East Calgary 5S)					**113% 555MVA**	108% 528MVA	
Open 911L 240 kV line (Foothills 237S to ENMAX No. 65)	936L 240 kV line (Langdon 102S to Janet 74S)	140% 705MVA	129% 654MVA	142% 693MVA	**155% 772MVA**	106% 534MVA		
	937L 240 kV line (Langdon 102S to Janet 74S)	140% 705MVA	129% 654MVA	142% 693MVA	**155% 772MVA**	106% 534MVA		
	765L 138 kV line (Janet 74S to Strathmore 151S)				**101% 86MVA**		**101% 86MVA**	

Table 4-2 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**112% 294MVA**	103% 270MVA	
	240/138 kV transformer (East Calgary 5S)					**103% 347MVA**	103% 345MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**102% 196MVA**		
Open 917L 240 kV line (Janet 74S to East Calgary 5S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)			111% 381MVA	**173% 603MVA**	149% 519MVA	108% 379MVA	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	115% 217MVA	110% 214MVA	116% 227MVA	129% 246MVA	**151% 286MVA**	140% 264MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			104% 282MVA	115% 304MVA	**132% 345MVA**	122% 318MVA	
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	104% 297MVA		103% 302MVA	111% 321MVA	**125% 356MVA**	119% 337MVA	
	765L 138 kV line (Janet 74S to Strathmore 151S)					102% 87MVA	**107% 91MVA**	
Open 932L 240 kV line (Janet 74S to Beddington SS-162)	917L 240 kV line (Janet 74S to East Calgary 5S)				103% 502MVA	**123% 602MVA**	117% 574MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				102% 270MVA	**116% 305MVA**	107% 280MVA	
	765L 138 kV line (Janet 74S to Strathmore 151S)						**103% 88MVA**	
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**103% 196MVA**		
Open 936L 240 kV line (Langdon 102S to Janet 74S)	937L 240 kV line (Langdon 102S to Janet 74S)	**219% 1100MVA**	190% 968MVA	196% 965MVA	187% 932MVA	116% 586MVA	104% 529MVA	112% 583MVA
	911L 240 kV line (Foothills 237S to ENMAX No. 65)			132% 447MVA	**192% 668MVA**	160% 557MVA	118% 413MVA	103% 370MVA
	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**145% 956MVA**	129% 852MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**108% 283MVA**		
	765L 138 kV line (Janet 74S to Strathmore 151S)	100% 86MVA					**102% 87MVA**	

Table 4-2 Continued.

Contingency	Overloaded Branch	Scenario						
		SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
Open 937L 240 kV line (Langdon 102S to Janet 74S)	936L 240 kV line (Langdon 102S to Janet 74S)	**219% 1100MVA**	190% 968MVA	196% 965MVA	187% 932MVA	116% 586MVA	104% 529MVA	112% 583MVA
	911L 240 kV line (Foothills 237S to ENMAX No. 65)			132% 447MVA	**192% 668MVA**	160% 557MVA	118% 413MVA	103% 370MVA
	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**145% 956MVA**	129% 852MVA	
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**108% 283MVA**		
	765L 138 kV line (Janet 74S to Strathmore 151S)	100% 86MVA					**102% 87MVA**	

4.2.1 Summary for the 2012LTO with HVDC Need Assessment

The results of the 2012LTO+HVDC Need Assessment sensitivity confirm the need assessment study results and conclusions in the FATD Engineering Report. Table 4-3 below compares the 2012LTO Need Assessment sensitivity results to the 2012LTO+HVDC Need Assessment sensitivity results. Many of the same branch overloads are observed both without and with the HVDC lines dispatched under the 2012LTO assumptions.

The following are some key results from the comparison of the 2012LTO Need Assessment to the 2012LTO+HVDC Need Assessment:

- Lines 936L and 937L, highlighted in Table 4-3, significantly overload in 2014 due to the WATL HVDC line dispatch at 1,000 MW.
- There is approximately a 10 percent increase in 2014 loading on lines 9.80L, 24.81L, 24.82L, 911L, 917L and 765L due to the HVDC line dispatch.
- All the identified 2014 overload conditions increased in percentage from the 2012LTO Need Assessment to the 2012LTO+HVDC Need Assessment.

Based on the results, the need assessment results for the previous FATD studies were confirmed due to persistent severe overloads reported on numerous branches for the 2012LTO+HVDC Need Assessment sensitivity.

Table 4-3: Comparison of 2012LTO to the 2012LTO+HVDC Need Assessments

Overloaded Branch	2014 2012LTO	2014 2012LTO+HVDC
1003L 240kV line (Janet 74S to ENMAX No. 25)	163% 1103MVA	164% 1086MVA
1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	169% 852MVA	172% 854MVA
2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	< 100%	< 100%
23.80L 138kV line (Janet 74S to ENMAX No. 23)	< 100%	< 100%
24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	116% 345MVA	125% 356MVA
24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	269% 712MVA	278% 711MVA
24.83L 138kV line (Janet 74S to ENMAX No. 24)	103% 336MVA	104% 325MVA
240/138 kV transformer (East Calgary 5S)	< 100%	103% 347MVA
240/138 kV transformer (ENMAX No. 65)	127% 509MVA	128% 512MVA
240/138 kV transformer (Janet 74S)	< 100%	< 100%
26.81L 138kV line (ENMAX No. 26 to ENMAX No. 54)	105% 278MVA	109% 279MVA
26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	116% 306MVA	120% 308MVA
32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	101% 164MVA	104% 162MVA
40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	< 100%	< 100%
727L 138kV line (Janet 74S to Okotoks 678S)	< 100%	< 100%
765L 138kV line (Janet 74S to Strathmore 151S)	116% 102MVA	135% 116MVA
850L 138kV line (Janet 74S to Carseland 525S)	< 100%	< 100%
9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	173% 340MVA	181% 339MVA
911L 240kV line (Foothills 237S to ENMAX No. 65)	193% 684MVA	211% 730MVA
916L 240kV line (Sarcee 42S to East Calgary 5S)	< 100%	< 100%
917L 240kV line (Janet 74S to East Calgary 5S)	111% 563MVA	123% 602MVA
936L 240kV line (Langdon 102S to Janet 74S)	< 100%	219% 1100MVA
937L 240kV line (Langdon 102S to Janet 74S)	< 100%	219% 1100MVA

4.3 2012LTO+HVDC with FATD Plan Assessment – 2019 Scenarios

The results of the 2012LTO+HVDC Need Assessment for 2014 showed that Scenarios 1A, 3 and 4 caused the highest system overloads with the HVDC lines

dispatched prior to the FATD Plan. Therefore, the FATD Plan configurations described in Section 2.6 were simulated for 2019 scenarios 1A, 3 and 4 under the 2012LTO+HVDC assumptions. The following power flow simulations were performed for the study area with the FATD Plan:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)
- Multiple transmission elements out of service (Category C5 or N-2 condition)

Table 4-4 below shows the study scenarios examined for the 2012LTO+HVDC with FATD sensitivity for 2019.

Table 4-4: 2012LTO+HVDC FATD Assessment Study Scenarios - 2019

Scenario	Load Condition	Import from BC (MW)	Shepard Generation (MW)	Saddlebrook Generation (MW)	Wind Generation Dispatch (MW)	WATL HVDC Dispatch (MW)*	EATL HVDC Dispatch (MW)
SC1A	Summer Peak	780	0	0	0	1,000	0
SC3	Summer Peak	0	0	350	2,540	300	150
SC4	Summer Peak	0	860	350	2,540	0	-200

* Positive values indicate the power flows from Genesee to Langdon
** Positive values indicate the power flows from Heathfield to Newell

4.3.1 Summary for the 2012LTO+HVDC FATD Assessment – Category A & B

There were no thermal overloads or voltage violations observed under normal system conditions (Category A) for all the FATD scenarios studied.

Table 4-5 below shows thermal overloads identified in the 2019 horizon for the FATD Plan under the 2012LTO+HVDC assumptions for Category B contingency events. The red highlight cells in the table indicate where overloads (>100%) were identified. Any branch loadings above 80 percent were also reported in the results to indicate the robustness of the FATD Plan to reduce the study area system loading.

The overload on 765L (Janet to Strathmore) is an existing overload which is mostly unaffected by the FATD Plan as demonstrated by the results. 765L is not part of the FATD Plan scope and is being addressed by the AESO in other studies. The loading on 765L was only monitored in this supplemental FATD report to confirm that the line's loading did not increase under the FATD Plan.

For the FATD-East configuration, the results show five remaining overloaded branches reported under Category B contingencies. The highest reported overload was 134 percent on 24.82L (ENMAX 65 – ENMAX 24). Based on these results, the FATD-East configuration alone would not adequately satisfy planning criteria in the 2019 horizon under the 2012LTO+HVDC assumptions.

For the East+3rdCkt configuration, the results show a marginal overload was reported on 9.80L (ENMAX 31 – ENMAX 9) with the outage of 23.80L (Janet to

ENMAX 23). The AESO intends to uprate the capacity of 9.80L to 287 MVA by resolving the line end CT limitation. Considering the 9.80L rating of 287 MVA, the FATD-East+3rdCkt configuration meets planning criteria in the 2019 horizon under the 2012LTO+HVDC assumptions.

For the FATD-Full configuration, the results show that no overloads (>100%) were observed for Category B contingencies. The maximum loading under Category B contingencies on any branch was at 94 percent. Based on the results, the FATD-Full configuration meets planning criteria in the 2019 horizon under the 2012LTO+HVDC assumptions.

Table 4-5: Comparison of 2014 Need Assessment to FATD Configurations + HVDC (2019 Cat B)

Contingency	Overloaded Branch	Scenario	System Configuration			
			2014 Need	2019 HVDC FATD East	2019 HVDC FATD East+3rdCkt	2019 HVDC FATD Full
			√ indicates loading below 80% N/A indicates the circuit does not exist			
BASE CASE	240 kV line (Langdon 102S to HVDC_P1)	SC1A	91% 960MVA	91% 960MVA	91% 960MVA	91% 960MVA
Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	SC4	**172% 854MVA**	√	√	√
	2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	95% 268MVA	√	√	√
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	**278% 711MVA**	100% 263MVA	√	√
	24.83L 138 kV line (Janet 74S to ENMAX No. 24)	SC4	**104% 325MVA**	√	√	√
	240/138 kV transformer (ENMAX No. 65)	SC4	**128% 512MVA**	√	√	√
	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	**109% 279MVA**	√	√	√
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	**120% 308MVA**	√	√	√
	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	**104% 162MVA**	√	√	√
	40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	92% 144MVA	√	√	√
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	**181% 339MVA**	86% 166MVA	√	√
	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	97% 997MVA	92% 949MVA	√
Open 1201L 500kV line (Langdon 102S to Chapel Rock 491S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)	SC3	**211% 730MVA**	N/A	N/A	N/A
Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	**120% 229MVA**	**113% 218MVA**	100% 193MVA	√
Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	82% 227MVA	86% 241MVA	√	√
Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	84% 335MVA	√	87% 349MVA	√
Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	95% 381MVA	91% 365MVA	89% 355MVA	80% 321MVA

Table 4-5 Continued.

Contingency	Overloaded Branch	Scenario	System Configuration			
			2014 Need	2019 HVDC FATD East	2019 HVDC FATD East+3rdCkt	2019 HVDC FATD Full
			√ indicates loading below 80% N/A indicates the circuit does not exist			
Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	**164% 1086MVA**	√	√	√
	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	89% 233MVA	82% 218MVA	√	√
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	100% 262MVA	98% 260MVA	83% 220MVA	√
Open 240/138 kV transformer (East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC3	N/A	89% 357MVA	88% 352MVA	91% 364MVA
	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	90% 377MVA	√	√	√
Open 240 kV line (Langdon 102S to HVDC_P1)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	**105% 89MVA**	**103% 86MVA**	**102% 85MVA**	94% 80MVA
Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	**120% 345MVA**	**124% 361MVA**	92% 266MVA	√
	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	**145% 382MVA**	**134% 351MVA**	94% 248MVA	80% 213MVA
	31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	√	92% 146MVA	√	√
Open 727L 138 kV line (Janet 74S to Okotoks 678S)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC5	**135% 116MVA**	N/A	N/A	N/A
	850L 138 kV line (Janet 74S to Carseland 525S)	SC5	97% 87MVA	N/A	N/A	N/A
Open 765L 138 kV line (Janet 74S to Strathmore 151S)	727L 138 kV line (Janet 74S to Okotoks 678S)	SC5	91% 109MVA	N/A	N/A	N/A
Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	91% 145MVA	86% 137MVA	√	√
Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	**103% 347MVA**	√	√	√
Open 917L 240 kV line (Janet 74S to East Calgary 5S)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	95% 259MVA	N/A	N/A	N/A
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	**125% 356MVA**	N/A	N/A	N/A
Open 932L 240 kV line (Janet 74S to Beddington SS-162)	917L 240 kV line (Janet 74S to East Calgary 5S)	SC4	**123% 602MVA**	N/A	N/A	N/A
Open 936L 240 kV line (Langdon 102S to East Calgary 5S)	937L 240 kV line (Langdon 102S to East Calgary 5S)	SC3	N/A	98% 489MVA	95% 474MVA	√
Open 936L 240 kV line (Langdon 102S to Janet 74S)	937L 240 kV line (Langdon 102S to Janet 74S)	SC1A	**219% 1100MVA**	N/A	N/A	N/A
Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC3	N/A	98% 489MVA	95% 474MVA	√
Open 937L 240 kV line (Langdon 102S to Janet 74S)	936L 240 kV line (Langdon 102S to Janet 74S)	SC1A	**219% 1100MVA**	N/A	N/A	N/A
Open 985L 240 kV line (Janet 74S to ENMAX No. 25)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	97% 997MVA	92% 949MVA	√

4.3.2 Category C Results for the 2012LTO+HVDC with FATD Assessment

Selected Category C5 contingency events were simulated for each of the FATD configurations in the 2019 horizon and the results are summarized below. Category C3 and C7 contingencies were also considered, however, results of the Category C3 and C7 events do not affect the need for the proposed FATD Plan and were not included in the supplemental report.

Only Scenarios SC1A, SC3 and SC4 were tested with Category C5 events since these were the scenarios which reported the highest loadings for Category B contingencies. Table 4-6 below shows thermal overloads identified in the 2019 horizon for the FATD Plan under the 2012LTO+HVDC assumptions for Category C5 contingency events. The red highlight values in the table indicate where loadings (>100%) were identified. The detailed Category C5 results and one-line diagrams for the 2012LTO+HVDC with FATD Assessment are contained in Attachment E.

Table 4-6: Category C5 Results for FATD Configurations – LTO2012+HVDC (2019)

Contingency	Overloaded Branch	Scenario	System Configuration		
			2019 HVDC FATD East	2019 HVDC FATD East+3rdCkt	2019 HVDC FATD Full
			√ indicates loading below 80% N/A indicates the circuit does not exist		
BASE CASE	240 kV line (Langdon 102S to HVDC_P1)	SC1A	91% 960MVA	91% 960MVA	91% 960MVA
Open 1003L 240 kV line (Janet 74S to ENMAX No. 25) Open 1064L 240 kV line (Langdon 102S to Janet 74S)	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	98% 1003MVA	93% 957MVA	√
Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	240/138 kV transformer (East Calgary 5S)	SC3	88% 351MVA	88% 351MVA	93% 372MVA
	240/138 kV transformer (East Calgary 5S)	SC1A	90% 361MVA	90% 359MVA	89% 356MVA
	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC3	100% 418MVA	100% 415MVA	√
	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC1A	**103% 511MVA**	**102% 509MVA**	**102% 512MVA**
	937L 240 kV line (Langdon 102S to East Calgary 5S)	SC1A	**103% 511MVA**	**102% 509MVA**	**102% 512MVA**
Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	**141% 371MVA**	99% 260MVA	√
	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	83% 73MVA	84% 74MVA	80% 71MVA
Open 1106L 240 kV line (Foothills 237S to ENMAX No. 65) Open 1107L 240 kV line (Foothills 237S to ENMAX No. 65)	1201L 500kV line (Langdon 102S to Chapel Rock 491S)	SC3	√	80% 830MVA	√
Open 985L 240 kV line (Janet 74S to ENMAX No. 25) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	98% 1003MVA	93% 957MVA	√

Table 4-6 Continued.

Contingency	Overloaded Branch	Scenario	System Configuration		
			2019 HVDC FATD East	2019 HVDC FATD East+3rdCkt	2019 HVDC FATD Full
			√ indicates loading below 80% N/A indicates the circuit does not exist		
Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	**109% 295MVA**	99% 269MVA	√
	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	**138% 388MVA**	**103% 293MVA**	√
	240/138 kV transformer (ENMAX No. 65)	SC4	√	80% 321MVA	√
	240/138 kV transformer (Janet 74S)	SC4	97% 389MVA	93% 372MVA	√
	26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	88% 229MVA	82% 212MVA	√
	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	81% 127MVA	√	√
	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	81% 69MVA	80% 69MVA	81% 70MVA
	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	**160% 300MVA**	**141% 266MVA**	86% 165MVA
	932L 240 kV line (Janet 74S to Beddington SS-162)	SC4	86% 414MVA	81% 396MVA	√
	2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	89% 226MVA	√	√

4.3.3 Category C5 Mitigation Requirements for 2012LTO+HVDC with FATD

While detailed mitigation planning is beyond the scope of this sensitivity study, mitigation options for Category C5 contingency events were developed according to the procedure and priority discussion in Section 2.4 above. Table 4-7, Table 4-8 and Table 4-9 below show the mitigation options identified for FATD-East, FATD-East+3rdCkt and FATD-Full configurations, respectively. These mitigation options illustrate that the Category C5 events can be relieved using appropriate operational measures in the planning horizon, albeit the mitigation measures required following the 3rd Ckt addition are significantly simplified. However, other mitigation options may exist for the same Category C5 events and detailed operational studies should be completed as FATD facilities get constructed to specify any required operating procedures. Such detailed operational studies are beyond the scope of this report and would be executed outside of the needs approval process.

Table 4-7: 2012LTO FATD-East Cat 5 Curtailment Plan

Contingency	Critical Circuit	Scenario	2019+HVDC FATD-East	Mitigation Option
Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	SC3	100% 418MVA	Shed 2x10 MW @ Enmax 21, 2x14.6 MW @ Enmax 28, 2x10.1 MW @ Enmax 30, 2x16.6 MW @ Enmax 7 = **Total 103 MW**
Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	103% 511MVA	Redispatch WATL to 875 MW (132 MW Reduction)**
	937L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	103% 511MVA	
Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	141% 371MVA	Shed 2x42 @ Enmax 24, 3x23.5 @ Enmax 31, 2x20.7MW @ Enmax 9 = **Total 196 MW Load Shed + 350 MW Saddlebrook Generation Shed**
Open 936L 240kV line (Langdon 102S to East Calgary 5S) Open 937L 240kV line (Langdon 102S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	SC4	109% 295MVA	Shed 3x20.7 MW @ Enmax 9, 3x23.5 MW @ Enmax 31, 4x12.7 MW @ Enmax 2, 23.7 MW @ Enmax 23, 2x17.6 MW @ Enmax 33, 2x29 @ Enmax 5 = **Total 300 MW + Open 1 x Enmax 65 240/138 kV transformer**
	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	138% 388MVA	
	9.80L 138kV line* (ENMAX No. 31 to ENMAX No. 9)	SC4	160% 300MVA	

*9.80L (SS-9 to SS-31) line rating can be increased to 287 MVA by adjusting the CT limit ratio to 1200 A. The amount of load shedding was based on this increased rating.

**WATL HVDC Line Dispatch measured at Genesee end.

Table 4-8: 2012LTO FATD-East+3rdCkt Cat 5 Curtailment Plan

Contingency	Critical Circuit	Scenario	2019+HVDC FATD-East+3rdCkt	Mitigation Option
Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	SC3	100% 415MVA	Shed 2x10 @ Enmax 21, 2x14.6 MW @ Enmax 28, 2x10.1 @ Enmax 30 = **Total of 69 MW**
Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 509MVA	Redispatch WATL to 885 MW (122 MW Reduction) **
	937L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 509MVA	
Open 936L 240kV line (Langdon 102S to East Calgary 5S) Open 937L 240kV line (Langdon 102S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	103% 293MVA	Shed 1x23.5 MW @ Enmax 31, 2x20.7 MW @ Enmax 9 = **Total of 65 MW**
	9.80L 138kV line* (ENMAX No. 31 to ENMAX No. 9)	SC4	141% 266MVA	

*9.80L (SS-9 to SS-31) line rating can be increased to 287 MVA by adjusting the CT limit ratio to 1200 A. The amount of load shedding was based on this increased rating.

**WATL HVDC Line Dispatch measured at Genesee end.

Table 4-9: 2012LTO FATD-Full Cat 5 Curtailment Plan

Contingency	Critical Circuit	Scenario	2019+HVDC FATD-Full	Mitigation Option
Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 512MVA	Redispatch WATL to 886 MW (122 MW Reduction) **
Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	937L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 512MVA	

**WATL HVDC Line Dispatch measured at Genesee end.

5. SUMMARY AND CONCLUSIONS

This supplementary report was prepared to determine whether the 2012LTO and the 2012LTO combined with various WATL and EATL HVDC line dispatch assumptions affect the conclusions and recommendations made in the FATD Engineering Report dated April 29, 2011. The following sensitivity studies were completed for the FATD planned facilities:

1. 2012LTO Sensitivity
    a. 2012LTO Need Assessment for 2014
    b. 2012LTO Need Assessment for 2019
    c. 2012LTO with FATD Assessment for 2019
2. 2012LTO with the WATL and EATL HVDC Line Dispatch Sensitivity
    a. 2012LTO+HVDC Need Assessment for 2014
    b. 2012LTO+HVDC with FATD Assessment for 2019

The study scenarios and applied criteria were consistent with those used in the FATD Engineering Report. The following FATD configurations were tested with the 2012LTO study and the 2012LTOcombined with WATL/EATL HVDC line dispatch sensitivity study.

- FATD East configuration
- FATD East plus 3rd Circuit configuration
- FATD Full configuration

The details of the FATD configurations are discussed in Section 2.6 of this supplementary report. The following power flow contingency studies were performed for the study area:

- All transmission elements in service (Category A or N-0 condition)
- One transmission element out of service (Category B or N-1 condition)

In addition, selected Category C events were investigated including Category C3, C5 and C7 contingencies.

The results of the sensitivity studies confirm the need assessment study results in the FATD Engineering Report. Substantial system overloads in the study area were again observed in the need assessments under the 2012LTO both without and with the WATL and EATL HVDC lines dispatched, indicating a need for significant system improvements in the 2014 timeframe. The 2012LTO+HVDC

The FATD-East configuration results for the 2012LTO and 2012LTO+HVDC sensitivities indicated that overloads under Category B contingency conditions will persist in the system by 2019 unless the 138 kV third circuit, i.e., 54.81L

(ENMAX 65 to ENMAX 54) and 41.84L (ENMAX 54 to ENMAX 41), is also constructed.

The FATD-East+3rdCkt configuration as studied in this supplementary report mitigated the identified overloads in 2019, with the exceptions of the overloads observed on 9.80L (ENMAX 31 – ENMAX 9) and 765L (Janet to Strathmore). The AESO intends to uprate 9.80L to 287 MVA by resolving the line end CT limitation. 765L is not part of the FATD Plan scope and is being addressed by the AESO in other studies.

The FATD-Full configuration as studied in this supplementary report fully mitigated the identified Category B overloads in the study area through the 2019 timeframe for the 2012LTO and 2012LTO+HVDC.

Since the FATD-East+3rdCkt configuration with the 9.80L capacity uprate addresses all Category B concerns in the 2012LTO and 2012LTO+HVDC, the timing for the need of the FATD-Full development will be confirmed by subsequent system studies. However, there were a number of highly loaded (>80%) facilities remaining under the FATD-East+3rdCkt configuration which had reduced loading under the FATD-Full configuration. Additional load and generation growth in the study area beyond the 2019 horizon may begin to introduce overloads under Category B contingencies, which may require additional transmission reinforcement in the area.

Curtailment options were successfully identified with the FATD Plan which could mitigate overloads observed under Category C outage conditions.

Attachment A – List of Critical System Elements

Table 1: List of Critical System Elements

Critical System Element	Description	2014 Need			2019 FATD-Full		
		Rate A (MVA)	Rate B (MVA)	Rate C (MVA)	Rate A (MVA)	Rate B (MVA)	Rate C (MVA)
1003L 240kV line (Janet 74S to ENMAX No. 25)	160[JANET 4 240.00] to 182[SHEPARD1 240.00] CKT 1	N/A			978	1212	1454
1003L 240kV line (Janet 74S to ENMAX No. 25)	160[JANET 4 240.00] to 182[SHEPARD1 240.00] CKT 11	638	788	788	N/A		
1064L 240kV line (Langdon 102S to Janet 74S)	159[LANGDON4 240.00] to 160[JANET 4 240.00] CKT 1	N/A			978	1212	1454
1065L 240kV line (Langdon 102S to Janet 74S)	159[LANGDON4 240.00] to 160[JANET 4 240.00] CKT 2	N/A			978	1212	1454
1066L 240kV line (Sarcee 42S to Foothills 237S)	161[SARCEE 4 240.00] to 598[FOOTHILLS240240.00] CKT 1	N/A			978	1213	1213
1067L 240kV line (Sarcee 42S to Foothills 237S)	161[SARCEE 4 240.00] to 598[FOOTHILLS240240.00] CKT 2	N/A			978	1213	1213
1080L 240kV line (ENMAX No. 25 to ENMAX No. 65)	182[SHEPARD1 240.00] to 602[ENMX65S4 240.00] CKT 11	492	606	606	489	606	727
1106L 240kV line (Foothills 237S to ENMAX No. 65)	598[FOOTHILLS240240.00] to 602[ENMX65S4 240.00] CKT 1	N/A			978	1212	1454
1107L 240kV line (Foothills 237S to ENMAX No. 65)	598[FOOTHILLS240240.00] to 602[ENMX65S4 240.00] CKT 2	N/A			978	1212	1454
1109L 240kV line (ENMAX No. 25 to ENMAX No. 65)	182[SHEPARD1 240.00] to 602[ENMX65S4 240.00] CKT 50	N/A			489	606	727
1201L 500kV line (Langdon 102S to Crowsnest 491S)	158[LANGDON2 500.00] to 458[CR_NEST1 500.00] CKT 01	1039	1039	1351	1039	1039	1351
2.80L 138kV line (ENMAX No. 2 to ENMAX No. 23)	208[ENMX2S 7 138.00] to 577[ENMX23S7 138.00] CKT 80	260	287	287	260	287	287
2.81L 138kV line (ENMAX No. 2 to ENMAX No. 9)	208[ENMX2S 7 138.00] to 585[ENMX9S 7 138.00] CKT 81	287	287	287	287	287	287
23.80L 138kV line (Janet 74S to ENMAX No. 23)	207[JANET 7 138.00] to 577[ENMX23S7 138.00] CKT 80	260	321	321	260	321	321
24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	579[ENMX31S7 138.00] to 590[ENMX24S7 138.00] CKT 81	287	287	287	287	287	287
24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	570[NEW TUC SUB 138.00] to 590[ENMX24S7 138.00] CKT 24	260	321	321	260	321	321
24.83L 138kV line (Janet 74S to ENMAX No. 24)	207[JANET 7 138.00] to 590[ENMX24S7 138.00] CKT 83	318	392	392	318	392	392
240/138 kV transformer (East Calgary 5S)	162[E CALGAR 240.00] to 208[ENMX2S 7 138.00] CKT T1	336	336	336	400	400	400
240/138 kV transformer (East Calgary 5S)	162[E CALGAR 240.00] to 208[ENMX2S 7 138.00] CKT T2	N/A			400	400	400
240/138 kV transformer (ENMAX No. 65)	570[NEW TUC SUB 138.00] to 602[ENMX65S4 240.00] CKT T1	400	400	400	400	400	400
240/138 kV transformer (ENMAX No. 65)	570[NEW TUC SUB 138.00] to 602[ENMX65S4 240.00] CKT T2	400	400	400	400	400	400
240/138 kV transformer (Foothills 237S)	598[FOOTHILLS240240.00] to 600[FOOTHILLS138138.00] CKT T1	N/A			400	400	400
240/138 kV transformer (Foothills 237S)	598[FOOTHILLS240240.00] to 600[FOOTHILLS138138.00] CKT T2	N/A			400	400	400
240/138 kV transformer (Janet 74S)	160[JANET 4 240.00] to 207[JANET 7 138.00] CKT T1	400	400	400	400	400	400
240/138 kV transformer (Janet 74S)	160[JANET 4 240.00] to 207[JANET 7 138.00] CKT T2	400	400	400	400	400	400
240/138 kV transformer (Sarcee 42S)	161[SARCEE 4 240.00] to 202[SARCEE 7 138.00] CKT T2	400	400	400	400	400	400
240/138 kV transformer (Sarcee 42S)	161[SARCEE 4 240.00] to 5161[SARCEE M 138.00] CKT T1	400	400	400	400	400	400
240kV line (Langdon 102S to HVDC_P1)	159[LANGDON4 240.00] to 485[HVDC_P1 240.00] CKT DC	1000	1000	1000	1000	1000	1000

Critical System Element	Description	2014 Need			2019 FATD-Full		
		Rate A (MVA)	Rate B (MVA)	Rate C (MVA)	Rate A (MVA)	Rate B (MVA)	Rate C (MVA)
26.81L 138kV line (ENMAX No. 26 to ENMAX No. 54)	562[54 SUB 138.00] to 589[ENMX26S7 138.00] CKT 81	260	321	321	N/A		
26.81L 138kV line (ENMAX No. 32 to ENMAX No. 26)	583[ENMX32S7 138.00] to 589[ENMX26S7 138.00] CKT 81	N/A			260	287	287
26.83L 138kV line (ENMAX No. 65 to ENMAX No. 26)	570[NEW TUC SUB 138.00] to 589[ENMX26S7 138.00] CKT 26	260	321	321	260	321	321
30.81L 138kV line (Sarcee 42S to ENMAX No. 30)	202[SARCEE 7 138.00] to 586[ENMX30S7 138.00] CKT 81	268	287	315	268	287	315
31.84L 138kV line (ENMAX No. 31 to ENMAX No. 32)	579[ENMX31S7 138.00] to 583[ENMX32S7 138.00] CKT 84	159	191	191	159	191	191
32.83L 138kV line (ENMAX No. 32 to ENMAX No. 40)	583[ENMX32S7 138.00] to 591[ENMX40S7 138.00] CKT 83	159	191	191	159	191	191
33.83L 138kV line (ENMAX No. 41 to ENMAX No. 33)	592[ENMX41S7 138.00] to 594[ENMX33S7 138.00] CKT 83	191	191	191	191	191	191
33.84L 138kV line (ENMAX No. 43 to ENMAX No. 33)	571[ENMX43S7 138.00] to 594[ENMX33S7 138.00] CKT 84	163	163	191	163	163	191
40.81L 138kV line (ENMAX No. 40 to ENMAX No. 41)	591[ENMX40S7 138.00] to 592[ENMX41S7 138.00] CKT 81	159	191	191	159	191	191
41.84L 138kV line (ENMAX No. 54 to ENMAX No. 41)	562[54 SUB 138.00] to 592[ENMX41S7 138.00] CKT 41	N/A			260	321	321
434L 138kV line (High River 65S to Foothills 237S)	242[HIGH RI7 138.00] to 600[FOOTHILLS138138.00] CKT 1	N/A			310	383	383
500/240 kV transformer (Langdon 102S)	158[LANGDON2 500.00] to 5158[102ST1 240.00] CKT T1	1200	1200	1200	1200	1200	1200
54.81L 138kV line (ENMAX No. 54 to ENMAX No. 65)	562[54 SUB 138.00] to 570[NEW TUC SUB 138.00] CKT 54	N/A			260	321	321
6.80L 138kV line (ENMAX No. 30 to ENMAX No. 6)	586[ENMX30S7 138.00] to 587[ENMX6S7 138.00] CKT 80	159	191	191	159	191	191
6.82L 138kV line (ENMAX No. 6 to ENMAX No. 41)	587[ENMX6S7 138.00] to 592[ENMX41S7 138.00] CKT 82	159	191	191	159	191	191
646L 138kV line (Okotoks 678S to Foothills 237S)	239[OKOTOKS7 138.00] to 600[FOOTHILLS138138.00] CKT 1	N/A			310	383	383
727L 138kV line (Janet 74S to Okotoks 678S)	207[JANET 7 138.00] to 239[OKOTOKS7 138.00] CKT 27	119	146	161	N/A		
765L 138kV line (Janet 74S to Strathmore 151S)	207[JANET 7 138.00] to 259[STRATHM7 138.00] CKT 65	85	90	99	85	90	99
833L 138kV line (ENMAX No. 2 to ENMAX No. 12)	208[ENMX2S 7 138.00] to 581[ENMX12S7 138.00] CKT 33	191	191	191	191	191	191
850L 138kV line (Janet 74S to Carseland 525S)	207[JANET 7 138.00] to 252[CARSELA7 138.00] CKT 50	89	109	120	N/A		
850L 138kV line (Okotoks 678S to Carseland 525S)	239[OKOTOKS7 138.00] to 252[CARSELA7 138.00] CKT 51	N/A			89	109	98
9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)	579[ENMX31S7 138.00] to 585[ENMX9S 7 138.00] CKT 80	191	191	191	191	191	191
911L 240kV line (Foothills 237S to ENMAX No. 65)	598[FOOTHILLS240240.00] to 602[ENMX65S4 240.00] CKT 11	337	407	407	N/A		
916L 240kV line (Sarcee 42S to East Calgary 5S)	161[SARCEE 4 240.00] to 162[E CALGAR 240.00] CKT 16	408	494	494	408	494	494
917L 240kV line (Janet 74S to East Calgary 5S)	160[JANET 4 240.00] to 162[E CALGAR 240.00] CKT 17	478	499	549	N/A		
932L 240kV line (Janet 74S to Beddington SS-162)	160[JANET 4 240.00] to 187[BEDDING1 240.00] CKT 32	481	499	499	481	499	499
936L 240kV line (Langdon 102S to East Calgary 5S)	159[LANGDON4 240.00] to 162[E CALGAR 240.00] CKT 1	N/A			489	606	727
936L 240kV line (Langdon 102S to Janet 74S)	159[LANGDON4 240.00] to 160[JANET 4 240.00] CKT 36	489	606	727	N/A		
937L 240kV line (Langdon 102S to East Calgary 5S)	159[LANGDON4 240.00] to 162[E CALGAR 240.00] CKT 2	N/A			489	606	727

Critical System Element	Description	2014 Need			2019 FATD-Full		
		Rate A (MVA)	Rate B (MVA)	Rate C (MVA)	Rate A (MVA)	Rate B (MVA)	Rate C (MVA)
937L 240kV line (Langdon 102S to Janet 74S)	159[LANGDON4 240.00] to 160[JANET 4 240.00] CKT 37	489	606	727	N/A		
985L 240kV line (Janet 74S to ENMAX No. 25)	160[JANET 4 240.00] to 182[SHEPARD1 240.00] CKT 2	N/A			978	1212	1454

All References in this Attachment to Crowsnest 491S means Chapel Rock 491S

Attachment B – Category B 2012LTO Results & Plots

Table of Contents

Attachment B – Category B 2012LTO Results & Plots

B-1: Need Assessment

2014 Loading Violations Scenario 1

2014 Loading Violations Scenario 2

2014 Loading Violations Scenario 3

2014 Loading Violations Scenario 4

2014 Loading Violations Scenario 4B

2014 Loading Violations Scenario 5

2014 Loading Violations Scenario 6

2014 Voltage Violations Scenario 4B

2019 Loading Violations Scenario 1

2019 Loading Violations Scenario 2

2019 Loading Violations Scenario 3

2019 Loading Violations Scenario 4

2019 Loading Violations Scenario 5

2019 Loading Violations Scenario 6

B-2: FATD-East Assessment

2019 Loading Violations Scenario 1

2019 Loading Violations Scenario 3

2019 Loading Violations Scenario 4

B-3: FATD-East+3rdCkt Assessment

2019 Loading Violations Scenario 1

2019 Loading Violations Scenario 3

2019 Loading Violations Scenario 4

B-4: FATD-Full Assessment

2019 Loading Violations Scenario 1

2019 Loading Violations Scenario 3

2019 Loading Violations Scenario 4

All References in this Attachment to Crowsnest 491S means Chapel Rock 491S

B-1: Need Assessment

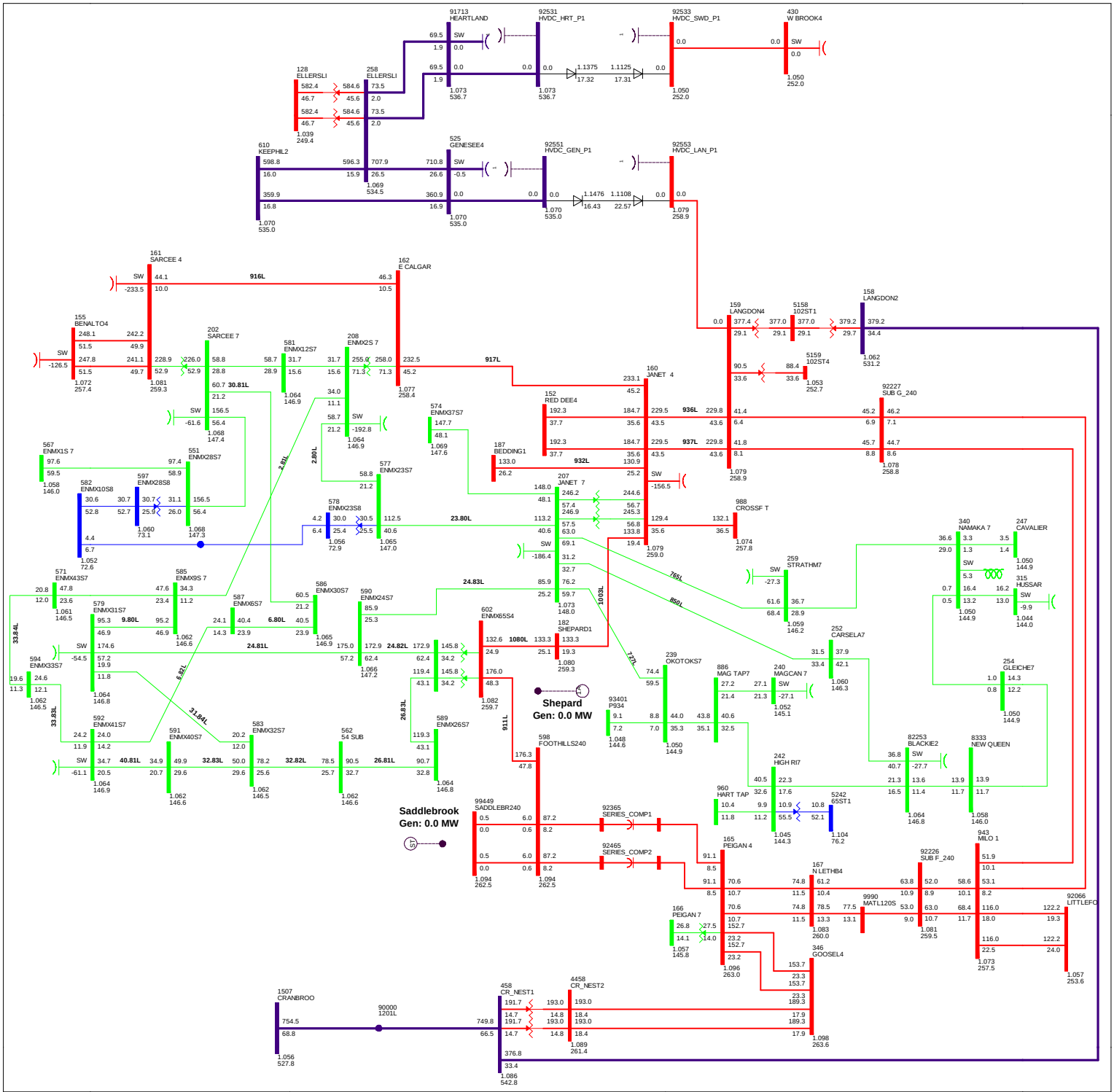
Table 1: 2012LTO Need Assessment - 2014 Loading Summary under Category B Contingencies (Over 100%)

Figure Number	Contingency	Overloaded Branch	Scenario						
			SC1	SC2	SC3	SC4	SC4B	SC5	SC6
A-Sc#-1	BASE CASE	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**140% 949MVA**	108% 900MVA	119% 817MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**101% 274MVA**			
		911L 240 kV line (Foothills 237S to ENMAX No. 65)			**154% 549MVA**	143% 505MVA	111% 473MVA		
A-Sc#-2	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)				**169% 852MVA**	138% 852MVA	166% 852MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**116% 342MVA**	116% 338MVA	109% 318MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			115% 315MVA	**269% 712MVA**	212% 686MVA	239% 630MVA	
		24.83L 138 kV line (Janet 74S to ENMAX No. 24)				**103% 336MVA**			
		240/138 kV transformer (ENMAX No. 65)				**127% 509MVA**	125% 499MVA	114% 454MVA	
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)				**105% 278MVA**			
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)				**116% 306MVA**		106% 279MVA	
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)				**101% 164MVA**			
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**173% 340MVA**	167% 323MVA	157% 304MVA	
A-Sc#-3	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)						**126% 863MVA**	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			**115% 315MVA**	114% 306MVA			
		911L 240 kV line (Foothills 237S to ENMAX No. 65)						**103% 372MVA**	
A-Sc#-4	Open 1201L 500kV line (Langdon 102S to Crowsnest 491S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**157% 1056MVA**	121% 1003MVA	151% 1019MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**107% 287MVA**		102% 272MVA	
		911L 240 kV line (Foothills 237S to ENMAX No. 65)	107% 383MVA	118% 419MVA	**194% 685MVA**	182% 640MVA	141% 598MVA	168% 598MVA	110% 404MVA
A-Sc#-5	Open 2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**101% 200MVA**			
		917L 240 kV line (Janet 74S to East Calgary 5S)				**100% 511MVA**			
A-Sc#-6	Open 2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**142% 963MVA**	109% 911MVA	121% 828MVA	
A-Sc#-7	Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**111% 220MVA**	107% 211MVA	104% 205MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**103% 524MVA**			
A-Sc#-8	Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**143% 971MVA**	111% 922MVA	123% 841MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**106% 538MVA**		101% 510MVA	
A-Sc#-9	Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**163% 1103MVA**	127% 1052MVA	141% 961MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**105% 534MVA**			
A-Sc#-10	Open 24.83L 138 kV line (Janet 74S to ENMAX No. 24)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**104% 281MVA**			
A-Sc#-11	Open 240/138 kV transformer (East Calgary 5S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**111% 299MVA**		102% 274MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**110% 217MVA**	108% 212MVA	104% 203MVA	
A-Sc#-12	Open 240/138 kV transformer (ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**154% 1044MVA**	120% 999MVA	133% 907MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**102% 521MVA**			
A-Sc#-13	Open 240/138 kV transformer (Janet 74S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**120% 325MVA**		111% 300MVA	
		911L 240 kV line (Foothills 237S to ENMAX No. 65)			**155% 552MVA**				
		917L 240 kV line (Janet 74S to East Calgary 5S)				**109% 554MVA**	101% 534MVA	104% 526MVA	
A-Sc#-14	Open 240/138 kV transformer (Sarcee 42S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**104% 282MVA**			

Table 1: 2012LTO Need Assessment - 2014 Loading Summary under Category B Contingencies (Over 100%)

Figure Number	Contingency	Overloaded Branch	Scenario						
			SC1	SC2	SC3	SC4	SC4B	SC5	SC6
A-Sc#-15	Open 26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**147% 994MVA**	114% 947MVA	126% 862MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				107% 321MVA	**110% 324MVA**	103% 304MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			108% 300MVA	**132% 357MVA**	107% 354MVA	121% 327MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**101% 513MVA**			
A-Sc#-16	Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**148% 1004MVA**	115% 960MVA	128% 873MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				114% 339MVA	**118% 349MVA**	109% 322MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		100% 282MVA	114% 315MVA	139% 376MVA	114% 379MVA	128% 346MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**102% 517MVA**			
A-Sc#-17	Open 32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**142% 960MVA**	109% 912MVA	121% 827MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**103% 279MVA**			
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**112% 222MVA**	110% 217MVA	104% 205MVA	
A-Sc#-18	Open 40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**141% 958MVA**	109% 908MVA	121% 825MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**103% 278MVA**			
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**105% 209MVA**	101% 199MVA		
A-Sc#-19	Open 500/240 kV transformer (Langdon 102S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**157% 1055MVA**	121% 1003MVA	150% 1018MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**107% 287MVA**		102% 272MVA	
		911L 240 kV line (Foothills 237S to ENMAX No. 65)	106% 379MVA	118% 418MVA	**193% 684MVA**	182% 640MVA	141% 598MVA	166% 596MVA	110% 405MVA
A-Sc#-20	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	765L 138 kV line (Janet 74S to Strathmore 151S)	104% 95MVA		102% 93MVA	111% 99MVA	**119% 111MVA**	116% 102MVA	
A-Sc#-21	Open 727L 138 kV line (Okotoks 678SS to Magcan 142S to High River 65S)	765L 138 kV line (Janet 74S to Strathmore 151S)					100% 94MVA	101% 89MVA	
A-Sc#-22	Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**144% 975MVA**	111% 925MVA	123% 843MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**102% 522MVA**			
A-Sc#-23	Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**107% 289MVA**			
A-Sc#-24	Open 917L 240 kV line (Janet 74S to East Calgary 5S)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**116% 345MVA**	116% 342MVA	111% 326MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**125% 336MVA**		115% 307MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**139% 274MVA**	134% 261MVA	129% 252MVA	
A-Sc#-25	Open 932L 240 kV line (Janet 74S to Beddington SS-162)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**110% 297MVA**		101% 271MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**111% 563MVA**	102% 537MVA	106% 534MVA	
A-Sc#-26	Open 936L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**144% 976MVA**	111% 922MVA	123% 843MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**102% 277MVA**			
		911L 240 kV line (Foothills 237S to ENMAX No. 65)			**164% 584MVA**	152% 536MVA	118% 500MVA	107% 386MVA	
A-Sc#-27	Open 937L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**144% 976MVA**	111% 922MVA	123% 843MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**102% 277MVA**			
		911L 240 kV line (Foothills 237S to ENMAX No. 65)			**164% 584MVA**	152% 536MVA	118% 500MVA	107% 386MVA	

2014 Loading Violations
Scenario 1



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

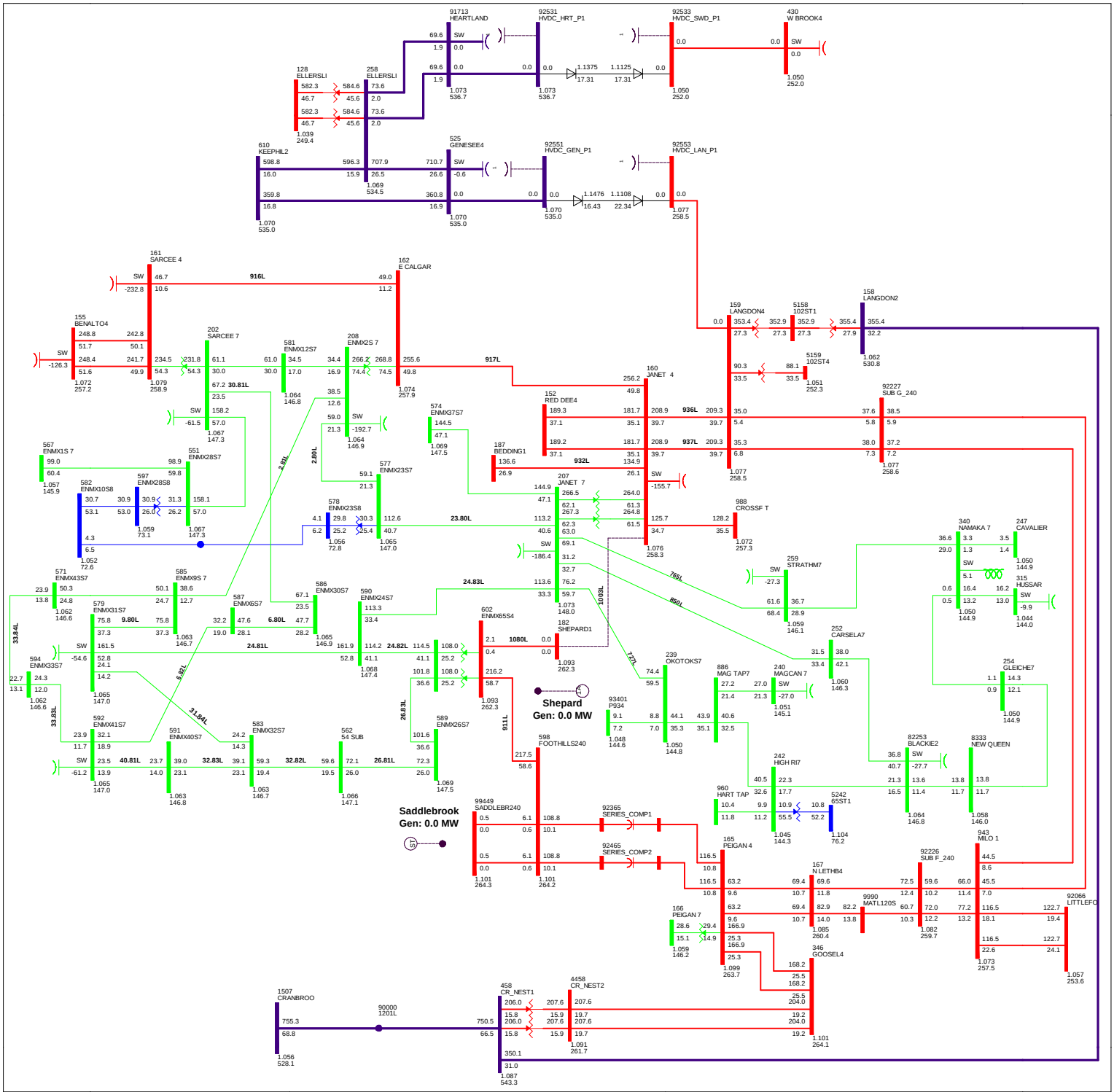
BCH Import: 780.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-1: BASECASE

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

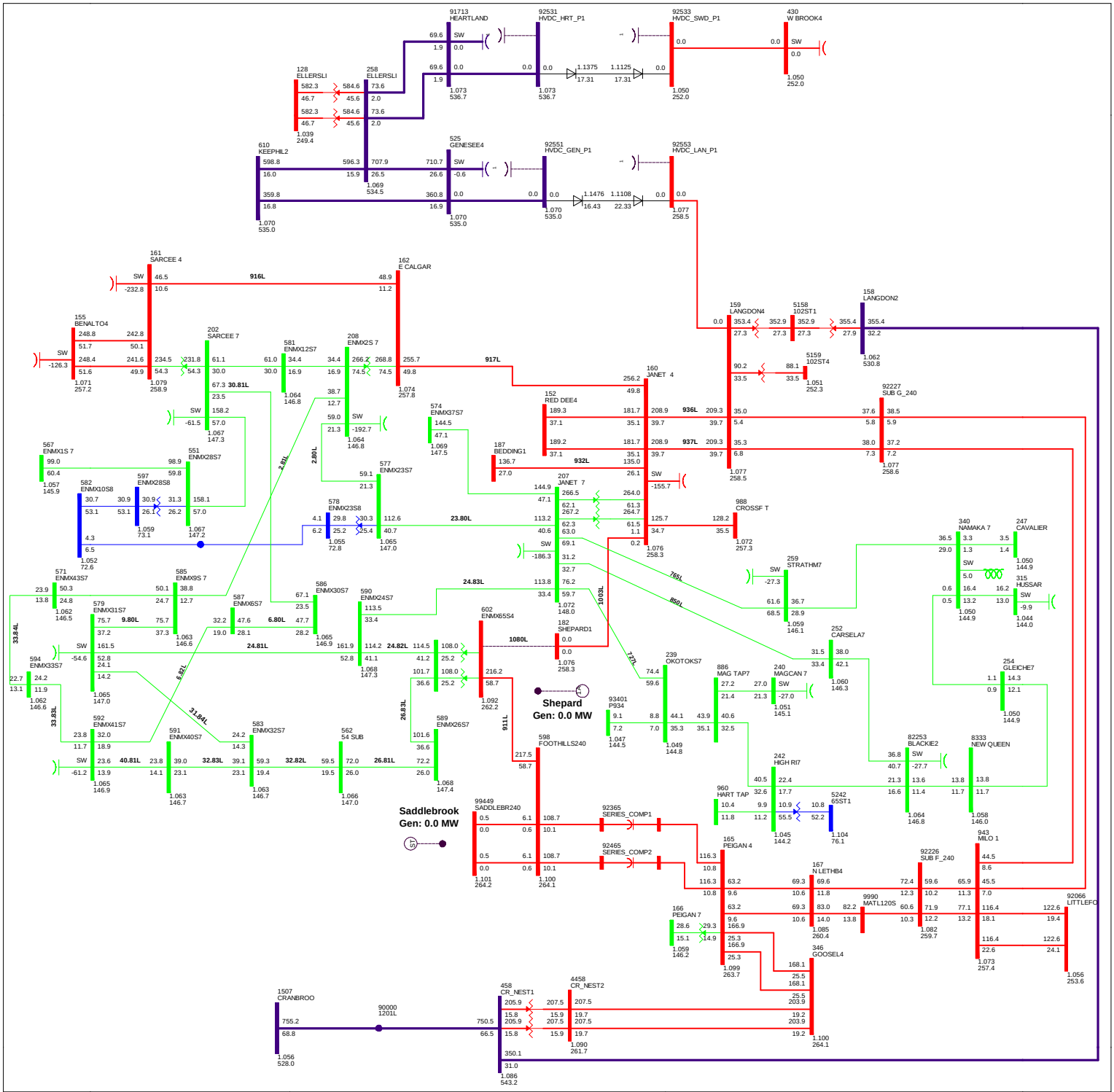
BCH Import: 780.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

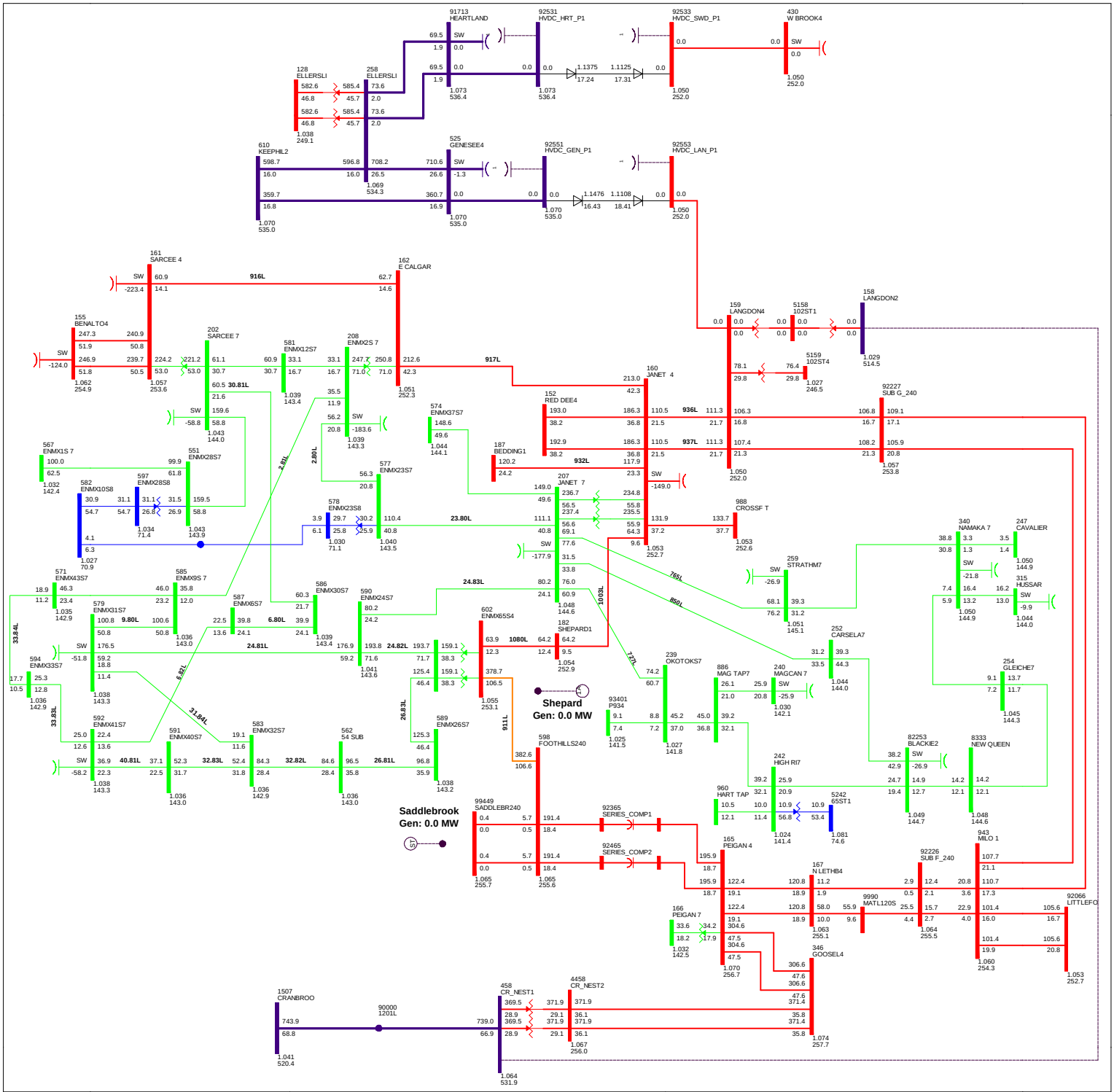
BCH Import: 780.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

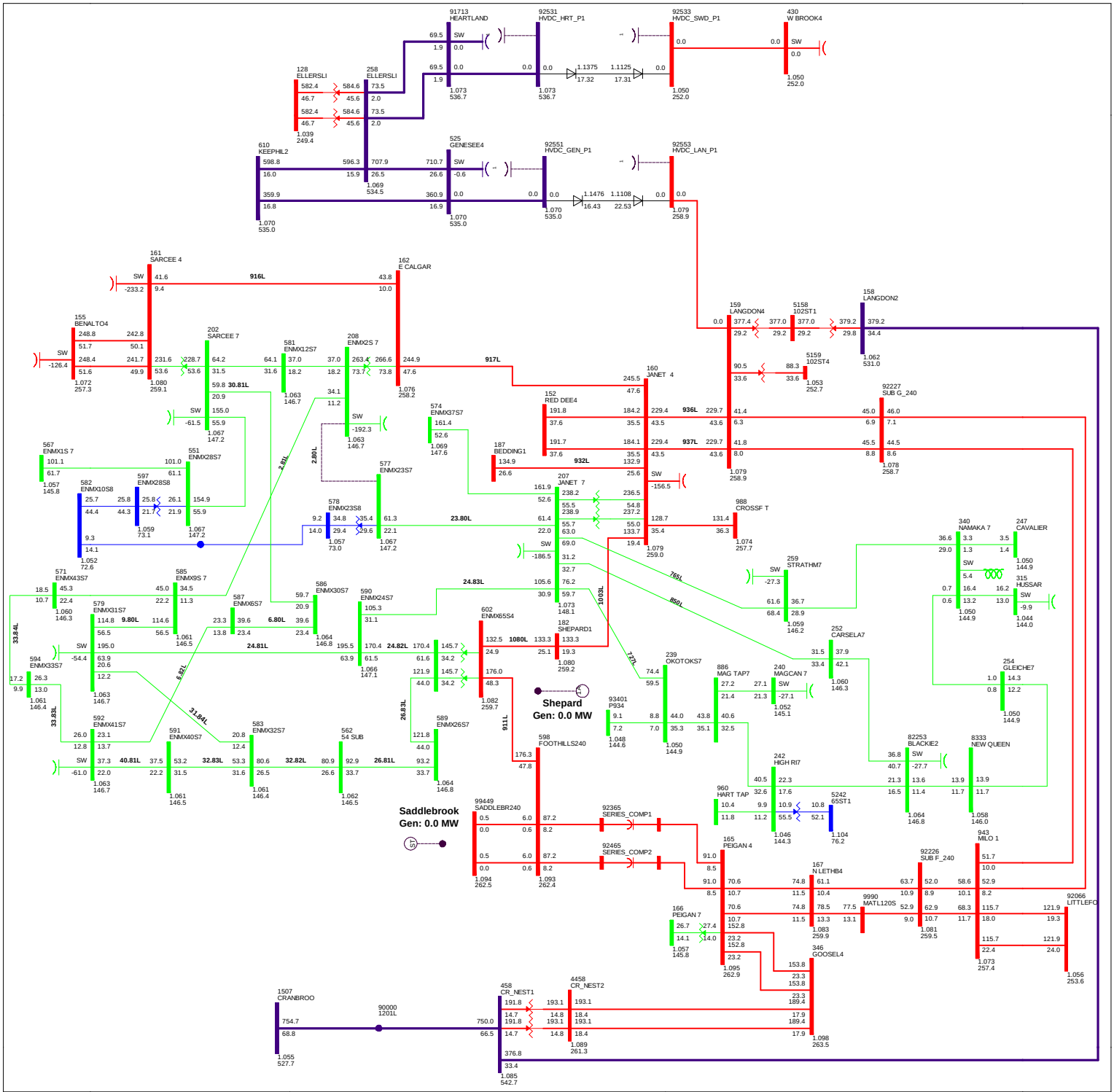
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 797.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

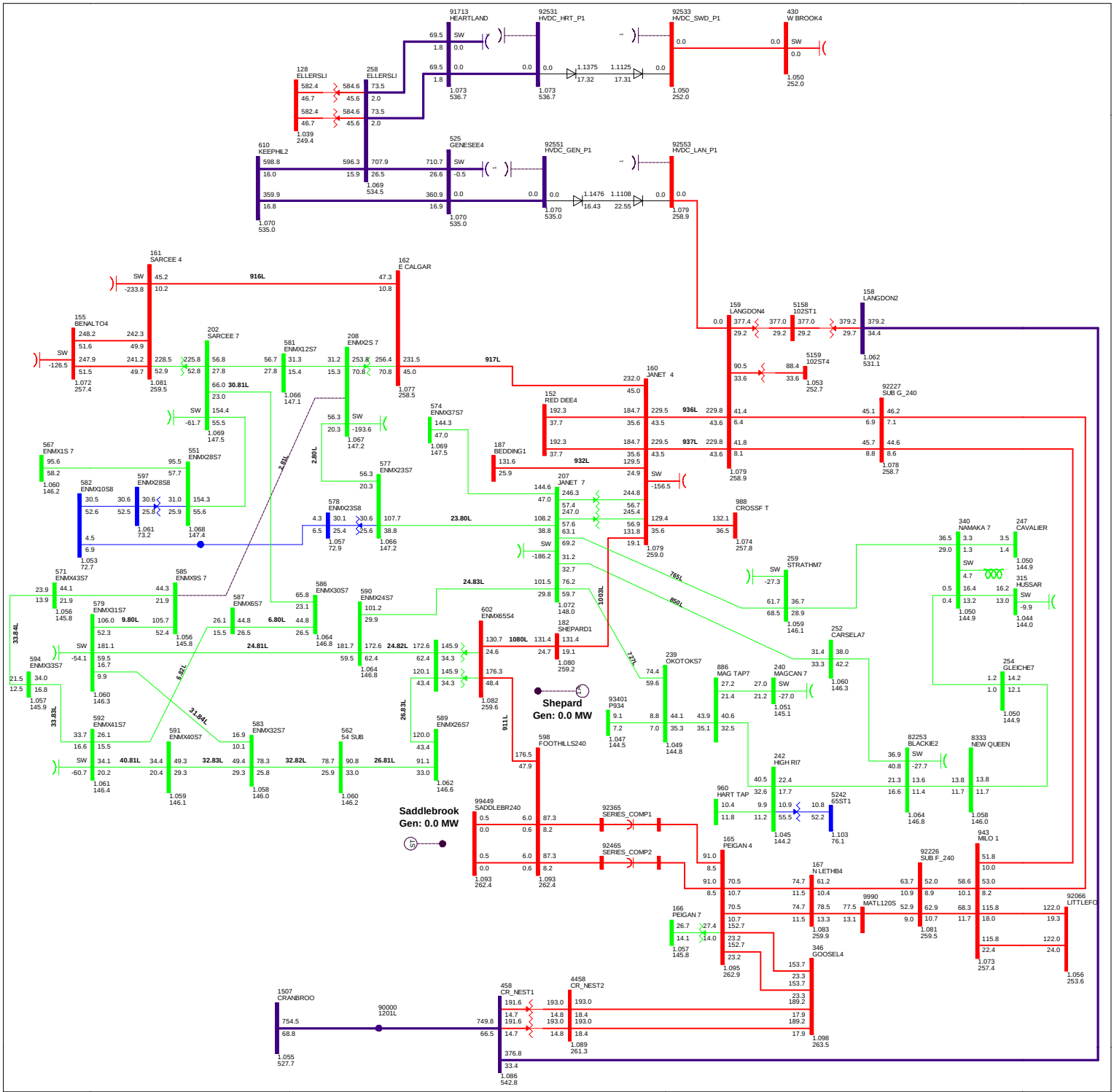
BCH Import: 780.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

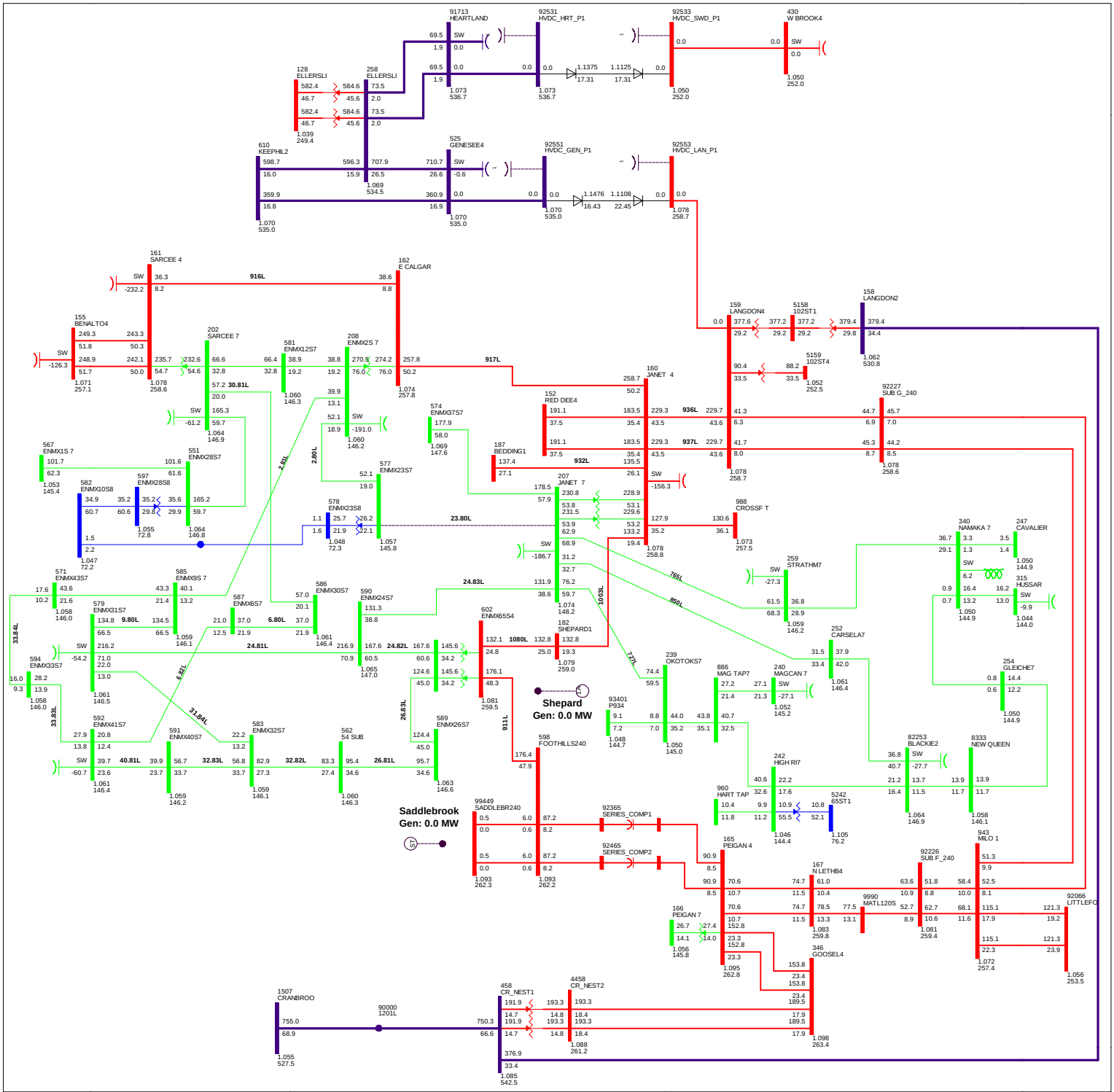
BCH Import: 780.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

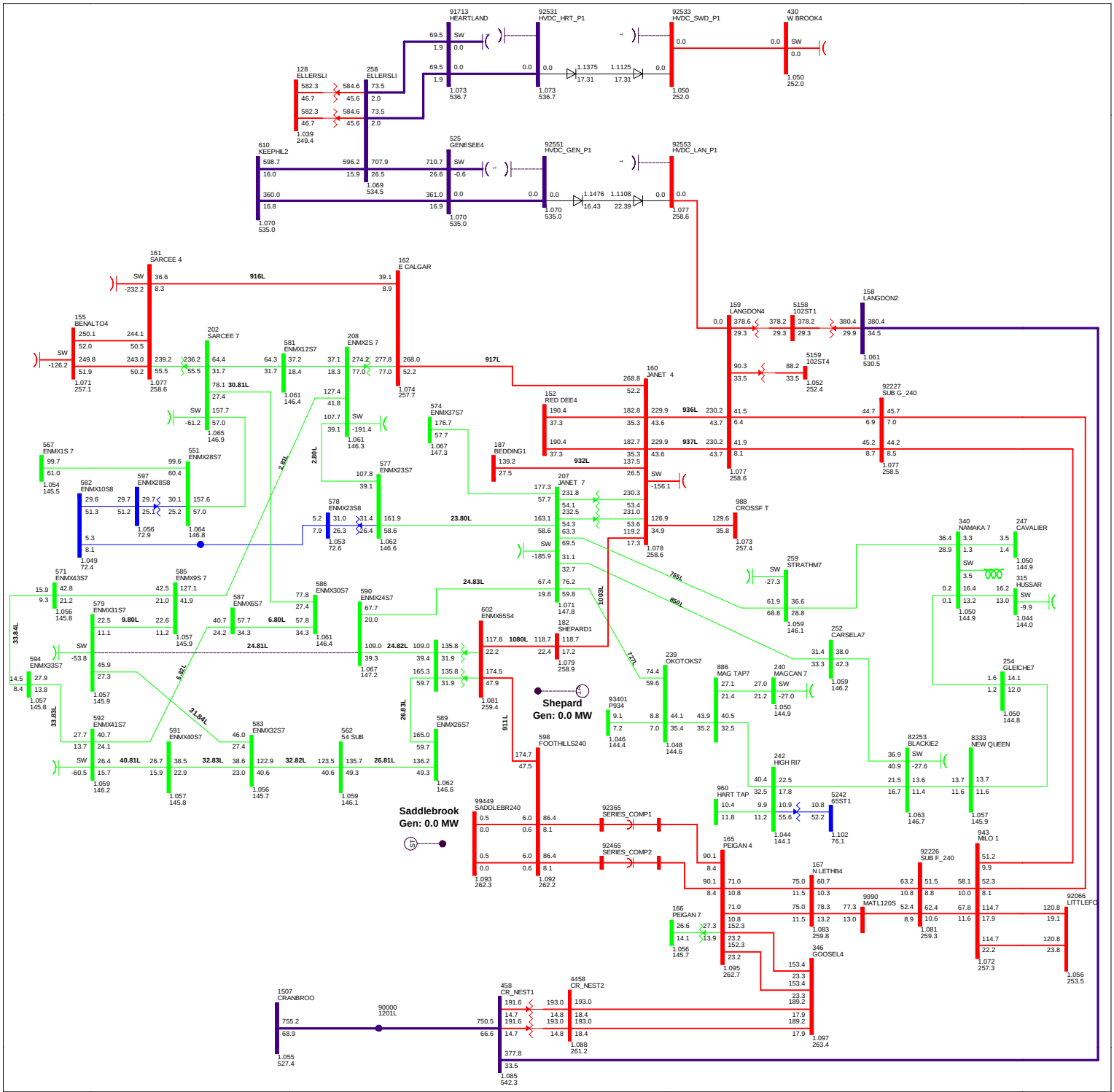
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

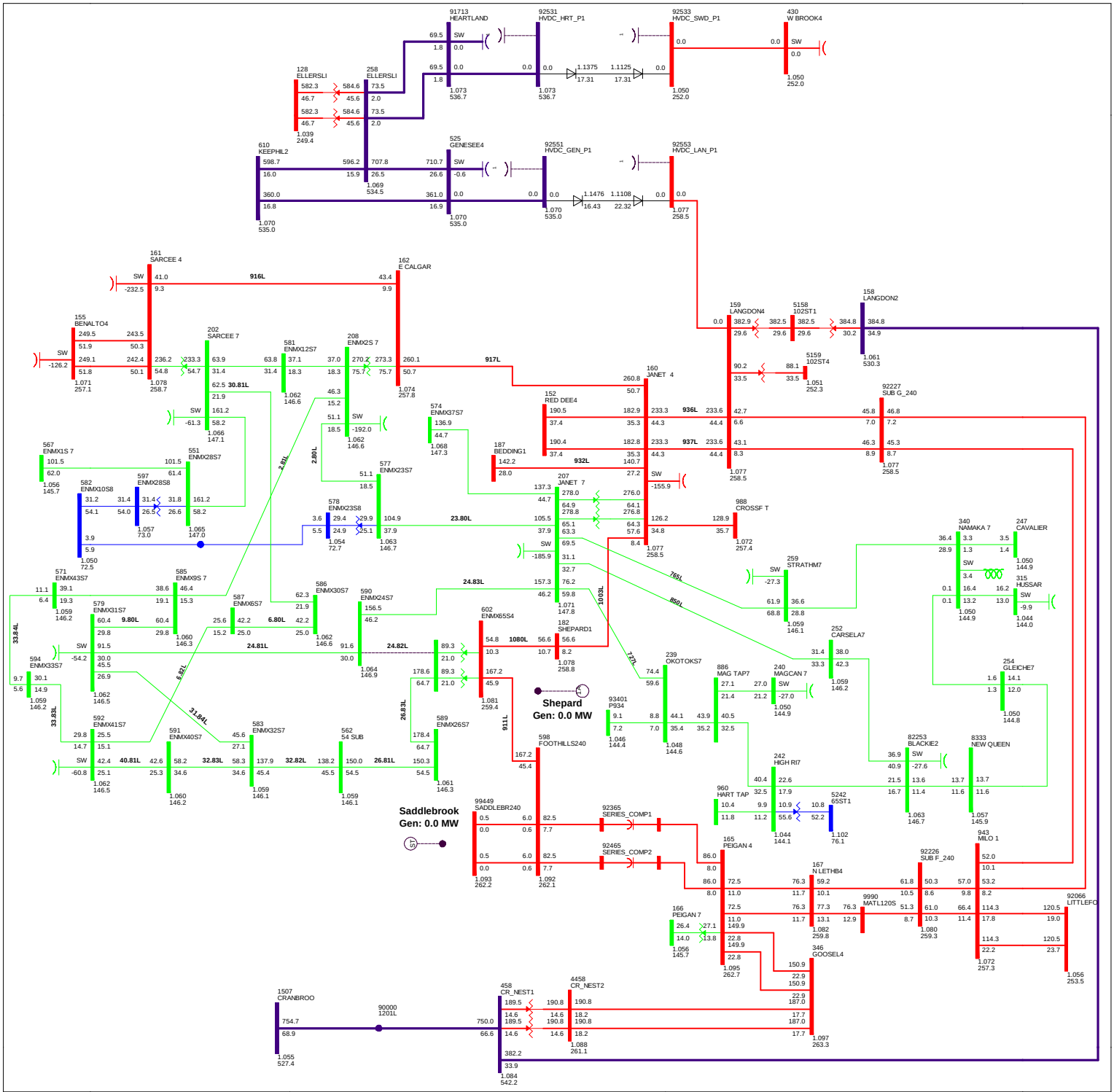
BCH Import: 781.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

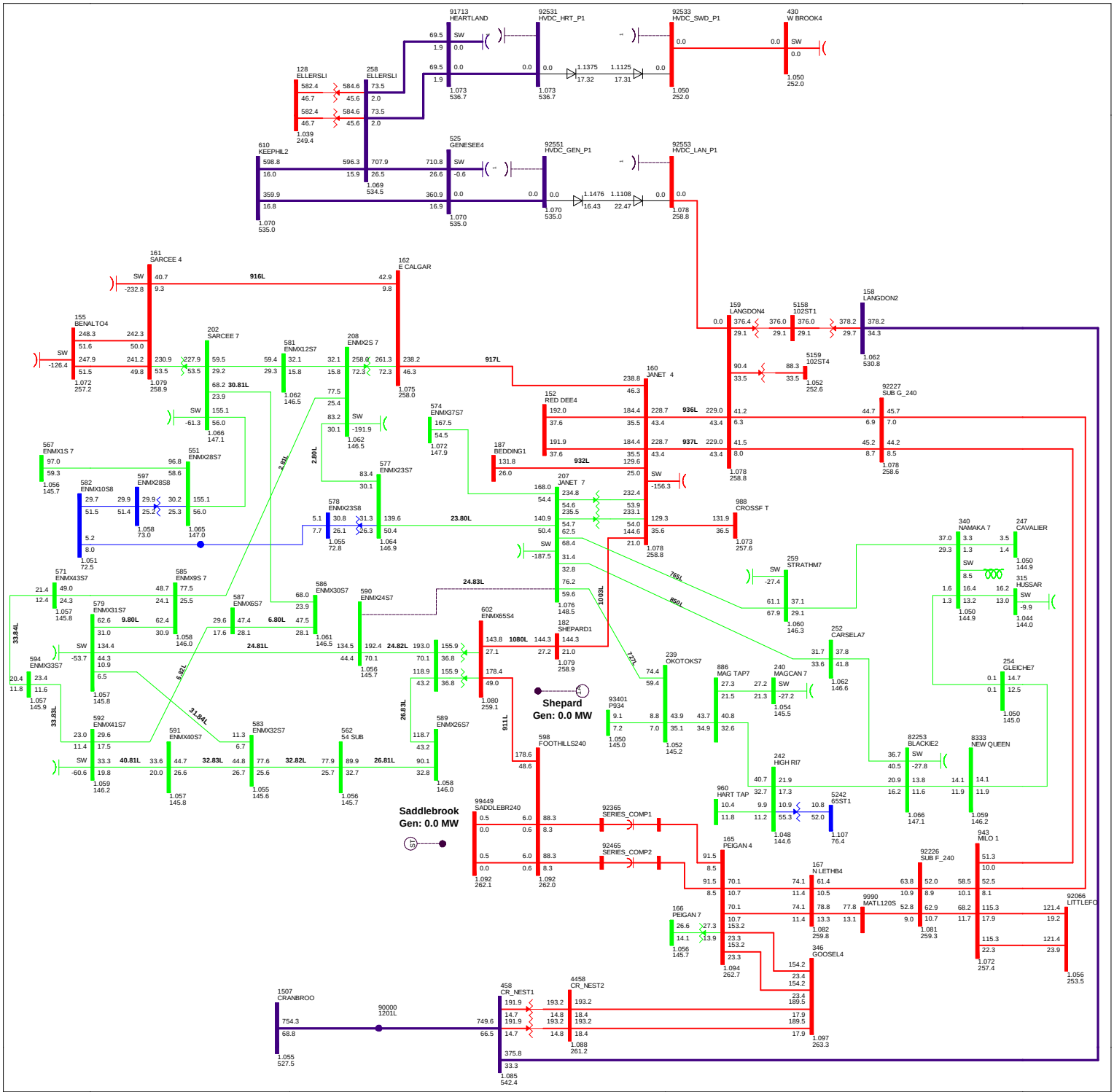
BCH Import: 781.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

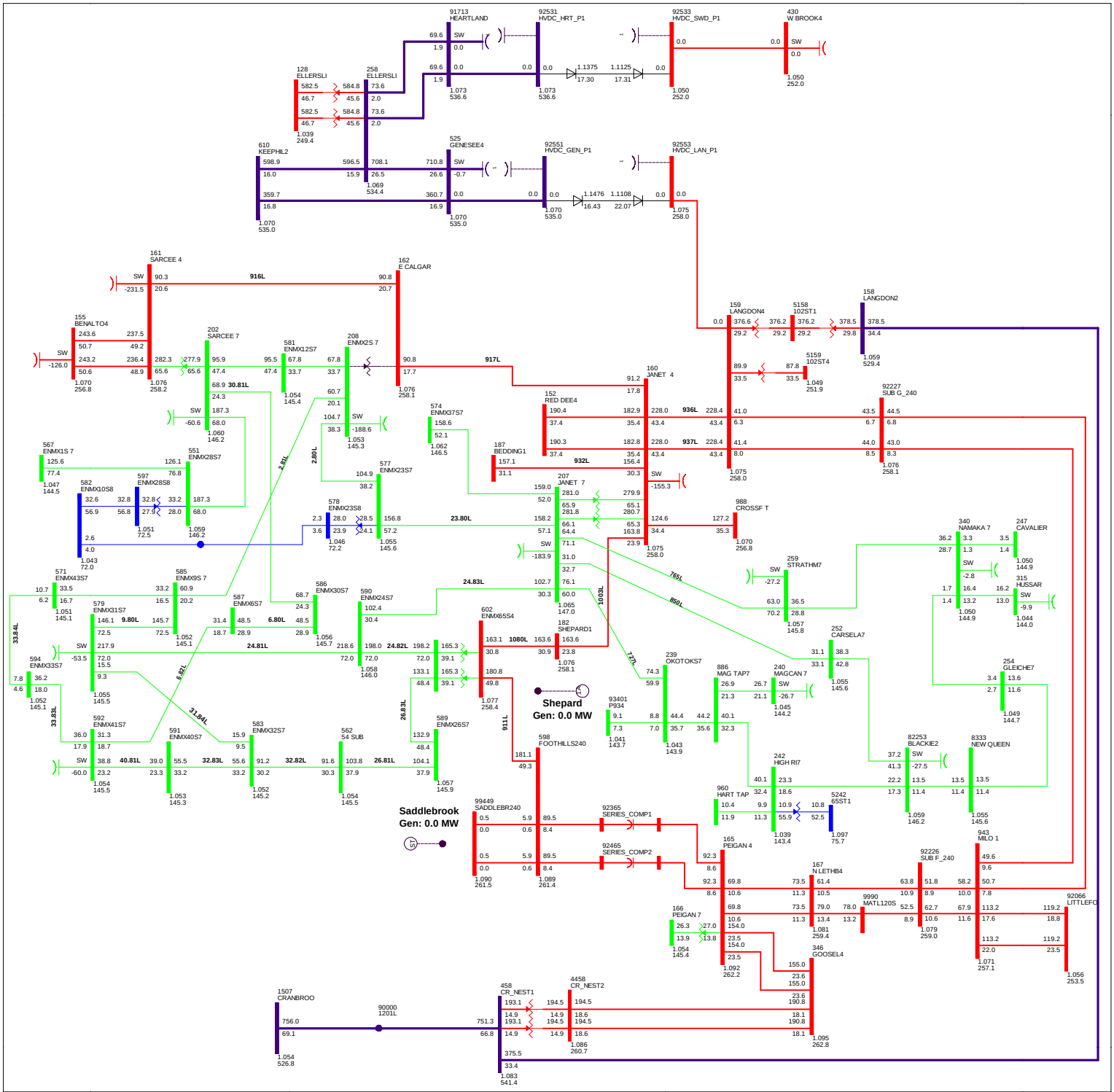
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

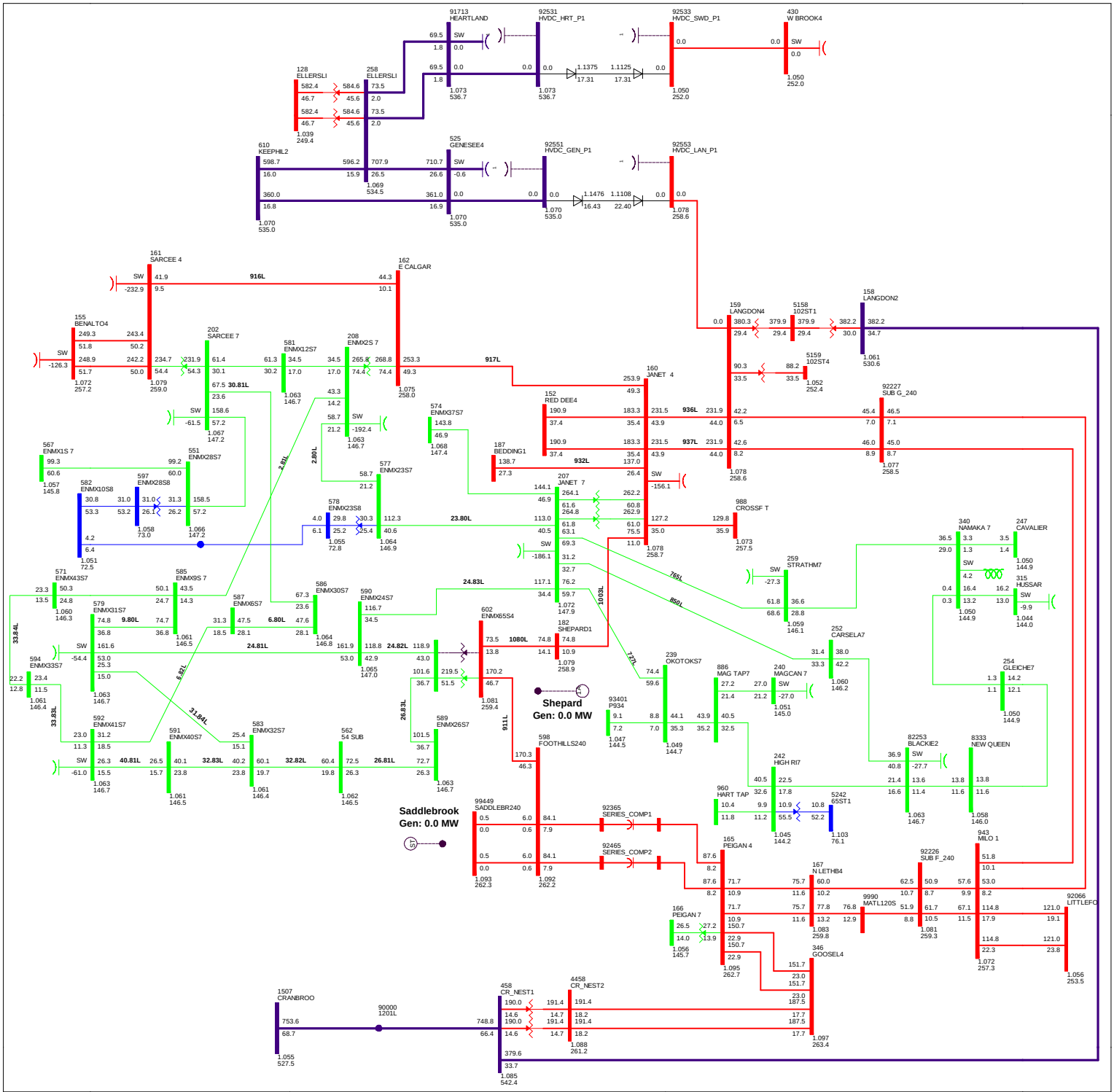
BCH Import: 784.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

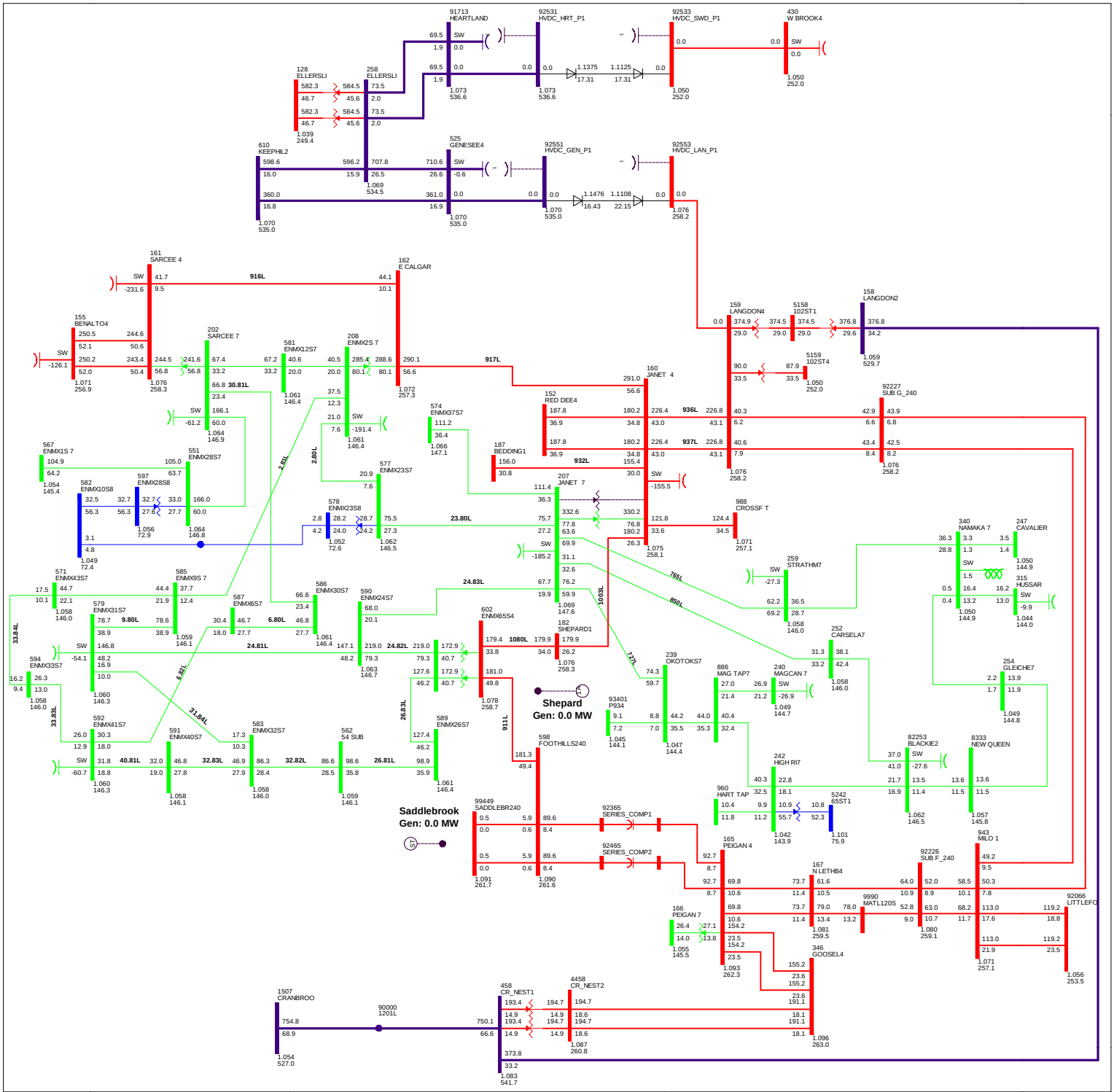
BCH Import: 780.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

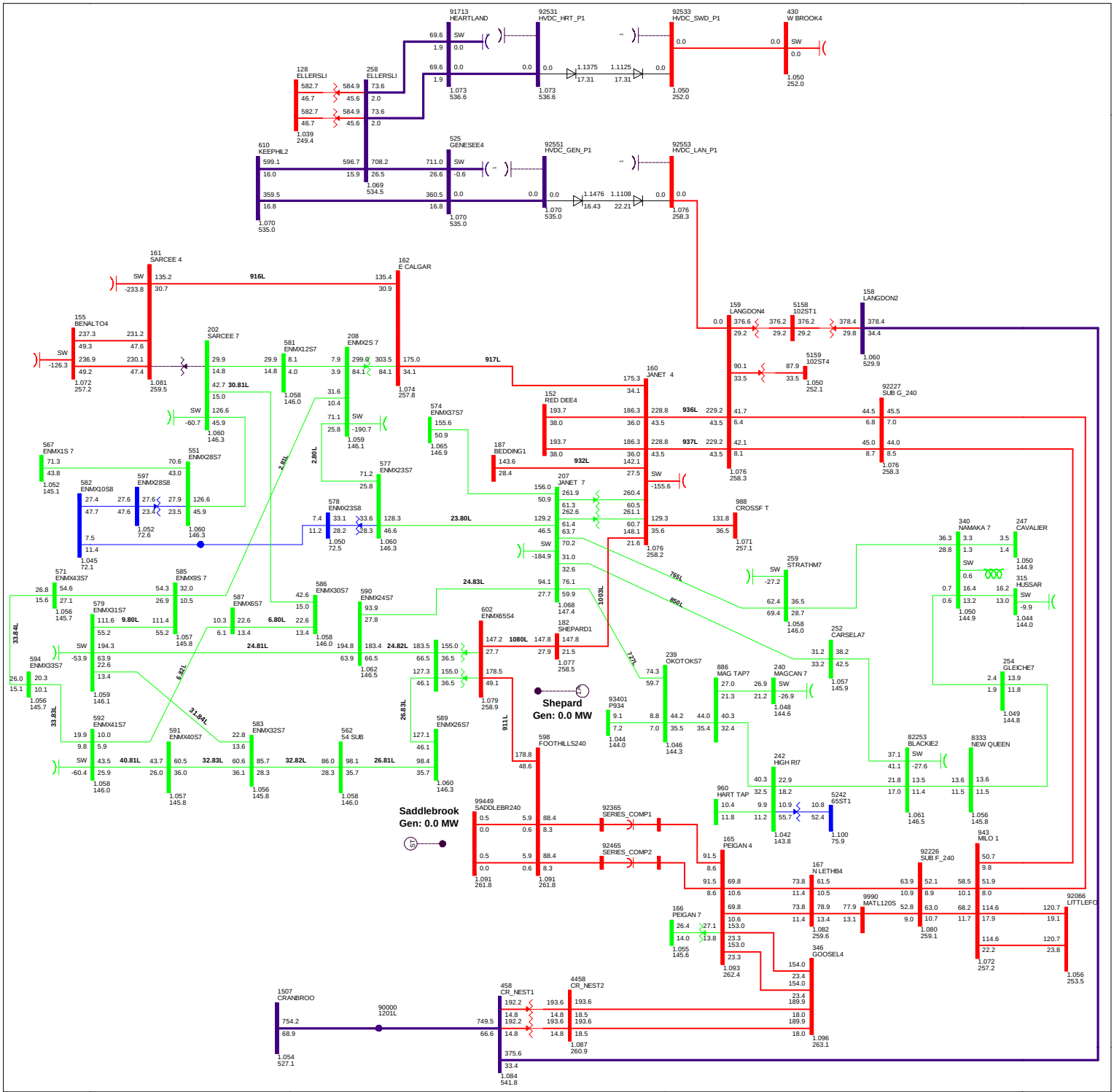
BCH Import: 782.4 MW

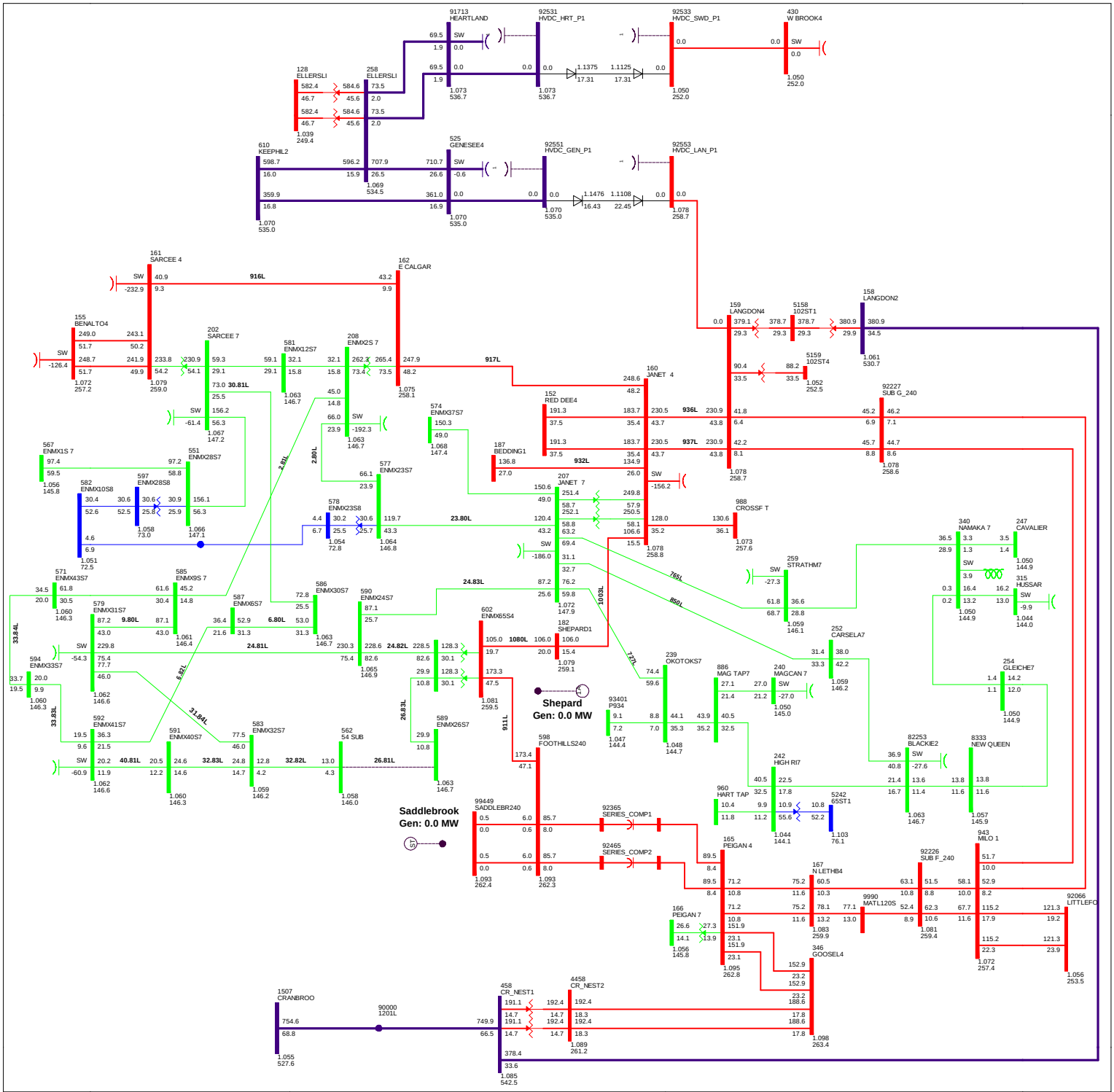
2012LTO EXISTING SYSTEM

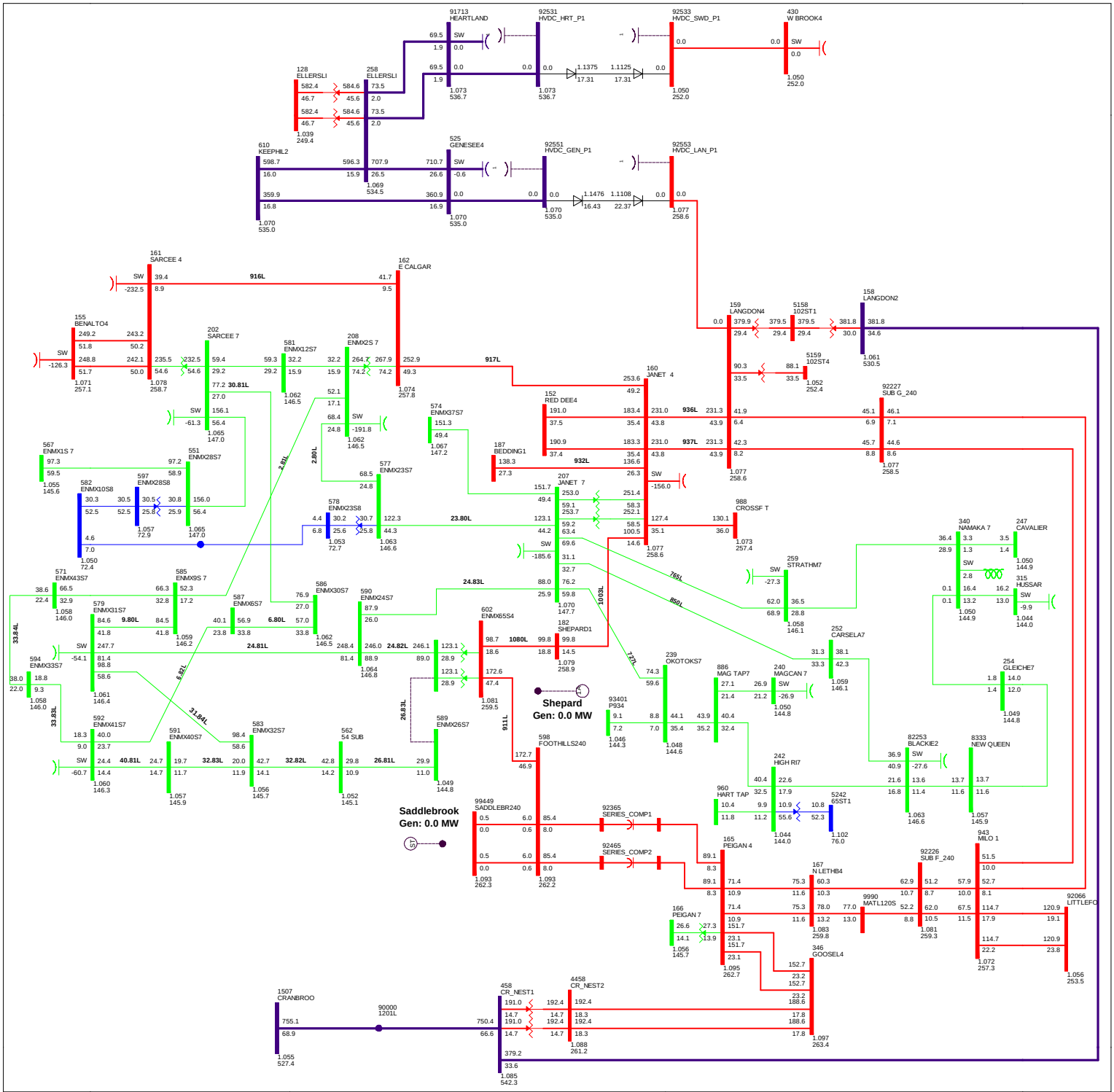
FIG A-SC1-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
BCH Import: 781.8 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG A-SC1-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)
2014_SP_EXISTING_SC1
FRI, JUN 08 2012 15:19


91713 HEARTLAND
92531 HVDC_HRT_P1
92533 HVDC_SWD_P1
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
525 GENESEE4
610 KEEPHIL2
92551 HVDC_GEN_P1
92553 HVDC_LAN_P1
161 SARCEE 4
162 E CALGAR
155 BENALTO4
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
574 ENMX37S7
187 BEDDING1
152 RED DEE4
160 JANET 4
159 LANGDON4
5158 102ST1
158 LANGDON2
5159 102ST4
92227 SUB G_240
916L
917L
932L
936L
937L
30.81L
2.80L
23.80L
24.83L
24.81L
9.80L
6.80L
6.82L
31.84L
33.84L
33.83L
26.83L
911L
1003L
765L
850L
771L
207 JANET 7
988 CROSSF T
259 STRATHM7
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
567 ENMX1S 7
582 ENMX10S8
597 ENMX28S8
551 ENMX28S7
577 ENMX23S7
578 ENMX23S8
571 ENMX43S7
585 ENMX9S 7
579 ENMX31S7
586 ENMX30S7
587 ENMX6S7
590 ENMX24S7
602 ENMX65S4
182 SHEPARD1
239 OKOTOKS7
886 MAG TAP7
240 MAGCAN 7
252 CARSELA7
254 GLEICHE7
594 ENMX33S7
592 ENMX41S7
591 ENMX40S7
583 ENMX32S7
562 54 SUB
589 ENMX26S7
598 FOOTHILLS240
93401 P934
Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
99449 SADDLEBR240
92365 SERIES_COMP1
92465 SERIES_COMP2
960 HART TAP
242 HIGH RI7
5242 65ST1
82253 BLACKIE2
8333 NEW QUEEN
165 PEIGAN 4
166 PEIGAN 7
167 N LETHB4
9990 MATL120S
92226 SUB F_240
943 MILO 1
92066 LITTLEFO
346 GOOSEL4
1507 CRANBROO
90000 1201L
458 CR_NEST1
4458 CR_NEST2
BCH Import: 780.9 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG A-SC1-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_SP_EXISTING_SC1
FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

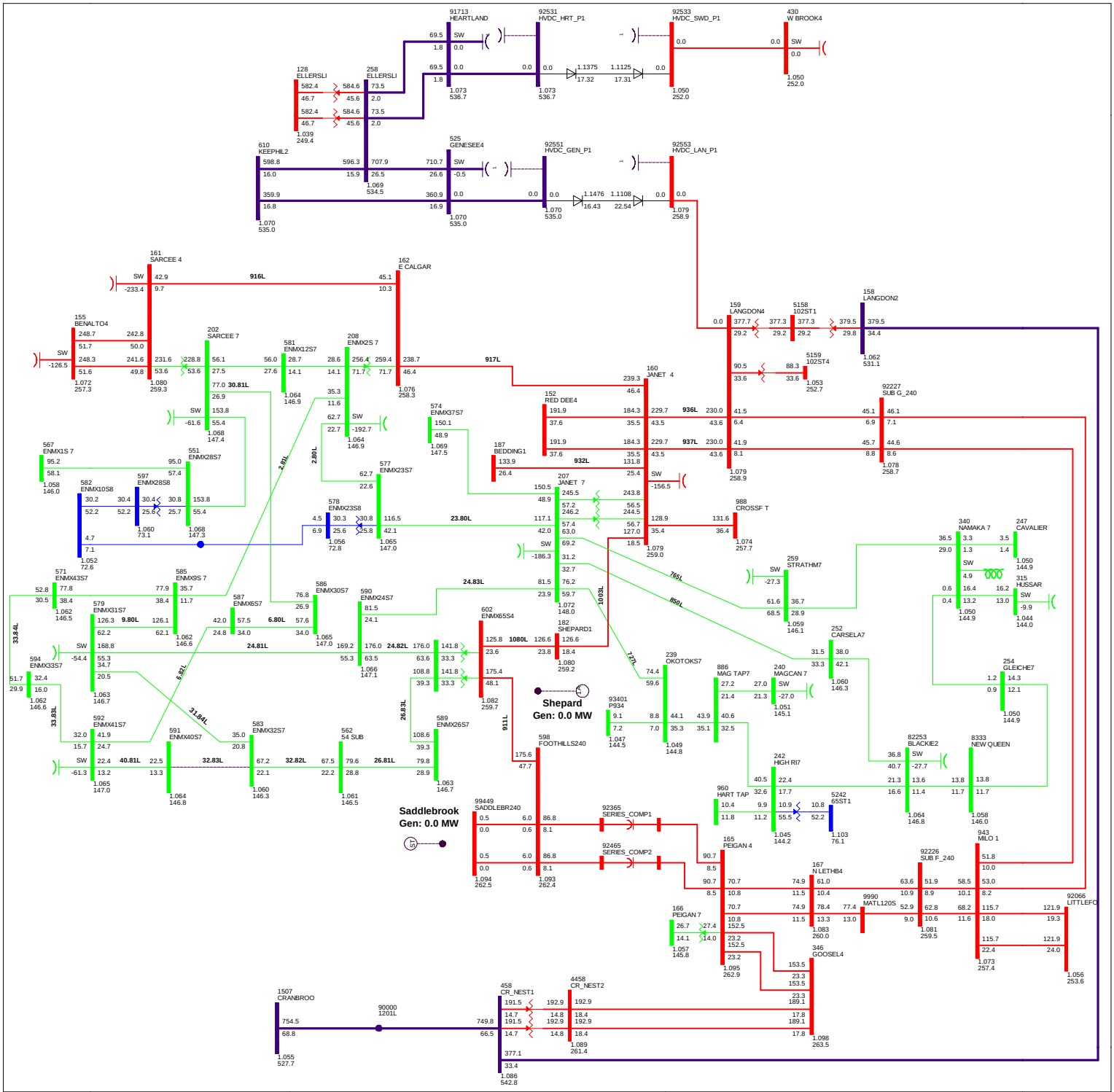
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



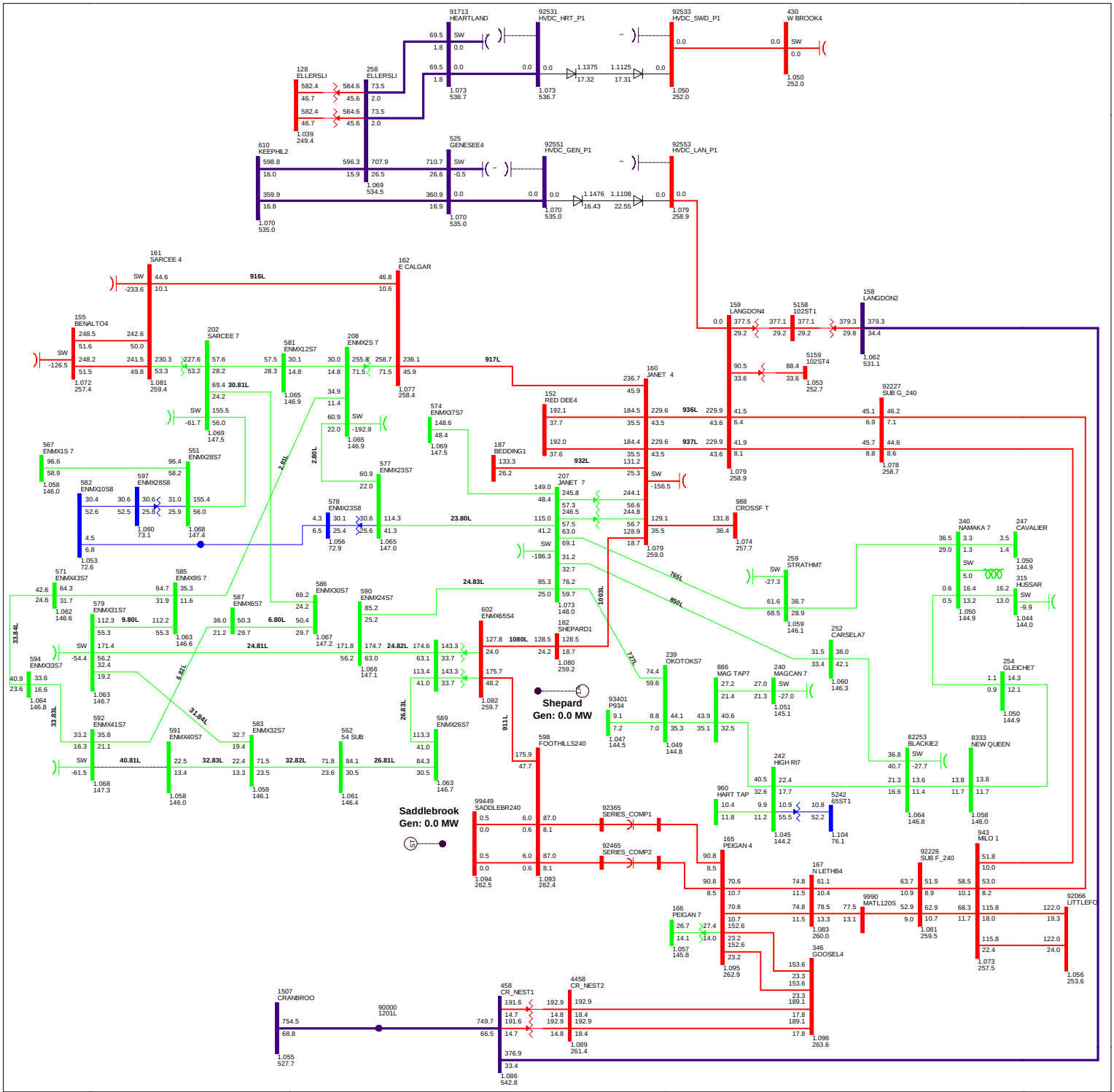
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



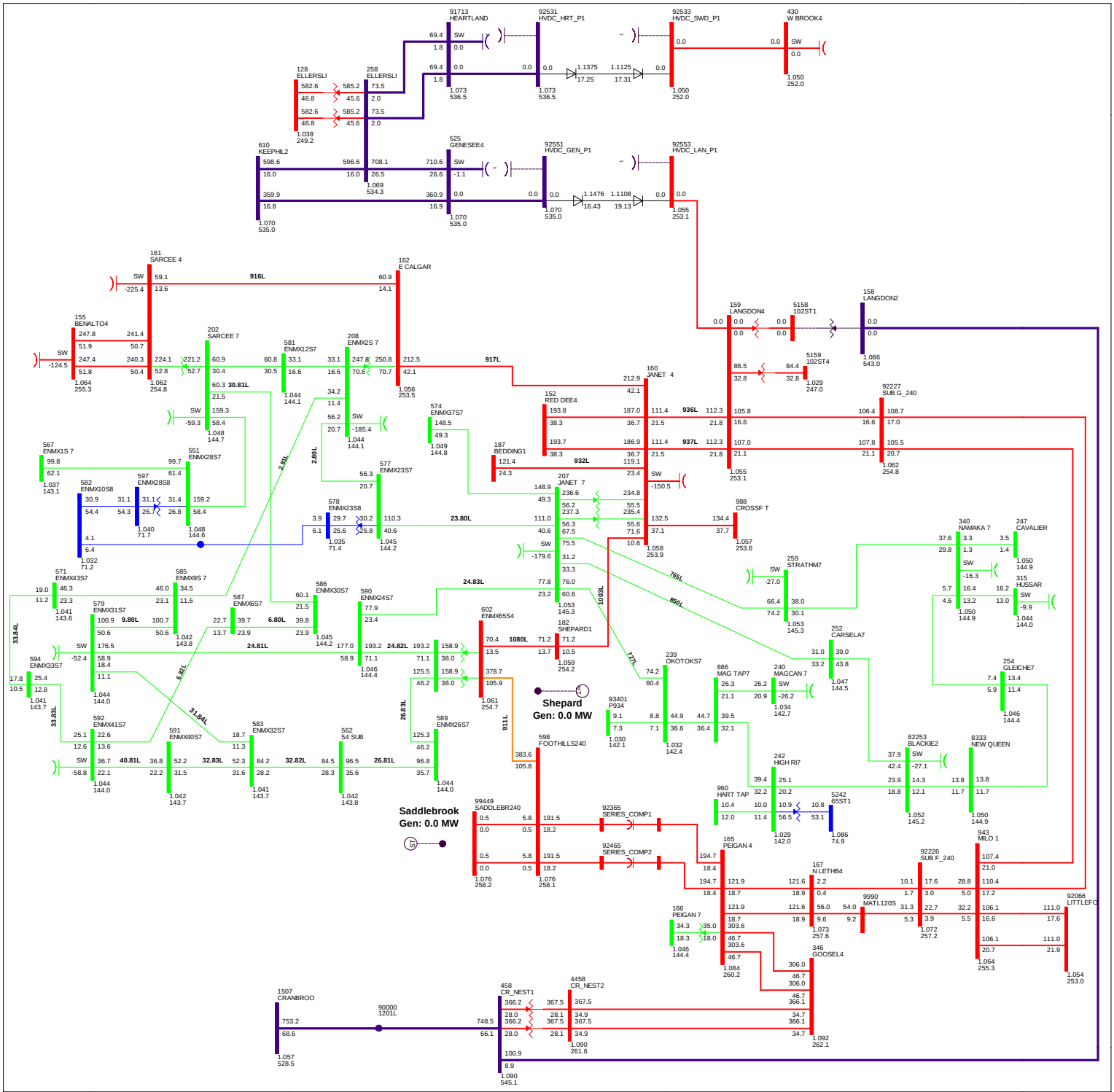
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

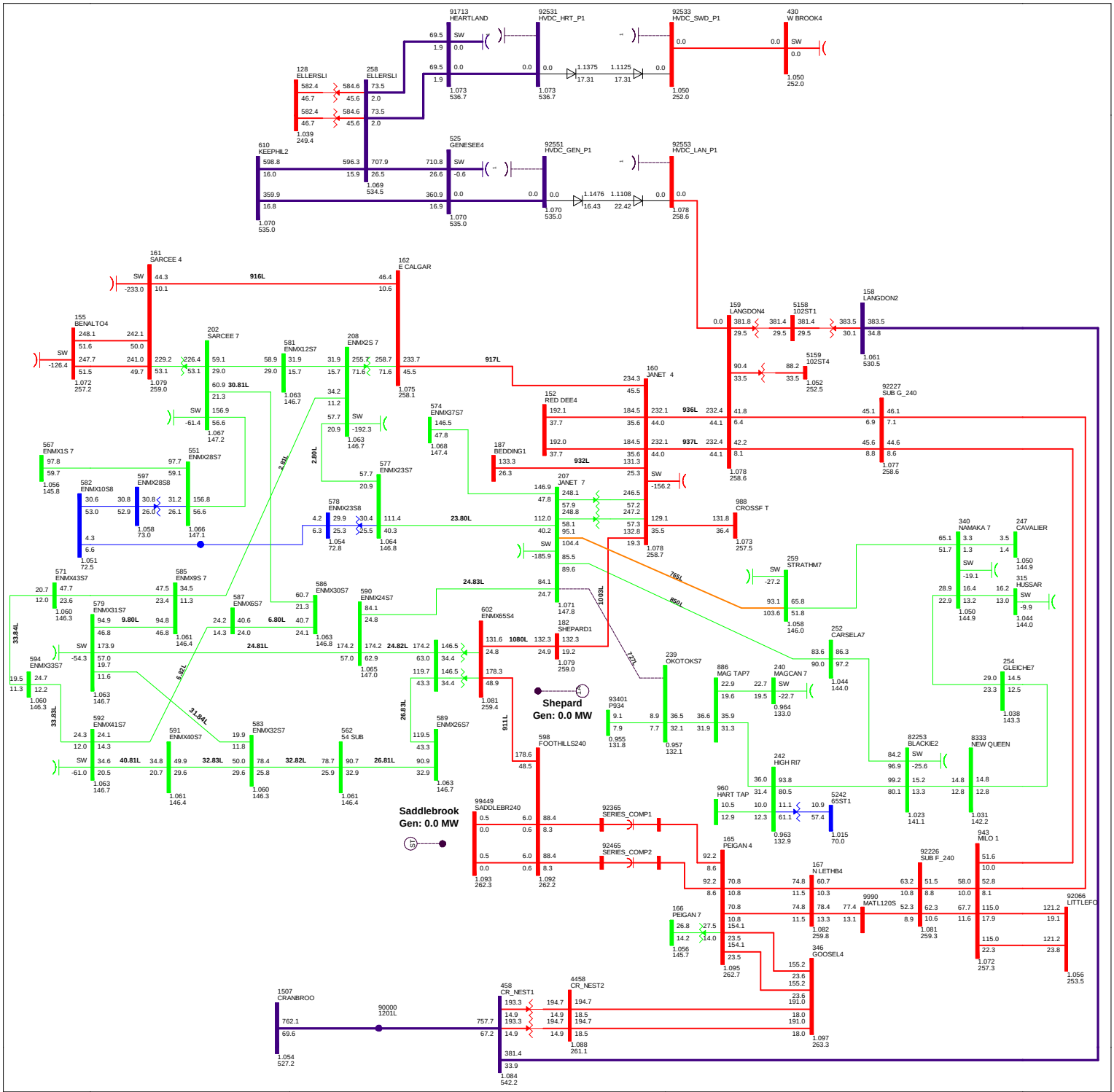
BCH Import: 796.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

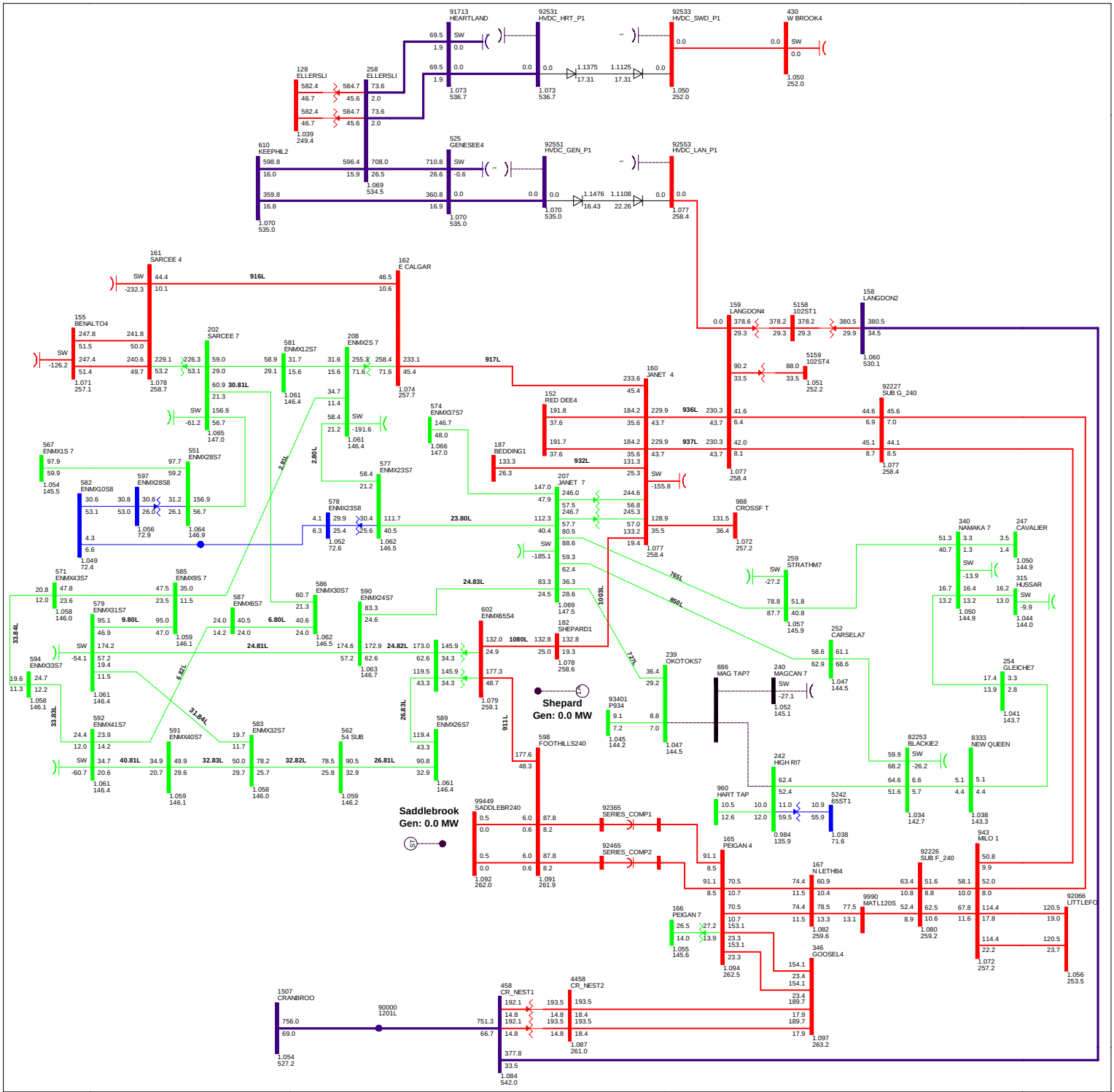
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 788.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



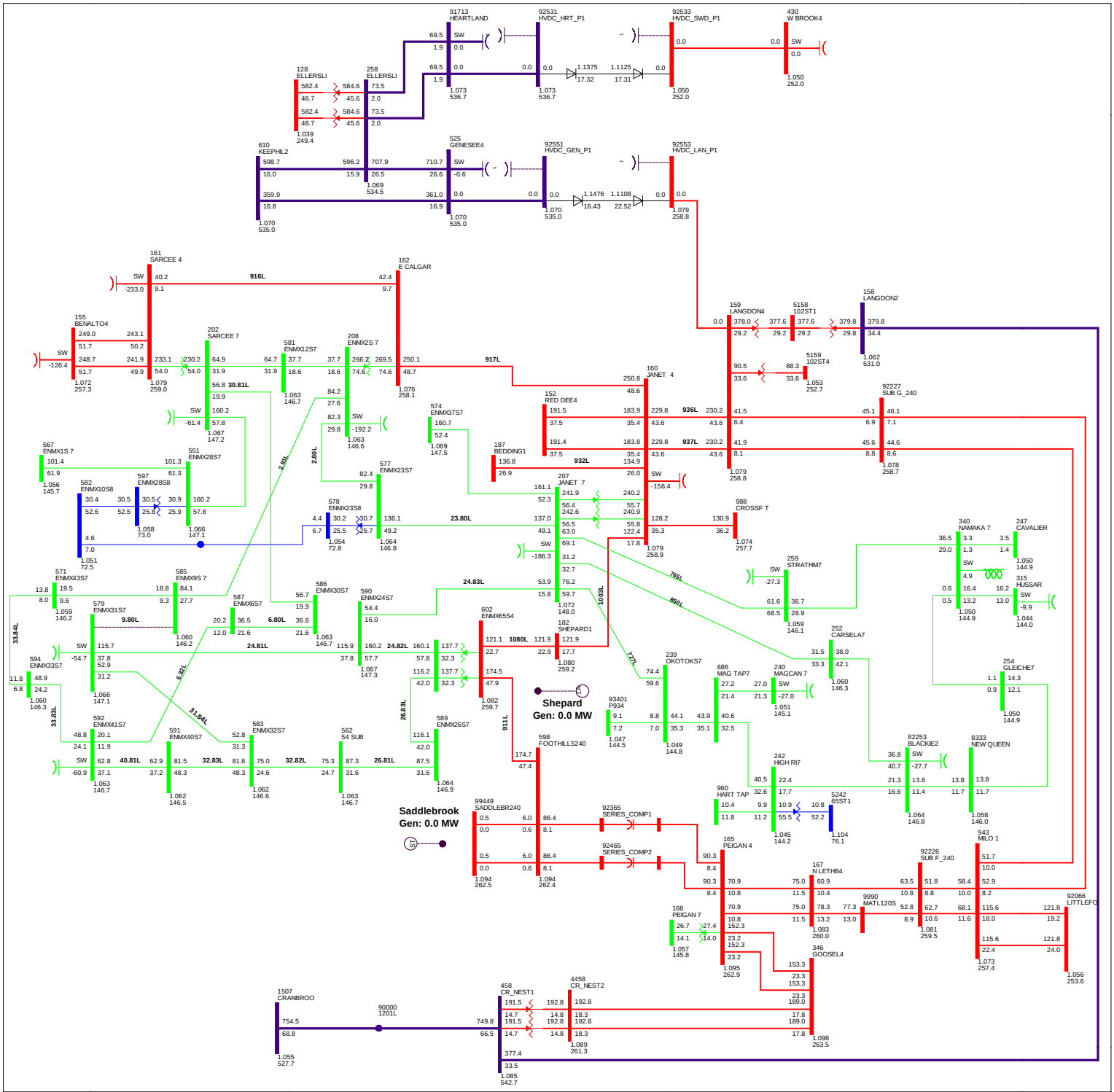
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

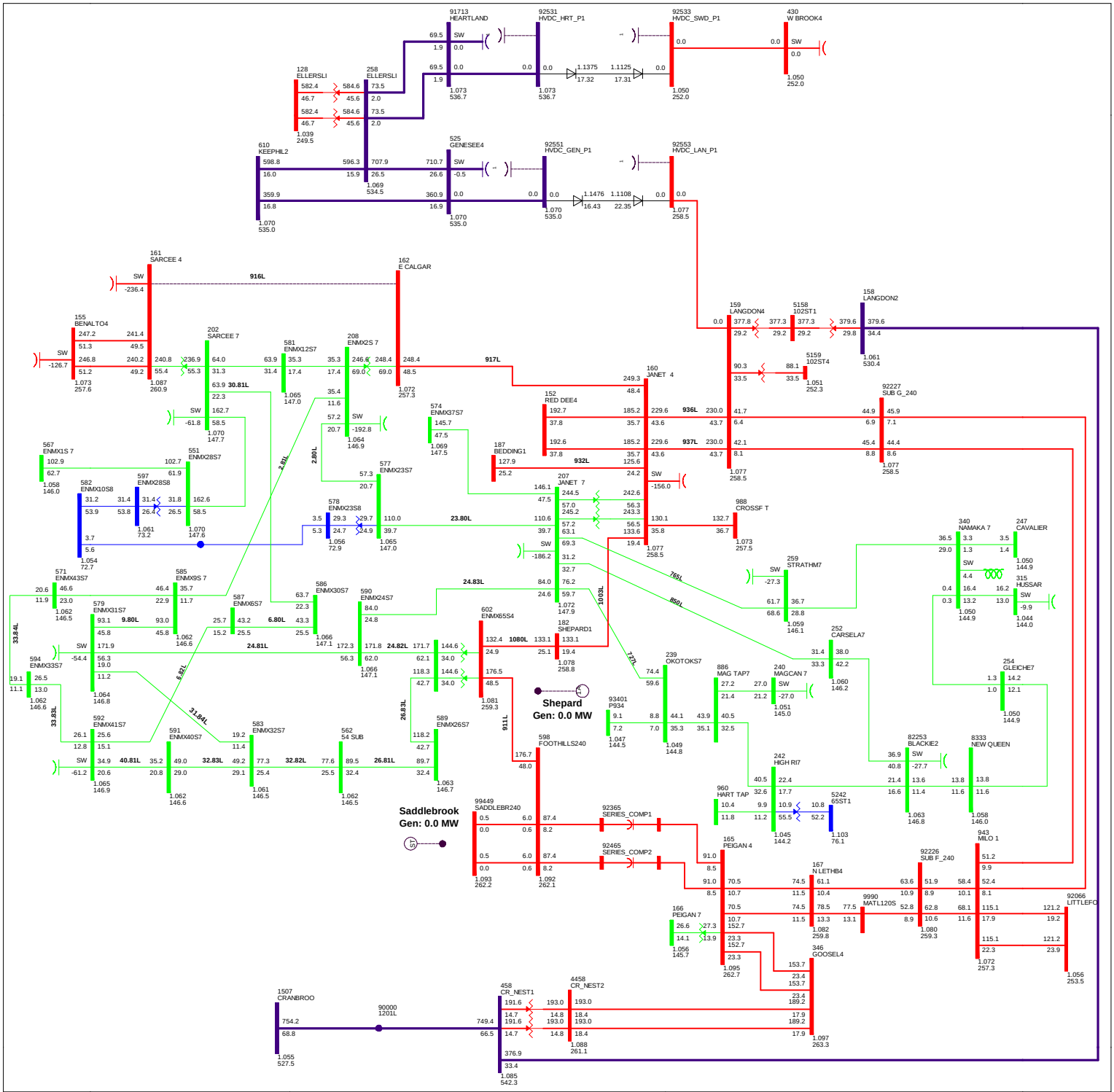
BCH Import: 780.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-22: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

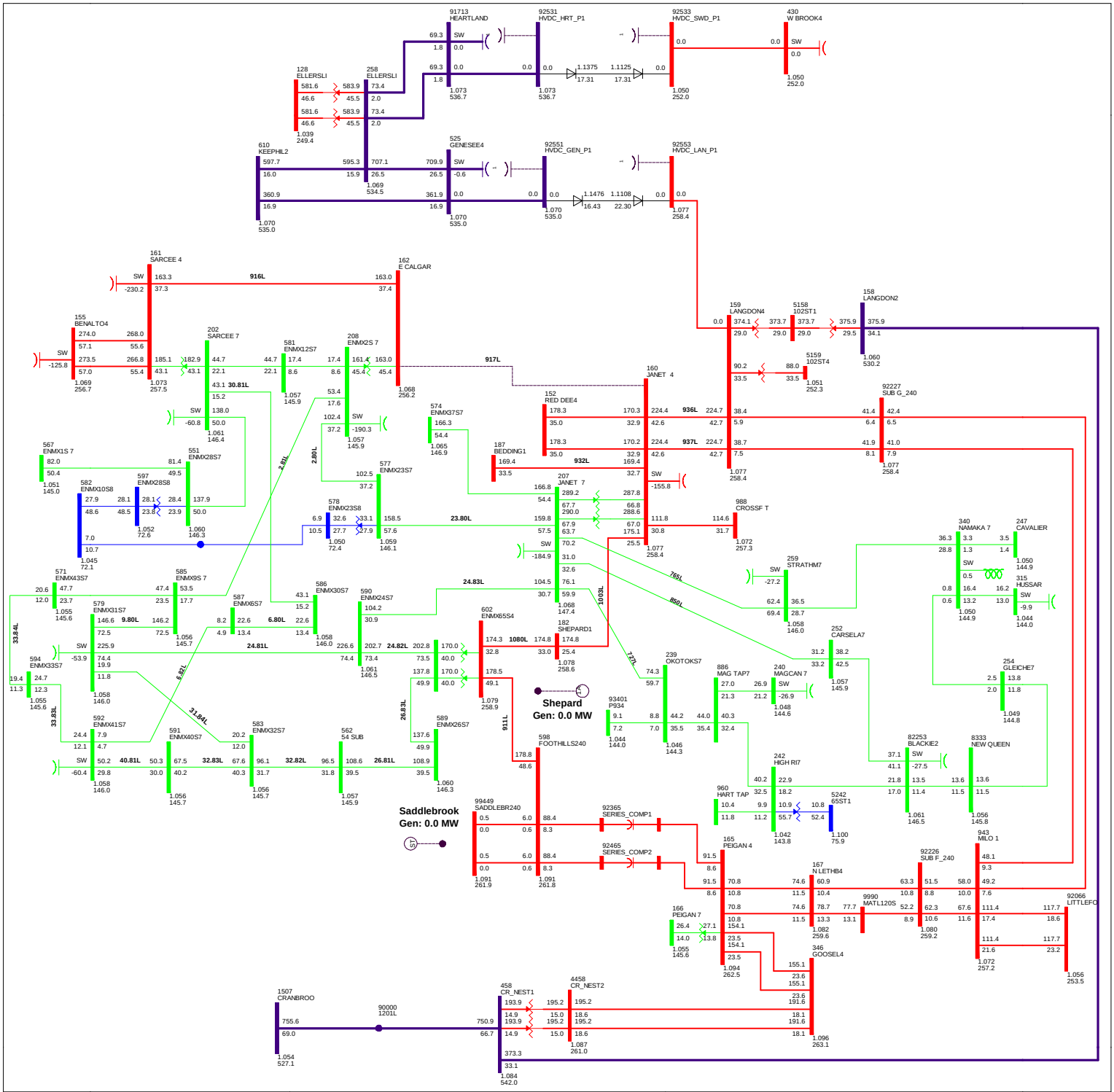
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-23: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

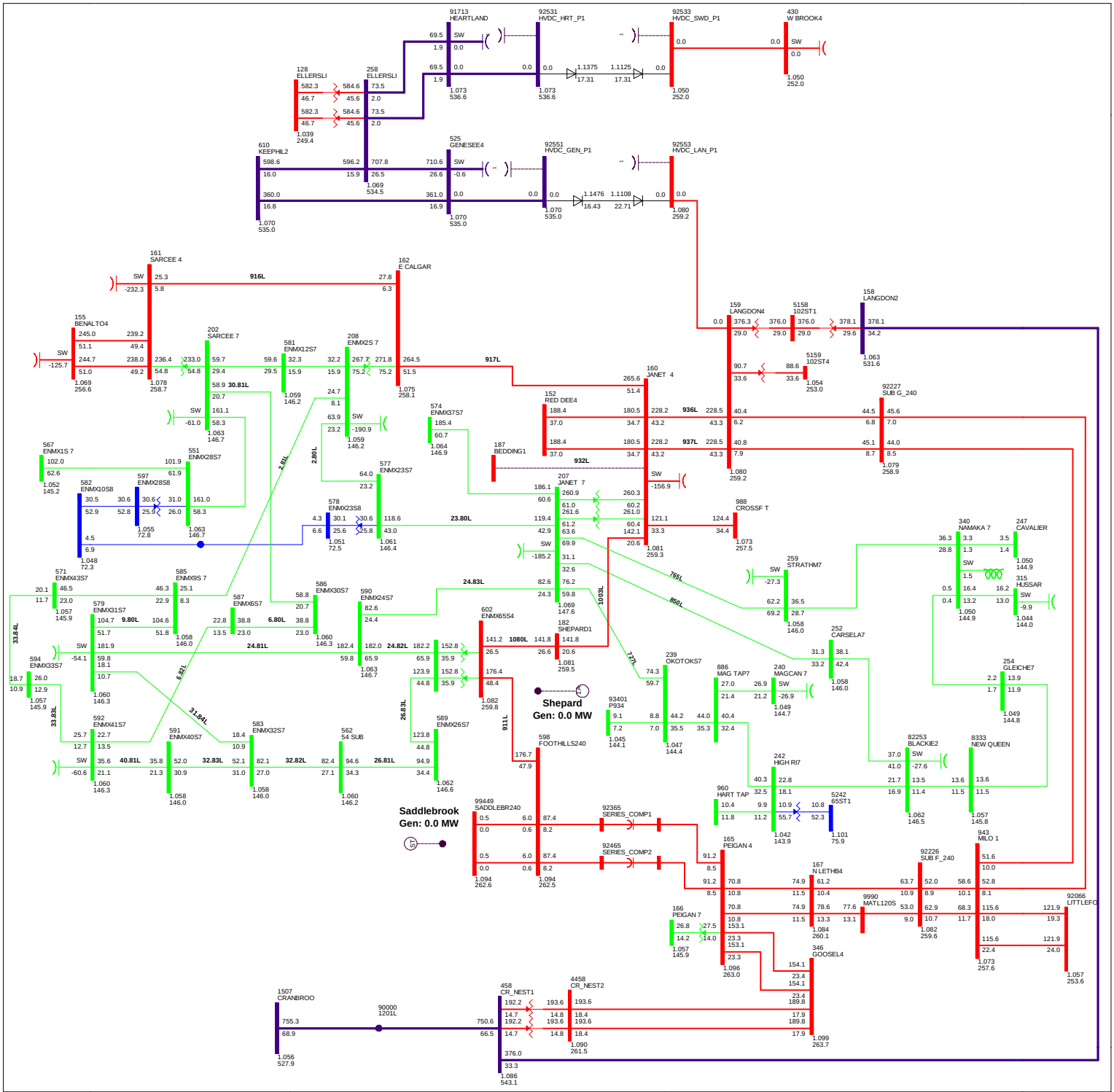
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 784.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-24: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

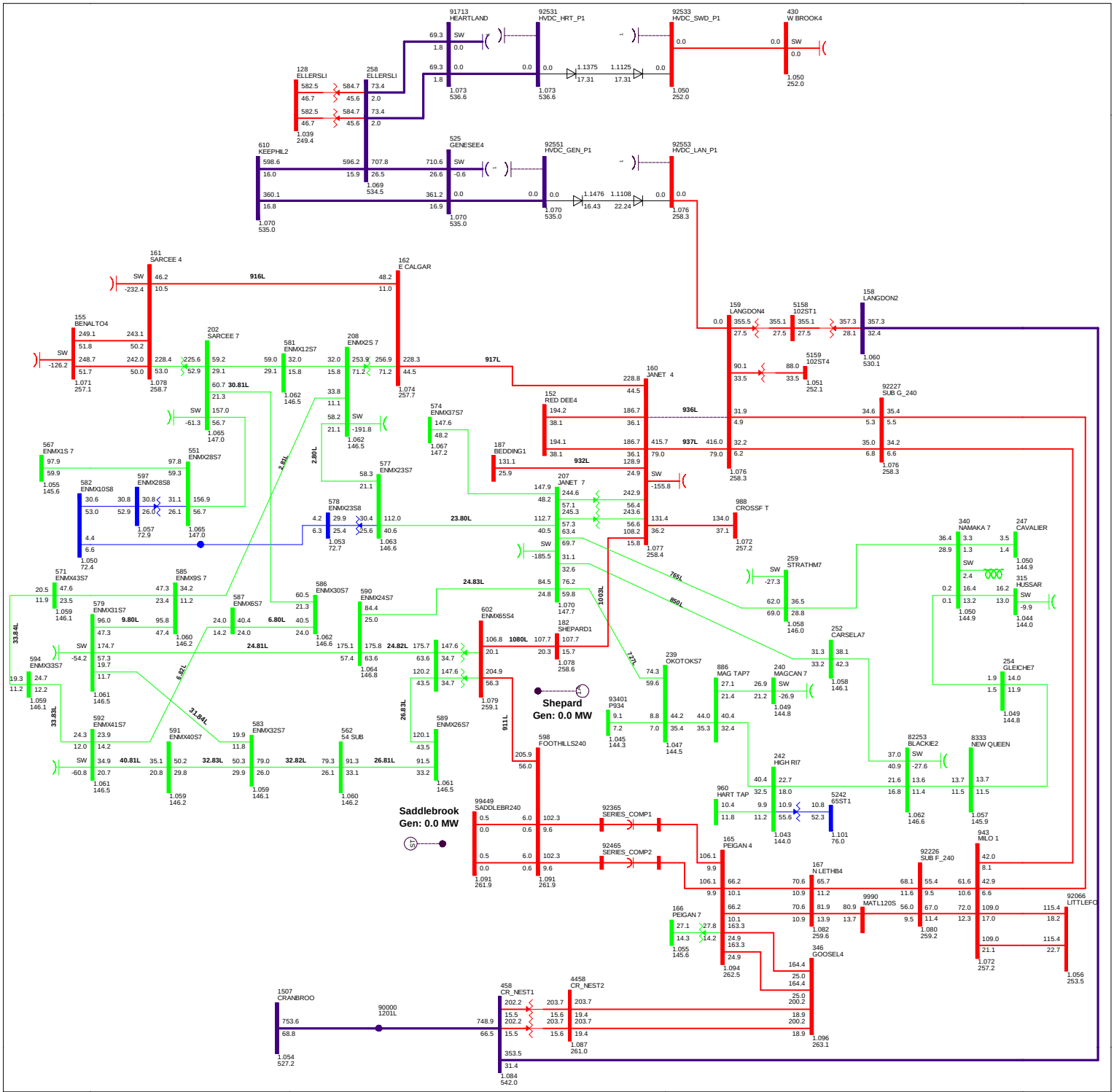
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC1-25: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

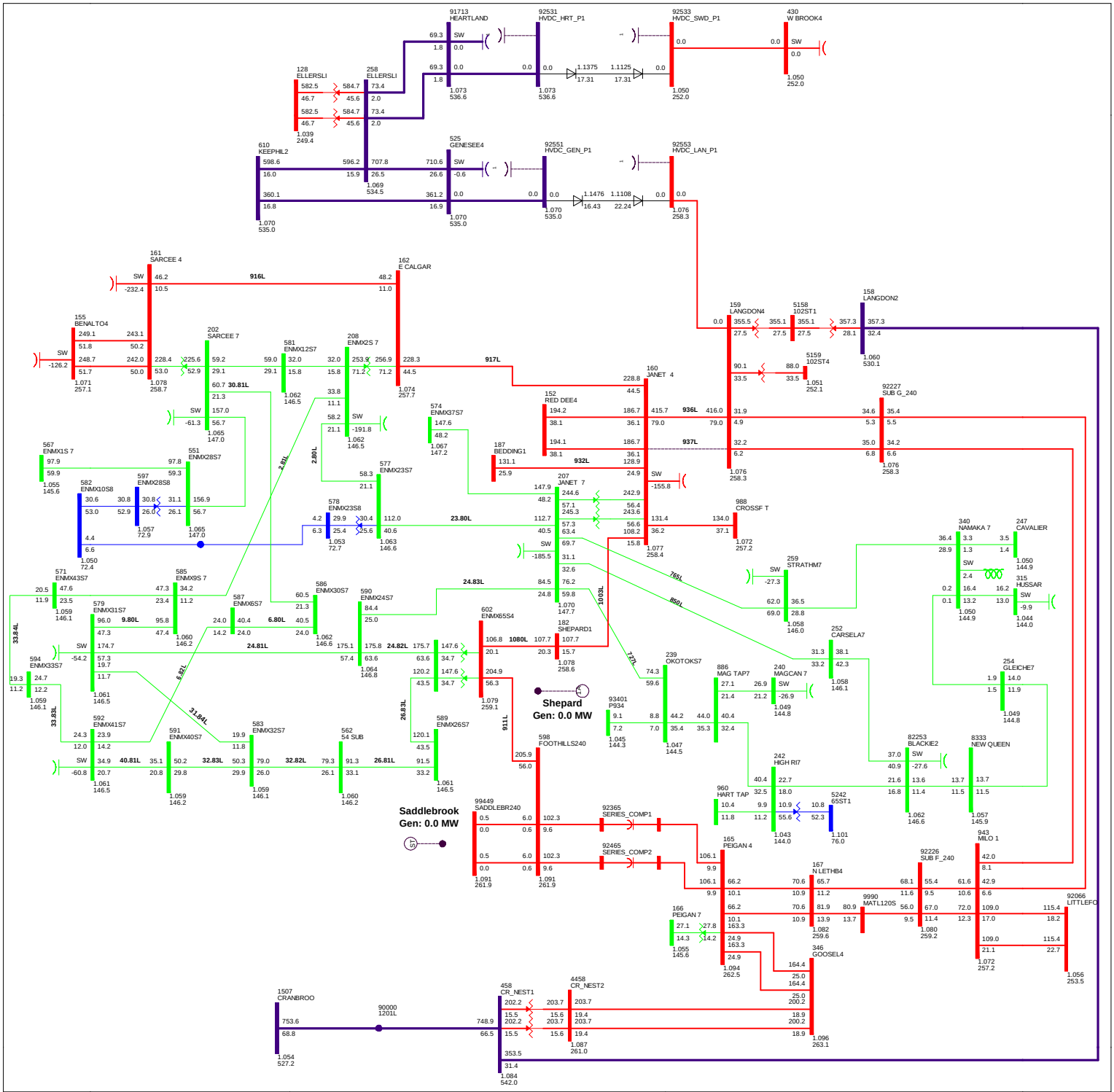
BCH Import: 781.8 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO EXISTING SYSTEM

FIG A-SC1-26: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 781.8 MW

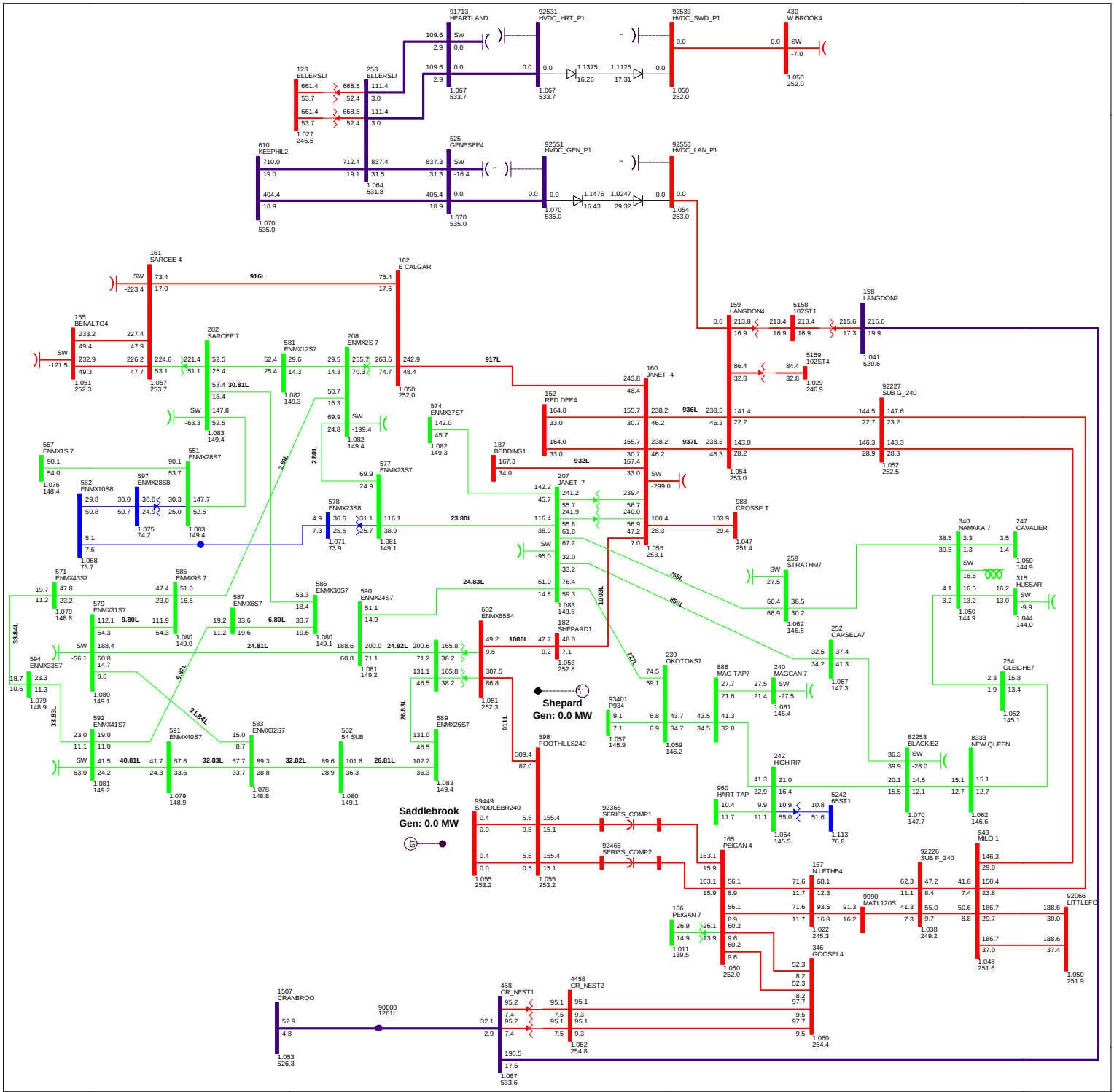
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO EXISTING SYSTEM

FIG A-SC1-27: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC1

FRI, JUN 08 2012 15:19

2014 Loading Violations
Scenario 2



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

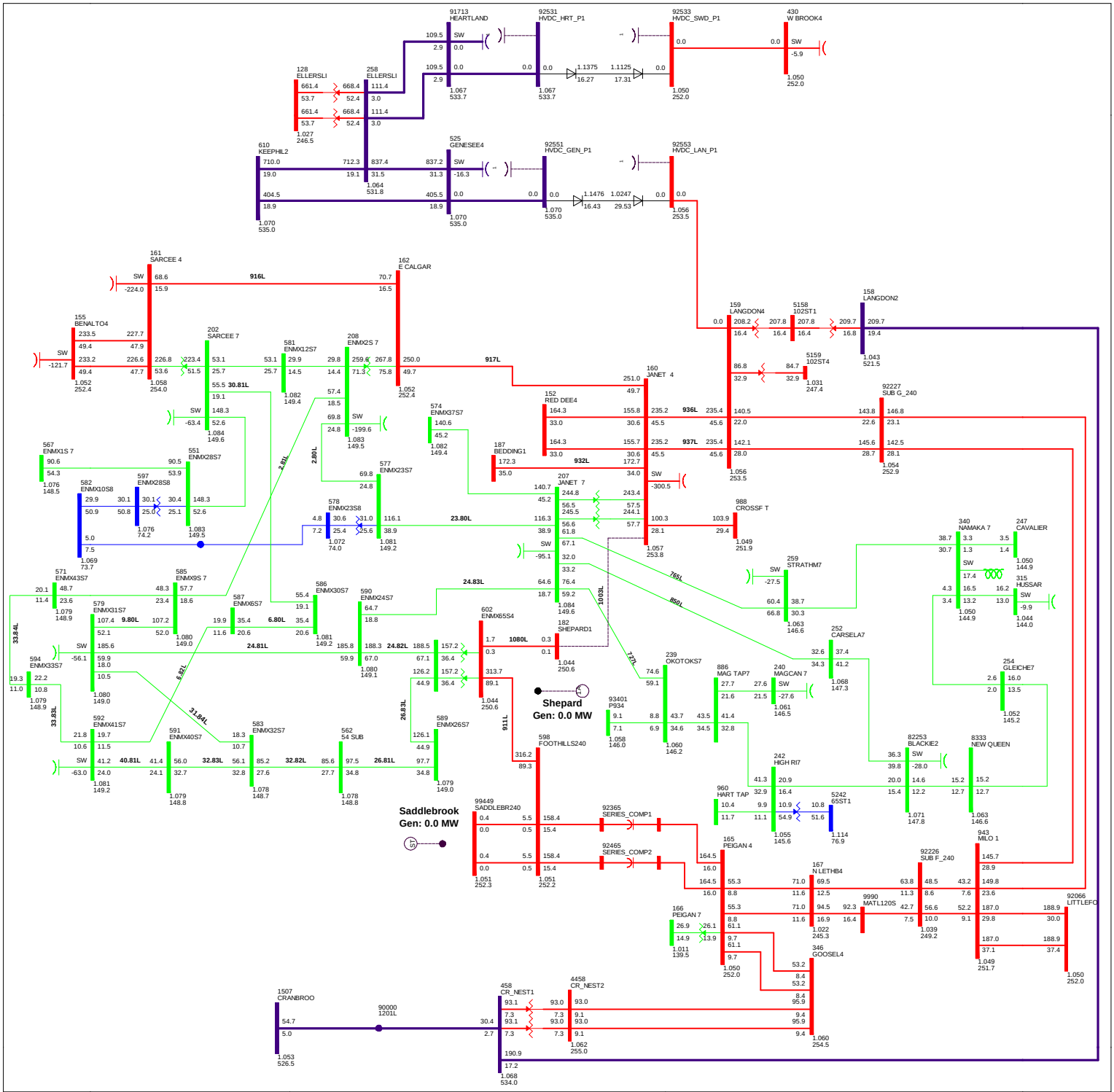
BCH Import: -0.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-1: BASECASE

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

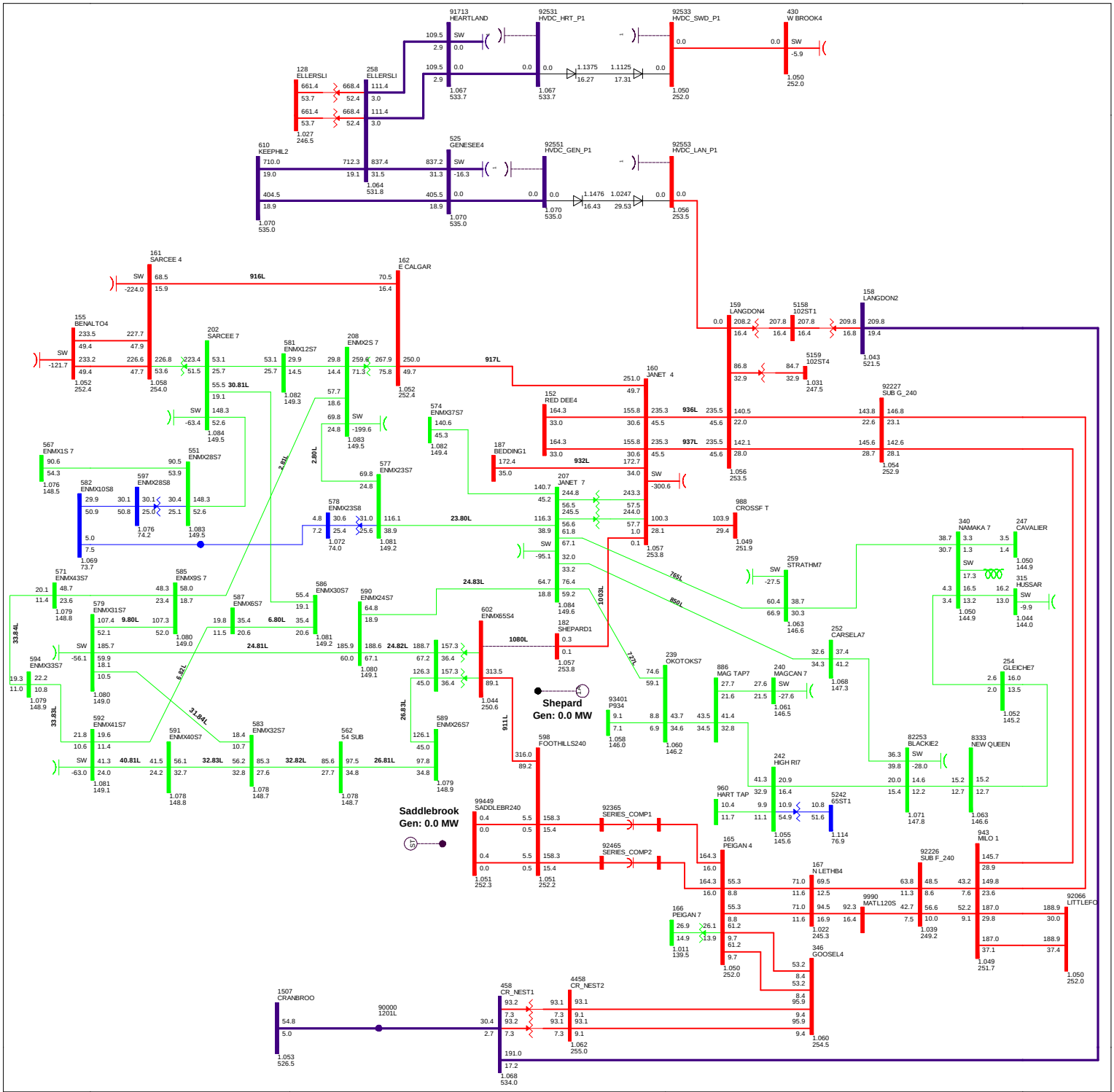
BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

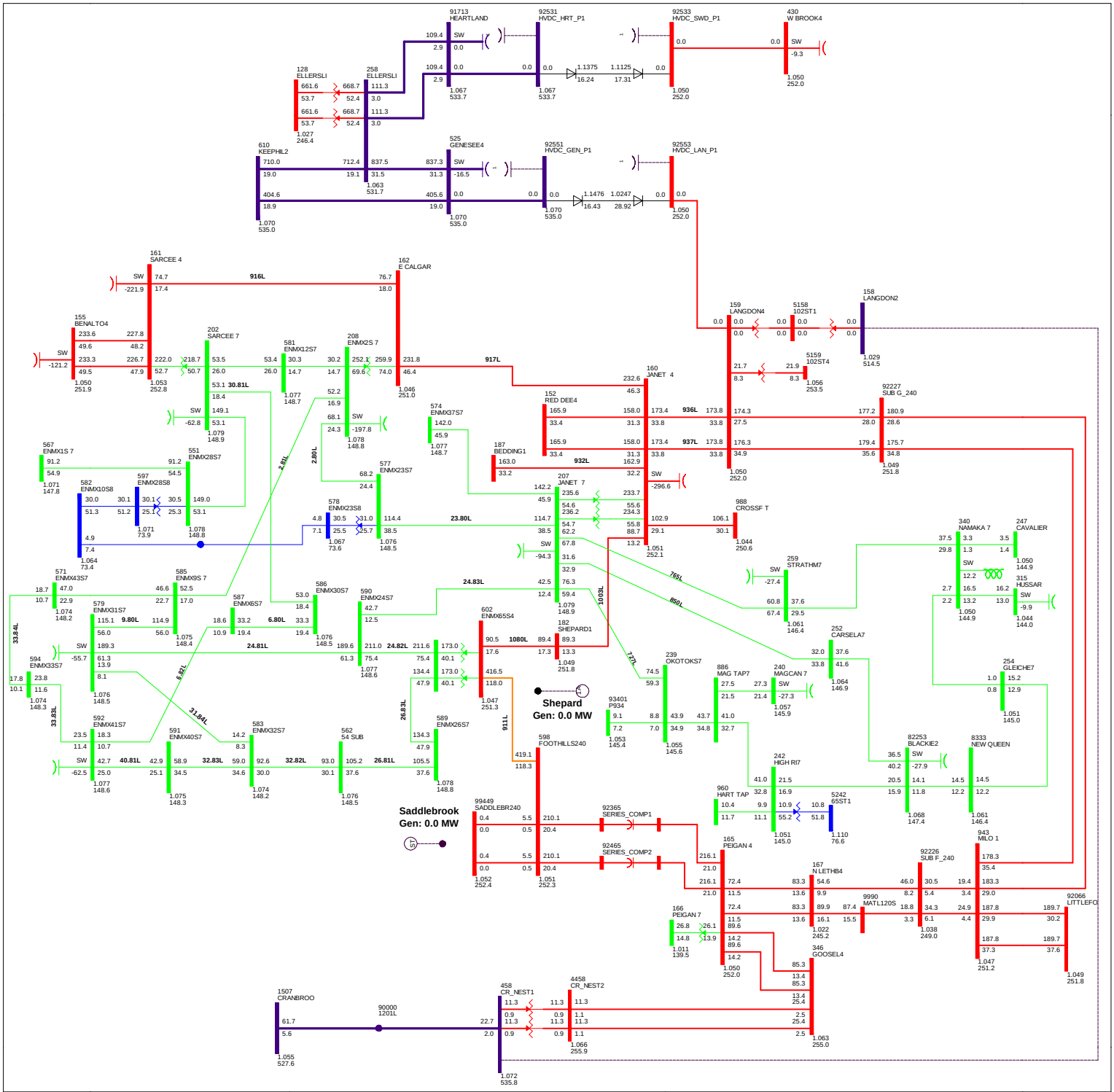
BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

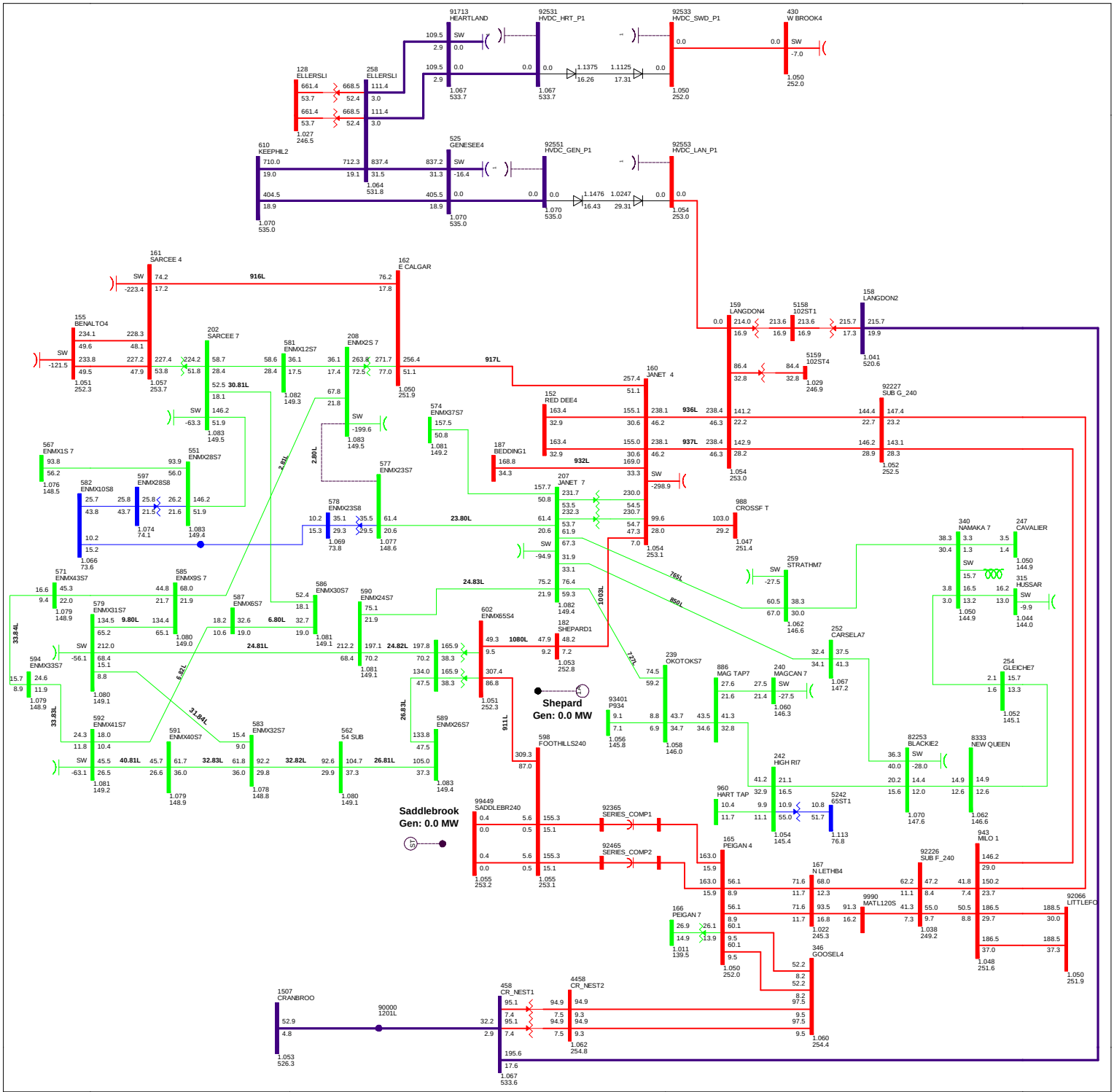
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 6.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

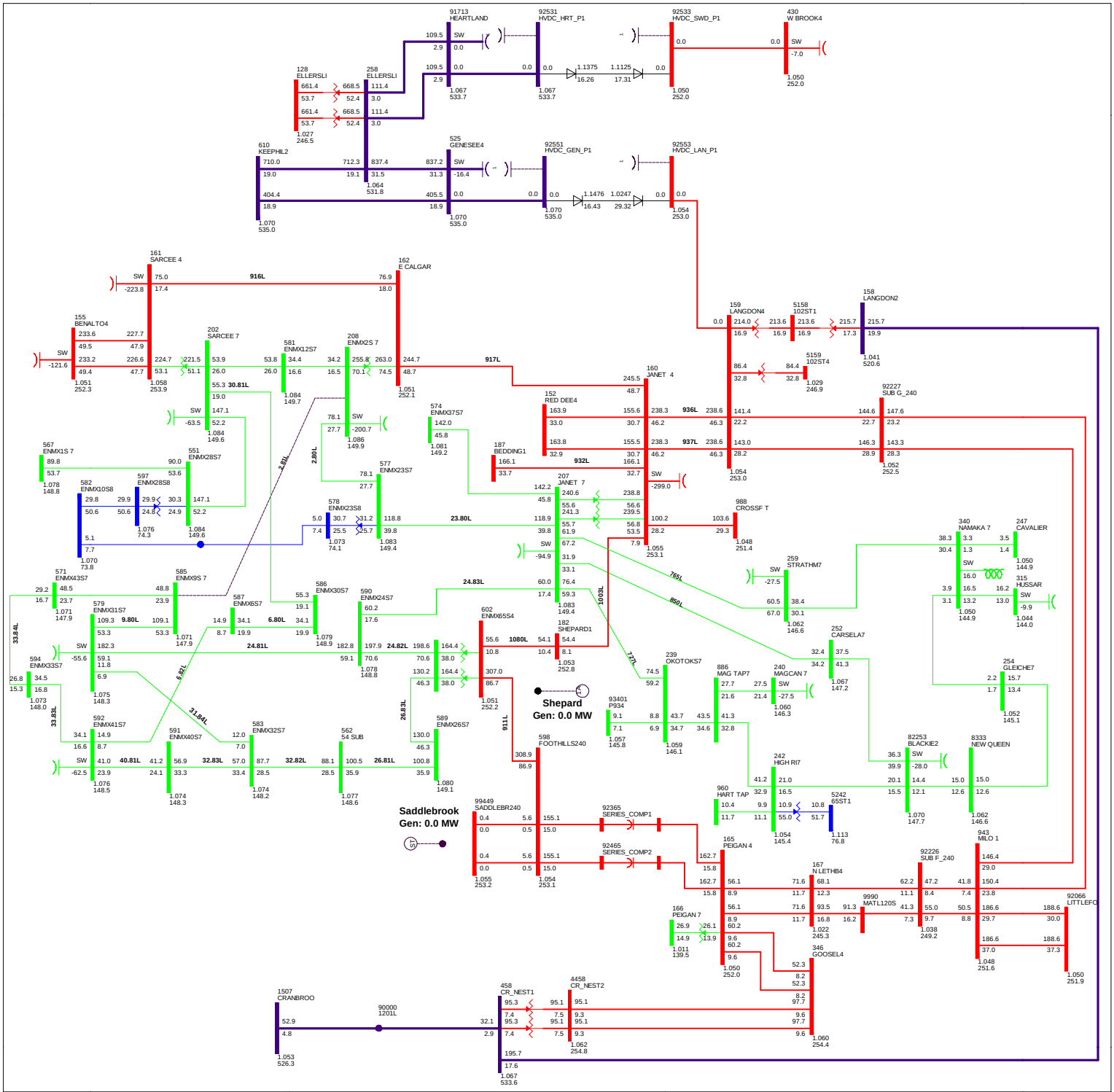
BCH Import: 0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

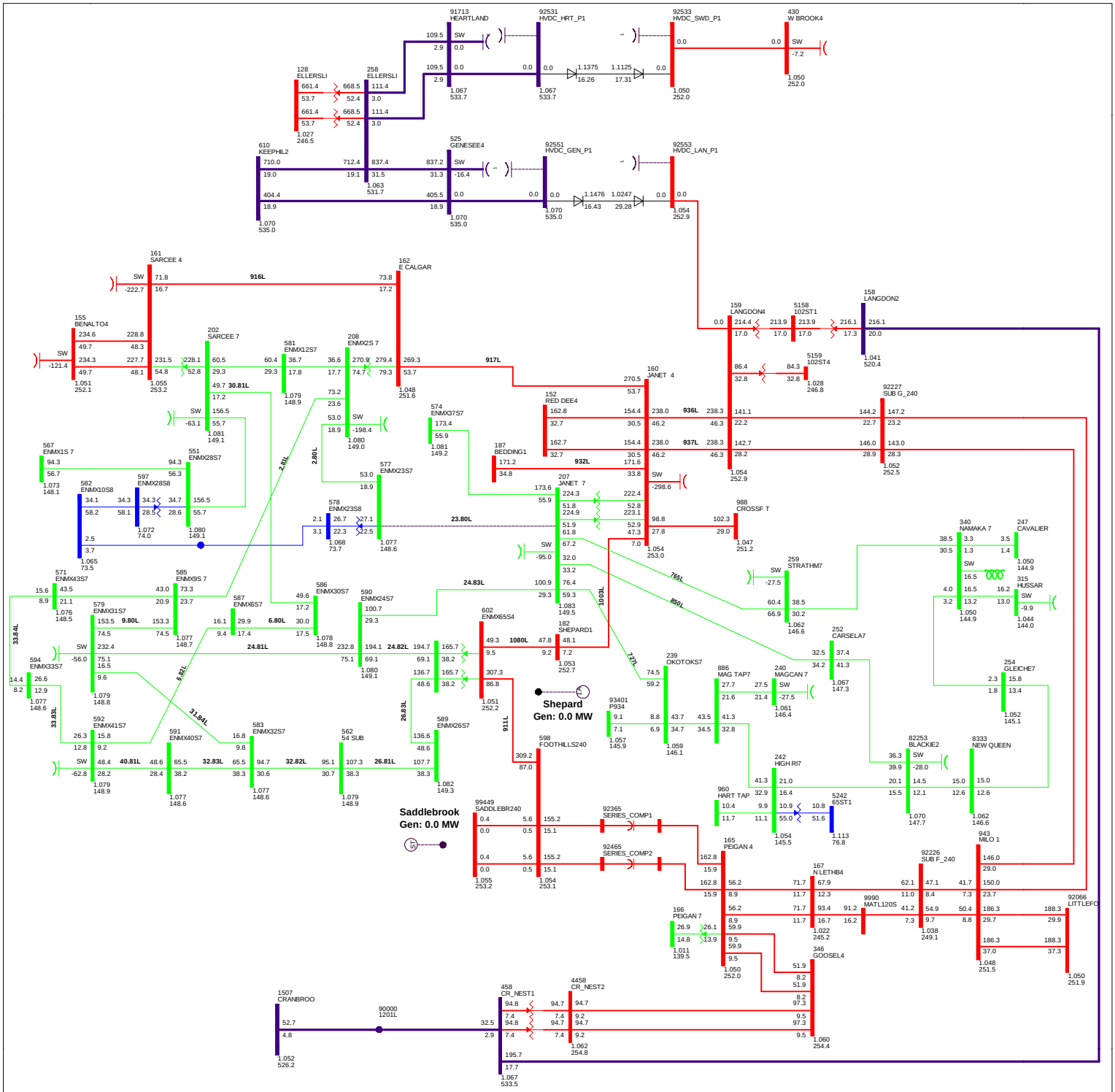
BCH Import: -0.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

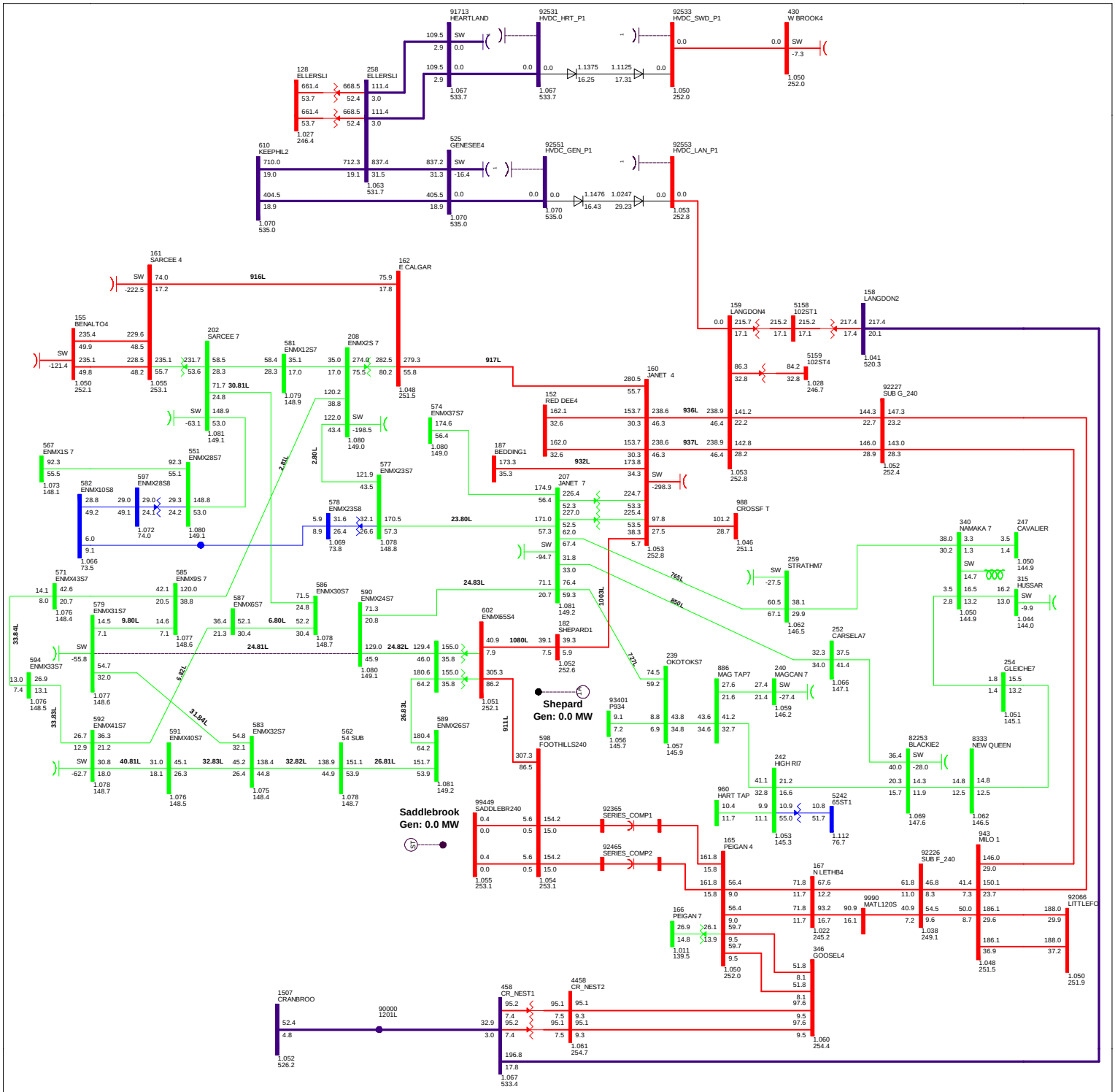
100.0%RATEA
KV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

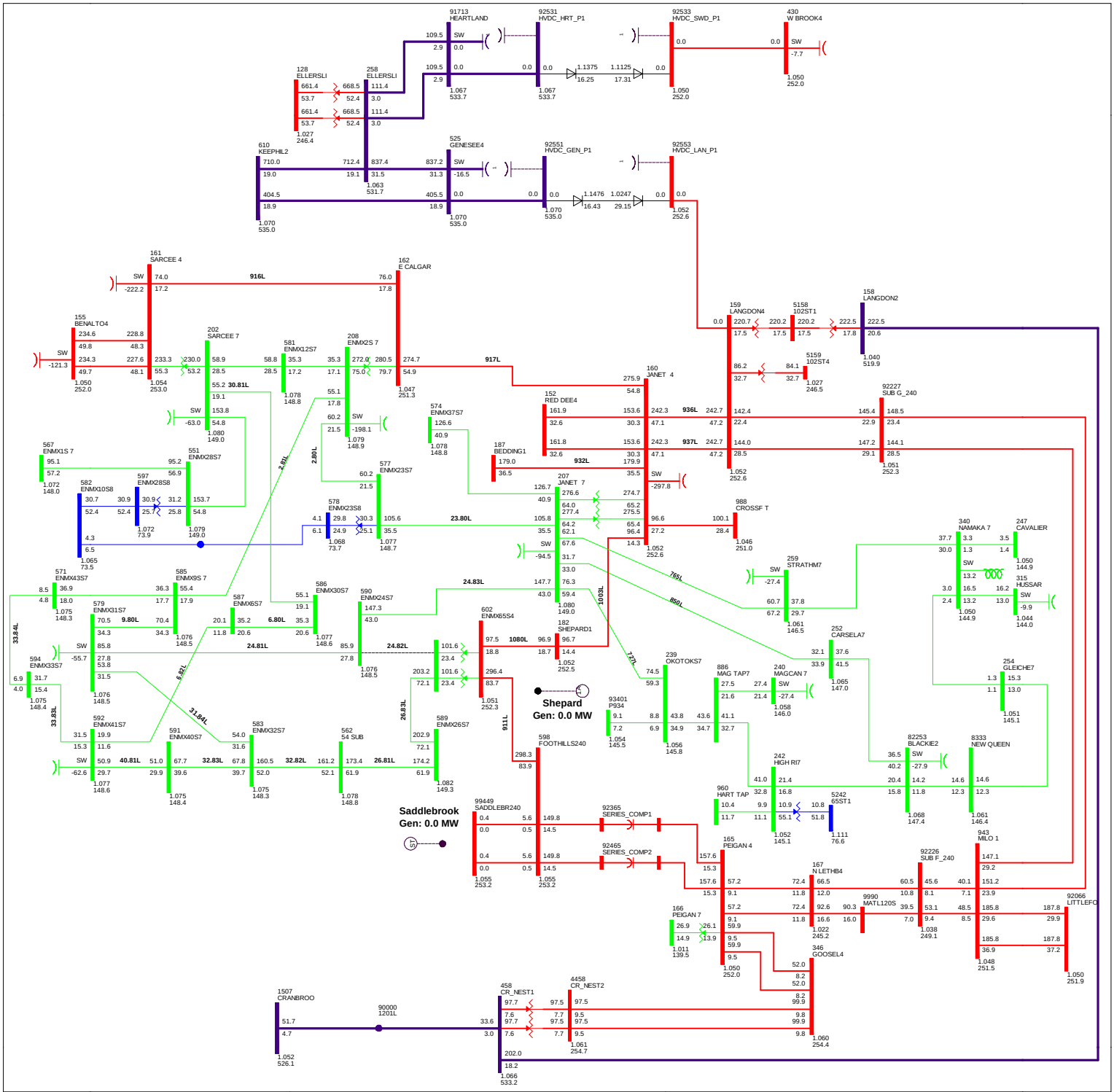
BCH Import: 1.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

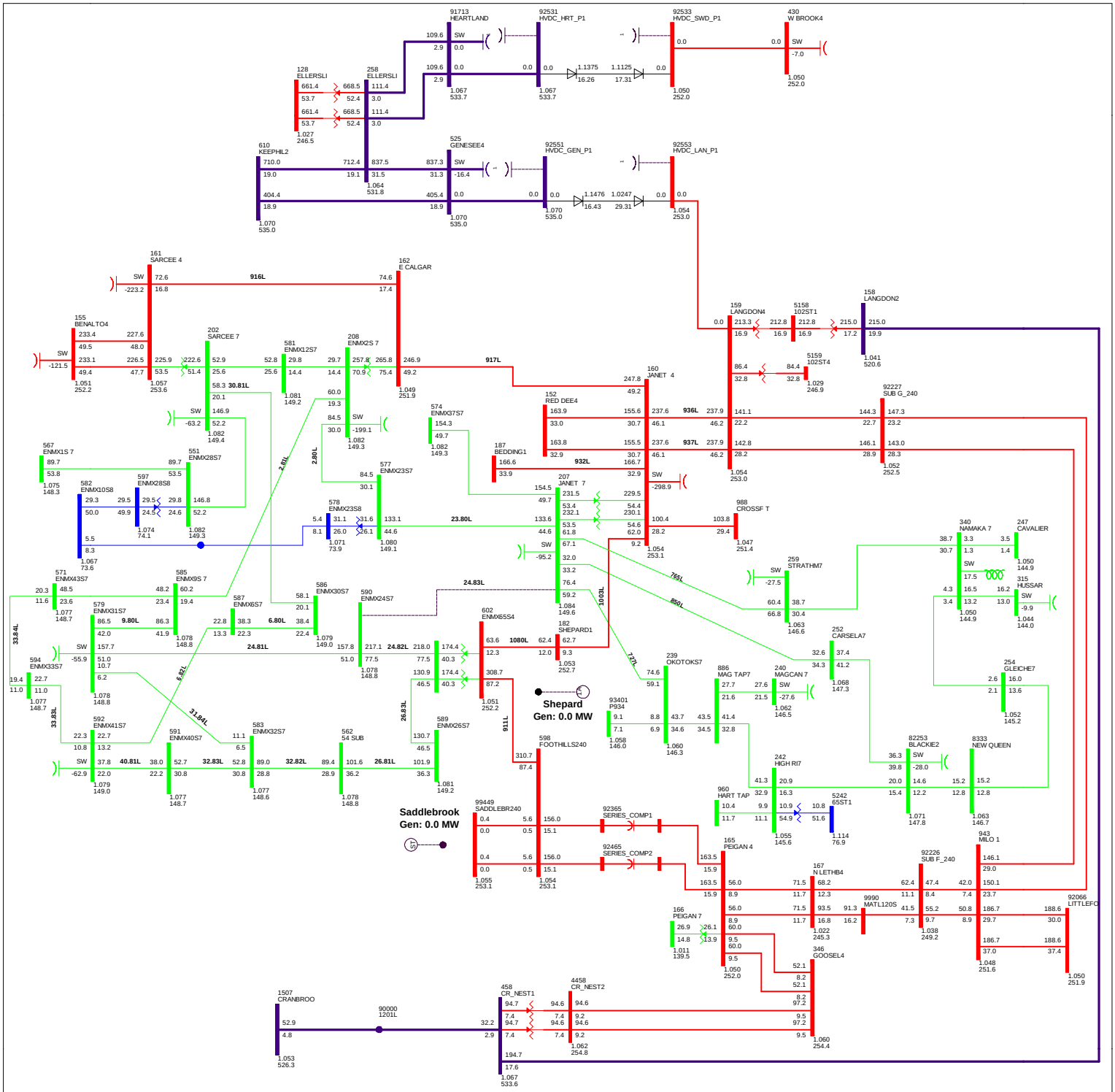
BCH Import: 1.5 MW

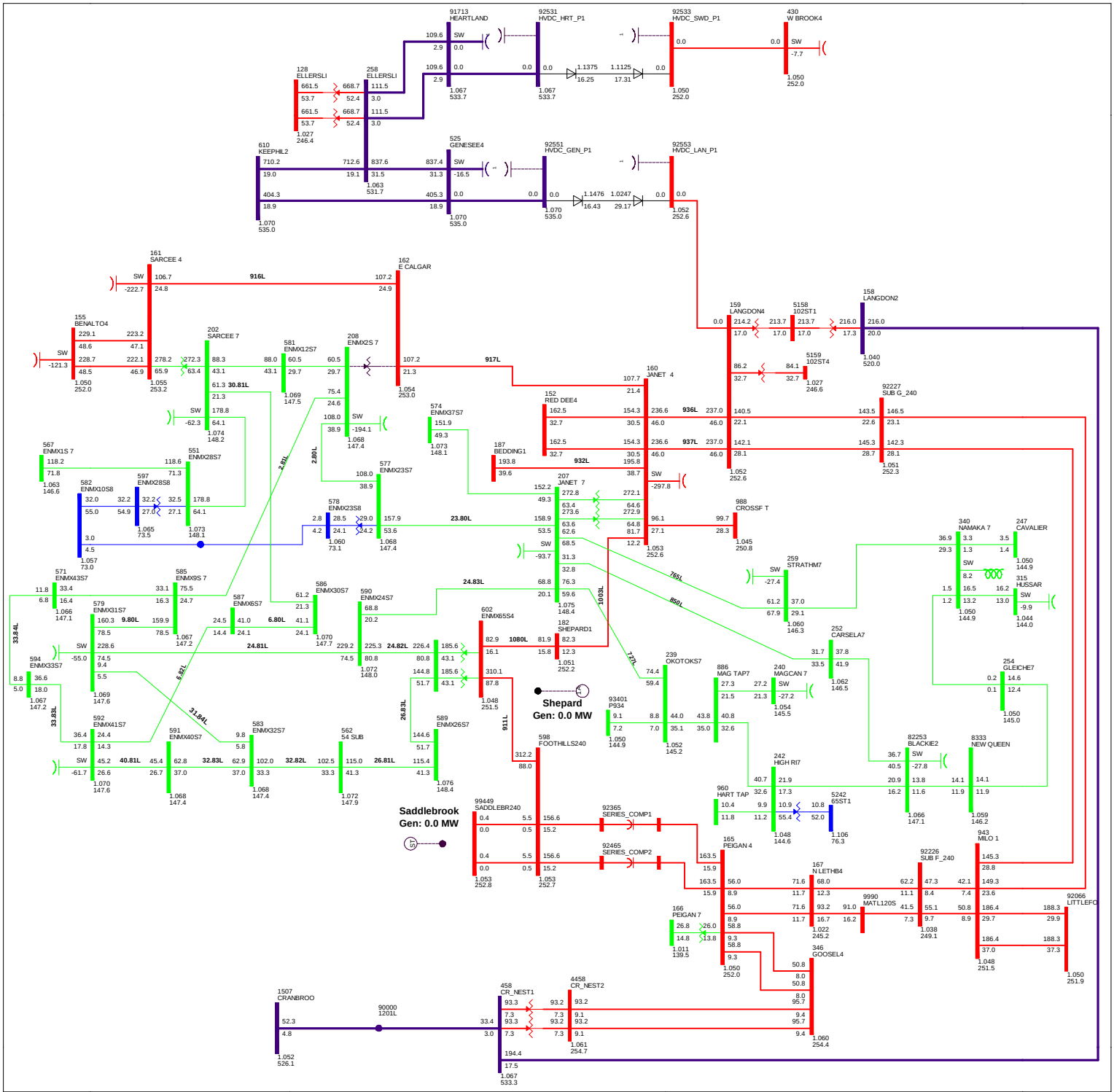
2012LTO EXISTING SYSTEM

FIG A-SC2-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:20


Saddlebrook
Gen: 0.0 MW
Shepard
Gen: 0.0 MW
BCH Import: -0.1 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG A-SC2-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_SP_EXISTING_SC2
FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

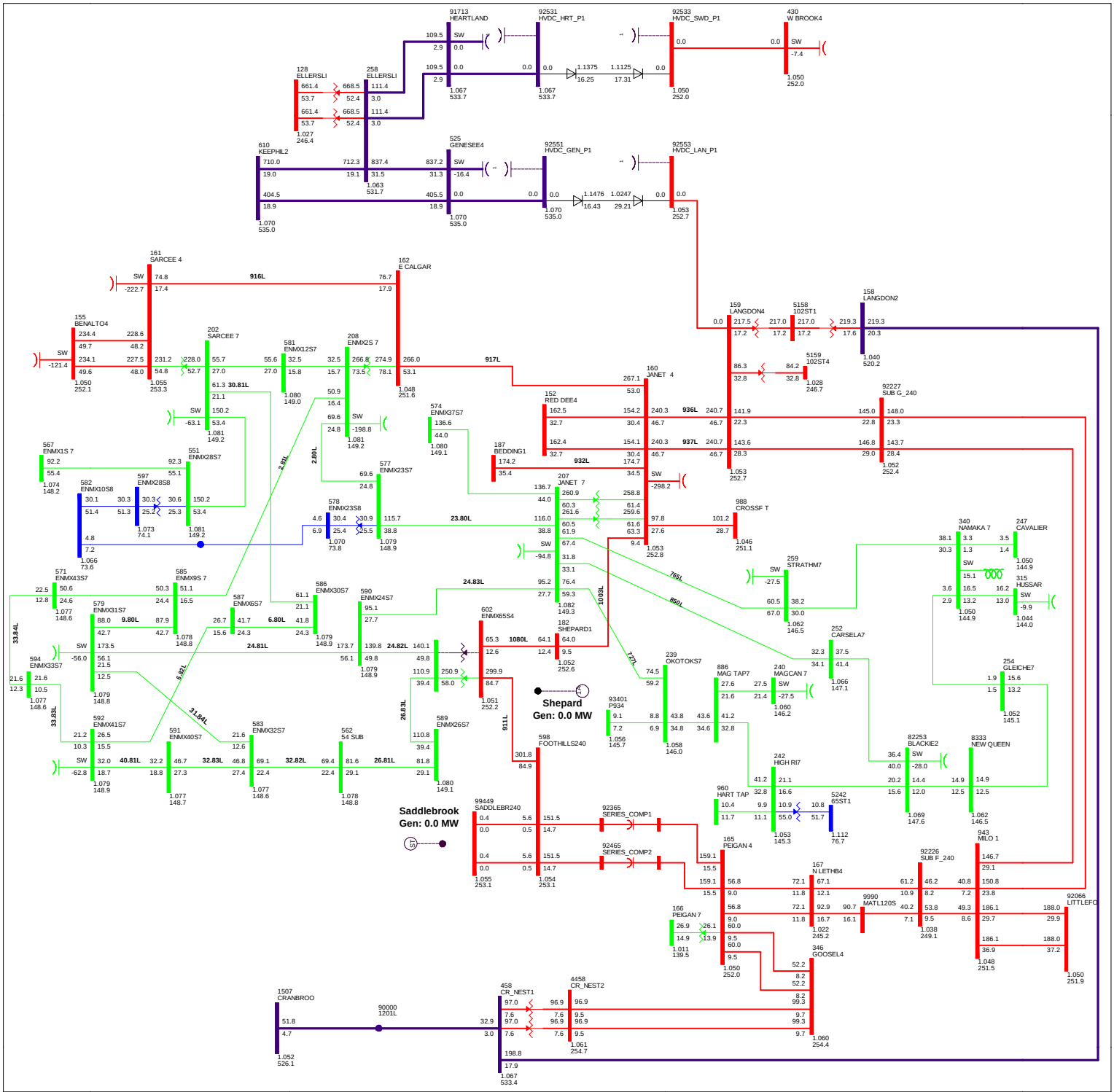
BCH Import: 3.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

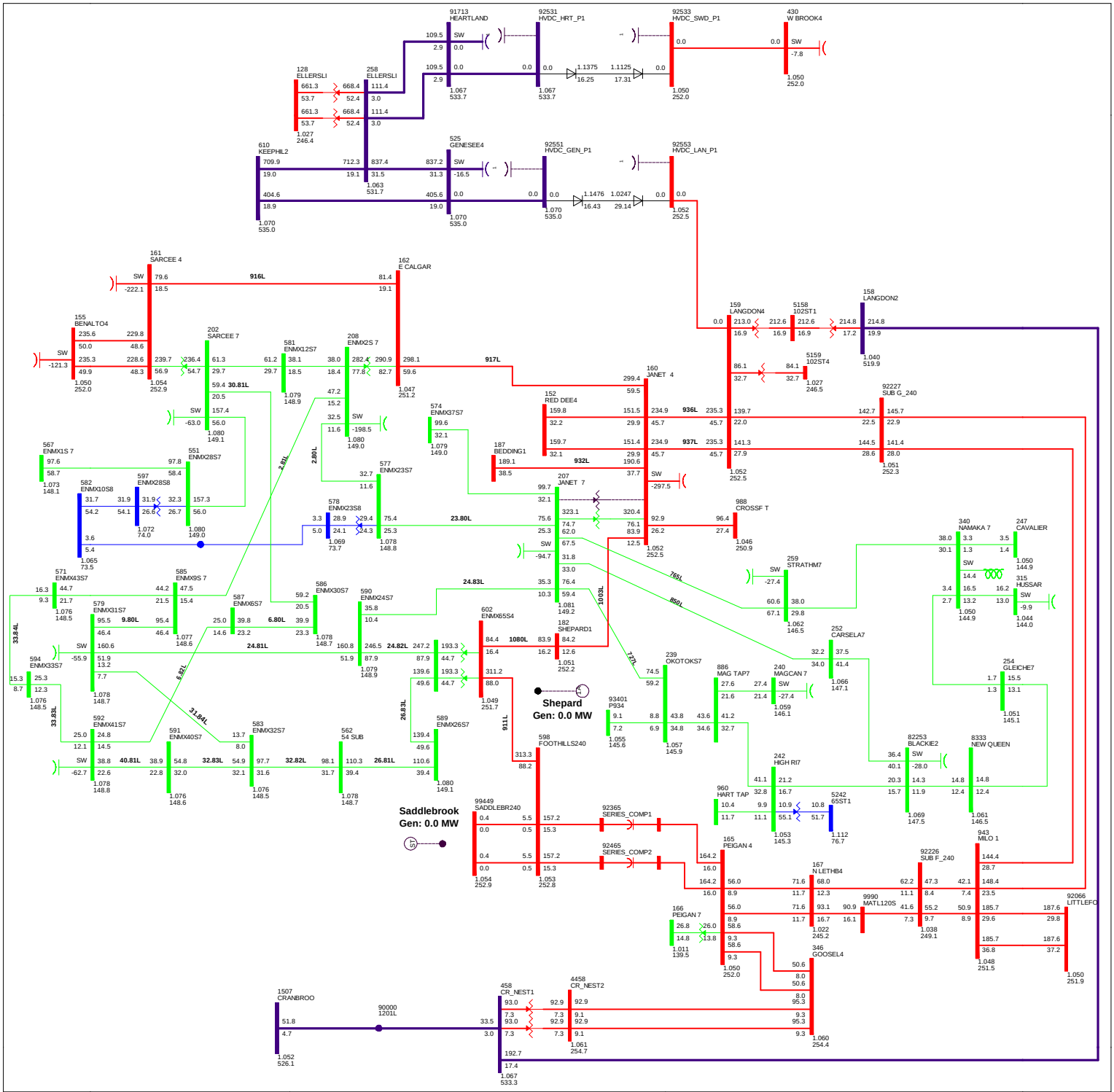
BCH Import: -0.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

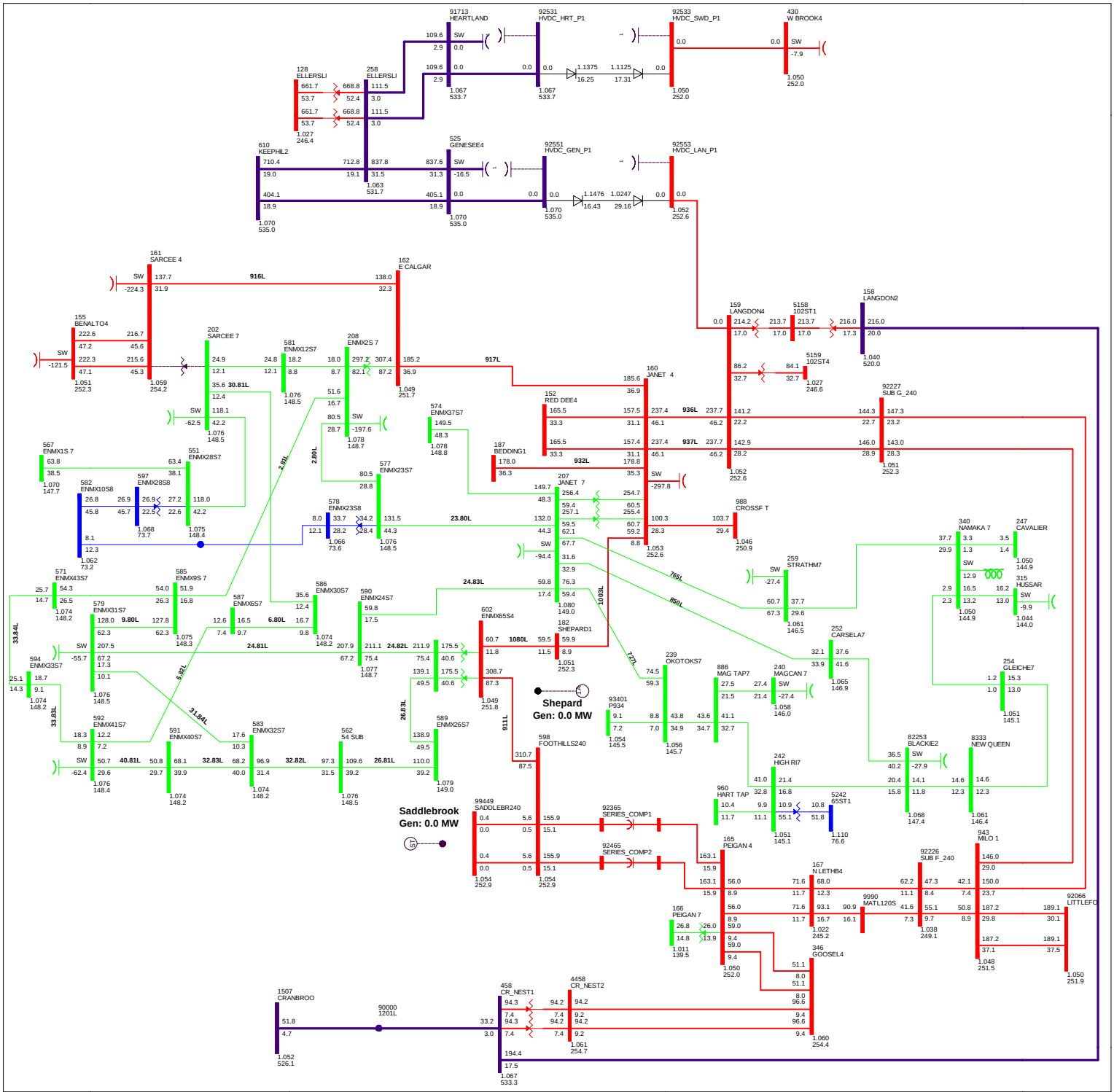
BCH Import: 1.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

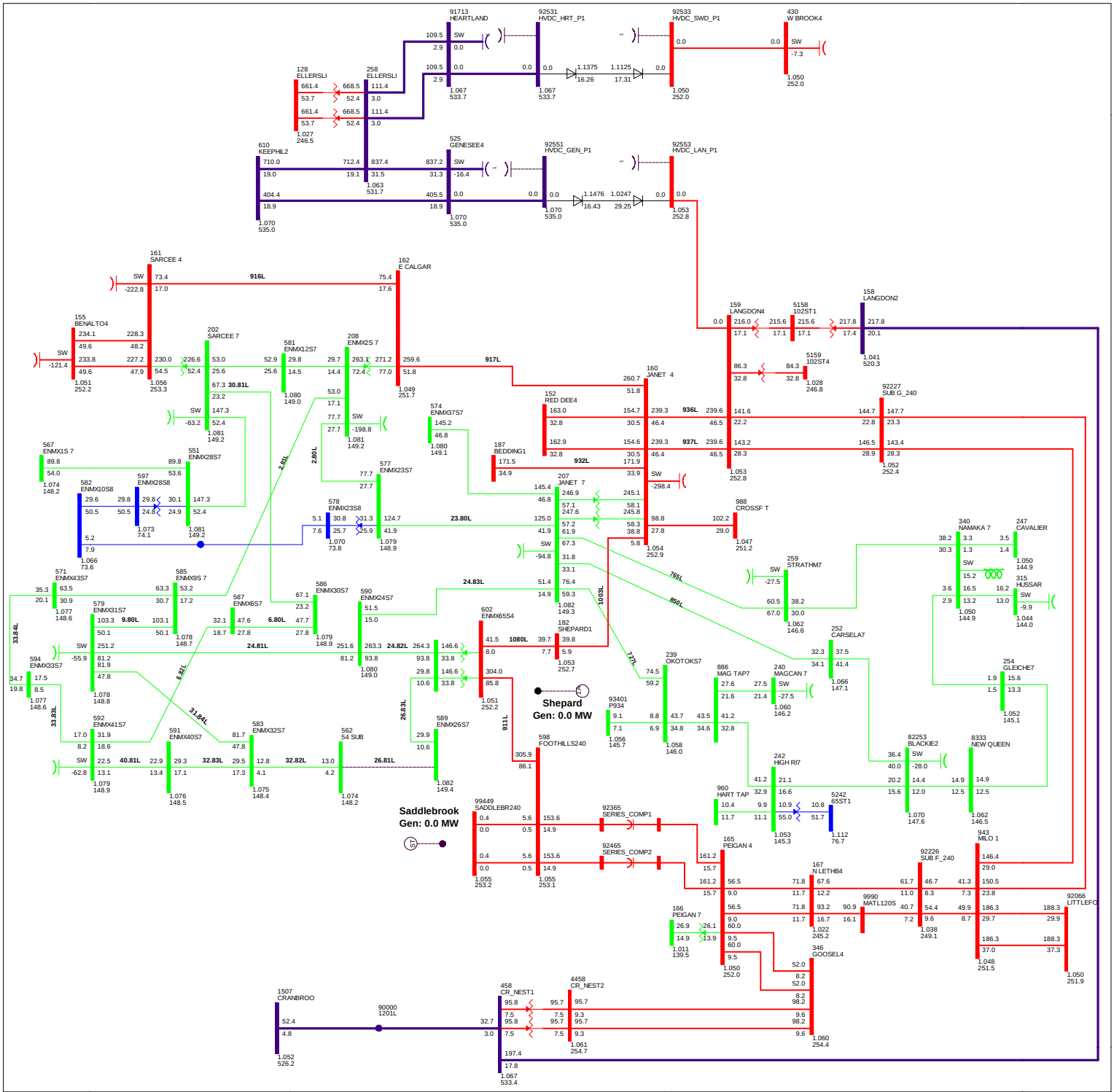
BCH Import: 1.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



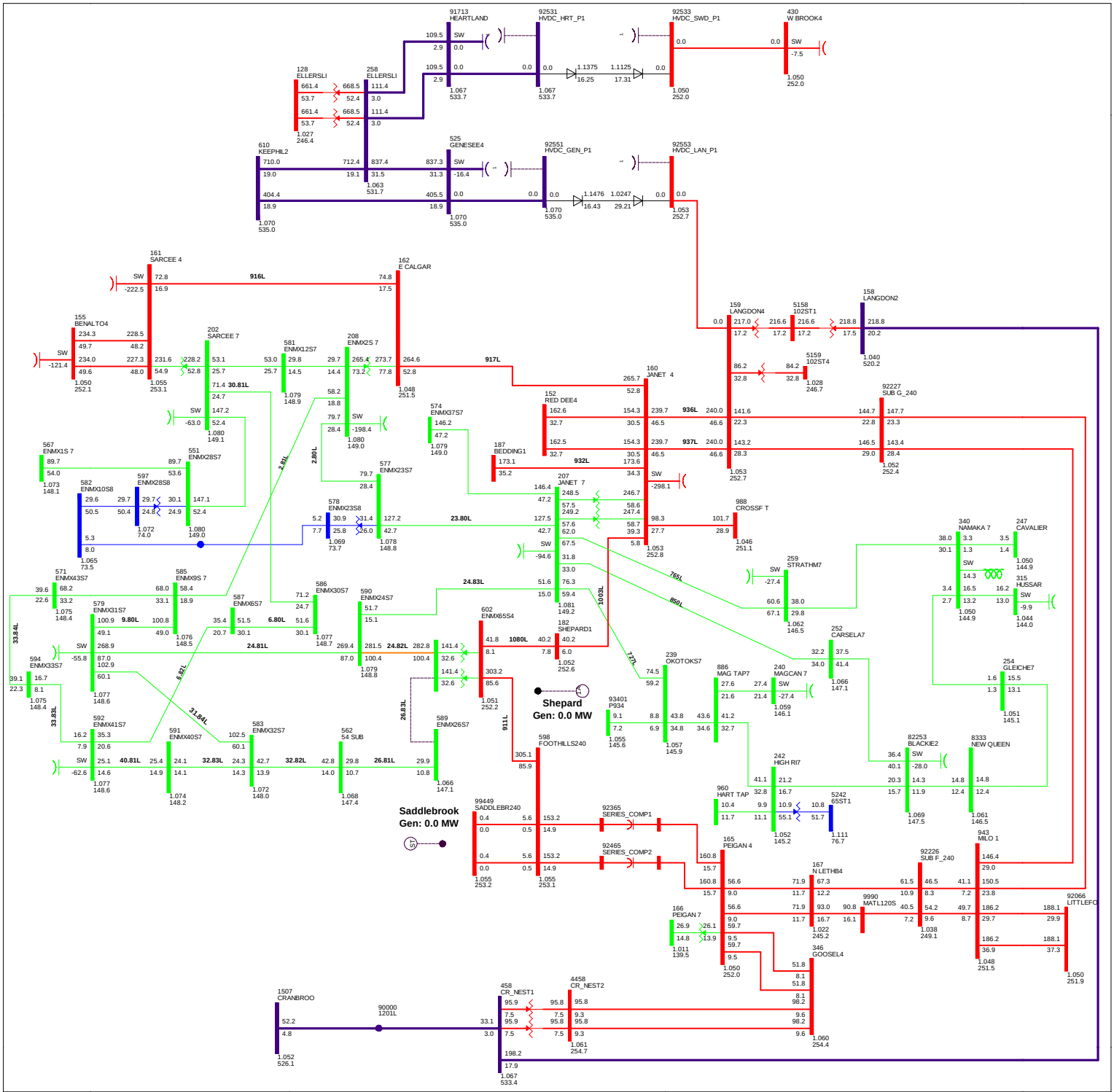
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

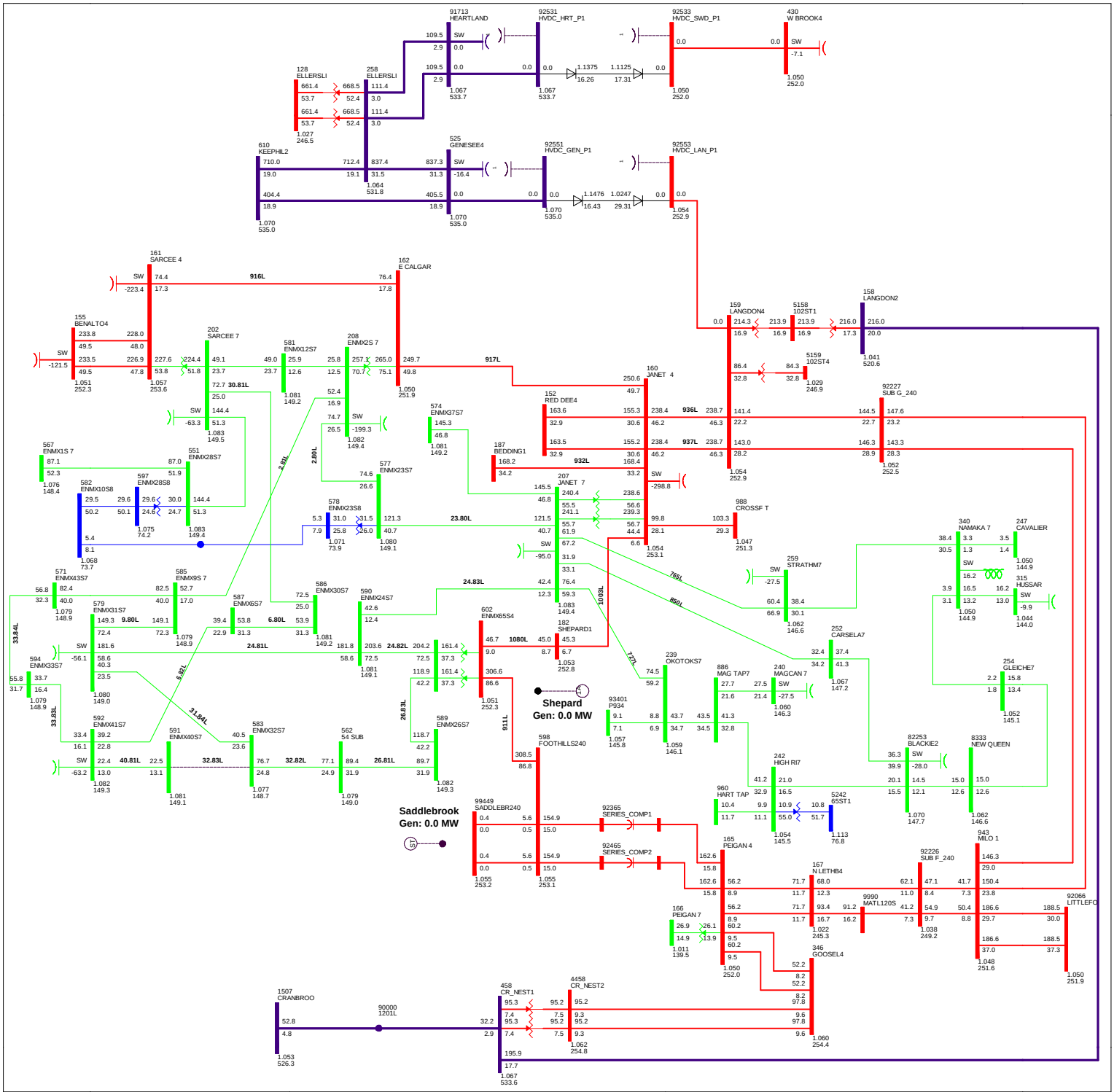
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



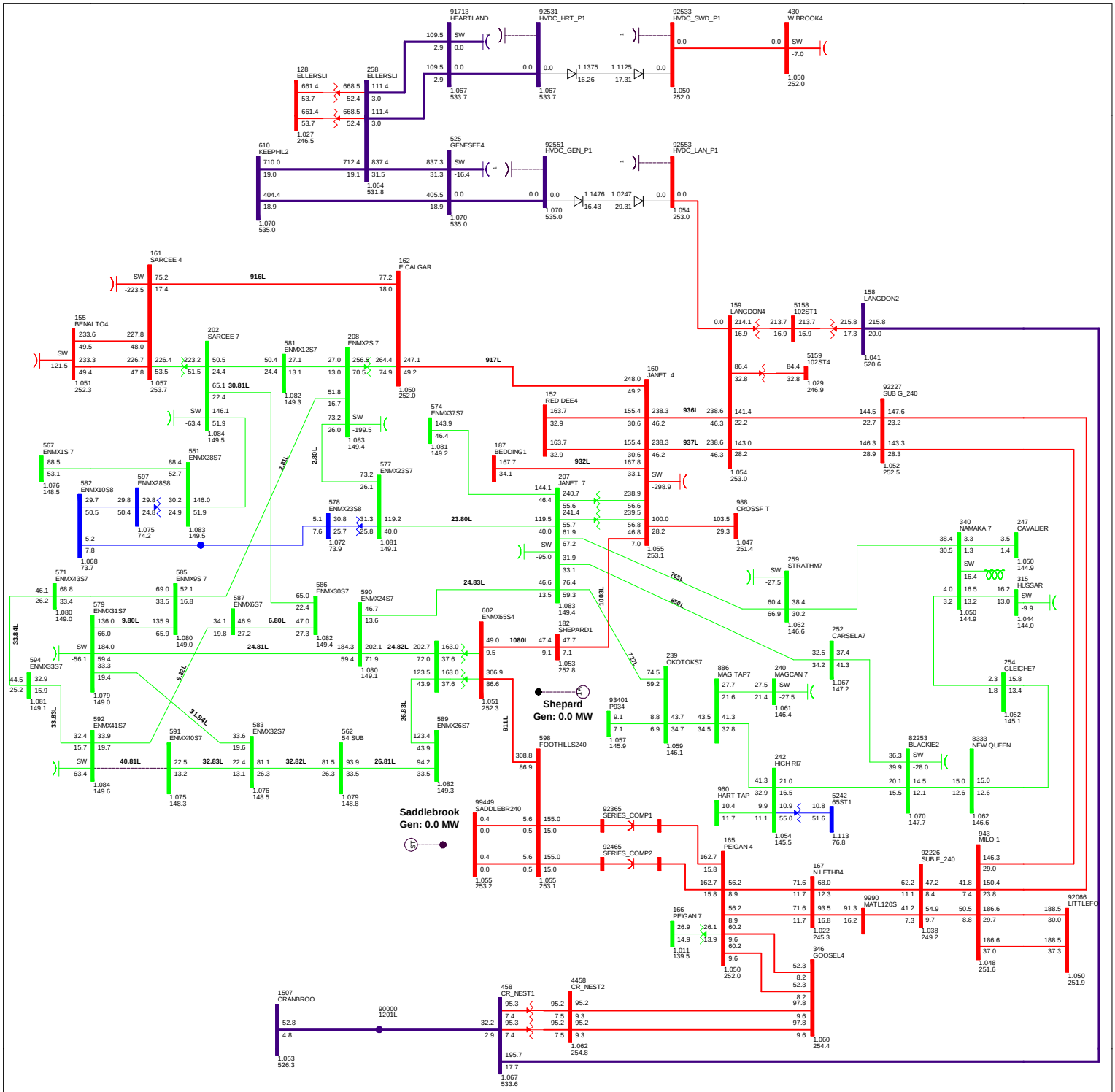
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

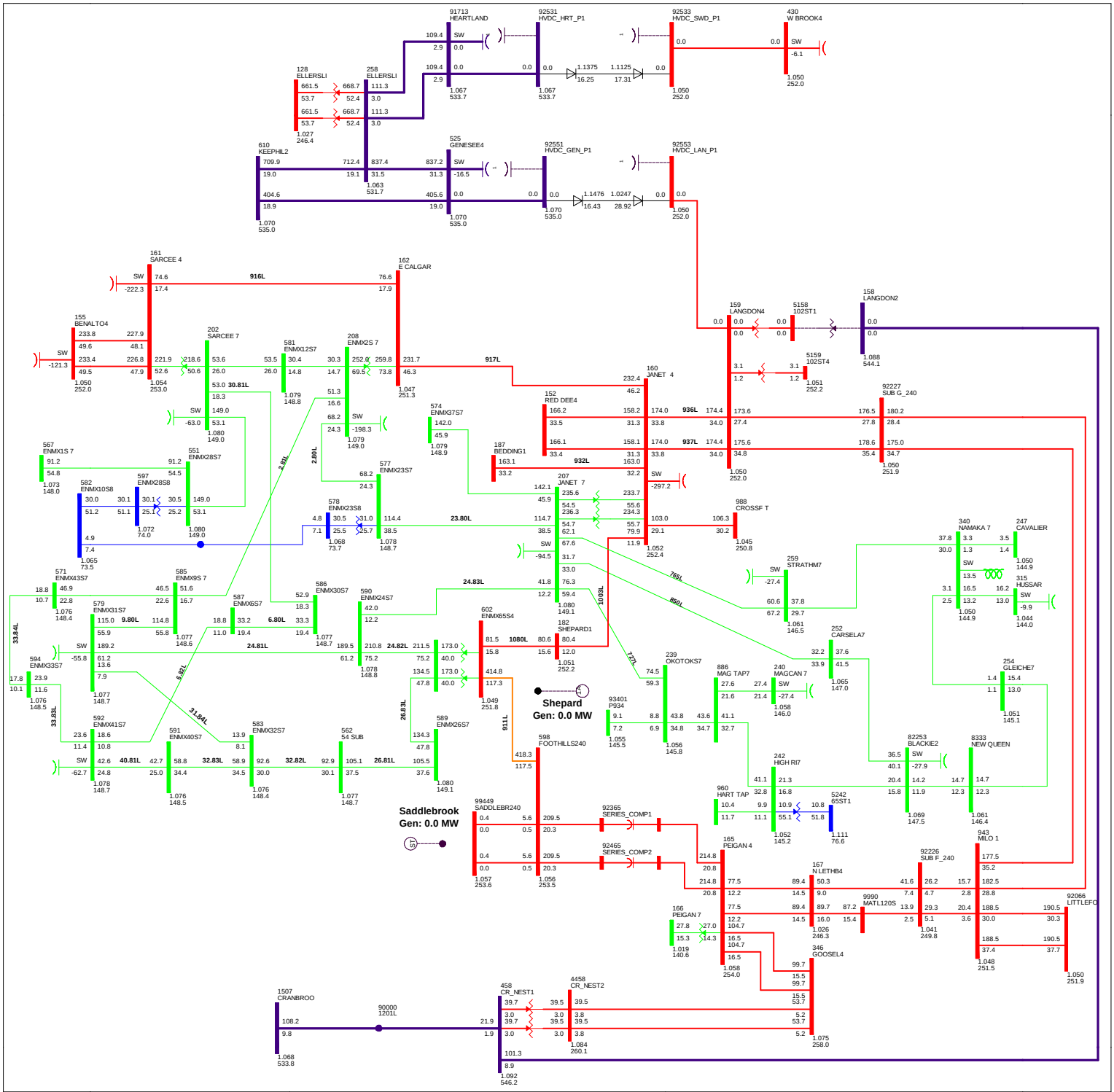
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

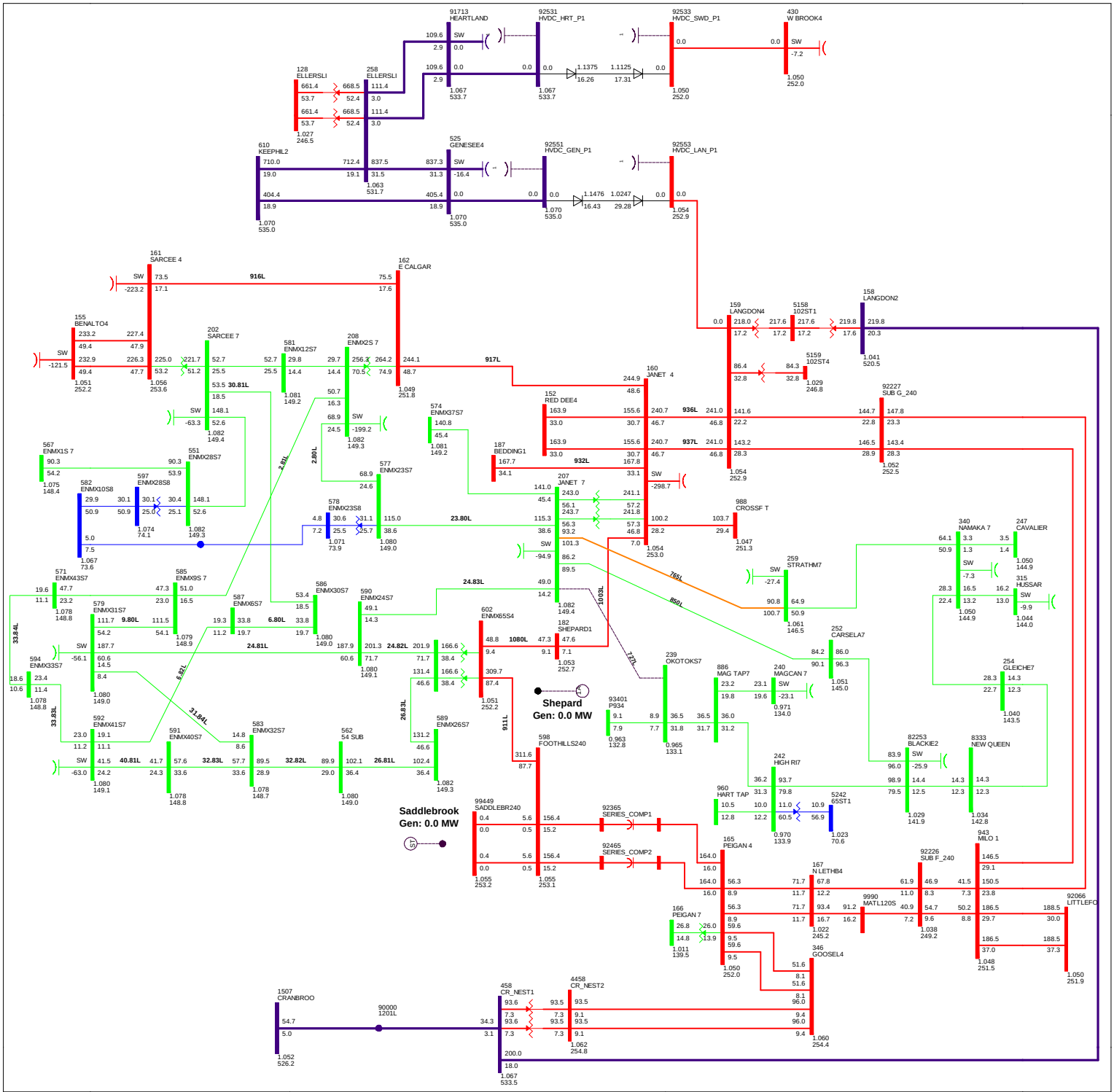
BCH Import: 6.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



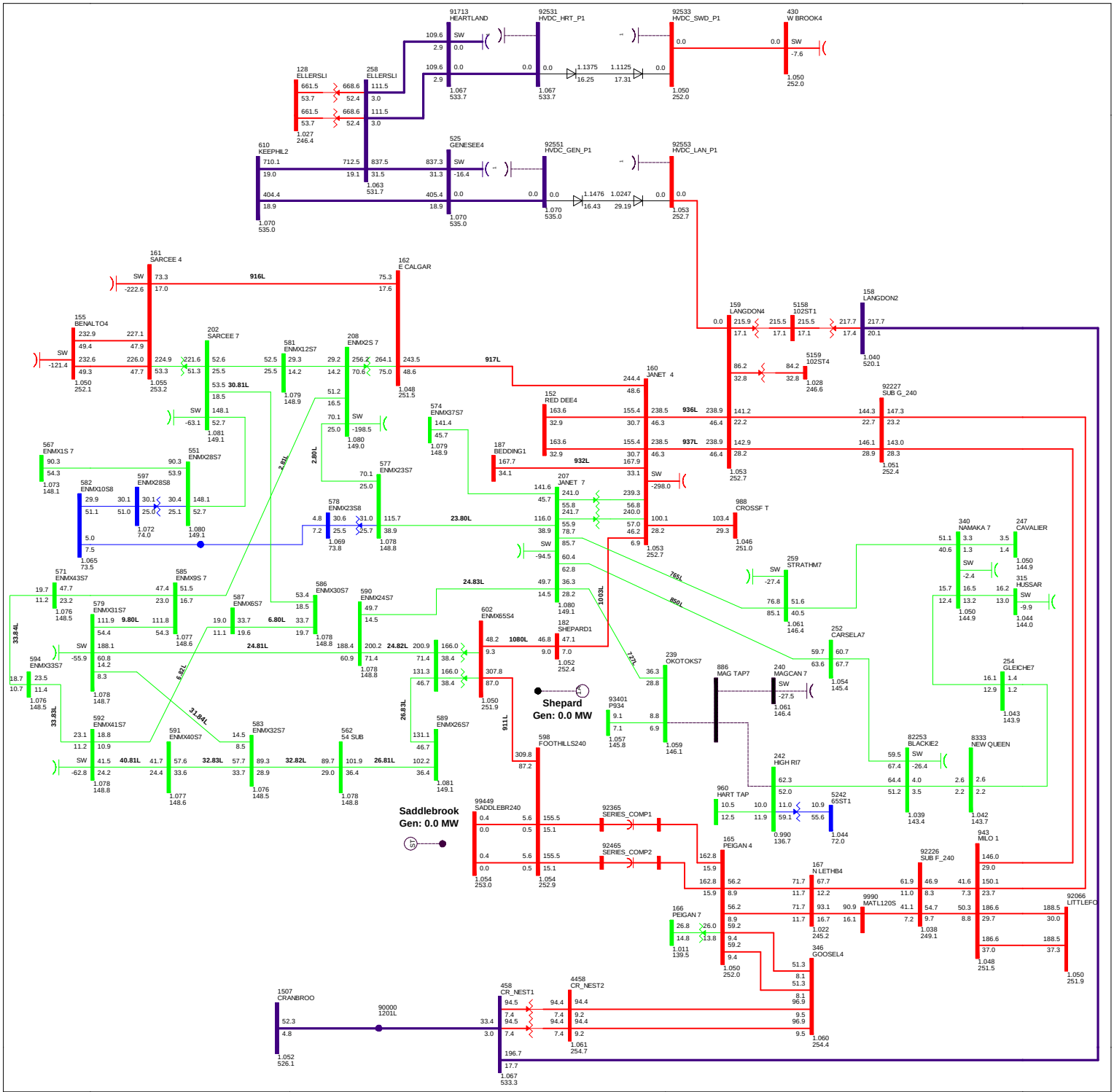
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

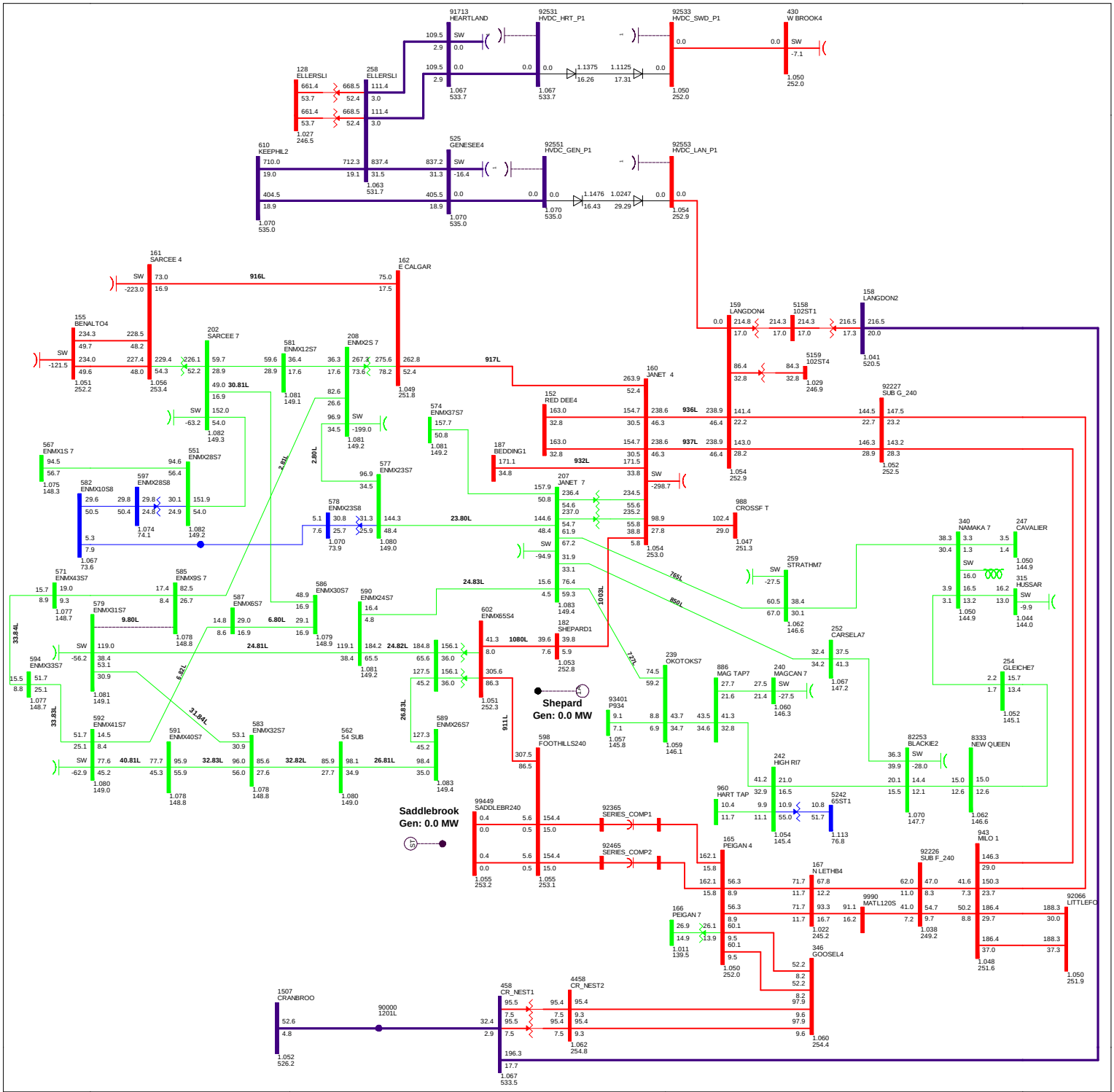
BCH Import: 7.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21


Saddlebrook
Gen: 0.0 MW
Shepard
Gen: 0.0 MW
2012LTO EXISTING SYSTEM
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
BCH Import: 2.0 MW
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
FIG A-SC2-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_SP_EXISTING_SC2
FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

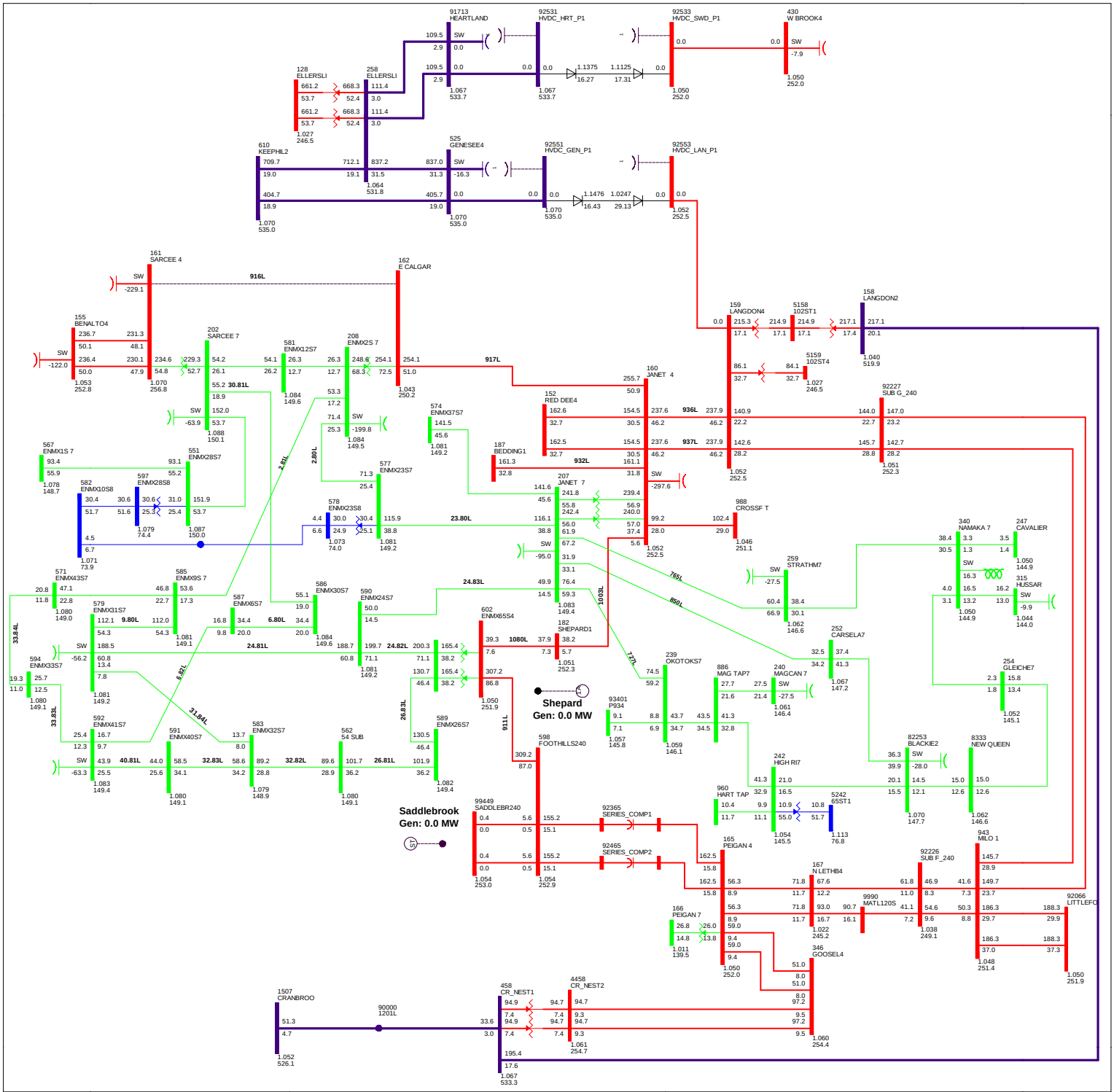
BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-22: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



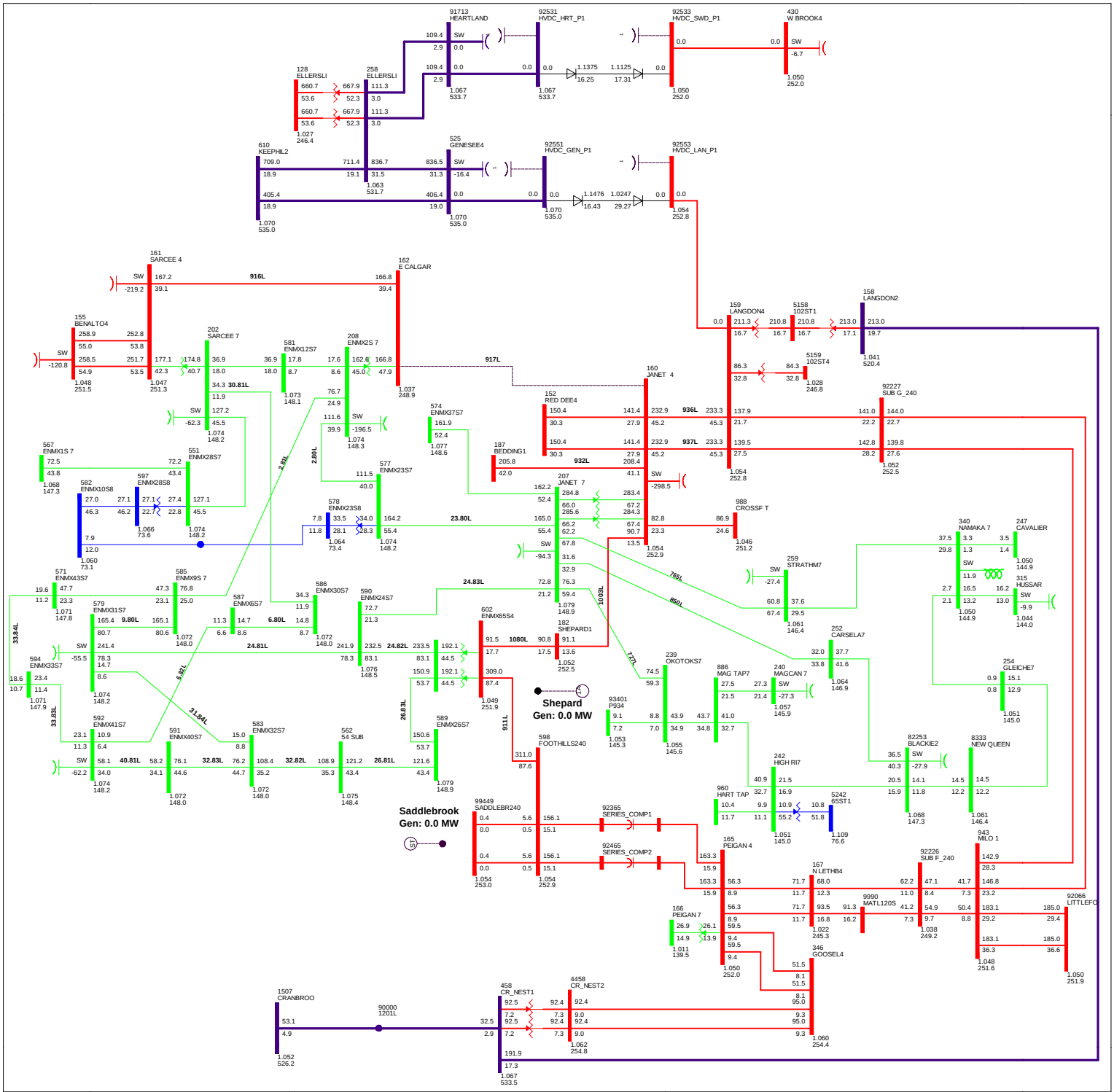
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-23: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



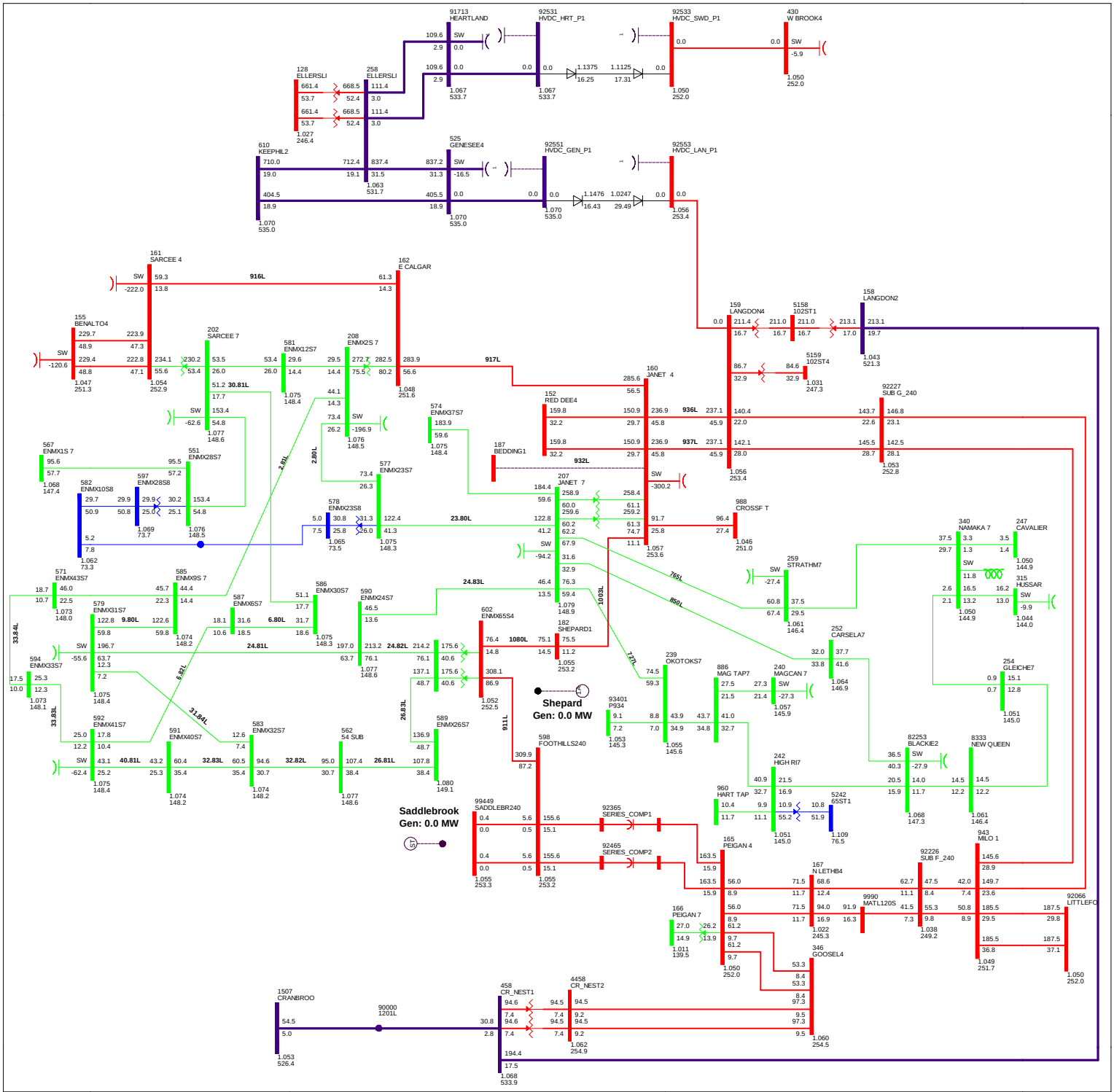
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-24: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

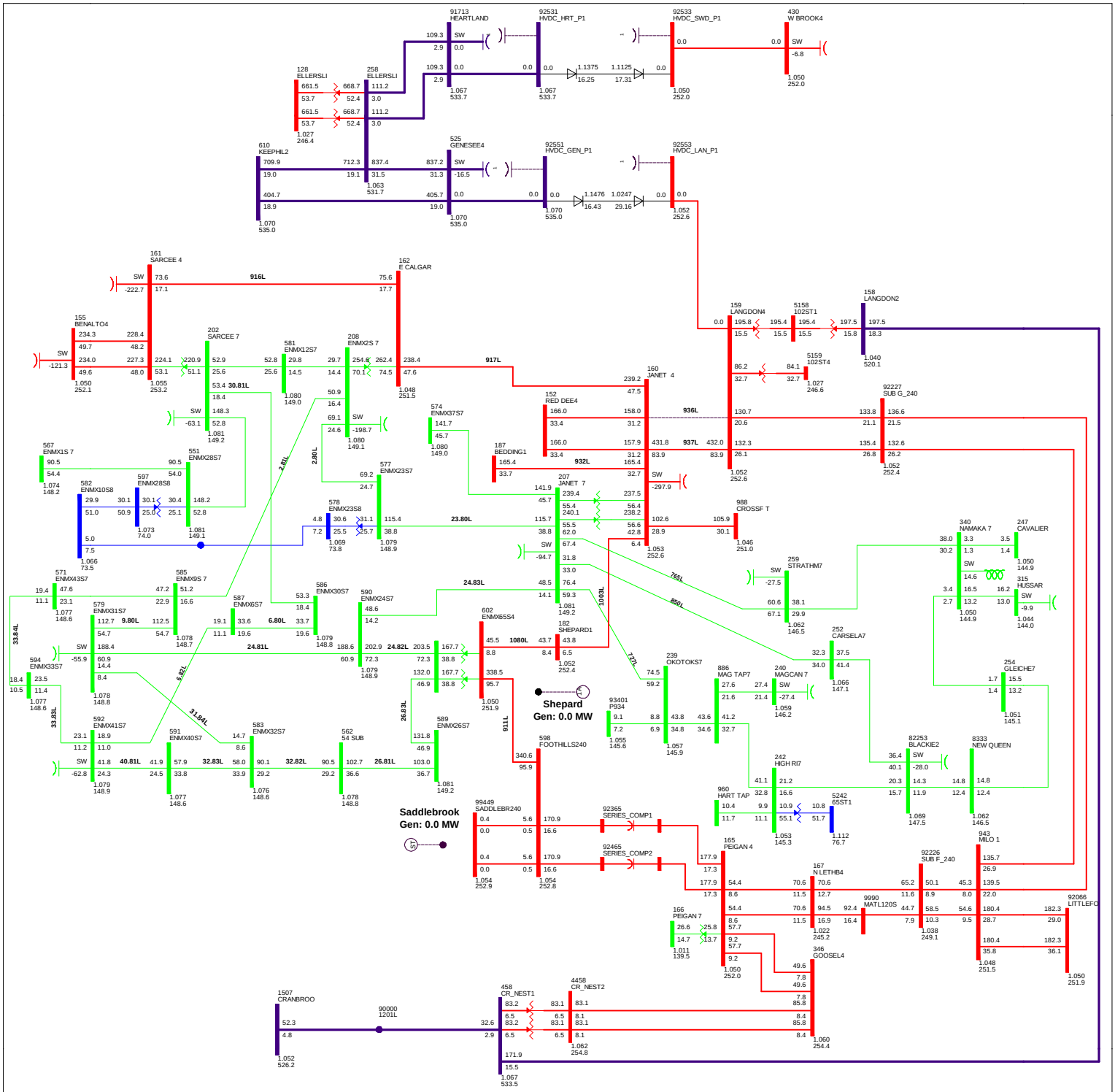
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-25: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

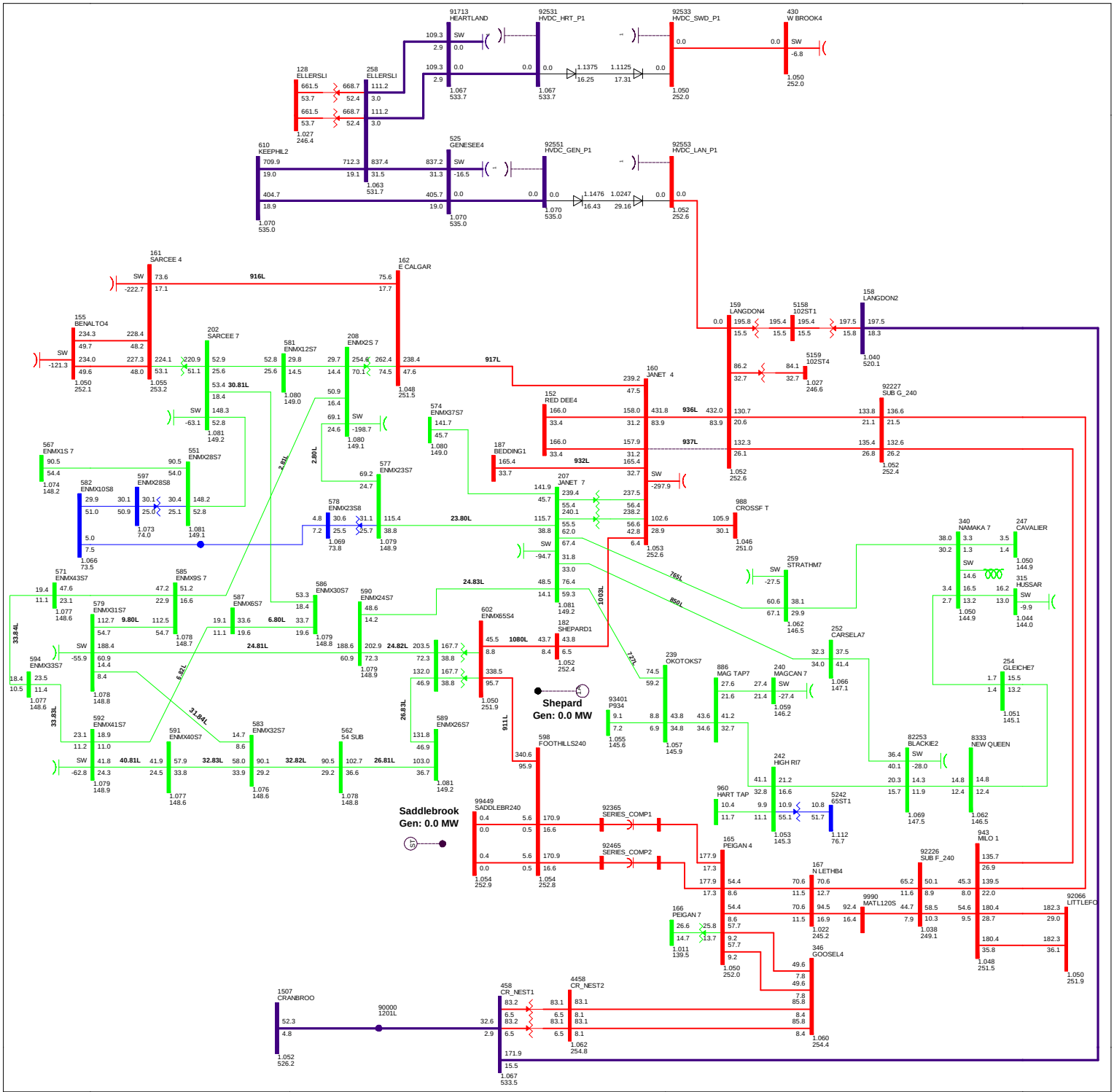
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-26: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

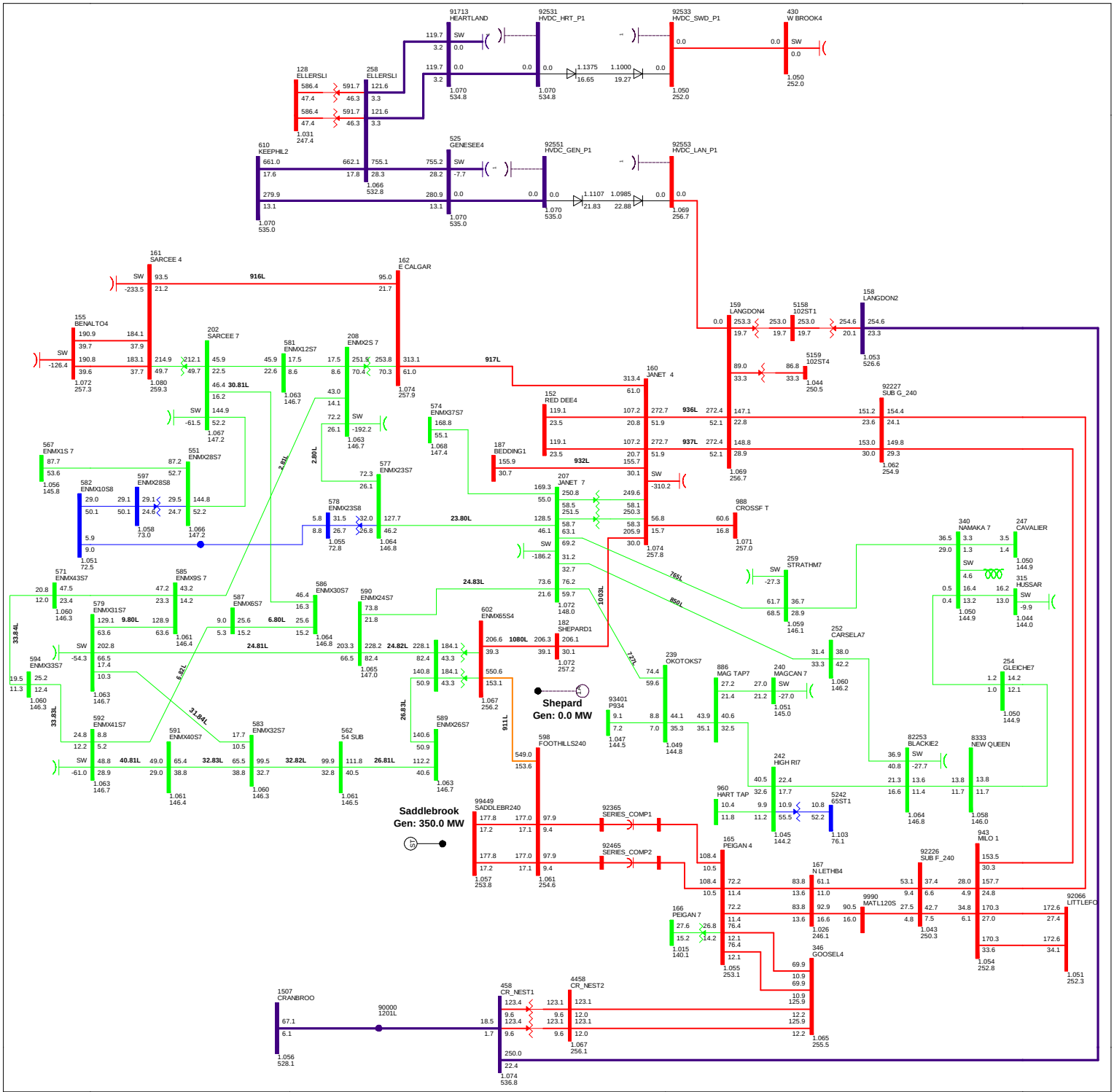
BCH Import: 1.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC2-27: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC2

FRI, JUN 08 2012 15:21

2014 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

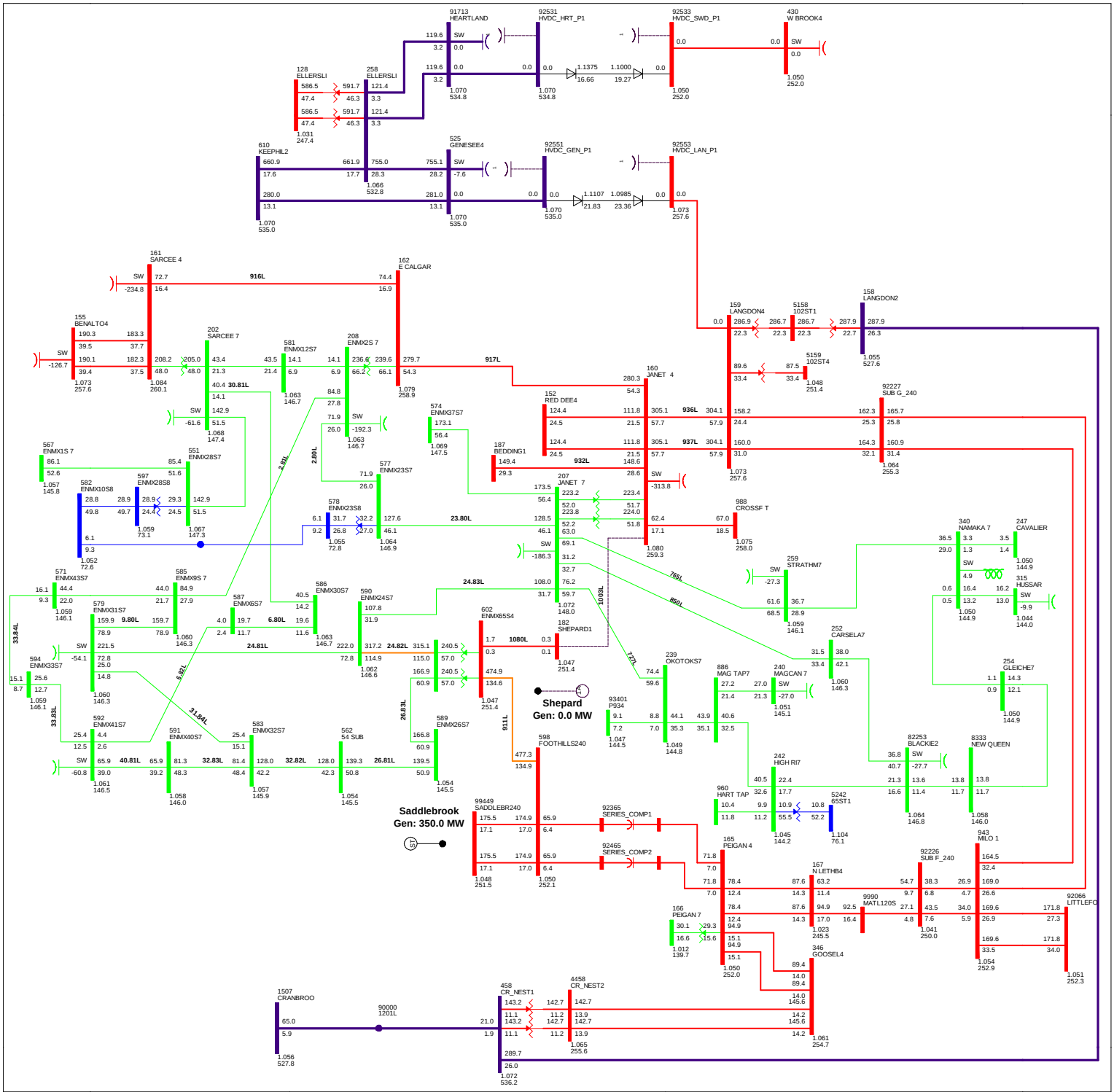
BCH Import: -0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-1: BASECASE

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

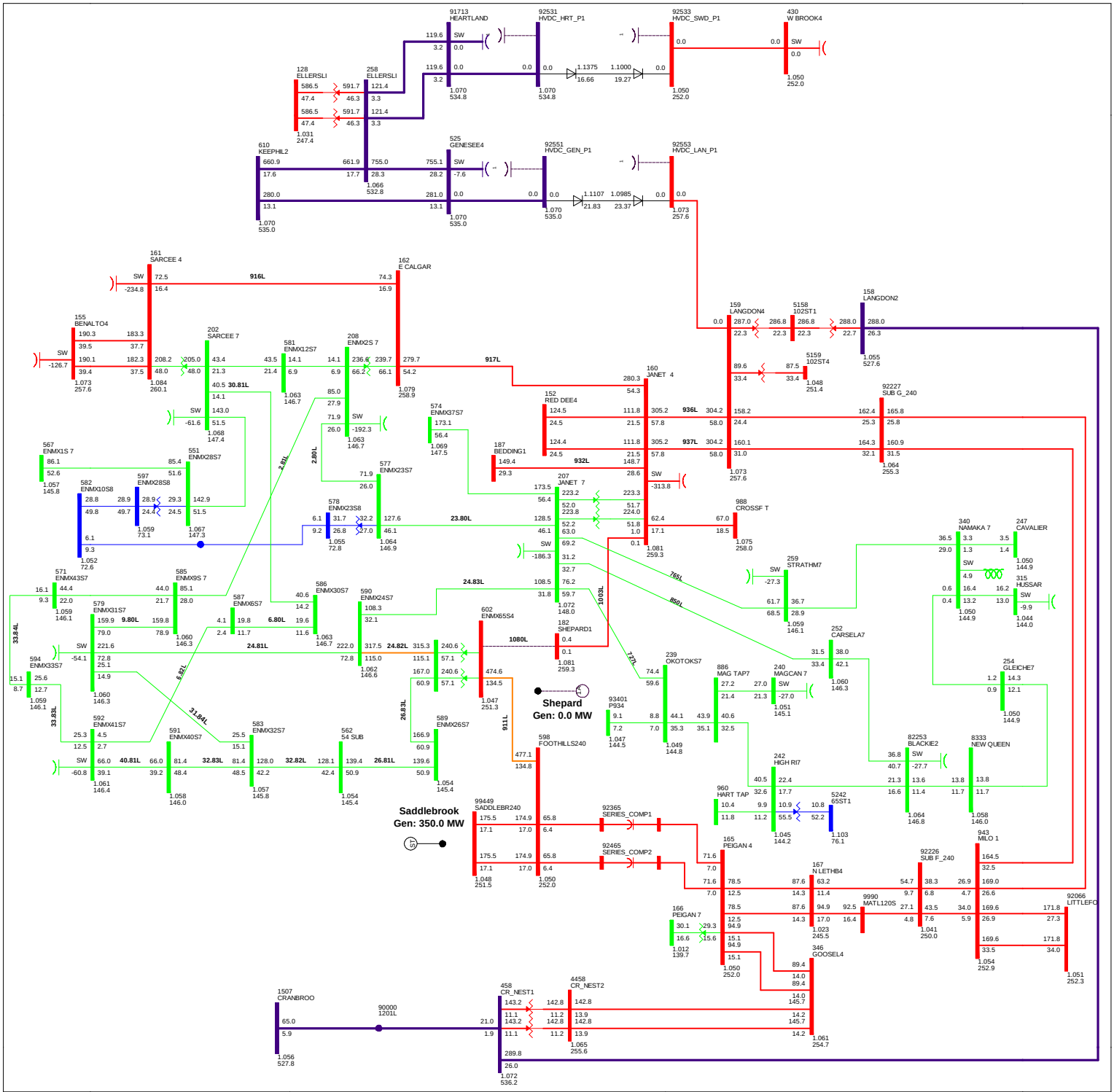
BCH Import: 1.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

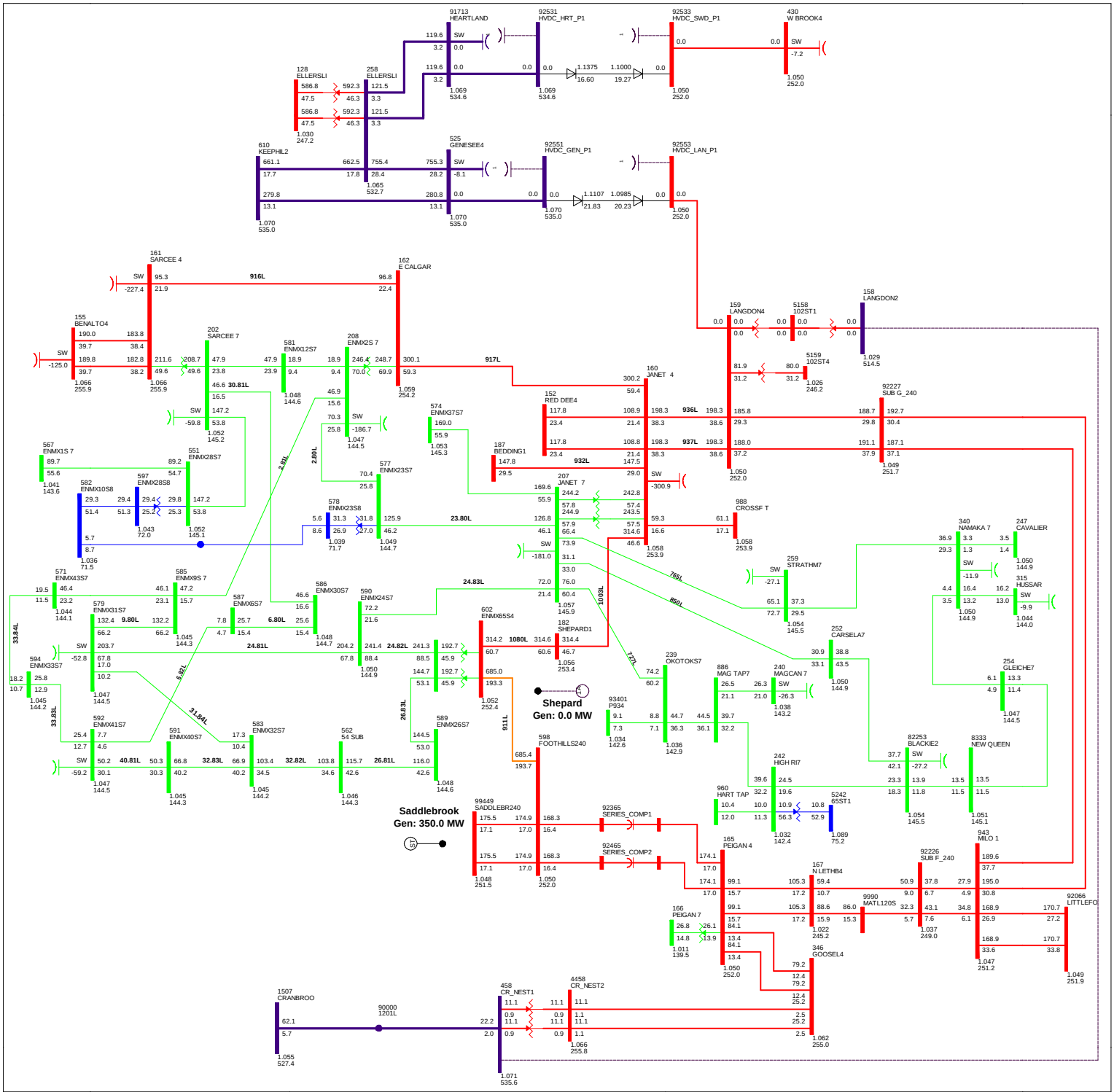
BCH Import: 1.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

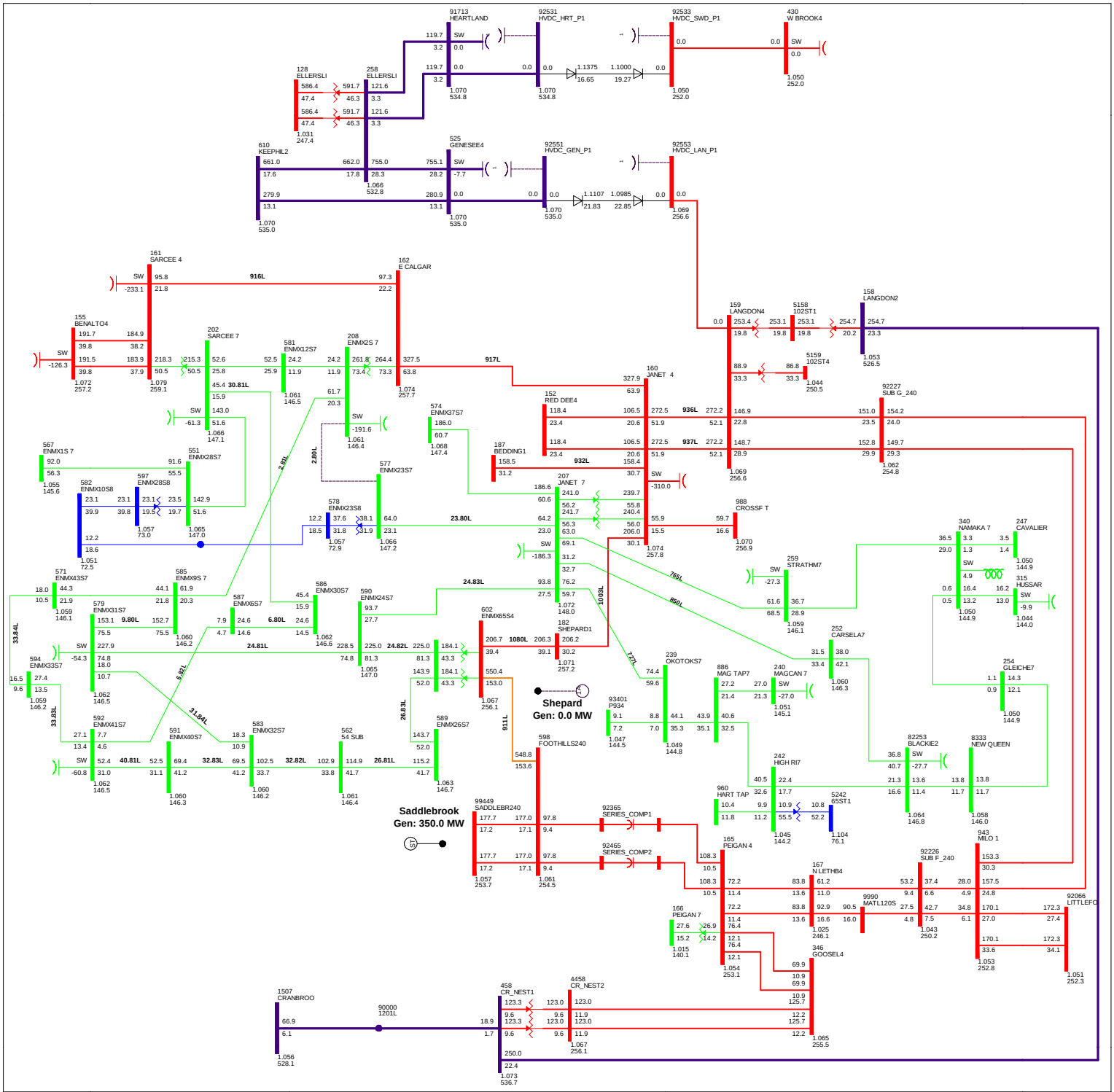
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 11.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

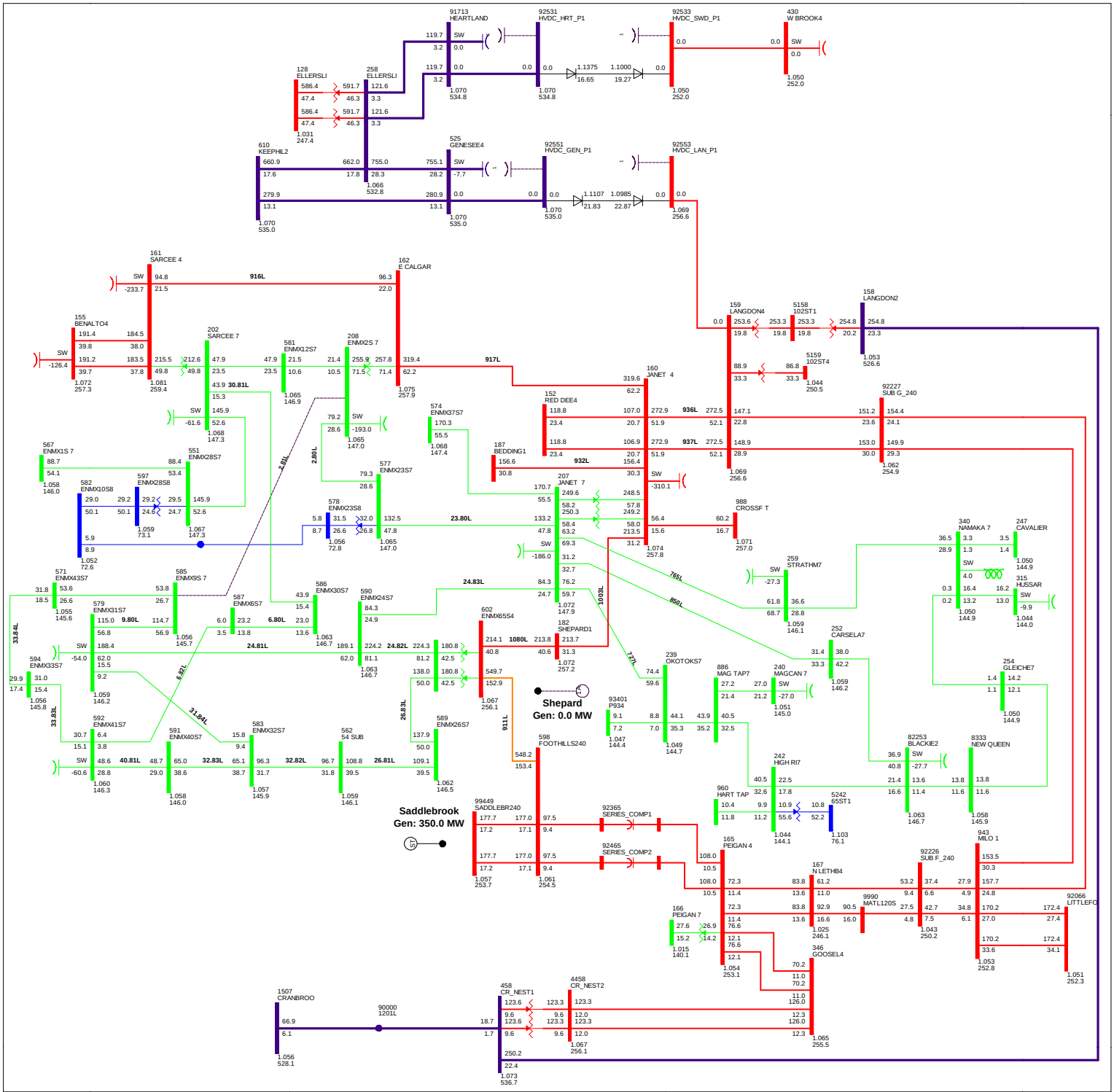
BCH Import: 0.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

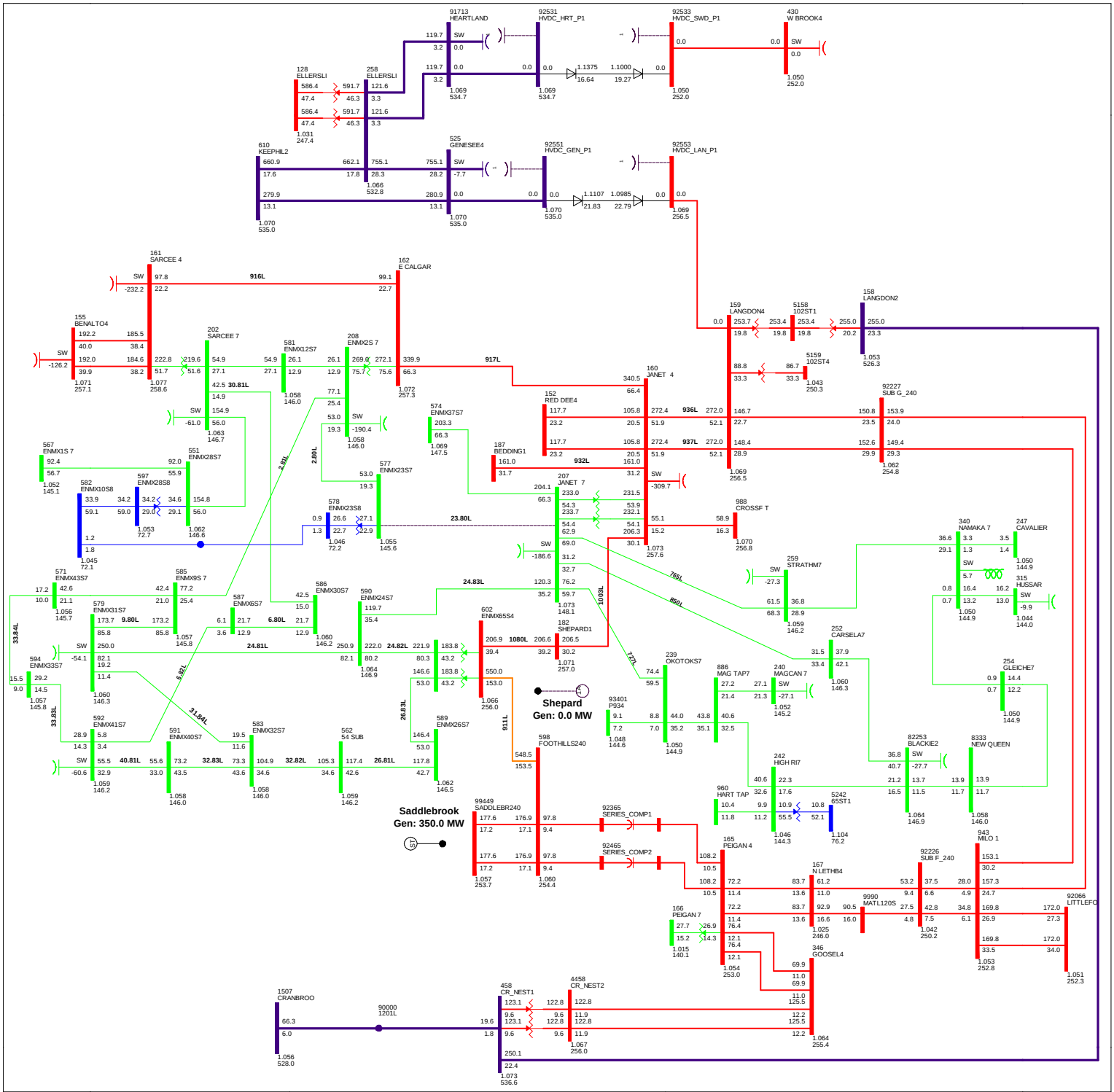
BCH Import: -0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

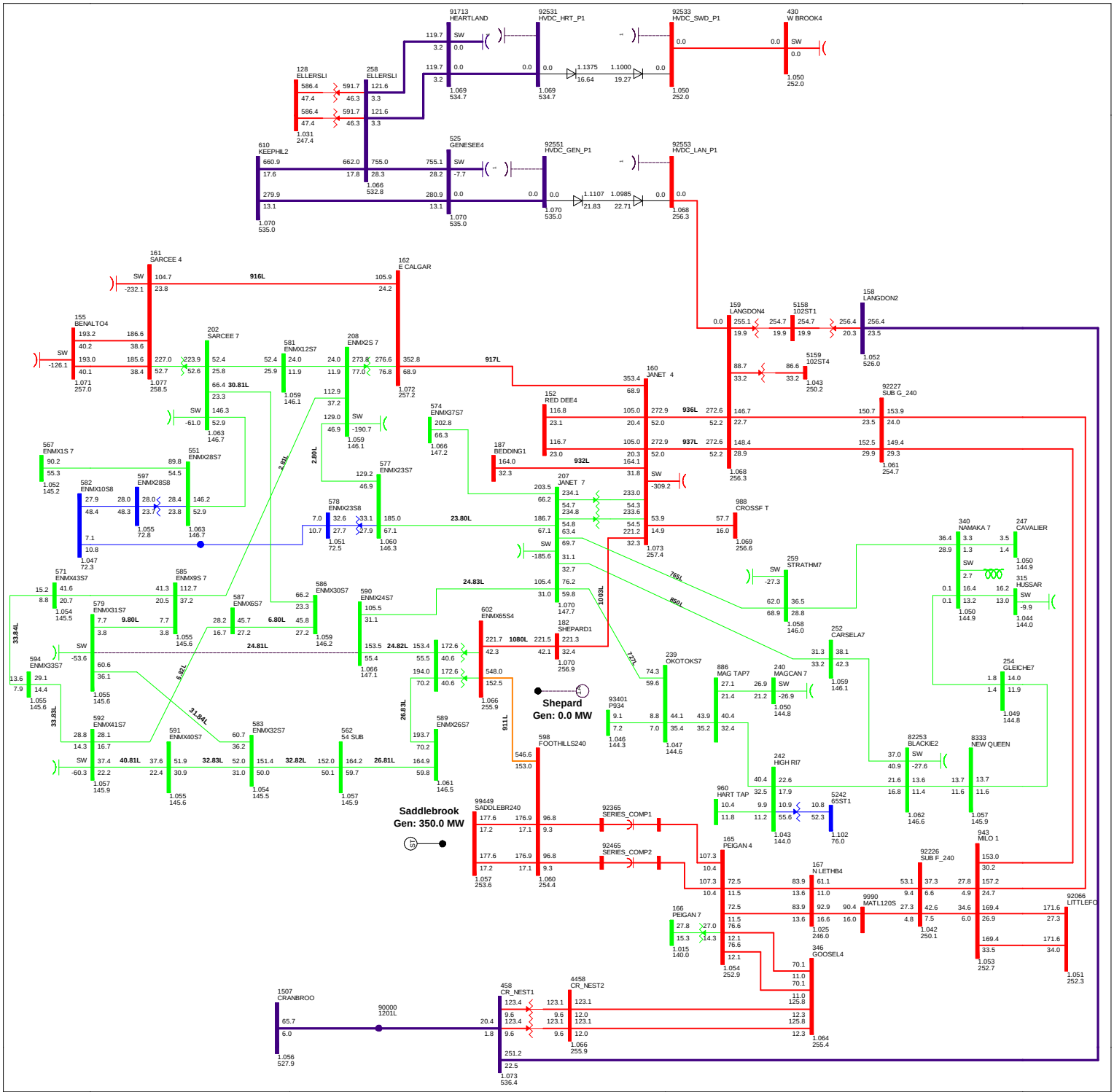
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

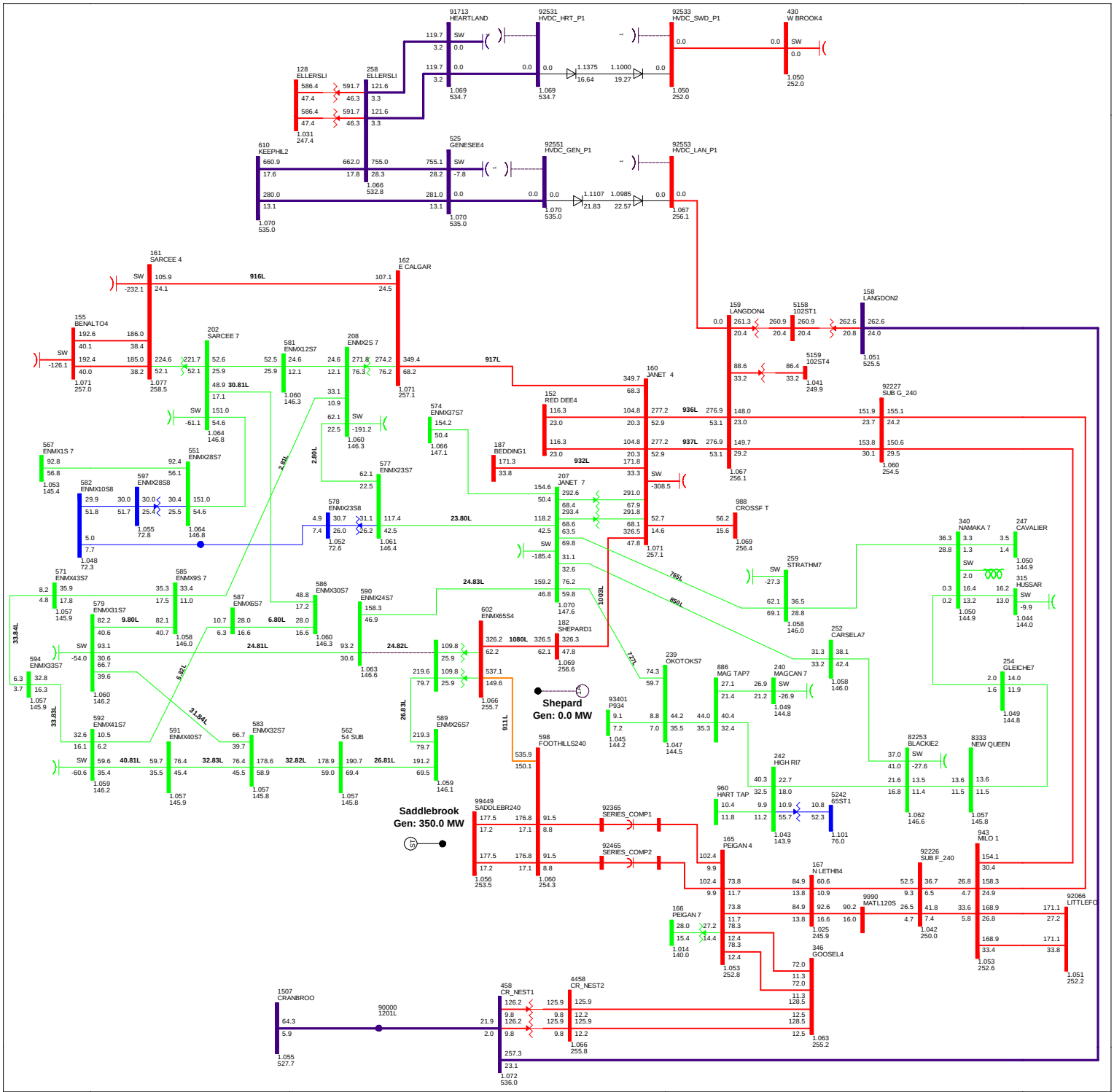
BCH Import: 2.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

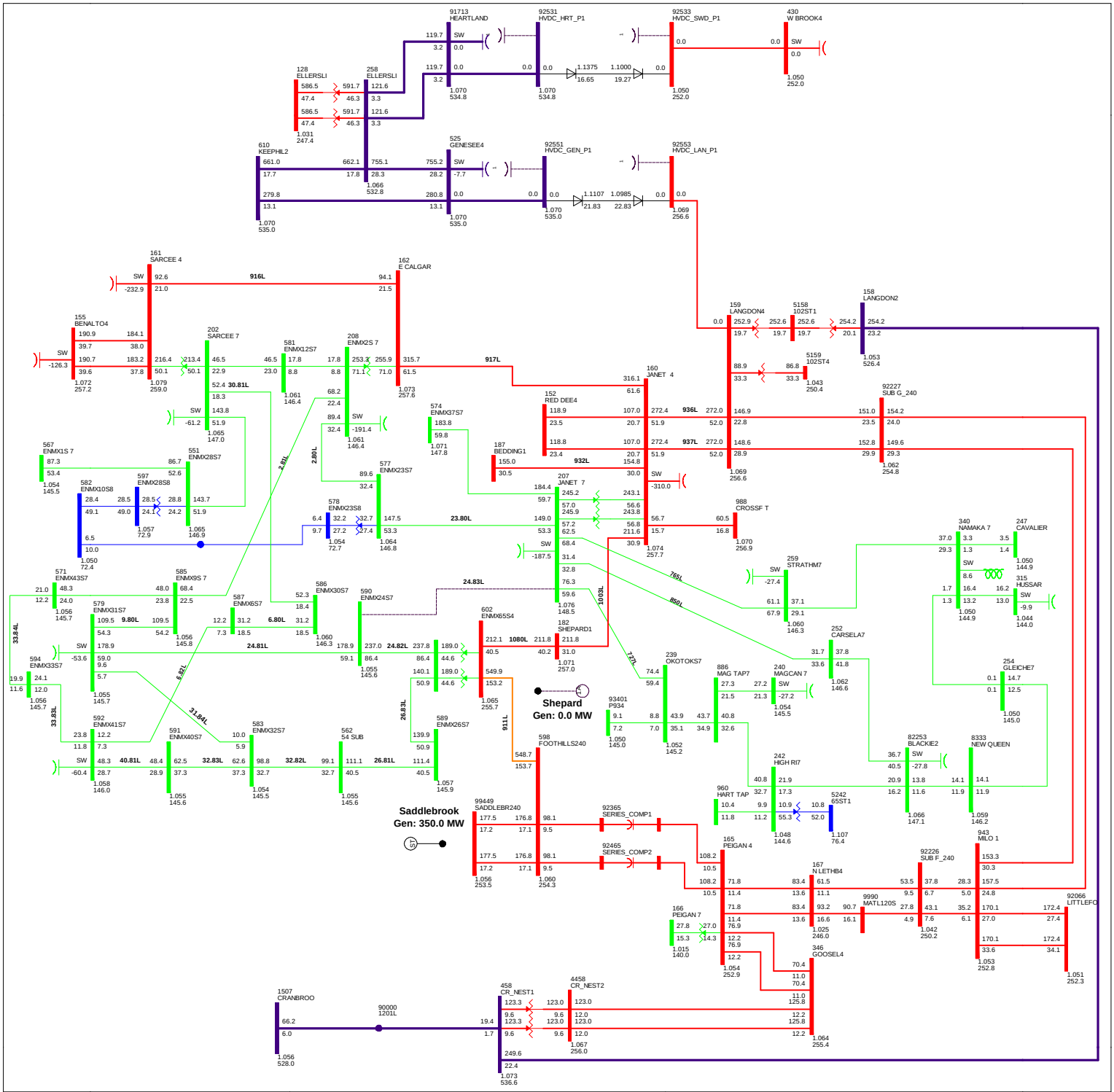
BCH Import: 2.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



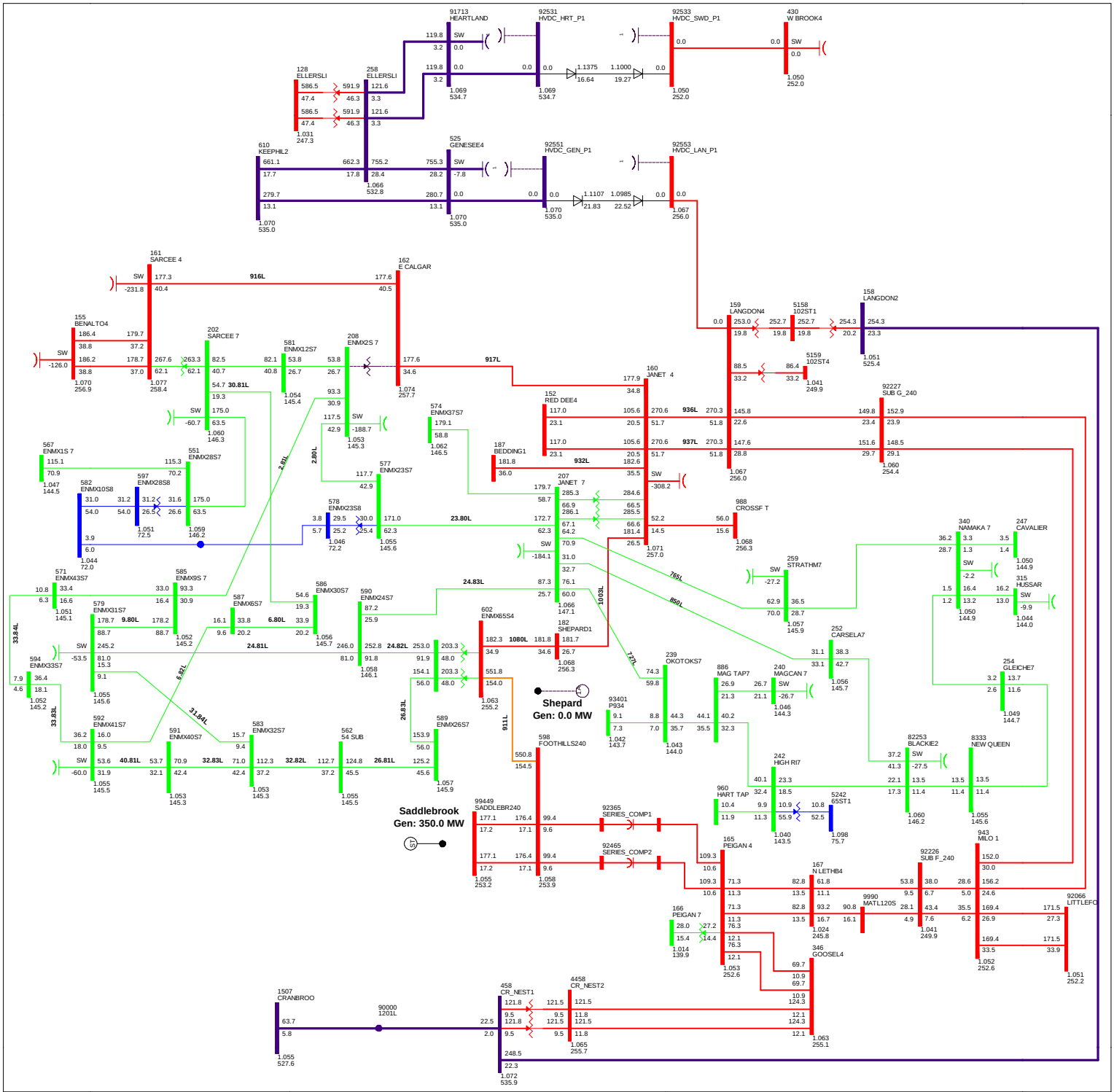
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

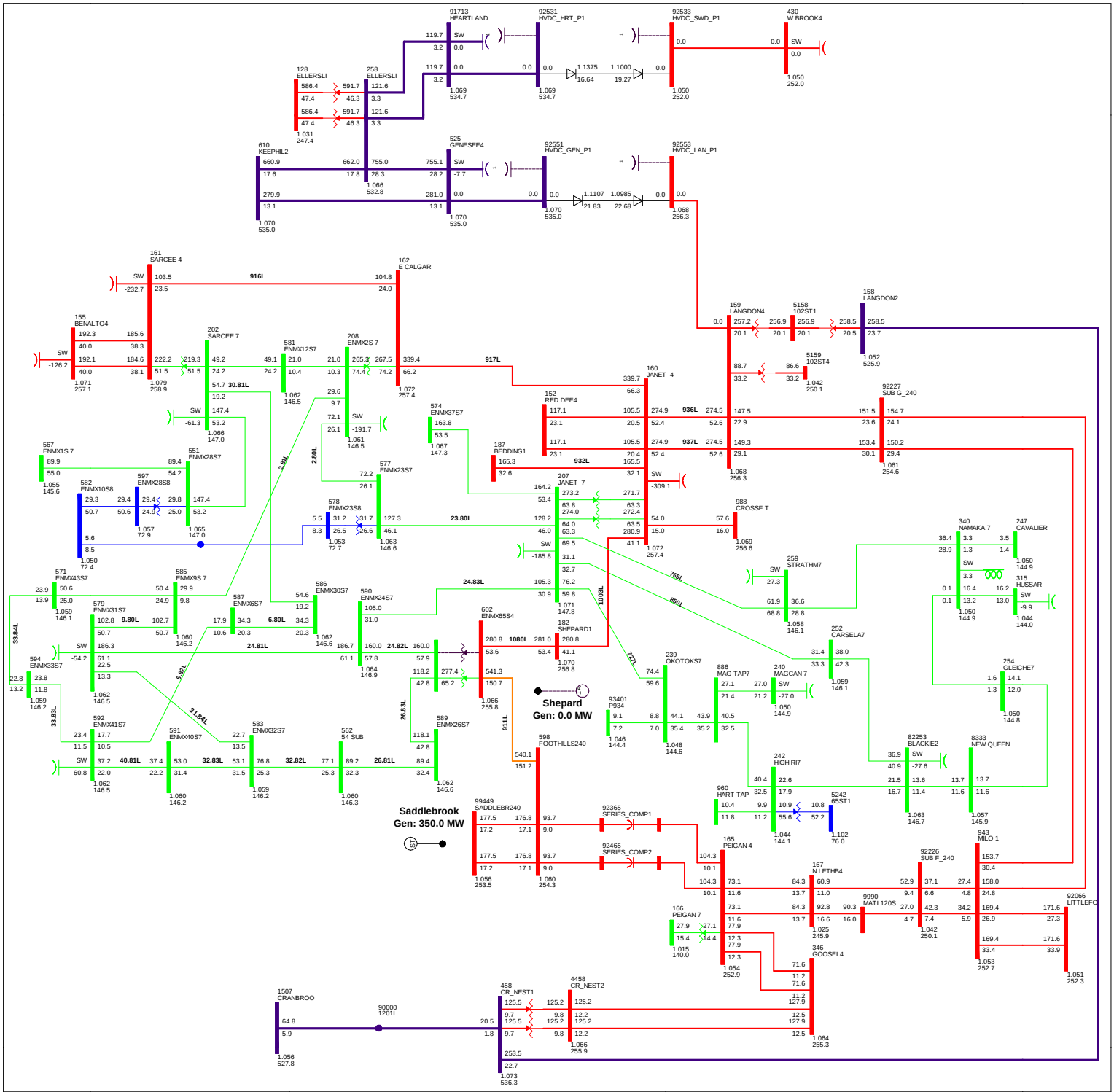
BCH Import: 3.4 MW

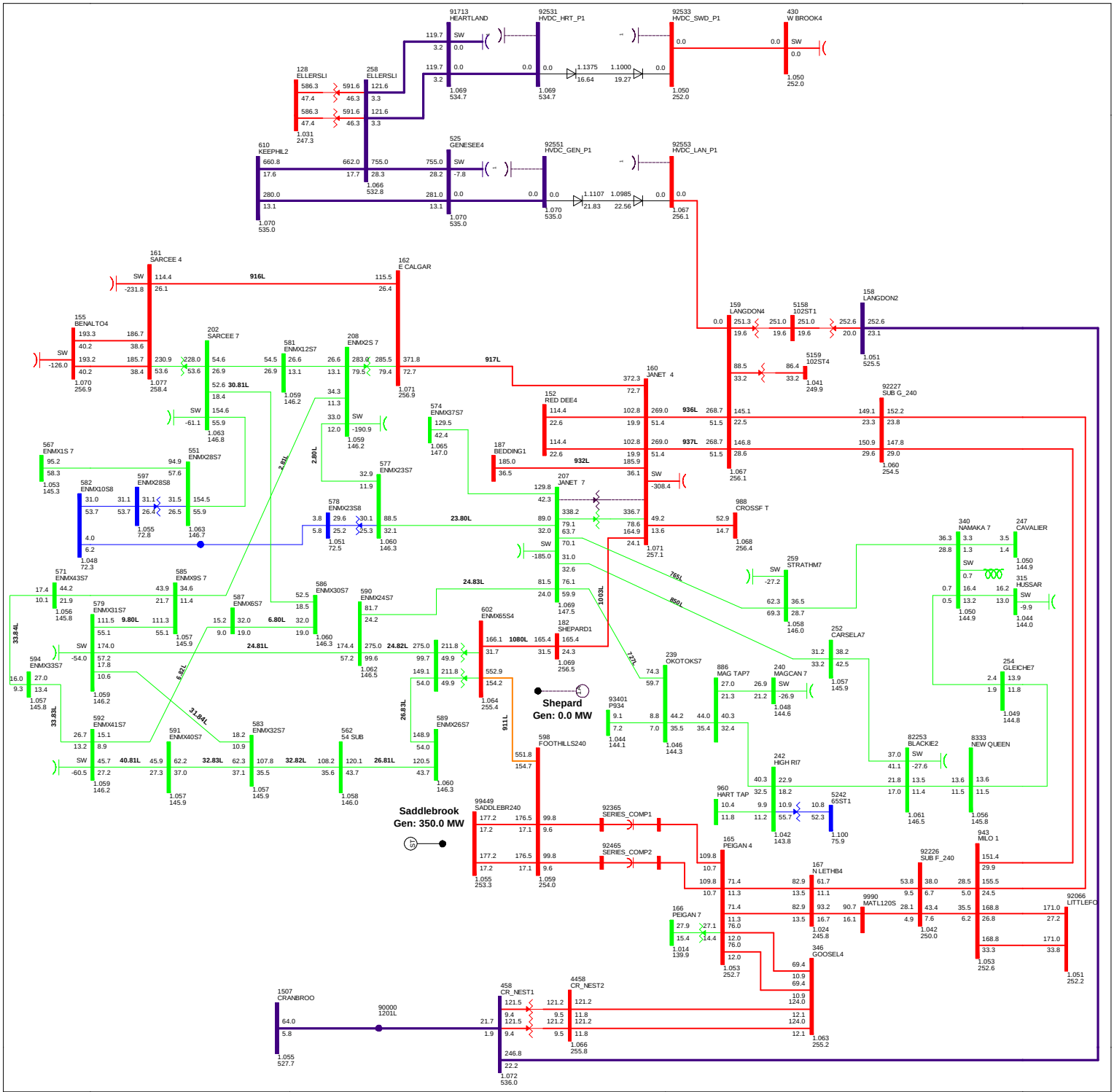
2012LTO EXISTING SYSTEM

FIG A-SC3-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
BCH Import: -0.1 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG A-SC3-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)
2014_SP_EXISTING_SC3
FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

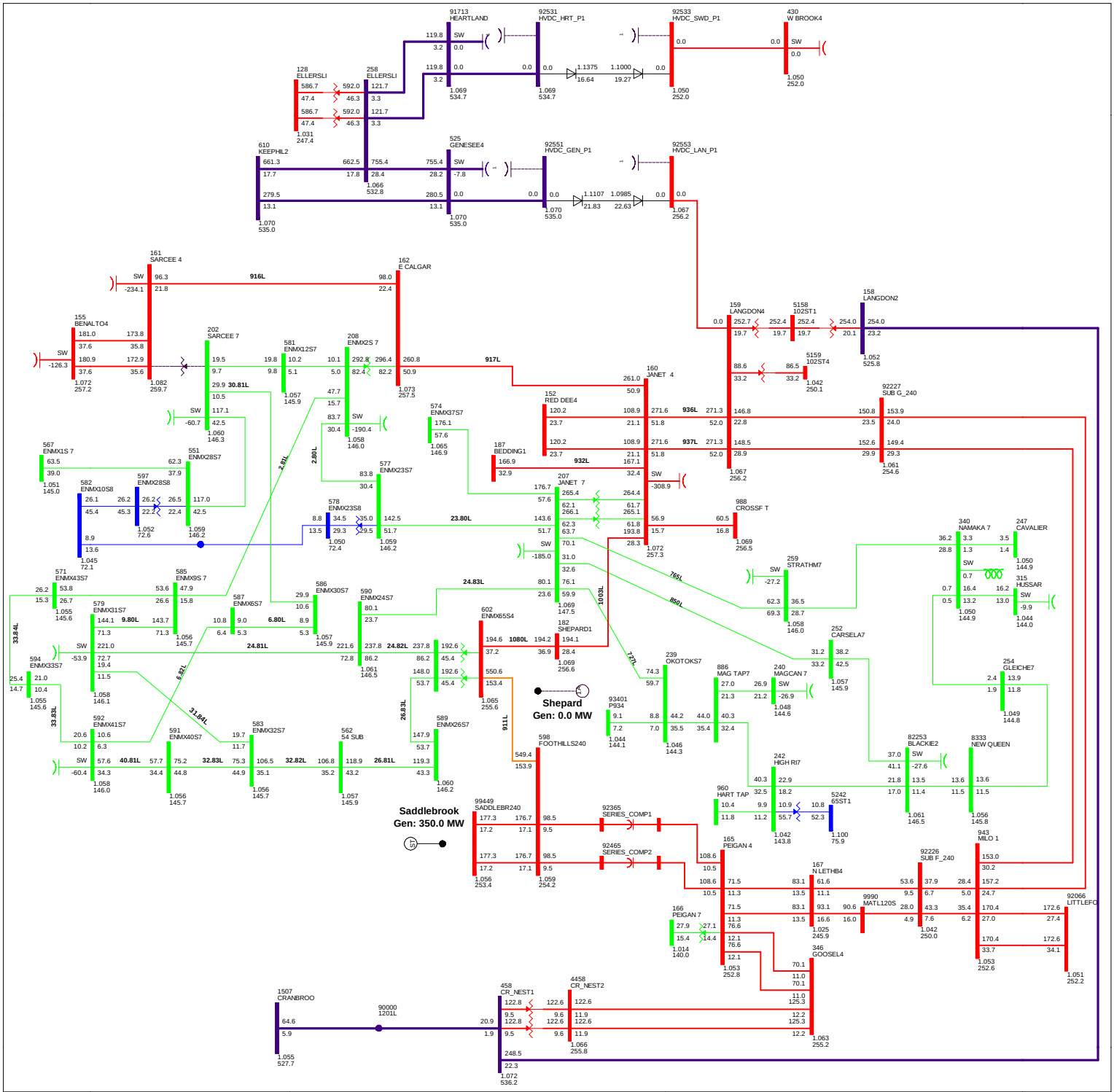
BCH Import: 2.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

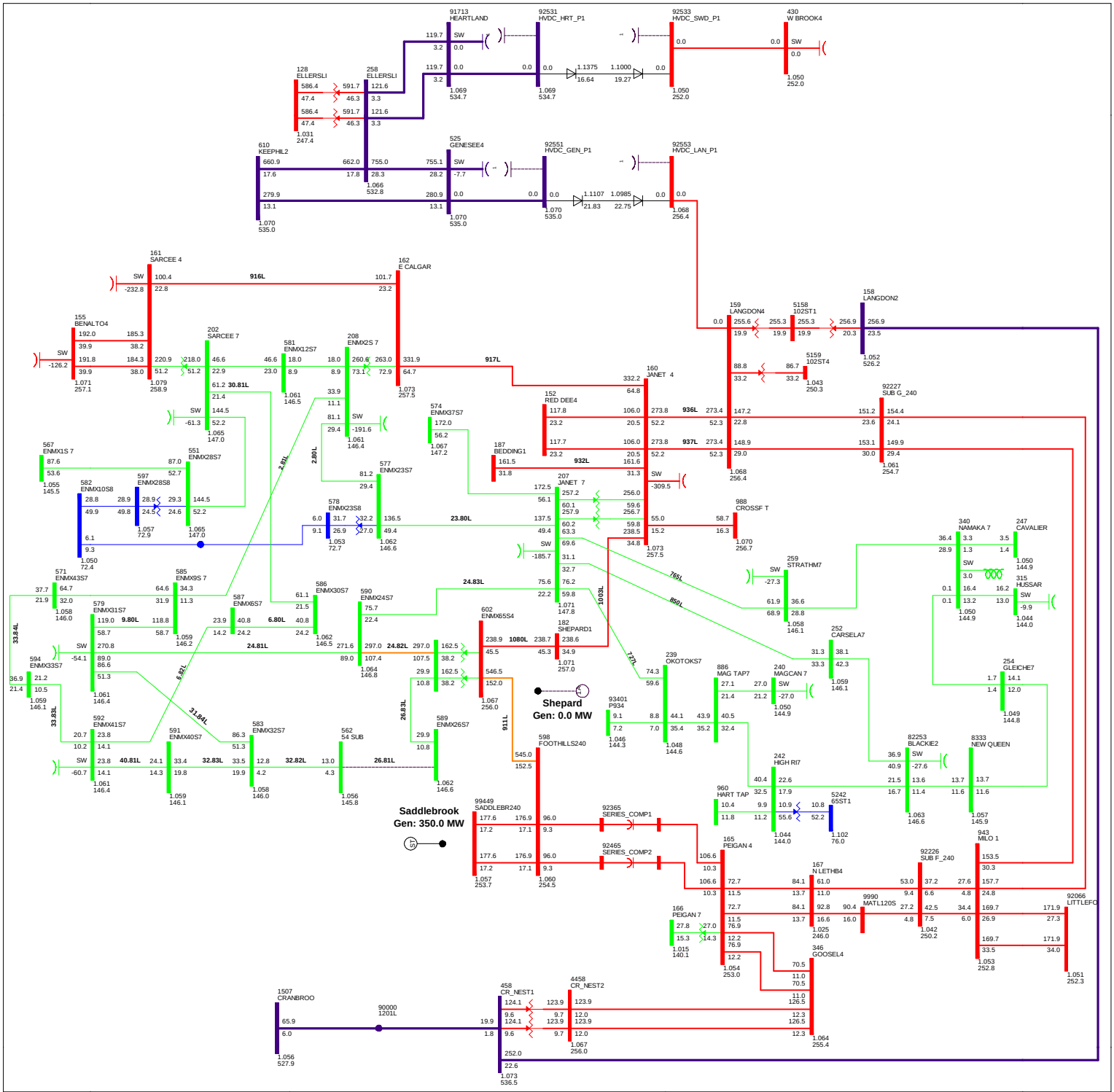
BCH Import: 1.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

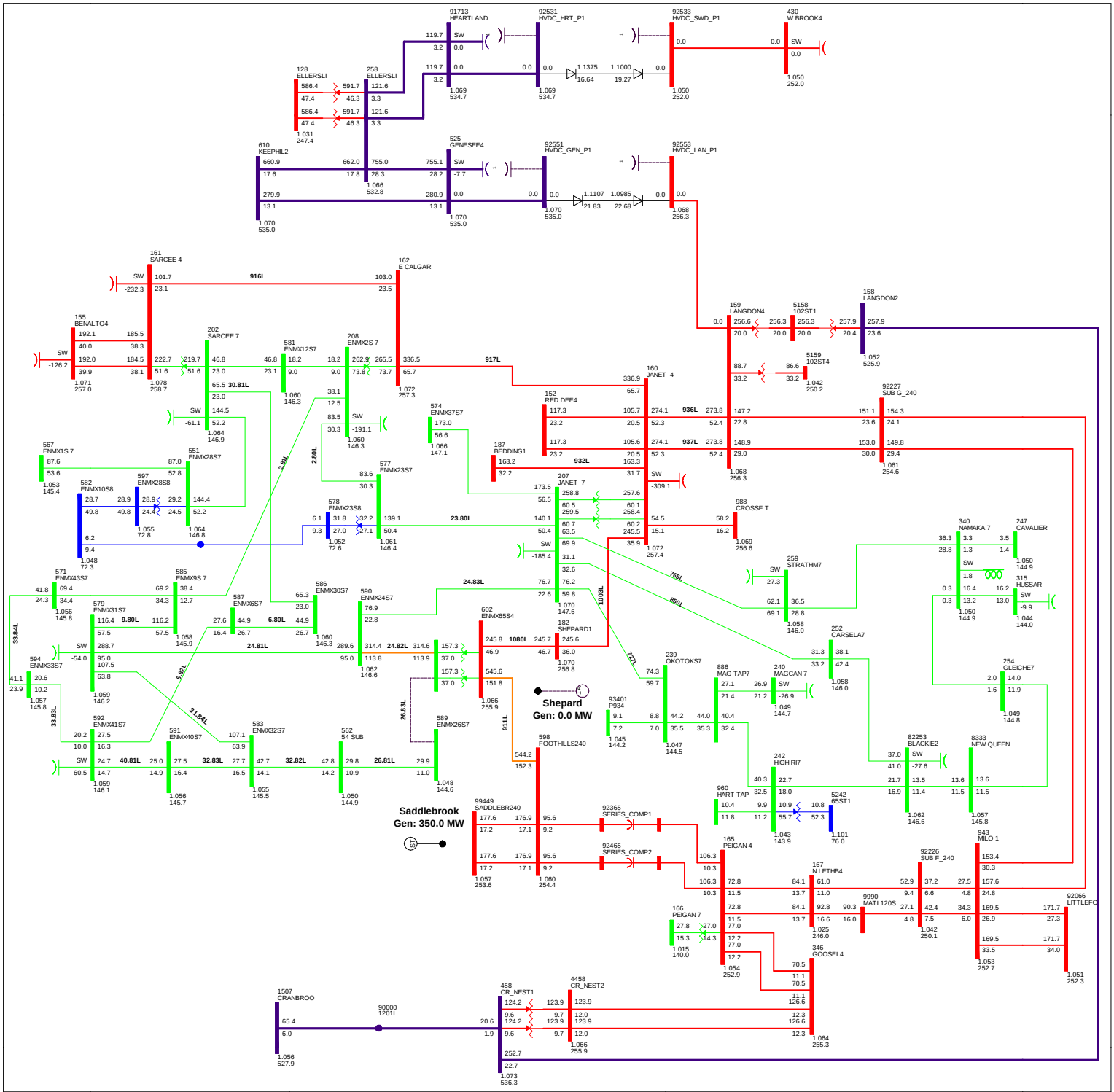
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

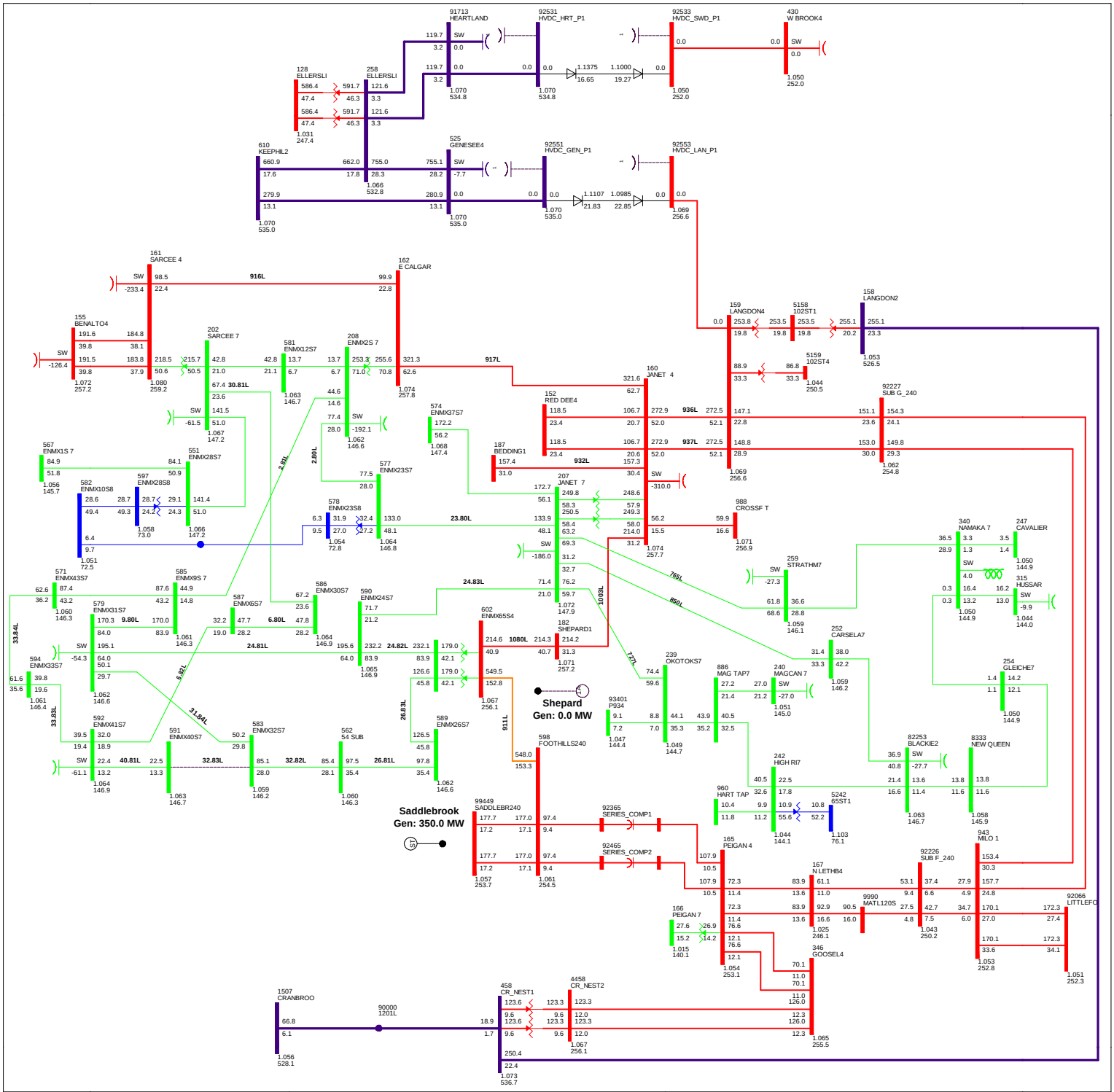
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



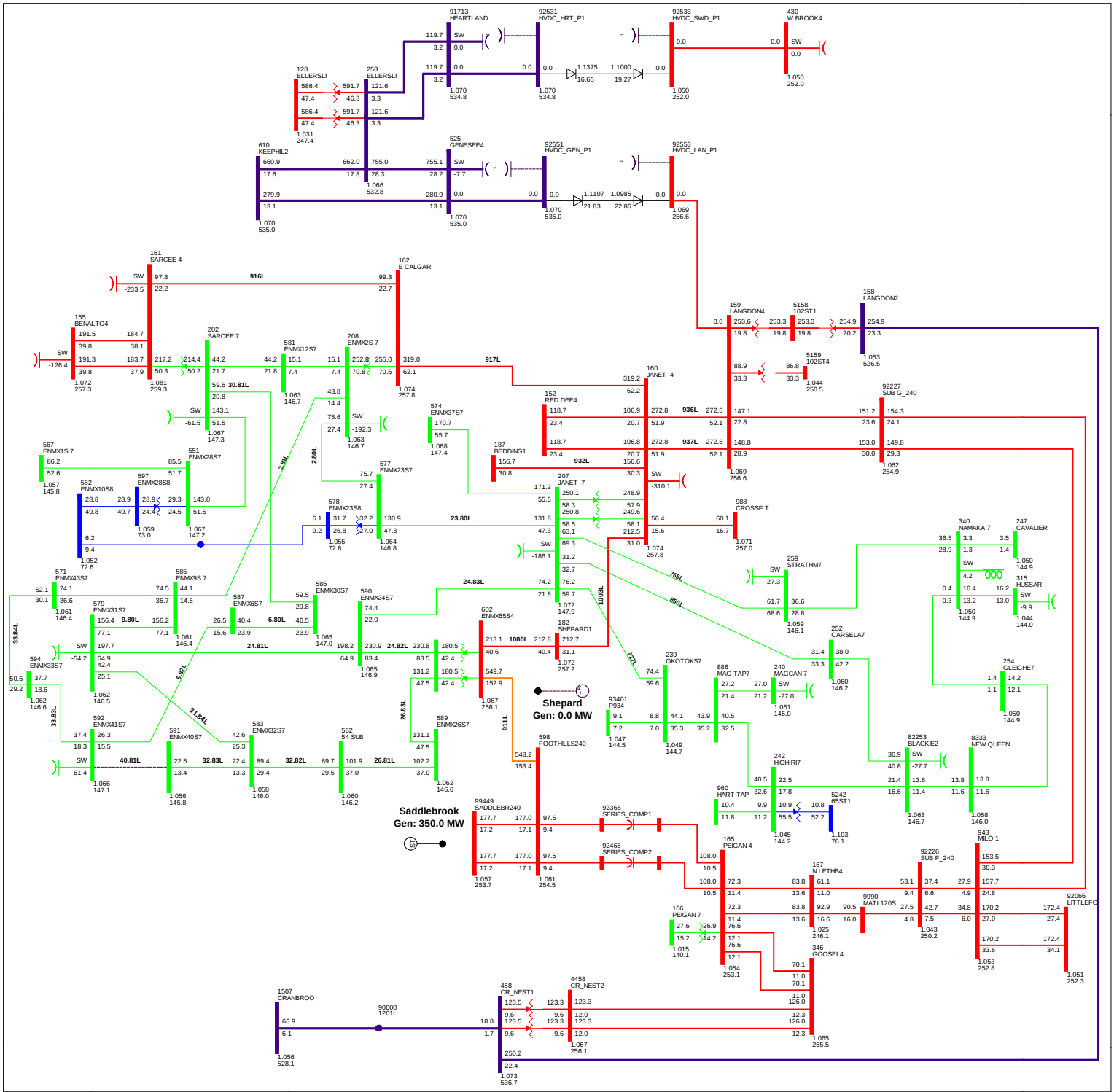
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

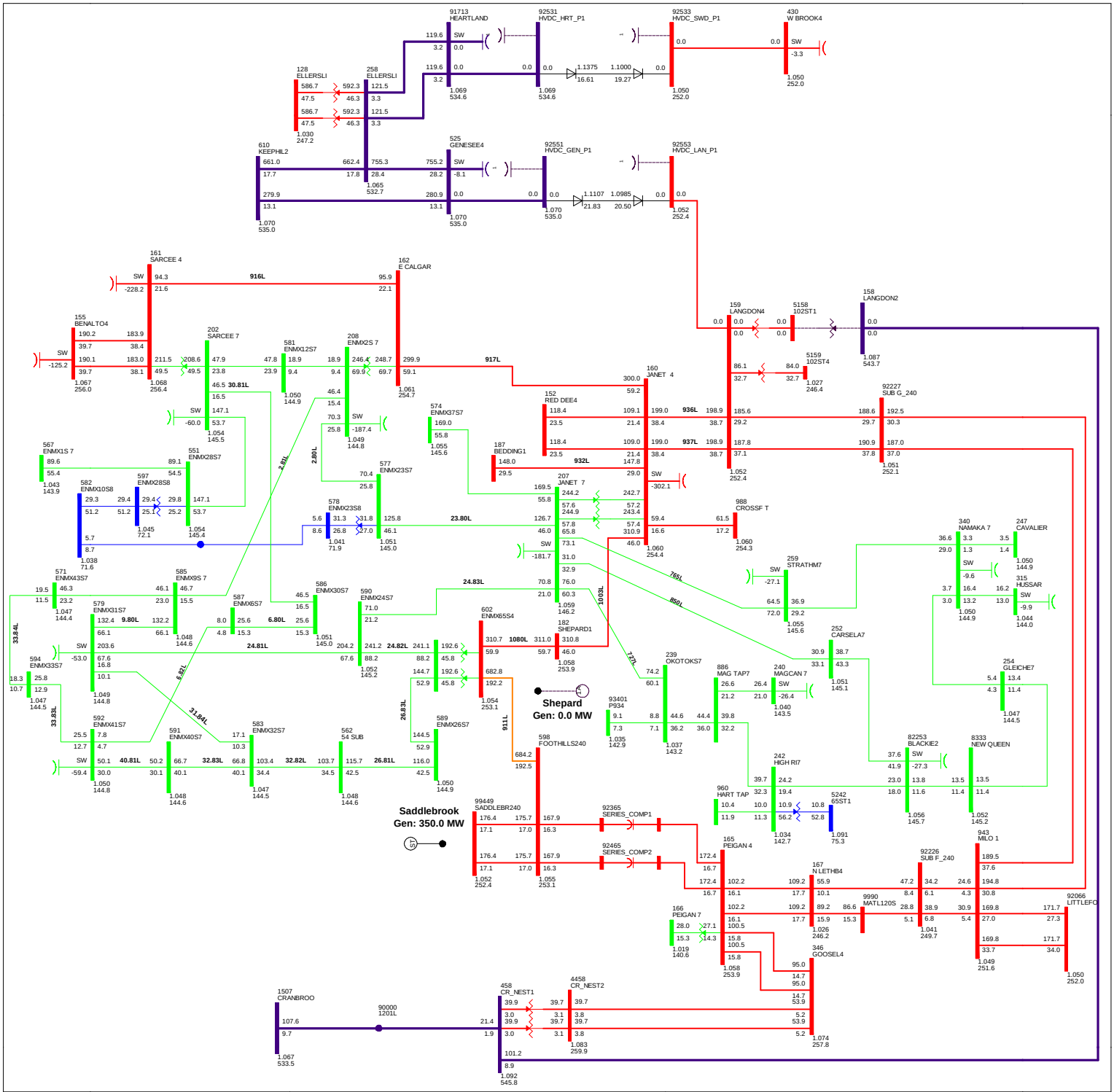
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

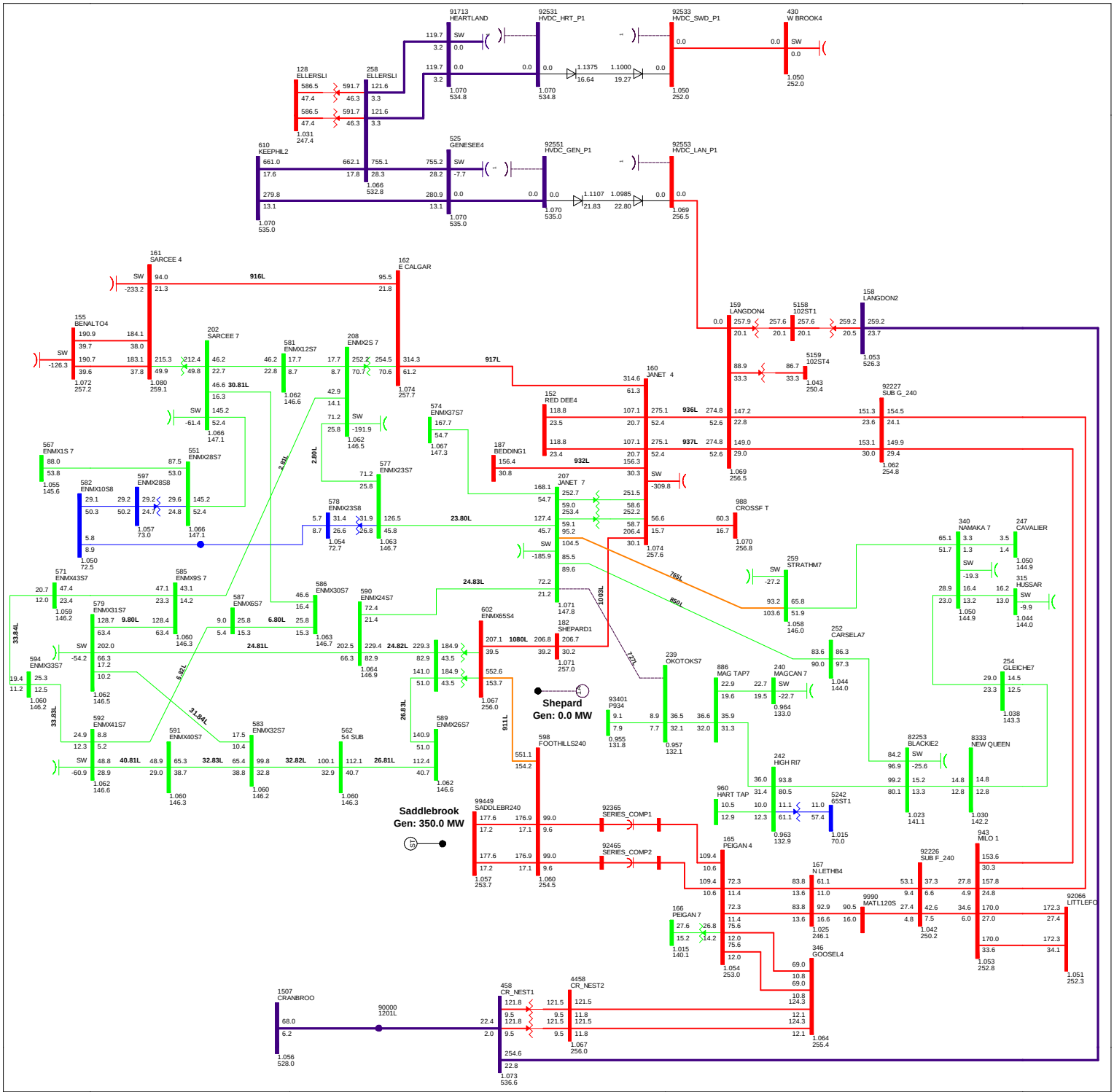
BCH Import: 11.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



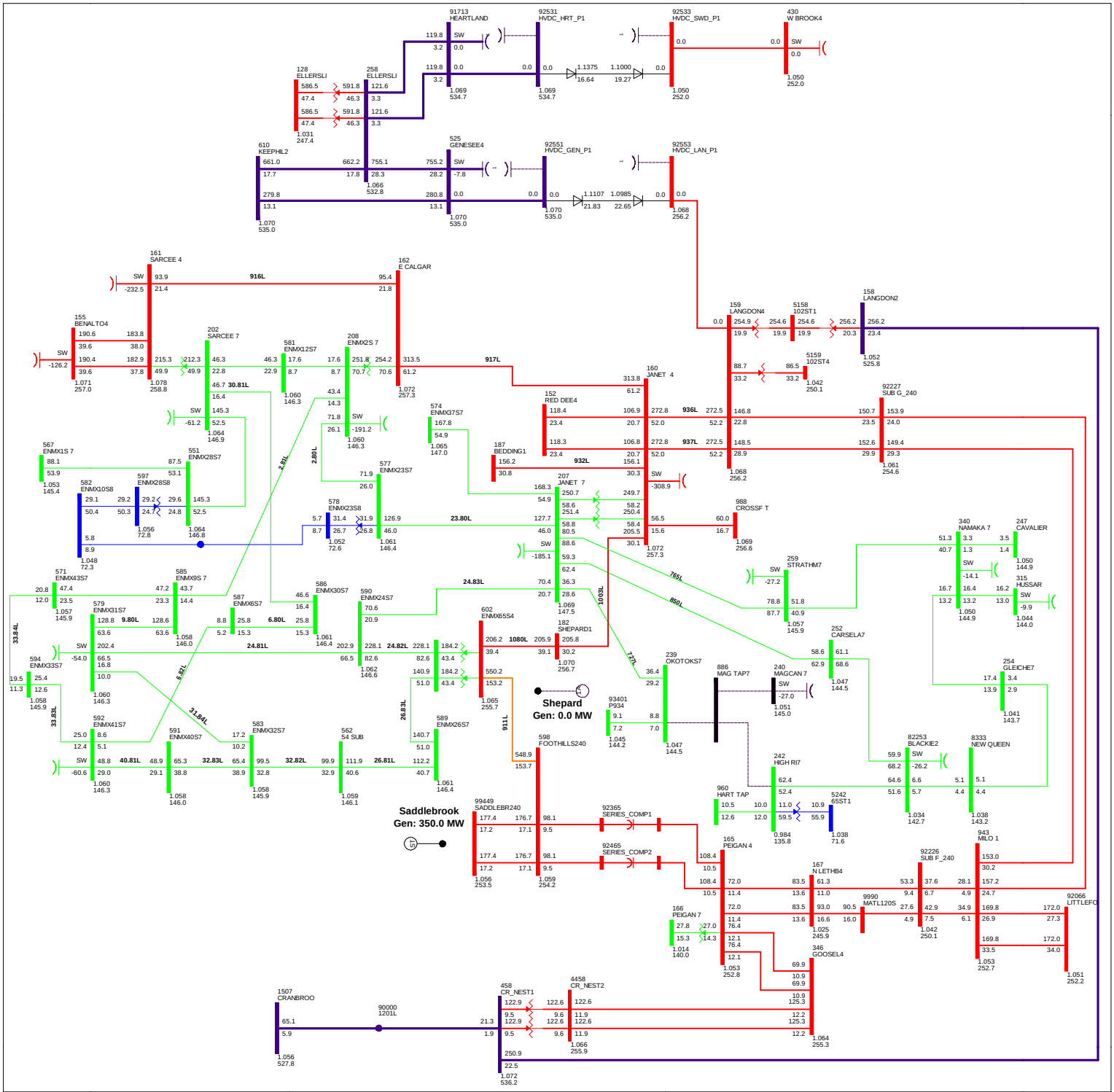
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 8.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



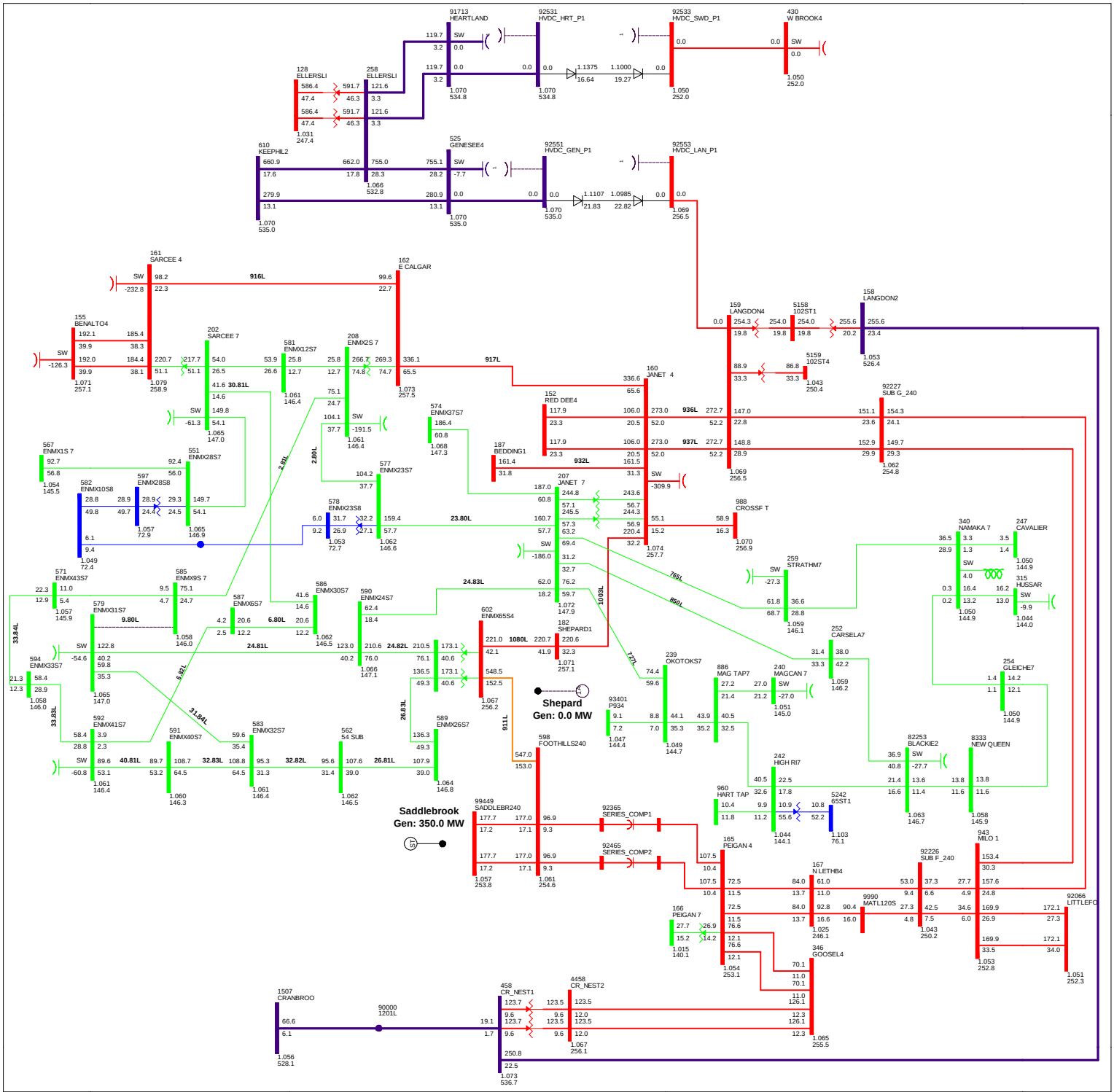
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

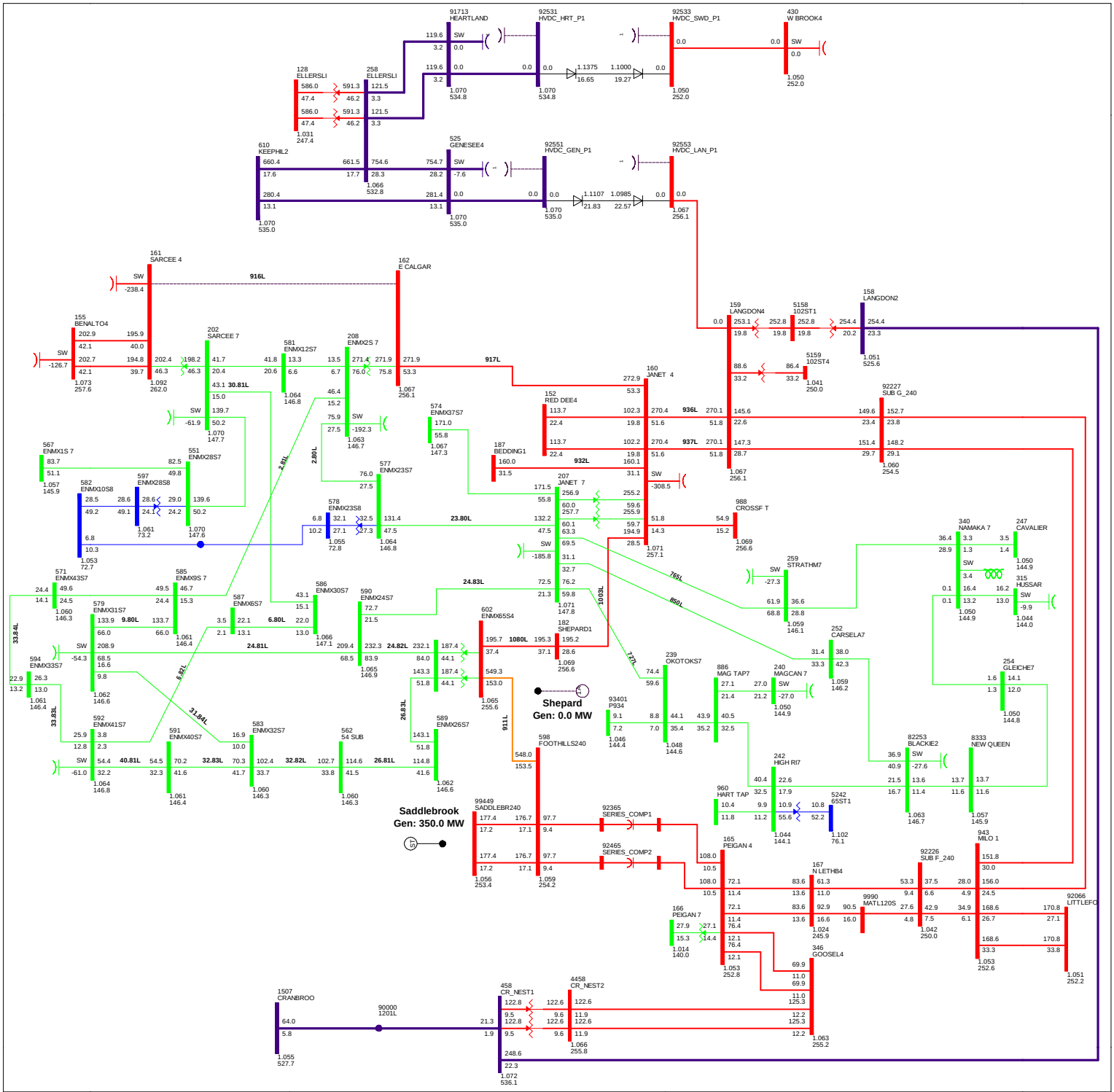
BCH Import: 0.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-22: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

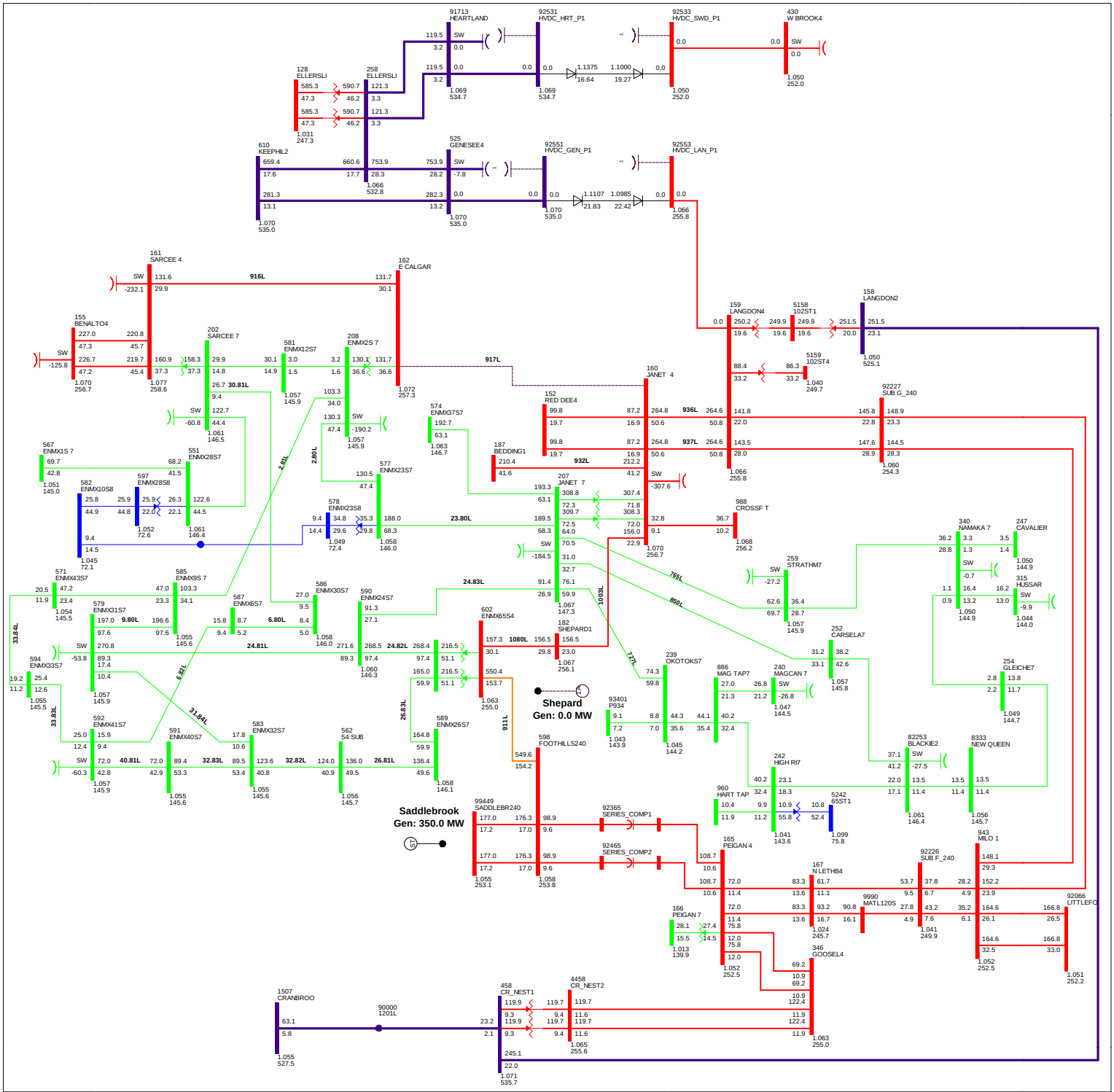
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-23: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



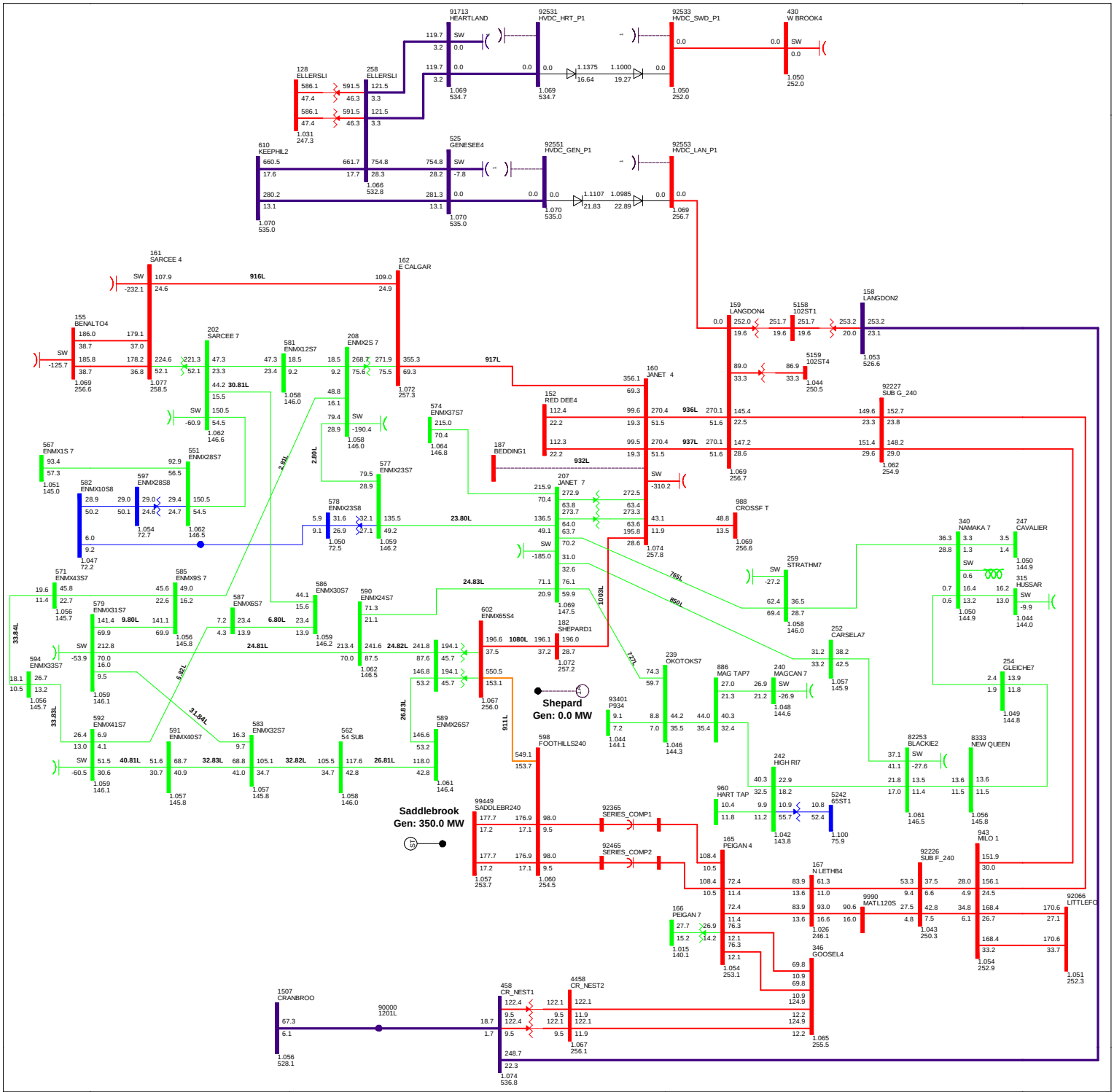
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 5.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-24: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

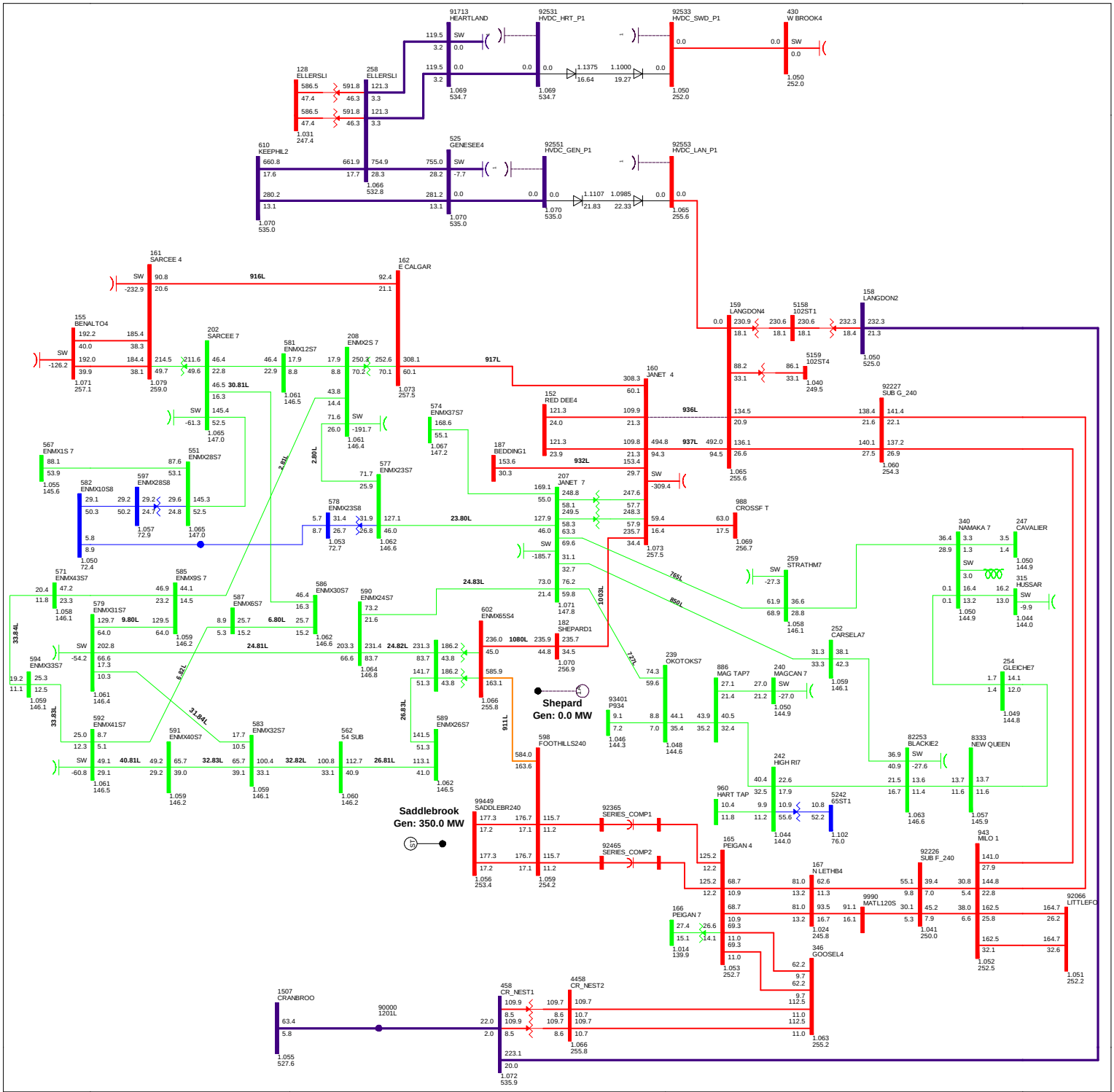
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-25: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

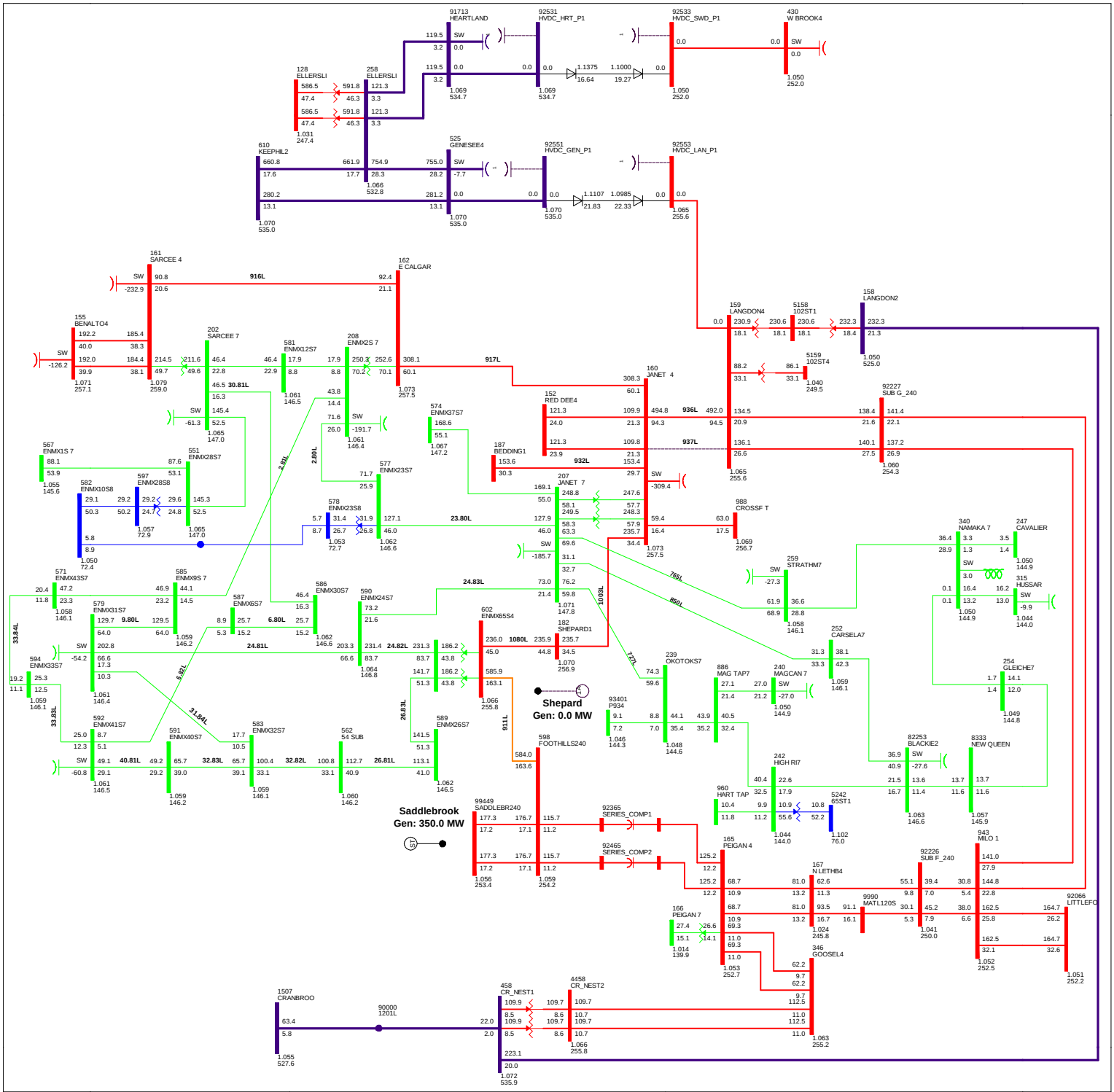
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-26: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

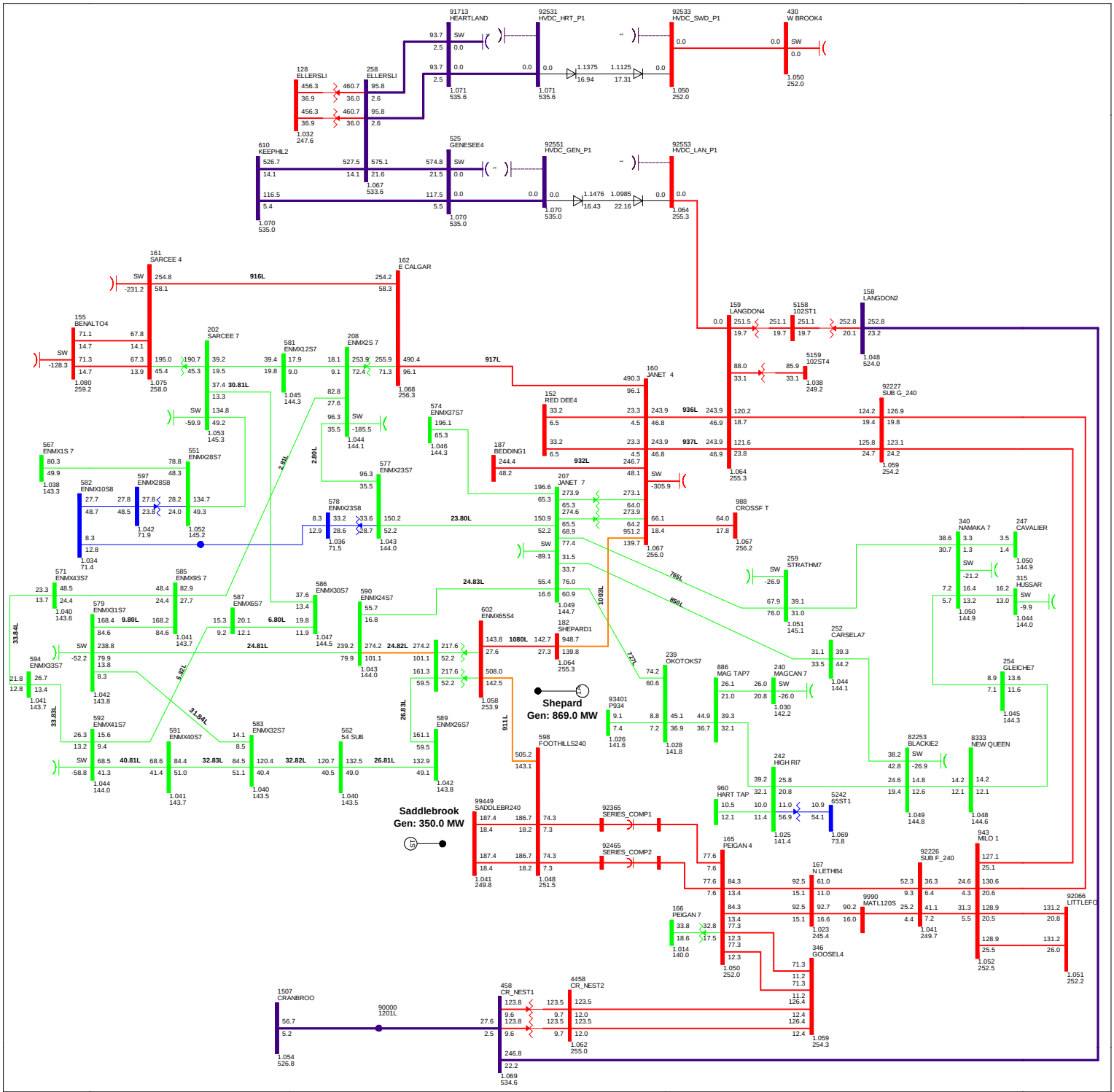
BCH Import: 2.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC3-27: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC3

FRI, JUN 08 2012 15:25

2014 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

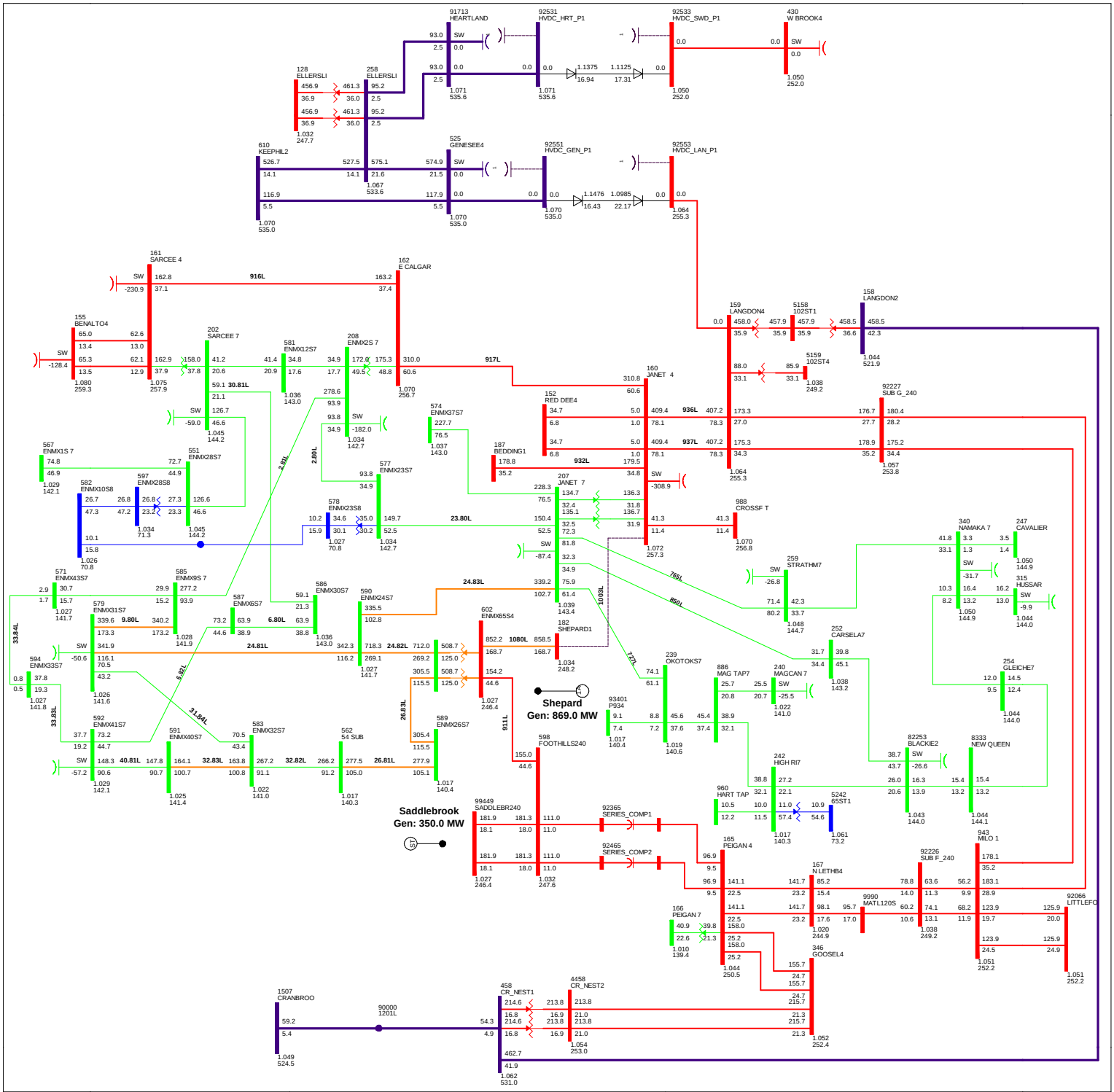
BCH Import: -0.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-1: BASECASE

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

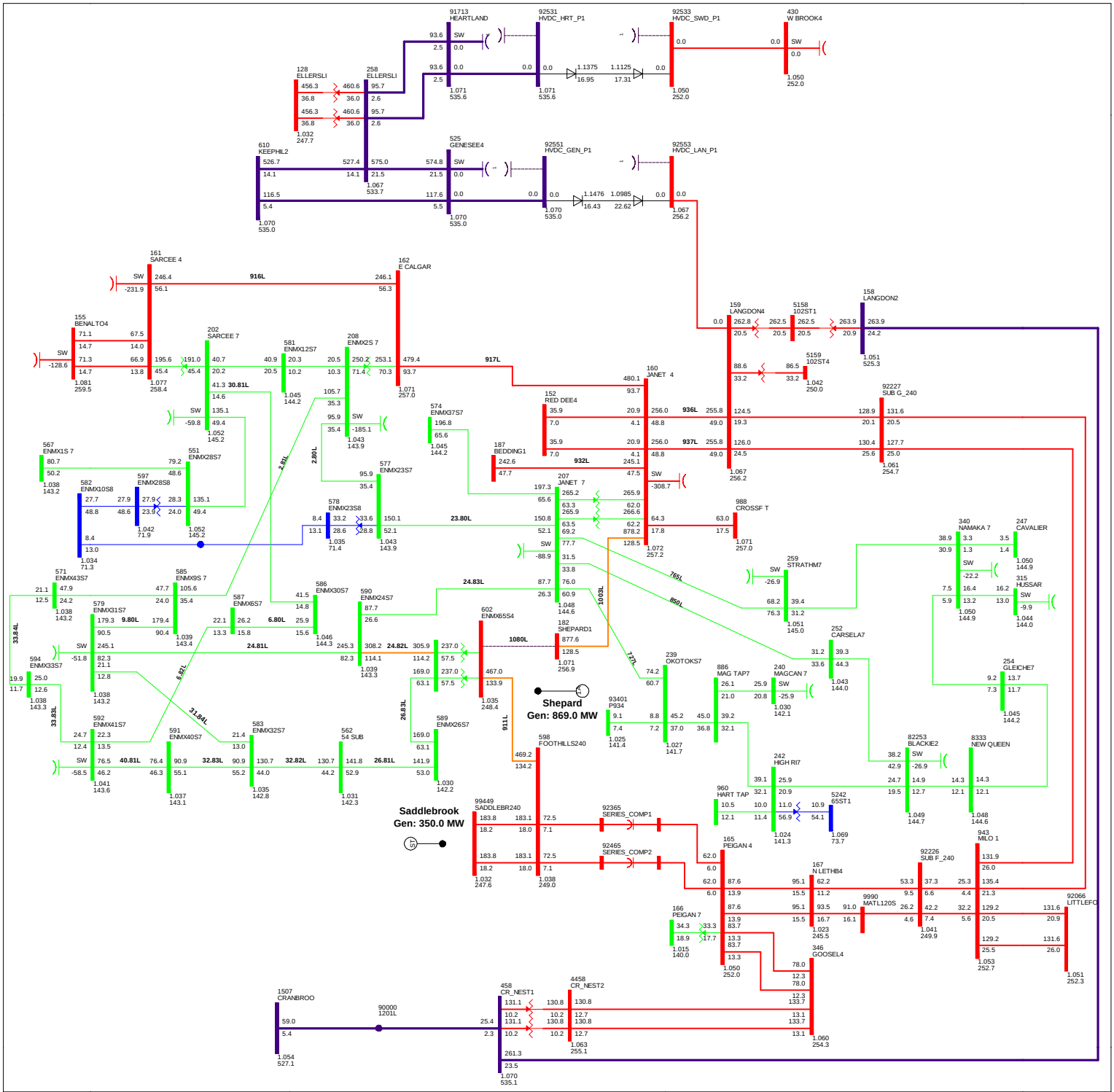
BCH Import: 35.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

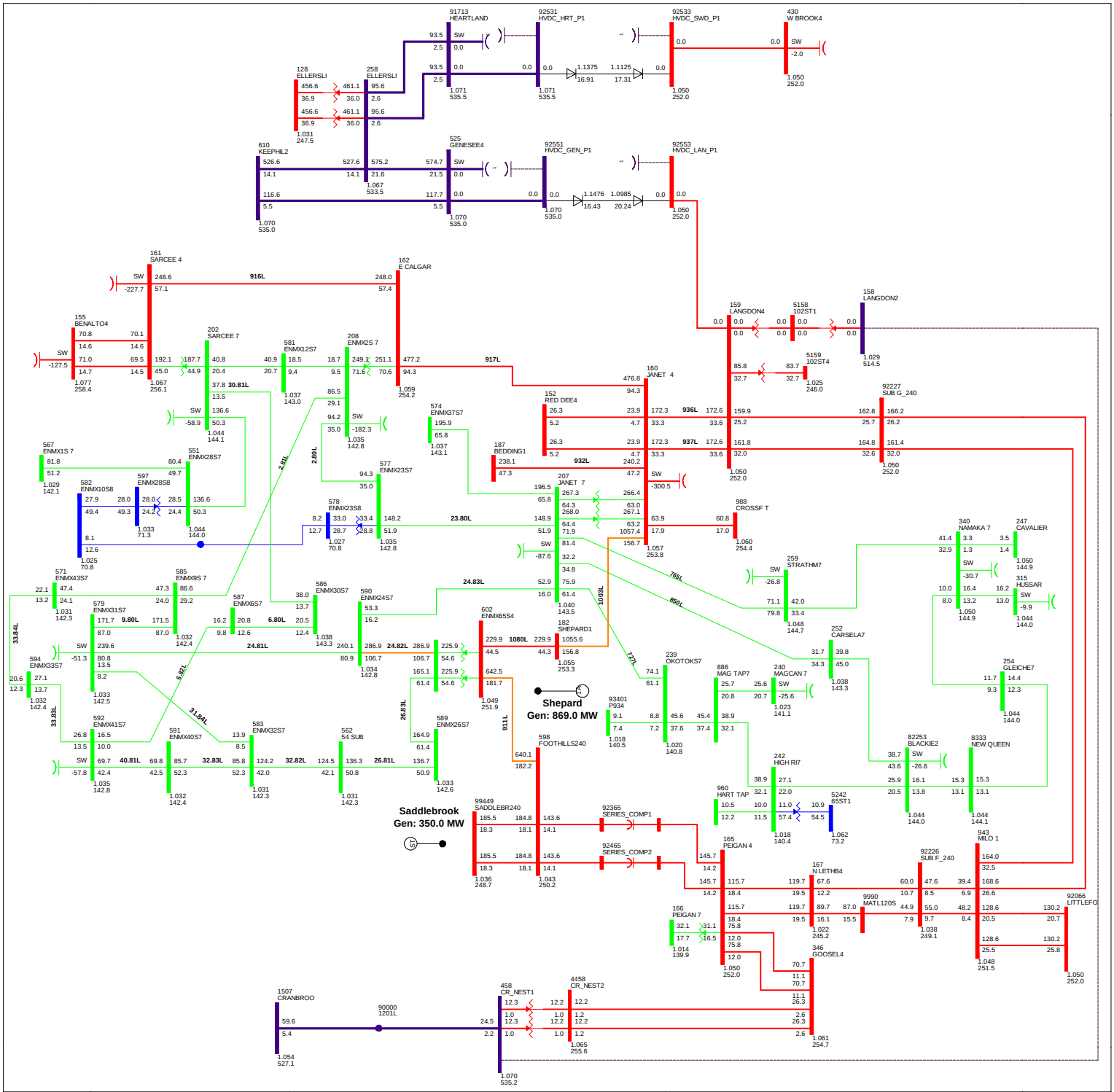
BCH Import: -0.3 MW

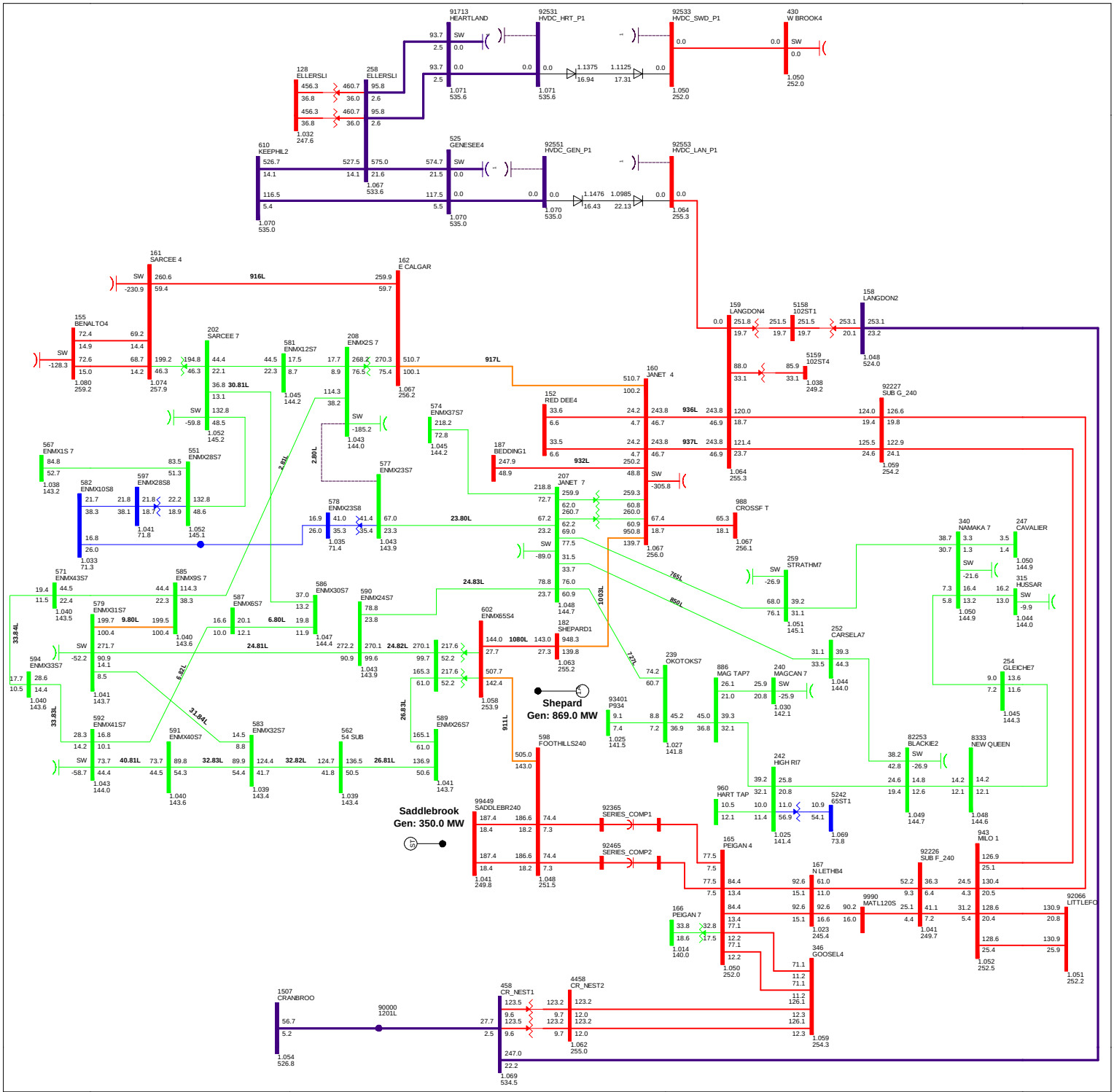
2012LTO EXISTING SYSTEM

FIG A-SC4-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:25


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
2012LTO EXISTING SYSTEM
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
BCH Import: 11.5 MW
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
FIG A-SC4-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_SP_EXISTING_SC4
FRI, JUN 08 2012 15:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

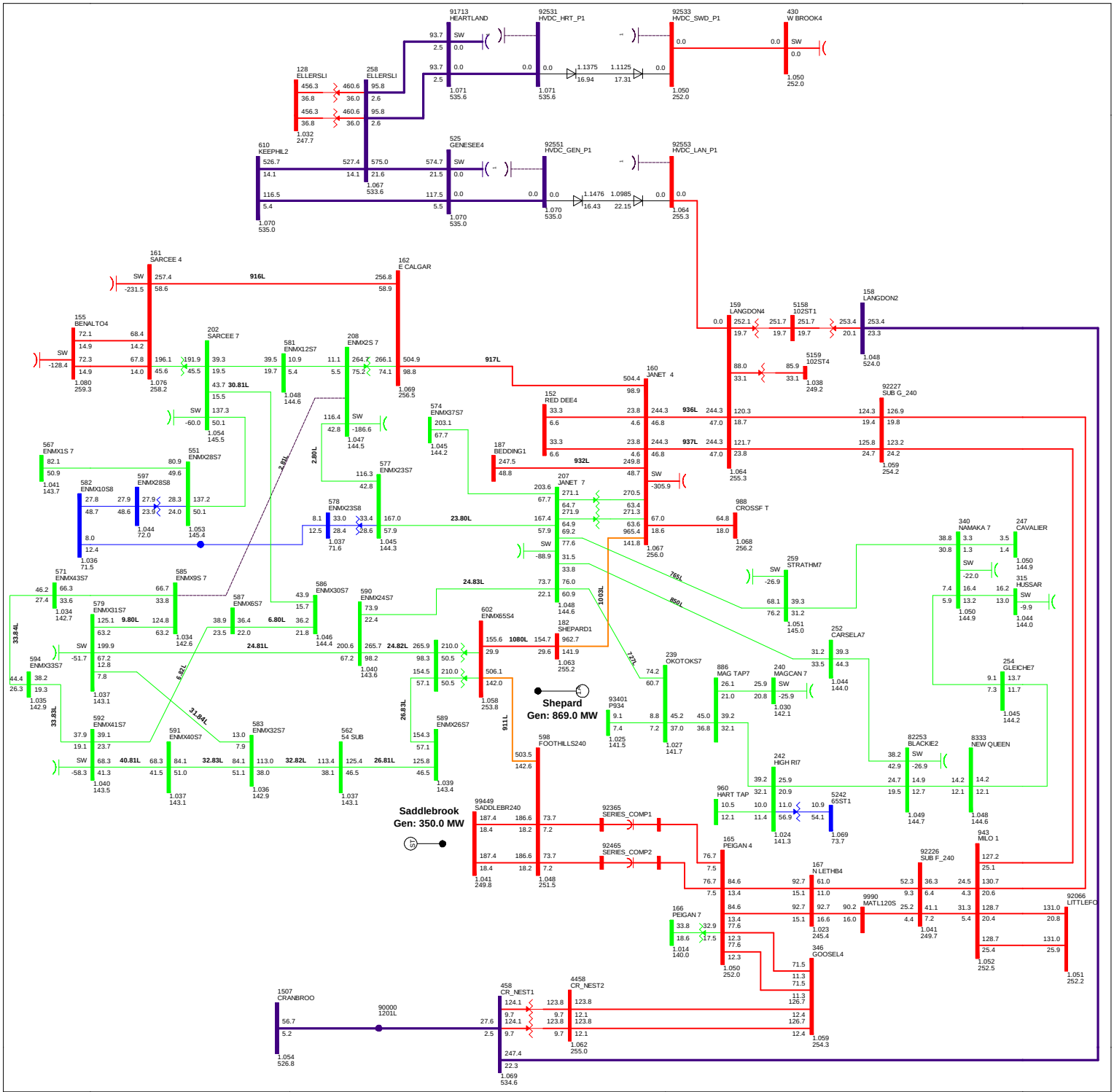
BCH Import: 0.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

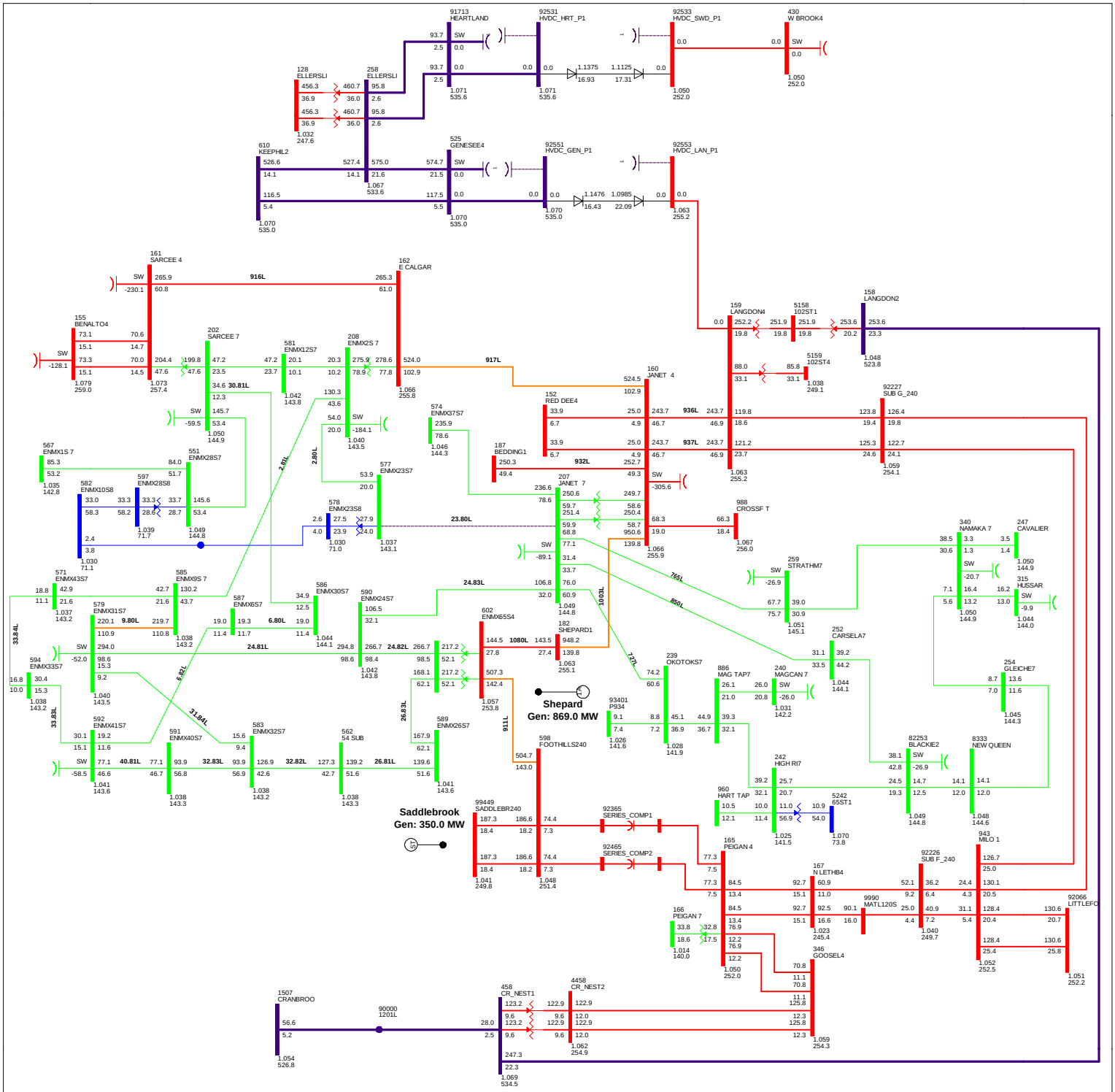
BCH Import: -0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

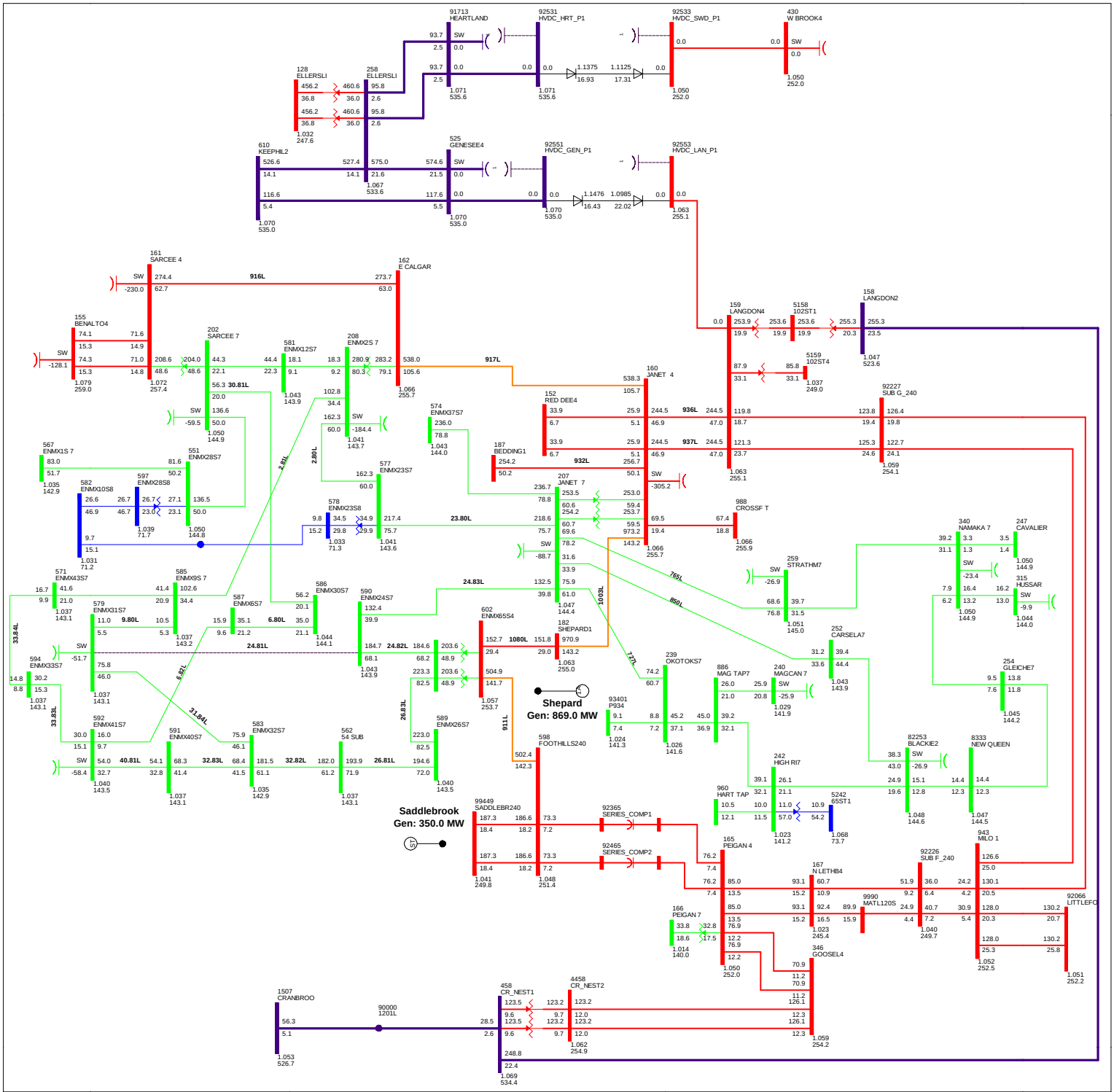
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

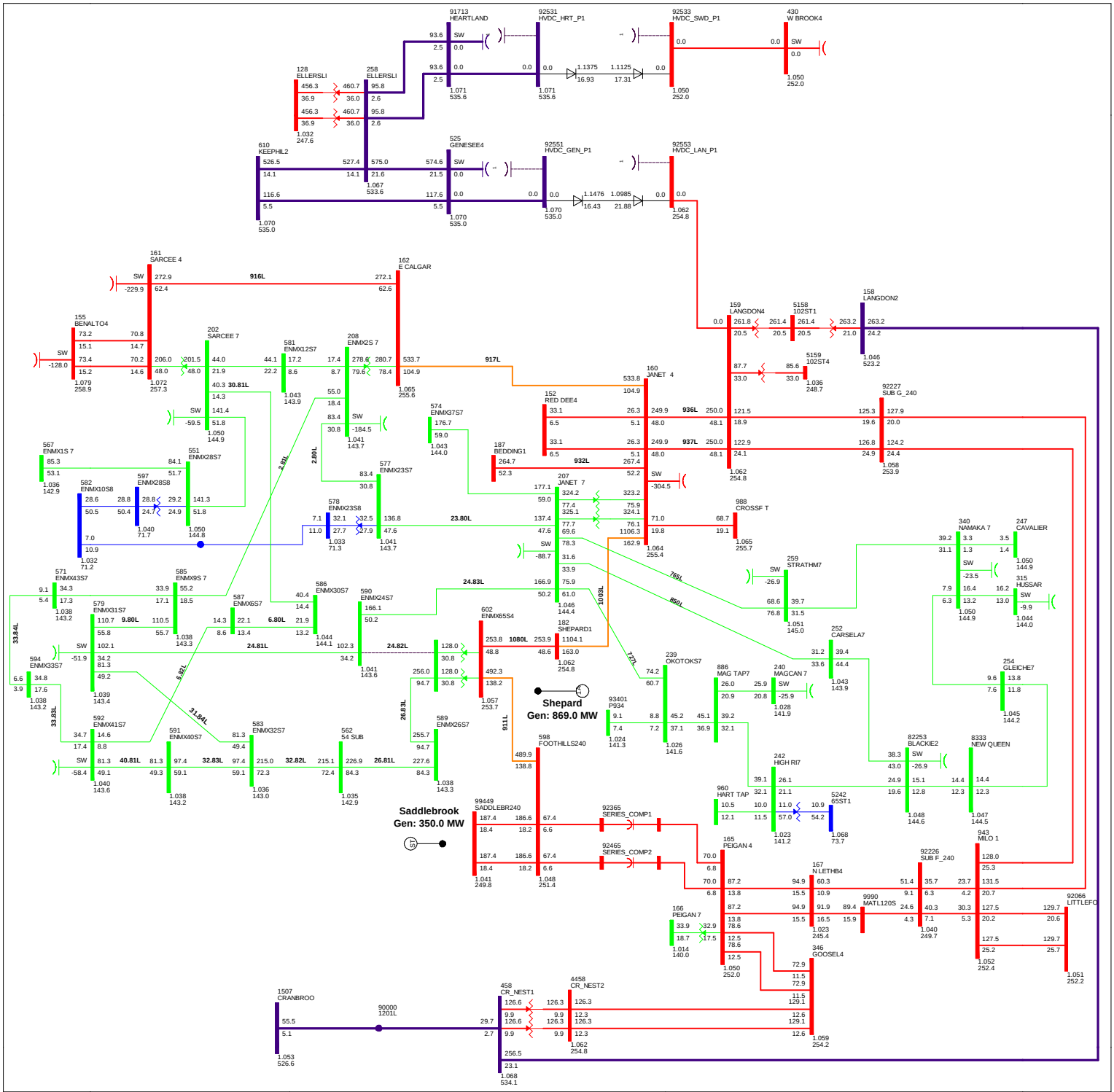
BCH Import: 3.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

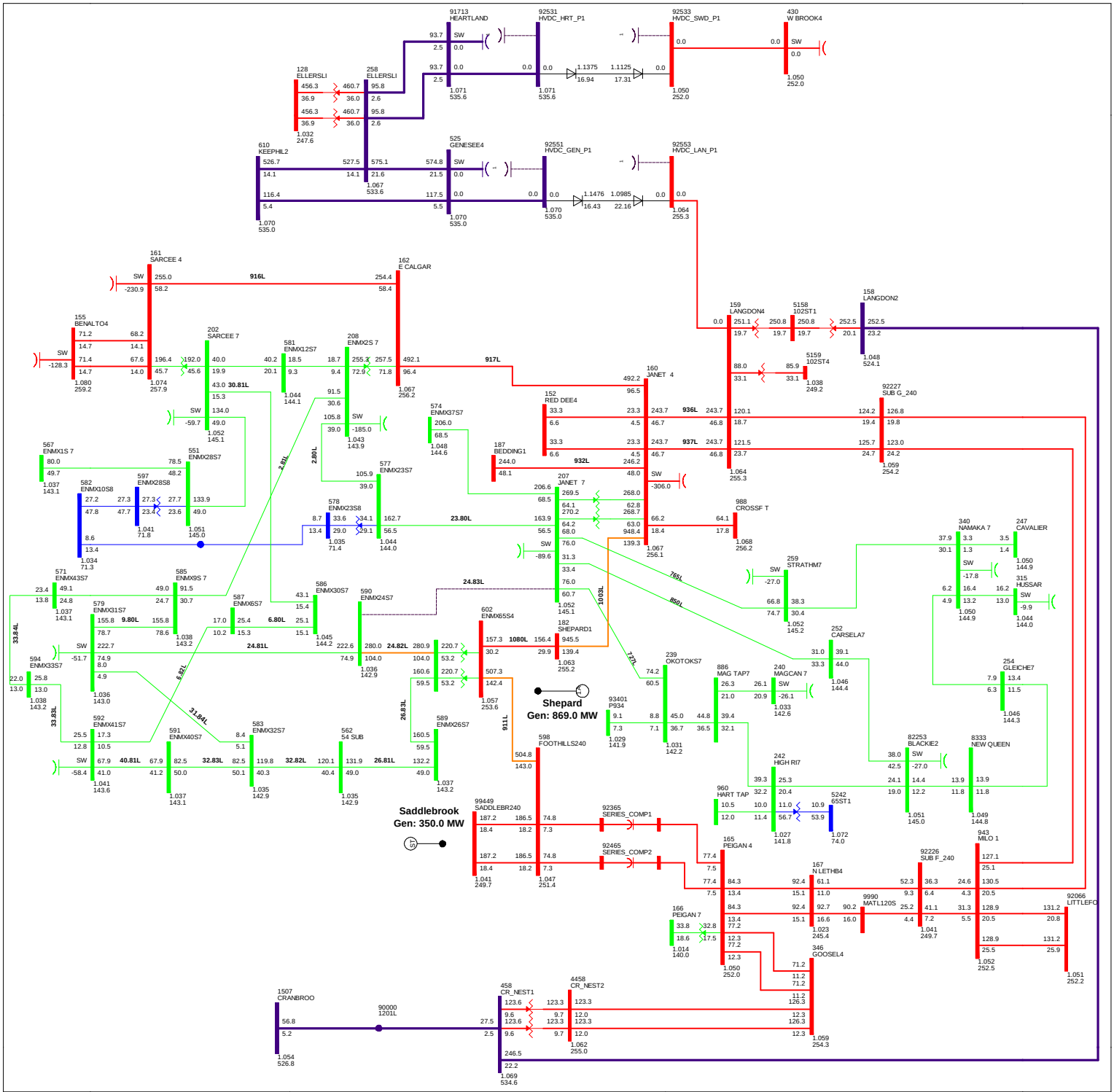
BCH Import: 4.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

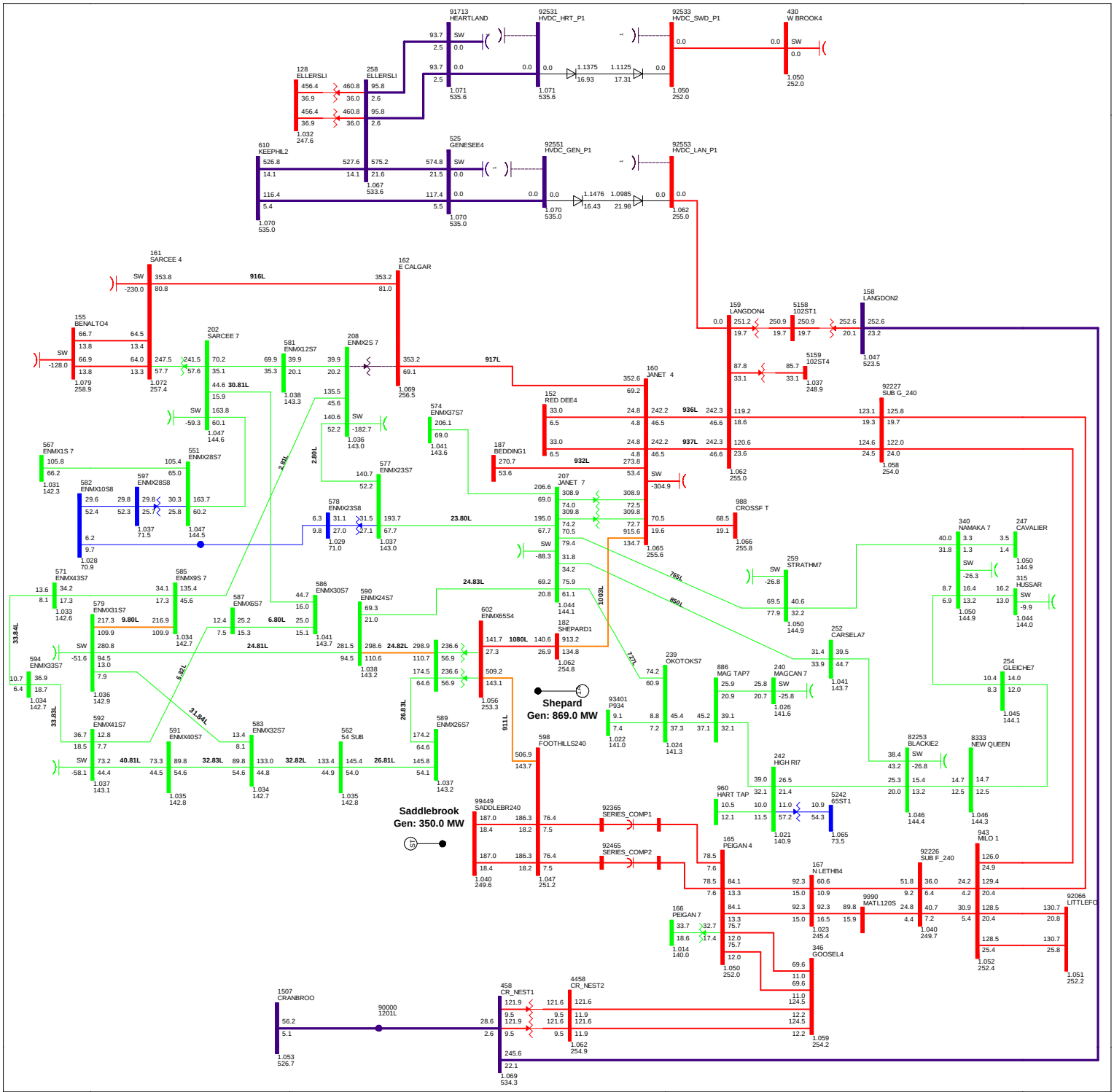
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

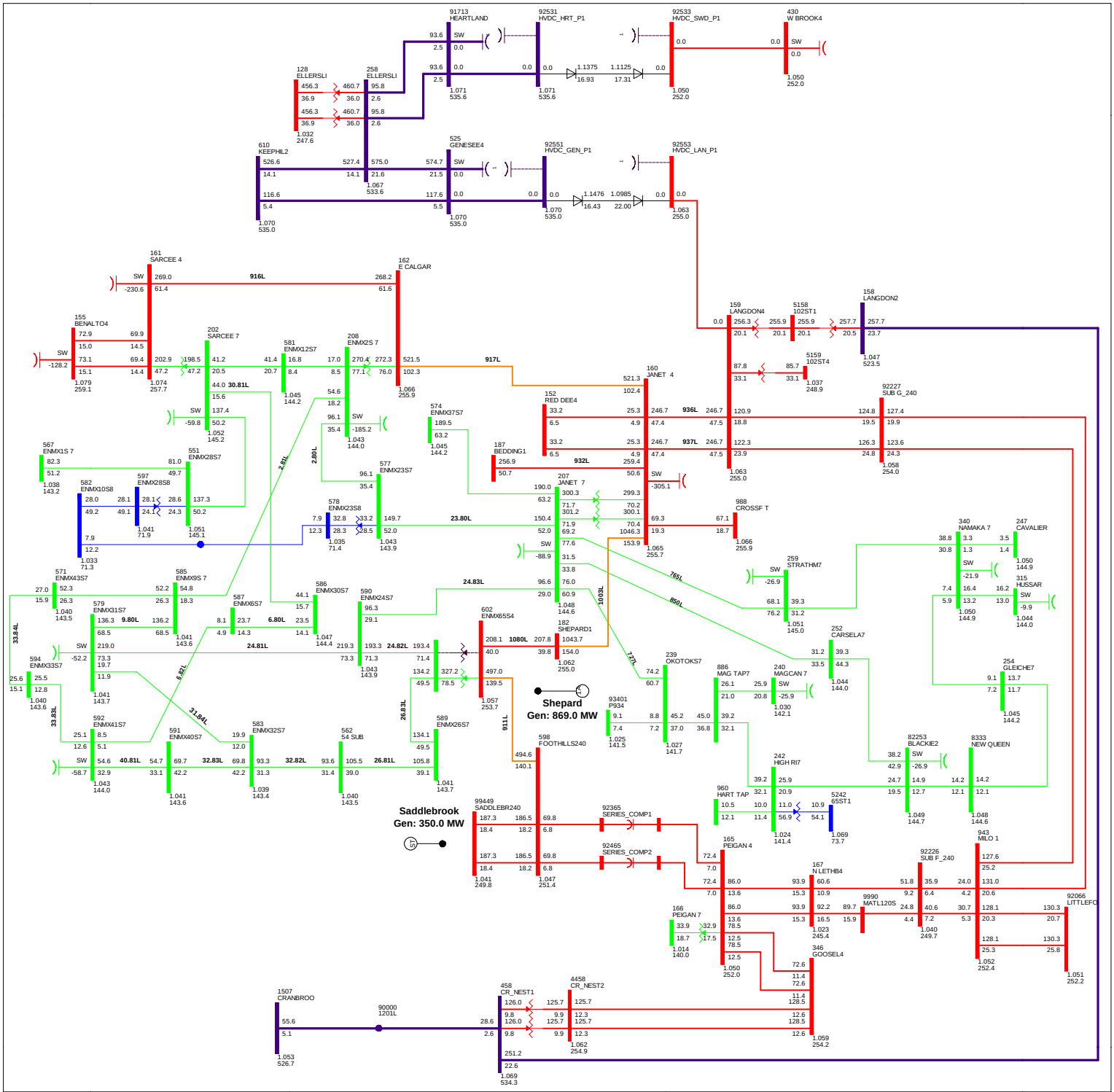
BCH Import: 3.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 0.0 MW

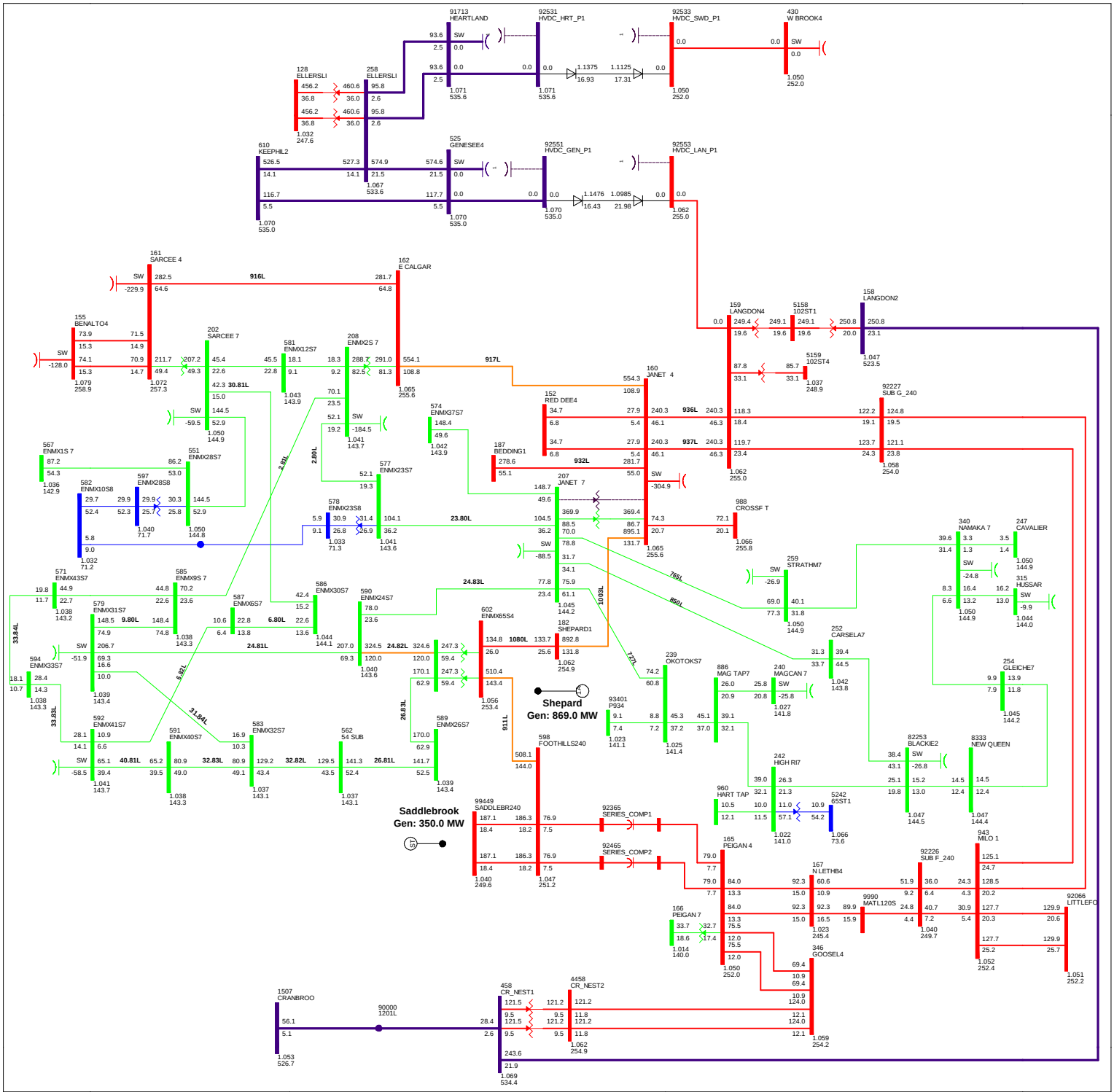
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO EXISTING SYSTEM

FIG A-SC4-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

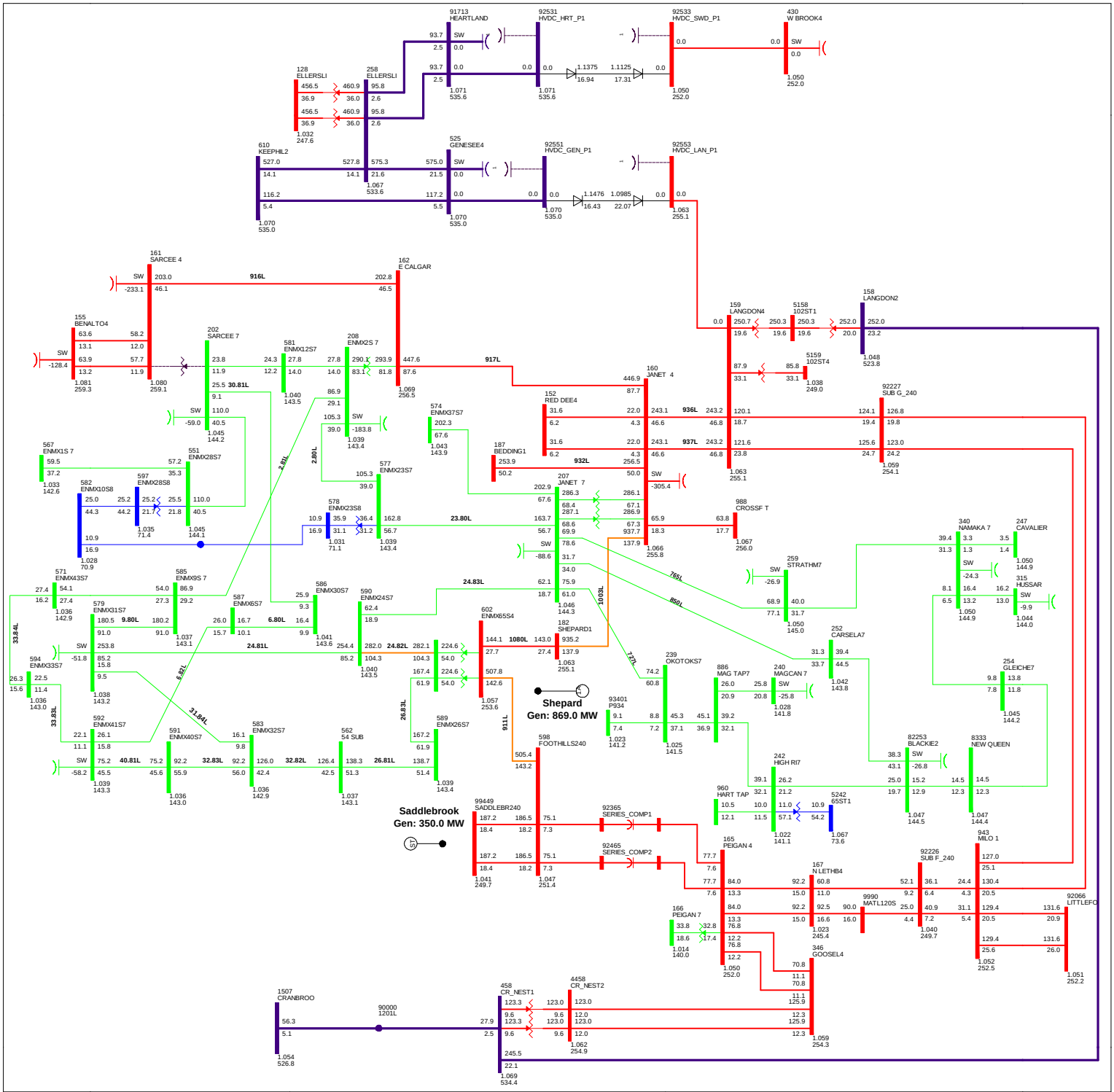
BCH Import: 2.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

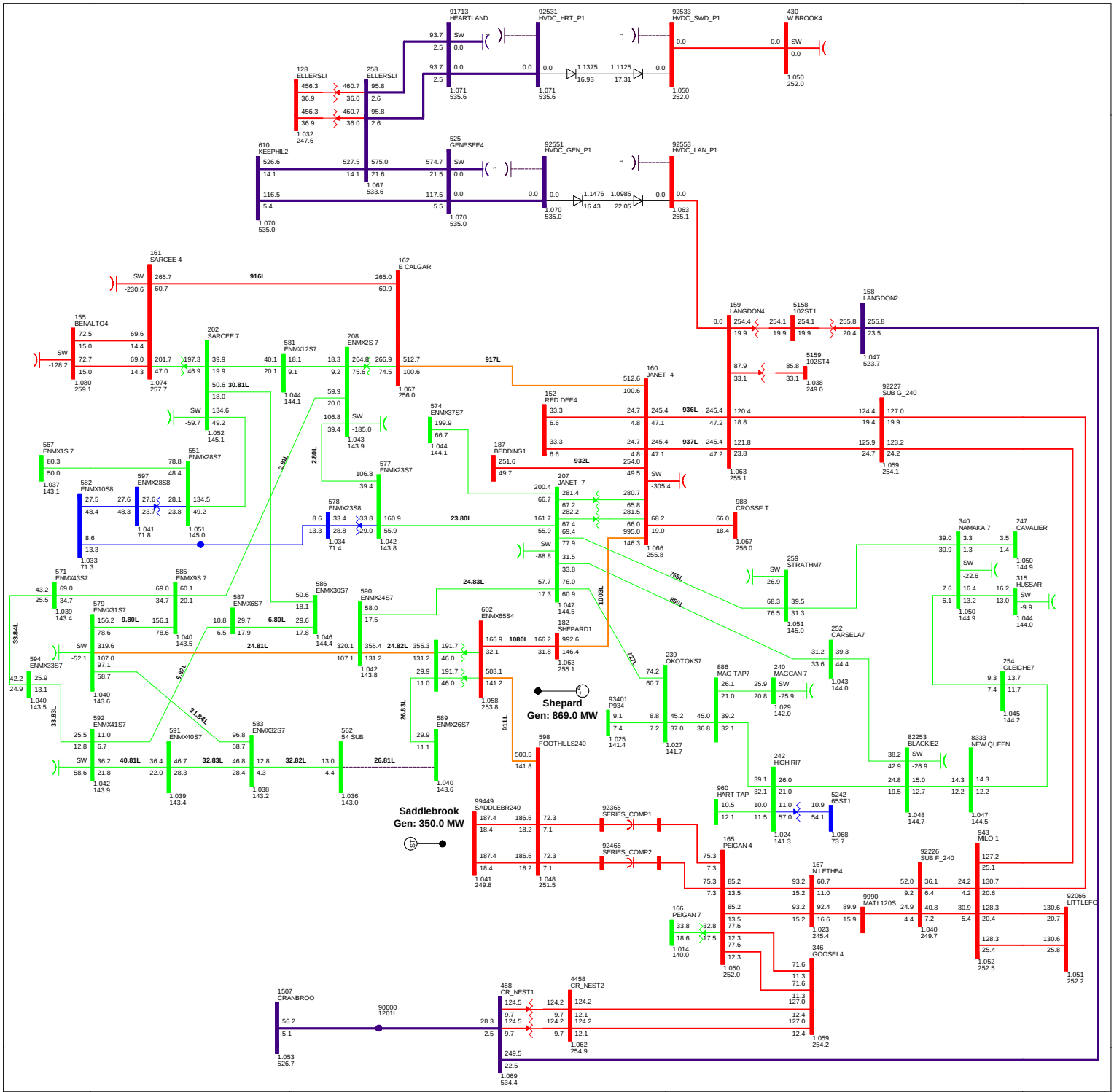
BCH Import: 0.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



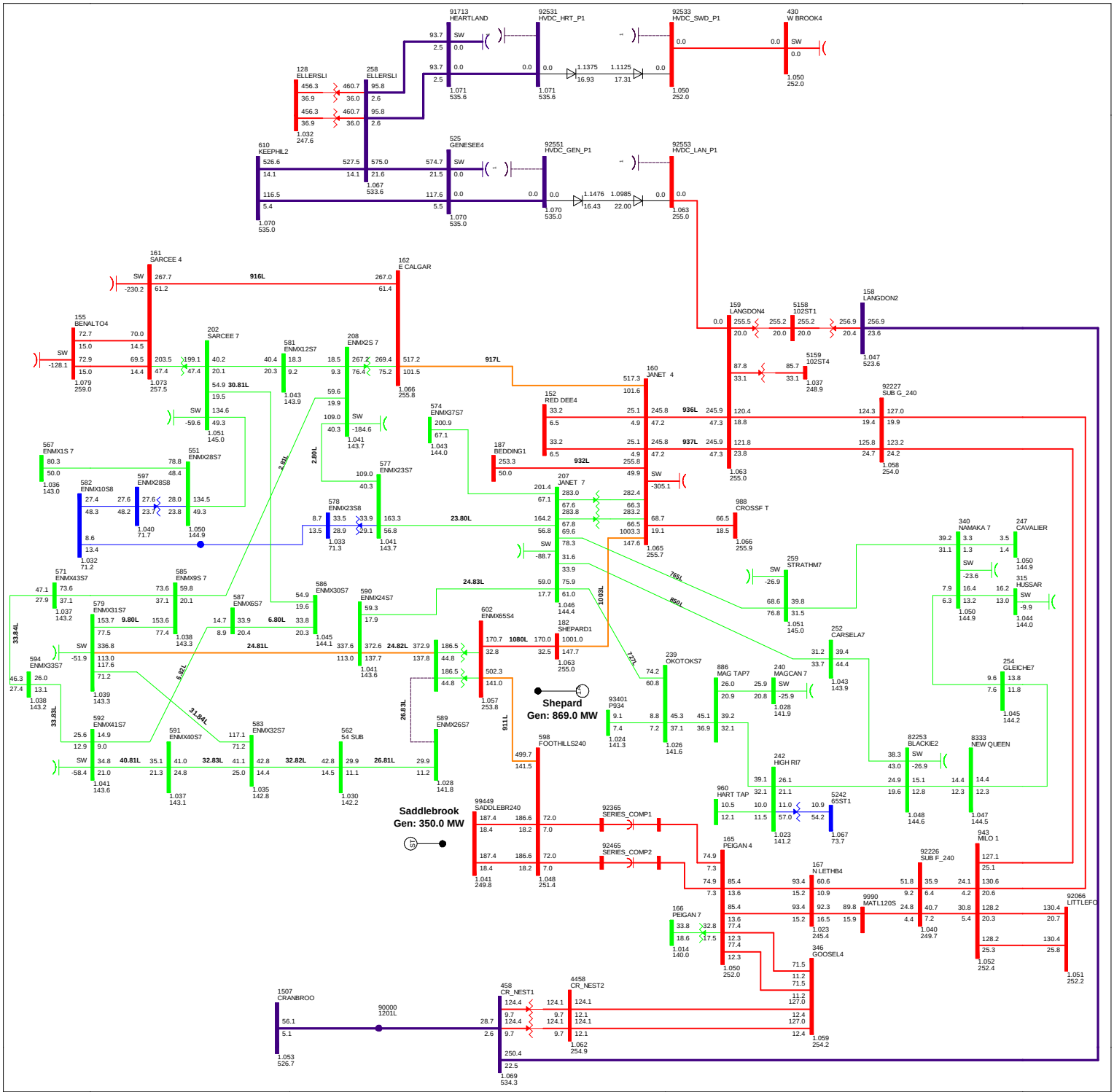
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



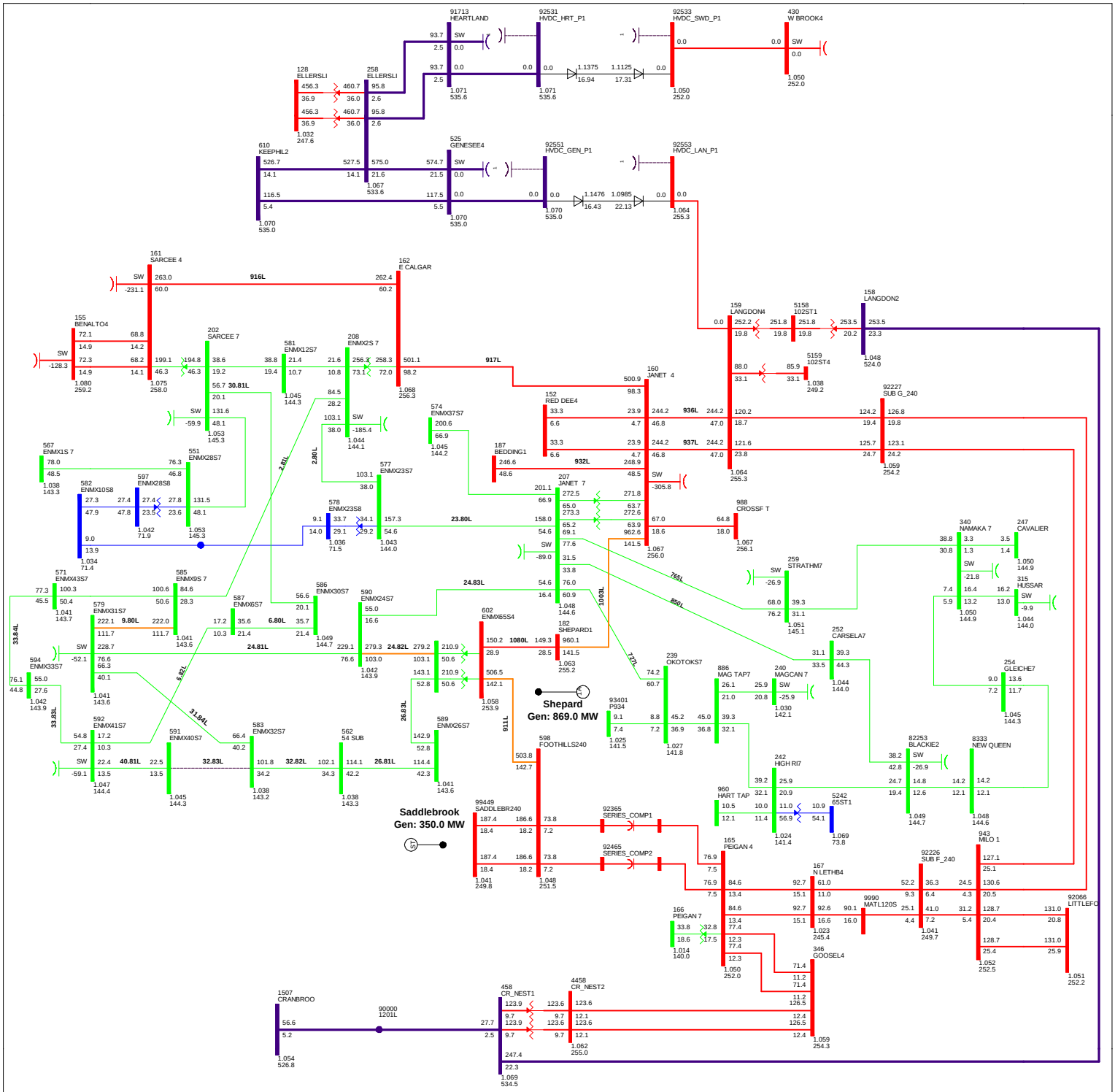
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

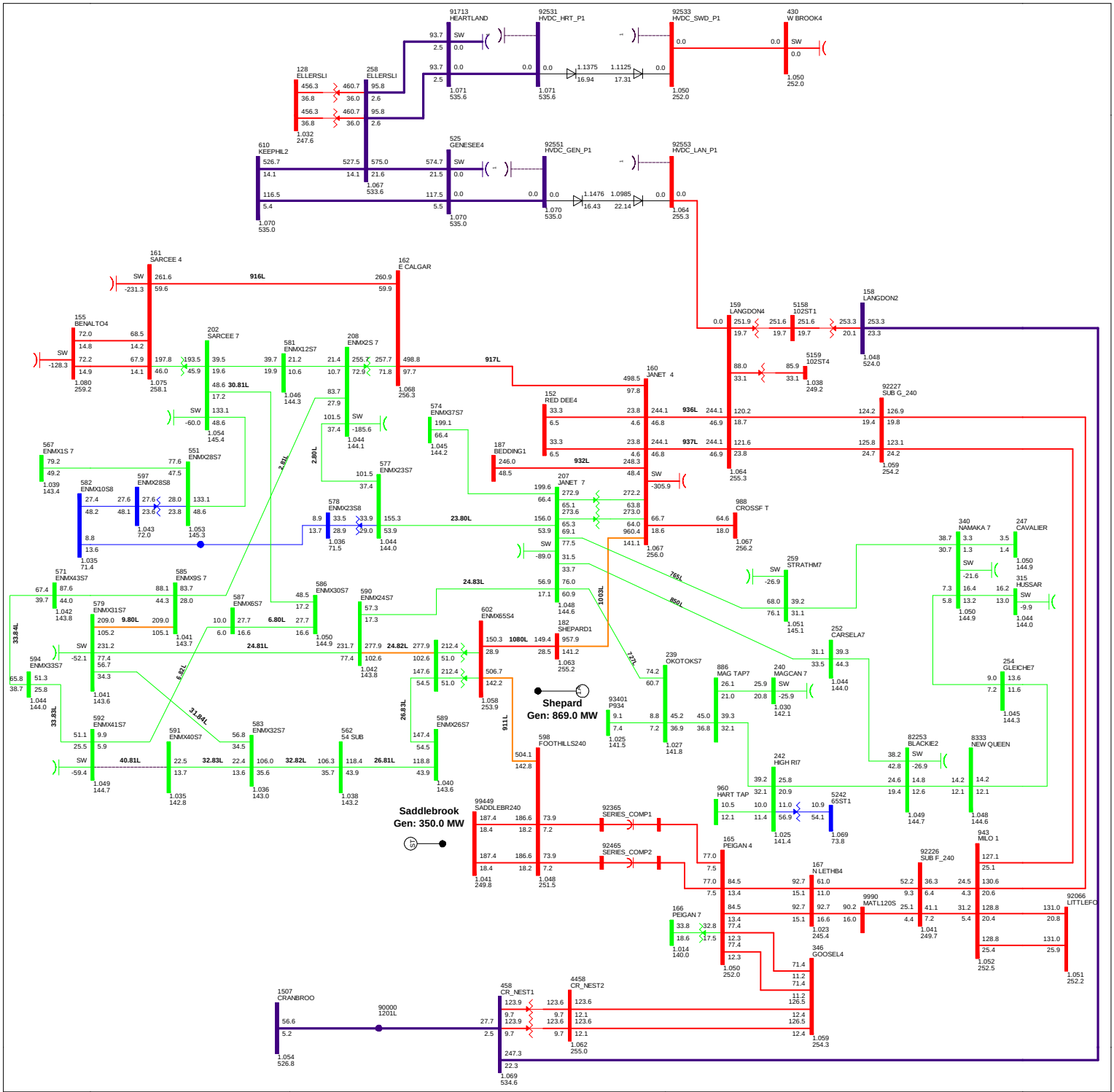
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



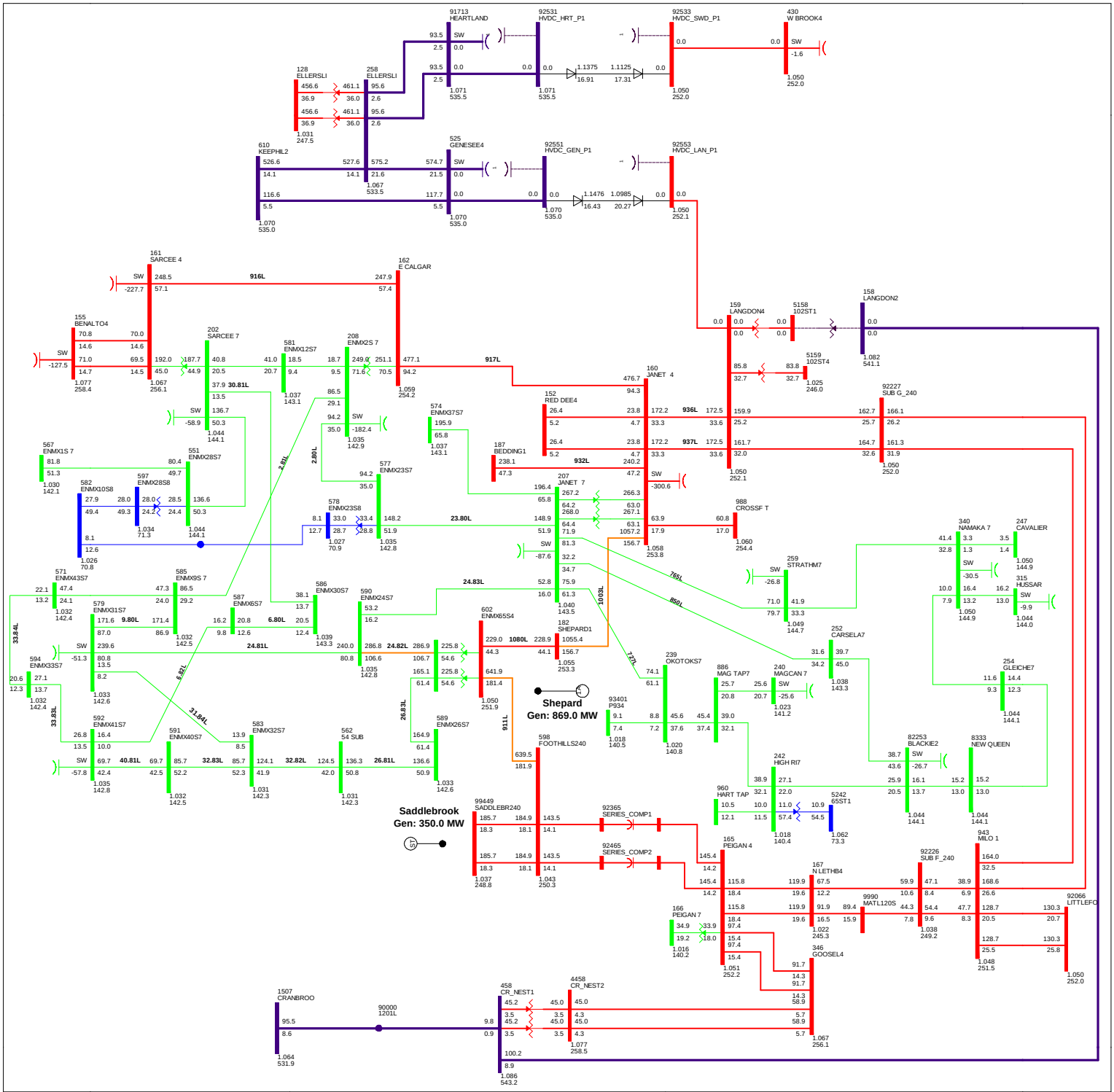
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

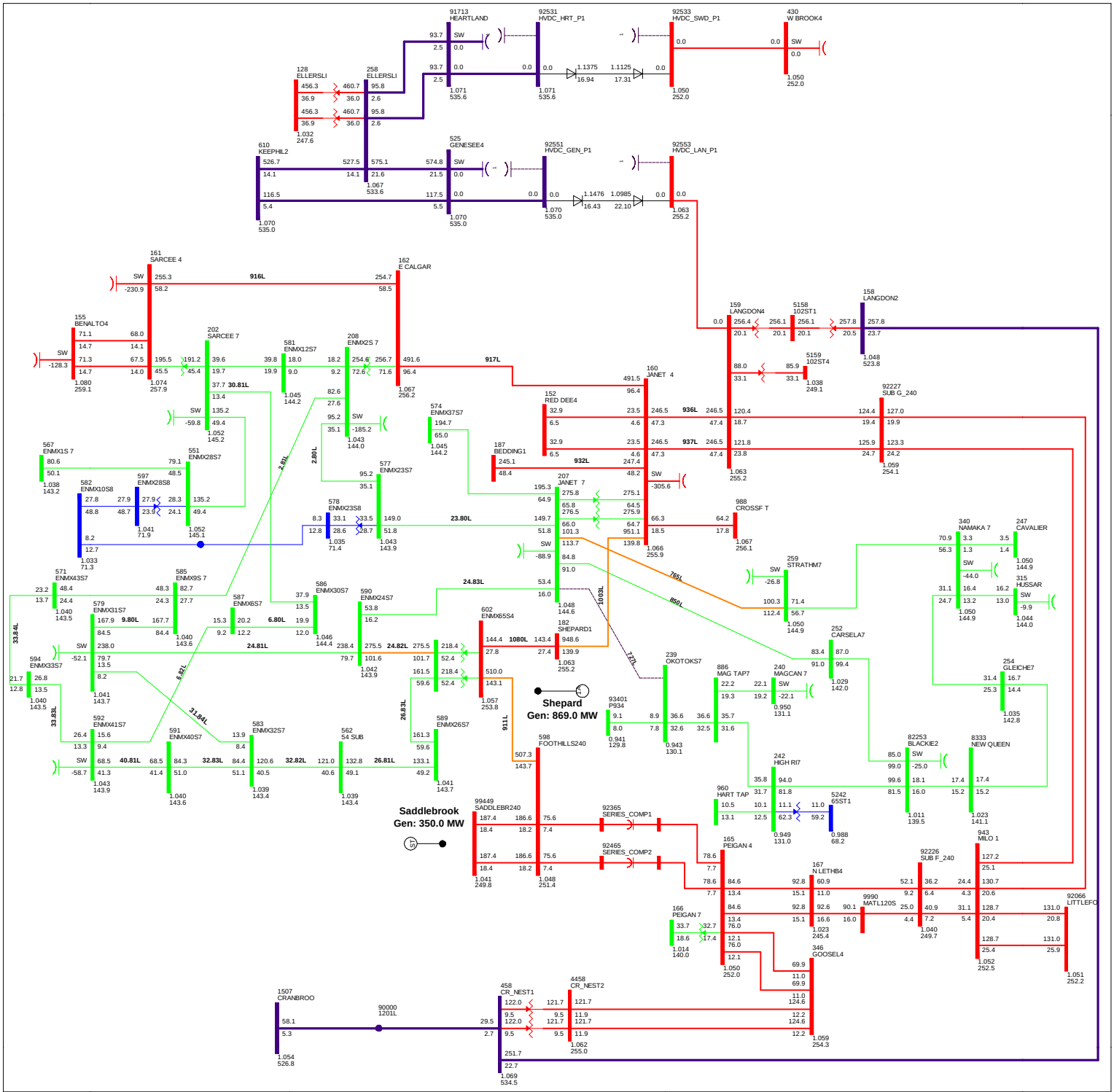
BCH Import: 11.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

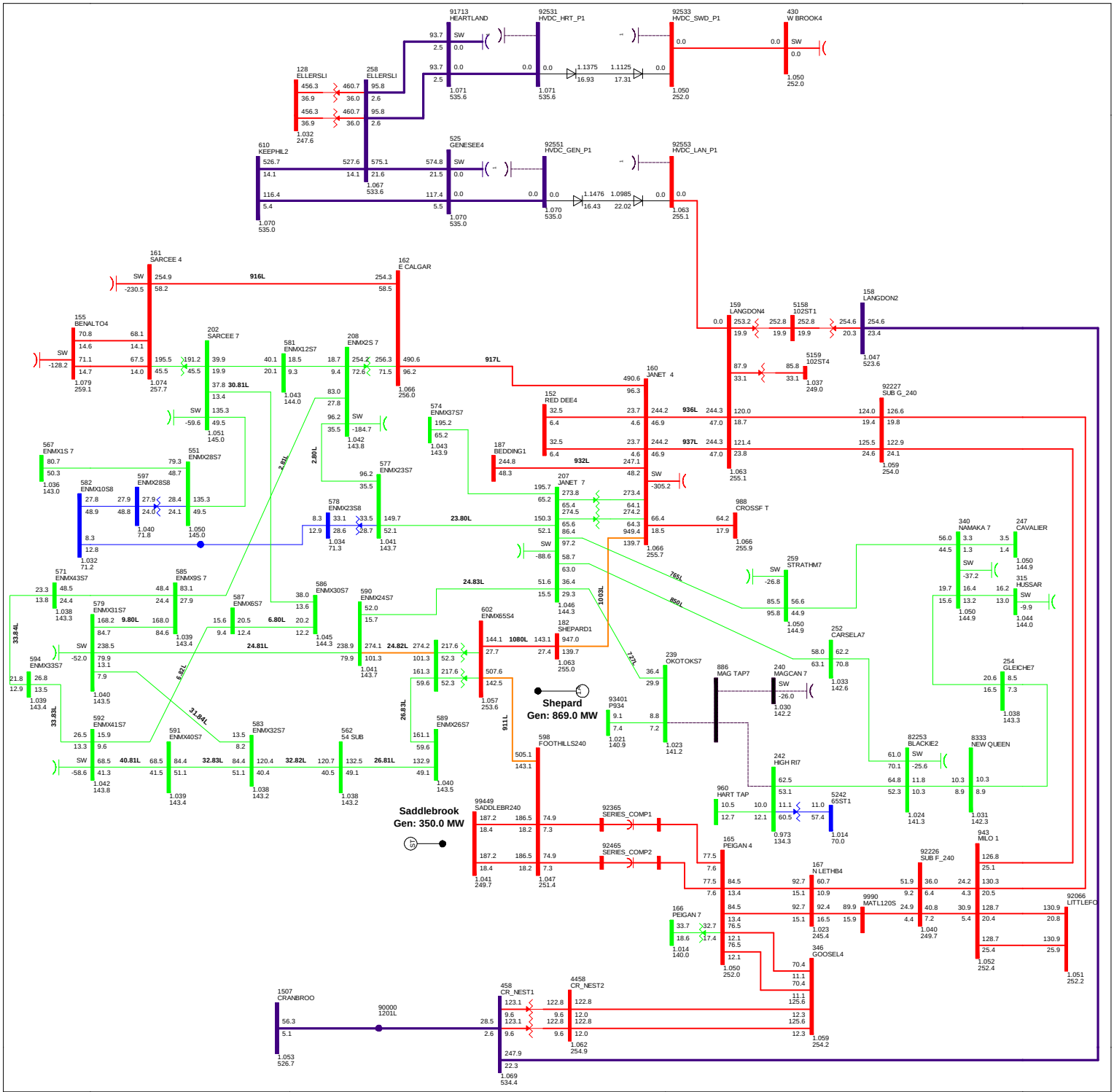
BCH Import: 8.8 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO EXISTING SYSTEM

FIG A-SC4-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



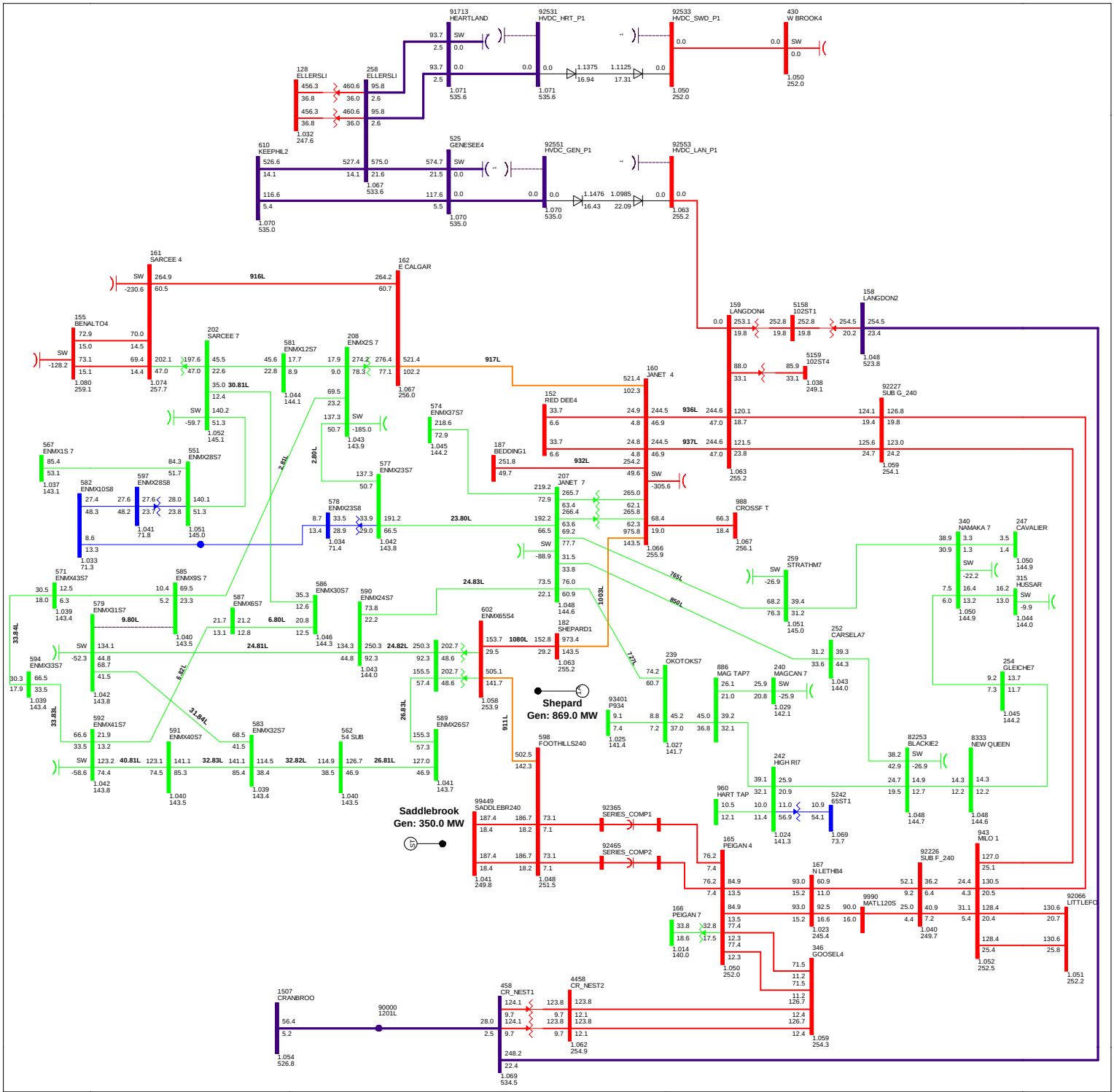
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

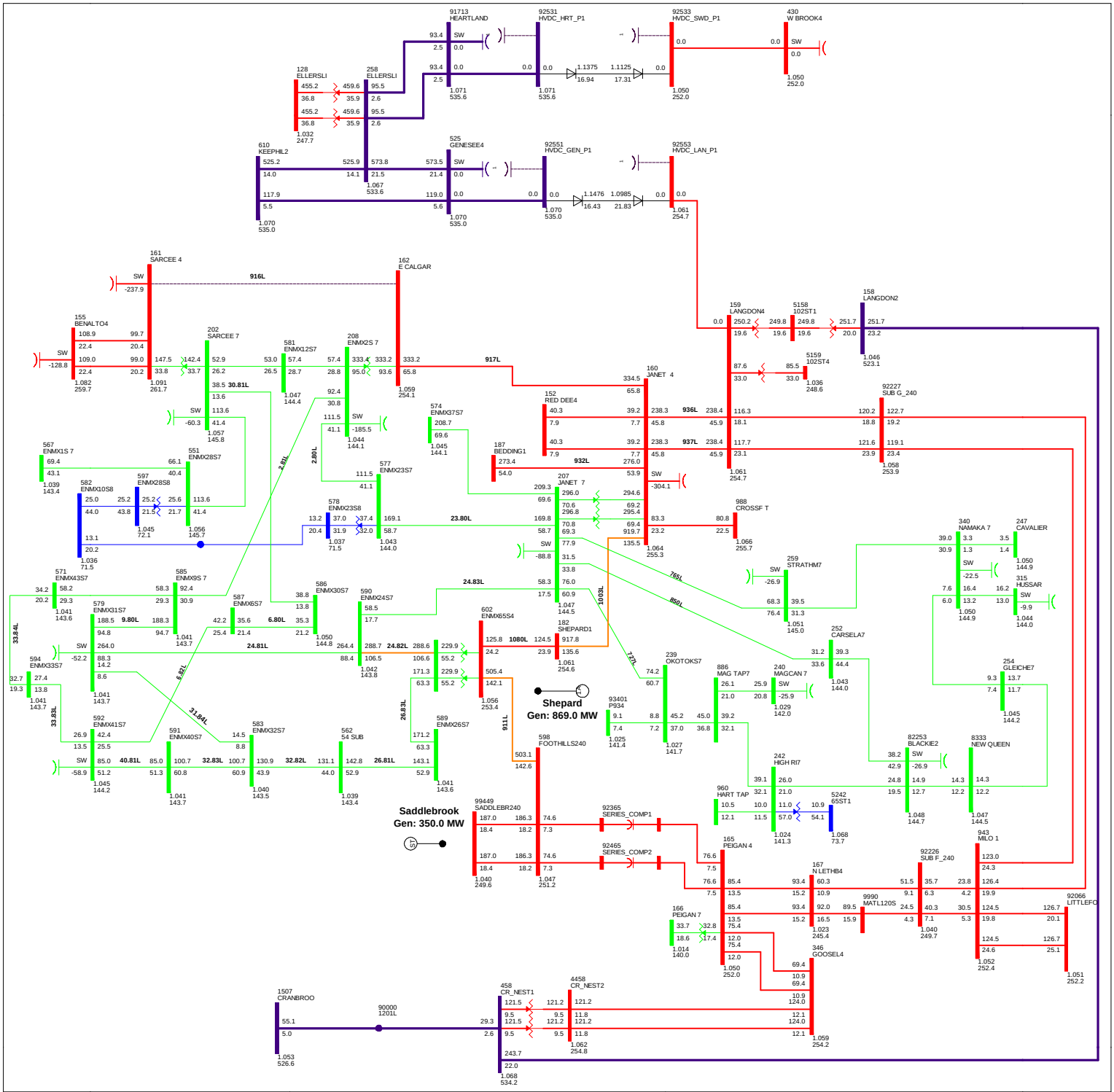
BCH Import: 1.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-22: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



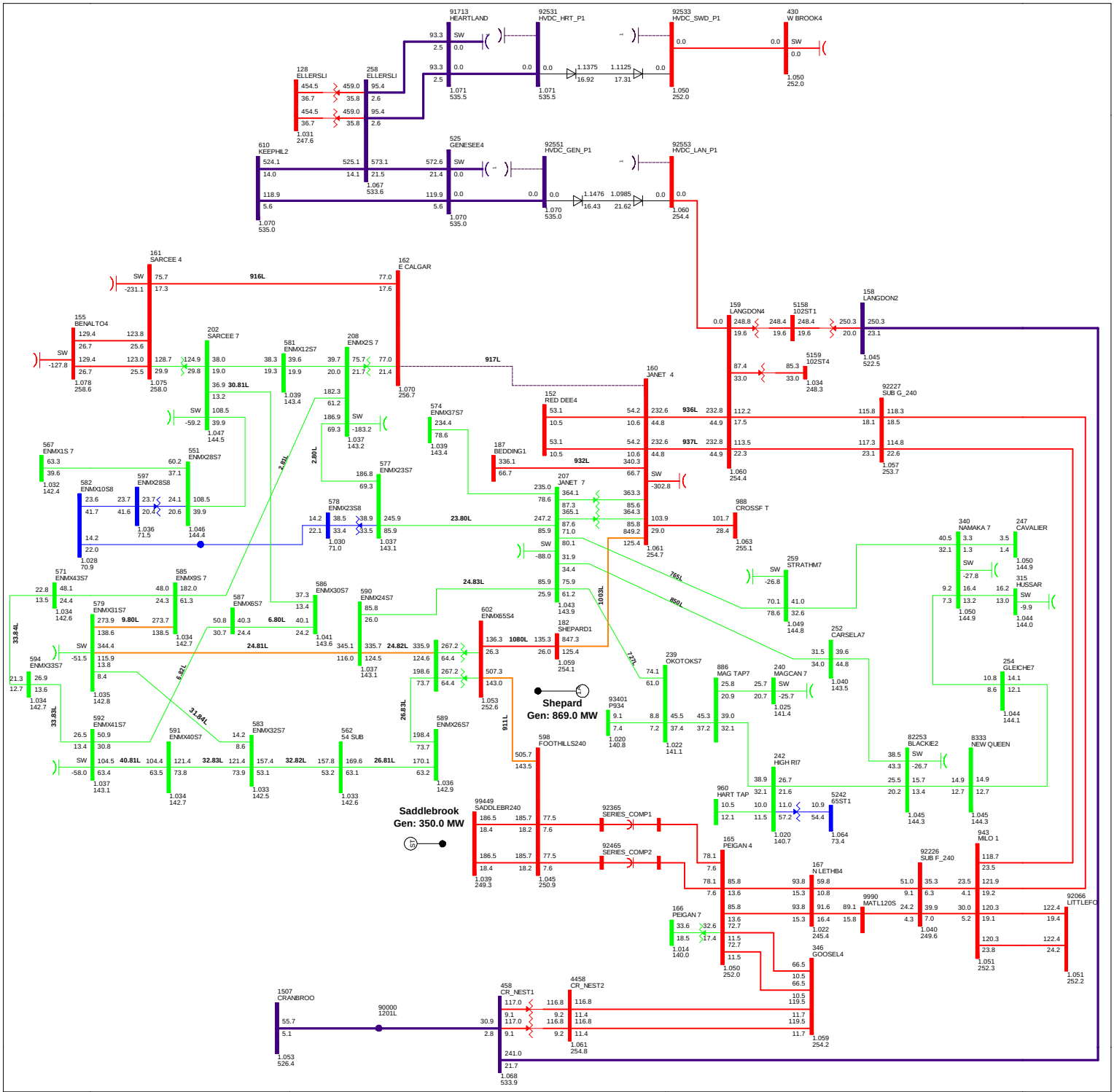
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-23: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

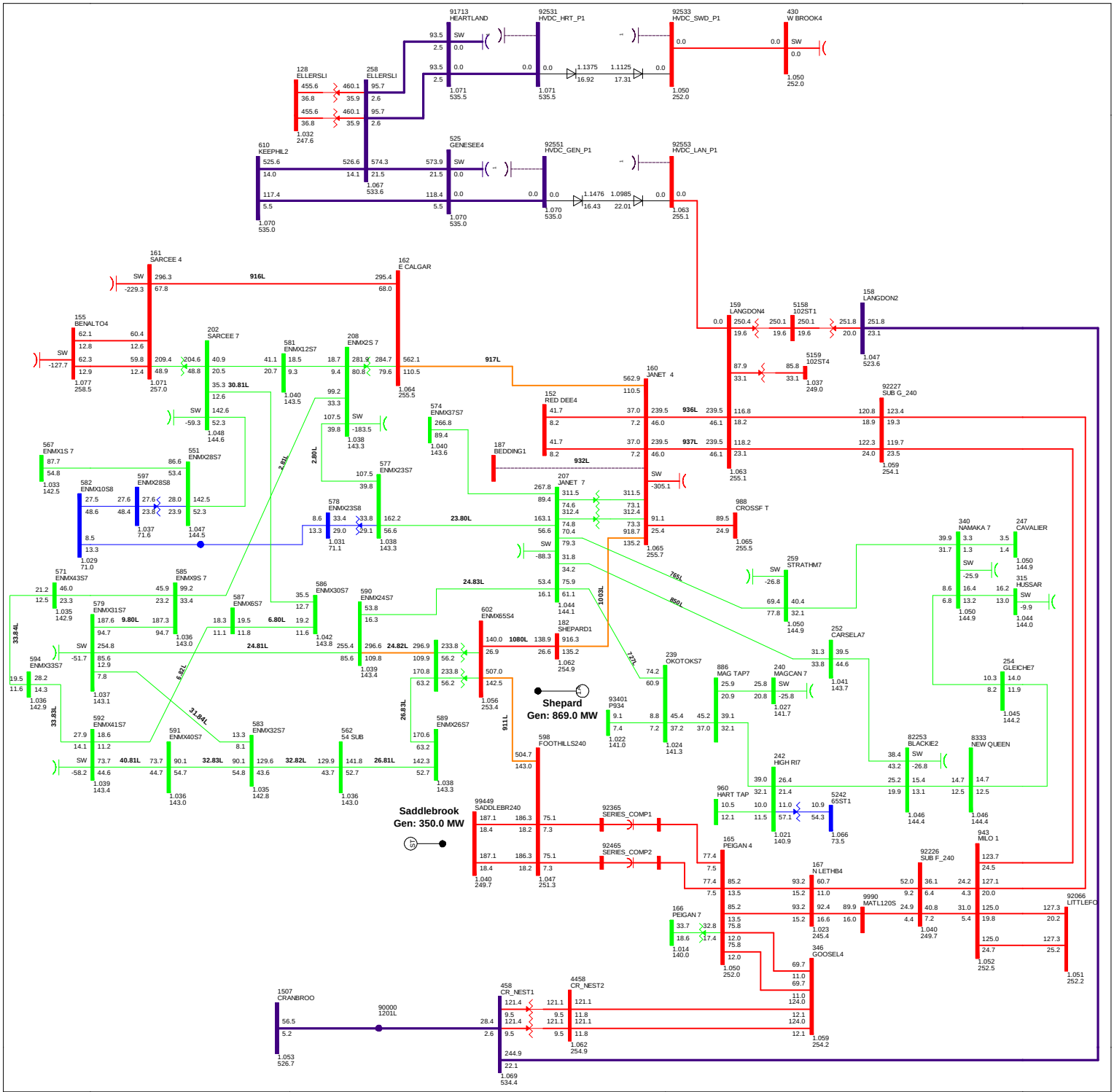
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 12.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-24: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

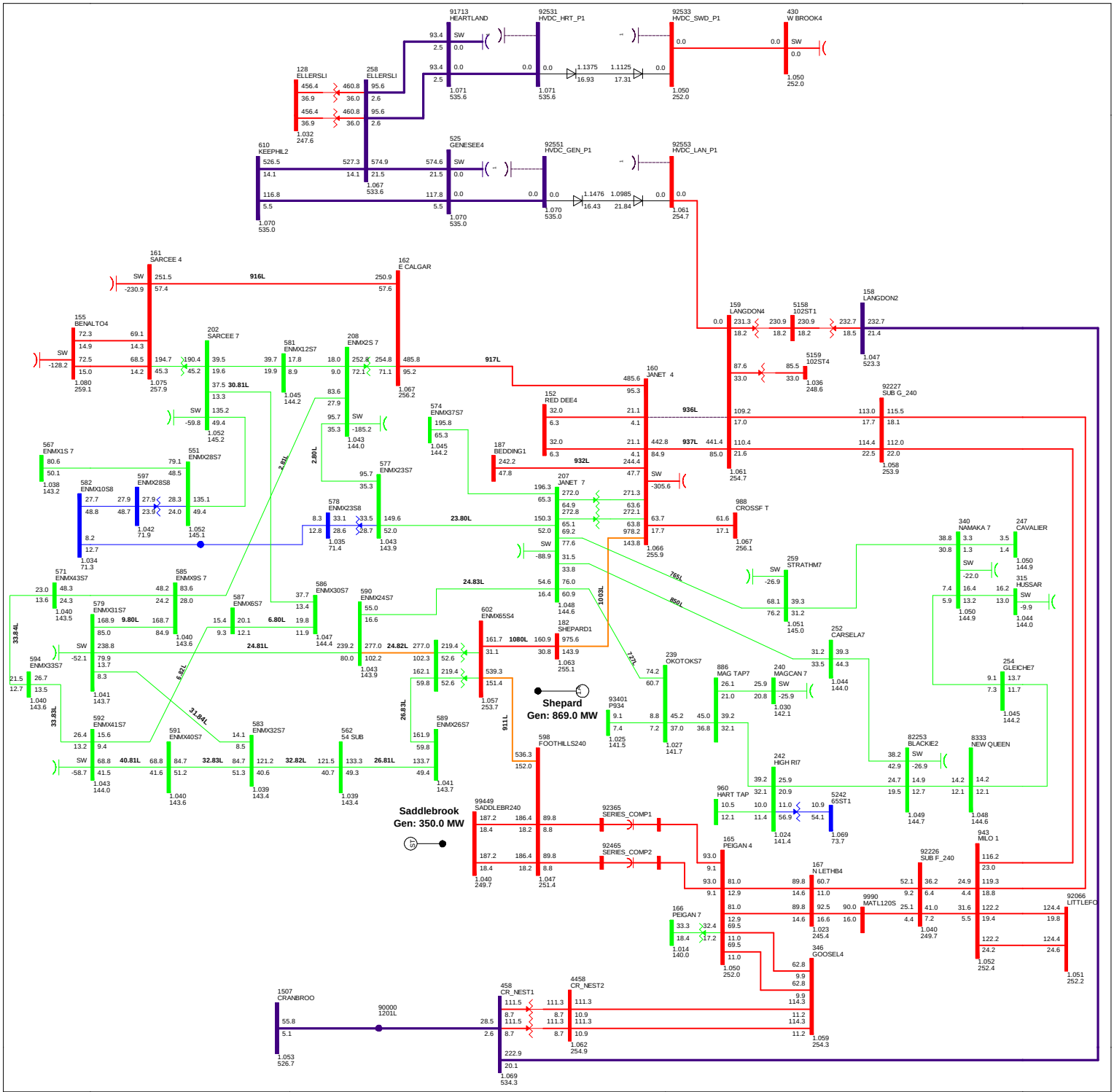
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-25: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

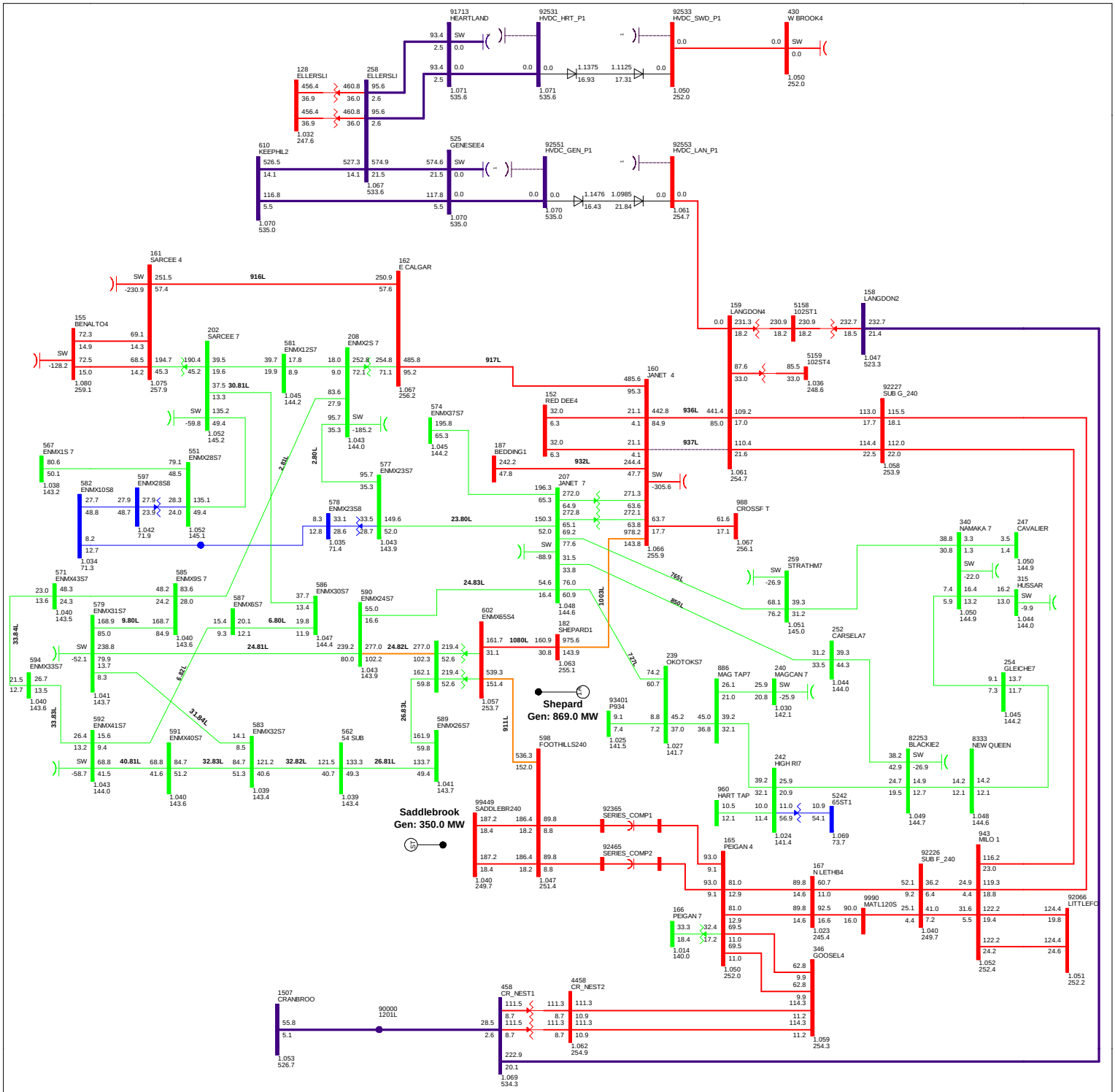
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-26: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

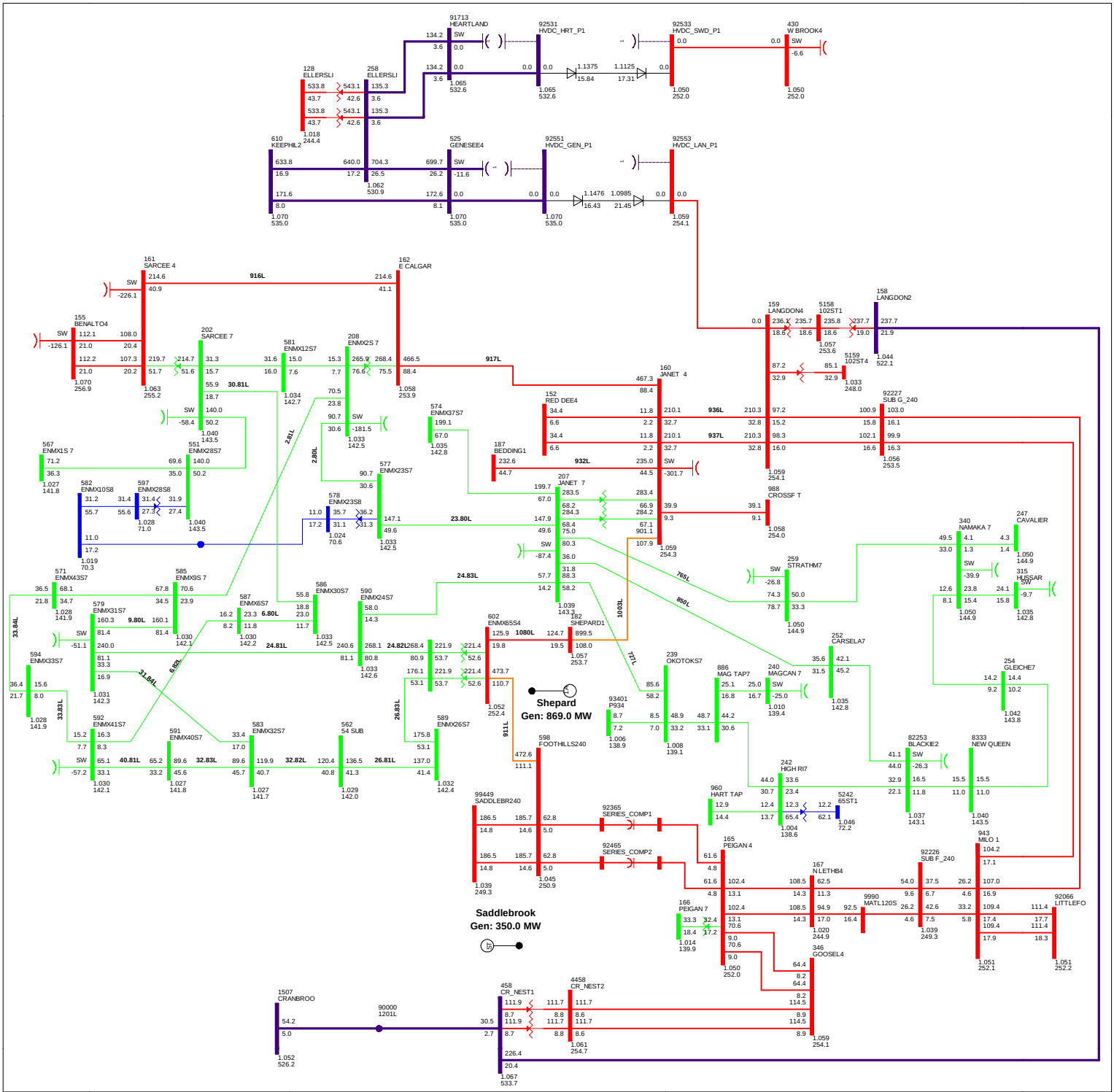
BCH Import: 2.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC4-27: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC4

FRI, JUN 08 2012 15:26

2014 Loading Violations
Scenario 4B



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100.0%RATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

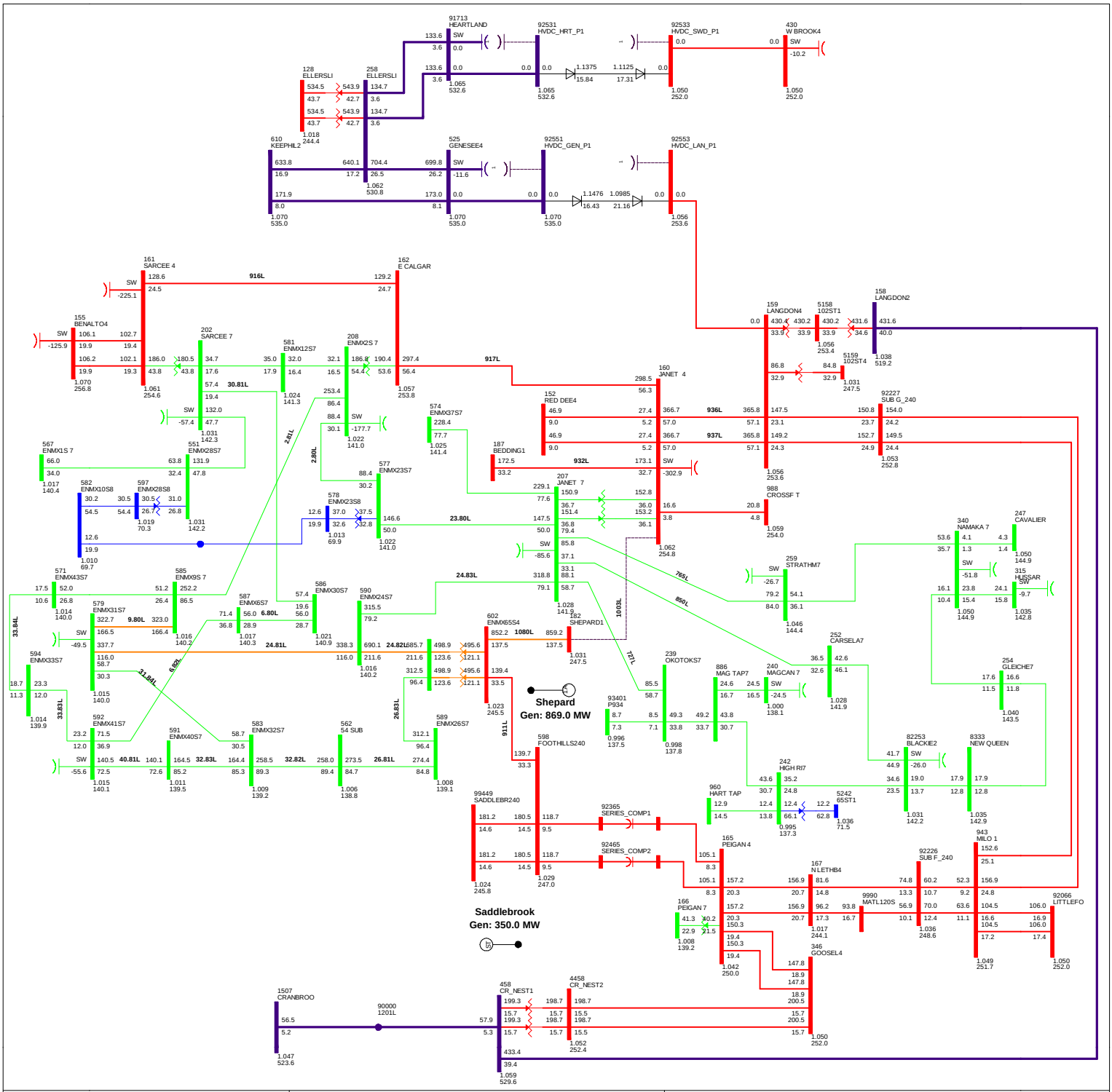
BCH Import: 0.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-1: BASECASE

2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar

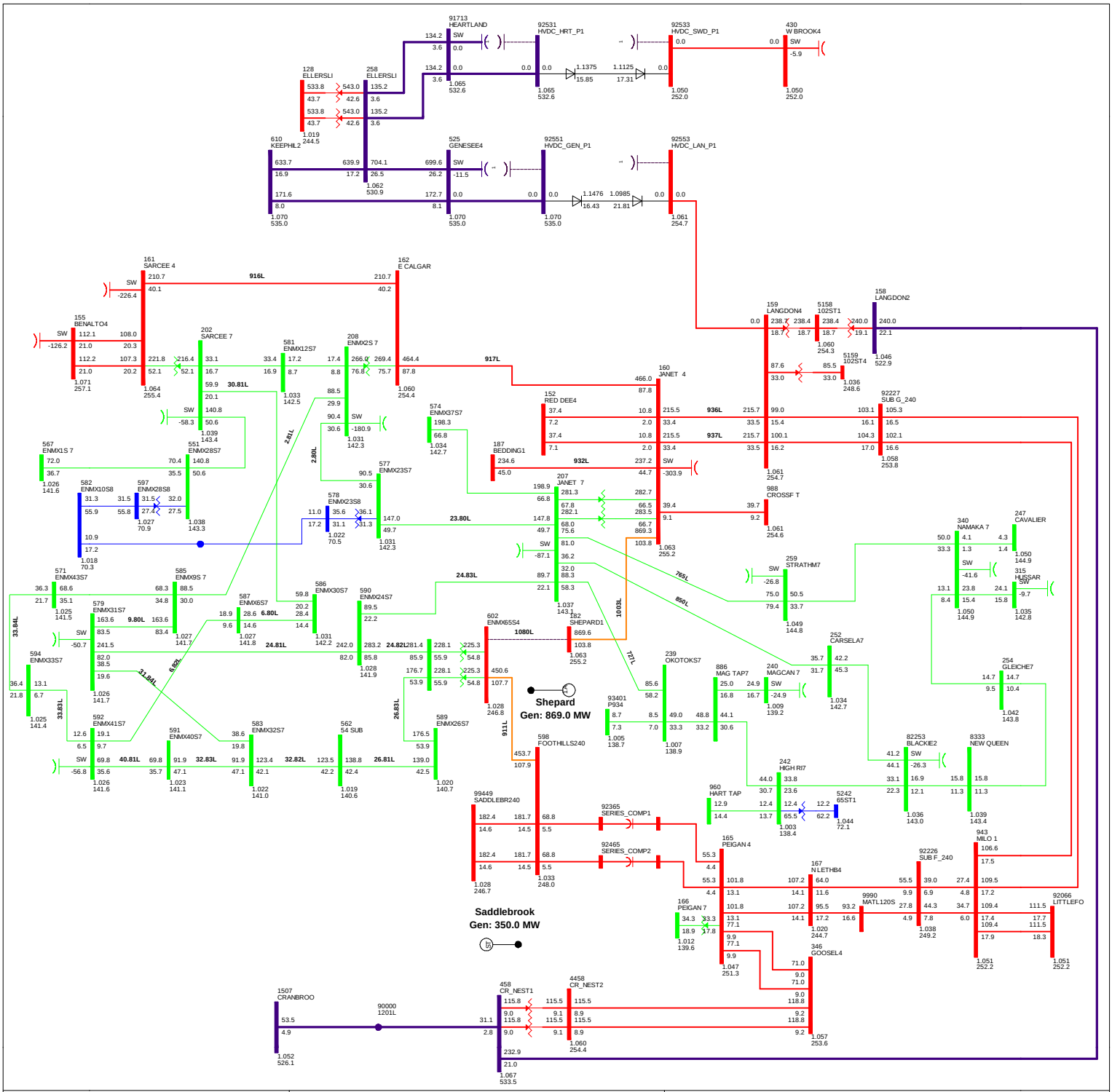
100 DNARATER
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 35.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

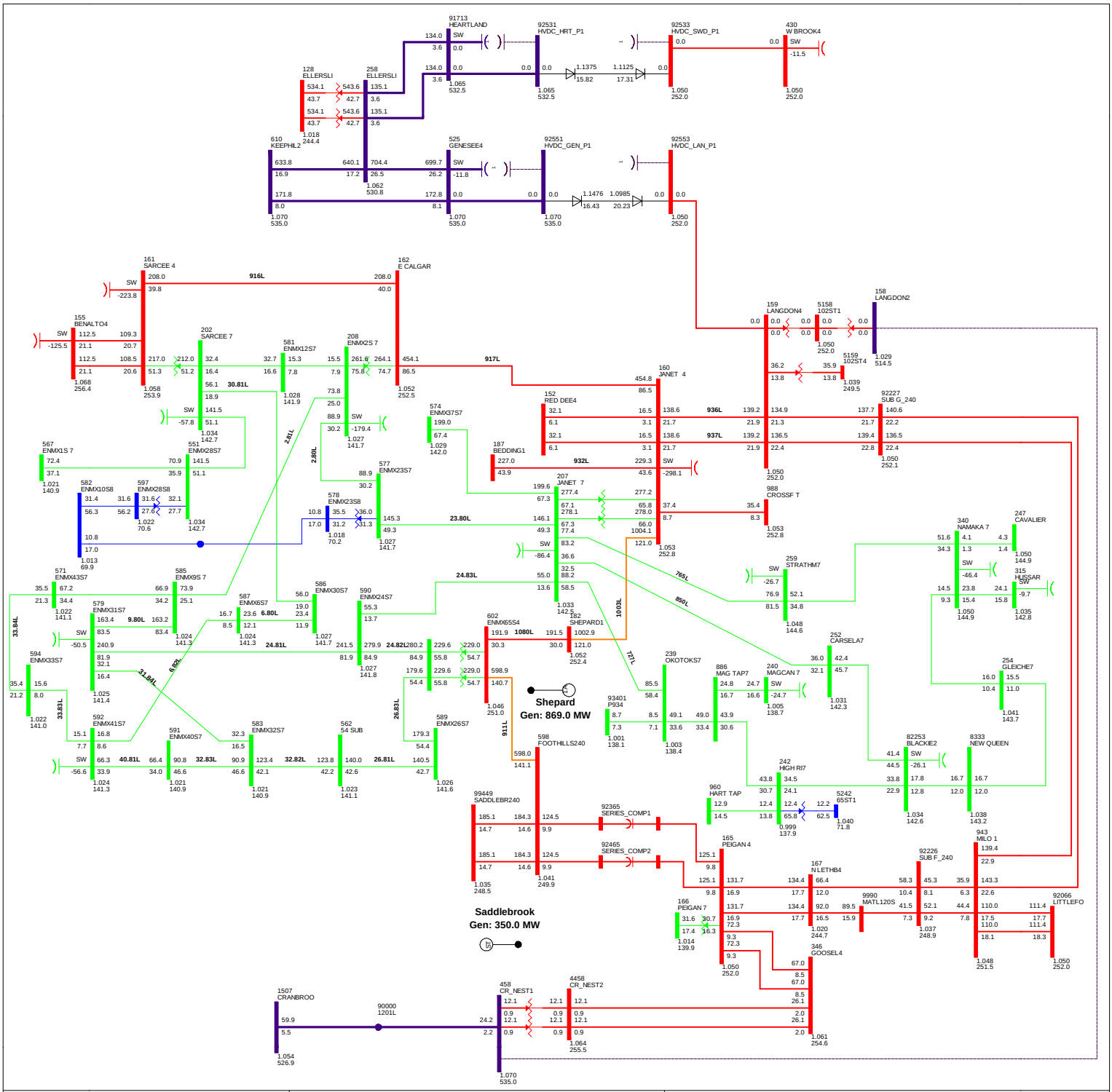
BCH Import: 0.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



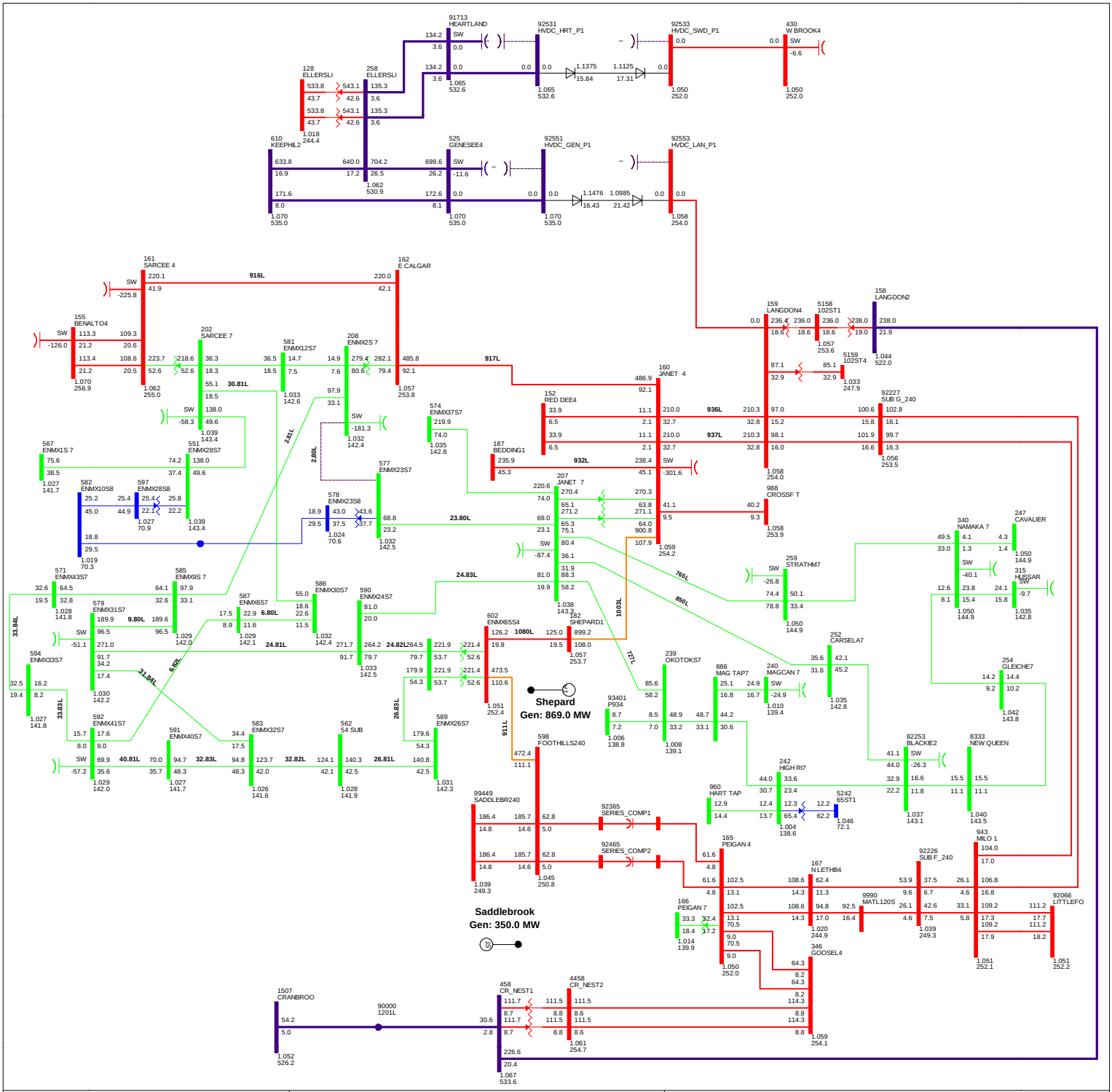
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 10.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSN 2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

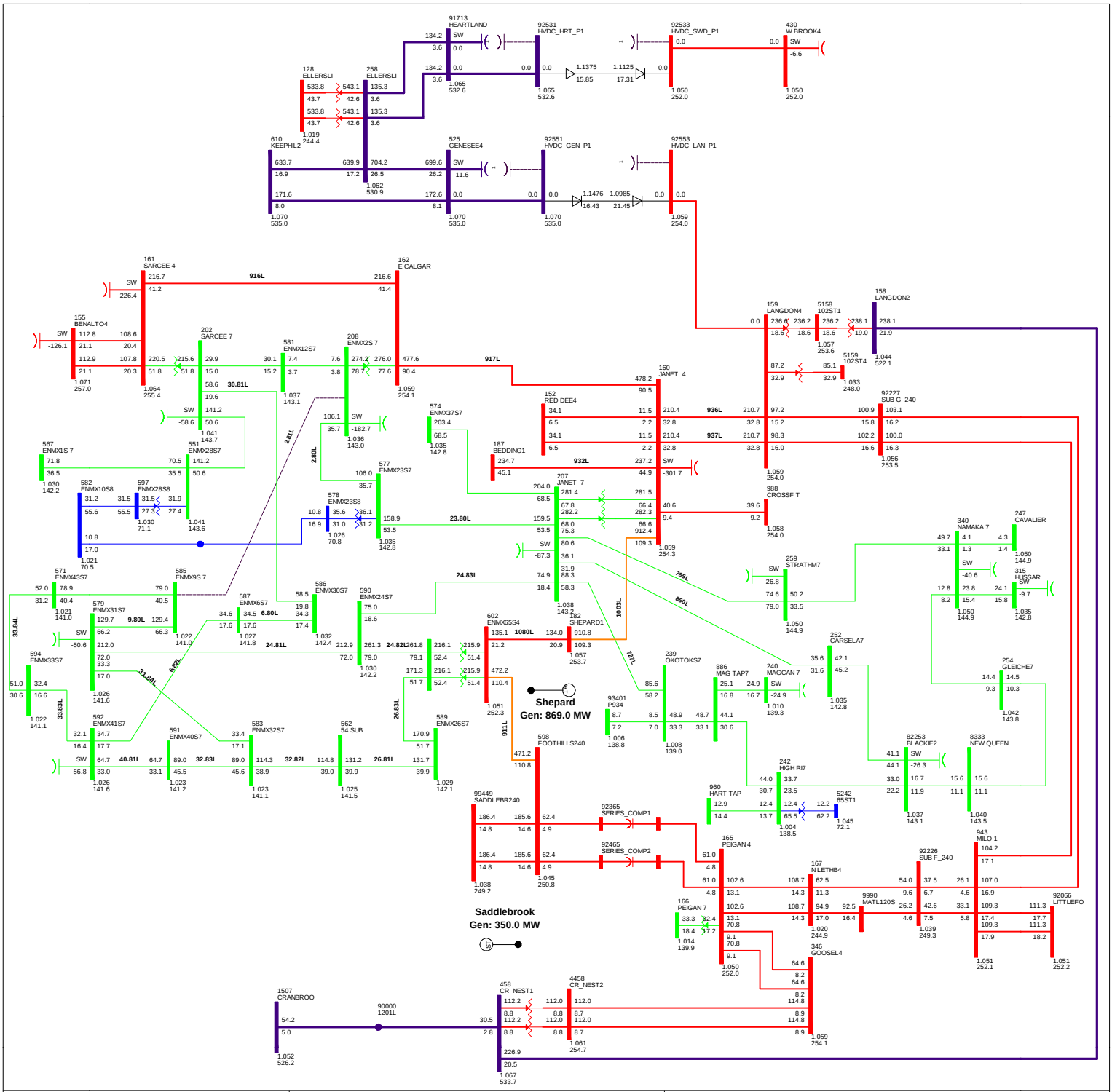
BCH Import: 1.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATES
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

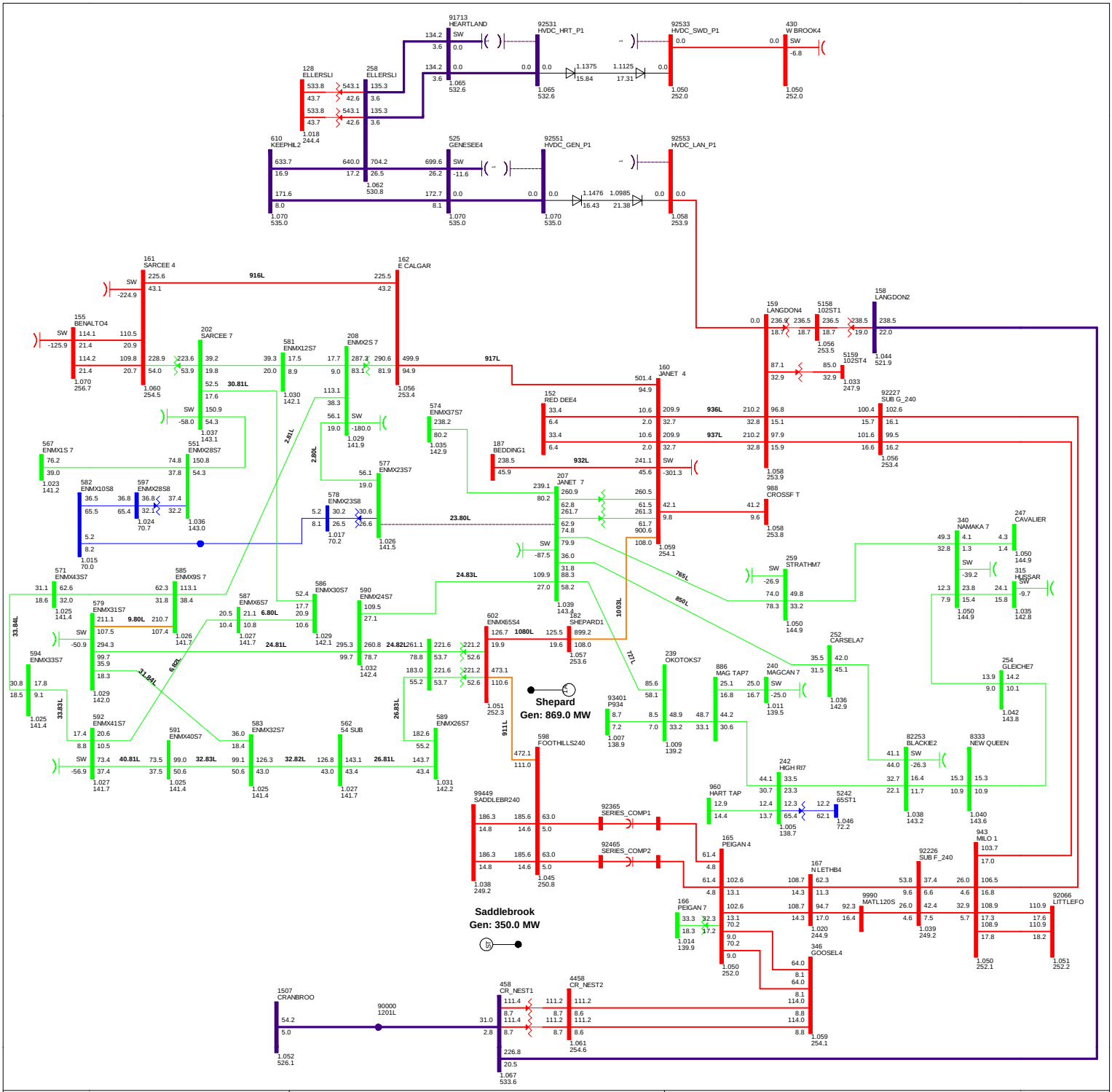
BCH Import: 0.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



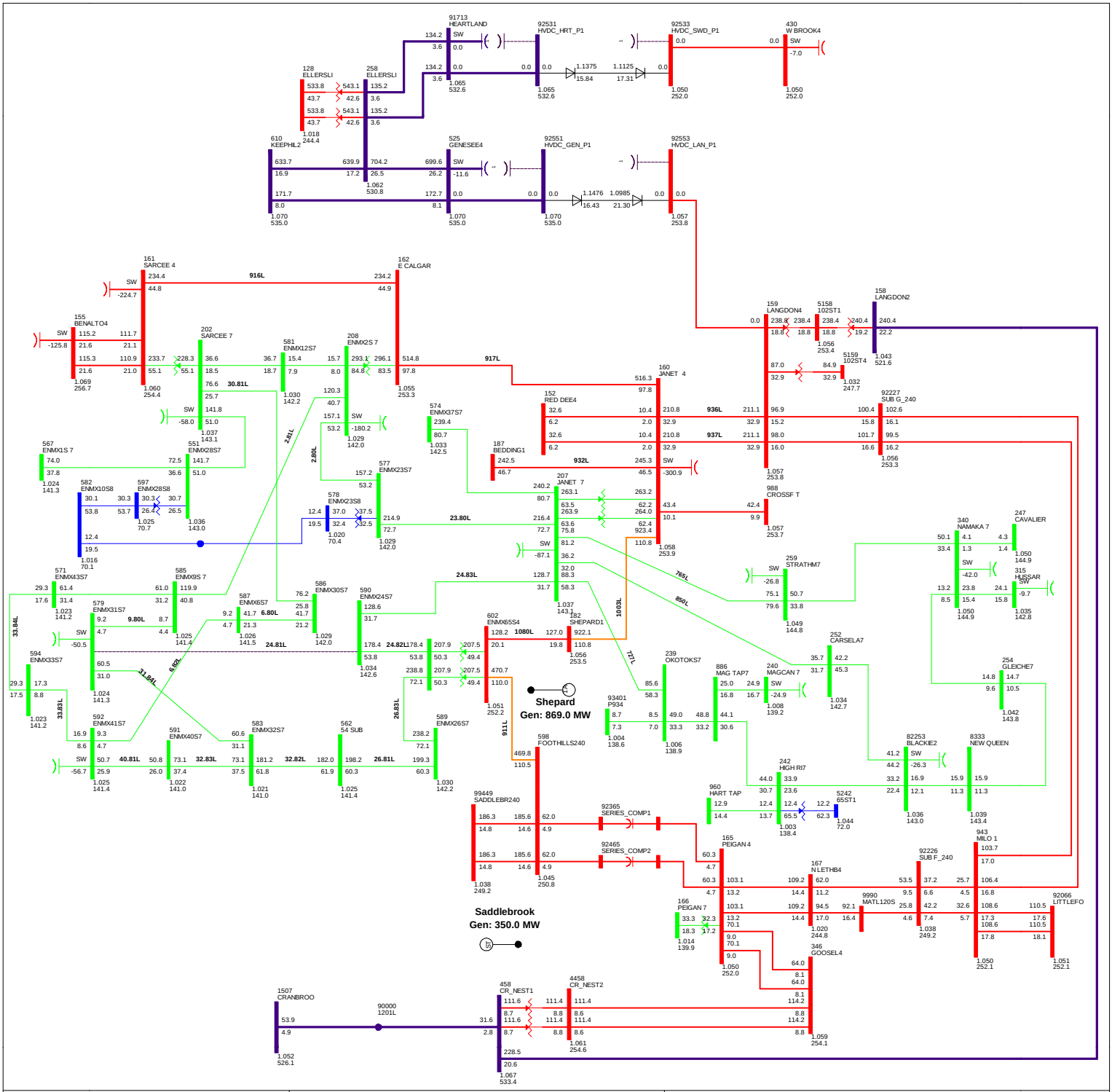
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100.0%RATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



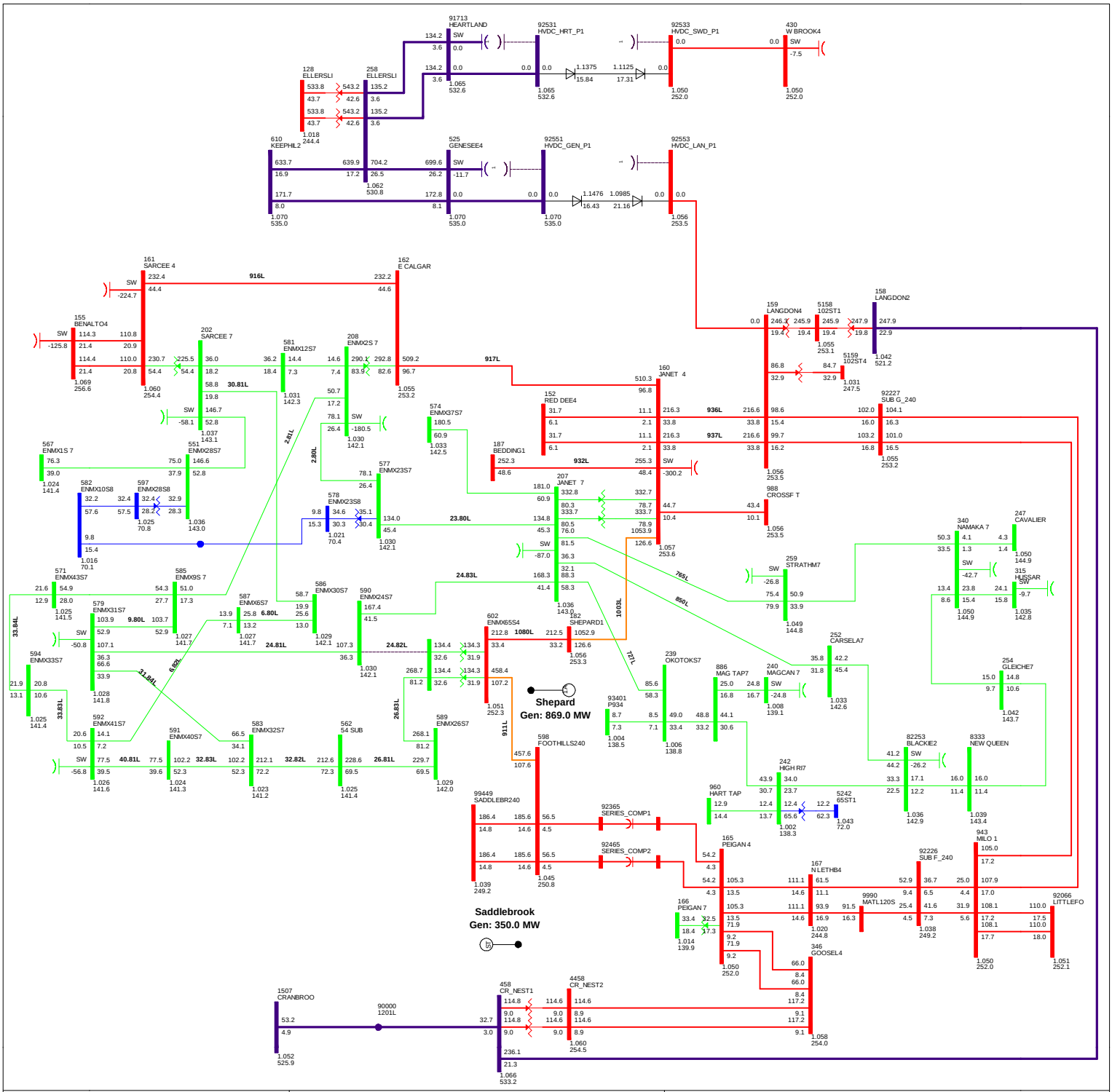
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



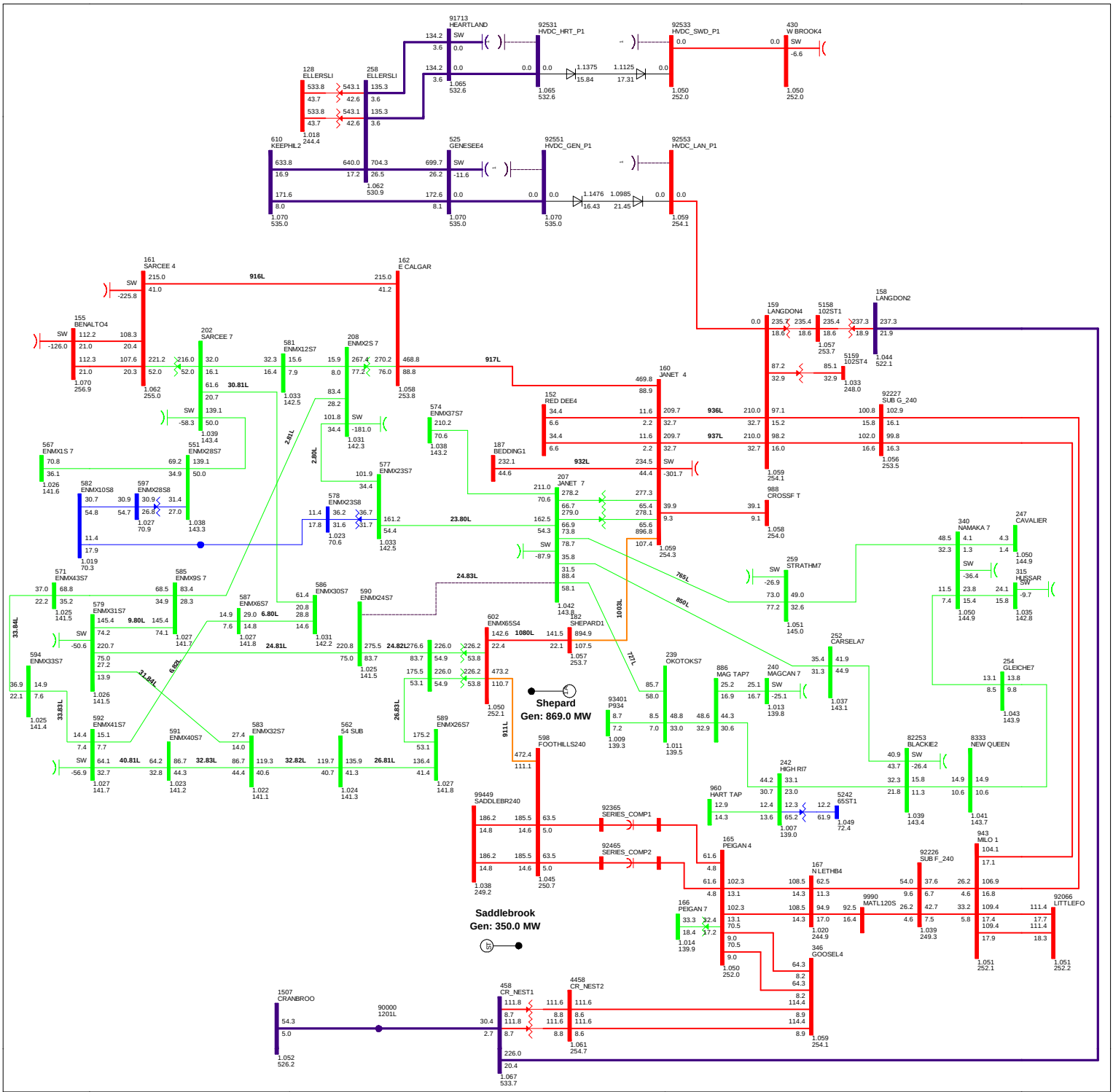
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATES
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 5.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



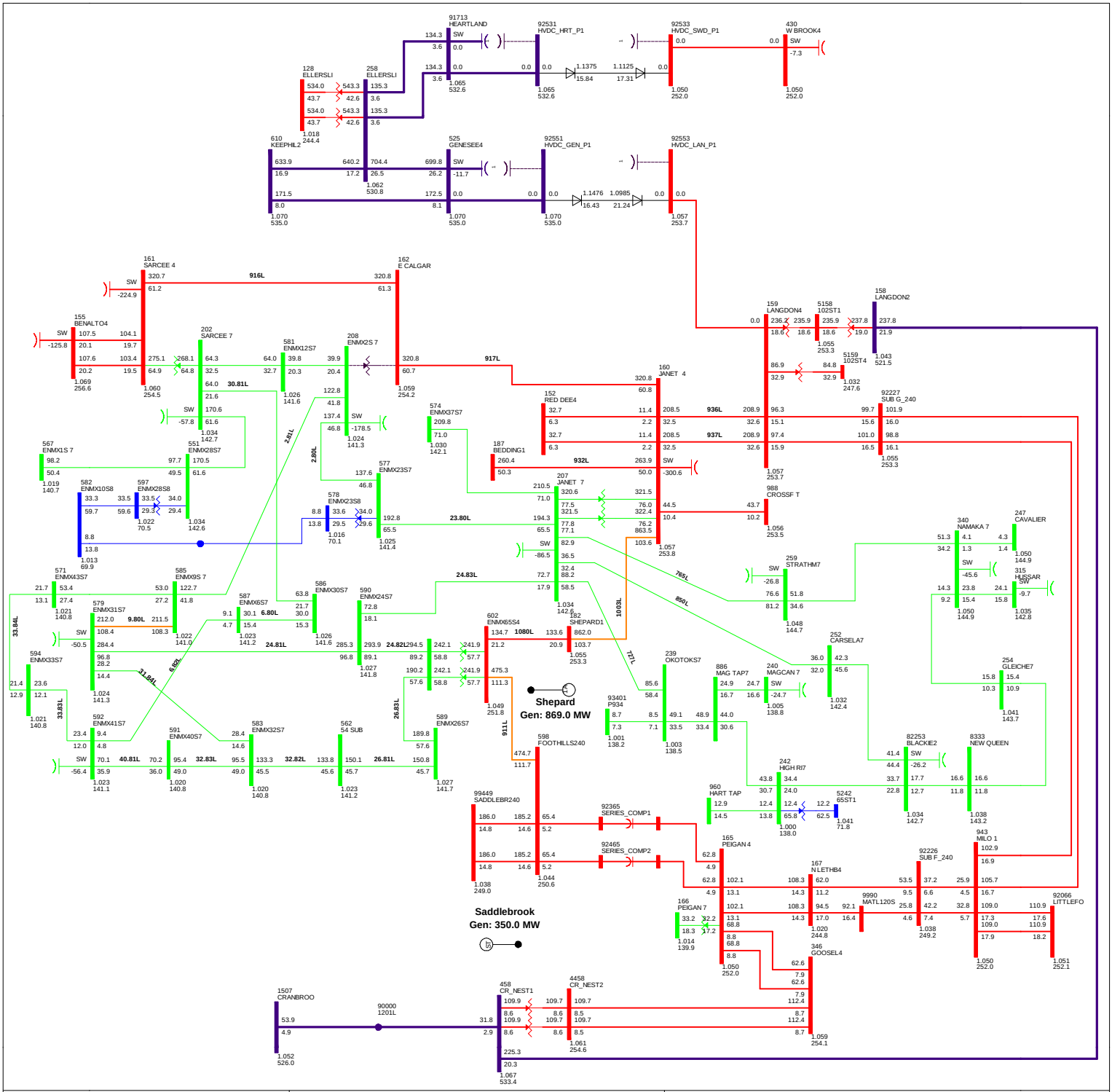
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 2
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



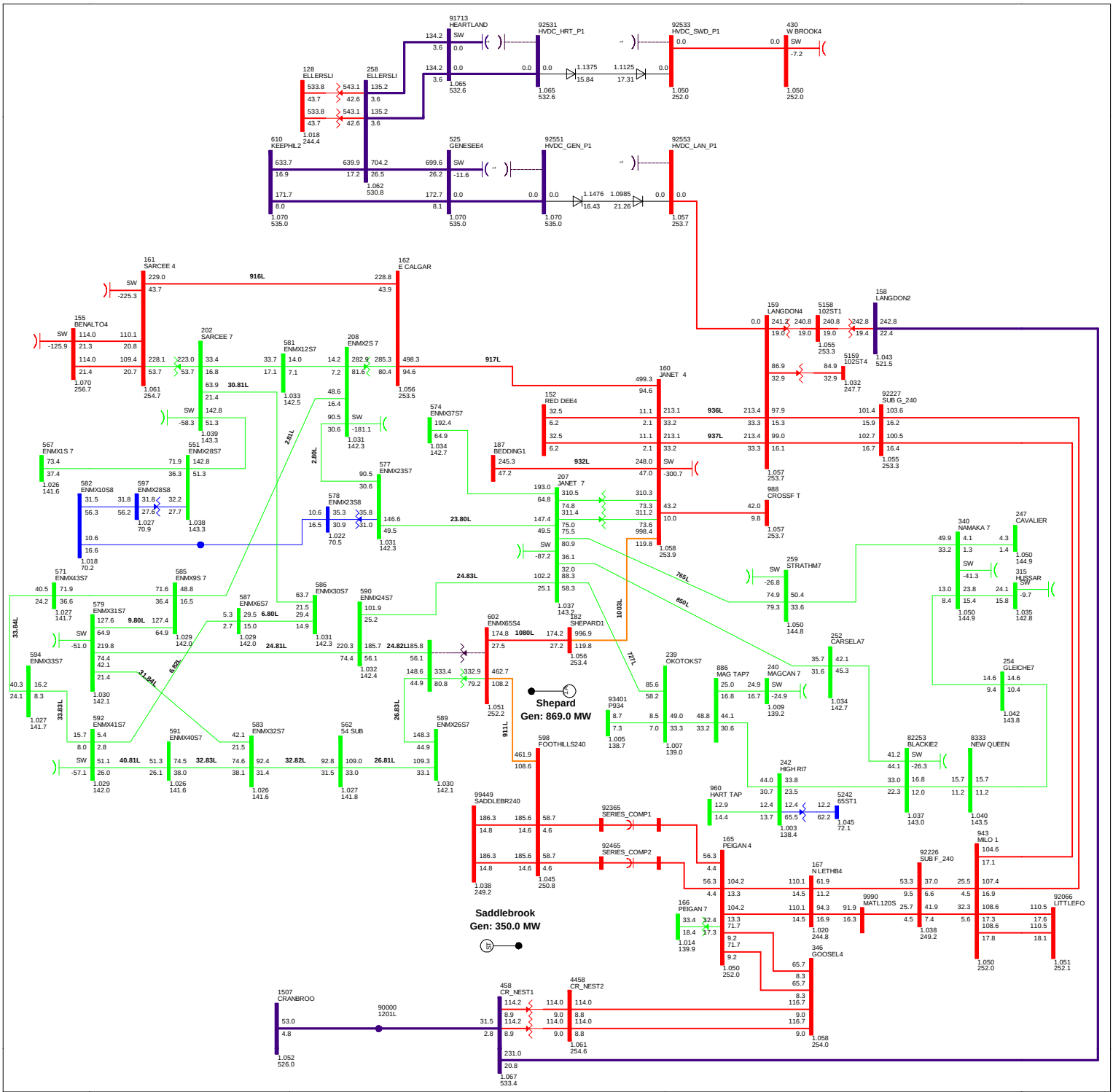
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

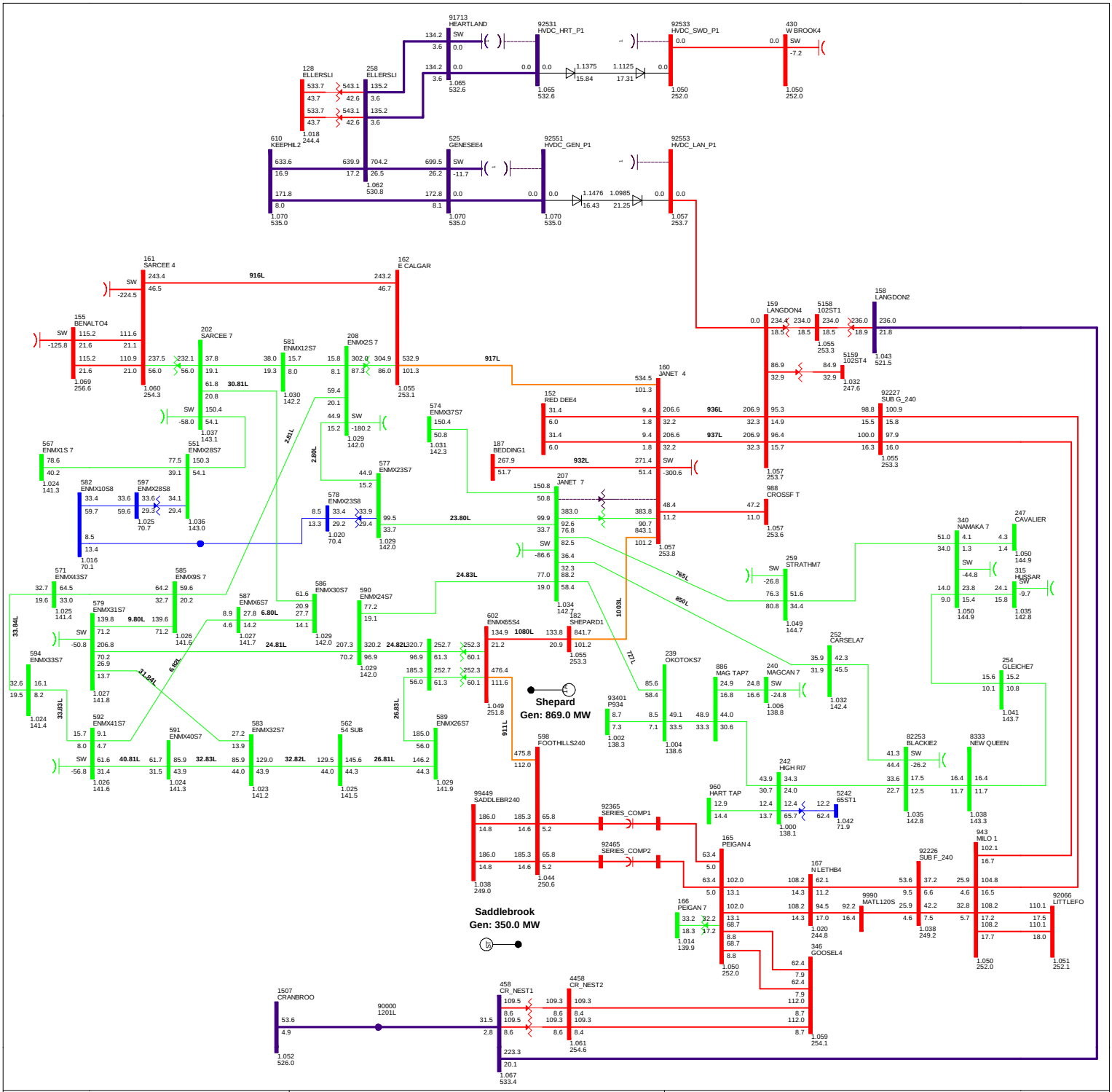
BCH Import: 1.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

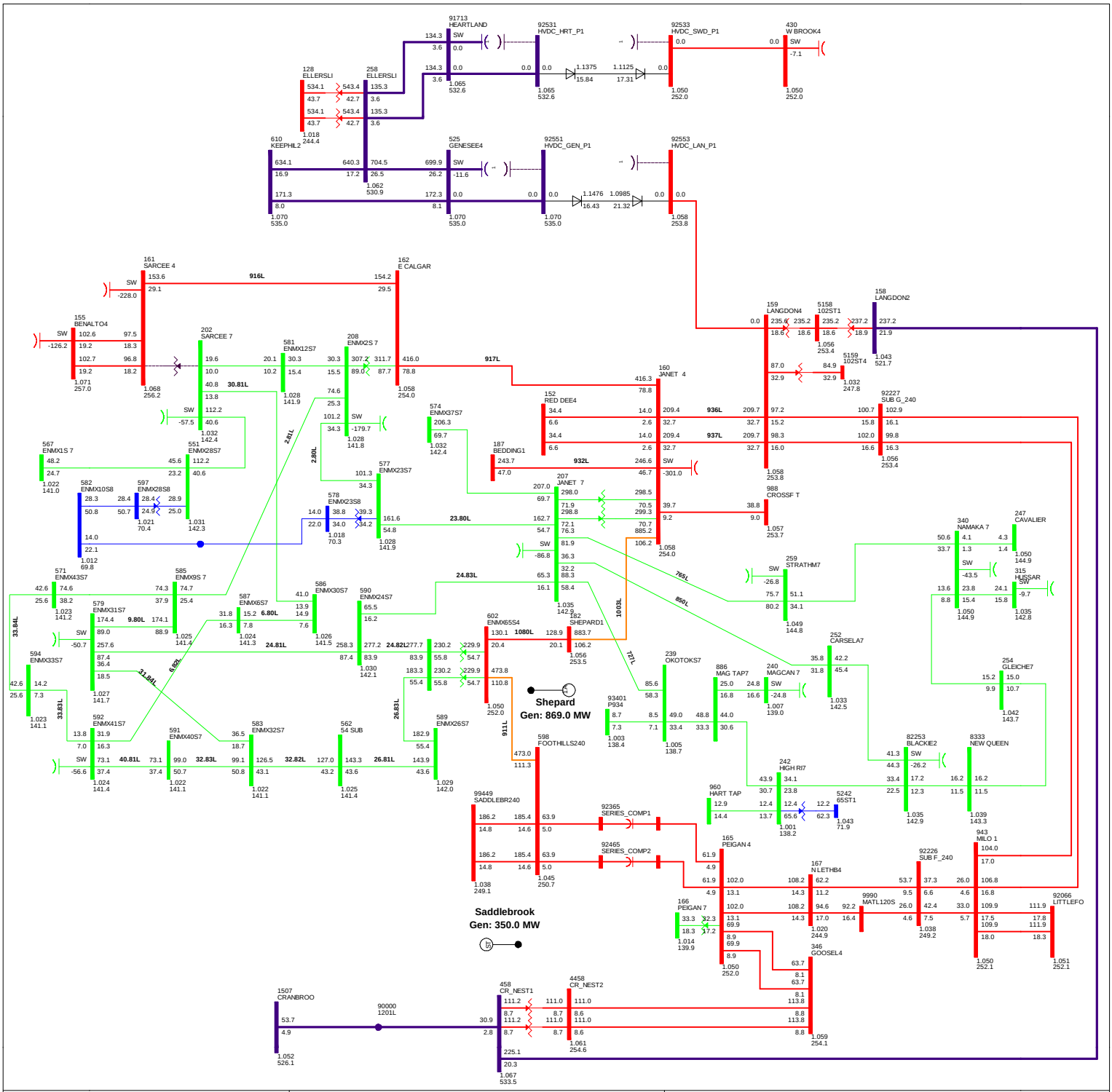
BCH Import: 3.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

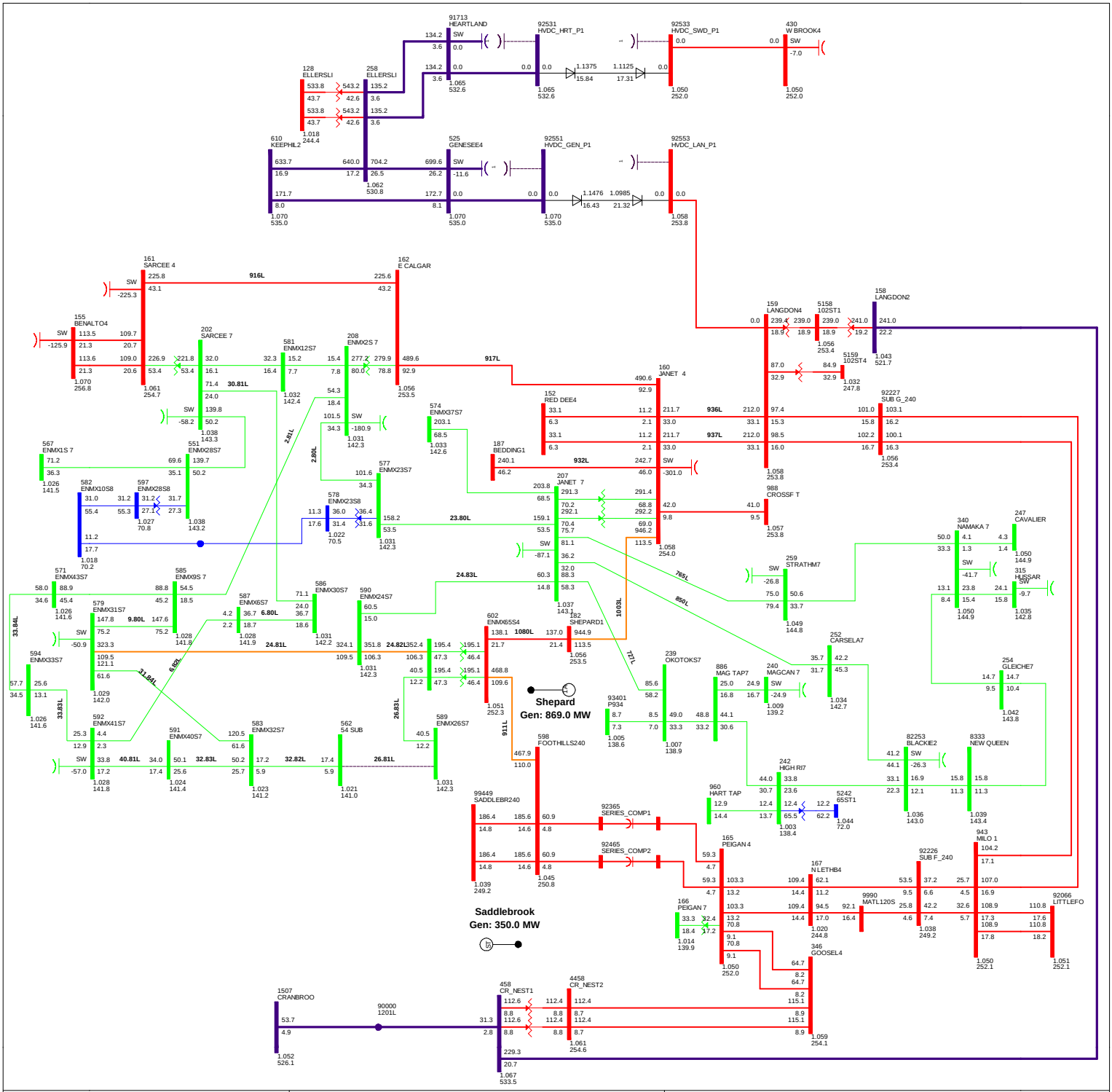
BCH Import: 1.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



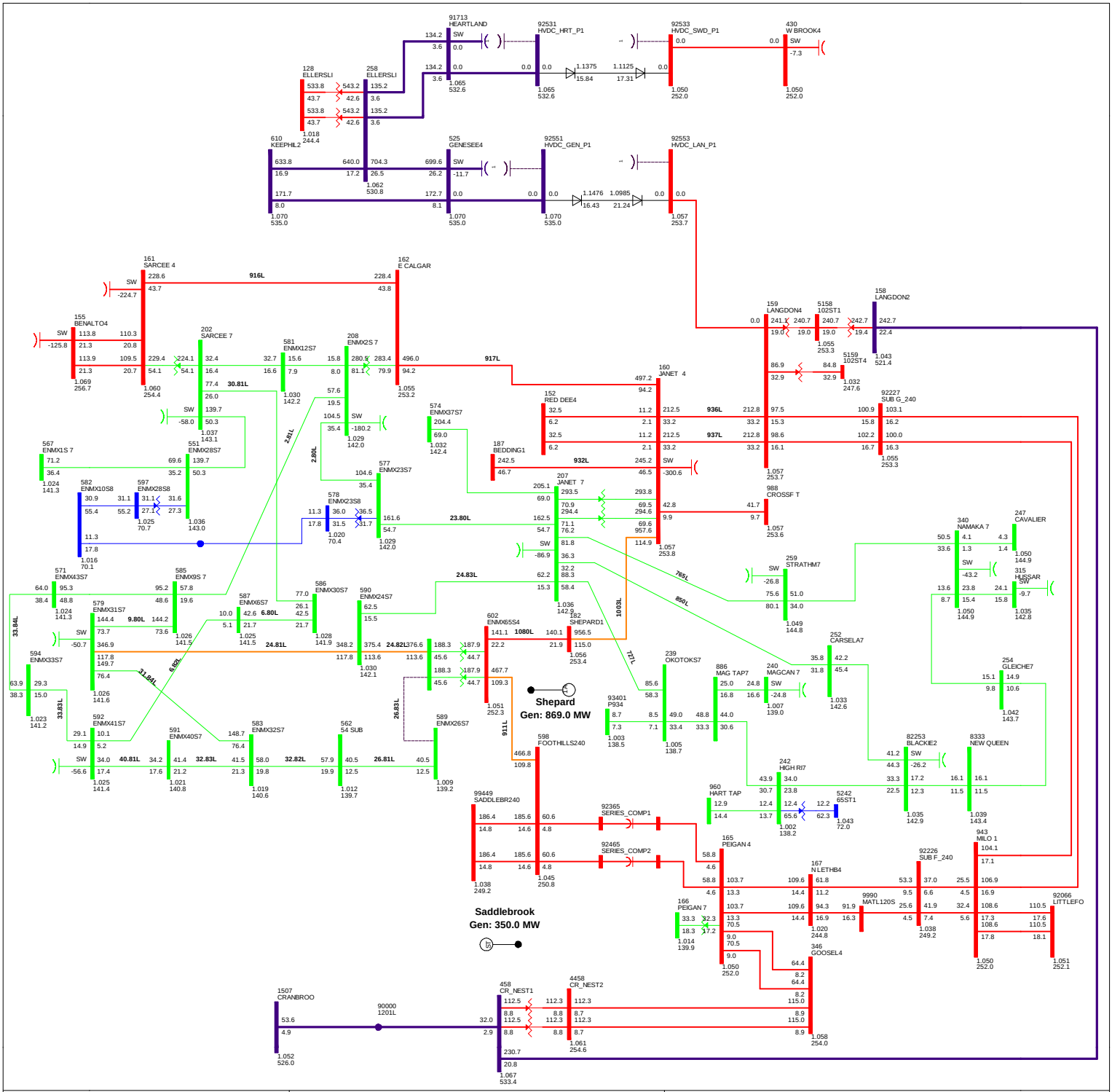
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



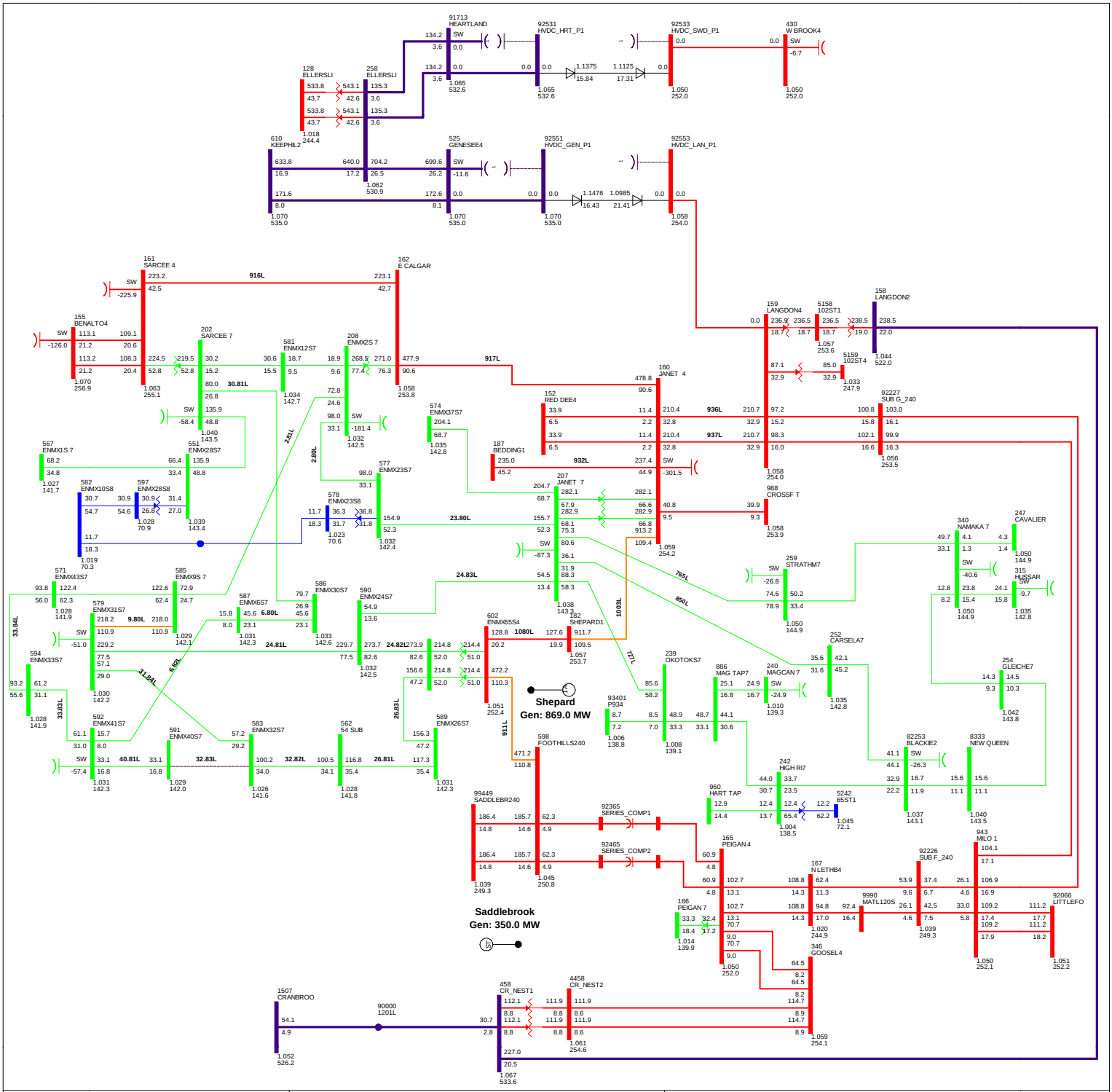
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100.0%RATE B
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



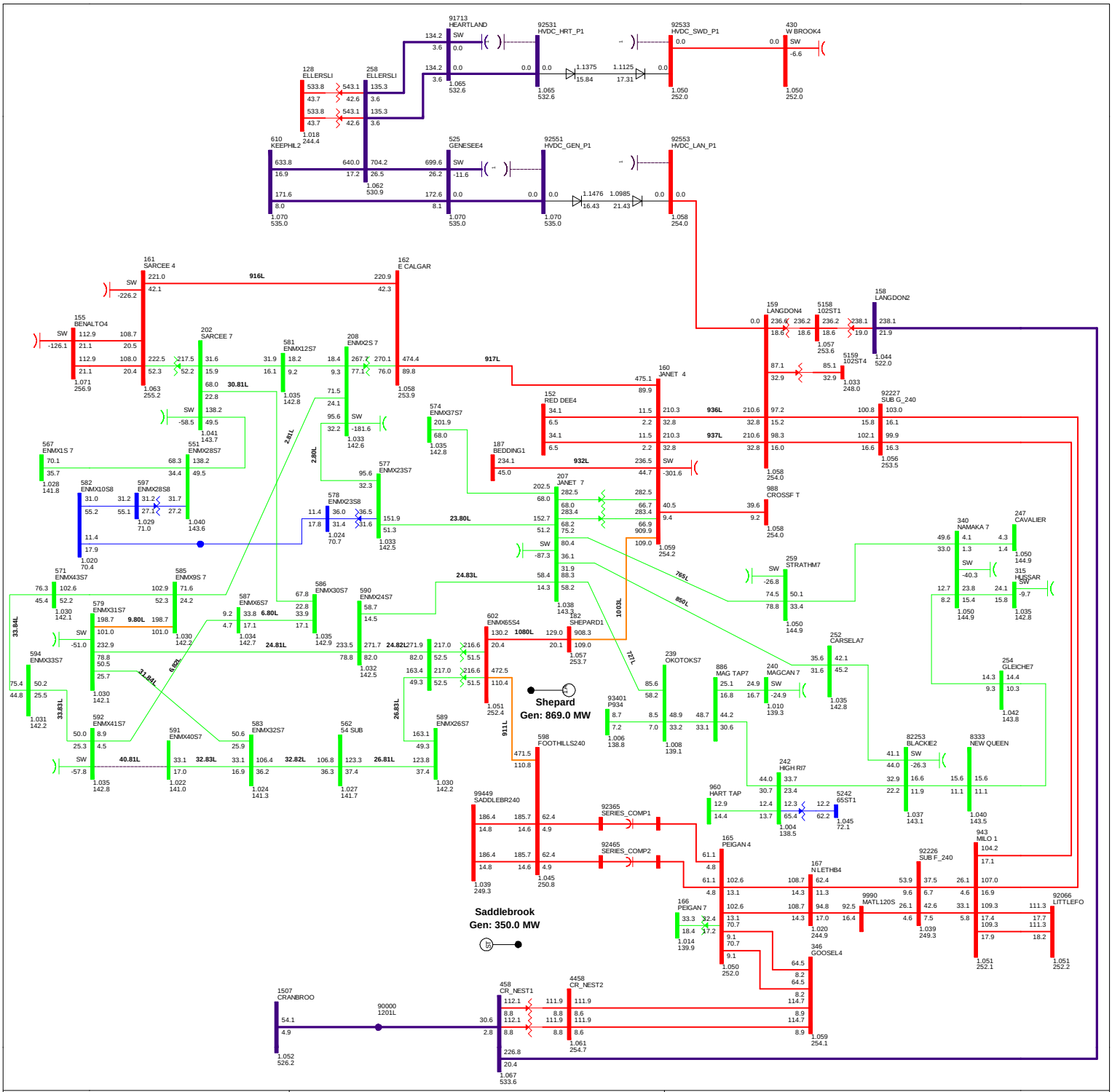
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



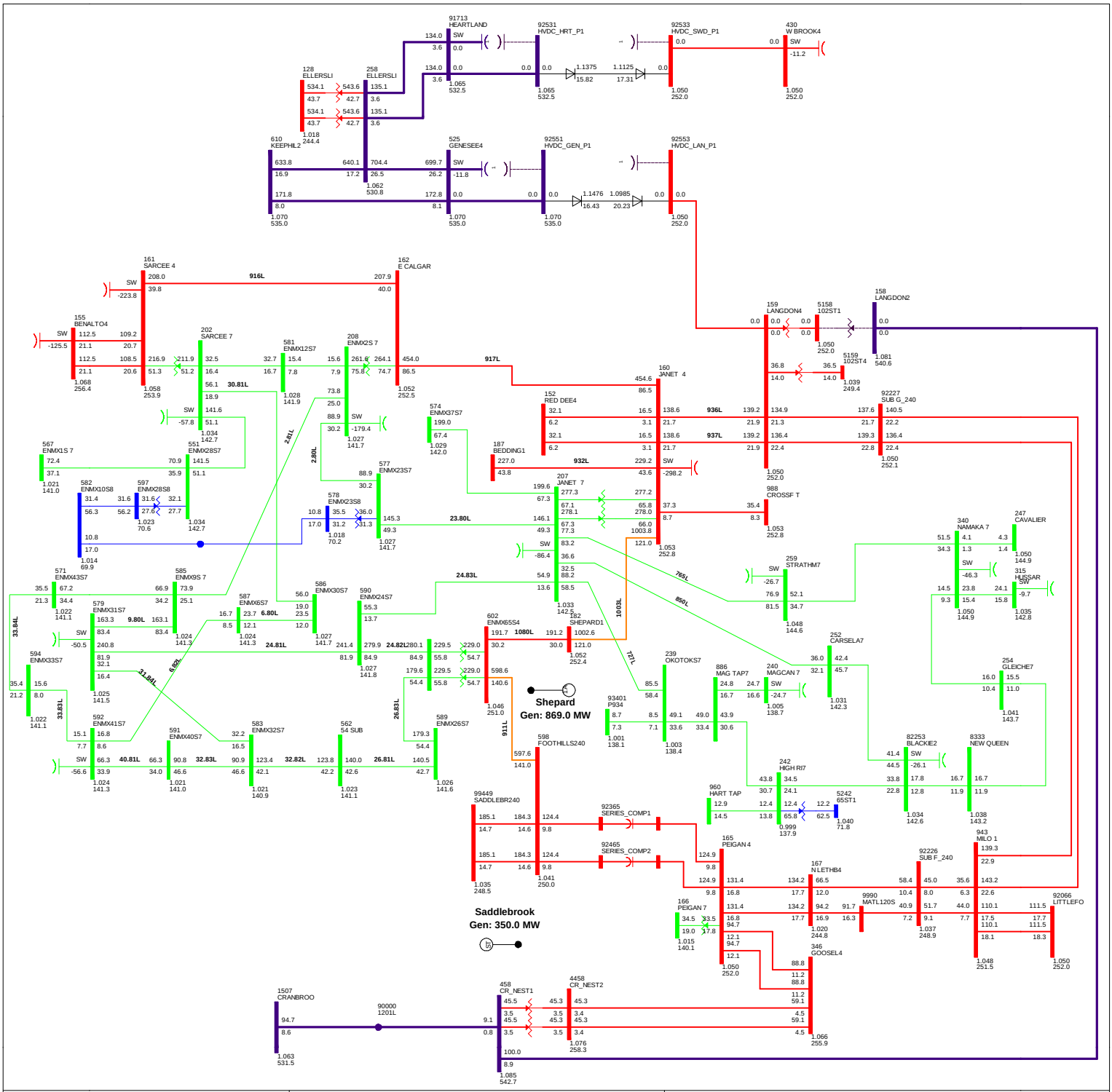
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATES
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

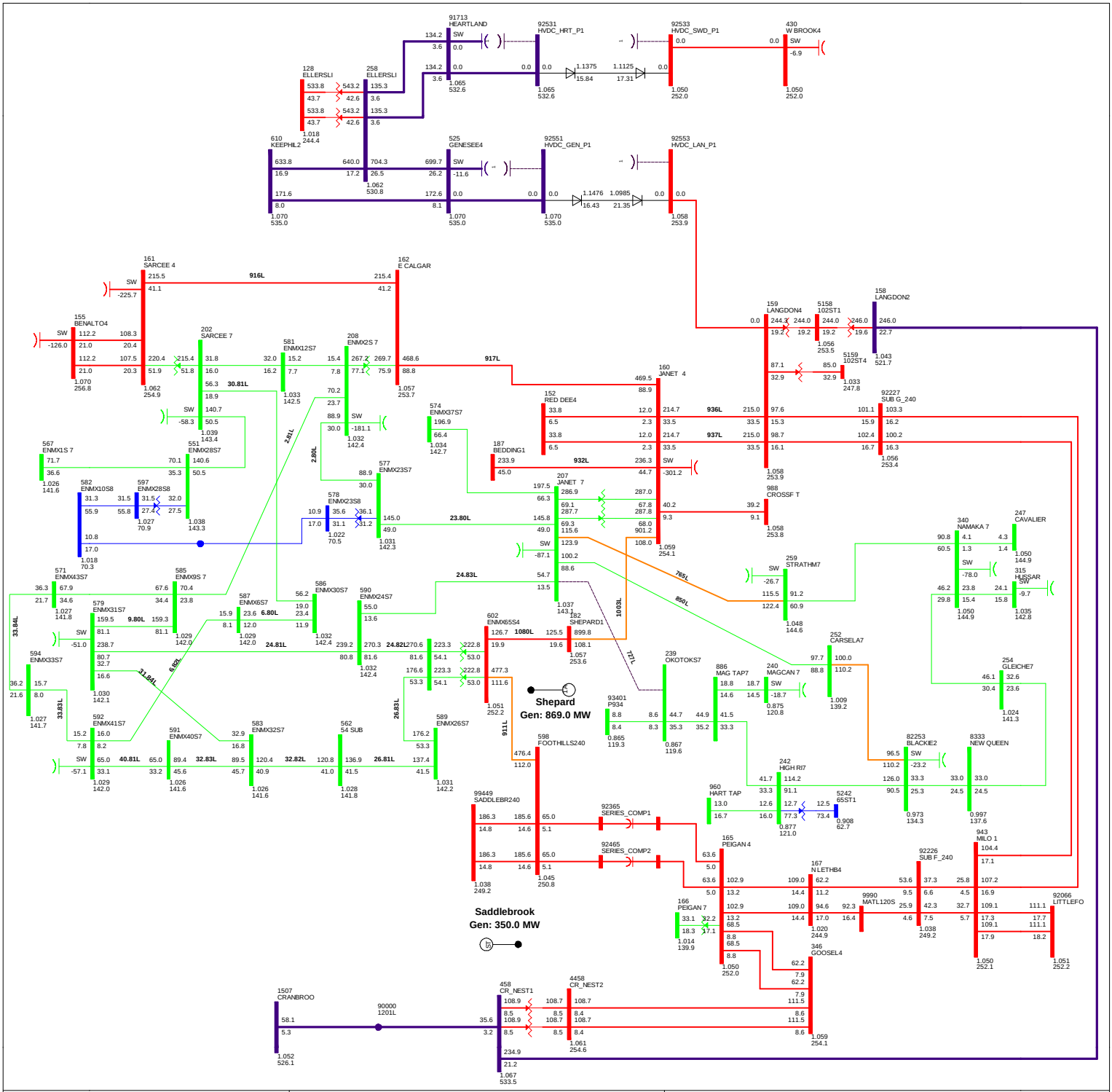
BCH Import: 10.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



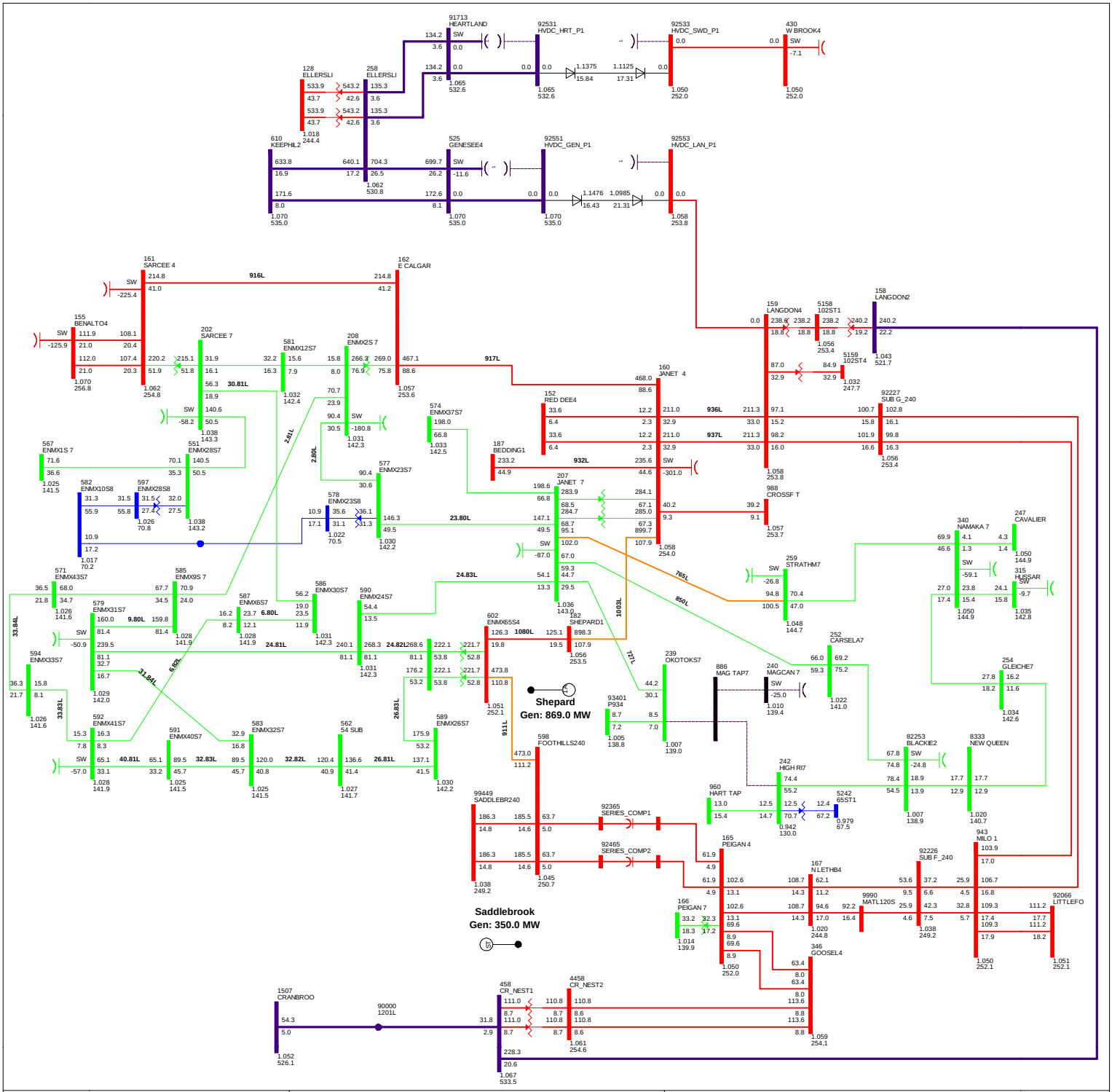
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 16.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 6
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



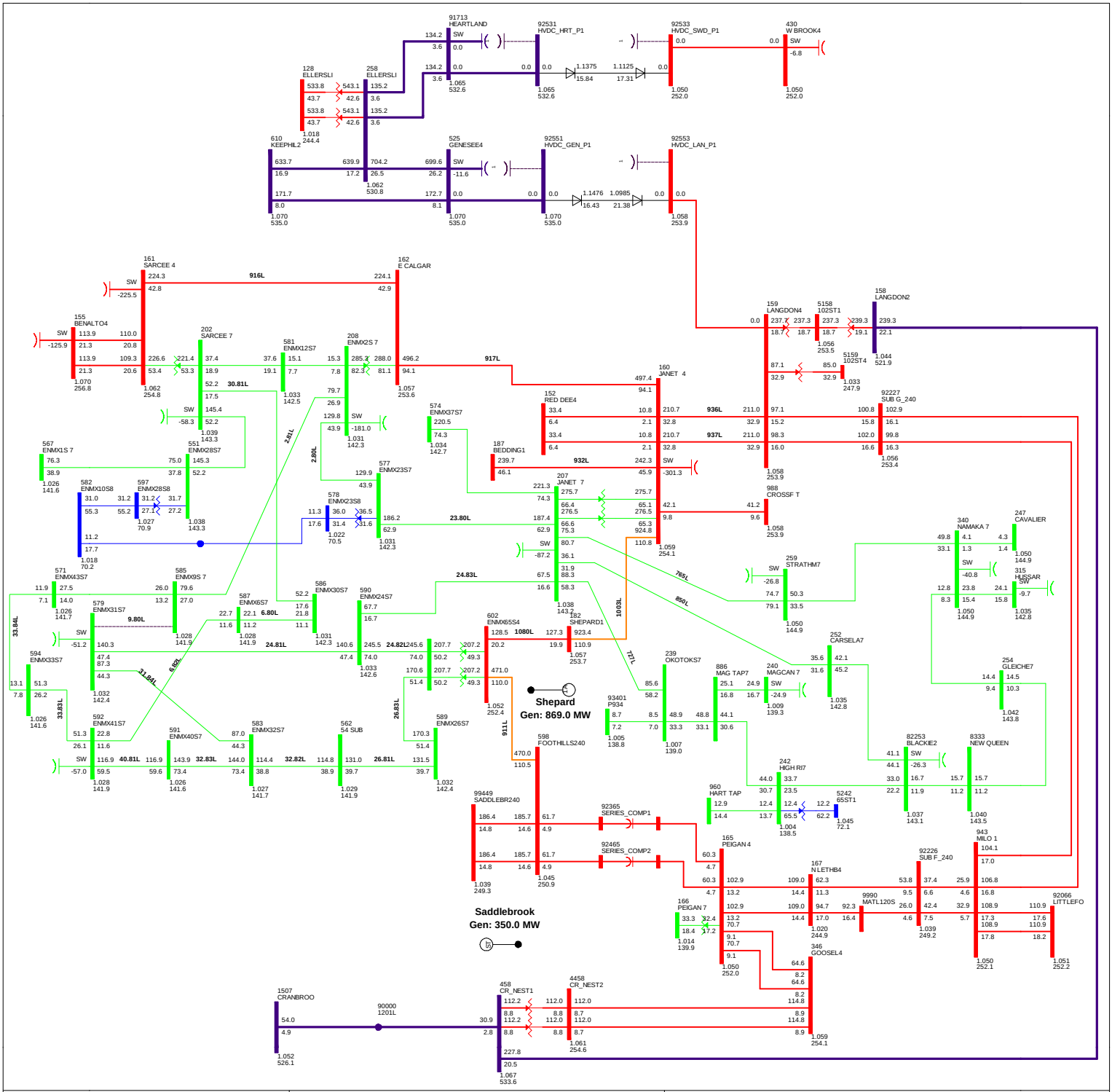
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100.0%RATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN 2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

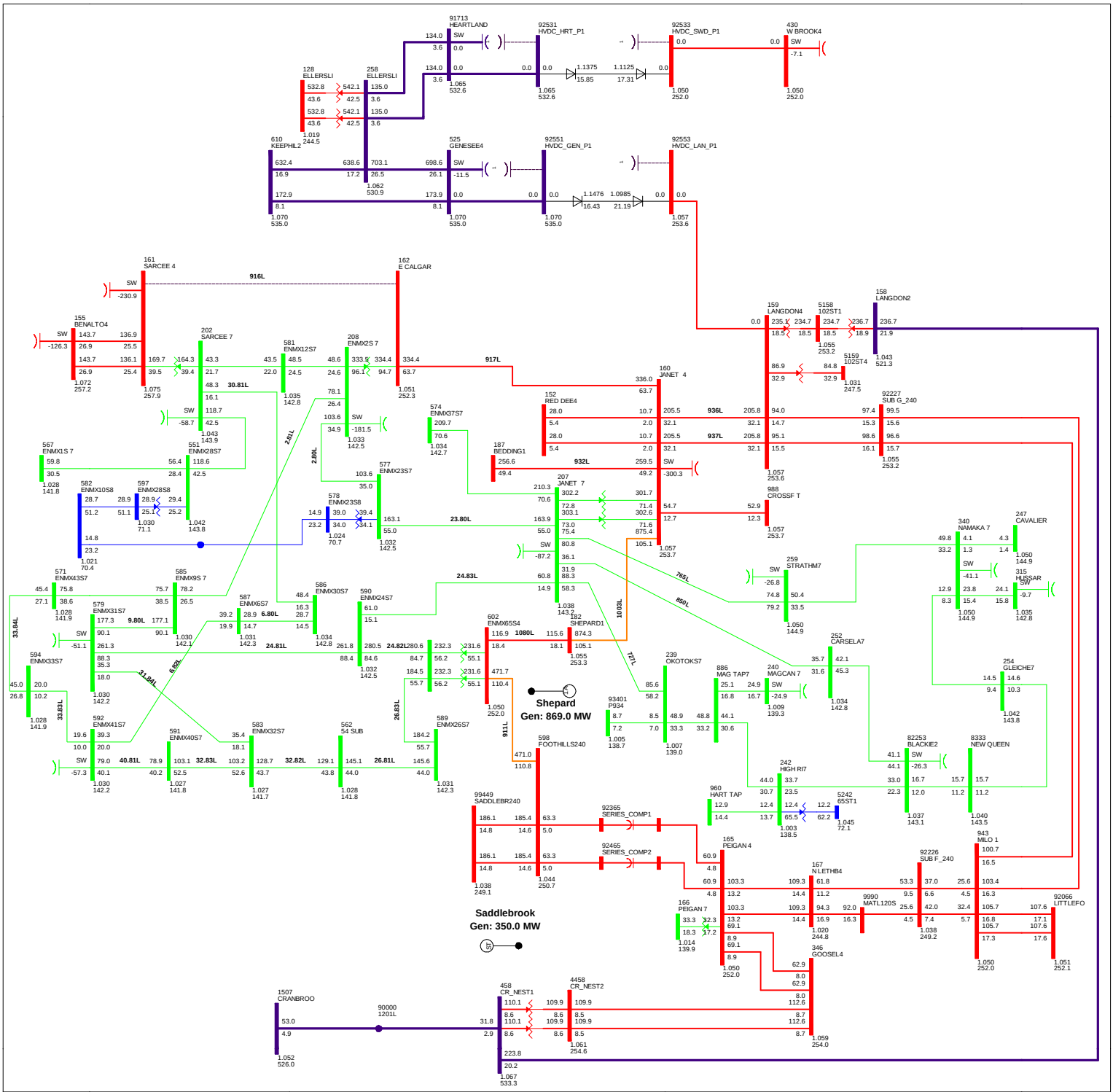
BCH Import: 2.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-22: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



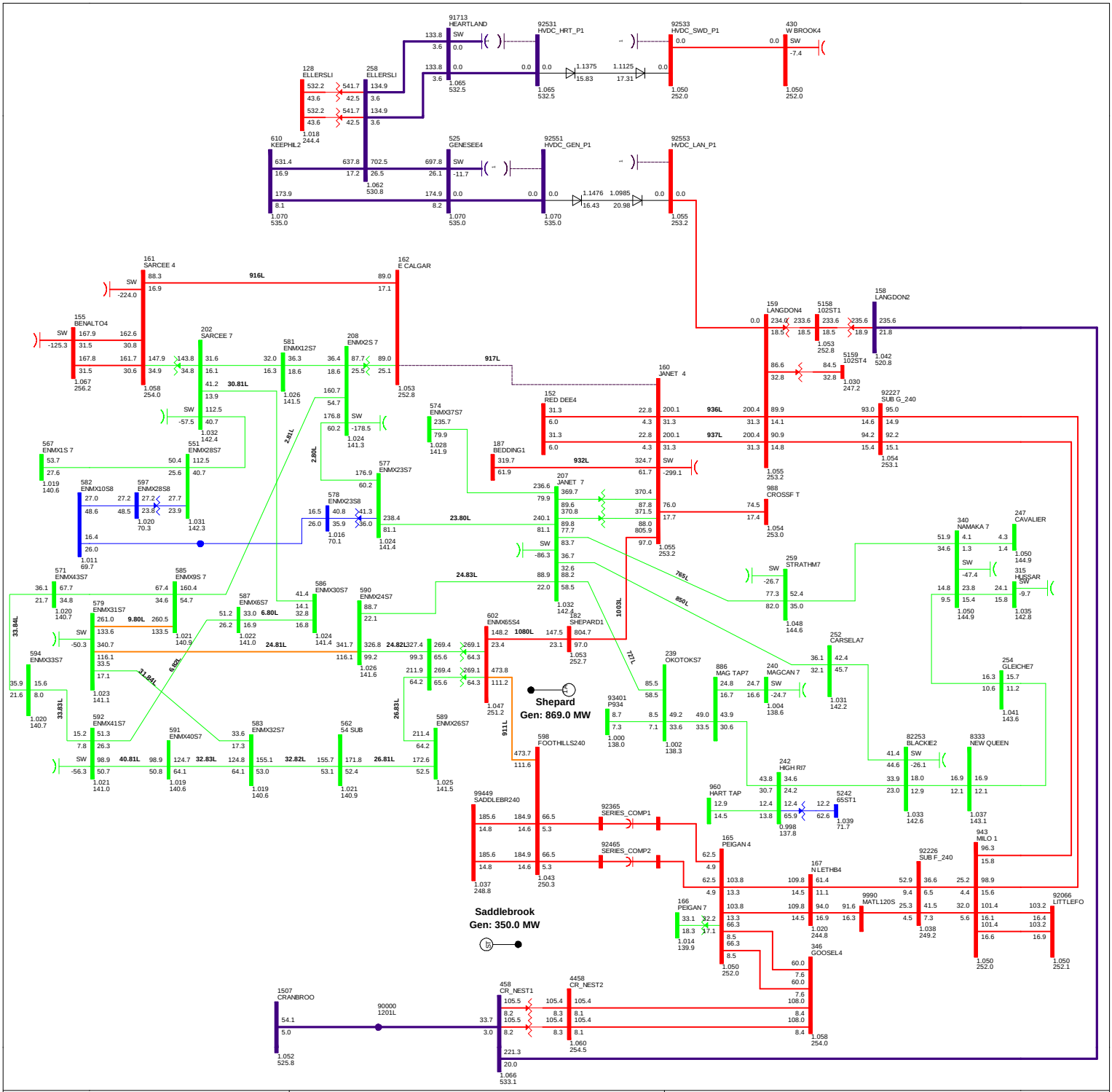
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-23: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CAL
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



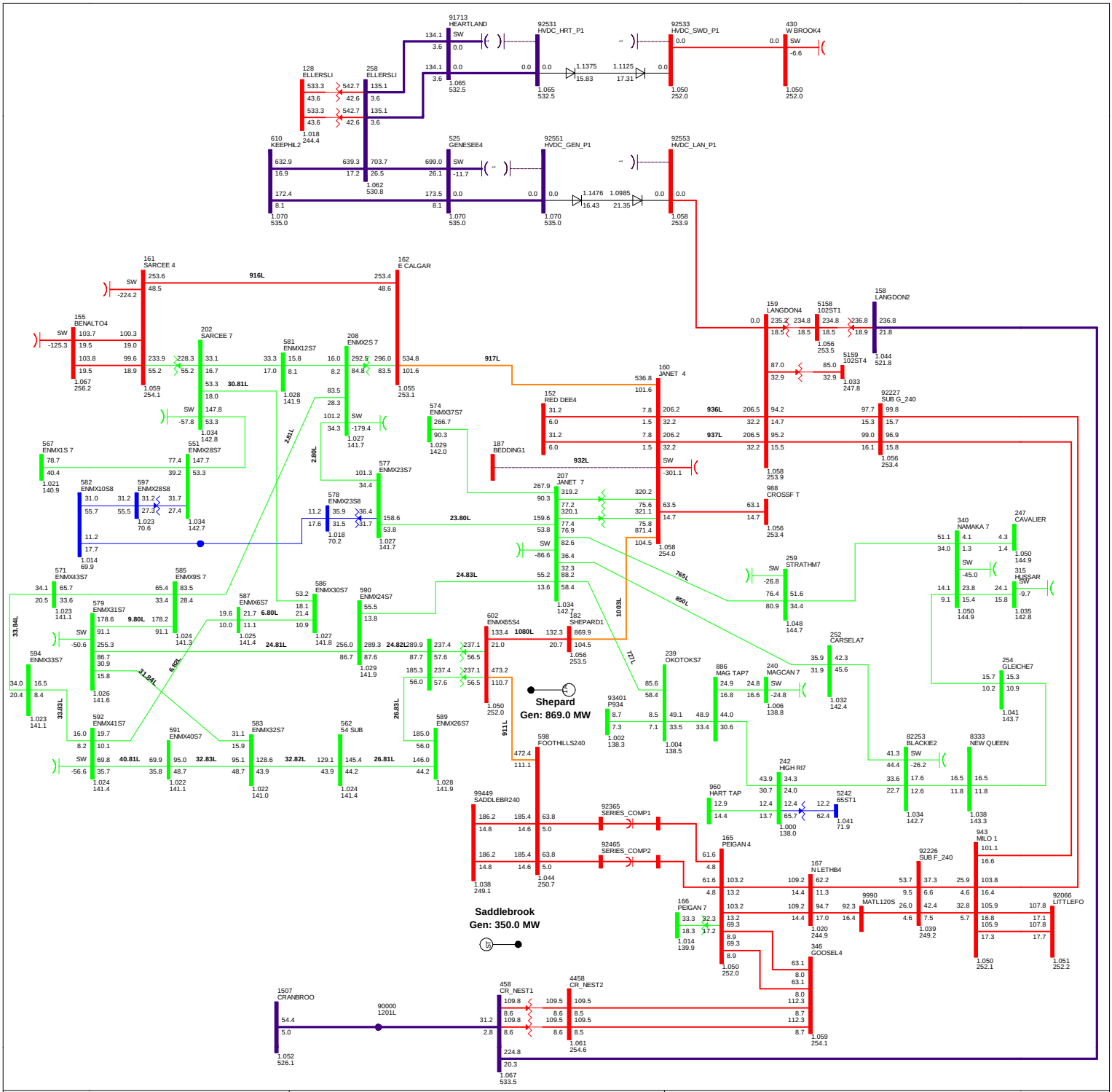
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 OVERRATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 13.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-24: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALG
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar

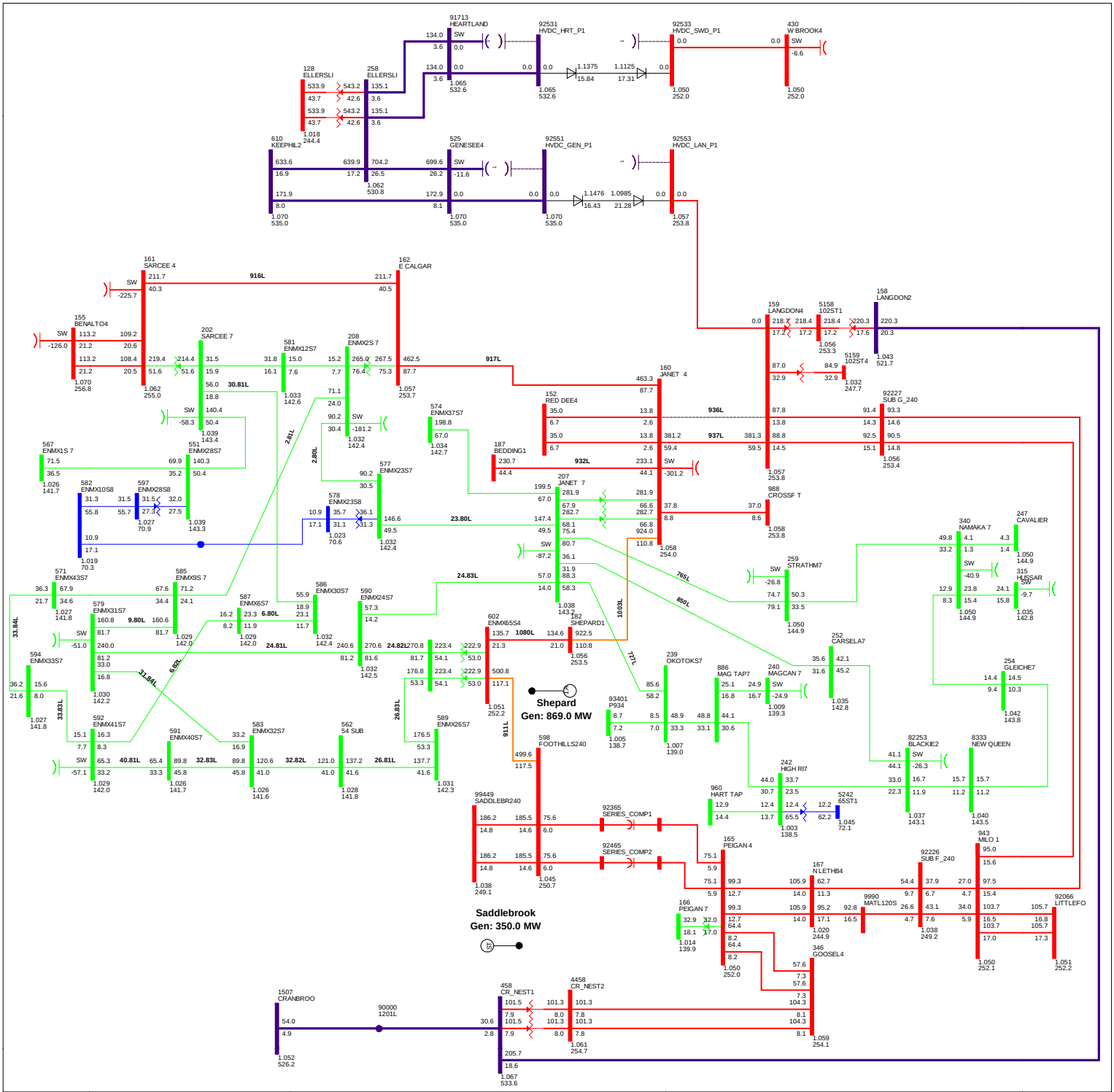
BCH Import: 4.9 MW

100 DNAPATER
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO EXISTING SYSTEM

FIG A-SC4B-25: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTO
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:32



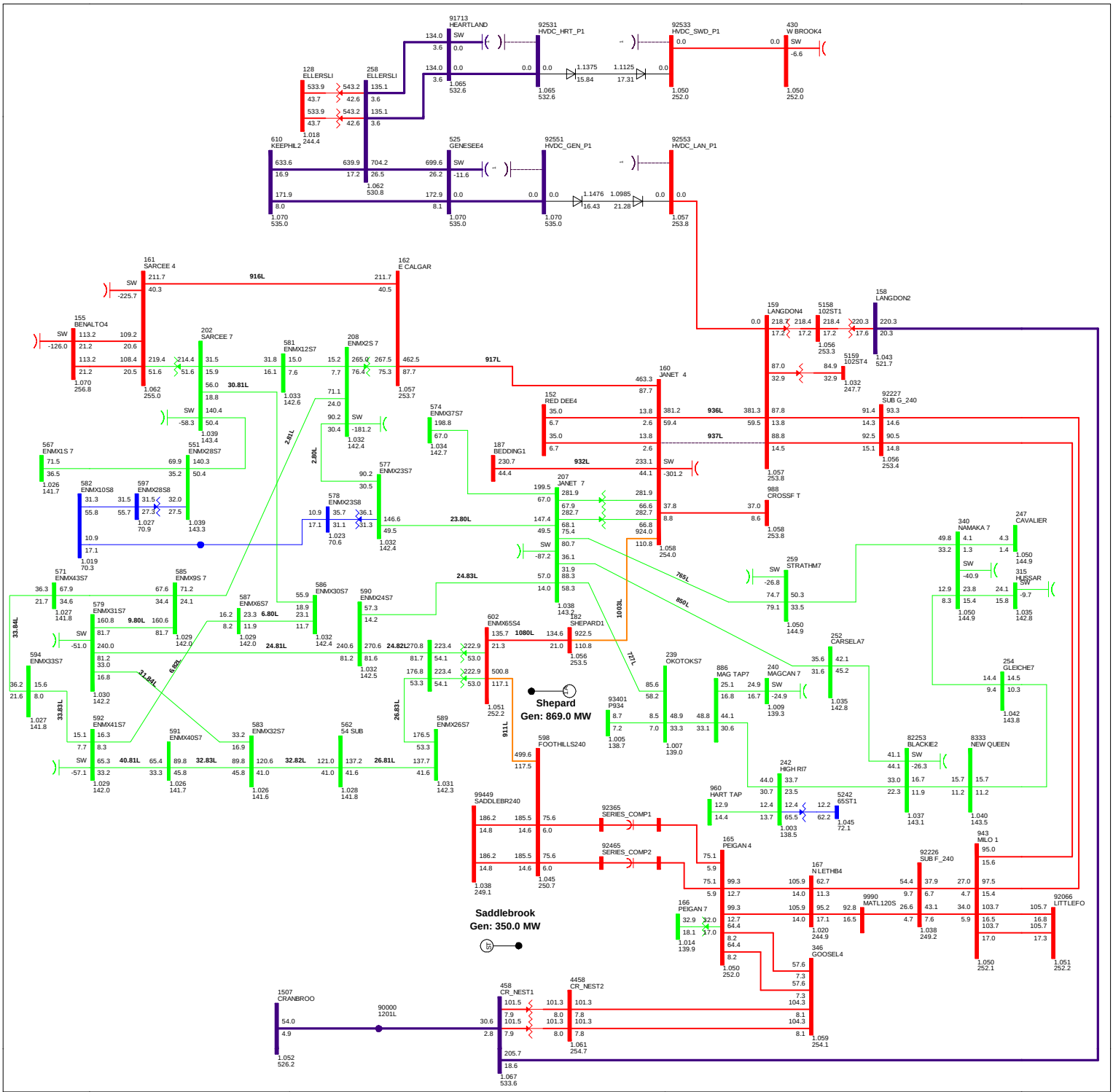
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100 DNARATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-26: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:32



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100.0%RATED
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

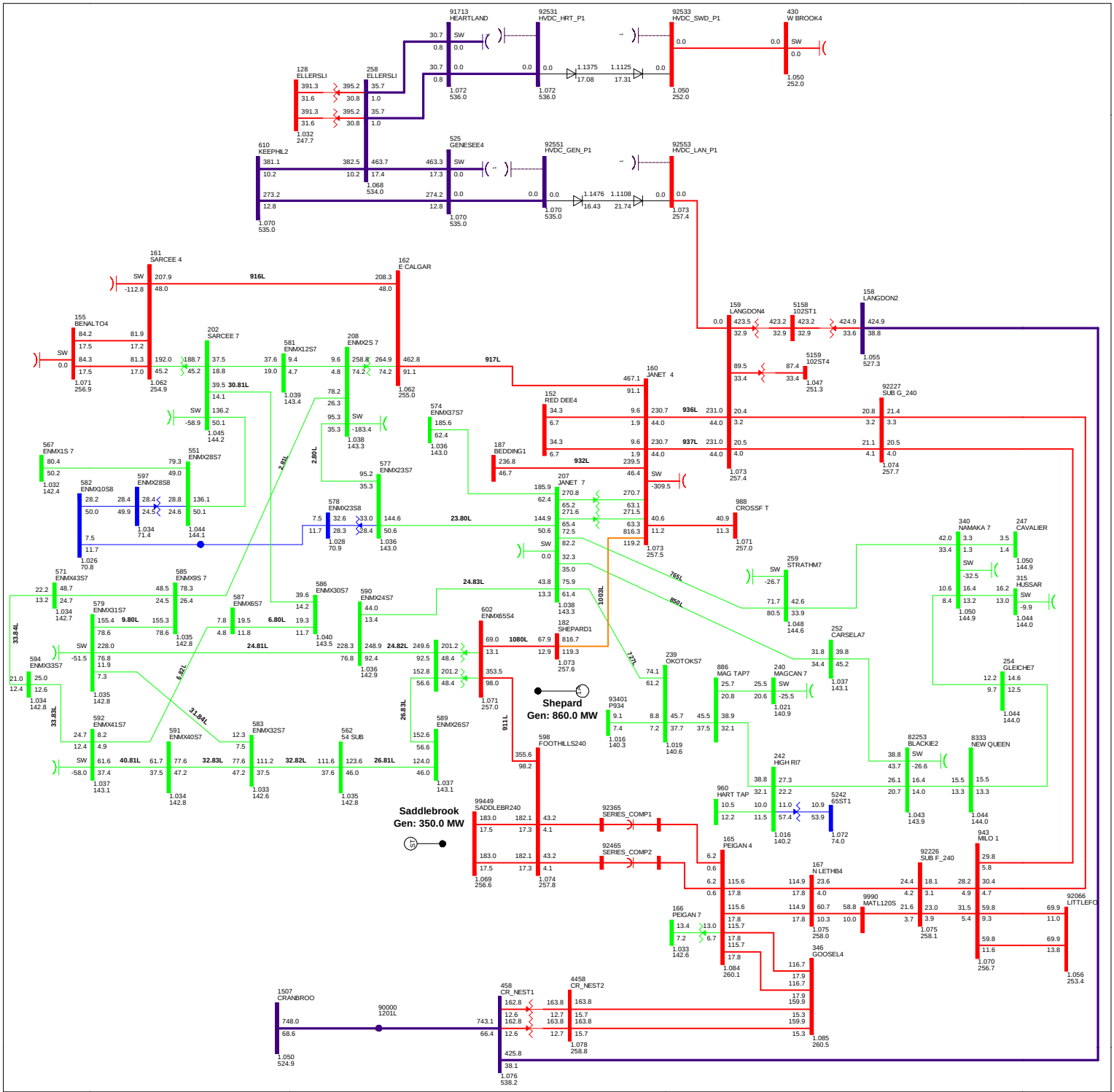
BCH Import: 2.6 MW

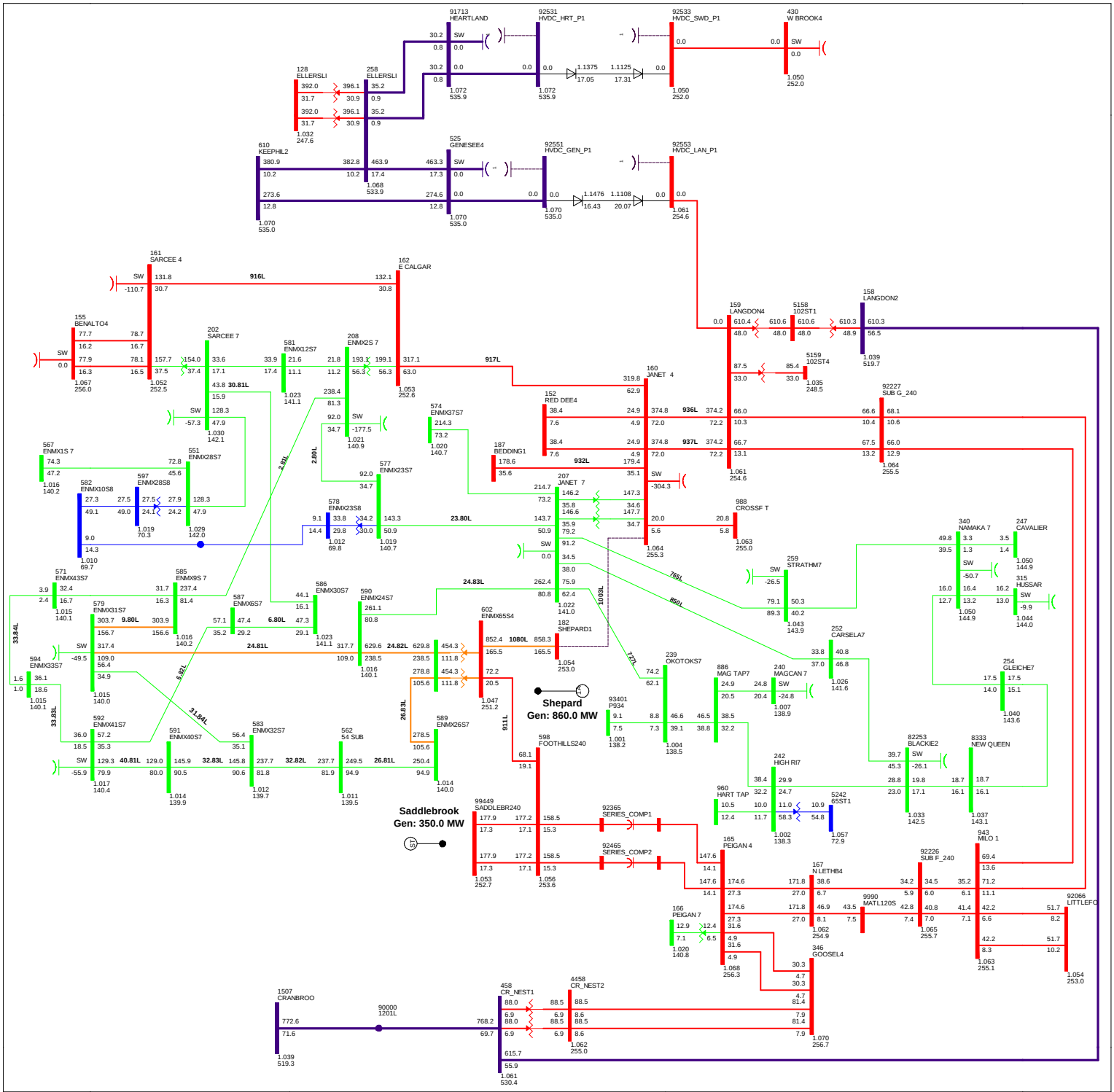
2012LTO EXISTING SYSTEM

FIG A-SC4B-27: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:32

2014 Loading Violations
Scenario 5


Shepard
Gen: 860.0 MW
Saddlebrook
Gen: 350.0 MW
91713 HEARTLAND
92531 HVDC_HRT_P1
92533 HVDC_SWD_P1
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
525 GENESEE4
92551 HVDC_GEN_P1
92553 HVDC_LAN_P1
610 KEEPHIL2
161 SARCEE 4
162 E CALGAR
155 BENALTO4
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
574 ENMX37S7
187 BEDDING1
152 RED DEE4
160 JANET 4
159 LANGDON4
5158 102ST1
158 LANGDON2
5159 102ST4
92227 SUB G_240
567 ENMX1S 7
551 ENMX28S7
582 ENMX10S8
597 ENMX28S8
577 ENMX23S7
578 ENMX23S8
207 JANET 7
988 CROSSF T
259 STRATHM7
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
571 ENMX43S7
585 ENMX9S 7
579 ENMX31S7
586 ENMX30S7
587 ENMX6S7
590 ENMX24S7
602 ENMX65S4
182 SHEPARD1
239 OKOTOKS7
886 MAG TAP7
240 MAGCAN 7
252 CARSELA7
254 GLEICHE7
594 ENMX33S7
592 ENMX41S7
591 ENMX40S7
583 ENMX32S7
562 54 SUB
589 ENMX26S7
598 FOOTHILLS240
93401 P934
242 HIGH RI7
960 HART TAP
5242 65ST1
82253 BLACKIE2
8333 NEW QUEEN
99449 SADDLEBR240
92365 SERIES_COMP1
92465 SERIES_COMP2
165 PEIGAN 4
166 PEIGAN 7
167 N LETHB4
9990 MATL120S
92226 SUB F_240
943 MILO 1
92066 LITTLEFO
346 GOOSEL4
1507 CRANBROO
90000 1201L
458 CR_NEST1
4458 CR_NEST2
33.84L
33.83L
31.84L
6.82L
24.81L
6.80L
24.82L
24.83L
23.80L
2.80L
916L
917L
936L
937L
932L
765L
850L
1003L
911L
26.83L
32.82L
32.83L
40.81L
26.81L
30.81L
9.80L
1080L
BCH Import: 780.3 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG A-SC5-1: BASECASE
2014_SP_EXISTING_SC5
FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

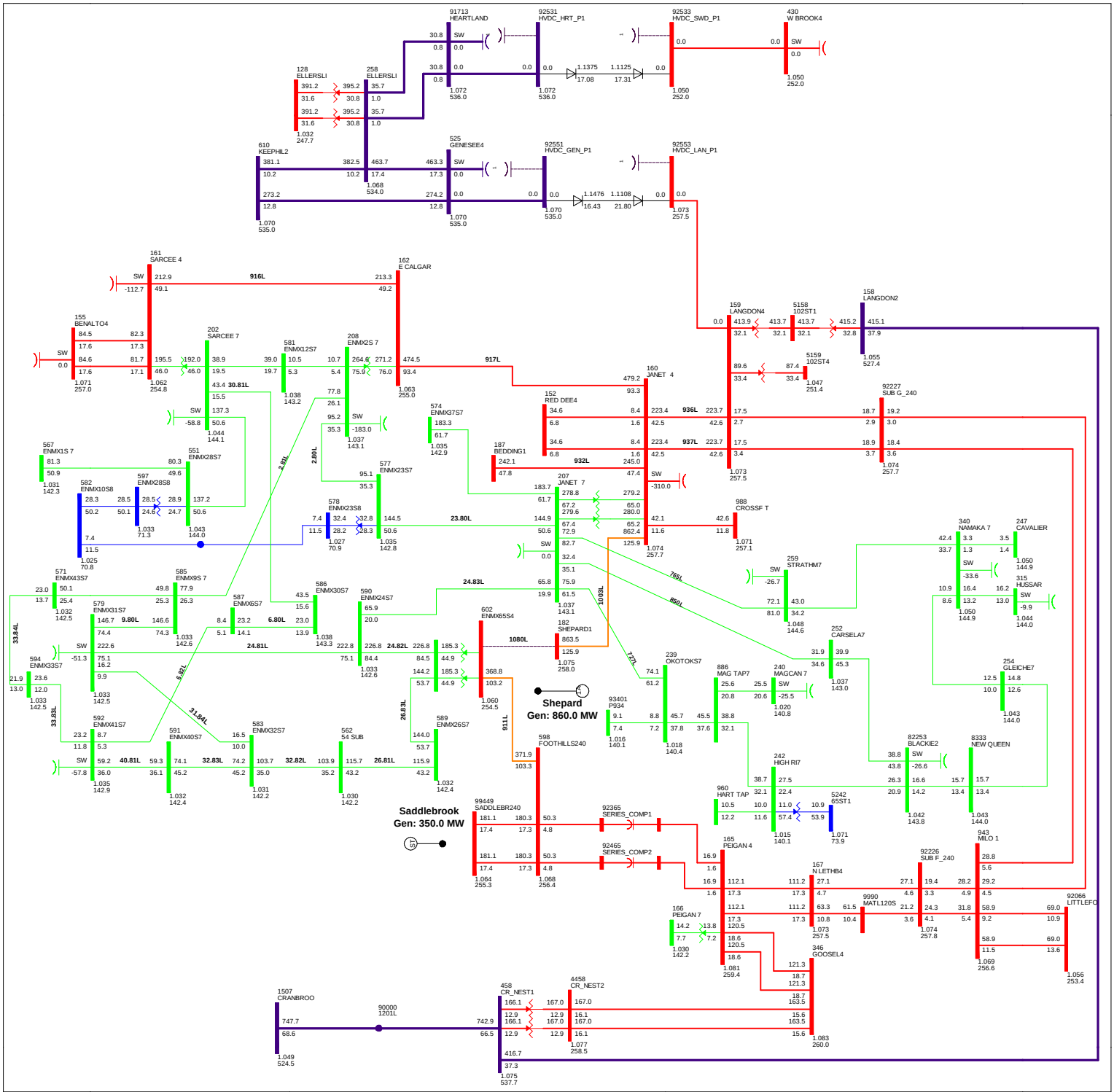
BCH Import: 809.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

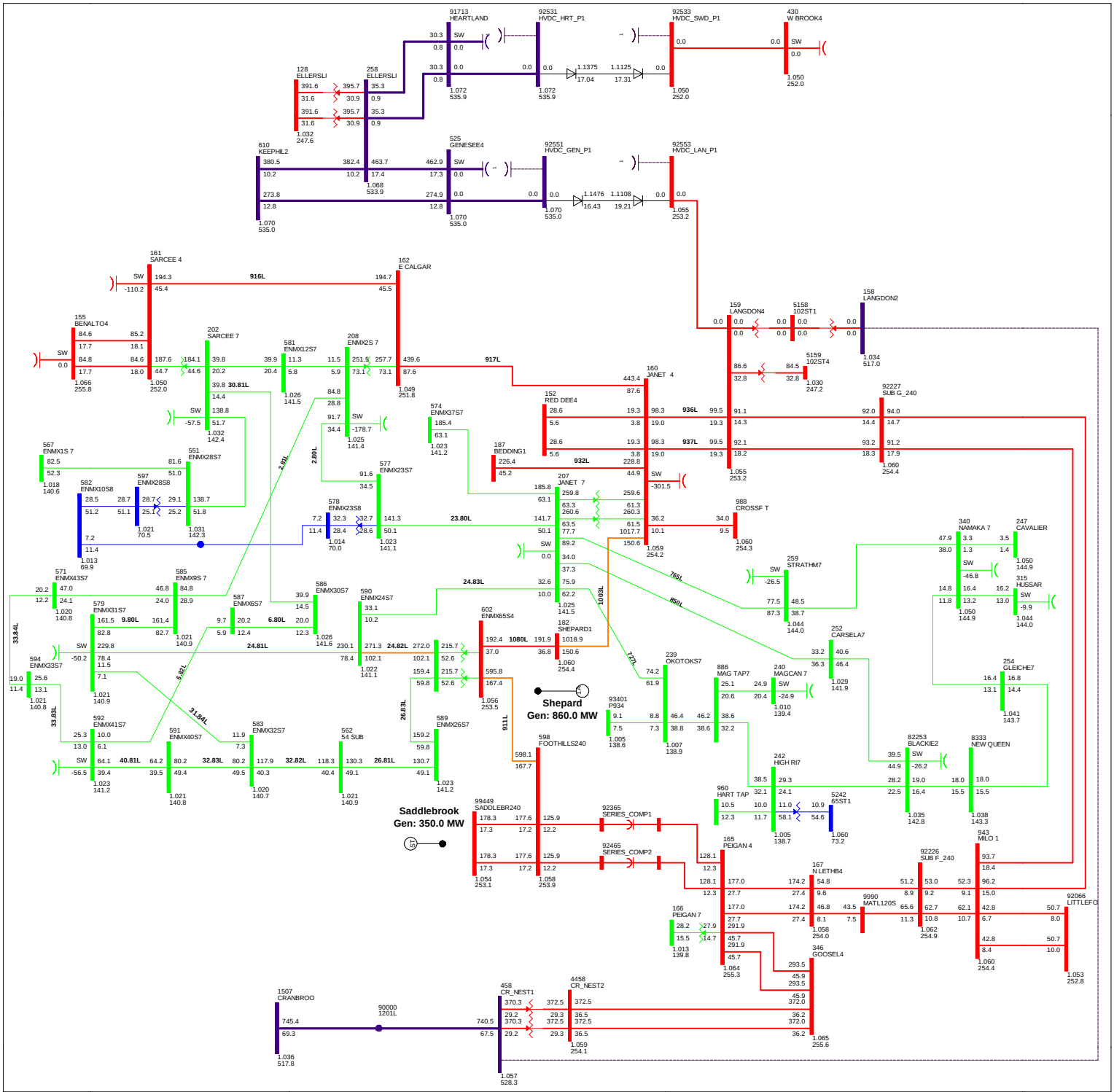
BCH Import: 780.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

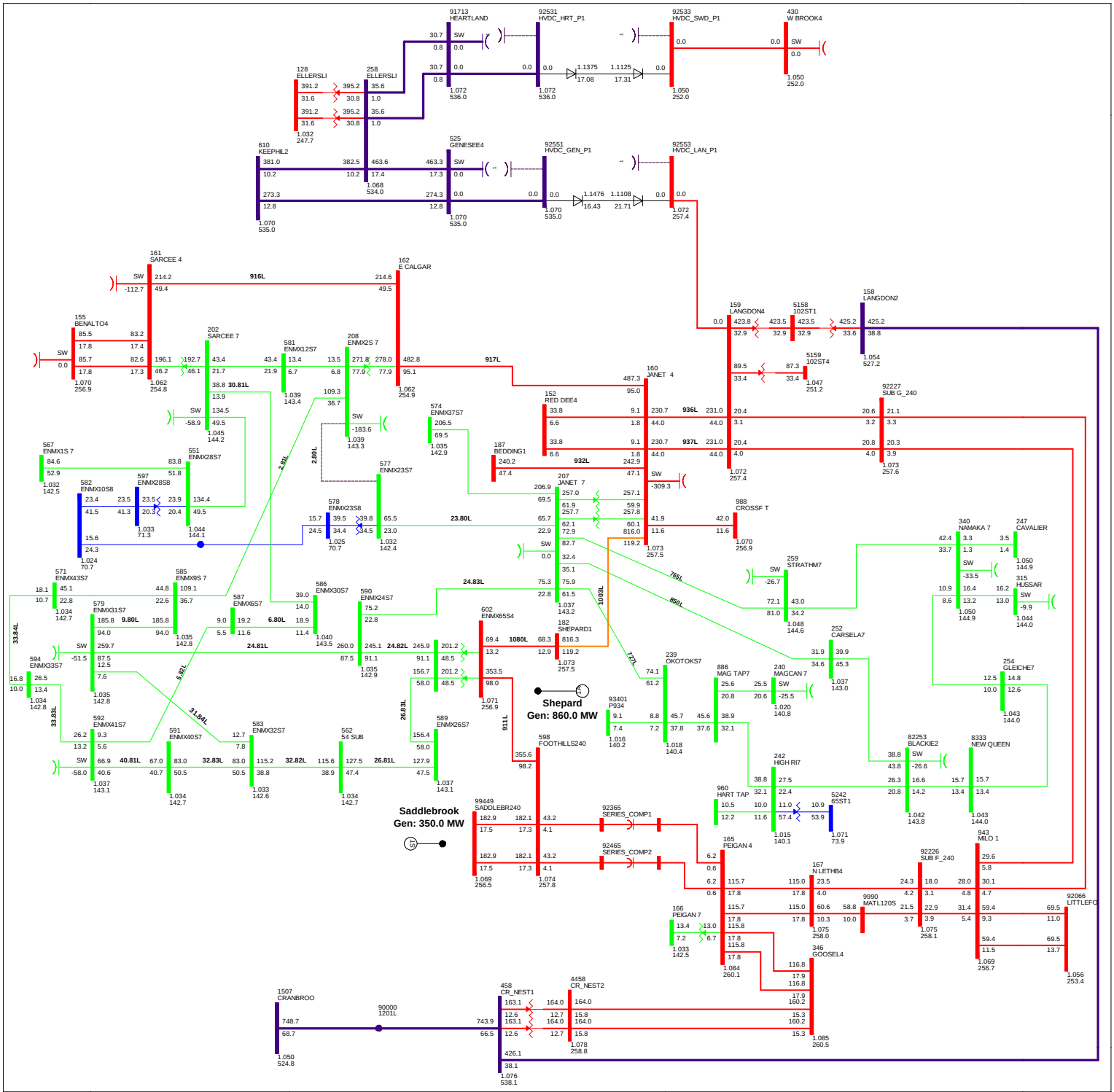
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 806.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

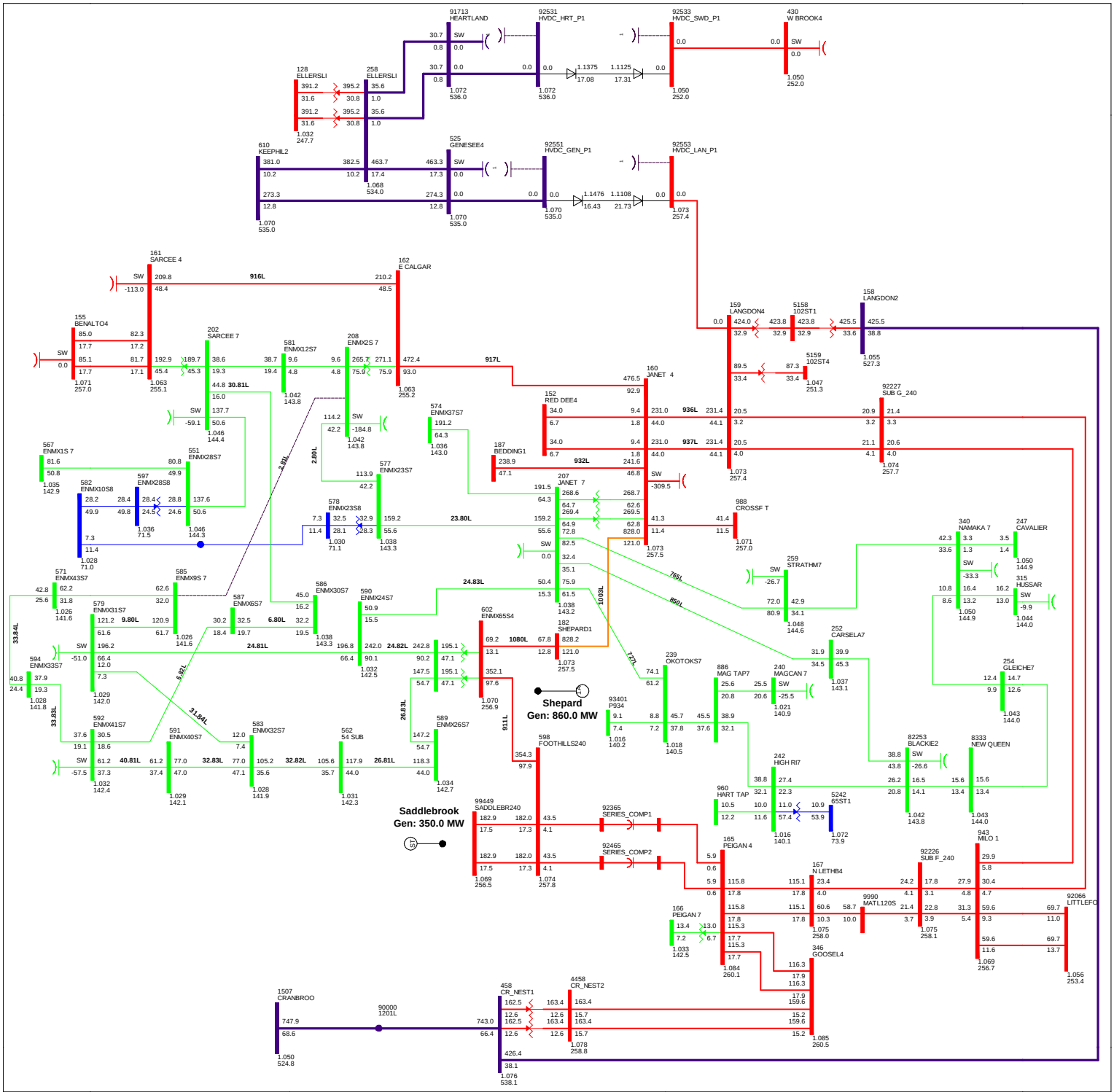
BCH Import: 781.5 MW

2012LTO EXISTING SYSTEM

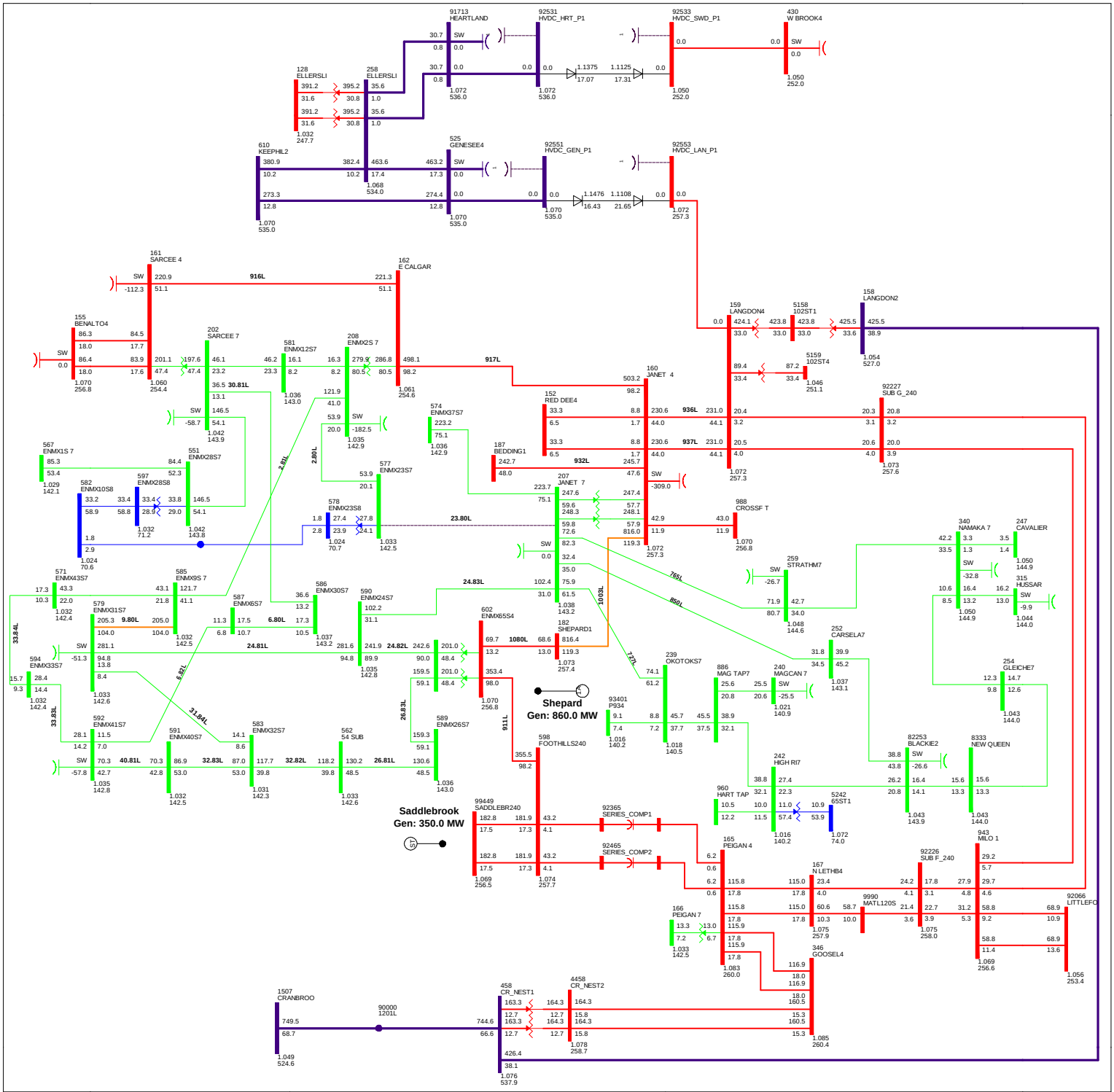
FIG A-SC5-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU) Branch - MVA/% OF RATE A Equipment - MW/Mvar 100.0%RATEA KV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000 BCH Import: 780.4 MW	2012LTO EXISTING SYSTEM	FIG A-SC5-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9) 2014_SP_EXISTING_SC5 FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

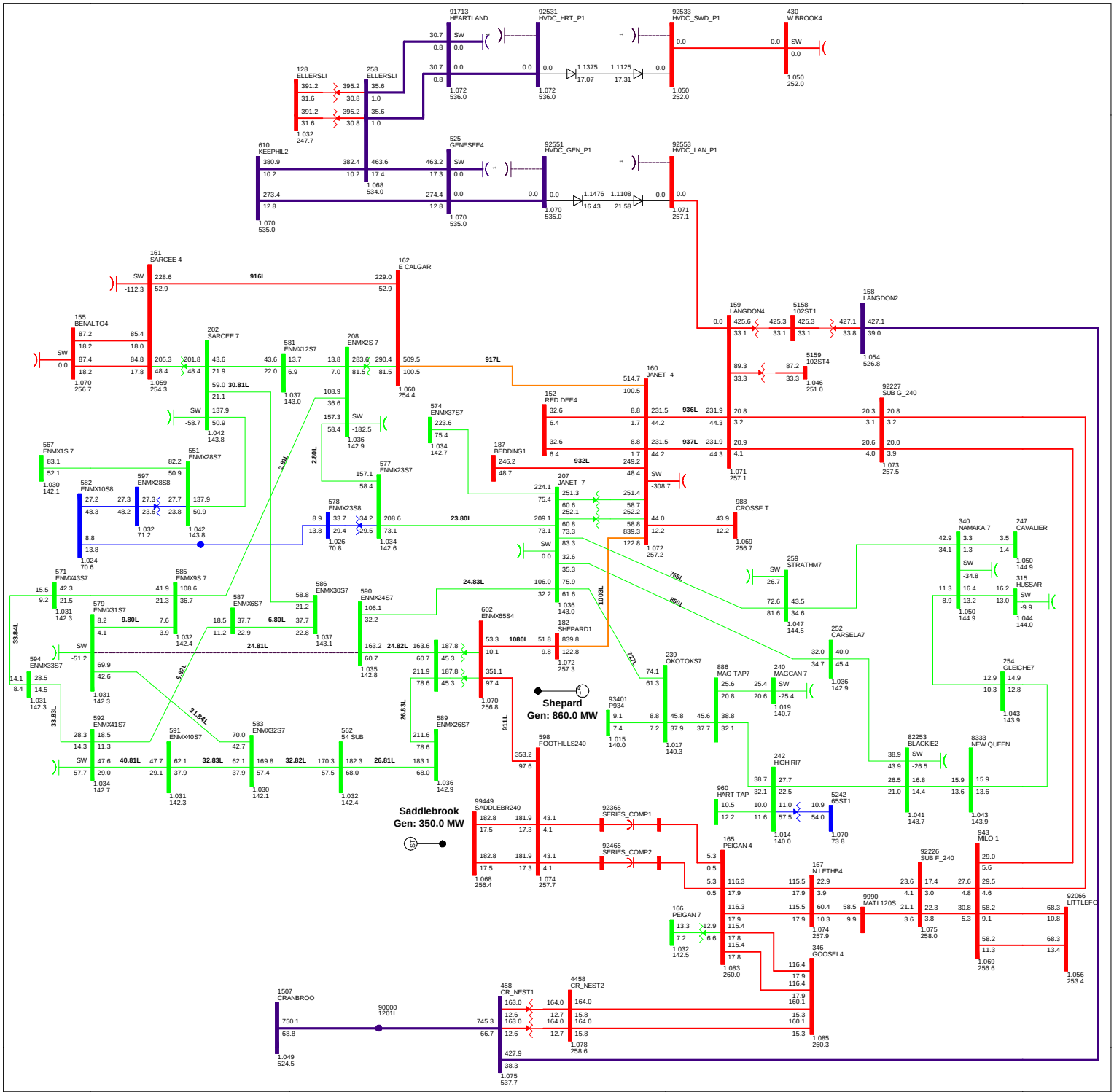
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

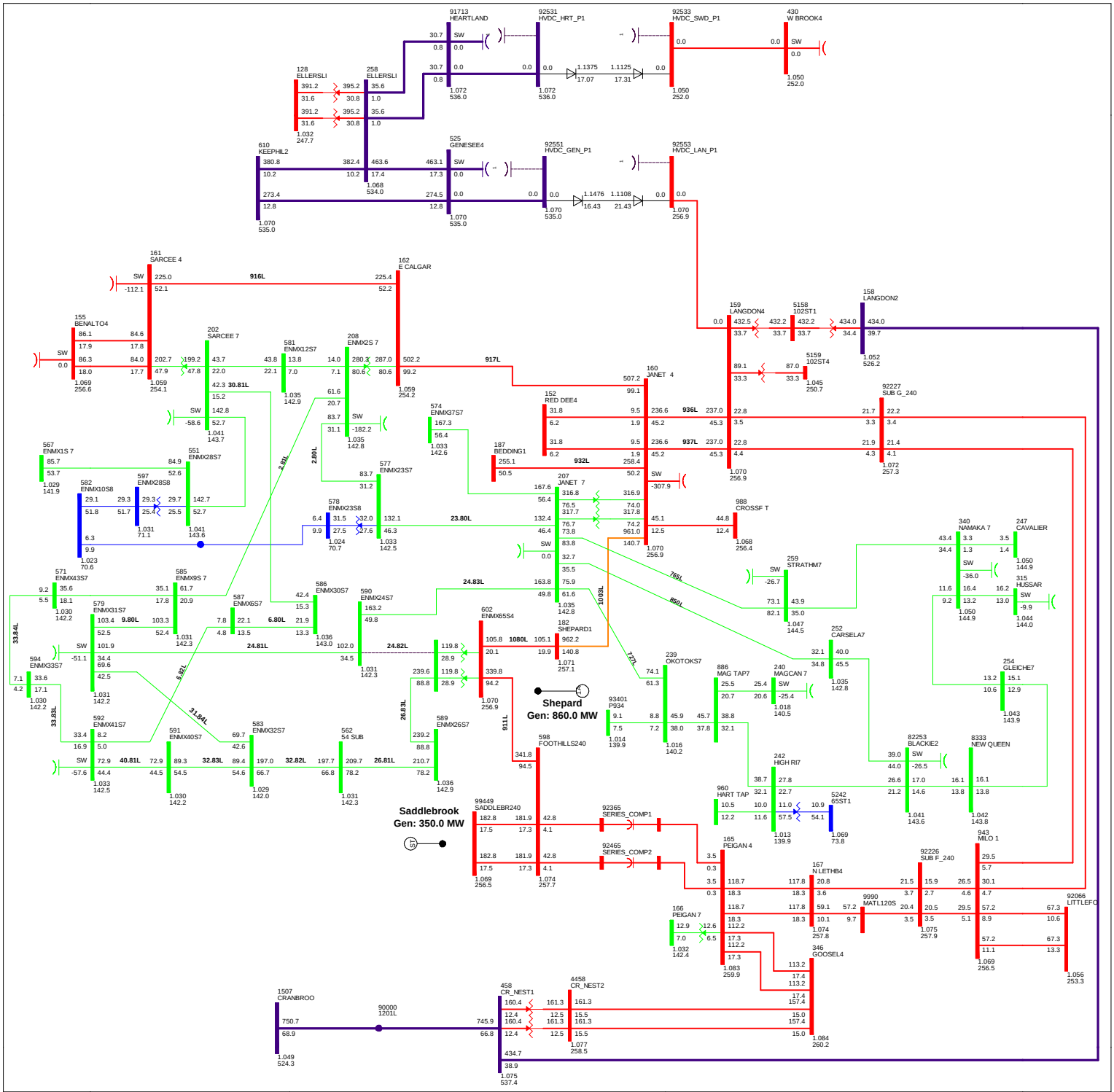
BCH Import: 783.6 MW

2012LTO EXISTING SYSTEM

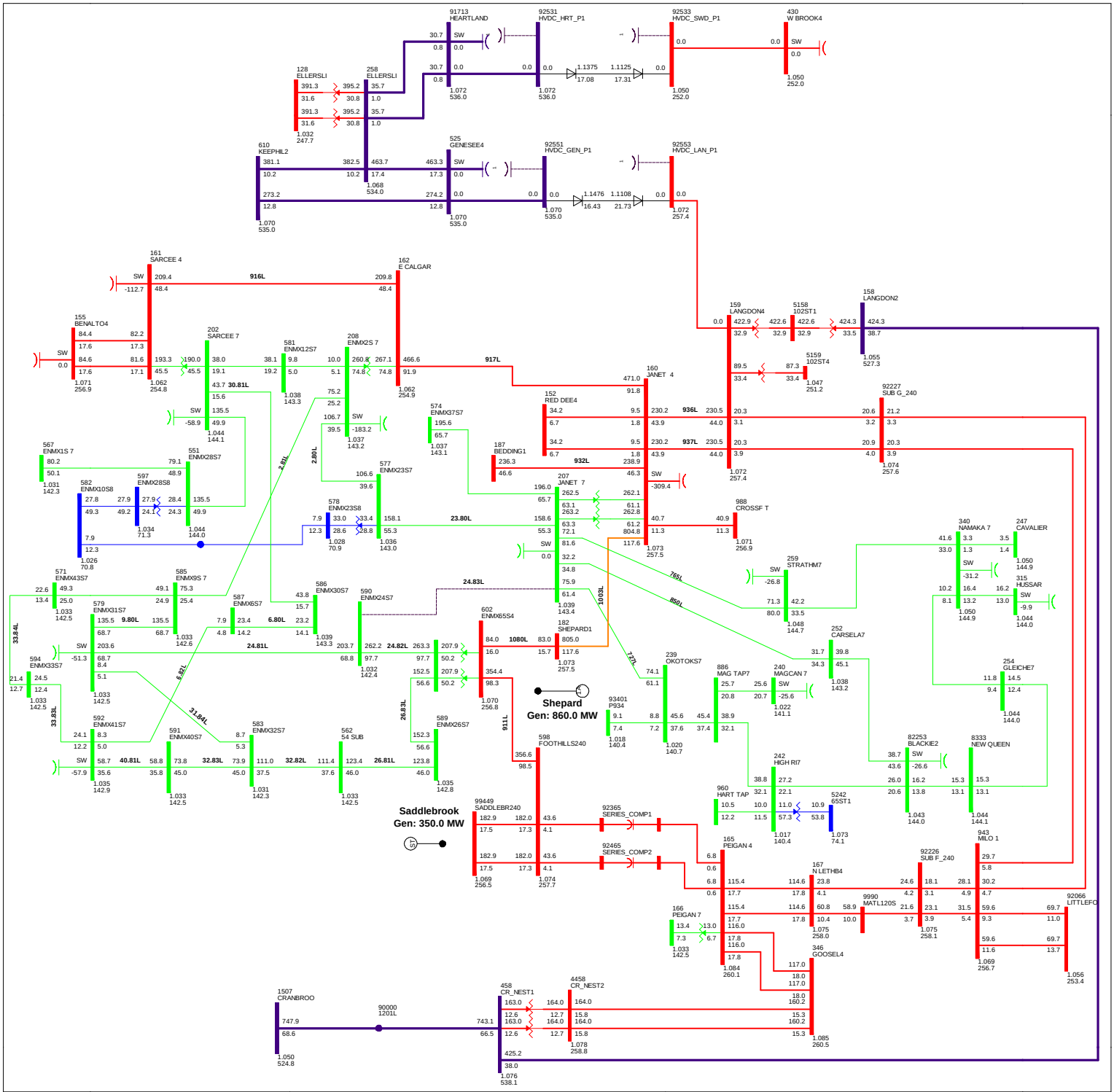
FIG A-SC5-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU) Branch - MVA/% OF RATE A Equipment - MW/Mvar 100.0%RATEA kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000 BCH Import: 784.4 MW	2012LTO EXISTING SYSTEM	FIG A-SC5-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24) 2014_SP_EXISTING_SC5 FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

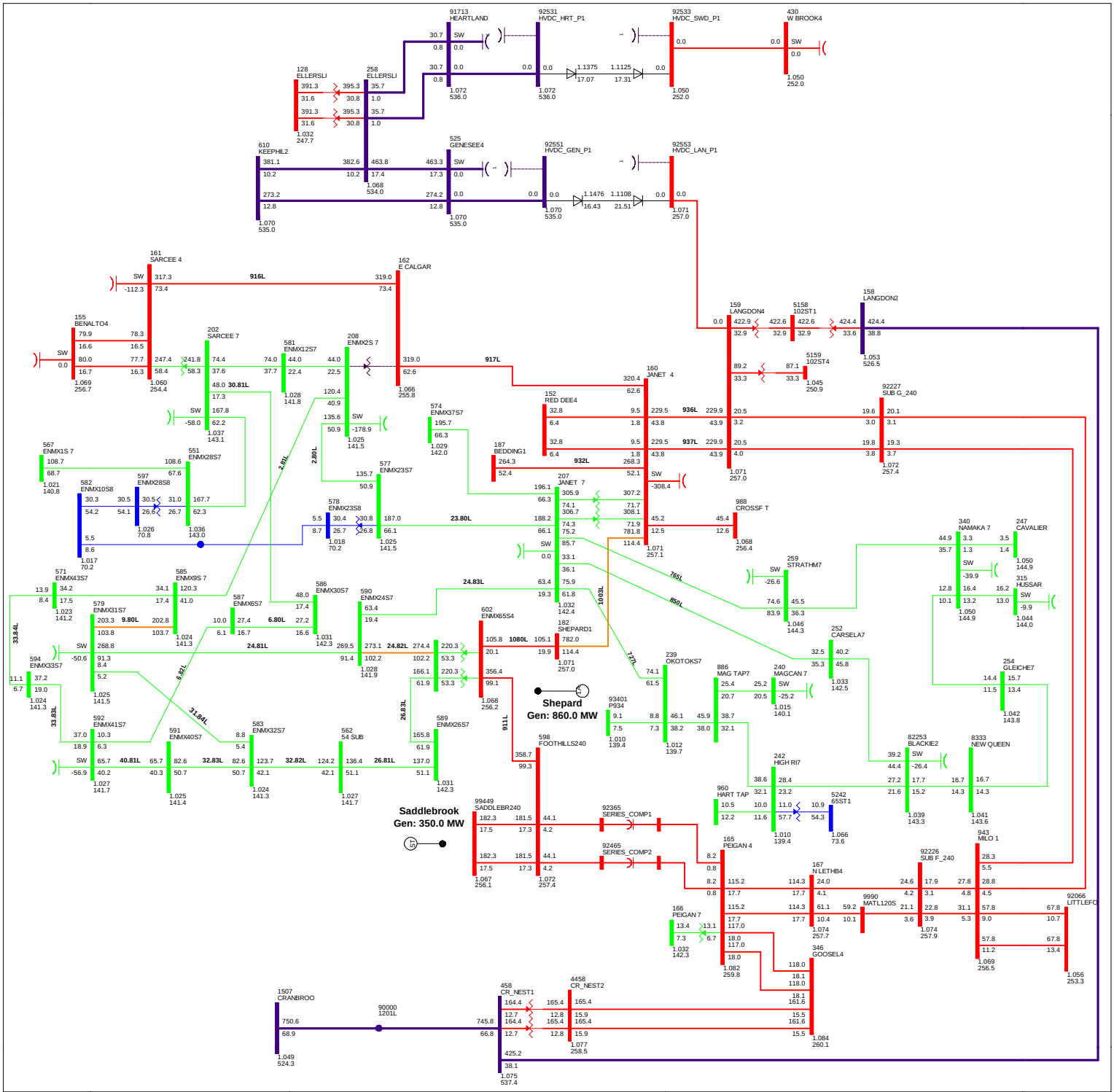
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

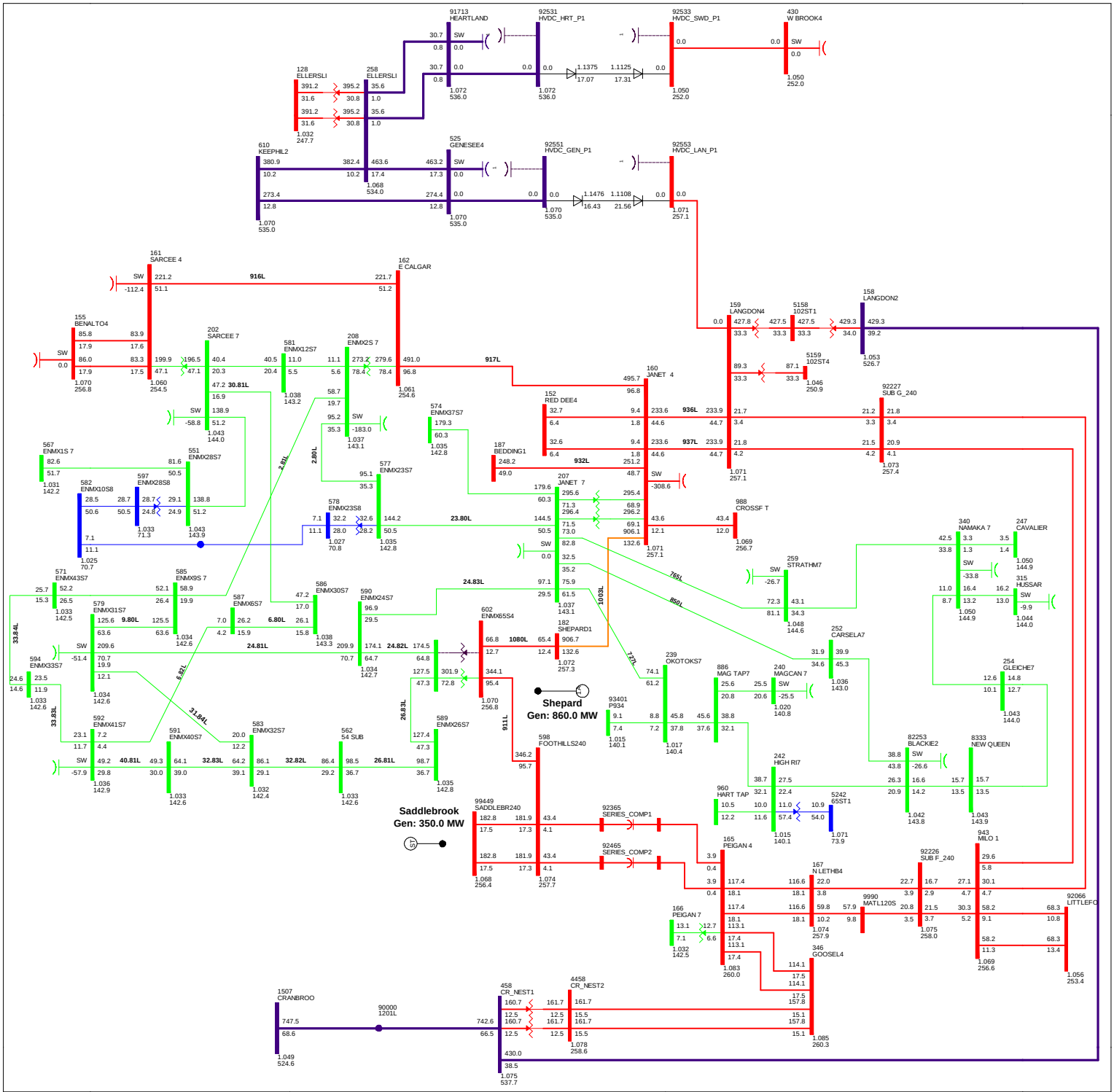
BCH Import: 784.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
KV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

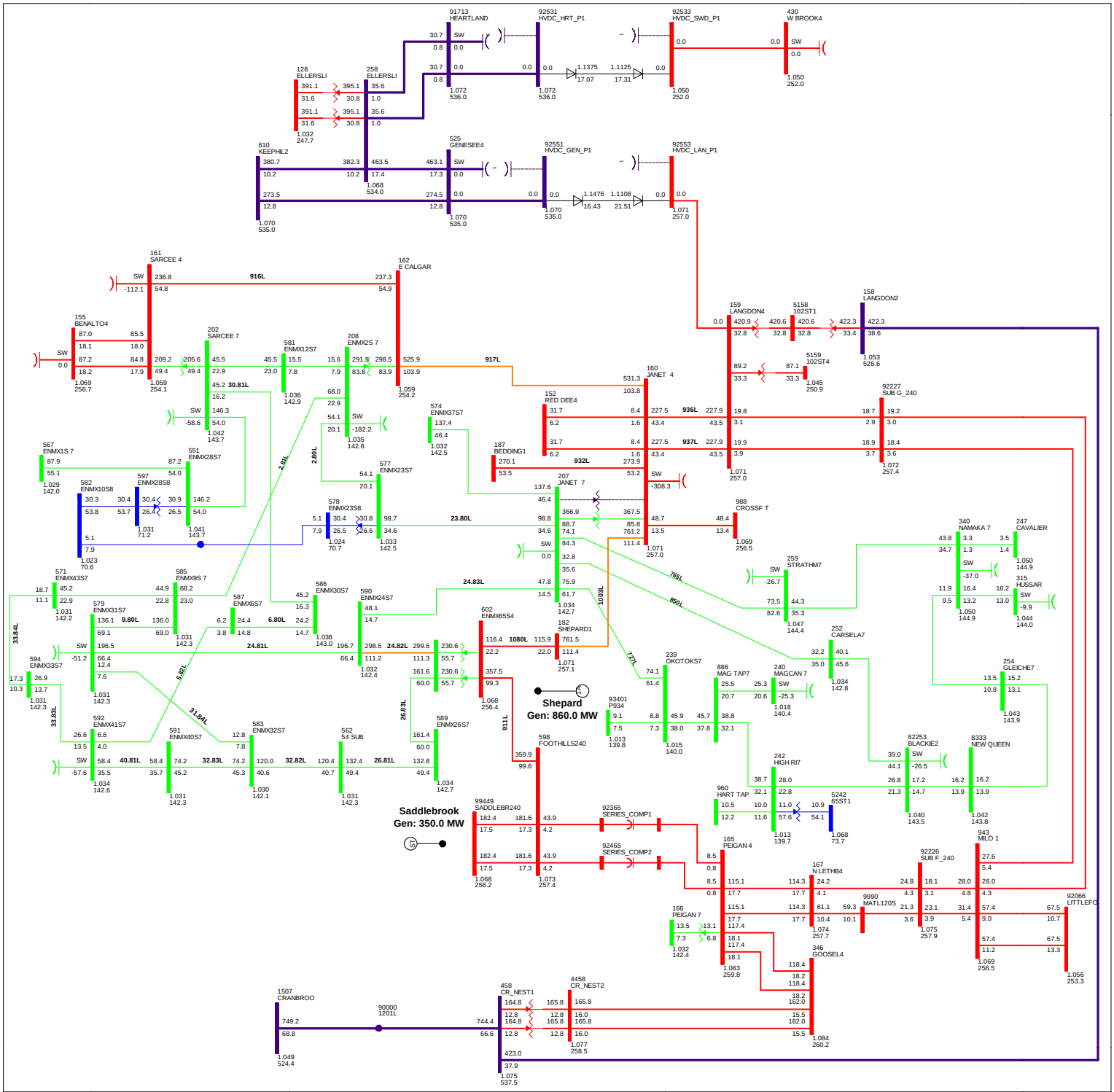
BCH Import: 780.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

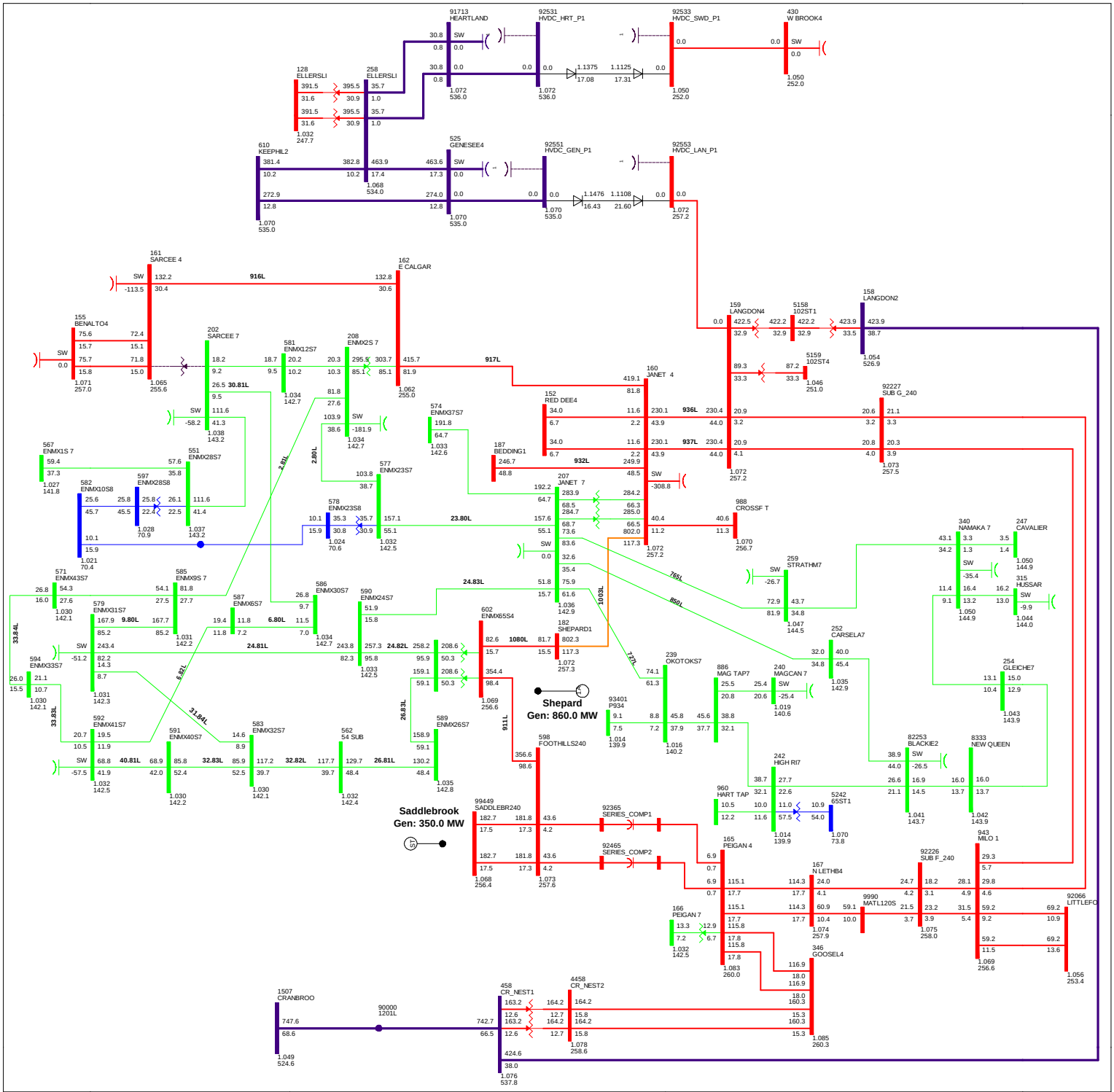
BCH Import: 783.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

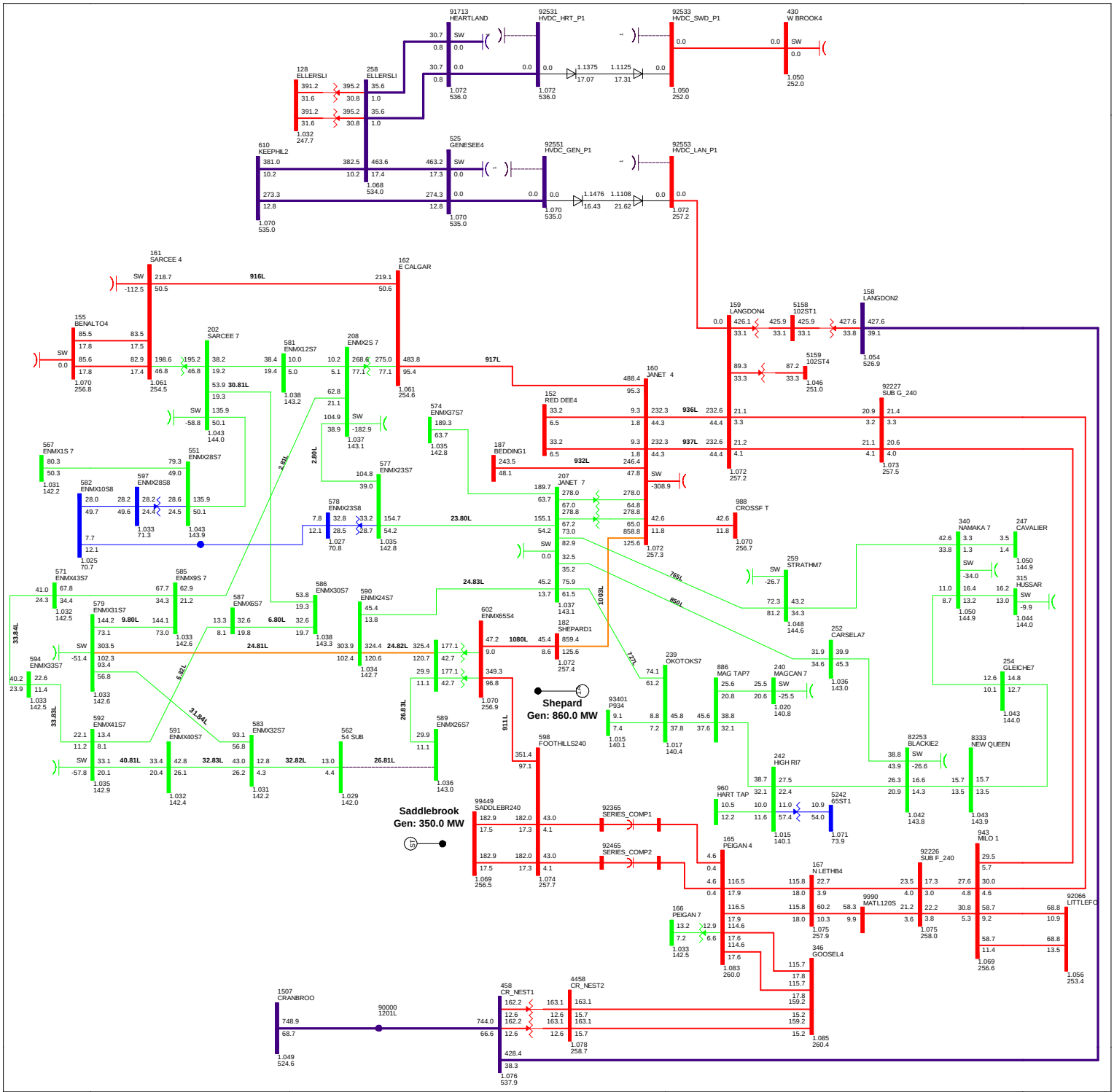
BCH Import: 781.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



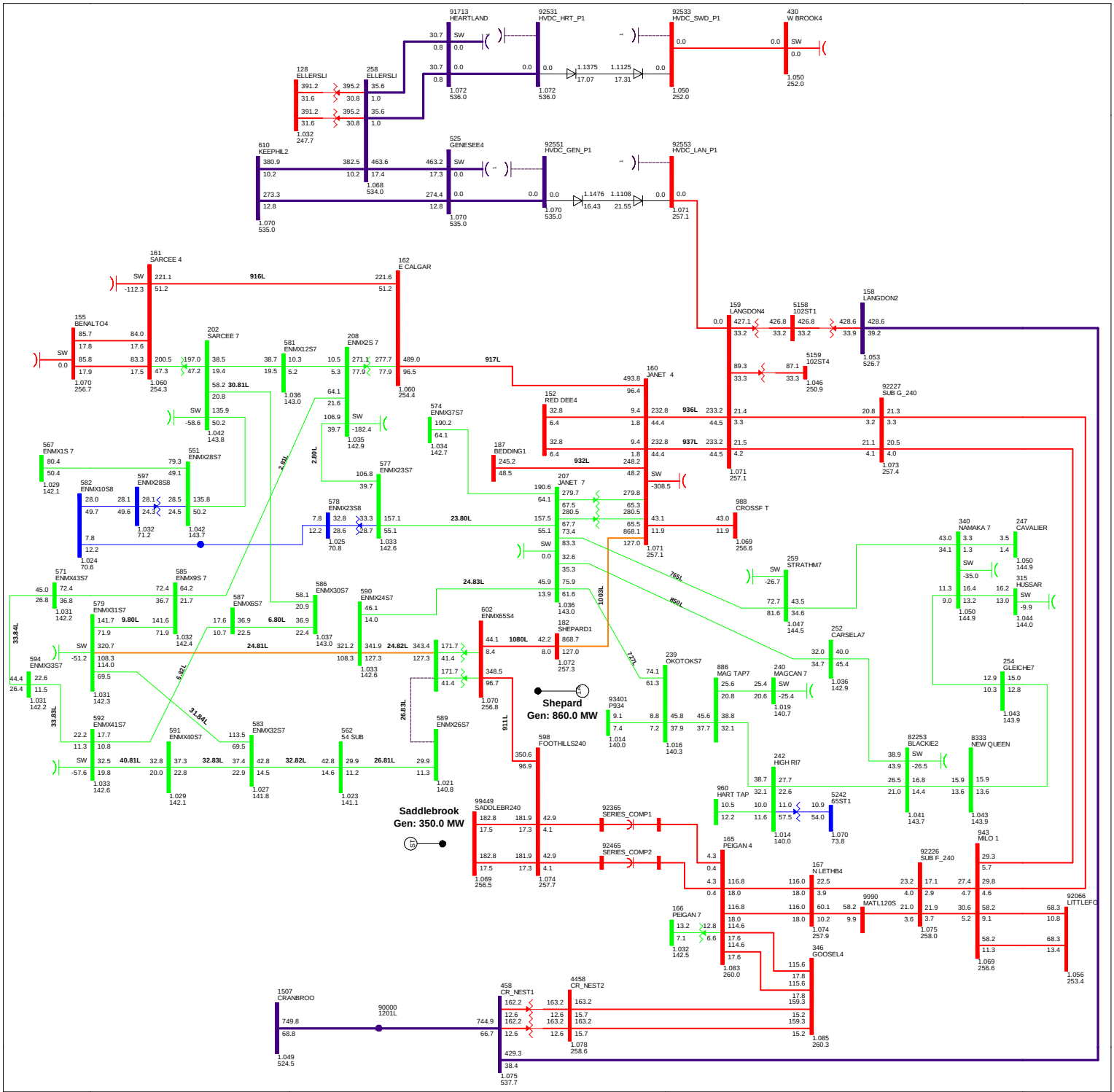
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



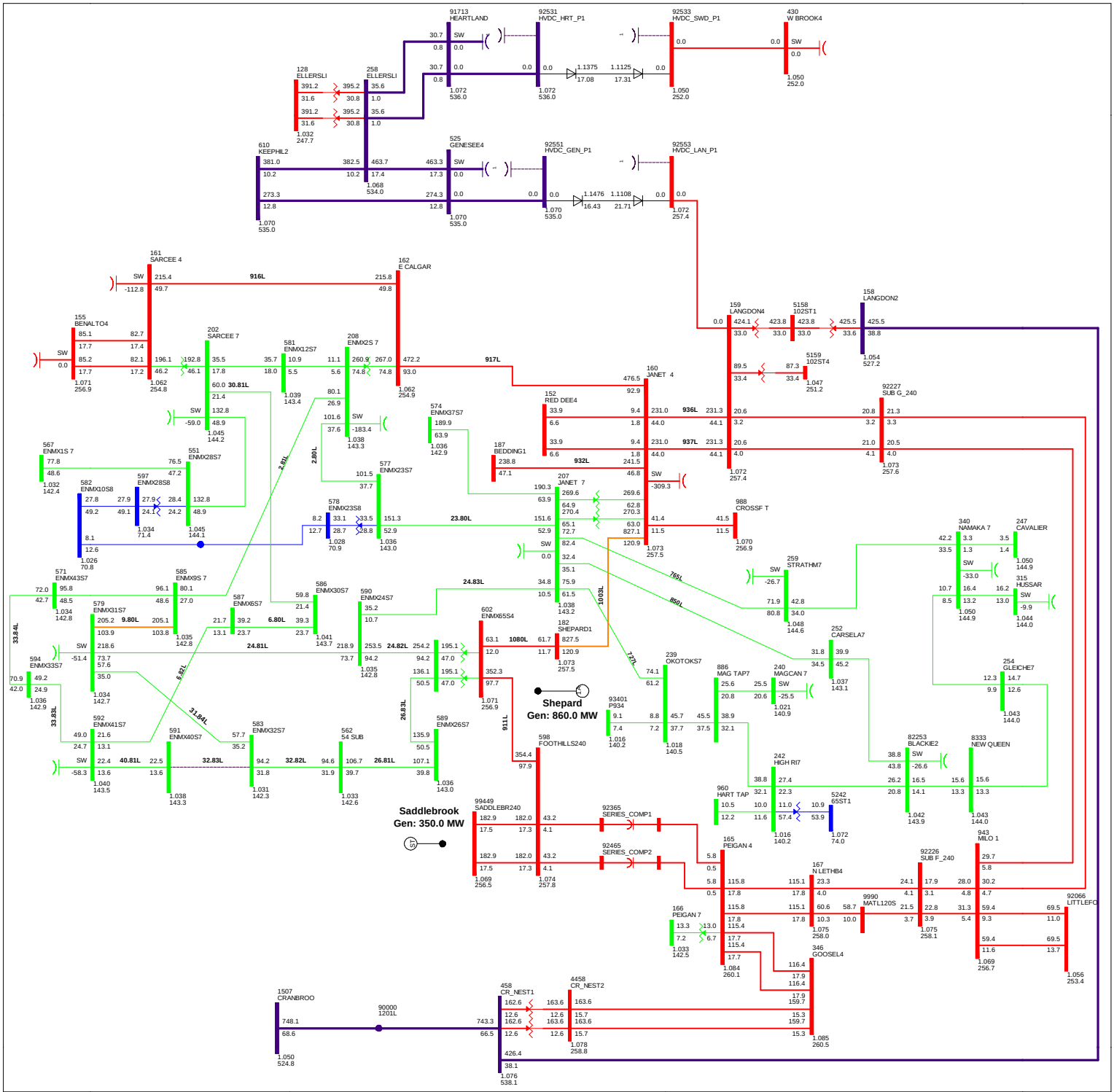
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 783.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

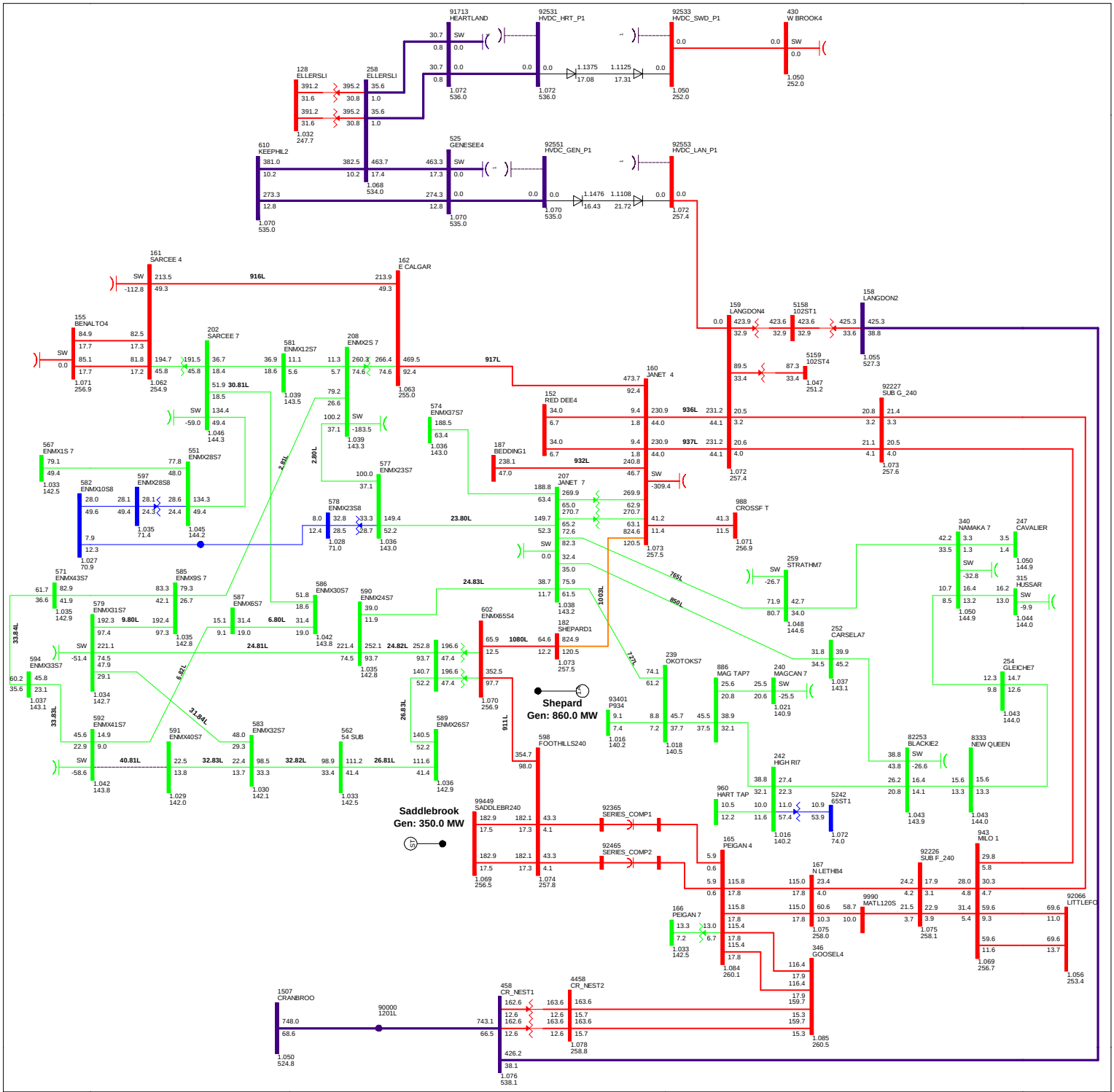
100.0%RATEA
KV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:33



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

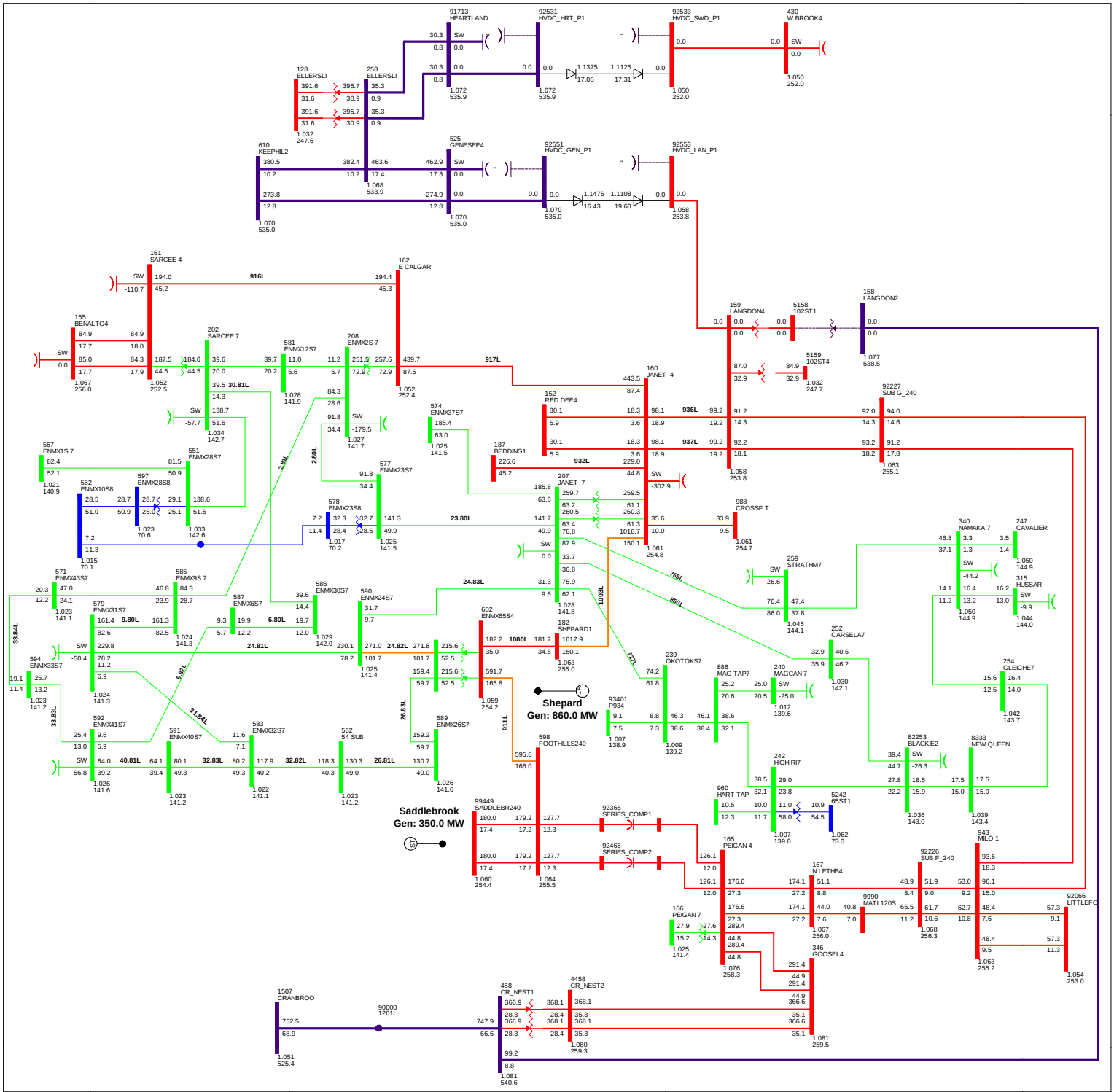
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

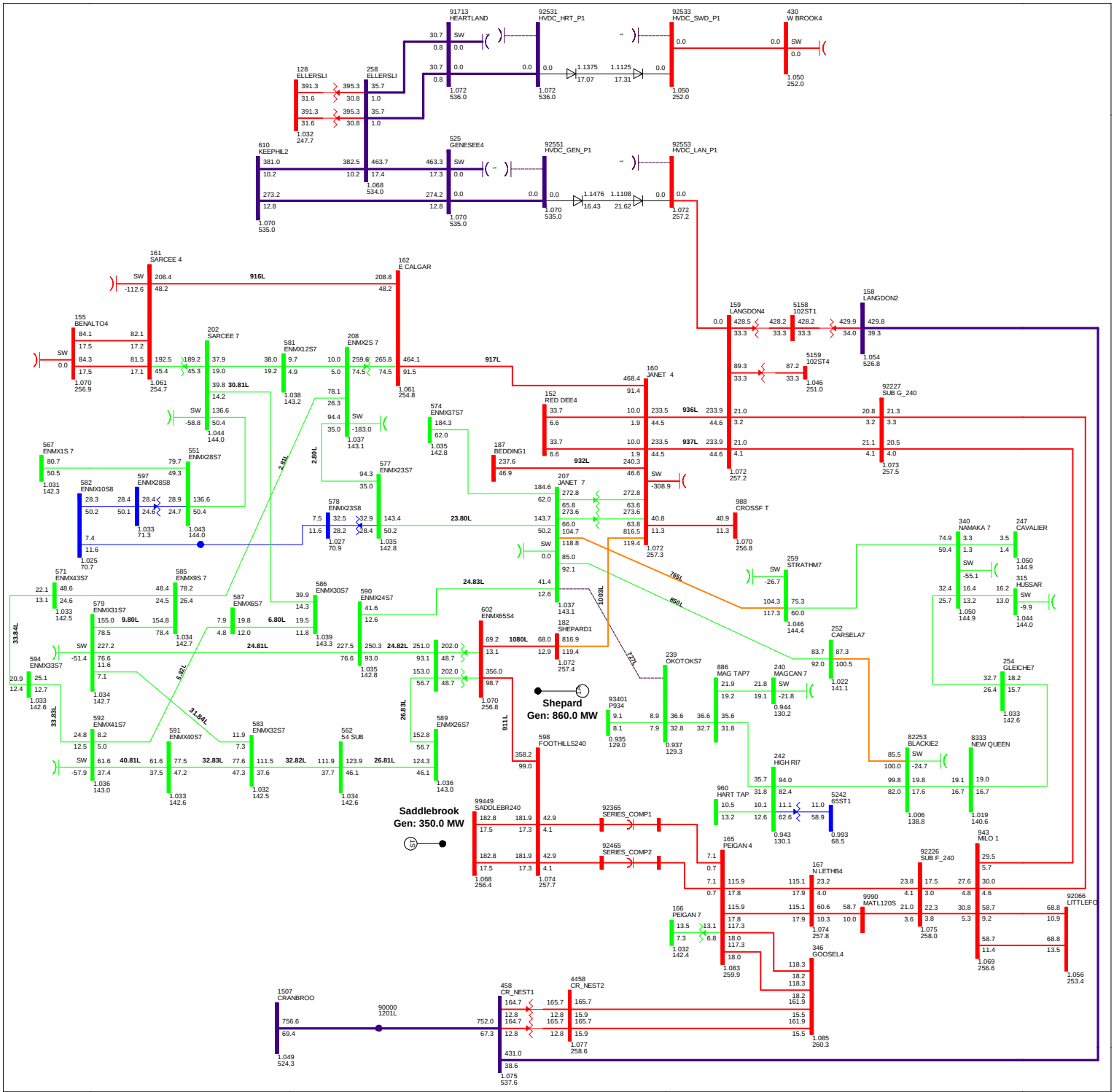
BCH Import: 805.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

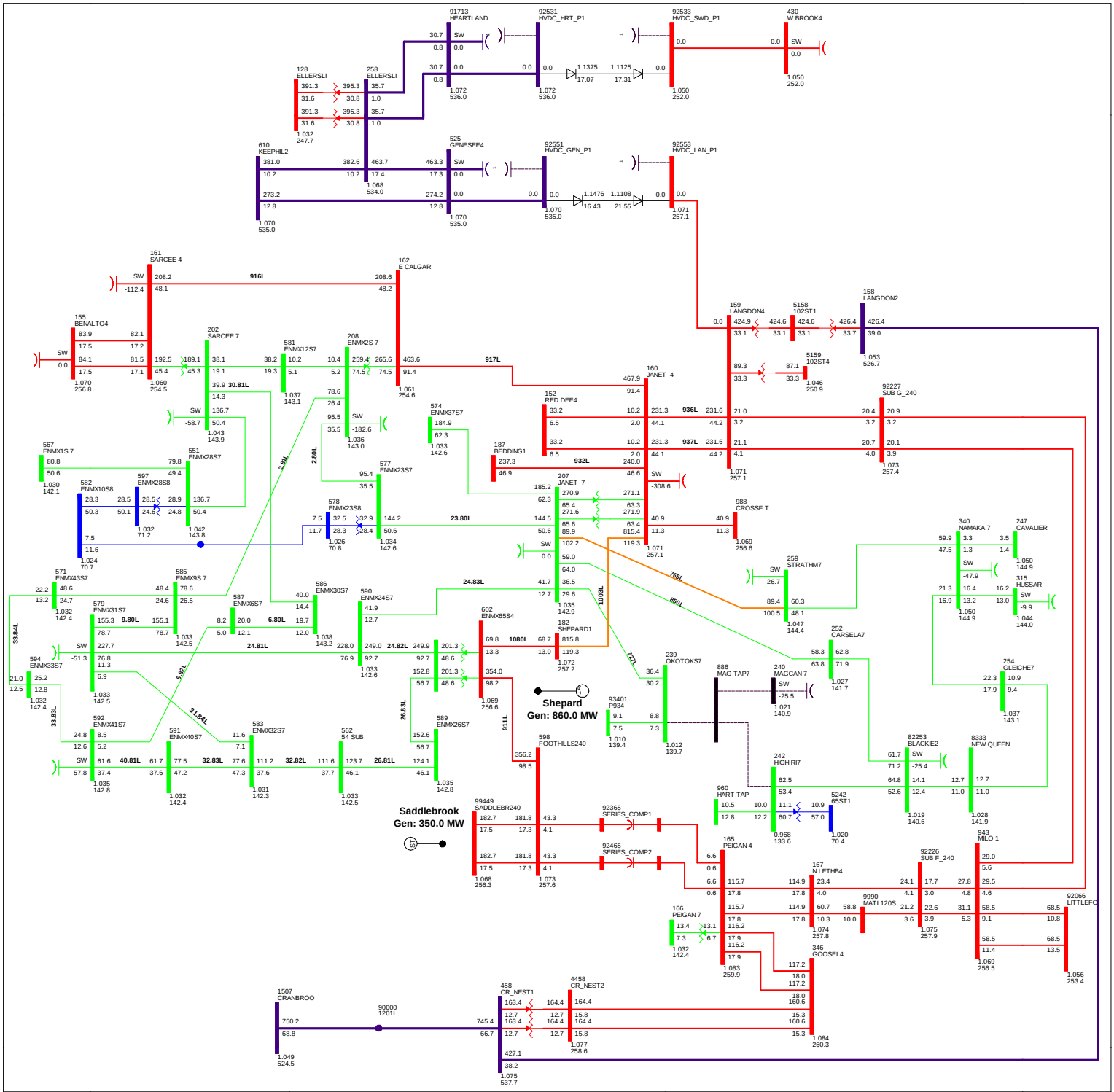
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 789.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

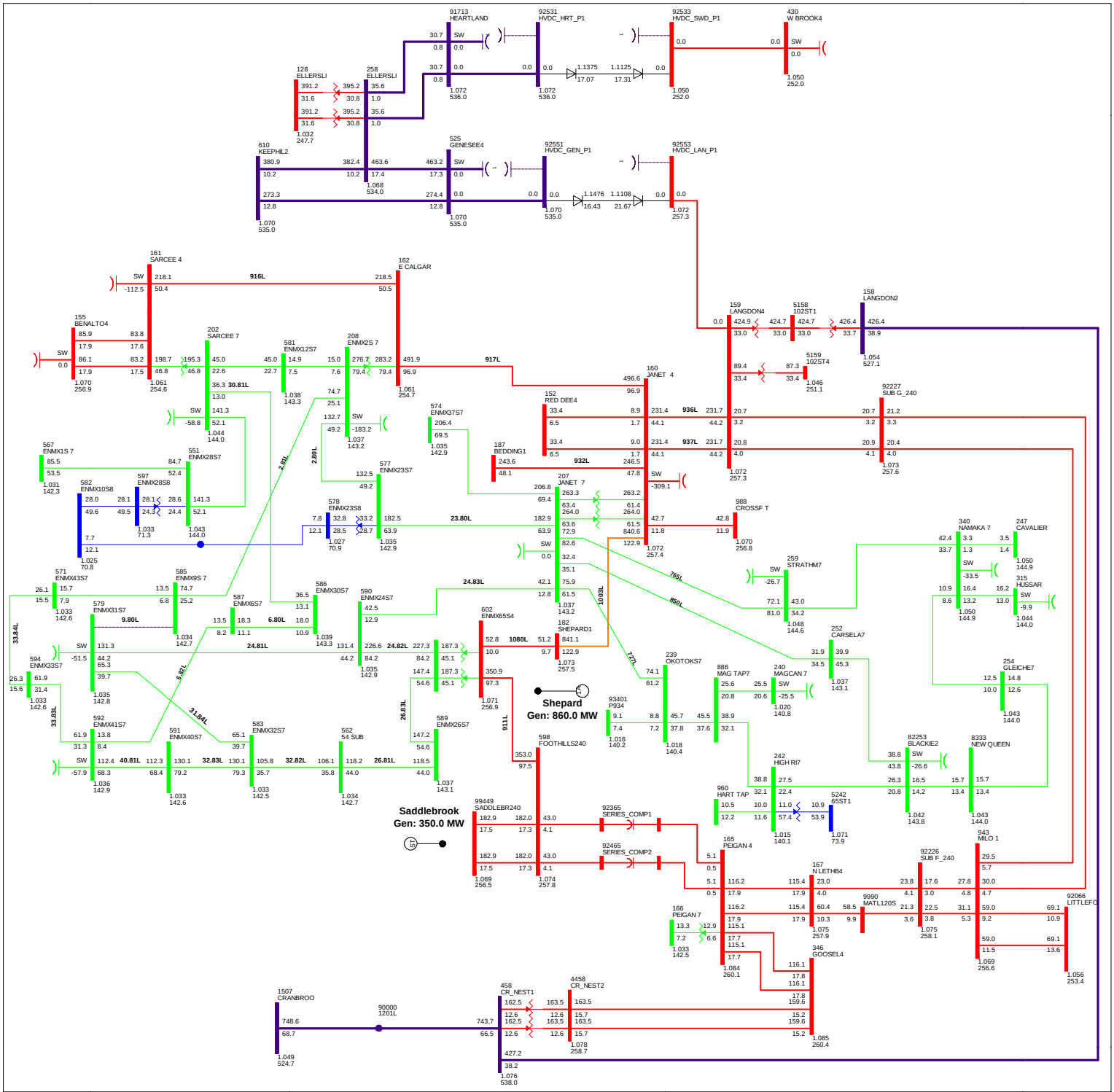
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 783.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

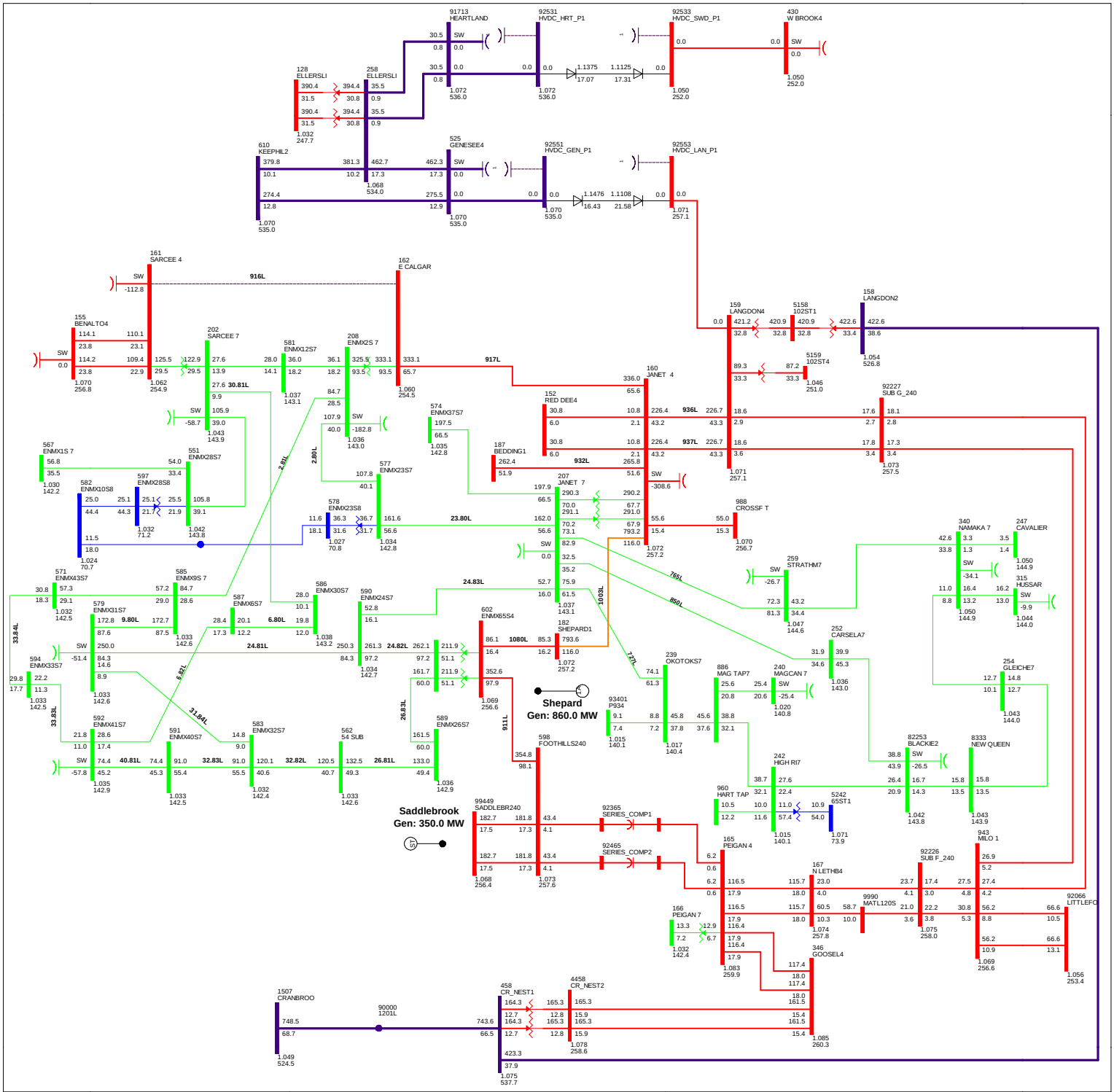
BCH Import: 781.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-22: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

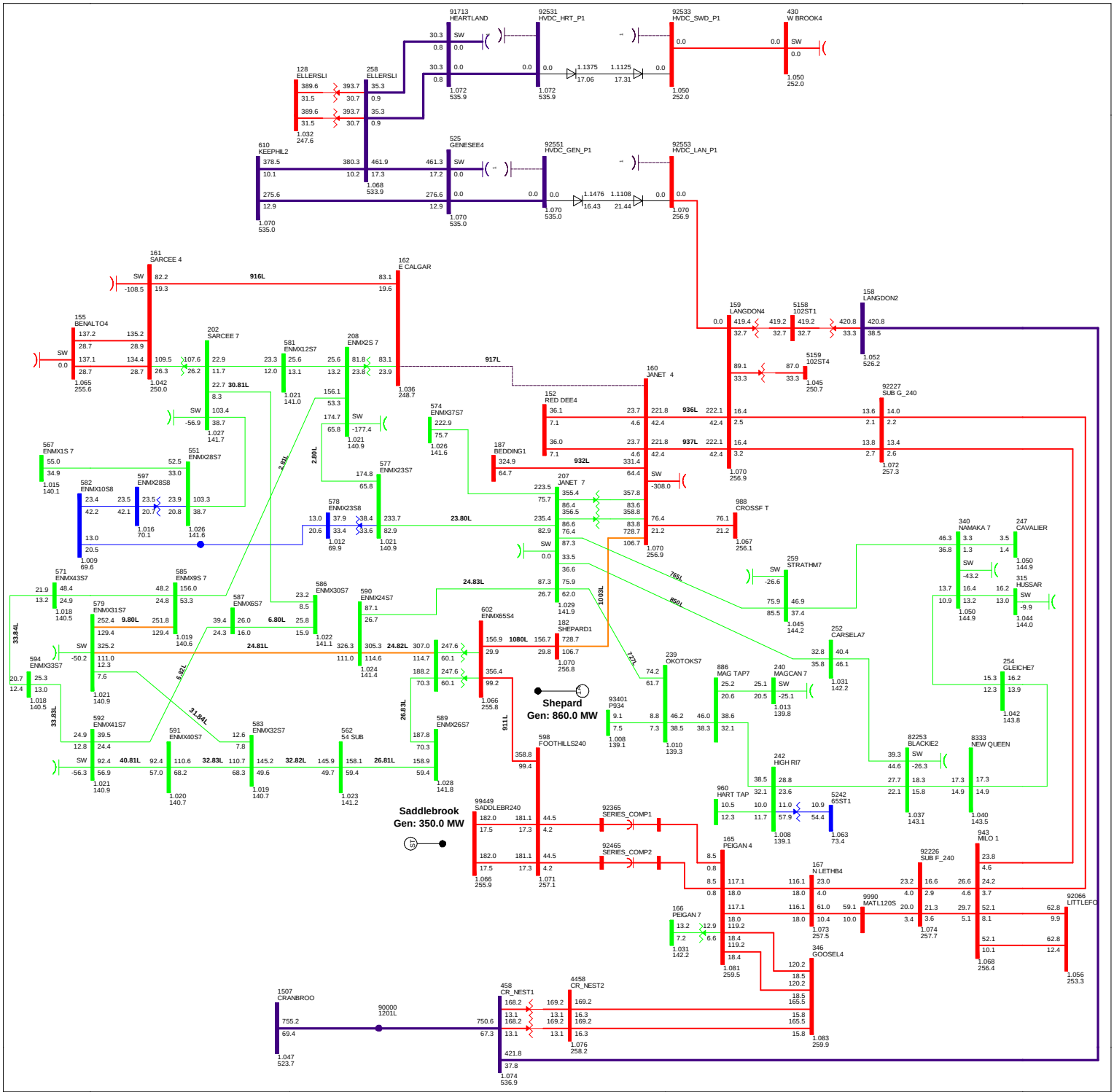
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-23: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

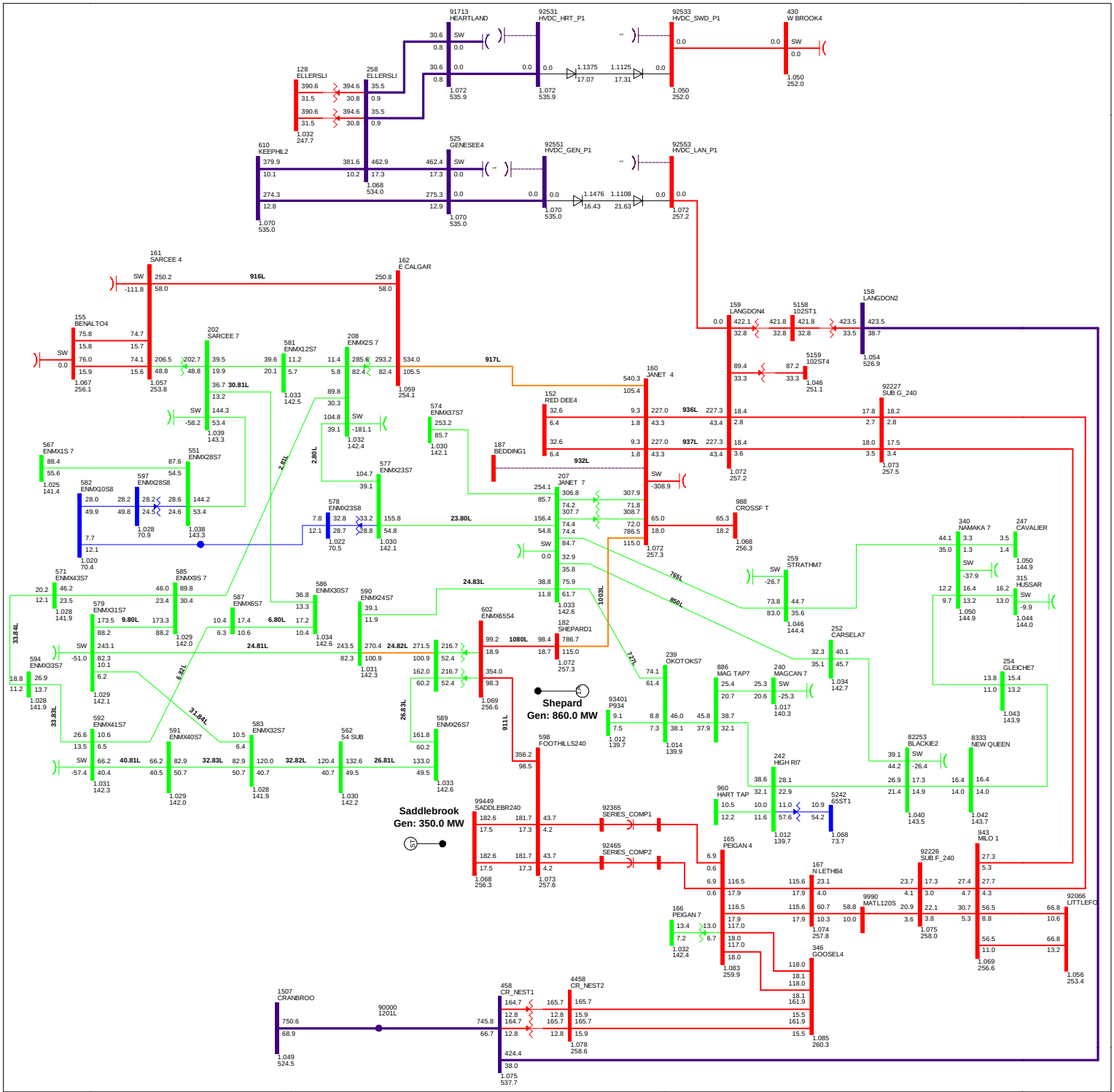
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 792.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-24: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34



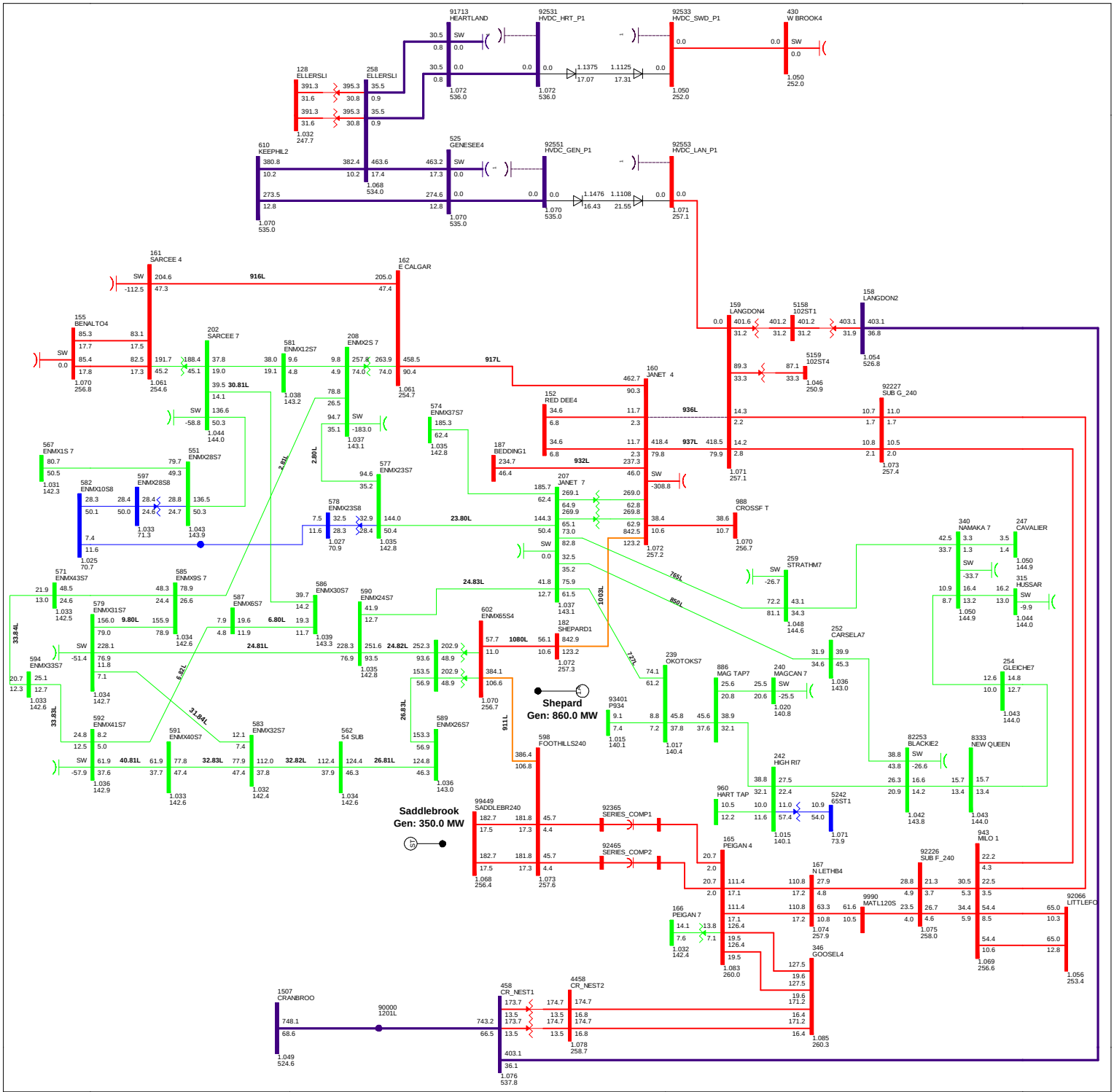
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 784.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-25: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON 2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

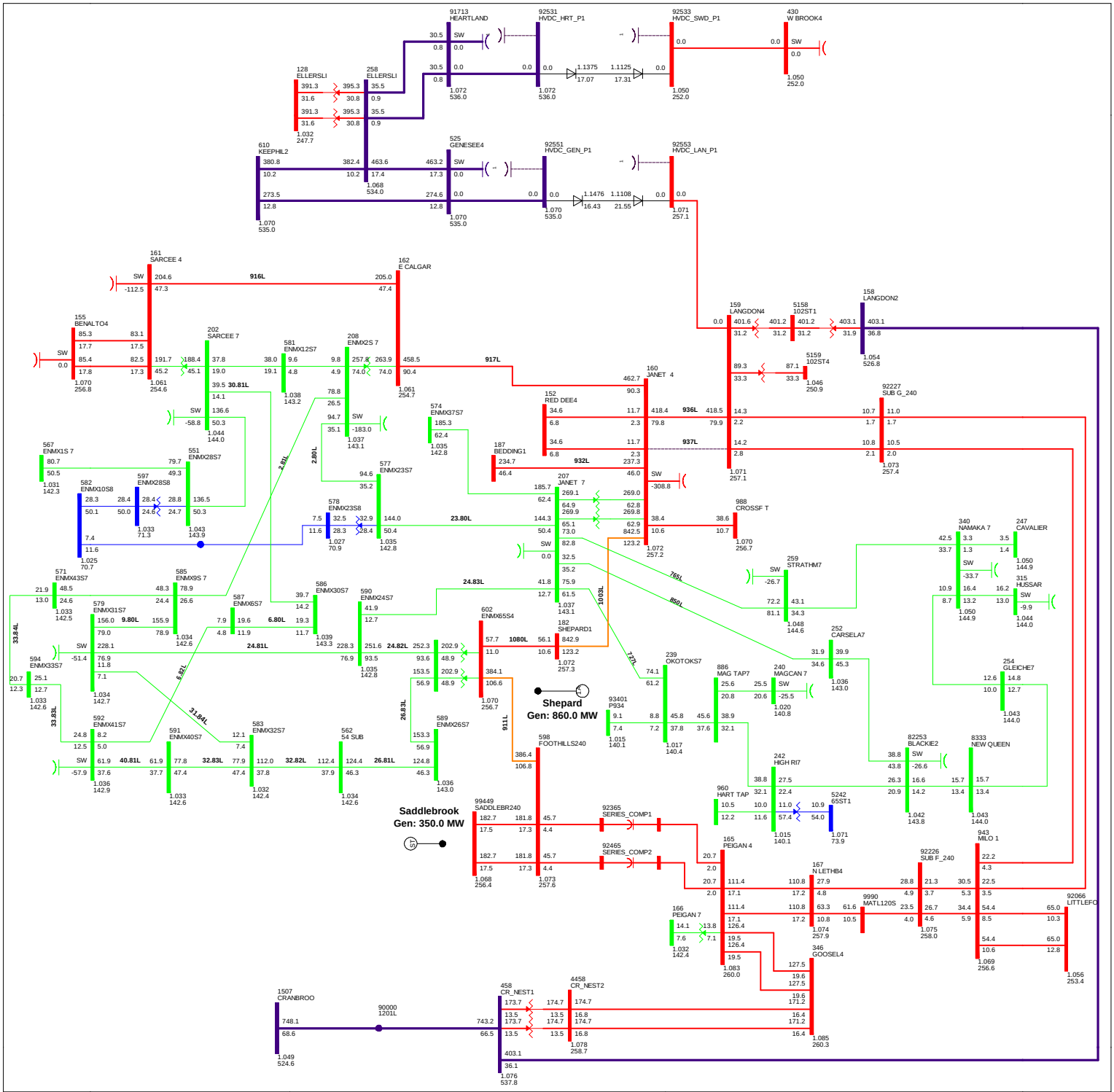
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-26: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

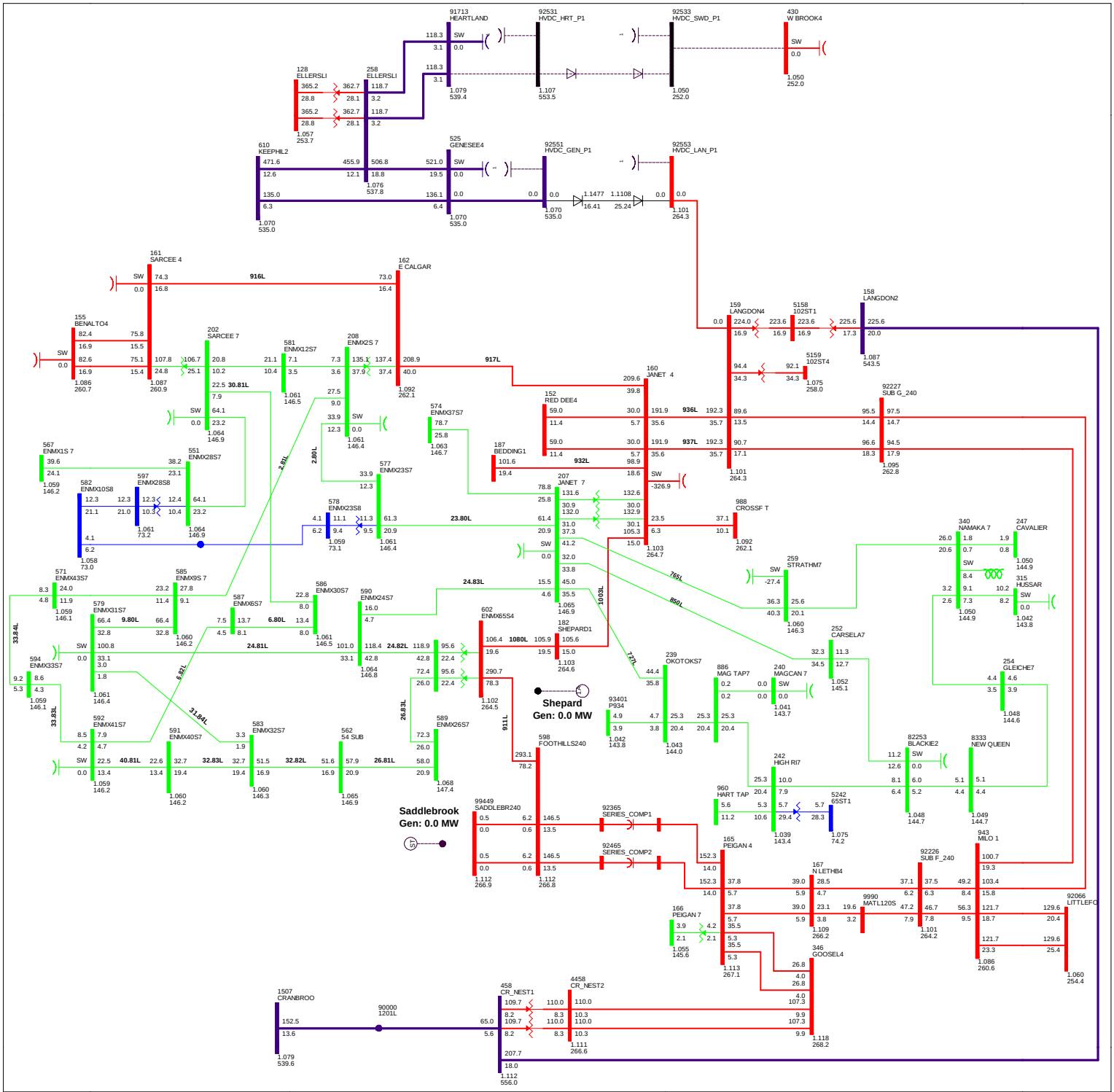
BCH Import: 782.5 MW

2012LTO EXISTING SYSTEM

FIG A-SC5-27: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SP_EXISTING_SC5

FRI, JUN 08 2012 15:34

2014 Loading Violations
Scenario 6



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

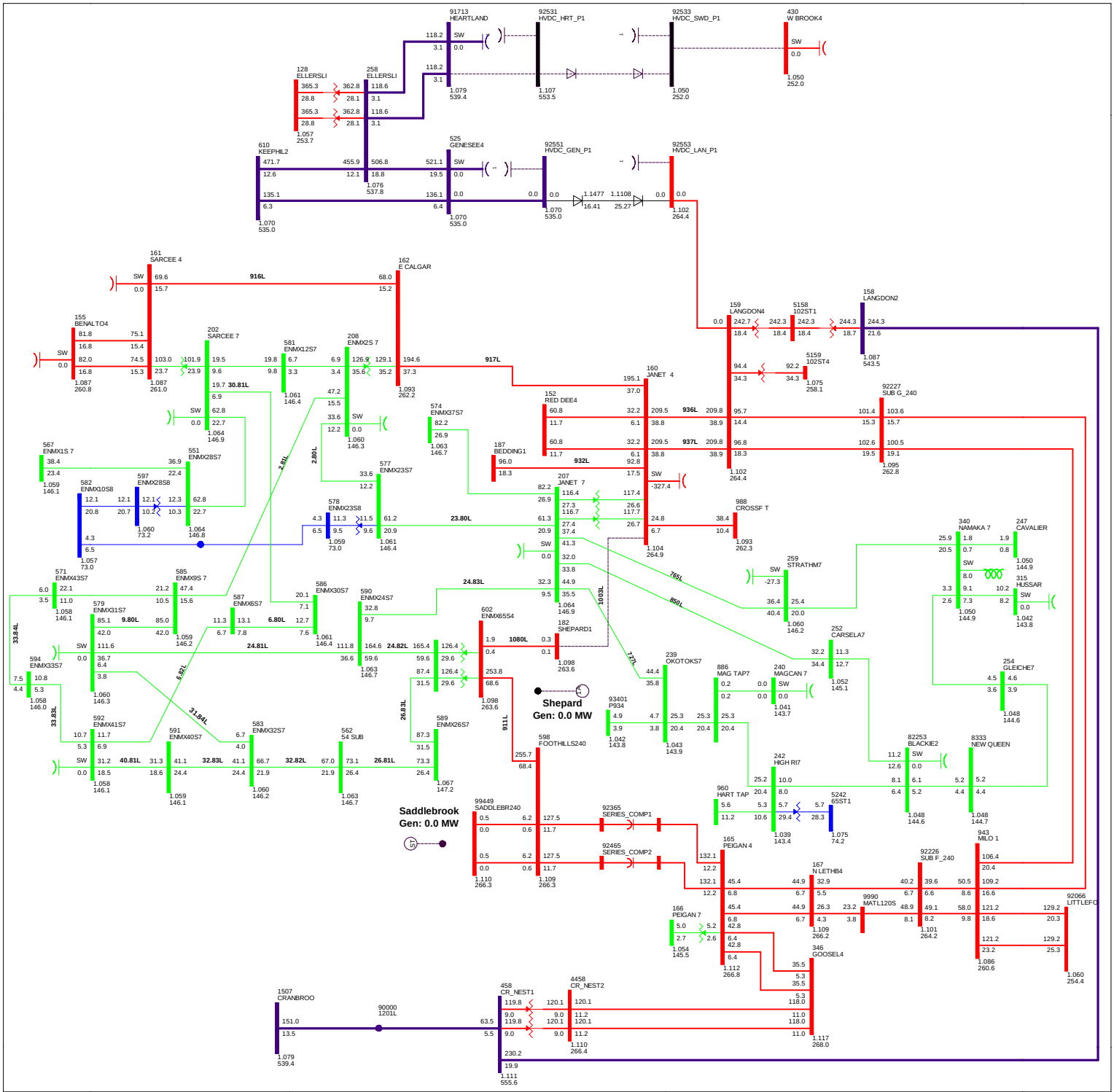
BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-1: BASECASE

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:34



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

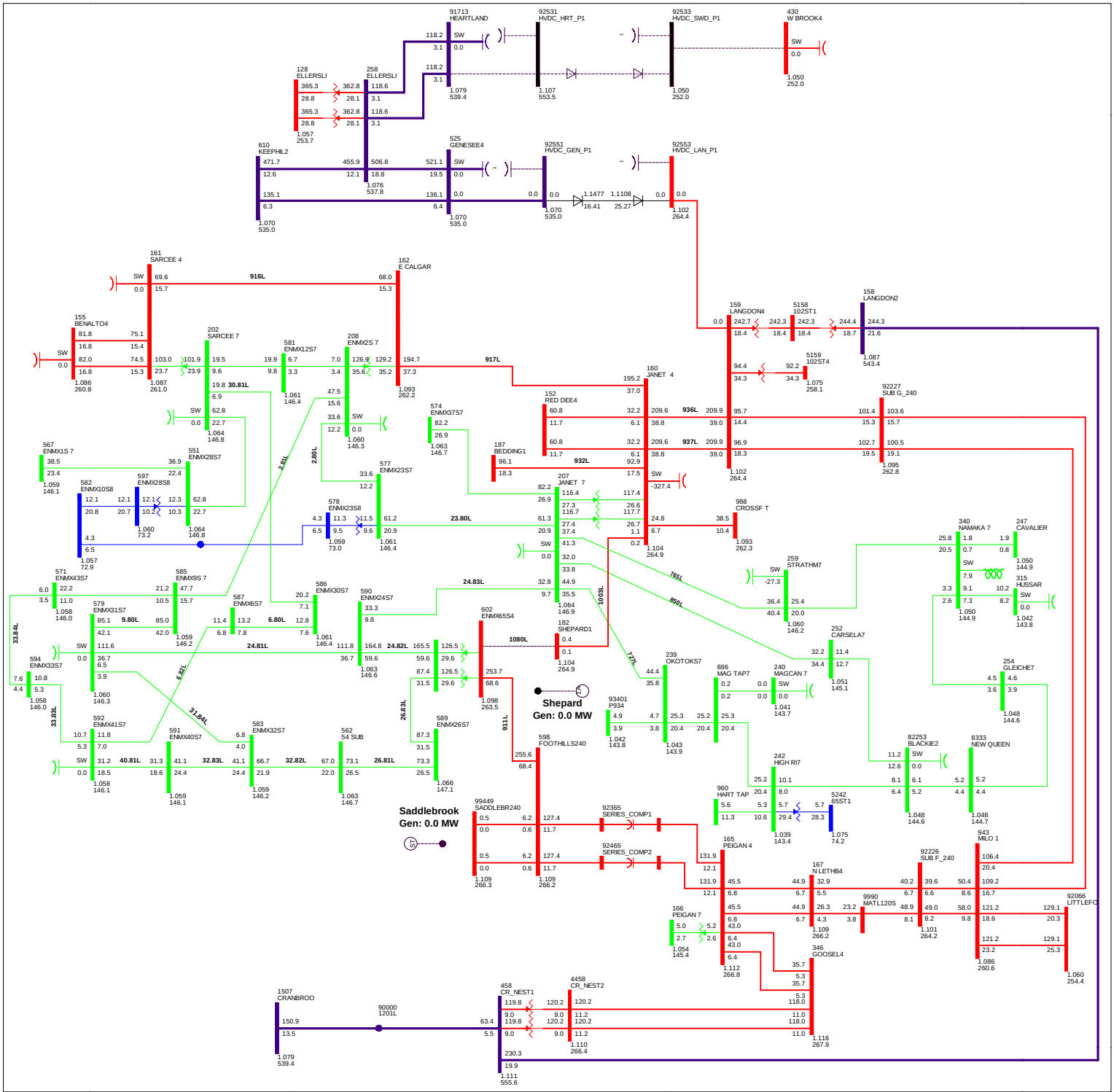
BCH Import: 0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

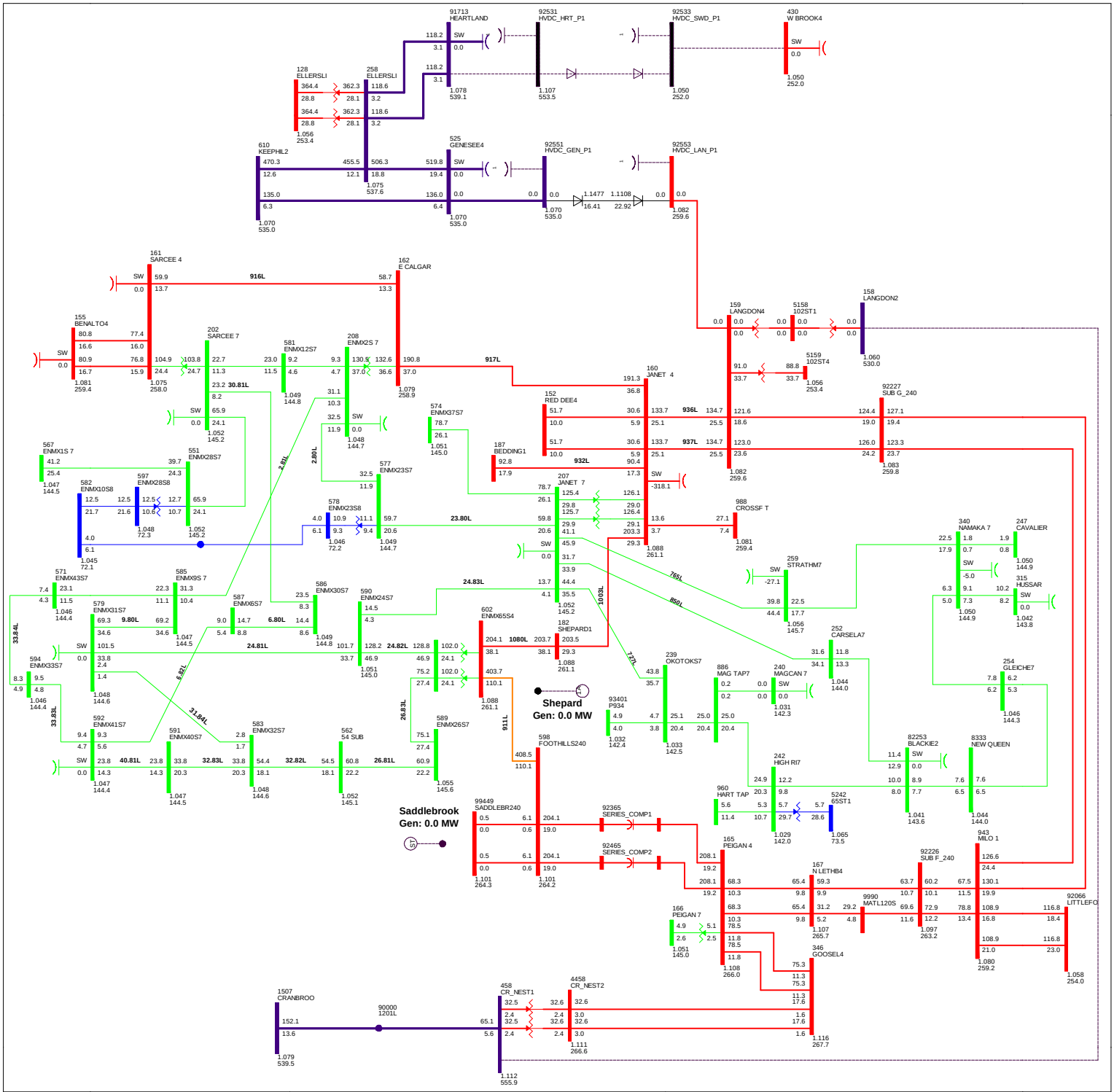
BCH Import: 0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

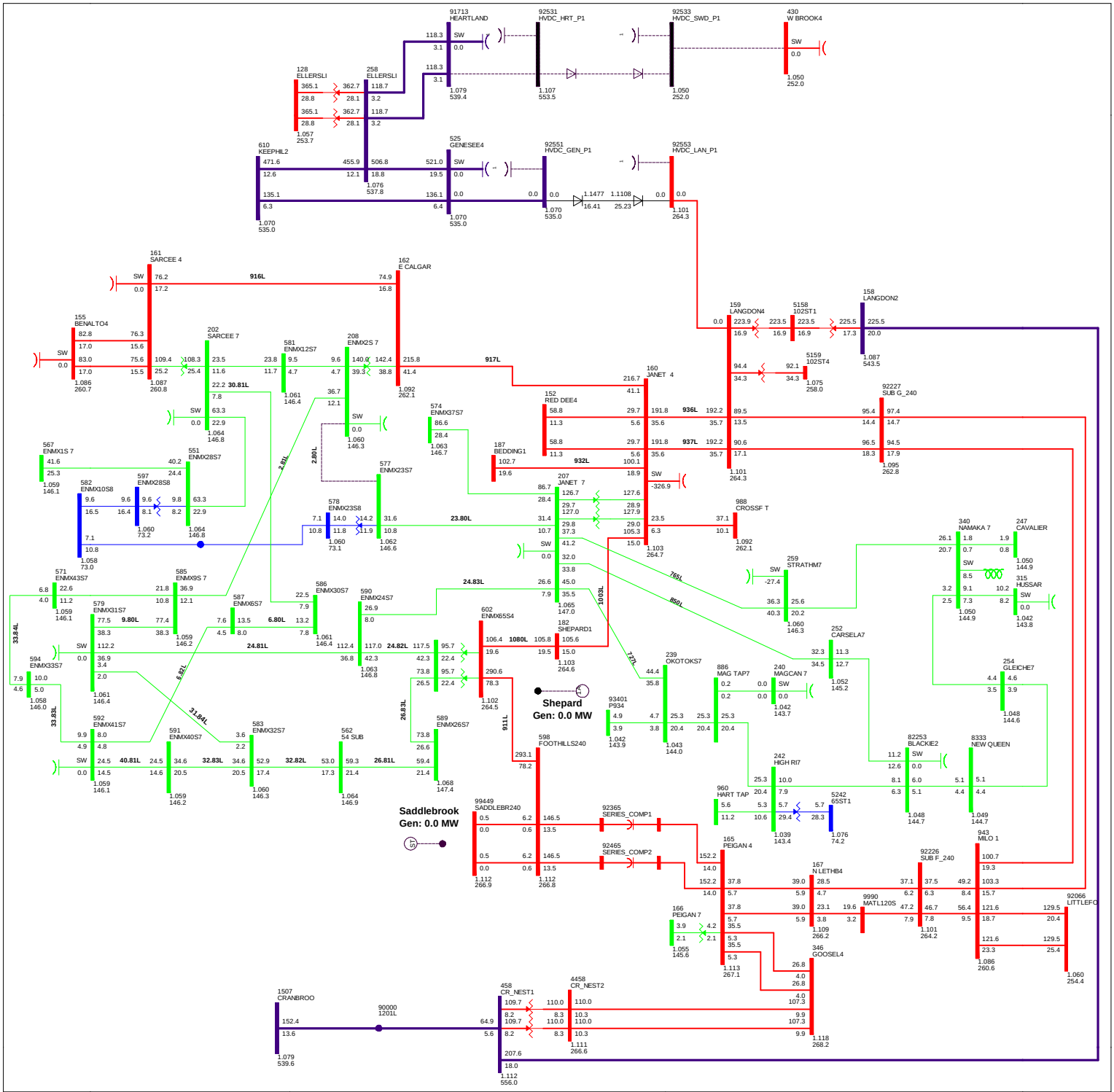
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 5.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

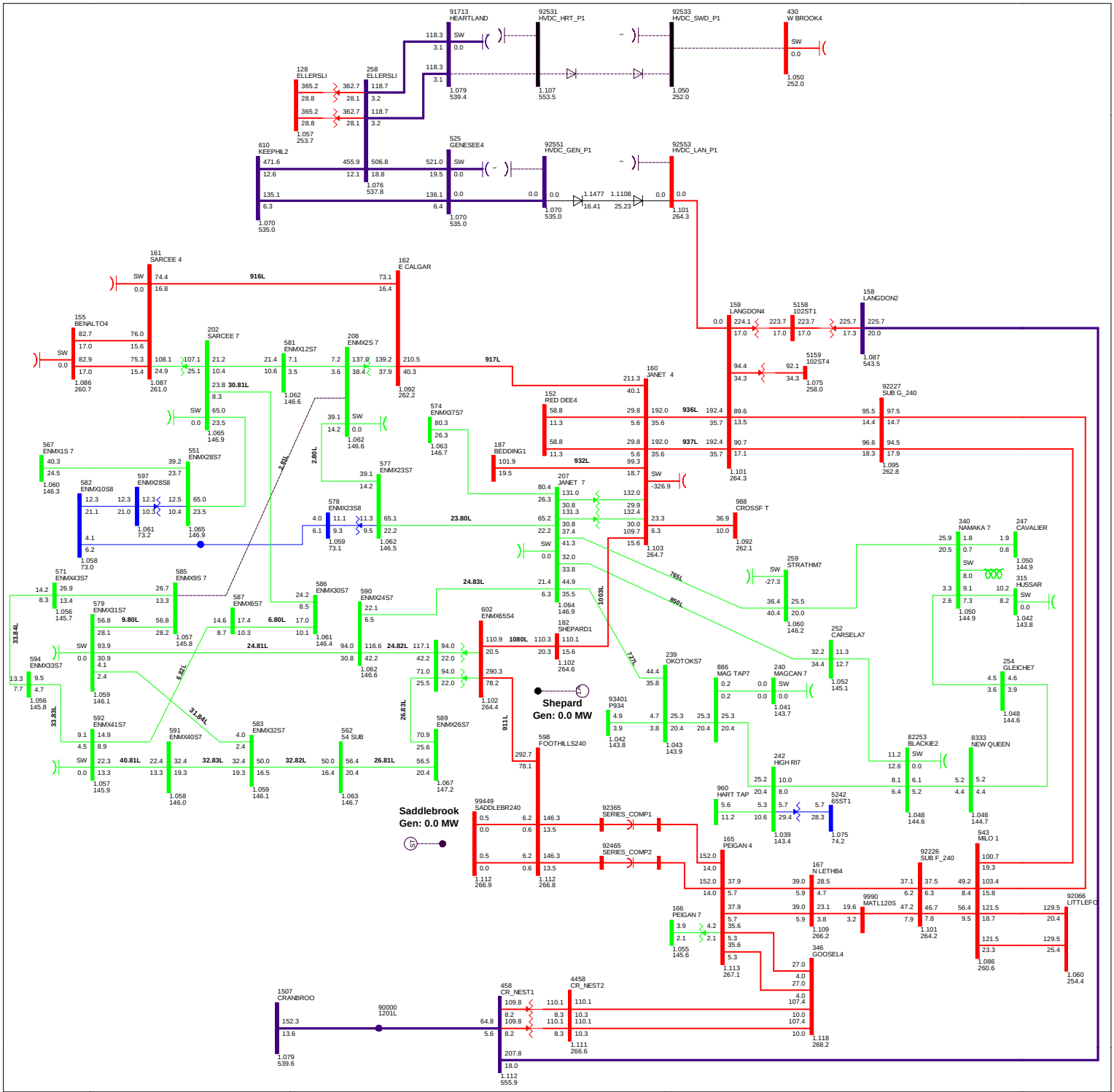
BCH Import: 0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

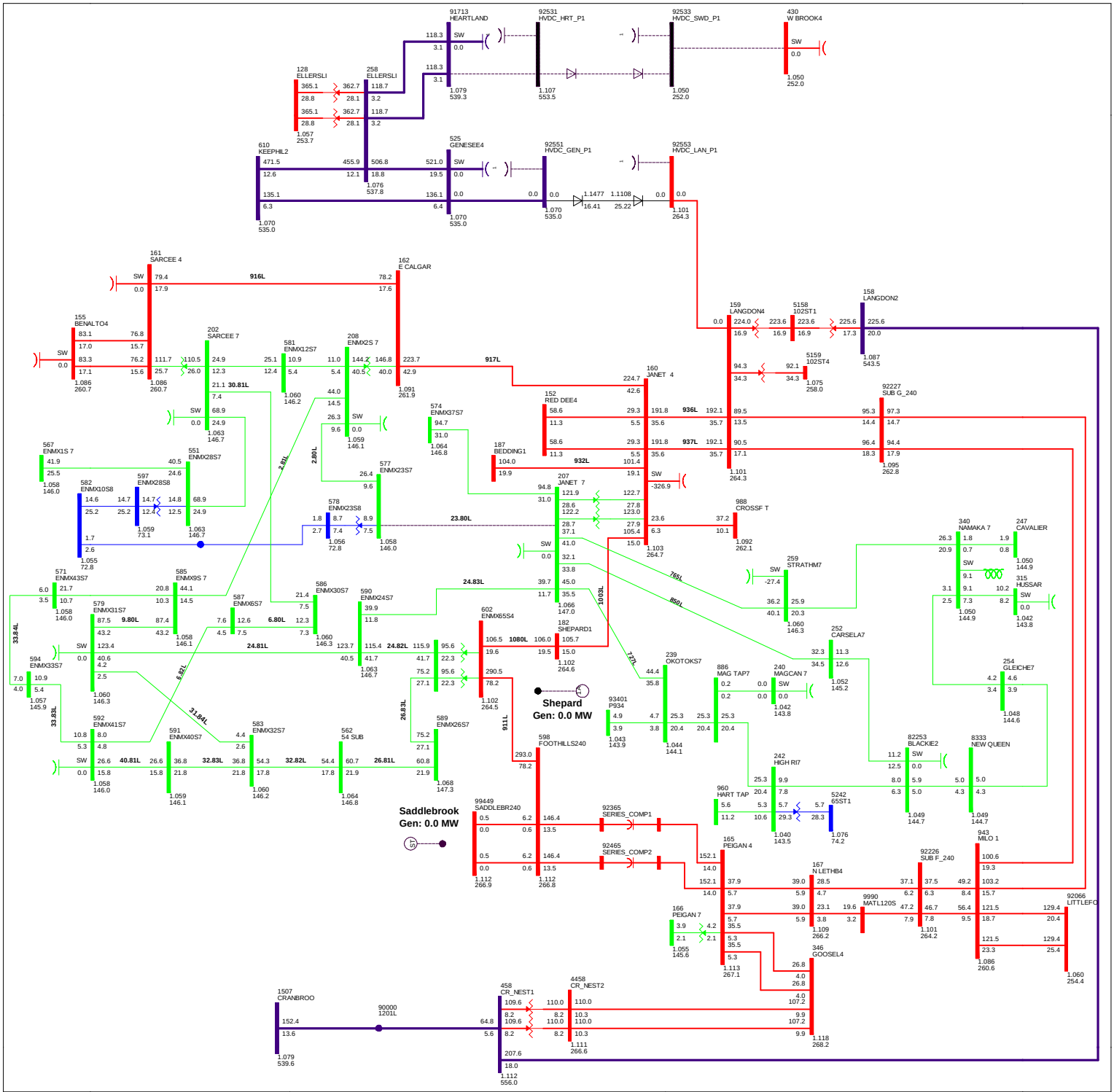
BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



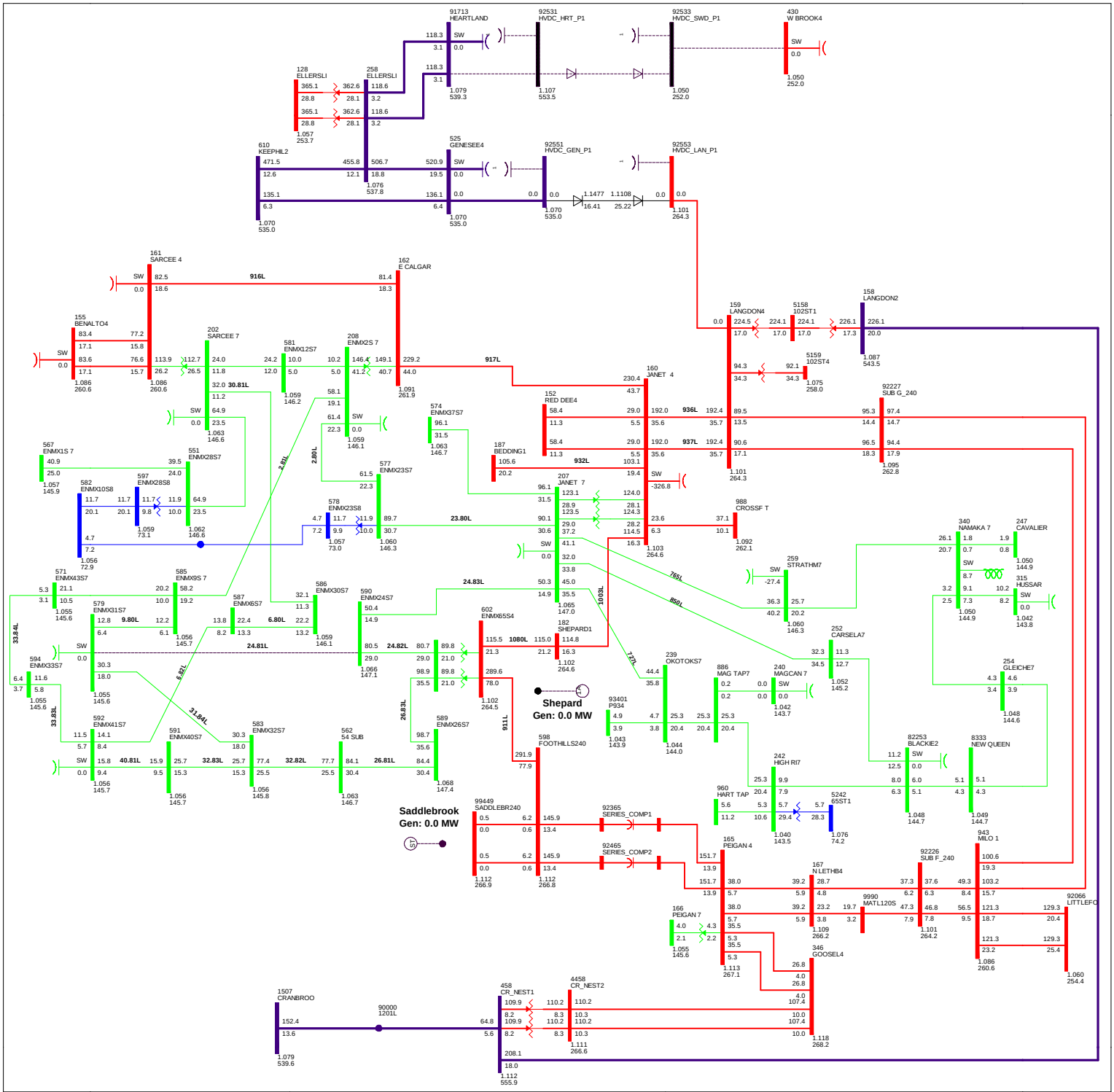
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

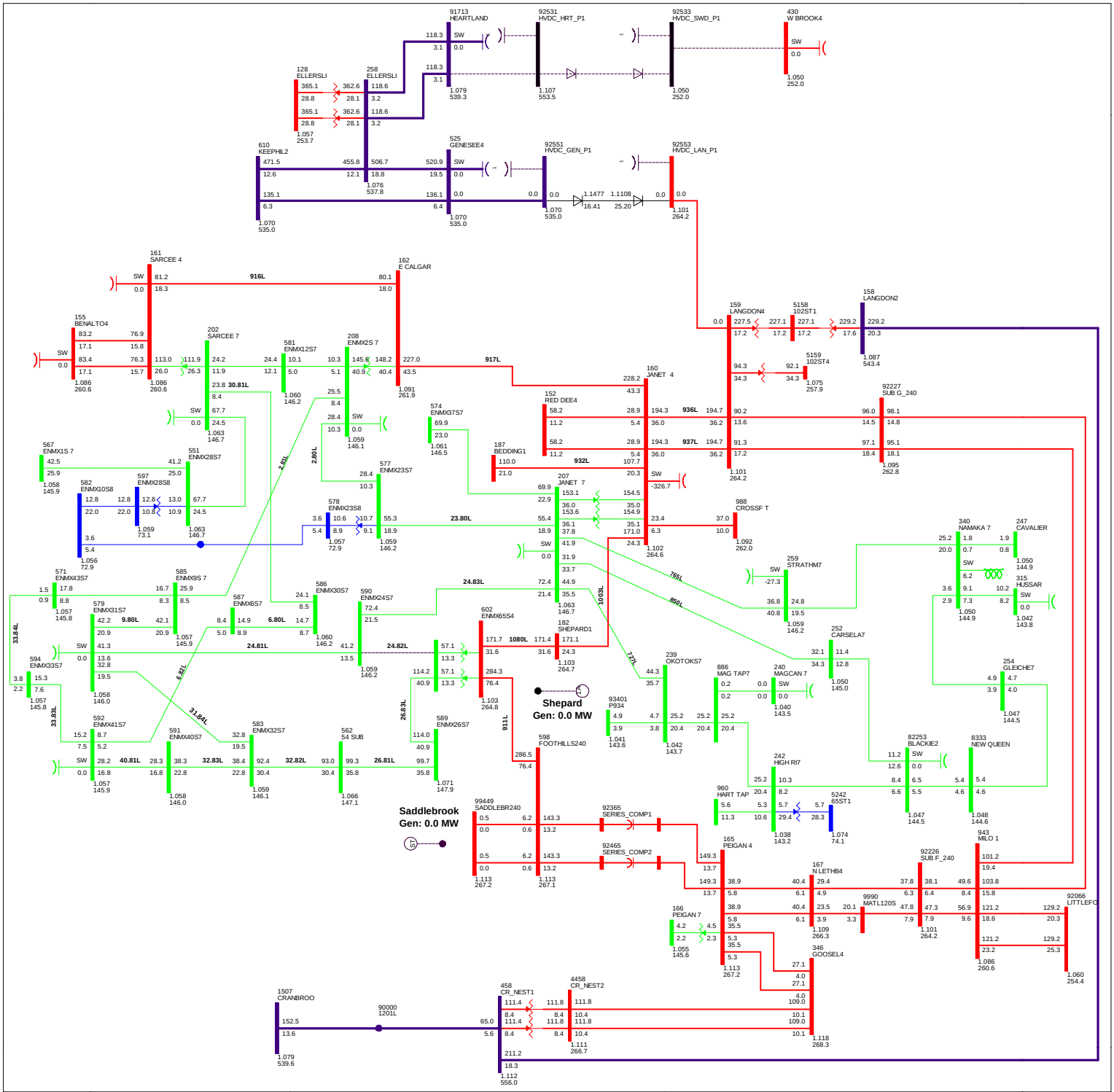
BCH Import: 0.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

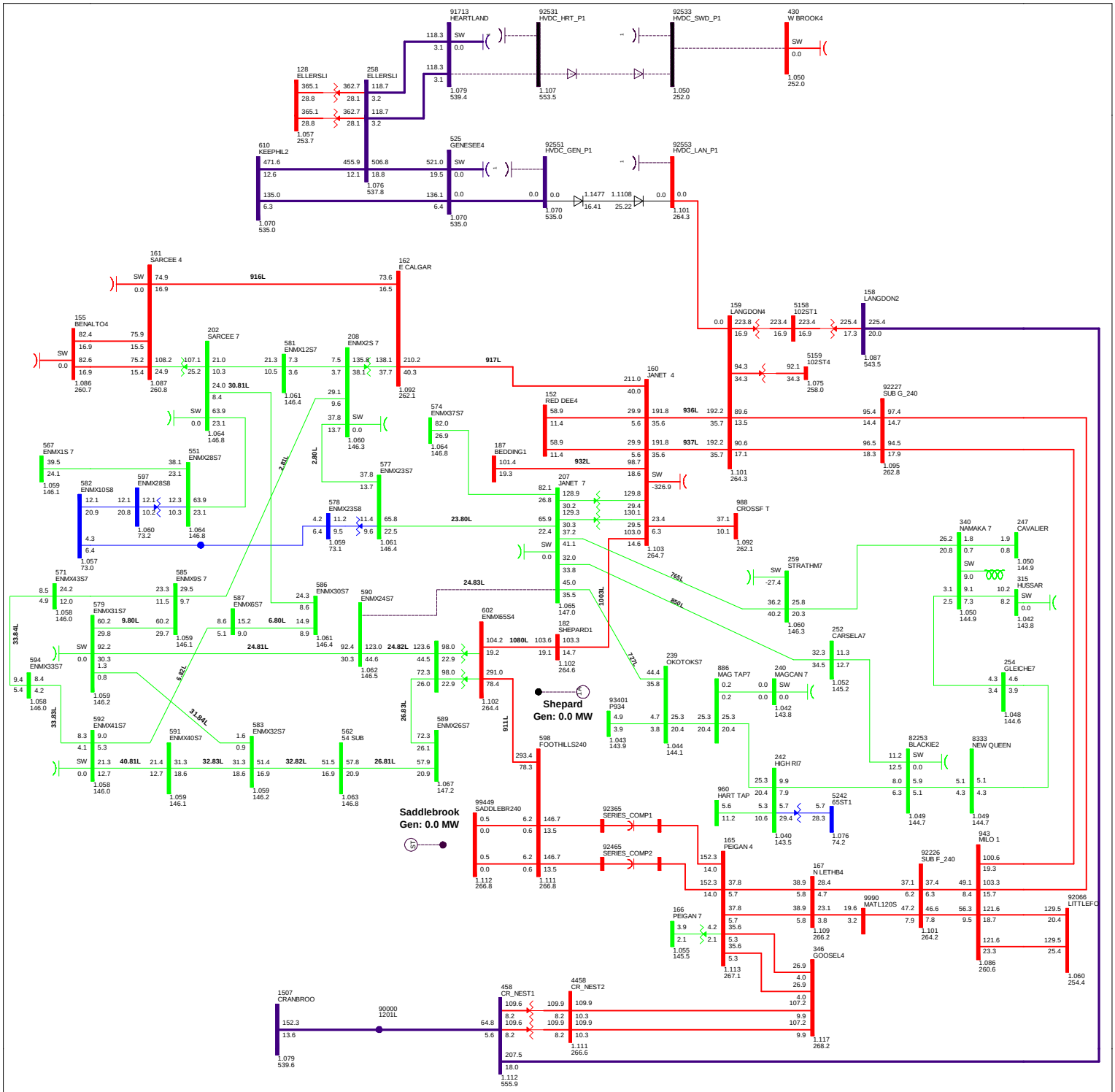
BCH Import: 0.8 MW

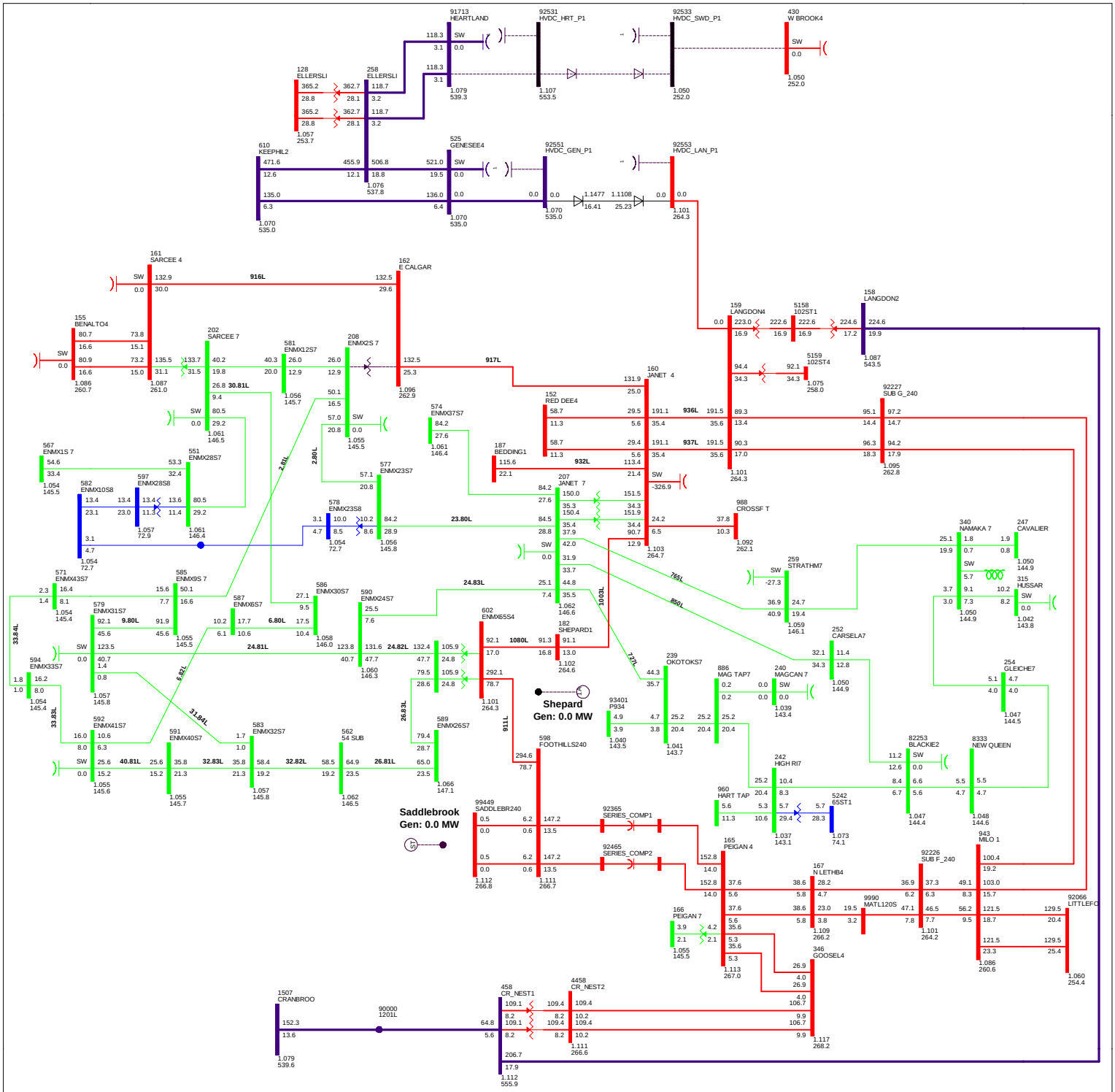
2012LTO EXISTING SYSTEM

FIG A-SC6-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35


91713 HEARTLAND
92531 HVDC_HRT_P1
92533 HVDC_SWD_P1
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
610 KEEPHIL2
525 GENESEE4
92551 HVDC_GEN_P1
92553 HVDC_LAN_P1
161 SARCEE 4
162 E CALGAR
155 BENALTO4
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
574 ENMX37S7
187 BEDDING1
152 RED DEE4
160 JANET 4
159 LANGDON4
5158 102ST1
158 LANGDON2
5159 102ST4
92227 SUB G_240
567 ENMX1S 7
551 ENMX28S7
582 ENMX10S8
597 ENMX28S8
577 ENMX23S7
578 ENMX23S8
207 JANET 7
988 CROSSF T
259 STRATHM7
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
571 ENMX43S7
585 ENMX9S 7
579 ENMX31S7
587 ENMX6S7
586 ENMX30S7
590 ENMX24S7
602 ENMX65S4
182 SHEPARD1
239 OKOTOKS7
886 MAG TAP7
240 MAGCAN 7
252 CARSELA7
254 GLEICHE7
594 ENMX33S7
592 ENMX41S7
591 ENMX40S7
583 ENMX32S7
562 54 SUB
589 ENMX26S7
598 FOOTHILLS240
93401 P934
242 HIGH RI7
960 HART TAP
5242 65ST1
82253 BLACKIE2
8333 NEW QUEEN
Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
99449 SADDLEBR240
92365 SERIES_COMP1
92465 SERIES_COMP2
165 PEIGAN 4
167 N LETHB4
166 PEIGAN 7
9990 MATL120S
92226 SUB F_240
943 MILO 1
92066 LITTLEFC
346 GOOSEL4
1507 CRANBROO
90000 1201L
458 CR_NEST1
4458 CR_NEST2
916L
917L
932L
936L
937L
30.81L
23.80L
24.83L
24.81L
9.80L
6.80L
2.80L
33.84L
33.83L
31.84L
40.81L
32.83L
32.82L
26.81L
26.83L
911L
1080L
1003L
765L
850L
777L
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
BCH Import: 0.1 MW
2012LTO EXISTING SYSTEM
FIG A-SC6-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_SL_EXISTING_SC6
FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

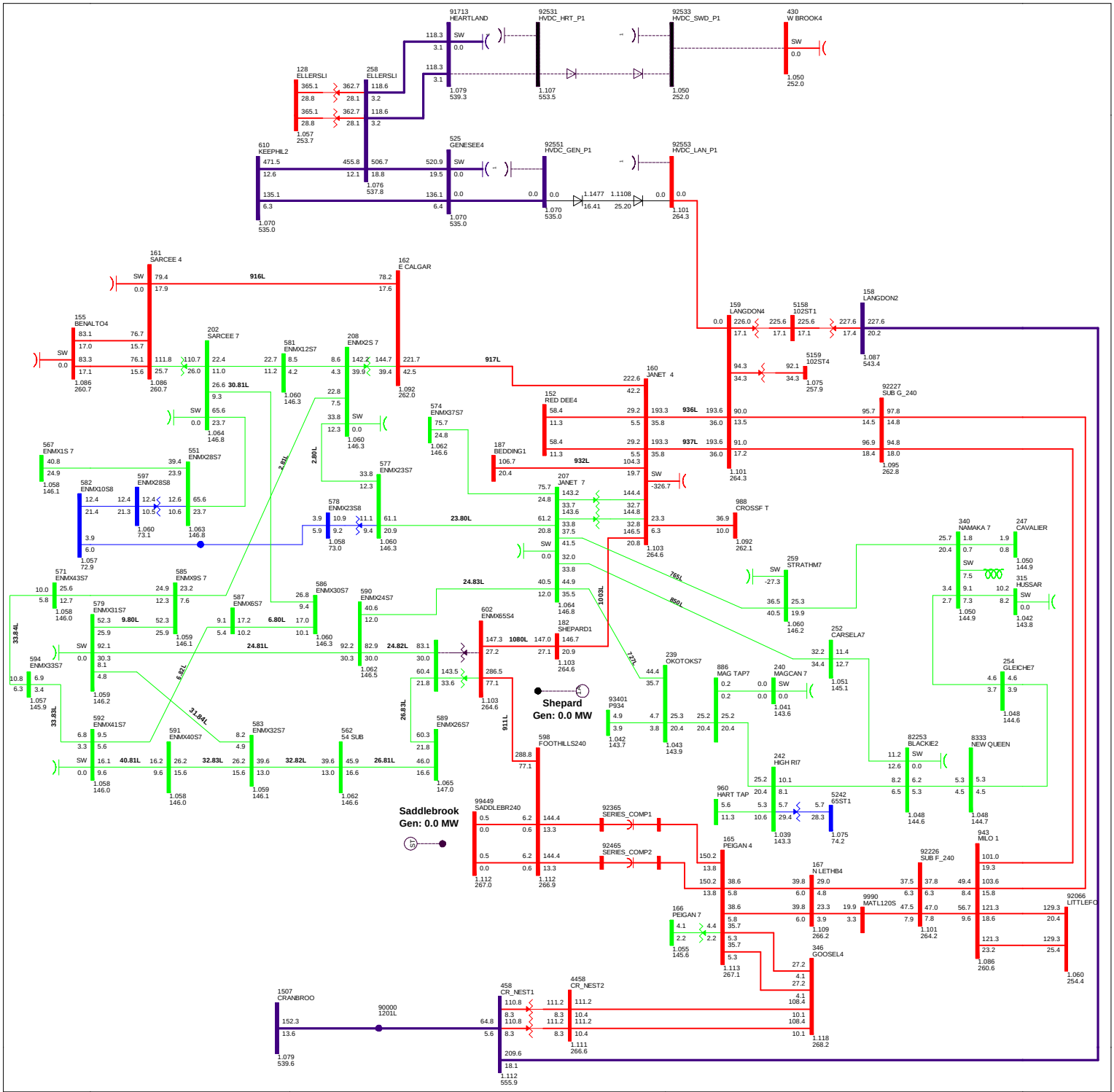
BCH Import: 0.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

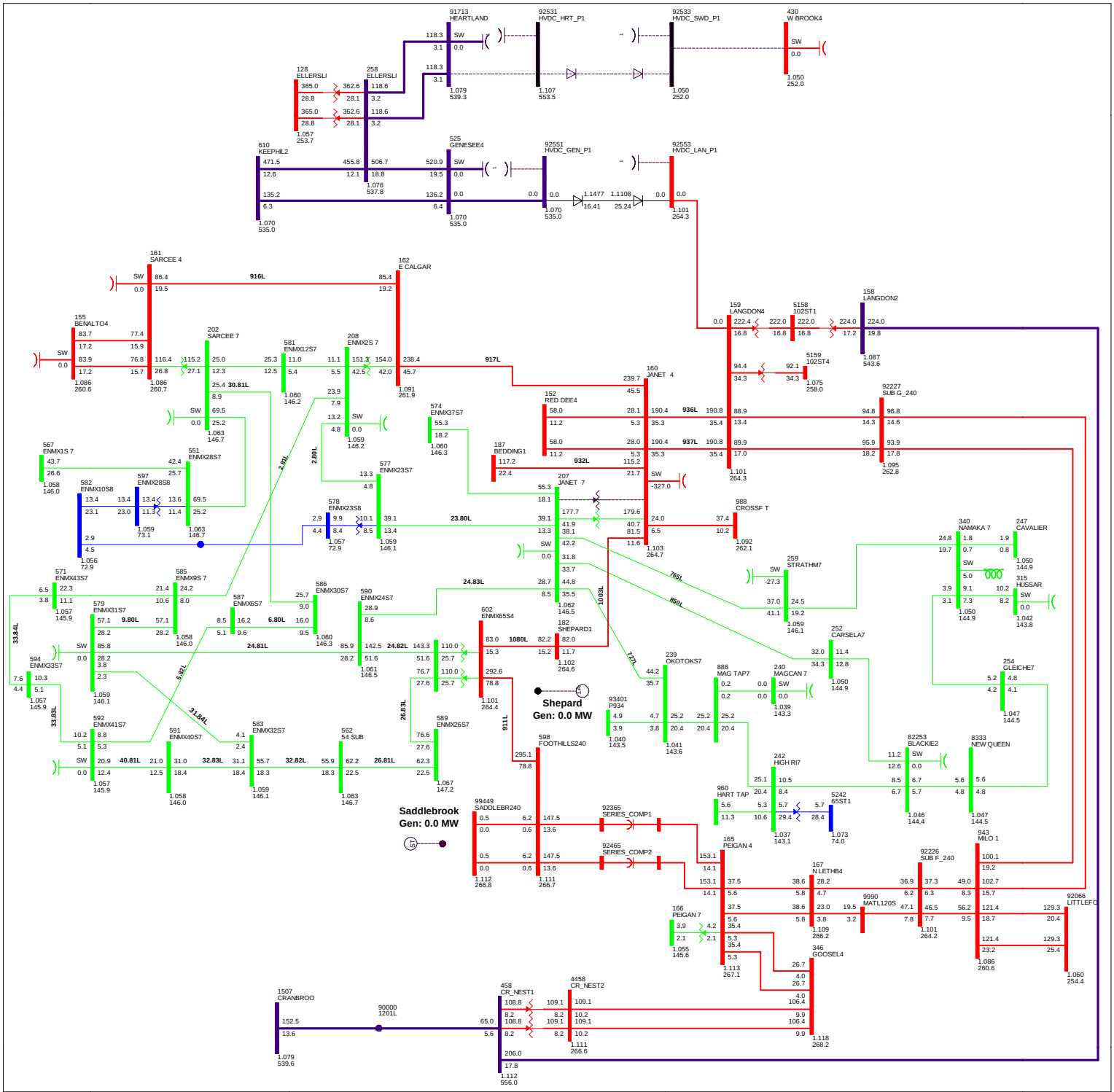
BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

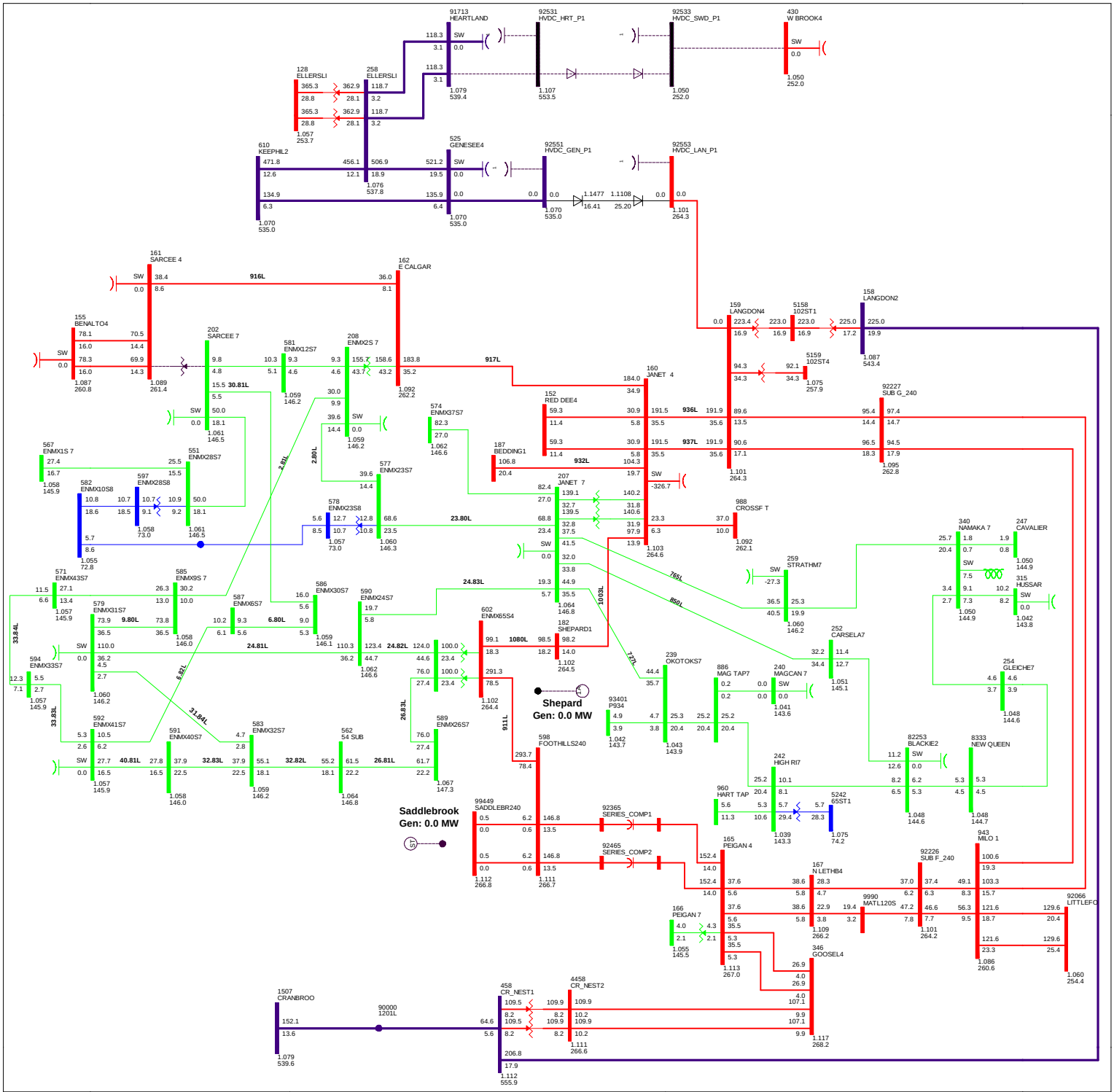
BCH Import: 0.7 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

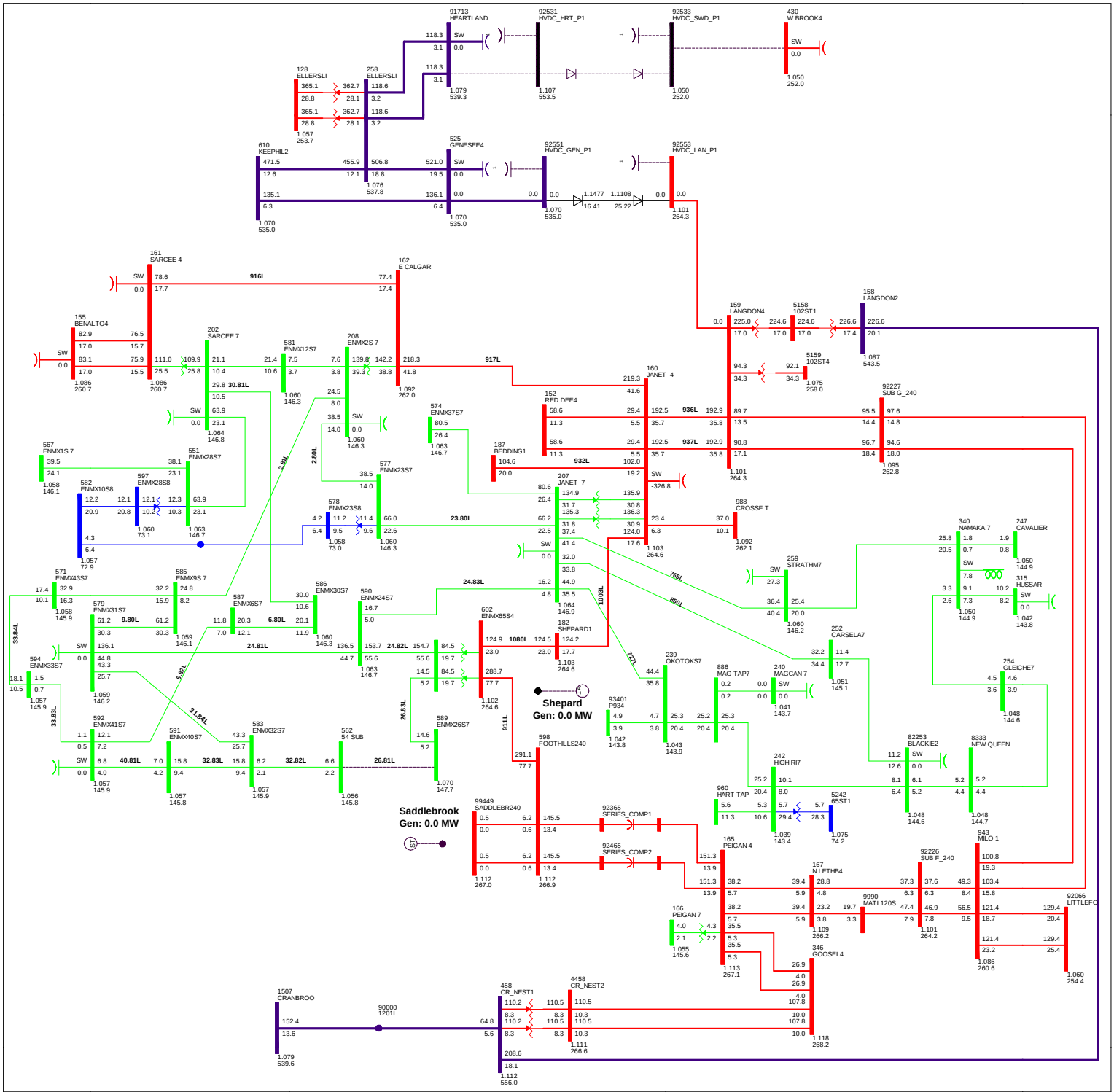
BCH Import: 0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

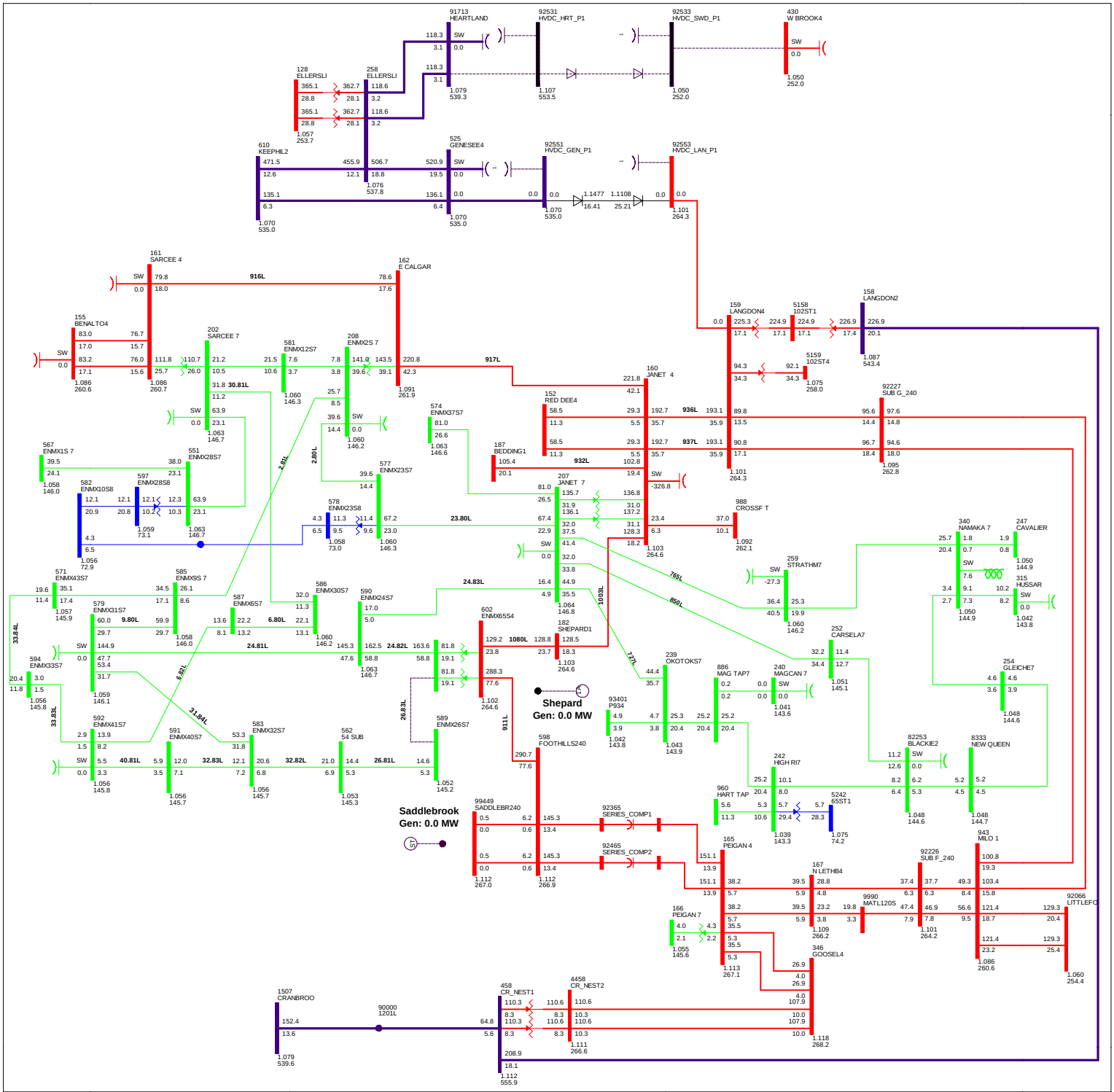
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.4 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



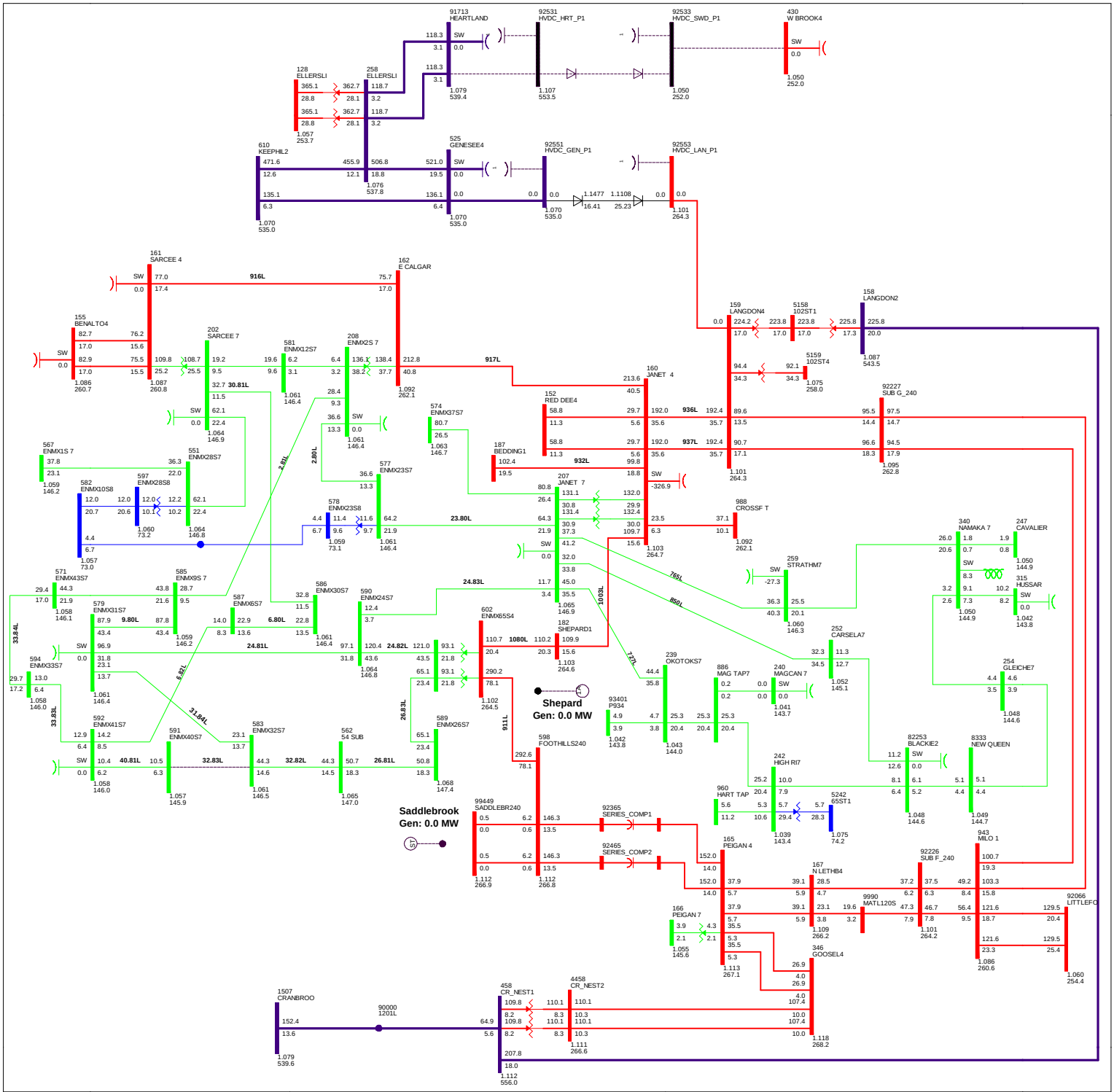
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



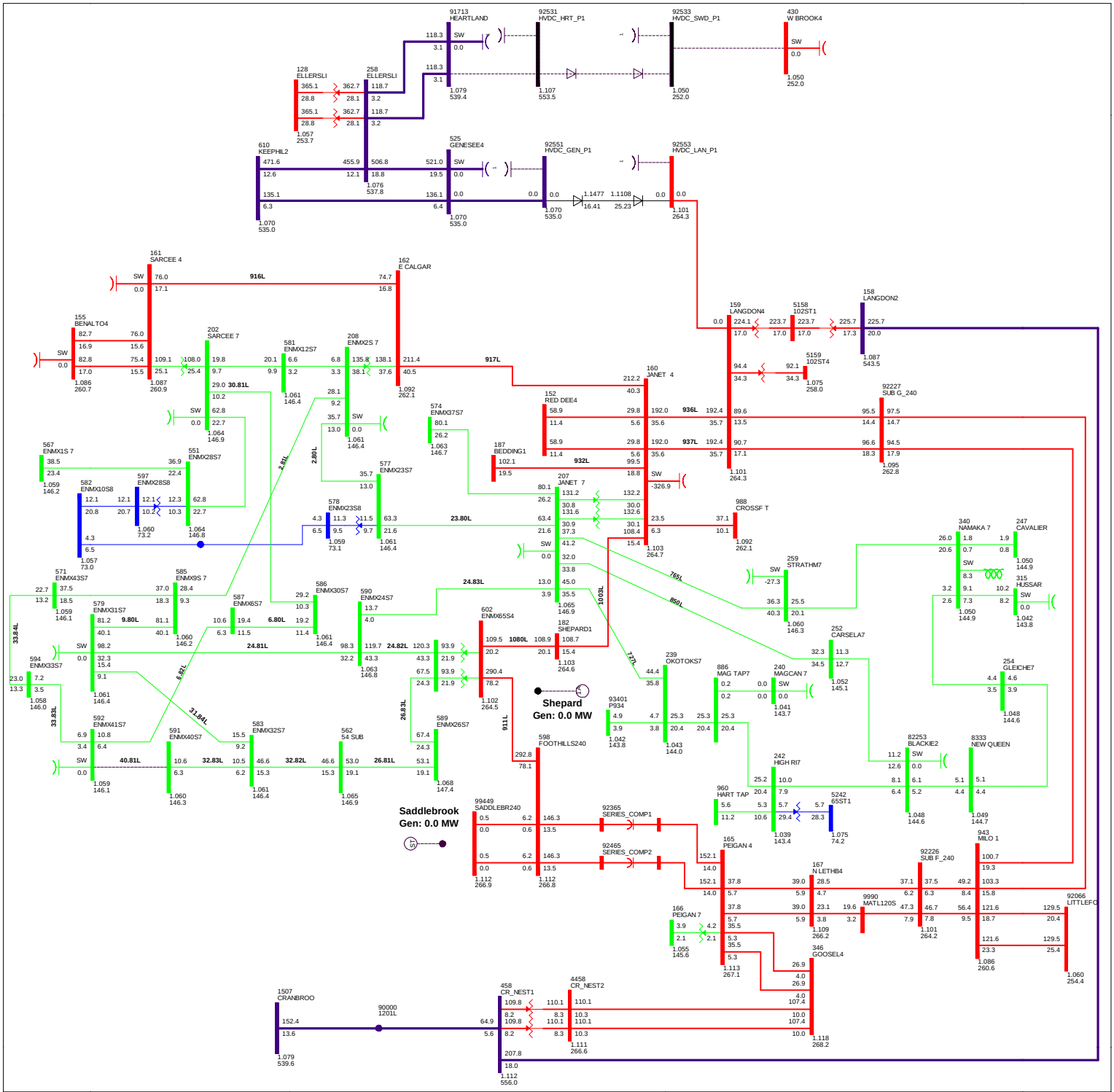
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



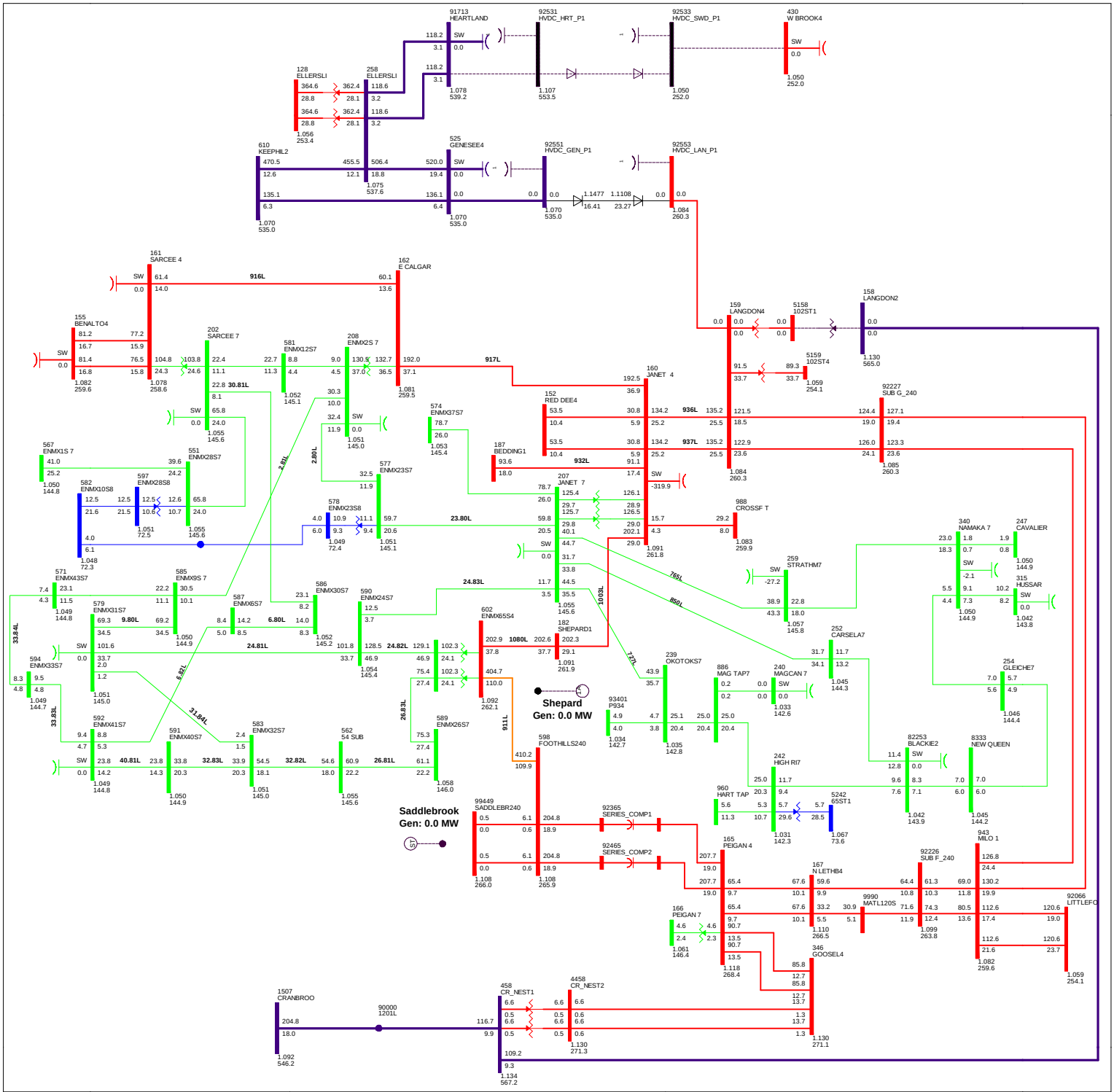
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

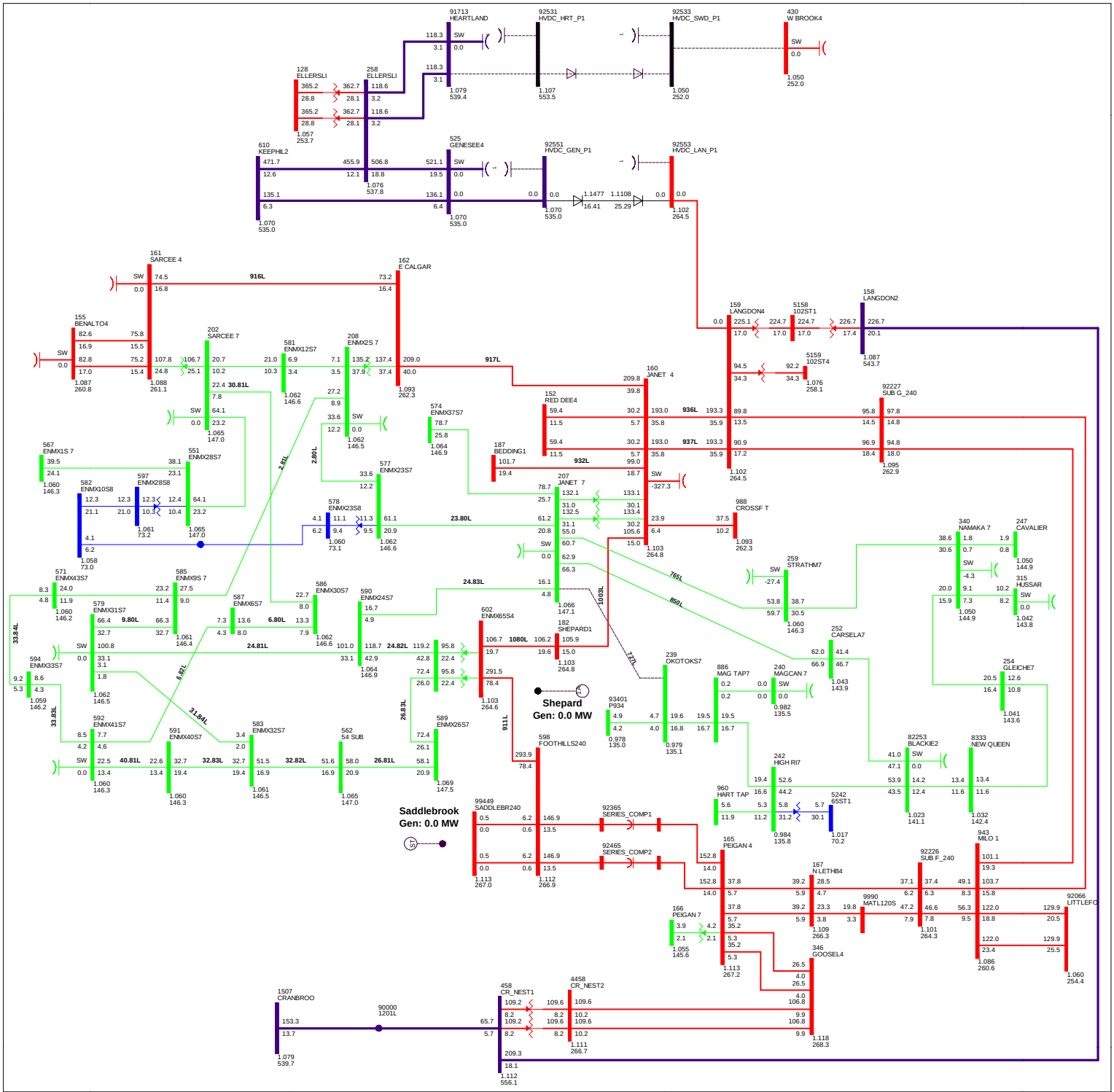
BCH Import: 5.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

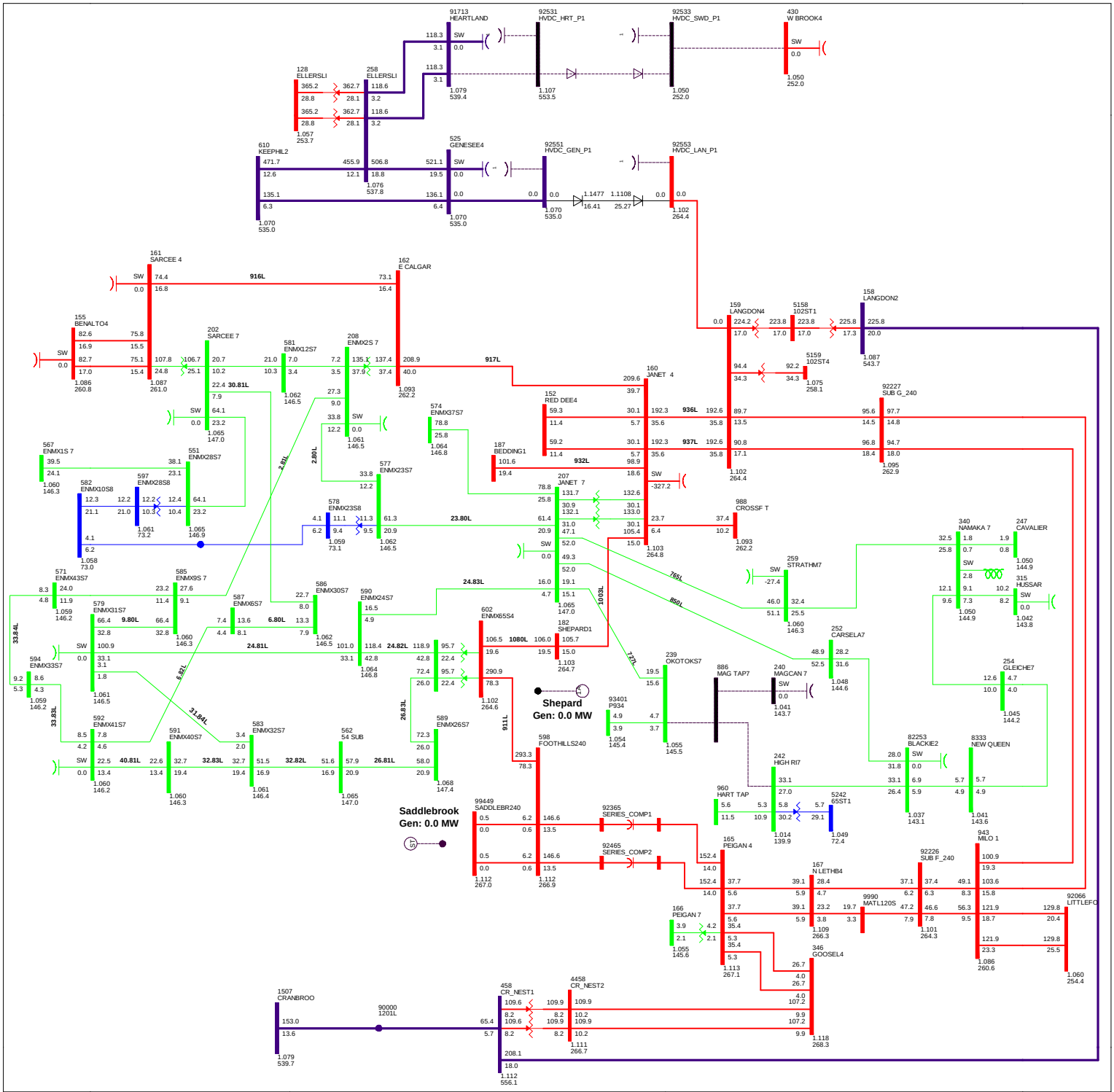
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.8 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

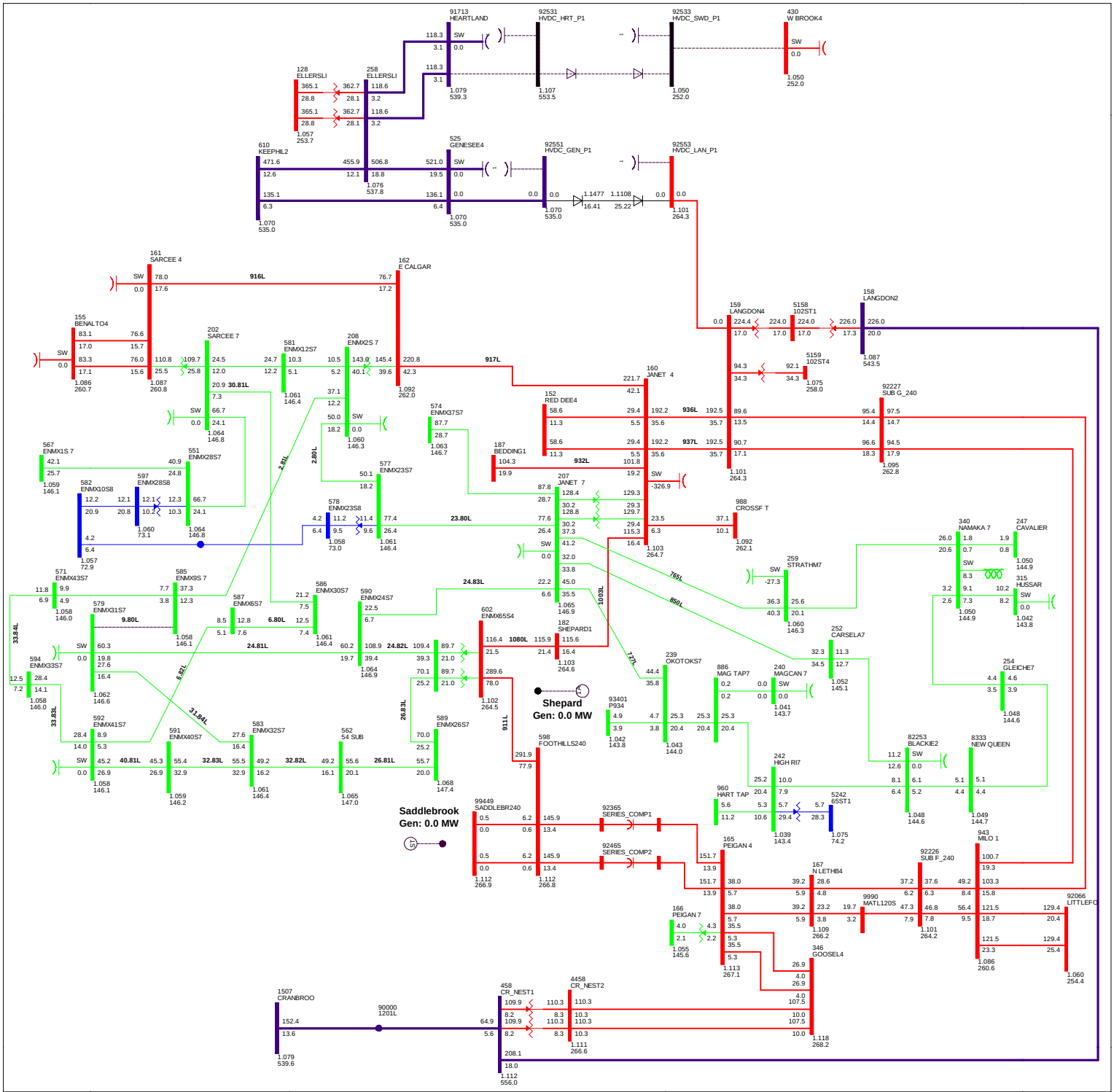
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.9 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

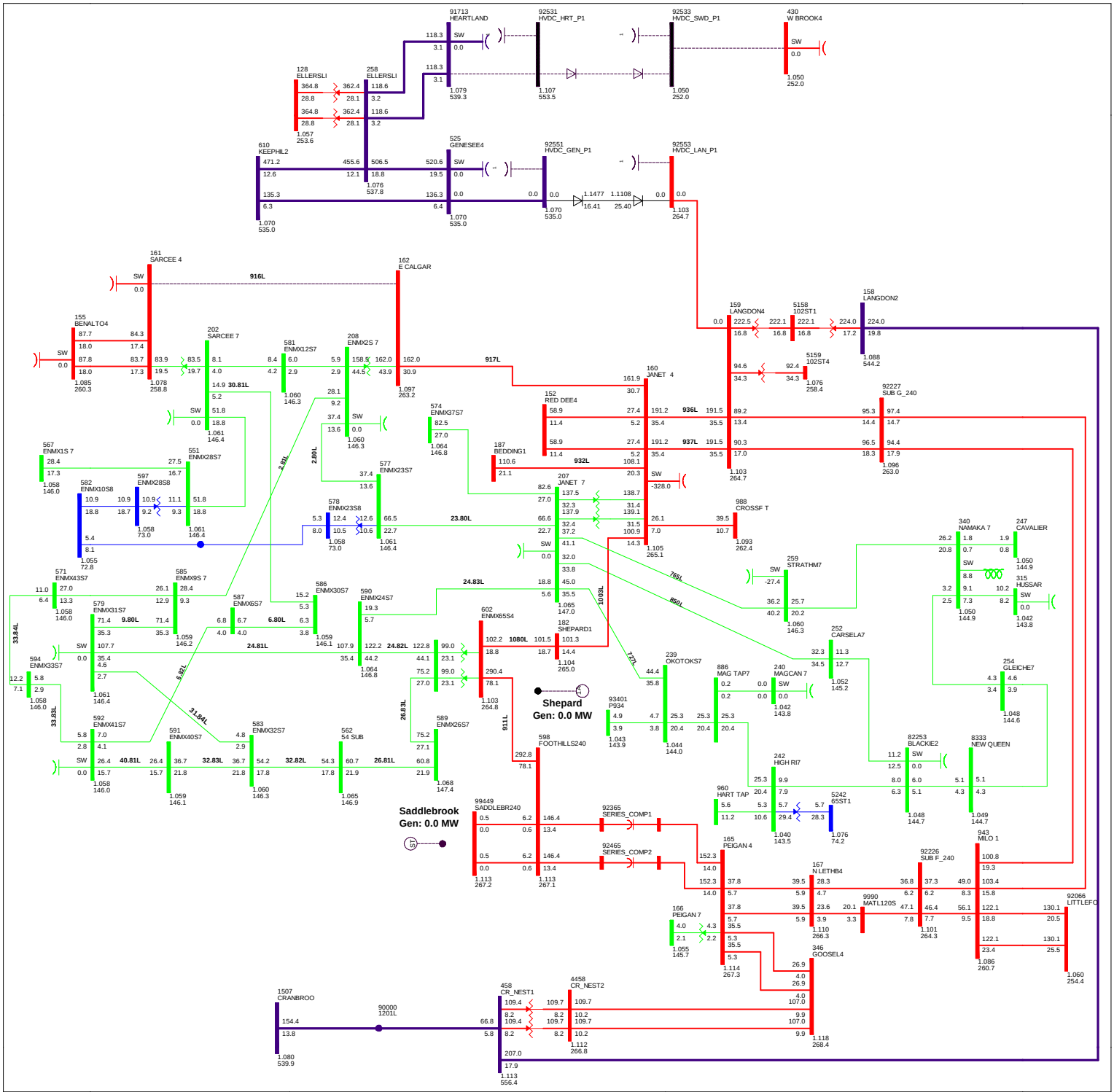
BCH Import: 0.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-22: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



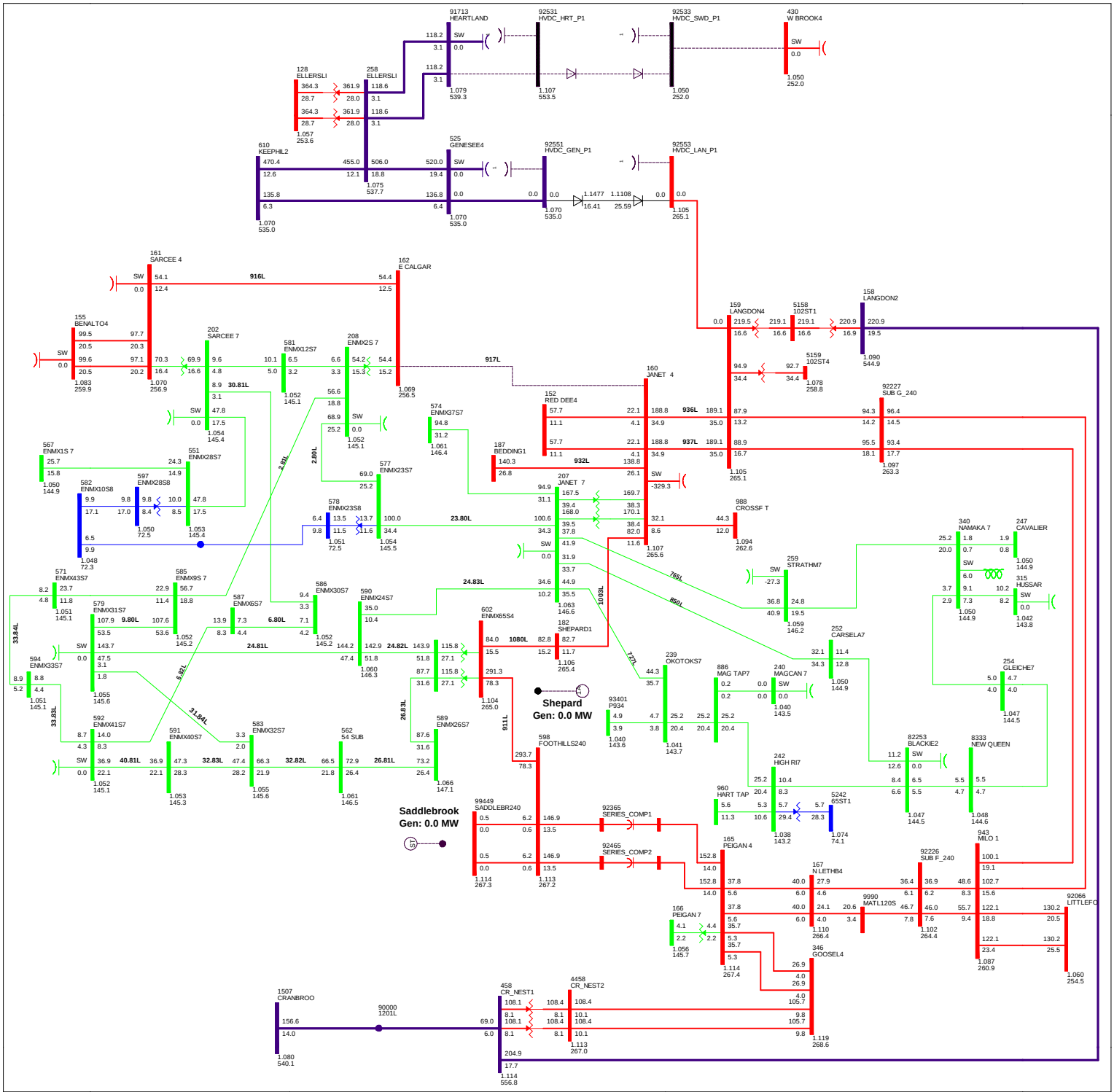
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.3 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-23: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



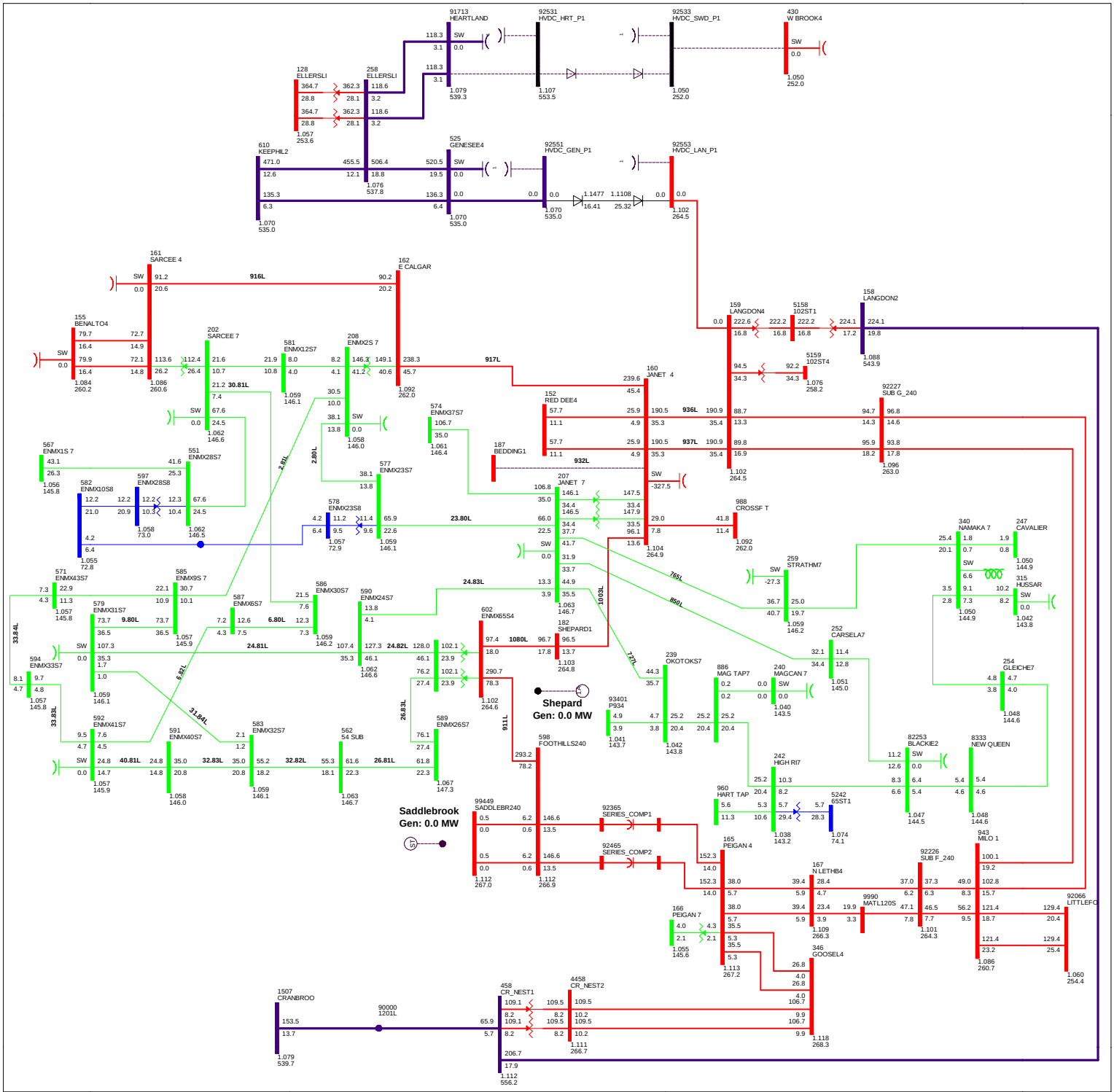
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.0 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-24: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

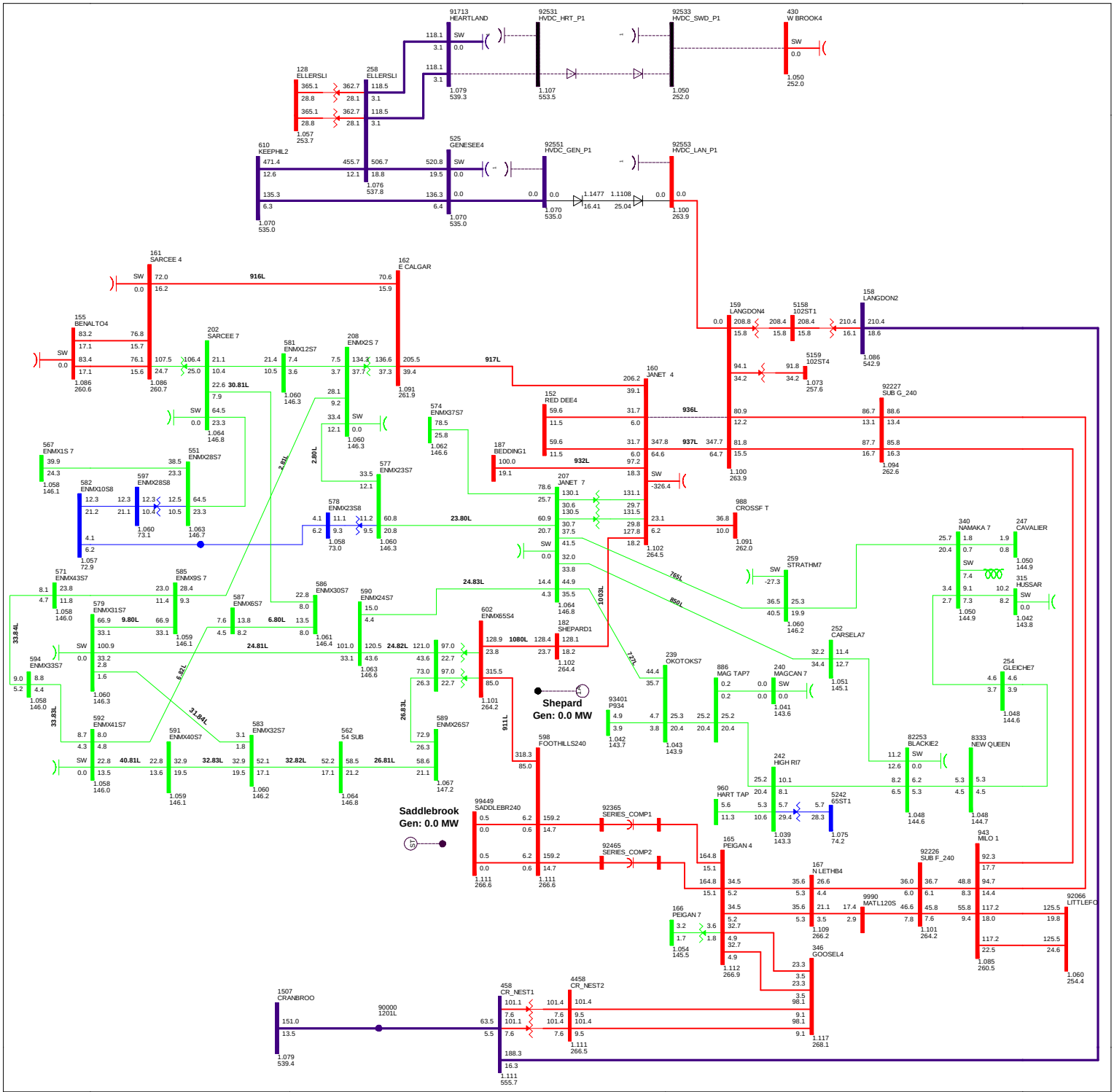
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.6 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-25: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

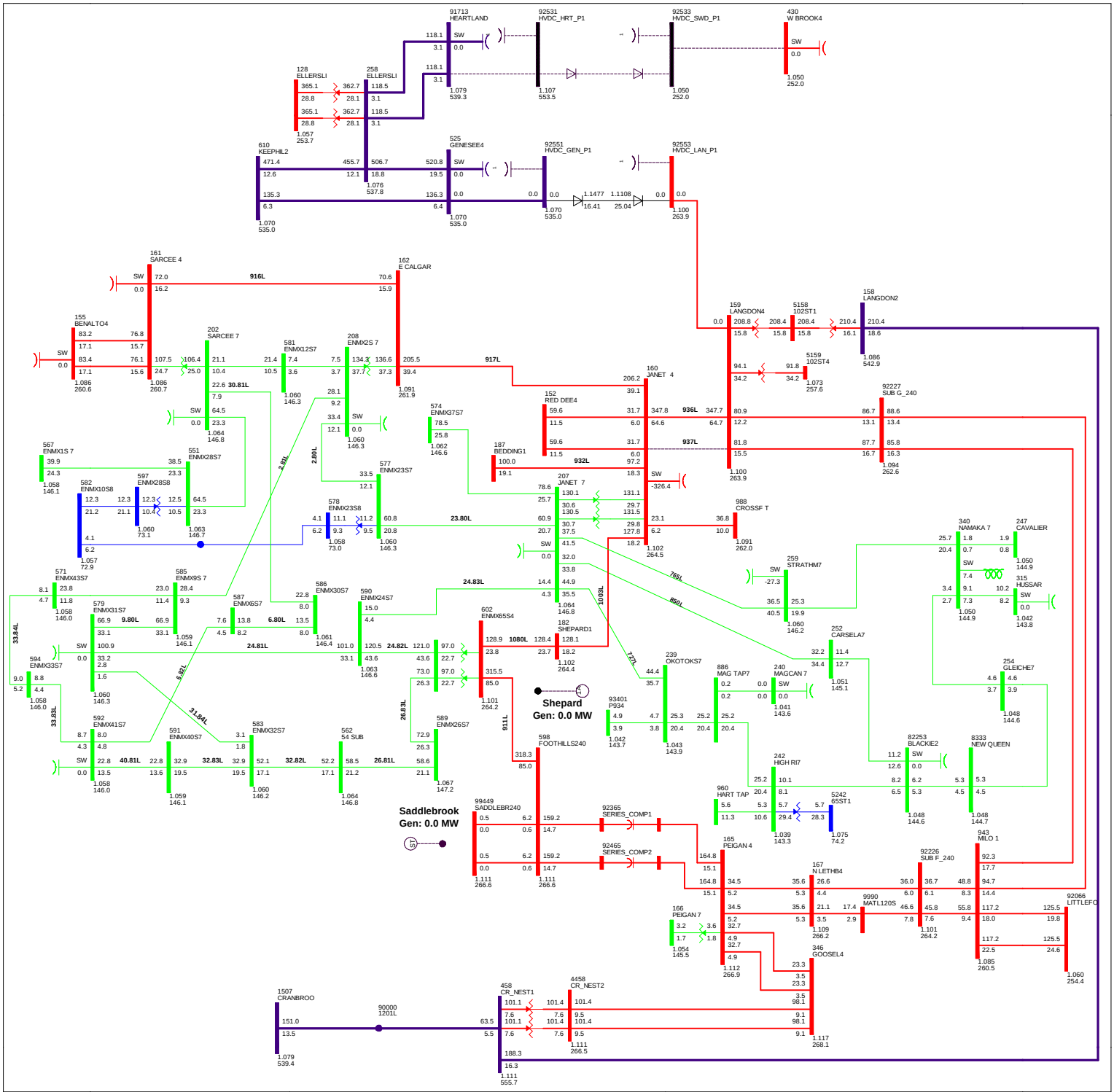
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC6-26: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.2 MW

2012LTO EXISTING SYSTEM

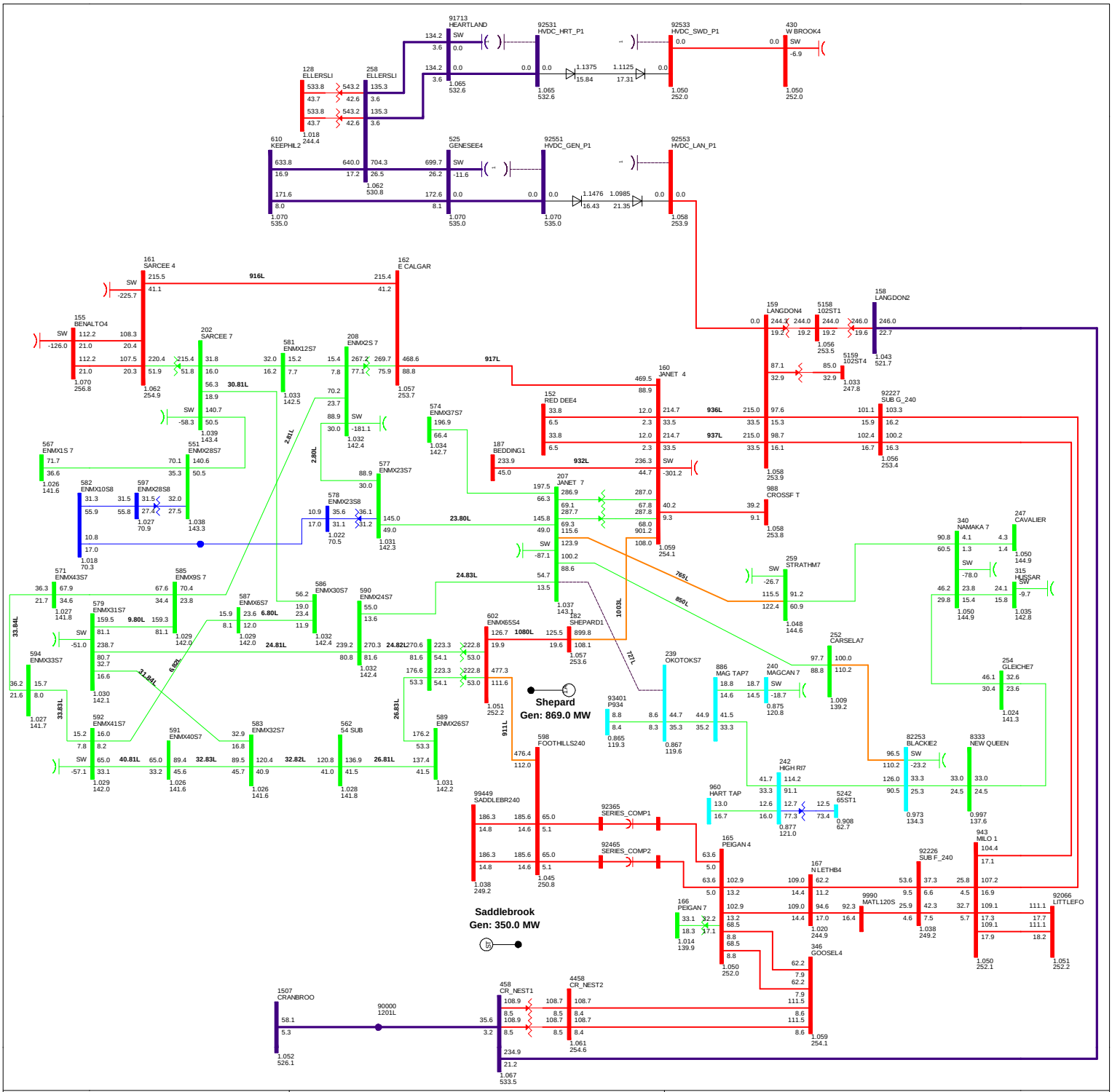
FIG A-SC6-27: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_SL_EXISTING_SC6

FRI, JUN 08 2012 15:35

2014 Voltage Violations
Scenario 4B

Table 2: 2012LTO Need Assessment - 2014 Undervoltage Summary

Figure Number	Contingency	Monitored Bus	SC4B
A-SC4B-28	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	238 BLACK D7 138.00	Vinit = 1 pu Vcont = 0.88 pu
	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	239 OKOTOKS7 138.00	Vinit = 1.01 pu Vcont = 0.88 pu
	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	240 MAGCAN 7 138.00	Vinit = 1.01 pu Vcont = 0.89 pu
	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	241 BLACK D8 69.000	Vinit = 1 pu Vcont = 0.88 pu
	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	242 HIGH RI7 138.00	Vinit = 1 pu Vcont = 0.89 pu
	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	243 HARTELL7 138.00	Vinit = 1 pu Vcont = 0.88 pu
	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	886 MAG TAP7 138.00	Vinit = 1.01 pu Vcont = 0.89 pu
	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	93401 P934 138.00	Vinit = 1.01 pu Vcont = 0.88 pu
	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	960 HART TAP 138.00	Vinit = 1 pu Vcont = 0.88 pu



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE B
Equipment - MW/Mvar
100.0%RATEB
1.10OV 0.90UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 16.2 MW

2012LTO EXISTING SYSTEM

FIG A-SC4B-28: OPEN 727L 138KV LINE (JANET 74S TO OKOTOKS 67
2014_WP_EXISTING_SC4

FRI, JUN 08 2012 15:48

2019 Loading Violations
Scenario 1

Table 3: 2012LTO Need Assessment - 2019 Loading Summary under Category B Contingencies (Over 100%)

Figure Number	Contingency	Overloaded Branch	Scenario					
			SC1	SC2	SC3	SC4	SC5	SC6
B-Sc#-1	BASE CASE	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**157% 1059MVA**	118% 794MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			105% 288MVA	**121% 322MVA**		
		911L 240 kV line (Foothills 237S to ENMAX No. 65)		168% 583MVA	**233% 810MVA**	218% 757MVA	108% 375MVA	171% 593MVA
		917L 240 kV line (Janet 74S to East Calgary 5S)				**120% 607MVA**		
B-Sc#-2	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)				**172% 875MVA**	169% 852MVA	
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)				**111% 321MVA**		
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**134% 385MVA**	109% 319MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		121% 325MVA	165% 443MVA	**316% 822MVA**	239% 631MVA	121% 318MVA
		24.83L 138 kV line (Janet 74S to ENMAX No. 24)				**120% 382MVA**		
		240/138 kV transformer (ENMAX No. 65)				**149% 596MVA**	116% 463MVA	
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)				**125% 323MVA**		
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)				**140% 365MVA**	112% 297MVA	
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)				**115% 182MVA**		
		40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)				**104% 165MVA**		
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			110% 219MVA	**201% 385MVA**	151% 293MVA	
		936L 240 kV line (Langdon 102S to Janet 74S)			100% 514MVA	**116% 597MVA**		
		937L 240 kV line (Langdon 102S to Janet 74S)			100% 514MVA	**116% 597MVA**		
B-Sc#-3	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**128% 863MVA**	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		121% 325MVA	**165% 444MVA**	163% 424MVA		121% 318MVA
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			110% 219MVA	**119% 230MVA**		
		911L 240 kV line (Foothills 237S to ENMAX No. 65)					**111% 386MVA**	
		936L 240 kV line (Langdon 102S to Janet 74S)			**100% 514MVA**			
		937L 240 kV line (Langdon 102S to Janet 74S)			**100% 514MVA**			
B-Sc#-4	Open 1201L 500kV line (Langdon 102S to Crowsnest 491S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**189% 1275MVA**	148% 988MVA	
		1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)			**119% 603MVA**	103% 528MVA		106% 545MVA
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		102% 275MVA	115% 312MVA	**130% 345MVA**	108% 288MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**101% 197MVA**		
		911L 240 kV line (Foothills 237S to ENMAX No. 65)	112% 388MVA	234% 814MVA	**307% 1067MVA**	290% 1005MVA	171% 594MVA	240% 834MVA
B-Sc#-5	Open 2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**104% 306MVA**		
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**117% 227MVA**		
		917L 240 kV line (Janet 74S to East Calgary 5S)				**125% 631MVA**		

Table 3: 2012LTO Need Assessment - 2019 Loading Summary under Category B Contingencies (Over 100%)

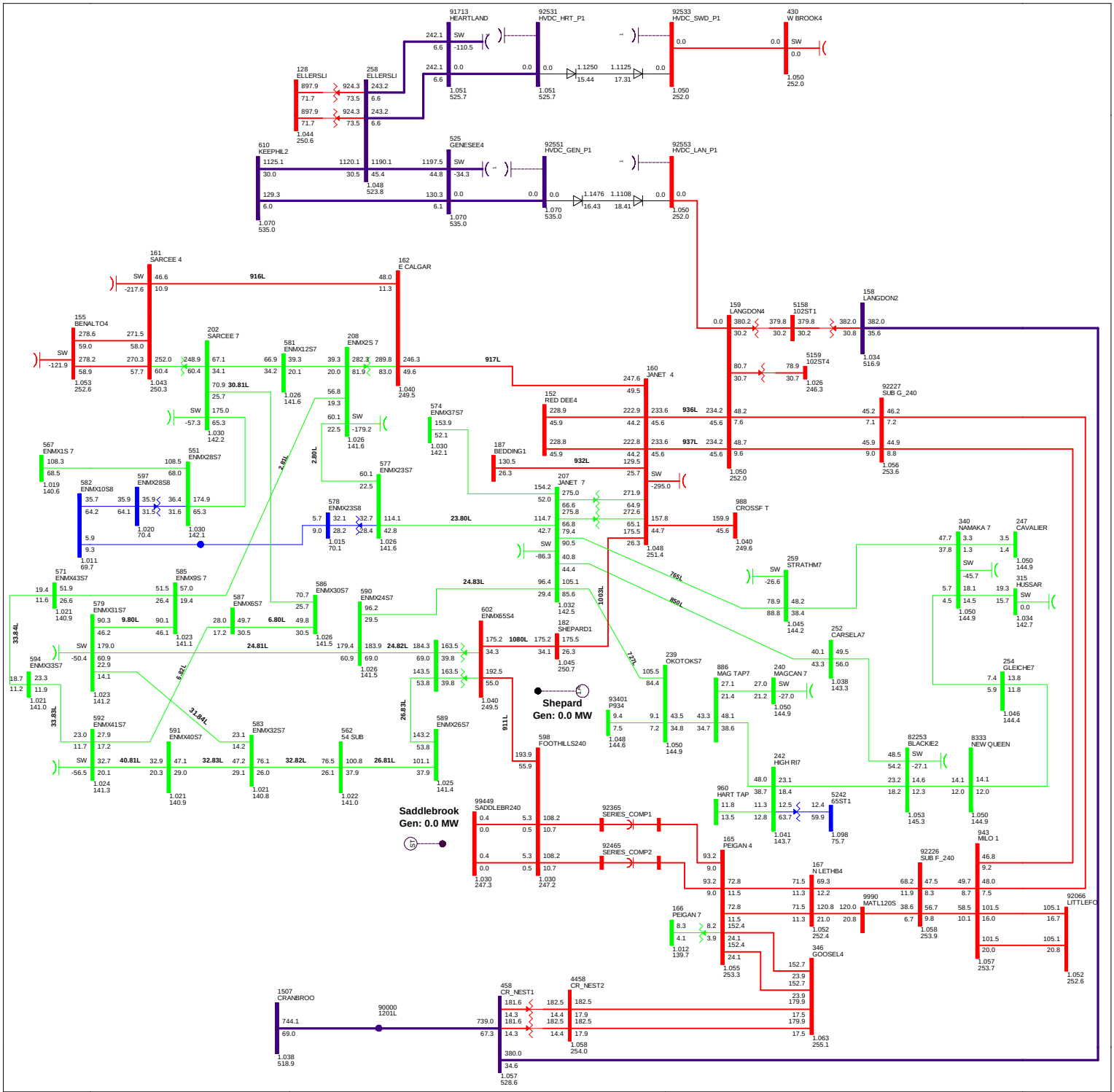
Figure Number	Contingency	Overloaded Branch	Scenario					
			SC1	SC2	SC3	SC4	SC5	SC6
B-Sc#-6	Open 2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**160% 1076MVA**	120% 804MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**124% 624MVA**		
B-Sc#-7	Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**113% 331MVA**		
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			106% 211MVA	**128% 249MVA**	103% 202MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**128% 647MVA**		
B-Sc#-8	Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**161% 1087MVA**	122% 816MVA	
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)				**101% 269MVA**		
		917L 240 kV line (Janet 74S to East Calgary 5S)				**131% 662MVA**	102% 514MVA	
B-Sc#-9	Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**185% 1250MVA**	141% 946MVA	
		1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)			**105% 534MVA**			
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)				**101% 269MVA**		
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)			105% 286MVA	**117% 311MVA**	101% 270MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**131% 659MVA**	101% 509MVA	
B-Sc#-10	Open 24.83L 138 kV line (Janet 74S to ENMAX No. 24)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			110% 297MVA	**124% 329MVA**	106% 282MVA	
B-Sc#-11	Open 240/138 kV transformer (East Calgary 5S)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**107% 313MVA**		
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		104% 279MVA	116% 314MVA	**131% 348MVA**	110% 294MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			107% 212MVA	**125% 242MVA**	105% 205MVA	
		916L 240 kV line (Sarcee 42S to East Calgary 5S)				**107% 461MVA**		
B-Sc#-12	Open 240/138 kV transformer (ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**175% 1177MVA**	133% 892MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**128% 645MVA**		
B-Sc#-13	Open 240/138 kV transformer (Janet 74S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		114% 307MVA	126% 344MVA	**143% 380MVA**	120% 323MVA	
		240/138 kV transformer (Janet 74S)				**107% 428MVA**	102% 409MVA	
		911L 240 kV line (Foothills 237S to ENMAX No. 65)		169% 587MVA	**234% 814MVA**			
		917L 240 kV line (Janet 74S to East Calgary 5S)			101% 507MVA	**135% 682MVA**	107% 537MVA	
B-Sc#-14	Open 240/138 kV transformer (Sarcee 42S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			109% 298MVA	**124% 330MVA**	103% 276MVA	
		240/138 kV transformer (East Calgary 5S)	**101% 339MVA**	**101% 339MVA**				
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**105% 203MVA**		

Table 3: 2012LTO Need Assessment - 2019 Loading Summary under Category B Contingencies (Over 100%)

Figure Number	Contingency	Overloaded Branch	Scenario					
			SC1	SC2	SC3	SC4	SC5	SC6
B-Sc#-15	Open 26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**165% 1115MVA**	125% 839MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)		101% 299MVA	109% 326MVA	**124% 364MVA**	107% 316MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		123% 332MVA	138% 376MVA	**157% 419MVA**	131% 350MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**126% 634MVA**		
B-Sc#-16	Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**167% 1129MVA**	127% 852MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)		109% 325MVA	117% 352MVA	**133% 389MVA**	116% 342MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	102% 273MVA	132% 358MVA	147% 402MVA	**167% 445MVA**	140% 376MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**127% 641MVA**		
B-Sc#-17	Open 31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**100% 195MVA**		
B-Sc#-18	Open 32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**159% 1072MVA**	120% 804MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			107% 293MVA	**123% 328MVA**	101% 271MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)			105% 209MVA	**129% 250MVA**	102% 199MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**123% 619MVA**		
B-Sc#-19	Open 33.83L 138 kV line (ENMAX No. 41 to ENMAX No. 33)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**101% 197MVA**		
B-Sc#-20	Open 40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**159% 1070MVA**	120% 801MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			107% 291MVA	**123% 326MVA**	101% 270MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**122% 237MVA**		
		917L 240 kV line (Janet 74S to East Calgary 5S)				**122% 616MVA**		
B-Sc#-21	Open 500/240 kV transformer (Langdon 102S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**189% 1274MVA**	147% 987MVA	
		1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)			**119% 603MVA**	103% 527MVA		107% 545MVA
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		102% 274MVA	115% 312MVA	**130% 345MVA**	108% 288MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**101% 197MVA**		
		911L 240 kV line (Foothills 237S to ENMAX No. 65)	112% 388MVA	234% 813MVA	**307% 1067MVA**	289% 1004MVA	171% 594MVA	240% 834MVA
B-Sc#-22	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	765L 138 kV line (Janet 74S to Strathmore 151S)	129% 113MVA	123% 109MVA	119% 106MVA	**131% 114MVA**	128% 112MVA	
		850L 138 kV line (Janet 74S to Carseland 525S)	112% 102MVA	109% 101MVA	106% 100MVA	**113% 103MVA**	111% 102MVA	
B-SC#-23	Open 727L 138 kV line (Okotoks 678SS to Magcan 142S to High River 65S)	765L 138 kV line (Janet 74S to Strathmore 151S)	112% 98MVA	106% 94MVA	102% 91MVA	**114% 99MVA**	111% 97MVA	

Table 3: 2012LTO Need Assessment - 2019 Loading Summary under Category B Contingencies (Over 100%)

Figure Number	Contingency	Overloaded Branch	Scenario					
			SC1	SC2	SC3	SC4	SC5	SC6
B-SC#-24	Open 765L 138 kV line (Janet 74S to Strathmore 151S)	727L 138 kV line (Janet 74S to Okotoks 678S)	115% 141MVA	107% 133MVA	102% 128MVA	**117% 142MVA**	113% 139MVA	
B-SC#-25	Open 850L 138 kV line (Janet 74S to Carseland 525S)	727L 138 kV line (Janet 74S to Okotoks 678S)	103% 126MVA			**105% 128MVA**	101% 124MVA	
		765L 138 kV line (Janet 74S to Strathmore 151S)	106% 93MVA			**107% 94MVA**	104% 92MVA	
B-SC#-26	Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**162% 1091MVA**	122% 818MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				**128% 643MVA**		
B-SC#-27	Open 911L 240 kV line (Foothills 237S to ENMAX No. 65)	936L 240 kV line (Langdon 102S to Janet 74S)		131% 670MVA	**154% 791MVA**	141% 723MVA		130% 669MVA
		937L 240 kV line (Langdon 102S to Janet 74S)		131% 670MVA	**154% 791MVA**	141% 723MVA		130% 669MVA
B-SC#-28	Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				**104% 304MVA**		
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			109% 299MVA	**129% 343MVA**	104% 278MVA	
		240/138 kV transformer (East Calgary 5S)				**117% 392MVA**	102% 343MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**113% 220MVA**		
B-SC#-29	Open 917L 240 kV line (Janet 74S to East Calgary 5S)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)				**102% 287MVA**		
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)		103% 305MVA	112% 334MVA	**136% 398MVA**	114% 334MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		112% 302MVA	127% 344MVA	**150% 398MVA**	122% 326MVA	
		240/138 kV transformer (Janet 74S)				**108% 430MVA**		
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)		112% 221MVA	128% 254MVA	**165% 320MVA**	129% 252MVA	
B-SC#-30	Open 932L 240 kV line (Janet 74S to Beddington SS-162)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)		101% 272MVA	114% 311MVA	**133% 353MVA**	108% 290MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				**111% 217MVA**		
		917L 240 kV line (Janet 74S to East Calgary 5S)			101% 508MVA	**140% 705MVA**	107% 540MVA	
B-SC#-31	Open 936L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**164% 1106MVA**	123% 822MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			108% 293MVA	**123% 327MVA**	101% 269MVA	
		911L 240 kV line (Foothills 237S to ENMAX No. 65)		184% 638MVA	**250% 868MVA**	234% 810MVA	117% 406MVA	186% 647MVA
		937L 240 kV line (Langdon 102S to Janet 74S)		152% 782MVA	**162% 831MVA**	146% 751MVA		151% 774MVA
B-SC#-32	Open 937L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)				**164% 1106MVA**	123% 822MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			108% 293MVA	**123% 327MVA**	101% 269MVA	
		911L 240 kV line (Foothills 237S to ENMAX No. 65)		184% 638MVA	**250% 868MVA**	234% 810MVA	117% 406MVA	186% 647MVA
		936L 240 kV line (Langdon 102S to Janet 74S)		152% 782MVA	**162% 831MVA**	146% 751MVA		151% 774MVA



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

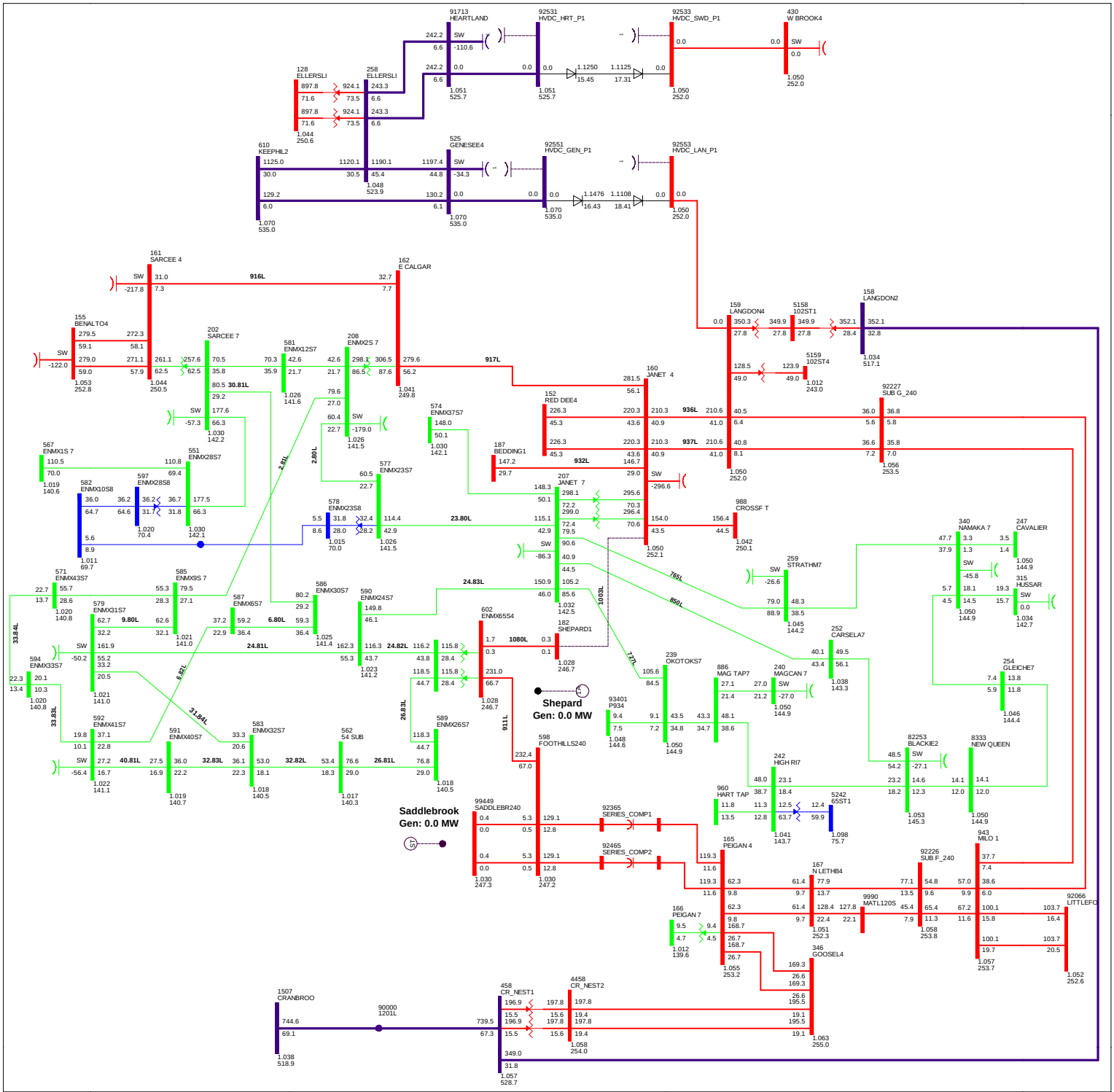
BCH Import: 779.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-1: BASECASE

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

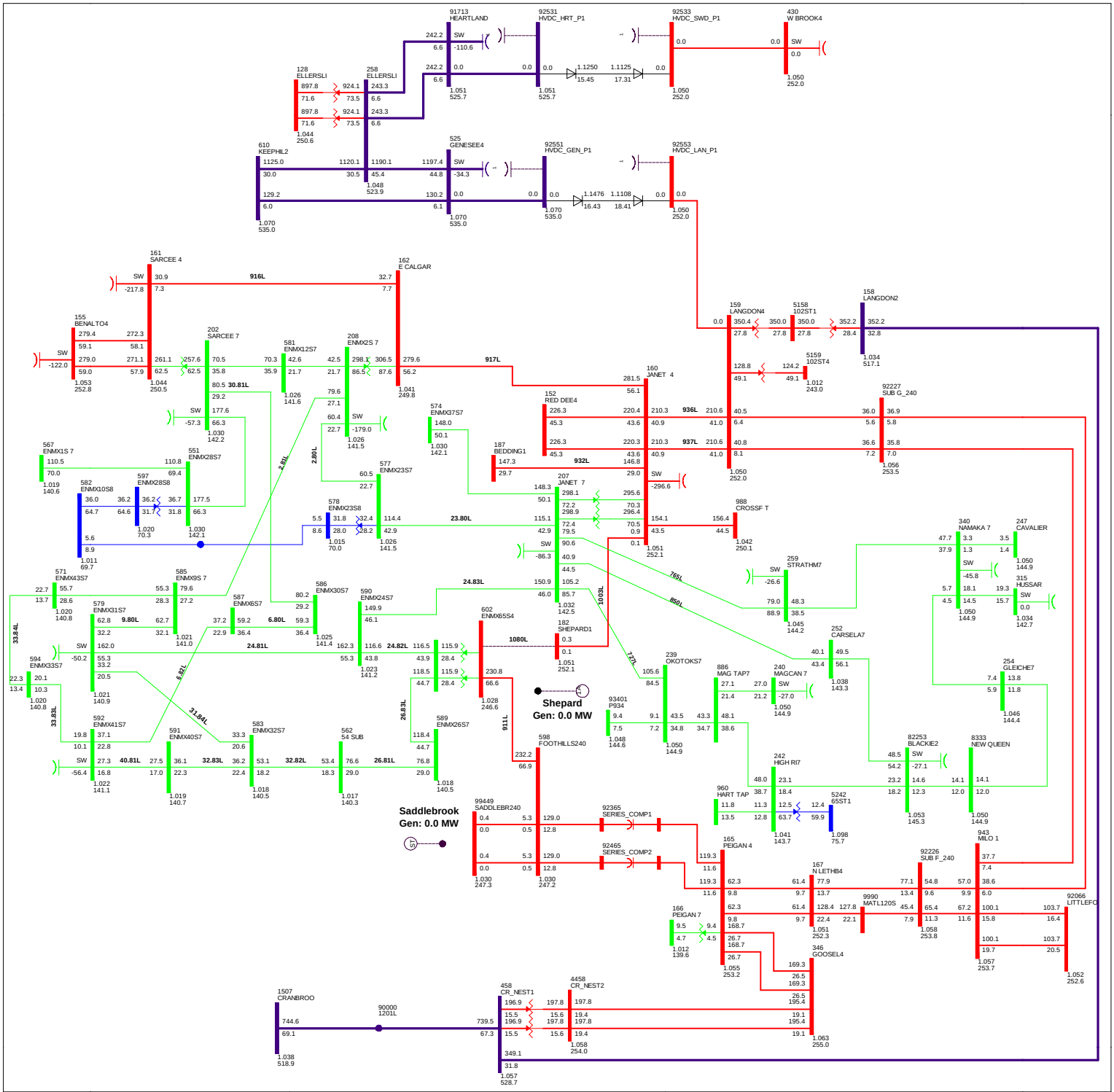
BCH Import: 780.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

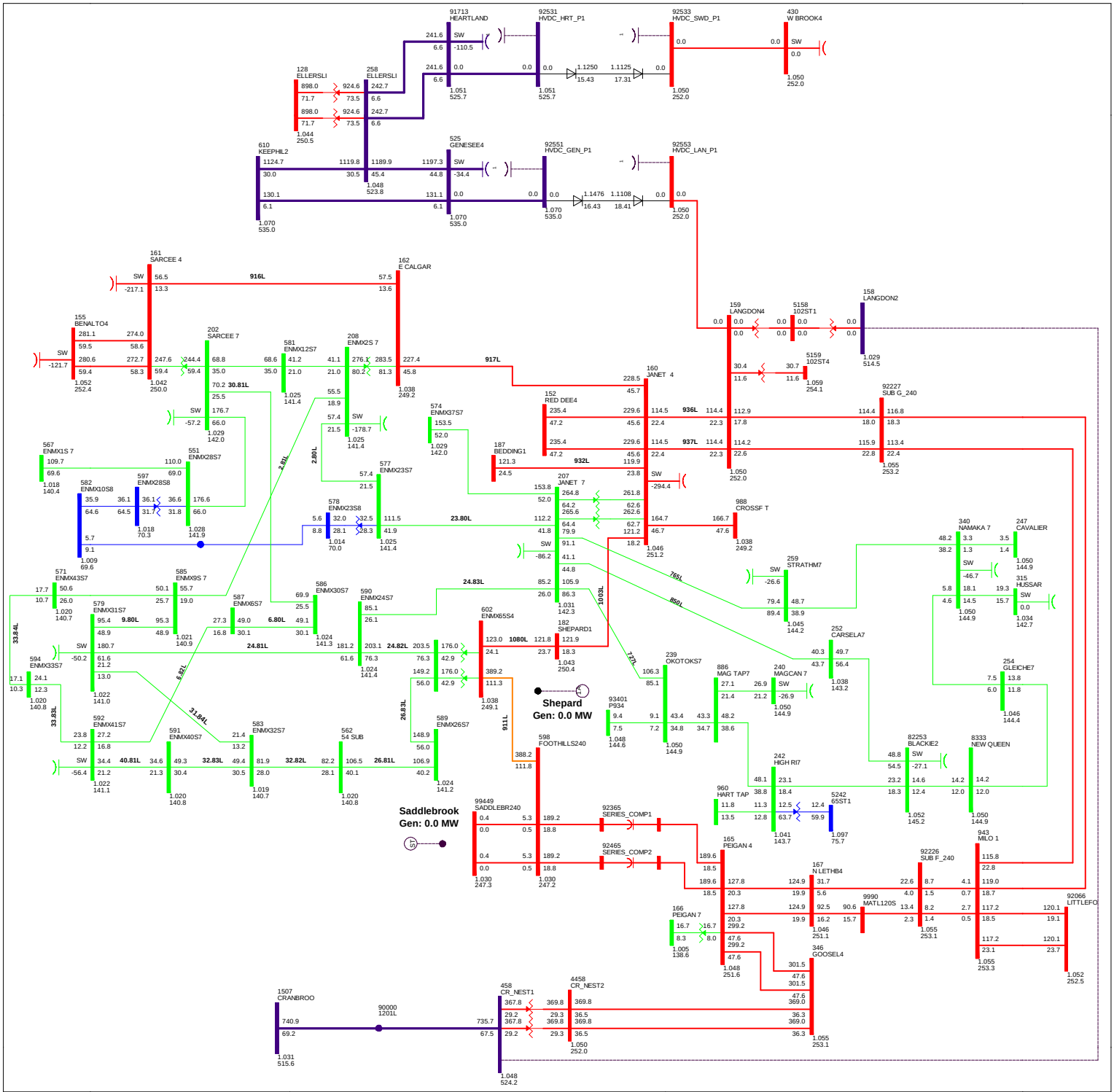
BCH Import: 780.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36



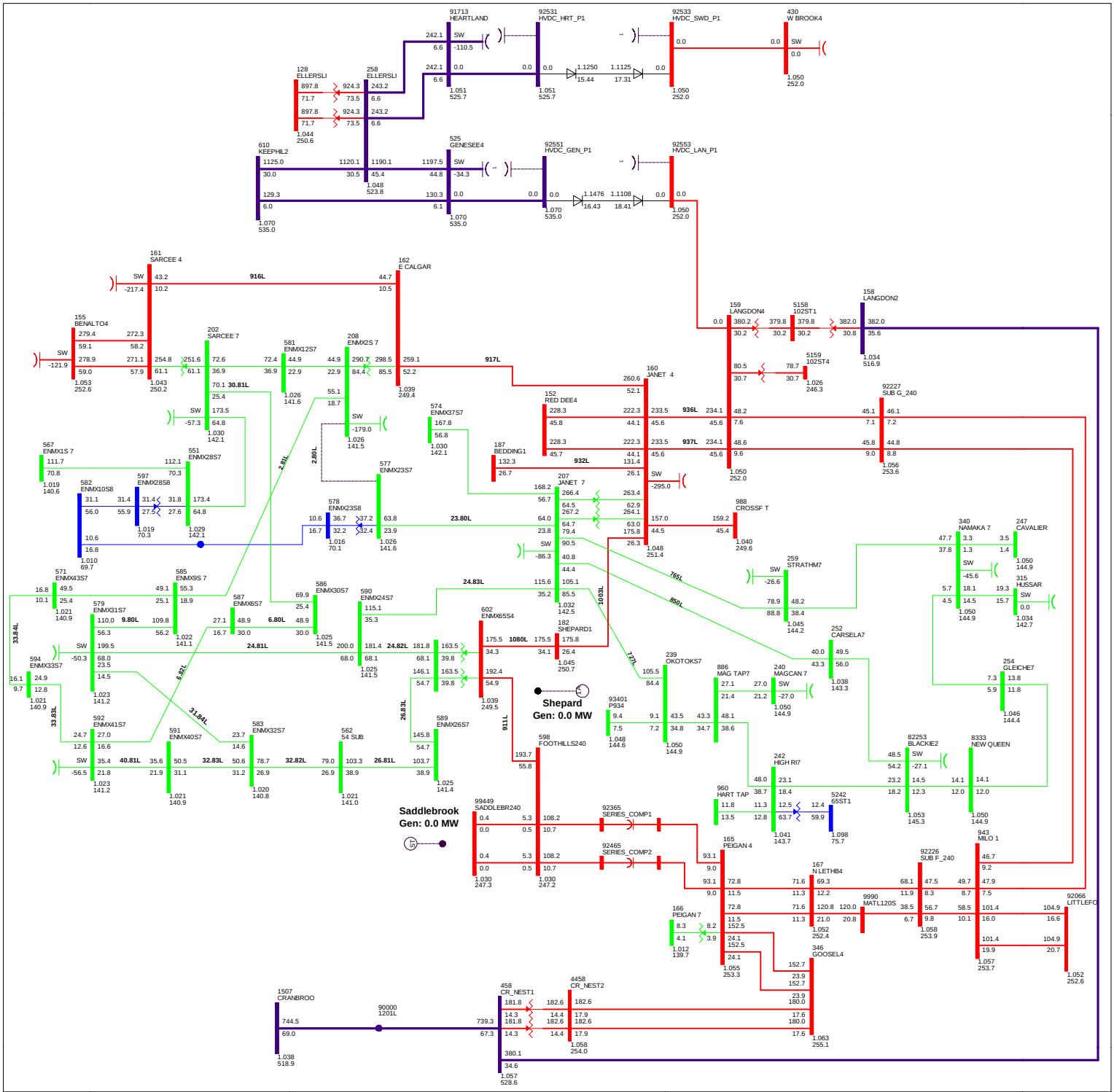
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 798.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

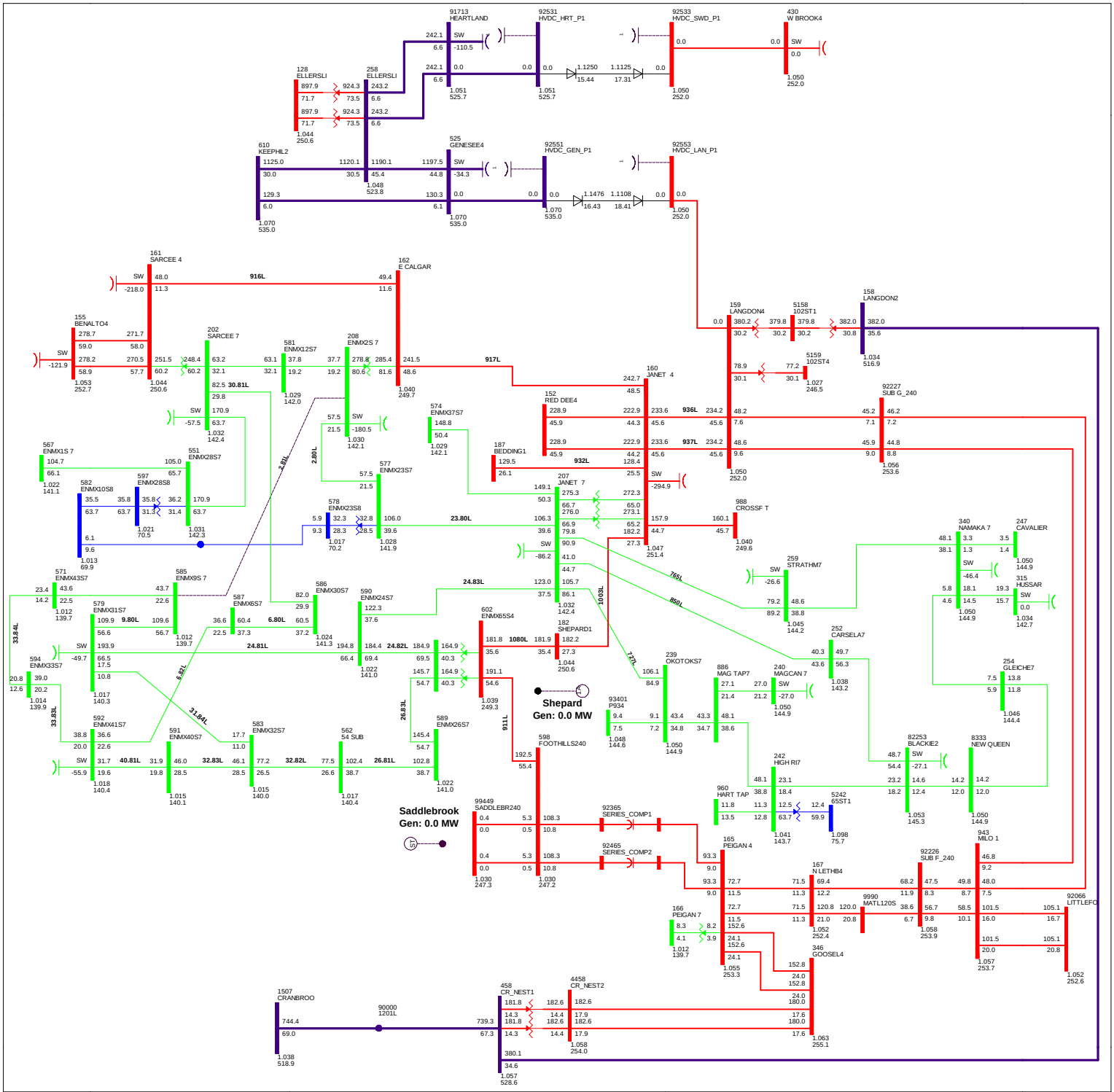
BCH Import: 780.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

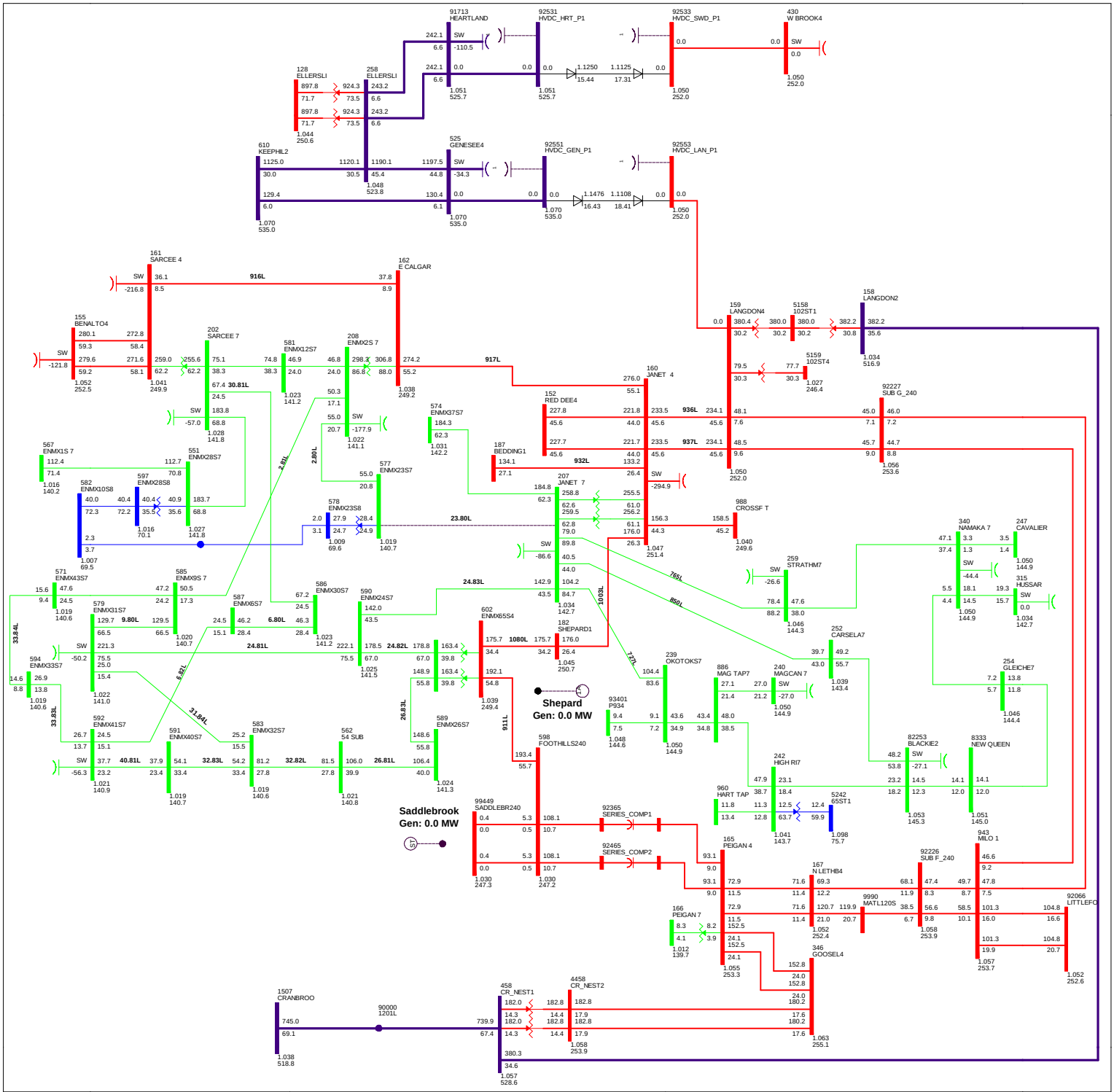
BCH Import: 779.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

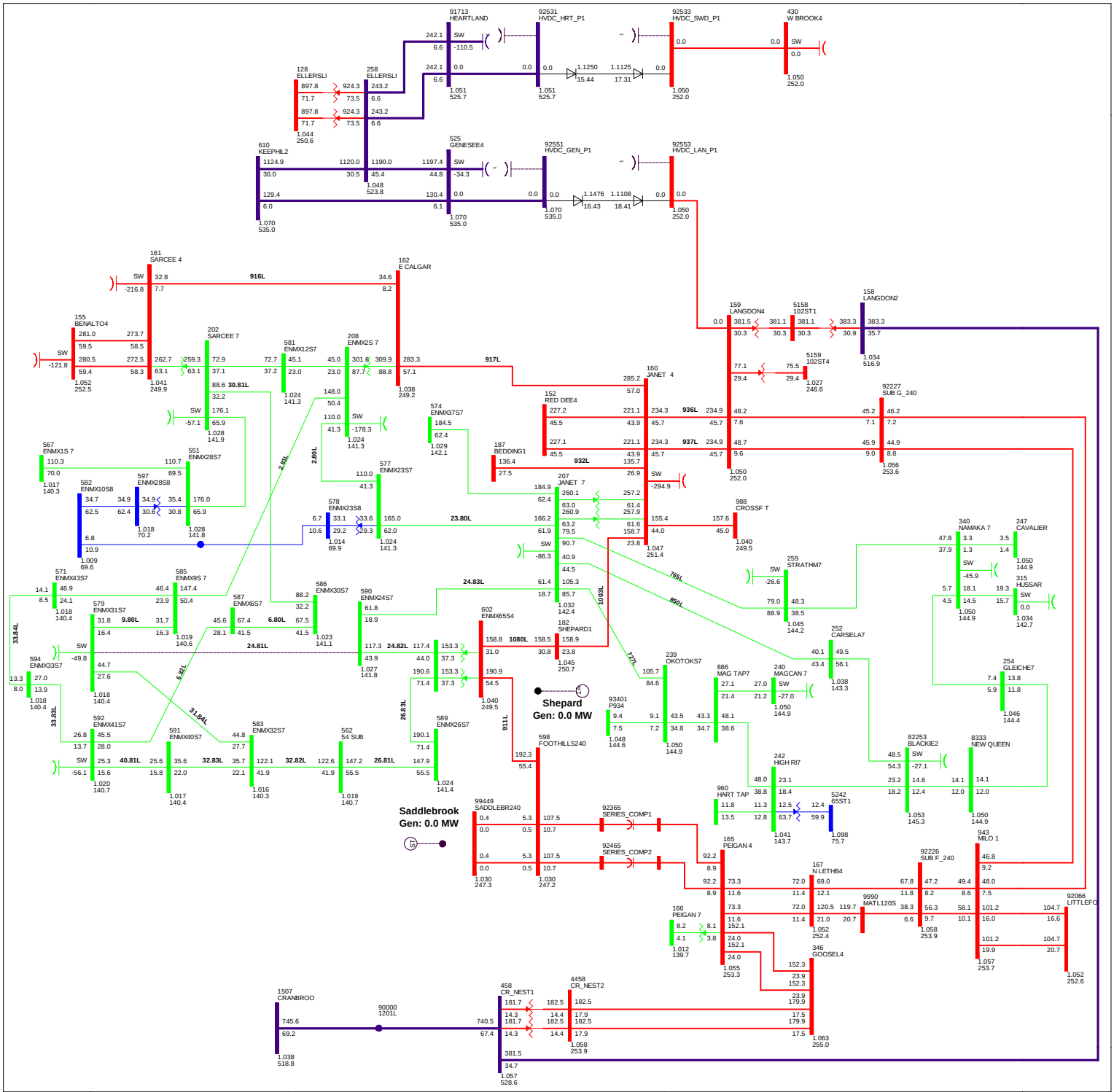
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

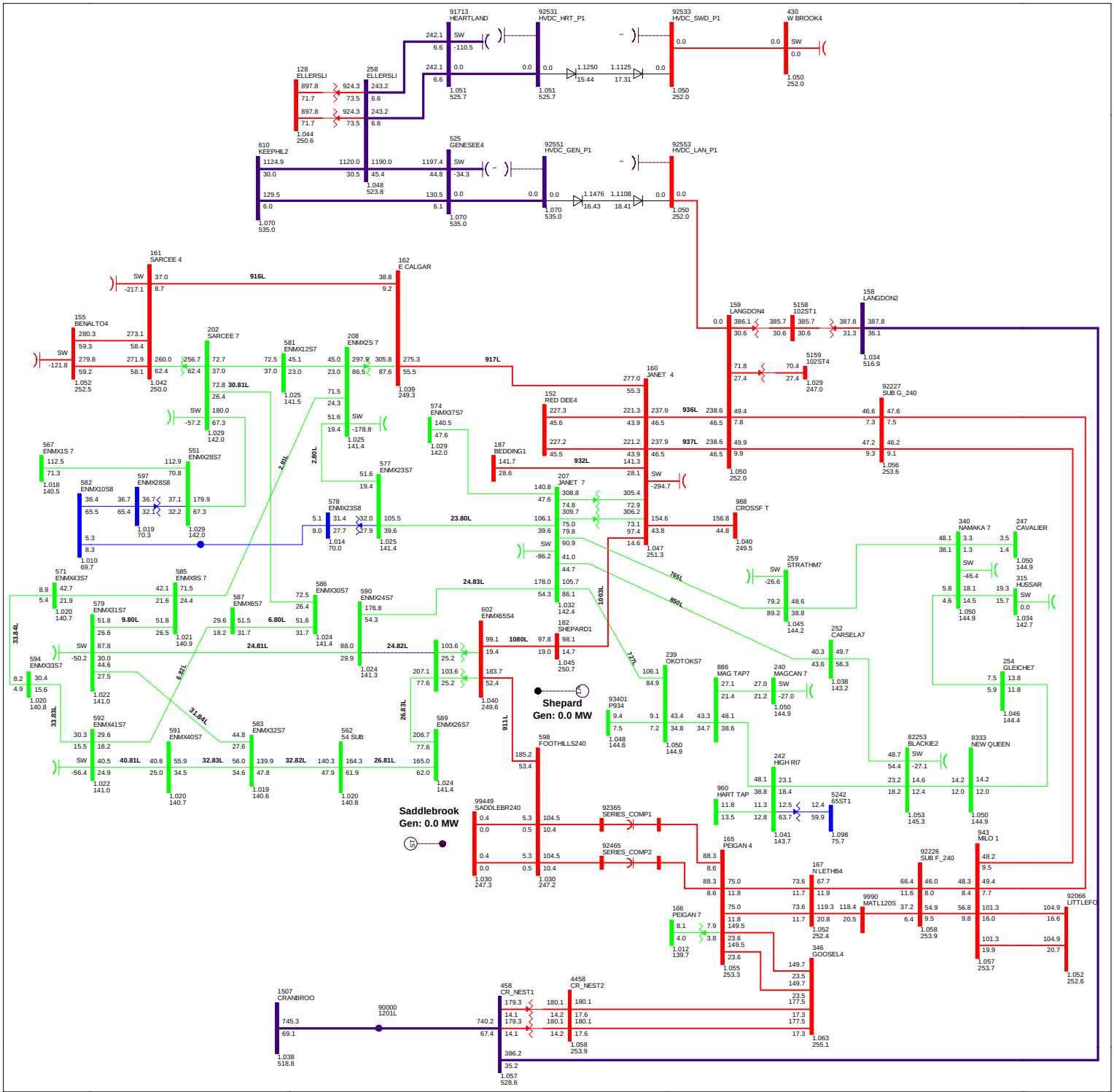
BCH Import: 781.6 MW

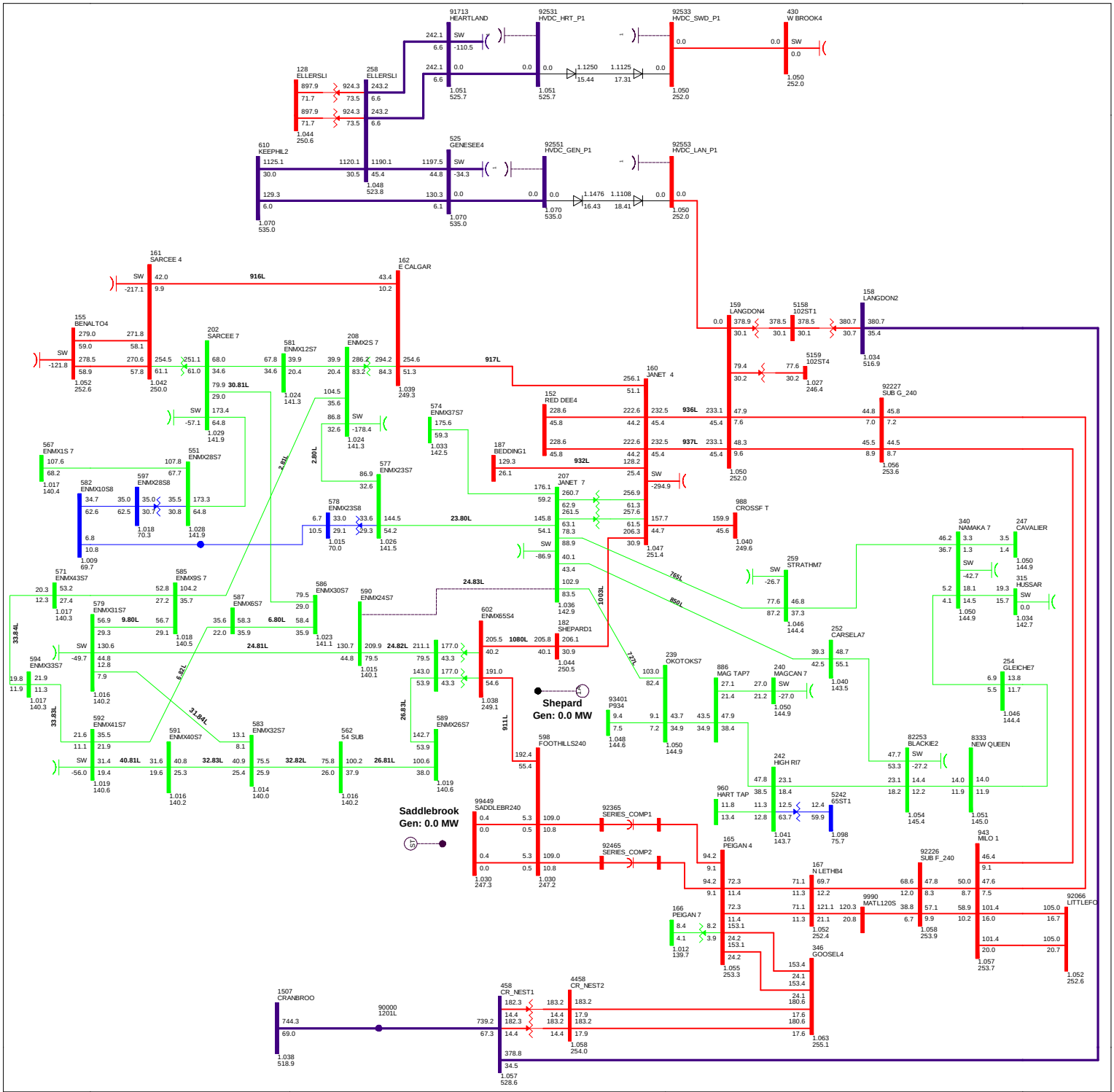
2012LTO EXISTING SYSTEM

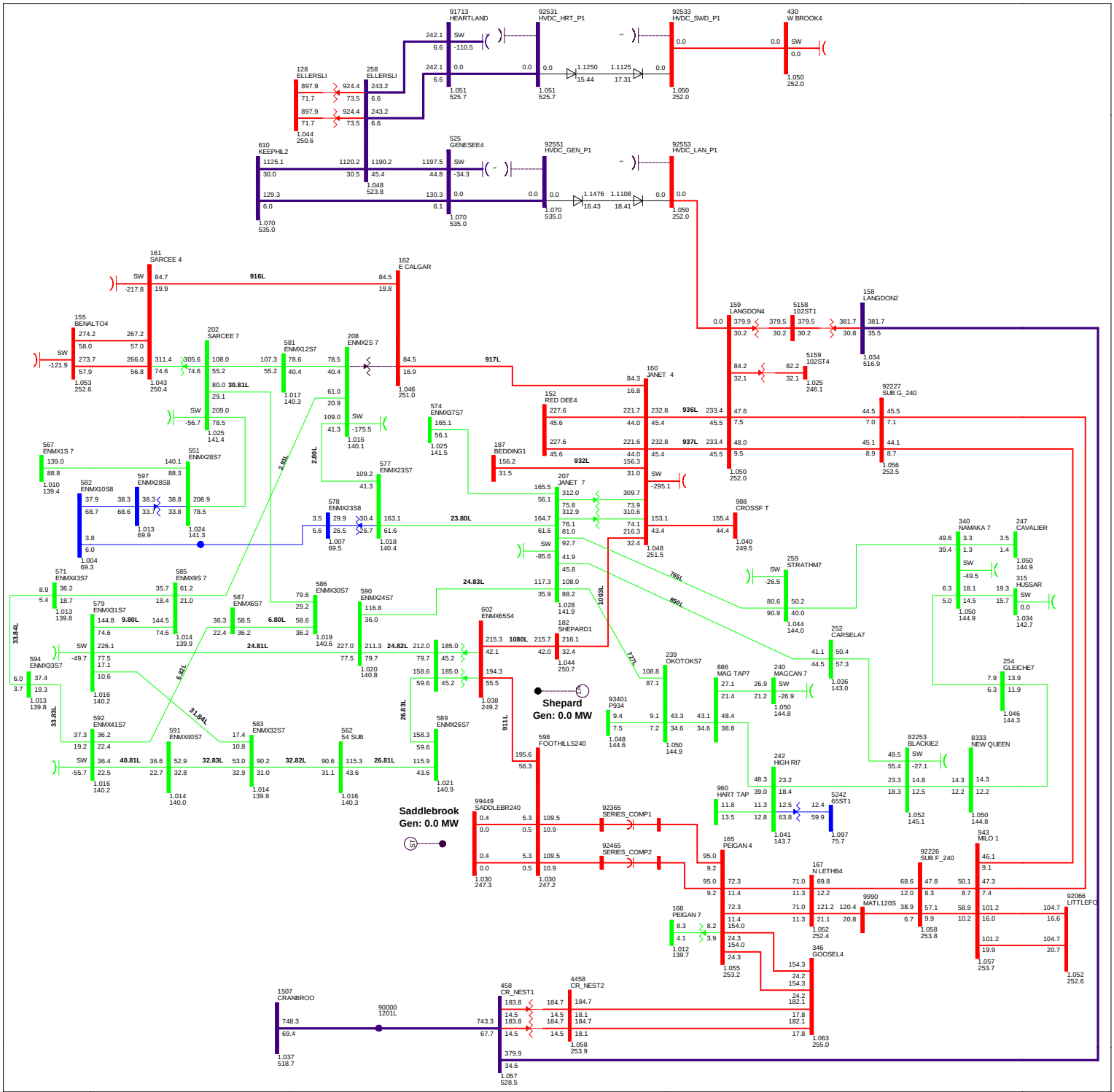
FIG B-SC1-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
BCH Import: 781.3 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC1-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)
2019_SP_EXISTING_SC1
FRI, JUN 08 2012 15:36


Saddlebrook
Gen: 0.0 MW
Shepard
Gen: 0.0 MW
BCH Import: 779.9 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC1-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2019_SP_EXISTING_SC1
FRI, JUN 08 2012 15:36



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

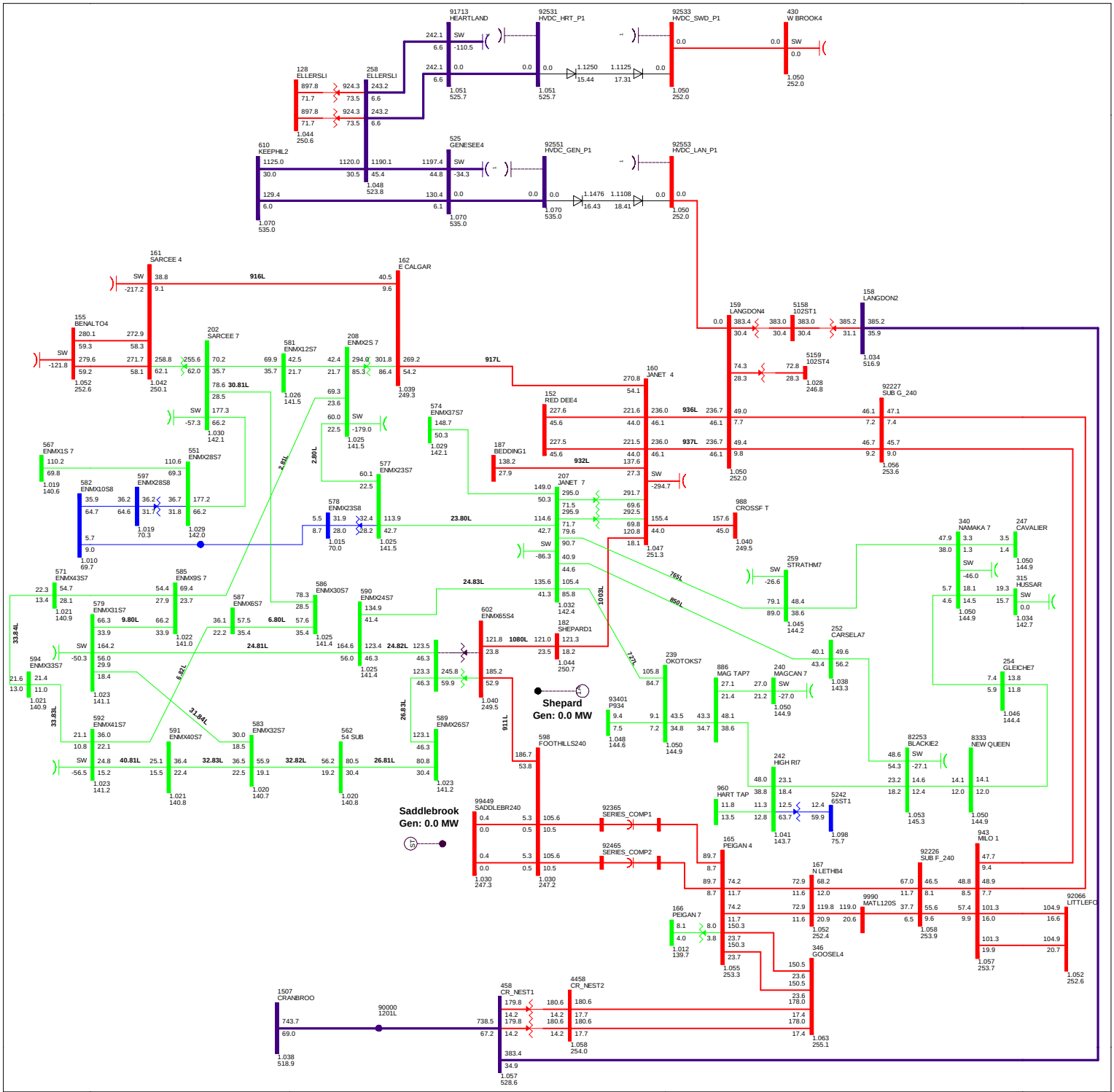
BCH Import: 785.0 MW

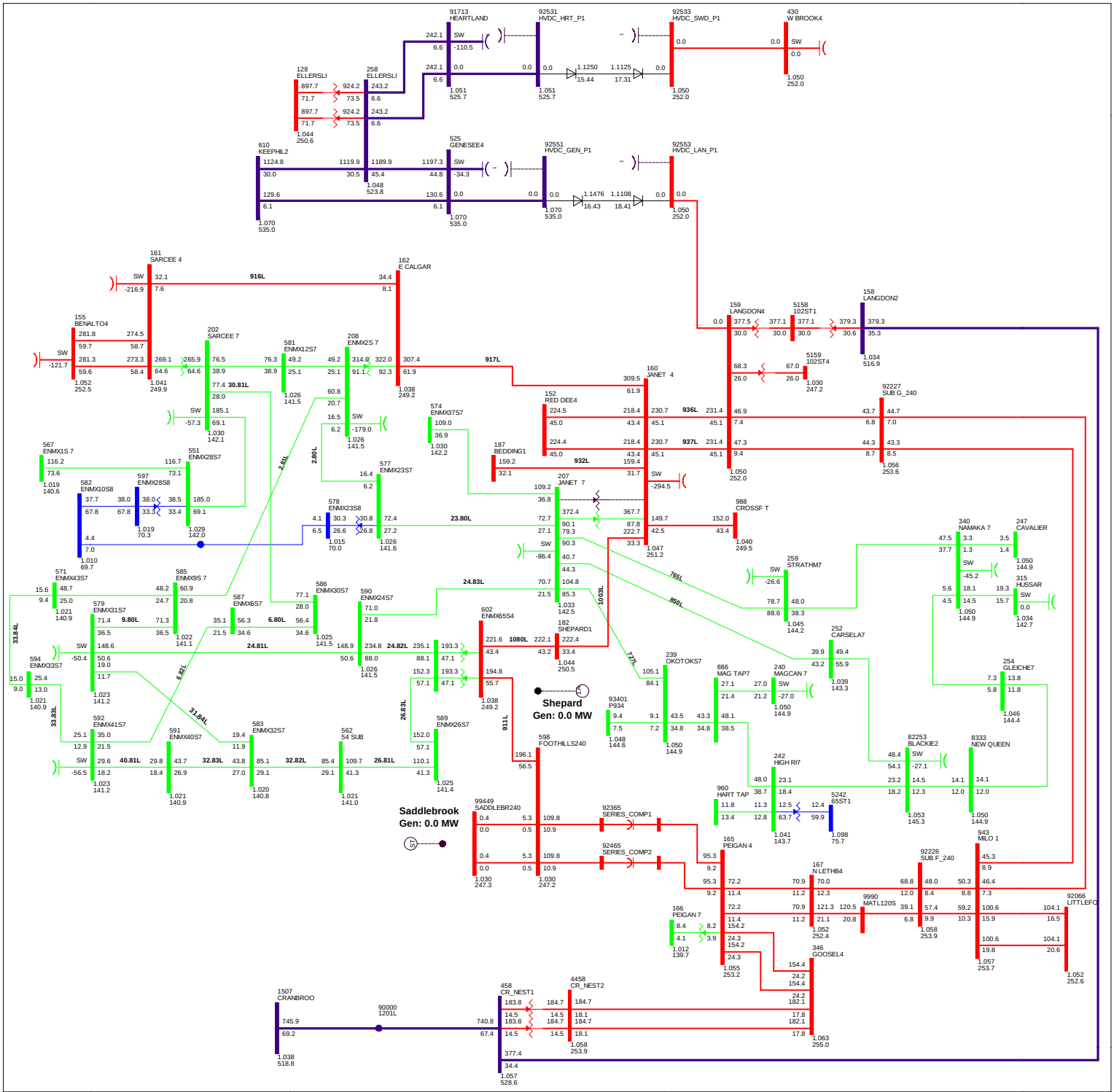
2012LTO EXISTING SYSTEM

FIG B-SC1-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36


Saddlebrook
Gen: 0.0 MW
Shepard
Gen: 0.0 MW
BCH Import: 779.4 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC1-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)
2019_SP_EXISTING_SC1
FRI, JUN 08 2012 15:36



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

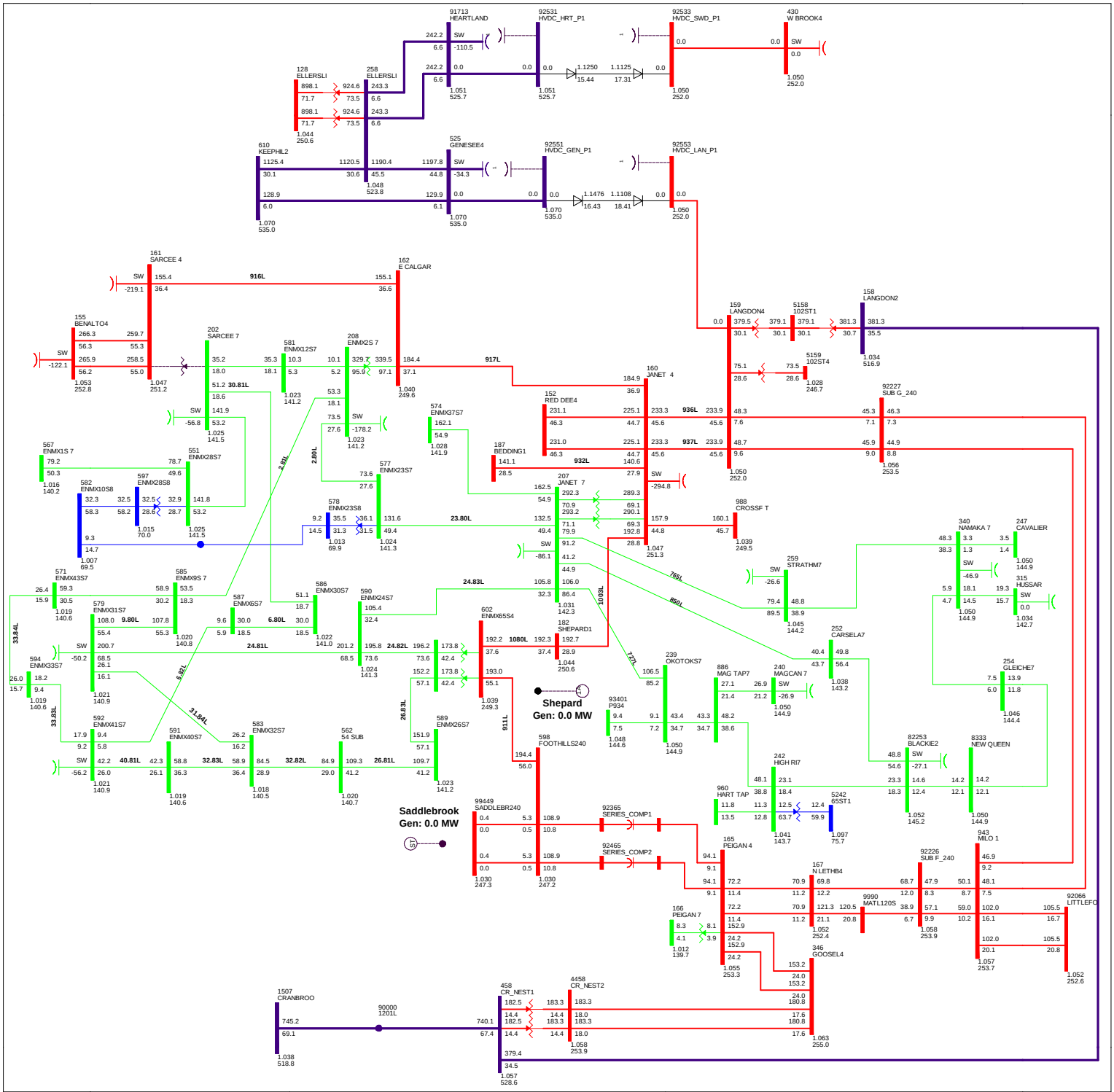
BCH Import: 782.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

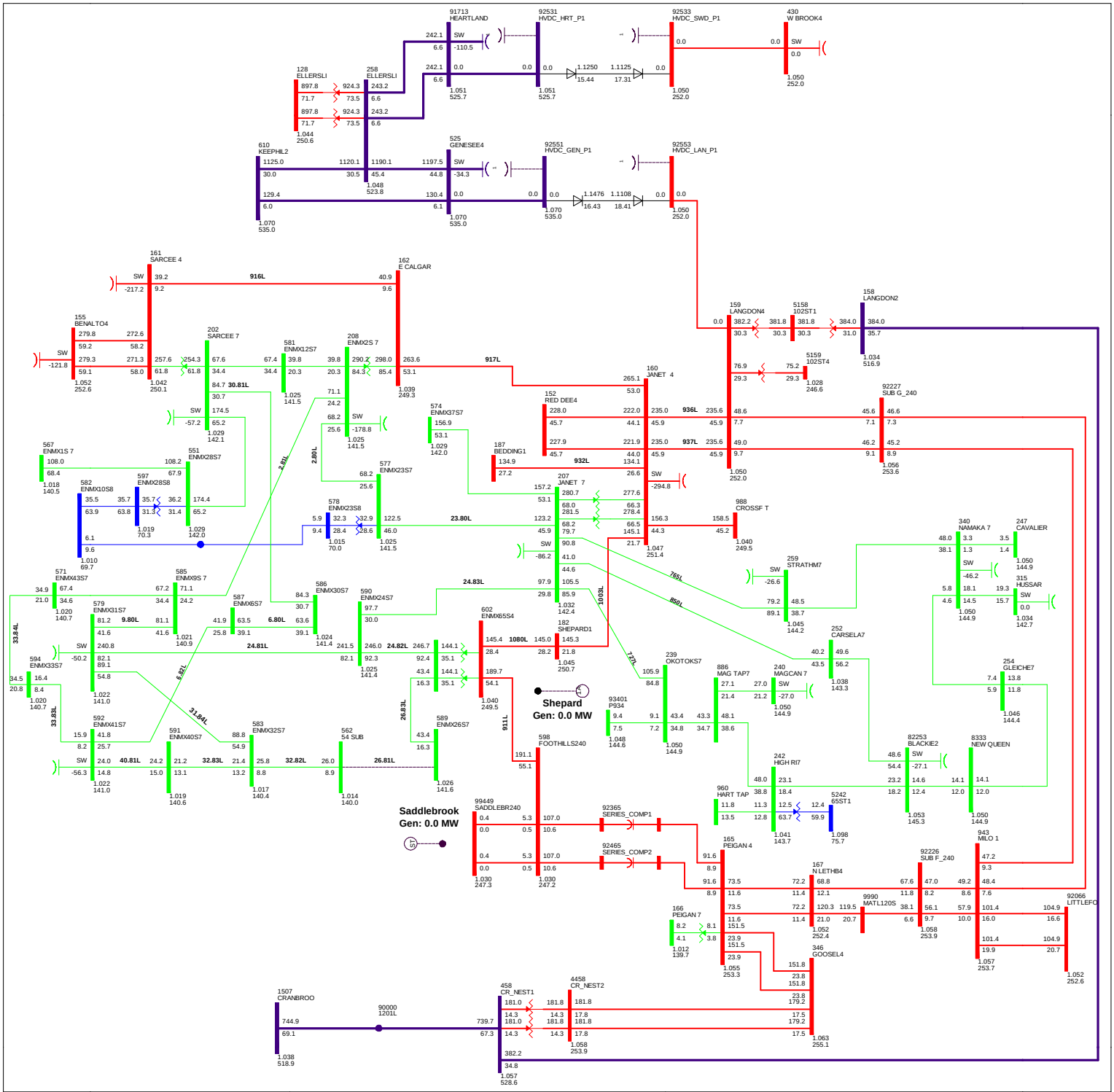
BCH Import: 781.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:36



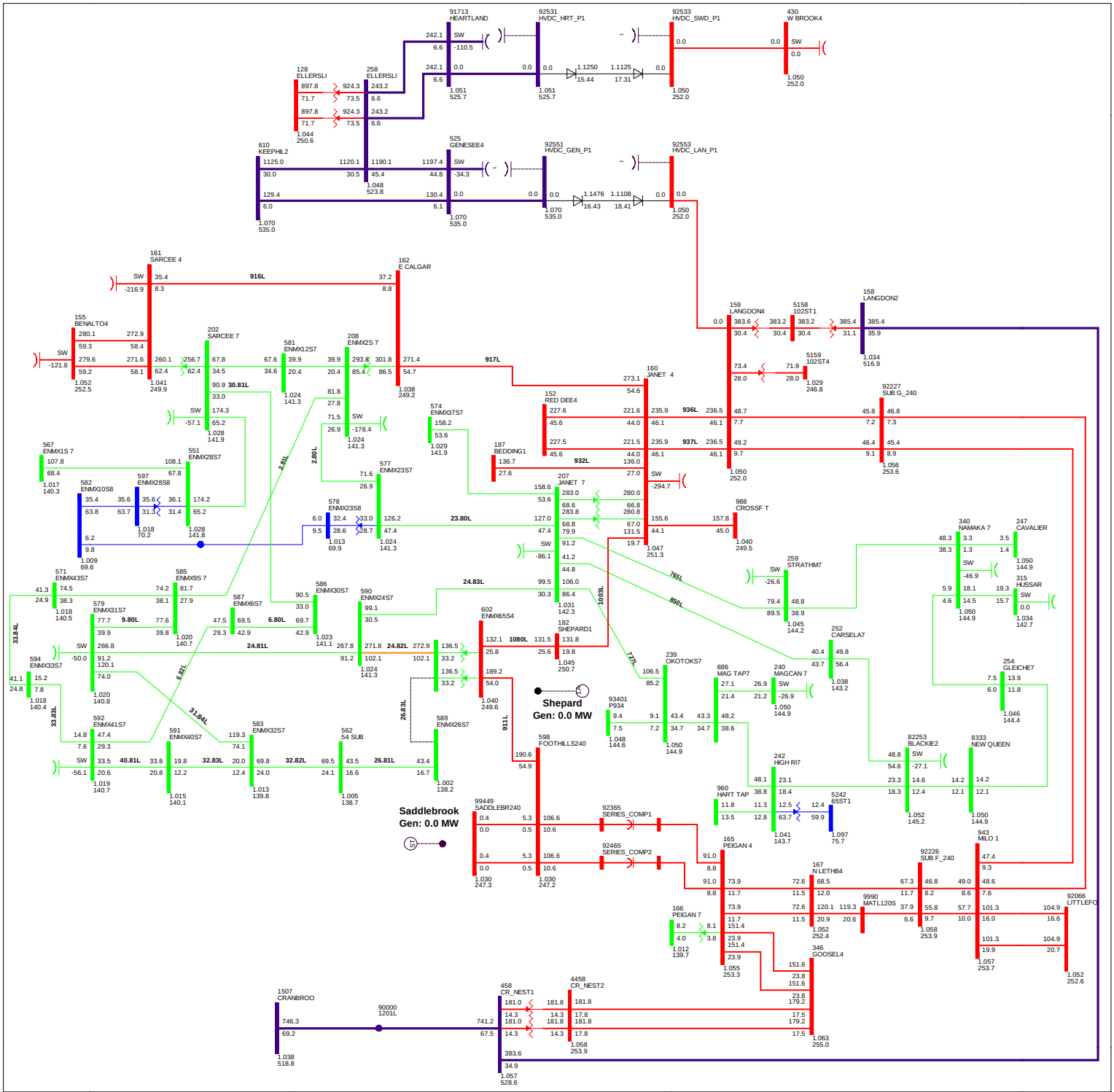
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



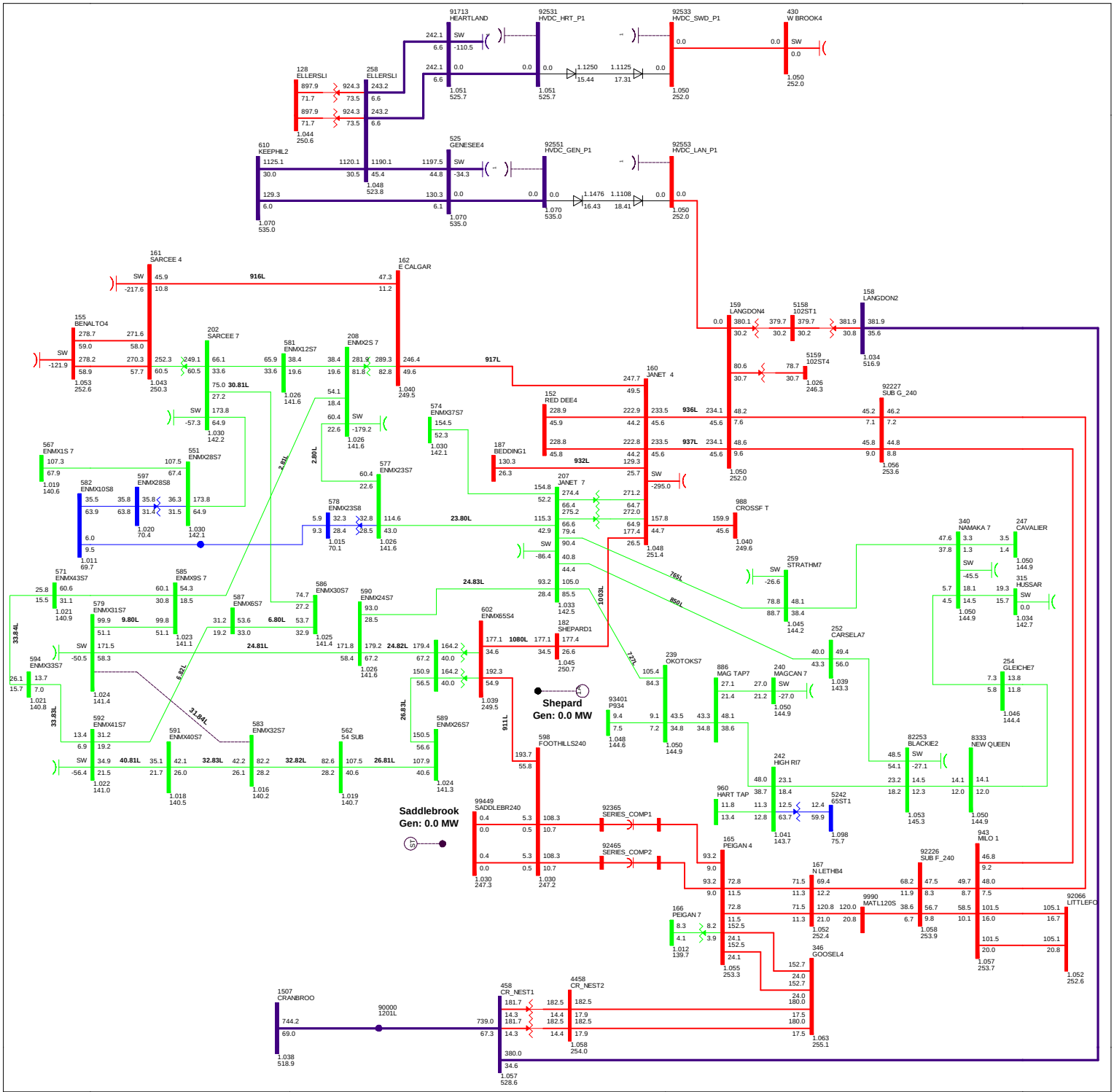
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



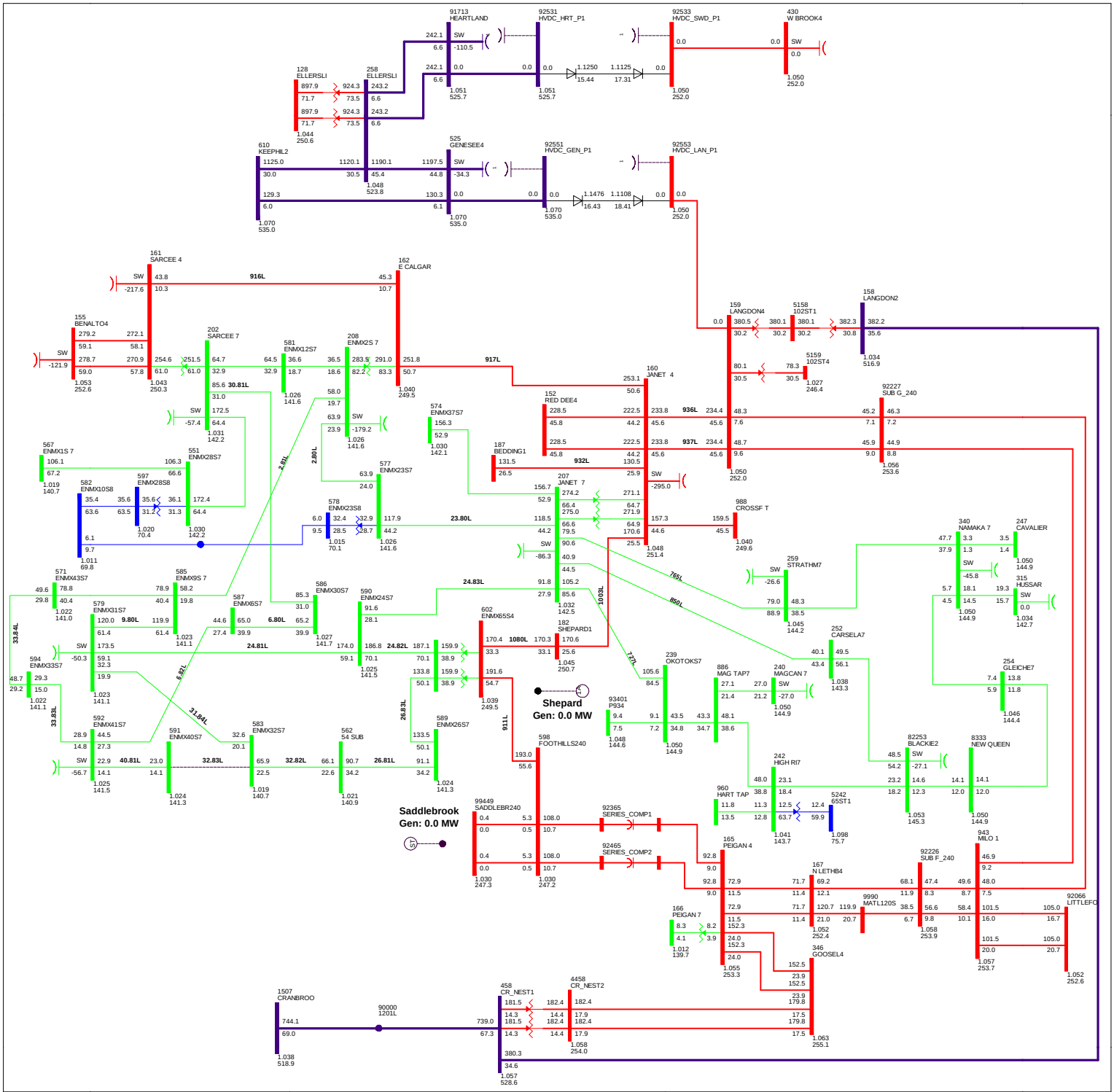
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-17: OPEN 31.84L 138 KV LINE (ENMAX 31 TO ENMAX 32)
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



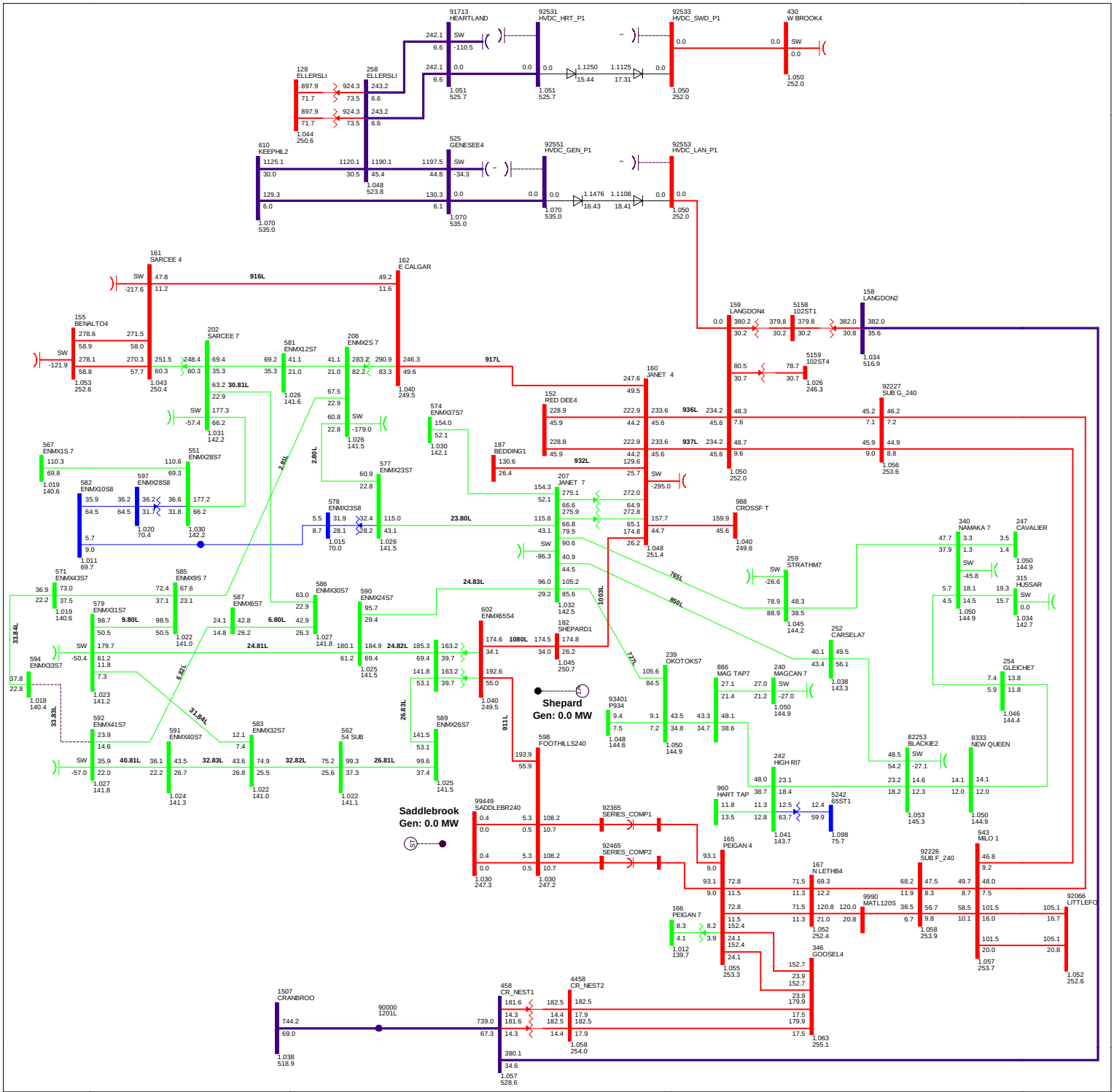
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-18: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

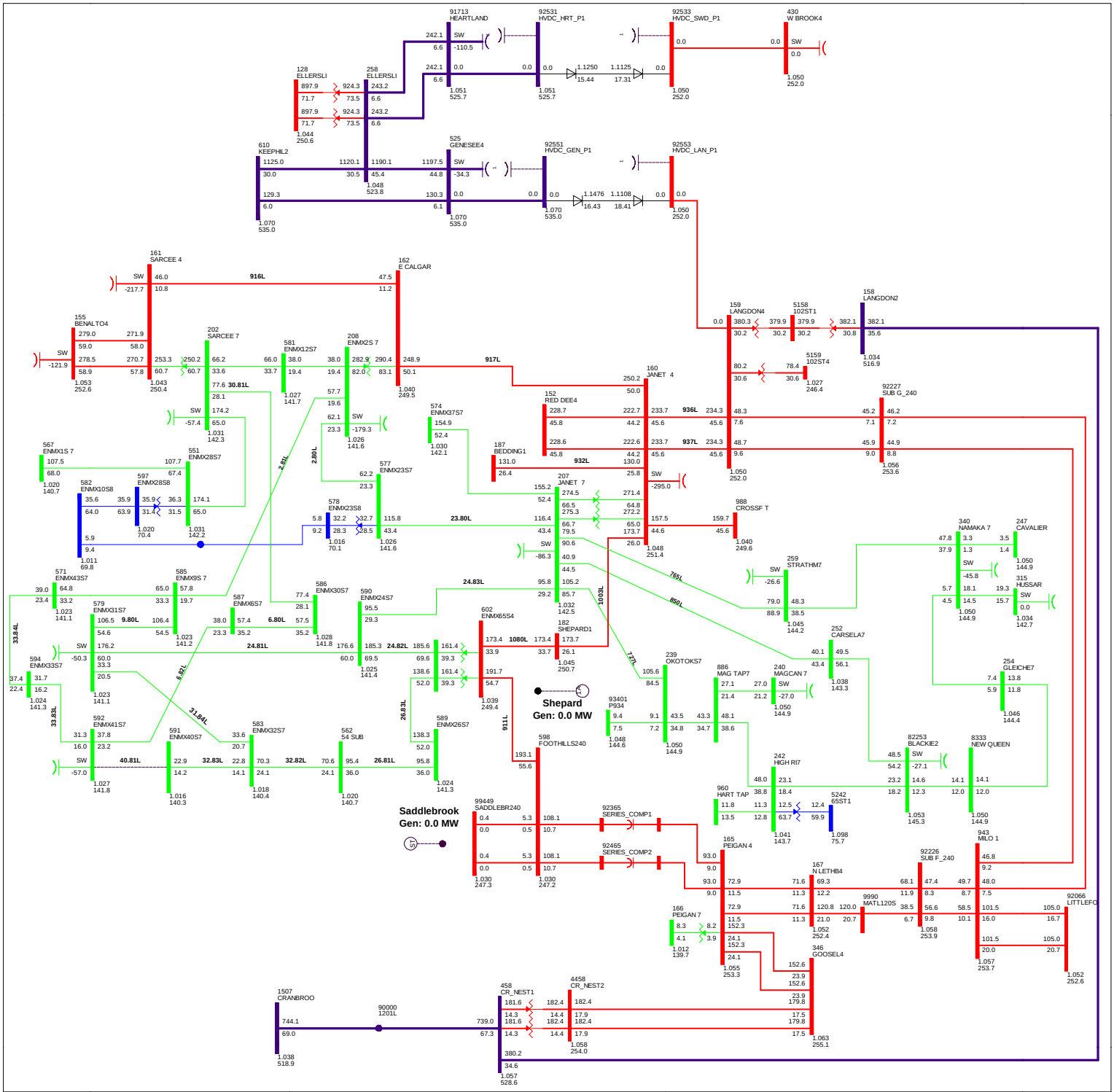
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-19: OPEN 33.83L 138 KV LINE (ENMAX 41 TO ENMAX 33)
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



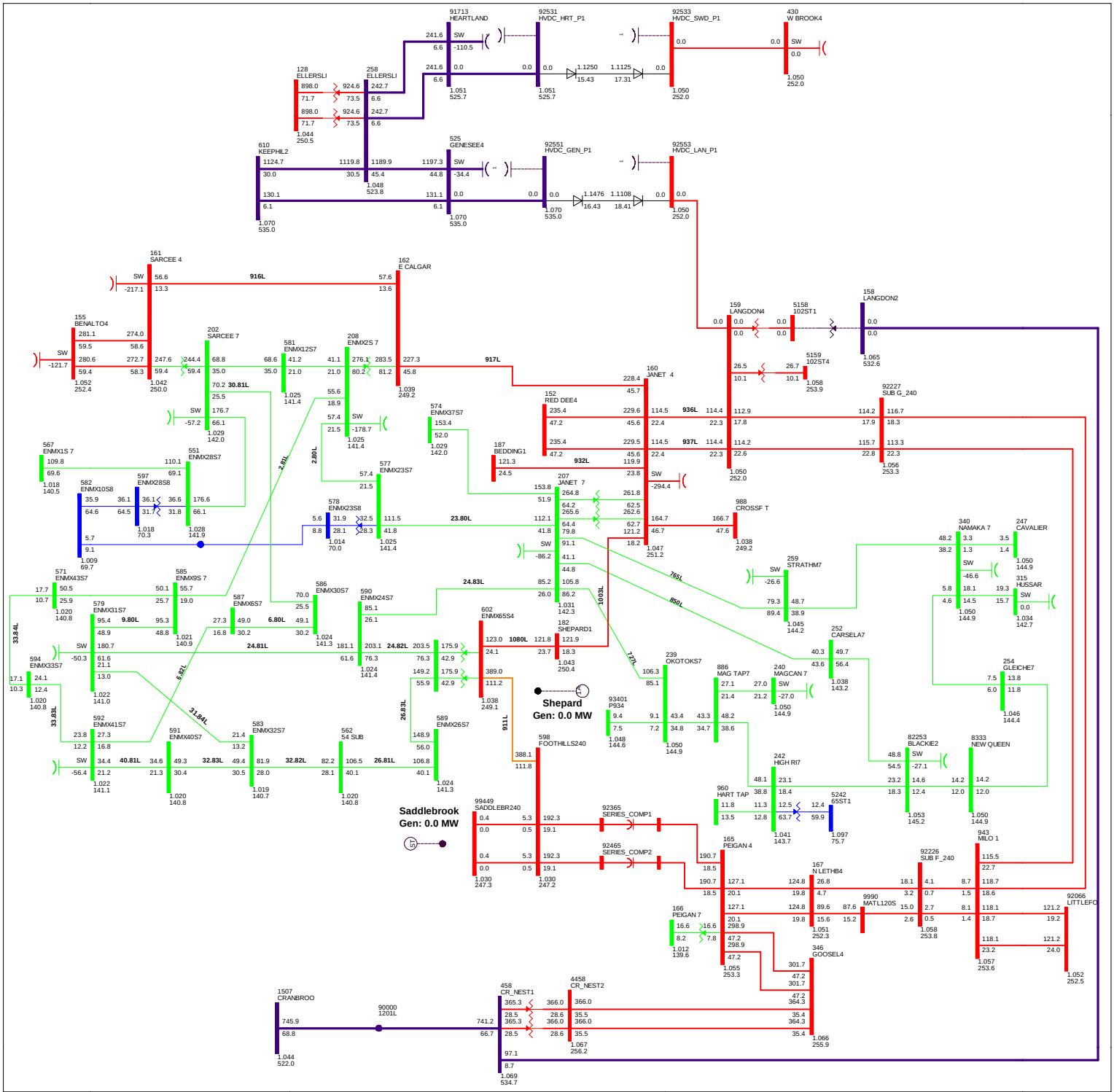
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-20: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

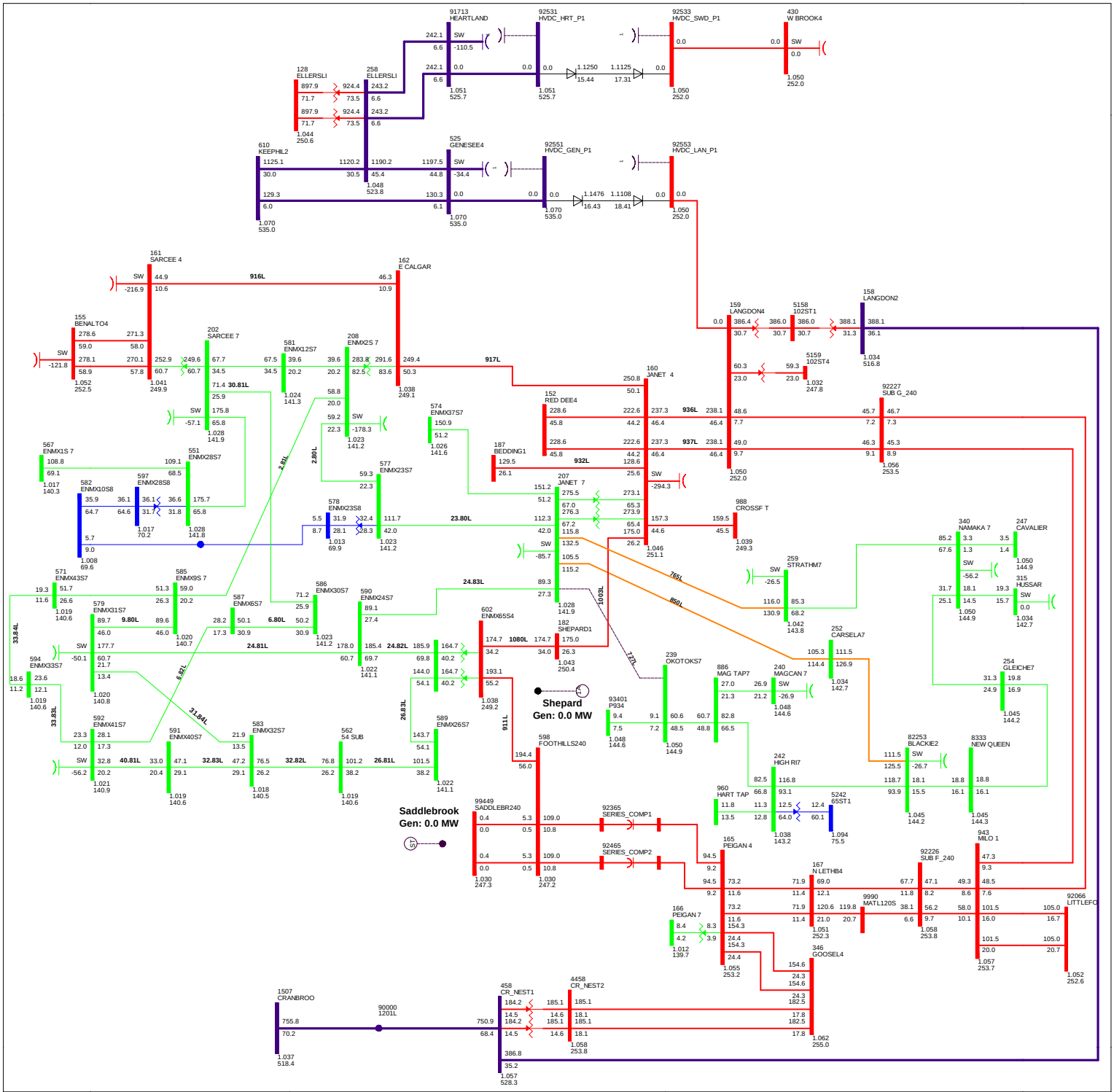
BCH Import: 798.4 MW

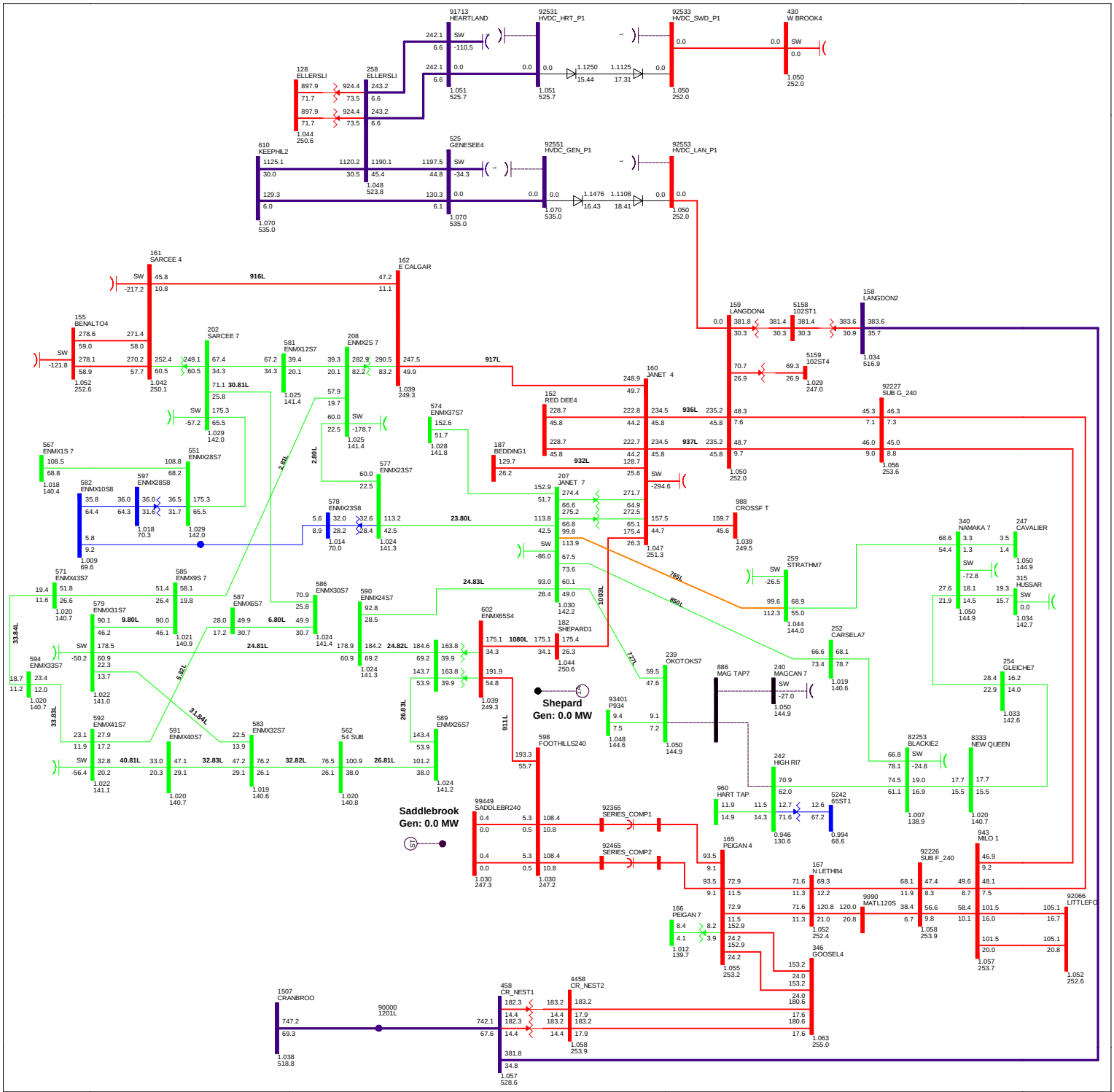
2012LTO EXISTING SYSTEM

FIG B-SC1-21: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37


Saddlebrook
Gen: 0.0 MW
Shepard
Gen: 0.0 MW
BCH Import: 792.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC1-22: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2019_SP_EXISTING_SC1
FRI, JUN 08 2012 15:37



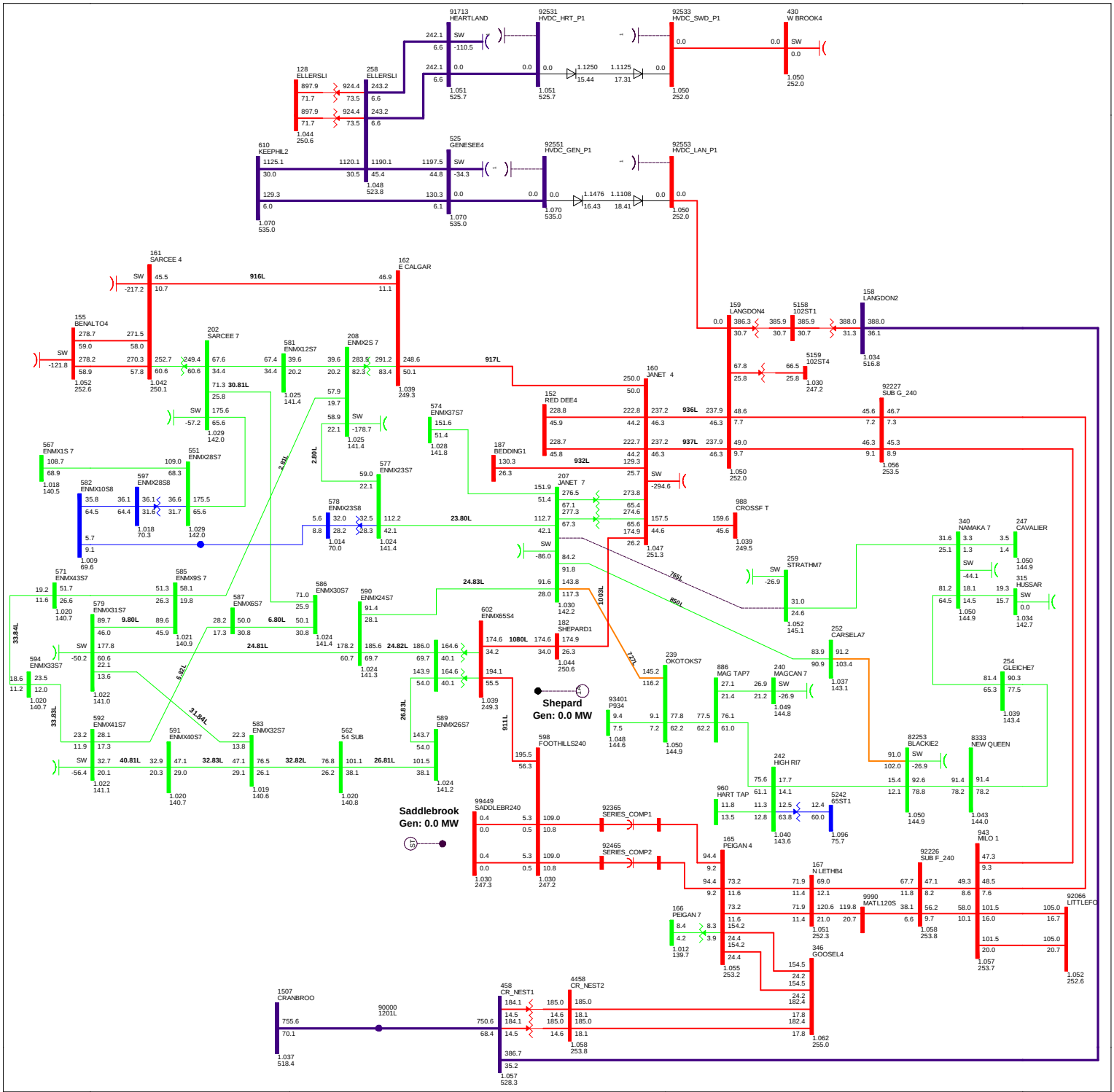
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

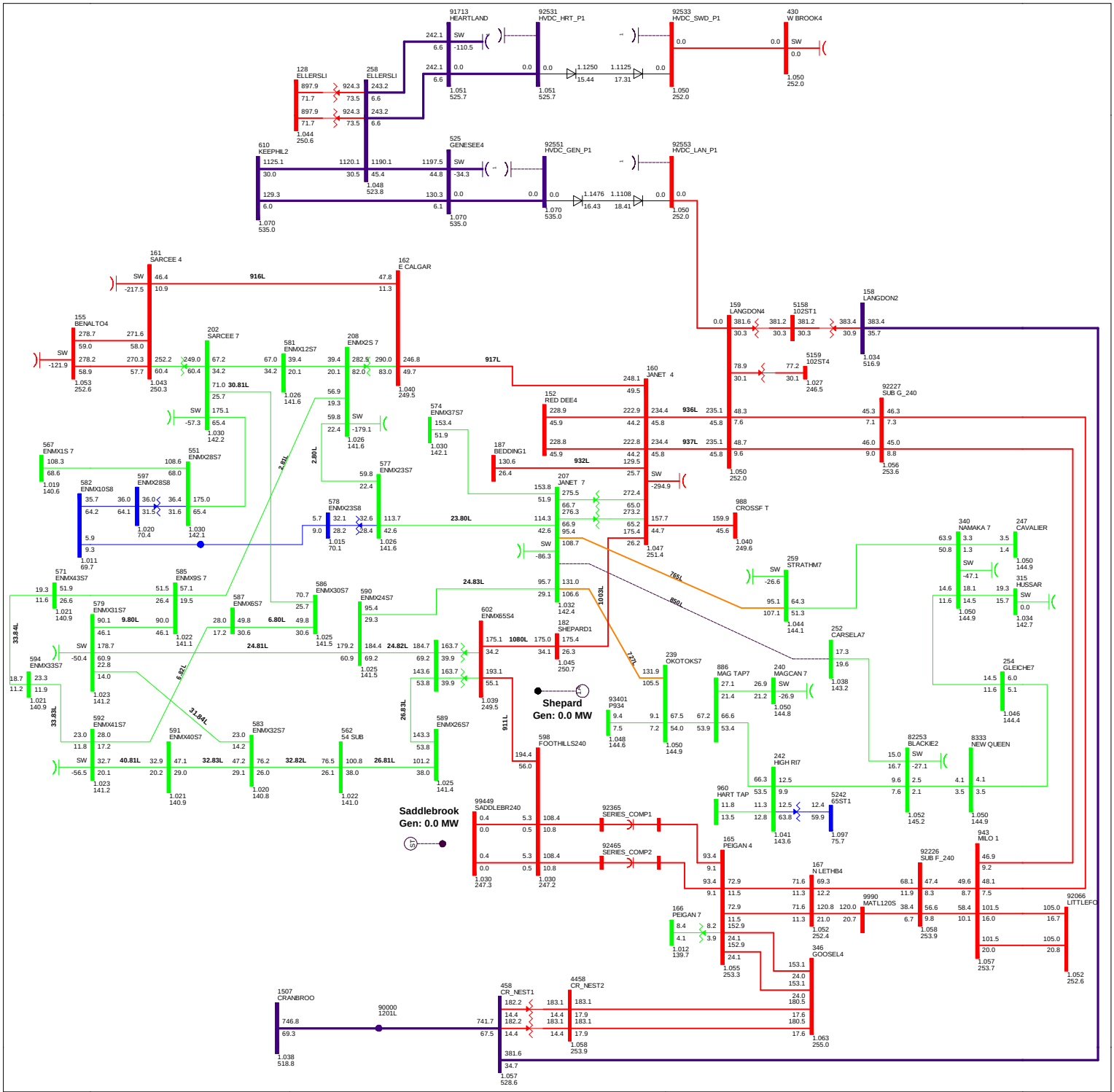
BCH Import: 782.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-23: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37


Saddlebrook
Gen: 0.0 MW
Shepard
Gen: 0.0 MW
BCH Import: 791.7 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC1-24: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2019_SP_EXISTING_SC1
FRI, JUN 08 2012 15:37



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

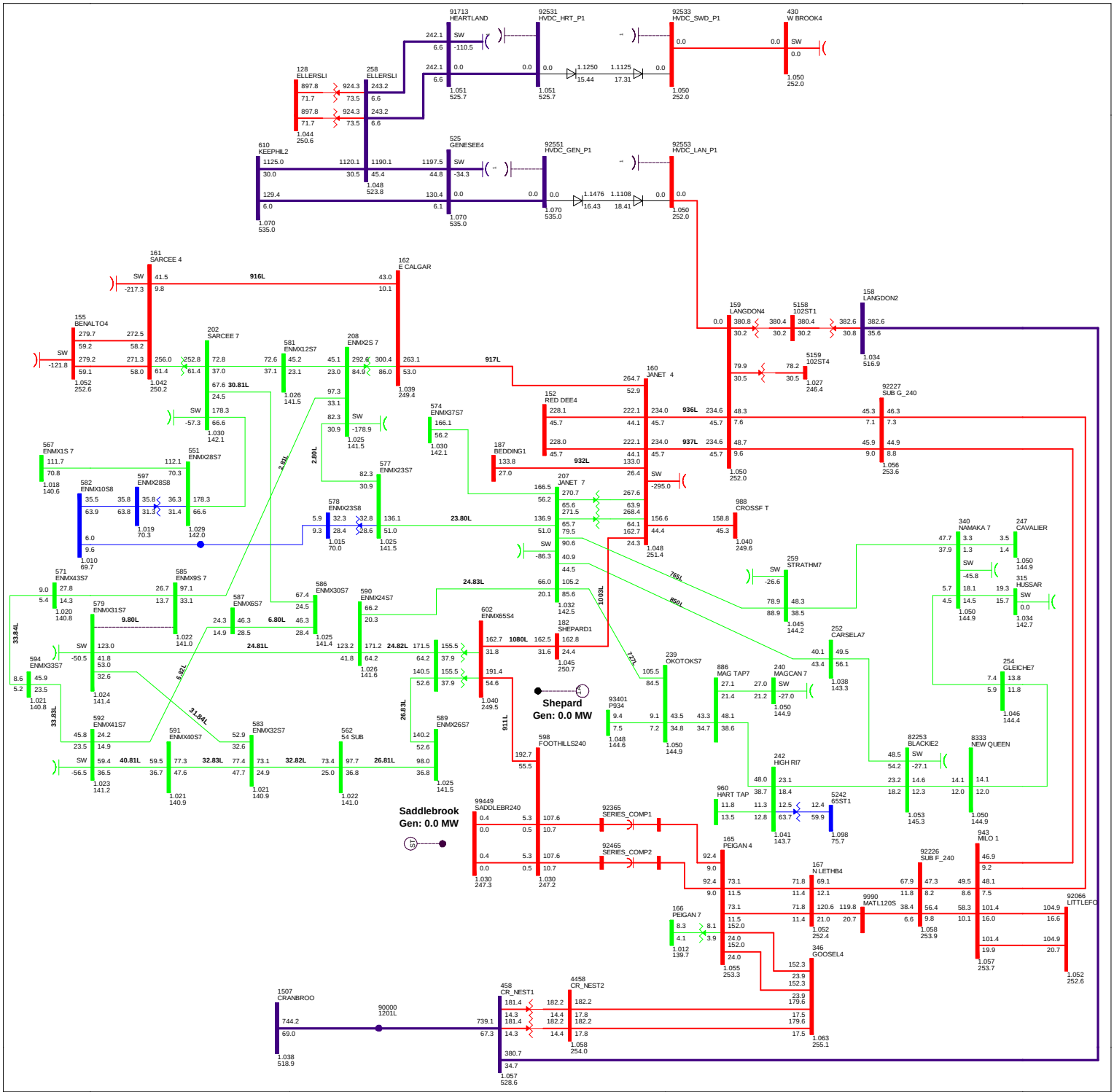
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-25: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

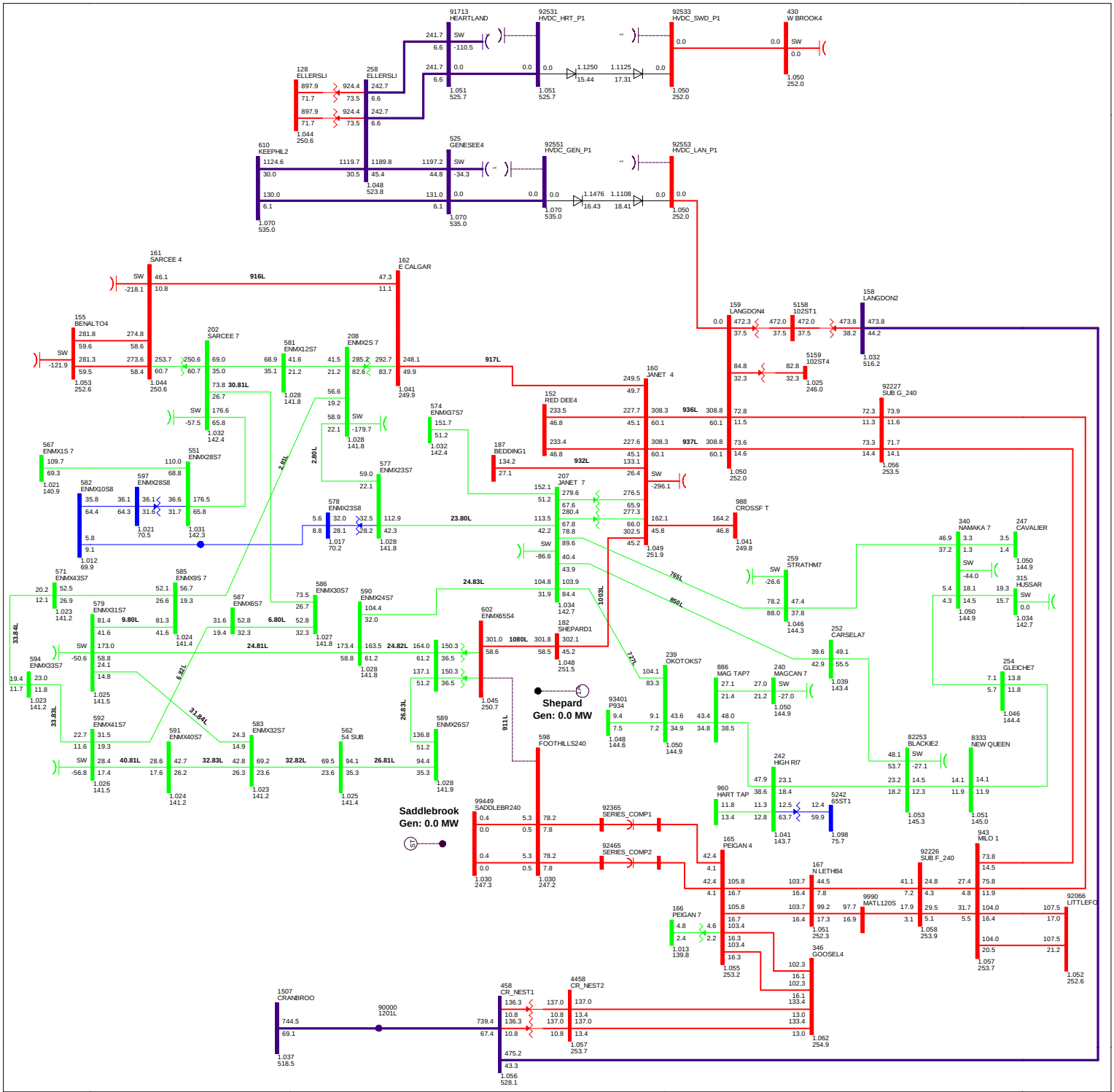
BCH Import: 779.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-26: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



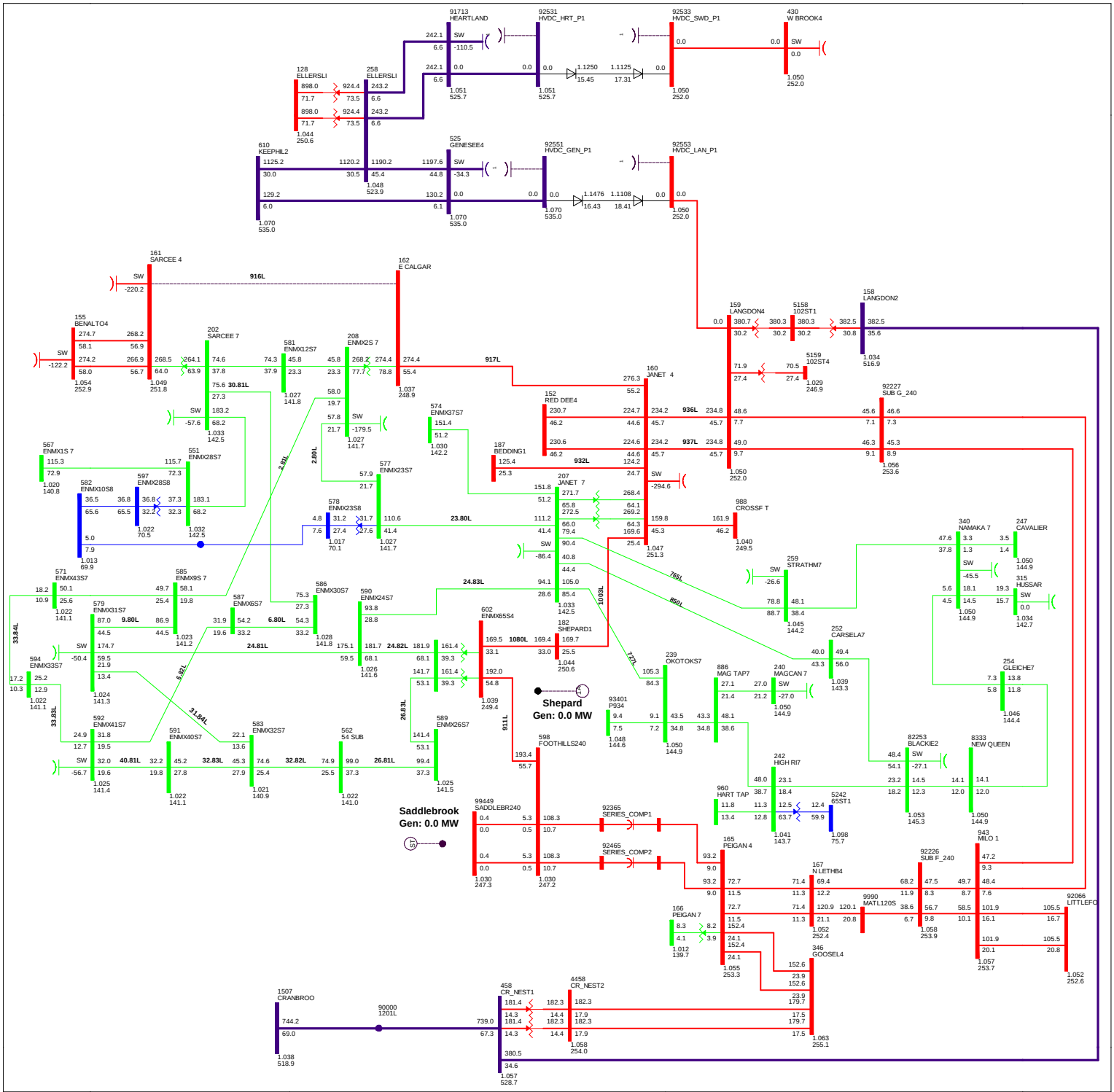
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-27: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX 2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

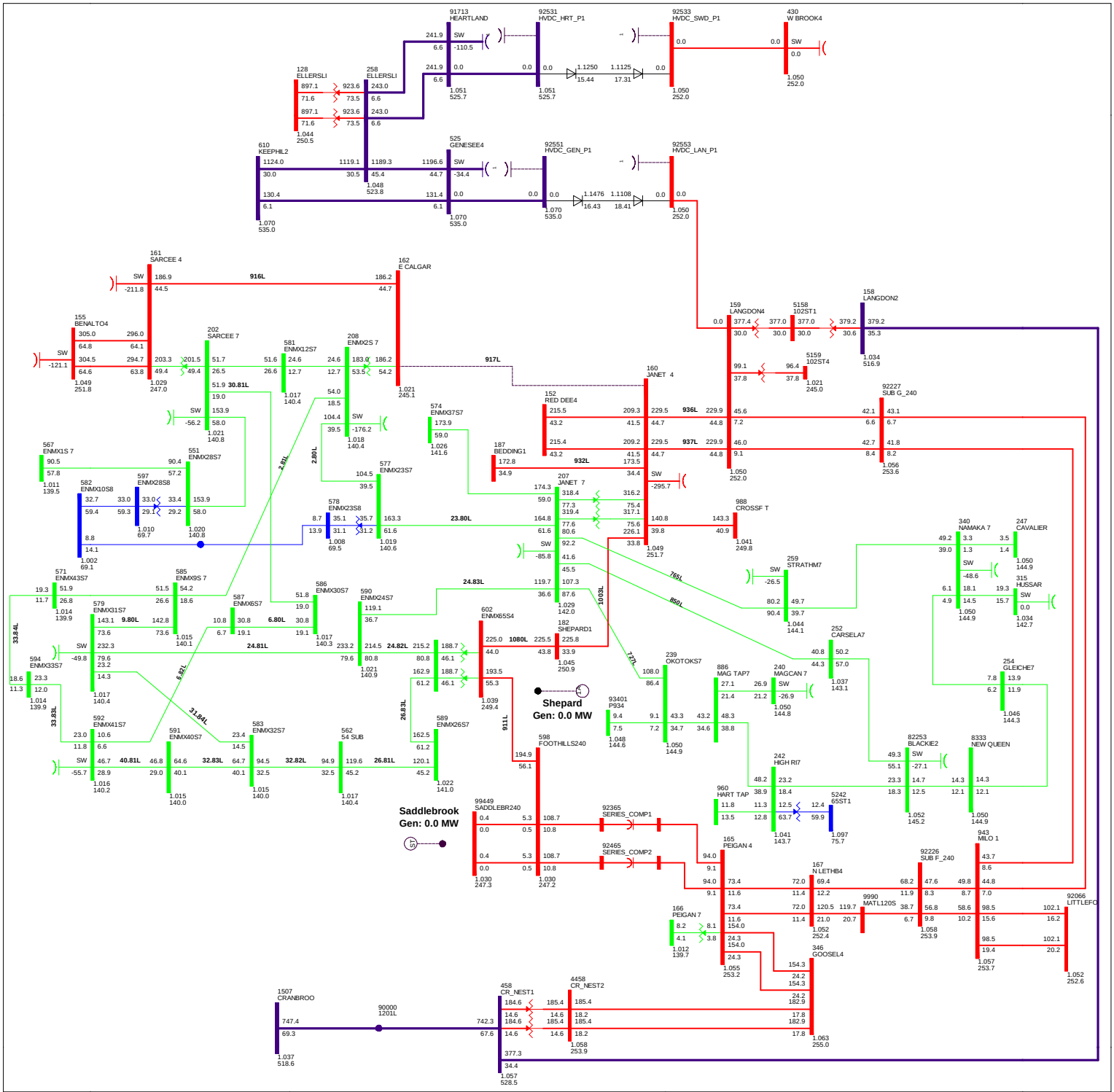
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

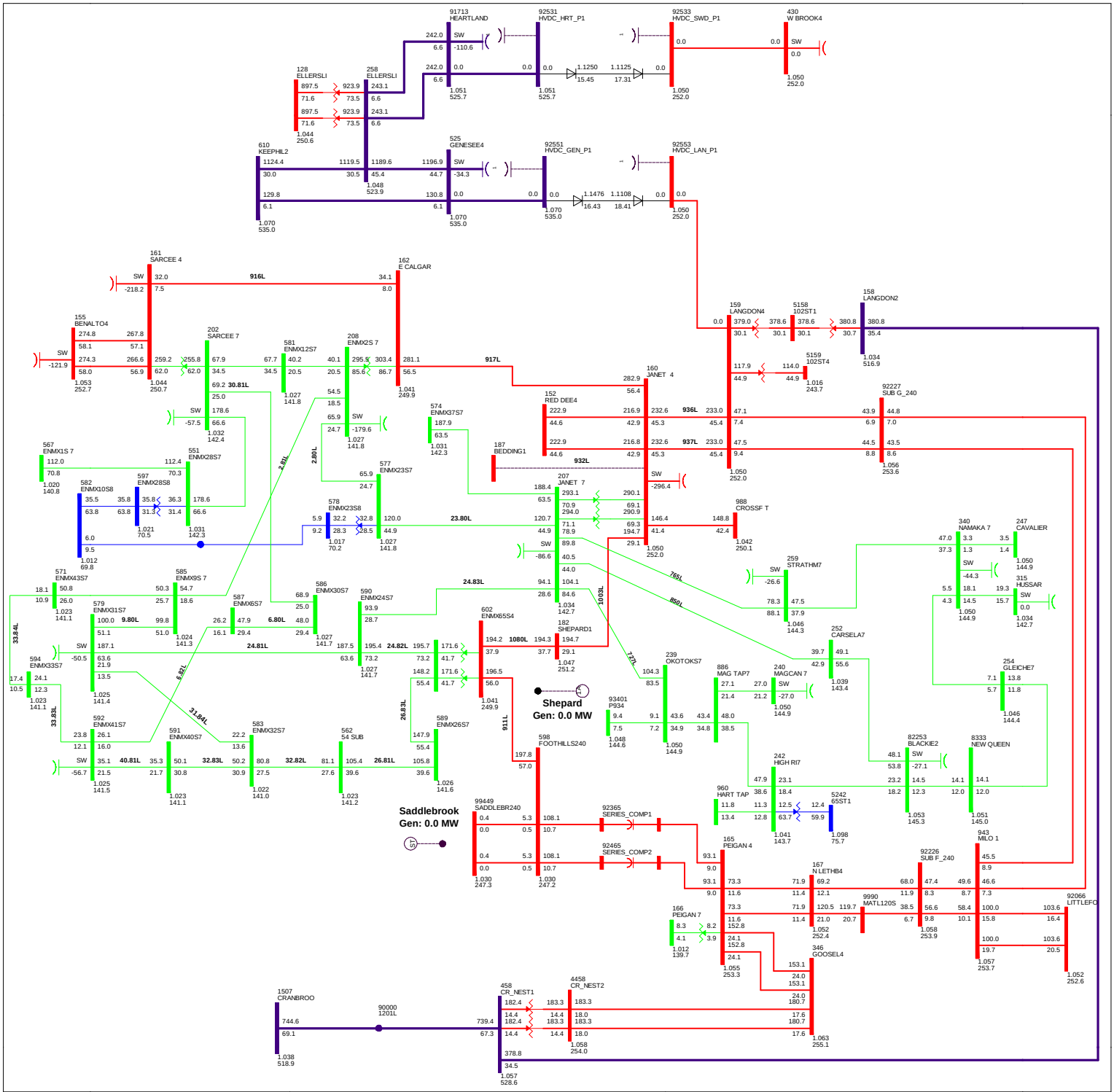
BCH Import: 779.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-28: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37


Saddlebrook
Gen: 0.0 MW
Shepard
Gen: 0.0 MW
BCH Import: 785.1 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC1-29: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2019_SP_EXISTING_SC1
FRI, JUN 08 2012 15:37



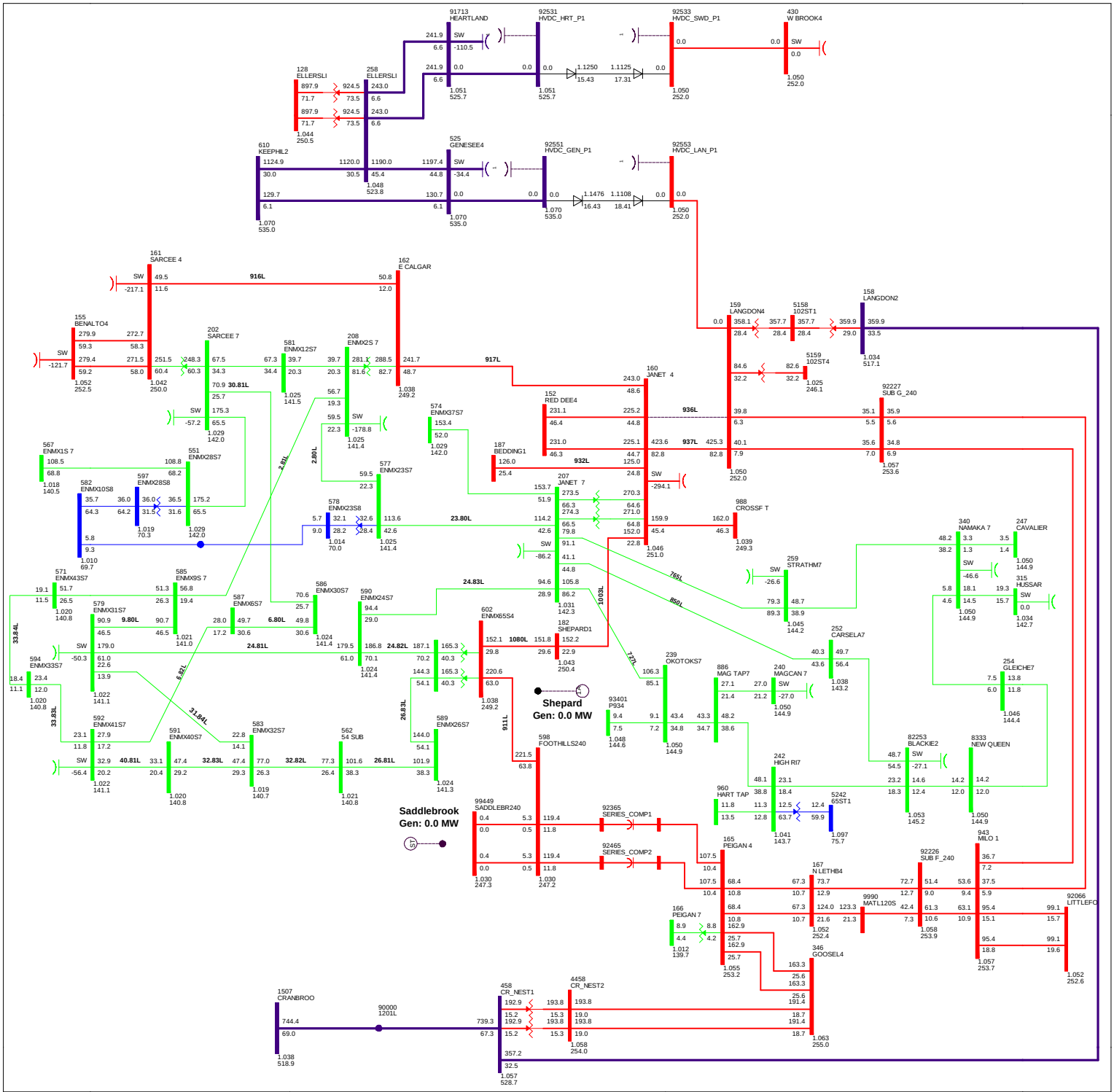
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-30: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON 2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

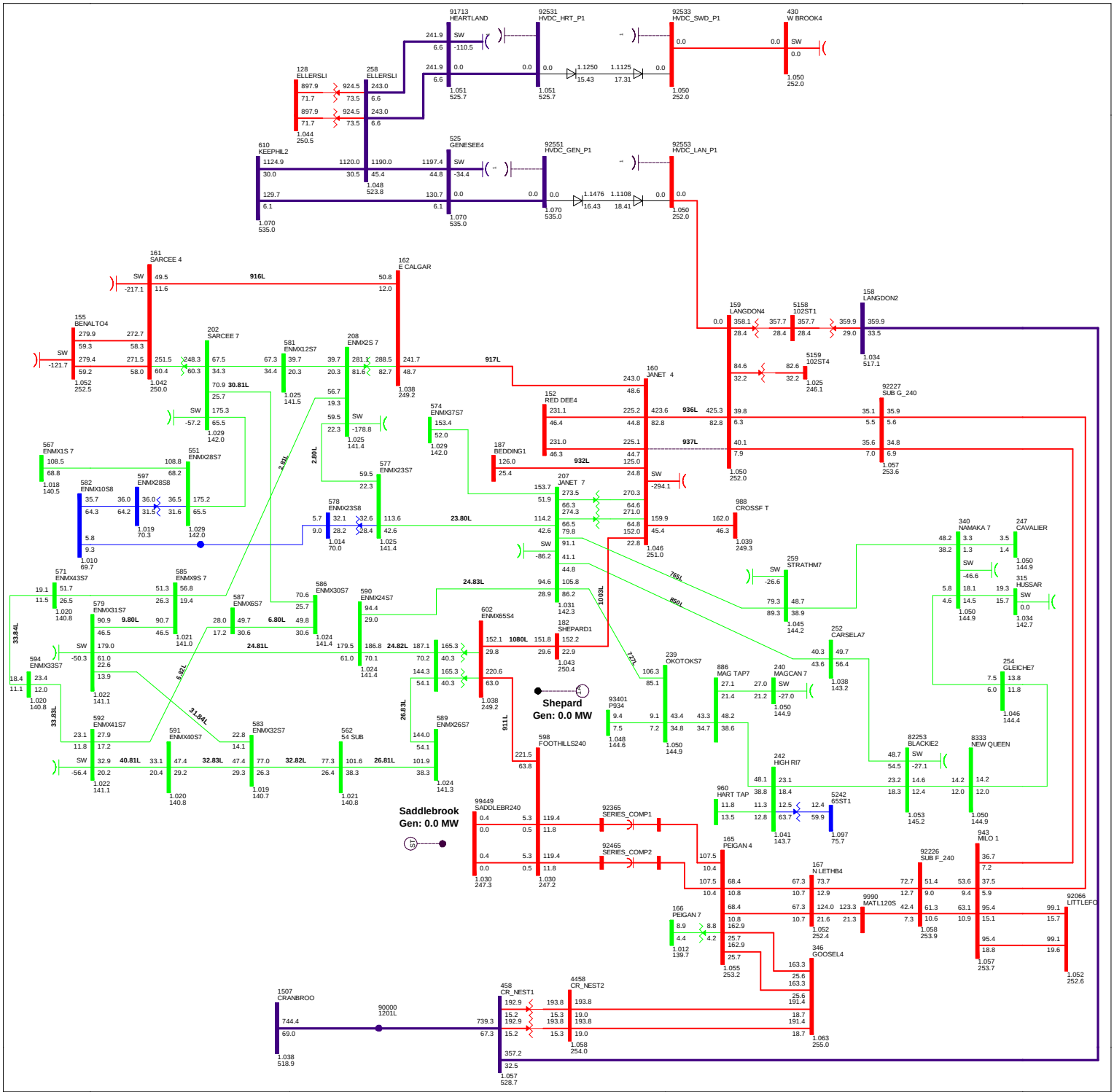
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-31: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

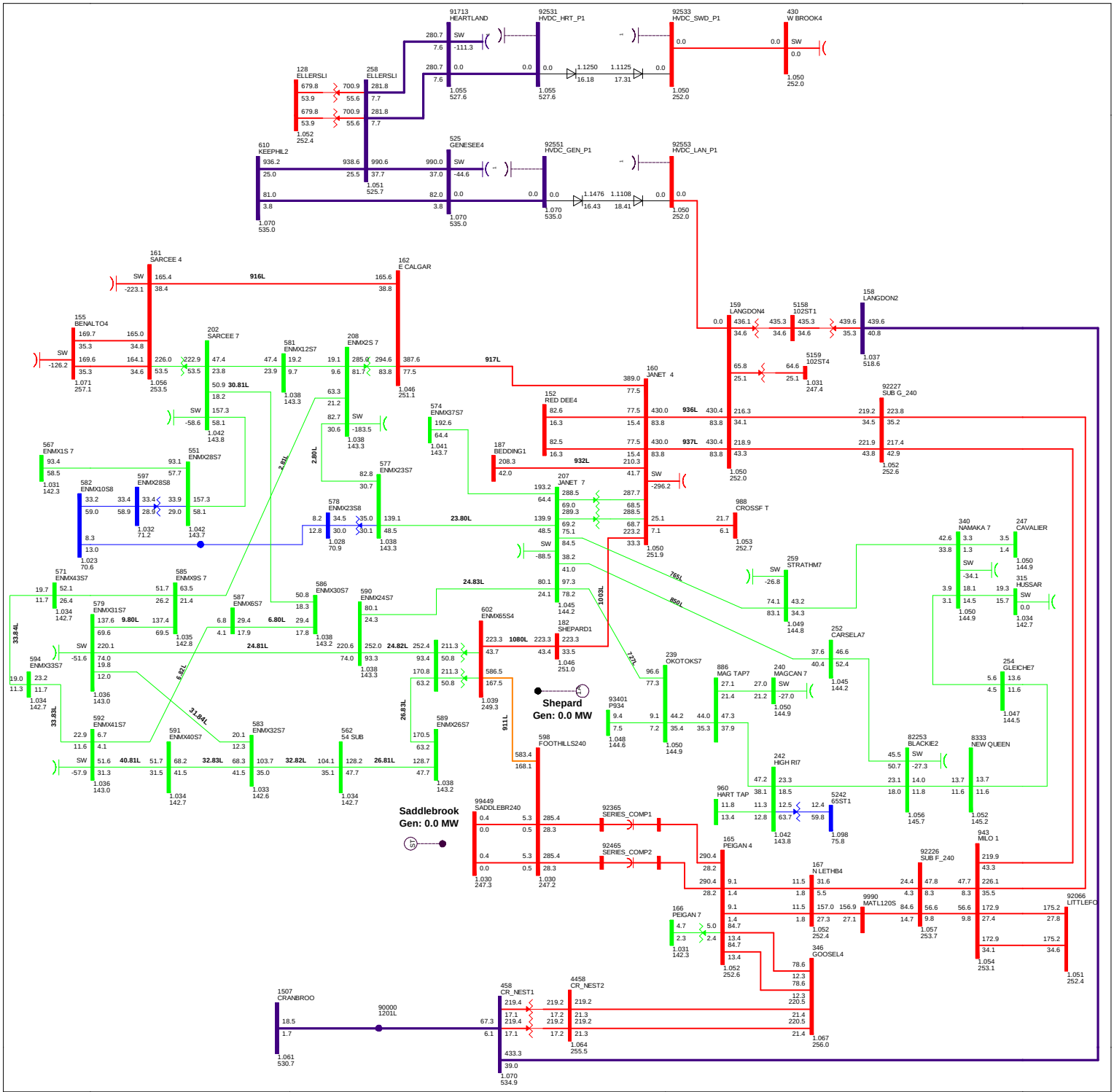
BCH Import: 781.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC1-32: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SP_EXISTING_SC1

FRI, JUN 08 2012 15:37

2019 Loading Violations
Scenario 2



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

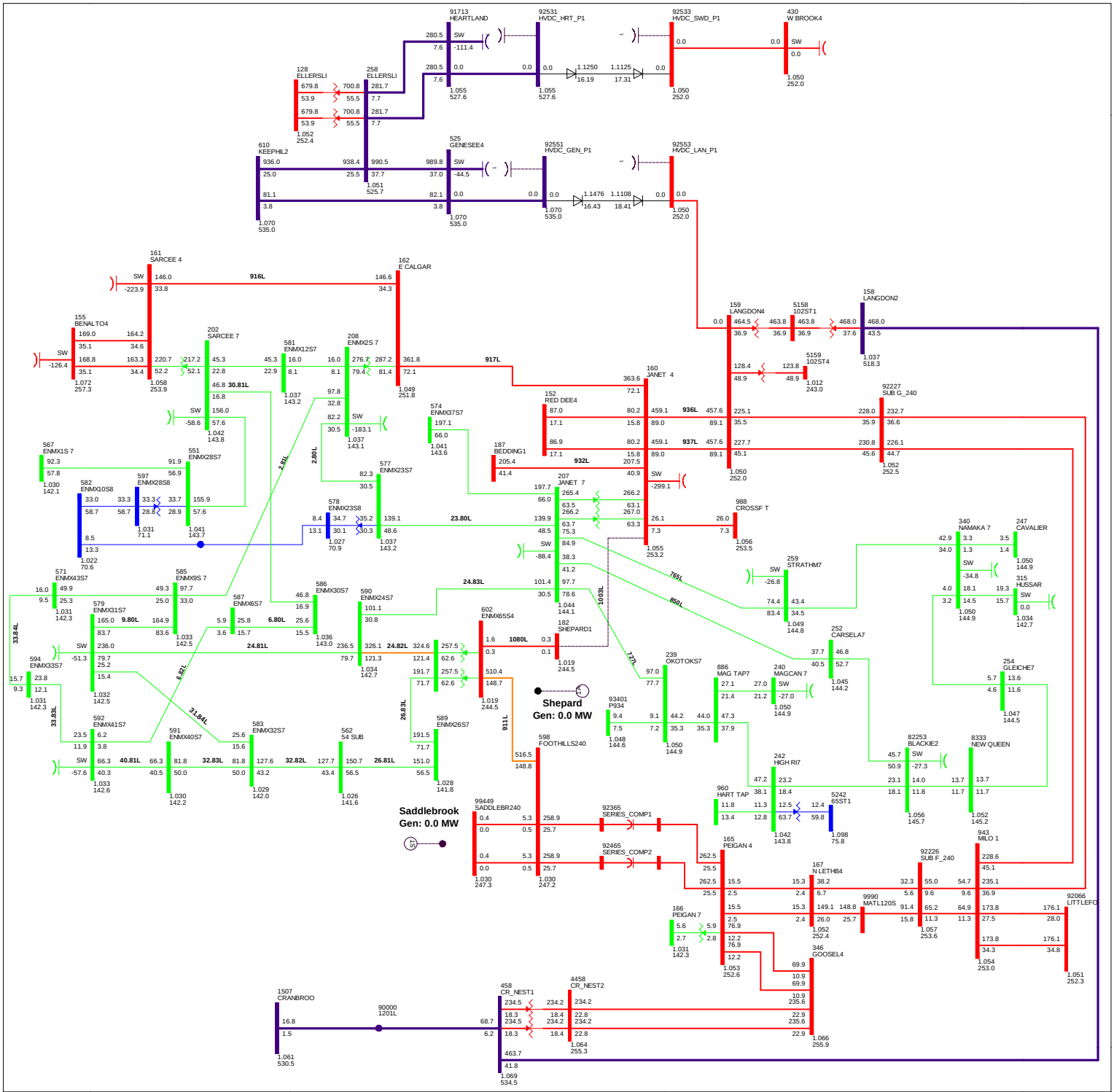
BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-1: BASECASE

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

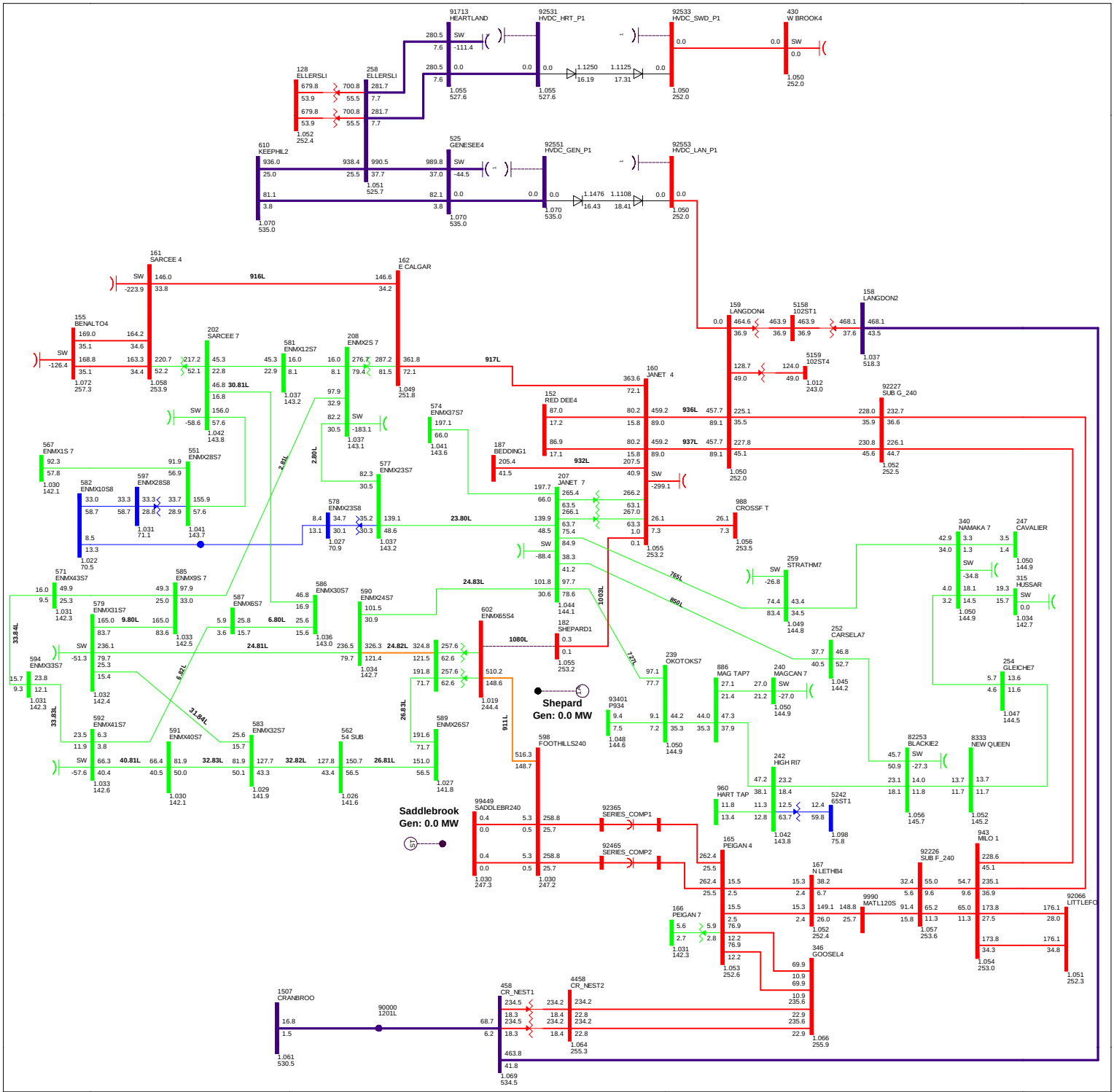
BCH Import: -0.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

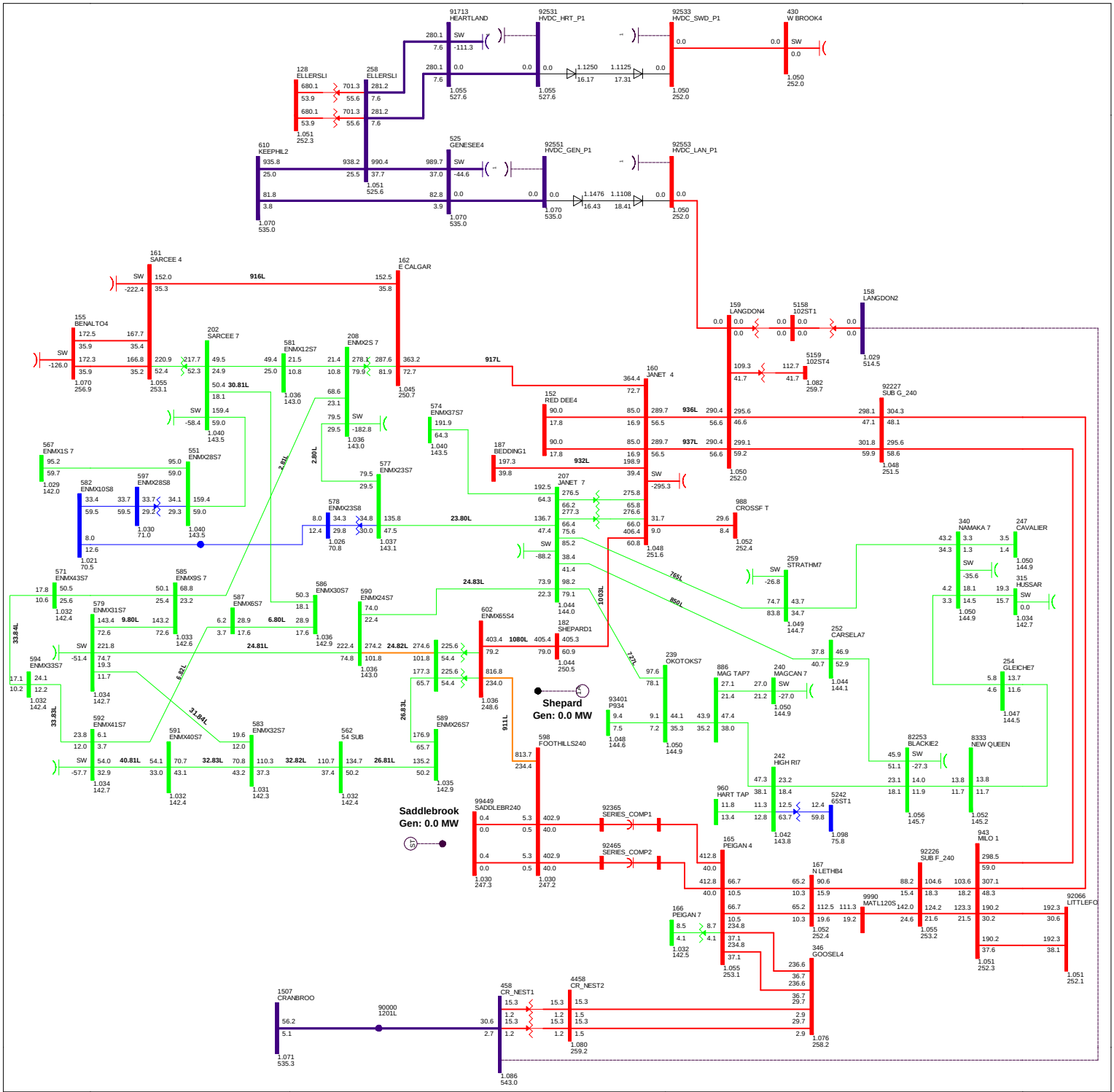
BCH Import: -0.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

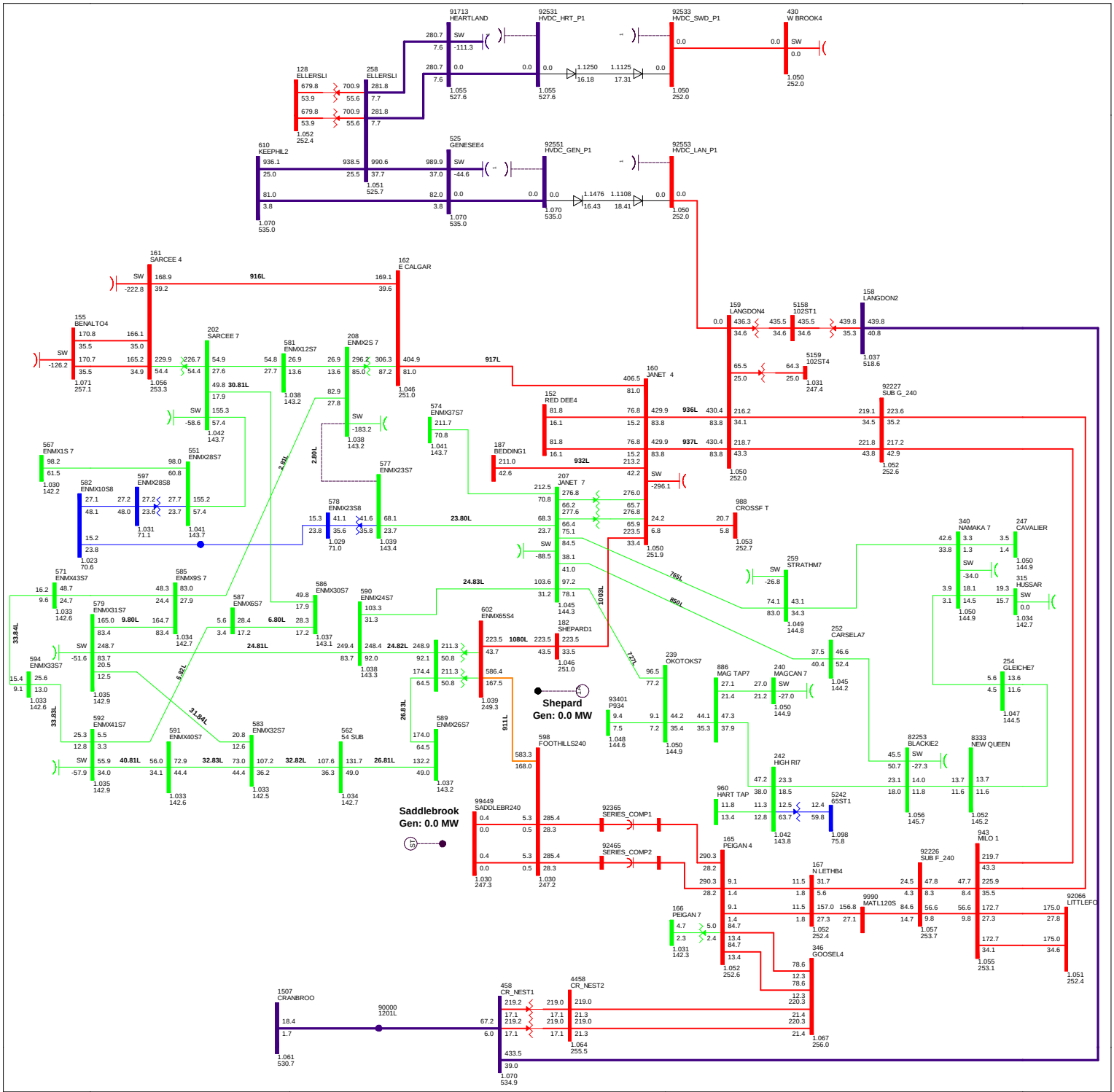
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 35.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

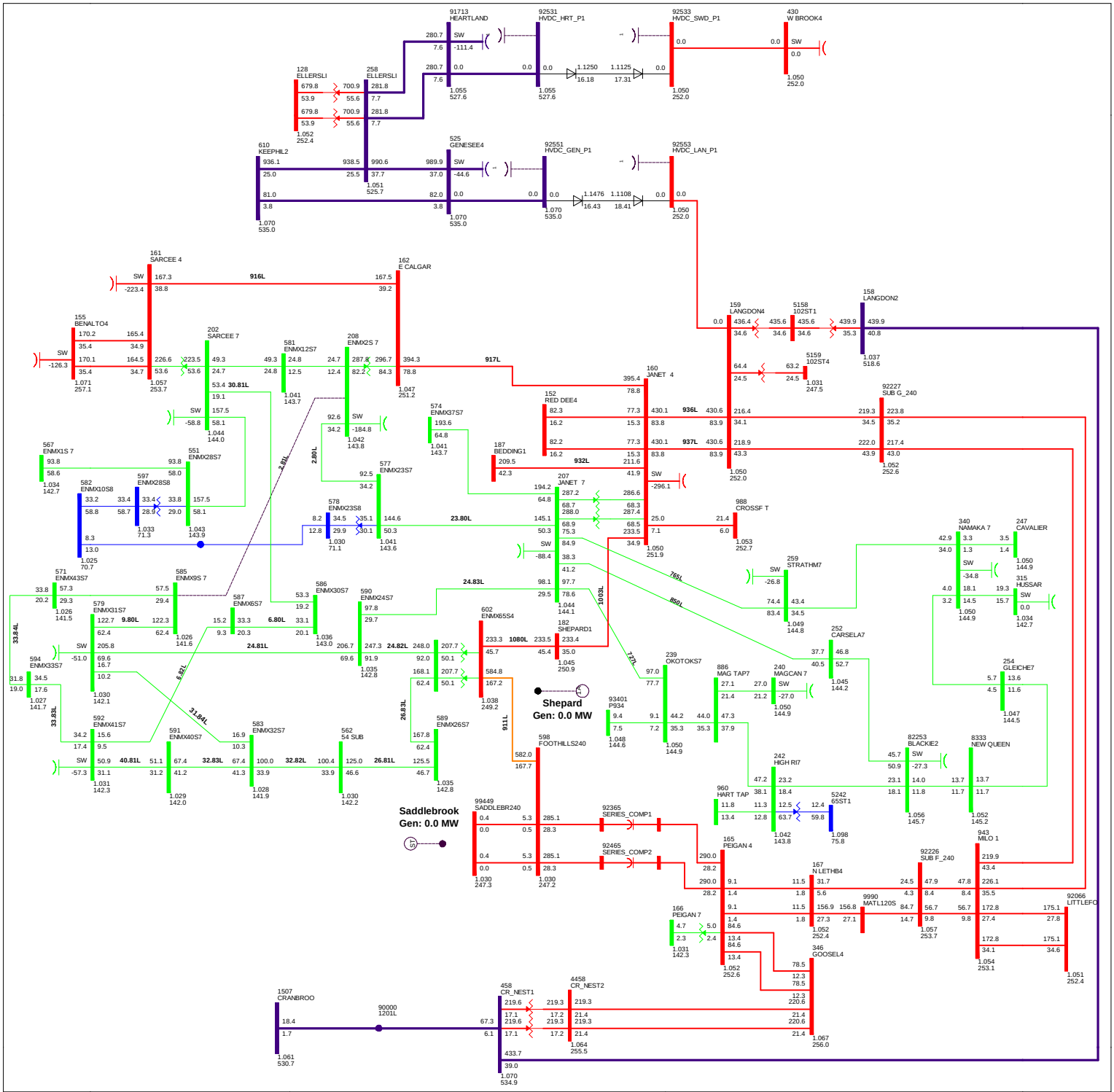
BCH Import: 0.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

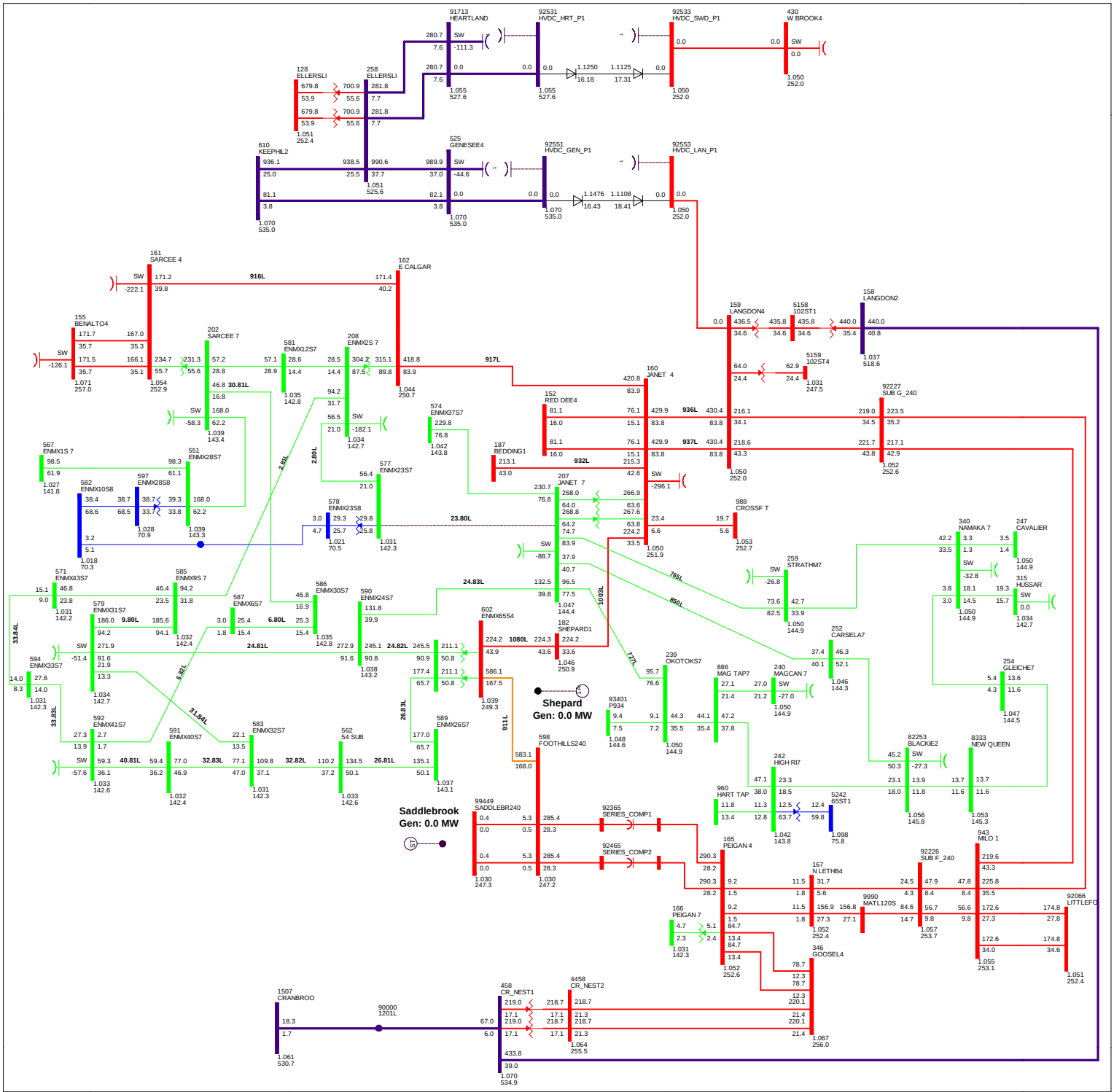
BCH Import: -0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

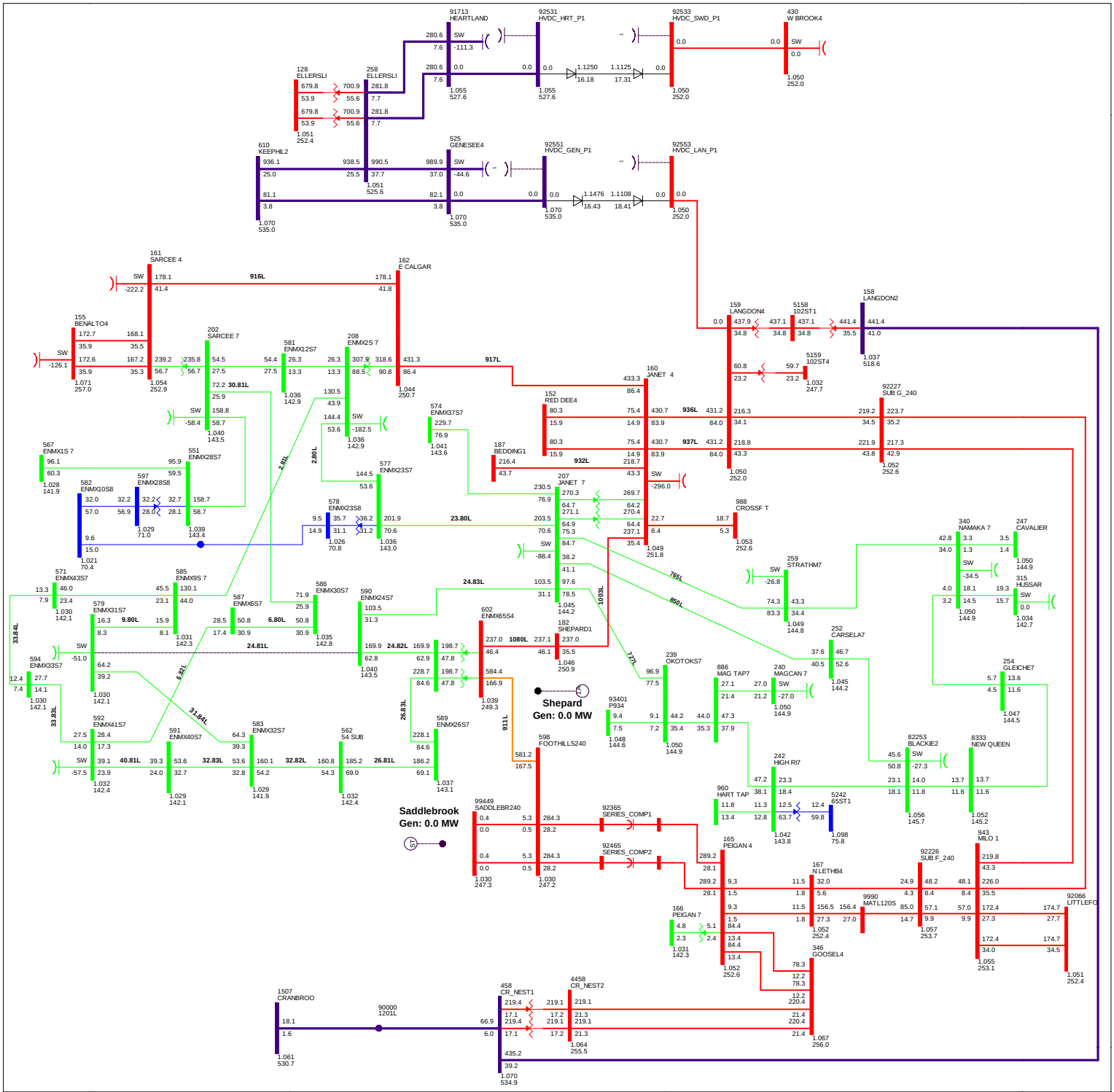
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

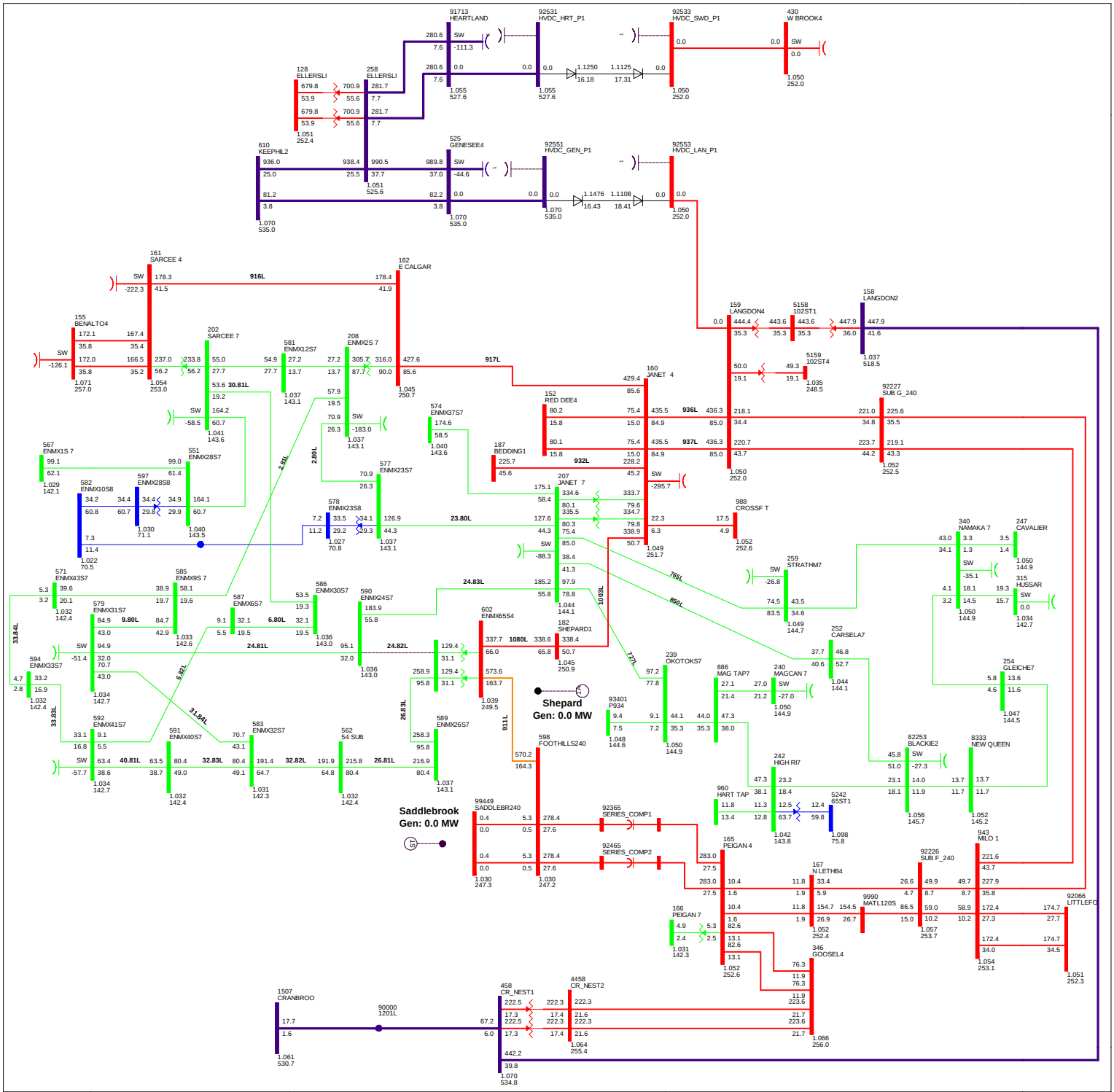
BCH Import: 2.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

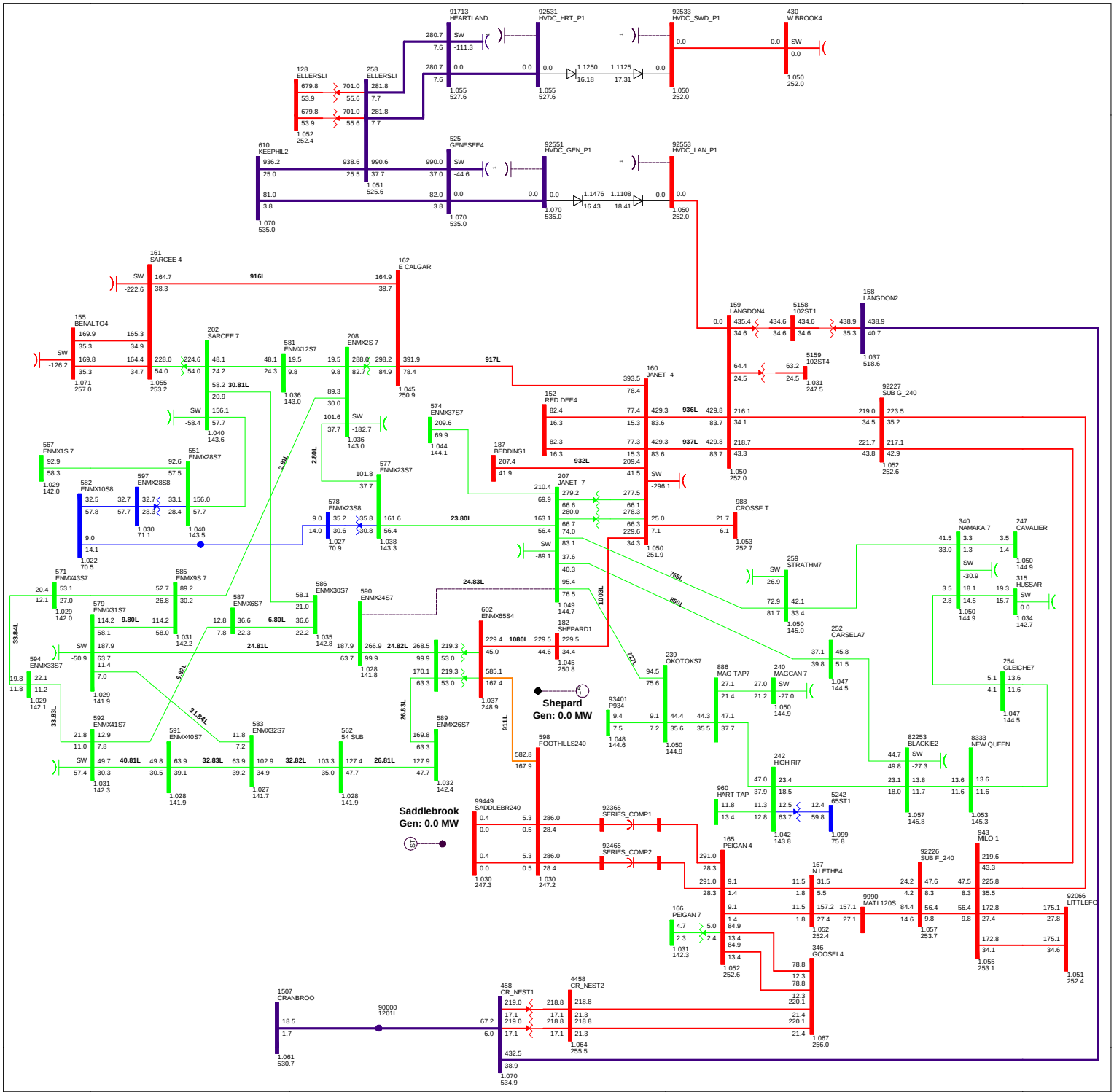
BCH Import: 3.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

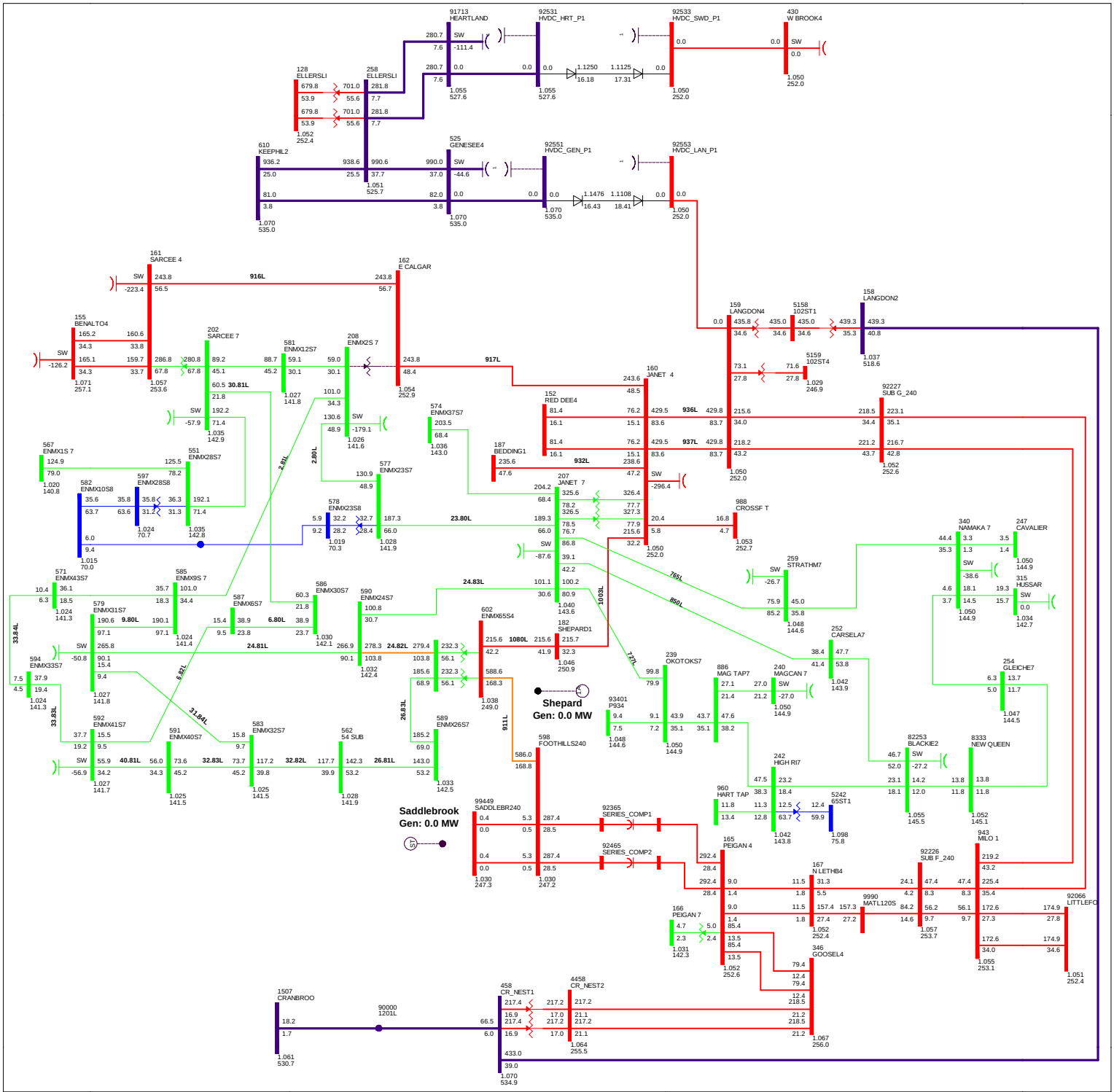
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

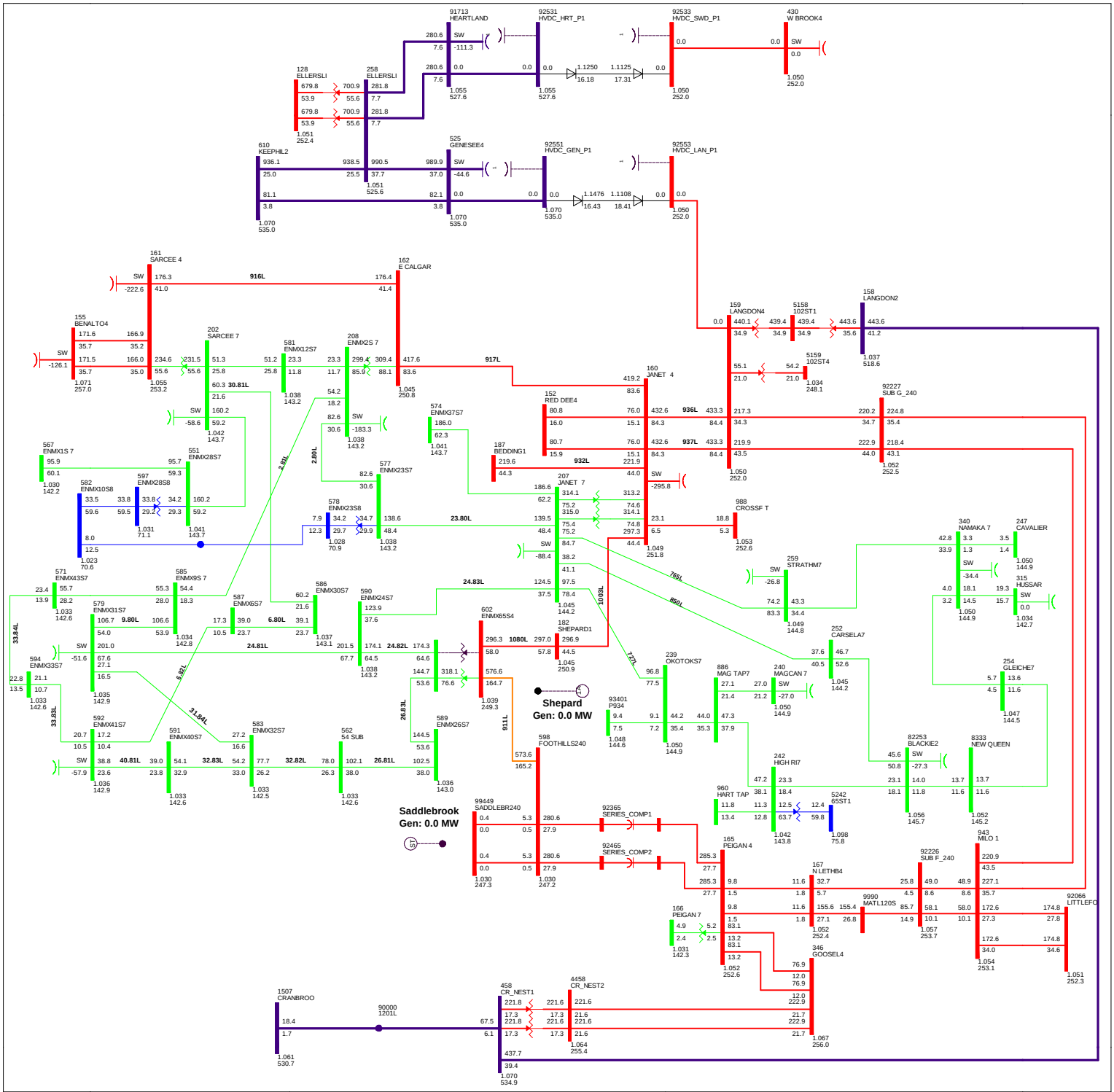
BCH Import: 4.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

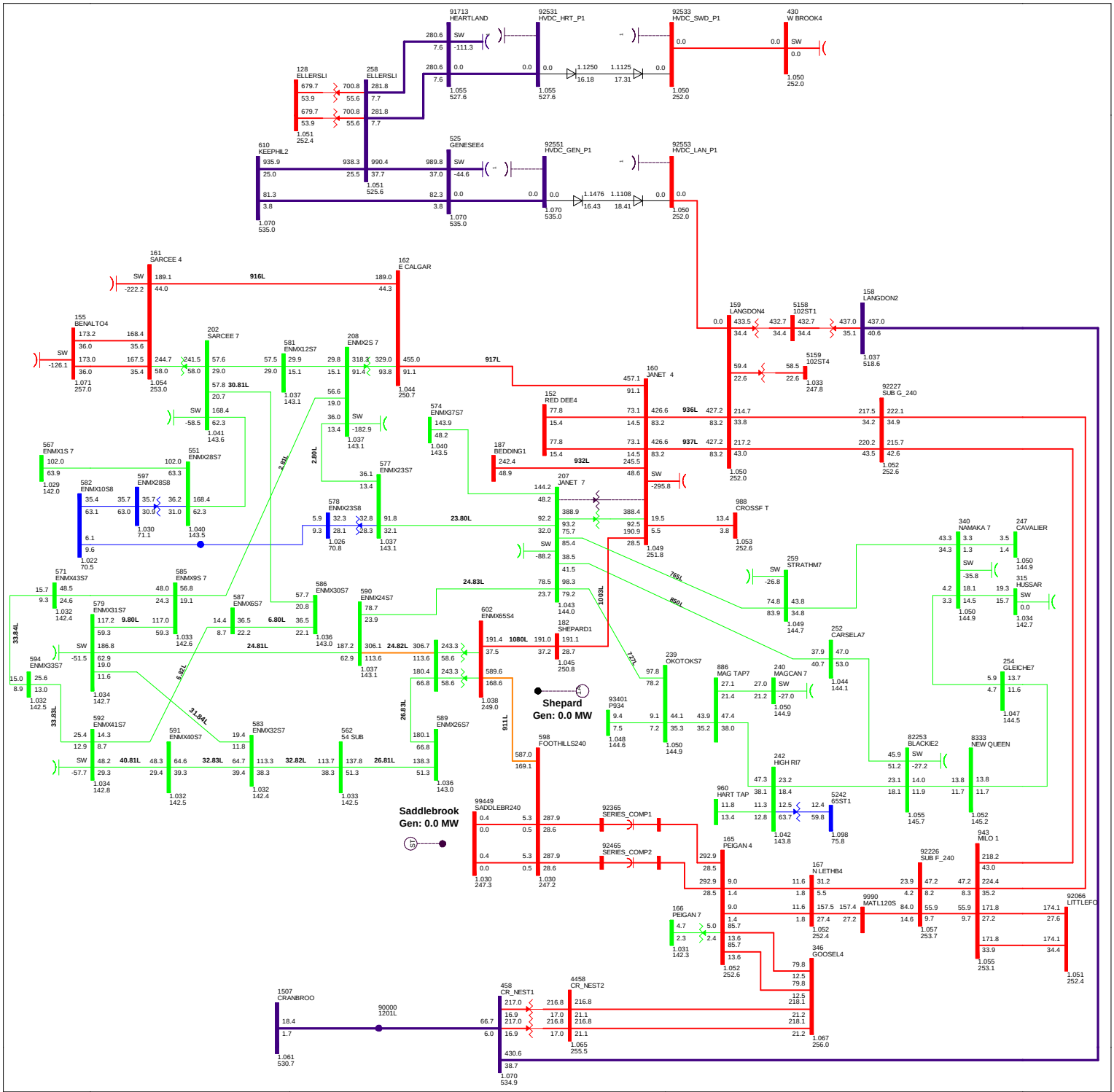
BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

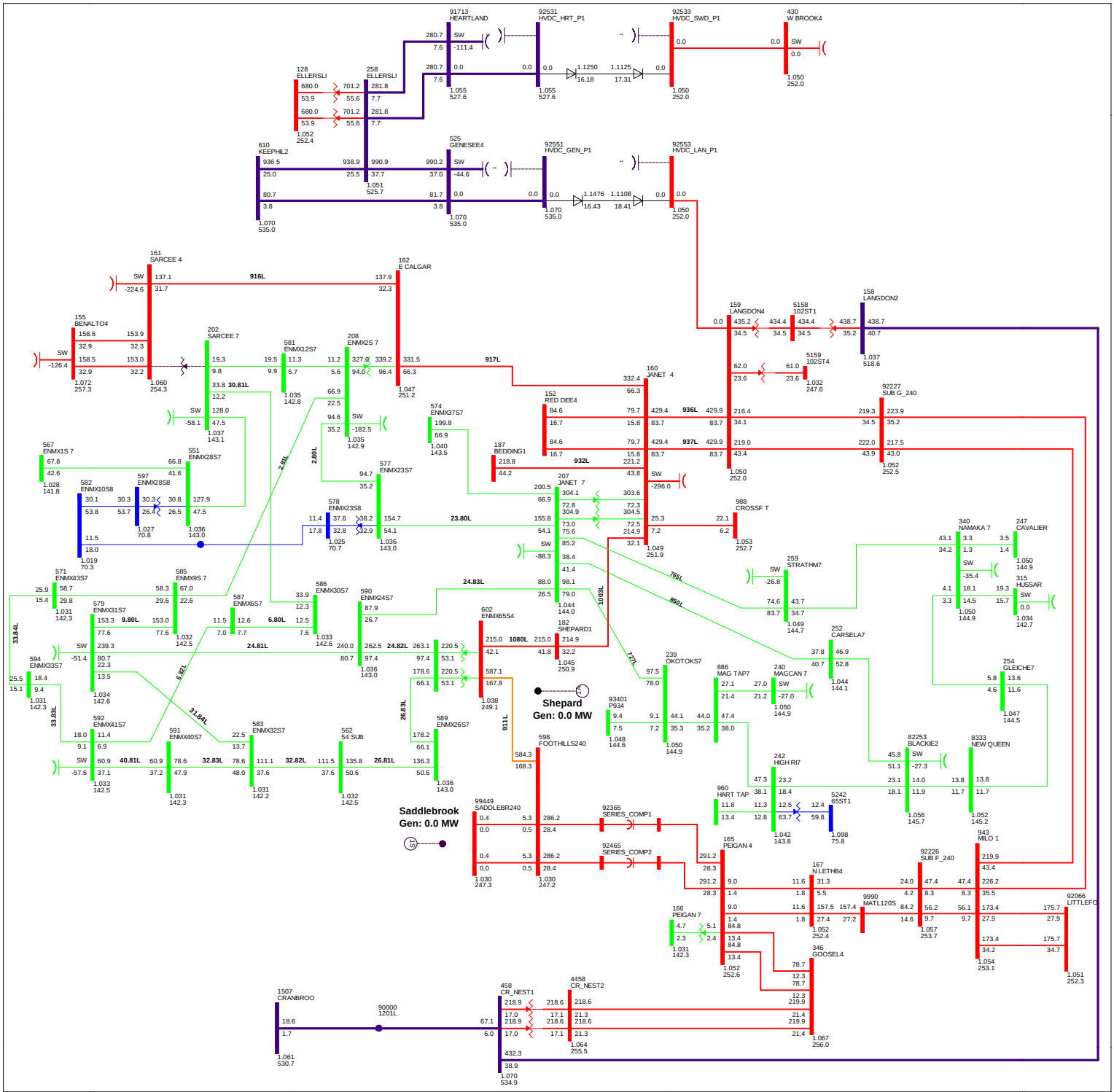
BCH Import: 3.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

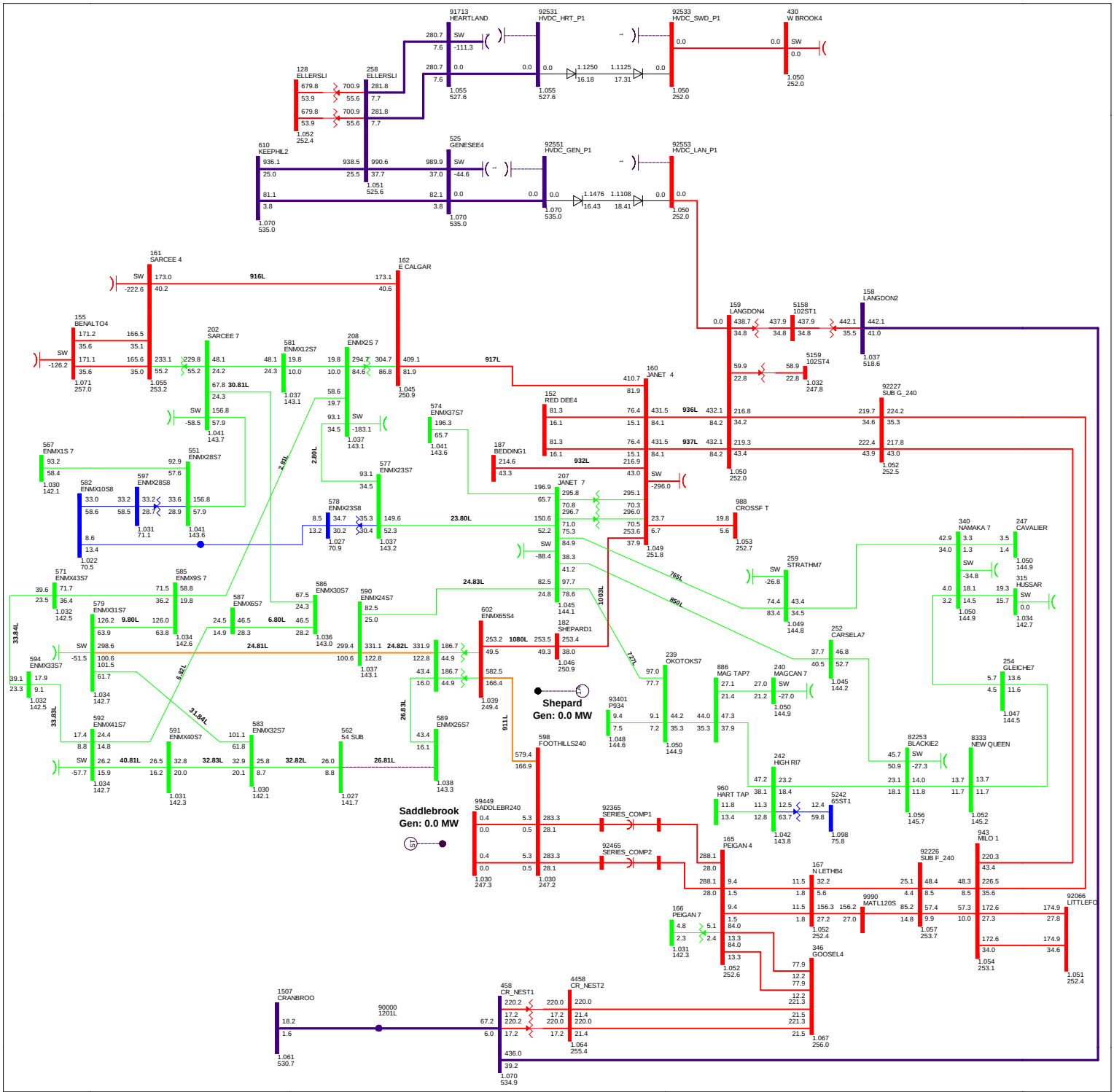
BCH Import: 1.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



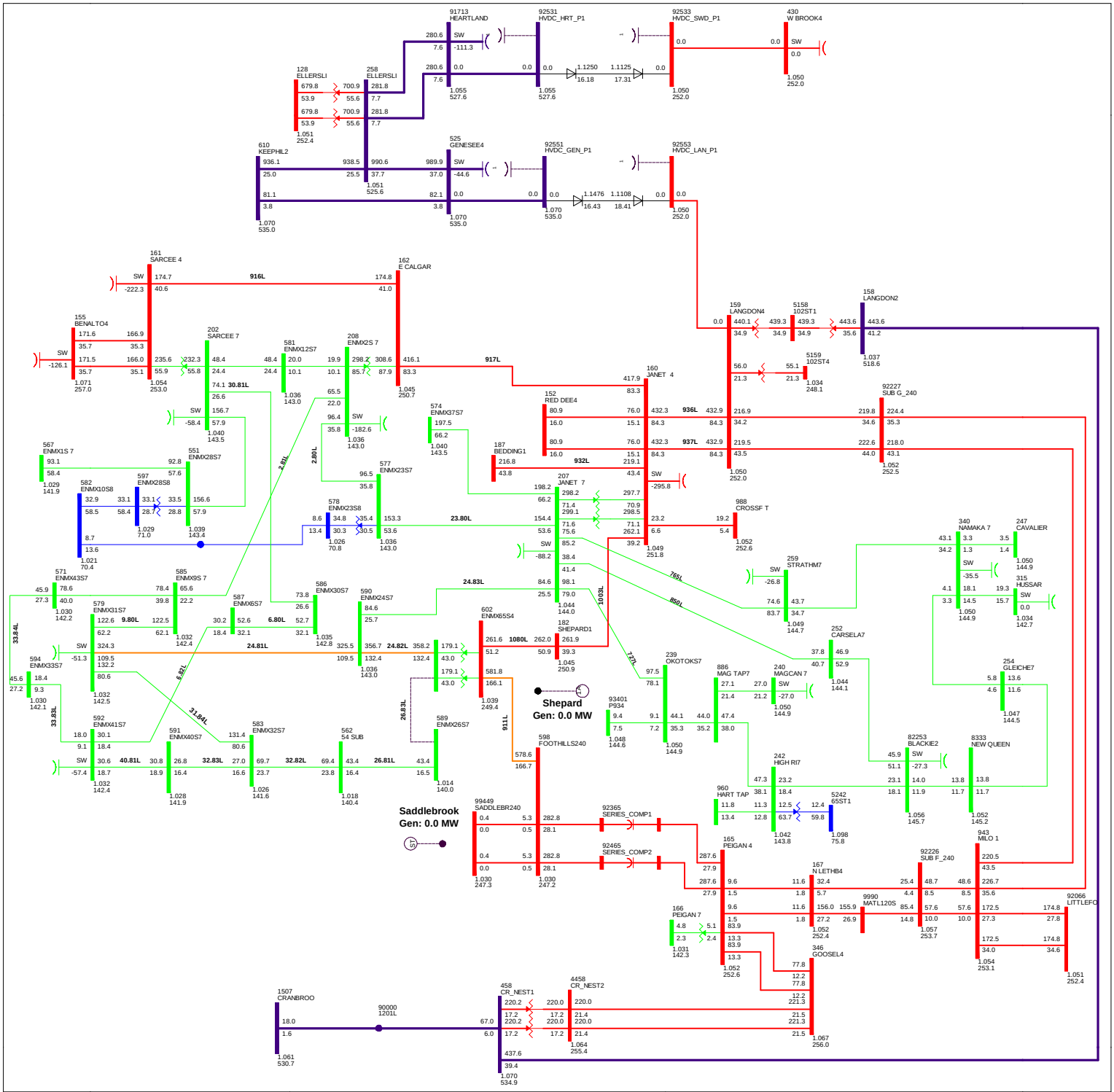
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

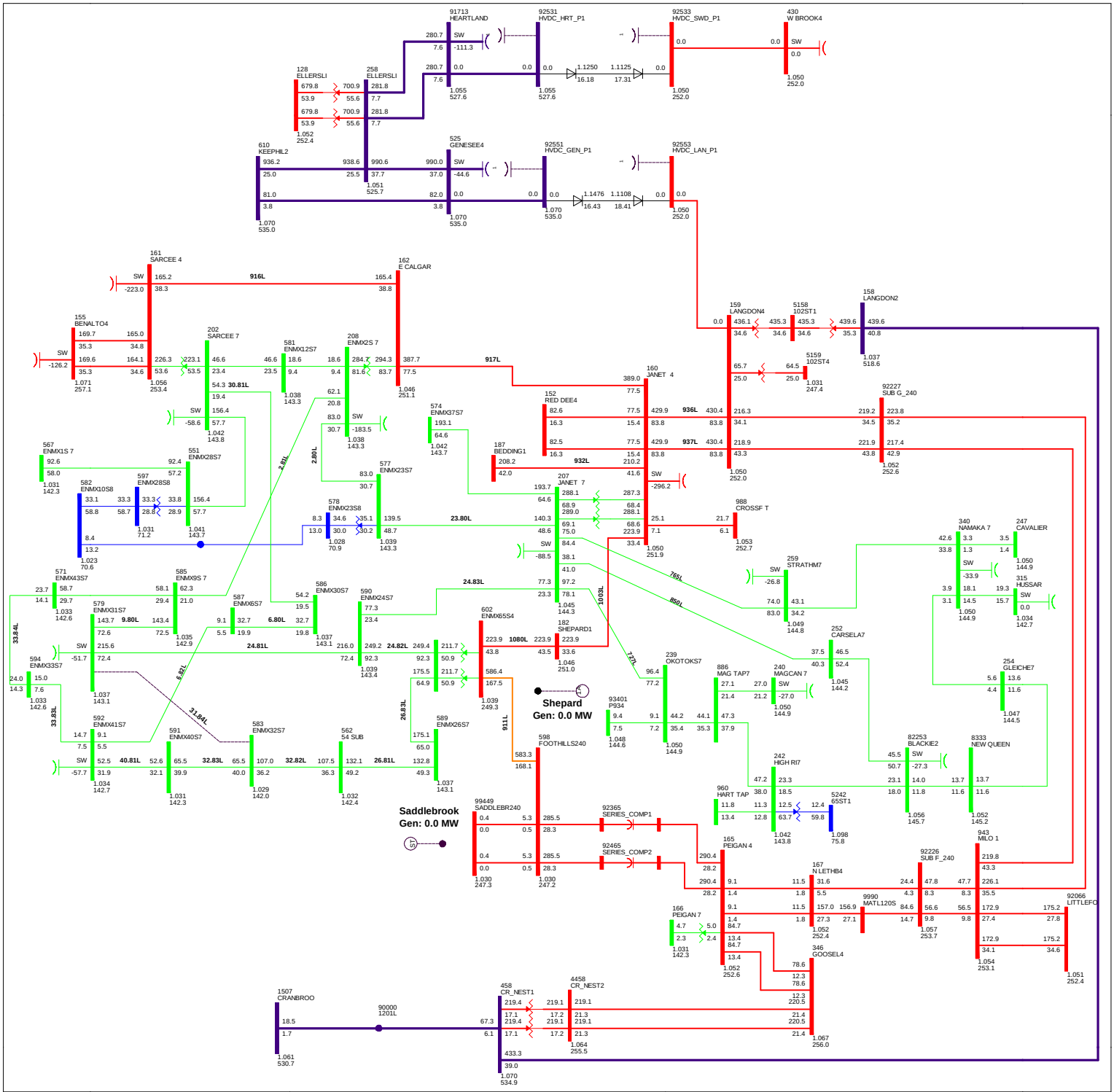
BCH Import: 1.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
BCH Import: 3.2 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC2-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_SP_EXISTING_SC2
FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

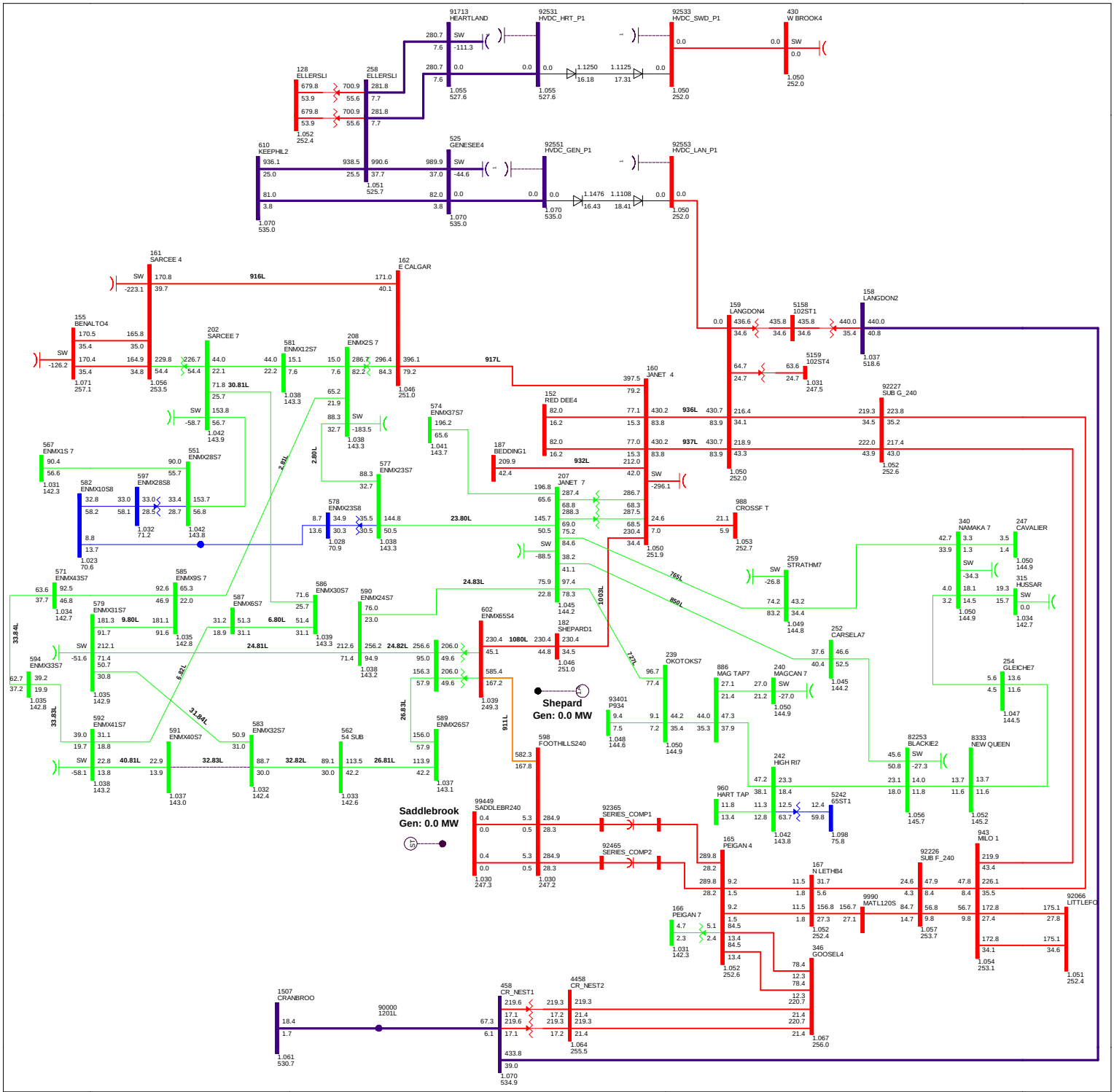
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-17: OPEN 31.84L 138 KV LINE (ENMAX 31 TO ENMAX 32)
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



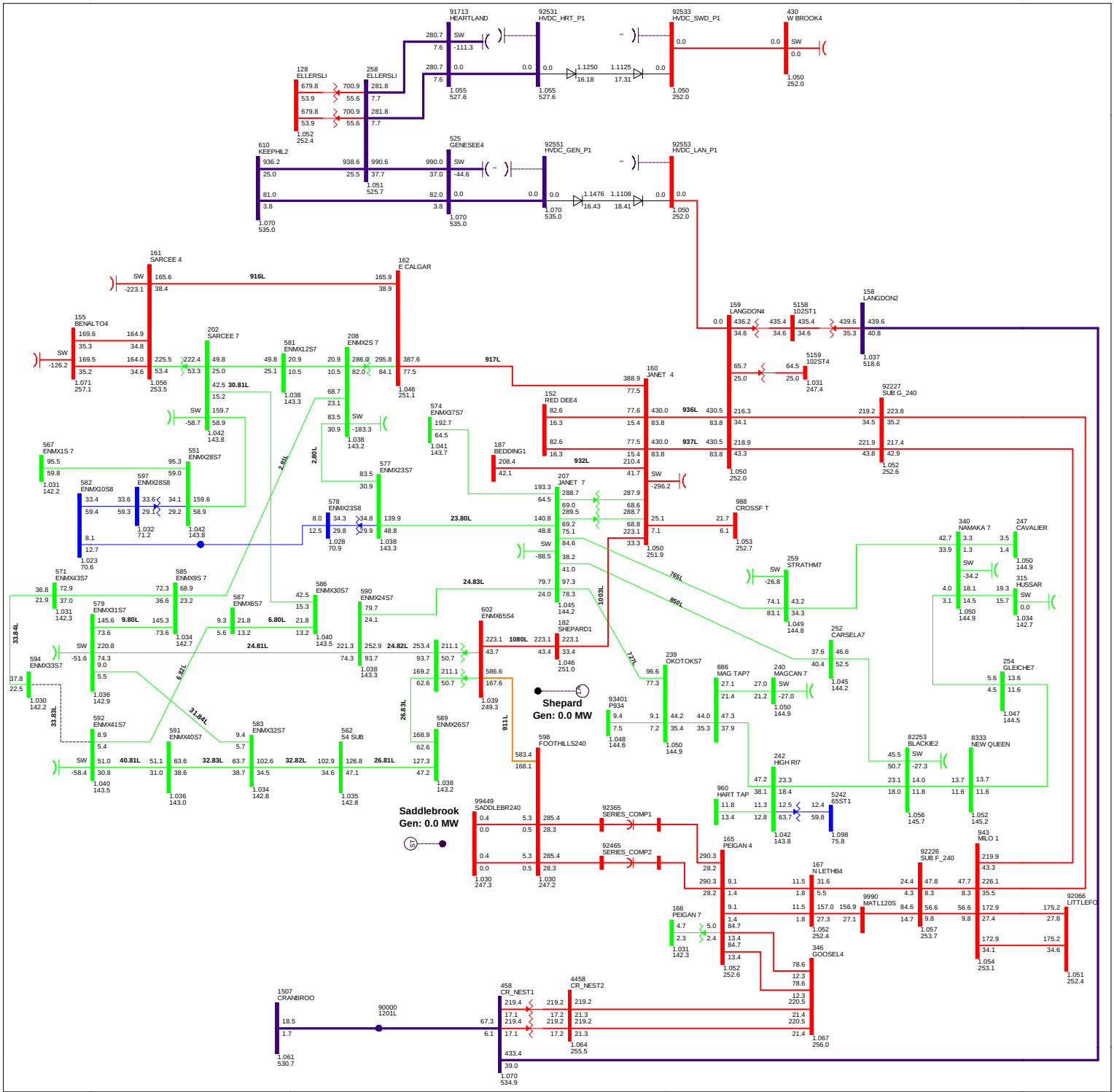
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-18: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

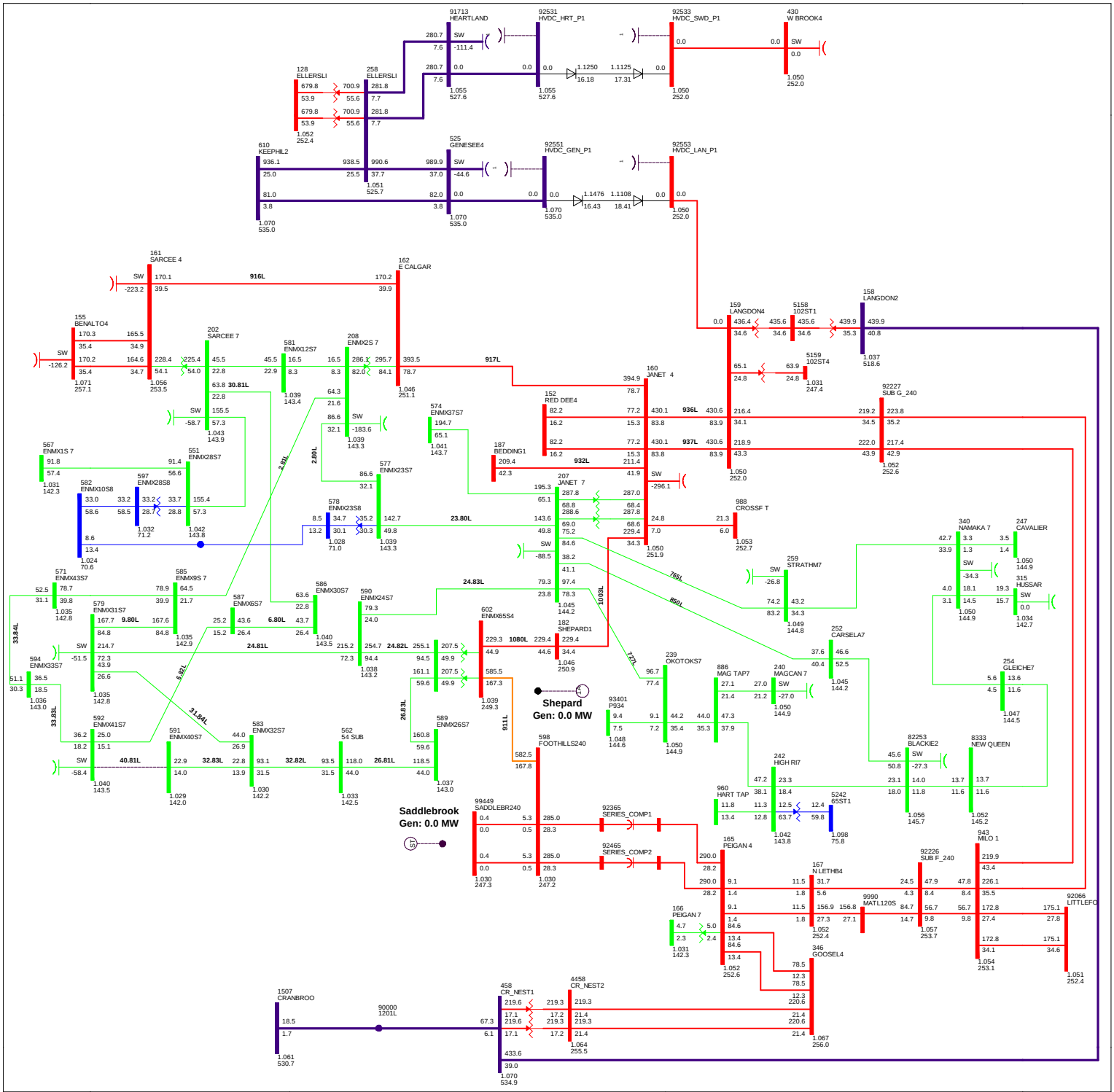
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-19: OPEN 33.83L 138 KV LINE (ENMAX 41 TO ENMAX 33)
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



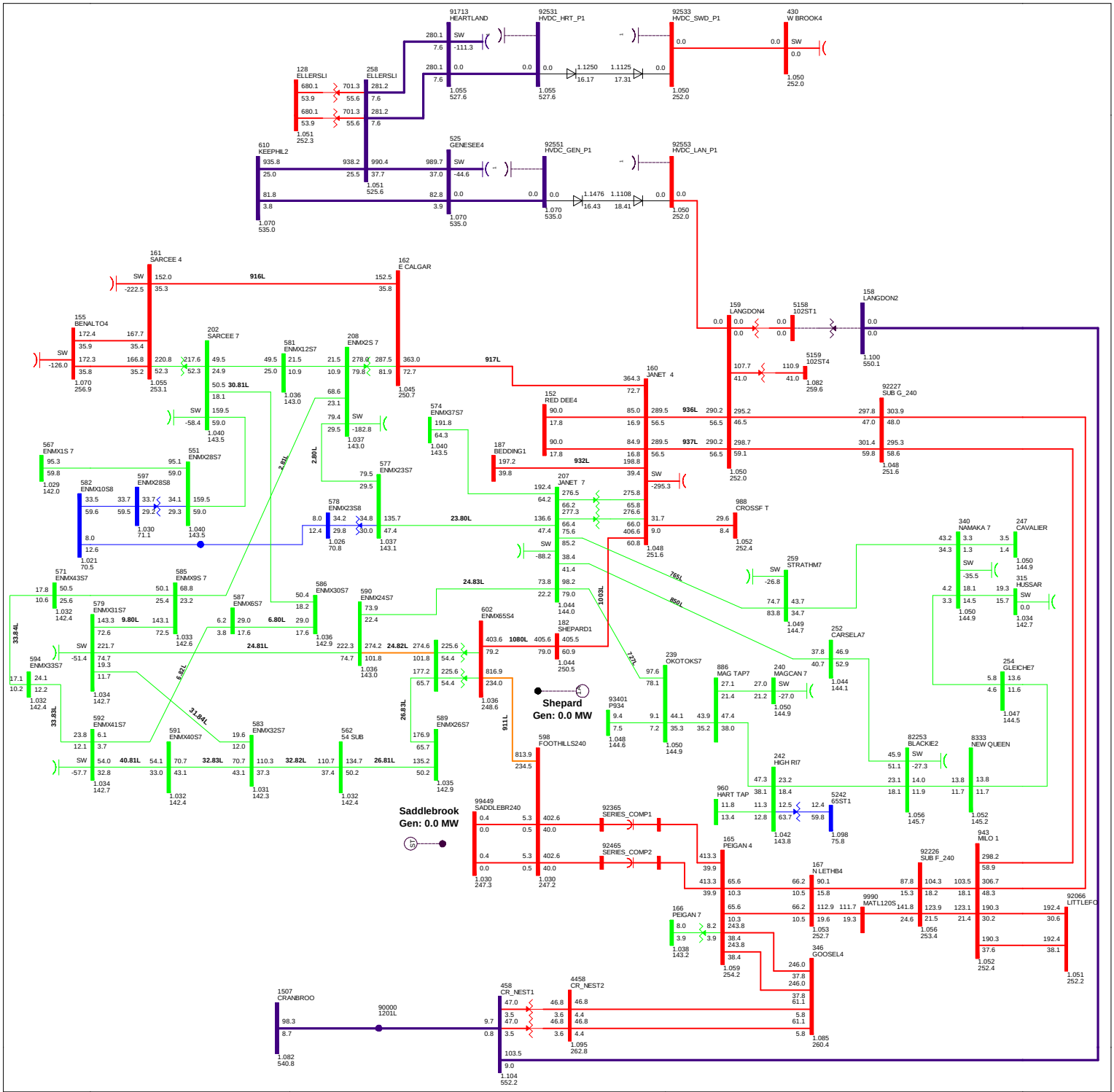
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-20: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

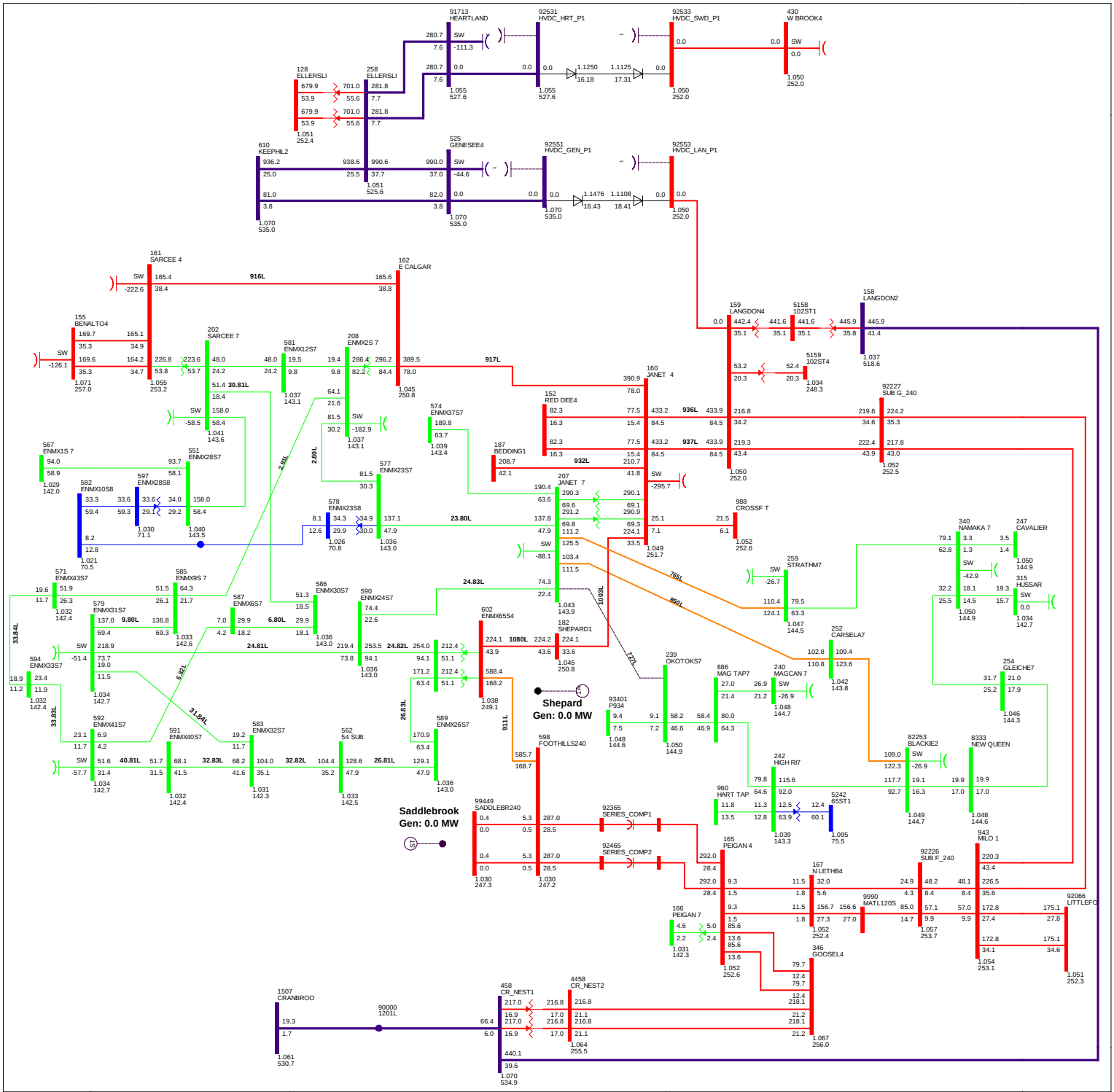
BCH Import: 35.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-21: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



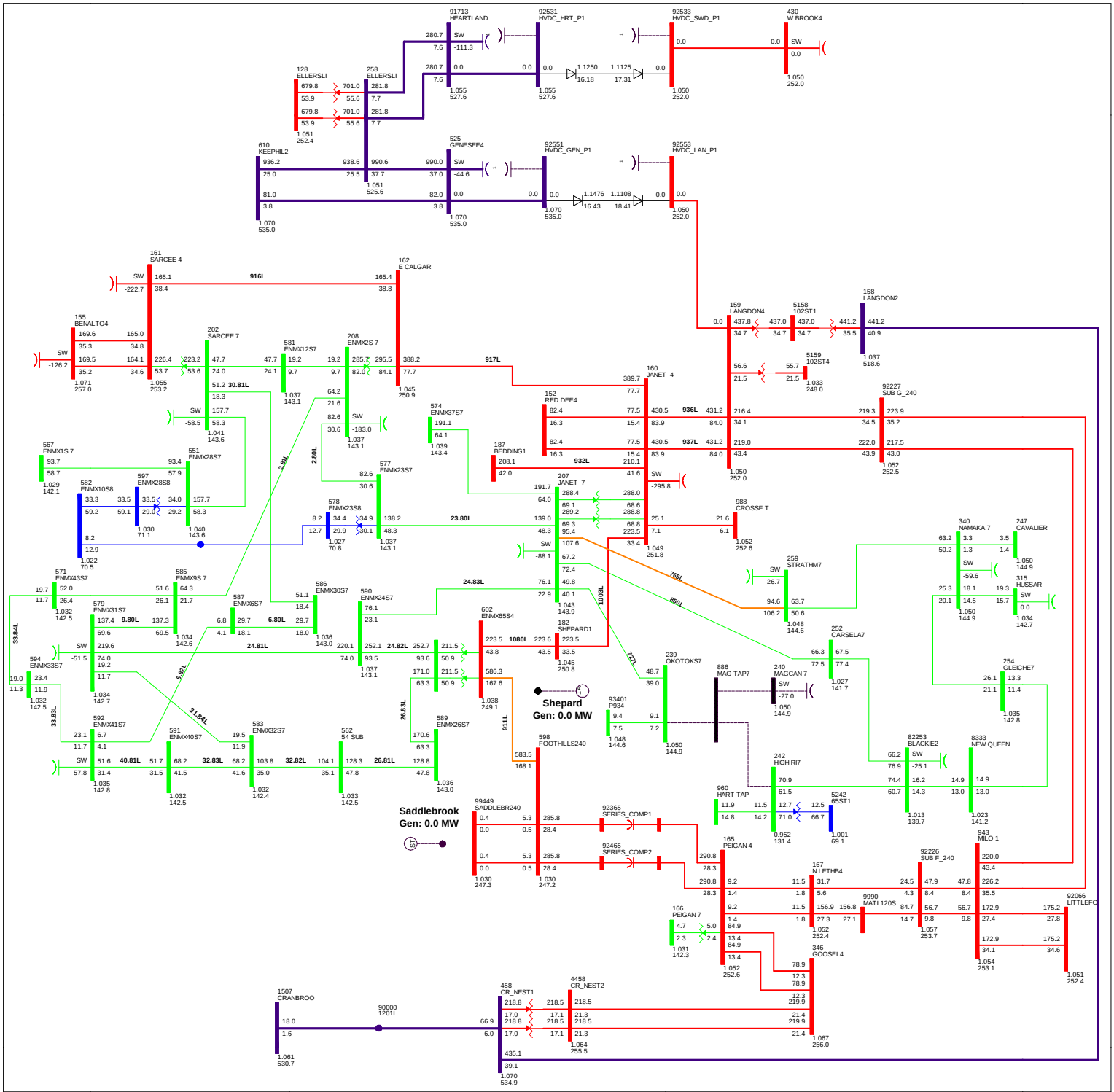
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 12.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-22: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

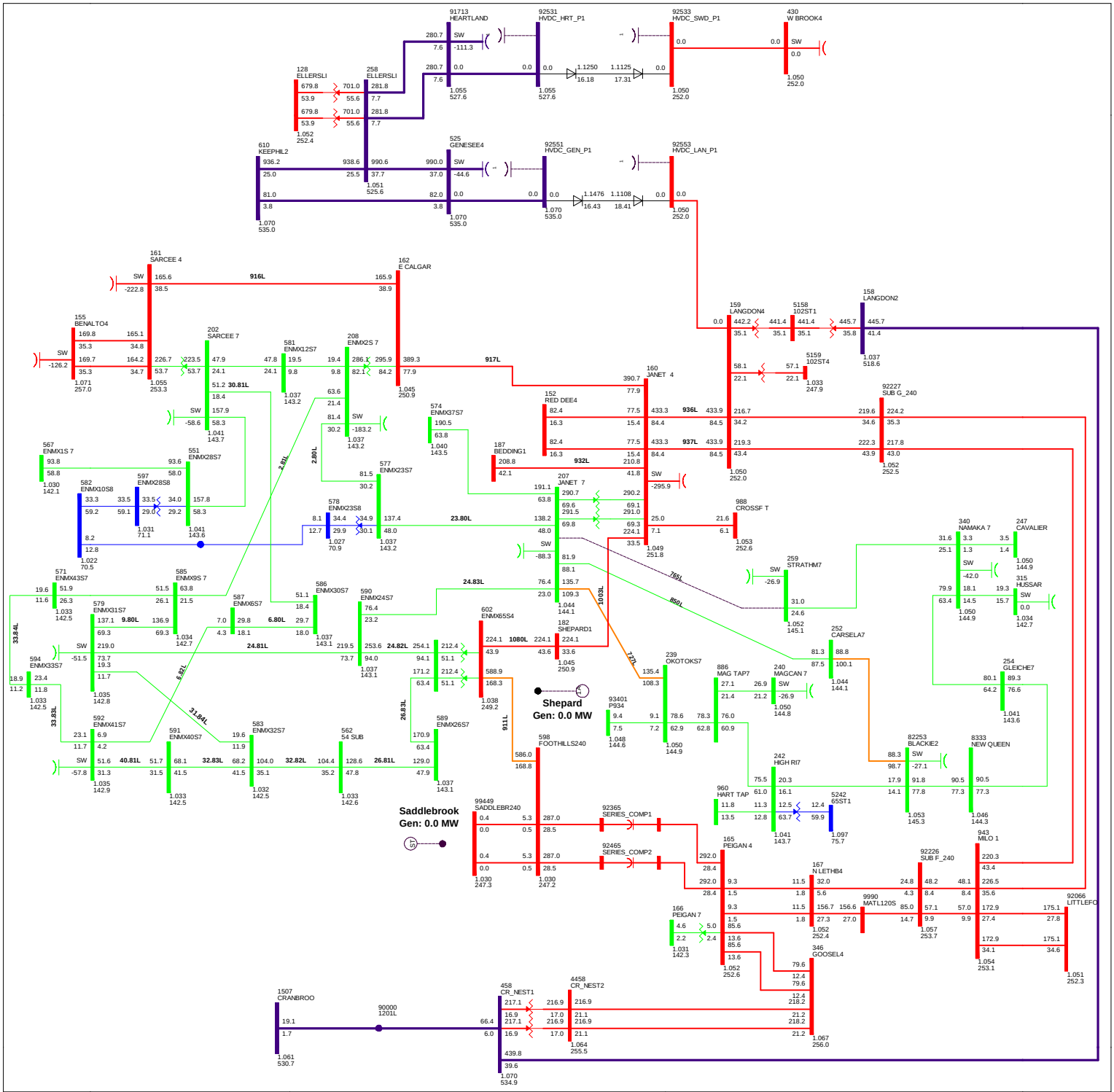
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-23: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

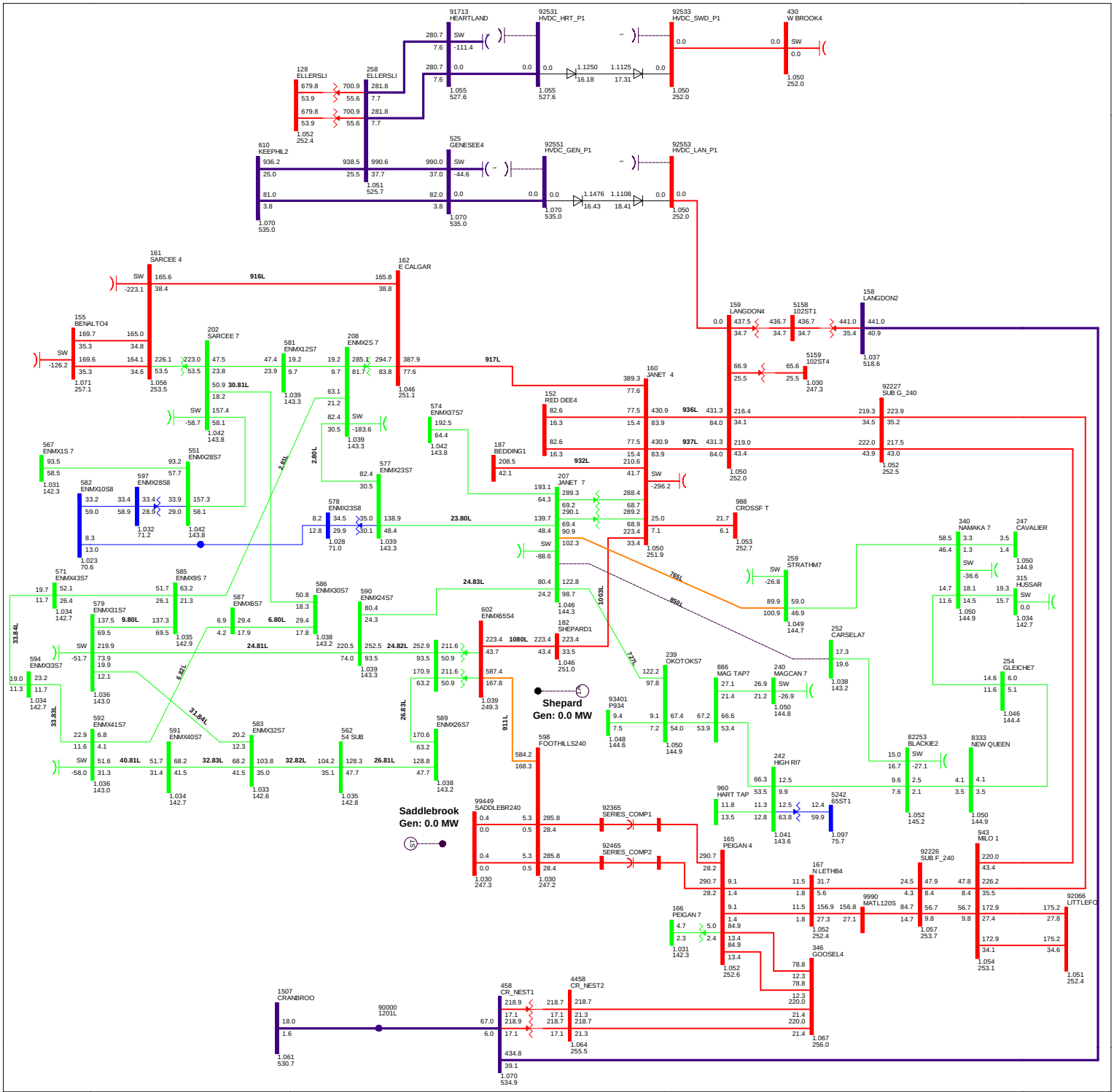
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 11.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-24: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



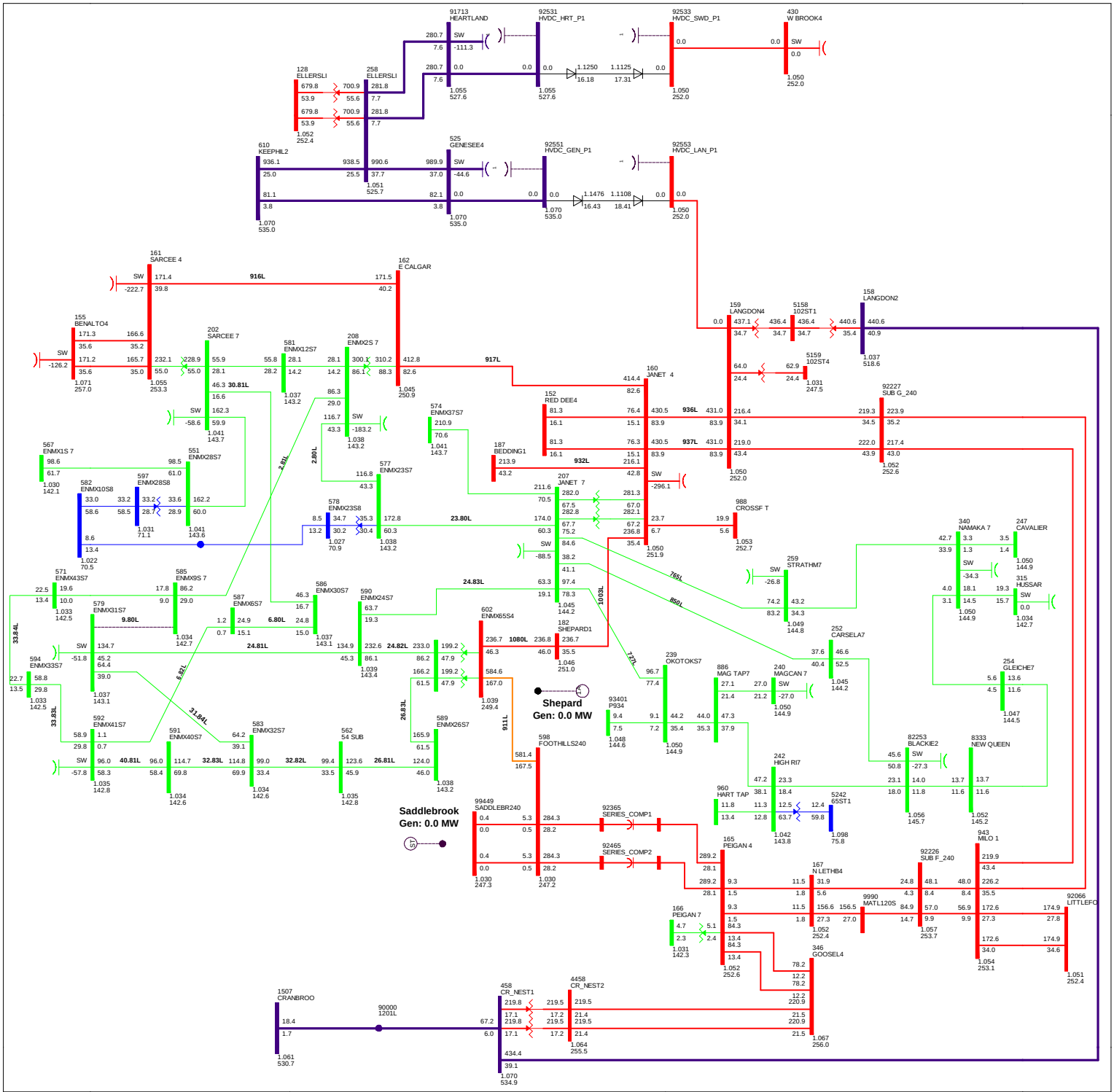
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-25: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:38



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

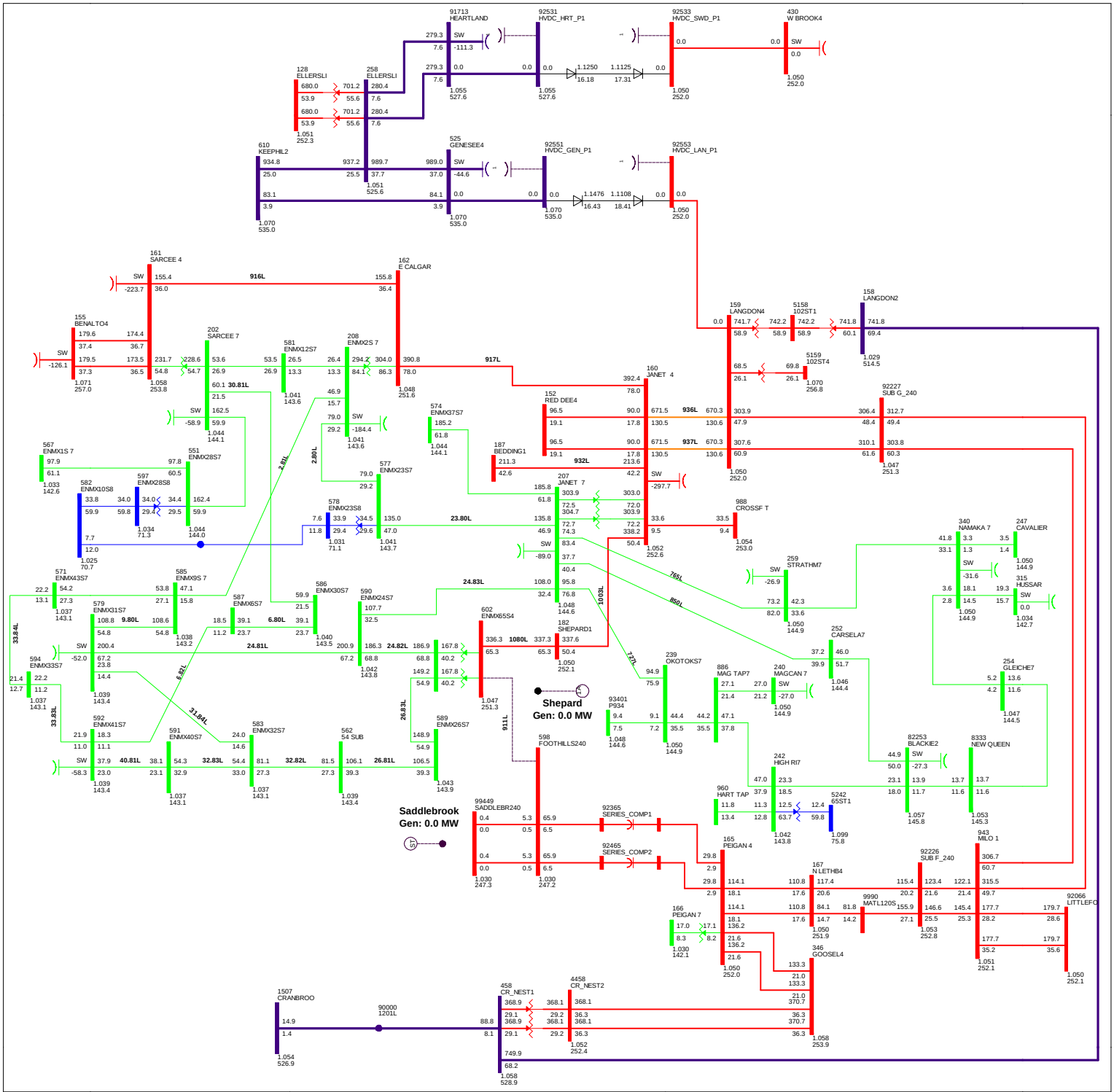
BCH Import: 0.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-26: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:39



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

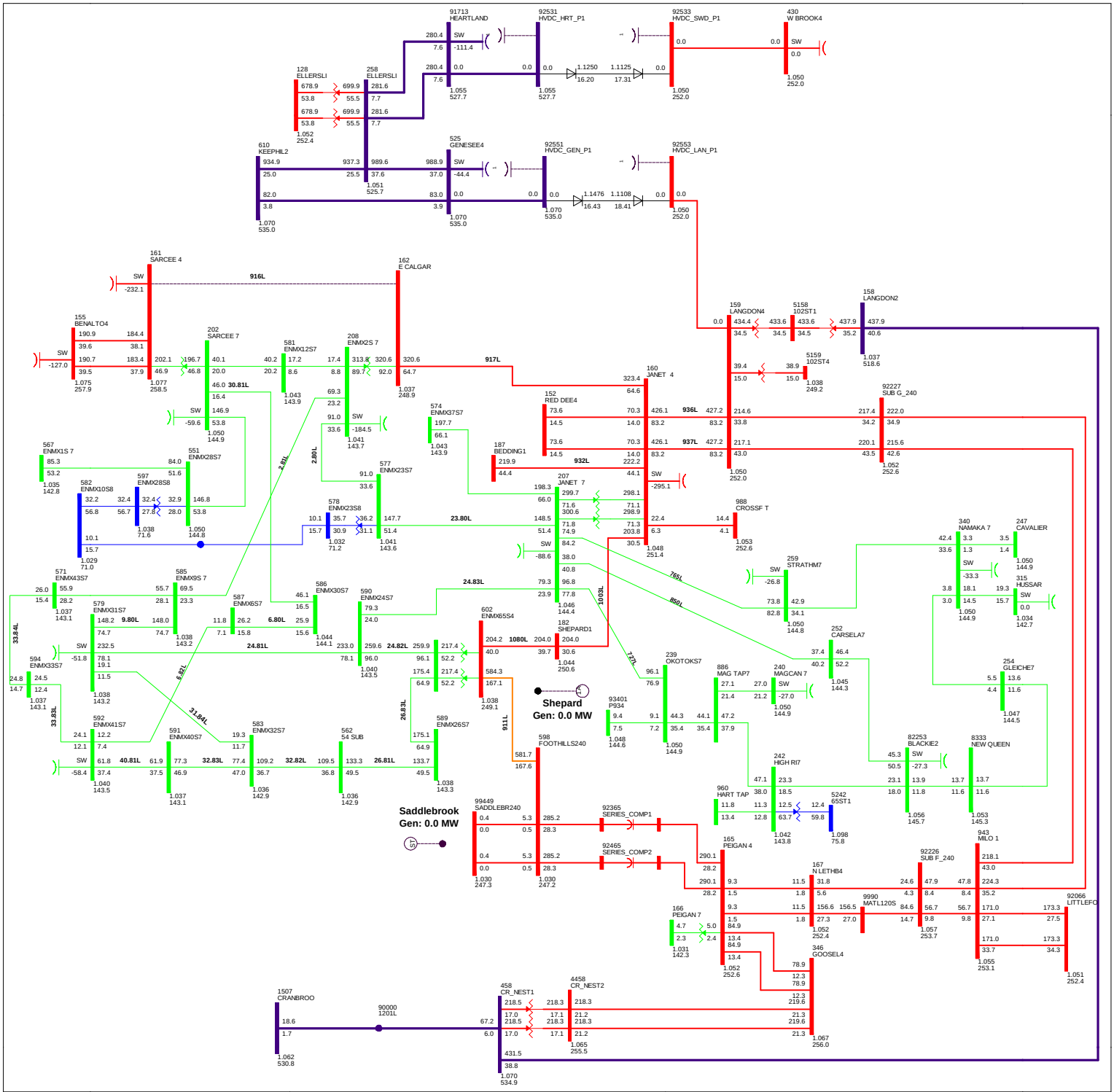
BCH Import: 21.9 MW

100.0%RATEA
KV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO EXISTING SYSTEM

FIG B-SC2-27: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX 2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:39



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

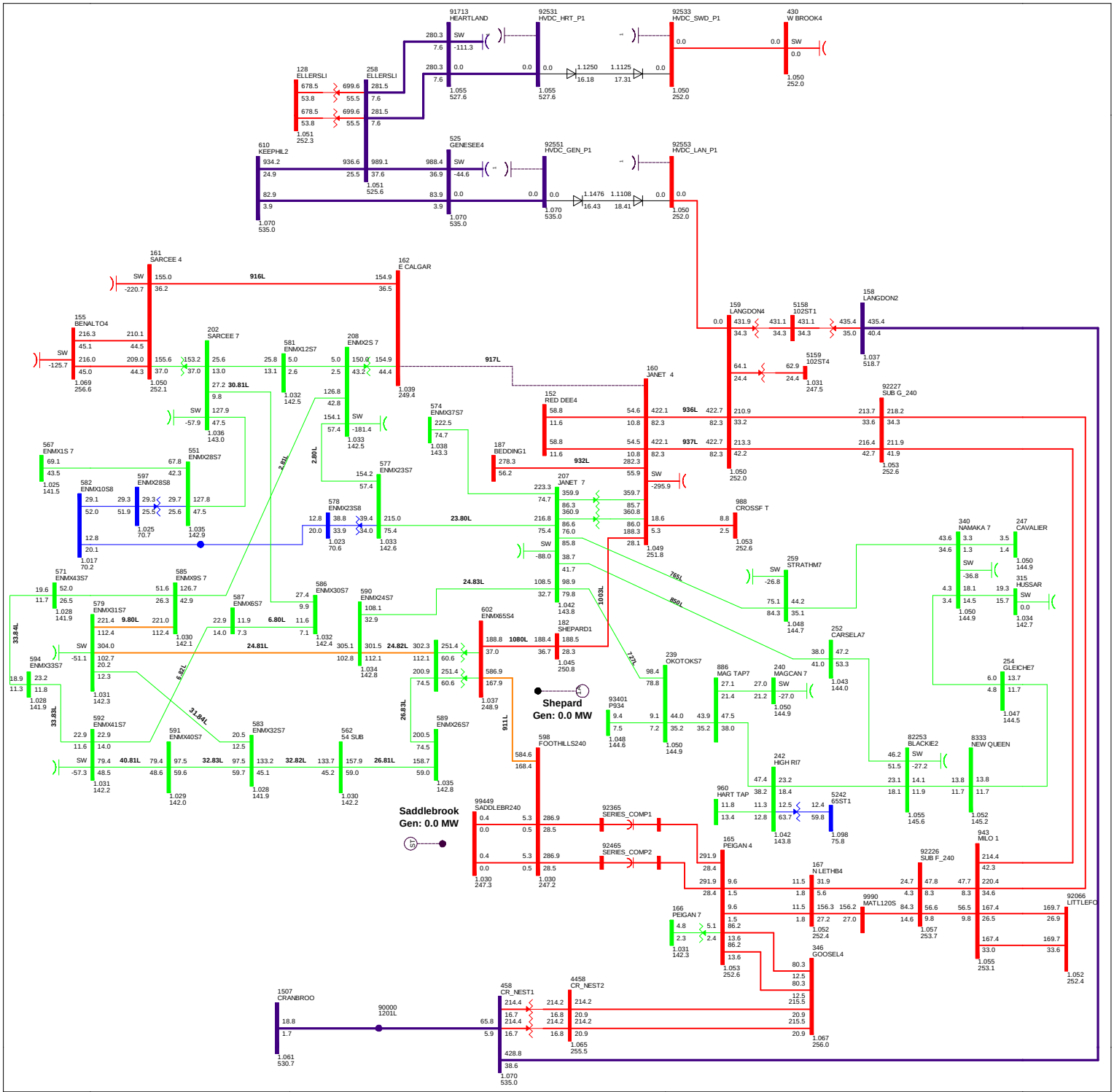
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-28: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:39



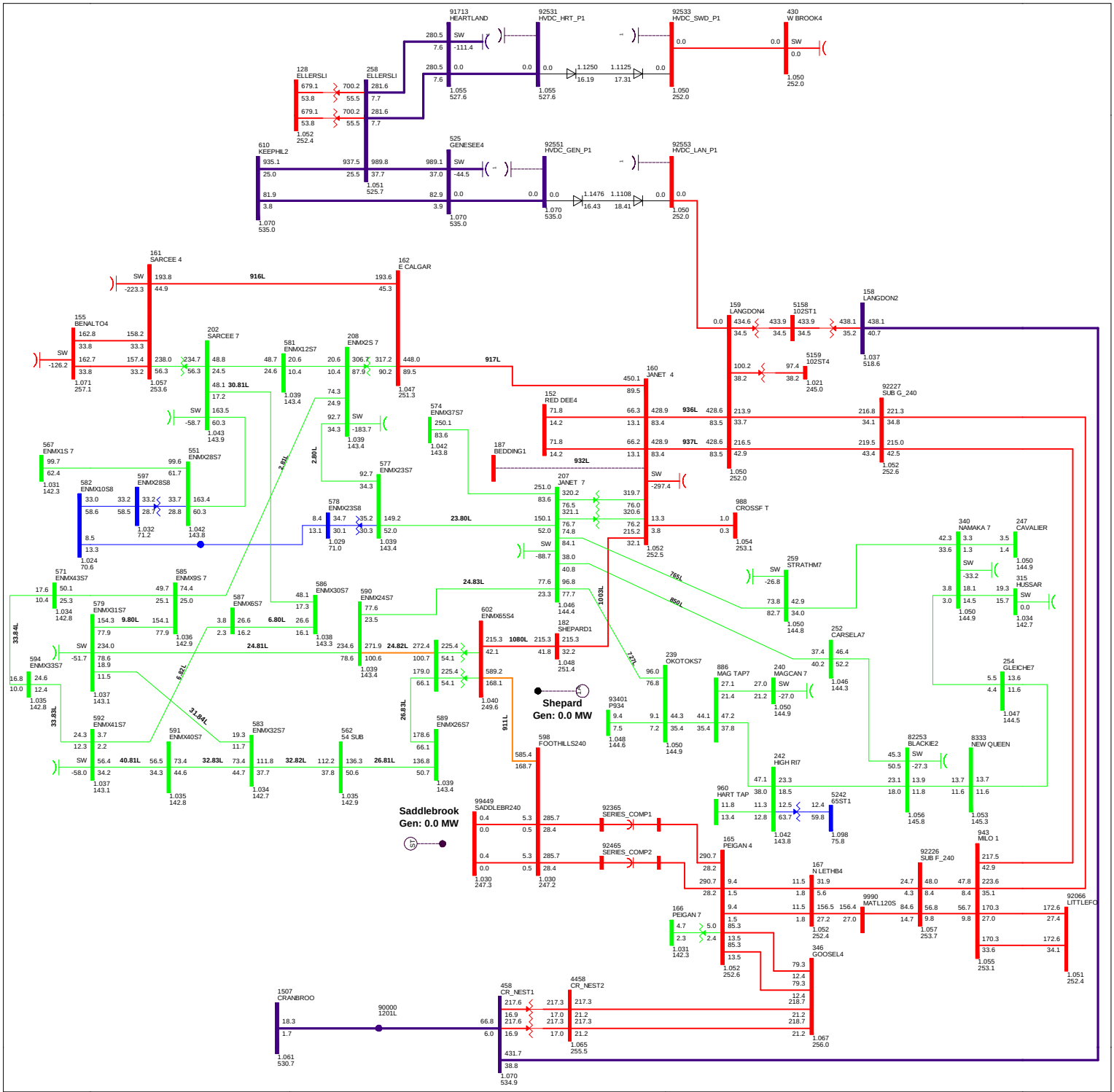
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 9.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-29: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:39



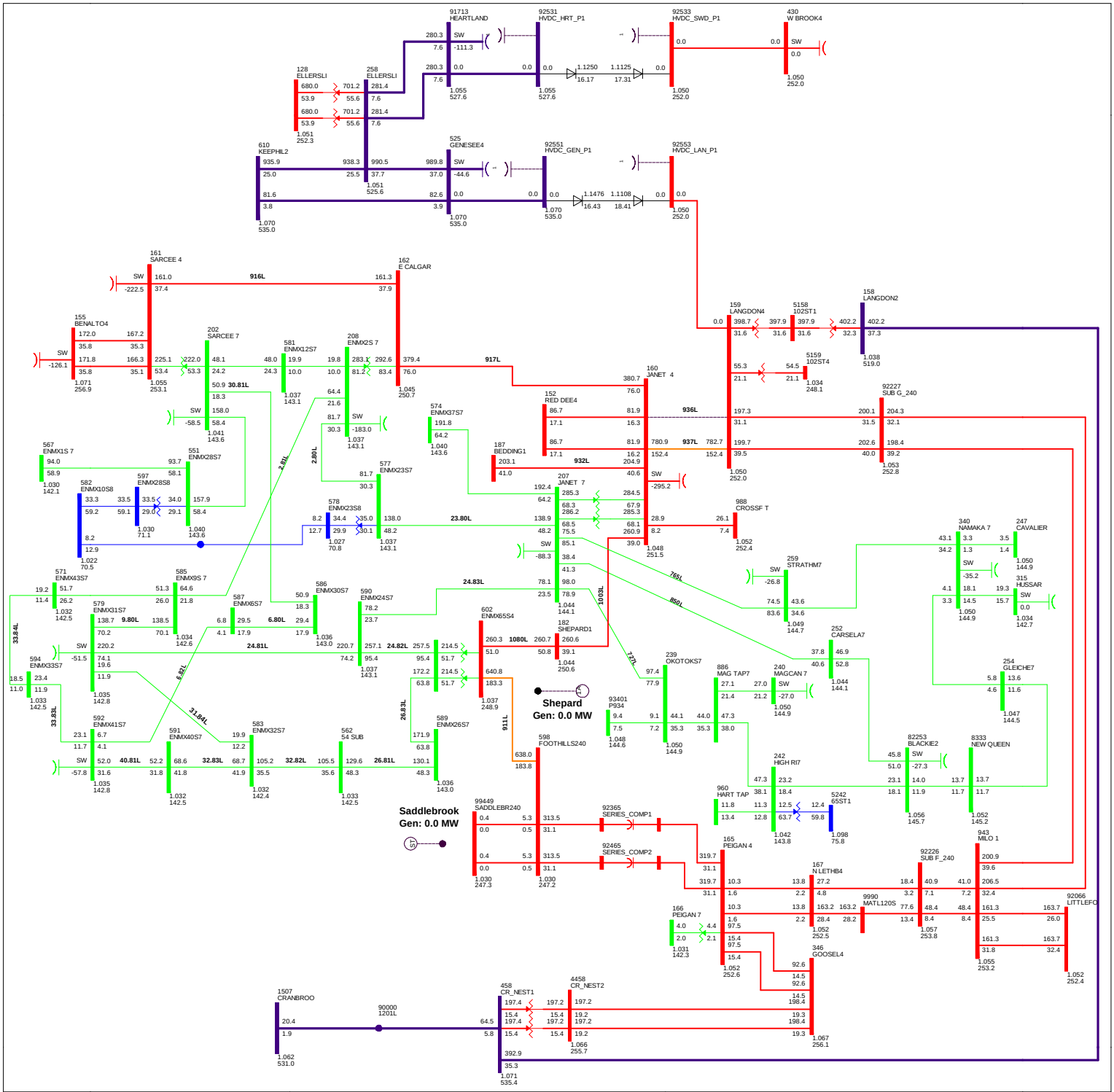
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-30: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:39



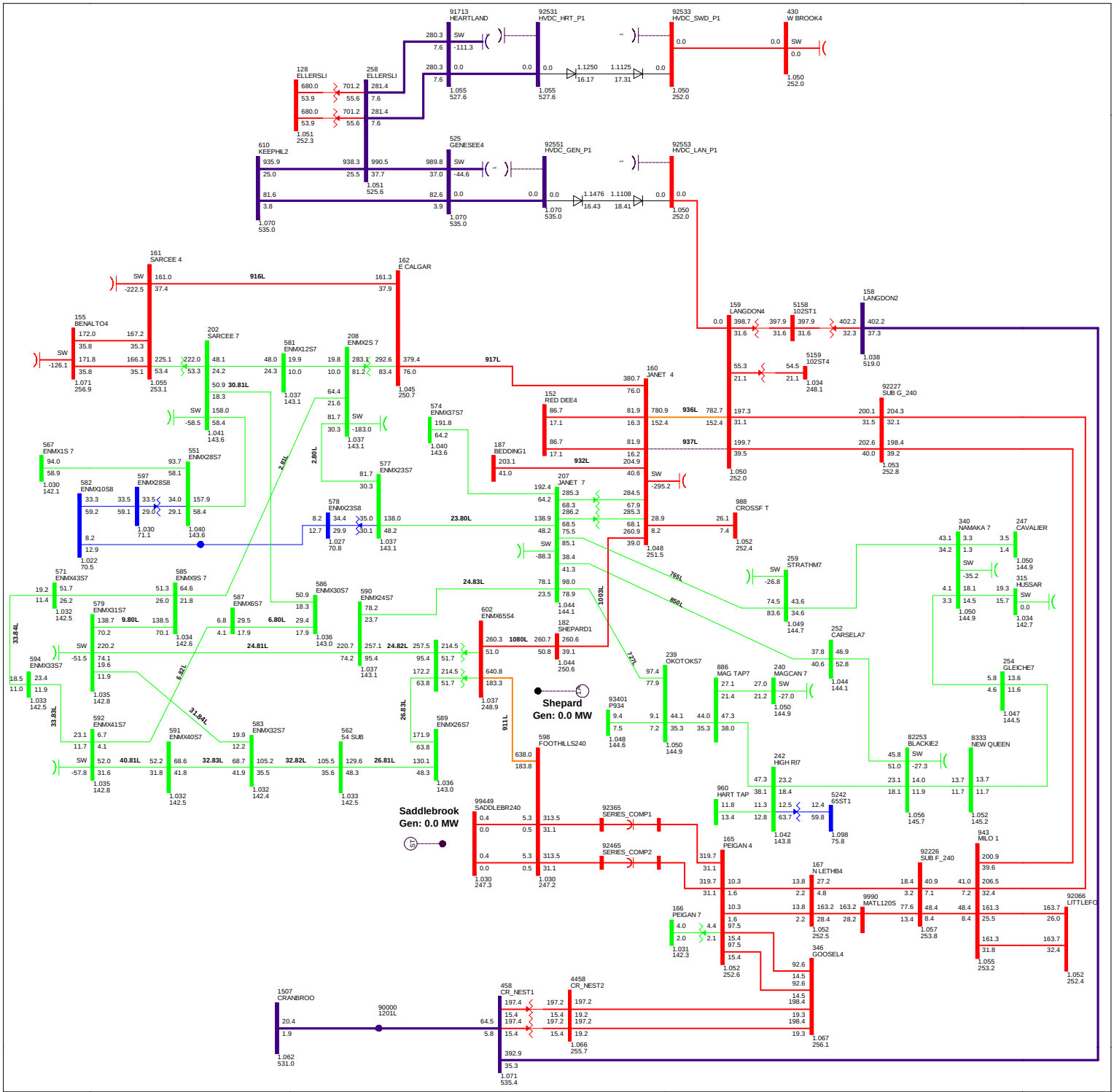
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 7.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC2-31: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7 2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:39



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

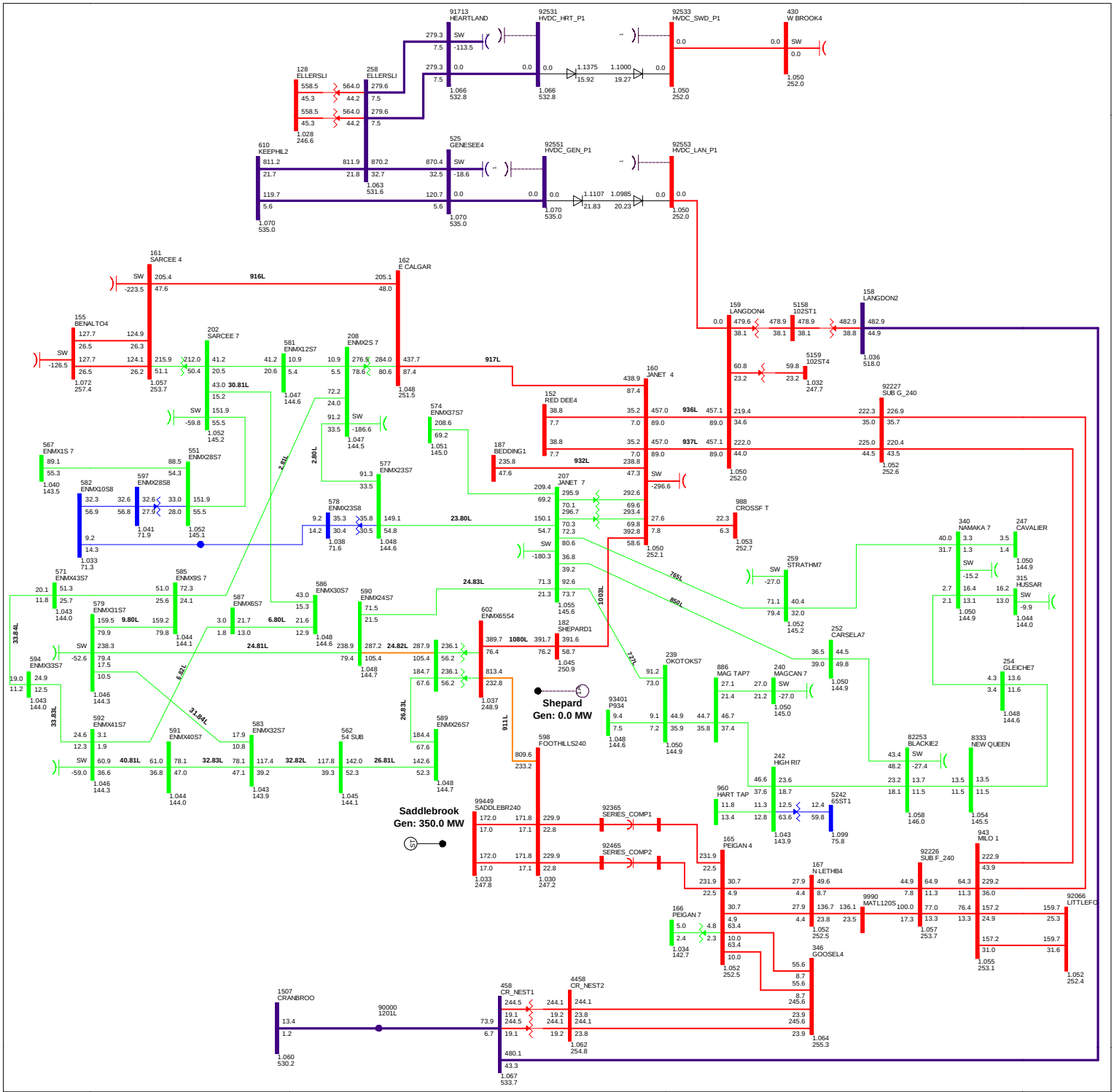
BCH Import: 7.1 MW

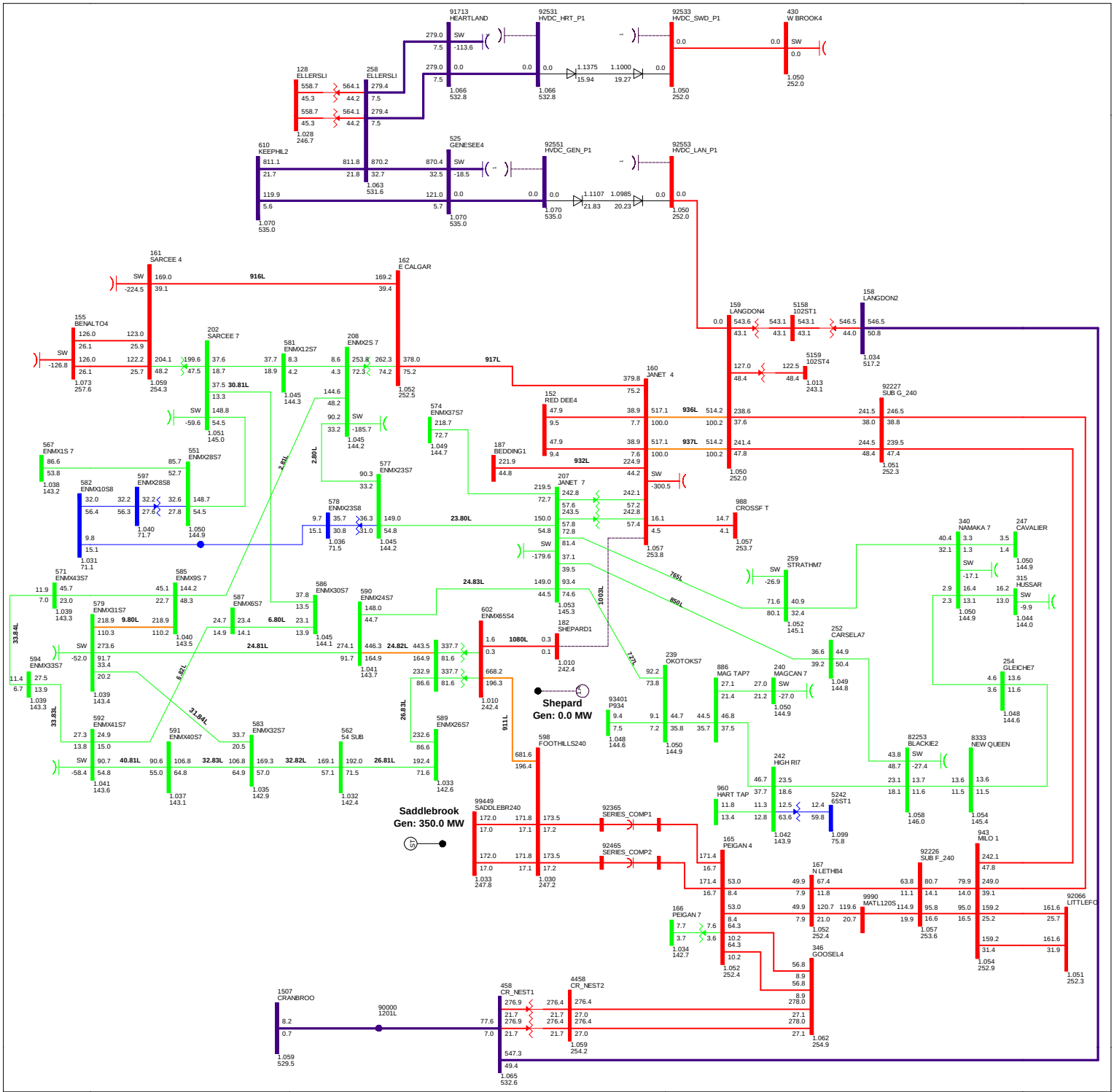
2012LTO EXISTING SYSTEM

FIG B-SC2-32: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SP_EXISTING_SC2

FRI, JUN 08 2012 15:39

2019 Loading Violations
Scenario 3


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
BCH Import: -0.9 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC3-1: BASECASE
2019_SP_EXISTING_SC3
FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

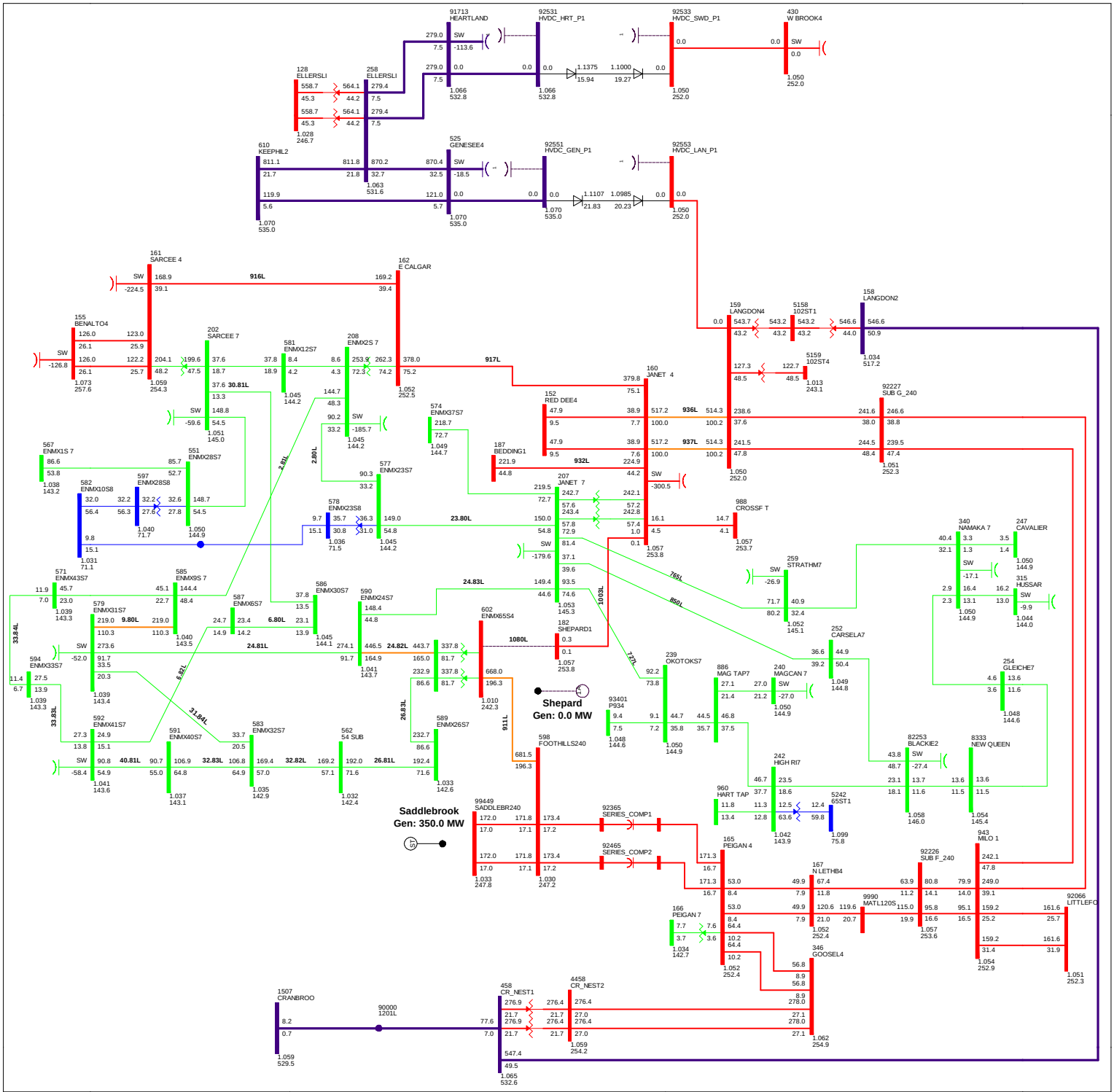
BCH Import: 1.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

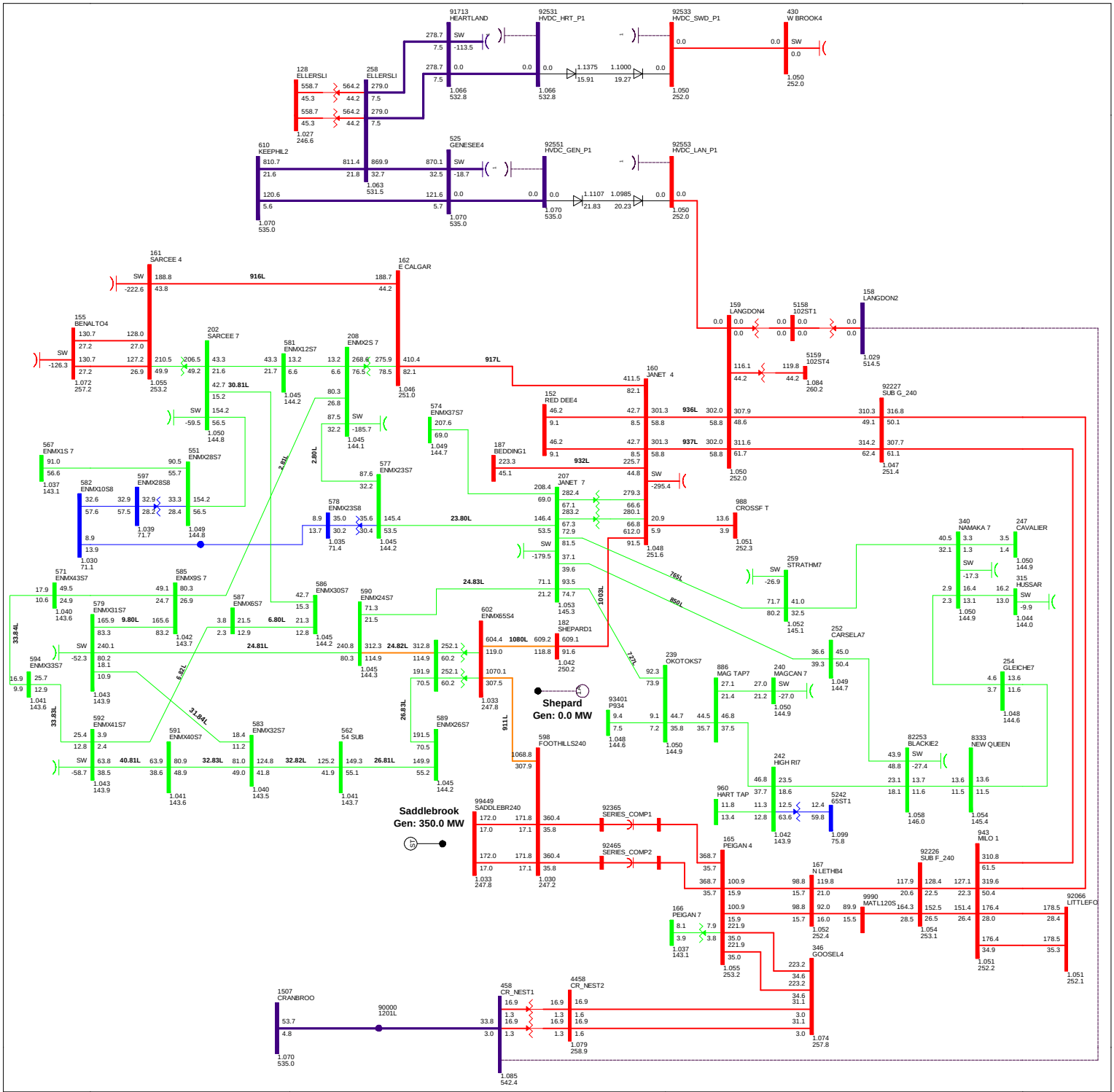
BCH Import: 1.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

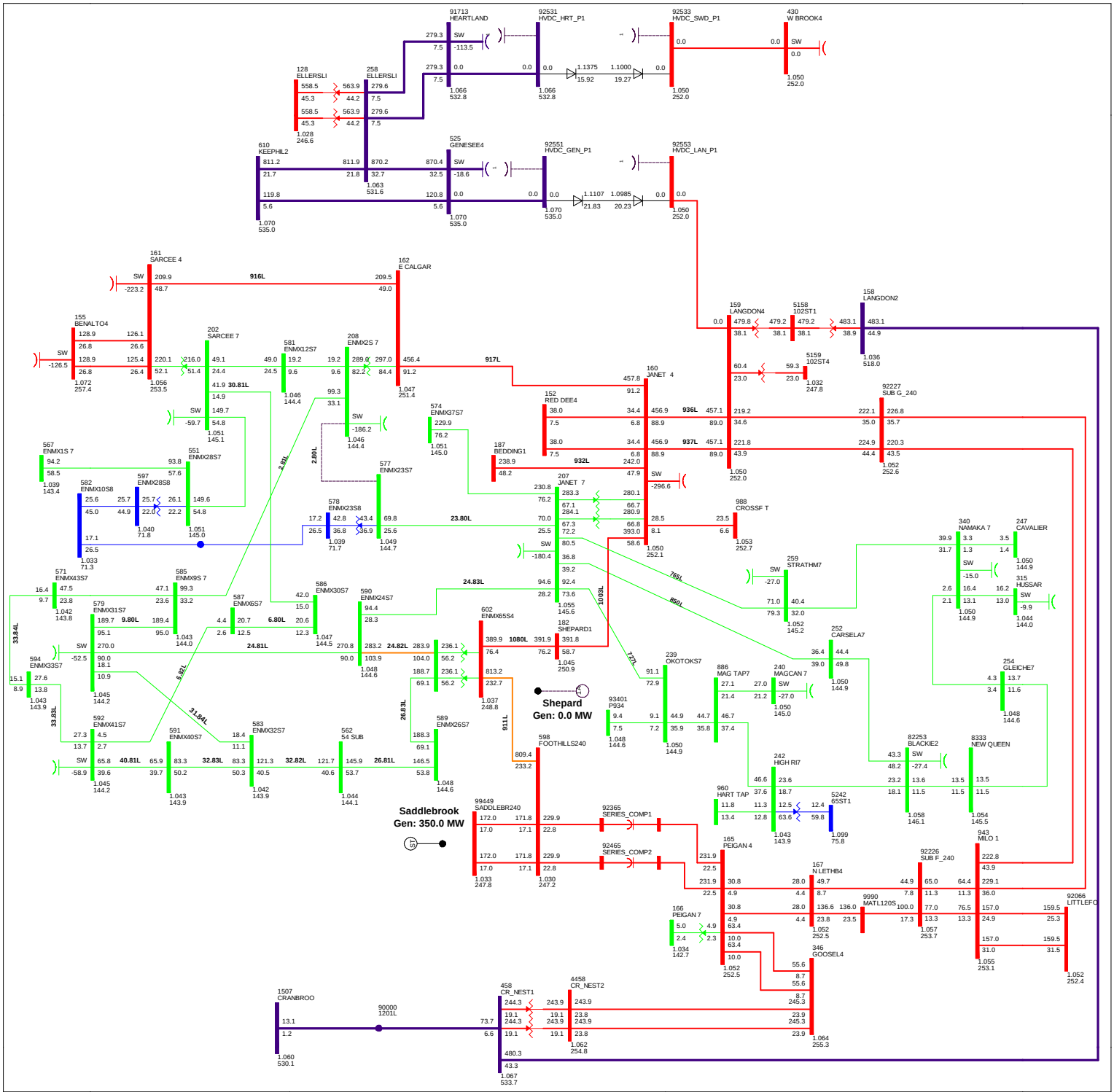
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 44.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

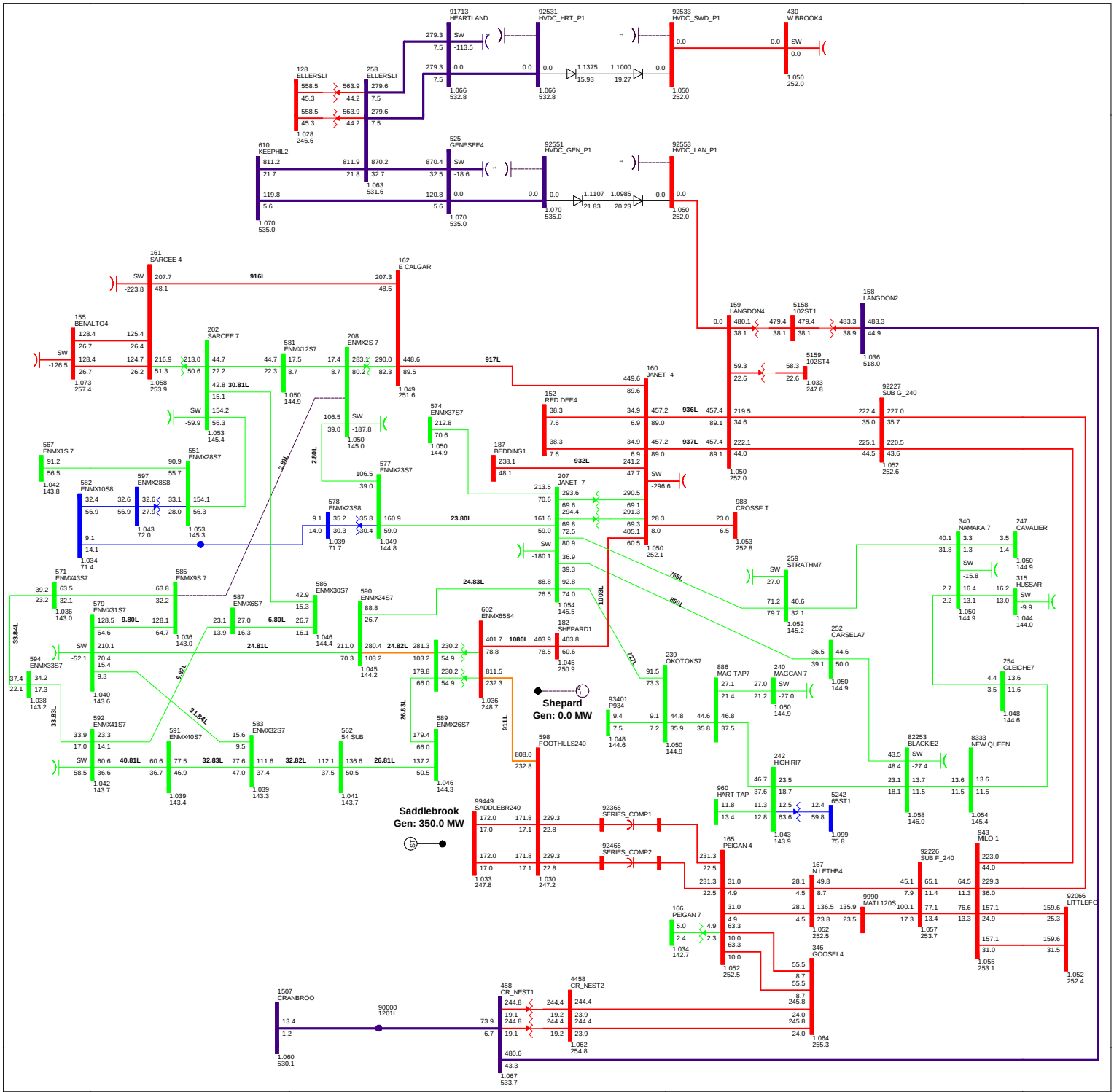
BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

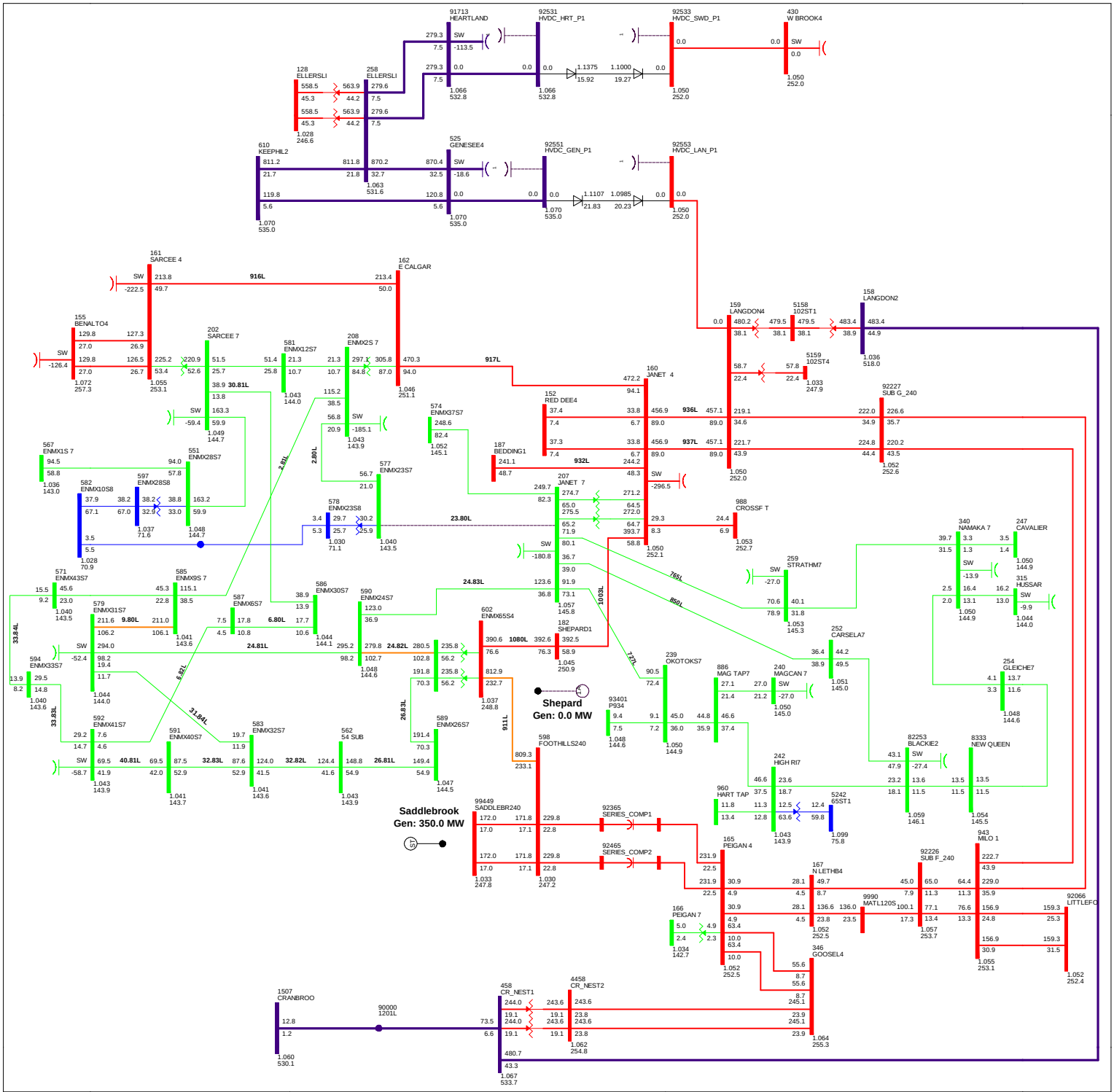
BCH Import: -0.8 MW

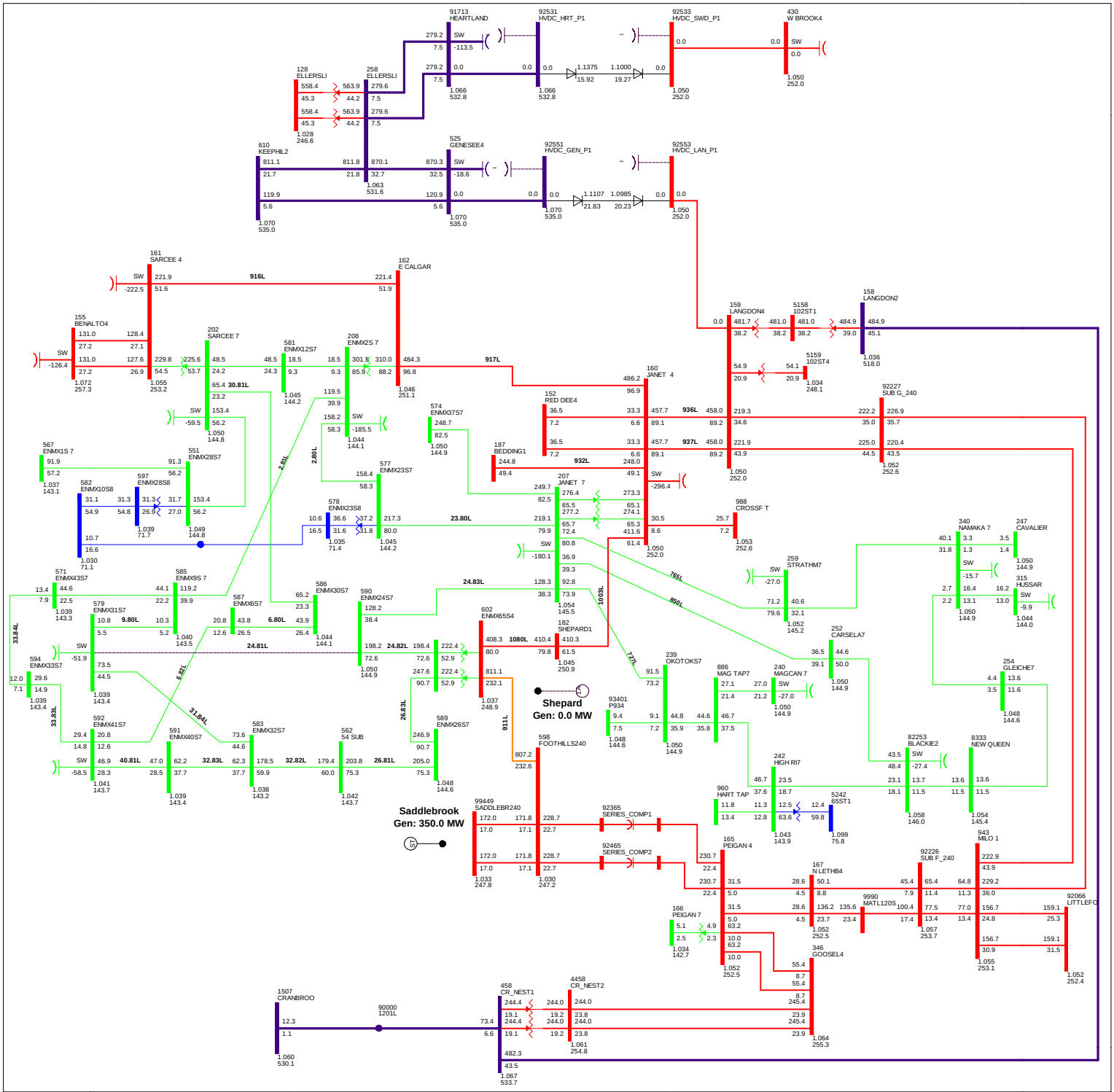
2012LTO EXISTING SYSTEM

FIG B-SC3-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
91713 HEARTLAND
92531 HVDC_HRT_P1
92533 HVDC_SWD_P1
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
610 KEEPHIL2
525 GENESEE4
92551 HVDC_GEN_P1
92553 HVDC_LAN_P1
161 SARCEE 4
162 E CALGAR
155 BENALTO4
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
574 ENMX37S7
187 BEDDING1
152 RED DEE4
160 JANET 4
159 LANGDON4
5158 102ST1
158 LANGDON2
5159 102ST4
92227 SUB G_240
567 ENMX1S 7
551 ENMX28S7
582 ENMX10S8
597 ENMX28S8
577 ENMX23S7
578 ENMX23S8
207 JANET 7
988 CROSSF T
259 STRATHM7
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
571 ENMX43S7
585 ENMX9S 7
579 ENMX31S7
587 ENMX6S7
586 ENMX30S7
590 ENMX24S7
602 ENMX65S4
182 SHEPARD1
239 OKOTOKS7
886 MAG TAP7
240 MAGCAN 7
252 CARSELA7
254 GLEICHE7
594 ENMX33S7
592 ENMX41S7
591 ENMX40S7
583 ENMX32S7
562 54 SUB
589 ENMX26S7
598 FOOTHILLS240
93401 P934
242 HIGH RI7
960 HART TAP
5242 65ST1
82253 BLACKIE2
8333 NEW QUEEN
99449 SADDLEBR240
92365 SERIES_COMP1
92465 SERIES_COMP2
165 PEIGAN 4
167 N LETHB4
92226 SUB F_240
943 MILO 1
166 PEIGAN 7
9990 MATL120S
92066 LITTLEFC
346 GOOSEL4
1507 CRANBROO
90000 1201L
458 CR_NEST1
4458 CR_NEST2
916L
917L
30.81L
24.83L
23.80L
24.81L
9.80L
6.80L
2.80L
33.84L
31.84L
32.83L
40.81L
32.82L
26.81L
911L
1080L
1003L
765L
850L
777L
BCH Import: 1.3 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC3-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_SP_EXISTING_SC3
FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

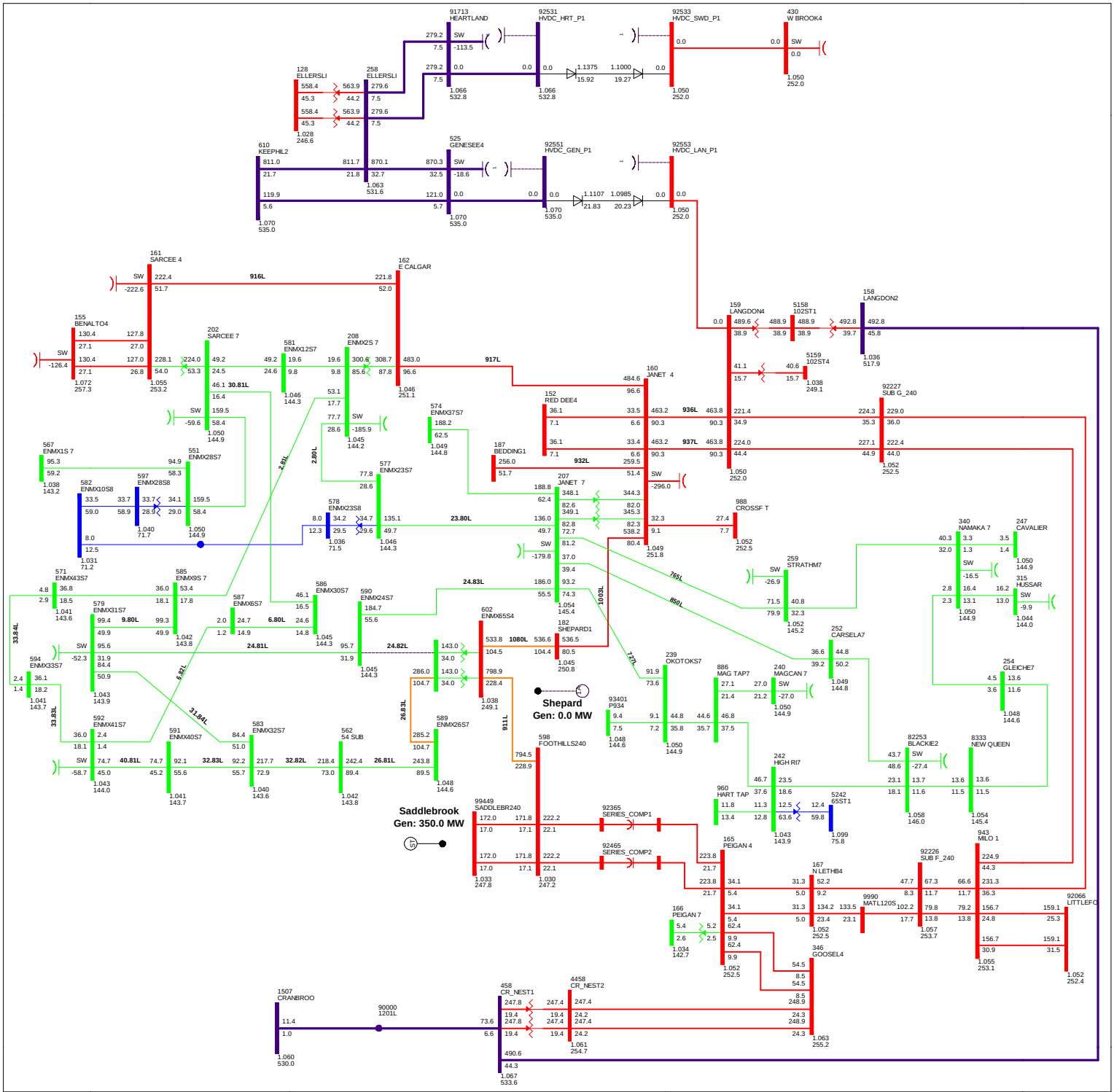
BCH Import: 2.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

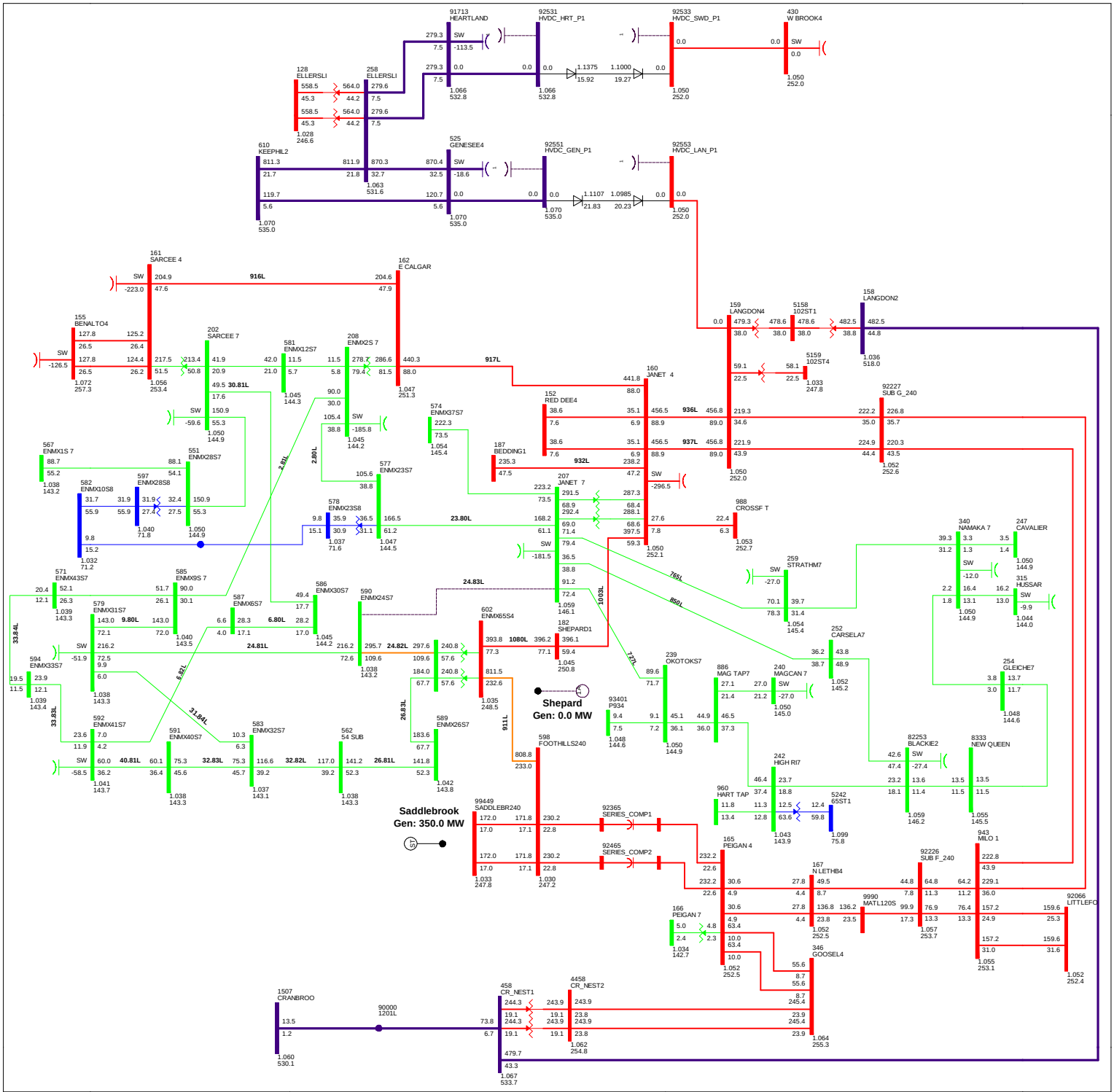
BCH Import: 4.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

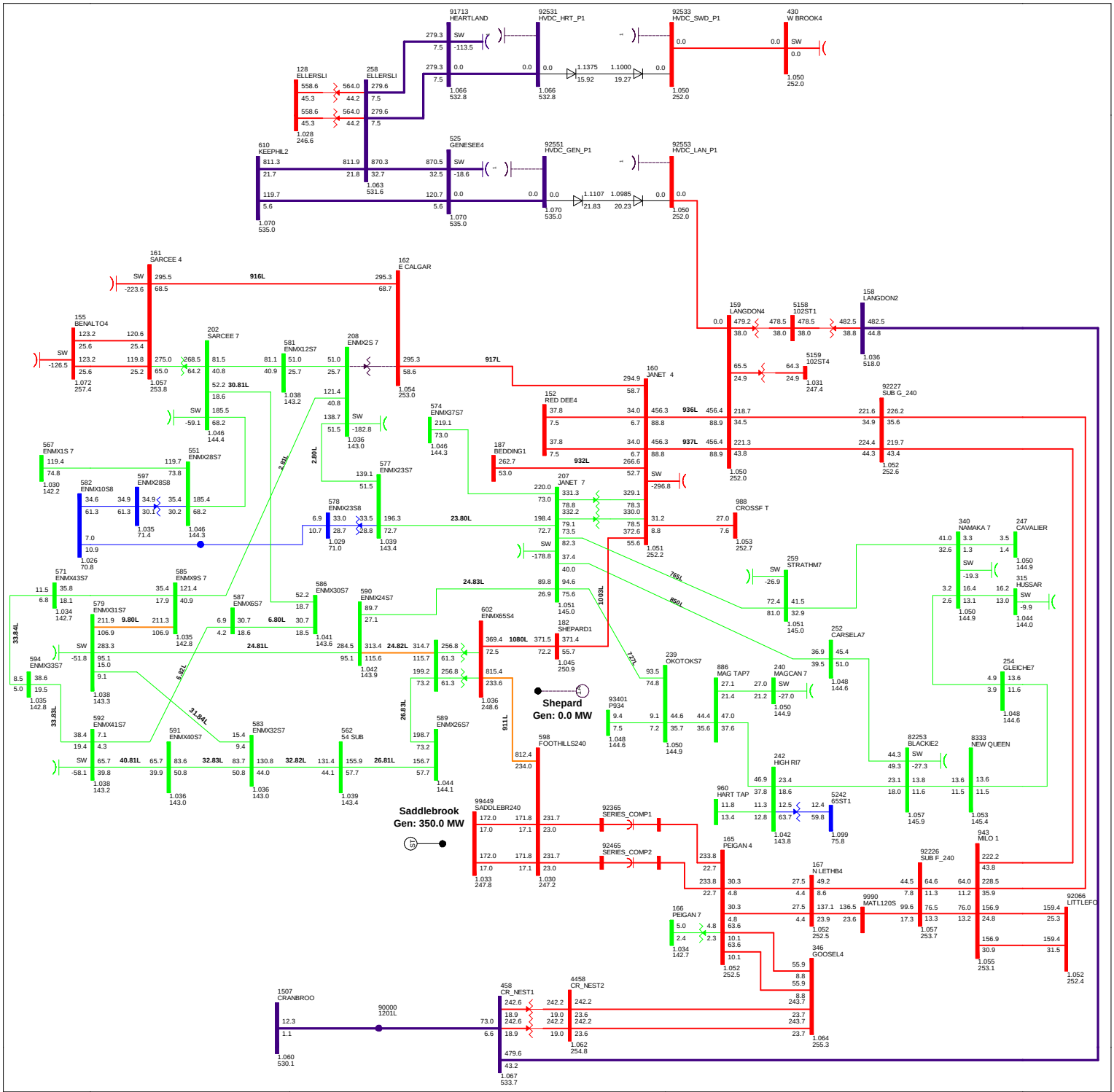
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

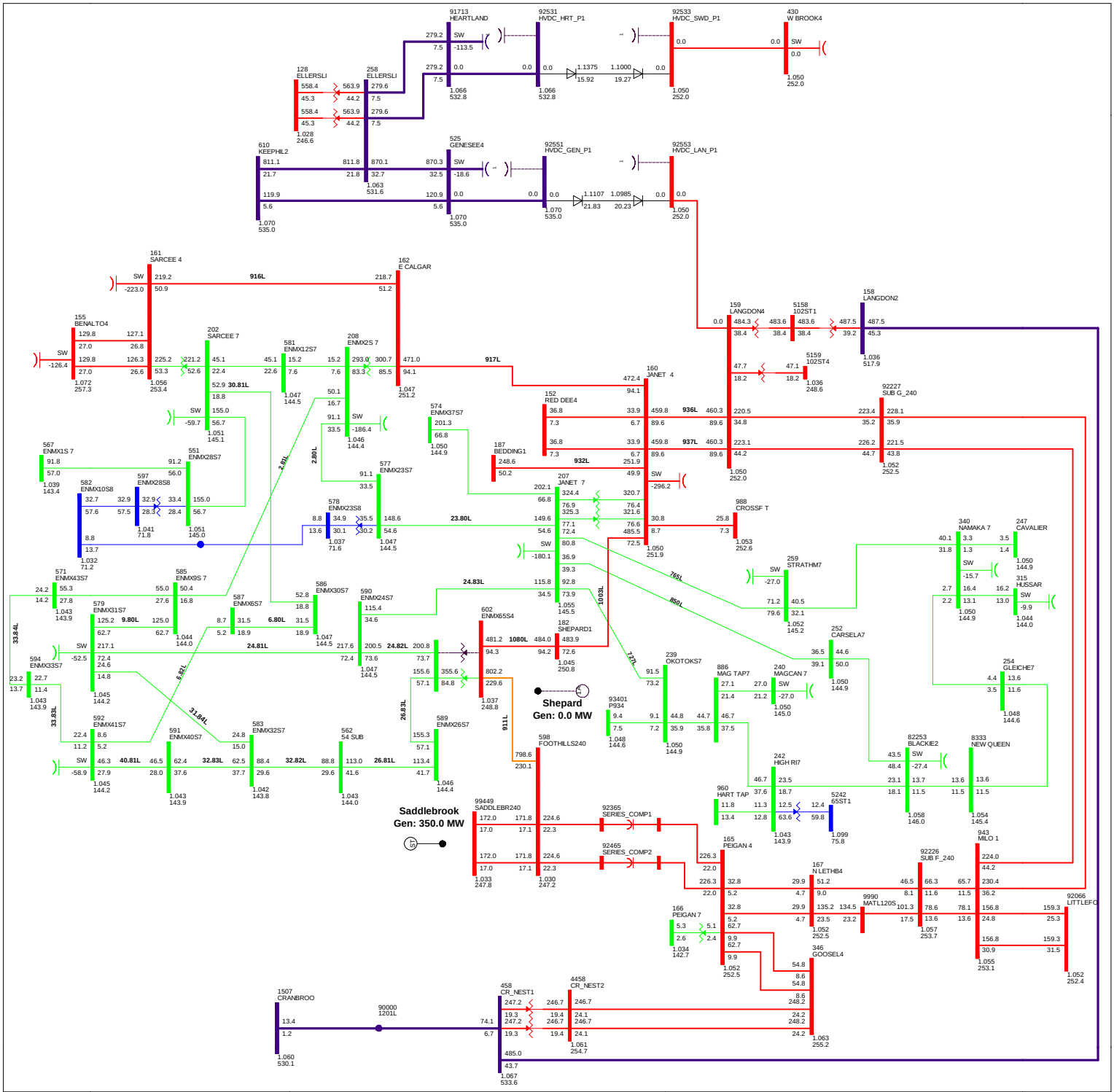
BCH Import: 3.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

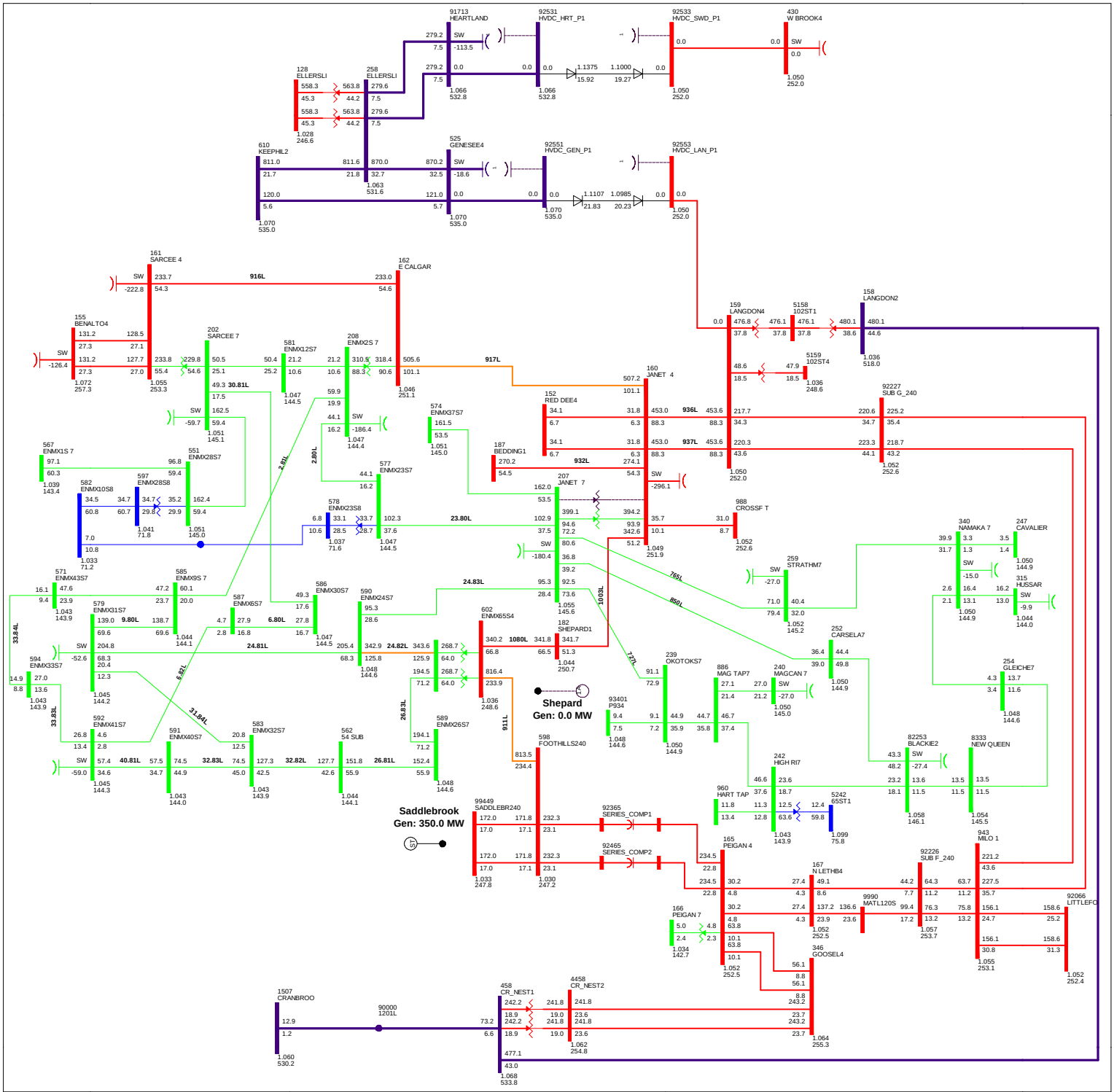
BCH Import: -0.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

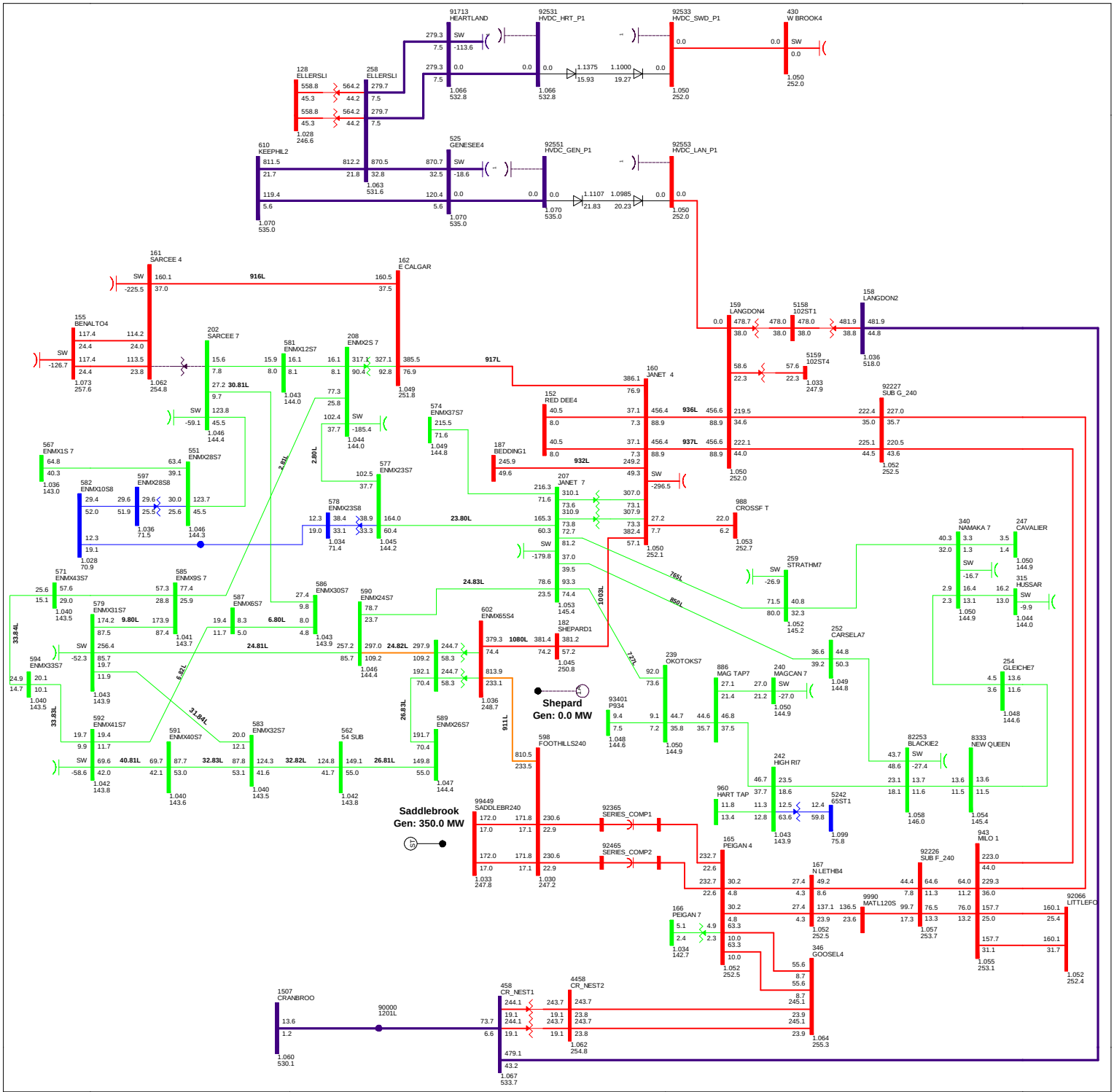
BCH Import: 2.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

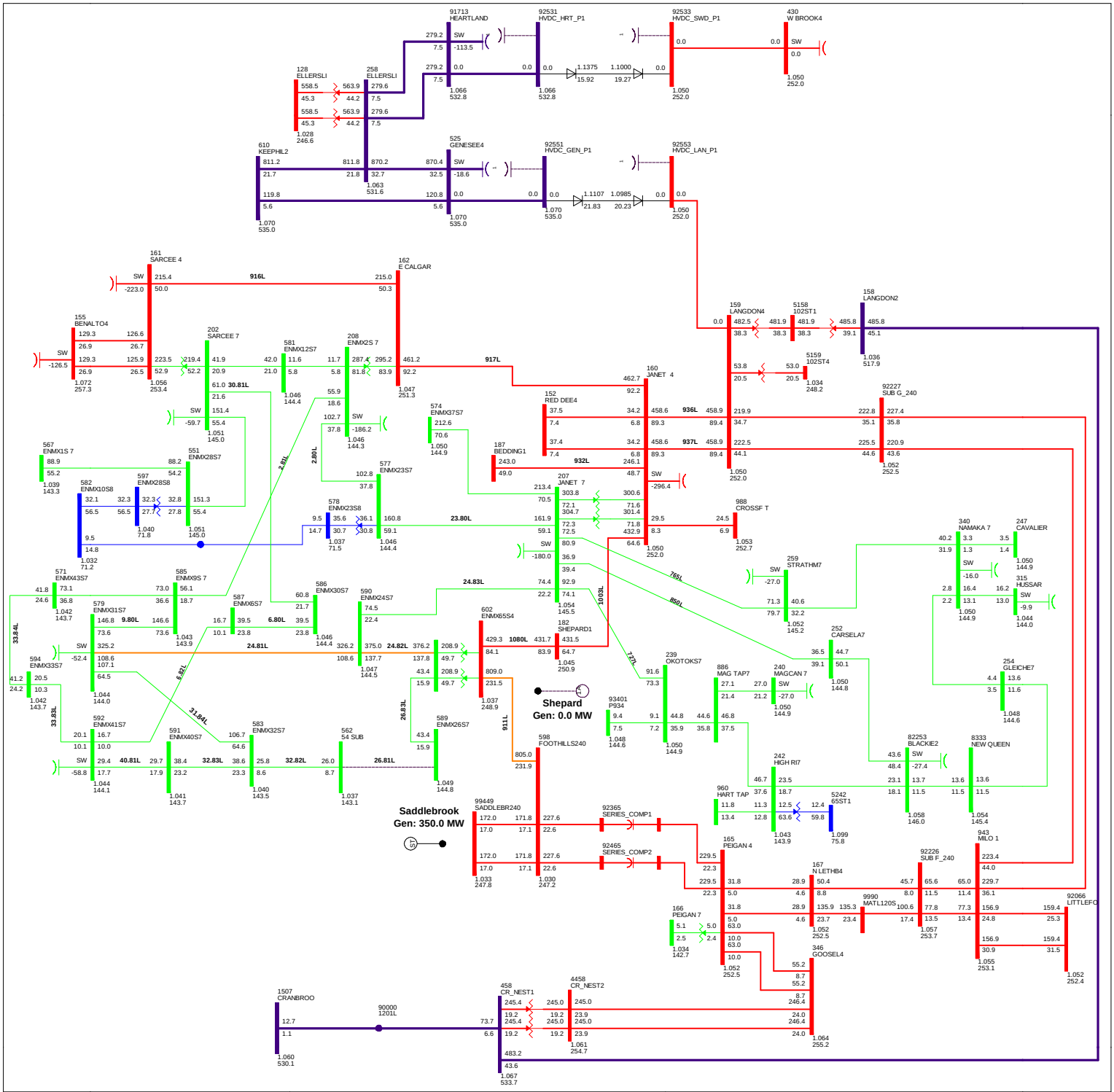
BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

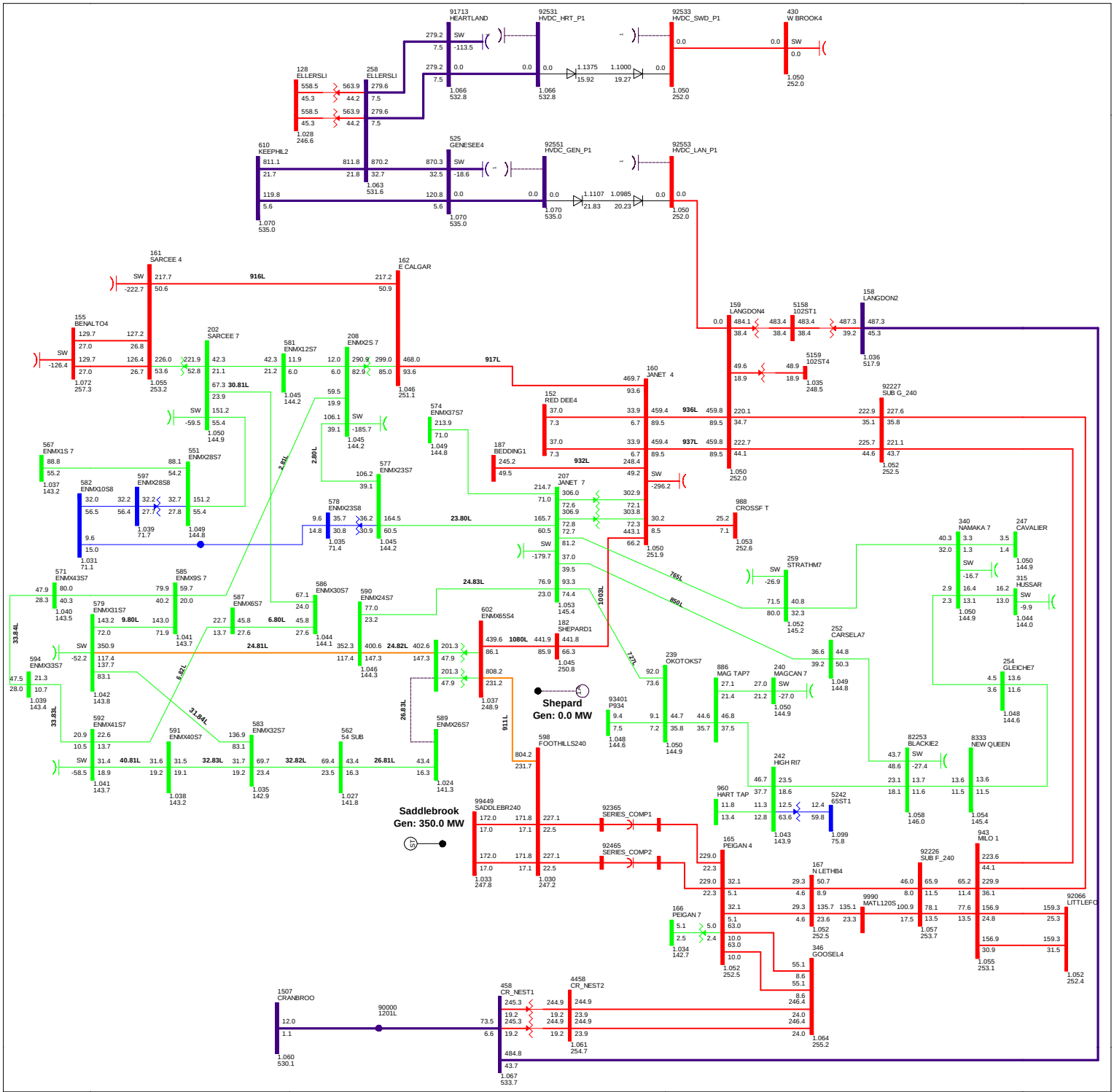
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

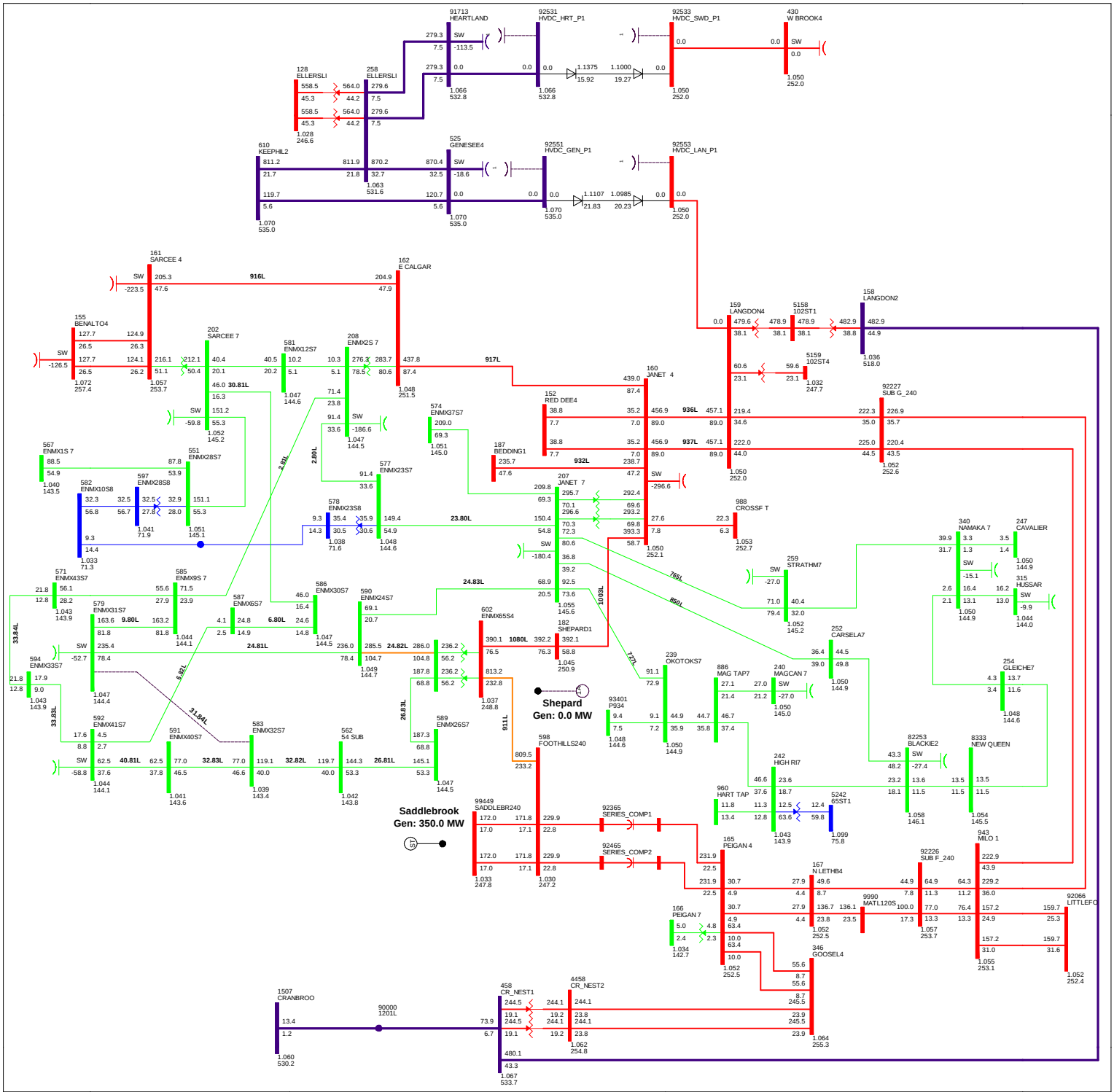
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

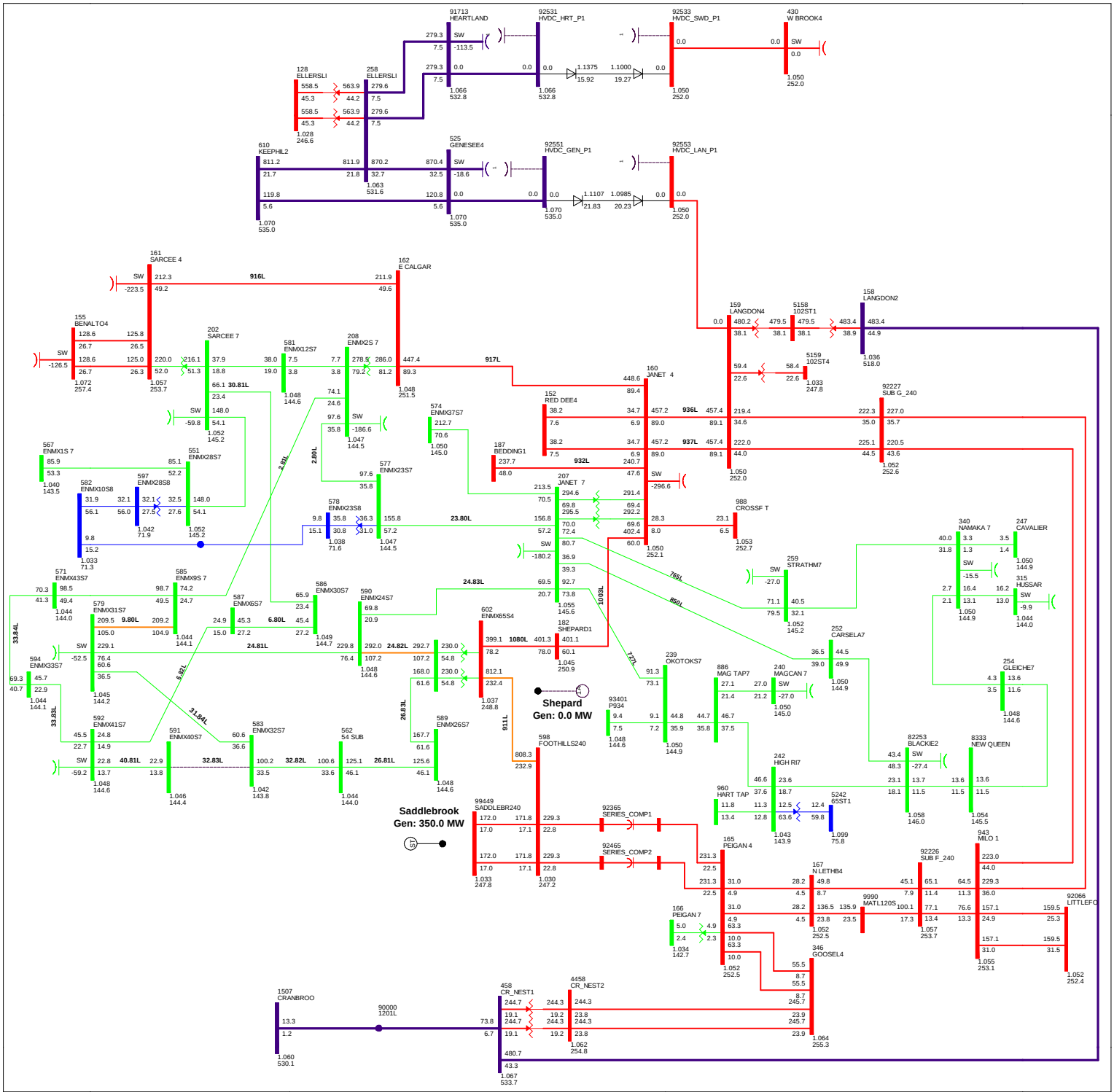
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-17: OPEN 31.84L 138 KV LINE (ENMAX 31 TO ENMAX 32)
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

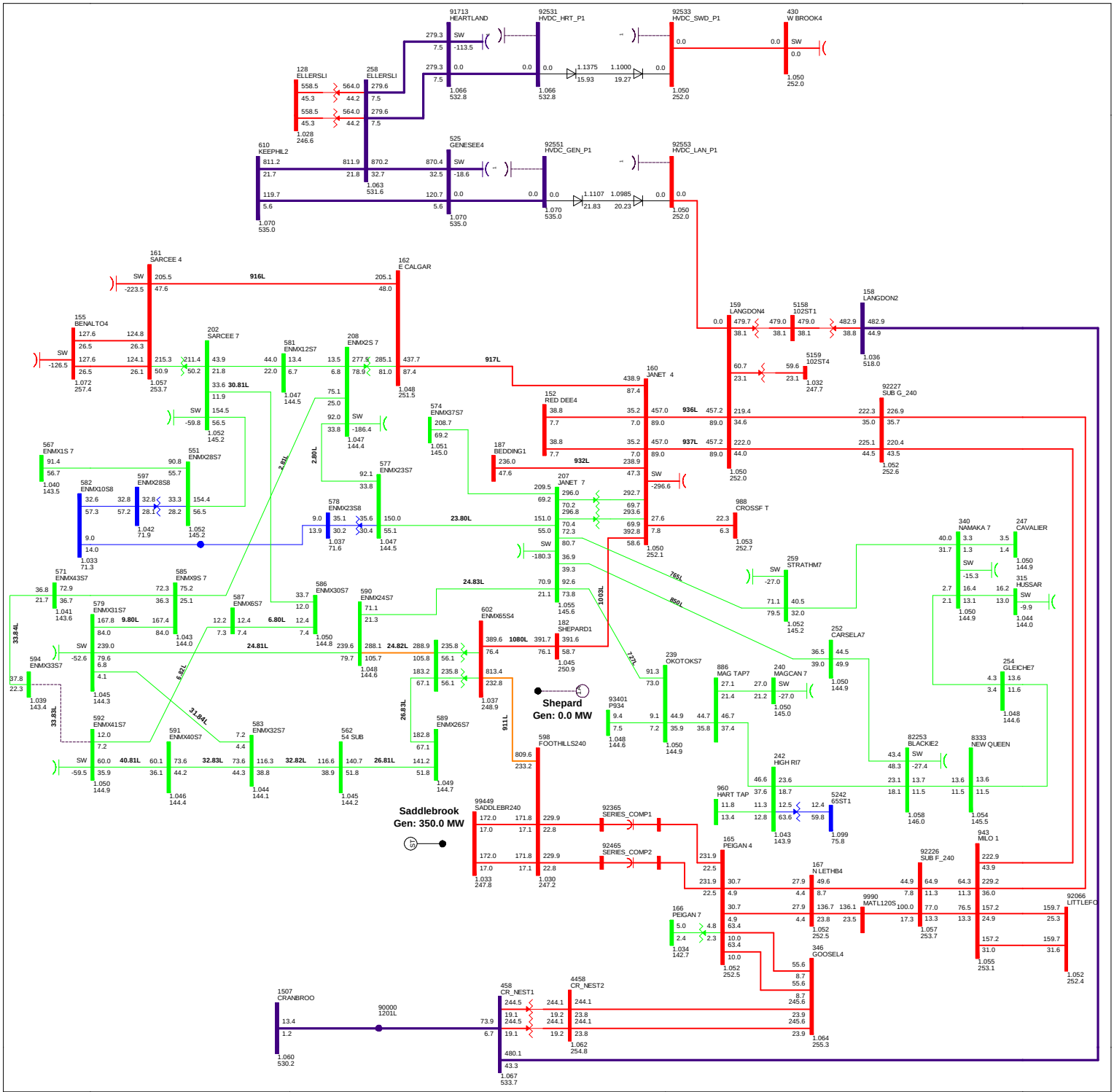
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-18: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

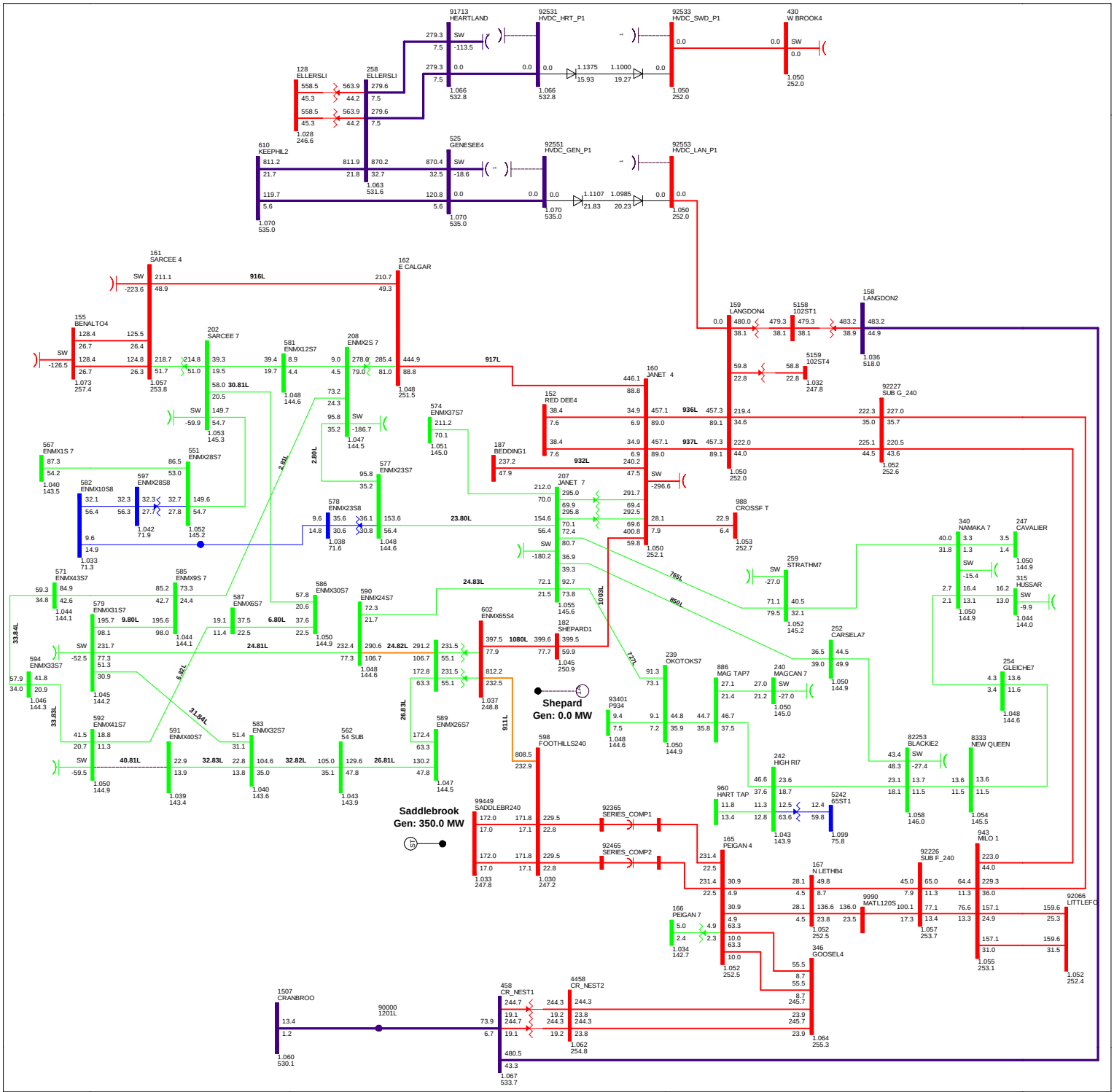
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-19: OPEN 33.83L 138 KV LINE (ENMAX 41 TO ENMAX 33)
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



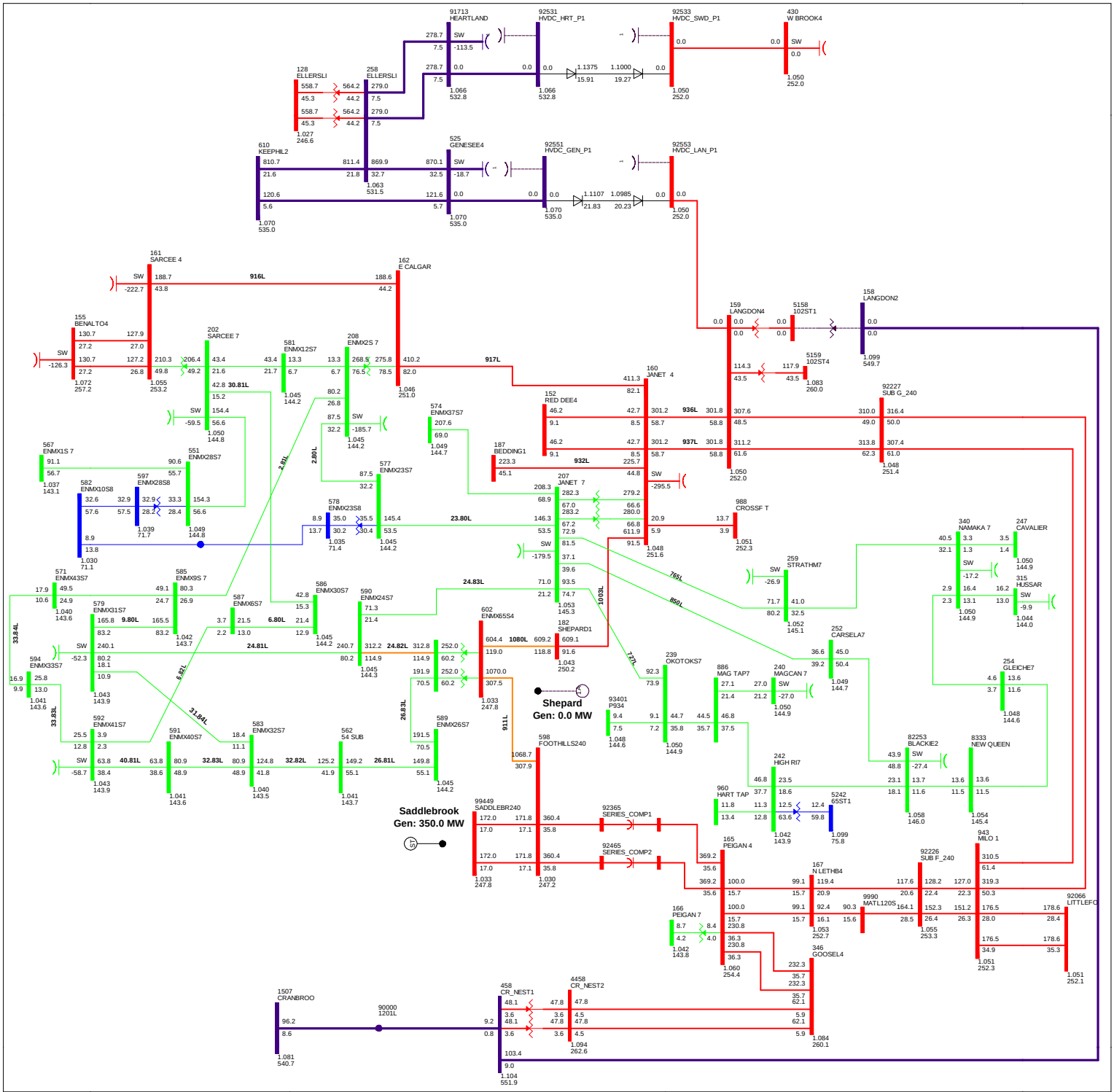
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

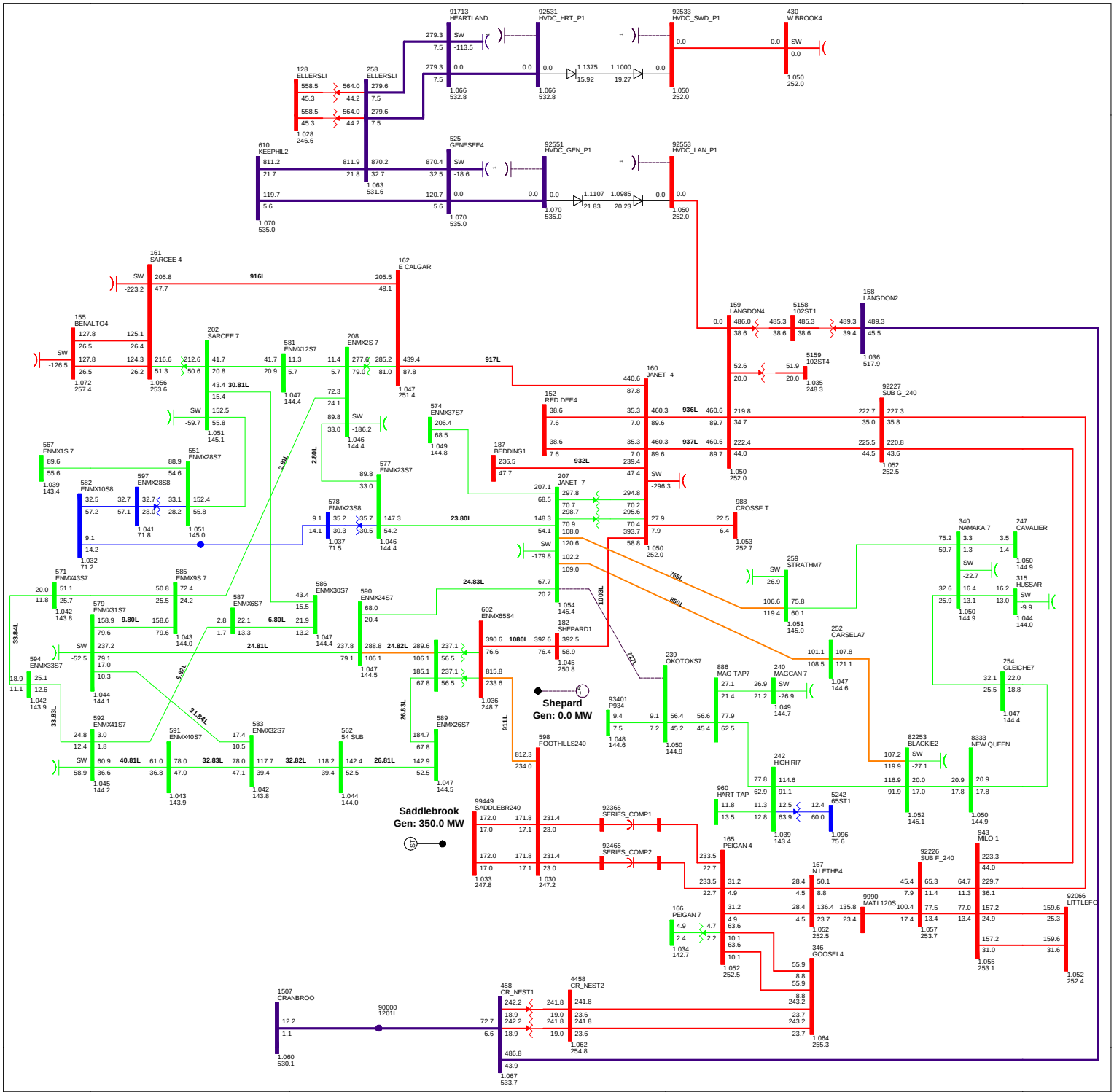
BCH Import: -0.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-20: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
BCH Import: 44.4 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC3-21: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)
2019_SP_EXISTING_SC3
FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

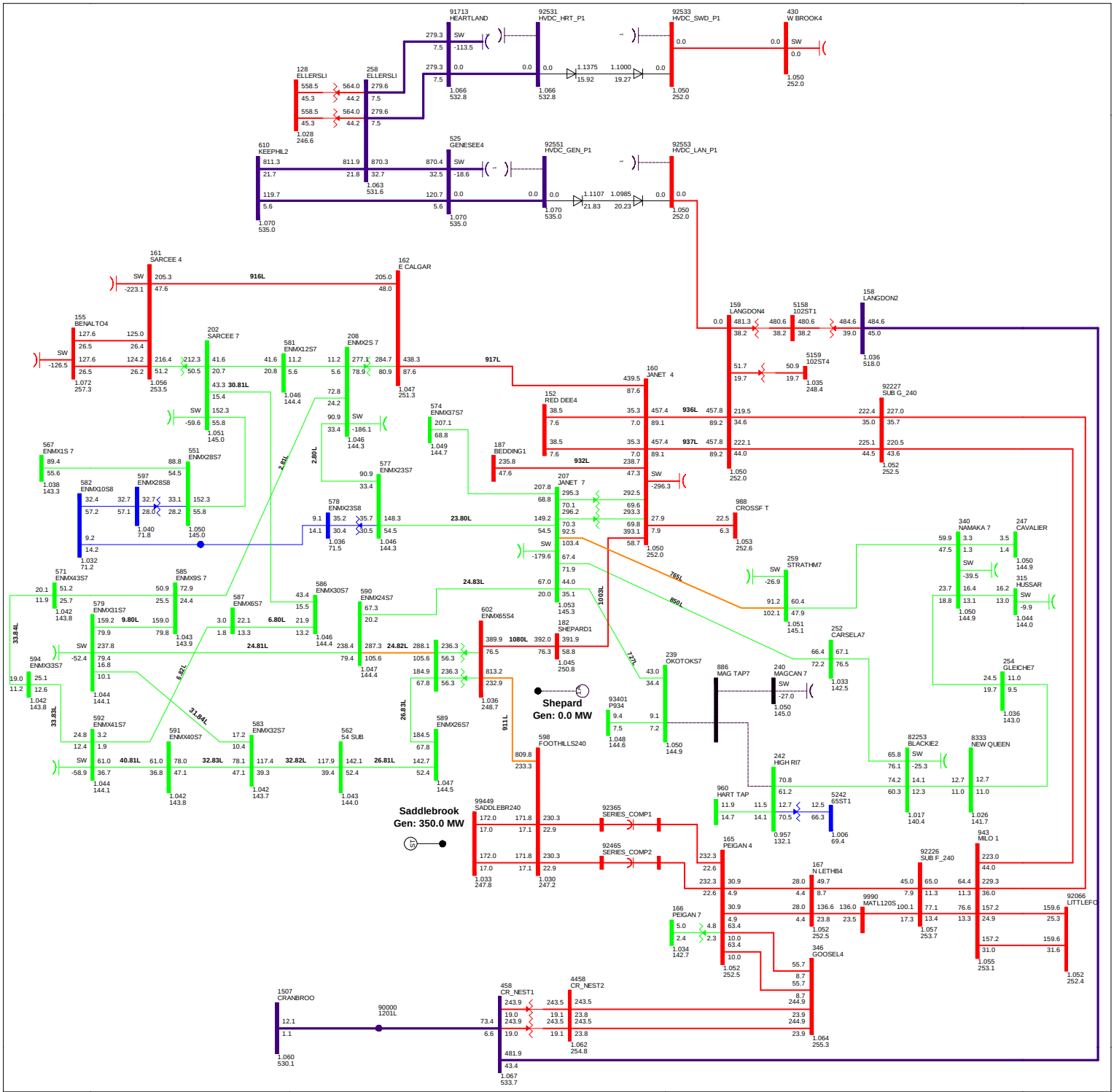
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 11.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-22: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

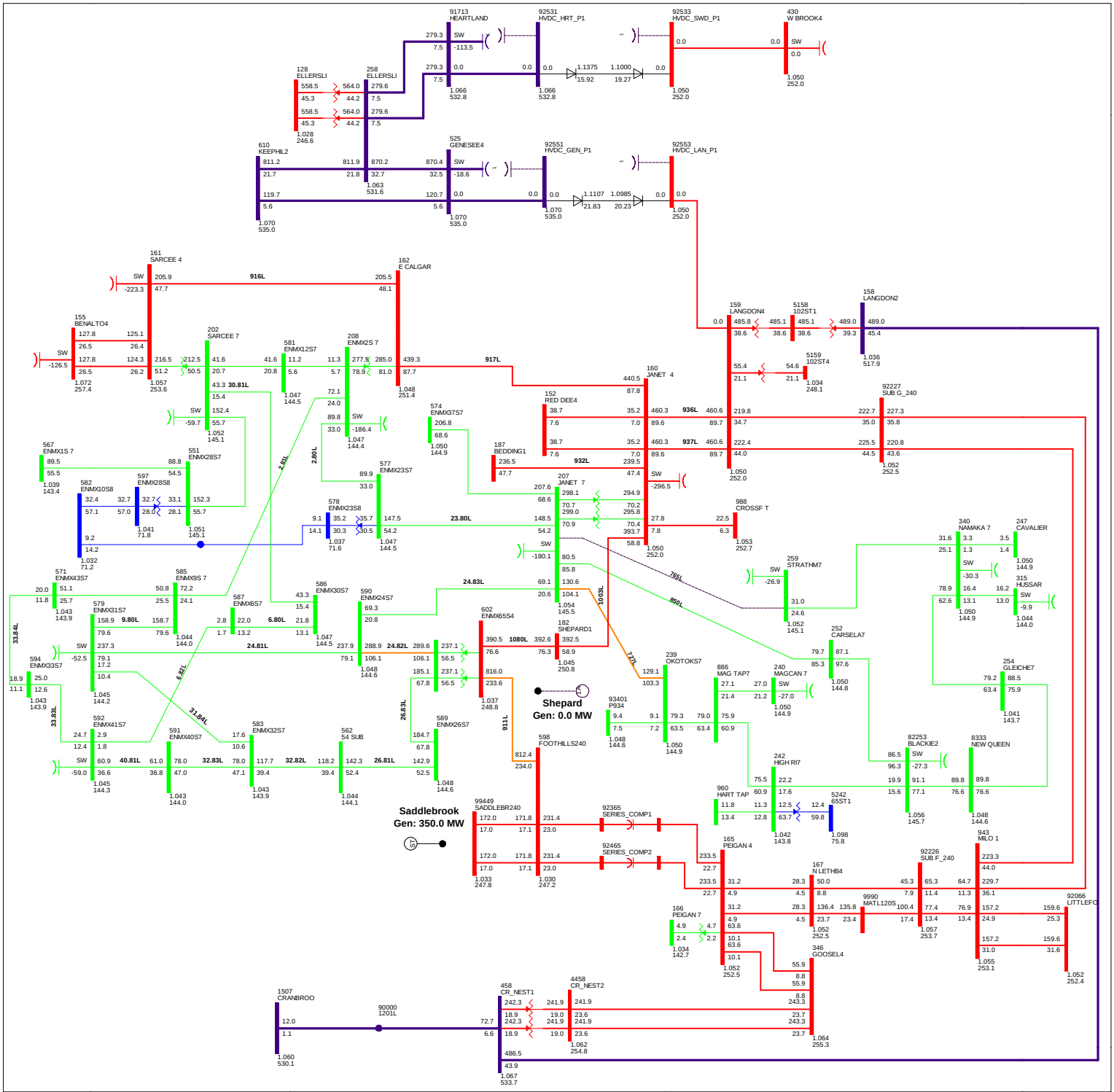
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-23: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



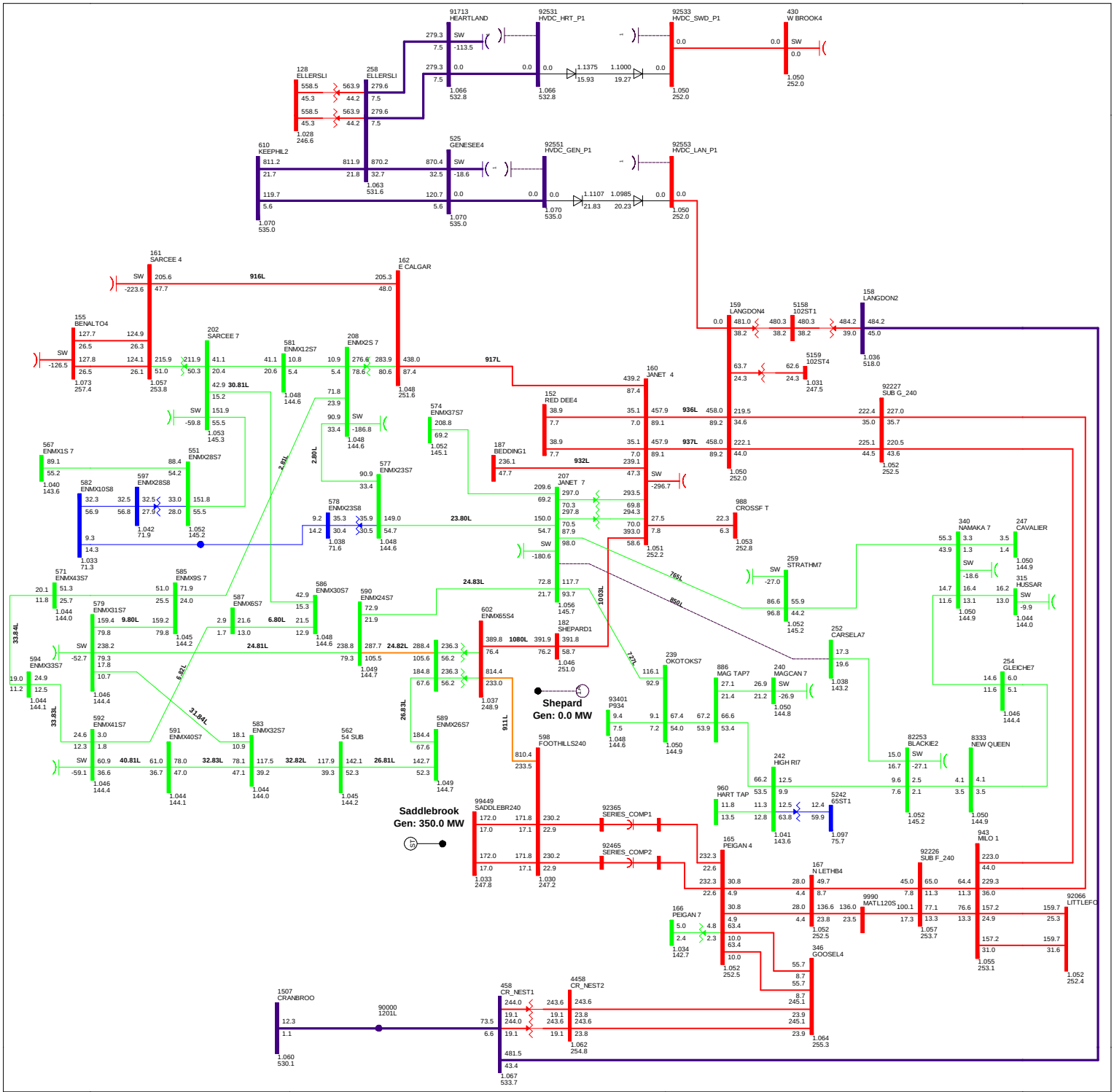
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 10.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-24: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

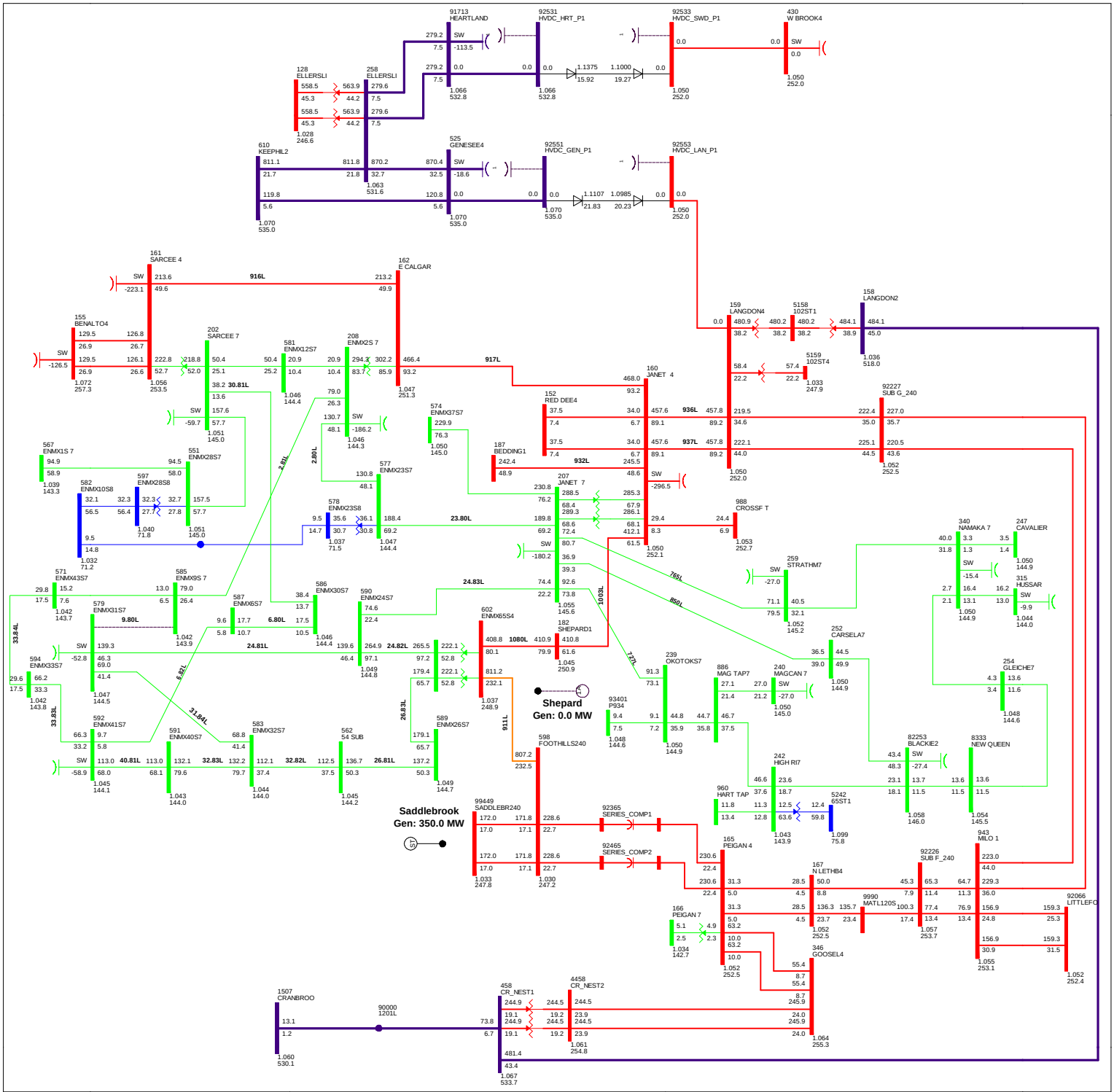
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-25: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

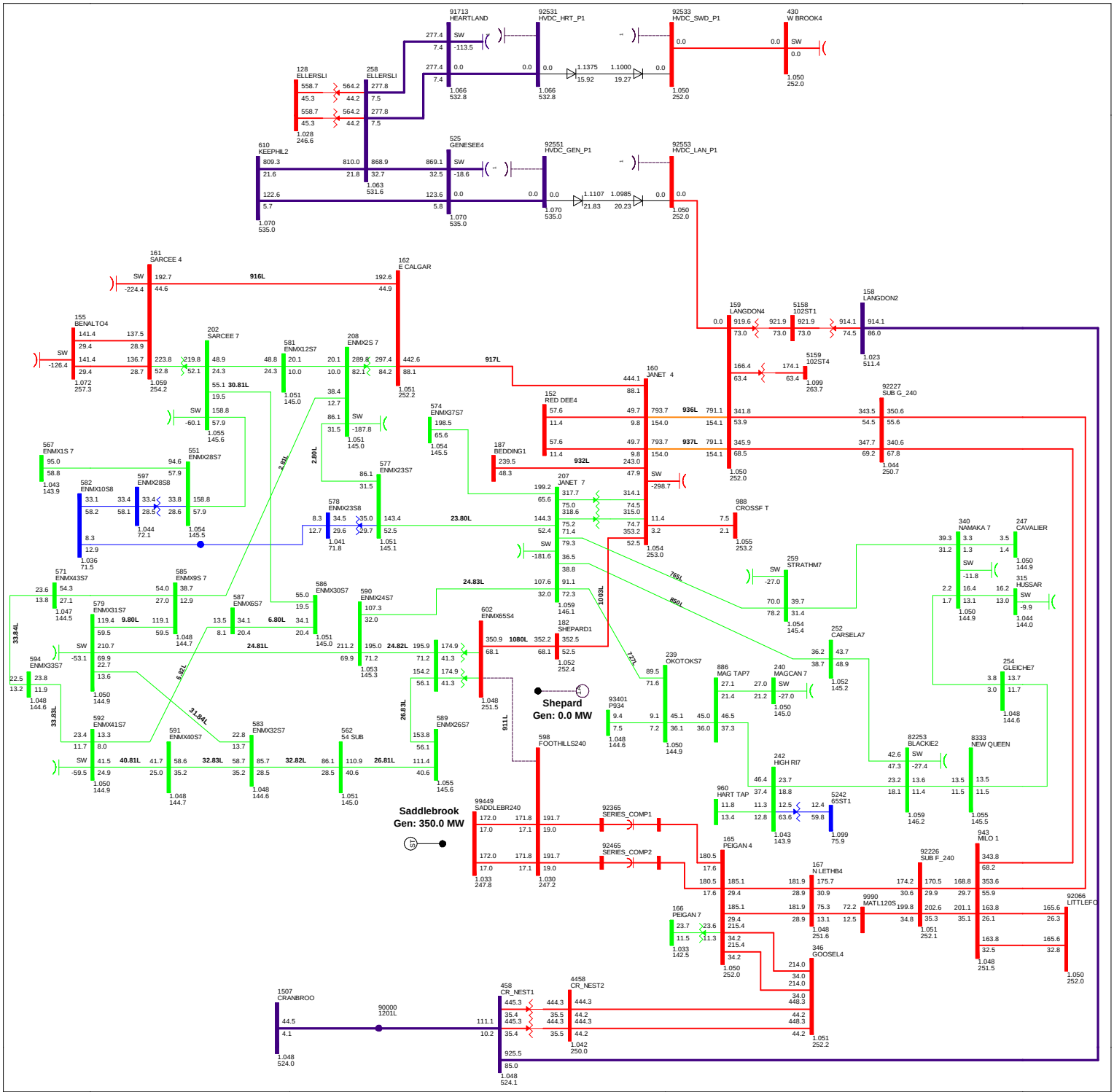
BCH Import: 0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-26: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



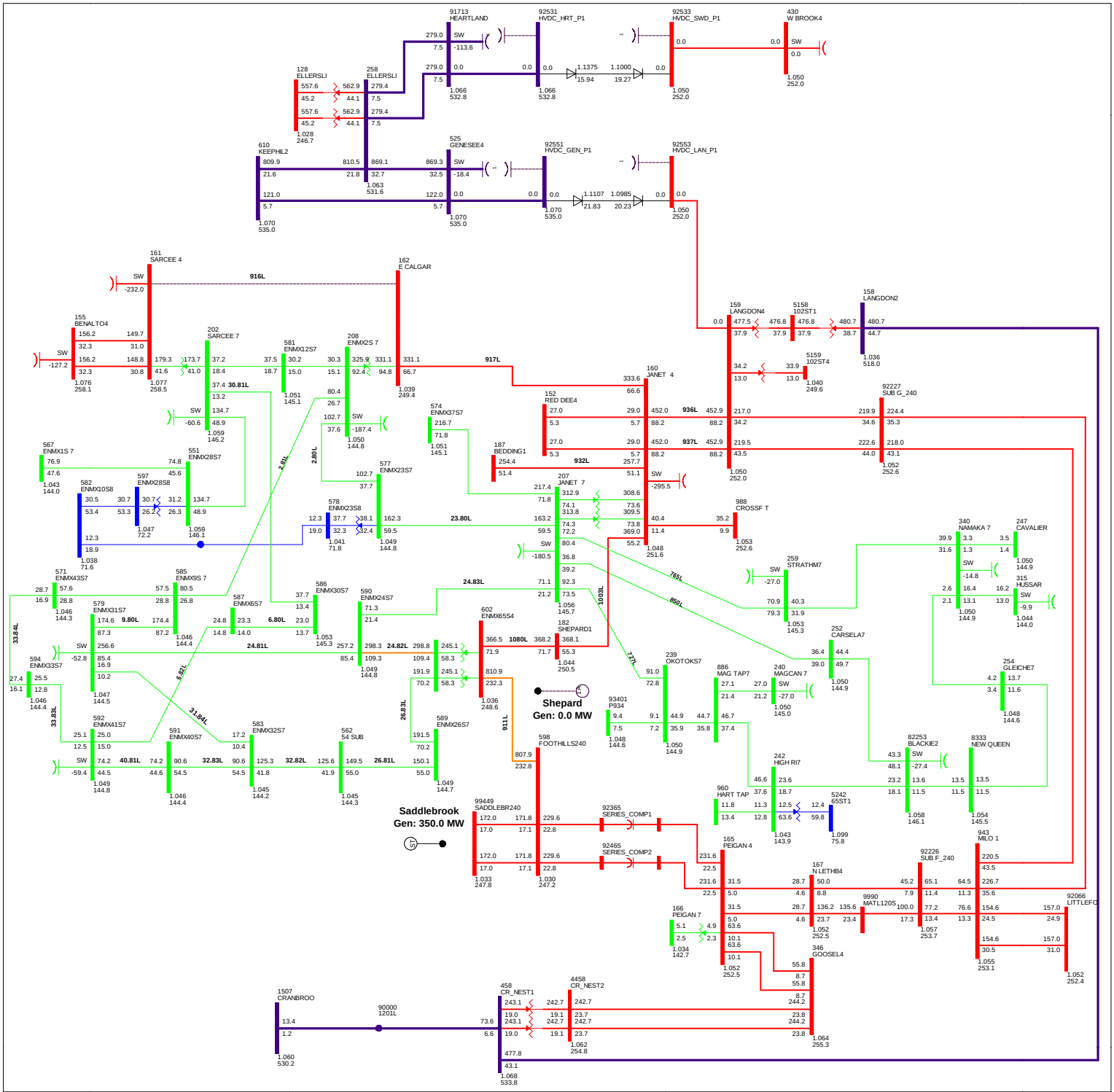
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 48.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-27: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX 2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

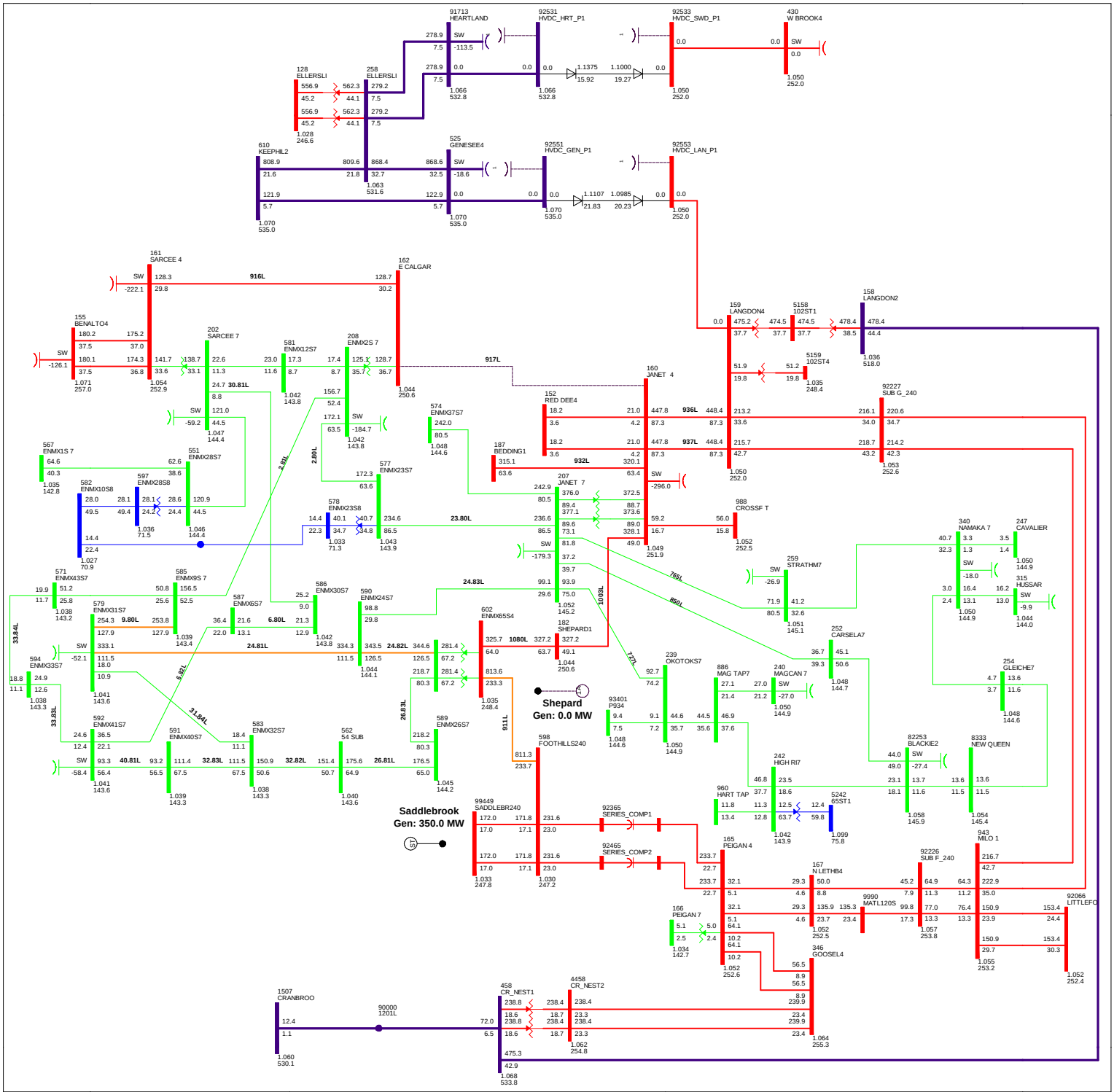
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

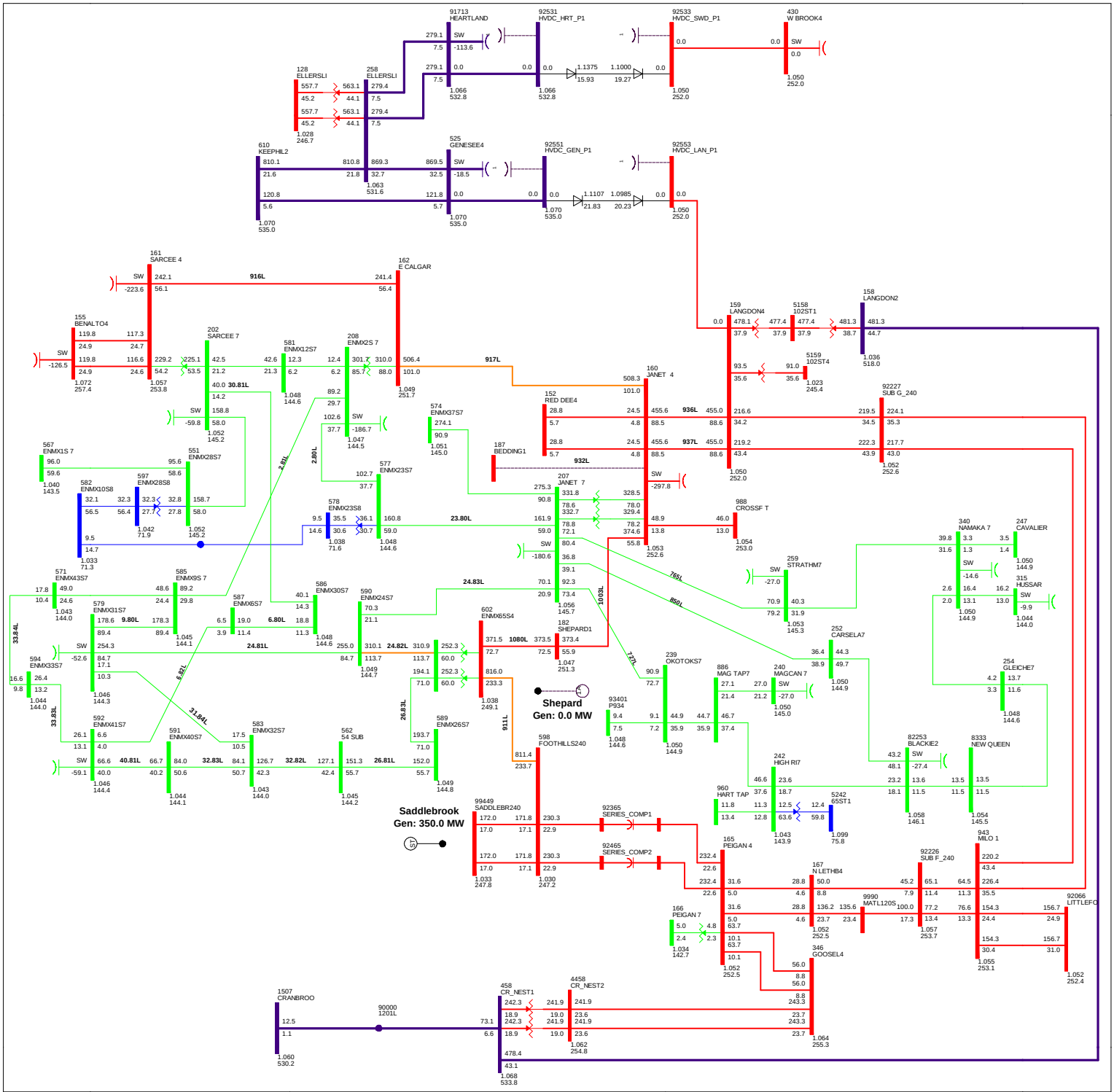
BCH Import: 0.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-28: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
BCH Import: 10.3 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO EXISTING SYSTEM
FIG B-SC3-29: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2019_SP_EXISTING_SC3
FRI, JUN 08 2012 15:41



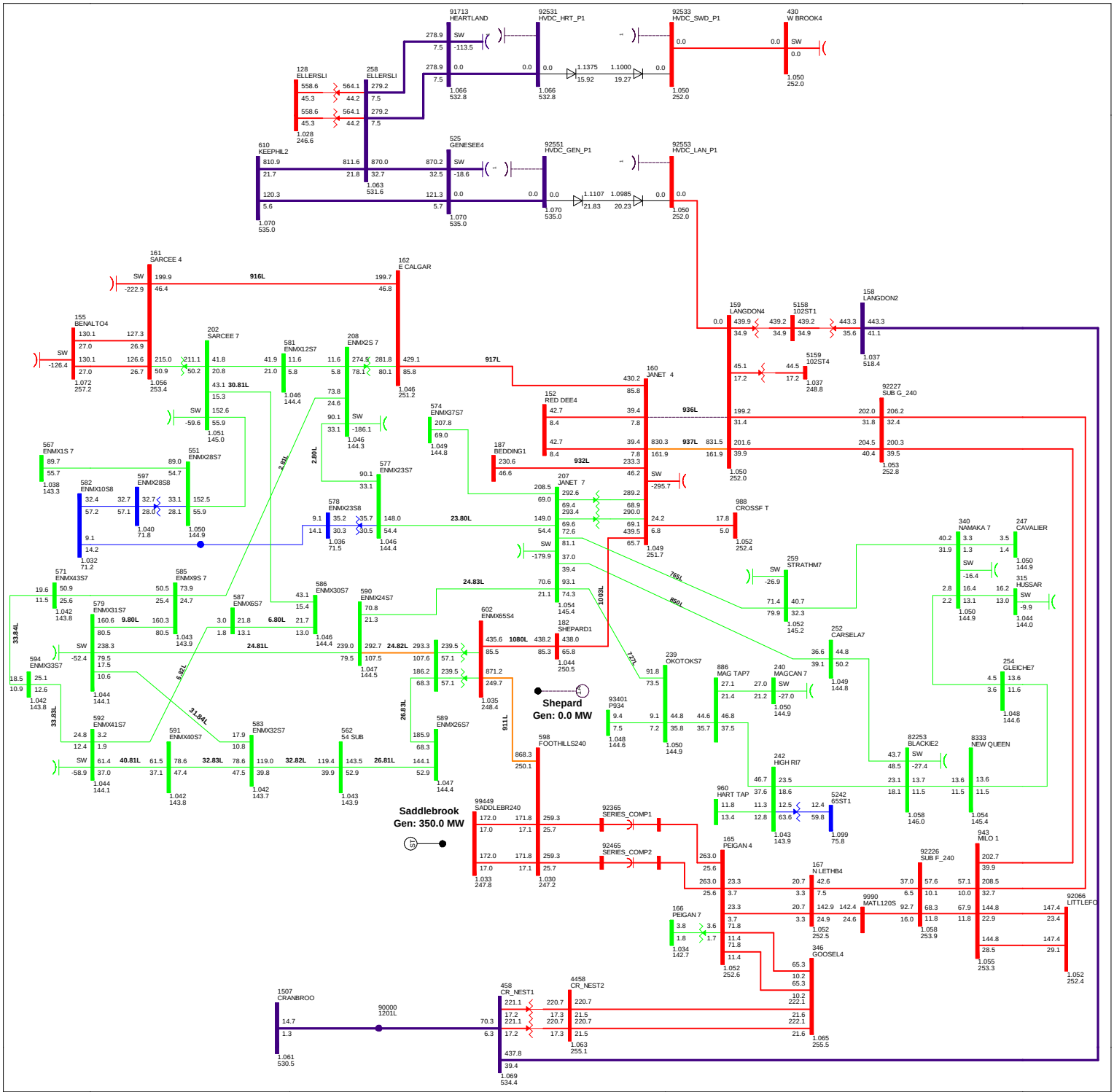
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-30: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



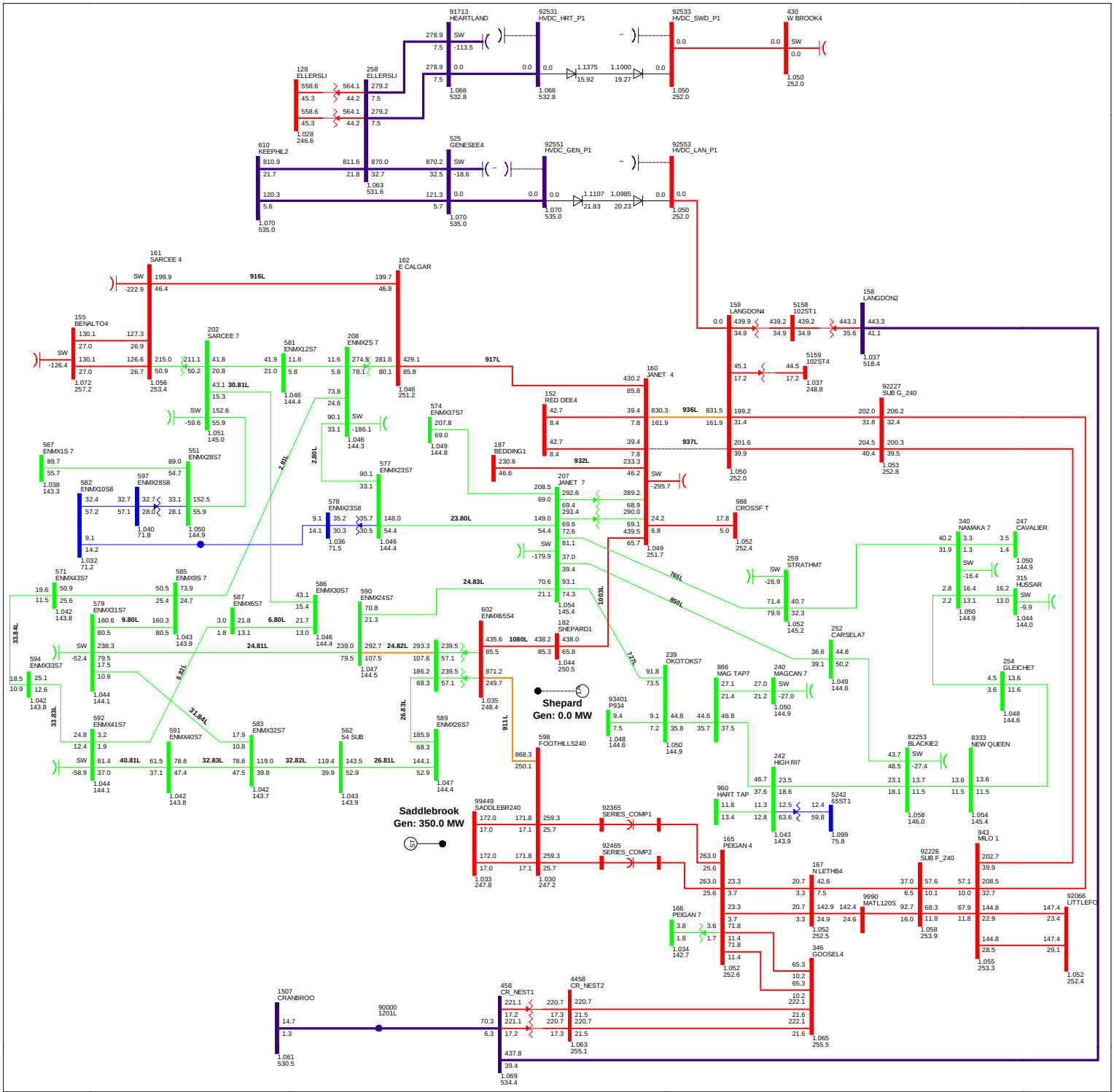
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 7.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-31: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

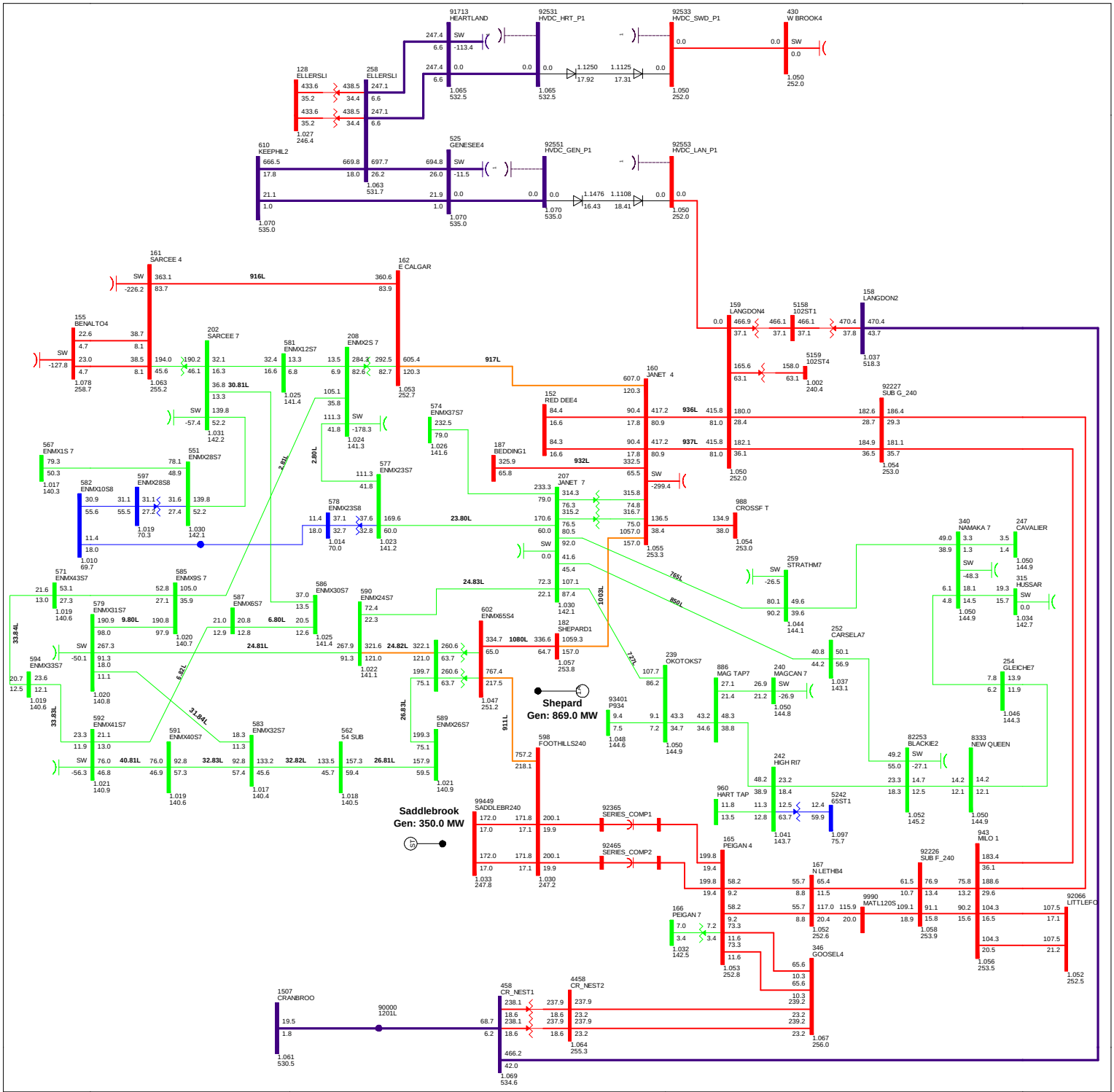
BCH Import: 7.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC3-32: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SP_EXISTING_SC3

FRI, JUN 08 2012 15:41

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

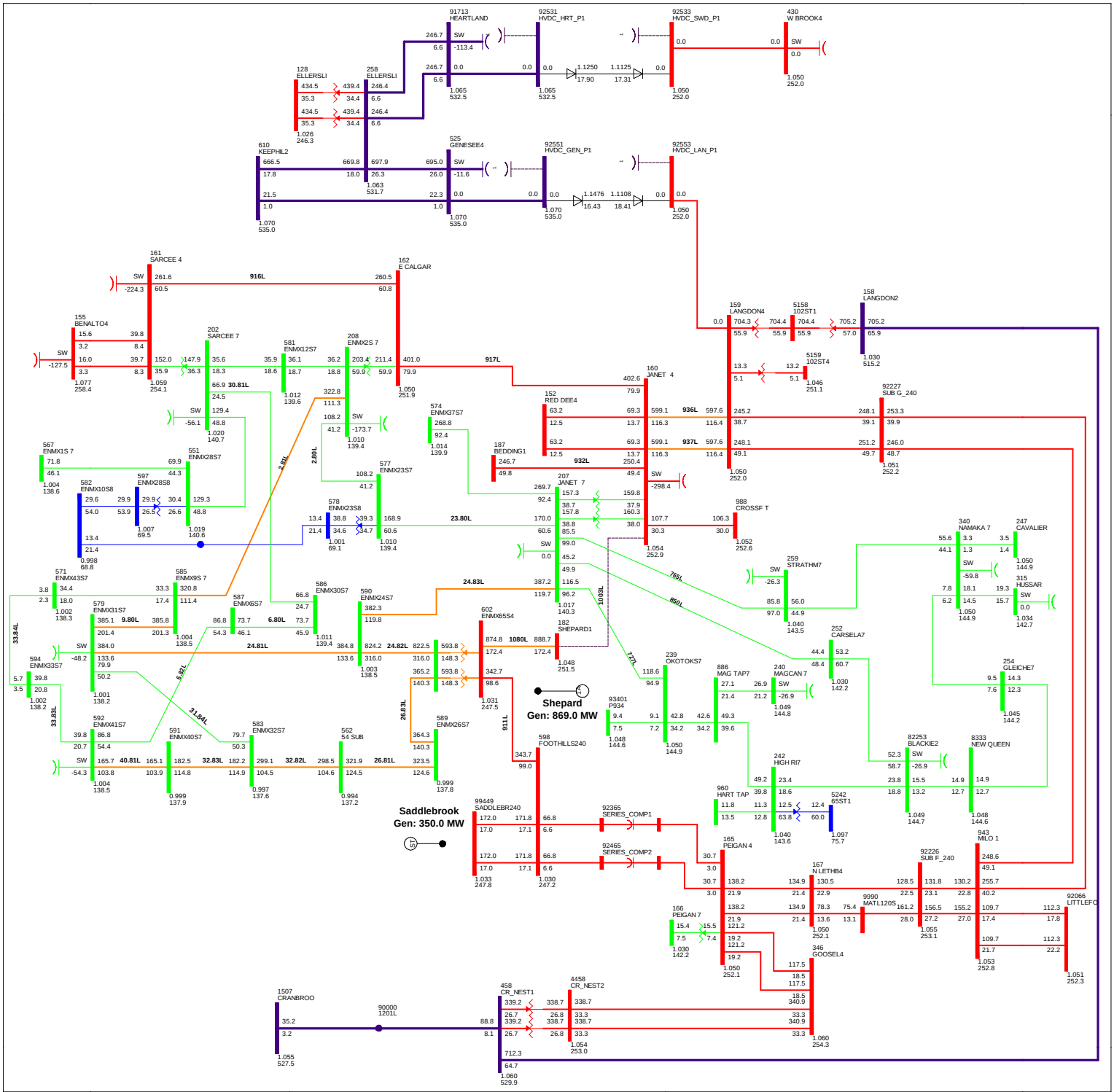
BCH Import: -0.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-1: BASECASE

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

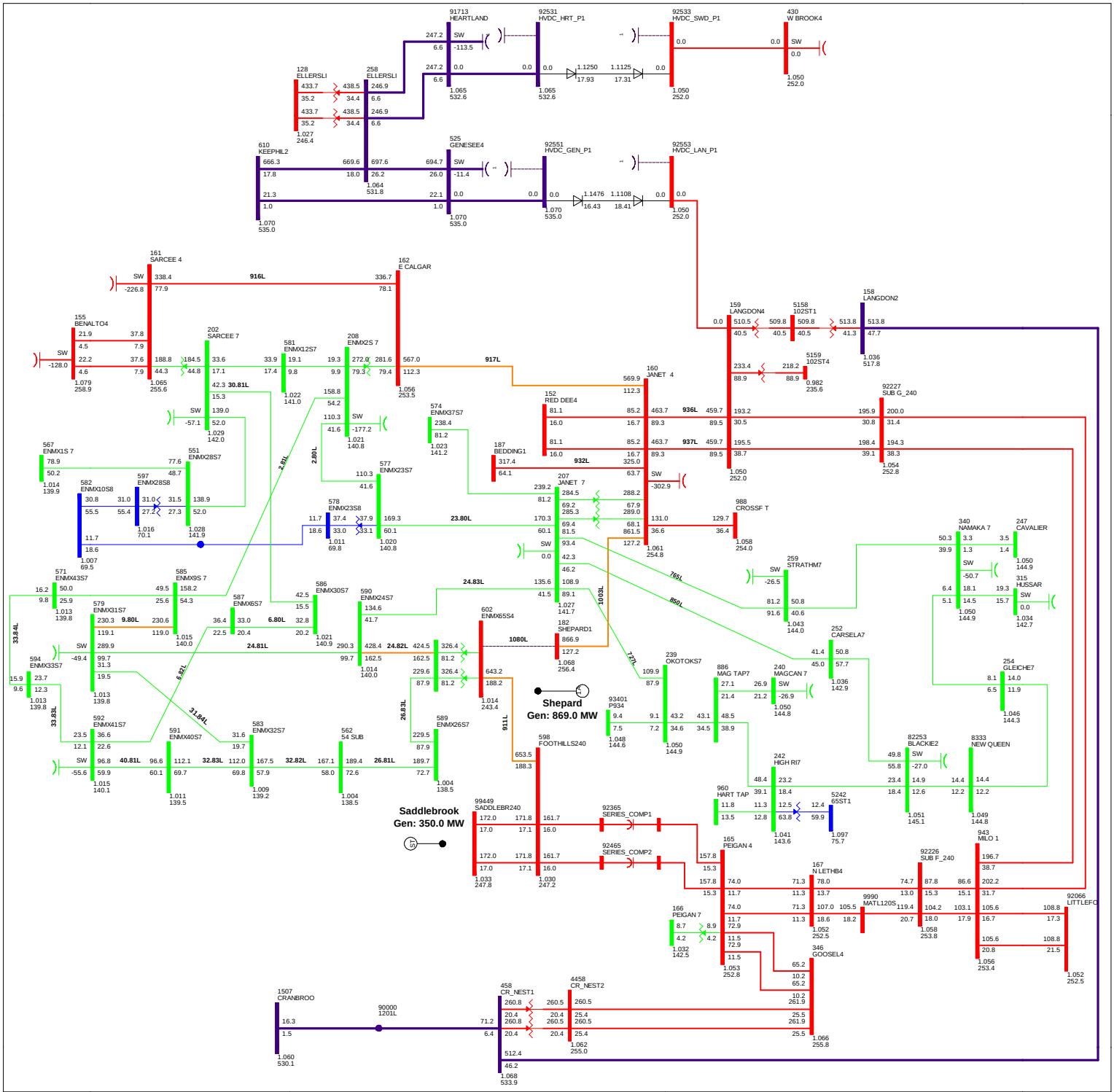
BCH Import: 45.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

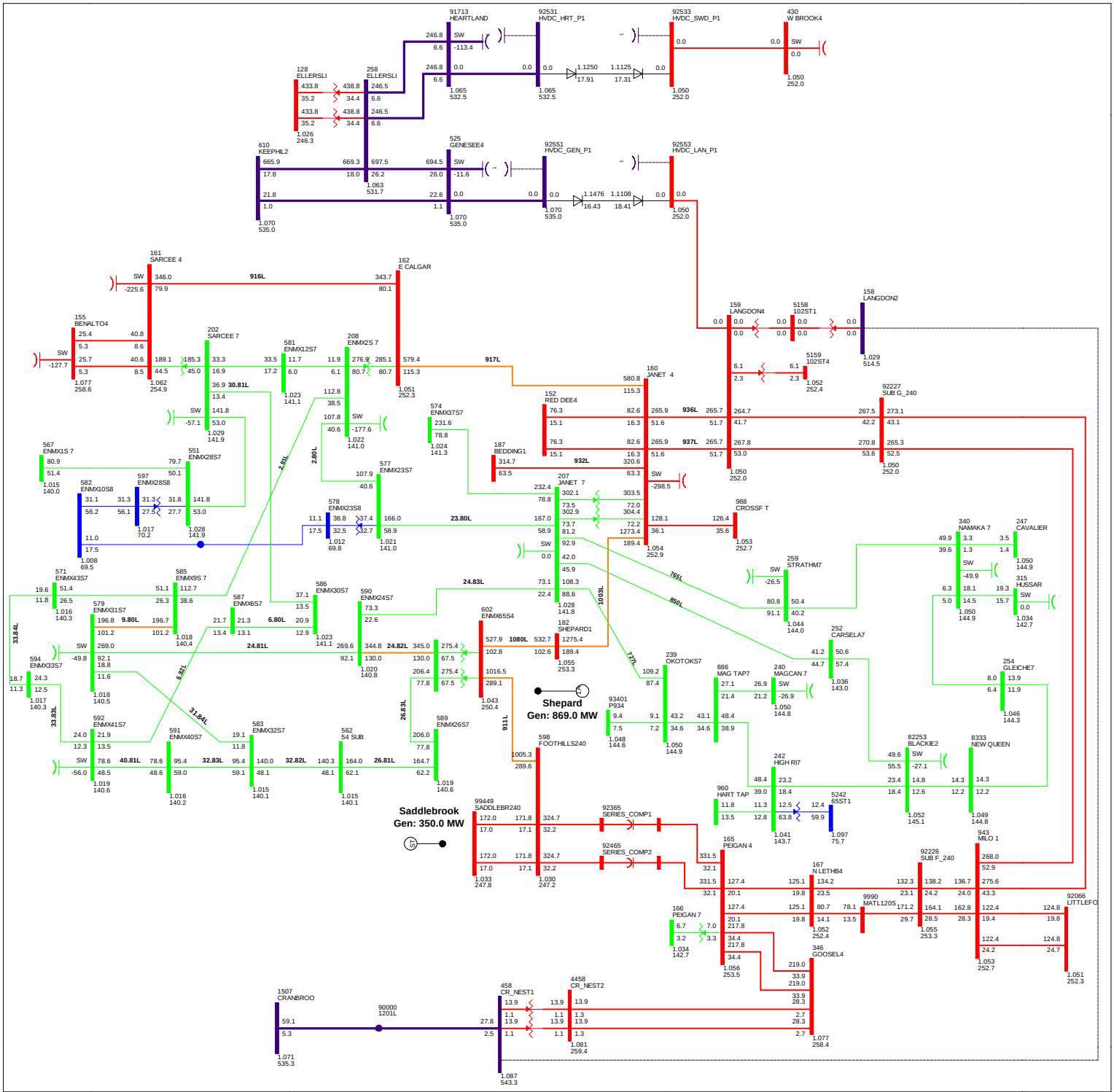
BCH Import: 0.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



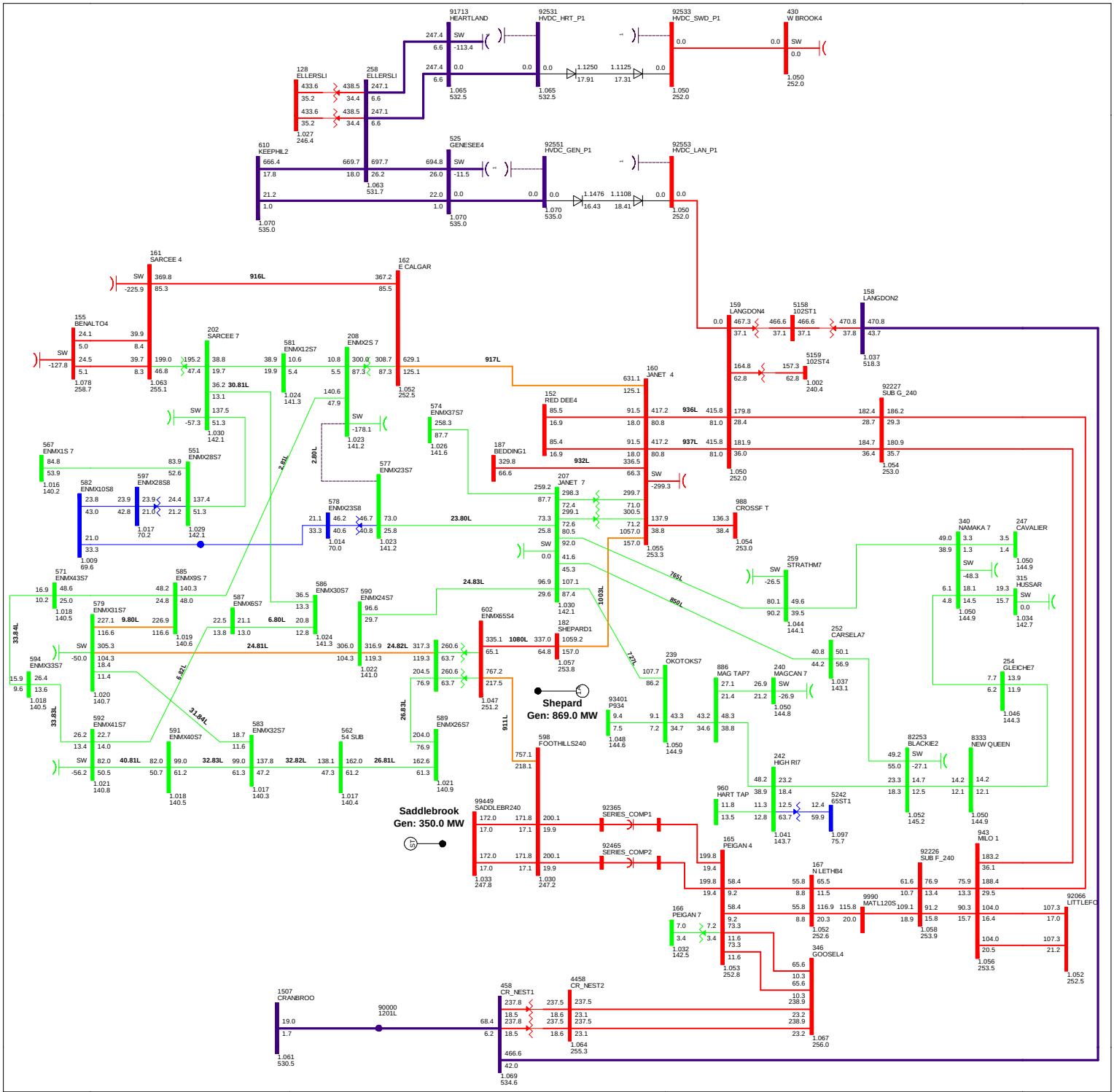
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 41.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

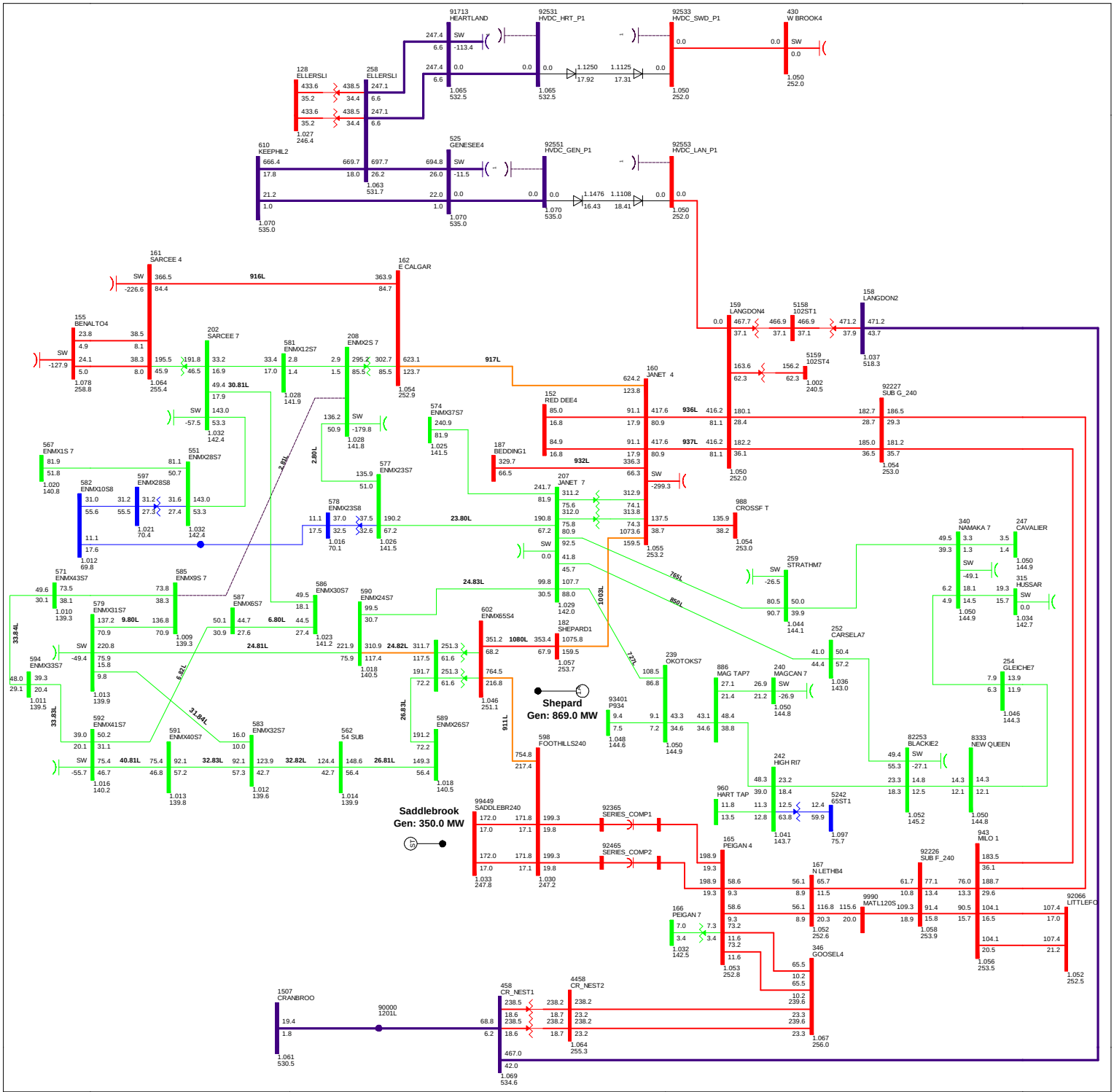
BCH Import: 1.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

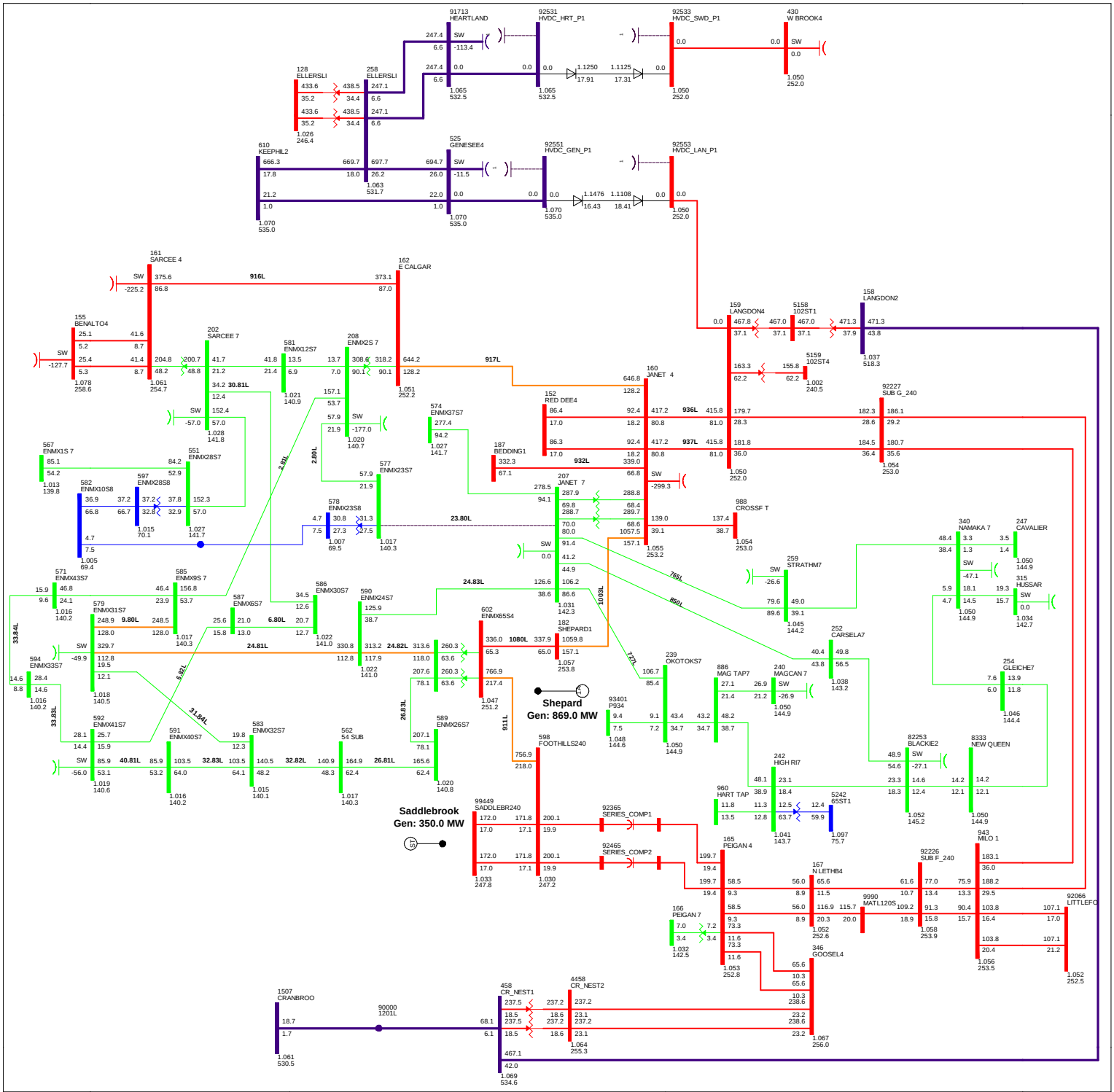
BCH Import: -0.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

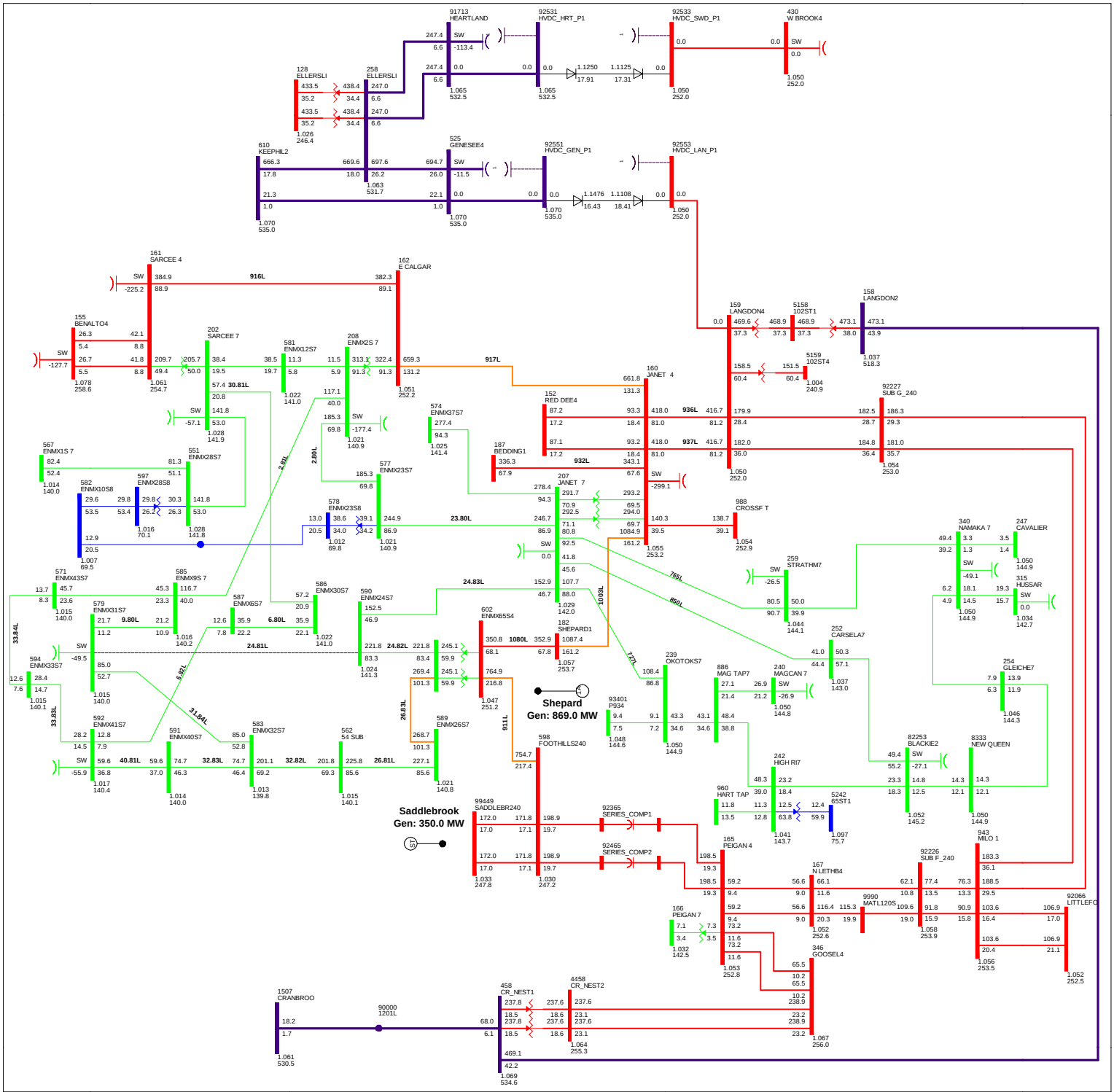
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

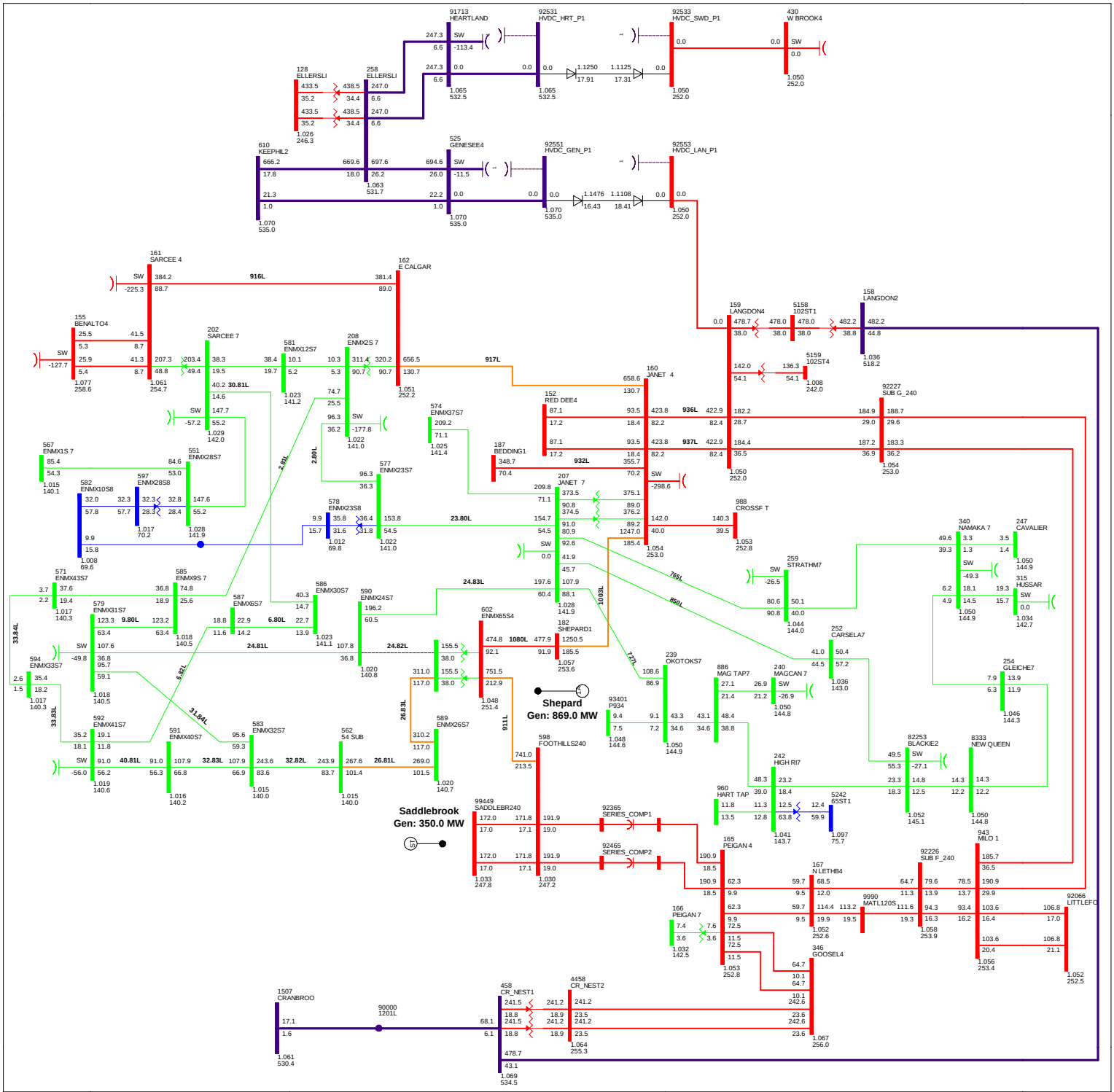
BCH Import: 4.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

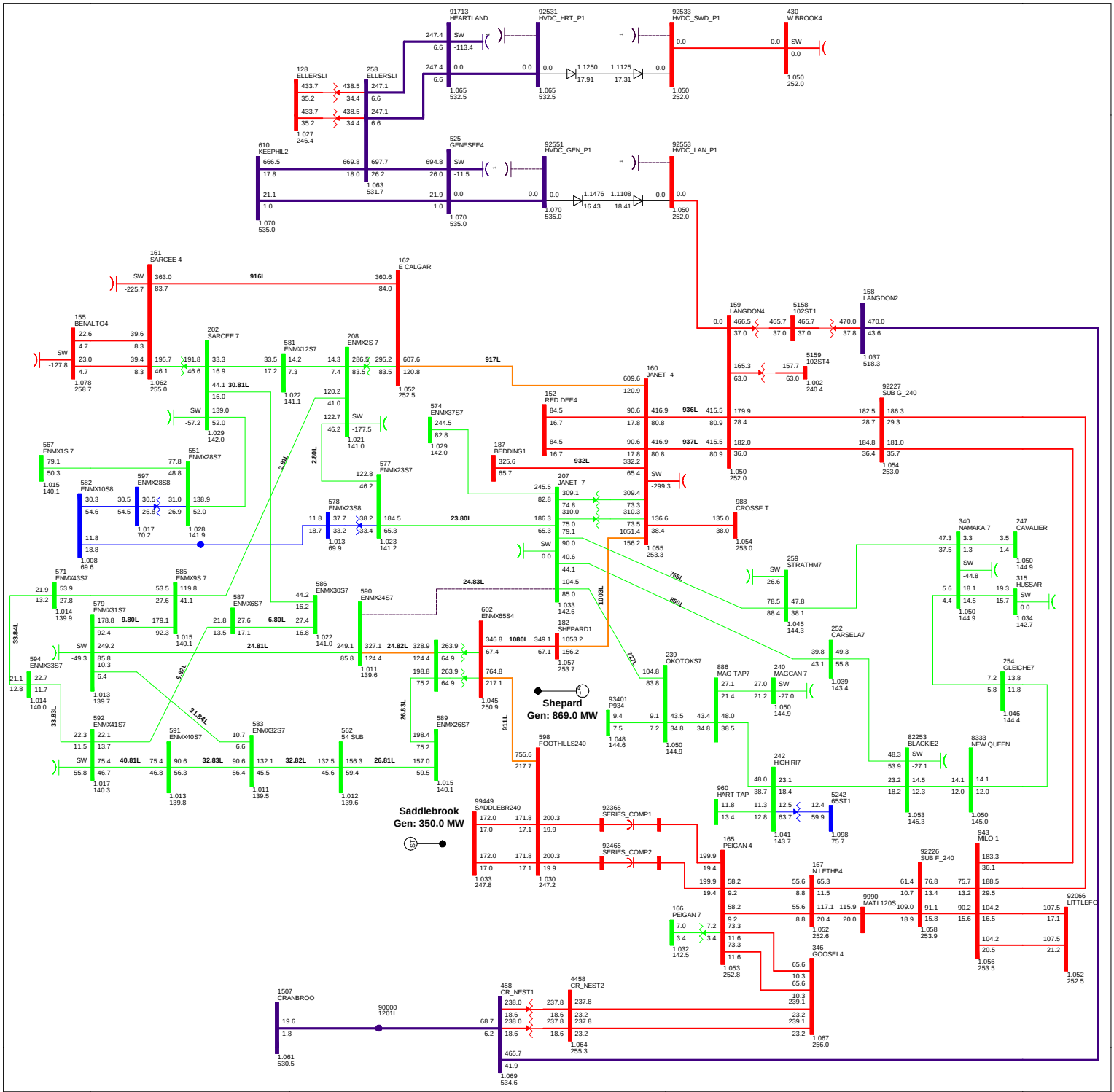
BCH Import: 6.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



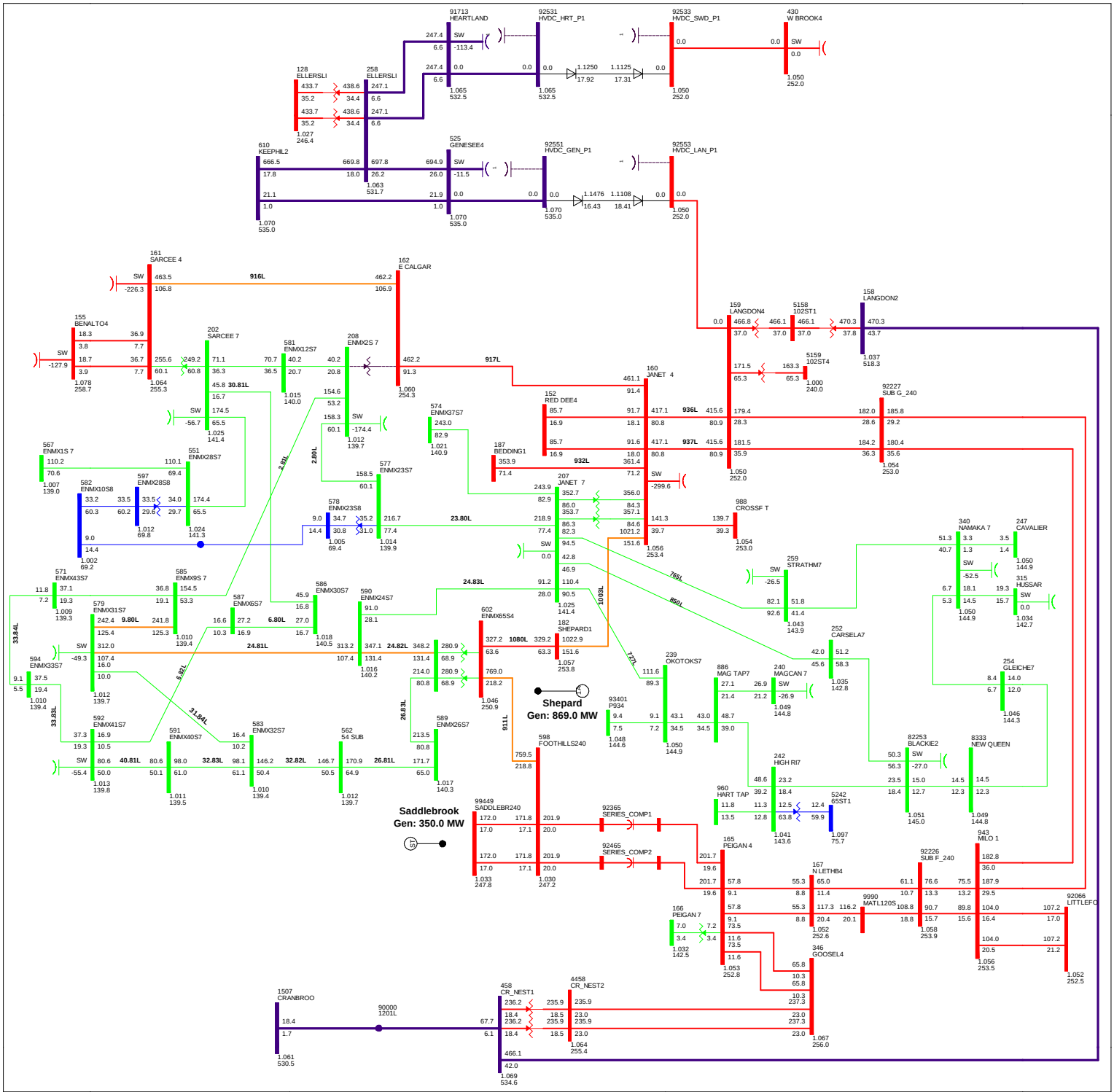
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

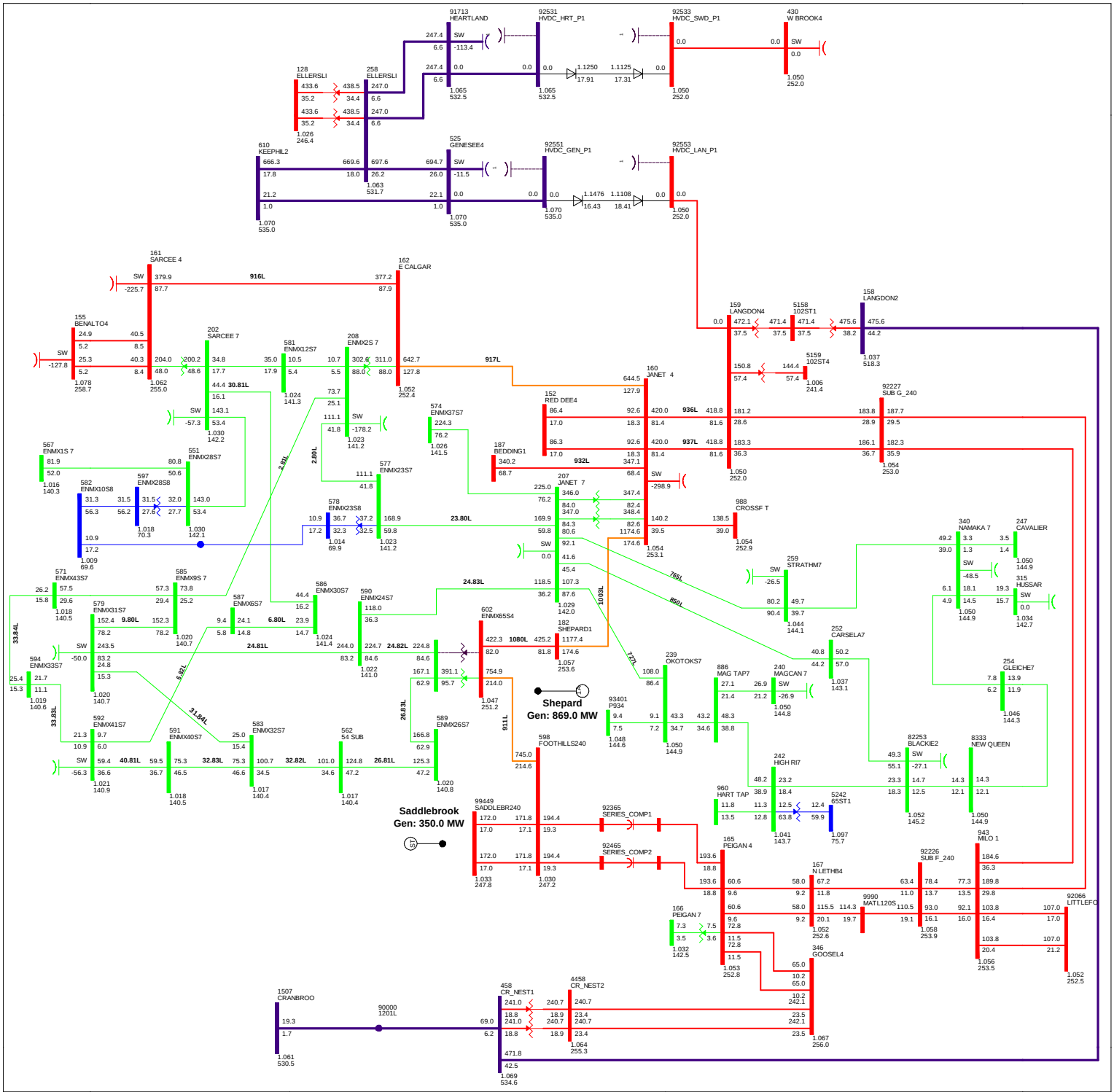
BCH Import: 4.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

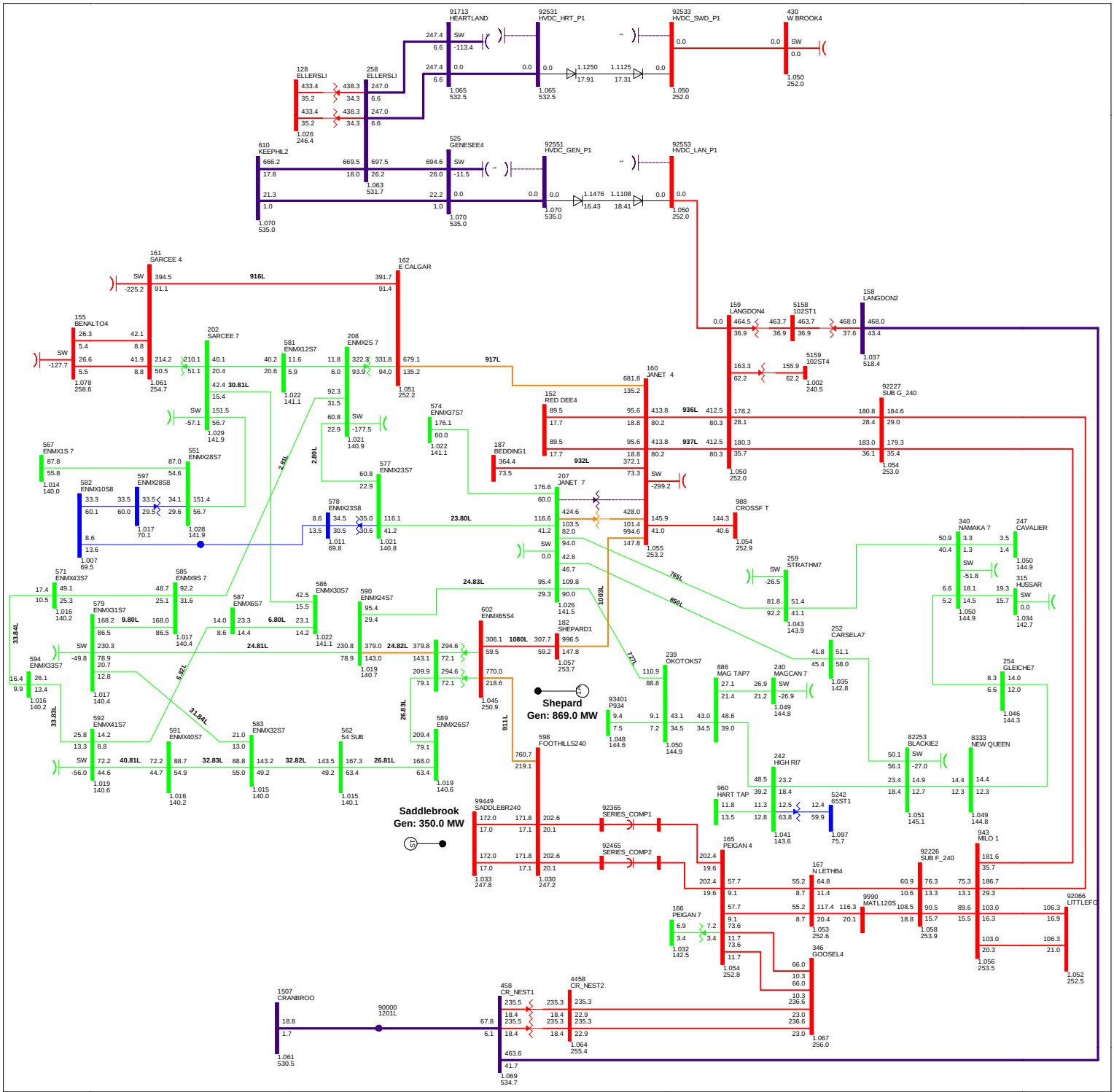
BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

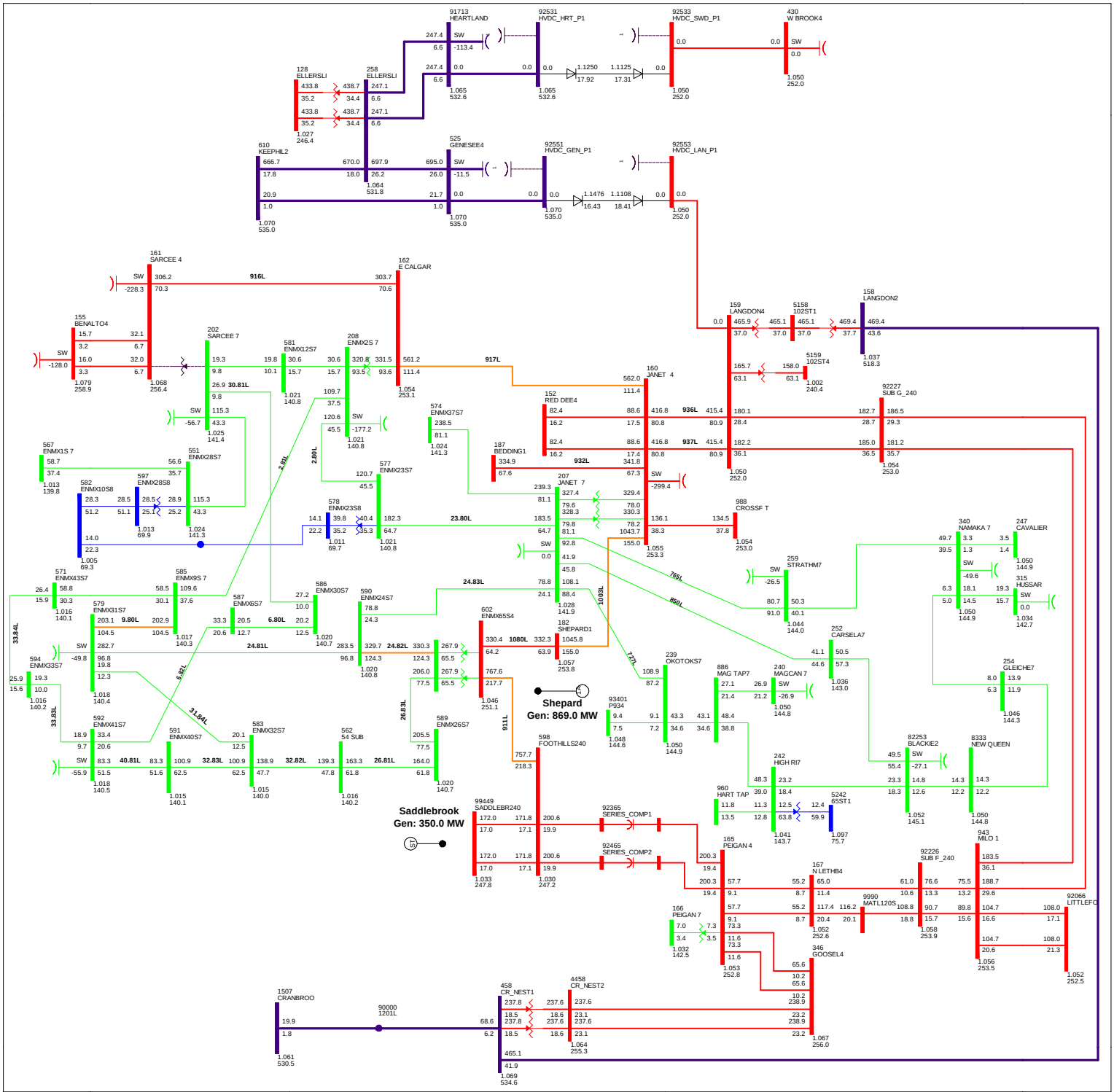
BCH Import: 3.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

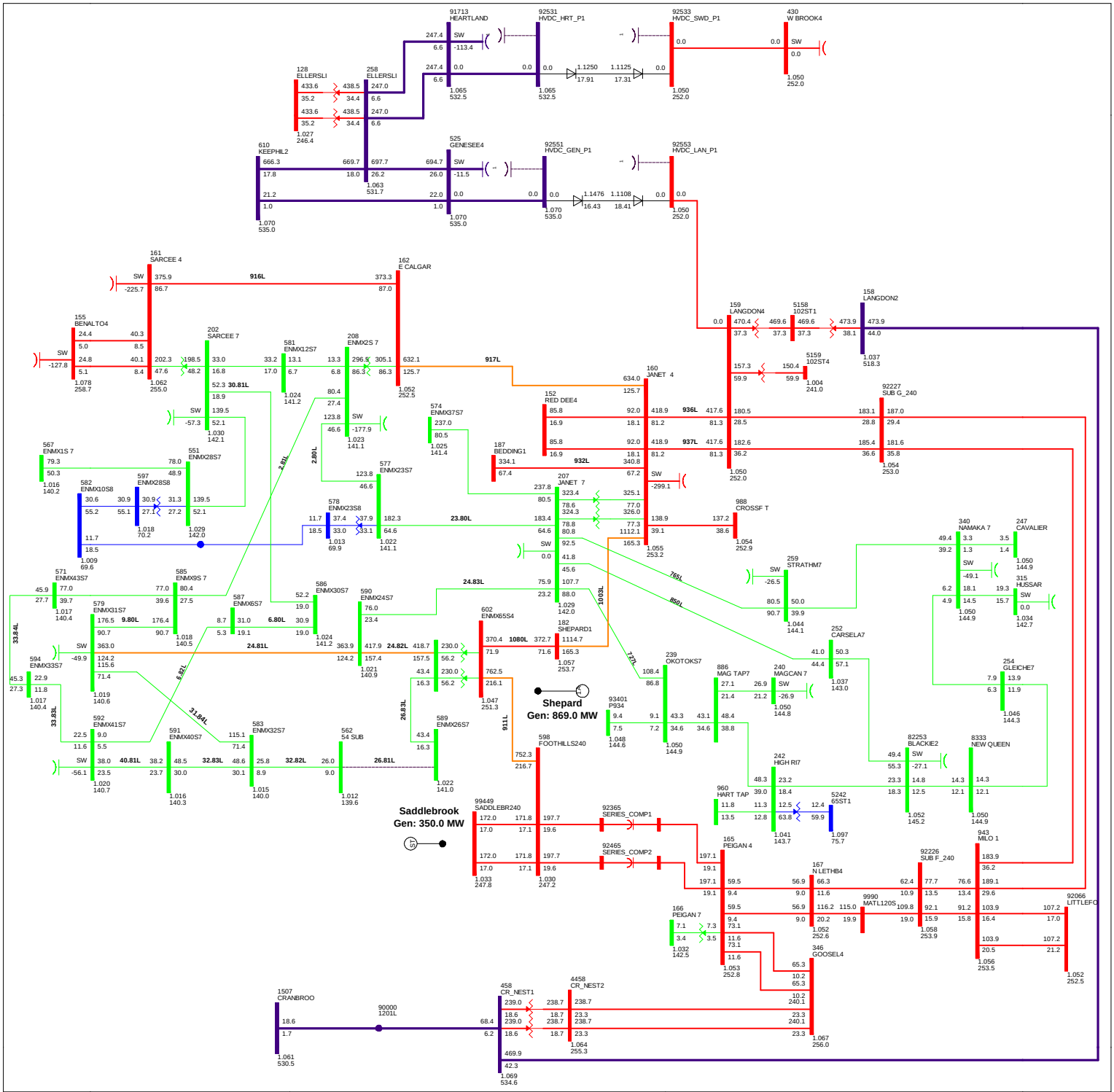
BCH Import: -0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:42



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

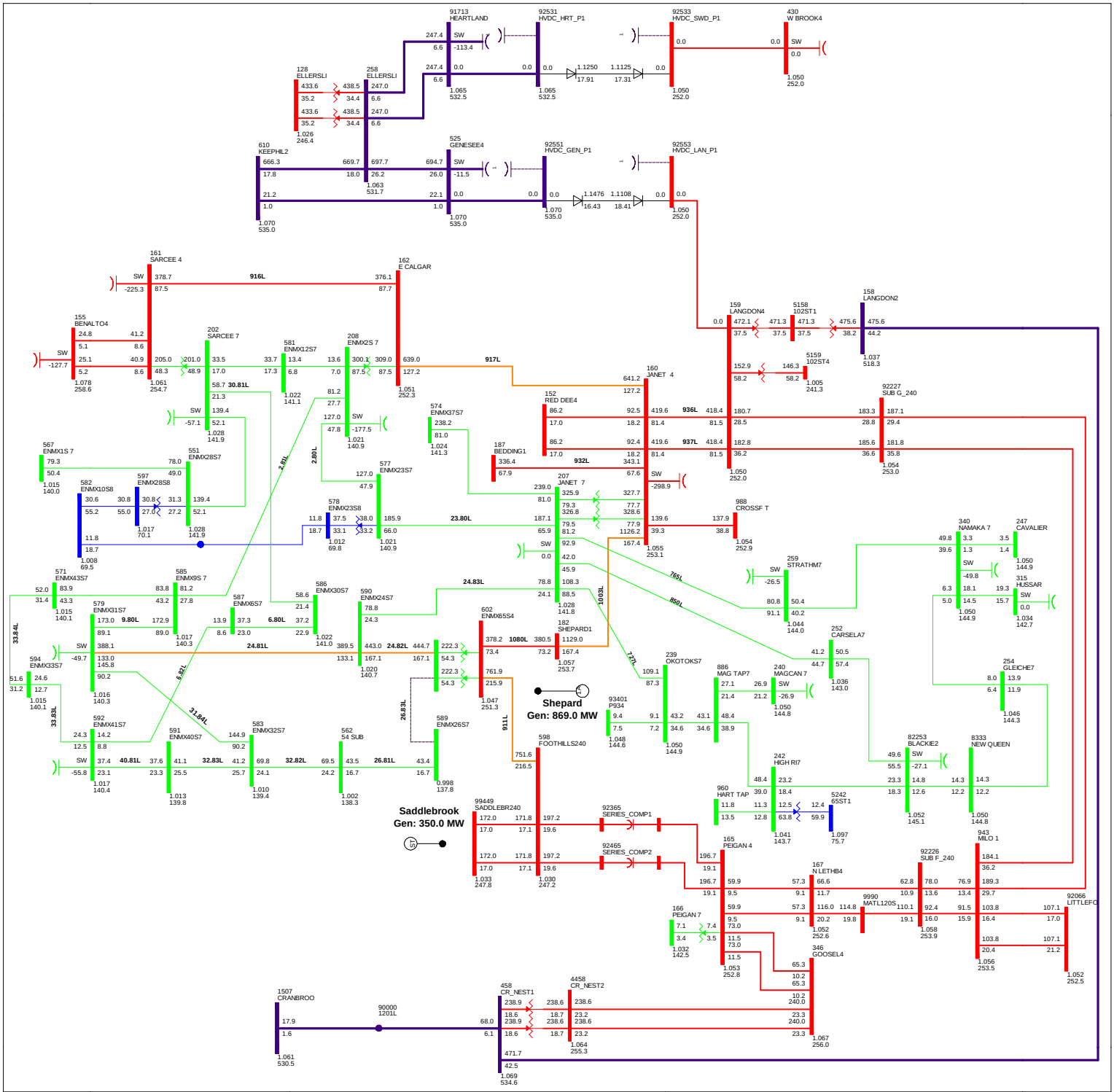
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

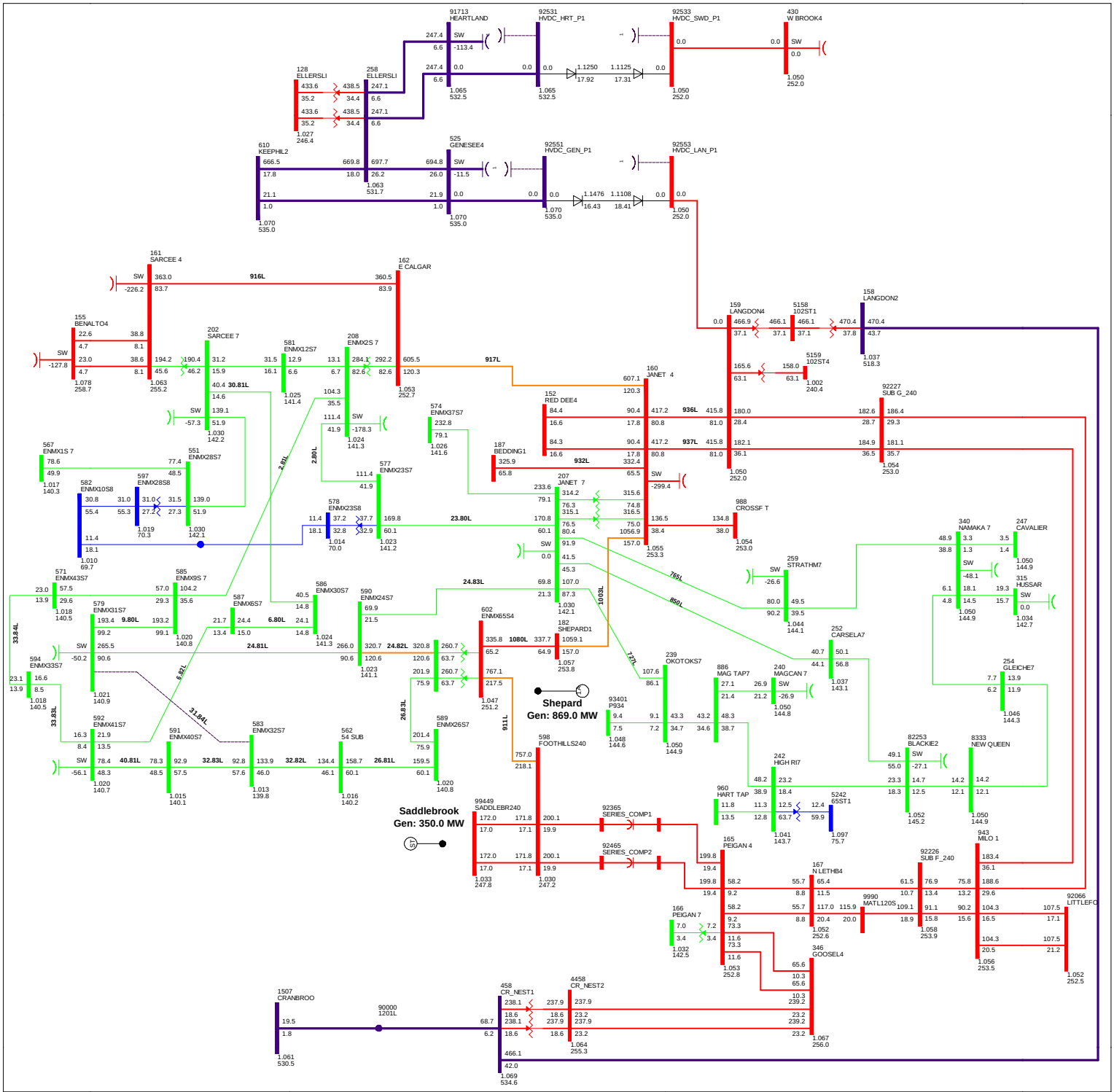
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



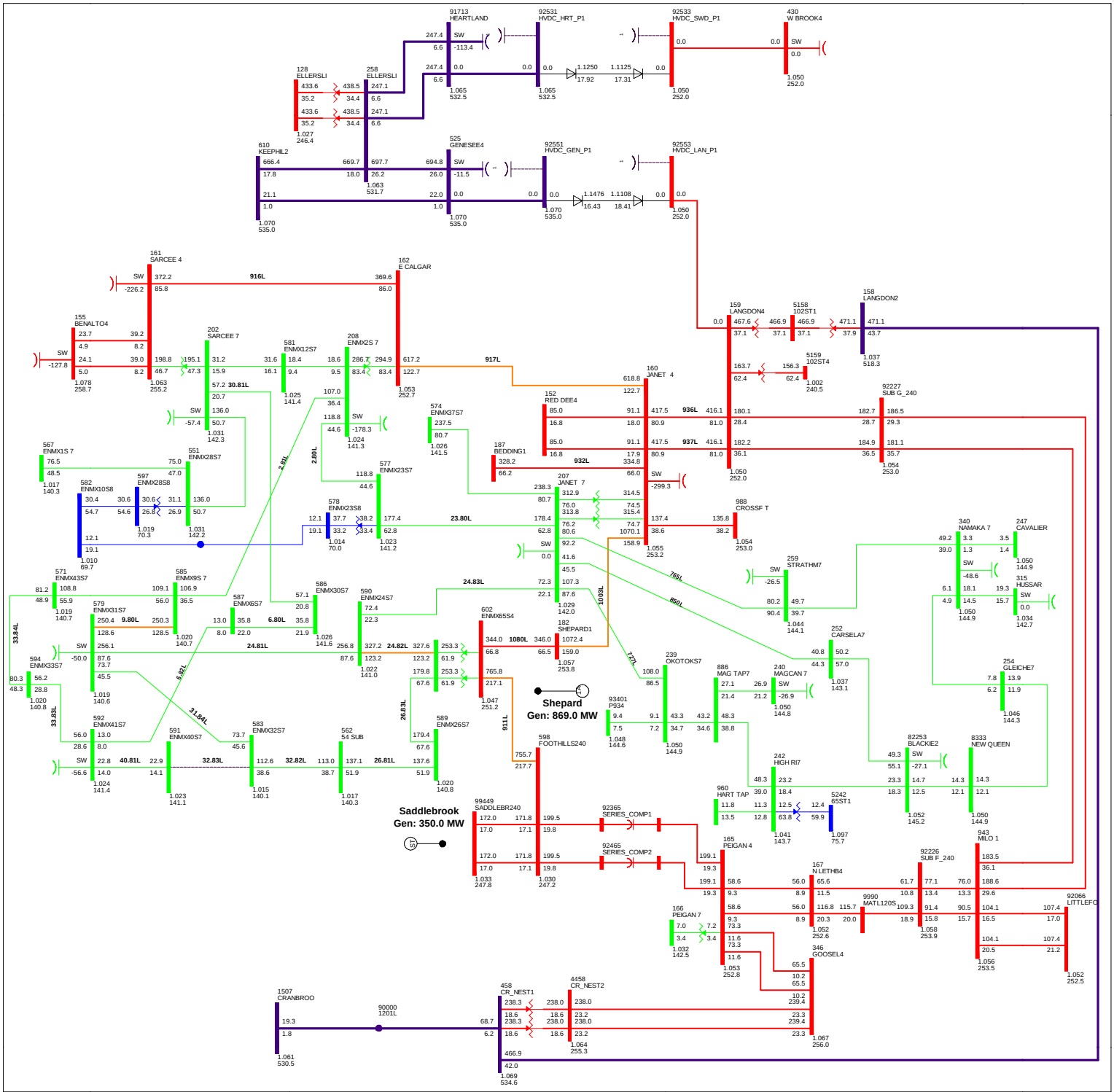
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-17: OPEN 31.84L 138 KV LINE (ENMAX 31 TO ENMAX 32)
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

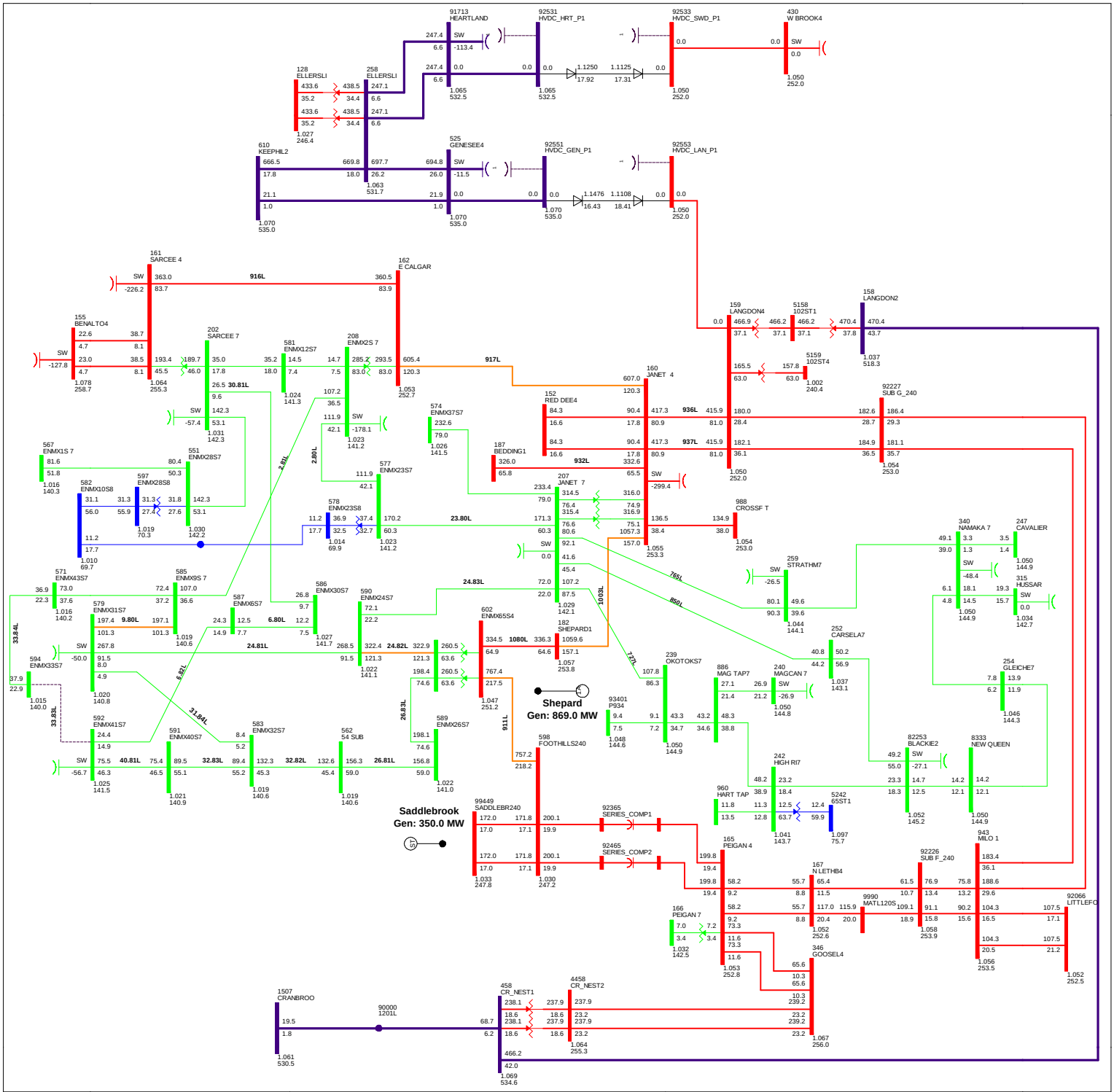
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-18: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

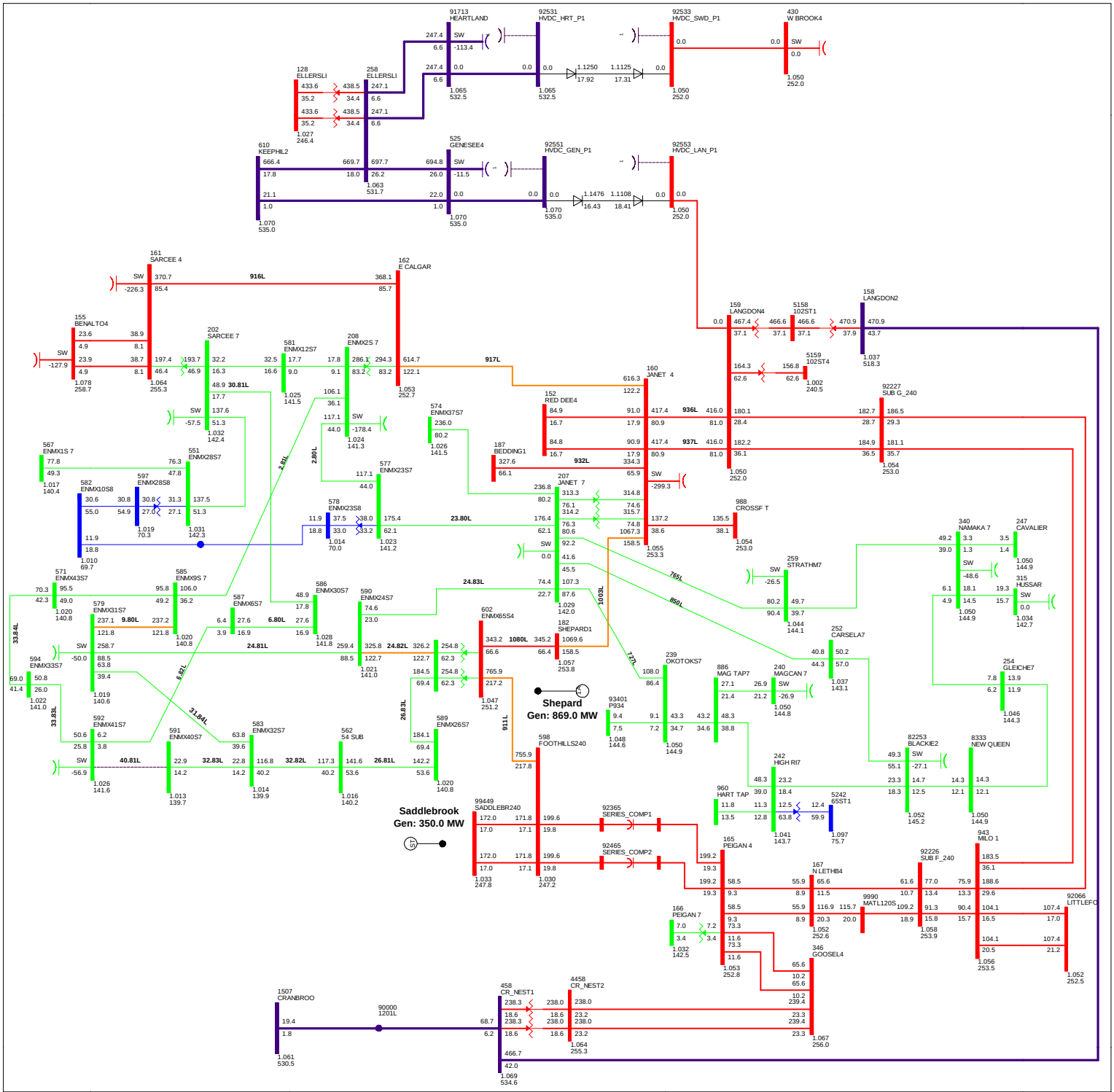
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-19: OPEN 33.83L 138 KV LINE (ENMAX 41 TO ENMAX 33)
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



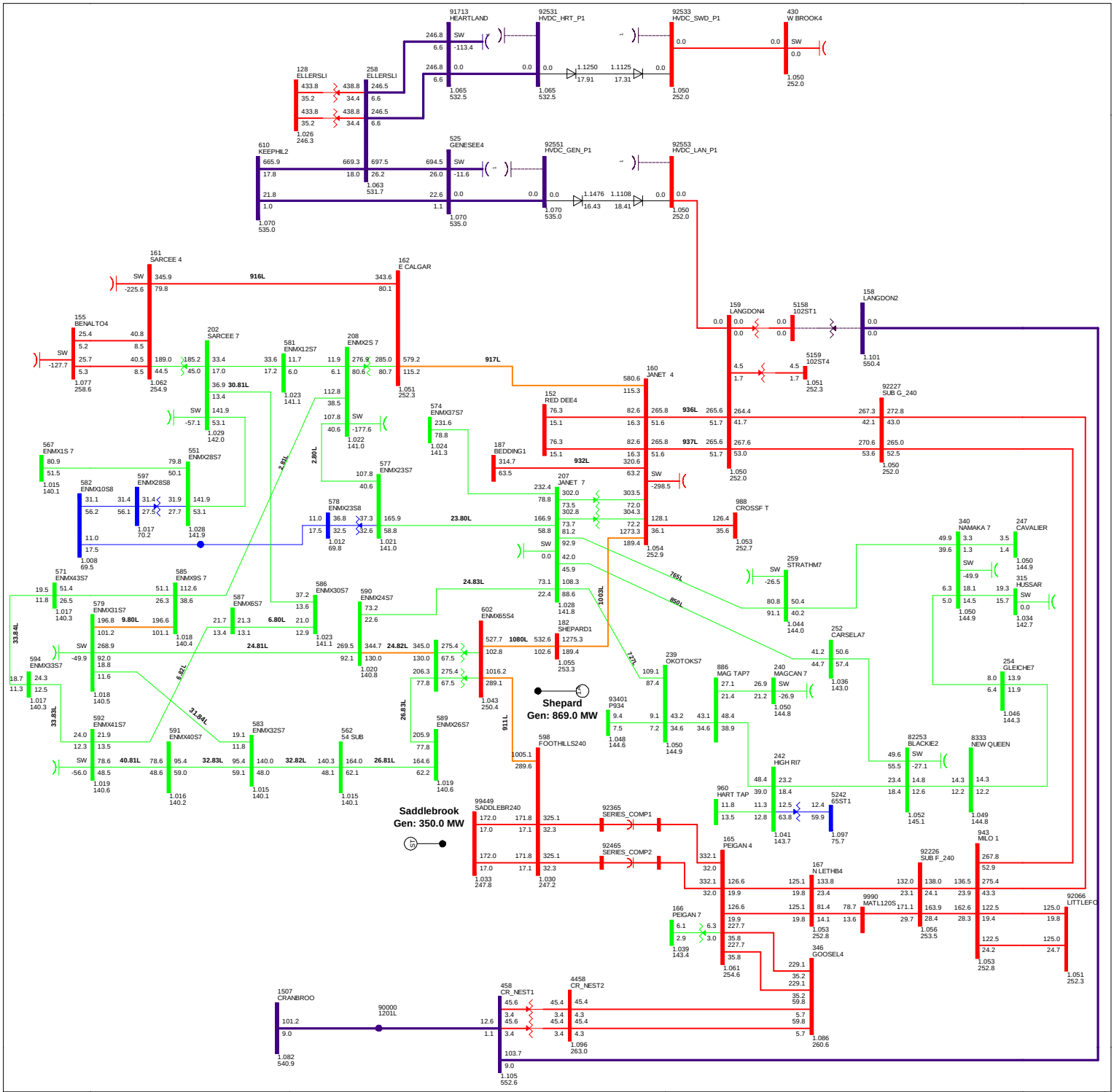
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-20: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

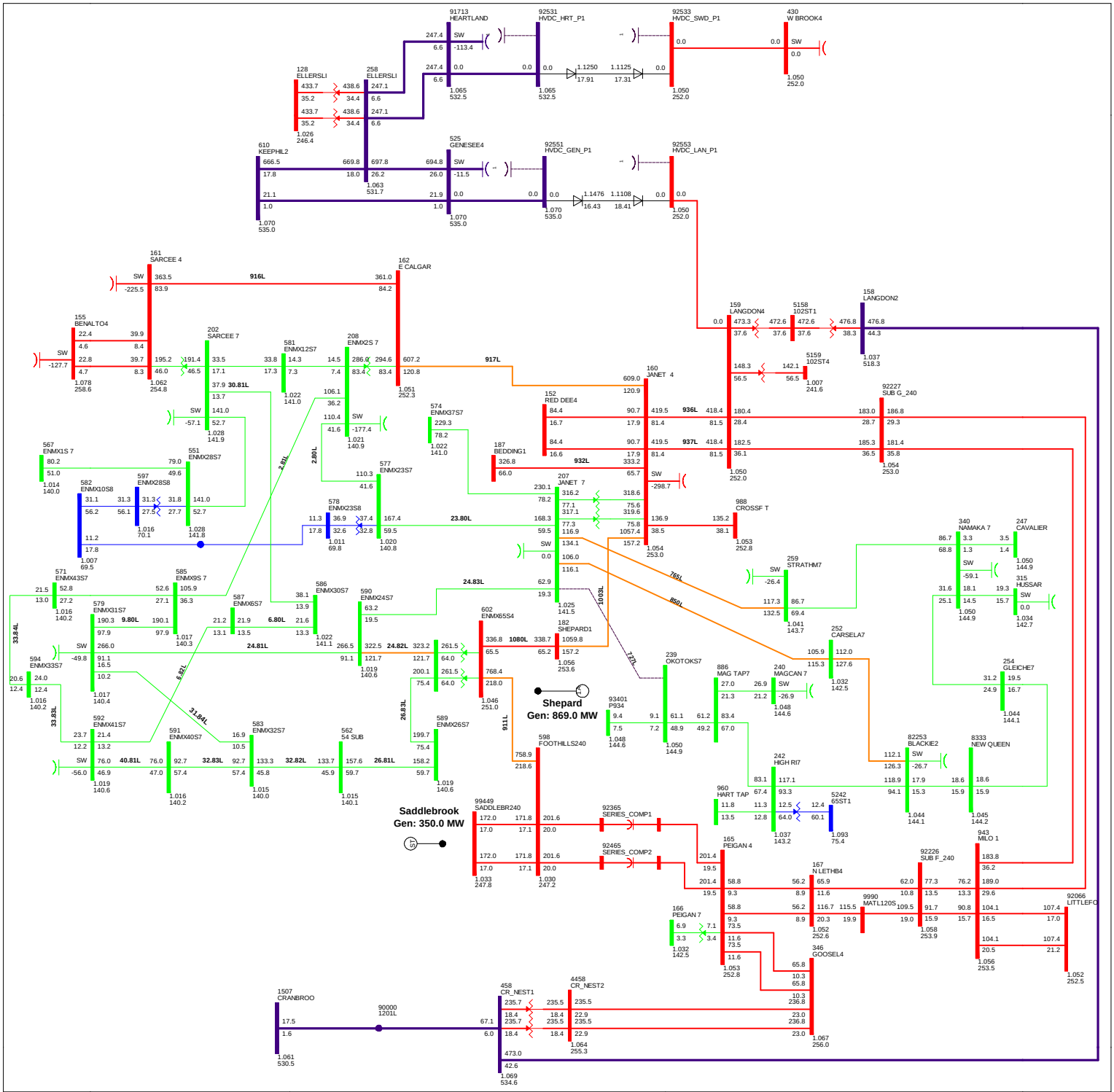
BCH Import: 41.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-21: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

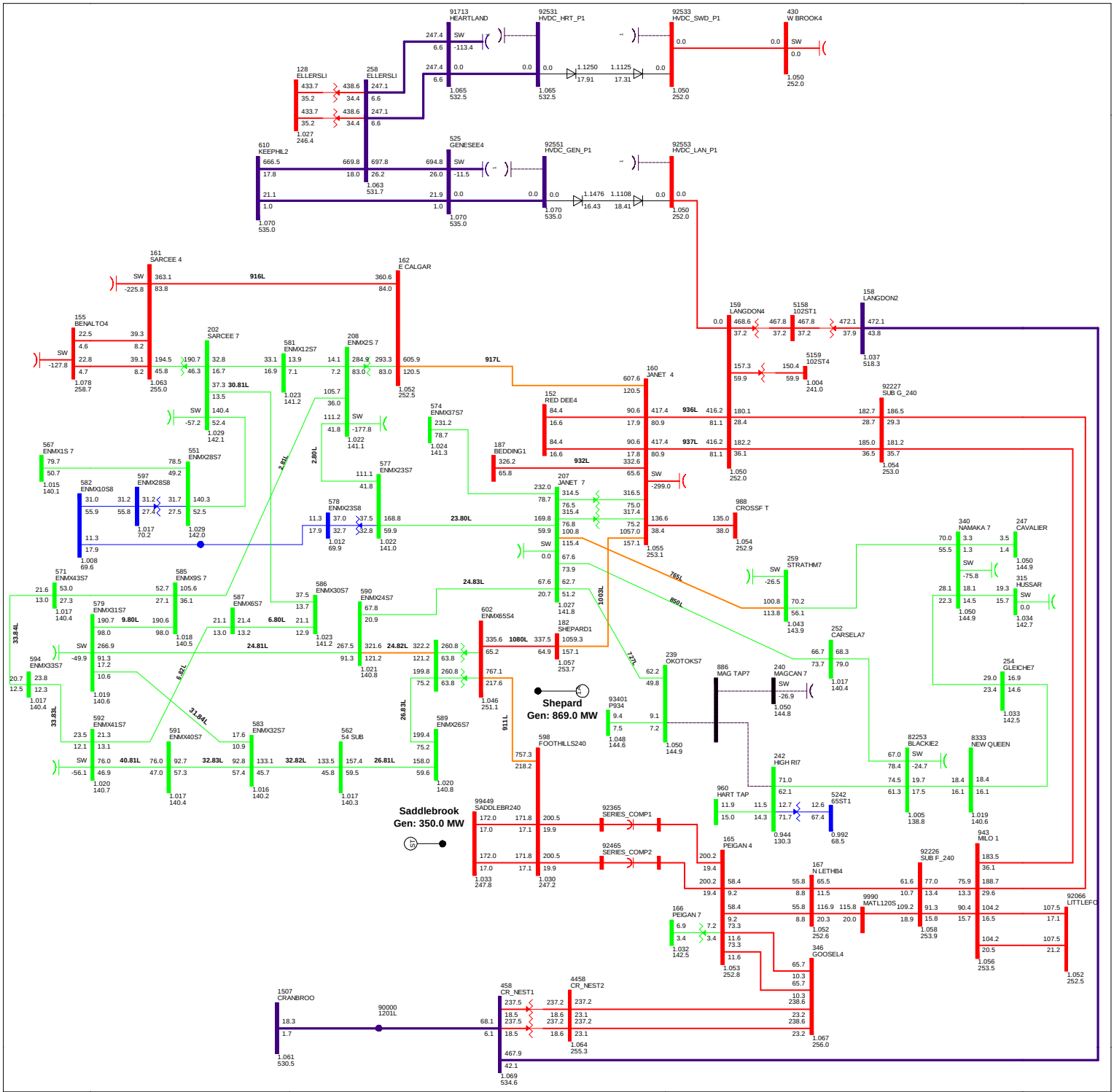
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 11.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-22: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

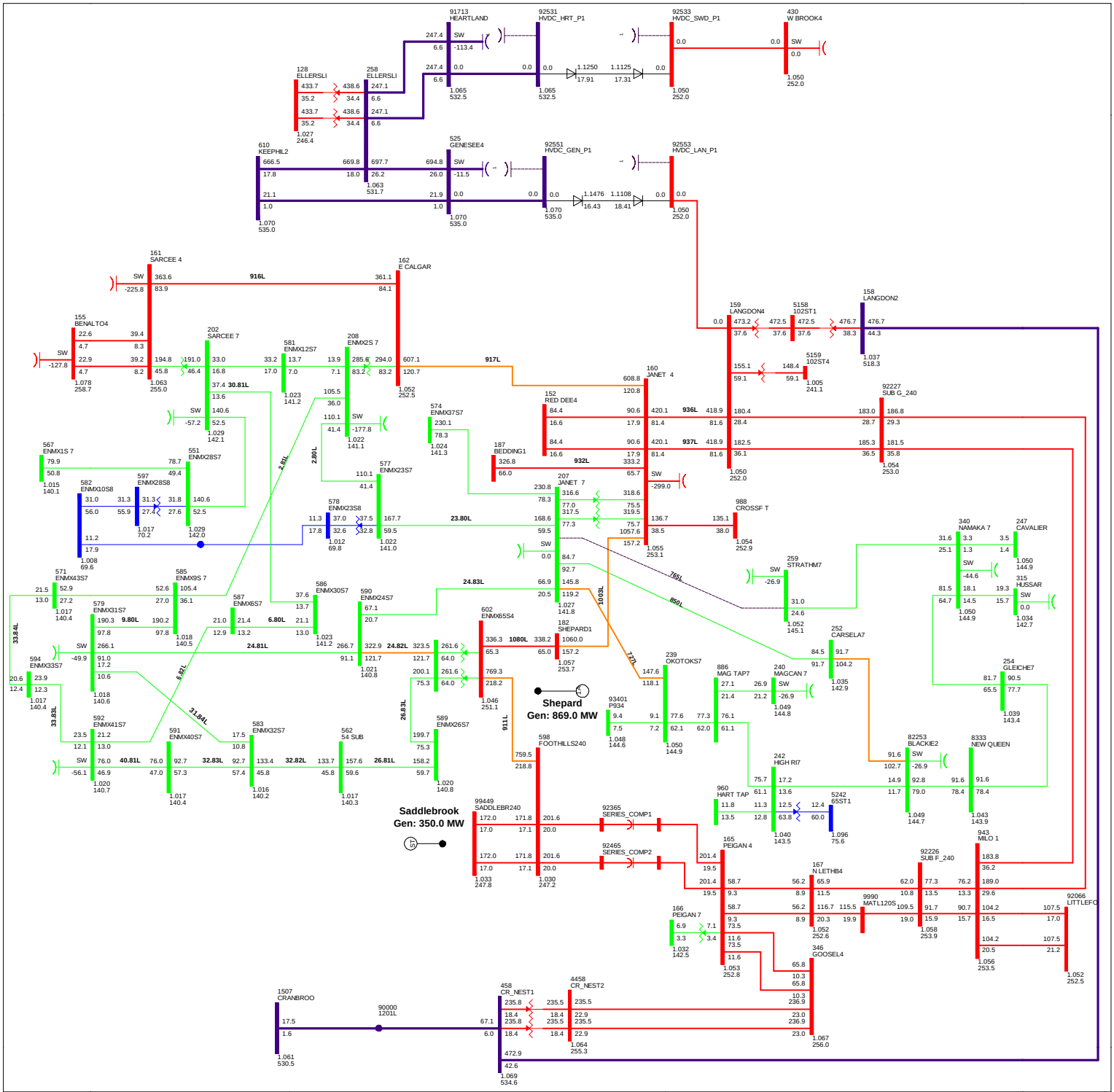
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-23: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

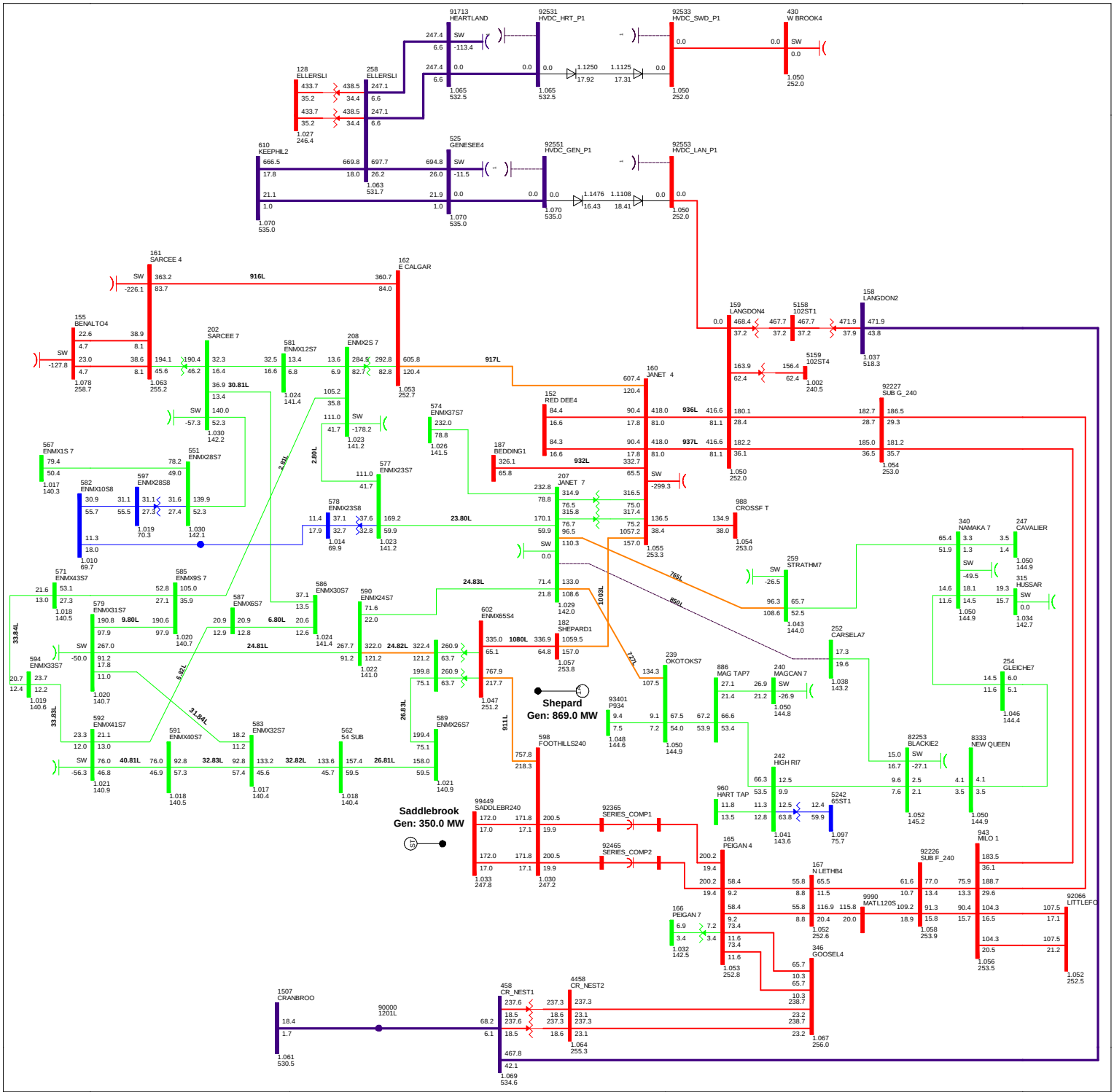
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 11.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-24: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



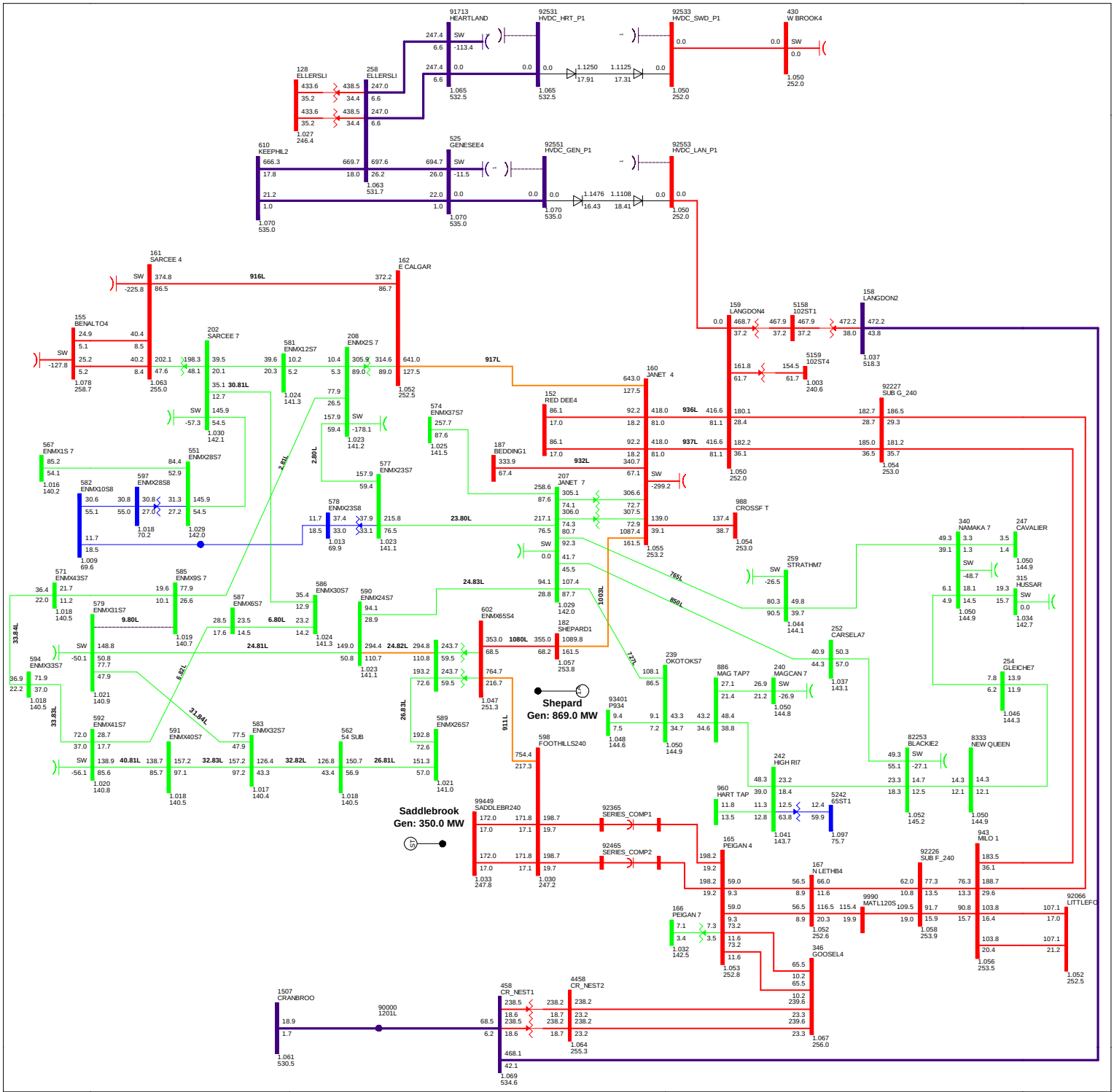
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-25: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

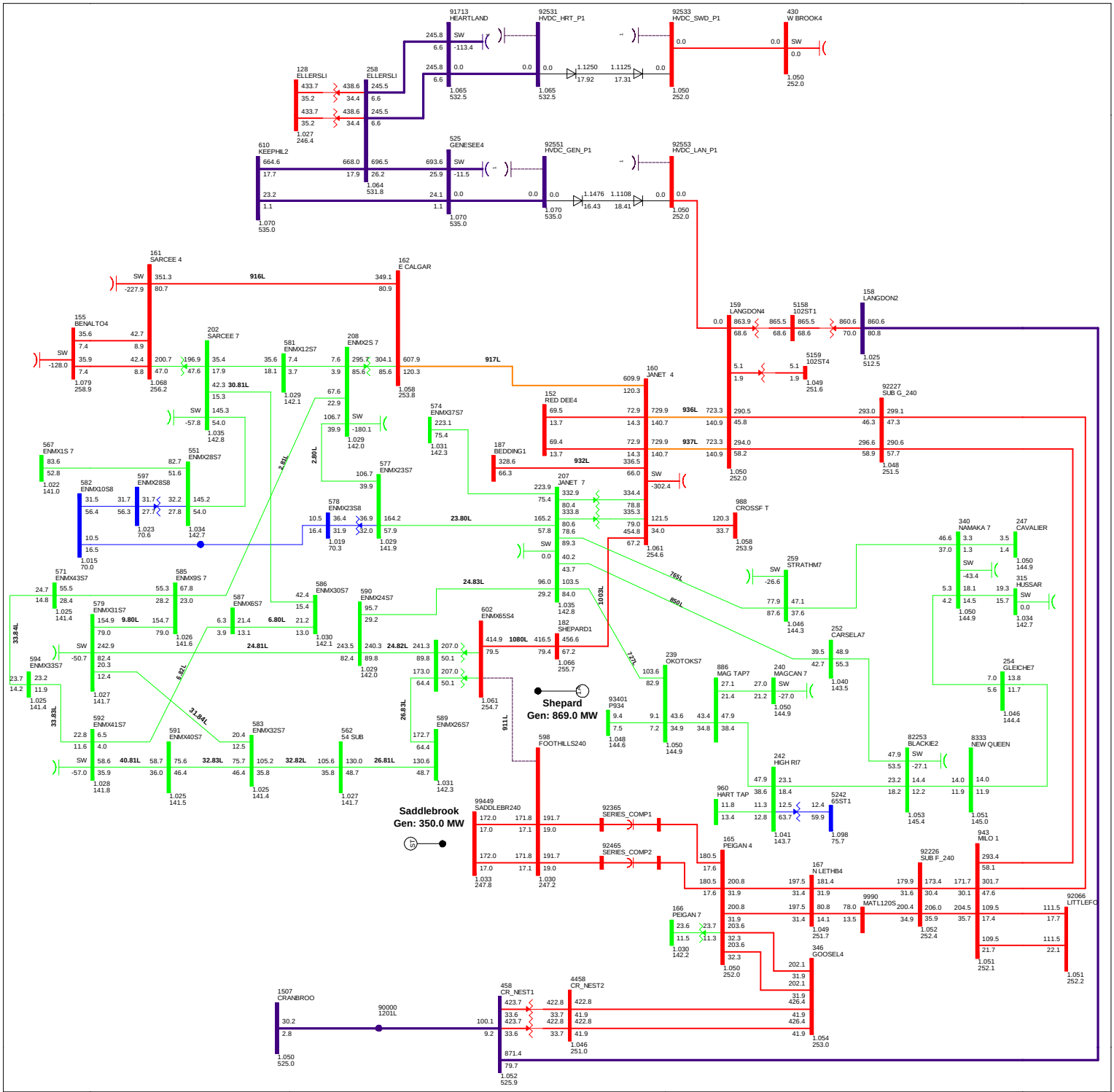
BCH Import: 1.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-26: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

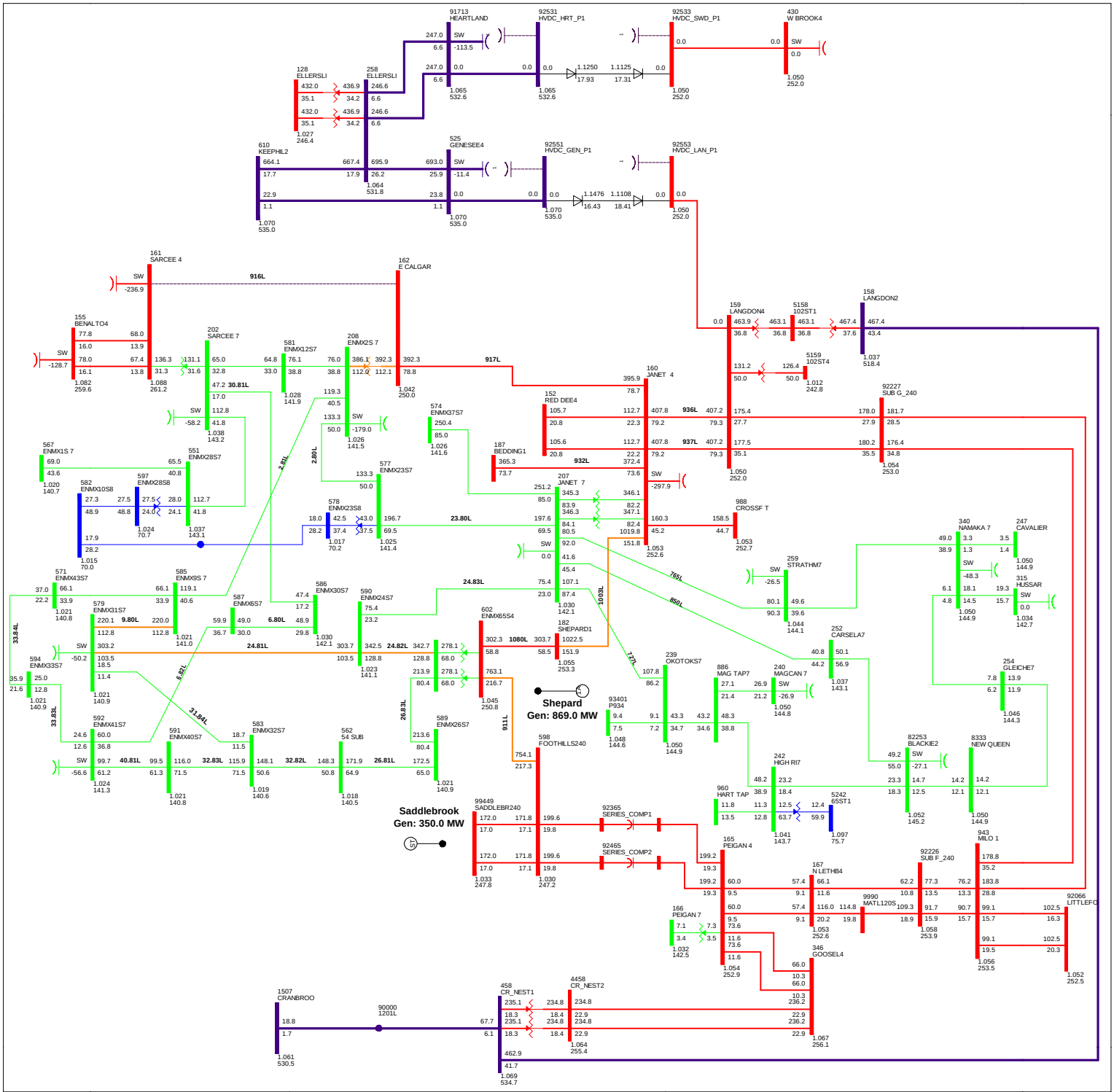
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 38.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-27: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX 2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



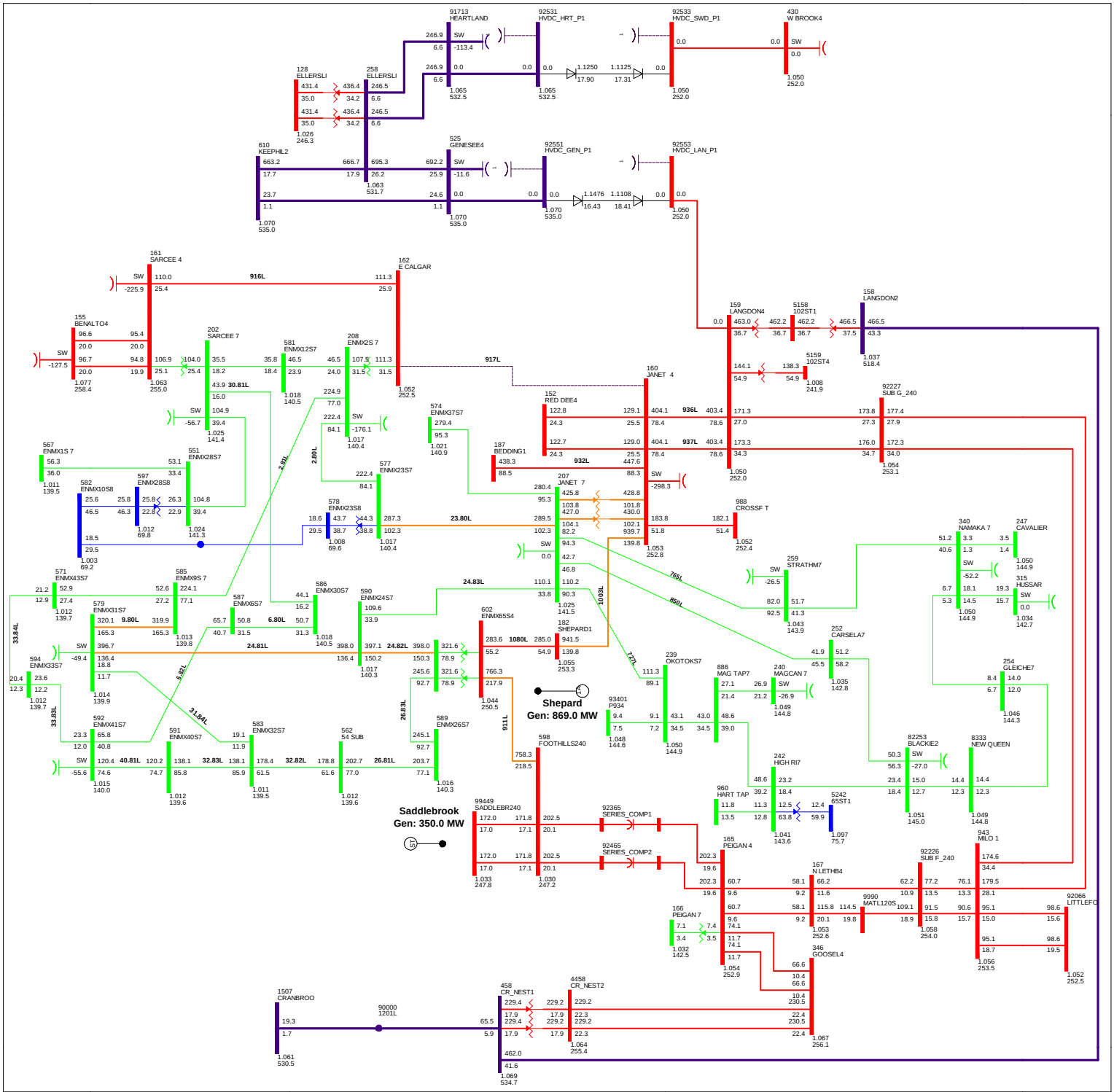
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-28: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

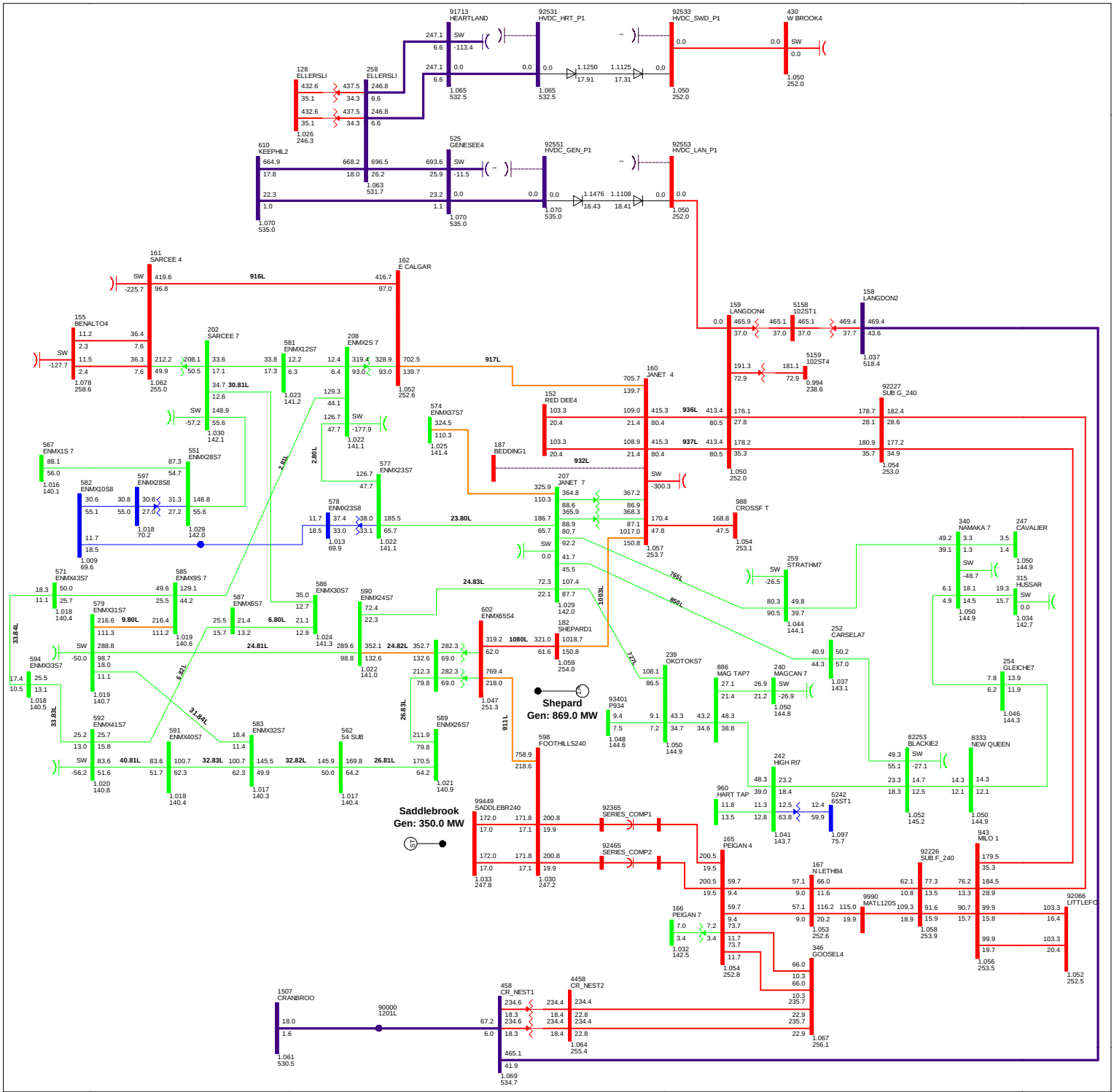
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

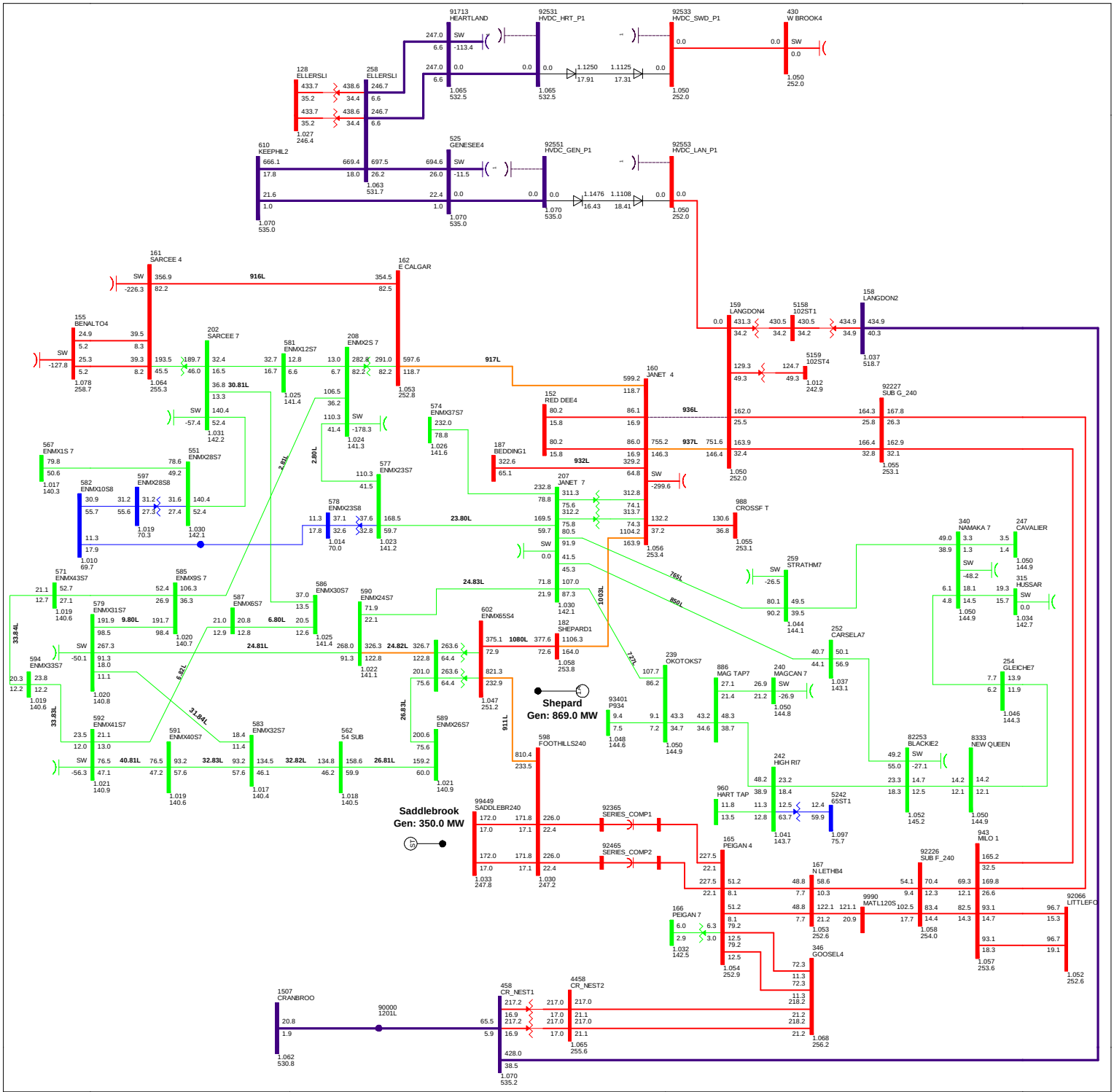
BCH Import: 19.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-29: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
2012LTO EXISTING SYSTEM
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
BCH Import: 7.3 MW
FIG B-SC4-30: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2019_SP_EXISTING_SC4
FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

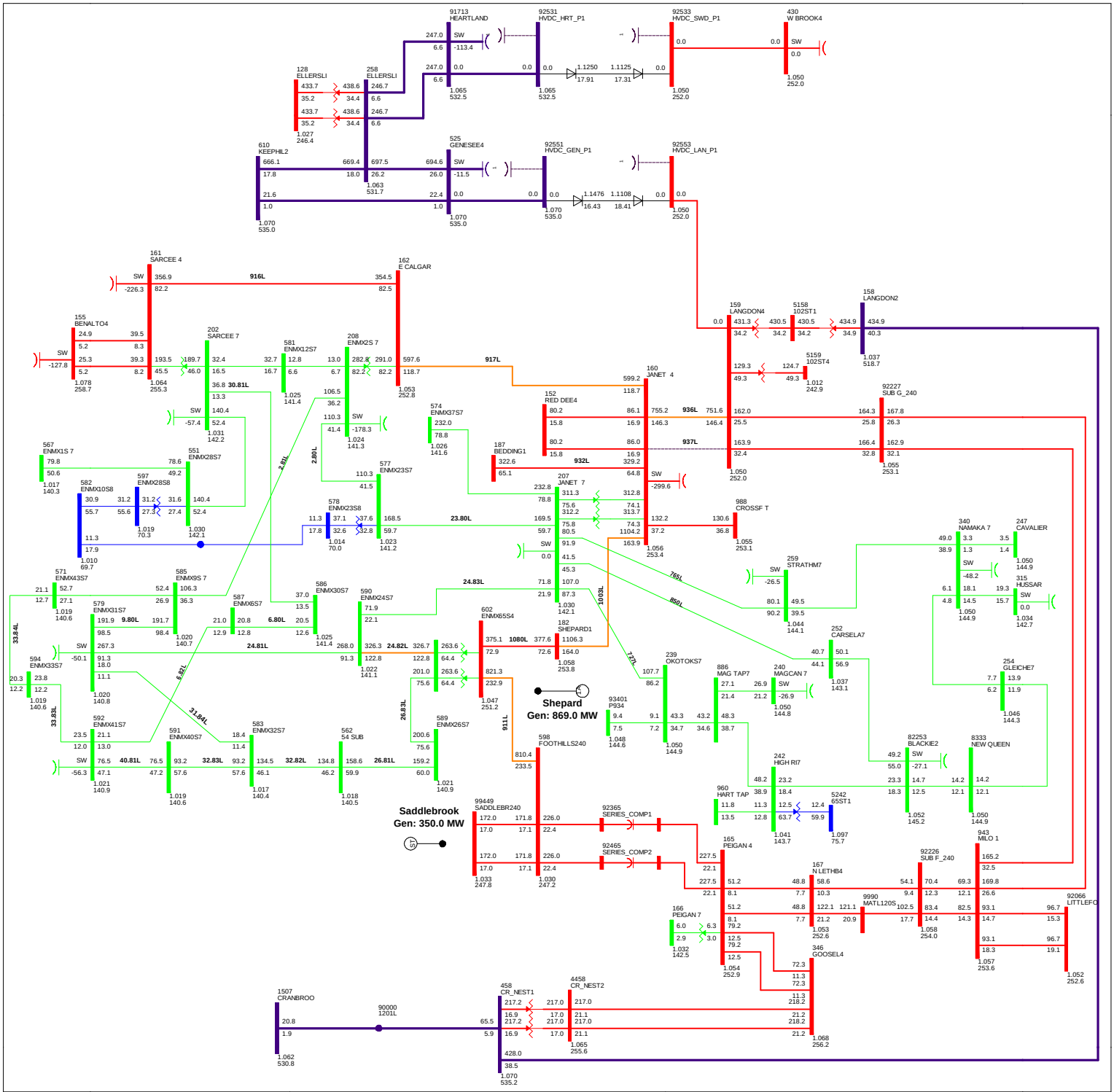
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 6.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-31: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

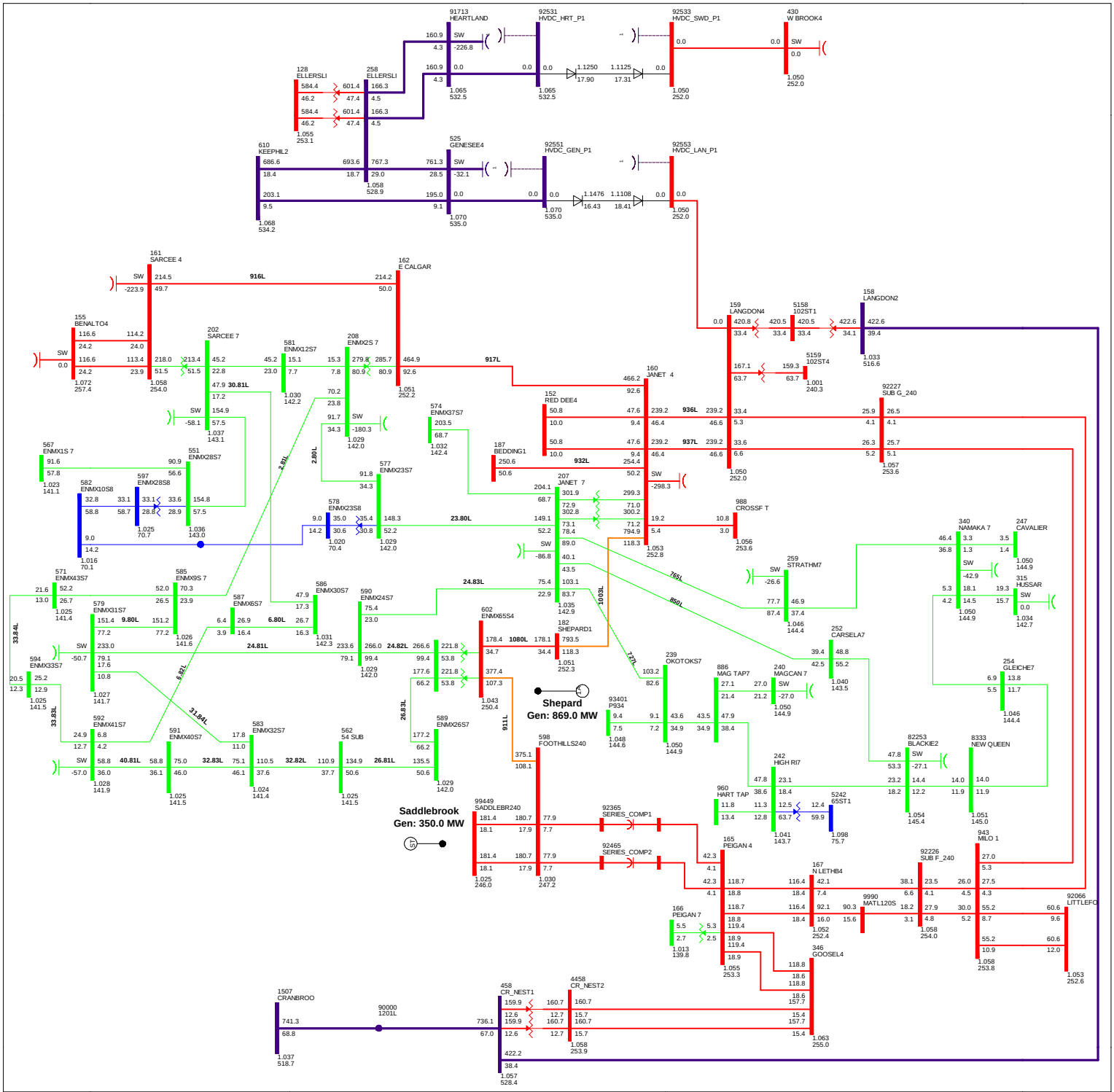
BCH Import: 6.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC4-32: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SP_EXISTING_SC4

FRI, JUN 08 2012 15:43

2019 Loading Violations
Scenario 5



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

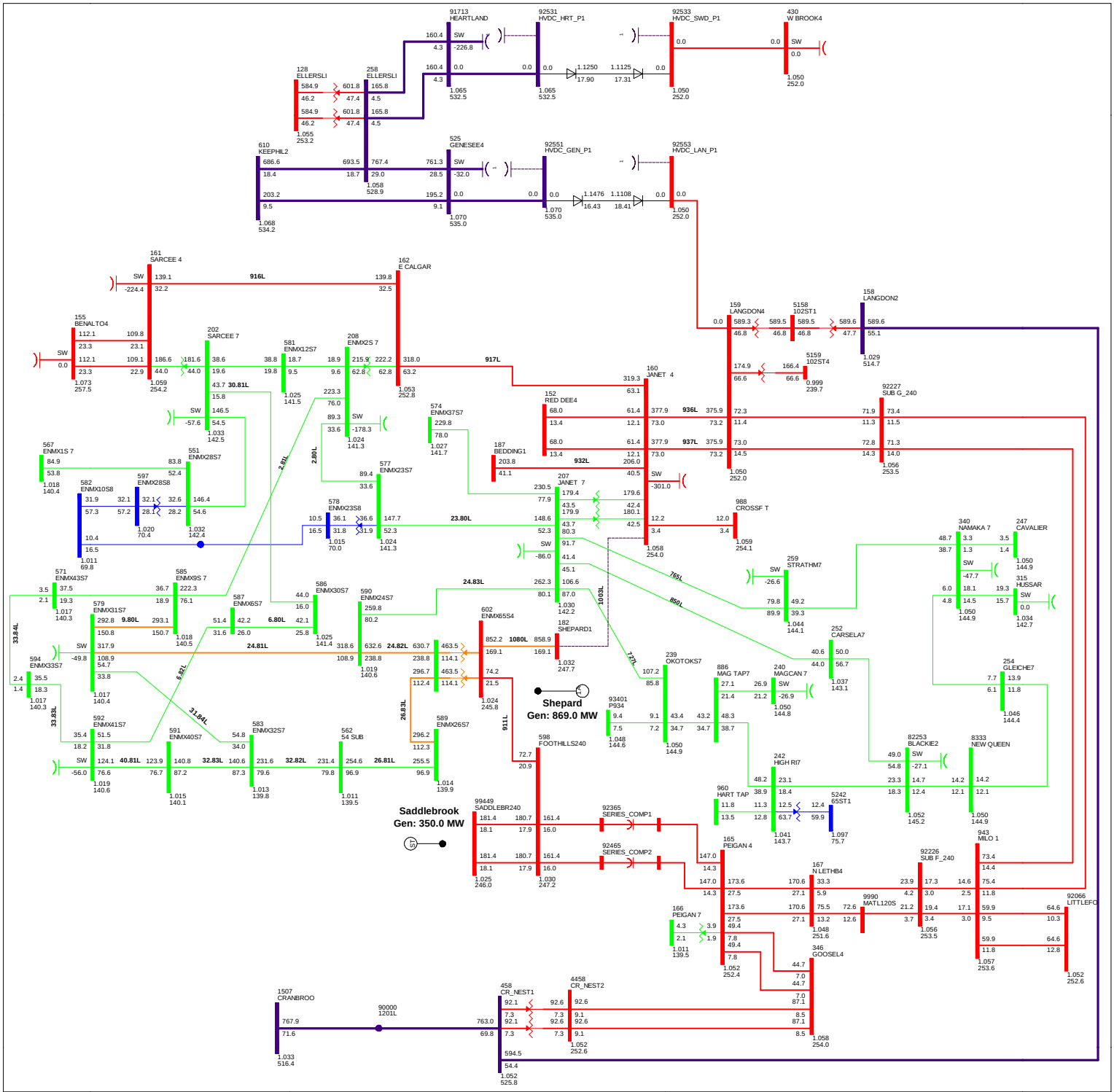
BCH Import: 779.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-1: BASECASE

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

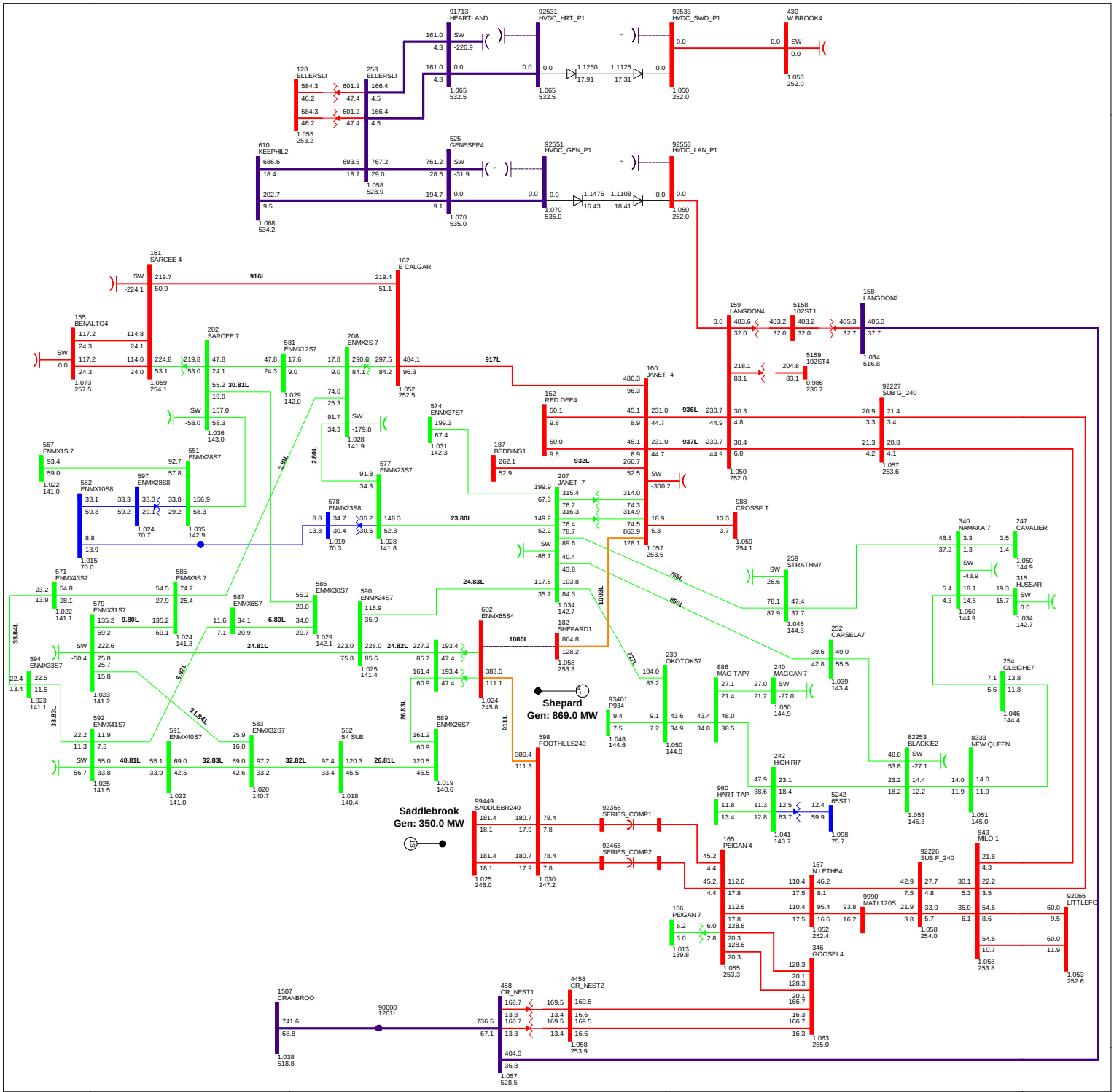
BCH Import: 807.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

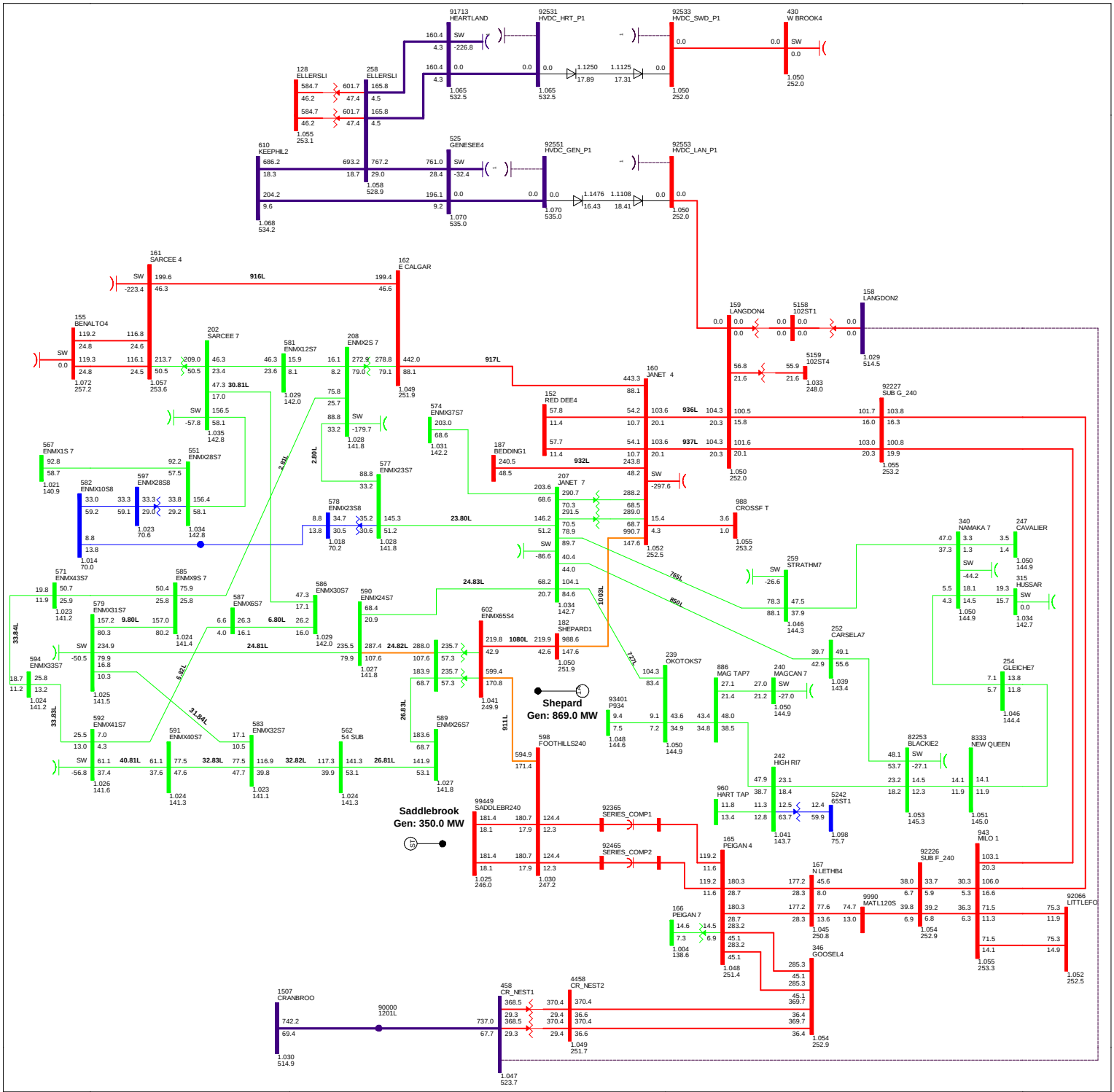
BCH Import: 780.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

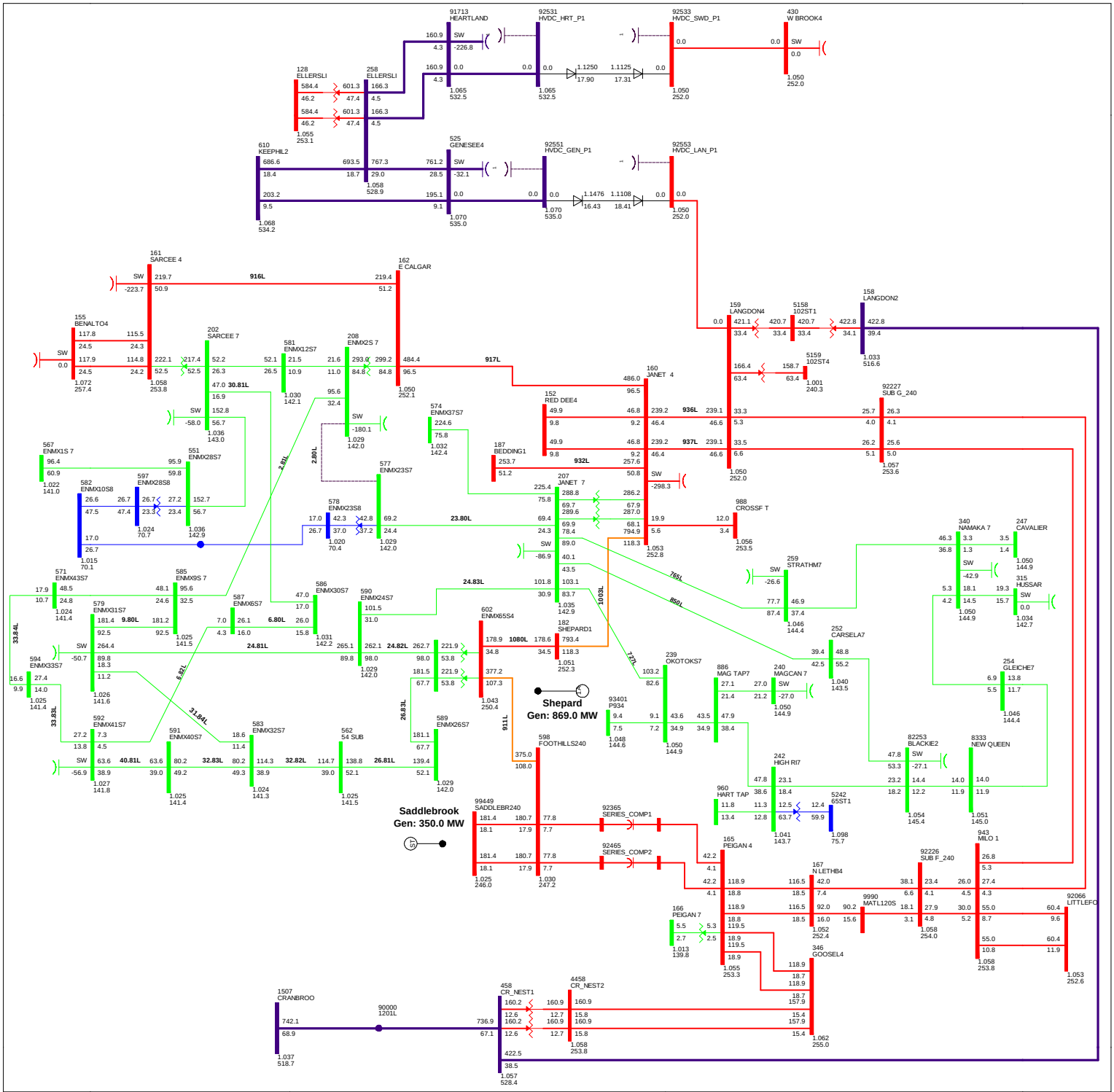
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 805.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

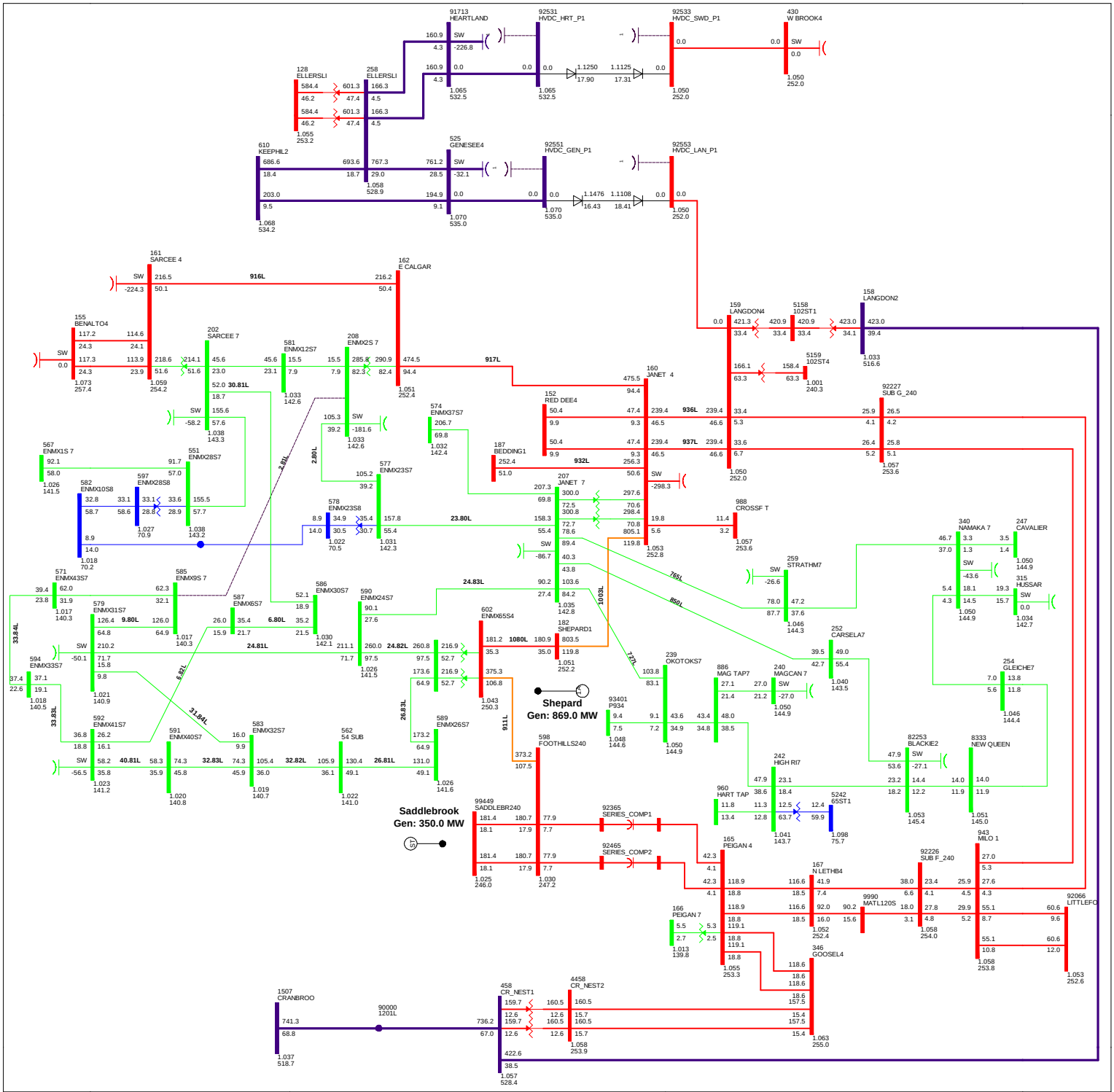
BCH Import: 780.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

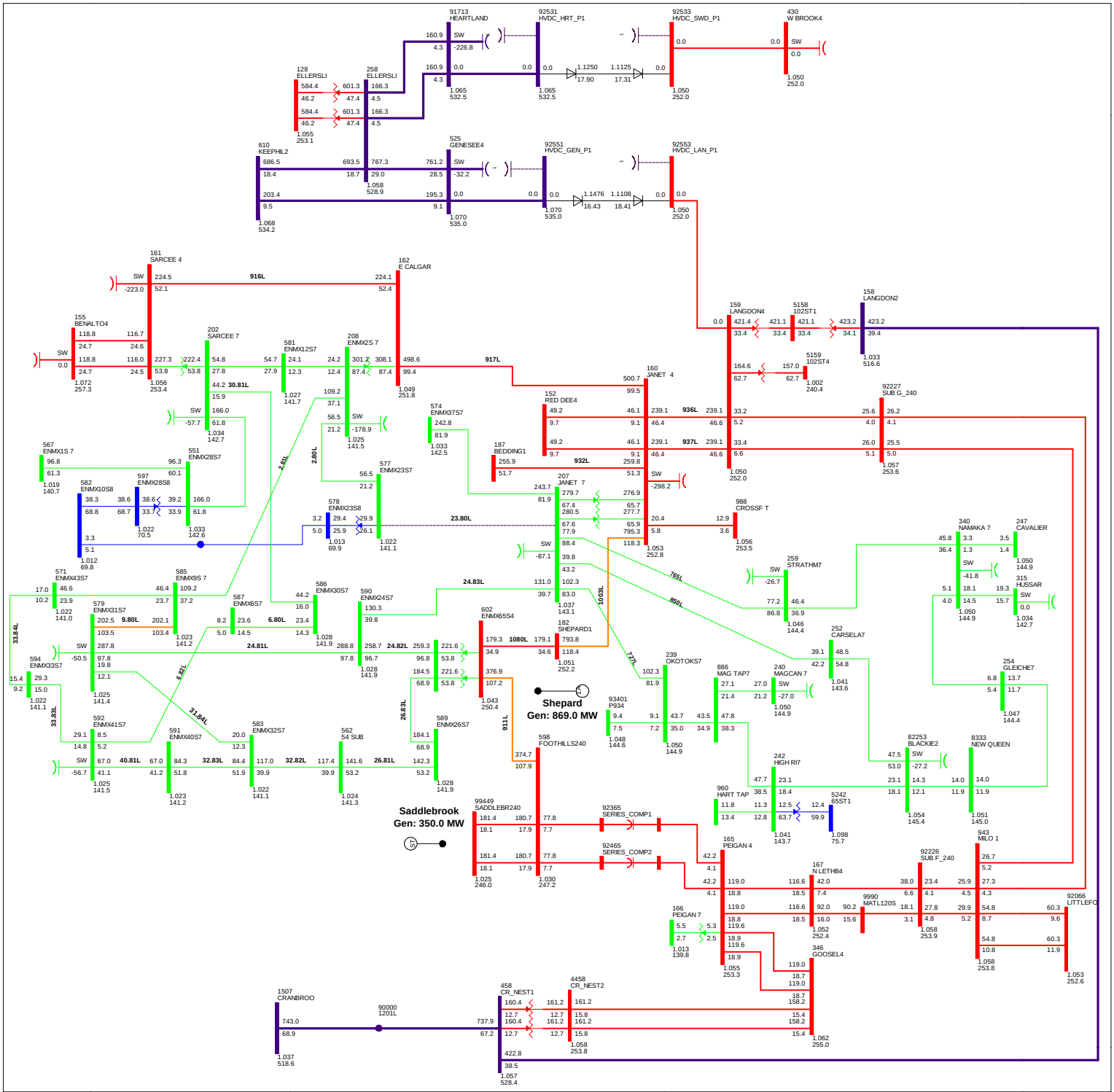
BCH Import: 779.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

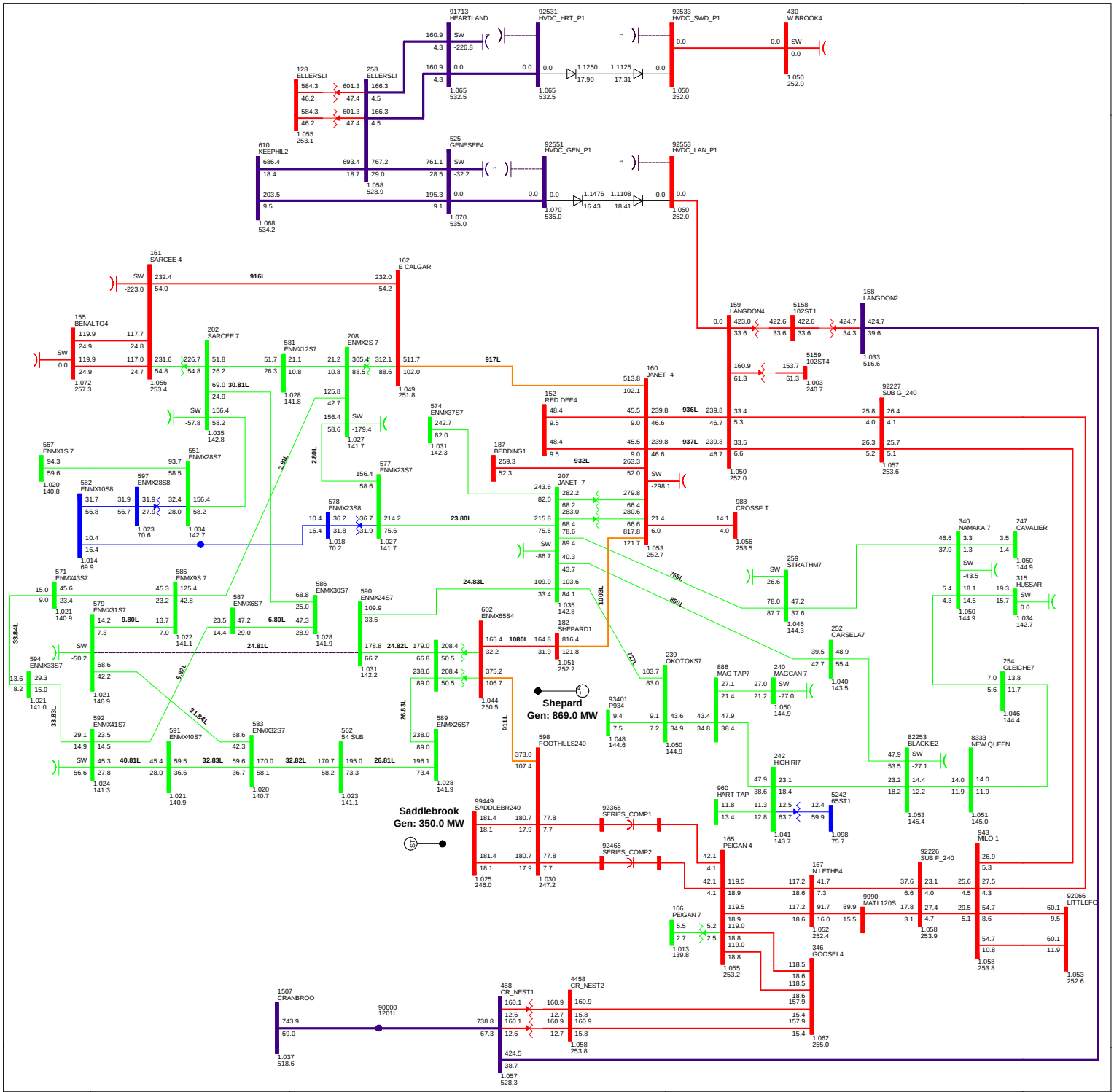
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

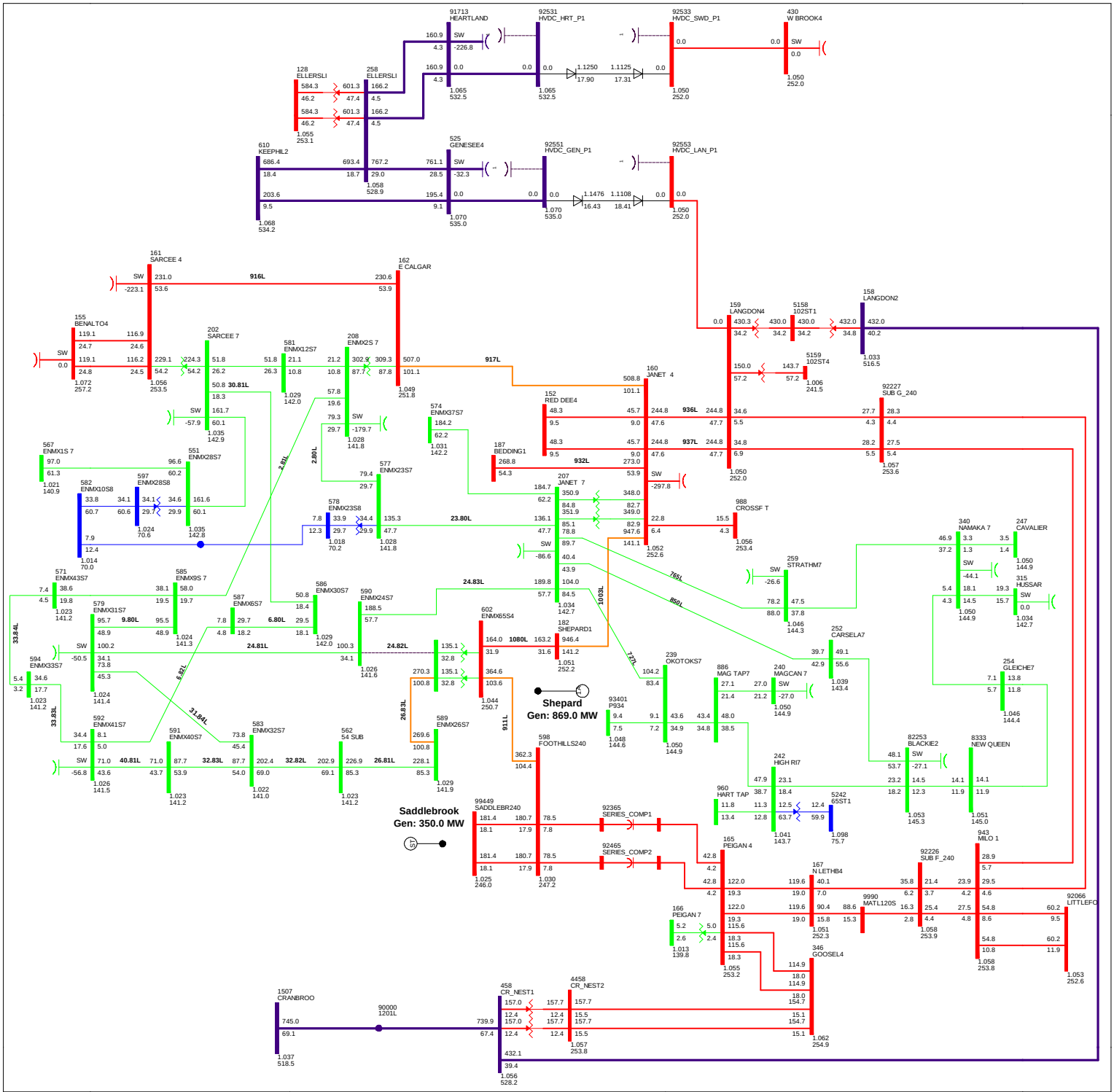
BCH Import: 783.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

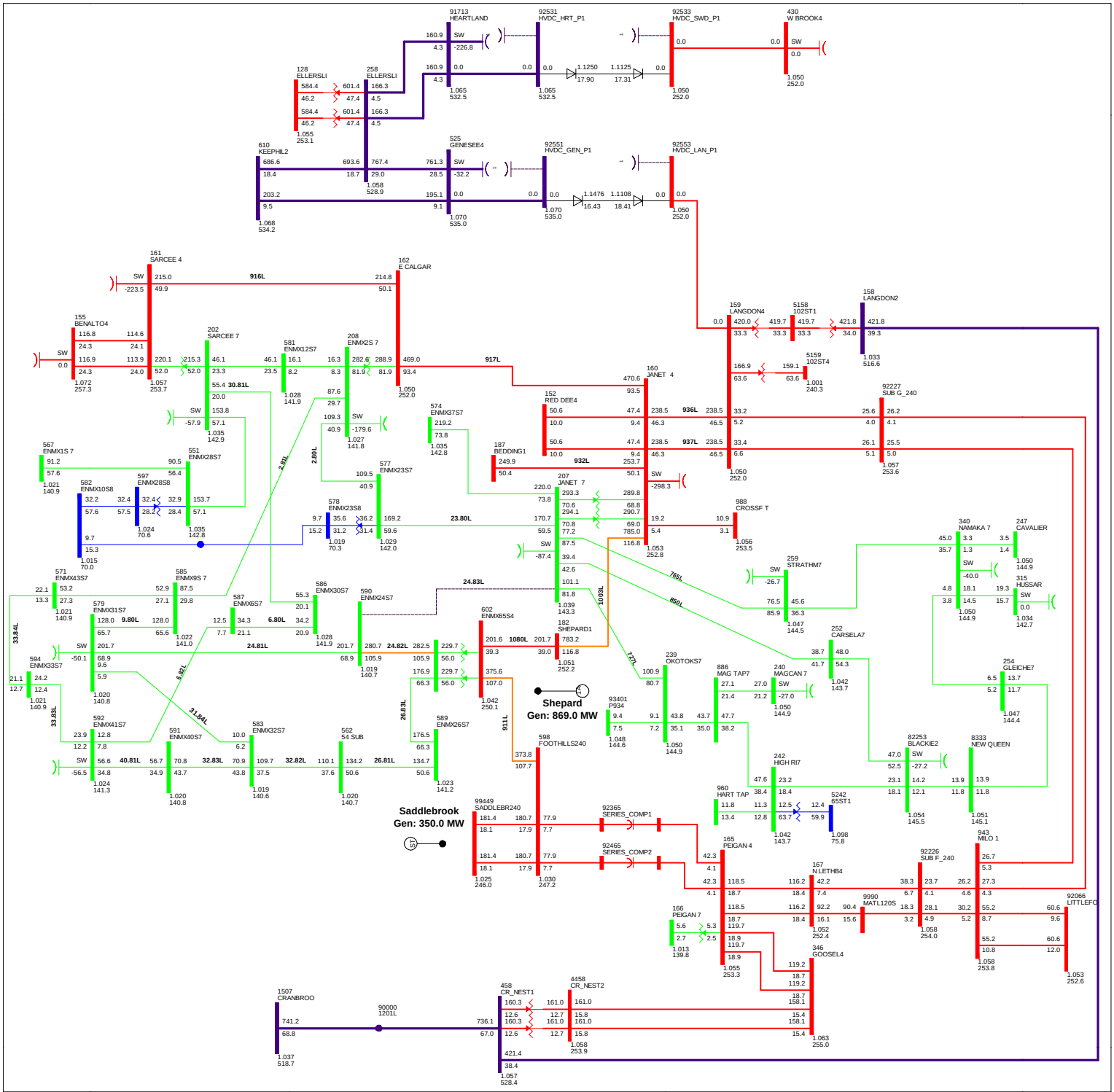
BCH Import: 784.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

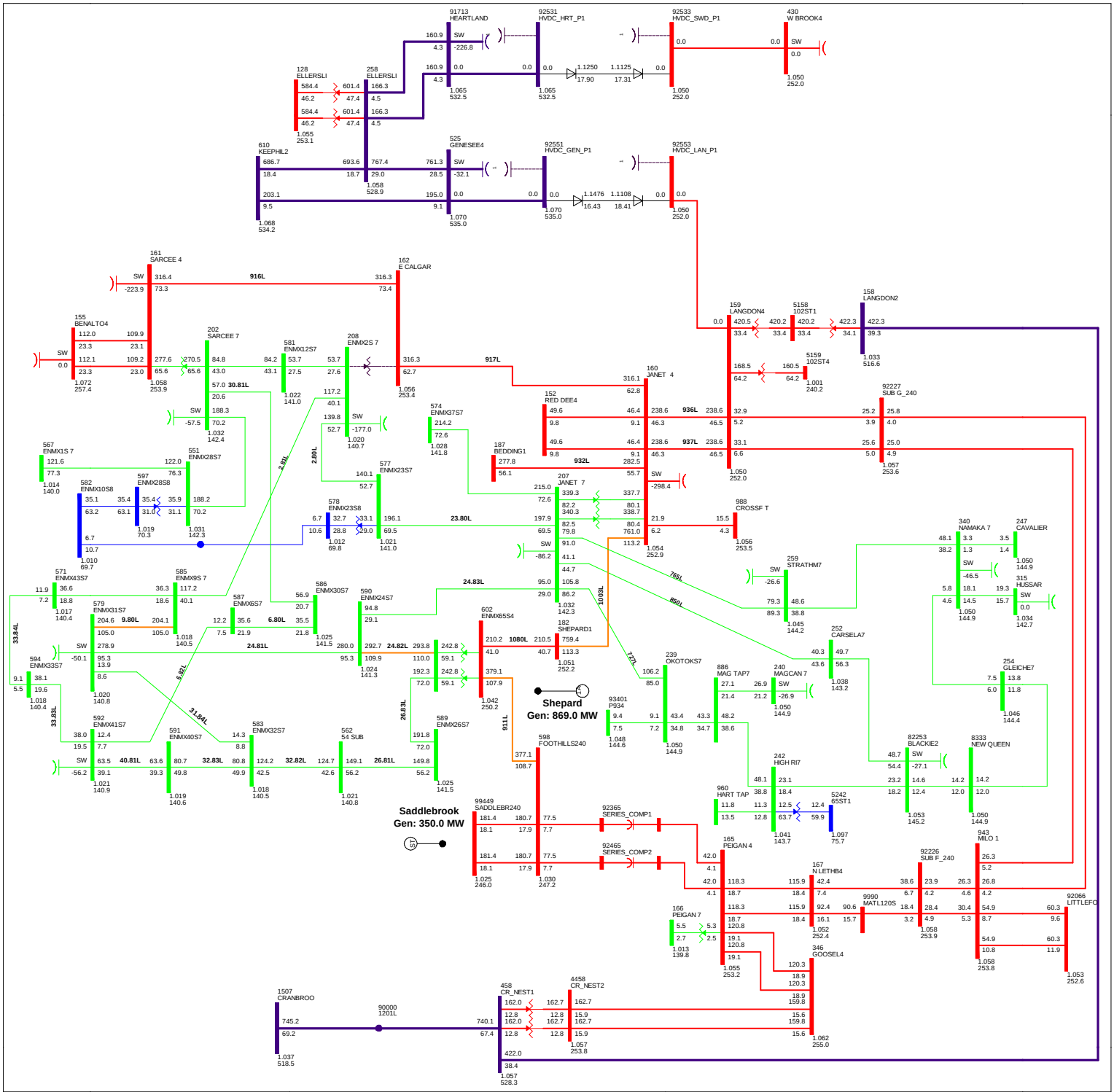
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:44



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

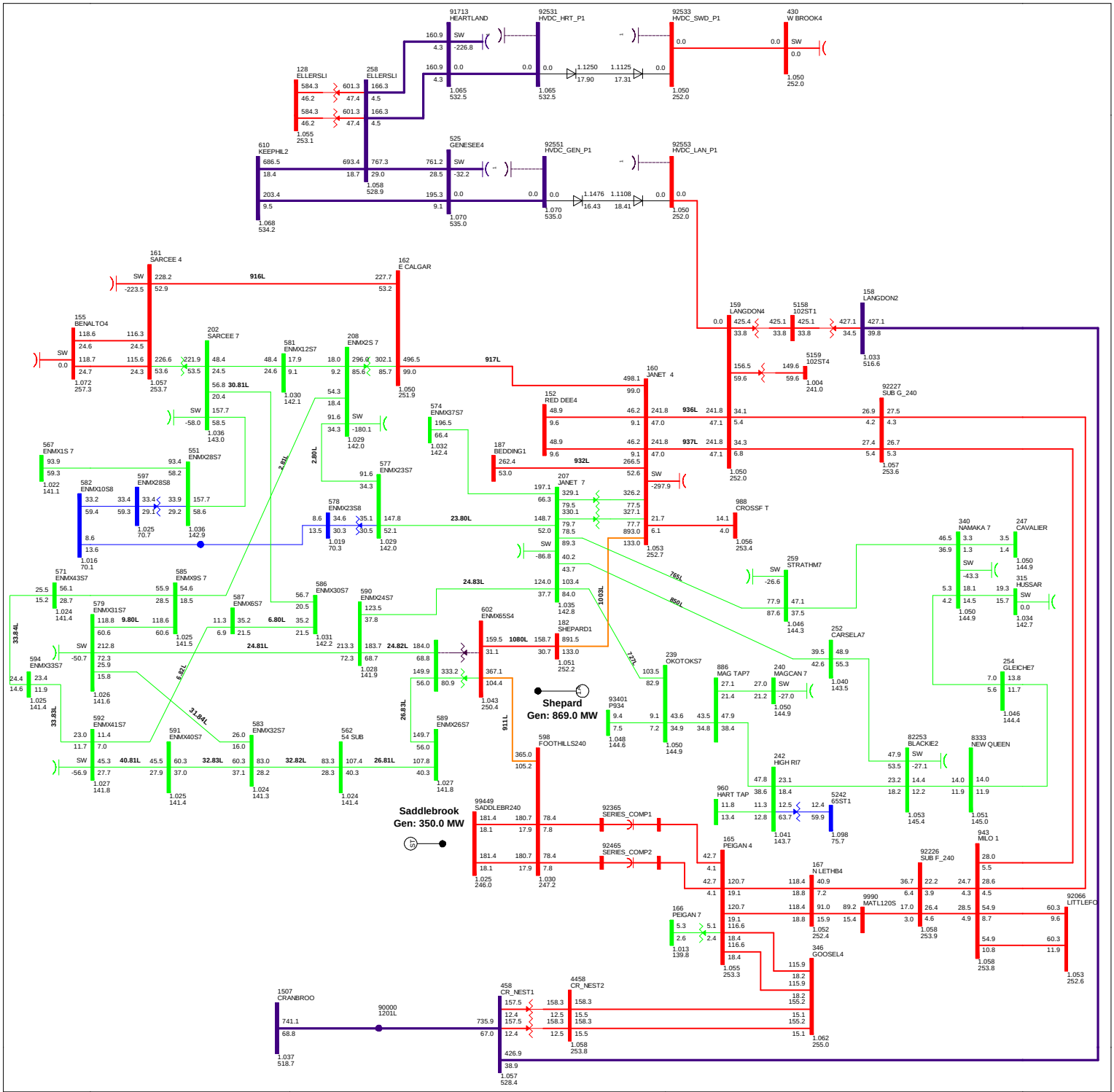
BCH Import: 784.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

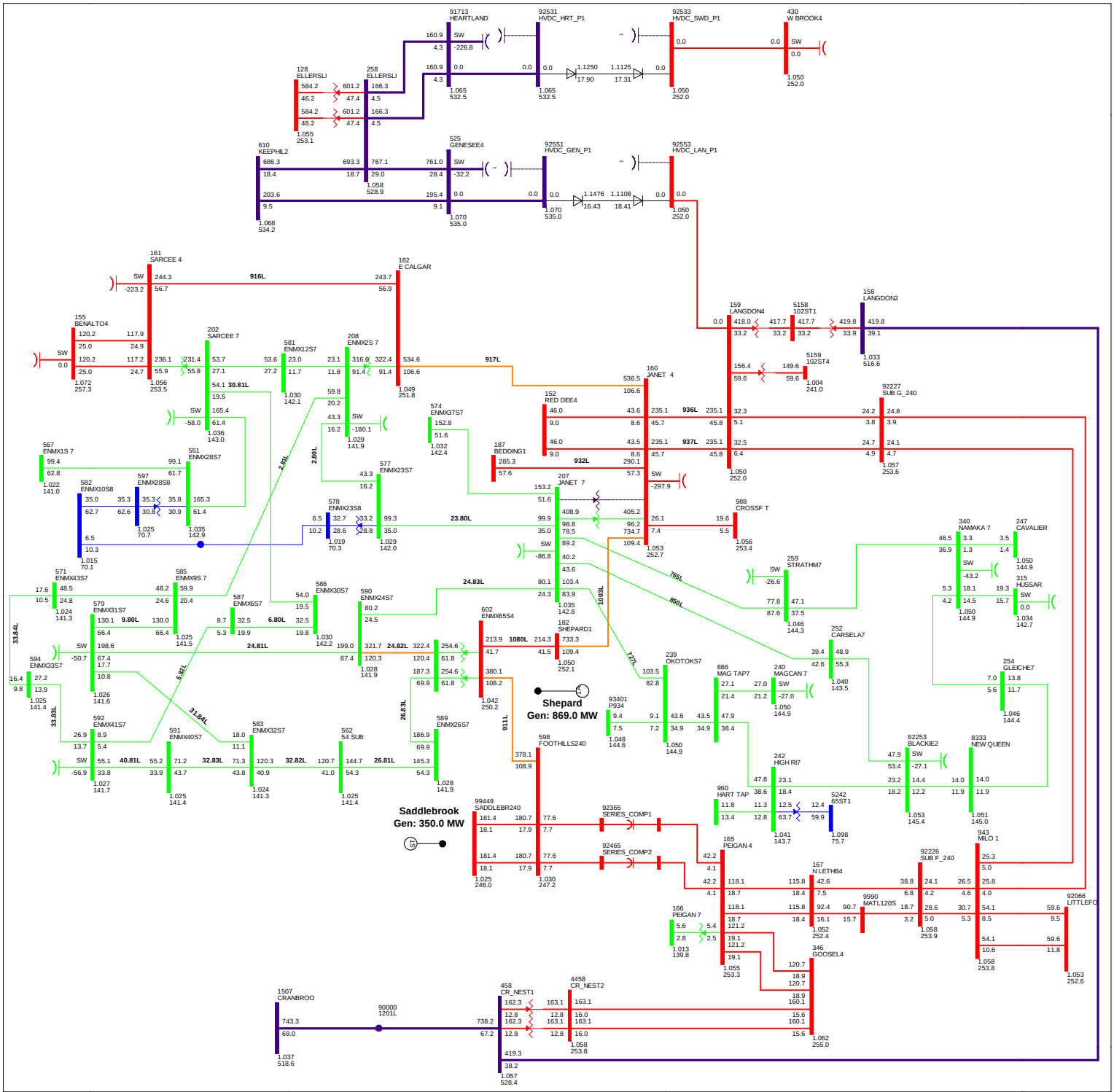
BCH Import: 780.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

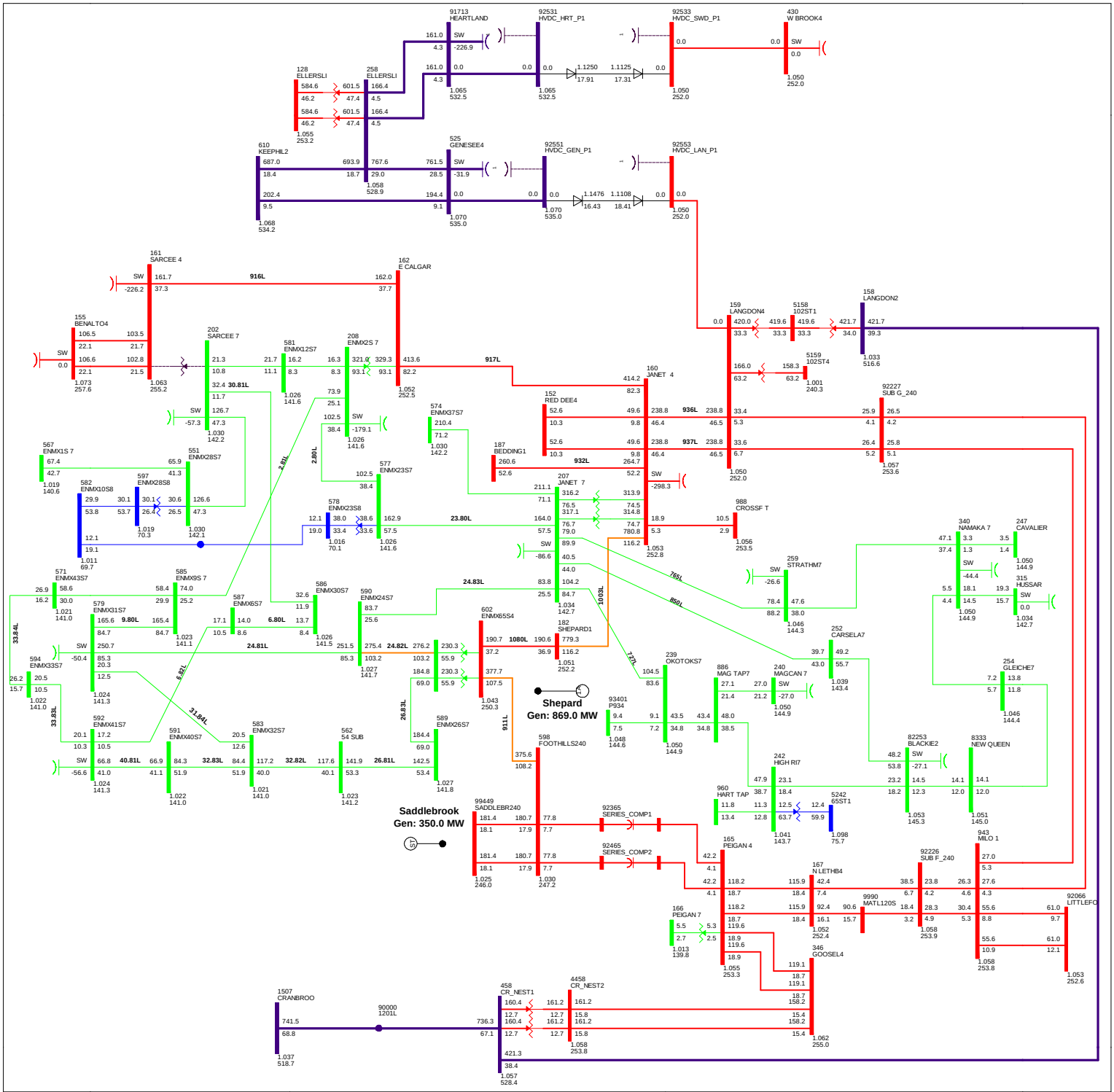
BCH Import: 782.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

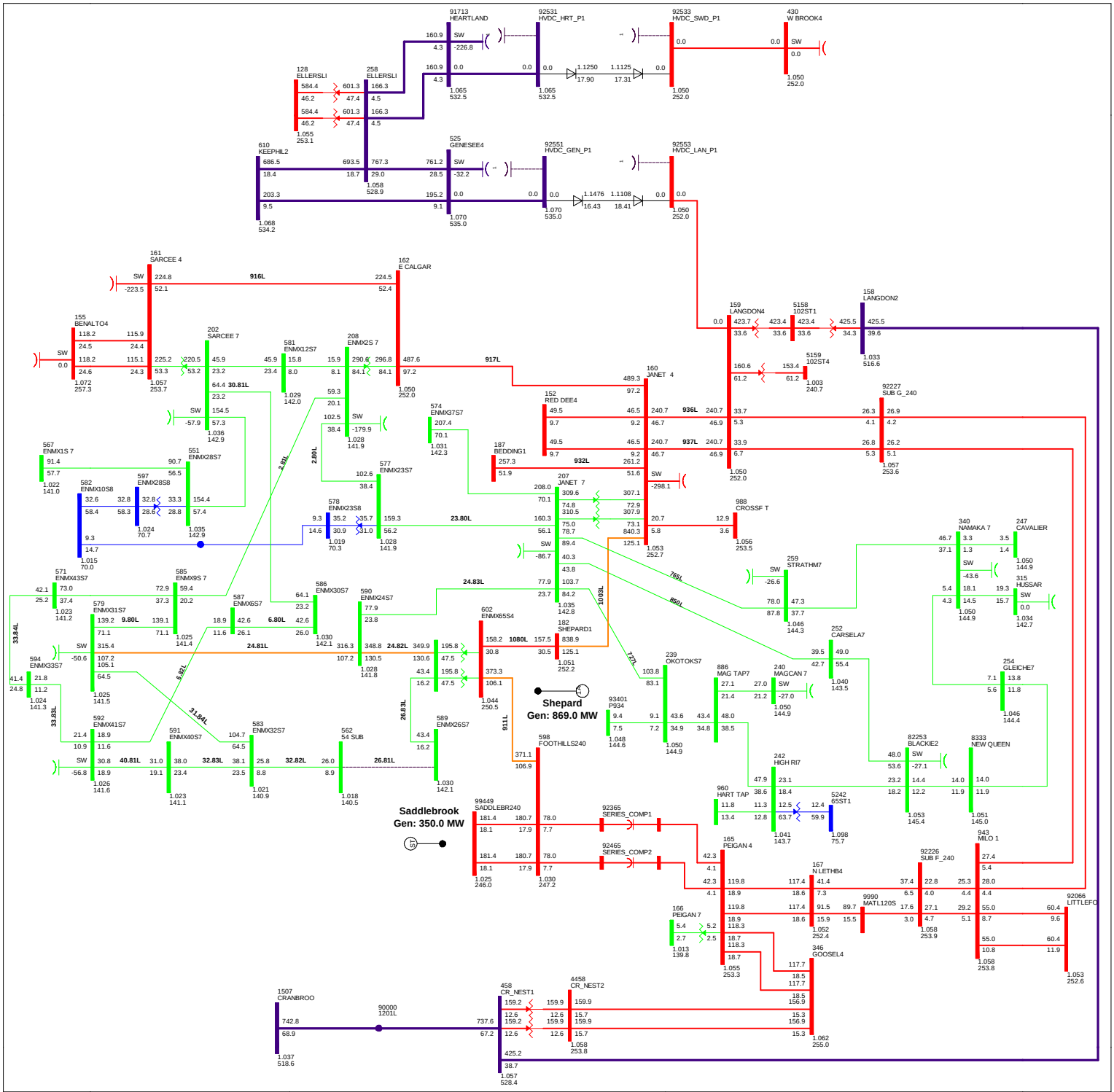
BCH Import: 780.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



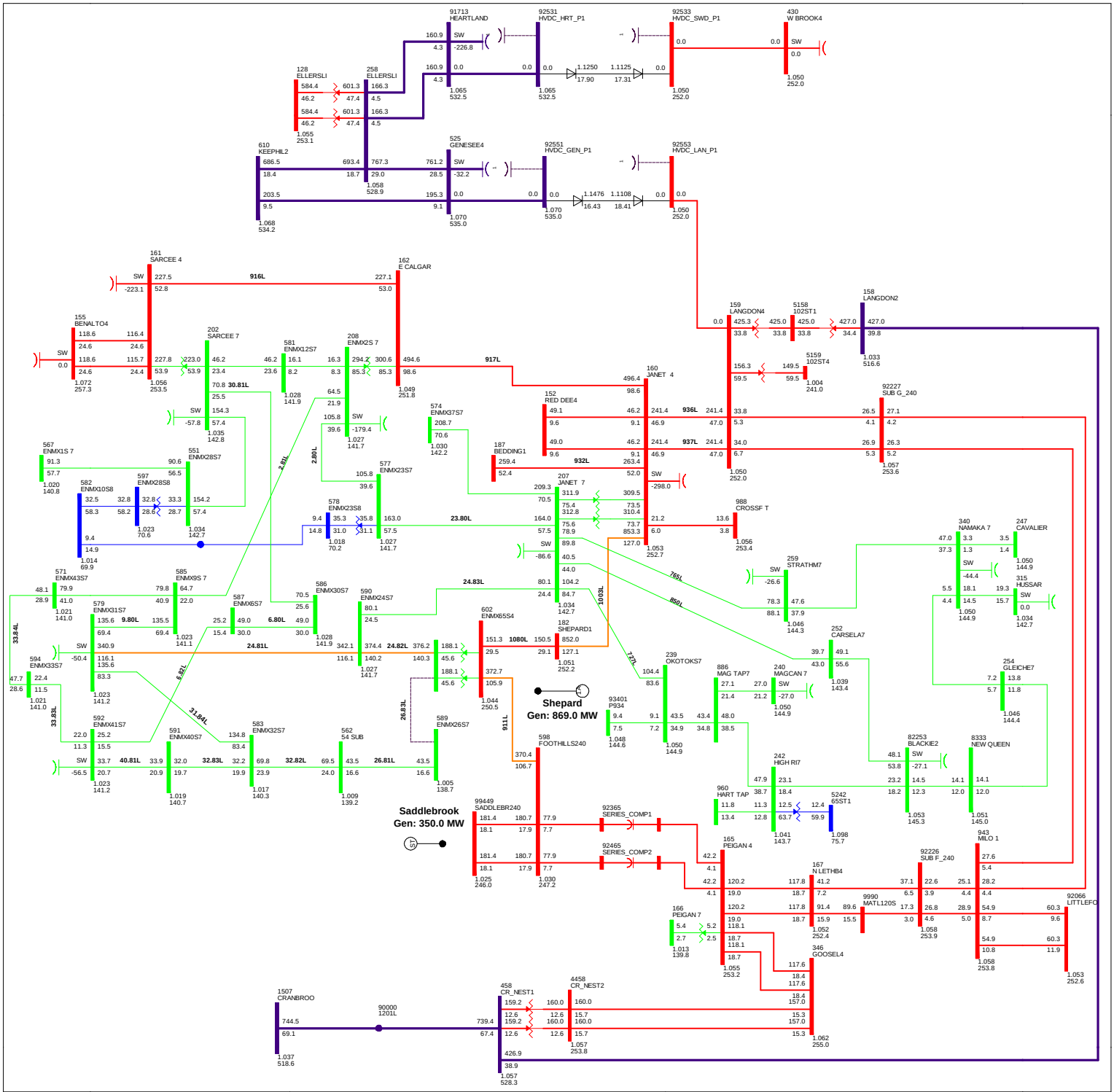
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



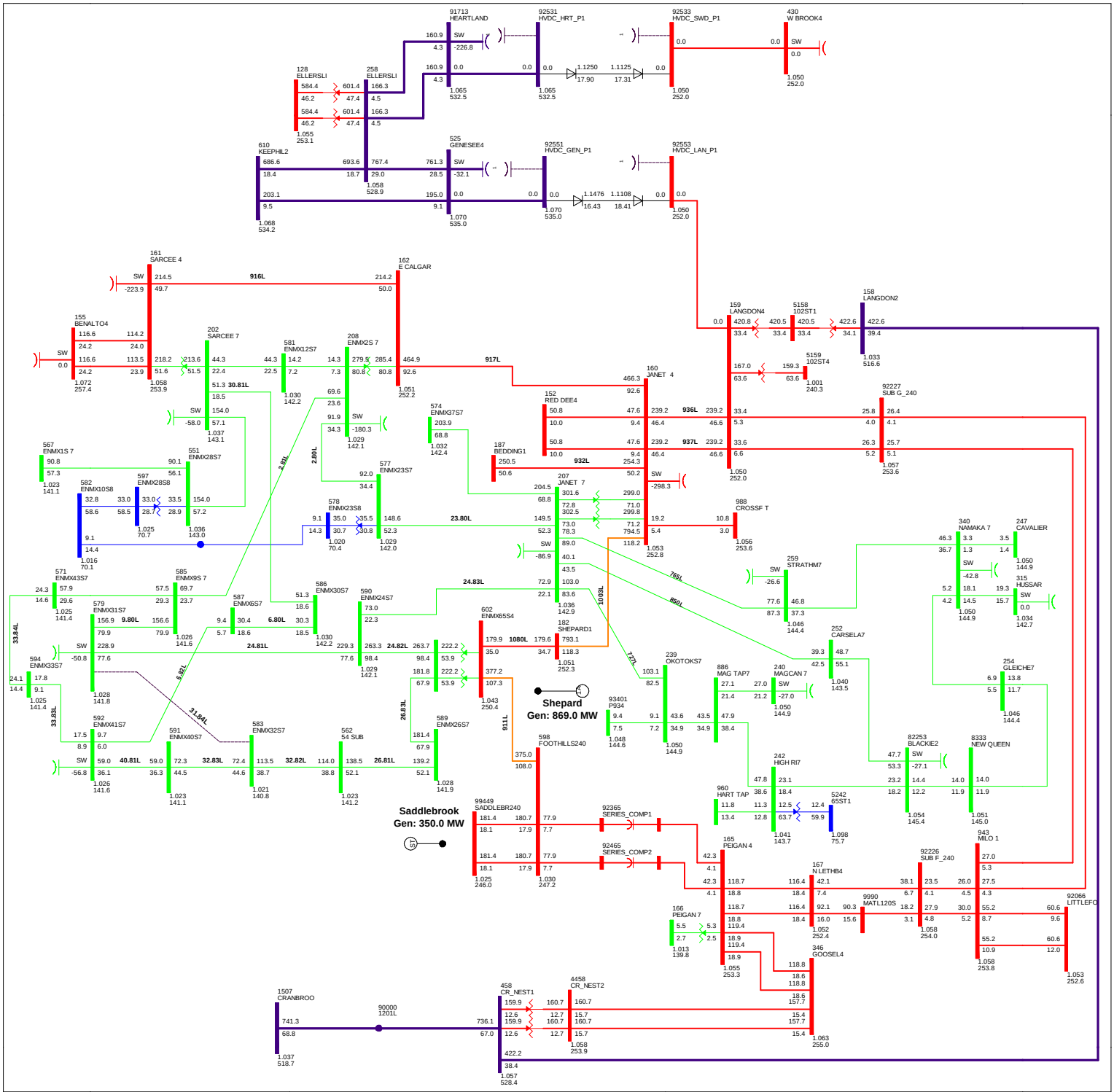
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 783.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

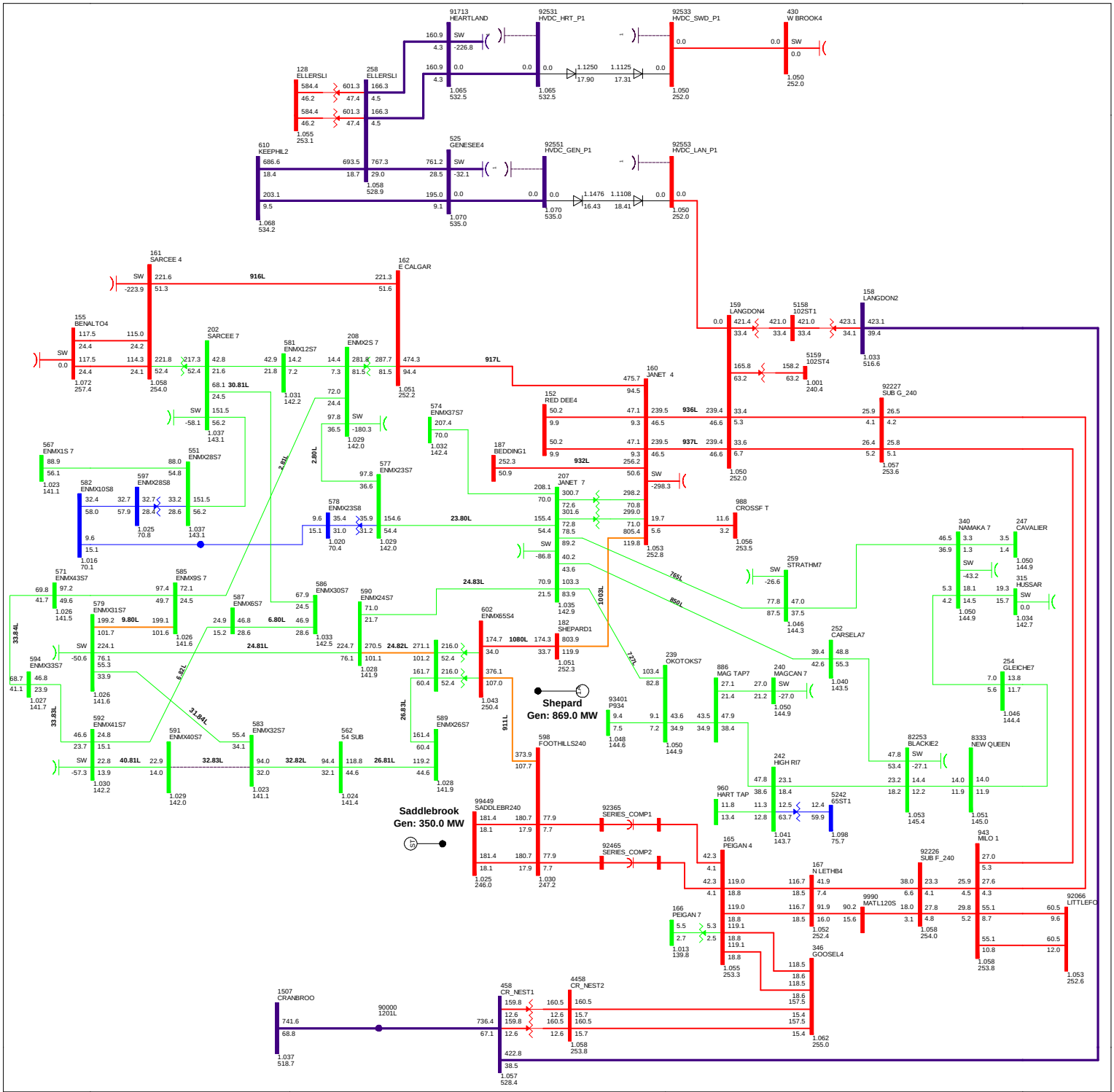
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-17: OPEN 31.84L 138 KV LINE (ENMAX 31 TO ENMAX 32)
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



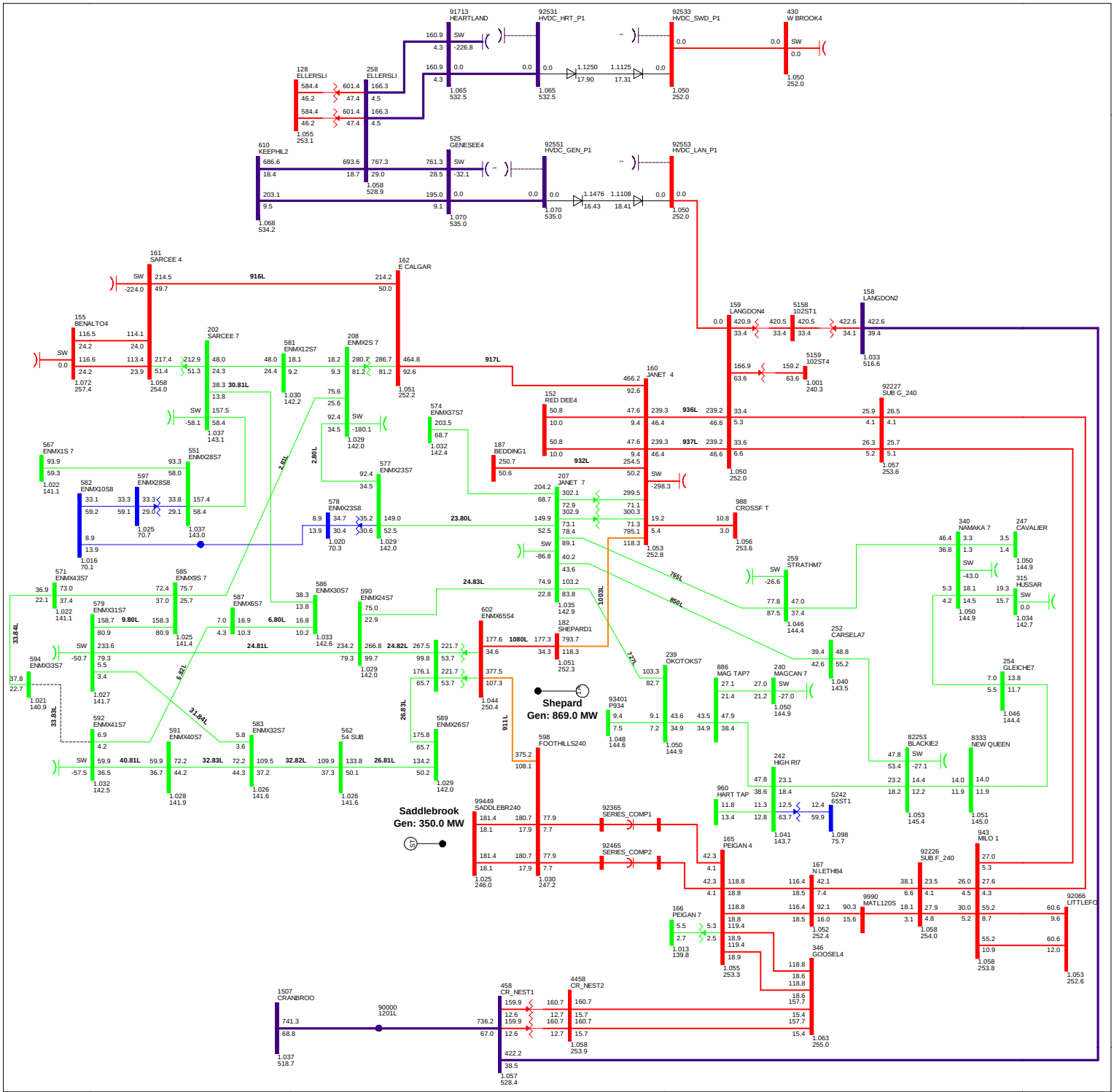
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-18: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



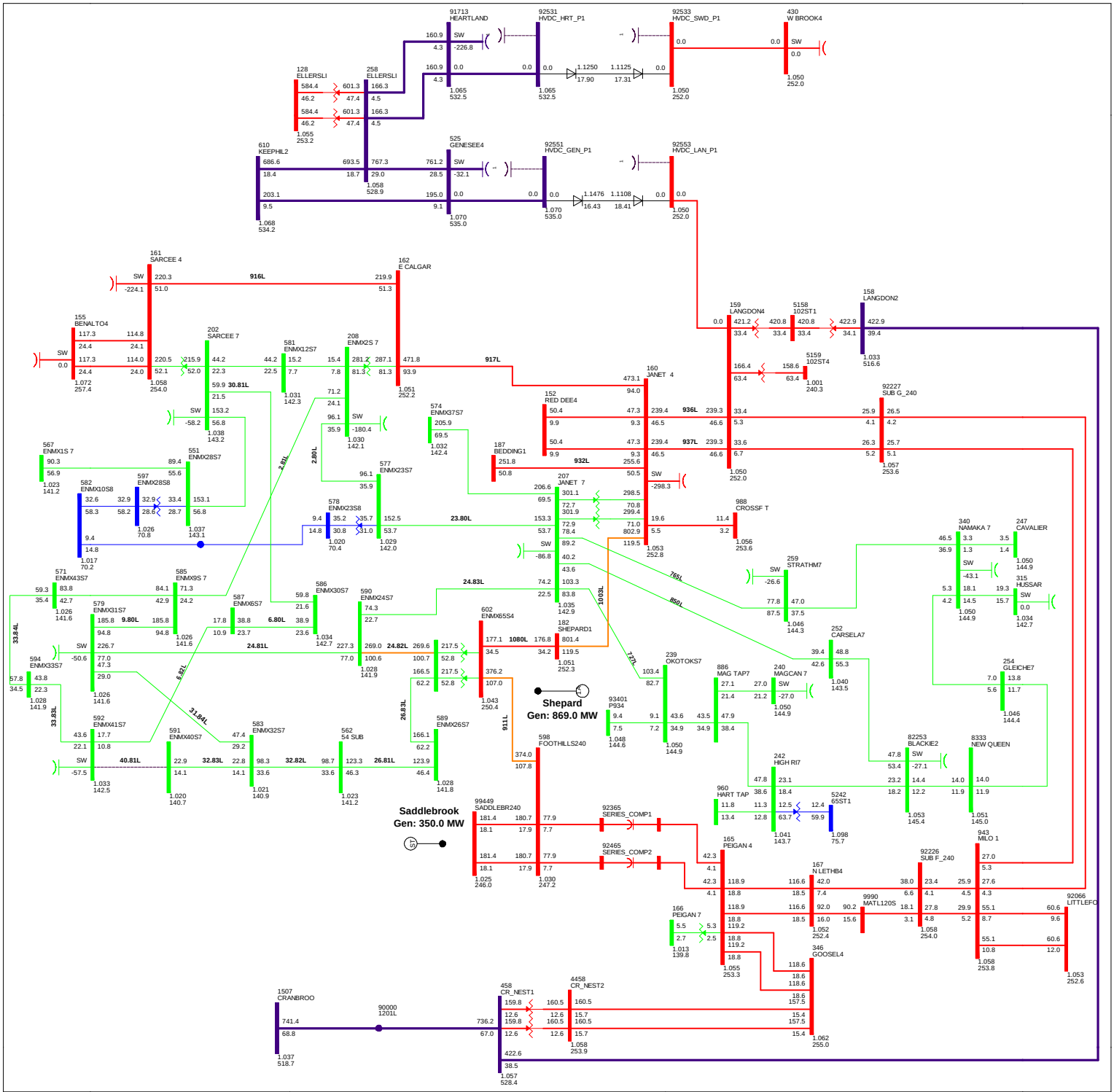
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-19: OPEN 33.83L 138 KV LINE (ENMAX 41 TO ENMAX 33)
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



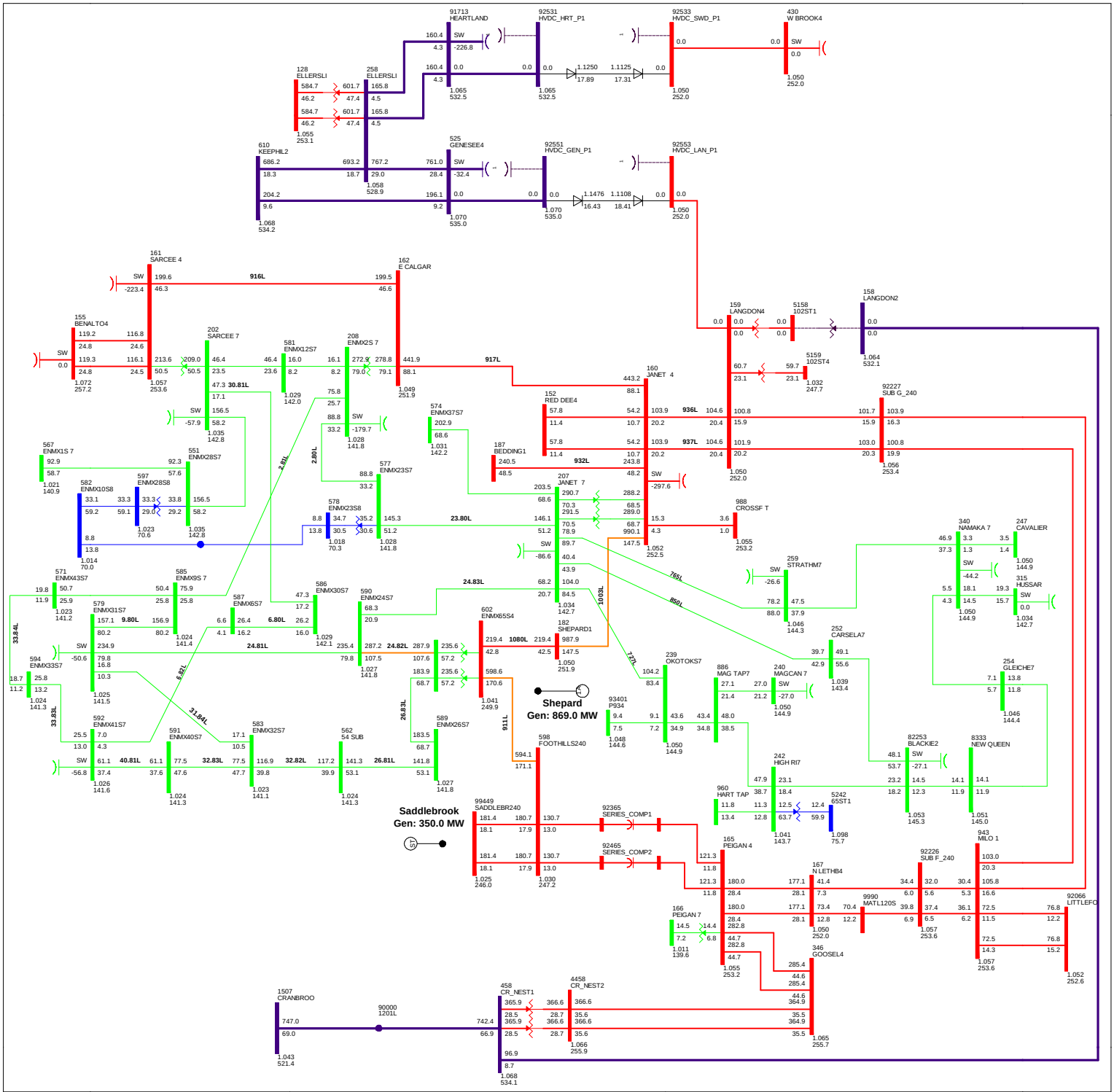
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-20: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

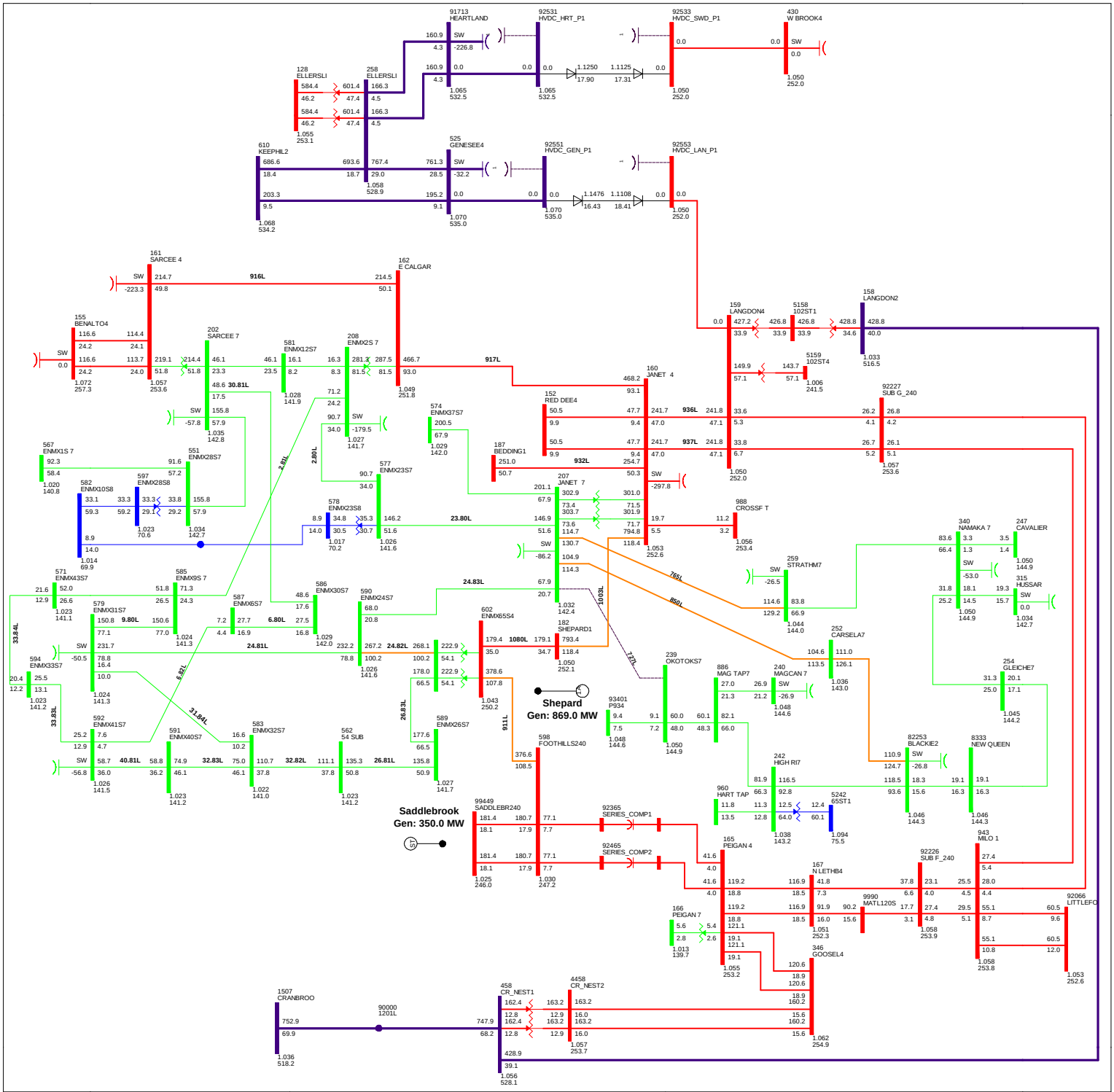
BCH Import: 804.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-21: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



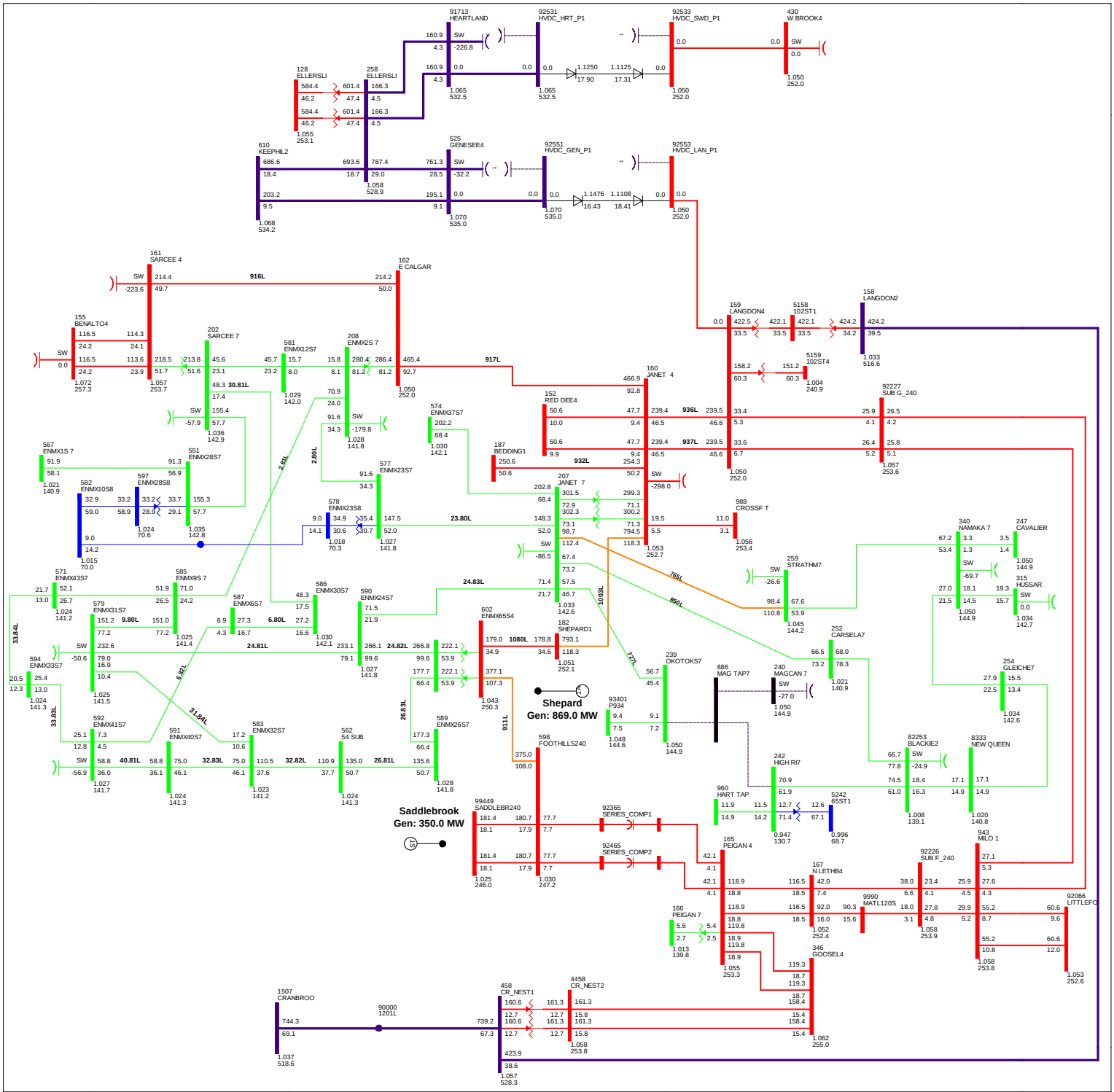
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 792.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-22: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

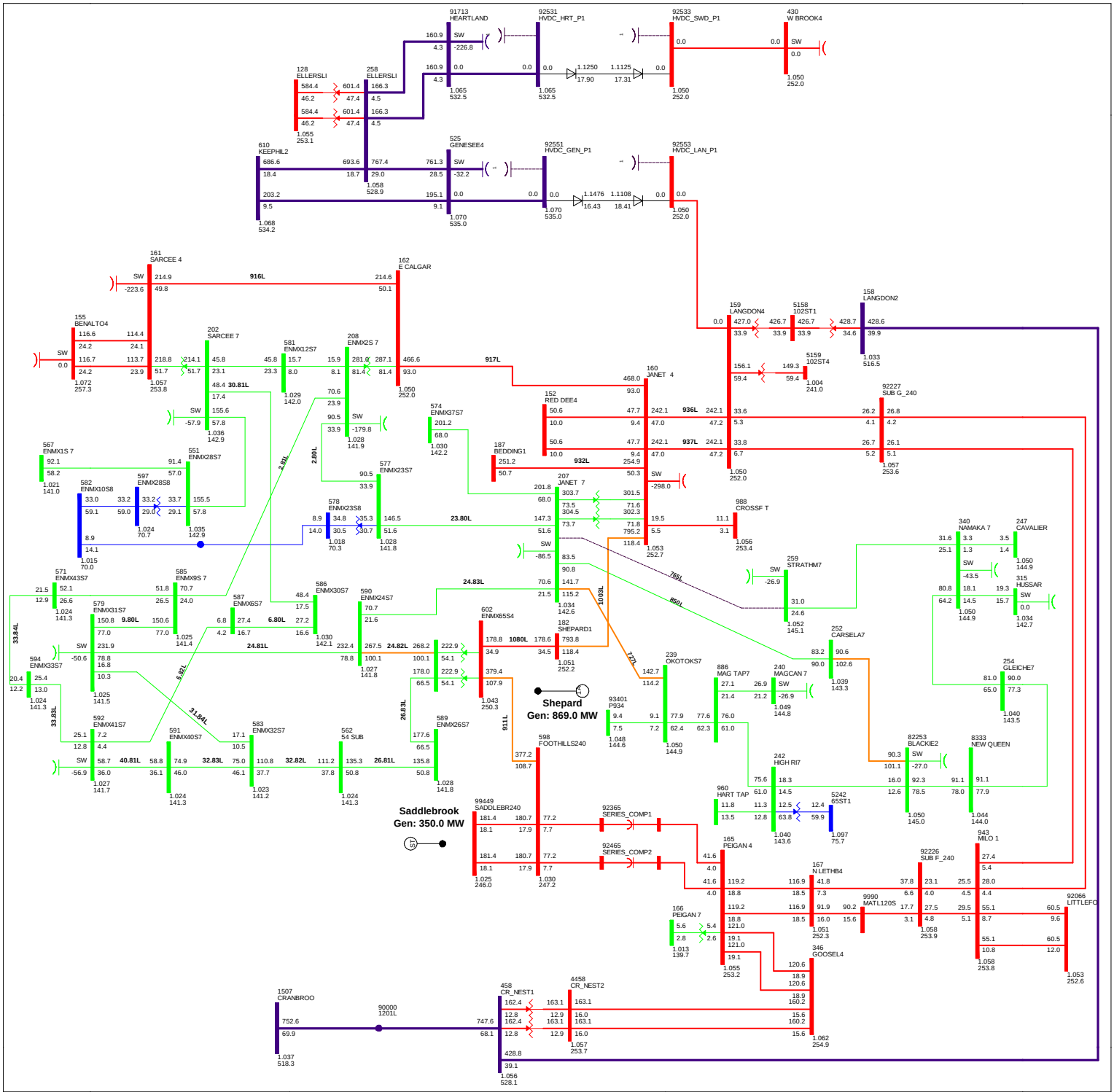
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-23: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



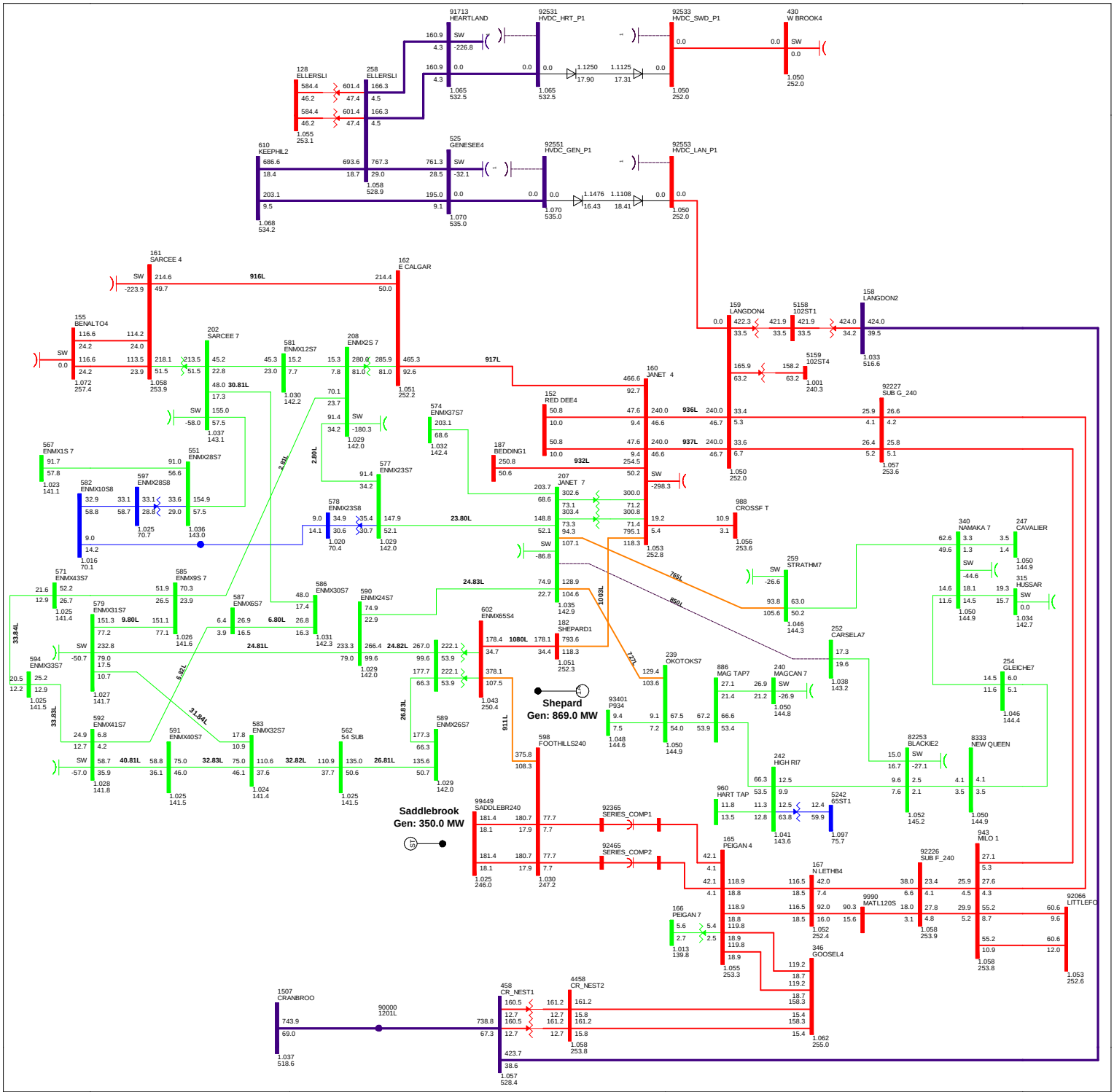
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 791.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-24: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

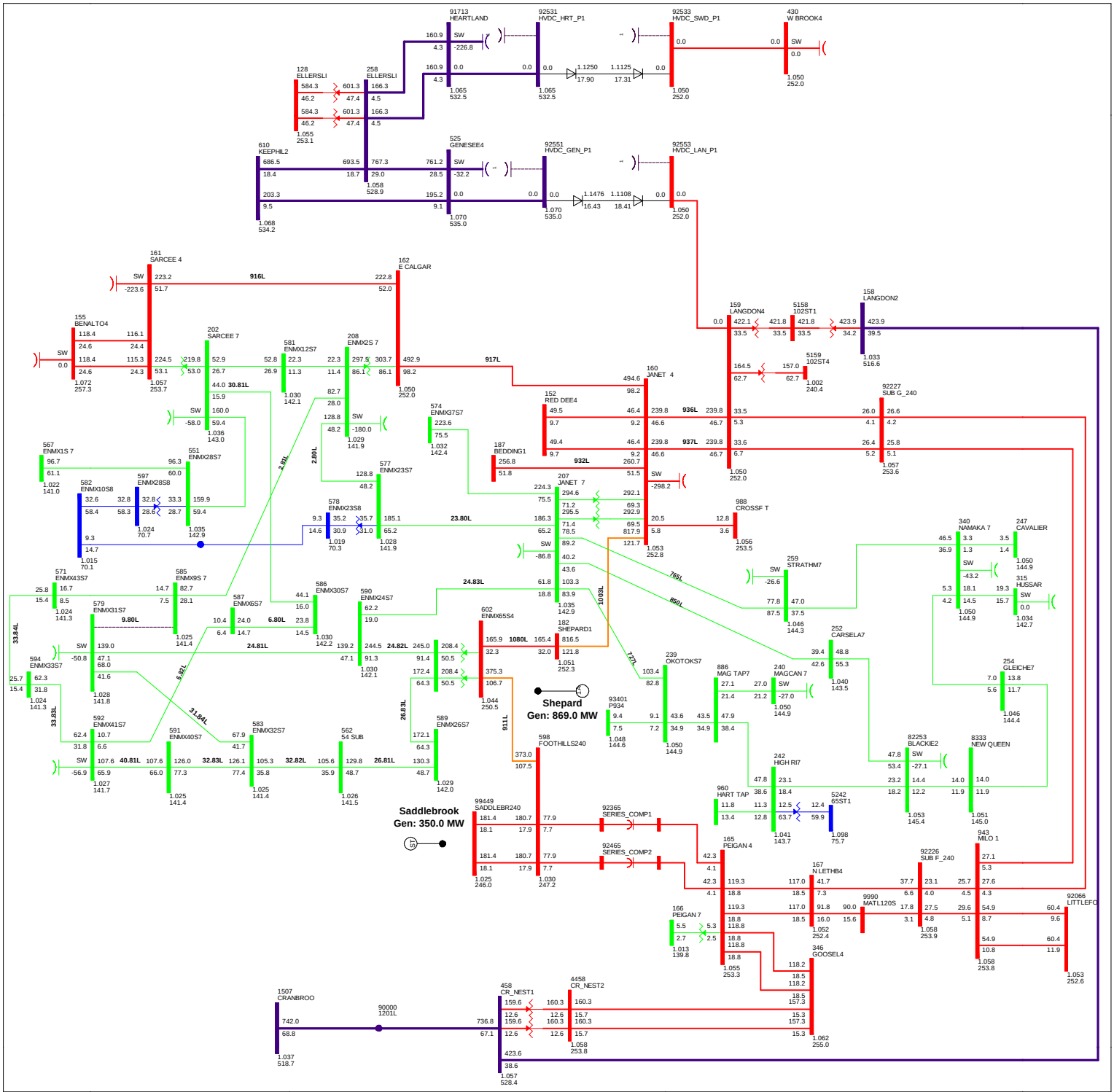
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-25: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

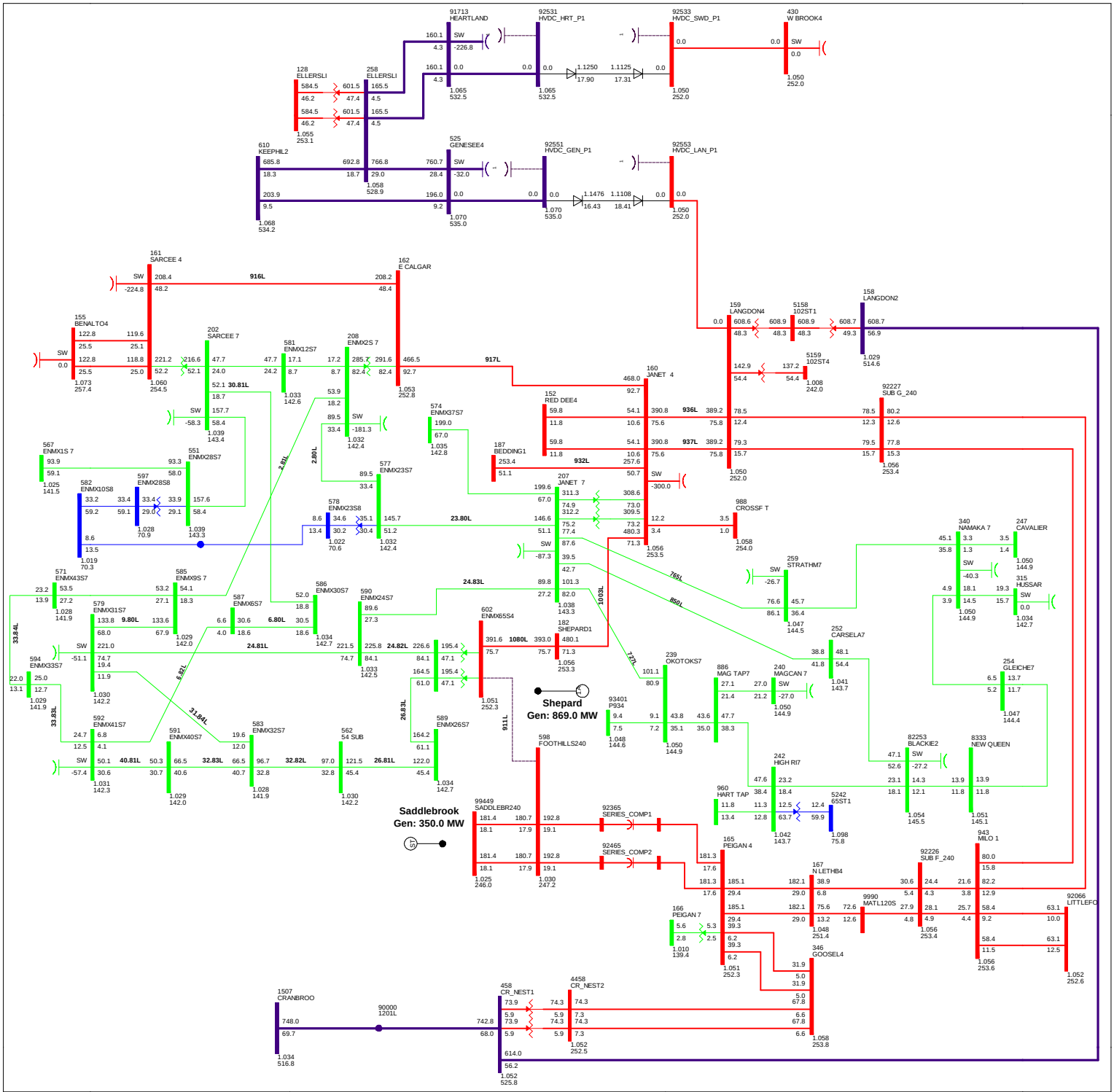
BCH Import: 780.8 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-26: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



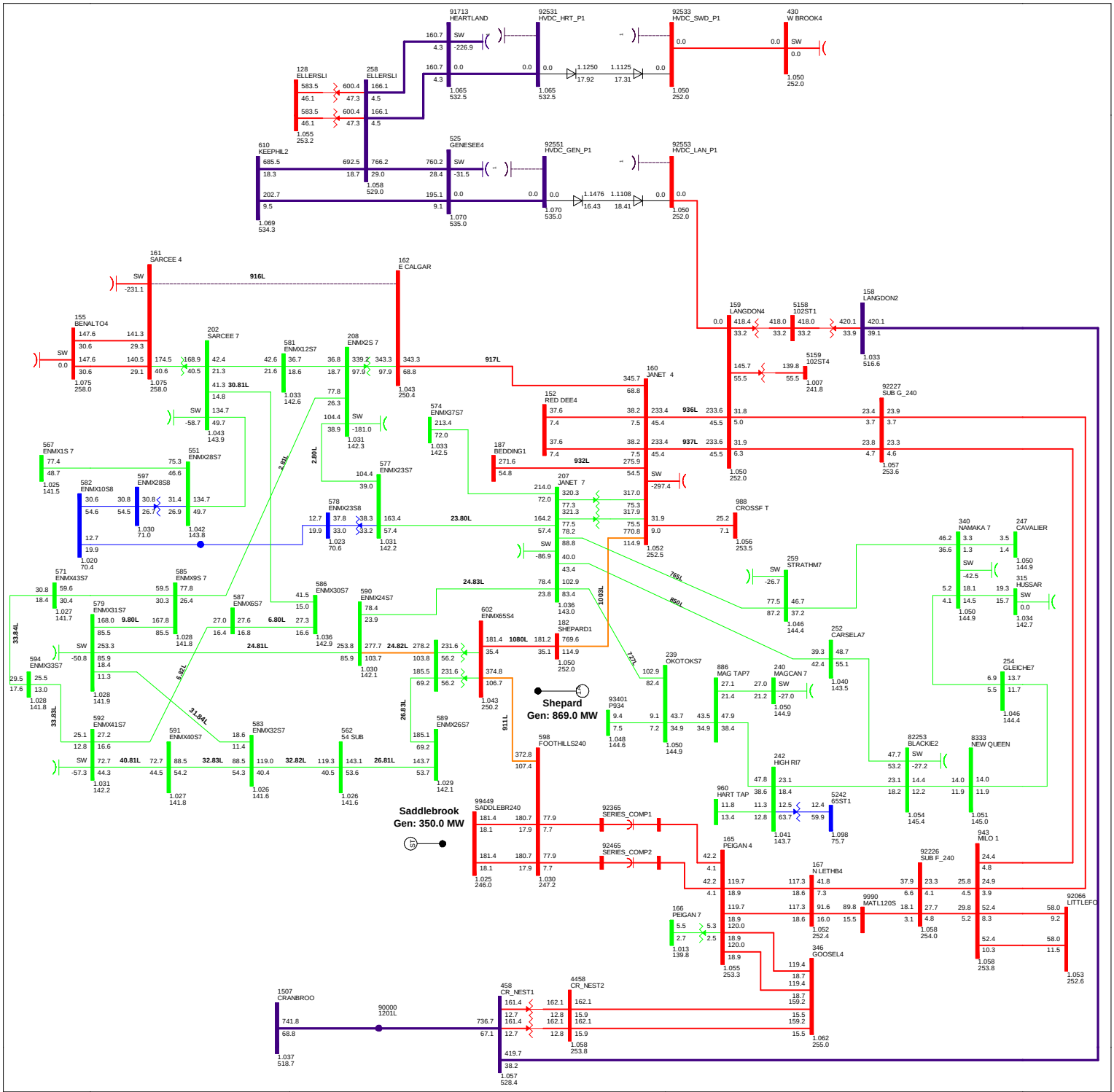
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 788.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-27: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX 2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



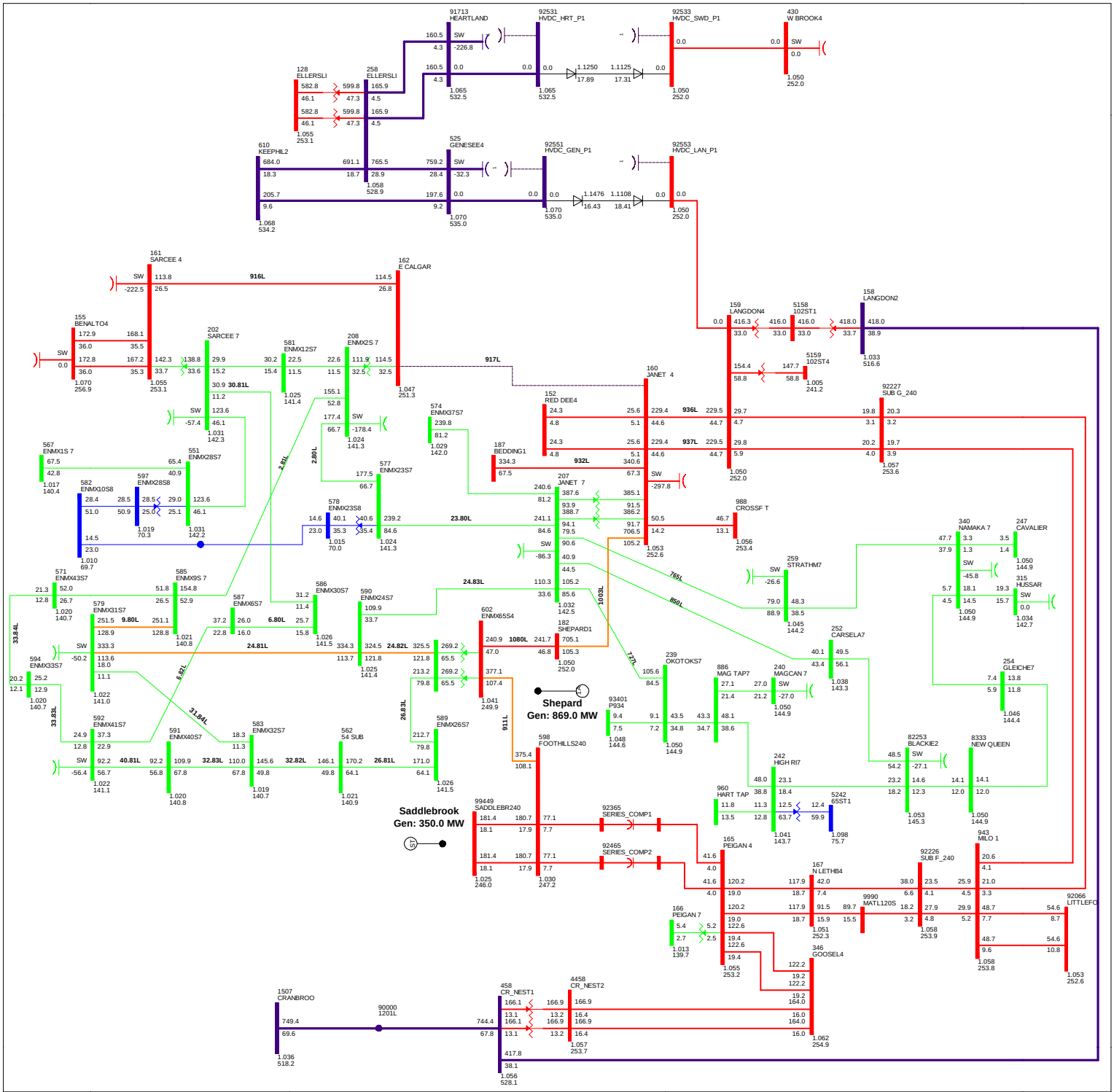
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.6 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-28: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

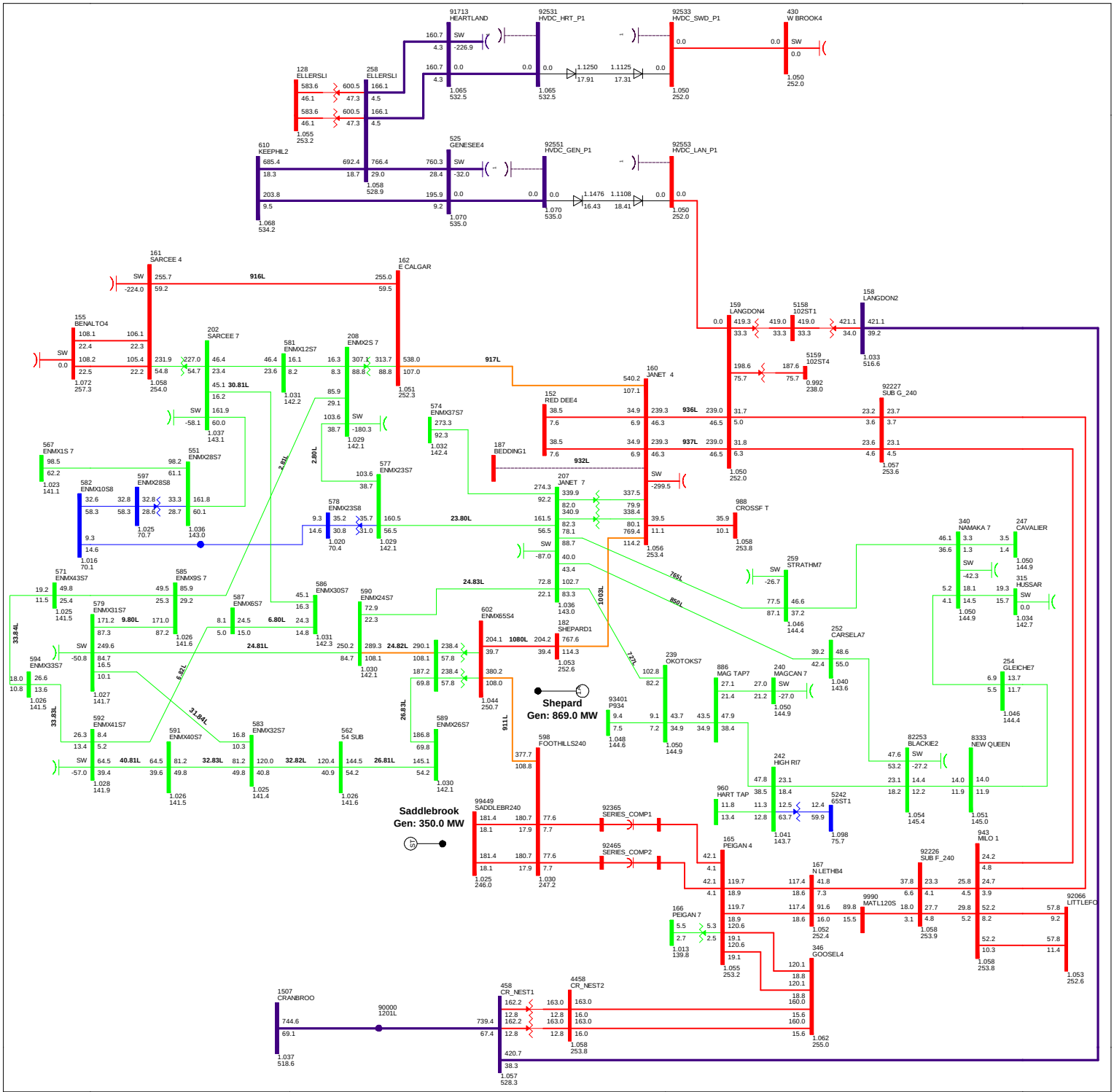
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 792.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-29: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

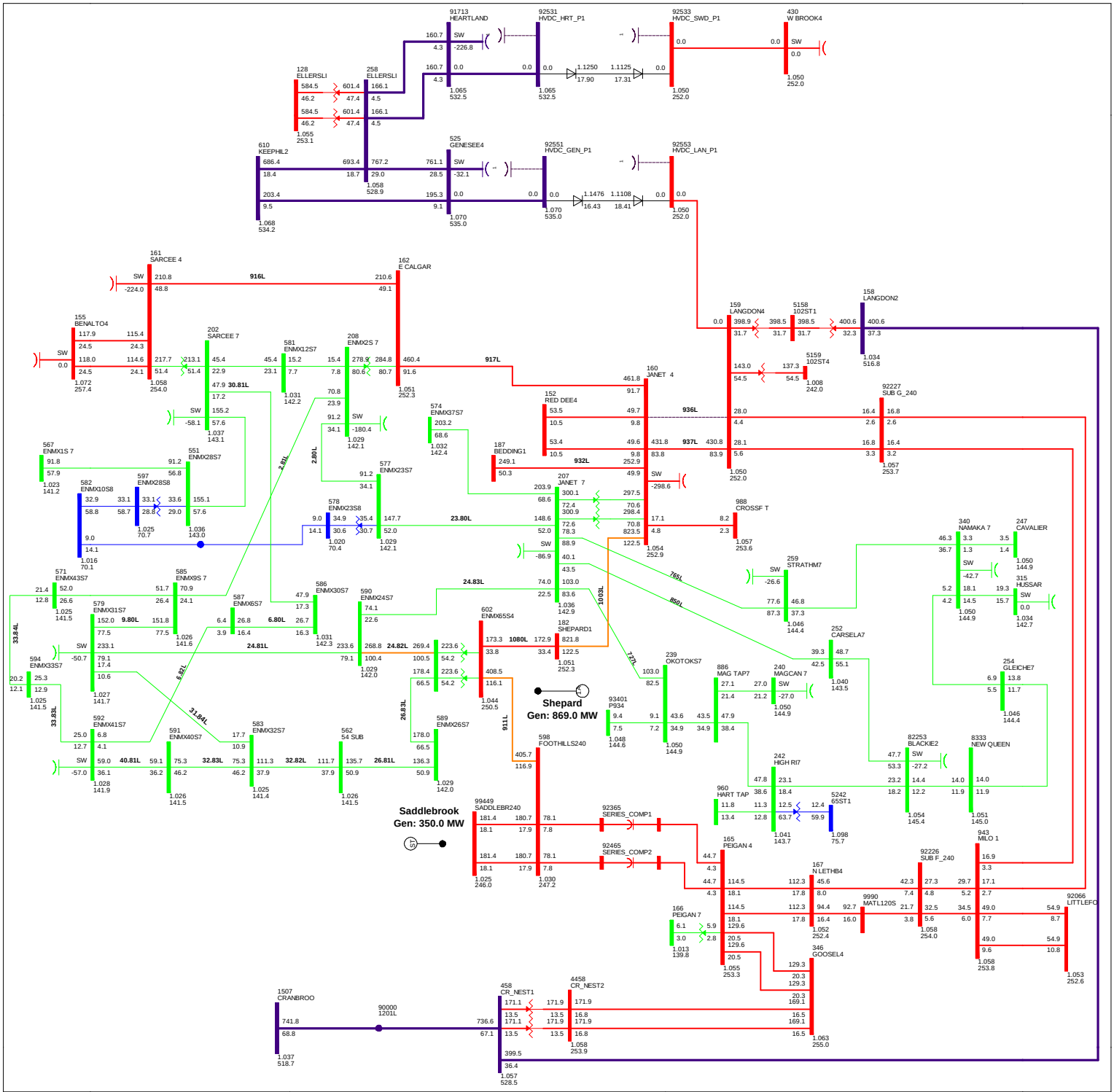
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 784.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-30: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON 2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



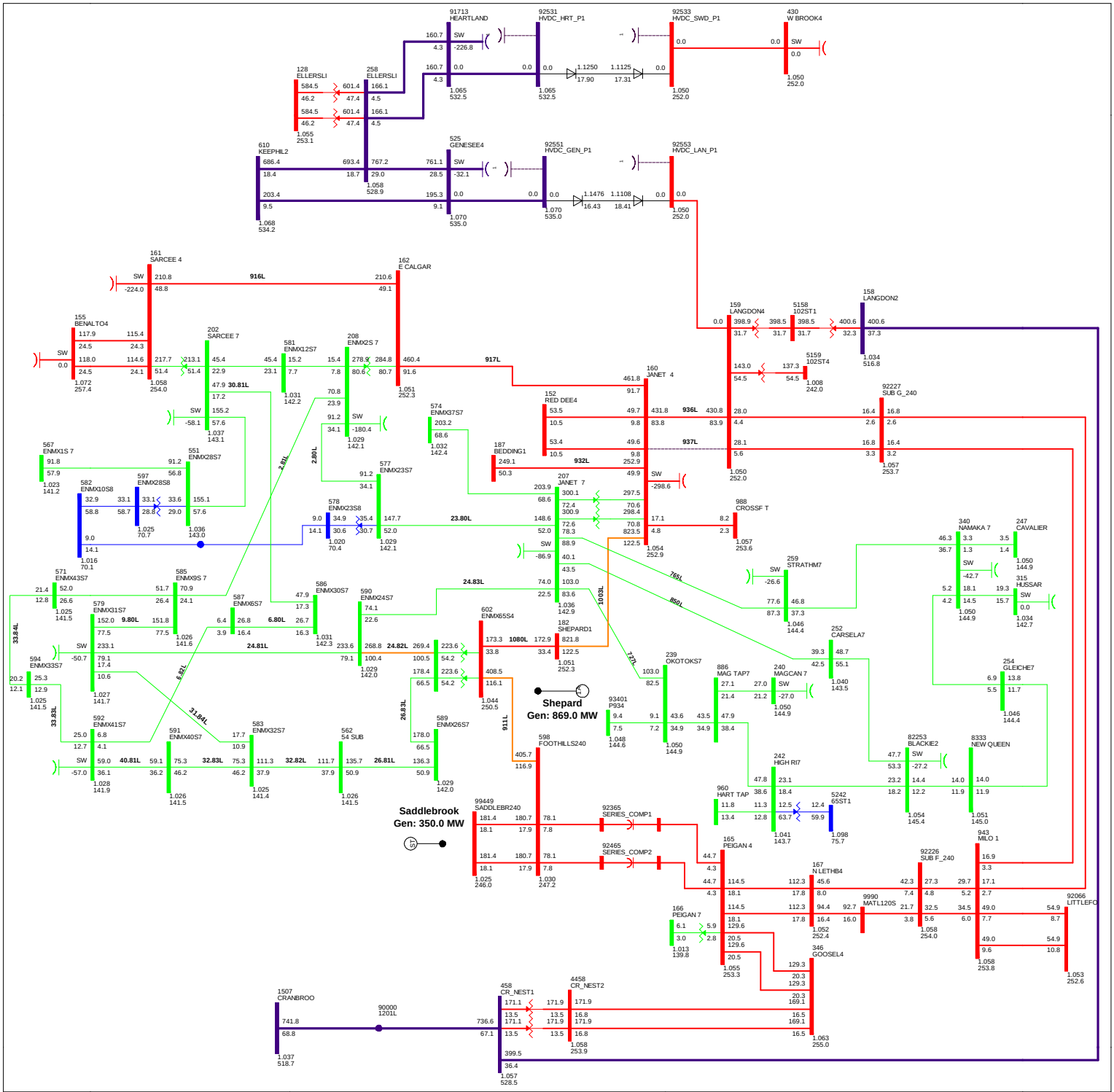
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-31: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

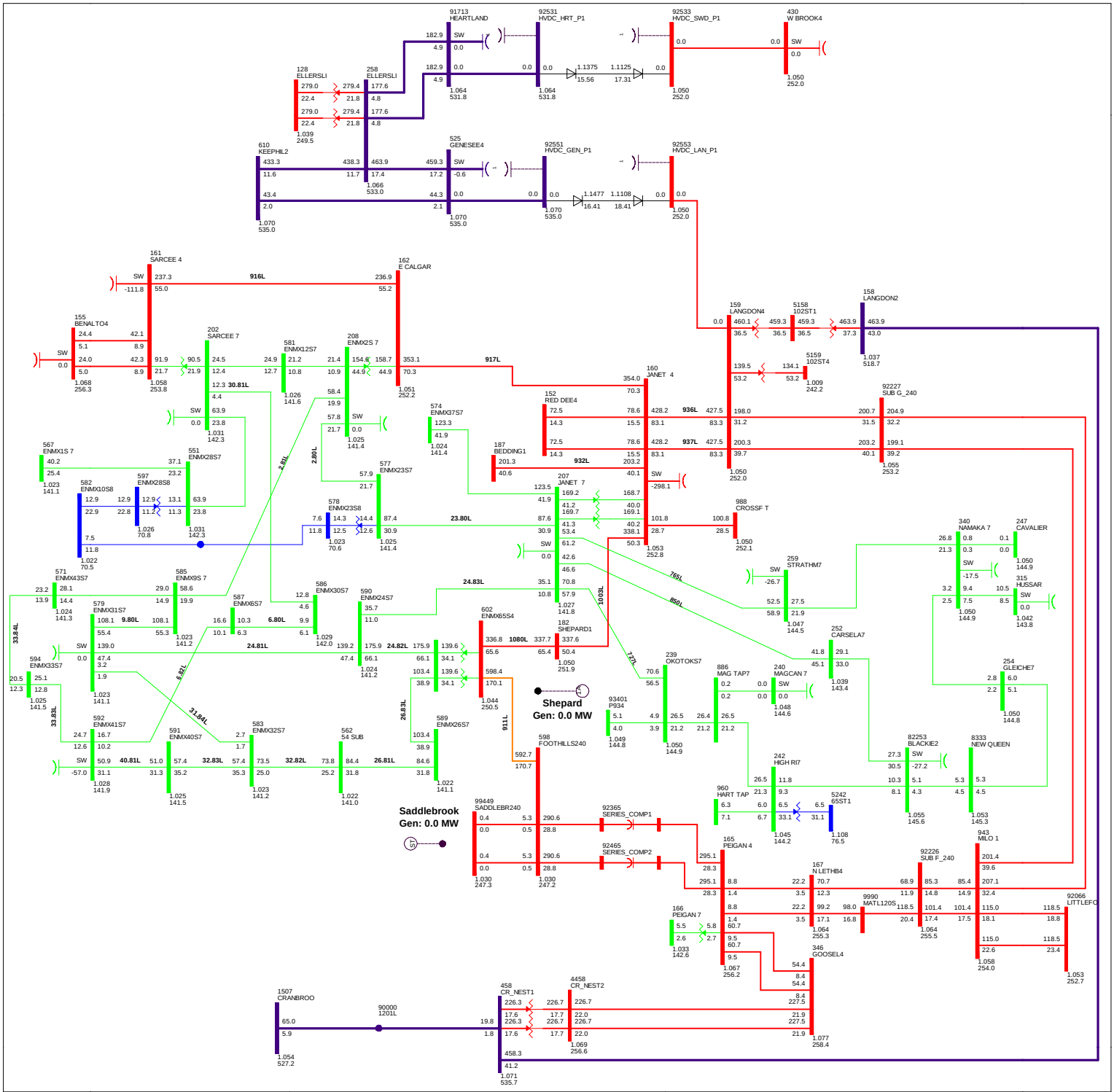
BCH Import: 782.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC5-32: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SP_EXISTING_SC5

FRI, JUN 08 2012 15:45

2019 Loading Violations
Scenario 6



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

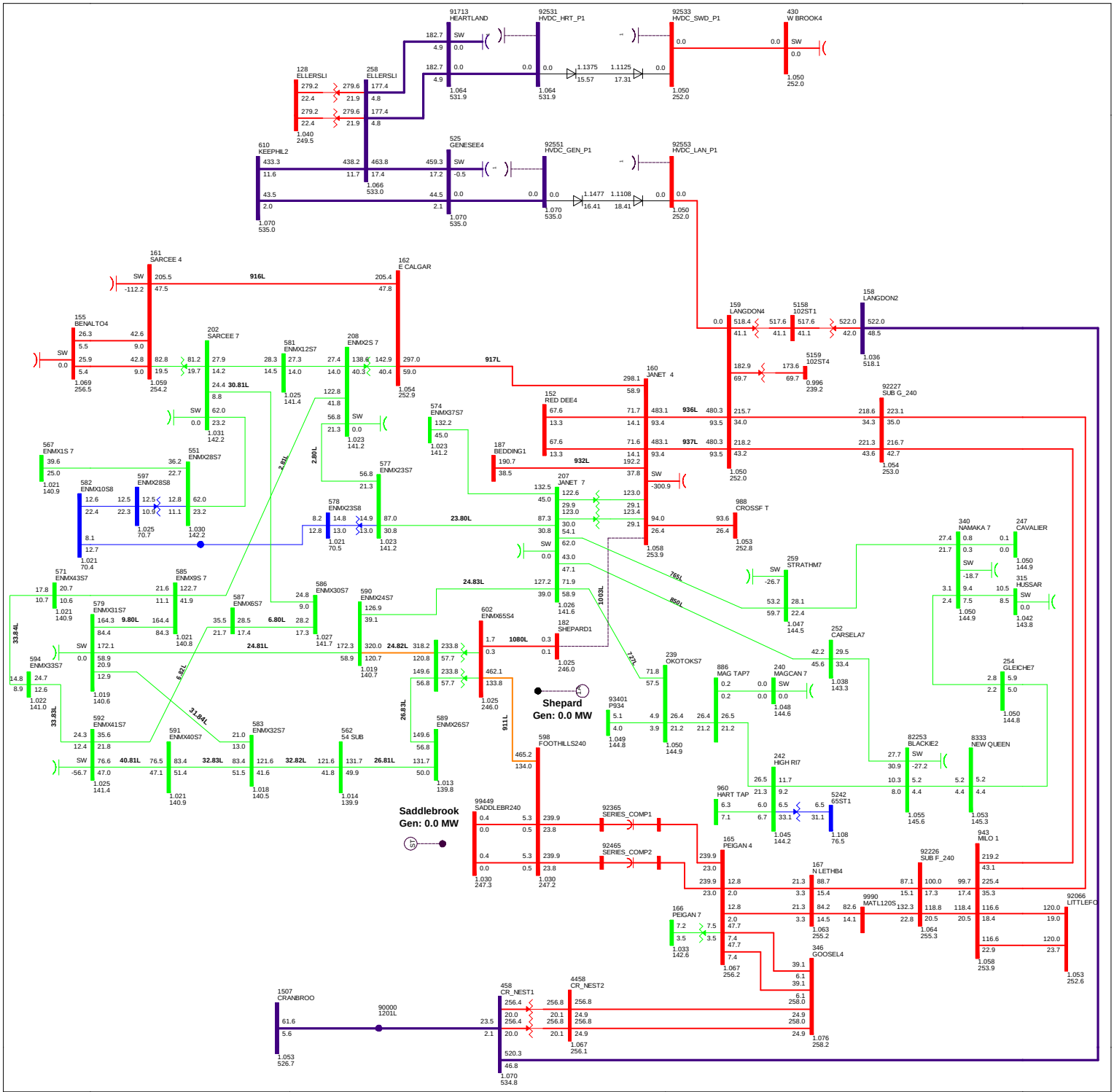
BCH Import: -0.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-1: BASECASE

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

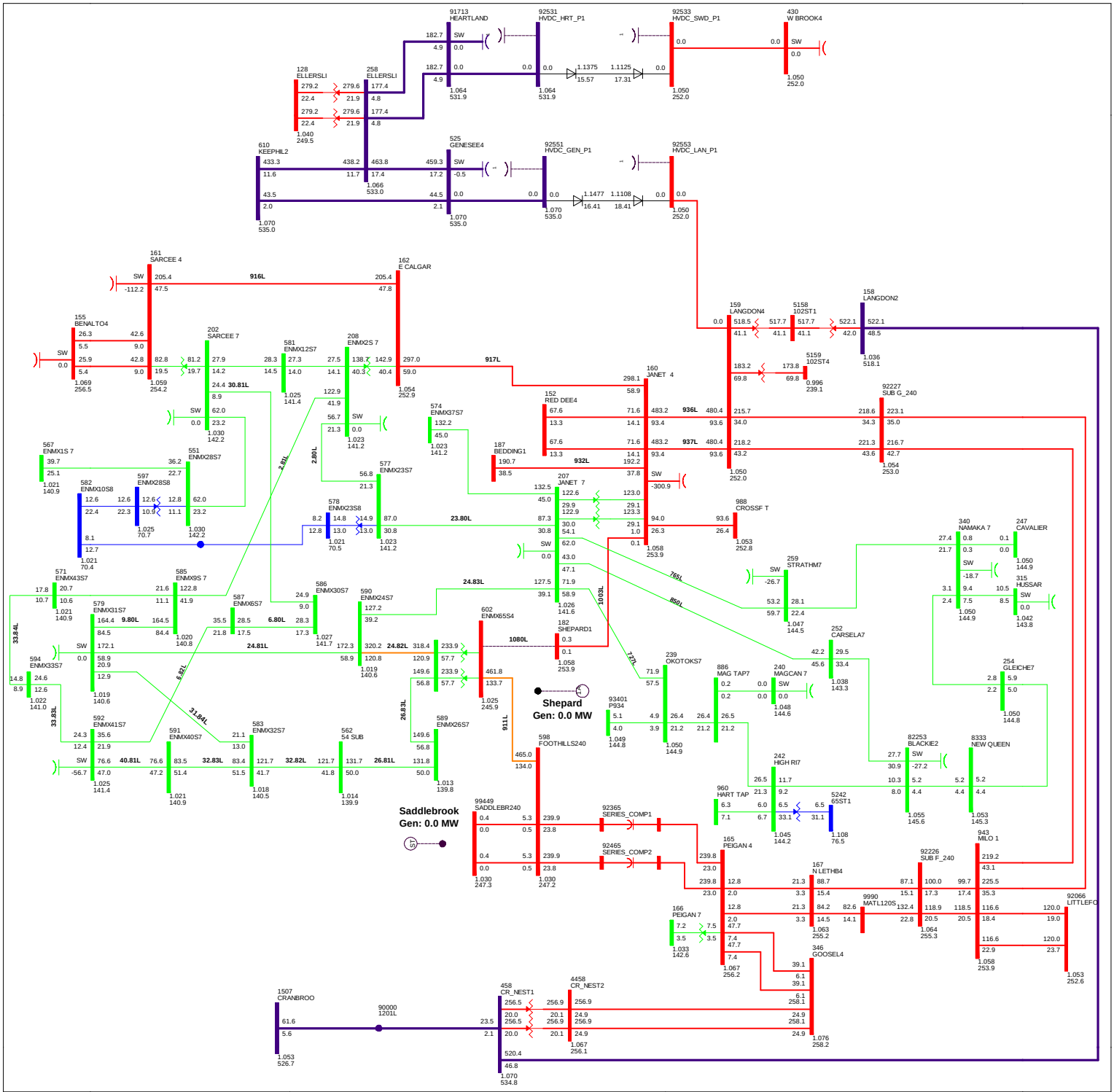
BCH Import: 1.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

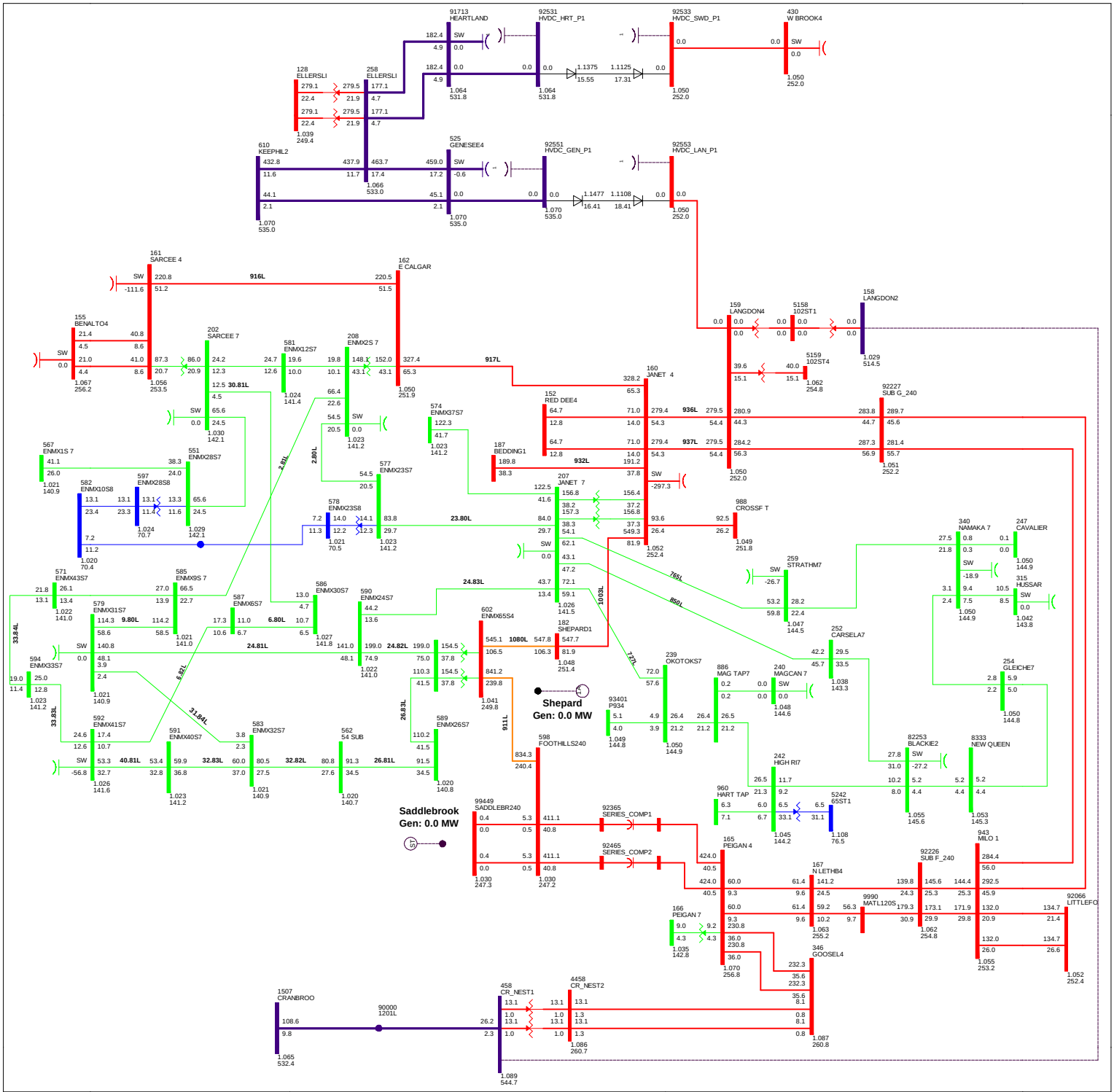
BCH Import: 1.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



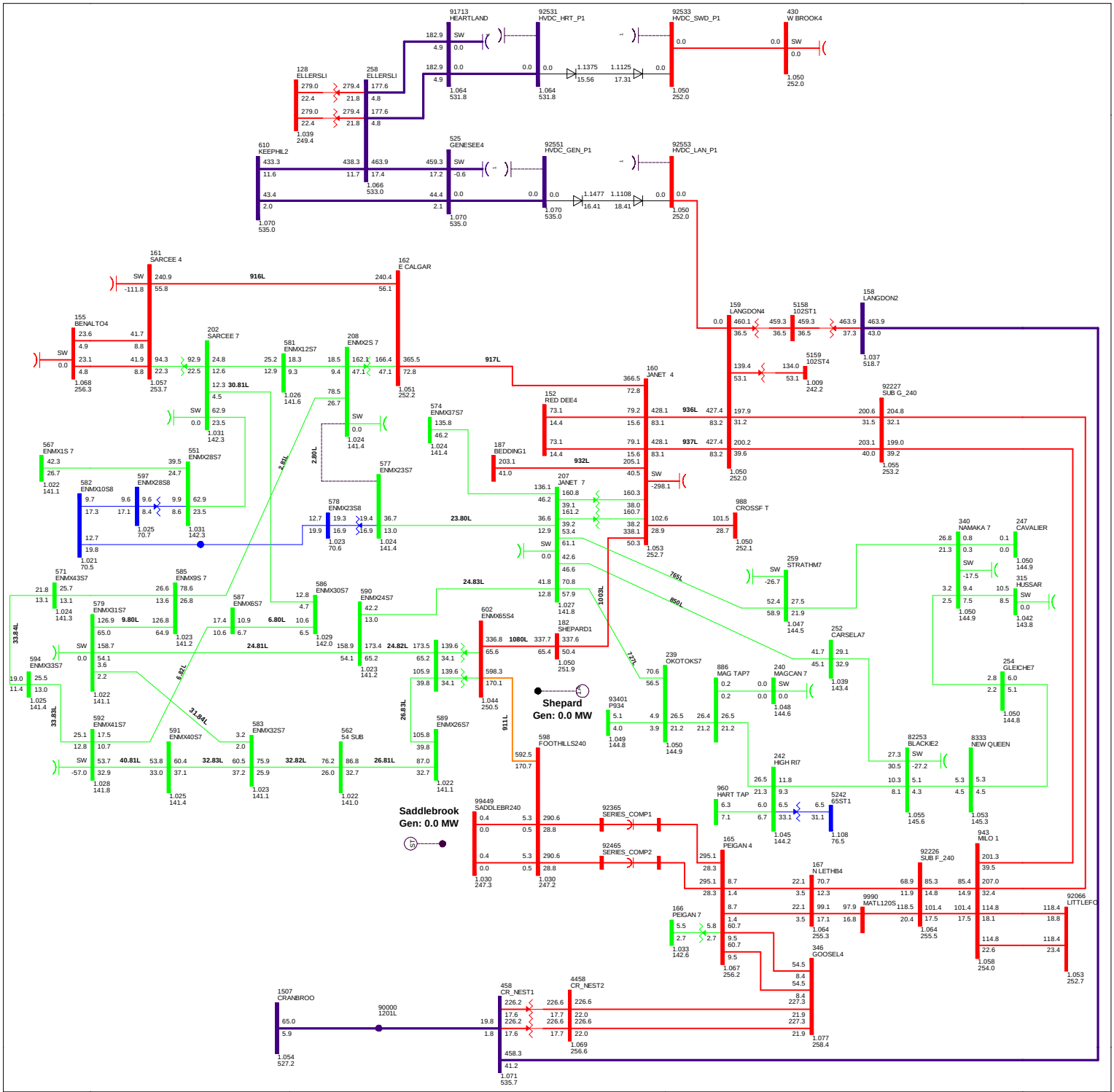
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 38.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

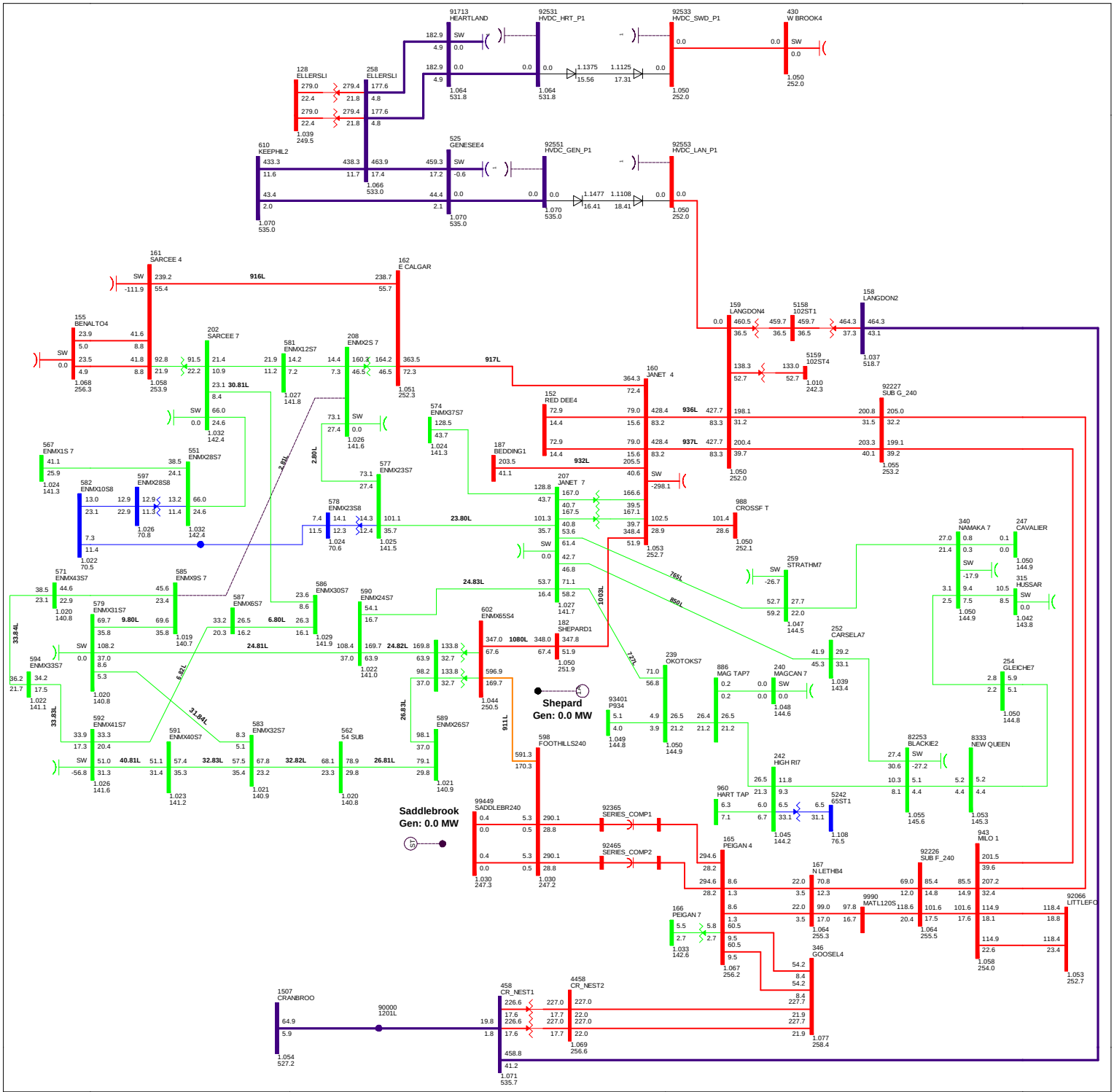
BCH Import: 0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

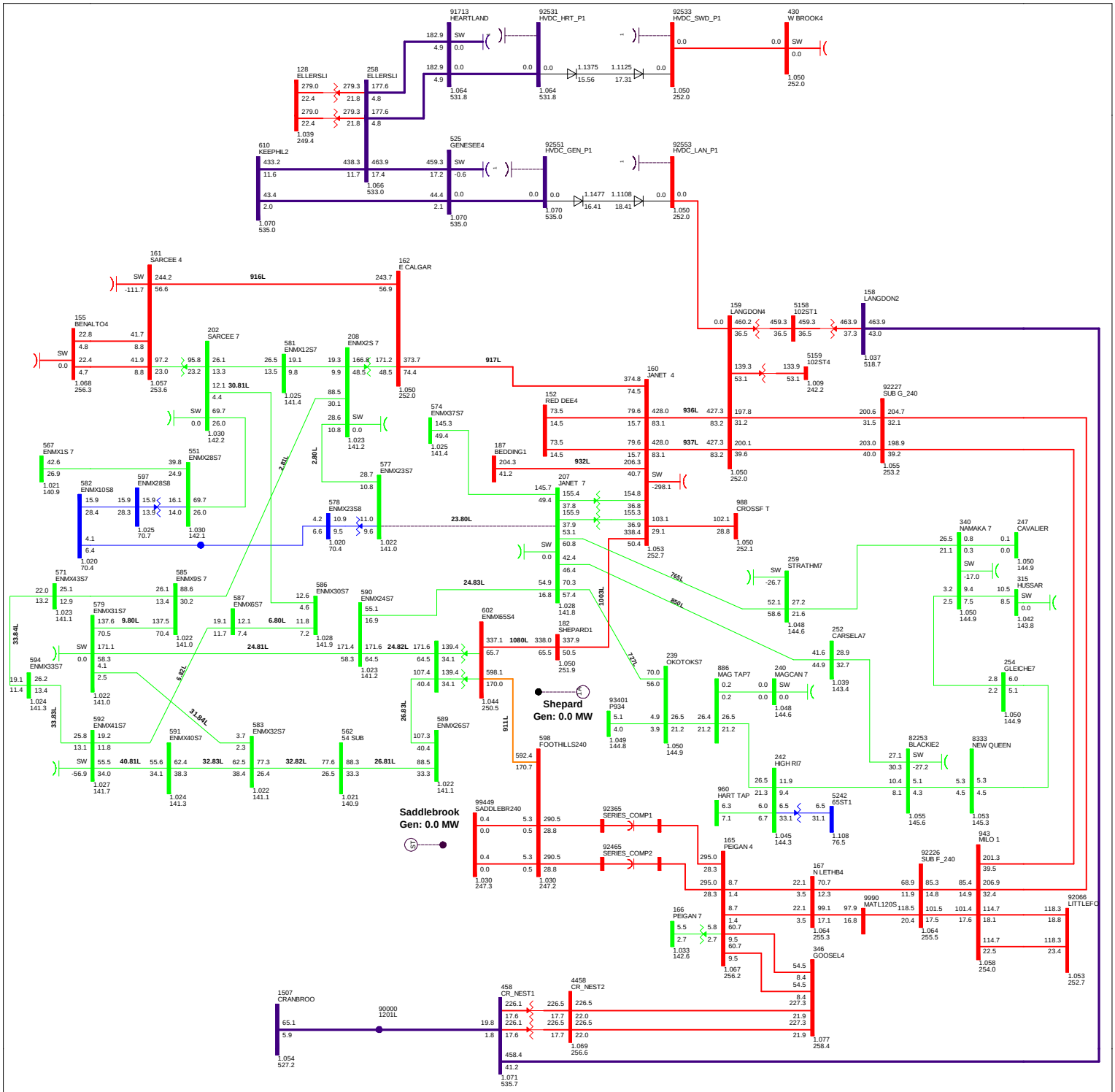
BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



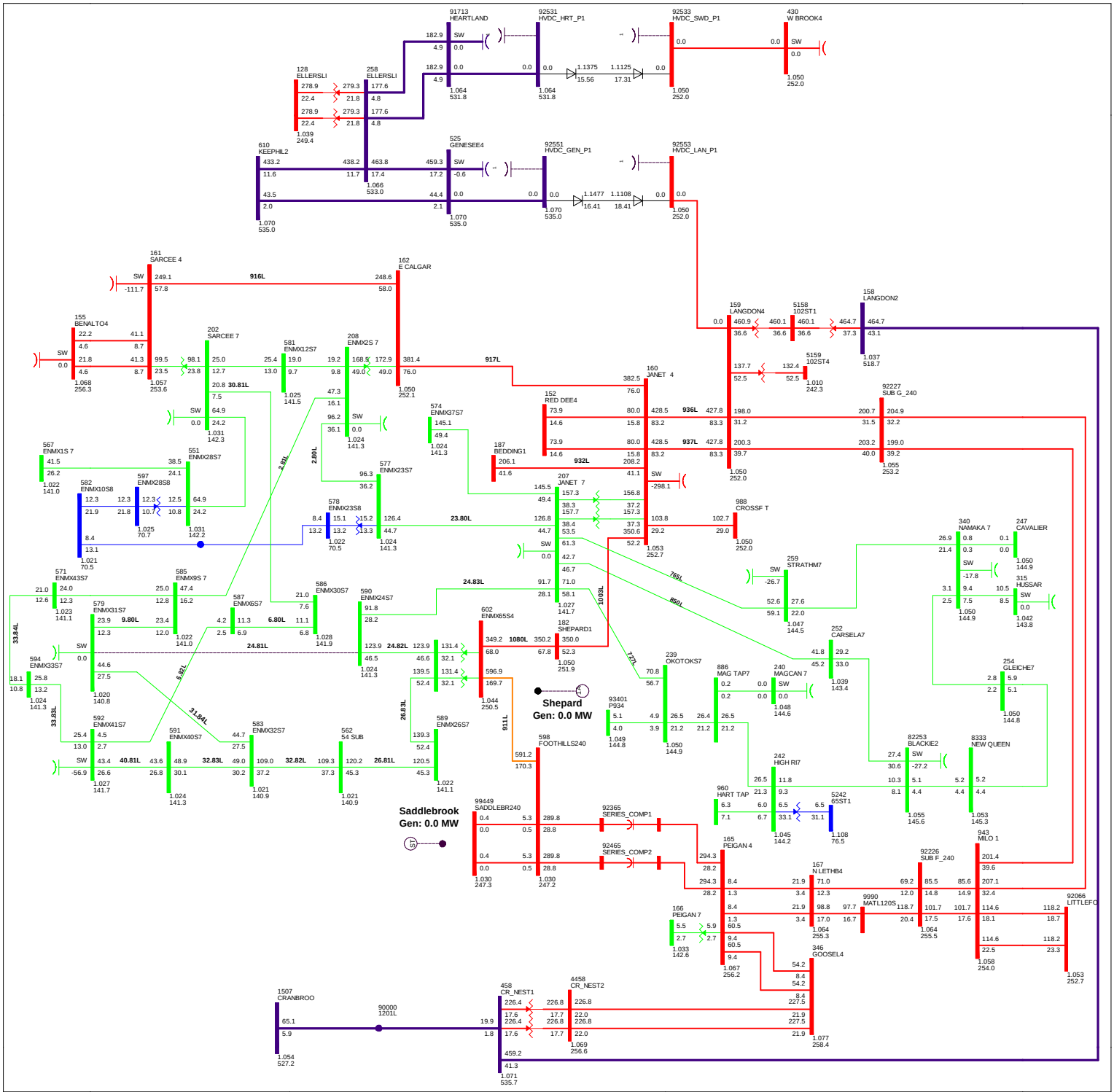
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

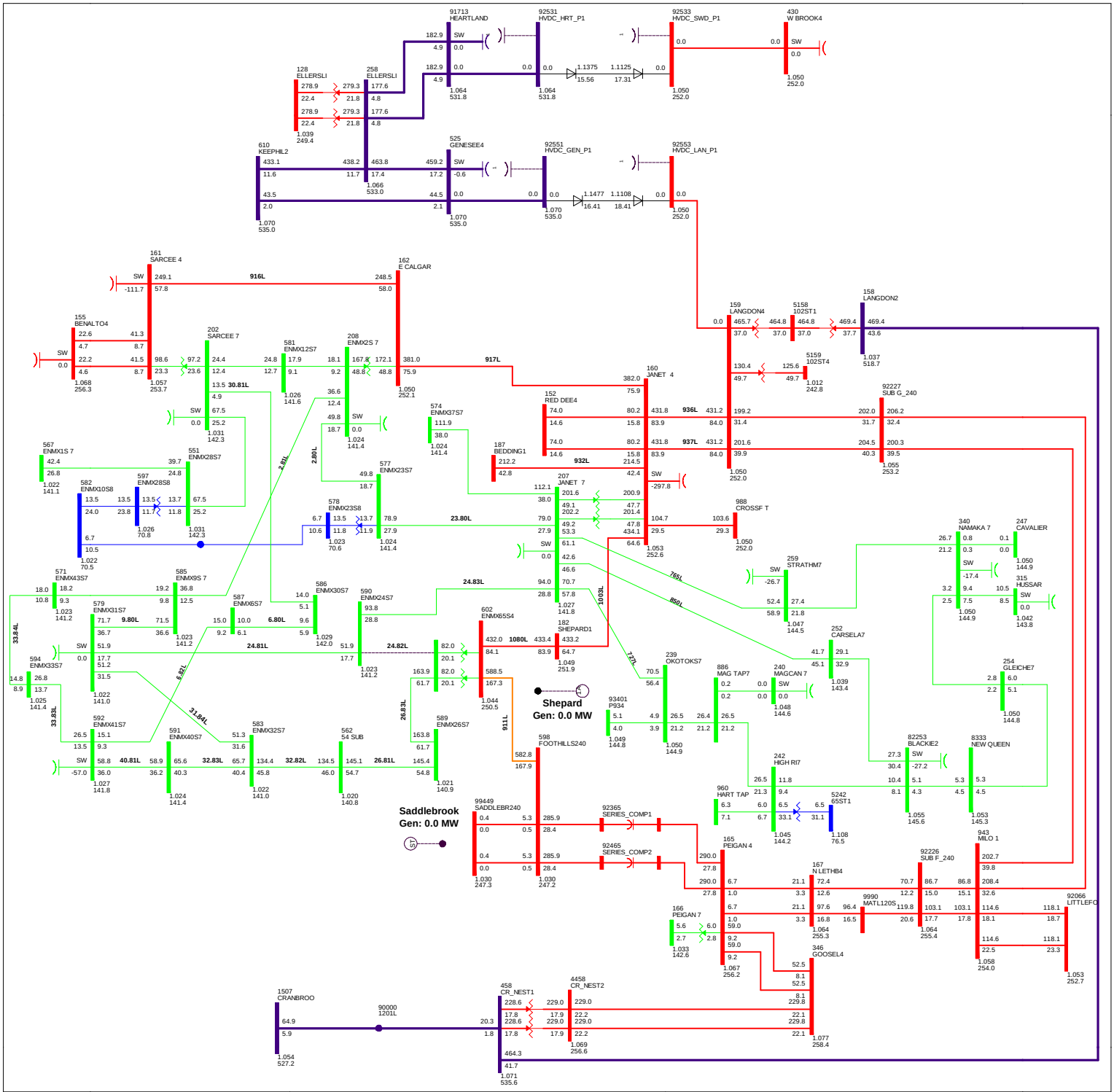
BCH Import: 0.5 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 0.0 MW
2012LTO EXISTING SYSTEM
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
BCH Import: 1.0 MW
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
FIG B-SC6-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)
2019_SL_EXISTING_SC6
FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

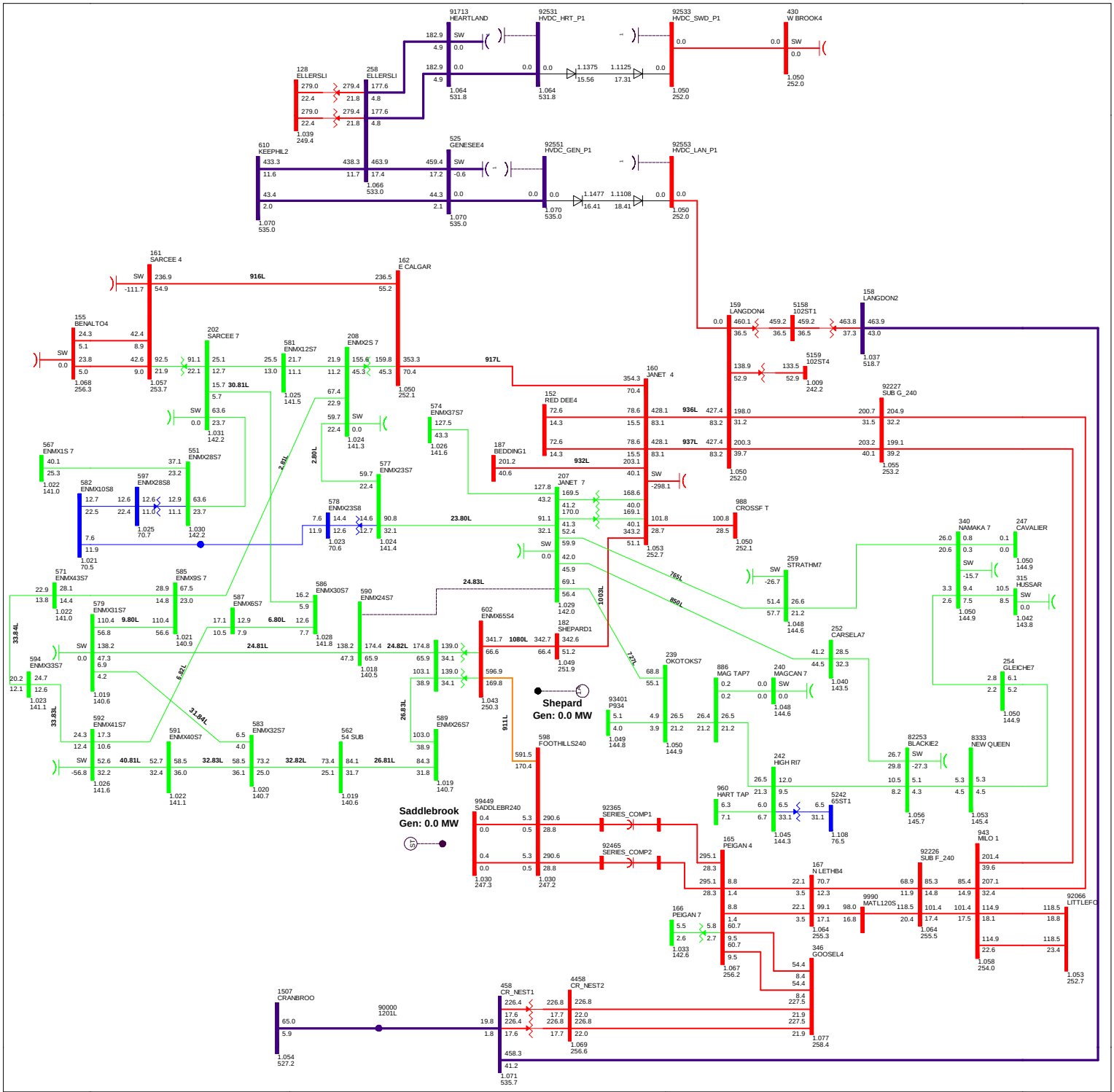
BCH Import: 1.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



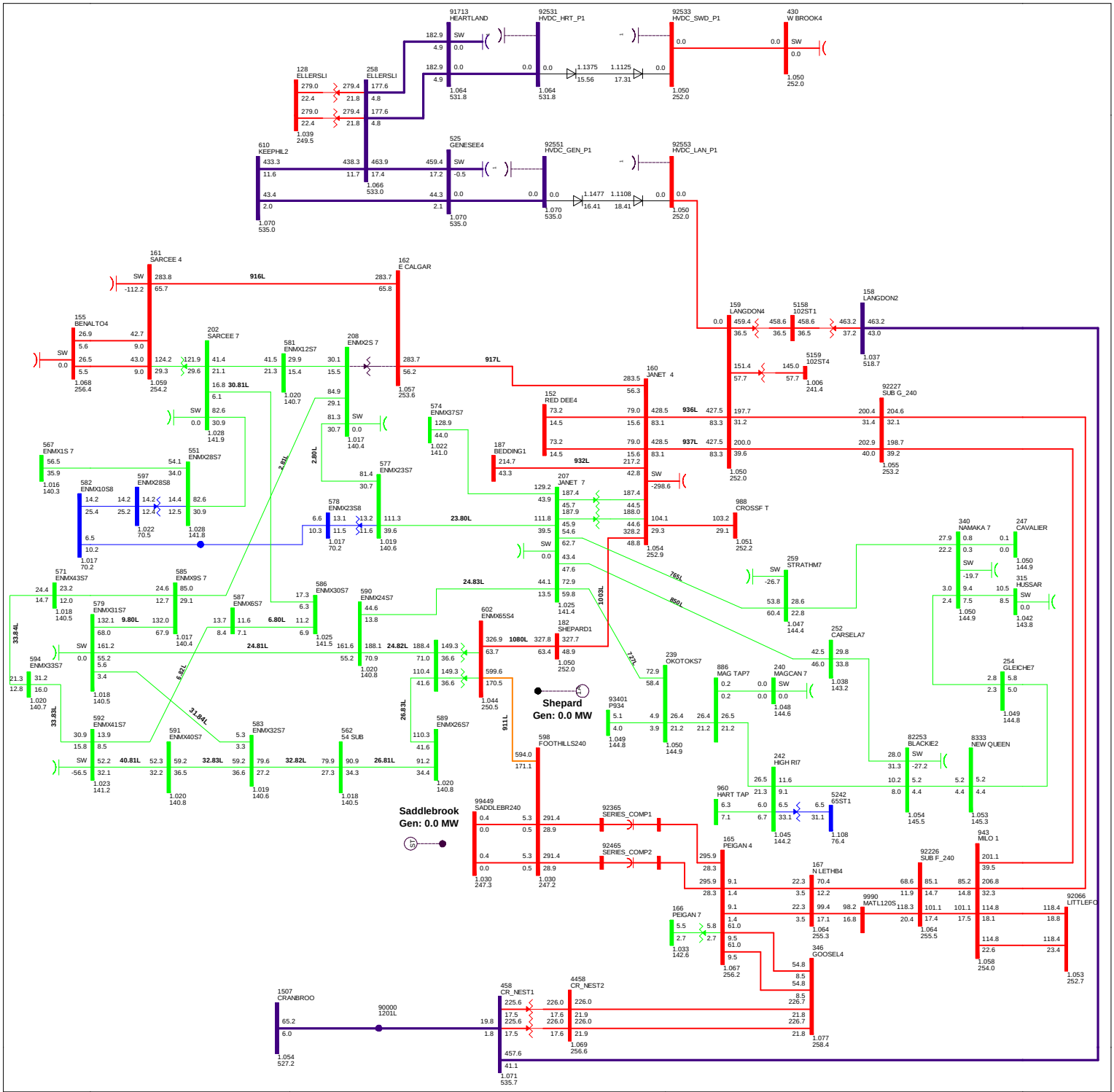
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

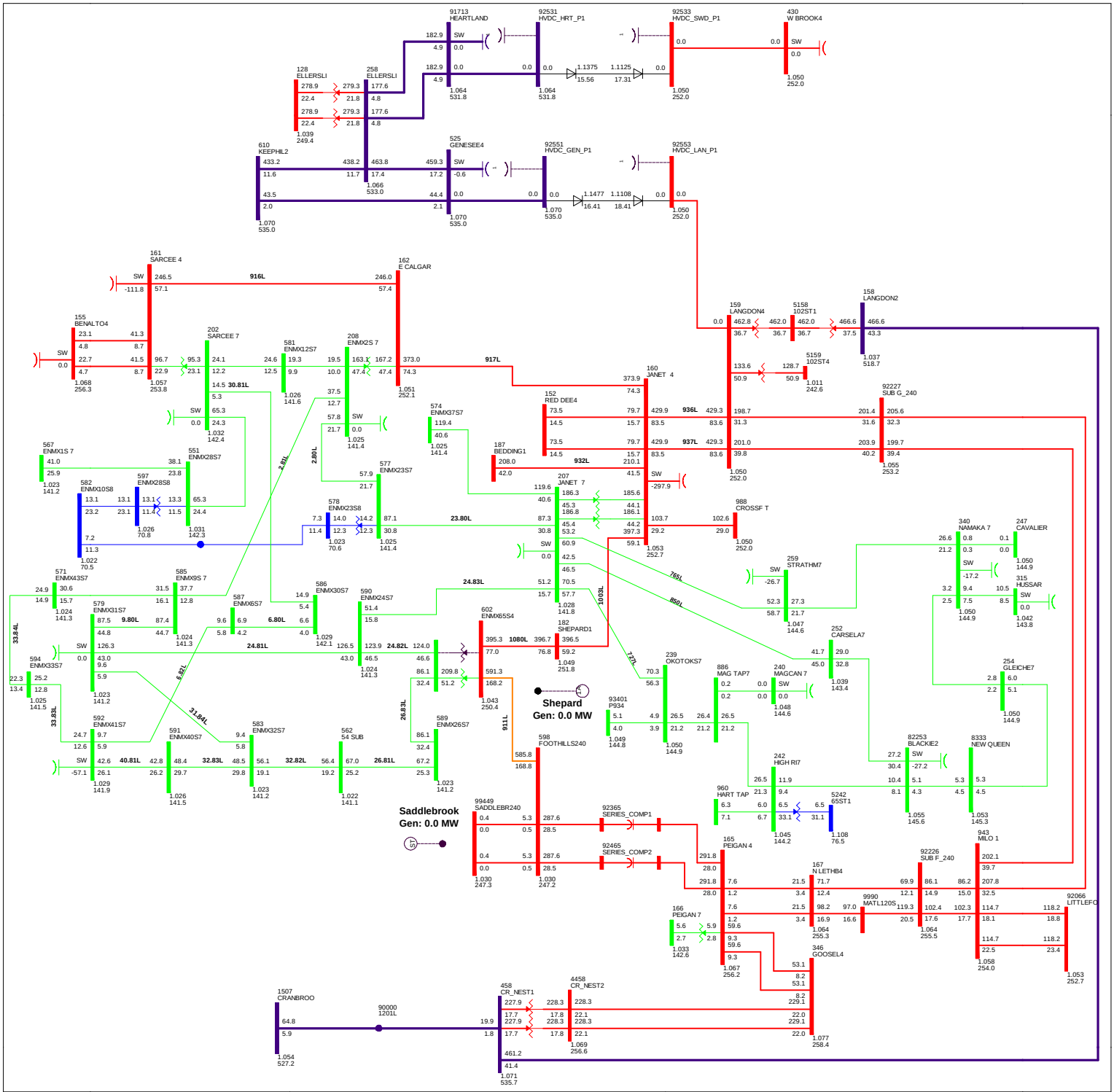
BCH Import: 1.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

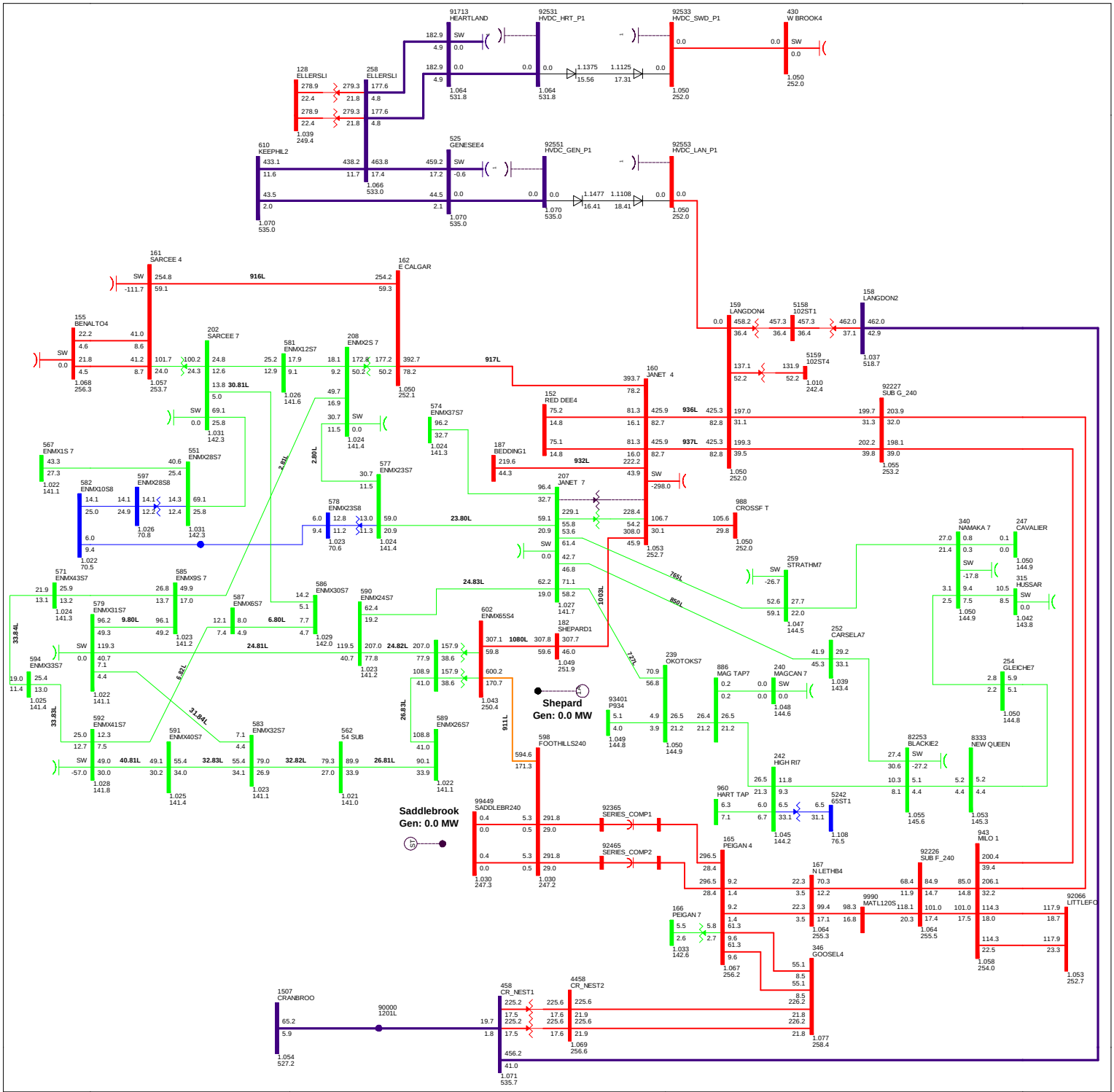
BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

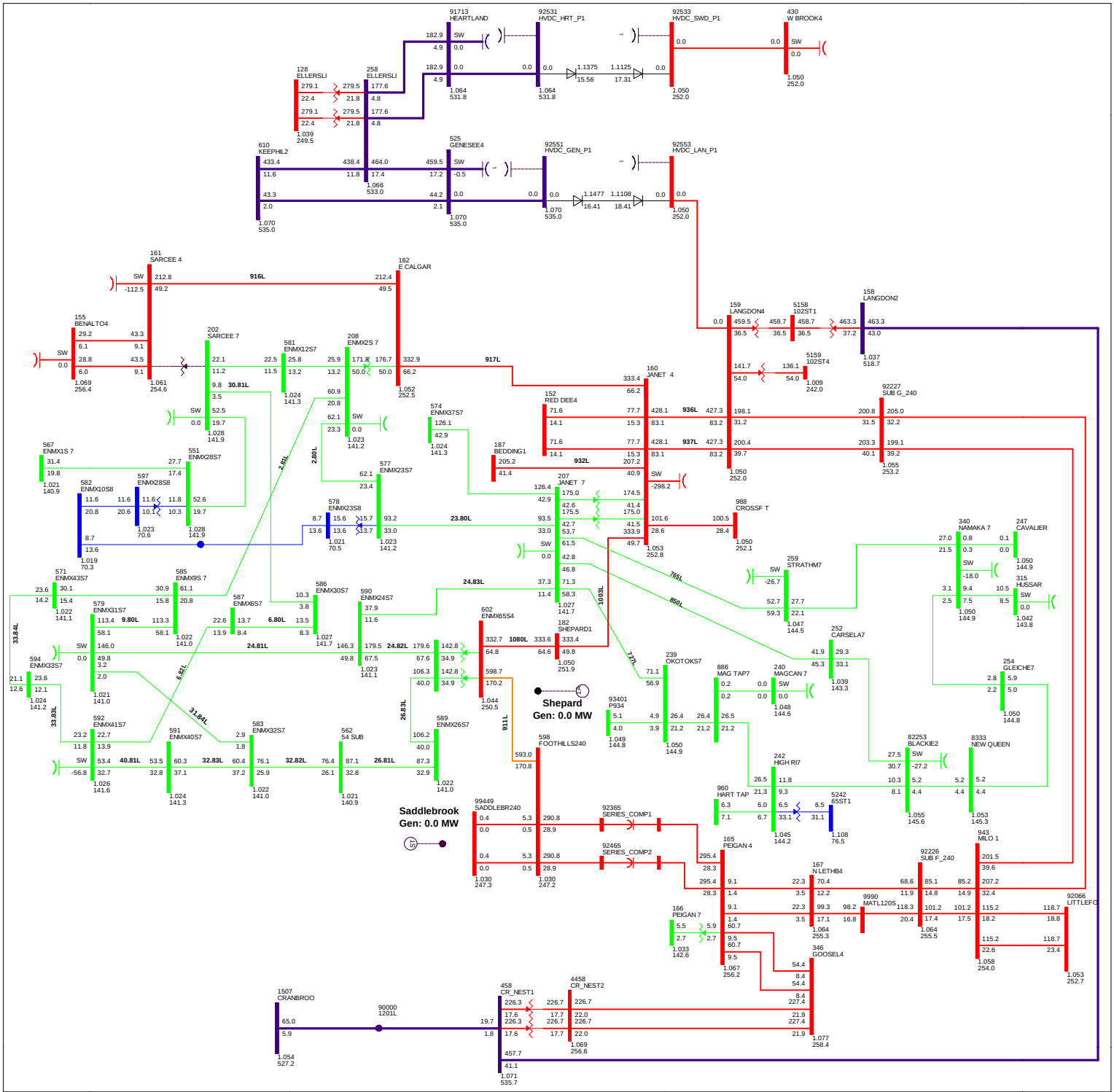
BCH Import: 0.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

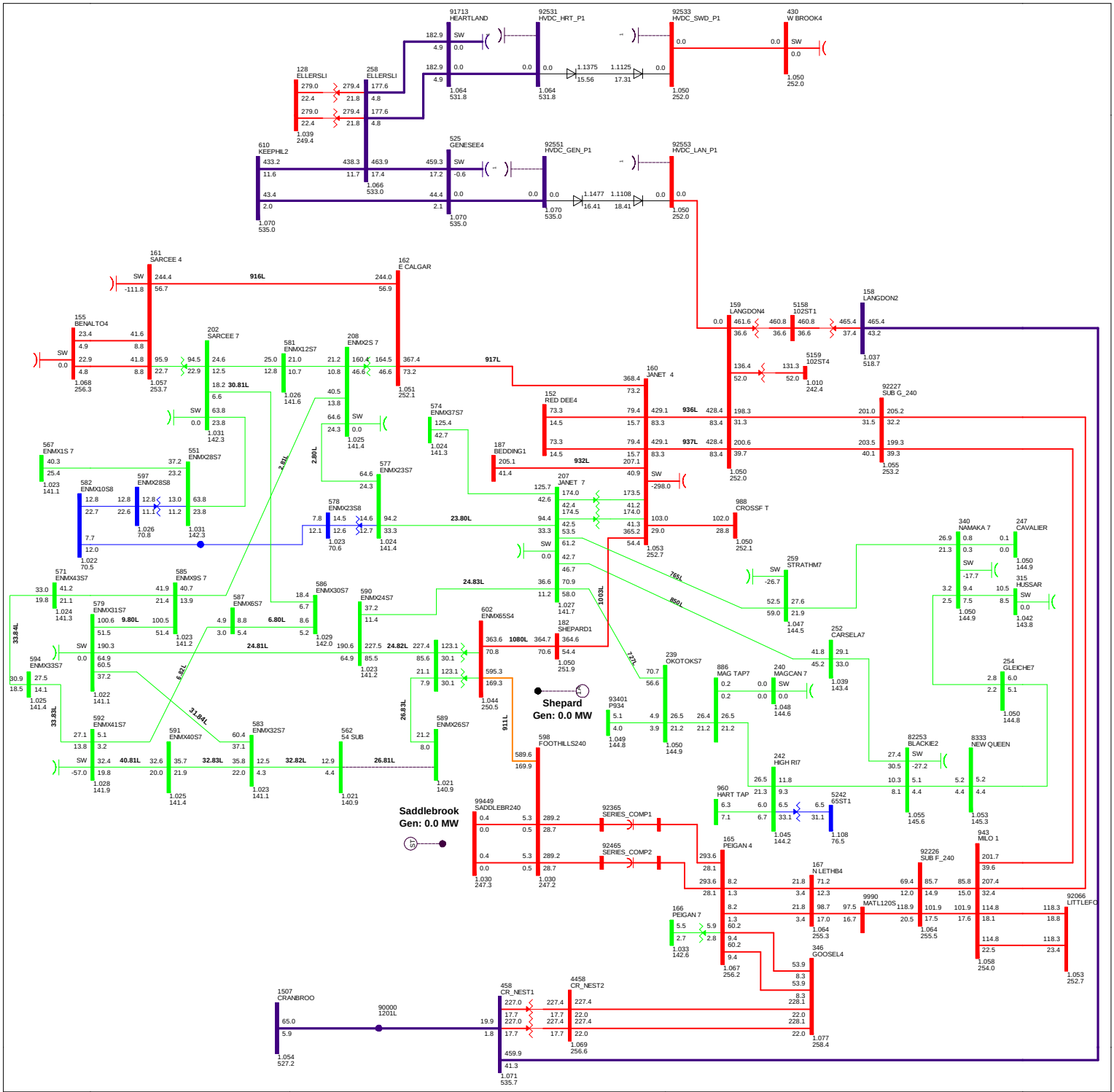
BCH Import: -0.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



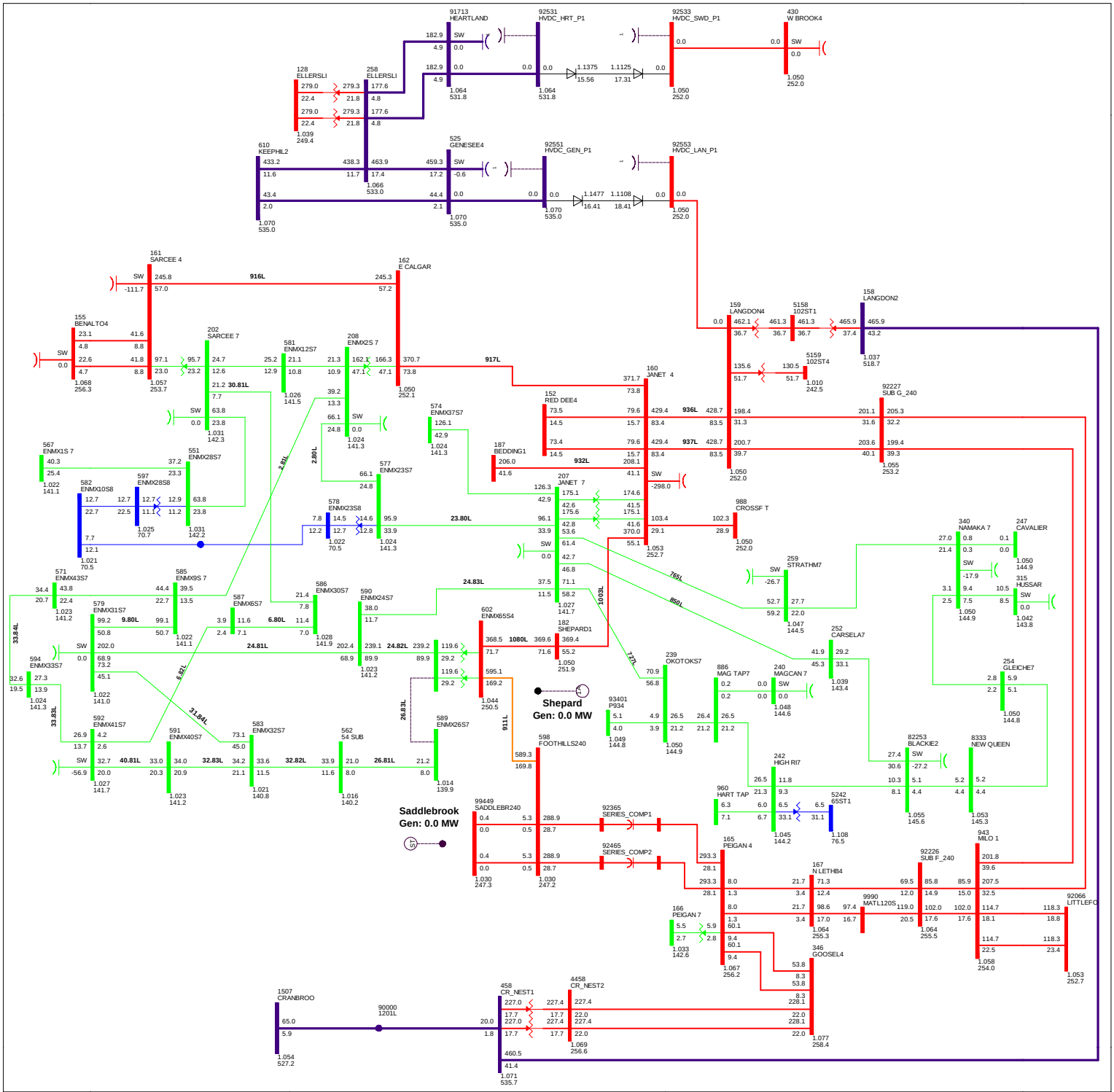
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



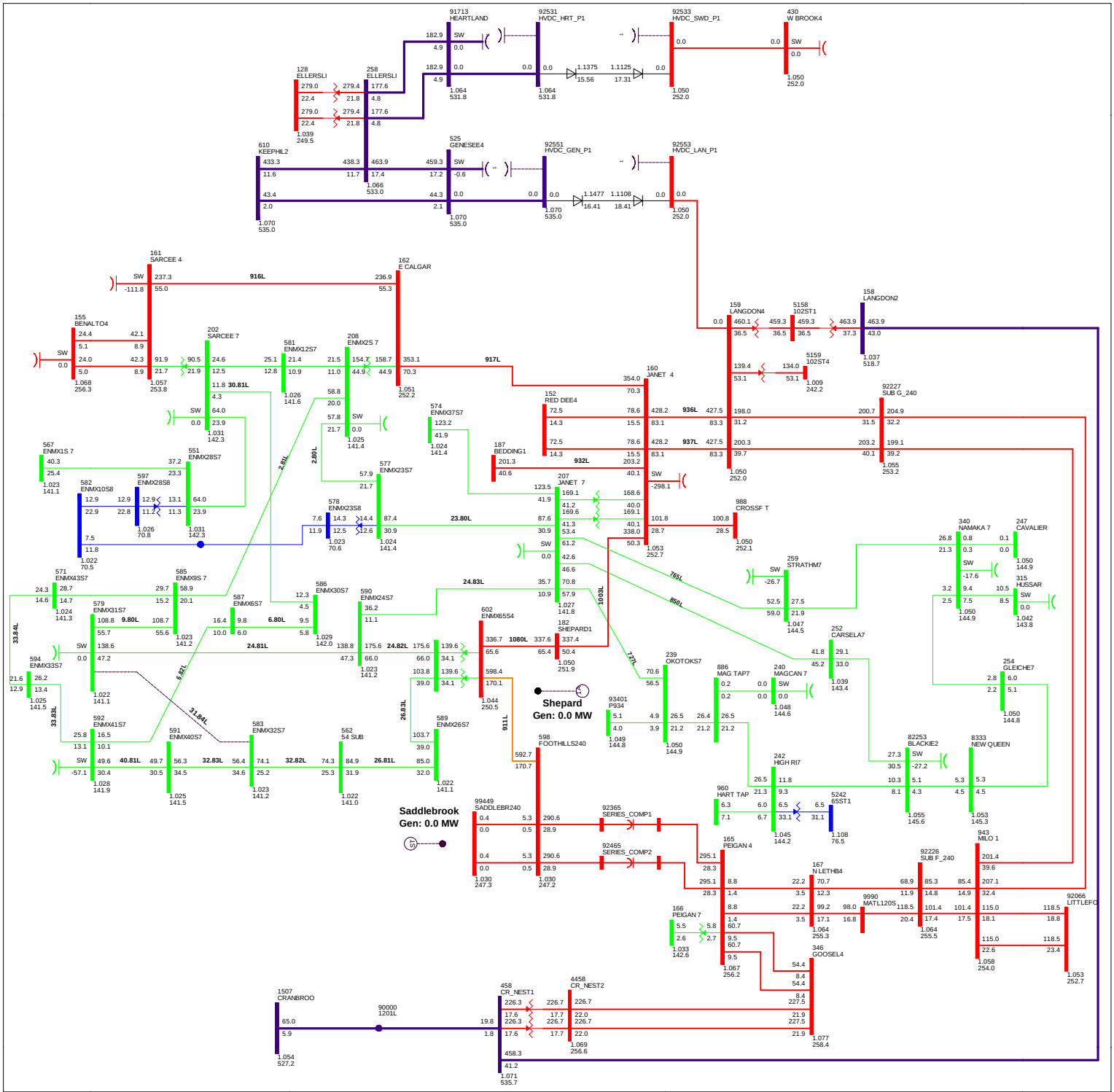
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



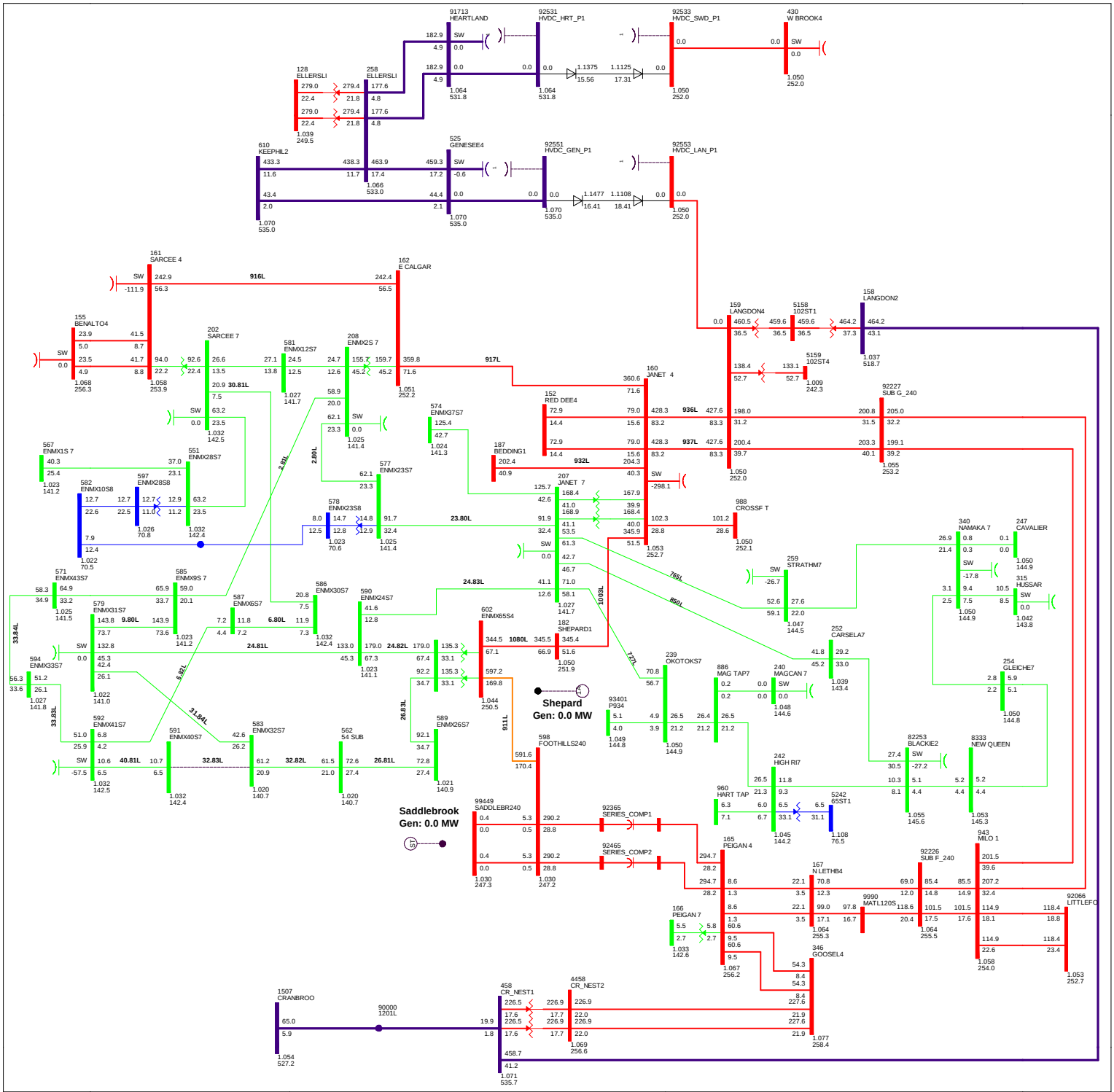
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-17: OPEN 31.84L 138 KV LINE (ENMAX 31 TO ENMAX 32)
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



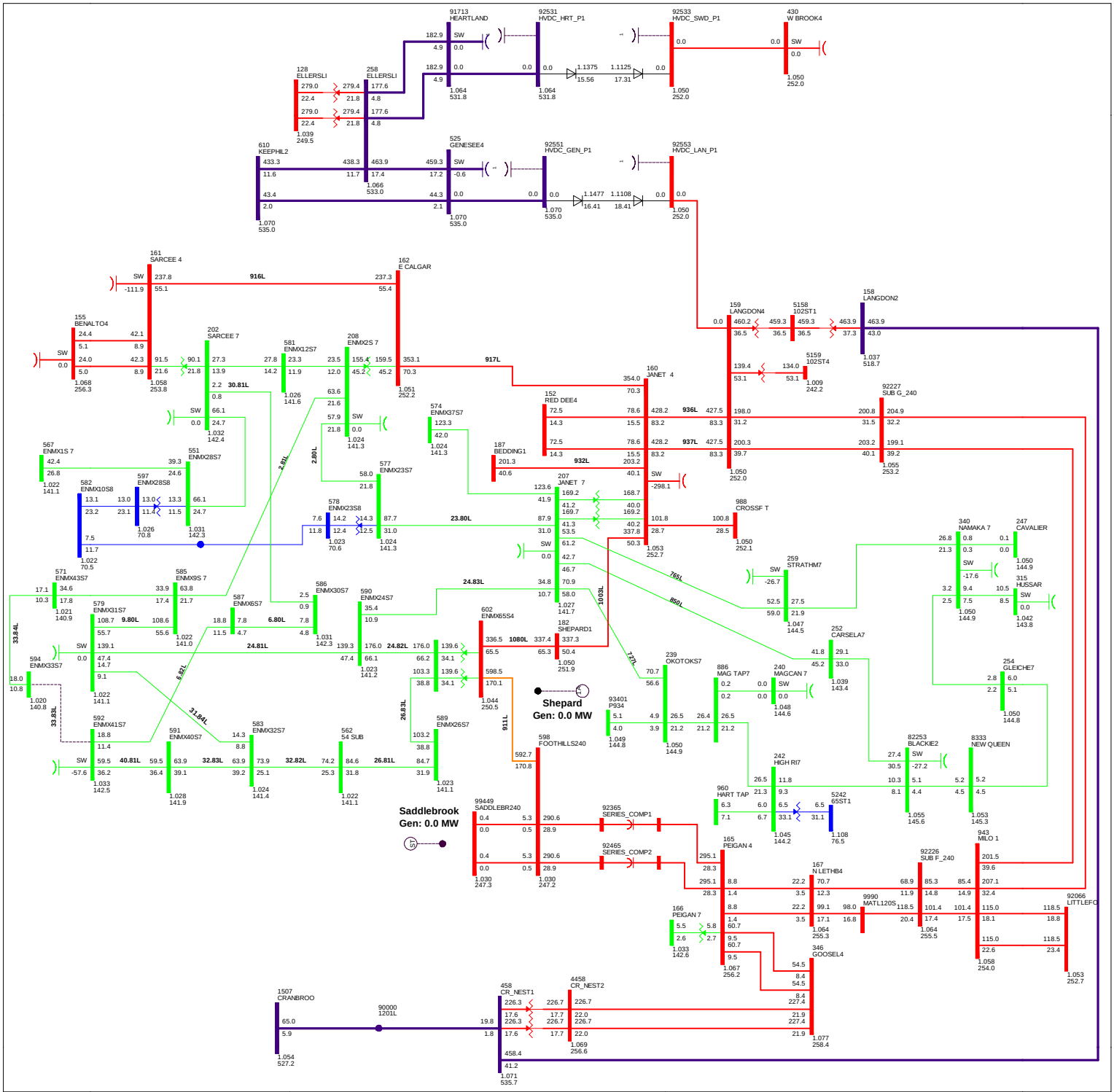
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-18: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

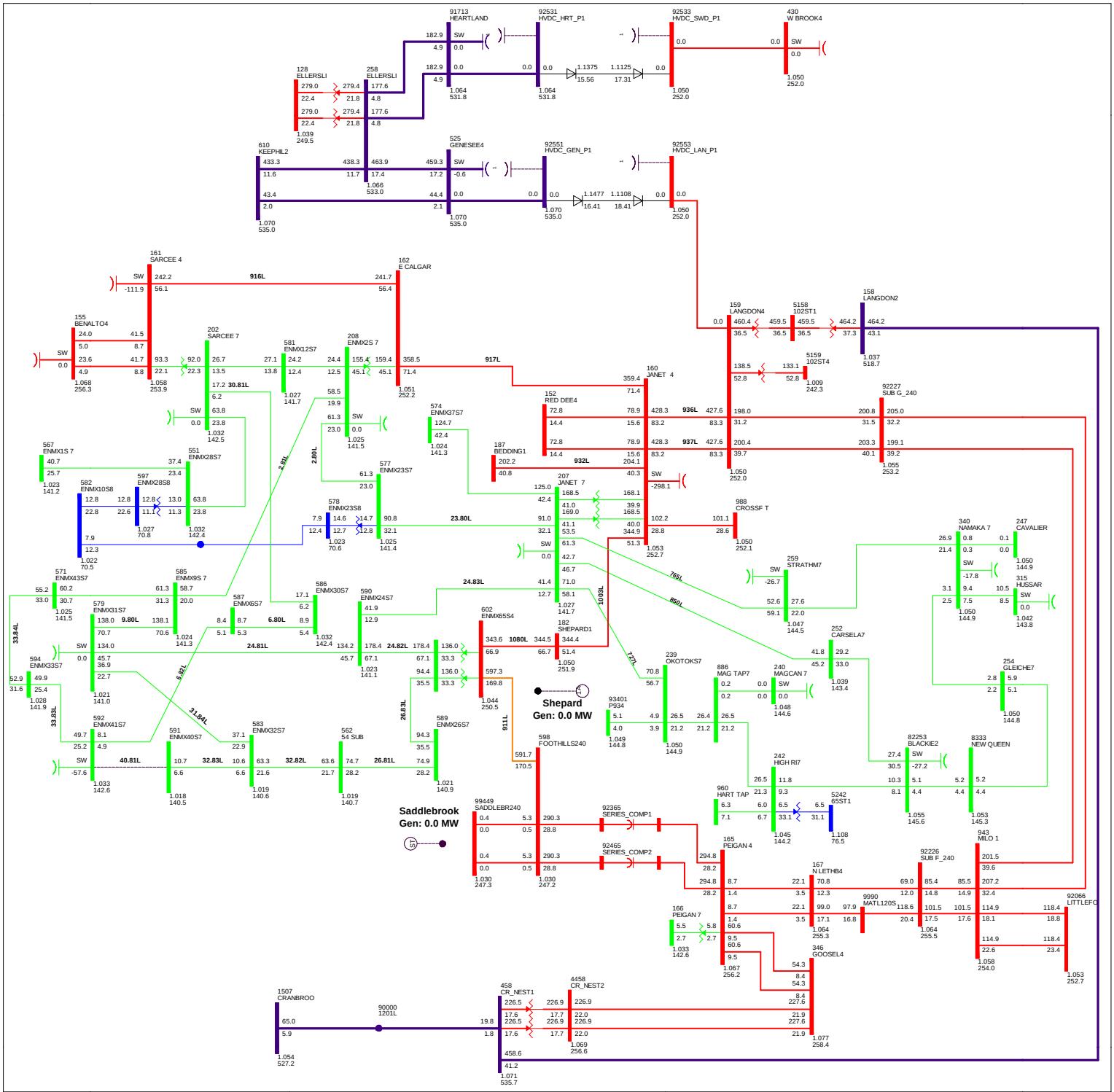
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-19: OPEN 33.83L 138 KV LINE (ENMAX 41 TO ENMAX 33)
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



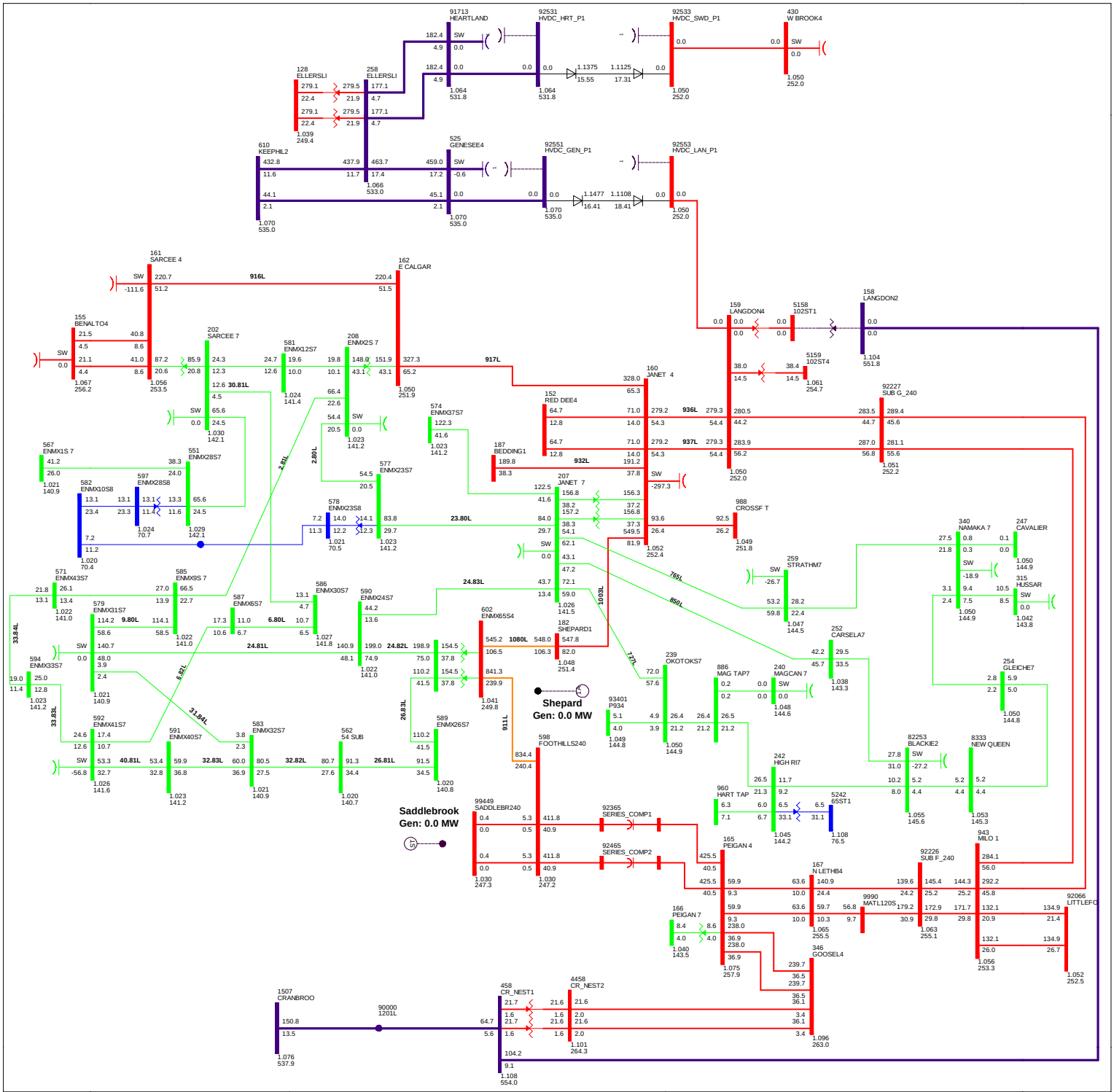
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-20: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

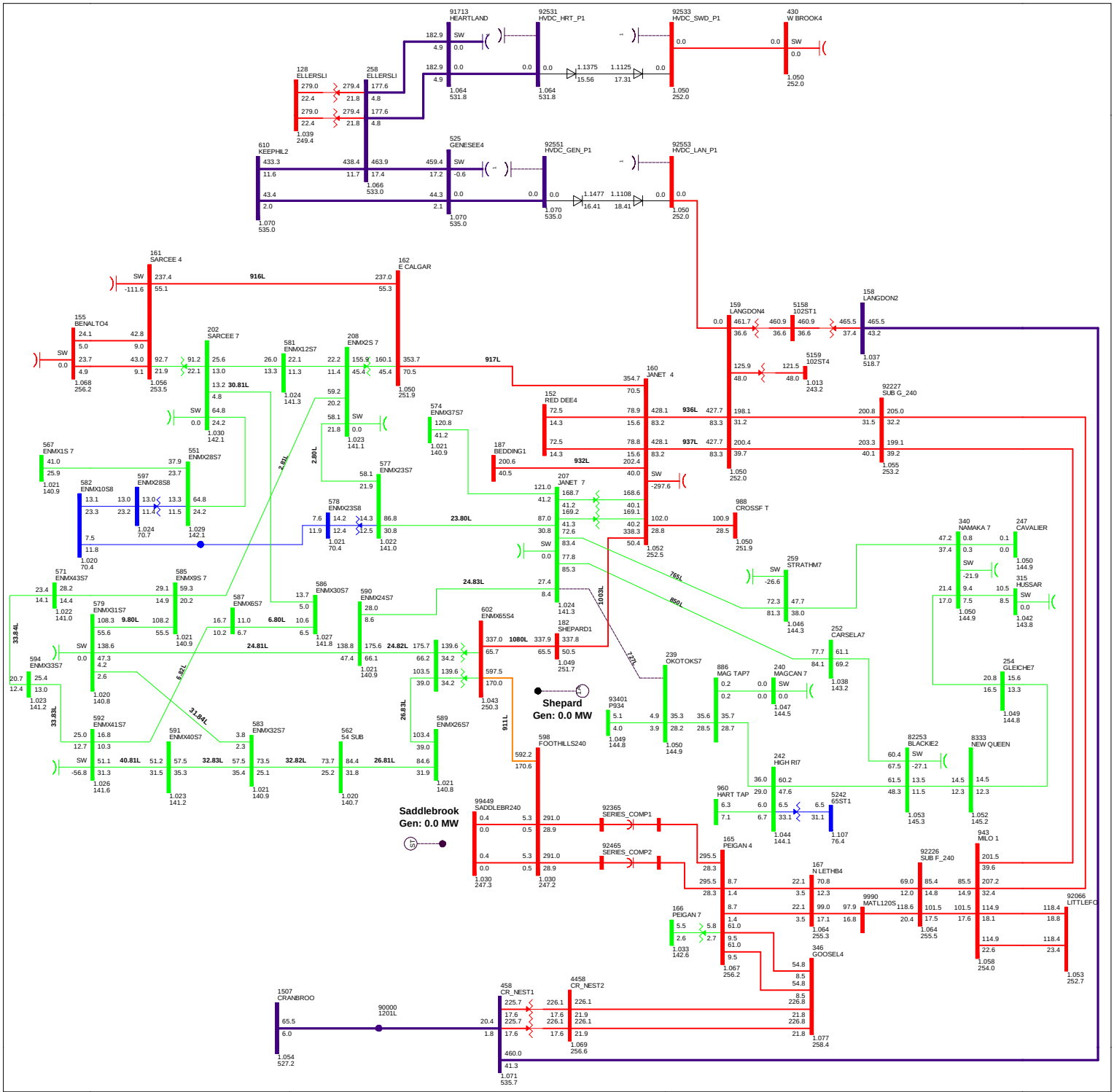
BCH Import: 38.7 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-21: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



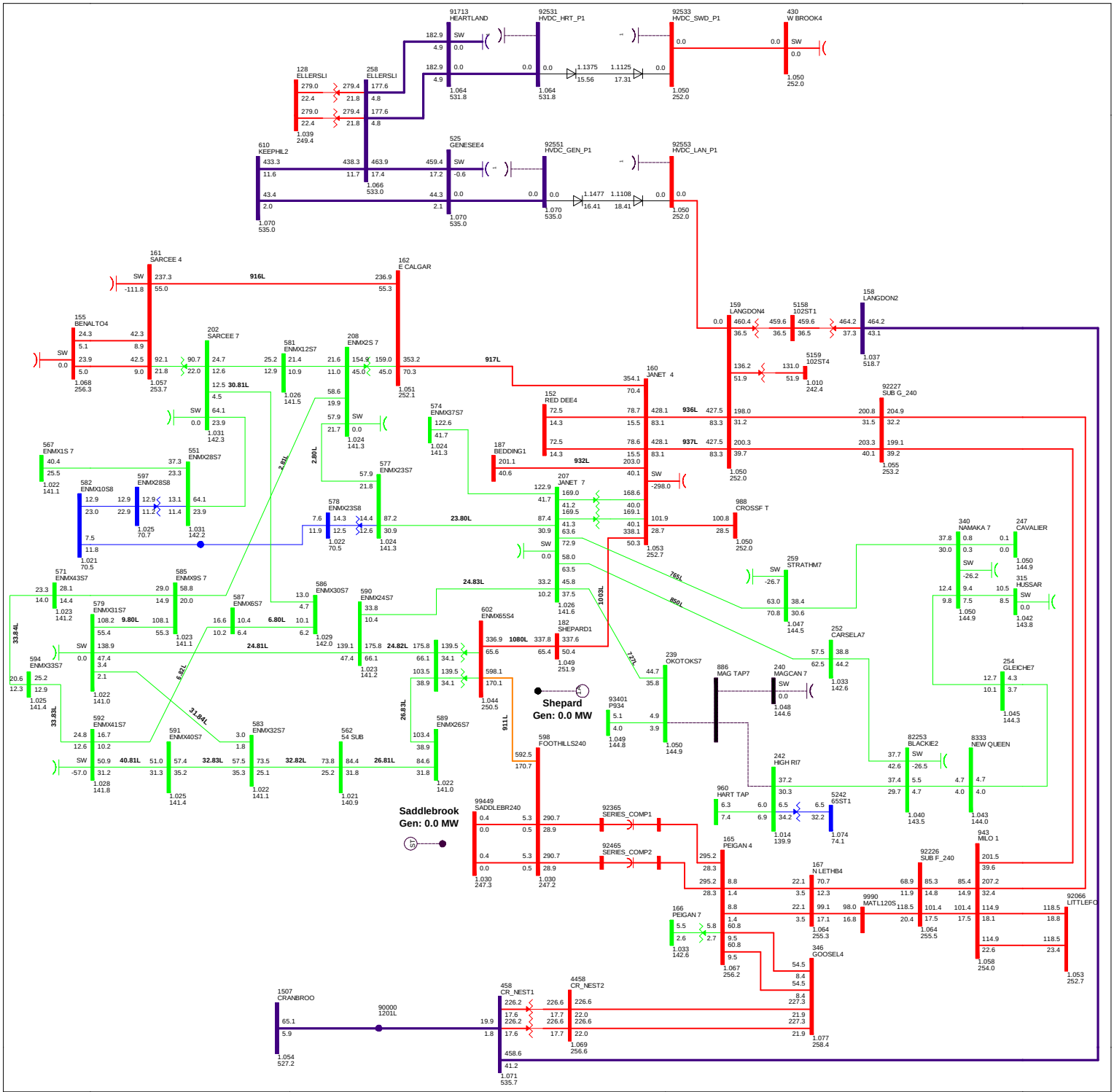
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.9 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-22: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

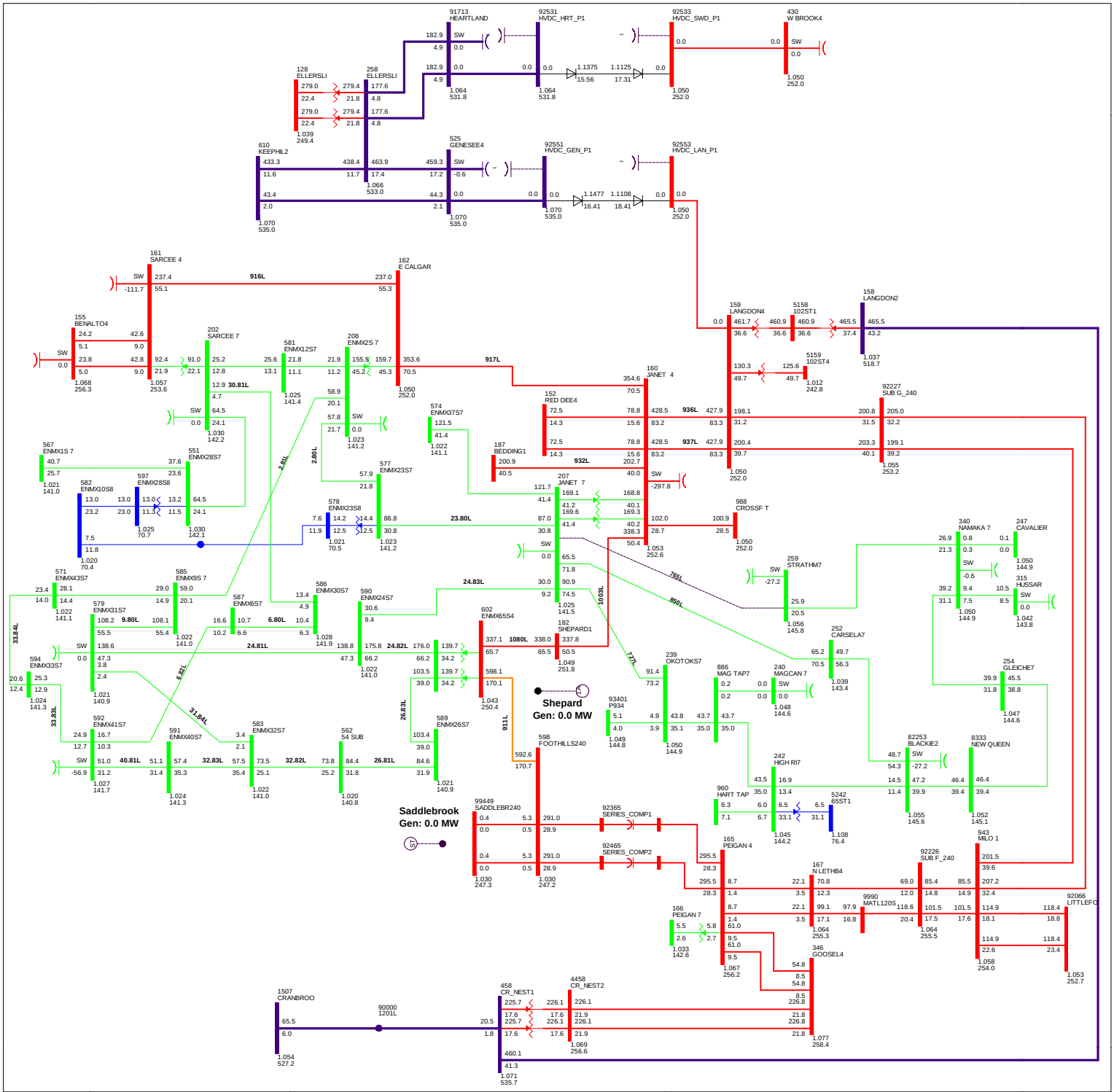
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-23: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

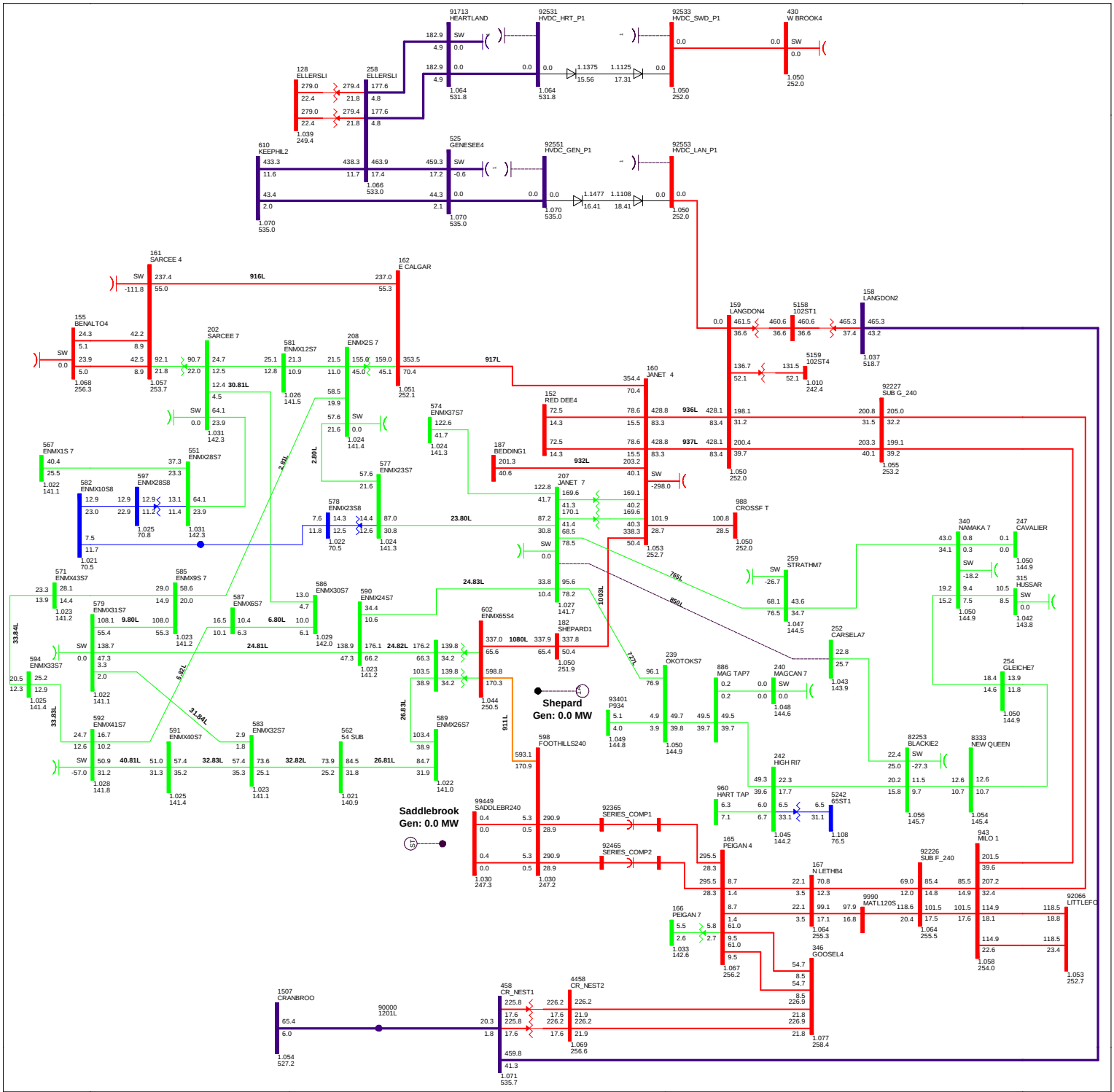
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-24: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:46



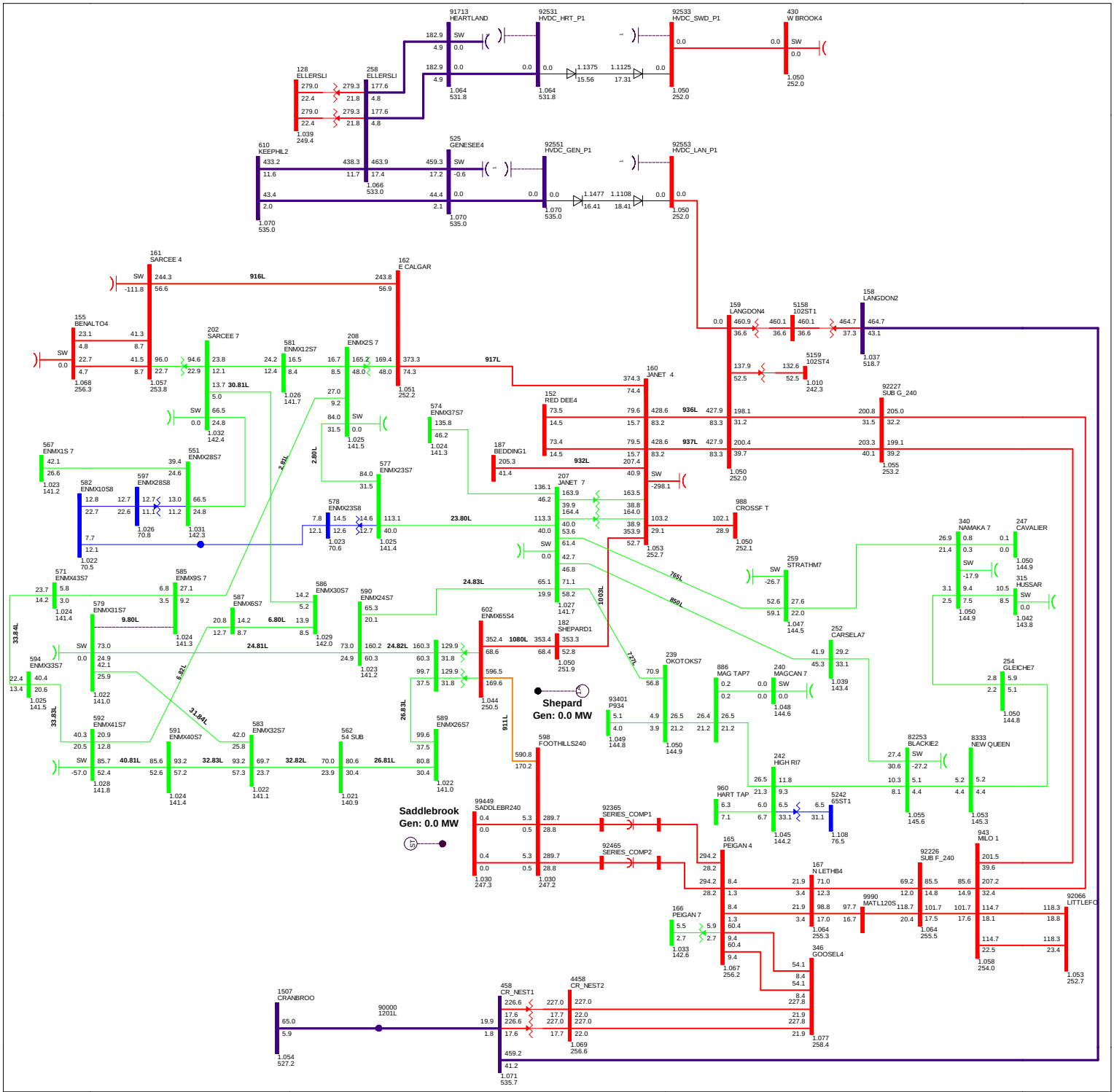
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-25: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:47



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

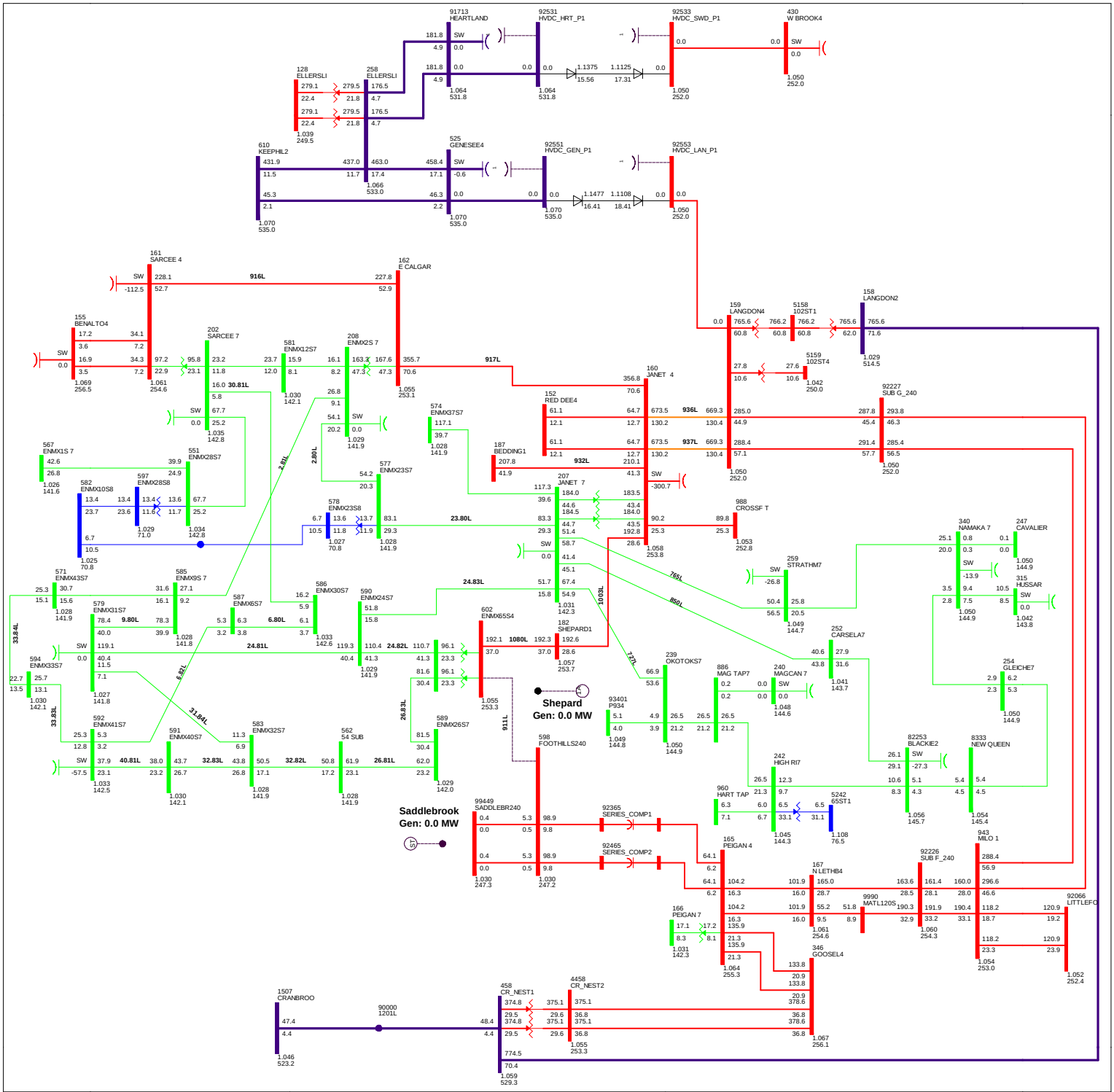
BCH Import: 0.3 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-26: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:47



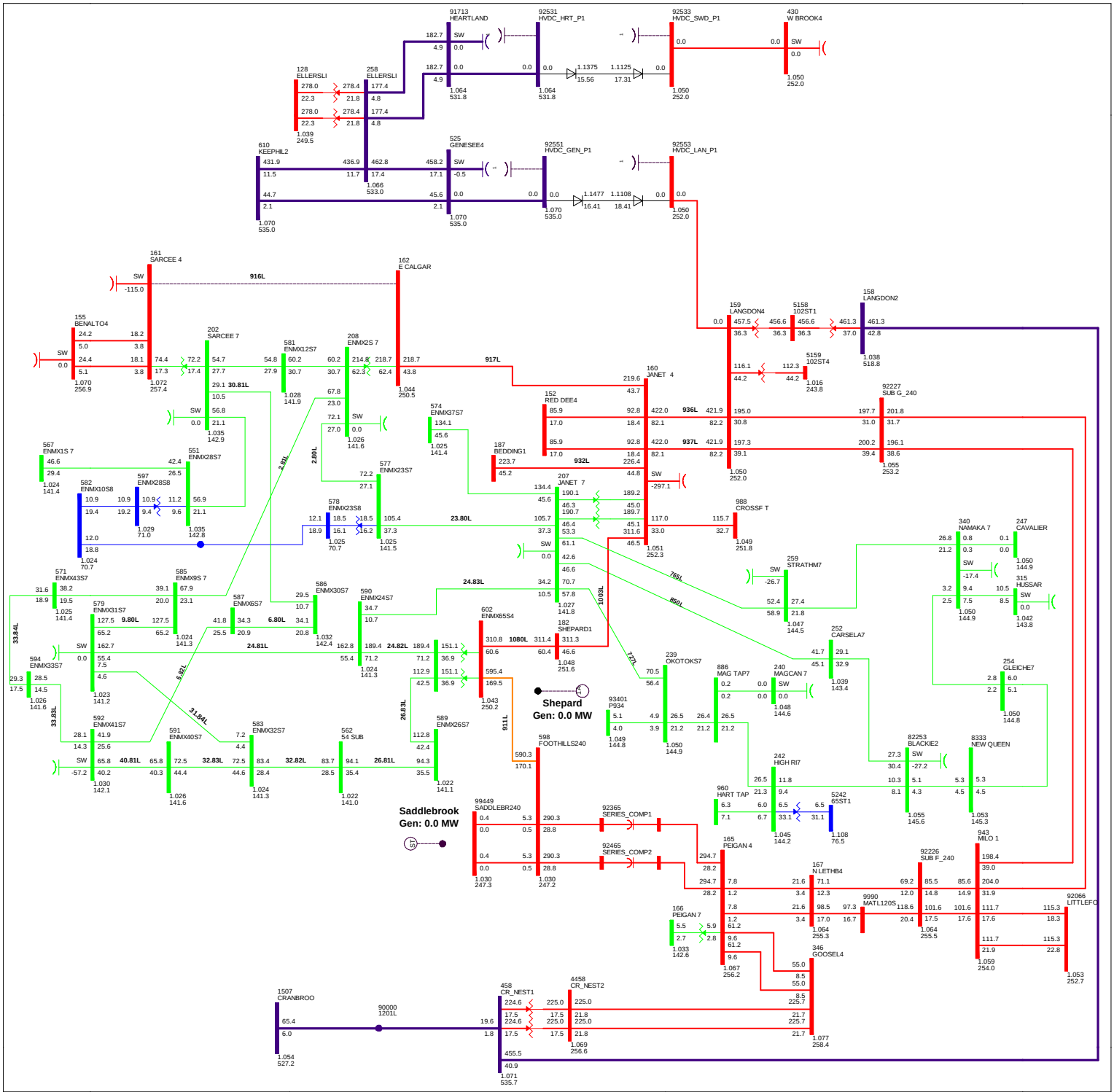
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 22.1 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-27: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX 2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:47



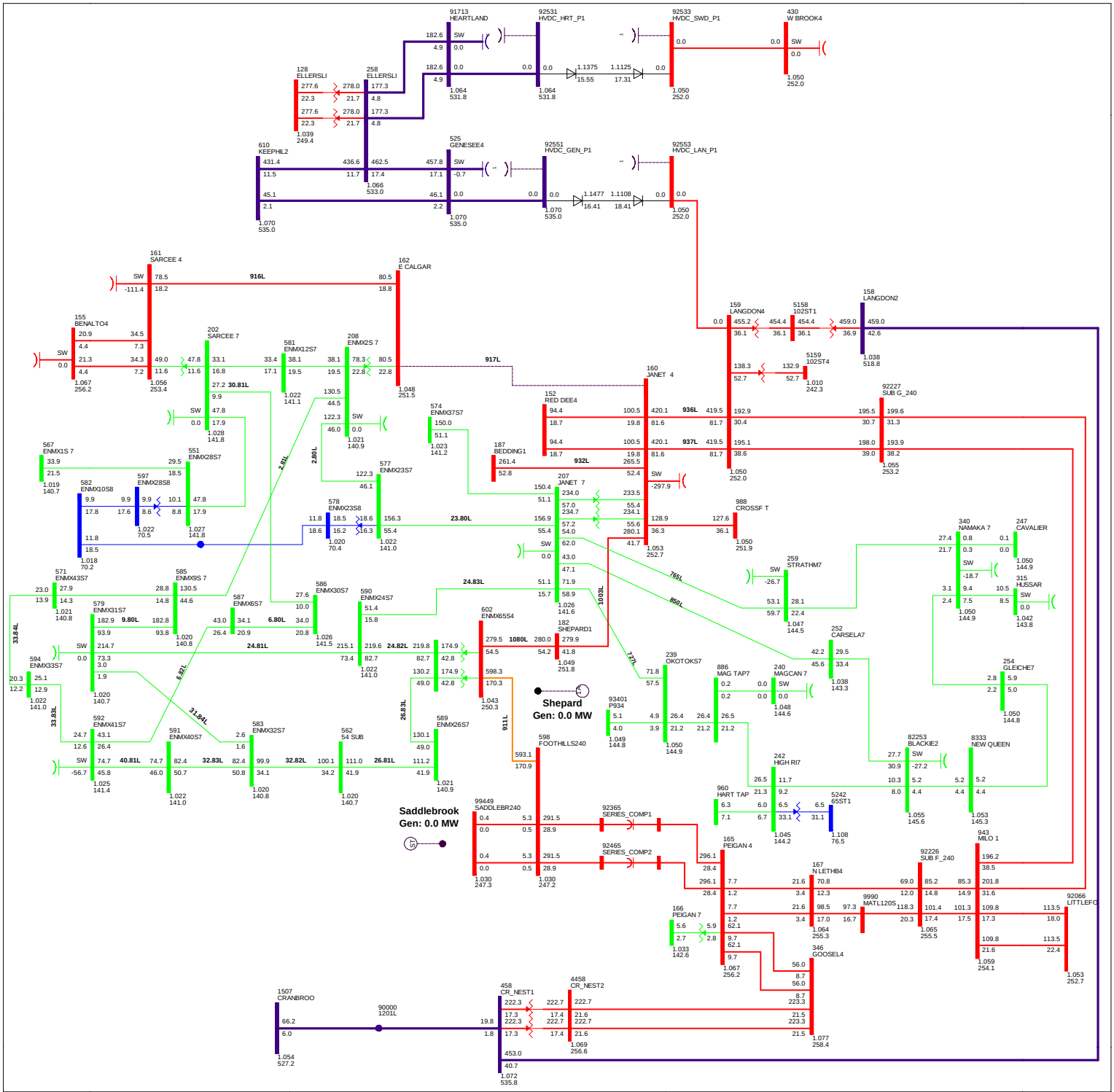
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-28: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:47



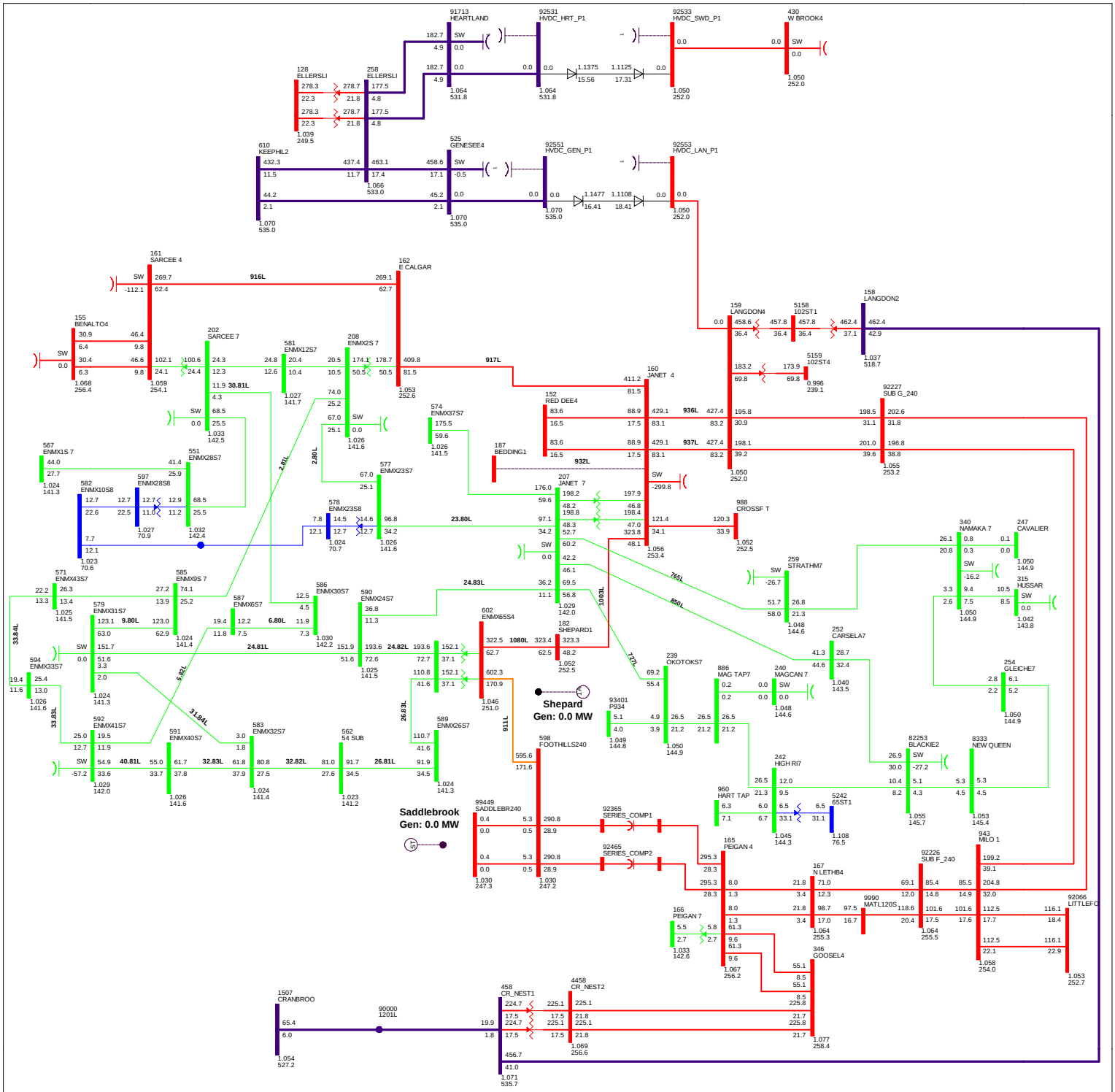
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 6.2 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-29: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:47



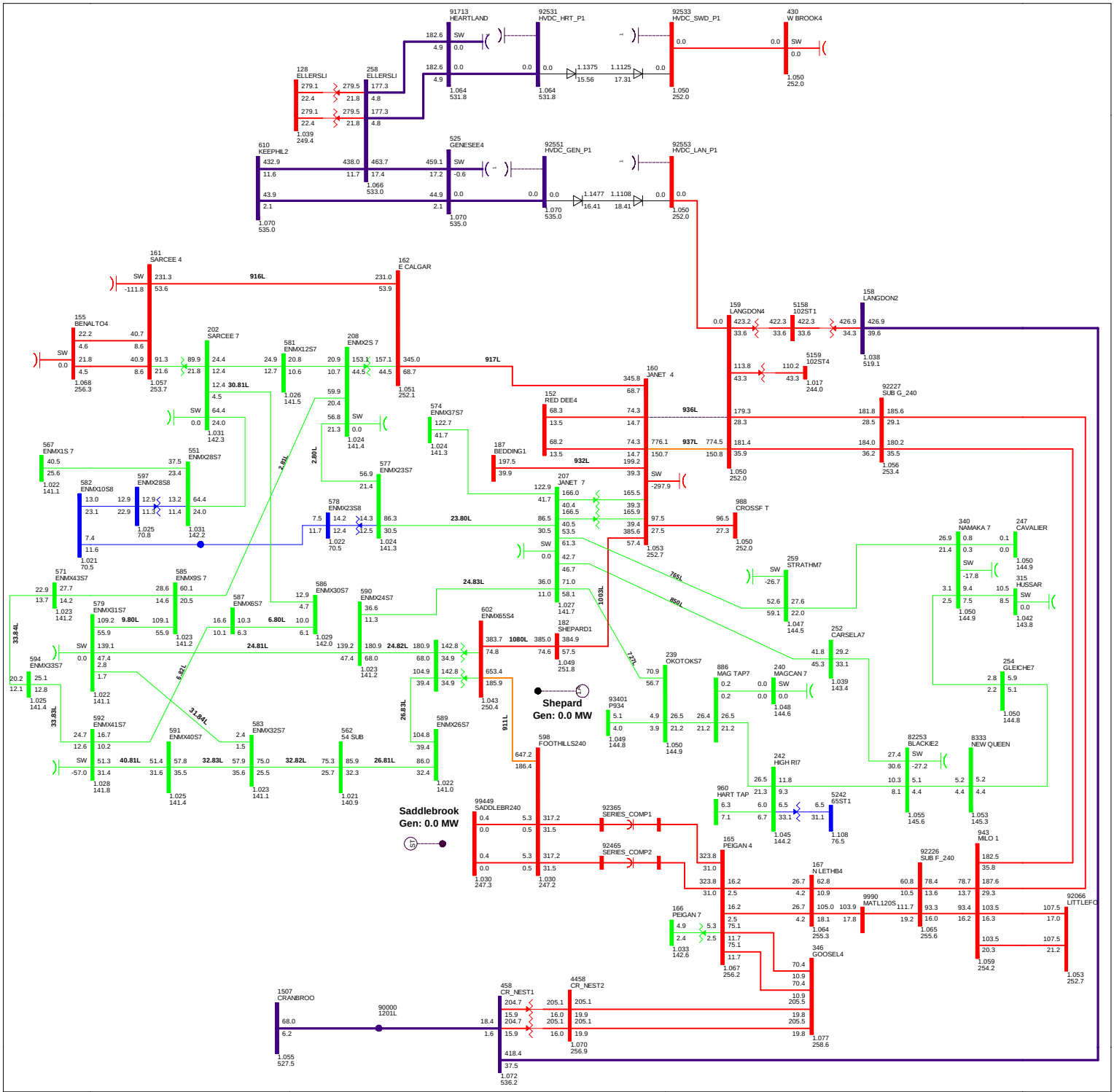
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.4 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-30: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:47



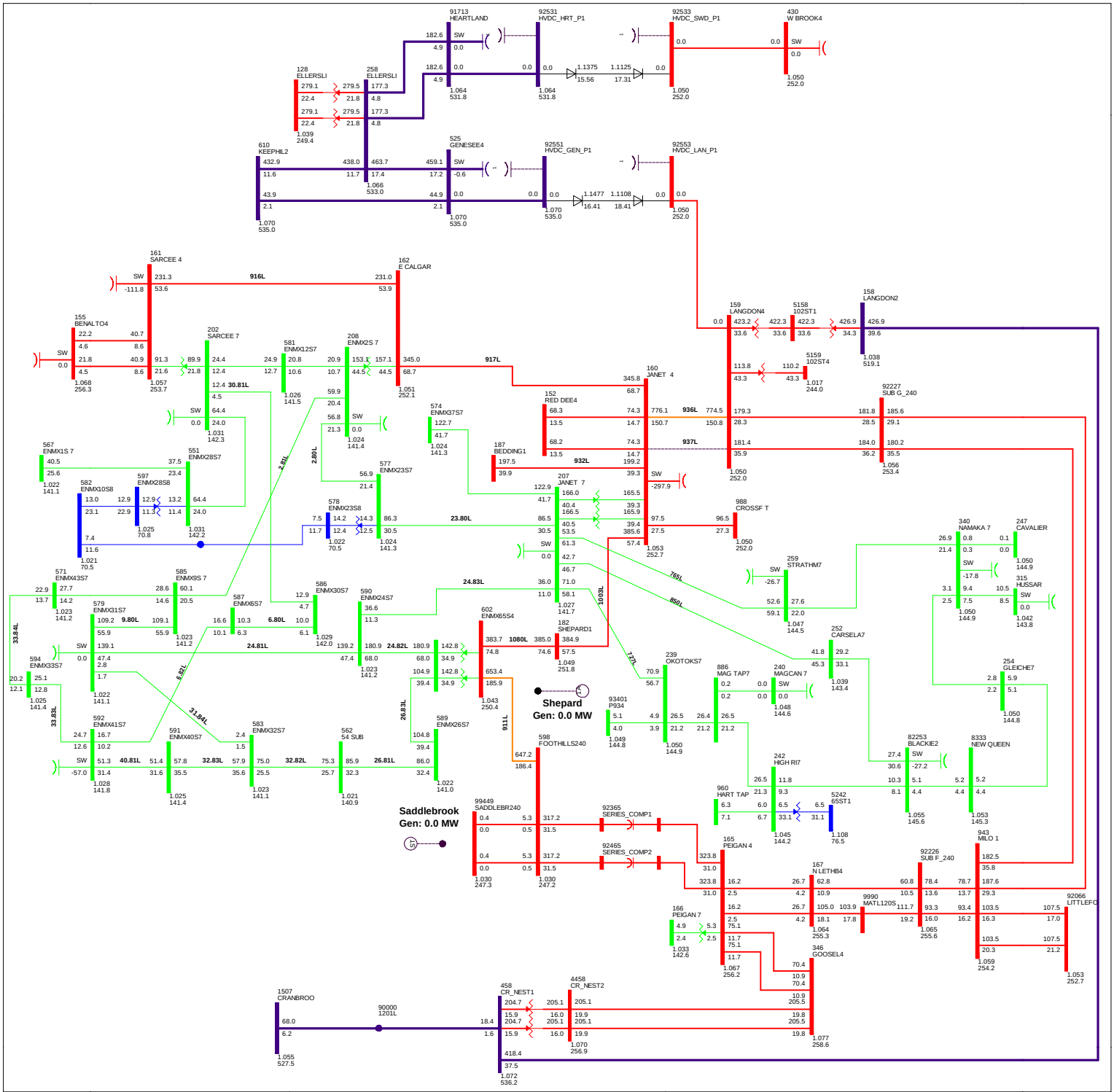
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 7.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-31: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SL_EXISTING_SC6

FRI, JUN 08 2012 15:47



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 7.0 MW

2012LTO EXISTING SYSTEM

FIG B-SC6-32: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2019_SL_EXISTING_SC6

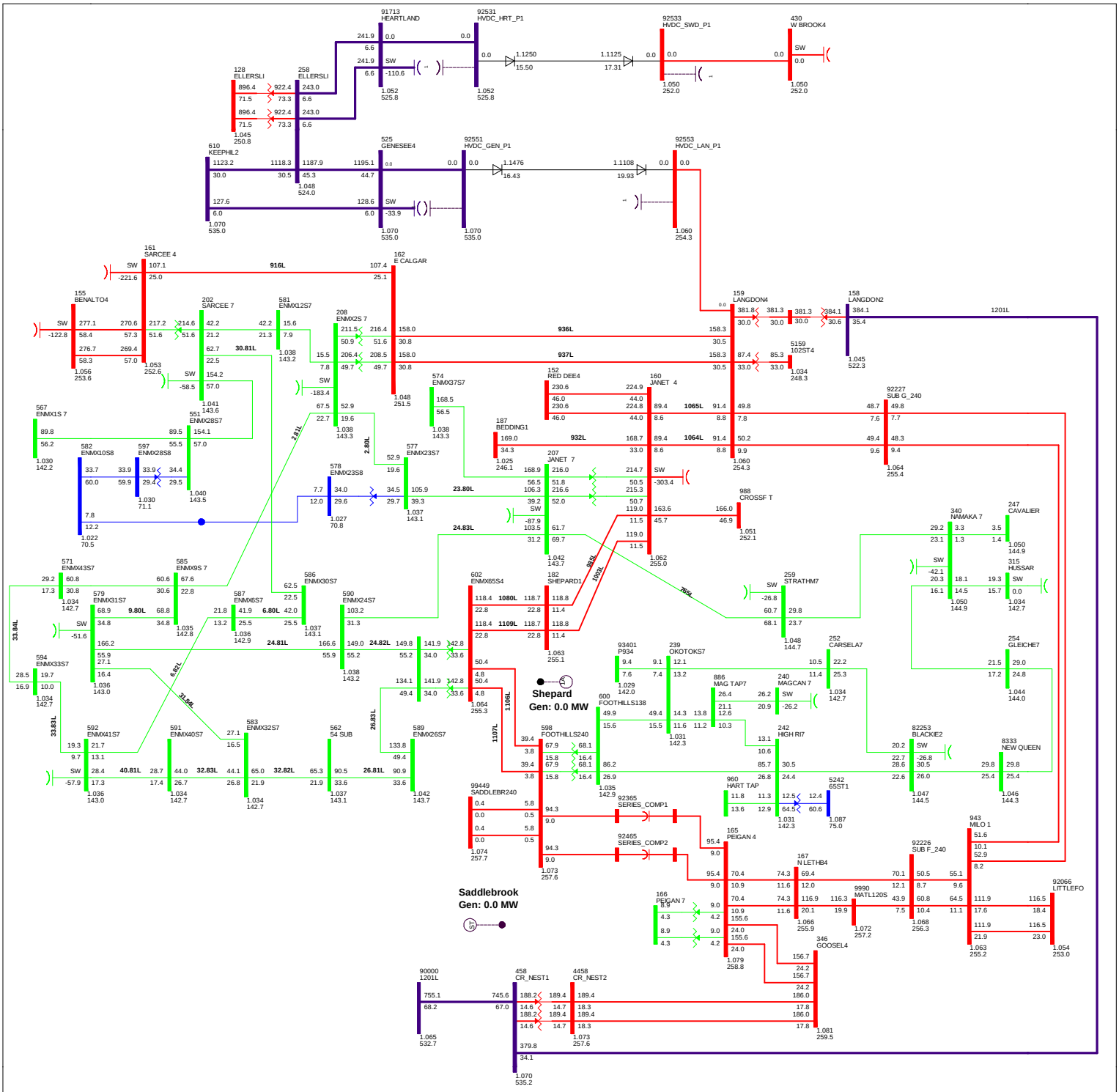
FRI, JUN 08 2012 15:47

B-2: FATD-East Assessment

Table 4: FATD East Maximum Loading on Critical Lines with 2019 FATD under Category B

Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration	
				NEED	FATD East
				√ indicates loading below 80% N/A indicates the circuit does not exist	
C-SC1-2	Open 240/138 kV transformer (Sarcee 42S)	240/138 kV transformer (Sarcee 42S)	SC1	92% 369MVA	√
C-SC3-2	Open 240/138 kV transformer T1 (East Calgary 5S)	240/138 kV transformer T2 (East Calgary 5S)	SC3	N/A	87% 349MVA
C-SC4-2	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	SC4	172% 875MVA	√
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	111% 321MVA	√
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	316% 822MVA	99% 271MVA
		24.83L 138 kV line (Janet 74S to ENMAX No. 24)	SC4	120% 382MVA	√
		240/138 kV transformer (ENMAX No. 65)	SC4	149% 596MVA	√
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	125% 323MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	140% 365MVA	√
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	115% 182MVA	√
		40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	104% 165MVA	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	201% 385MVA	87% 174MVA
		985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	97% 1028MVA
C-SC4-3	Open 1201L 500kV line (Langdon 102S to Crowsnest 491S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	189% 1275MVA	√
C-SC4-4	Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	128% 249MVA	113% 227MVA
C-SC4-5	Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	87% 245MVA	85% 247MVA
C-SC4-6	Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	101% 269MVA	81% 221MVA
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	117% 311MVA	96% 263MVA
C-SC4-7	Open 240/138 kV transformer T1 (East Calgary 5S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	107% 461MVA	82% 359MVA
C-SC4-8	Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	98% 391MVA	80% 321MVA
C-SC4-9	Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	107% 428MVA	92% 367MVA
C-SC4-10	Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	133% 389MVA	122% 368MVA
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	167% 445MVA	132% 361MVA
		31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	90% 145MVA	88% 146MVA
C-SC4-11	Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	97% 156MVA	87% 145MVA
C-SC4-12	Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	117% 392MVA	√
C-SC4-13	Open 936L 240 kV line (Langdon 102S to East Calgary 5S)	937L 240 kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	96% 507MVA
C-SC4-14	Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	96% 507MVA
C-SC4-15	Open 985L 240 kV line (Janet 74S to ENMAX No. 25)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	97% 1028MVA

2019 Loading Violations
Scenario 1



Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

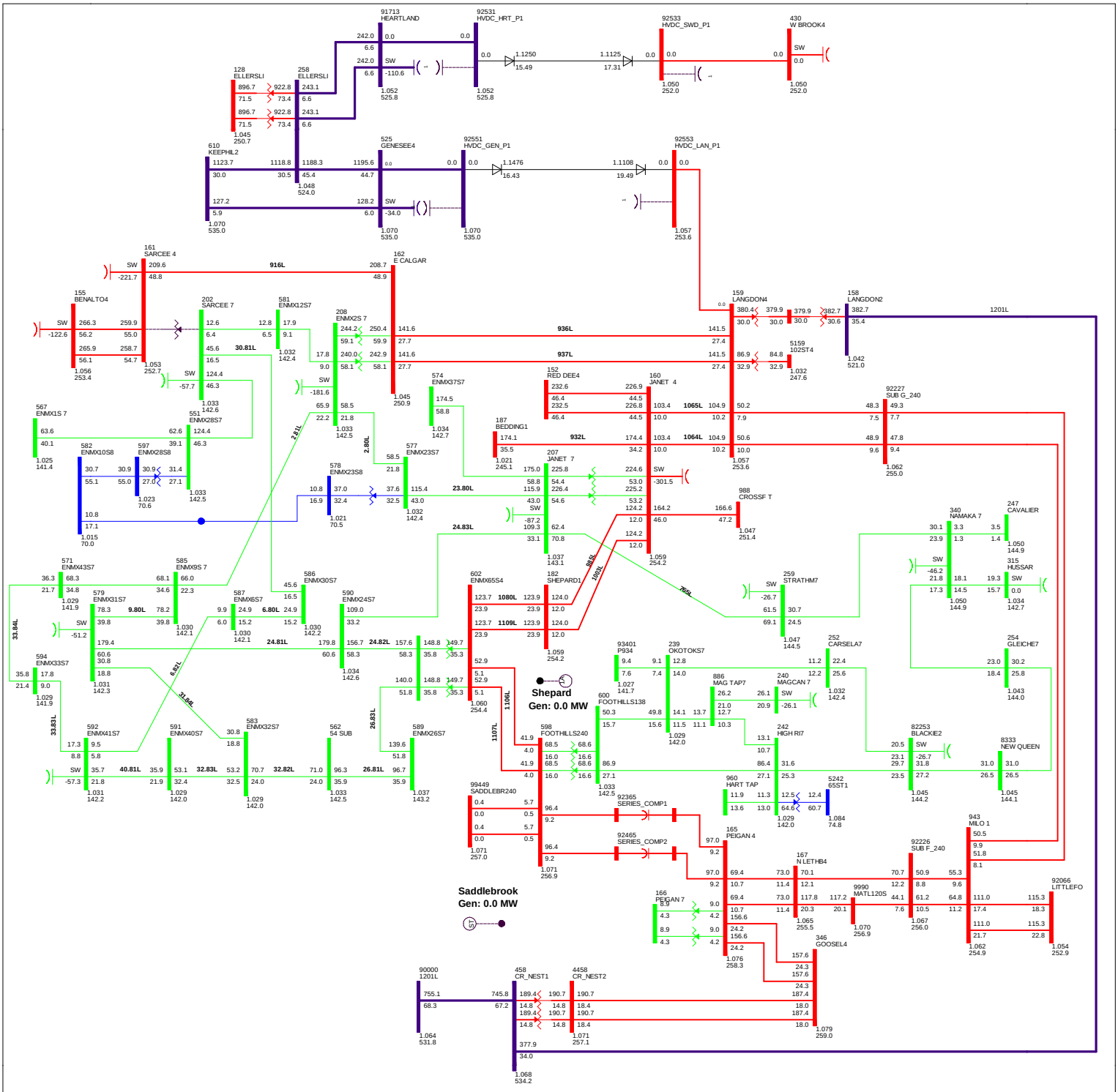
BCH Import: 779.7 MW

2012LTO FATD EAST SYSTEM

FIG C-SC1-1: BASECASE

2019_SP_STG3_ALT1_SC1

FRI, JUN 08 2012 15:54



Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.7 MW

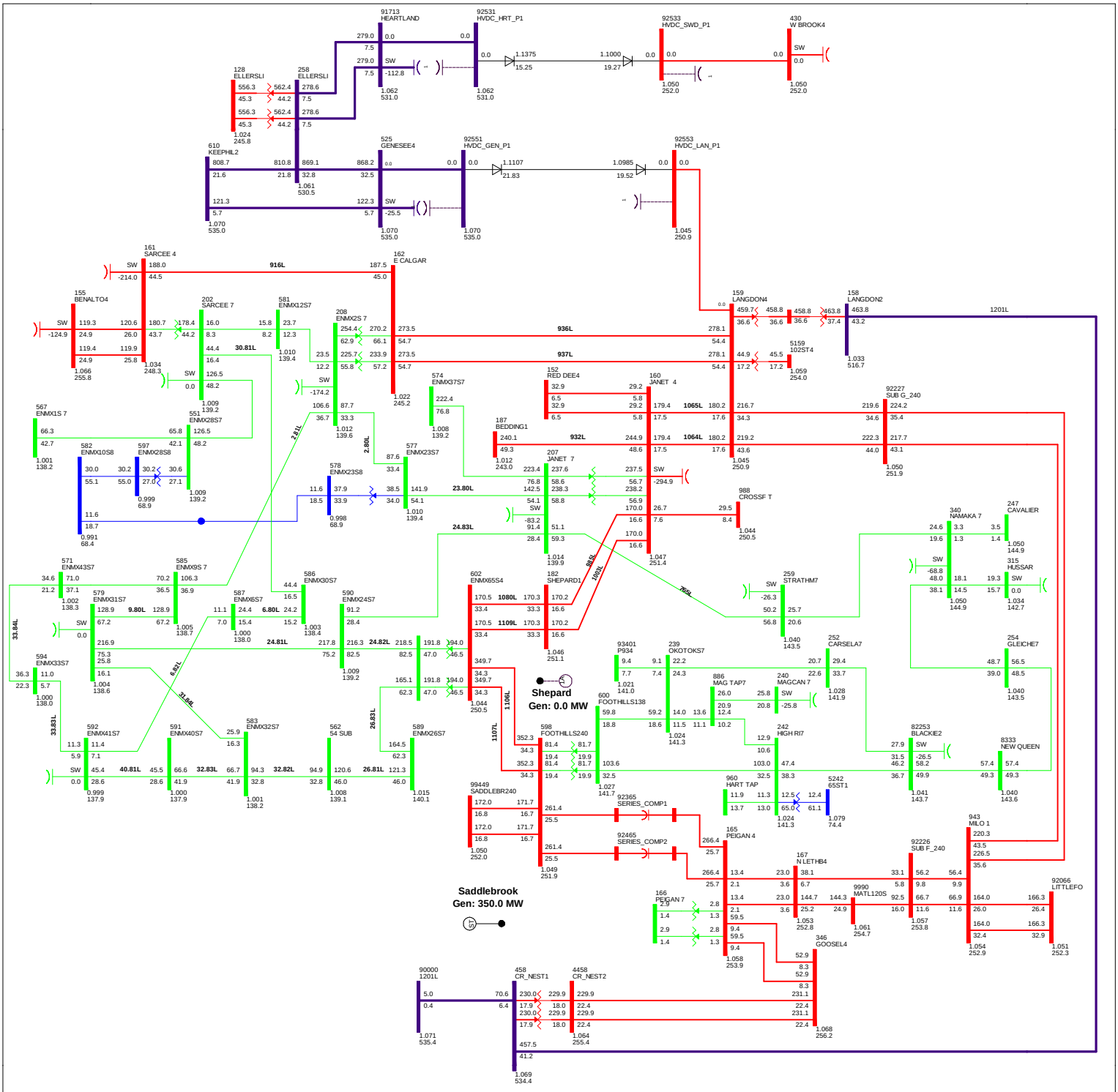
2012LTO FATD EAST SYSTEM

FIG C-SC1-2: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2019_SP_STG3_ALT1_SC1

FRI, JUN 08 2012 15:54

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

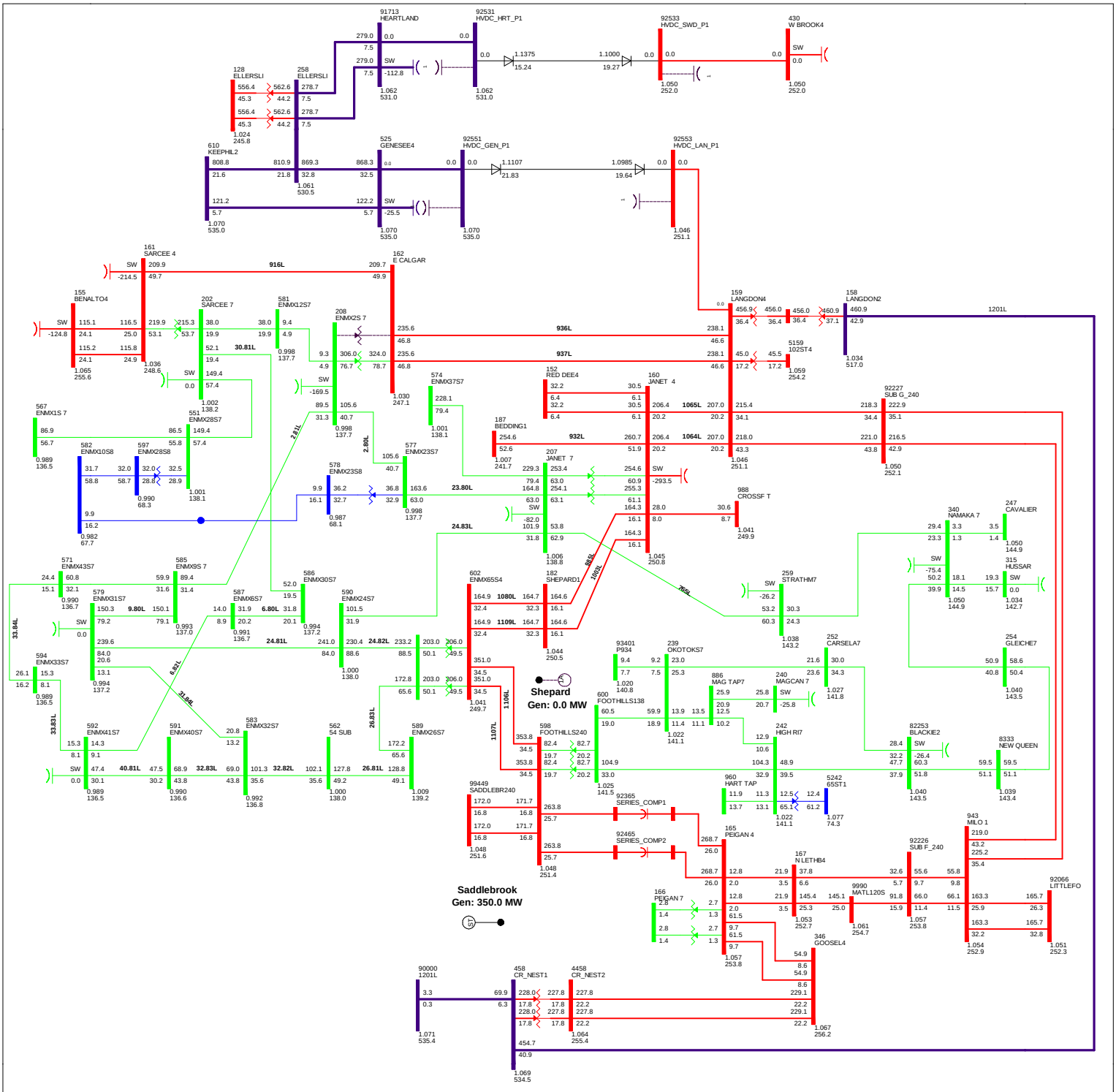
BCH Import: -0.9 MW

2012LTO FATD EAST SYSTEM

FIG C-SC3-1: BASECASE

2019_SP_STG3_ALT1_SC3

FRI, JUN 08 2012 15:54



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

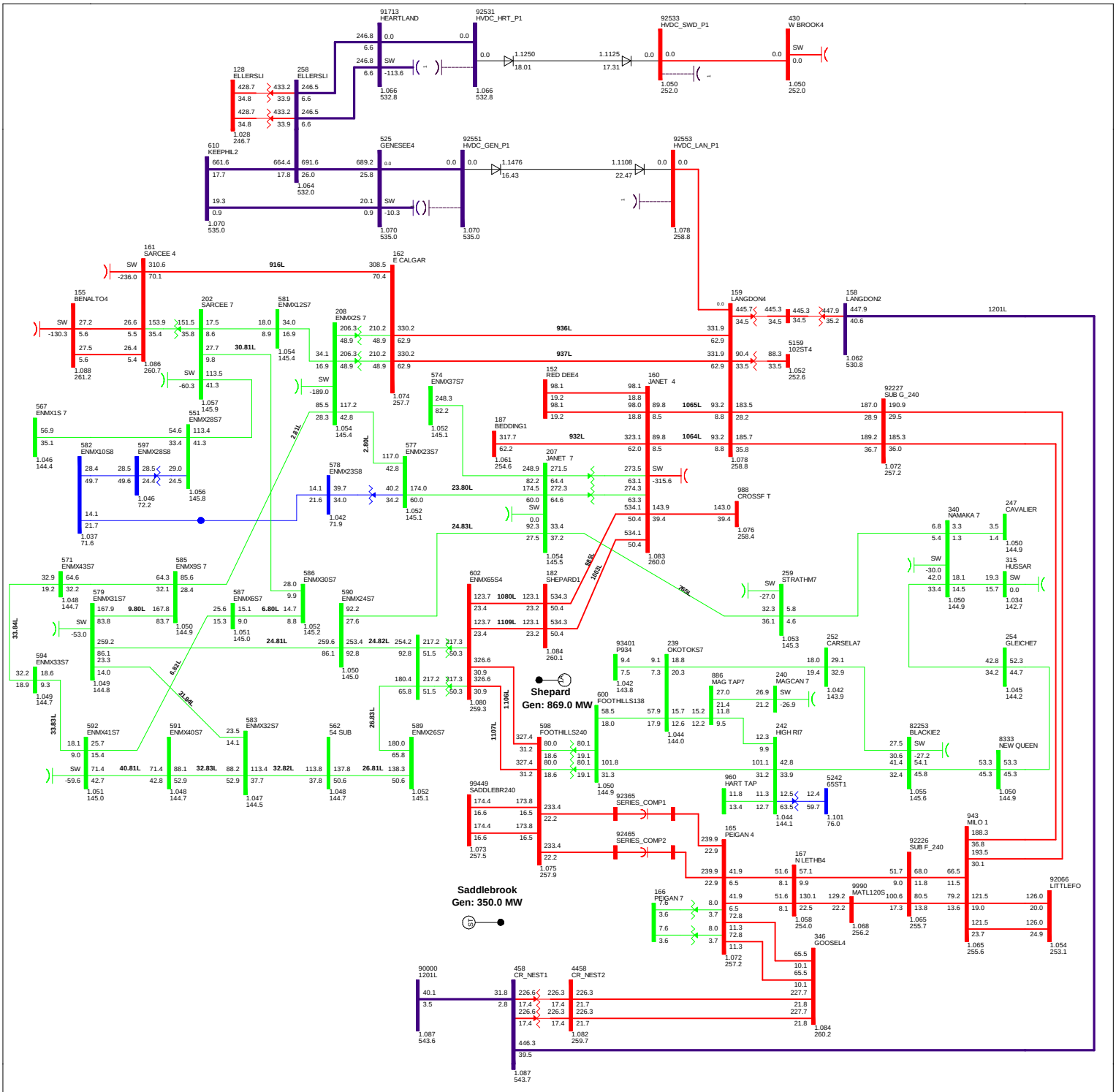
BCH Import: 1.6 MW

2012LTO FATD EAST SYSTEM

FIG C-SC3-2: OPEN 240/138 KV TRANSFORMER T1 (EAST CALGARY 5S
2019_SP_STG3_ALT1_SC3

FRI, JUN 08 2012 15:54

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

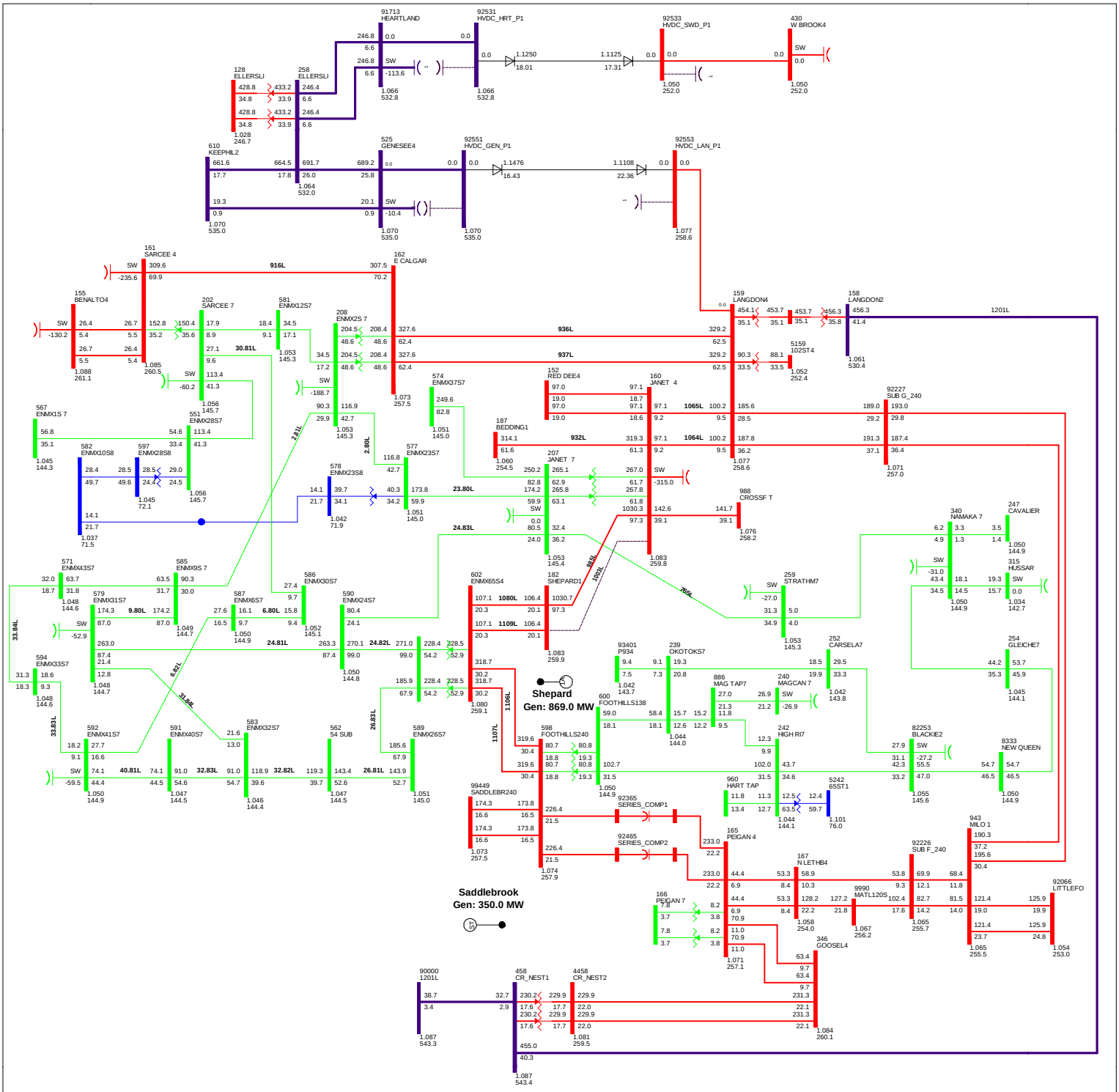
BCH Import: 0.0 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-1: BASECASE

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

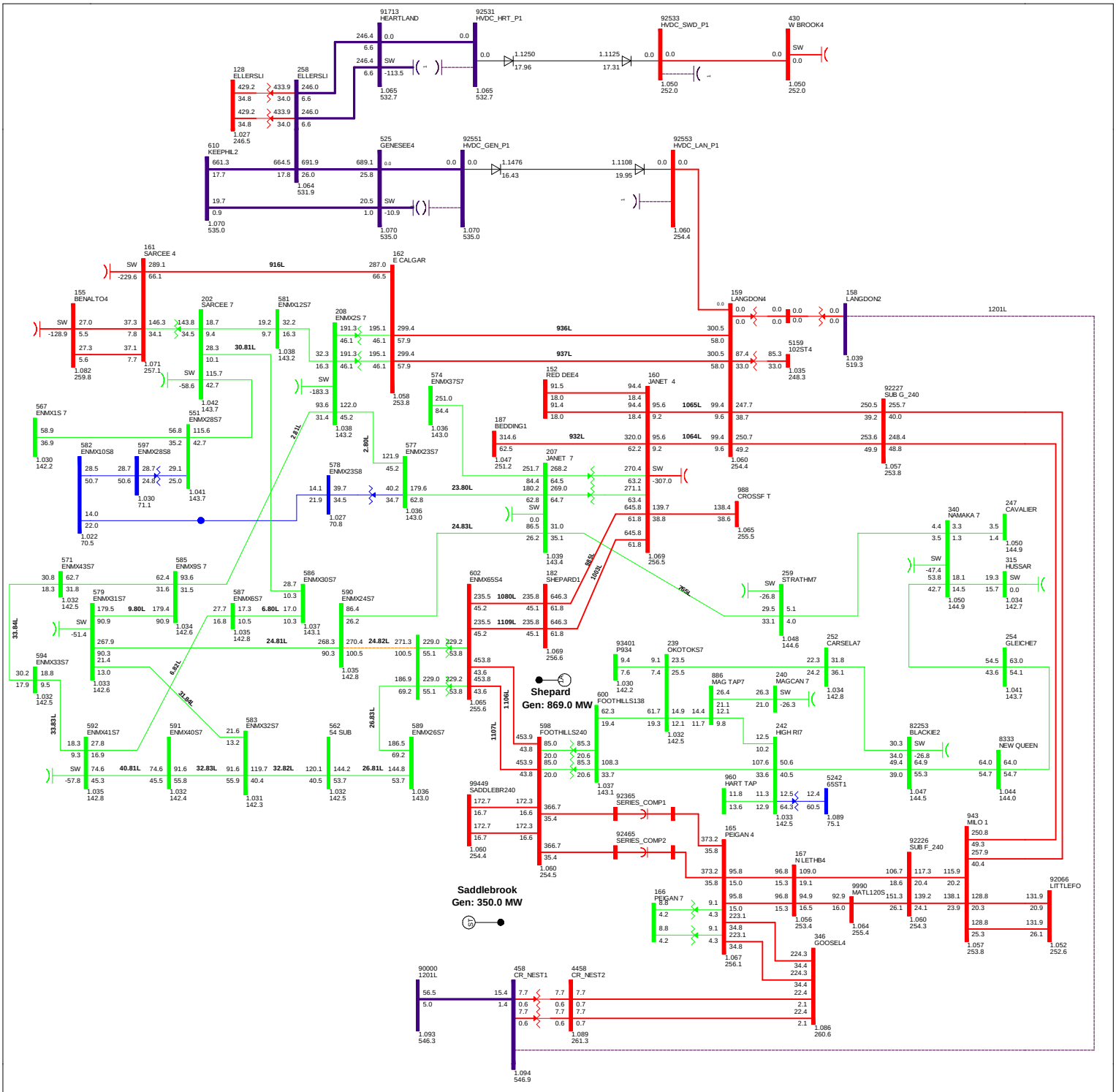
BCH Import: 1.5 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



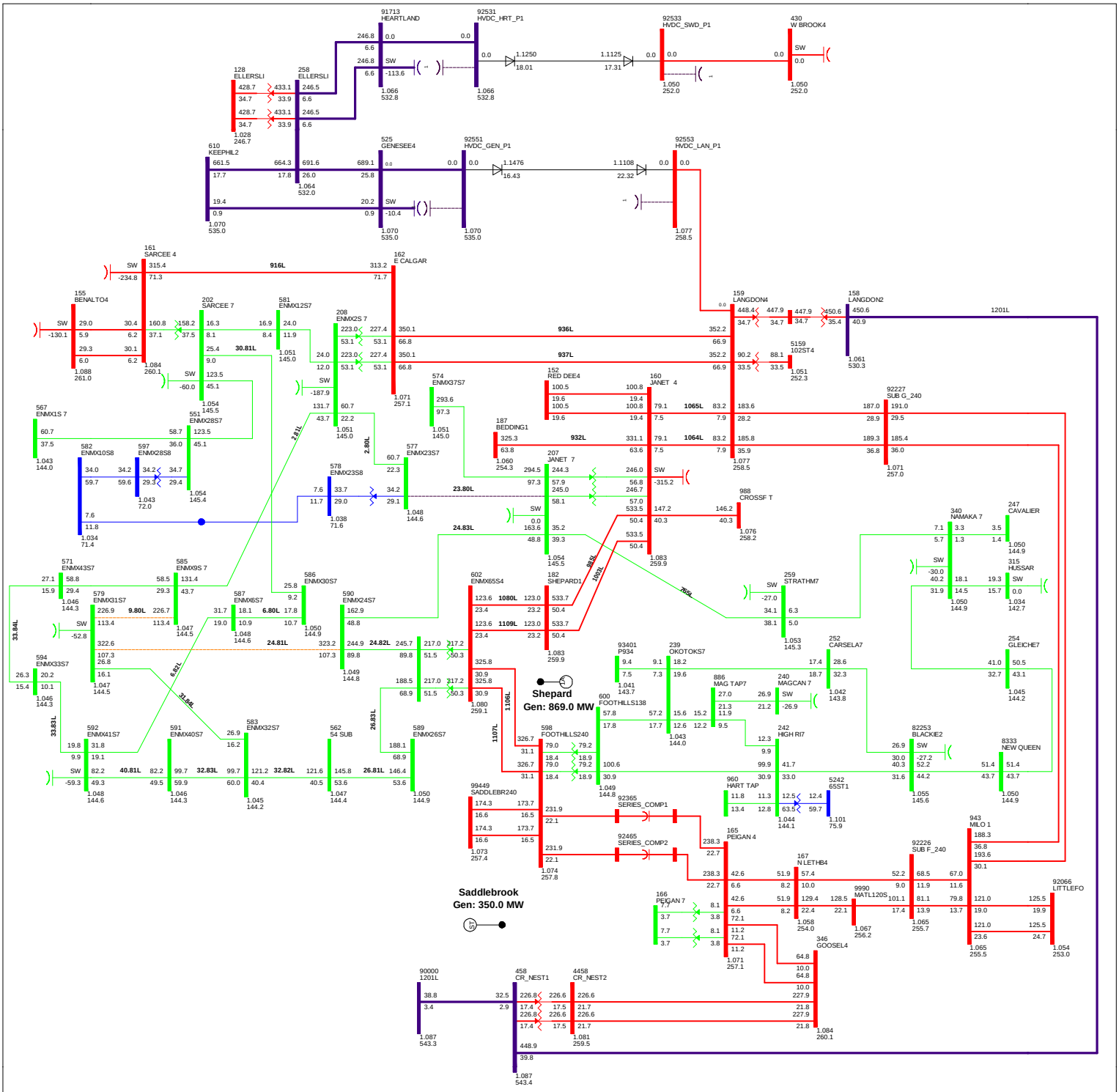
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 31.4 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-3: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE
2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



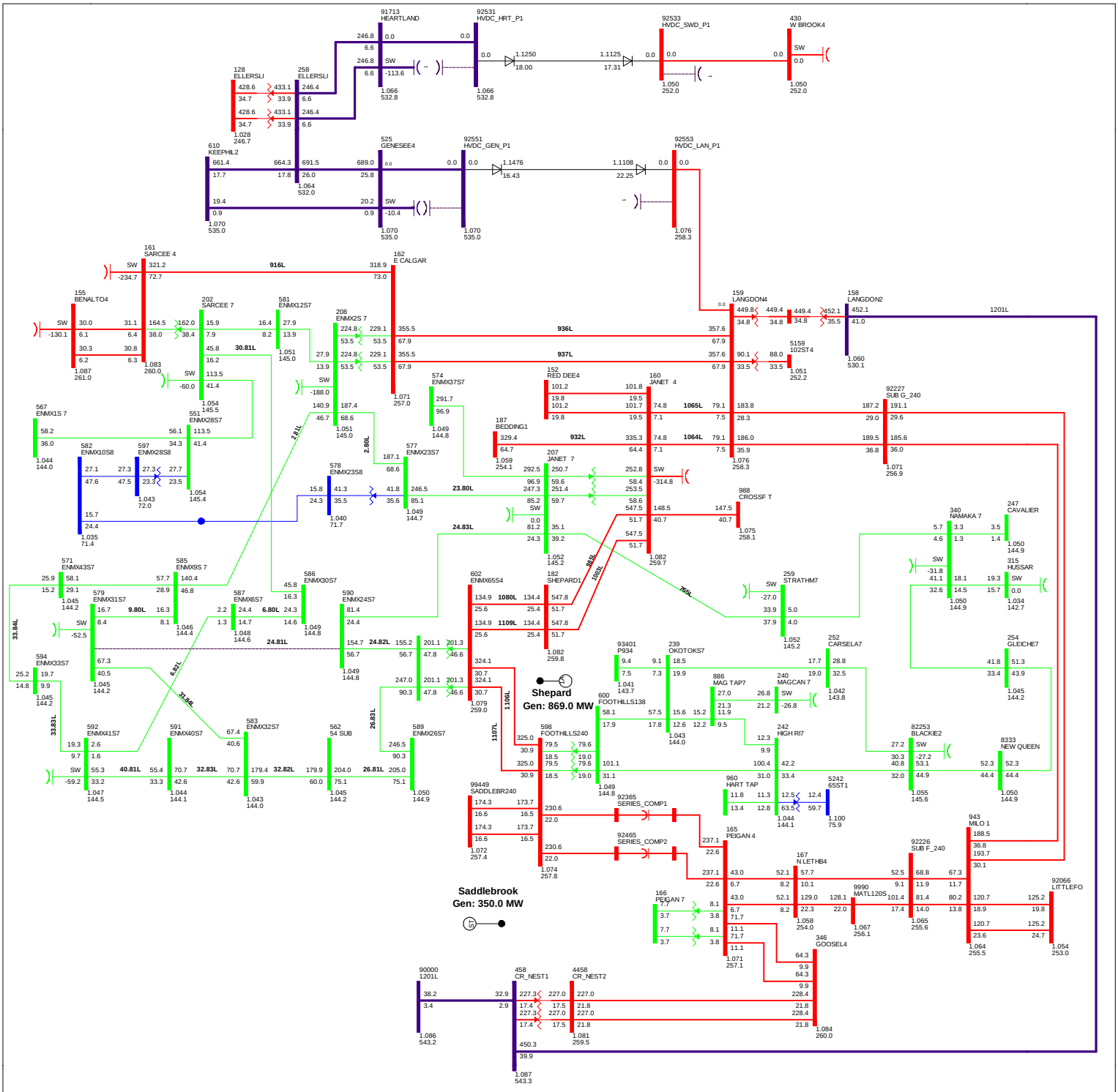
Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.7 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-4: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

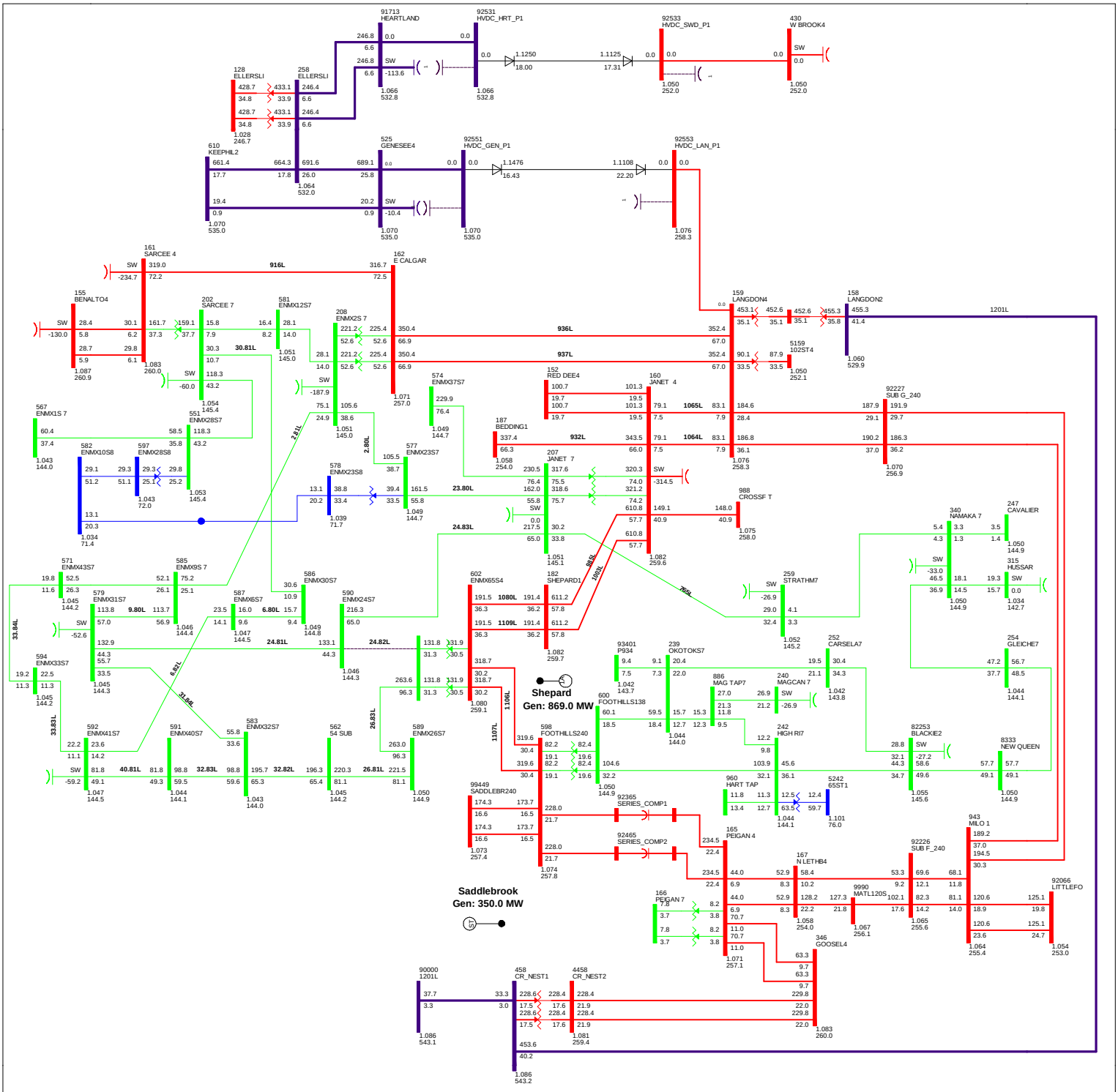
BCH Import: 3.5 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-5: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

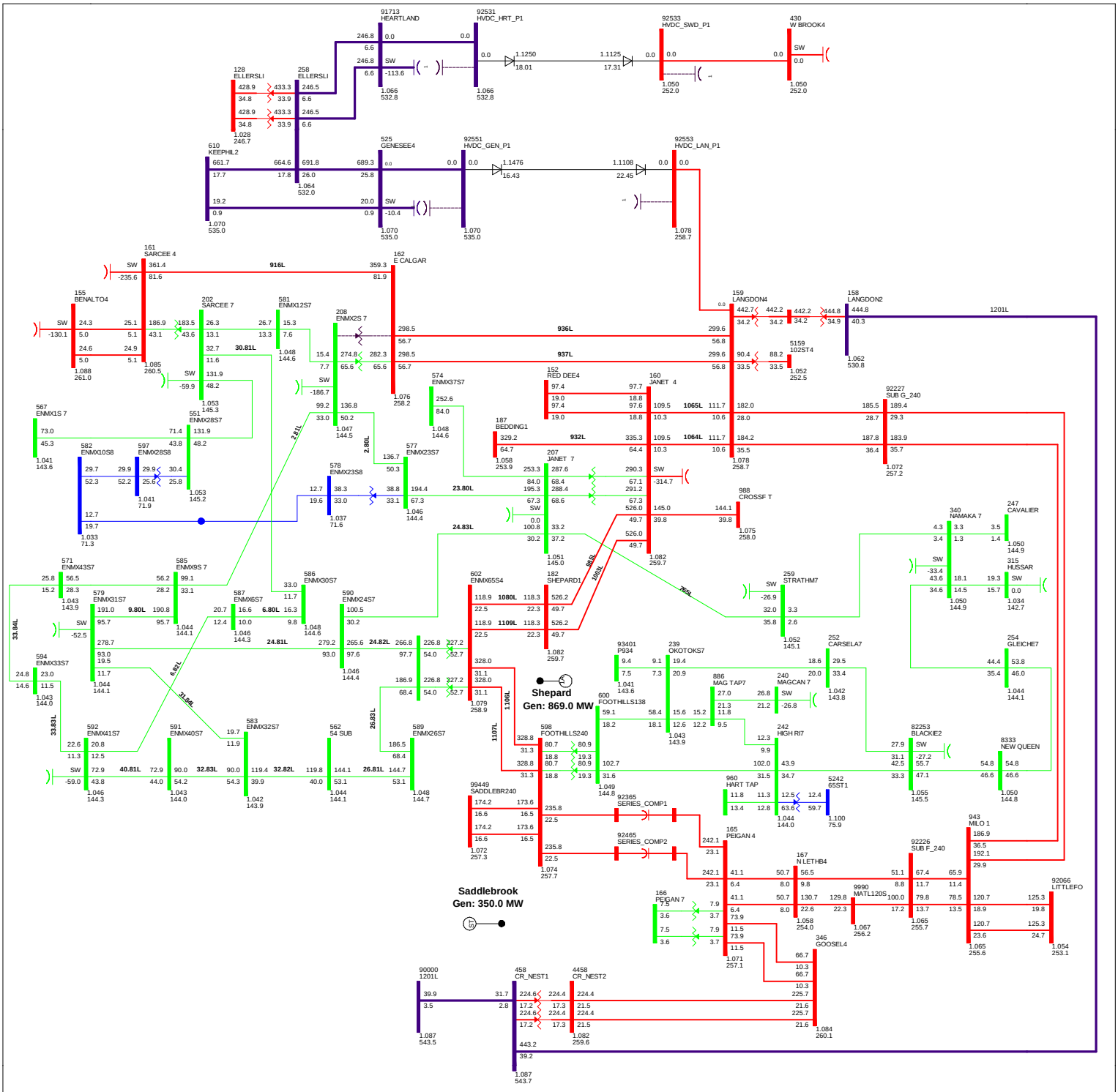
BCH Import: 3.9 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-6: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

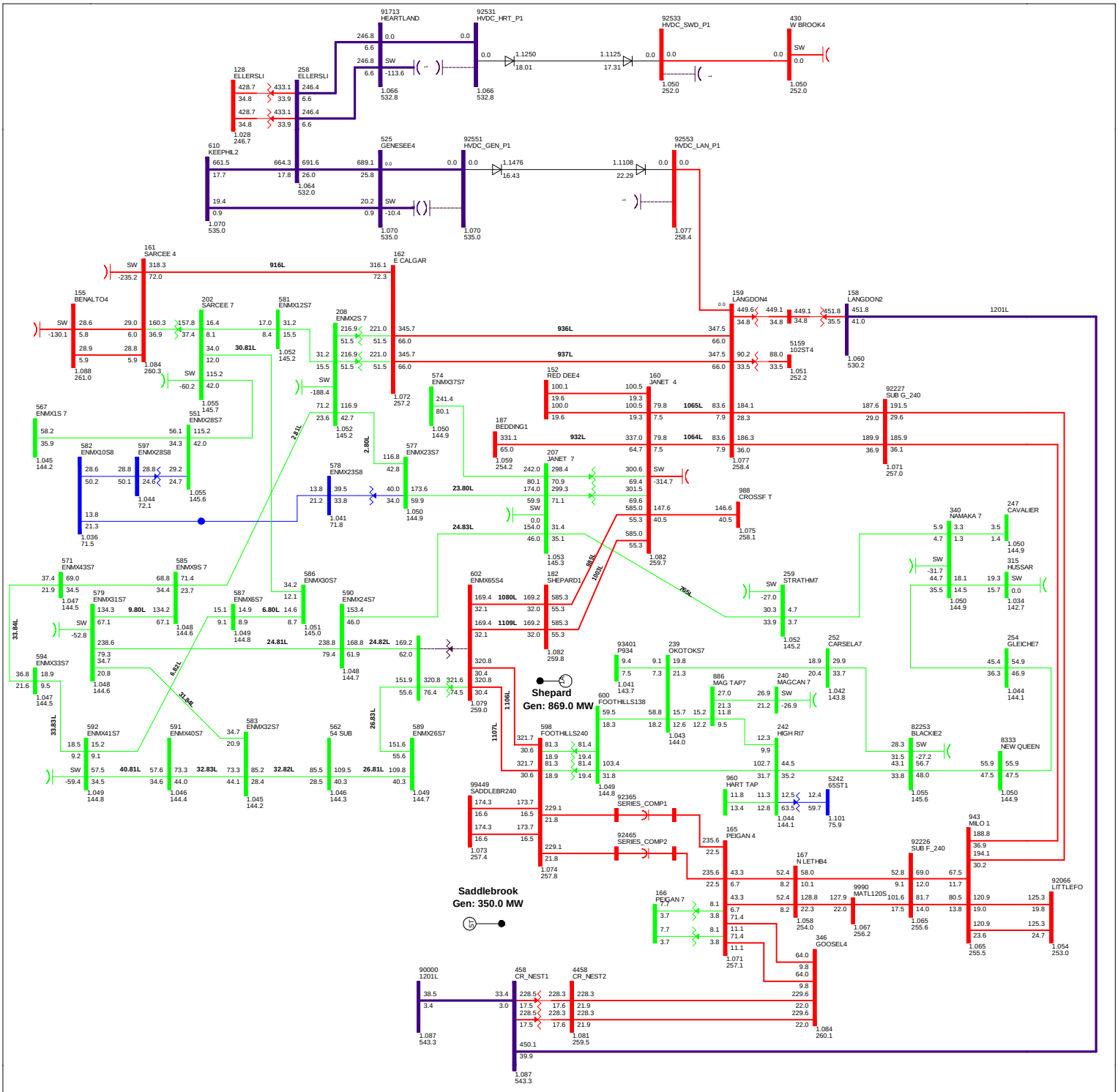
BCH Import: 1.7 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-7: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

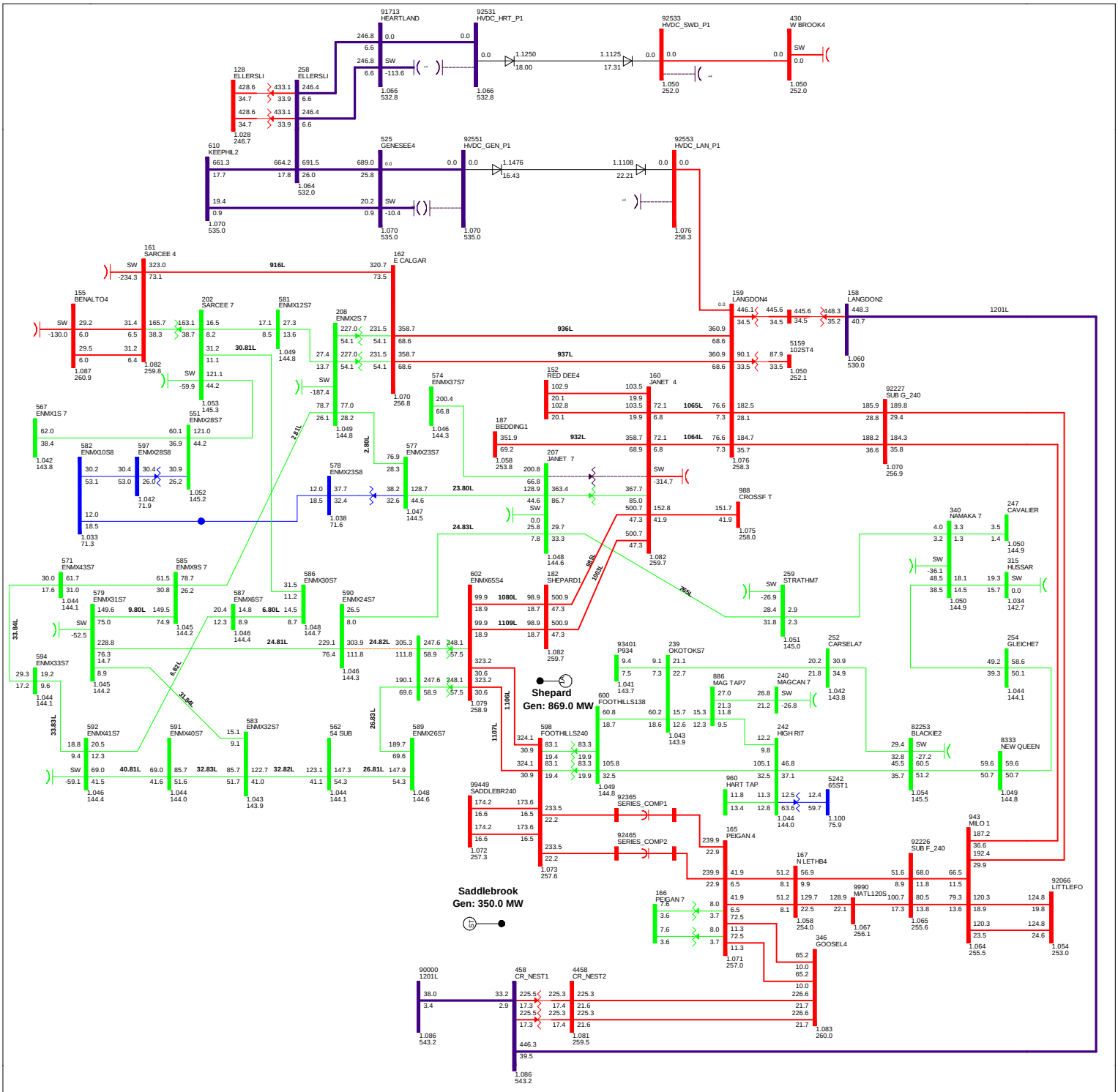
BCH Import: 0.3 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-8: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

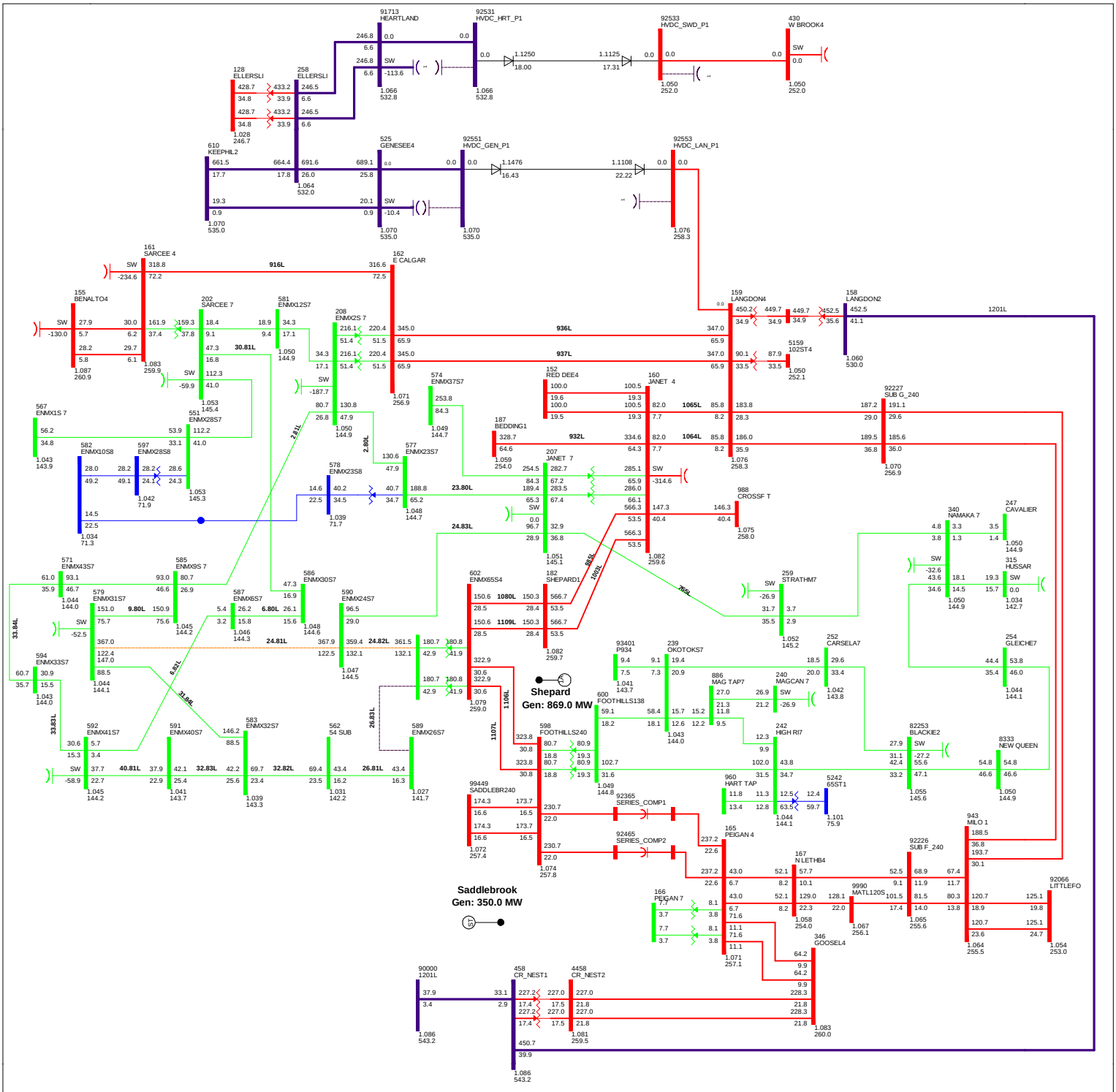
BCH Import: 3.1 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-9: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



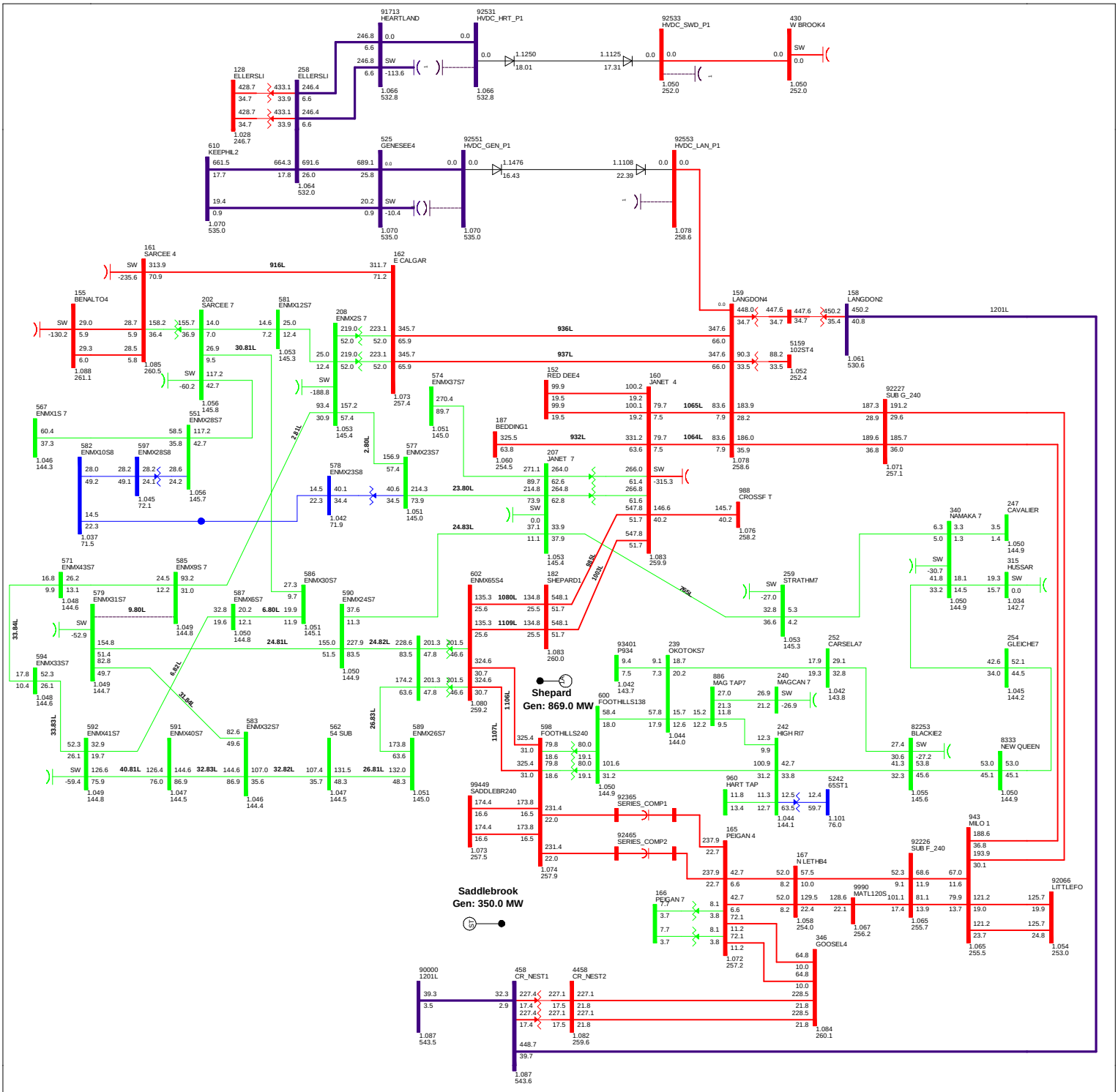
Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.7 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-10: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

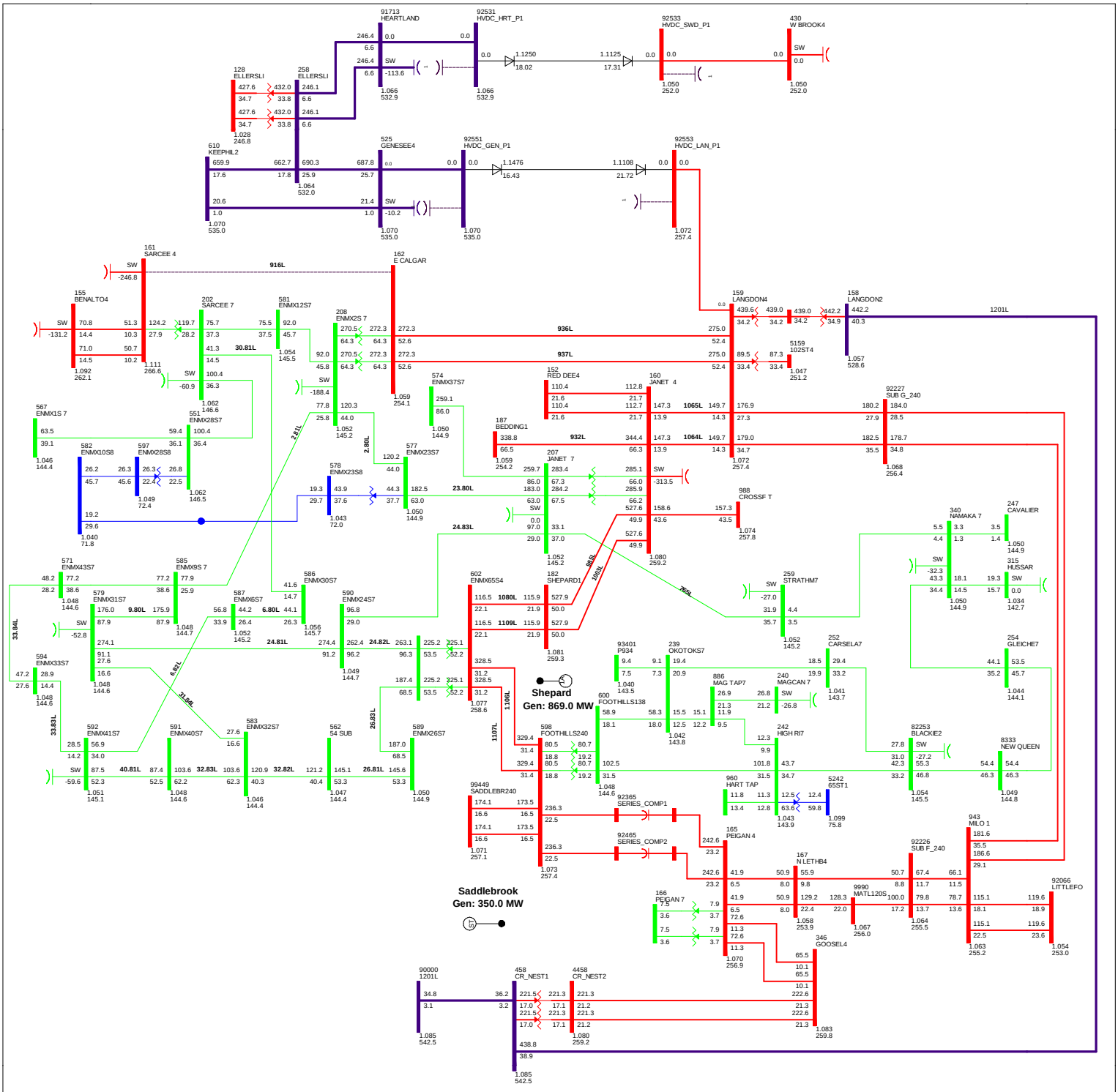
BCH Import: 1.1 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-11: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



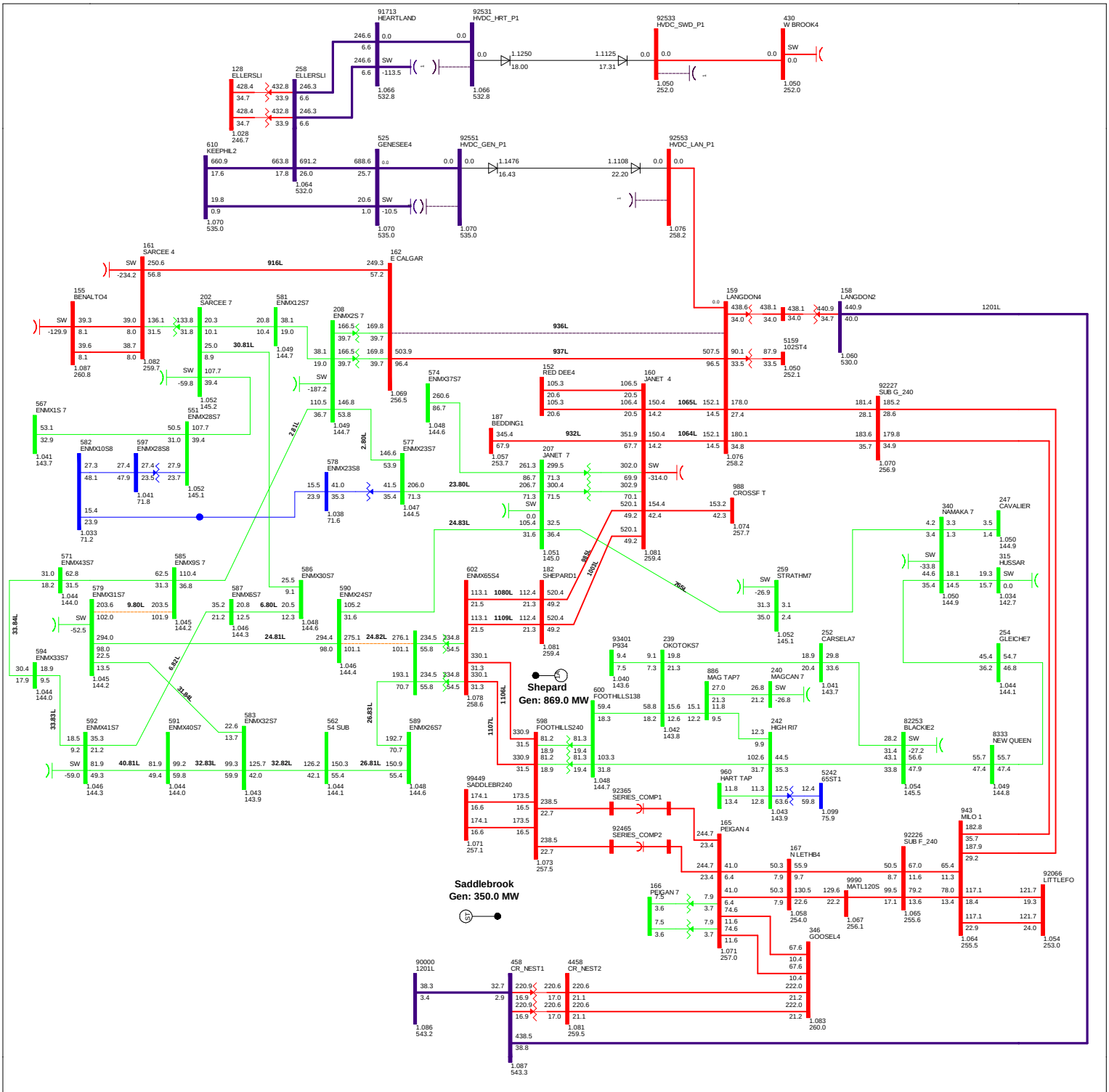
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.3 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-12: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



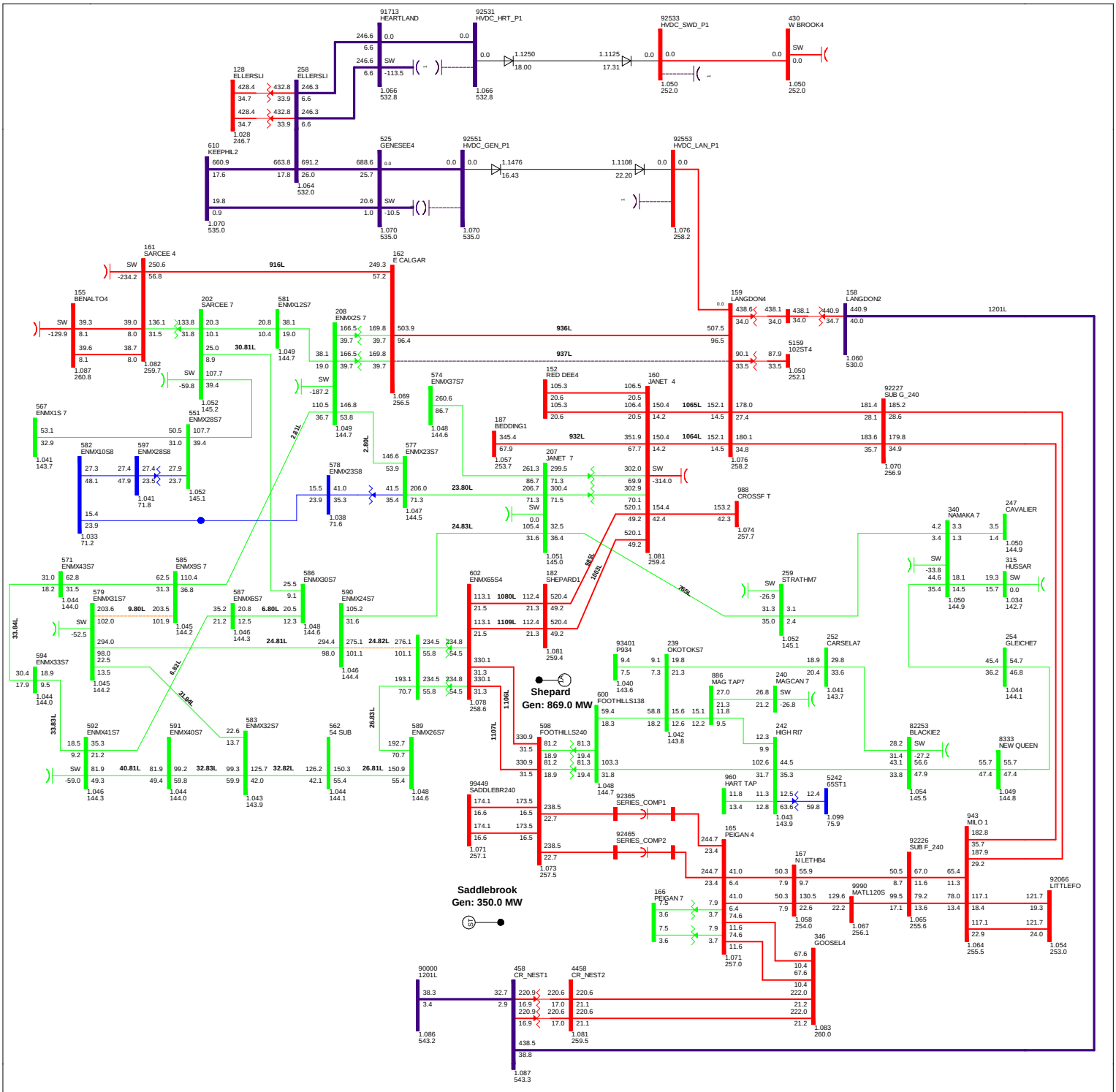
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 5.9 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-13: OPEN 936L 240 KV LINE (LANGDON 102S TO EAST CA
2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



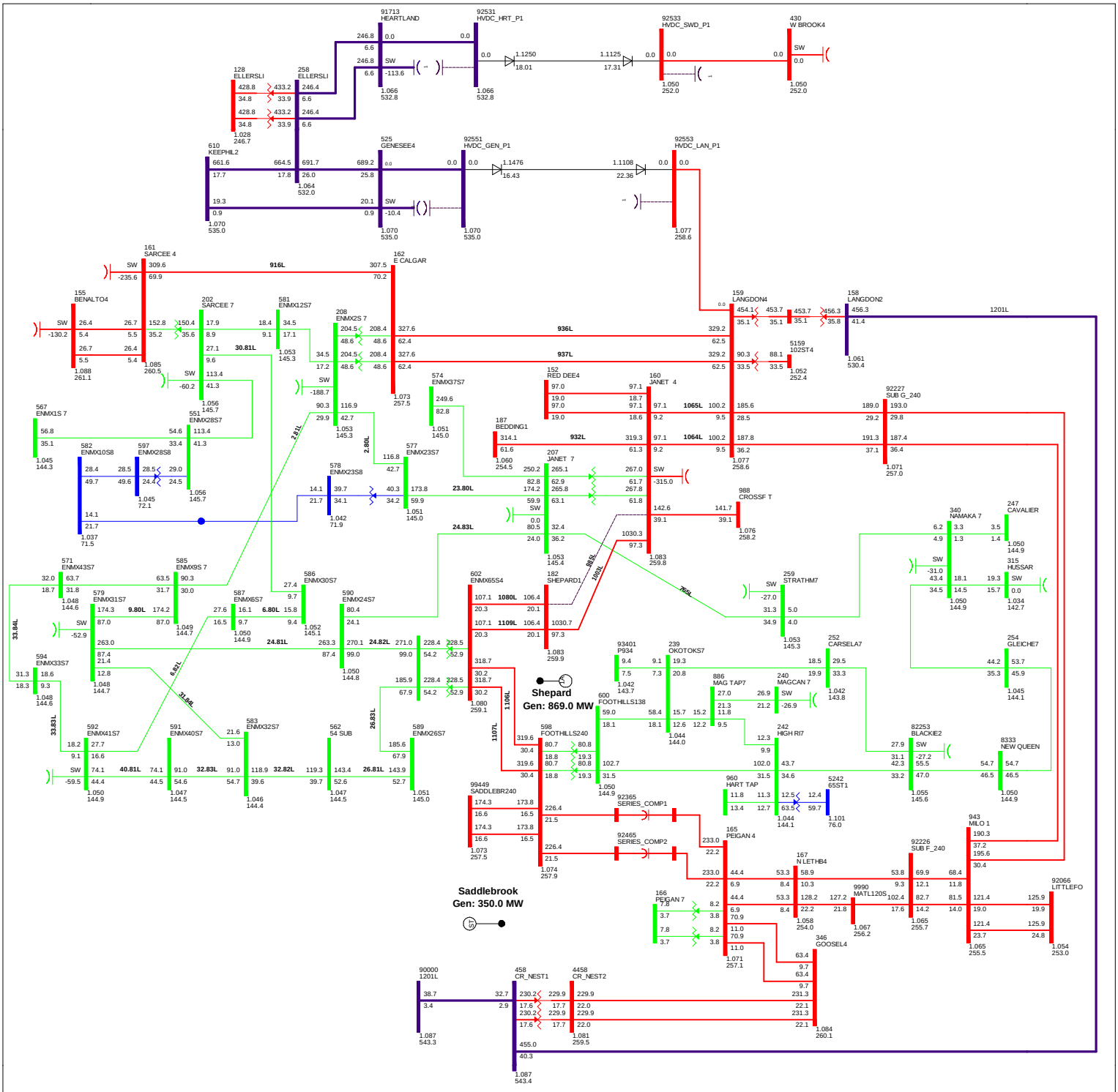
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 5.9 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-14: OPEN 937L 240 KV LINE (LANGDON 102S TO EAST CA
2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 15:55



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.5 MW

2012LTO FATD EAST SYSTEM

FIG C-SC4-15: OPEN 985L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_STG3_ALT1_SC4

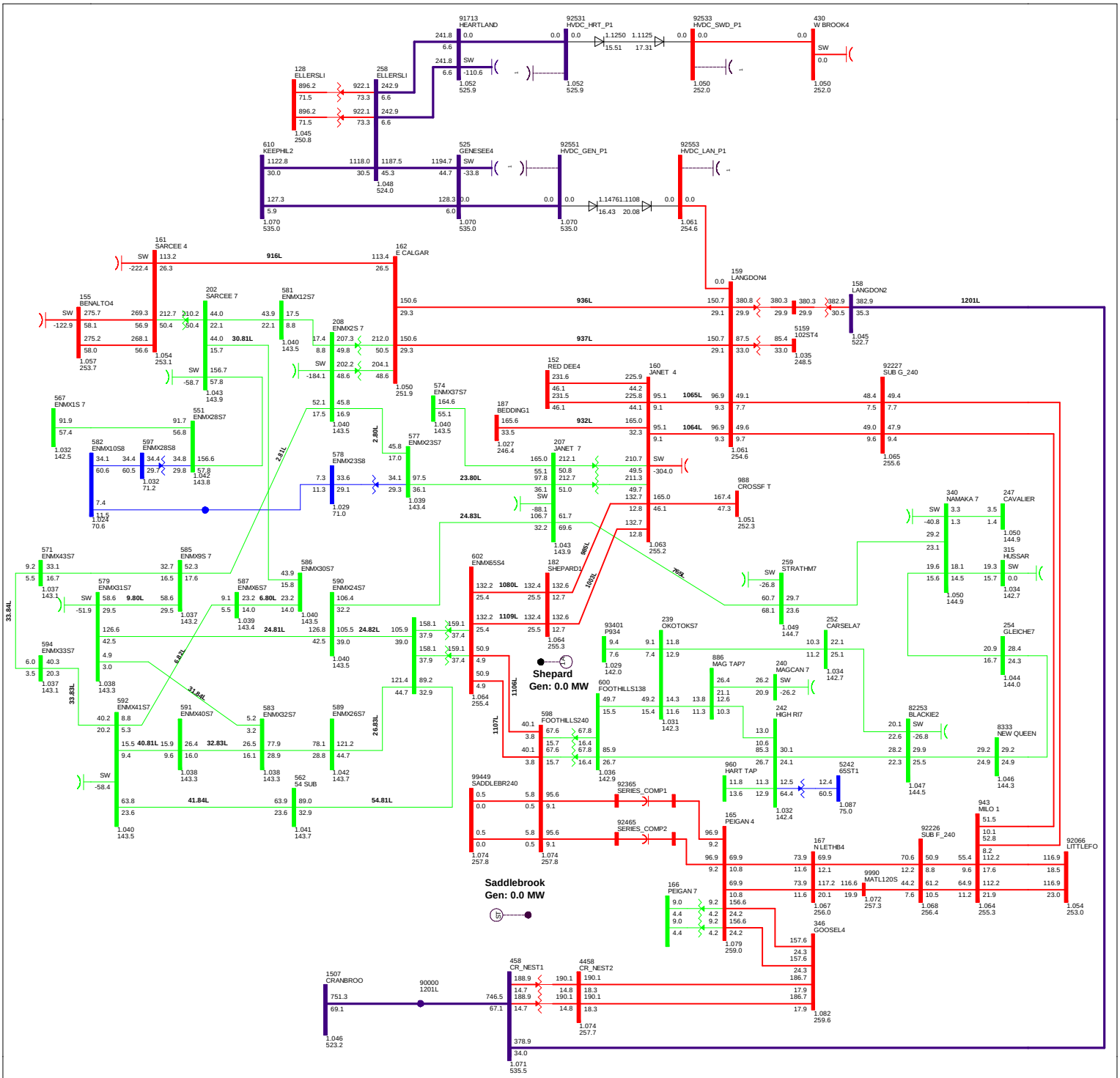
FRI, JUN 08 2012 15:55

B-3: FATD-East+3rdCkt Assessment

Table 5: FATD East+3rdCkt Maximum Loading on Critical Lines with 2019 FATD under Category B

Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration	
				NEED	FATD East+3rdCkt
				√ indicates loading below 80% N/A indicates the circuit does not exist	
D-Sc1-2	Open 240/138 kV transformer (Sarcee 42S)	240/138 kV transformer (Sarcee 42S)	SC1	92% 369MVA	√
D-Sc3-2	Open 240/138 kV transformer T1 (East Calgary 5S)	240/138 kV transformer T2 (East Calgary 5S)	SC3	N/A	85% 341MVA
D-Sc4-2	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	SC4	172% 875MVA	√
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	111% 321MVA	√
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	316% 822MVA	√
		24.83L 138 kV line (Janet 74S to ENMAX No. 24)	SC4	120% 382MVA	√
		240/138 kV transformer (ENMAX No. 65)	SC4	149% 596MVA	√
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	125% 323MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	140% 365MVA	√
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	115% 182MVA	√
		40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	104% 165MVA	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	201% 385MVA	√
		985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	92% 979MVA
D-Sc4-3	Open 1201L 500kV line (Langdon 102S to Crowsnest 491S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	189% 1275MVA	√
D-Sc4-4	Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	128% 249MVA	100% 200MVA
D-Sc4-5	Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	87% 245MVA	√
D-Sc4-6	Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	101% 269MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	117% 311MVA	82% 223MVA
D-Sc4-7	Open 240/138 kV transformer T1 (East Calgary 5S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	107% 461MVA	√
D-Sc4-8	Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	98% 391MVA	88% 353MVA
D-Sc4-9	Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	107% 428MVA	89% 357MVA
D-Sc4-10	Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	133% 389MVA	90% 271MVA
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	167% 445MVA	93% 255MVA
		31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	90% 145MVA	√
D-Sc4-11	Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	97% 156MVA	√
D-Sc4-12	Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	117% 392MVA	√
D-Sc4-13	Open 936L 240 kV line (Langdon 102S to East Calgary 5S)	937L 240 kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	92% 486MVA
D-Sc4-14	Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	92% 486MVA
D-Sc4-15	Open 985L 240 kV line (Janet 74S to ENMAX No. 25)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	92% 979MVA

2019 Loading Violations
Scenario 1



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 780.1 MW

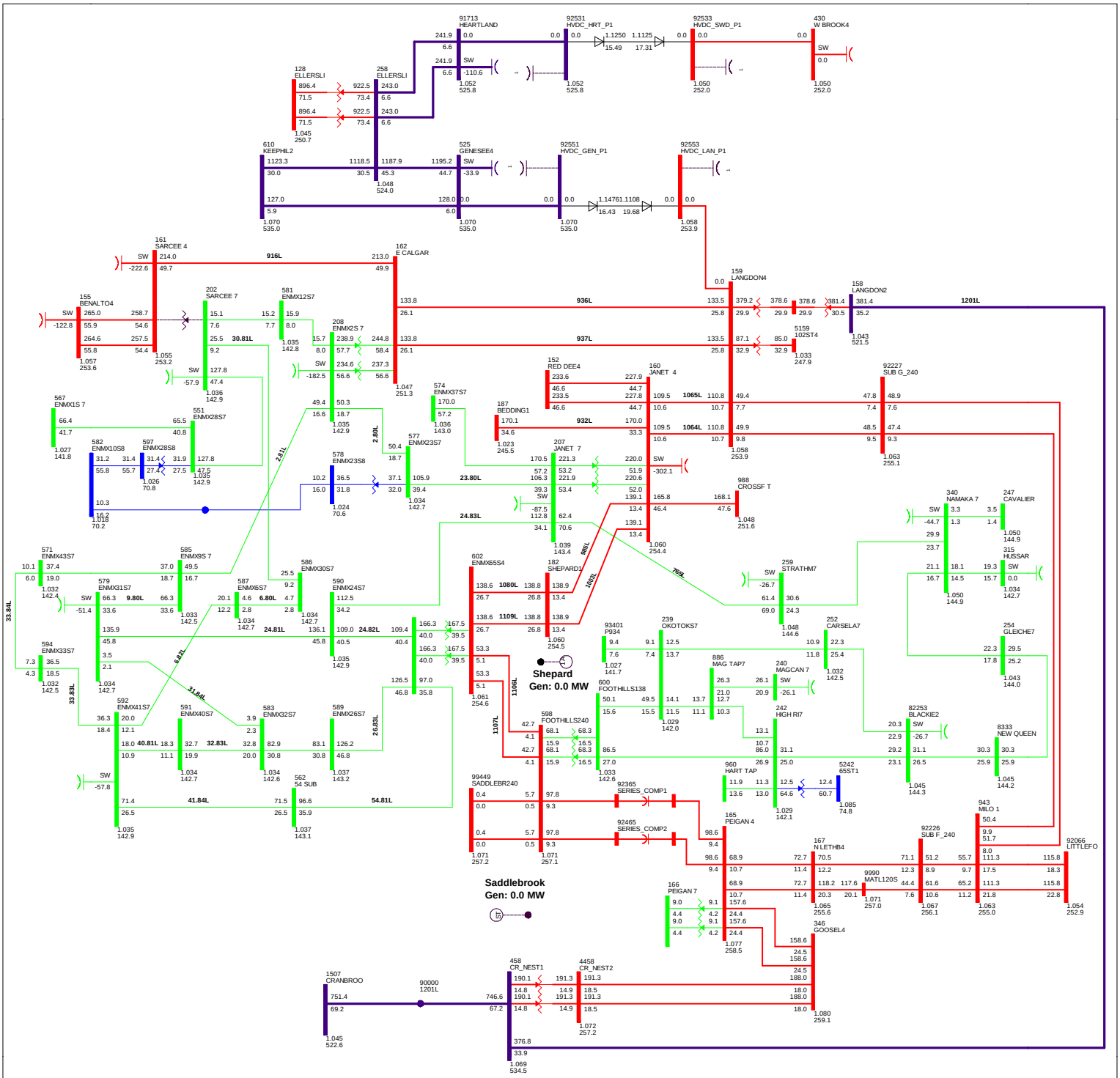
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC1-1: BASECASE

2019_SP_STG3_3RDCKT_SC1

FRI, JUN 08 2012 15:58



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 781.9 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

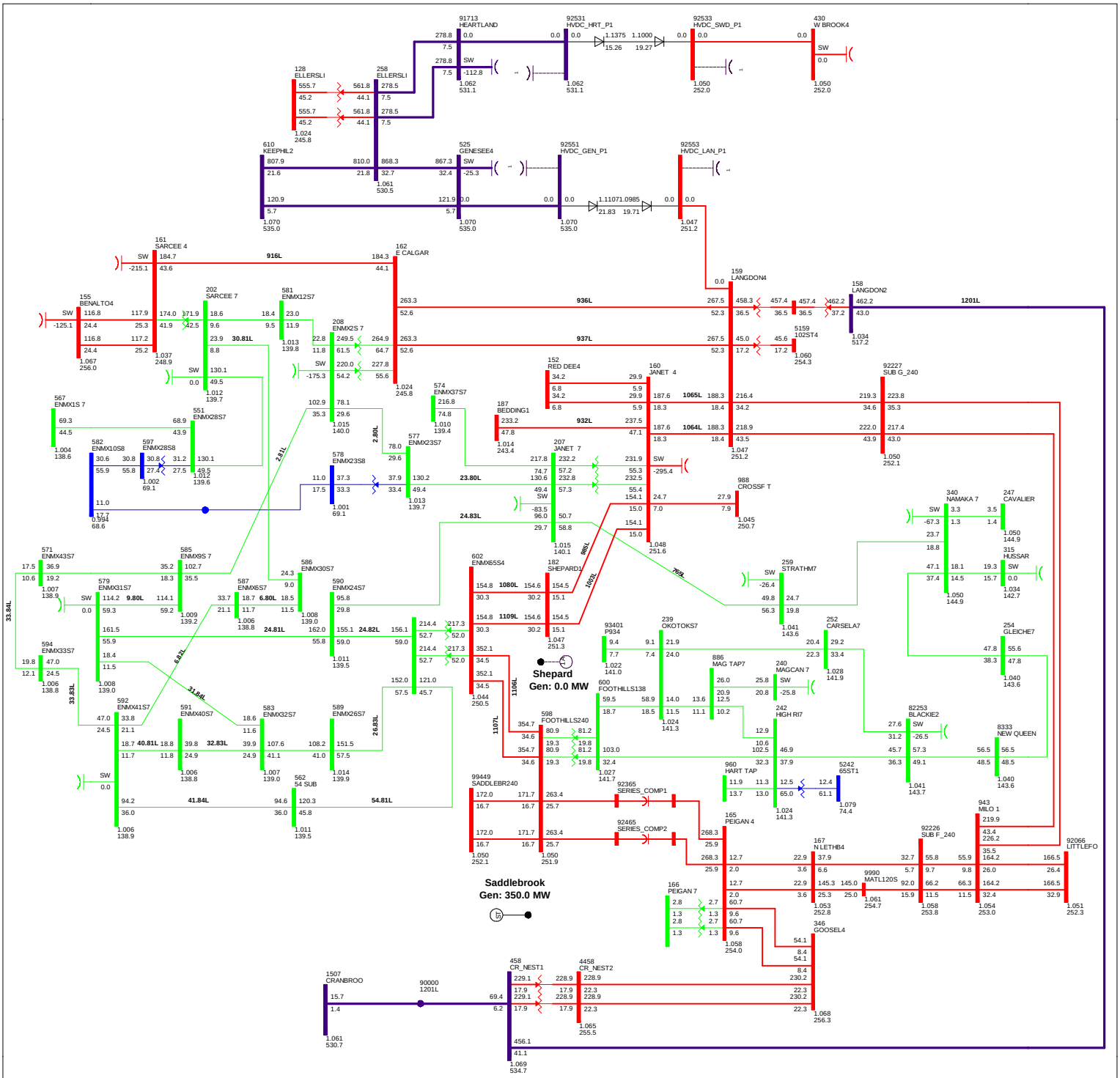
2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC1-2: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2019_SP_STG3_3RDCKT_SC1

FRI, JUN 08 2012 15:58

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

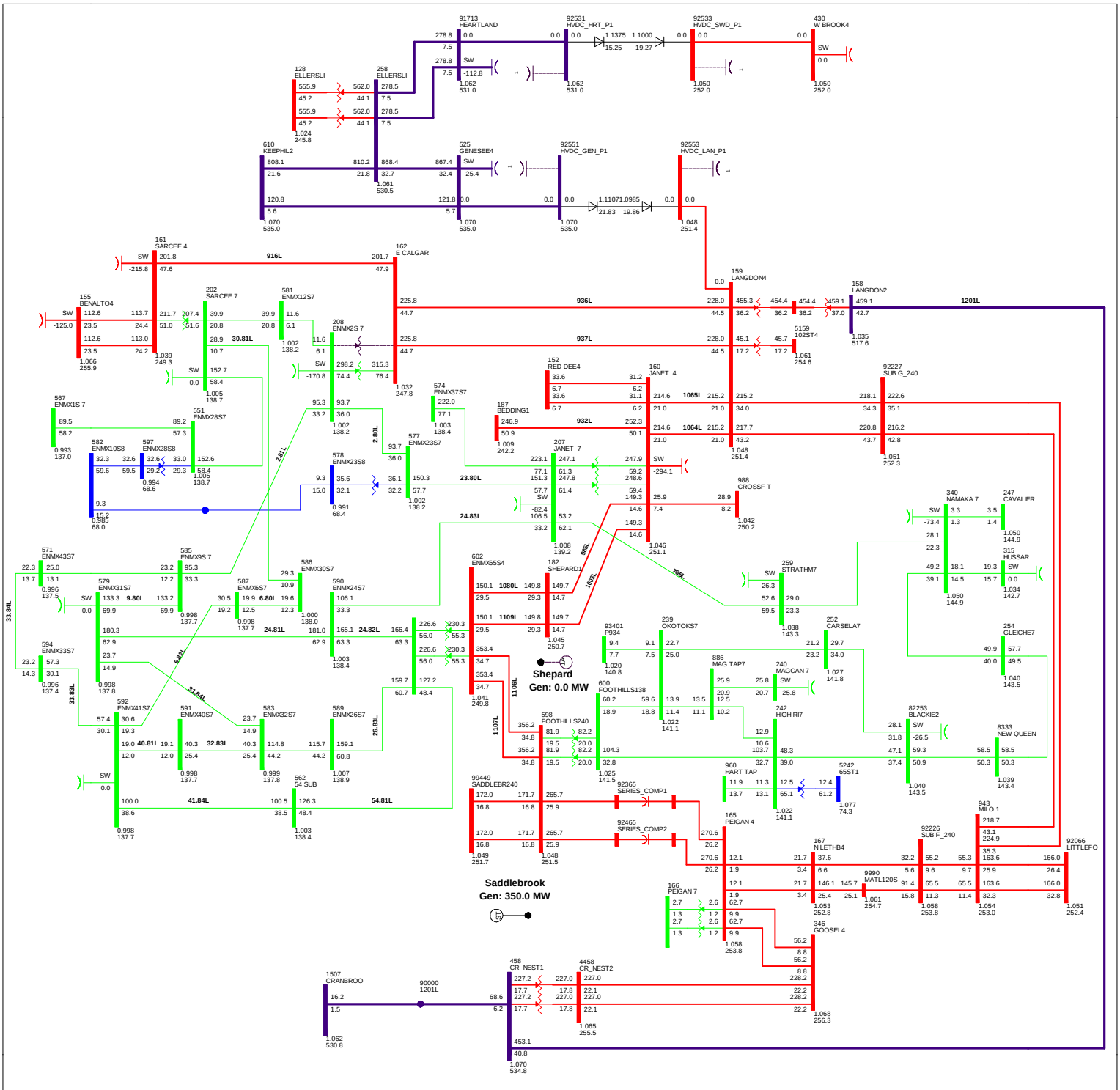
BCH Import: -0.5 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC3-1: BASECASE

2019_SP_STG3_3RDCKT_SC3

FRI, JUN 08 2012 15:58



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

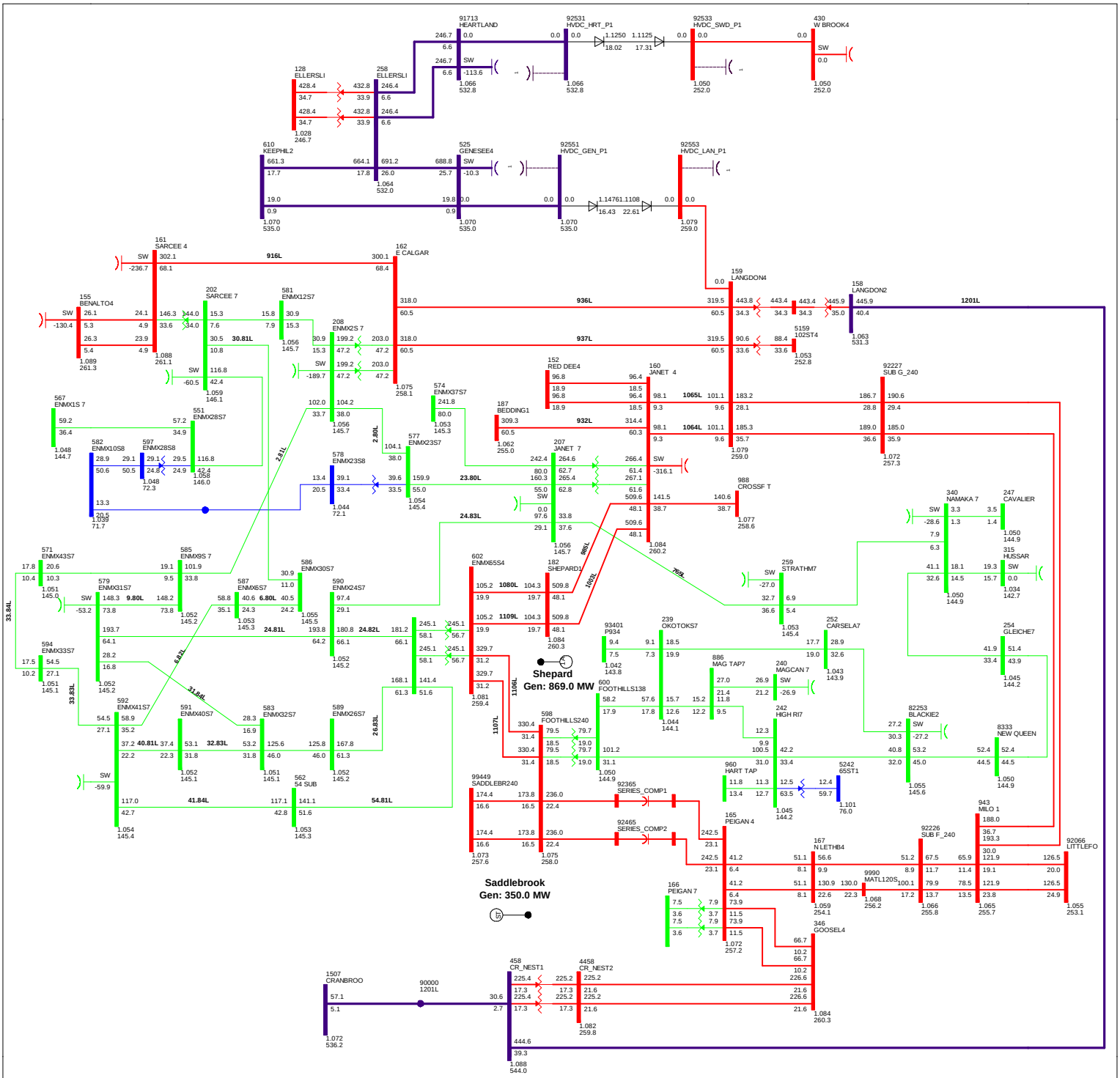
BCH Import: 1.6 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC3-2: OPEN 240/138 KV TRANSFORMER T1 (EAST CALGARY 5S
2019_SP_STG3_3RDCKT_SC3

FRI, JUN 08 2012 15:58

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

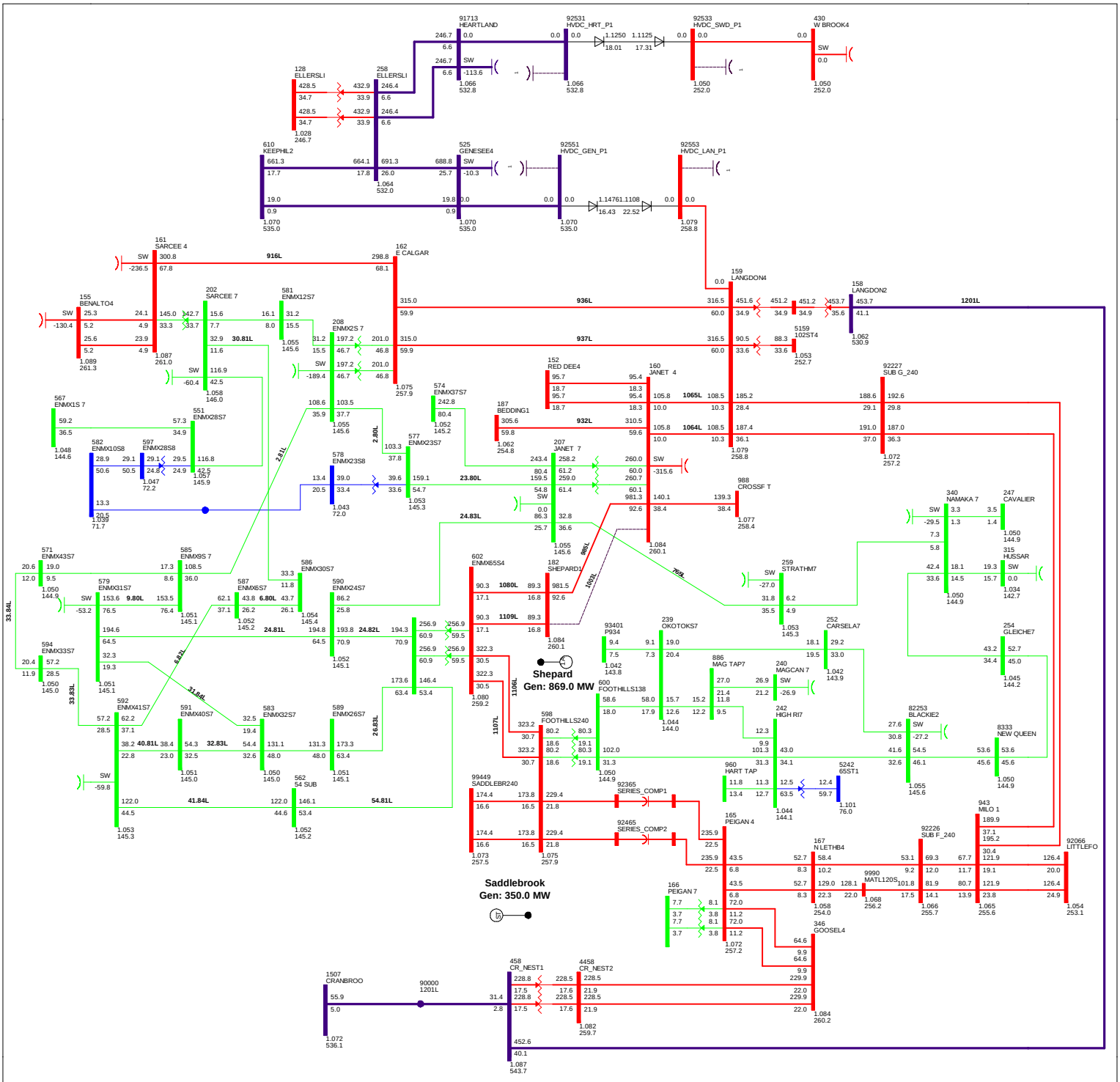
BCH Import: 0.2 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-1: BASECASE

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

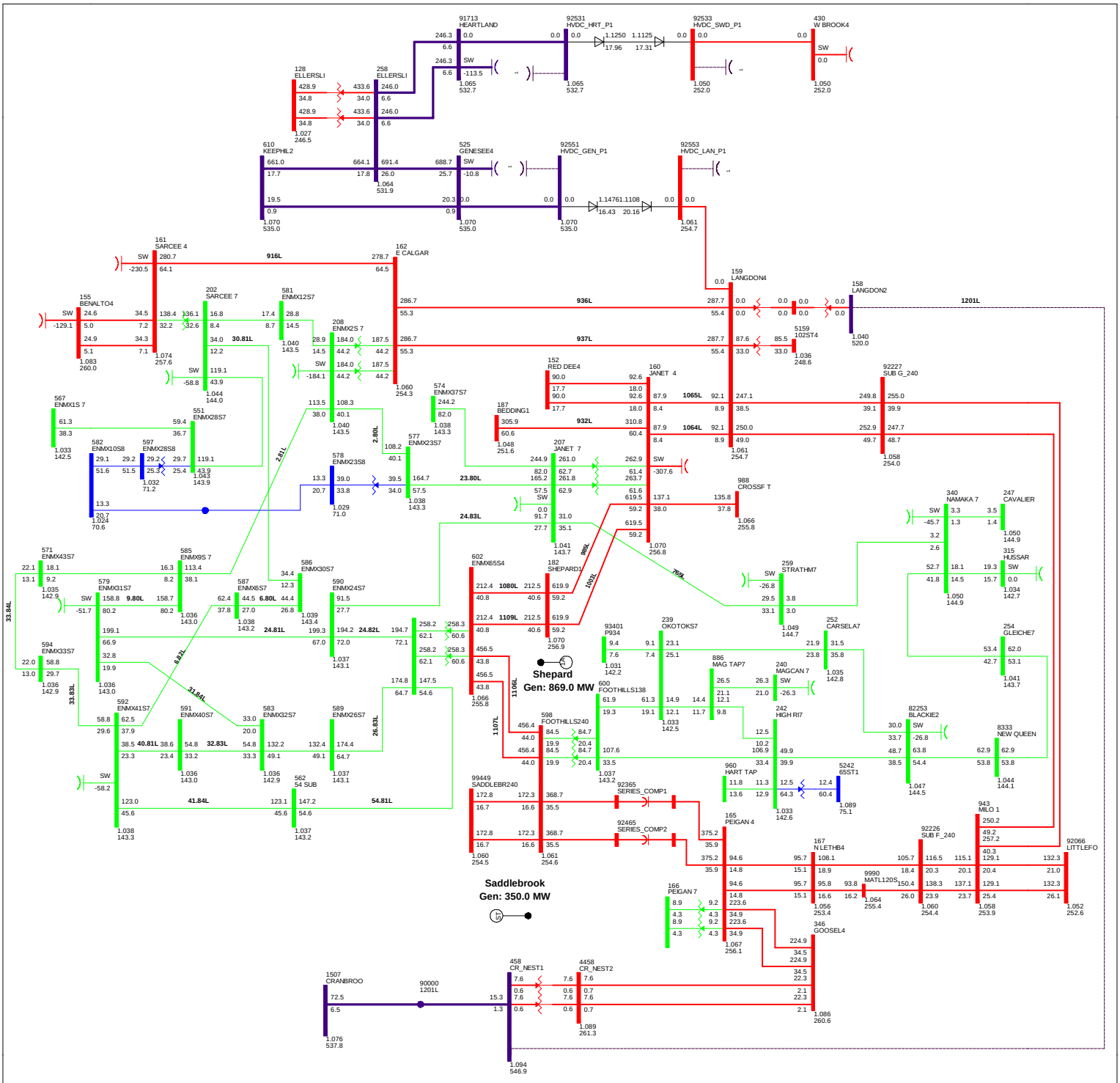
BCH Import: 1.4 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

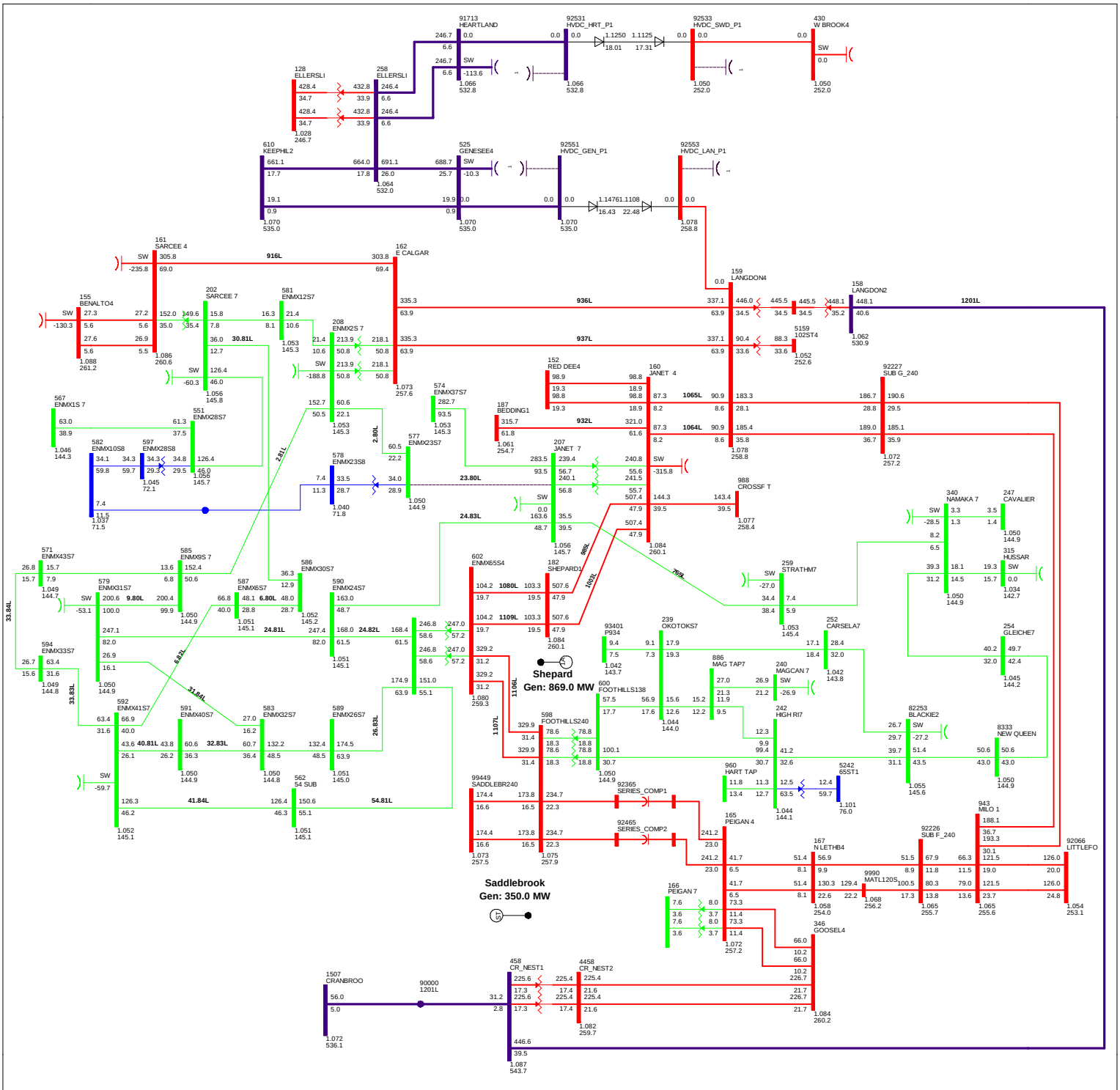
BCH Import: 31.0 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-3: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

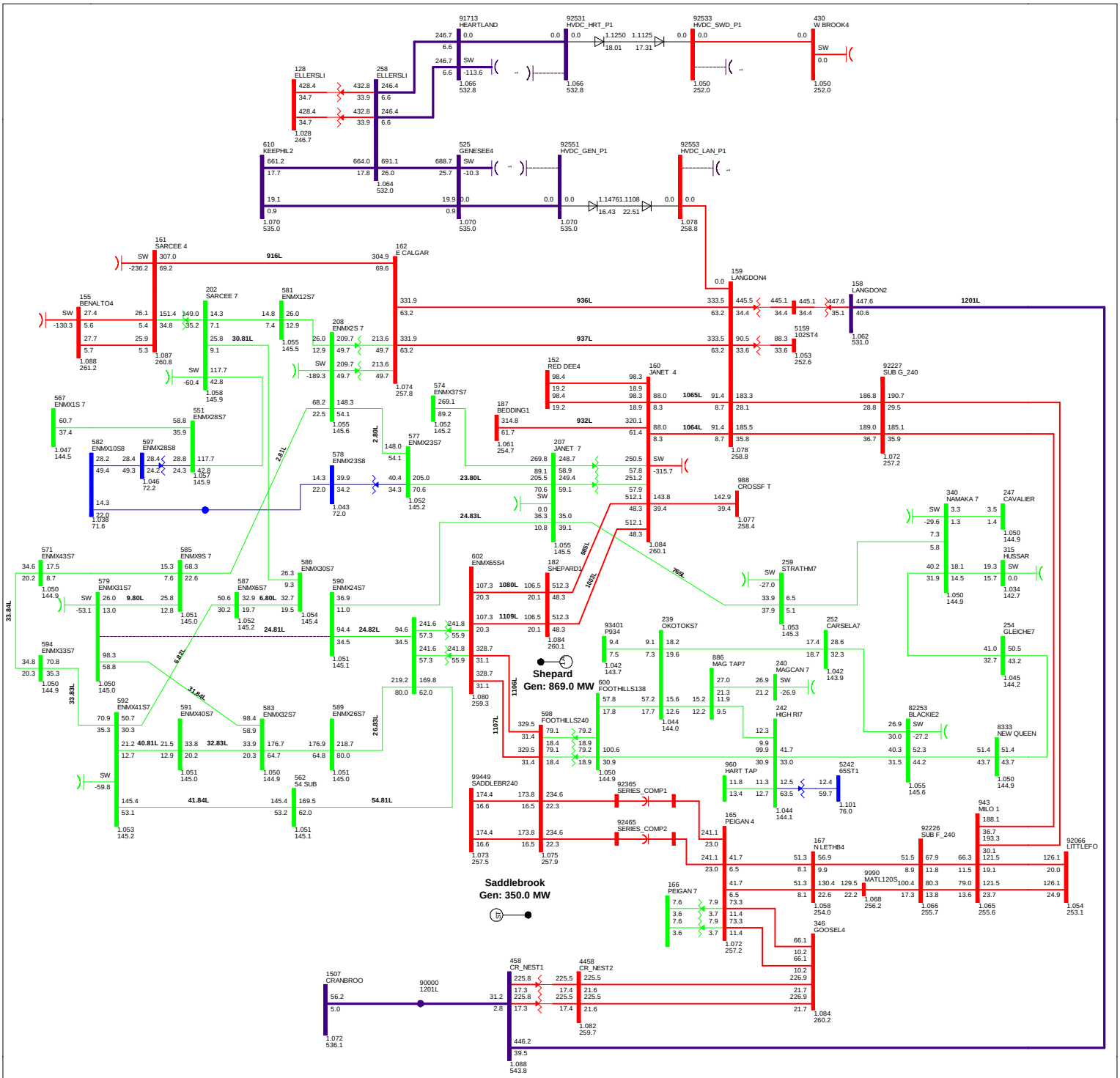
BCH Import: 2.4 MW

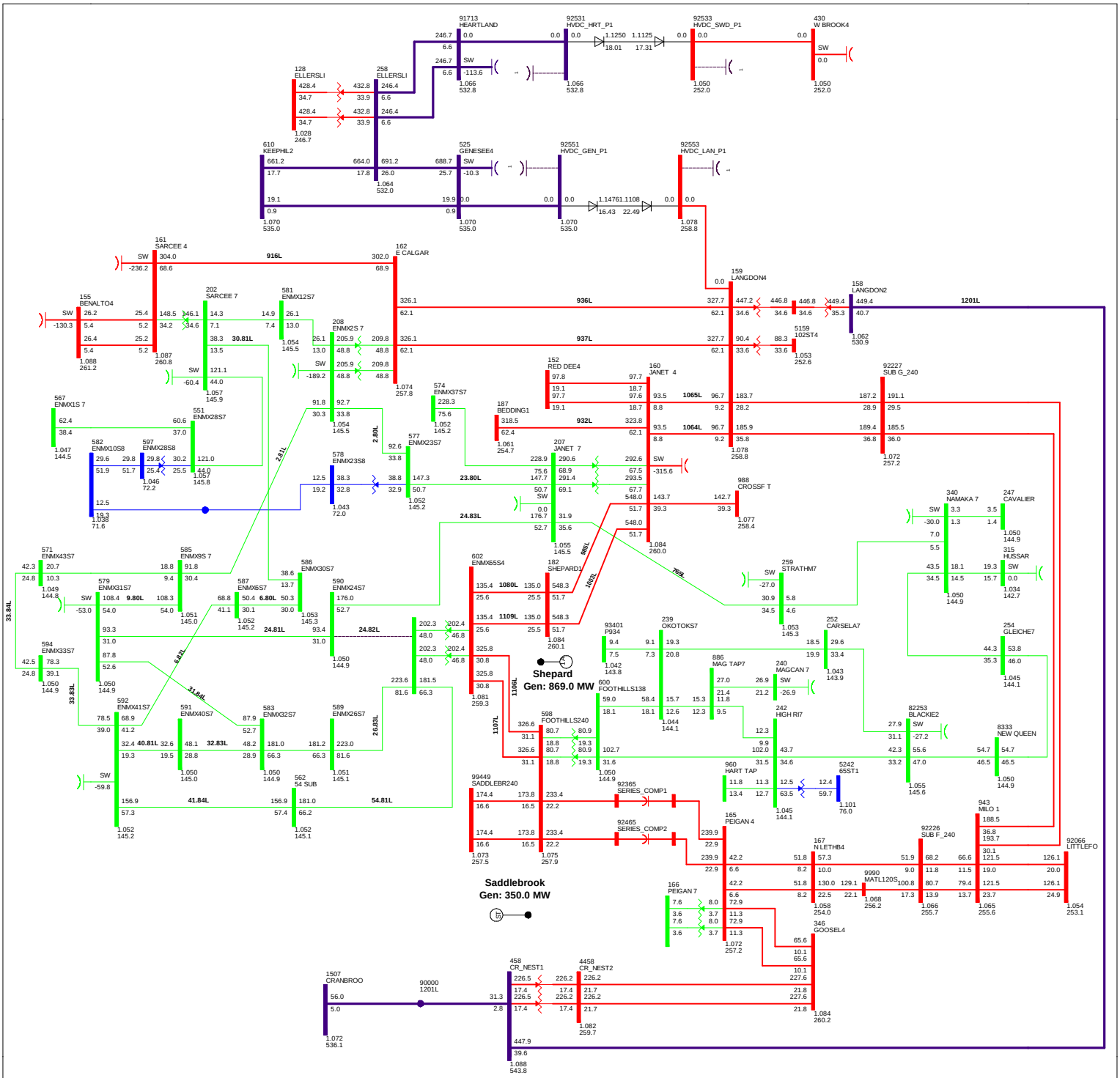
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-4: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
916L
936L
937L
1201L
1080L
1109L
1106L
1107L
1065L
1064L
932L
1201L
2.80L
23.80L
24.83L
24.81L
24.82L
9.80L
6.80L
40.81L
32.83L
41.84L
54.81L
26.83L
33.84L
33.83L
30.81L
BCH Import: 1.5 MW
2012LTO FATD EAST + 3RD CKT SYSTEM
FIG D-SC4-5: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)
2019_SP_STG3_3RDCKT_SC4
FRI, JUN 08 2012 15:59
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 1.8 MW

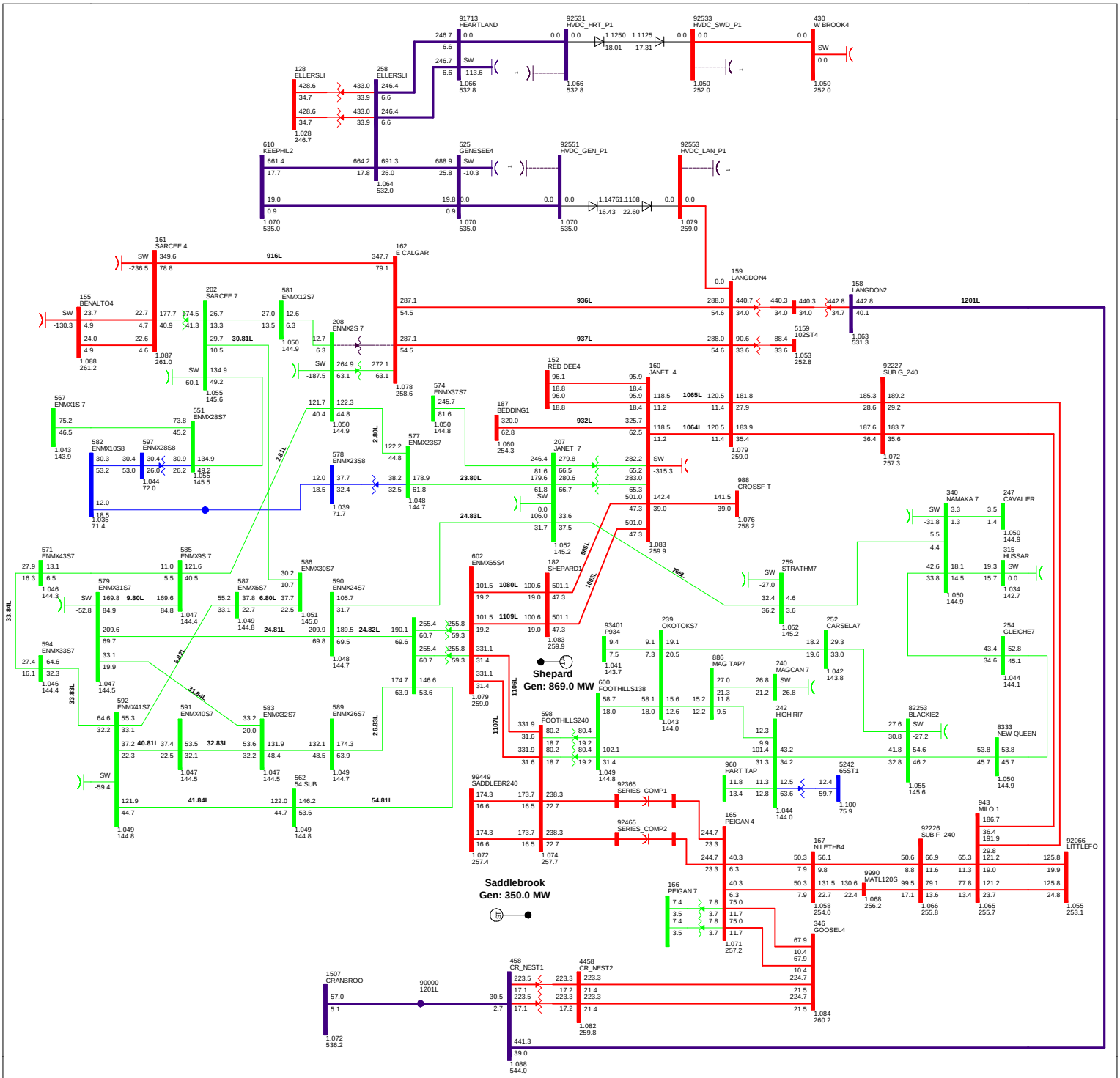
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-6: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

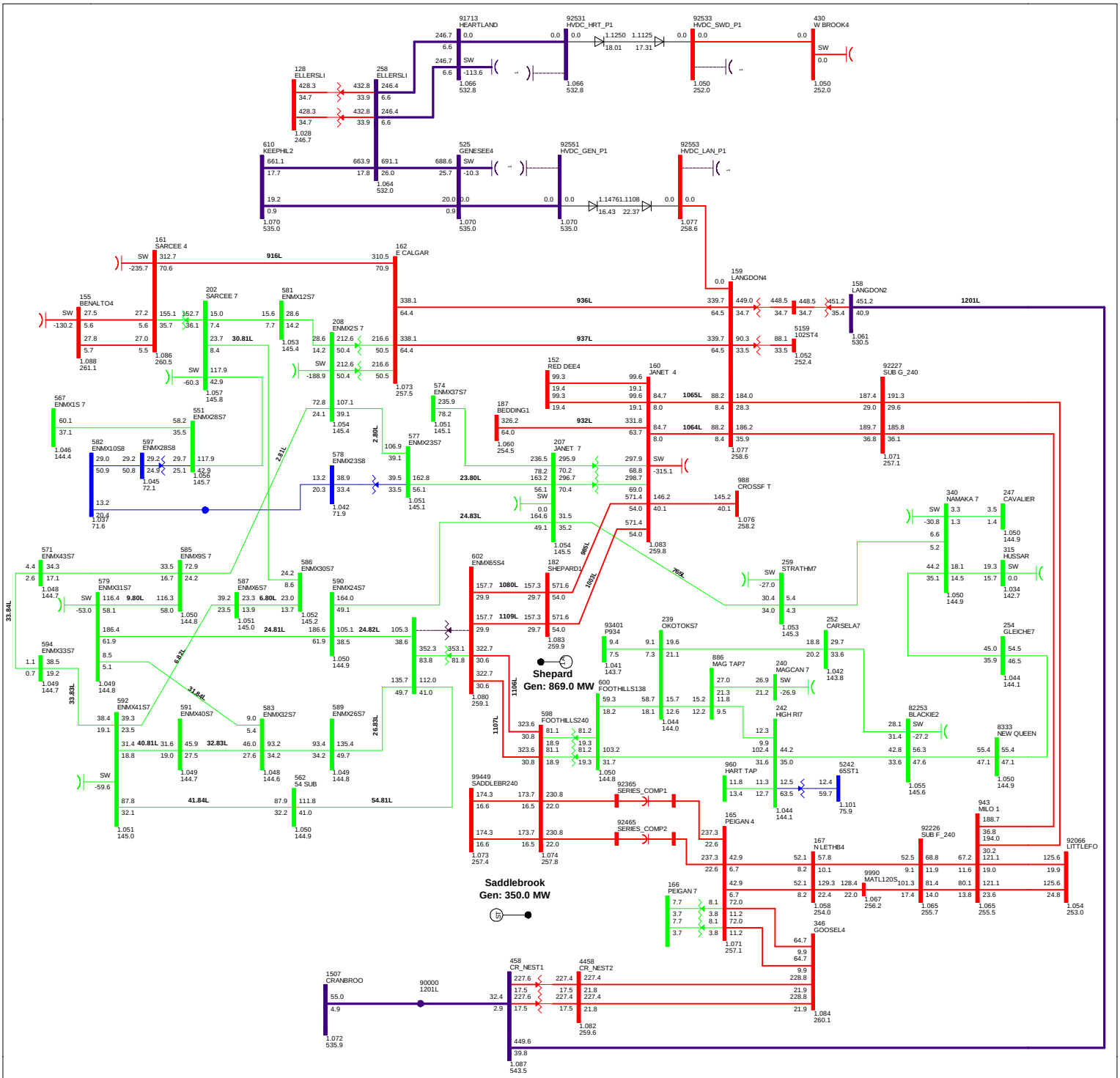
BCH Import: 1.6 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-7: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

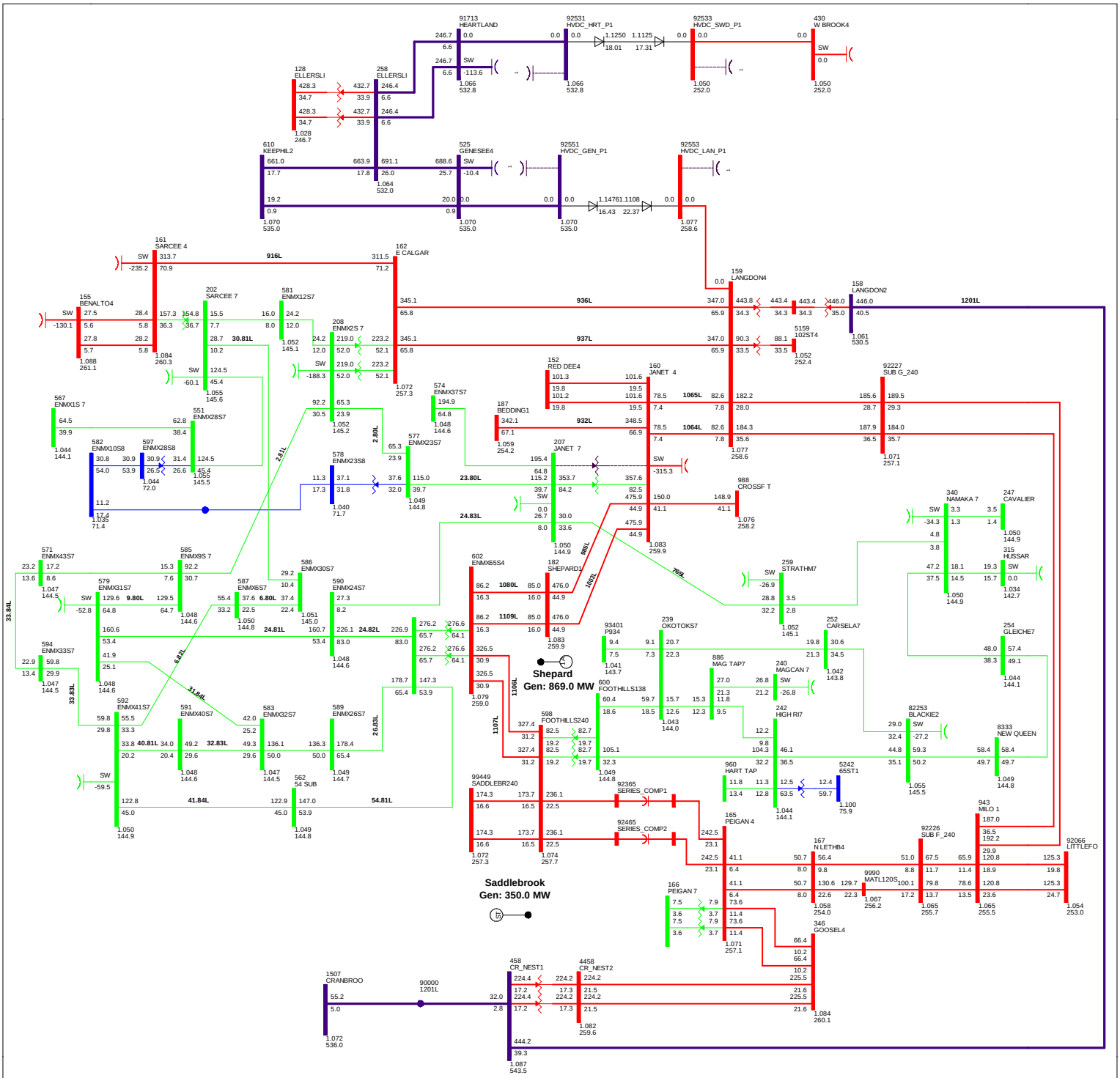
BCH Import: 1.4 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-8: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

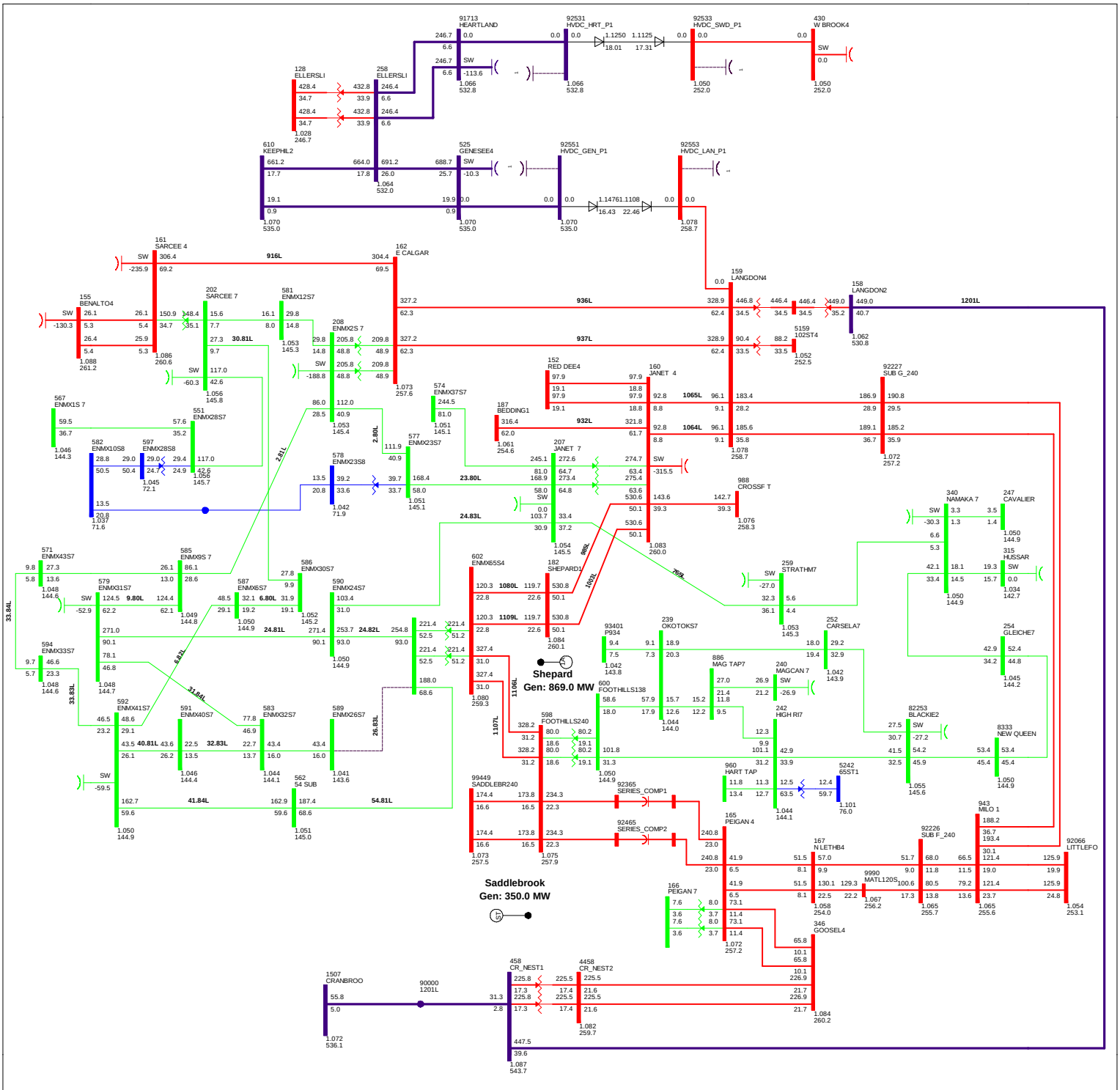
BCH Import: 2.8 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-9: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

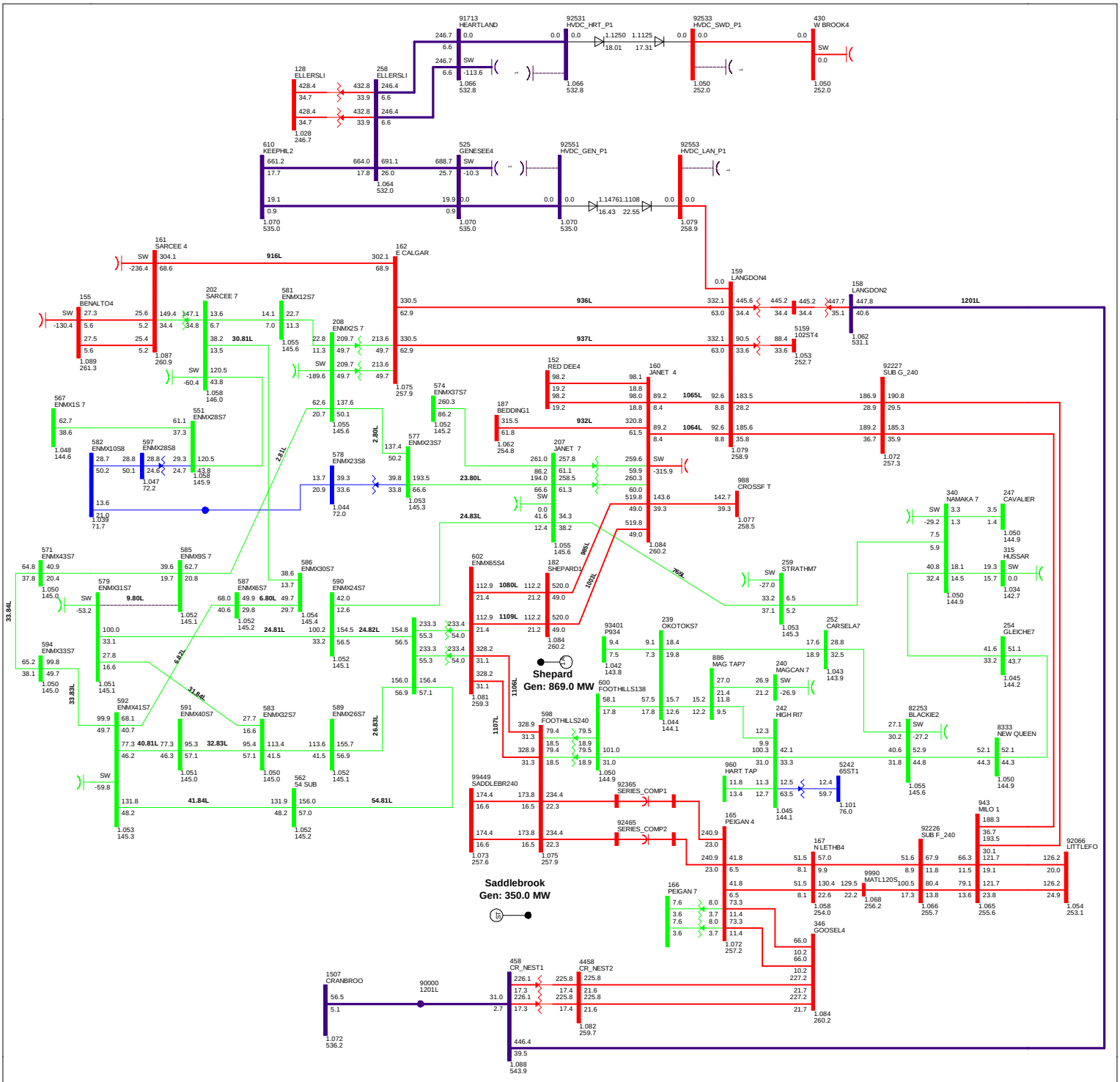
BCH Import: 2.8 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-10: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

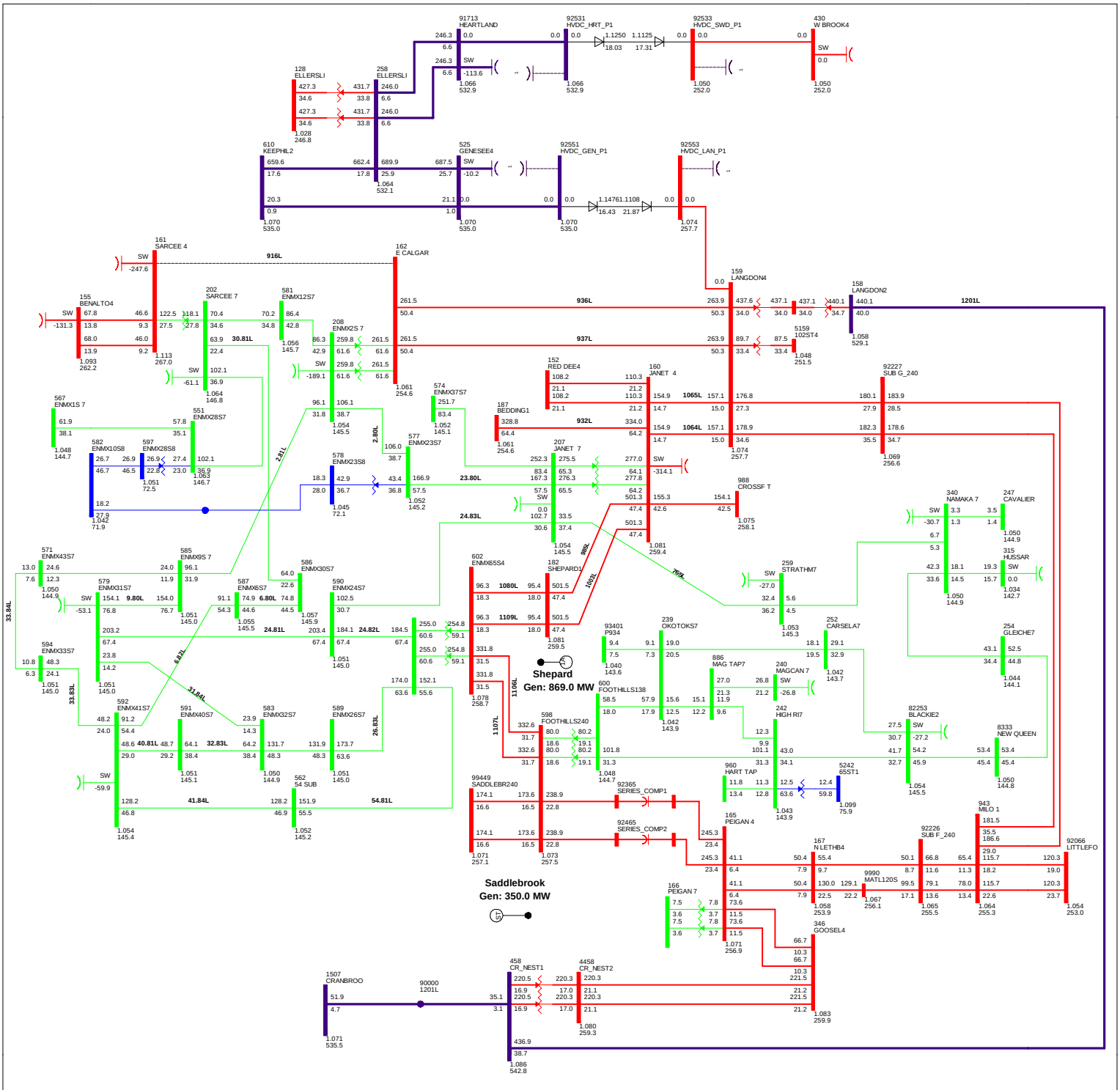
BCH Import: 1.1 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-11: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

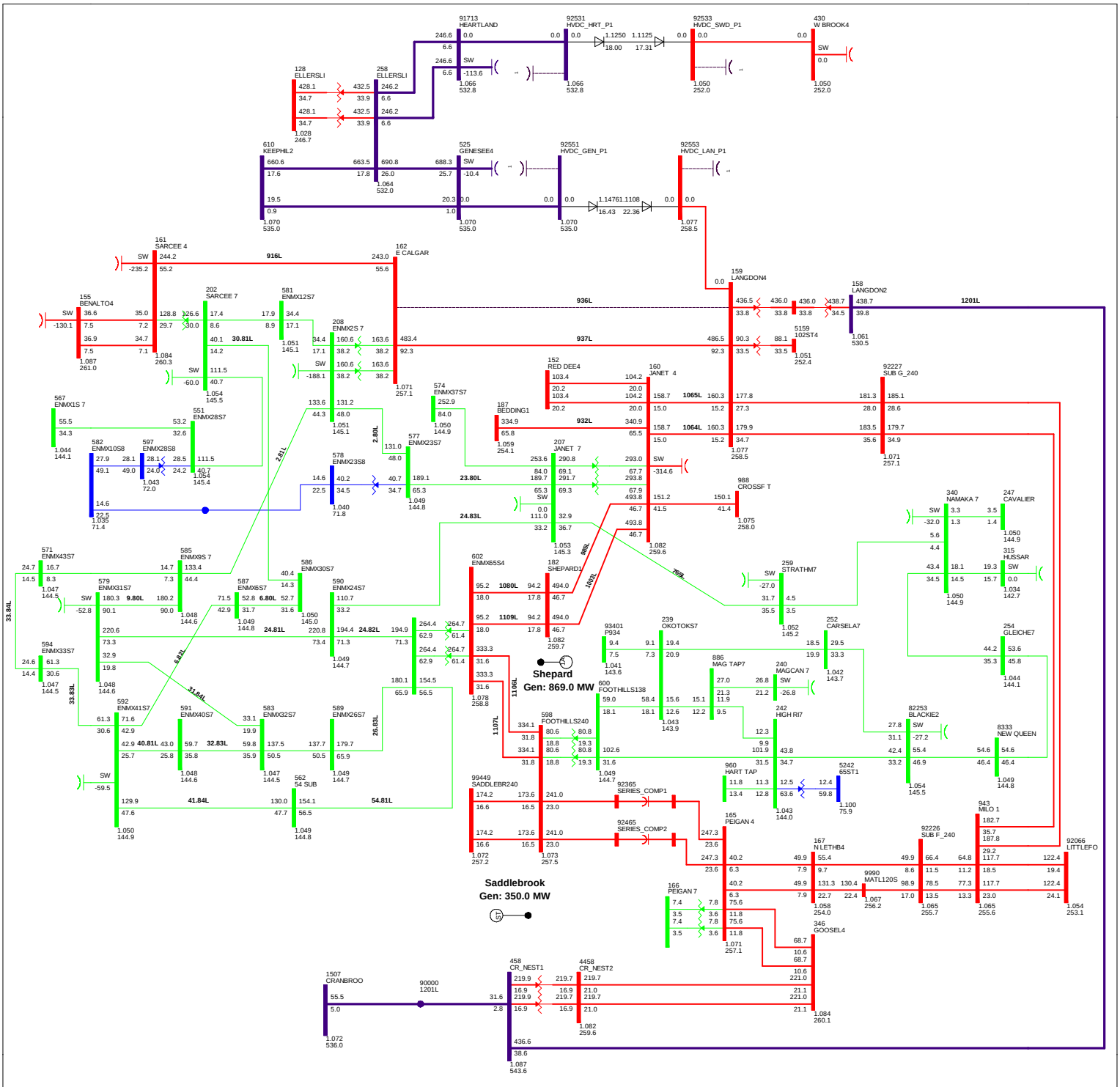
BCH Import: 4.1 MW

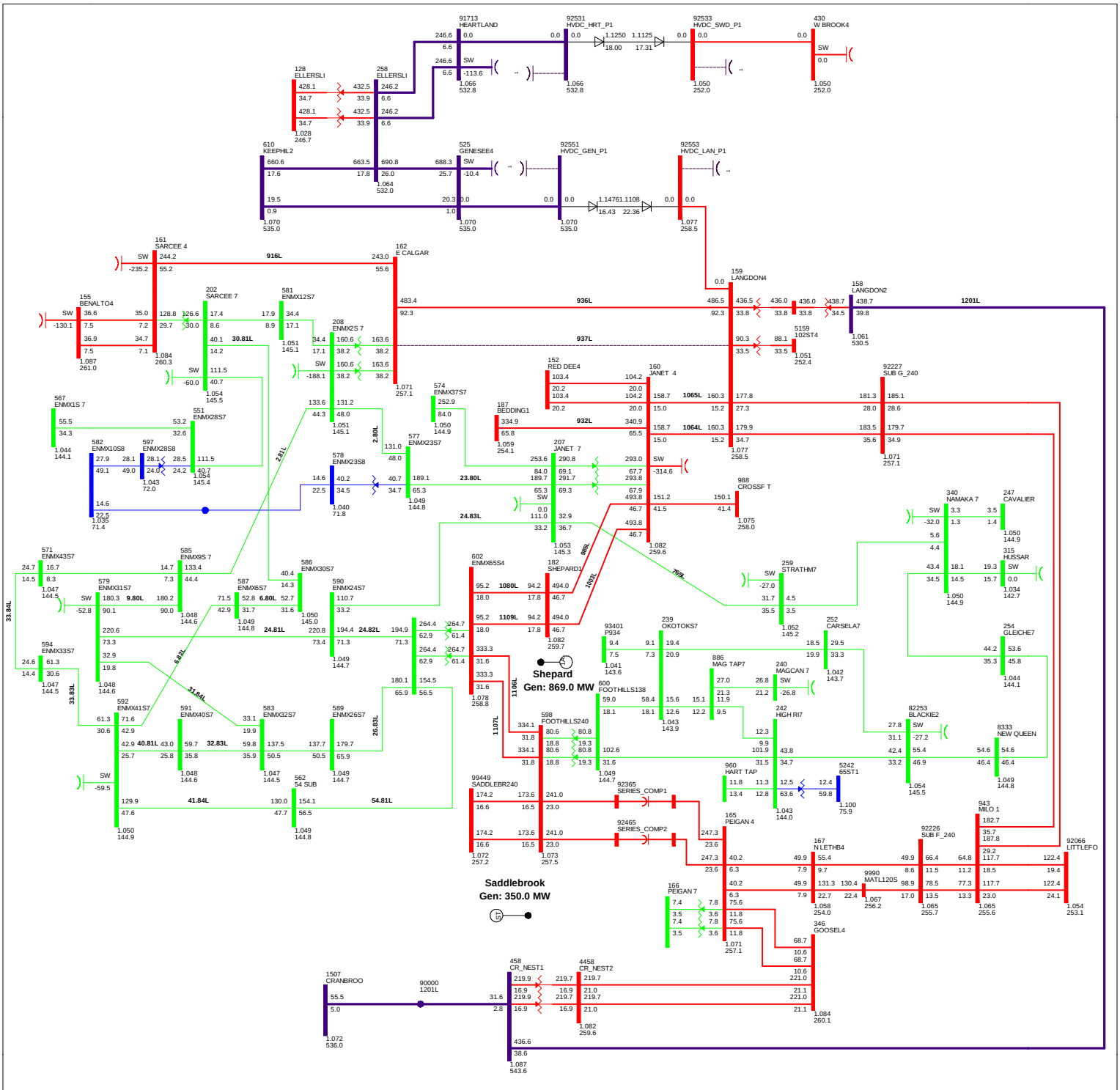
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-12: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59


91713 HEARTLAND
92531 HVDC_HRT_P1
92533 HVDC_SWD_P1
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
610 KEEPHIL2
525 GENESEE4
92551 HVDC_GEN_P1
92553 HVDC_LAN_P1
161 SARCEE 4
162 E CALGAR
159 LANGDON4
158 LANGDON2
155 BENALTO4
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
936L
937L
1201L
916L
5159 102ST4
152 RED DEE4
160 JANET 4
92227 SUB G_240
187 BEDDING1
932L
1065L
1064L
207 JANET 7
988 CROSSF T
567 ENMX1S 7
551 ENMX28S7
582 ENMX10S8
597 ENMX28S8
578 ENMX23S8
577 ENMX23S7
574 ENMX37S7
2.80L
2.81L
23.80L
24.83L
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
259 STRATHM7
571 ENMX43S7
585 ENMX9S 7
579 ENMX31S7
9.80L
586 ENMX30S7
587 ENMX6S7
6.80L
590 ENMX24S7
24.82L
24.81L
602 ENMX65S4
1080L
1109L
182 SHEPARD1
1007L
769L
868L
Shepard
Gen: 869.0 MW
93401 P934
239 OKOTOKS7
252 CARSELA7
254 GLEICHE7
886 MAG TAP7
240 MAGCAN 7
594 ENMX33S7
33.84L
33.83L
6.83L
31.84L
592 ENMX41S7
40.81L
591 ENMX40S7
32.83L
583 ENMX32S7
589 ENMX26S7
26.83L
562 54 SUB
41.84L
54.81L
598 FOOTHILLS240
600 FOOTHILLS138
242 HIGH RI7
82253 BLACKIE2
8333 NEW QUEEN
11.06L
1.07L
99449 SADDLEBR240
92365 SERIES_COMP1
92465 SERIES_COMP2
960 HART TAP
5242 65ST1
165 PEIGAN 4
943 MILO 1
92226 SUB F_240
92066 LITTLEFO
Saddlebrook
Gen: 350.0 MW
167 N LETHTB4
9990 MATL120S
166 PEIGAN 7
346 GOOSEL4
1507 CRANBROO
90000 1201L
458 CR_NEST1
4458 CR_NEST2
BCH Import: 5.3 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO FATD EAST + 3RD CKT SYSTEM
FIG D-SC4-13: OPEN 936L 240 KV LINE (LANGDON 102S TO EAST CA
2019_SP_STG3_3RDCKT_SC4
FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

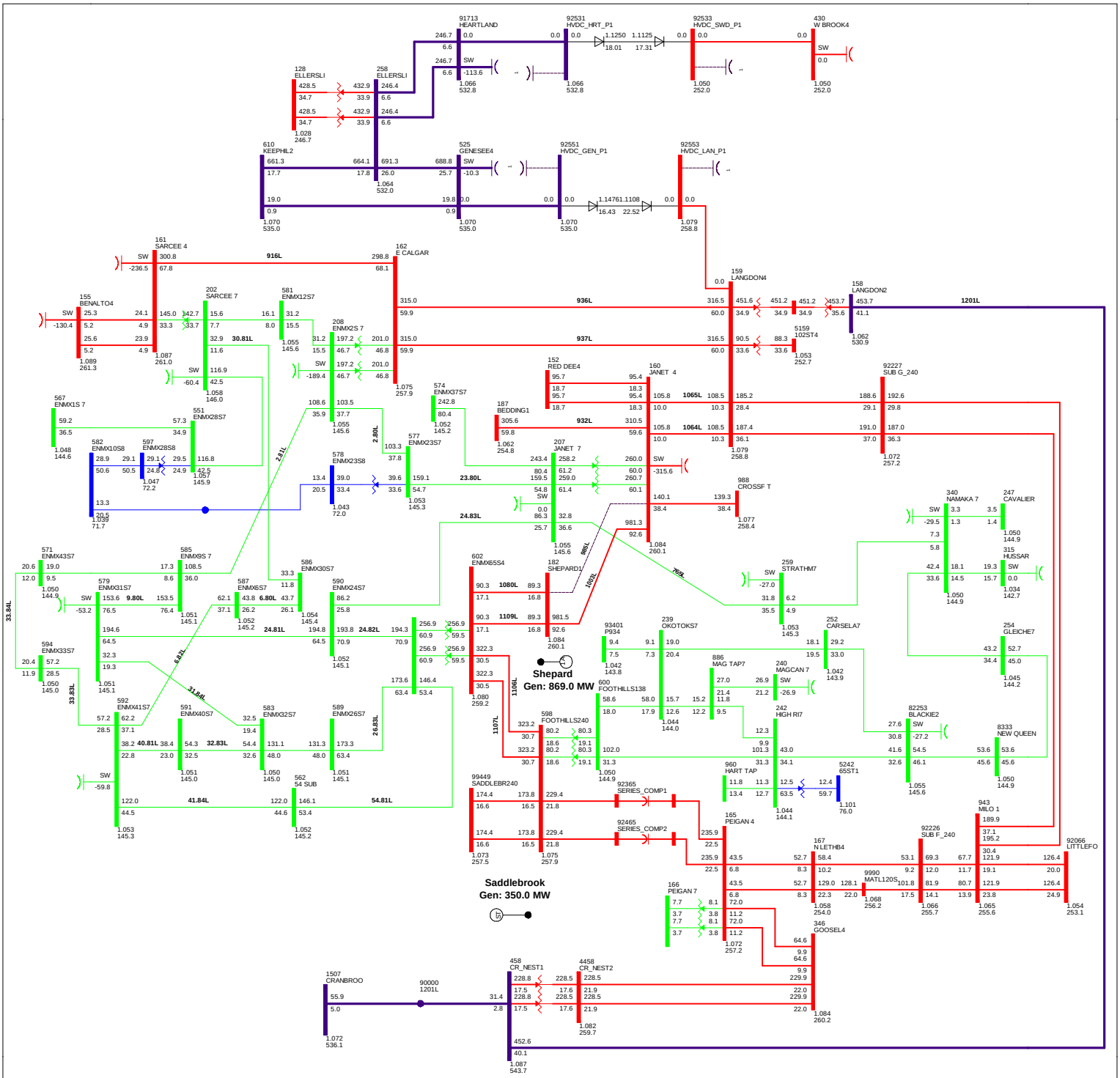
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 5.3 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-14: OPEN 937L 240 KV LINE (LANGDON 102S TO EAST CA
2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 15:59



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.4 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG D-SC4-15: OPEN 985L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_STG3_3RDCKT_SC4

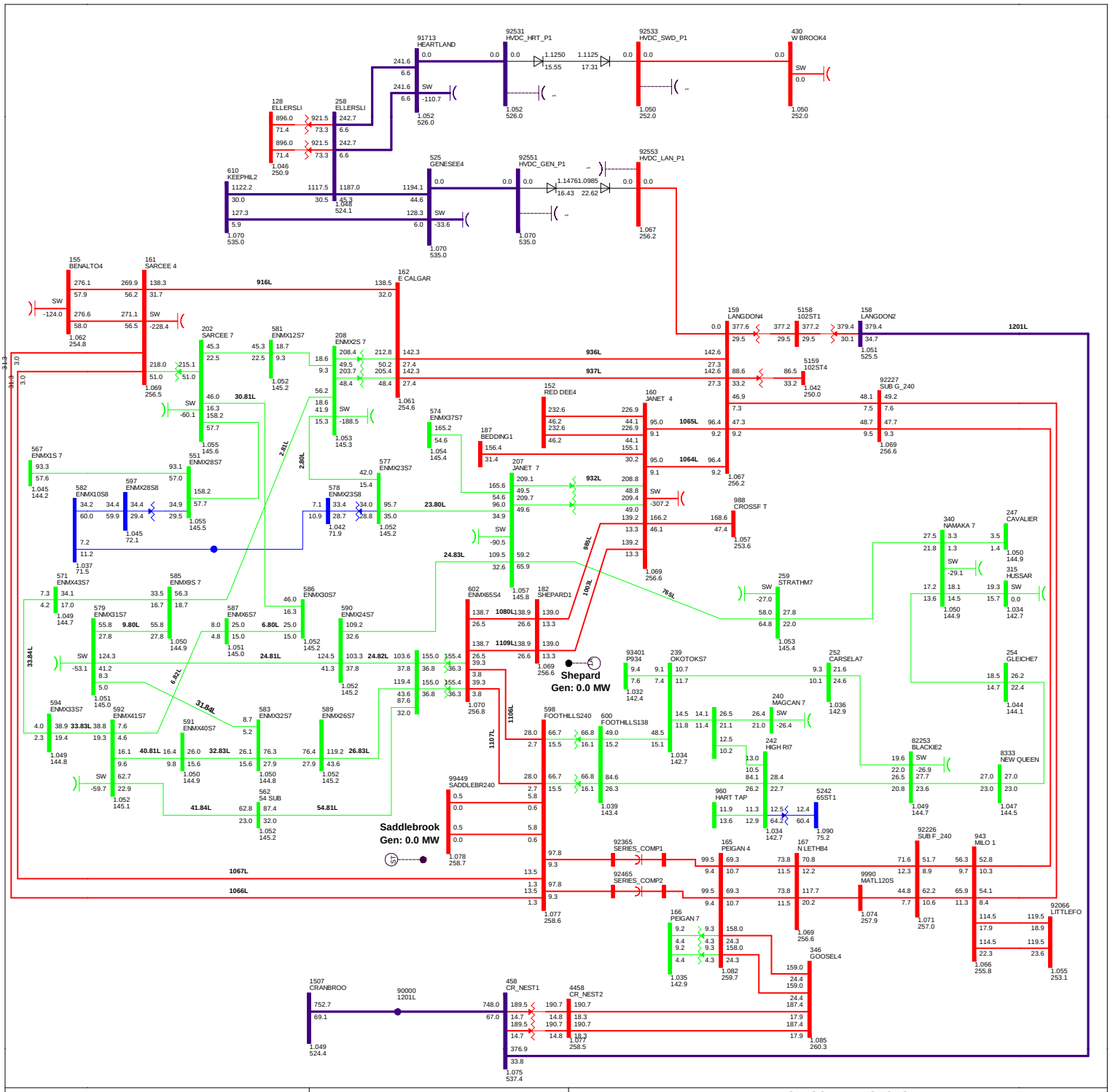
FRI, JUN 08 2012 15:59

B-4: FATD-Full Assessment

Table 6: FATD Full Maximum Loading on Critical Lines with 2019 FATD under Category B

Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration	
				NEED	FATD Full
				√ indicates loading below 80% N/A indicates the circuit does not exist	
E-Sc1-2	Open 240/138 kV transformer (Sarcee 42S)	240/138 kV transformer (Sarcee 42S)	SC1	92% 369MVA	√
E-Sc3-2	Open 240/138 kV transformer T1 (East Calgary 5S)	240/138 kV transformer T2 (East Calgary 5S)	SC3	N/A	91% 362MVA
E-Sc4-2	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	SC4	172% 875MVA	√
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	111% 321MVA	√
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	316% 822MVA	√
		24.83L 138 kV line (Janet 74S to ENMAX No. 24)	SC4	120% 382MVA	√
		240/138 kV transformer (ENMAX No. 65)	SC4	149% 596MVA	√
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	125% 323MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	140% 365MVA	√
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	115% 182MVA	√
		40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	104% 165MVA	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	201% 385MVA	√
		985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	√
E-Sc4-3	Open 1201L 500kV line (Langdon 102S to Crowsnest 491S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	189% 1275MVA	√
E-Sc4-4	Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	128% 249MVA	√
E-Sc4-5	Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	87% 245MVA	√
E-Sc4-6	Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	101% 269MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	117% 311MVA	√
E-Sc4-7	Open 240/138 kV transformer T1 (East Calgary 5S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	107% 461MVA	√
E-Sc4-8	Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	98% 391MVA	√
E-Sc4-9	Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	107% 428MVA	80% 322MVA
E-Sc4-10	Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	133% 389MVA	√
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	167% 445MVA	√
		31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	90% 145MVA	√
E-Sc4-11	Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	97% 156MVA	√
E-Sc4-12	Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	117% 392MVA	√
E-Sc4-13	Open 936L 240 kV line (Langdon 102S to East Calgary 5S)	937L 240 kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	√
E-Sc4-14	Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC4	N/A	√
E-Sc4-15	Open 985L 240 kV line (Janet 74S to ENMAX No. 25)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	√

2019 Loading Violations
Scenario 1



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

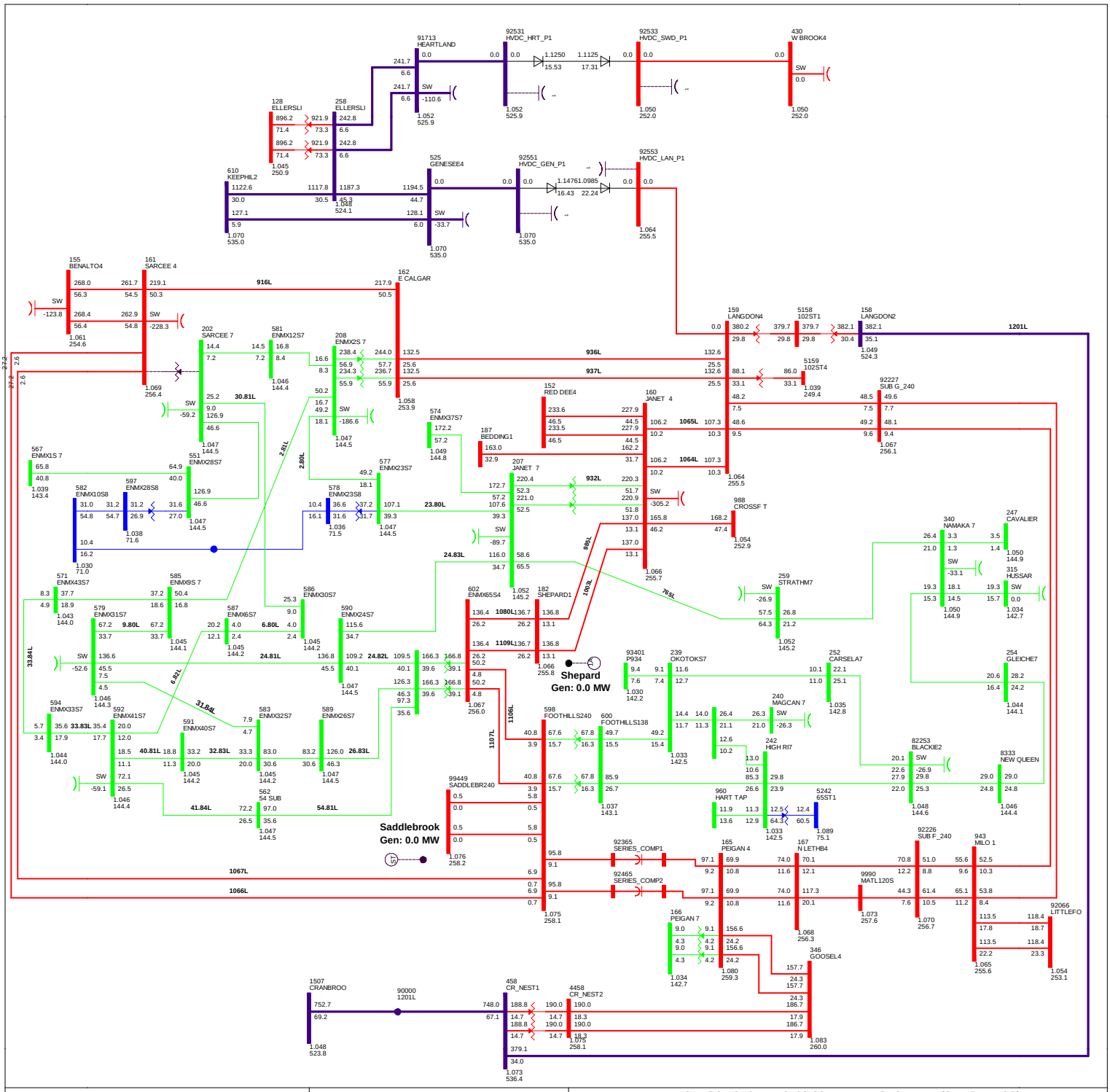
BCH Import: 780.1 MW

2012LTO FATD FULL SYSTEM

FIG E-SC1-1: BASECASE

2019_SP_STG4_ALT1_SC1

FRI, JUN 08 2012 16:00



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 781.9 MW

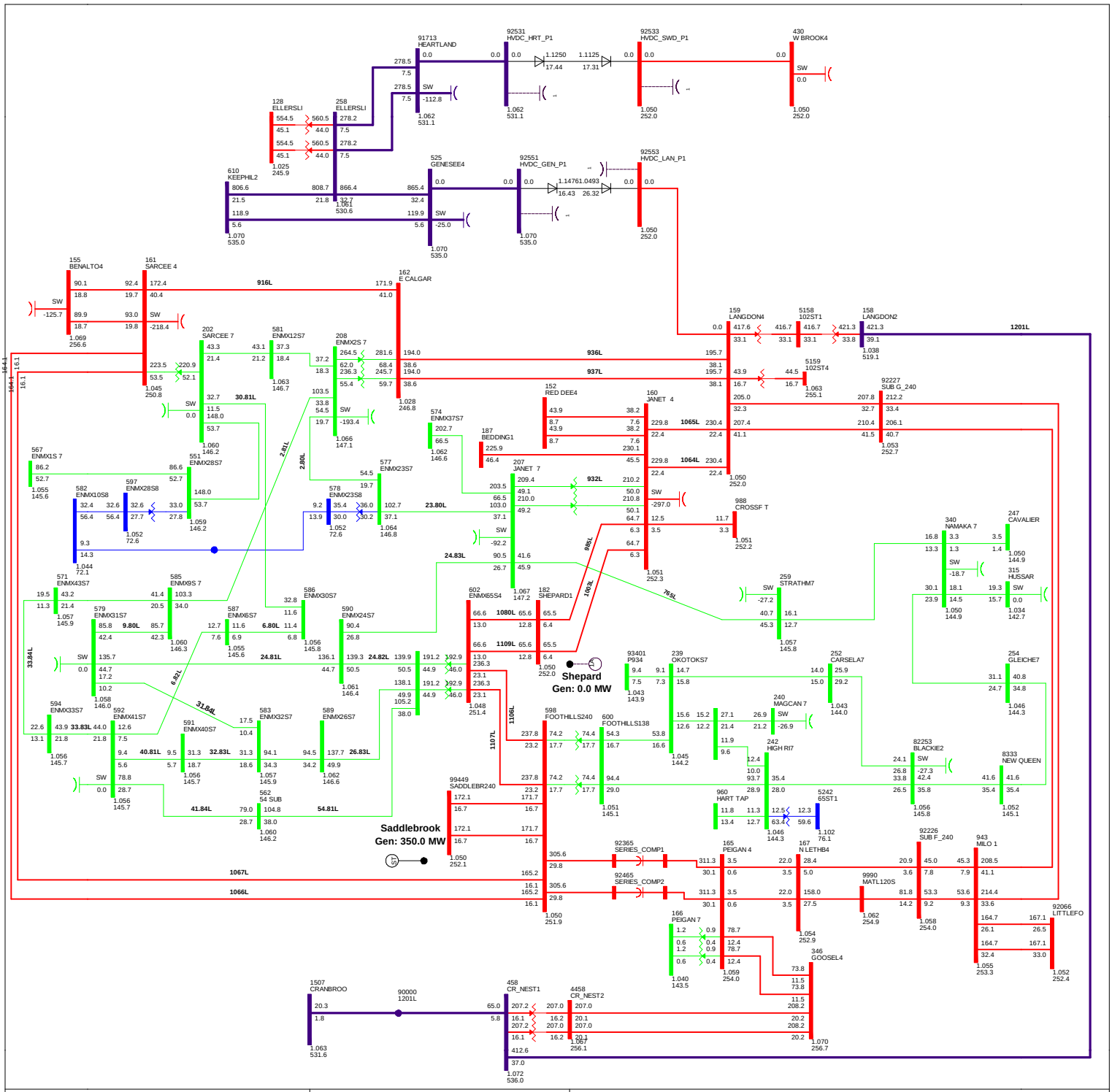
2012LTO FATD FULL SYSTEM

FIG E-SC1-2: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2019_SP_STG4_ALT1_SC1

FRI, JUN 08 2012 16:00

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

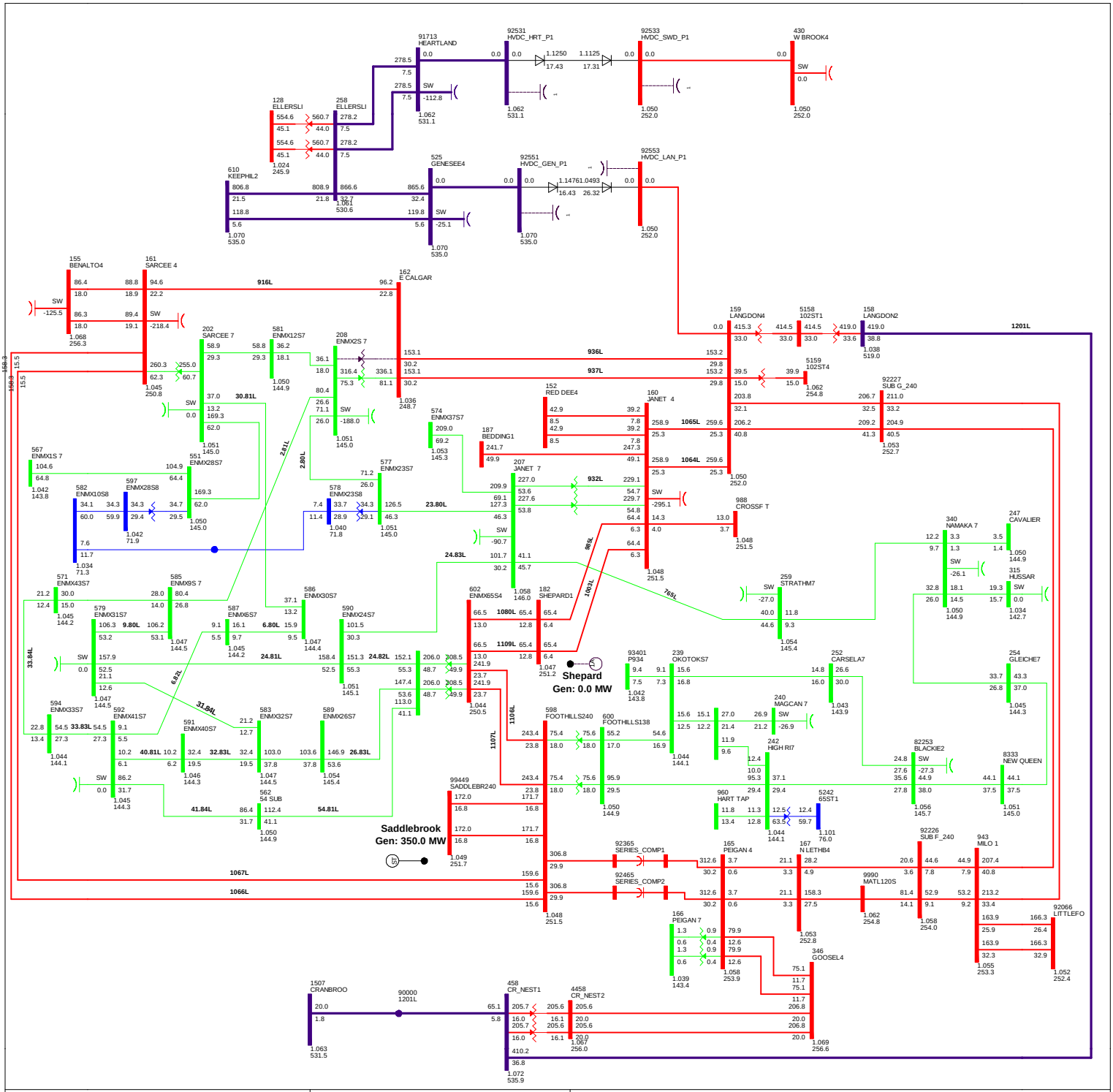
BCH Import: -1.5 MW

2012LTO FATD FULL SYSTEM

FIG E-SC3-1: BASECASE

2019_SP_STG4_ALT1_SC3

FRI, JUN 08 2012 16:01



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

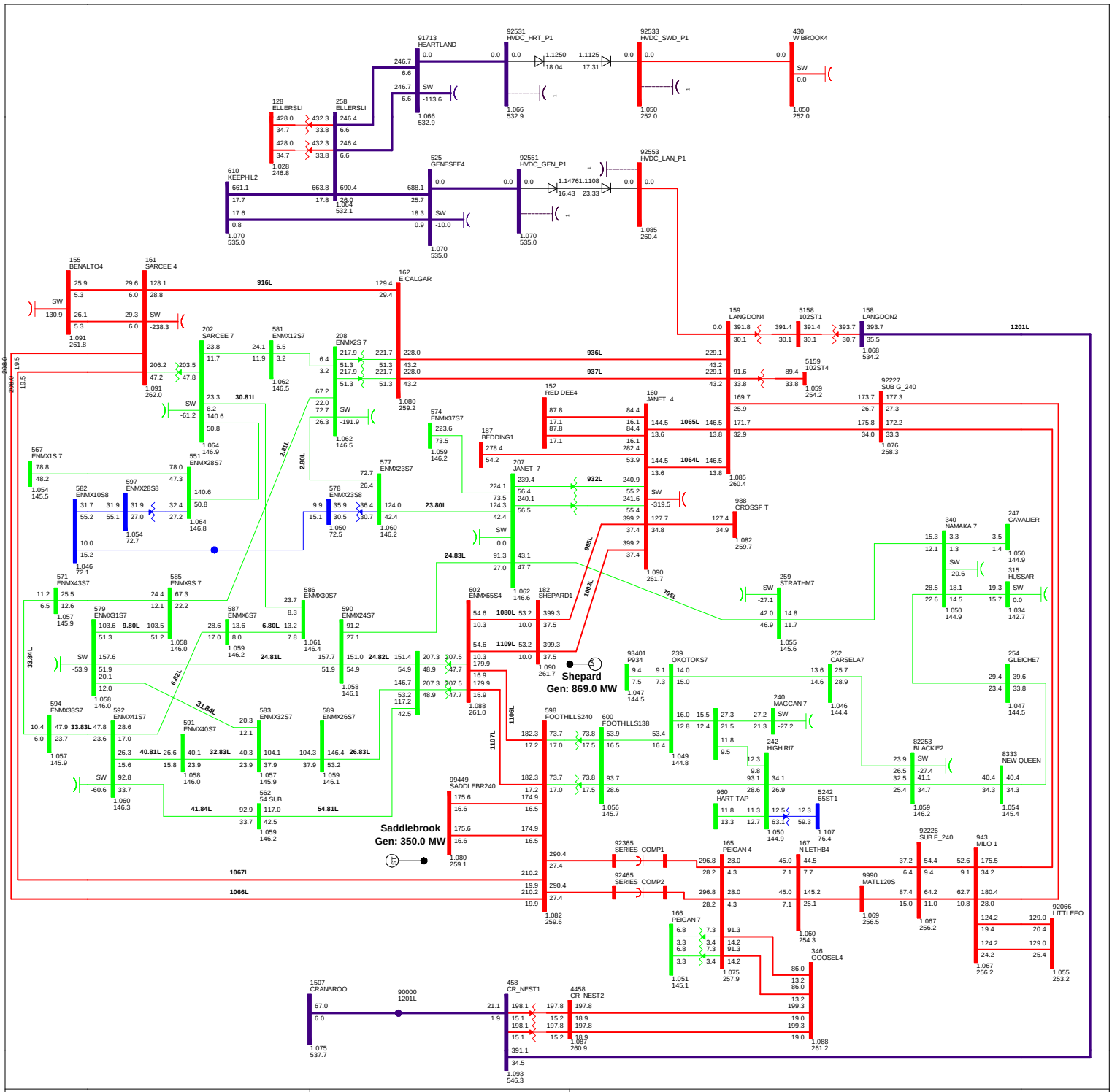
BCH Import: 0.1 MW

2012LTO FATD FULL SYSTEM

FIG E-SC3-2: OPEN 240/138 KV TRANSFORMER T1 (EAST CALGARY 5S
2019_SP_STG4_ALT1_SC3

FRI, JUN 08 2012 16:01

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

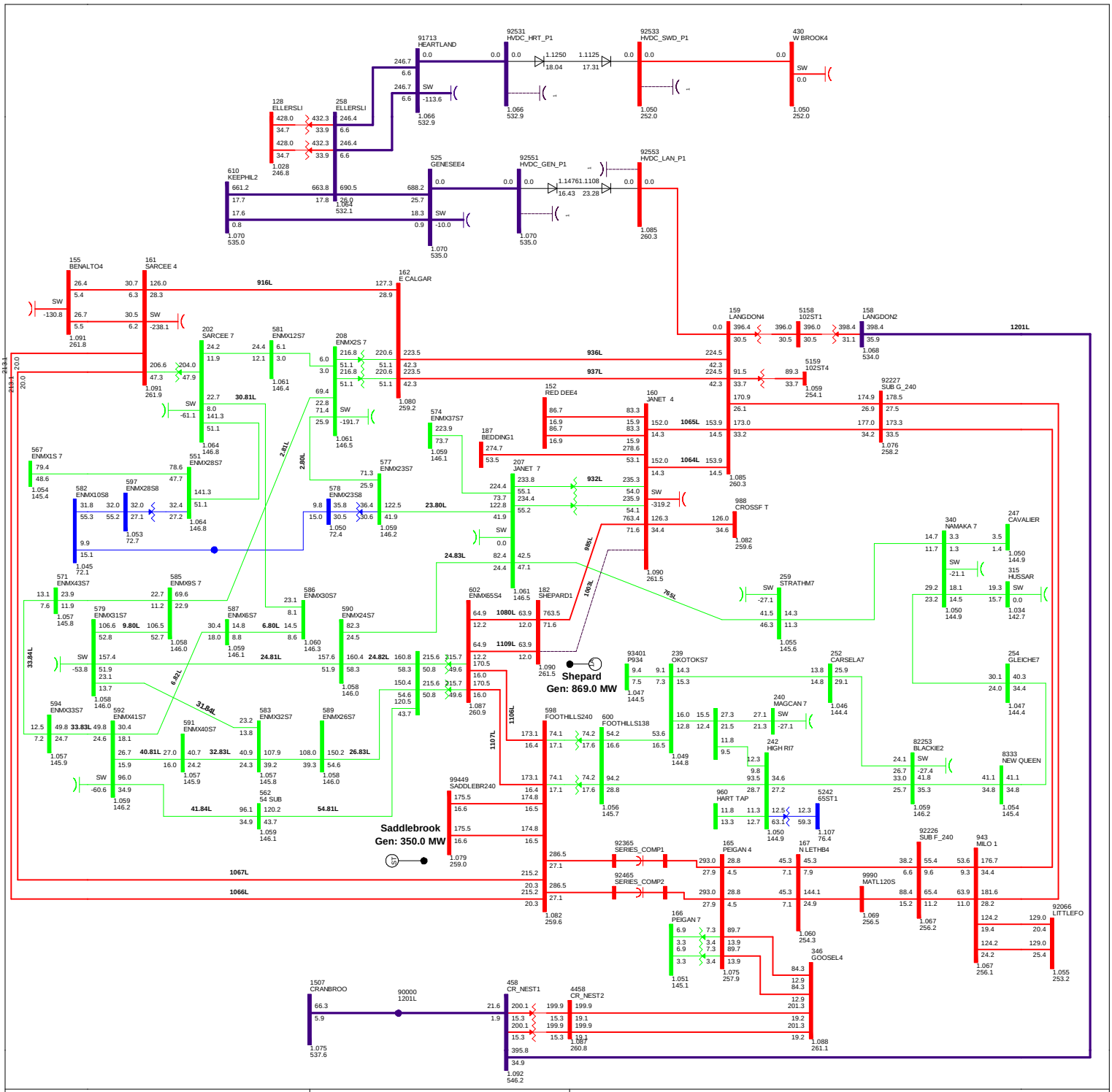
BCH Import: 0.0 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-1: BASECASE

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:01



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

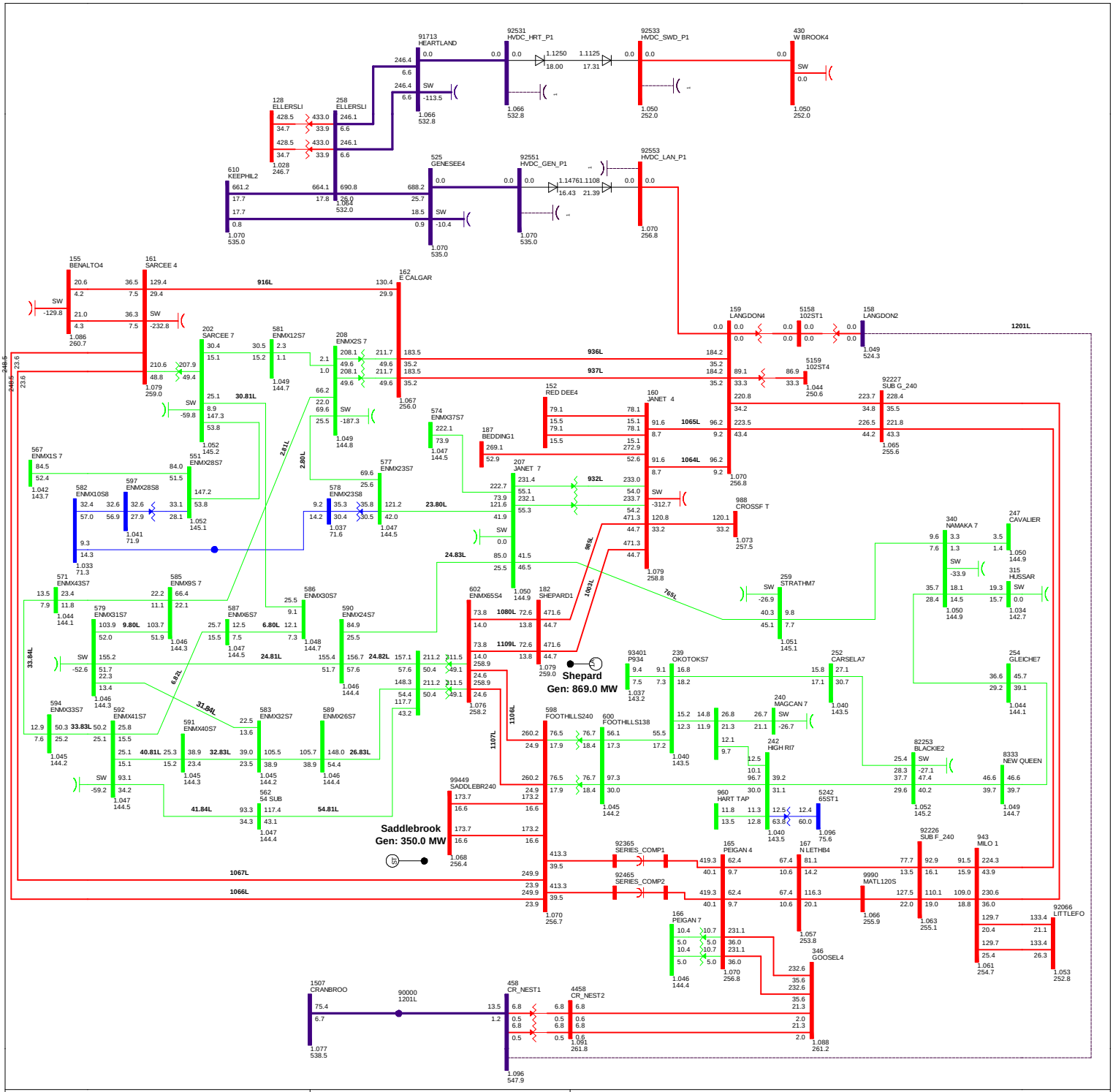
BCH Import: 0.6 MW

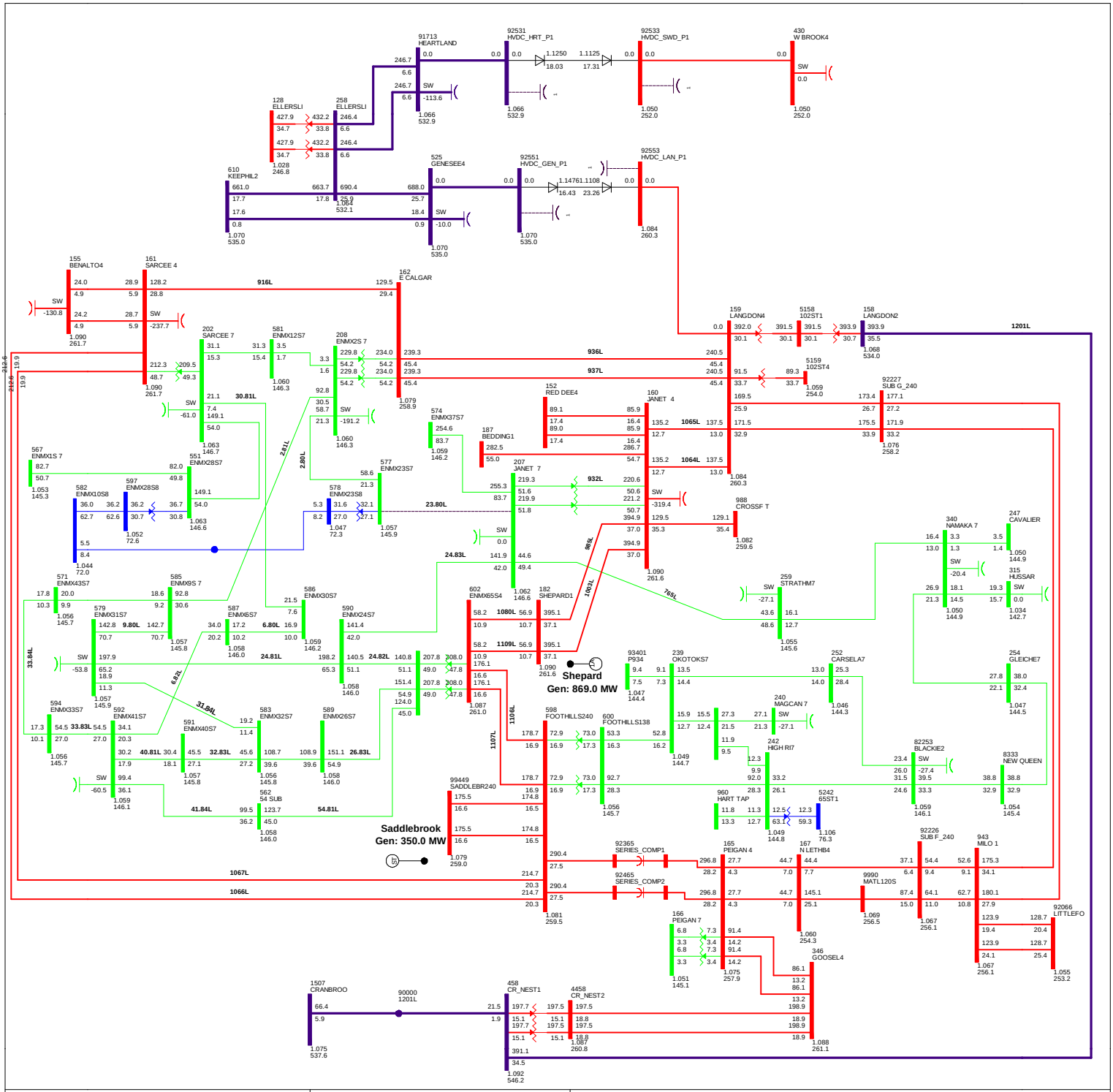
2012LTO FATD FULL SYSTEM

FIG E-SC4-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:01


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
916L
936L
937L
932L
1065L
1064L
1201L
1080L
1109L
1080L
1107L
1106L
1067L
1066L
23.80L
24.83L
24.81L
24.82L
30.81L
33.84L
31.84L
41.84L
54.81L
26.83L
40.81L
33.83L
32.83L
6.80L
9.80L
2.81L
2.80L
6.82L
7.65L
10.03L
9.85L
91713 HEARTLAND
92531 HVDC_HRT_P1
92533 HVDC_SWD_P1
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
610 KEEPHIL2
525 GENESEE4
92551 HVDC_GEN_P1
92553 HVDC_LAN_P1
155 BENALTO4
161 SARCEE 4
162 E CALGAR
159 LANGDON4
5158 102ST1
158 LANGDON2
5159 102ST4
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
152 RED DEE4
160 JANET 4
92227 SUB G_240
187 BEDDING1
207 JANET 7
574 ENMX37S7
577 ENMX23S7
578 ENMX23S8
988 CROSSF T
567 ENMX1S 7
582 ENMX10S8
597 ENMX28S8
551 ENMX28S7
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
259 STRATHM7
571 ENMX43S7
585 ENMX9S 7
586 ENMX30S7
587 ENMX6S7
590 ENMX24S7
602 ENMX65S4
182 SHEPARD1
93401 P934
239 OKOTOKS7
252 CARSELA7
254 GLEICHE7
240 MAGCAN 7
242 HIGH RI7
82253 BLACKIE2
8333 NEW QUEEN
594 ENMX33S7
592 ENMX41S7
591 ENMX40S7
583 ENMX32S7
589 ENMX26S7
562 54 SUB
598 FOOTHILLS240
600 FOOTHILLS138
99449 SADDLEBR240
960 HART TAP
5242 65ST1
92365 SERIES_COMP1
92465 SERIES_COMP2
165 PEIGAN 4
167 N LETHB4
9990 MATL120S
92226 SUB F_240
943 MILO 1
92066 LITTLEFO
166 PEIGAN 7
346 GOOSEL4
1507 CRANBROO
90000 1201L
458 CR_NEST1
4458 CR_NEST2
BCH Import: 22.0 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000
2012LTO FATD FULL SYSTEM
FIG E-SC4-3: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2019_SP_STG4_ALT1_SC4
FRI, JUN 08 2012 16:01



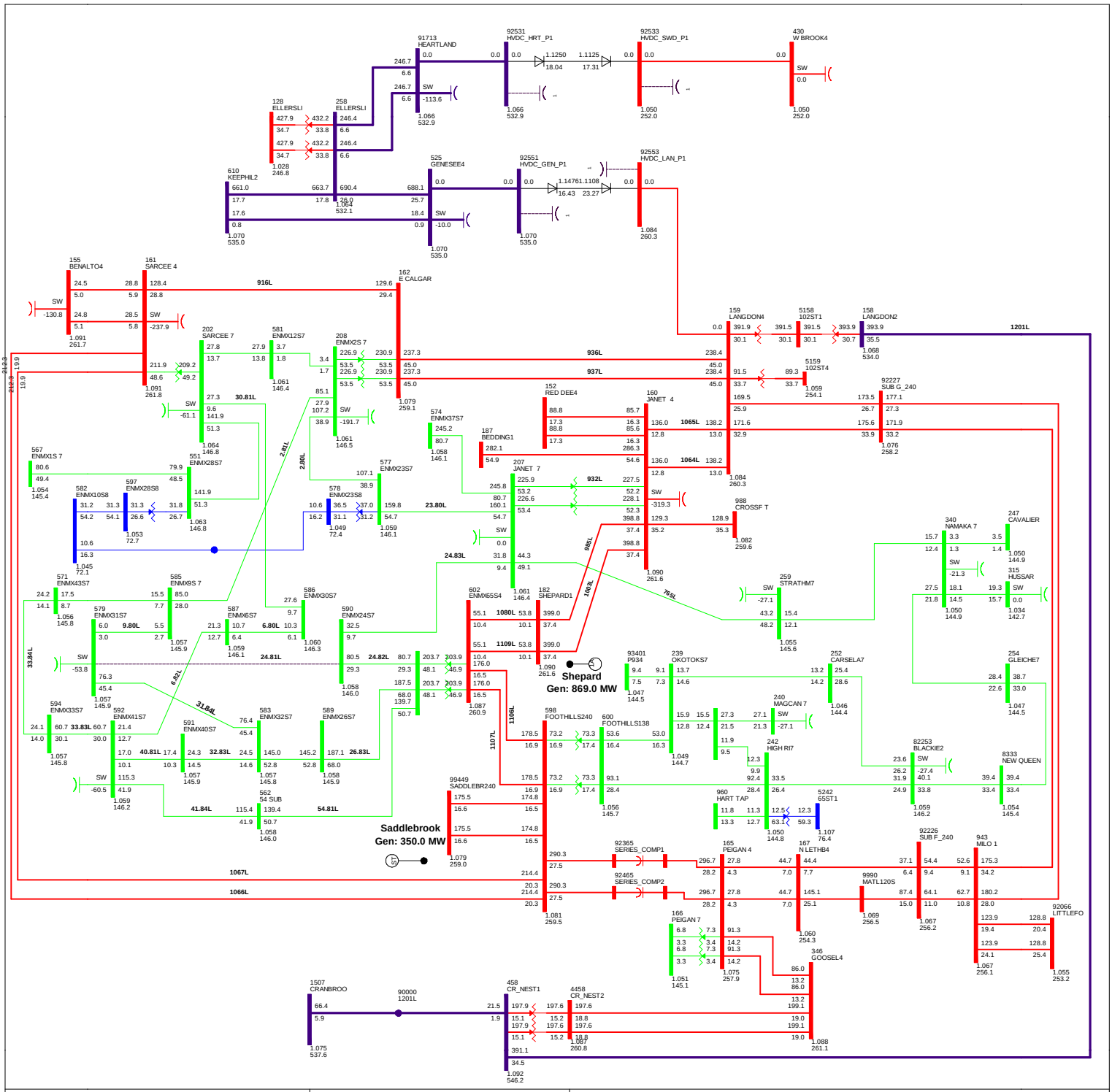
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 1.1 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-4: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

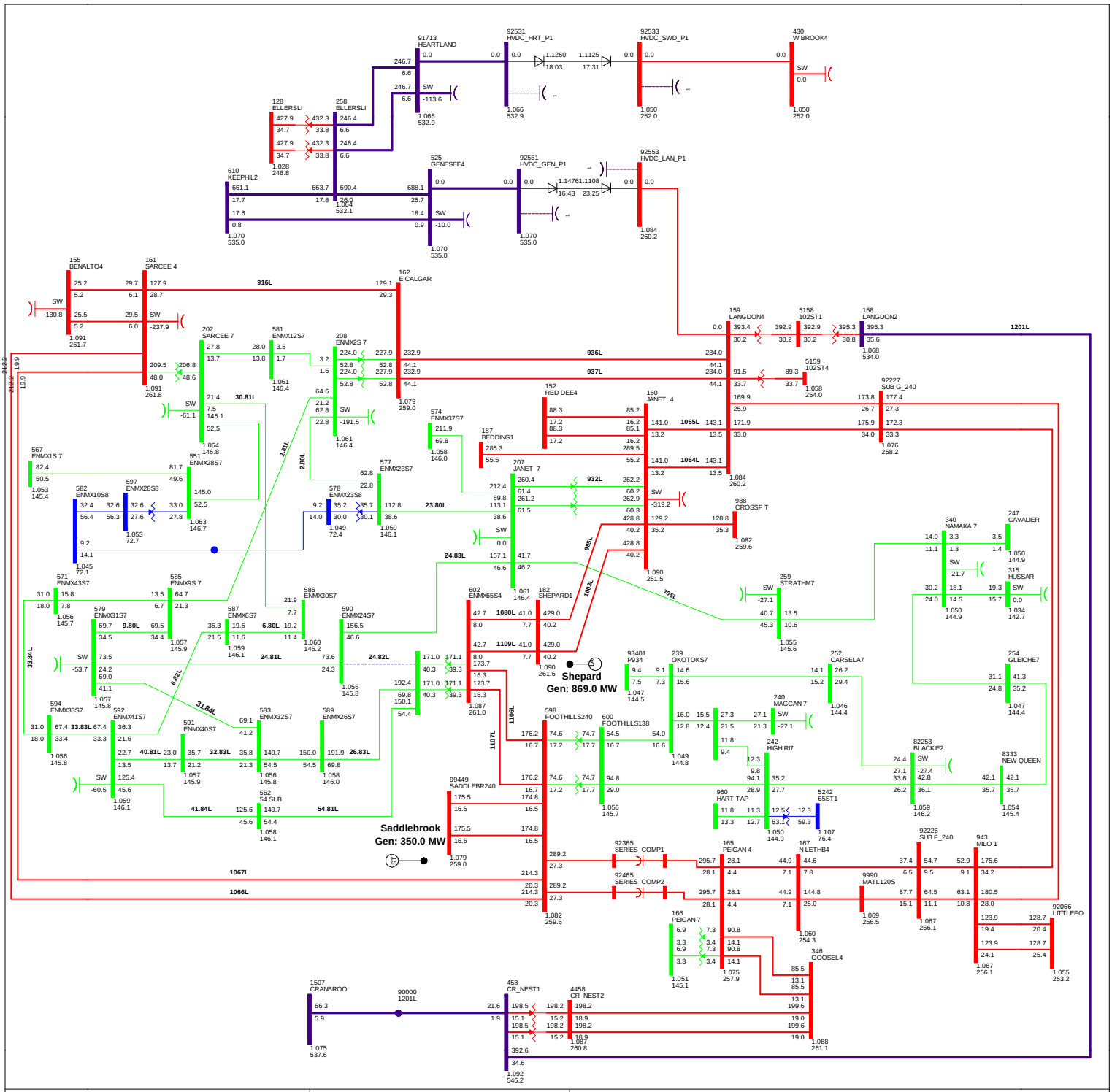
BCH Import: 0.7 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-5: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

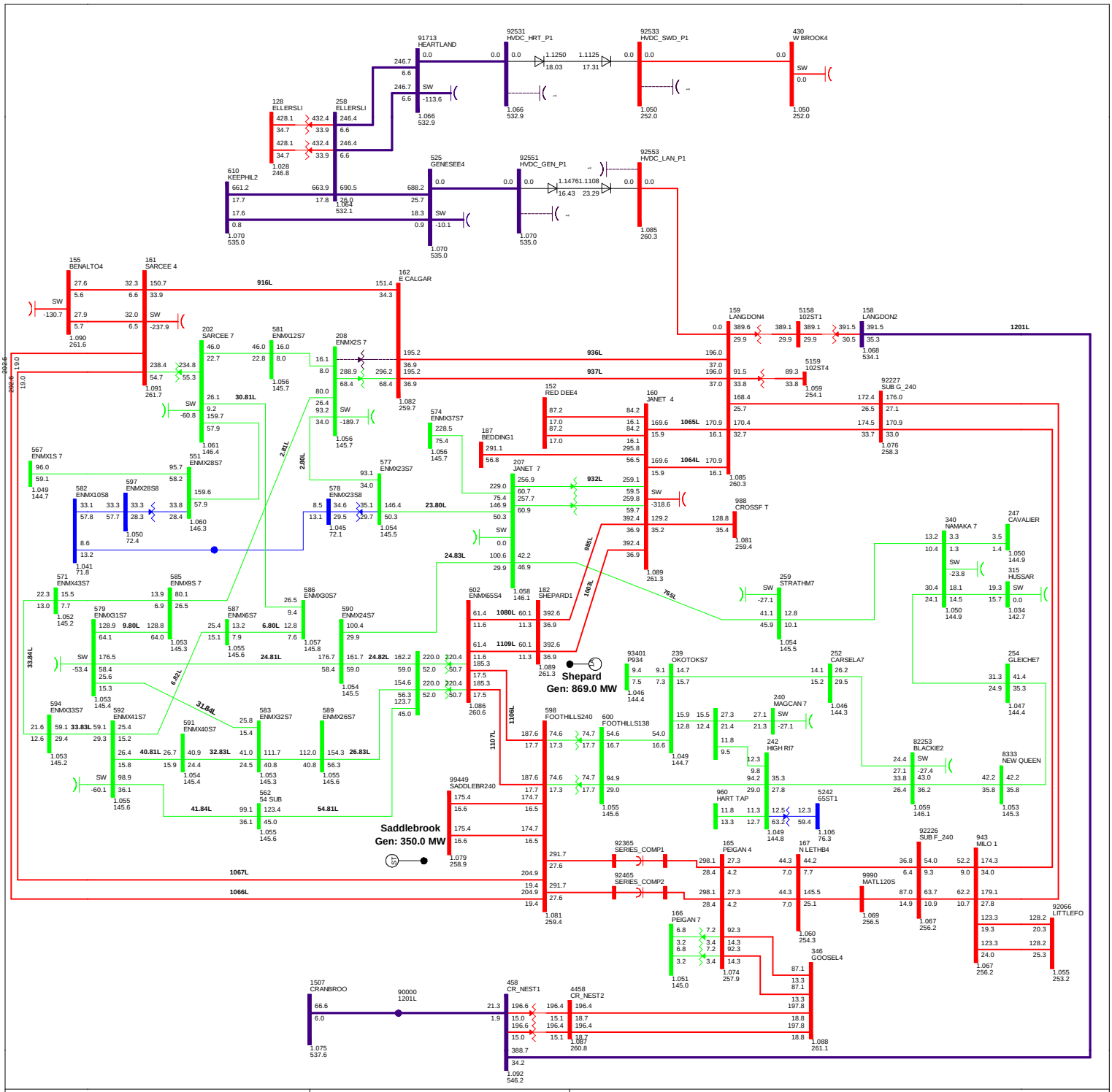
BCH Import: 0.9 MW

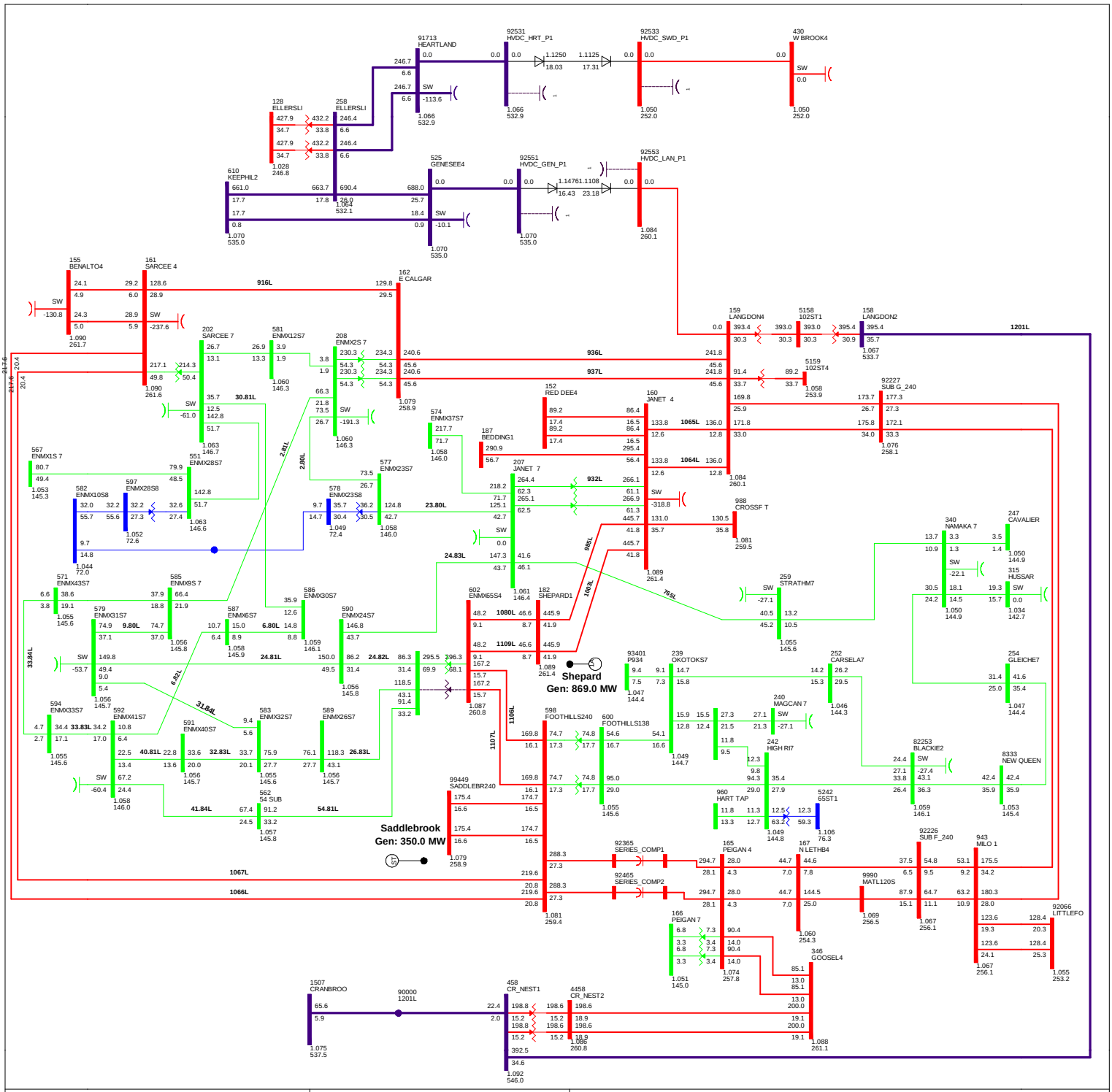
2012LTO FATD FULL SYSTEM

FIG E-SC4-6: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
91713 HEARTLAND
92531 HVDC_HRT_P1
92533 HVDC_SWD_P1
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
610 KEEPHIL2
525 GENESEE4
92551 HVDC_GEN_P1
92553 HVDC_LAN_P1
155 BENALTO4
161 SARCEE 4
162 E CALGAR
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
574 ENMX37S7
187 BEDDING1
152 RED DEE4
160 JANET 4
159 LANGDON4
5158 102ST1
158 LANGDON2
5159 102ST4
92227 SUB G_240
207 JANET 7
988 CROSSF T
567 ENMX1S 7
551 ENMX28S7
582 ENMX10S8
597 ENMX28S8
577 ENMX23S7
578 ENMX23S8
571 ENMX43S7
585 ENMX9S 7
579 ENMX31S7
586 ENMX30S7
587 ENMX6S7
590 ENMX24S7
602 ENMX65S4
182 SHEPARD1
93401 P934
239 OKOTOKS7
252 CARSELA7
259 STRATHM7
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
254 GLEICHE7
594 ENMX33S7
592 ENMX41S7
591 ENMX40S7
583 ENMX32S7
589 ENMX26S7
562 54 SUB
598 FOOTHILLS240
600 FOOTHILLS138
99449 SADDLEBR240
240 MAGCAN 7
242 HIGH RI7
960 HART TAP
5242 65ST1
82253 BLACKIE2
8333 NEW QUEEN
92365 SERIES_COMP1
92465 SERIES_COMP2
165 PEIGAN 4
167 N LETHB4
166 PEIGAN 7
9990 MATL120S
92226 SUB F_240
943 MILO 1
92066 LITTLEFO
346 GOOSEL4
1507 CRANBROO
90000 1201L
458 CR_NEST1
4458 CR_NEST2
916L
936L
937L
1065L
1064L
932L
1201L
1067L
1066L
1080L
1109L
1107L
1100L
2.81L
2.80L
23.80L
24.83L
24.81L
24.82L
6.80L
9.80L
30.81L
32.83L
26.83L
40.81L
41.84L
54.81L
6.82L
31.84L
33.84L
9.85L
7.85L
SW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000
BCH Import: 1.4 MW
2012LTO FATD FULL SYSTEM
FIG E-SC4-7: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)
2019_SP_STG4_ALT1_SC4
FRI, JUN 08 2012 16:02



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

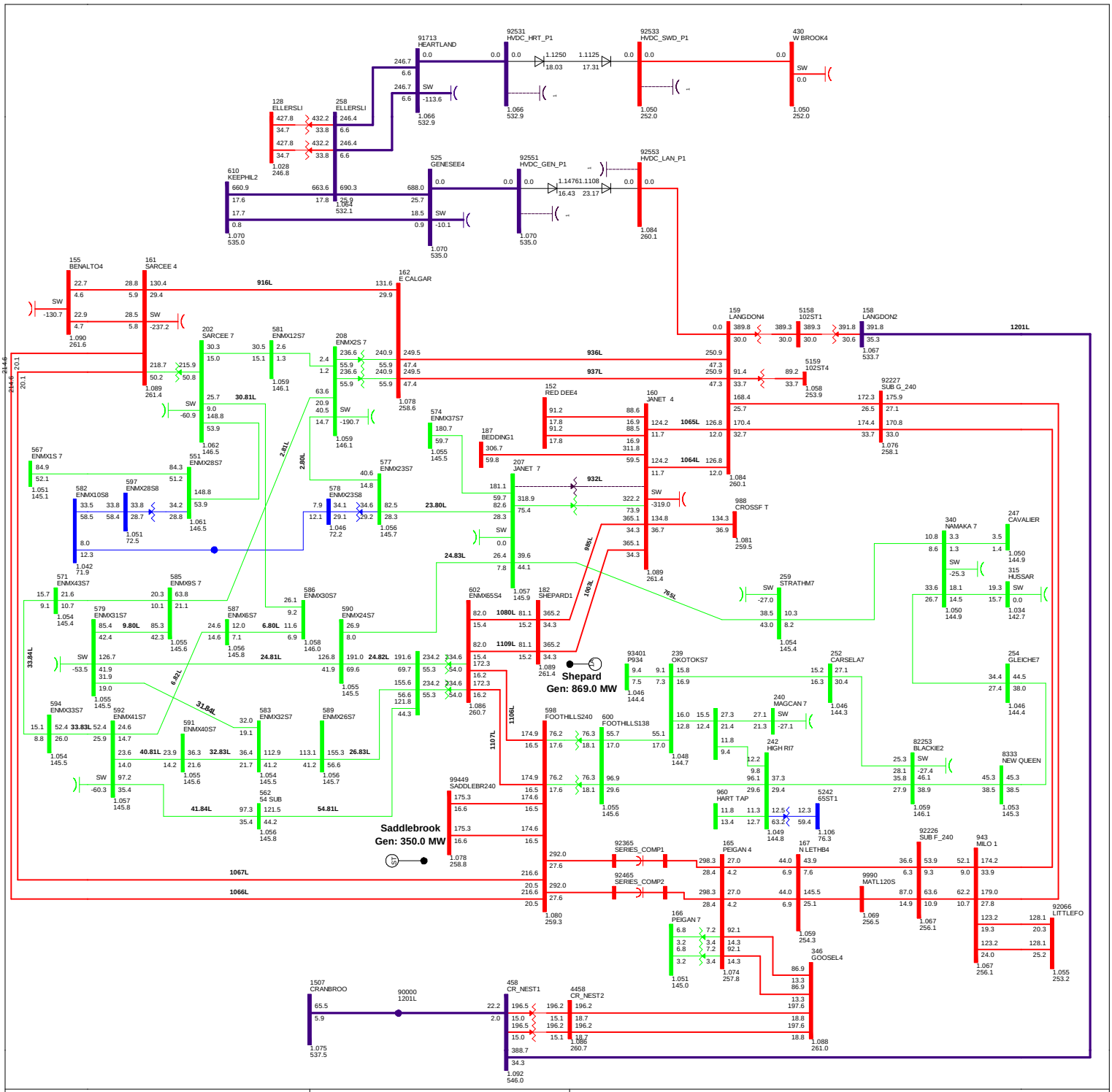
BCH Import: 0.5 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-8: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

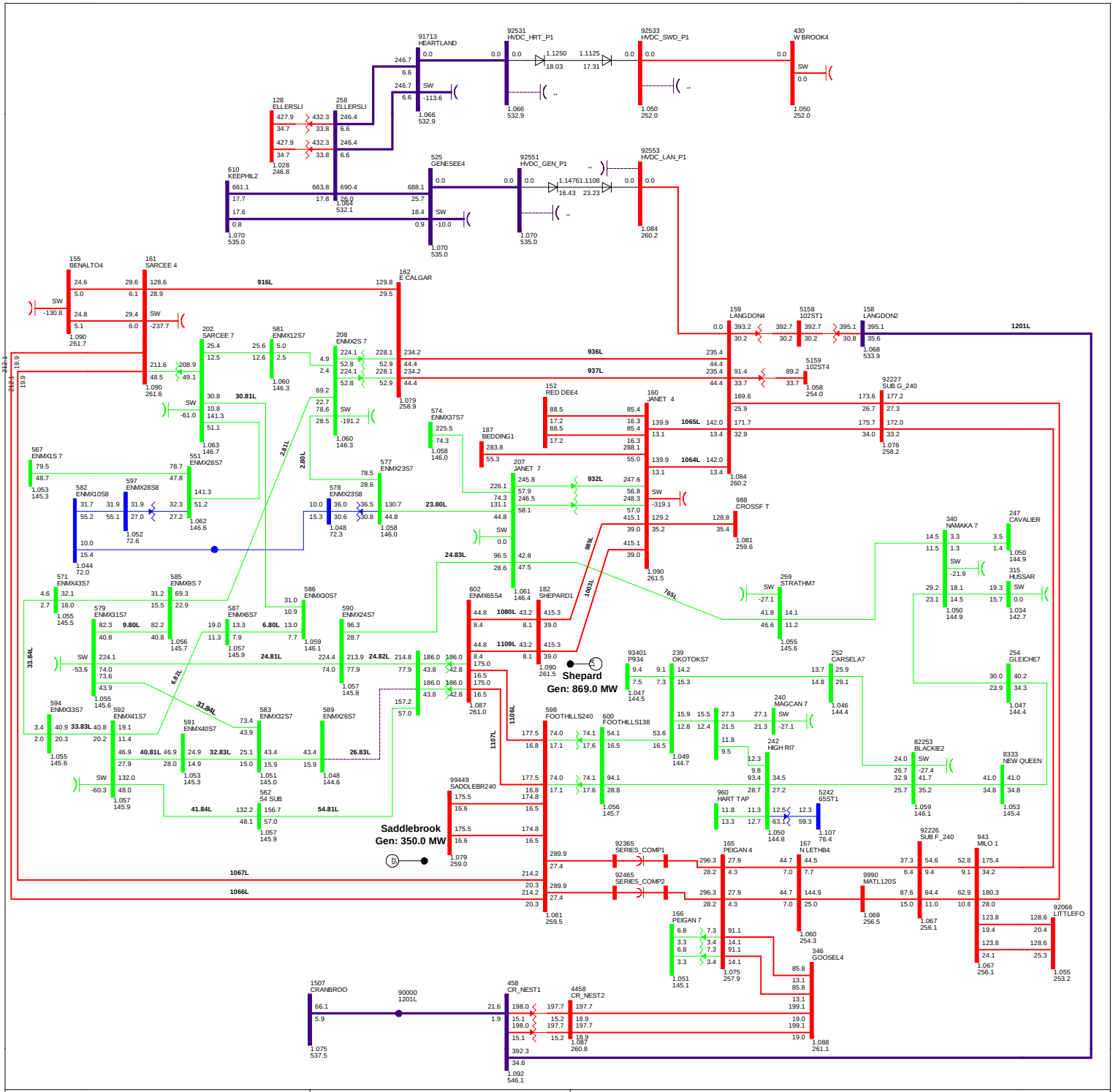
BCH Import: 1.6 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-9: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02



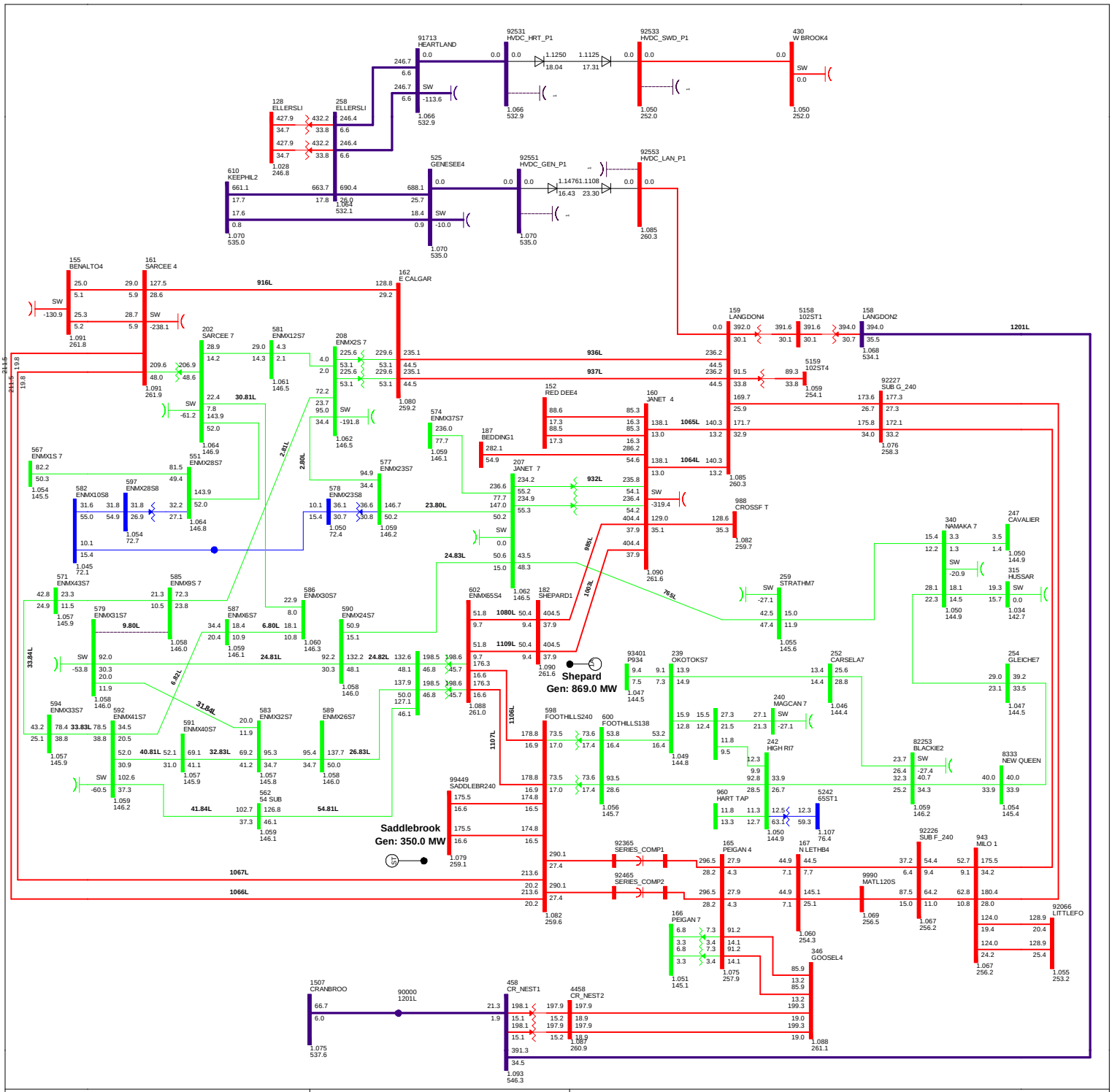
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 1.8 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-10: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

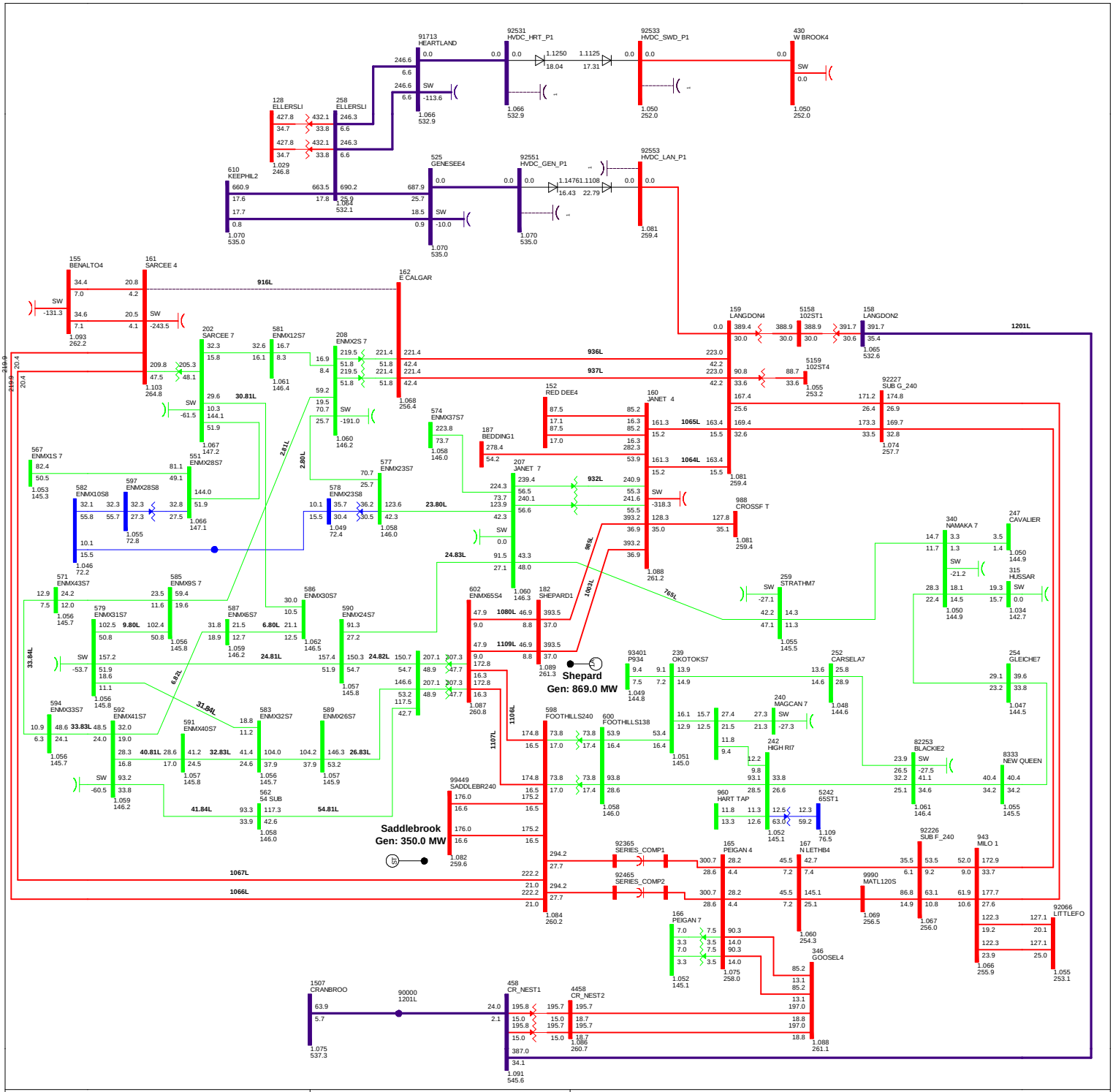
BCH Import: 0.3 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-11: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02



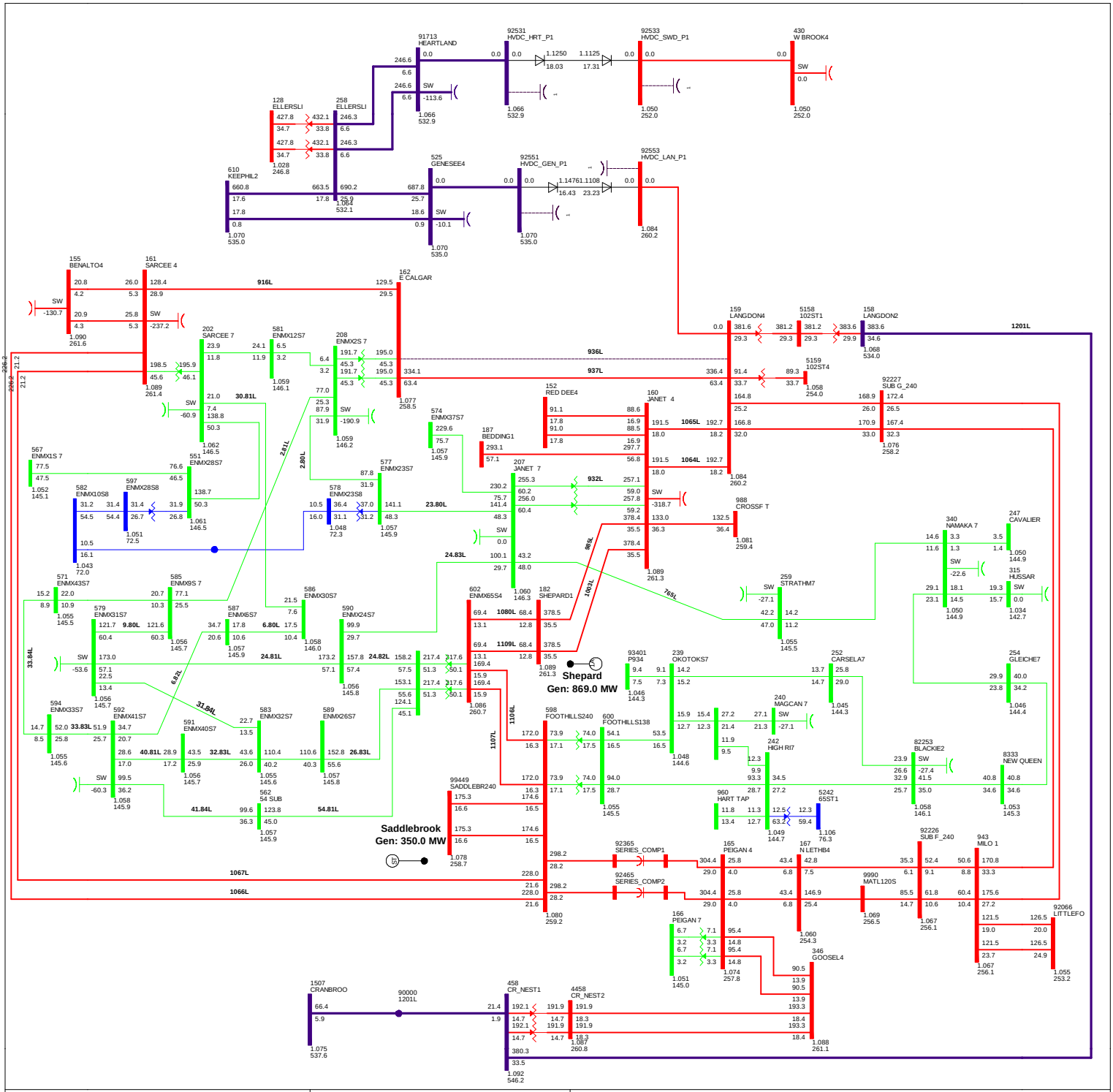
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 0.2 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-12: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02



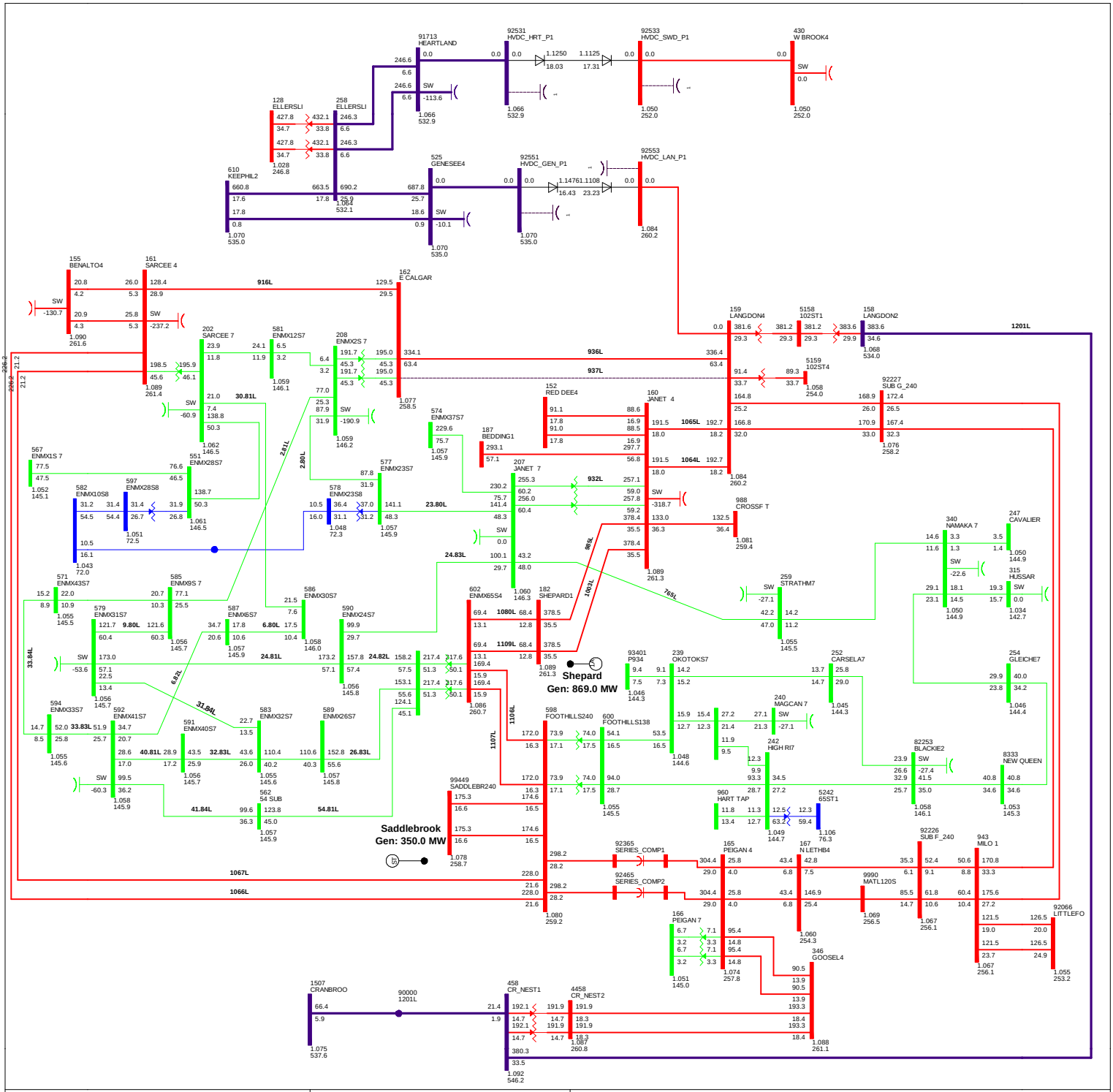
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 2.4 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-13: OPEN 936L 240 KV LINE (LANGDON 102S TO EAST CA
2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02



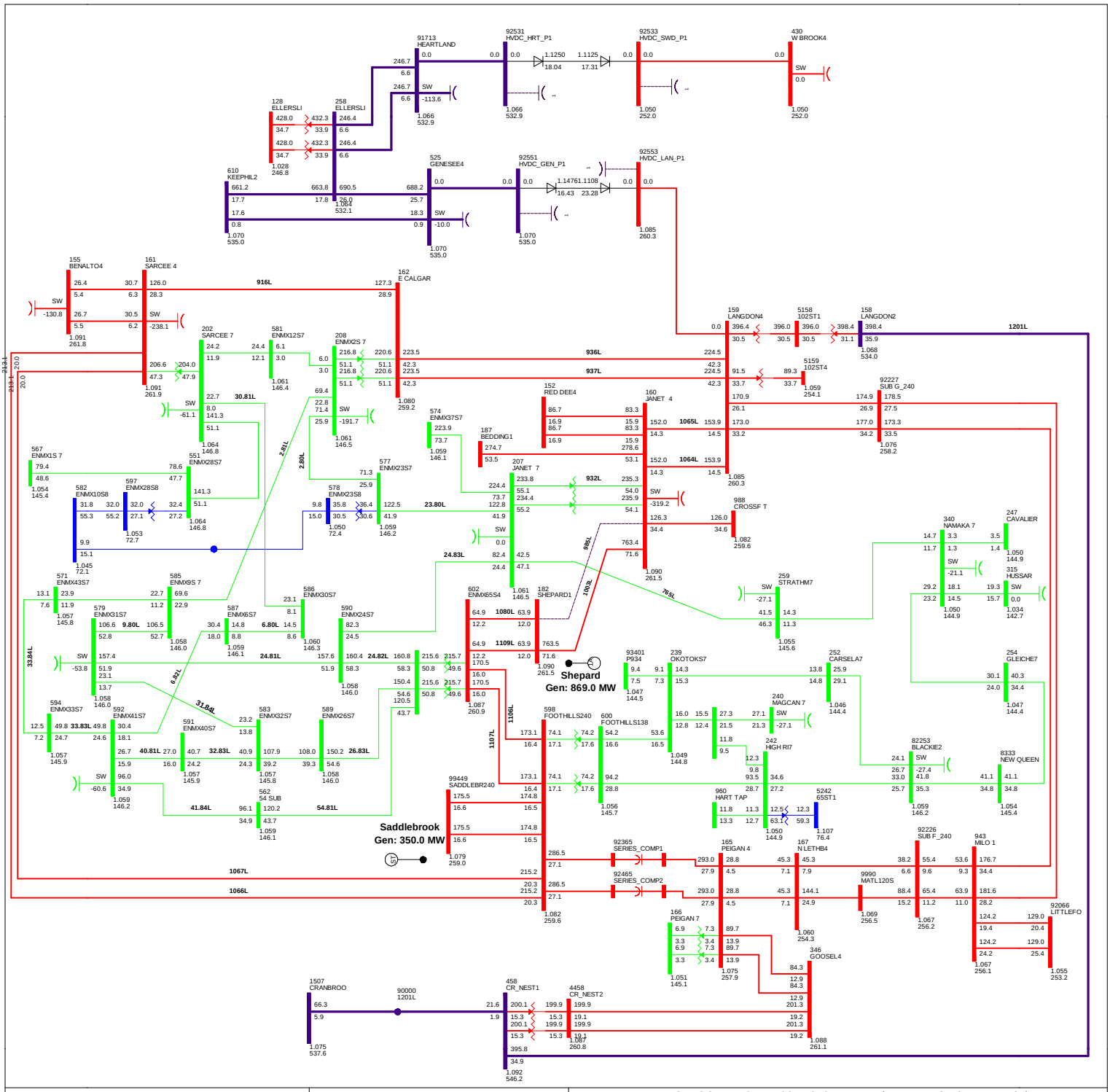
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 2.4 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-14: OPEN 937L 240 KV LINE (LANGDON 102S TO EAST CA
2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 0.6 MW

2012LTO FATD FULL SYSTEM

FIG E-SC4-15: OPEN 985L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:02

Attachment C – Category B 2012LTO+HVDC Results & Plots

Table of Contents

Attachment C – Category B 2012LTO+HVDC Results & Plots

C-1: Need Assessment

2014 Loading Violations Scenario 1A

2014 Loading Violations Scenario 1B

2014 Loading Violations Scenario 2

2014 Loading Violations Scenario 3

2014 Loading Violations Scenario 4

2014 Loading Violations Scenario 5

2014 Loading Violations Scenario 6

C-2: FATD-East Assessment

2019 Loading Violations Scenario 1A

2019 Loading Violations Scenario 3

2019 Loading Violations Scenario 4

C-3: FATD-East+3rdCkt Assessment

2019 Loading Violations Scenario 1A

2019 Loading Violations Scenario 3

2019 Loading Violations Scenario 4

C-4: FATD-Full Assessment

2019 Loading Violations Scenario 1A

2019 Loading Violations Scenario 3

2019 Loading Violations Scenario 4

All References in this Attachment to Crowsnest 491S means Chapel Rock 491S

C-1: Need Assessment

Table 1: 2012LTO+HVDC Need Assessment - 2014 Loading Summary (Over 100%)

Figure Number	Contingency	Overloaded Branch	Scenario						
			SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
A-Sc#-1	BASE CASE	911L 240 kV line (Foothills 237S to ENMAX No. 65)			110% 377MVA	**171% 599MVA**	148% 515MVA	106% 374MVA	
		1003L 240 kV line (Janet 74S to ENMAX No. 25)					**139% 923MVA**	123% 817MVA	
		936L 240 kV line (Langdon 102S to Janet 74S)	**120% 611MVA**	104% 536MVA	107% 535MVA	102% 515MVA			
		937L 240 kV line (Langdon 102S to Janet 74S)	**120% 611MVA**	104% 536MVA	107% 535MVA	102% 515MVA			
		917L 240 kV line (Janet 74S to East Calgary 5S)					**106% 522MVA**	101% 498MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**106% 279MVA**		
A-Sc#-2	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				129% 340MVA	**278% 711MVA**	247% 636MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**181% 339MVA**	164% 306MVA	
		1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)					**172% 854MVA**	168% 853MVA	
		240/138 kV transformer (ENMAX No. 65)					**128% 512MVA**	116% 465MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)					**122% 345MVA**	114% 322MVA	
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)					**120% 308MVA**	110% 283MVA	
		765L 138 kV line (Janet 74S to Strathmore 151S)					109% 92MVA	**113% 95MVA**	
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)					**109% 279MVA**		
		936L 240 kV line (Langdon 102S to Janet 74S)				**108% 546MVA**			
		937L 240 kV line (Langdon 102S to Janet 74S)				**108% 546MVA**			
		24.83L 138 kV line (Janet 74S to ENMAX No. 24)					**104% 325MVA**		
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)					**104% 162MVA**		
A-Sc#-3	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)						**129% 860MVA**	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				**129% 340MVA**	119% 310MVA		
		911L 240 kV line (Foothills 237S to ENMAX No. 65)						**111% 388MVA**	
		936L 240 kV line (Langdon 102S to Janet 74S)				**108% 546MVA**			
		937L 240 kV line (Langdon 102S to Janet 74S)				**108% 546MVA**			
		917L 240 kV line (Janet 74S to East Calgary 5S)						**103% 506MVA**	
A-Sc#-4	Open 1201L 500kV line (Langdon 102S to Crowsnest 491S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)	110% 383MVA	136% 486MVA	140% 471MVA	**211% 730MVA**	188% 651MVA	174% 616MVA	122% 435MVA
		1003L 240 kV line (Janet 74S to ENMAX No. 25)					**158% 1034MVA**	154% 1021MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**112% 292MVA**	107% 278MVA	
		765L 138 kV line (Janet 74S to Strathmore 151S)					101% 86MVA	**105% 89MVA**	
A-Sc#-5	Open 2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	917L 240 kV line (Janet 74S to East Calgary 5S)					**111% 544MVA**	106% 518MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**108% 208MVA**		

Table 1: 2012LTO+HVDC Need Assessment - 2014 Loading Summary (Over 100%)

Figure Number	Contingency	Overloaded Branch	Scenario						
			SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
A-Sc#-6	Open 2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**142% 936MVA**	125% 828MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)					**109% 536MVA**	103% 508MVA	
A-Sc#-7	Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				107% 205MVA	**120% 229MVA**	111% 212MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)					**114% 558MVA**	109% 534MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)					**106% 304MVA**	100% 289MVA	
A-Sc#-8	Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**143% 948MVA**	127% 842MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)					**117% 572MVA**	111% 546MVA	
A-Sc#-9	Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**164% 1086MVA**	146% 968MVA	
		936L 240 kV line (Langdon 102S to Janet 74S)	**121% 615MVA**	105% 540MVA	108% 539MVA				
		937L 240 kV line (Langdon 102S to Janet 74S)	**121% 615MVA**	105% 540MVA	108% 539MVA				
		917L 240 kV line (Janet 74S to East Calgary 5S)					**116% 565MVA**	110% 538MVA	
		765L 138 kV line (Janet 74S to Strathmore 151S)						**101% 87MVA**	
A-Sc#-10	Open 24.83L 138 kV line (Janet 74S to ENMAX No. 24)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**110% 287MVA**	103% 271MVA	
A-Sc#-11	Open 240/138 kV transformer (East Calgary 5S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)			111% 381MVA	**172% 602MVA**		107% 378MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				106% 203MVA	**118% 224MVA**	110% 209MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				104% 274MVA	**116% 304MVA**	108% 281MVA	
		765L 138 kV line (Janet 74S to Strathmore 151S)						**103% 88MVA**	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)					**100% 288MVA**		
A-Sc#-12	Open 240/138 kV transformer (ENMAX No. 65)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**155% 1022MVA**	137% 910MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)					**113% 553MVA**	107% 527MVA	
A-Sc#-13	Open 240/138 kV transformer (Janet 74S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)					**149% 519MVA**	108% 379MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			103% 279MVA	113% 298MVA	**126% 332MVA**	117% 307MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)				102% 498MVA	**120% 587MVA**	115% 562MVA	
		765L 138 kV line (Janet 74S to Strathmore 151S)						**102% 87MVA**	
A-Sc#-14	Open 240/138 kV transformer (Sarcee 42S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**109% 287MVA**	101% 264MVA	
A-Sc#-16	Open 26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**147% 971MVA**	130% 862MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	100% 266MVA	100% 271MVA	112% 304MVA	122% 325MVA	**138% 363MVA**	127% 334MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)				103% 301MVA	**113% 327MVA**	108% 311MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)					**111% 544MVA**	106% 519MVA	
A-Sc#-16	Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**148% 981MVA**	131% 872MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	107% 285MVA	106% 287MVA	118% 321MVA	129% 344MVA	**145% 382MVA**	134% 352MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)			103% 307MVA	110% 319MVA	**120% 345MVA**	114% 329MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)					**112% 549MVA**	107% 525MVA	

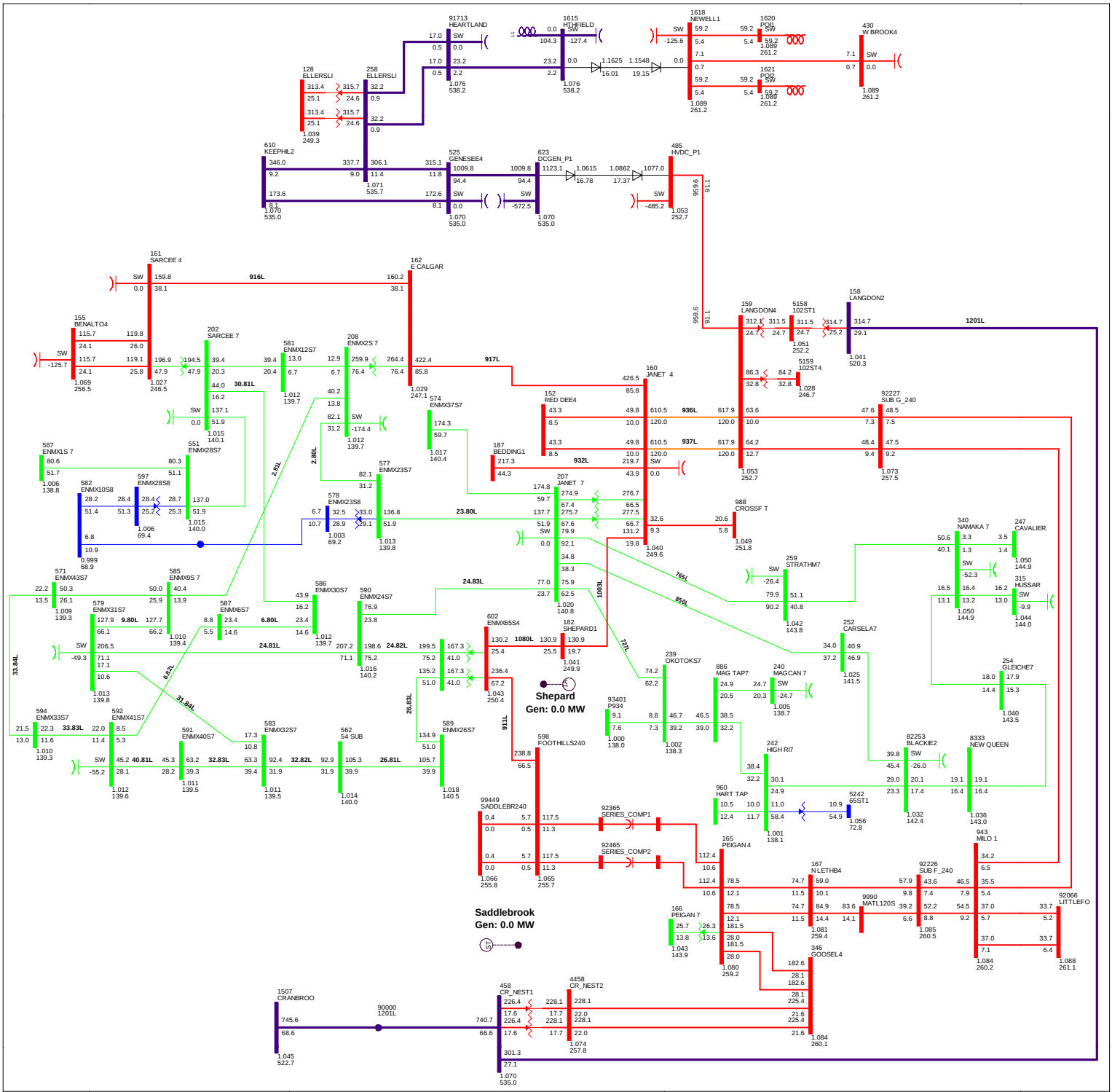
Table 1: 2012LTO+HVDC Need Assessment - 2014 Loading Summary (Over 100%)

Figure Number	Contingency	Overloaded Branch	Scenario						
			SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
A-Sc#-17	Open 32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**141% 934MVA**	125% 828MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)				103% 200MVA	**120% 230MVA**	110% 211MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)					**109% 532MVA**	103% 508MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**108% 285MVA**		
A-Sc#-18	Open 40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**141% 932MVA**	124% 826MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**112% 215MVA**	103% 197MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)					**108% 530MVA**	103% 505MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**108% 283MVA**		
A-Sc#-19	Open 500/240 kV transformer (Langdon 102S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)	110% 386MVA	136% 480MVA	140% 472MVA	**210% 730MVA**	187% 650MVA	173% 614MVA	122% 437MVA
		1003L 240 kV line (Janet 74S to ENMAX No. 25)					**158% 1035MVA**	153% 1020MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**112% 292MVA**	106% 277MVA	
		765L 138 kV line (Janet 74S to Strathmore 151S)					101% 86MVA	**102% 87MVA**	
A-Sc#-20	Open 727L 138 kV line (Janet 74S to Okotoks 678S)	765L 138 kV line (Janet 74S to Strathmore 151S)	126% 109MVA	111% 99MVA	112% 99MVA	121% 105MVA	129% 111MVA	**135% 116MVA**	
A-Sc#-21	Open 727L 138 kV line (Okotoks 678SS to Magcan 142S to High River 65S)	765L 138 kV line (Janet 74S to Strathmore 151S)	113% 98MVA			106% 92MVA	114% 98MVA	**118% 101MVA**	
A-Sc#-22	Open 765L 138 kV line (Janet 74S to Strathmore 151S)	936L 240 kV line (Langdon 102S to Janet 74S)	**121% 614MVA**						
		937L 240 kV line (Langdon 102S to Janet 74S)	**121% 614MVA**						
A-Sc#-23	Open 850L 138 kV line (Janet 74S to Carseland 525S)	765L 138 kV line (Janet 74S to Strathmore 151S)	105% 91MVA				108% 93MVA	**115% 99MVA**	
A-Sc#-24	Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	1003L 240 kV line (Janet 74S to ENMAX No. 25)					**144% 952MVA**	127% 845MVA	
		917L 240 kV line (Janet 74S to East Calgary 5S)					**113% 555MVA**	108% 528MVA	
A-Sc#-25	Open 911L 240 kV line (Foothills 237S to ENMAX No. 65)	936L 240 kV line (Langdon 102S to Janet 74S)	140% 705MVA	129% 654MVA	142% 693MVA	**155% 772MVA**	106% 534MVA		
		937L 240 kV line (Langdon 102S to Janet 74S)	140% 705MVA	129% 654MVA	142% 693MVA	**155% 772MVA**	106% 534MVA		
		765L 138 kV line (Janet 74S to Strathmore 151S)				**101% 86MVA**		**101% 86MVA**	
A-Sc#-26	Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**112% 294MVA**	103% 270MVA	
		240/138 kV transformer (East Calgary 5S)					**103% 347MVA**	103% 345MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**102% 196MVA**		
A-Sc#-27	Open 917L 240 kV line (Janet 74S to East Calgary 5S)	911L 240 kV line (Foothills 237S to ENMAX No. 65)			111% 381MVA	**173% 603MVA**	149% 519MVA	108% 379MVA	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	115% 217MVA	110% 214MVA	116% 227MVA	129% 246MVA	**151% 286MVA**	140% 264MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)			104% 282MVA	115% 304MVA	**132% 345MVA**	122% 318MVA	
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	104% 297MVA		103% 302MVA	111% 321MVA	**125% 356MVA**	119% 337MVA	
		765L 138 kV line (Janet 74S to Strathmore 151S)					102% 87MVA	**107% 91MVA**	

Table 1: 2012LTO+HVDC Need Assessment - 2014 Loading Summary (Over 100%)

Figure Number	Contingency	Overloaded Branch	Scenario						
			SC1A	SC1B	SC2	SC3	SC4	SC5	SC6
A-Sc#-28	Open 932L 240 kV line (Janet 74S to Beddington SS-162)	917L 240 kV line (Janet 74S to East Calgary 5S)				103% 502MVA	**123% 602MVA**	117% 574MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)				102% 270MVA	**116% 305MVA**	107% 280MVA	
		765L 138 kV line (Janet 74S to Strathmore 151S)						**103% 88MVA**	
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)					**103% 196MVA**		
A-Sc#-29	Open 936L 240 kV line (Langdon 102S to Janet 74S)	937L 240 kV line (Langdon 102S to Janet 74S)	**219% 1100MVA**	190% 968MVA	196% 965MVA	187% 932MVA	116% 586MVA	104% 529MVA	112% 583MVA
		911L 240 kV line (Foothills 237S to ENMAX No. 65)			132% 447MVA	**192% 668MVA**	160% 557MVA	118% 413MVA	103% 370MVA
		1003L 240 kV line (Janet 74S to ENMAX No. 25)					**145% 956MVA**	129% 852MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**108% 283MVA**		
		765L 138 kV line (Janet 74S to Strathmore 151S)	100% 86MVA					**102% 87MVA**	
A-Sc#-30	Open 937L 240 kV line (Langdon 102S to Janet 74S)	936L 240 kV line (Langdon 102S to Janet 74S)	**219% 1100MVA**	190% 968MVA	196% 965MVA	187% 932MVA	116% 586MVA	104% 529MVA	112% 583MVA
		911L 240 kV line (Foothills 237S to ENMAX No. 65)			132% 447MVA	**192% 668MVA**	160% 557MVA	118% 413MVA	103% 370MVA
		1003L 240 kV line (Janet 74S to ENMAX No. 25)					**145% 956MVA**	129% 852MVA	
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)					**108% 283MVA**		
		765L 138 kV line (Janet 74S to Strathmore 151S)	100% 86MVA					**102% 87MVA**	
A-Sc#-31	Open 240 kV line (Langdon 102S to HVDC_P1)	765L 138 kV line (Janet 74S to Strathmore 151S)	**105% 89MVA**						

2014 Loading Violations
Scenario 1A



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

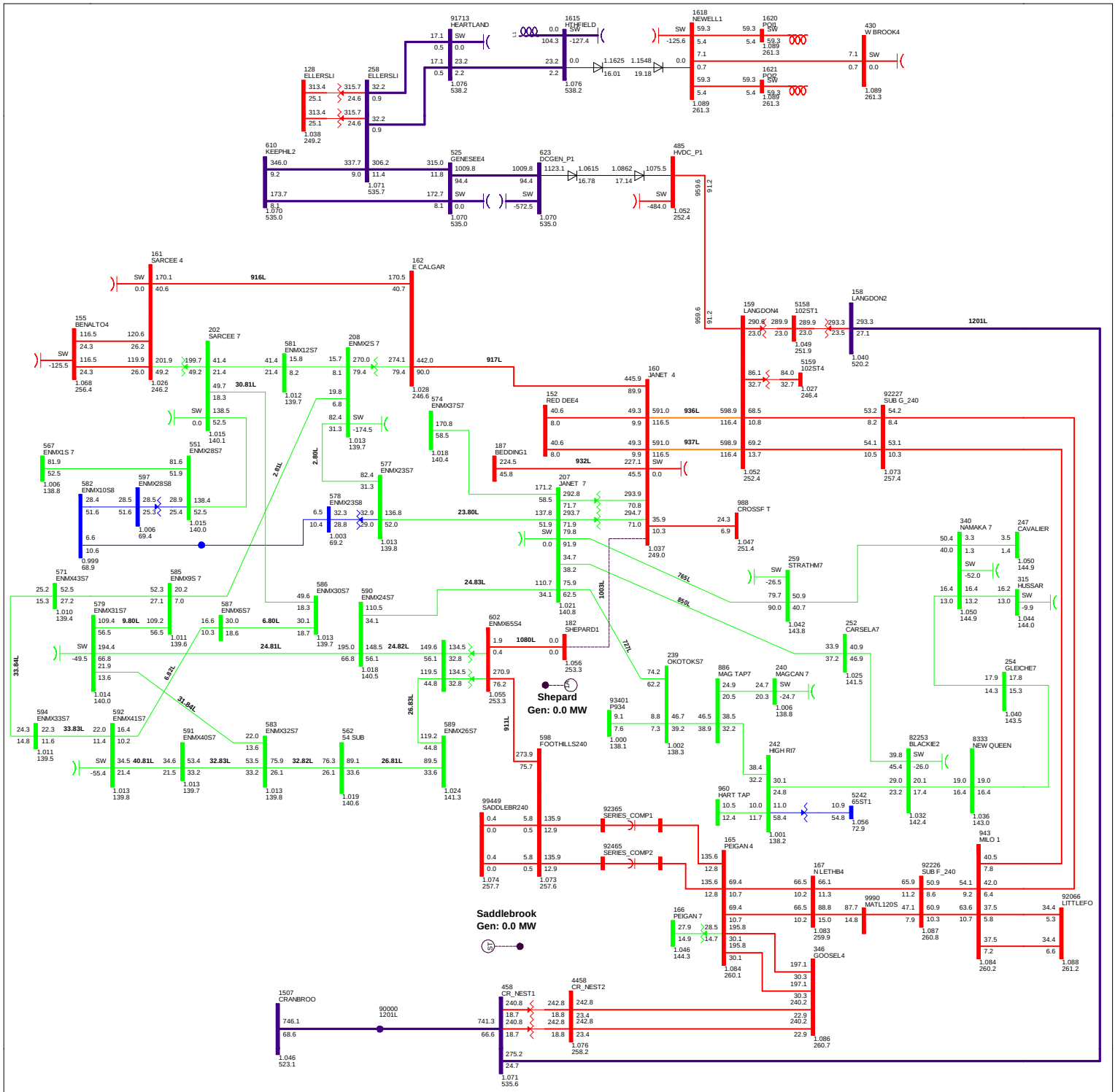
BCH Import: 784.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-1: BASECASE

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

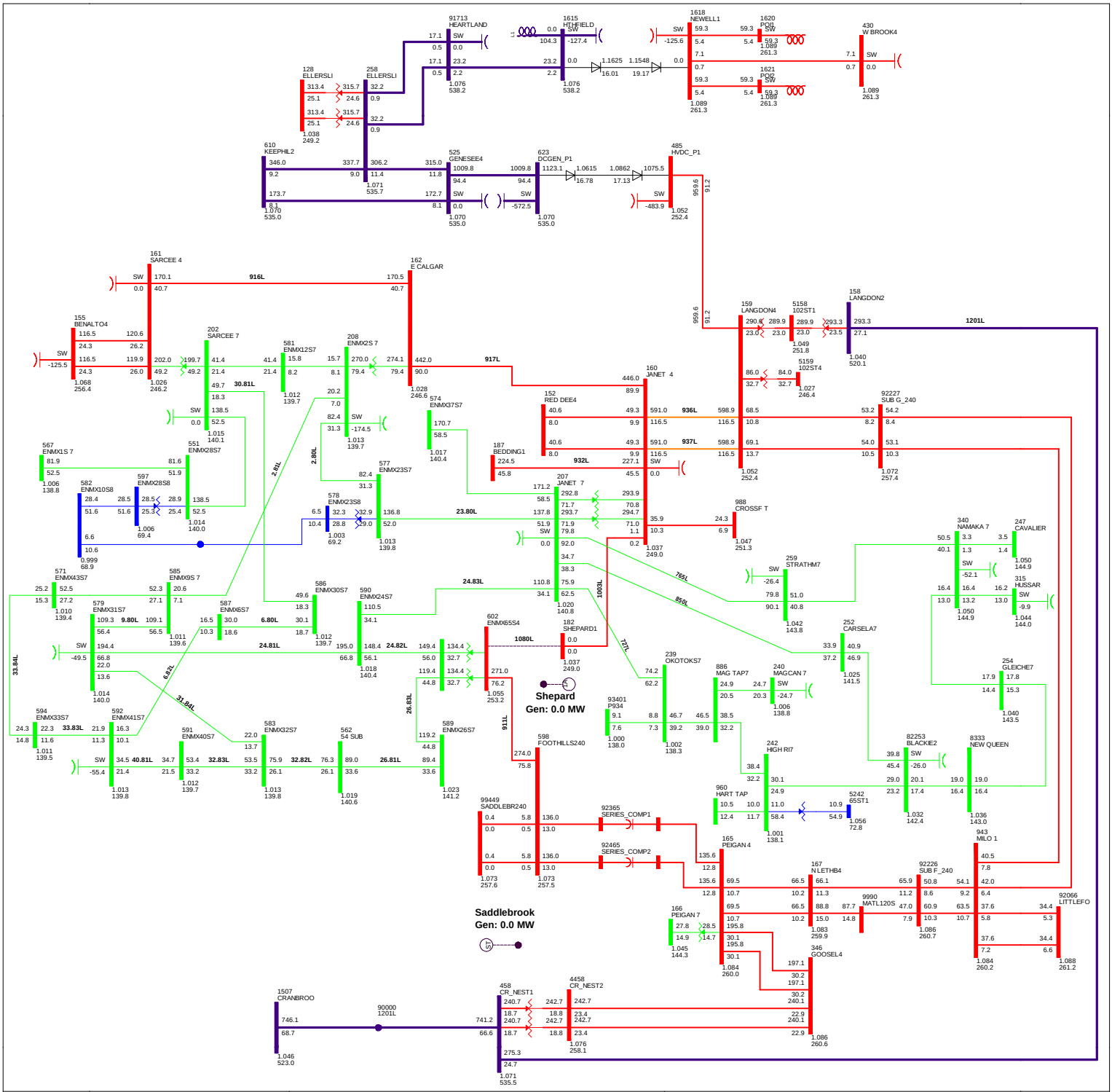
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 784.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

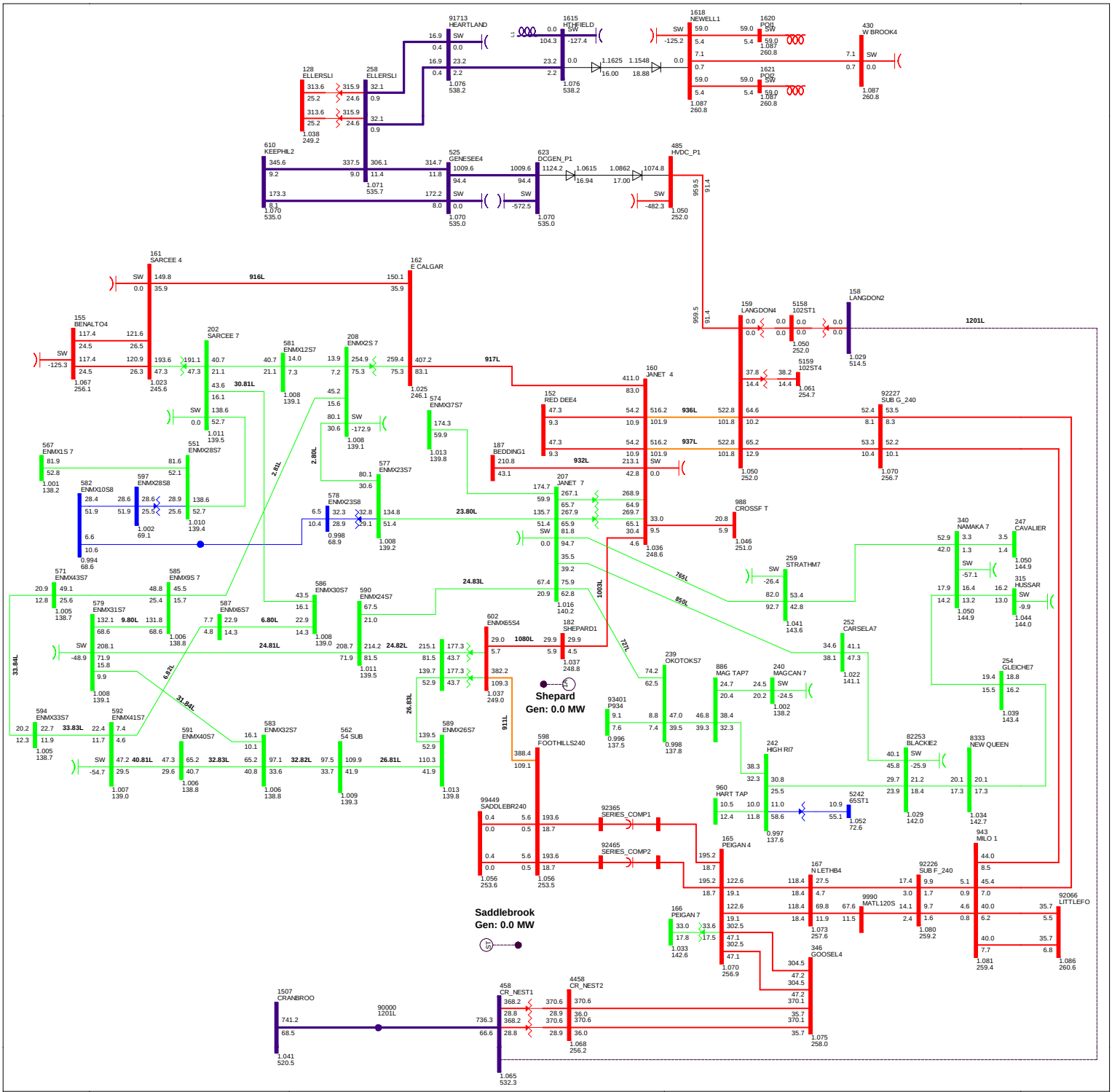
BCH Import: 784.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

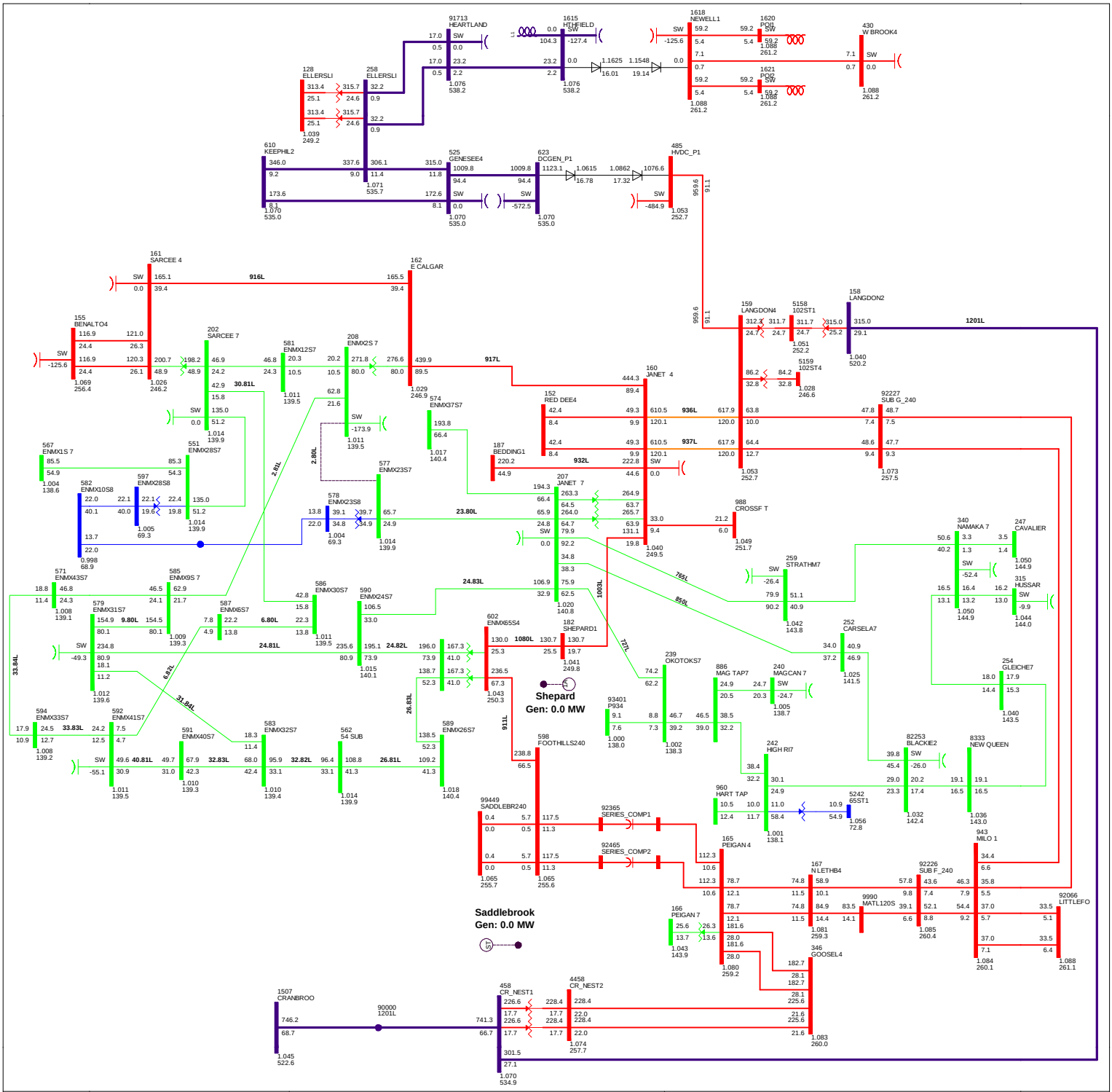
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 796.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSN 2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

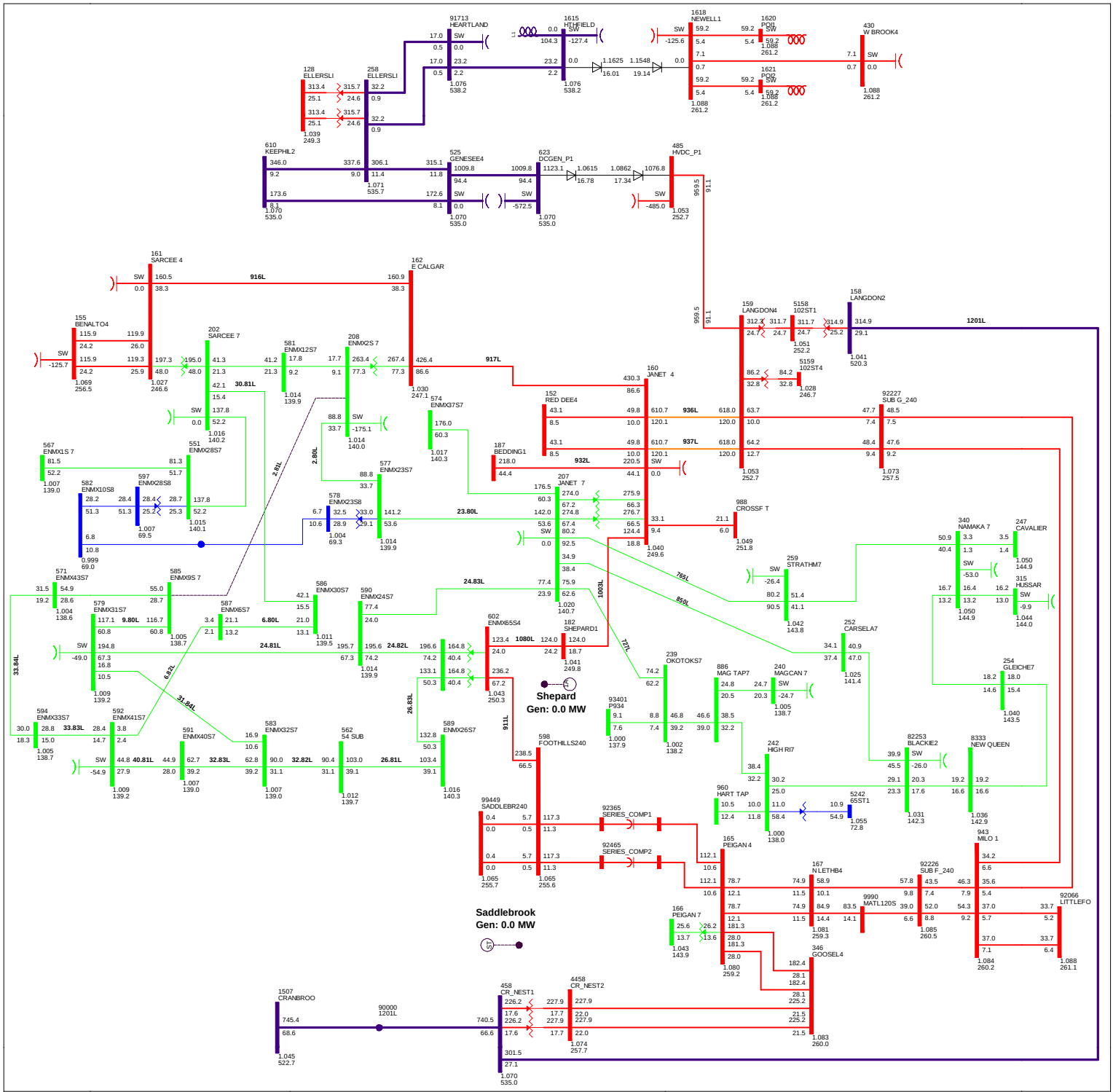
BCH Import: 785.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

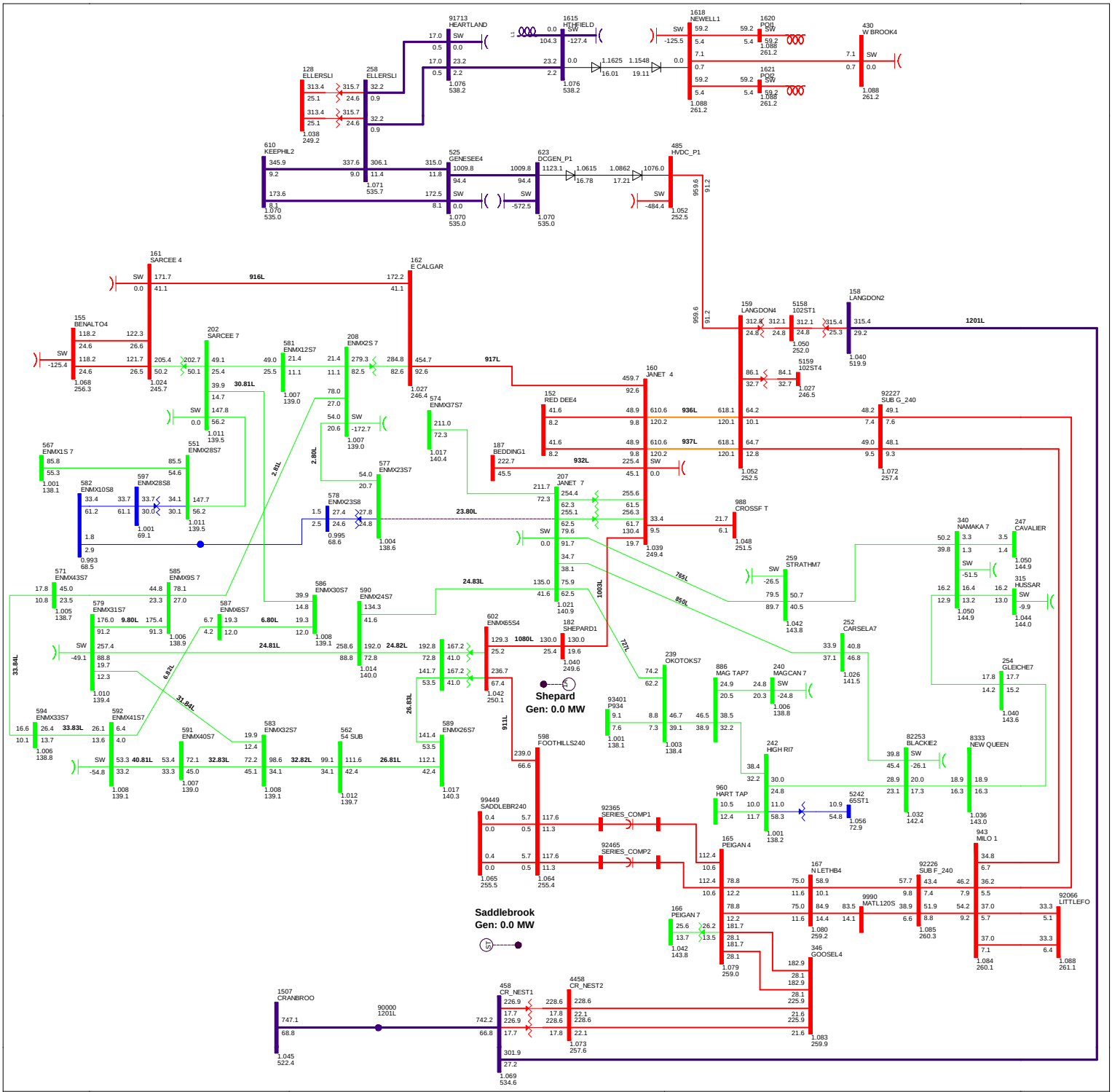
BCH Import: 783.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

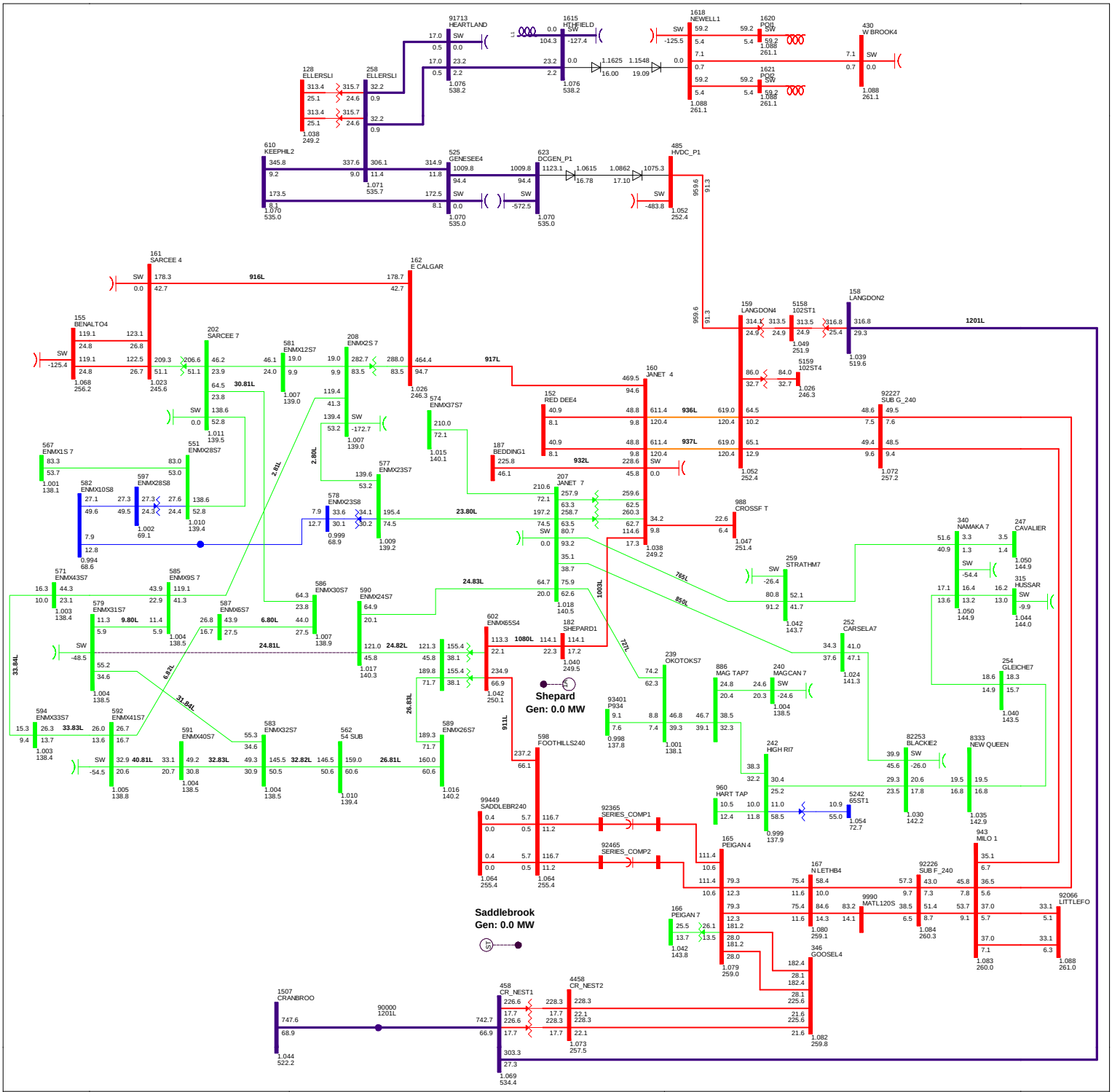
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 786.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

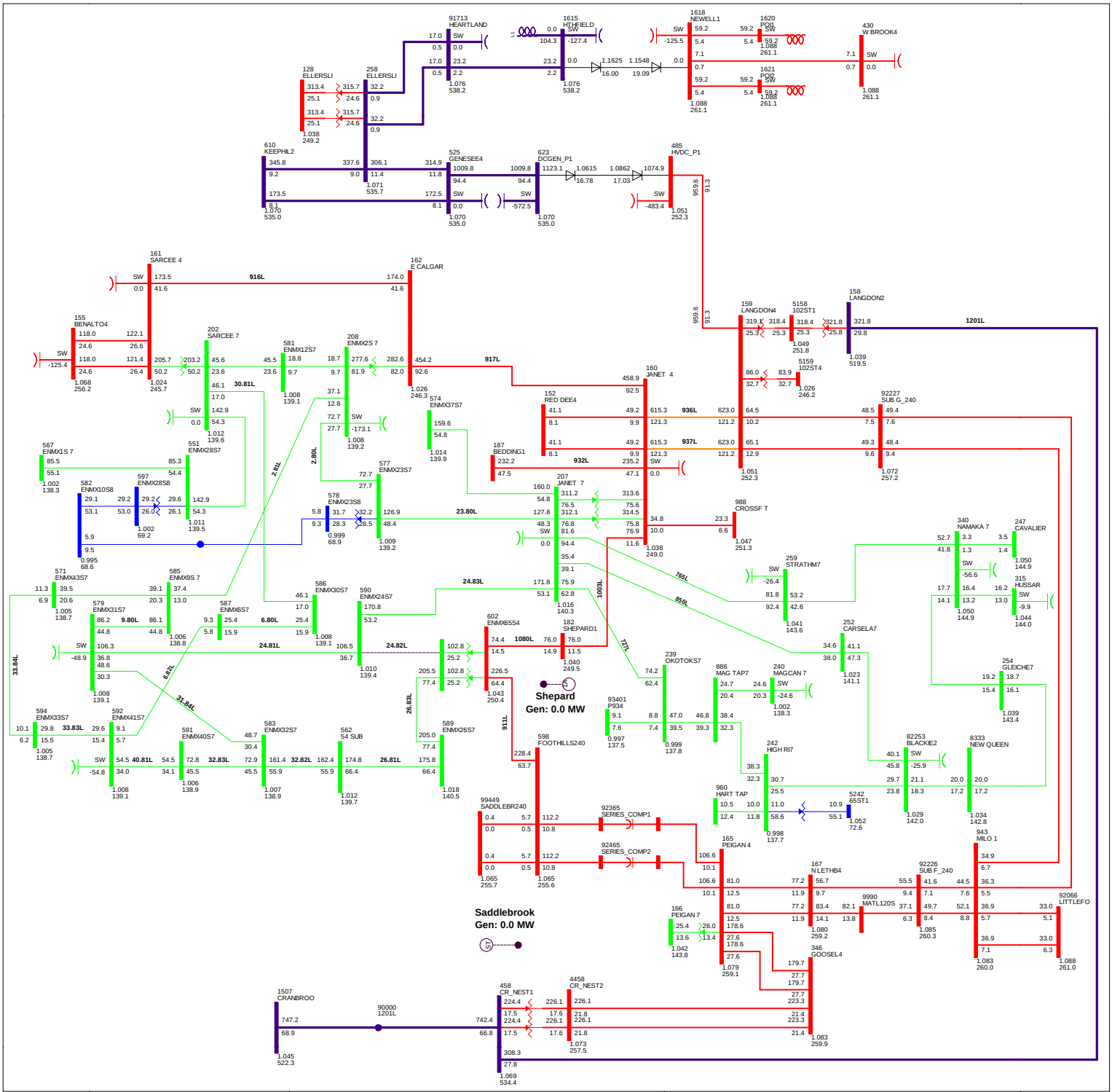
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 787.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

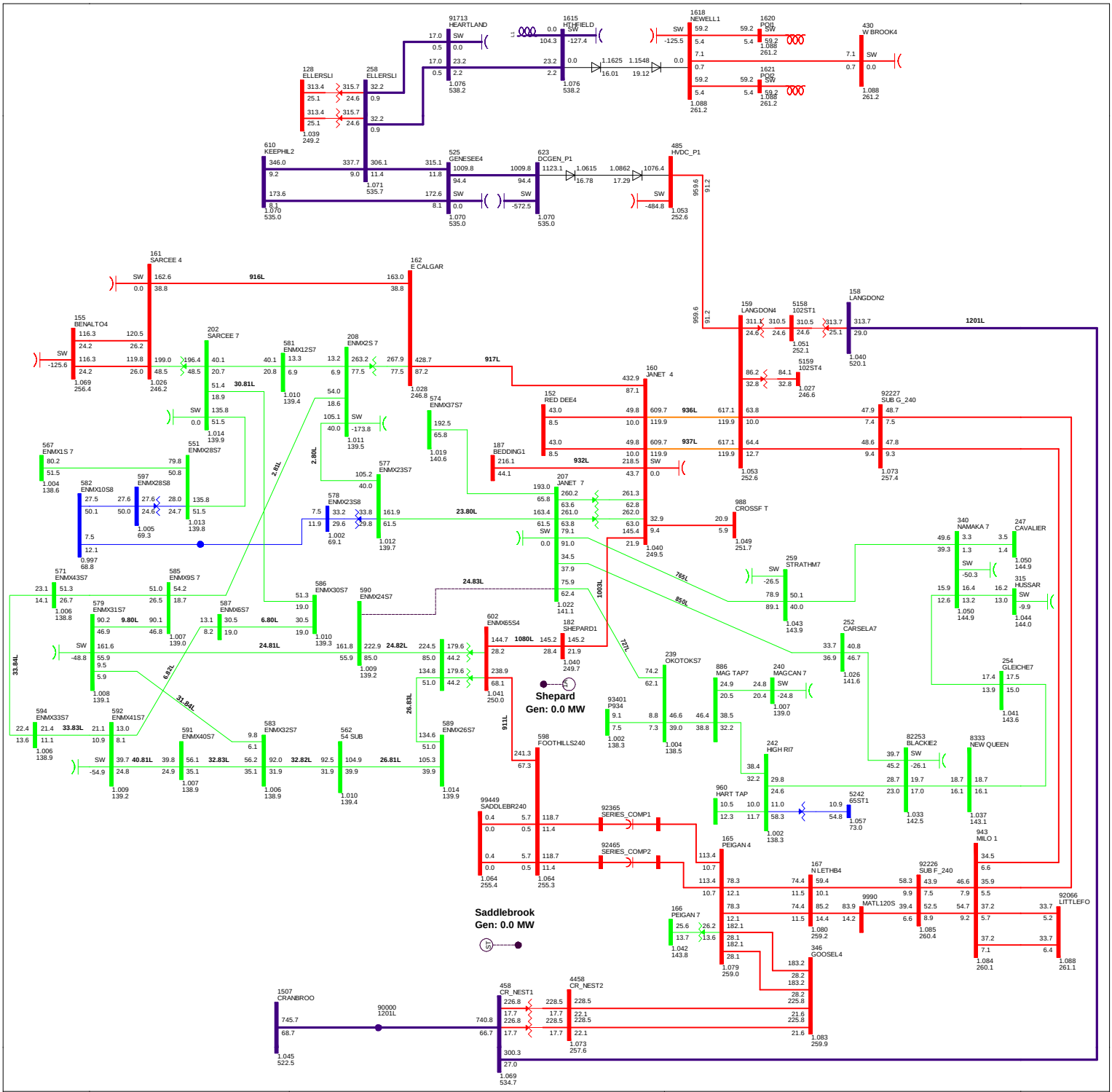
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 786.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

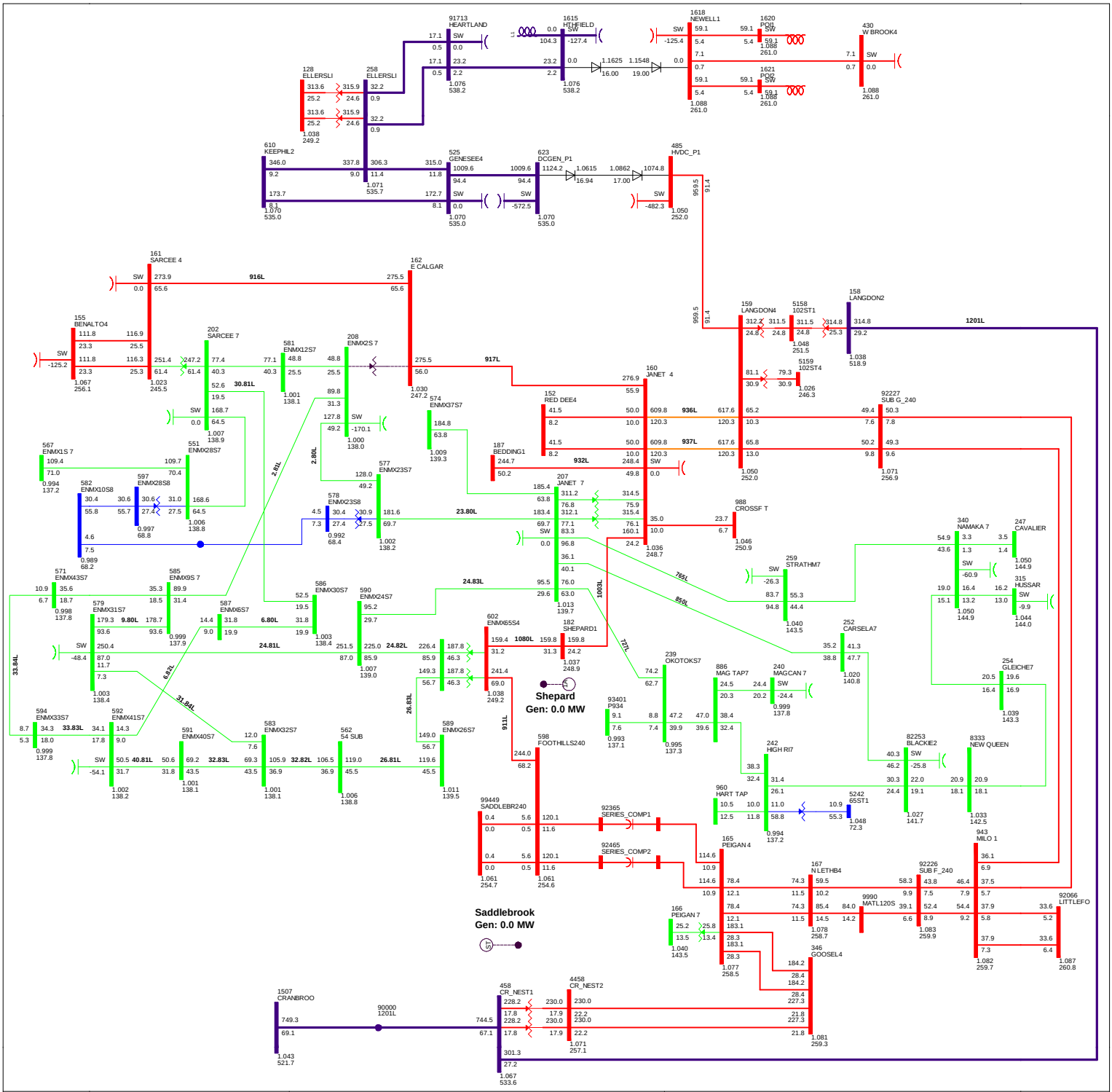
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 784.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 2
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

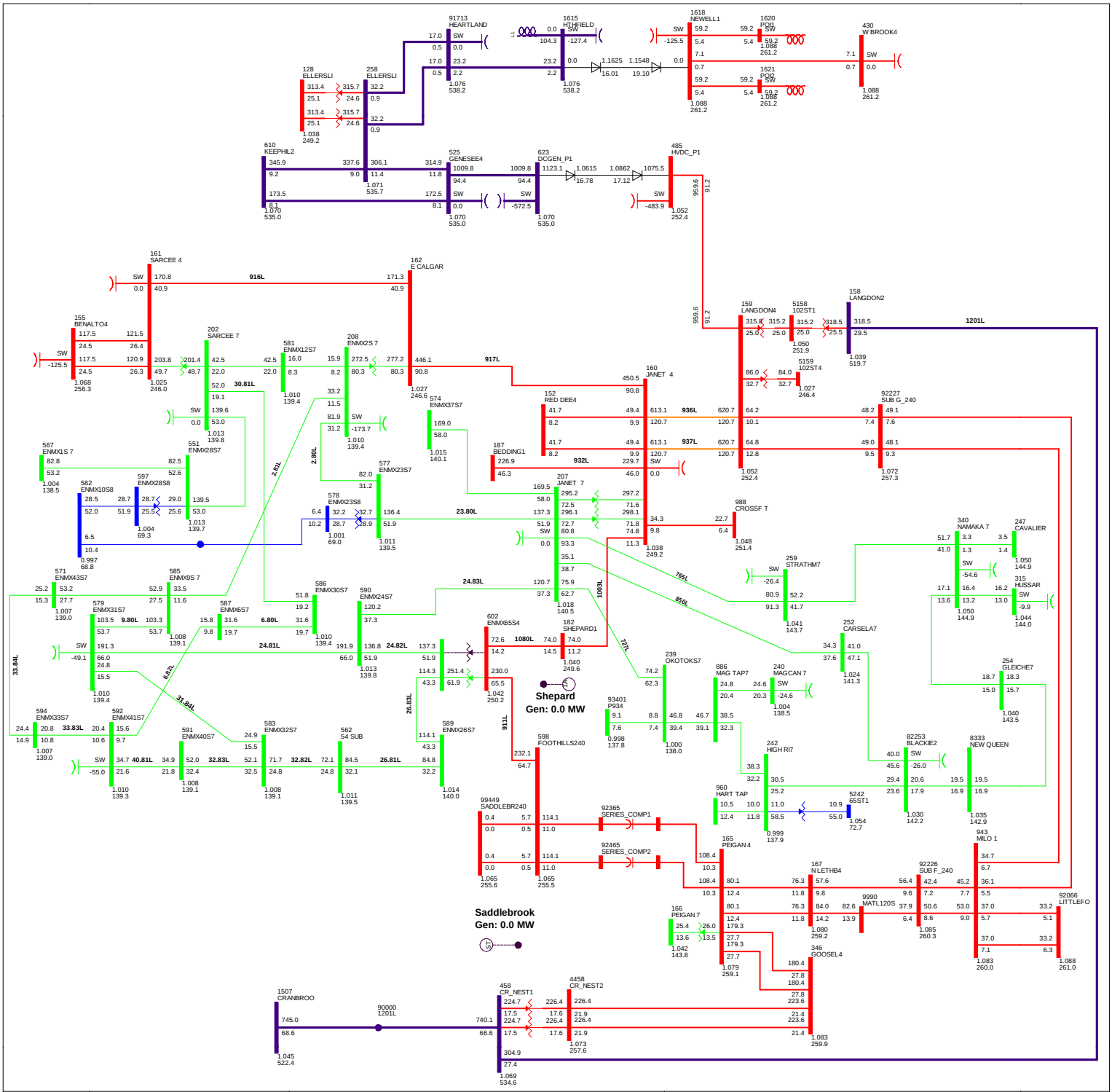
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 789.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

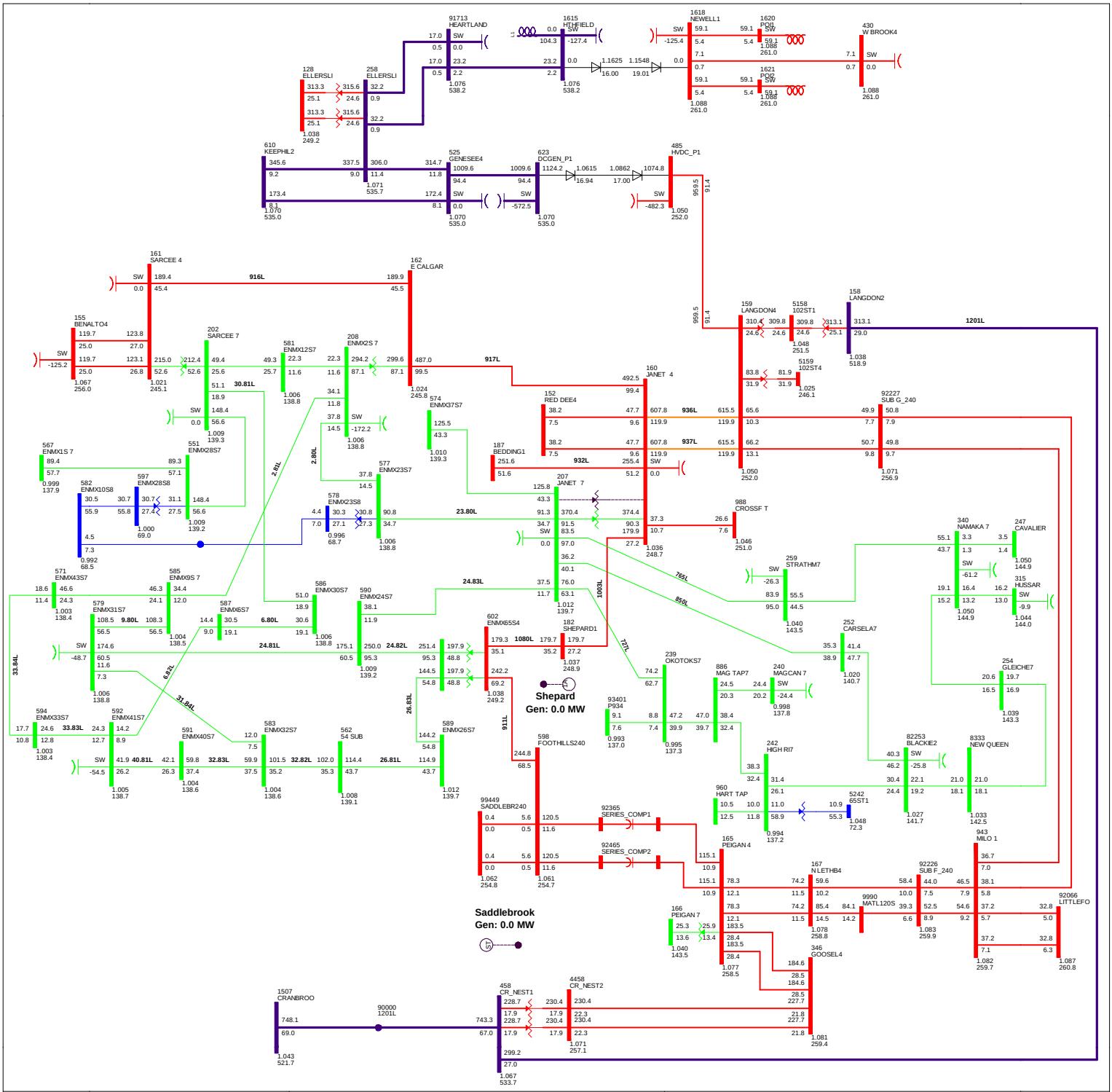
BCH Import: 784.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:12



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

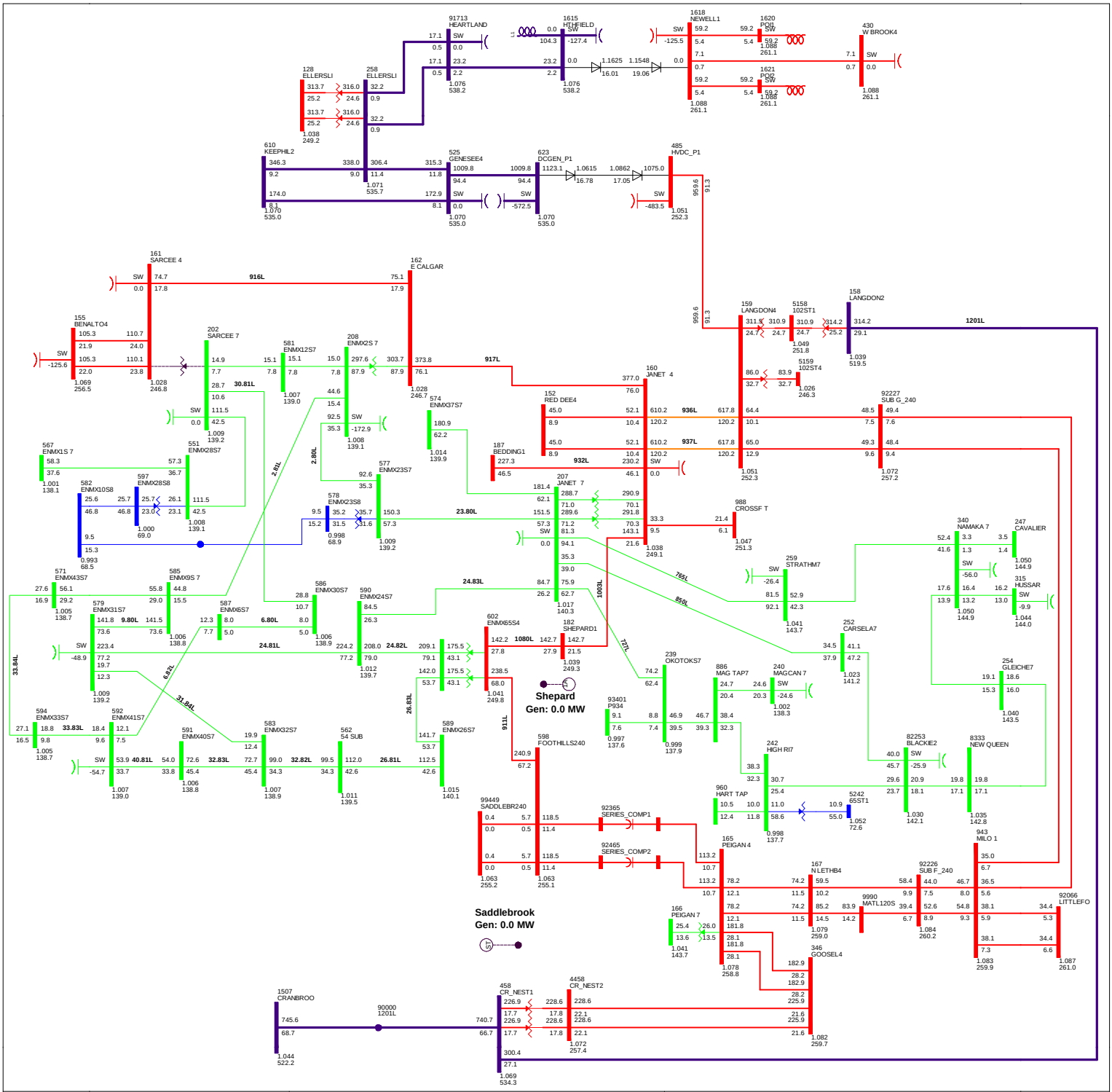
BCH Import: 788.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

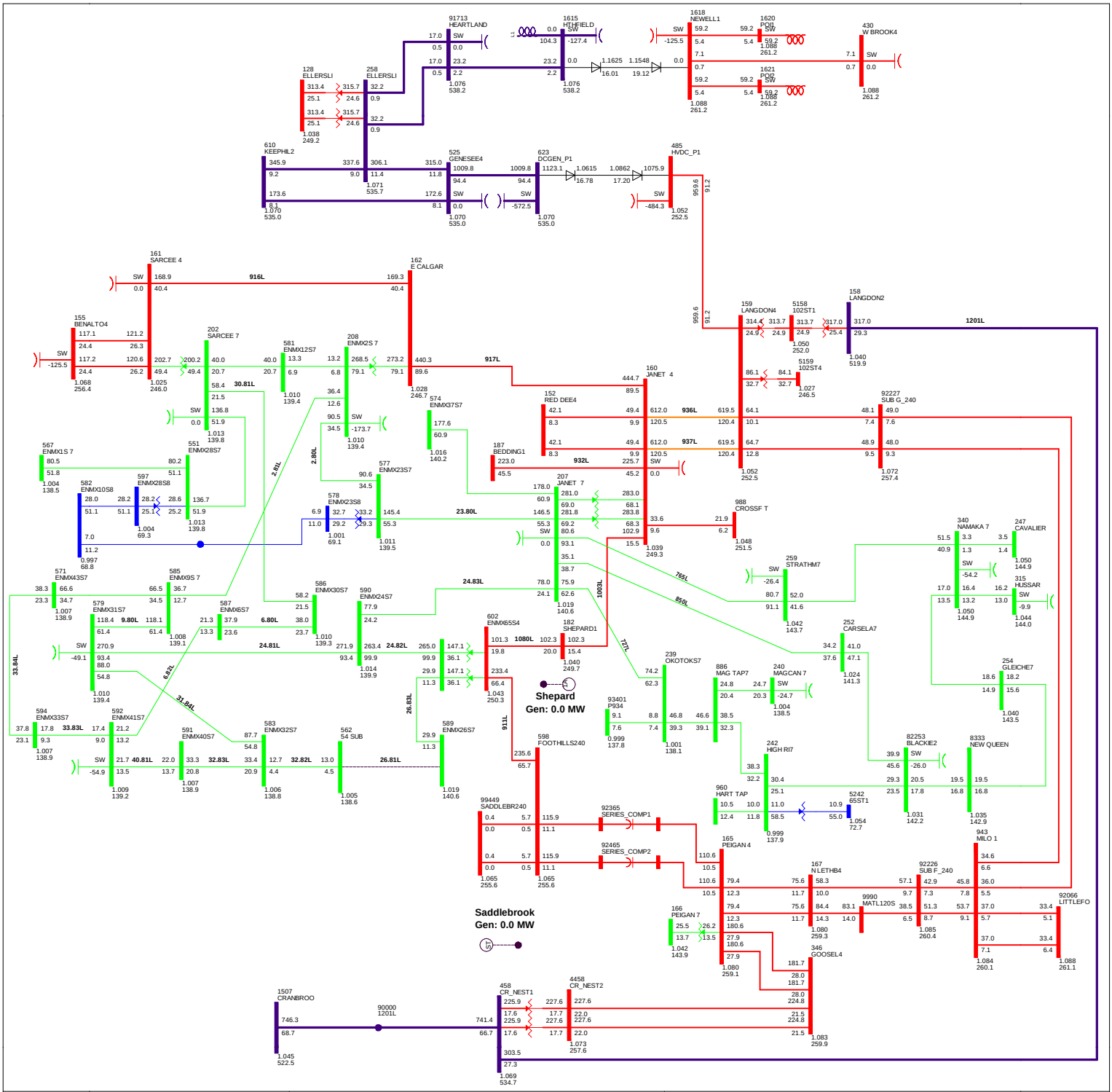
BCH Import: 785.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

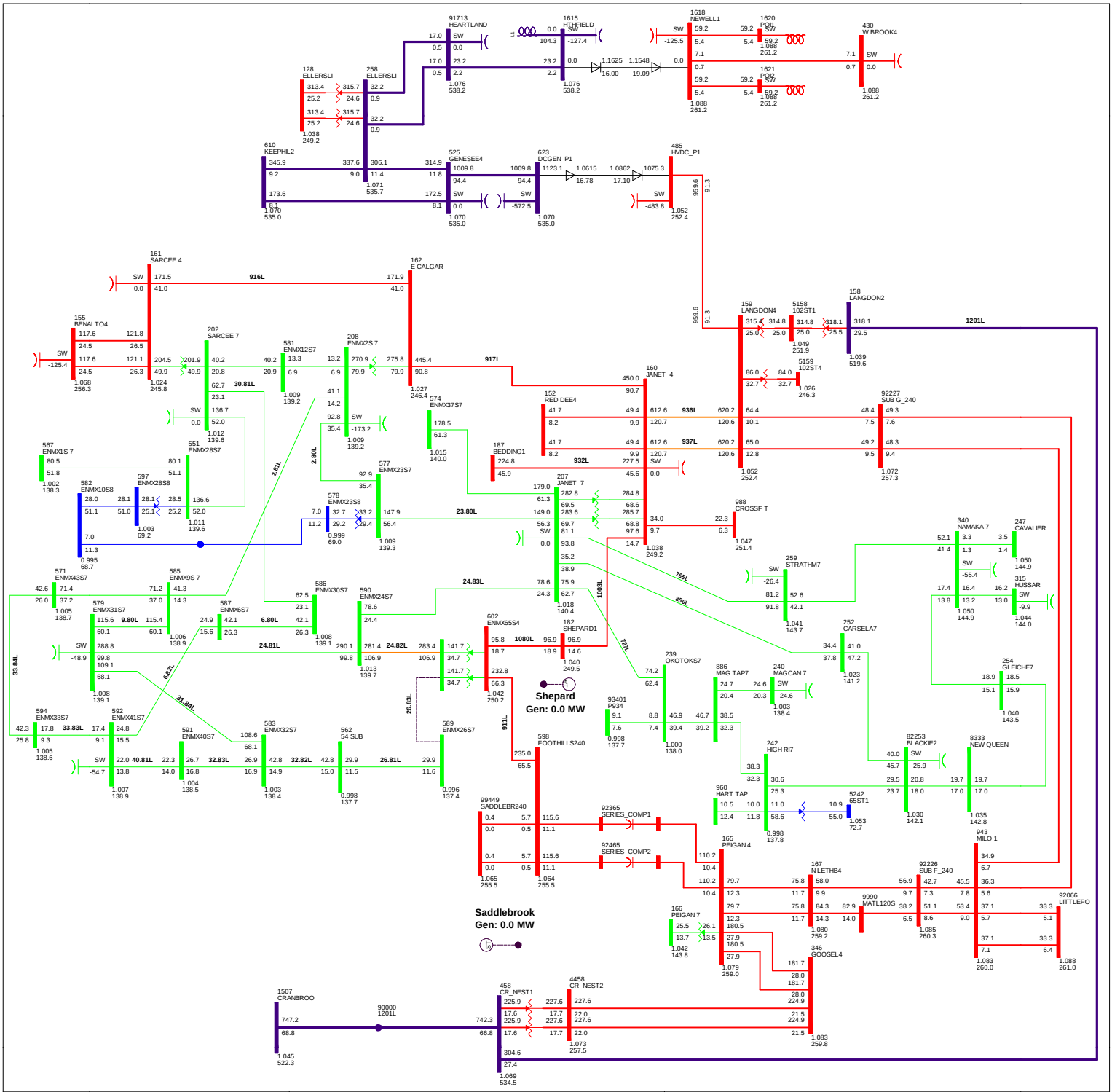
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 785.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

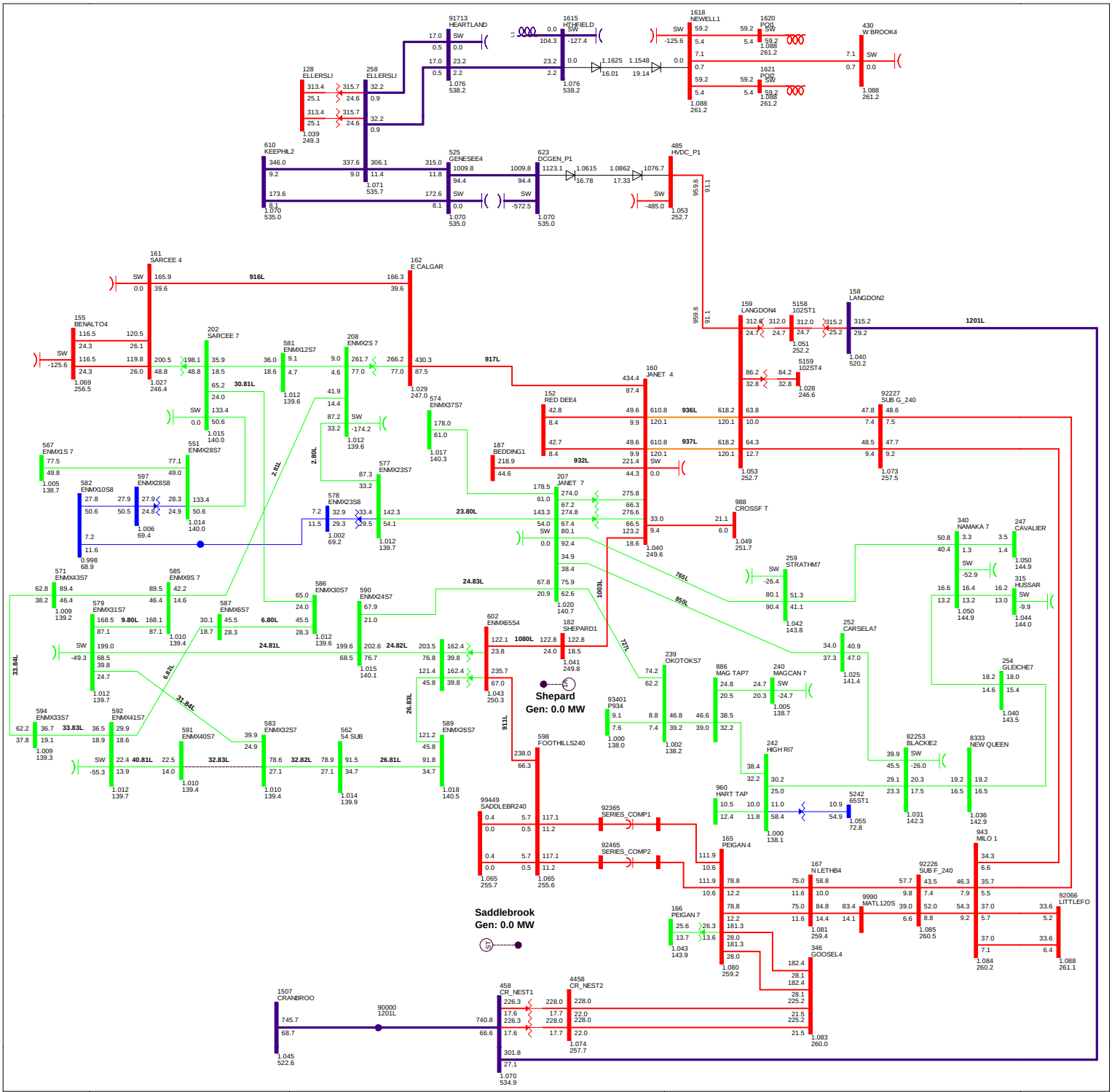
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 786.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

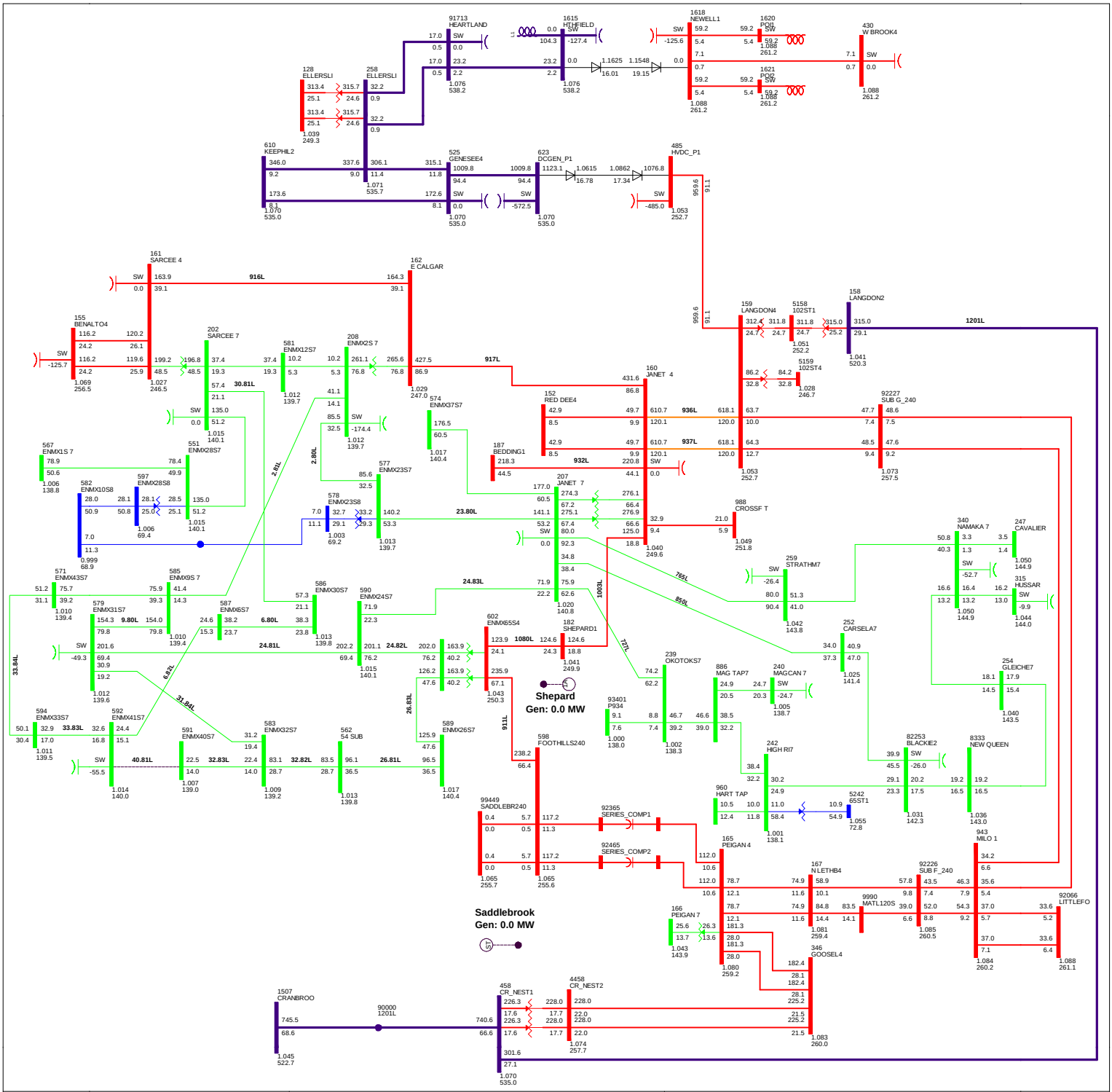
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 784.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

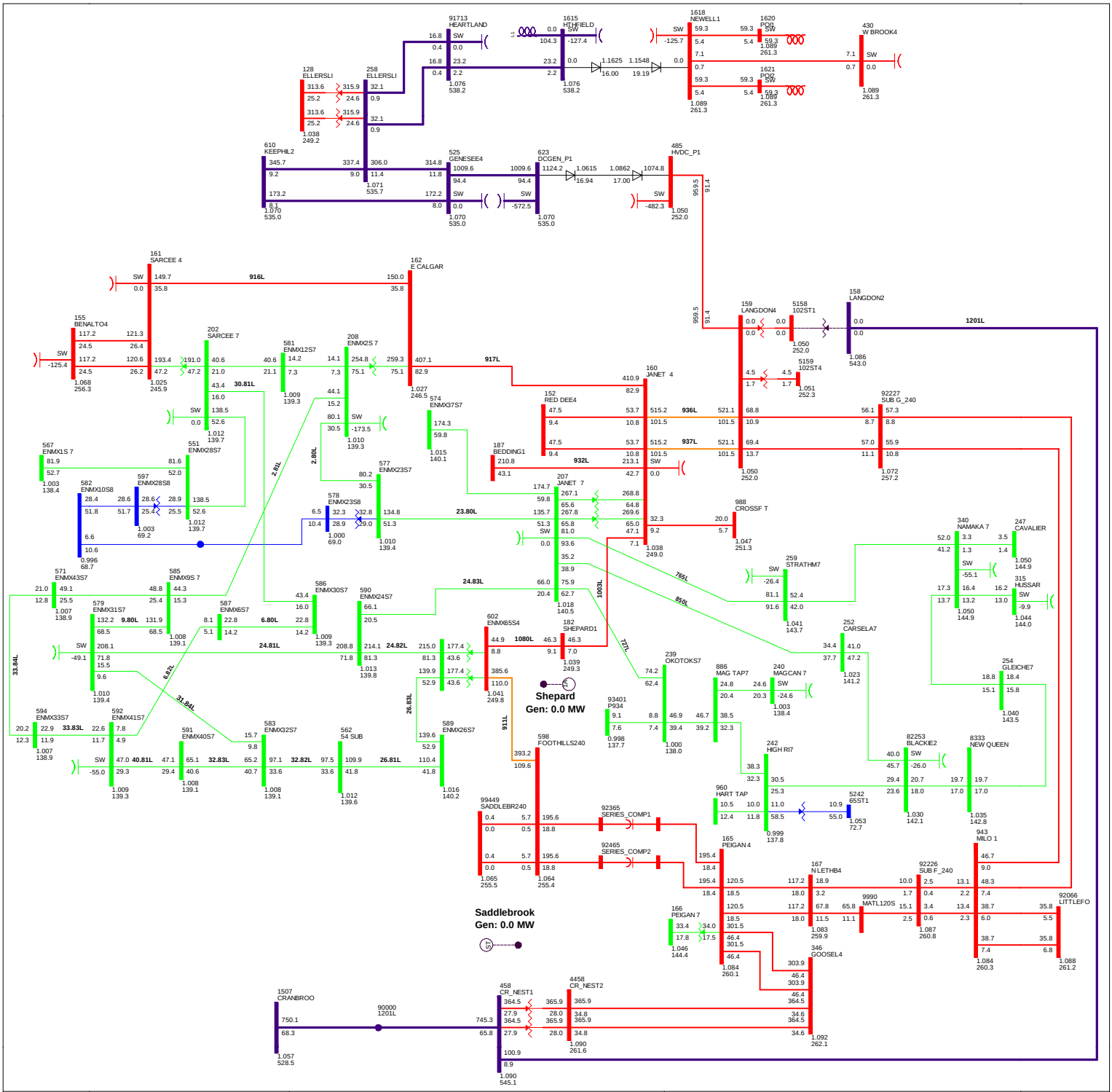
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 784.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

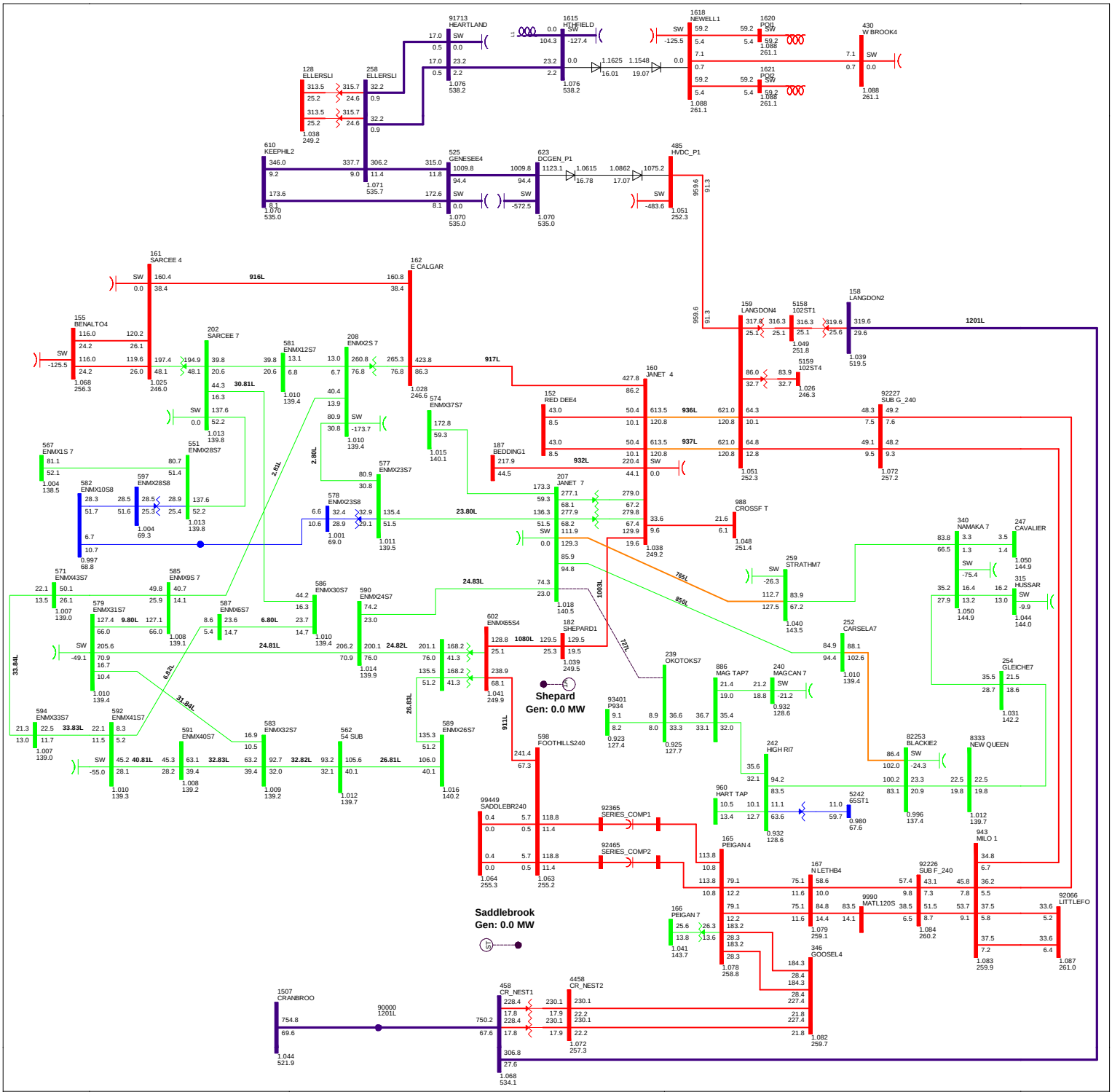
BCH Import: 795.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

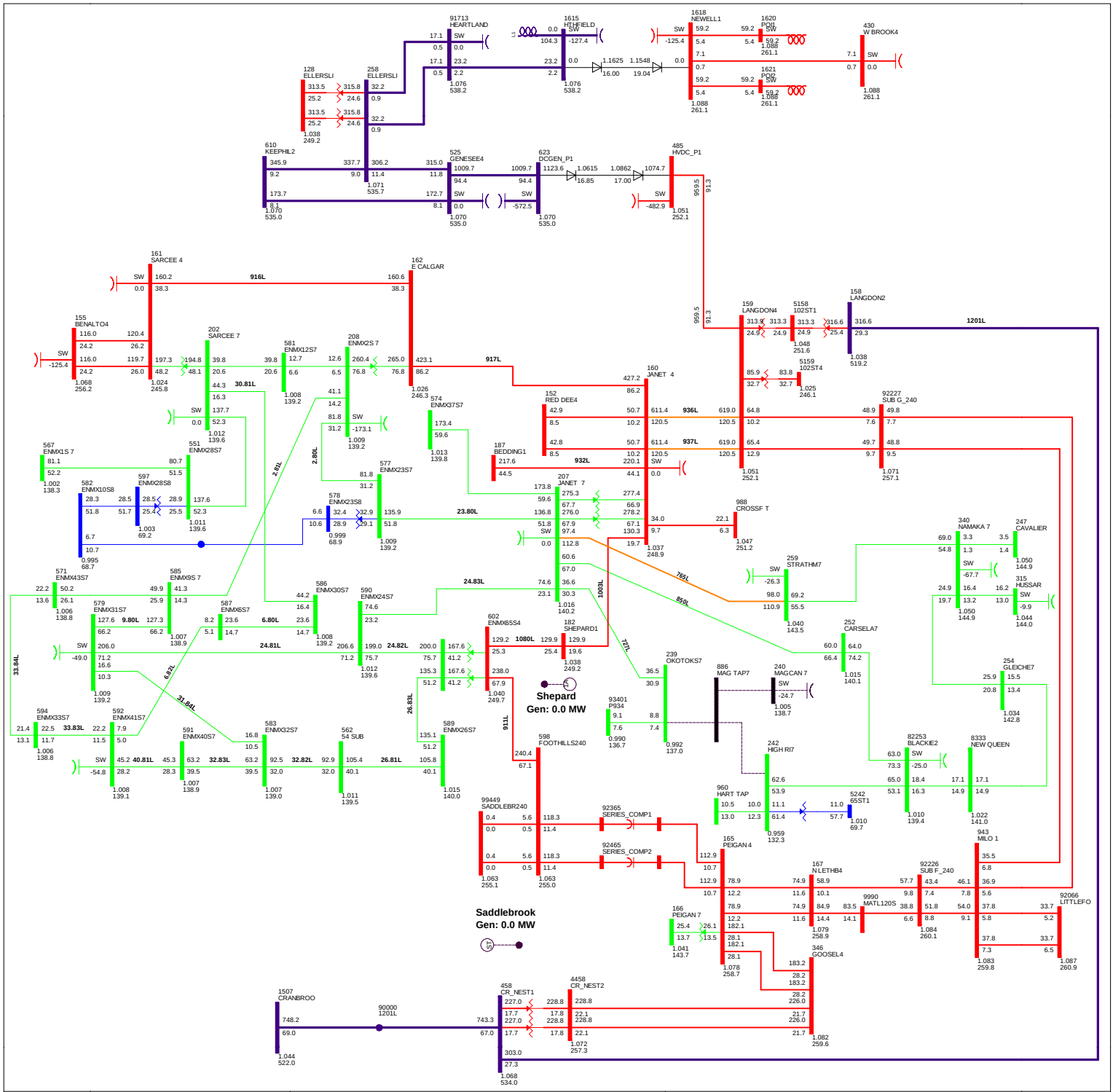
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 794.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 6
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

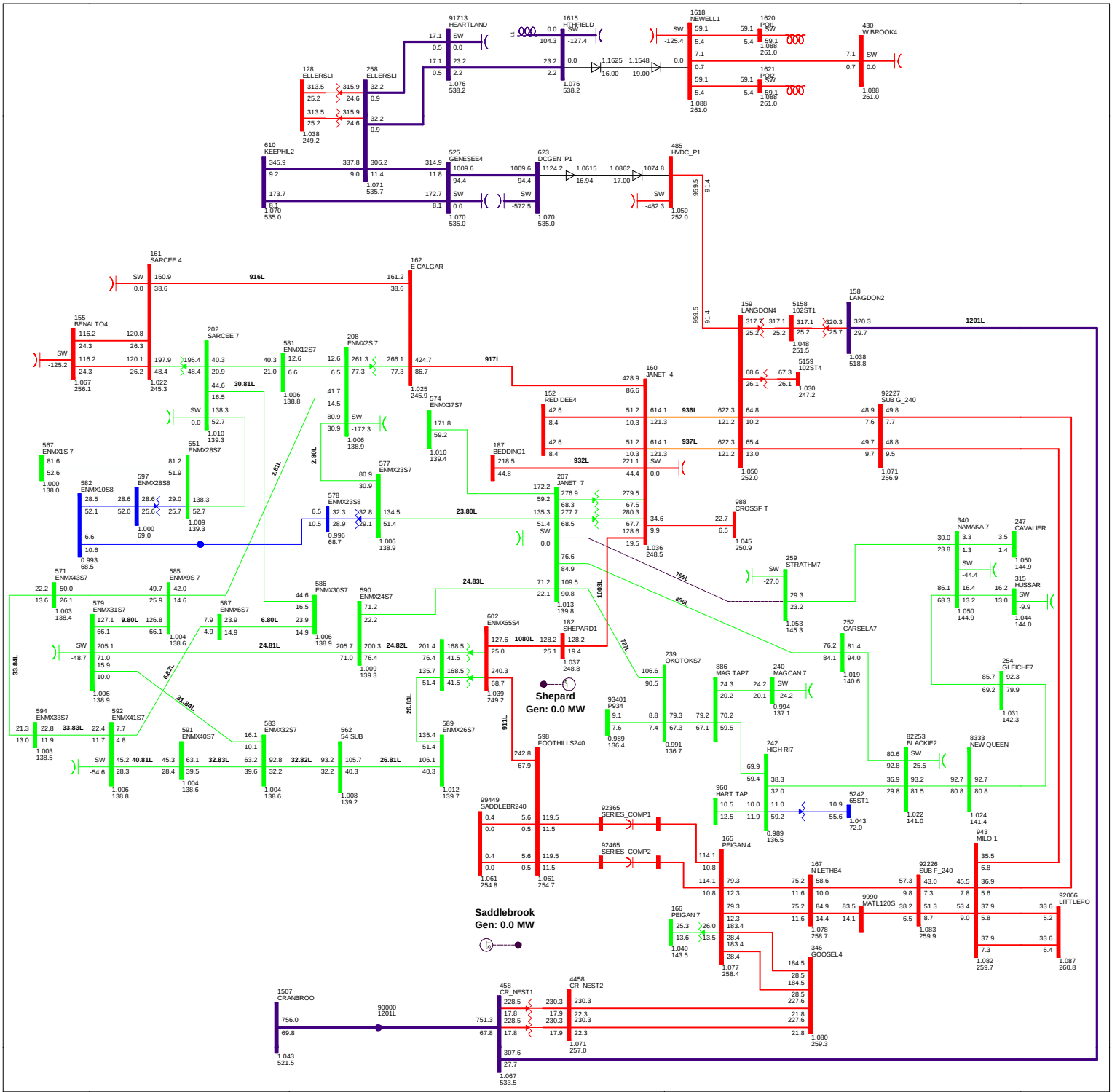
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 787.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

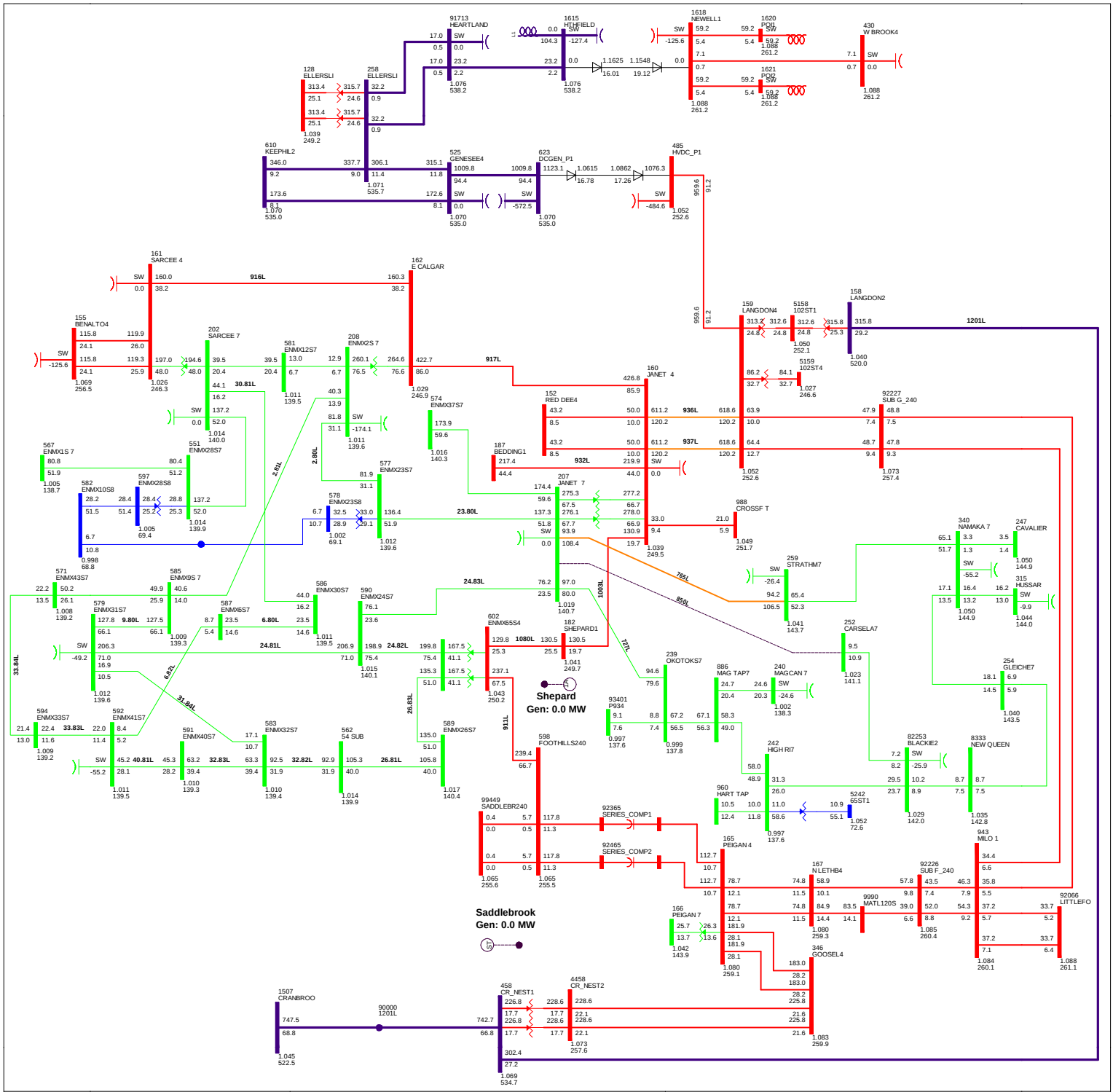
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 796.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-22: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMOR 2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

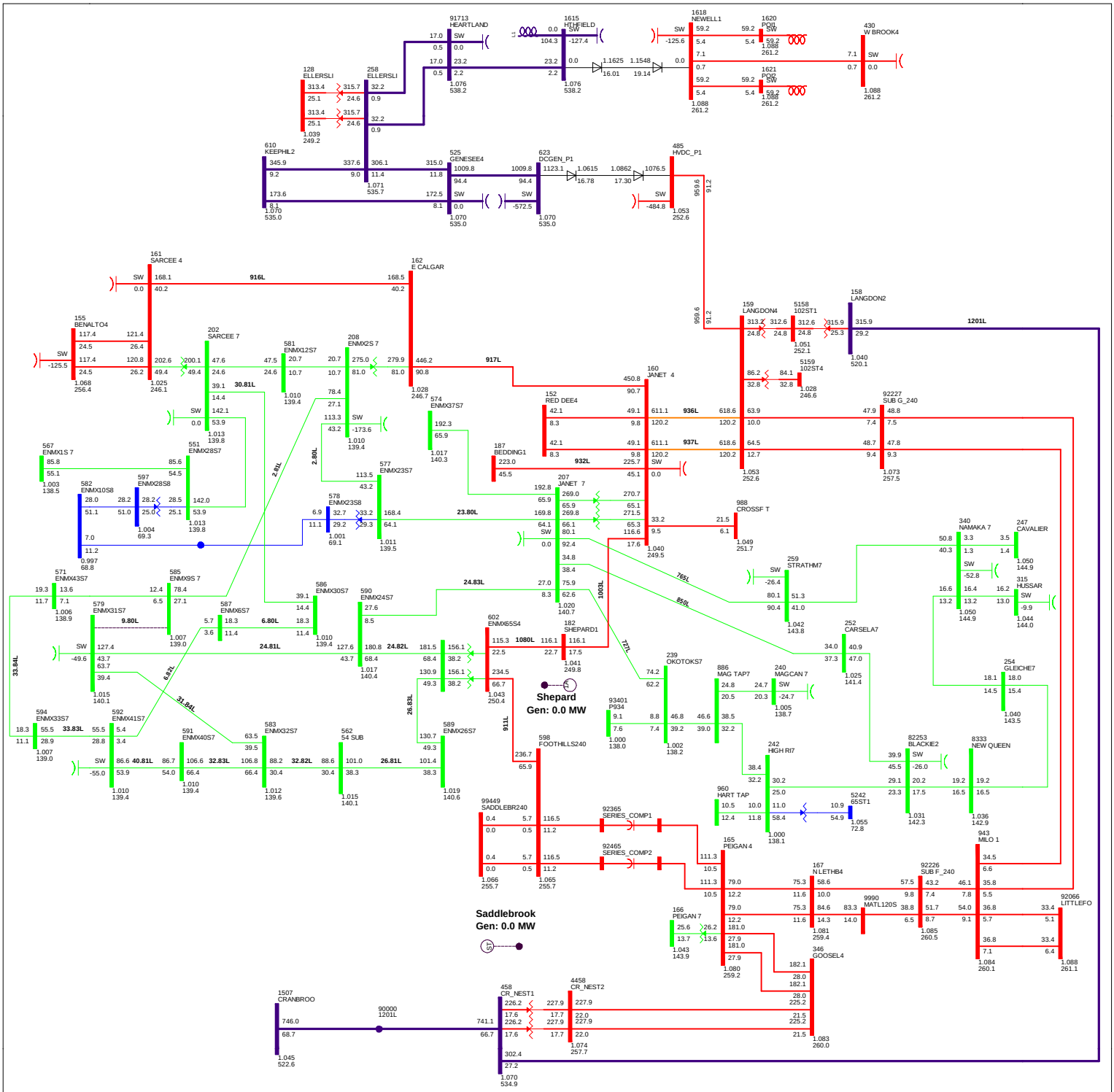
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 786.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-23: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

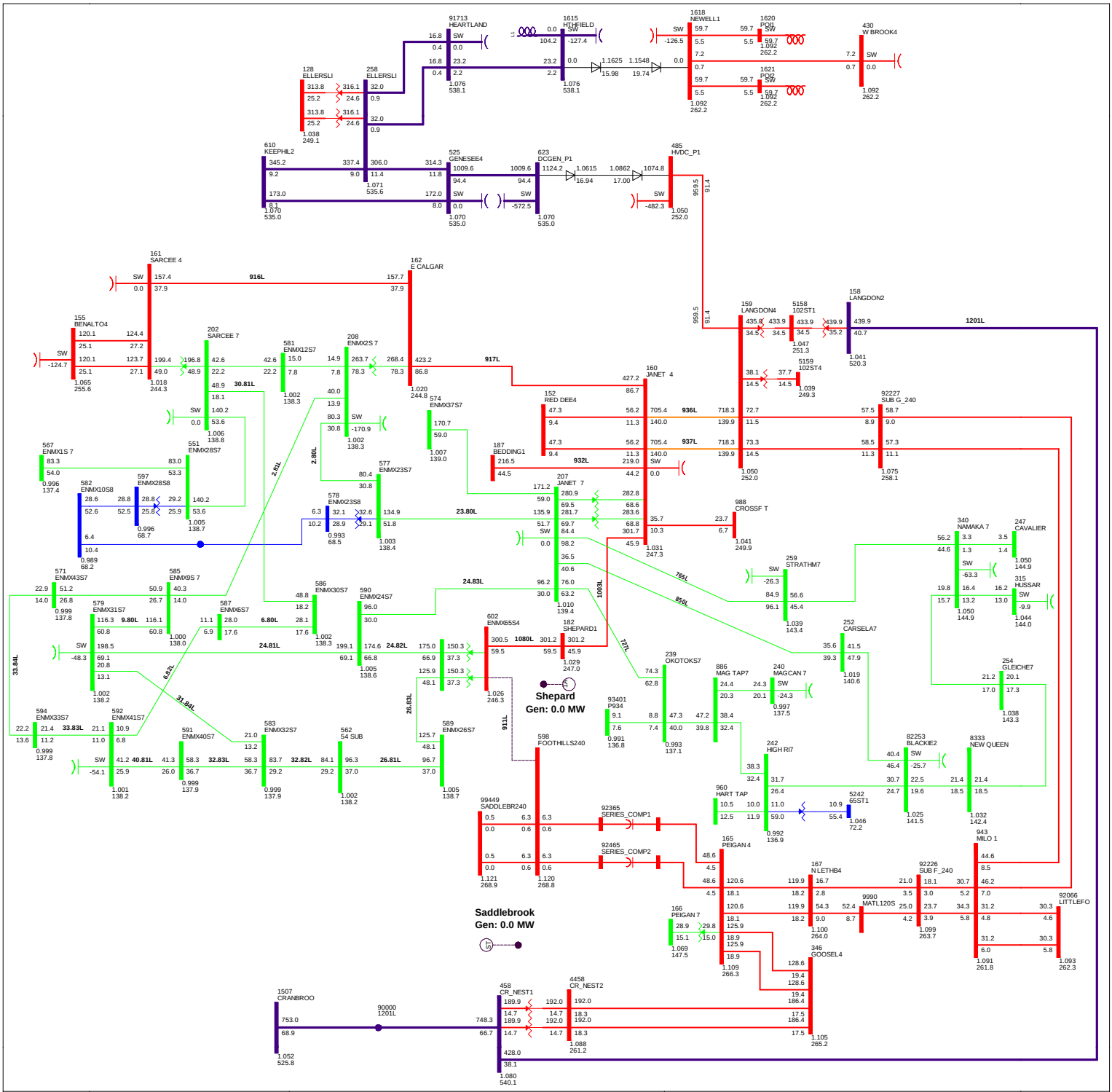
BCH Import: 784.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-24: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

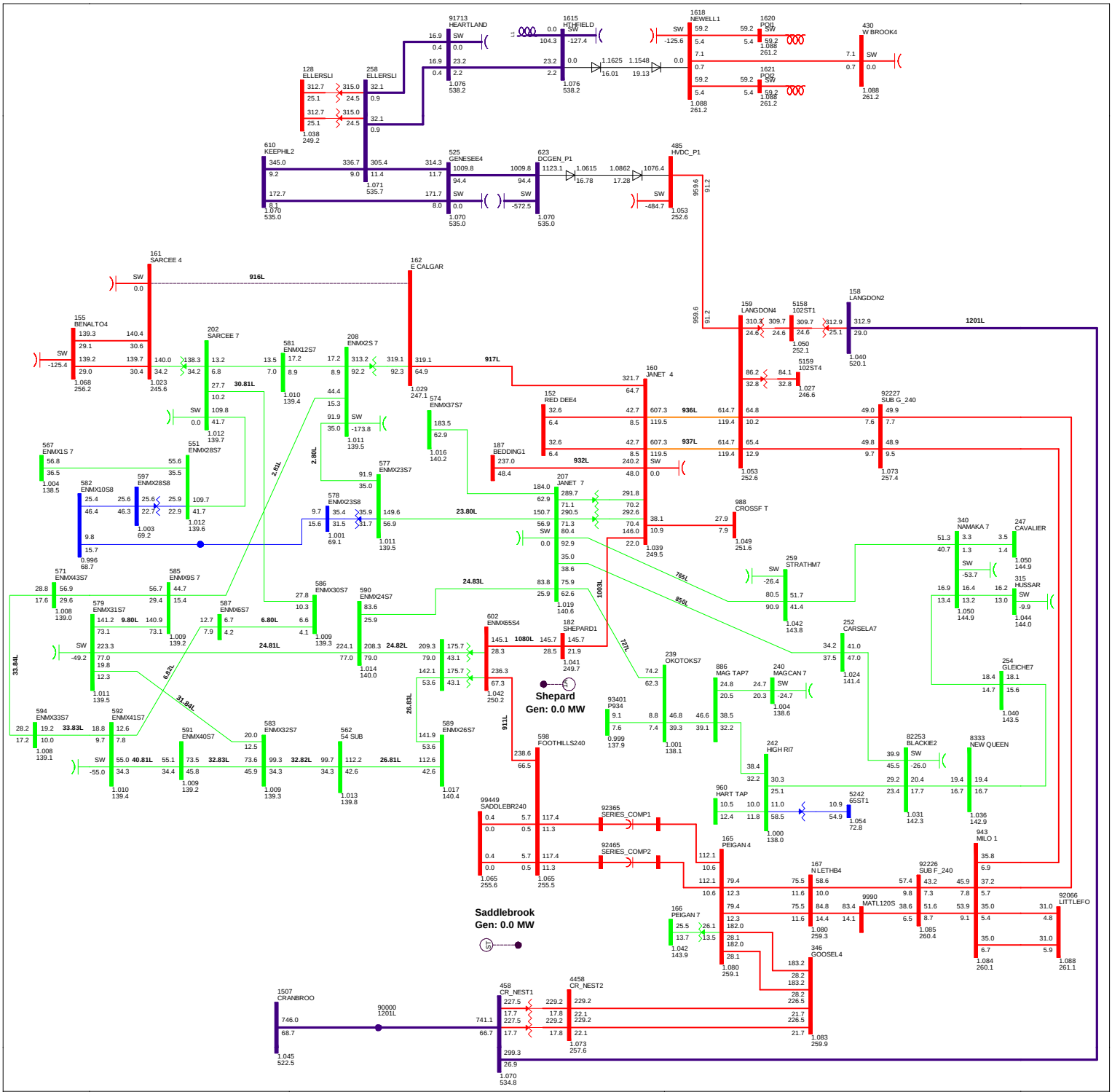
BCH Import: 788.7 MW

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-25: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMA
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

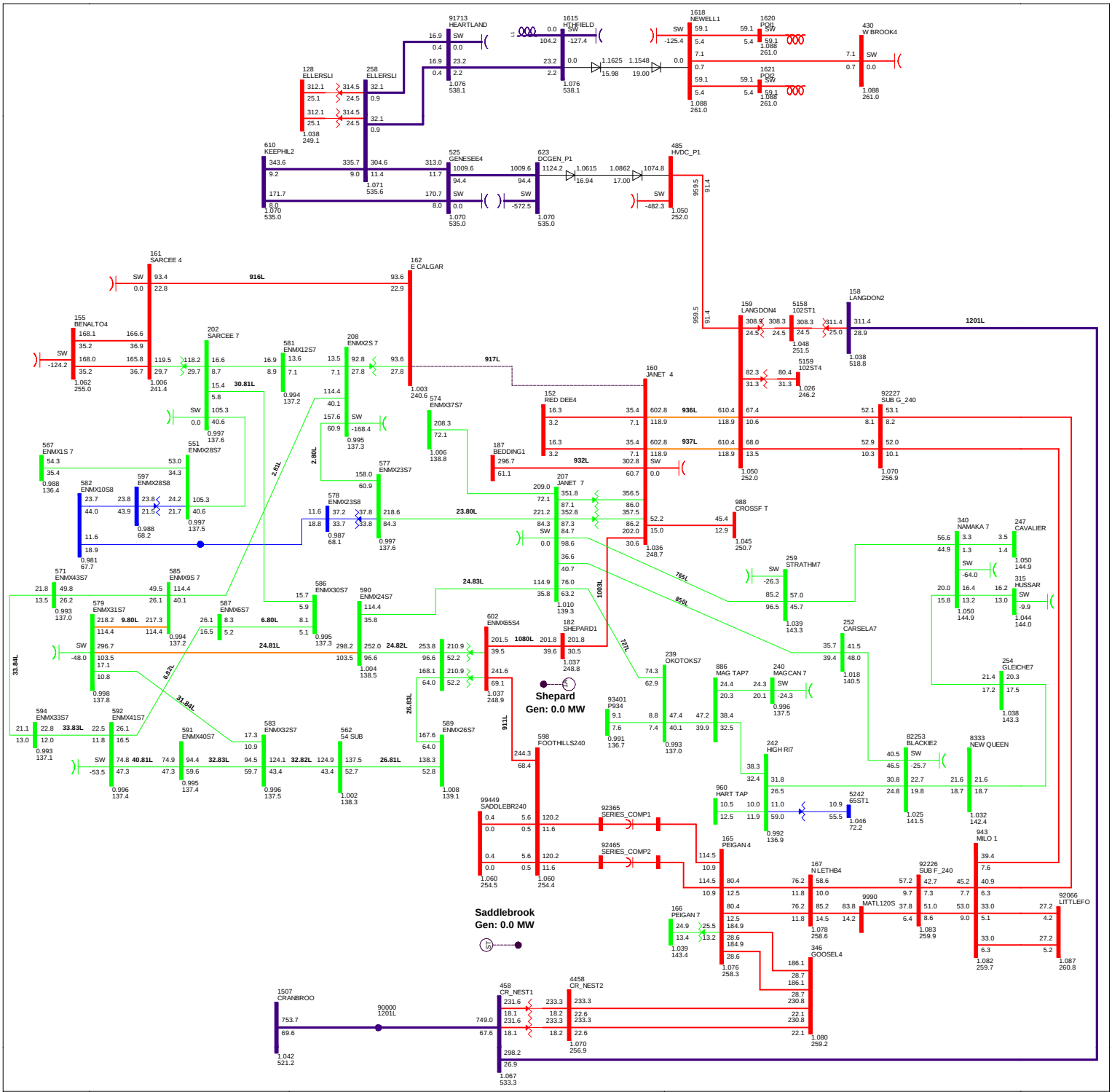
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 785.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-26: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CAL
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

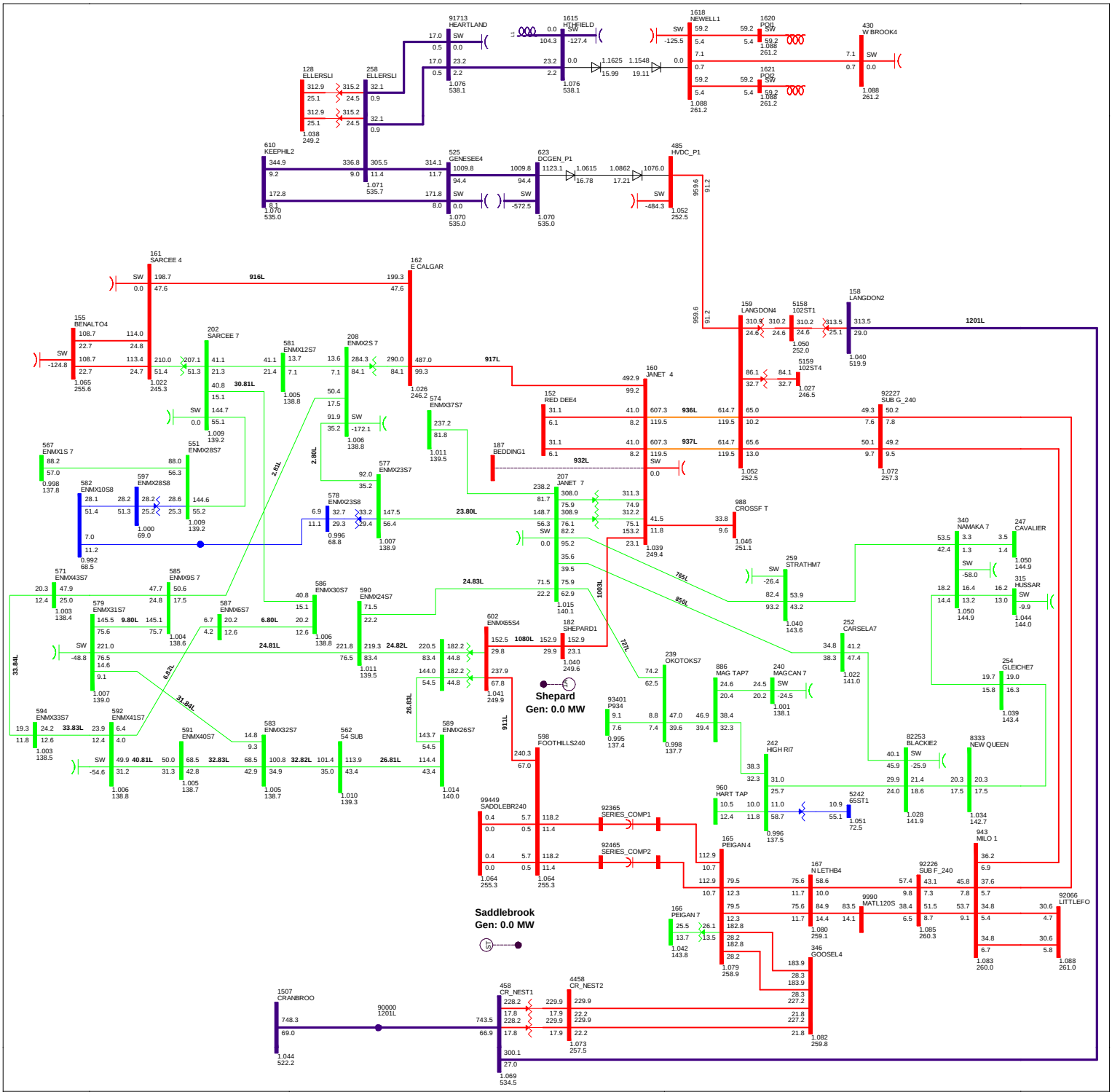
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 797.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-27: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALG
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

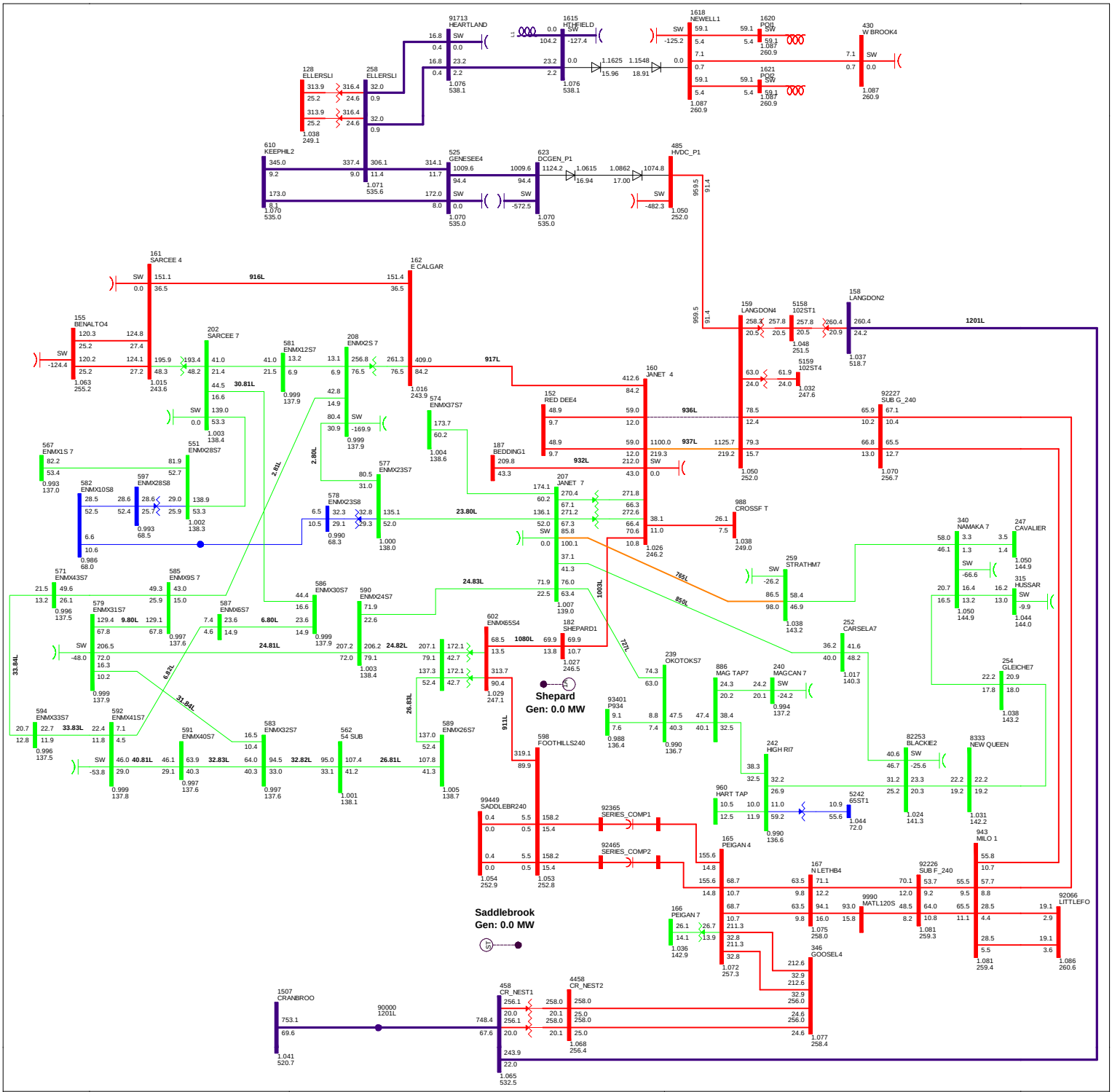
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 788.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-28: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTO
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

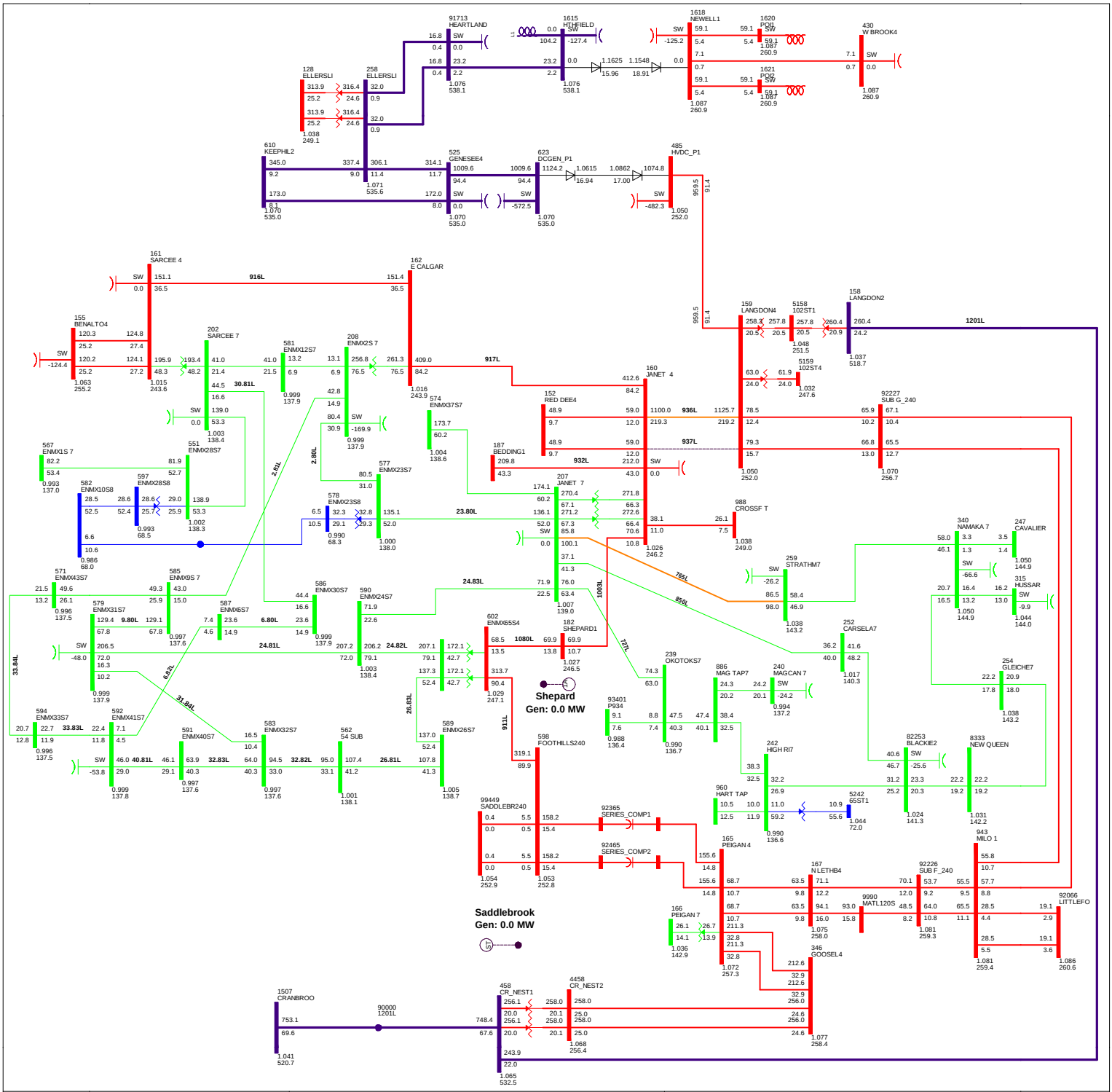
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 798.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-29: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

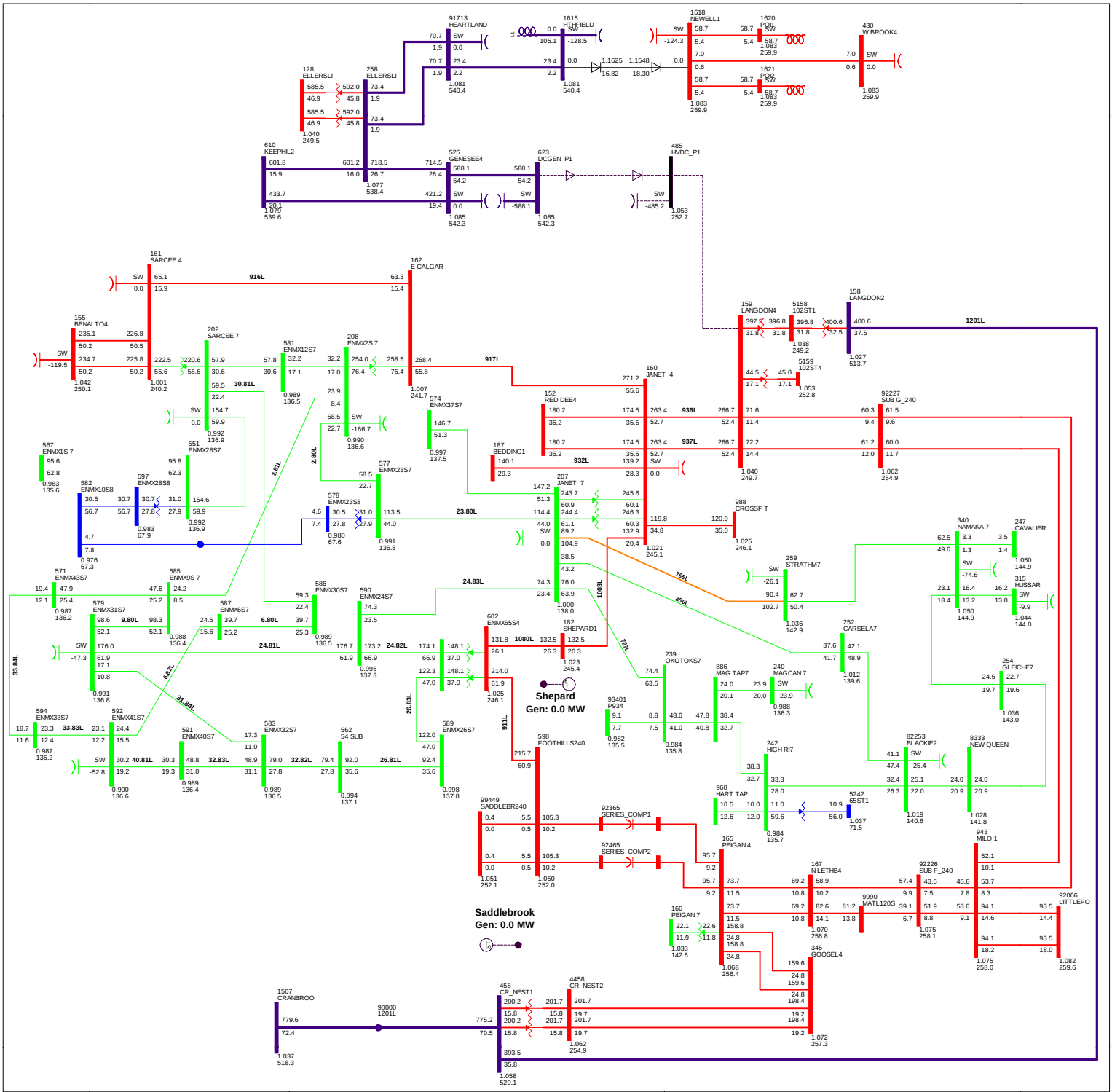
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 798.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-30: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET
2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 816.8 MW

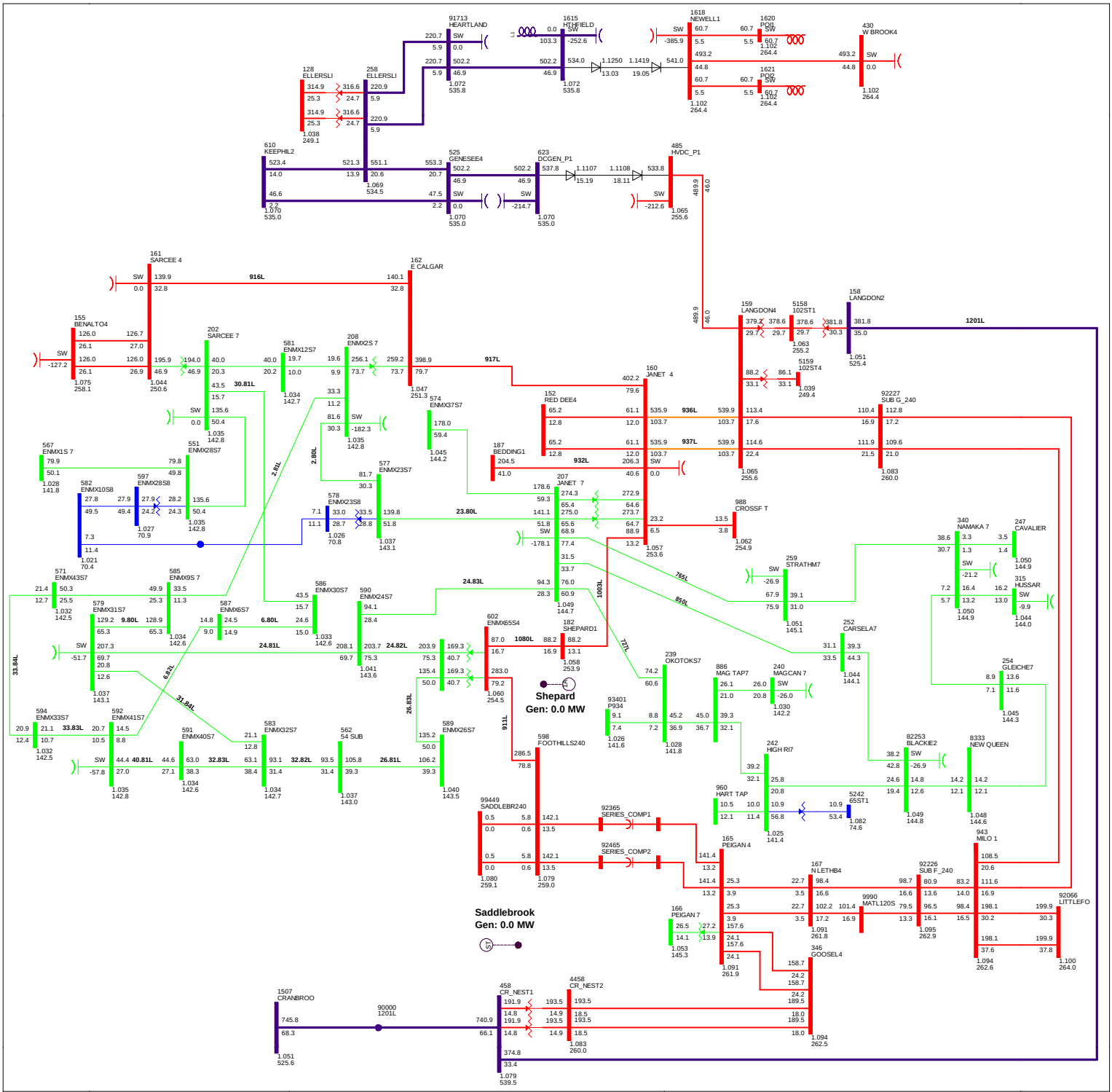
2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1A-31: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2014_NEED_HVDC_SC1A

FRI, JUN 08 2012 16:13

2014 Loading Violations
Scenario 1B



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

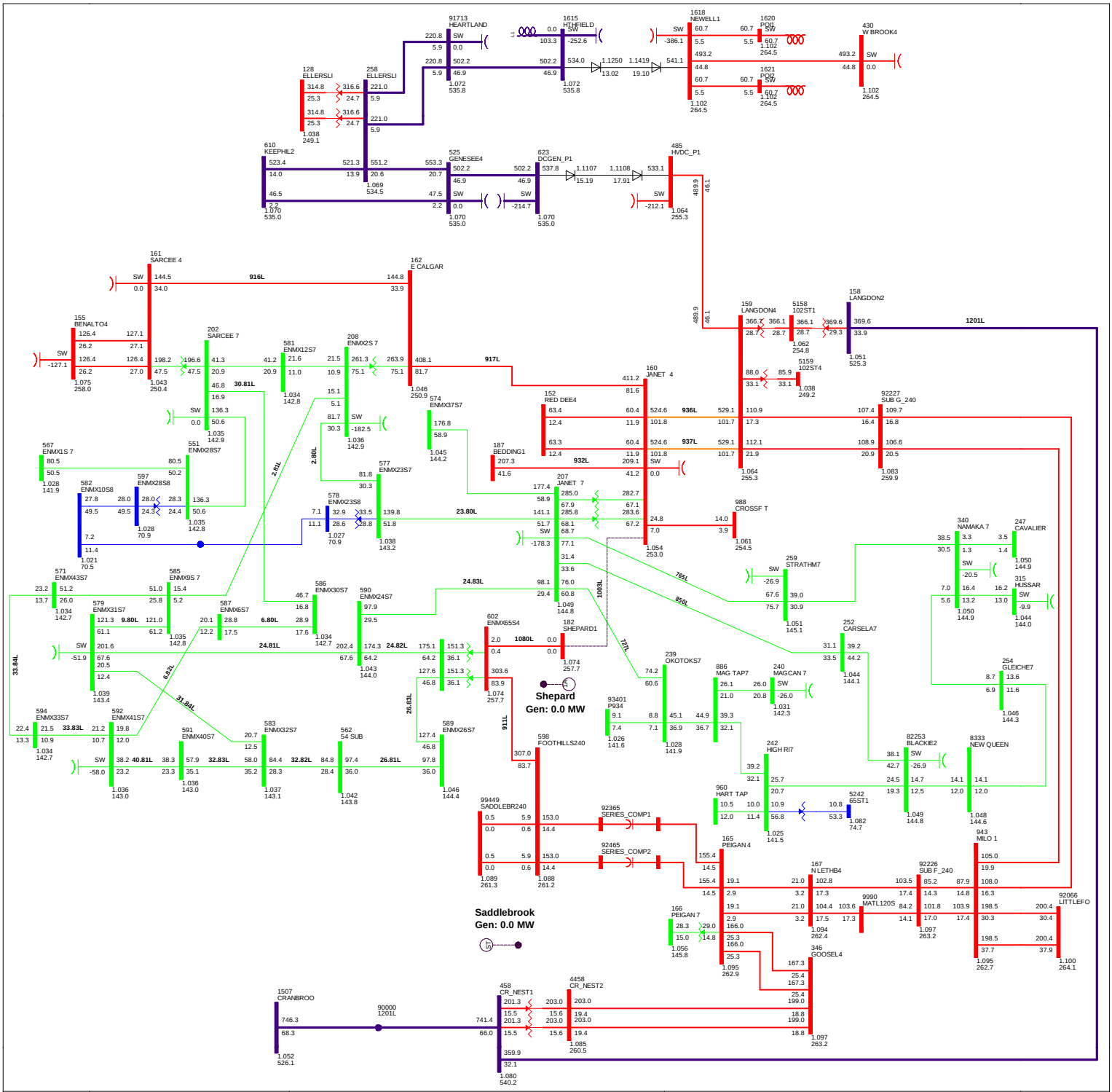
BCH Import: 779.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-1: BASECASE

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

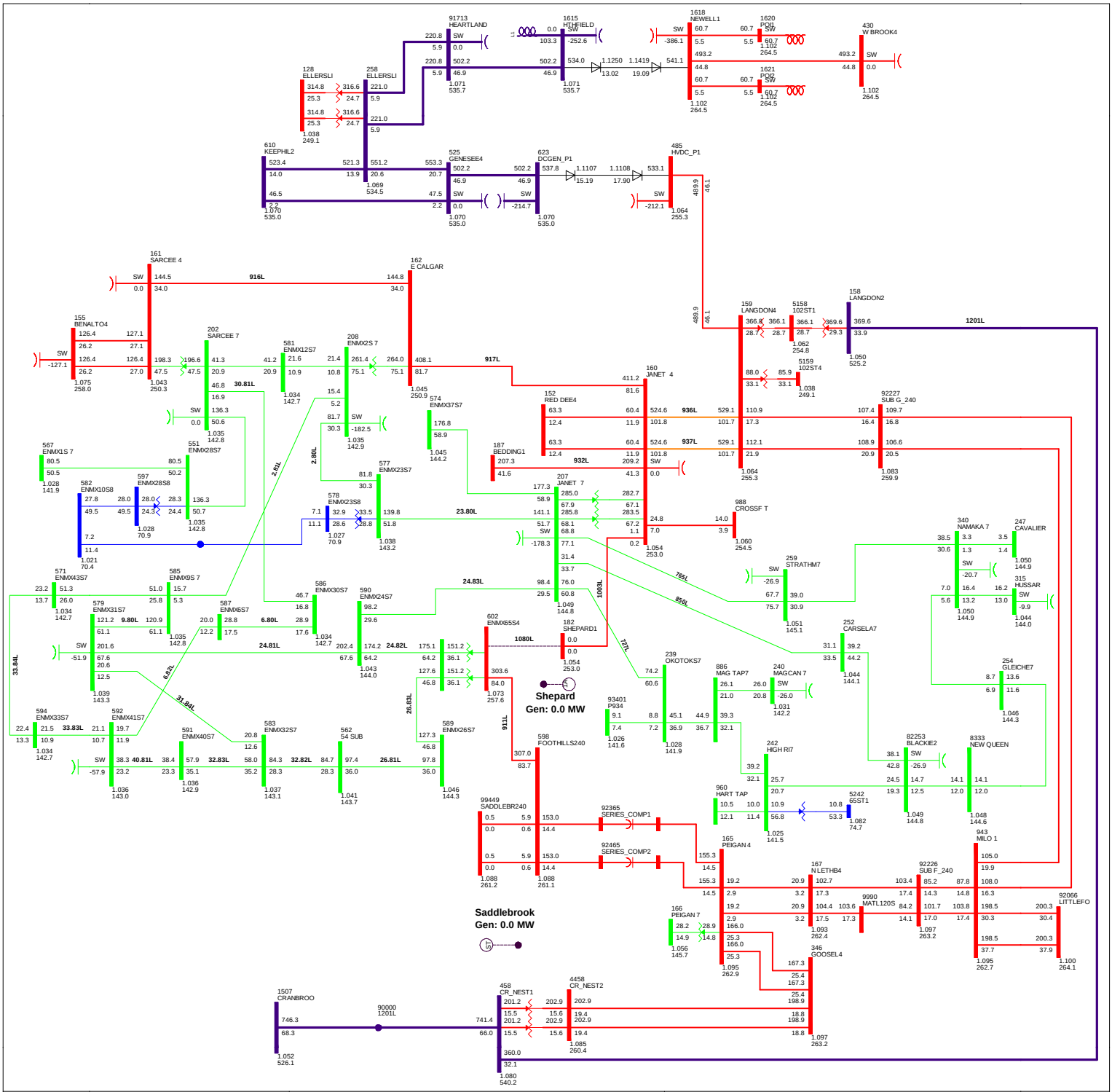
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

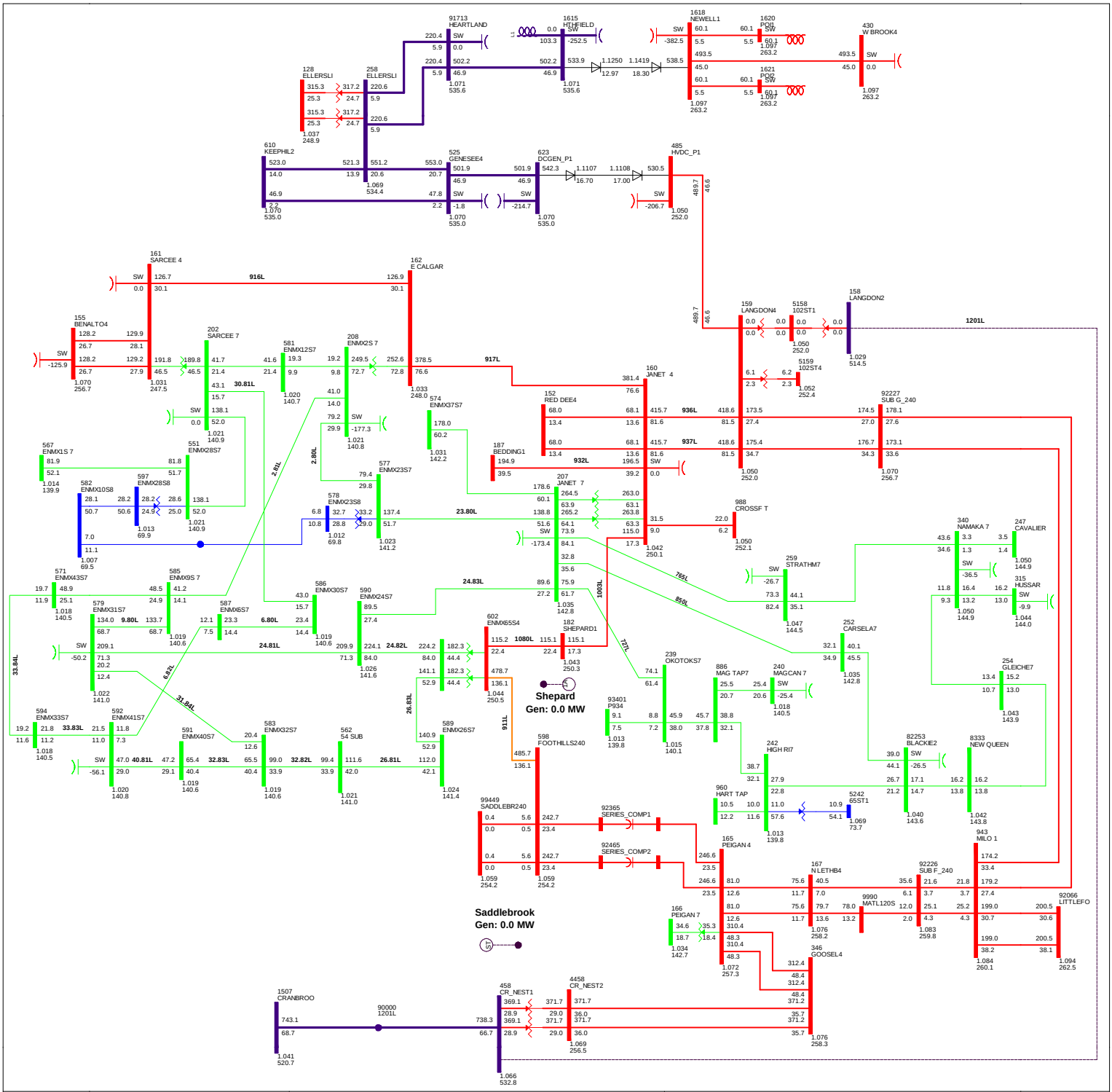
BCH Import: 779.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

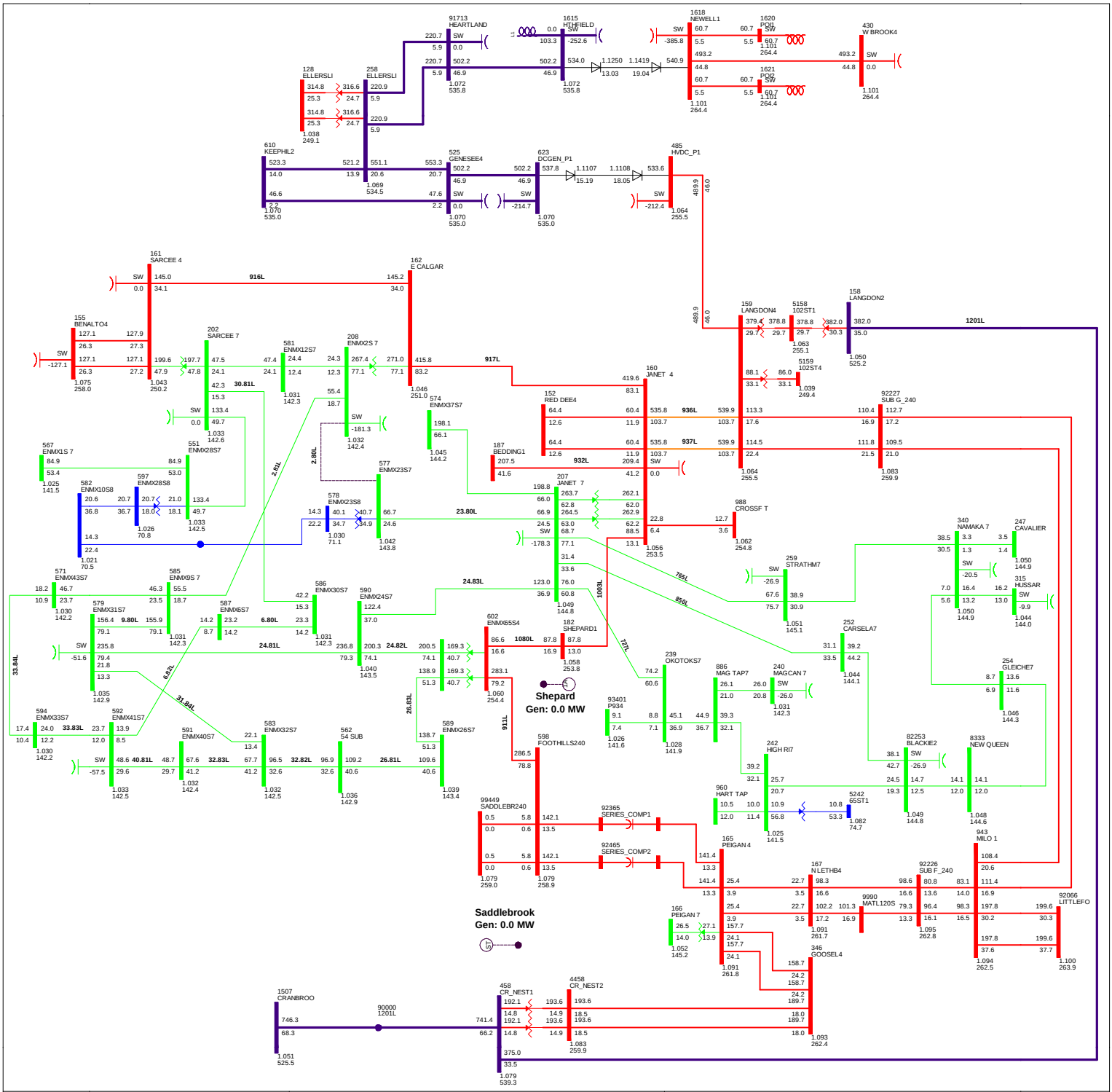
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 800.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSN 2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

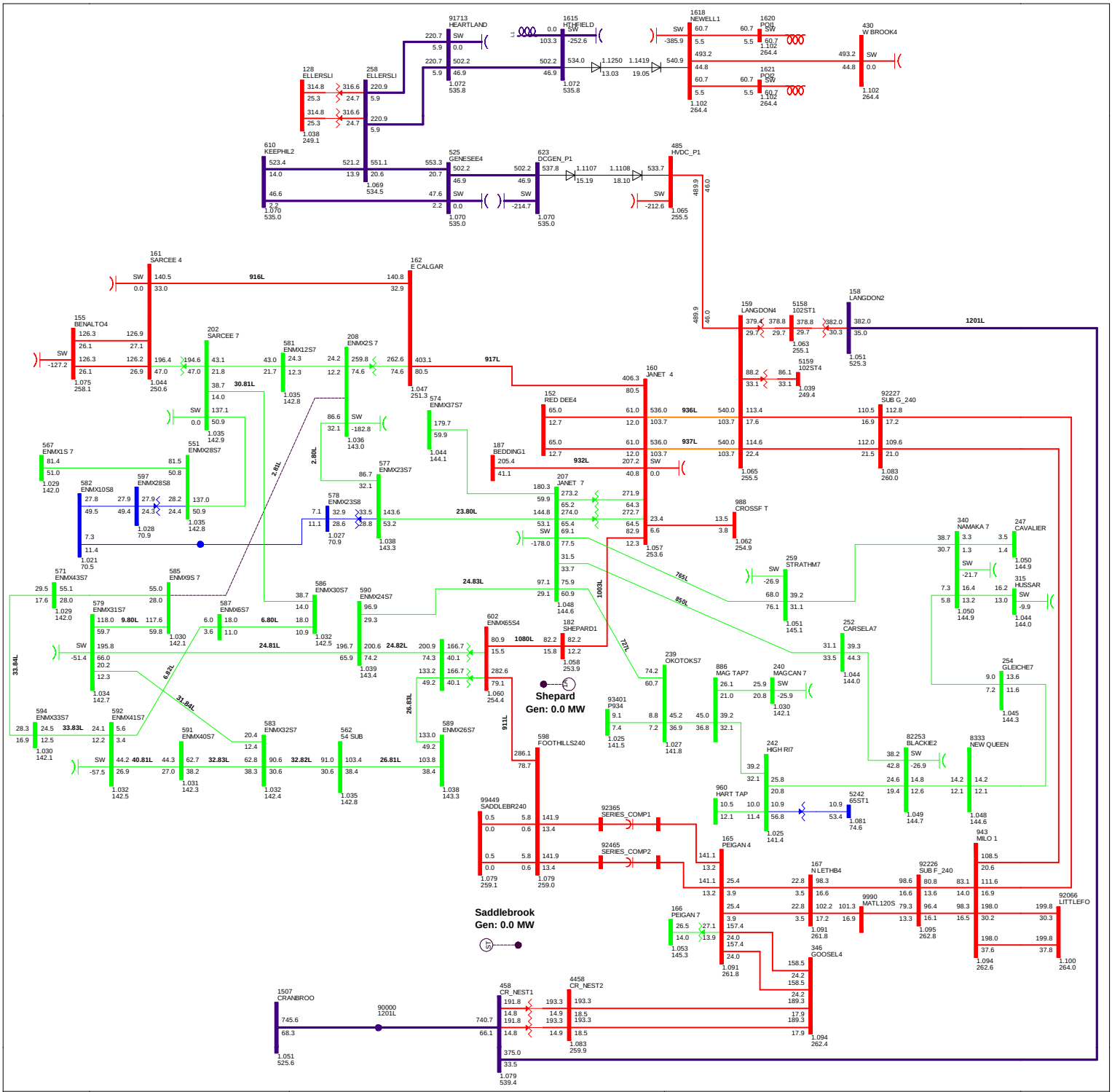
BCH Import: 780.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

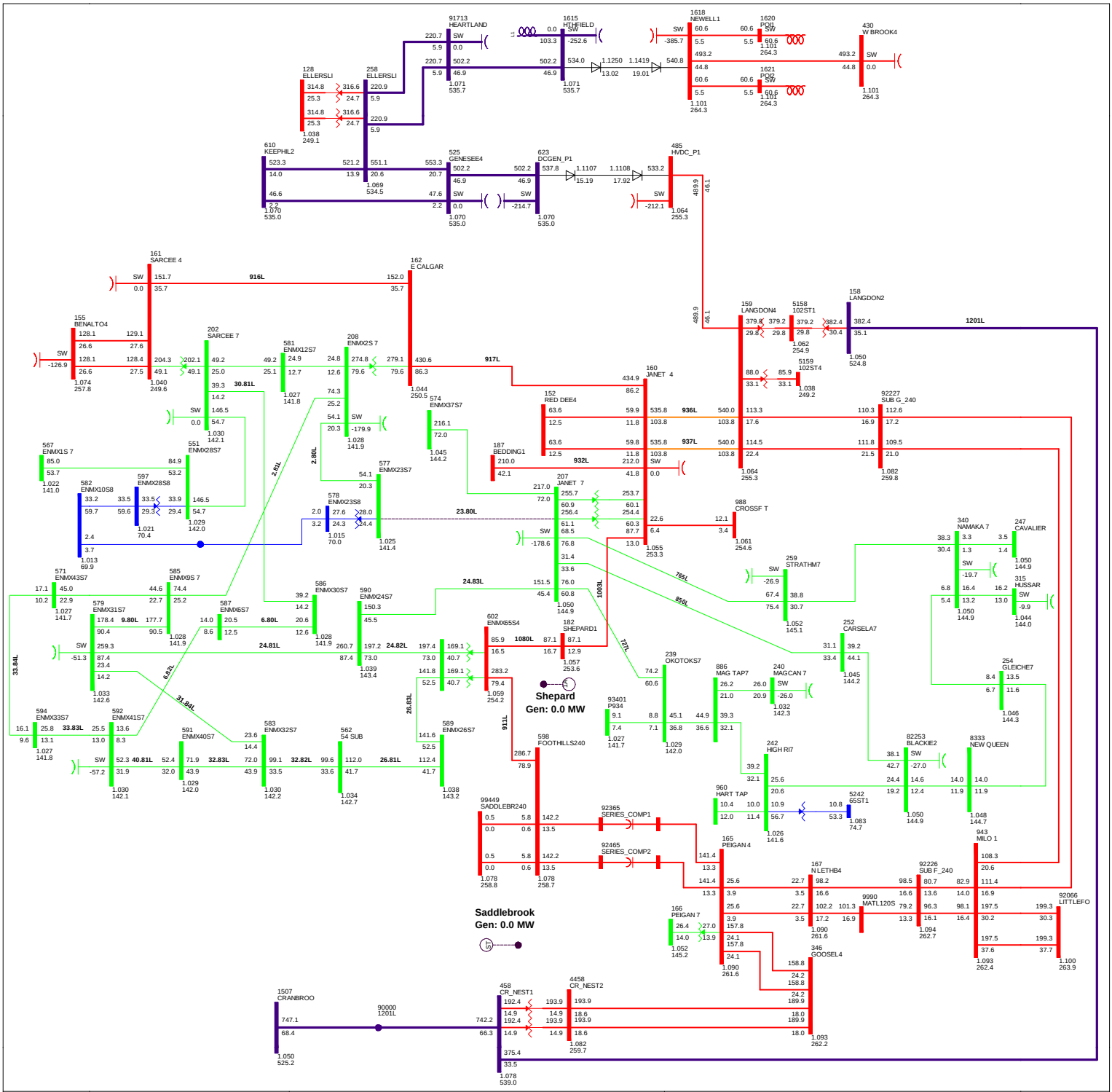
BCH Import: 779.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

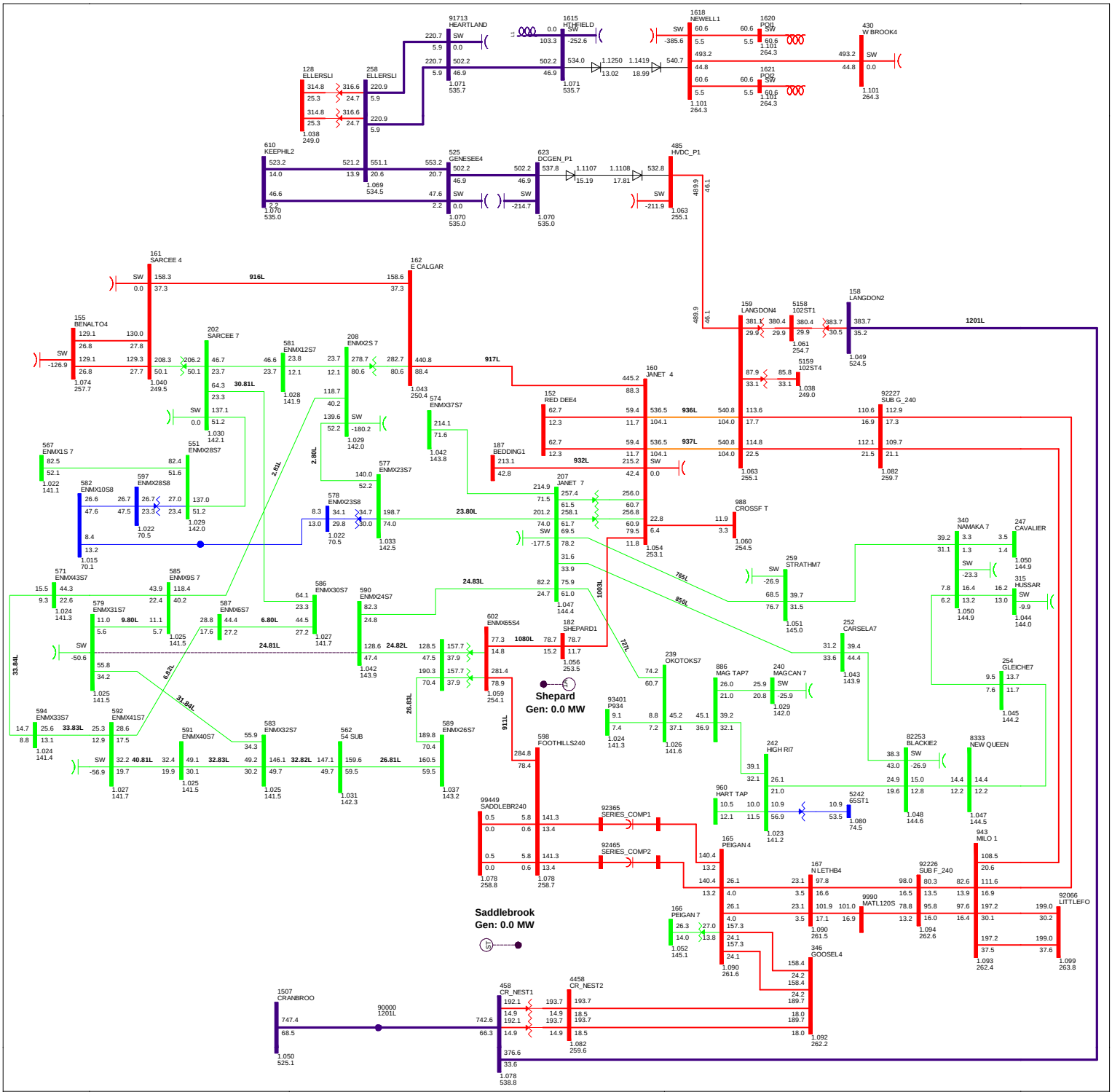
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

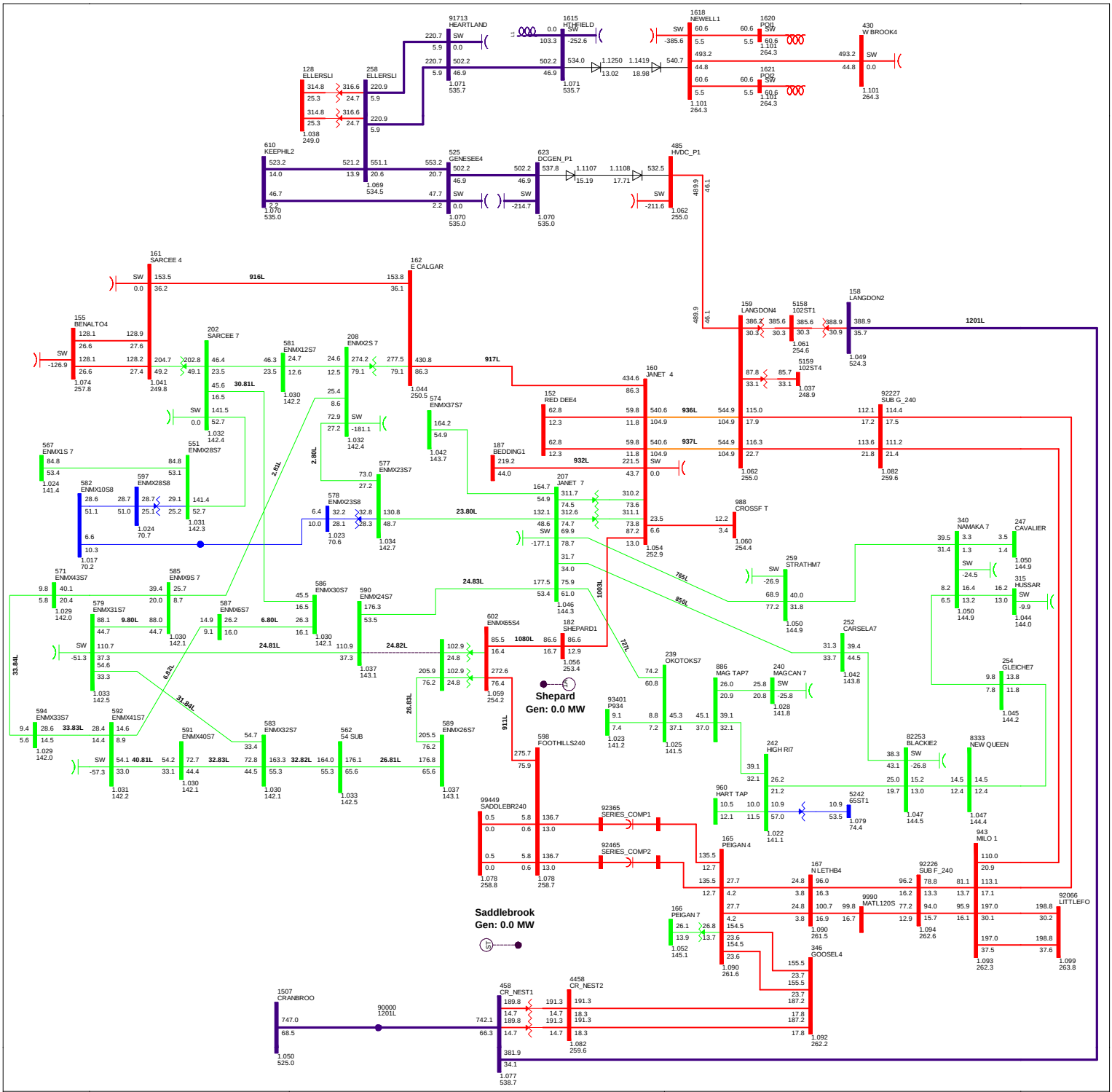
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

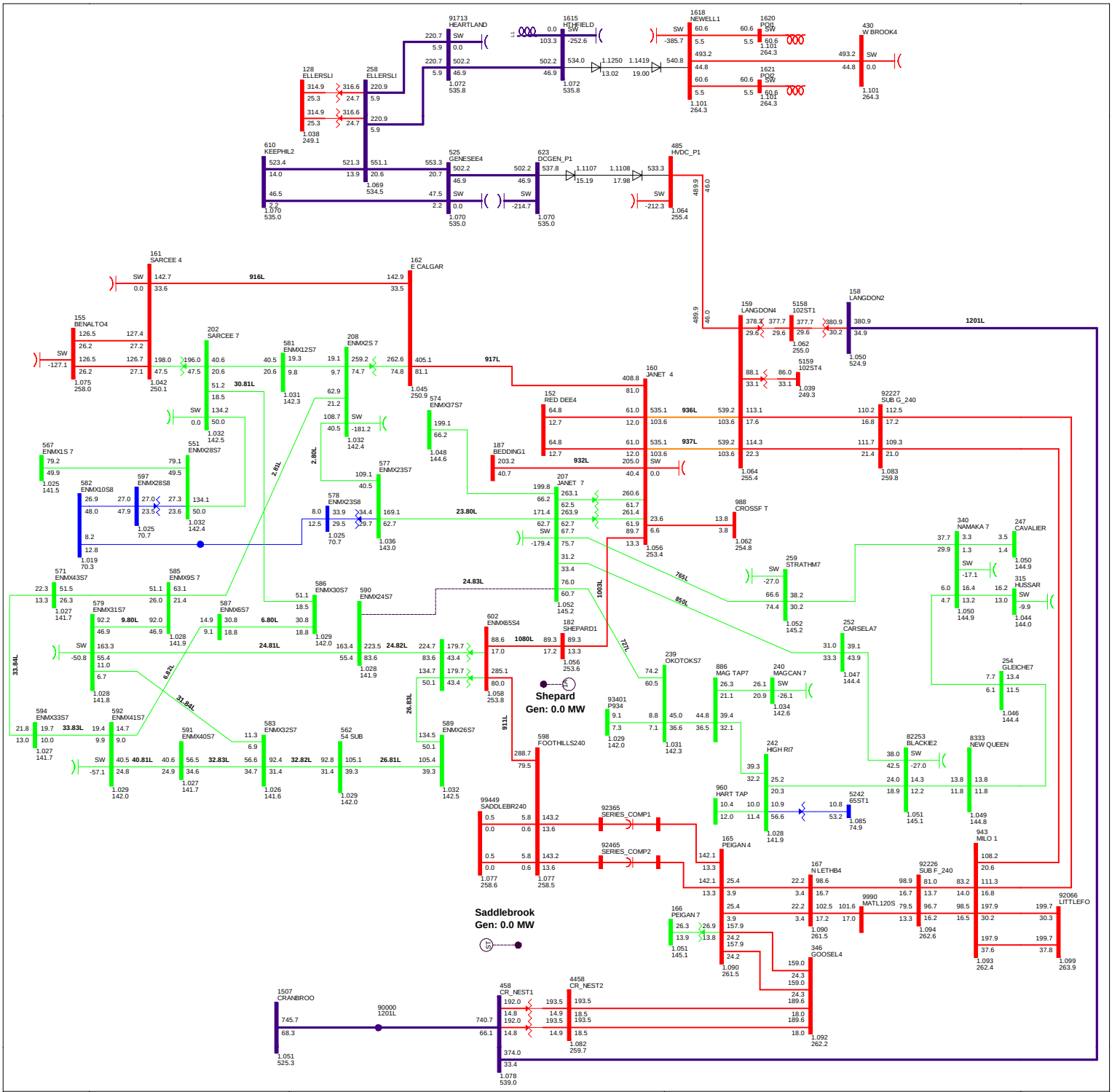
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

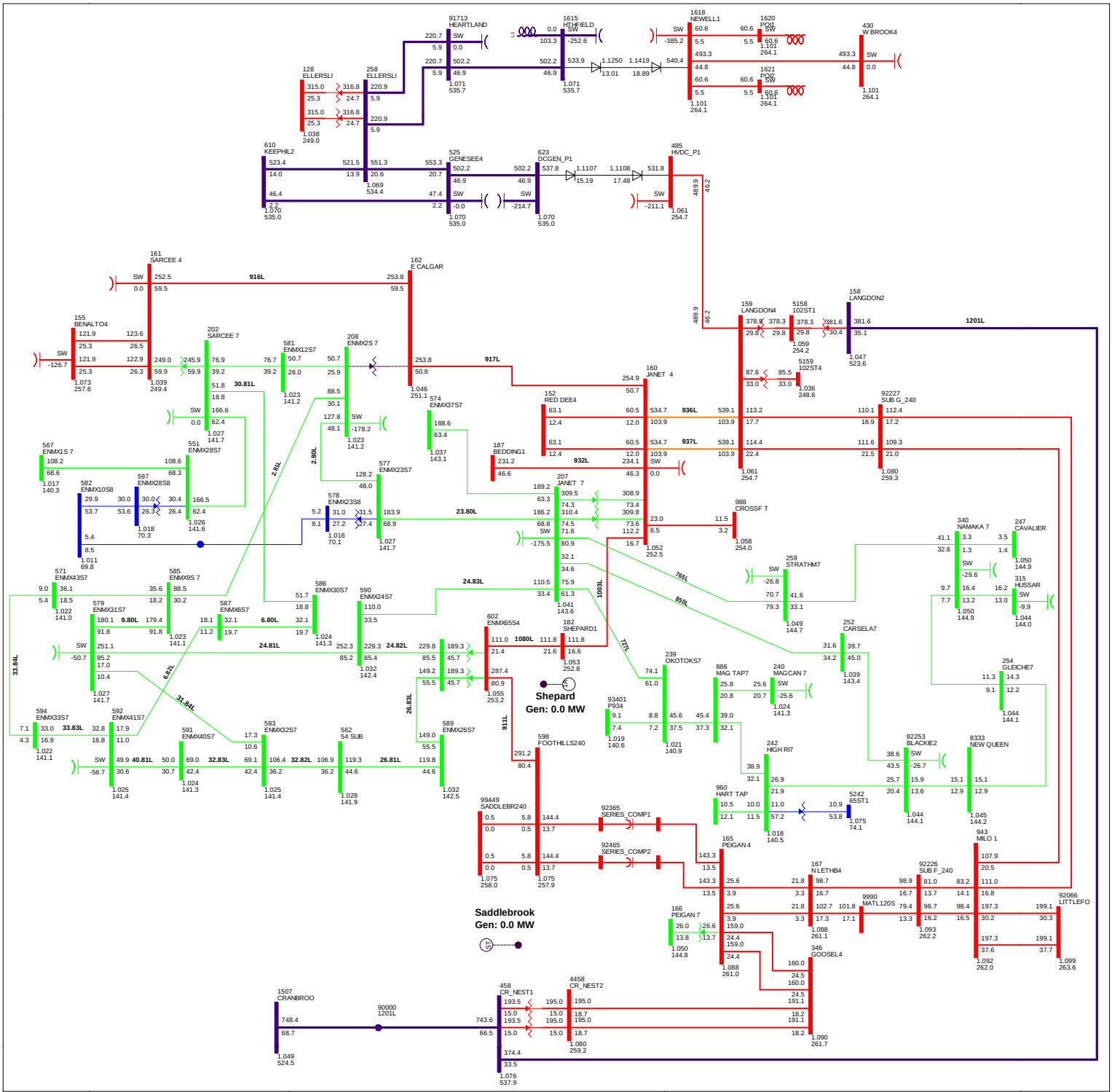
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 2
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

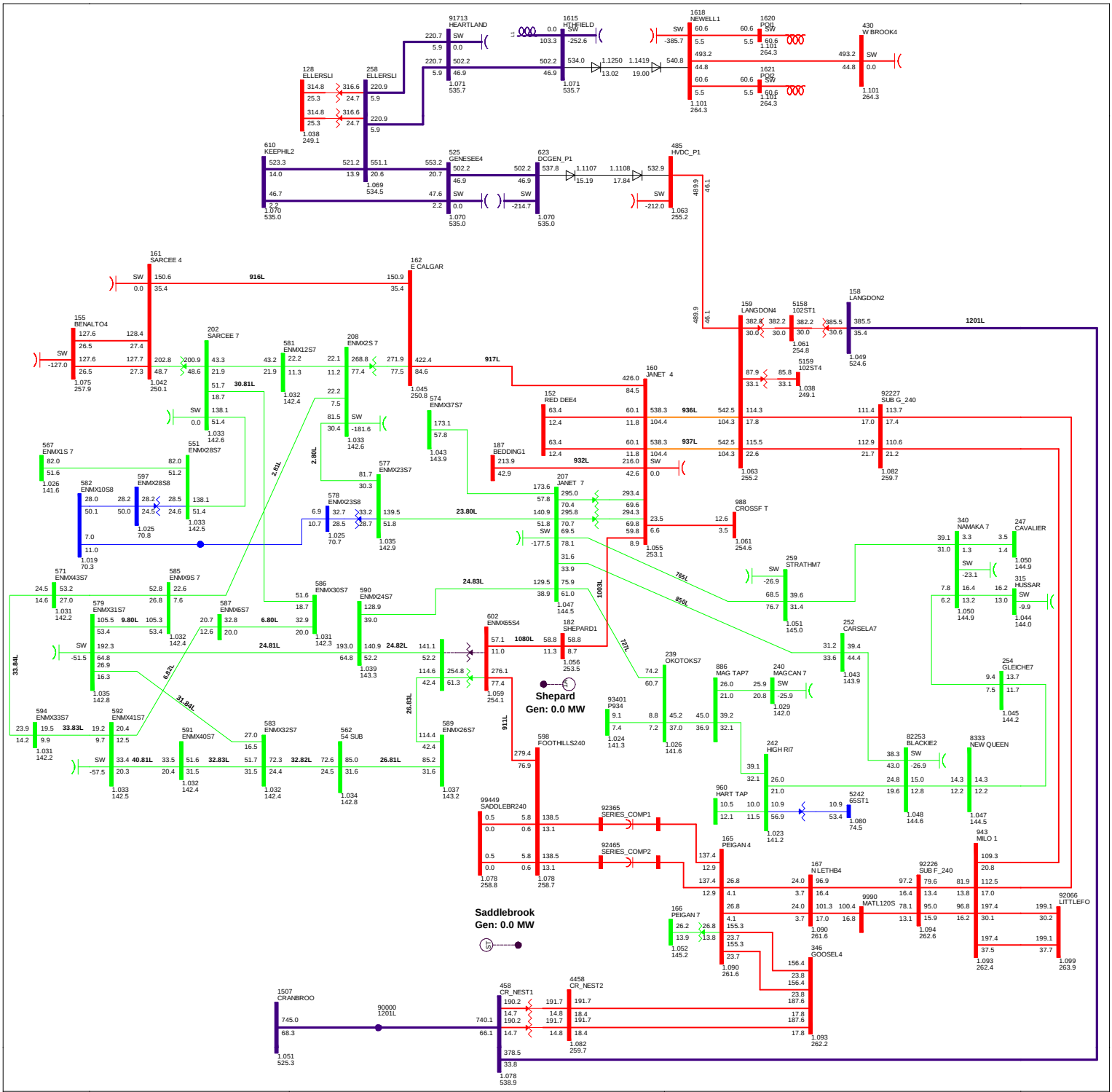
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 784.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

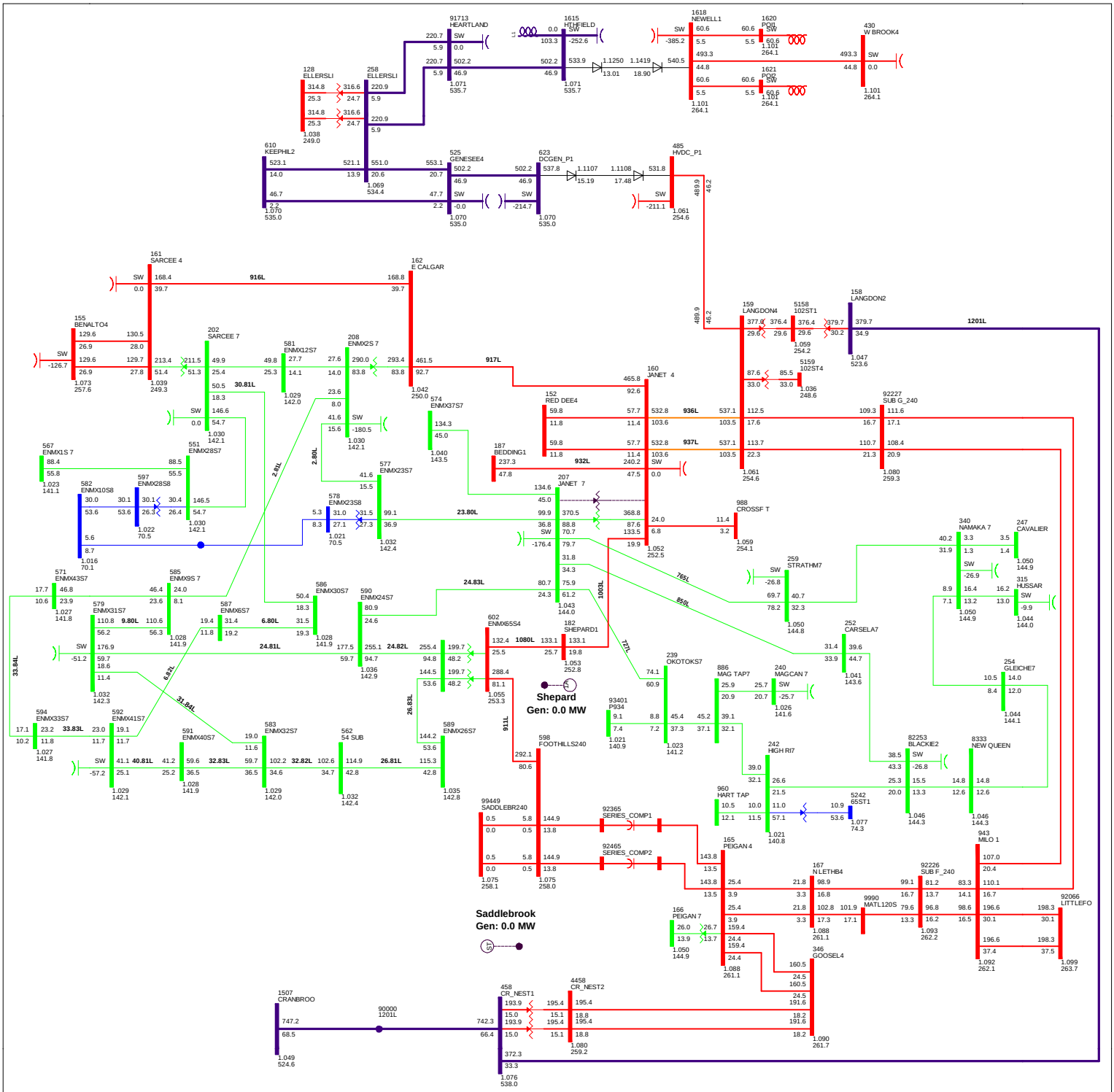
BCH Import: 779.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

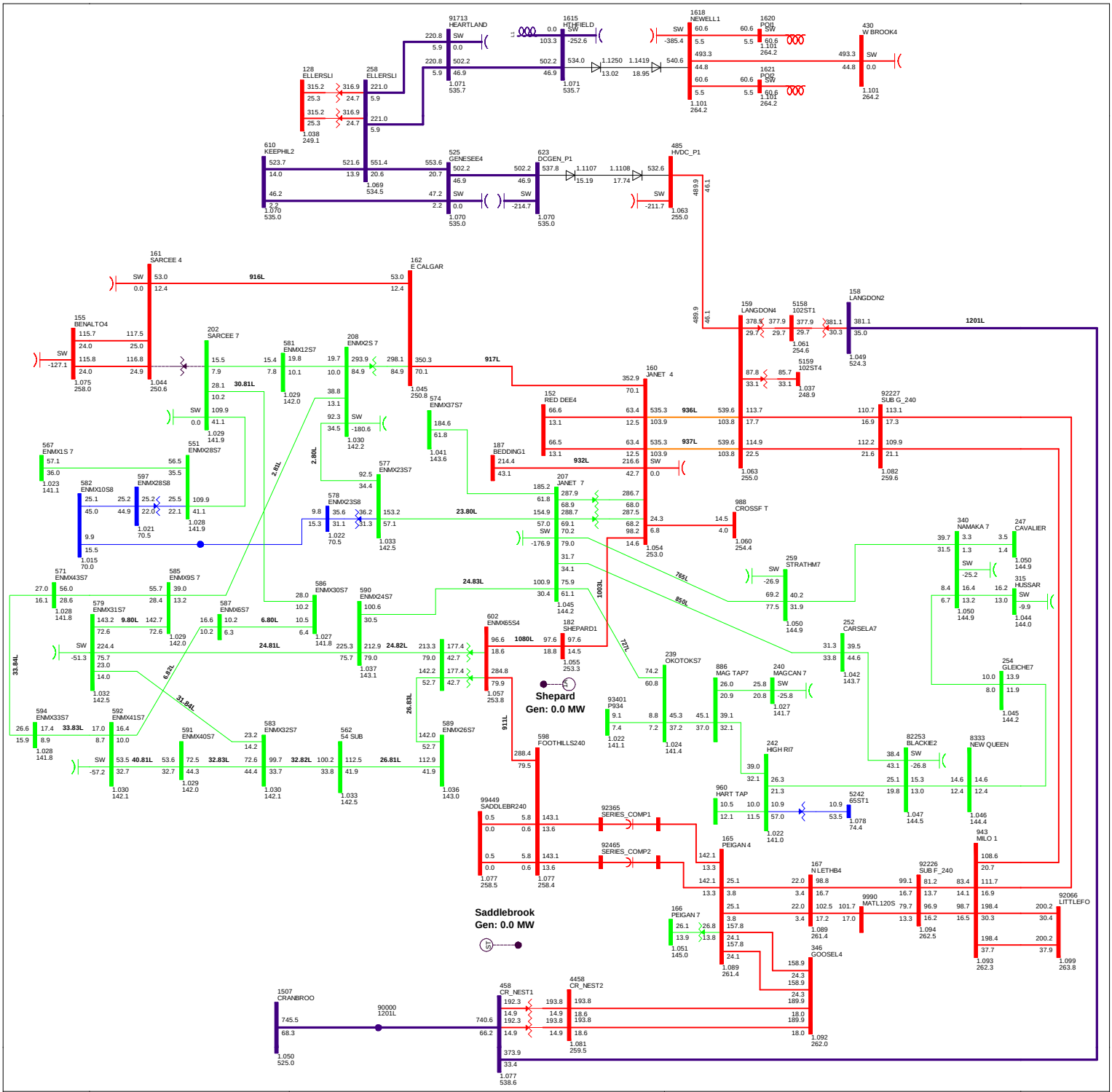
BCH Import: 782.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

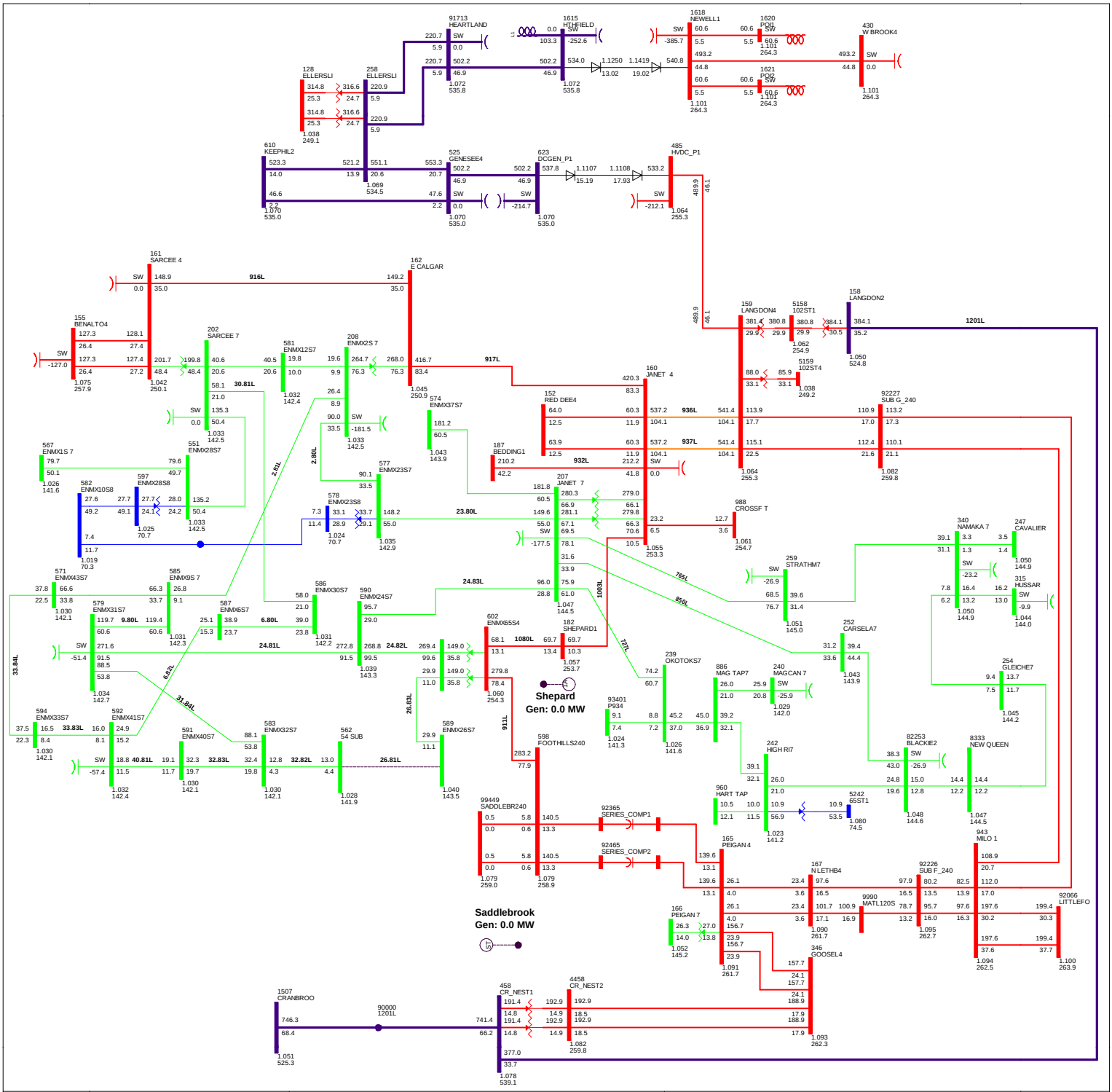
BCH Import: 780.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

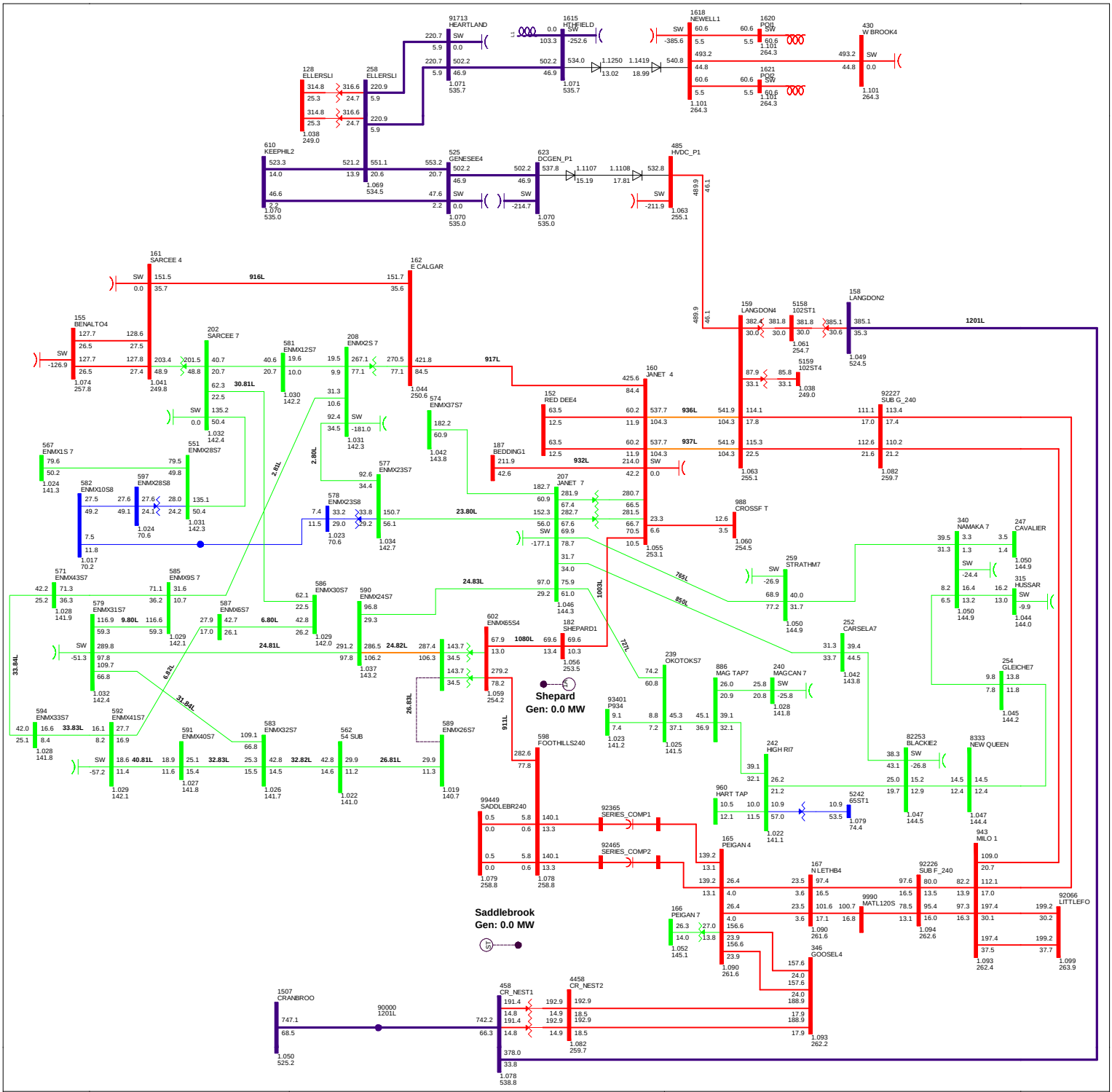
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

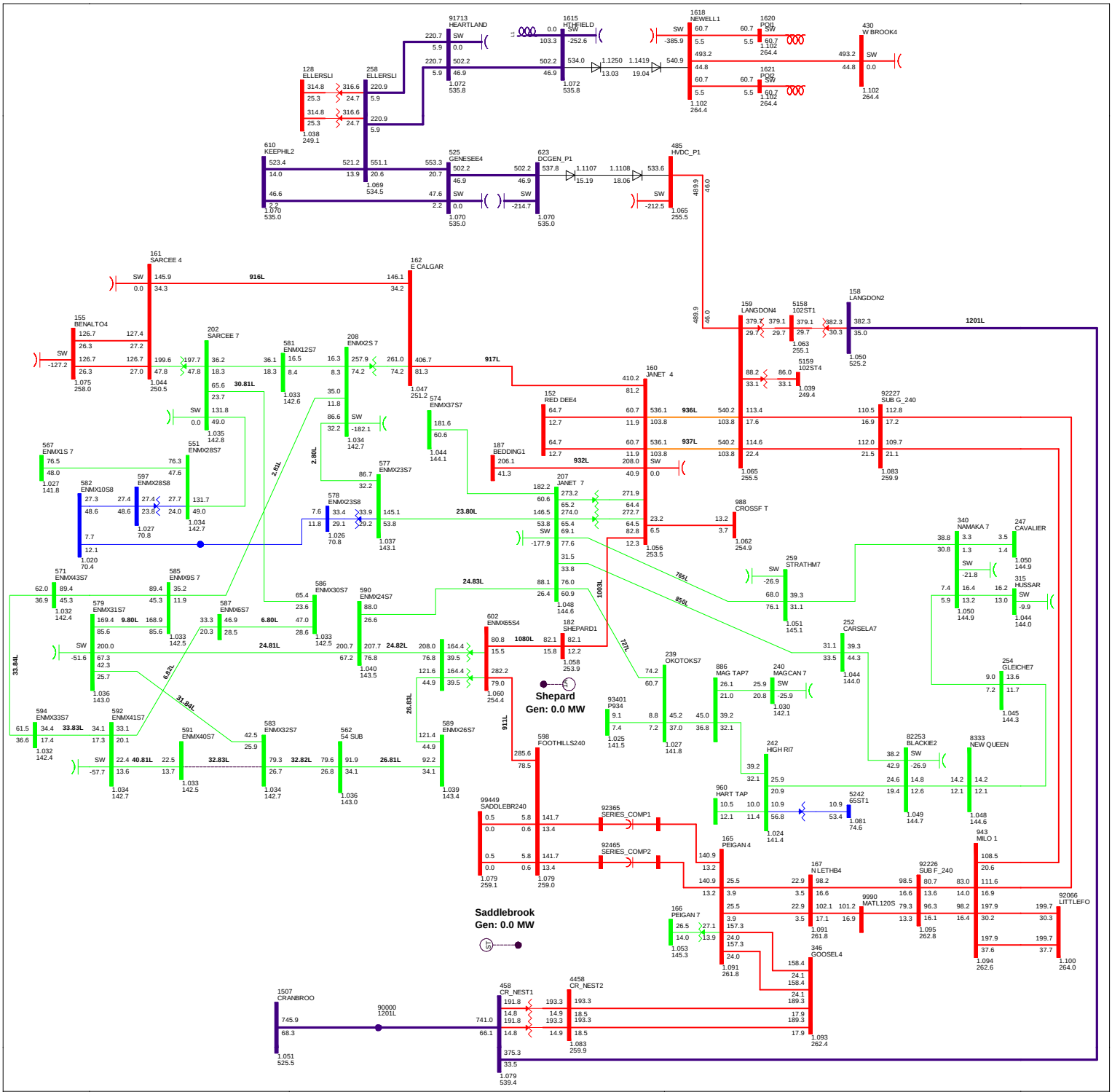
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 781.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

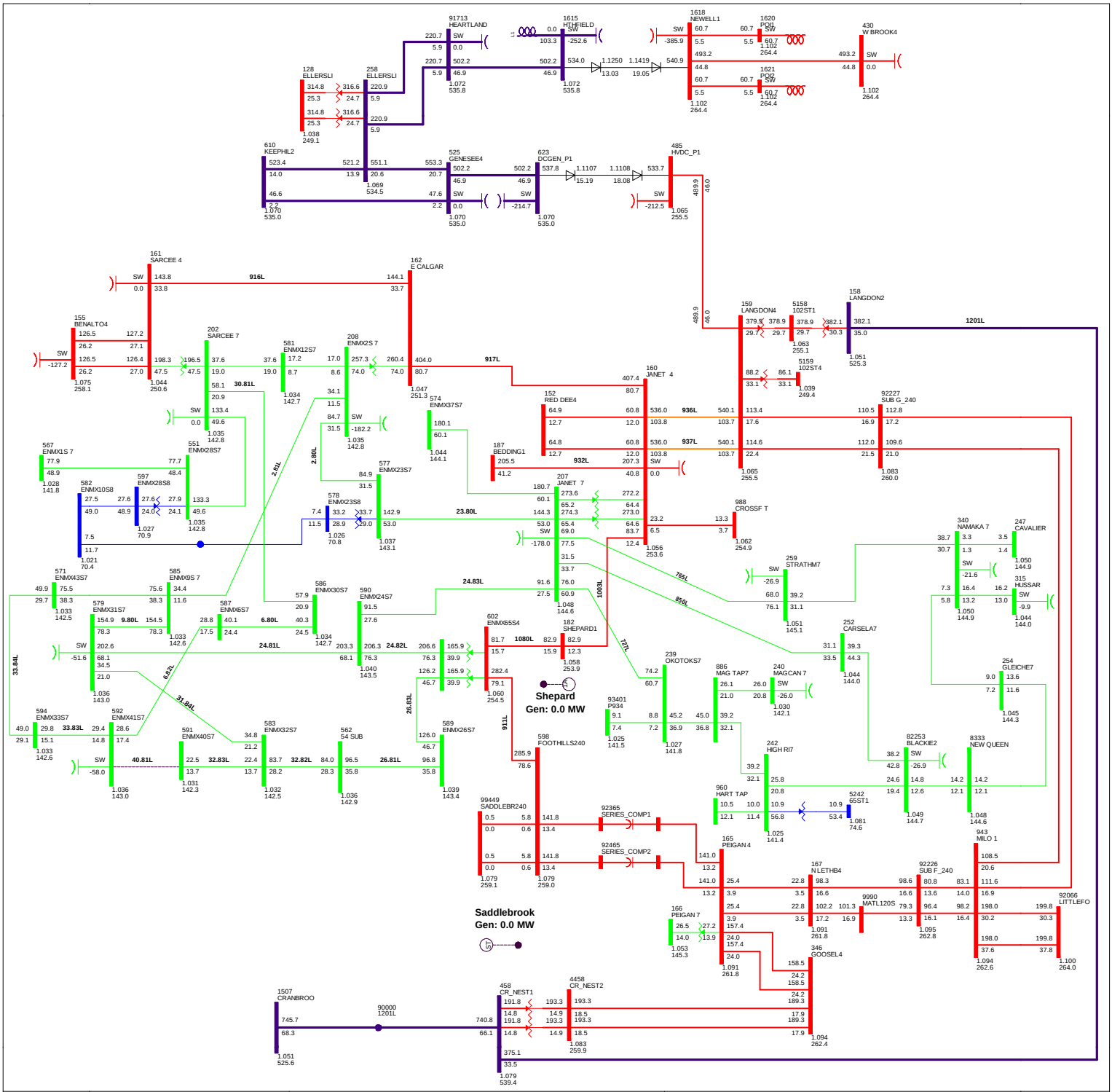
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

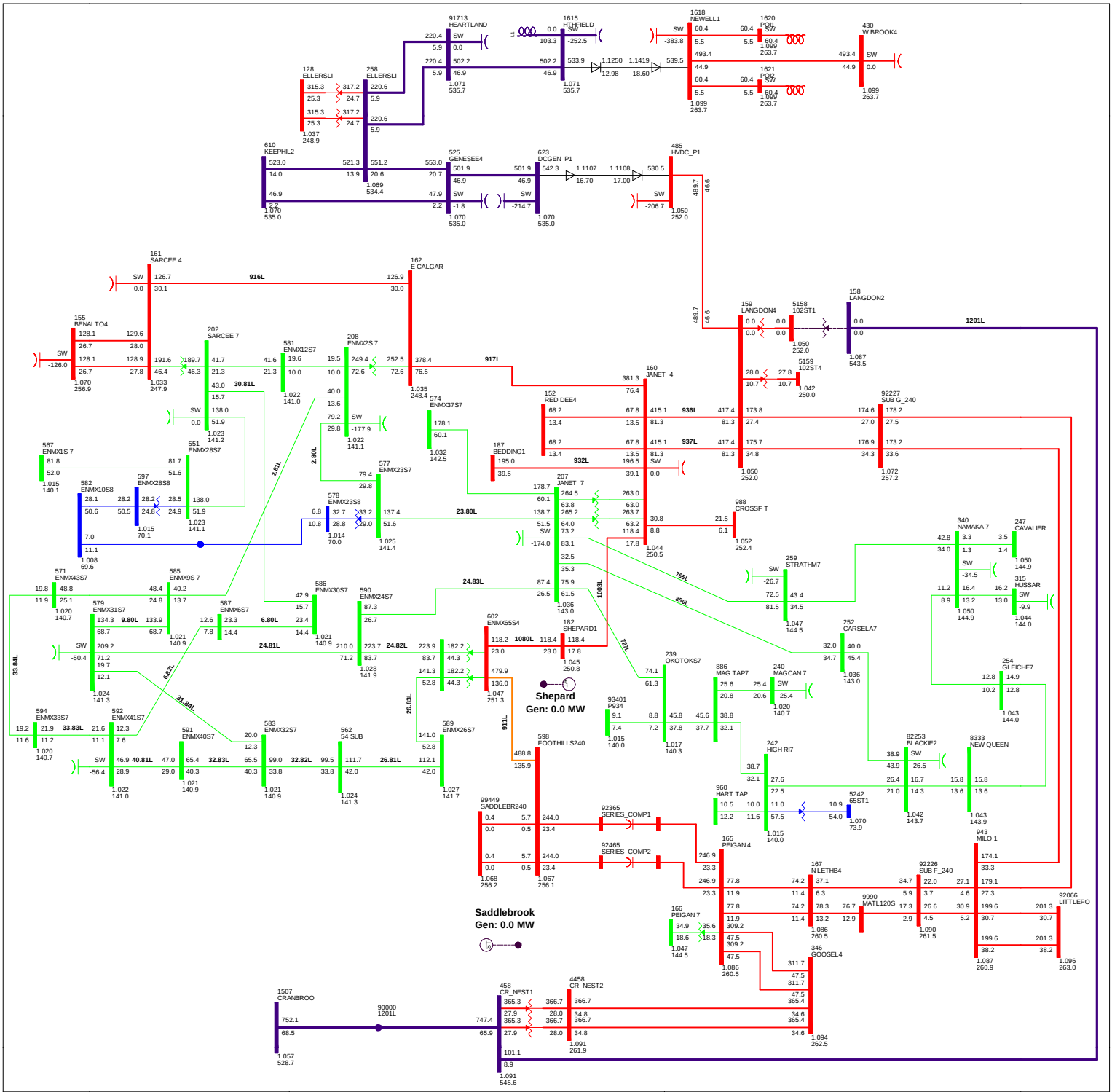
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 779.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

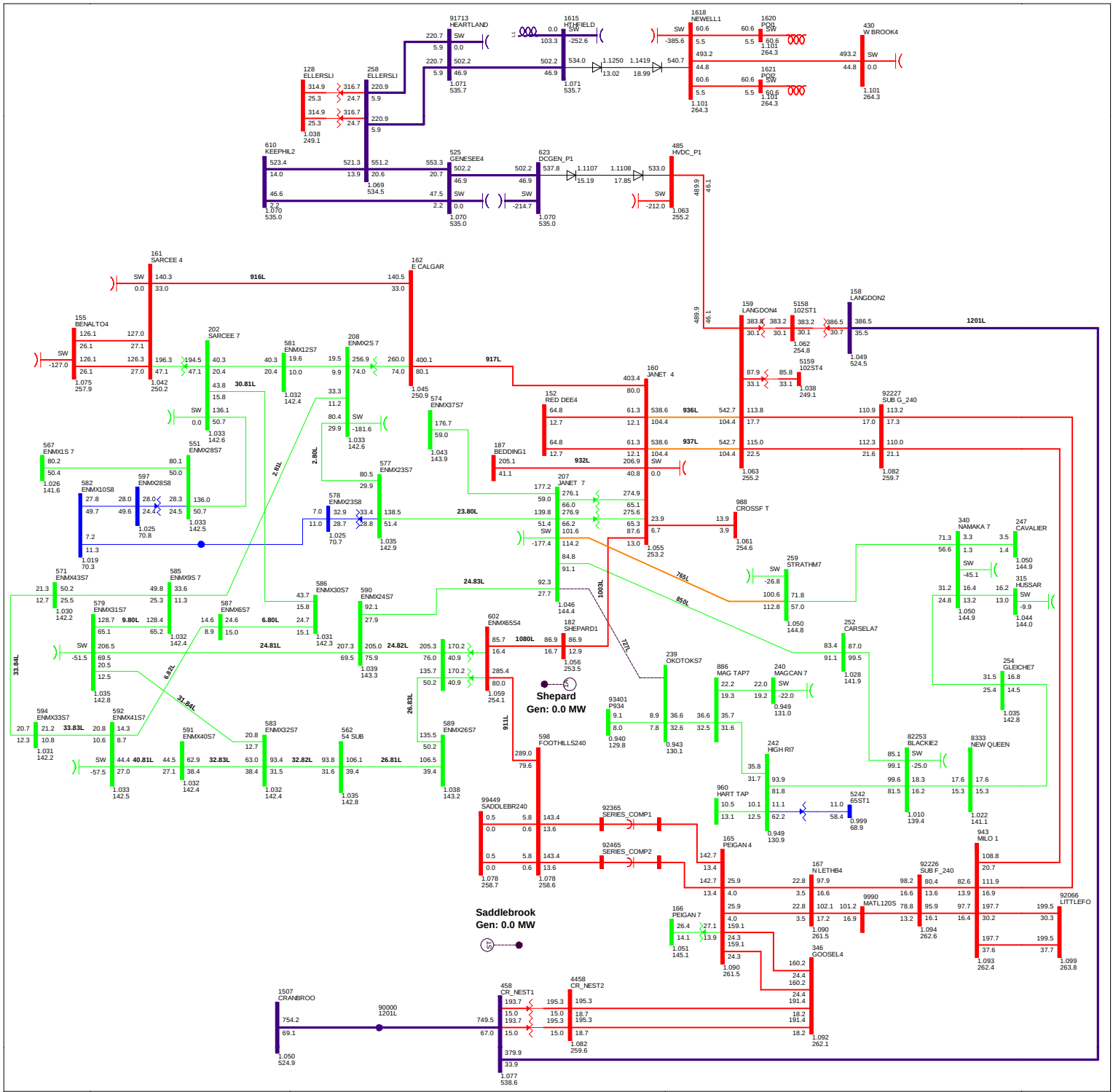
BCH Import: 799.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

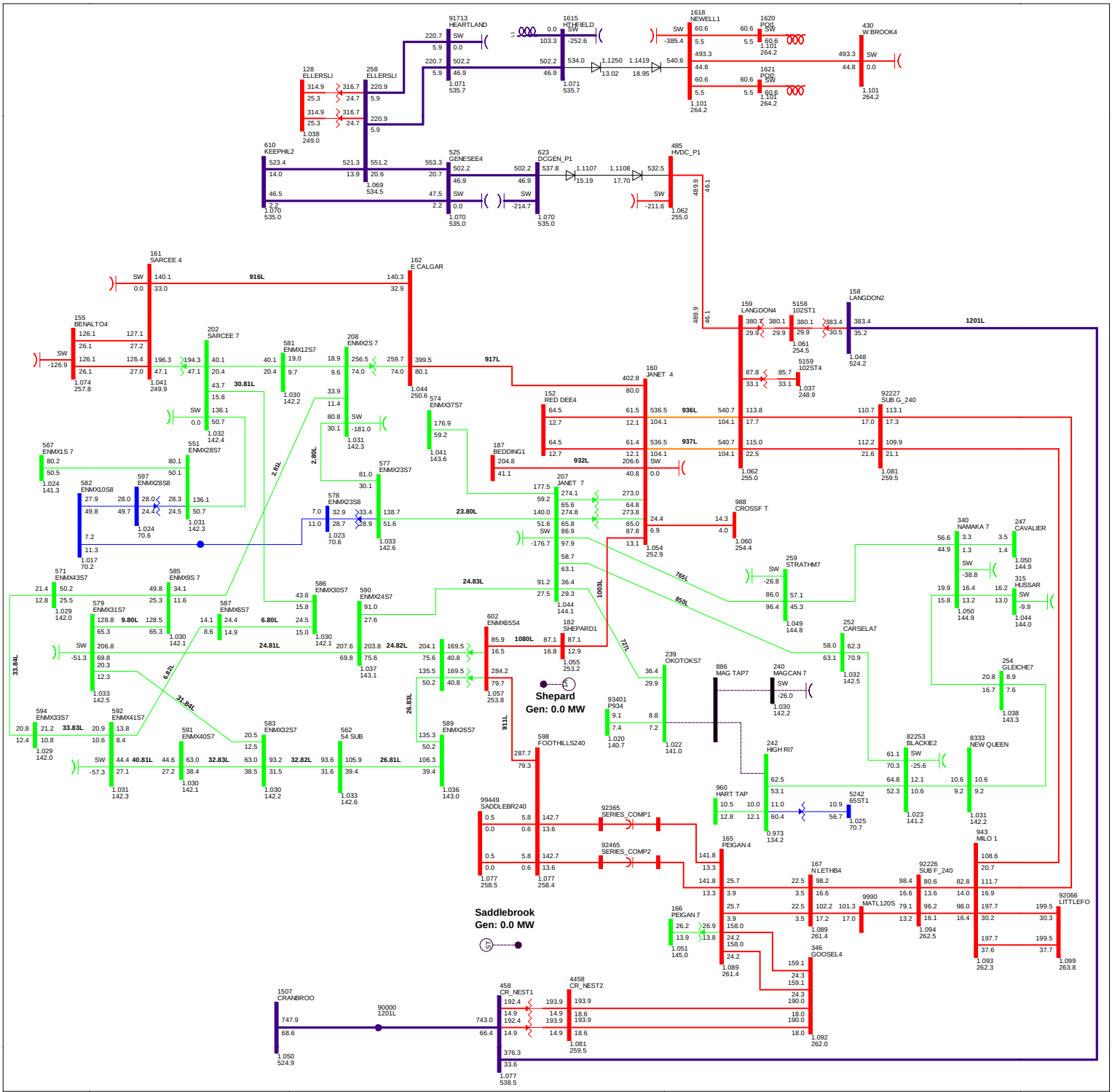
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 788.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 6
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:14



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

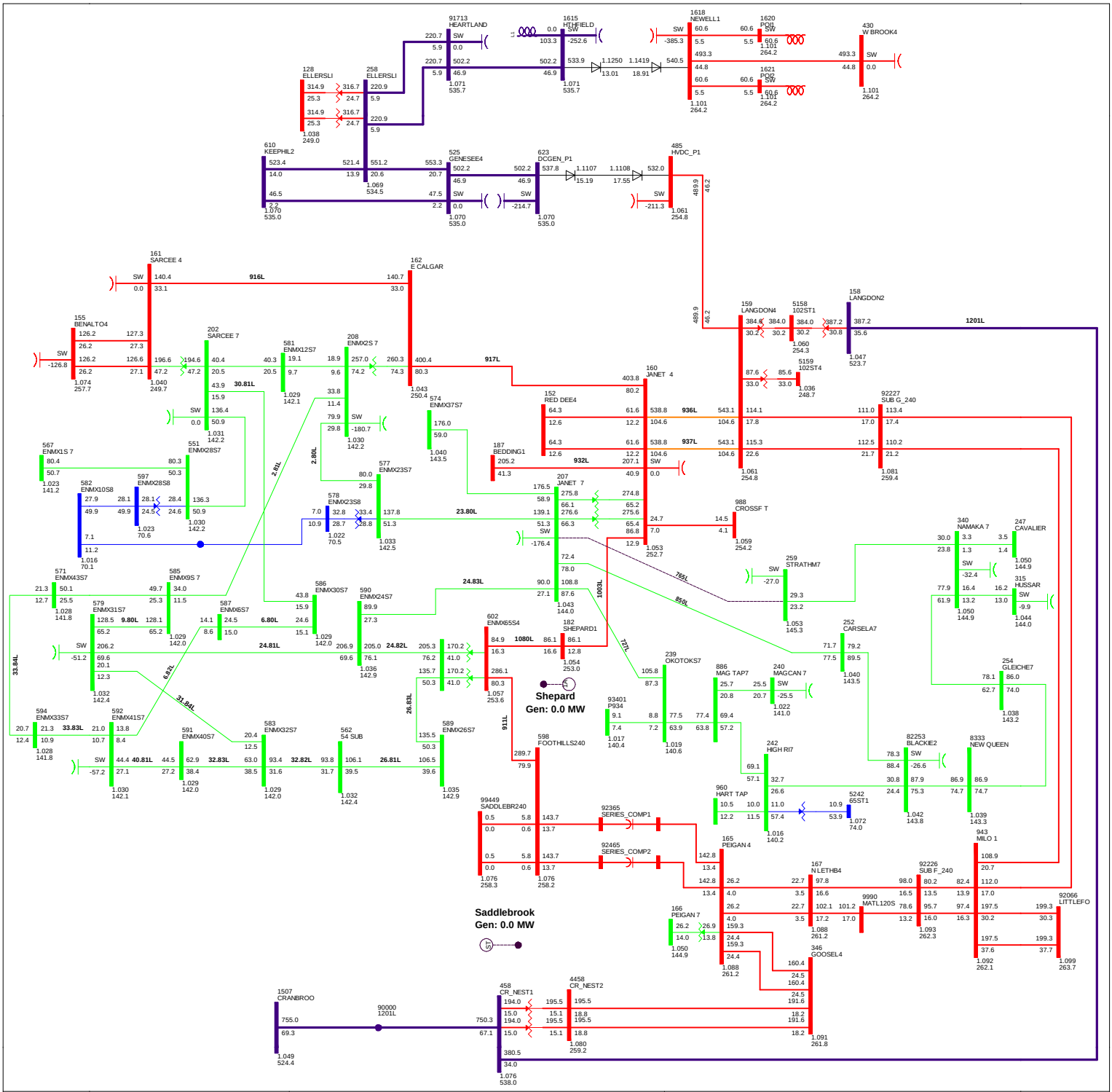
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN 2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

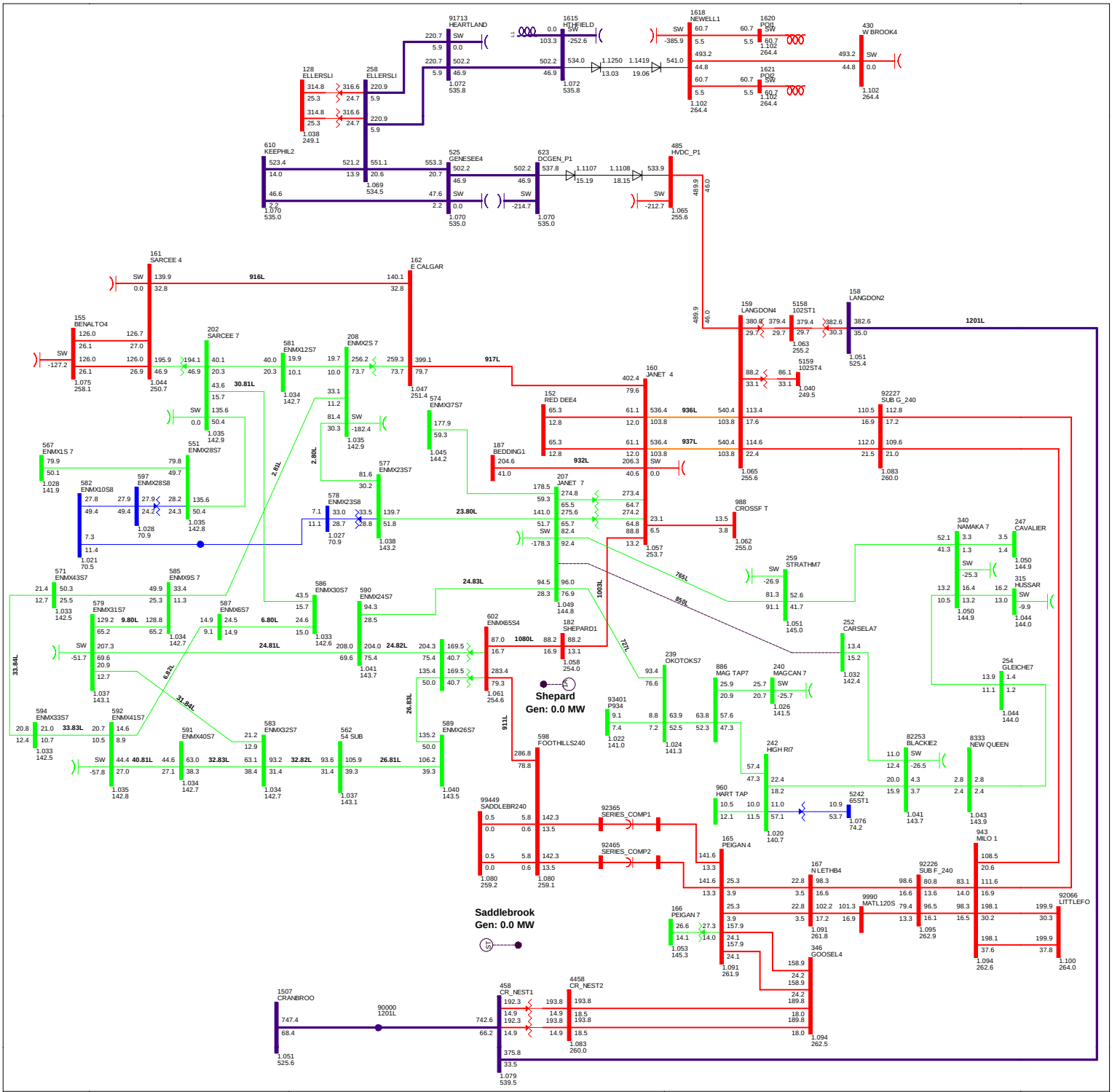
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 789.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-22: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMOR 2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

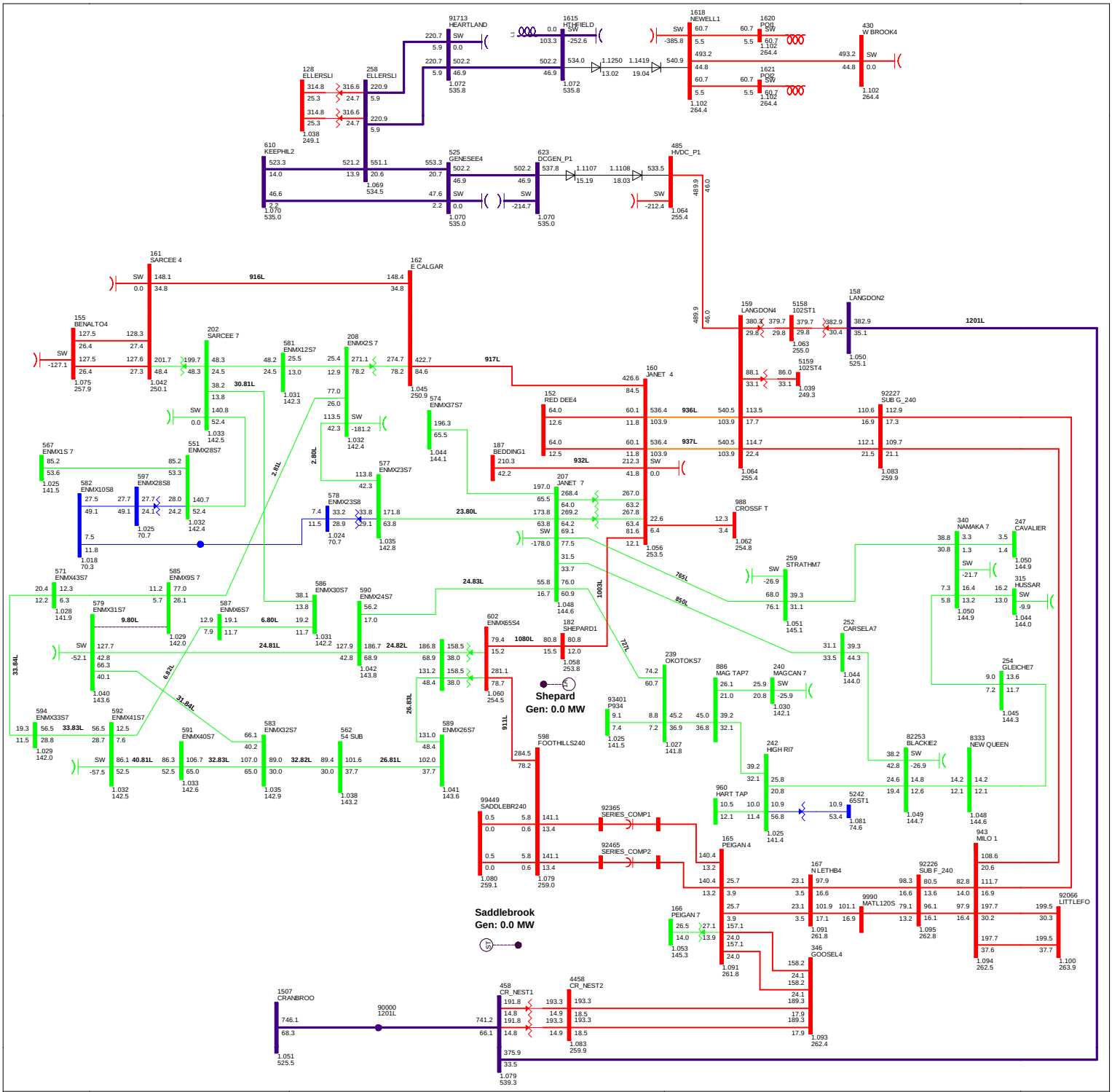
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-23: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

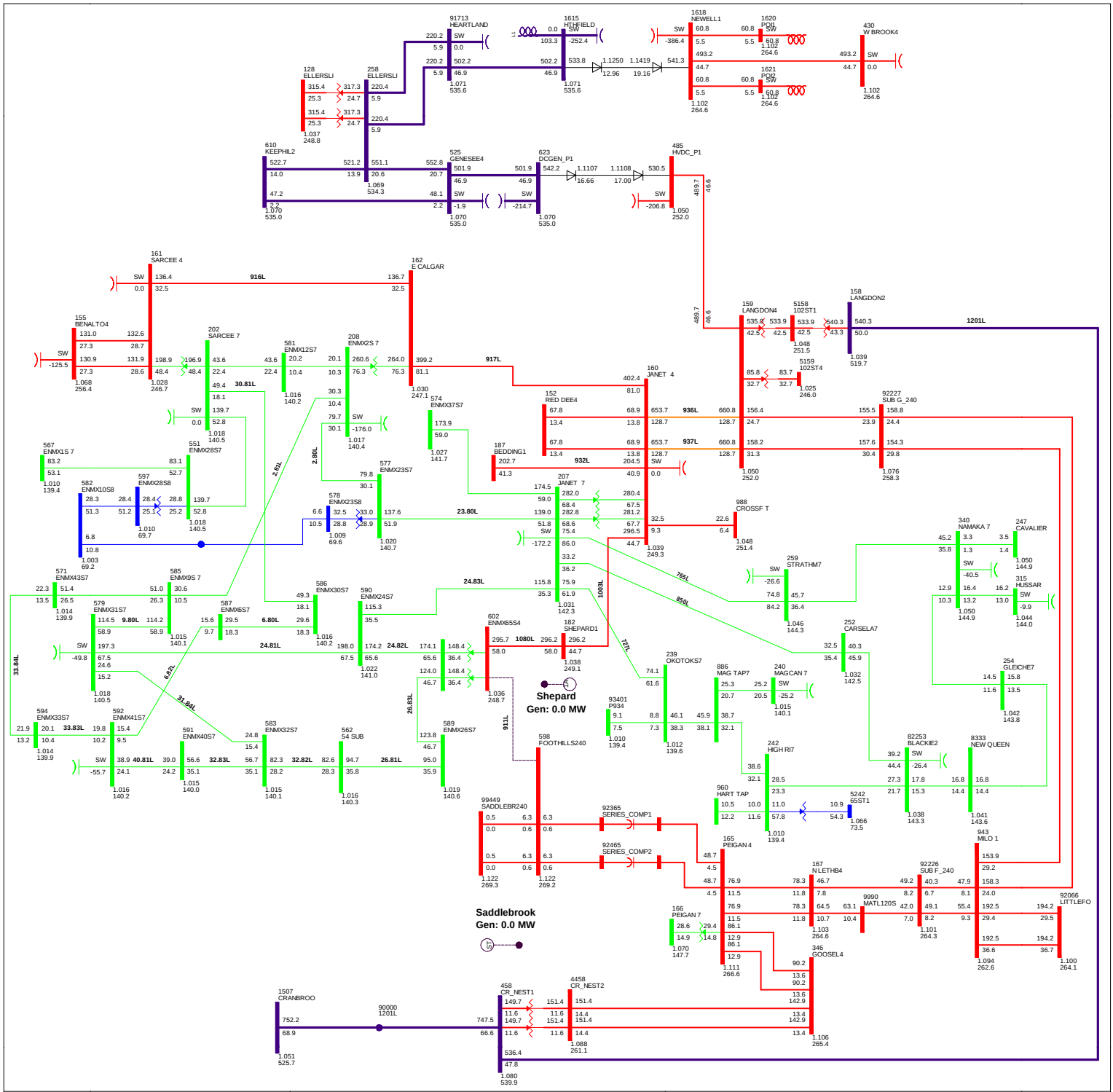
BCH Import: 779.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-24: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

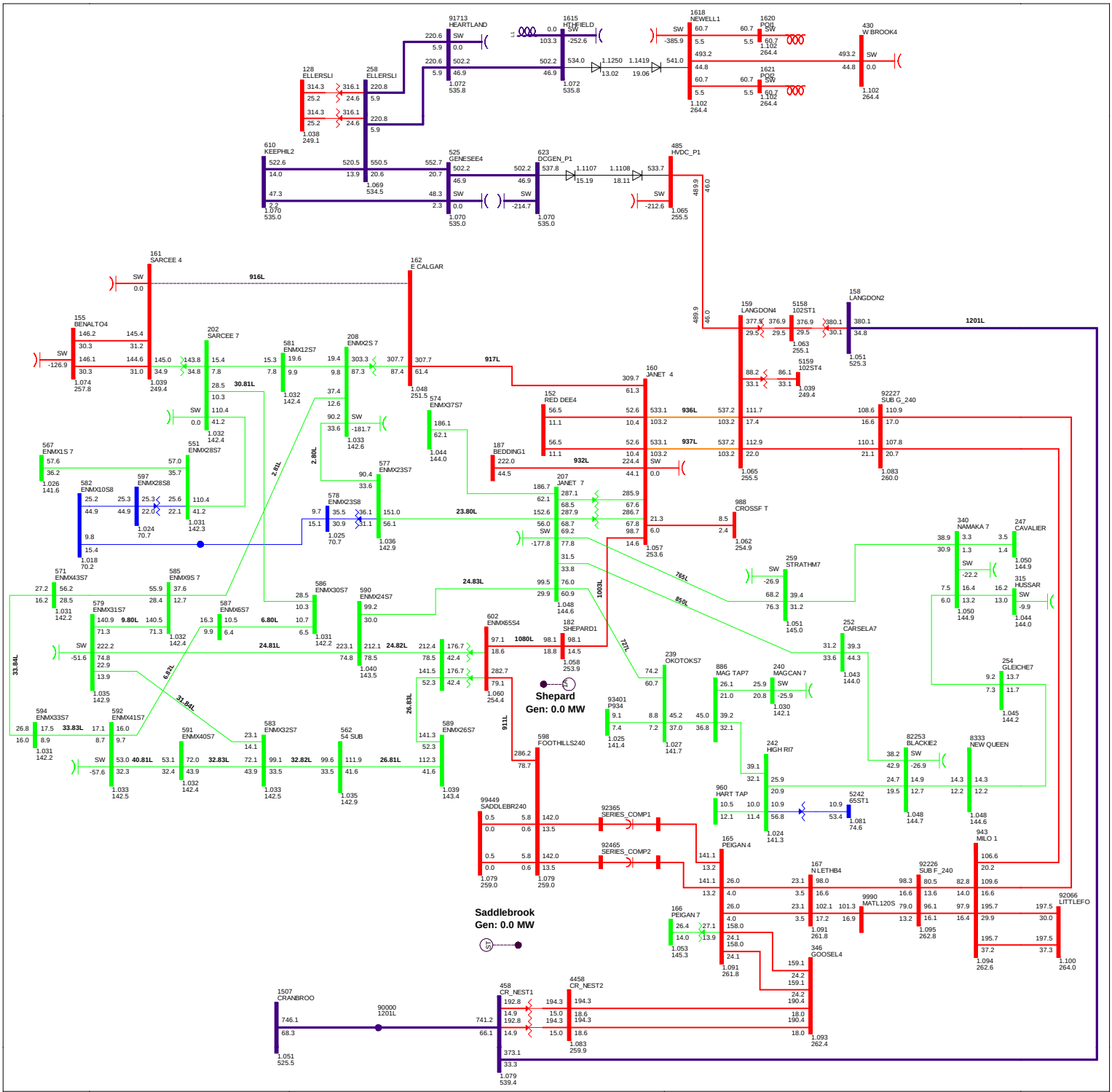
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 786.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-25: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMA 2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

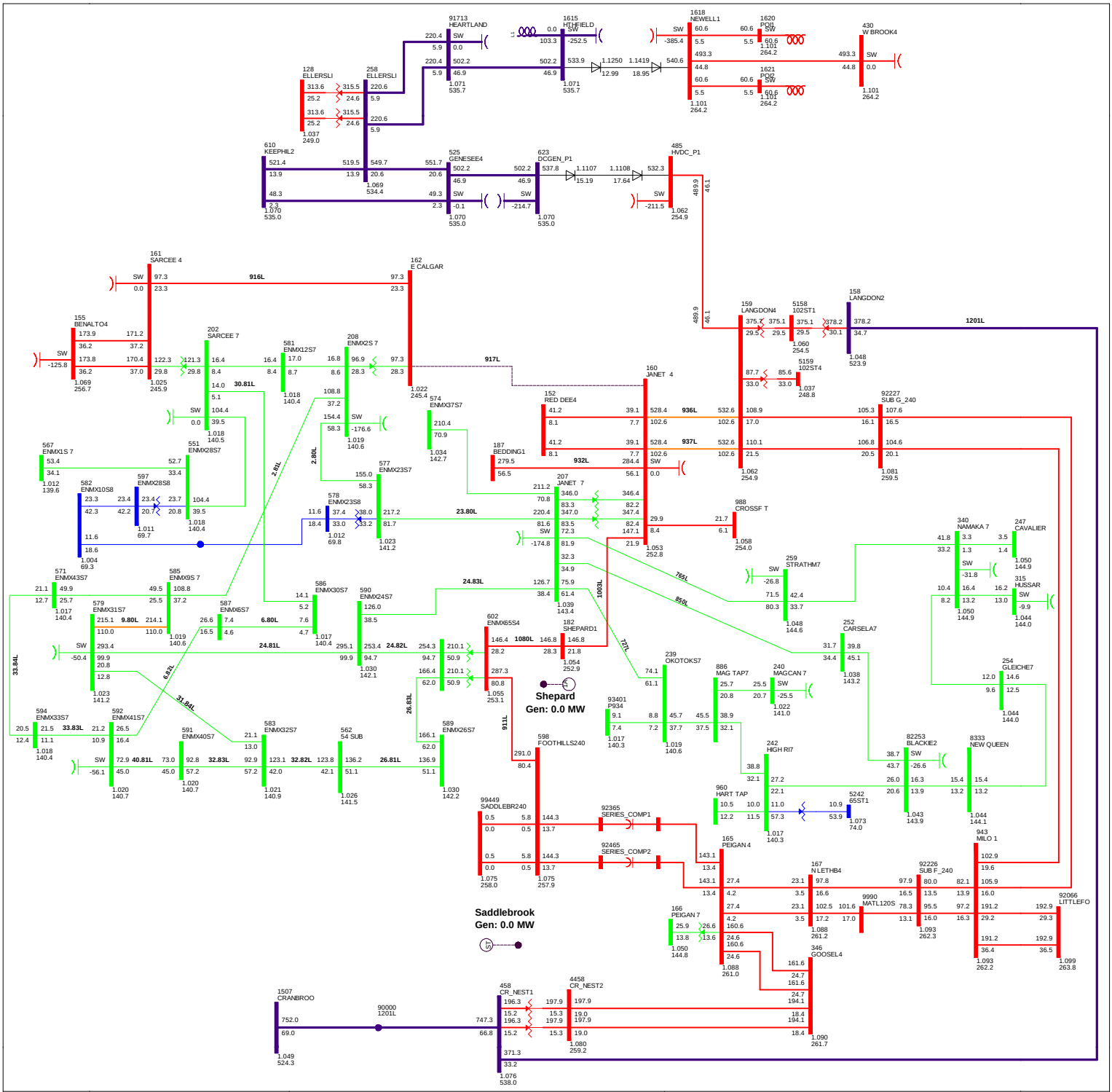
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 780.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-26: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CAL
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

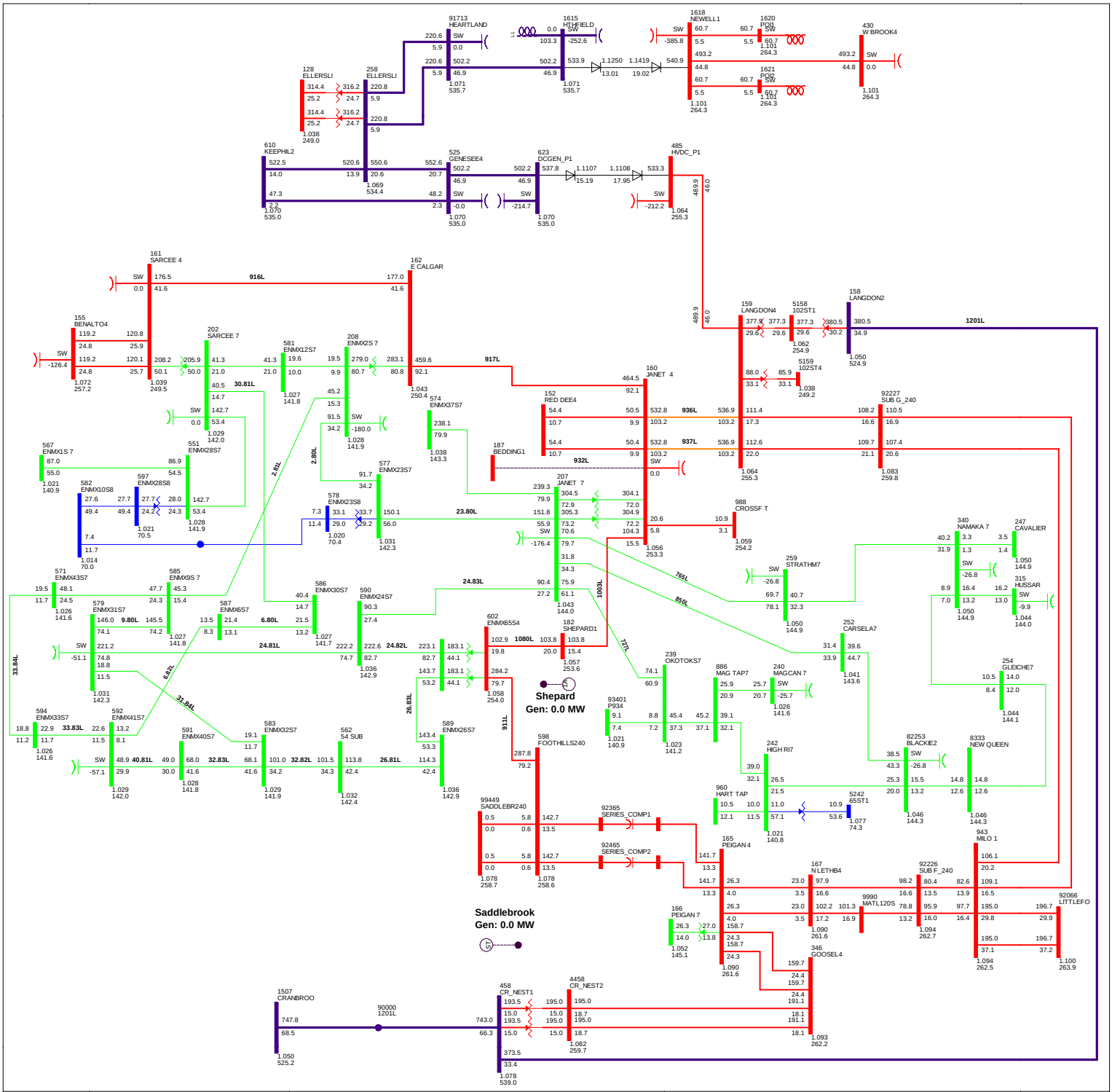
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 790.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-27: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALG
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

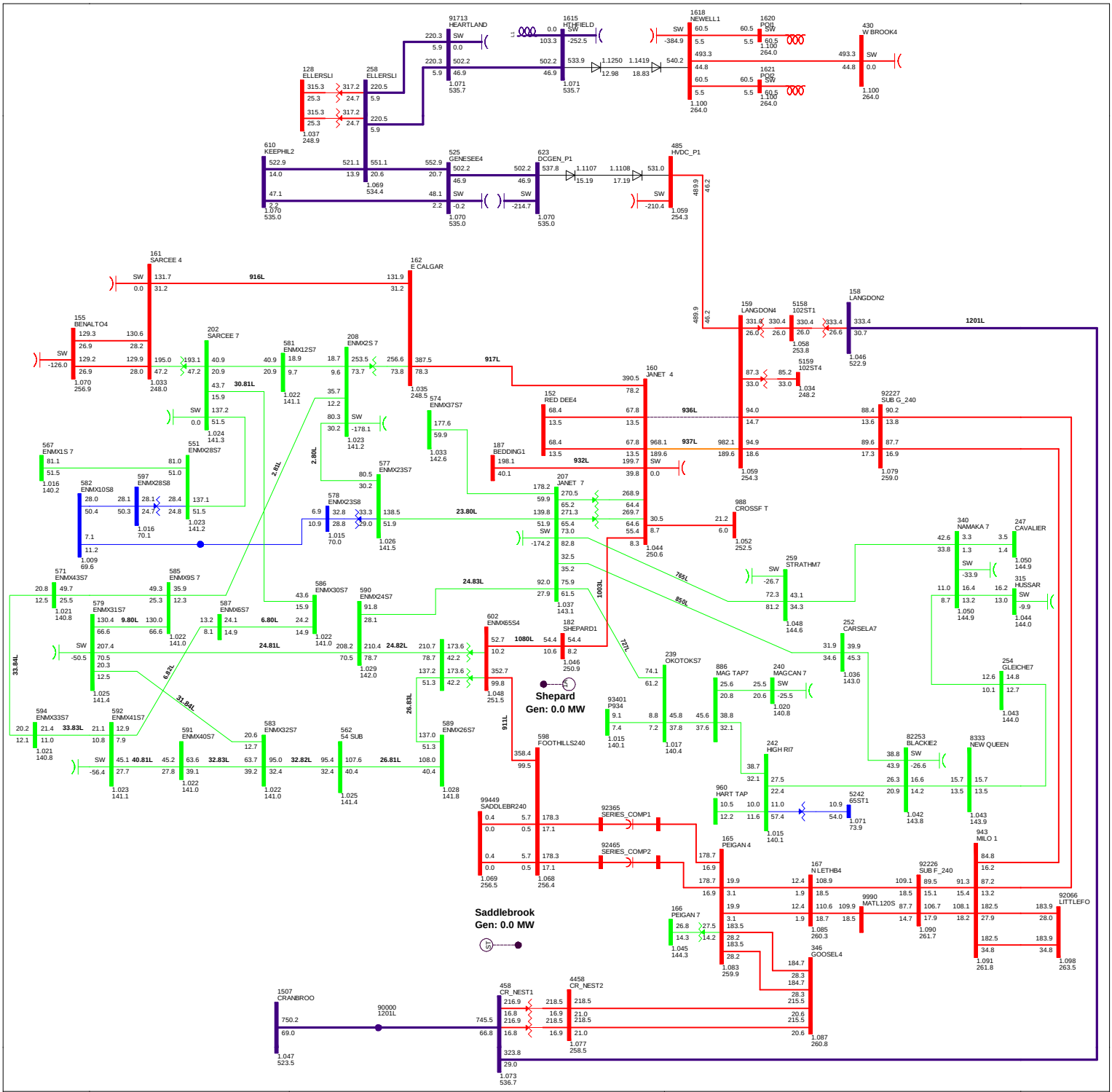
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 782.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-28: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTO 2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

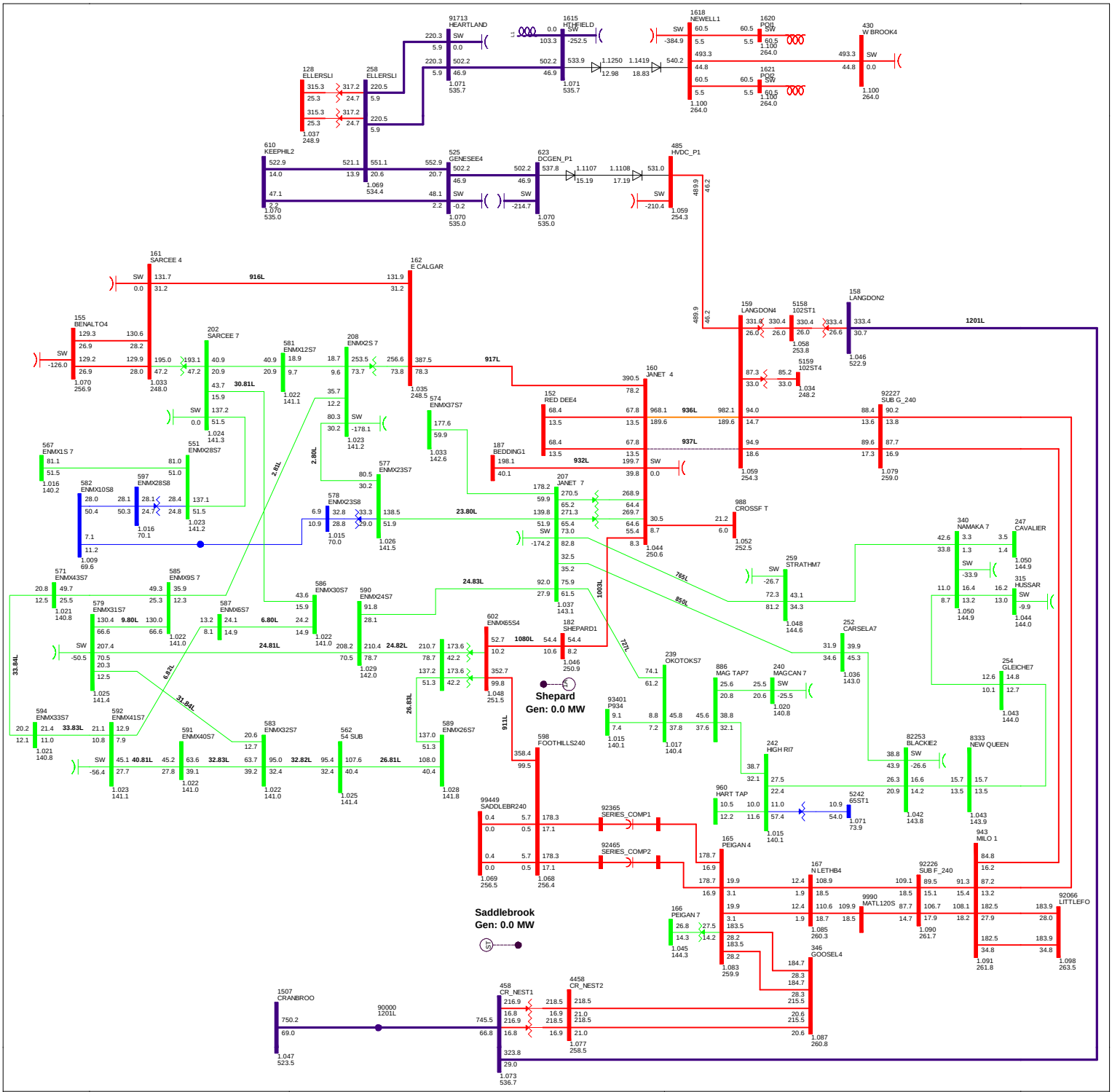
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 789.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-29: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

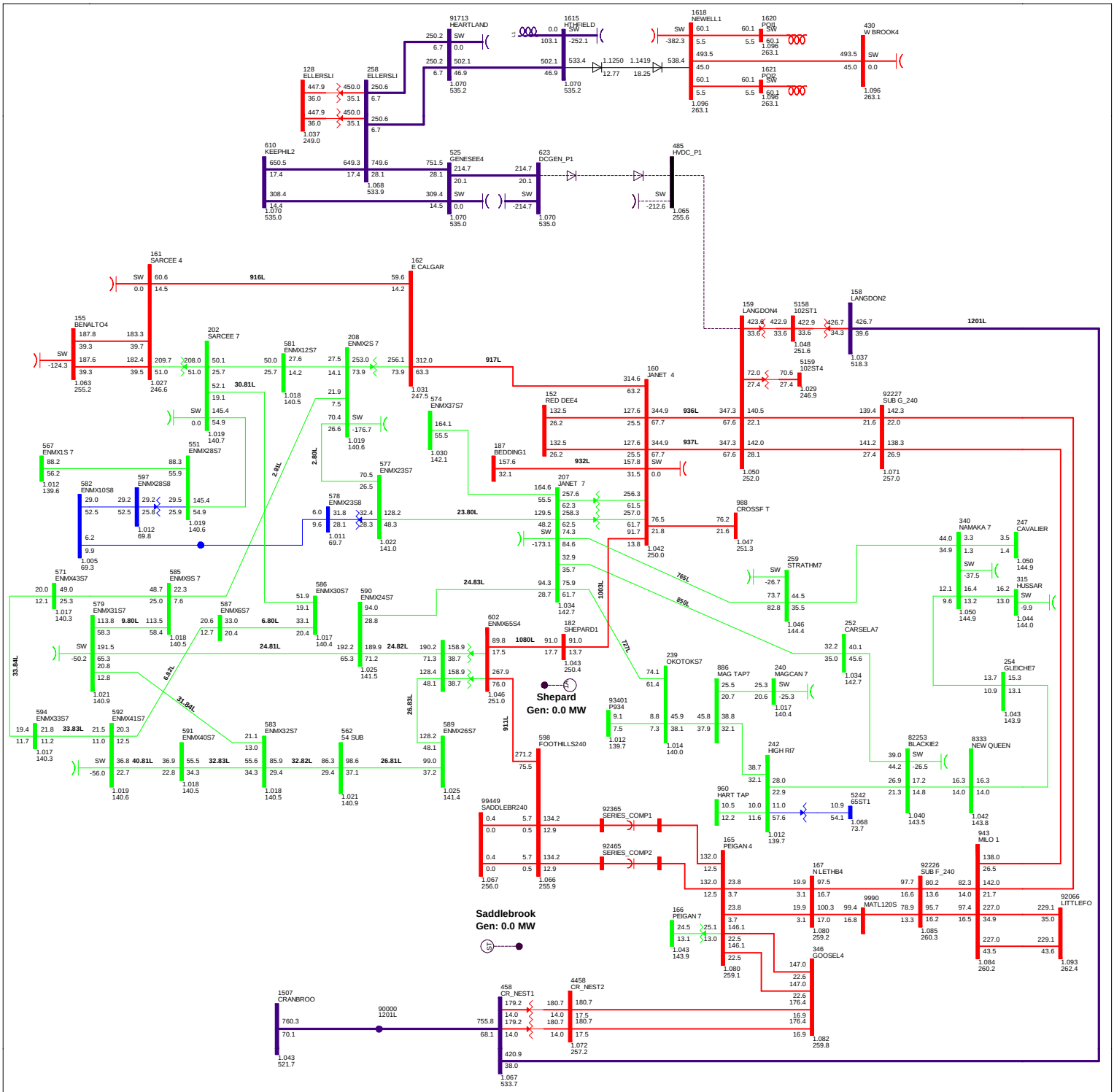
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 789.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-30: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET
2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 795.4 MW

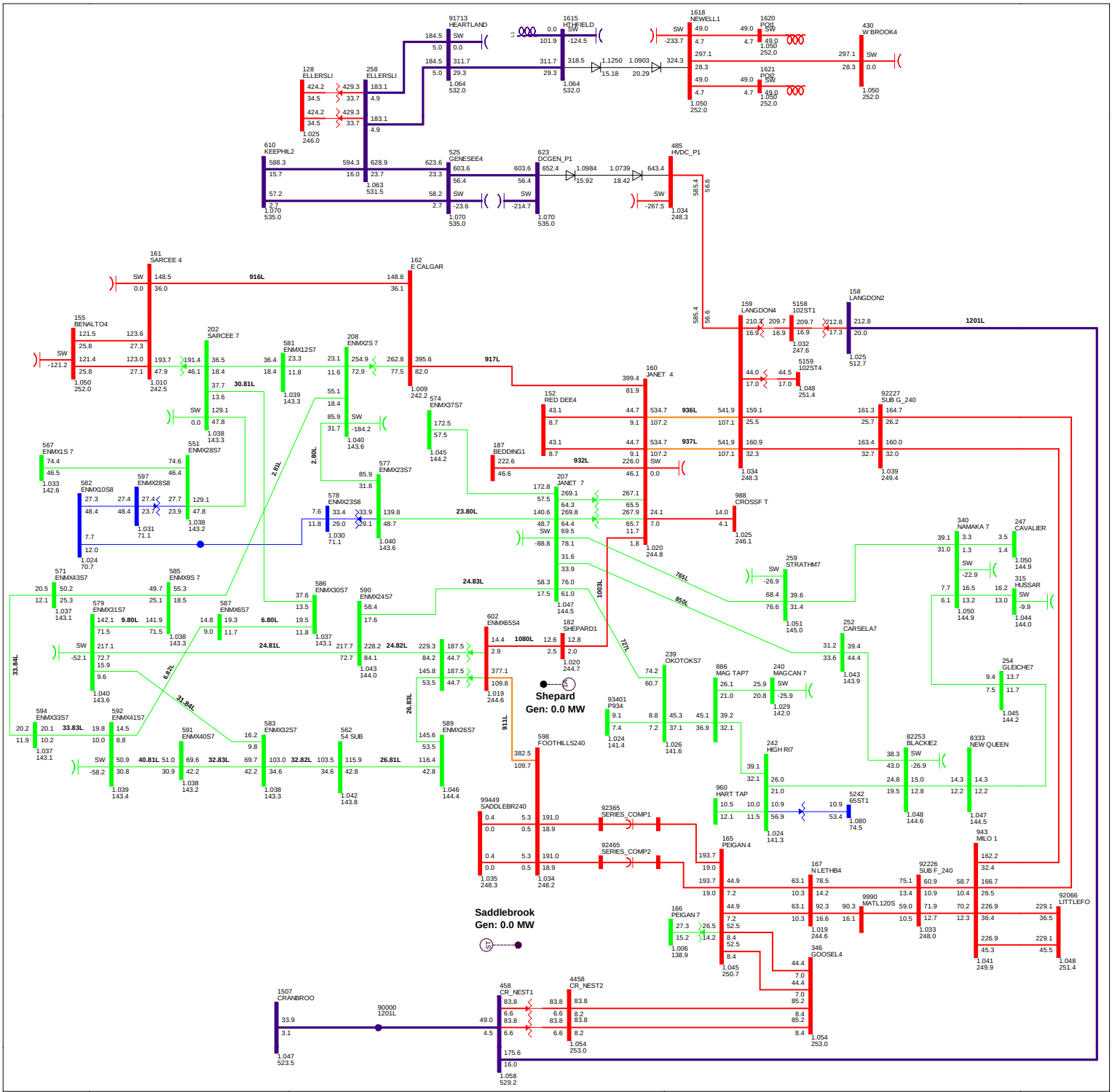
2012LTO+HVDC EXISTING SYSTEM

FIG A-SC1B-31: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2014_NEED_HVDC_SC1B

FRI, JUN 08 2012 16:15

2014 Loading Violations
Scenario 2



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

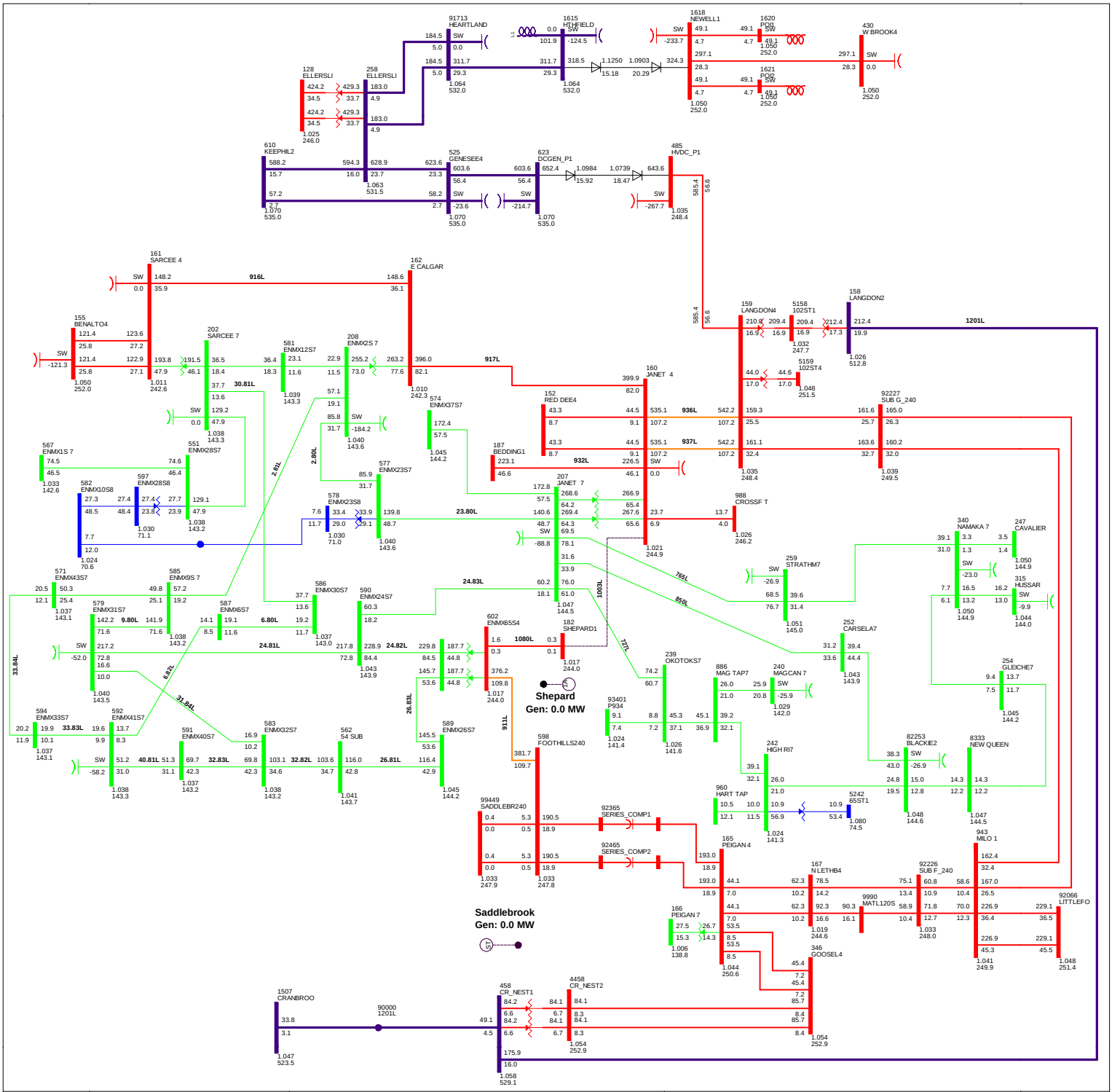
BCH Import: 2.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-1: BASECASE

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

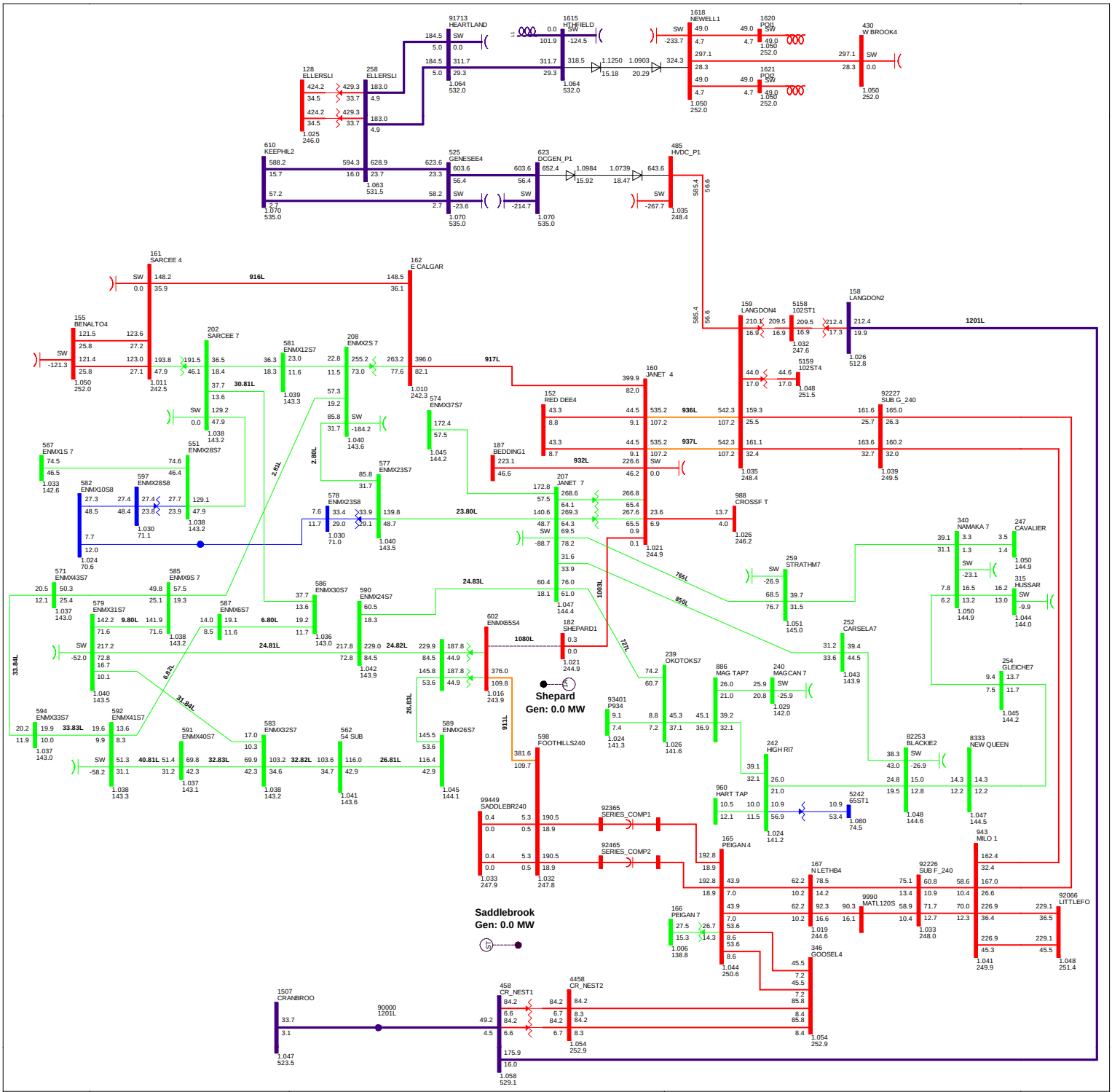
BCH Import: 2.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

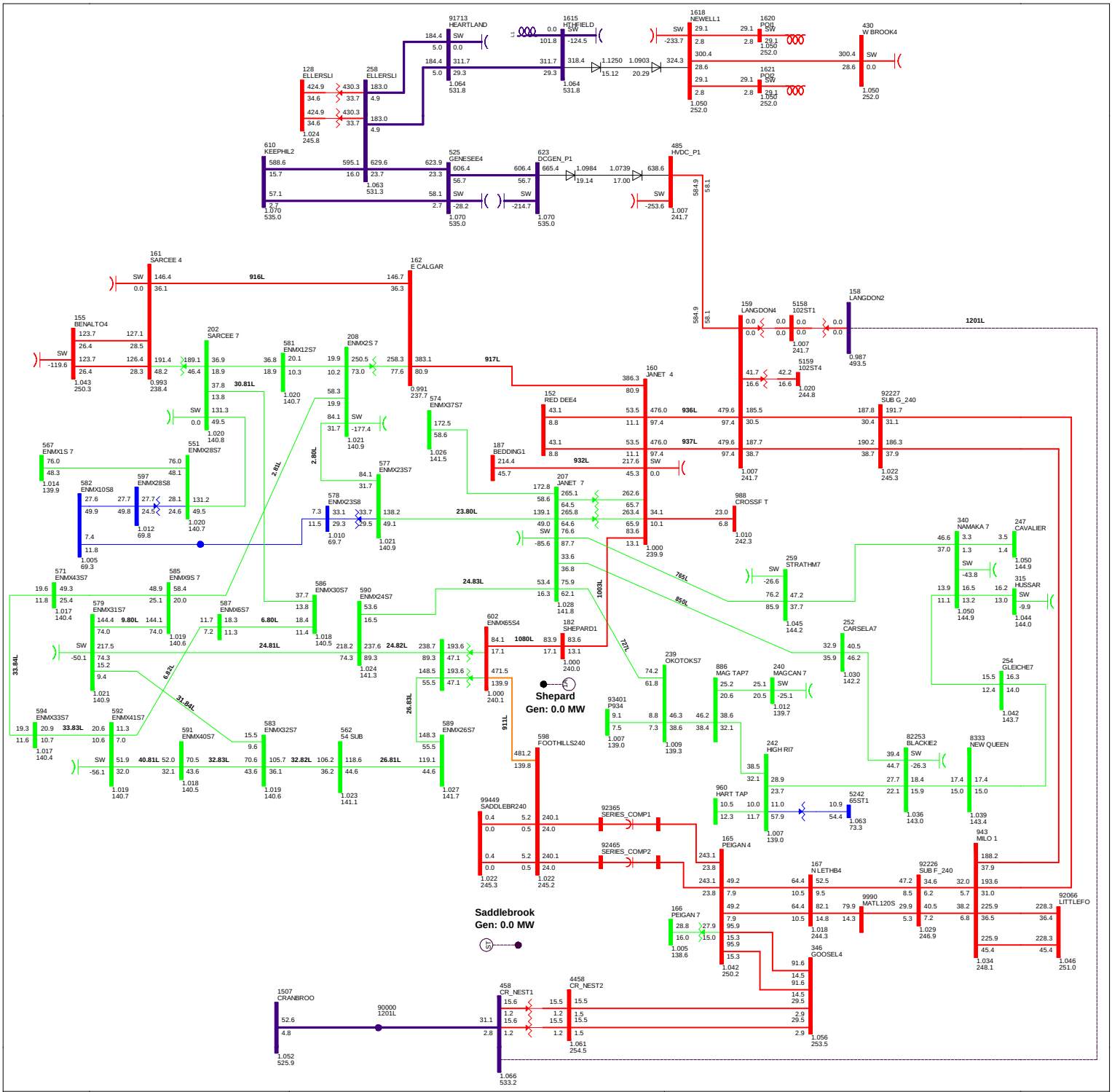
BCH Import: 2.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

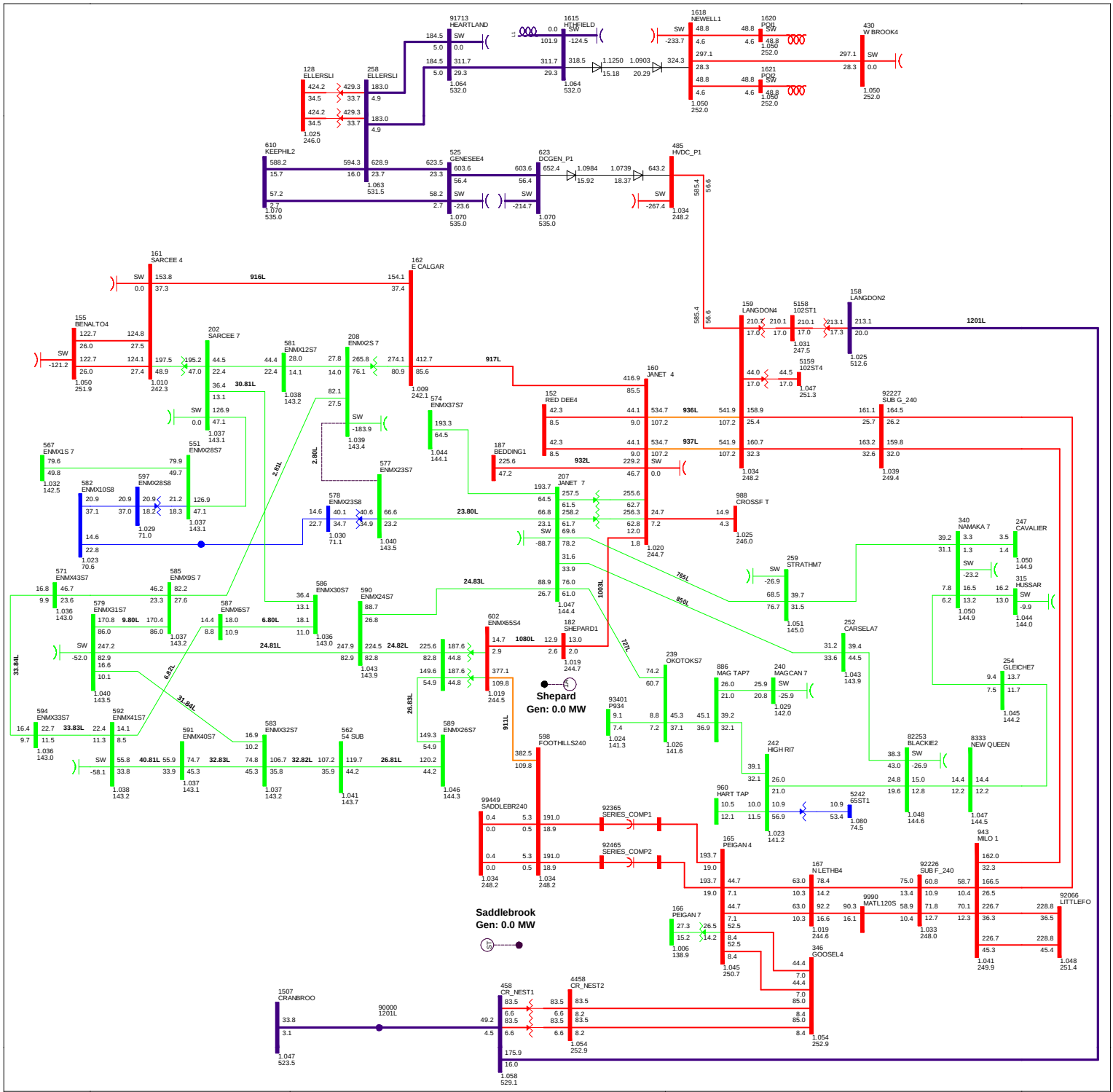
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 12.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

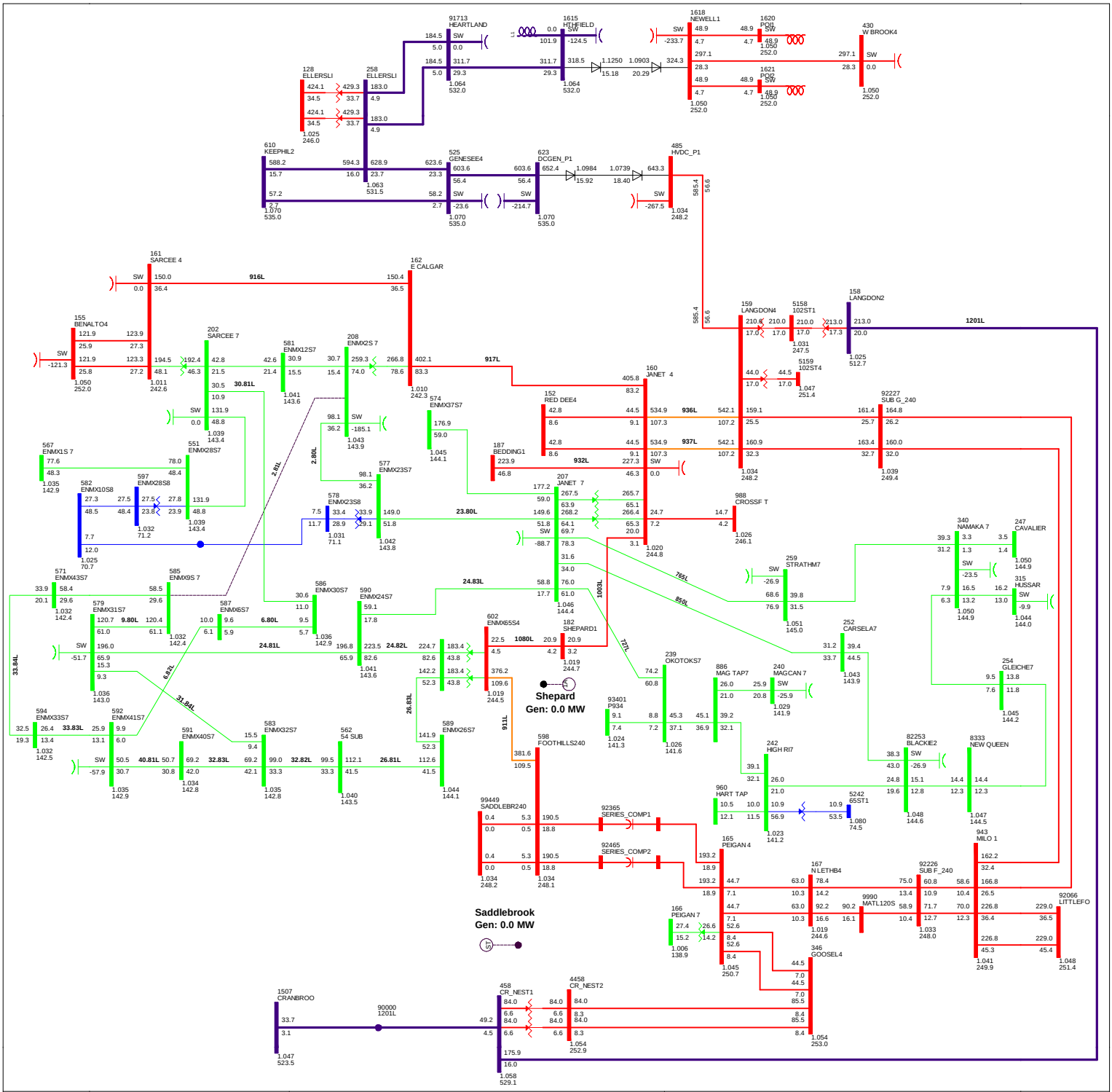
BCH Import: 3.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

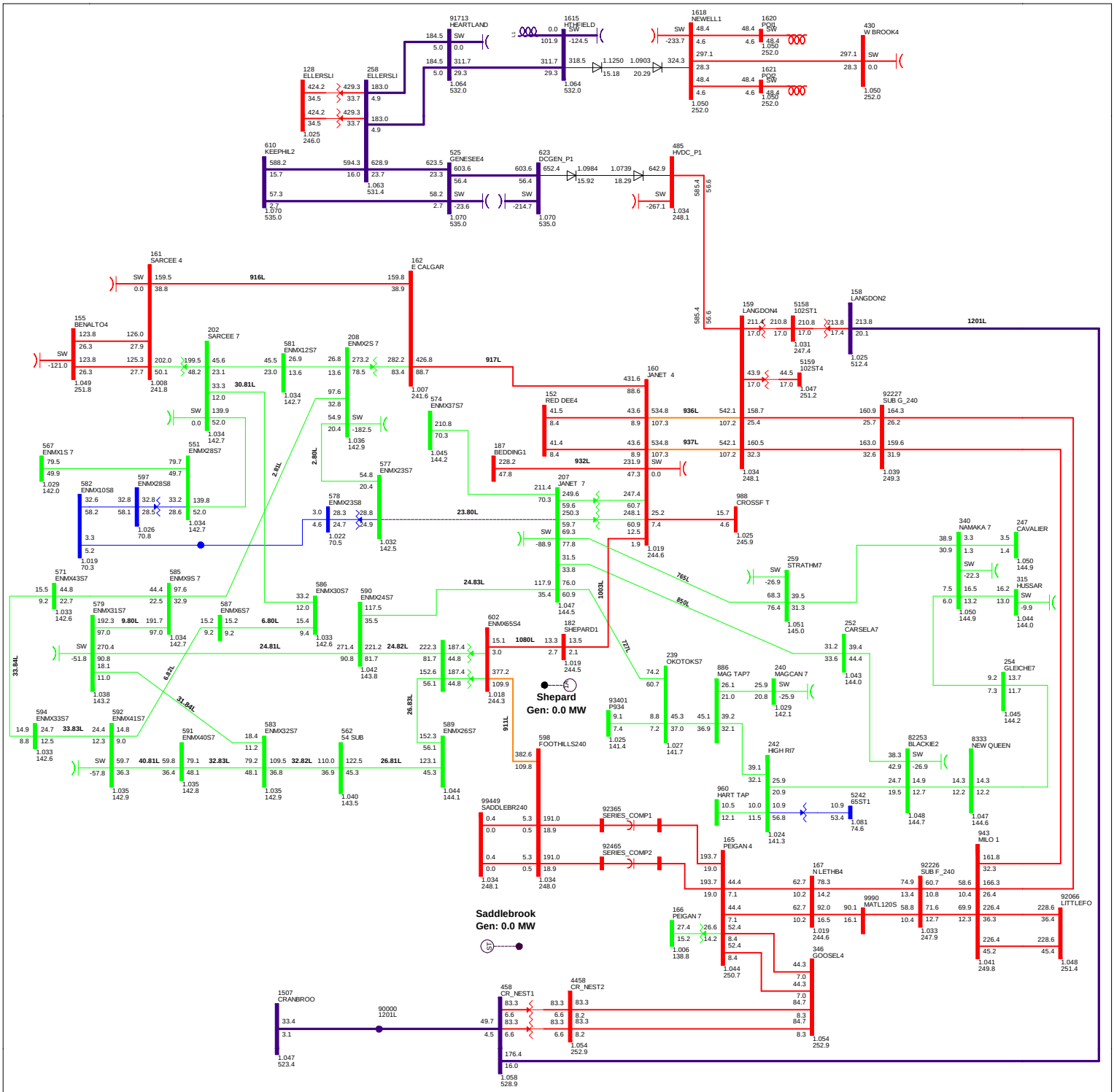
BCH Import: 2.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

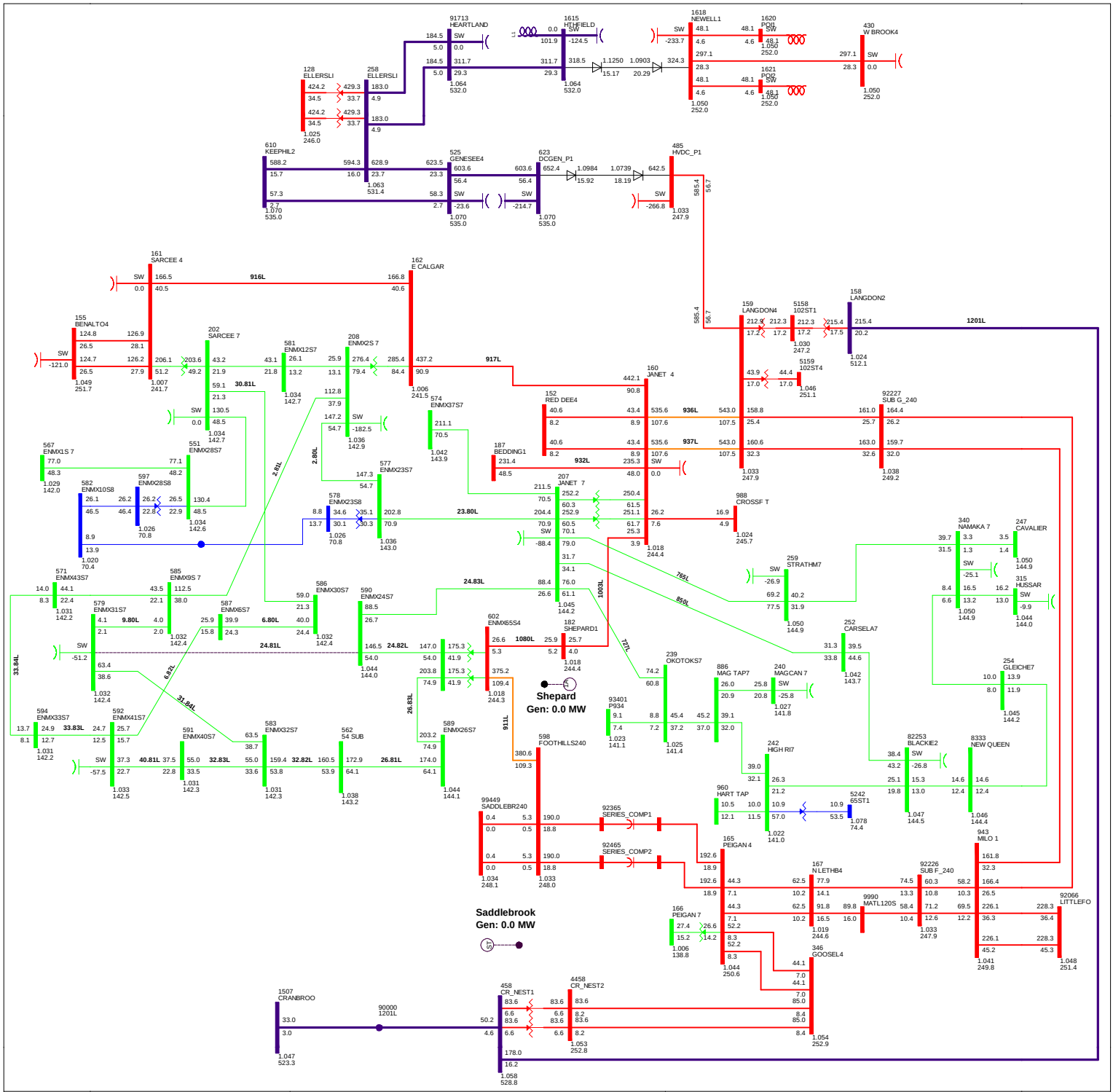
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

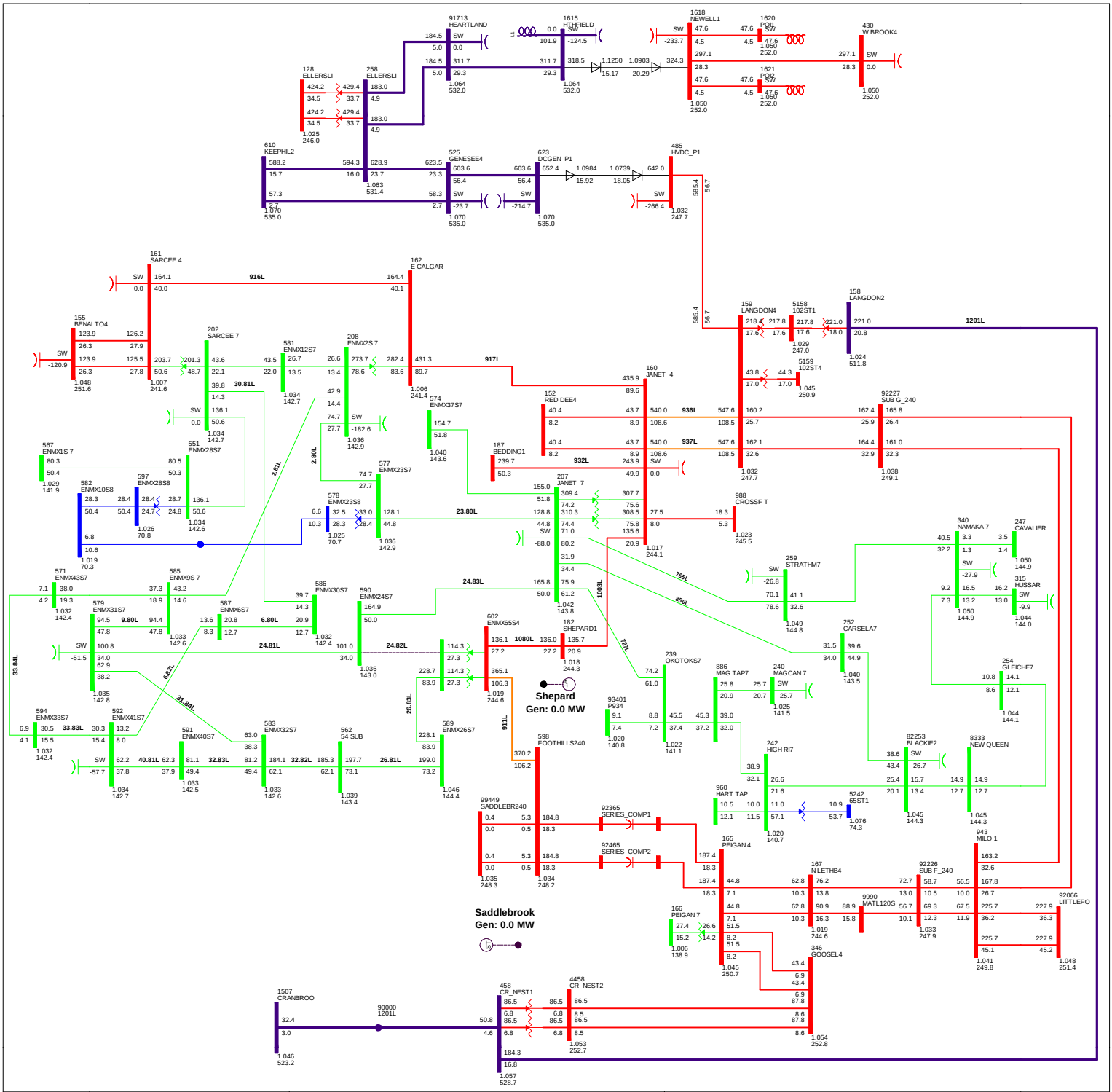
BCH Import: 5.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

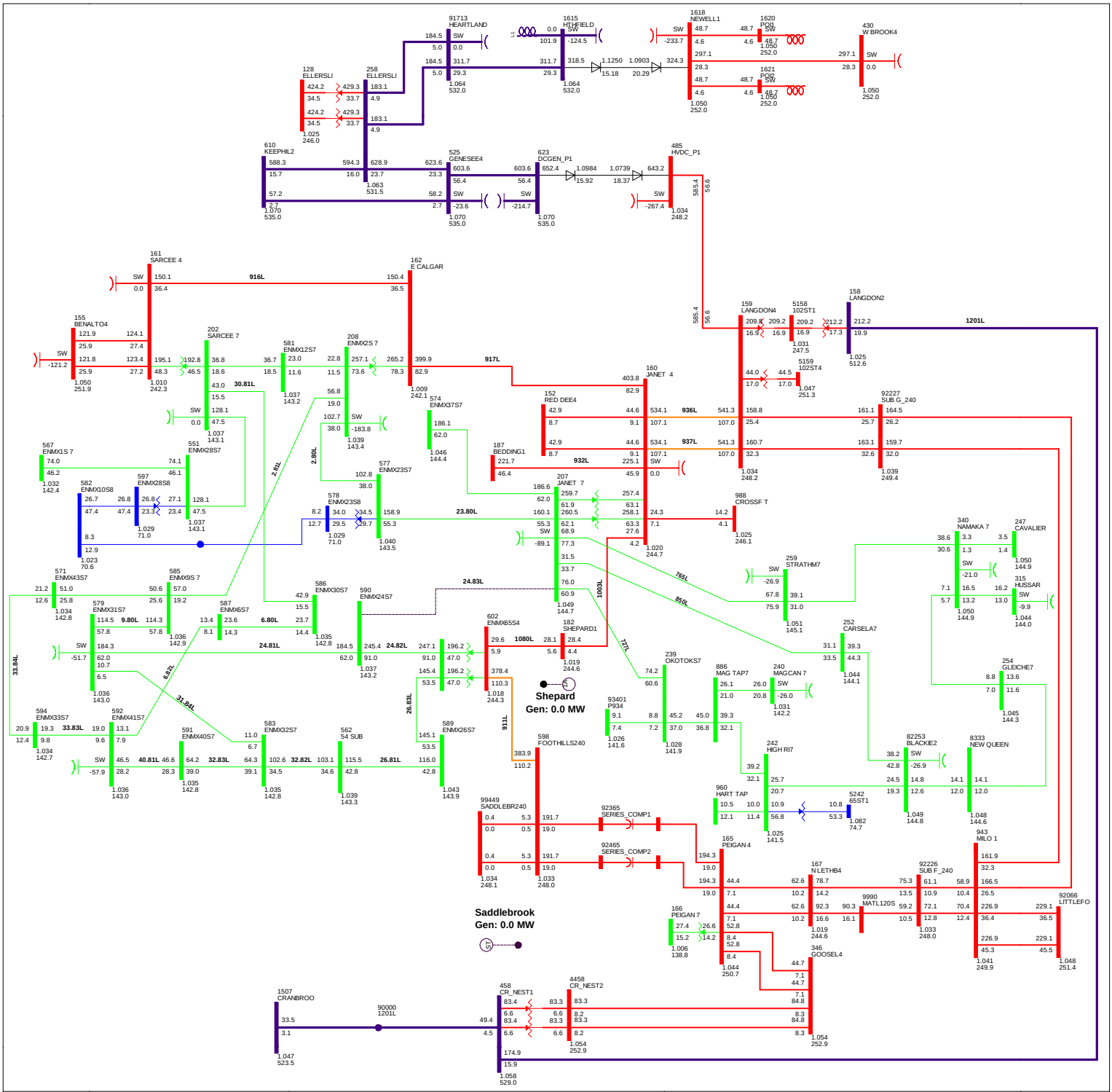
BCH Import: 5.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

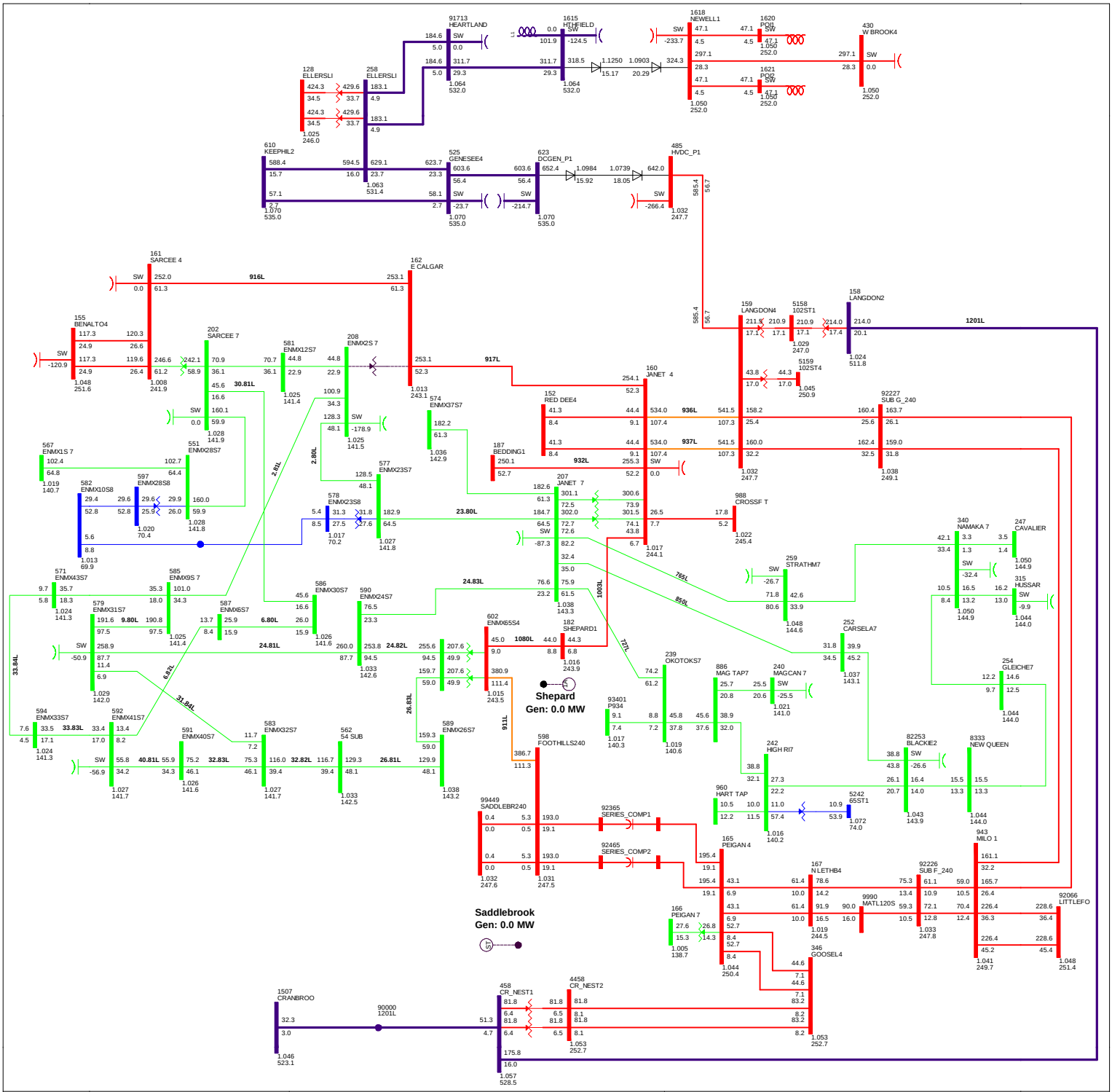
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

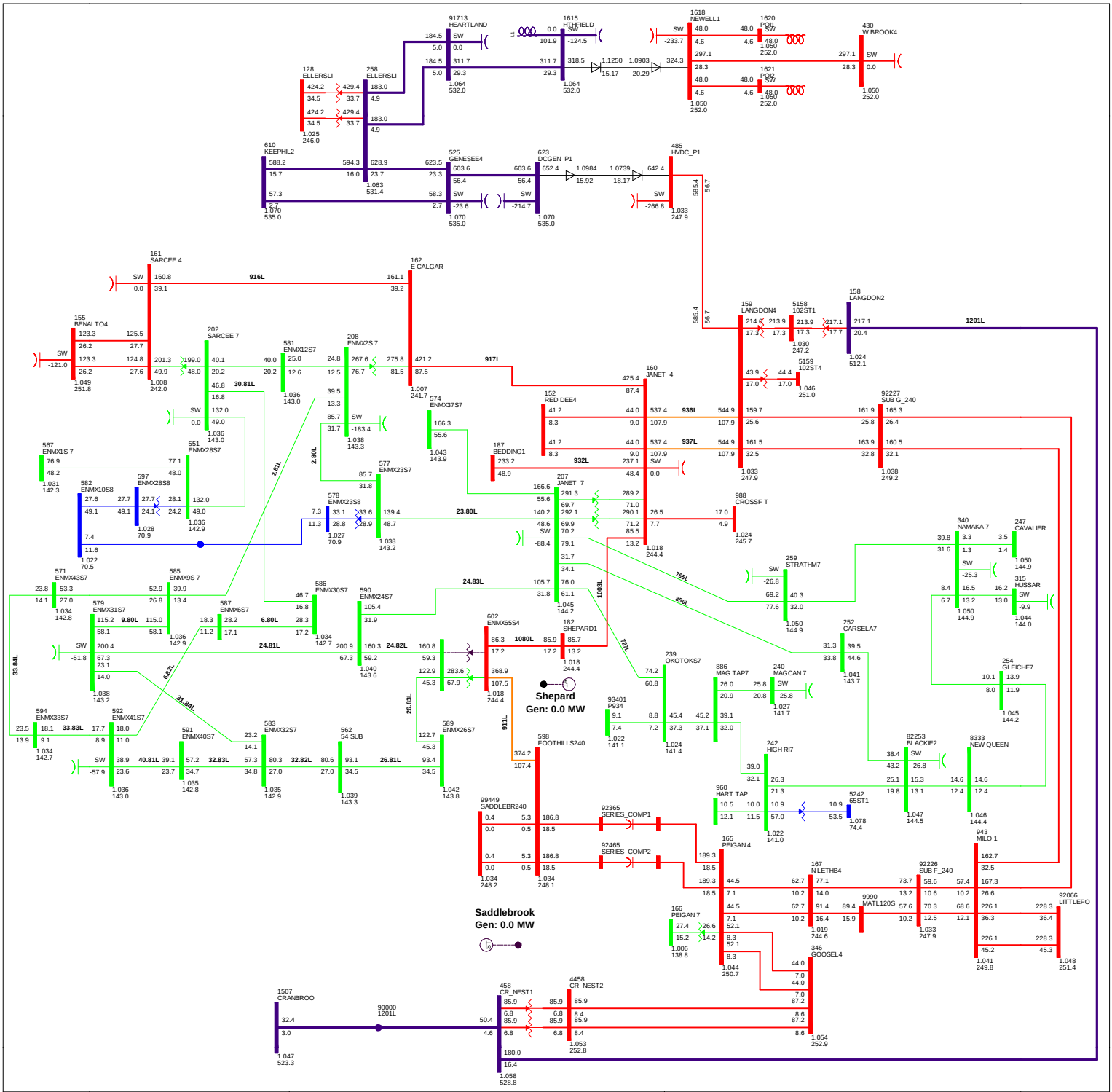
BCH Import: 7.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

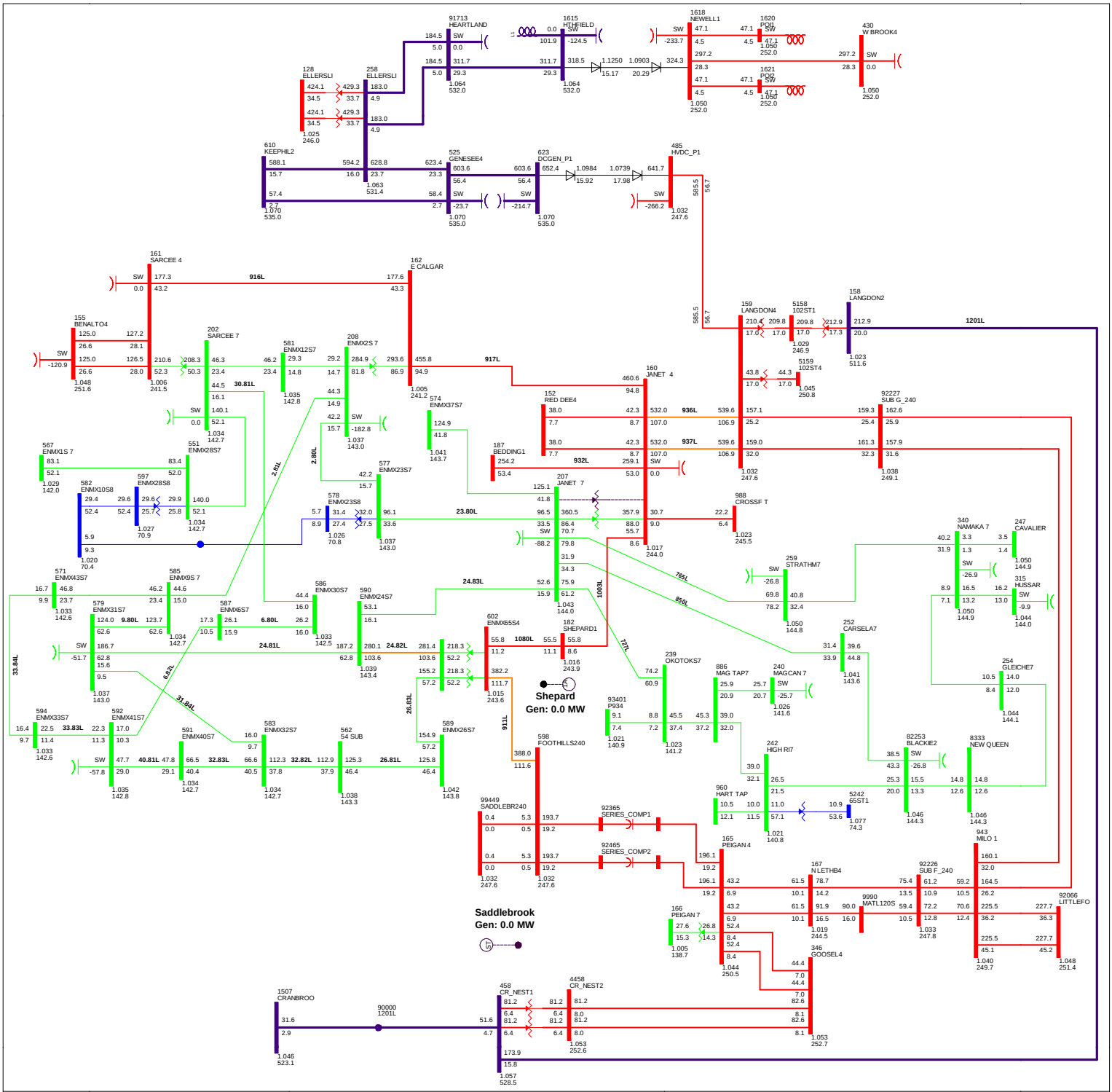
BCH Import: 2.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

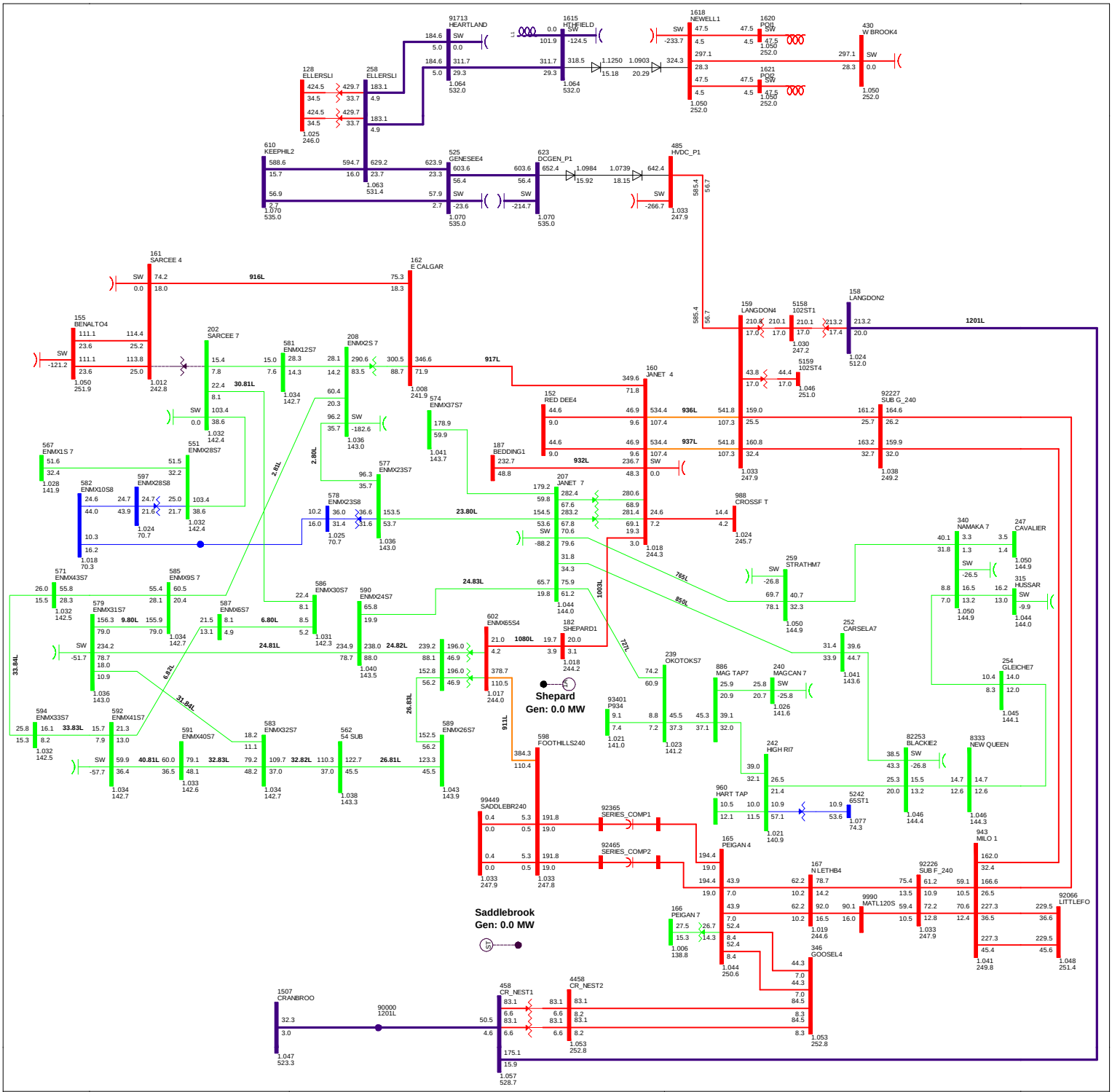
BCH Import: 5.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

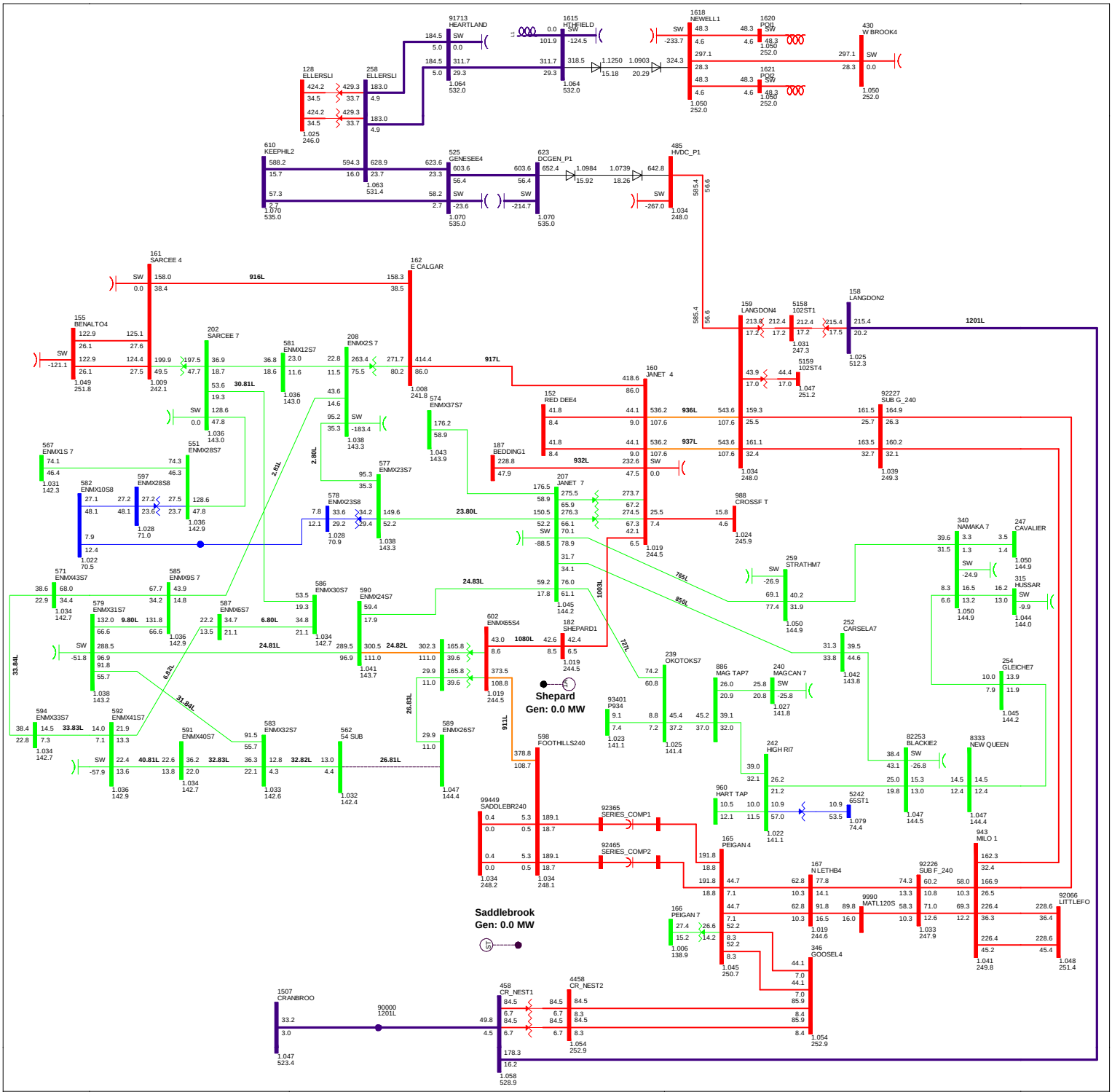
BCH Import: 3.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

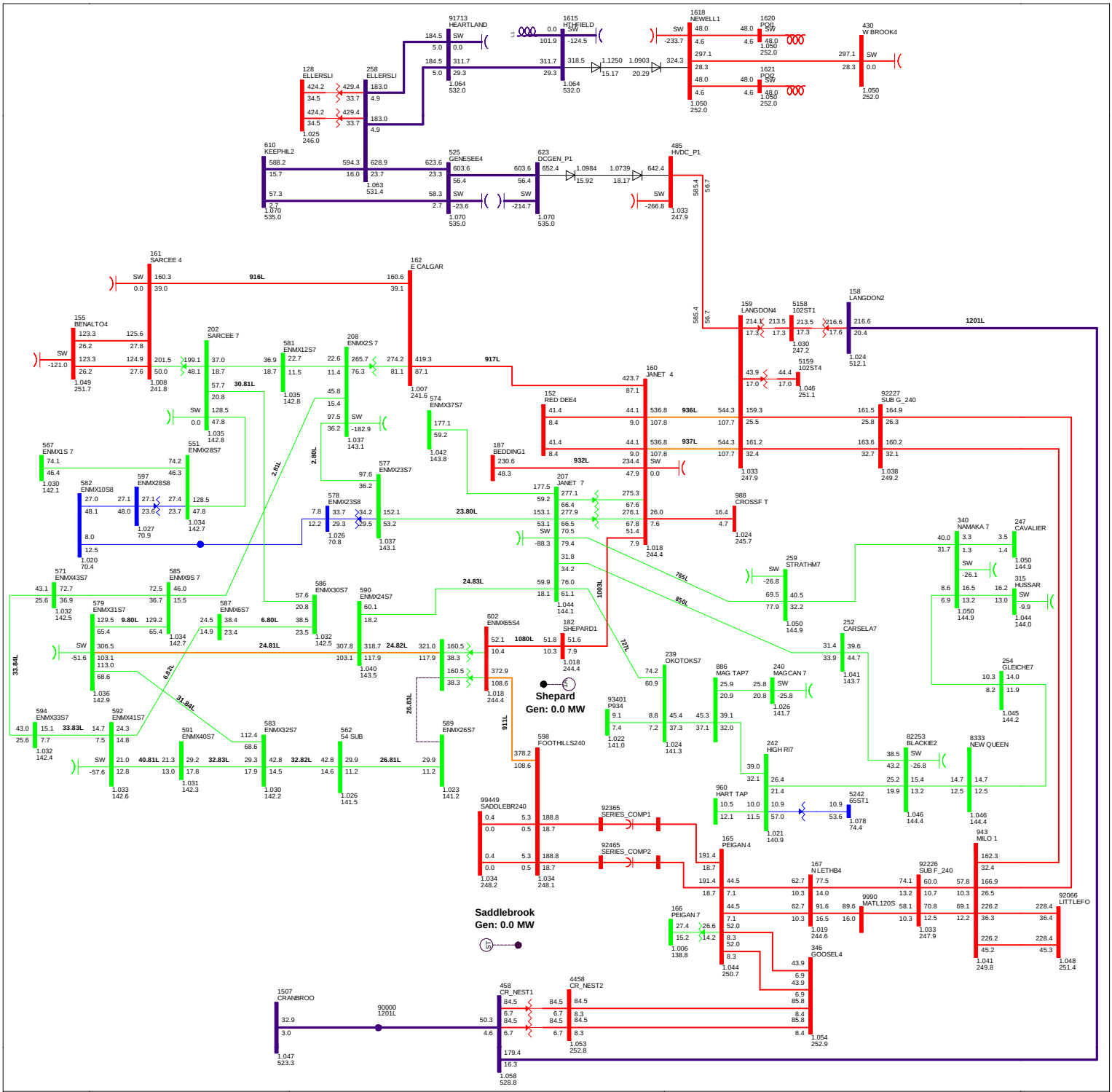
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

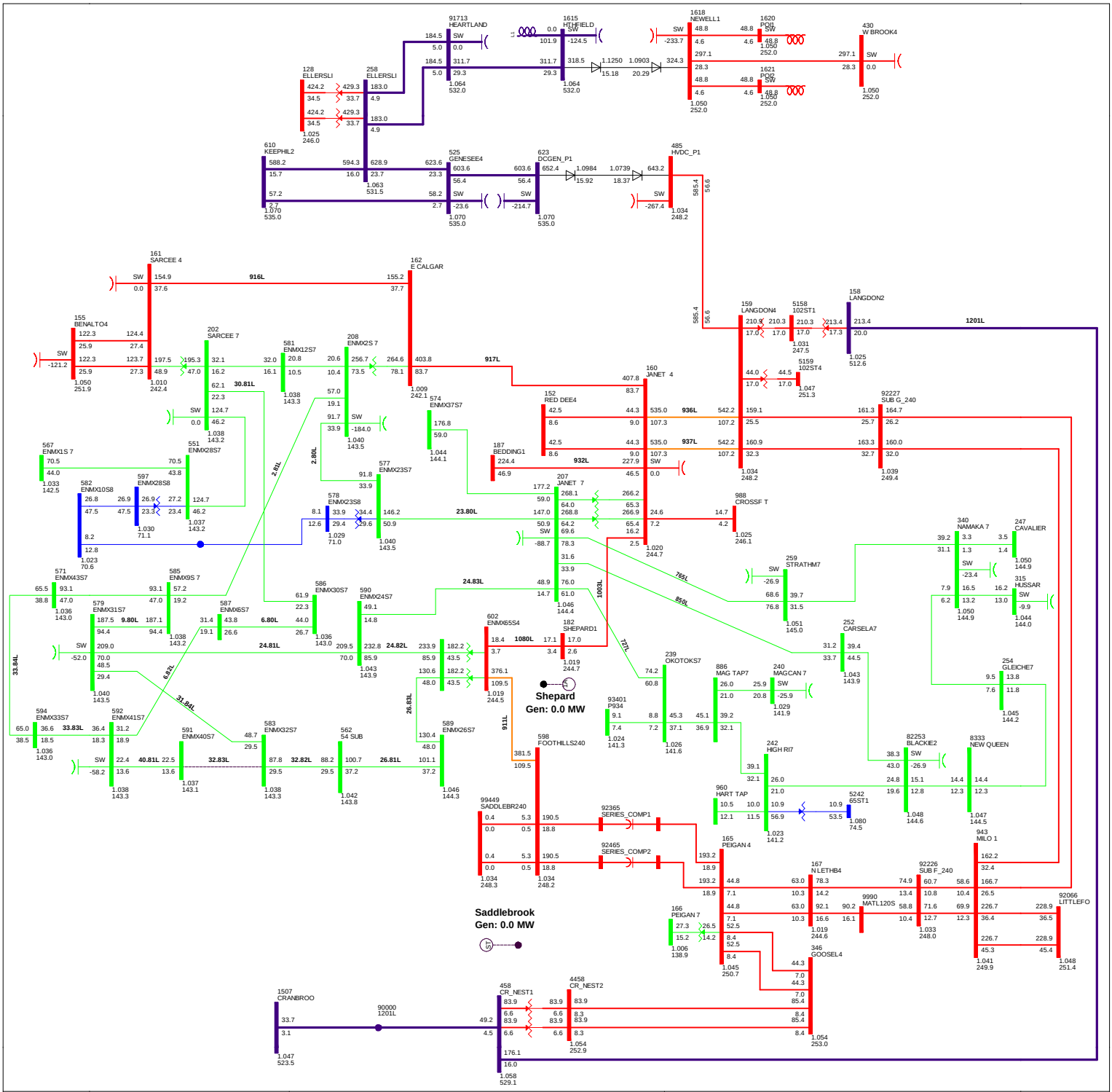
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

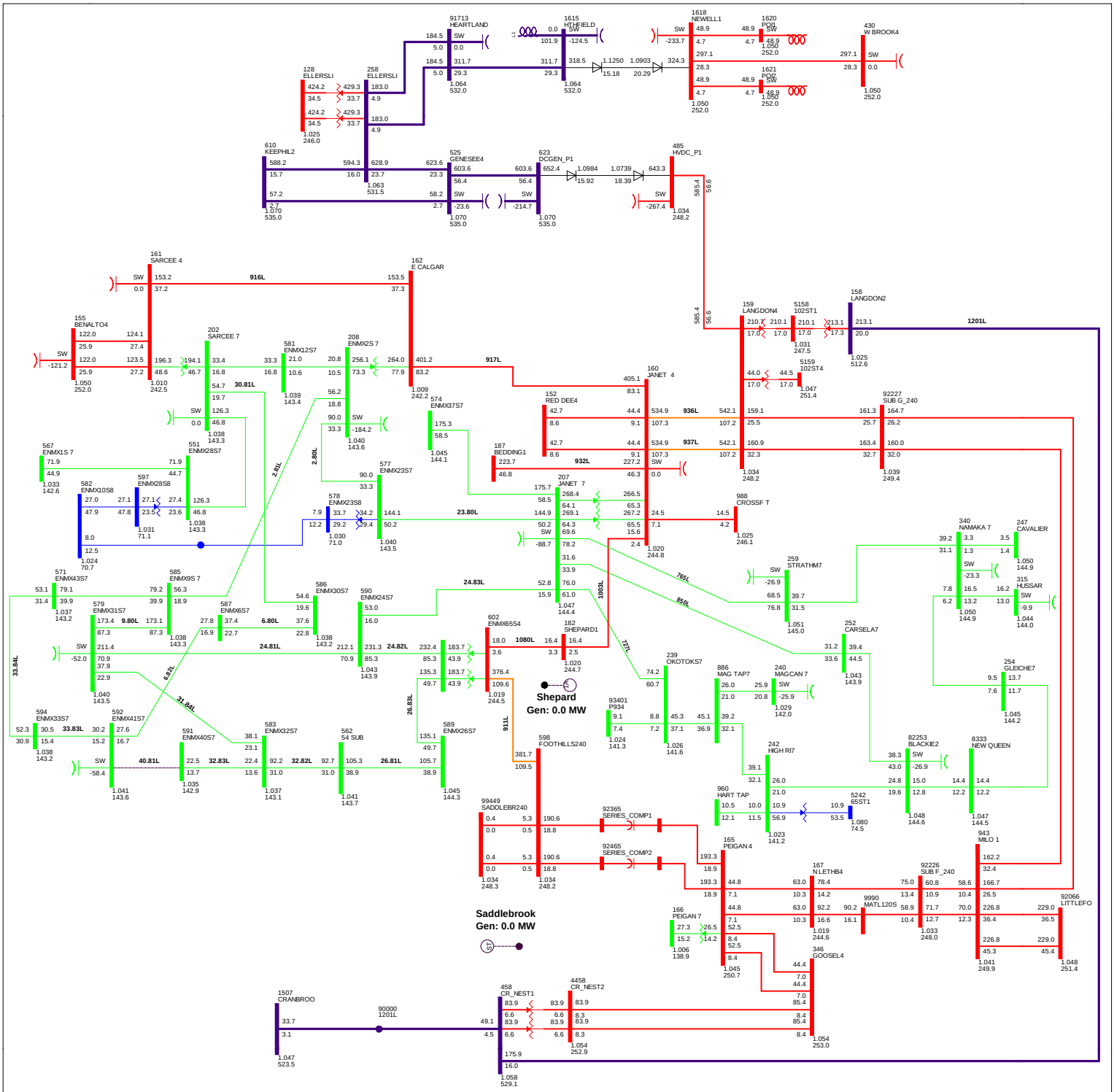
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

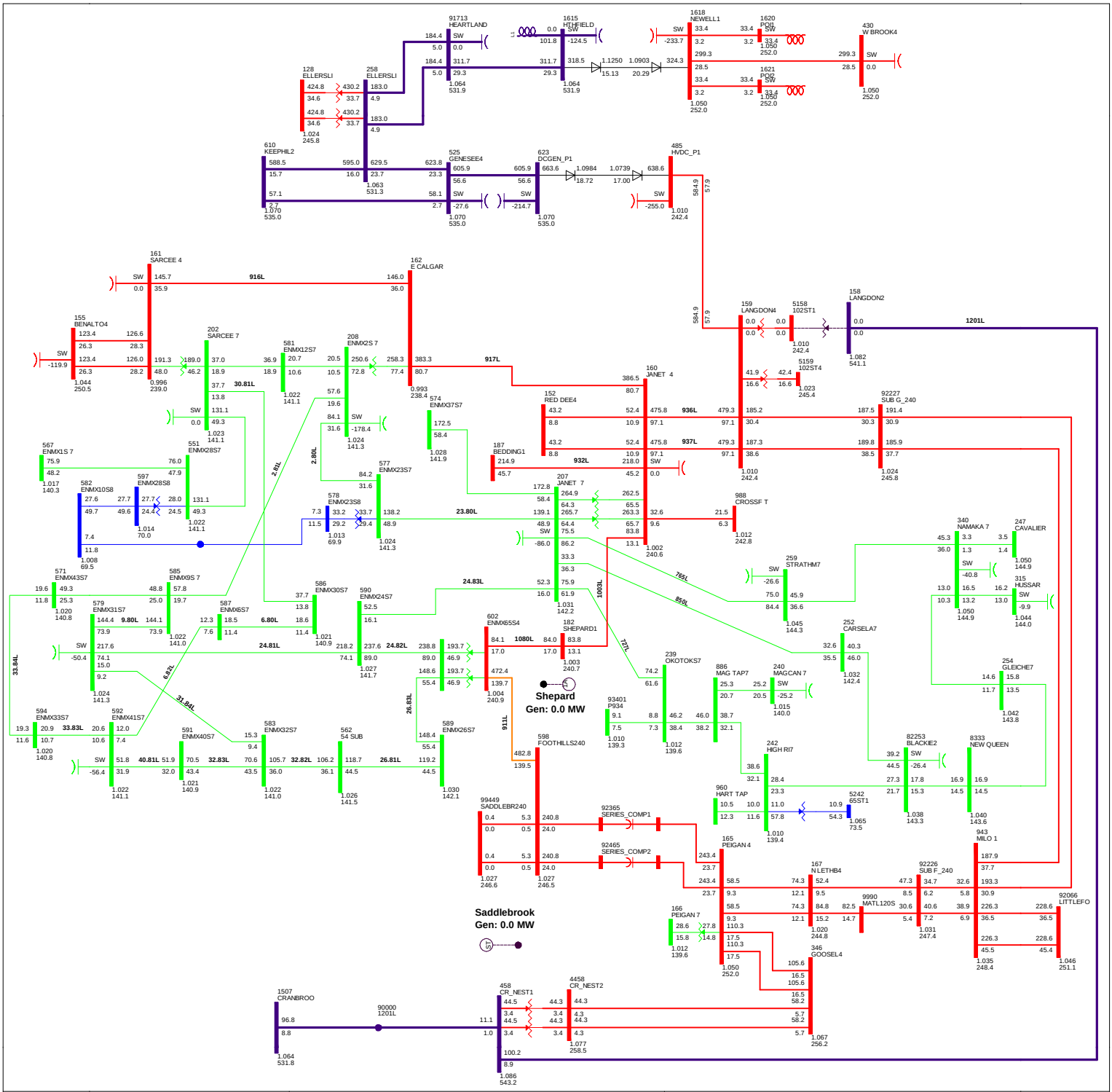
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

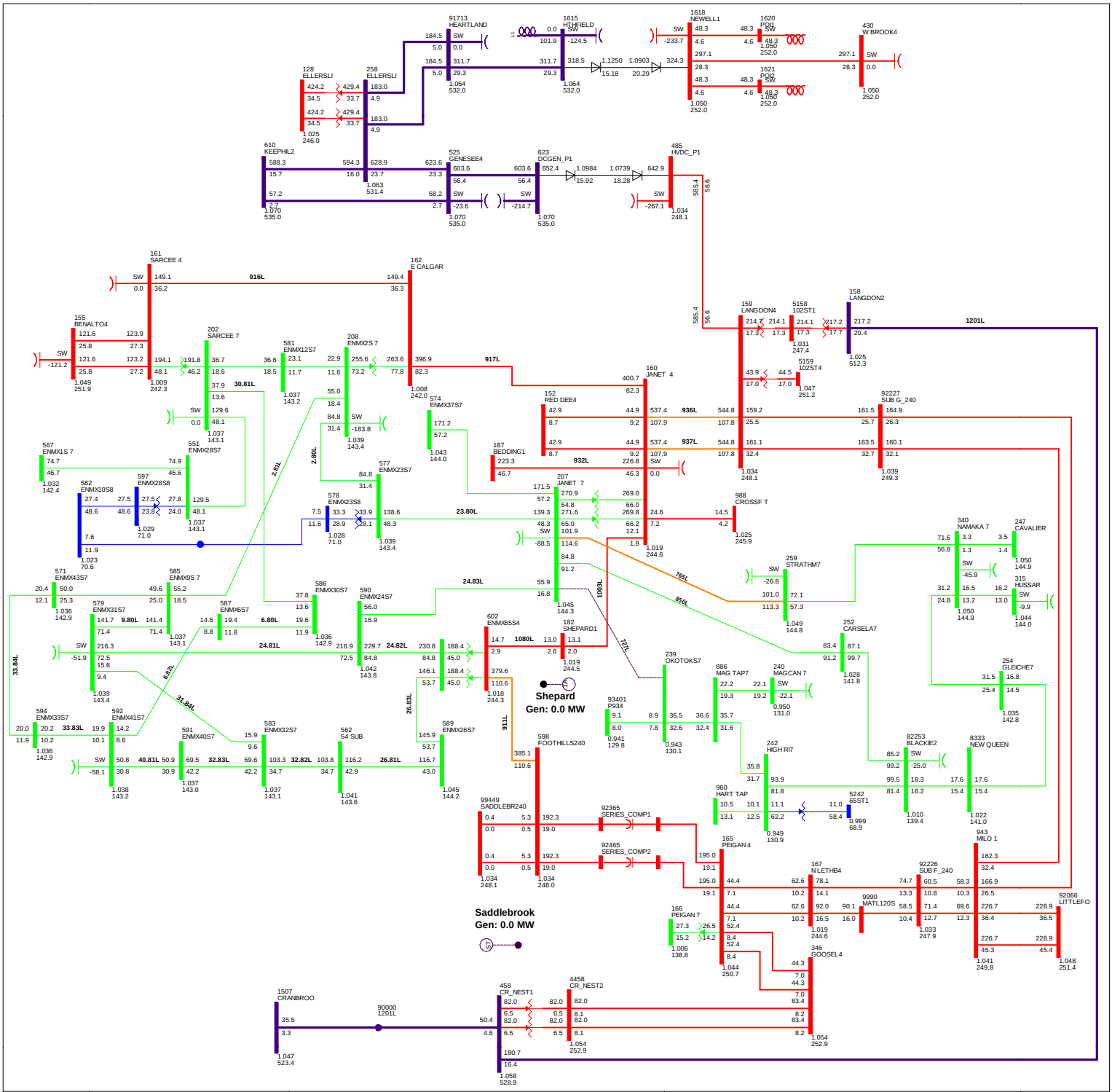
BCH Import: 12.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

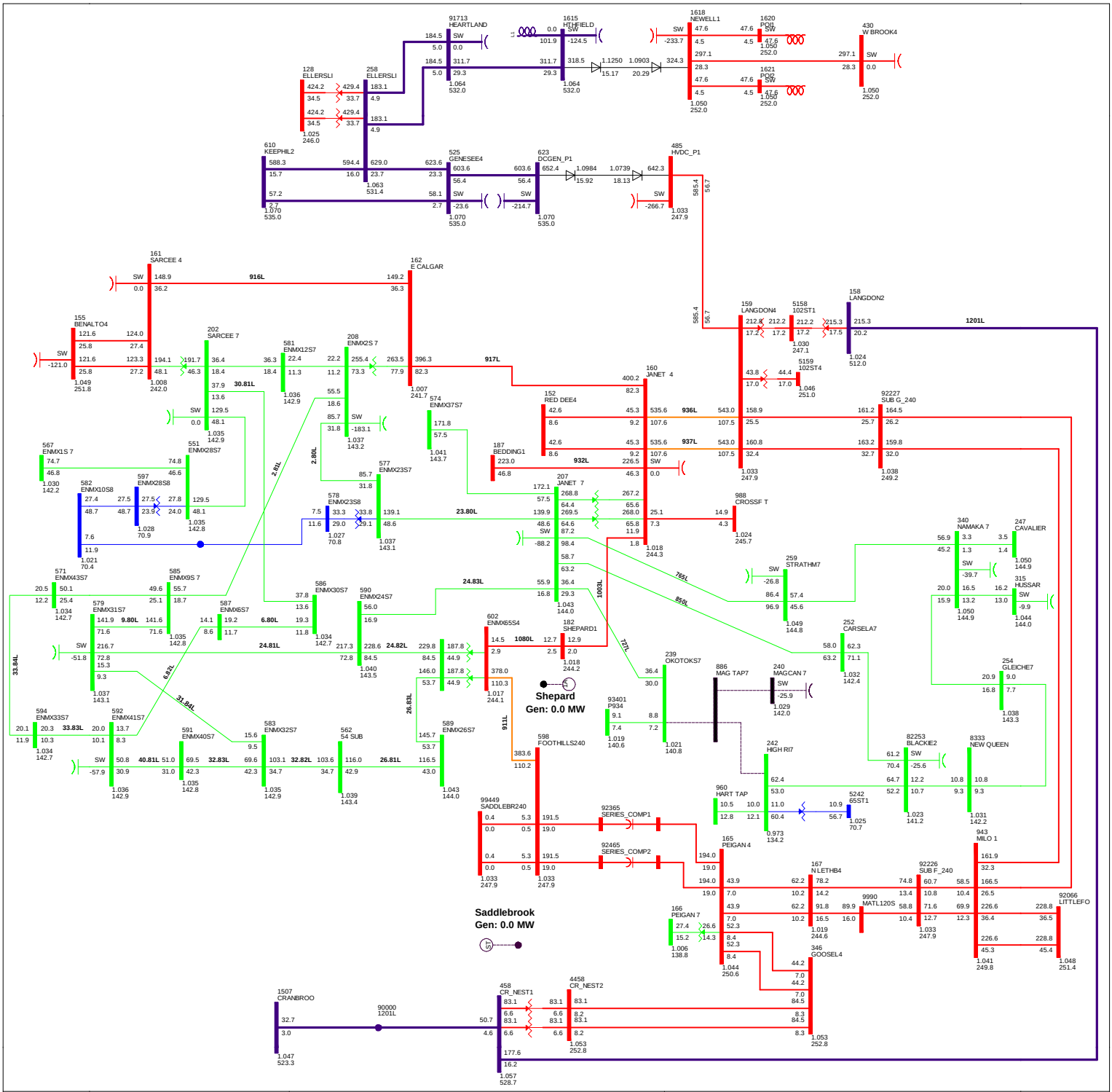
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 11.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

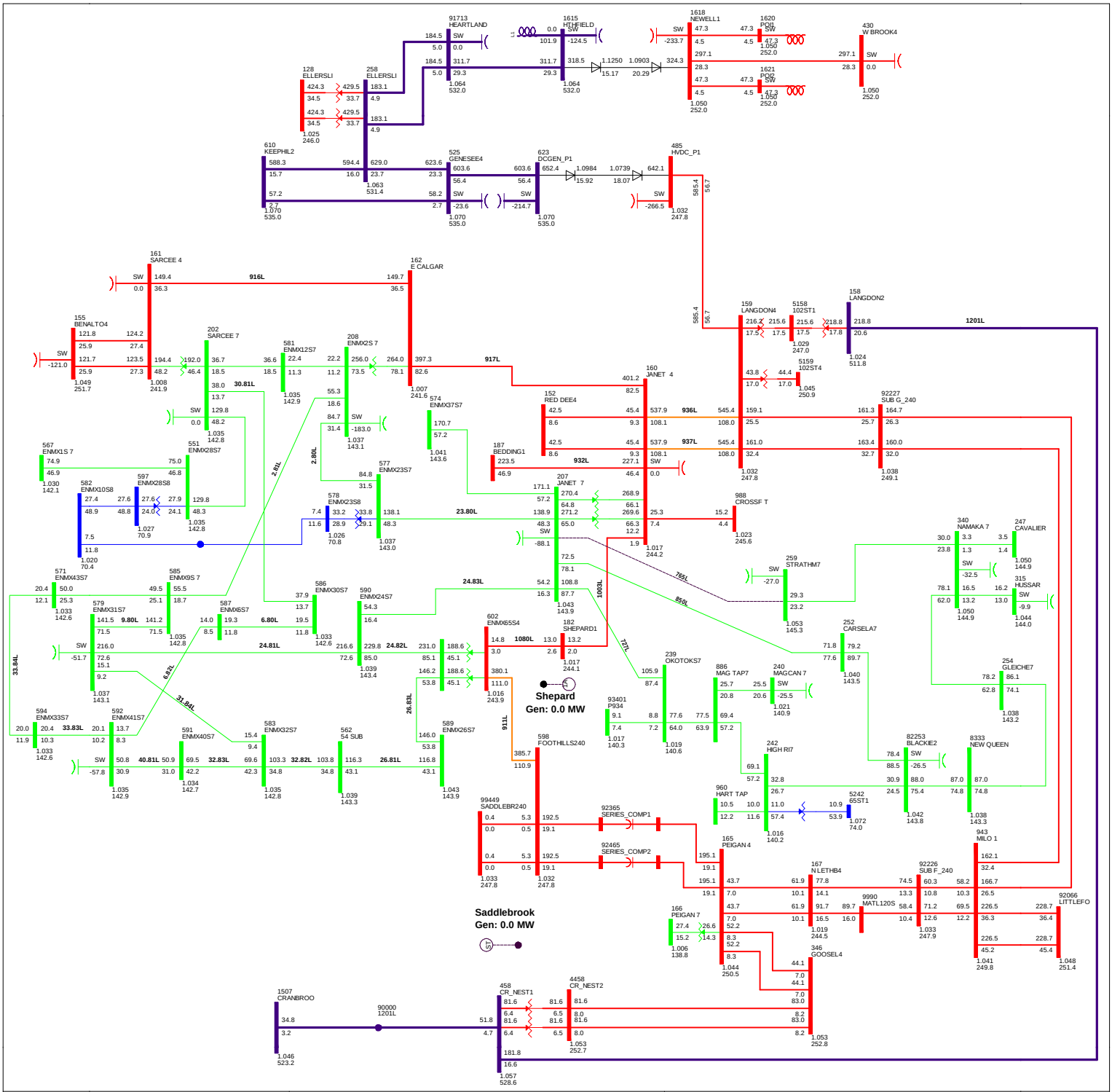
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 5.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

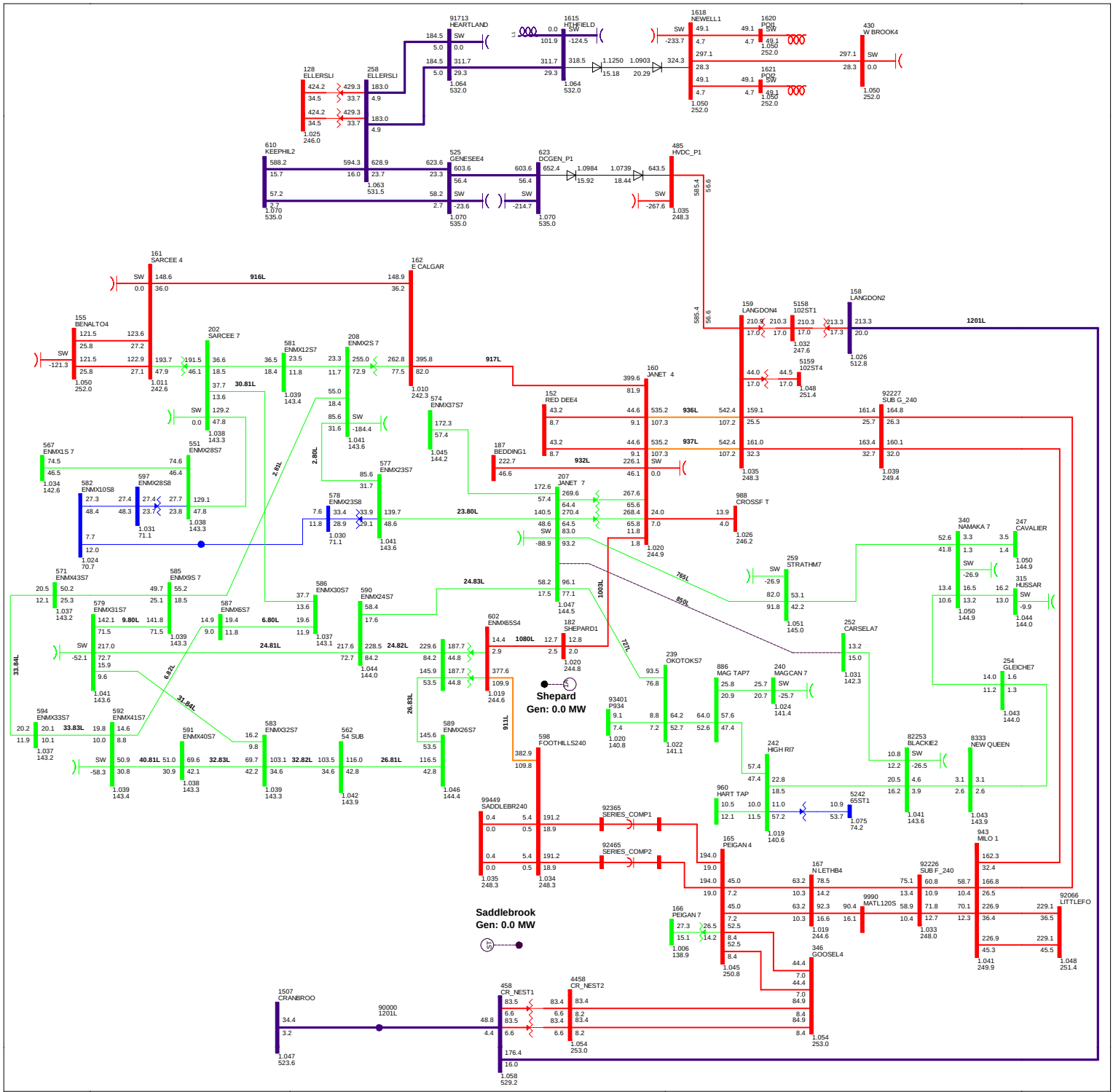
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 12.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-22: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

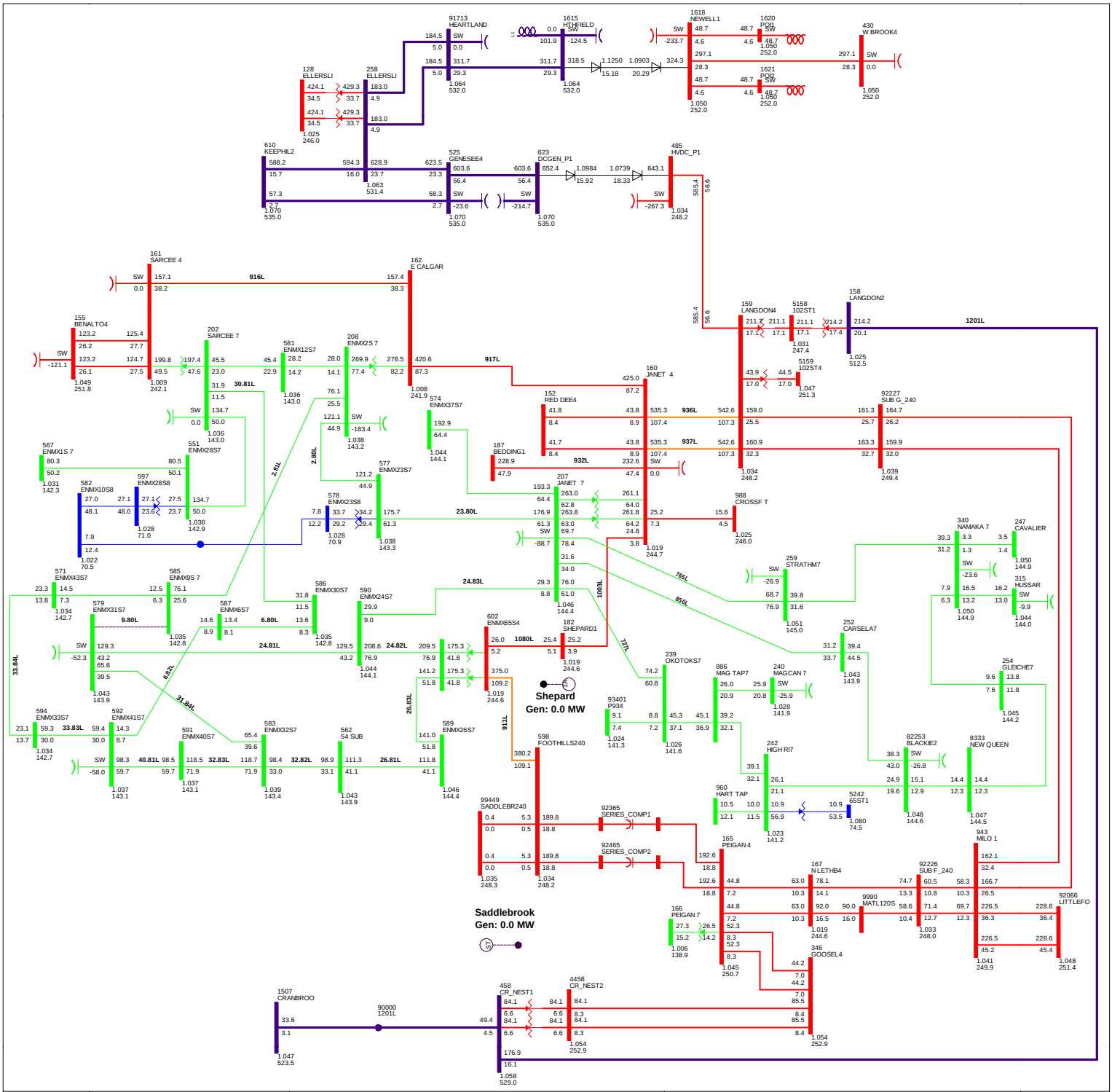
BCH Import: 4.0 MW

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-23: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:16



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

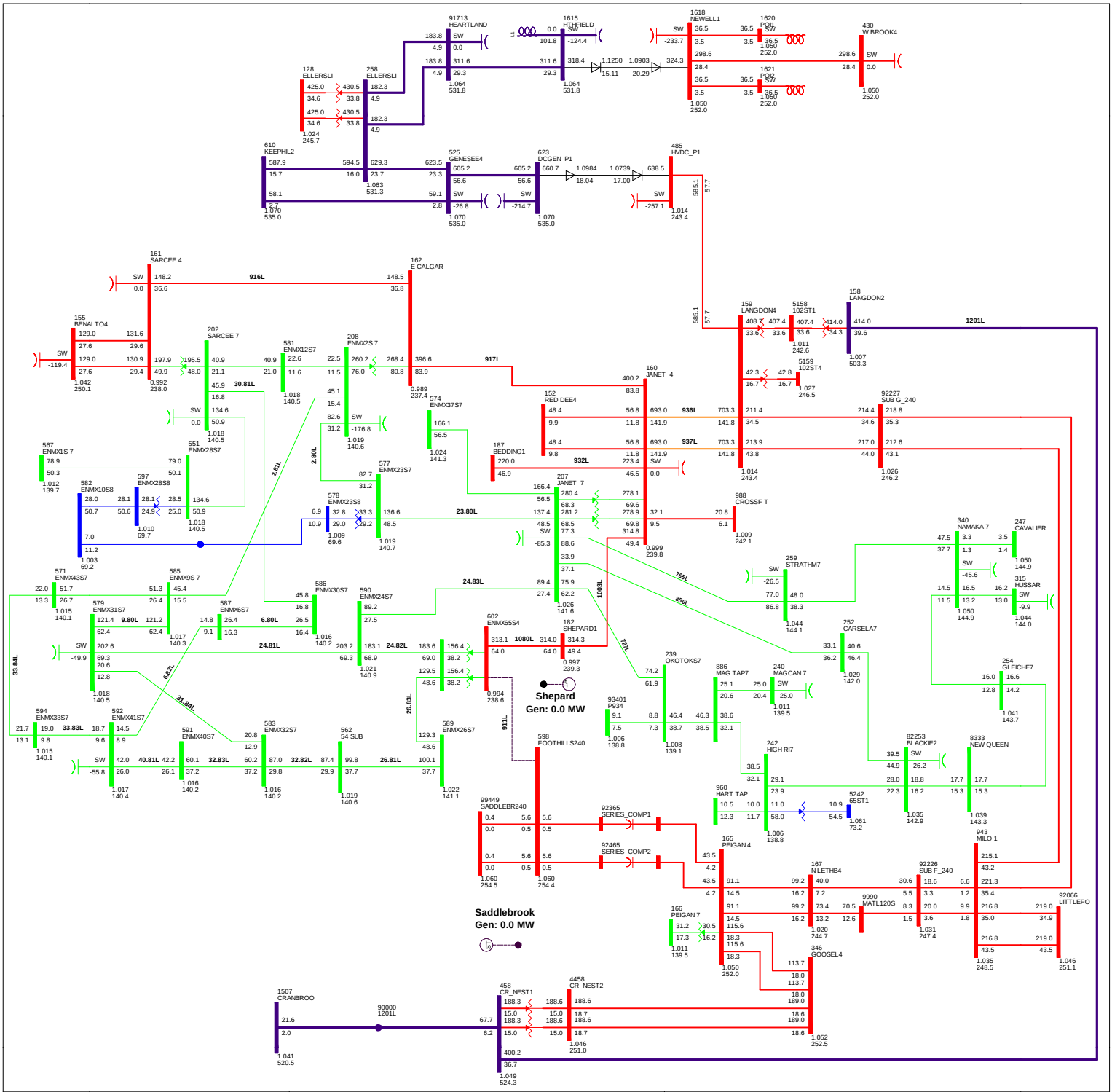
BCH Import: 3.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-24: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

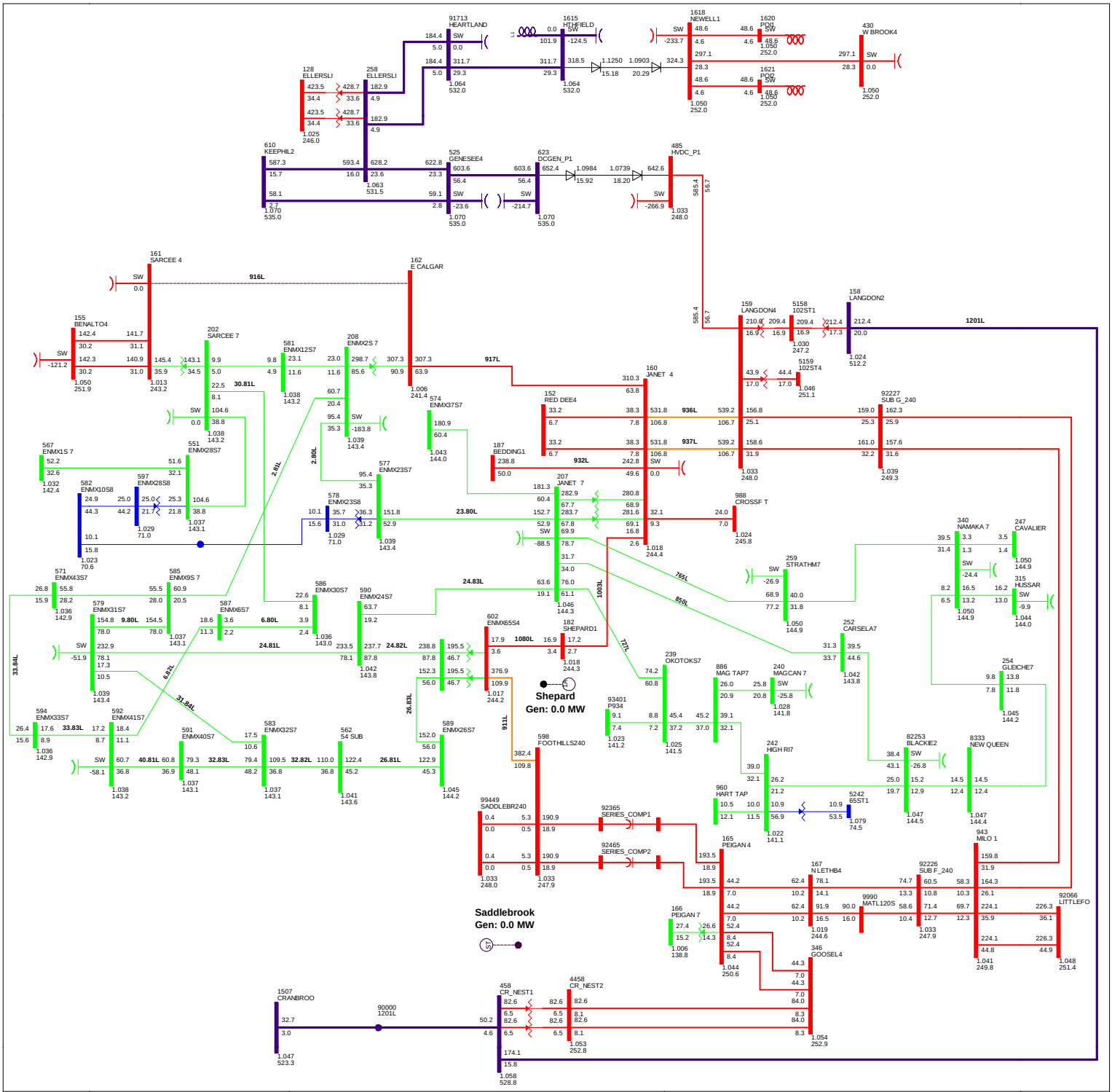
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 17.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-25: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX 2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

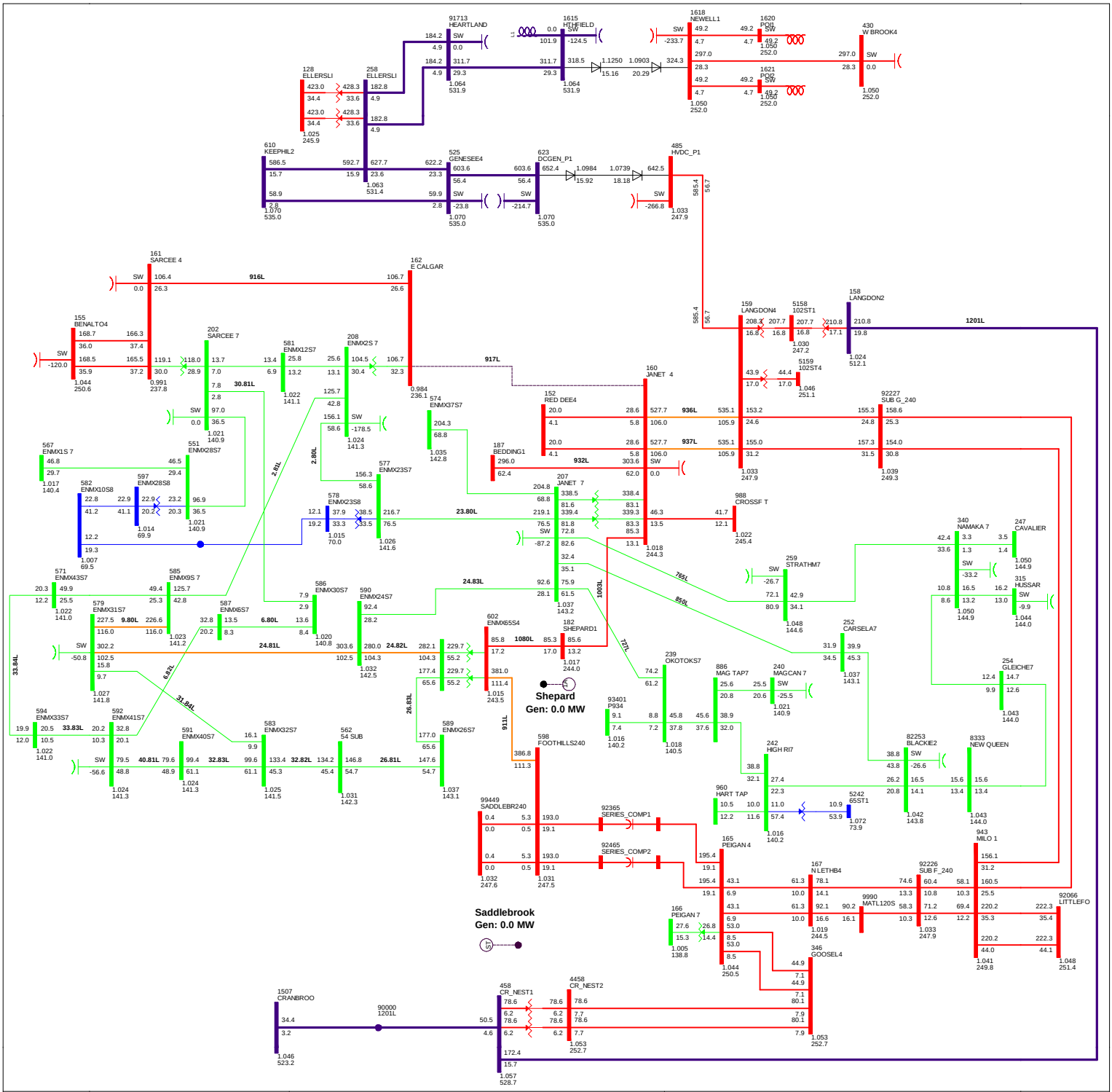
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-26: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

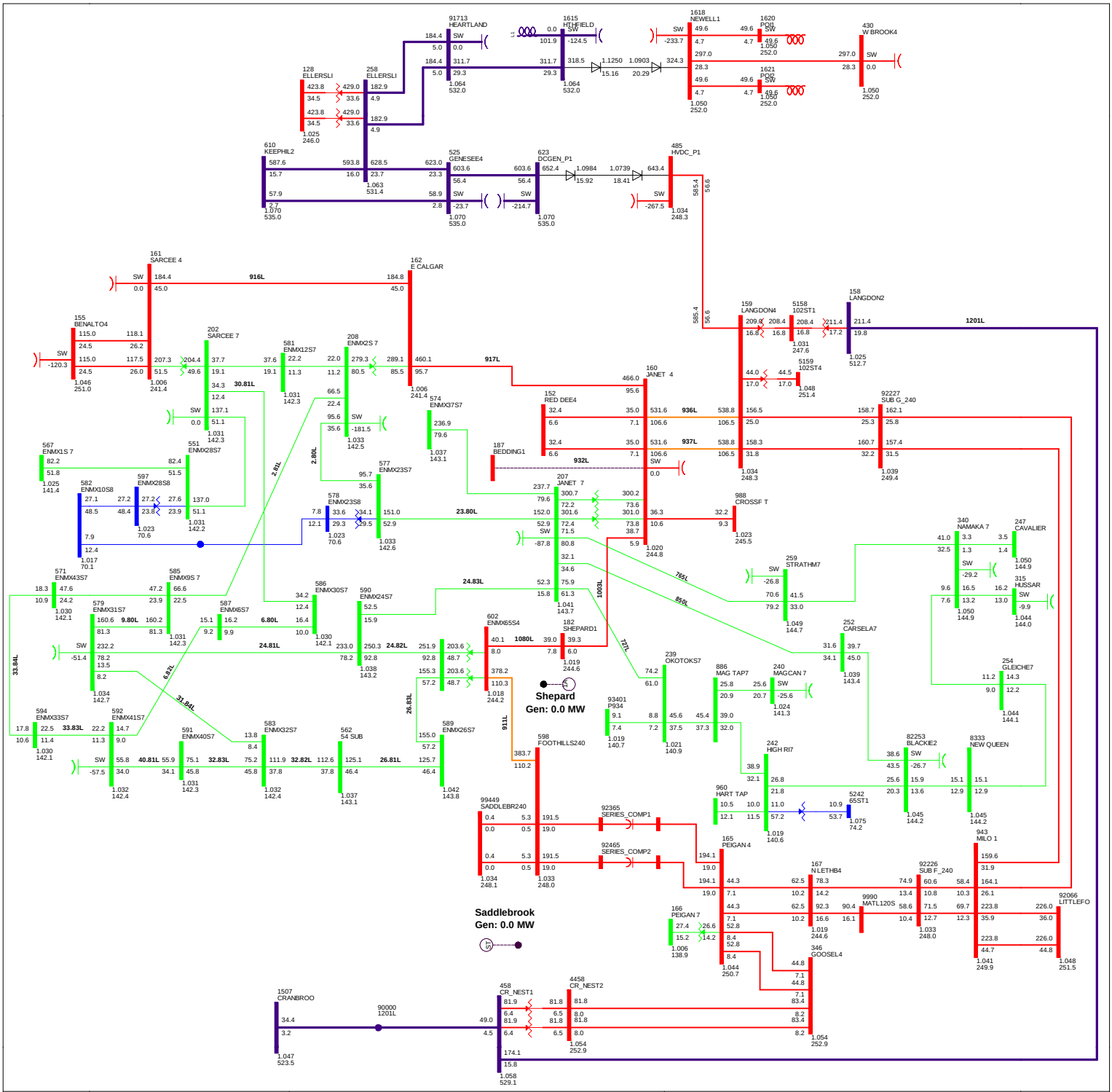
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 13.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-27: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

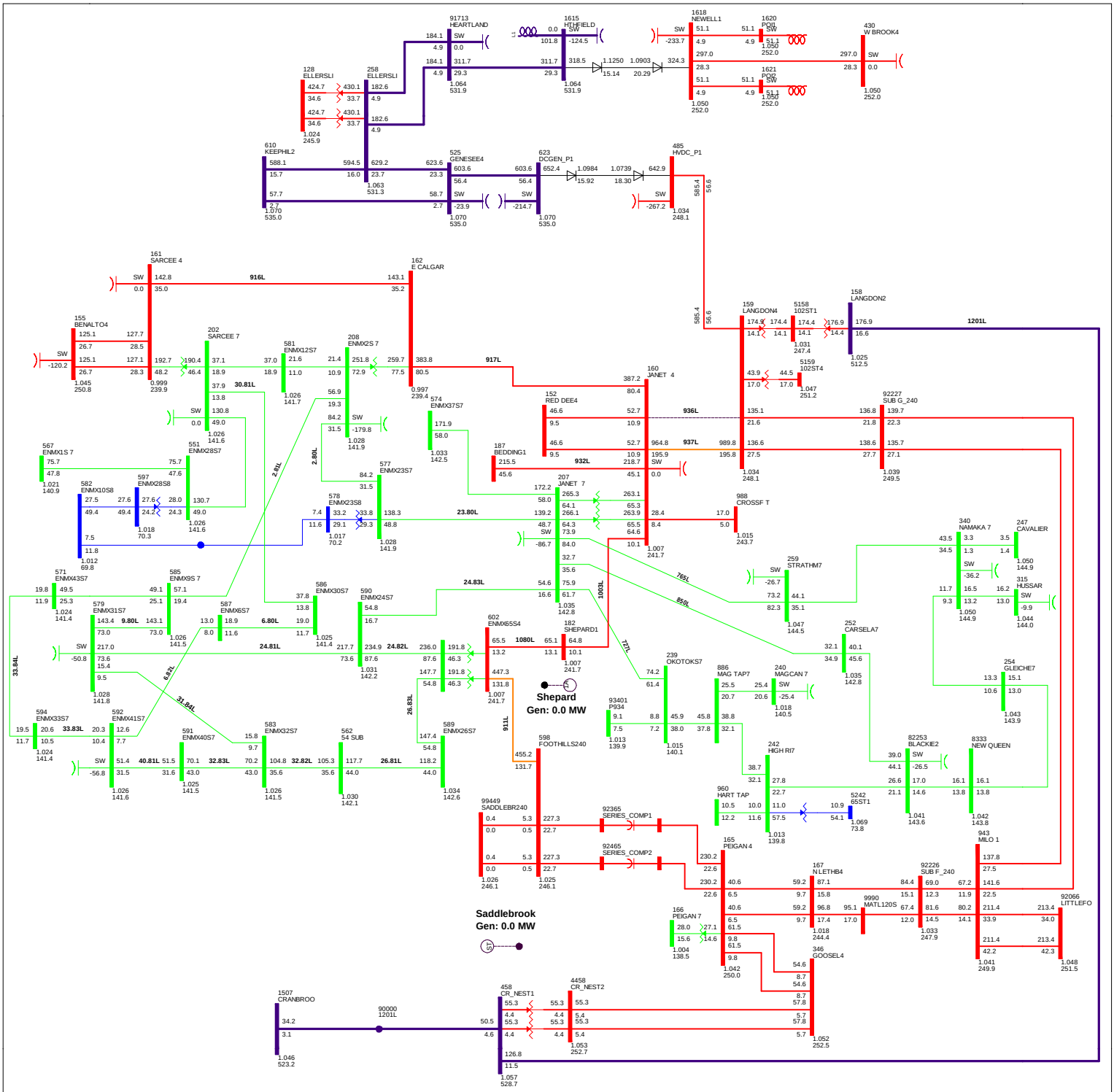
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 6.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-28: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

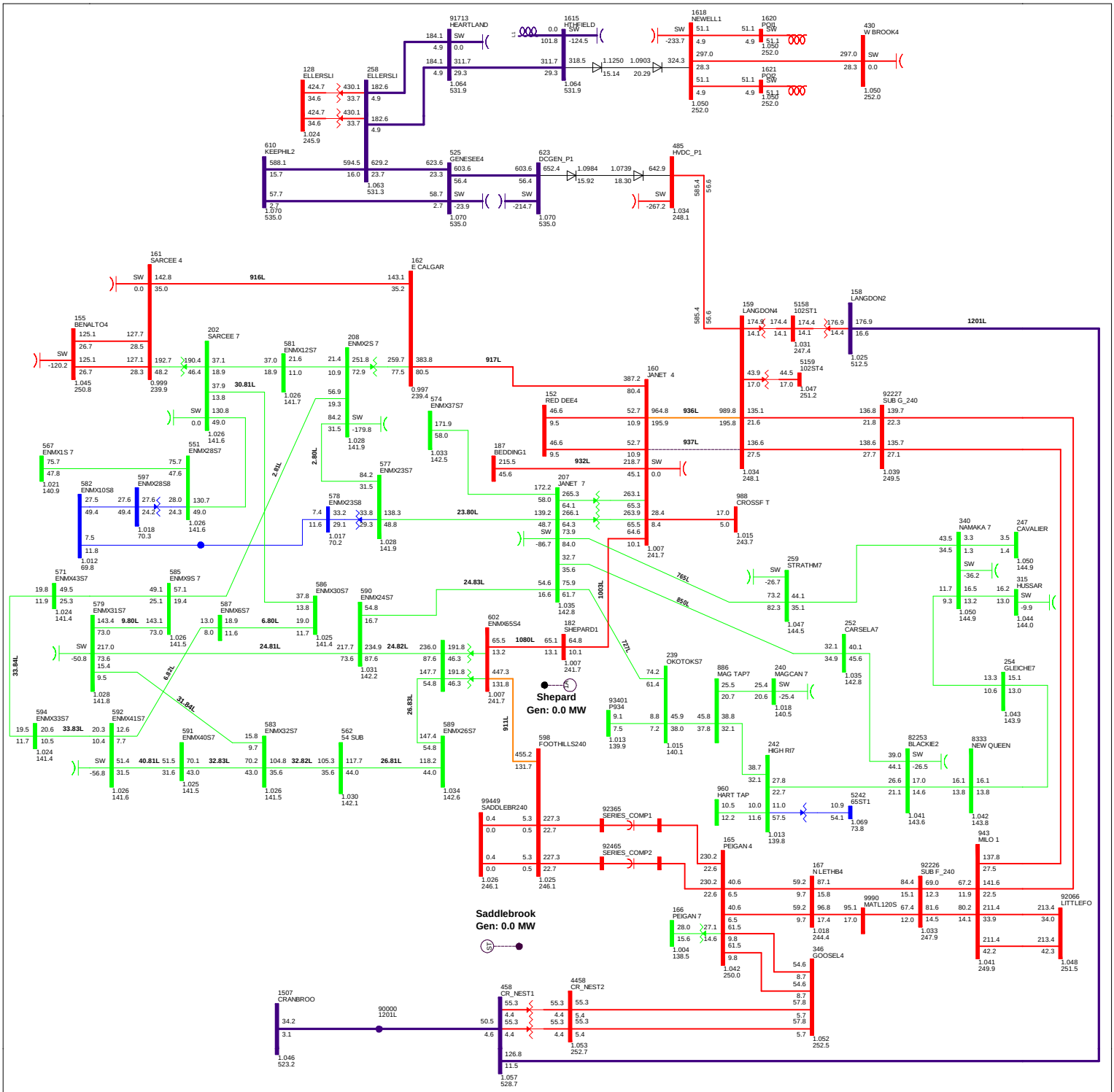
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 14.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-29: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

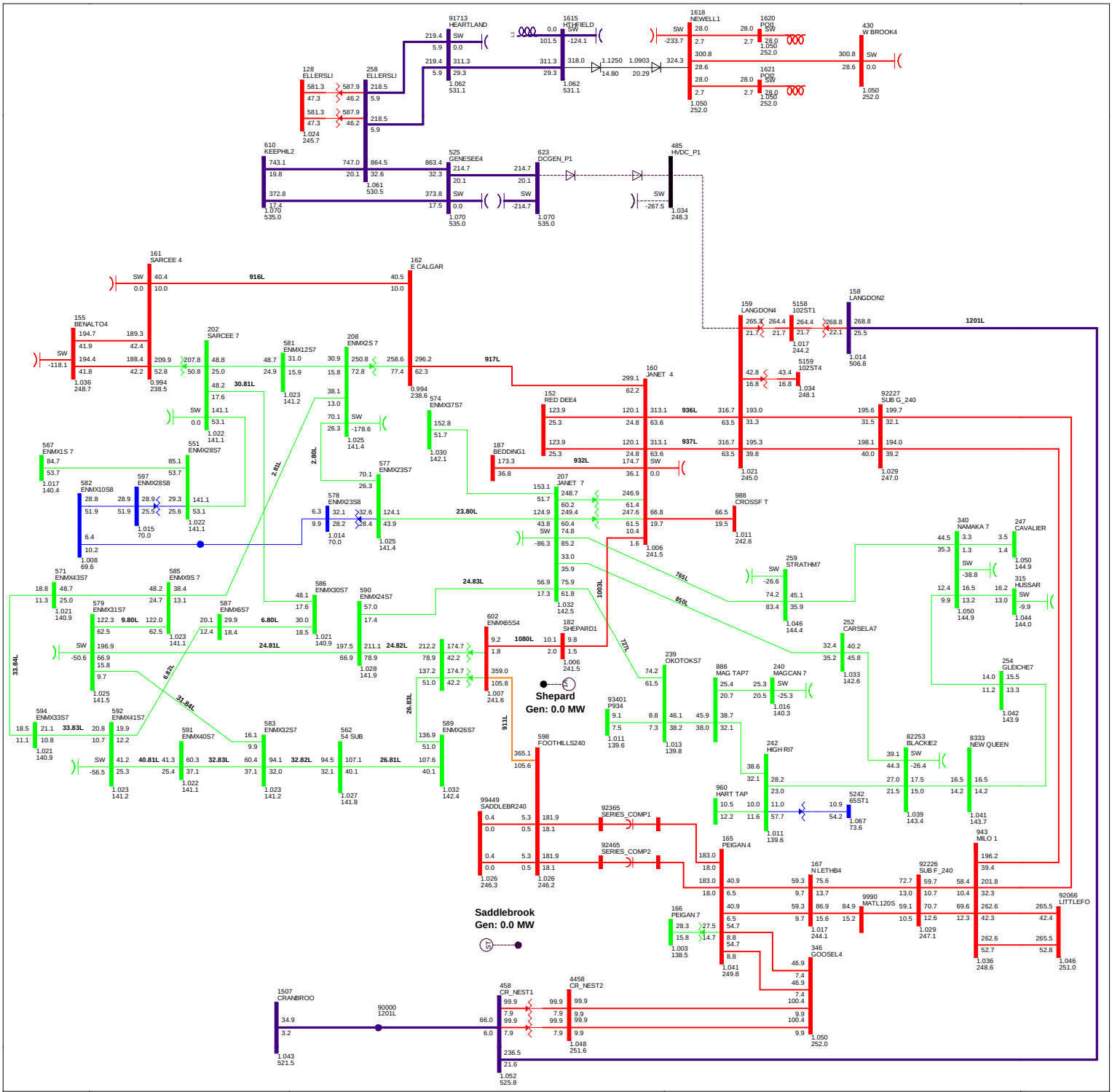
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 14.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-30: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 23.9 MW

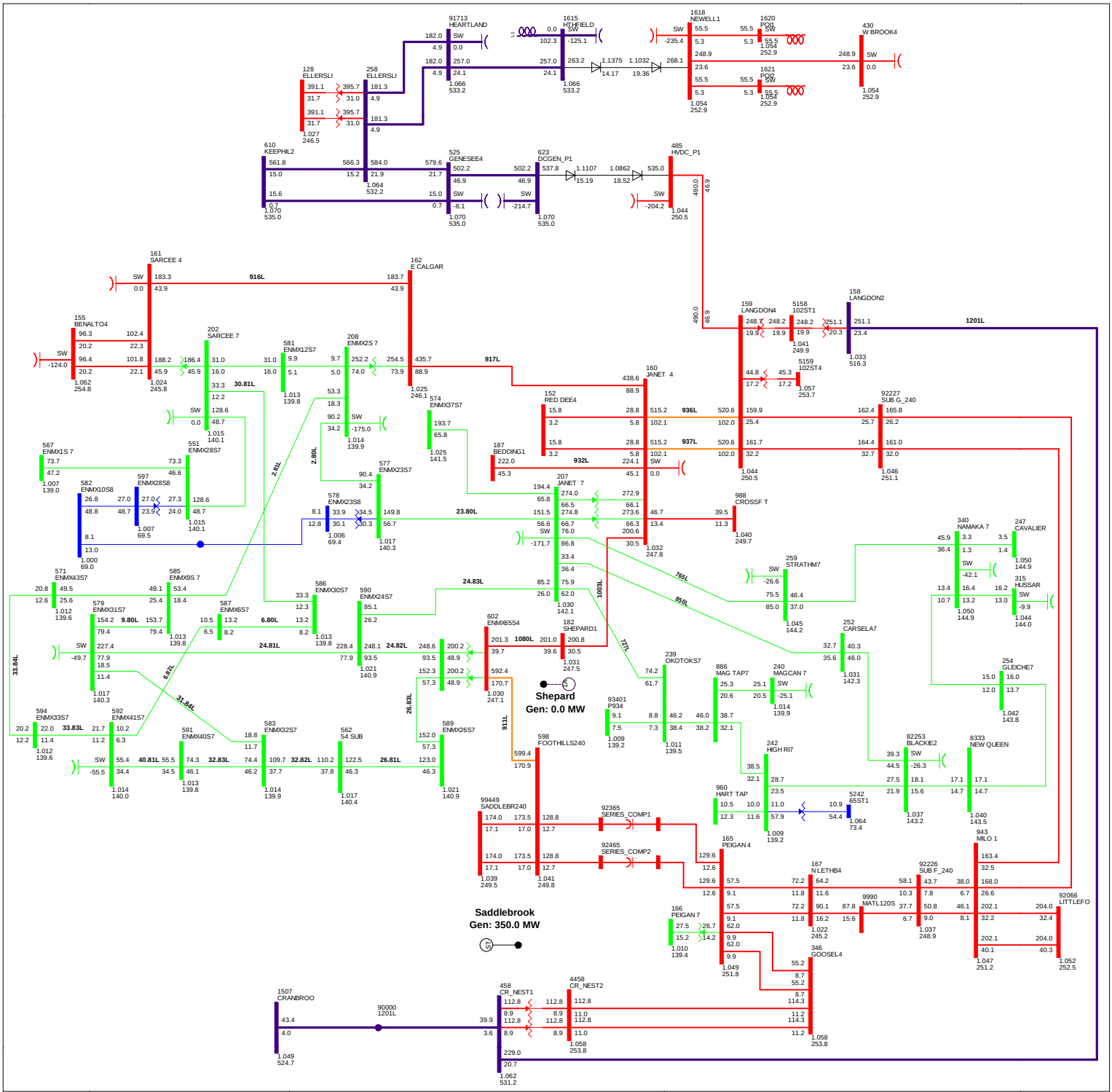
2012LTO+HVDC EXISTING SYSTEM

FIG A-SC2-31: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2014_NEED_HVDC_SC2

FRI, JUN 08 2012 16:17

2014 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

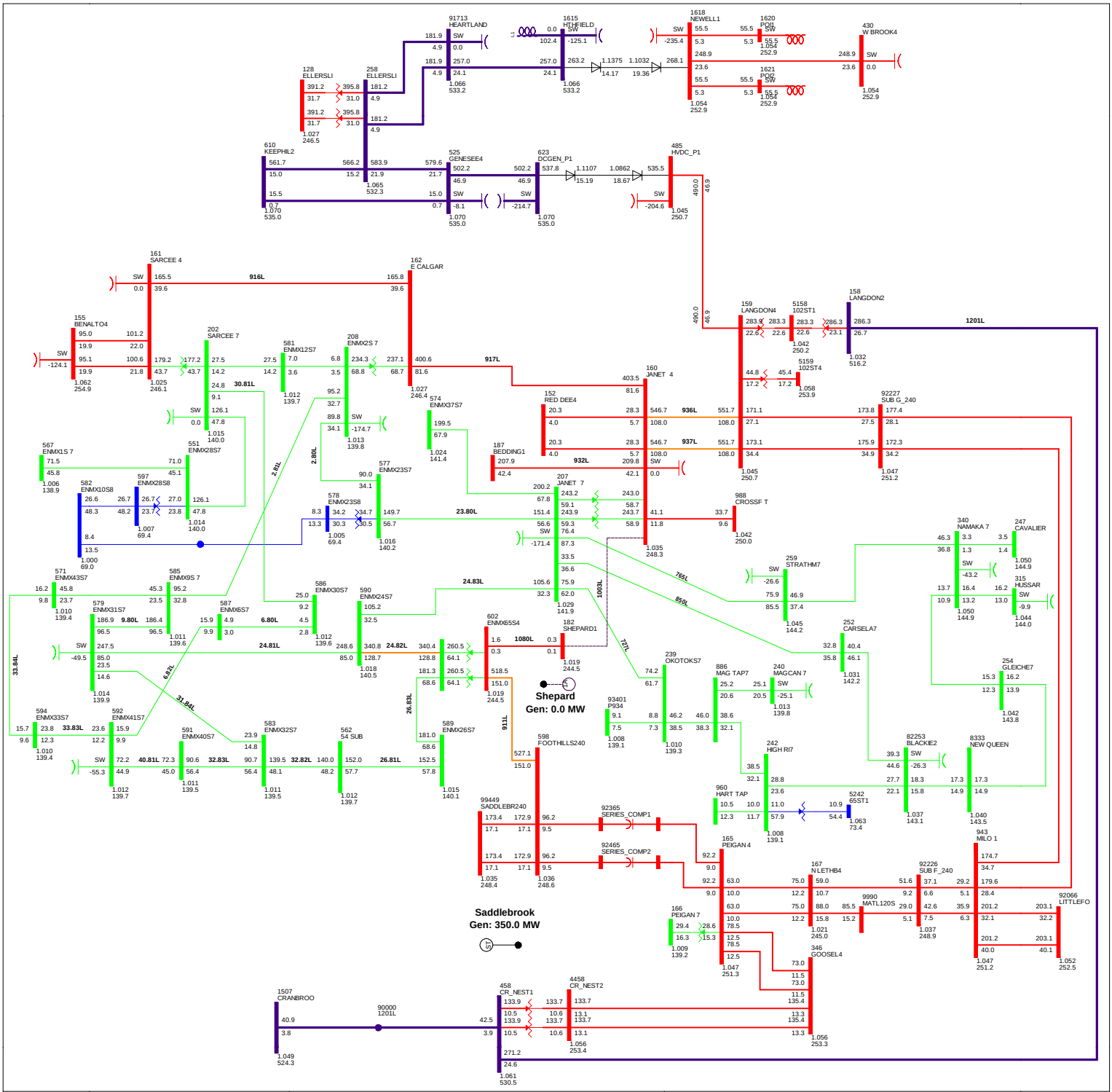
BCH Import: 2.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-1: BASECASE

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

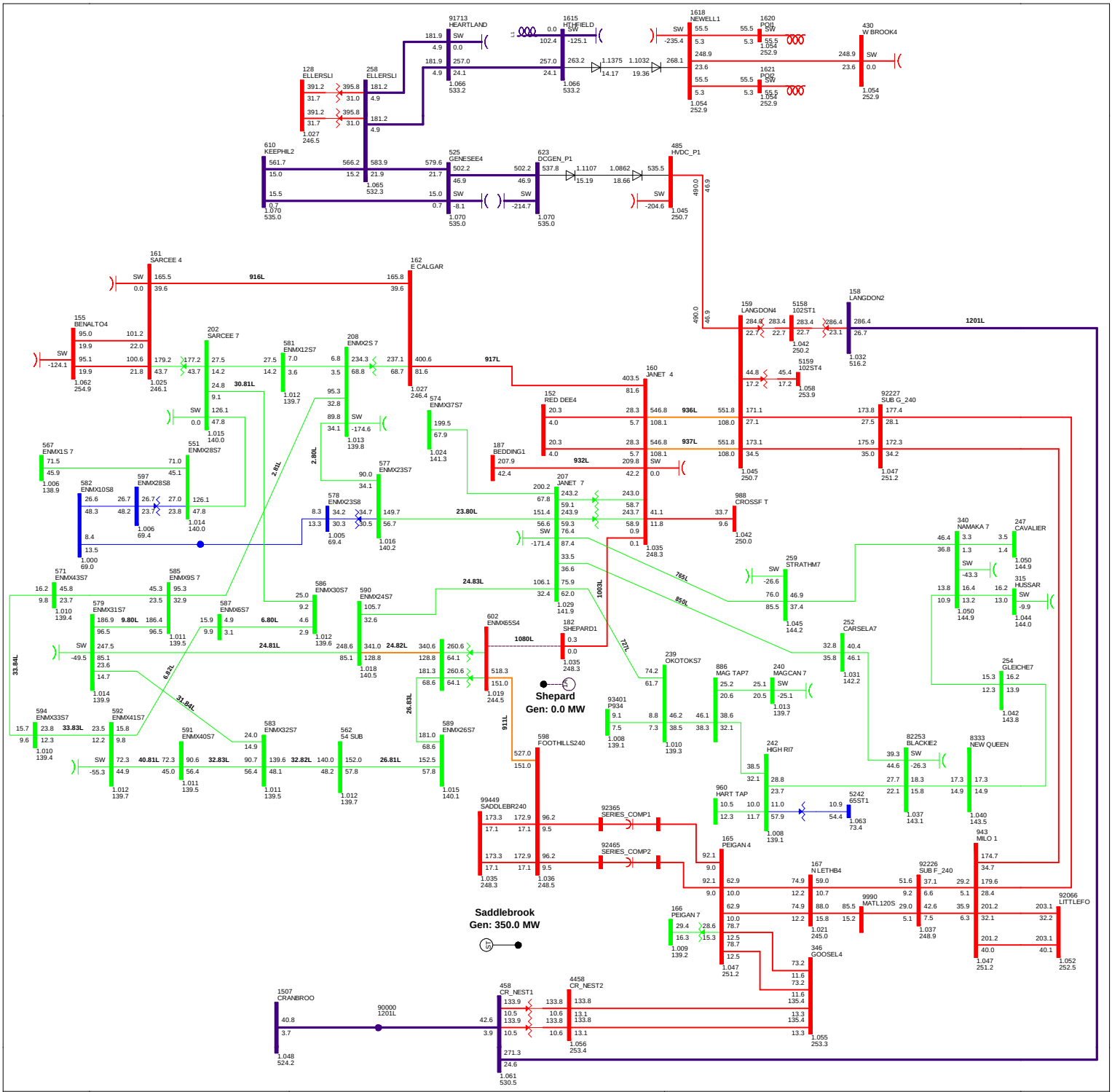
BCH Import: 3.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

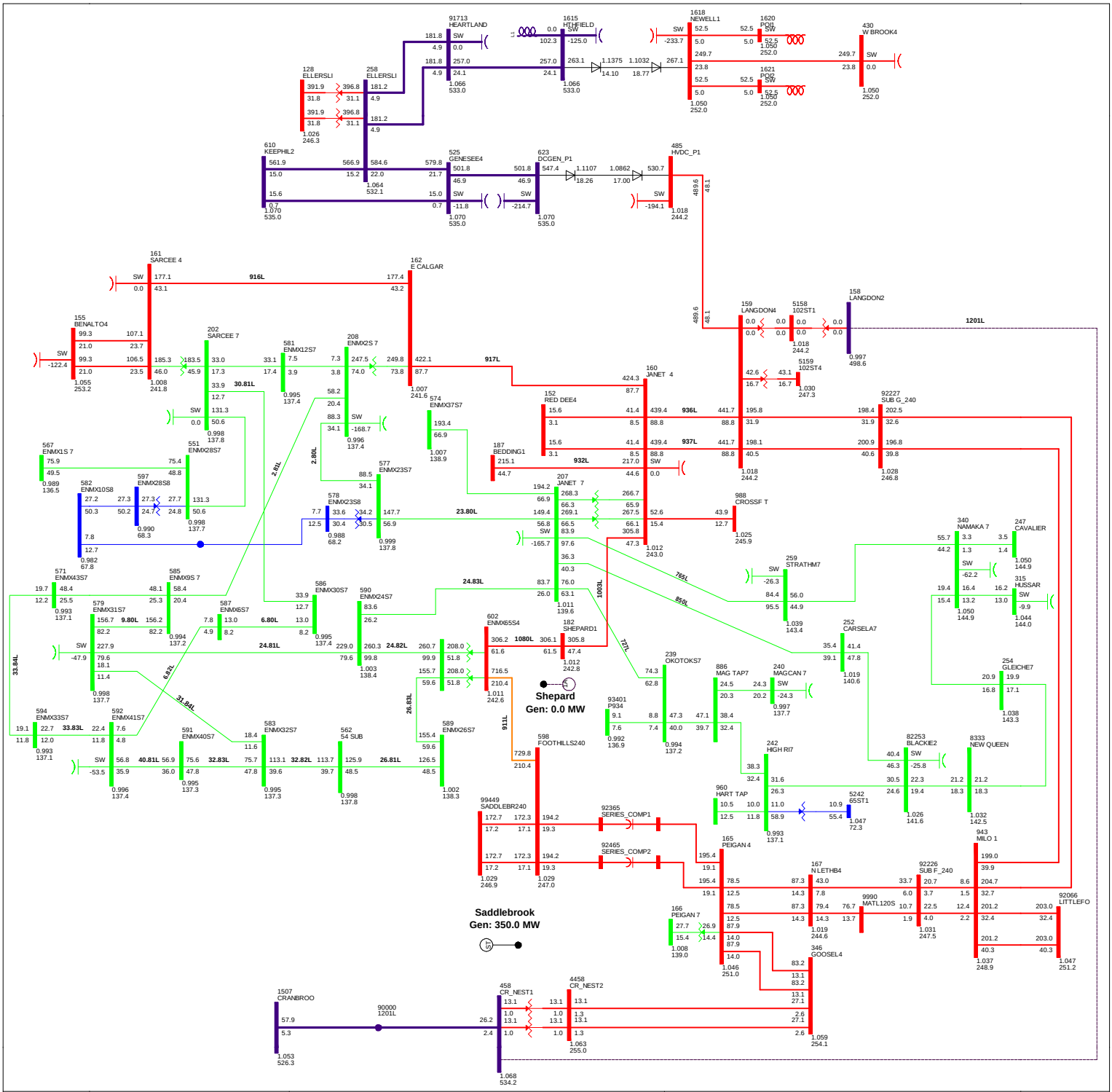
BCH Import: 3.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

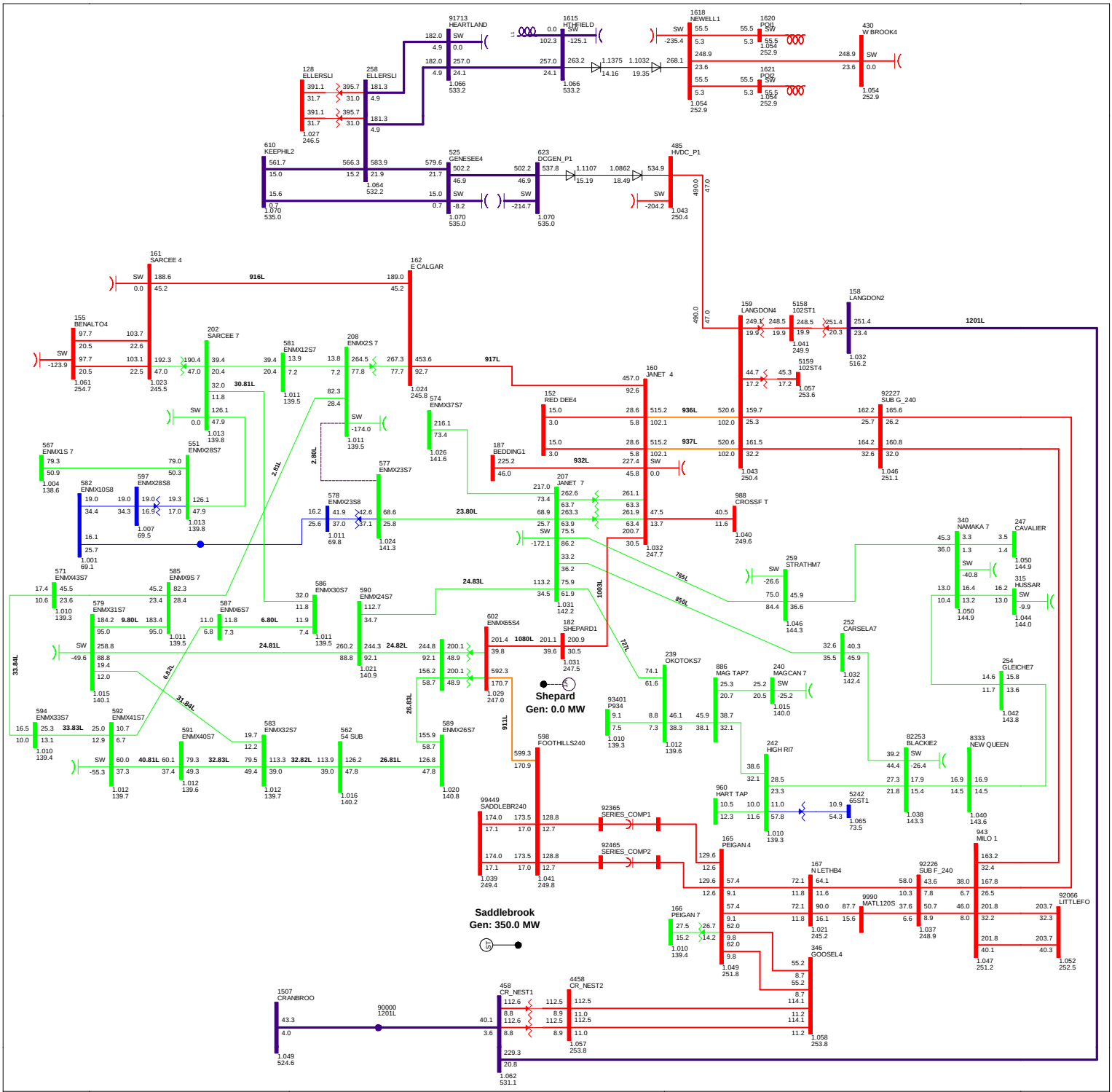
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 17.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

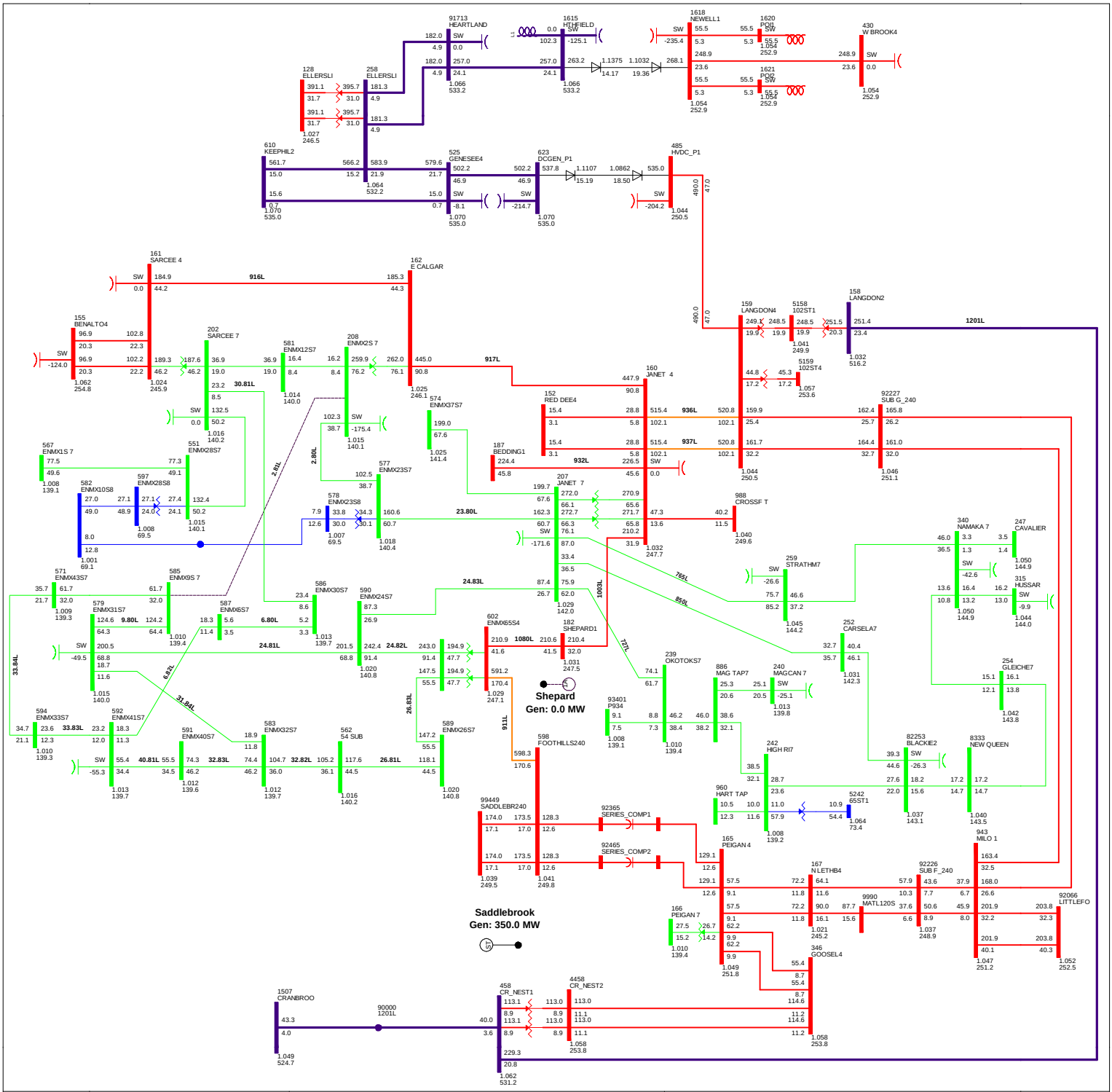
BCH Import: 3.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

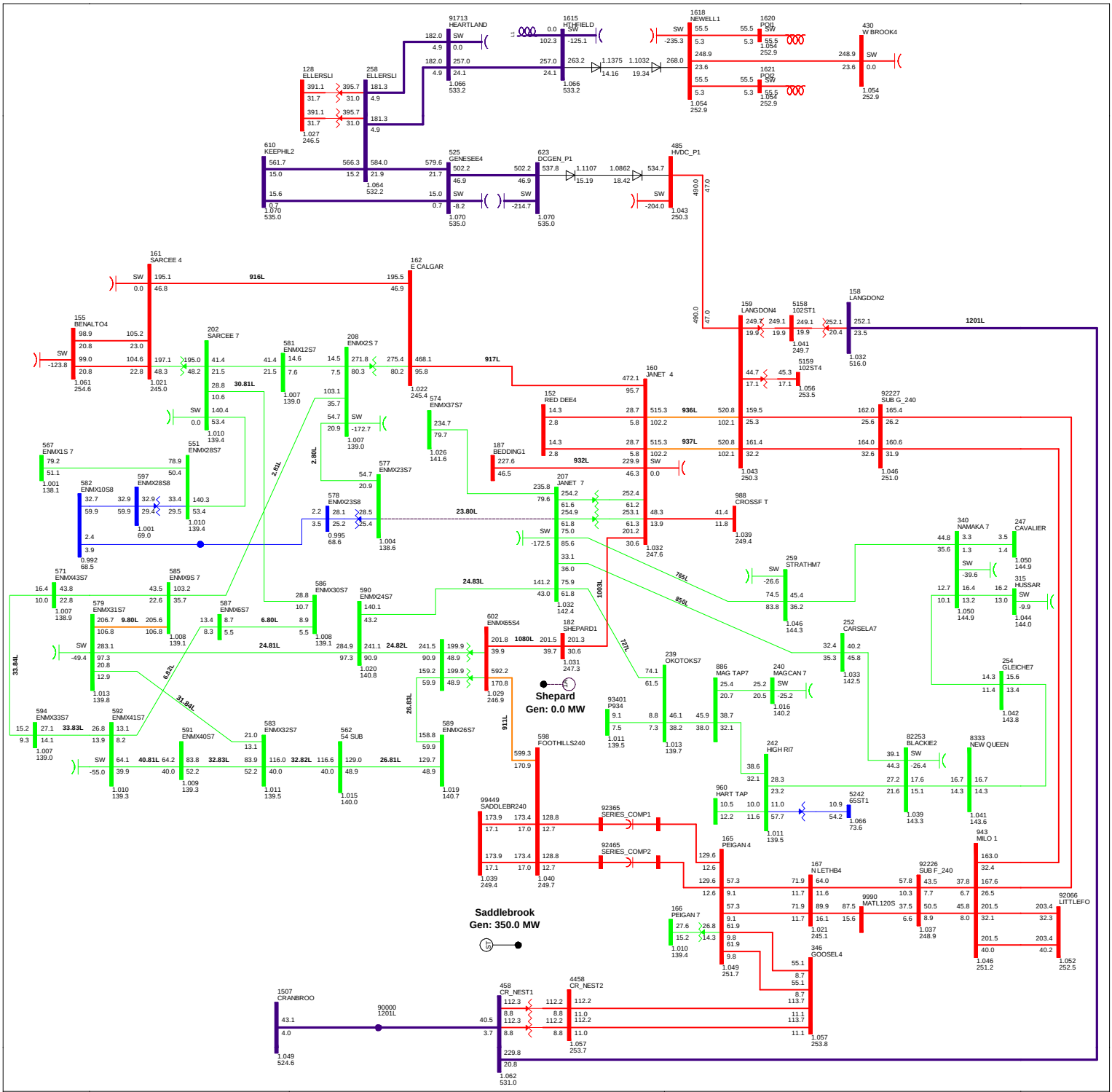
BCH Import: 2.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

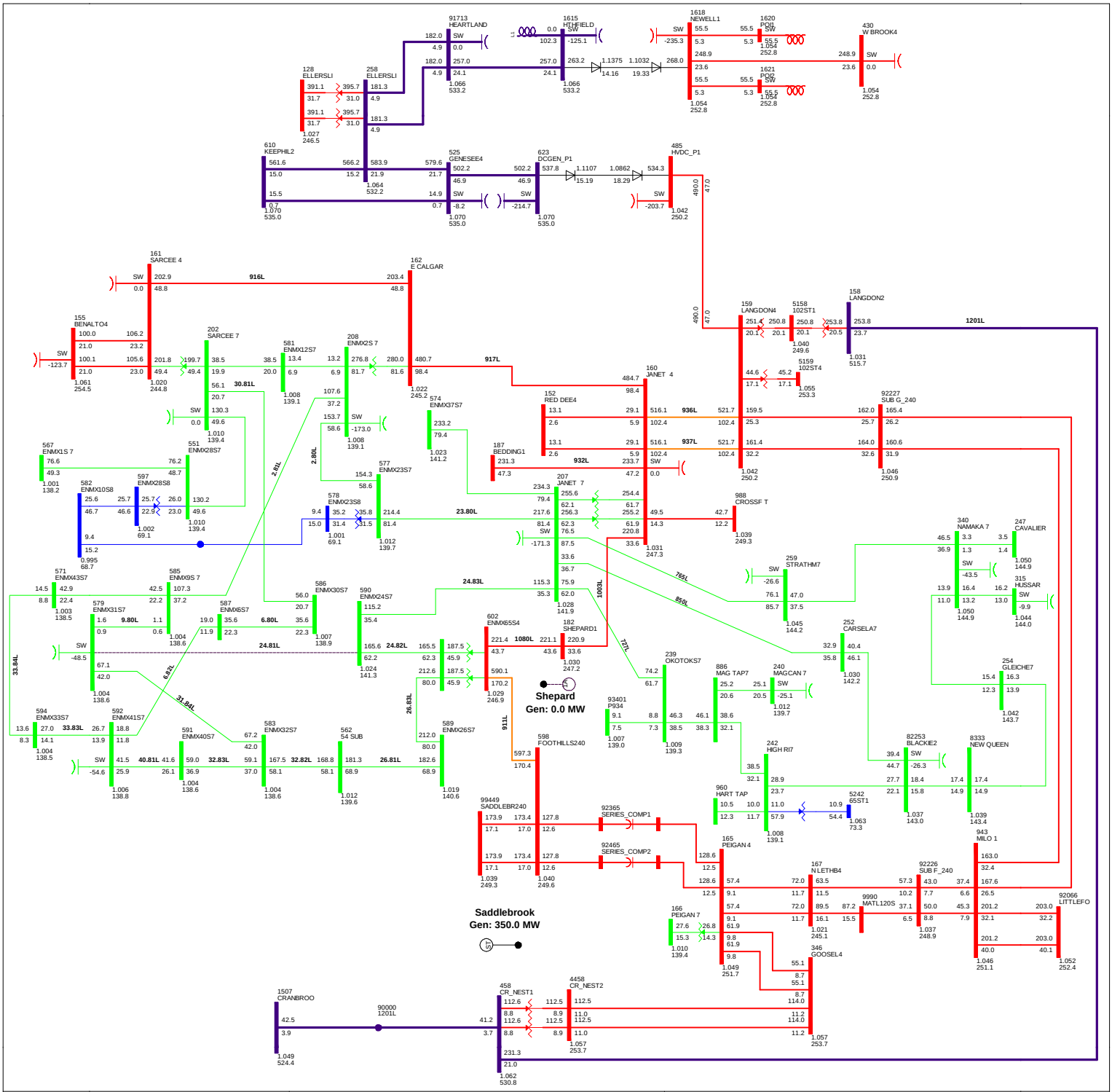
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:17



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

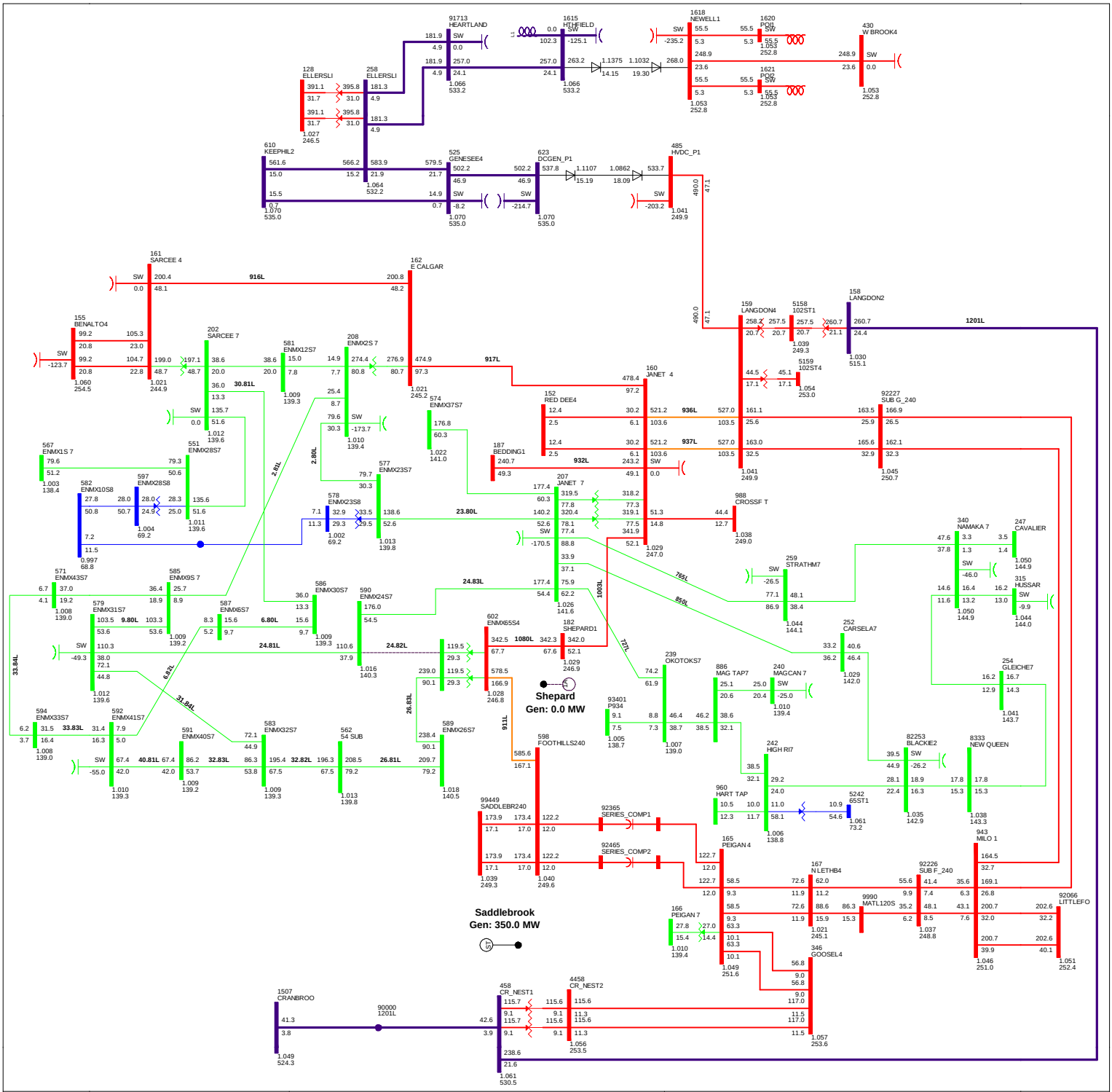
BCH Import: 5.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

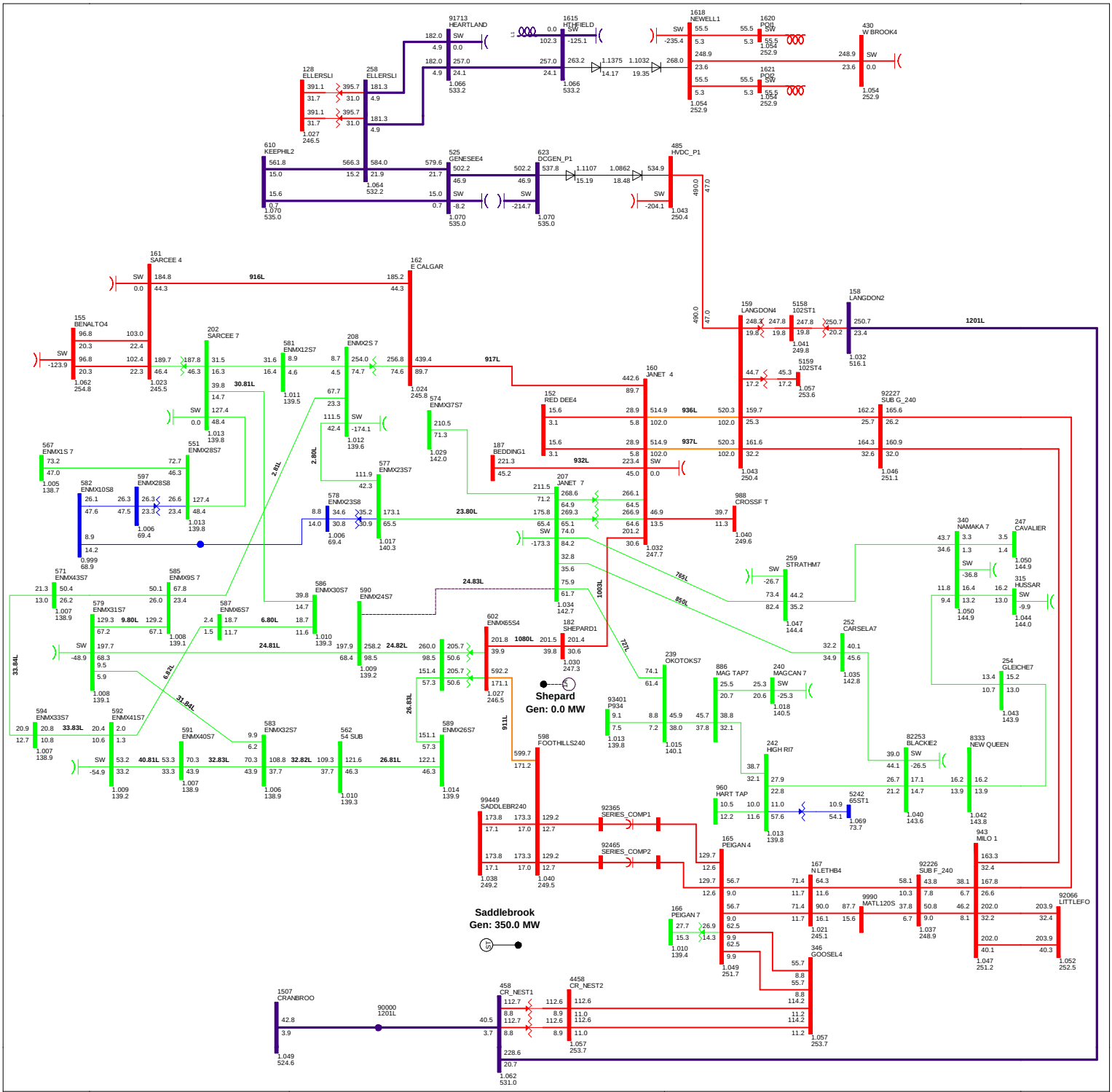
BCH Import: 6.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

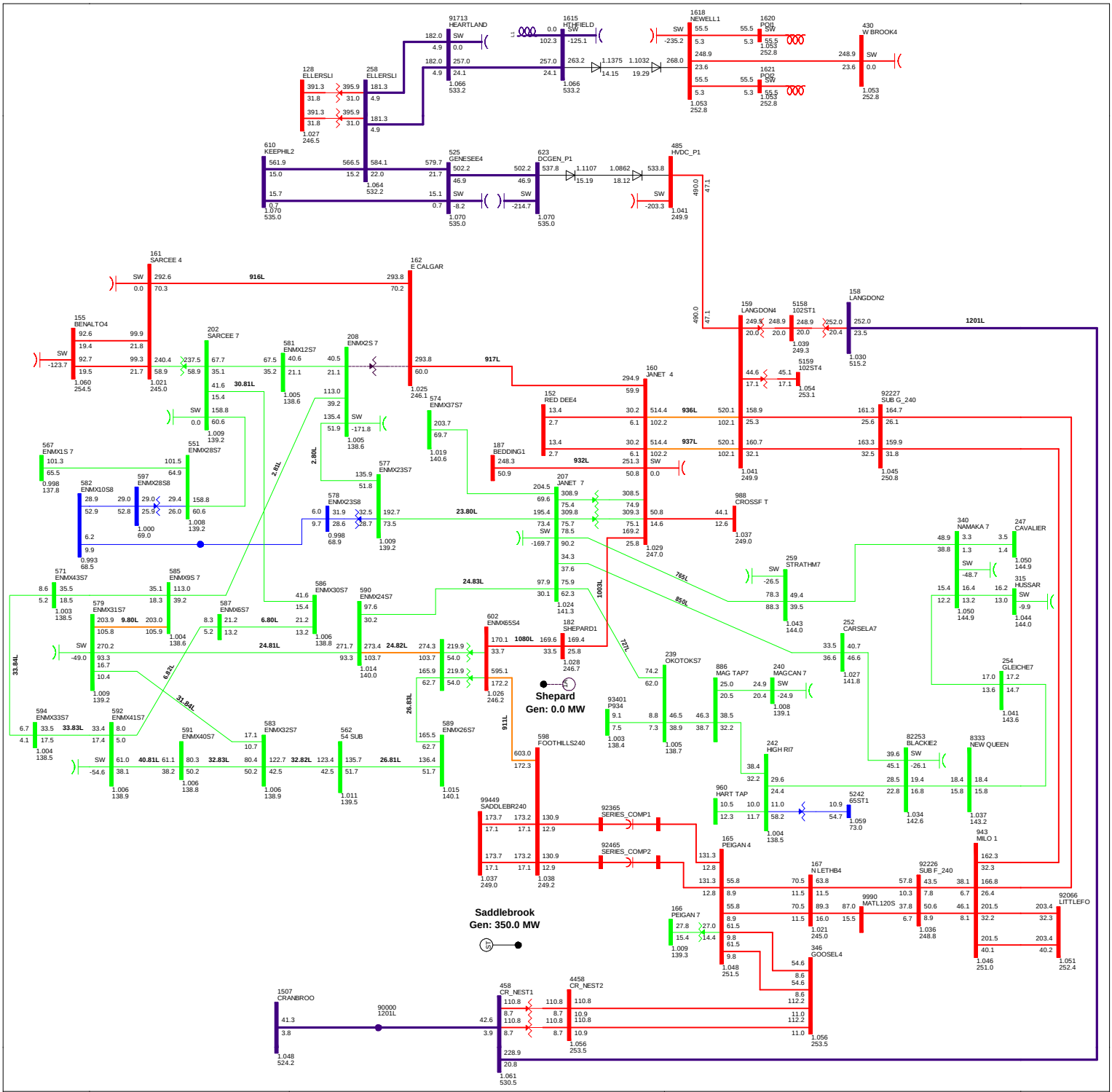
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

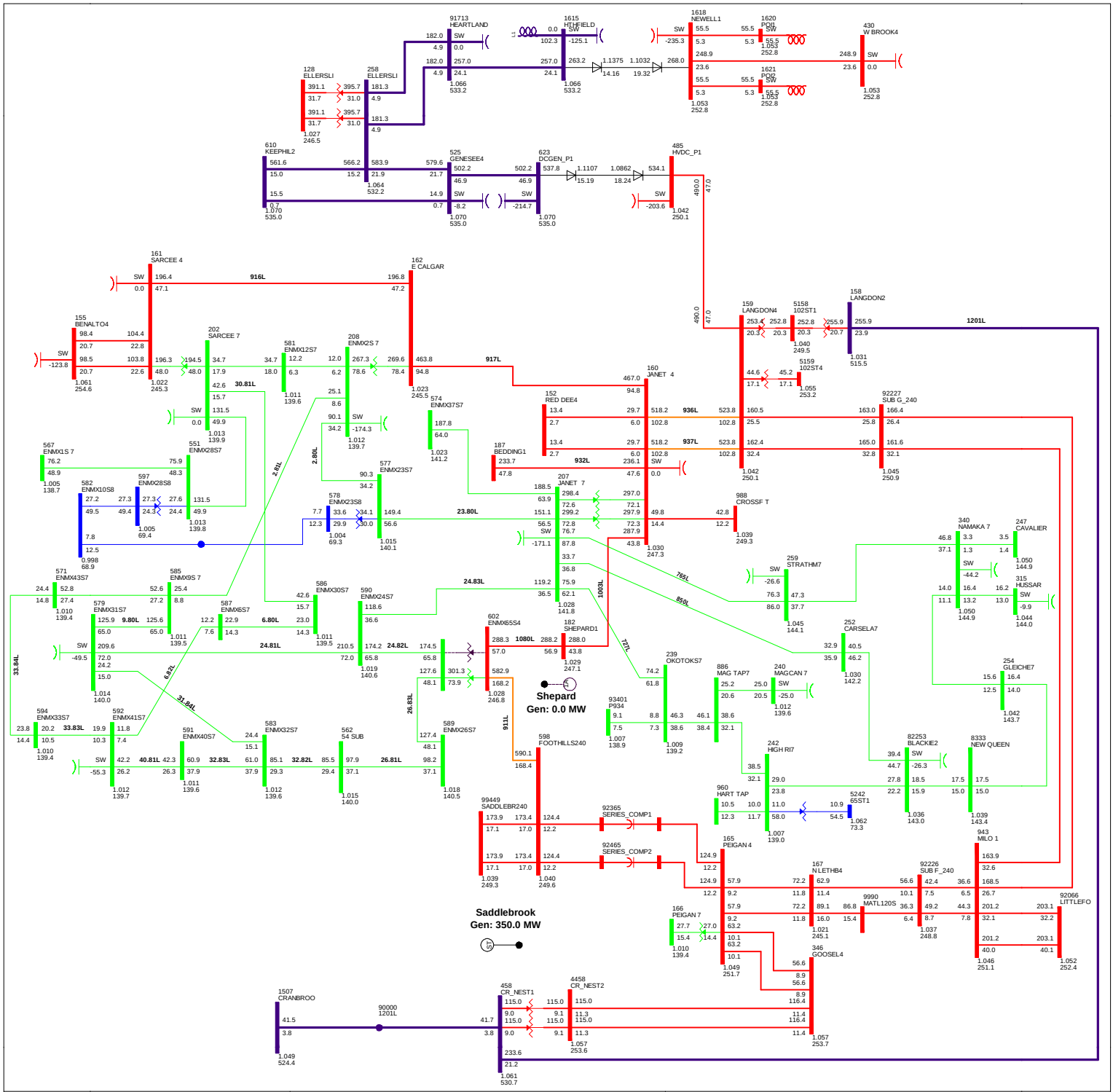
BCH Import: 7.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

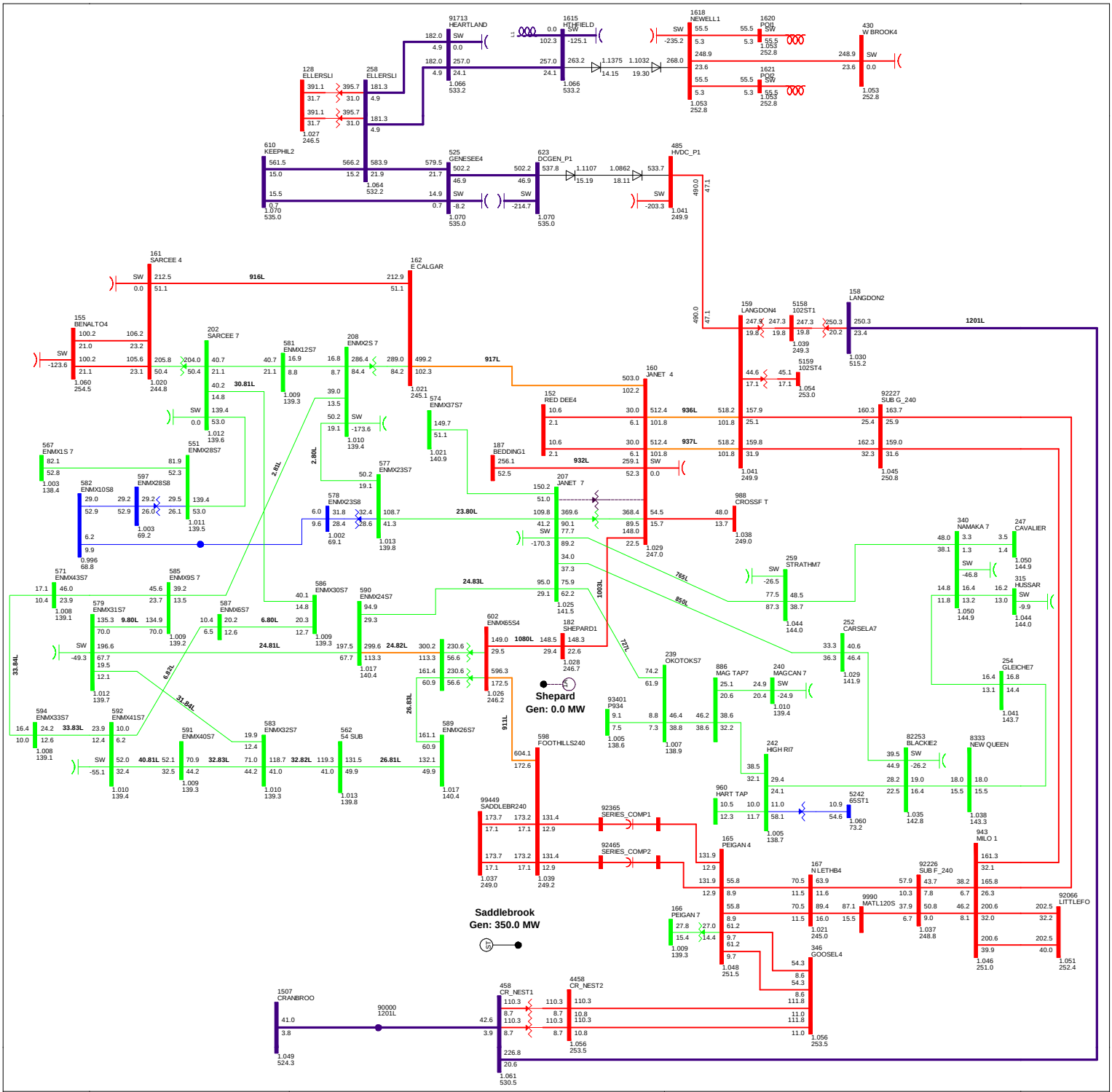
BCH Import: 2.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

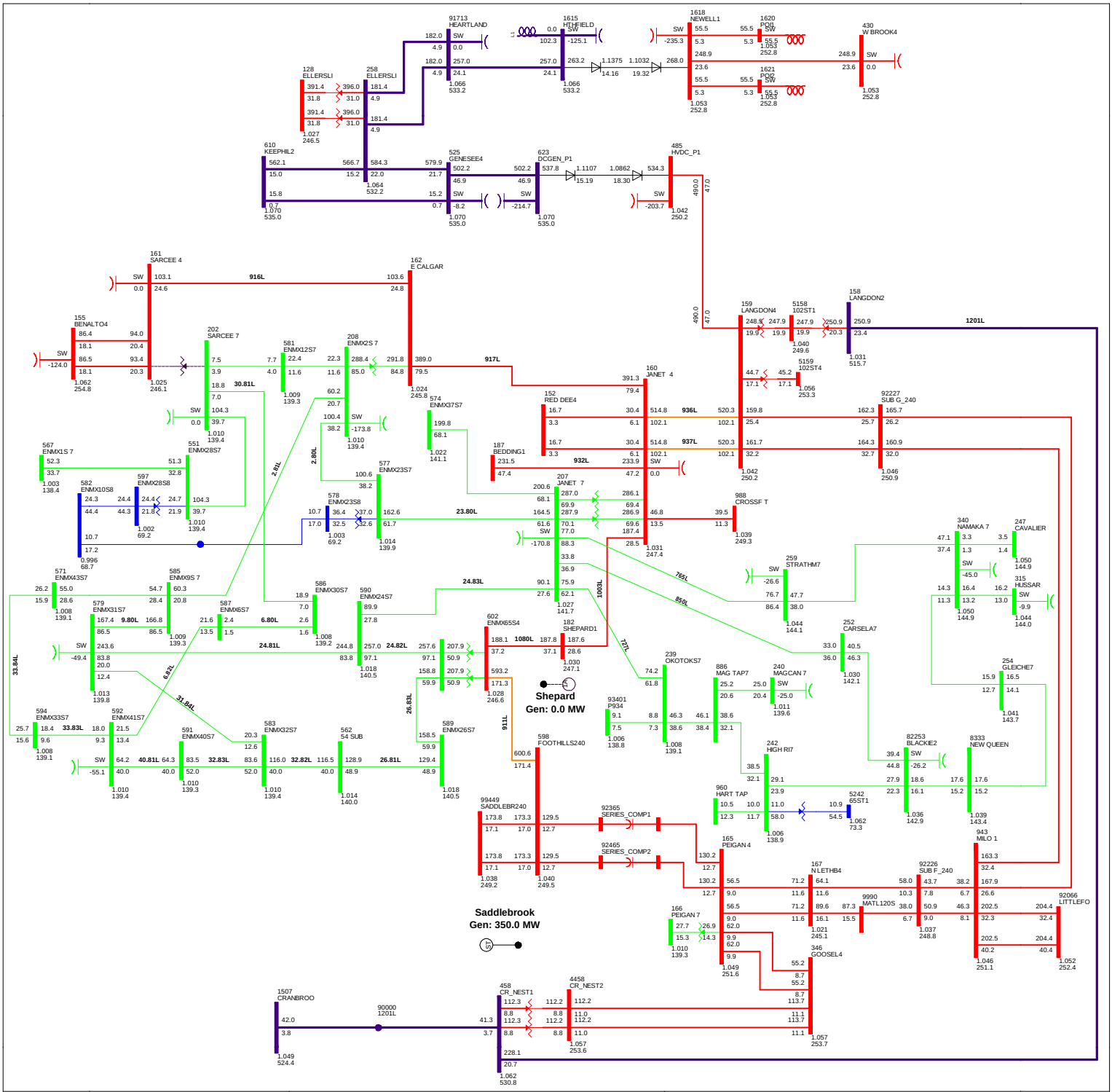
BCH Import: 5.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

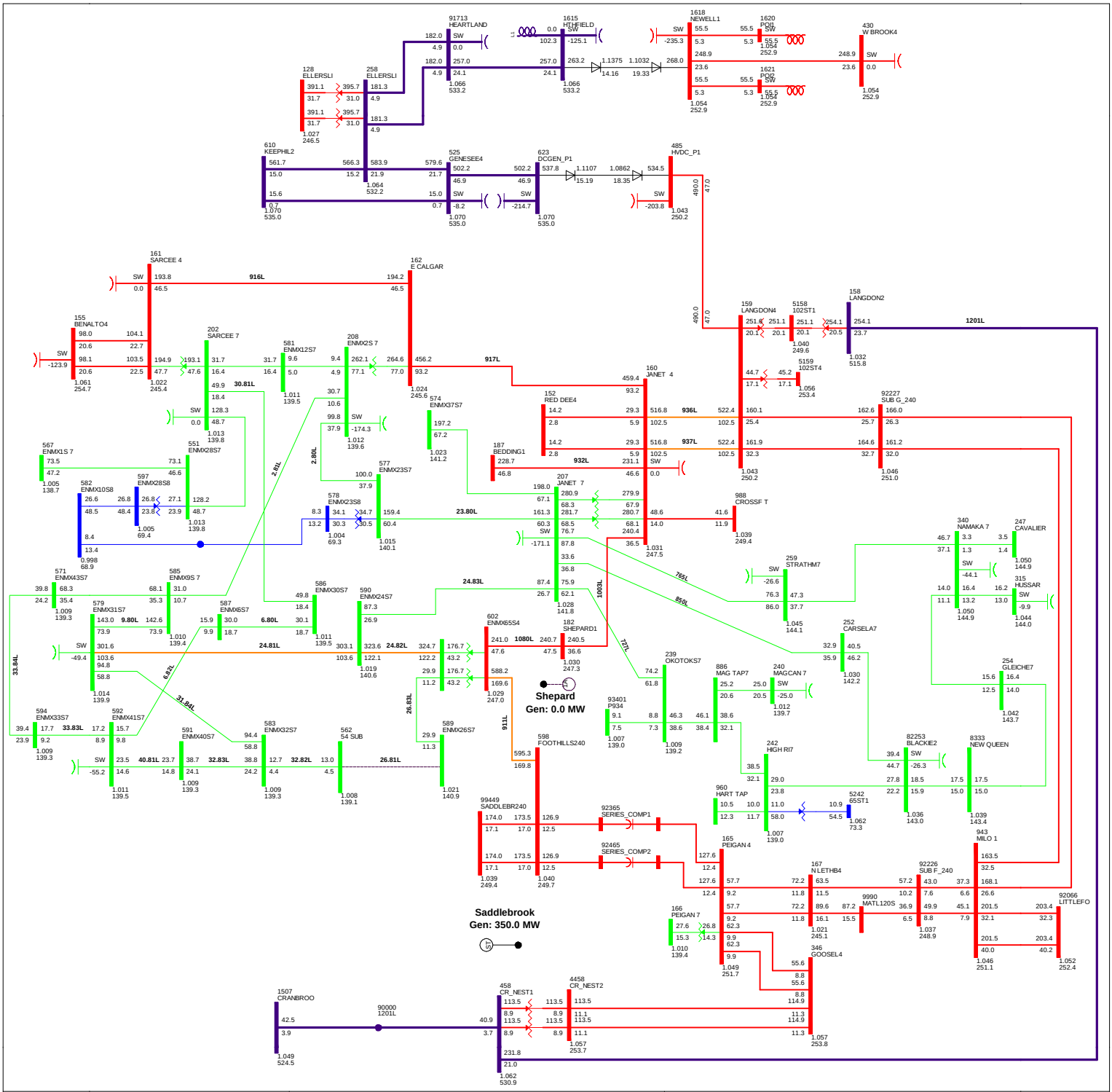
BCH Import: 3.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

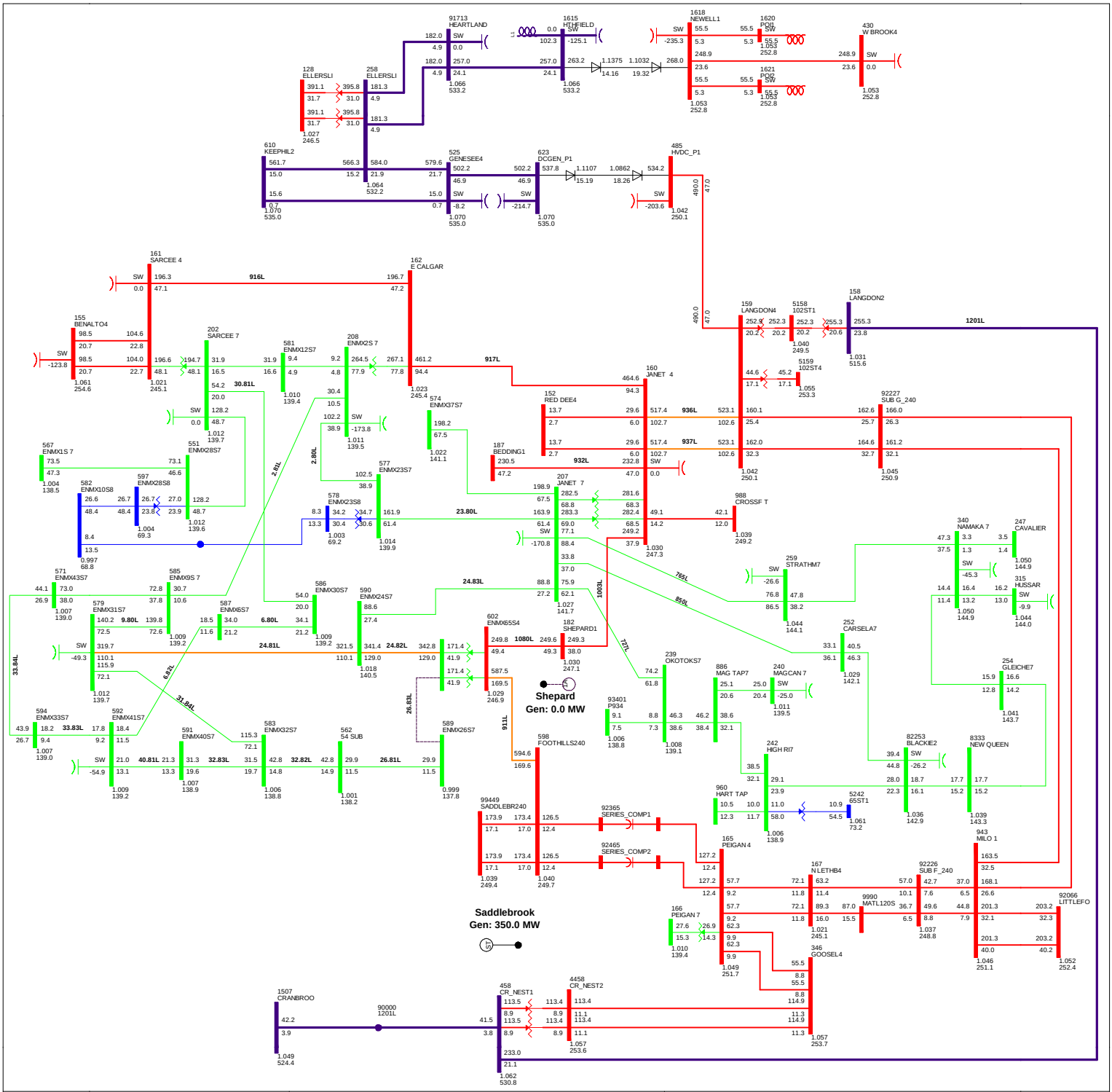
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



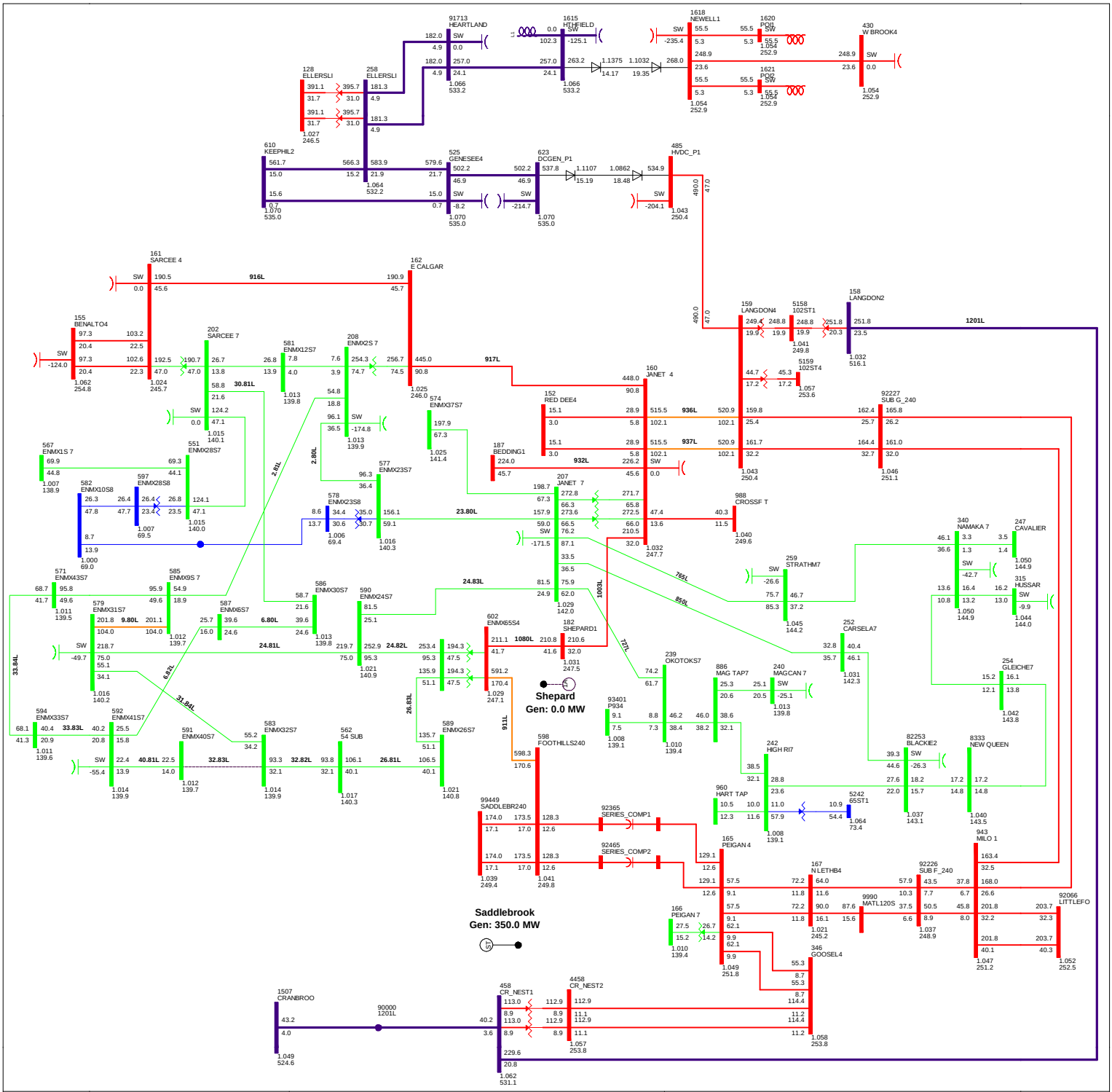
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 5.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

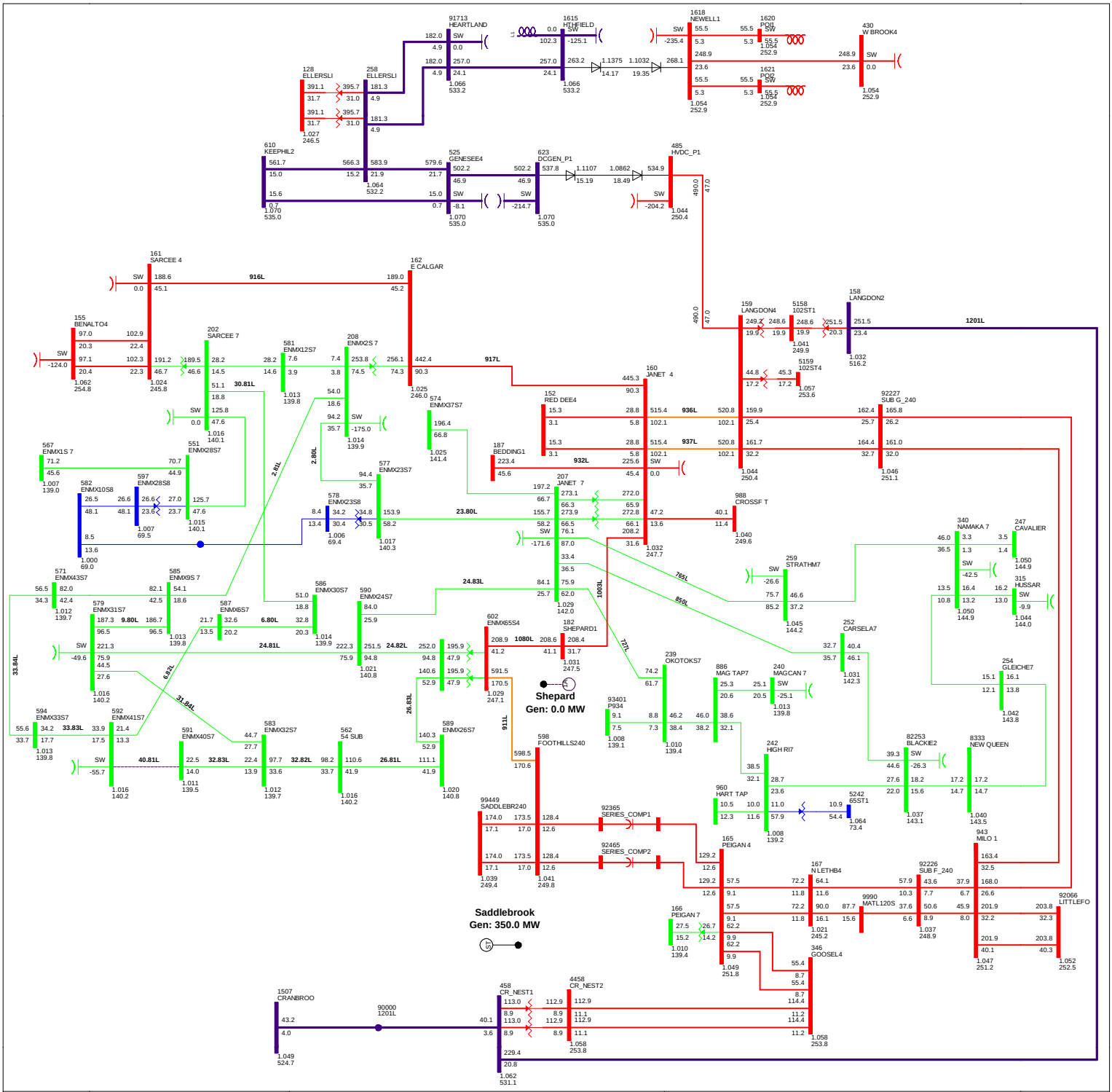
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

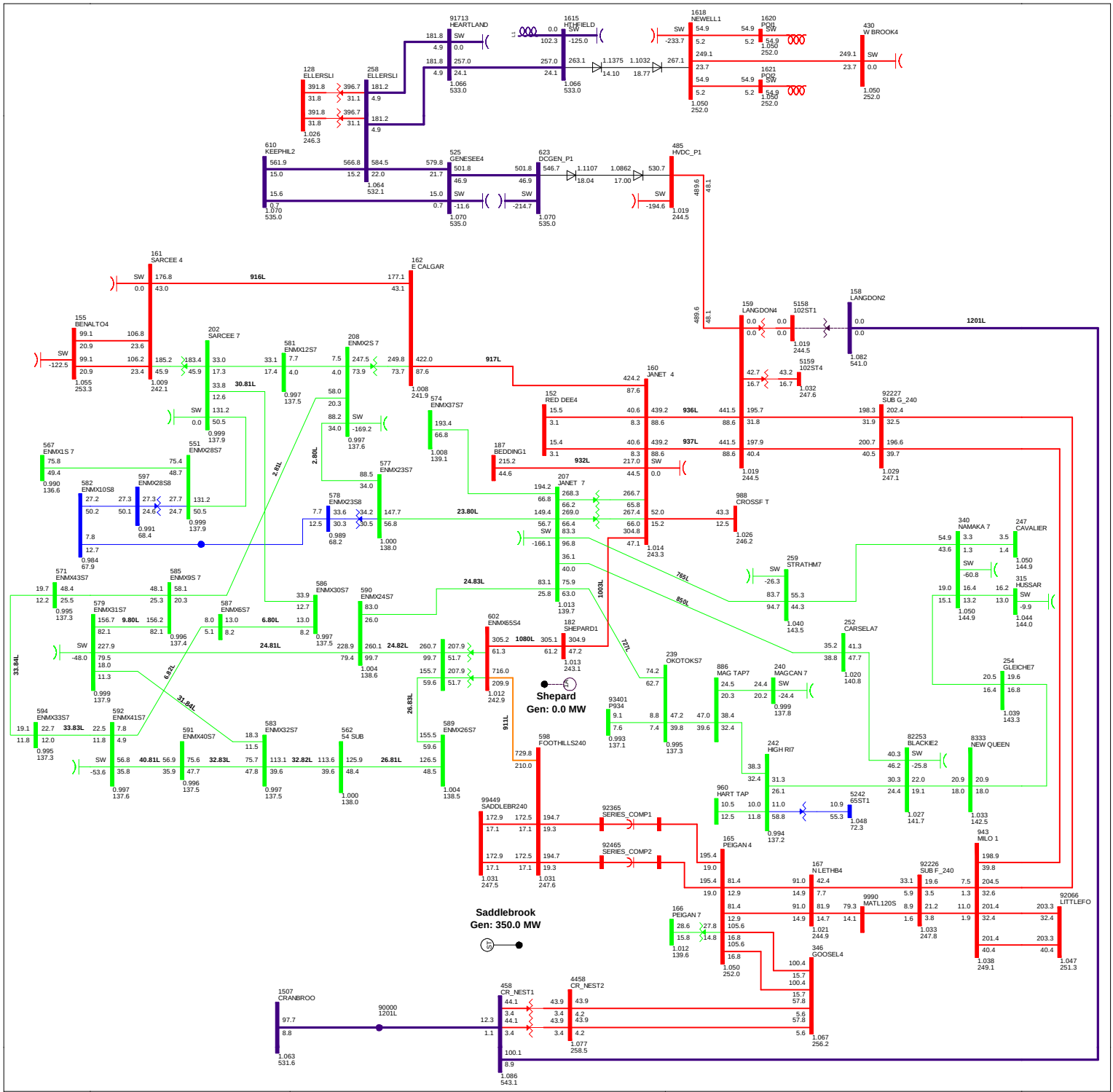
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

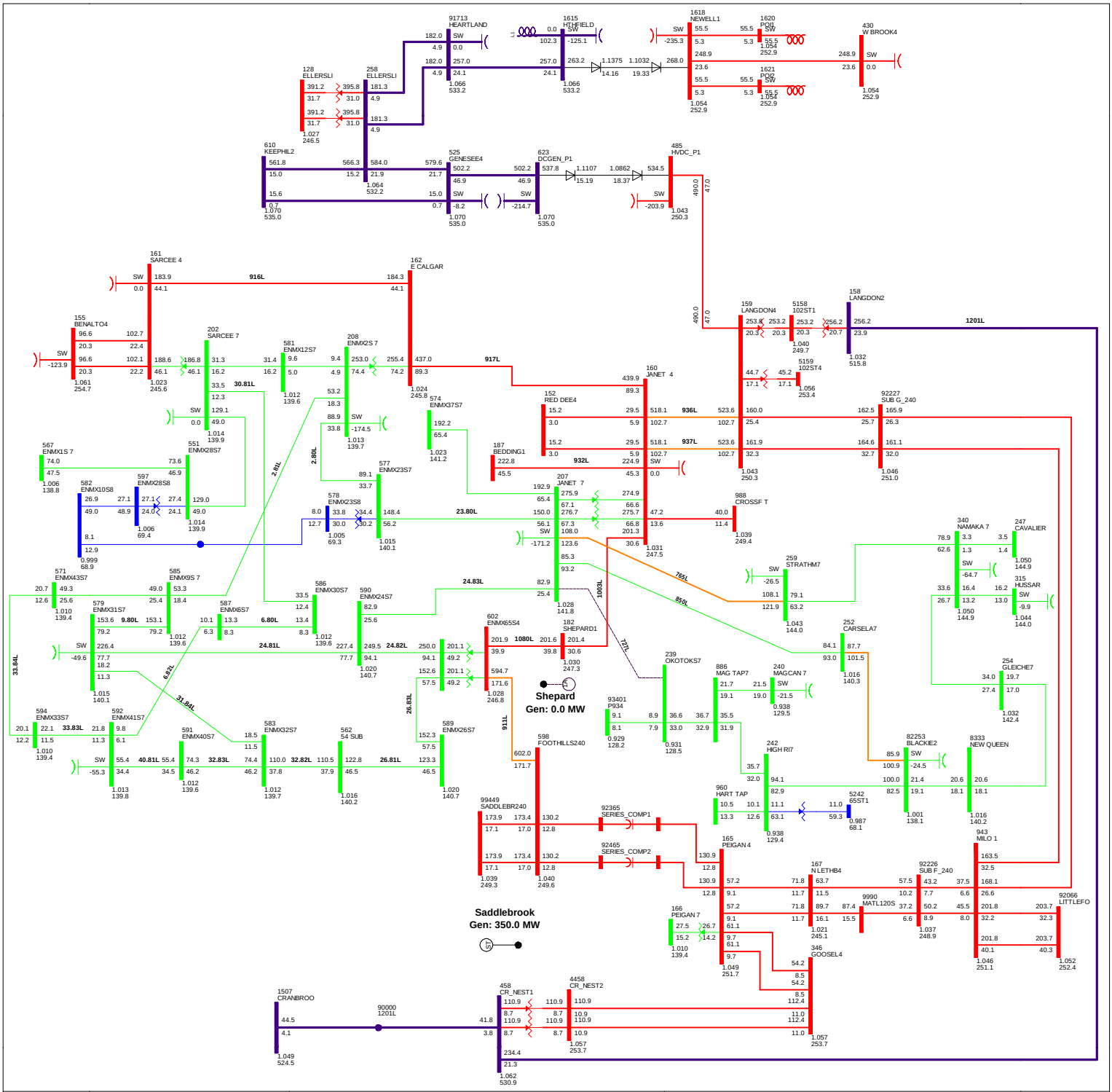
BCH Import: 17.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

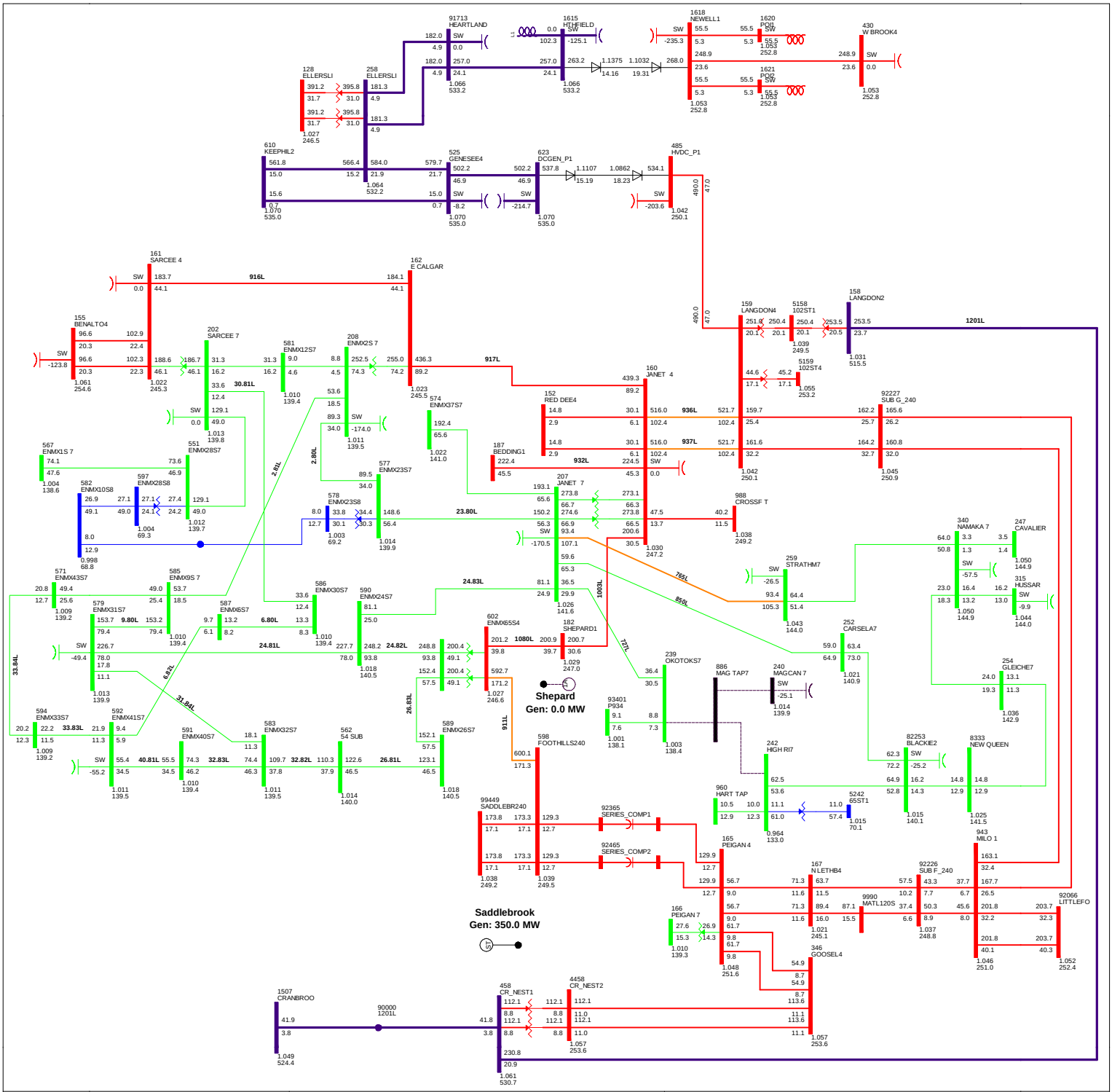
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 12.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

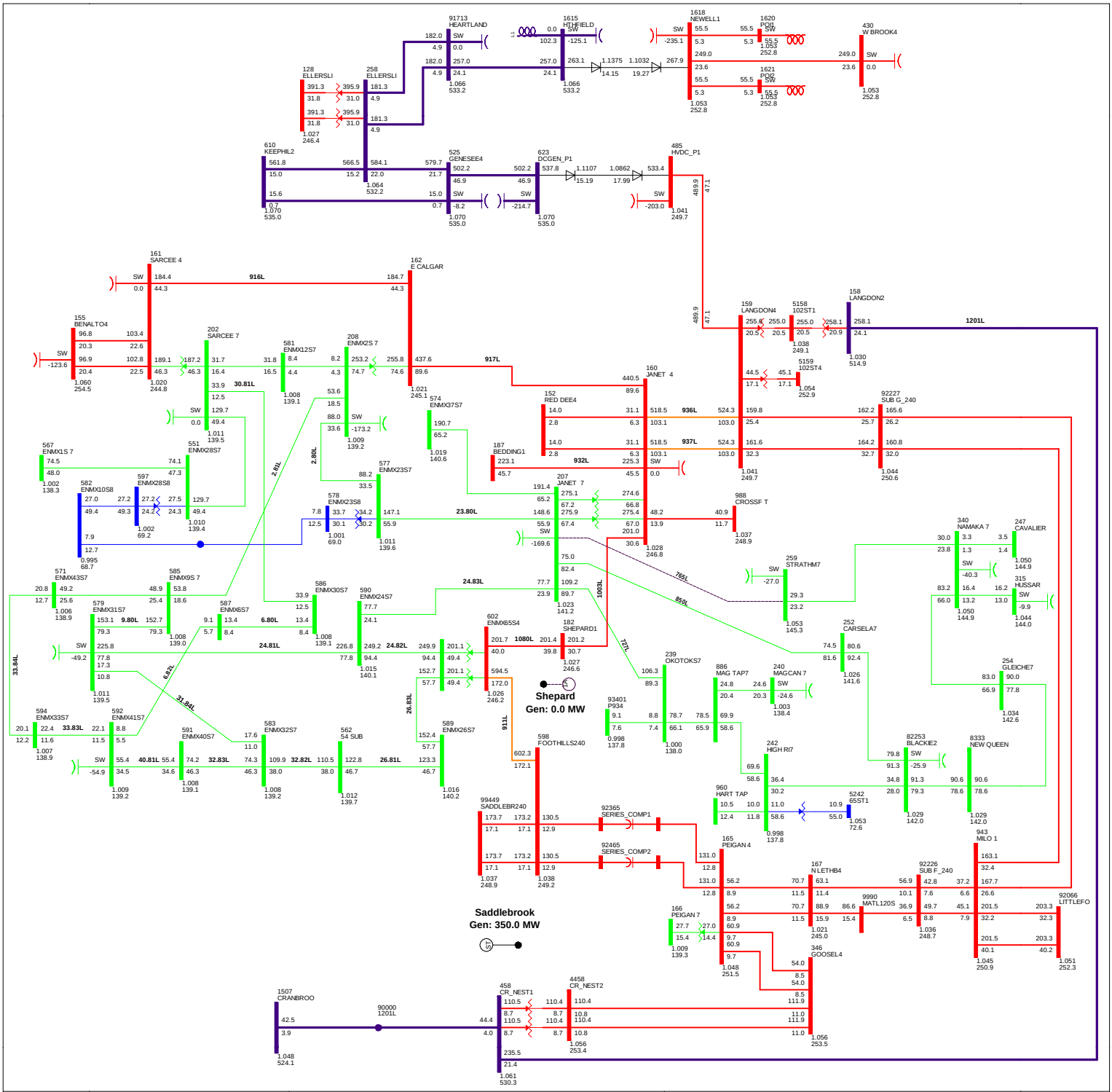
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 5.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

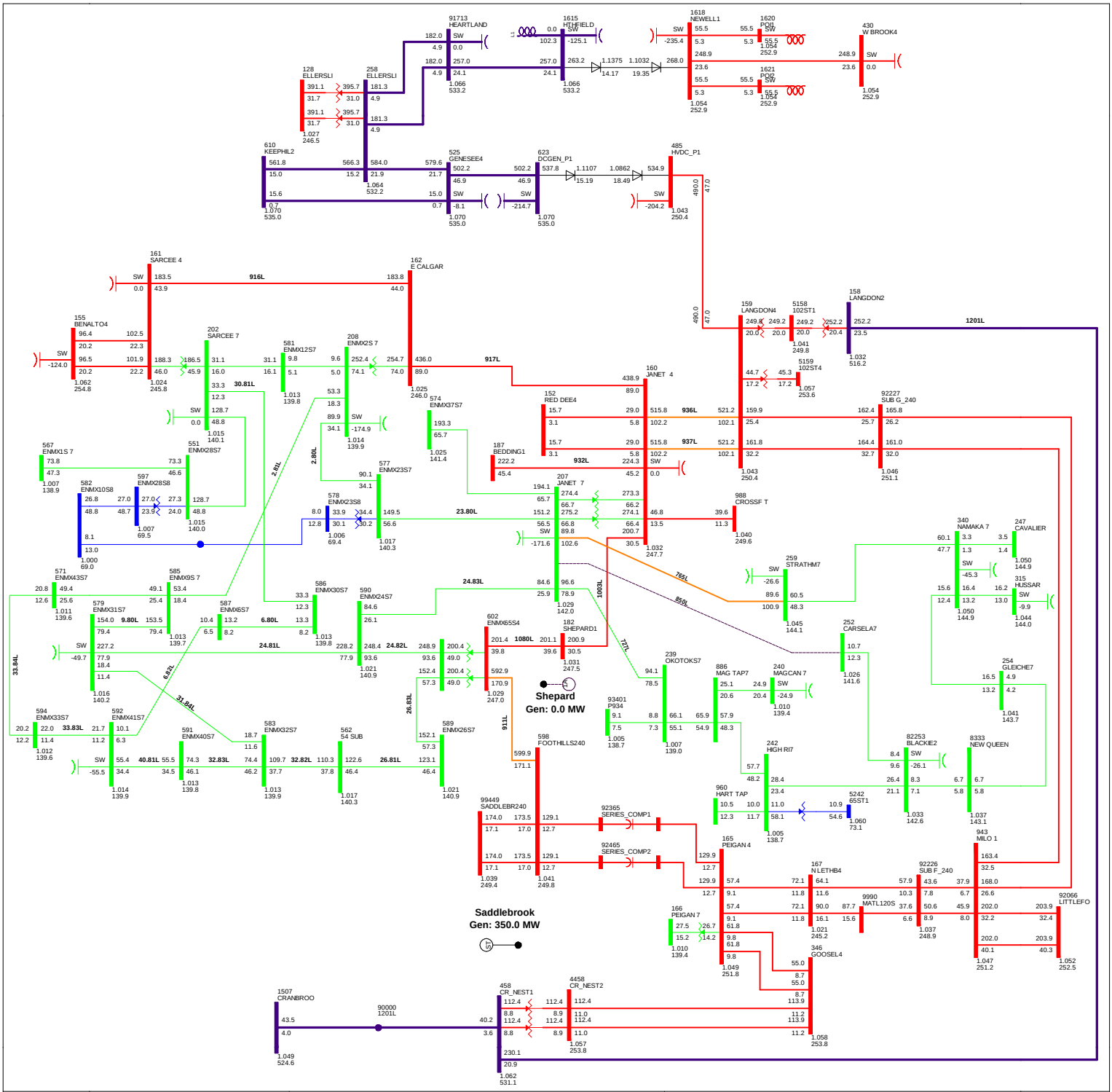
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 13.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-22: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

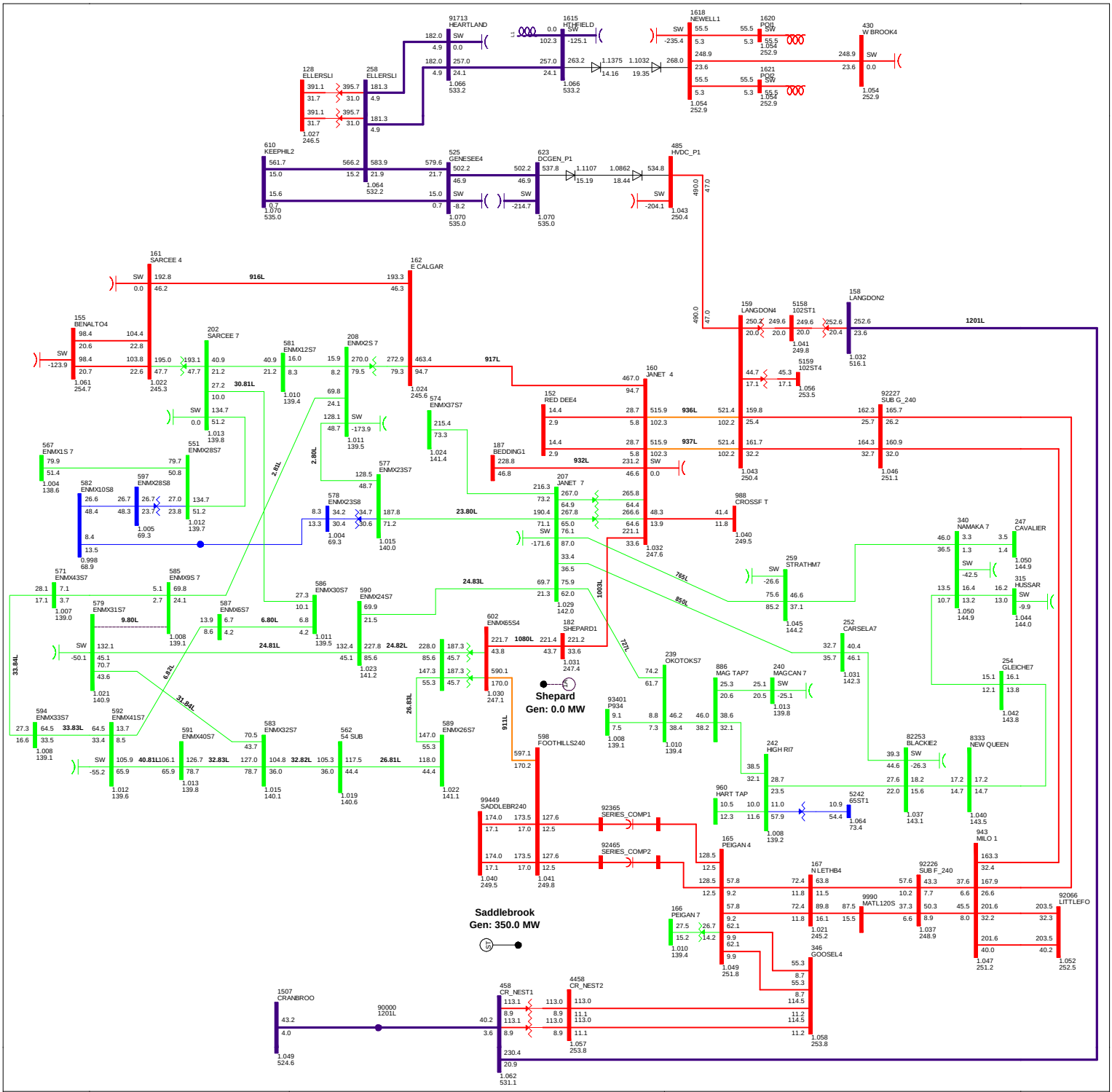
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-23: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

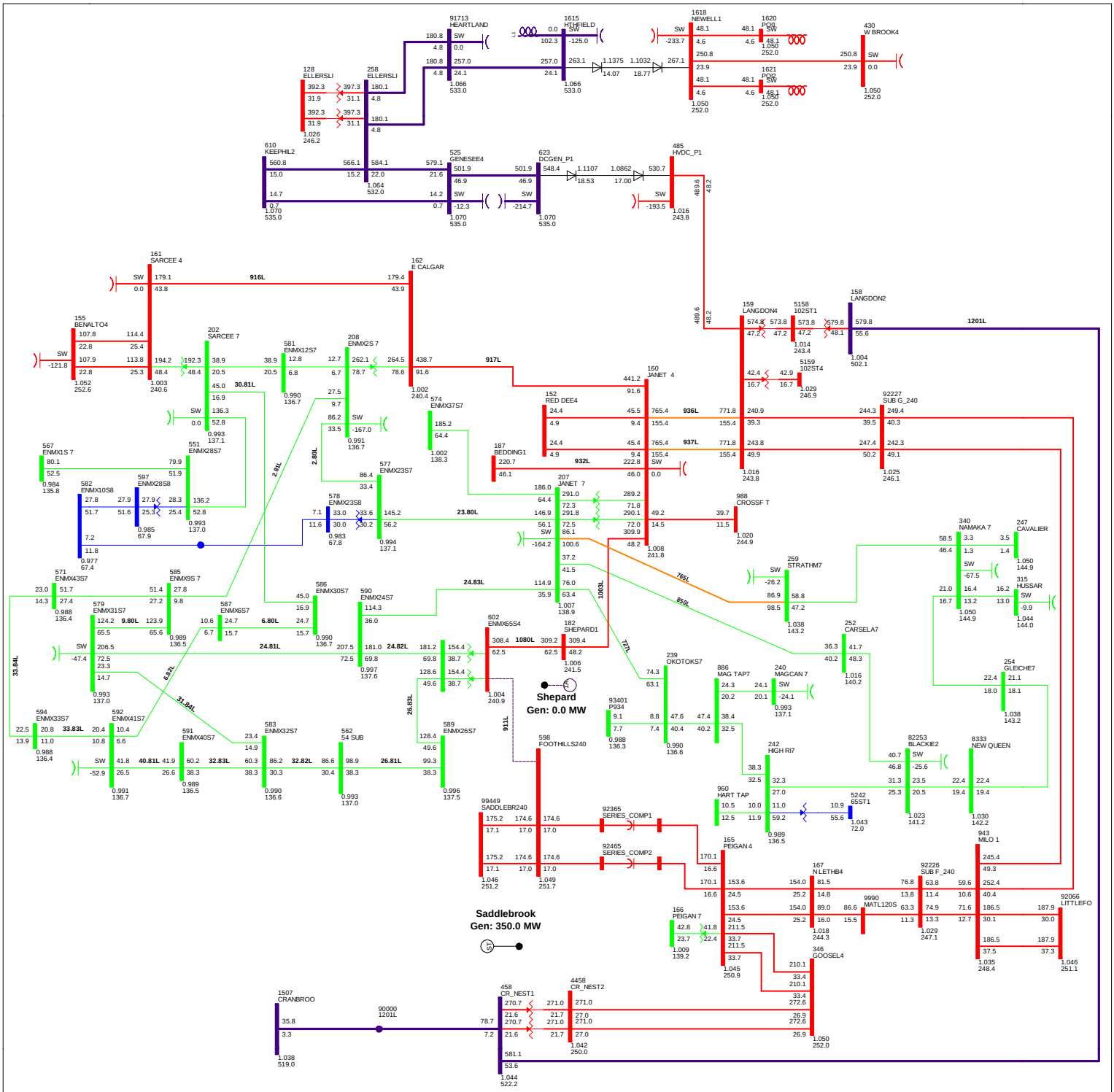
BCH Import: 3.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-24: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

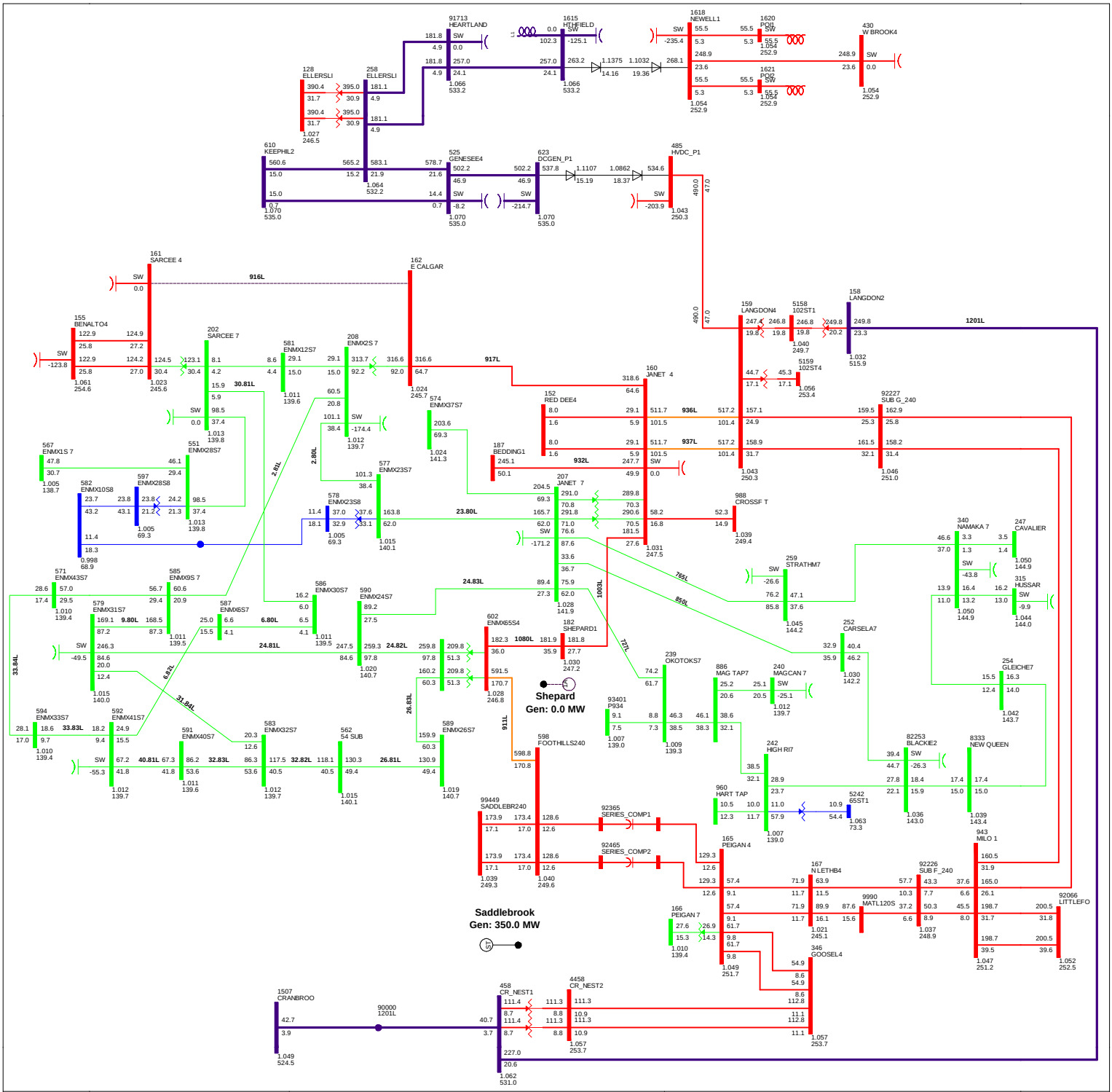
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 38.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-25: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



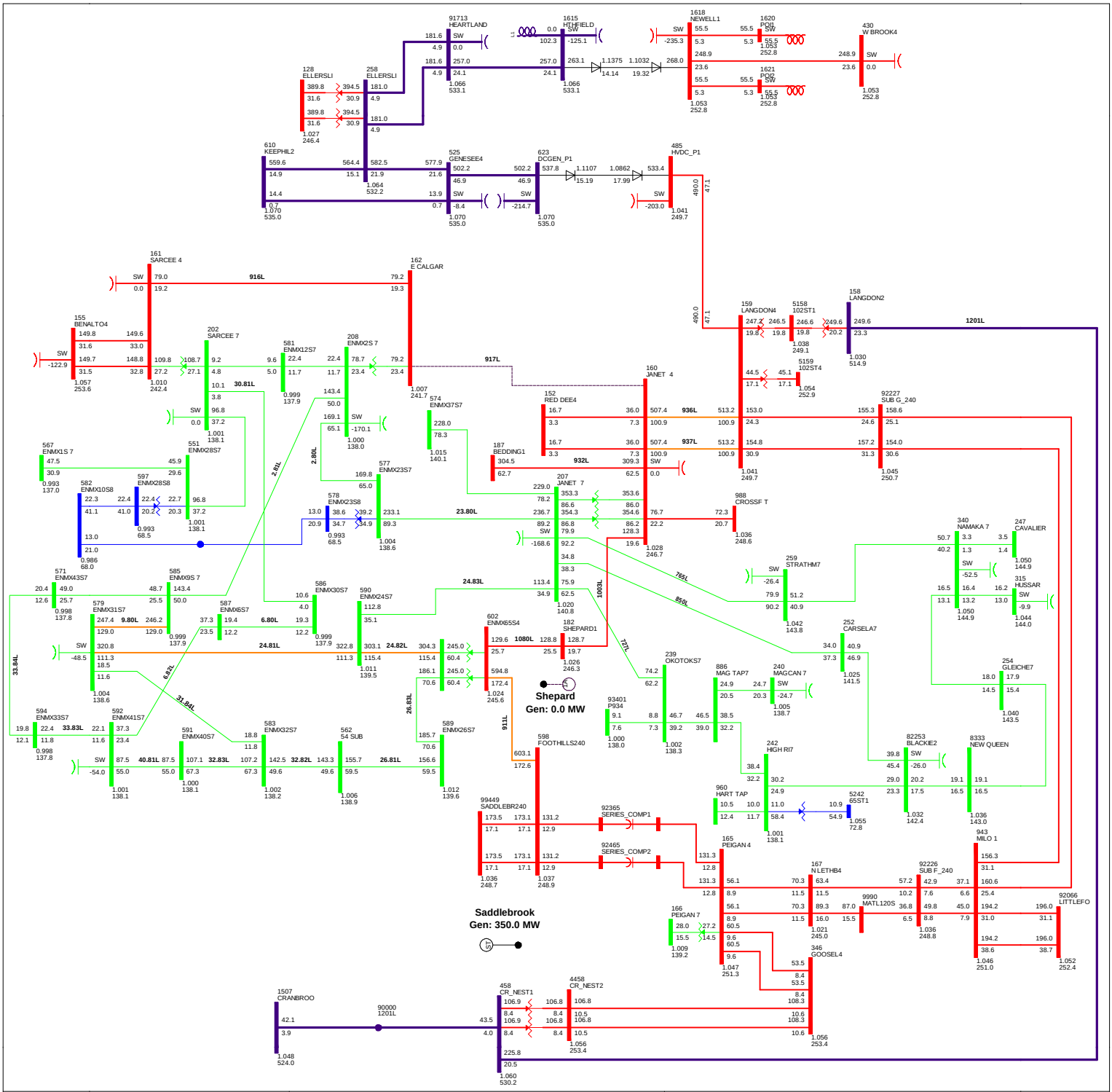
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-26: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

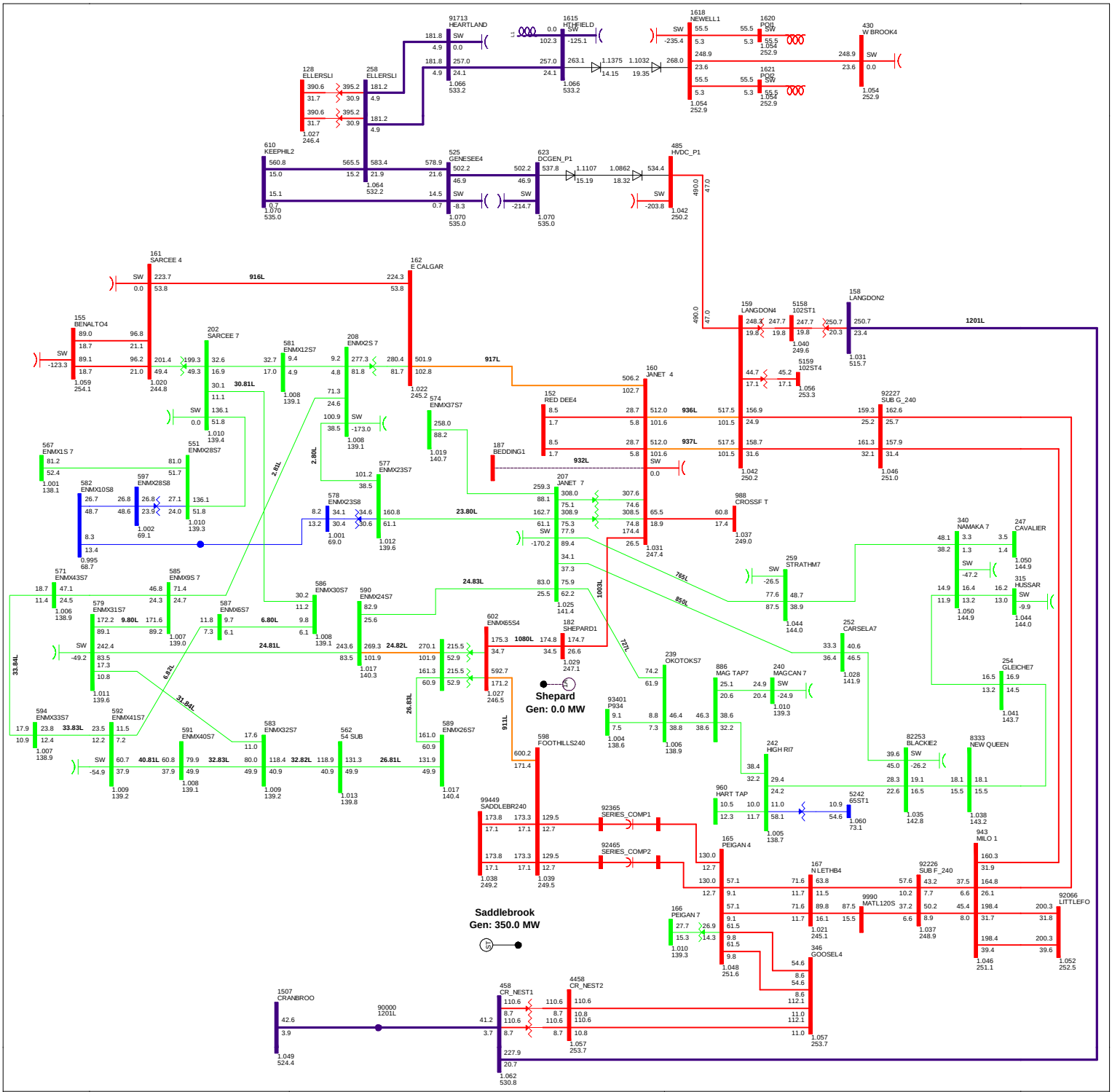
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 15.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-27: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

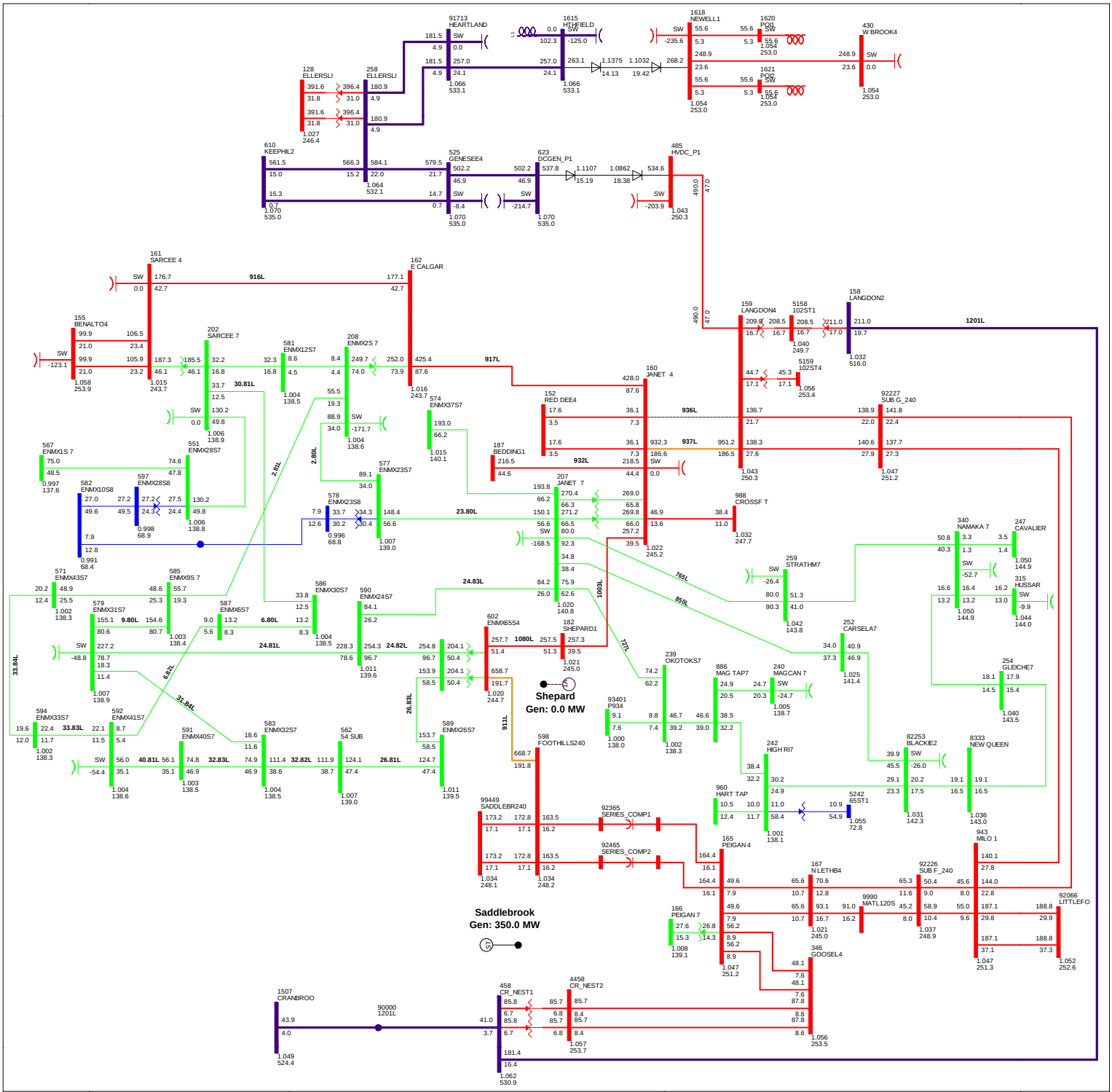
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 6.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-28: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

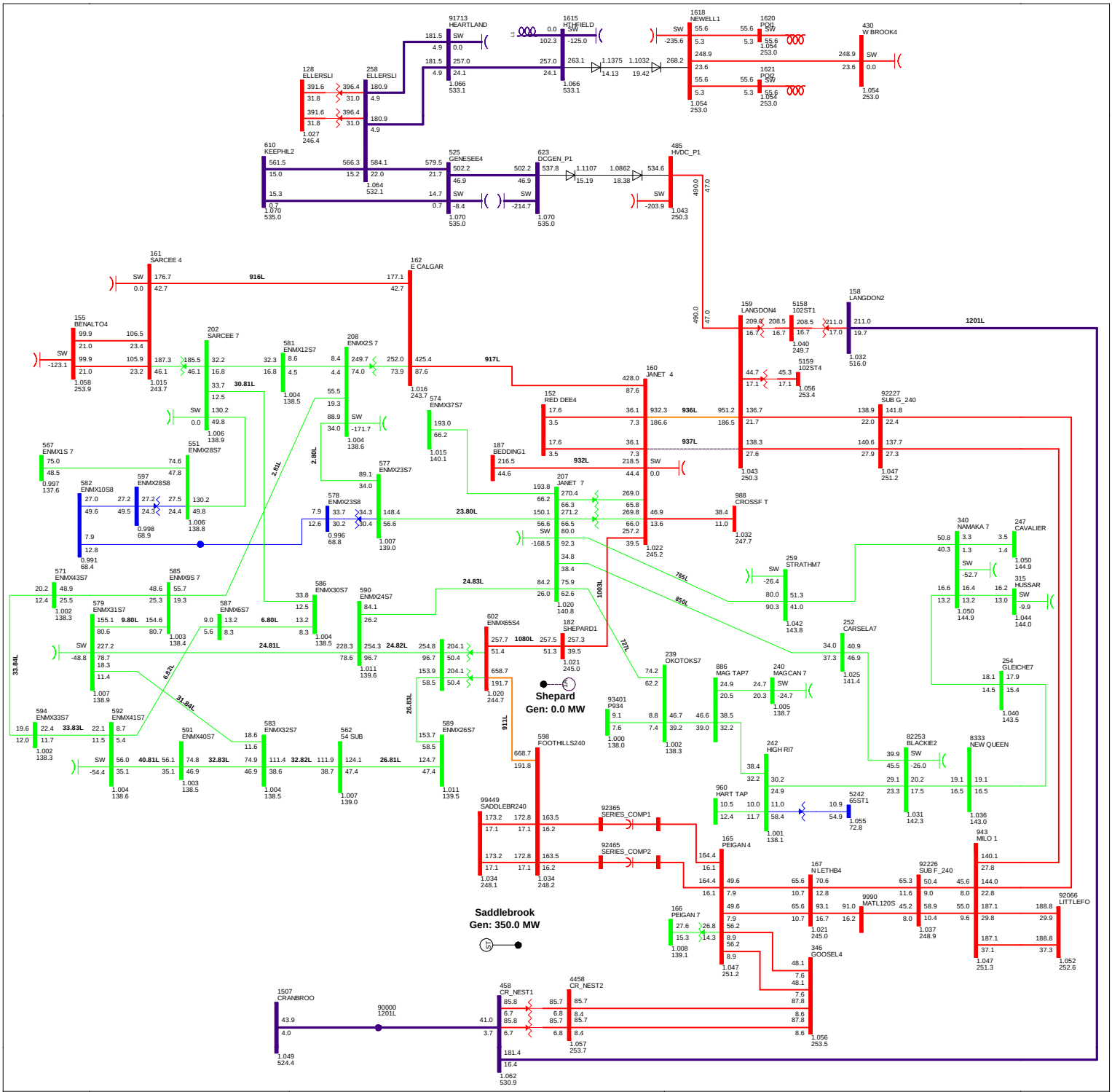
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 13.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-29: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

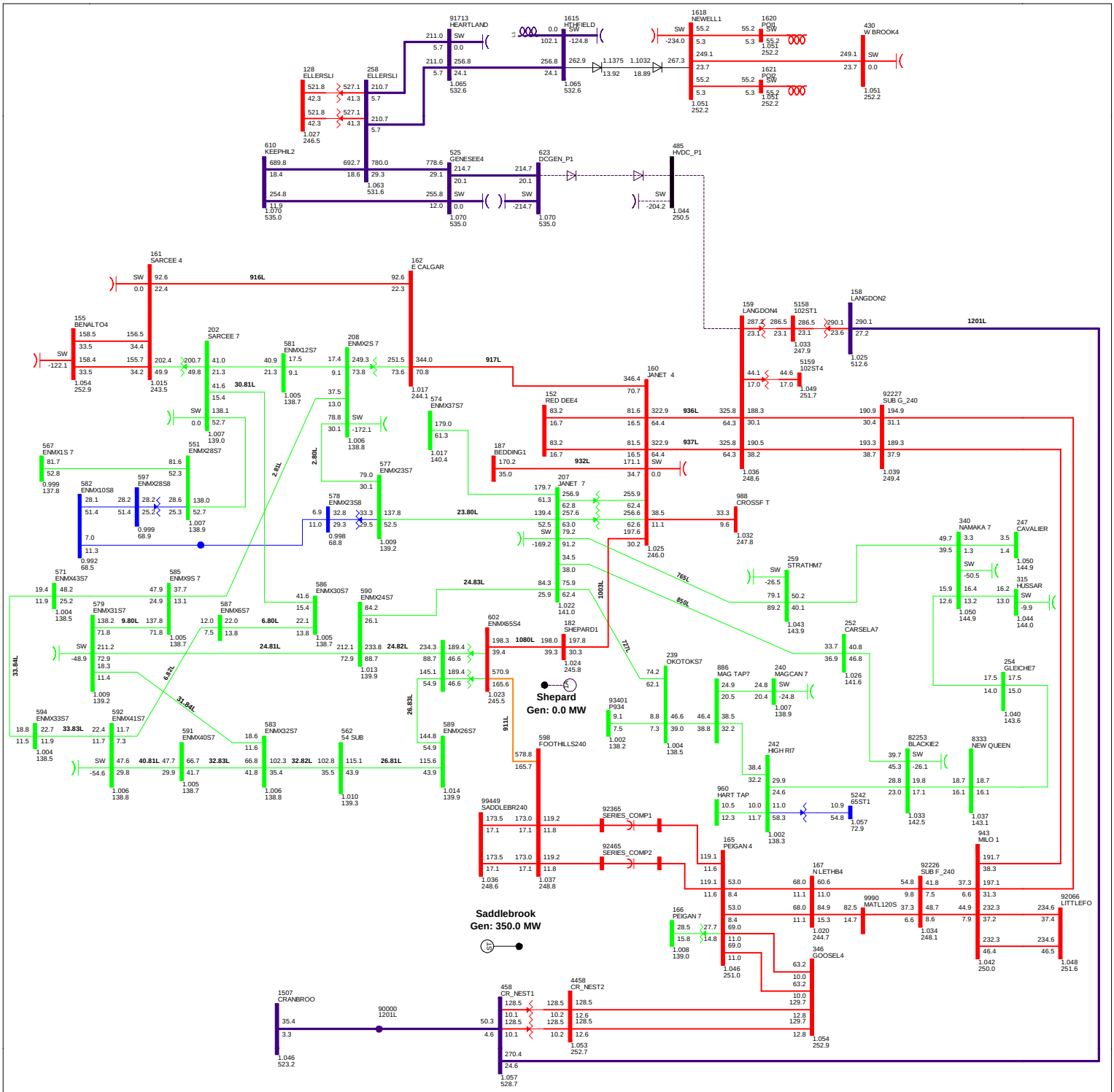
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 13.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-30: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 7.9 MW

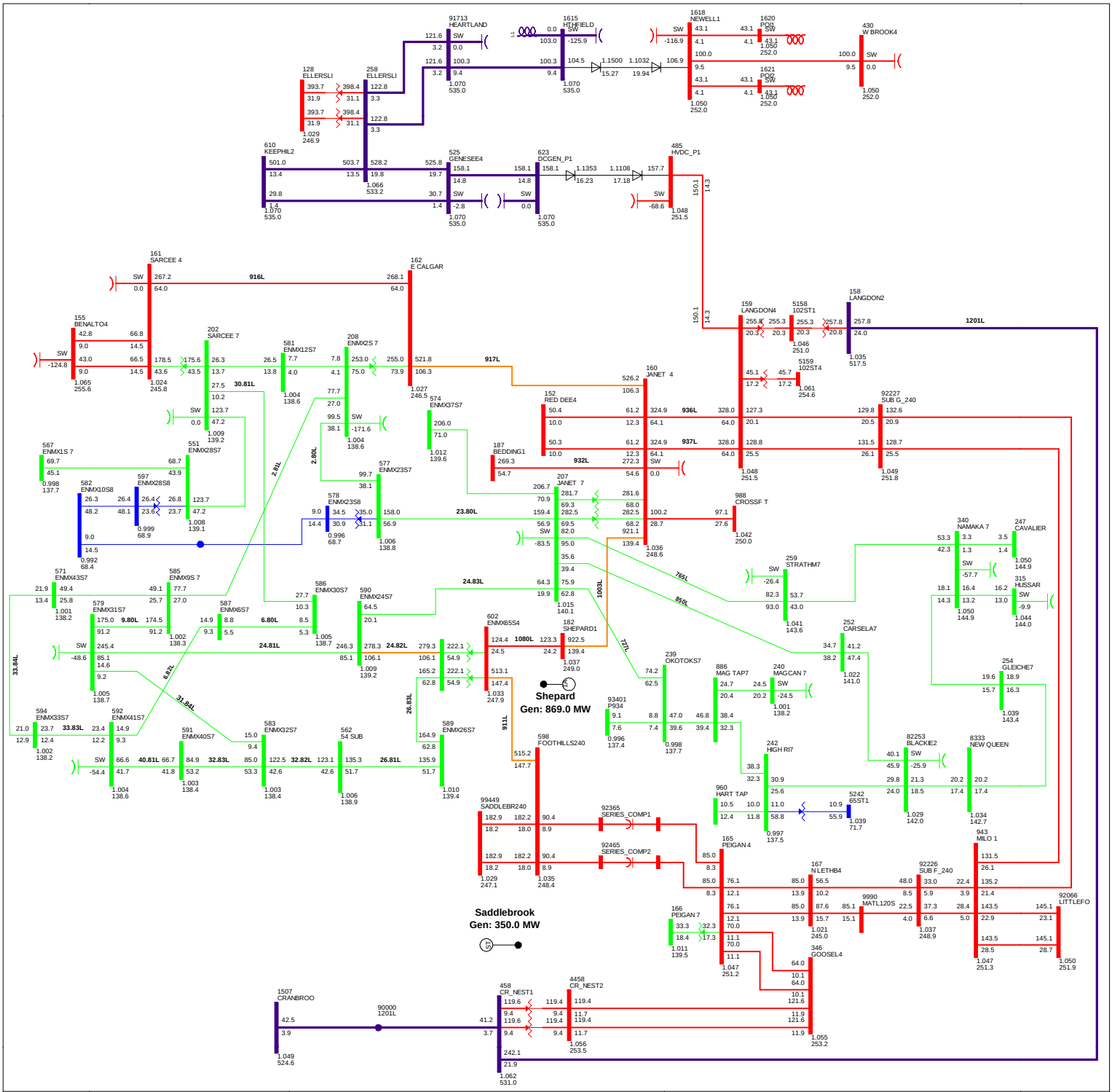
2012LTO+HVDC EXISTING SYSTEM

FIG A-SC3-31: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2014_NEED_HVDC_SC3

FRI, JUN 08 2012 16:18

2014 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

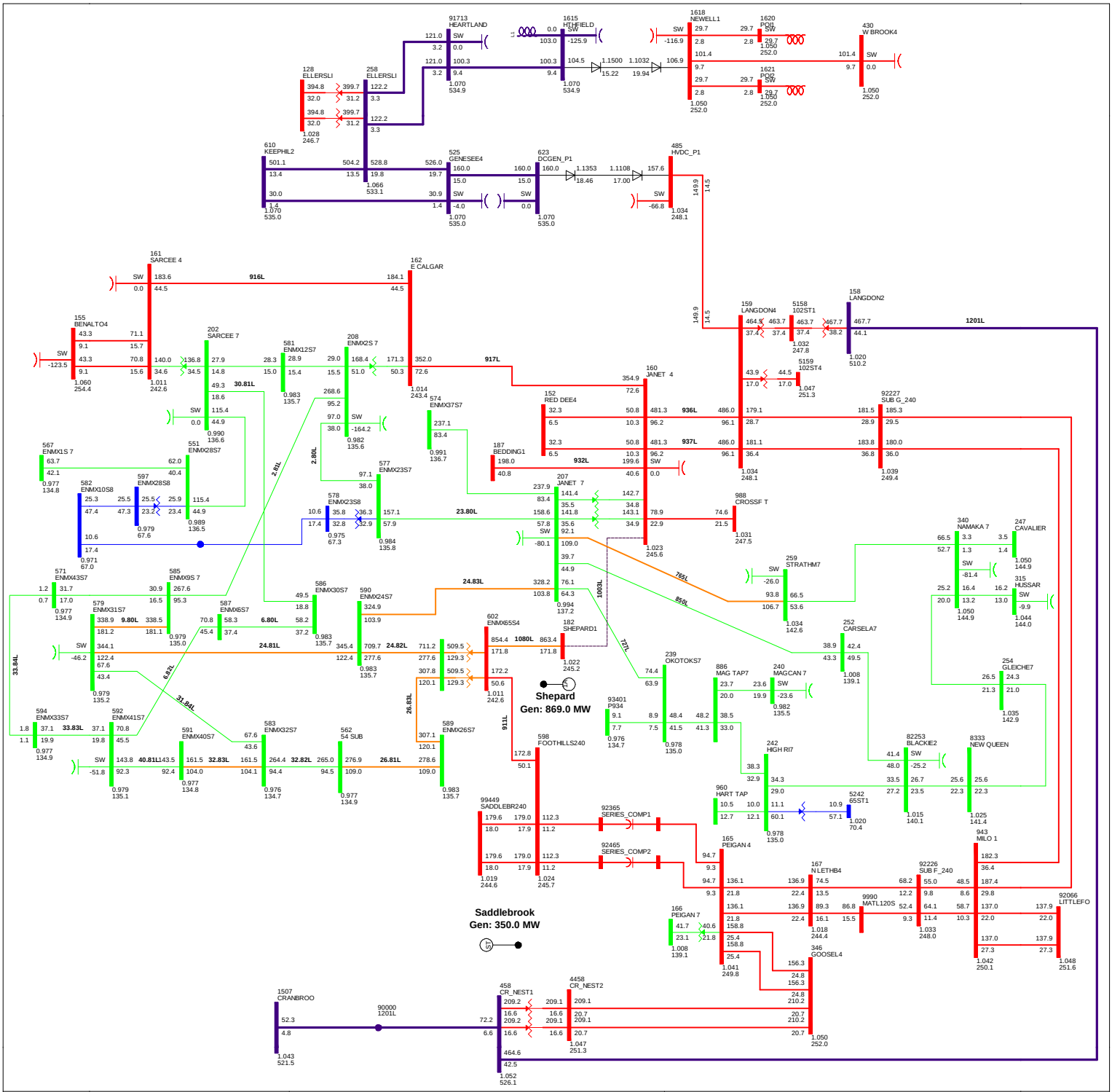
BCH Import: 3.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-1: BASECASE

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

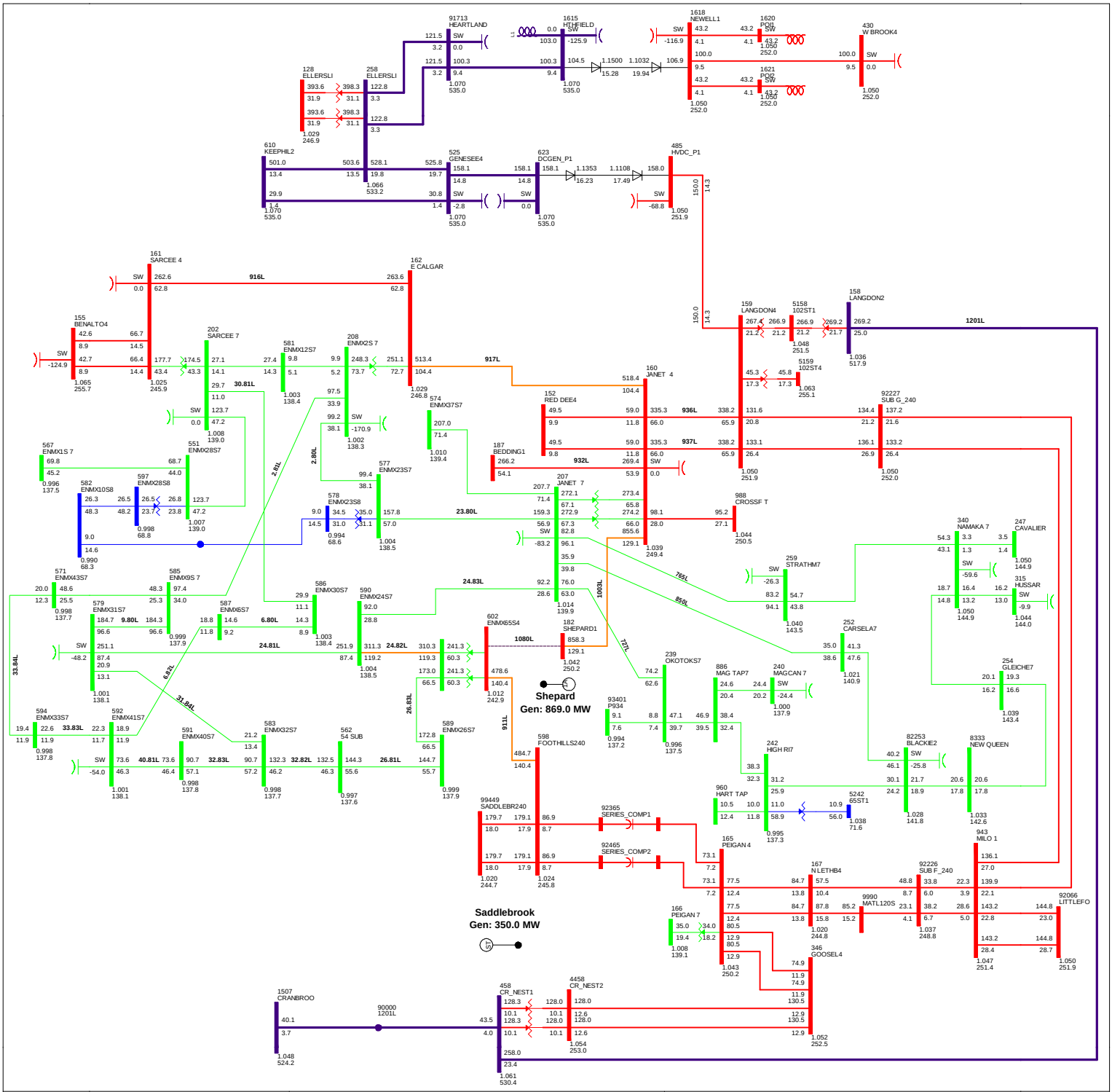
BCH Import: 45.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

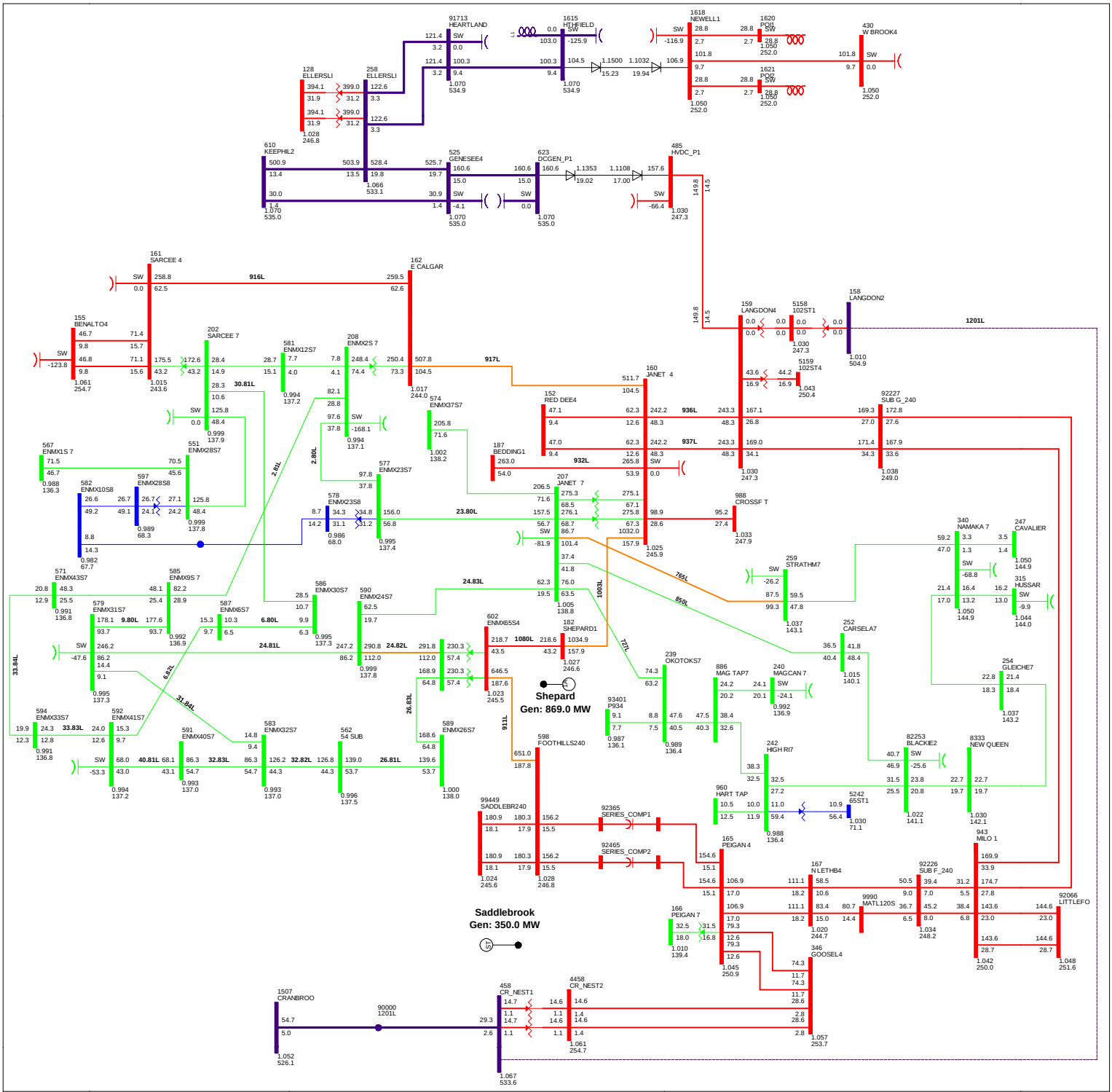
BCH Import: 4.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

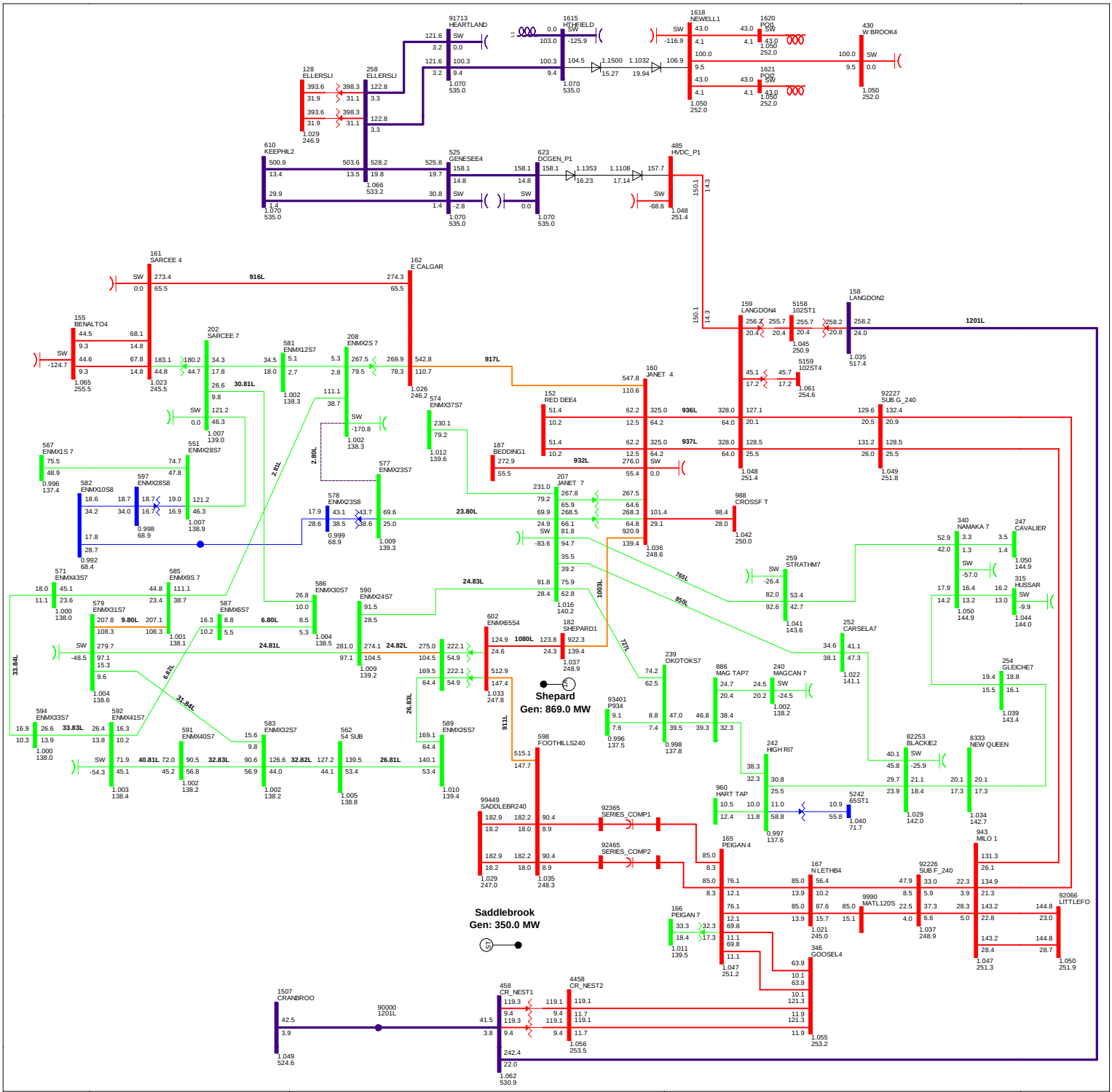
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 17.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

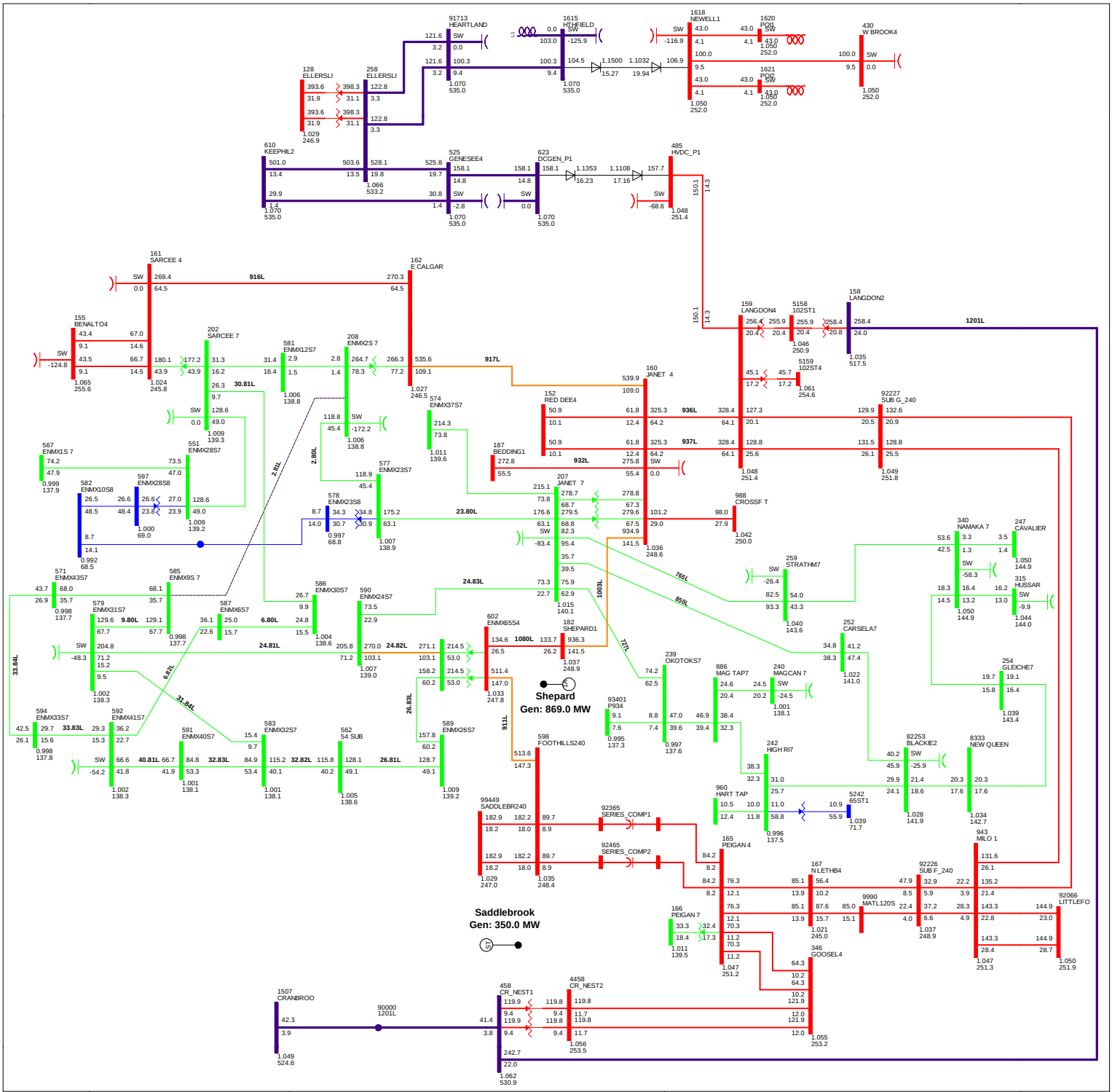
BCH Import: 5.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

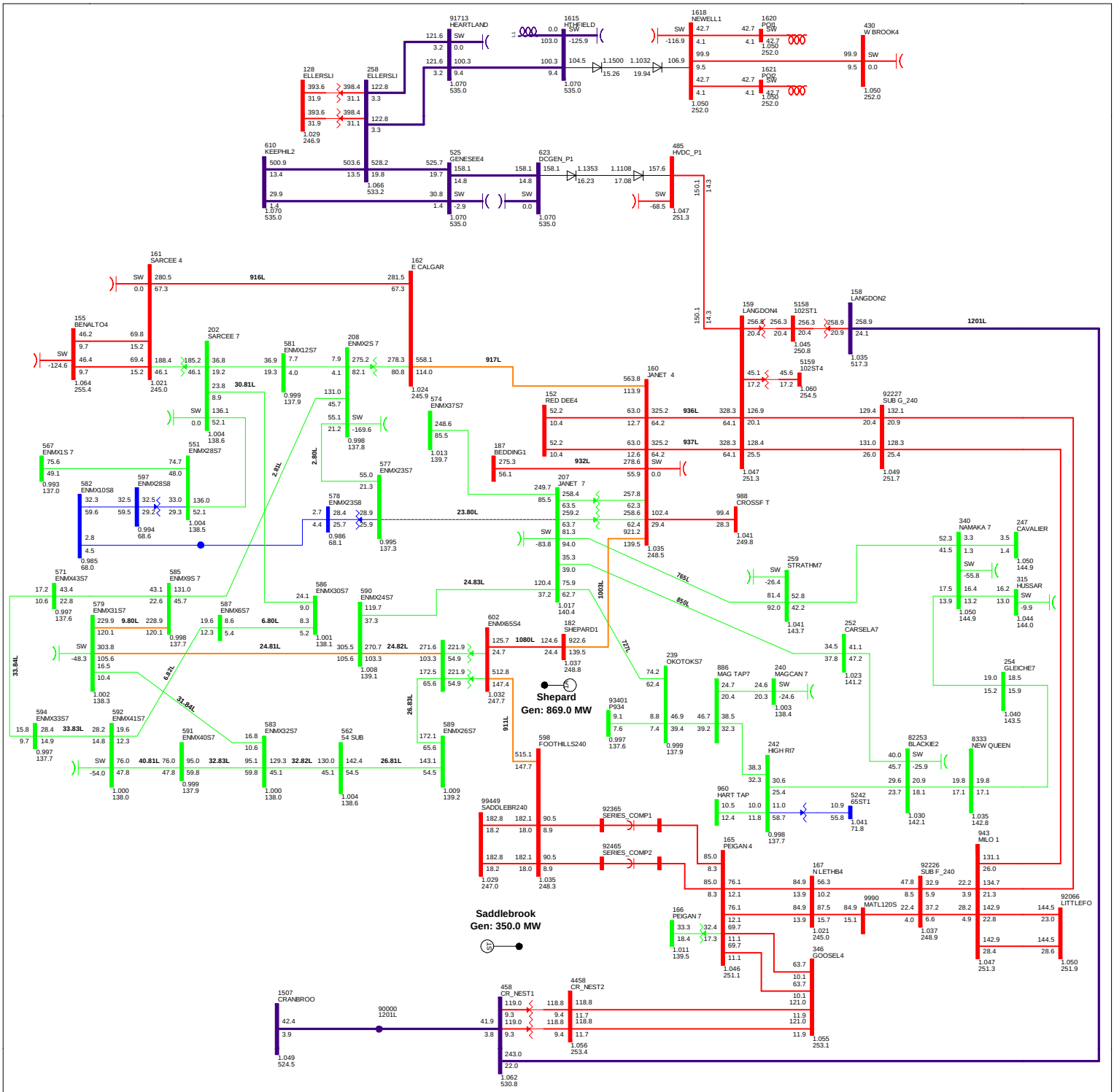
BCH Import: 4.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

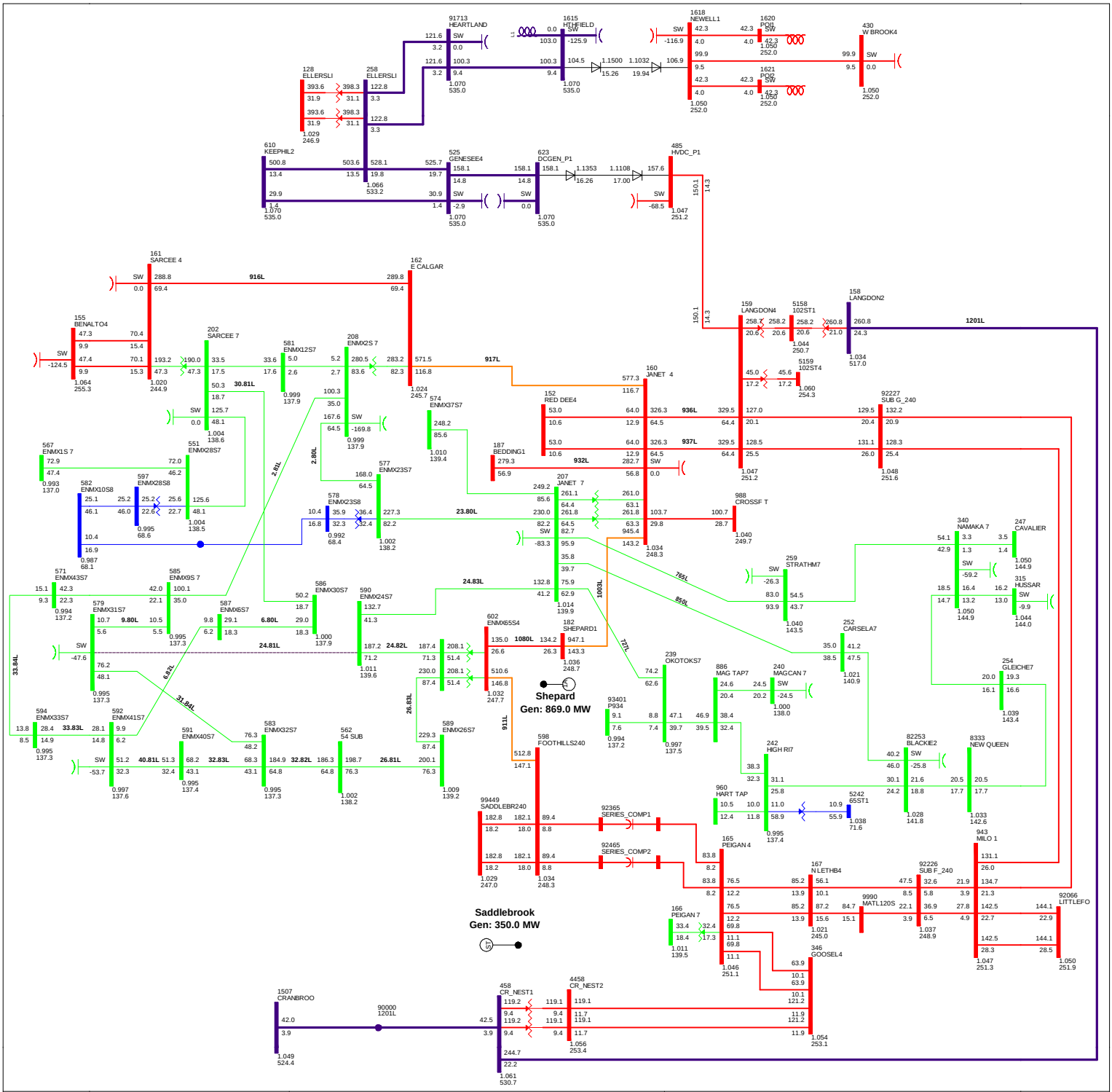
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 6.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

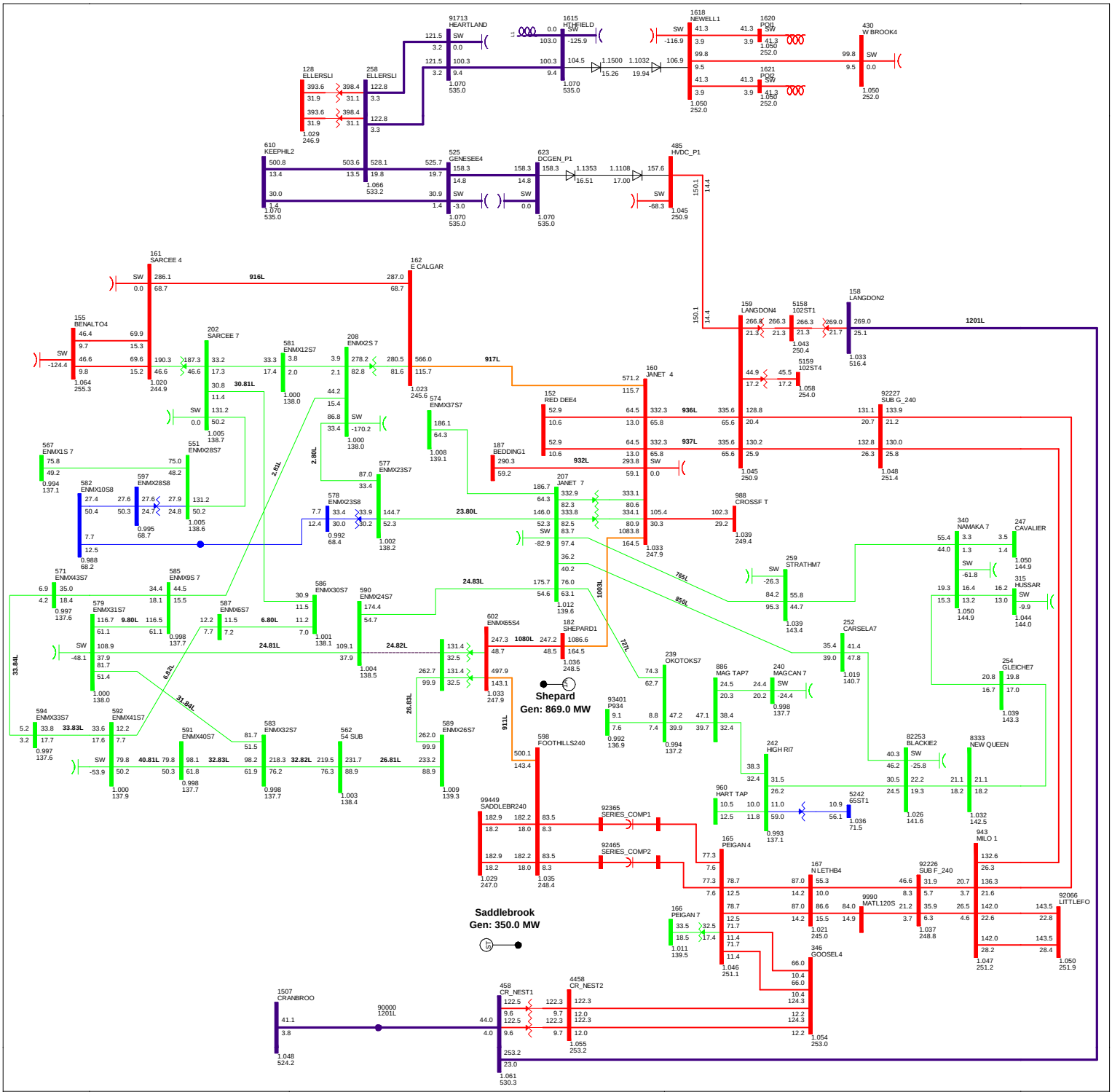
BCH Import: 8.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

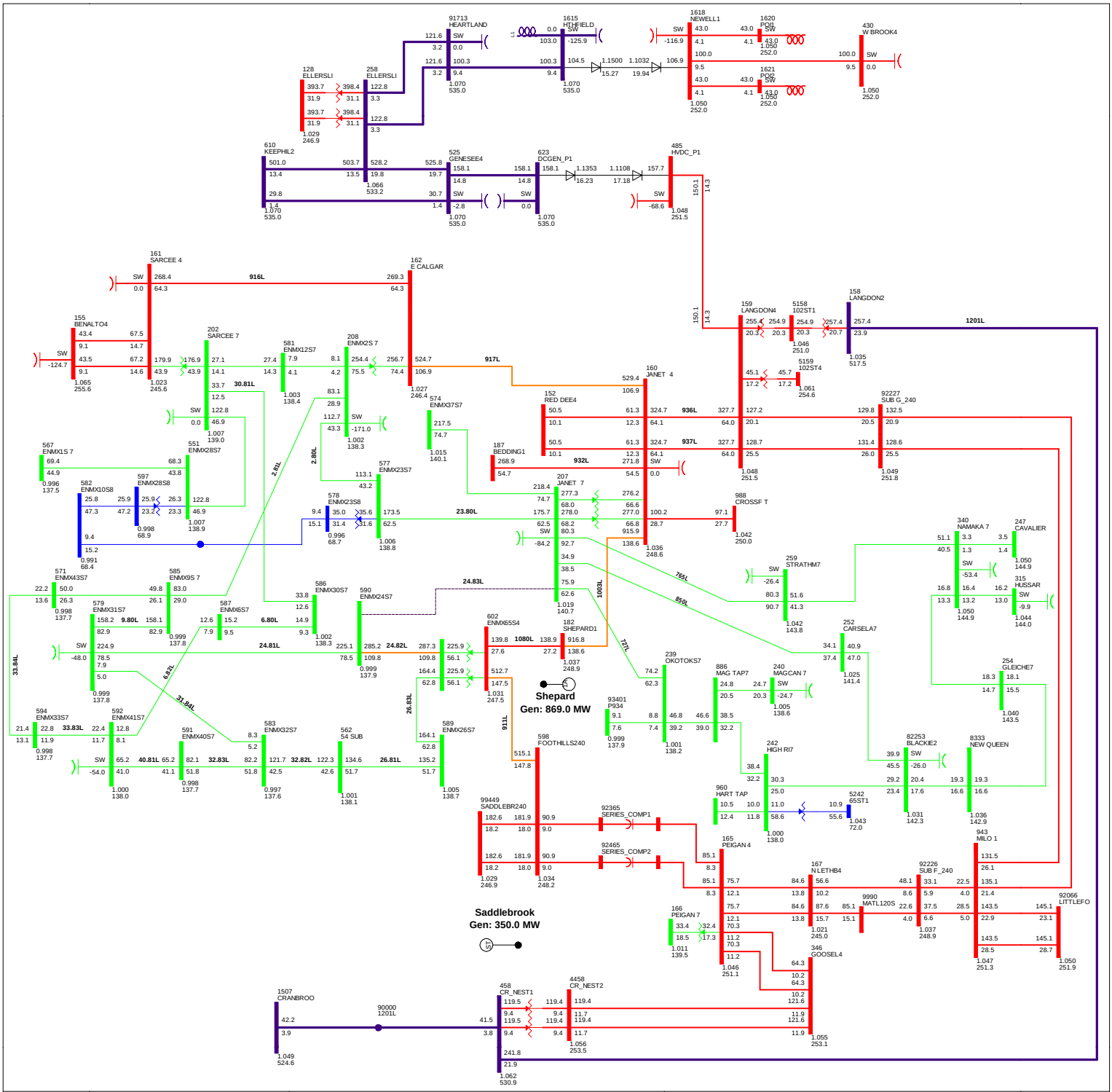
BCH Import: 9.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

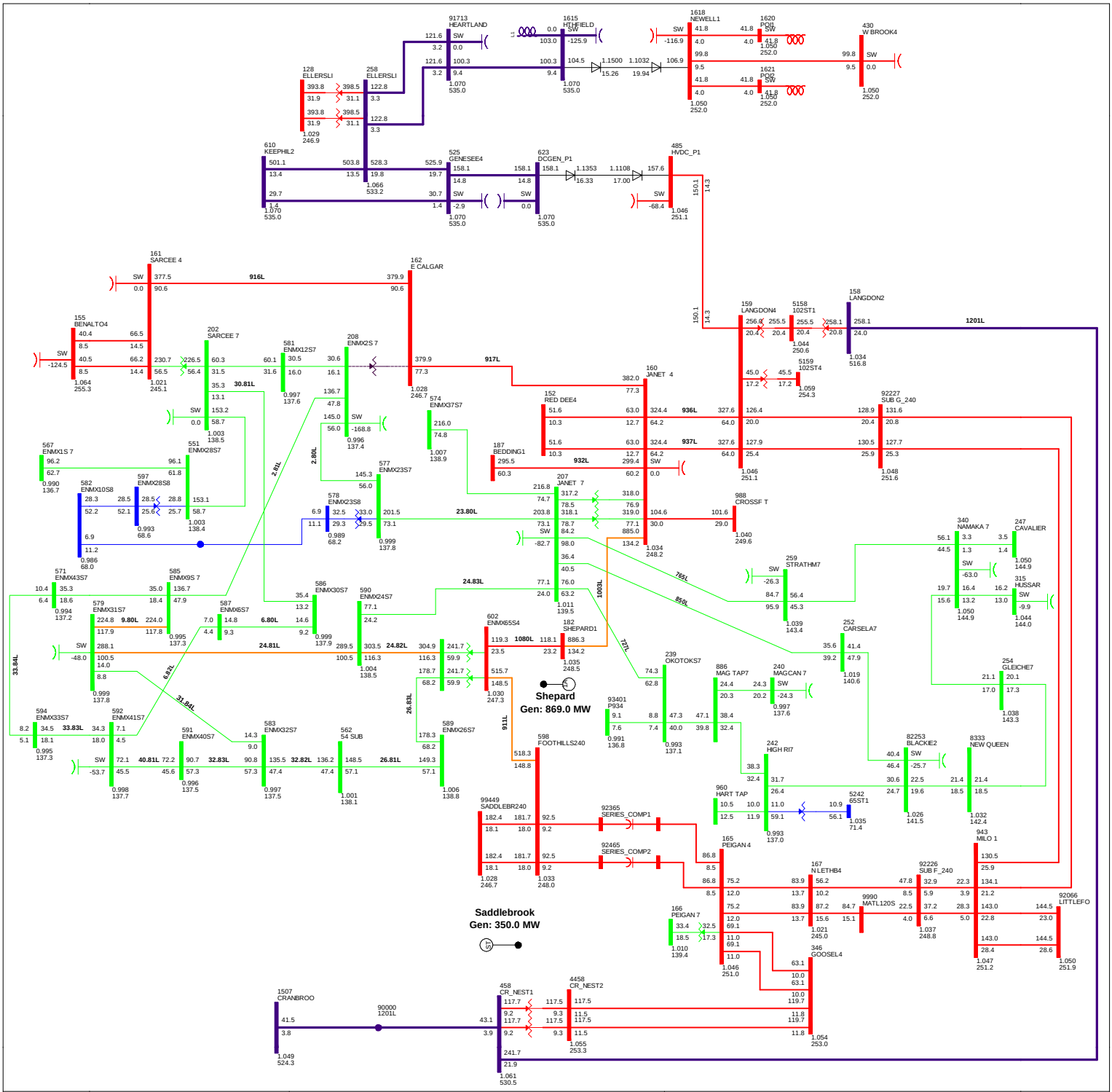
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 3.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

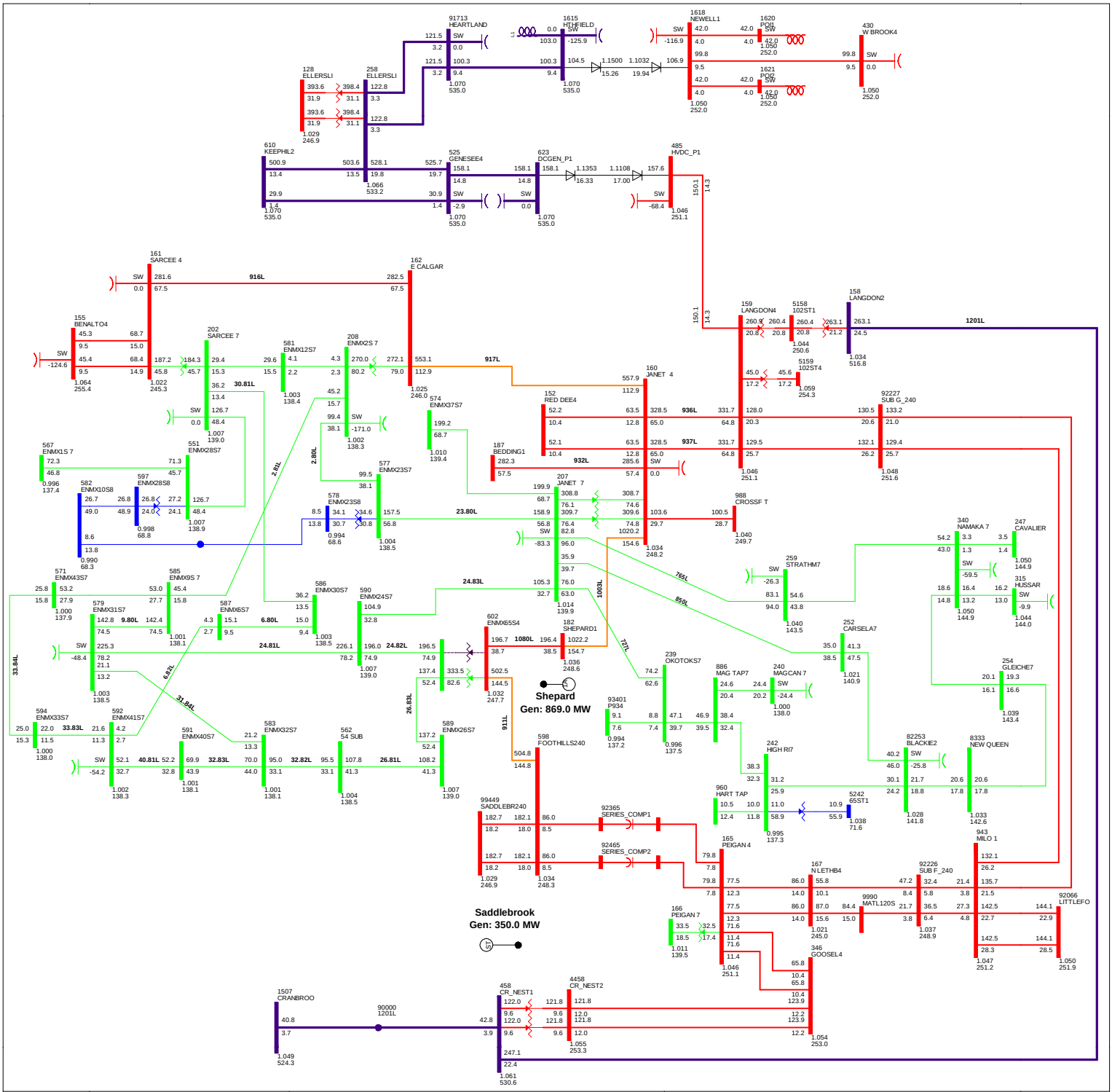
BCH Import: 8.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

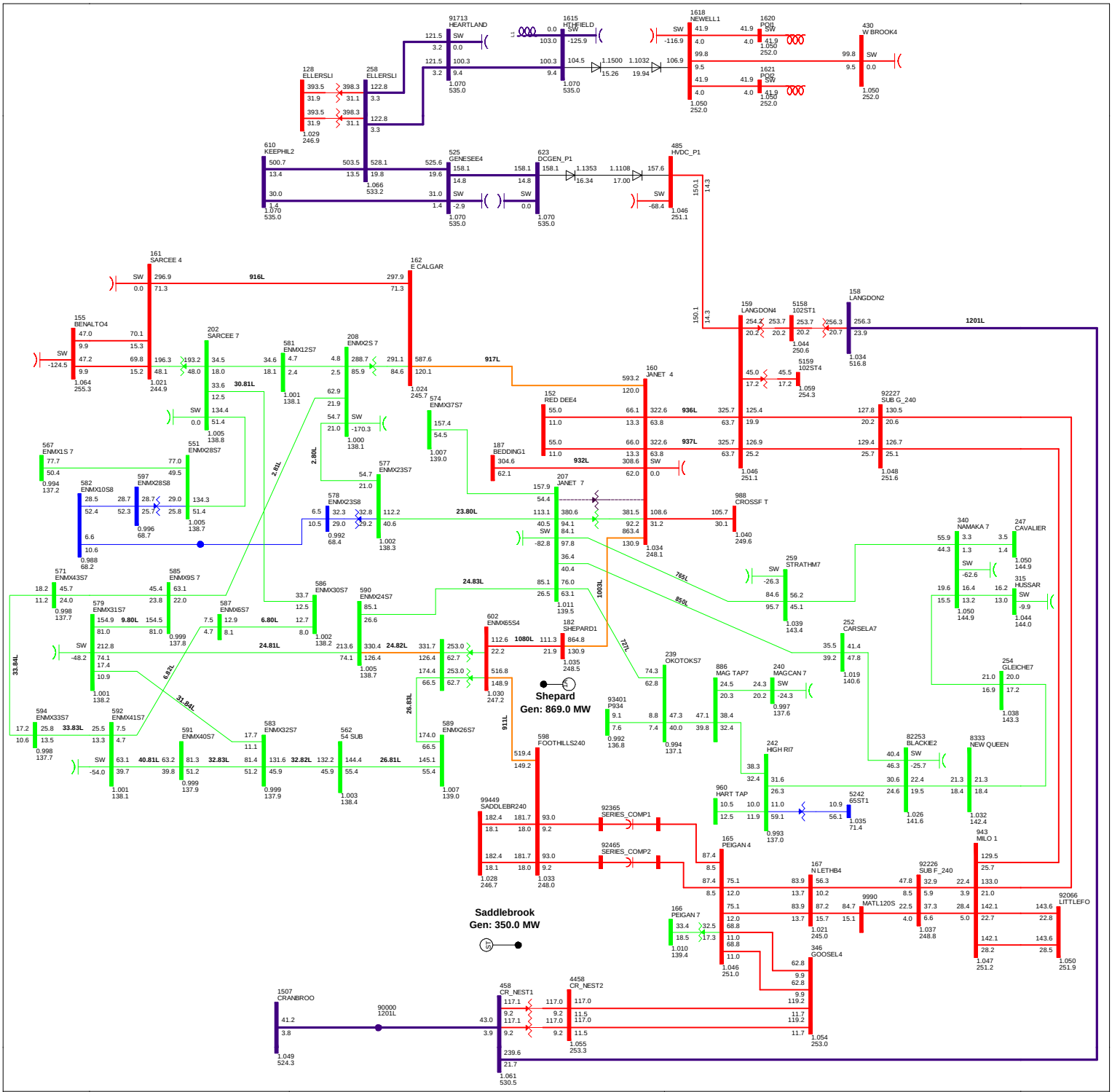
BCH Import: 4.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

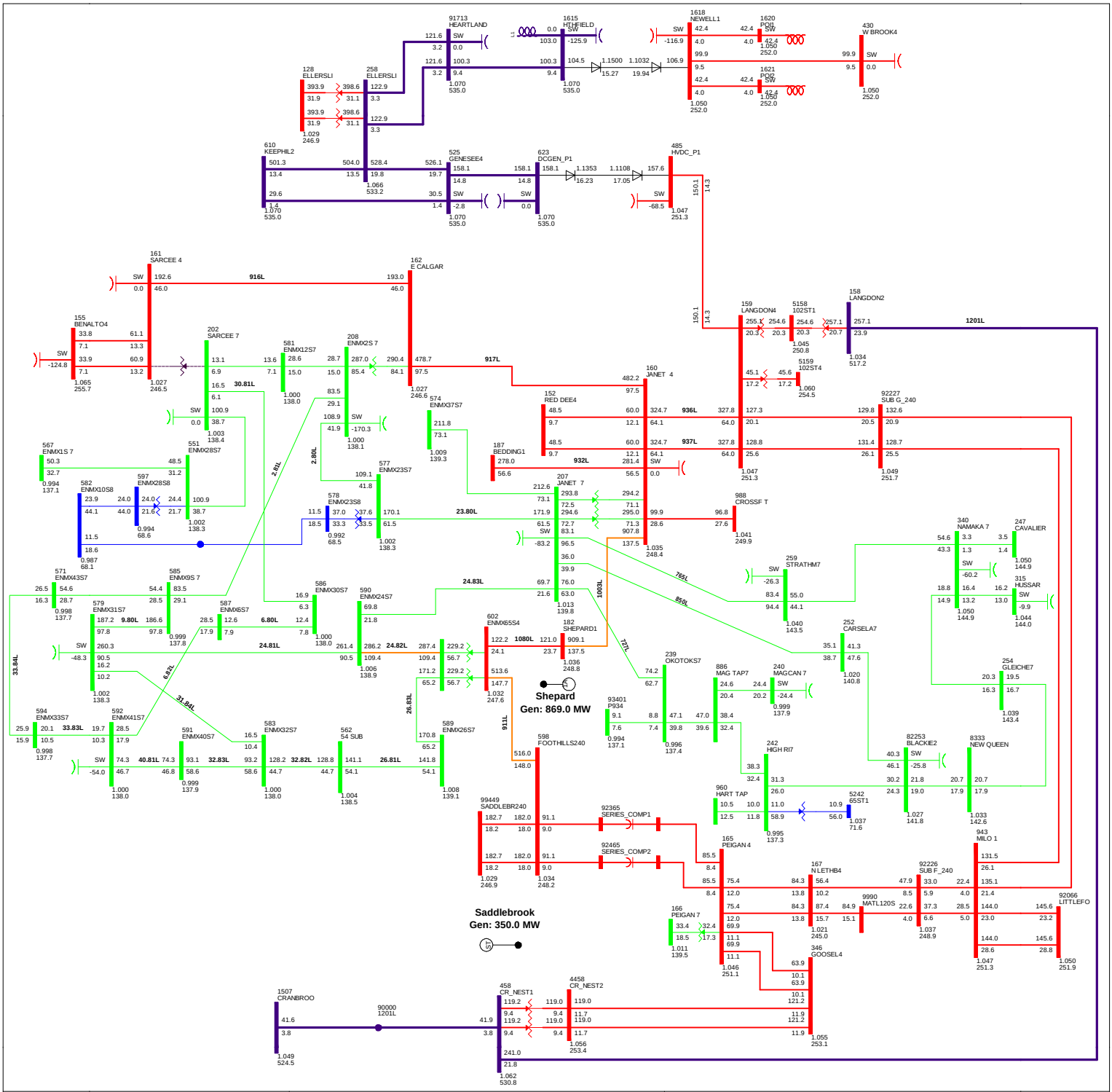
BCH Import: 7.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

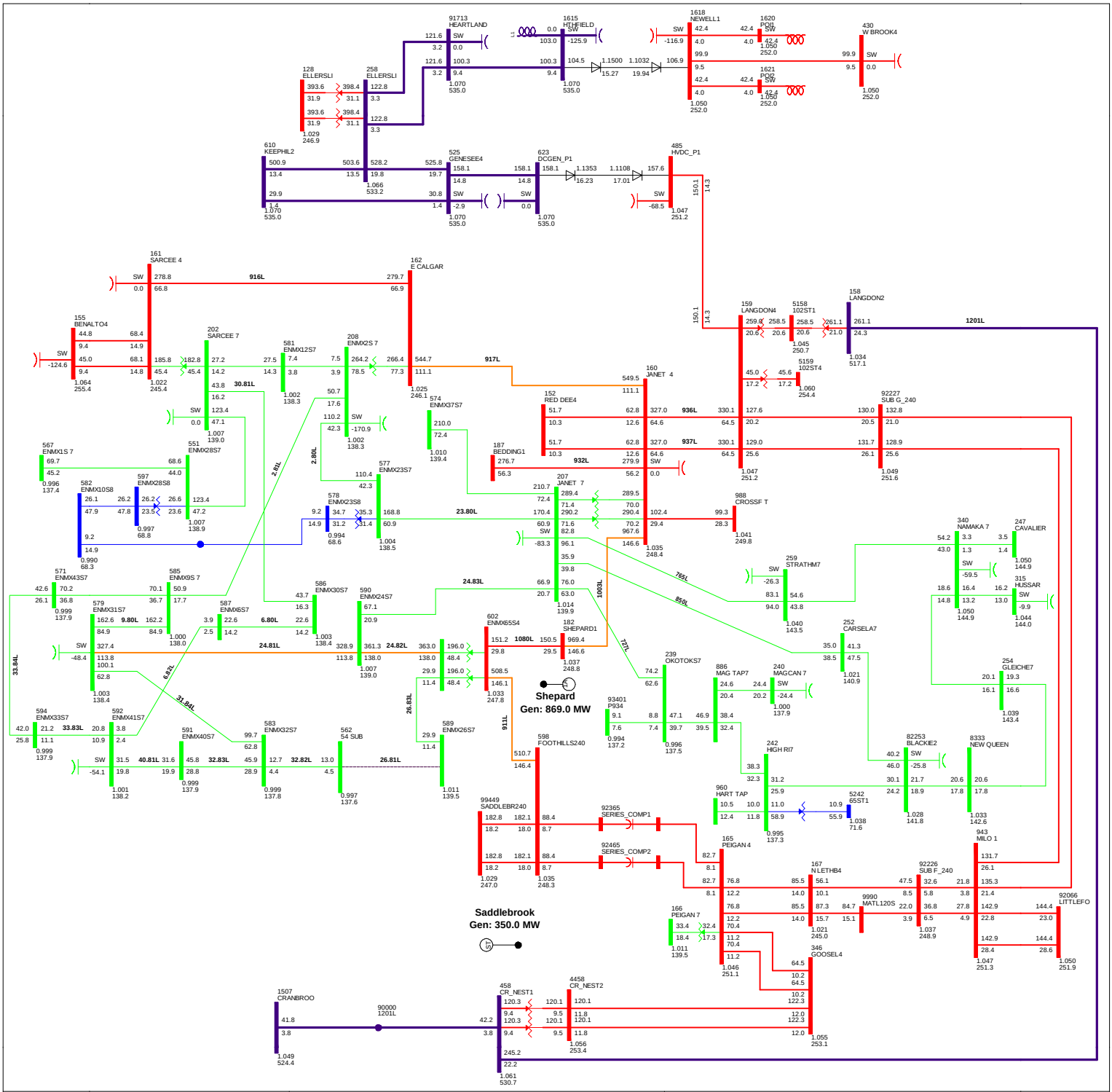
BCH Import: 4.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

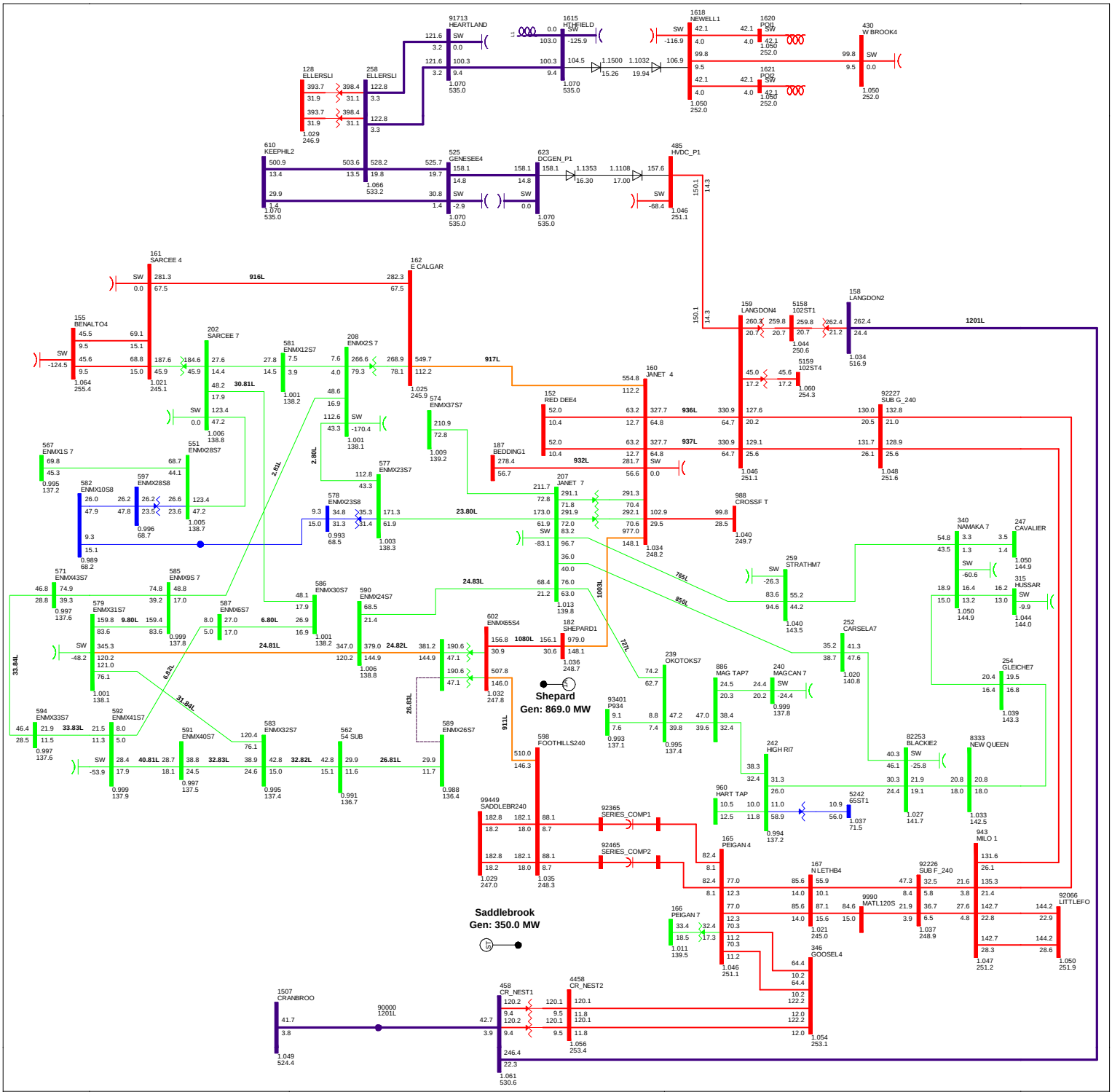
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 6.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

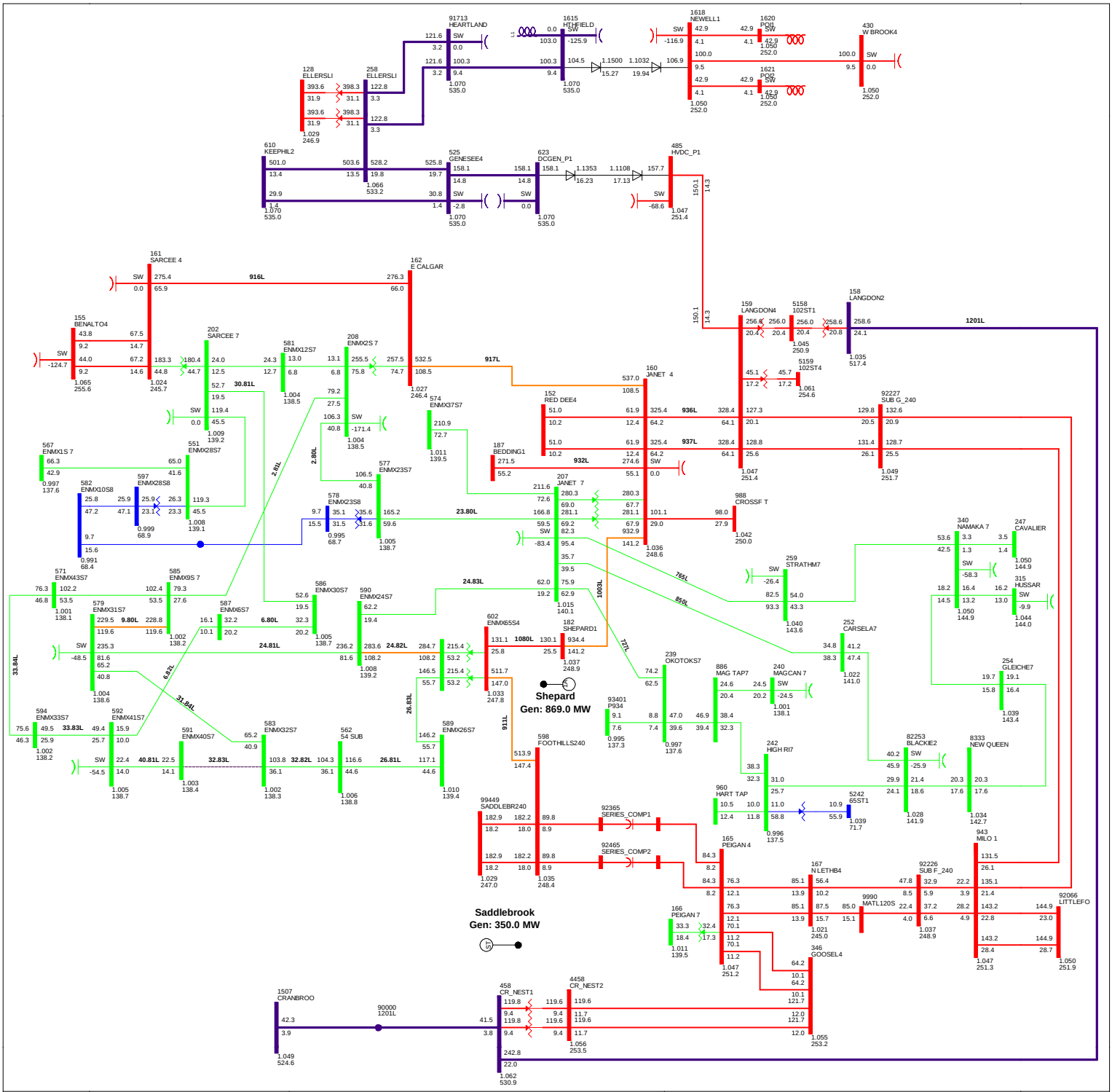
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 7.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

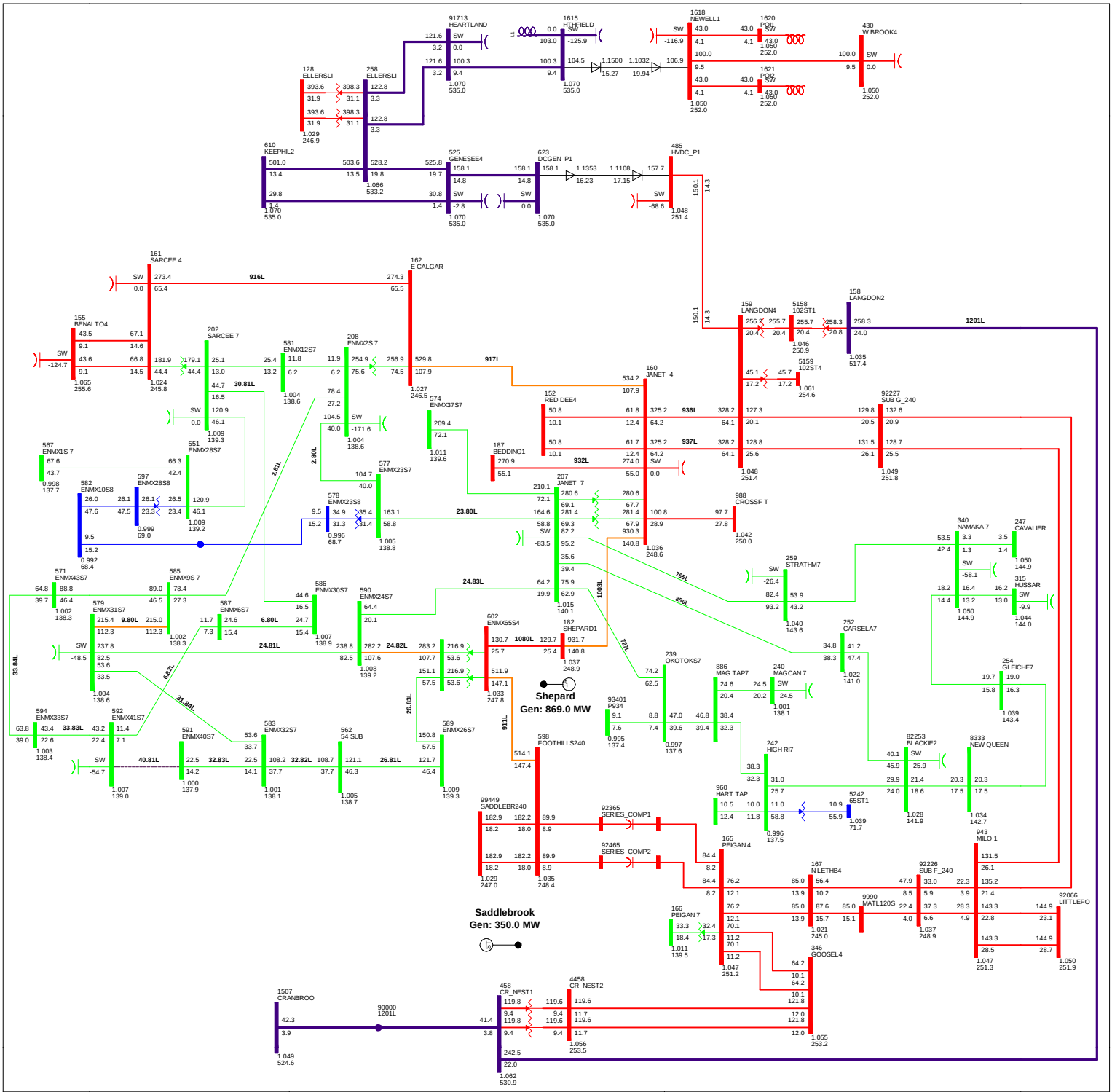
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

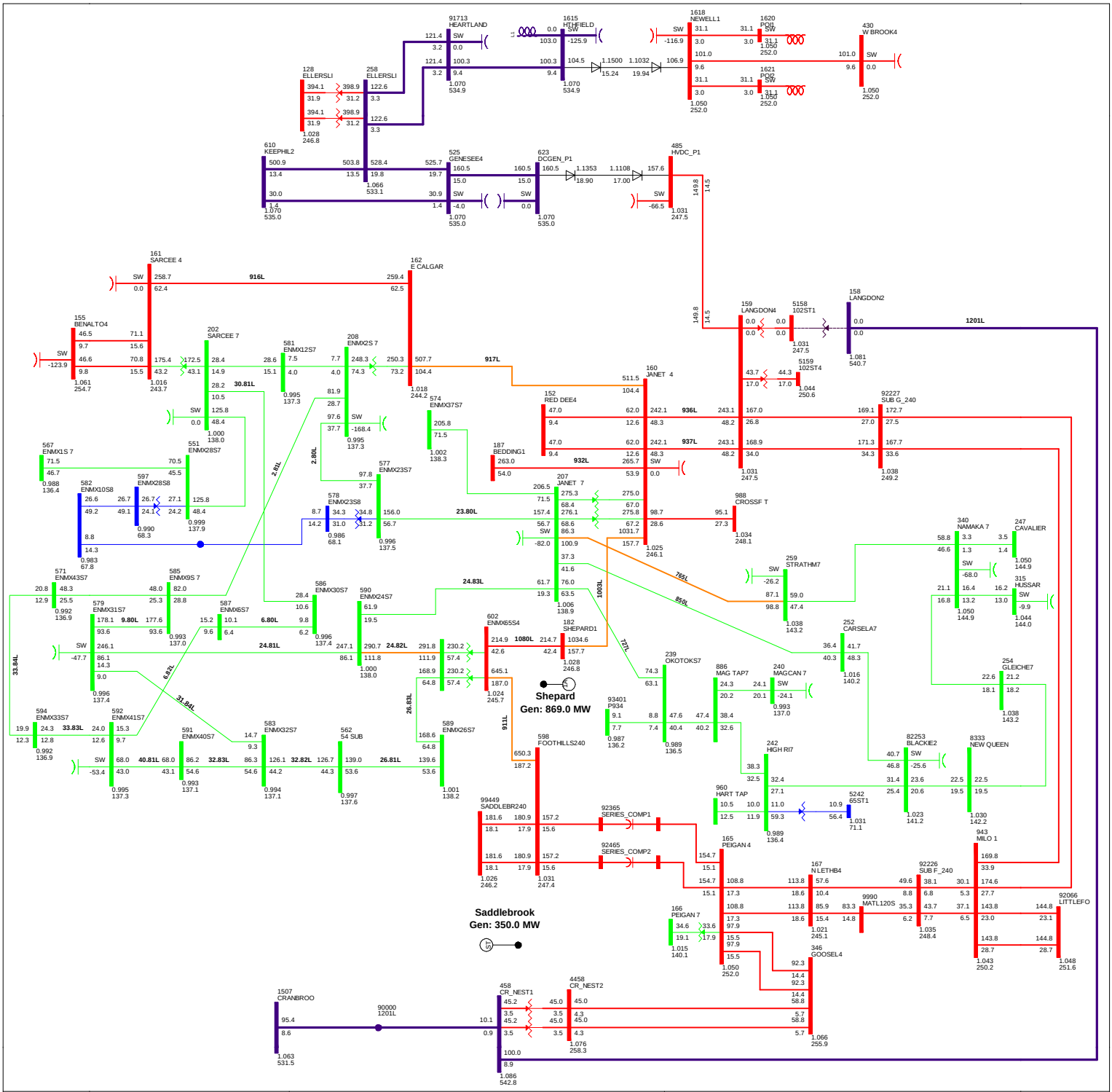
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 4.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

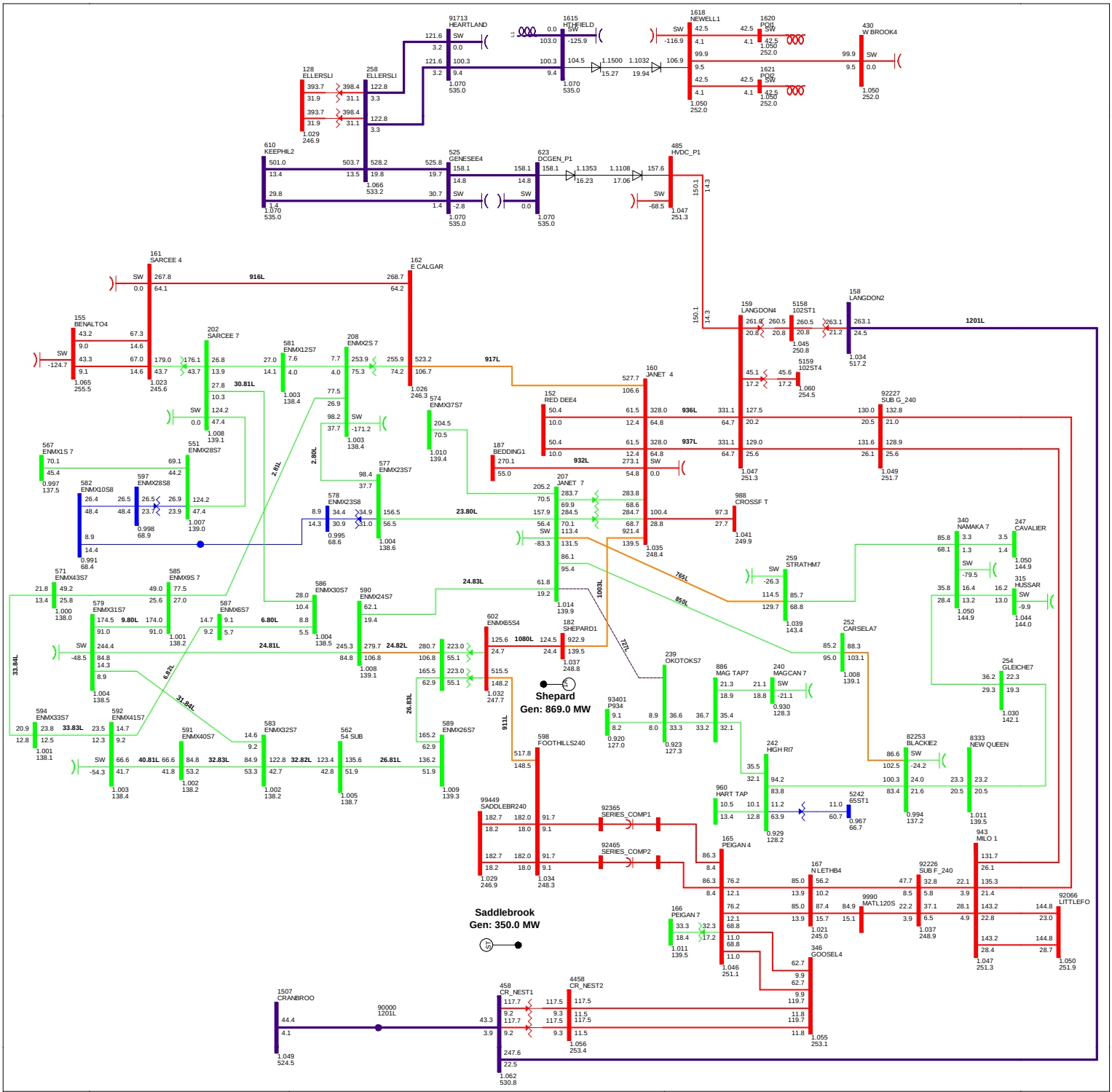
BCH Import: 17.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

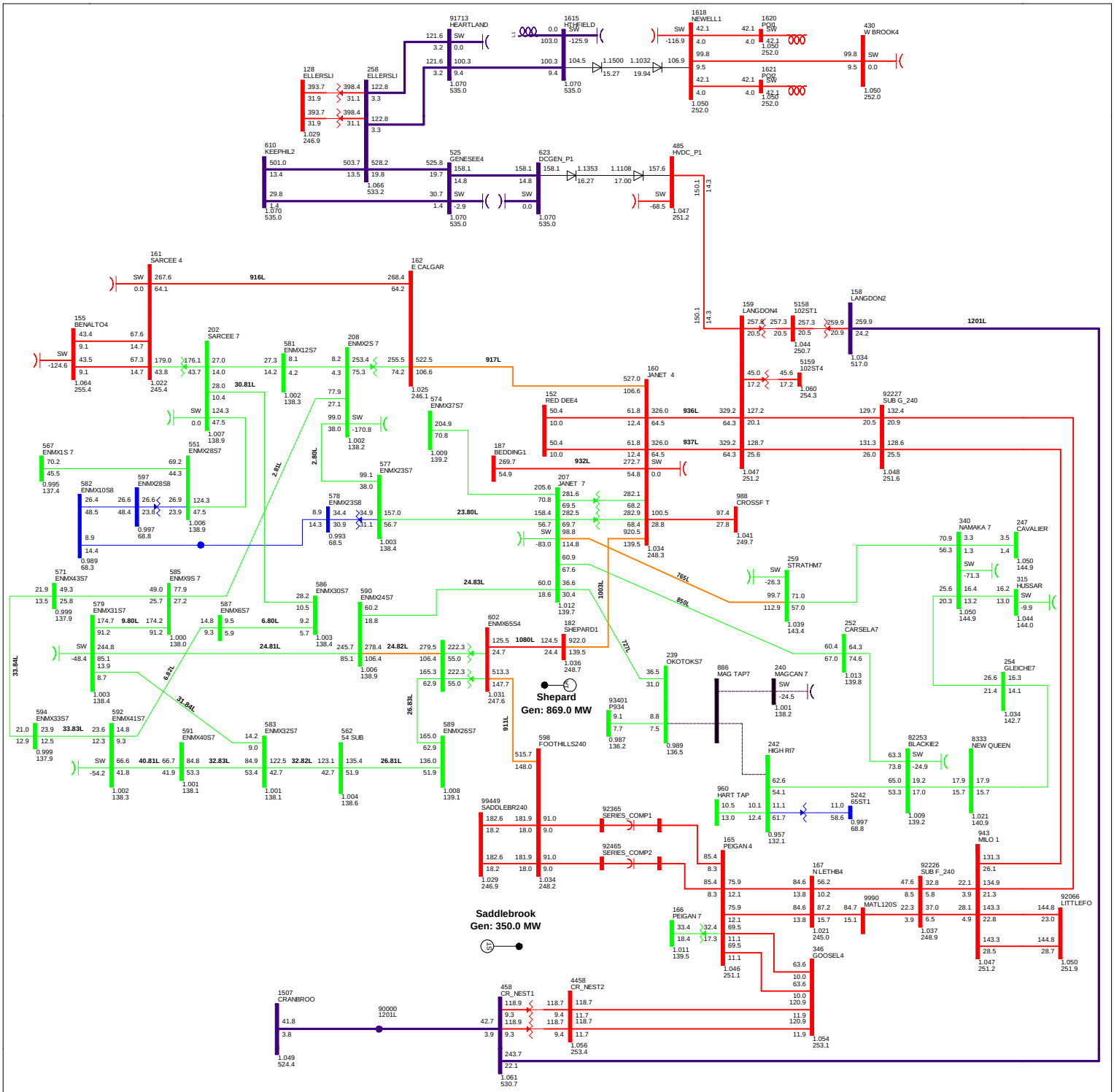
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 13.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

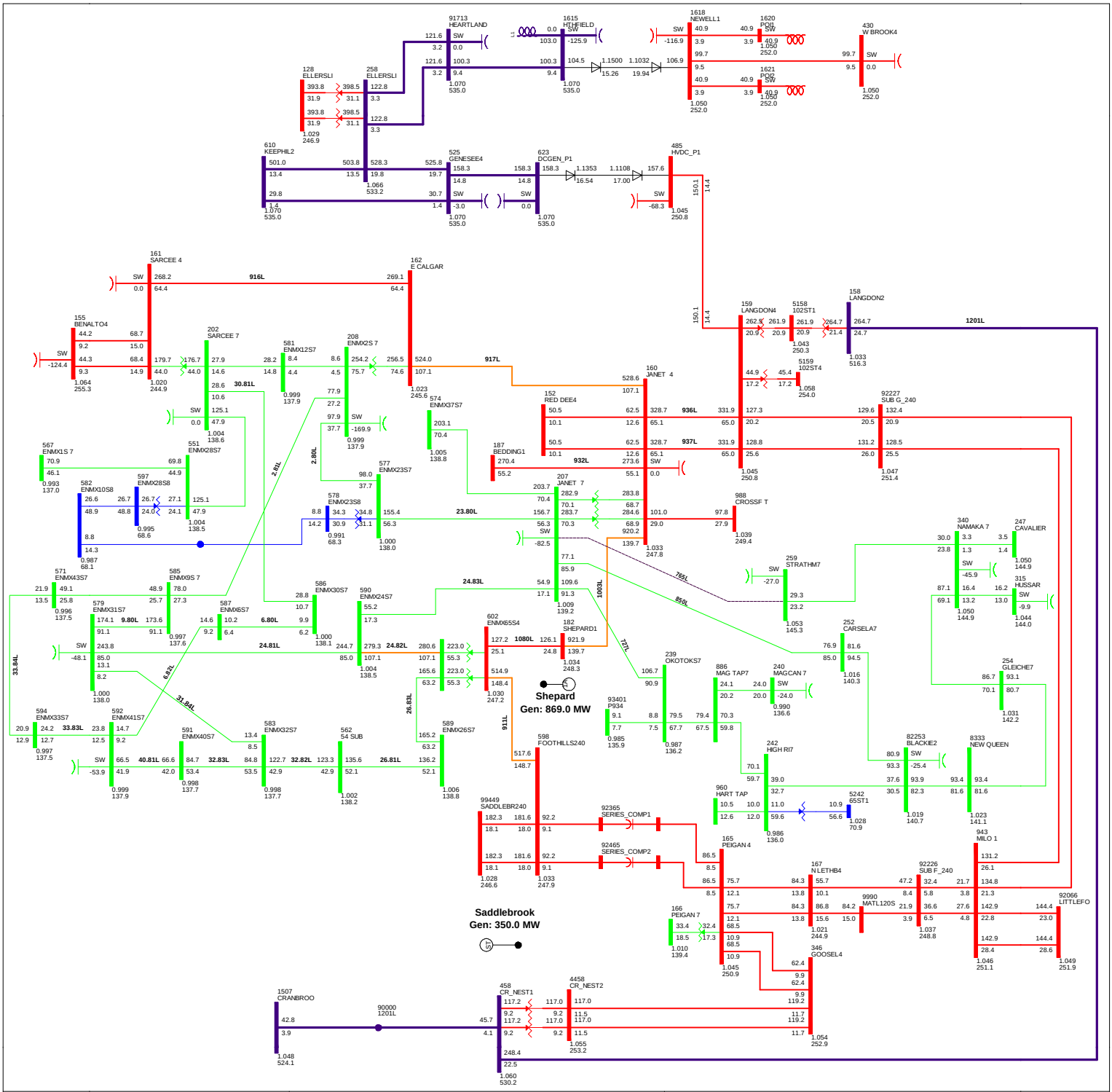
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 7.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:19



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

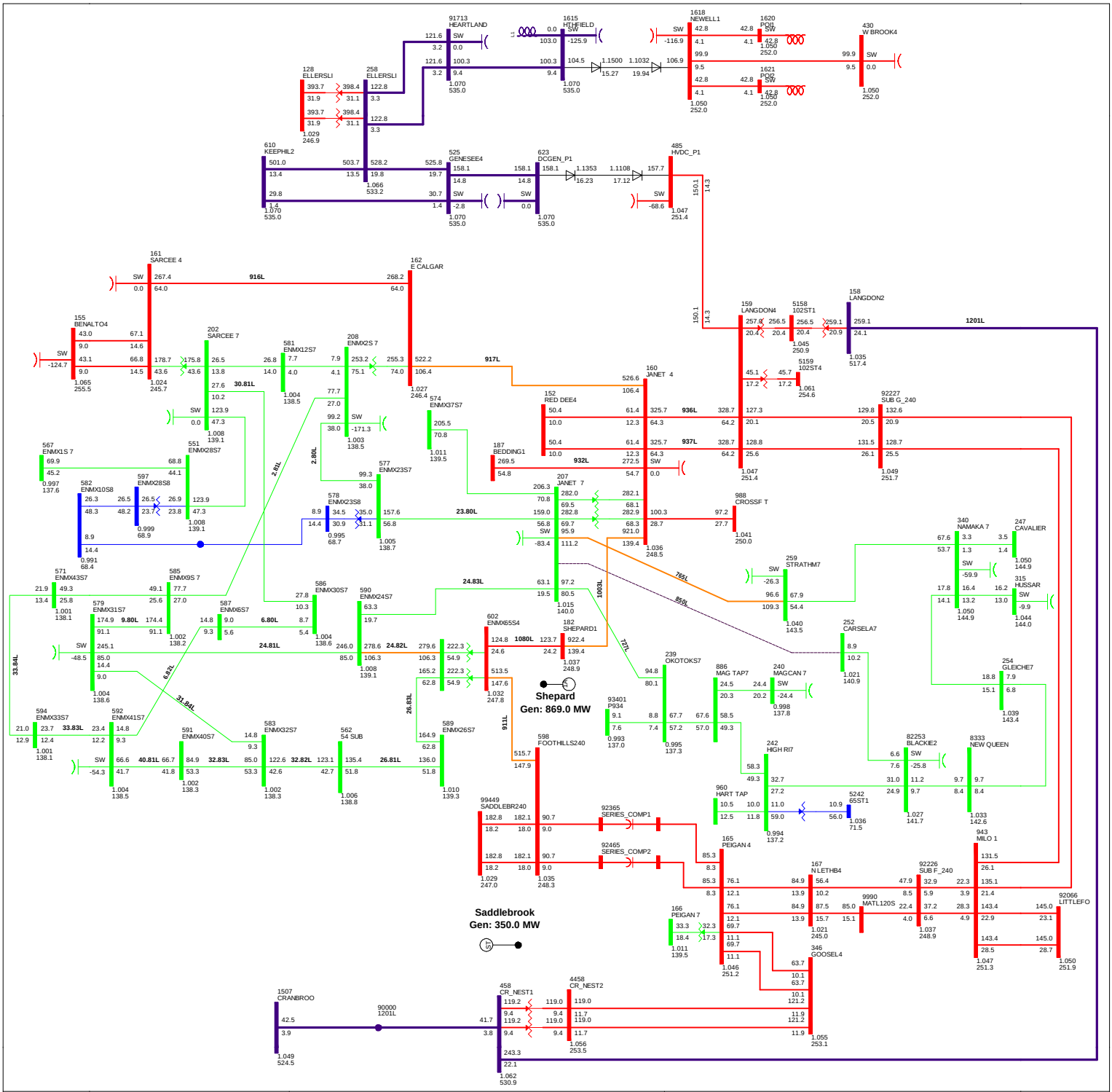
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 15.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-22: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

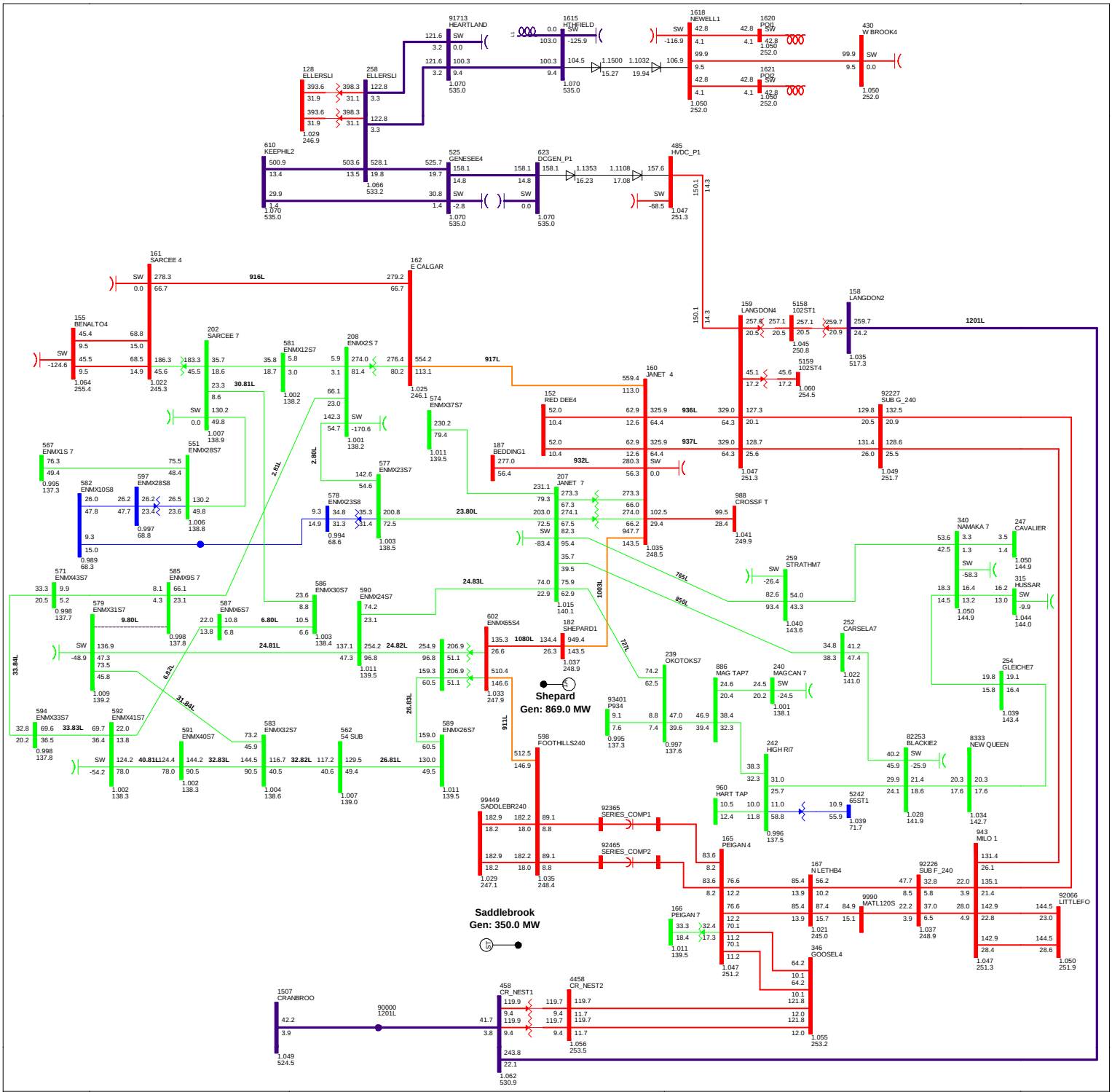
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 6.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-23: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

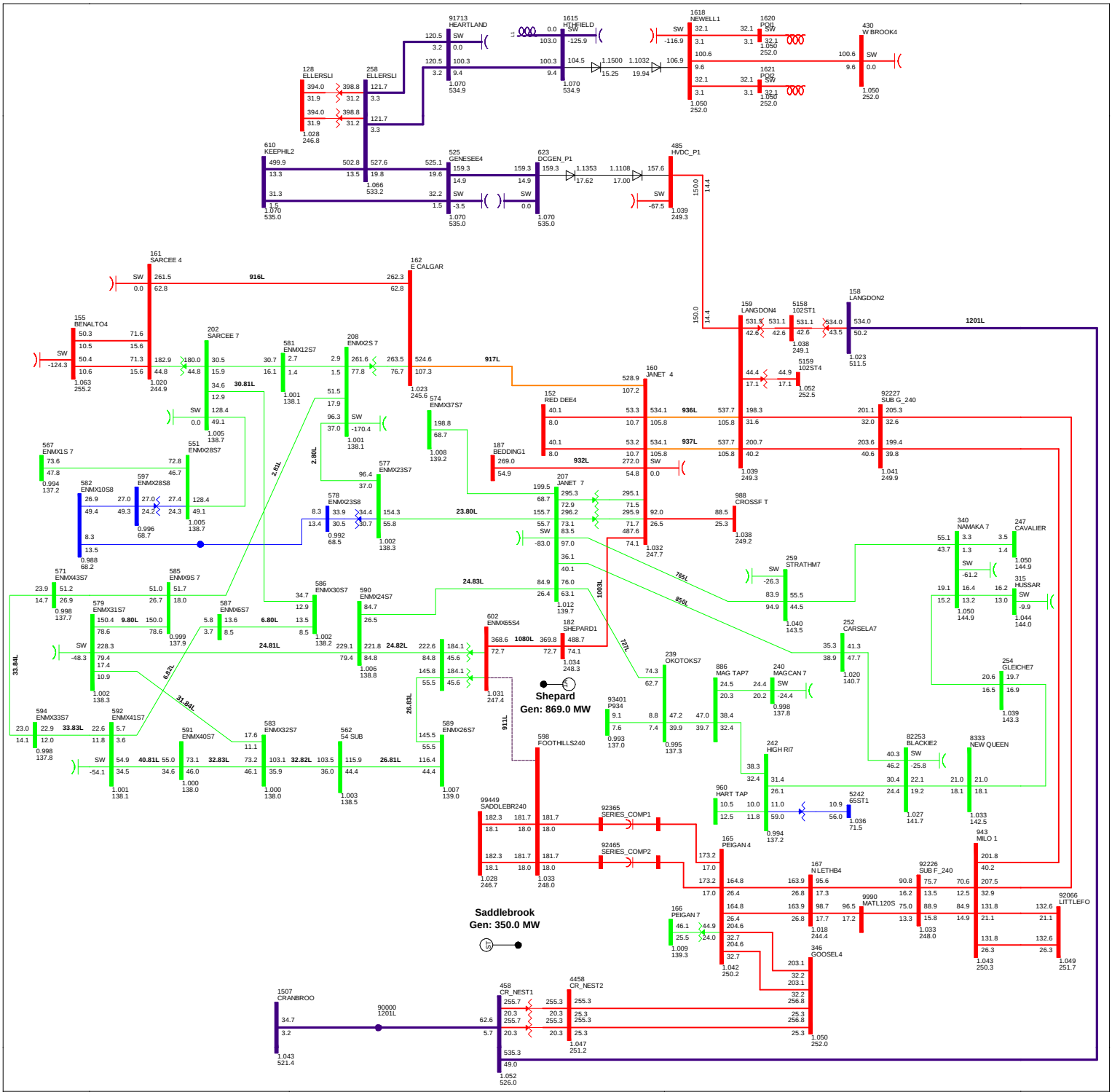
BCH Import: 5.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-24: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

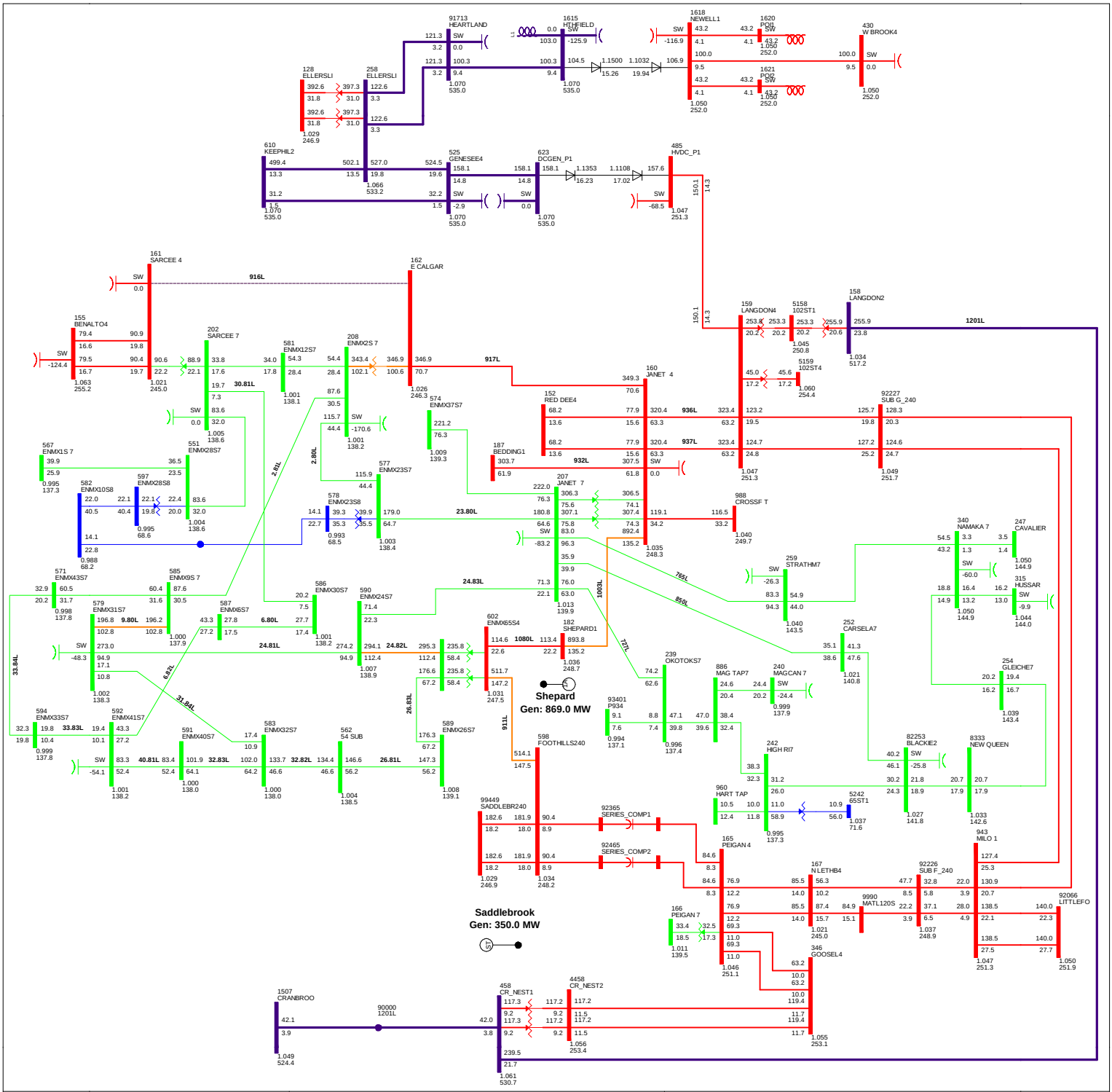
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 26.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-25: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

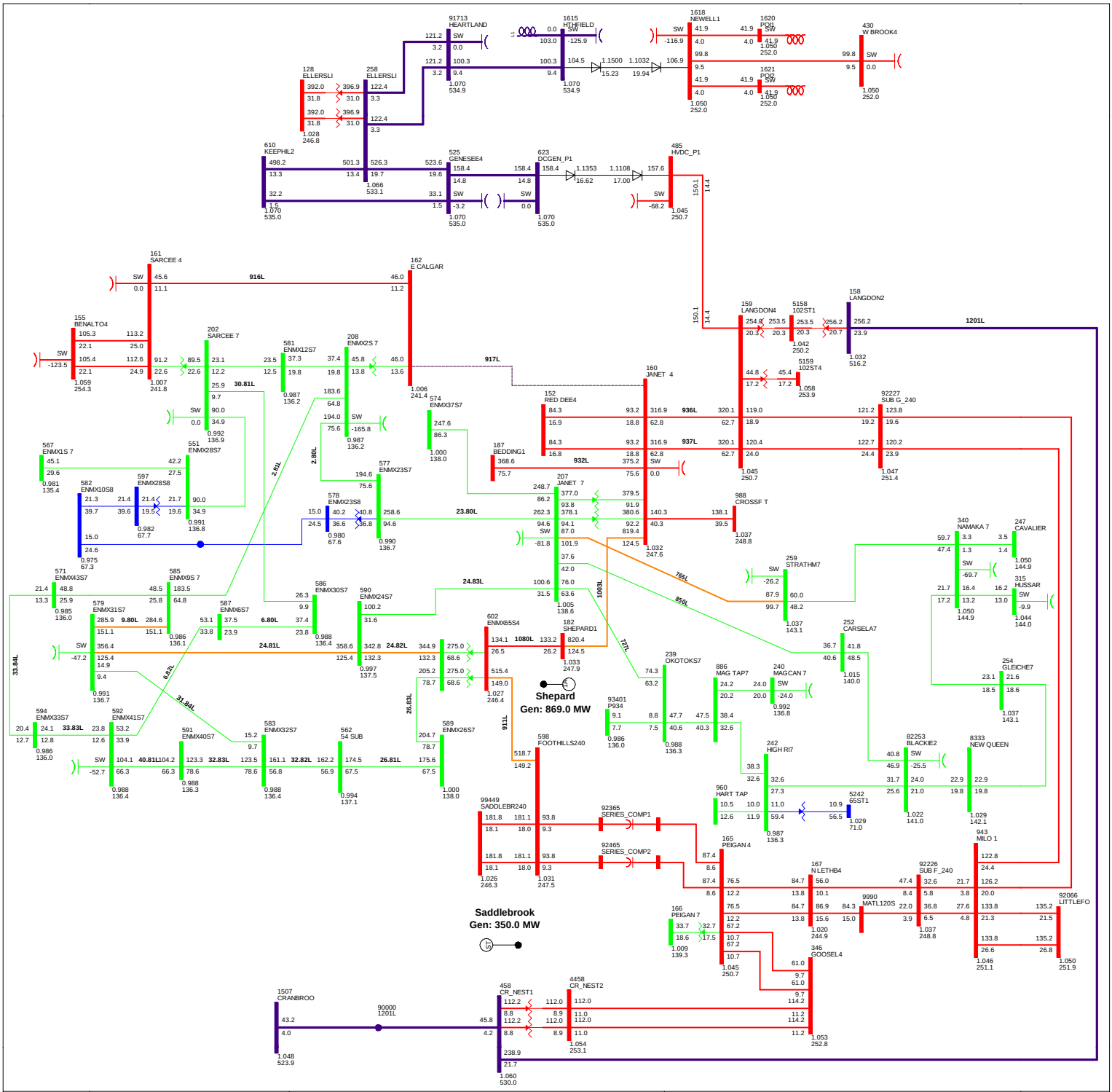
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 8.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-26: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

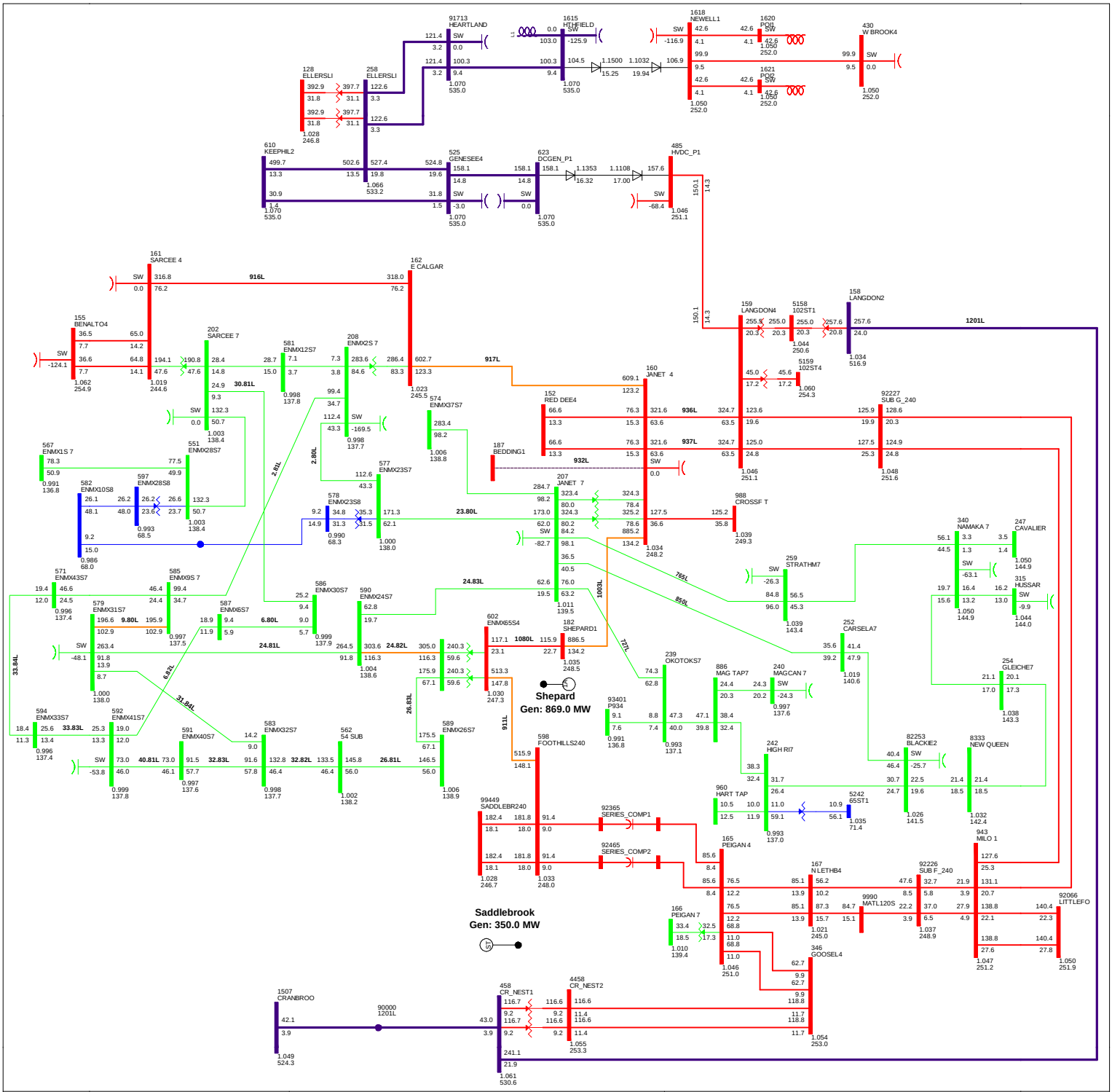
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 21.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-27: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

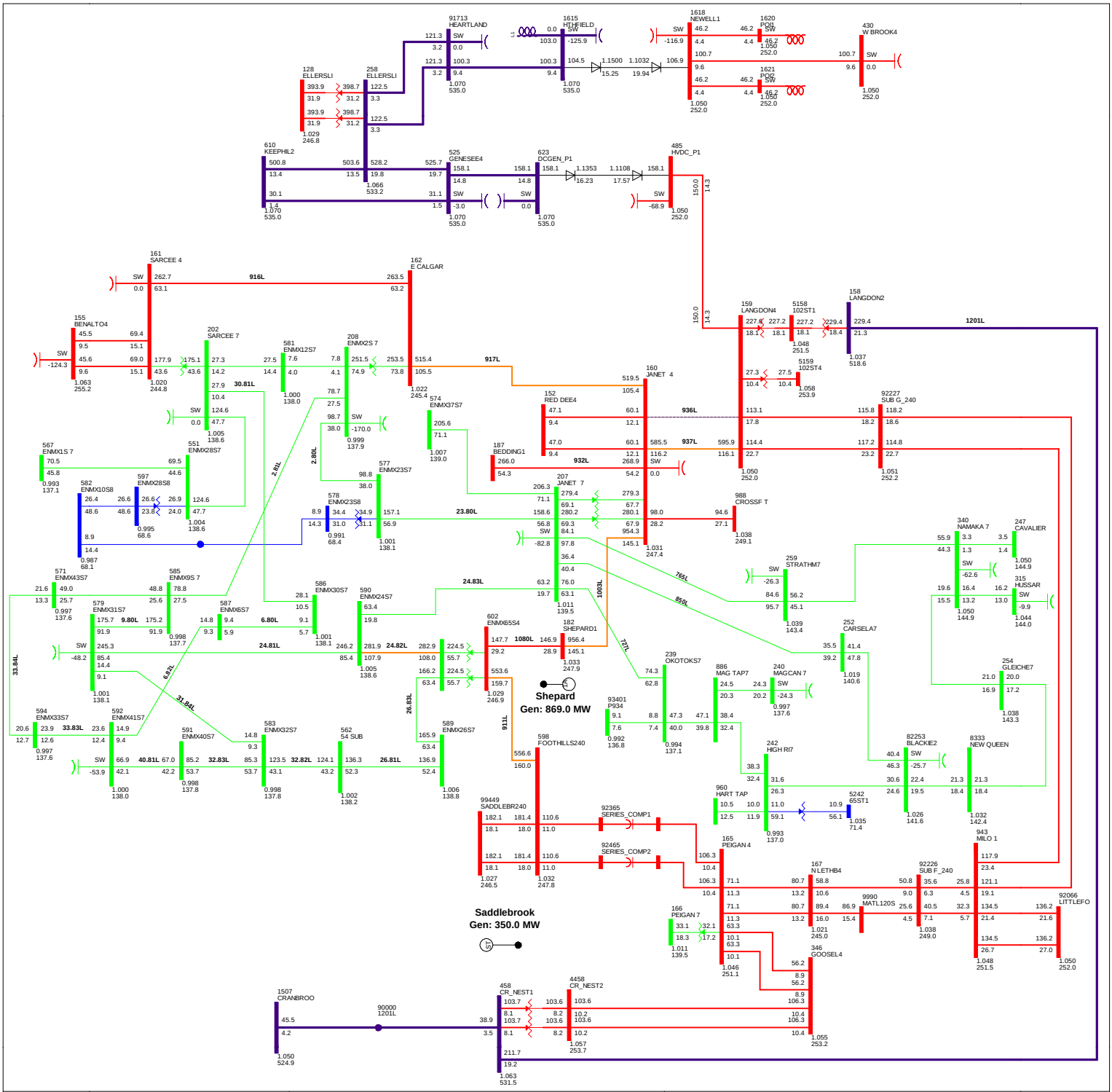
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 10.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-28: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

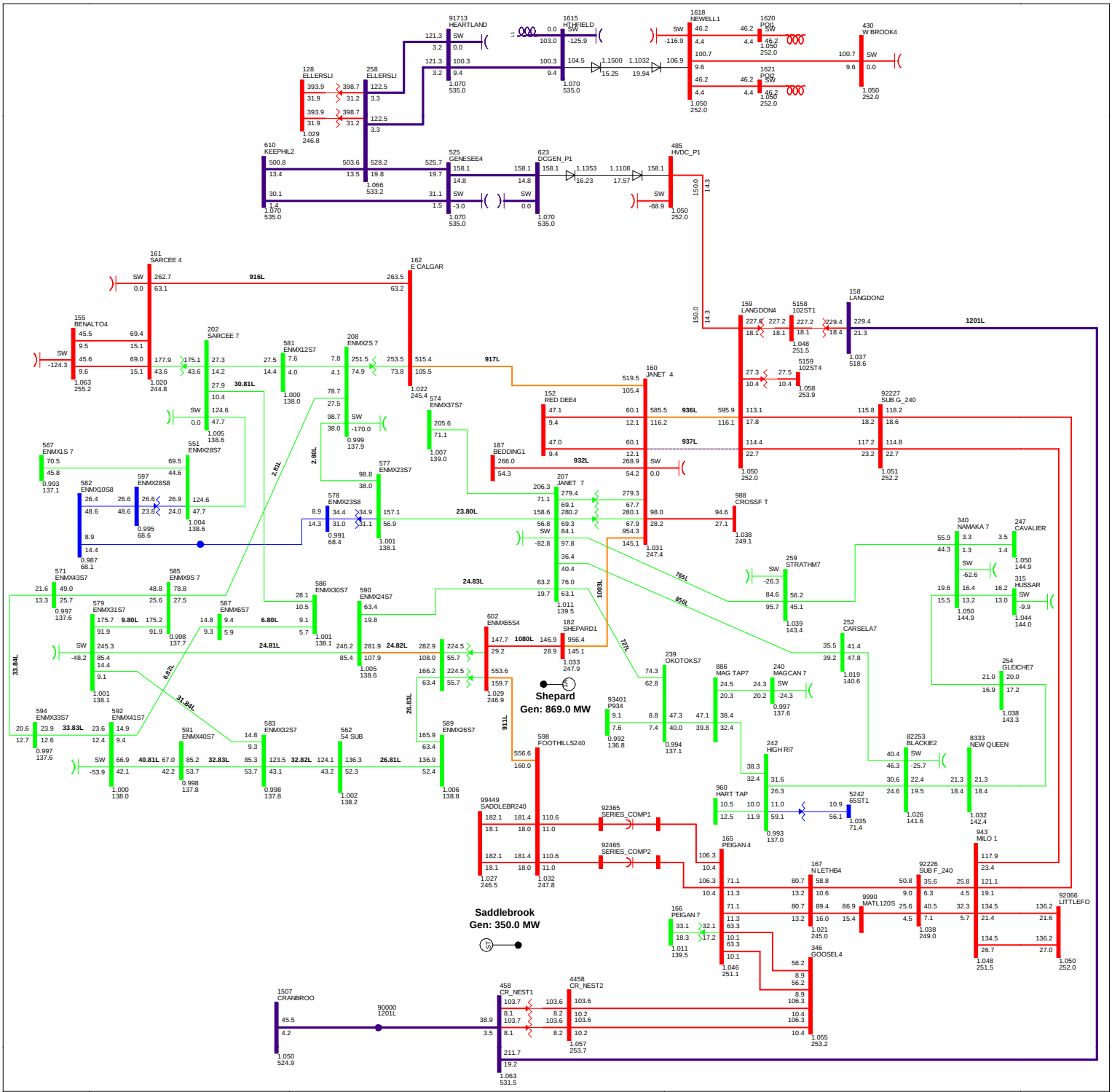
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 9.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-29: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

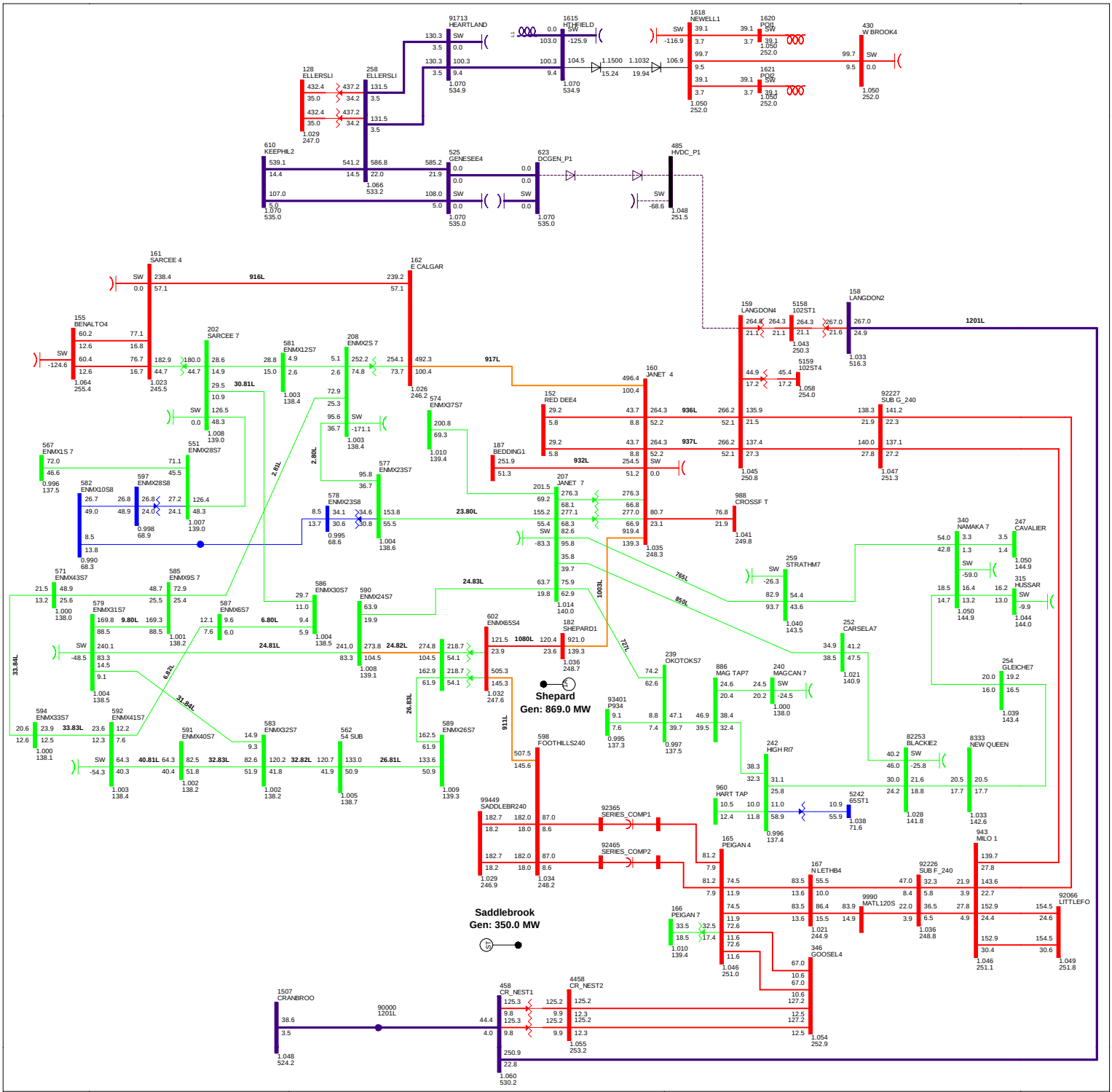
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 9.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-30: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.6 MW

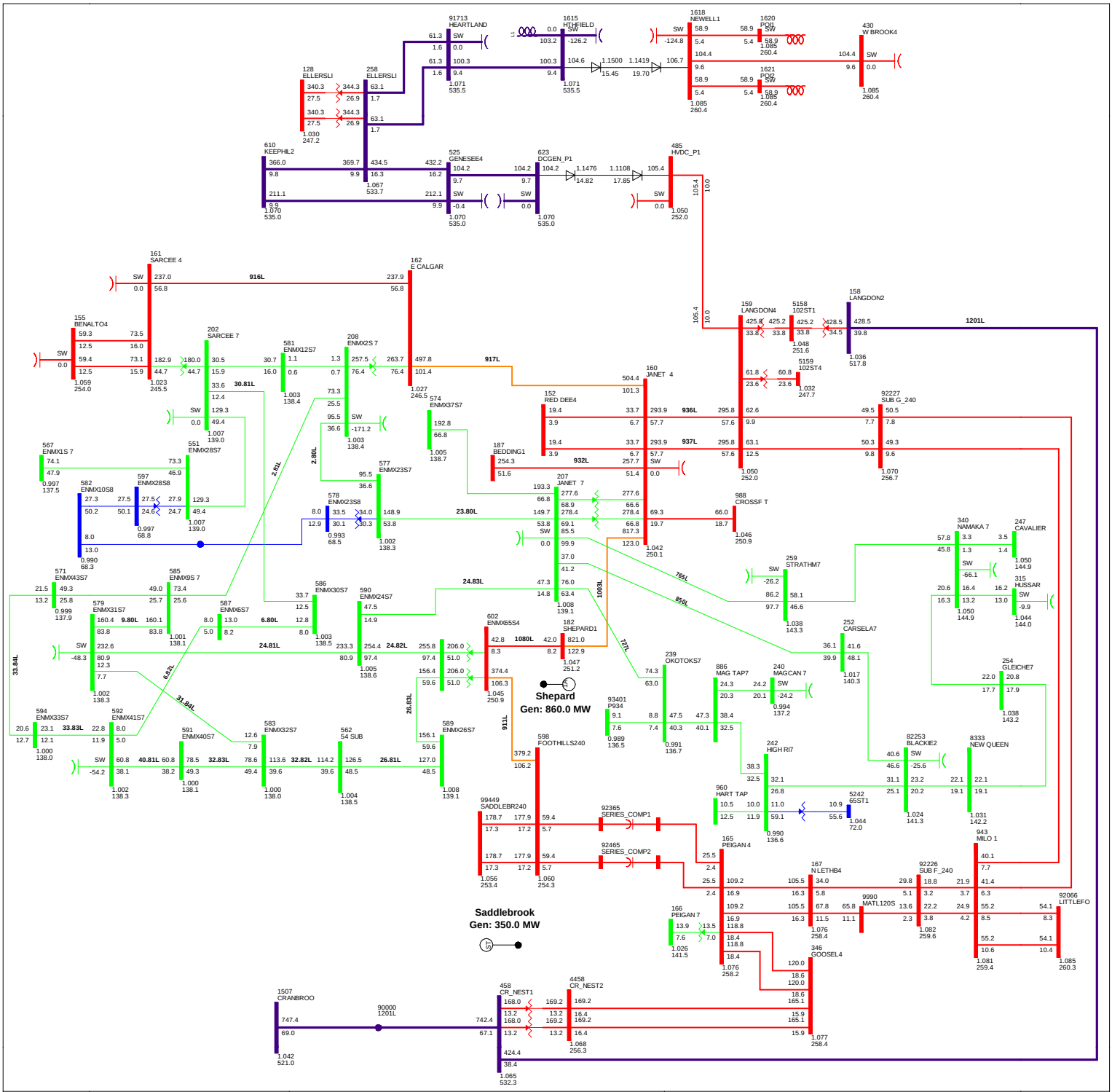
2012LTO+HVDC EXISTING SYSTEM

FIG A-SC4-31: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2014_NEED_HVDC_SC4_SP

FRI, JUN 08 2012 16:20

2014 Loading Violations
Scenario 5



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

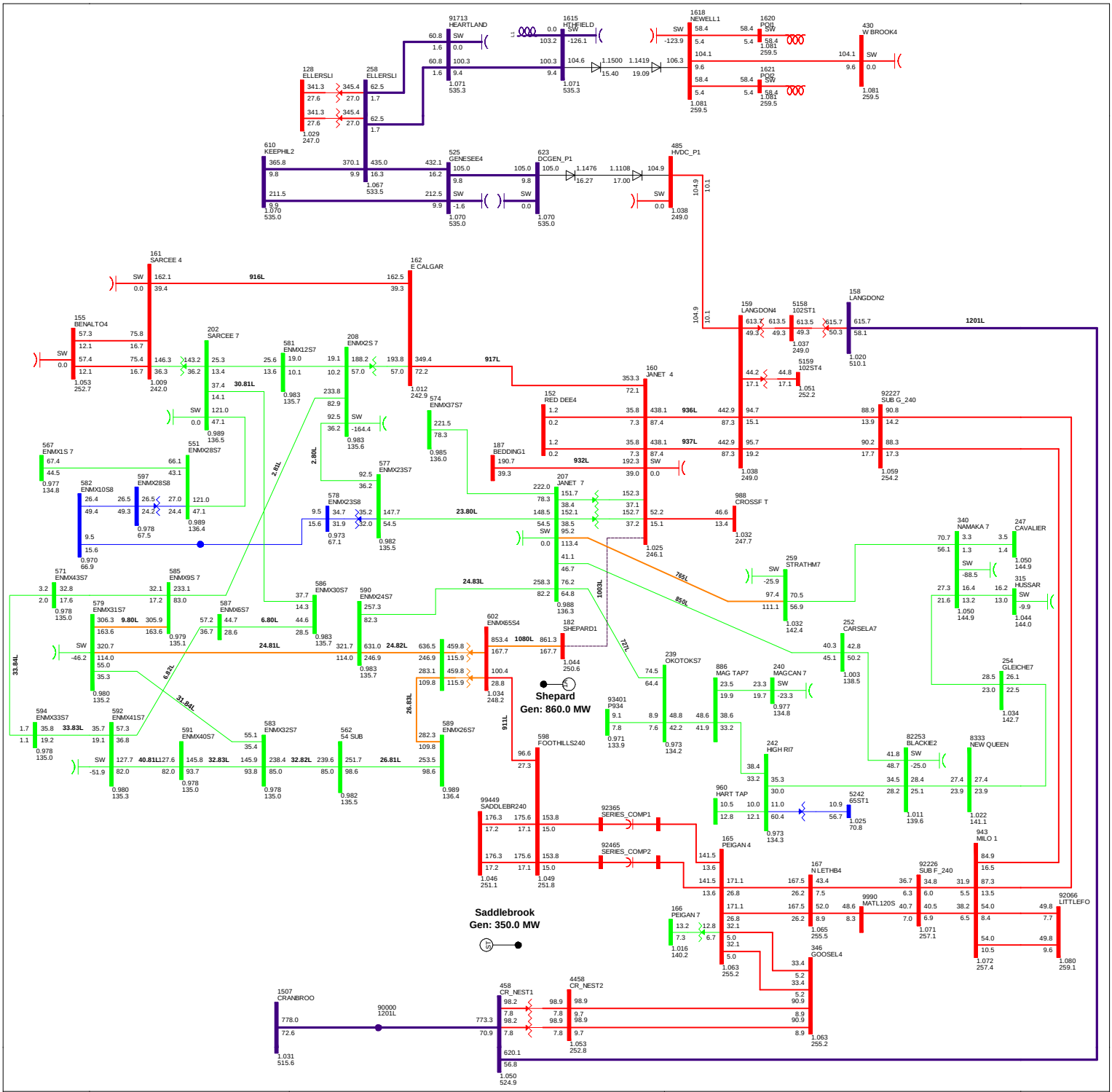
BCH Import: 785.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-1: BASECASE

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

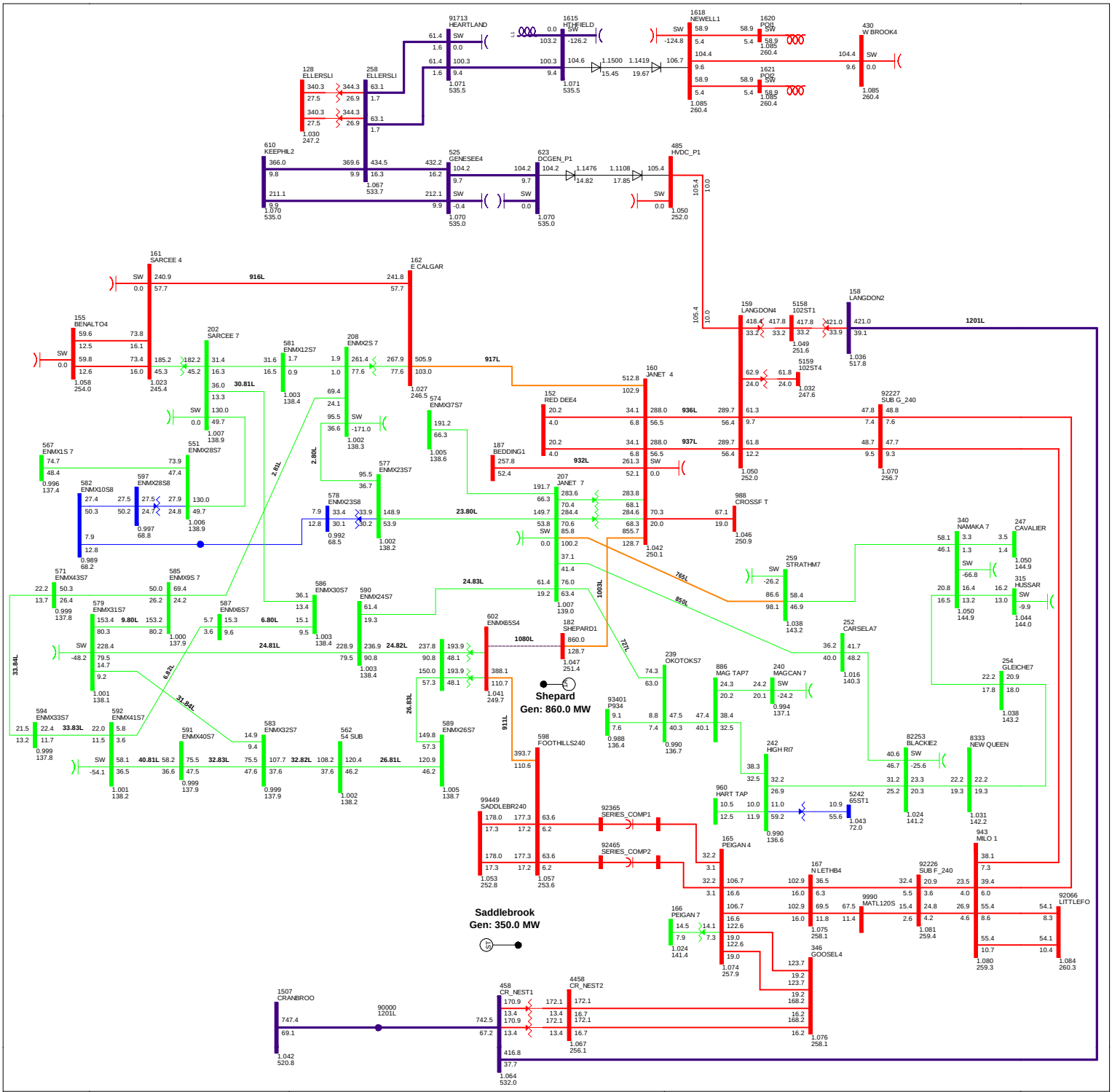
BCH Import: 819.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

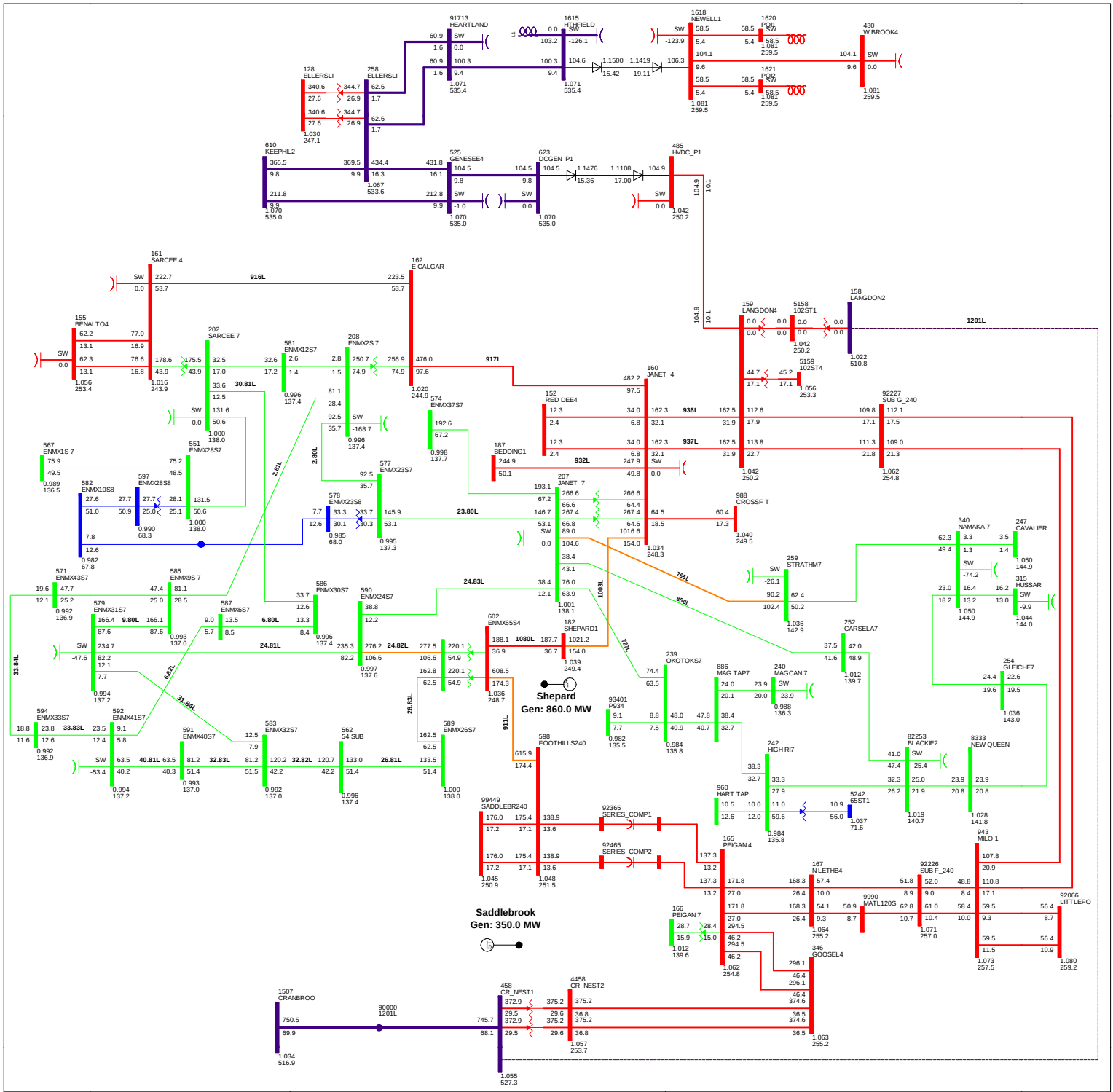
BCH Import: 785.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

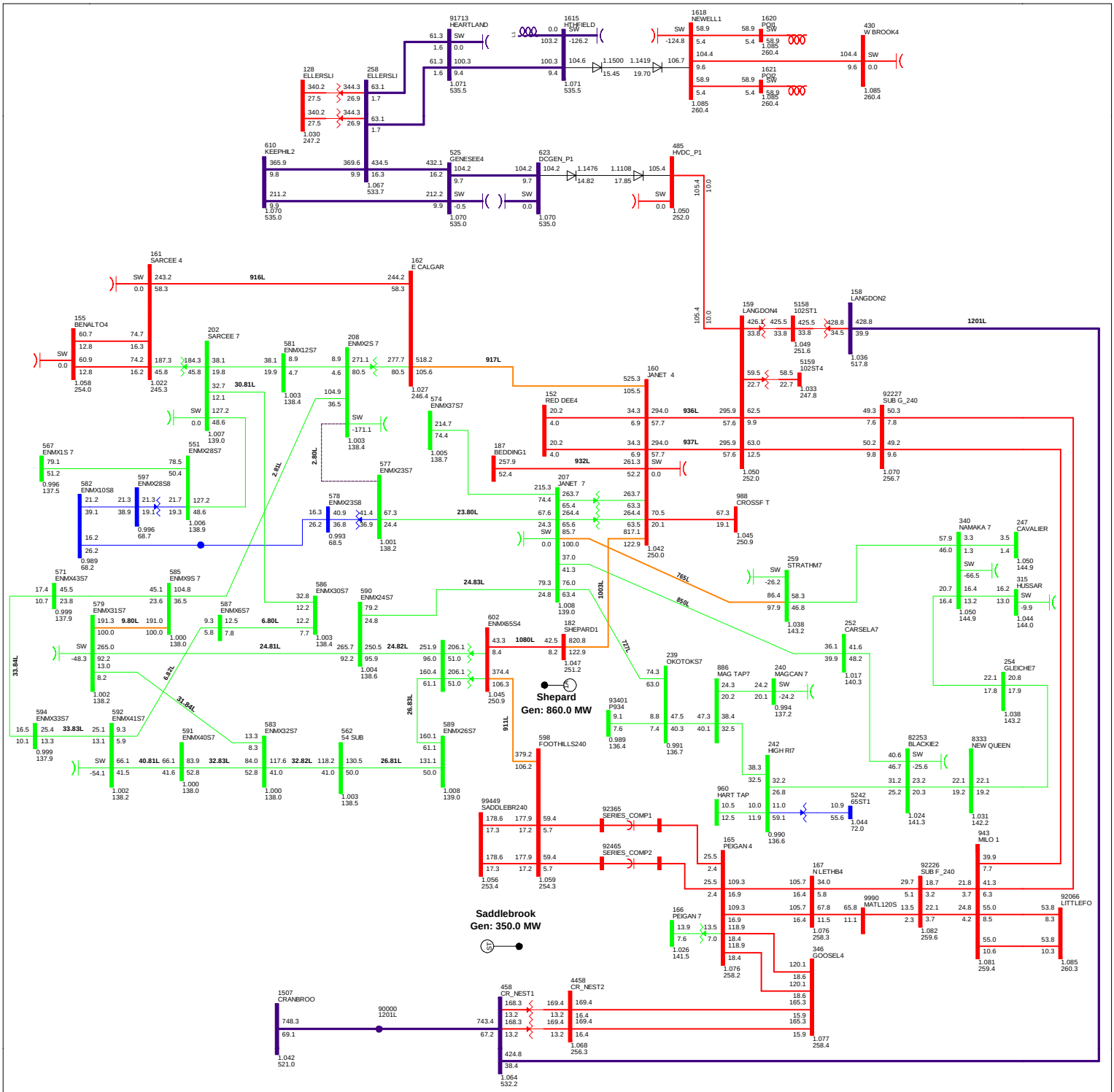
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 813.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

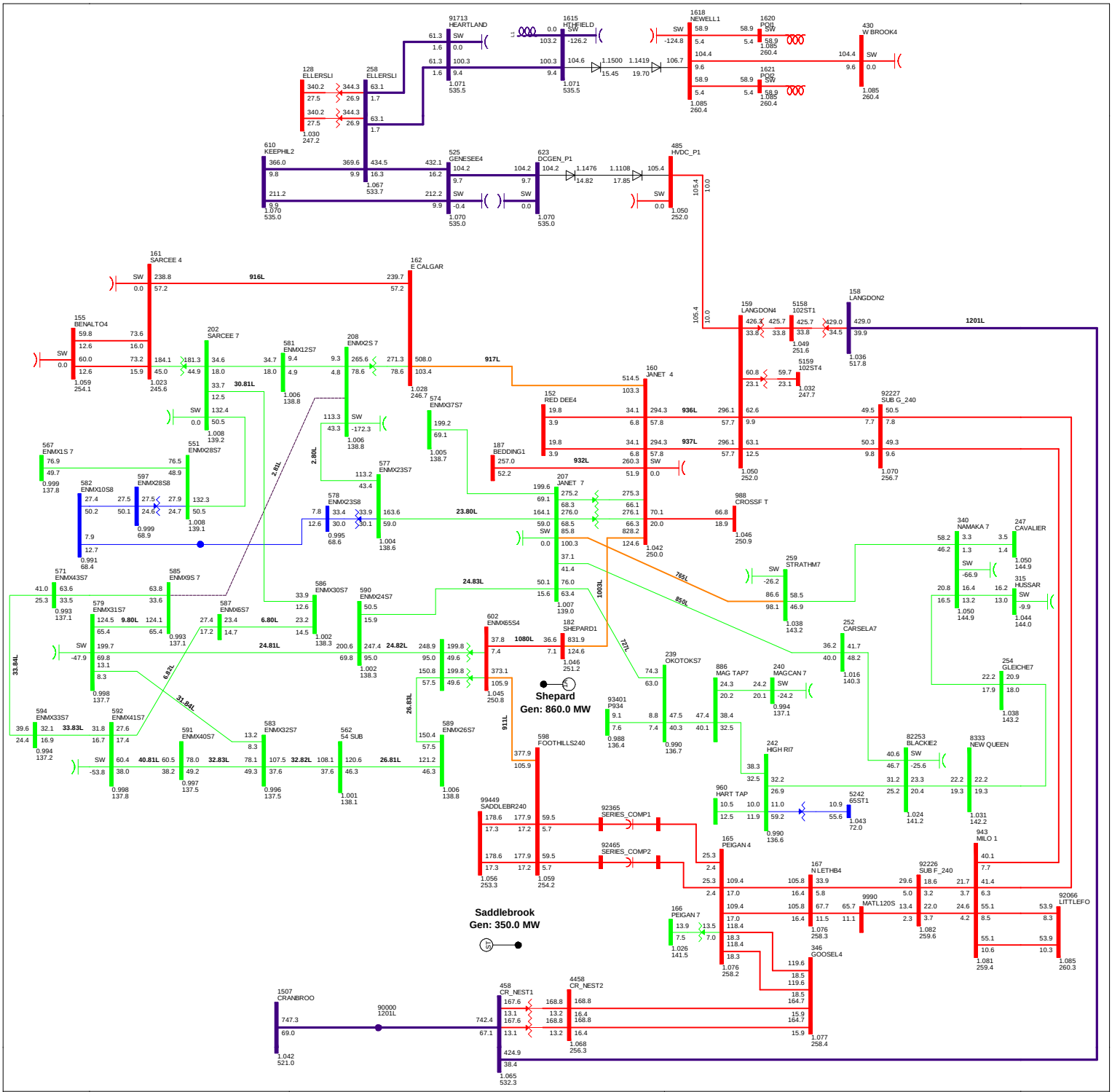
BCH Import: 786.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

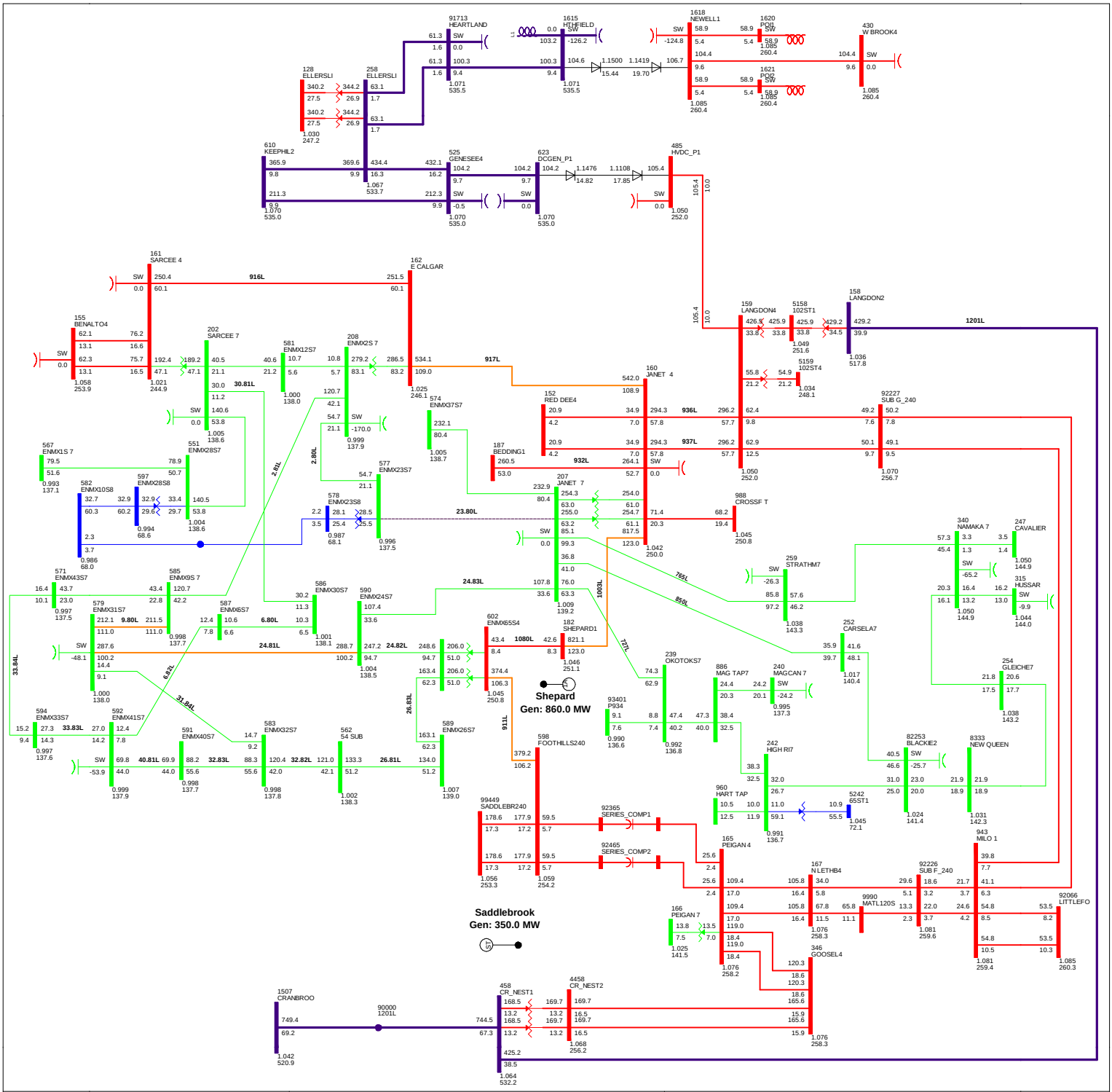
BCH Import: 785.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

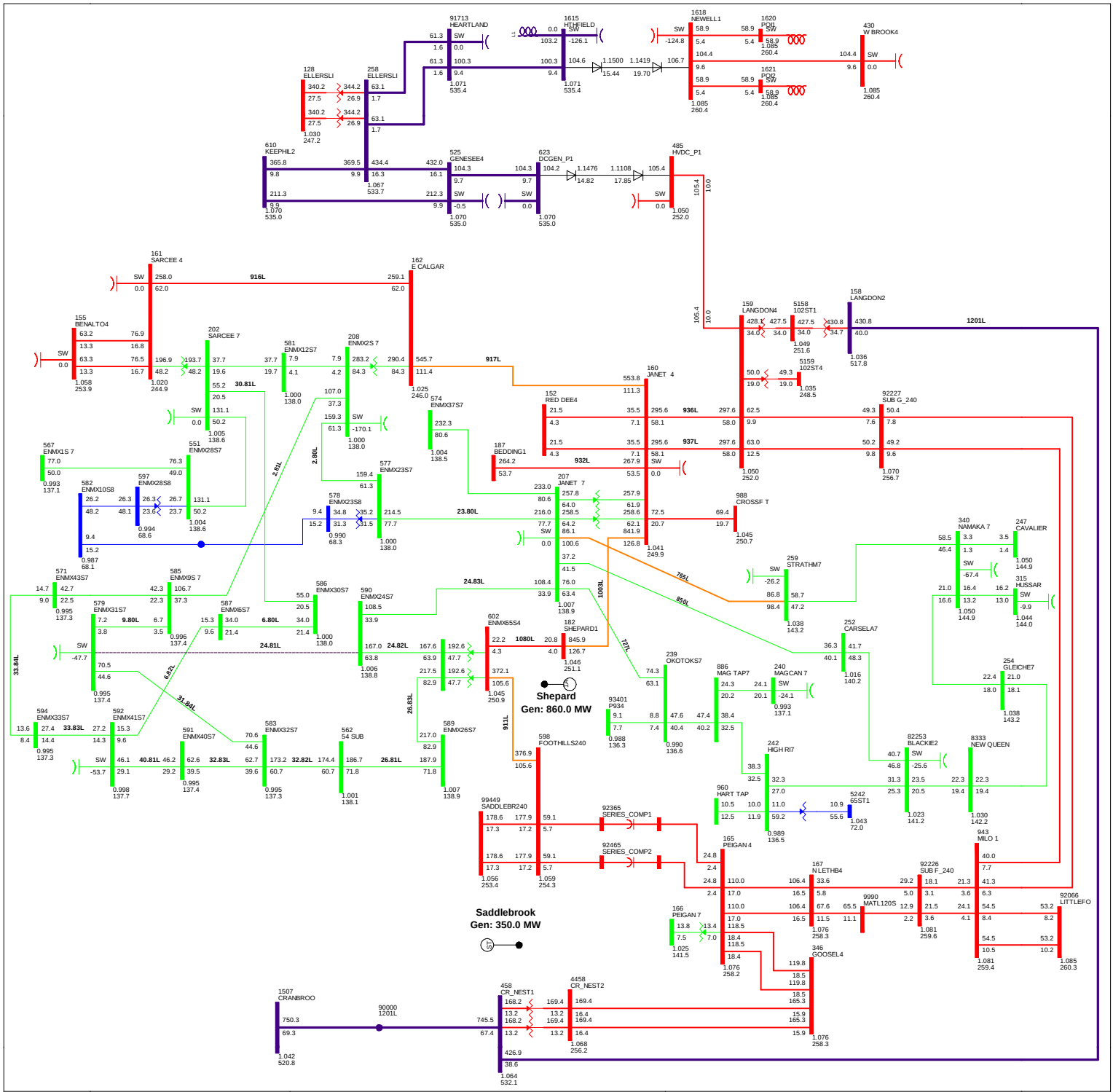
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 787.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

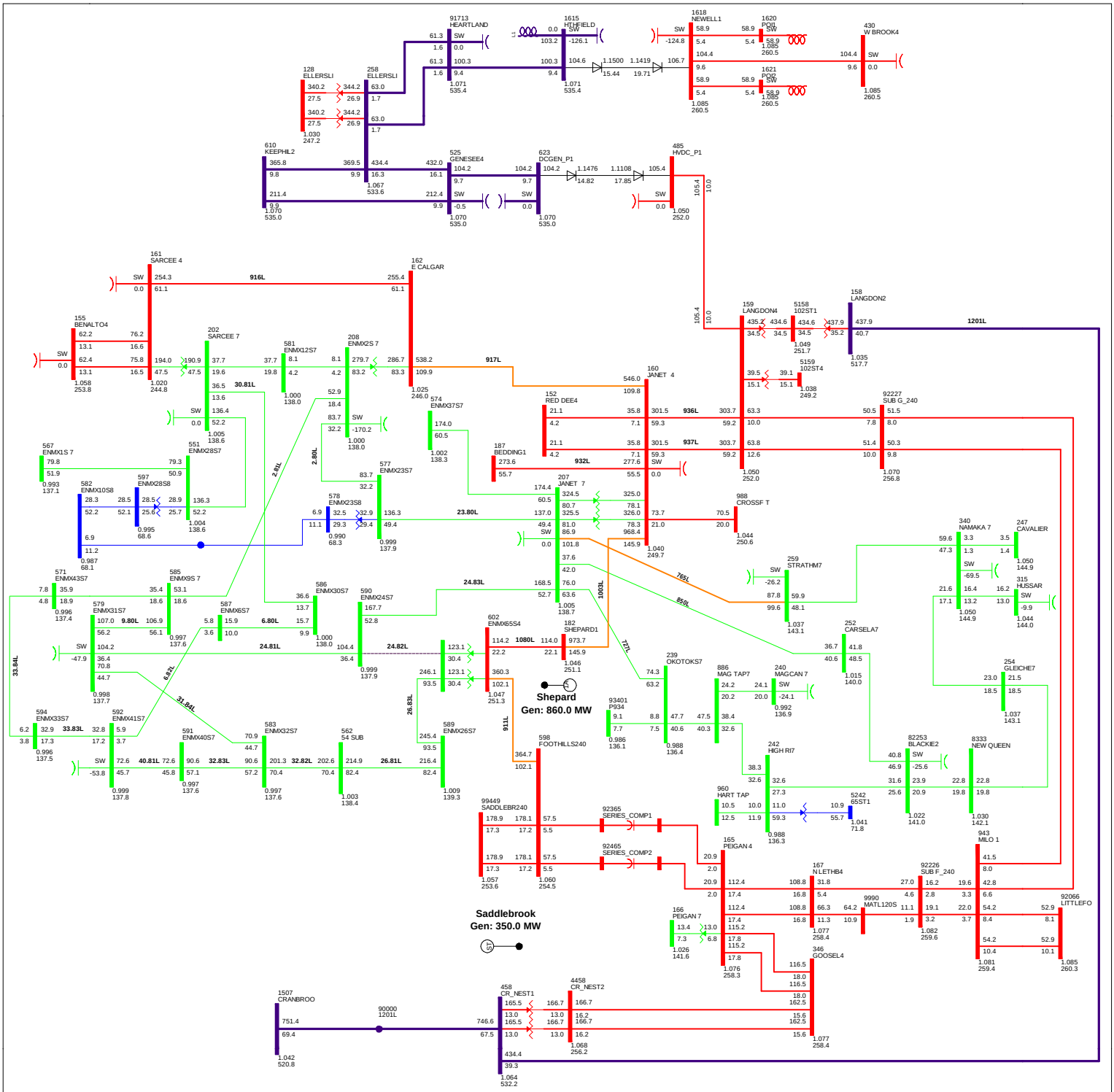
BCH Import: 789.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

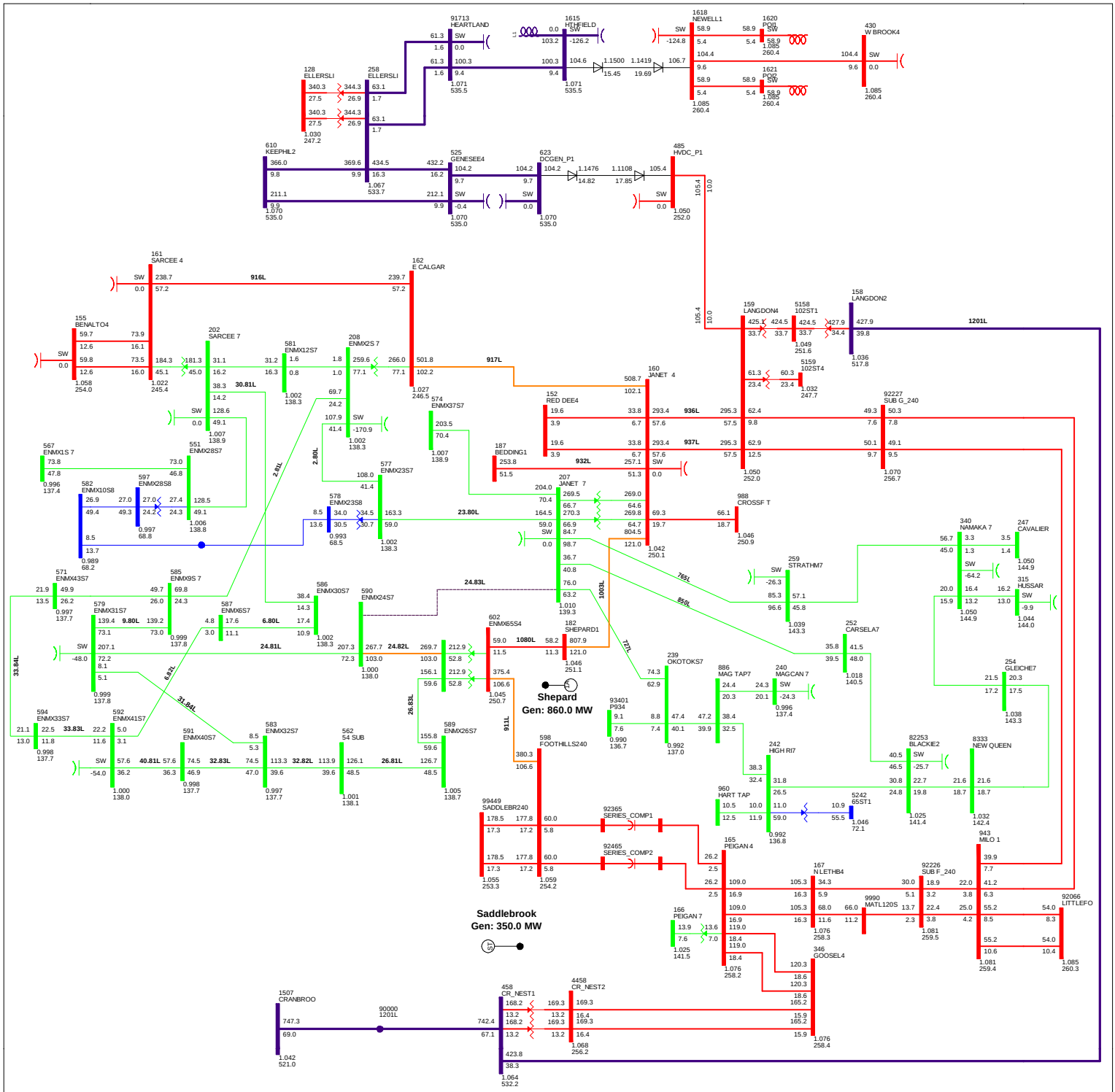
BCH Import: 790.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

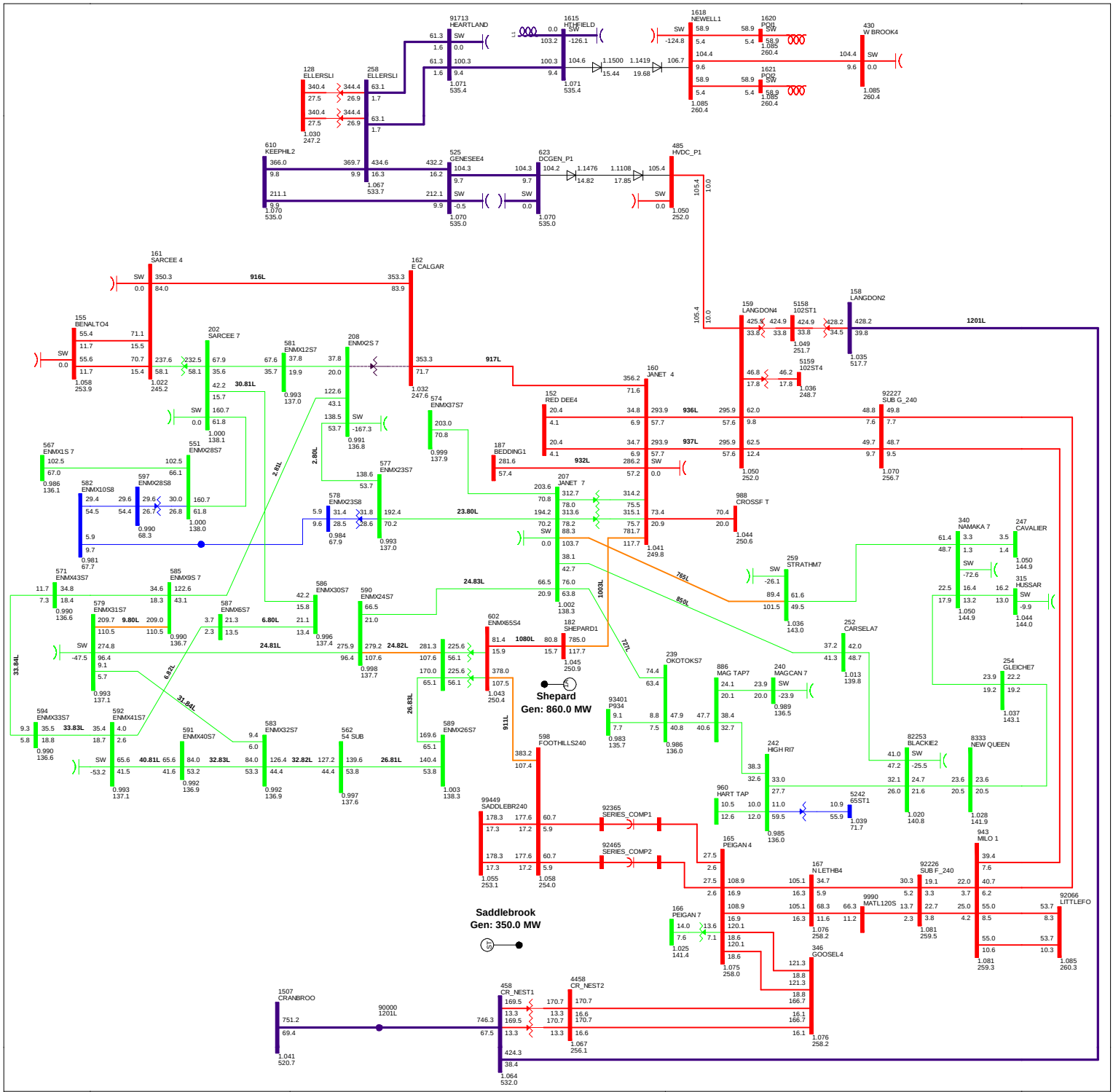
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 785.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

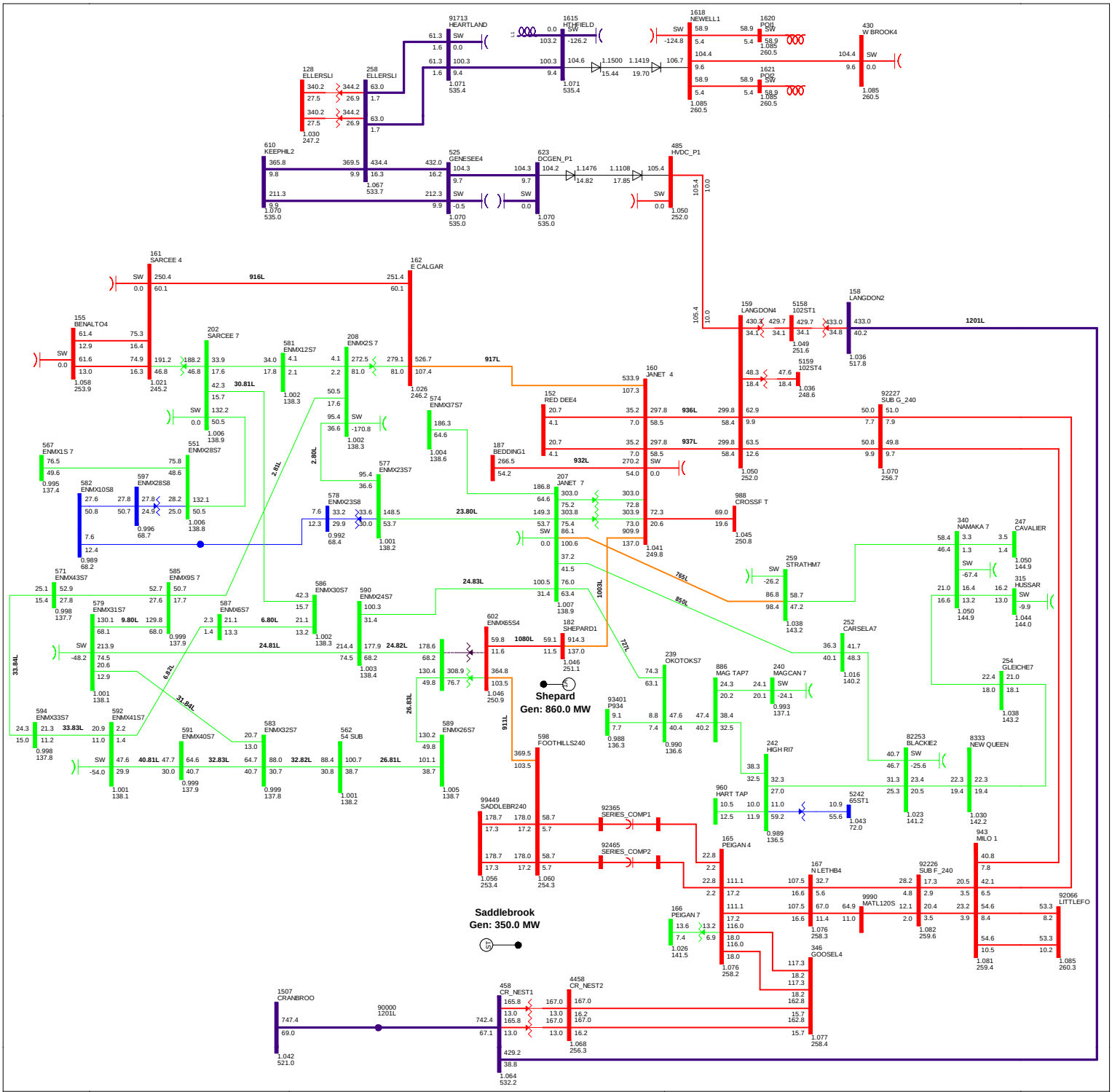
BCH Import: 790.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

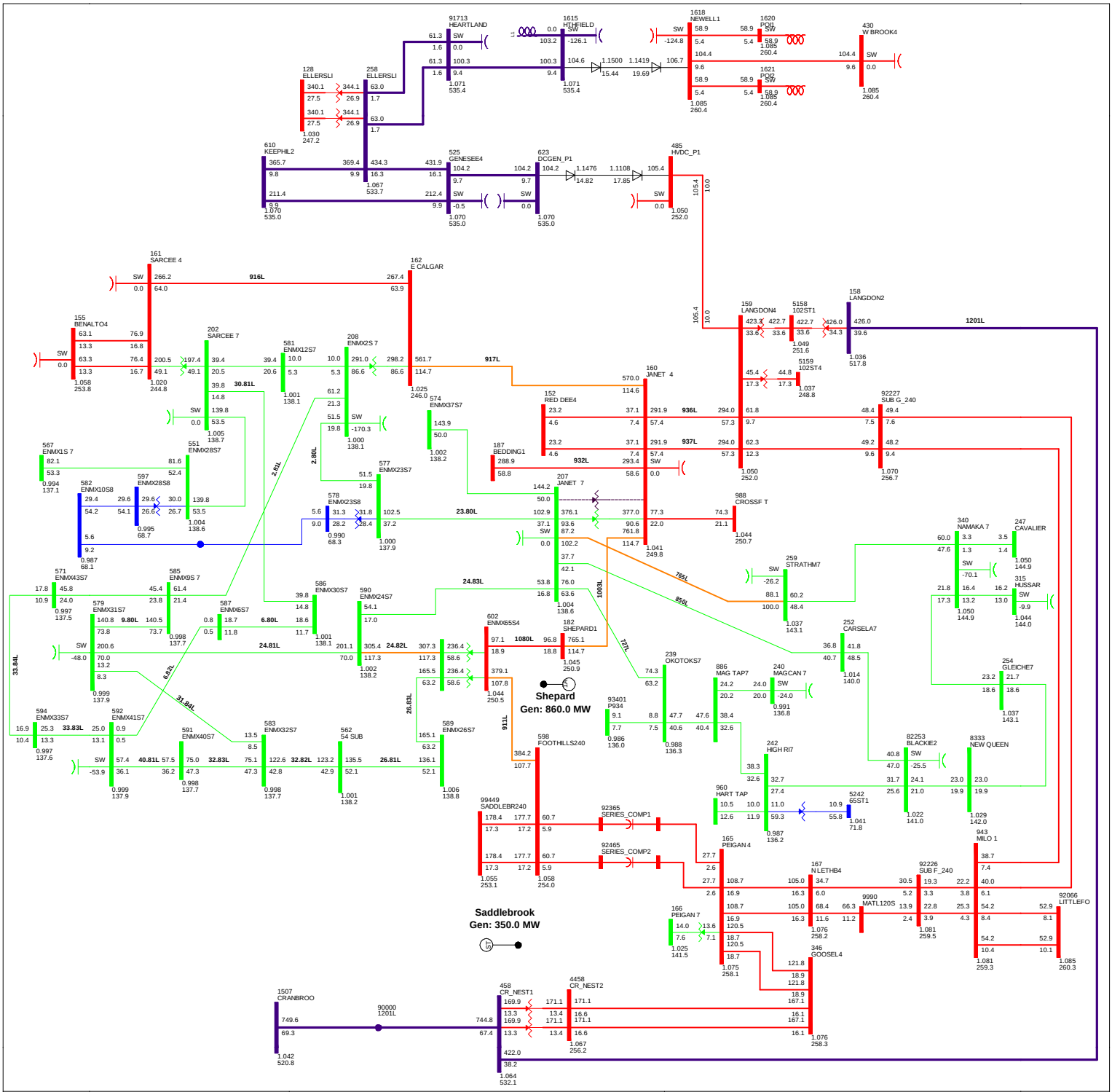
BCH Import: 785.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

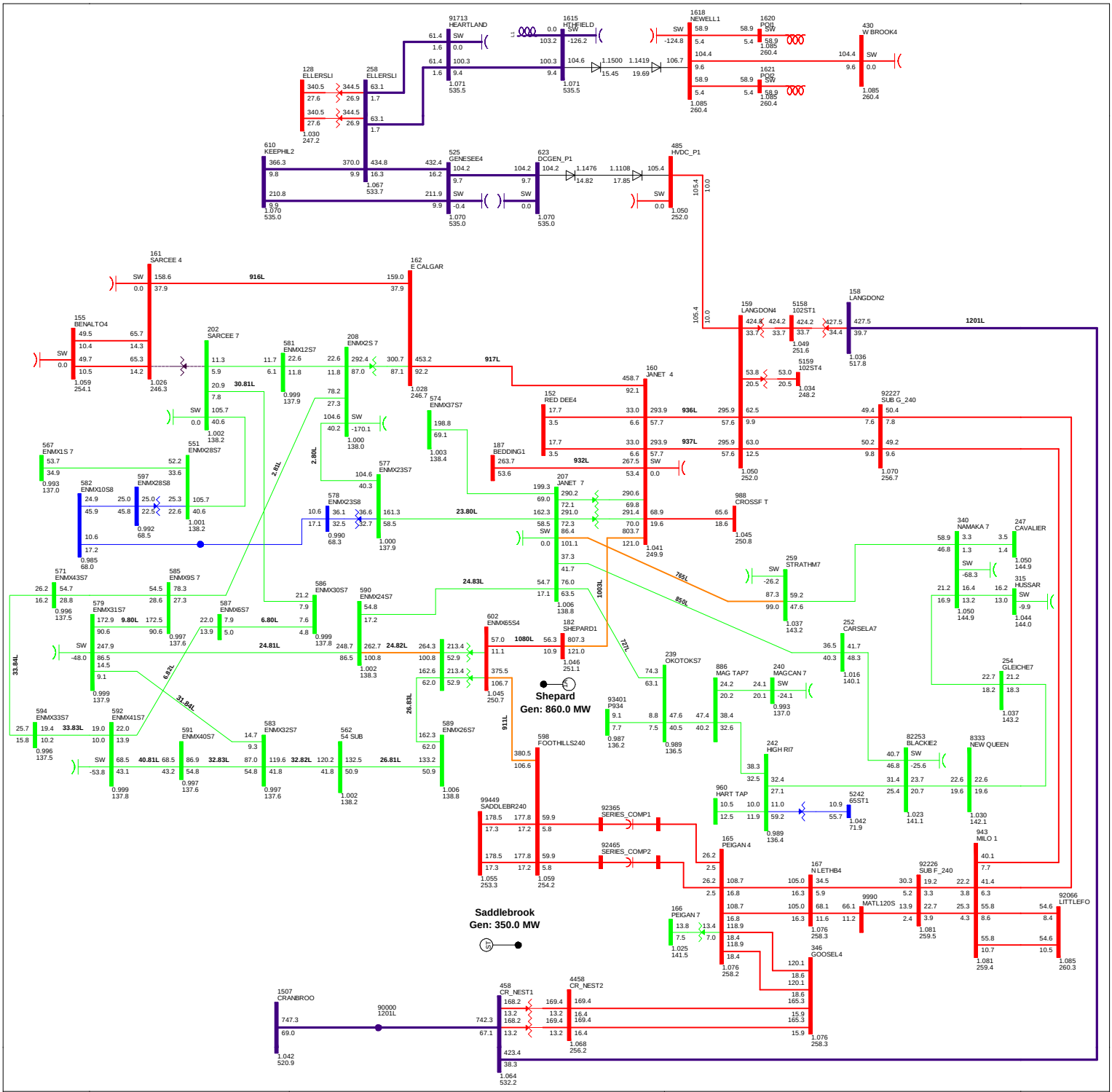
BCH Import: 788.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

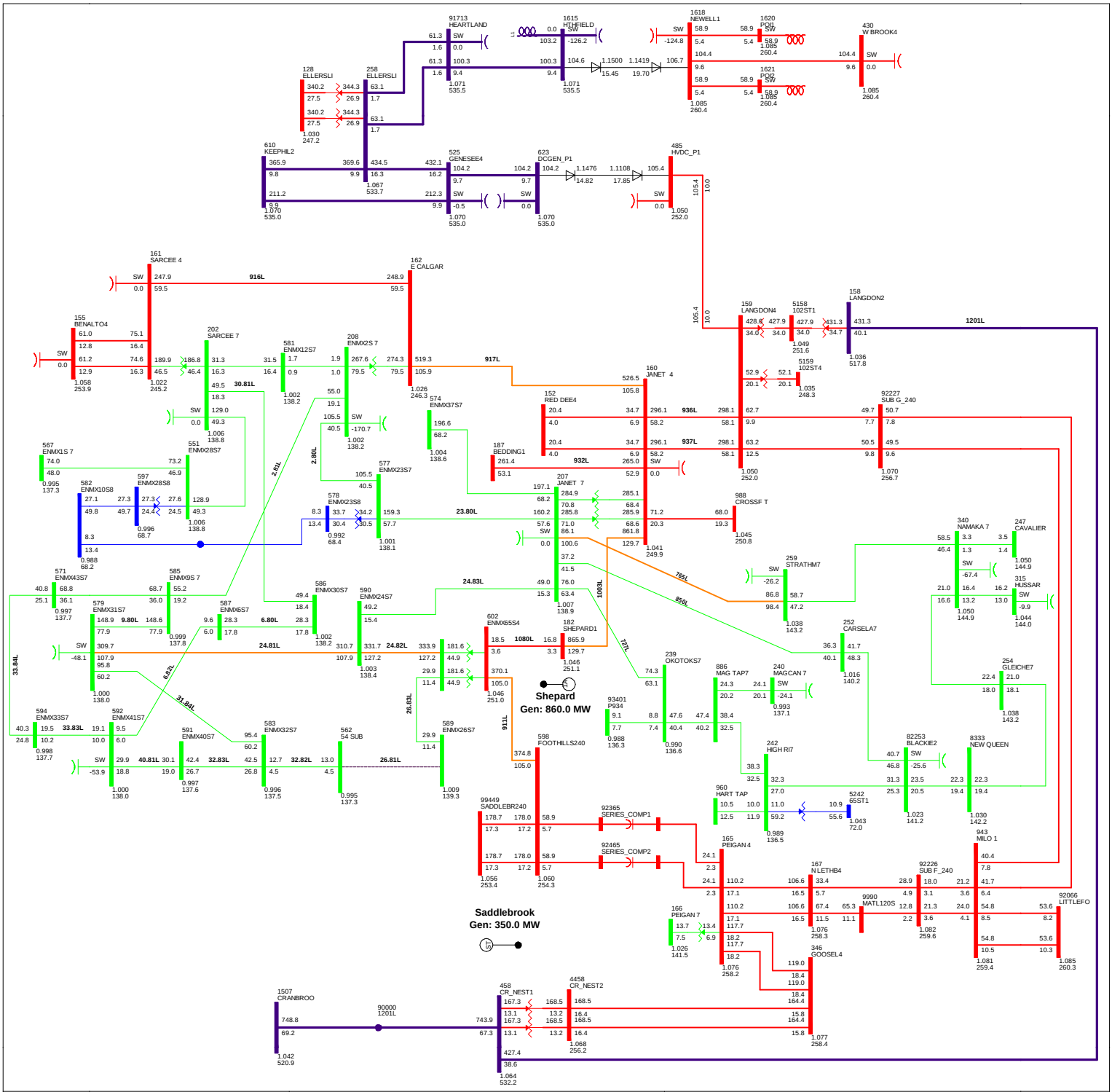
BCH Import: 786.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

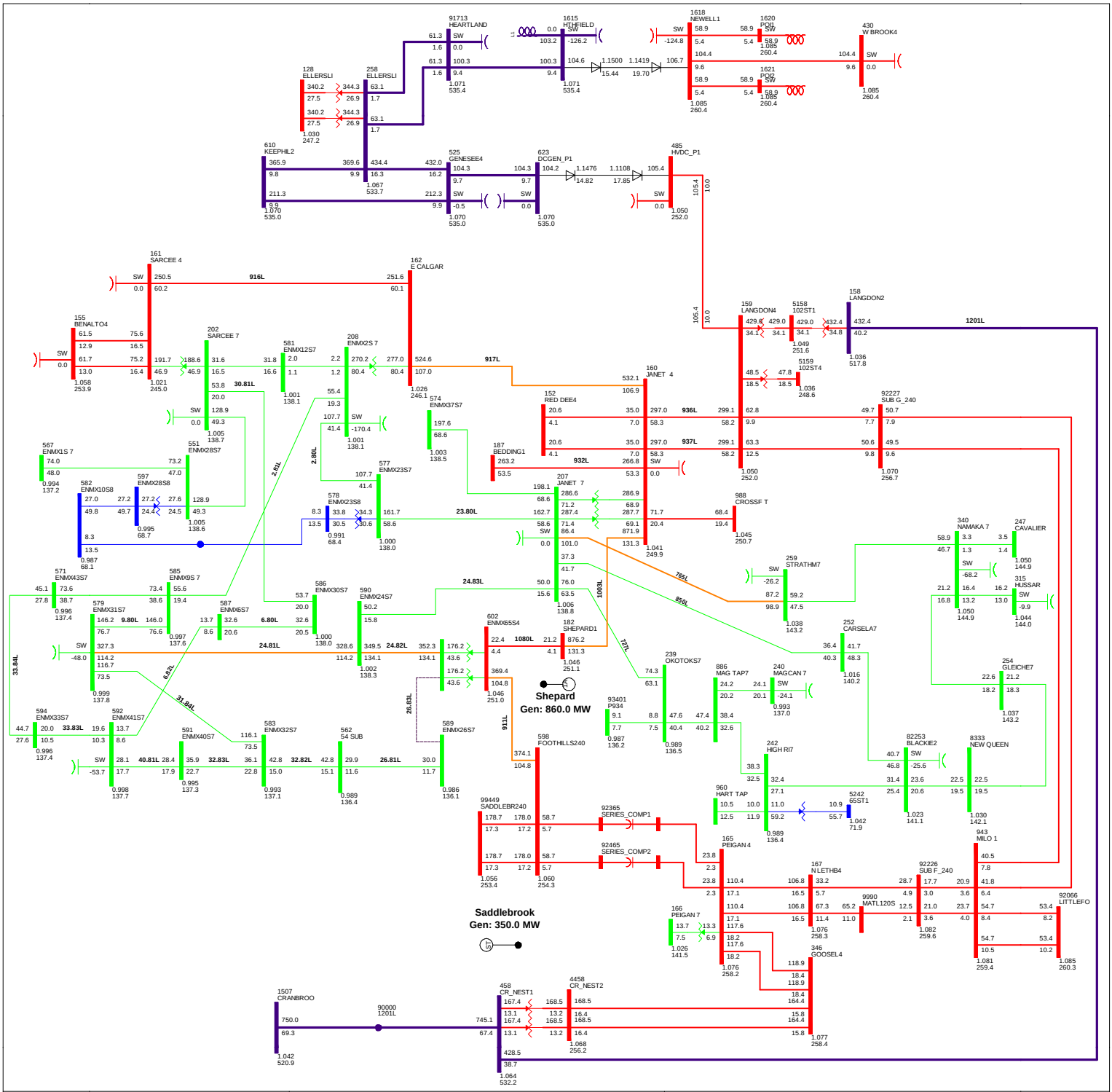
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 787.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

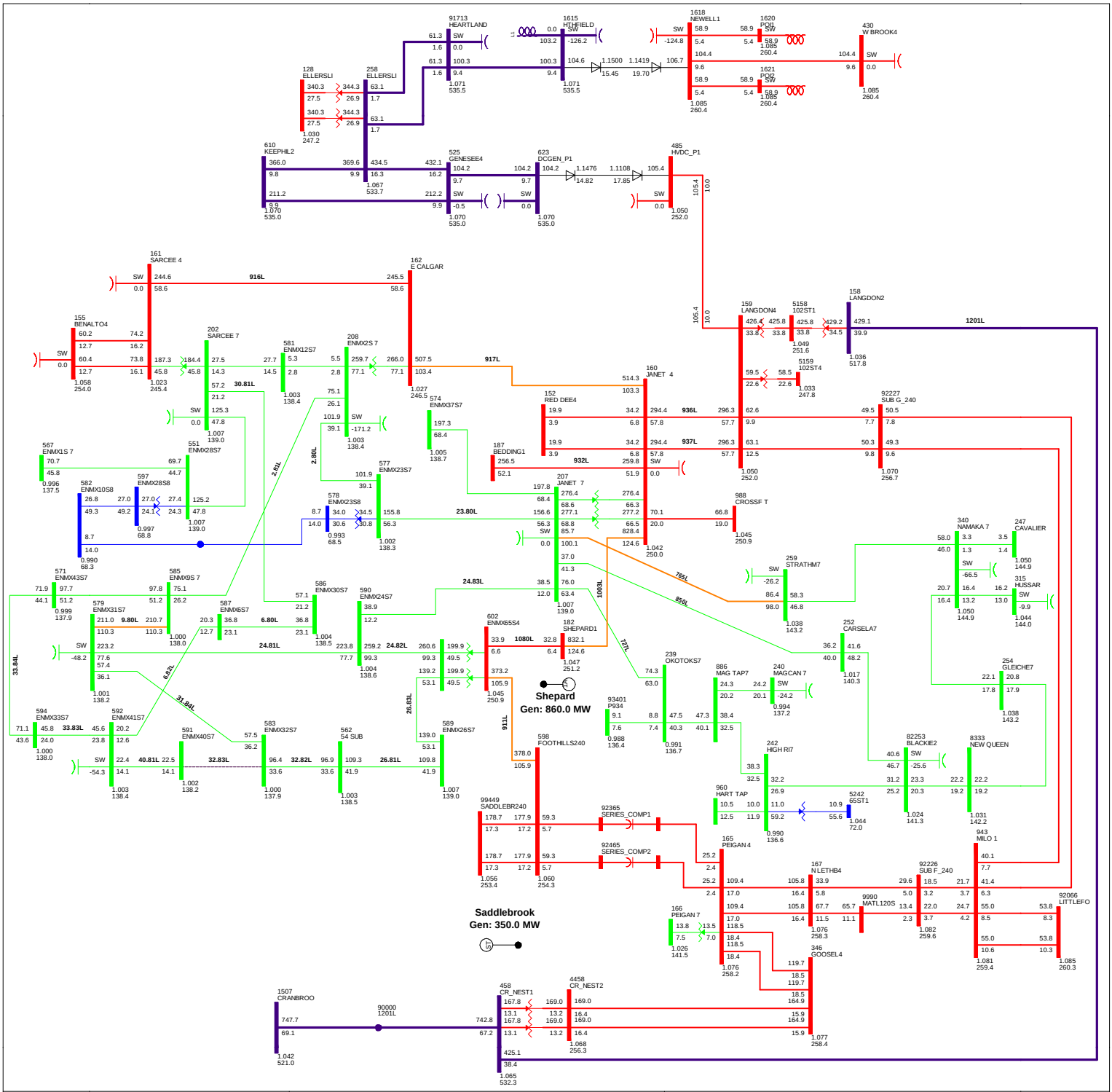
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 788.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

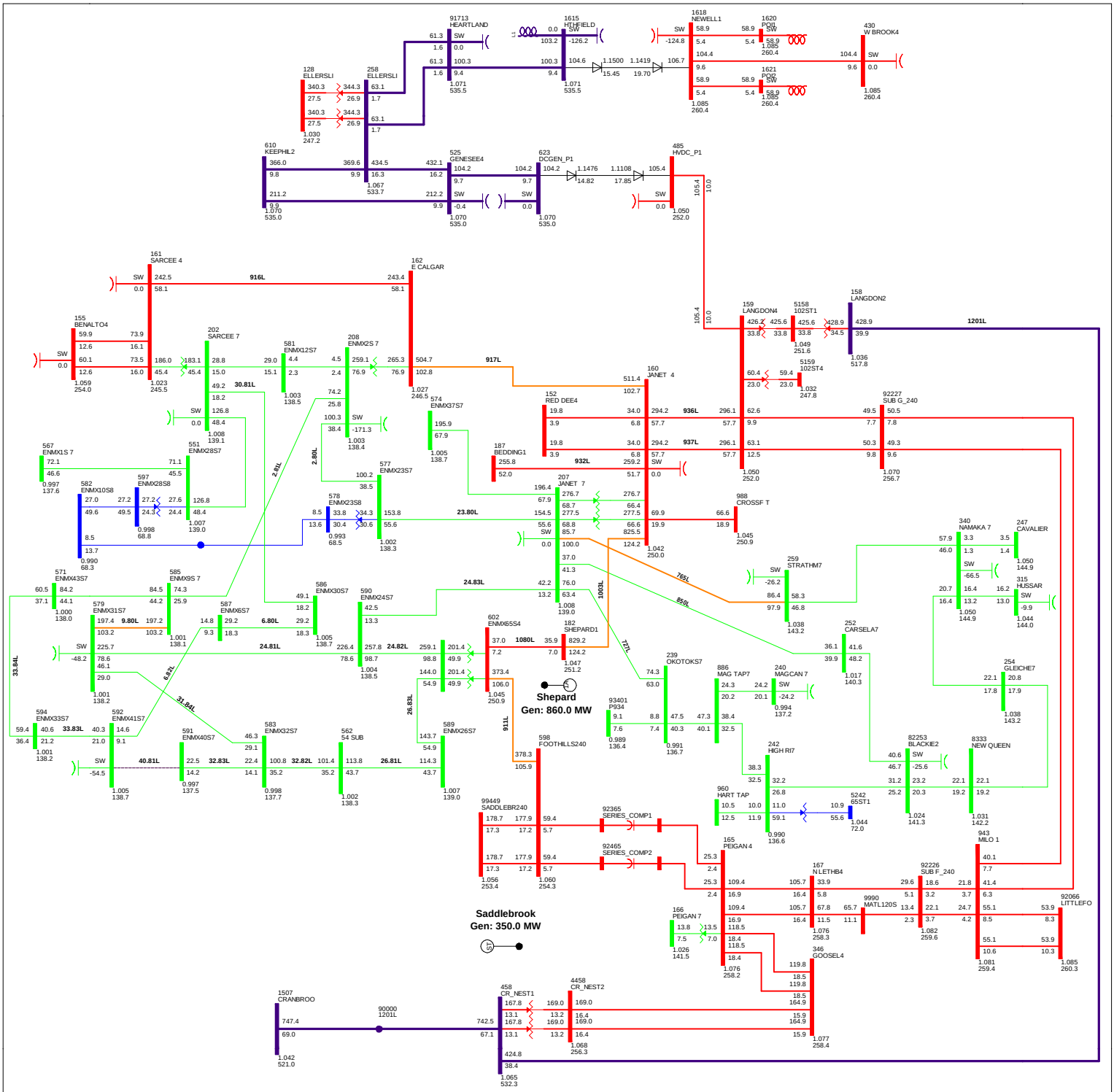
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 785.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

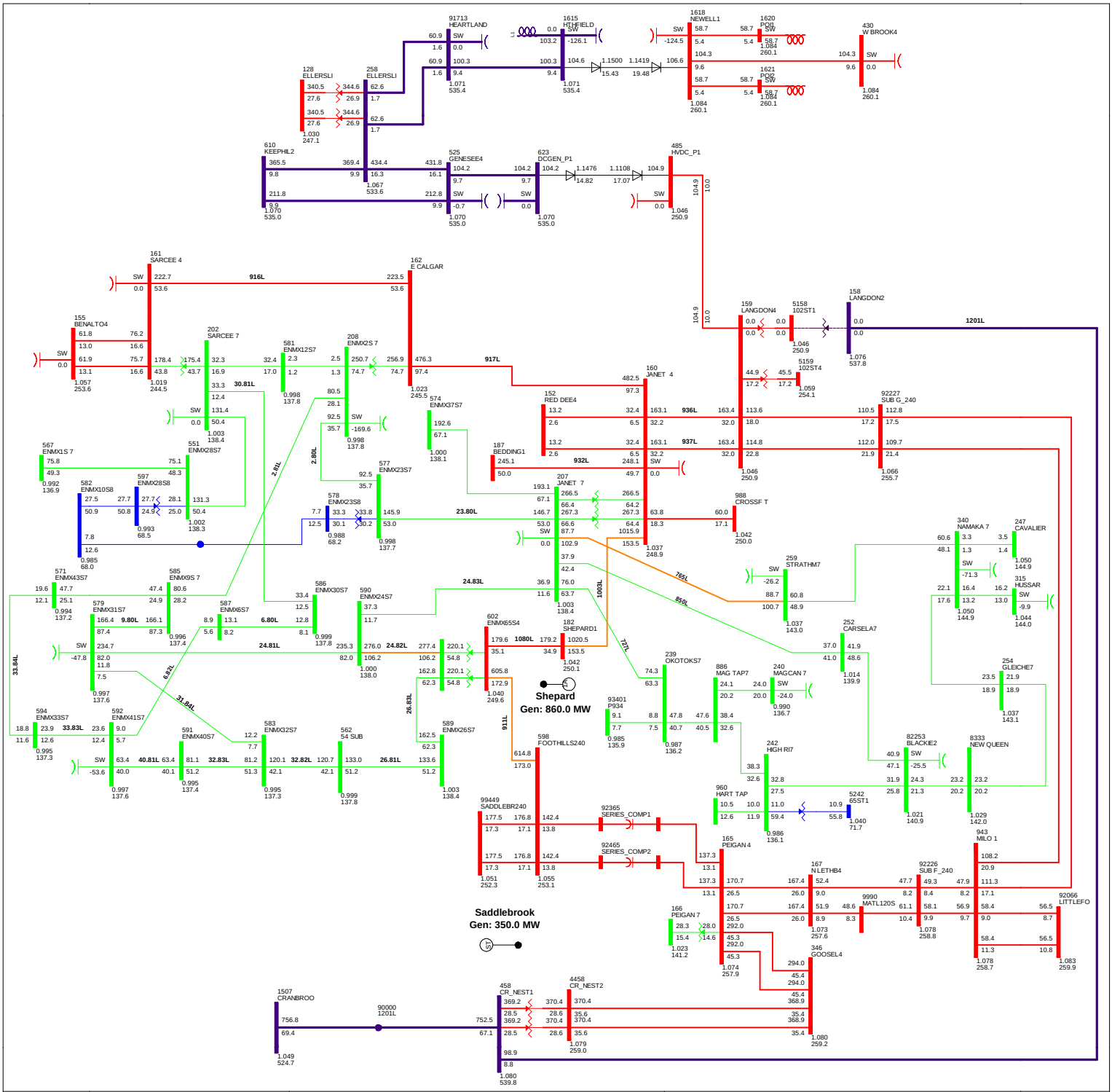
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 785.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

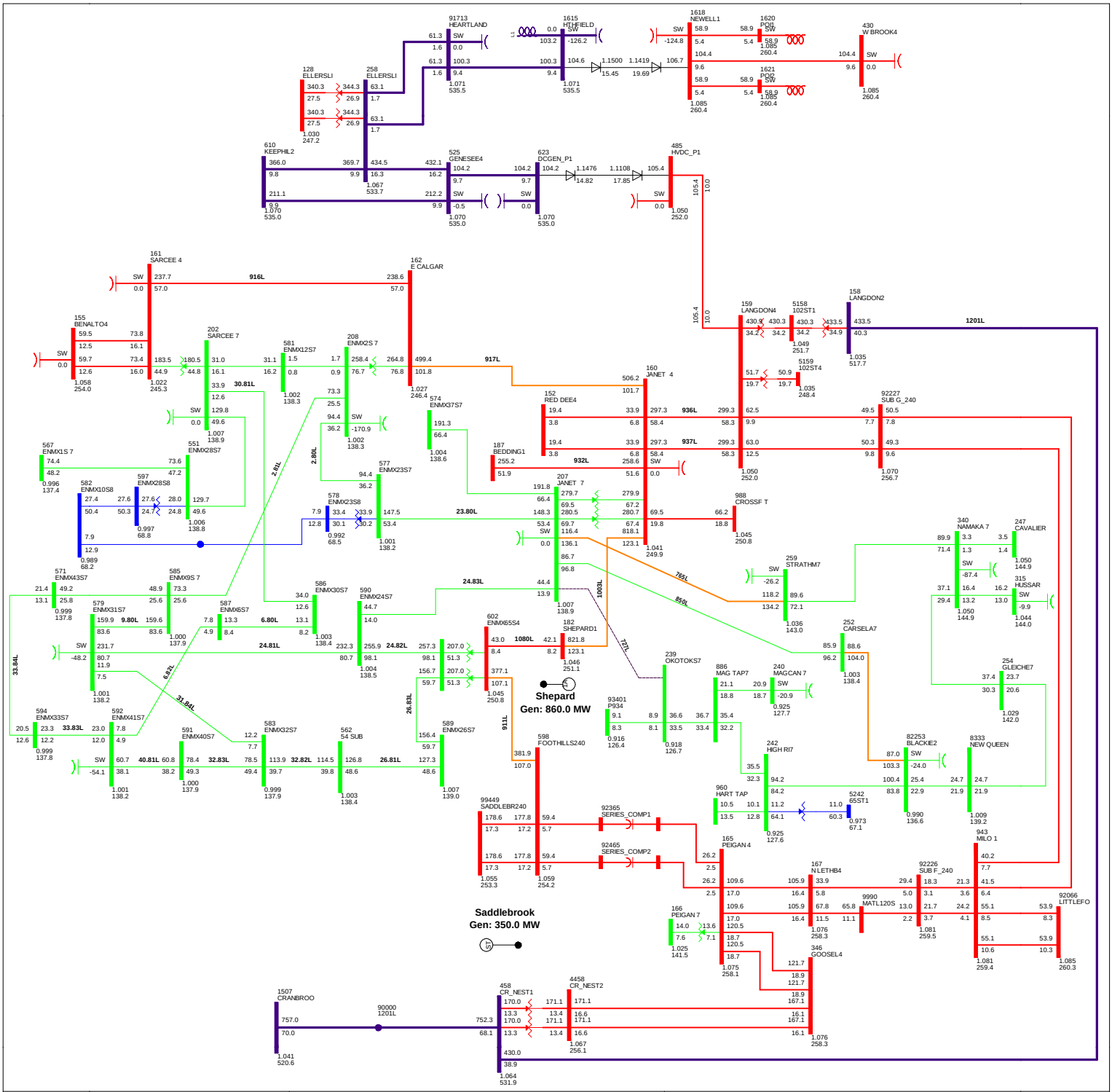
BCH Import: 811.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

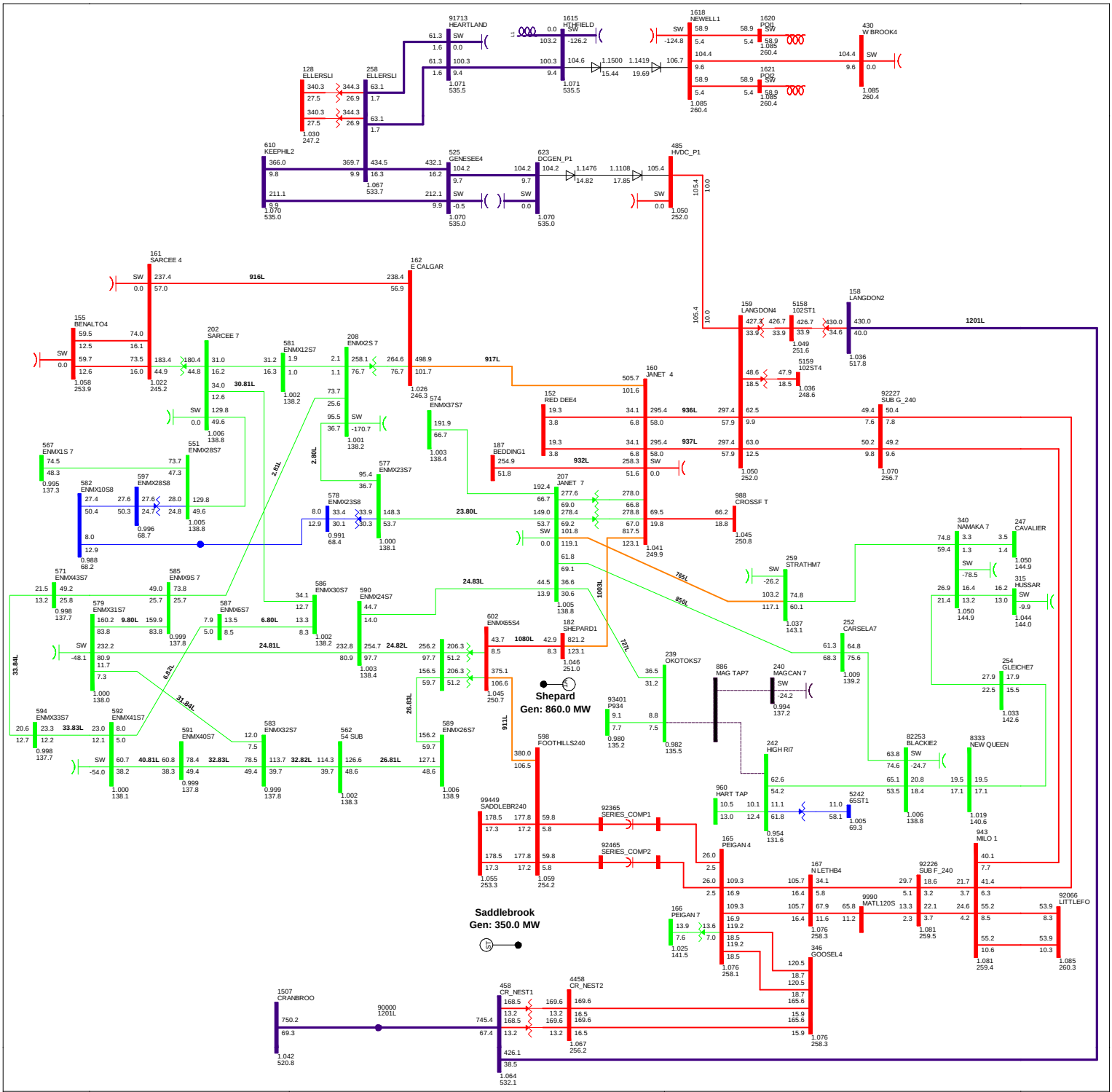
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 795.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

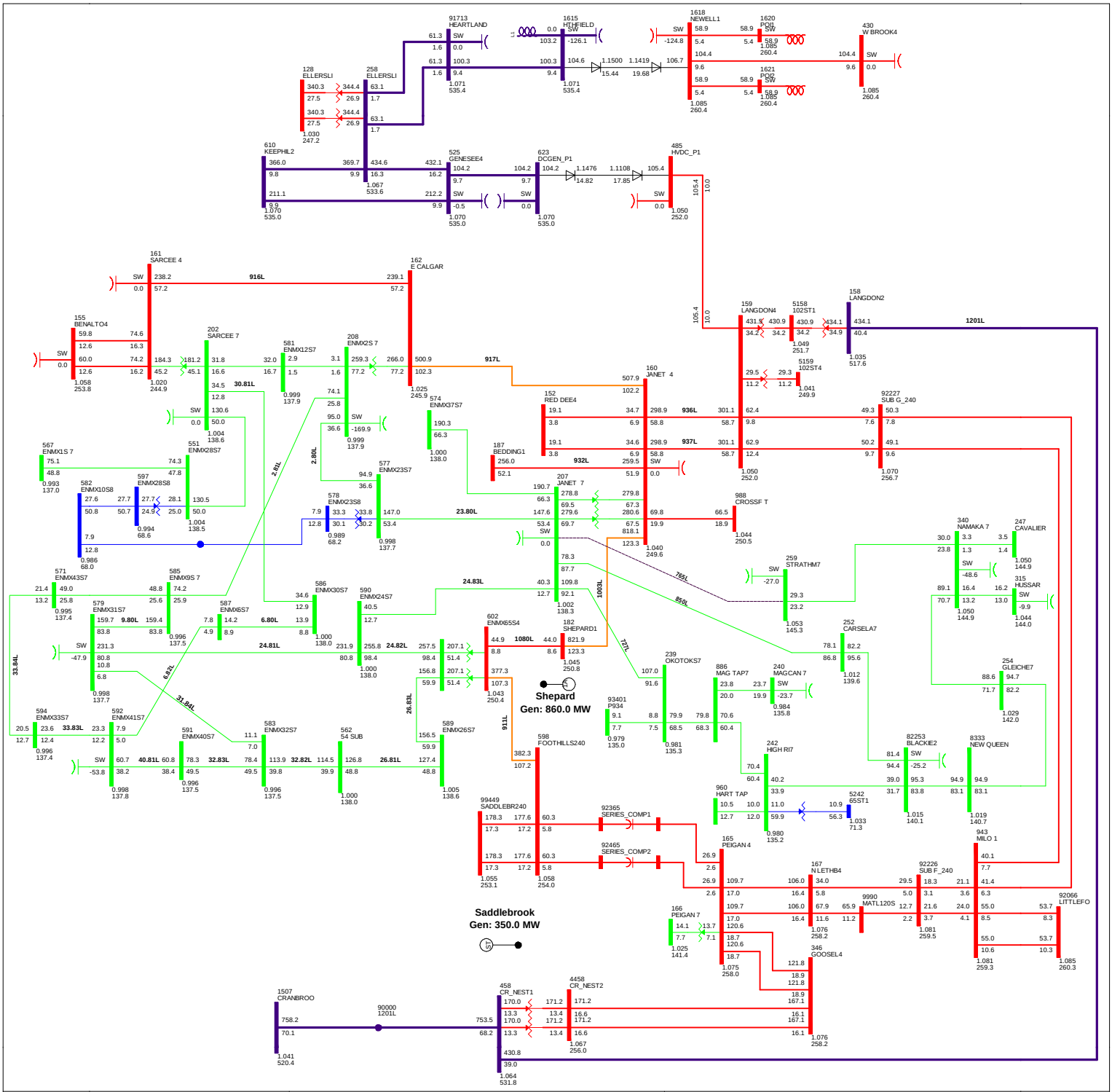
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 788.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-21: OPEN 727L 138 KV LINE (OKOTOKS 678S TO MAGCAN
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

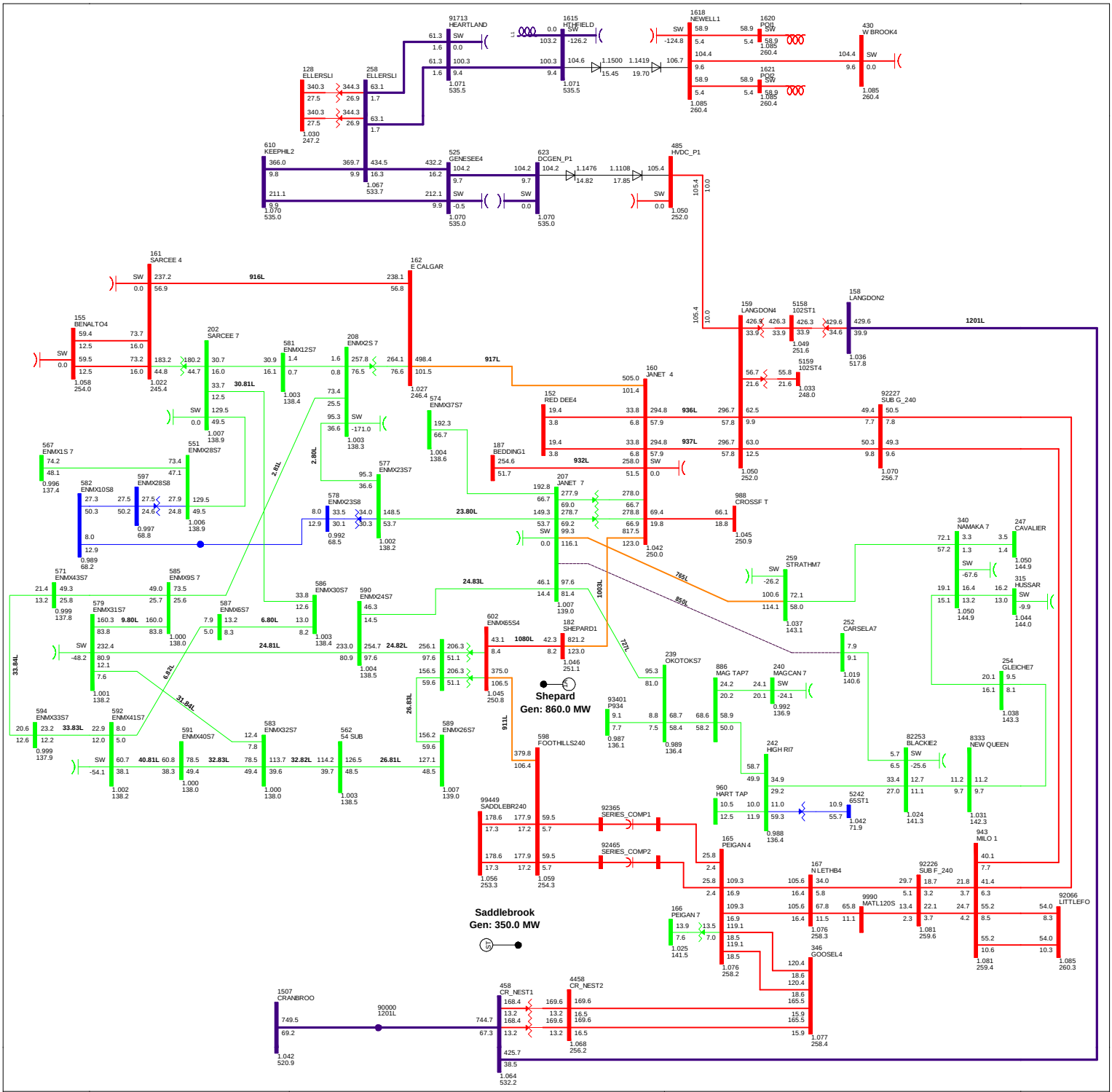
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 796.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-22: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

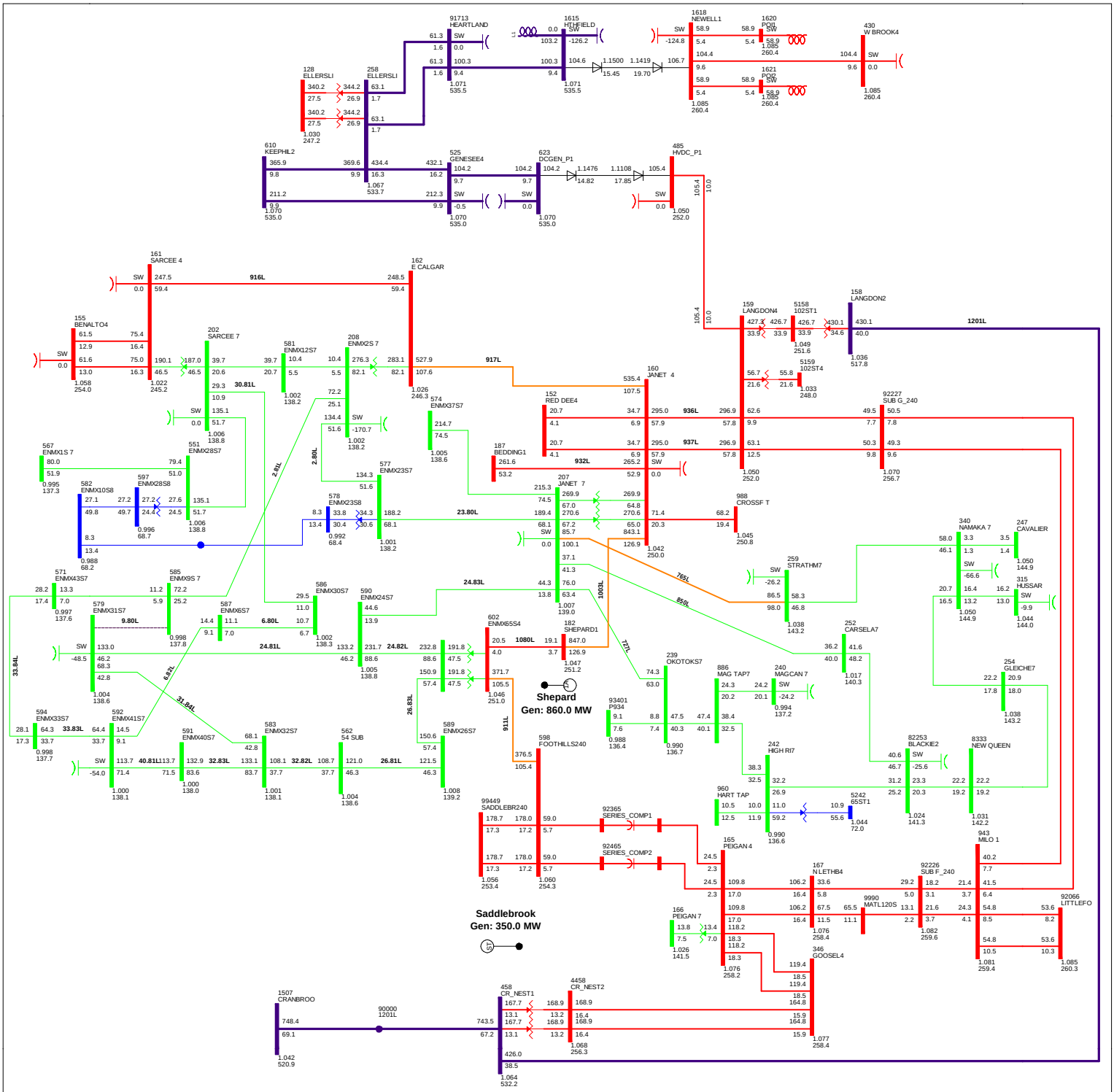
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 787.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-23: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

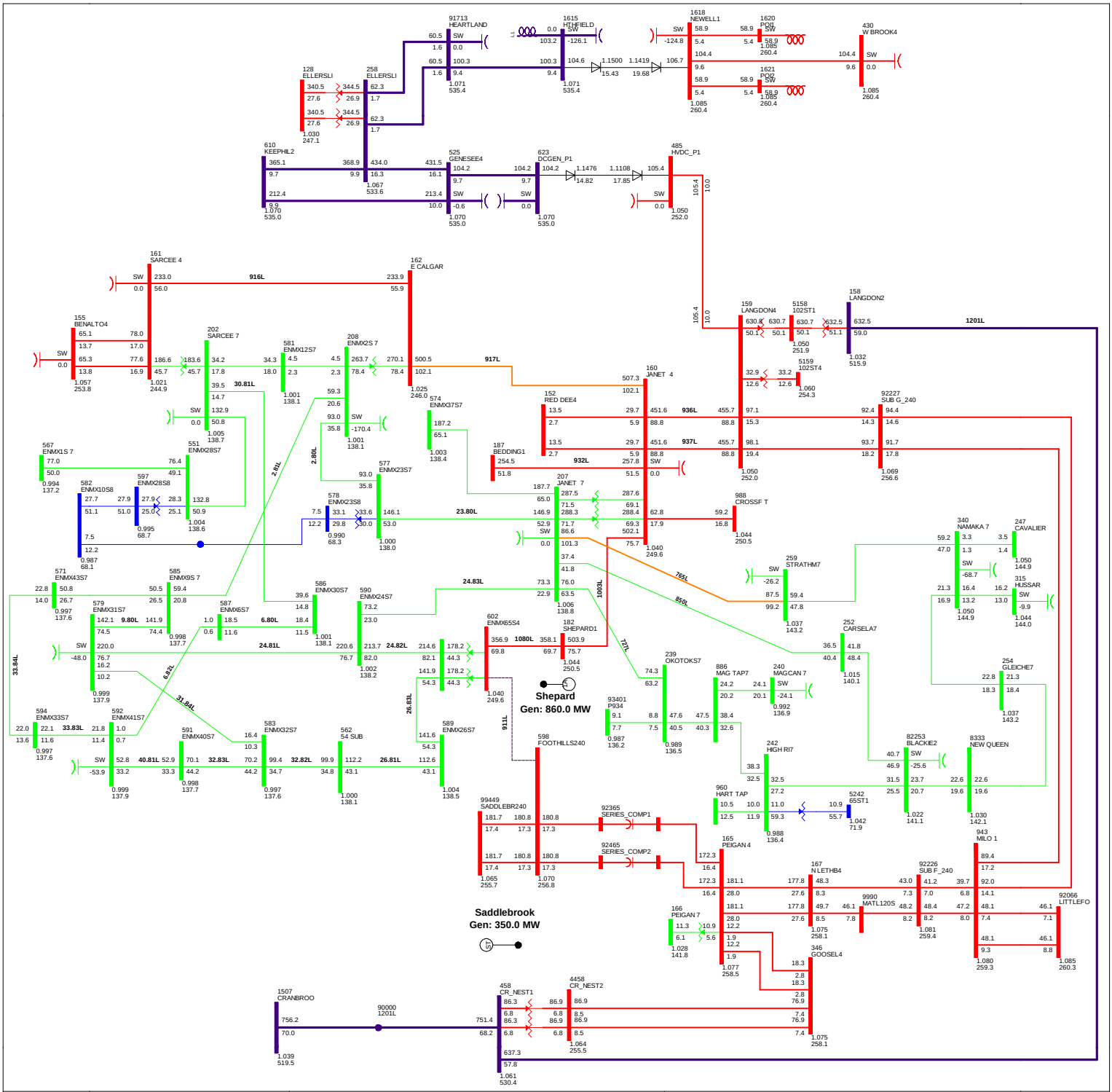
BCH Import: 786.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-24: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

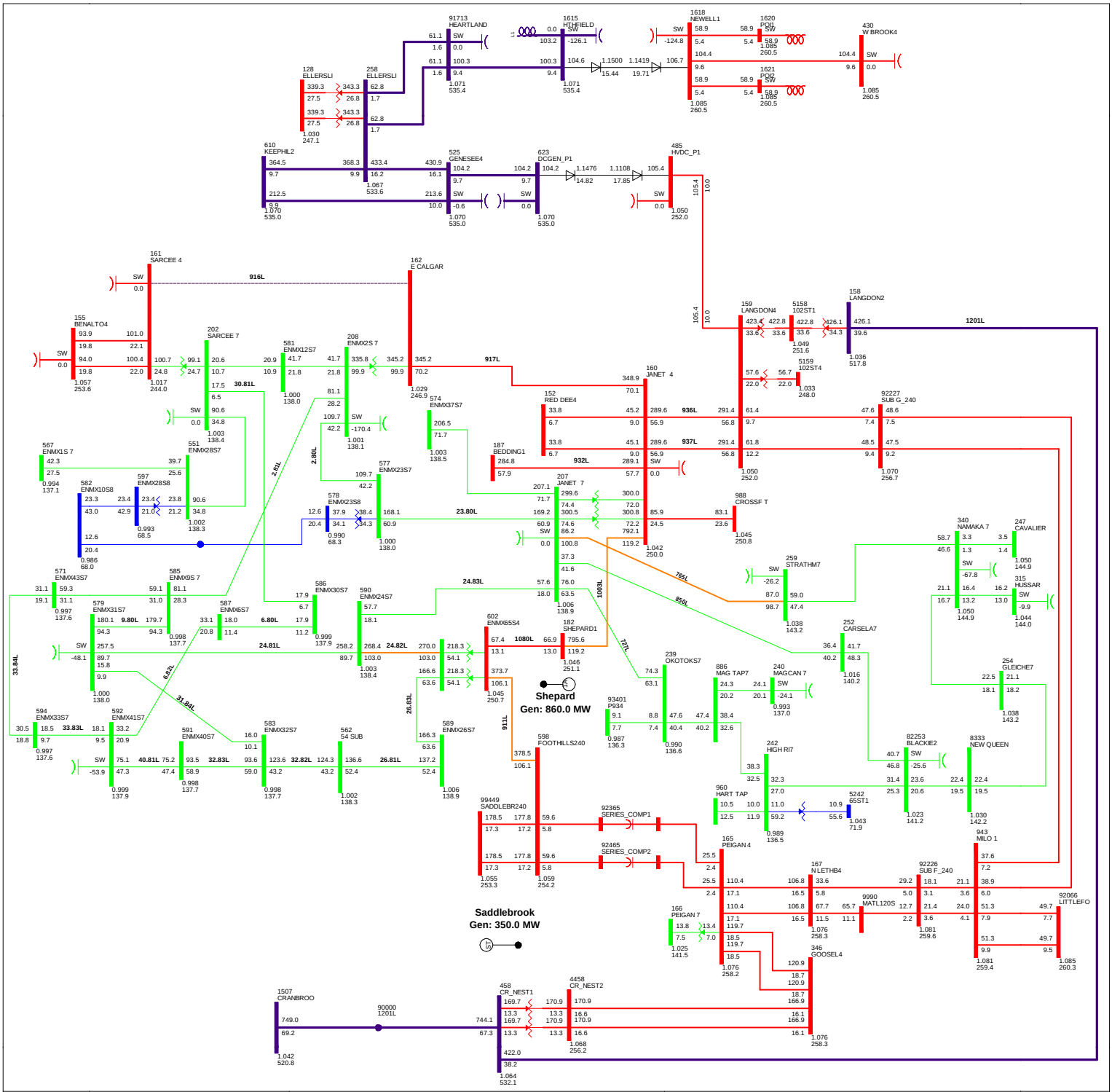
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 795.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-25: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:22



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

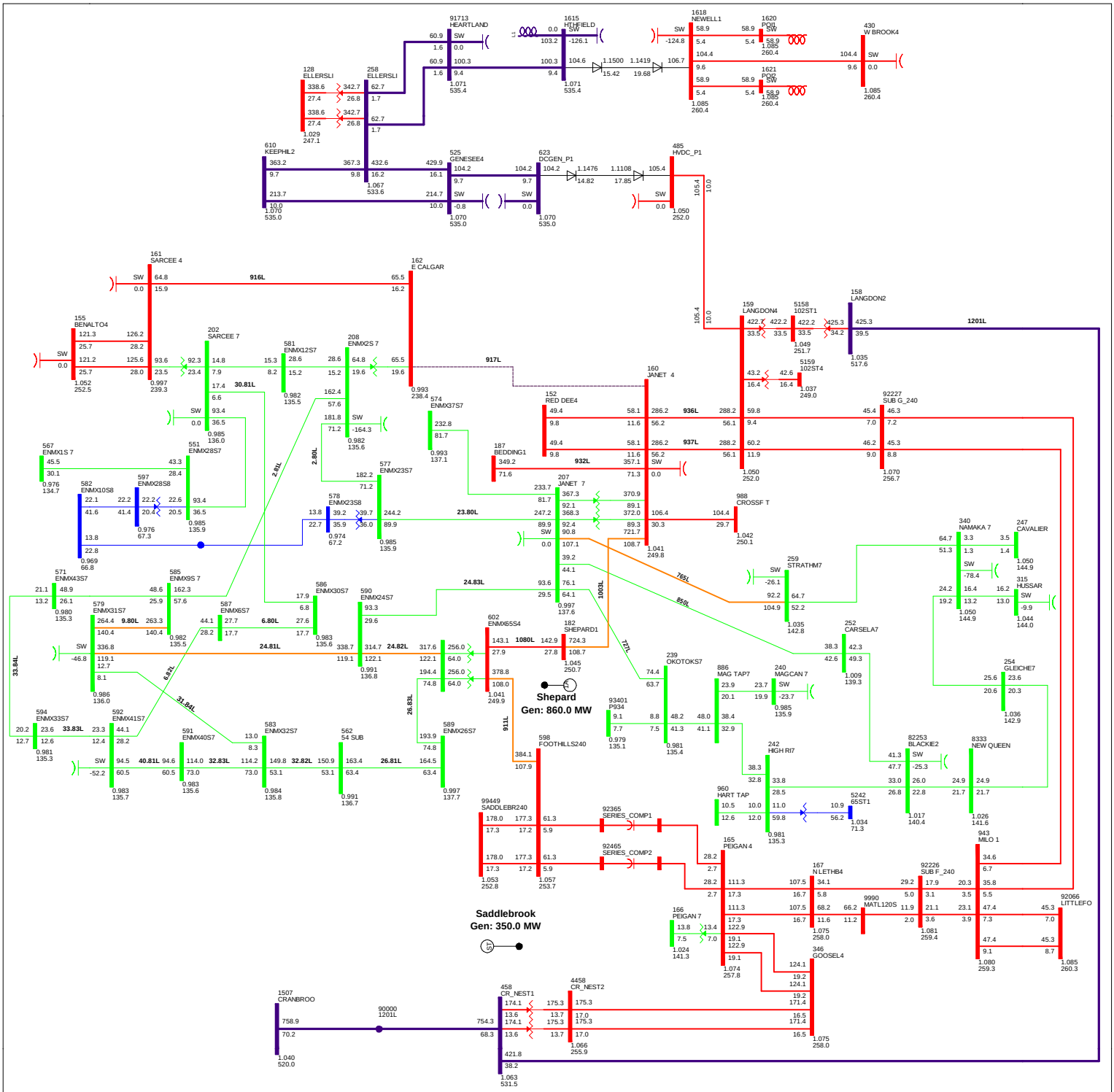
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 788.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-26: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:23



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

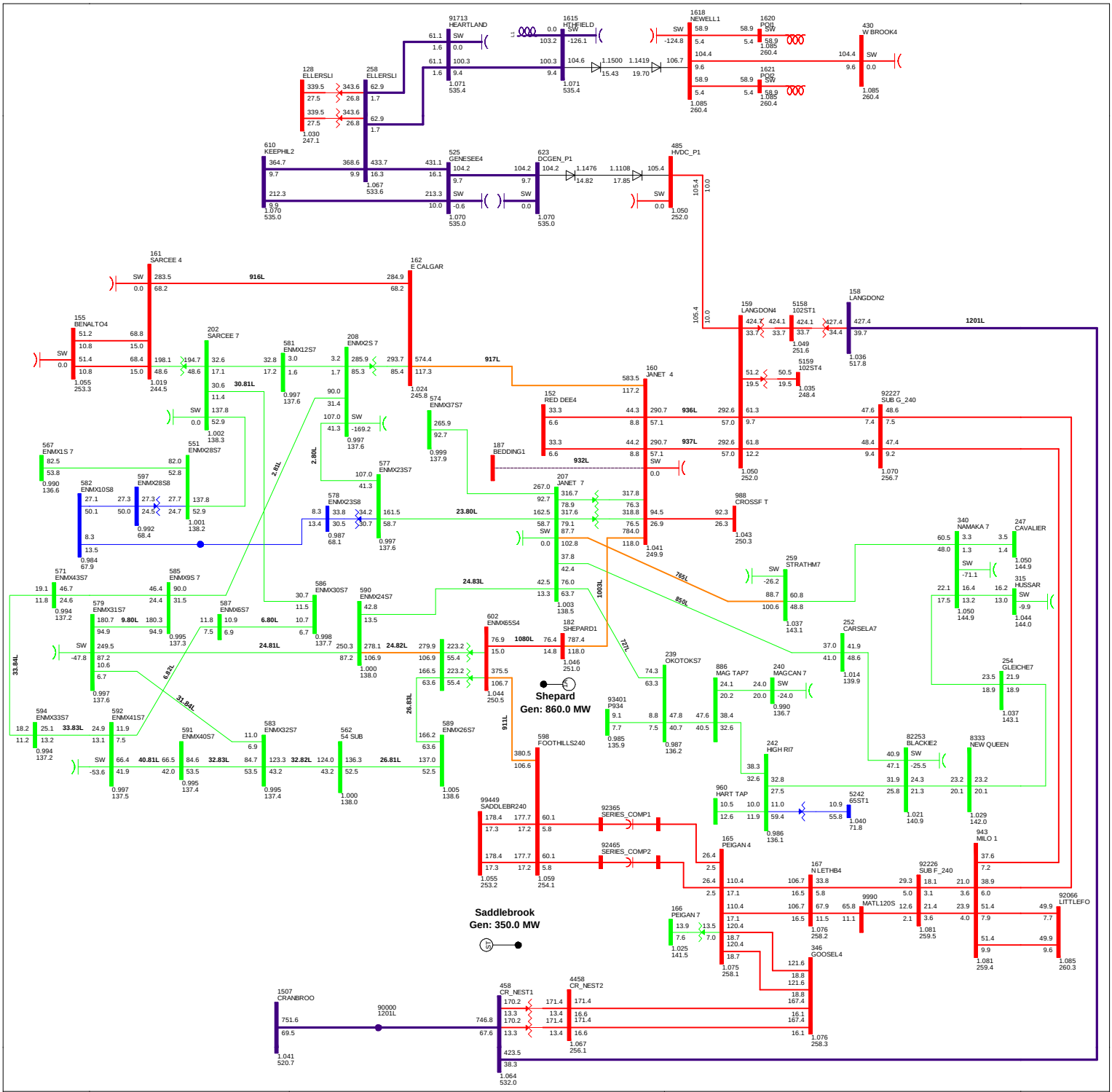
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 801.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-27: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:23



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

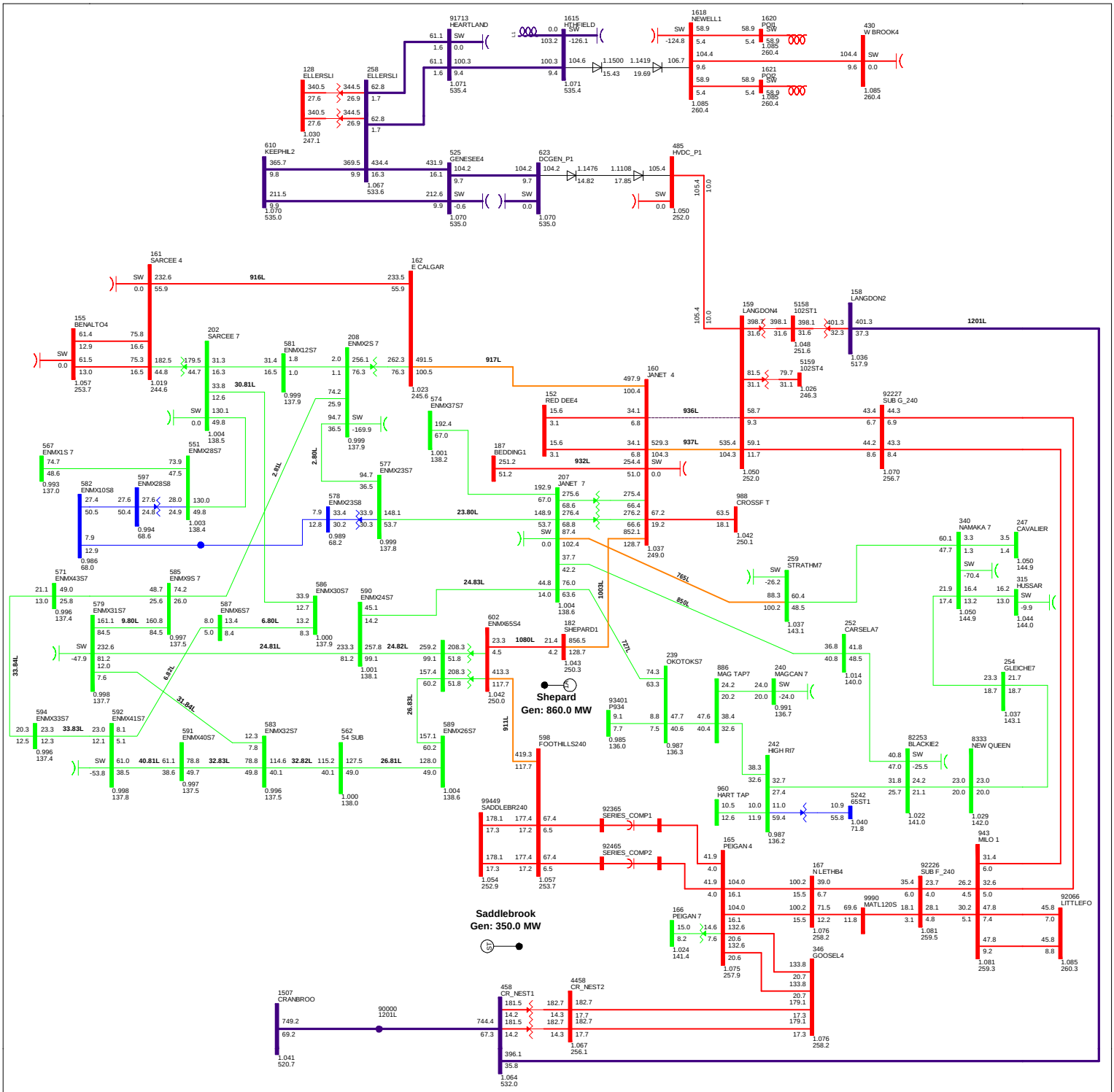
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 791.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-28: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:23



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

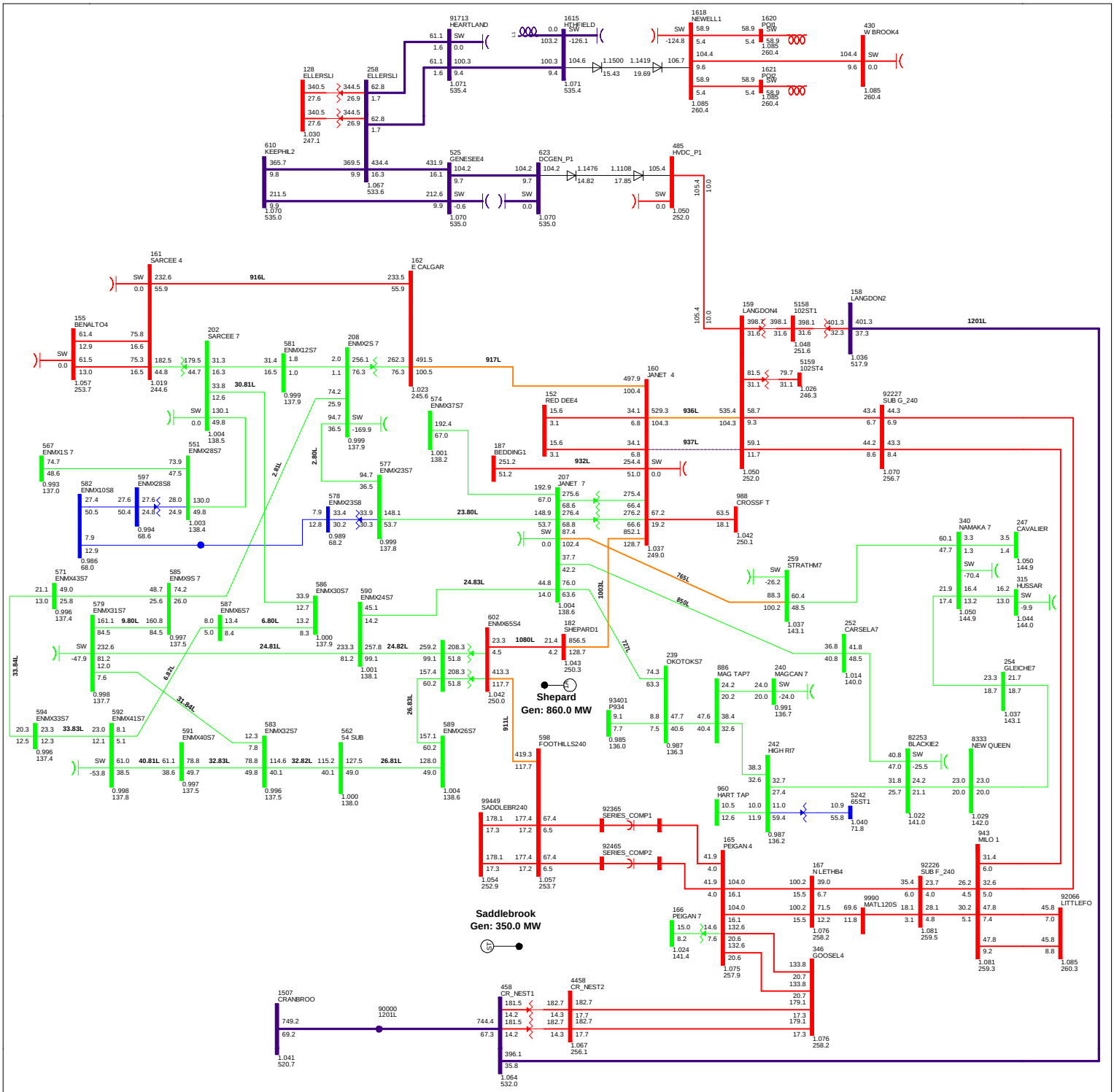
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 789.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-29: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:23



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

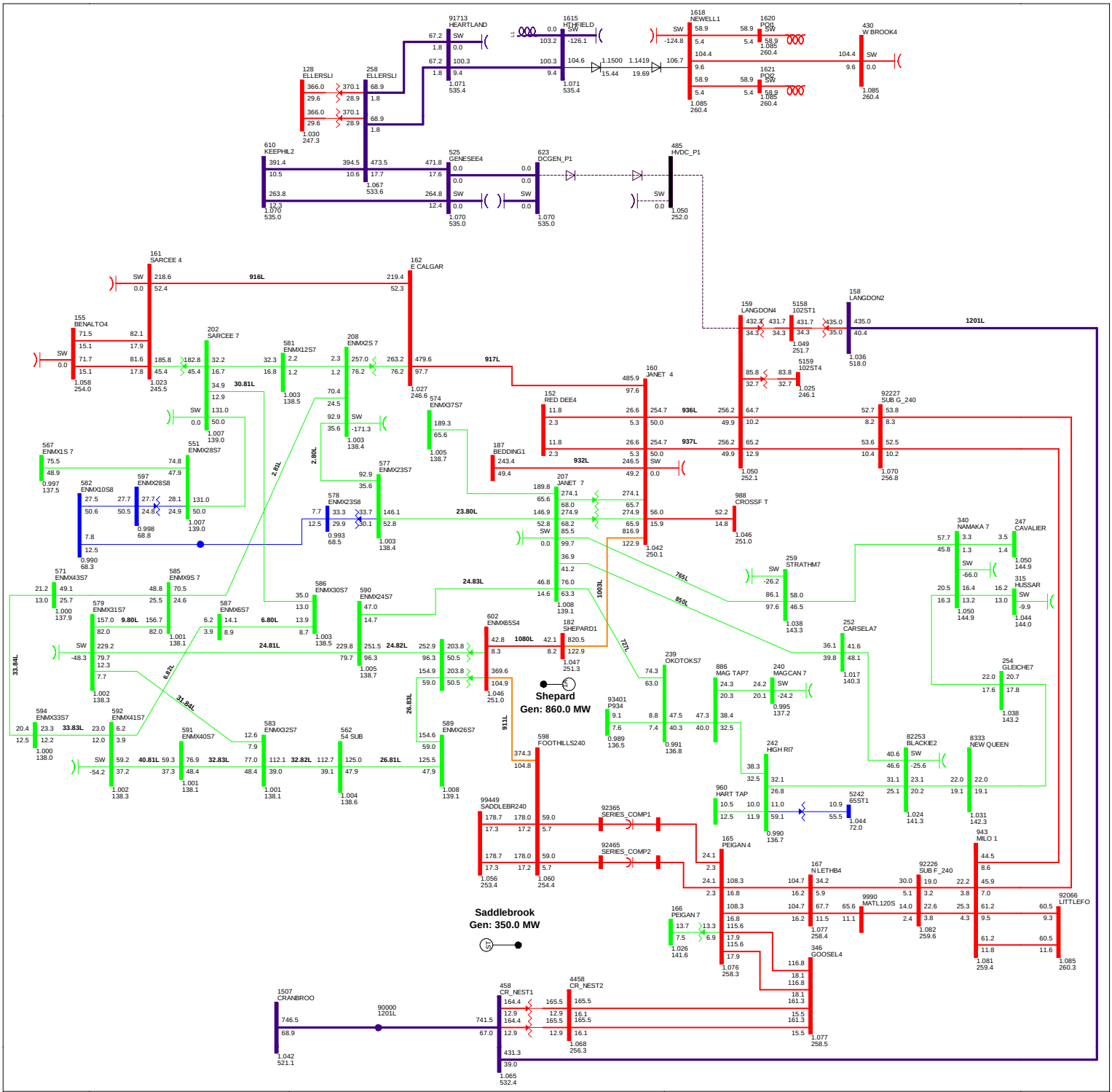
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 789.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-30: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:23



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 783.5 MW

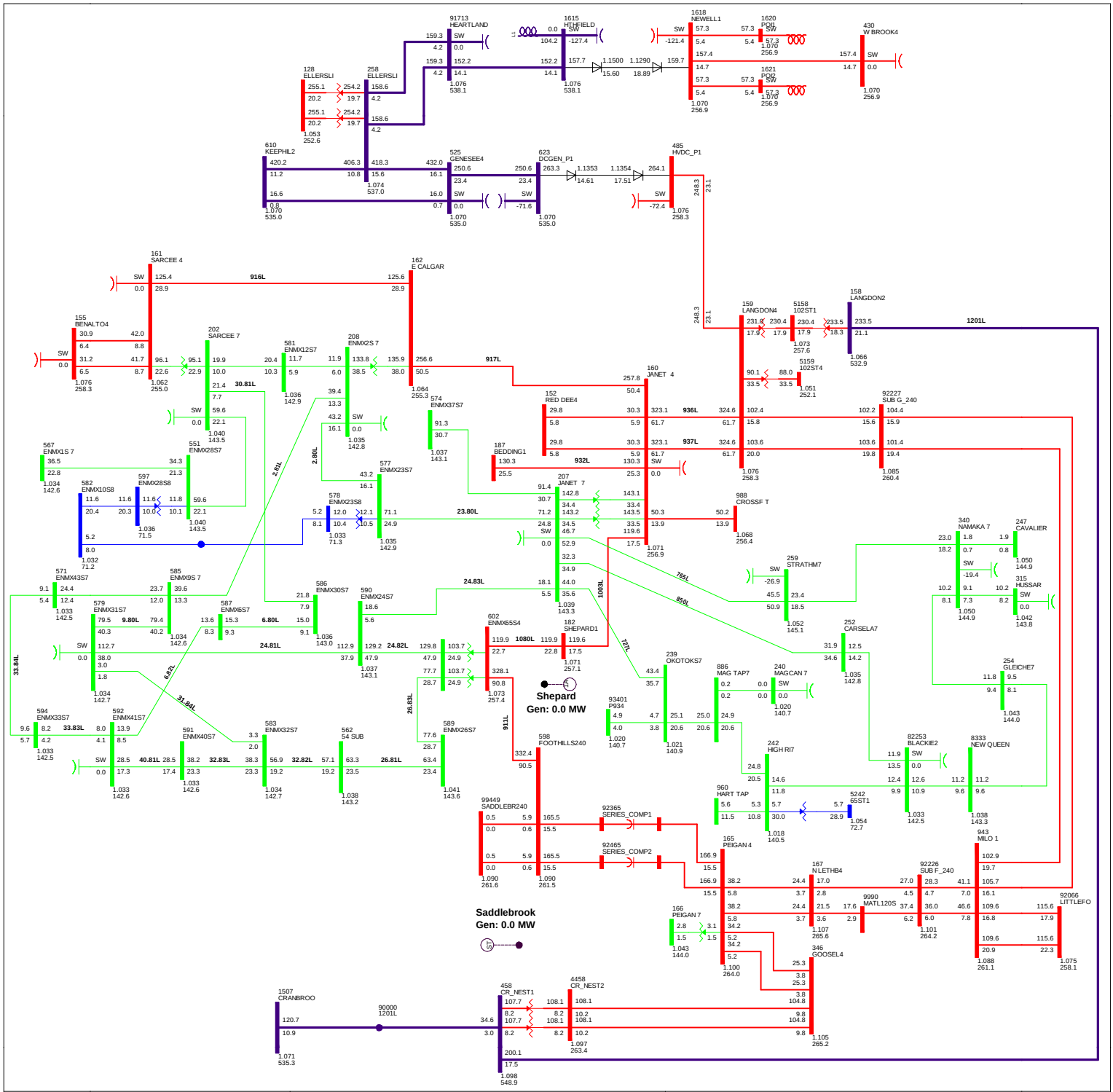
2012LTO+HVDC EXISTING SYSTEM

FIG A-SC5-31: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2014_NEED_HVDC_SC5_SP

FRI, JUN 08 2012 16:23

2014 Loading Violations
Scenario 6



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

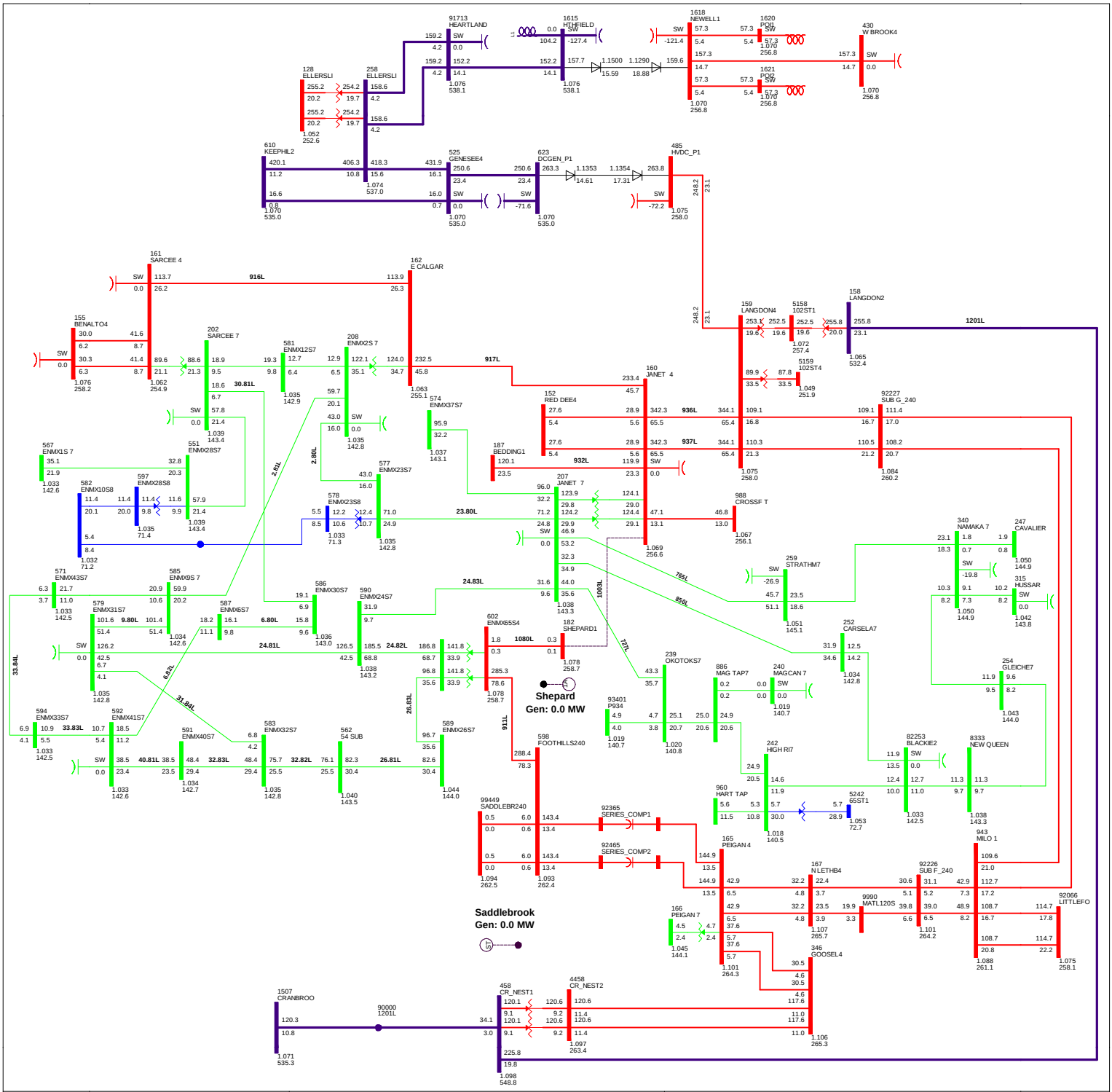
BCH Import: -0.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-1: BASECASE

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

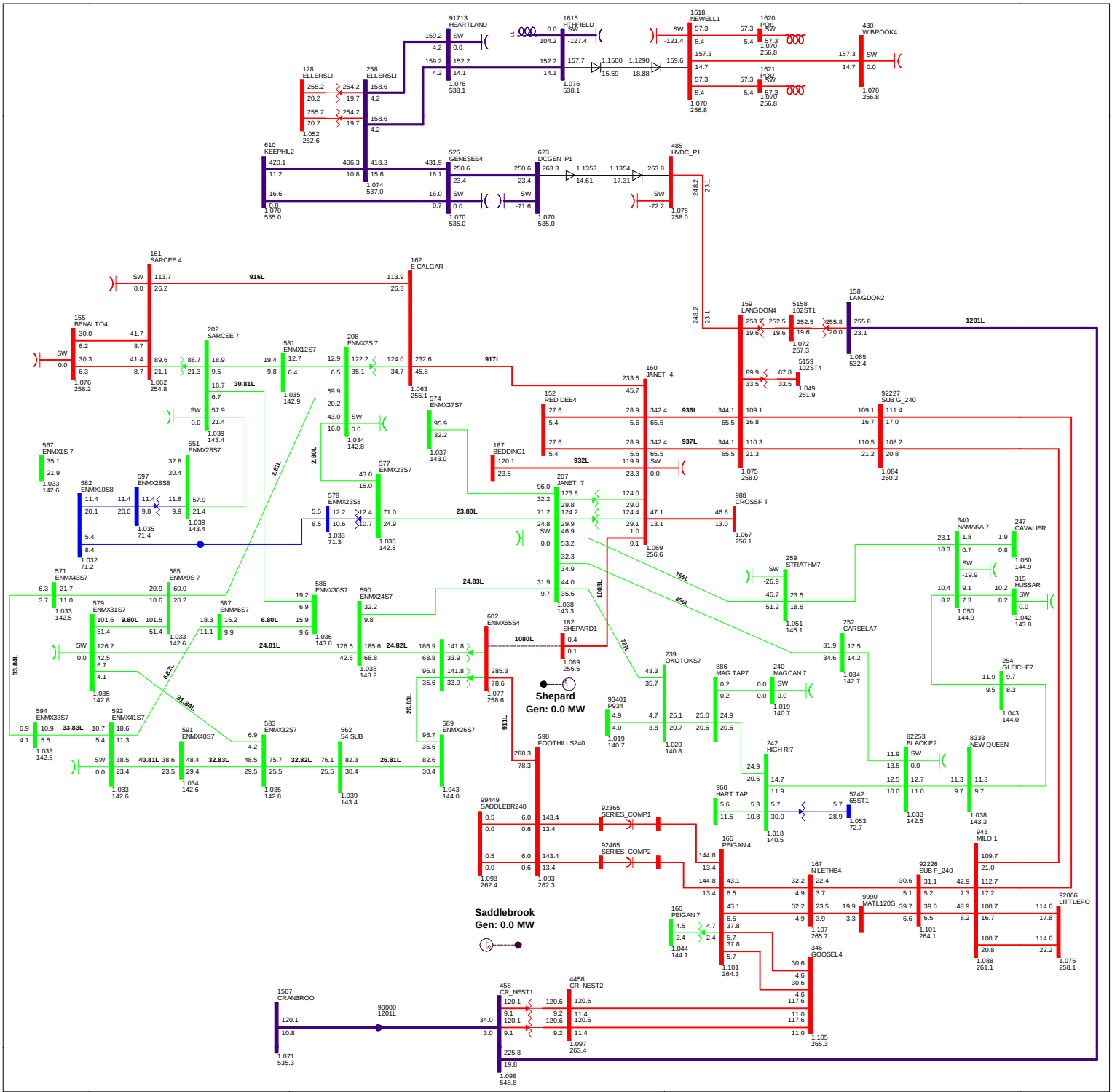
BCH Import: -0.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

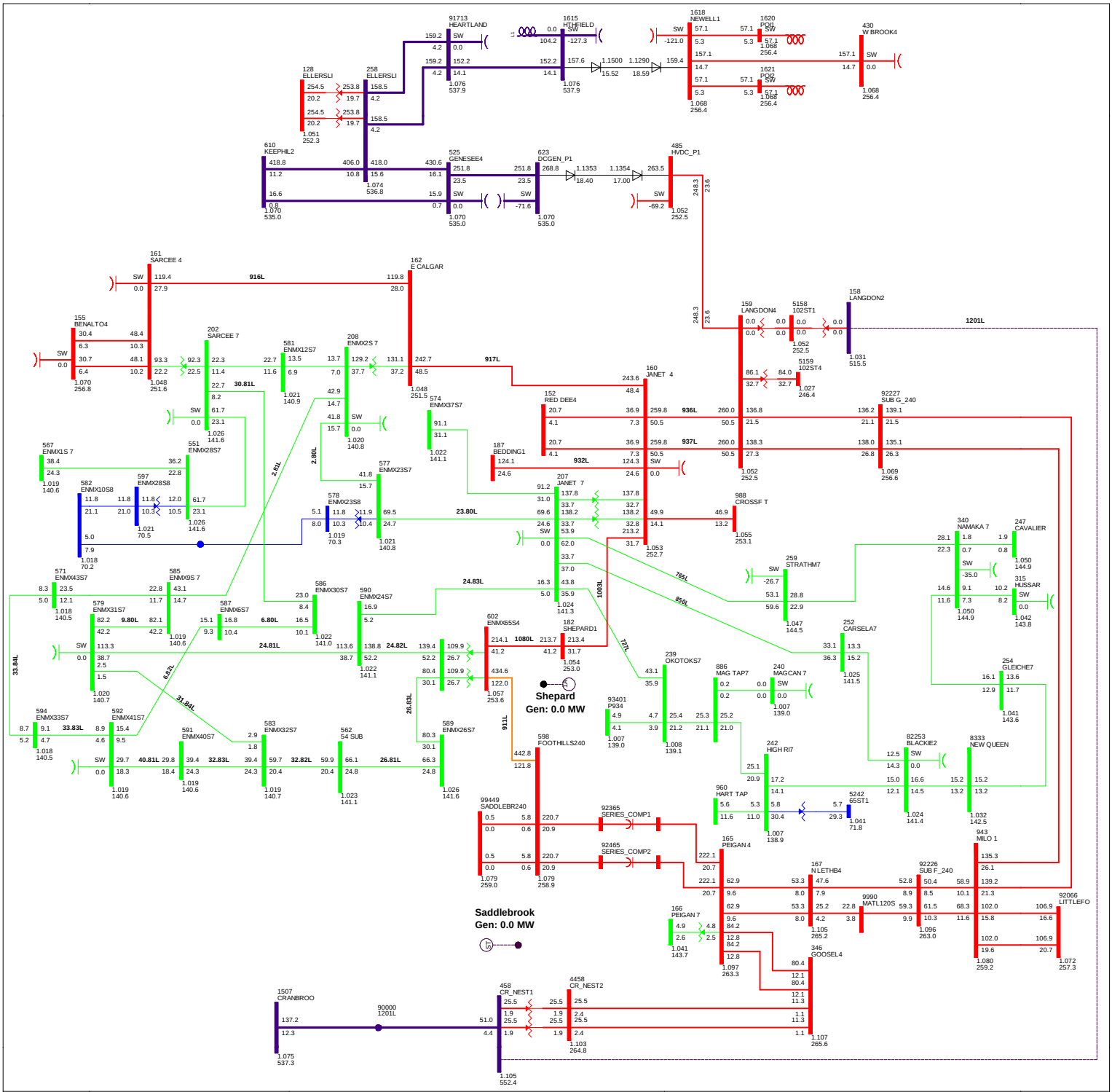
BCH Import: -0.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-3: OPEN 1080L 240 KV LINE (ENMAX 25 TO ENMAX 65)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

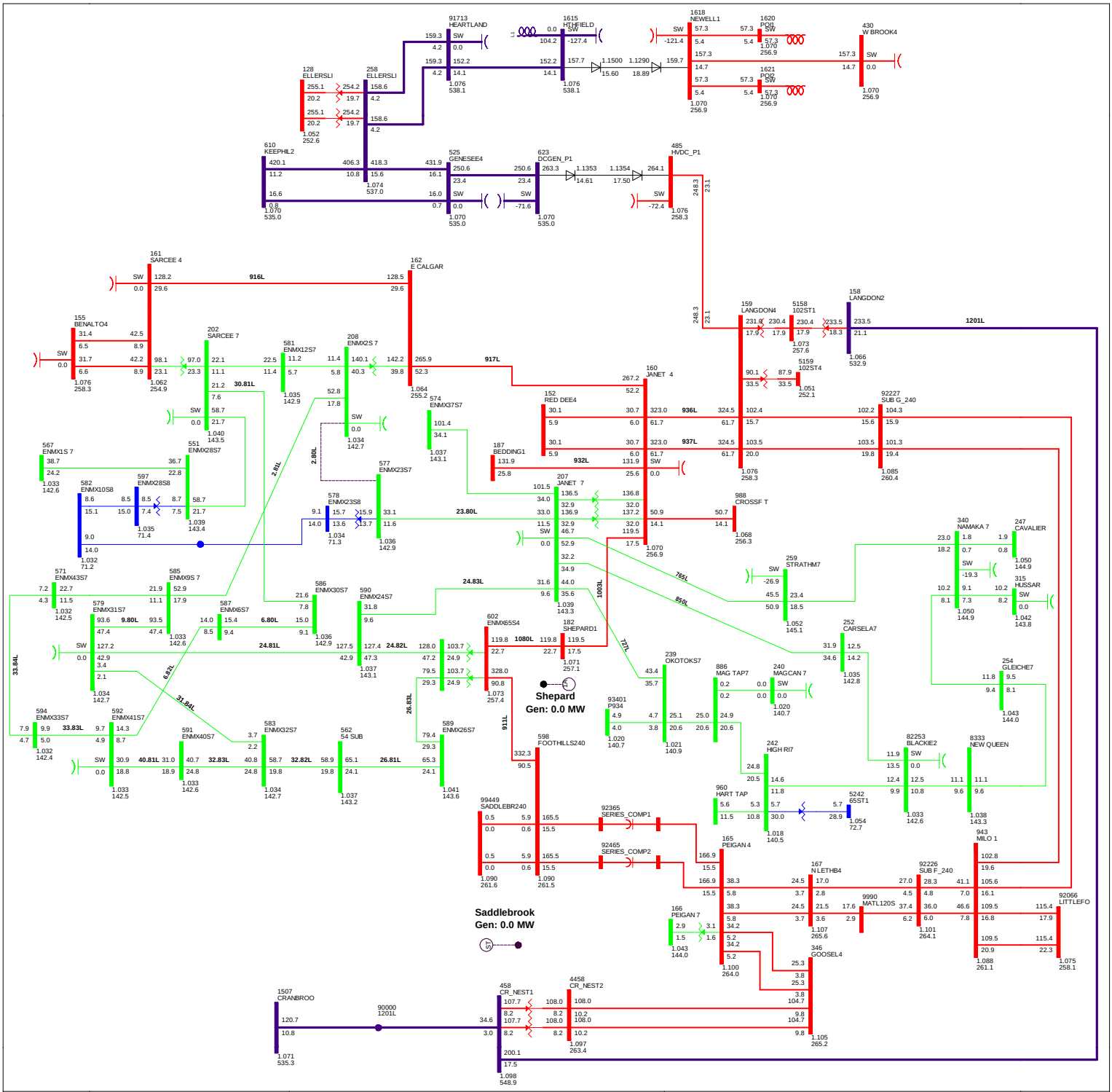
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 7.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-4: OPEN 1201L 500 KV LINE (LANGDON 102S TO CROWSNE 2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

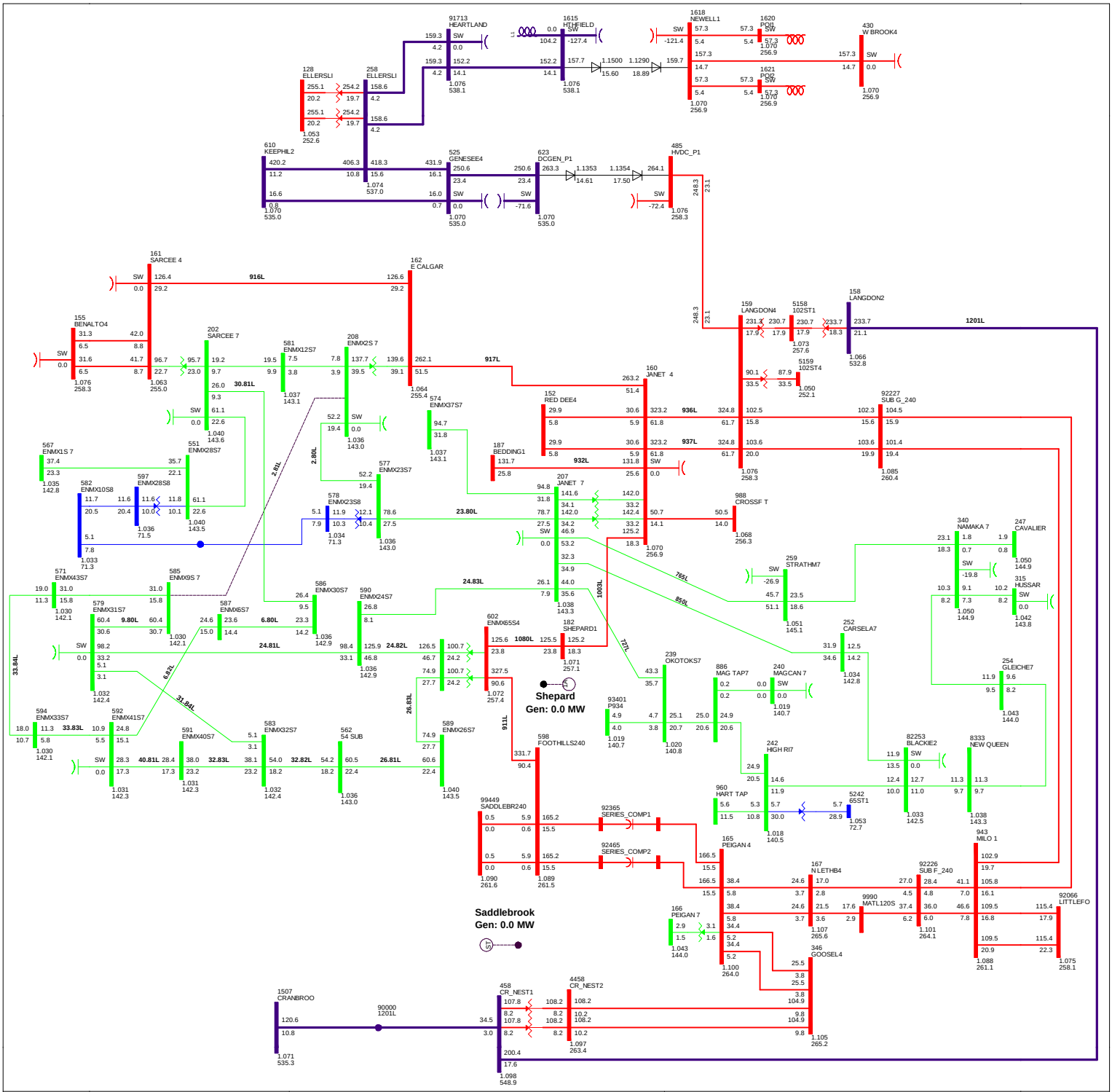
BCH Import: -0.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-5: OPEN 2.80L 138 KV LINE (ENMAX 2 TO ENMAX 23)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

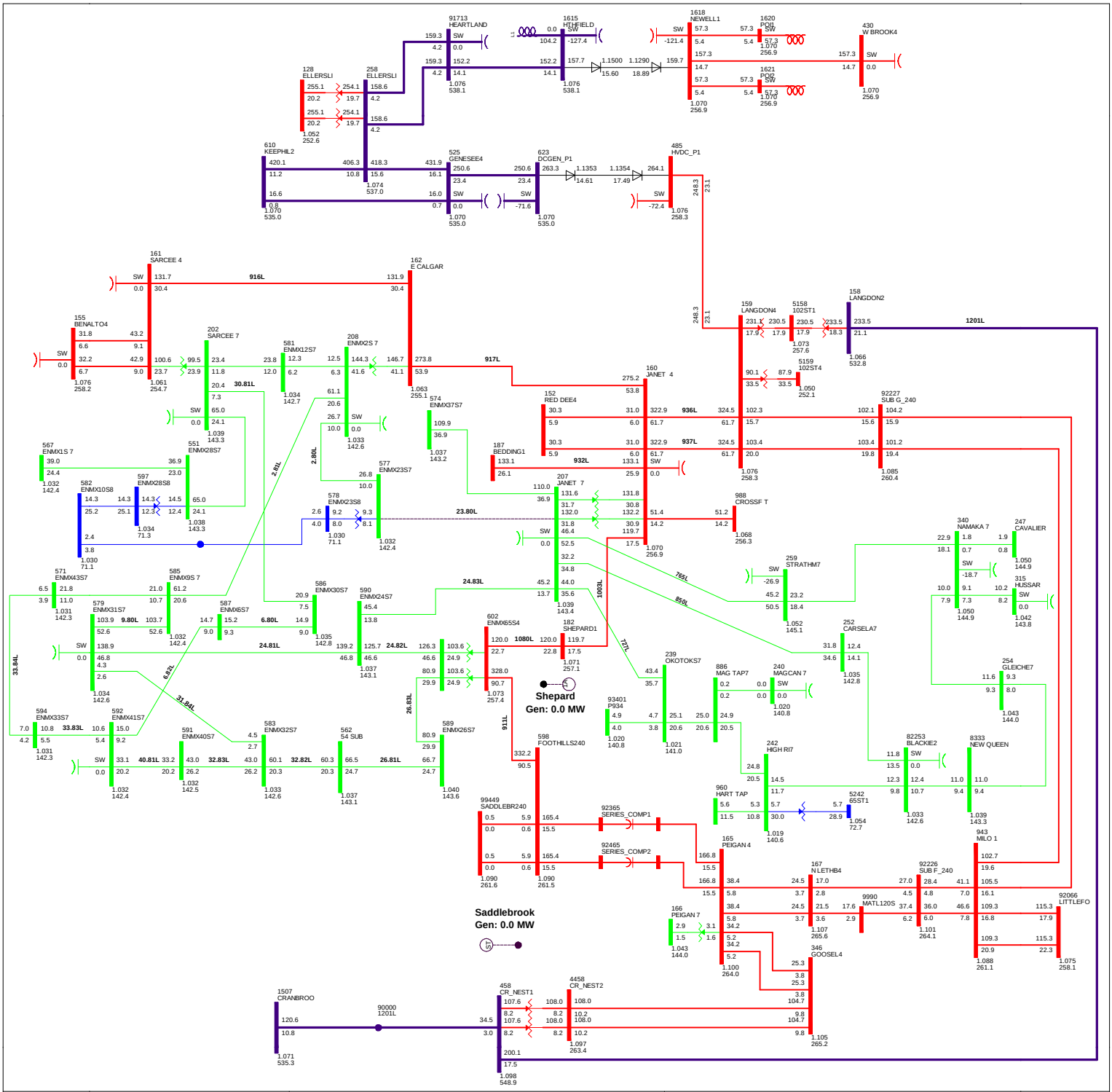
BCH Import: -0.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-6: OPEN 2.81L 138 KV LINE (ENMAX 2 TO ENMAX 9)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

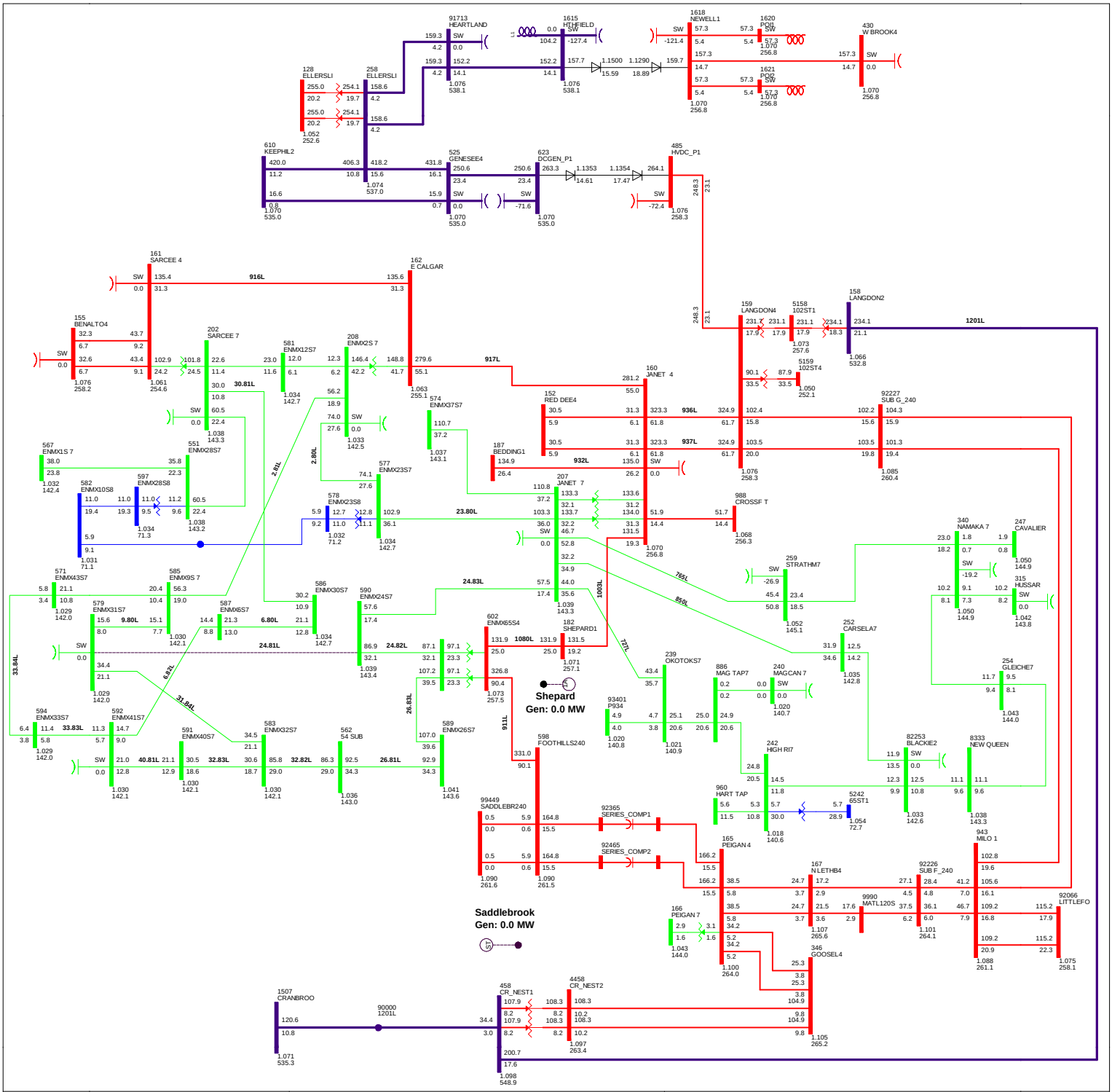
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-7: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

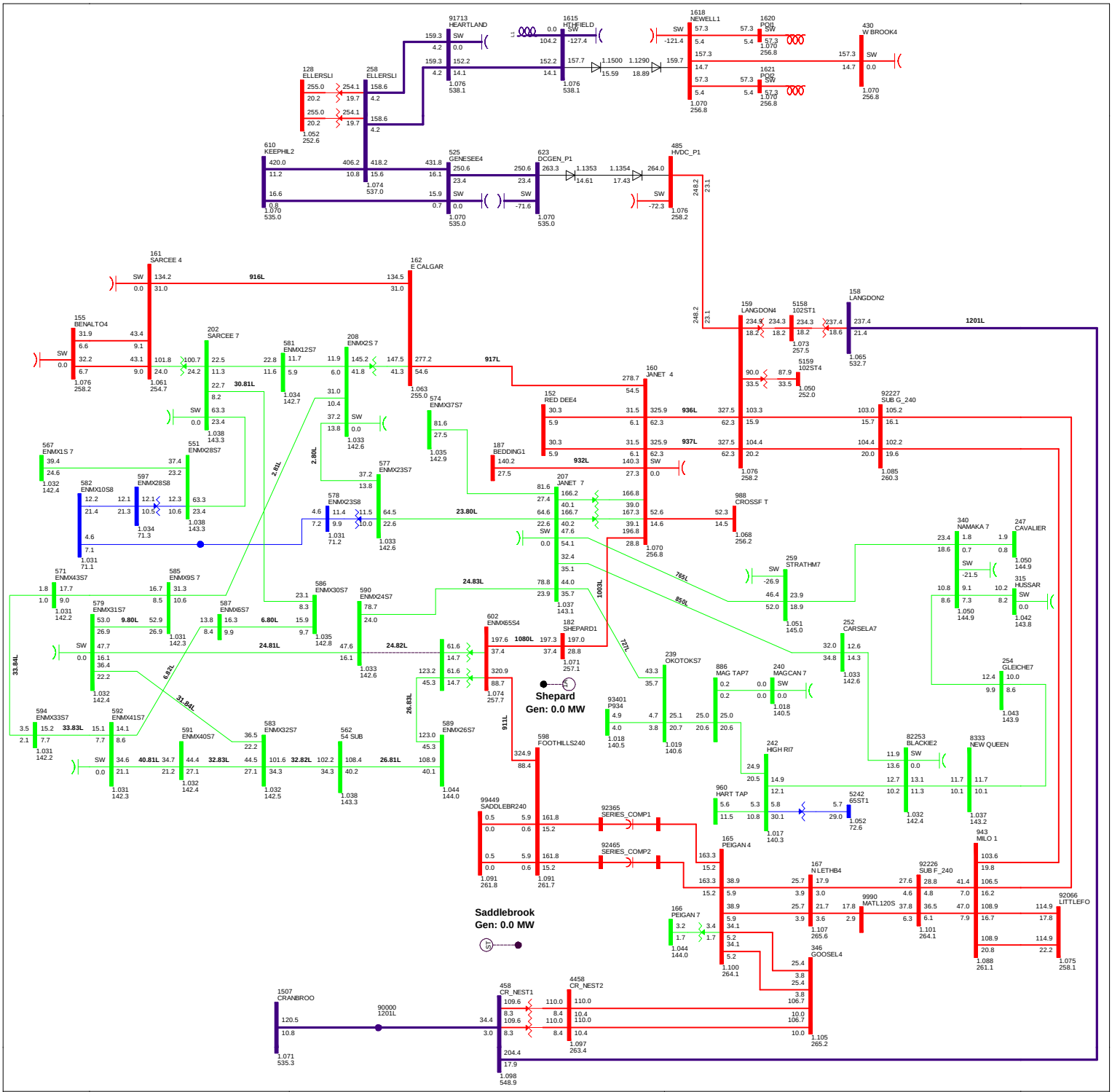
BCH Import: -0.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-8: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

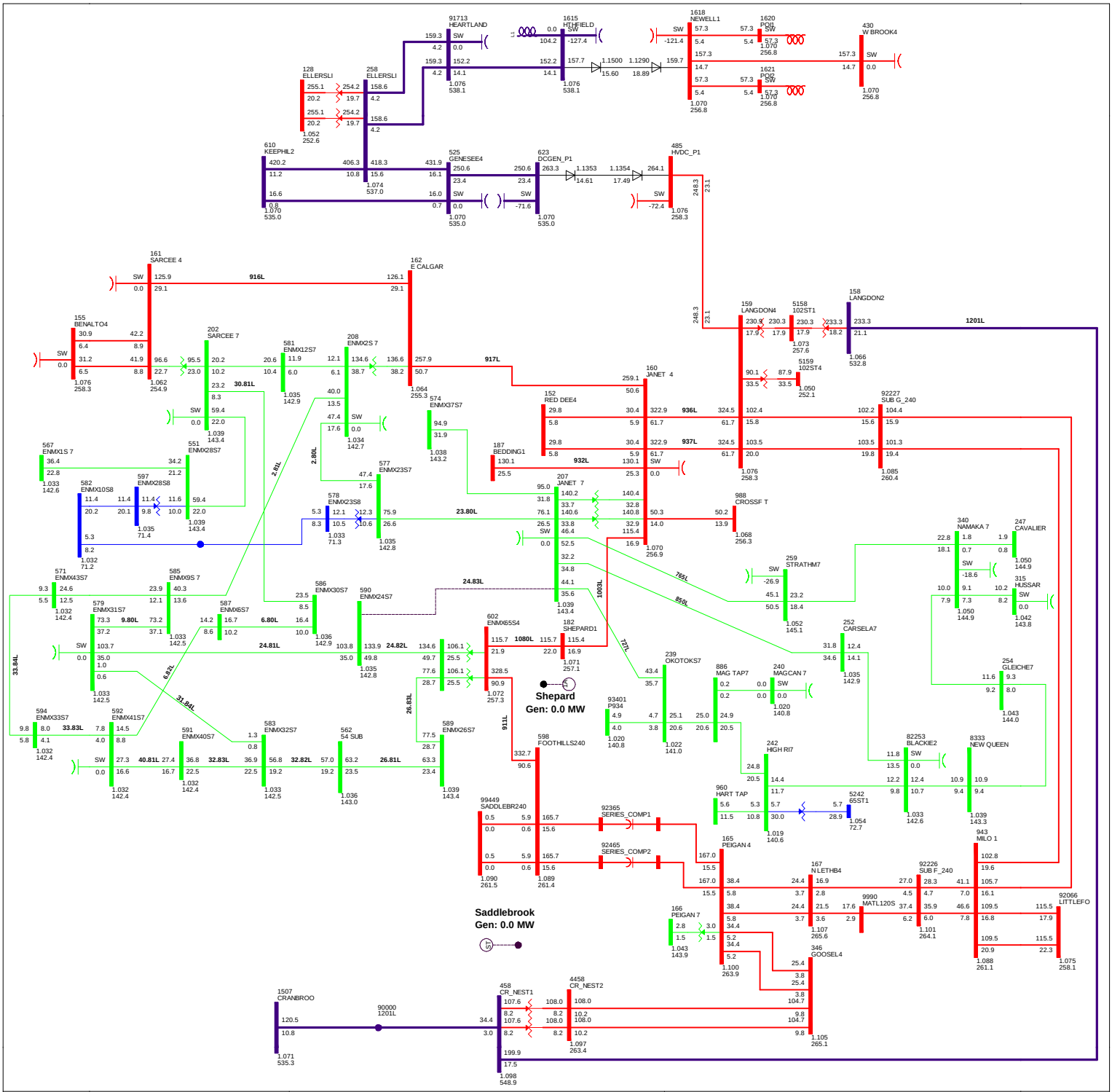
BCH Import: 0.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-9: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

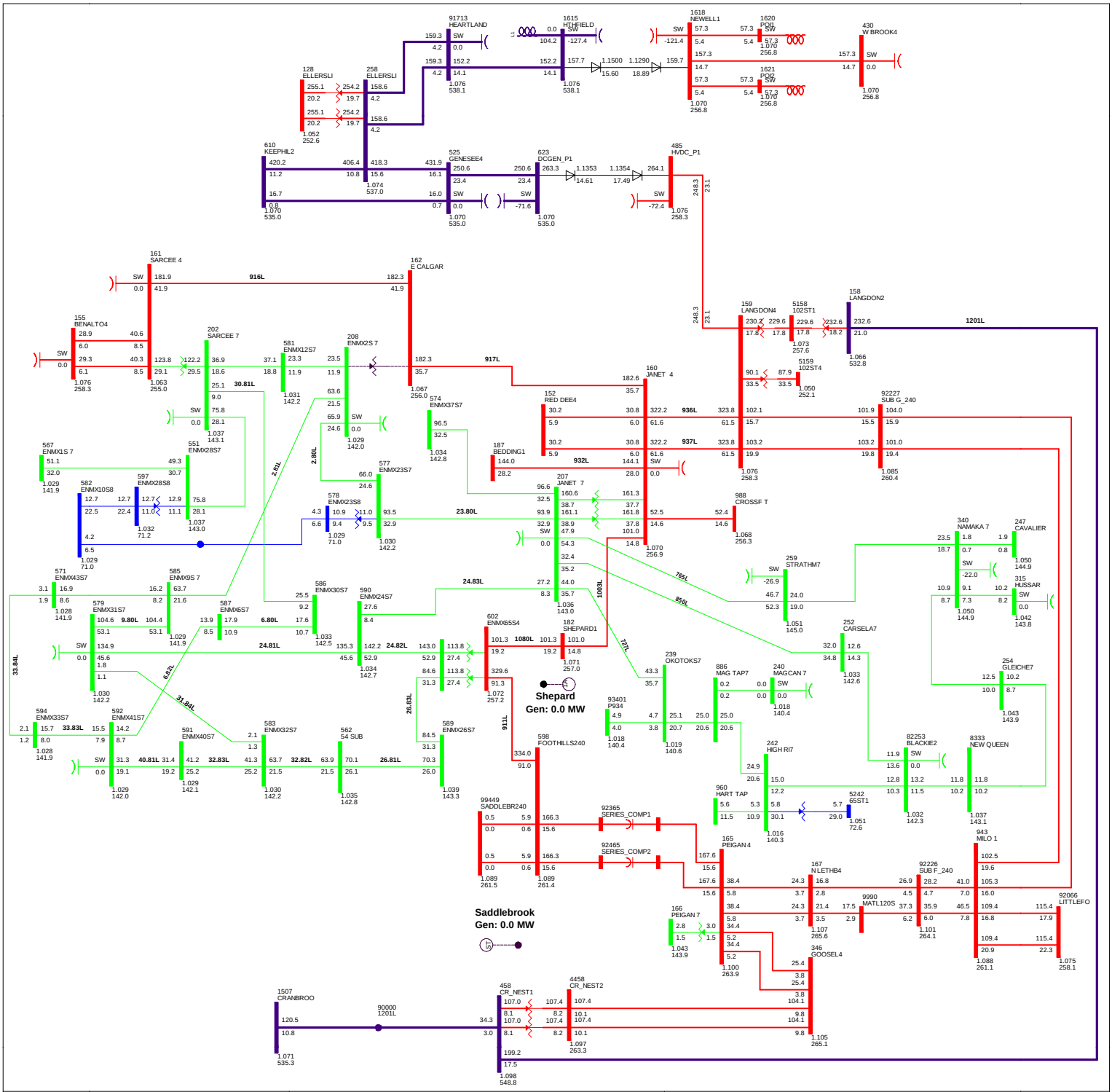
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-10: OPEN 24.83L 138 KV LINE (JANET 74S TO ENMAX 24
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

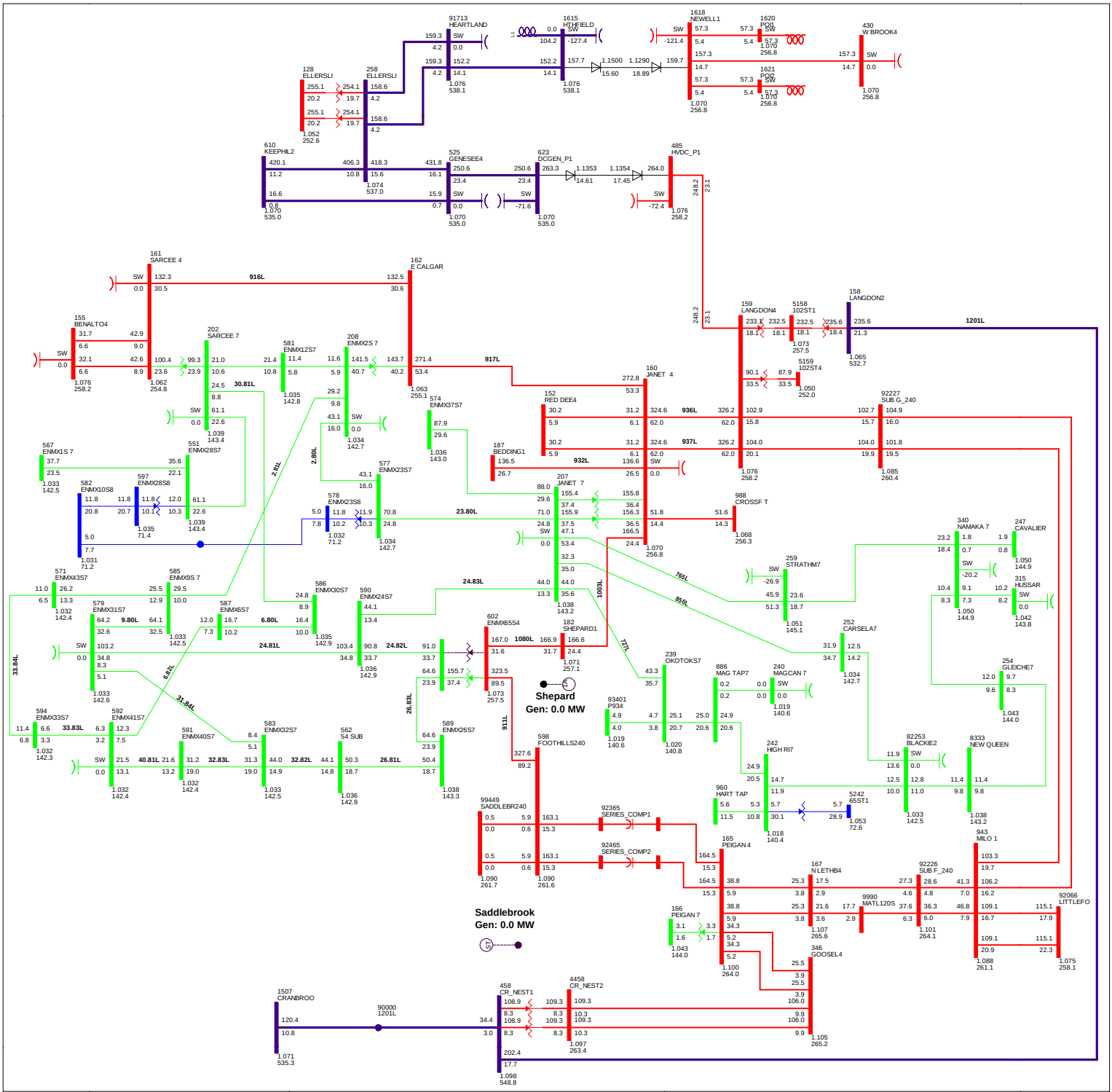
BCH Import: 0.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-11: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

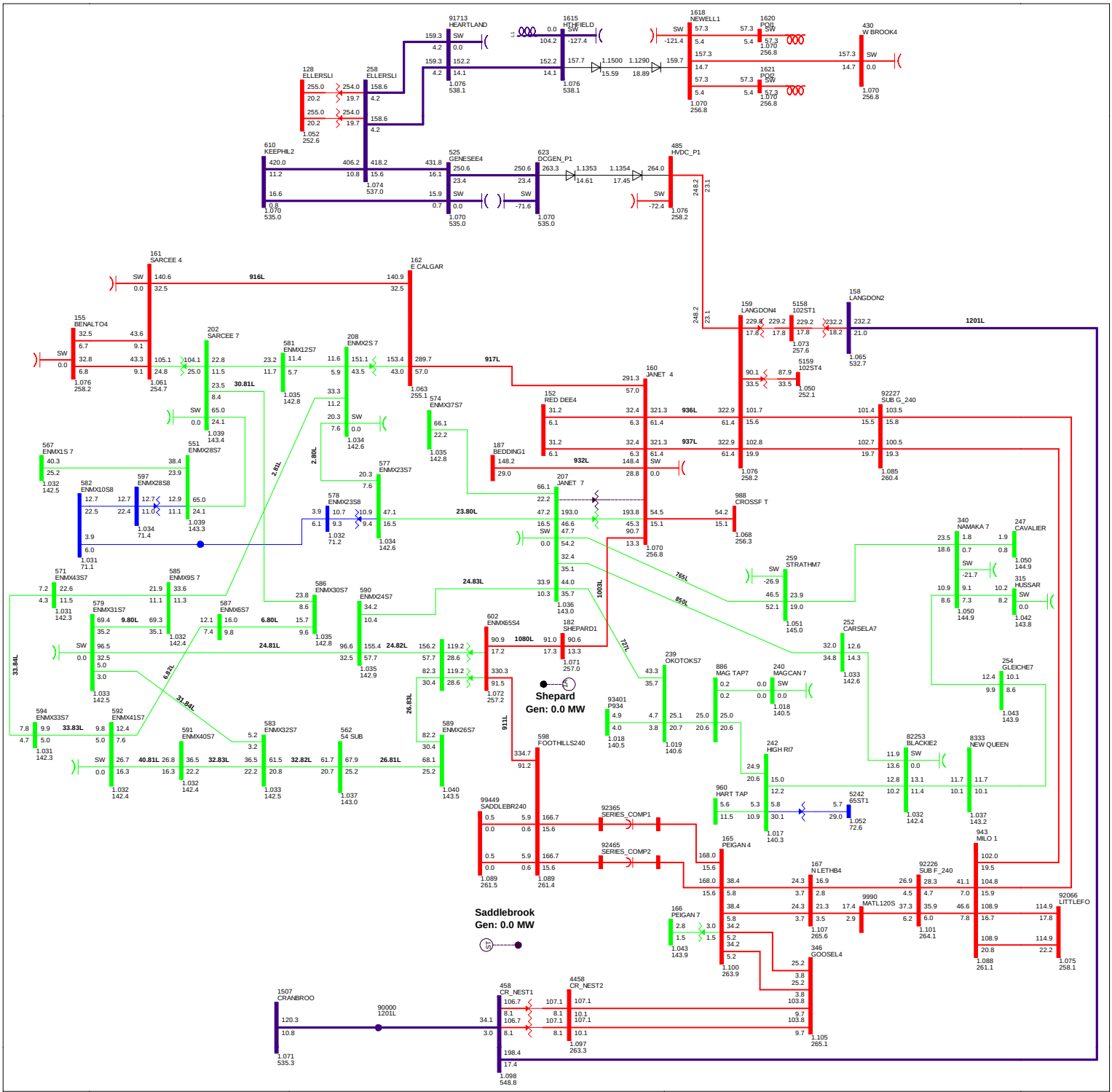
BCH Import: -0.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-12: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

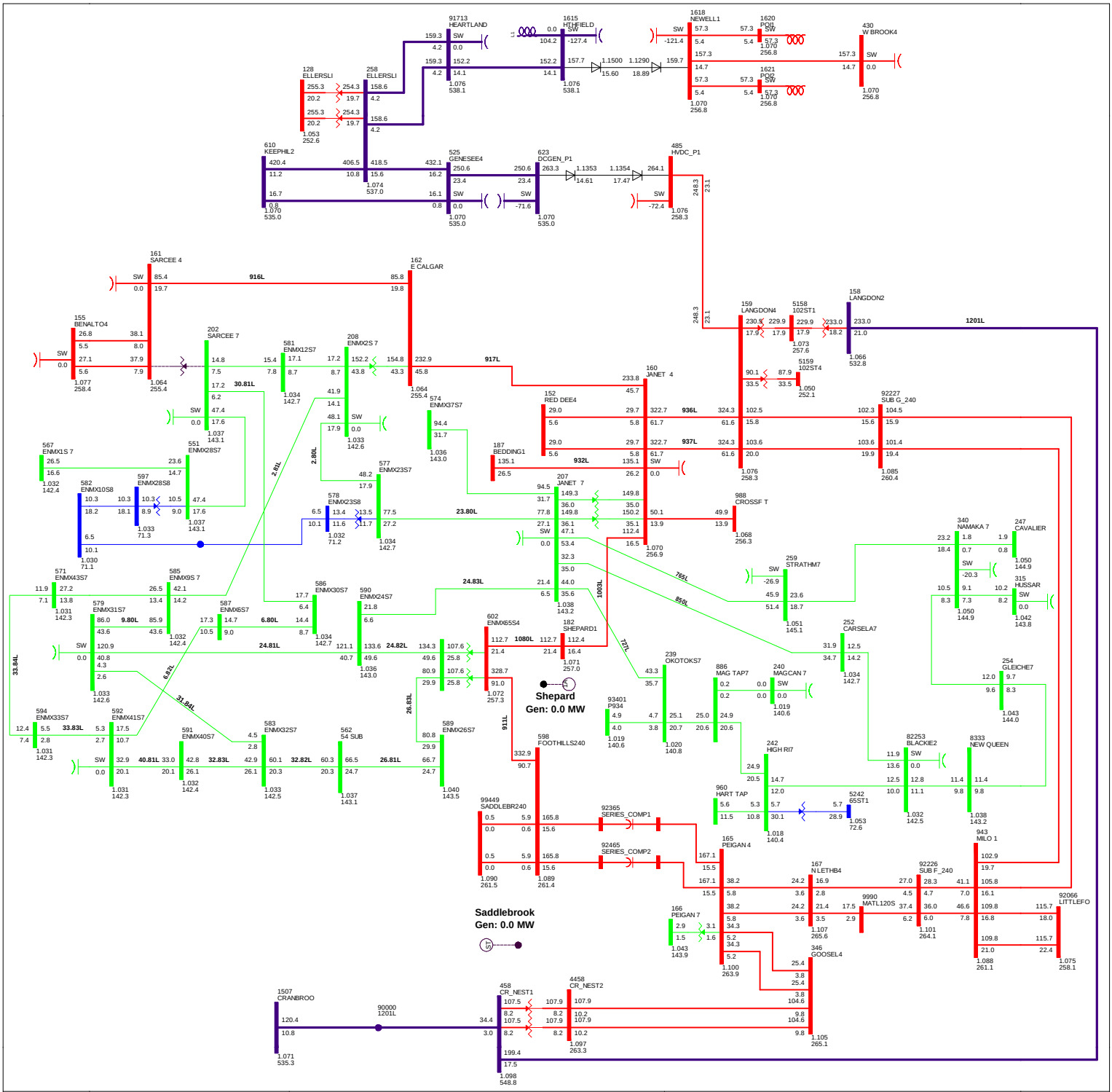
BCH Import: -0.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-13: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

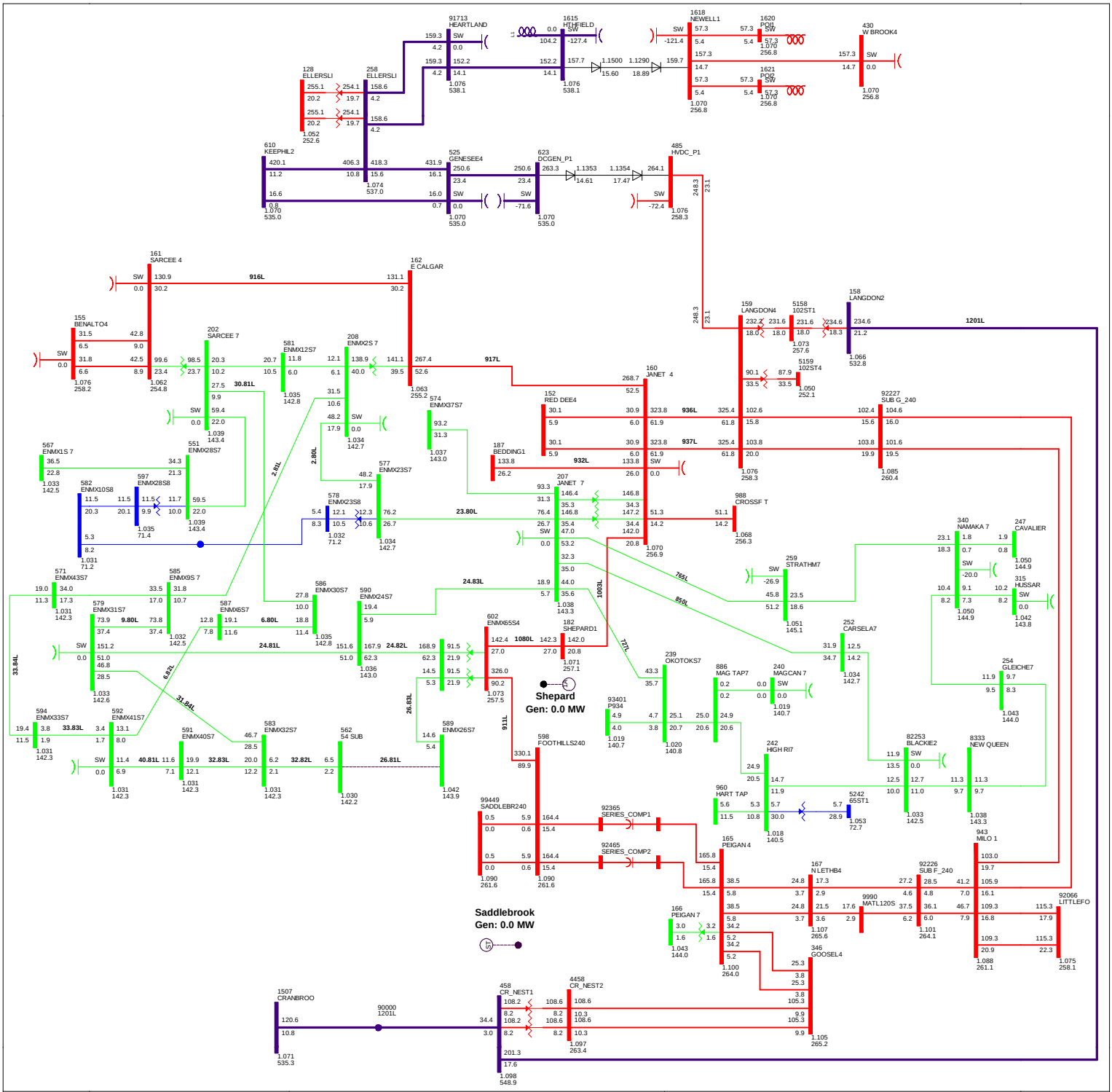
BCH Import: -0.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-14: OPEN 240/138 KV TRANSFORMER (SARCEE 42S)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

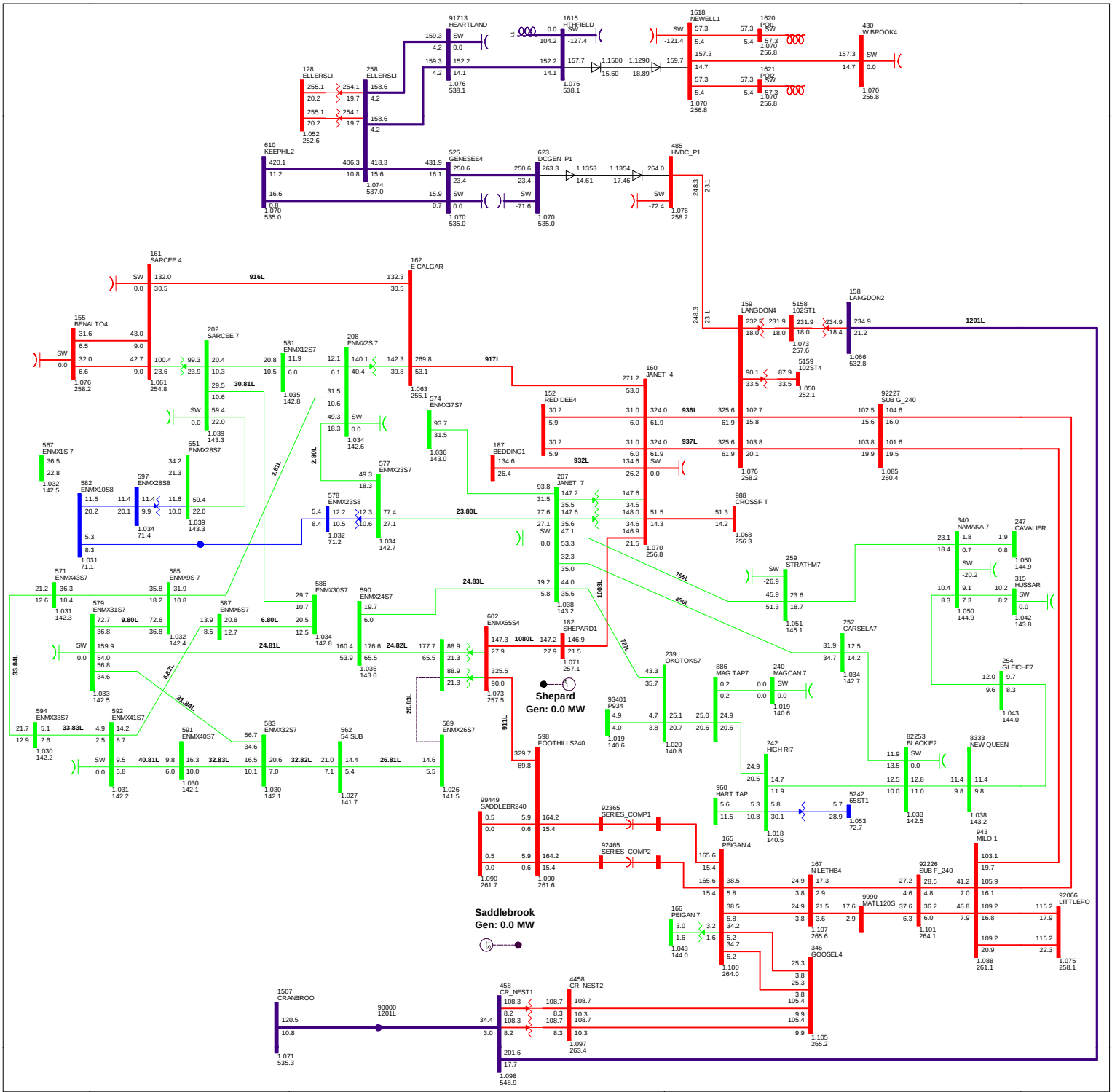
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-15: OPEN 26.81L 138 KV LINE (ENMAX 26 TO ENMAX 54)
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

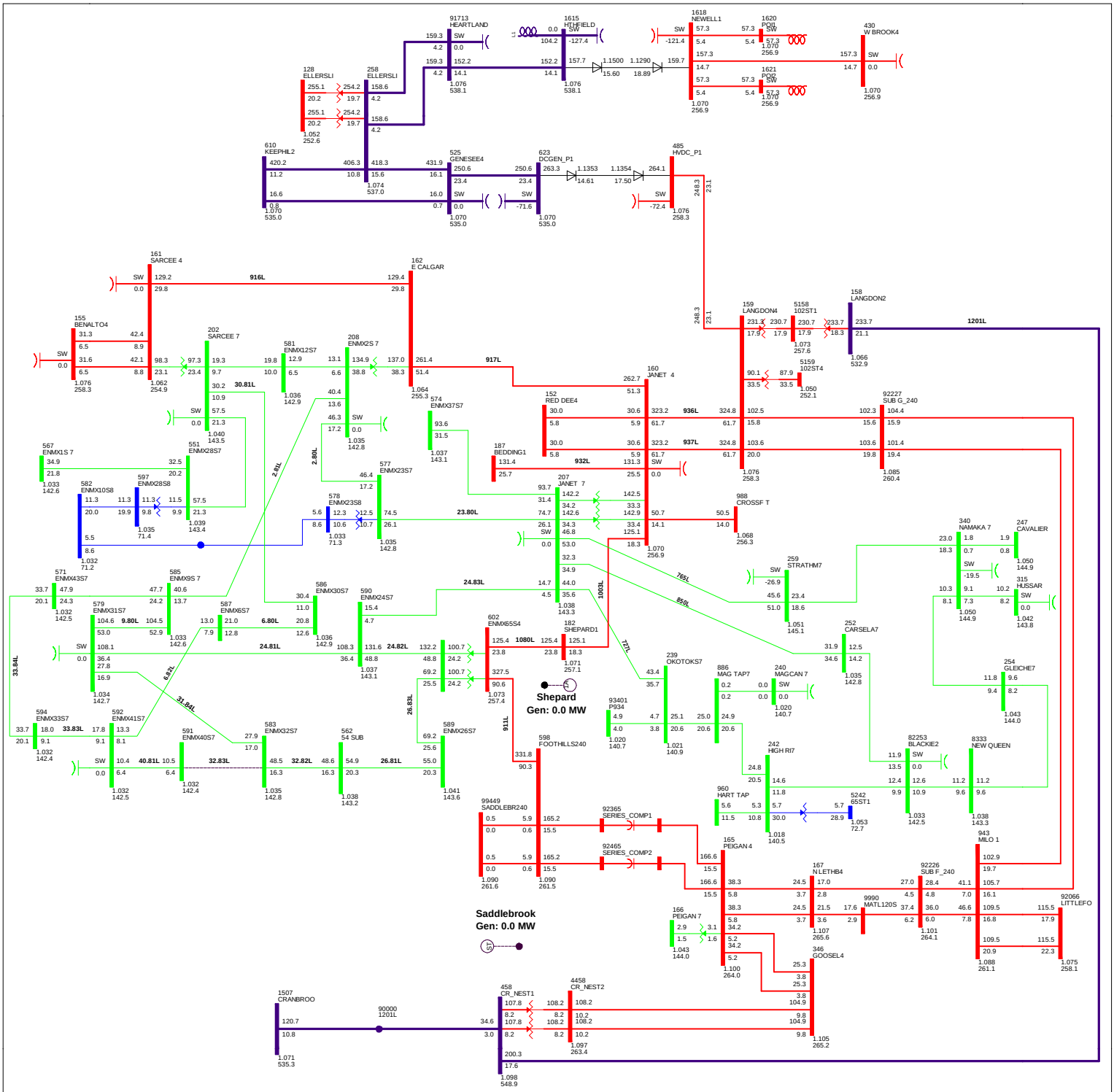
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-16: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

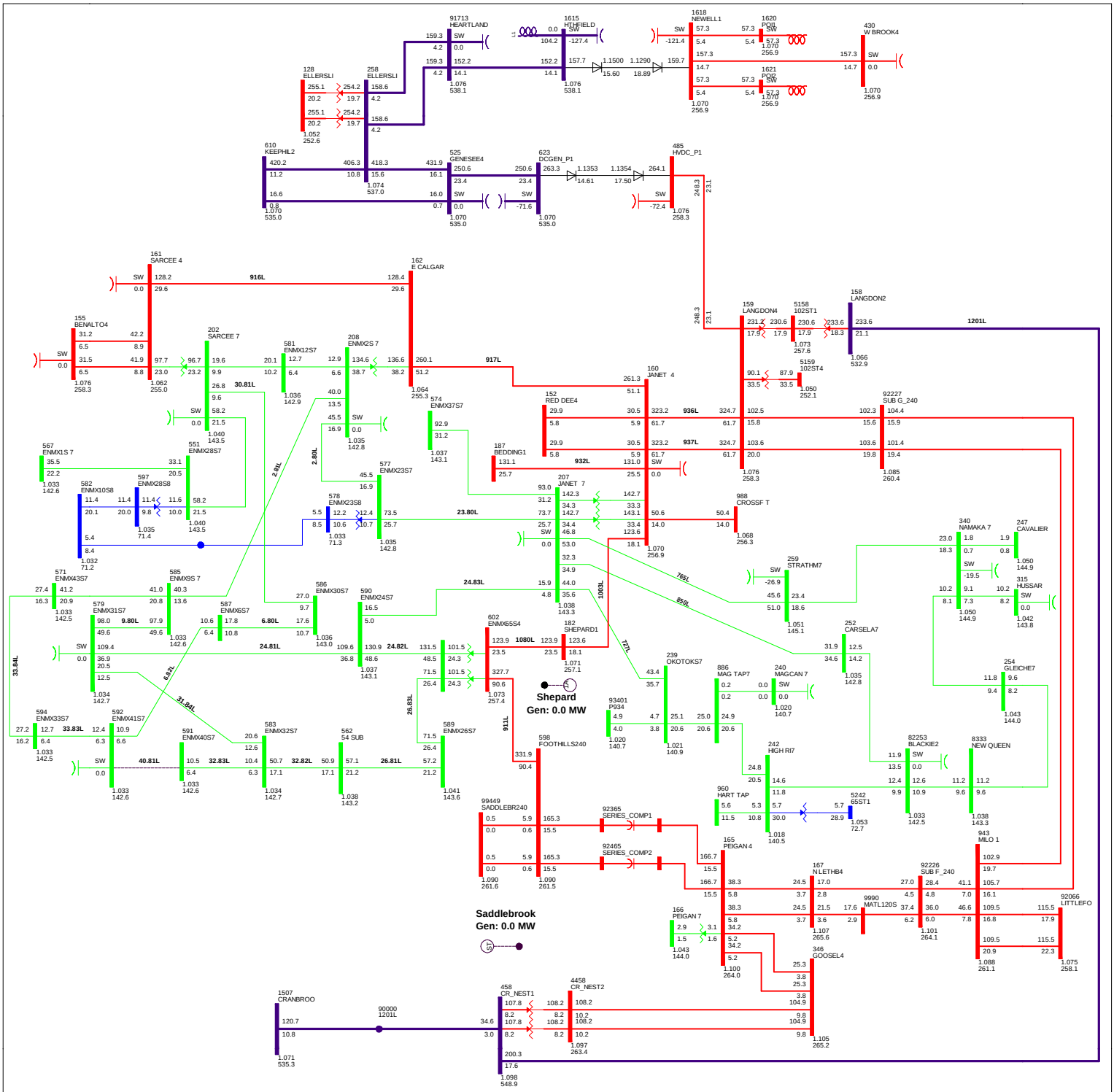
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.8 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-17: OPEN 32.83L 138 KV LINE (ENMAX 32 TO ENMAX 40)
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

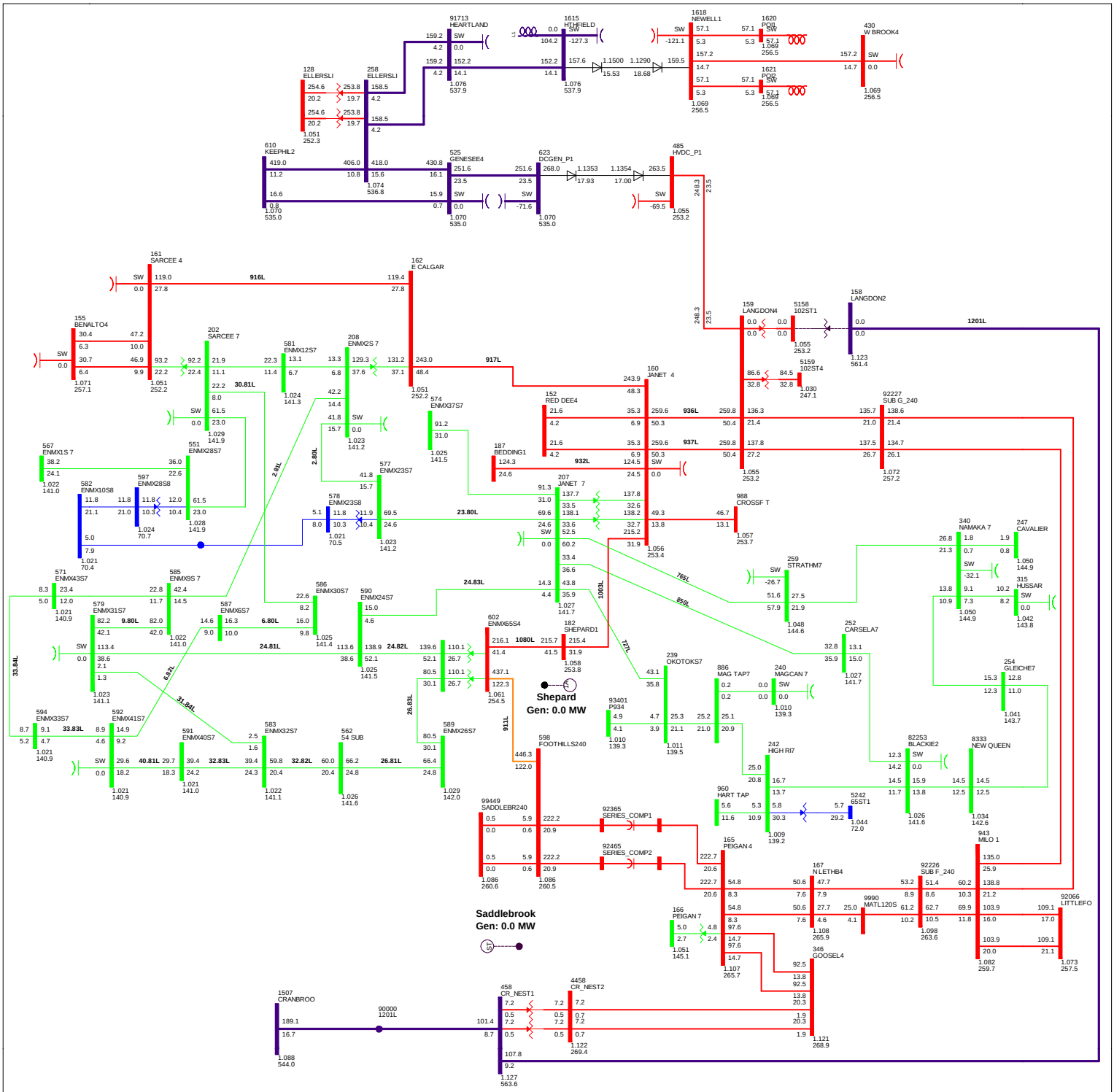
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-18: OPEN 40.81L 138 KV LINE (ENMAX 40 TO ENMAX 41)
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:24



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

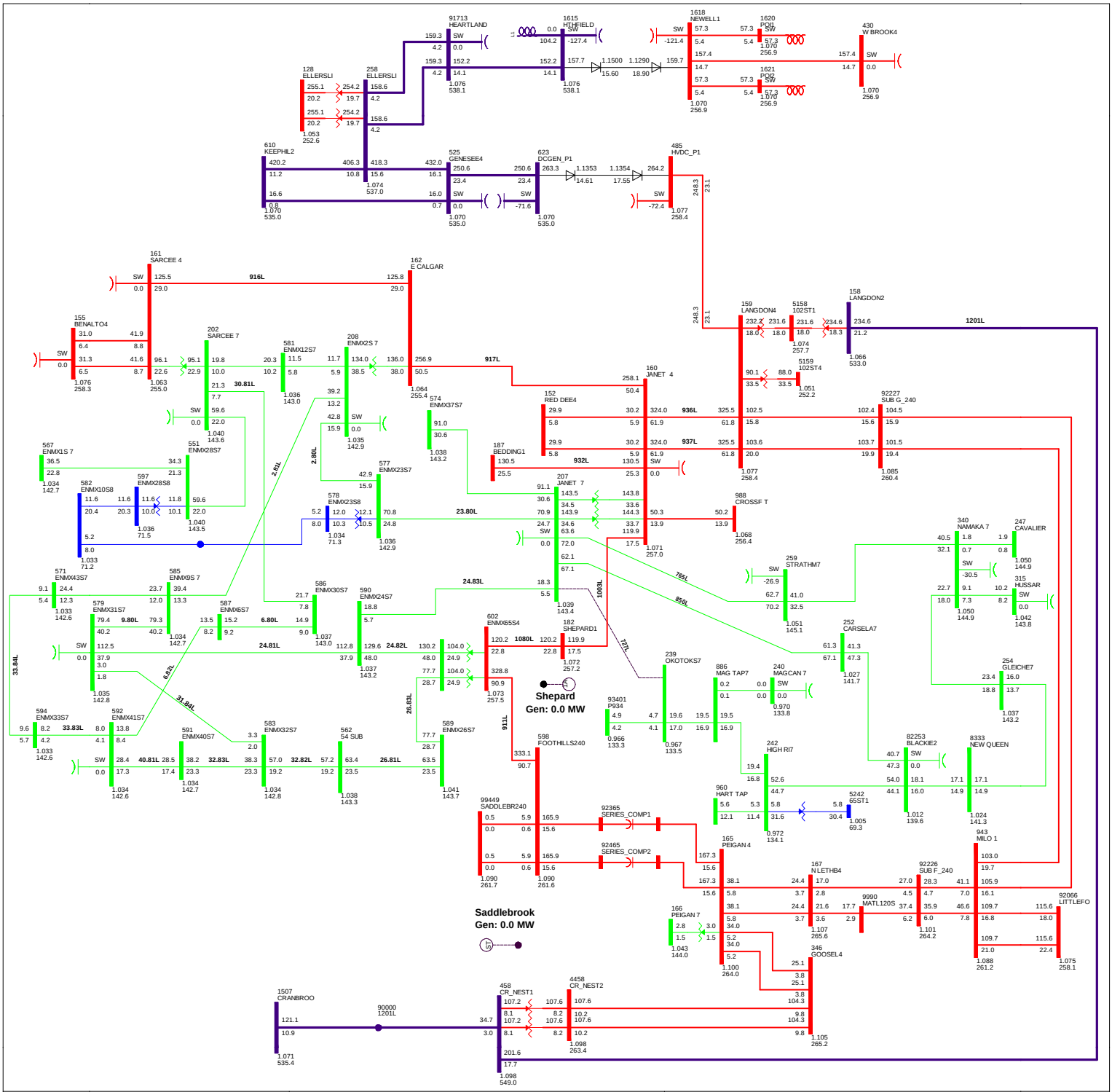
BCH Import: 7.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-19: OPEN 500/240 KV TRANSFORMER (LANGDON 102S)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

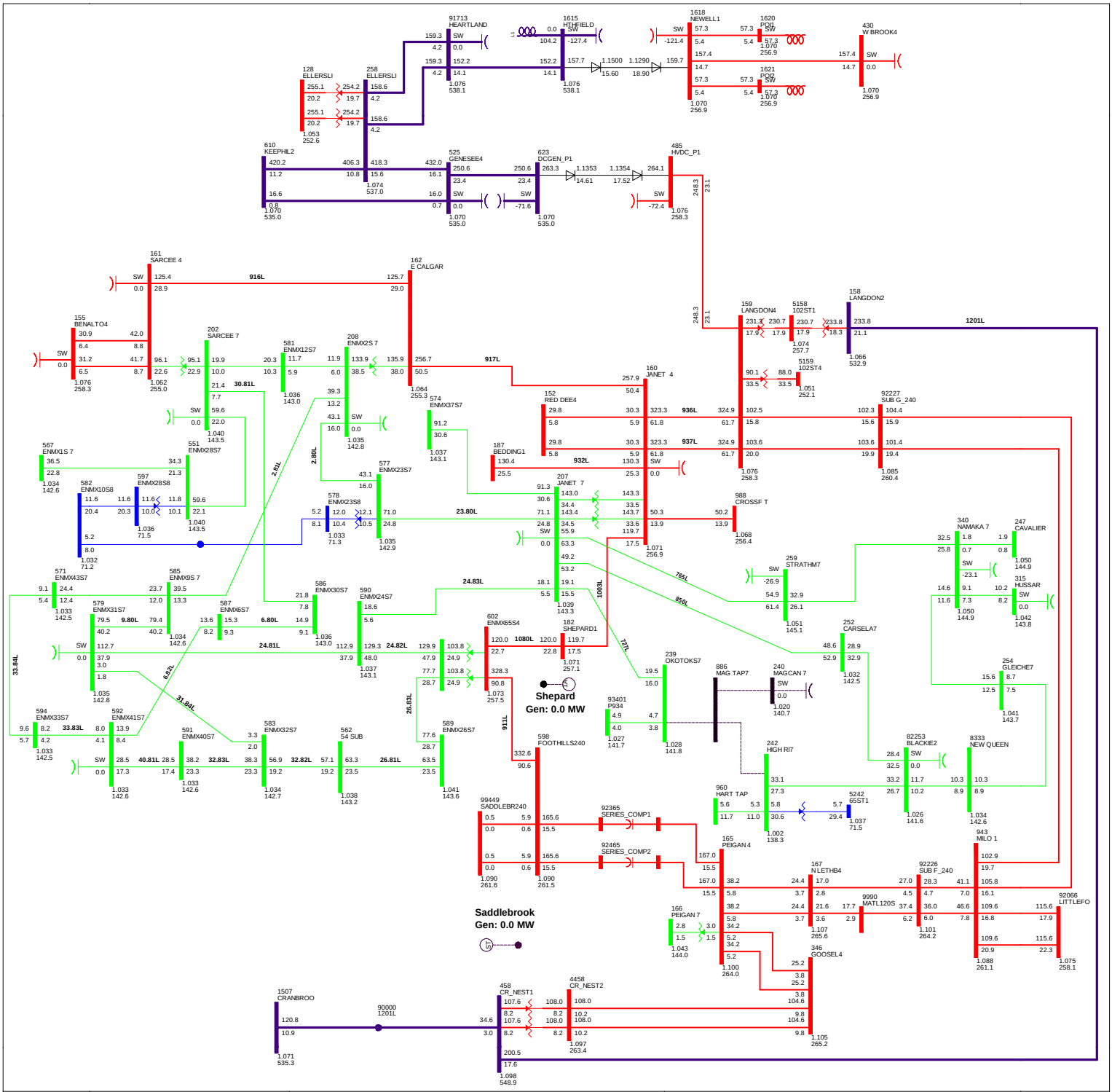
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.0 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-20: OPEN 727L 138 KV LINE (JANET 74S TO OKOTOKS 67
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

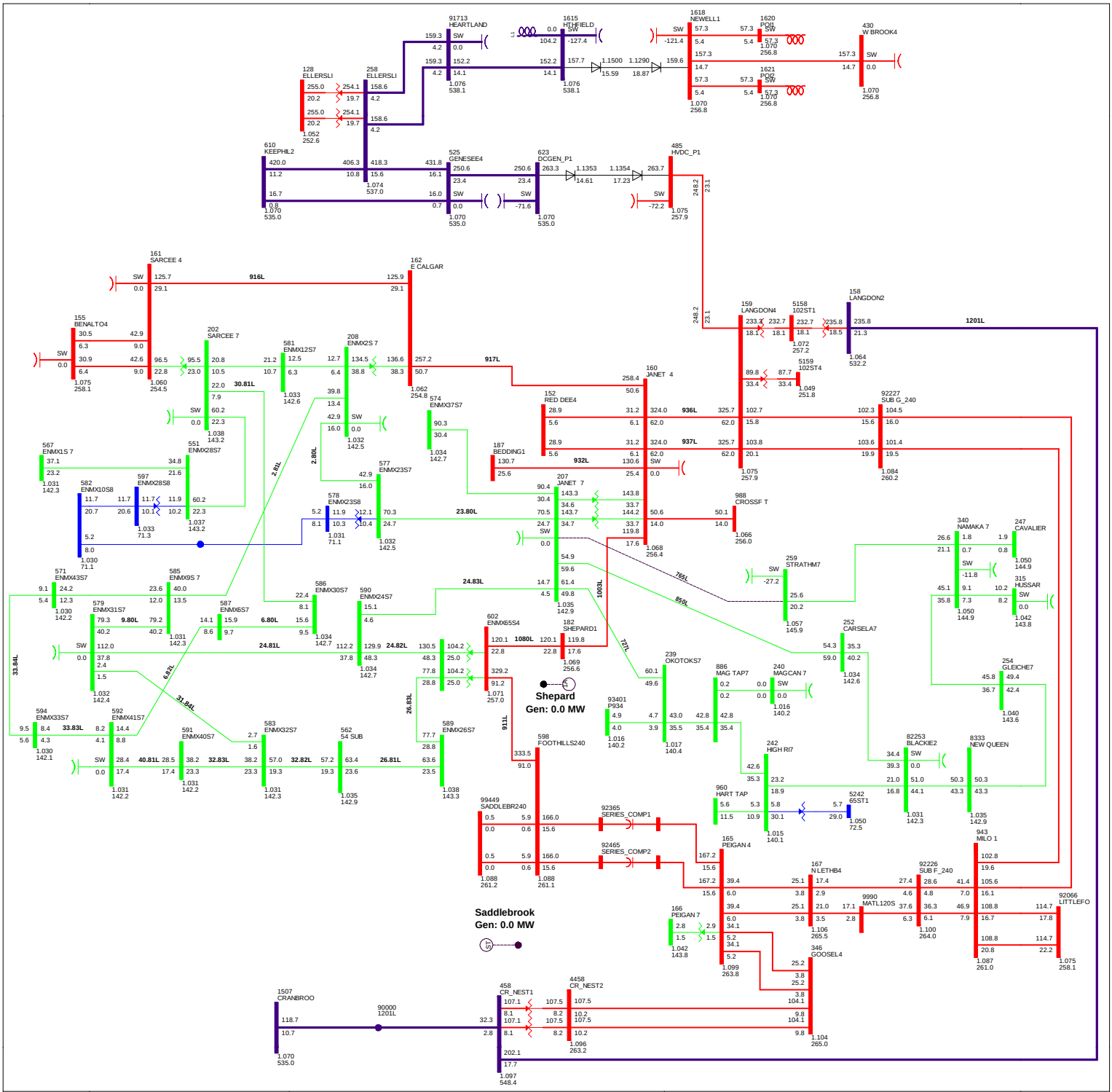
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.1 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-21: OPEN 727L 138 KV LINE (OKOTOKS 678SS TO MAGCAN
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

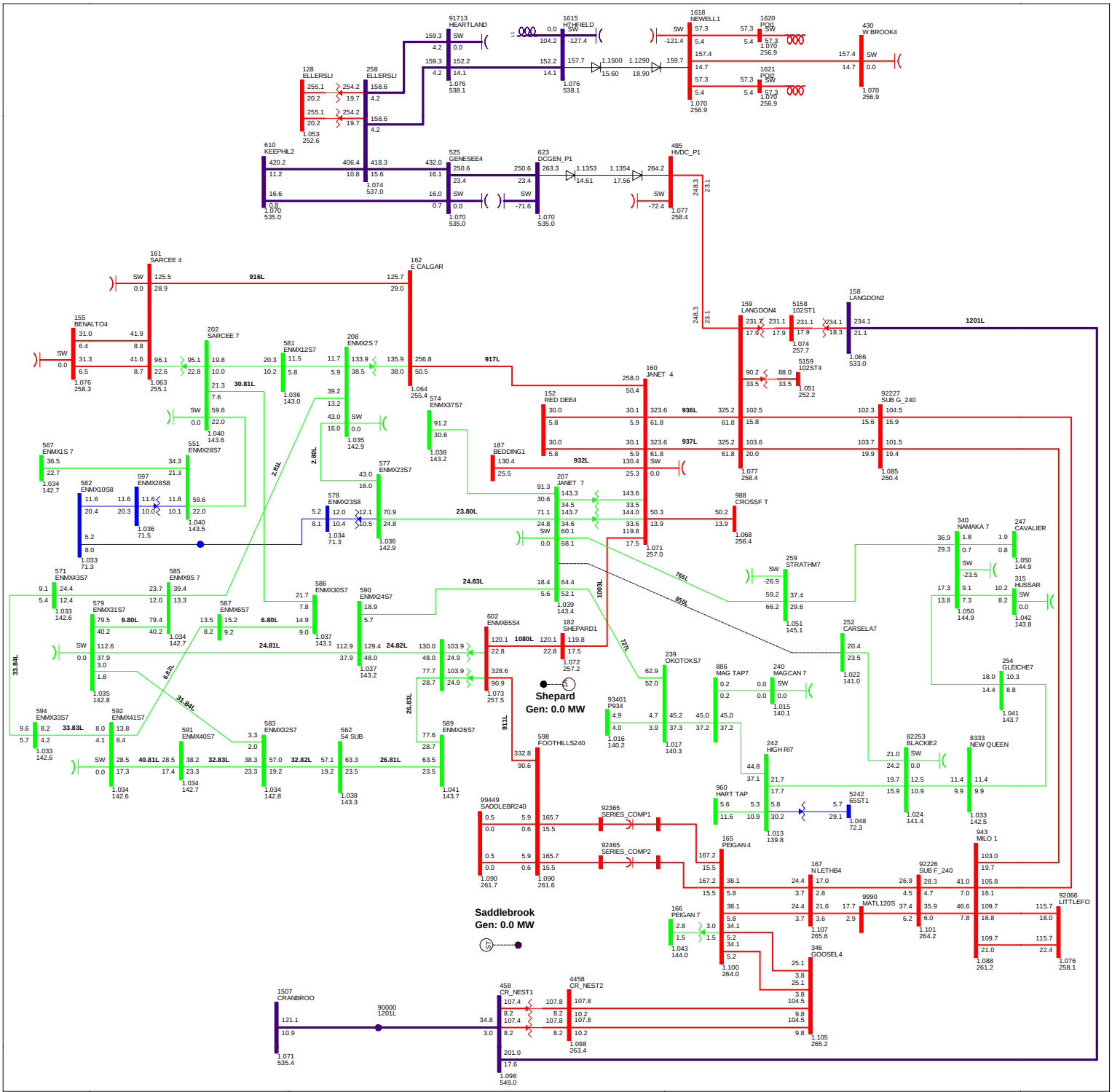
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-22: OPEN 765L 138 KV LINE (JANET 74S TO STRATHMORE
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

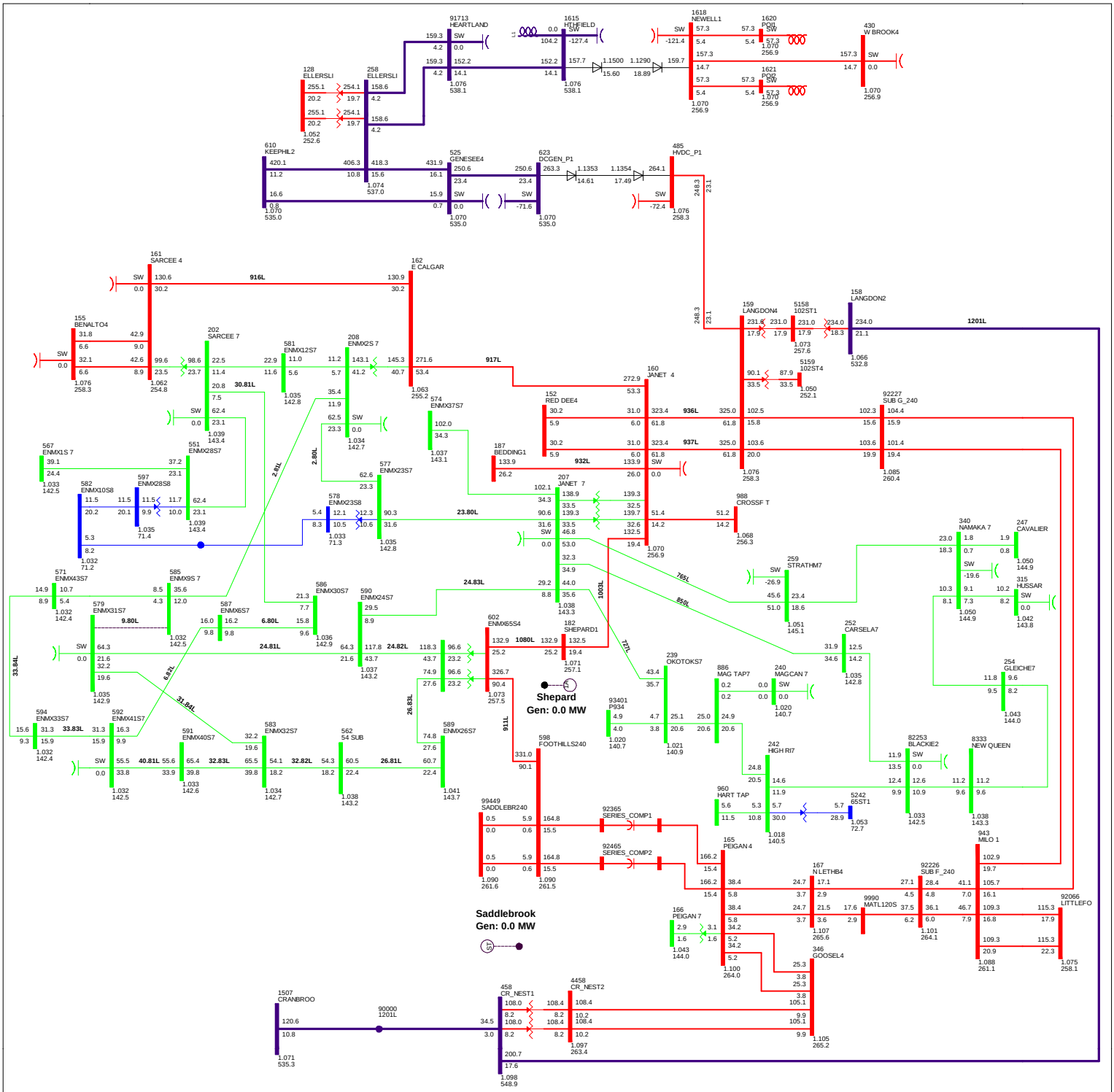
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.9 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-23: OPEN 850L 138 KV LINE (JANET 74S TO CARSELAND 2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

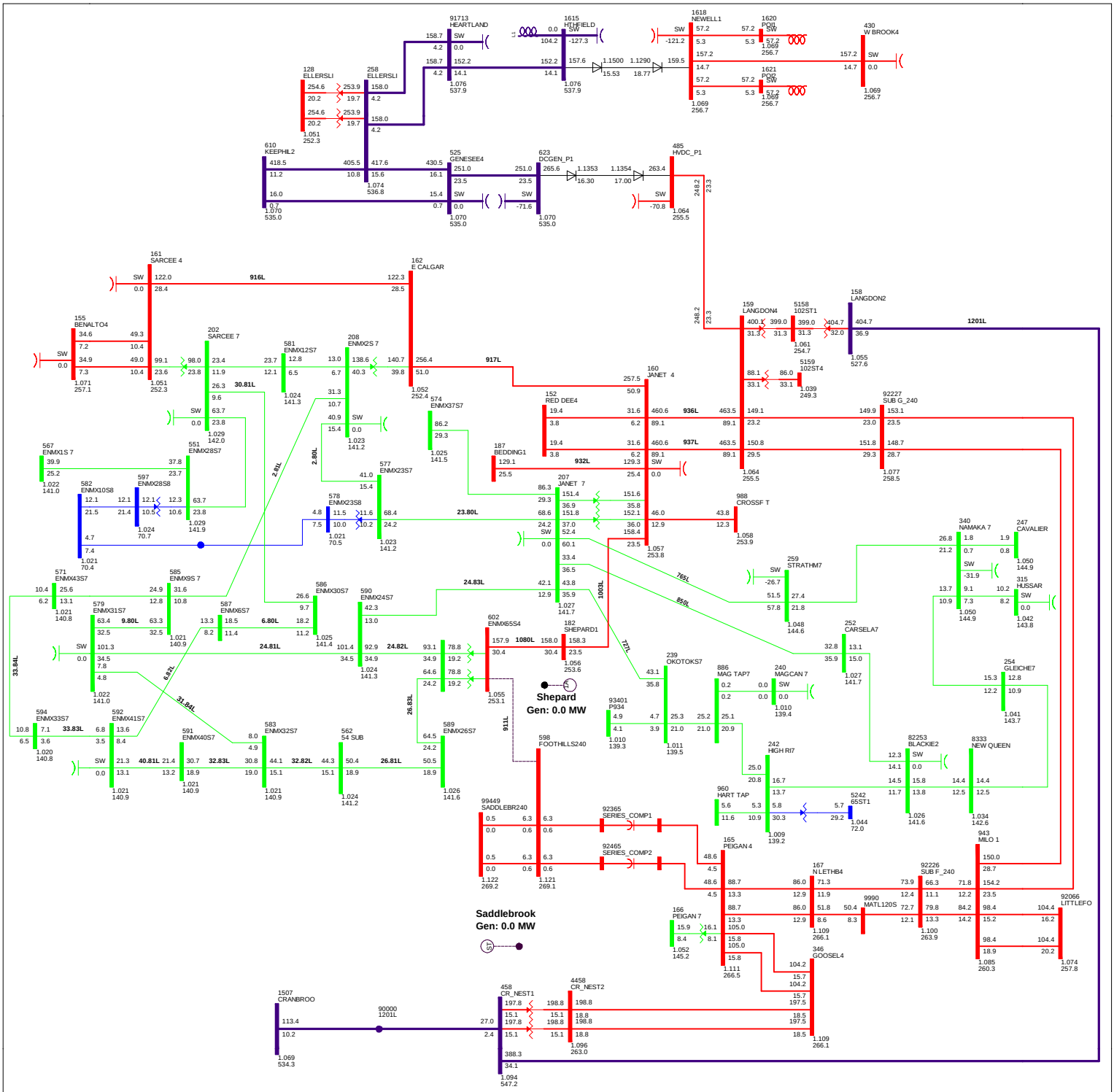
BCH Import: -0.6 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-24: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

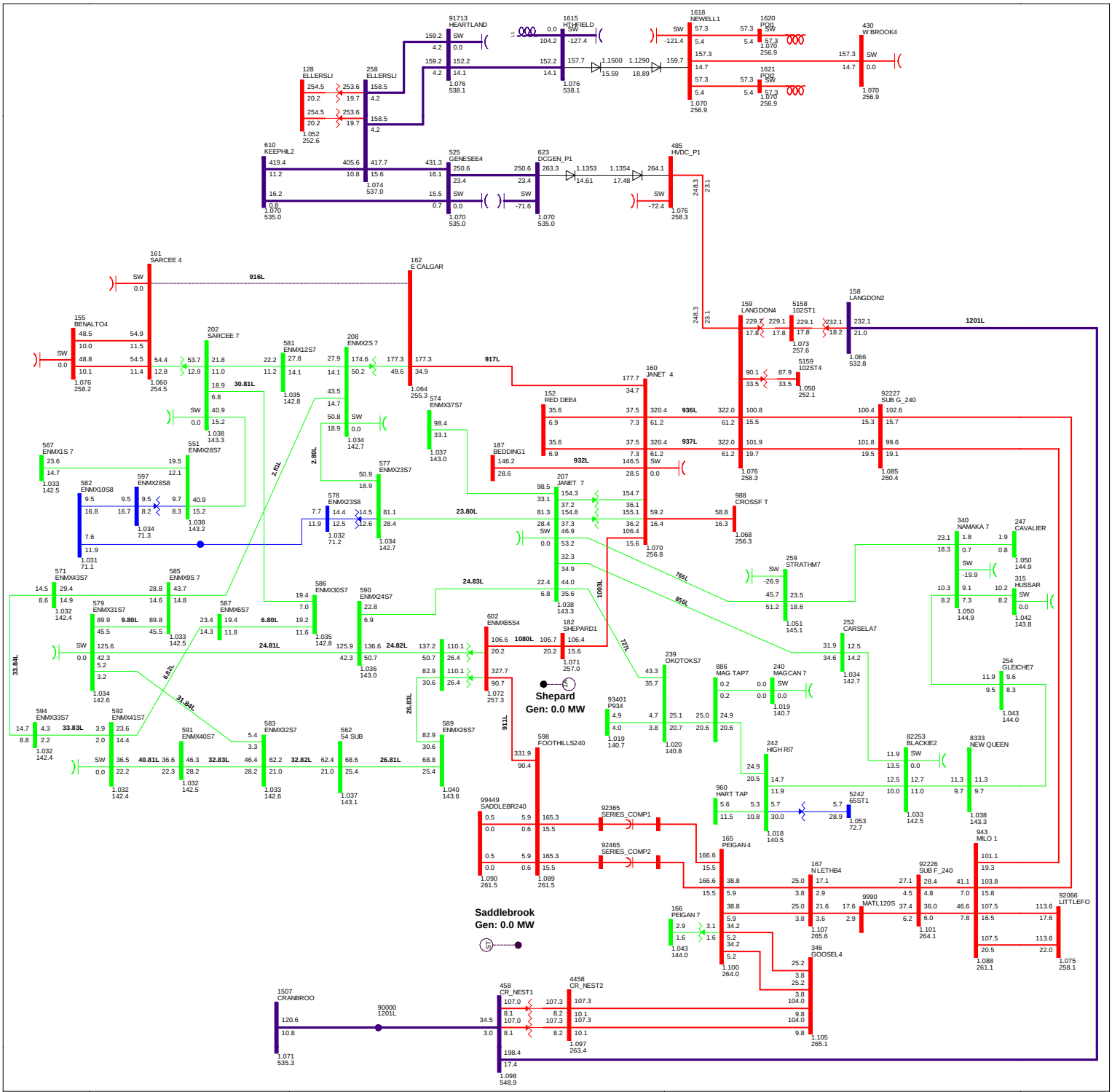
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 6.5 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-25: OPEN 911L 240 KV LINE (FOOTHILLS 237S TO ENMAX
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

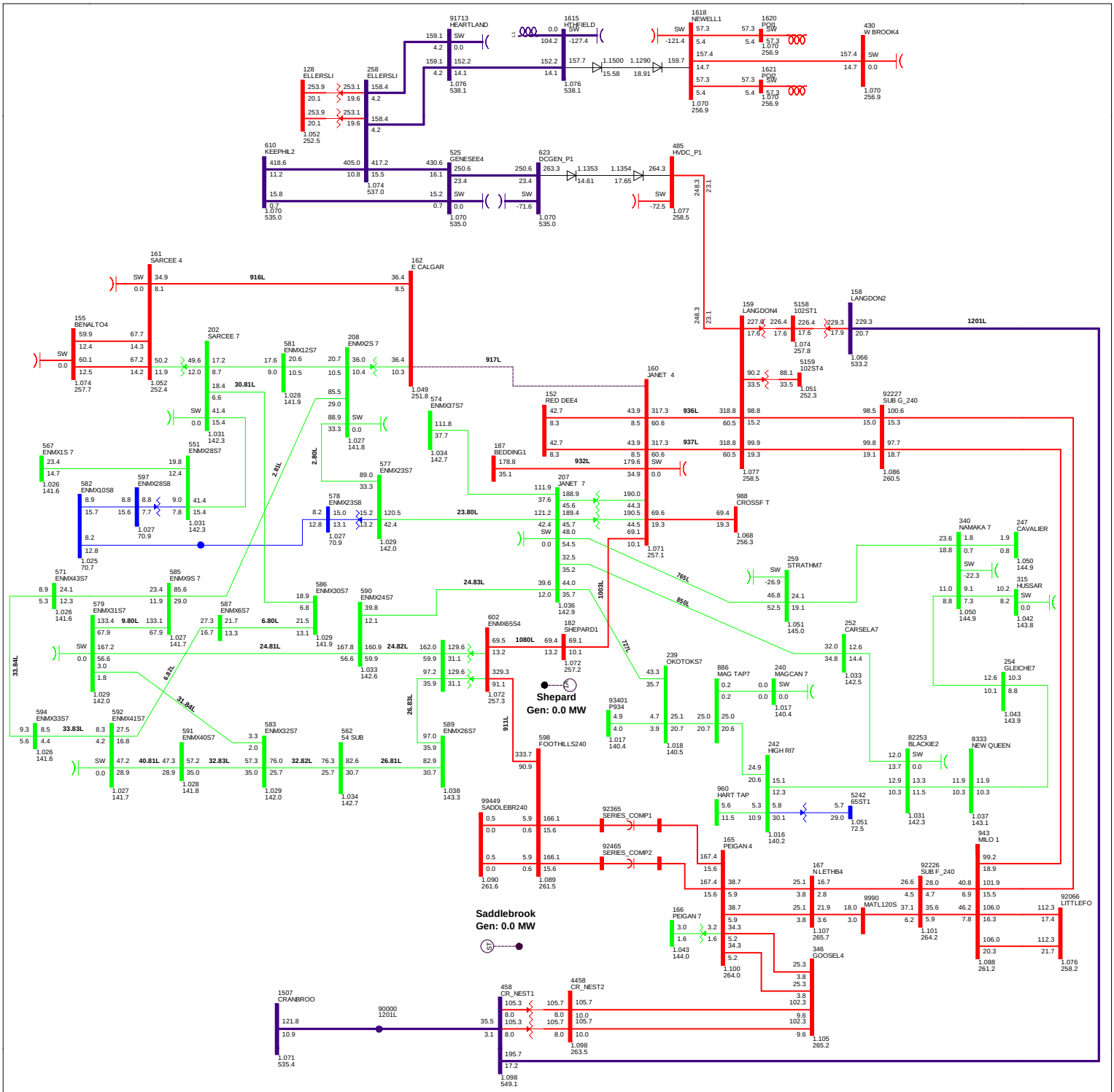
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-26: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

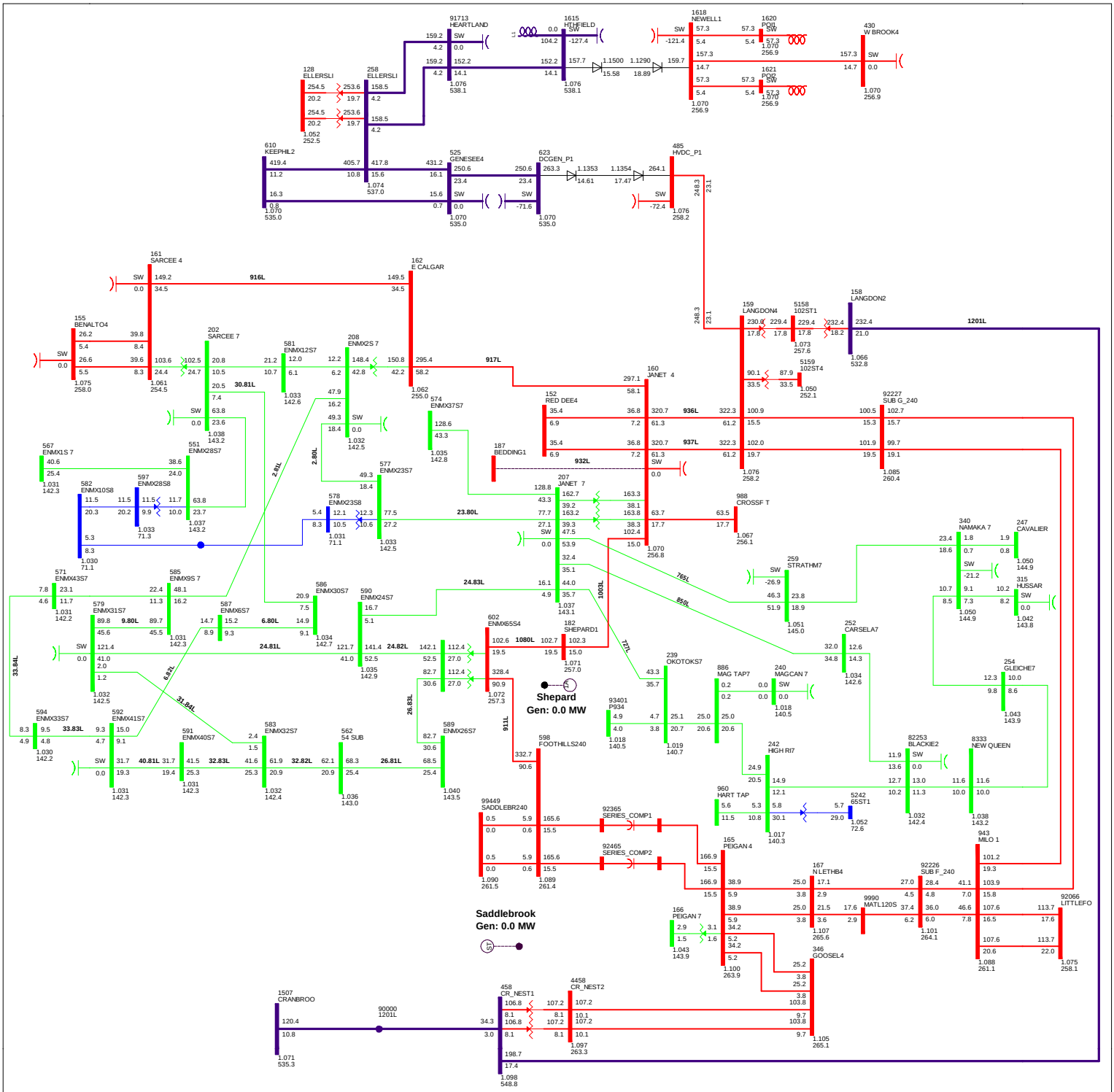
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.4 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-27: OPEN 917L 240 KV LINE (JANET 74S TO EAST CALGA
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

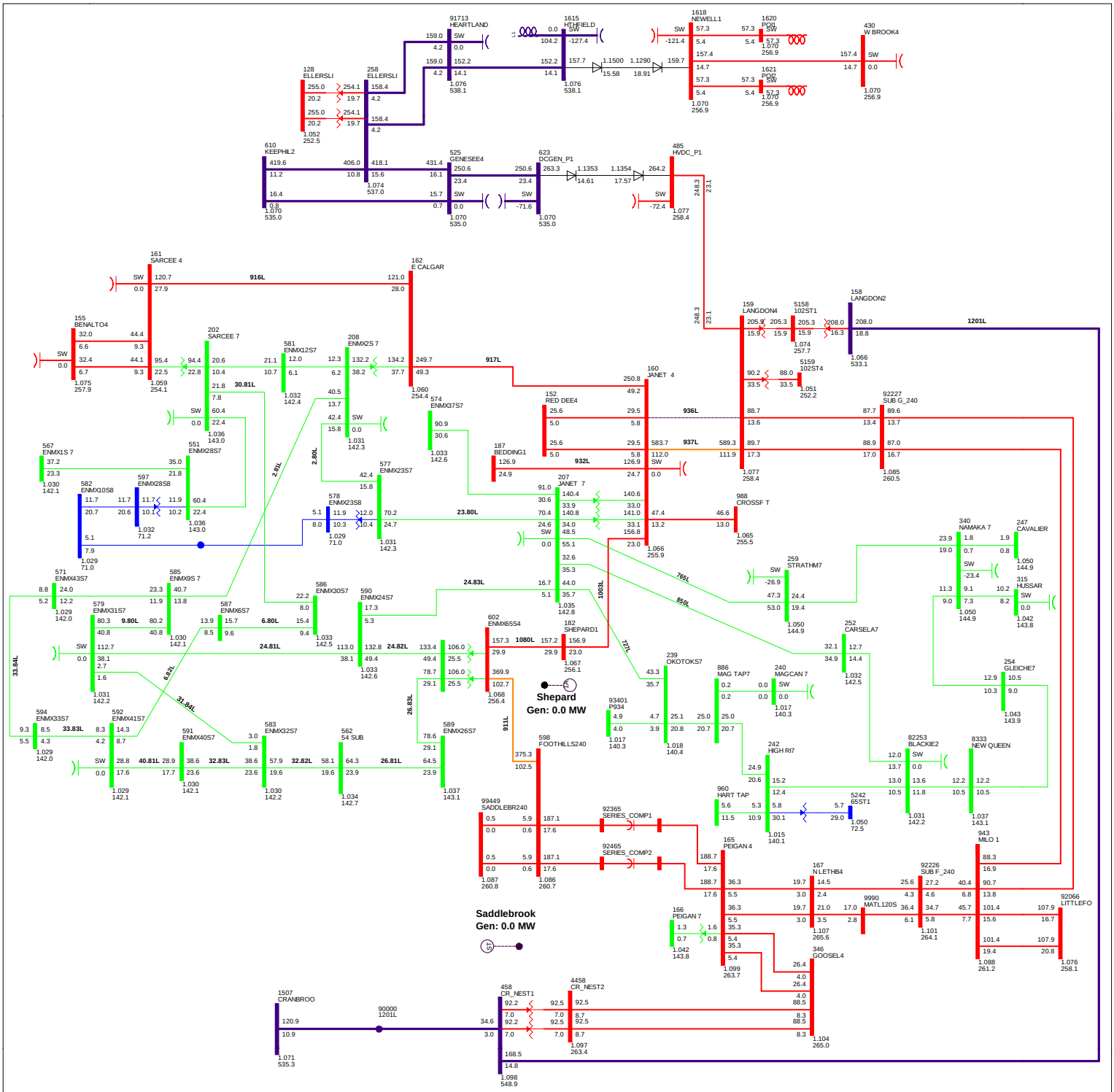
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 0.3 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-28: OPEN 932L 240 KV LINE (JANET 74S TO BEDDINGTON
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

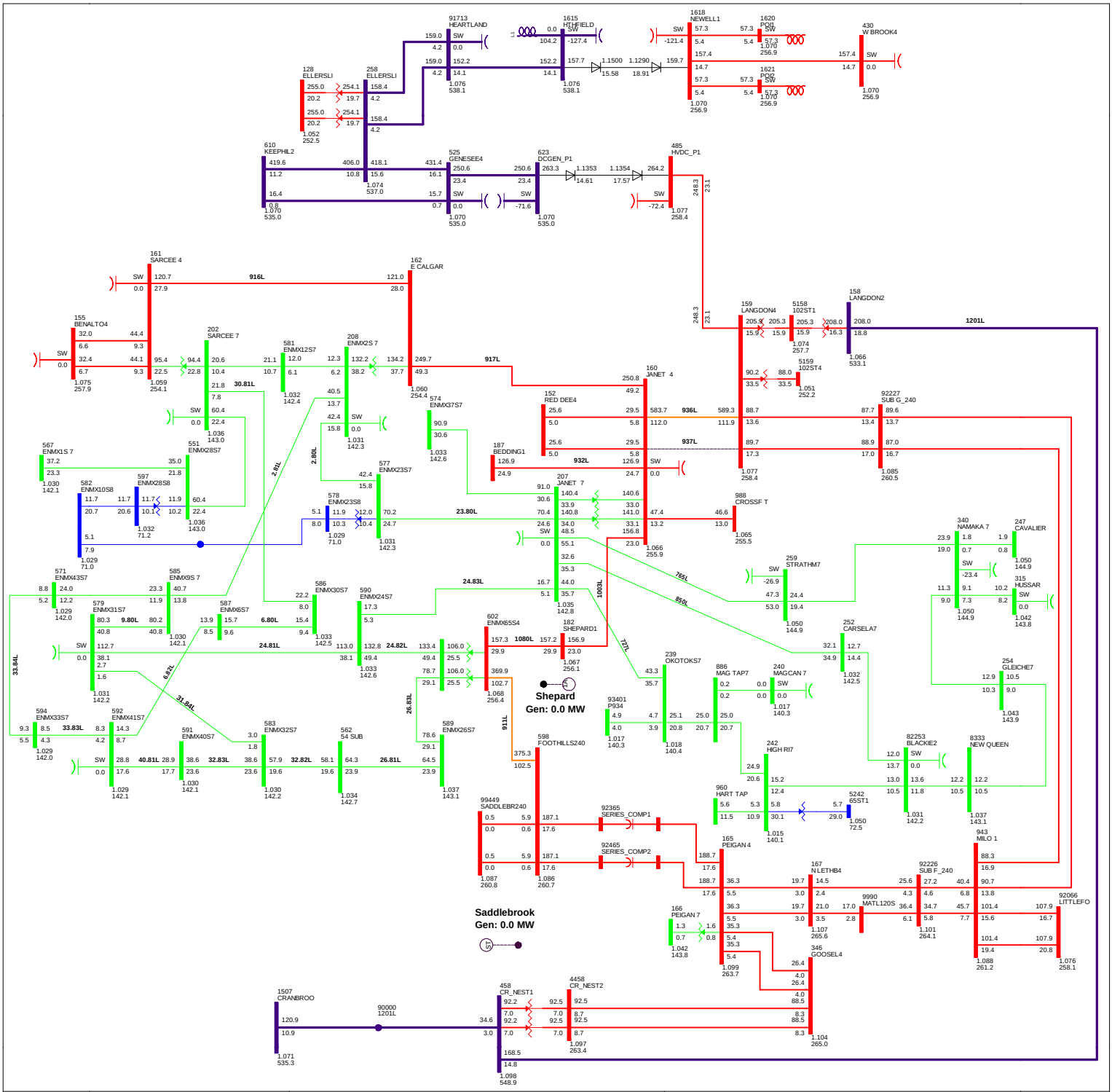
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-29: OPEN 936L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

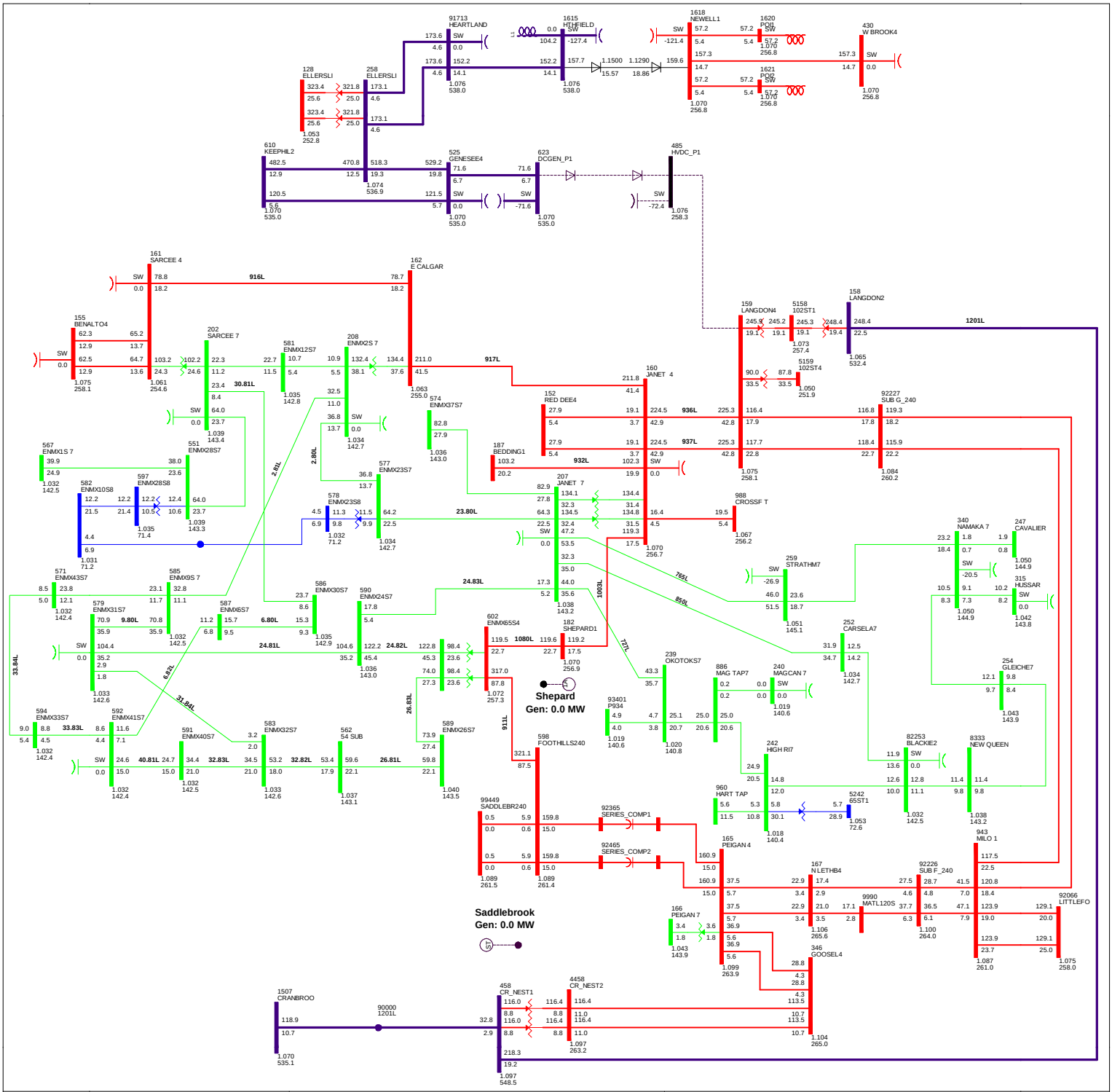
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.7 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-30: OPEN 937L 240 KV LINE (LANGDON 102S TO JANET 7
2014_NEED_HVDC_SC6

FRI, JUN 08 2012 16:25



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -2.2 MW

2012LTO+HVDC EXISTING SYSTEM

FIG A-SC6-31: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2014_NEED_HVDC_SC6

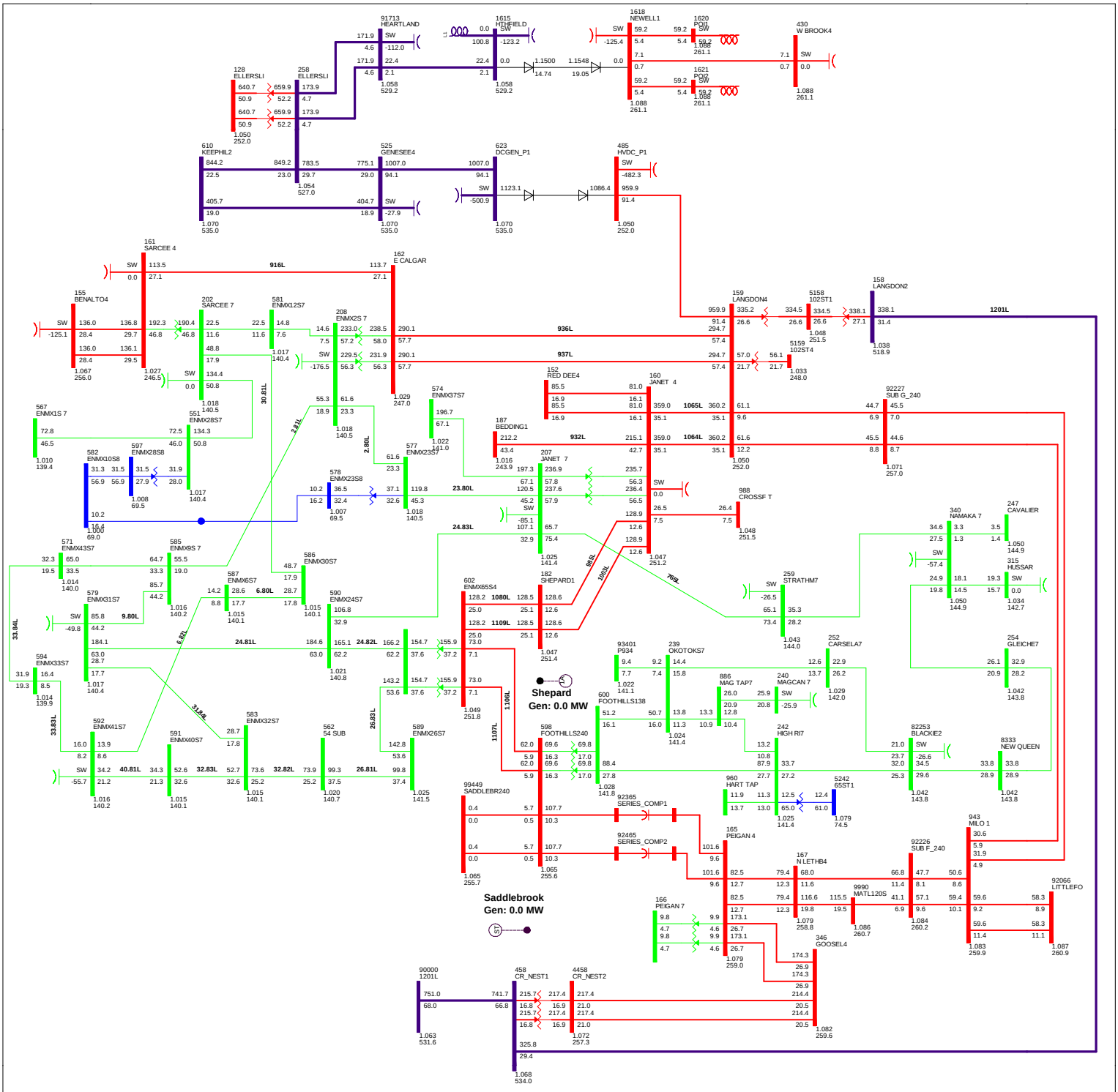
FRI, JUN 08 2012 16:25

C-2: FATD-East Assessment

Table 2: FATD EAST Maximum Loading on Critical Lines with FATD+HVDC under Category B

Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration	
				2014 Need	2019 HVDC FATD East
				√ indicates loading below 80% N/A indicates the circuit does not exist	
B-SC1A-1	BASE CASE	240 kV line (Langdon 102S to HVDC_P1)	SC1A	91% 960MVA	91% 960MVA
B-SC1A-2	Open 240 kV line (Langdon 102S to HVDC_P1)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	105% 89MVA	103% 86MVA
B-SC3-2	Open 240/138 kV transformer (East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC3	N/A	89% 357MVA
B-SC3-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S)	937L 240 kV line (Langdon 102S to East Calgary 5S)	SC3	N/A	98% 489MVA
B-SC3-4	Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC3	N/A	98% 489MVA
B-SC4-2	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	SC4	172% 854MVA	√
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	95% 268MVA	√
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	278% 711MVA	100% 263MVA
		24.83L 138 kV line (Janet 74S to ENMAX No. 24)	SC4	104% 325MVA	√
		240/138 kV transformer (ENMAX No. 65)	SC4	128% 512MVA	√
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	109% 279MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	120% 308MVA	√
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	104% 162MVA	√
		40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	92% 144MVA	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	181% 339MVA	86% 166MVA
		985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	97% 997MVA
B-SC4-3	Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	120% 229MVA	113% 218MVA
B-SC4-4	Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	82% 227MVA	86% 241MVA
B-SC4-5	Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	164% 1086MVA	√
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	89% 233MVA	82% 218MVA
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	100% 262MVA	98% 260MVA
B-SC4-6	Open 240/138 kV transformer (East Calgary 5S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	90% 377MVA	√
B-SC4-7	Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	84% 335MVA	√
B-SC4-8	Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	95% 381MVA	91% 365MVA
B-SC4-9	Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	120% 345MVA	124% 361MVA
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	145% 382MVA	134% 351MVA
		31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	√	92% 146MVA
B-SC4-10	Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	91% 145MVA	86% 137MVA
B-SC4-11	Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	103% 347MVA	√
B-SC4-12	Open 985L 240 kV line (Janet 74S to ENMAX No. 25)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	97% 997MVA

2019 Loading Violations
Scenario 1A



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

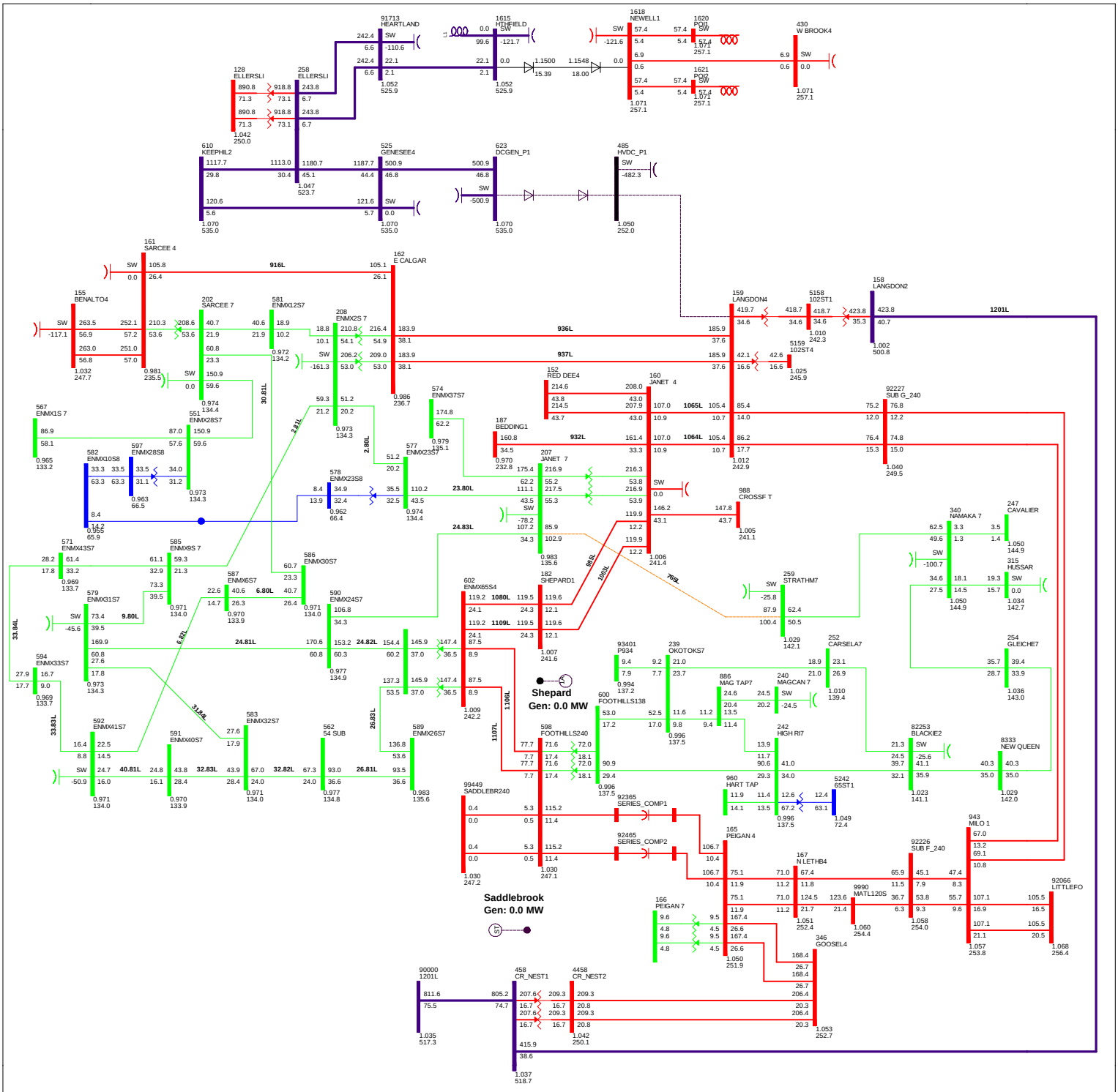
BCH Import: 781.2 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC1A-1: BASECASE

2019_FATD-E_HVDC_SC1A_SP

FRI, JUN 08 2012 16:30



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 851.0 MW

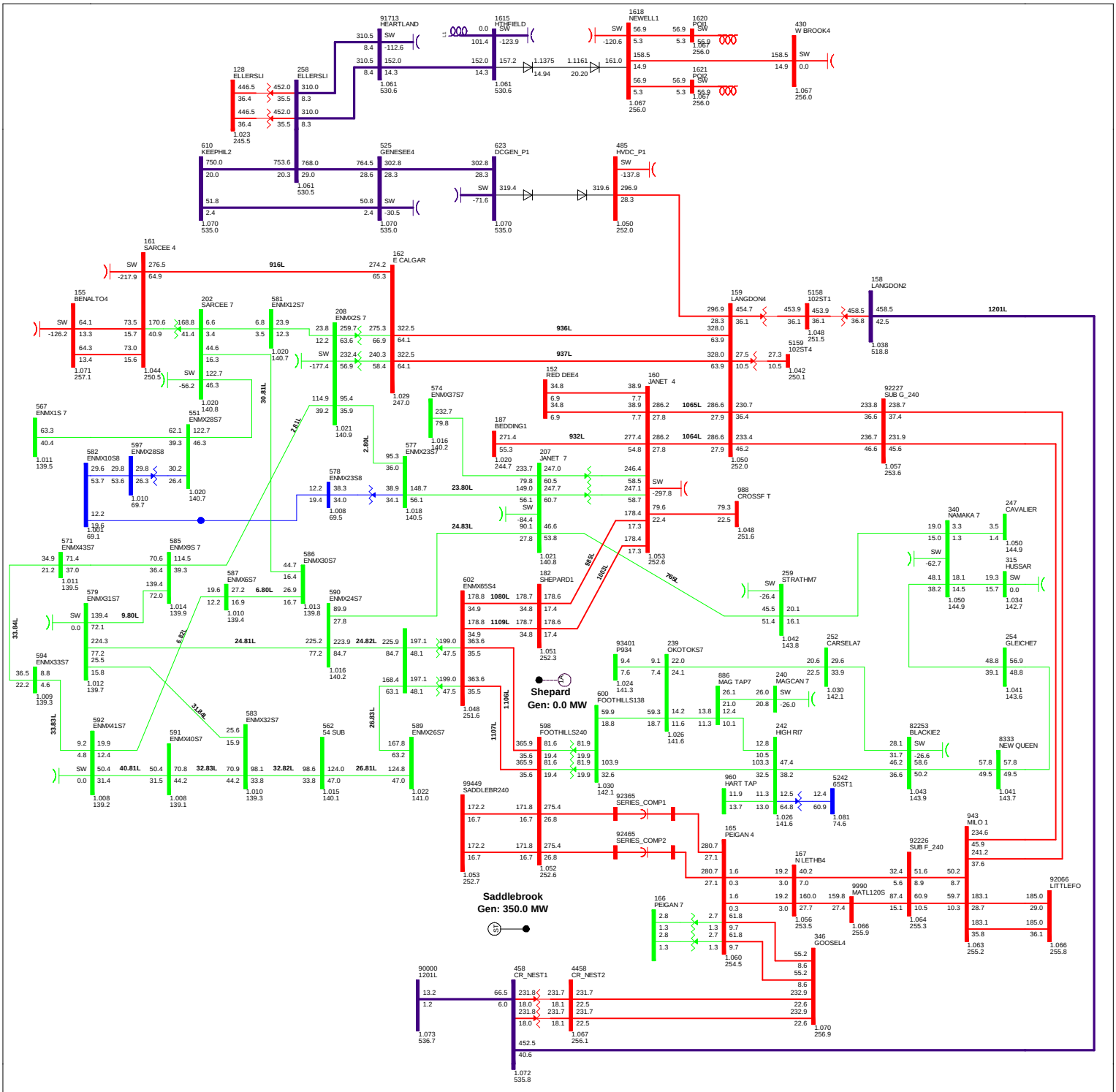
2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC1A-2: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2019_FATD-E_HVDC_SC1A_SP

FRI, JUN 08 2012 16:30

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

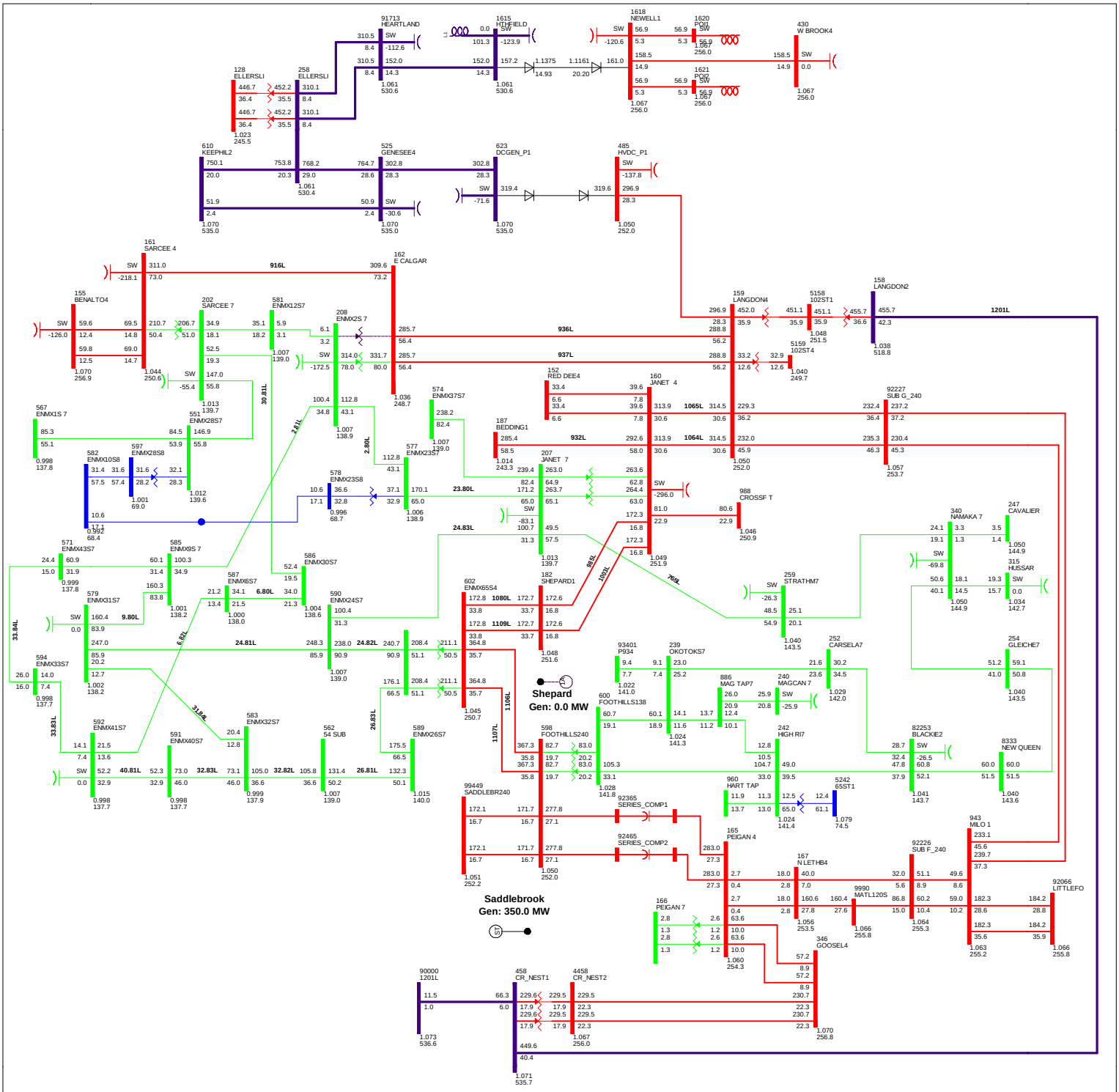
BCH Import: -7.7 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC3-1: BASECASE

2019_FATD-E_HVDC_SC3_SP

FRI, JUN 08 2012 16:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

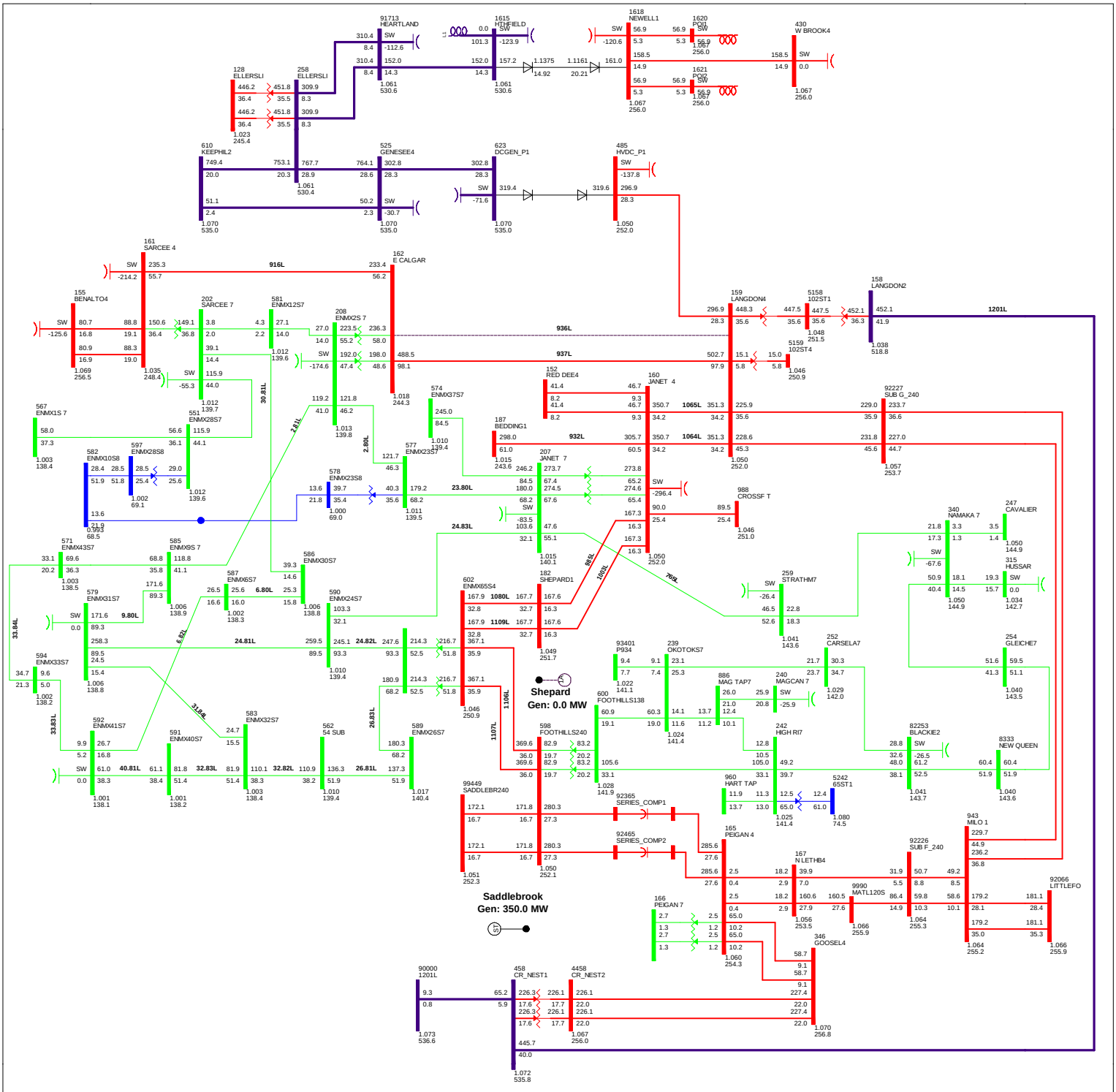
BCH Import: -5.0 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC3-2: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_FATD-E_HVDC_SC3_SP

FRI, JUN 08 2012 16:31



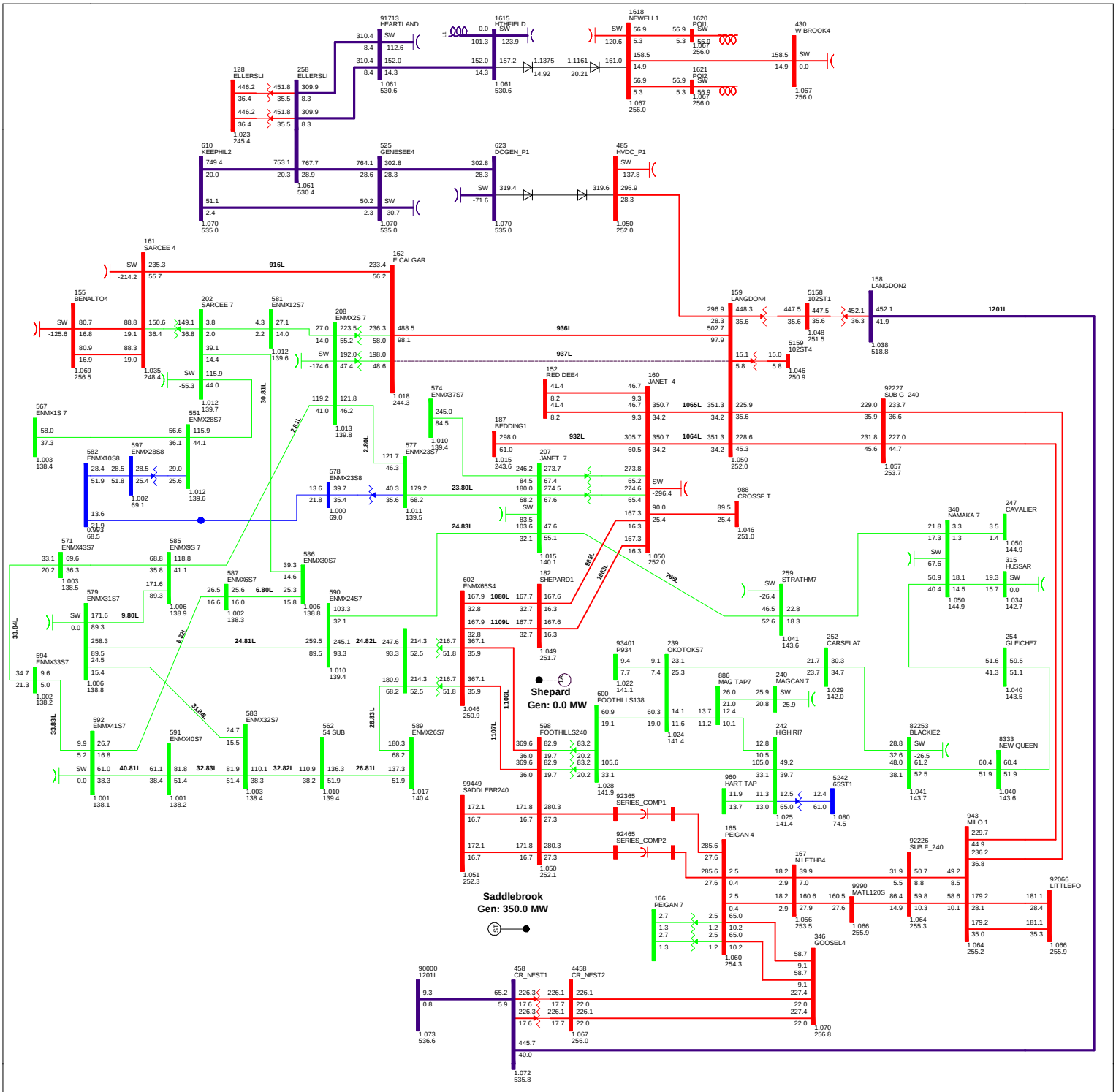
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -0.9 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC3-3: OPEN 936L 240 KV LINE (LANGDON 102S TO EAST CAL
2019_FATD-E_HVDC_SC3_SP

FRI, JUN 08 2012 16:31



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

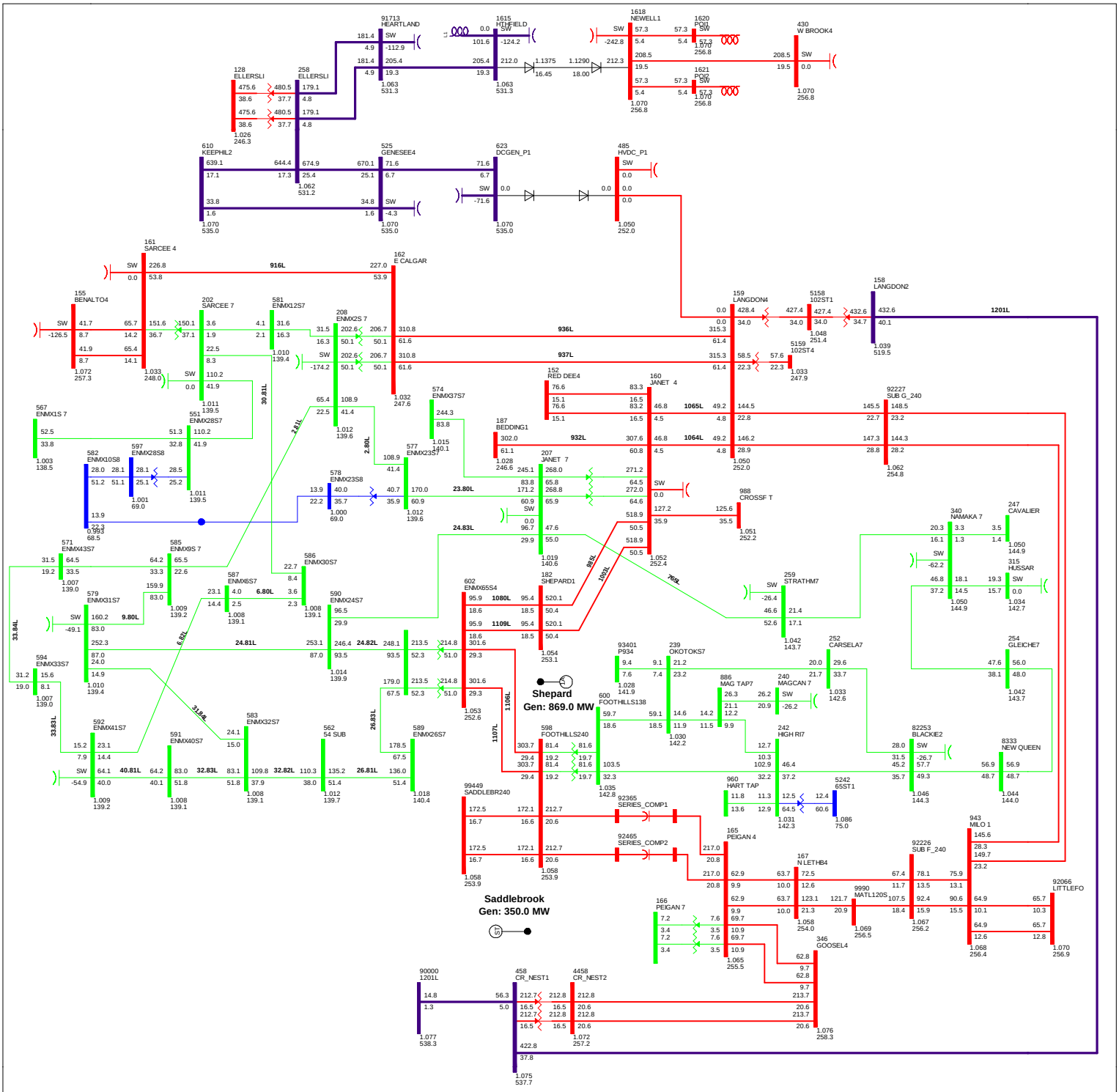
BCH Import: -0.9 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC3-4: OPEN 937L 240 KV LINE (LANGDON 102S TO EAST CAL
2019_FATD-E_HVDC_SC3_SP

FRI, JUN 08 2012 16:31

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

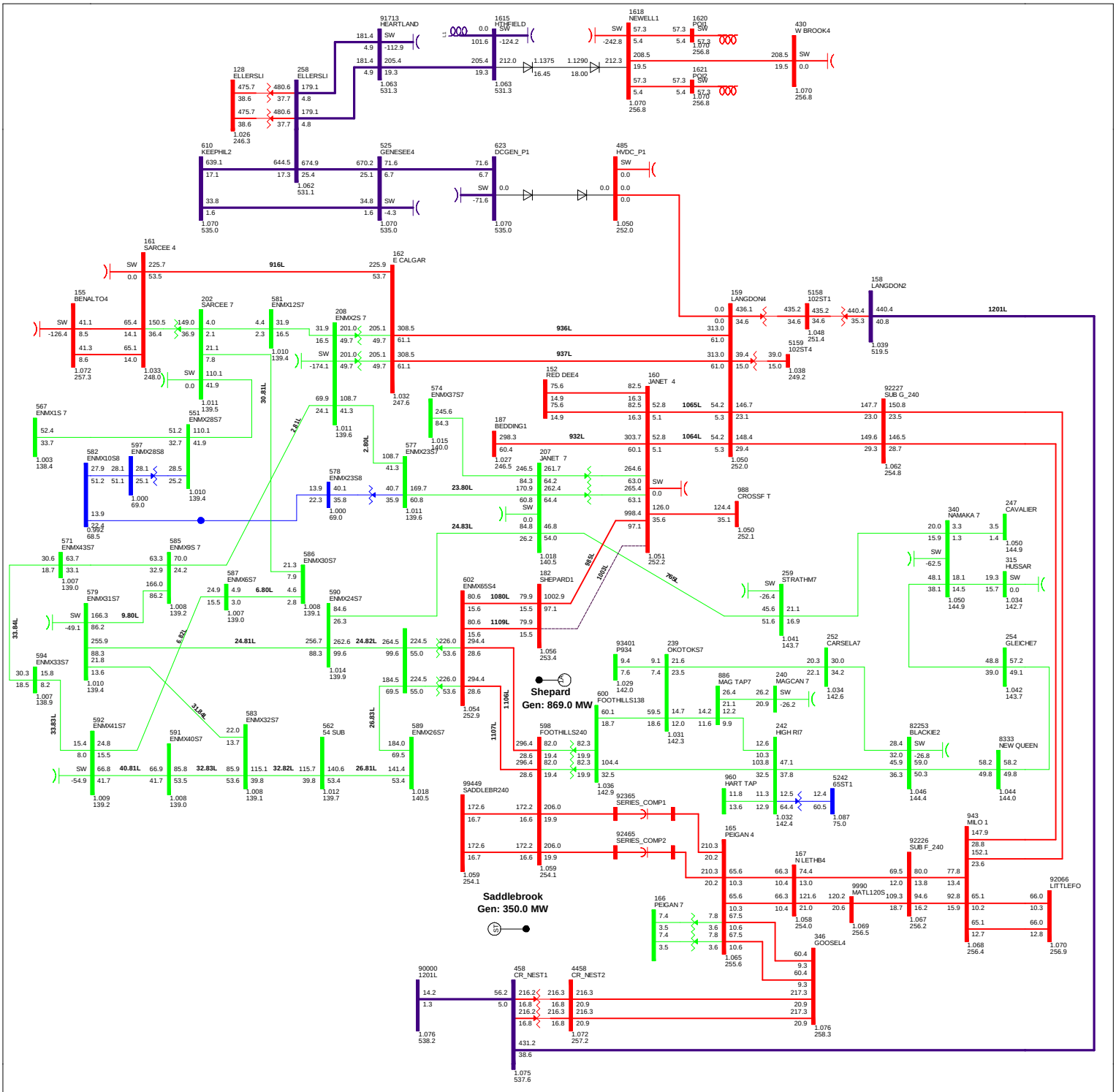
BCH Import: -0.1 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-1: BASECASE

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:32



Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

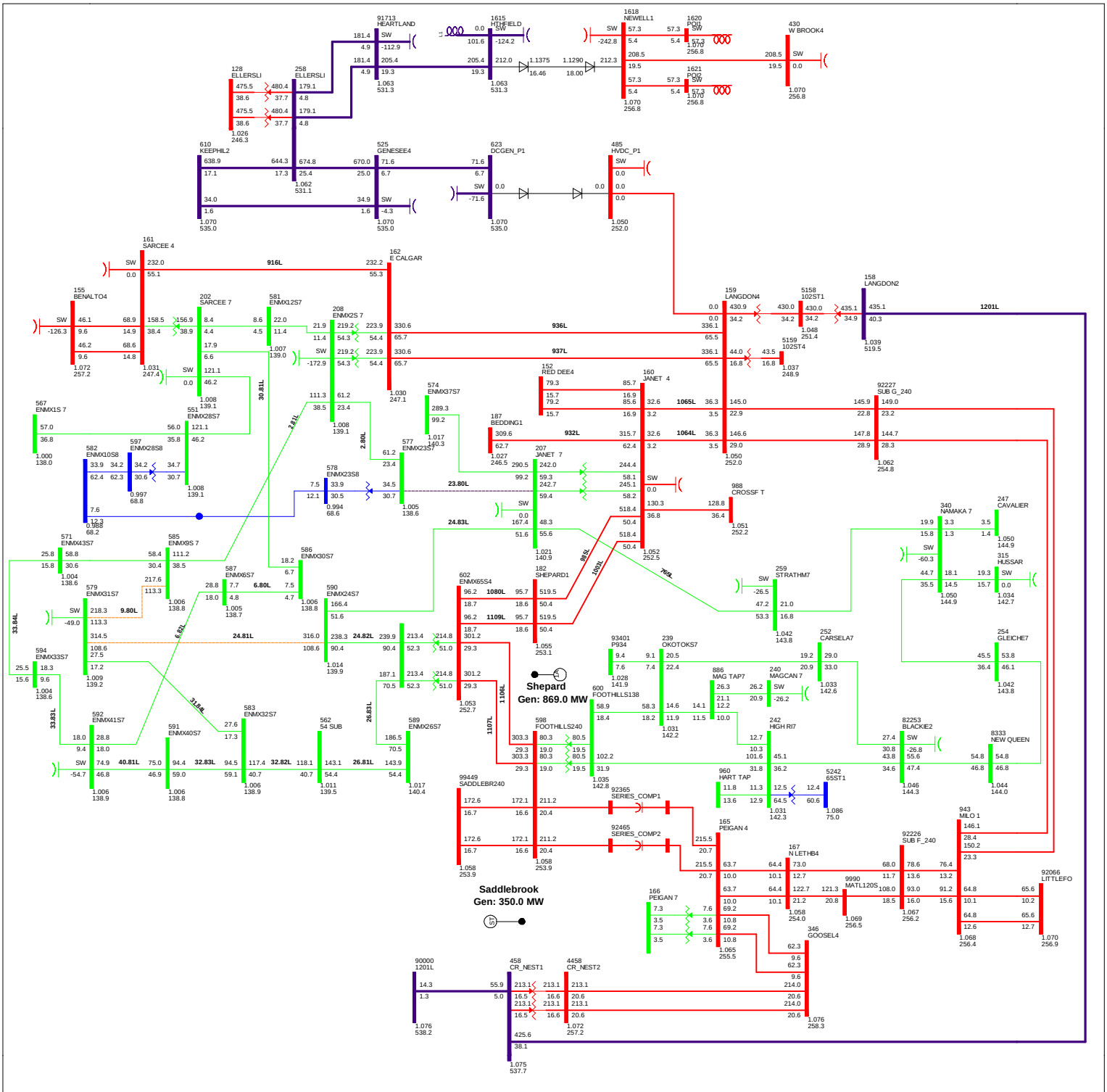
BCH Import: 1.3 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:32



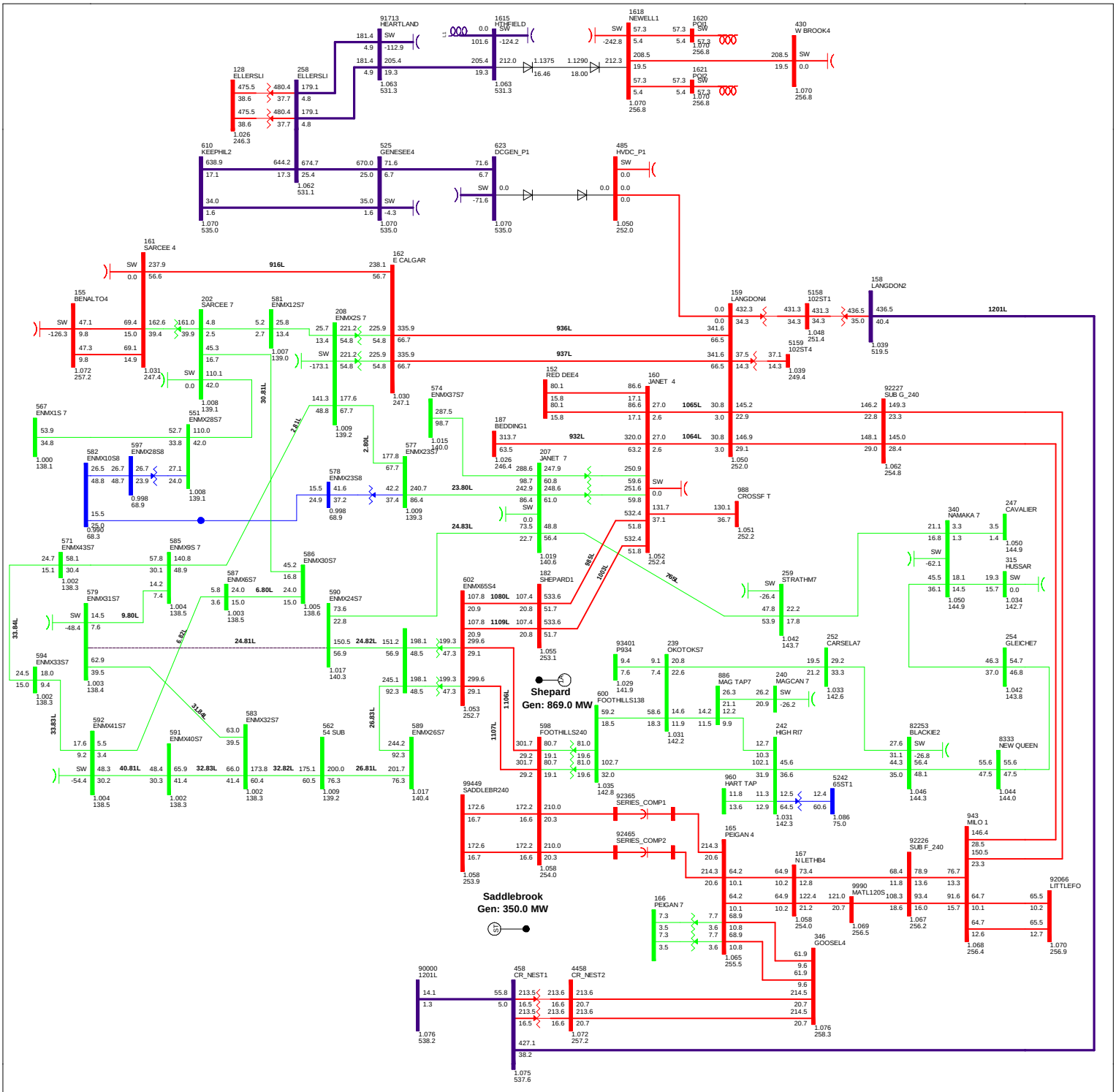
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

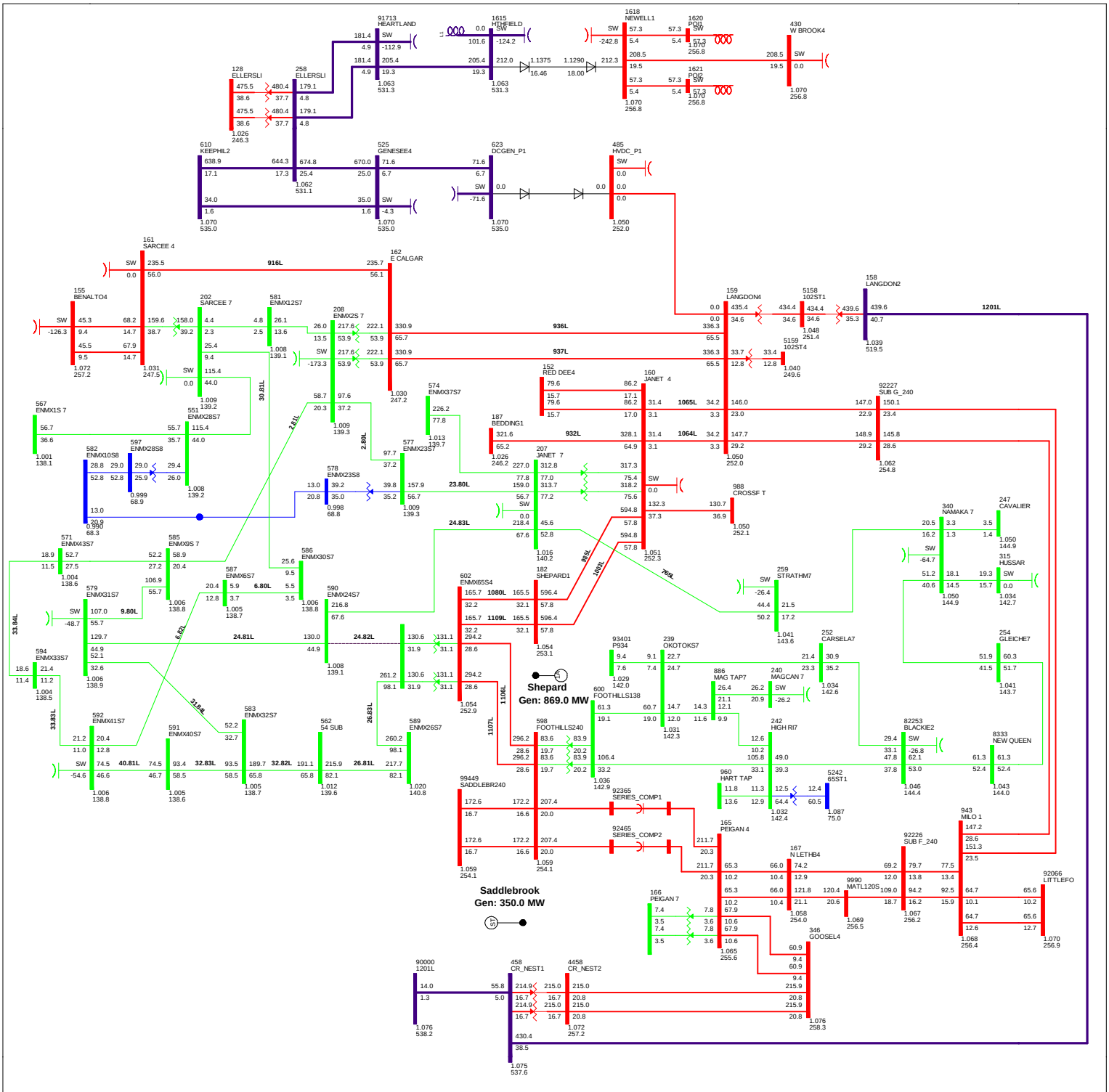
BCH Import: 2.7 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-3: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:32


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
91713 HEARTLAND
1615 HTHFIELD
1618 NEWELL1
1620 POI1
1621 POI2
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
610 KEEPHIL2
525 GENESEE4
623 DCGEN_P1
485 HVDC_P1
161 SARCEE 4
162 E CALGAR
155 BENALTO4
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
574 ENMX37S7
577 ENMX23S7
578 ENMX23S8
582 ENMX10S8
597 ENMX28S8
551 ENMX28S7
567 ENMX1S 7
571 ENMX43S7
585 ENMX9S 7
586 ENMX30S7
587 ENMX6S7
579 ENMX31S7
590 ENMX24S7
594 ENMX33S7
592 ENMX41S7
591 ENMX40S7
583 ENMX32S7
562 54 SUB
589 ENMX26S7
602 ENMX65S4
598 FOOTHILLS240
600 FOOTHILLS138
99449 SADDLEBR240
92365 SERIES_COMP1
92465 SERIES_COMP2
93401 P934
239 OKOTOKS7
886 MAG TAP7
240 MAGCAN 7
242 HIGH RI7
960 HART TAP
5242 65ST1
165 PEIGAN 4
166 PEIGAN 7
167 N LETHB4
9990 MATL120S
346 GOOSEL4
90000 1201L
458 CR_NEST1
4458 CR_NEST2
152 RED DEE4
160 JANET 4
187 BEDDING1
207 JANET 7
182 SHEPARD1
988 CROSSF T
259 STRATHM7
252 CARSELA7
254 GLEICHE7
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
82253 BLACKIE2
8333 NEW QUEEN
92226 SUB F_240
943 MILO 1
92066 LITTLEFO
159 LANGDON4
5158 102ST1
5159 102ST4
158 LANGDON2
92227 SUB G_240
916L
936L
937L
1201L
1065L
1064L
932L
1080L
1109L
1107L
1106L
24.83L
23.80L
30.81L
2.81L
2.80L
6.80L
9.80L
24.81L
40.81L
32.83L
32.82L
26.81L
33.84L
33.83L
31.84L
26.83L
BCH Import: 3.6 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
2012LTO+HVDC FATD EAST SYSTEM
FIG B-SC4-4: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)
2019_FATD-E_HVDC_SC4_SP
FRI, JUN 08 2012 16:32



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

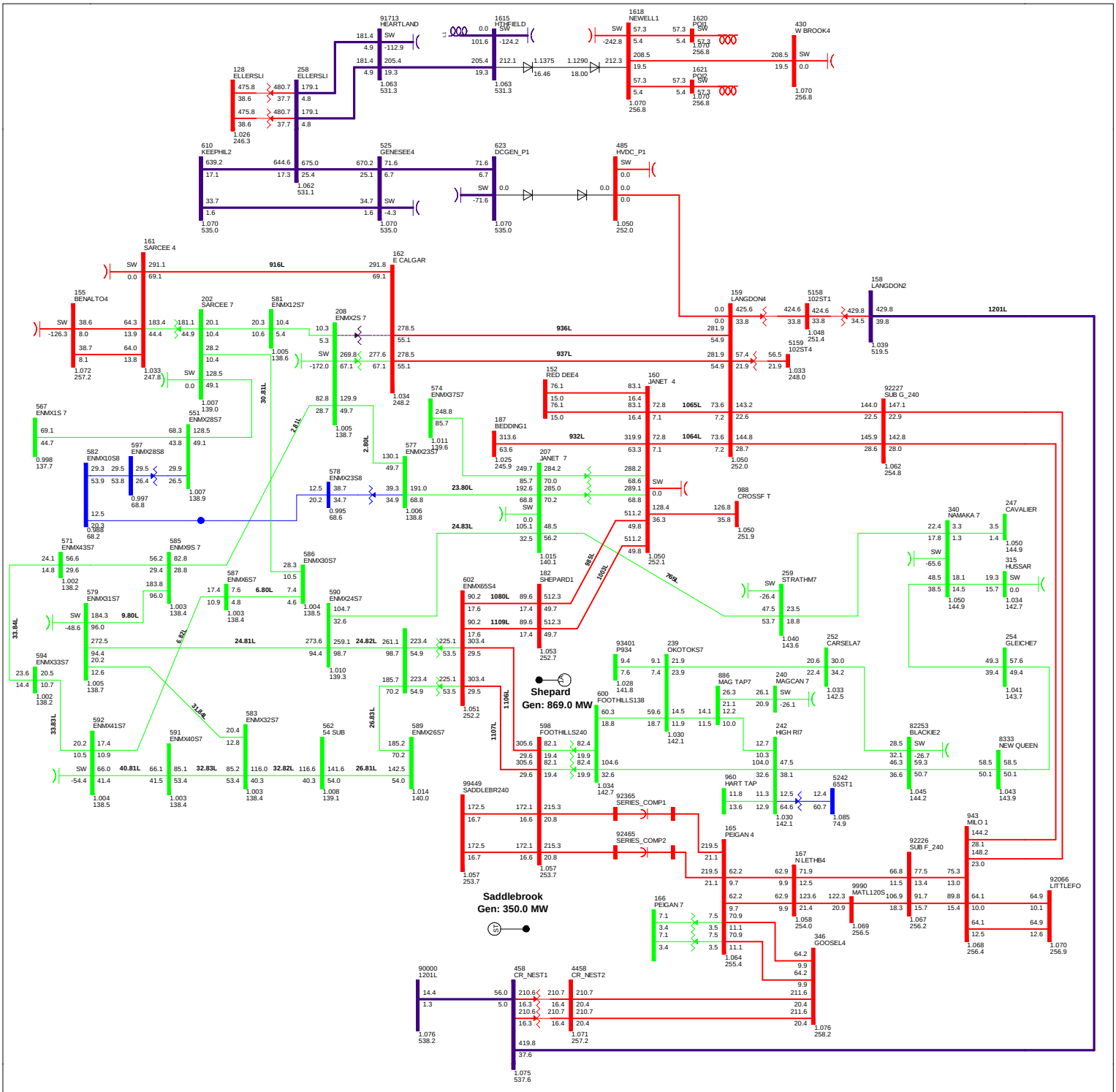
BCH Import: 4.0 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-5: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:32



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

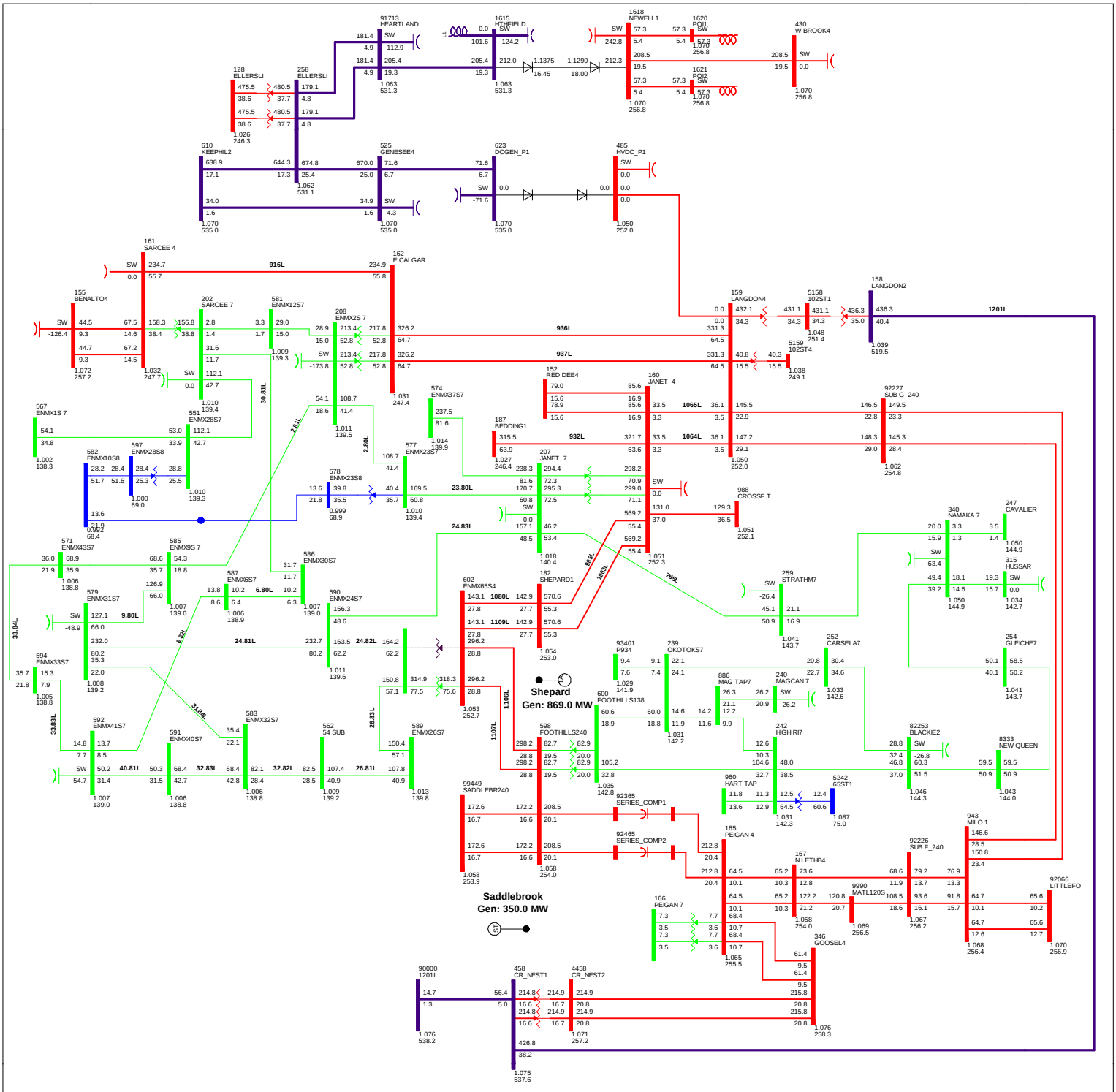
BCH Import: 2.0 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-6: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:32



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

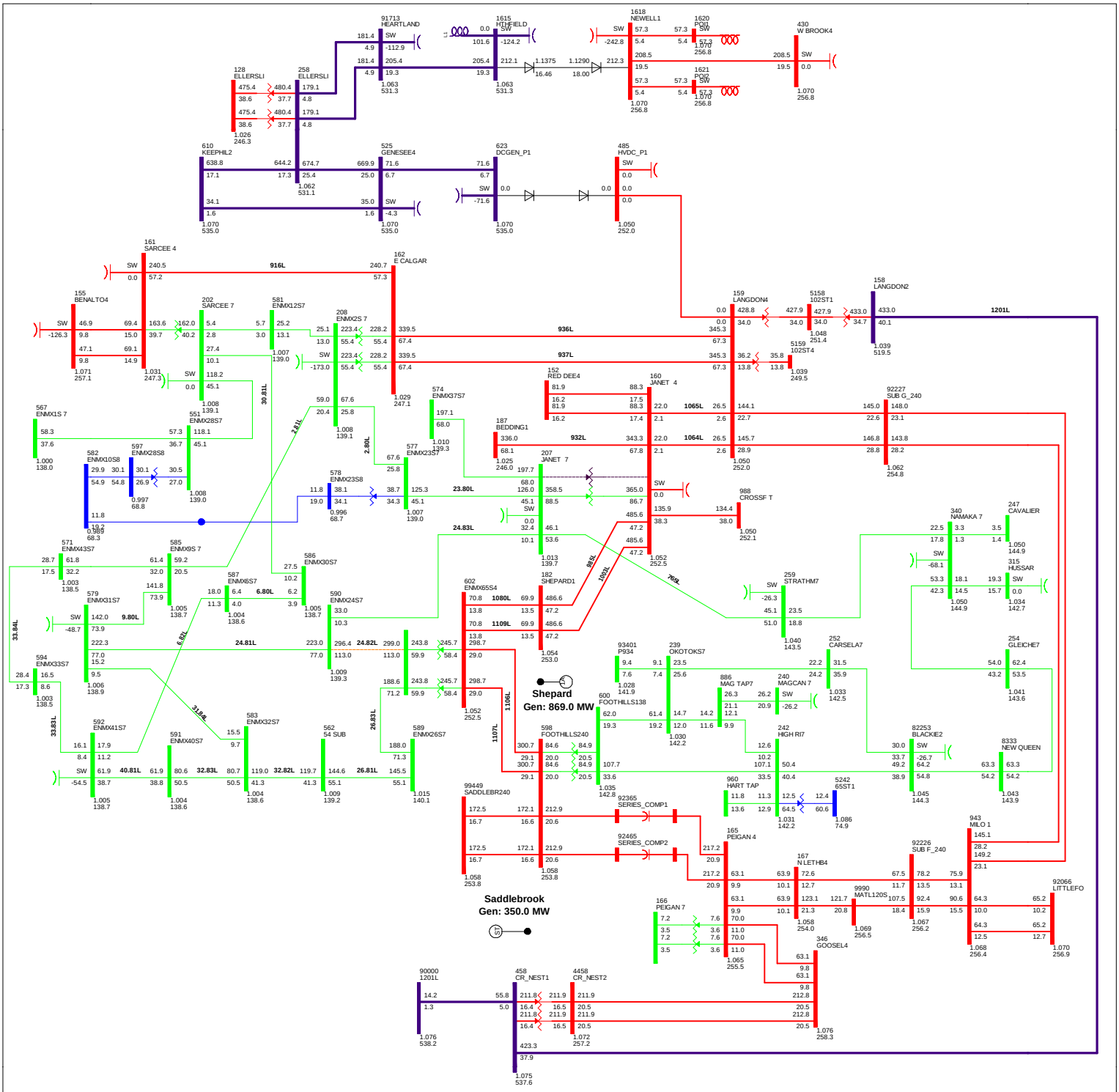
BCH Import: 0.3 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-7: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:32



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

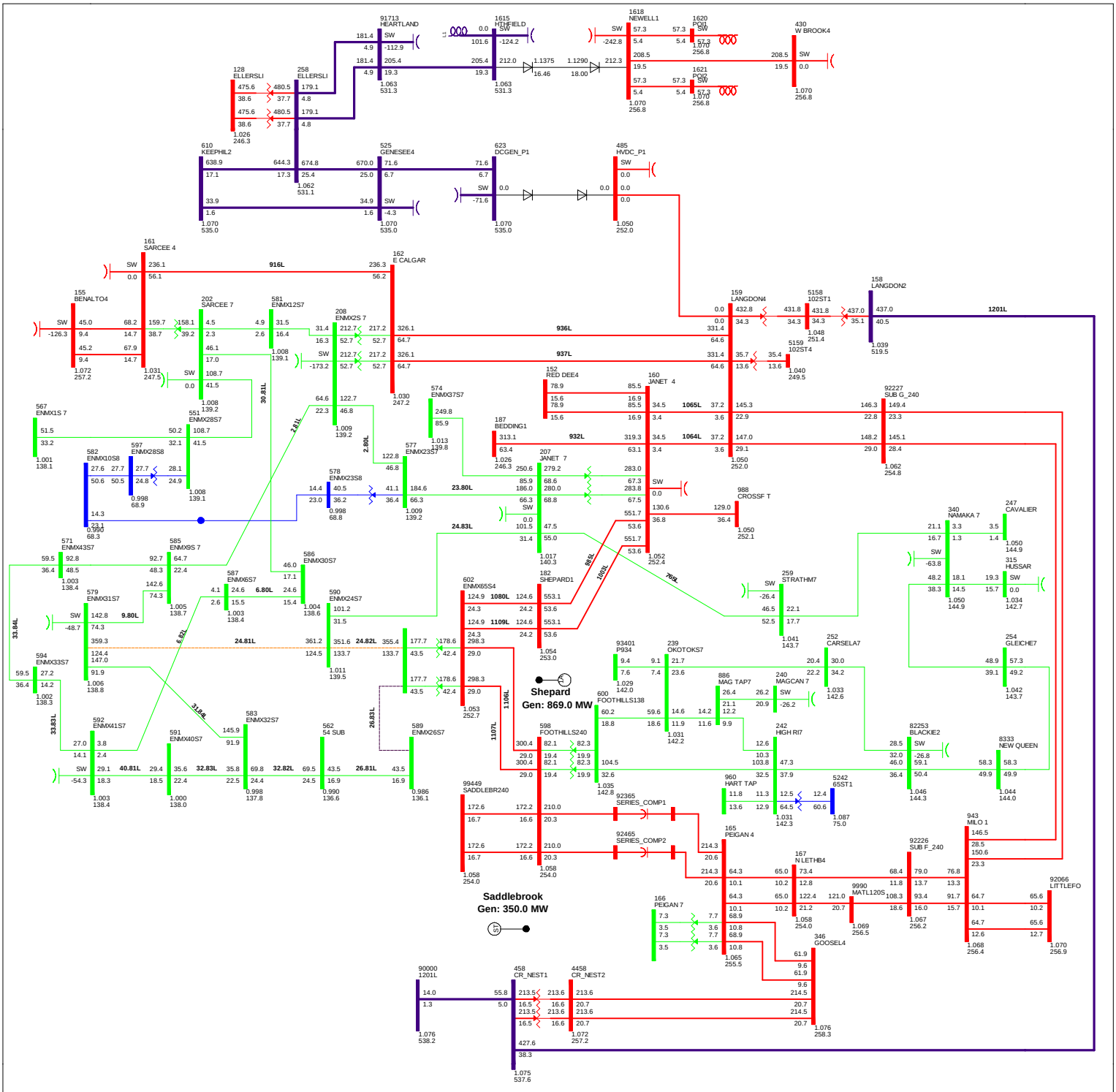
BCH Import: 3.4 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-8: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:32



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

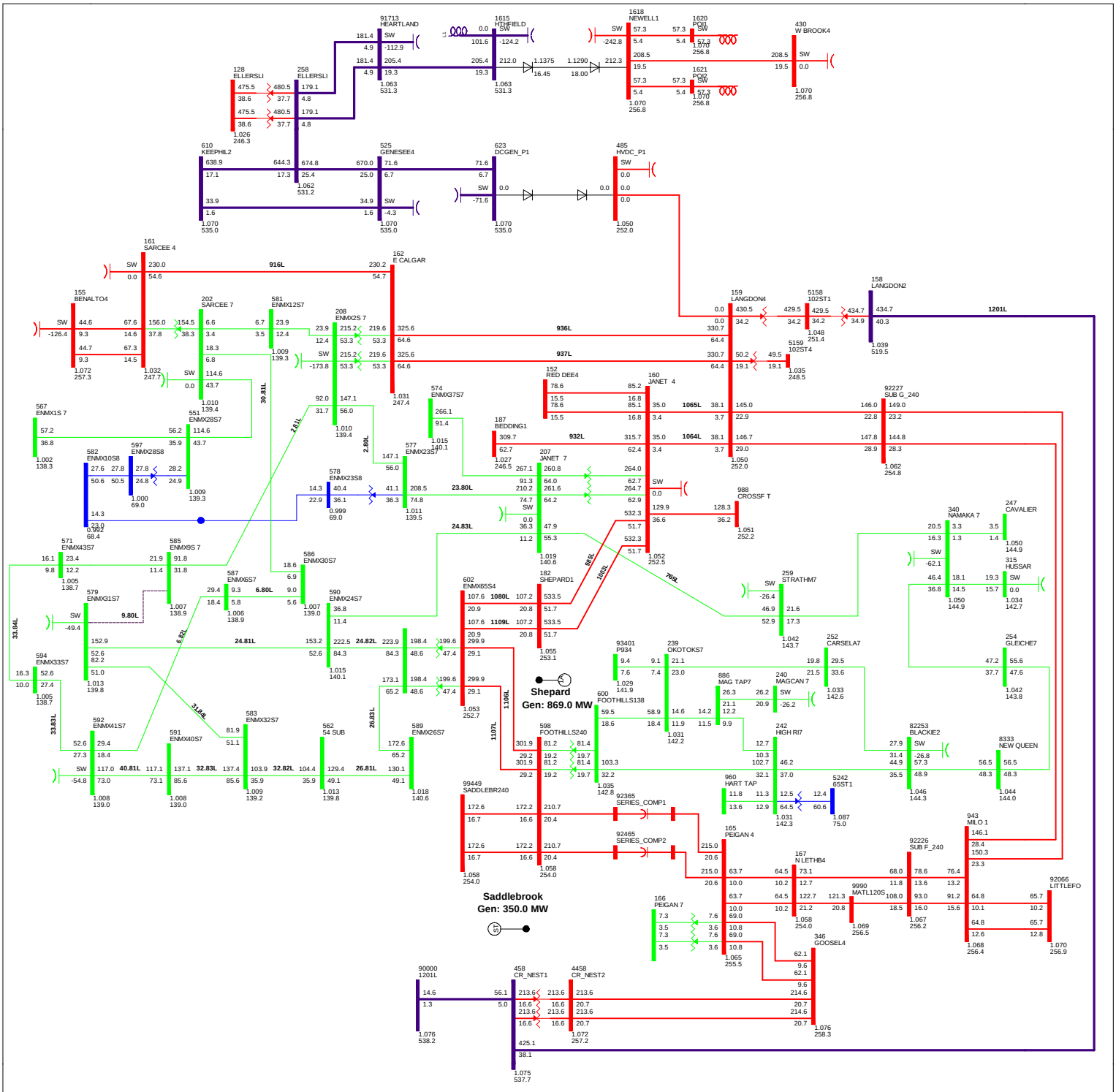
BCH Import: 3.9 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-9: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:32



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

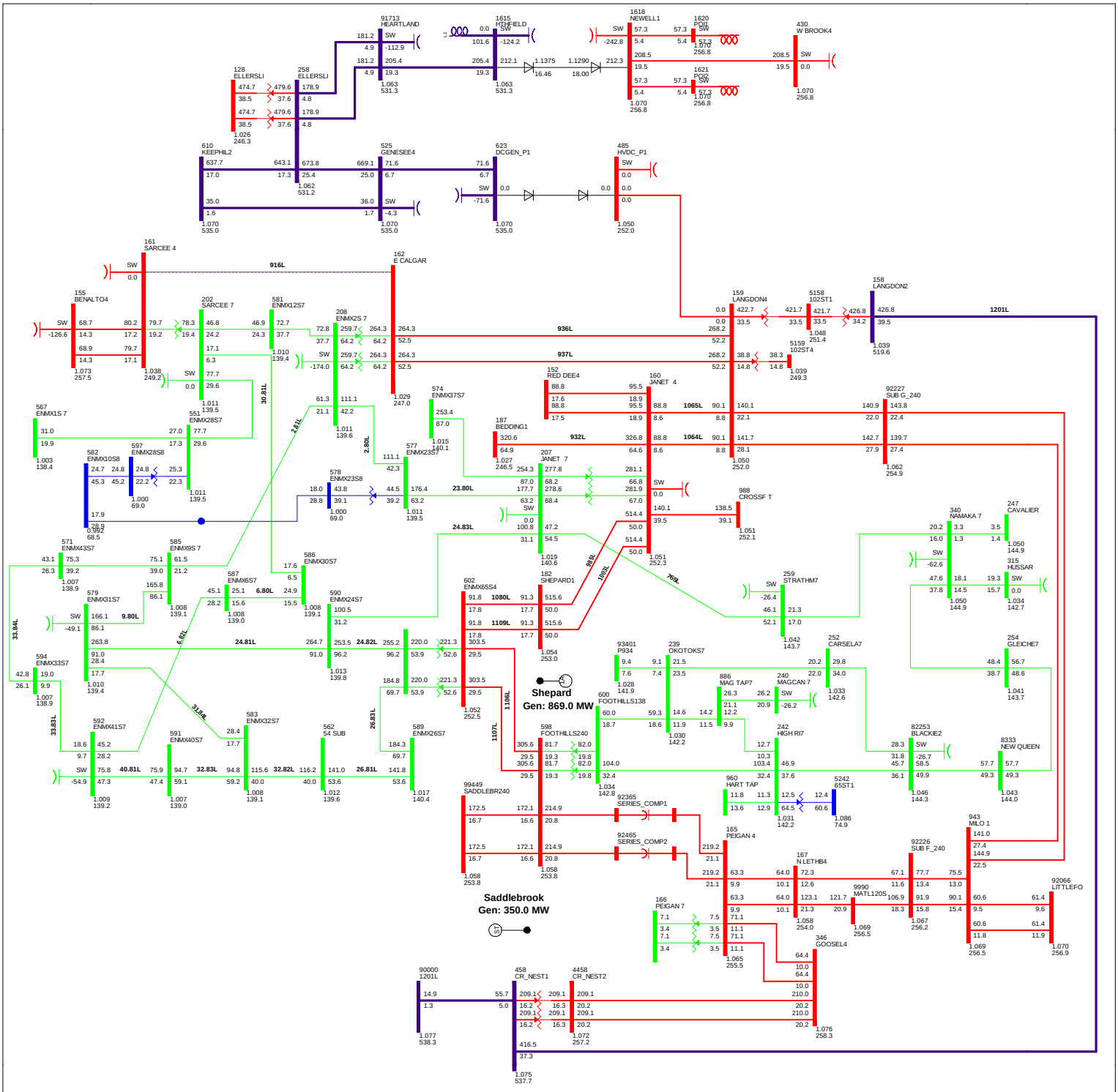
BCH Import: 1.0 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-10: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:32



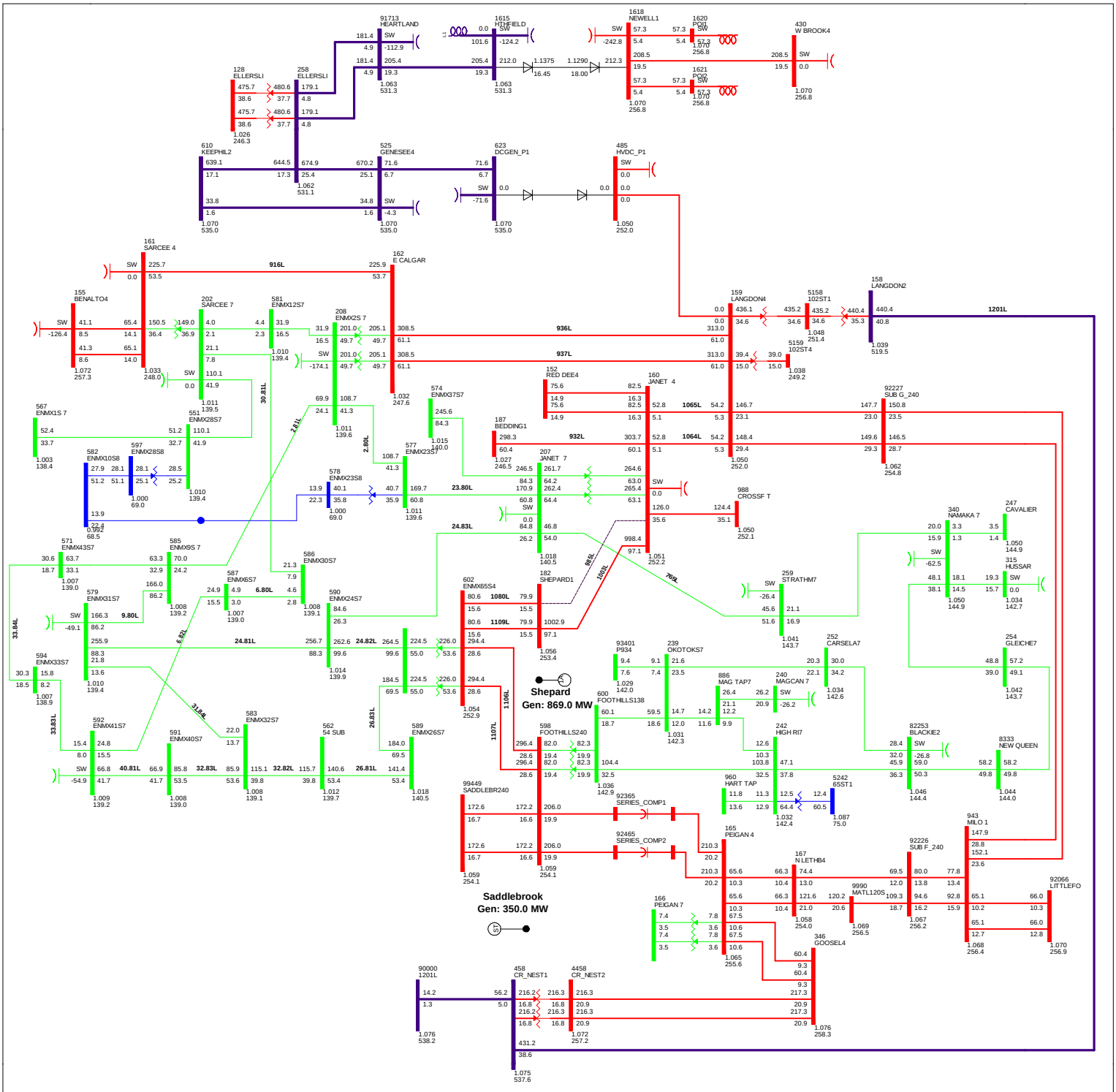
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 2.7 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG B-SC4-11: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:33

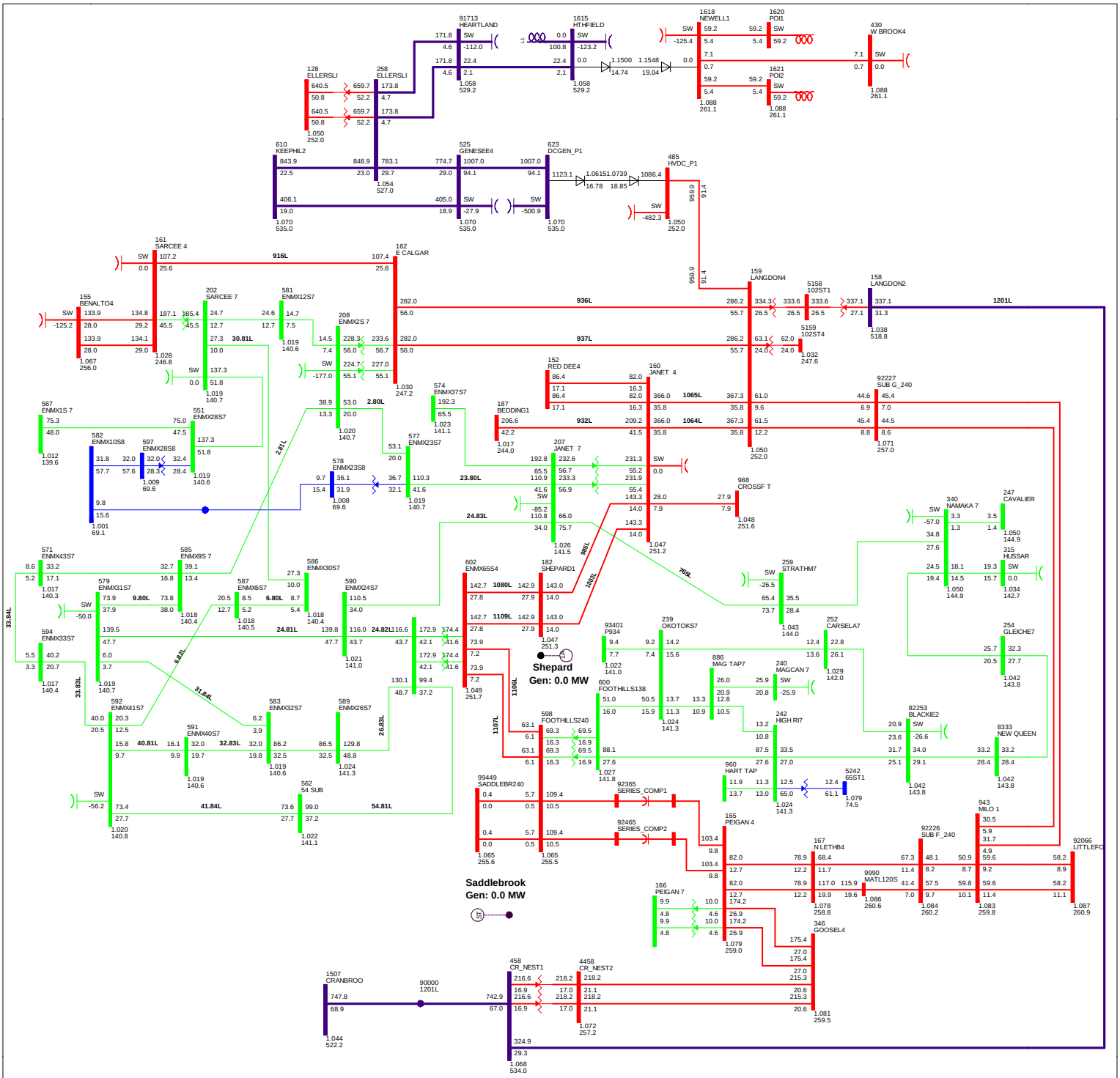

Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
91713 HEARTLAND
1615 HTHFIELD
1618 NEWELL1
1620 PON1
1621 PON2
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
610 KEEPHIL2
525 GENESEE4
623 DCGEN_P1
485 HVDC_P1
161 SARCEE 4
162 E CALGAR
155 BENALTO4
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
574 ENMX37S7
567 ENMX1S 7
551 ENMX28S7
582 ENMX10S8
597 ENMX28S8
577 ENMX23S7
578 ENMX23S8
152 RED DEE4
160 JANET 4
187 BEDDING1
207 JANET 7
182 SHEPARD1
159 LANGDON4
5158 102ST1
5159 102ST4
158 LANGDON2
92227 SUB G_240
988 CROSSF T
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
259 STRATHM7
252 CARSELA7
254 GLEICHE7
8333 NEW QUEEN
82253 BLACKIE2
242 HIGH RI7
240 MAGCAN 7
886 MAG TAP7
239 OKOTOKS7
93401 P934
600 FOOTHILLS138
598 FOOTHILLS240
602 ENMX65S4
99449 SADDLEBR240
92365 SERIES_COMP1
92465 SERIES_COMP2
960 HART TAP
5242 65ST1
165 PEIGAN 4
166 PEIGAN 7
167 N LETHB4
9990 MATL120S
92226 SUB F_240
943 MILO 1
92066 LITTLEFO
346 GOOSEL4
90000 1201L
458 CR_NEST1
4458 CR_NEST2
1201L
936L
937L
1065L
1064L
932L
1080L
1109L
1106L
1107L
24.83L
23.80L
24.81L
30.81L
33.84L
9.80L
6.80L
4.80L
2.81L
2.80L
26.81L
32.83L
40.81L
6.80L
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
BCH Import: 1.3 MW
2012LTO+HVDC FATD EAST SYSTEM
FIG B-SC4-12: OPEN 985L 240 KV LINE (JANET 74S TO ENMAX 25)
2019_FATD-E_HVDC_SC4_SP
FRI, JUN 08 2012 16:33

C-3: FATD-East+3rdCkt Assessment

Table 3: FATD East+3rdCkt Maximum Loading on Critical Lines with FATD+HVDC under Category B

Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration	
				2014 Need	2019 HVDC FATD East+3rdCkt
				√ indicates loading below 80% N/A indicates the circuit does not exist	
C-Sc1A-1	BASE CASE	240 kV line (Langdon 102S to HVDC_P1)	SC1A	91% 960MVA	91% 960MVA
C-Sc1A-2	Open 240 kV line (Langdon 102S to HVDC_P1)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	105% 89MVA	102% 85MVA
C-Sc3-2	Open 240/138 kV transformer (East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC3	N/A	88% 352MVA
C-Sc3-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S)	937L 240 kV line (Langdon 102S to East Calgary 5S)	SC3	N/A	95% 474MVA
C-Sc3-4	Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC3	N/A	95% 474MVA
C-Sc4-2	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	SC4	172% 854MVA	√
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	95% 268MVA	√
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	278% 711MVA	√
		24.83L 138 kV line (Janet 74S to ENMAX No. 24)	SC4	104% 325MVA	√
		240/138 kV transformer (ENMAX No. 65)	SC4	128% 512MVA	√
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	109% 279MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	120% 308MVA	√
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	104% 162MVA	√
		40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	92% 144MVA	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	181% 339MVA	√
		985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	92% 949MVA
C-Sc4-3	Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	120% 229MVA	100% 193MVA
C-Sc4-4	Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	82% 227MVA	√
C-Sc4-5	Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	164% 1086MVA	√
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	89% 233MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	100% 262MVA	83% 220MVA
C-Sc4-6	Open 240/138 kV transformer (East Calgary 5S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	90% 377MVA	√
C-Sc4-7	Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	84% 335MVA	87% 349MVA
C-Sc4-8	Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	95% 381MVA	89% 355MVA
C-Sc4-9	Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	120% 345MVA	92% 266MVA
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	145% 382MVA	94% 248MVA
		31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	√	√
C-Sc4-10	Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	91% 145MVA	√
C-Sc4-11	Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	103% 347MVA	√
C-Sc4-12	Open 985L 240 kV line (Janet 74S to ENMAX No. 25)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	92% 949MVA

2019 Loading Violations
Scenario 1A



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

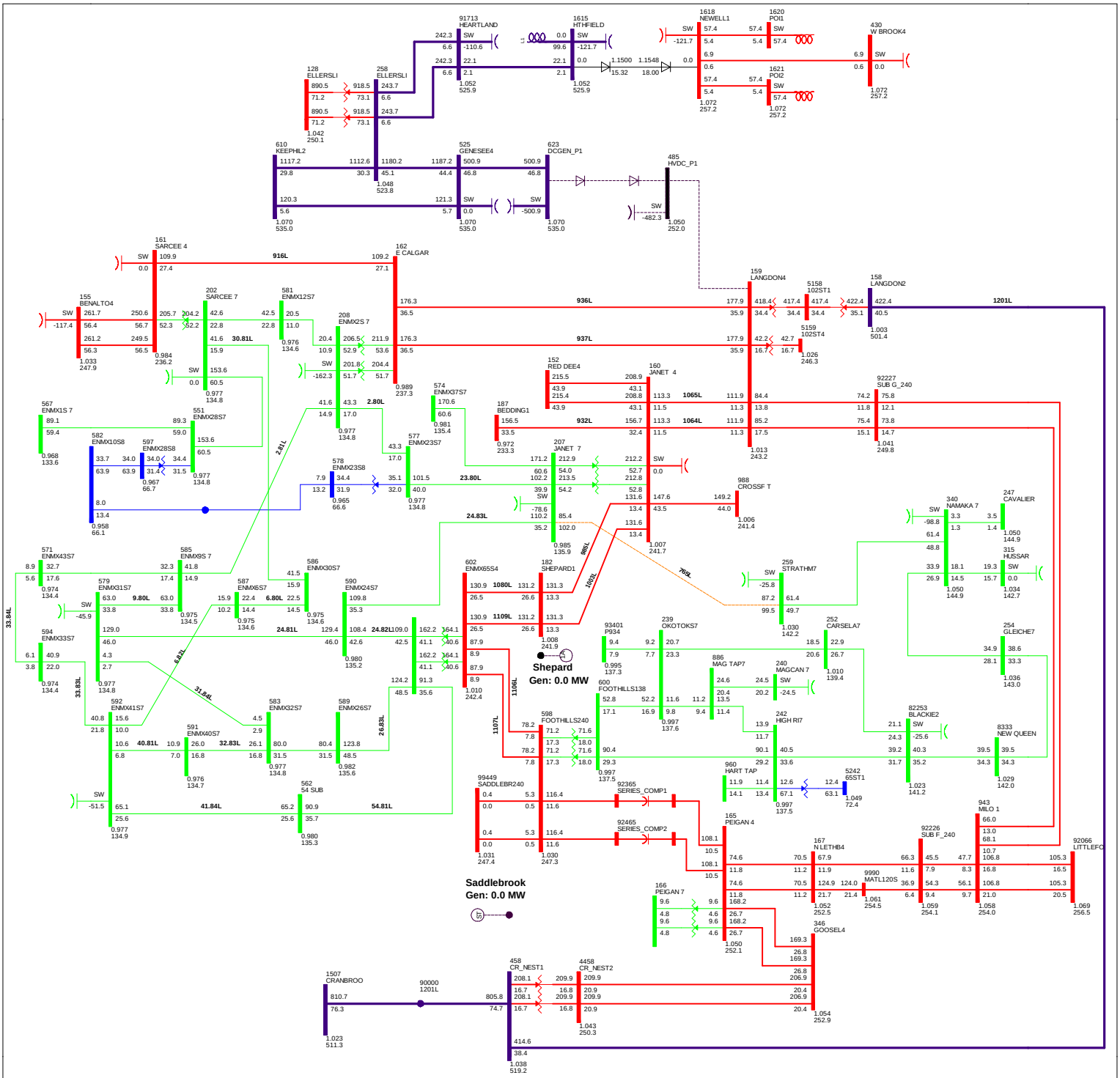
BCH Import: 782.1 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC1A-1: BASECASE

2019_FATD-E3_HVDC_SC1A_SP

FRI, JUN 08 2012 16:37



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

BCH Import: 851.1 MW

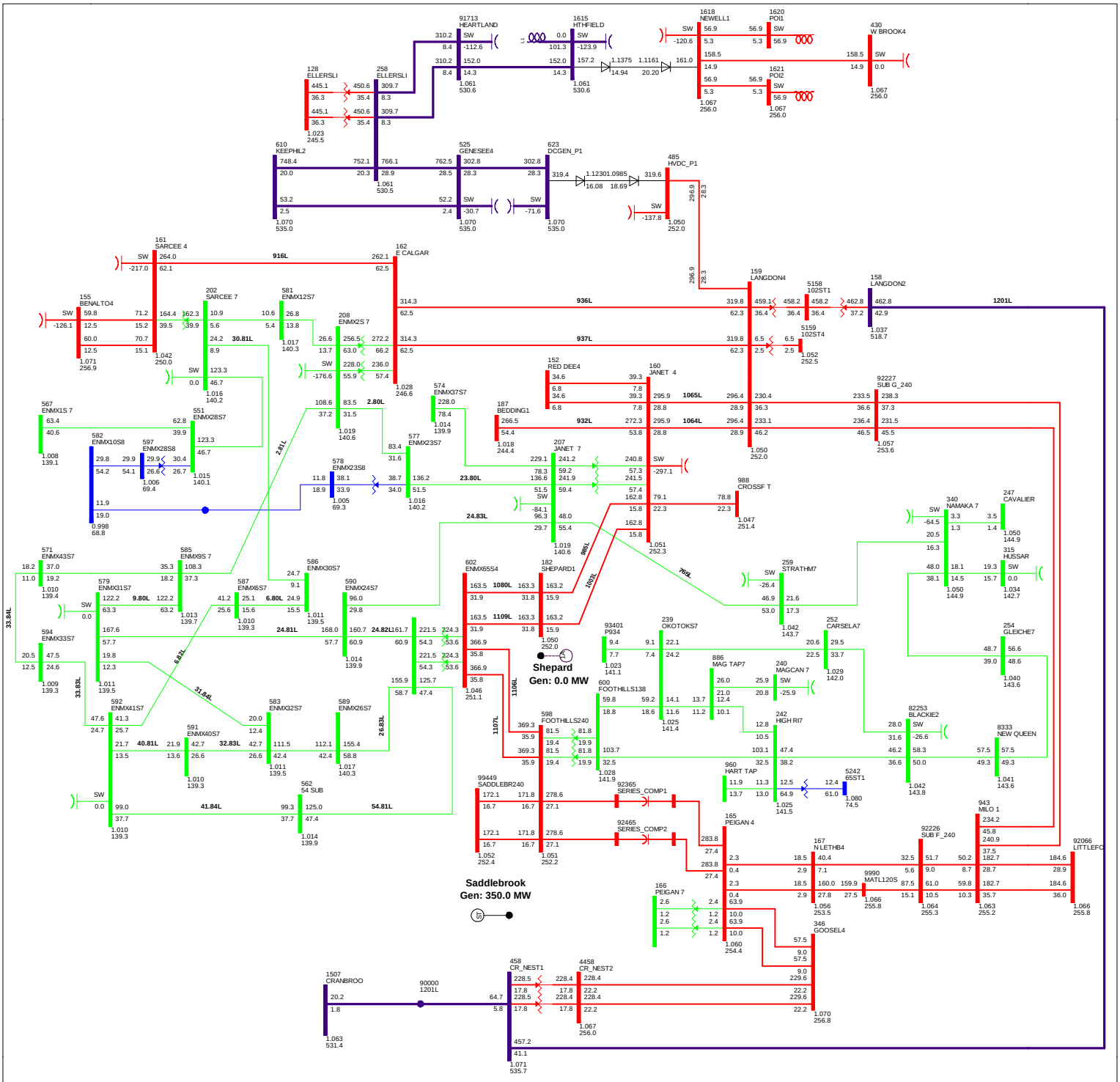
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC1A-2: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2019_FATD-E3_HVDC_SC1A_SP

FRI, JUN 08 2012 16:37

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

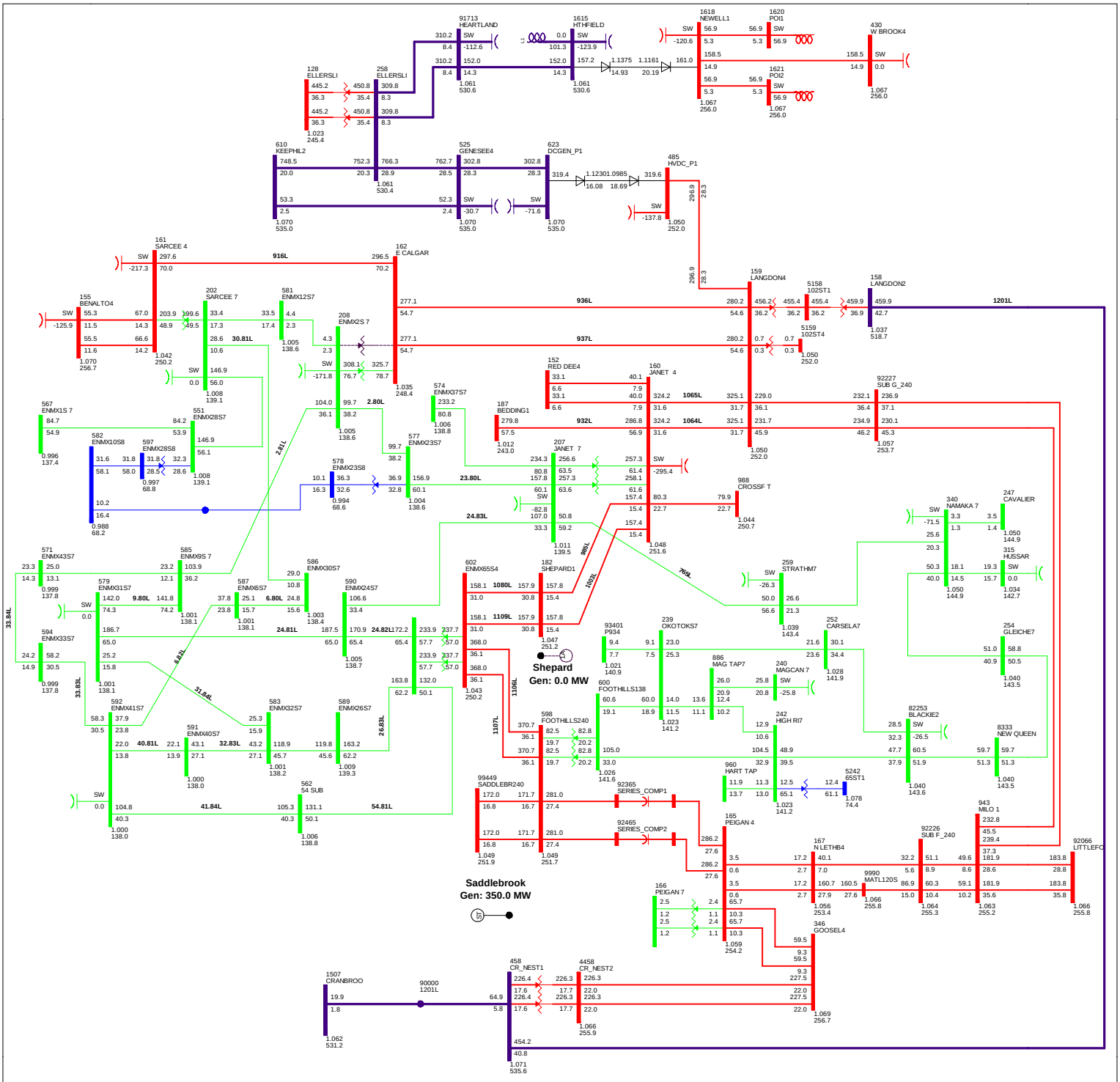
BCH Import: 4.1 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC3-1: BASECASE

2019_FATD-E3_HVDC_SC3

FRI, JUN 08 2012 16:39



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

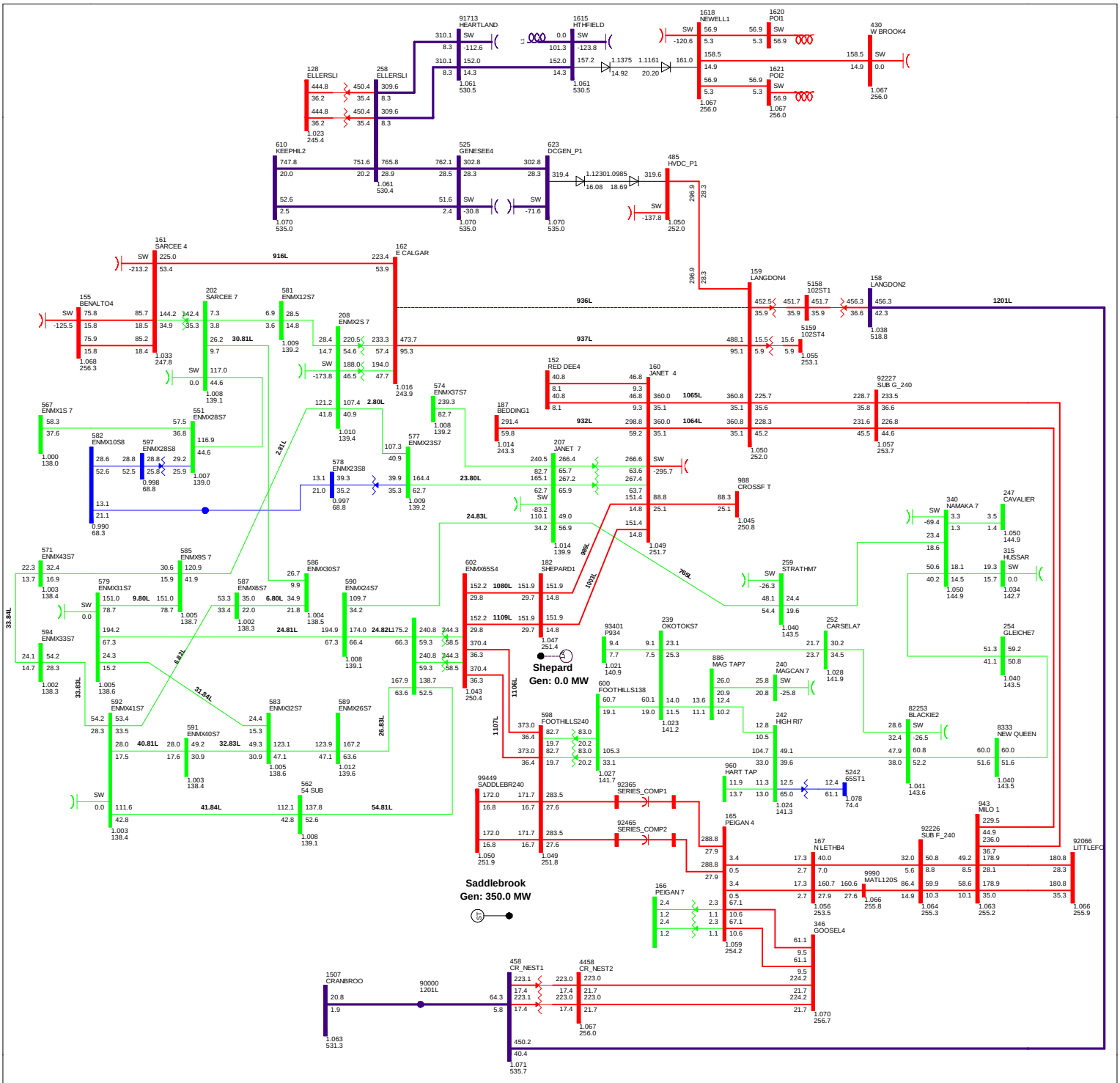
BCH Import: 6.5 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC3-2: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_FATD-E3_HVDC_SC3

FRI, JUN 08 2012 16:39



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

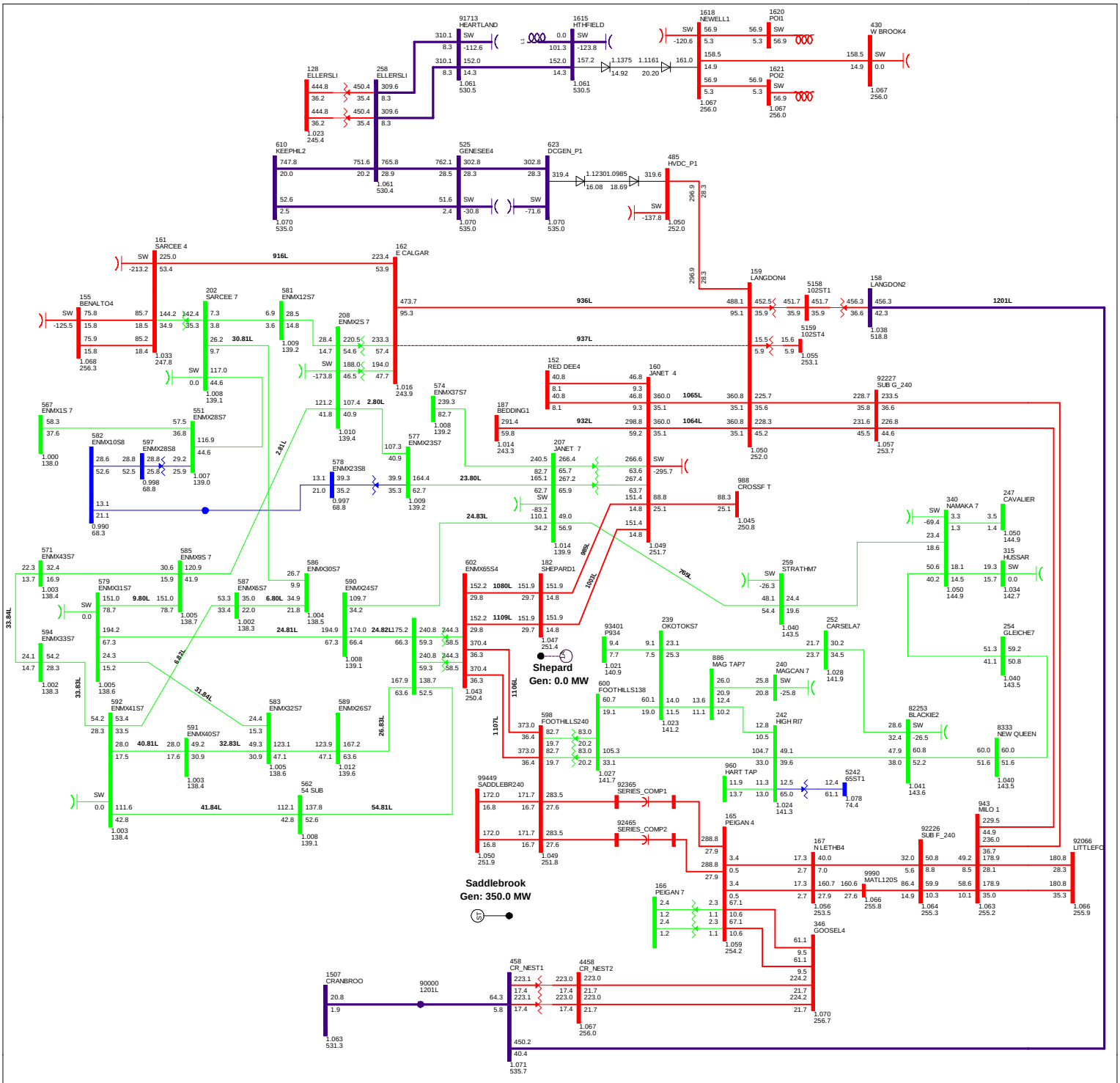
BCH Import: 10.3 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC3-3: OPEN 936L 240 KV LINE (LANGDON 102S TO EAST CAL
2019_FATD-E3_HVDC_SC3

FRI, JUN 08 2012 16:39



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

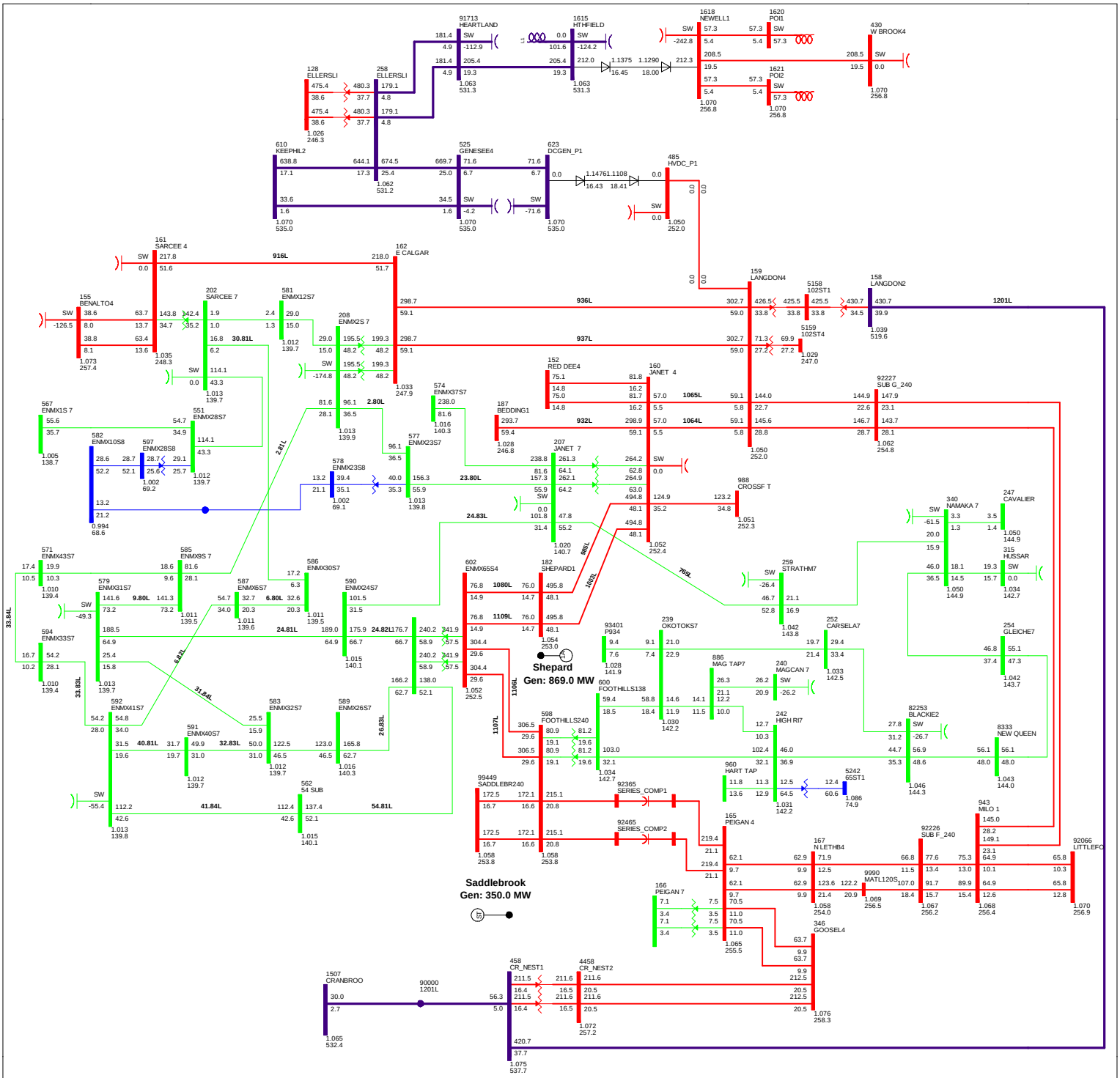
BCH Import: 10.3 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC3-4: OPEN 937L 240 KV LINE (LANGDON 102S TO EAST CAL
2019_FATD-E3_HVDC_SC3

FRI, JUN 08 2012 16:39

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

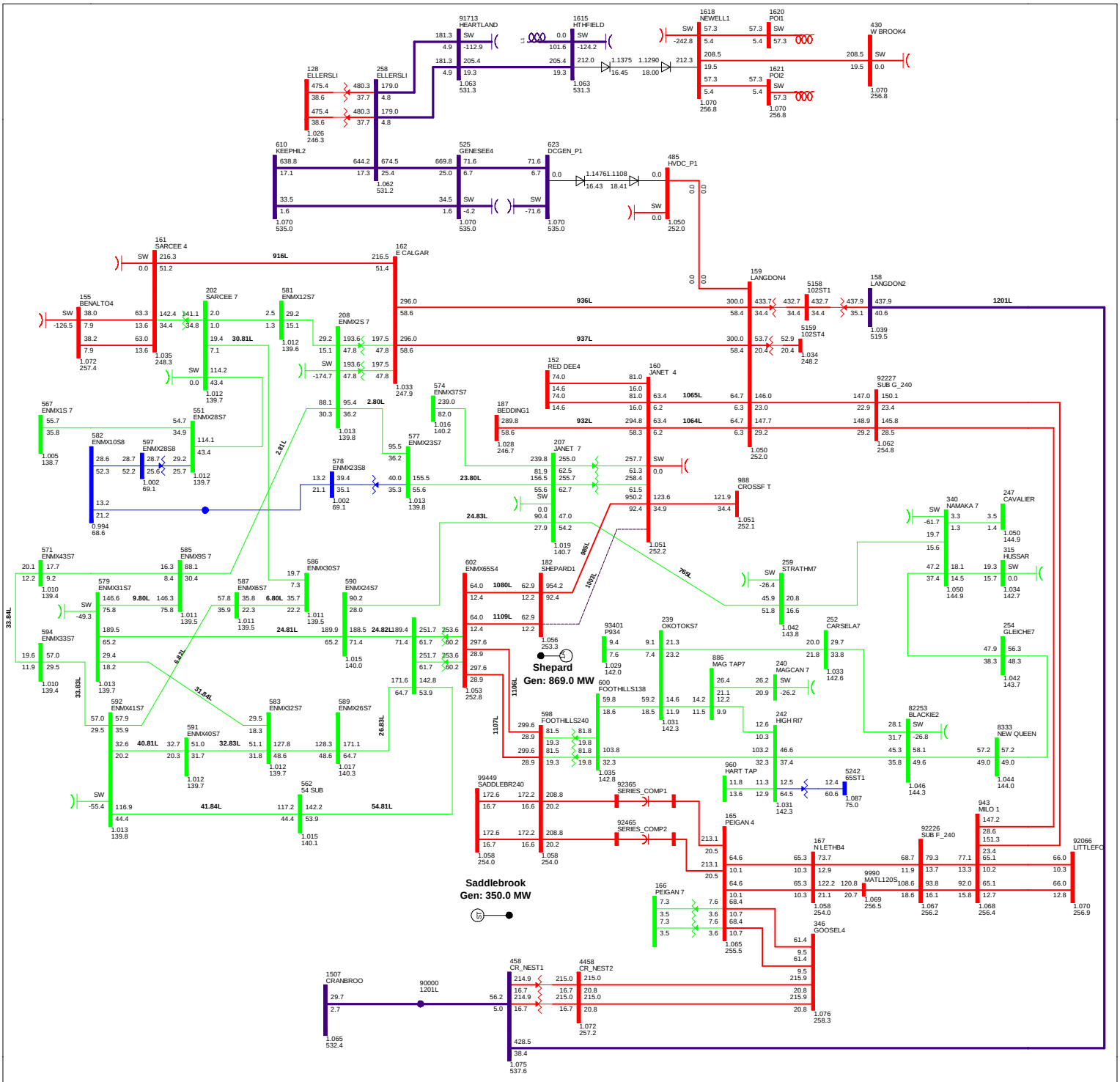
BCH Import: -0.3 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-1: BASECASE

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:39



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

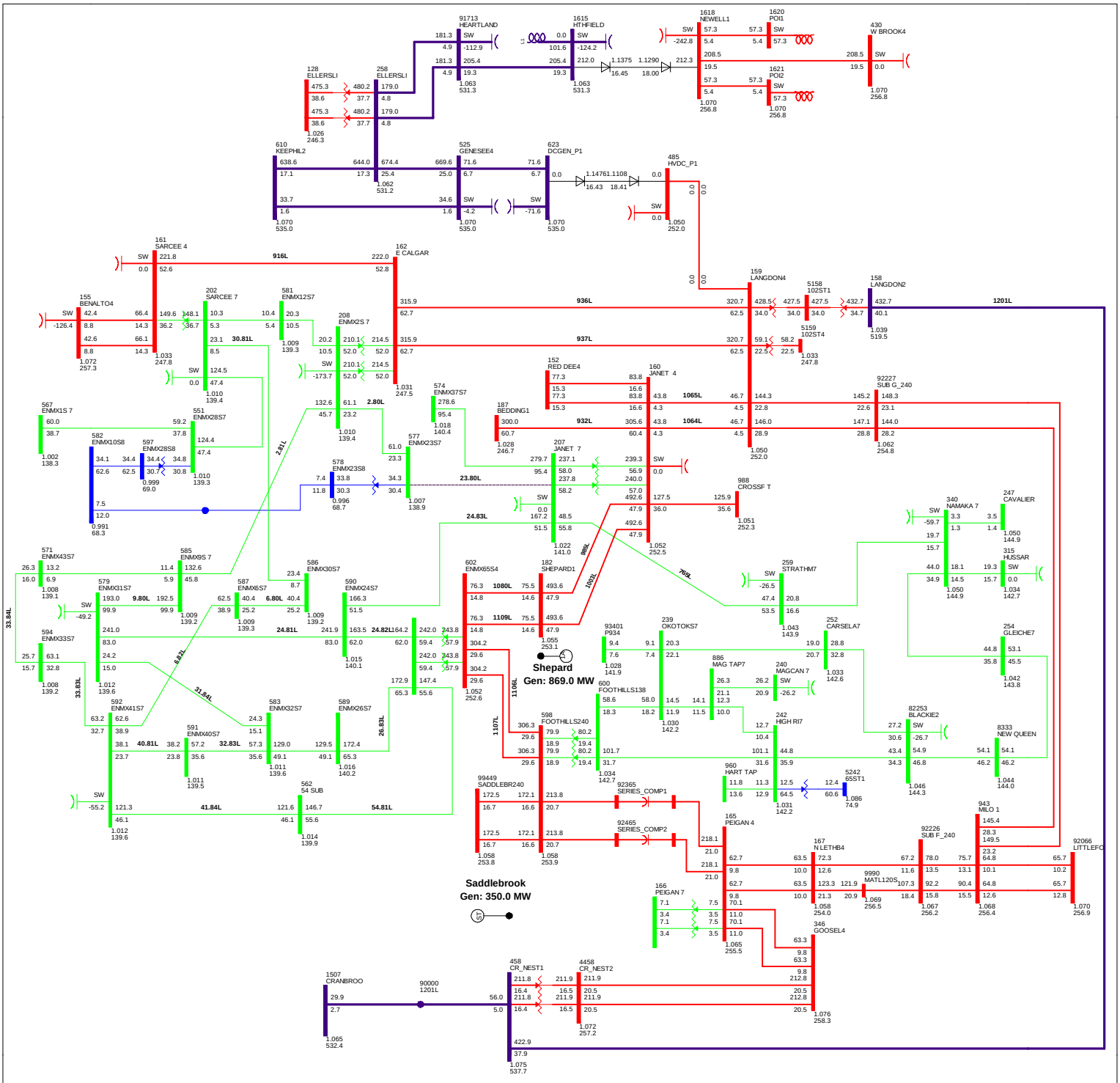
BCH Import: 0.9 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:39



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

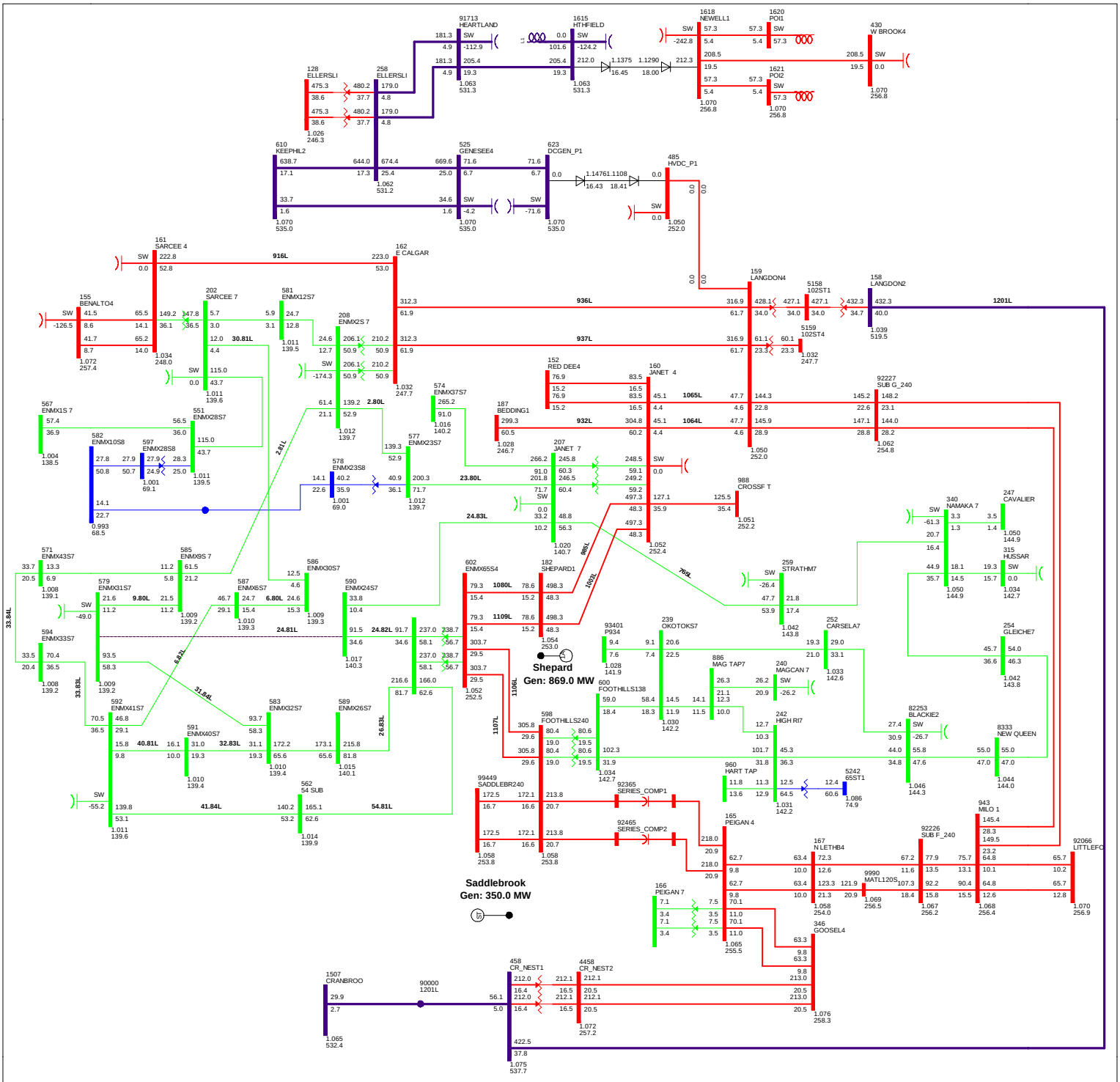
BCH Import: 2.0 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-3: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

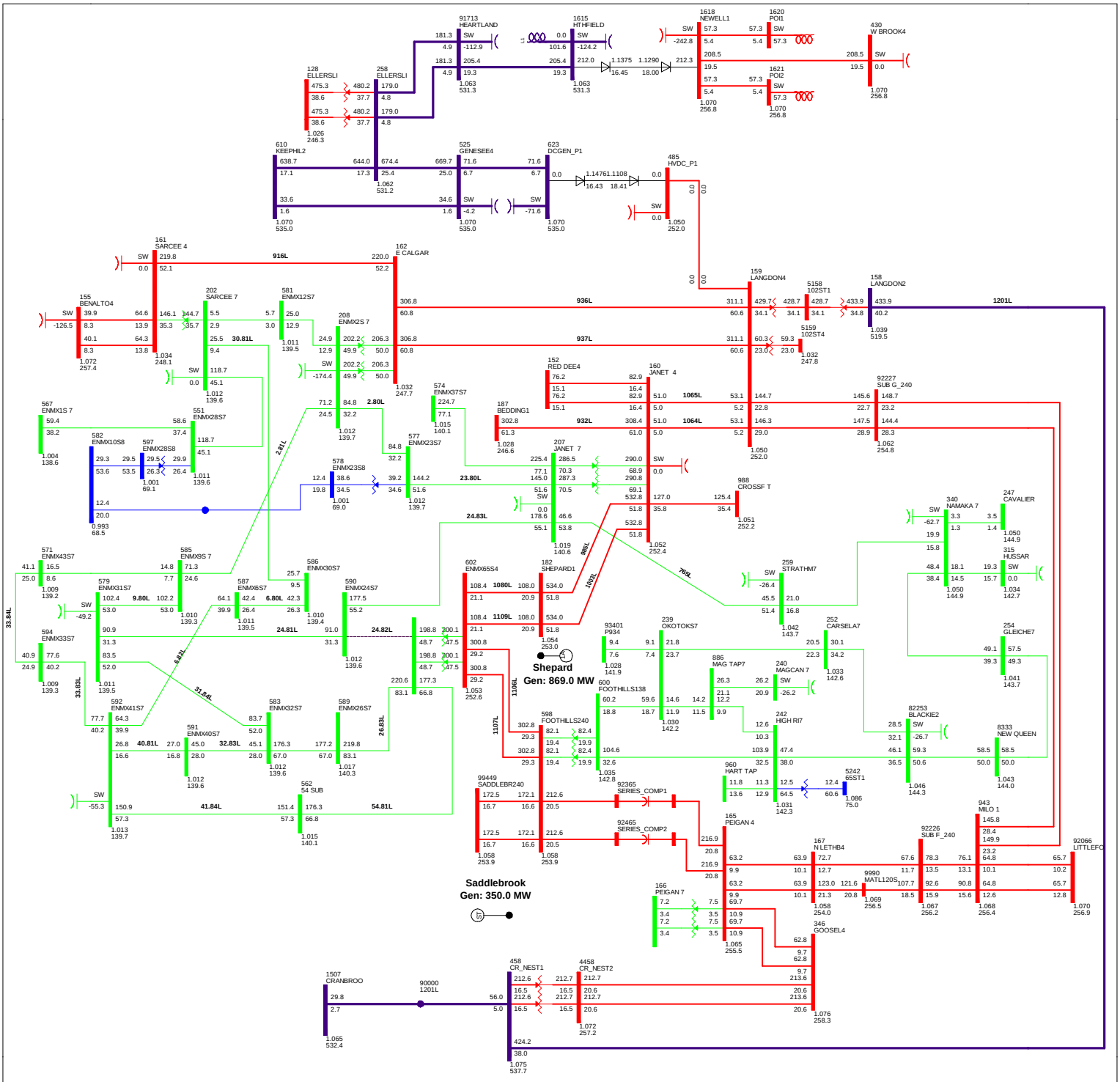
BCH Import: 1.1 MW

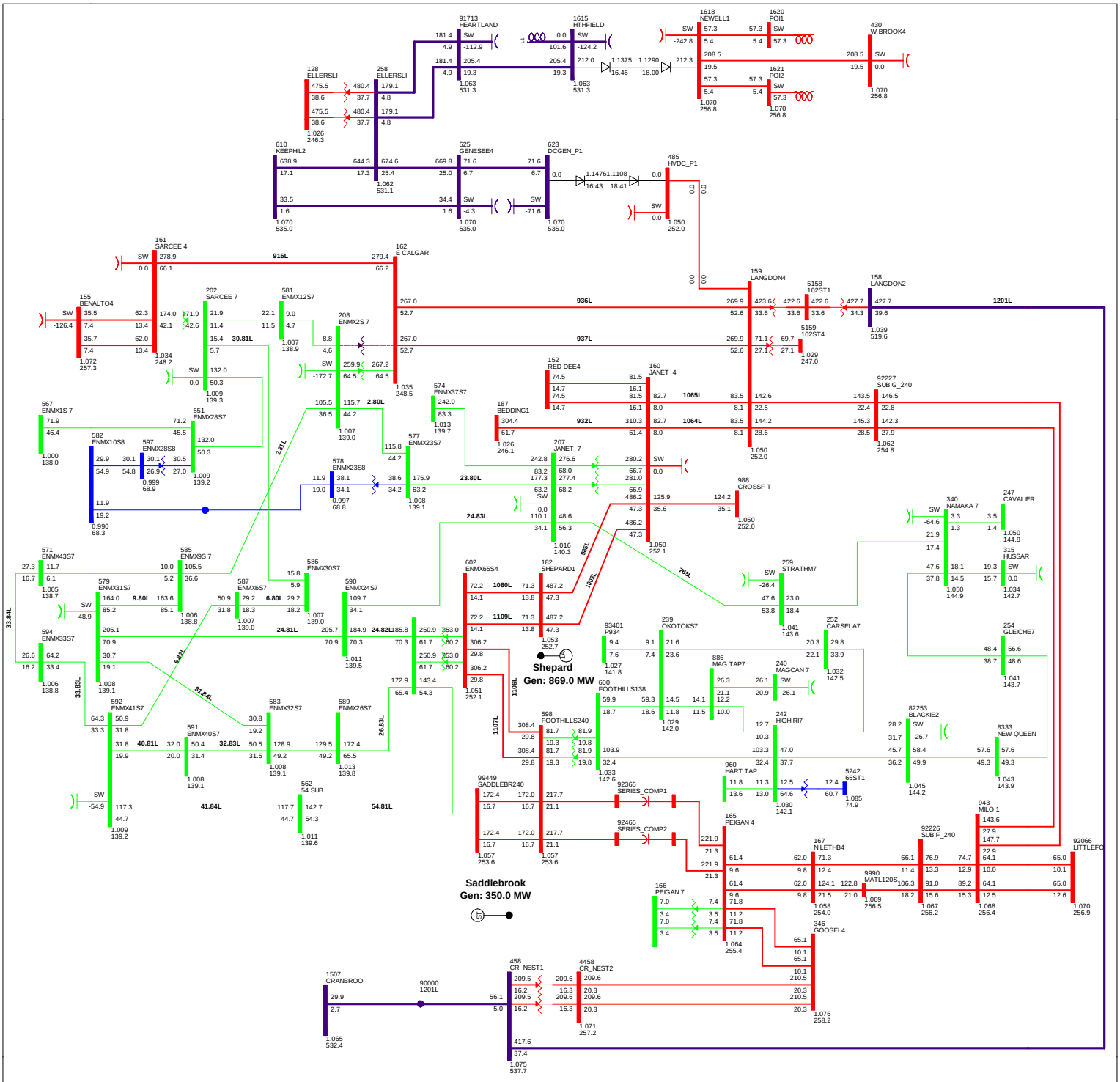
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-4: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:40


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
BCH Import: 1.4 MW
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM
FIG C-SC4-5: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)
2019_FATD-E3_HVDC_SC4_SP
FRI, JUN 08 2012 16:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

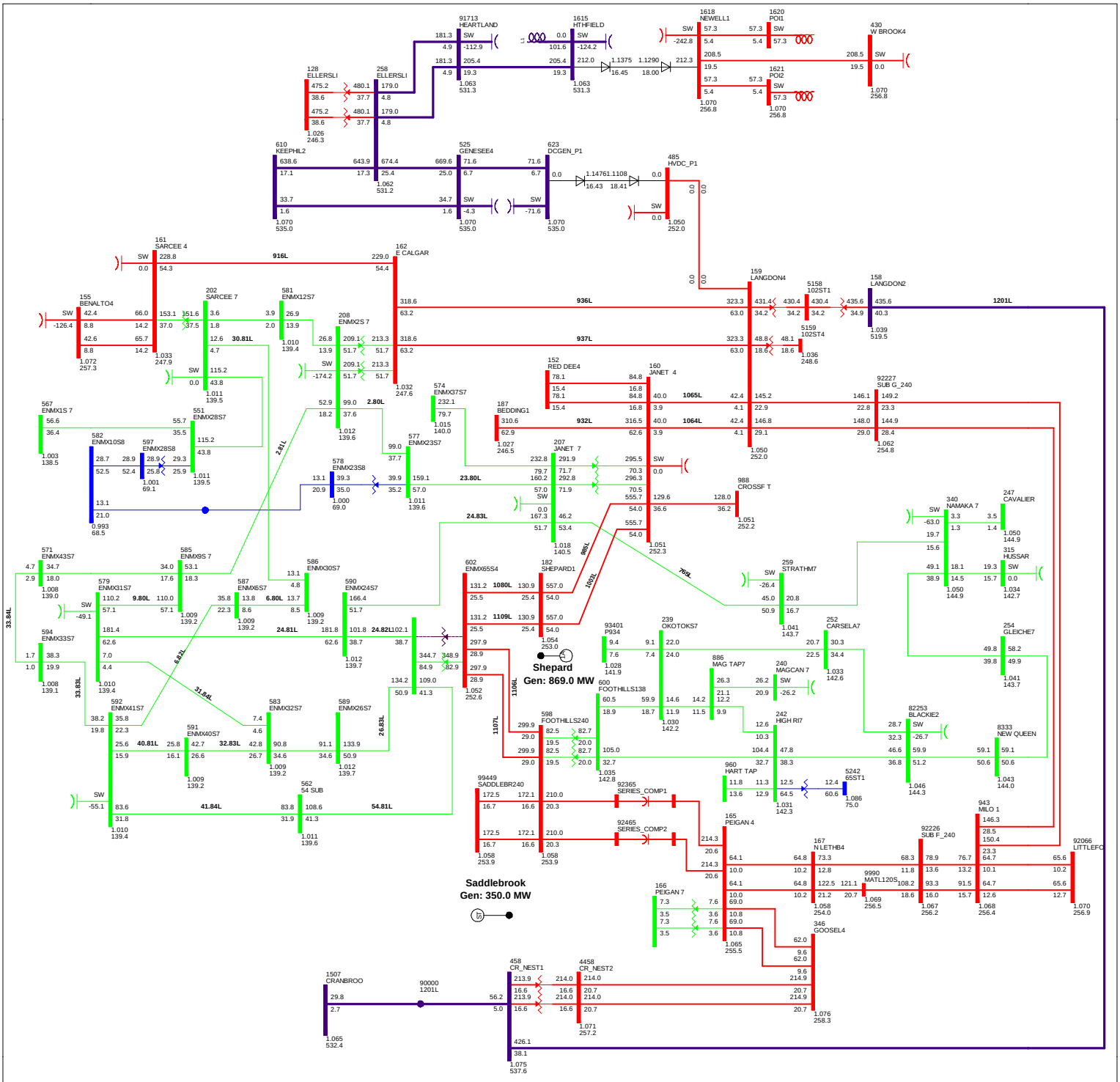
BCH Import: 1.5 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-6: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

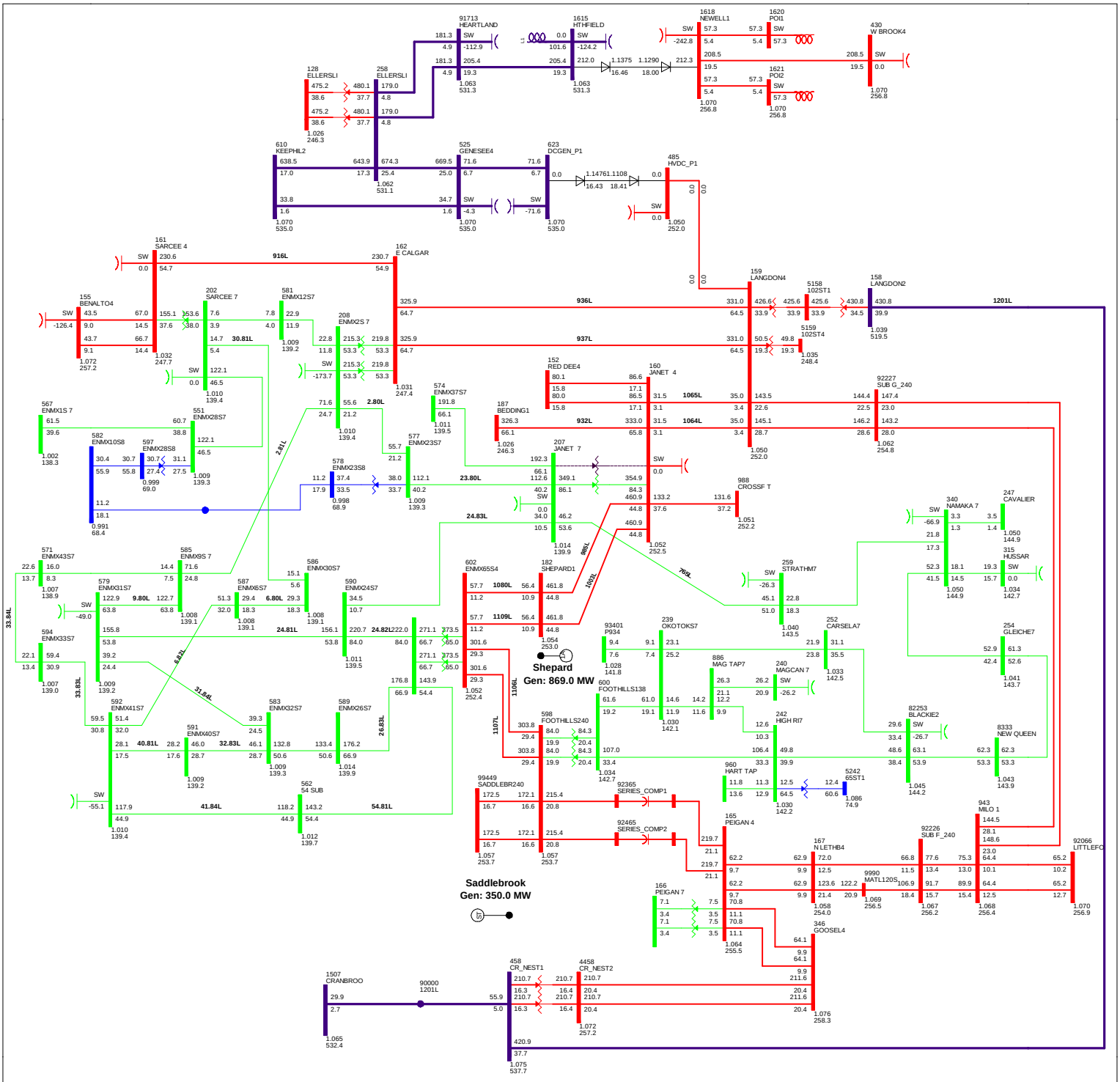
BCH Import: 1.1 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-7: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

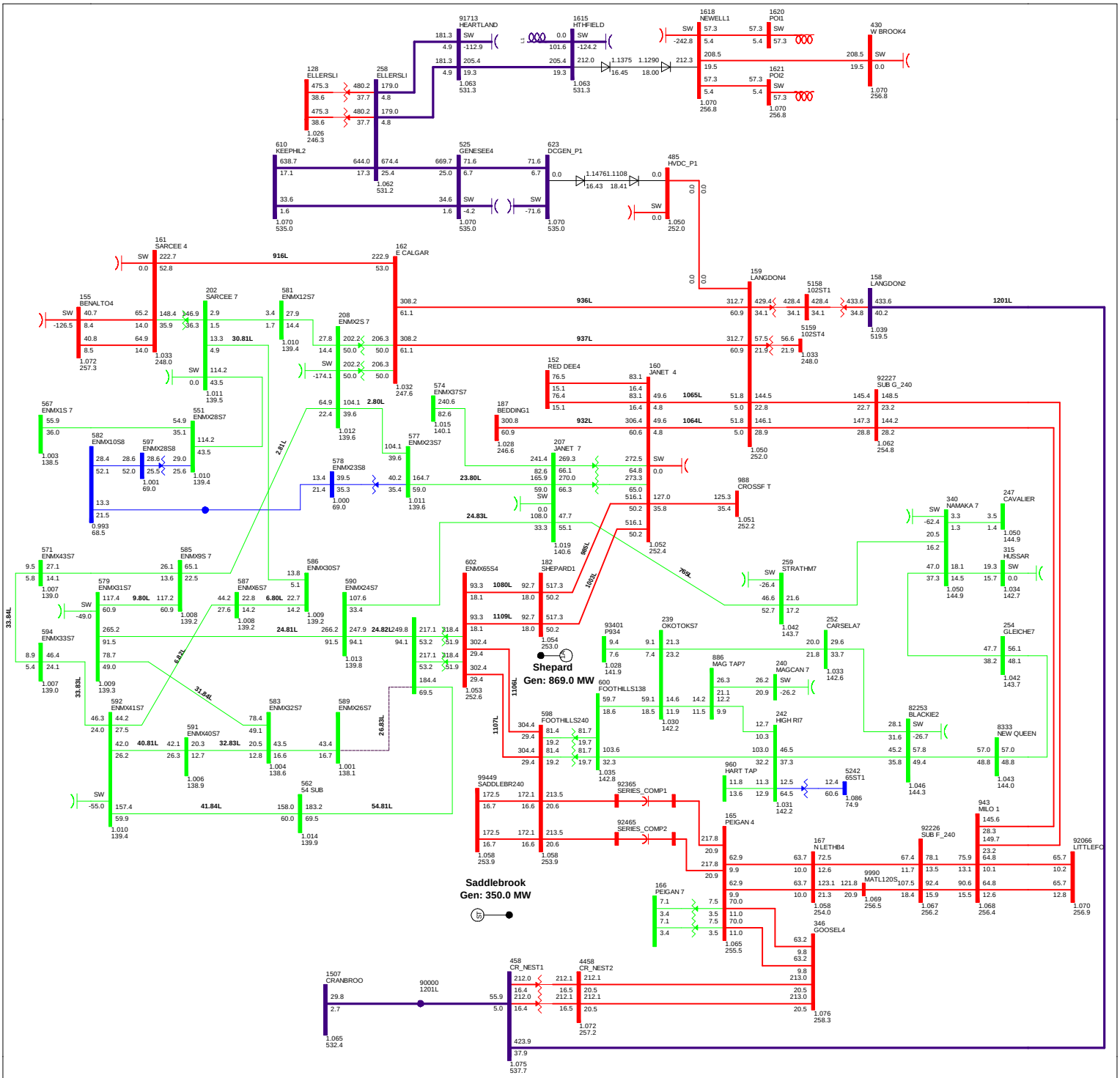
BCH Import: 2.7 MW

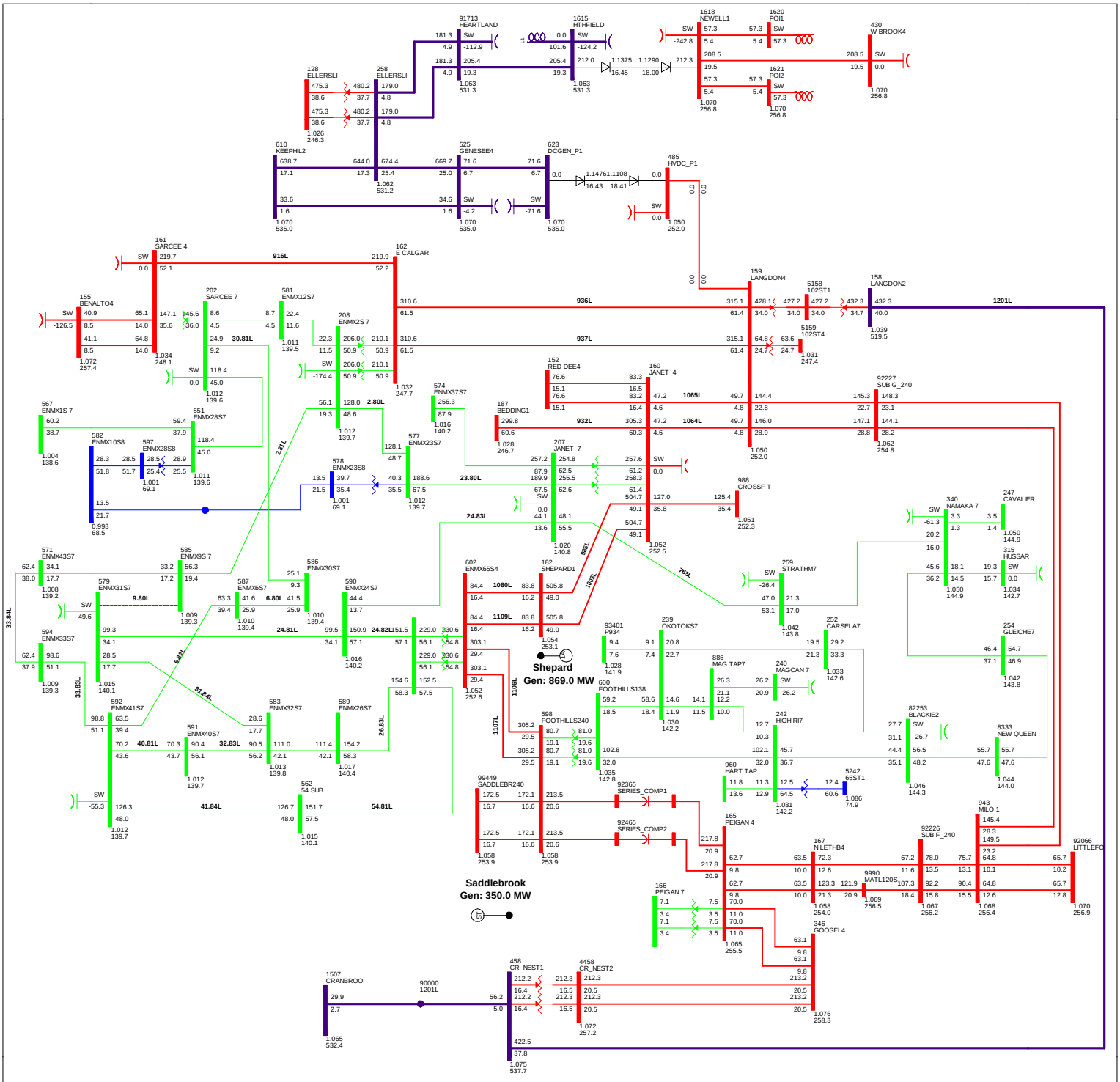
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-8: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:40


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
91713 HEARTLAND
1615 HTHFIELD
1618 NEWELL1
1620 POI1
1621 POI2
430 W BROOK4
128 ELLERSLI
258 ELLERSLI
610 KEEPHIL2
525 GENESEE4
623 DCGEN_P1
485 HVDC_P1
161 SARCEE 4
162 E CALGAR
155 BENALTO4
202 SARCEE 7
581 ENMX12S7
208 ENMX2S 7
574 ENMX37S7
152 RED DEE4
160 JANET 4
187 BEDDING1
207 JANET 7
577 ENMX23S7
578 ENMX23S8
567 ENMX1S 7
551 ENMX28S7
582 ENMX10S8
597 ENMX28S8
159 LANGDON4
5158 102ST1
5159 102ST4
158 LANGDON2
92227 SUB G_240
988 CROSSF T
340 NAMAKA 7
247 CAVALIER
315 HUSSAR
259 STRATHM7
252 CARSELA7
254 GLEICHE7
571 ENMX43S7
585 ENMX9S 7
579 ENMX31S7
586 ENMX30S7
587 ENMX6S7
590 ENMX24S7
602 ENMX65S4
182 SHEPARD1
594 ENMX33S7
592 ENMX41S7
591 ENMX40S7
583 ENMX32S7
589 ENMX26S7
562 54 SUB
93401 PS34
239 OKOTOKS7
886 MAG TAP7
240 MAGCAN 7
600 FOOTHILLS138
598 FOOTHILLS240
242 HIGH RI7
82253 BLACKIE2
8333 NEW QUEEN
99449 SADDLEBR240
92365 SERIES_COMP1
92465 SERIES_COMP2
960 HART TAP
5242 65ST1
165 PEIGAN 4
166 PEIGAN 7
167 N LETHB4
9990 MATL120S
92226 SUB F_240
943 MILO 1
92066 LITTLEFC
346 GOOSEL4
458 CR_NEST1
4458 CR_NEST2
1507 CRANBROO
90000 1201L
33.84L
33.83L
2.81L
6.82L
31.84L
23.80L
24.83L
24.81L
24.82L
40.81L
32.83L
41.84L
54.81L
26.83L
916L
936L
937L
1201L
1065L
1064L
932L
1080L
1109L
1107L
1106L
1070L
998L
769L
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000
BCH Import: 2.5 MW
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM
FIG C-SC4-9: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)
2019_FATD-E3_HVDC_SC4_SP
FRI, JUN 08 2012 16:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

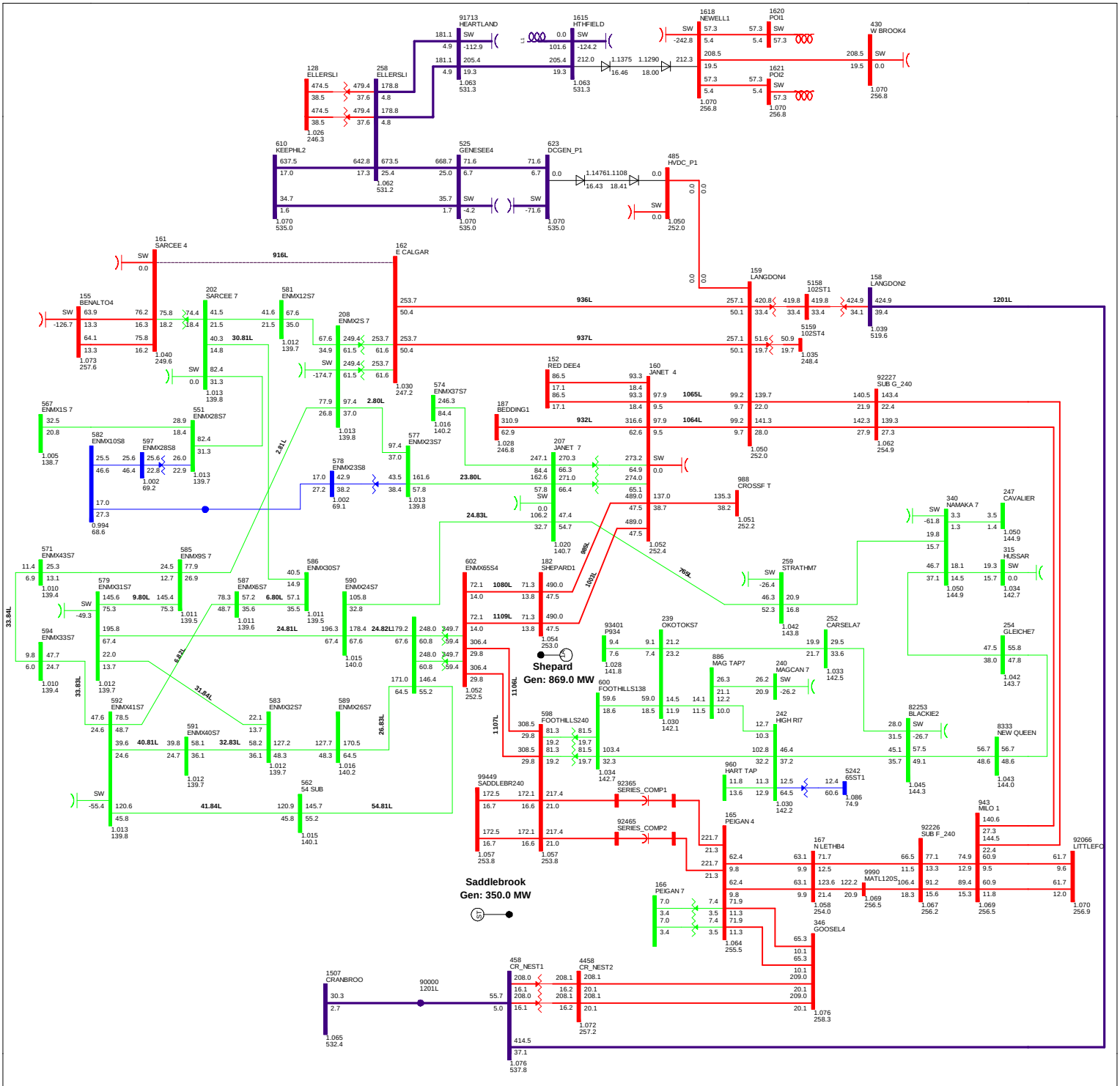
BCH Import: 0.6 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-10: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

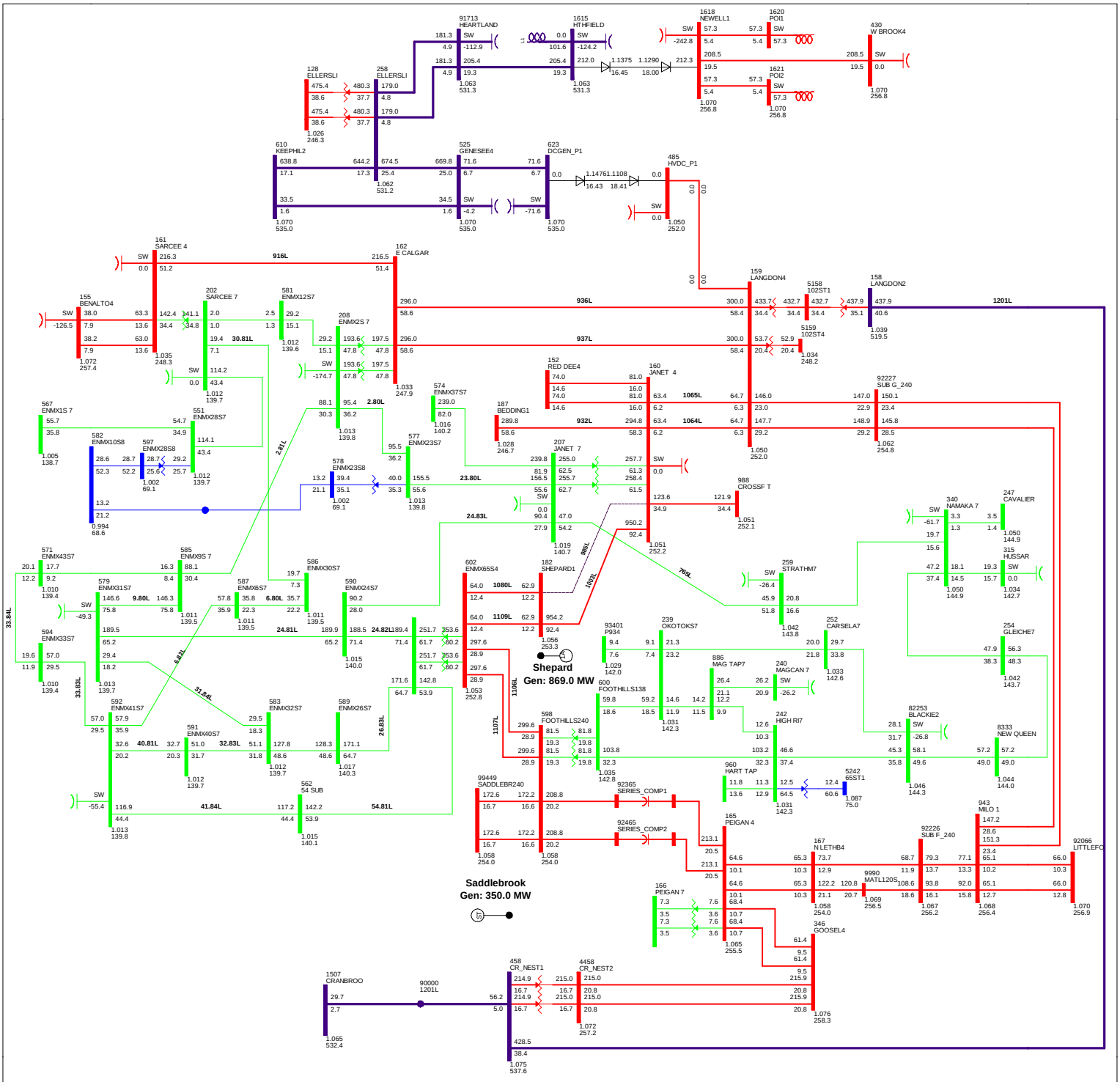
BCH Import: 2.1 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-11: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:40



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

BCH Import: 0.9 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C-SC4-12: OPEN 985L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_FATD-E3_HVDC_SC4_SP

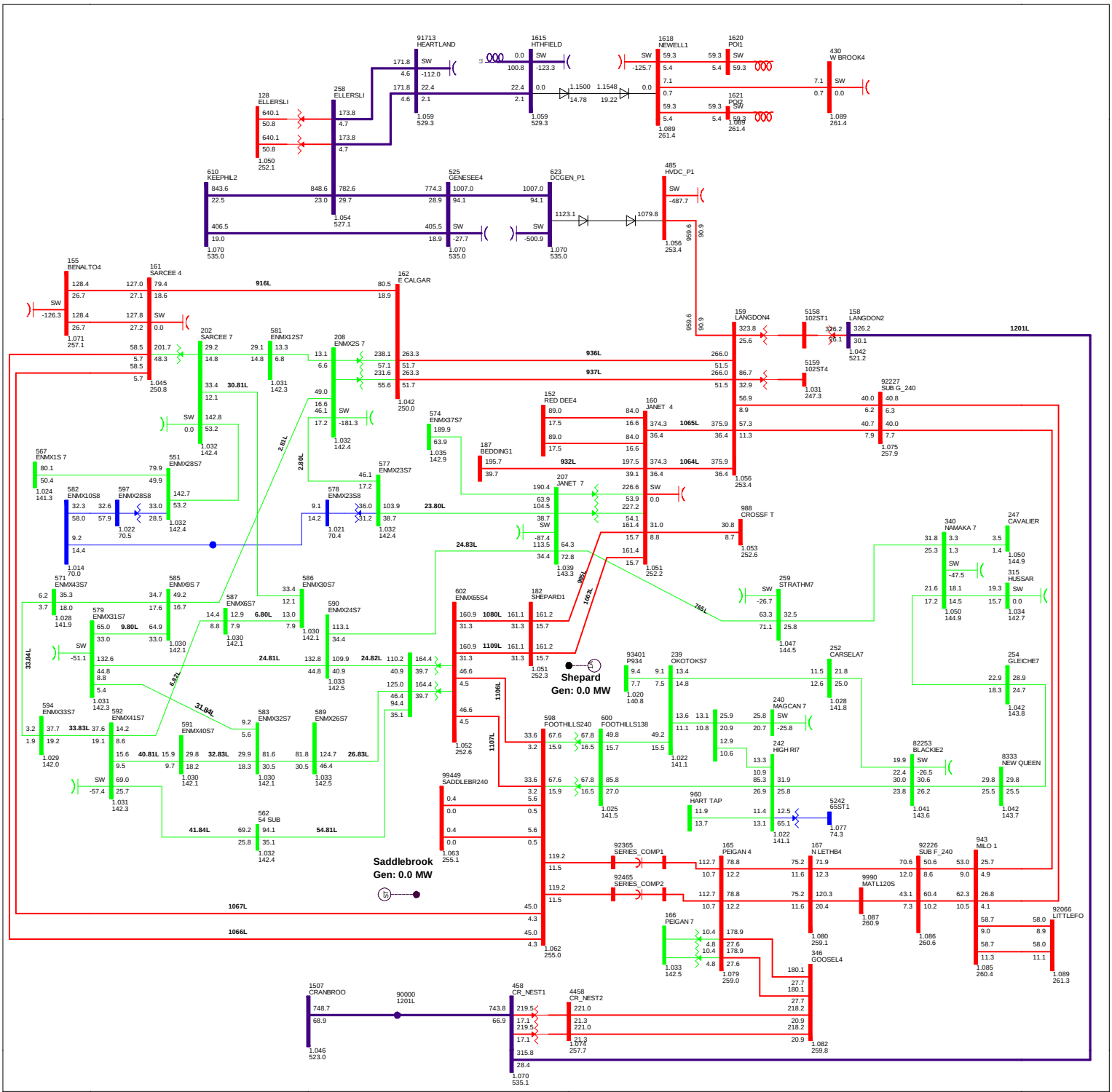
FRI, JUN 08 2012 16:40

C-4: FATD-Full Assessment

Table 4: FATD Full Maximum Loading on Critical Lines with FATD+HVDC under Category B

Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration	
				2014 Need	2019 HVDC FATD Full
				√ indicates loading below 80% N/A indicates the circuit does not exist	
D-Sc1A-1	BASE CASE	240 kV line (Langdon 102S to HVDC_P1)	SC1A	91% 960MVA	91% 960MVA
D-Sc1A-2	Open 240 kV line (Langdon 102S to HVDC_P1)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	105% 89MVA	94% 80MVA
D-Sc3-2	Open 240/138 kV transformer (East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC3	N/A	91% 364MVA
D-Sc3-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S)	937L 240 kV line (Langdon 102S to East Calgary 5S)	SC3	N/A	√
D-Sc3-4	Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC3	N/A	√
D-Sc4-2	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25)	1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	SC4	172% 854MVA	√
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	95% 268MVA	√
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	278% 711MVA	√
		24.83L 138 kV line (Janet 74S to ENMAX No. 24)	SC4	104% 325MVA	√
		240/138 kV transformer (ENMAX No. 65)	SC4	128% 512MVA	√
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	109% 279MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	120% 308MVA	√
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	104% 162MVA	√
		40.81L 138 kV line (ENMAX No. 40 to ENMAX No. 41)	SC4	92% 144MVA	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	181% 339MVA	√
		985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	√
D-Sc4-3	Open 23.80L 138 kV line (Janet 74S to ENMAX No. 23)	9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	120% 229MVA	√
D-Sc4-4	Open 24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	82% 227MVA	√
D-Sc4-5	Open 24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	164% 1086MVA	√
		26.81L 138 kV line (ENMAX No. 26 to ENMAX No. 54)	SC4	89% 233MVA	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	100% 262MVA	√
D-Sc4-6	Open 240/138 kV transformer (East Calgary 5S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	90% 377MVA	√
D-Sc4-7	Open 240/138 kV transformer (ENMAX No. 65)	240/138 kV transformer (ENMAX No. 65)	SC4	84% 335MVA	√
D-Sc4-8	Open 240/138 kV transformer (Janet 74S)	240/138 kV transformer (Janet 74S)	SC4	95% 381MVA	80% 321MVA
D-Sc4-9	Open 26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	120% 345MVA	√
		24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC4	145% 382MVA	80% 213MVA
		31.84L 138 kV line (ENMAX No. 31 to ENMAX No. 32)	SC4	√	√
D-Sc4-10	Open 9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	91% 145MVA	√
D-Sc4-11	Open 916L 240 kV line (Sarcee 42S to East Calgary 5S)	240/138 kV transformer (East Calgary 5S)	SC4	103% 347MVA	√
D-Sc4-12	Open 985L 240 kV line (Janet 74S to ENMAX No. 25)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	N/A	√

2019 Loading Violations
Scenario 1A



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

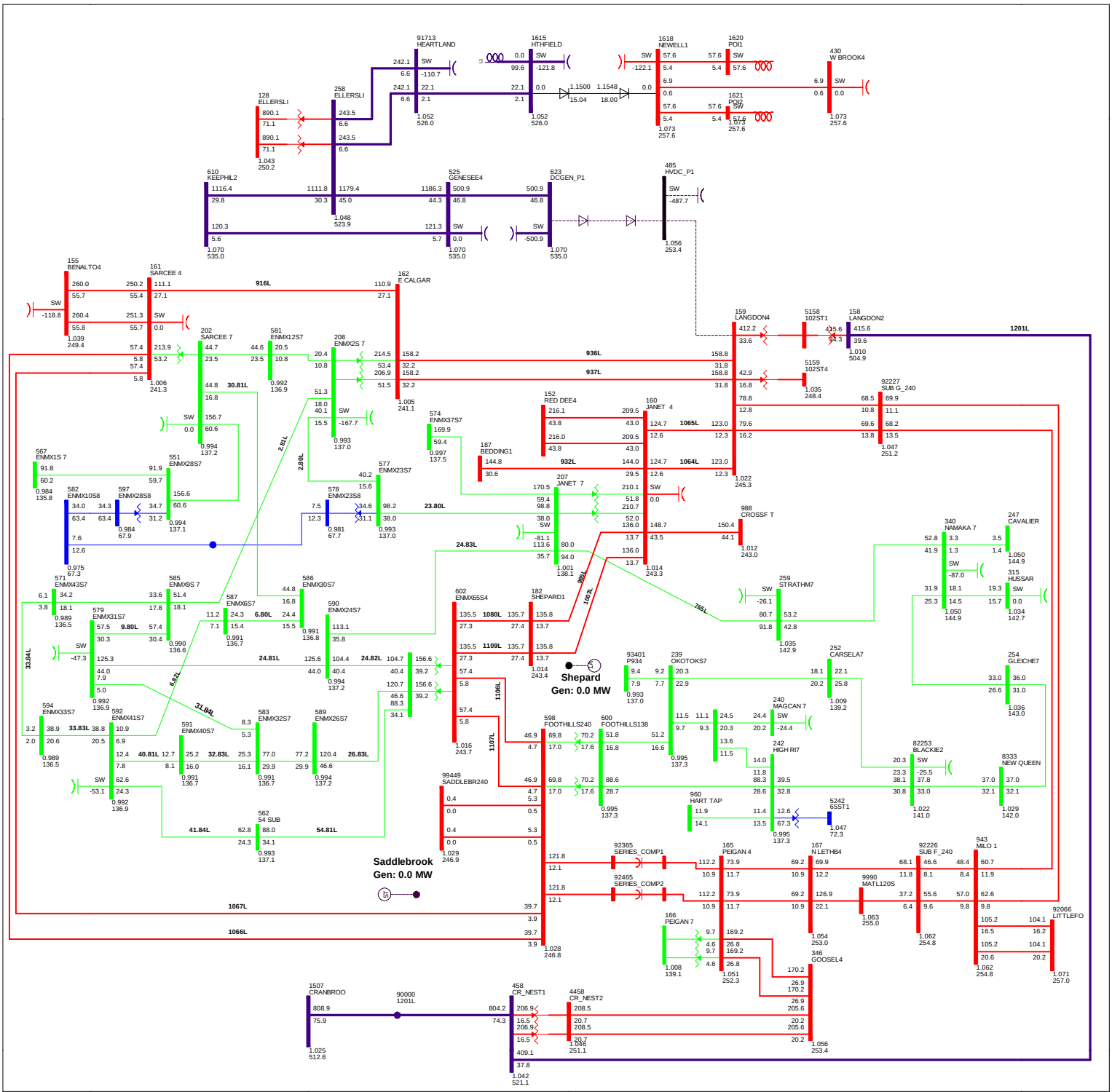
BCH Import: 781.9 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC1A-1: BASECASE

2019_FATD-F_HVDC_SC1A_SP

FRI, JUN 08 2012 16:49



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import:848.3 MW

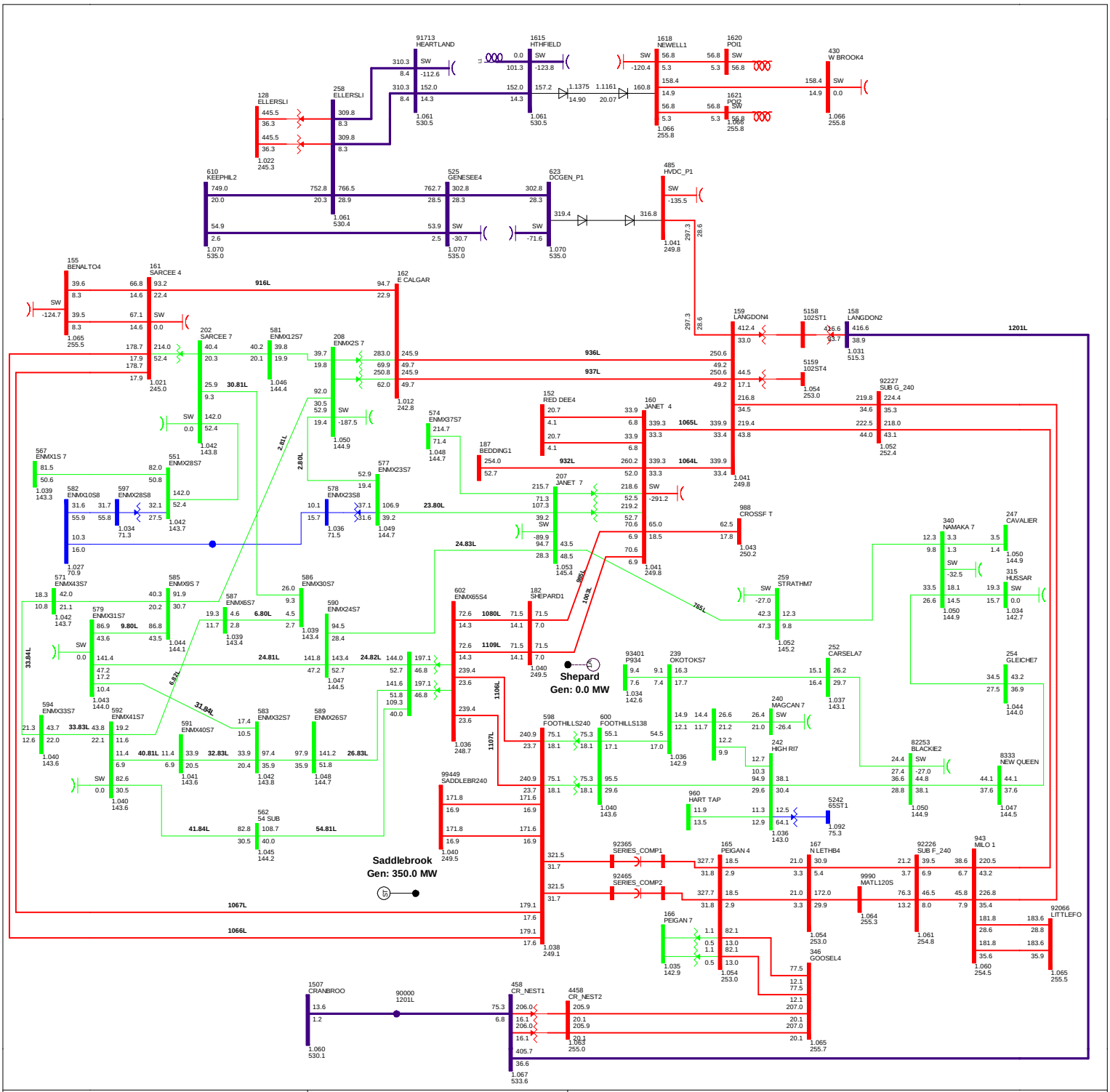
2012LTO+HVDC FULL SYSTEM

FIG D-SC1A-2: OPEN 240 KV LINE (LANGDON 102S TO HVDC_P1)

2019_FATD-F_HVDC_SC1A_SP

FRI, JUN 08 2012 16:49

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

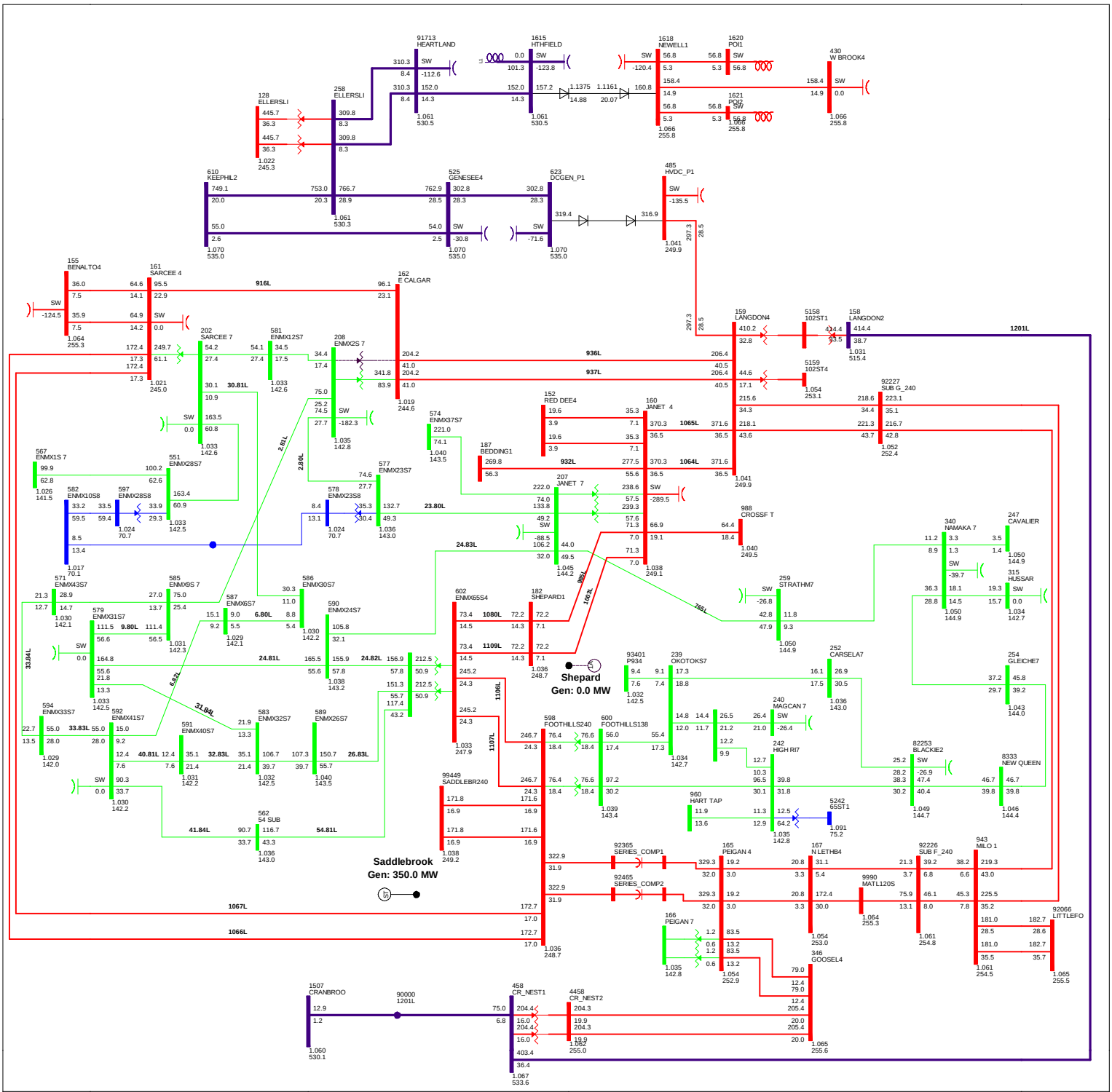
BCH Import: -6.4 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC3-1: BASECASE

2019_FATD-F_HVDC_SC3_SP

FRI, JUN 08 2012 16:49



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

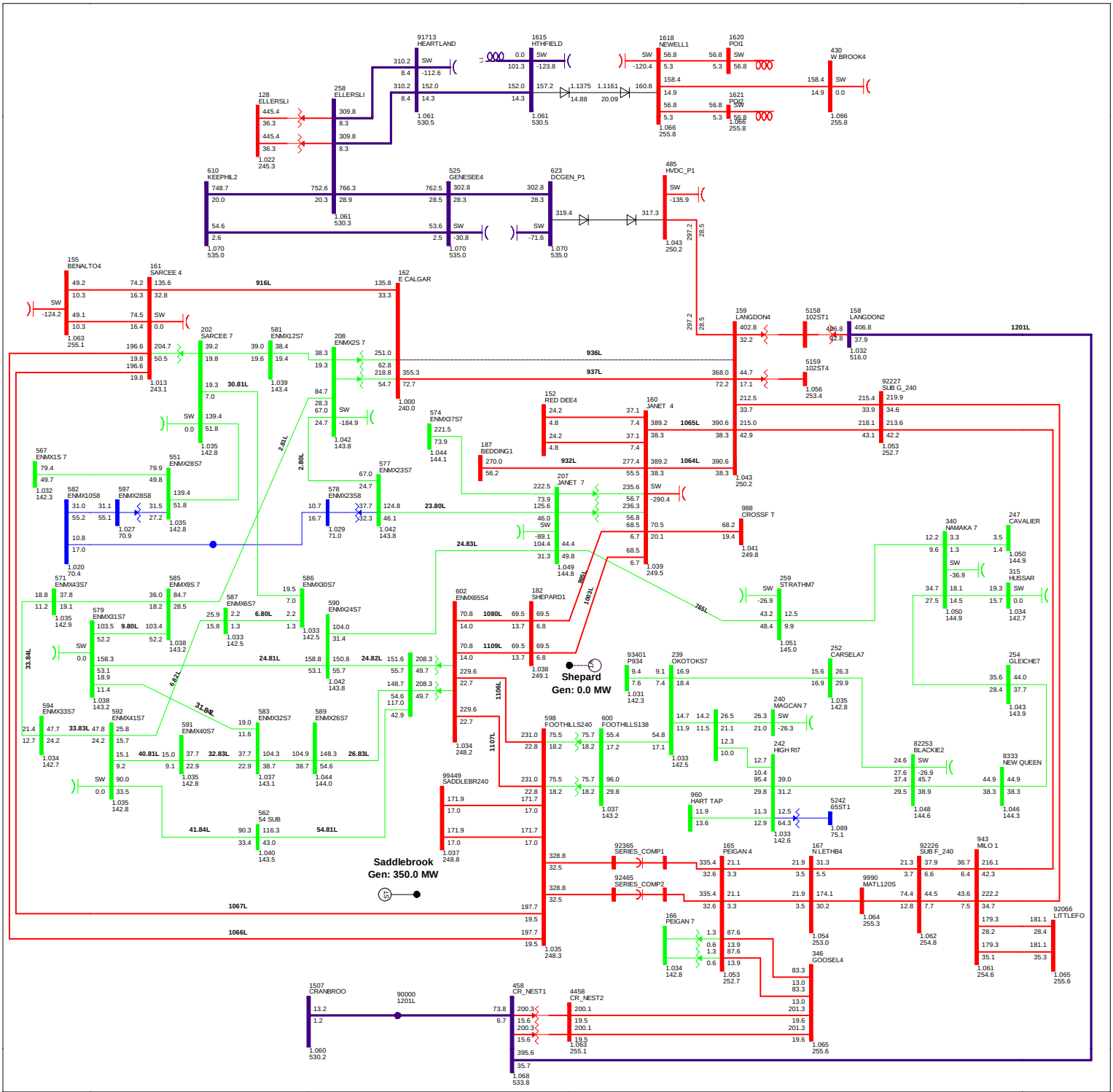
BCH Import: -4.3 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC3-2: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_FATD-F_HVDC_SC3_SP

FRI, JUN 08 2012 16:49



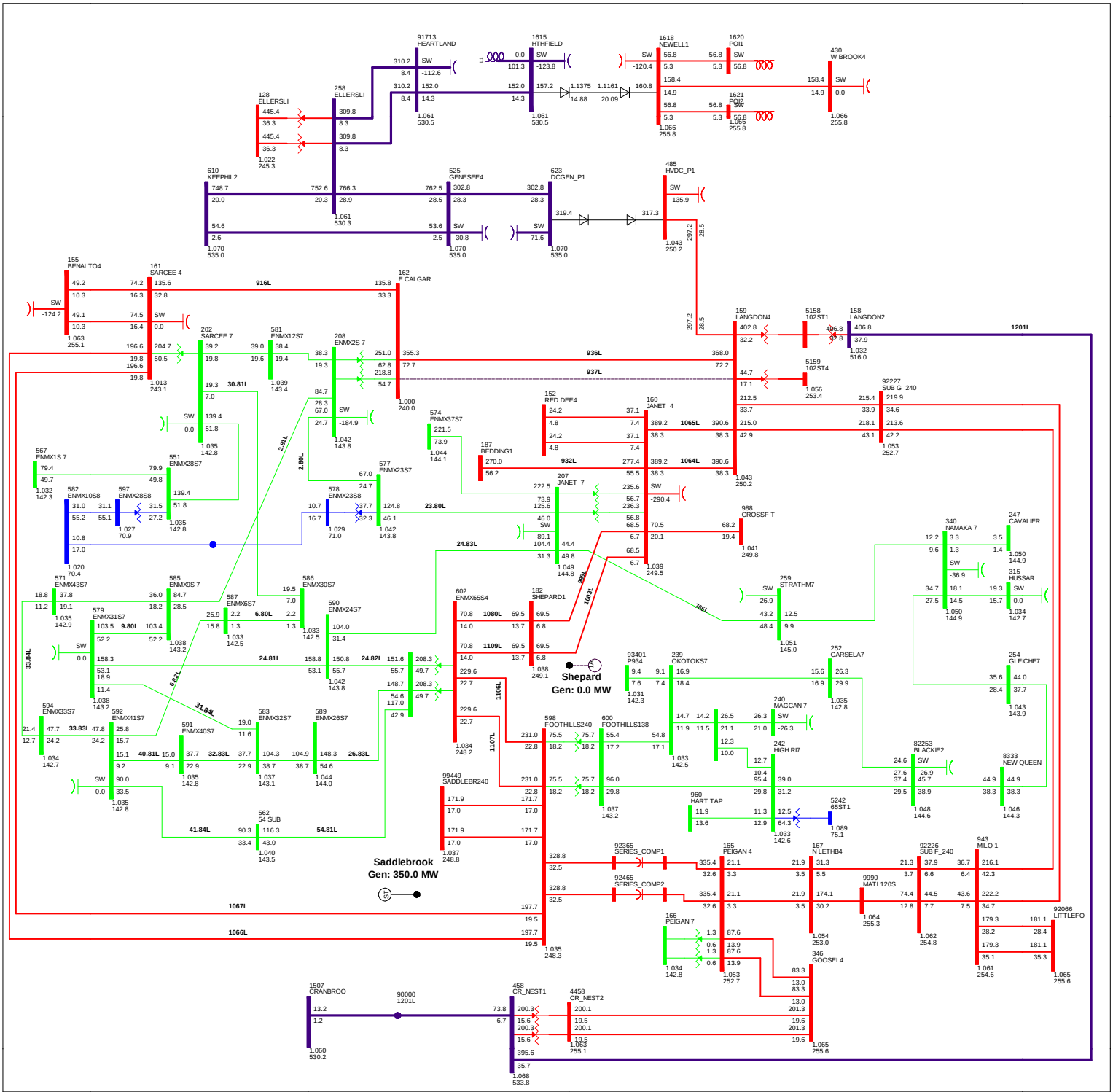
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: -2.9 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC3-3: OPEN 936L 240 KV LINE (LANGDON 102S TO EAST CAL
2019_FATD-F_HVDC_SC3_SP

FRI, JUN 08 2012 16:49



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

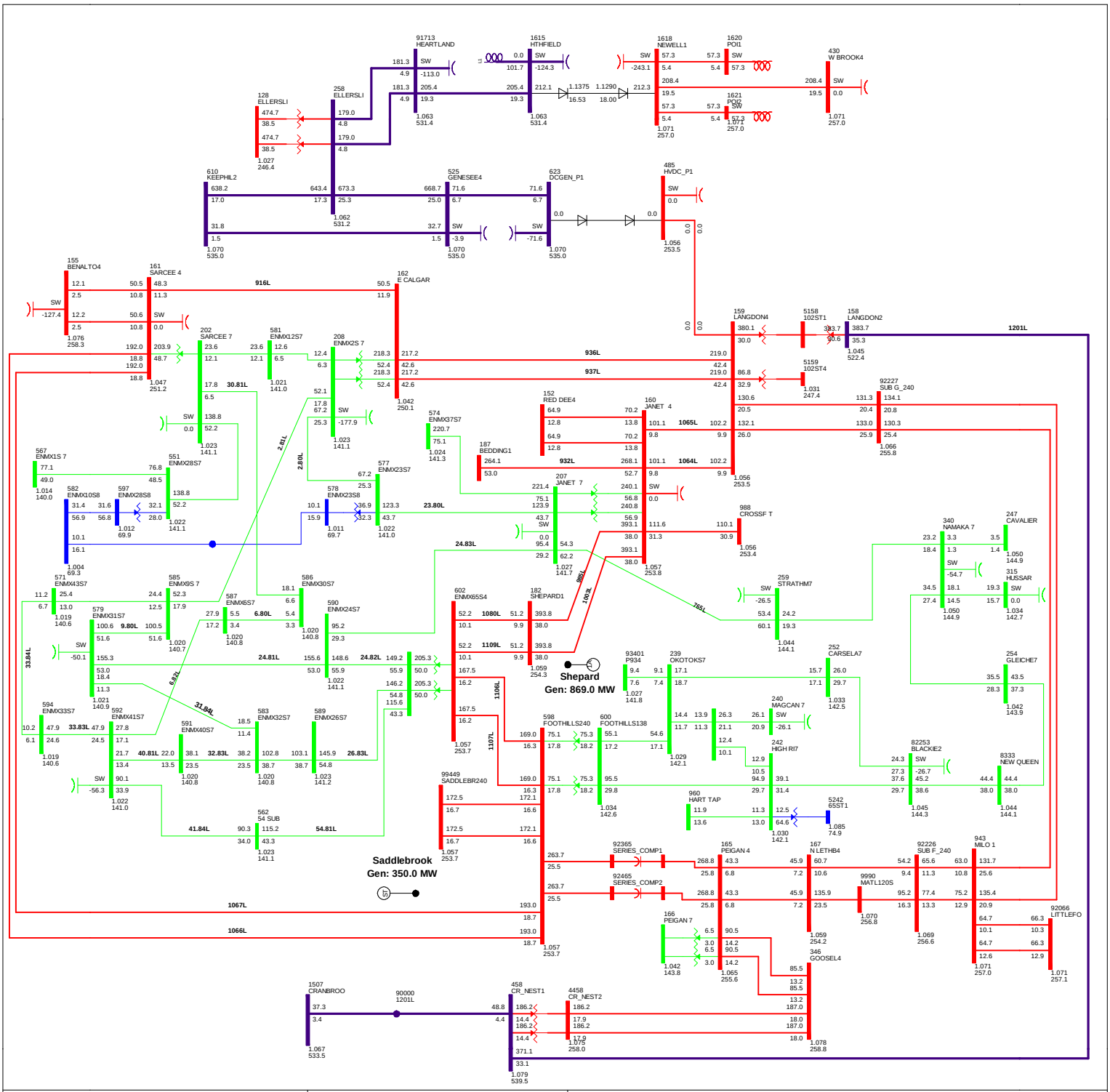
BCH Import: -2.9 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC3-4: OPEN 937L 240 KV LINE (LANGDON 102S TO EAST CAL
2019_FATD-F_HVDC_SC3_SP

FRI, JUN 08 2012 16:49

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

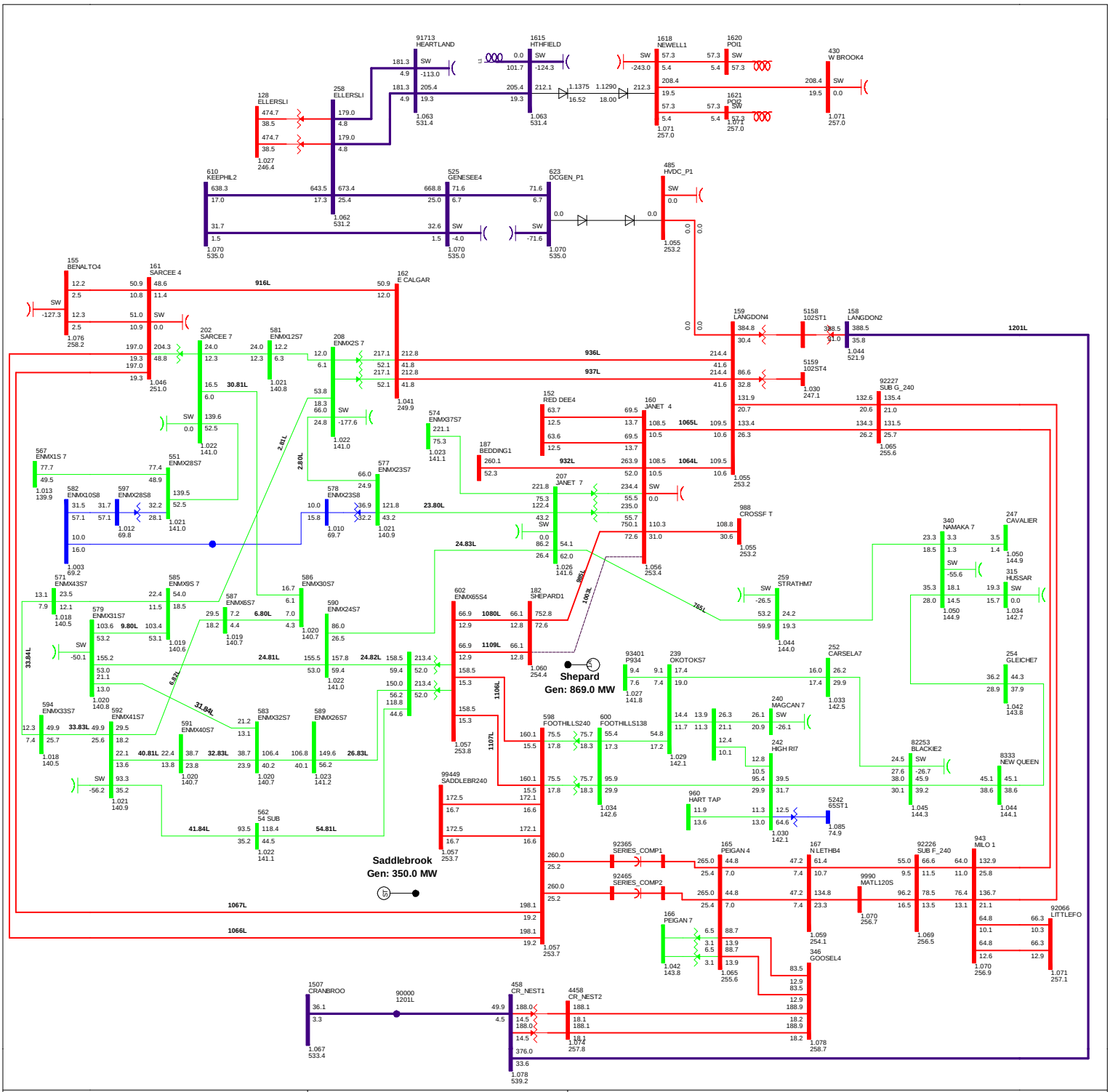
BCH Import: 0.7 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-1: BASECASE

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

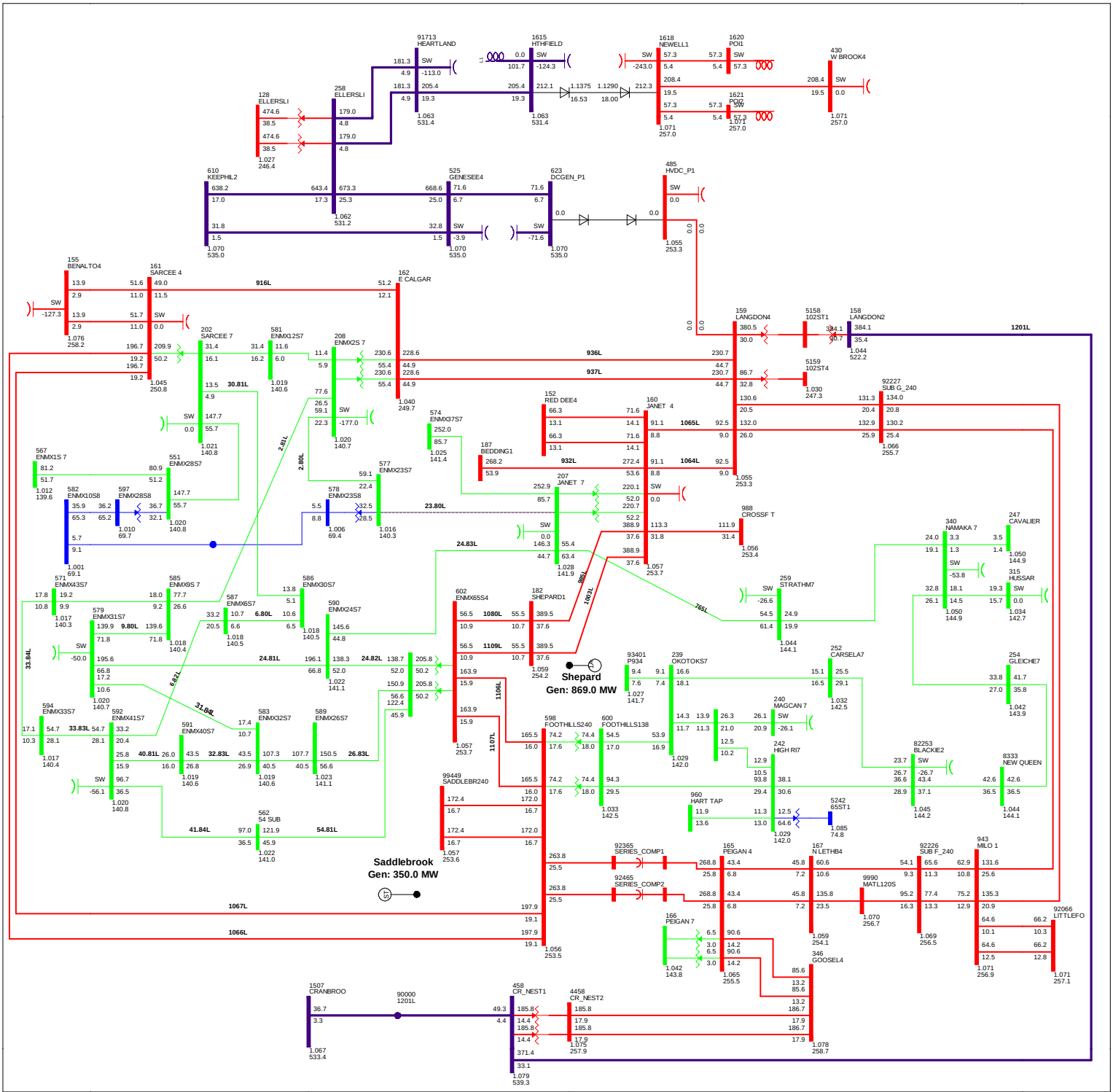
BCH Import: 1.4 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-2: OPEN 1003L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



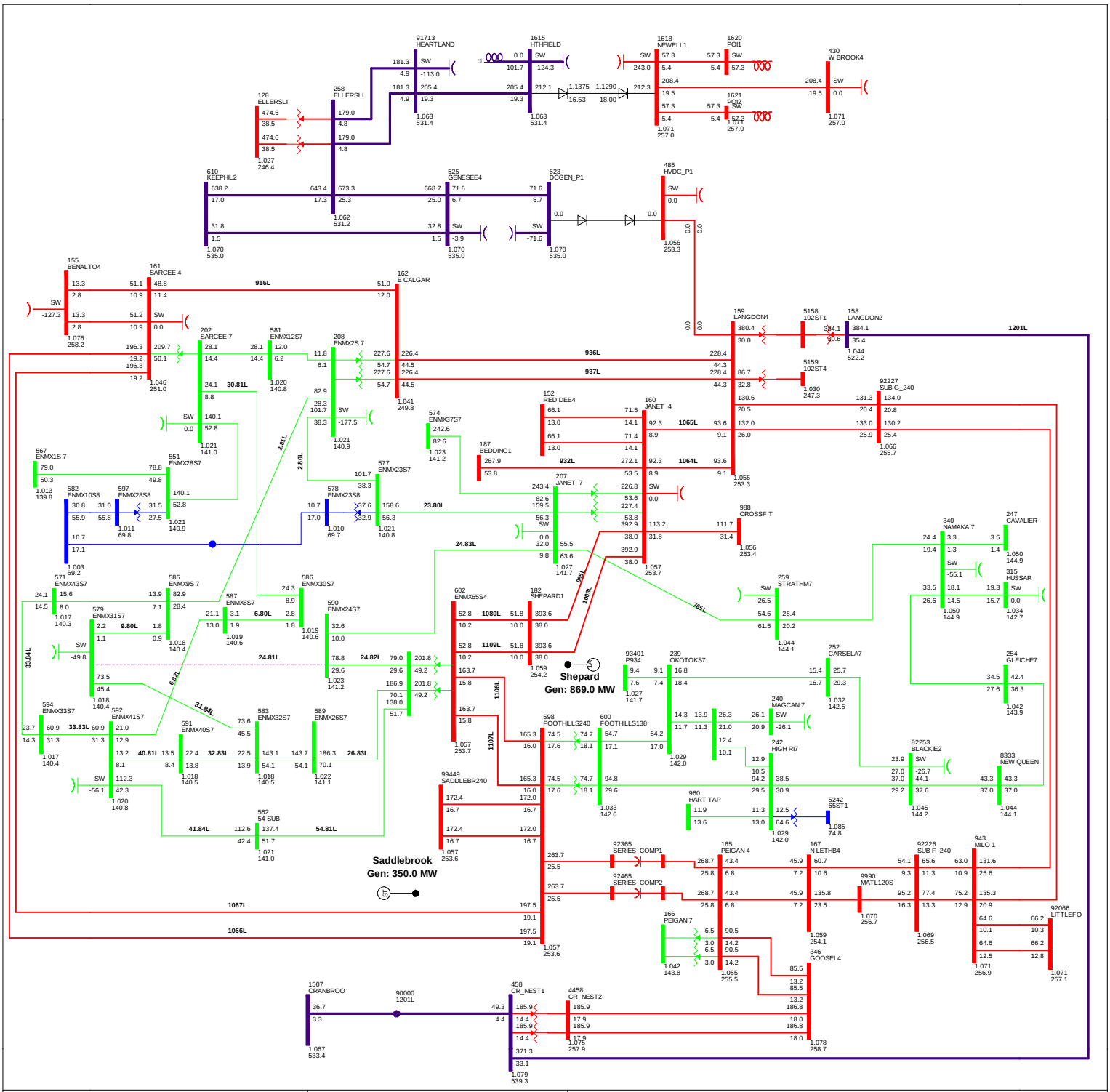
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 2.0 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-3: OPEN 23.80L 138 KV LINE (JANET 74S TO ENMAX 23)
2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

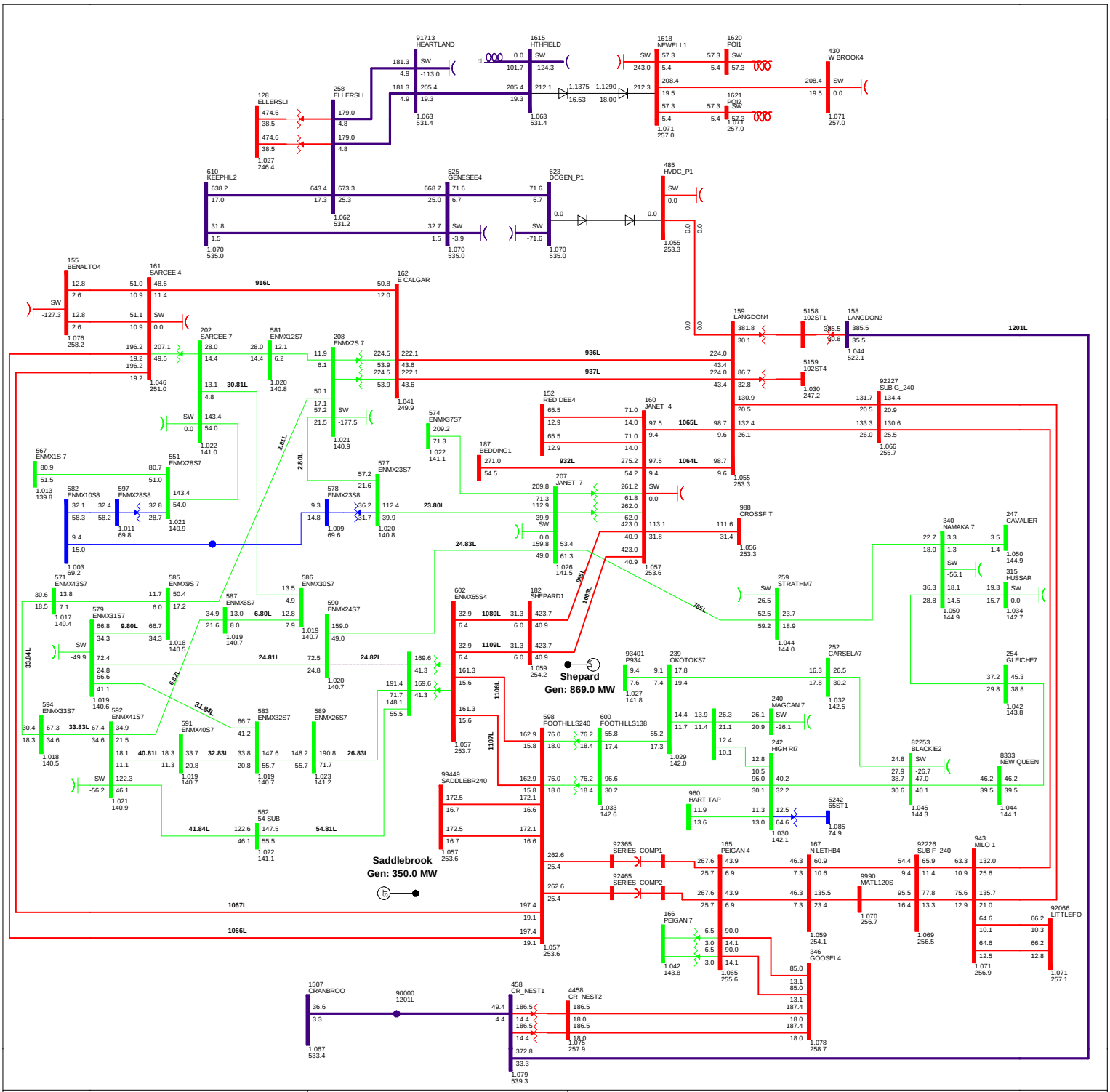
BCH Import: 1.5 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-4: OPEN 24.81L 138 KV LINE (ENMAX 31 TO ENMAX 24)

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

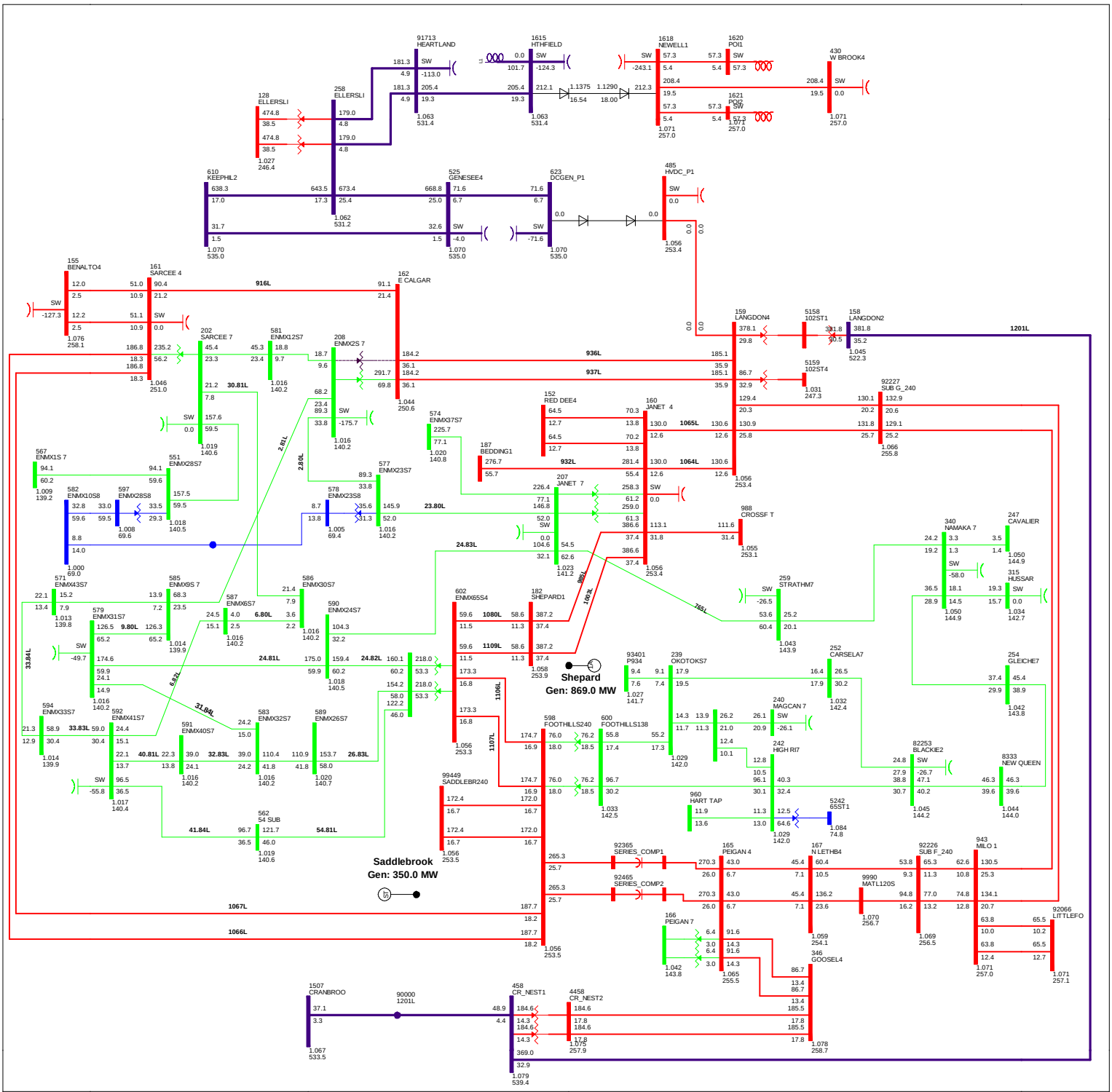
BCH Import: 1.8 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-5: OPEN 24.82L 138 KV LINE (ENMAX 65 TO ENMAX 24)

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

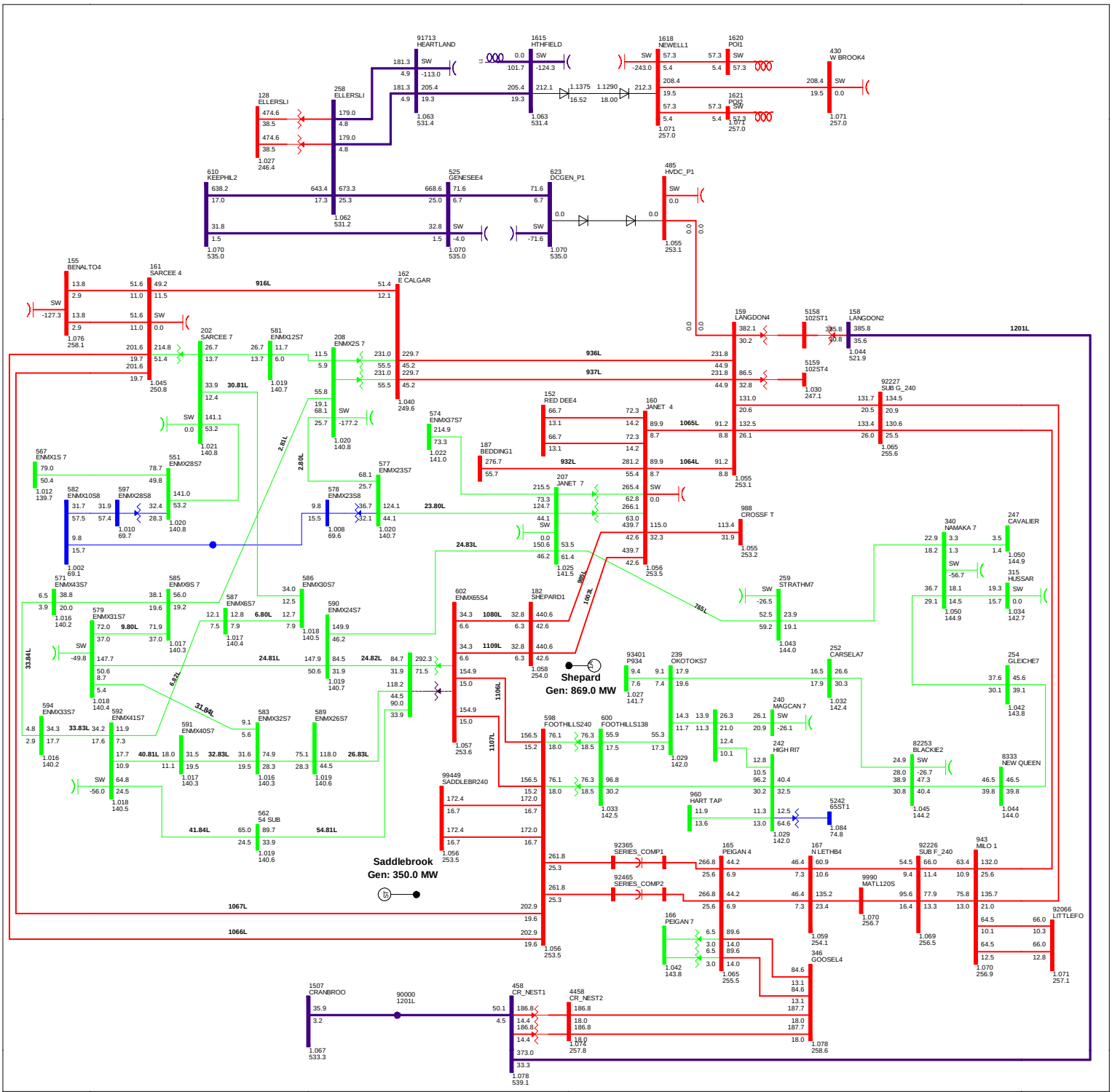
BCH Import: 2.5 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-6: OPEN 240/138 KV TRANSFORMER (EAST CALGARY 5S)

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

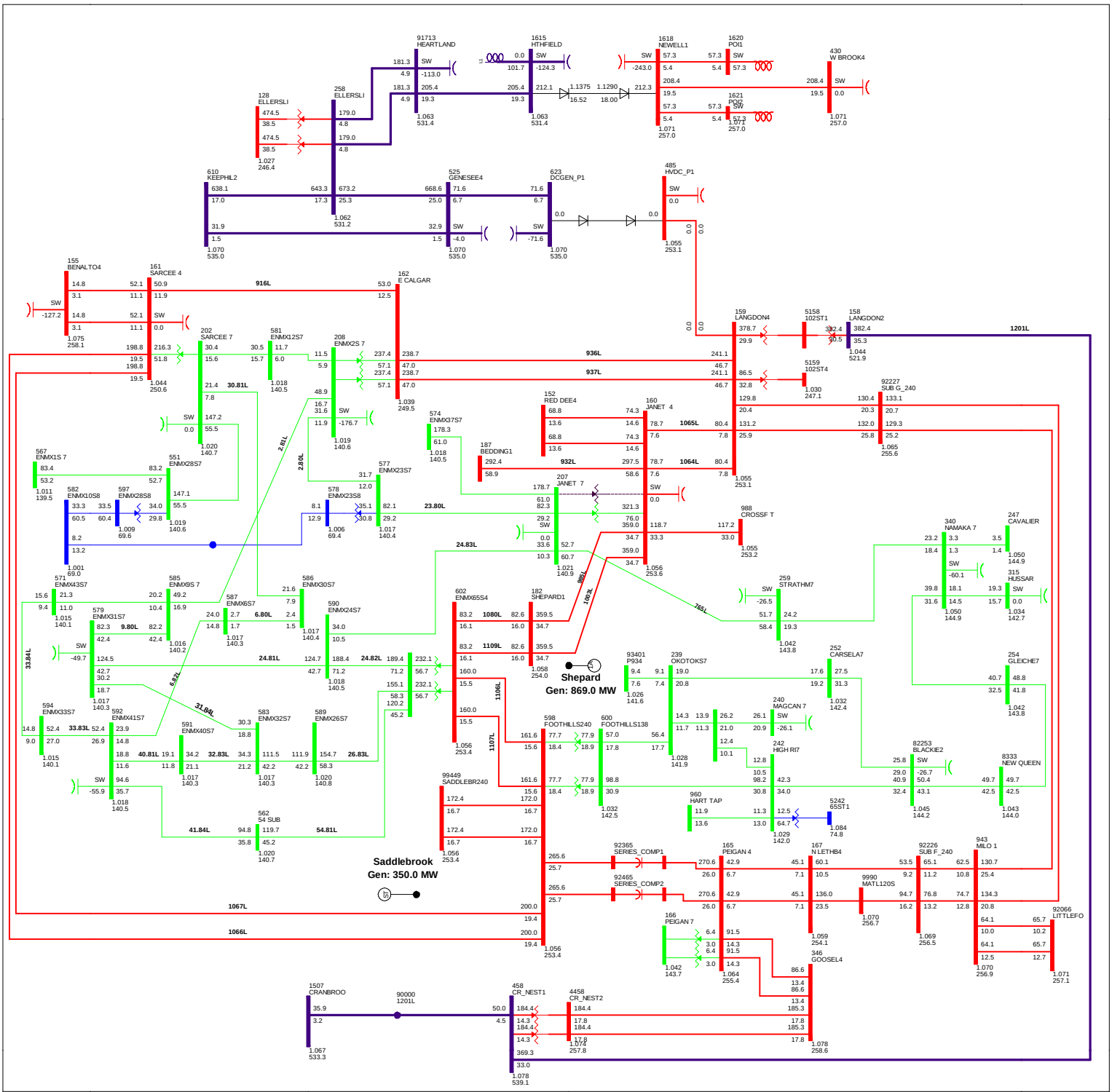
BCH Import: 1.5 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-7: OPEN 240/138 KV TRANSFORMER (ENMAX 65)

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

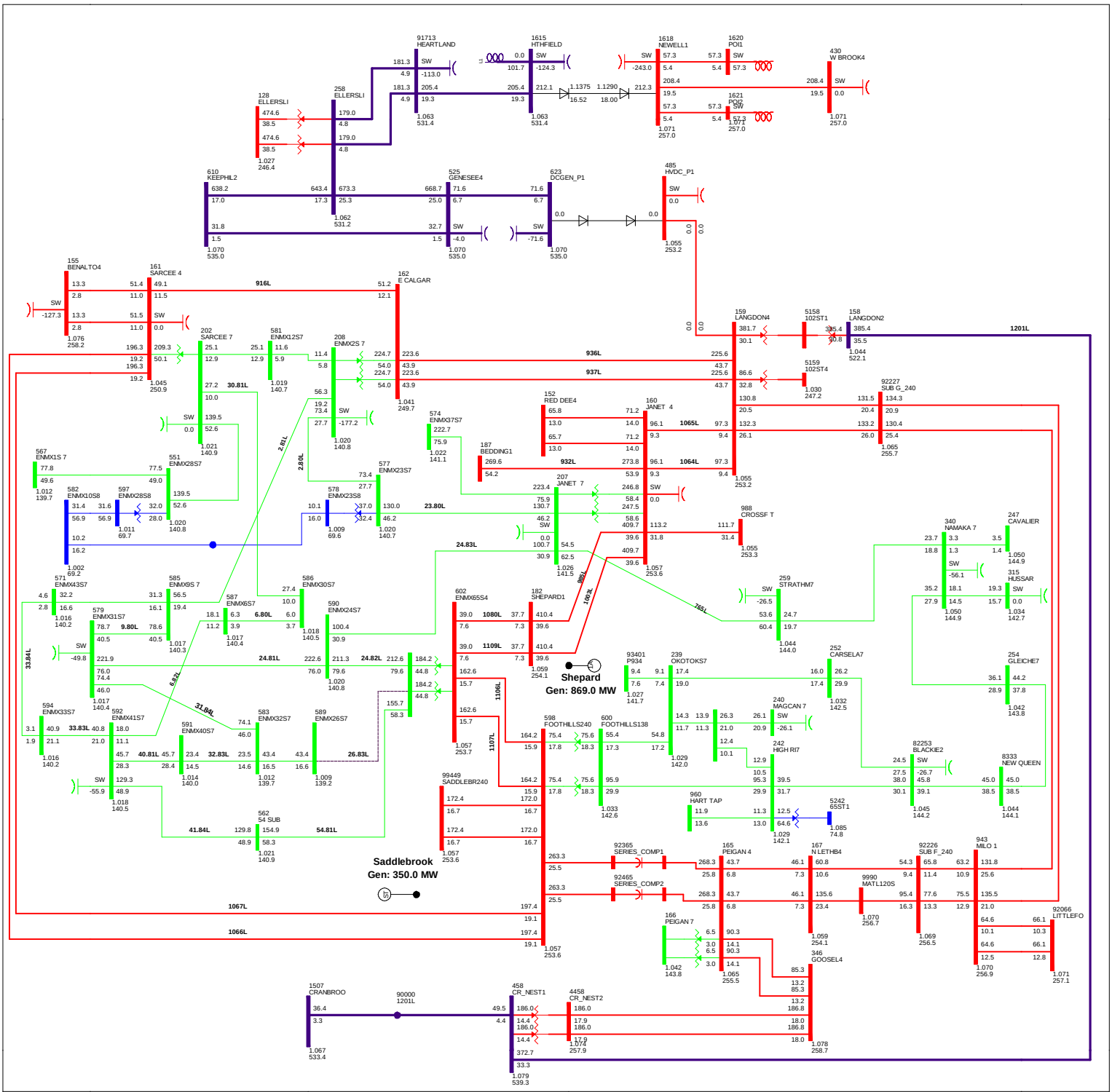
BCH Import: 2.8 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-8: OPEN 240/138 KV TRANSFORMER (JANET 74S)

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

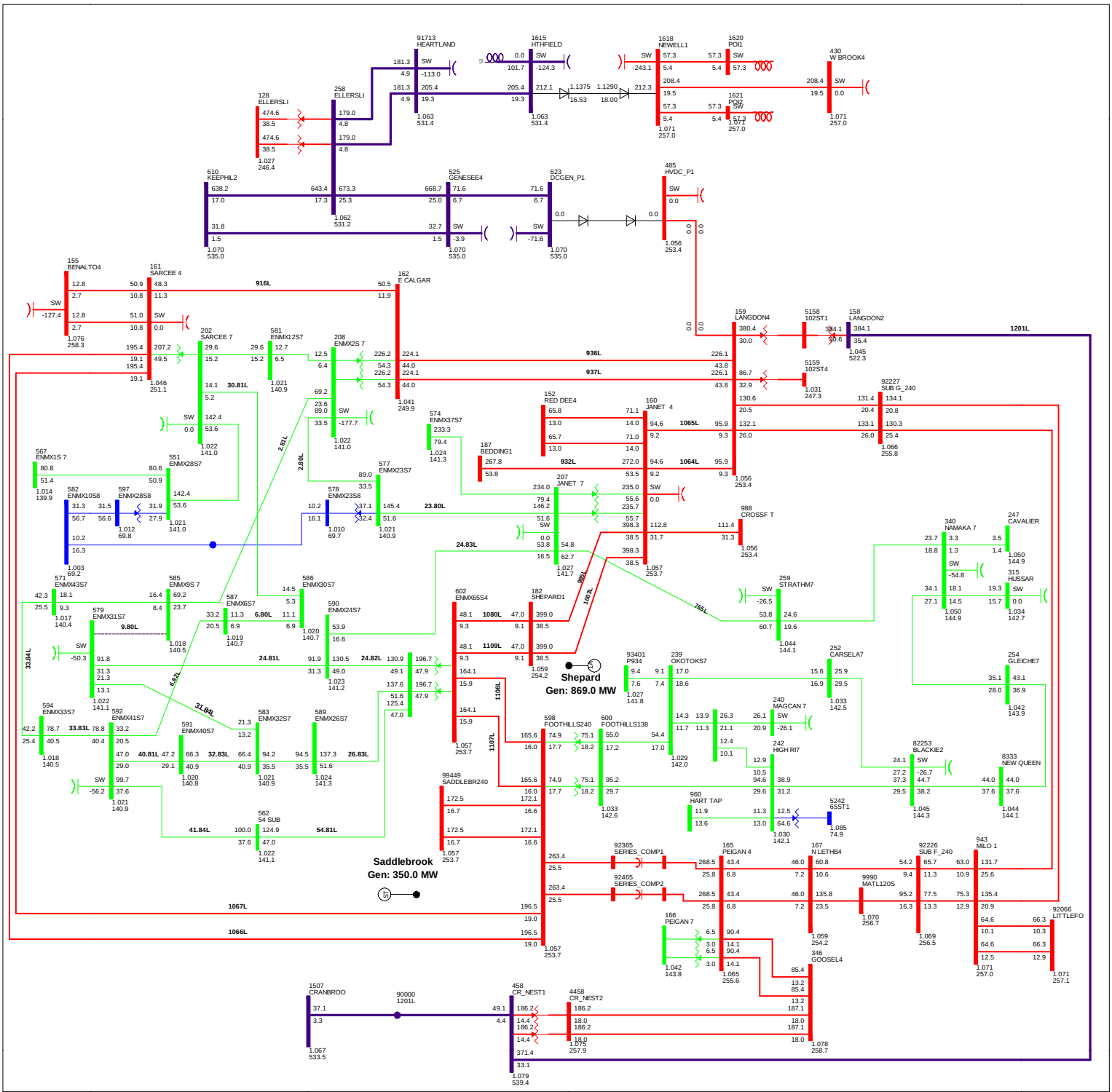
BCH Import: 2.8 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-9: OPEN 26.83L 138 KV LINE (ENMAX 65 TO ENMAX 26)

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

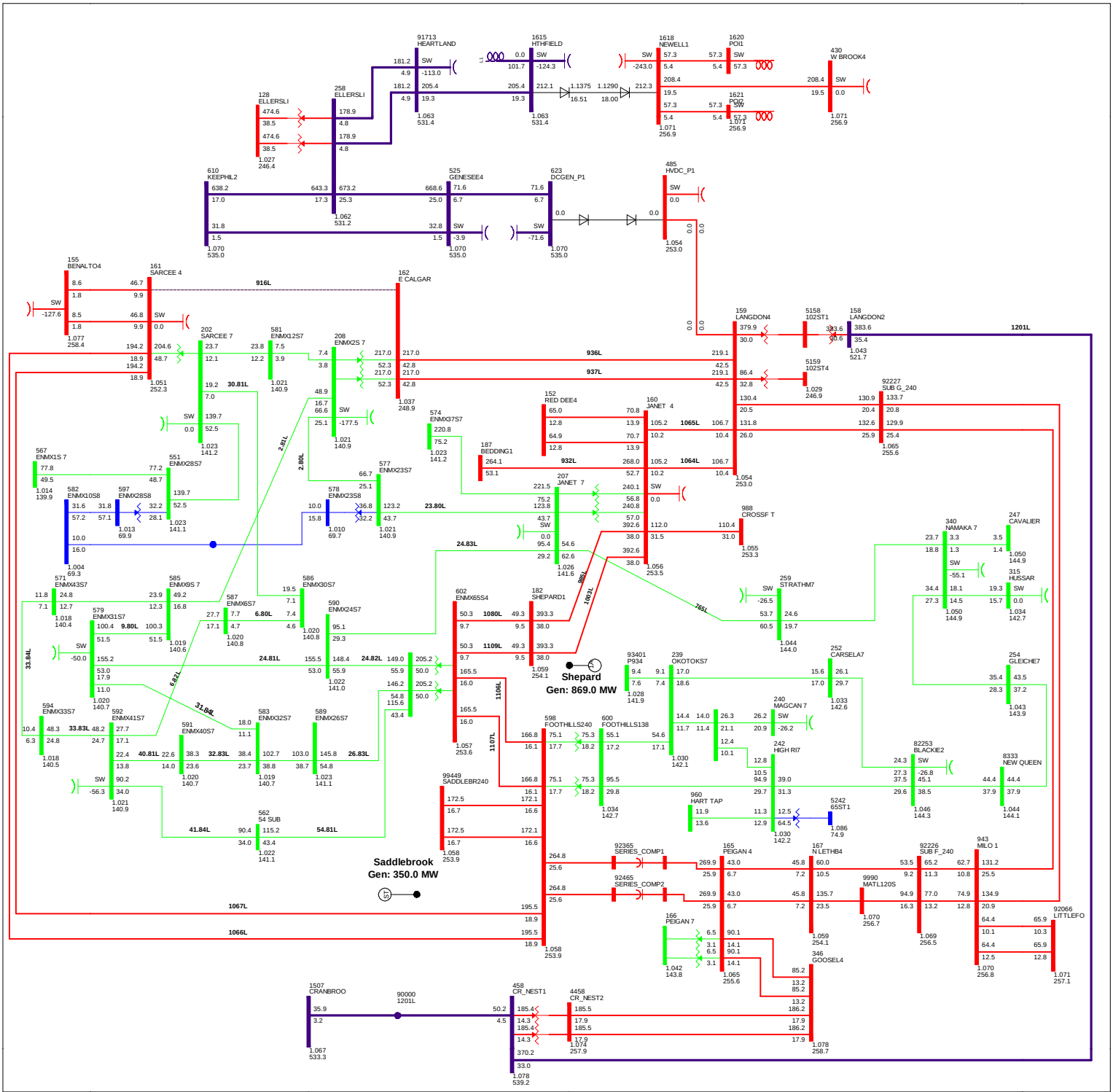
BCH Import: 1.0 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-10: OPEN 9.80L 138 KV LINE (ENMAX 31 TO ENMAX 9)

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



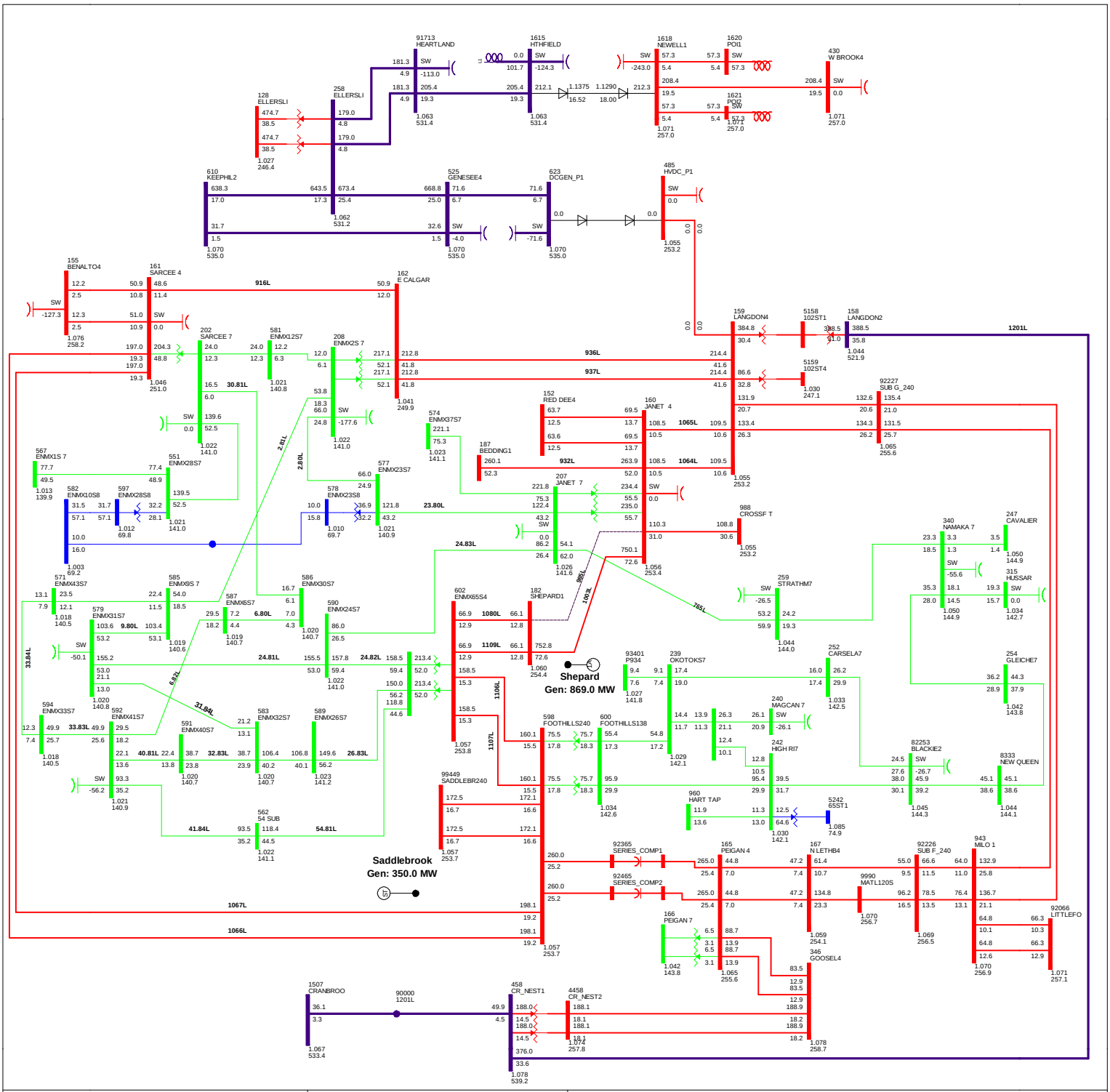
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 0.7 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-11: OPEN 916L 240 KV LINE (SARCEE 42S TO EAST CALG
2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 1.4 MW

2012LTO+HVDC FULL SYSTEM

FIG D-SC4-12: OPEN 985L 240 KV LINE (JANET 74S TO ENMAX 25)

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:50

Attachment D – Category C5 2012LTO Results & Plots

Table of Contents

Attachment D – Category C5 2012LTO Results & Plots

- **D-1: FATD-East Assessment**
  - **2019 Loading Violations Scenario 3**
  - **2019 FATD-East Curtailment Assessment Scenario 3**
  - **2019 Loading Violations Scenario 4**
  - **2019 FATD-East Curtailment Assessment Scenario 4**
- **D-2: FATD-East + 3rd Circuit Assessment**
  - **2019 Loading Violations Scenario 3**
  - **2019 Loading Violations Scenario 4**
  - **2019 FATD-East + 3rd Circuit Curtailment Assessment Scenario 4**
- **D-3: FATD-Full Assessment**
  - **2019 Loading Violations Scenario 3**
  - **2019 Loading Violations Scenario 4**

All References in this Attachment to Crowsnest 491S means Chapel Rock 491S

D-1: FATD-East Assessment

Table 1: FATD East Maximum Loading on Critical Lines with 2019 FATD under Category C5

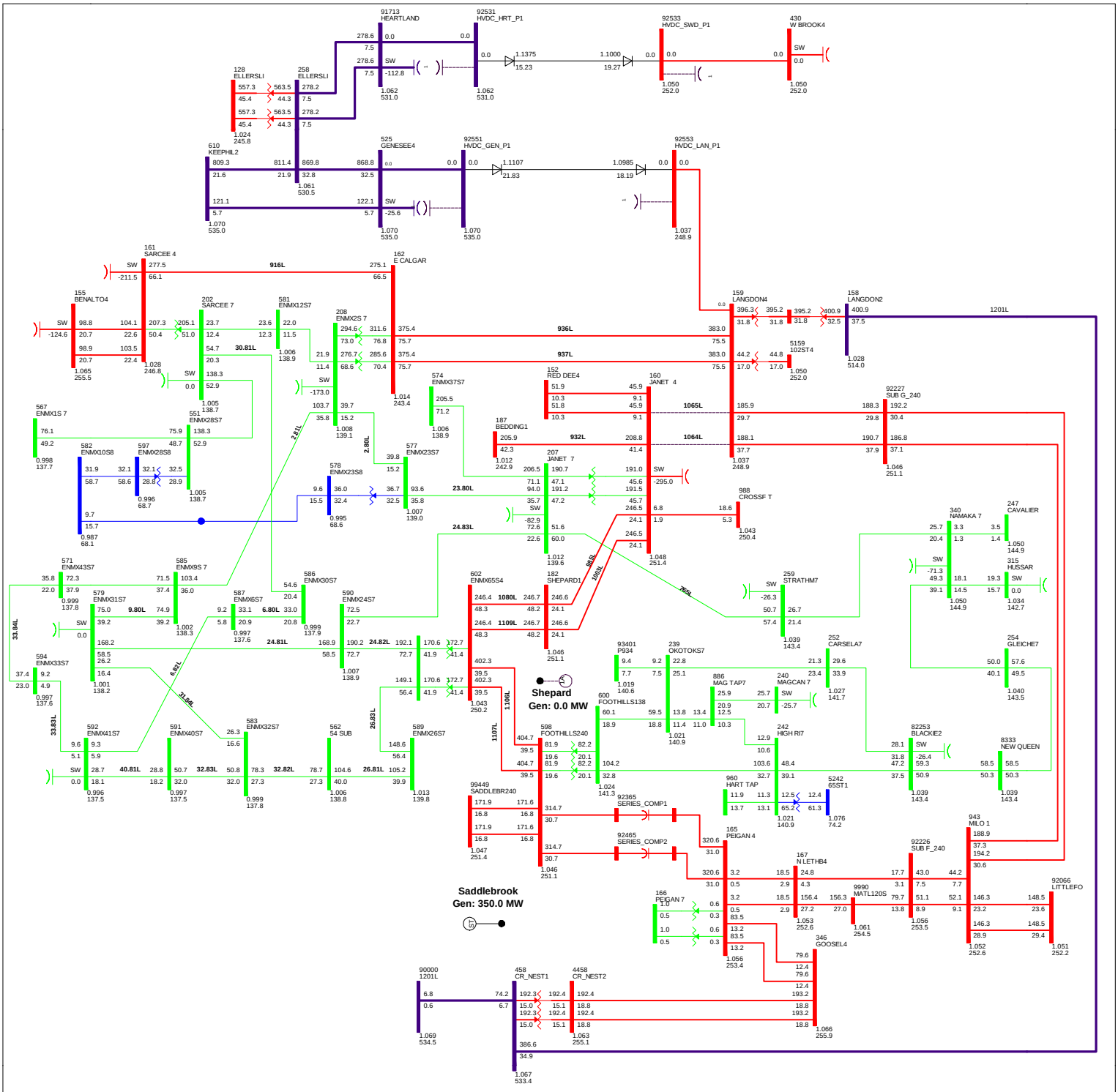
Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration FATD East √ indicates loading below 80% N/A indicates the circuit does not exist
C5-C-SC3-1	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	240/138 kV transformer (East Calgary 5S)	SC3	√
C5-C-SC3-2	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	135% 355MVA
C5-C-SC3-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC3	√
C5-C-SC4-1	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25) Open 1064L 240 kV line (Langdon 102S to Janet 74S)	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	98% 1042MVA
C5-C-SC4-2	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	81% 353MVA
C5-C-SC4-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	91% 244MVA
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	√
		23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	108% 311MVA
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	137% 407MVA
		240/138 kV transformer (ENMAX No. 65)	SC4	√
		240/138 kV transformer (Janet 74S)	SC4	99% 396MVA
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	87% 234MVA
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	83% 135MVA
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	162% 319MVA
		932L 240 kV line (Janet 74S to Beddington SS-162)	SC4	87% 435MVA
C5-C-SC4-4	Open 985L 240 kV line (Janet 74S to ENMAX No. 25) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	98% 1042MVA

Table 2: FATD East Required Curtailment "TO" Generation Levels and Load Levels to achieve < 95% Loading Critical Lines with 2019 FATD under Category C

Figure Number	Contingency	Critical Circuit	Scenario	FATD East	Mitigation Option
CURTAIL-C-SC3-1	Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	135% 355MVA	Shed 2x42 @ Enmax 24 and 2x23.5 @ Enmax 31 = **Total 131 MW Load Shed + 350 MW Saddlebrook Generation Shed**
CURTAIL-C-SC4-1	Open 936L 240kV line (Langdon 102S to East Calgary 5S) Open 937L 240kV line (Langdon 102S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	SC4	108% 311MVA	Shed 23.7 MW @ Enmax 23, 4x12.7 MW @ Enmax 2, 3x23.5 MW @ Enmax 31, 2x17.6 MW @ Enmax 33, 3x7.9 MW @ Enmax 43, 3x20.7 MW @ Enmax 9, 2x = 15.9MW @ Enmax 41 **Total 297 MW + Open 1 x Enmax 65 240/138 kV transformer** **(24.81L reduced to 96% Loading)**
		24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	137% 407MVA	
		9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)*	SC4	162% 319MVA	

*9.80L (SS-9 to SS-31) line rating can be increased to 287 MVA by adjusting the CT limit ratio to 1200 A. The amount of load shedding was based on this increased rati

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

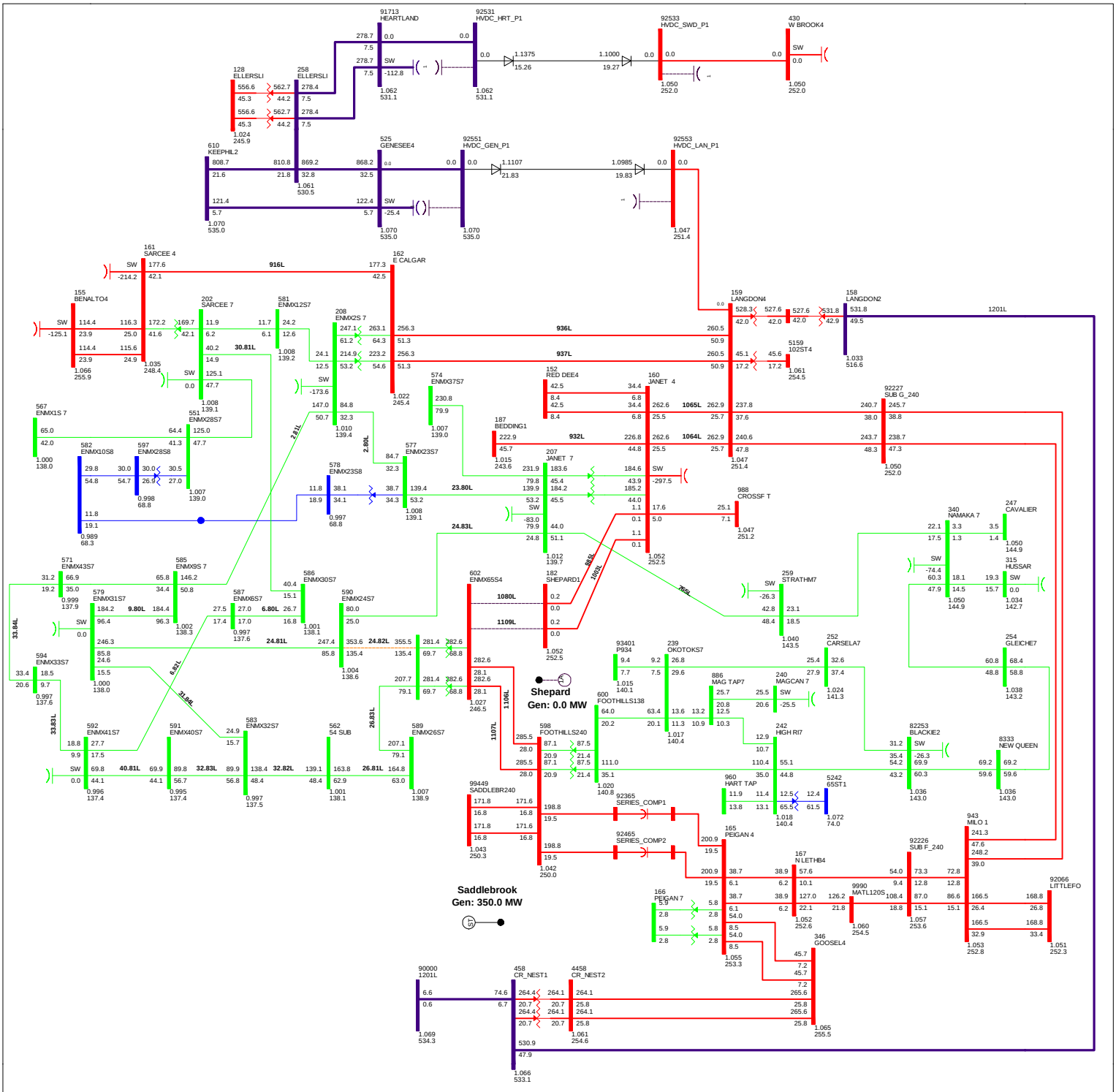
BCH Import: 4.1 MW

2012LTO FATD EAST SYSTEM

FIG C5-C-SC3-1: DOUBLE OUTAGE 1064L AND 1065L

2019_SP_STG3_ALT1_SC3

FRI, JUN 08 2012 16:03



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

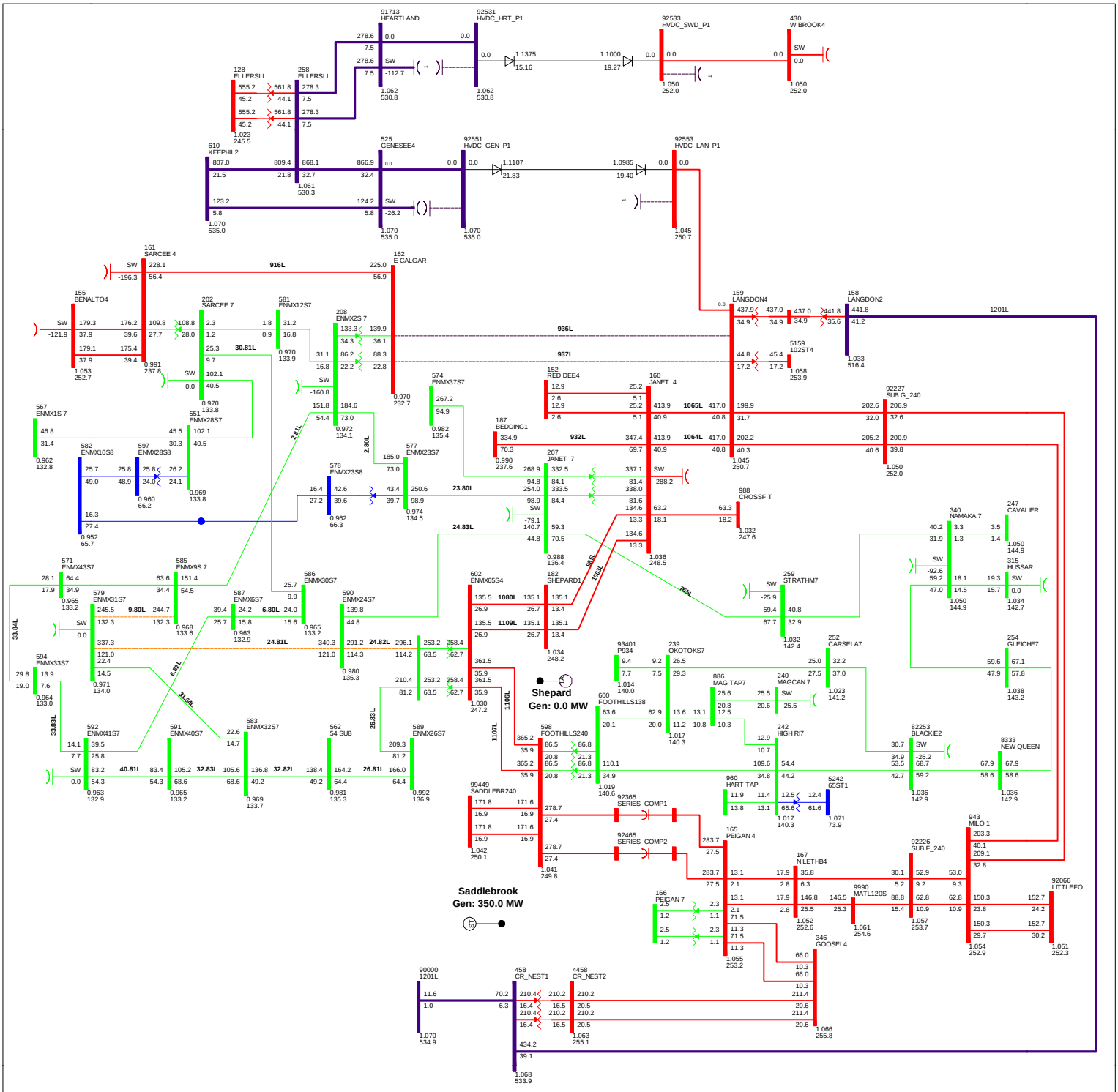
BCH Import: 5.2 MW

2012LTO FATD EAST SYSTEM

FIG C5-C-SC3-2: DOUBLE OUTAGE 1080L AND 1109L

2019_SP_STG3_ALT1_SC3

FRI, JUN 08 2012 16:03



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 24.0 MW

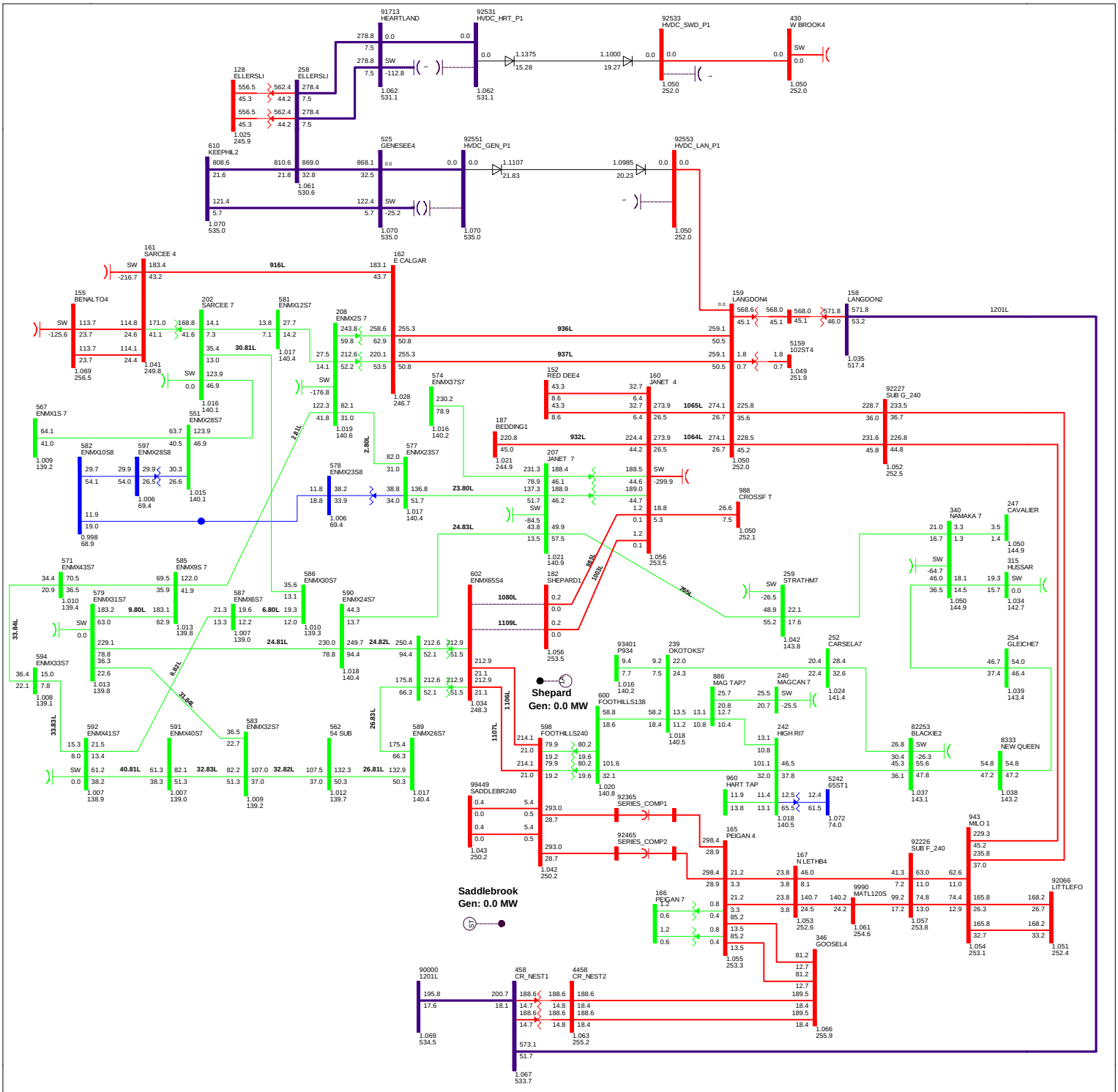
2012LTO FATD EAST SYSTEM

FIG C5-C-SC3-3: DOUBLE OUTAGE 936L AND 937L

2019_SP_STG3_ALT1_SC3

FRI, JUN 08 2012 16:03

2019 FATD-East Curtailment Assessment
Scenario 3



Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

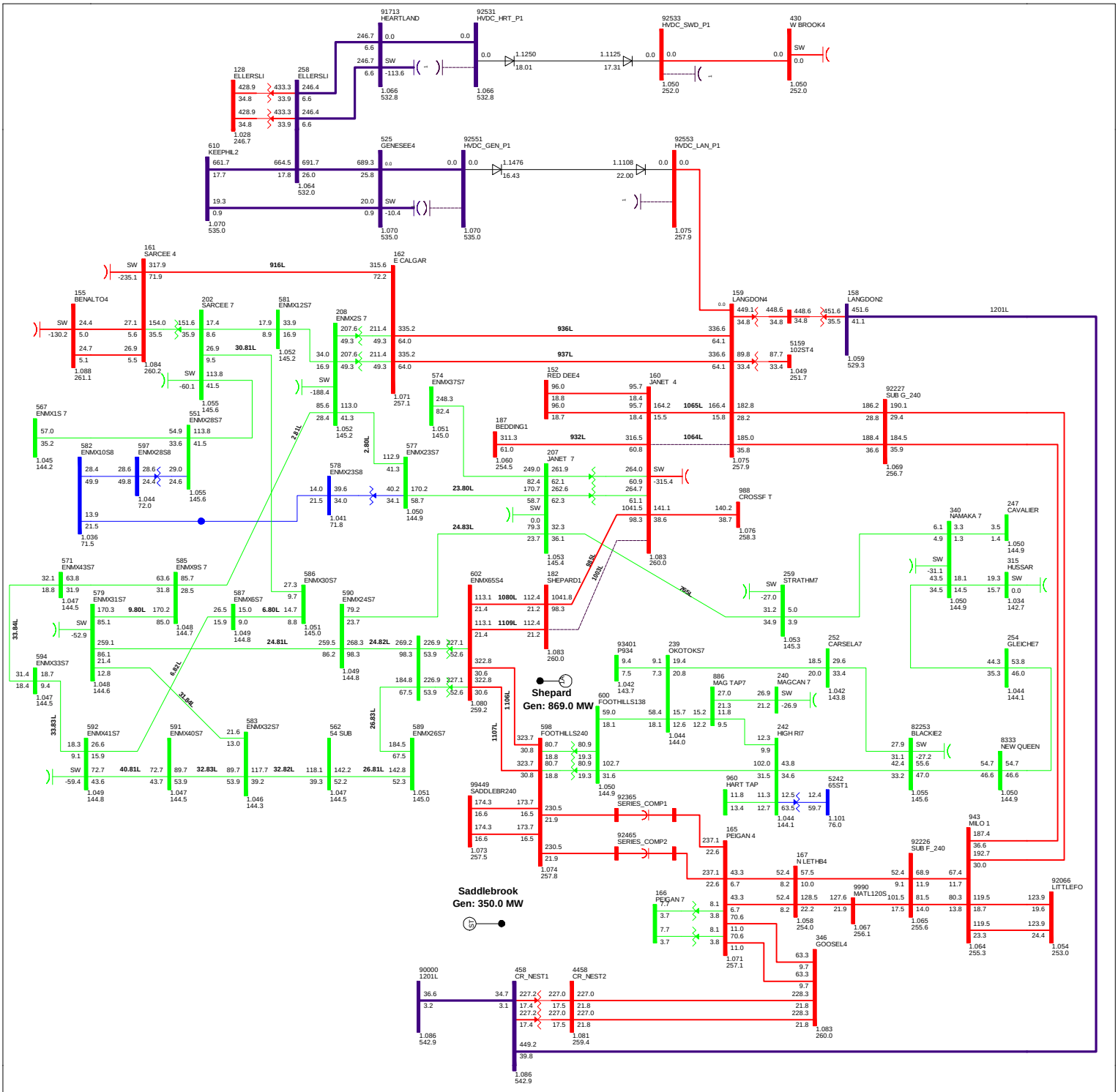
BCH Import: 211.2 MW

2012LTO FATD EAST SYSTEM

FIG CURTAIL-C-SC3-1: 1080L-1109L 131MW LOAD SHED & SABK @0MW
2019_SP_STG3_ALT1_SC3

FRI, JUN 08 2012 16:04

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

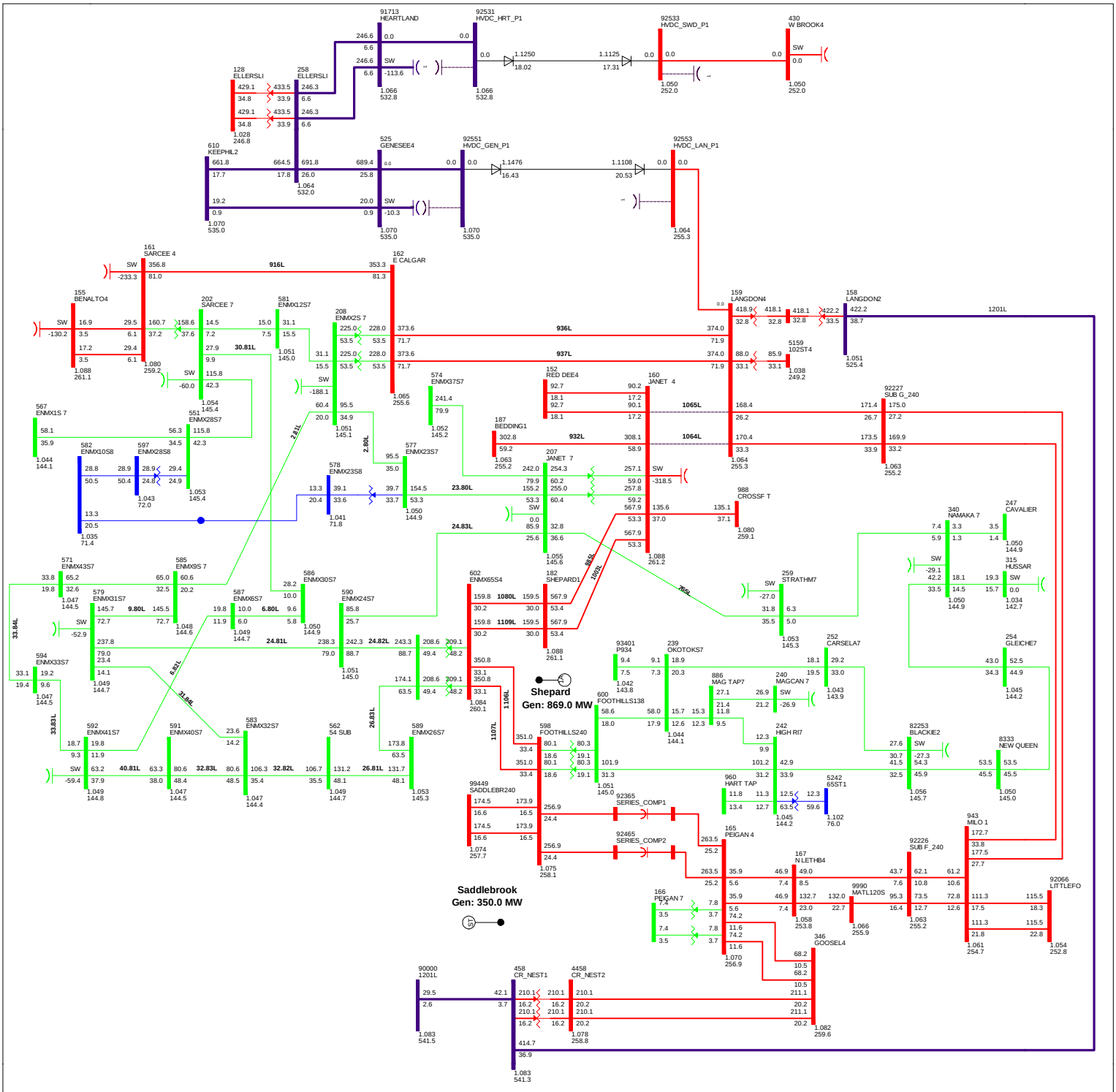
BCH Import: 1.7 MW

2012LTO FATD EAST SYSTEM

FIG C5-C-SC4-1: DOUBLE OUTAGE 1003L AND 1064L

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 16:03



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATE A
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

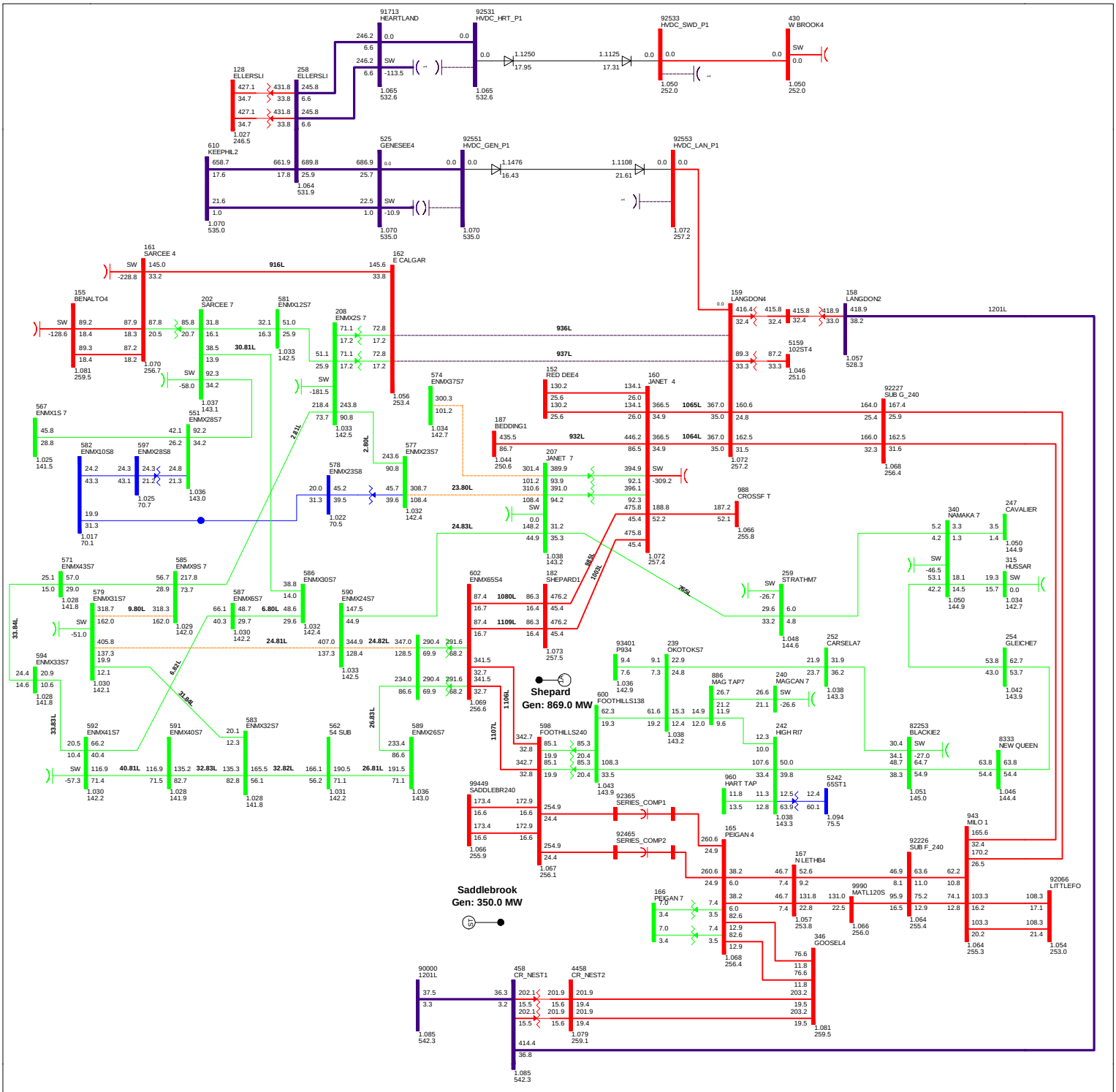
BCH Import: 0.7 MW

2012LTO FATD EAST SYSTEM

FIG C5-C-SC4-2: DOUBLE OUTAGE 1064L AND 1065L

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 16:03



Bus - VOLTAGE (kv/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

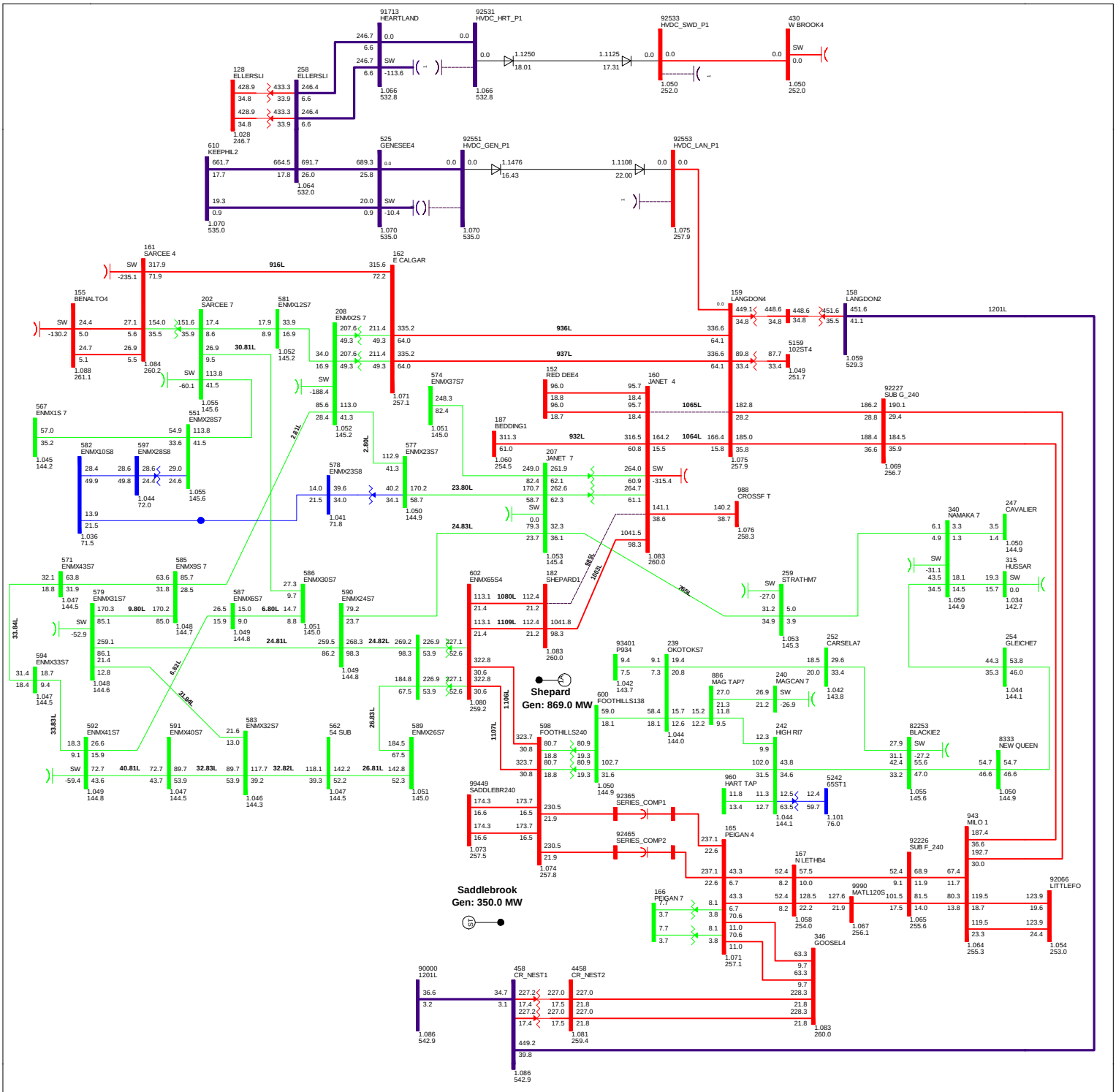
BCH Import: 26.4 MW

2012LTO FATD EAST SYSTEM

FIG C5-C-SC4-3: DOUBLE OUTAGE 936L AND 937L

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 16:03



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.7 MW

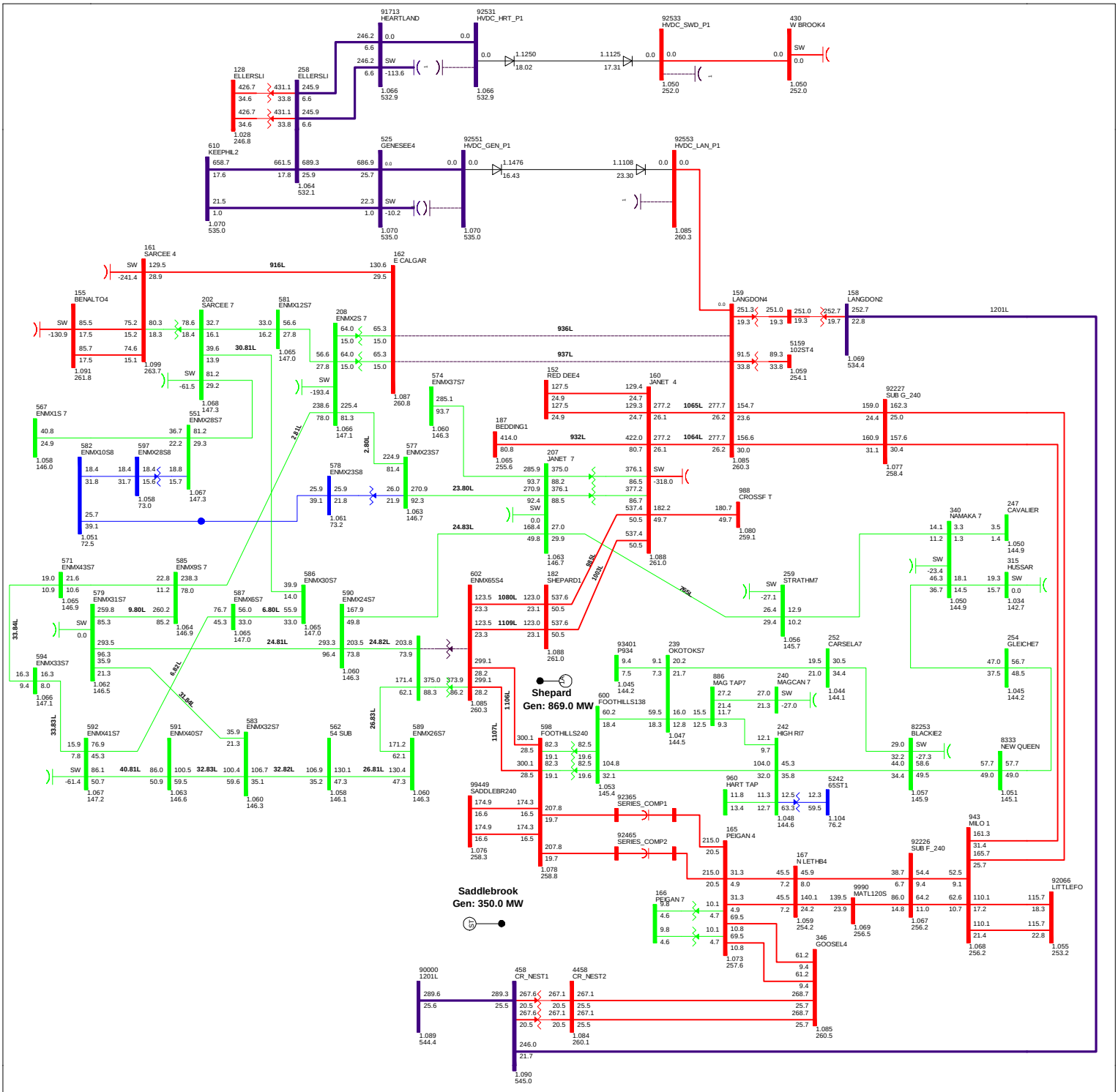
2012LTO FATD EAST SYSTEM

FIG C5-C-SC4-4: DOUBLE OUTAGE 985L AND 1065L

2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 16:03

2019 FATD-East Curtailment Assessment
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import:-292.7 MW

2012LTO FATD EAST SYSTEM

FIG CURTAIL-C-SC4-1: 936L-937L SHED 297 MW CALGARY LOAD & OP
2019_SP_STG3_ALT1_SC4

FRI, JUN 08 2012 16:04

D-2: FATD-East + 3rd Circuit Assessment

Table 3:FATD East+3rdCkt Maximum Loading on Critical Lines with 2019 FATD under Category C5

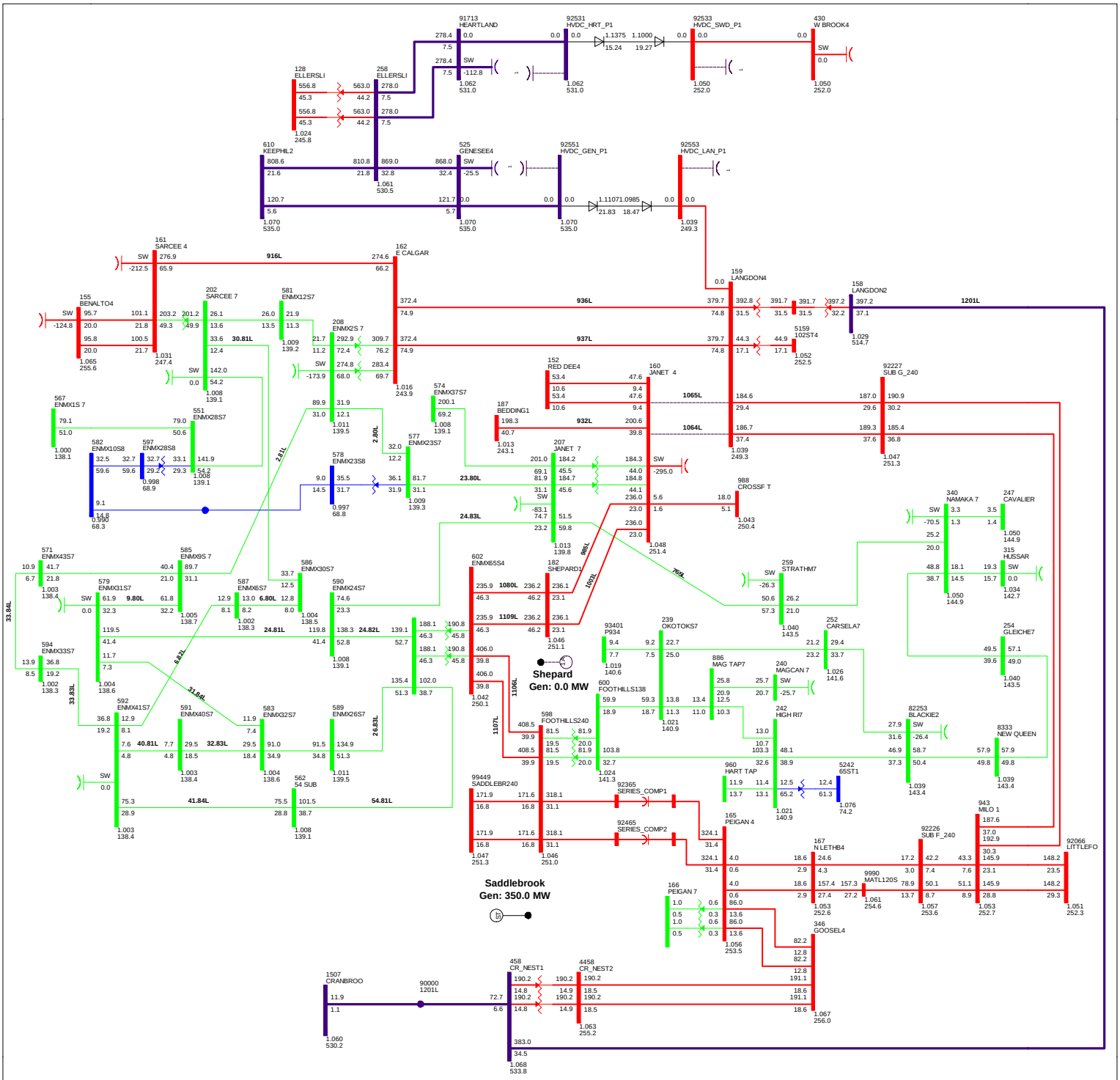
Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration FATD East+3rdCkt √ indicates loading below 80% N/A indicates the circuit does not exist
C5-D-SC3-1	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	240/138 kV transformer (East Calgary 5S)	SC3	√
C5-D-SC3-2	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	95% 249MVA
C5-D-SC3-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC3	√
C5-D-SC4-1	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25) Open 1064L 240 kV line (Langdon 102S to Janet 74S)	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	94% 992MVA
C5-D-SC4-2	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	81% 351MVA
C5-D-SC4-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	81% 218MVA
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	84% 249MVA
		23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	98% 283MVA
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	103% 306MVA
		240/138 kV transformer (ENMAX No. 65)	SC4	82% 327MVA
		240/138 kV transformer (Janet 74S)	SC4	95% 379MVA
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	81% 217MVA
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	143% 282MVA
		932L 240 kV line (Janet 74S to Beddington SS-162)	SC4	83% 417MVA
C5-D-SC4-4	Open 985L 240 kV line (Janet 74S to ENMAX No. 25) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	94% 992MVA

Table 4: FATD East+3rdCkt Required Curtailment to achieve < 95% Loading Critical Lines with 2019 FATD+3rdCkt under Category C5

Figure Number	Contingency	Critical Circuit	Scenario	FATD East+3rdCkt	Mitigation Option
CURTAIL-D-SC4-1	Open 936L 240kV line (Langdon 102S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	103% 306MVA	Shed 23.5 MW @ Enmax 31 and 2x20.7 MW @ Enmax 9 = **Total of 64.9 MW**
	Open 937L 240kV line (Langdon 102S to East Calgary 5S)	9.80L 138kV line (ENMAX No. 31 to ENMAX No. 9)*	SC4	143% 282MVA	

*9.80L (SS-9 to SS-31) line rating can be increased to 287 MVA by adjusting the CT limit ratio to 1200 A. The amount of load shedding is based on this increased rating.

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 5.4 MW

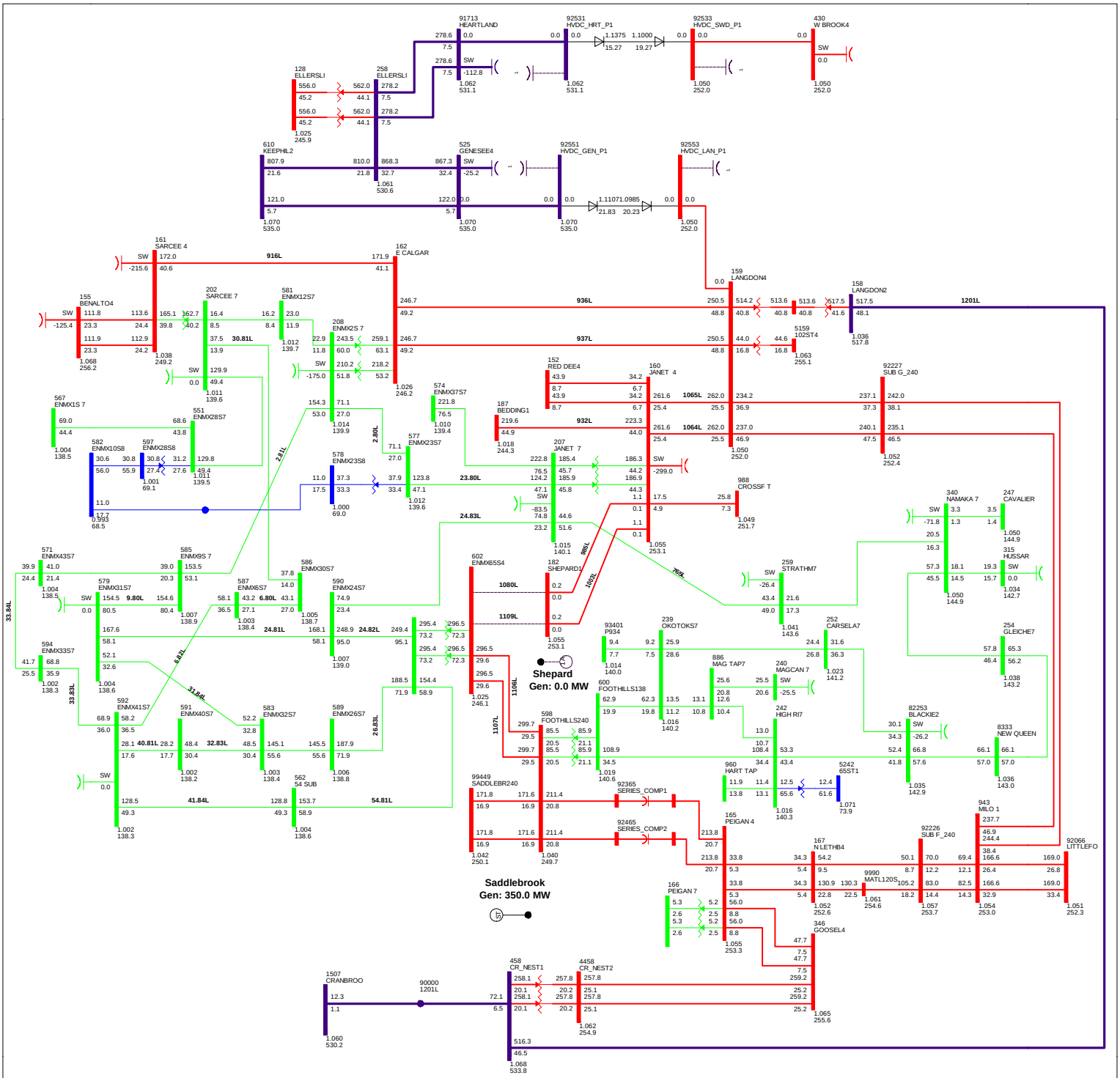
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG C5-D-SC3-1: DOUBLE OUTAGE 1064L AND 1065L

2019_SP_STG3_3RDCKT_SC3

FRI, JUN 08 2012 16:05



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

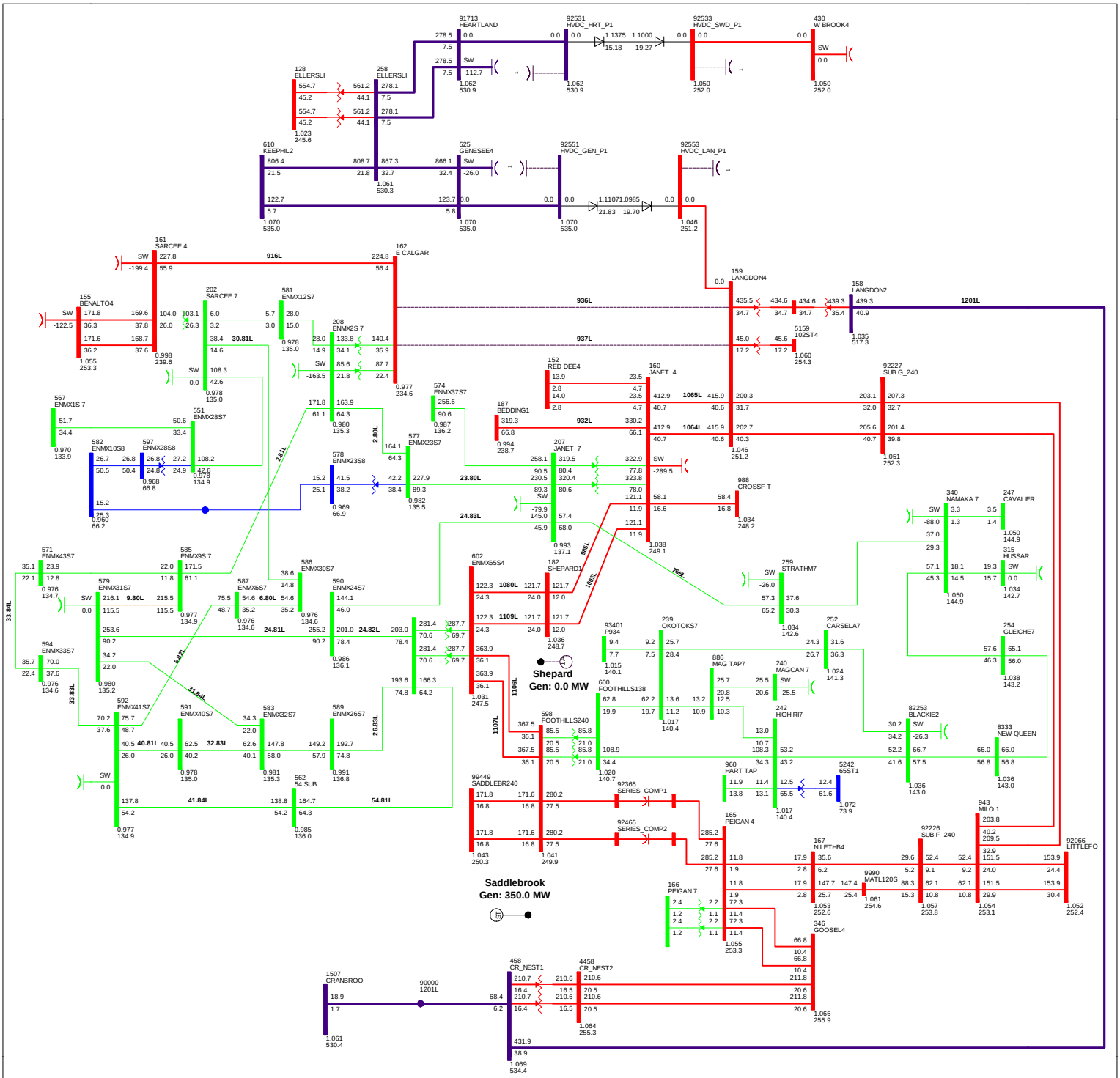
BCH Import: 3.2 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG C5-D-SC3-2: DOUBLE OUTAGE 1080L AND 1109L

2019_SP_STG3_3RDCKT_SC3

FRI, JUN 08 2012 16:05



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 20.2 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

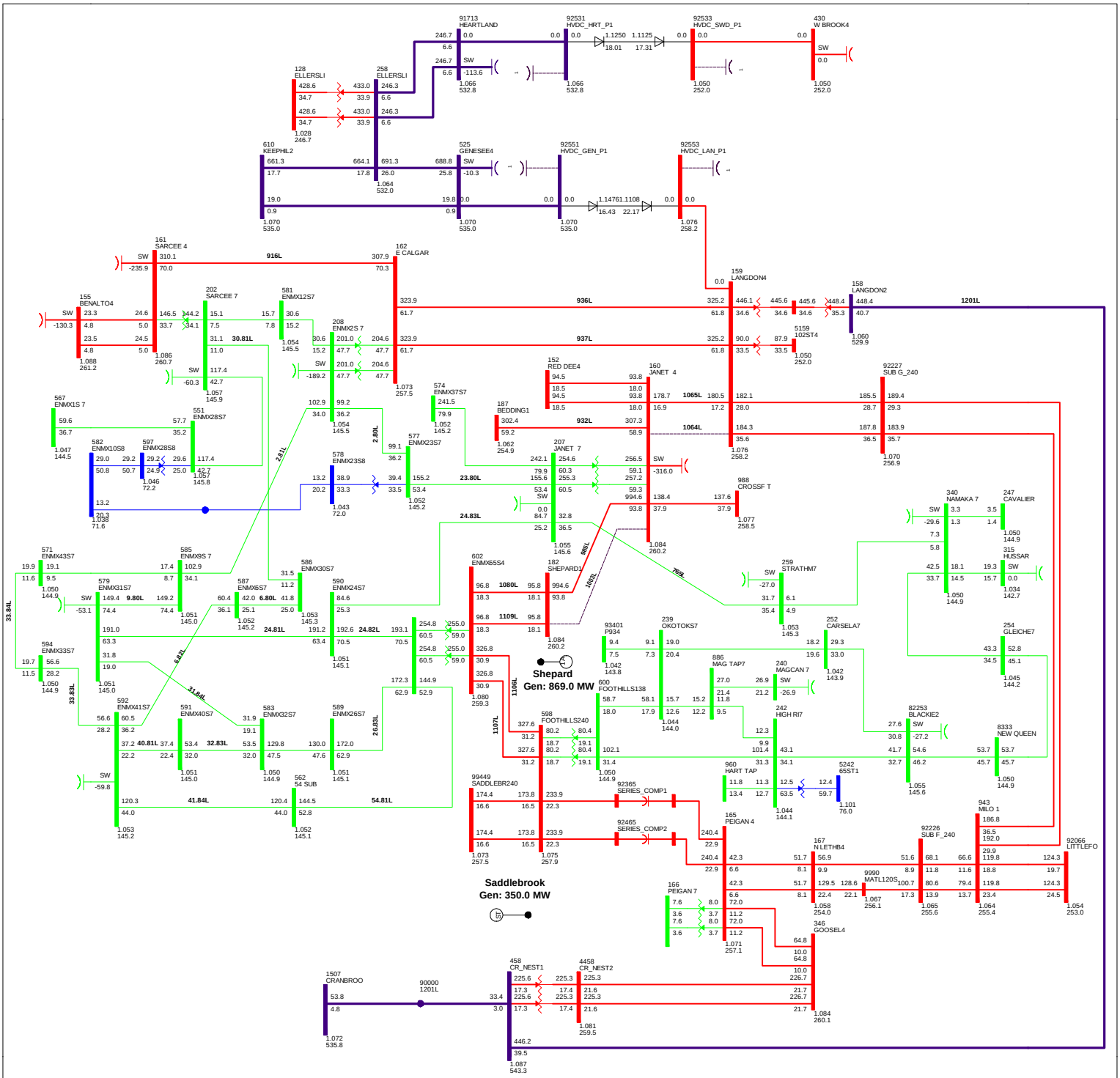
2012LTO FATD EAST + 3RD CKT SYSTEM

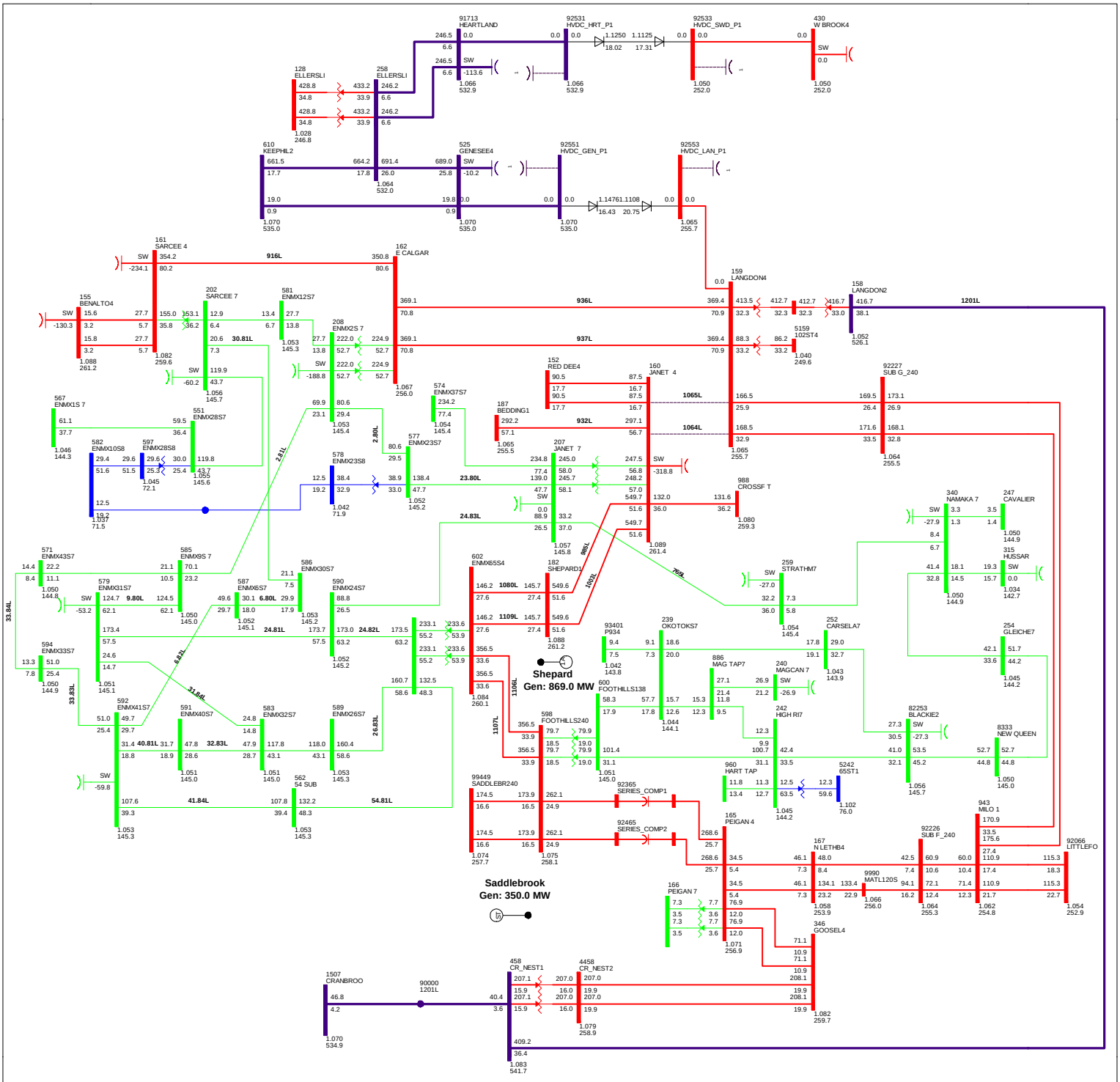
FIG C5-D-SC3-3: DOUBLE OUTAGE 936L AND 937L

2019_SP_STG3_3RDCKT_SC3

FRI, JUN 08 2012 16:05

2019 Loading Violations
Scenario 4


Shepard
Gen: 869.0 MW
Saddlebrook
Gen: 350.0 MW
916L
936L
937L
1201L
1064L
1080L
1109L
1106L
1107L
1065L
932L
24.83L
23.80L
2.80L
2.81L
24.81L
24.82L
32.83L
33.84L
31.84L
6.82L
41.84L
54.81L
26.83L
40.81L
30.81L
6.80L
9.80L
9901
7659
15701
BCH Import: 1.7 MW
2012LTO FATD EAST + 3RD CKT SYSTEM
FIG C5-D-SC4-1: DOUBLE OUTAGE 1003L AND 1064L
2019_SP_STG3_3RDCKT_SC4
FRI, JUN 08 2012 16:05



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 1.4 MW

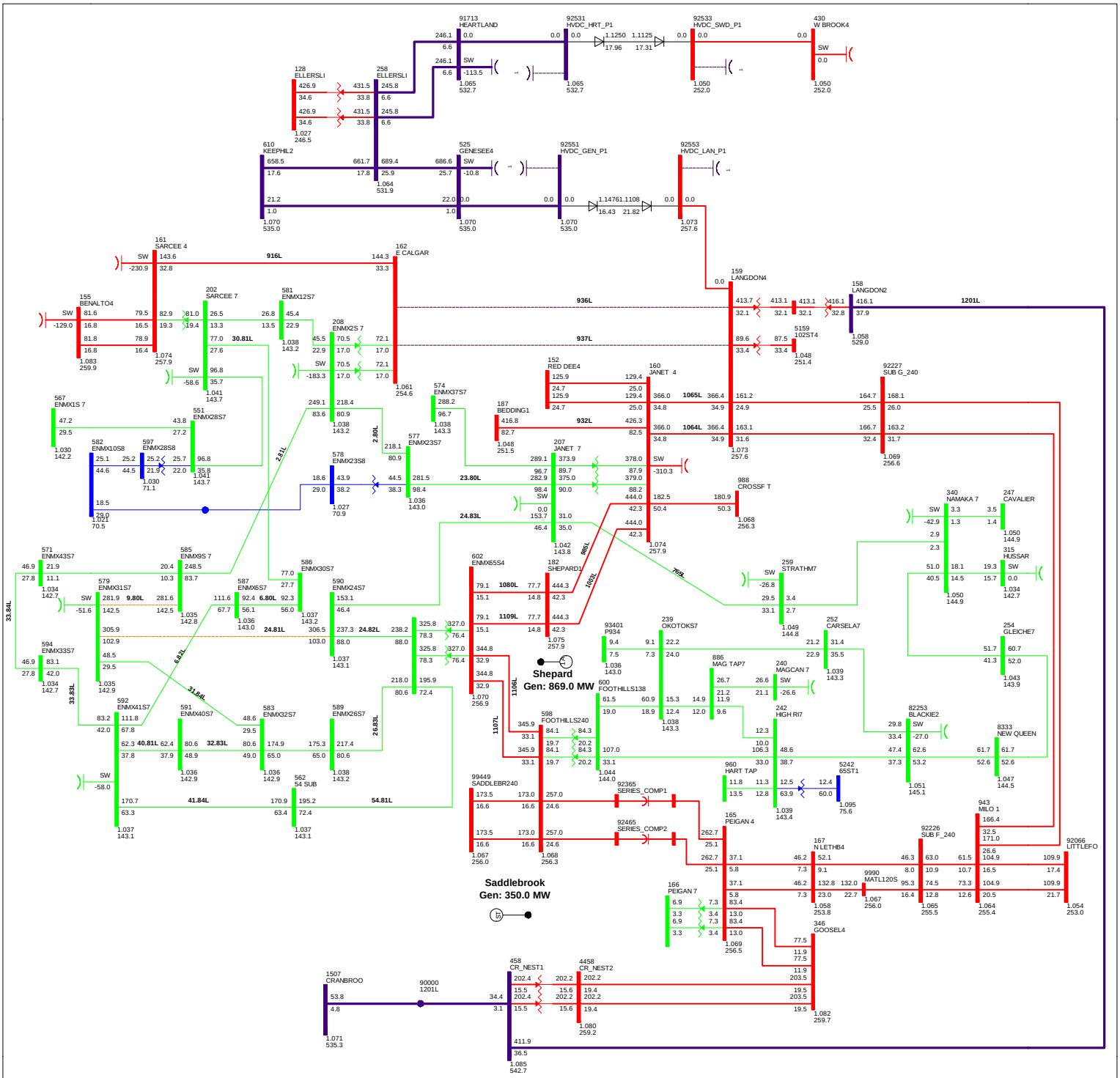
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG C5-D-SC4-2: DOUBLE OUTAGE 1064L AND 1065L

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 16:05



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 22.2 MW

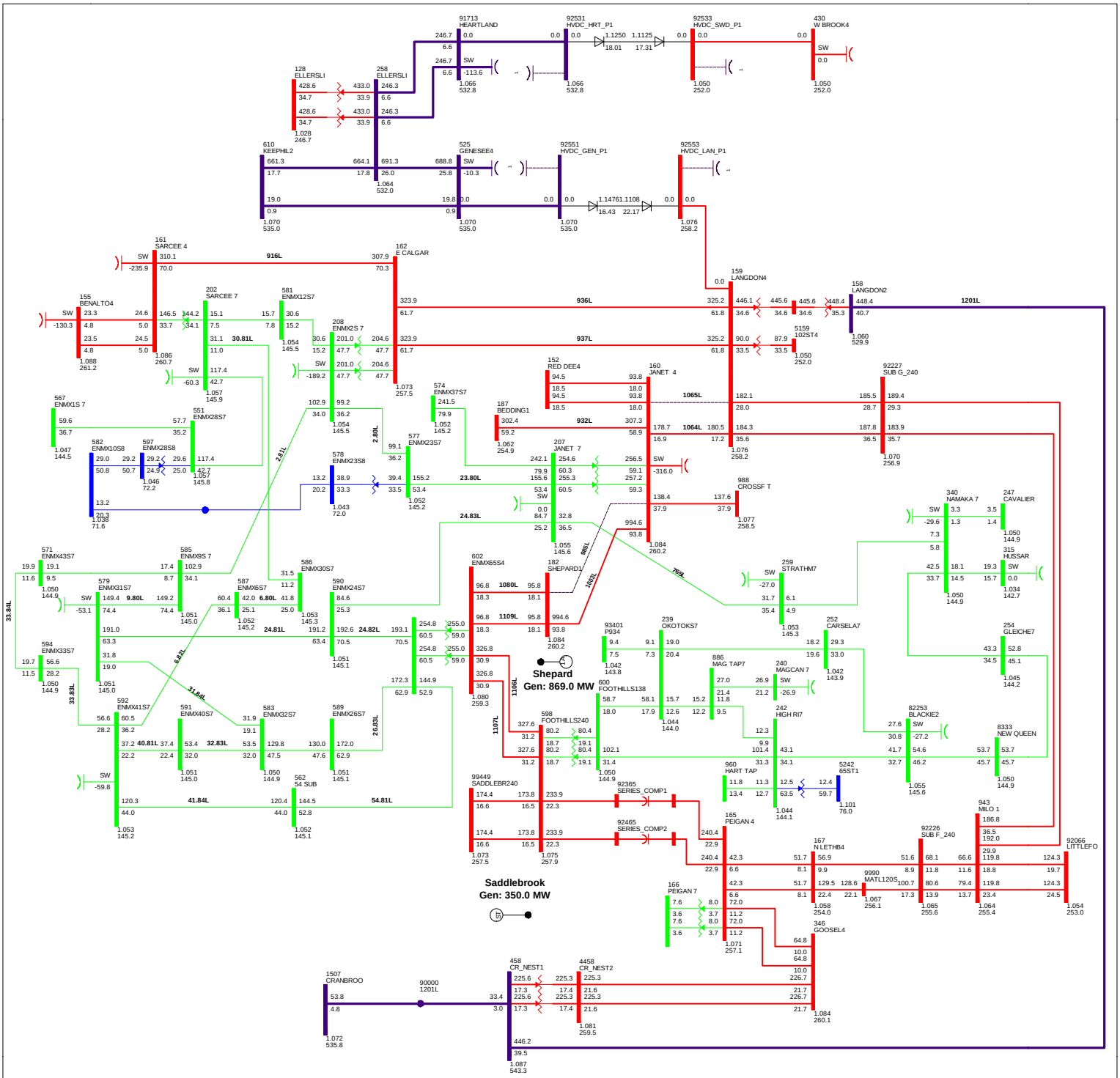
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG C5-D-SC4-3: DOUBLE OUTAGE 936L AND 937L

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 16:05



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 1.7 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

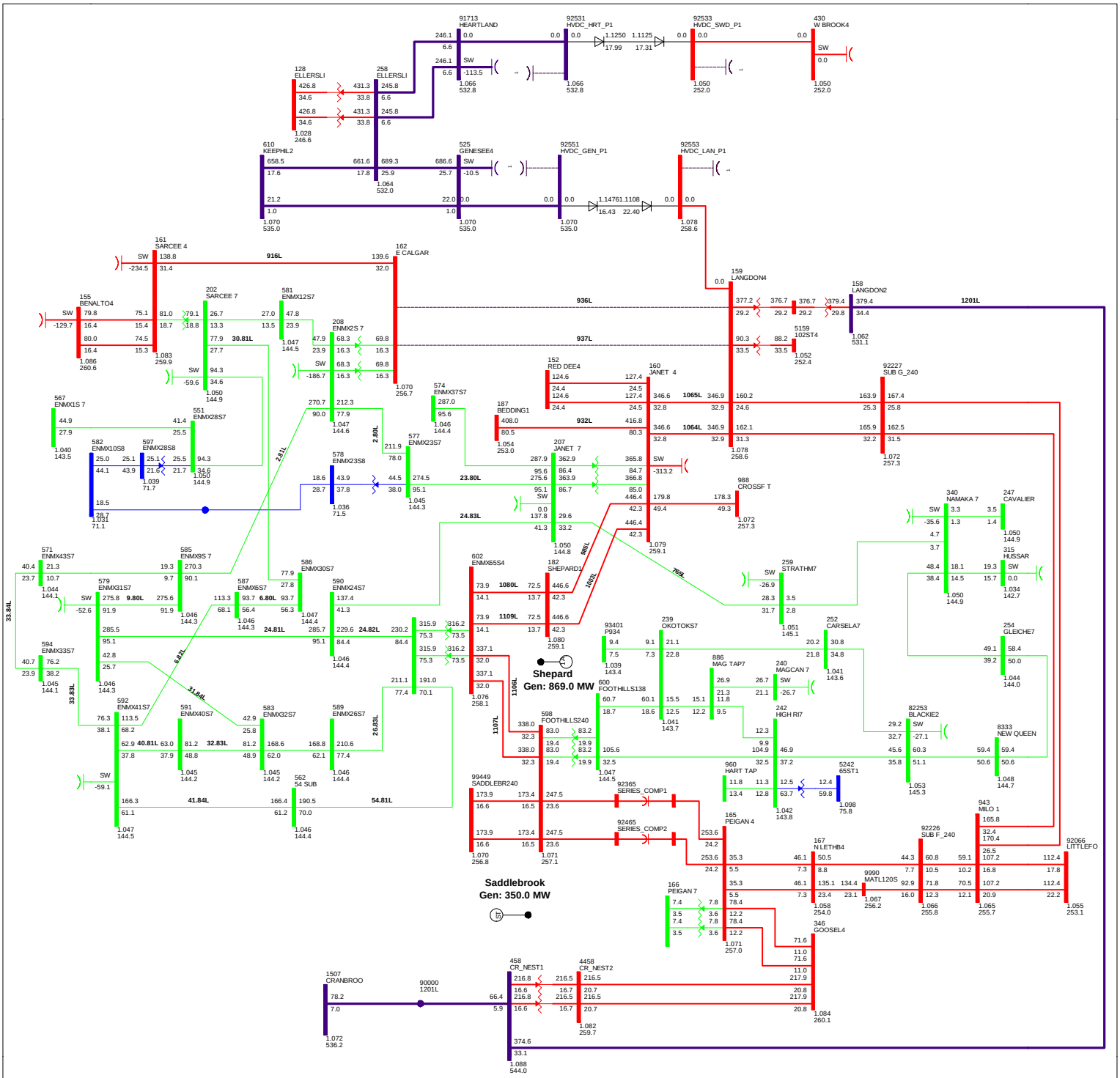
2012LTO FATD EAST + 3RD CKT SYSTEM

FIG C5-D-SC4-4: DOUBLE OUTAGE 985L AND 1065L

2019_SP_STG3_3RDCKT_SC4

FRI, JUN 08 2012 16:05

2019 FATD-East + 3rd Circuit Curtailment Assessment
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: -48.1 MW

2012LTO FATD EAST + 3RD CKT SYSTEM

FIG CURTAIL-D-SC4-1: 936L-937L 65 MW CALGARY LOAD SHED

2019_SP_STG3_3RDCKT_SC4

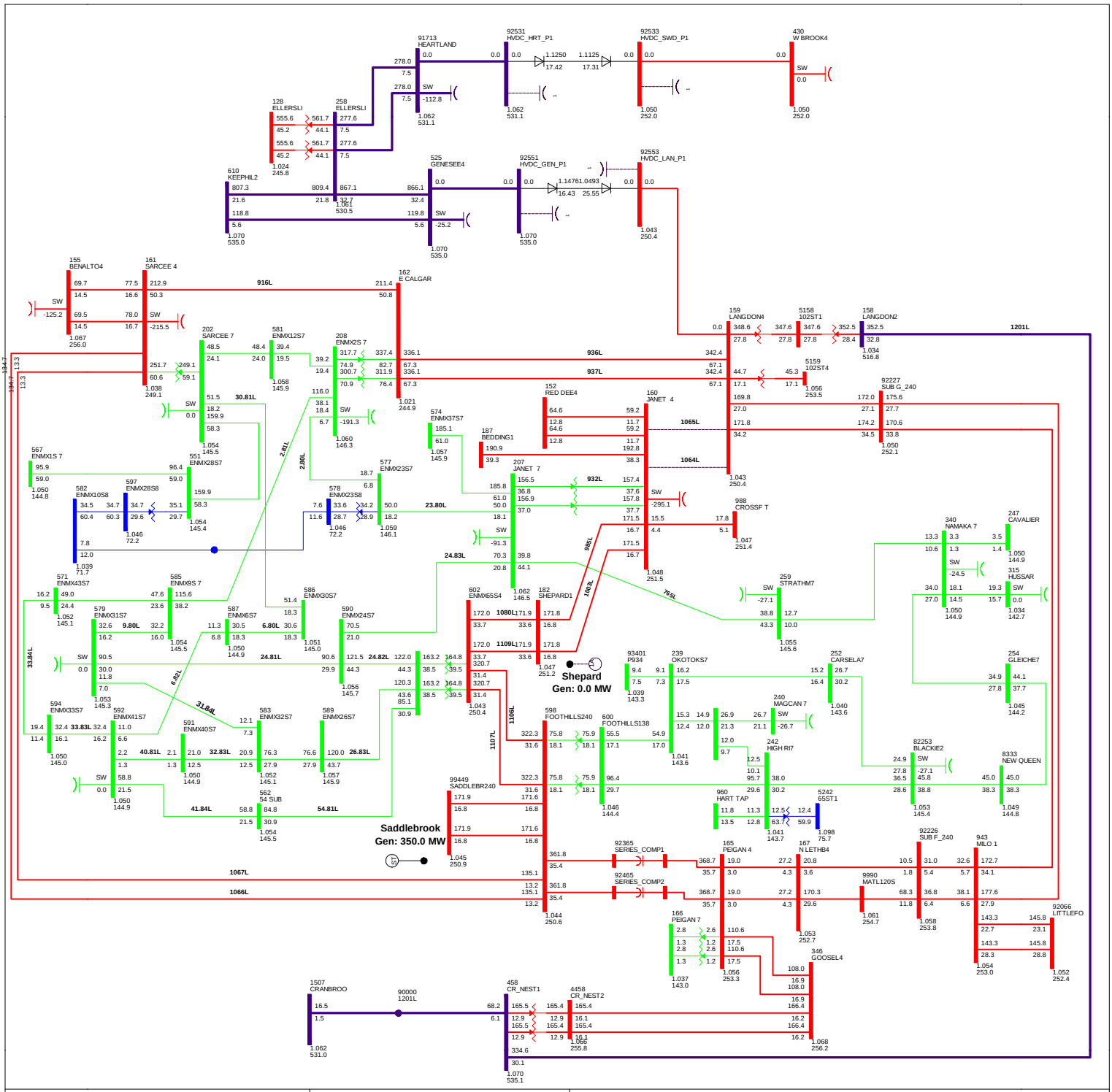
FRI, JUN 08 2012 16:06

D-3: FATD-Full Assessment

Table 5: FATD Full Maximum Loading on Critical Lines with 2019 FATD under Category C5

Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration FATD Full √ indicates loading below 80% N/A indicates the circuit does not exist
C5-E-SC3-1	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	240/138 kV transformer (East Calgary 5S)	SC3	84% 337MVA
C5-E-SC3-2	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	√
C5-E-SC3-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC3	85% 344MVA
C5-E-SC4-1	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25) Open 1064L 240 kV line (Langdon 102S to Janet 74S)	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	√
C5-E-SC4-2	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC4	√
C5-E-SC4-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	√
		2.81L 138 kV line (ENMAX No. 2 to ENMAX No. 9)	SC4	√
		23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	√
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	√
		240/138 kV transformer (ENMAX No. 65)	SC4	√
		240/138 kV transformer (Janet 74S)	SC4	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	√
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	86% 172MVA
		932L 240 kV line (Janet 74S to Beddington SS-162)	SC4	√
C5-E-SC4-4	Open 985L 240 kV line (Janet 74S to ENMAX No. 25) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	√

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

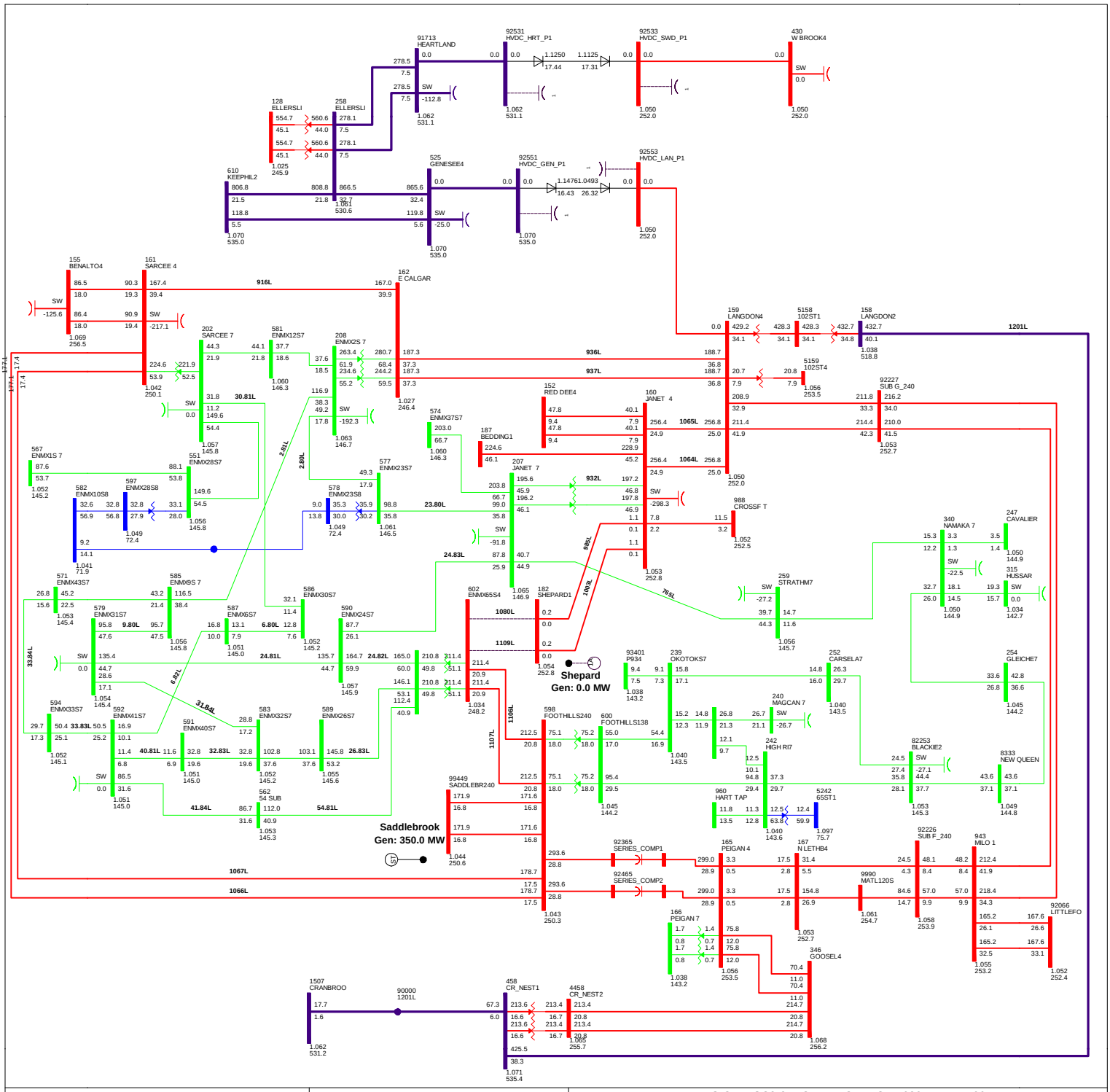
BCH Import: 6.7 MW

2012LTO FATD FULL SYSTEM

FIG C5-E-SC3-1: DOUBLE OUTAGE 1064L AND 1065L

2019_SP_STG4_ALT1_SC3

FRI, JUN 08 2012 16:06



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

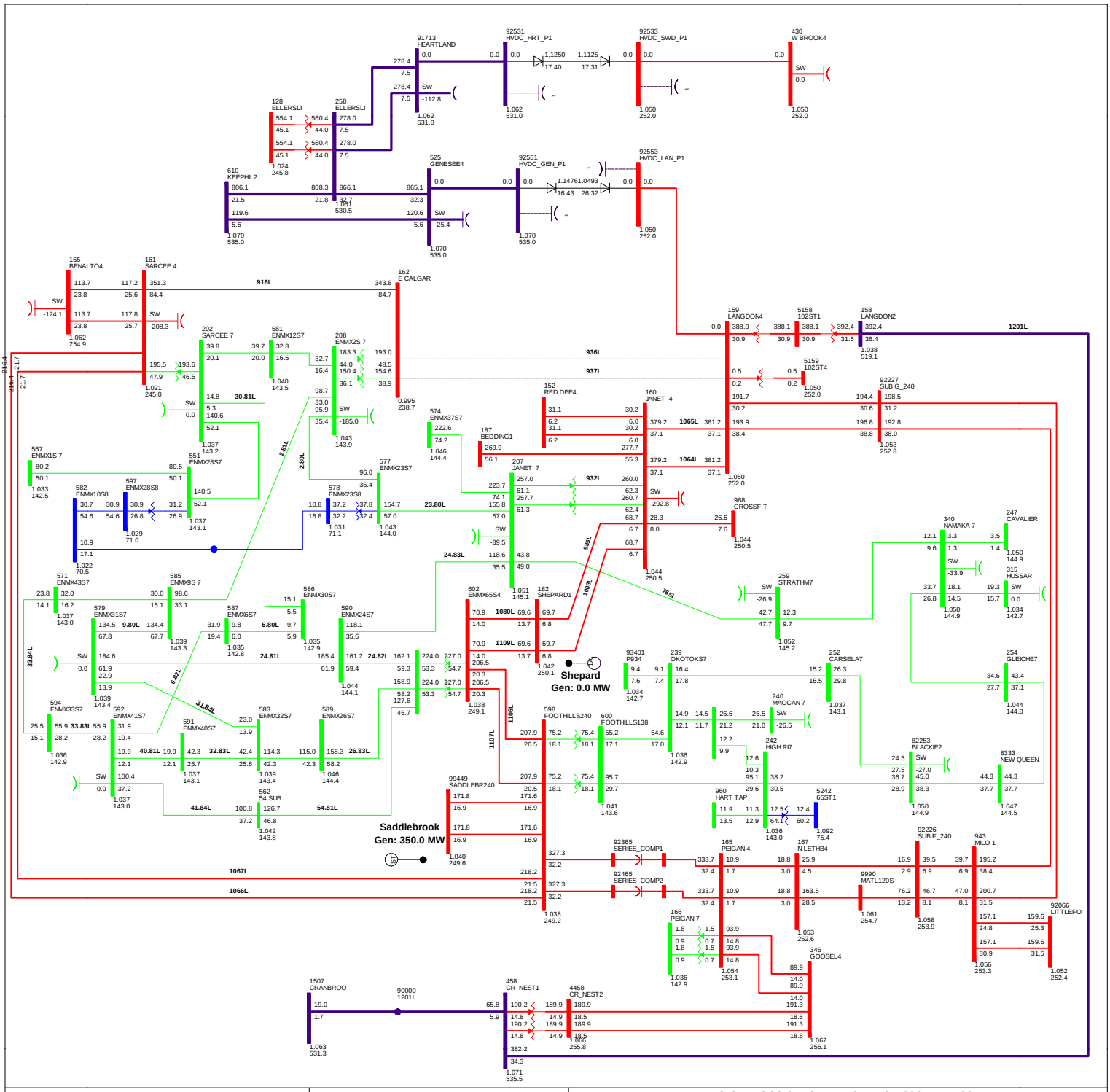
BCH Import: -0.9 MW

2012LTO FATD FULL SYSTEM

FIG C5-E-SC3-2: DOUBLE OUTAGE 1080L AND 1109L

2019_SP_STG4_ALT1_SC3

FRI, JUN 08 2012 16:07



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 7.2 MW

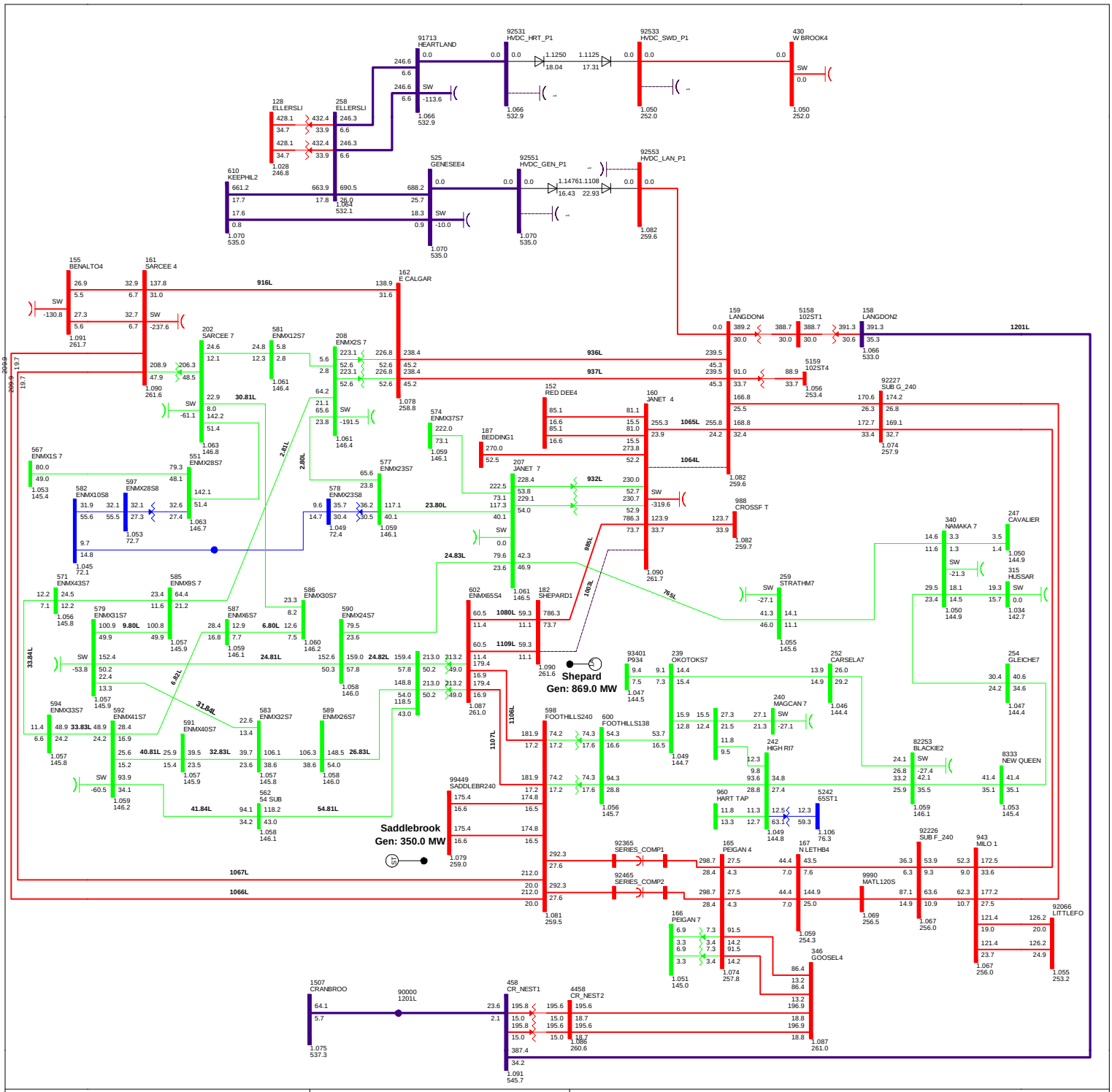
2012LTO FATD FULL SYSTEM

FIG C5-E-SC3-3: DOUBLE OUTAGE 936L AND 937L

2019_SP_STG4_ALT1_SC3

FRI, JUN 08 2012 16:07

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

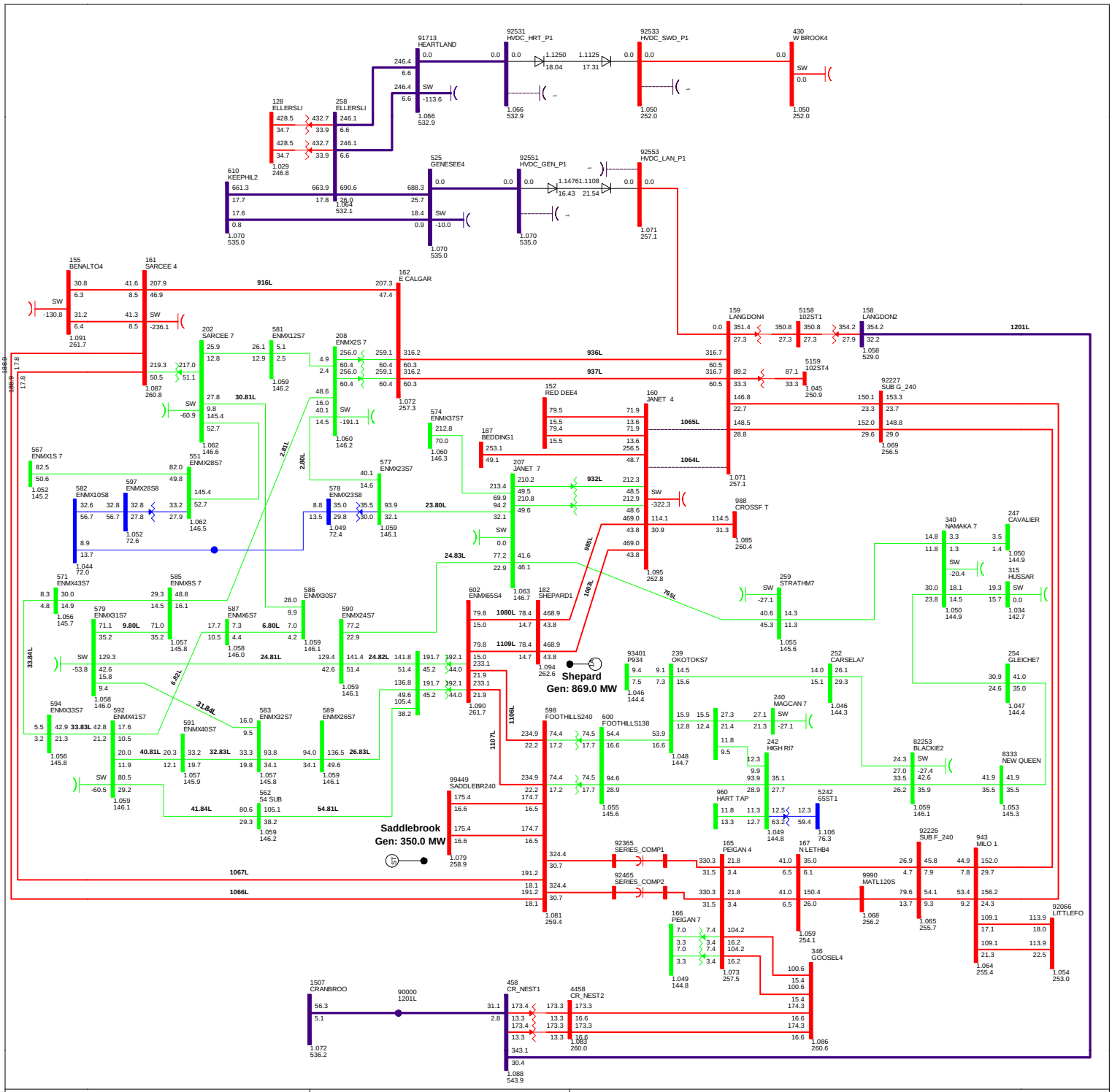
BCH Import: 1.1 MW

2012LTO FATD FULL SYSTEM

FIG C5-E-SC4-1: DOUBLE OUTAGE 1003L AND 1064L

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:07



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100PU 0.950PU
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

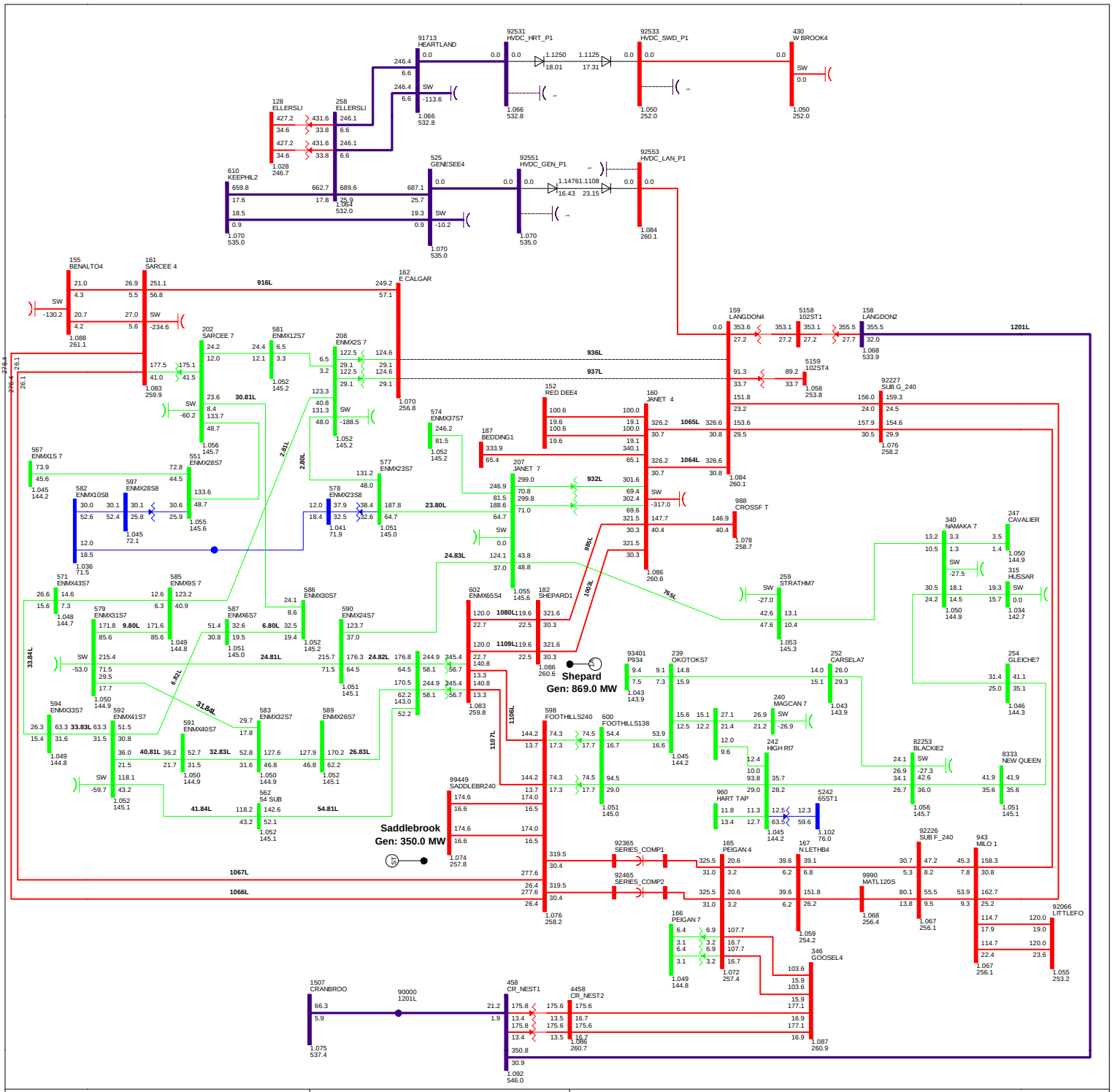
BCH Import: 2.8 MW

2012LTO FATD FULL SYSTEM

FIG C5-E-SC4-2: DOUBLE OUTAGE 1064L AND 1065L

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:07



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

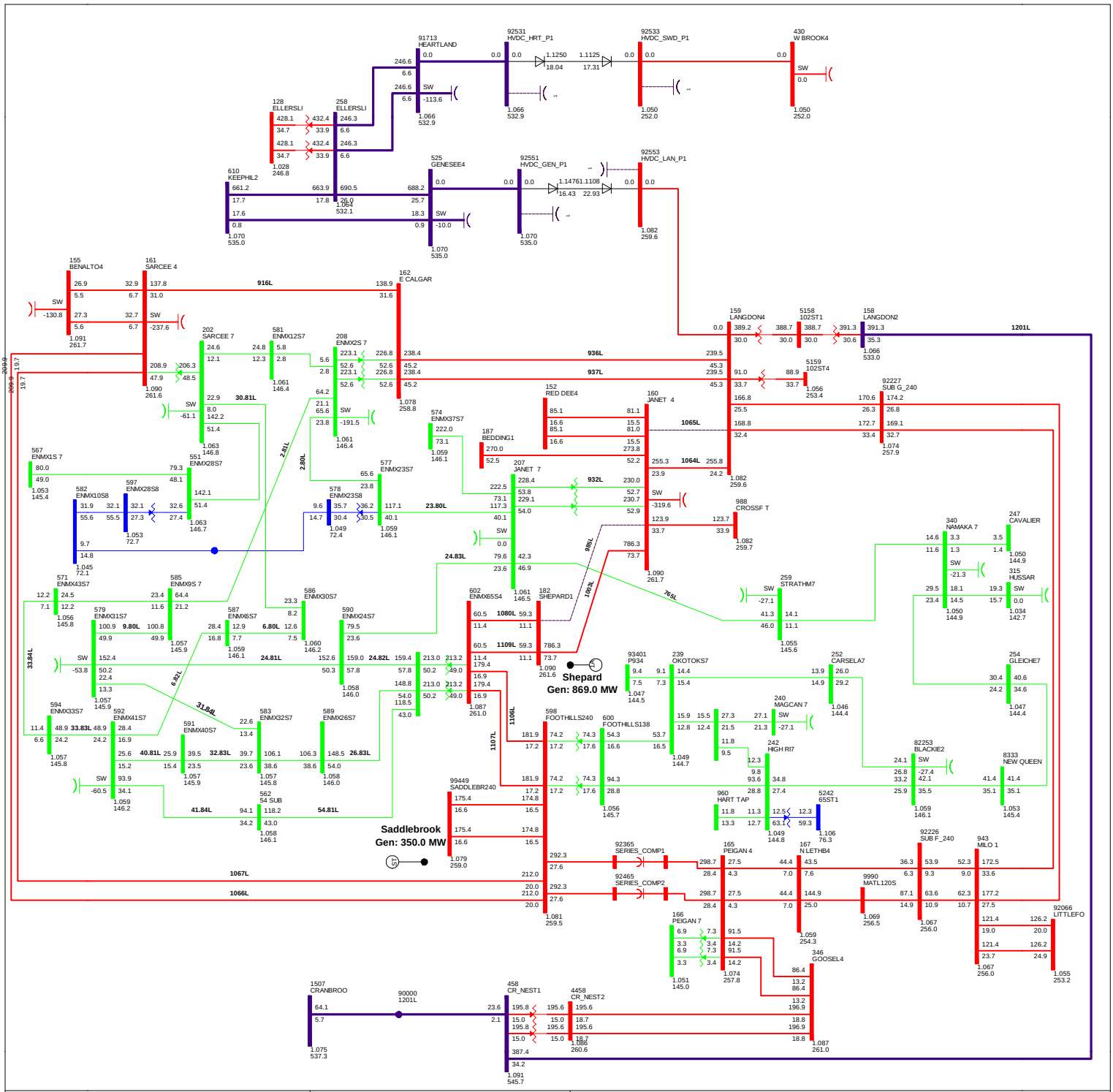
BCH Import: 9.2 MW

2012LTO FATD FULL SYSTEM

FIG C5-E-SC4-3: DOUBLE OUTAGE 936L AND 937L

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:07



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 1.1 MW

2012LTO FATD FULL SYSTEM

FIG C5-E-SC4-4: DOUBLE OUTAGE 985L AND 1065L

2019_SP_STG4_ALT1_SC4

FRI, JUN 08 2012 16:07

Attachment E – Category C5 2012LTO+HVDC Results & Plots

Table of Contents

Attachment E – Category C5 2012LTO+HVDC Results & Plots

E-1: FATD+HVDC-East Assessment

2019 Loading Violations Scenario 1A

2019 FATD+HVDC-East Curtailment Assessment Scenario 1A

2019 Loading Violations Scenario 3

2019 FATD+HVDC-East Curtailment Assessment Scenario 3

2019 Loading Violations Scenario 4

2019 FATD+HVDC-East Curtailment Assessment Scenario 4

E-2: FATD+HVDC-East + 3rd Circuit Assessment

2019 Loading Violations Scenario 1A

2019 FATD+HVDC-East + 3rd Circuit Curtailment Assessment Scenario 1A

2019 Loading Violations Scenario 3

2019 FATD+HVDC-East + 3rd Circuit Curtailment Assessment Scenario 3

2019 Loading Violations Scenario 4

2019 FATD+HVDC-East + 3rd Circuit Curtailment Assessment Scenario 4

E-3: FATD+HVDC-Full Assessment

2019 Loading Violations Scenario 1A

2019 FATD+HVDC-Full Curtailment Assessment Scenario 1A

2019 Loading Violations Scenario 3

2019 Loading Violations Scenario 4

All References in this Attachment to Crowsnest 491S means Chapel Rock 491S

E-1: FATD+HVDC-East Assessment

Table 1: FATD East Maximum Loading on Critical Lines with 2019 FATD+HVDC under Category C5

Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration 2019 HVDC FATD East √ indicates loading below 80% N/A indicates the circuit does not exist
C5-B-SC1A-1	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC1A	103% 511MVA
		937L 240 kV line (Langdon 102S to East Calgary 5S)	SC1A	103% 511MVA
		240/138 kV transformer (East Calgary 5S)	SC1A	90% 361MVA
C5-B-SC1A-2	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	83% 73MVA
C5-B-SC1A-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	81% 69MVA
C5-B-SC3-1	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	240/138 kV transformer (East Calgary 5S)	SC3	88% 351MVA
		916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC3	100% 418MVA
C5-B-SC3-2	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	141% 371MVA
C5-B-SC3-3	Open 1106L 240 kV line (Foothills 237S to ENMAX No. 65) Open 1107L 240 kV line (Foothills 237S to ENMAX No. 65)	1201L 500kV line (Langdon 102S to Crowsnest 491S)	SC3	√
C5-B-SC4-1	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25) Open 1064L 240 kV line (Langdon 102S to Janet 74S)	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	98% 1003MVA
C5-B-SC4-2	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	109% 295MVA
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	138% 388MVA
		240/138 kV transformer (ENMAX No. 65)	SC4	√
		240/138 kV transformer (Janet 74S)	SC4	97% 389MVA
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	88% 229MVA
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	81% 127MVA
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	160% 300MVA
		932L 240 kV line (Janet 74S to Beddington SS-162)	SC4	86% 414MVA
		2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	89% 226MVA
C5-B-SC4-3	Open 985L 240 kV line (Janet 74S to ENMAX No. 25) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	98% 1003MVA

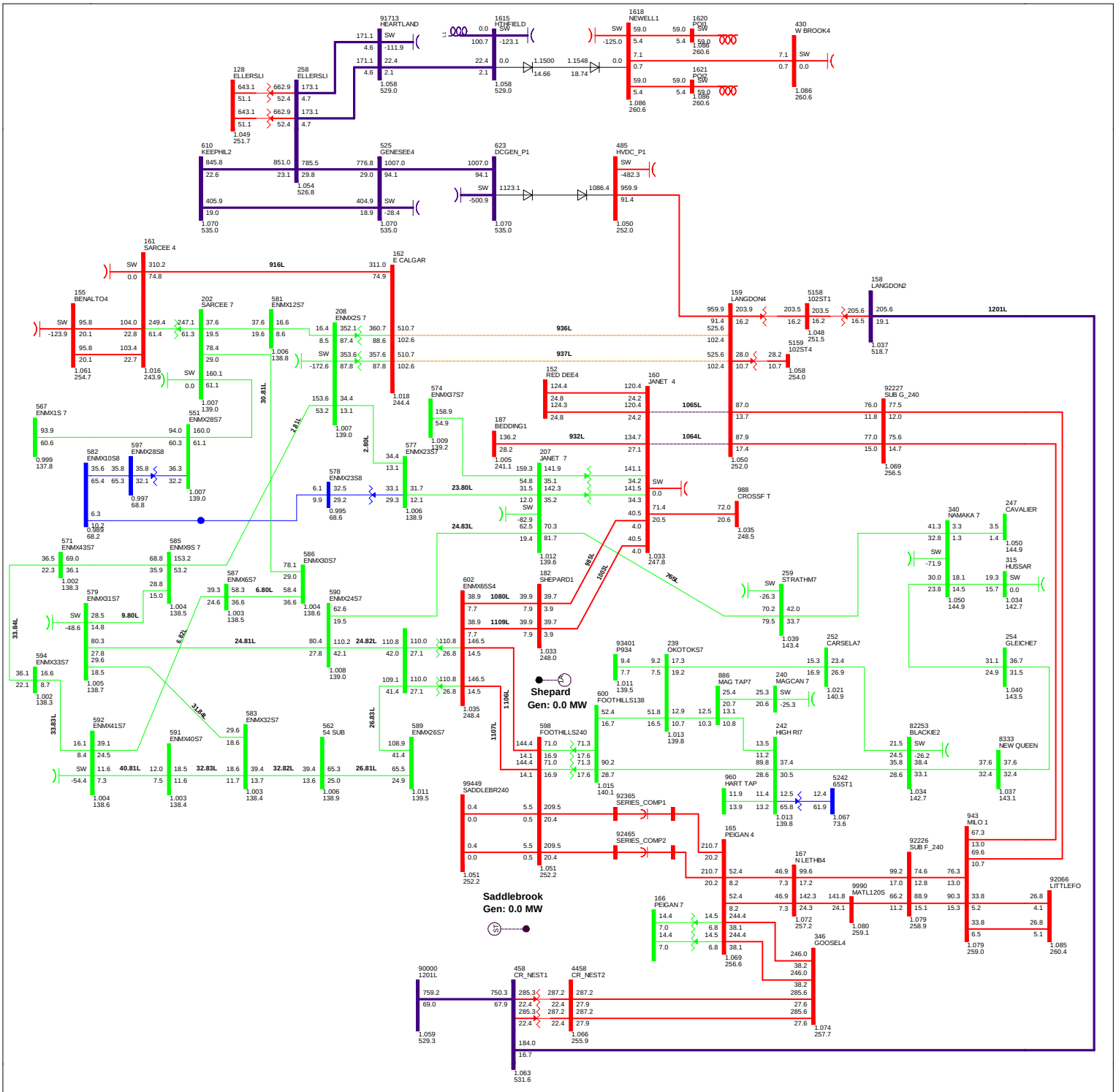
Table 2: FATD-East Required Curtailment "TO" Generation Levels and Load Levels to achieve < 95% Loading Critical Lines with 2019+HVDC FATD East under Category C!

Figure Number	Contingency	Critical Circuit	Scenario	2019+HVDC FATD-East	Mitigation Option
CURTAIL-B-SC1A-1	Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	103% 511MVA	Redispatch WATL to 875 MW (132 MW Reduction)**
		937L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	103% 511MVA	
CURTAIL-B-SC3-1	Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	SC3	100% 418MVA	Shed 2x10 MW @ Enamx 21, 2x14.6 MW @ Enmax 28, 2x10.1 MW @ Enmax 30, 2x16.6 MW @ Enmax 7 = **Total 103 MW**
CURTAIL-B-SC3-2	Open 1080L 240kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	141% 371MVA	Shed 2x42 @ Enmax 24, 3x23.5 @ Enmax 31, 2x20.7MW @ Enmax 9 = **Total 196 MW Load Shed + 350 MW Saddlebrook Generation Shed**
CURTAIL-B-SC4-1	Open 936L 240kV line (Langdon 102S to East Calgary 5S) Open 937L 240kV line (Langdon 102S to East Calgary 5S)	23.80L 138kV line (Janet 74S to ENMAX No. 23)	SC4	109% 295MVA	Shed 3x20.7 MW @ Enmax 9, 3x23.5 MW @ Enmax 31, 4x12.7 MW @ Enmax 2, 23.7 MW @ Enmax 23, 2x17.6 MW @ Enmax 33, 2x29 @ Enmax 5 = **Total 300 MW + Open 1 x Enmax 65 240/138 kV transformer**
		24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	138% 388MVA	
		9.80L 138kV line* (ENMAX No. 31 to ENMAX No. 9)	SC4	160% 300MVA	

*9.80L (SS-9 to SS-31) line rating can be increased to 287 MVA by adjusting the CT limit ratio to 1200 A. The amount of load shedding is based on this increased rating

**WATL HVDC Line Dispatch measured at Genesee end

2019 Loading Violations
Scenario 1A



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

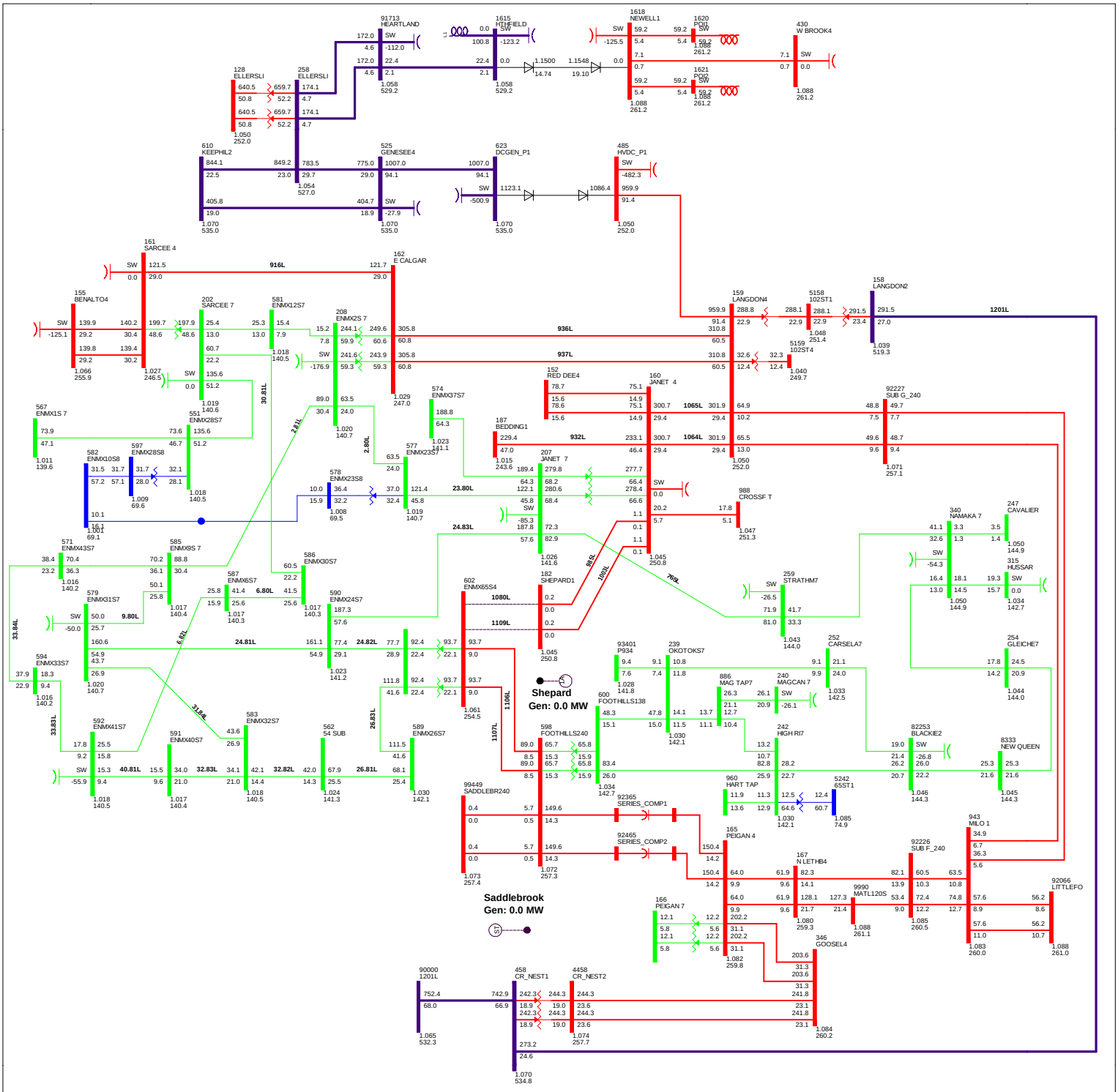
BCH Import: 798.6 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG C5-B-SC1A-1: DOUBLE OUTAGE 1064L AND 1065L

2019_FATD-E_HVDC_SC1A_SP

FRI, JUN 08 2012 16:52



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

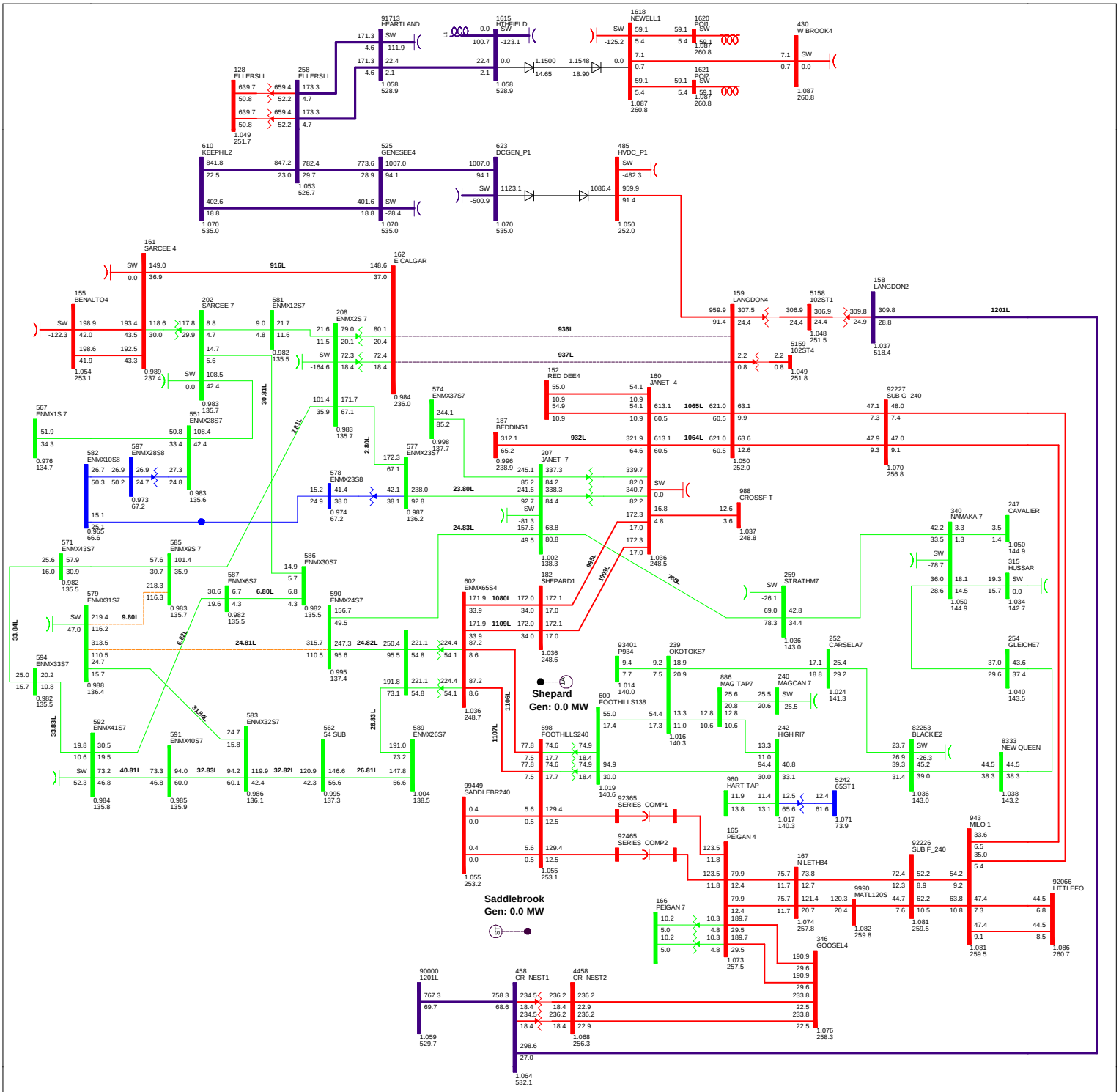
BCH Import: 782.5 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG C5-B-SC1A-2: DOUBLE OUTAGE 1080L AND 1109L

2019_FATD-E_HVDC_SC1A_SP

FRI, JUN 08 2012 16:52



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 805.8 MW

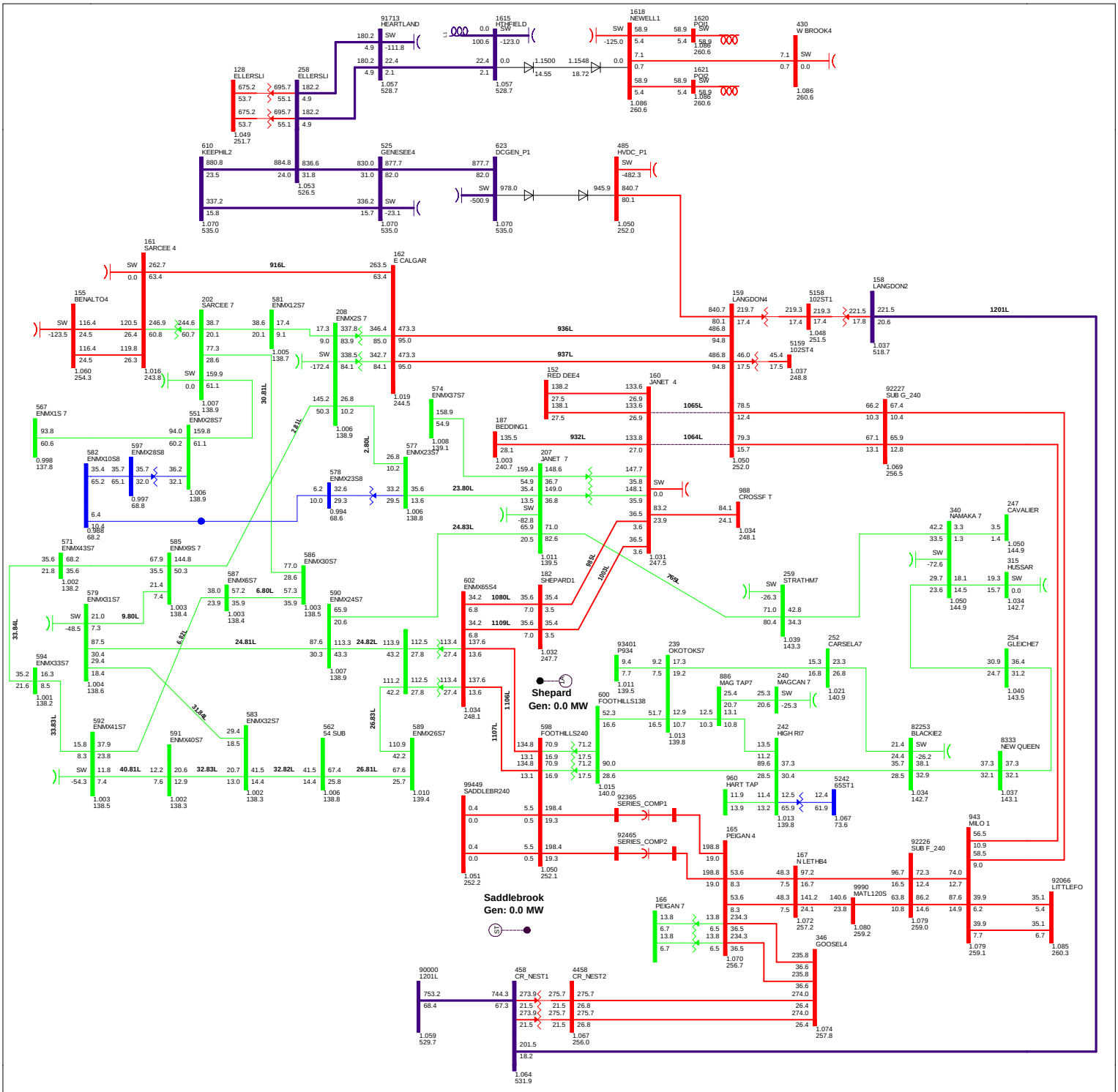
2012LTO+HVDC FATD EAST SYSTEM

FIG C5-B-SC1A-3: DOUBLE OUTAGE 936L AND 937L

2019_FATD-E_HVDC_SC1A_SP

FRI, JUN 08 2012 16:52

2019 FATD+HVDC-East Curtailment Assessment
Scenario 1A



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 791.1 MW

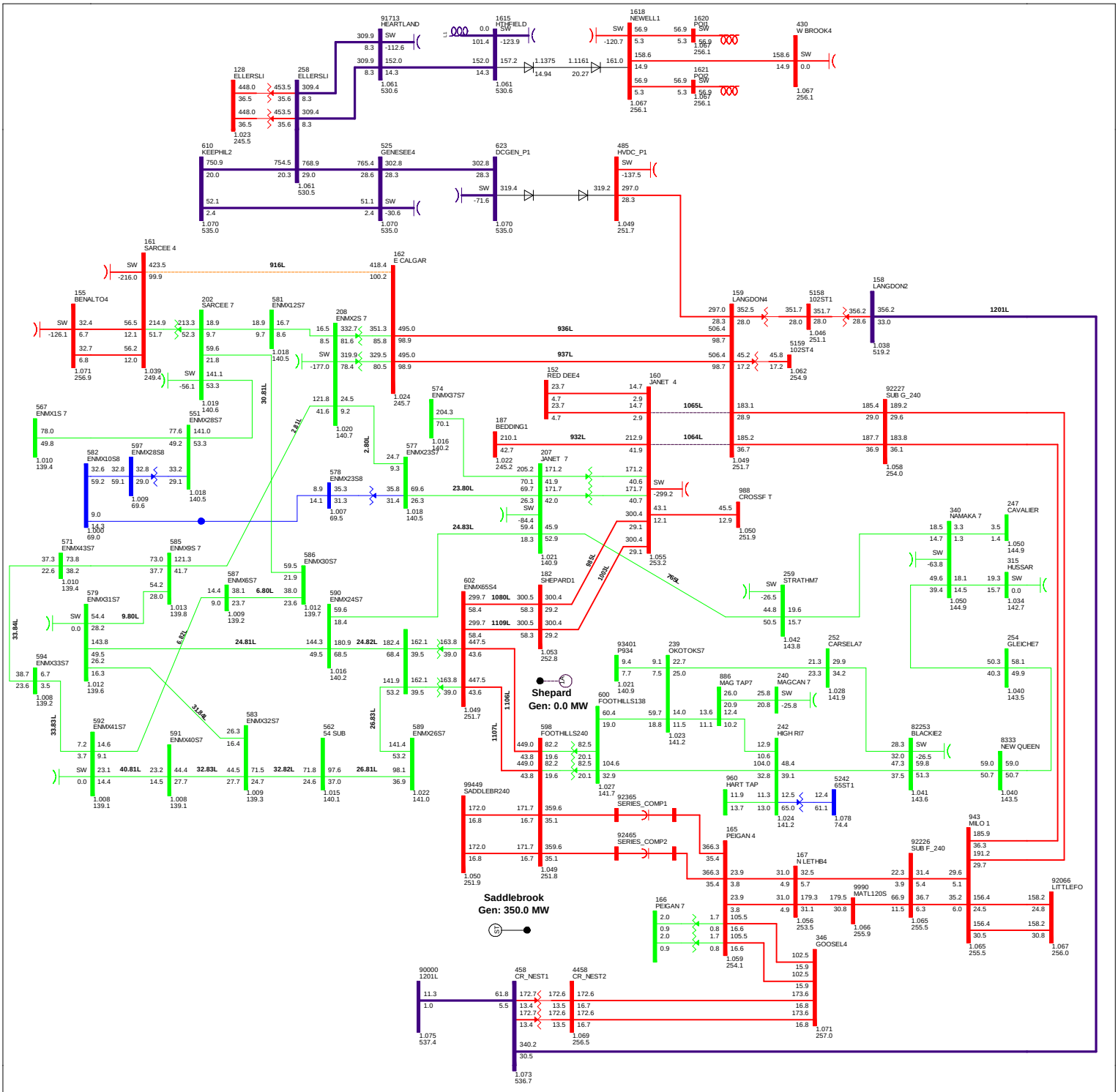
2012LTO+HVDC FATD EAST SYSTEM

FIG CURTAIL-B-SC1A-1: 1064L-1065L REDISPATCH WATL TO 875MW

2019_FATD-E_HVDC_SC1A_SP

FRI, JUN 08 2012 16:54

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

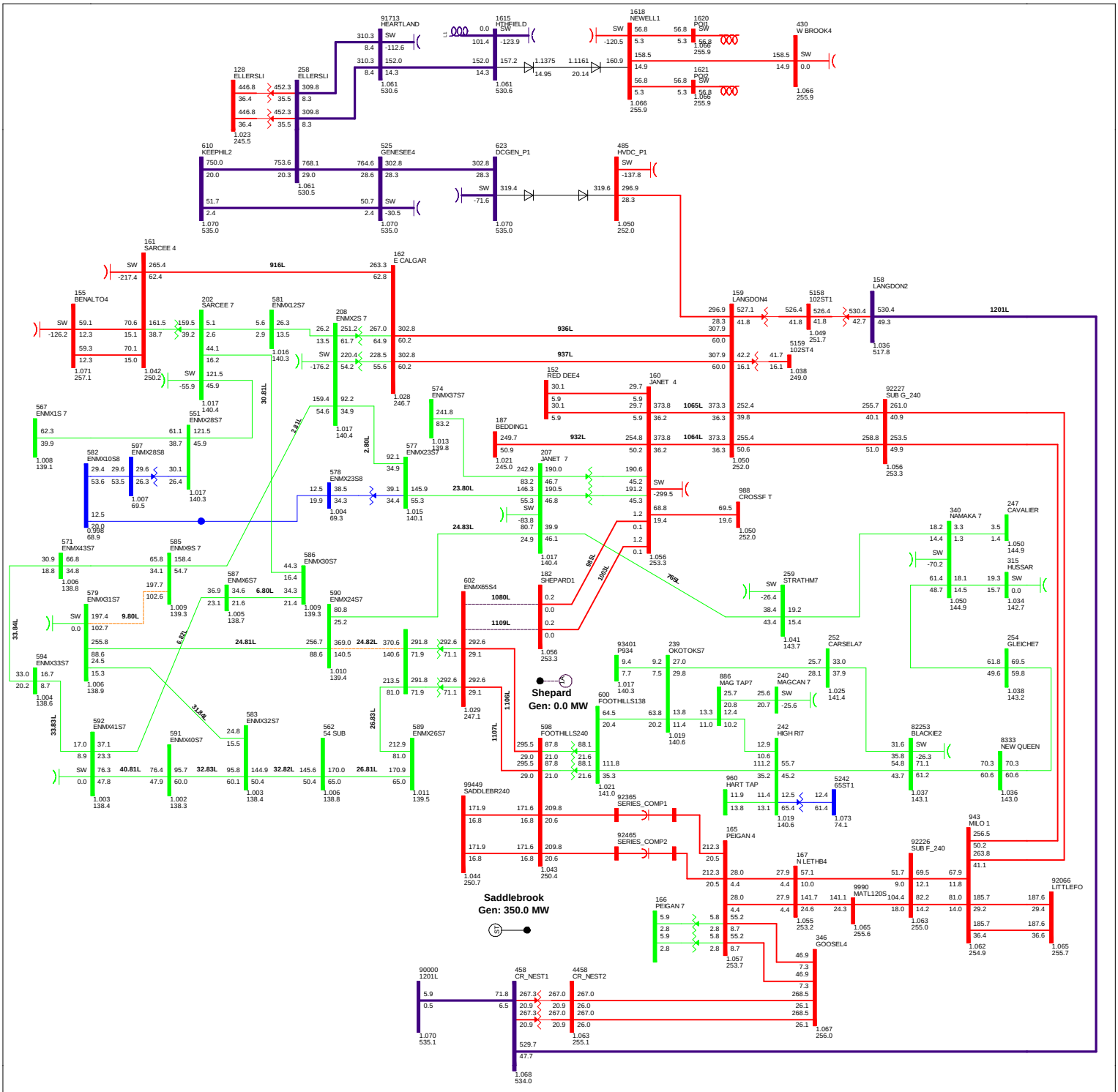
BCH Import: 3.7 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG C5-B-SC3-1: DOUBLE OUTAGE 1064L AND 1065L

2019_FATD-E_HVDC_SC3_SP

FRI, JUN 08 2012 16:53



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

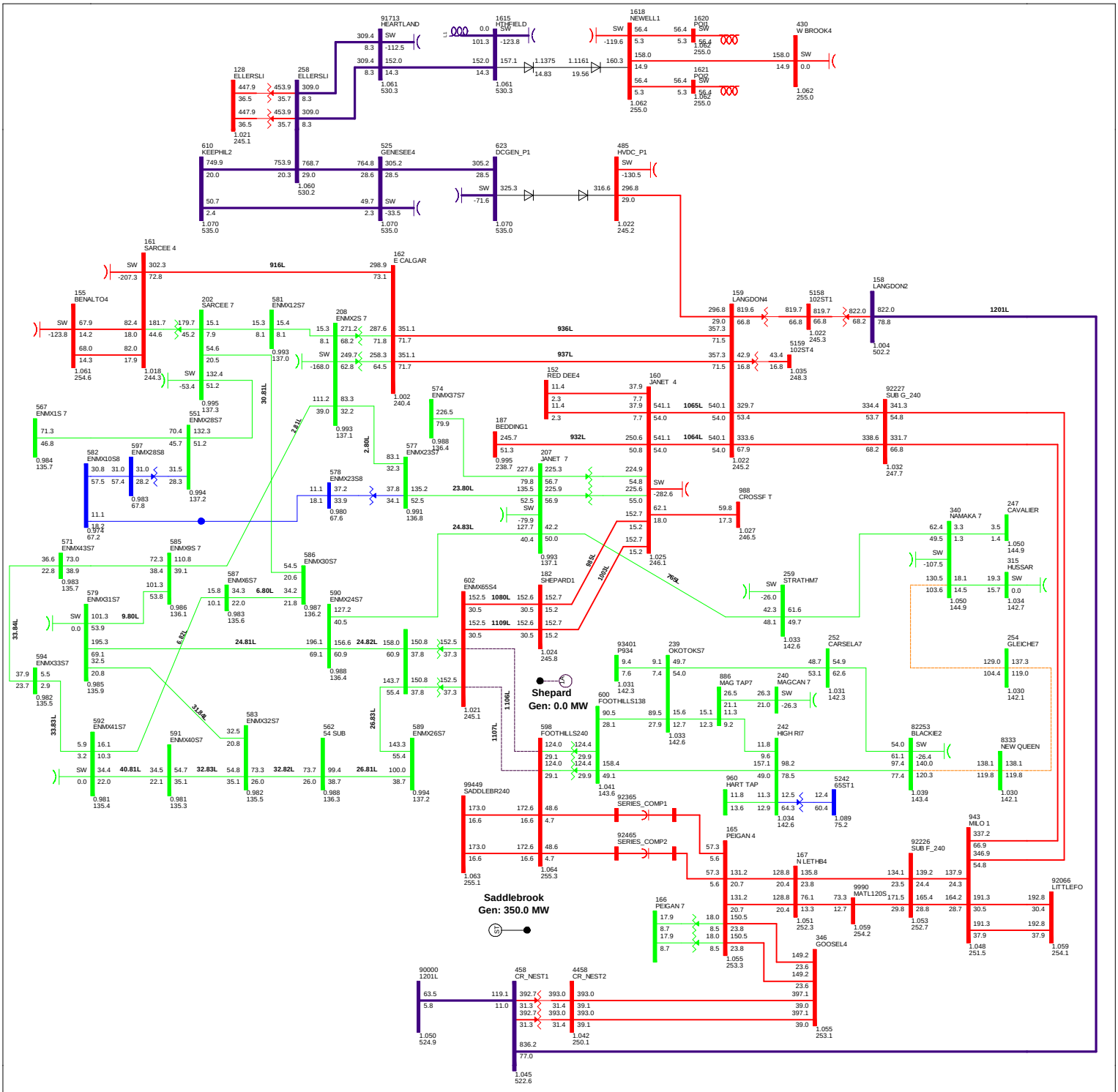
BCH Import: -0.5 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG C5-B-SC3-2: DOUBLE OUTAGE 1080L AND 1109L

2019_FATD-E_HVDC_SC3_SP

FRI, JUN 08 2012 16:54



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 53.5 MW

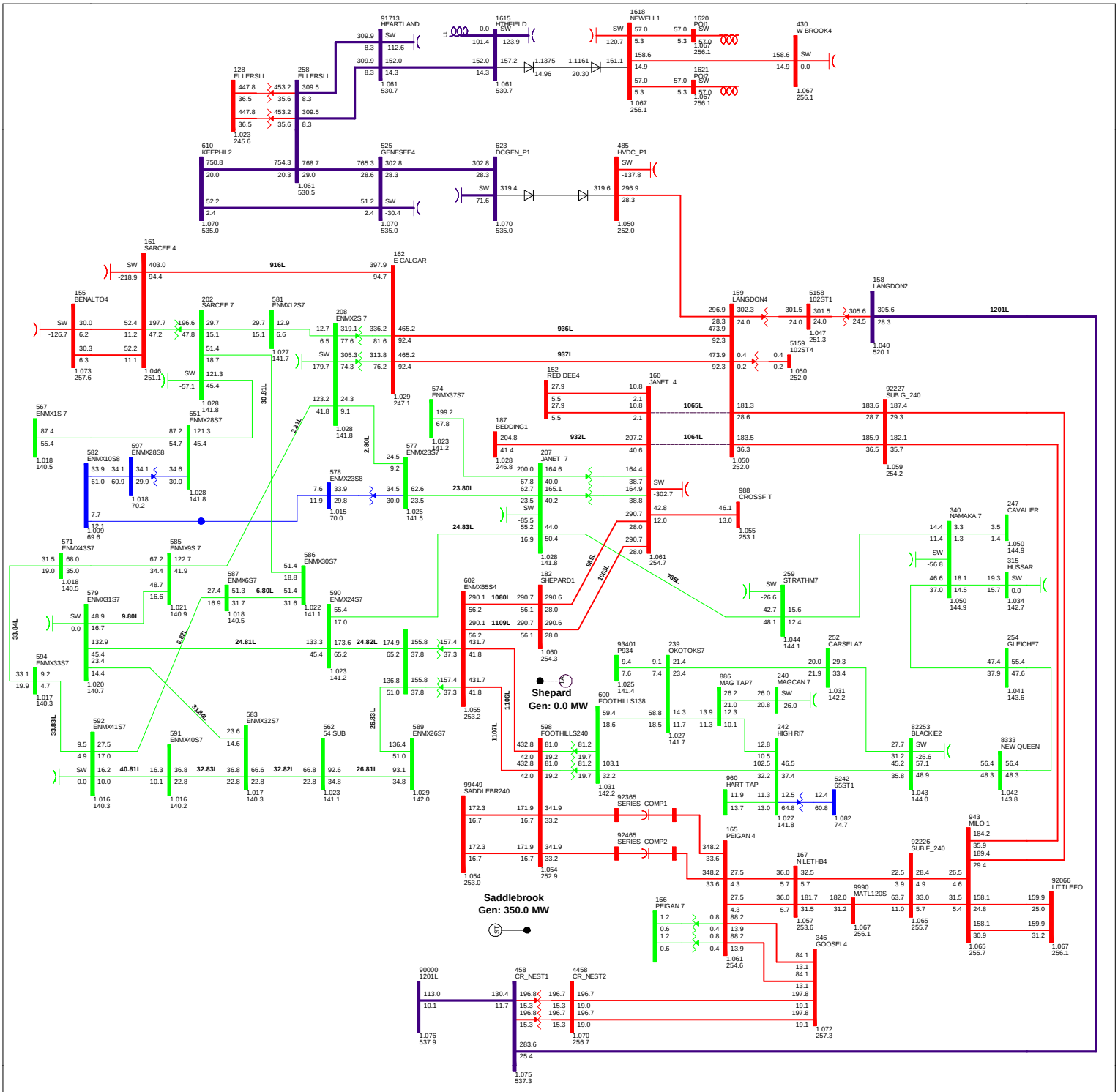
2012LTO+HVDC FATD EAST SYSTEM

FIG C5-B-SC3-3: DOUBLE OUTAGE 1106L AND 1107L

2019_FATD-E_HVDC_SC3_SP

FRI, JUN 08 2012 16:54

2019 FATD+HVDC-East Curtailment Assessment
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

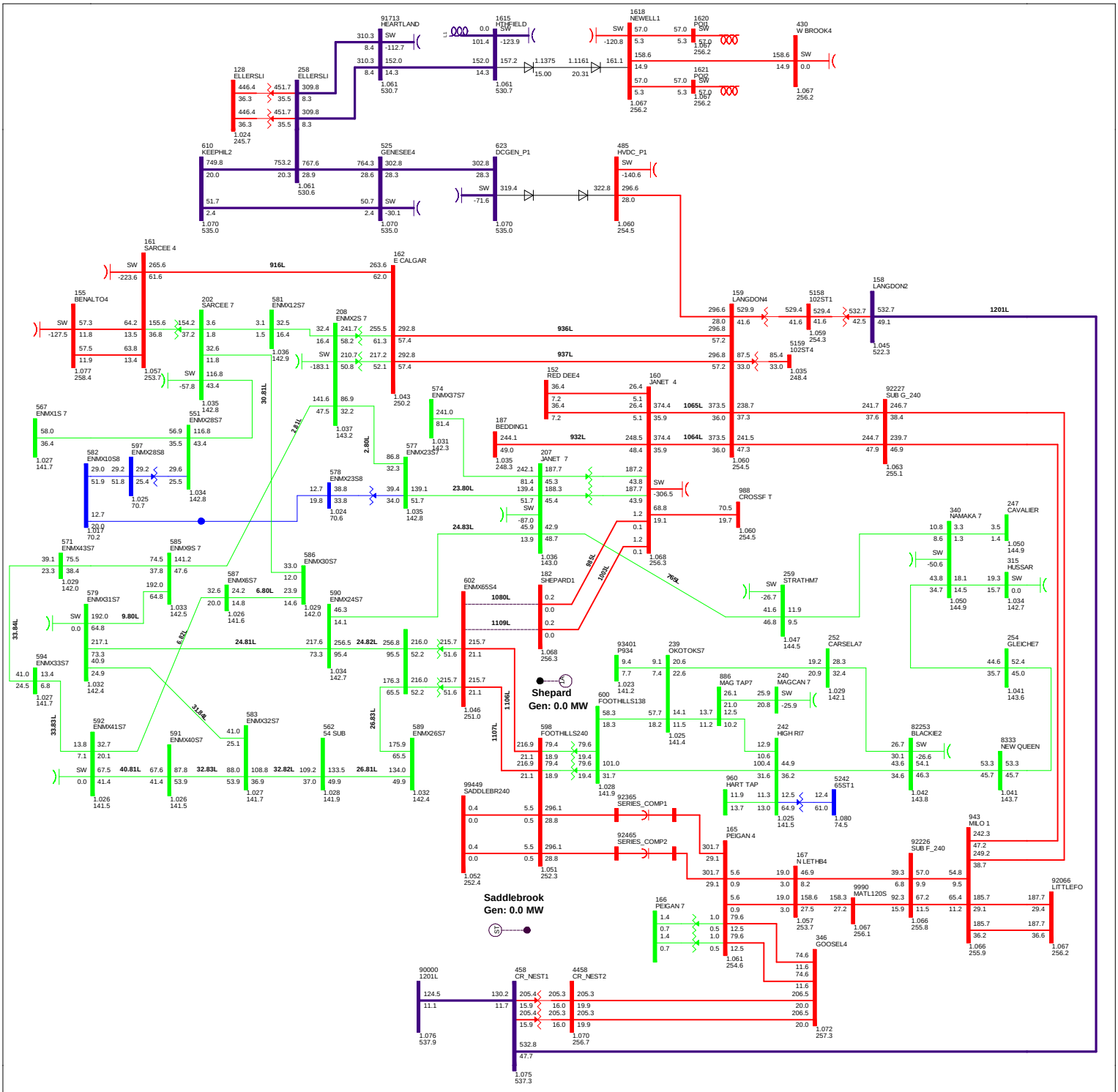
BCH Import:-109.3 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG CURTAIL-B-SC3-1: 1064L-1065L 105 MW CALGARY LOAD SHED

2019_FATD-E_HVDC_SC3_SP

FRI, JUN 08 2012 16:55



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

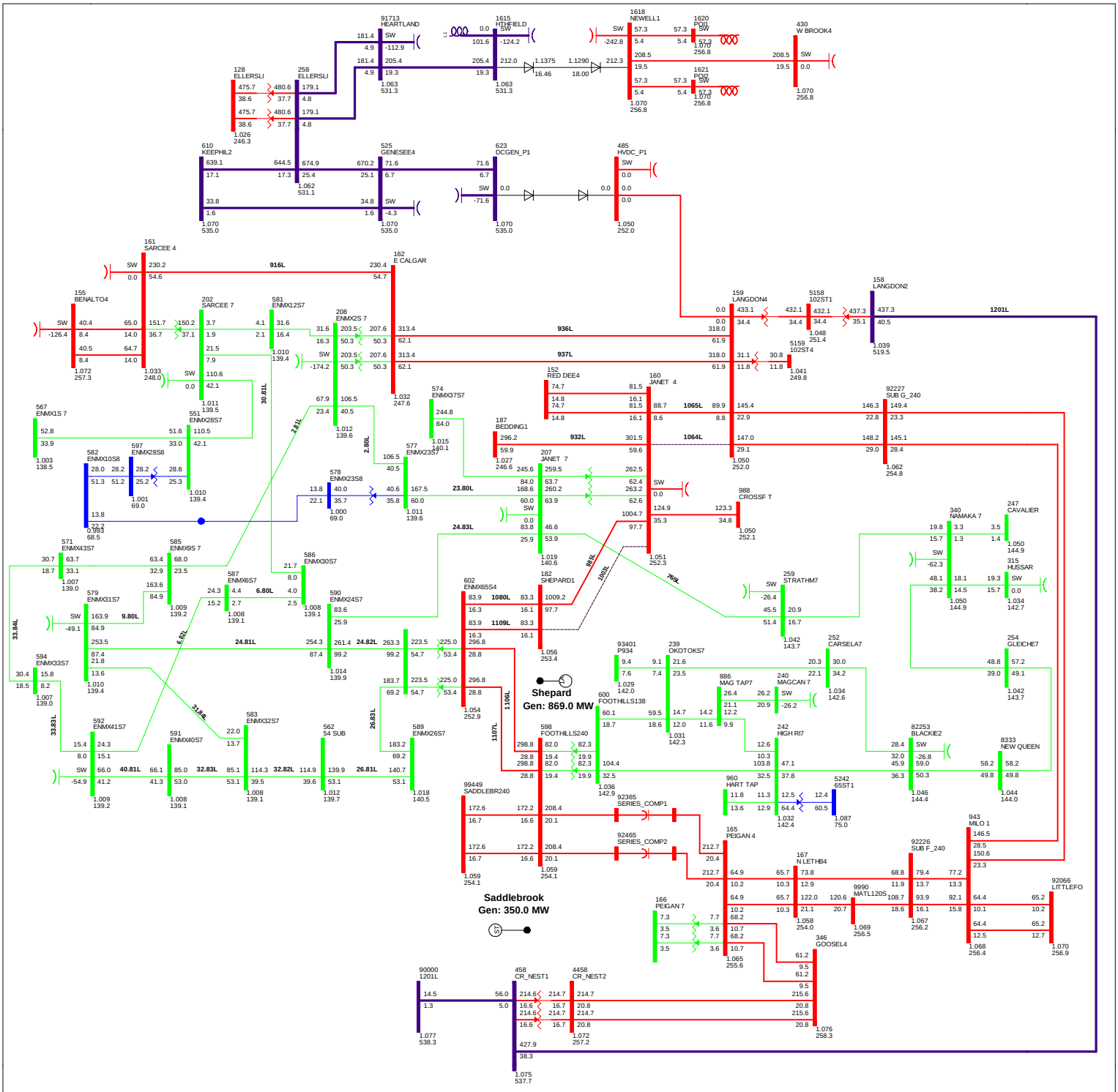
BCH Import: 134.8 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG CURTAIL-B-SC3-2: 1080L-1109L 196 MW CALG LOADSHED & SADD
2019_FATD-E_HVDC_SC3_SP

FRI, JUN 08 2012 16:55

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

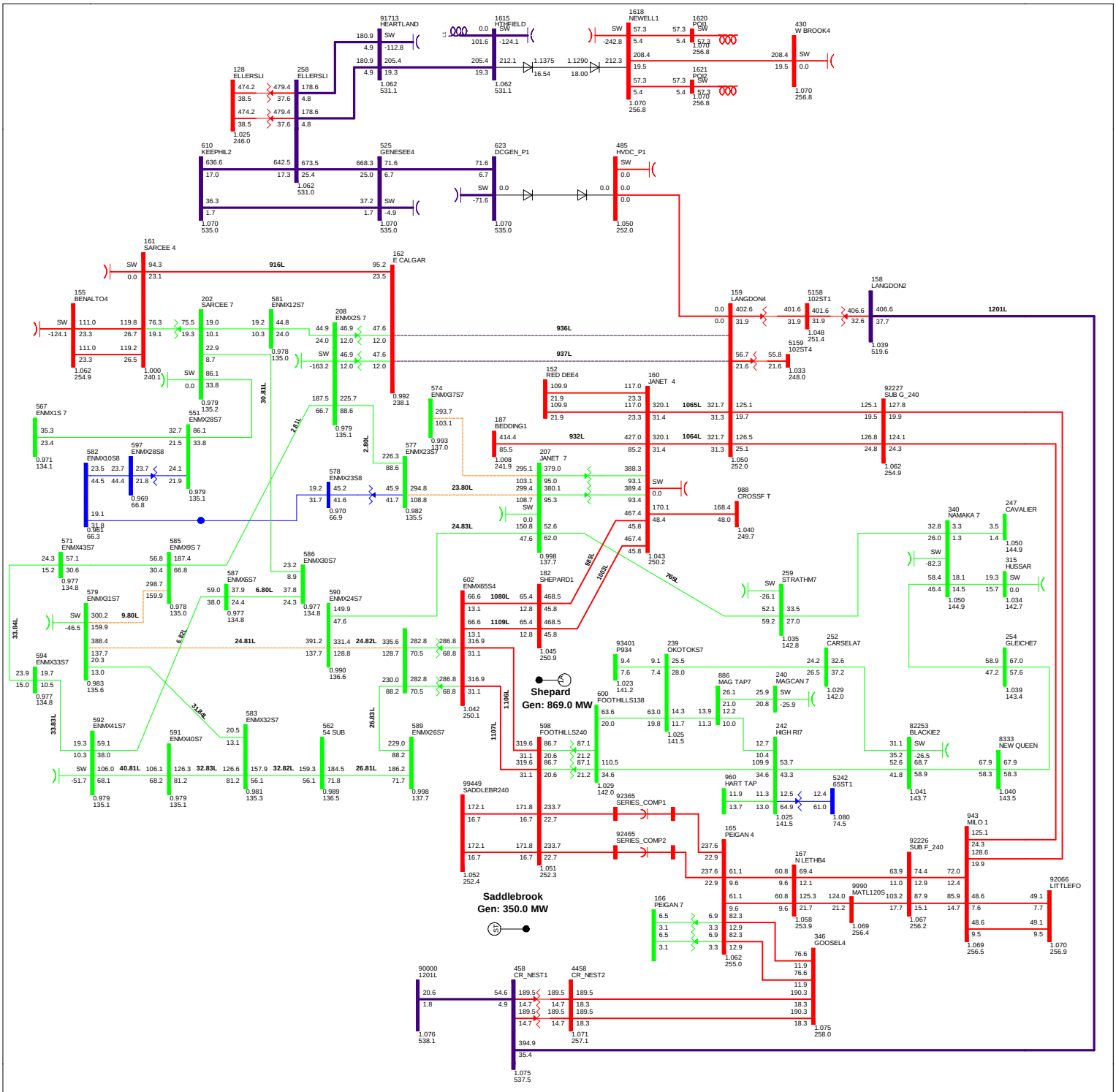
BCH Import: 1.4 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG C5-B-SC4-1: DOUBLE OUTAGE 1003L AND 1064L

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:54



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

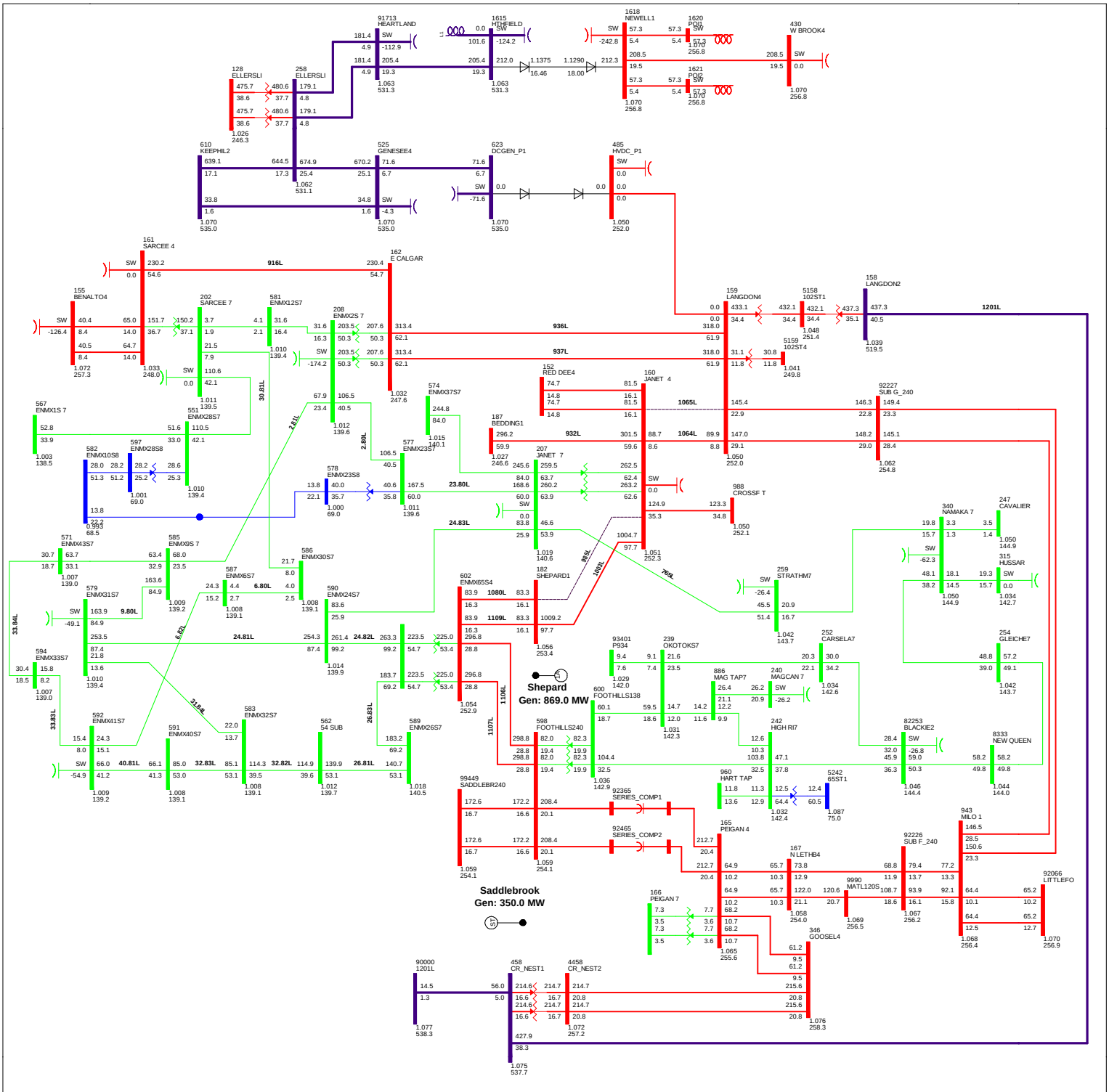
BCH Import: 28.4 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG C5-B-SC4-2: DOUBLE OUTAGE 936L AND 937L

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:54



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 1.4 MW

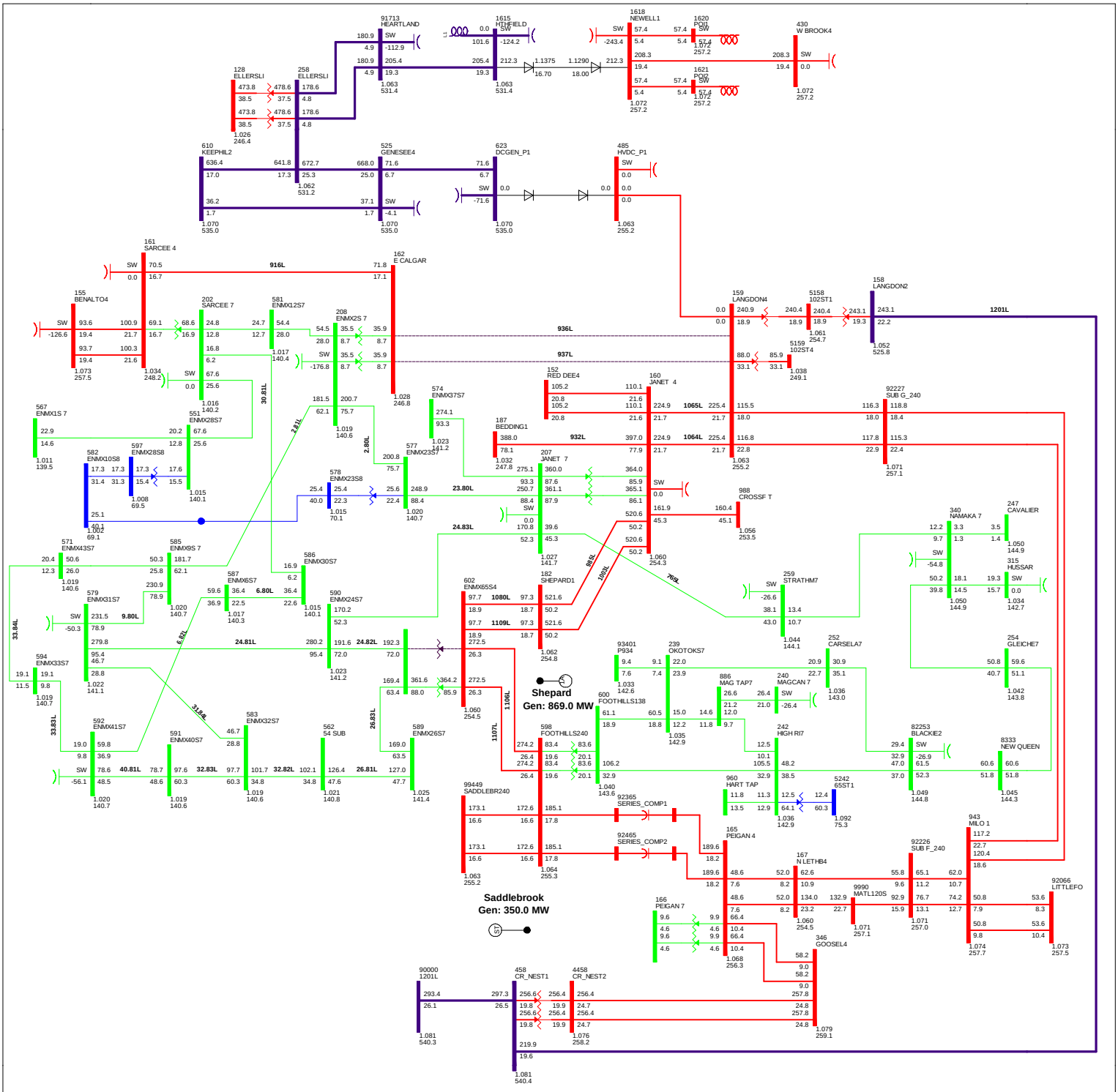
2012LTO+HVDC FATD EAST SYSTEM

FIG C5-B-SC4-3: DOUBLE OUTAGE 985L AND 1065L

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:54

2019 FATD+HVDC-East Curtailment Assessment
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import:-298.8 MW

2012LTO+HVDC FATD EAST SYSTEM

FIG CURTAIL-B-SC4-1: 936L-937L 300 MW CALGARY LOAD SHED

2019_FATD-E_HVDC_SC4_SP

FRI, JUN 08 2012 16:55

E-2: FATD+HVDC-East + 3rd Circuit Assessment

Table 3: FATD East+3rdCkt Maximum Loading on Critical Lines with 2019 FATD+HVDC under Category C5

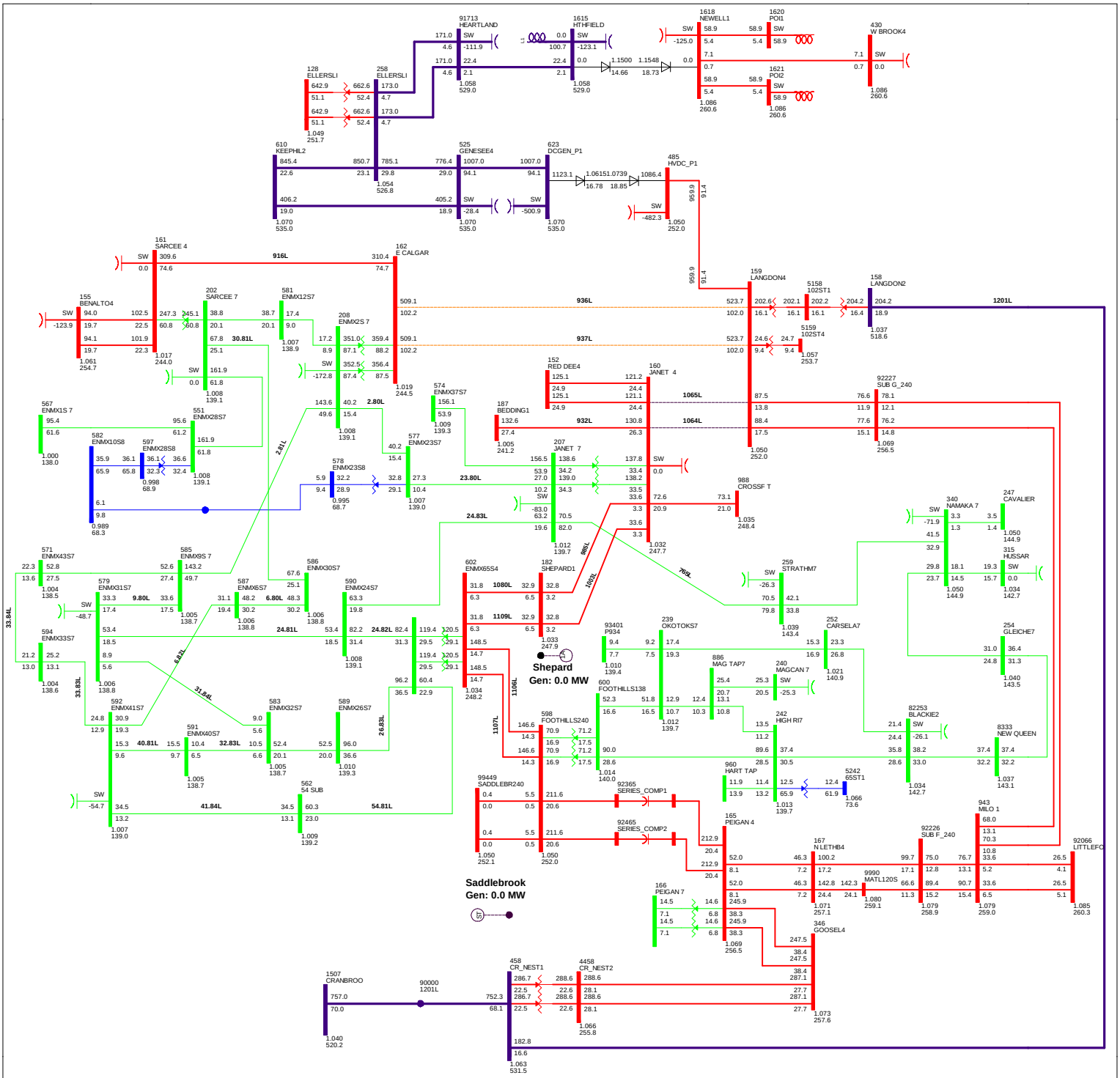
Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration 2019 HVDC FATD East+3rdCkt √ indicates loading below 80% N/A indicates the circuit does not exist
C5-C-SC1A-1	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 509MVA
		937L 240 kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 509MVA
		240/138 kV transformer (East Calgary 5S)	SC1A	90% 359MVA
C5-C-SC1A-2	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	84% 74MVA
C5-C-SC1A-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	80% 69MVA
C5-C-SC3-1	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	240/138 kV transformer (East Calgary 5S)	SC3	88% 351MVA
		916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC3	100% 415MVA
C5-C-SC3-2	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	99% 260MVA
C5-C-SC3-3	Open 1106L 240 kV line (Foothills 237S to ENMAX No. 65) Open 1107L 240 kV line (Foothills 237S to ENMAX No. 65)	1201L 500kV line (Langdon 102S to Crowsnest 491S)	SC3	80% 830MVA
C5-C-SC4-1	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25) Open 1064L 240 kV line (Langdon 102S to Janet 74S)	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	93% 957MVA
C5-C-SC4-2	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	99% 269MVA
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	103% 293MVA
		240/138 kV transformer (ENMAX No. 65)	SC4	80% 321MVA
		240/138 kV transformer (Janet 74S)	SC4	93% 372MVA
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	82% 212MVA
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	141% 266MVA
		932L 240 kV line (Janet 74S to Beddington SS-162)	SC4	81% 396MVA
		2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	√
C5-C-SC4-3	Open 985L 240 kV line (Janet 74S to ENMAX No. 25) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	93% 957MVA

Table 4: FATD-East+3rdCkt Required Curtailment to achieve < 95% Loading Critical Lines with 2019+HVDC FATD East+3rdCkt under Category C5

Figure Number	Contingency	Critical Circuit	Scenario	2019+HVDC FATD-East+3rdCkt	Mitigation Option
CURTAIL-C-SC1A-1	Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 509MVA	Redispatch WATL to 885 MW (122 MW Reduction) **
		937L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 509MVA	
CURTAIL-C-SC3-1	Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	916L 240kV line (Sarcee 42S to East Calgary 5S)	SC3	100% 415MVA	Shed 2x10 @ Enmax 21, 2x14.6 MW @ Enmax 28, 2x10.1 @ Enmax 30 = **Total of 69 MW**
CURTAIL-C-SC4-1	Open 936L 240kV line (Langdon 102S to East Calgary 5S)	24.81L 138kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	103% 293MVA	Shed 1x23.5 MW @ Enmax 31, 2x20.7 MW @ Enmax 9 = **Total of 65 MW**
	Open 937L 240kV line (Langdon 102S to East Calgary 5S)	9.80L 138kV line* (ENMAX No. 31 to ENMAX No. 9)	SC4	141% 266MVA	

*9.80L (SS-9 to SS-31) line rating can be increased to 287 MVA by adjusting the CT limit ratio to 1200 A. The amount of load shedding is based on this increased rating.
**WATL HVDC Line Dispatch measured at Genesee end

2019 Loading Violations
Scenario 1A



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

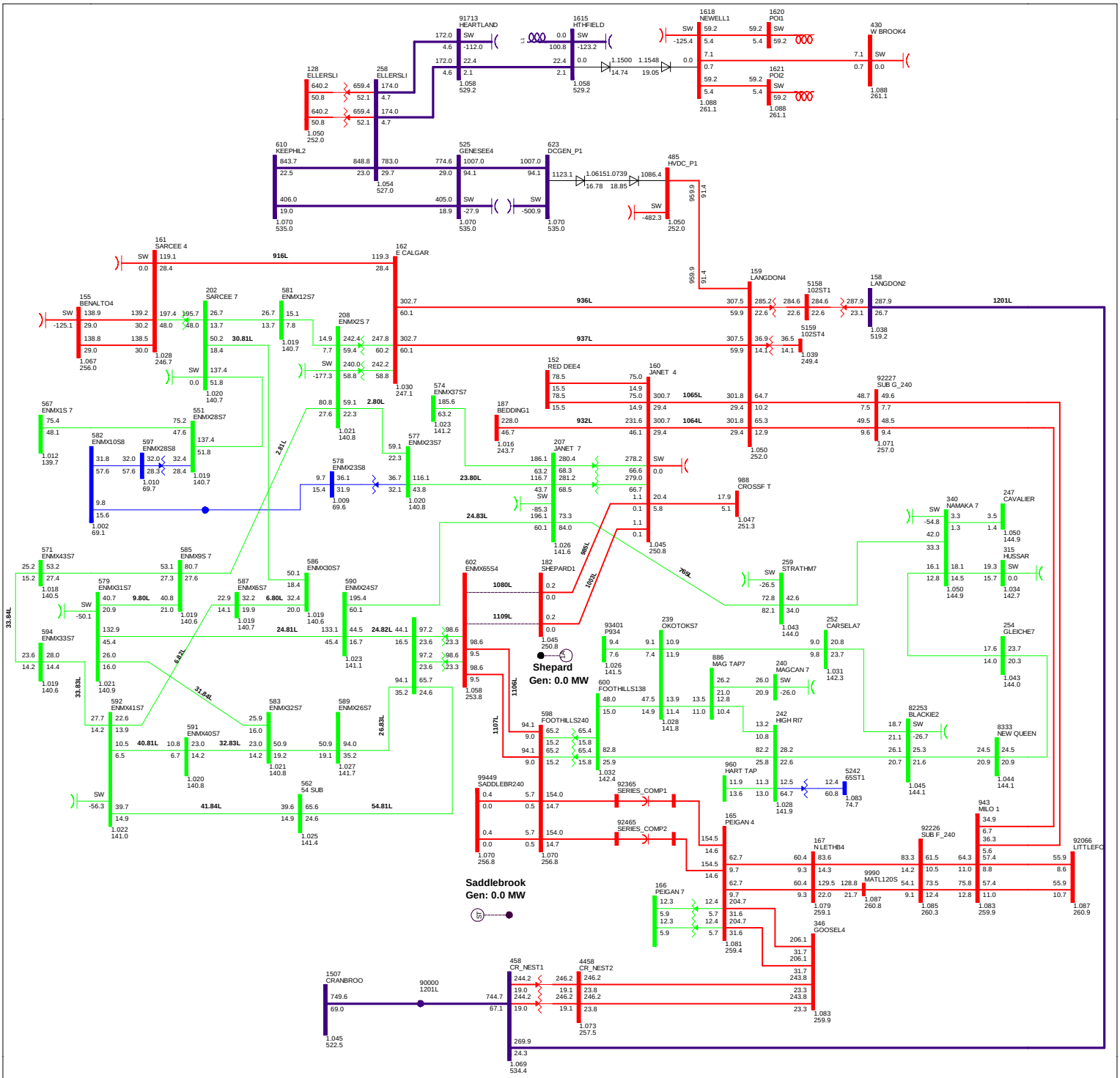
BCH Import: 800.6 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C5-C-SC1A-1: DOUBLE OUTAGE 1064L AND 1065L

2019_FATD-E3_HVDC_SC1A_SP

FRI, JUN 08 2012 16:56



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

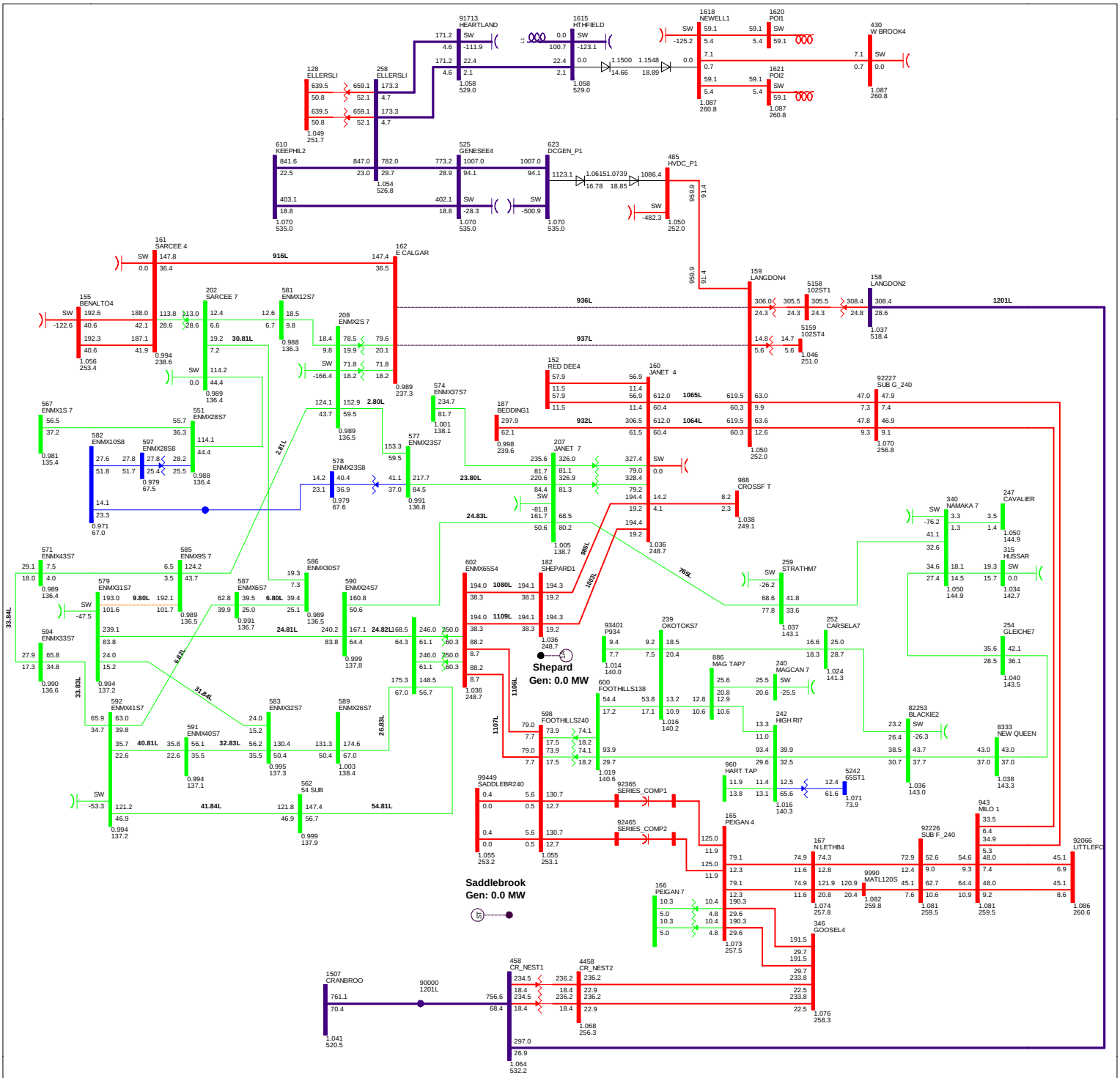
BCH Import: 784.5 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C5-C-SC1A-2: DOUBLE OUTAGE 1080L AND 1109L

2019_FATD-E3_HVDC_SC1A_SP

FRI, JUN 08 2012 16:56



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 803.4 MW

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

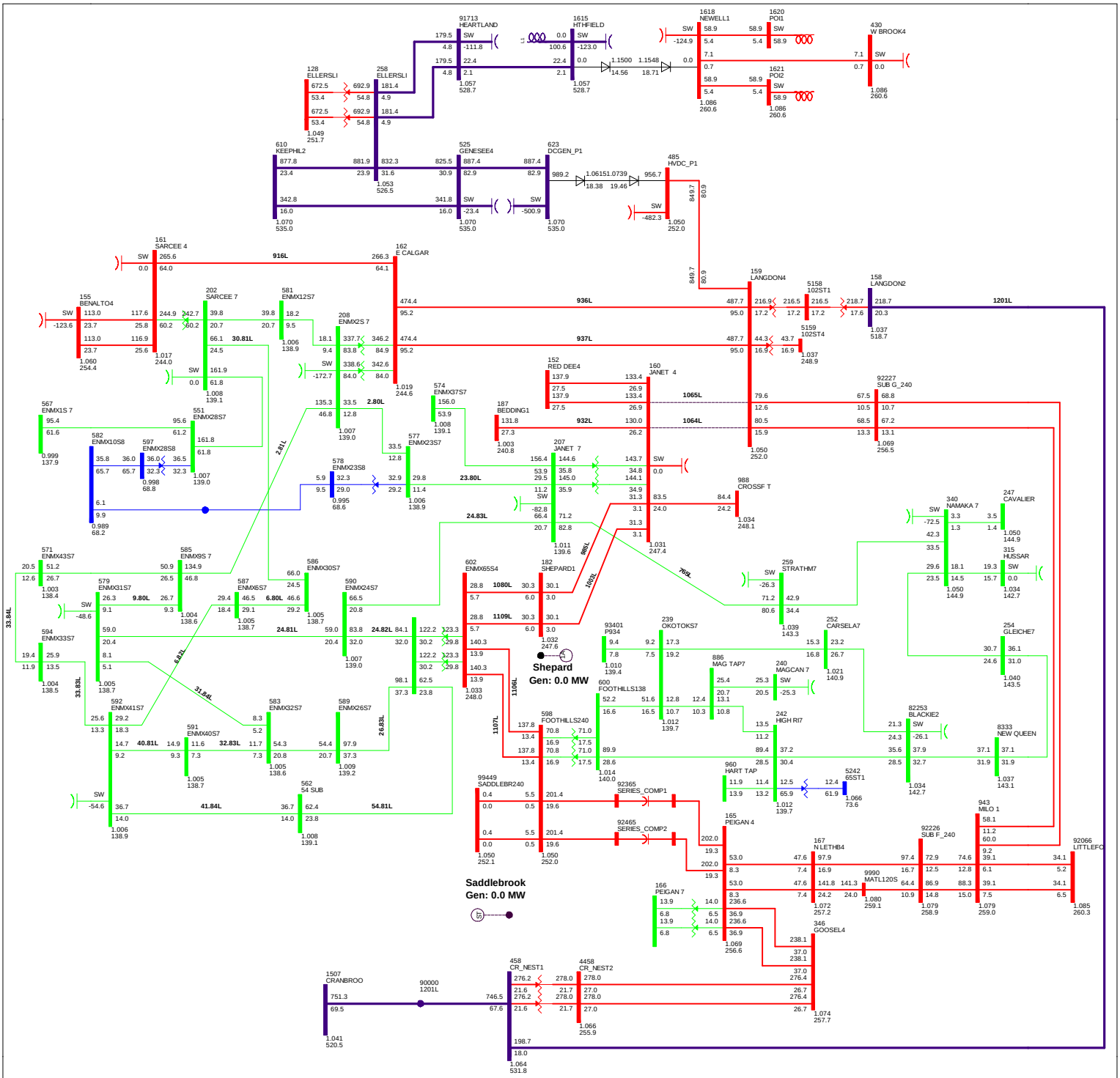
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C5-C-SC1A-3: DOUBLE OUTAGE 936L AND 937L

2019_FATD-E3_HVDC_SC1A_SP

FRI, JUN 08 2012 16:56

2019 FATD+HVDC-East + 3rd Circuit Curtailment Assessment
Scenario 1A



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

BCH Import: 793.4 MW

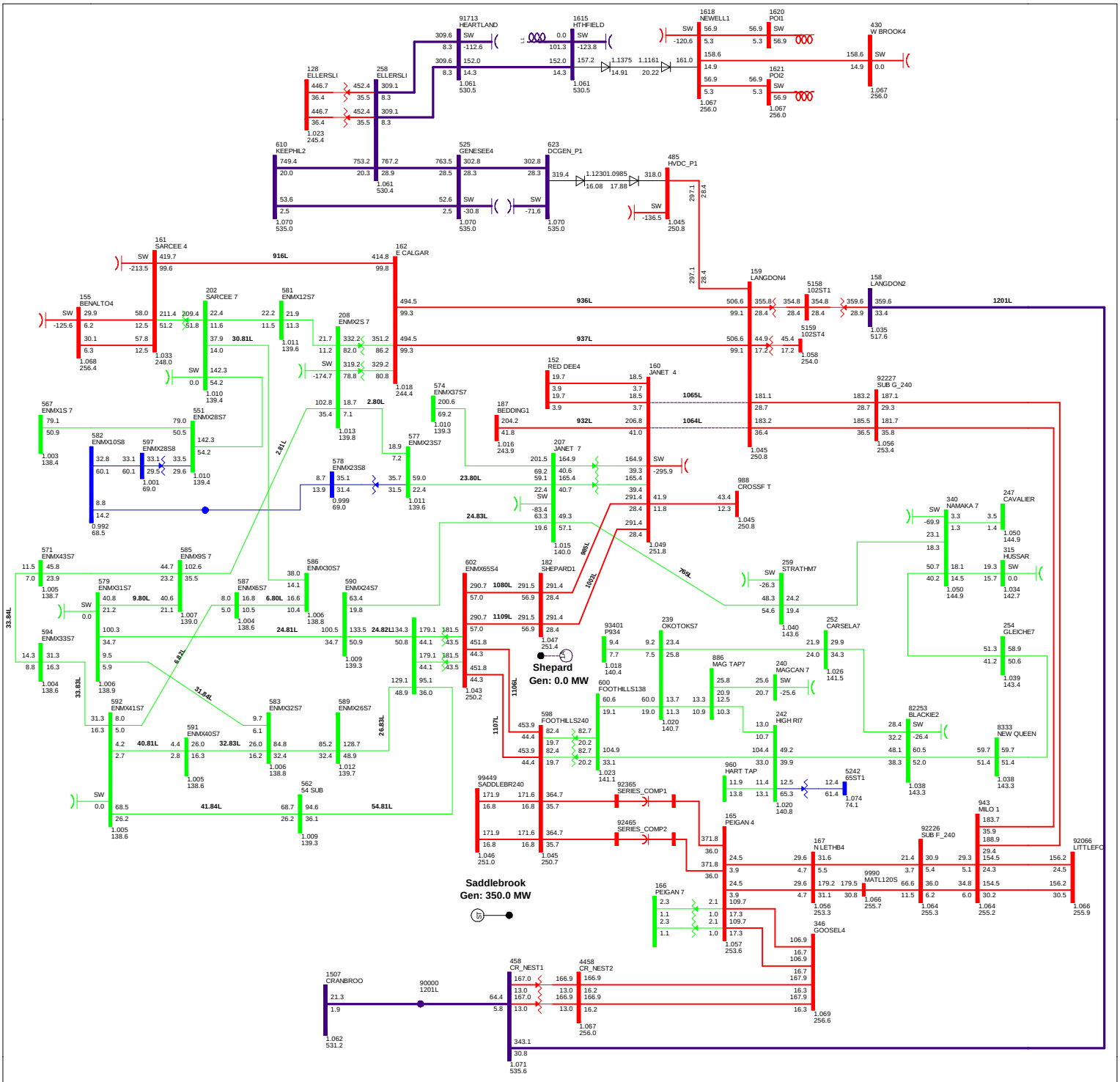
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG CURTAIL-C-SC1A-1: 1064L-1065L REDISPATCH WATL TO 885 MW

2019_FATD-E3_HVDC_SC1A_SP

FRI, JUN 08 2012 16:57

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

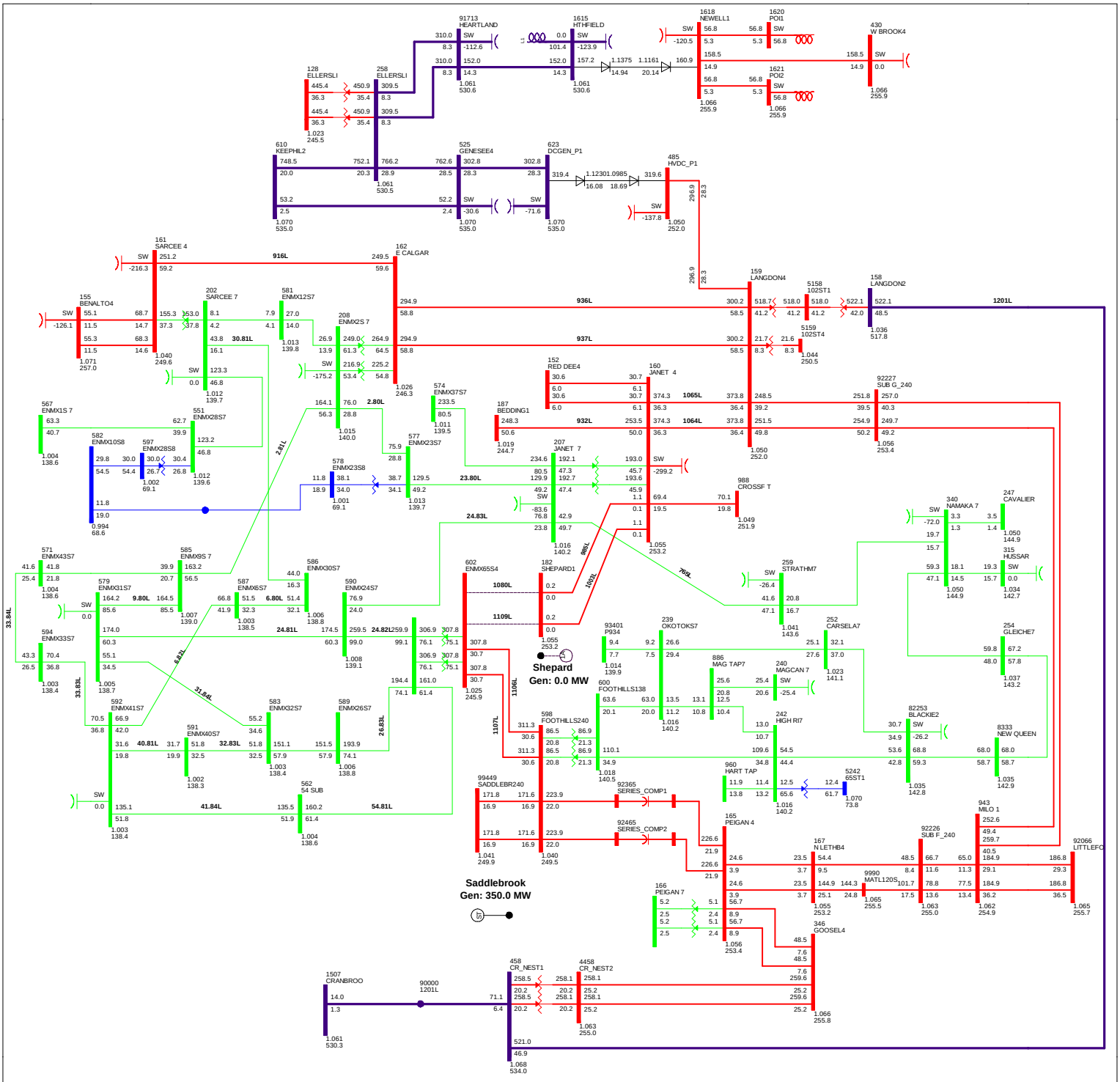
BCH Import: 18.0 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C5-C-SC3-1: DOUBLE OUTAGE 1064L AND 1065L

2019_FATD-E3_HVDC_SC3_SP

FRI, JUN 08 2012 16:56



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

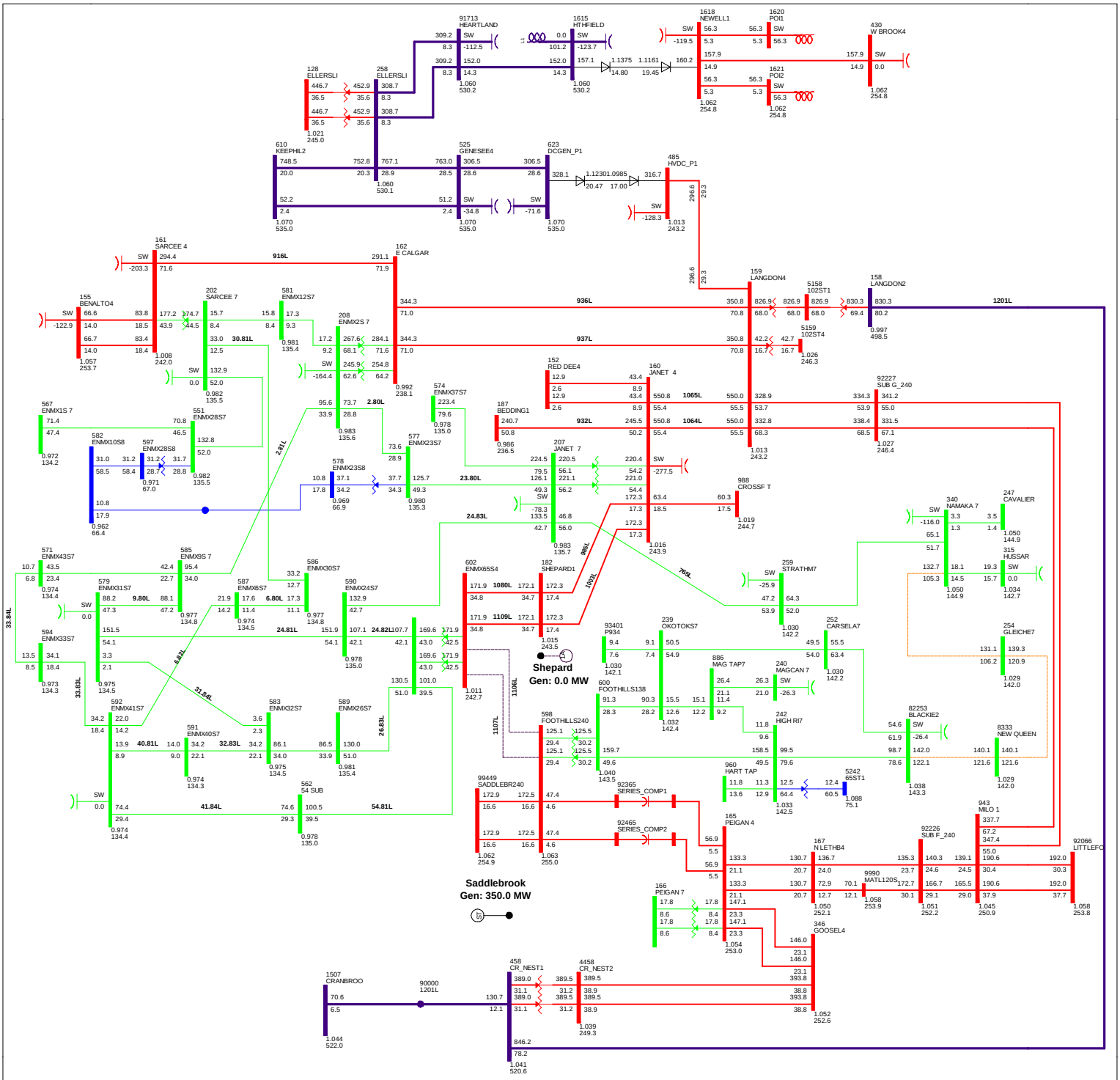
BCH Import: 8.9 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C5-C-SC3-2: DOUBLE OUTAGE 1080L AND 1109L

2019_FATD-E3_HVDC_SC3_SP

FRI, JUN 08 2012 16:56



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000 >500.000

BCH Import: 69.6 MW

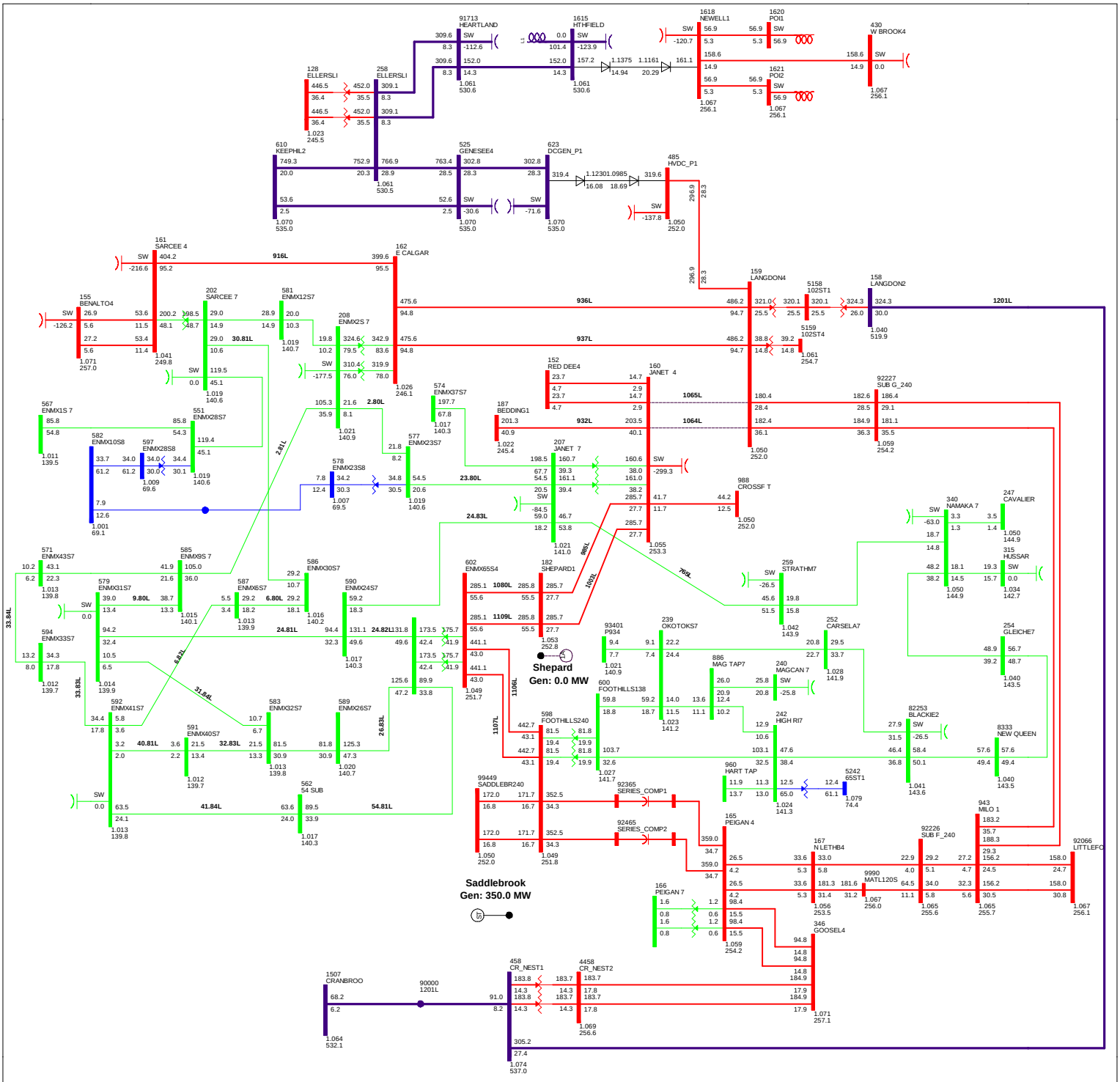
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C5-C-SC3-3: DOUBLE OUTAGE 1106L AND 1107L

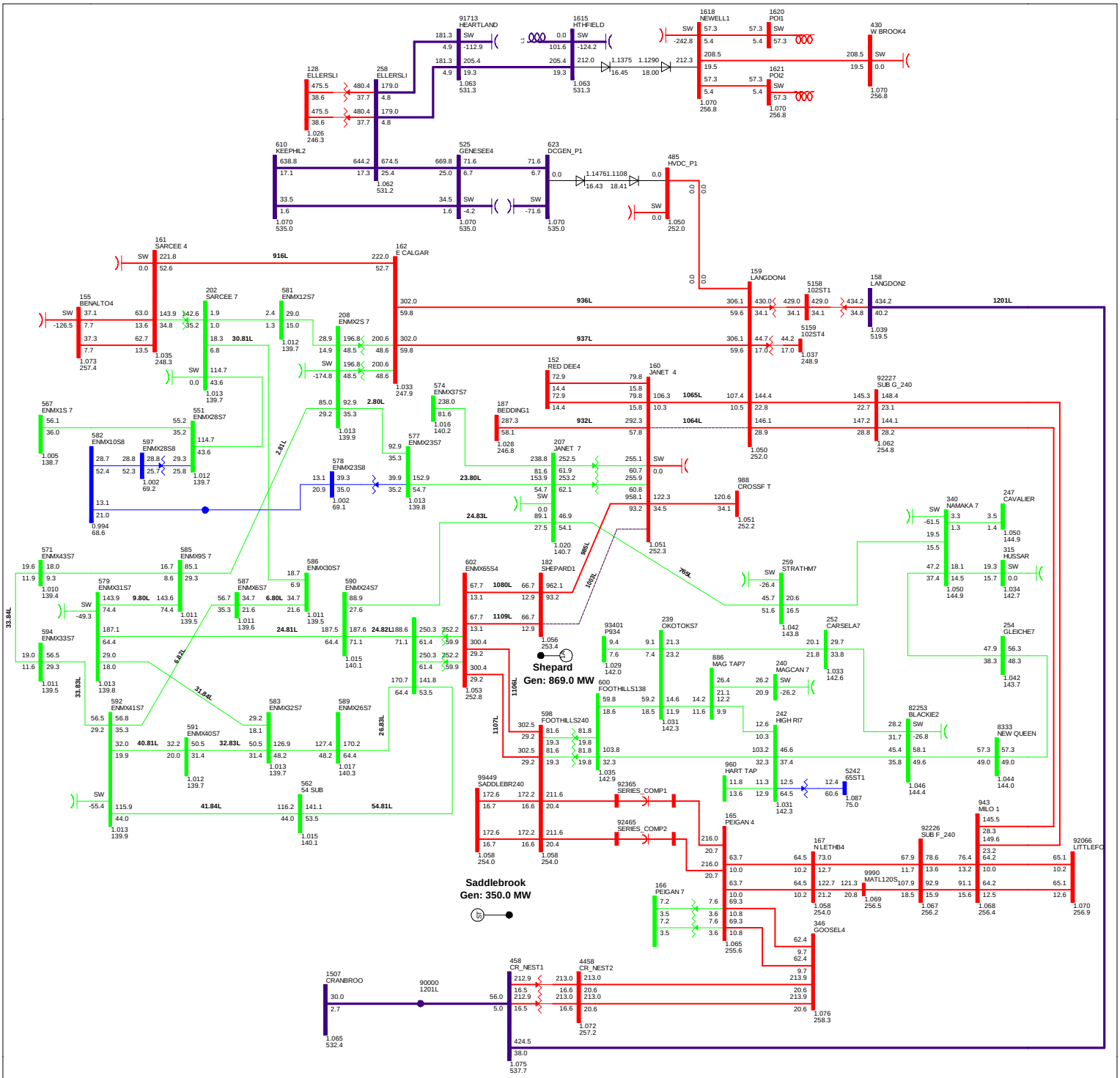
2019_FATD-E3_HVDC_SC3_SP

FRI, JUN 08 2012 16:56

2019 FATD+HVDC-East + 3rd Circuit Curtailment Assessment
Scenario 3


Shepard
Gen: 0.0 MW
Saddlebrook
Gen: 350.0 MW
BCH Import: -57.8 MW
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM
FIG CURTAIL-C-SC3-1: 1064L-1065L 69 MW CALGARY LOAD SHED
2019_FATD-E3_HVDC_SC3_SP
FRI, JUN 08 2012 16:57
Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

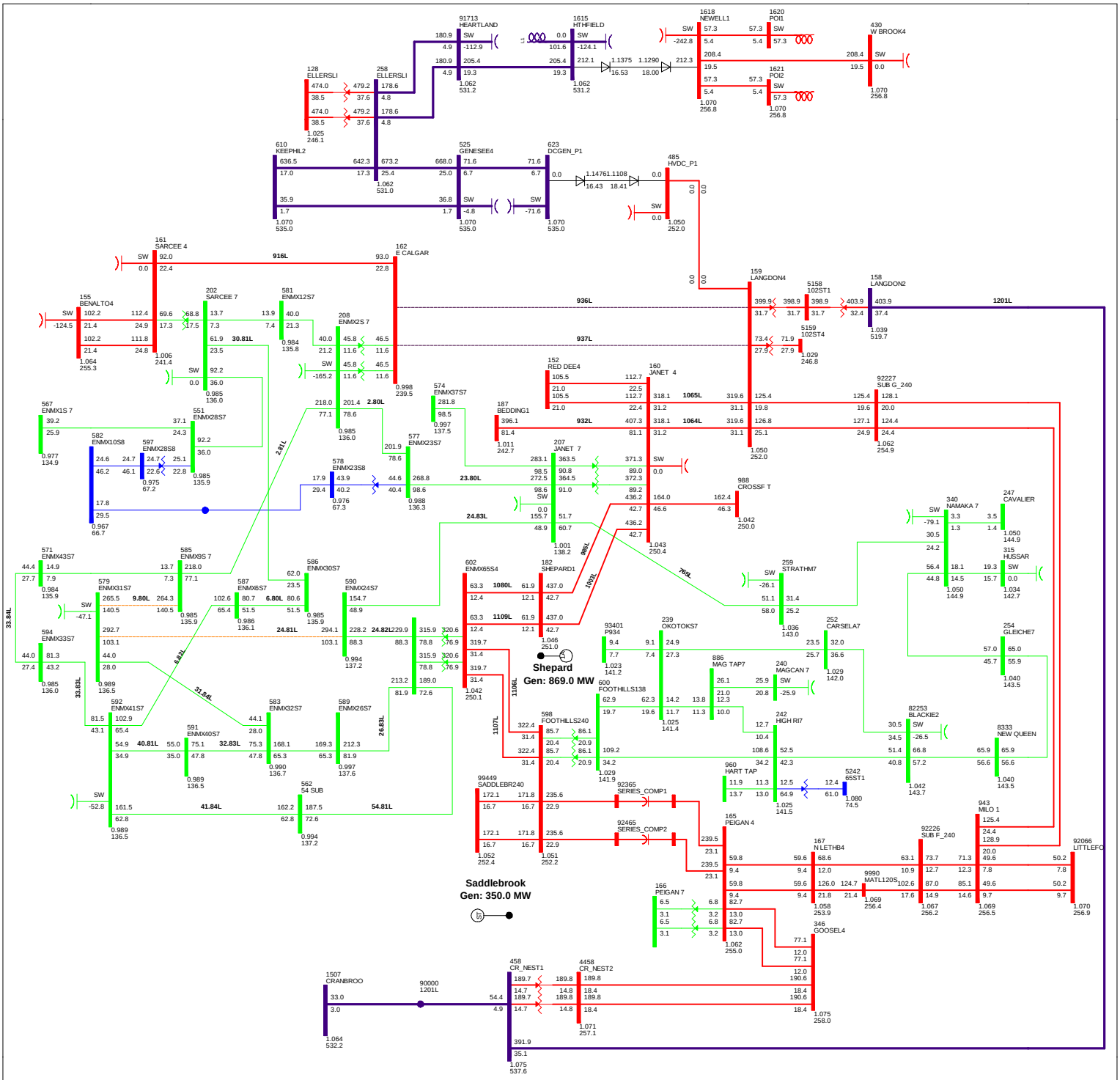
BCH Import: 1.0 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C5-C-SC4-1: DOUBLE OUTAGE 1003L AND 1064L

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:57



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

BCH Import: 23.5 MW

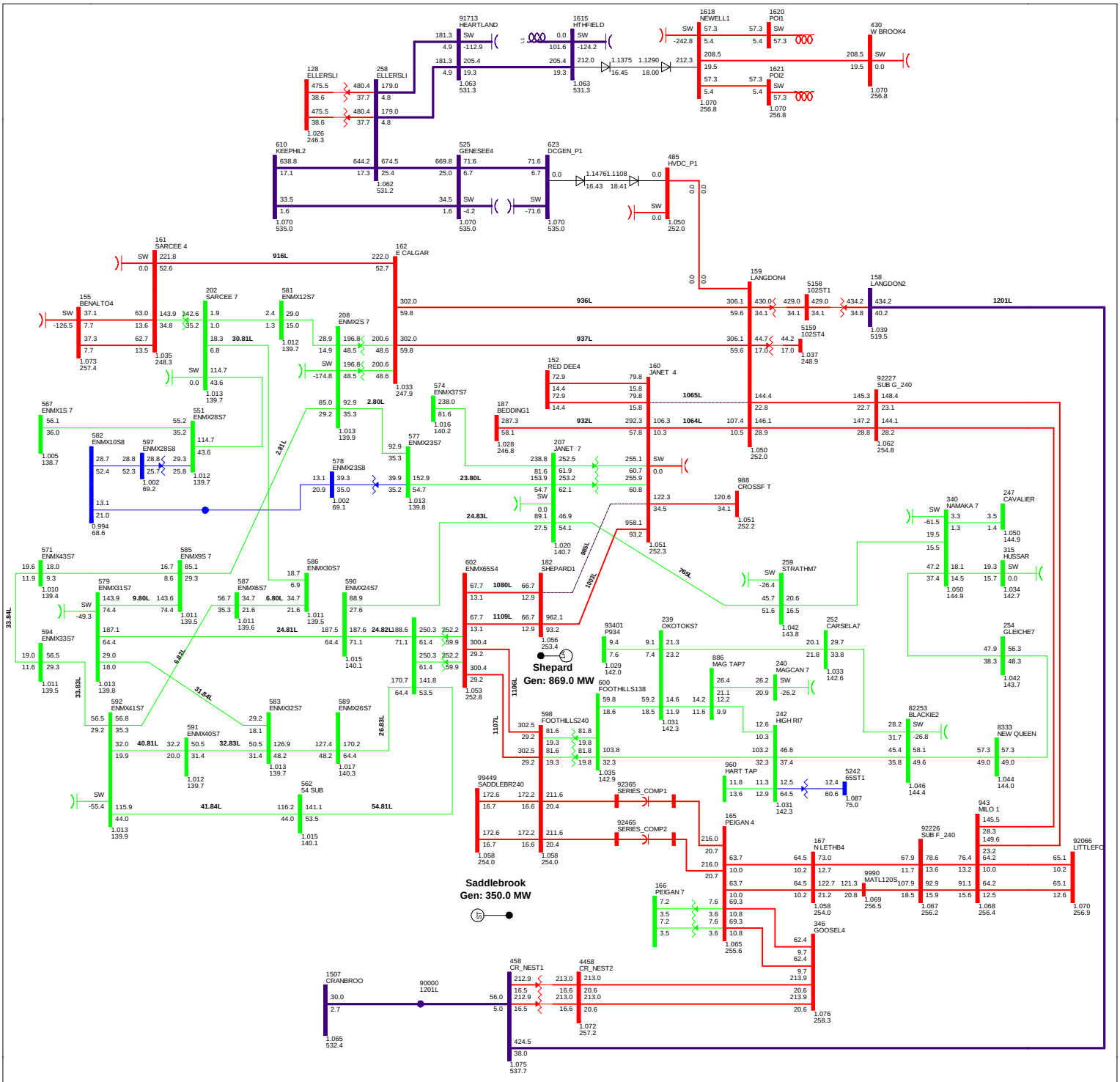
100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C5-C-SC4-2: DOUBLE OUTAGE 936L AND 937L

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:57



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

BCH Import: 1.0 MW

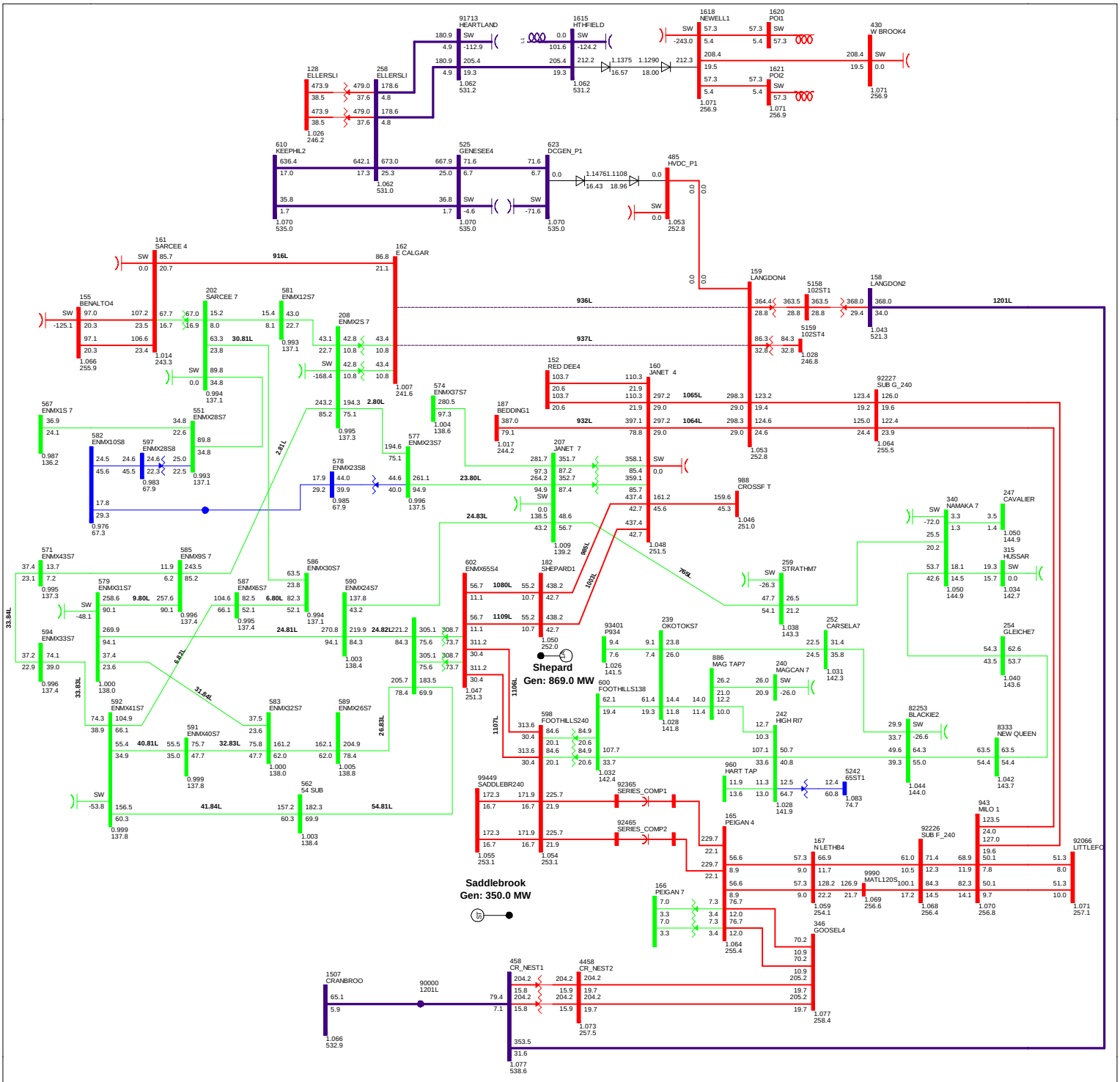
2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG C5-C-SC4-3: DOUBLE OUTAGE 985L AND 1065L

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:57

2019 FATD+HVDC-East + 3rd Circuit Curtailment Assessment
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/Mvar

100.0%RATEA
kV: <=34.500 <=69.000 <=138.000<=240.000 <=500.000 >500.000

BCH Import: -48.1 MW

2012LTO+HVDC
FATD EAST + 3RD CKT SYSTEM

FIG CURTAIL-C-SC4-1: 936L-937L 65 MW CALGARY LOAD SHED

2019_FATD-E3_HVDC_SC4_SP

FRI, JUN 08 2012 16:58

E-3: FATD+HVDC-Full Assessment

Table 5: FATD Full Maximum Loading on Critical Lines with 2019 FATD+HVDC under Category C5

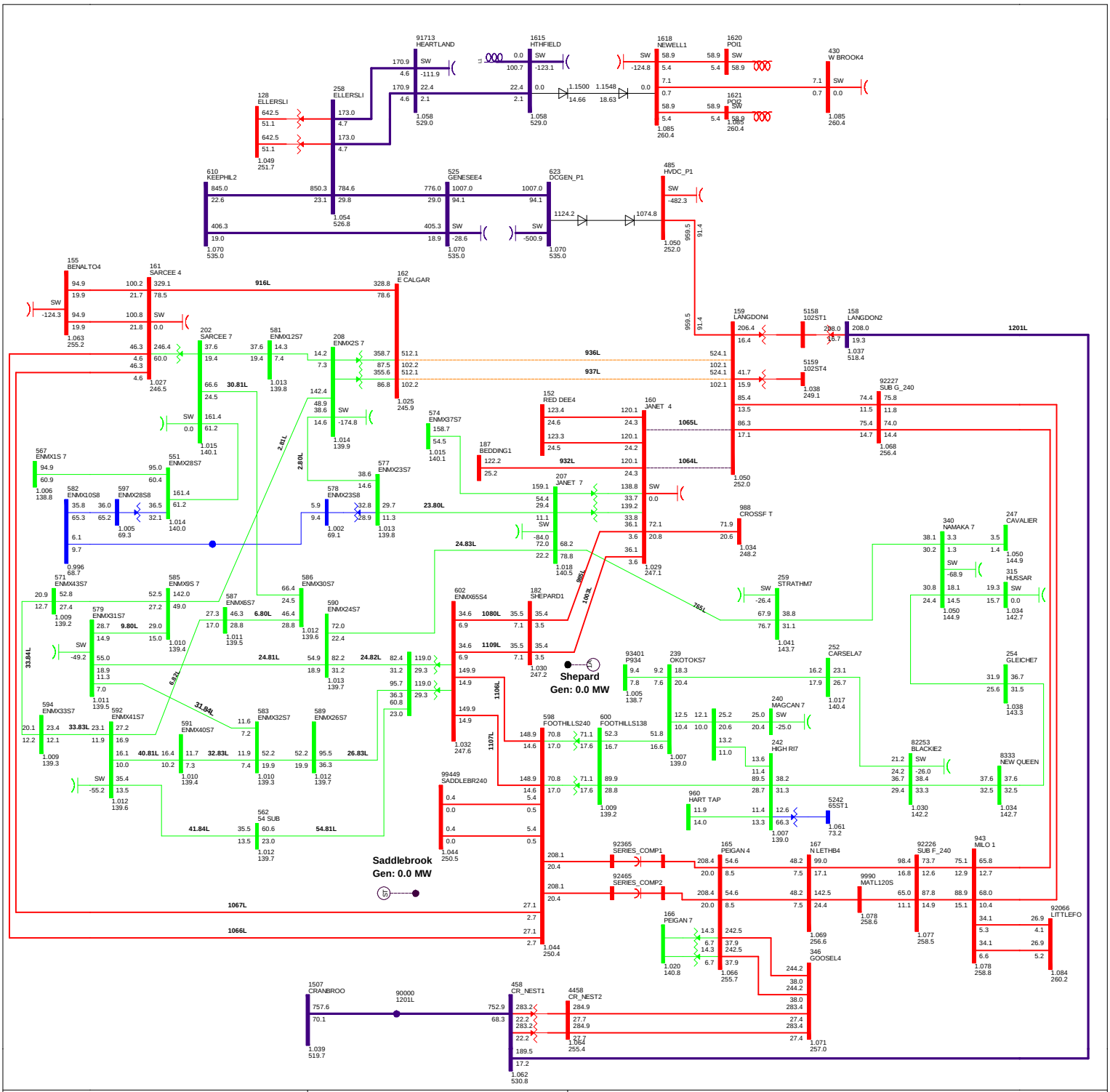
Figure Number	Contingency	Overloaded Branch	Scenario	System Configuration 2019 HVDC FATD Full √ indicates loading below 80% N/A indicates the circuit does not exist
C5-D-SC1A-1	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	936L 240 kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 512MVA
		937L 240 kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 512MVA
		240/138 kV transformer (East Calgary 5S)	SC1A	89% 356MVA
C5-D-SC1A-2	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	80% 71MVA
C5-D-SC1A-3	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	765L 138 kV line (Janet 74S to Strathmore 151S)	SC1A	81% 70MVA
C5-D-SC3-1	Open 1064L 240 kV line (Langdon 102S to Janet 74S) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	240/138 kV transformer (East Calgary 5S)	SC3	93% 372MVA
		916L 240 kV line (Sarcee 42S to East Calgary 5S)	SC3	√
C5-D-SC3-2	Open 1080L 240 kV line (ENMAX No. 25 to ENMAX No. 65) Open 1109L 240 kV line (ENMAX No. 25 to ENMAX No. 65)	24.82L 138 kV line (ENMAX No. 65 to ENMAX No. 24)	SC3	√
C5-D-SC3-3	Open 1106L 240 kV line (Foothills 237S to ENMAX No. 65) Open 1107L 240 kV line (Foothills 237S to ENMAX No. 65)	1201L 500kV line (Langdon 102S to Crowsnest 491S)	SC3	√
C5-D-SC4-1	Open 1003L 240 kV line (Janet 74S to ENMAX No. 25) Open 1064L 240 kV line (Langdon 102S to Janet 74S)	985L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	√
C5-D-SC4-2	Open 936L 240 kV line (Langdon 102S to East Calgary 5S) Open 937L 240 kV line (Langdon 102S to East Calgary 5S)	23.80L 138 kV line (Janet 74S to ENMAX No. 23)	SC4	√
		24.81L 138 kV line (ENMAX No. 31 to ENMAX No. 24)	SC4	√
		240/138 kV transformer (ENMAX No. 65)	SC4	√
		240/138 kV transformer (Janet 74S)	SC4	√
		26.83L 138 kV line (ENMAX No. 65 to ENMAX No. 26)	SC4	√
		32.83L 138 kV line (ENMAX No. 32 to ENMAX No. 40)	SC4	√
		9.80L 138 kV line (ENMAX No. 31 to ENMAX No. 9)	SC4	86% 165MVA
		932L 240 kV line (Janet 74S to Beddington SS-162)	SC4	√
		2.80L 138 kV line (ENMAX No. 2 to ENMAX No. 23)	SC4	√
C5-D-SC4-3	Open 985L 240 kV line (Janet 74S to ENMAX No. 25) Open 1065L 240 kV line (Langdon 102S to Janet 74S)	1003L 240 kV line (Janet 74S to ENMAX No. 25)	SC4	√

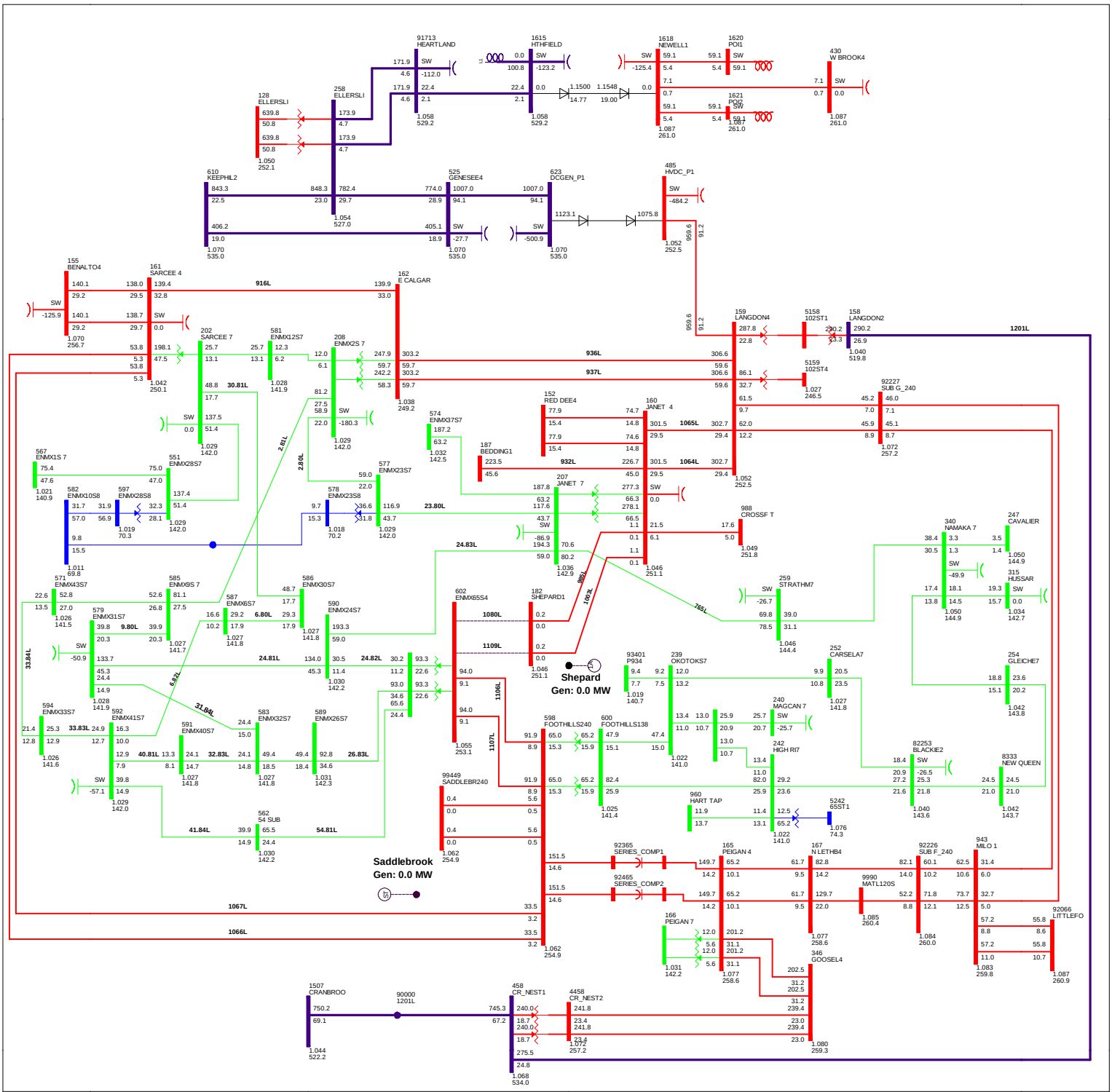
Table 6: FATD-Full Required Curtailment "TO" Generation Levels and Load Levels to achieve < 95% Loading Critical Lines with 2019+HVDC FATD East under Category C5

Figure Number	Contingency	Critical Circuit	Scenario	2019+HVDC FATD-Full	Mitigation Option
CURTAIL-D-SC1A-1	Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	936L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 512MVA	Redispatch WATL to 886 MW (122 MW Reduction) **
	Open 1064L 240kV line (Langdon 102S to Janet 74S) Open 1065L 240kV line (Langdon 102S to Janet 74S)	937L 240kV line (Langdon 102S to East Calgary 5S)	SC1A	102% 512MVA	

**WATL HVDC Line Dispatch measured at Genesee end

2019 Loading Violations
Scenario 1A


Saddlebrook
Gen: 0.0 MW
Shepard
Gen: 0.0 MW
BCH Import:801.6 MW
Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000
2012LTO+HVDC FULL SYSTEM
FIG C5-D-SC1A-1: DOUBLE OUTAGE 1064L AND 1065L
2019_FATD-F_HVDC_SC1A_SP
FRI, JUN 08 2012 16:58



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

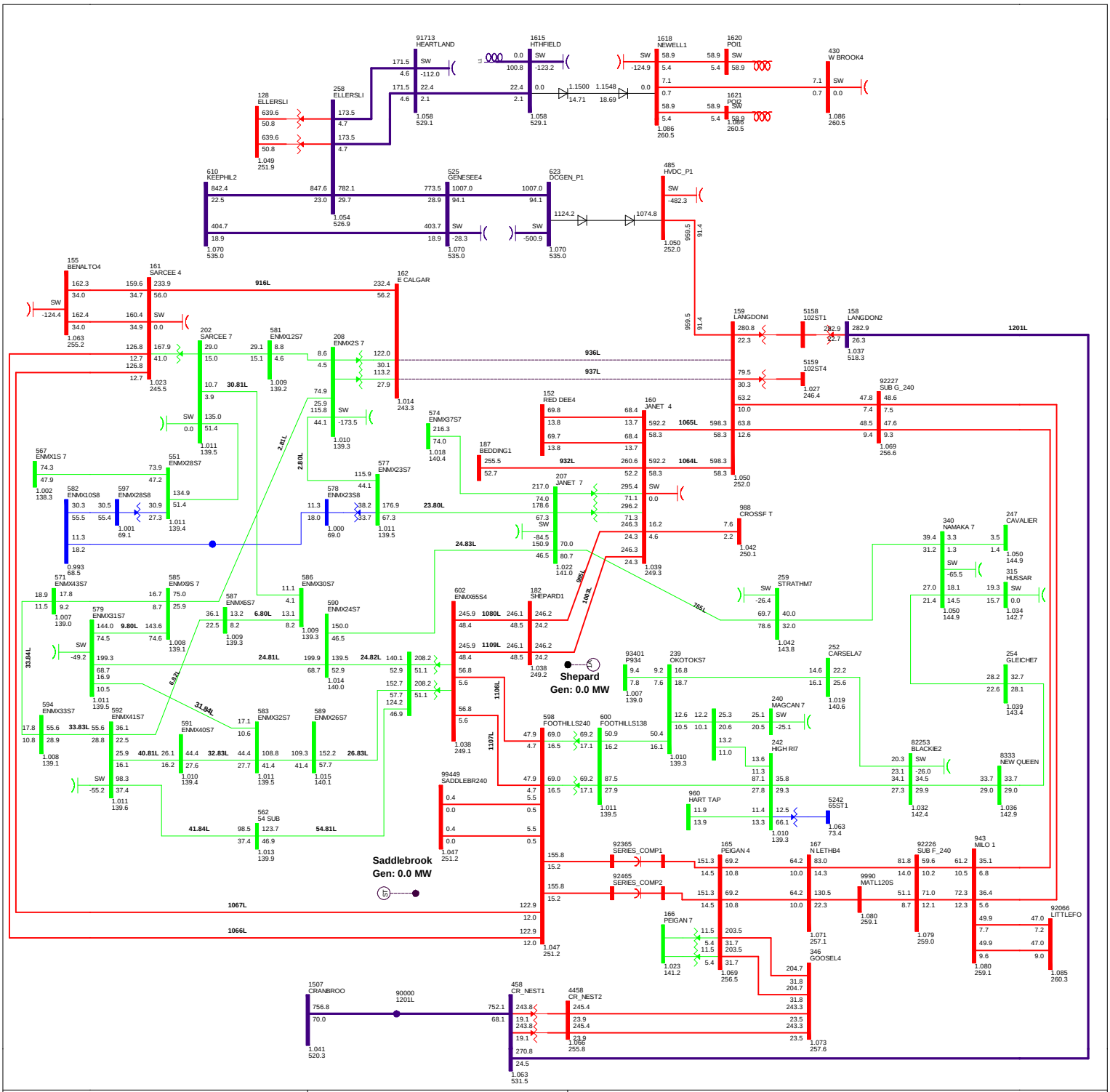
BCH Import: 785.3 MW

2012LTO+HVDC FULL SYSTEM

FIG C5-D-SC1A-2: DOUBLE OUTAGE 1080L AND 1109L

2019_FATD-F_HVDC_SC1A_SP

FRI, JUN 08 2012 16:58



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 797.4 MW

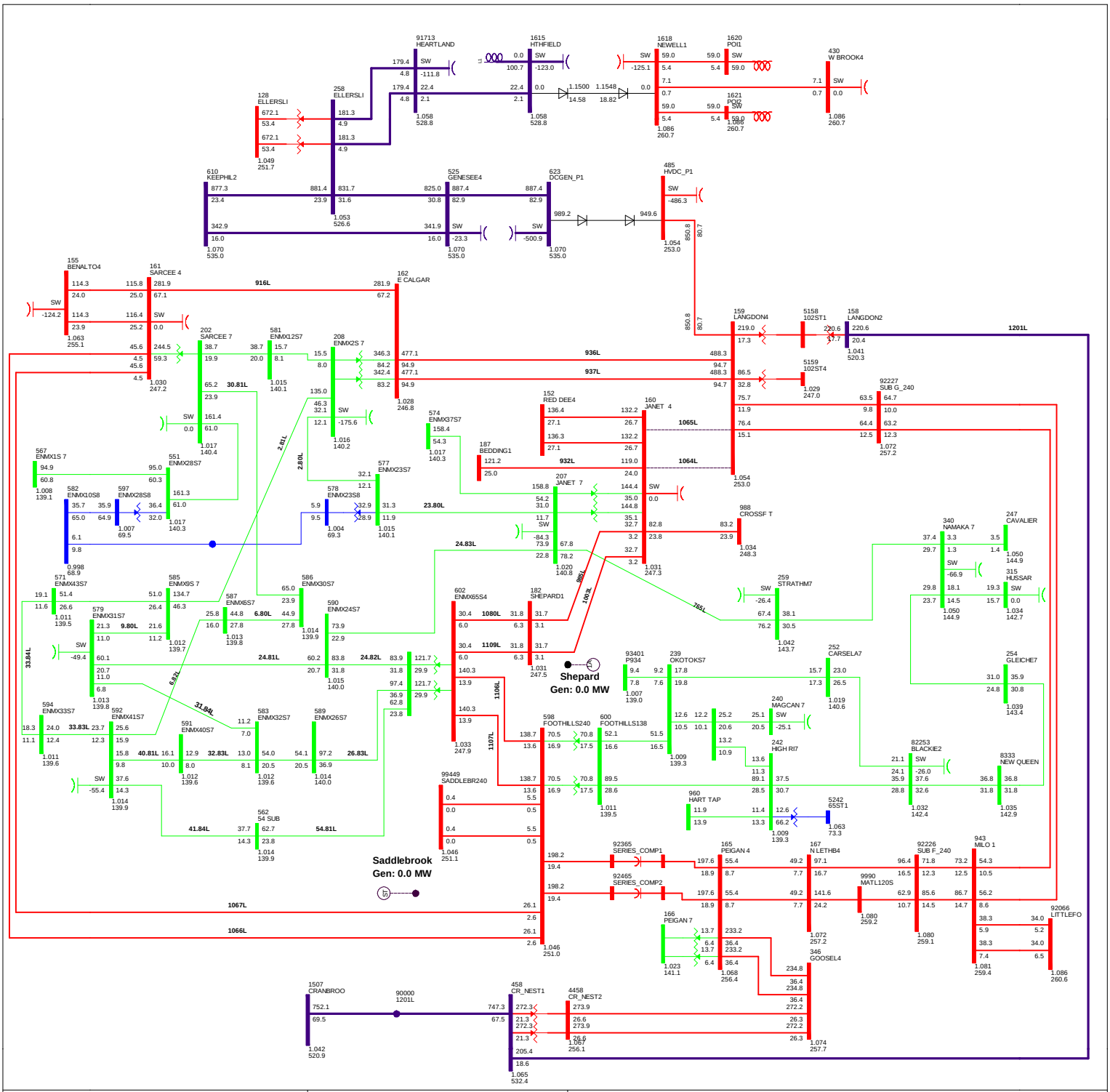
2012LTO+HVDC FULL SYSTEM

FIG C5-D-SC1A-3: DOUBLE OUTAGE 936L AND 937L

2019_FATD-F_HVDC_SC1A_SP

FRI, JUN 08 2012 16:58

2019 FATD+HVDC-Full Curtailment Assessment
Scenario 1A



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 793.7 MW

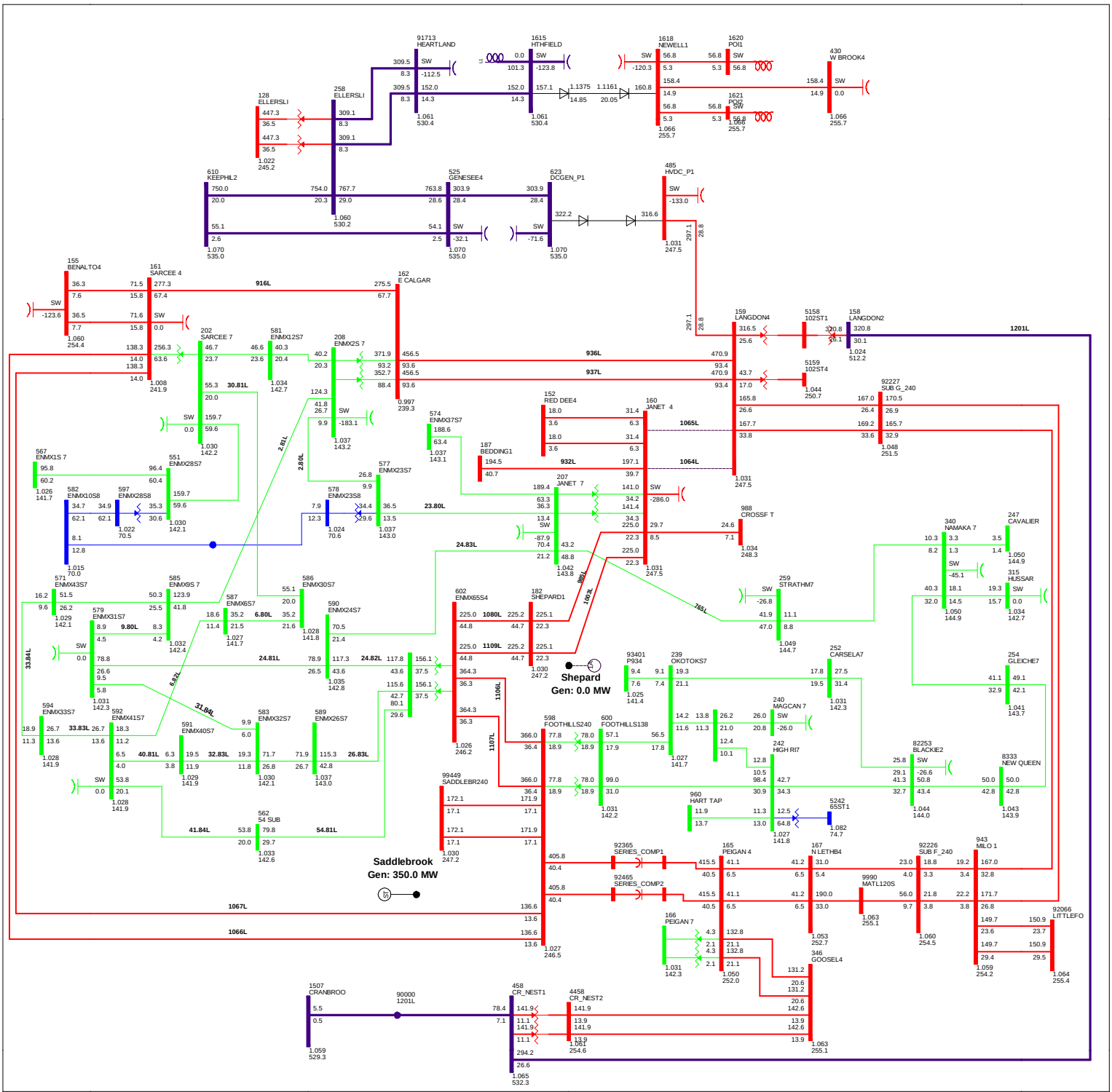
2012LTO+HVDC FULL SYSTEM

FIG CURTAIL-D-SC1A-1: 1064L-1065L REDISPATCH WATL TO 886 MW

2019_FATD-F_HVDC_SC1A_SP

FRI, JUN 08 2012 16:59

2019 Loading Violations
Scenario 3



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

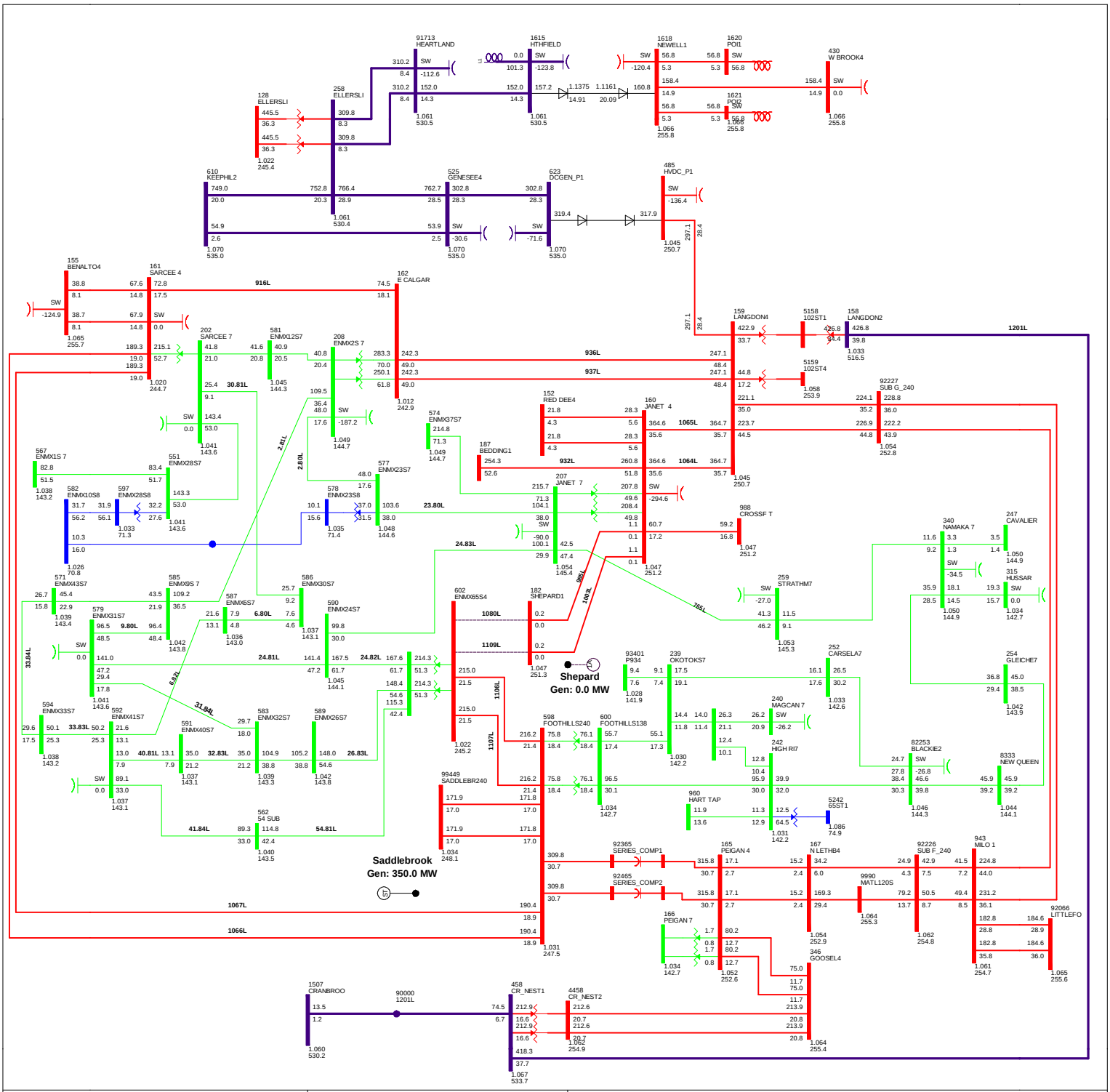
BCH Import: 12.9 MW

2012LTO+HVDC FULL SYSTEM

FIG C5-D-SC3-1: DOUBLE OUTAGE 1064L AND 1065L

2019_FATD-F_HVDC_SC3_SP

FRI, JUN 08 2012 16:58



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

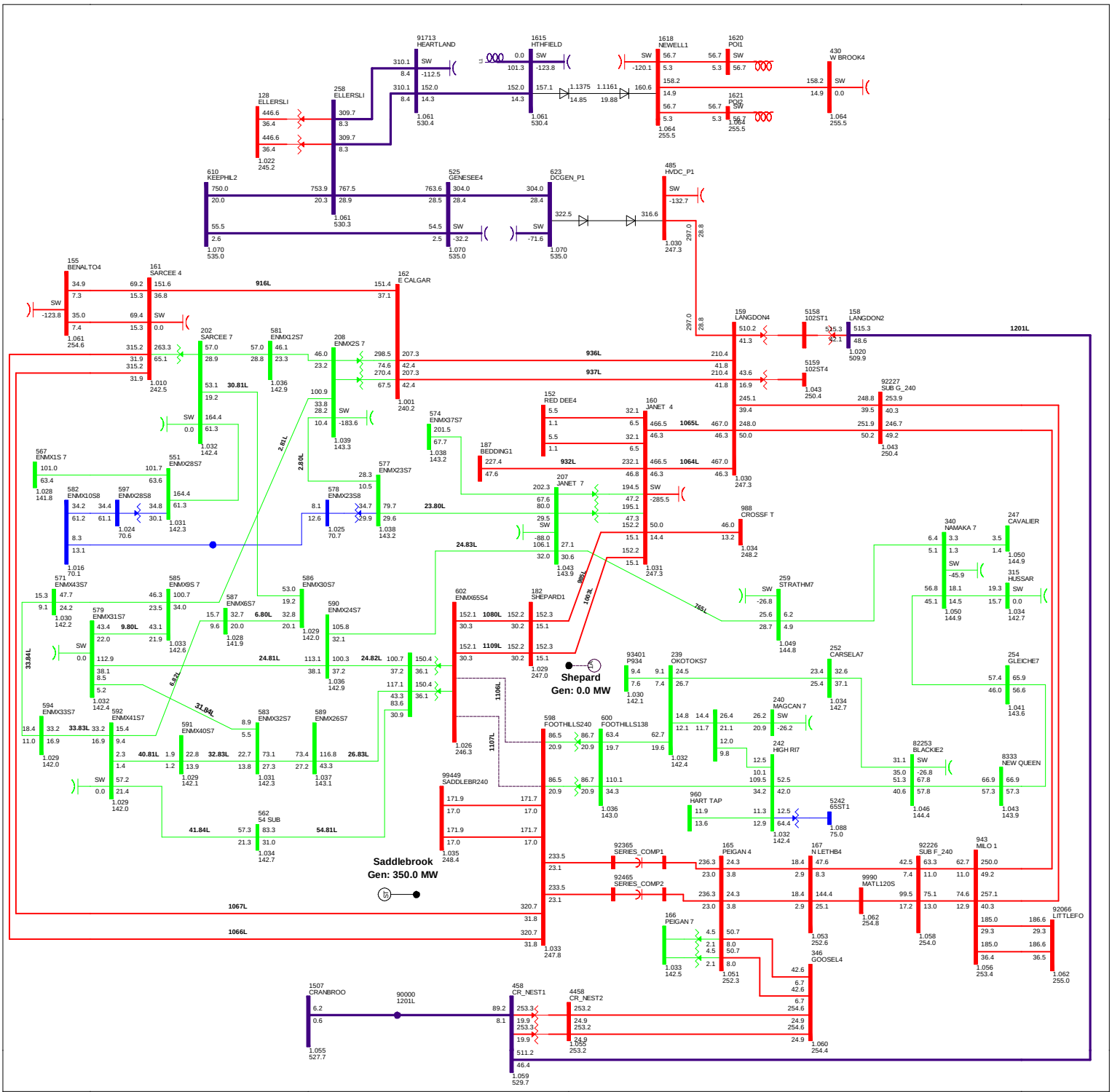
BCH Import: -5.8 MW

2012LTO+HVDC FULL SYSTEM

FIG C5-D-SC3-2: DOUBLE OUTAGE 1080L AND 1109L

2019_FATD-F_HVDC_SC3_SP

FRI, JUN 08 2012 16:58



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 2.9 MW

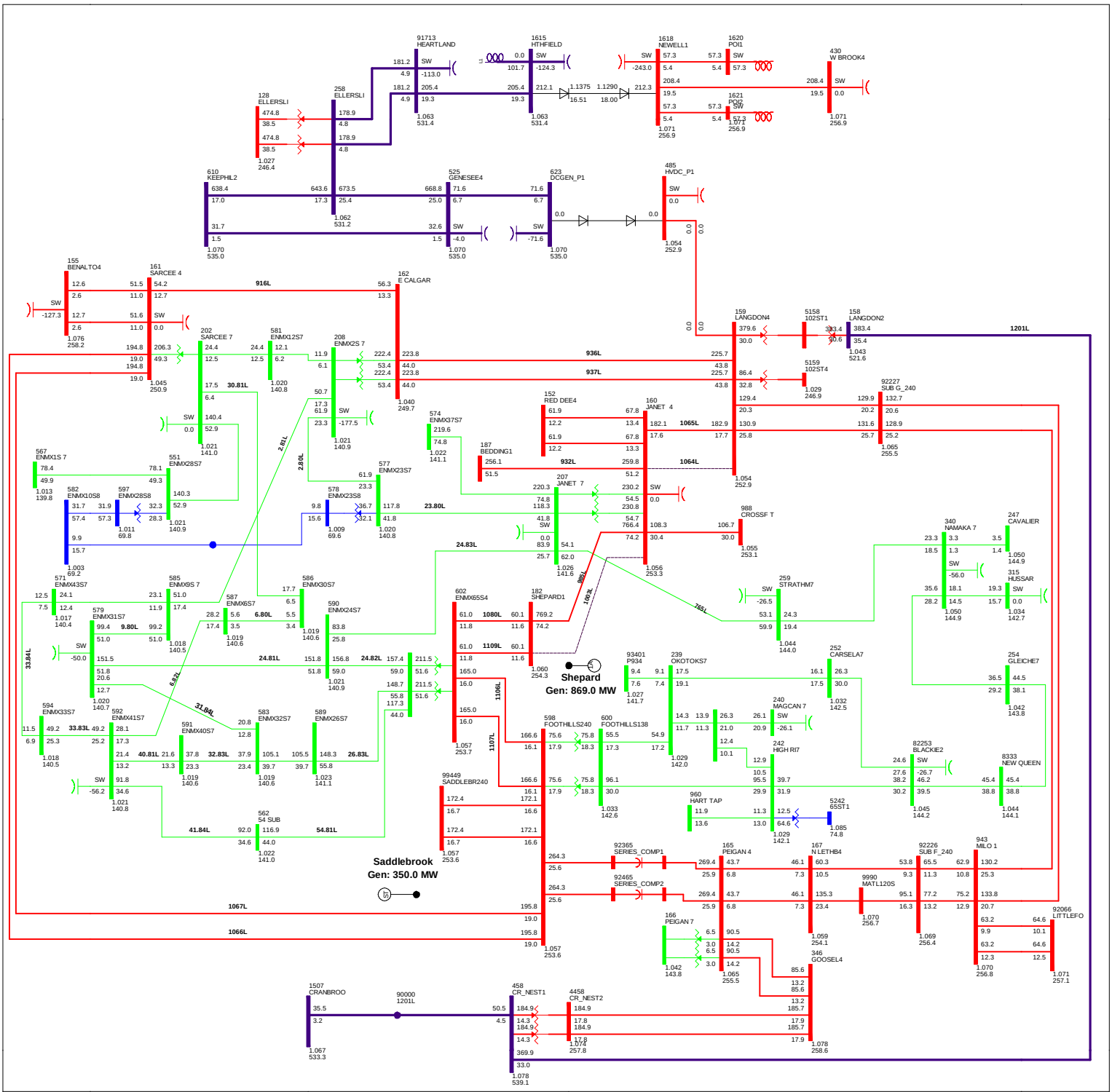
2012LTO+HVDC FULL SYSTEM

FIG C5-D-SC3-3: DOUBLE OUTAGE 1106L AND 1107L

2019_FATD-F_HVDC_SC3_SP

FRI, JUN 08 2012 16:58

2019 Loading Violations
Scenario 4



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

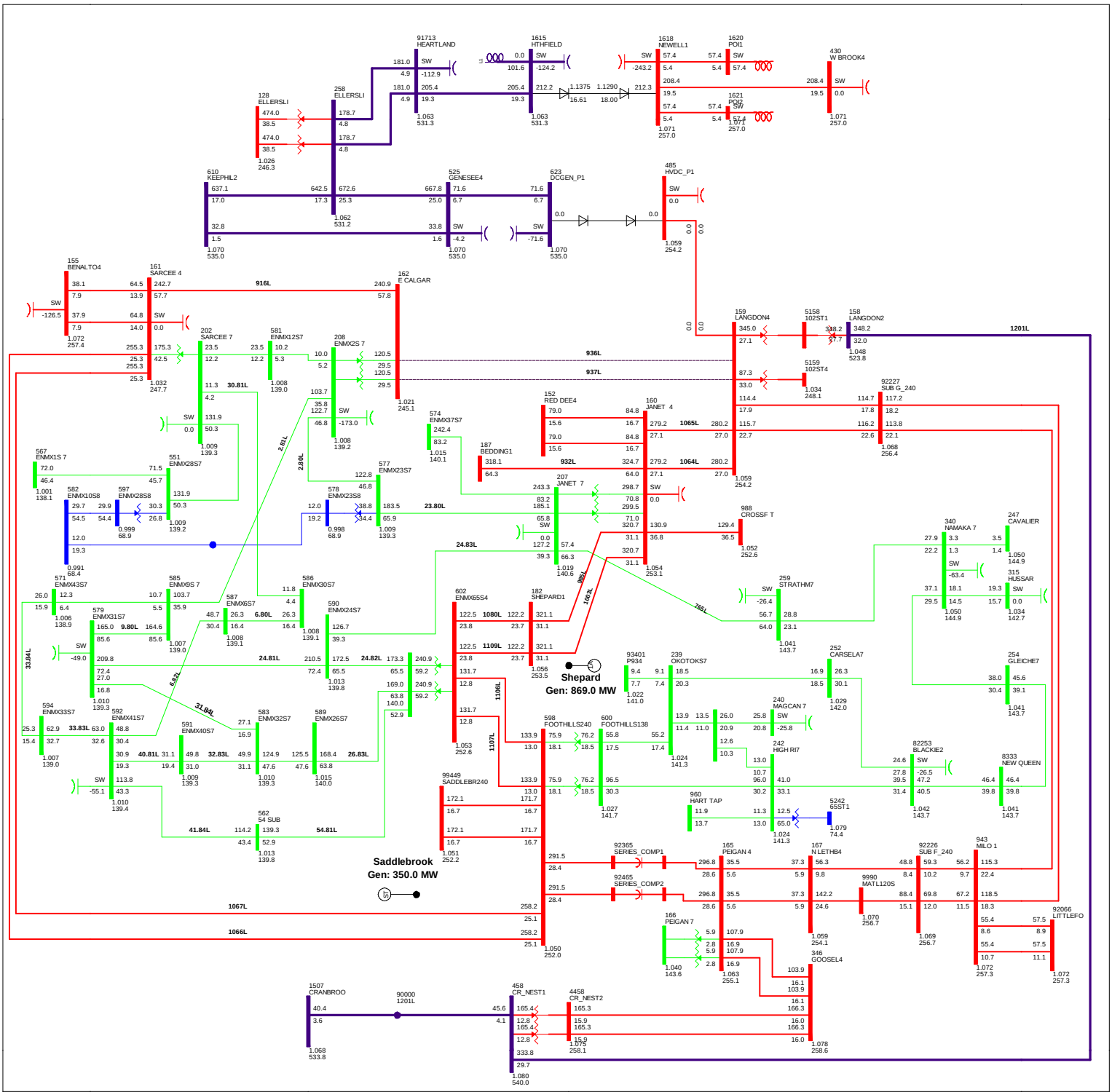
BCH Import: 1.9 MW

2012LTO+HVDC FULL SYSTEM

FIG C5-D-SC4-1: DOUBLE OUTAGE 1003L AND 1064L

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:59



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

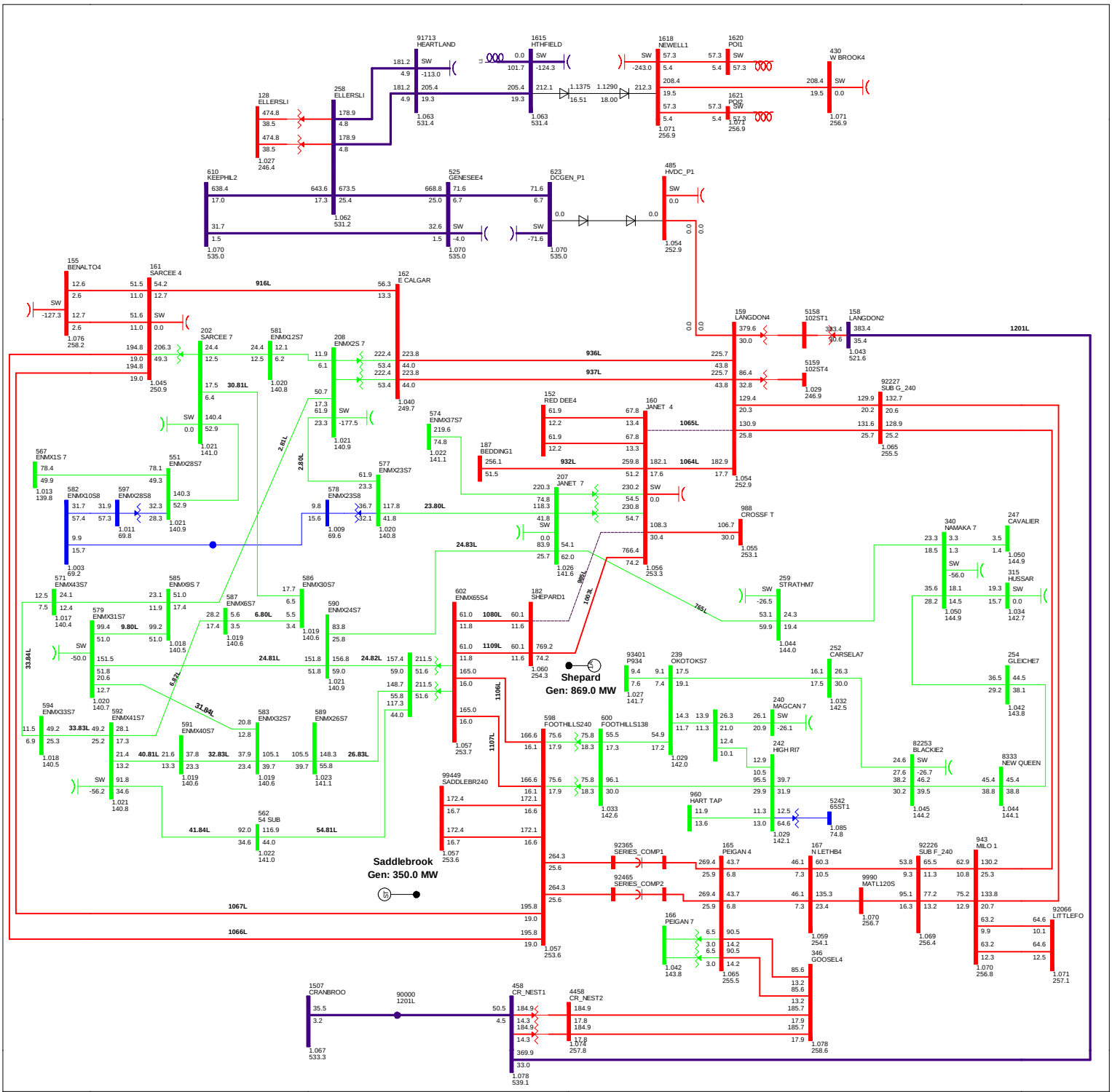
BCH Import: 10.7 MW

2012LTO+HVDC FULL SYSTEM

FIG C5-D-SC4-2: DOUBLE OUTAGE 936L AND 937L

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:59



Bus - VOLTAGE (kV/PU)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATEA
1.100OV 0.950UV
kV: <=34.500 <=69.000 <=138.000 <=240.000 <=500.000

BCH Import: 1.9 MW

2012LTO+HVDC FULL SYSTEM

FIG C5-D-SC4-3: DOUBLE OUTAGE 985L AND 1065L

2019_FATD-F_HVDC_SC4_SP

FRI, JUN 08 2012 16:59

APPENDIX E AESO LOAD AND GENERATION FORECAST

1 Introduction

1.1 The AESO's responsibilities with respect to forecasting the need for transmission in Alberta are described in section 33(1) of the *Electric Utilities Act* and section 8 of the *Transmission Regulation*. System Planning studies contained in the *Foothills Area Transmission Development: Engineering Report* (FATD Study) use the load and generation forecasts described by this document. The load and generation forecasts chosen for this system study were chosen in accordance with the AESO Transmission Reliability Criteria principle that requires the design of the system to meet or exceed Reliability Criteria under credible worst-case loading and generation conditions[1].

1.2 Load and generation forecasts in this document are a subset of the forecasts published separately by the AESO. The corporate load forecast is found in *Future Demand and Energy Outlook (2009-2029),* also referred to as FC2009. This forecast is available online on the AESO Forecasting page found at: http://www.aeso.ca/transmission/8638.html

The corporate generation forecast is found in *2009 AESO Long-Term Transmission System Plan*. This forecast is available online on the AESO Forecasting page found at:

http://www.aeso.ca/downloads/AESO_LTTSP_Final_July_2009.pdf

Since the inception of the FATD Study, new generation scenarios have been developed for use in the *2011 Long-Term Transmission System Plan*, these are discussed in section 4.6.

1.3 The FATD Study Area and its adjacent areas include AESO planning areas 6 (Calgary), 45 (Strathmore/Blackie) and 46 (High River). Forecasts for each planning area, and combined forecasts for the planning areas, are described in this report. The three planning areas reside in AESO South Planning

[1] AESO Transmission Reliability Criteria, Part II System Planning. March 11, 2005. Section 2.0

Region as described in more detail in Appendices C and K of the *2009 AESO Long-Term Transmission System Plan*.

2 Historical Load

2.1 Table 2.1 summarizes historic winter load levels for Calgary, Strathmore/Blackie and High River AESO planning areas, for the total areas, and for the Alberta system, at the time the planning areas reached peak demand.

Table 2-1: Historical Winter Load at Planning Area Peak (MW)

Year	Area 6 Calgary	Area 45 Strathmore /Blackie	Area 46 High River	Total Areas	System Load
2005 HX	1,481	106	96	1,683	9,580
2006 HX	1,535	105	101	1,741	9,636
2007 HX	1,550	107	105	1,762	9,458
2008 HX	1,612	102	108	1,822	9,806
2009 HX	1,619	98	111	1,828	10,236
2010 HX	1,600	114	111	1,824	10,130

HX = Historical

2.2 Table 2.2 summarizes summer load levels at the time the planning areas reached peak demand.

Table 2-2: Historical Summer Load at Planning Area Peak (MW)

Year	Area 6 Calgary	Area 45 Strathmore /Blackie	Area 46 High River	Total Areas	System Load
2005 HX	1,345	97	77	1,520	8,020
2006 HX	1,465	97	87	1,649	8,896
2007 HX	1,523	94	83	1,700	9,107
2008 HX	1,557	106	86	1,749	9,455
2009 HX	1,494	97	90	1,681	8,714
2010 HX	1,496	102	90	1,688	9,214

HX = Historical

3 Load Forecast

3.1 Recent load growth in the Study Area has been driven by residential, industrial, commercial and general economic growth. Load growth is expected to continue, consistent with forecasts for continued strong Alberta economic growth. The AESO's forecasts have considered information from the distribution facility owners (DFO) in the area, and comparisons between AESO and DFO forecasts indicate alignment in long-term growth expectations.

3.2 Load forecasts used in the FATD Study are based on the AESO annual forecast, referred to as the *Future Demand and Energy Outlook (2009-2029)* (FC2009), published in February 2010. As part of its planning responsibilities, the AESO verifies and updates its corporate load forecasts routinely to ensure they reflect the latest economic projections and factors.

3.3 Table 3-1 below summarizes forecasted winter loads for Calgary, Strathmore/Blackie and High River planning areas, combined loads for these areas, and for the Alberta system, at the time the planning areas are expected to reach peak demand.

Table 3-1: FC2009
Winter Load at Planning Area Peak (MW)

Year	Area 6 Calgary	Area 45 Strathmore/ Blackie	Area 46 High River	Total Areas	System Load
2011 F	1,537	105	114	1,766	10,445
2012 F	1,580	120	120	1,819	11,027
2013 F	1,665	124	126	1,916	11,638
2014 F	1,730	129	134	1,992	12,162
2015 F	1,804	134	141	2,079	12,801
2016 F	1,892	139	149	2,179	13,251
2017 F	1,923	141	154	2,218	13,742
2018 F	2,011	145	160	2,315	14,310
2019 F	2,040	148	166	2,353	14,759
2020 F	2,109	151	172	2,432	15,162

3.4 Table 3-2 summarizes summer load levels at the time the planning areas reached peak demand.

Table 3-2: FC2009
Summer Load at Planning Area Peak (MW)

Year	Area 6 Calgary	Area 45 Strathmore/ Blackie	Area 46 High River	Total Areas	System Load
2011 F	1,526	106	97	1,623	9,854
2012 F	1,578	108	101	1,679	10,356
2013 F	1,660	113	107	1,766	10,836
2014 F	1,741	117	113	1,854	11,548
2015 F	1,823	121	119	1,942	11,977
2016 F	1,901	126	126	2,027	12,539
2017 F	1,965	130	132	2,098	13,042
2018 F	1,988	132	137	2,125	13,451
2019 F	2,060	136	143	2,202	13,974
2020 F	2,121	138	148	2,269	14,261

The average annual load growth rate for Calgary, Strathmore/Blackie and High River areas is 3.6%, 3.1% and 4.7%, respectively, over the study period. These growth rates are consistent with economic and other load assumptions detailed in the FC2009 report.

4 Generation Forecast

4.1 Current generation capacity in planning area 6 (Calgary) and 46 (High River) is 420 MW. This generation is from the gas-fired Calgary Energy Centre and Balzac power plants. Wind generation (located outside of the FATD Study Area) is also an important component to the FATD Study and currently there is 777 MW of wind capacity on the system with the majority located in southern Alberta.

4.2 The AESO has, as of March 2011, received applications to connect 1,315 MW of gas-fired generation within the Study Area. These connection projects are shown in Table 3-1. The projects listed below have planned in-service dates from 2011 to 2015.

Table 4-1: Generation connection requests for Foothills Area and southern wind

Project Name	Planning Area (s)	Gen (MW)
ENMAX Shepard Energy Centre	6	800
TransCanada Saddlebrook Generating Station	46	350
ENMAX Bonnybrook Energy Centre	6	165

4.3 Generation forecast assumptions used in the study are based on the generation scenarios presented in the AESO *2009 Long-term Transmission System Plan*[2] (the Plan)*, Appendices E, F and G*. Table 4.0-2 on page 266 of the Plan presents scenarios representing a reasonable range of future generation expansions for system planning purposes. The FATD Study considers both generation scenario A1 and B5. These two scenarios, in combination with the forecasted load provide credible worst-case combinations of load and

[2] The 2009 AESO Long-Term Transmission System Plan can be found on the AESO website at: http://www.aeso.ca/downloads/AESO_LTTSP_Final_July_2009.pdf

generation conditions on the regional transmission system as required by the applicable AESO System Planning Criteria[3]. Since wind generation is an intermittent source of energy, studies test situations when wind is available and when it is not. These combinations consider both the situation when wind energy is being transmitted into the Study Area to serve load, and when wind is not available and Study Area load is being served by either locally integrated gas-fired sources, or alternatively, from remote generation sources outside of the Study Area (i.e. primarily from northern generation sources). For situations when wind is not available, scenario B5 stresses the local transmission system between local generation and load and the other scenario (A1) stresses the broader transmission system, including transmission elements transmitting energy into the area from non-wind generation sources located outside of the Study Area. Scenario B5 is consistent with the forecasts for wind development used in the AESO's Southern Alberta Transmission Reinforcement (SATR) application, previously approved by Commission, which provides the ability to connect future wind projects.

4.4 It is anticipated that transmission connected generation additions in the Study Area prior to 2019 will be made up of gas-fired facilities. Scenario B5 includes the addition of ENMAX Shepard Energy Centre, Bonnybrook Energy Centre and TransCanada Saddlebrook by 2019. Scenario B5 also includes the addition of substantial wind capacity, forecasting a total of 4,488 MW in Alberta by 2019. Scenario A1, which forecasts the addition of generation in Northern Alberta, was also used to test the FATD Study Area as described in section 4.3. This scenario contains a substantial amount of generation additions in northern Alberta. Further details on the generation scenarios can be found in Appendix E of the *2009 Long-Term Transmission System Plan*.

[3] AESO Transmission Reliability Criteria Part II System Planning. March 11, 2005. Section 2.0

4.5 Generation in the Study Area, as well as wind capacity in Alberta, for 2009, 2014, 2019 are presented in Table 4-2 for scenario B5 and Table 4-3 for scenario A1.

Table 4-2. Study Area and Wind Generation in Scenario B5

Generation Name	2009 MCR (MW)	2014 MCR (MW)	2019 MCR (MW)
Calgary Energy Centre Gas-Fired	300	300	300
Balzac	120	120	120
Shepard Energy Centre	-	-	860
Saddlebrook	-	350	350
Bonnybrook Energy Centre	-	167	167
Alberta Wind Capacity	497	2,388	4,488

Table 4-3. Study Area and Wind Generation in Scenario A1

Generation Name	2009 MCR (MW)	2014 MCR (MW)	2019 MCR (MW)
Calgary Energy Centre	300	300	300
Balzac	120	120	120
Shepard Energy Centre	-	-	-
Saddlebrook	-	-	-
Bonnybrook Energy Centre	-	167	167
Alberta Wind Capacity	497	1,603	2,683

4.6 Since the inception of the FATD Study, new generation scenarios have been developed for use in the *2011 Long-Term Transmission System Plan.* These generation scenarios use more recent information and contain differences from those generation scenarios used in the FATD study. As noted in section 4.3, the FATD study was designed to test two generation related aspects of the

transmission system: the ability of the transmission system to transmit large amounts of wind and the ability to connect future local generation within the Study Area. A comparison between the generation scenarios used within the study and the latest comparable generation scenarios (Greenest and Southern Baseline) can be found below.

4.7 Wind capacity forecasts used within the study have been compared with the latest Southern Baseline and Greenest scenario to be used in the *2011 Long-Term Transmission System Plan.* The table below shows that forecasted wind capacity in the Southern Baseline and Greenest scenario is lower than the previous B5 generation scenario, indicating reduced wind integration rates than was previously forecast to 2019.

Table 4-4 Comparison of wind capacity in Generation Scenario B5, Southern Baseline and Greenest

Alberta Wind Capacity (MW)	B5	Southern Baseline	Greenest
2014	2,388	1,700	1,974
2019	4,488	2,300	3,600

4.8 Generation forecasted within the Study Area has also been compared between the previous B5 generation scenario and the Southern Baseline scenario. The table below shows that generation additions within the area are lower in the 2014 timeframe and higher in the 2019 timeframe. Differences in the 2014 timeframe occur as a result of a later in-service date (ISD) of a gas-fired generator in the Southern Baseline scenario. In the 2019 timeframe, additional conceptual gas-fired generation was assumed in the Southern Baseline scenario in the Study Area.

Table 4-5 Comparison of Study Area generation additions in Generation Scenario B5 and Southern Baseline

Study Area Generation Additions (MW)	B5	Southern Baseline
2014	460	168
2019	1260	1690

4.9 While a comparison between the AESO's current generation forecasts and the forecasts used in the majority of the studies in the FATD Study is provided herein, it is beyond the purview of this report to assess the materiality of these changes or impact, if any, of the forecast differences on the study results and conclusions. The sensitivities on the updated scenarios that were undertaken in the FATD Report provide such an assessment. Details can be found in section 8.5.

APPENDIX F AESO 2012 SUPPLEMENT TO LOAD AND GENERATION FORECAST

Foothills Area Transmission Development

SUPPLEMENTAL INFORMATION: 2012 LTO Summary

1 Introduction

1.1 System Planning studies contained in the FATD Engineering Study Report use a subset of the AESO's load and generation forecasts available at the time. Forecasts applicable to the FATD planning studies are described in *Foothills Area Transmission Development Load and Generation Forecasts*[1]. As part of its planning responsibilities, the AESO regularly verifies and updates its corporate forecasts to ensure they reflect the latest economic projections and factors, and up-to-date information regarding future generation. Since the completion of the FATD Engineering Study Report, the AESO has updated and replaced the corporate load and generation forecasts with the 2012 Long-term Outlook (2012 LTO).[2]

1.2 The AESO has recently undertaken a set of studies to assess the sensitivity of the FATD Engineering Study Report to, among other things, the 2012 LTO. This document summarizes the 2012 LTO forecasts applicable to the FATD Engineering studies and compares to the forecasts used in the FATD Engineering Study Report.

2 Load Forecast

2.1 In the 2012 LTO, load growth in the study area is expected to continue, however at a slower pace than previously forecast. Table 1 below summarizes historical and 2012 LTO forecast summer loads for Calgary, Strathmore/Blackie and High River planning areas, combined loads for these areas, and for the Alberta system, at the time the planning areas are expected to reach peak demand.

[1] Appendix C to the East Calgary 240kV and 138kV Transmission System Upgrades and the Shepard Energy Centre Connection NID, filed May 10, 2011. Commission Application Number 1607312. Proceeding ID No. 1229.

[2] The 2012 LTO was presented to stakeholders April 3, 2012. Available material can be found at: http://www.aeso.ca/downloads/2012LTO_Stakeholder_Presentation.pdf.

Table 1: 2012 LTO Summer Load at Planning Area Peak (MW)

Year	Area 6 Calgary	Area 45 Strathmore/Blackie	Area 46 High River	Total Areas	System Demand
2007 HX	1,523	94	83	1,700	9,107
2008 HX	1,557	106	86	1,749	9,455
2009 HX	1,494	97	90	1,681	8,714
2010 HX	1,496	102	90	1,688	9,214
2011 HX	1,563	100	86	1,749	9,552
2012 F	1,571	107	90	1,767	9,857
2013 F	1,640	109	90	1,839	10,226
2014 F	1,695	110	92	1,897	10,621
2015 F	1,742	110	93	1,945	10,991
2016 F	1,780	112	96	1,989	11,411
2017 F	1,816	113	99	2,028	11,836
2018 F	1,857	115	120	2,074	12,166
2019 F	1,900	117	105	2,123	12,500
2020 F	1,937	119	109	2,164	12,818
2021 F	1,970	122	114	2,205	13,137

*HX – Historical, F - Forecast

The average annual load growth rate for Calgary, Strathmore/Blackie and High River to 2021 are 2.3%, 2.0% and 2.8% respectively over the study period, recognizing 2011 as the starting point for this calculation.

Table 2 below provides a comparison between the forecast used in the FATD Engineering Report (FC2009) and 2012 LTO forecast of load for the FATD study areas.

Table 2: Comparison of Study Area Load Forecast

Load Forecast	2014		2019	
	Summer Peak			
	2012LTO	FC2009	2012LTO	FC2009
Area 6 Load (MW)	1,695	1,741	1,900	2,060
Area 45 Load (MW)	110	117	117	136
Area 46 Load (MW)	92	113	105	143
Total Areas 6,45,46 (MW)	1,897	1,971	2,123	2,338
AIL (MW)	10,621	11,548	12,500	13,974

3 Generation Forecast

3.1 Generation forecast assumptions used in the FATD Engineering Study Report are based on generation scenarios representing a reasonable range of future generation expansions for system planning purposes. The 2012 LTO contains updates to the range of scenarios.

3.2 Gas-fired generation assumptions in the study area remain unchanged from the assumptions used in the FATD Engineering Study Report. Alberta wind generation is also an important component to the FATD planning studies. Current installed wind capacity in Alberta, as of mid-June 2012, is 939 MW, an increase of 162 MW over the installed wind reported in *Foothills Area Transmission Development Load and Generation Forecasts*. Forecasted wind capacity in the 2012 LTO Environmental scenario is lower than the assumptions in the FATD Engineering Study Report (2012 LTO Environmental scenario compared to the B5, Southern Baseline and the Greenest scenarios referred to in the *Foothills Area Transmission Development Load and Generation Forecasts*). This indicates reduced wind integration rates than was previously forecast in the 2014 to 2019 timeframe. Table 3 below provides a comparison between the wind forecasts used in the FATD Engineering Study Report and 2012 LTO Environmental scenario forecast of installed wind generation for the 2014 and 2019 timeframes.

Table 3: Comparison of Installed Wind Generation Forecast

Year		Total Alberta Installed Wind Generation			
		FATD ESR			2012 LTO
		Scenario B5 (MW)	Southern Baseline (MW)	Greenest (MW)	Environmental Scenario (MW)
2014	Total Alberta	2,388	1,700	1,974	1,247
2019	Total Alberta	4,488	2,300	3,600	2,544

APPENDIX G AESO 2014 LONG-TERM OUTLOOK

1 Introduction

1.1 The AESO's responsibilities with respect to forecasting the need for transmission in Alberta are described in section 33(1) of the *Electric Utilities Act* and section 8 of the *Transmission Regulation*.

1.2 Load and generation forecasts in this document are a subset of the forecasts published separately by the AESO. The AESO's latest corporate load forecast is found in the *2014 Long-term Outlook,* also referred to as 2014 LTO. This forecast is available online on the AESO Forecasting page found at: http://www.aeso.ca/downloads/AESO_2014_Long-term_Outlook.pdf

The AESO's previous corporate forecast can be found in the *2012 Long-Term Outlook*, also referred to as 2012 LTO. The 2012 LTO was the basis of the forecast assumptions used in the *2013 Long-term Transmission System Plan*, *2013 Regional Plans* and other specific planning studies conducted in 2012 and 2013. This forecast is available online on the AESO Forecasting page found at:

http://www.aeso.ca/downloads/AESO_2012_Long-term_Outlook_bookmarked.pdf

1.3 This report provides a comparison between the 2012 LTO and 2014 LTO for the Calgary area and the AESO's south planning region.

1.4 Load forecasts for the AESO planning area 6 (Calgary),[1] and the South Region are described in this report. Generation forecasts for the south region are also described in this report.

[1] The AESO Calgary Planning Region is described in more detail in the *Calgary Regional Plan found at:* http://www.aeso.ca/downloads/Calgary_LRP_Report_Final.pdf

2 Historical Load

2.1 Table 2.1 summarizes historic winter load levels for the Calgary planning area, South Region and for the Alberta system at peak demand.

Table 2-1: Historical Winter Load at Peak (MW)

Year	Area 6 Calgary	South Region	Alberta Internal Load (AIL)
2009 HX	1,619	2,982	10,236
2010 HX	1,600	2,956	10,137
2011 HX	1,607	2,971	10,481
2012 HX	1,560	2,878	10,586
2013 HX	1,664	3,041	11,134

HX = Historical

2.2 Table 2.2 summarizes summer load levels at peak demand.

Table 2-2: Historical Summer Load at Peak (MW)

Year	Area 6 Calgary	South Region	Alberta Internal Load (AIL)
2009 HX	1,494	2,831	9,041
2010 HX	1,496	2,831	9,338
2011 HX	1,563	2,976	9,376
2012 HX	1,582	2,969	9,885
2013 HX	1,670	3,059	10,063
2014 HX (to-date)	1,644	3,098	11,419

HX = Historical

The average annual summer load growth rate for the Calgary Area and South Region is 2.8% and 2.0%, respectively from 2009 to 2013.

3 Load Forecast

3.1 Recent load growth in the Calgary area has been driven by residential, industrial, commercial and general economic growth. Load growth is expected to continue, consistent with forecasts for continued strong Alberta economic growth. The AESO's forecasts have considered information from the distribution facility owners (DFO) in the area, and comparisons between AESO and DFO forecasts indicate alignment in long-term growth expectations.

3.2 Table 3-3 below summarizes 2012 LTO forecasted winter loads for the Calgary planning area, the South Region and Alberta Internal Load (AIL) at peak demand.

Table 3-3: 2012 LTO
Winter Load at Peak (MW)

Year	Area 6 Calgary	South Region	Alberta Internal Load (AIL)
2014 F	1,782	3,276	11,768
2015 F	1,836	3,354	12,130
2016 F	1,877	3,438	12,580
2017 F	1,917	3,510	13,005
2018 F	1,962	3,597	13,383
2019 F	2,011	3,687	13,778
2020 F	2,051	3,771	14,145
2021 F	2,088	3,864	14,515
2022 F	2,125	3,936	14,801
2023 F	2,163	4,010	15,061
2024 F	2,202	4,083	15,325

3.3 Table 3-4 summarizes 2012 LTO forecasted summer load levels at peak demand.

Table 3-4: 2012 LTO
Summer Load at Peak (MW)

Year	Area 6 Calgary	South Region	Alberta Internal Load (AIL)
2014 F	1,695	3,169	10,673
2015 F	1,742	3,240	11,045
2016 F	1,780	3,320	11,457
2017 F	1,816	3,387	11,923
2018 F	1,857	3,469	12,266
2019 F	1,900	3,551	12,617
2020 F	1,937	3,630	12,948
2021 F	1,970	3,719	13,277
2022 F	2,004	3,786	13,528
2023 F	2,038	3,855	13,756
2024 F	2,073	3,923	13,985

The average annual load growth rate for the Calgary Area and South Region is 2.0% and 2.3%, respectively, over the 10-year forecast period. These growth rates are consistent with economic and other load assumptions detailed in the 2012 LTO report.

3.4 Table 3-5 below summarizes 2014 LTO forecasted winter loads for the Calgary areas, the South Region and Alberta Internal Load (AIL) at peak demand.

Table 3-5: 2014 LTO
Winter Load at Peak (MW)

Year	Area 6 Calgary	South Region	Alberta Internal Load (AIL)
2014 F	1,684	3,047	11,323
2015 F	1,742	3,131	11,811
2016 F	1,782	3,208	12,531
2017 F	1,821	3,301	13,192
2018 F	1,856	3,392	13,783
2019 F	1,894	3,473	14,274
2020 F	1,930	3,556	14,722
2021 F	1,966	3,628	15,033
2022 F	2,016	3,715	15,376
2023 F	2,067	3,797	15,672
2024 F	2,129	3,900	16,014

3.5 Table 3-6 summarizes 2014 LTO forecasted summer load levels at peak demand.

Table 3-6: 2014 LTO
Summer Load at Peak (MW)

Year	Area 6 Calgary	South Region	Alberta Internal Load (AIL)
2014 F	1,630	3,040	10,421
2015 F	1,667	3,089	10,765
2016 F	1,709	3,129	11,170
2017 F	1,748	3,208	11,799
2018 F	1,786	3,301	12,390
2019 F	1,821	3,393	12,938
2020 F	1,859	3,475	13,429
2021 F	1,895	3,559	13,865
2022 F	1,931	3,632	14,148
2023 F	1,980	3,719	14,460
2024 F	2,030	3,800	14,731

The average annual load growth rate for the Calgary Area and South Region is 1.8% and 2.0%, respectively, over the 10-year forecast period. These growth rates are consistent with economic and other load assumptions detailed in the 2014 LTO report.

3.6 Table 3-7 summarizes the differences between the 2012 LTO and 2014 LTO summer forecasted Calgary area peak. By 2024, the 2014 LTO area load is approximately 40 MW less than forecast in the 2012 LTO or, effectively, one year delay in load growth.

Table 3-7: Differences (2012 LTO, 2014 LTO)
Calgary Area Summer Load at Peak (MW)

Year	2012LTO Calgary Area	2014LTO Calgary Area	Differences (2014LTO – 2012LTO)
2014 F	1,695	1,630	-65
2015 F	1,742	1,667	-76
2016 F	1,780	1,709	-72
2017 F	1,816	1,748	-68
2018 F	1,857	1,786	-71
2019 F	1,900	1,821	-79
2020 F	1,937	1,859	-78
2021 F	1,970	1,895	-75
2022 F	2,004	1,931	-73
2023 F	2,038	1,980	-58
2024 F	2,073	2,030	-43

F = Forecast

4 Generation Forecast

4.1 Current generation capacity in the Calgary area is 452 MW. This capacity is from the gas-fired Calgary Energy Centre, Balzac and University of Calgary power plants. The ENMAX Shepard Energy Centre (851 MW) is currently being commissioned and expected to begin commercial operation in Q1 2015, increasing Calgary area generation capacity to 1,303 MW. Additional existing gas-fired generation in the South Region totals 610 MW of capacity, for total installed southern gas-fired capacity of 1,913 MW.

4.2 Both the 2012 LTO and 2014 LTO generation forecasts have additions of combined-cycle and simple-cycle capacity of 500 – 600 MW by 2022 in the South region. The forecasts of southern gas-fired generation capacity by 2022 are show below in Table 4.1

Table 4.1. Comparison of Gas-Fired Generation Forecast (South Region)

Year	South Region Installed Gas-fired Generation (MW)	
	2012 LTO	2014 LTO
	Main Outlook	Main Outlook
Existing	1,913	
2022	2,424	2,521

4.3 The AESO has, as of August 2014, received applications to connect approximately 430 MW of gas-fired generation within the South Region, including Calgary, with planned in-service dates from 2014 – 2018, which is consistent with its generation forecast.

4.4 Current installed wind capacity in Alberta, as of August 2014, is 1,434 MW, which exceeds the 2012 LTO forecast of 1,247 MW in 2014. Forecasted wind capacity in the 2014 LTO main Outlook and Environmental Scenario by 2019 is lower than the assumptions in the 2012 LTO. This indicates

that while almost 200 MW more wind has been installed prior to 2014 than was previously forecast, the AESO is forecasting lower wind integration rates than was previously forecast in the 2019 timeframe for its range of wind forecast scenarios. Table 4.2 below provides a comparison between the wind forecasts in the 2012 LTO Environmental scenario forecast and the 2014 LTO environmental scenarios for the 2014 and 2019 timeframes.

Table 4.2. Comparison of Installed Wind Generation Forecast (Total Alberta)

Year	Total Alberta Installed Wind Generation (MW)			
	2012 LTO		2014 LTO	
	Main Outlook	Environmental Scenario	Main Outlook	Environmental Scenarios
2014	1,247	1,247	1,435	1,435
2019	1,894	2,544	1,551	2,014

APPENDIX H TFO CAPITAL COST ESTIMATES

Proposal to Provide Services (PPS) - Estimate Summary

Project Name: FATD South Calgary - Preferred Route
Estimate Prepared by: ENMAX Power Corporation
Estimate Date: May 27, 2014
Estimate Accuracy: +20 / -10 %

	System Portion	Customer Portion	TOTAL
Transmission Line Costs			
Material	$ 5,717,174	N/A	$ 5,717,174
Labour	$ 8,157,576	N/A	$ 8,157,576
Total-Transmission line	**$ 13,874,750**	**N/A**	**$ 13,874,750**
Substation Facilities Cost			
Material	$ 1,068,484	N/A	$ 1,068,484
Labour	$ 1,871,724	N/A	$ 1,871,724
Total-Substations	**$ 2,940,209**	**N/A**	**$ 2,940,209**
Telecommunication Cost			
Material	$ 2,520	N/A	$ 2,520
Labour	$ 18,312	N/A	$ 18,312
Total-Telecommunication	**$ 20,832**	**N/A**	**$ 20,832**
Owner Costs			
Conceptual Engineering	$ 468,002	N/A	$ 468,002
Proposal to Provide Service	$ 457,478	N/A	$ 457,478
Facility Applications	$ 737,388	N/A	$ 737,388
Total - Owner's Cost	**$ 1,662,868**	**N/A**	**$ 1,662,868**
Distributed Costs			
Procurement	$ 24,000	N/A	$ 24,000
Project Management	$ 816,000	N/A	$ 816,000
Construction Management	$ 380,775	N/A	$ 380,775
Contingency	$ 1,901,811	N/A	$ 1,901,811
Total - Distributed Costs	**$ 3,122,586**	**N/A**	**$ 3,122,586**
Total Direct Costs	**$ 21,621,245**	**N/A**	**$ 21,621,245**
Salvage			
Transmission Line Labour	N/A	N/A	N/A
Substation Labour	N/A	N/A	N/A
Land Remediation and Reclamation	N/A	N/A	N/A
Total-Salvage	**$ -**	**N/A**	**$ -**
Other Costs			
IDC	$ 1,092,617	$ -	$ 1,092,617
AOH	$ 560,498	N/A	$ 560,498
Escalation	$ 1,112,556	N/A	$ 1,112,556
Total - Other Costs	**$ 2,765,671**	**N/A**	**$ 2,765,671**
Total In-Direct Costs	**$ 2,765,671**	**N/A**	**$ 2,765,671**
TOTAL PROJECT COSTS	**$ 24,386,916**	**N/A**	**$ 24,386,916**
AESO NID Adjustment to remove scalable pole cost*	$ (1,900,000)	N/A	$ (1,900,000)
ADJ. TOTAL PROJECT COSTS	**$ 22,486,916**	**N/A**	**$ 22,486,916**

AESO Notes:
* $1.9 million scaleable pole adjustment provided as a lump-sum estimate by ENMAX within PPS. Subtracted from total project costs by AESO. Additional detail could be provided by ENMAX if required.

APPENDIX I PARTICIPANT INVOLVEMENT PROGRAM (PIP)

1.0 Participant Involvement Program (PIP)

From February to August 2014, the AESO conducted a Participant Involvement Program (PIP) to assist in preparing its *Needs identification Document for 138 kV Transmission System Reinforcement in South Calgary – Foothills Area Transmission Development Plan* (Application)**.** The AESO directed transmission facility owner (TFO) ENMAX Power Corporation (ENMAX) to assist the AESO in providing notification in accordance with NID 14 and Appendix A of Alberta Utilities Commission (AUC) Rule 007.

The AESO relied on ENMAX's distribution of its project-specific information to fulfill its Rule 007 notification requirements to notify and provide information to all occupants, residents and landowners in areas where transmission facilities could be located to implement the AESO's preferred development. ENMAX also identified the following interested parties, government agencies and other organizations:

- Councillor Shane Keating, Ward 12
- Councillor Peter Demong, Ward 14
- Councillor Diane Colley-Urquhart, Ward 13
- MLA Ric McIver, Calgary Hays
- MLA Rick Fraser, Calgary Southeast
- MLA Jeff Wilson, Calgary Shaw
- Westcreek Developments
- Genstar Development Company
- Mahogany Association
- Auburn Bay Association
- McKenzie Towne Community Association
- McKenzie Lake Community Association
- Cranston Community Association
- MidSun Community Association
- Chaparral Community Association
- City of Calgary Land Use Planning and Policy
- Walden Community Association
- Heritage Pointe Community Association
- Silverado Community Association
- Somerset Community Association
- Shawnessy Community Association
- Midnapore Community Association
- Tsuu T'ina Nation
- Alberta Sustainable Resource Development – Fish & Wildlife
- Alberta Transportation
- Alberta Environment
- Alberta Parks – Fish Creek Park District Office
- City of Calgary Roads
- Shaw / Telus /ATCO
- Brookfield Residential (Alberta) Ltd.

The AESO did not identify any additional stakeholders to be notified to meet its Rule 007 requirements.

1.1 Description of Participant Involvement Program

The AESO used a variety of methods to notify stakeholders on the need for the 138 kV transmission system reinforcement in South Calgary. These methods included distributing a newsletter to stakeholders describing the need for the proposed transmission development, and posting this same document on the AESO's website. Open houses were jointly hosted by the TFO and AESO. AESO representatives addressed questions related to the need for the proposed transmission development. Finally, the AESO placed notifications in newspapers to inform stakeholders of its intention to file its Application with the AUC.

The AESO's PIP activities were coordinated with the PIP activities of the TFO and are more fully described below.

1.1.1 AESO Newsletter

The AESO relied on ENMAX's distribution of its project-specific information to fulfill its Rule 007 notification requirements. The AESO's February 2014 newsletter, titled '*Foothills Area Transmission Development South Calgary'* was included with ENMAX's project-specific information package mailed on February 18, 2014 to all occupants, residents and landowners in areas where transmission facilities could be located to implement the AESO's preferred development, as well as to the government agencies and other organizations listed above. A copy of this document was posted to the AESO website at http://www.aeso.ca/transmission/30128.html on February 18, 2014. The AESO's February 18, 2014 AESO bi-weekly stakeholder newsletter (described further in Section 1.1.3) included a link to the AESO's newsletter. A copy of the AESO's newsletter is included in Attachment 1.

Attachment 2 includes a copy of ENMAX's information brochure.

1.1.2 Open Houses

The AESO and ENMAX jointly hosted ten open houses held at various times and locations, as described in the table below. AESO personnel were on hand at all open houses to discuss the need for the proposed transmission development, answer questions, and arrange for follow up to enquiries, as necessary. The AESO's newsletter was available at these open houses and was distributed to interested persons.

Date	Location	Day	Evening
April 1, 2014	Heritage Pointe Golf Club	11 a.m. - 2 p.m.	4 – 7 p.m.
April 2, 2014	Century Hall/Cranston Residents Association	11 a.m. - 2 p.m.	4 – 7 p.m.
April 3, 2014	Fish Creek Recreation Centre	11 a.m. - 2 p.m.	4 – 7 p.m.

April 8, 2014	Fish Creek Recreation Centre	11 a.m. - 2 p.m.	4 – 7 p.m.
April 9, 2014	Century Hall/Cranston Residents Association	11 a.m. - 2 p.m.	4 – 7 p.m.

1.1.3 Stakeholder Newsletter

The February 18, 2014 AESO bi-weekly stakeholder newsletter included a link to the AESO's newsletter. The July 29, 2014 AESO bi-weekly stakeholder newsletter included a link to the AESO's Notice of Filing advertisement. The AESO's bi-weekly newsletter is offered by subscription to any party wishing to receive it.

1.1.4 Stakeholder Meetings

The AESO met with Calgary councillors, Shane Keating and Dianne Colley-Urquhart on February 10, 2014 to discuss the need for transmission system development and address any questions they may have had. Both ENMAX and AESO representatives were in attendance.

1.1.5 Notice of Filing Advertisement

Most recently, the AESO advertised its intention to file its Application in the Calgary Herald newspaper on July 25, 2014. A copy of the final proof has been included as Attachment 3.

1.1.6 Opportunities to Directly Contact the AESO

To ensure that stakeholders had the opportunity to provide feedback, the AESO also provided stakeholders with a dedicated, toll-free telephone line (1-888-866-2959) and a dedicated email address (stakeholder.relations@aeso.ca). AESO contact information, along with the AESO's mailing address (2500, 330 5th Ave, SW, Calgary) and website addresses (www.aeso.ca, www.poweringalberta.com), were included on all AESO communications related to this application.

1.2 Issues and Concerns Raised

The AESO received enquiries directly from stakeholders. As these enquiries generally related to routing and siting, the stakeholders were directed to the TFO for further information. Similarly, had the TFO received enquiries or concerns about the need for the Proposed Transmission Development, it would have directed the stakeholder to the AESO. The AESO did not receive any specific concerns regarding the need for the proposed transmission development either directly or through the TFO. Therefore, the AESO is not aware of any outstanding stakeholder concerns regarding the need for the Proposed Transmission Developments.

1.3 List of Attachments

- Attachment 1 – AESO Newsletter
  - *"Foothills Area Transmission Development South Calgary"* (February 2014)
- Attachment 2 – ENMAX Information Brochure
  - "*Foothills Area Transmission Development South Calgary Project - Proposed 138kV Transmission Line*" (February 2014)
- Attachment 3– Notification of Filing Advertisement – Final Proof

Attachment 1 – AESO Newsletter

Foothills Area Transmission Development

South Calgary

February 2014

At the Alberta Electric System Operator (AESO), we plan the province's electric transmission system. We study the transmission system to determine what future upgrades and expansions will be needed to continue to serve Alberta's growing power demands.

> HOW DOES THE AESO DETERMINE THE NEED FOR TRANSMISSION DEVELOPMENT?

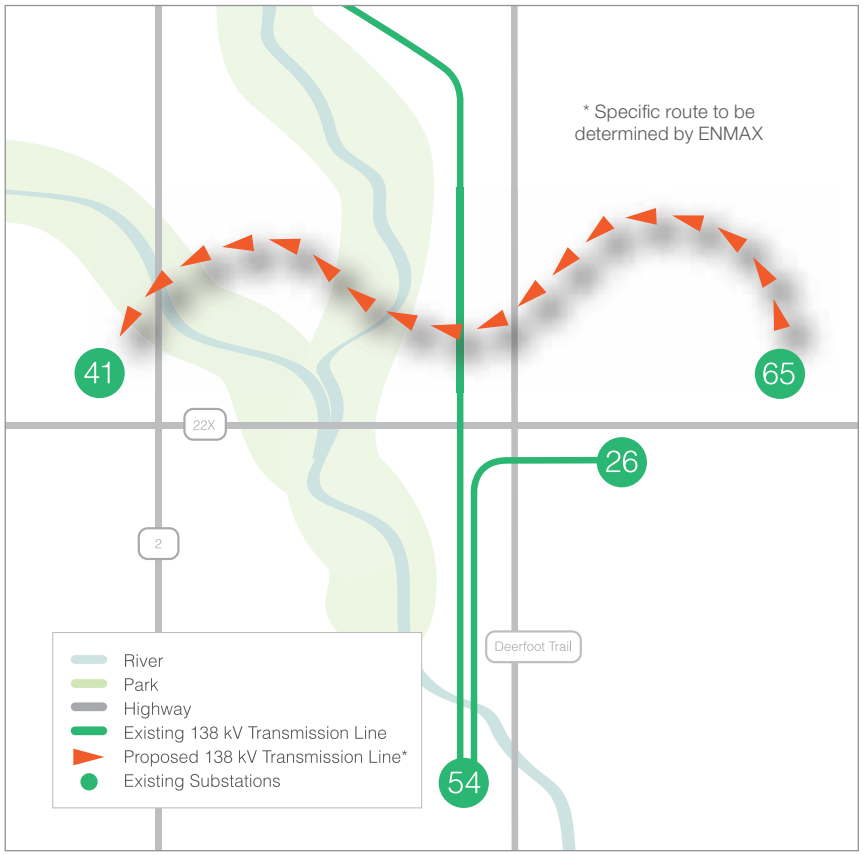
Alberta's growing population and expanding industry are driving an increasing demand for power. Power generation developers are planning and building new power plants to meet this demand. The transmission system must have enough capacity to transmit power from where it is generated to where it will be used.

As Alberta's transmission system planner, the AESO forecasts both demand from consumers and supply from generators. We study the location and amount of new generation and growing demand and develop plans to ensure Albertans continue receiving reliable power.

Why is Development Needed in South Calgary?

Calgary continues to grow, and along with that growth comes an increasing demand for power. The AESO has determined that the existing transmission system in south Calgary will become overloaded under certain conditions. Overloaded transmission lines reduce the reliability of your power supply by increasing the likelihood of outages.

As the province's transmission system planner, we plan upgrades or expansions to the transmission system to avoid outages. In this case, the AESO is proposing a new transmission line from ENMAX No. 65 Substation to ENMAX No. 41 Substation to reduce the likelihood of outages.



The AESO is proposing a new transmission line between ENMAX No. 65 and ENMAX No. 41 substations. ENMAX Power Corporation will be consulting with stakeholders on the specific routes it is considering for the construction of this line.

AESO AND TFO ROLES

The AESO plans the provincial transmission system, but the job of building, operating and maintaining the transmission facilities is the responsibility of companies known as Transmission Facility Owners (TFOs). ENMAX Power Corporation (ENMAX), the TFO in Calgary, is responsible for identifying routes for new transmission lines and for building the lines once they are approved.

TFOS IN ALBERTA

There are four major TFOs in Alberta:

- AltaLink Management Ltd.
- ATCO Electric Ltd.
- ENMAX Power Corporation
- EPCOR Utilities Inc.



Foothills Area Transmission Development

South Calgary

PROPOSED TRANSMISSION DEVELOPMENTS

The proposed transmission system developments include:

- A new single-circuit 138 kV transmission line from the new ENMAX No. 65 Substation (located at Highway 22X and 88 Street S.E.) to the existing ENMAX No. 41 Substation (located at Macleod Trail and Shalom Way S.W.).
- Associated modifications to the ENMAX No. 65 and ENMAX No. 41 substations and some existing transmission lines in the area.

RELATED TRANSMISSION PLANS

We are referring to this transmission development as Foothills Area Transmission Development (FATD) South Calgary because it is a part of our broader FATD Plan. Many parts of the broader FATD Plan have already been approved for construction by the Alberta Utilities Commission (AUC). Also, the Southern Alberta Transmission Reinforcement (SATR) was approved by the AUC in 2009 and is being implemented throughout southern Alberta. Together, SATR and FATD are major new transmission developments designed to gather power from new wind developments and other generation sources and supply it to Calgary and the surrounding communities. FATD South Calgary is an extension of these developments, providing the ability to move power into south Calgary.

WHAT ARE THE OTHER COMPONENTS OF THE FATD PLAN?

East Calgary and Shepard Energy Centre Generator Connection

- Approved in November 2012 by the AUC, with construction nearing completion

FATD-East

- Approved in October 2013 by the AUC and currently under construction

There is one remaining component to the FATD Plan that has not yet been filed with the AUC for approval. This is a future double-circuit transmission line planned from the recently approved Foothills 237S substation near High River, to the Sarcee 42S substation in Calgary. AESO studies indicate this development is not needed until sometime after 2020.

WHO IS THE ALBERTA ELECTRIC SYSTEM OPERATOR?

The AESO is an independent, not-for-profit organization acting in the public interest of all Albertans. We plan Alberta's transmission system, which is made up of the transmission lines, substations and other related equipment that transmit electricity from where electricity is generated to where it will ultimately be used.

Transmission Development Approval in Alberta

A TWO PART PROCESS



1 PART ONE: APPROVAL OF NEED

The AESO studies the transmission system to identify needed upgrades or expansions, and applies to the Alberta Utilities Commission (AUC) for review and approval of our plans. The AUC is the regulator for transmission development in Alberta.

The AESO's application to the AUC is called a Needs Identification Document, or NID. The NID outlines our specific plans to upgrade or expand the transmission system, which the AUC must approve.

2 PART TWO: APPROVAL TO CONSTRUCT

TFOs build what is in the AESO's plans. They consult with stakeholders to find specific routes for transmission lines and sites for substations.

Before TFOs begin building, they submit details to the AUC in what are called Facility Applications (FAs). The AUC must review and approve the specific routes and facility locations in the TFOs' applications.

FAST FACT

> In Alberta's electricity industry, transmission lines, substations and other related equipment used to move power are called facilities.

AESO Process

- AESO identifies need for transmission development
- AESO stakeholder engagement (mailouts, open houses, meetings)
- AESO submits a NID to the AUC for approval of need and plan

TFO Process

- TFO consultation, detailed design, routing and siting
- TFO submits a FA to the AUC for approval of siting and routing, and to construct and operate

AUC Review and Approval

- Approval of need
- Approval of siting and routing, and to construct and operate

The AUC must review and provide a decision on both the AESO's and the TFO's applications before developments can proceed. In some cases, such as for FATD South Calgary, the processes can be run in parallel.

To learn more about the transmission approval process please contact the Alberta Utilities Commission (AUC):

Web: www.auc.ab.ca
Phone: 780-427-4903

Dial 310-0000 before the 10-digit number to be connected toll-free from anywhere in Alberta.

Open Houses

YOU'RE INVITED

Please join the AESO and ENMAX at an upcoming open house for FATD South Calgary. AESO staff will be on hand to discuss our plans and the proposed transmission development. Representatives from ENMAX will be available at the open houses to discuss detailed siting and routing, and the construction and maintenance of the associated transmission facilities.

Please refer to ENMAX's project brochure included in this package for details, including dates and times of upcoming open houses.

After receiving your input, we will prepare and file a Needs Identification Document (NID) with the Alberta Utilities Commission (AUC) for approval.



WE WANT TO HEAR FROM YOU

We appreciate your views, both on the need for transmission system development and our proposed transmission plans. Your comments are encouraged. If you have any questions or suggestions regarding our proposed transmission system development in the south Calgary area, or our application regarding this need, please contact:

Megan Harris
AESO Stakeholder Relations

2500, 330–5th Avenue SW
Calgary, Alberta T2P 0L4
Email: stakeholder.relations@aeso.ca
Phone: 1-888-866-2959

To learn more about the complex electricity industry and its importance to our quality of life and the province's economic well-being, please visit **www.poweringalberta.com**

Next Steps

We will discuss our plan with you over the coming months and are happy to respond to any of your questions or comments. Before the proposed transmission developments can be built, the AUC must approve our plan. ENMAX, the company that builds, owns and maintains transmission facilities in Calgary, must also apply to the AUC for approval to build the transmission facilities. We will apply to the AUC in the spring or summer of 2014, and ENMAX expects to file its application shortly afterward. The AUC will review both applications through a process in which you will have the opportunity to participate.

When we submit our NID application to the AUC, it will be available on our website at **www.aeso.ca/transmission/8969.html**

REV 0114

Attachment 2 – ENMAX Information Brochure

FOOTHILLS AREA TRANSMISSION DEVELOPMENT SOUTH CALGARY PROJECT

Proposed 138kV Transmission Line



Photo courtesy of The City of Calgary

Project Overview

The demand for power is increasing as Calgary continues to grow. The Alberta Electric System Operator (AESO) has determined the existing transmission system in south Calgary will become overloaded as the demand for power rises. The reliability of your power supply is reduced as transmission lines become overloaded and the likelihood of power outages increases.

The AESO has identified the need to add a new 138 kV transmission line between ENMAX No. 65 Substation (intersection of Highway 22X and 88 Street SE) and ENMAX No. 41 Substation (213 Shalom Way SW) via ENMAX No.54 Substation (3023 210 Avenue SE) in order to prevent transmission line overloads in the South Calgary area.

To meet this need, ENMAX Power Corporation (ENMAX Power) has identified two viable transmission routes – a preferred and an alternate. The total length of the proposed transmission line to be constructed is approximately 14 – 22 kilometres depending upon the approved route. New equipment will be added at ENMAX Substations No. 65 and No. 41 to accommodate the new transmission line (see attached map).

Electricity consumption in the Calgary area is forecast to increase by approximately 26 per cent in the next decade. Source: Alberta Electric System Operator

Potential Route Locations

During the process of determining possible route options, ENMAX Power considers the following factors to select a route(s) with the lowest overall impact:

- agricultural
- residential
- environmental
- electrical
- cost
- visual
- special constraints

After assessing several transmission route options, ENMAX Power has selected two route options, a preferred and alternate as identified in the map on the next page.

The preferred route:

- Is approximately 14 km and is the shorter of the two routes
- Is the lower cost option
- Utilizes the existing Transportation Utility Corridor (TUC)

The alternate route

- Has fewer residences at this point, however is zoned for future development
- Is the longer of the two routes at 22 kilometres
- Is the more expensive option

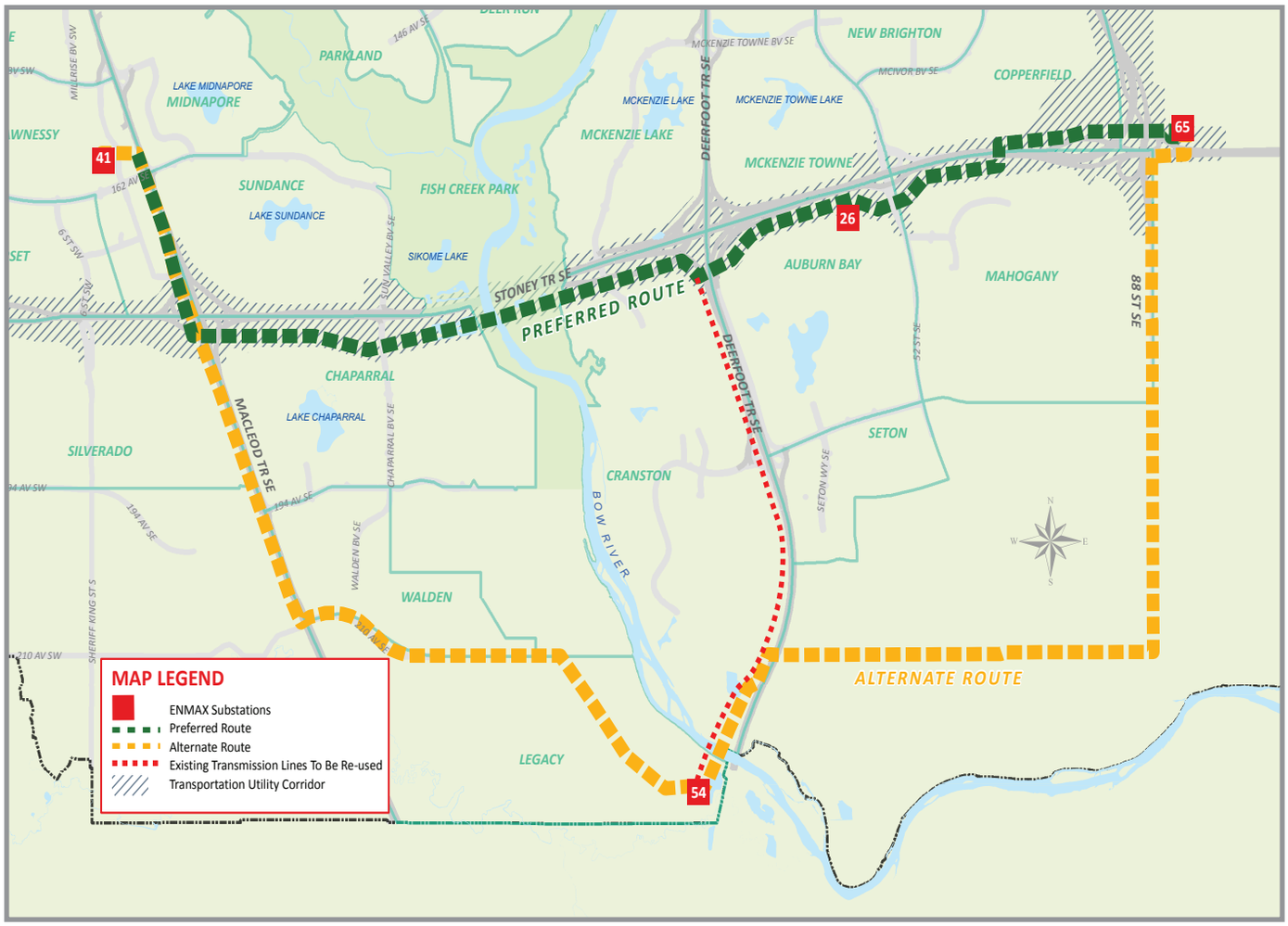
Only one route will be required for the project, however, both route options will be included in the Facilities Application (FA) submitted for decision to the Alberta Utilities Commission (AUC).



What is a Transportation Utility Corridor?

In the mid-1970s, the Government of Alberta established Restricted Development Areas (RDAs) around Calgary. The lands included in these RDAs were designated to accommodate linear transportation and utility facilities. These uses include ring roads (and associated interchanges), stormwater management facilities, petroleum pipelines, power transmission lines and municipal regional water, sanitary and storm sewer lines.

Rendering – map of route options



Preferred Route - green

The Preferred Route runs from ENMAX Substation No. 65 west along Highway 22X to MacLeod Trail in the TUC and then north on MacLeod Trail to ENMAX Substation No. 41. The existing double circuit transmission line along Deerfoot Trail from 22X to ENMAX Substation No. 54 will be used to connect this new line to ENMAX Substation No. 54.

The Preferred Route is the least costly of the two routes. In addition, the route passes through the TUC specifically allocated by the provincial government for utility facilities such as power transmission lines.

Alternate Route - yellow

The Alternate Route proceeds south on 88 Street from ENMAX Substation No. 65 to 210 Ave; west on 210 Ave, via ENMAX Substation No. 54 to MacLeod Trail and then north to ENMAX Substation No. 41.

The Alternate Route currently impacts a lower number of residences; however, it is adjacent to several undeveloped areas which are zoned for future residential development and have conceptual plans in place for new and emerging communities.

Transmission Structures

The proposed single circuit transmission structures for both the preferred and alternate routes would be self-supporting steel monopoles and will have a:

- Height of 18 to 24 metres (58 to 78 feet)
- Distance between structures of 100 to 125 metres (325 to 410 feet)





Examples of single circuit steel monopoles

Transmission line

To move our electricity from power generating facilities to local areas, ENMAX Power relies on a system of high-voltage power lines across Alberta, including our own 288 kilometre transmission network within the City of Calgary. These transmission lines enter a substation where a transformer reduces voltage to a level that can be *safely delivered to customers.*



Electric and Magnetic Fields (EMF)

ENMAX Power understands some individuals may have concerns regarding electric and magnetic fields (EMF). Scientific evidence to date has not established adverse health effects resulting from exposure to power frequency EMF at levels normally encountered in homes, schools and offices. However, we continue to monitor this issue through our work with the Canadian Electrical Association's task group, and recognize no single study will resolve this issue. Information and in-home measurements are available to our customers so they can make their own informed decisions regarding this issue.

Electric and magnetic fields are invisible lines of force surrounding any wire or device that uses electricity. They are created whenever electricity flows through a wire (eg. overhead power lines, electric appliances, or electrical cords or wiring) because these fields are found wherever there is electricity.

For further information, please visit
https://www.enmax.com/Safety/electrical-safety/electric-and-magnetic-fields-(emf)

Safety and Reliability

Calgarians rely on us every day to provide them with safe and reliable power. As our city grows, so do our needs for electricity. At ENMAX Power, we are committed to providing long-term, innovative solutions to meet the growing demands of our city.

What is a Substation?

Substations are important components of the electrical infrastructure required to keep reliable electricity available for customers. Substations consist of high voltage electrical equipment like transformers, switchgear, circuit breakers and associated devices.



Industry Partners and the Regulatory Process

The AUC must approve this project before upgrades to the system can begin. The AUC is a quasi-judicial agency that ensures the fair and responsible delivery of utility services.

Before any work takes place, the AESO identifies a transmission system requirement and determines the manner in which that need can be met. The AESO is then required to submit a Needs Identification Document (NID) outlining their recommendation to the AUC for review and approval.

The AESO is an independent, not-for-profit organization responsible for the safe, reliable and economic planning and operation of the provincial transmission grid. For more information about why this project is needed, please refer to the AESO's newsletter included with this package, or visit www. aeso.ca. If you have any questions or concerns about the need for this project you may contact the AESO directly or you can make your concerns known to an ENMAX Power representative who will communicate them to the AESO on your behalf.

In Alberta, the system that delivers electricity to consumers is owned, built and maintained by companies known as Transmission Facility Owners (TFOs). Based on system requirements, the AESO will direct a TFO to determine routing and infrastructure. In this instance, ENMAX Power is the TFO as the proposed project occurs in ENMAX Power's service territory and will explore various alternatives to locate the transmission lines, considering routing, environment, costs, stakeholder input and project components.

ENMAX Power submits an FA to the AUC for review and approval describing how it proposes to meet the requirements for the transmission project. The application includes technical details, routing and results of the participant involvement program. The NID created by the AESO and the application created by ENMAX Power will be submitted for AUC review simultaneously.

The AUC then reviews both the NID application from the AESO and the FA from ENMAX Power. The AUC ensures there is an opportunity for interested parties to provide feedback and input on the applications before a decision is made. Additional information on participant involvement is included in the AUC booklet as part of the information package.

aeso
ALBERTA ELECTRIC SYSTEM OPERATOR

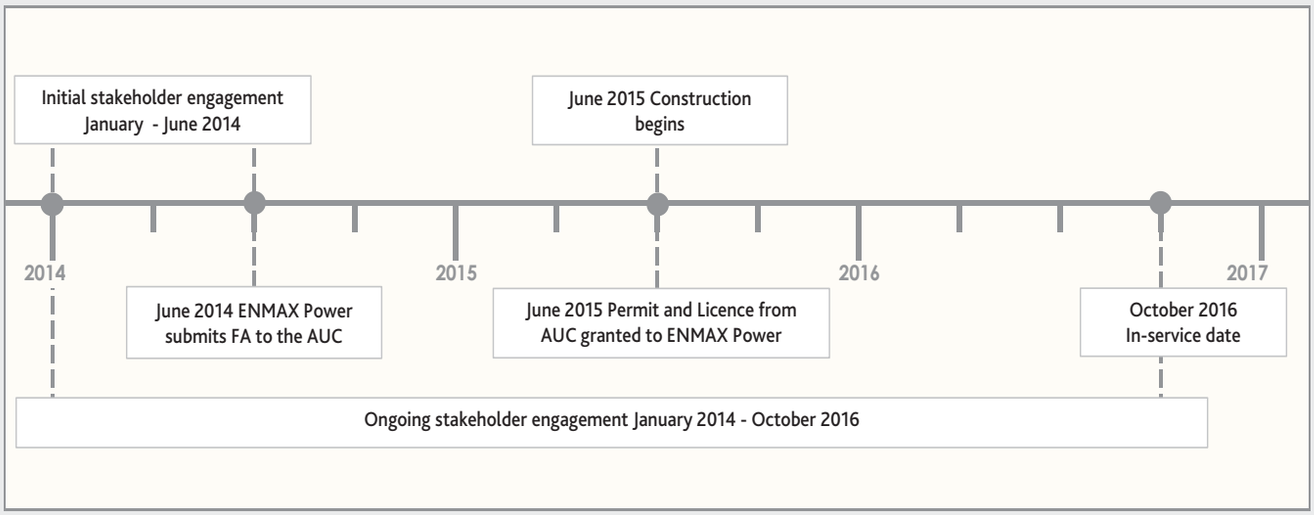
Privacy Commitment

ENMAX Power is committed to protecting your privacy. Your personal information that is collected will be protected under ENMAX's Privacy Policy and Freedom of Information and Protection of Privacy Act. As part of the regulatory process for new transmission projects, ENMAX Power may provide your personal information to the Alberta Utilities Commission. If there is more than one TFO involed For more information about how ENMAX Power protects your personal information, visit our website at https://www.enmax.com/Legal/privacy or contact us directly via email at privacy@enmax.com.

Proposed Schedule

ENMAX Power plans to file the FA with the AUC in late June 2014. Subject to approvals being granted, ENMAX Power expects construction to begin in June 2015 with a proposed in-service date of October 2016.

Proposed Project Schedule



Open Houses

ENMAX Power and AESO representatives will be available at open houses to share information, gather your input and address any questions or concerns you may have. We hope to see you there.

Date	Location	Morning	Evening
April 1, 2014	Heritage Pointe Golf Course #1 Heritage Pointe Drive, DeWinton	11:00 am - 2:00 pm	4:00 pm - 7:00 pm
April 2, 2014	Century Hall Heritage Room, 11 Cranarch Road SE, Calgary	11:00 am - 2:00 pm	4:00 pm - 7:00 pm
April 3, 2014	South Fish Creek Recreation Centre Super 8 Room, #100, 333 Shawville Blvd. SE	11:00 am - 2:00 pm	4:00 pm - 7:00 pm
April 8, 2014	South Fish Creek Recreation Centre Super 8 Room, #100, 333 Shawville Blvd. SE	11:00 am - 2:00 pm	4:00 pm - 7:00 pm
April 9, 2014	Century Hall Heritage Room, 11 Cranarch Road SE, Calgary	11:00 am - 2:00 pm	4:00 pm - 7:00 pm



About ENMAX Power

ENMAX Power Corporation, a subsidiary of ENMAX Corporation, and its predecessors have provided Albertans with safe and reliable electricity for more than 100 years. One of the most reliable urban utilities in Canada, ENMAX Power owns, operates and maintains the distribution and much of the transmission network in and around Calgary, which are activities regulated by the Alberta Utilities Commission. Non-regulated subsidiaries of ENMAX Power provide engineering, procurement, and construction services as well as maintenance for electrical servicing of residential and commercial developments and light rail transit systems. Visit our website at enmax.com

For more than 100 years, ENMAX has delivered safe and reliable electricity in Calgary. Moving electricity from the point where it is generated to our customers' homes and businesses is split into two areas: transmission and distribution.

Commitment to Community

ENMAX Power is committed to being a responsible corporate neighbour in the community. This commitment includes providing timely and meaningful engagement with stakeholders about this project.

We have developed a comprehensive public involvement program to provide opportunities for area residents, occupants and landowners to be informed about this proposal and to engage with ENMAX Power in dialogue from the planning phase through to construction.

More Information

Your input is very valuable to us. We will work with you to ensure you get answers to your questions and your concerns are understood. For more information about the proposed transmission line, please contact:

ENMAX Power Corporation
Phone: (403) 514-1471
E-mail: stakeholderrelations@enmax.com
Website: enmax.com/transmissionprojects

For more information about the need for this project, please contact:
Alberta Electric System Operator (AESO)
Phone: 1-888-866-2959
E-mail: stakeholder.relations@aeso.ca
Website: poweringalberta.com

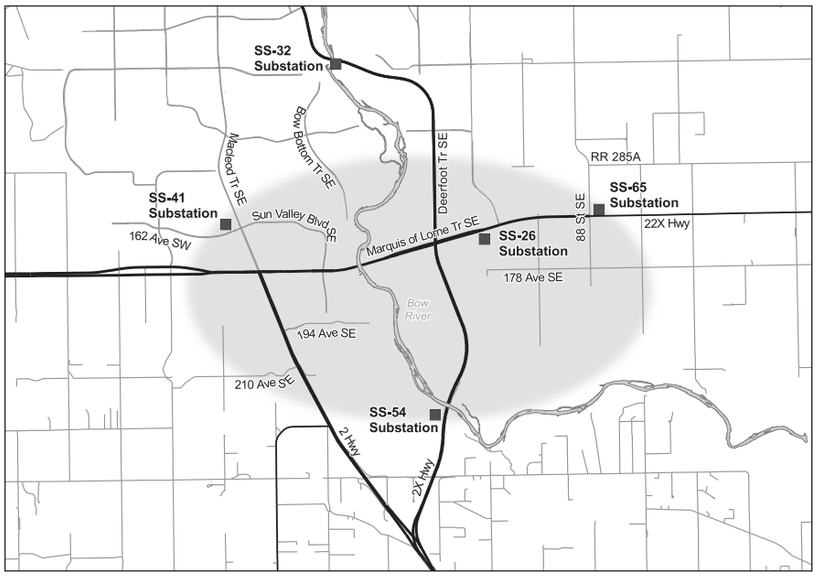
For more information about the regulatory process, please contact:
Alberta Utilities Commission (AUC)
Phone: (780) 427-4903
(Toll free: dial 310-0000 before the 10 digit number)
Website: auc.ab.ca

Attachment 3 – AESO Notification of Filing Advertisement – Final Proof

Notification of AESO Regulatory Filing for Foothills Area Transmission Development South Calgary

The Alberta Electric System Operator (AESO) advises you of its intention to file a Needs Identification Document (NID) for upgrades to the South Calgary transmission system as shown below. The AESO's application will be filed with the Alberta Utilities Commission (AUC), on or after August 11, 2014.

Calgary continues to grow, and along with that growth comes an increasing demand for power. The AESO has determined that the existing transmission system in south Calgary will become overloaded under certain conditions. Overloaded transmission lines reduce the reliability of your power supply by increasing the likelihood of outages. As the province's transmission system planner, we plan upgrades or expansions to the transmission system to avoid outages. As part of its Foothills Area Transmission Development Plan and to reduce the likelihood of outages, the AESO has identified the need for a new single-circuit 138 kV transmission line from the existing ENMAX No. 65 Substation to the existing ENMAX No. 41 Substation, and associated modifications to some existing substations and transmission lines in the area.



The shaded area on the map indicates the approximate area where transmission system upgrades are needed. Existing substations where modifications are required are also shown. In a separate application called a Facility Application, ENMAX Power Corporation, the transmission facilities owner (TFO) in the area, will describe the specific routes they propose to implement the transmission system upgrades, and request AUC approval to construct and operate the specific transmission facilities. The specific transmission line routes applied for by the TFO may extend beyond the area shown.

The AESO presented the need for the transmission system upgrades to stakeholders, including residents, occupants and landowners near the proposed developments, from February 2014 to July 2014. The AESO has considered feedback gathered from stakeholders, and technical and cost considerations, and will apply to the AUC for approval of the need for the transmission system upgrades. Once filed, the NID will be posted on the AESO website at http://www.aeso.ca/transmission/30128.html

aeso
ALBERTA ELECTRIC SYSTEM OPERATOR

tmp.worldwide
Integrated Marketing Communications

Artist: 2N

Docket: 103288

Date: May 28, 2014

Size: 5.1x10.21" (fixed)

Proof: 4

1 of 1

Publications(s):
CH

APPENDIX J TFO CONFIRMATION THAT COMMISSION RULE 007 NID 13 ASPECTS ARE BEING ADDRESSED IN TFO FACILITY PROPOSALS

ENMAX Power Corporation
141 – 50 Avenue SE
Calgary, AB T2G 4S7
Tel (403) 514-3000
enmax.com

July 9, 2014

Alberta Electric System Operator
2500, 330 – 5th Avenue SW
Calgary, AB T2P 0L4

Attention: Ms. Sonja Tessari

Dear Ms. Tessari:

RE: ENMAX Power Corporation's ("EPC")
Confirmation of AUC Rule 007 Requirements
For the FATD South Calgary Application

EPC is submitting this letter to the Alberta Electric System Operator ("AESO") in order to provide confirmation that the seven aspects of AUC Rule 007 NID 13, will be addressed in the ENMAX FATD South Calgary Facility Application ("FA").

The seven major aspects of the AUC Rule 007 NID13 will include, but are not limited to:

1. **Agricultural Impact**
   Any agricultural impacts identified for the project, will be identified and addressed with mitigation measures if required, within the environmental sections of the FA;
2. **Residential Impact**
   Any Residential impact will be identified and addressed within the Stakeholder Consultation sections of the FA, as well as the Participant Involvement Program report included in an appendix to the FA;
3. **Environmental Impact**
   All environment issues are carefully considered by EPC and any potential environmental impact will be identified and addressed complete with mitigation measures if required, within the environmental sections of the FA;
4. **Cost**
   All costs associated with this project will be addressed in the economic assessment section of the FA, and in further detail in an appendix to the FA;
5. **Electrical Considerations**
   All Electrical considerations will be addressed within the FA;
6. **Visual Impact**
   Visual impacts and any aesthetics or landscape plans proposed to minimize visual impacts of this project will be outlined within the FA; and

7. **Special Constraints**
   Any special constraints required for this project will be identified and addressed within the FA.

If you require anything further, please contact me direct at (403) 514-3238.

Sincerely,
ENMAX Power Corporation

Willem DuToit
Manager, Major Projects

APPENDIX K AESO TRANSMISSION PLANNING CRITERIA – BASIS AND ASSUMPTIONS

Transmission Planning Criteria - Basis and Assumptions

Version 1.0

2500, 330-5th Avenue SW, Calgary, Alberta T2P 0L4 Phone: 403-539-2450 Fax: 403-539-2949
www.aeso.ca www.poweringalberta.com

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.

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

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

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	152
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 in Level A

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)
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 with telecommunications	6	8
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