Northern Greeley Area Transmission Plan
System Impact Study Report

Northeast Colorado (NECO) Subcommittee

Analysis Performed and Prepared by:
Public Service Company of Colorado
Transmission Planning

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Executive Summary

The transmission system in and around the City of Greeley is experiencing reliability issues due to aging transmission infrastructure, increasing customer demand for electricity, and resource capacity constraints. This system is primarily owned and operated by Public Service Company of Colorado (PSCo). In response to these issues, and to develop a transmission improvement plan for the area, PSCo participated in a joint study conducted through a subcommittee of the Colorado Coordinated Planning Group (CCPG). The Northeast Colorado (NECO) Subcommittee was formed by CCPG to develop a transmission plan in northeast Colorado that would improve reliability, increase load serving capability and resource accommodation, and align with other transmission planning efforts in the area. In 2016, the NECO Subcommittee focused on transmission plans to the north of Greeley and developed this "Northern Greeley Area Transmission Plan".

The primary objective of this transmission plan is to replace the existing, antiquated and non-standard, 44 kV system with higher voltage transmission facilities. The existing loads, which are served radially from the 44 kV transmission system, will be transferred to the higher voltage network, which will be configured in a more reliable interconnected (or looped) manner.

The load serving capability of the region is also an important consideration since Weld County produces more oil and gas than any other county in the state of Colorado. Utilities in the county have received a significant number of interconnection requests to serve oil and gas loads. These requests include not only those for new electrical service, but also those that desire a change from traditional gas-powered equipment to more efficient electrical equipment.

Northeast Colorado also has a high potential for beneficial resource development, such as renewables. The area is located within what has been defined as Energy Resource Zone (ERZ) #1 as identified by Colorado Senate Bill 07-100. Within ERZ #1 there are three identified wind Generation Development Areas (GDA's), each located north of the Greeley area. There are currently 1,275 MW of developed wind resources located in the region and the potential exists for significant additional renewable generation development.

In June 2016, the NECO Subcommittee developed a study scope and began evaluating alternatives, leading to the development of this coordinated transmission plan. The study results indicate that replacing the 44 kV system with a new 230/115 kV transmission network in the northern Greeley area will not only improve reliability, but also serve new customer load requests, and allow for the accommodation of potential new resources.

The study specifically indicates the Northern Greeley Area Transmission Plan successfully mitigates potential overloads for both system intact and contingency conditions. The plan will transfer almost 70 MW of existing loads from the 44 kV radial transmission system to a new higher voltage system, and allows for at least 120 MW of new load to be added to the area. The plan also adds another transmission outlet to the constrained transmission path south of the Ault substation, which in turn increases the system operating limit . The plan allows for future generation resource accommodation and aligns with other transmission planning efforts in northeast Colorado.

The proposed "Northern Greeley Area Transmission Plan" would establish over 25 miles of new 230 kV and 115 kV transmission from the existing jointly-owned Ault Substation to a new Cloverly Substation, add two new load serving substations and expand on a third substation for a cost of approximately $64.5 million dollars. The Northern Greeley Area Transmission Plan includes the following components:

- Ault – Husky 230 kV Transmission Line: A new 6-mile transmission line built from the Western Area Power Administration (Western) Ault Substation to a new "Husky" Substation, located near the existing PSCo 44 kV Ault Substation. The transmission would initially be operated as single-circuit 230 kV, but may be built with the capability to accommodate two 230 kV circuits.
- Husky Substation: The Husky Substation is planned to replace the existing PSCo Ault 44 kV Substation. The substation would allow 44 kV loads to be transferred to 115 kV and accommodate future load interconnection requests.
- Husky – Graham Creek – Cloverly 115 kV Line: A new 19-mile transmission line built from the Husky Substation, having an intermediate interconnection to a new "Graham Creek" Substation, and terminating at the Cloverly Substation. The transmission would initially be operated as single-circuit 115 kV, but may be built with the capability to accommodate two 230 kV circuits.
- Graham Creek Substation: The Graham Creek Substation is planned to replace the existing PSCo Eaton 44 kV Substation. The substation would allow 44 kV loads to be transferred to 115 kV and accommodate future load interconnection requests.
- Cloverly Substation: The Cloverly Substation was completed by PSCo in 2016 and is an expansion of the existing PSCo Pleasant Valley 44 kV Substation in east Greeley. The substation can accommodate future load interconnection requests and provide flexibility to continue additional 115 kV or 230 kV transmission to the south.

Figure 1 below illustrates the proposed Northern Greeley Area Transmission Plan[1].

[1] Note that all of the maps in this report indicate general routing of transmission facilities and are not meant to depict any specific routes or locations for those facilities.

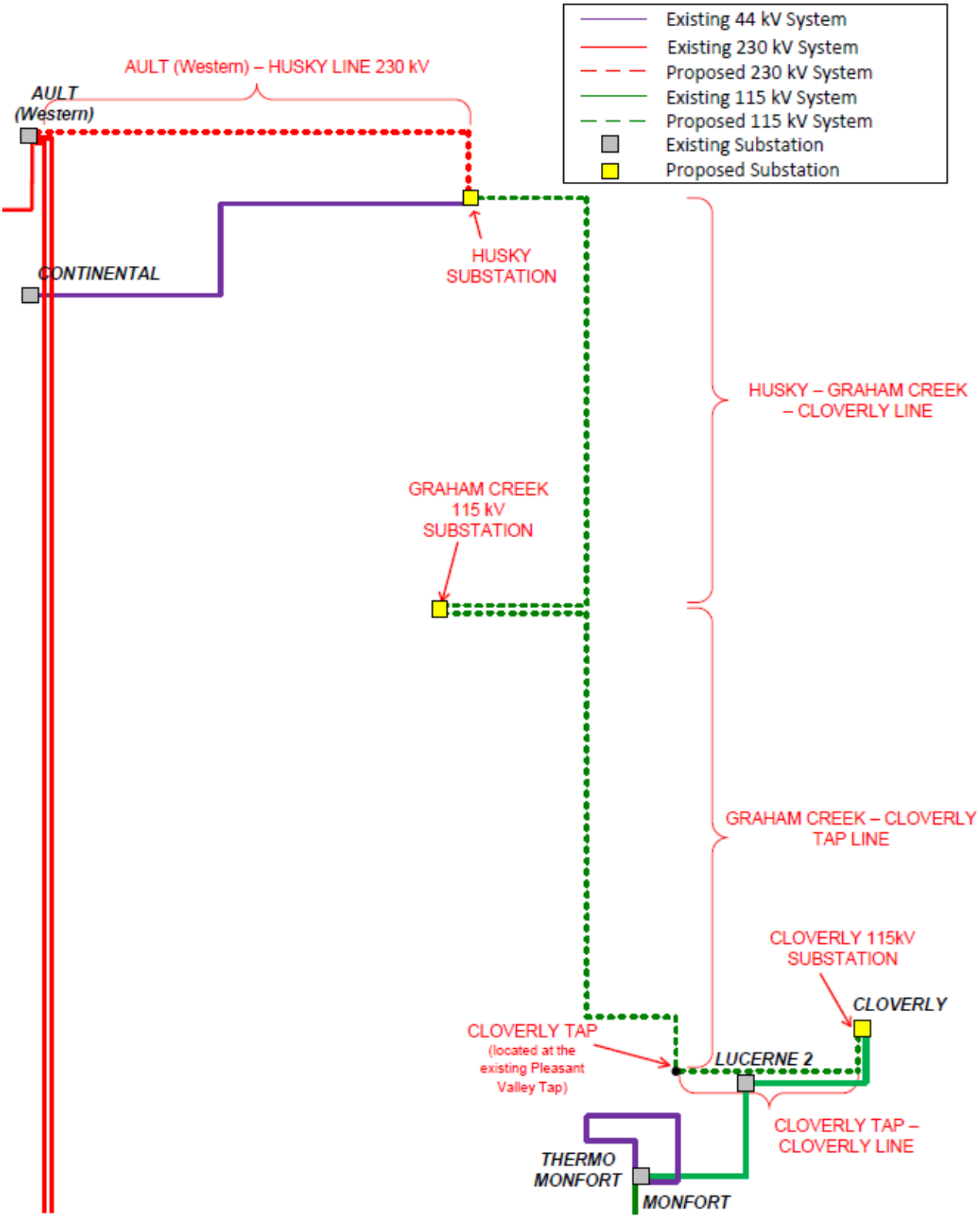

Figure 1: Northern Greeley Area Transmission Plan

I. Study Objective

The purpose of this study lays out the plan for a coordinated and joint transmission study effort to develop a transmission plan in and immediately north of the City of Greeley. The key objective of the transmission plan is the elimination of the existing, antiquated and non-standard, 44 kV system, and replacing it with higher voltage transmission facilities. Other objectives of the plan include ensuring system reliability, providing flexibility to accommodate future load growth and beneficial resource development, and aligning with other ongoing transmission projects and studies in northeast Colorado.

II. Stakeholder Process

The study was conducted through the Northeast Colorado (NECO) Subcommittee of the Colorado Coordinated Planning Group (CCPG). "*The Colorado Coordinated Planning Group (CCPG) is a joint, high voltage transmission system planning forum. The purpose is to assure a high degree of reliability in the planning, development and operation of the high voltage transmission system in the Rocky Mountain Region.*[2]" The objective of the NECO Subcommittee is to develop transmission plans that will support and facilitate load growth related to oil and gas development, coordinate with reliability improvements in the Greeley area, and complement other longer-term transmission plans in northeast Colorado. In 2016, the NECO Subcommittee focused on transmission plans in the northern Greeley area. This study was limited to the transmission system in northeast Colorado, commonly referred to as the "Foothills" area, which is primarily within Weld County, but also extends to Boulder and Larimer Counties. Specifically within the Foothills area, the study area expands east to west from Range 62 West to Range 70 West, and north to south from Township 7 North to Township 2 North. Figure 2 below shows a picture of the study focus area.

NECO Subcommittee Participants		
Name		**Company**
Dylan	Fate	Tri-State Generation and Transmission
Jeremy	Brownrigg	Platte River Power Authority
Paul	Caldara	Colorado Public Utilities Commission
Shawn	Carlson	Basin Electric Power Cooperative
Patrick	Corrigan	Xcel Energy
Jim	Farby	Black Hills Corporation
Roy	Gearhart	Western Area Power Administration
Tom	Green	Xcel Energy
David	Gustad	Tri-State Generation and Transmission
Joel	Hendrickson	Colorado Public Utilities Commission
James	Hirning	Western Area Power Administration
Ryan	Hubbard	Tri-State Generation and Transmission
Joe	Mercer	Peak Reliability Corporation
Betty	Mirzayi	Xcel Energy
Chris	Neil	Office of Consumer Council
Connie	Paoletti	Xcel Energy
Jason	Parker	Western Area Power Administration
Chris	Pink	Tri-State Generation and Transmission
Michael	Rein	Xcel Energy
Paul	Runanu	Western Area Power Administration
Charles	Shue	Black Hills Corporation
John P	Skeath	Xcel Energy
Wes	Wingen	Black Hills Corporation

[2] CCPG Charter, http://regplanning.westconnect.com/ccpg.htm

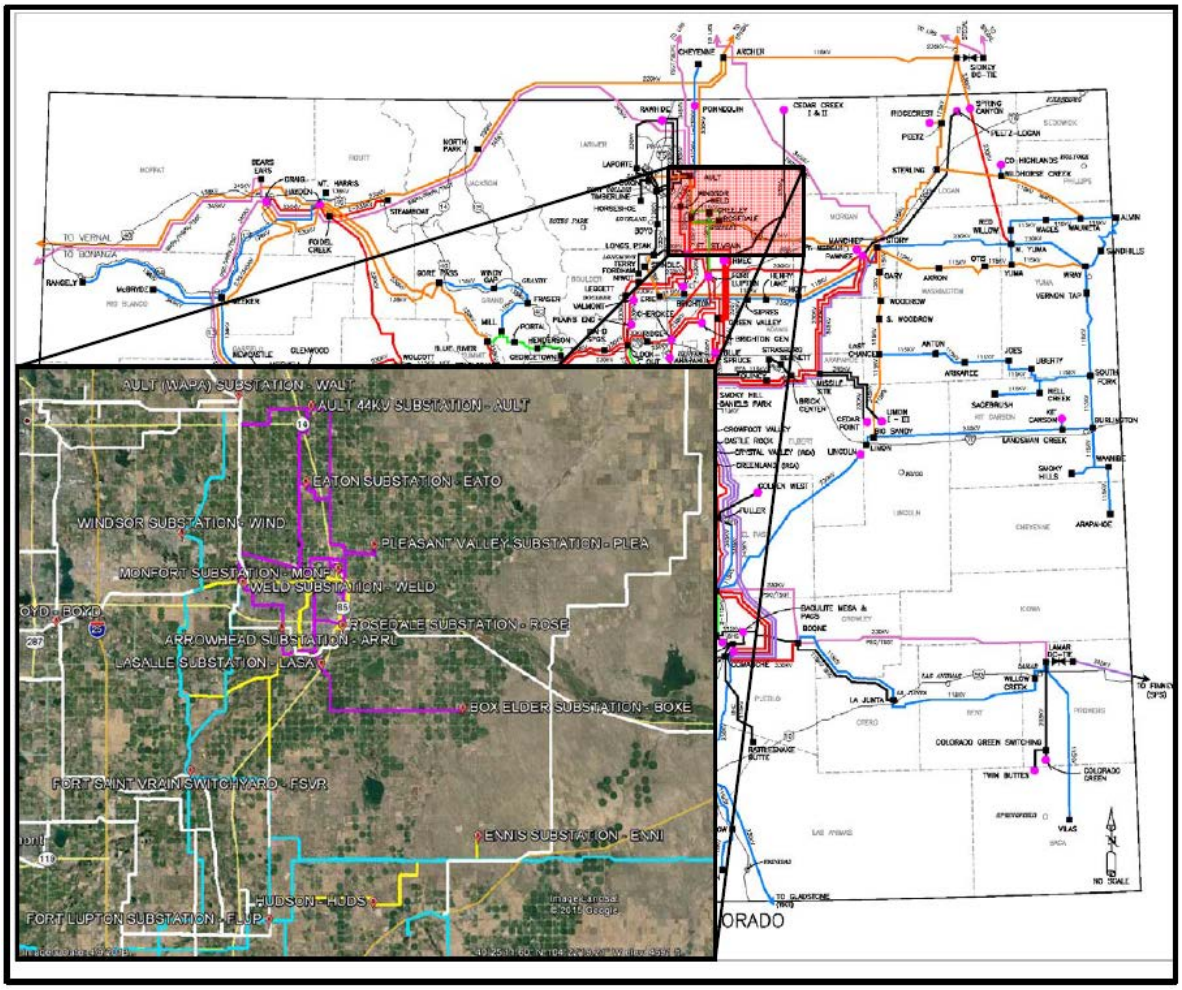

Figure 2: Study Focus Area

A kickoff meeting was held in the fall of 2015, and participation has been open to any interested stakeholders. To ensure transparency, meetings have been held regularly, generally on a monthly basis, and meeting materials are publically posted on the WestConnect web site, under the Northeast Colorado Subcommittee of CCPG[3].

The study scope and all alternatives, sensitivities and scenario studies were agreed to by the NECO Subcommittee participants. PSCo acted as the facilitator in the study effort, in both conducting and presenting studies and their results.

III. Background

In response to the aging and non-standard transmission infrastructure, capacity limitations due to increasing retail demand, and resource constraints, the NECO Subcommittee worked to develop a transmission improvement plan for the northern Greeley area to improve the reliability, load serving capability, resource accommodation and align with other ongoing transmission projects and studies in the Greeley area.

[3] http://regplanning.westconnect.com/ccpg_neco_sc.htm

The Greeley Area 44 kV Transmission System

The Greeley area 44 kV transmission system is one of the oldest transmission assets owned by PSCo with significant portions of the infrastructure dating back to the early 1900's. The system consists of approximately 80 miles of transmission lines and 9 substations, and serves approximately 15,500 customers, or approximately 90 MW of load. The system covers approximately 6,000 square miles of PSCo service territory, much of which is located in rural areas outside of Greeley.

The 44 kV system was acquired by PSCo from Home Light and Power in the 1980's. Due to its age, much of the infrastructure on the system has become outdated and is not constructed to current PSCo standards. Furthermore, 44 kV is a non-standard transmission level voltage and is no longer incorporated in bulk transmission systems.

Over the past century, the City of Greeley and the surrounding area have grown in around the existing 44 kV transmission equipment, making operation and maintenance difficult due to clearance and spacing limitations. Making matters worse, the majority of the 44 kV infrastructure has deteriorated to the point where substantial maintenance work is required to keep the equipment in-service, which has led to significant cost expenditures. Additionally, the system is nearing its load serving capacity with limited potential to provide service for future retail customers.

For reliability purposes, the 44 kV system is almost always operated as three radial transmission branches, each served from a separate 115 kV transmission source within the City of Greeley. These three source substations are Weld Substation, Greeley Substation and Monfort Substation. Because of this configuration, there are risks of losing customer electric service loads amounting to approximately one-third (1/3) of the 44 kV system during certain equipment failure conditions. Figure 3 below shows a diagram of the typical configuration of the three radial branches of the 44 kV system.

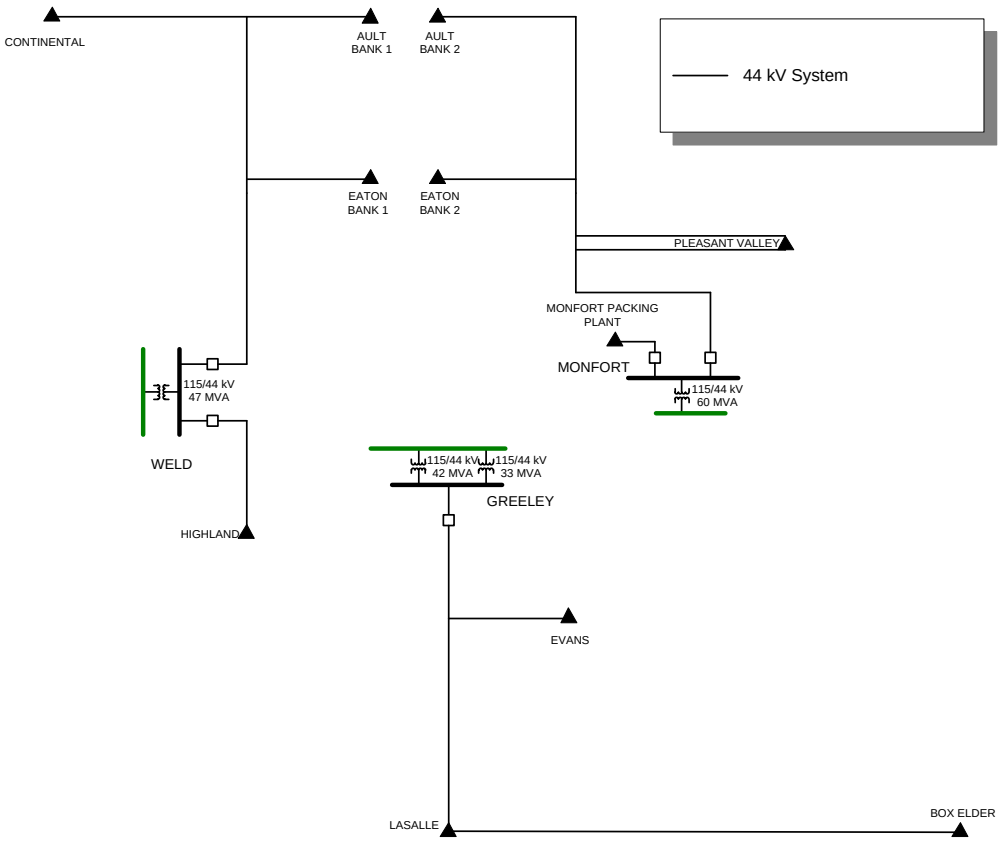

Figure 3: Radial Configuration of the 44 kV System

During certain conditions, these three radial branches can be connected by closing the normal open switches at the Ault, Eaton, Monfort, and/or Highland Substations to help with operational flexibility in serving loads. However, operating under this configuration lowers the reliability of the 44 kV system by increasing the risk of de-energizing one-half (1/2) the system rather than one-third (1/3) each time there is an equipment failure or line fault. This elevated risk is due to the lack of circuit breakers at certain 44 kV substations. Furthermore, connecting the 44 kV system in this manner does not significantly increase the load serving capability of the system, and depending on its configuration, may in fact lower it due to low voltage conditions arising on the system. Figure 4 below shows a diagram of the location of the normal open switch locations on the 44 kV system.

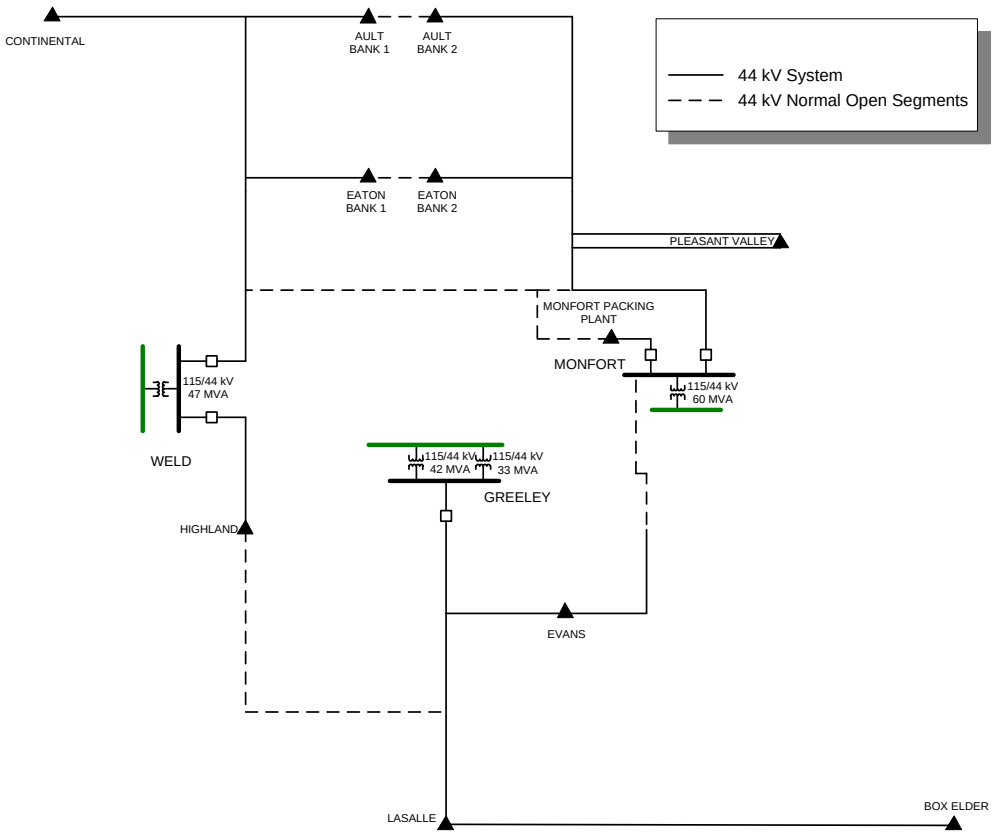

Figure 4: Normal Open Locations of the 44 kV System

Due to the radial configuration necessary for reliability purposes, the load serving capability of the 44 kV system is limited to the summation of the ratings of the Weld source (the 115/44 kV transformer at Weld – about 47 MVA) and the Greeley source (the single 44 kV transmission line exiting the Greeley Substation – about 48 MVA), for a total of approximately **95 MVA** (47+48). This rating is based on the single contingency (N-1) outage of the higher rated Monfort source (115/44 kV transformer at Monfort – approximately 60 MVA). Even in the less reliable configuration of the connected, or closed-loop 44 kV system, the load serving capability is limited to approximately **107 MVA** (47+60) by the 115/44 kV transformers at Weld and Monfort with the loss of the Greeley – Greeley Tap 44 kV line. For the past few years the coincident summer peak for the 44 kV system has been approximately 90 MVA and continues to grow.

Recent challenges with the system include the need to order specialized 44 kV equipment, having to coordinate outages with the distribution system due to feeders being located underneath the transmission lines on the existing transmission structures, utilizing traffic control to conduct maintenance work, and restoring property damage incurred during maintenance construction.

Retail Load Growth

Over the past few years, companies have been drawn to Northeast Colorado in search of oil and natural gas from the Niobrara Shale Formation. Load-serving entities such as PSCo and Tri-State Generation & Transmission (Tri-State) have recognized the potential for increased demand for electricity due to oil and gas development in this area. These oil and gas processing and gas compression loads tend to be relatively large in nature, ranging from 6 MW – 60 MW per facility, and are located in remote areas which lacks adequate transmission infrastructure. In addition to

these large, retail customer load interconnection requests, PSCo has observed an approximate 2% annual retail customer load growth in the Greeley area over the past 5 years.

From the City of Greeley 2016 Annual Growth and Development Projections Report[4], the City of Greeley has experienced an average annual population growth rate of about 1.9% over the past 25 years. In 2015 the City experienced a 2.51% annual growth rate in residential permits and a 1.97% population growth rate. From this report, Figure 5 shows a graphical representation of the last 25 years of new residential building permits filed, while Figure 6 shows the City's housing forecast for 2016 - 2021.

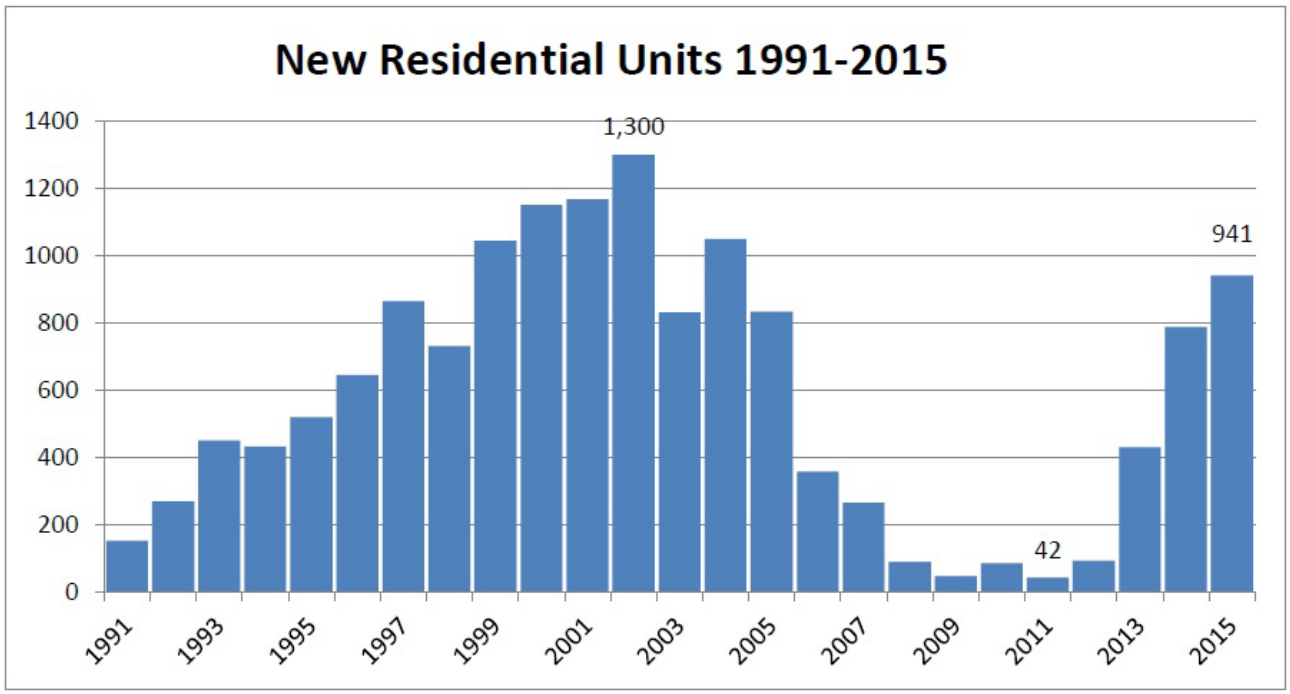

Figure 5: City of Greeley New Residential Units 1991 - 2015

[4] http://greeleygov.com/docs/default-source/community-development/long-range-planning/growth-and-development-projections/2016-annual-growth-and-development-report.pdf?sfvrsn=2

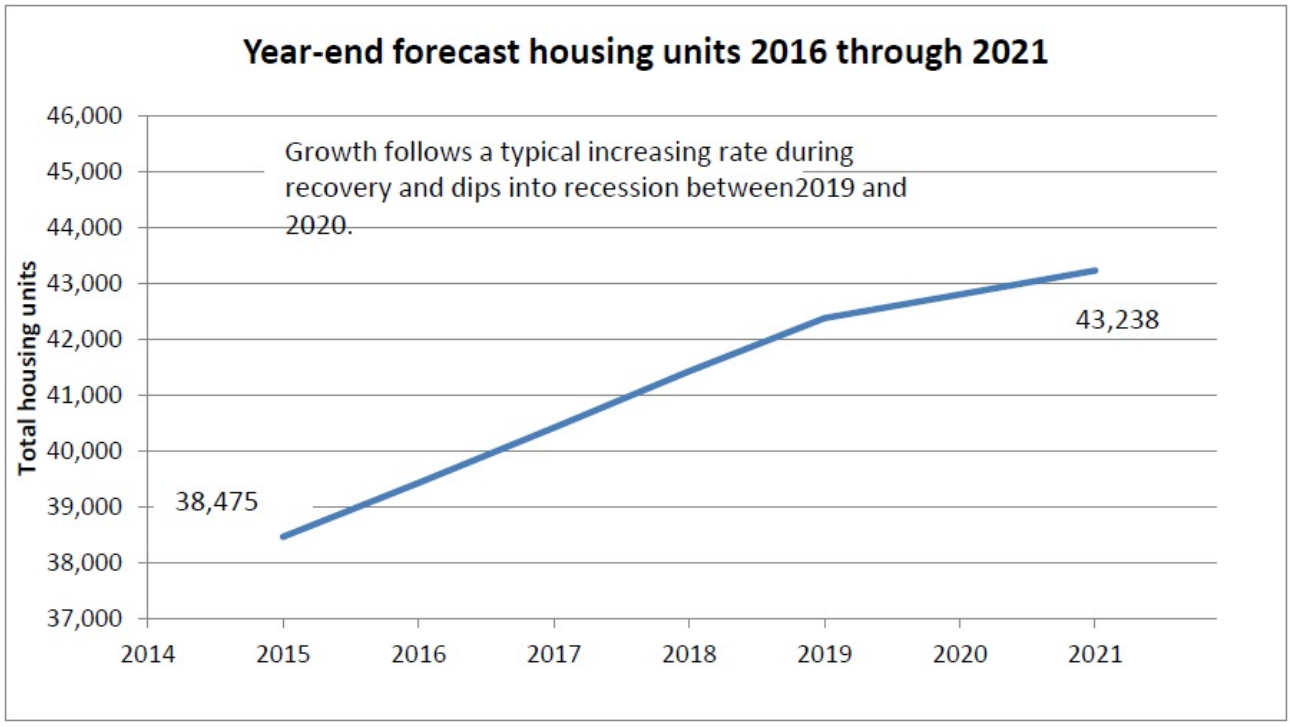

Figure 6: City of Greeley 5 Year Housing Forecast

In an effort to serve the new retail load interconnection requests, as well as the anticipated retail load growth in the Greeley area, the NECO Subcommittee performed a reliability study to develop a transmission plan.

Transmission & Generation Serving the Greeley Area 44 kV System

NECO participants are always committed to ensuring reliability for their customers in the region. This is especially true for PSCo with the City of Greeley and the surrounding area. As previously mentioned the loads in and around the City of Greeley are primarily served by the aging 44 kV transmission network which has a maximum load serving capability of **95 MVA**. That 44 kV network is sourced by three 115 kV substations; Weld, Greeley and Monfort. In addition to the 44 kV system, a portion of the loads within the City of Greeley are served by an existing 115 kV system.

The 115 kV load serving system in the study area can be divided into two groups, the 115 kV system in the City of Greeley and the 115 kV system in the surrounding Greeley area. The 115 kV system in the City of Greeley consists of seven 115 kV load serving substations; Greeley, UNC, Rosedale, Leprino, Monfort, Lucerne and Arrowhead Lake, while the 115 kV load serving system in the Greeley area consists of the Johnstown, Gilcrest, Boomerang, South Kersey, Kodak, Bracewell, Windsor and substations in addition to the seven substations comprising the 115 kV load serving system in the City of Greeley. Like the 44 kV system, over the past few years, the coincident summer peak for the City of Greeley and the Greeley area 115 kV systems have been approximately **170 MW** and **260 MW,** respectively, and also continue to grow. These totals do not include the loads served by the 44 kV system. When considering the two together, the total loading of the 115 kV system in the Greeley area is approximately **350 MVA**. A single 115 kV

transmission line (Western's Kersey West – Rosedale 115 kV line) rated at 120 MVA acts as a source to the Greeley area, importing power from the east.

Similar to how the 115 kV system sources the 44 kV system in Greeley, an even higher voltage 230 kV system sources the 115 kV system. The single 230 kV source for the 115 kV system in the Greeley area is located at the jointly owned Weld Substation where there are three 230/115 kV transformers, two of which are owned by Western and the other is owned by PSCo. Furthermore also located on PSCo's 230 kV bus at the Weld Substation, are two distribution transformers rated at 50 MVA, that help to serve loads within the City of Greeley. Approximately **30 MW** of load during the summer peak is served from these distribution transformers.

A table listing the various loads and their voltages can be found in APPENDIX A: Greeley Area Loads.

Two local generation resources are located within the City of Greeley 115 kV system; one, rated at approximately 30 MW, is near the Monfort Substation, and the other, rated at approximately 70 MW is located near the UNC Substation. Within the past six years, both of these local generation facilities have been retired and were disconnected from the 115 kV transmission system.

From its configuration, the load serving capability of the 115 kV transmission system in the Greeley area is limited to the summation of its 230 kV source (the 230/115 kV transformation capacity at the Weld Substation) and the single 115 kV transmission source at the Rosedale Substation (Western's Kersey West – Rosedale 115 kV line). As described above, this is because the loads on both the 115 kV and 44 kV systems in the Greeley area are sourced by those three 230/115kV transformers at the Weld Substation and the Kersey West – Rosedale 115 kV line.

For the contingency of the two 230/115 kV 150 MVA transformers at the Weld Substation, a result of a 115 kV bus fault on the Western owned half of the substation, the load serving capability of the 115 kV system (which includes the 44 kV system loads) is limited to **400 MVA**. This limit is the result of the remaining 230/115 kV 280 MVA transformer at Weld Substation and the Kersey West – Rosedale 115 kV 120 MVA line. Studies show that as load is increased within and east of Greeley, additional power flows through the Weld transformers and the 115 kV system in Greeley, resulting in the potential for unacceptable loading of the transformers and 115 kV transmission lines. Figure 7 provides a depiction of the higher voltage transmission sources to the Greeley area.

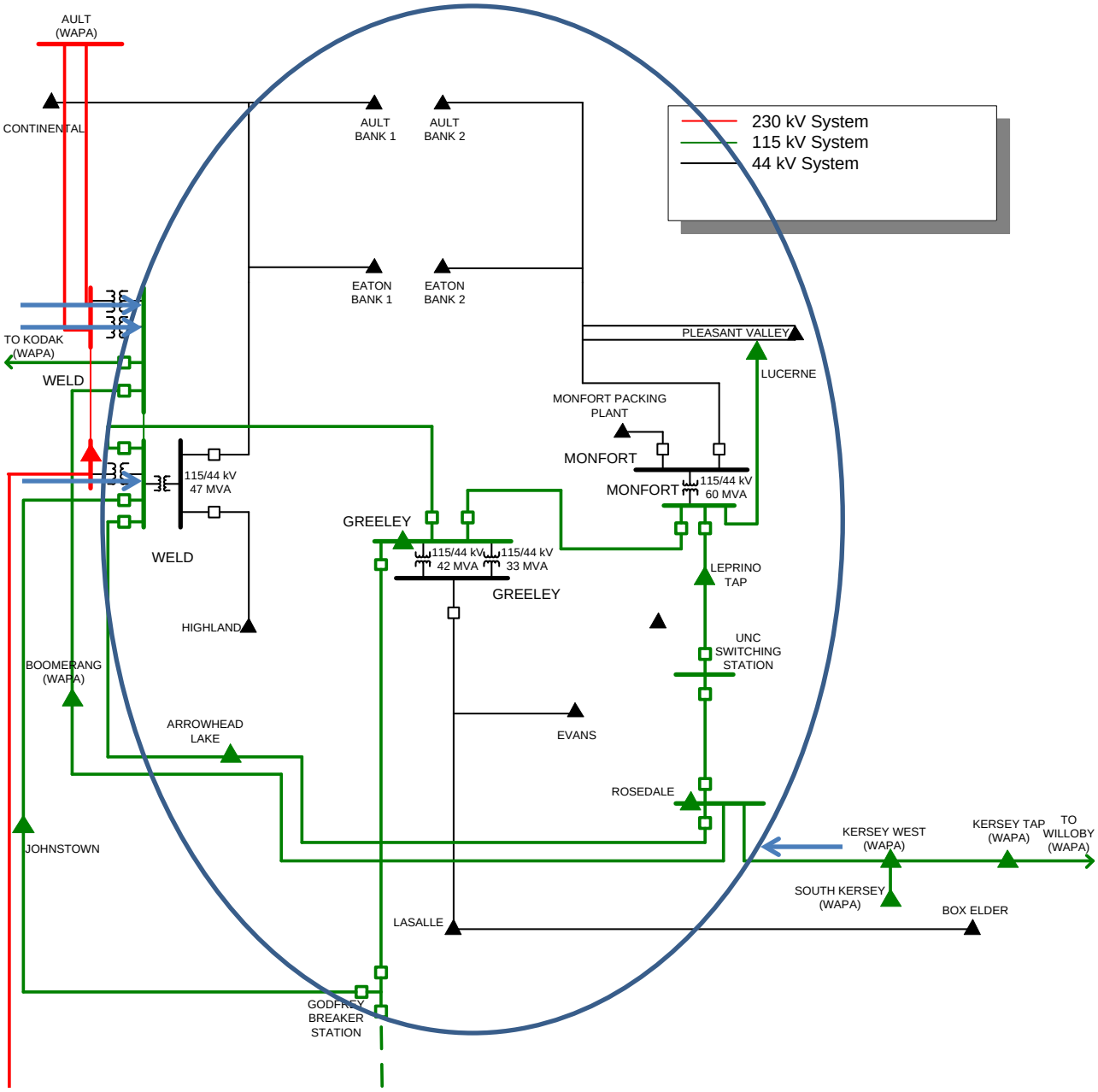

Figure 7: Greeley Area Transmission Sources

Future Resources Accommodation

The Greeley area transmission system is located electrically adjacent to the TOT 7 transfer path. The Western Electricity Coordinating Council (WECC) defines a transfer path as "a facility(ies) between systems or internal to a system, for which schedules and/or actual flows can be monitored for reliability purposes.[5]" The TOT 7 path is recognized by the WECC as Path 40 and has an existing rating of 890 MW north to south. The transfer capability is divided between PSCo and Platte River Power Authority (PRPA). The TOT 7 transfer path is an essential transmission path for the delivery of power into the Denver-metropolitan load center from the north, and it consists of three 230 kV transmission lines:

- Ault – Windsor – Fort St. Vrain

[5] WECC: Project Coordination, Path Rating and Progress Report Process, June 6, 2017, p.13

- Weld – Fort St. Vrain
- Longs Peak – Fort St. Vrain

Figure 8: TOT 7 Transfer Path below shows the TOT 7 transfer path.

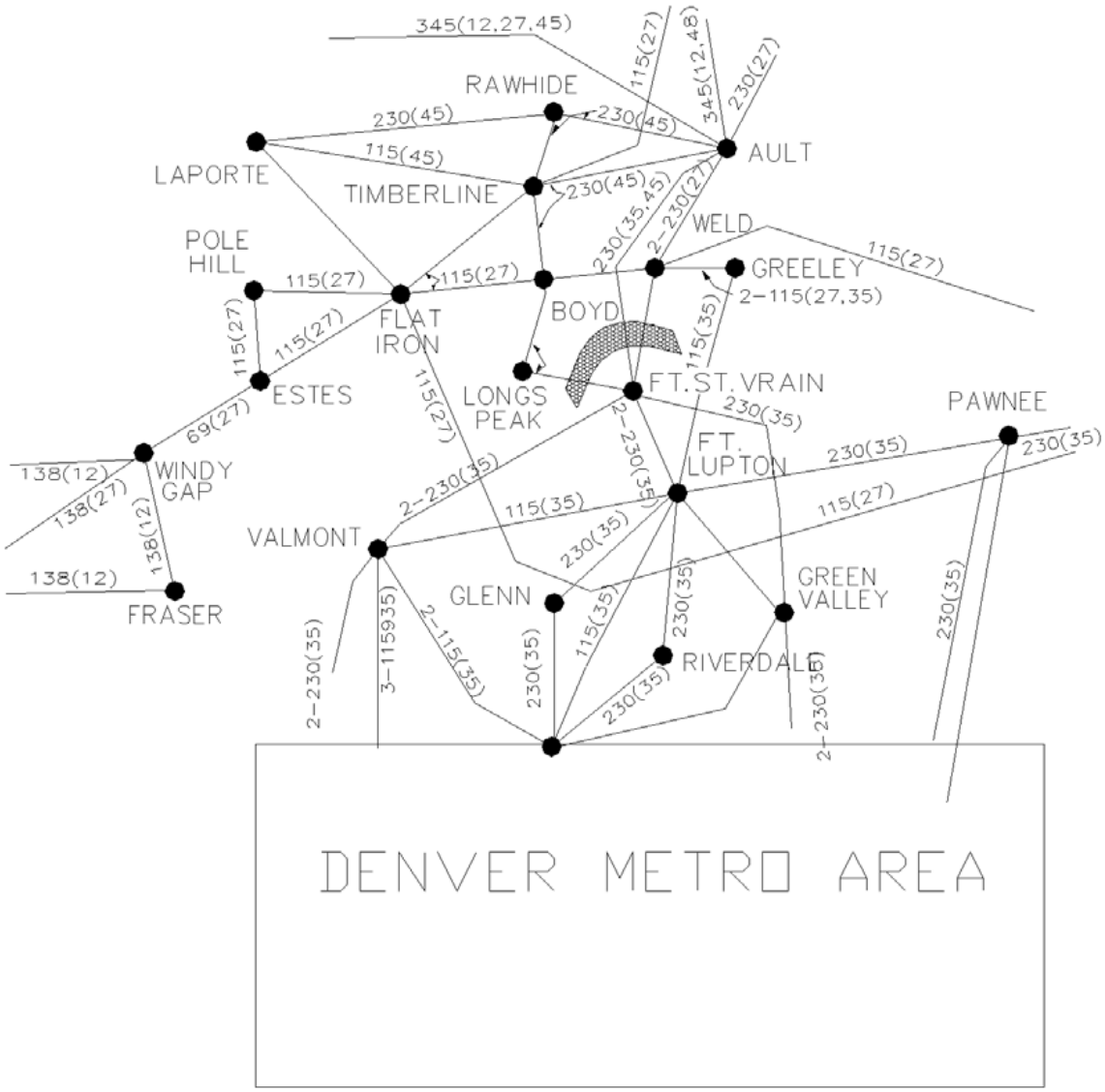

Figure 8: TOT 7 Transfer Path

Generally, the direction of power flow through the region is in the north to south direction. This is due to resources in Wyoming, such as Laramie River Station (LRS), and northern Colorado, such as Fort St. Vrain (FSV), delivering their energy to Denver-metropolitan area loads.

In 2007, the Colorado Legislature passed Senate Bill 07-100, which requires rate-regulated utilities to develop plans for transmission facilities to accommodate the development of beneficial energy resources located in or near Energy Resource Zones (ERZ's). The TOT 7 transfer path and much of

the Greeley area and Foothills electrical system lie in ERZ #1, which encompasses most of northeastern Colorado. Senate Bill 07-091, also signed into law in 2007, resulted in the identification of renewable resource generation development areas (GDA's) within Colorado that have potential to support the development of renewable resources. GDA #1 is directly north of the Greeley area and has the potential for wind generation development.

The Greeley area is located within ERZ #1, and within ERZ #1 there are three identified wind GDA's, each located north of the Greeley area. There is currently 1,275 MW of developed wind resources (1,215 MW owned by PSCo) located in ERZ #1, and future renewable generation development potential exists within the GDA's and ERZ #1.

Additional Transfer Capability

As part of the Northern Greeley Area Transmission Plan, the addition of a new transmission pathway originating north of the City of Greeley and connecting to the bulk transmission system south of the City of Greeley has the potential to impact the TOT 7 path rating. This study considered the potential impacts to the TOT 7 path by monitoring the path power flows for each scenario as well as determining the TOT 7 system operating limits for the base and recommended alternative study models. The studies indicate a new transmission path originating at the Western owned Ault Substation that terminates at the PSCo owned Cloverly Substation has the potential to divert power flow away from the existing TOT 7 pathway through the creation of a new parallel pathway. In this study, approximately 104 MW of power flow was observed to flow along this new pathway, and the system operating limit was increased from approximately 390 MW to approximately 562 MW. The development of this alternative branch may require a redefinition of the TOT 7 path to adequately identify power flow limitations, should any exist in the future.

IV. Methodology

Studies

This study included steady state power flow, and voltage stability analyses. Facility loadings and voltages were monitored within the study area consistent with NERC and WECC standards. Since the transmission plan includes an interconnection to a non-PSCo facility at Ault, additional studies were performed to evaluate the Western owned Ault interconnection and how the project might impact the power flows in and out of the Ault substation.

A benchmark analysis was performed in order to compare alternatives and sensitivities to benchmark conditions. All models were reviewed by the NECO Subcommittee. Once the benchmark case was developed, a steady state power flow and voltage comparison analysis was conducted for various transmission system alternatives developed by the NECO Subcommittee within the identified study area. From this analysis the recommended transmission improvements necessary to satisfy the objectives of increasing the reliability, load serving capability and future resource accommodation of the transmission system that also aligns with other ongoing transmission projects and studies in northeast Colorado were identified.

A sensitivity analysis also consisting of steady state power flow and voltage stability analysis was then performed for scenarios developed and agreed to by the NECO Subcommittee on the

benchmark case and recommended transmission alternative cases. These sensitivities included variations of load, generation, and transmission configurations. Results of the sensitivity analysis were then compared.

In addition to the steady state studies, a voltage stability analysis was performed. This type of study utilized Power – Voltage, or "PV" analysis to determine how much load (power, or "P") could be served before hitting voltage ("V") limitations. These studies were performed using the NECO Subcommittee recommended transmission alternative case to identify the maximum load serving capability of the transmission project.

As a step beyond, voltage stability analysis was also performed on transmission expansions to the recommended alternative. These expansions were suggested by participants of the NECO Subcommittee and included the addition of higher voltages and new 115 kV transmission extending from various portions of the transmission plan to areas of the existing transmission system. Results of this analysis were examined and compared to determine the incremental increases to the load serving capability based on the expansion.

Finally, the system operating limit of the TOT 7 transfer path was determined for the base and recommended alternative models to determine the potential impacts to TOT 7. This was accomplished by increasing generation to the north of the transfer path and decreasing generation to the south of it.

Case Development

The benchmark study model was derived from the CCPG approved 2024hs_r4 case which has been reviewed and approved by members of the CCPG. Participants of the NECO Subcommittee reviewed and provided modifications to the case to accurately reflect the best assumptions of transmission load, generation and topology within the CCPG footprint for the year 2026. Case modifications were provided by Basin Electric, Black Hills, Colorado Springs Utilities, Platter River Power Authority, Tri-State and Western. The derived benchmark case, titled NECO_2026hs_Base Case R4 was approved by the NECO Subcommittee on March 10th, 2016. Studies based on this case included benchmarking and modeling of individual alternatives and sensitivities, using the latest forecasted loads and topology in the study footprint, which were also provided by participants of the NECO Subcommittee.

CCPG Approved Case (PSS/E v33.4.0 Software Format)

- File name: ccpg_2024hs_r4.sav

Derived Benchmark Case (PSS/E v33.4.0 Software Format)

- File name: NECO_2026hs_Base Case R4.sav

System Topology Changes

The following section describes the significant and major transmission topology changes that were included in the benchmark case as provided by PSCo, Basin Electric, Black Hills, Colorado Springs Utilities, Platter River Power Authority, Tri-State and Western based on their review of the case as participating members of the NECO Subcommittee.

Greeley Area 44 kV Transmission System

Included in the benchmark case was the detailed model of the 44 kV transmission system. Typically, the 44 kV transmission system is not modeled in power flow cases due to it being classified as a sub transmission system and operated radially. Instead, the 44 kV system loads are captured by representing them as lumped equivalent loads modeled at each of the three 115/44 kV source substation buses in Greeley (Weld, Greeley and Monfort). These lumped load equivalents represent the radial loads being served from their respective 115 kV source as illustrated above in Figure 3.

Recall from Figure 3 that the Greeley 44 kV system is generally operated as three radial transmission systems served from three 115 kV sources (the Weld, Greeley and Monfort Substations). The addition of the detailed model of this system resulted in the addition of nine (9) 44 kV load serving substations (Ault, Eaton, Continental, Pleasant Valley, Highland, Evans, Monfort, LaSalle and Box Elder) and the subsequent transmission lines between them. A tenth 44 kV substation, Weber, was removed from service and de-commissioned in June of 2015, and its load was electrically transferred to the Greeley 115 kV substation via the distribution system.

The detailed model of the 44 kV system loads assumes a 2% annual growth factor based on the 2014 coincident peak load. A list of these loads and the calculated 2026 loads can be found in APPENDIX B: Calculated 44 kV System Loads.

In addition to the detailed model of the 44 kV system, the 115 kV portion of Tri-State developed Southwest Weld Expansion Project (SWEP) was included in the benchmark case model.

Southwest Weld Expansion Project

The following is from the 10-Year Transmission Plan provided by Tri-State and is found on their website:

> Tri-State is developing the Southwest Weld Expansion Project ("SWEP"), which will initiate the transmission development in the region for serving oil and gas loads. The SWEP consists of 230 kV and 115 kV transmission that begins near Ft. Lupton, Colorado, travels east towards Hudson, and then heads north and ultimately connects to existing transmission a few miles south of Kersey. Tri-State received a CPCN for the project from the CPUC in 2014. Much of the SWEP transmission is planned to be constructed as double-circuit with 230 kV capability, with one circuit initially energized at 115 kV. The SWEP passes near or through Public Service customer service territory, and the Company (Tir-State) has received requests for load interconnections in the area. The SWEP also provides opportunity to link with longer term transmission plans in northeast Colorado. As a result, Public Service plans to participate in SWEP. Tri-State has agreed to Public Service participation at a 40 percent share, and Public Service intends to seek CPUC approval for their participation in 2016. [6]

[6] https://www.tristategt.org/sites/ts/files/PDF/10-year%20transmission%20plan%20filing%20details%20020116/10-year%20transmission%20plan%202016.pdf

The SWEP will consist of a new, double-circuit 230 kV capable transmission line between two new substations, Greenhouse and Milton. The new transmission will initially be operated as single circuit 115 kV and will interconnect with the new proposed Colfer and Rattlesnake Ridge and existing Davis load serving substations. An additional new 115 kV line originating at Greenhouse and connecting to Davis will also be constructed, and the Davis Substation will be removed from PSCo's Ft. Lupton – Hudson 115 kV line. From Milton, The transmission line will extend north to the South Kersey Substation to form a transmission loop. Greenhouse will also interconnect with the Tri-State's JM Shafer facility and the Henry Lake Substation. Figure 9 below shows a diagram of the Study Area with SWEP included.

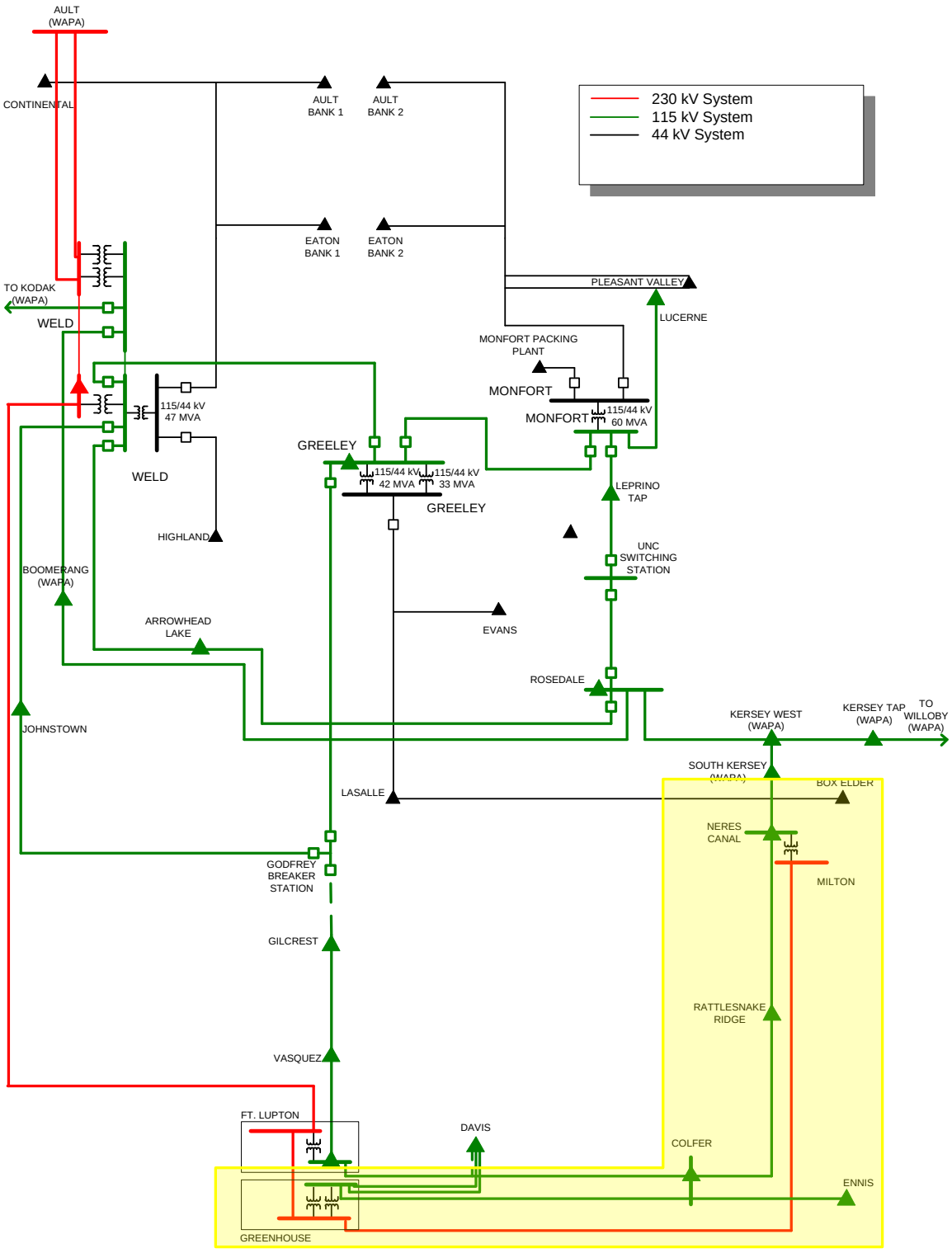

Figure 9: Tri-State Proposed SWEP (Highlighted in Yellow)

The SWEP model, including the 230 kV line, was already part of the CCPG Approved 2024hs case. For the benchmark case, Tri-State requested that only the 115 kV line connecting to the Davis, Colfer, Rattlesnake Ridge and Neres Canal (Milton) Substations be in-service.

Pawnee – Daniels Park 345 kV Transmission Project

While outside the identified Study Area, the Pawnee – Daniels Park 345 kV Transmission Project (In-Service Date 10/1/2019) was also included in the benchmark case to maintain accuracy.

Finally, the following transmission lines and elements were included in the model, but listed as out-of-service for the benchmark scenario:

- SWEP 230 kV transmission line
- New Ault (Husky) 115 kV Substation
- New Eaton (Graham Creek) 115 kV Substation
- Ault – Cloverly 115/230 kV
    - The 115 kV transmission line is modeled out of service for the benchmark model. Upon removal of the northern portion of the Greeley area 44 kV system the line can be switched in-service. Detailed switching instructions were provided to participants of the NECO Study Group and can also be found in APPENDIX C: Detailed Switching Instructions for Removal of the 44 kV System.
    - The proposed future 230 kV expansion on this double-circuit capable transmission line was modeled out of service
- 30 MVAr capacitor bank at New Ault (Husky) Substation
- Rosedale 230 kV Substation
- Beebe Draw 230 kV Substation
- Weld – Beebe Draw – Rosedale 230 kV transmission line
- Rosedale – Milton 230 kV transmission line
- Husky – Rosedale 230 kV transmission line

The purpose of including and modeling these lines as out-of-service is for future analysis using the benchmark case.

Load Modeling

In developing the benchmark model, loads were modified to reflect the latest 2026 heavy summer load forecasts as provided by PSCO, Basin Electric, Black Hills, Colorado Springs Utilities, Platter River Power Authority, Tri-State and Western based on their review of the case as participating members of the NECO Subcommittee.

Greeley Area 44 kV System Model Loads

In the CCPG approved 2024hs case the Greeley area 44 kV system loads were represented as lumped load equivalents at the Weld, Greeley and Monfort Substations. The total lumped 44 kV system load in the case was approximately 84 MW and 8 MVAr (**84.4 MVA**). With the application of the PSCo 2026 heavy summer load forecast modifications, the total lumped 44 kV system load was approximately 99 MW and 19 MVAr (**100.8 MVA**). These lumped loads were changed to 0 in preparation for the addition of the detailed 44 kV model in order to avoid double counting. Table

1 below provides a list of the loads and buses in the Greeley area that were modified from the CCPG approved 2024hs case in preparation for the detailed 44 kV model.

Substation	Approved CCPG 2024HS Case Bus Number	Bus Voltage	CCPG 2024HS Load		PSCo 2026HS Load Forecast		Description
					MW	MVAR	
Greeley 'P1'	70210	44	7.14	1.52	7.17	1.53	Lumped 44 kV load modeled at Greeley 115 kV Sub
Greeley 'P2'	70210	44	7.14	5.69	7.17	5.71	Lumped 44 kV load modeled at Greeley 115 kV Sub
Weld 'P2'	70469	44	37.86	1.12	38.00	1.14	Lumped 44 kV load modeled at Weld 115 kV Sub
Monfort 'P1'	70290	115	31.47	(0.70)	31.59	(0.70)	Lumped 44 kV load modeled at Monfort 115 kV Sub
Monfort 'P2'	70290	115	-	-	-	-	
Monfort 'IN'	70290	115	-	-	14.78	11.46	Lumped 44 kV load for Monfort Packing Plant
Total			83.62	7.63	98.71	19.14	

Table 1: Removal of the Lumped 44 kV System Loads

The loads for the detailed Greeley area 44 kV system were derived from the 2014 Greeley area coincident peak which occurred on July 22nd, 2014 at 17:00 hours. At the time of this analysis, the 2014 coincident peak data was the most recent loading data available. The 2014 coincident peak for the Greeley area 44 kV system showed approximately 84 MW and 25 MVAr (**87.6 MVA**) being served by the 44 kV transmission system. This total included the Weber Substation which was removed from service and de-commissioned in June of 2015, and its load electrically transferred to the Greeley 115 kV Substation via the distribution system. Because of this, the Weber Substation load is assumed to be represented at the Greeley 115 kV Substation as part of the PSCo 2026 load forecast in the 2026 load model.

A 2% annual growth factor was used to estimate the 2026 heavy summer loads. The total load modeled for the Greeley area 44 kV system in the detailed 2026 heavy summer model was approximately 97 MW and 27 MVAr (**100.7 MVA**). This total does not include the 2018 planned 6.5 MW expansion the Monfort Packing Plant outlined in the Retail Customer Load Requests section. When considering this load, the total load modeled for the Greeley area 44 kV system is approximately 104 MW and 32 MVAr (**108.8 MVA**). Table 2 below shows a list of the detailed Greeley area 44 kV system loads based on the 2014 coincident peak as well as the assumed 2026 heavy summer loads as calculated using a 2% annual growth factor. More detail is also provided in APPENDIX B: Calculated 44 kV System Loads.

Substation	Approved CCPG 2024HS Case Bus Number	Benchmark 2026 Case Bus Number	SCADA 2014 Peak Load		2026 Forecast Assumptions		Benchmark 2026 Case Load Additions		Comments
			MW	MVAR	MW	MVAR	MW	MVAR	
44 kV System									
Continental	N/A	70803	1.95	0.77	2.47	0.98	2.47	0.98	Customer has requested facility to remain on the 44 kV system.
Ault 1	N/A	70810	1.66	0.57	2.11	0.72	2.11	0.72	
Ault 2	N/A	70808	3.70	1.16	4.69	1.47	4.69	1.47	
Eaton 1	N/A	70819	5.06	0.98	6.42	1.24	6.42	1.24	
Eaton 2	N/A	70817	10.37	1.33	13.15	1.69	13.15	1.69	
Pleasant Valley 1	N/A	70838	14.63	2.32	18.55	2.94	18.55	2.94	
Highland	N/A	70875	9.80	0.31	12.43	0.39	12.43	0.39	
Evans	N/A	70877	12.26	3.88	15.55	4.92	15.55	4.92	
Weber	N/A	N/A	4.80	1.81	6.09	2.30	-	-	Retired. Assume load moved to Greeley 115 kV substation as part of 2026 forecast
LaSalle	N/A	70865	4.47	0.52	5.67	0.66	5.67	0.66	
Box Elder	N/A	70870	2.29	1.25	2.90	1.59	2.90	1.59	
Monfort	70290	70845	13.04	10.01	20.00	15.20	20.00	15.20	Customer has requested facility to remain on the 44 kV system. Phase II 6.5 MW expansion ISD 2018 included.
Total			84.03	24.91	110.03	34.10	103.94	31.80	

Table 2: Addition of Detailed Greeley Area 44 kV System Loads

Retail Customer Load Requests

PSCo has received a multitude of large, single customer, transmission load interconnection service requests from potential retail oil and gas customers. These facilities are typically large in demand size (ranging from a few to several hundred megawatts) and require continuous operation.

As agreed by the NECO Subcommittee, the benchmark case does not take into consideration the addition of any PSCo retail load interconnection requests other than those that already have a signed electric service agreement (ESA) with PSCo. Rather, the inclusion and impacts of these loads were evaluated in a high load sensitivity analysis.

Retail loads that were added to the benchmark case include the following:

- A 6.5 MW expansion was added to the existing 13.5 MW Monfort Packing Plant load located on the 44 kV system. This load represents the planned facility expansion request received by PSCo and scheduled to be in-service by 2018.
- A 20 MW load at a new Cloverly Substation, and subsequent 2 mile 115 kV transmission line connecting it to the existing Lucerne load tap location. This load represents the addition of an oil and gas customer that has a signed electric service agreement (ESA) with PSCo and whose facility went into service in the second quarter of 2016. As part of the PSCo 2026 heavy summer load forecast, this 20 MW load was modeled at the Monfort Substation ('PS'). The Monfort representation of this load was removed from the case.
- The Leprino load was increased from 9.78 MW to 15 MW to represent the full output of the facility.

SWEP Loads

Also agreed upon by the NECO Subcommittee, two load levels were provided by Tri-State for this study; low oil (198 MW) and high oil (288 MW). Tri-State requested, and the NECO Subcommittee agreed, that the low oil scenario be used for the benchmark case, while the high oil scenario be used for the high load sensitivity. The main difference between the two scenarios is an increase of load at the Davis, Colfer, Rattle Snake Ridge and Neres Canal (Milton) Substations as well as the addition of the Greenhouse – Milton 230 kV line. The SWEP and loads were already included in

the CCPG Approved 2024hs case model. A breakdown between the SWEP loads in the CCPG Approved case and the benchmark case can be seen in Table 3 below:

	Bus Number	CCPG 2024HS R4 Case		NECO 2026HS R4 Case (Benchmark)	
		MW	MVAr	MW	MVAr
SWEP		**350.8**	**115.2**	**198**	**65.08**
Neres Canal (Milton)	72226	50	16.4	18	5.92
Rattle Snake	72222	115.4	37.9	40	13.15
Colfer	72218	72.7	23.9	30	9.86
Davis	72221	112.7	37	110	36.15

Table 3: SWEP Case Loads

Finally, the following loads were included in the model, but listed as out-of-service for the benchmark scenario:

- New Ault (Husky) 115 kV – This load represents the conversion of the existing Ault and Cloverly 44 kV loads to a new 115 kV system.
- New Eaton (Graham Creek) 115 kV – This load represents the conversion of the existing Eaton 44 kV loads to a new 115 kV system.
- Cloverly 115 kV – This load represents the conversion of the existing Pleasant Valley 44 kV loads to a new 115 kV system.
    - The 115 kV transmission line is modeled out of service for the benchmark model. Upon removal of the northern portion of the Greeley area 44 kV system the line can be switched in-service. Detailed switching instructions were provided to participants of the NECO Subcommittee and can also be found in APPENDIX C: Detailed Switching Instructions for Removal of the 44 kV System.
- Beebe Draw 230 kV – This load represents the conversion of the existing LaSalle 44 kV load to a new 230 kV system.
- Arrowhead Lake 115 kV 'P2' – This load represents the conversion of the existing Evans and Highland 44 kV loads to the existing Arrowhead Lake Substation.
- New Box Elder 115 kV – This load represents the conversion of the existing Box Elder 44 kV load to a new 115 kV system.

The purpose of including and modeling these loads as out-of-service is for future analysis using the benchmark case.

Generation Modeling

Generation in the benchmark case was only changed in accordance with updates provided by Basin Electric, Black Hills, Colorado Springs Utilities, Platte River Power Authority, Tri-State and Western based on their review of the case as participating members of the NECO Subcommittee. Outside of the provided changes, area swing generation units were allowed to adjust

automatically based on the load. Best efforts were given to ensure unit generation was modeled as physically possible and economically reasonable.

At the time of this study, announcement of the retirement of Craig Unit 1 had not been made; therefore Craig Unit 1 is included in the benchmark case model. However, sensitivity studies were conducted to determine the impact of the retirement of this unit and are discussed in the Sensitivity Analysis section.

For the benchmark case model the power flows across TOT 3 and TOT 7 were 669.5 MW and -34.0 MW respectively. Typically TOT 3 and TOT 7 power flows are approximately 1200 MW and 500 MW respectively. At these typical levels, the power flows represent a general north to south direction through the region. This is due to resources in Wyoming, such as Laramie River Station (LRS), and northern Colorado, such as Fort St. Vrain (FSV), delivering their energy to Denver-metropolitan area loads. A sensitivity analysis was conducted to determine the impacts to the regional transmission system at these higher TOT levels and is also discussed in the Sensitivity Analysis section.

A detailed list of the generation in Areas 70 and Area 73 in the benchmark case model can be found in APPENDIX D: Benchmark Generation Tables.

Line Ratings

Line ratings were added to each branch of the detailed Greeley area 44 kV model. A list of these ratings can be found in APPENDIX E: Line Ratings for the 44 kV Transmission System. All other line ratings in the study utilize the line ratings provided in the CCPG Approved 2024hs case model or ass otherwise specified and provided by participating members of the NECO Subcommittee.

Criteria

As a general rule, the following system parameters were monitored during the study and are tabulated in this report as needed:

1. All buses, lines, and transformers with base voltages equal to or greater than 44 kV in the Colorado power flow Areas 70 and 73 were monitored in all study cases.
2. Post contingency element loadings were only tabulated when an element rating was exceeded and the loading increase was at least 1% from the normal system loading. Specifically, if an element was overloaded in the normal condition and increased no more than 1% in the outage condition, the overload was not reported.
3. Post contingency voltage violations were tabulated only if the deviation was more than 0.08 p.u. from the normal system voltage or higher if allowed by local criteria. Base case and contingency low voltage violations were determined, however contingency voltage violations were ignored if voltage changes were less than 0.08 p.u.
4. Transient and voltage stability criteria will be provided by the Study Group.

The NECO Subcommittee adhered to the following criteria for these load flow studies:

- **Category P0 – System Normal**
  "N-0" System Performance Under Normal (No Contingency) Conditions

NERC Standard TPL-001-4

Voltage:	0.95 to 1.05 per unit
Line Loading:	100 percent of continuous rating
Transformer Loading:	100% of highest 65 °C rating

Manual or automatic system adjustments such as shunt capacitor or reactor switching, generator scheduling, or LTC tap adjustment are allowed. Area interchanges and phase shifter adjustments are allowed.

- **Category P1 – Loss of generator, line, or transformer (Forced Outage)**
  "N-1" System Performance Following Loss of a Single Element
  NERC Standard TPL-001-4

Voltage:	0.90 to 1.10 per unit
Line Loading:	100 percent of continuous rating.
Transformer Loading:	115% of highest 65 °C rating (for load-serving xfmr's)

Manual system adjustments such as generation dispatch will not be allowed. Area interchange adjustments will not be allowed. Adjustments of shunt capacitors or reactors, phase shifting transformers and load tap changing (LTC) transformers will not be allowed.

- **Category P2 – P7 – Multiple contingency outages**
  Multiple contingency outages – Refer to the NERC contingency table in Reliability Standard
  NERC Standard TPL-001-4

Voltage:	0.90 to 1.10 per unit
Line Loading:	100 percent of continuous rating.
Transformer Loading:	115% of highest 65 °C rating (for load-serving xfmr's)

Manual system adjustments such as generation dispatch will not be allowed. Area interchange adjustments will not be allowed. Adjustments of shunt capacitors or reactors, phase shifting transformers and load tap changing (LTC) transformers will not be allowed.

V. Studies

Alternatives

In order to achieve the key objective of eliminating the existing, antiquated and non-standard, 44 kV system, and replacing it with higher voltage transmission facilities, the NECO Subcommittee was limited in potential transmission alternatives. Nevertheless, the Subcommittee developed and discussed multiple transmission alternatives to try and satisfy the study objectives of

eliminating the 44 kV transmission system, ensuring system reliability, and providing flexibility to accommodate future load growth and beneficial resource development while aligning with other ongoing transmission projects and studies in the northeastern Colorado area.

Alternatives Considered but Eliminated prior to the Technical Study Process

Below is a list of the transmission alternatives that were considered by the NECO Subcommittee, but were not evaluated through the technical study process and discussion as to why they were eliminated as potential alternatives:

1. Closing the Normal Open Elements on the Existing 44 kV System:
   This alternative explored the option of looping the existing 44 kV transmission system together by closing necessary normal open elements on the system. The alternative was eliminated because when the normally open switches are closed on the 44 kV system to form a looped configuration, two electrically continuous loops are formed, one in the north and the other in the south. With this alternative, due to the absence of circuit breakers at all of the 44 kV substations except for the three sources; Weld, Greeley and Monfort, the risk of de-energizing the 44 kV system increases from one-third (1/3) to one-half (1/2) each time there is an equipment failure or line fault in either system loop, thereby reducing the reliability of the system. Furthermore, the creation of the looped system does not increase the load serving capability of the 44 kV transmission system, as it would still limited to approximately **107 MVA** by the 115/44 kV transformers at Weld and Monfort with the loss of the Greeley – Greeley Tap 44 kV line. Finally, looping the transmission system does not address the reliability of the aging and outdated infrastructure, nor does it allow for the accommodation of future resources. As such, this alternative was eliminated due to its inability to satisfy the objectives of the study.

2. Rebuilding the Existing 44 kV System to 115 kV:
   This alternative explored upgrading the existing 44 kV transmission system to a 115 kV system. While this alternative would improve the load serving capability, it would not address the reliability issues of the radial 44 kV system unless each new 115 kV substation was constructed with circuit breakers and tied together as a looped system. Additionally, it was determined that there was insufficient right-of-way available in the existing 44 kV corridor for new 115 kV construction so the lines would need to be relocated. Finally, upgrading the 44 kV system would require more transmission than constructing new transmission that connected in the north and terminated at Cloverly. Therefore, this alternative was eliminated based on the need for more transmission which would lead to higher costs.

3. Upgrading the 230/115 kV transformers at the Weld Substation:
   This alternative explored upgrading the three 230/115 kV transformers at the Weld Substation. While this alternative potentially increases the reliability and load serving capability of the 115 kV system in the Greeley area, it does not address the reliability issues or load serving capability of the existing 44 kV system north of Greeley.

4. Upgrading the 115/44 kV transformers Sourcing the 44 kV Transmission System:

This alternative explored upgrading the three 115/44 kV transformers at the 44 kV transmission source substations; Weld, Greeley and Monfort. This alternative would potentially increase the transformation capacity of the source substations; however, it fails to address the reliability issues of the existing 44 kV system north of Greeley. Furthermore, the 44 kV systems load serving capability would still be limited by the low capacity of the 44 kV transmission lines.

5. Interconnecting a New Transmission Line North or South of the Ault Substation:
   This alternative explored terminating a new transmission line to the north or south of the Western owned Ault Substation that would ultimately connect to the existing Greeley area 115 kV transmission system. While this would be similar to the proposed alternative, which would terminate a new transmission line at the Ault Substation, this alternative would require a new line tap or substation to be constructed. Because of this, the alternative was eliminated based on the likelihood for higher costs than terminating a new transmission line at the existing WAPA Ault Substation.

6. Interconnecting a New Transmission Line on the LRS – Story 345 kV Line:
   Also similar to interconnecting a new transmission line to the north or south of the Ault Substation, this alternative explored terminating a new transmission line on the LRS – Story 345 kV transmission line that would ultimately connect to the existing Greeley area 115 kV transmission system. While this alternative would improve the load serving capability and potentially allow for the interconnection of resources, it does not address the reliability issues of the existing 44 kV system north of Greeley. This is because the new transmission line would be located much further east in order to connect to the LRS – Story line, and routing it through northern Greeley where the existing 44 kV transmission system is located would not be practical. Also, this alternative would again require a new line tap or substation to be constructed along the LRS – Story line, which would increase project costs. This alternative was eliminated based on its inability to meet the reliability objectives and due to the likelihood for higher project costs associated with a new termination at a location other than the Ault Substation.

7. Utilizing the Cedar Creek – Rocky Mountain Energy Center (RMEC) 230 kV line:
   This alternative explored using the Cedar Creek – RMEC 230 kV line. This line is a privately owned, radial, generation tie line that connects the Cedar Creek Wind Farm to the RMEC Substation and is rated for the output capacity of the wind farm. It is located on the eastern side of the Study area, and east of the existing 44 kV transmission system. While the line could potentially serve new load interconnection requests, dues to its location and configuration, the line does not improve the reliability of the transmission system or allow for the removal of the existing 44 kV transmission system. Furthermore, there is no additional capacity available on the line to accommodate potential new generation resources. This alternative was eliminated based on its inability to meet all the study objectives.

Alternatives Evaluated through the Technical Study Process

Alternatives were developed and agreed to by the NECO Subcommittee based on their potential ability to satisfy the study objectives of improving the reliability, load serving capability, resource accommodation and aligning with other ongoing transmission projects and studies in the northeast Colorado area. Table 4 below lists the developed transmission alternatives that were included in the Study Scope:

Case Label	Alternative No.	Description
0-01		Benchmark
1-01	1	Ault - New Ault (Husky) 230 kV line and New Ault (Husky) - New Eaton (Graham Creek) - Cloverly 115 kV line
2-01	2	Alternative 1 plus New Eaton (Graham Creek) – Weld 115 kV line
3-01	3	Alternative 1 plus New Eaton (Graham Creek) – Greeley 115 kV line
4-01	4	Greeley South Substation located near the existing Arrowhead Lake substation
5-01	5	Non transmission alternatives (local area generation)

Table 4: Study Alternatives List

Alternative 1: Construct a new Ault – New Ault (Husky) 230 kV transmission line, approximately 6.5 miles in length and a new New Ault (Husky) – New Eaton (Graham Creek) – Cloverly 115 kV line, approximately 19 miles in length. Both segments will be constructed as double-circuit capable, however the Ault – New Ault (Husky) 230 kV line will initially be operated as single-circuit 230 kV and the New Ault (Husky) – New Eaton (Graham Creek) – Cloverly 115 kV line will initially be operated as single-circuit 115 kV. This alternative requires a new 230 kV termination at Western's Ault Substation, the construction of two new distribution substations (New Ault (Husky) and New Eaton (Graham Creek)) and the expansion of the existing Cloverly Substation

Alternative 2: Starting with Alternative 1, construct a new, single-circuit, New Eaton (Graham Creek) – Weld 115 kV line, approximately 12 miles in length.

Alternative 3: Starting with Alternative 1, construct a new, single-circuit, New Eaton (Graham Creek) – Greeley 115 kV line, approximately 10 miles in length.

Alternative 4: Construct a new Greeley South Substation located near the existing PSCo Arrowhead Lake Substation. At this new substation location, construct new terminations for the existing PSCo Arrowhead Lake – Rosedale and Godfrey – Greeley 115 kV lines and the Western Boomerang – Rosedale 115 kV line.

Alternative 5: Interconnect and energize local area natural gas fired generation. Two facilities were identified that could be studied for this alternative; the University of Northern Colorado (UNC) facility (69 MW) and the Thermo Monfort facility (32 MW). The power purchase agreements for both facilities have expired and neither facility is currently generating power for

the transmission system. Based on the size and age of the facility, the NECO Subcommittee decided to study only the use of the UNC generation facility.

Benchmark and Selected Alternatives Analysis
Steady state power flow and voltage comparison analysis were conducted for the developed benchmark case and for select transmission system alternatives developed and agreed to by the NECO Subcommittee within the identified study area.

Steady State Power Flow and Voltage Analysis
The benchmark and alternative studies focused on the North American Electric Reliability Corporation (NERC) Category P0 (system intact, N-0) and NERC Category P1 (single contingency, N-1) performance. Eight selected NERC Category P2 through P7 disturbances were also performed. The selected NERC Category P2 through P7 are listed below:

- Weld - Boomerang - Rosedale 115 kV common tower outage (breaker to breaker)
- Ault - Weld 230 kV common tower outage
- Weld LM 115 kV bus fault (breaker to breaker for Weld - Boomerang - Rosedale 115 kV)
- Monfort 115 kV main bus fault
- PSCo 230/115 kV transformer failure followed by breaker 5221 failure at Weld
- Breaker 2186 failure at Ault
- Loss of the Windsor 230 kV substation (breaker to breaker)
- Breaker failure at Greeley 115 kV (loss of Weld – Greeley and Godfrey – Greeley 115 kV lines)

A detailed list of the contingency files can be found in APPENDIX F: Steady State Power Flow and Voltage Automation Files.

Studies monitored loading and voltages on elements within Areas 70 and 73, consistent with NERC, WECC, and PSCo standards and criteria as outlined in the study methodology. Special attention was paid to the power flows in and out of Western's Ault Substation. For all contingency analyses the following solution parameters were selected:

- Tap Adjustment - Lock Taps
- Area Interchange Control - Off
- Switched Shunt Adjustments - Lock All
- Non-divergent solution selected
- Adjust DC taps
- Solution Engine - Full Newton-Raphson

The subsystem and monitor files can also be found in APPENDIX F: Steady State Power Flow and Voltage Automation Files.

Results of the alternative scenarios were compared side-by-side with the benchmark case and pre-existing thermal and voltage violations falling within the study methodology criteria were excluded from the tabulated results to avoid them from being attributed to the alternatives examined.

At the July 29th, 2016 NECO Subcommittee meeting, NECO participants decided Alternative 4-01 was outside the scope of study, thus Alternative 4-01 is not tabulated in the tables below.

Based on the benchmark and alternative analysis, the recommended transmission improvements necessary to satisfy the objectives of increasing the reliability, load serving capability and future resource accommodation of the transmission system that also aligns with other ongoing transmission projects and studies in the Greeley area were identified.

All studies were performed through the NECO Subcommittee of the CCPG with PSCo acting as the study facilitator. Steady state power flow and voltage analysis was performed using Siemen's PSS/E v33.4.0 software.

Tabulated Study Results

Tables for the steady state power flow results can be found in APPENDIX G: Steady State Power Flow Results Tables. Similarly, the tables for the steady state voltage results can be found in APPENDIX H: Steady State Voltage Results Tables.

Steady State Analysis Summary

From the steady state power flow and voltage study results, the Monfort 115/44 kV 60 MVA transformer is loaded to 105.4% of its thermal limit under system intact (N-0) conditions in the benchmark case and 105.2% of its thermal limit under system intact conditions in Alternative 5. Alternatives 1 – 3 mitigate this overload for both system intact and single contingency scenarios, however, the transformer loading is increased to 107.1% of its thermal limit for the single contingency of the Pleasant Valley Tap in Alternative 5.

Additionally, the Weld 230/115 kV 150 MVA transformers #1 and #3 are loaded to 115.5% and 111.5% of their thermal limit respectively for the single contingency of the Weld 230/115 kV 280 MVA transformer #2 in the benchmark case. Again, Alternatives 1 – 3 mitigate this overload, however the Weld 230/115 kV 150 MVA transformer #1 is still loaded to 102.2% of its thermal limit for Alternative 5.

The Monfort – Leprino, Rosedale – UNC, Rosedale – Kersey West, UNC – Leprino, Airport – Boyd, Airport – Windsor, Kersey Tap – Willoby, Weld – Boomerang, Weld – Whitney, and Windsor - Whitney 115 kV lines as well as the Monfort 115/44 kV 60 MVA and Weld 230/115 kV 280 MVA transformer #2 were all loaded beyond their thermal limits in the benchmark case for select multiple contingency outages. While Alternative 5 was able to mitigate some of these overloads, Alternatives 1 and 2 were able to mitigate all except for the Airport – Boyd 115 kV line overload. Additionally, Alternative 3 was able to mitigate all overloads except for the Airport – Boyd 115 kV line, and the New Ault (Husky) – New Eaton (Graham Creek) 115 kV line.

From the steady state voltage analysis, only Alternatives 1 – 3 mitigate the voltage violations observed in the benchmark case for both single and multiple contingencies.

Recall that due to its configuration, the 44 kV system is currently limited to serving approximately 95 MVA of load. Assuming a 2% annual retail load growth and the planned 6.5 MW expansion of the Monfort Packing Plant (2018), the 44 kV system load will be approximately 109 MVA by 2026; beyond the system's capability. At this point, the 44 kV system will have reached its ability to support an annual 2% retail load growth, and the interconnection of single, large load, retail Customers will not be feasible. It is anticipated that the system will no longer be able to support retail load growth by 2018 without significant transmission upgrades.

Based on the results of the steady state power flow and voltage study analysis, Alternatives 1, 2 and 3 satisfy the objectives of ensuring system reliability, providing the flexibility to accommodate future load growth and generation resources while aligning with other ongoing transmission projects and studies in the northern Colorado area and also eliminate portions of the 44 kV system. Section VII (Voltage Stability Analysis) indicates that there could be at least a 120 MW improvement in load-serving capability. Both Alternatives 2 and 3 are expansions of Alternative 1, and are therefore not economically feasible to be the lowest cost option, and as such were not selected as the preferred solution. Nevertheless, these can be added to Alternative 1 in the future, should the need arise.

Alternative 4 was determined to be outside the scope of study by the study group participants at the July 29th, 2016 NECO Subcommittee meeting. Even though Alternative 4 does potentially provide future reliability improvements to the Greeley 115 kV system, it fails to satisfy the reliability and load serving capabilities of the 44 kV system, and does not allow for load growth north of Greeley. Therefore Alternative 4 was eliminated as the preferred solution.

While the local generation added in Alternative 5 helps to increase the reliability and load serving capability of the existing 115 kV system in Greeley, it does not address one of the key objectives of the study, the reliability issues or load serving capabilities of the 44 kV system. This is due not only in part to the radial configuration of the 44 kV system, but also to the 115 kV point of interconnection to the transmission system. Because of its limitation to satisfy the objectives of the study, Alternative 5 was not selected as the preferred solution.

In order to adequately satisfy the outlined objectives; ensure system reliability, provide flexibility to accommodate future load growth and allow beneficial resource development while aligning with other ongoing transmission projects and studies in the northeast Colorado area and eliminate portions of the antiquated 44 kV system, the NECO Subcommittee proposes to construct Alternative 1 as the preferred Northern Greeley Area Transmission Plan.

In addition to providing the capability to serve the Customer load request, Alternative 1 aligns with the Tri-State proposed SWEP by beginning to extend interconnected, higher voltage transmission north of the City of Greeley. This provides additional transmission sources and upgraded voltages to increase capacity, load-serving capability and resource accommodation north of Greeley which facilitates the long-range transmission plans in northeastern Colorado, and can potentially interconnect to future transmission expansion projects that will be studied starting in 2017.

Recommended Project Plan (Alternative 1: Northern Greeley Area Transmission Plan)

Detailed Northern Greeley Area Transmission Plan Description

This project consists of approximately 21 miles of new 230/115 kV transmission, and three new substations in order to increase reliability, load-serving capability and resource accommodation both in and northeast of Greeley. The transmission will originate from the existing Western Area Power Administration (Western) Ault Substation and ultimately terminate at the PSCo Cloverly Substation, adjacent to the existing PSCo Pleasant Valley Substation. Besides terminating at the Cloverly Substation, the transmission will interconnect with two new substations. The first is referred to as "Husky" formerly "New Ault", and is planned to be built near the existing PSCo Ault 44 kV substation. The second is referred to as "Graham Creek" formerly "New Eaton" and is planned to be built near the existing PSCo Eaton 44 kV Substation. The transmission will be built to allow for future double-circuit, 230 kV operation, but will initially be operated as a single-circuit.

Below is a list of the transmission segments of the proposed Northern Greeley Area Transmission Plan:

Transmission:

1. **Ault – New Ault (Husky) 230 kV line:** A new transmission line would be built from the Western Ault Substation to the New Ault (Husky) Substation, which would be located near the existing PSCo Ault 44 kV Substation. This transmission line would be approximately 6.5 miles long and built double-circuit 230 kV capable. Only one circuit would initially be installed and operated at 230 kV.
2. **New Ault (Husky) – New Eaton (Graham Creek) 115 kV line:** A new transmission line would be built from the New Ault (Husky) Substation to the New Eaton (Graham Creek) Substation, which would be located near the existing PSCo Eaton 44 kV Substation. This transmission line would be approximately 7 miles long and built double-circuit 230 kV capable. Only one circuit would initially be installed and operated at 115 kV.
3. **New Eaton (Graham Creek) – Cloverly Tap 115 kV line:** A new transmission line would be built from the New Eaton (Graham Creek) Substation to the Cloverly Tap location (currently Pleasant Valley Tap), the location of the existing double-circuit 44 kV line to the Pleasant Valley 44 kV Substation. This transmission line would be approximately 7.5 miles long and built double-circuit 230 kV capable. Only one circuit would initially be installed and operated at 115 kV.
4. **Cloverly Tap – Cloverly 115 kV line:** From Cloverly Tap, utilize the existing 2.5 miles of 115 kV capable structures (presently strung and operated at 44 kV). Jumper the existing 0.75 miles of 44 kV transmission conductor between Cloverly Tap and the DCP Lucerne 2 Tap, forming a two-conductor bundle. From DCP Lucerne 2, reconductor the existing northern 44 kV transmission line to complete the 115 kV circuit into Cloverly Substation which is located adjacent to the existing PSCo Pleasant Valley 44 kV Substation. From Cloverly Substation, reconductor the existing southern 44 kV transmission line to the DCP Lucerne 2 location as scoped in the Rimrock – Blue Grama Project.

Substations:

1. **New Ault (Husky) Substation:** A new substation would be built at a location near the existing PSCo Ault 44 kV Substation. The substation needs to accommodate 230 kV, 115 kV, and 44 kV terminations and equipment, including:
    a. A new 230/115 kV, 280 MVA autotransformer (allow space for one more)
    b. A single 115/44 kV, 60 MVA autotransformer (can use existing system spare)
    c. A new 115/12.47 kV, 50 MVA distribution transformer (allow space for two more)
    d. termination equipment for the 230 kV line to the Western Ault substation
    e. termination equipment for the 115 kV line to Graham Creek Substation
    f. termination equipment for the 44 kV line to Continental Substation
    g. A new 115 kV – 30 MVAr Capacitor bank with two steps of 15 MVAr for voltage regulation
    h. miscellaneous substation equipment associated with protection, communication, etc.
    i. Enough land to accommodate the ultimate configuration (6 – 230 kV termination, 8 – 115 kV terminations, 2 – 44 kV terminations)
2. **New Eaton (Graham Creek) Substation:** A new substation would be built at a location near the existing PSCo Eaton 44 kV Substation. The substation needs to accommodate 115 kV terminations and equipment, including:
    a. A new 115/12.47 kV, 50 MVA distribution transformer (allow space for two more)
    b. termination equipment for the 115 kV line to the Husky Substation
    c. termination equipment for the 115 kV line to Cloverly Substation
    d. miscellaneous substation equipment associated with protection, communication, etc.
    e. Enough land to accommodate the ultimate configuration (6 – 115 kV terminations)
3. **Cloverly Substation:** Expand the existing Cloverly Substation located adjacent to the existing PSCo Pleasant Valley 44 kV Substation. The substation needs to accommodate 115 kV terminations and equipment, including:
    a. A new 115/12.47 kV, 50 MVA distribution transformer (allow space for two more)
    b. termination equipment for the 115 kV line to the Graham Creek Substation
    c. termination equipment for the 115 kV line to Monfort Substation
    d. termination equipment for the 115 kV line to the retail Customer (Rimrock – Blue Grama) – in-service by Q4 2016
    e. miscellaneous substation equipment associated with protection, communication, etc.
    f. enough land to accommodate the ultimate configuration (8 – 115 kV terminations)

Figure 10 below shows a map of the proposed Northern Greeley Transmission Plan, and Figure 11 shows the Cloverly Tap – Clovely segment in greater detail.

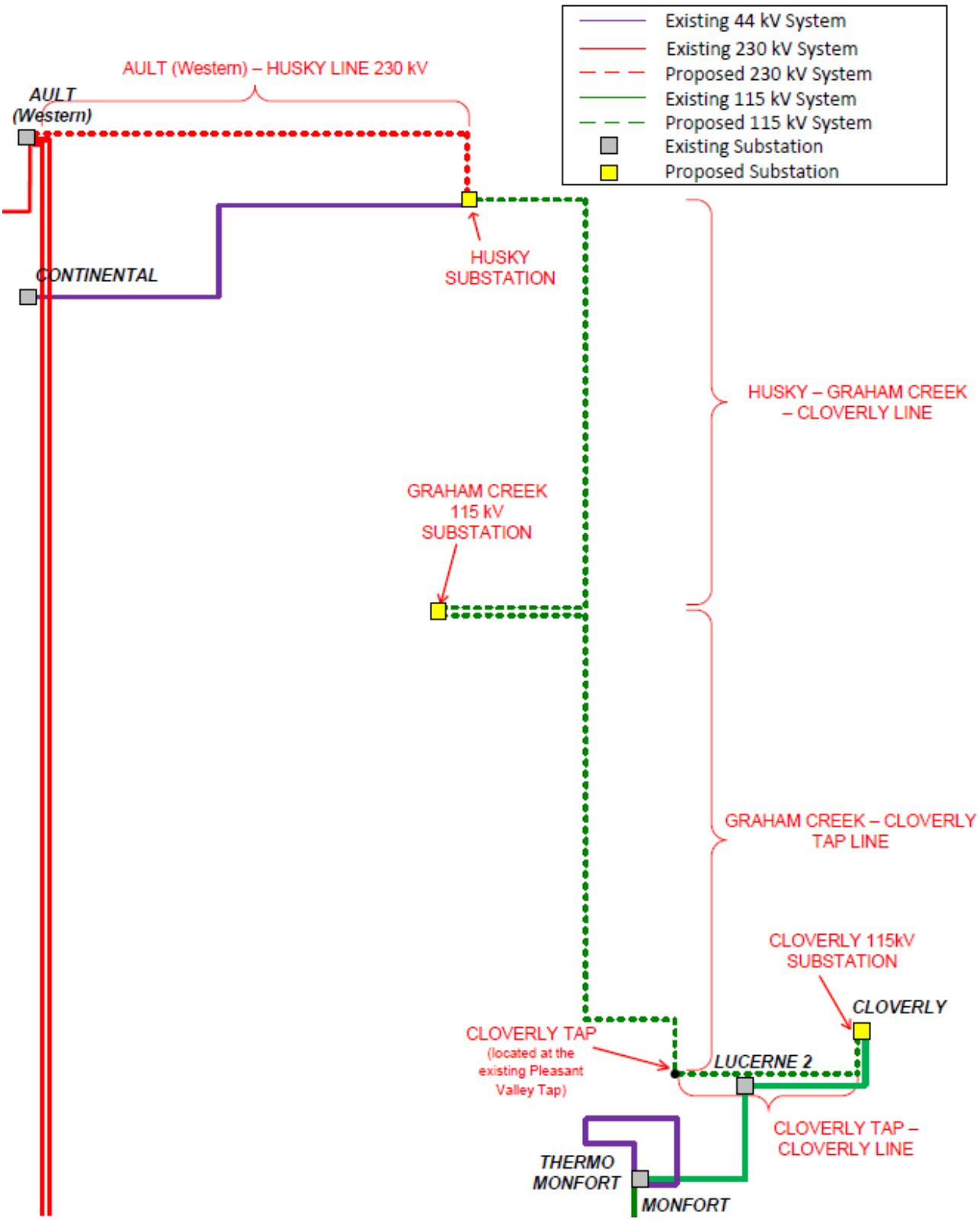

Figure 10: Northern Greeley Transmission Plan

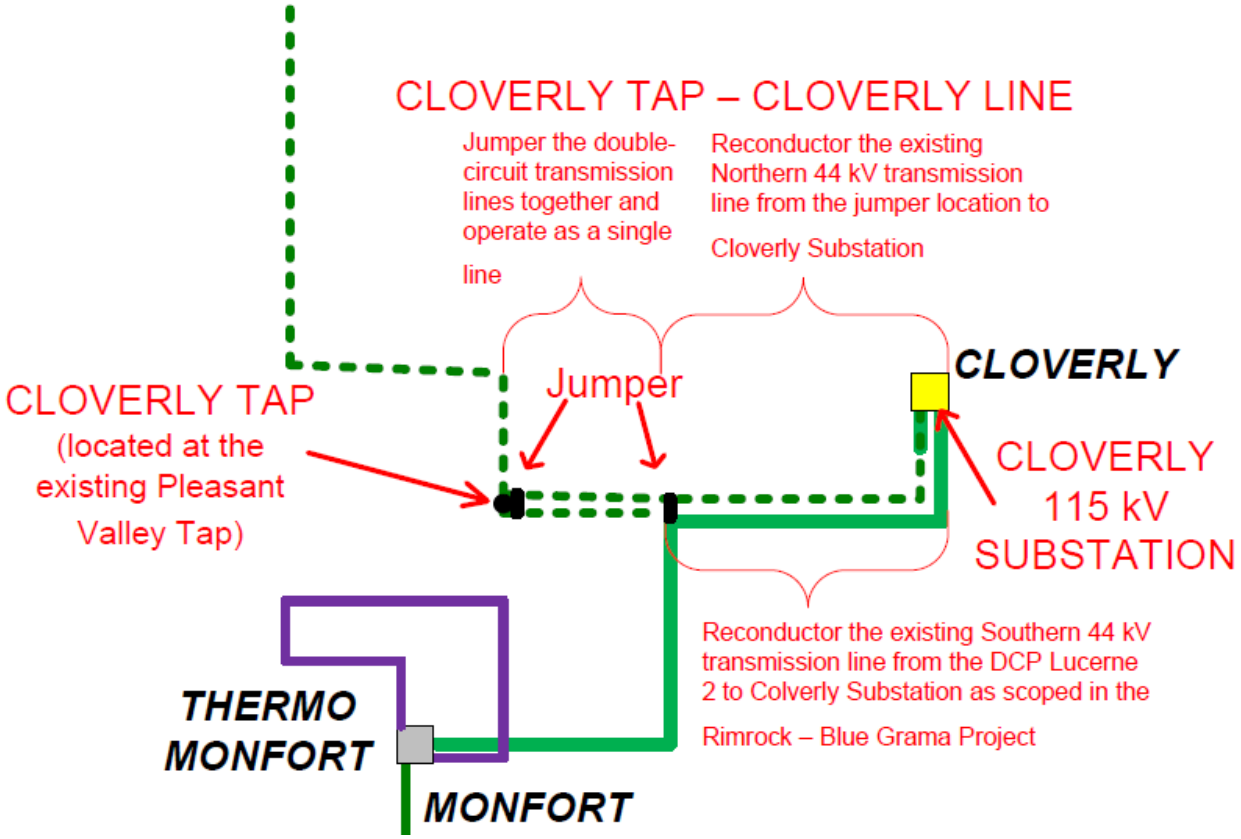

Figure 11: Cloverly Tap – Cloverly Detail

The result of Northern Greeley Area Transmission Plan effectively increases the load-serving capability of the transmission system north of the City of Greeley as well as upgrades the exiting 44 kV system to 115 kV, allowing for the transfer of existing radially served 44 kV retail customers to a more reliable interconnected (looped) 115 kV system.

The preliminary estimated transmission costs for the Northern Greeley Area Transmission is $64.5 million dollars. Table 5 below provides a breakdown of the estimated transmission costs.

GAP-North	TAM
LAND	$ 497,293
LINE	$ 36,881,833
ROW	$ 2,892,032
SUB	$ 24,248,106
Grand Total	**$ 64,519,264**

Table 5: Transmission Costs for the Northern Greeley Area Transmission Plan

Figure 12 shows a side-by-side comparison of the transmission in the Greeley Area before and after the addition of the Northern Greeley Area Transmission Plan.

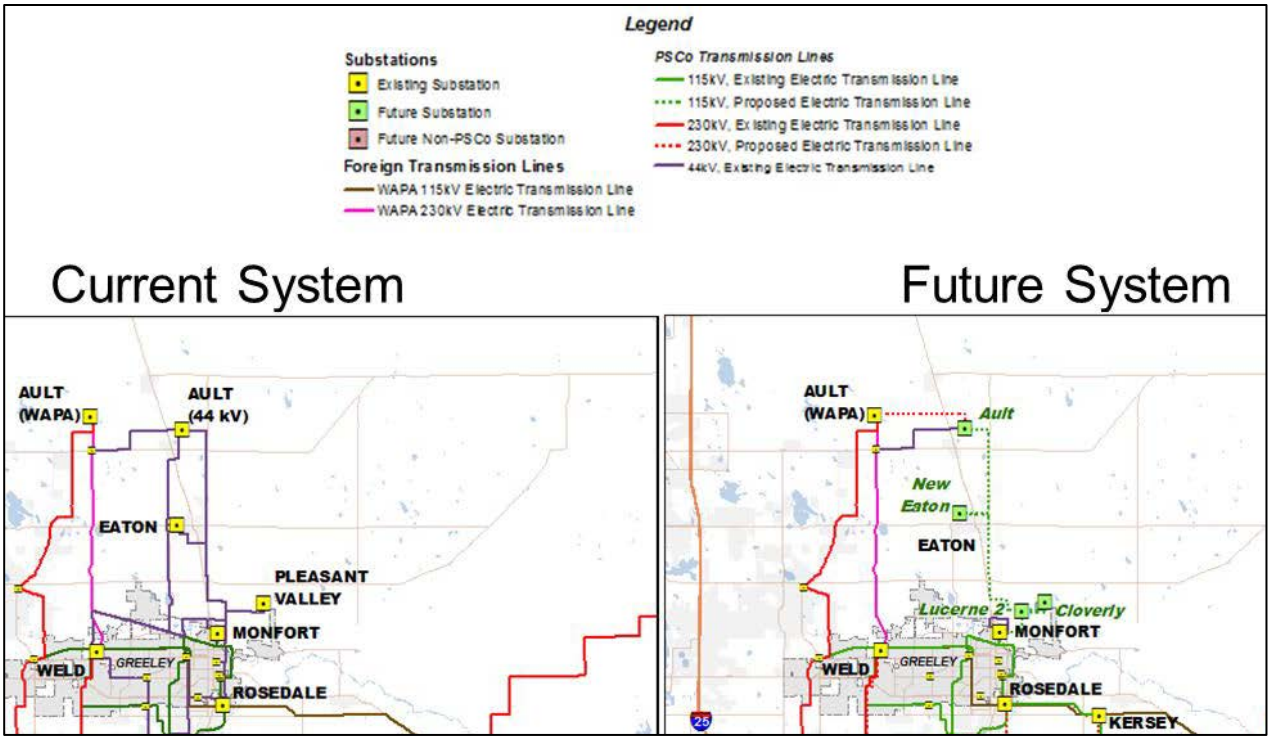

Figure 12: Side-by-Side Comparison of Northern Greeley Transmission

In addition to increasing the load serving capability, the project aligns with long range transmission plans in northeastern Colorado. Figure 13 below depicts a conceptual long range plan for the Greeley area. The NECO Subcommittee will continue its analysis of this area by evaluating the Southern Greeley area beginning in 2017.

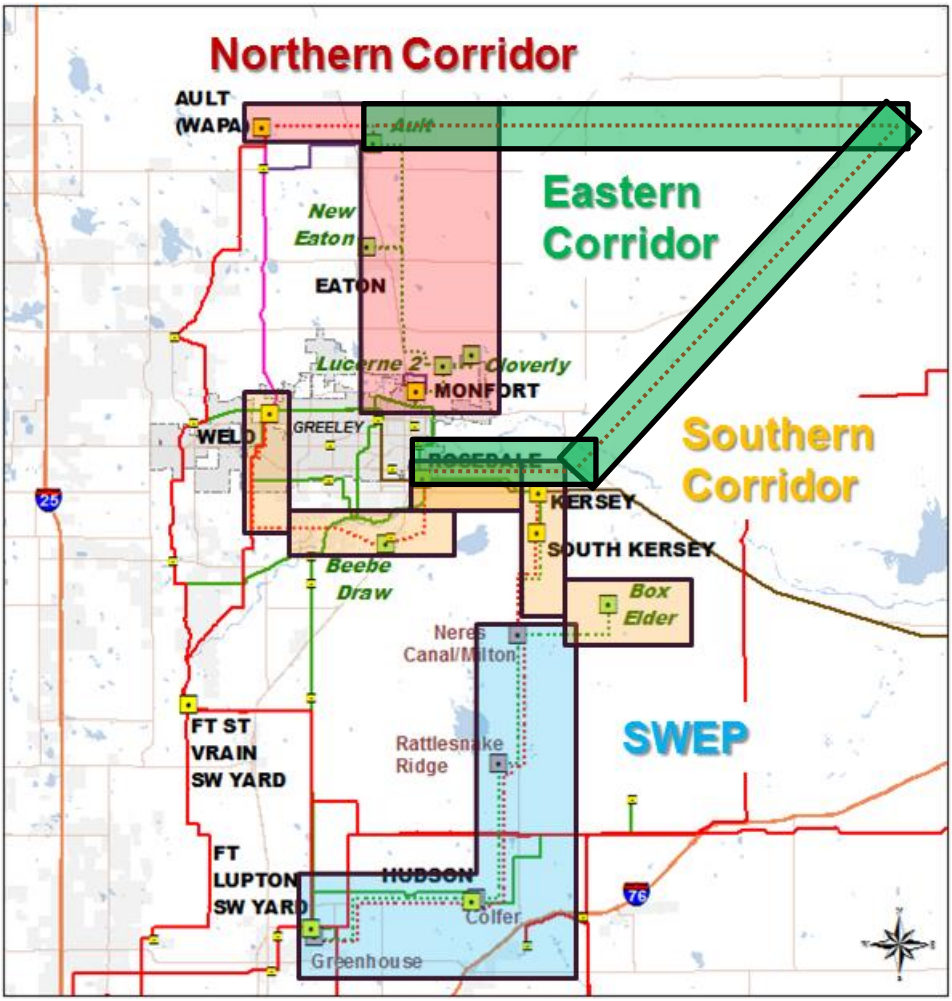

Figure 13: Conceptual Long Range Transmission Plan

VI. Sensitivity Analysis

In addition to the steady state power flow and voltage analysis performed on the benchmark and alternative 1 cases, further analysis was conducted by the NECO Subcommittee to better understand the impact of the additions to the transmission system. This analysis consisted of several sensitivities that were developed and agreed to by the NECO Subcommittee for the benchmark and alternative 1 cases. Upon request from a NECO Subcommittee participant, an expanded analysis of the Craig Unit 1 retirement sensitivity was conducted to determine the impact to the benchmark and alternative 1 cases.

Sensitivity Analysis

The NECO Subcommittee worked together to develop a list of sensitivities to study using the benchmark and alternative 1 cases. The list below describes those sensitivities that were developed agreed to be studied by the NECO Subcommittee.

1. Case
2. Case with the Godfrey – Gilcrest 115 kV "normal open" closed
3. Case with high north to south power flow along the TOT 7 path

4. Case with high north to south power flow along the TOT 7 path and the Godfrey – Gilcrest 115 kV "normal open" closed
5. Case with high oil and gas load development for PSCo and Tri-State (SWEP and North Greeley)
6. Case with high oil and gas load development for PSCo and Tri-State and high north to south power flow along the TOT 7 path
7. Case with high oil and gas load development for PSCo and Tri-State, high north to south power flow along the TOT 7 path and the Godfrey – Gilcrest 115 kV "normal open" closed
8. Case with low and high renewable generation
9. Case with the retirement of Craig Unit 1
10. Case with the addition of local generation in the Greeley area
11. Case with high oil and gas load development for PSCo and Tri-State and the addition of local generation in the Greeley area

The sensitivity analysis was conducted in the same manner as the steady state power flow and voltage analysis using the same methodology and criteria. Results for the sensitivities using the benchmark model were compared side-by-side with the benchmark case while results for the sensitivities using the alternative 1 model were compared side-by-side with the alternative 1 case. Again, any pre-existing thermal and voltage violations falling within the study methodology criteria were excluded from the tabulated results to avoid them from being attributed to the sensitivities that were studied.

Closing the Godfrey – Gilcrest 115 kV segment was evaluated as a sensitivity to analyze the power flows through the Greeley area 115 kV transmission system. When this transmission pathway is closed and alternate pathway for power to flow across TOT 7 is created by diverting power through the Greeley area 115 kV system. The closing of this segment allowed for increased operational flexibility, however, it also increased the loadings of certain 115 kV elements, specifically the 230/115 kV transformers at Weld and the Weld – Greeley 115 kV line.

For the sensitivities studying high north to south power flows along the TOT 7 path, generation was generally increased at units located north of the Greeley area and reduced in units located to the south. Area interchange was also adjusted to import power from the north of the study area. From these adjustments, the TOT 7 power flows in the benchmark and alternative 1 cases were increased from -34.0 MW and -40.3 MW (the negative indicating a south to north power flow) respectively to around 500 MW. A detailed list of the generation units that were adjusted for each of the high TOT 7 sensitivity scenarios can be found in APPENDIX I: Generation Adjustments for Sensitivities.

The high oil and gas load sensitivity was developed to analyze the impacts of large retail oil and gas development in the area. Through the NECO Subcommittee, PSCo and Tri-State provided a high oil and gas load forecast for the Greeley area. These loads were added to the cases to simulate and study their development to the transmission system. A list of the loads and their locations can be found in APPENDIX I: Generation Adjustments for Sensitivities.

Based on the TOT 7 values in the benchmark and alternative 1 cases, and in an effort to speed up the study process, the NECO Subcommittee decided to eliminate the low and high renewable penetration sensitivity from the analysis at the July 29th, 2016 meeting.

For sensitivities evaluating the development of local area generation, the NECO Subcommittee determined the 69 MW, gas fired generator near the existing PSCo UNC 115 kV Substation would be used. This generation facility consists of three gas fired turbines, is the largest in the City of Greeley, and until 2013, obtained a power purchase agreement with PSCo. Although not in operation at this time, the generation facility still exists and recently had an upgrade to the natural gas supply line for the turbines. The facility does not have a purchase power agreement with any transmission provider, and therefore does not provide power. The NECO Subcommittee selected this unit for the sensitivity based on its, location, size and ability to be quickly connected to the transmission system.

Sensitivity Analysis Results

Based on the results of the sensitivity analysis, for the benchmark case, voltage collapse was observed on the 44 kV transmission system for the high oil and gas load scenarios, indicative that the 44 kV system is not capable of accommodating significant load growth. The addition of Alternative 1 and subsequent removal of the northern 44 kV transmission system allows for the high oil and gas load sensitivities to solve, thereby increasing the load serving capability of the transmission system.

Furthermore, the addition of Alternative 1 mitigated the thermal overloads of the existing Monfort 115/44 kV 60 MVA transformer that are seen in benchmark case sensitivities for closing the Godfrey – Gilcrest 115 kV line segment, stressing the north to south TOT 7 power flows with the Godfrey – Gilcrest 115 kV line segment closed and for adding local generation to the 115 kV system. Alternative 1 also reduced the loadings of the two Weld 230/115 kV 150 MVA transformers to below 100% of their thermal ratings for all benchmark case sensitivities except for those with stressed north to south TOT 7 power flows, where there remaining overloads were below the transformer emergency ratings. However, Alternative 1 does not mitigate the overloads of these transformers in the event of a Weld 230 kV bus fault.

For the stressed north to south TOT 7 power flow sensitivities in the benchmark case, the Western owned, double circuit, Ault – Weld 230 kV line was loaded to approximately 112% of its thermal rating limit when one of the lines was taken out of service. This overload is a result of the generation dispatch and area interchange changes made to increase the north to south power flows. Again, with the addition of Alternative 1 and removal of the northern 44 kV transmission system, the flows on the 230 kV lines are redistributed through the new 115 kV transmission, eliminating the overload of the lines. Approximately (104 MW) of power flow was observed to be diverted through the addition of the Northern Greeley Area Transmission Plan.

Additionally, Alternative 1 mitigated all of the selected multiple contingency (P4) overloads observed in the benchmark case sensitivities with the exception of the Airport – Boyd 115 kV line. Alternative 1 was however able to significantly reduce the loading of this line. Western has indicated they have a project in their 10 year plan to address this issue.

The sensitivity examining the retirement of the Craig Unit 1 generation facility for both the benchmark and alternative 1 cases showed that the unit retirement has a minimal impact on the study results. Additional details of this sensitivity are discussed below in the Craig Unit 1 Retirement Analysis section.

Finally, the addition of Alternative 1 provides a higher voltage transmission system with two points of service to the Husky, Graham Creek and Cloverly Substations, thereby increasing their reliability of service.

It is important to note that with the addition of Alternative 1 the power flows on the Monfort – Lucerne 115 kV line on the east side of Greeley are increased as they become part of the looped higher voltage transmission system.

Tables for the steady state power flow results for the sensitivity analysis can be found in APPENDIX J: Sensitivity Steady State Power Flow Results Tables.

Craig Unit 1 Retirement Analysis

In September 2016, an announcement was made that Craig Unit 1 would be shut down by 2025. Because this date was prior to the study case date, a member of the NECO Subcommittee requested an expanded analysis of the Craig Unit 1 retirement sensitivity.

The expanded analysis for the Craig Unit 1 retirement sensitivity explored two additional generation dispatch scenarios and used the power flows in and out of Western's Ault Substation to compare their impact to the Greeley and study areas. These scenarios were labeled 9B and 9C. One of the additional sensitivities was run to model the generation exactly as suggested by a member of the NECO Subcommittee (9B), while the other was run to reflect a more accurate dispatch with the Valmont generation unit shut down (scheduled to retire by 2017), and the Cabin Creek generation at levels that more accurately reflect actual operation (9C).

A contingency analysis was performed for each of the additional sensitivities, and the results were compared in a side-by-side analysis with the benchmark case and the Craig Unit 1 retirement sensitivity (sensitivity 9 in the above mentioned sensitivity list). Furthermore, a list of the generation tables were developed to show the dispatch of the generation units in Area 70 and 73, and indicate generation that was changed. Finally, one-line diagrams for the Ault 230 kV and 345 kV buses were developed for each of the scenarios to show how power flows are distributed out of the Ault Substation.

From these results the NECO Subcommittee concluded that the impacts due to the retirement of Craig Unit 1 are minimal to the Greeley and study areas.

The side-by-side contingency comparison list, generation dispatch tables and one-line diagrams for the Craig Unit 1 Retirement Analysis can be found in APPENDIX K: Craig Unit 1 Retirement Sensitivity Data.

VII. Voltage Stability Analysis

The voltage stability study utilized Power – Voltage, or "PV" analysis to determine how much load (power, or "P") could be served before hitting voltage ("V") limitations. The alternative 1 case was used for the voltage stability analysis to identify the maximum load serving capability of the transmission project. Three (3) scenarios were studied, with load being added in 10 MW increments to a maximum of 500 MW at each of the new substations; Husky, Graham Creek and Cloverly independently. Prior to the incremental load additions, **67.4 MW** of load was transferred from the 44 kV system to the new 115 kV transmission line in the following distribution:

- Husky – 9.3 MW
- Graham Creek – 19.6 MW
- Cloverly – 38.5 MW

The load transfers represent the 44 kV loads at the existing Ault, Eaton and Pleasant Valley 44 kV Substations that will be transferred to the new 115 kV system as part of Alternative 1.

For each study, three (3) selected contingencies were taken:

- Ault –Husky 230 kV
- Husky 230/115 kV Transformer
- Monfort – Lucerne 115 kV

Each study was allowed to run until the full 500 MW was added at each substation or until voltage collapse occurred on the system. Generation for the incremental load additions were supplied from the area swing at Comanche 2 with generation limits turned off. Parameters for the study analysis are listed below:

	Base Case Solutions	**Contingency Solutions**
Tap Adjustments	Stepping	Lock Taps
Area Interchange Control	Tie Lines Only	Disabled
Switched Shunt Adjustments	Enable All	Lock All

Table 6: PV Study Analysis Parameters

In addition to the voltage stability analysis performed on the alternative 1 case, the same analysis was performed on seven (7) potential expansion scenarios to the alternative 1 case to identify the maximum load serving capability of the transmission projects that could be added to Alternative 1 in the future. Below lists the cases for which a voltage stability analysis was performed.

Case Label	Description
PV01	01 - Alternative 1
PV02	02 - Alternative 1 + Graham Creek - Weld 115 kV
PV03	03 - Alternative 1 + Graham Creek - Greeley 115 kV
PV04	04 - Alternative 1 + Cloverly - Rosedale 115 kV
PV05	05 - Alternative 1 + Husky - Rosedale 230 kV
PV06	06 - Alternative 1 + Husky - Cloverly - Rosedale 230 kV
PV07	07 - Alternative 1 + Husky - Graham Creek - Rosedale 230 kV
PV08	08 - Alternative 1 + Double Circuit Ault - Husky AND Two Husky 230/115 kV Transformers

Table 7: List of PV Analysis Study Scenarios

Both the voltage and thermal limits were identified along with the limiting element and subsequent contingency and the results were tabulated for each scenario. Furthermore, the next voltage and thermal limit and limiting element beyond the initial limit were identified and tabulated.

Finally, a voltage stability analysis was performed for all 8 scenarios using the same parameters with the exception of enabling the switched shunt devices for the contingency solution.

Voltage Stability Analysis Results

The complete tables from the voltage stability analysis for all the scenarios can be found in APPENDIX L: Voltage Stability Analysis Tables.

From the voltage stability analysis, the load serving capability, in addition to the 67.4 MW of transferred load from the existing 44 kV transmission system, for Alternative 1 (PV01) based on thermal limitations is 120 MW at the Husky Substation, and 130 MW at the Graham Creek and Cloverly Substations. The next limiting element for each substation is the Weld – Greeley 115 kV line which is loaded beyond its thermal limit when 140 MW is added at the Husky Substation or when 160 MW is added at the Graham Creek or Cloverly Substations.

When considering the other potential expansion scenarios, the load serving capability was increased in each instance. The addition of the Graham Creek – Weld 115 kV line provides a greater load serving capability (160 MW with Graham Creek – Cloverly 115 kV being the limit) than the addition of the Graham Creek – Greeley 115 kV line (120 MW with Weld – Greeley 115 kV being the limit). When considering the next limiting elements, the load serving capabilities are increased to 220 MW and 200 MW respectively.

The addition of a Cloverly – Rosedale 115 kV line increases the load serving capability of Alternative 1 to 170 MW.

Adding a Husky – Rosedale 230 kV line to Alternative 1 and interconnecting the 230 kV line at the Cloverly Substation provides greater load serving capability (170 MW with Graham Creek – Cloverly 115 kV being the limit) than interconnecting it at the Graham Creek Substation (160 MW with Graham Creek – Cloverly 115 kV also being the limit.

Finally, when adding a second Ault –Husky 230 kV line and a second 230/115 kV 280 MVA transformer at Husky the load serving capability is 130 MW.

VIII. Ault Interconnection Evaluation

As part of the recommended Alternative 1, a new 230 kV termination is required at the Western owned Ault Substation. Special attention was paid to the power flows both in and out of the 230 kV and 345 kV buses at the Ault Substation to determine the impact of the new interconnection. Table 8 below shows a side-by-side comparison of the 230 kV bus power flows at the Ault Substation for the benchmark case and alternatives studied.

Ault 230 kV Powerflow Data						
		Case				
	Branch	0-01	1-01	2-01	3-01	5-01
IN	Ault 230kV - Ault 345kV	-168.2	-169.7	-169.7	-169.9	-165.4
	Ault 230kV - Ault 345kV	-166.9	-168.4	-168.5	-168.6	-164.2
	Ault 230kV - Ault 345kV	-184.6	-186.2	-186.3	-186.4	-181.5
	Ault 230kV - Archer 230kV	-87.5	-89.7	-89.7	-90	-84.1
	Ault 230kV - Terry Ranch 230kV	-68.7	-71.6	-71.7	-72	-64.2
	Ault 230kV - Rawhide 230kV	-97.1	-102.4	-102.7	-103.3	-97.6
OUT	Ault 230kV - Windsor 230kV	117.8	106.6	106.2	104.9	123.9
	Ault 230kV - Carey 230kV	152.4	141.9	141.4	140.2	152.2
	Ault 230kV - Weld 230kV	219.7	187	185.2	181.1	208.5
	Ault 230kV - Weld 230kV	219.7	187	185.2	181.1	208.5
	Ault 230kV - Ault 115kV	63.5	61.5	61.4	61.2	63.8
	Ault 230kV - New Ault 230kV	N/A	103.8	109	121.5	N/A
	Total Flow In to Ault	-773	-788	-788.6	-790.2	-757
	Total Flow Out from Ault	773.1	787.8	788.4	790	756.9

Table 8: Ault 230 kV Power Flow Comparison

From the table it can be seen that constructing Alternative 1 provides an alternate path for approximately 104 MW of power flow out of the Ault Substation to the Greeley area while minimally impacting the total power flow in and out of the substation.

APPENDIX M: One-line Diagrams of the Ault Substation Power Flows provides the power flow diagrams for the Ault 230 kV bus that supports the values listed in the table for the benchmark and alternative 1 cases.

Similarly, Table 9 below shows a side-by-side comparison of the 345 kV bus power flows at the Ault Substation for the benchmark case and alternatives studied.

Ault 345 kV Powerflow Data						
		Case				
	Branch	0-01	1-01	2-01	3-01	5-01
IN	Ault 345kV - Craig 345kV	-122.2	-124.7	-124.8	-125.0	-117.6
	Ault 345kV - Laramie River 345kV	-397.9	-400.1	-400.1	-400.4	-394.0
OUT	Ault 230kV - Ault 345kV	168.4	169.9	169.9	170.1	165.6
	Ault 230kV - Ault 345kV	167.1	168.6	168.7	168.8	164.4
	Ault 230kV - Ault 345kV	184.6	186.2	186.3	186.5	181.6
	Total Flow In to Ault	-520.1	-524.8	-524.9	-525.4	-511.6
	Total Flow Out from Ault	520.1	524.7	524.9	525.4	511.6

Table 9: Ault 345 kV Power Flow Comparison

The table indicates that flows on the 345 kV bus are minimally impacted by the addition of Alternative 1.

APPENDIX M: One-line Diagrams of the Ault Substation Power Flows provides the power flow diagrams for the Ault 345 kV bus that supports the values listed in the table for the benchmark and alternative 1 cases.

A contingency analysis was performed as part of the steady state power flow and voltage analysis. From this analysis, no overloads were observed on transmission elements in or out of the Ault Substation as a result of the addition of Alternative 1. Power flows on the Ault – Weld, Ault – Windsor and Ault – Carey 230 kV lines were all observed to decrease with the addition of Alternative 1. Results of the contingency analysis can also be found in APPENDIX M: One-line Diagrams of the Ault Substation Power Flows.

Ault Interconnection Results

The studies indicate that there are no adverse impacts associated with interconnecting new 230 kV transmission to the Ault Substation. The Project improves the reliability in the area by providing another high voltage path from Ault, which improves steady state and contingency performance.

TOT 7 System Operating Limit

This study considered the potential impacts to the TOT 7 transfer path by determining the TOT 7 operating limit in both the base case and the case with Alternative 1 in-service. In this study, when generation was increased to the north of TOT 7, and decreased to the south of it, the system intact TOT 7 operating limit was increased from approximately 390 MW to 562 MW with the addition of Alternative 1. The limiting element for determining the operating limit was the loss of one of the Ault – Weld 230 kV lines, which resulted in the overload of the other Ault – Weld 230 kV line.

From this analysis it was determined that with the addition of Alternative 1 there are no adverse impacts on TOT 7.

IX. Conclusion

Based on these studies, the NECO Subcommittee has identified that the transmission system in and around the City of Greeley is experiencing reliability issues due to aging transmission infrastructure and the increasing customer demand for electricity. Specifically, it has identified the reliability issues associated with the radial configuration of the 44 kV system. It has also identified that at current growth rates, the 44 kV transmission system will no longer be able to adequately support load growth beyond 2018. The studies have also indicated the load serving capability limitations of the 115 kV system in the Greeley area as well as the resource capacity constraints in an area where there is significant resource development potential.

In response to these issues, and to develop a transmission improvement plan for the area, the NECO Subcommittee has developed and is recommending a transmission plan that would accomplish the objective of this study; replace the existing, antiquated and non-standard, 44 kV system with higher voltage transmission facilities, transfer the loads from the 44 kV system to a higher and more reliable transmission network, improve overall reliability, load serving capability, and resource accommodation in the area, and align with other transmission planning efforts in the Greeley area of northeast Colorado.

The NECO Subcommittee is recommending Alternative 1 as the Northern Greeley Area Transmission Plan. This plan is recommended to successfully mitigates both system intact and single contingency (N-1) overloads, as well as certain select multiple contingency overloads. The plan also transfers almost 70 MW of existing loads from the 44 kV radial transmission system to a new higher voltage system, and increases the load-serving capability in area by at least 120 MW. The plan also adds another transmission outlet to the constrained transmission path south of the Ault Substation, and although not specifically determined, the plan allows for future generation resource accommodation, and aligns with other transmission planning efforts in northeast Colorado such as Tri-State's SWEP. Finally, the proposed plan makes practical use of existing facilities and transmission corridors.

On February 16, 2017, the CCPG agreed that this report met the objectives of the scope, and the results were technically adequate and accurate. One party, the Office of Consumer Counsel, did not agree with the rest of CCPG.

APPENDIX A: Greeley Area Loads

	Bus Number	NECO 2026HS Case (Benchmark)	
		MW	MVAr
Weld 230kV	***70471***	***30.589***	***11.202***
P4	70471	16.244	4.964
P5	70471	14.345	6.238
Weld 115kV	***70470***	**0**	**0**
Weld 44kV		**26.01**	**4.08**
Eaton 1 (P1)	70819	6.42	1.24
Ault 2 (P1)	70808	4.69	1.47
Continental	70803	2.47	0.98
Highland	70875	12.43	0.39
Arrowhead Lake	***70475***	**26.338**	**5.718**
P1	70475	26.338	5.718
P2	70475	0	0
Rosedale	***70368***	**39.831**	**8.176**
P1	70368	23.089	1.741
P2	70368	16.742	6.435
P3	70368	0	0
UNC	***70439***	**0.31**	**0.47**
Leprino	***70805***	**15**	**4.93**
Monfort 115	***70290***	**0**	**0**
IN	70290	0	0
P1	70290	0	0
P2	70290	0	0
PS	70290	0	0
Monfort 44		**53.81**	**20.55**
Monfpack (P1)	70845	20	15.2
PV 1 (P1)	70838	18.55	2.94
PV 2 (P2)	70838	0	0
Eaton 2 (P1)	70817	13.15	1.69
Ault 1 (P1)	70810	2.11	0.72
Greeley 115	***70209***	**72.299**	**26.054**
P3	70209	35.919	11.268
P4	70209	36.38	14.786
Greeley 44		**24.12**	**7.17**
Evans	70877	15.55	4.92
LaSalle	70865	5.67	0.66
Box Elder	70870	2.9	1.59
Johnstown1	***70240***	**8.178**	**-0.648**
Johnstown2	***70246***	**13.549**	**5.679**
Lucerne	***70899***	**12.5**	**4.11**
P1	70899	12.5	4.11
P2	70899	0	0
IN	70899	0	0
Boomerang	***73554***	**4.6**	**0.5**
South Kersey	***72403***	**12.3**	**4**
Kodak	***73098***	**27.25**	**8.96**
Bracewell	***73555***	**11.92**	**3.92**
Windsor	***73218***	**19.53**	**4.57**
City of Greeley 115 kV Total		**166.278**	**49.458**
Greeley Area 115 kV Total		**263.605**	**76.439**
Greeley 44 kV System Total		**103.94**	**31.8**
Greeley 230 kV System Total		**30.589**	**11.202**

Table 10: Greeley Area Loads

APPENDIX B: Calculated 44 kV System Loads

Load Modification Table

Assumptions:
2014 SCADA Data for 7/22/2014 17:00 (Greeley 115 kV System Peak)

Forecast Years			12
Load Growth Factor (%)			2

Substation	Approved CCPG 2024HS Case Bus Number	Benchmark 2026 Case Bus Number	SCADA 2014 Peak Load		2026 Forecast Assumptions		Benchmark 2026 Case Load Additions		Comments
			MW	MVAR	MW	MVAR	MW	MVAR	
44 kV System									
Continental	N/A	70803	1.95	0.77	2.47	0.98	2.47	0.98	Customer has requested facility to remain on the 44 kV system.
Ault 1	N/A	70810	1.66	0.57	2.11	0.72	2.11	0.72	Constant P/Q ratio, 2% growth factor per year
Ault 2	N/A	70808	3.70	1.16	4.69	1.47	4.69	1.47	Constant P/Q ratio, 2% growth factor per year
Eaton 1	N/A	70819	5.06	0.98	6.42	1.24	6.42	1.24	Constant P/Q ratio, 2% growth factor per year
Eaton 2	N/A	70817	10.37	1.33	13.15	1.69	13.15	1.69	Constant P/Q ratio, 2% growth factor per year
Pleasant Valley 1	N/A	70838	14.63	2.32	18.55	2.94	18.55	2.94	Constant P/Q ratio, 2% growth factor per year
Highland	N/A	70875	9.80	0.31	12.43	0.39	12.43	0.39	Constant P/Q ratio, 2% growth factor per year
Evans	N/A	70877	12.26	3.88	15.55	4.92	15.55	4.92	Constant P/Q ratio, 2% growth factor per year
Weber	N/A	N/A	4.80	1.81	6.09	2.30	-	-	Retired. Assume load moved to Greeley 115 kV substation as part of 2026 forecast
LaSalle	N/A	70865	4.47	0.52	5.67	0.66	5.67	0.66	Constant P/Q ratio, 2% growth factor per year
Box Elder	N/A	70870	2.29	1.25	2.90	1.59	2.90	1.59	Constant P/Q ratio, 2% growth factor per year
Monfort	70290	70845	13.04	10.01	20.00	15.20	20.00	15.20	Customer has requested facility to remain on the 44 kV system. Phase II 6.5 MW expansion ISD 2018 included.

Table 11: Calculated Loads for the 44 kV System in Greeley

APPENDIX C: Detailed Switching Instructions for Removal of the 44 kV System

Northern Greeley Transmission Plan 115kV

Prior Projects Required:

1. None

Switch the following elements to "***in-service***" status:

1. Line segments
   - 70898 NEW AULT 230.00 73011 AULT 230.00
   - 70901 NEW AULT 115.00 70902 NEW EATON 115.00
   - 70902 NEW EATON 115.00 70903 CLOVERLY 115.00
   - 70828 MUMPERHL 44.000 70831 COWHERD 44.000
   - 70828 MUMPERHL 44.000 70845 MONFPACK 44.000
2. Buses
   - 70898 NEW AULT 230.0
   - 70901 NEW AULT 115.0
   - 70902 NEW EATON 115.0
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
   - 70898 NEW AULT 230.00 70901 NEW AULT 115.00 T1
   - 70901 NEW AULT 115.00 P1
   - 70901 NEW AULT 115.00 P2
   - 70902 NEW EATON 115.00 P1
   - 70903 CLOVERLY 115.00 P1

Switch the following elements to "***out of service***" status:

1. Line segments
   - 70469 WELD 46.000 70802 16L004 44.000
   - 70802 16L004 44.000 70827 BOYD JCT 44.000
   - 70827 BOYD JCT 44.000 70828 MUMPERHL 44.000
   - 70818 EATONTAP 44.000 70827 BOYD JCT 44.000
   - 70818 EATONTAP 44.000 70819 EATON1 44.000
   - 70804 CONTINTP 44.000 70818 EATONTAP 44.000
   - 70803 CONTINTL 44.000 70804 CONTINTP 44.000
   - 70804 CONTINTP 44.000 70808 AULT2 44.000
   - 70810 AULT1 44.000 70812 AULT TAP 44.000
   - 70812 AULT TAP 44.000 70817 EATON2 44.000
   - 70812 AULT TAP 44.000 70836 P.V. TAP 2 44.000
   - 70835 P.V. TAP 44.000 70836 P.V. TAP 2 44.000
   - 70836 P.V. TAP 2 44.000 70838 PLEASVAL 44.000
   - 70835 P.V. TAP 44.000 70838 PLEASVAL 44.000
   - 70831 COWHERD 44.000 70835 P.V. TAP 44.000
2. Buses
   - 70802 16L004 44.0

- 70827 BOYD JCT 44.0
- 70818 EATONTAP 44.0
- 70819 EATON1 44.0
- 70804 CONTINTP 44.0
- 70803 CONTINTL 44.0
- 70808 AULT2 44.0
- 70810 AULT1 44.0
- 70817 EATON2 44.0
- 70812 AULT TAP 44.0
- 70836 P.V. TAP 2 44.0
- 70838 PLEASVAL 44.0

3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
   - 70469 WELD 46.000 P2
   - 70819 EATON1 44.000 P1
   - 70803 CONTINTL 44.000 P1
   - 70808 AULT2 44.000 P1
   - 70810 AULT1 44.000 P1
   - 70817 EATON2 44.000 P1
   - 70838 PLEASVAL 44.000 P1
   - 70838 PLEASVAL 44.000 P2

Northern Greeley Transmission Plan 230kV

Prior Projects Required:

1. Northern Greeley Transmission Plan 115kV

Switch the following elements to "***in-service***" status:

1. Line segments
   - 70468 ROSEDALE 230.00 70898 NEW AULT 230.00
2. Buses
   - 70468 ROSEDALE 230.0
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
   - 70368 ROSEDALE 115.00 70468 ROSEDALE 230.00 T1

Switch the following elements to "***out of service***" status:

1. Line segments
   - None
2. Buses
   - None
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
   - None

Southern Greeley Transmission Plan (Weld – Rosedale 230kV with LaSalle Load Transfer)

Prior Projects Required:

1. None

Switch the following elements to "***in-service***" status:

1. Line segments
    - 70373 BB_DRAW 230.00 70471 WELD_PS 230.00
    - 70373 BB_DRAW 230.00 70468 ROSEDALE 230.00
2. Buses
    - 70373 BB_DRAW 230.0
    - 70468 ROSEDALE 230.0
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
    - 70373 BB_DRAW 230.00 P1
    - 70368 ROSEDALE 115.00 70468 ROSEDALE 230.00 T1

Switch the following elements to "***out of service***" status:

1. Line segments
    - 70861 LASALLTP 44.000 70865 LASALLE 44.000
2. Buses
    - 70865 LASALLE 44.0
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
    - 70865 LASALLE 44.000 P1

Southern Greeley Transmission Plan (Milton – Rosedale 230kV)

Prior Projects Required:

1. None

Switch the following elements to "***in-service***" status:

1. Line segments
    - 70468 ROSEDALE 230.00 72225 MILTON 230.00
2. Buses
    - 72225 MILTON 230.0
    - 70468 ROSEDALE 230.0
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
    - 72225 MILTON 230.00 72226 MILTON 115.00 T2
    - 72225 MILTON 230.00 72226 MILTON 115.00 T3
    - 70368 ROSEDALE 115.00 70468 ROSEDALE 230.00 T1

Switch the following elements to "***out of service***" status:

1. Line segments
    - None
2. Buses
    - None
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
    - None

Southern Greeley Transmission Plan (Box Elder Load Transfer)

Prior Projects Required:

1. None

Switch the following elements to "***in-service***" status:

1. Line segments
    - 70872 NEW BOX E 115.00 72226 MILTON 115.00
2. Buses
    - 70872 NEW BOX E 115.0
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
    - 70872 NEW BOX E 115.00 P1

Switch the following elements to "***out of service***" status:

1. Line segments
    - 70866 MCMILLEN 44.000 70870 BOXELDER 44.000
    - 70861 LASALLTP 44.000 70866 MCMILLEN 44.000
2. Buses
    - 70870 BOXELDER 44.0
    - 70866 MCMILLEN 44.0
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
    - 70870 BOXELDER 44.000 P1

Southern Greeley Transmission Plan (44 kV Removal)

Prior Projects Required:

1. Southern Greeley Transmission Plan (Weld – Rosedale 230kV with LaSalle Load Transfer)
2. Southern Greeley Transmission Plan (Box Elder Load Transfer)

Switch the following elements to "***in-service***" status:

1. Line segments
    - None other than previously required projects
2. Buses
    - None other than previously required projects
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
    - 70475 ARROWHLK 115.00 P2

Switch the following elements to "***out of service***" status:

1. Line segments
    - 70469 WELD 46.000 70801 16L003 44.000
    - 70801 16L003 44.000 70871 HIGHLDTP 44.000
    - 70871 HIGHLDTP 44.000 70875 HIGHLAND 44.000
    - 70210 GREELEY1 46.000 70852 GREELYTP 44.000
    - 70849 EVANSTAP 44.000 70852 GREELYTP 44.000
    - 70849 EVANSTAP 44.000 70877 EVANS 44.000

- 70846 WEBERTAP 44.000 70849 EVANSTAP 44.000
- 70852 GREELYTP 44.000 70857 BRANTNER 44.000
- 70857 BRANTNER 44.000 70861 LASALLTP 44.000

2. Buses
   - 70801 16L003 44.0
   - 70871 HIGHLDTP 44.0
   - 70875 HIGHLAND 44.0
   - 70210 GREELEY1 46.0
   - 70852 GREELYTP 44.0
   - 70849 EVANSTAP 44.0
   - 70877 EVANS 44.0
   - 70846 WEBERTAP 44.0
   - 70857 BRANTNER 44.0
   - 70861 LASALLTP 44.0
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
   - 70875 HIGHLAND 44.000 P1
   - 70210 GREELEY1 46.000 P1
   - 70210 GREELEY1 46.000 P2
   - 70209 GREELEY 115.00 70210 GREELEY1 46.000 T1
   - 70209 GREELEY 115.00 70210 GREELEY1 46.000 T2
   - 70877 EVANS 44.000 P1

Eastern Greeley Transmission Plan (Super 7 230kV)

Prior Projects Required:

1. Northern Greeley Transmission Plan 115kV

Switch the following elements to "***in-service***" status:

1. Line segments
   - 70468 ROSEDALE 230.00 70898 NEW AULT 230.00
2. Buses
   - 70468 ROSEDALE 230.0
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
   - 70368 ROSEDALE 115.00 70468 ROSEDALE 230.00 T1

Switch the following elements to "***out of service***" status:

1. Line segments
   - None other than previously required projects
2. Buses
   - None other than previously required projects
3. Bus Elements (Loads, Transformers, Capacitors, Reactors, etc.)
   - None other than previously required projects

APPENDIX D: Benchmark Generation Tables

Benchmark Case Generation Table

Bus Number	Bus Name	Area Num	Area Name	In Service	PGen (MW)	QGen (Mvar)
70069	CABCRKA 13.800	70	PSCOLORADO	1	110	12.4861
70070	CABCRKB 13.800	70	PSCOLORADO	1	110	12.536
70083	CANON_55 13.800	70	PSCOLORADO	0	0	0
70084	CANON_59 13.800	70	PSCOLORADO	0	0	0
70104	CHEROK2 15.500	70	PSCOLORADO	1	0	-35
70106	CHEROK4 22.000	70	PSCOLORADO	1	375	93.9602
70119	COMAN_1 24.000	70	PSCOLORADO	1	355	60.0204
70120	COMAN_2 24.000	70	PSCOLORADO	1	334.0659	18.5736
70133	CTY_LAM 13.800	70	PSCOLORADO	0	24.8	0
70135	CTY LAM 13.800	70	PSCOLORADO	0	16.9	0
70145	CHEROKEE5 18.000	70	PSCOLORADO	1	160	34.1189
70146	CHEROKEE6 18.000	70	PSCOLORADO	1	160	34.1189
70147	CHEROKEE7 18.000	70	PSCOLORADO	1	240	37.3434
70160	E_CANON 69.000	70	PSCOLORADO	0	0	0
70180	FRUITA 13.800	70	PSCOLORADO	1	15	-1.4021
70188	FTLUP1-2 13.800	70	PSCOLORADO	0	50	0
70188	FTLUP1-2 13.800	70	PSCOLORADO	0	50	0
70306	PP_MINE 69.000	70	PSCOLORADO	0	0	0
70310	PAWNEE 22.000	70	PSCOLORADO	1	505	112.8628
70314	MANCHEF1 16.000	70	PSCOLORADO	1	130	32.8098
70315	MANCHEF2 16.000	70	PSCOLORADO	1	130	32.8098
70334	PUB_DSLS 4.1600	70	PSCOLORADO	0	0	0
70337	PUEBPLNT 14.000	70	PSCOLORADO	0	0	0
70337	PUEBPLNT 14.000	70	PSCOLORADO	0	0	0
70344	R.F.DSLS 4.1600	70	PSCOLORADO	0	0	0
70350	RAWHIDE 24.000	70	PSCOLORADO	1	300	65.2401
70351	RAWHIDEA 13.800	70	PSCOLORADO	1	63	10.2321
70385	SHOSHA&B 4.0000	70	PSCOLORADO	1	7	5
70385	SHOSHA&B 4.0000	70	PSCOLORADO	1	7	5
70406	ST.VR_2 18.000	70	PSCOLORADO	1	130	48.6155
70407	ST.VR_3 18.000	70	PSCOLORADO	1	130	46.4815
70408	ST.VR_4 18.000	70	PSCOLORADO	1	130	59.2571
70409	ST.VRAIN 22.000	70	PSCOLORADO	1	342	93.7345
70446	VALMONT 20.000	70	PSCOLORADO	1	140	53.0476
70448	VALMONT6 13.800	70	PSCOLORADO	0	50	0
70485	ALMSACT1 13.800	70	PSCOLORADO	0	16	0
70486	ALMSACT2 13.800	70	PSCOLORADO	0	18	0
70487	JMSHAFR4 13.800	70	PSCOLORADO	1	33	2.0509
70487	JMSHAFR4 13.800	70	PSCOLORADO	1	33	2.0509

Bus Number	Bus Name	Area Num	Area Name	In Service	PGen (MW)	QGen (Mvar)
70490	JMSHAFR3 13.800	70	PSCOLORADO	1	33	2.8543
70490	JMSHAFR3 13.800	70	PSCOLORADO	1	50.3	4.3507
70493	JMSHAFR2 13.800	70	PSCOLORADO	1	51	1.9743
70495	JMSHAFR1 13.800	70	PSCOLORADO	1	35	1.9581
70495	JMSHAFR1 13.800	70	PSCOLORADO	1	34.6	1.9357
70498	QF_BCP2T 13.800	70	PSCOLORADO	1	30	-2.4139
70498	QF_BCP2T 13.800	70	PSCOLORADO	1	35.3	-2.8404
70499	QF_B4-4T 13.800	70	PSCOLORADO	1	24	-5.0676
70499	QF_B4-4T 13.800	70	PSCOLORADO	1	23	-4.8565
70500	QF_CPP1T 13.800	70	PSCOLORADO	1	23	6.9289
70500	QF_CPP1T 13.800	70	PSCOLORADO	1	23	6.9289
70501	QF_CPP3T 13.800	70	PSCOLORADO	1	26	3.0398
70503	PONNEQUI 26.100	70	PSCOLORADO	1	6.3	0.0128
70548	APT_DSLS 4.1600	70	PSCOLORADO	0	0	0
70553	ARAP5&6 13.800	70	PSCOLORADO	1	37	-10.4316
70553	ARAP5&6 13.800	70	PSCOLORADO	1	37	-10.4316
70554	ARAP7 13.800	70	PSCOLORADO	1	45	4.8466
70556	QF_B4D4T 12.500	70	PSCOLORADO	1	50	-12.0271
70557	VALMNT7 13.800	70	PSCOLORADO	1	36	-5.6415
70558	VALMNT8 13.800	70	PSCOLORADO	1	36	-5.6415
70560	LAMAR_DC 230.00	70	PSCOLORADO	1	101	-17.9764
70561	RAWHIDEF 18.000	70	PSCOLORADO	1	123	22.9077
70562	SPRUCE1 18.000	70	PSCOLORADO	1	132	-11.697
70563	SPRUCE2 18.000	70	PSCOLORADO	1	136	-11.5643
70564	RAWHIDE_PV 34.500	70	PSCOLORADO	1	20	-0.7189
70565	KNUTSON1 13.800	70	PSCOLORADO	1	68	11.6452
70566	KNUTSON2 13.800	70	PSCOLORADO	1	68	11.6452
70567	RAWHIDED 13.800	70	PSCOLORADO	0	65	0
70568	RAWHIDEB 13.800	70	PSCOLORADO	1	63	10.2024
70569	RAWHIDEC 13.800	70	PSCOLORADO	1	63	10.1944
70577	FTNVL1&2 13.800	70	PSCOLORADO	1	40	0.4768
70577	FTNVL1&2 13.800	70	PSCOLORADO	1	40	0.4768
70578	FTNVL3&4 13.800	70	PSCOLORADO	1	40	0.4768
70578	FTNVL3&4 13.800	70	PSCOLORADO	1	40	0.4768
70579	FTNVL5&6 13.800	70	PSCOLORADO	1	40	0.4768
70579	FTNVL5&6 13.800	70	PSCOLORADO	1	40	0.4768
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321

Bus Number	Bus Name	Area Num	Area Name	In Service	PGen (MW)	QGen (Mvar)
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321
70580	PLNENDG1 13.800	70	PSCOLORADO	1	4.8	-0.2321
70585	PLNENDG3 13.800	70	PSCOLORADO	1	7.2	-0.7597
70585	PLNENDG3 13.800	70	PSCOLORADO	1	7.2	-0.7597
70585	PLNENDG3 13.800	70	PSCOLORADO	1	7.2	-0.7597
70585	PLNENDG3 13.800	70	PSCOLORADO	1	7.2	-0.7597
70585	PLNENDG3 13.800	70	PSCOLORADO	1	7.2	-0.7597
70585	PLNENDG3 13.800	70	PSCOLORADO	1	7.2	-0.7597
70585	PLNENDG3 13.800	70	PSCOLORADO	1	7.2	-0.7597
70586	PLNENDG4 13.800	70	PSCOLORADO	1	7.2	-0.7597
70586	PLNENDG4 13.800	70	PSCOLORADO	1	7.2	-0.7597
70586	PLNENDG4 13.800	70	PSCOLORADO	1	7.2	-0.7597
70586	PLNENDG4 13.800	70	PSCOLORADO	1	7.2	-0.7597
70586	PLNENDG4 13.800	70	PSCOLORADO	1	7.2	-0.7597
70586	PLNENDG4 13.800	70	PSCOLORADO	1	7.2	-0.7597
70586	PLNENDG4 13.800	70	PSCOLORADO	1	7.2	-0.7597
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70587	PLNENDG2 13.800	70	PSCOLORADO	1	4.8	-0.2333
70588	RMEC1 15.000	70	PSCOLORADO	1	150	37.4427
70589	RMEC2 15.000	70	PSCOLORADO	1	150	37.4504
70591	RMEC3 23.000	70	PSCOLORADO	1	300	67.2243
70593	SPNDLE1 18.000	70	PSCOLORADO	1	134	38.8227
70594	SPNDLE2 18.000	70	PSCOLORADO	1	134	38.8227
70622	MIS_SITE 34.500	70	PSCOLORADO	1	52.5	0
70635	LIMON1_W 34.500	70	PSCOLORADO	1	42.2	25.649
70636	LIMON2_W 34.500	70	PSCOLORADO	1	42.2	16.9268
70637	LIMON3_W 34.500	70	PSCOLORADO	1	42.2	19.4582
70665	JKFUL_W1 0.6900	70	PSCOLORADO	1	26.1	13.4571
70666	JKFUL_W2 0.6900	70	PSCOLORADO	1	26.4	13.1558
70701	CO_GRN_E 34.500	70	PSCOLORADO	1	17	-13.2487

Bus Number	Bus Name	Area Num	Area Name	In Service	PGen (MW)	QGen (Mvar)
70702	CO_GRN_W 34.500	70	PSCOLORADO	1	17	-12.1469
70703	TWNBUTTE 34.500	70	PSCOLORADO	1	15.8	-9.5233
70710	PTZLOGN1 34.500	70	PSCOLORADO	1	42.2	-16.4703
70712	PTZLOGN2 34.500	70	PSCOLORADO	1	25.2	-9.4051
70713	PTZLOGN3 34.500	70	PSCOLORADO	1	16.7	-2.6727
70714	PTZLOGN4 34.500	70	PSCOLORADO	1	36.8	3.836
70721	SPRNGCAN 34.500	70	PSCOLORADO	1	12.6	-15.7541
70723	RDGCREST 34.500	70	PSCOLORADO	1	6.3	0
70724	SPRNGCAN 34.500	70	PSCOLORADO	1	12.6	-15.7541
70777	COMAN_3 27.000	70	PSCOLORADO	1	805	157.0344
70822	CEDARCK1 34.500	70	PSCOLORADO	1	31.5	-1.1485
70823	CEDARCK2 34.500	70	PSCOLORADO	1	31.5	-4.7542
70824	CEDARCK3 34.500	70	PSCOLORADO	1	52.5	-16.4585
70931	G-SANDHIL_PV34.500	70	PSCOLORADO	1	12.4	0
70932	IBERDROLA_PV34.500	70	PSCOLORADO	1	19.5	0
70933	COGENTRIX_PV34.500	70	PSCOLORADO	1	19.5	0
70934	COMAN_PV 34.500	70	PSCOLORADO	1	78	0
70935	SLV_SOLAR 34.500	70	PSCOLORADO	1	28.6	0
70950	ST.VR_5 18.000	70	PSCOLORADO	1	150	7.2103
70951	ST.VR_6 18.000	70	PSCOLORADO	1	150	45.2659
71001	BAC_MSA GEN113.800	70	PSCOLORADO	1	90	2.1643
71002	BAC_MSA GEN213.800	70	PSCOLORADO	1	90	2.1643
71003	BAC_MSA GEN313.800	70	PSCOLORADO	1	40	1.1462
71003	BAC_MSA GEN313.800	70	PSCOLORADO	1	40	1.1462
71003	BAC_MSA GEN313.800	70	PSCOLORADO	1	24	0.6877
71004	BAC_MSA GEN413.800	70	PSCOLORADO	1	40	1.1462
71004	BAC_MSA GEN413.800	70	PSCOLORADO	1	40	1.1462
71004	BAC_MSA GEN413.800	70	PSCOLORADO	1	24	0.6877
71005	BAC_MSA GEN513.800	70	PSCOLORADO	1	40	-2.4198
71009	BUSCHRWTG1 0.7000	70	PSCOLORADO	1	4	-2.4772
71012	BUSCHRWTG2 0.6900	70	PSCOLORADO	1	4	-2.4772
71015	BUSCHRWTG3 0.6900	70	PSCOLORADO	1	4	-2.4772
71016	RTLSNKWNDLO 0.7000	70	PSCOLORADO	1	8	-2.4772
72500	SPR GEN3 21.000	73	WAPA R.M.	1	458.1	61.2449
72703	CRSL_GEN 0.7000	73	WAPA R.M.	1	30	0
72714	KC_GEN 0.6900	73	WAPA R.M.	1	12.3	-16.7
72742	RIDGEWAY 4.2000	73	WAPA R.M.	1	7.2	-2.4
72742	RIDGEWAY 4.2000	73	WAPA R.M.	1	0.8	-0.3
73054	ELBERT-1 11.500	73	WAPA R.M.	1	85.71	-5.7065
73129	MBPP-1 24.000	73	WAPA R.M.	1	317.1977	90.3534
73130	MBPP-2 24.000	73	WAPA R.M.	1	605	90.3534

Bus Number	Bus Name	Area Num	Area Name	In Service	PGen (MW)	QGen (Mvar)
73181	SIDNEYDC 230.00	73	WAPA R.M.	1	196	-125.056
73226	YELLO1-2 13.800	73	WAPA R.M.	1	50	13.2144
73226	YELLO1-2 13.800	73	WAPA R.M.	1	50	13.2144
73227	YELLO3-4 13.800	73	WAPA R.M.	1	50	28.8565
73227	YELLO3-4 13.800	73	WAPA R.M.	1	50	28.8565
73289	RCCT1 13.800	73	WAPA R.M.	1	17	8.0048
73291	RCCT2 13.800	73	WAPA R.M.	1	17	7.9985
73292	RCCT3 13.800	73	WAPA R.M.	1	17	7.9641
73293	RCCT4 13.800	73	WAPA R.M.	1	17	7.9483
73299	BIGTHOMP 4.2000	73	WAPA R.M.	1	3	0
73302	BRLNGTN1 13.800	73	WAPA R.M.	1	46.9	-12.4864
73303	BRLNGTN2 13.800	73	WAPA R.M.	1	46.4	-12.499
73306	ESTES1 6.9000	73	WAPA R.M.	1	10	5.9232
73307	ESTES2 6.9000	73	WAPA R.M.	1	10	5.9232
73308	ESTES3 6.9000	73	WAPA R.M.	1	10	5.9232
73316	GREENMT1 6.9000	73	WAPA R.M.	1	7	1.0968
73317	GREENMT2 6.9000	73	WAPA R.M.	1	7	1.0968
73319	MARYLKPP 6.9000	73	WAPA R.M.	1	4	-6.8
73324	POLEHILL 13.800	73	WAPA R.M.	1	25	19.527
73328	WILLMFRK 2.4000	73	WAPA R.M.	1	2	0
73332	ALCOVA1 6.9000	73	WAPA R.M.	1	12	5.2029
73333	BOYSEN1 4.2000	73	WAPA R.M.	1	4	-0.4723
73333	BOYSEN1 4.2000	73	WAPA R.M.	1	4	-0.4723
73334	BBILL1-2 6.9000	73	WAPA R.M.	1	4	3.3163
73334	BBILL1-2 6.9000	73	WAPA R.M.	1	3	2.4872
73337	GARCANPP 4.2000	73	WAPA R.M.	1	0	0
73339	HEART MT 2.3000	73	WAPA R.M.	1	3	3.2416
73341	NSS2 13.800	73	WAPA R.M.	1	93	16.9222
73347	SHOSHONE 6.9000	73	WAPA R.M.	1	2	0
73349	FREMONT1 11.500	73	WAPA R.M.	1	22	-3.0164
73350	FREMONT2 11.500	73	WAPA R.M.	1	22	-3.0164
73351	GLENDO1 6.9000	73	WAPA R.M.	1	7	6.983
73352	GLENDO2 6.9000	73	WAPA R.M.	1	7	6.983
73353	GUERNSY1 2.4000	73	WAPA R.M.	1	2	0
73356	KORTES1 6.9000	73	WAPA R.M.	1	6	5.0521
73357	KORTES2 6.9000	73	WAPA R.M.	1	6	5.0521
73358	KORTES3 6.9000	73	WAPA R.M.	1	6	5.0521
73363	SEMINOE1-2 6.9000	73	WAPA R.M.	1	6	0.8496
73363	SEMINOE1-2 6.9000	73	WAPA R.M.	1	6	0.8496
73381	BIRDSAL1 13.800	73	WAPA R.M.	0	0	0
73382	BIRDSAL2 13.800	73	WAPA R.M.	0	0	0

Bus Number	Bus Name	Area Num	Area Name	In Service	PGen (MW)	QGen (Mvar)
73383	BIRDSAL3 13.800	73	WAPA R.M.	0	0	1.5969
73418	RD_NIXON 20.000	73	WAPA R.M.	1	220.47	22.0602
73424	TESLA1 13.800	73	WAPA R.M.	1	13.2	-4.0662
73427	DRAKE 5 13.800	73	WAPA R.M.	0	0	5.2278
73428	DRAKE 6 13.800	73	WAPA R.M.	1	80.6	5.6206
73429	DRAKE 7 13.800	73	WAPA R.M.	1	137.1	10.8962
73434	NIXONCT1 12.500	73	WAPA R.M.	0	0	0
73435	NIXONCT2 12.500	73	WAPA R.M.	0	0	0
73438	ALCOVA2 6.9000	73	WAPA R.M.	1	12	5.2029
73439	BBILL3-4 6.9000	73	WAPA R.M.	1	4	3.8
73441	SEMINOE3 6.9000	73	WAPA R.M.	1	6	1.6992
73444	GUERNSY2 2.4000	73	WAPA R.M.	1	2.9	0
73448	FLATIRN1 13.800	73	WAPA R.M.	1	30	-1.8124
73449	FLATIRN2 13.800	73	WAPA R.M.	1	30	-1.8124
73449	FLATIRN2 13.800	73	WAPA R.M.	1	4	0
73461	ELBERT-2 11.500	73	WAPA R.M.	1	85	-5.7065
73462	SPIRTMTN 6.9000	73	WAPA R.M.	1	2	-1.8
73507	FTRNG1CC 18.000	73	WAPA R.M.	1	137.3	34.8882
73508	FTRNG2CC 18.000	73	WAPA R.M.	1	136.9	35.0982
73509	FTRNG3CC 21.000	73	WAPA R.M.	1	176.19	47.1214
73520	BFDIESEL 4.1600	73	WAPA R.M.	0	0	0
73532	LINCOLN1 13.800	73	WAPA R.M.	1	68	-14.2285
73533	LINCOLN2 13.800	73	WAPA R.M.	1	68	-13.8453
73631	COHIWND_G1 0.6900	73	WAPA R.M.	1	13.1	4.7509
73635	COHIWND_G2 0.6900	73	WAPA R.M.	1	5.1	3.1148
73997	ENGYCNTR 22.000	73	WAPA R.M.	0	0	0
73999	BURLNGTN 22.000	73	WAPA R.M.	0	0	0
74014	NSS_CT1 13.800	73	WAPA R.M.	1	40	6.7746
74015	NSS_CT2 13.800	73	WAPA R.M.	1	40	6.5074
74016	WYGEN 13.800	73	WAPA R.M.	1	93	22.7242
74017	WYGEN2 13.800	73	WAPA R.M.	1	100	24.1371
74018	WYGEN3 13.800	73	WAPA R.M.	1	110	26.9808
74029	LNG_CT1 13.800	73	WAPA R.M.	1	40	-6.5453
74042	CLR_1 0.6000	73	WAPA R.M.	1	1.5	1.0843
74043	SS_GEN1 0.6000	73	WAPA R.M.	1	2	1.5549
74061	CPGSTN_1 13.800	73	WAPA R.M.	1	40	5.9333
74061	CPGSTN_1 13.800	73	WAPA R.M.	1	40	5.9333
74061	CPGSTN_1 13.800	73	WAPA R.M.	1	20	2.9666
74062	CPGSTN_2 13.800	73	WAPA R.M.	1	40	6.2895
74063	CPGSTN_3 13.800	73	WAPA R.M.	1	50	23.4037
74063	CPGSTN_3 13.800	73	WAPA R.M.	1	50	23.4037

Bus Number	Bus Name	Area Num	Area Name	In Service	PGen (MW)	QGen (Mvar)
74063	CPGSTN_3 13.800	73	WAPA R.M.	1	20	9.3615
74399	BHPLPLAN 13.800	73	WAPA R.M.	0	0	0
76301	ARVADA1 13.800	73	WAPA R.M.	0	0	0
76302	ARVADA2 13.800	73	WAPA R.M.	0	0	0
76303	ARVADA3 13.800	73	WAPA R.M.	0	0	0
76305	BARBERC1 13.800	73	WAPA R.M.	0	0	0
76306	BARBERC2 13.800	73	WAPA R.M.	0	0	0
76307	BARBERC3 13.800	73	WAPA R.M.	0	0	0
76309	HARTZOG1 13.800	73	WAPA R.M.	0	0	0
76310	HARTZOG2 13.800	73	WAPA R.M.	0	0	0
76311	HARTZOG3 13.800	73	WAPA R.M.	0	0	0
76313	TK DVAR1 0.4800	73	WAPA R.M.	0	0	0
76314	TK DVAR2 0.4800	73	WAPA R.M.	0	0	0
76351	RCDC W 230.00	73	WAPA R.M.	1	100	-10
76404	DRYFORK 19.000	73	WAPA R.M.	1	420	54.5212
76502	SPFSHPRK 69.000	73	WAPA R.M.	0	0	0
79015	CRAIG 1 22.000	73	WAPA R.M.	1	451	18.2225
79016	CRAIG 2 22.000	73	WAPA R.M.	1	451	18.2225
79017	CRAIG 3 22.000	73	WAPA R.M.	1	479	-32
79019	MORRO1-2 12.500	73	WAPA R.M.	1	60	-21.1386
79019	MORRO1-2 12.500	73	WAPA R.M.	1	60	-21.1386
79040	HAYDEN1 18.000	73	WAPA R.M.	1	183	-11.353
79041	HAYDEN2 22.000	73	WAPA R.M.	1	260	130
79123	FONTNLLE 4.1600	73	WAPA R.M.	1	5	2.8031
79154	FLGORG1 11.500	73	WAPA R.M.	1	35	-5.6219
79155	FLGORG2 11.500	73	WAPA R.M.	1	35	-5.6219
79156	FLGORG3 11.500	73	WAPA R.M.	1	35	-5.6219
79157	BMESA1-2 11.000	73	WAPA R.M.	1	25	-11.5
79157	BMESA1-2 11.000	73	WAPA R.M.	1	25	-11.5
79158	NUCLA 1 13.800	73	WAPA R.M.	0	0	0
79159	NUCLA 2 13.800	73	WAPA R.M.	0	0	0
79160	NUCLA 3 13.800	73	WAPA R.M.	0	0	0
79161	NUCLA 4 13.800	73	WAPA R.M.	0	0	0
79162	CRYSTAL 12.500	73	WAPA R.M.	1	25	3.3599
79164	TOWAOC 6.9000	73	WAPA R.M.	1	6	-3.4508
79166	MOLINA-L 4.2000	73	WAPA R.M.	1	2	1.7772
79172	MOLINA-U 4.2000	73	WAPA R.M.	1	4	0.9149
79176	MCPHEE 2.4000	73	WAPA R.M.	1	1	0
79251	QFATLAS1 13.800	73	WAPA R.M.	0	0	0
79251	QFATLAS1 13.800	73	WAPA R.M.	0	0	0
79252	QFATLAS2 13.800	73	WAPA R.M.	0	0	0

Bus Number	Bus Name	Area Num	Area Name	In Service	PGen (MW)	QGen (Mvar)
79252	QFATLAS2 13.800	73	WAPA R.M.	0	0	0

Table 12: Benchmark Case Generation

APPENDIX E: Line Ratings for the 44 kV Transmission System

Branch Name	Rating (MVA)	Line Length (mi.)
Weld bus to Breaker 16L003	48.0	0
Weld bus to Breaker 16L004	48.0	0
Continental to Continental Tap	22.0	5.75
Continental Tap to Ault #2	22.0	0.3
Bus Tie at Ault	48.0	0
Ault Tap to Ault #1	48.0	7.4
Ault Tap to Eaton #2	48.0	2.5
Bus Tie at Eaton	48.0	0
Eaton #1 to Eaton Tap	48.0	0.5
Eaton Tap to Continental Tap	22.0	5.5
Boyd Jct. to Eaton Tap	48.0	5.8
Boyd Jct. to Mumper Hill	48.0	4.4
16L004 to Boyd Jct.*1	42.0	6.9
Mumper Hill to Cowherd Corner	48.0	0.5
Mumper Hill to Monfort Packing Plant	48.0	0.7
Monfort Tap to Cowherd Corner	48.0	0.7
Cowherd Corner to PV Tap	48.0	0.5
PV Tap to Pleasant Valley	48.0	2.5
Bus tie between PV tap and PV tap 2 (Should be a single switch, 2 spans)	48.0	0
PV Tap 2 to Pleasant Valley	48.0	2.5
PV Tap 2 to Ault Tap	48.0	4.5
Monfort Tap to Weber Tap	48.0	1.6
Weber Tap to Evans Tap	48.0	4.4
Evans Tap to Evans	48.0	0.5
Evans Tap to Greeley Tap	48.0	0.8
Greeley Tap to Greeley	48.0	2.3
Greeley Tap to Brantner Tap	48.0	2
Brantner Tap to Lasalle Tap	48.0	1.7
Tap at Lasalle	48.0	0
Lasalle Tap to McMillen Corner	22.0	3.7
McMillen Corner to Box Elder	22.0	9
Brantner Tap to Highland Tap	48.0	3.3
Highland Tap to Highland	48.0	1
Highland Tap to 16L003 *2	42.0	5.1
Monfort 44 kV to Monfort Tap	48.0	0.5
Monfort Packing Plant to Monfort 44 kV	48.0	0.7

Table 13: Line Rating for the 44 kV Transmission System in Greeley

APPENDIX F: Steady State Power Flow and Voltage Automation Files

Contingencies

SINGLE BRANCH IN SUBSYSTEM Greeley
SINGLE MACHINE IN SUBSYSTEM Greeley

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contingency DBL_CKT_001                 / Weld - Boomerang - Rosedale 115kV common tower outage (breaker to breaker)
  trip bus 70475                                / Trip Arrowhead Lake 115kV (breaker to breaker)
  trip bus 73554                                / Trip Boomerang 115kV (breaker to breaker)

contingency DBL_CKT_002                 / Ault - Weld 230kV common tower outage
  open branch from bus 73011 to bus 73212 ckt 1
  open branch from bus 73011 to bus 73212 ckt 2

contingency BUS_FAULT_001               / Weld LM 115kV bus fault (breaker to breaker for Weld - Boomerang - Rosedale 115kV)
  trip bus 73211                                / Trip WAPA Weld 115kV
  trip bus 73554                                / Trip Boomerang 115kV (breaker to breaker)

contingency BUS_FAULT_002               / Monfort 115kV main bus fault
  trip bus 70290                                / Trip Monfort 115kV

contingency P4_BREAKER_FAILURE_001              / PSCo 230/115kV transformer failure followed by breaker 5221 failure
  open branch from bus 70470 to bus 70471 ckt T2
  trip bus 73212

contingency P4_BREAKER_FAILURE_002              / Breaker 2186 failure at Ault
  open branch from bus 72404 to bus 73011 ckt 1
  trip bus 70474                                / Trip Windsor 230kV (breaker to breaker)

contingency P4_BREAKER_FAILURE_003              / Breaker failure at Greeley 115kV
  open branch from bus 70209 to bus 70470 ckt 1
  open branch from bus 70209 to bus 70202 ckt 1
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Subsystem

SUBSYSTEM NECO
AREA 70
AREA 73

SUBSYSTEM Greeley
ZONE 700
ZONE 703
ZONE 706
ZONE 754
ZONE 752
ZONE 780

Monitor

MONITOR BRANCHES IN SUBSYSTEM NECO 3WLOWVOLTAGE
MONITOR VOLTAGE RANGE SUBSYSTEM NECO 0.95 1.05
MONITOR VOLTAGE DEVIATION SUBSYSTEM NECO 0.08

APPENDIX G: Steady State Power Flow Results Tables

System Intact Overloads (N-0)

			0-01		1-01		2-01		3-01		5-01 (0-10)	
Monitered Element	***Contingency***	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
SYSTEM INTACT OVERLOADS (N-0)												
70290 MONFORT 115.00 70844 MONFORT 46.000 T1	NONE	60	63	105.4							63	105.2

Table 14: Case Comparison of System Intact Overloads

Single Contingency Overloads (N-1)

			0-01		1-01		2-01		3-01		5-01 (0-10)	
Monitered Element	***Contingency***	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
SINGLE CONTINGENCY OUTAGES (N-1)												
70290 MONFORT 115.00 70844 MONFORT 46.000 T1	OPEN LINE FROM BUS 70835 [P.V. TAP 44.000] TO BUS 70836 [P.V. TAP 2 44.000] CKT 1	60									64	107.10%
73211 WELD LM 115.00 73212 WELD LM 230.00 1	OPEN LINE FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2	150	173	115.50%							153	102.20%
73211 WELD LM 115.00 73212 WELD LM 230.00 3	OPEN LINE FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2	150	167	111.50%								

Table 15: Case Comparison of Single Contingency Overloads

Multiple Contingency Overloads

			0-01		1-01		2-01		3-01		5-01 (0-10)	
Monitered Element	***Contingency***	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
MULTIPLE CONTINGENCY OUTAGES												
70290 MONFORT 115.00 70805 LEPRINO_PS 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1		188	107.40%							188	104.40%
70290 MONFORT 115.00 70844 MONFORT 46.000 T1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		65	107.80%								
70368 ROSEDALE 115.00 70439 UNC 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1		203	115.90%								
70368 ROSEDALE 115.00 73055 KERSEY_W 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		140	130.20%								
70439 UNC 115.00 70805 LEPRINO_PS 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1		203	115.80%							203	112.30%
70470 WELD_PS 115.00 70471 WELD_PS 230.00 T2	OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73554 [BOOMERNG 115.00] CKT 1 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73558 [WHITNEY 115.00] CKT 1 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73212 [WELD LM 230.00] CKT 1 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73212 [WELD LM 230.00] CKT 3 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN LINE FROM BUS 73554 [BOOMERNG 115.00] TO BUS 70368 [ROSEDALE 115.00] CKT 1		303	108.10%								

			0-01		1-01		2-01		3-01		5-01 (0-10)	
Monitered Element	***Contingency***	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
MULTIPLE CONTINGENCY OUTAGES												
73002 AIRPORT 115.00 73026 BOYD 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		316	203.50%	201	123.60%	175	107.20%	176	107.80%	272	170.20%
3002 AIRPORT 115.00 73433 WINDSORT 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		253	165.90%							212	134.10%
73095 KERSEYTP 115.00 73543 WILLOBY 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		114	103.70%								
73211 WELD LM 115.00 73554 BOOMERNG 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1		124	104.00%								
73211 WELD LM 115.00 73558 WHITNEY 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		187	125.80%								

			0-01		1-01		2-01		3-01		5-01 (0-10)	
Monitered Element	***Contingency***	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
MULTIPLE CONTINGENCY OUTAGES												
73433 WINDSORT 115.00 73558 WHITNEY 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		230	152.70%							191	121.60%
70901 NEW AULT 115.00 70902 NEW EATON 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3								218	100.00%		

Table 16: Case Comparison of Select Multiple Contingency Overloads

APPENDIX H: Steady State Voltage Results Tables

System Intact Voltages Above 1.05

None

System Intact Voltage Below 0.95

None

Single Contingency Voltage Above 1.10

None

Single Contingency Voltages Below 0.90

		0-01	1-01	2-01	3-01	5-01 (0-10)
Monitered Element	***Contingency***	Voltage (pu)	Voltage (pu)	Voltage (pu)	Voltage (pu)	Voltage (pu)
SINGLE CONTINGENCY VOLTAGES BELOW 0.90						
73031 BRUSHTAP 115.00	OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1	0.89735				
73305 EFMORGTP 115.00	OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1	0.89736				
73309 HENDERSON 115.00	OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1	0.897				
73310 FME 115.00	OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1	0.89582				
73311 FMS 115.00	OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1	0.89918				
73377 EXCEL 115.00	OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1	0.89508				
73378 FMN 115.00	OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1	0.89736				
73379 FMWEST 115.00	OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1	0.89919				

Table 17: Case Comparison of Single Contingency Voltage Below 0.90

Multiple Contingency Voltages Below 0.90

		0-01	1-01	2-01	3-01	5-01 (0-10)
Monitered Element	*Contingency*	Voltage (pu)	Voltage (pu)	Voltage (pu)	Voltage (pu)	Voltage (pu)
SINGLE CONTINGENCY VOLTAGES BELOW 0.90						
70202 GODFRETP 115.00	BREAKER_FAILURE_001	0.89296				
70209 GREELEY 115.00	BREAKER_FAILURE_001	0.8929				
70210 GREELEY1 46.000	BREAKER_FAILURE_001	0.89789				
70240 JOHNSTN 115.00	BREAKER_FAILURE_001	0.89263				
70246 JOHNSTN2 115.00	BREAKER_FAILURE_001	0.89262				
70290 MONFORT 115.00	BREAKER_FAILURE_001	0.88861				
70368 ROSEDALE 115.00	BREAKER_FAILURE_001	0.89429				
70439 UNC 115.00	BREAKER_FAILURE_001	0.8919				
70469 WELD 46.000	BREAKER_FAILURE_001	0.89742				
70470 WELD_PS 115.00	BREAKER_FAILURE_001	0.89779				
70475 ARROWHLK 115.00	BREAKER_FAILURE_001	0.89327				
70805 LEPRINO_PS 115.00	BREAKER_FAILURE_001	0.89046				
70899 LUCERENE 115.00	BREAKER_FAILURE_001	0.88749				
73211 WELD_LM 115.00	BREAKER_FAILURE_001	0.89788				
73554 BOOMERNG 115.00	BREAKER_FAILURE_001	0.8972				
70801 16L003 44.000	BREAKER_FAILURE_001	0.89742				
70802 16L004 44.000	BREAKER_FAILURE_001	0.89742				
70803 CONTINTL 44.000	BREAKER_FAILURE_001	0.82641				0.87765
70804 CONTINTP 44.000	BREAKER_FAILURE_001	0.83697				0.88758
70808 AULT2 44.000	BREAKER_FAILURE_001	0.83599				0.88666
70810 AULT1 44.000	BREAKER_FAILURE_001	0.8419				
70812 AULT TAP 44.000	BREAKER_FAILURE_001	0.84663				
70817 EATON2 44.000	BREAKER_FAILURE_001	0.83928				
70819 EATON1 44.000	BREAKER_FAILURE_001	0.84845				0.89837
70818 EATONTAP 44.000	BREAKER_FAILURE_001	0.84924				0.89912
70827 BOYD JCT 44.000	BREAKER_FAILURE_001	0.87211				
70828 MUMPERHL 44.000	BREAKER_FAILURE_001	0.87213				
70831 COWHERD 44.000	BREAKER_FAILURE_001	0.86728				
70835 P.V. TAP 44.000	BREAKER_FAILURE_001	0.86322				
70836 P.V. TAP 2 44.000	BREAKER_FAILURE_001	0.86322				
70838 PLEASVAL 44.000	BREAKER_FAILURE_001	0.85789				
70839 MONFORTP 44.000	BREAKER_FAILURE_001	0.87302				
70844 MONFORT 46.000	BREAKER_FAILURE_001	0.87724				
70845 MONFPACK 44.000	BREAKER_FAILURE_001	0.87073				
70846 WEBERTAP 44.000	BREAKER_FAILURE_001	0.87923				
70849 EVANSTAP 44.000	BREAKER_FAILURE_001	0.87919				
70852 GREELYTP 44.000	BREAKER_FAILURE_001	0.8828				
70857 BRANTNER 44.000	BREAKER_FAILURE_001	0.87821				
70861 LASALLTP 44.000	BREAKER_FAILURE_001	0.87432				
70865 LASALLE 44.000	BREAKER_FAILURE_001	0.87432				
70866 MCMILLEN 44.000	BREAKER_FAILURE_001	0.86578				
70870 BOXELDER 44.000	BREAKER_FAILURE_001	0.84481				0.89915
70871 HIGHLDTP 44.000	BREAKER_FAILURE_001	0.8875				
70875 HIGHLAND 44.000	BREAKER_FAILURE_001	0.88536				
70877 EVANS 44.000	BREAKER_FAILURE_001	0.87696				
70903 CLOVERLY 115.00	BREAKER_FAILURE_001	0.88662				

Table 18: Case Comparison of Multiple Contingency Voltages Below 0.90

BREAKER_FAILURE_001:
OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2
OPEN LINE FROM BUS 73212 [WELD_LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1
OPEN LINE FROM BUS 73212 [WELD_LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1
OPEN LINE FROM BUS 73212 [WELD_LM 230.00] TO BUS 73211 [WELD_LM 115.00] CKT 1

Multiple Contingency Voltage Deviation Beyond 0.08

Monitered Element	Contingency	0-01 Voltage (pu)	1-01 Voltage (pu)	2-01 Voltage (pu)	3-01 Voltage (pu)	5-01 (0-10) Voltage (pu)
SINGLE CONTINGENCY VOLTAGES DEVIATION BEYOND 0.08						
70202 GODFRETP 115.00	BREAKER_FAILURE_001	0.89296				
70209 GREELEY 115.00	BREAKER_FAILURE_001	0.8929				
70210 GREELEY1 46.000	BREAKER_FAILURE_001	0.89789				
70240 JOHNSTN 115.00	BREAKER_FAILURE_001	0.89263				
70246 JOHNSTN2 115.00	BREAKER_FAILURE_001	0.89262				
70290 MONFORT 115.00	BREAKER_FAILURE_001	0.88861				
70368 ROSEDALE 115.00	BREAKER_FAILURE_001	0.89429				
70439 UNC 115.00	BREAKER_FAILURE_001	0.8919				
70469 WELD 46.000	BREAKER_FAILURE_001	0.89742				
70470 WELD_PS 115.00	BREAKER_FAILURE_001	0.89779				
70475 ARROWHLK 115.00	BREAKER_FAILURE_001	0.89327				
70805 LEPRINO_PS 115.00	BREAKER_FAILURE_001	0.89046				
70899 LUCERENE 115.00	BREAKER_FAILURE_001	0.88749				
73098 KODAK 115.00	BREAKER_FAILURE_001	0.90657				
73211 WELD_LM 115.00	BREAKER_FAILURE_001	0.89788				
73218 WINDSOR 115.00	BREAKER_FAILURE_001	0.91683				
73433 WINDSORT 115.00	BREAKER_FAILURE_001	0.91792				
73554 BOOMERNG 115.00	BREAKER_FAILURE_001	0.8972				
73555 BRACEWLL 115.00	BREAKER_FAILURE_001	0.9063				
73558 WHITNEY 115.00	BREAKER_FAILURE_001	0.90659				
70801 16L003 44.000	BREAKER_FAILURE_001	0.89742				
70802 16L004 44.000	BREAKER_FAILURE_001	0.89742				
70803 CONTINTL 44.000	BREAKER_FAILURE_001	0.82641				0.87765
70804 CONTINTP 44.000	BREAKER_FAILURE_001	0.83697				0.88758
70808 AULT2 44.000	BREAKER_FAILURE_001	0.83599				0.88666
70810 AULT1 44.000	BREAKER_FAILURE_001	0.8419				0.90593
70812 AULT TAP 44.000	BREAKER_FAILURE_001	0.84663				0.91031
70817 EATON2 44.000	BREAKER_FAILURE_001	0.83928				0.90349
70819 EATON1 44.000	BREAKER_FAILURE_001	0.84845				0.89837
70818 EATONTAP 44.000	BREAKER_FAILURE_001	0.84924				0.89912
70827 BOYD JCT 44.000	BREAKER_FAILURE_001	0.87211				
70828 MUMPERHL 44.000	BREAKER_FAILURE_001	0.87213				
70831 COWHERD 44.000	BREAKER_FAILURE_001	0.86728				
70835 P.V. TAP 44.000	BREAKER_FAILURE_001	0.86322				0.9256
70836 P.V. TAP 2 44.000	BREAKER_FAILURE_001	0.86322				0.9256
70838 PLEASVAL 44.000	BREAKER_FAILURE_001	0.85789				0.92064
70839 MONFORTP 44.000	BREAKER_FAILURE_001	0.87302				
70844 MONFORT 46.000	BREAKER_FAILURE_001	0.87724				
70845 MONFPACK 44.000	BREAKER_FAILURE_001	0.87073				
70846 WEBERTAP 44.000	BREAKER_FAILURE_001	0.87923				
70849 EVANSTAP 44.000	BREAKER_FAILURE_001	0.87919				
70852 GREELYTP 44.000	BREAKER_FAILURE_001	0.8828				
70857 BRANTNER 44.000	BREAKER_FAILURE_001	0.87821				
70861 LASALLTP 44.000	BREAKER_FAILURE_001	0.87432				
70865 LASALLE 44.000	BREAKER_FAILURE_001	0.87432				
70866 MCMILLEN 44.000	BREAKER_FAILURE_001	0.86578				
70870 BOXELDER 44.000	BREAKER_FAILURE_001	0.84481				
70871 HIGHLDTP 44.000	BREAKER_FAILURE_001	0.8875				
70875 HIGHLAND 44.000	BREAKER_FAILURE_001	0.88536				
70877 EVANS 44.000	BREAKER_FAILURE_001	0.87696				
70903 CLOVERLY 115.00	BREAKER_FAILURE_001	0.88662				

Table 19: Case Comparison of Multiple Contingency Voltage Deviations Beyond 0.08

BREAKER_FAILURE_001:
OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2
OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1
OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1
OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1

APPENDIX I: Generation Adjustments for Sensitivities

Benchmark High TOT7 Generation Adjustments

Generation Decreases					Generation Increases					Area Interchange			
Unit	Bus No.	Initial (MW)	Adjusted (MW)	Delta (MW)	Unit	Bus No.	Initial (MW)	Adjusted (MW)	Delta (MW)	Area	Initial (MW)	Adjusted (MW)	Delta (MW)
St. Vrain G1	70409	342	35	-307	Lamar DC Tie	70560	101	210	109	73	636.07	1269.07	633
St. Vrain G2	70406	130	0	-130	Manchief G1	70314	130	140	10	70	-110.16	-1043.16	-933
St. Vrain G3	70407	130	0	-130	Manchief G2	70315	130	140	10	40	3956.17	4256.17	300
St. Vrain G4	70408	130	0	-130	Morrow Point G1	79019	60	81	21				0
St. Vrain G5	70950	150	0	-150	Morrow Point G2	79019	60	81	21				0
St. Vrain G6	70951	150	0	-150	BHP G1	74399	0	100	100				0
Cherokee G7	70147	240	140	-100	Yellowtail G1	73226	50	65	15				0
Cherokee G6	70146	160	110	-50	Yellowtail G2	73226	50	65	15				0
Cherokee G5	70145	160	110	-50	Yellowtail G3	73227	50	65	15				0
				0	Yellowtail G4	73227	50	65	15				0
				0	Flaming Gorge 1	79154	35	55	20				0
				0	Flaming Gorge 2	79155	35	55	20				0
				0	Flaming Gorge 3	79156	35	55	20				0
				0	Grand Coulee	40298	0	697.7	697.7				0
				0	Pawnee C1	70310	505	530	25				0
				0	Hayden 2	79041	260	286	26				0
				0	Hayden 1	79040	183	212	29				0
				0	Dry Fork	76404	420	440	20				0
				0	Rawhide A	70351	63	70	7				0
				0	Rawhide D	70567	0	70	70				0
				0	Rawhide B	70568	63	70	7				0
				0	Rawhide C	70568	63	70	7				0
				0	Rawhide F	70561	123	138	15				0
				0	RCDC	76351	100	200	100				0
Total				-1197					1395				0

Table 20: Benchmark High TOT7 Generation Adjustments

Alternative 1 High TOT7 Generation Adjustments

Generation Decreases					Generation Increases					Area Interchange			
Unit	Bus No.	Initial (MW)	Adjusted (MW)	Delta (MW)	Unit	Bus No.	Initial (MW)	Adjusted (MW)	Delta (MW)	Area	Initial (MW)	Adjusted (MW)	Delta (MW)
St. Vrain G1	70409	342	35	-307	Lamar DC Tie	70560	101	210	109	73	636.07	1269.07	633
St. Vrain G2	70406	130	0	-130	Manchief G1	70314	130	140	10	70	-110.16	-1043.16	-933
St. Vrain G3	70407	130	0	-130	Manchief G2	70315	130	140	10	40	3956.17	4256.17	300
St. Vrain G4	70408	130	0	-130	Morrow Point G1	79019	60	81	21				0
St. Vrain G5	70950	150	0	-150	Morrow Point G2	79019	60	81	21				0
St. Vrain G6	70951	150	0	-150	BHP G1	74399	0	100	100				0
Cherokee G7	70147	240	140	-100	Yellowtail G1	73226	50	65	15				0
Cherokee G6	70146	160	110	-50	Yellowtail G2	73226	50	65	15				0
Cherokee G5	70145	160	110	-50	Yellowtail G3	73227	50	65	15				0
				0	Yellowtail G4	73227	50	65	15				0
				0	Flaming Gorge 1	79154	35	55	20				0
				0	Flaming Gorge 2	79155	35	55	20				0
				0	Flaming Gorge 3	79156	35	55	20				0
				0	Grand Coulee	40298	0	697.7	697.7				0
				0	Pawnee C1	70310	505	530	25				0
				0	Hayden 2	79041	260	286	26				0
				0	Hayden 1	79040	183	212	29				0
				0	Dry Fork	76404	420	440	20				0
				0	Rawhide A	70351	63	70	7				0
				0	Rawhide D	70567	0	70	70				0
				0	Rawhide B	70568	63	70	7				0
				0	Rawhide C	70568	63	70	7				0
				0	Rawhide F	70561	123	138	15				0
				0	RCDC	76351	100	200	100				0
Total				-1197					1395				0

Table 21: Alternative 1 High TOT7 Generation Adjustments

Alternative 1 High Load Generation Adjustments

Generation Decreases					Generation Increases					Area Interchange			
Unit	Bus No.	Initial (MW)	Adjusted (MW)	Delta (MW)	Unit	Bus No.	Initial (MW)	Adjusted (MW)	Delta (MW)	Area	Initial (MW)	Adjusted (MW)	Delta (MW)
				0					0	73	636.07	836.07	200
				0					0	70	-110.16	-310.16	-200
Total				0					0				0

Table 22: Alternative 1 High Load Generation Adjustments

Alternative 1 High Load and High TOT7 Generation Adjustments

Generation Decreases					Generation Increases					Area Interchange			
Unit	Bus No.	Initial (MW)	Adjusted (MW)	Delta (MW)	Unit	Bus No.	Initial (MW)	Adjusted (MW)	Delta (MW)	Area	Initial (MW)	Adjusted (MW)	Delta (MW)
St. Vrain G1	70409	342	35	-307	Lamar DC Tie	70560	101	210	109	73	636.07	1319.07	683
St. Vrain G2	70406	130	0	-130	Manchief G1	70314	130	140	10	70	-110.16	-1143.16	-1033
St. Vrain G3	70407	130	0	-130	Manchief G2	70315	130	140	10	40	3956.17	4306.17	350
St. Vrain G4	70408	130	0	-130	Morrow Point G1	79019	60	81	21				0
St. Vrain G5	70950	150	0	-150	Morrow Point G2	79019	60	81	21				0
St. Vrain G6	70951	150	0	-150	BHP G1	74399	0	100	100				0
Cherokee G7	70147	240	140	-100	Yellowtail G1	73226	50	65	15				0
				0	Yellowtail G2	73226	50	65	15				0
				0	Yellowtail G3	73227	50	65	15				0
				0	Yellowtail G4	73227	50	65	15				0
				0	Flaming Gorge 1	79154	35	55	20				0
				0	Flaming Gorge 2	79155	35	55	20				0
				0	Flaming Gorge 3	79156	35	55	20				0
				0	Grand Coulee	40298	0	697.7	697.7				0
				0	Pawnee C1	70310	505	530	25				0
				0	Hayden 2	79041	260	286	26				0
				0	Hayden 1	79040	183	212	29				0
				0	Dry Fork	76404	420	440	20				0
				0	Rawhide A	70351	63	70	7				0
				0	Rawhide D	70567	0	70	70				0
				0	Rawhide B	70568	63	70	7				0
				0	Rawhide C	70568	63	70	7				0
				0	Rawhide F	70561	123	138	15				0
				0	RCDC	76351	100	200	100				0
				0	RMEC 3	70591	300	322	22				0
				0	Craig 3	79017	451	479	28				0
				0	Sidney DC	73181	196	200	4				0
Total				-1097					1449				0

Table 23: Alternative 1 High Load and High TOT7 Generation Adjustments

APPENDIX J: Sensitivity Steady State Power Flow Results Tables

Benchmark Sensitivity Tables

System Intact Overloads (N-0)

			NO ALTERNATIVE 1 (NORTHERN GREELEY)											
			0-01		0-02		0-03		0-04		0-09		0-10	
Monitered Element	*Contingency*	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
SYSTEM INTACT OVERLOADS (N-0)														
70290 MONFORT 115.00 70844 MONFORT 46.000 T1	NONE	60	63.24	105.4	63.2	105.34	63	105.6	63	105.5	63.00	105.40	63	105.2

Table 24: Comparison of System Intact Overloads for the Benchmark Case Sensitivity Analysis

Single Contingency Overloads (N-1)

			NO ALTERNATIVE 1 (NORTHERN GREELEY)											
			0-01		0-02		0-03		0-04		0-09		0-10	
Monitered Element	*Contingency*	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
SINGLE CONTINGENCY OUTAGES (N-1)														
70290 MONFORT 115.00 70844 MONFORT 46.000 T1	OPEN LINE FROM BUS 70835 [P.V. TAP 44.000] TO BUS 70836 [P.V. TAP 2 44.000] CKT 1				64.38	107.3			64.46	107.44			64.25	107.08
70290 MONFORT 115.00 70899 LUCERENE 115.00 1	OPEN LINE FROM BUS 70898 [NEW AULT 230.00] TO BUS 73011 [AULT 230.00] CKT 1													
70463 WATERTON 115.00 70484 MARTN2TP 115.00 1	OPEN LINE FROM BUS 70018 [SODALAKE 230.00] TO BUS 70400 [SODALAKE 115.00] CKT T2						130.81	104.28	130.7	104.2				
73011 AULT 230.00 73212 WELD LM 230.00 1	OPEN LINE FROM BUS 73011 [AULT 230.00] TO BUS 73212 [WELD LM 230.00] CKT 2						573.97	111.78	579.06	112.72				
73011 AULT 230.00 73212 WELD LM 230.00 2	OPEN LINE FROM BUS 73011 [AULT 230.00] TO BUS 73212 [WELD LM 230.00] CKT 1						573.97	111.78	579.06	112.72				
73179 SIDNEY 115.00 73180 SIDNEY 230.00 1	OPEN LINE FROM BUS 73143 [N.YUMA 230.00] TO BUS 73579 [SPRNGCAN 230.00] CKT 1						224.43	110.56	224.29	110.49	204.00	100.30		
73211 WELD LM 115.00 73212 WELD LM 230.00 1	OPEN LINE FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2		173.29	115.52	170.53	113.69					174.00	116.10	153.35	102.23
73211 WELD LM 115.00 73212 WELD LM 230.00 1	OPEN LINE FROM BUS 70471 [WELD_PS 230.00] TO BUS 73212 [WELD LM 230.00] CKT 1						207.59	138.39	212.4	141.6				
73211 WELD LM 115.00 73212 WELD LM 230.00 3	OPEN LINE FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2		167.24	111.49	164.94	109.96					168.00	112.10		
73211 WELD LM 115.00 73212 WELD LM 230.00 3	OPEN LINE FROM BUS 70471 [WELD_PS 230.00] TO BUS 73212 [WELD LM 230.00] CKT 1						203.25	135.5	208.64	139.09				

Table 25: Comparison of Single Contingency Overloads for the Benchmark Case Sensitivity Analysis

Multiple Contingency Overloads

			NO ALTERNATIVE 1 (NORTHERN GREELEY)													
			0-01		0-02		0-03		0-04		0-09		0-10			
Monitered Element	***Contingency***	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)		
MULTIPLE CONTINGENCY OUTAGES																
70191 FTLUPTON 115.00 70192 FTLUPTON 230.00 T1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3				273.06	100.02									
70290 MONFORT 115.00 70805 LEPRINO_PS 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1		187.59	107.4	187.62	107.22	187.38	108.92	187.4	108.7	188.00	107.60	188.37	104.36		
70290 MONFORT 115.00 70844 MONFORT 46.000 T1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		64.69	107.82			64.71	107.85			65.00	107.90				
70368 ROSEDALE 115.00 70439 UNC 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1		203.39	115.94	203.39	115.73	203.45	117.65	203.44	117.4	203.00	116.20				
70368 ROSEDALE 115.00 73055 KERSEY_W 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		139.69	130.17			131.05	122.83			139.00	130.10				

			NO ALTERNATIVE 1 (NORTHERN GREELEY)											
			0-01		0-02		0-03		0-04		0-09		0-10	
Monitered Element	***Contingency***	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
MULTIPLE CONTINGENCY OUTAGES														
70368 ROSEDALE 115.00 73554 BOOMERNG 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1						116.46	101.58						
70439 UNC 115.00 70805 LEPRINO_PS 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1		202.53	115.77	202.54	115.56	202.48	117.47	202.49	117.23	203.00	116.00	202.93	112.31
70470 WELD_PS 115.00 70471 WELD_PS 230.00 T2	OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73554 [BOOMERNG 115.00] CKT 1 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73558 [WHITNEY 115.00] CKT 1 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73212 [WELD LM 230.00] CKT 1 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73212 [WELD LM 230.00] CKT 3 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN LINE FROM BUS 73554 [BOOMERNG 115.00] TO BUS 70368 [ROSEDALE 115.00] CKT 1		302.77	108.13	296.79	106	307.32	109.76	314.34	112.26	304.00	108.60		
73002 AIRPORT 115.00 73026 BOYD 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		315.87	203.53	261.03	163.07	318.54	208.47	275.39	174.02	317.00	204.50	271.98	170.22
73002 AIRPORT 115.00 73433 WINDSORT 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		252.72	165.86	201.32	127.04	257.48	170.81	219.43	138.66	253.00	166.70	212.1	134.15

			NO ALTERNATIVE 1 (NORTHERN GREELEY)											
			0-01		0-02		0-03		0-04		0-09		0-10	
Monitered Element	*Contingency*	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
MULTIPLE CONTINGENCY OUTAGES														
73095 KERSEYTP 115.00 73543 WILLOBY 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		113.62	103.69			122.9	111.54			115.00	105.10		
73211 WELD LM 115.00 73554 BOOMERNG 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1		124.45	103.99	123.1	102.63	128.74	108.84	126.39	106.6	125.00	104.70		
73211 WELD LM 115.00 73558 WHITNEY 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		187.48	125.79			196.21	131.4	160.76	102.65	188.00	126.50		
73433 WINDSORT 115.00 73558 WHITNEY 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		229.85	152.73	180.21	114.52	235.45	157.68	198.85	126.39	230.00	153.60	190.86	121.6
70898 NEW AULT 230.00 70901 NEW AULT 115.00 T1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3													
70901 NEW AULT 115.00 70902 NEW EATON 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3													

Table 26: Comparison of Multiple Contingency Overloads for the Benchmark Case Sensitivity Analysis

Alternative 1 Sensitivity Tables

System Intact Overloads (N-0)

			WITH ALTERNATIVE 1 (NORTHERN GREELEY)																	
			1-01		1-02		1-03		1-04		1-05		1-06		1-07		1-09		1-10	
Monitered Element	*Contingency*	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
SYSTEM INTACT OVERLOADS (N-0)																				
70290 MONFORT 115.00 70844 MONFORT 46.000 T1	NONE	60																		

Table 27: Comparison of System Intact Overloads for the Alternative 1 Case Sensitivity Analysis

Single Contingency Overloads (N-1)

			WITH ALTERNATIVE 1 (NORTHERN GREELEY)																	
			1-01		1-02		1-03		1-04		1-05		1-06		1-07		1-09		1-10	
Monitered Element	*Contingency*	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
SINGLE CONTINGENCY OUTAGES (N-1)																				
70290 MONFORT 115.00 70844 MONFORT 46.000 T1	OPEN LINE FROM BUS 70835 [P.V. TAP 44.000] TO BUS 70836 [P.V. TAP 2 44.000] CKT 1																			
70290 MONFORT 115.00 70899 LUCERENE 115.00 1	OPEN LINE FROM BUS 70898 [NEW AULT 230.00] TO BUS 73011 [AULT 230.00] CKT 1										216.79	102.65	217.04	104.15	216.93	103.49				
70463 WATERTON 115.00 70484 MARTN2TP 115.00 1	OPEN LINE FROM BUS 70018 [SODALAKE 230.00] TO BUS 70400 [SODALAKE 115.00] CKT T2						130.64	104.11	130.48	103.98			129.45	103.22	129.32	103.12				
73011 AULT 230.00 73212 WELD_LM 230.00 1	OPEN LINE FROM BUS 73011 [AULT 230.00] TO BUS 73212 [WELD_LM 230.00] CKT 2												516.47	101.01	521.92	102.05				
73011 AULT 230.00 73212 WELD_LM 230.00 2	OPEN LINE FROM BUS 73011 [AULT 230.00] TO BUS 73212 [WELD_LM 230.00] CKT 1												516.47	101.01	521.92	102.05				
73179 SIDNEY 115.00 73180 SIDNEY 230.00 1	OPEN LINE FROM BUS 73143 [N.YUMA 230.00] TO BUS 73579 [SPRNGCAN 230.00] CKT 1						222.27	109.49	222.06	109.39			225.27	110.97	225.1	110.88				
73211 WELD_LM 115.00 73212 WELD_LM 230.00 1	OPEN LINE FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2																			
73211 WELD_LM 115.00 73212 WELD_LM 230.00 1	OPEN LINE FROM BUS 70471 [WELD_PS 230.00] TO BUS 73212 [WELD_LM 230.00] CKT 1						176.07	117.38	182.31	121.54			183.99	122.66	189.01	126.01				
73211 WELD_LM 115.00 73212 WELD_LM 230.00 3	OPEN LINE FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2																			
73211 WELD_LM 115.00 73212 WELD_LM 230.00 3	OPEN LINE FROM BUS 70471 [WELD_PS 230.00] TO BUS 73212 [WELD_LM 230.00] CKT 1						173.27	115.52	179.79	119.86			181.11	120.74	186.46	124.31				

Table 28: Comparison of Single Contingency Overloads for the Alternative 1 Case Sensitivity Analysis

Multiple Contingency Overloads

			WITH ALTERNATIVE 1 (NORTHERN GREELEY)																			
			1-01		1-02		1-03		1-04		1-05		1-06		1-07		1-09		1-10	
Monitered Element	***Contingency***	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
MULTIPLE CONTINGENCY OUTAGES																				
70191 FTLUPTON 115.00 70192 FTLUPTON 230.00 T1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3																			
70290 MONFORT 115.00 70805 LEPRINO_PS 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1																			
70290 MONFORT 115.00 70844 MONFORT 46.000 T1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3																			
70368 ROSEDALE 115.00 70439 UNC 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1																			
70368 ROSEDALE 115.00 73055 KERSEY_W 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3																			

			WITH ALTERNATIVE 1 (NORTHERN GREELEY)																			
			1-01		1-02		1-03		1-04		1-05		1-06		1-07		1-09		1-10	
Monitered Element	***Contingency***	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
MULTIPLE CONTINGENCY OUTAGES																				
70368 ROSEDALE 115.00 73554 BOOMERNG 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1																			
70439 UNC 115.00 70805 LEPRINO_PS 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1																			
70470 WELD_PS 115.00 70471 WELD_PS 230.00 T2	OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73554 [BOOMERNG 115.00] CKT 1 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73558 [WHITNEY 115.00] CKT 1 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73212 [WELD LM 230.00] CKT 1 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73212 [WELD LM 230.00] CKT 3 OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN LINE FROM BUS 73554 [BOOMERNG 115.00] TO BUS 70368 [ROSEDALE 115.00] CKT 1																			
73002 AIRPORT 115.00 73026 BOYD 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3		200.95	123.62	182.74	111.49	196.09	121.28	188.22	115.61	210.49	130.54	209.12	130.62	199.25	123.43	201.00	123.70	172.53	104.8
73002 AIRPORT 115.00 73433 WINDSORT 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3																			

			WITH ALTERNATIVE 1 (NORTHERN GREELEY)																	
			1-01		1-02		1-03		1-04		1-05		1-06		1-07		1-09		1-10	
Monitered Element	*Contingency*	Line Rating (MVA)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)	Flow (MVA)	Percent Loading (%)
MULTIPLE CONTINGENCY OUTAGES																				
73095 KERSEYTP 115.00 73543 WILLOBY 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3																			
73211 WELD LM 115.00 73554 BOOMERNG 115.00 1	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1 OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1																			
73211 WELD LM 115.00 73558 WHITNEY 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3																			
73433 WINDSORT 115.00 73558 WHITNEY 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3																			
70898 NEW AULT 230.00 70901 NEW AULT 115.00 T1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3												288.44	103.01	282.35	100.84				
70901 NEW AULT 115.00 70902 NEW EATON 115.00 1	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1 OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3											243.91	115.04	267.36	127.35	262.87	124.18				

Table 29: Comparison of Multiple Contingency Overloads for the Alternative 1 Case Sensitivity Analysis

APPENDIX K: Craig Unit 1 Retirement Sensitivity Data

Contingency Comparison

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E TUE, SEP 20 2016 10:26 PAGE 24

AC CONTINGENCY REPORT FOR 4 AC CONTINGENCY CALCULATION RUNS

BASE CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - ALL VIOLATIONS

% LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES

X--- MONITORED ELEMENT ----X	0-01 Ben chmark.a cc	0-09 Ben chmark - Craig 1	0-09B No Change Benchmar	0-09C Be nchmark - Craig
70290 MONFORT 115.00	105.4%	105.4%	105.4%	105.4%
70844 MONFORT 46.000 T1	63MVA	63MVA	63MVA	63MVA
73197 THERMOPL 115.00	107.5%	107.4%	107.4%	107.4%
73624 THERMOPL 34.500 1	27MVA	27MVA	27MVA	27MVA

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E TUE, SEP 20 2016 10:26 PAGE 25

AC CONTINGENCY REPORT FOR 4 AC CONTINGENCY CALCULATION RUNS

CONTINGENCY CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - WORST CASE VIOLATIONS

% LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES

THRESHOLD FOR THE COUNT OF CONTINGENCIES CAUSING OVERLOADING IS 100.0% OF RATING SET A

X--- MONITORED ELEMENT ----X	X-----LABEL----X	0-01 Ben chmark.a cc	0-09 Ben chmark - Craig 1	0-09B No Change Benchmar	0-09C Be nchmark - Craig
70023 ALLISON 115.00	SINGL1 70045-702	102.6%	102.6%	102.5%	102.8%
70400 SODALAKE 115.00 1	42(1)	159MVA (1x)	159MVA (1x)	159MVA (1x)	159MVA (1x)
70037 ARAP_B 115.00	SINGL1 70463-704	142.8%	142.9%	142.8%	143.1%
70165 ENGLE3TP 115.00 1	83(1)	169MVA (2x)	169MVA (2x)	169MVA (2x)	169MVA (2x)
70045 BANCROFT 115.00	SINGL1 70023-704	103.0%	103.0%	102.9%	103.2%
70242 KENDRICK 115.00 1	00(1)	159MVA (1x)	159MVA (1x)	159MVA (1x)	159MVA (1x)
70065 BROOMFLD 115.00	SINGL1 70110-701				108.2%
70174 FEDERHT23 115.00 1	75(1)				150MVA (1x)
70065 BROOMFLD 115.00	SINGL1 70110-701	114.7%	114.7%	114.7%	116.1%
70382 SEMPER 115.00 1	75(1)	135MVA (1x)	135MVA (1x)	135MVA (1x)	135MVA (1x)
70073 CALIFOR 115.00	SINGL1 70108-702	106.9%	107.3%	109.5%	109.8%
70108 CHEROKEE_S 115.00 1	76(1)	150MVA (2x)	150MVA (2x)	153MVA (3x)	153MVA (3x)
70087 CAPHILL 115.00	SINGL1 70039-701				103.7%
70148 DENVTM 115.00 1	08(1)				139MVA (1x)
70127 COORSREC 115.00	SINGL1 70244-704	129.0%	129.1%	129.4%	129.1%
70191 FTLUPTON 115.00 1	44(1)	155MVA (1x)	155MVA (1x)	155MVA (1x)	155MVA (1x)
70162 EAST 115.00	SINGL1 70537-705	120.0%	120.3%	118.5%	116.3%
70538 CHMBERS 115.00 1	38(1)	148MVA (1x)	148MVA (1x)	146MVA (1x)	143MVA (1x)
70290 MONFORT 115.00	P4_BREAKER_FAILU	107.4%	107.6%	107.2%	107.5%
70805 LEPRINO_PS 115.00 1	RE_003	188MVA (1x)	188MVA (1x)	188MVA (1x)	188MVA (1x)
70290 MONFORT 115.00	P4_BREAKER_FAILU	107.8%	107.9%	107.7%	107.8%
70844 MONFORT 46.000 T1	RE_001	65MVA (752x)	65MVA (752x)	65MVA (752x)	65MVA (751x)

PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E TUE, SEP 20 2016 10:26 PAGE 26

AC CONTINGENCY REPORT FOR 4 AC CONTINGENCY CALCULATION RUNS

CONTINGENCY CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - WORST CASE VIOLATIONS

% LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES

THRESHOLD FOR THE COUNT OF CONTINGENCIES CAUSING OVERLOADING IS 100.0% OF RATING SET A

X--- MONITORED ELEMENT ----X	X-----LABEL----X	0-01 Ben chmark.a cc	0-09 Ben chmark - Craig 1	0-09B No Change Benchmar	0-09C Be nchmark - Craig
70310 PAWNEE 22.000	SINGL1 70310-703	131.5%	131.6%	138.3%	138.5%
70311 PAWNEE 230.00 U1	11(U2)	478MVA (1x)	479MVA (1x)	503MVA (1x)	504MVA (1x)
70310 PAWNEE 22.000	SINGL1 70310-703	131.4%	131.6%	138.2%	138.4%

70311 PAWNEE	230.00 U2	11(U1)	478MVA (1x)	479MVA (1x)	503MVA (1x)	504MVA (1x)
70368 ROSEDALE	115.00	P4_BREAKER_FAILU	115.9%	116.2%	115.7%	116.0%
70439 UNC	115.00 1	RE_003	203MVA (1x)	203MVA (1x)	203MVA (1x)	203MVA (1x)
70368 ROSEDALE	115.00	P4_BREAKER_FAILU	130.2%	130.1%	135.6%	133.1%
73055 KERSEY_W	115.00 1	RE_001	140MVA (1x)	139MVA (1x)	146MVA (1x)	143MVA (1x)
70397 B.CRK_PS	115.00	SINGL1 70397-730	100.4%	100.3%	100.5%	100.4%
70399 B.CRK_PS	230.00 T1	20(1)	222MVA (1x)	222MVA (1x)	222MVA (1x)	222MVA (1x)
70439 UNC	115.00	P4_BREAKER_FAILU	115.8%	116.0%	115.6%	115.8%
70805 LEPRINO_PS	115.00 1	RE_003	203MVA (1x)	203MVA (1x)	203MVA (1x)	203MVA (1x)
70463 WATERTON	115.00	SINGL1 70037-701	120.5%	120.5%	120.5%	120.7%
70483 MARTN1TP	115.00 1	65(1)	168MVA (1x)	168MVA (1x)	168MVA (1x)	168MVA (1x)
70470 WELD_PS	115.00	BUS_FAULT_001	108.1%	108.6%	104.9%	106.6%
70471 WELD_PS	230.00 T2		303MVA (1x)	304MVA (1x)	294MVA (1x)	298MVA (1x)
72107 SLATERTS	115.00	SINGL1 73502-735	110.8%	111.0%	110.7%	110.9%
73049 DELCAMIN	115.00 1	03(1)	141MVA (1x)	141MVA (1x)	141MVA (1x)	141MVA (1x)
72142 REDBOX	115.00	SINGL1 72142-721	125.4%	125.4%	125.3%	125.4%
72143 REDBOX	69.000 1	43(2)	63MVA (1x)	63MVA (1x)	63MVA (1x)	63MVA (1x)
72142 REDBOX	115.00	SINGL1 72142-721	125.4%	125.4%	125.3%	125.4%
72143 REDBOX	69.000 2	43(1)	63MVA (1x)	63MVA (1x)	63MVA (1x)	63MVA (1x)

AC CONTINGENCY REPORT FOR 4 AC CONTINGENCY CALCULATION RUNS

CONTINGENCY CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - WORST CASE VIOLATIONS
% LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES
THRESHOLD FOR THE COUNT OF CONTINGENCIES CAUSING OVERLOADING IS 100.0% OF RATING SET A

X--- MONITORED ELEMENT ----X		X-----LABEL----X	0-01 Benchmark.acc	0-09 Benchmark - Craig 1	0-09B No Change Benchmar	0-09C Benchmark - Craig
73002 AIRPORT	115.00	P4_BREAKER_FAILU	203.5%	204.5%	199.1%	201.9%
73026 BOYD	115.00 1	RE_001	316MVA (1x)	317MVA (1x)	310MVA (1x)	313MVA (1x)
73002 AIRPORT	115.00	P4_BREAKER_FAILU	165.9%	166.7%	161.5%	164.1%
73433 WINDSORT	115.00 1	RE_001	253MVA (1x)	253MVA (1x)	247MVA (1x)	250MVA (1x)
73095 KERSEYTP	115.00	P4_BREAKER_FAILU	103.7%	105.1%	105.5%	106.5%
73543 WILLOBY	115.00 1	RE_001	114MVA (1x)	115MVA (1x)	116MVA (1x)	116MVA (1x)
73179 SIDNEY	115.00	SINGL1 73143-735		100.3%		
73180 SIDNEY	230.00 1	79(1)		204MVA (1x)		
73197 THERMOPL	115.00	SINGL1 70005-703	107.5%		107.4%	107.4%
73624 THERMOPL	34.500 1	97(1)	27MVA (760x)		27MVA (760x)	27MVA (759x)
73197 THERMOPL	115.00	UNIT 70310(C1)		107.5%		
73624 THERMOPL	34.500 1			27MVA (760x)		
73211 WELD LM	115.00	SINGL1 70470-704	115.5%	116.1%	112.5%	114.2%
73212 WELD LM	230.00 1	71(T2)	173MVA (2x)	174MVA (2x)	169MVA (1x)	171MVA (1x)
73211 WELD LM	115.00	SINGL1 70470-704	111.5%	112.1%	108.4%	110.1%
73212 WELD LM	230.00 3	71(T2)	167MVA (2x)	168MVA (2x)	163MVA (1x)	165MVA (1x)
73211 WELD LM	115.00	P4_BREAKER_FAILU	104.0%	104.7%		102.1%
73554 BOOMERNG	115.00 1	RE_003	124MVA (1x)	125MVA (1x)		122MVA (1x)
73211 WELD LM	115.00	P4_BREAKER_FAILU	125.8%	126.5%	121.4%	124.0%
73558 WHITNEY	115.00 1	RE_001	187MVA (1x)	188MVA (1x)	181MVA (1x)	185MVA (1x)
73433 WINDSORT	115.00	P4_BREAKER_FAILU	152.7%	153.6%	148.4%	151.0%
73558 WHITNEY	115.00 1	RE_001	230MVA (1x)	230MVA (1x)	224MVA (1x)	227MVA (1x)

AC CONTINGENCY REPORT FOR 4 AC CONTINGENCY CALCULATION RUNS

CONTINGENCY CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - WORST CASE VIOLATIONS
% LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES
THRESHOLD FOR THE COUNT OF CONTINGENCIES CAUSING OVERLOADING IS 100.0% OF RATING SET A

X--- MONITORED ELEMENT ----X	X-----LABEL----X	0-01 Benchmark.acc	0-09 Benchmark - Craig 1	0-09B No Change Benchmar	0-09C Benchmark - Craig
73502 DACONO 115.00	SINGL1 72107-730	101.7%	101.8%	101.5%	101.7%
73503 ERIE SW 115.00 1	48(1)	167MVA (1x)	167MVA (1x)	167MVA (1x)	167MVA (1x)

CONTINGENCY LEGEND:

<----- CONTINGENCY LABEL ------>	EVENTS
SINGL1 70005-70397(1)	OPEN LINE FROM BUS 70005 [BRUSH_SS 115.00] TO BUS 70397 [B.CRK_PS 115.00] CKT 1
SINGL1 70023-70400(1)	OPEN LINE FROM BUS 70023 [ALLISON 115.00] TO BUS 70400 [SODALAKE 115.00] CKT 1
SINGL1 70037-70165(1)	OPEN LINE FROM BUS 70037 [ARAP_B 115.00] TO BUS 70165 [ENGLE3TP 115.00] CKT 1
SINGL1 70039-70108(1)	OPEN LINE FROM BUS 70039 [ARGO 115.00] TO BUS 70108 [CHEROKEE_S 115.00] CKT 1
SINGL1 70045-70242(1)	OPEN LINE FROM BUS 70045 [BANCROFT 115.00] TO BUS 70242 [KENDRICK 115.00] CKT 1
SINGL1 70108-70276(1)	OPEN LINE FROM BUS 70108 [CHEROKEE_S 115.00] TO BUS 70276 [MAPLETO1 115.00] CKT 1
SINGL1 70110-70175(1)	OPEN LINE FROM BUS 70110 [CHEROKEE_N 115.00] TO BUS 70175 [FEDERHT1 115.00] CKT 1
SINGL1 70244-70444(1)	OPEN LINE FROM BUS 70244 [LAFAYETT 115.00] TO BUS 70444 [VALMONT 115.00] CKT 1
SINGL1 70310-70311(U1)	OPEN LINE FROM BUS 70310 [PAWNEE 22.000] TO BUS 70311 [PAWNEE 230.00] CKT U1
SINGL1 70310-70311(U2)	OPEN LINE FROM BUS 70310 [PAWNEE 22.000] TO BUS 70311 [PAWNEE 230.00] CKT U2
SINGL1 70397-73020(1)	OPEN LINE FROM BUS 70397 [B.CRK_PS 115.00] TO BUS 73020 [BEAVERCK 115.00] CKT 1
SINGL1 70463-70483(1)	OPEN LINE FROM BUS 70463 [WATERTON 115.00] TO BUS 70483 [MARTN1TP 115.00] CKT 1
SINGL1 70470-70471(T2)	OPEN LINE FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2
SINGL1 70537-70538(1)	OPEN LINE FROM BUS 70537 [FITZSMNS 115.00] TO BUS 70538 [CHMBERS 115.00] CKT 1
SINGL1 72107-73048(1)	OPEN LINE FROM BUS 72107 [SLATERTS 115.00] TO BUS 73048 [DEL CTAP 115.00] CKT 1
SINGL1 72142-72143(1)	OPEN LINE FROM BUS 72142 [REDBOX 115.00] TO BUS 72143 [REDBOX 69.000] CKT 1
SINGL1 72142-72143(2)	OPEN LINE FROM BUS 72142 [REDBOX 115.00] TO BUS 72143 [REDBOX 69.000] CKT 2
SINGL1 73143-73579(1)	OPEN LINE FROM BUS 73143 [N.YUMA 230.00] TO BUS 73579 [SPRNGCAN 230.00] CKT 1
SINGL1 73502-73503(1)	OPEN LINE FROM BUS 73502 [DACONO 115.00] TO BUS 73503 [ERIE SW 115.00] CKT 1
UNIT 70310(C1)	REMOVE UNIT C1 FROM BUS 70310 [PAWNEE 22.000]
BUS_FAULT_001	OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73554 [BOOMERNG 115.00] CKT 1
	OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73558 [WHITNEY 115.00] CKT 1
	OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73212 [WELD LM 230.00] CKT 1
	OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 73212 [WELD LM 230.00] CKT 3
	OPEN LINE FROM BUS 73211 [WELD LM 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1
	OPEN LINE FROM BUS 73554 [BOOMERNG 115.00] TO BUS 70368 [ROSEDALE 115.00] CKT 1
P4_BREAKER_FAILURE_001	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3
P4_BREAKER_FAILURE_003	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70470 [WELD_PS 115.00] CKT 1
	OPEN BRANCH FROM BUS 70209 [GREELEY 115.00] TO BUS 70202 [GODFRETP 115.00] CKT 1

Generation Tables

Craig Unit 1 Retirement Generation Dispatch for Sensitivity 9B

Bus Number	Bus Name	Id	Area Num	Area Name	Code	VSched (pu)	In Service	PGen (MW)	PMax (MW)
70069	CABCRKA 13.800	HA	70	PSCOLORADO	2	0.9719	1	162	162
70070	CABCRKB 13.800	HB	70	PSCOLORADO	2	0.9714	1	162	162
70106	CHEROK4 22.000	C4	70	PSCOLORADO	2	0.9861	1	383	383
70119	COMAN_1 24.000	C1	70	PSCOLORADO	2	0.9649	1	360	360
70120	COMAN_2 24.000	C2	70	PSCOLORADO	2	0.9562	1	361.6244	365
70145	CHEROKEE5 18.000	G5	70	PSCOLORADO	2	1.0316	1	168.6	168.6
70146	CHEROKEE6 18.000	G6	70	PSCOLORADO	2	1.0316	1	168.6	168.6
70147	CHEROKEE7 18.000	G7	70	PSCOLORADO	2	1.0437	1	249.5	249.5
70310	PAWNEE 22.000	C1	70	PSCOLORADO	2	0.9862	1	530	530
70314	MANCHEF1 16.000	G1	70	PSCOLORADO	2	1.0169	1	140	140
70315	MANCHEF2 16.000	G2	70	PSCOLORADO	2	1.0169	1	140	140
70562	SPRUCE1 18.000	G1	70	PSCOLORADO	2	0.9784	1	140	140
70563	SPRUCE2 18.000	G2	70	PSCOLORADO	2	0.9783	1	140	140
70580	PLNENDG1 13.800	G0	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G1	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G2	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G3	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G4	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G5	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G6	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G7	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1	G8	70	PSCOLORADO	2	0.9967	1	5.5	5.5

Bus Number	Bus Name	Id	Area Num	Area Name	Code	VSched (pu)	In Service	PGen (MW)	PMax (MW)
	13.800								
70580	PLNENDG1 13.800	G9	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70585	PLNENDG3 13.800	G1	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G2	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G3	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G4	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G5	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G6	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G7	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G1	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G2	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G3	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G4	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G5	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G6	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G7	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70587	PLNENDG2 13.800	G0	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G1	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G2	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G3	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G4	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G5	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G6	70	PSCOLORADO	2	0.999	1	5.5	5.5

Bus Number	Bus Name	Id	Area Num	Area Name	Code	VSched (pu)	In Service	PGen (MW)	PMax (MW)
70587	PLNENDG2 13.800	G7	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G8	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G9	70	PSCOLORADO	2	0.999	1	5.5	5.5
70591	RMEC3 23.000	G3	70	PSCOLORADO	2	0.9882	1	322	322
73129	MBPP-1 24.000	1	73	WAPA R.M.	2	1.03	1	311.1523	605
73226	YELLO1-2 13.800	1	73	WAPA R.M.	2	1.026	1	50	65.789
73226	YELLO1-2 13.800	2	73	WAPA R.M.	2	1.026	1	50	65.789
73227	YELLO3-4 13.800	3	73	WAPA R.M.	2	1.0217	1	50	65.789
73227	YELLO3-4 13.800	4	73	WAPA R.M.	2	1.0217	1	50	65.789
73381	BIRDSAL1 13.800	1	73	WAPA R.M.	-2	1.01	1	17.2	17.2
73382	BIRDSAL2 13.800	1	73	WAPA R.M.	-2	0.98	1	17.2	17.2
73383	BIRDSAL3 13.800	1	73	WAPA R.M.	-2	0.98	1	24.6	24.6
73418	RD_NIXON 20.000	1	73	WAPA R.M.	2	1.01	1	225.39	225.39
73428	DRAKE 6 13.800	1	73	WAPA R.M.	2	1	1	83.19	83.19
73429	DRAKE 7 13.800	1	73	WAPA R.M.	2	1	1	141.03	141.03
73434	NIXONCT1 12.500	1	73	WAPA R.M.	-2	1	1	27	27
73435	NIXONCT2 12.500	1	73	WAPA R.M.	-2	1.02	1	27	27
73507	FTRNG1CC 18.000	1	73	WAPA R.M.	2	1	1	142	142
73508	FTRNG2CC 18.000	1	73	WAPA R.M.	2	1	1	142	142
73509	FTRNG3CC 21.000	1	73	WAPA R.M.	2	1	1	207	207
74399	BHPLPLAN 13.800	1	73	WAPA R.M.	2	1.02	0	0	100
79154	FLGORG1 11.500	1	73	WAPA R.M.	2	1	1	35	56.1
79155	FLGORG2	1	73	WAPA R.M.	2	1	1	35	56.1

Bus Number	Bus Name	Id	Area Num	Area Name	Code	VSched (pu)	In Service	PGen (MW)	PMax (MW)
	11.500								
79156	FLGORG3 11.500	1	73	WAPA R.M.	2	1	1	35	56.1

Table 30: Generation Dispatch for the Craig Unit 1 Retirement Sensitivity 9B

Craig Unit 1 Retirement Generation Dispatch for Sensitivity 9C

Bus Number	Bus Name	Id	Area Num	Area Name	Code	VSched (pu)	In Service	PGen (MW)	PMax (MW)
70069	CABCRKA 13.800	HA	70	PSCOLORADO	2	0.9719	1	110	162
70070	CABCRKB 13.800	HB	70	PSCOLORADO	2	0.9714	1	110	162
70106	CHEROK4 22.000	C4	70	PSCOLORADO	2	0.9861	1	383	383
70119	COMAN_1 24.000	C1	70	PSCOLORADO	2	0.9649	1	360	360
70120	COMAN_2 24.000	C2	70	PSCOLORADO	2	0.9562	1	359.221	365
70145	CHEROKEE5 18.000	G5	70	PSCOLORADO	2	1.0316	1	168.6	168.6
70146	CHEROKEE6 18.000	G6	70	PSCOLORADO	2	1.0316	1	168.6	168.6
70147	CHEROKEE7 18.000	G7	70	PSCOLORADO	2	1.0437	1	249.5	249.5
70310	PAWNEE 22.000	C1	70	PSCOLORADO	2	0.9862	1	530	530
70314	MANCHEF1 16.000	G1	70	PSCOLORADO	2	1.0169	1	140	140
70315	MANCHEF2 16.000	G2	70	PSCOLORADO	2	1.0169	1	140	140
70446	VALMONT 20.000	C5	70	PSCOLORADO	2	1	0	0	150
70562	SPRUCE1 18.000	G1	70	PSCOLORADO	2	0.9784	1	140	140
70563	SPRUCE2 18.000	G2	70	PSCOLORADO	2	0.9783	1	140	140
70580	PLNENDG1 13.800	G0	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G1	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G2	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G3	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G4	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G5	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G6	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G7	70	PSCOLORADO	2	0.9967	1	5.5	5.5

Bus Number	Bus Name	Id	Area Num	Area Name	Code	VSched (pu)	In Service	PGen (MW)	PMax (MW)
70580	PLNENDG1 13.800	G8	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70580	PLNENDG1 13.800	G9	70	PSCOLORADO	2	0.9967	1	5.5	5.5
70585	PLNENDG3 13.800	G1	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G2	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G3	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G4	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G5	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G6	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70585	PLNENDG3 13.800	G7	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G1	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G2	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G3	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G4	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G5	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G6	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70586	PLNENDG4 13.800	G7	70	PSCOLORADO	2	0.9558	1	8.4	8.4
70587	PLNENDG2 13.800	G0	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G1	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G2	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G3	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G4	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G5	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2	G6	70	PSCOLORADO	2	0.999	1	5.5	5.5

Bus Number	Bus Name	Id	Area Num	Area Name	Code	VSched (pu)	In Service	PGen (MW)	PMax (MW)
	13.800								
70587	PLNENDG2 13.800	G7	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G8	70	PSCOLORADO	2	0.999	1	5.5	5.5
70587	PLNENDG2 13.800	G9	70	PSCOLORADO	2	0.999	1	5.5	5.5
70591	RMEC3 23.000	G3	70	PSCOLORADO	2	0.9882	1	322	322
73129	MBPP-1 24.000	1	73	WAPA R.M.	2	1.03	1	317.1285	605
73226	YELLO1-2 13.800	1	73	WAPA R.M.	2	1.026	1	50	65.789
73226	YELLO1-2 13.800	2	73	WAPA R.M.	2	1.026	1	50	65.789
73227	YELLO3-4 13.800	3	73	WAPA R.M.	2	1.0217	1	50	65.789
73227	YELLO3-4 13.800	4	73	WAPA R.M.	2	1.0217	1	50	65.789
73381	BIRDSAL1 13.800	1	73	WAPA R.M.	-2	1.01	0	17.2	17.2
73382	BIRDSAL2 13.800	1	73	WAPA R.M.	-2	0.98	0	17.2	17.2
73383	BIRDSAL3 13.800	1	73	WAPA R.M.	-2	0.98	0	24.6	24.6
73418	RD_NIXON 20.000	1	73	WAPA R.M.	2	1.01	1	225.39	225.39
73428	DRAKE 6 13.800	1	73	WAPA R.M.	2	1	1	83.19	83.19
73429	DRAKE 7 13.800	1	73	WAPA R.M.	2	1	1	141.03	141.03
73434	NIXONCT1 12.500	1	73	WAPA R.M.	-2	1	0	27	27
73435	NIXONCT2 12.500	1	73	WAPA R.M.	-2	1.02	0	27	27
73507	FTRNG1CC 18.000	1	73	WAPA R.M.	2	1	1	142	142
73508	FTRNG2CC 18.000	1	73	WAPA R.M.	2	1	1	142	142
73509	FTRNG3CC 21.000	1	73	WAPA R.M.	2	1	1	207	207
74399	BHPLPLAN 13.800	1	73	WAPA R.M.	2	1.02	1	0	100
79154	FLGORG1 11.500	1	73	WAPA R.M.	2	1	1	35	56.1

Bus Number	Bus Name	Id	Area Num	Area Name	Code	VSched (pu)	In Service	PGen (MW)	PMax (MW)
79155	FLGORG2 11.500	1	73	WAPA R.M.	2	1	1	35	56.1
79156	FLGORG3 11.500	1	73	WAPA R.M.	2	1	1	35	56.1

Table 31: Generation Dispatch for the Craig Unit 1 Retirement Sensitivity 9C

Ault One-line Diagrams for Craig Unit 1 Retirement Sensitivity

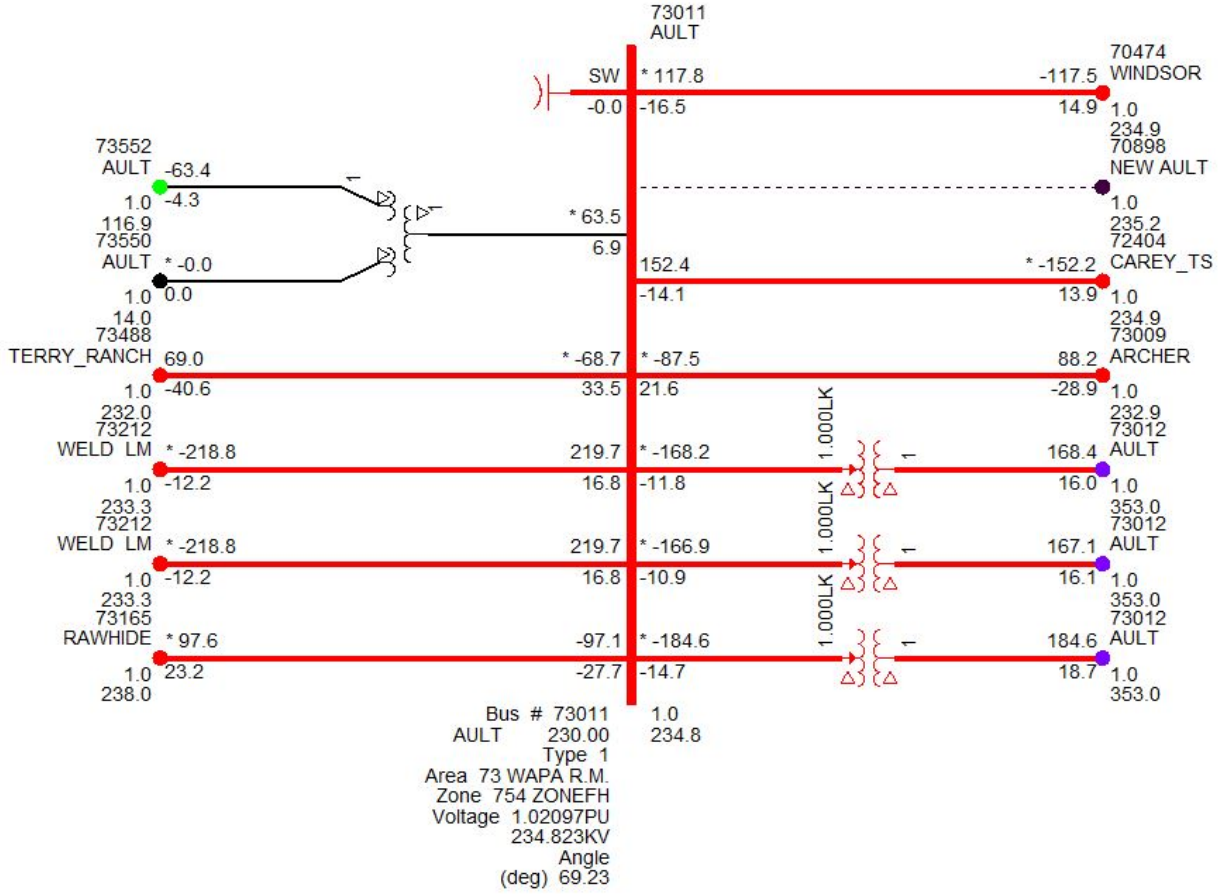

Figure 14: One-line for Benchmark Case Ault 230 kV Power Flows

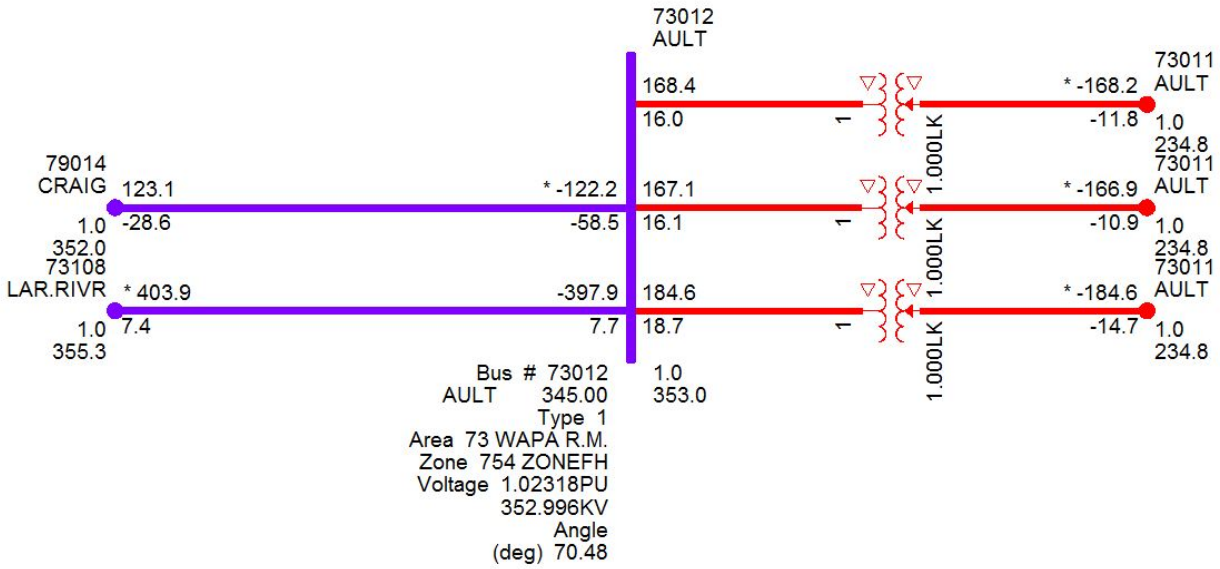

Figure 15: One-line for Benchmark Case Ault 345 kV Power Flows

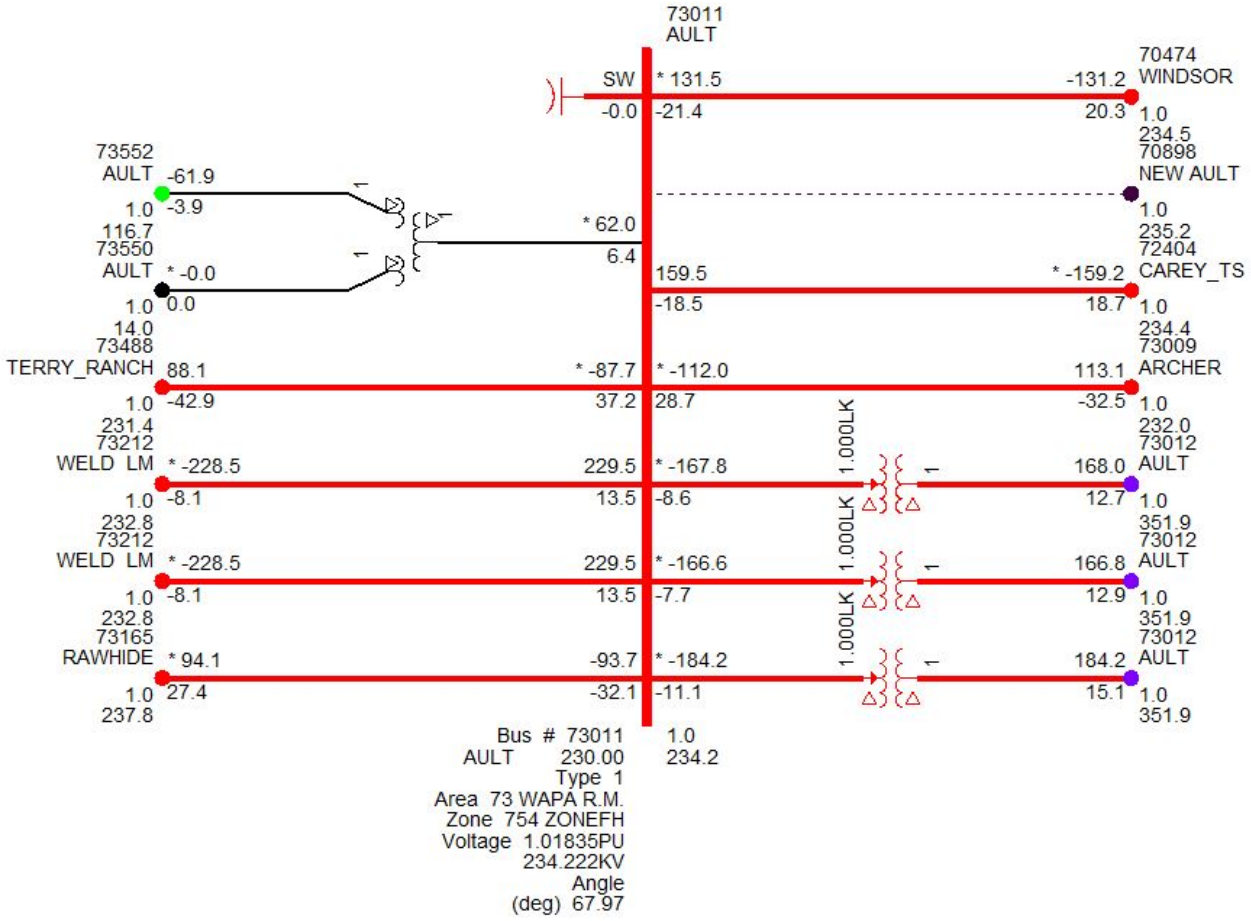

Figure 16: One-line for Craig Unit 1 Retirement Sensitivity (0-09) Ault 230 kV Power Flows

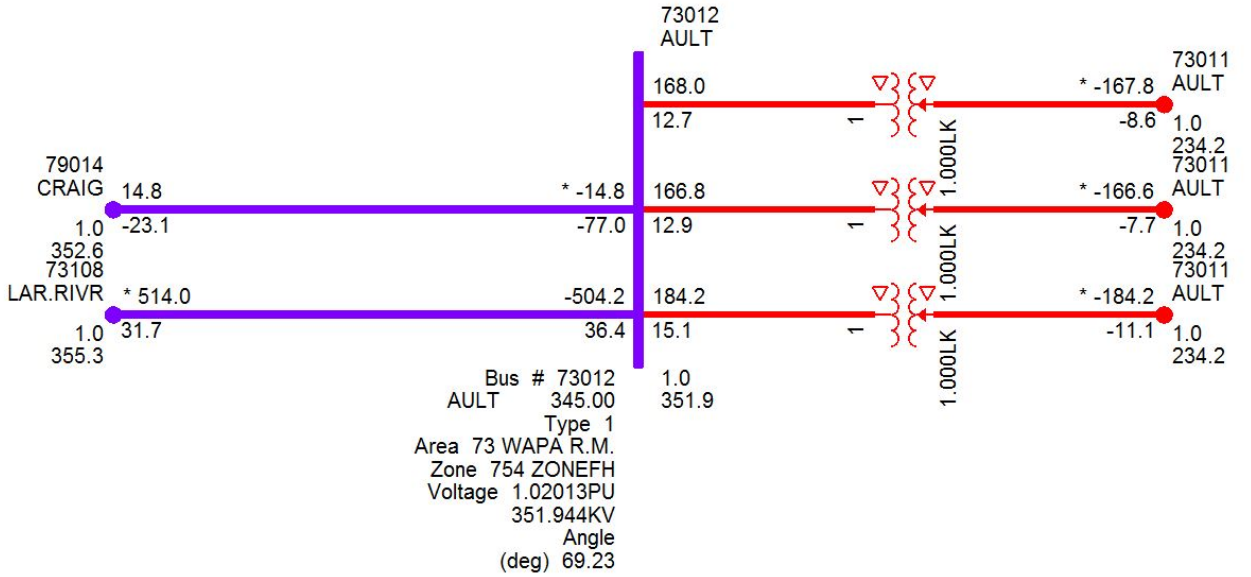

Figure 17: One-line for Craig Unit 1 Retirement Sensitivity (0-09) Ault 345 kV Power Flows

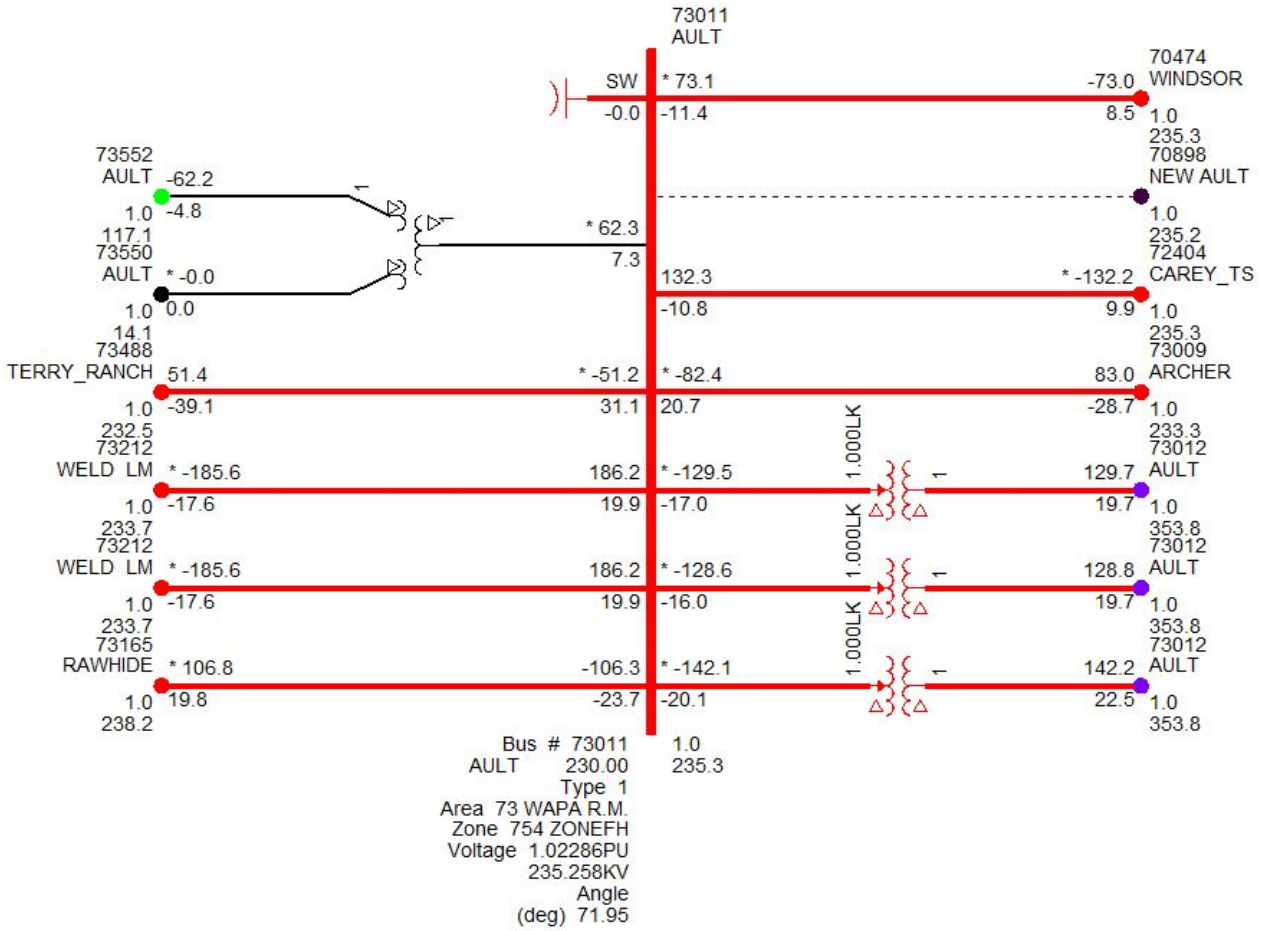

Figure 18: One-line for Craig Unit 1 Retirement Sensitivity (0-09B) Ault 230 kV Power Flows

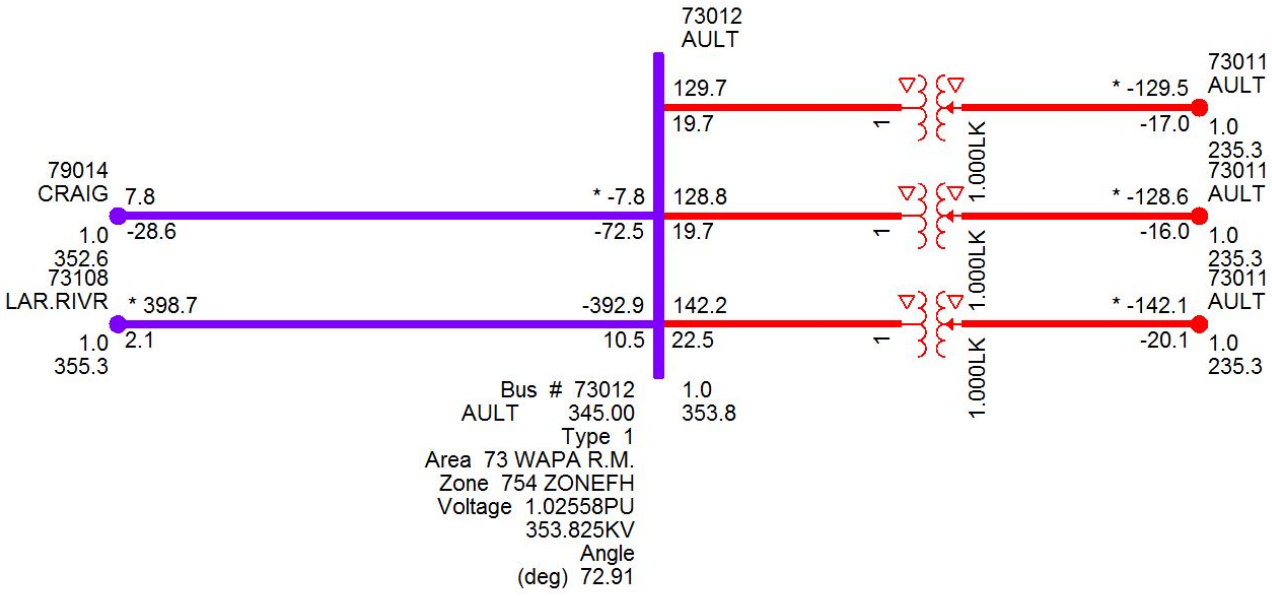

Figure 19: One-line for Craig Unit 1 Retirement Sensitivity (0-09B) Ault 345 kV Power Flows

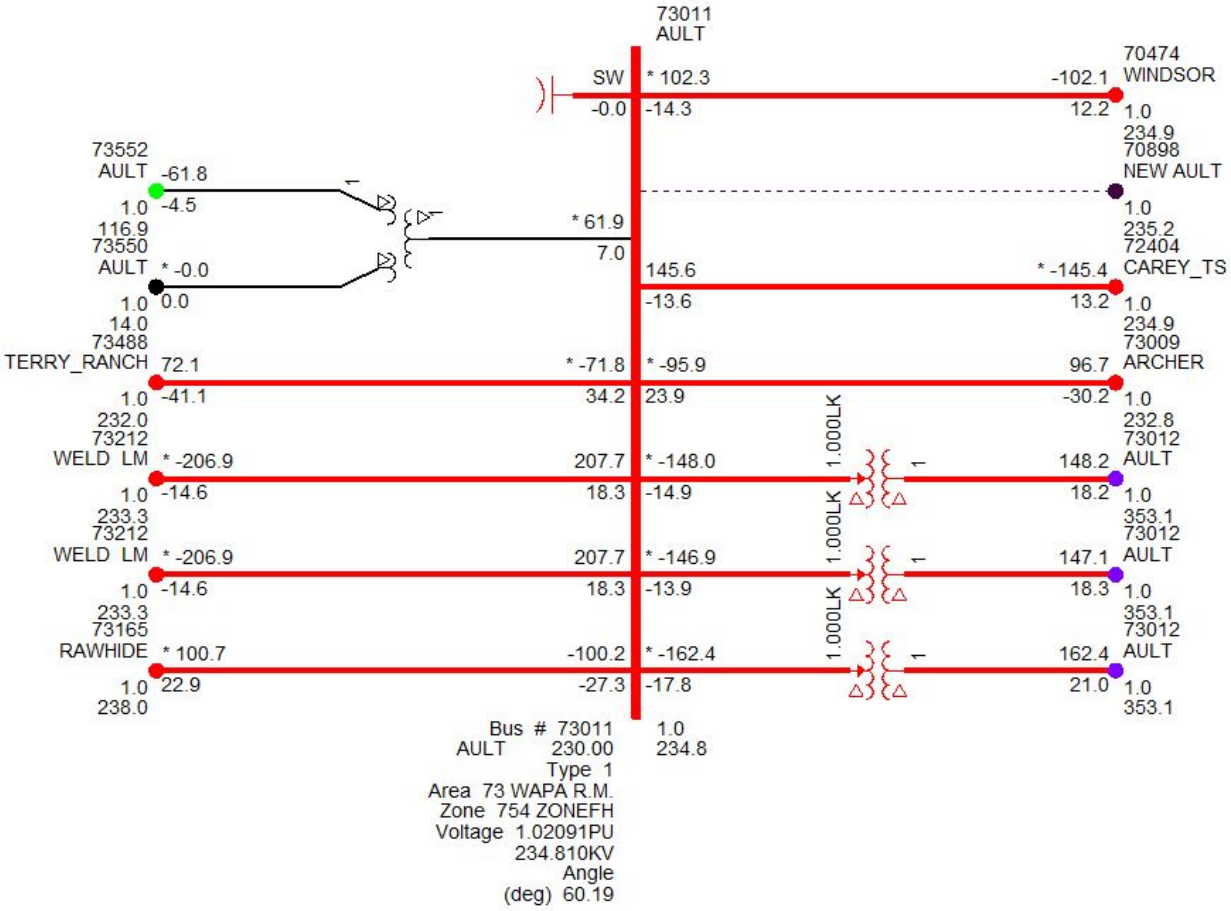

Figure 20: One-line for Craig Unit 1 Retirement Sensitivity (0-09C) Ault 230 kV Power Flows

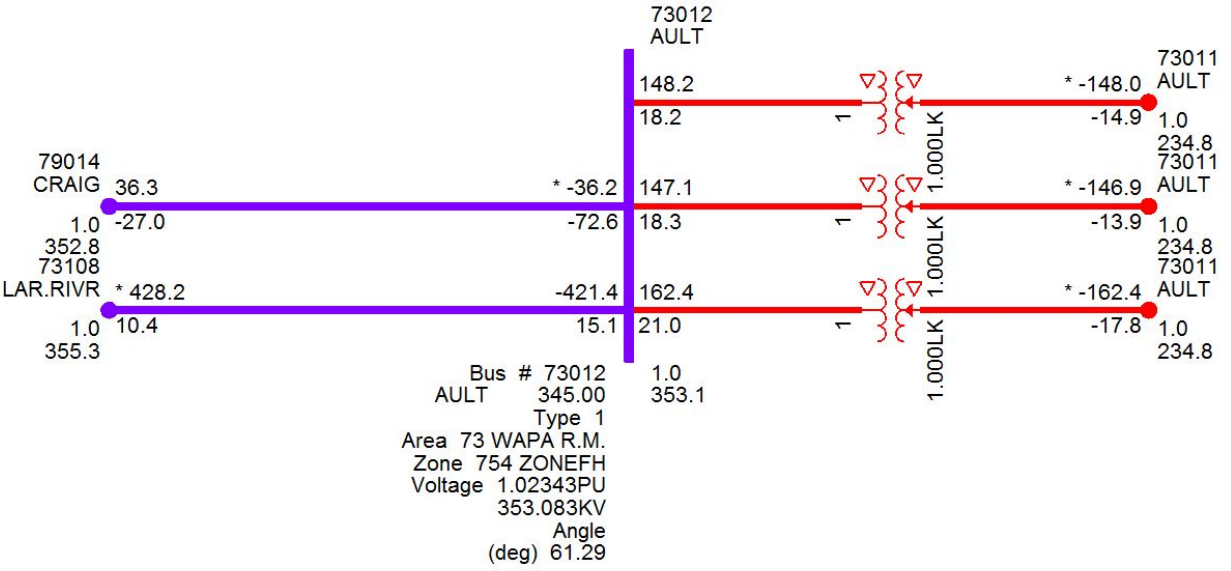

Figure 21: One-line for Craig Unit 1 Retirement Sensitivity (0-09C) Ault 345 kV Power Flows

APPENDIX L: Voltage Stability Analysis Tables

Locked Shut Device Analysis Results

Load Location	Type	01 - Alternative 1			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	90	Bus Voltage at Husky below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	100 Graham Creek
	Thermal Limit	120	Monfort - Lucerne 115 kV220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	140 Weld - Greeley 115 kV
Graham Creek					
	Voltage Limit	150	Bus Voltage at Husky and Graham Creek below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	160 Husky
	Thermal Limit	130	Monfort - Lucerne 115 kV 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	140 Husky - Graham Creek 115 kV, 160 Weld - Greeley 115 kV
Cloverly					
	Voltage Limit	130	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	170 Graham Creek
	Thermal Limit	130	Monfort - Lucerne and Husky - Graham Creek 220MVA limit	Ault - Husky 230 kV, Husky 230/115 kV Transformer and Monfort Lucerne 115 kV	160 Weld - Greeley 115 kV, Graham Creek - Cloverly 115 kV, Husky 230/115 kV Transformer

Table 32: PV Analysis Results for Alternative 1

Load Location	Type	02 - Alternative 1 + Graham Creek - Weld 115 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	160	Bus Voltage at Husky below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	220 Graham Creek
	Thermal Limit	200	Husky - Graham Creek 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	220 Husky 230/115 kV Transformer 250 Weld - Graham Creek 115 kV and Weld 230/115 kV Transformer
Graham Creek					
	Voltage Limit	380	Bus Voltage at Graham Creek below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	390 Husky
	Thermal Limit	270	Weld - Graham Creek and Husky - Graham Creek 115 kV 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer for Weld - Graham Creek Monfort - Lucerne 115 kV for Husky - Graham Creek	280 Weld 230/115 kV Transformer
Cloverly					
	Voltage Limit	190	Bus Voltage at Lucerne below 0.90	Monfort - Lucerne 115 kV	300 Graham Creek
	Thermal Limit	160	Graham Creek - Cloverly 220MVA limit	Monfort - Lucerne 115 kV	250 Monfort - Lucerne 115 kV and Husky - Graham Creek 115 kV

Table 33: PV Analysis Results for Alternative 1 with a Graham Creek - Weld 115 kV Line

Load Location	Type	03 - Alternative 1 + Graham Creek - Greeley 115 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	140	Bus Voltage at Husky below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	180 Graham Creek
	Thermal Limit	120	Weld - Greeley 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	200 Husky 230/115 kV Transformer and Husky - Graham Creek 115 kV 240 Weld 230/115 kV Transformer
Graham Creek					
	Voltage Limit	280	Bus Voltage at Graham Creek below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	290 Husky
	Thermal Limit	120	Weld - Greeley 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	220 Husky - Graham Creek 115 kV 280 Weld 230/115 kV Transformer
Cloverly					
	Voltage Limit	190	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	290 Graham Creek
	Thermal Limit	140	Weld - Greeley 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	160 Graham Creek - Cloverly 115 kV 210 Monfort - Lucerne 115 kV and Husky - Graham Creek 115 kV

Table 34: PV Analysis Results for Alternative 1 with a Graham Creek - Greeley 115 kV Line

Load Location	Type	04 - Alternative 1 + Cloverly - Rosedale 115 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	100	Bus Voltage at Husky below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	120 Graham Creek
	Thermal Limit	170	Graham Creek - Cloverly 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	190 Weld - Greeley 115 kV
Graham Creek					
	Voltage Limit	180	Bus Voltage at Husky and Graham Creek below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	240 Cloverly
	Thermal Limit	190	Graham Creek - Cloverly 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	210 Husky - Graham Creek 115 kV 220 Weld - Greeley 115 kV
Cloverly					
	Voltage Limit	360	Bus Voltage at Graham Creek and Cloverly below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	370 Husky
	Thermal Limit	230	Weld - Greeley 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	270 Monfort - Lucerne 115 kV

Table 35: PV Analysis Results for Alternative 1 with a Cloverly - Rosedale kV Line

Load Location	Type	05 - Alternative 1 + Husky - Rosedale 230 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	110	Bus Voltage at Husky below 0.90	Husky 230/115 kV Transformer	130 Graham Creek
	Thermal Limit	120	Monfort - Lucerne 115 kV220MVA limit	Husky 230/115 kV Transformer	150 Rosedale - Monfort 115 kV
Graham Creek					
	Voltage Limit	200	Bus Voltage at Graham Creek and Husky below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	210 Husky 230 kV
	Thermal Limit	130	Monfort - Lucerne 115 kV 220MVA limit	Husky 230/115 kV Transformer	140 Lucerne - Cloverly 115 kV and Husky - Graham Creek 115 kV 170 Rosedale - Monfort 115 kV
Cloverly					
	Voltage Limit	120	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	170 Graham Creek
	Thermal Limit	130	Monfort - Lucerne and Husky - Graham Creek 115 kV 220MVA limit	Husky 230/115 kV Transformer for Monfort - Lucerne 115 kV and Monfort - Lucerne 115 kV for Husky - Graham Creek 115 kV	150 Lucerne - Cloverly 115 kV

Table 36: PV Analysis Results for Alternative 1 with a Husky - Rosedale 230 kV Line

Load Location	Type	06 - Alternative 1 + Husky - Cloverly - Rosedale 230 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	140	Bus Voltage at Husky below 0.90	Ault - Husky 230 kV	150 Cloverly 230 kV
	Thermal Limit	170	Graham Creek - Cloverly 220MVA limit	Husky 230/115 kV Transformer	200 Husky - Graham Creek 115 kV 220 Weld - Greeley 115 kV
Graham Creek					
	Voltage Limit	200	Bus Voltage at Husky and Cloverly 230kV Graham Creek 115kV below 0.90	Ault - Husky 230 kV	210 Husky
	Thermal Limit	190	Graham Creek - Cloverly 220MVA limit	Husky 230/115 kV Transformer	210 Weld - Greeley 115 kV
Cloverly					
	Voltage Limit	240	Bus Voltage at Rosedale and Cloverly 230kV below 0.90	Ault - Husky 230 kV	250 Husky 230 kV
	Thermal Limit	200	Weld - Greeley 220MVA limit	Ault - Husky 230 kV	210 Monfort - Lucerne 115 kV

Table 37: PV Analysis Results for Alternative 1 with a Husky - Cloverly - Rosedale 230 kV Line

Load Location	Type	07 - Alternative 1 + Husky - Graham Creek - Rosedale 230 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	80	Bus Voltage at Husky and Graham Creek 230kV below 0.90	Ault - Husky 230 kV	90 Husky
	Thermal Limit	190	Husky - Graham Creek 220MVA limit	Husky 230/115 kV Transformer	230 Weld - Greeley 115 kV
Graham Creek					
	Voltage Limit	130	Bus Voltage at Husky, Graham Creek and Rosedale 230kV below 0.90	Ault - Husky 230 kV	150 Husky
	Thermal Limit	230	Weld - Greeley 220MVA limit	Ault - Husky 230 kV	260 Graham Creek 230/115 kV Transformer 270 Weld 230/115 kV Transformer
Cloverly					
	Voltage Limit	160	Bus Voltage at Graham Creek and Rosedale 230kV below 0.90	Ault - Husky 230 kV	180 Husky 230 kV
	Thermal Limit	160	Graham Creek - Cloverly 220MVA limit	Monfort - Lucerne 115 kV	180 Monfort - Lucerne 115 kV

Table 38: PV Analysis Results for Alternative 1 with a Husky - Graham Creek - Rosedale 230 kV Line

Load Location	Type	08 - Alternative 1 + Double Circuit Ault - Husky AND Two Husky 230/115 kV Transformers			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	N/A	N/A	N/A	N/A
	Thermal Limit	210	Husky 230/115kV 280MVA transformer limit	Husky 230/115 kV Transformer	N/A
Graham Creek					
	Voltage Limit	340	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	360 Graham Creek
	Thermal Limit	140	Husky - Graham Creek 220MVA limit	Monfort - Lucerne 115 kV	190 Husky - Graham Creek 115 kV 280 Husky 230/115 kV Transformer N/A
Cloverly					
	Voltage Limit	160	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	220 Graham Creek
	Thermal Limit	130	Husky - Graham Creek 220MVA limit	Monfort - Lucerne 115 kV	160 Graham Creek - Cloverly 270 Husky 230/115 kV Transformer 340 Monfort - Lucerne 115 kV

Table 39: PV Analysis Results for Alternative 1 with Double Circuit Ault - Husky 230 kV and Two Husky 230/115 kV Transformers

Adjusting Shunt Device Analysis Results

Load Location	Type	01 - Alternative 1			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	110	Bus Voltage at Husky below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	130 Graham Creek
	Thermal Limit	120	Monfort - Lucerne 115 kV 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	150 Weld - Greeley 115 kV
Graham Creek					
	Voltage Limit	190	Bus Voltage at Husky and Graham Creek below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	230 Cloverly
	Thermal Limit	130	Monfort - Lucerne 115 kV 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	140 Husky - Graham Creek 115 kV, 160 Weld - Greeley 115 kV
Cloverly					
	Voltage Limit	130	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	170 Graham Creek
	Thermal Limit	130	Monfort - Lucerne and Husky - Graham Creek 115 kV 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	160 Weld - Greeley 115 kV, Graham Creek - Cloverly 115 kV, Husky 230/115 kV Transformer

Table 40: PV Analysis Results for Alternative 1

Load Location	Type	02 - Alternative 1 + Graham Creek - Weld 115 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	190	Bus Voltage at Husky below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	240 Graham Creek
	Thermal Limit	200	Husky - Graham Creek 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	220 Husky 230/115 kV Transformer 250 Weld - Graham Creek 115 kV 260 Weld 230/115 kV Transformer
Graham Creek					
	Voltage Limit	400	Bus Voltage at Graham Creek below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	420 Husky
	Thermal Limit	270	Weld - Graham Creek and Husky - Graham Creek 115 kV 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer for Weld - Graham Creek Monfort - Lucerne 115 kV for Husky - Graham Creek	280 Weld 230/115 kV Transformer
Cloverly					
	Voltage Limit	190	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	300 Graham Creek
	Thermal Limit	160	Graham Creek - Cloverly 220MVA limit	Monfort - Lucerne 115 kV	250 Monfort - Lucerne 115 kV and Husky - Graham Creek 115 kV

Table 41: PV Analysis Results for Alternative 1 with a Graham Creek - Weld 115 kV Line

Load Location	Type	03 - Alternative 1 + Graham Creek - Greeley 115 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	170	Bus Voltage at Husky below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	200 Graham Creek
	Thermal Limit	120	Weld - Greeley 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	200 Husky 230/115 kV Transformer and Husky - Graham Creek 115 kV 250 Weld 230/115 kV Transformer
Graham Creek					
	Voltage Limit	320	Bus Voltage at Graham Creek below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	340 Husky
	Thermal Limit	120	Weld - Greeley 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	220 Husky - Graham Creek 115 kV 290 Weld 230/115 kV Transformer
Cloverly					
	Voltage Limit	190	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	290 Graham Creek
	Thermal Limit	140	Weld - Greeley 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	160 Graham Creek - Cloverly 115 kV 210 Monfort - Lucerne 115 kV and Husky - Graham Creek 115 kV

Table 42: PV Analysis Results for Alternative 1 with a Graham Creek - Greeley 115 kV Line

Load Location	Type	04 - Alternative 1 + Cloverly - Rosedale 115 kV			
		Load (MW)	Limitling Element		Limitling Element
Husky					
	Voltage Limit	120	Bus Voltage at Husky below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	140 Graham Creek
	Thermal Limit	170	Graham Creek - Cloverly 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	190 Weld - Greeley 115 kV
Graham Creek					
	Voltage Limit	210	Bus Voltage at Graham Creek below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	220 Husky
	Thermal Limit	190	Graham Creek - Cloverly 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	210 Husky - Graham Creek 115 kV 220 Weld - Greeley 115 kV
Cloverly					
	Voltage Limit	360	Bus Voltage at Cloverly and Lucerne below 0.90	Ault - Husky 230 kV and Husky 230/115 kV Transformer	370 Husky
	Thermal Limit	220	Weld - Greeley 220MVA limit	Ault - Husky 230 kV and Husky 230/115 kV Transformer	280 Monfort - Lucerne 115 kV

Table 43: PV Analysis Results for Alternative 1 with a Cloverly - Rosedale kV Line

Load Location	Type	05 - Alternative 1 + Husky - Rosedale 230 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	130	Bus Voltage at Husky below 0.90	Husky 230/115 kV Transformer	140 Graham Creek
	Thermal Limit	120	Monfort - Lucerne 115 kV220MVA limit	Husky 230/115 kV Transformer	160 Rosedale - Monfort 115 kV
Graham Creek					
	Voltage Limit	230	Bus Voltage at Husly and Graham Creek below 0.90	Husky 230/115 kV Transformer	240 Graham Creek 230 kV
	Thermal Limit	130	Monfort - Lucerne 115 kV 220MVA limit	Husky 230/115 kV Transformer	140 Lucerne - Cloverly 115 kV and Husky - Graham Creek 115 kV 170 Rosedale - Monfort 115 kV
Cloverly					
	Voltage Limit	120	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	170 Graham Creek
	Thermal Limit	130	Monfort - Lucerne and Husky - Graham Creek 115 kV 220MVA limit	Husky 230/115 kV Transformer for Monfort - Lucerne 115 kV and Monfort - Lucerne 115 kV for Husky - Graham Creek 115 kV	150 Lucerne - Cloverly 115 kV

Table 44: PV Analysis Results for Alternative 1 with a Husky - Rosedale 230 kV Line

Load Location	Type	06 - Alternative 1 + Husky - Cloverly - Rosedale 230 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	170	Bus Voltage at Husky 230kV below 0.90	Ault - Husky 230 kV	180 Husky
	Thermal Limit	170	Graham Creek - Cloverly 220MVA limit	Husky 230/115 kV Transformer	200 Husky - Graham Creek 115 kV 220 Weld - Greeley 115 kV
Graham Creek					
	Voltage Limit	240	Bus Voltage at Husky and Cloverly 230kV Graham Creek 115kV below 0.90	Ault - Husky 230 kV	250 Husky
	Thermal Limit	190	Graham Creek - Cloverly 220MVA limit	Husky 230/115 kV Transformer	210 Weld - Greeley 115 kV
Cloverly					
	Voltage Limit	290	Bus Voltage at Cloverly 230kV below 0.90	Ault - Husky 230 kV	300 Husky 230 kV
	Thermal Limit	200	Weld - Greeley 220MVA limit	Ault - Husky 230 kV	220 Monfort - Lucerne 115 kV

Table 45: PV Analysis Results for Alternative 1 with a Husky - Cloverly - Rosedale 230 kV Line

Load Location	Type	07 - Alternative 1 + Husky - Graham Creek - Rosedale 230 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	130	Bus Voltage at Husky and Graham Creek 230kV below 0.90	Ault - Husky 230 kV	150 Husky
	Thermal Limit	200	Husky - Graham Creek 220MVA limit	Husky 230/115 kV Transformer	240 Weld - Greeley 115 kV
Graham Creek					
	Voltage Limit	200	Bus Voltage at Graham Creek and Rosedale 230kV below 0.90	Ault - Husky 230 kV	210 Husky 230 kV
	Thermal Limit	230	Weld - Greeley 220MVA limit	Ault - Husky 230 kV	260 Graham Creek 230/115 kV Transformer 290 Weld 230/115 kV Transformer and Monfort - Lucerne 115 kV
Cloverly					
	Voltage Limit	220	Bus Voltage at Lucerne and Cloverly below 0.90	Monfort - Lucerne 115 kV	270 Rosedale 230 kV
	Thermal Limit	160	Graham Creek - Cloverly 220MVA limit	Monfort - Lucerne 115 kV	190 Weld - Greeley 115 kV and Monfort - Lucerne 115 kV

Table 46: PV Analysis Results for Alternative 1 with a Husky - Graham Creek - Rosedale 230 kV Line

Load Location	Type	08 - Alternative 1 + Double Circuit Ault - Husky AND Two Husky 230/115 kV			
		Load (MW)	Limitling Element	Contingency	Next Limit (MW)*
Husky					
	Voltage Limit	None	None	N/A	N/A
	Thermal Limit	210	Husky 230/115kV 280MVA transformer limit	Husky 230/115 kV Transformer	N/A
Graham Creek					
	Voltage Limit	340	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	360 Graham Creek
	Thermal Limit	140	Husky - Graham Creek 220MVA limit	Monfort - Lucerne 115 kV	190 Husky - Graham Creek 115 kV 280 Husky 230/115 kV Transformer N/A
Cloverly					
	Voltage Limit	160	Bus Voltage at Cloverly and Lucerne below 0.90	Monfort - Lucerne 115 kV	220 Graham Creek
	Thermal Limit	130	Husky - Graham Creek 220MVA limit	Monfort - Lucerne 115 kV	160 Graham Creek - Cloverly 270 Husky 230/115 kV Transformer 320 Monfort - Lucerne 115 kV

Table 47: PV Analysis Results for Alternative 1 with Double Circuit Ault - Husky 230 kV and Two Husky 230/115 kV Transformers

APPENDIX M: One-line Diagrams of the Ault Substation Power Flows

One-line Diagrams

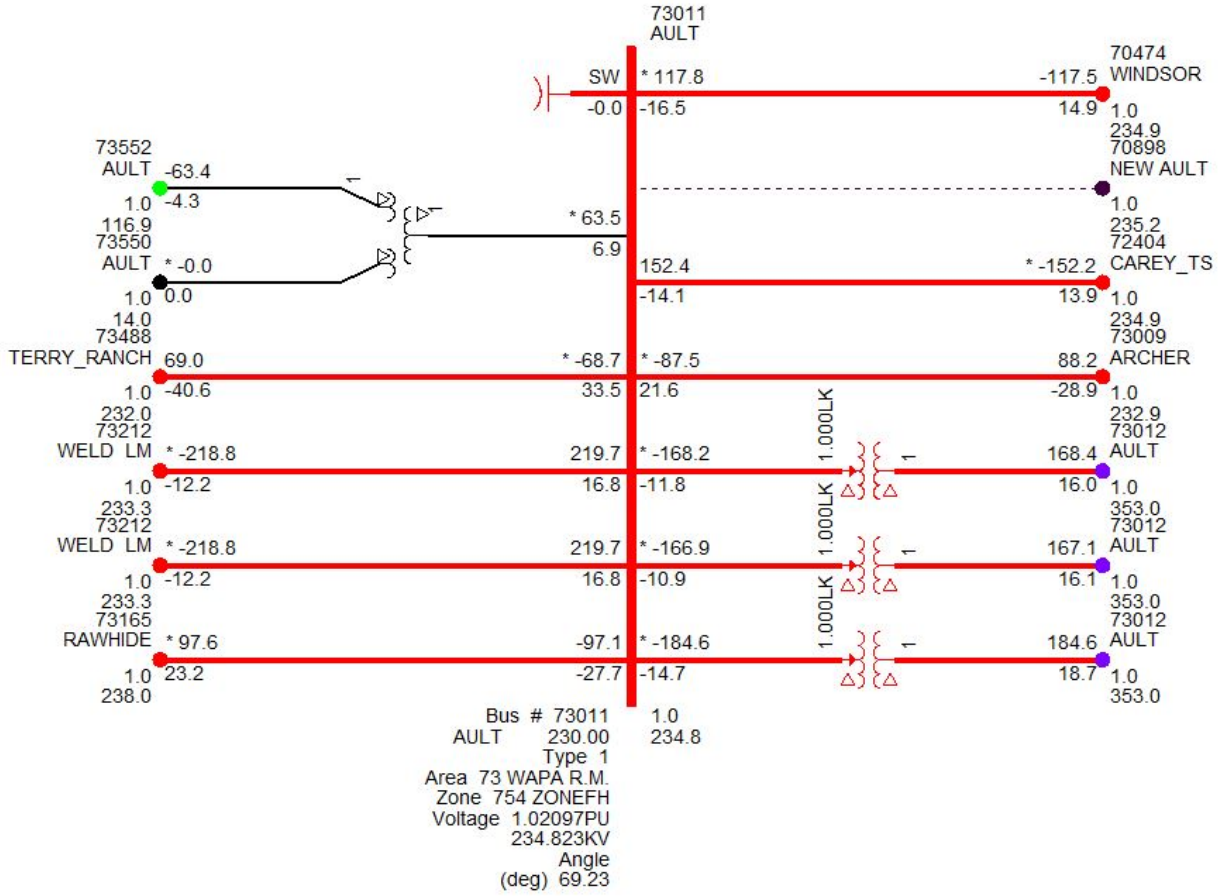

Figure 22: One-line Diagram for the Ault 230 kV Power Flows in the Benchmark Case

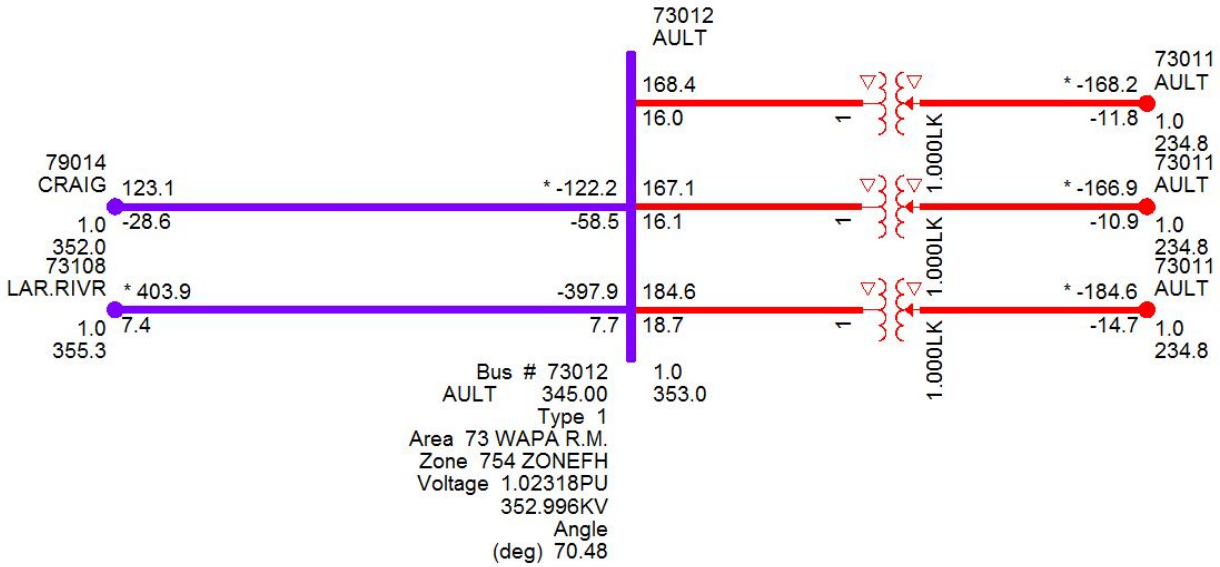

Figure 23: One-line Diagram for the Ault 345 kV Power Flows in the Benchmark Case

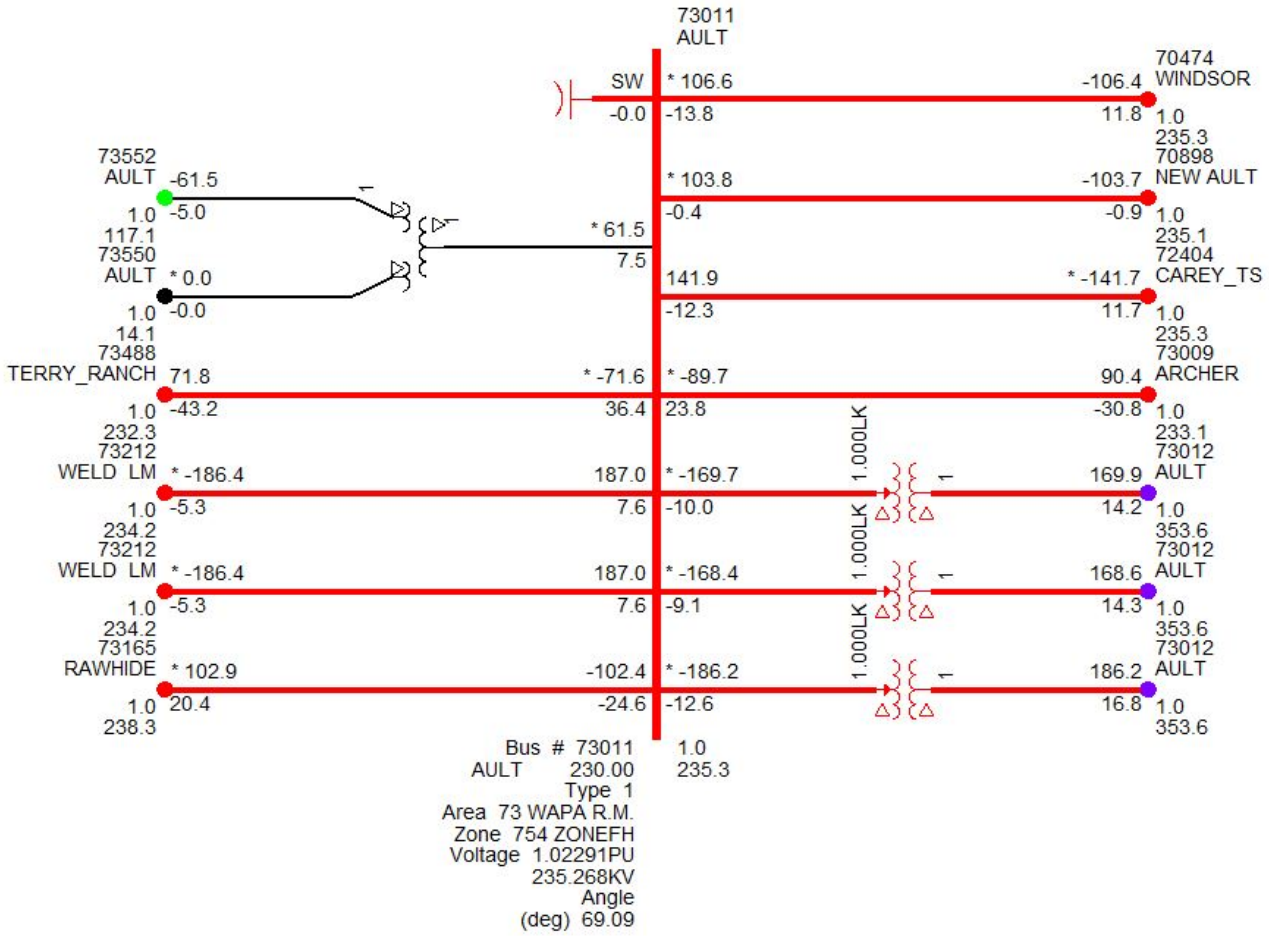

Figure 24: One-line Diagram for the Ault 230 kV Power Flows in the Alternative 1 Case

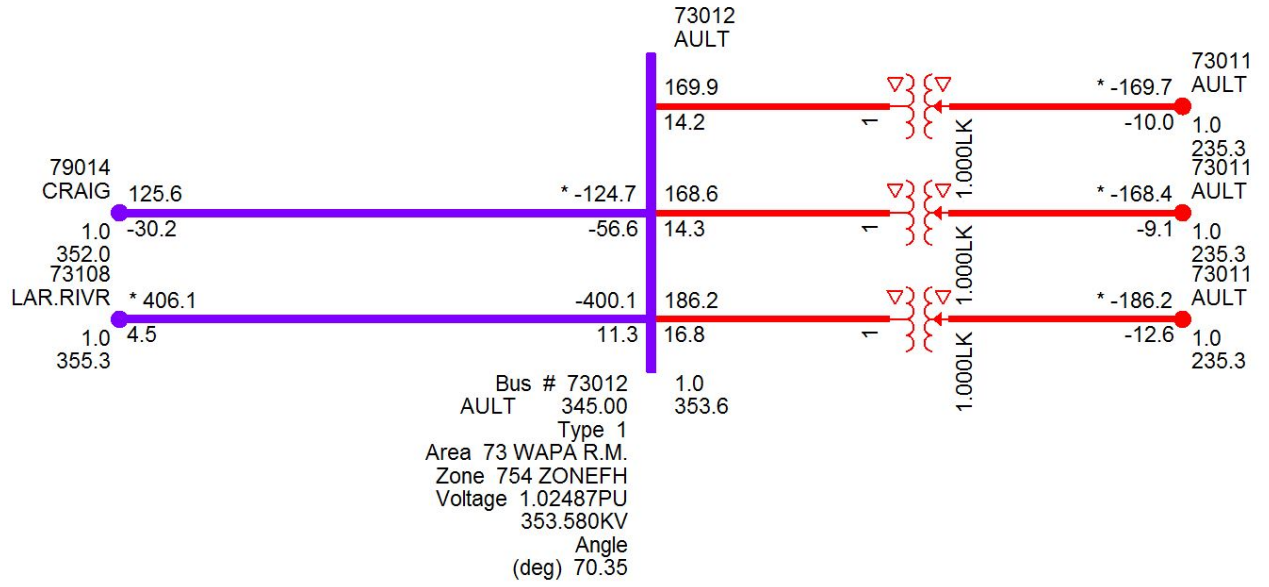

Figure 25: One-line Diagram for the Ault 345 kV Power Flows in the Alternative 1 Case

Contingency Analysis Table

AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

BASE CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - ALL VIOLATIONS
% LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES

X--- MONITORED ELEMENT ----X	0-01 Ben chmark.a cc	1-01 Alt 1.acc
70290 MONFORT 115.00	105.4%	
70844 MONFORT 46.000 T1	63MVA	
73197 THERMOPL 115.00	107.5%	107.5%
73624 THERMOPL 34.500 1	27MVA	27MVA

AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

CONTINGENCY CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - WORST CASE VIOLATIONS
% LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES
THRESHOLD FOR THE COUNT OF CONTINGENCIES CAUSING OVERLOADING IS 100.0% OF RATING SET A

X--- MONITORED ELEMENT ----X	X-----LABEL----X	0-01 Ben chmark.a cc	1-01 Alt 1.acc
70023 ALLISON 115.00	SINGL1 70045-702	102.6%	102.6%
70400 SODALAKE 115.00 1	42(1)	159MVA	159MVA
		(1x)	(1x)
70037 ARAP_B 115.00	SINGL1 70463-704	142.8%	142.8%
70165 ENGLE3TP 115.00 1	83(1)	169MVA	169MVA
		(2x)	(2x)
70045 BANCROFT 115.00	SINGL1 70023-704	103.0%	102.9%
70242 KENDRICK 115.00 1	00(1)	159MVA	159MVA
		(1x)	(1x)
70065 BROOMFLD 115.00	SINGL1 70110-701	114.7%	114.7%
70382 SEMPER 115.00 1	75(1)	135MVA	135MVA
		(1x)	(1x)
70073 CALIFOR 115.00	SINGL1 70108-702	106.9%	106.9%
70108 CHEROKEE_S 115.00 1	76(1)	150MVA	150MVA
		(2x)	(2x)
70127 COORSREC 115.00	SINGL1 70244-704	129.0%	129.3%
70191 FTLUPTON 115.00 1	44(1)	155MVA	155MVA
		(1x)	(1x)
70162 EAST 115.00	SINGL1 70537-705	120.0%	120.0%
70538 CHMBERS 115.00 1	38(1)	148MVA	148MVA
		(1x)	(1x)
70290 MONFORT 115.00	P4_BREAKER_FAILU	107.4%	
70805 LEPRINO_PS 115.00 1	RE_003	188MVA	
		(1x)	
70290 MONFORT 115.00	P4_BREAKER_FAILU	107.8%	
70844 MONFORT 46.000 T1	RE_001	65MVA	
		(752x)	
70310 PAWNEE 22.000	SINGL1 70310-703	131.5%	131.4%
70311 PAWNEE 230.00 U1	11(U2)	478MVA	478MVA
		(1x)	(1x)
70310 PAWNEE 22.000	SINGL1 70310-703	131.4%	131.4%
70311 PAWNEE 230.00 U2	11(U1)	478MVA	478MVA
		(1x)	(1x)

AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

CONTINGENCY CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - WORST CASE VIOLATIONS
% LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES
THRESHOLD FOR THE COUNT OF CONTINGENCIES CAUSING OVERLOADING IS 100.0% OF RATING SET A

X--- MONITORED ELEMENT ----X	X-----LABEL----X	0-01 Ben chmark.a cc	1-01 Alt 1.acc
70368 ROSEDALE 115.00	P4_BREAKER_FAILU	115.9%	
70439 UNC 115.00 1	RE_003	203MVA	
		(1x)	
70368 ROSEDALE 115.00	P4_BREAKER_FAILU	130.2%	
73055 KERSEY_W 115.00 1	RE_001	140MVA	
		(1x)	

70397 B.CRK_PS	115.00	SINGL1 70397-730	100.4%	100.5%
70399 B.CRK_PS	230.00 T1	20(1)	222MVA (1x)	222MVA (1x)
70439 UNC	115.00	P4_BREAKER_FAILU	115.8%	
70805 LEPRINO_PS	115.00 1	RE_003	203MVA (1x)	
70463 WATERTON	115.00	SINGL1 70037-701	120.5%	120.5%
70483 MARTN1TP	115.00 1	65(1)	168MVA (1x)	168MVA (1x)
70470 WELD_PS	115.00	BUS_FAULT_001	108.1%	
70471 WELD_PS	230.00 T2		303MVA (1x)	
72107 SLATERTS	115.00	SINGL1 73502-735	110.8%	110.7%
73049 DELCAMIN	115.00 1	03(1)	141MVA (1x)	141MVA (1x)
72142 REDBOX	115.00	SINGL1 72142-721	125.4%	125.3%
72143 REDBOX	69.000 1	43(2)	63MVA (1x)	63MVA (1x)
72142 REDBOX	115.00	SINGL1 72142-721	125.4%	125.3%
72143 REDBOX	69.000 2	43(1)	63MVA (1x)	63MVA (1x)
73002 AIRPORT	115.00	P4_BREAKER_FAILU	203.5%	123.6%
73026 BOYD	115.00 1	RE_001	316MVA (1x)	201MVA (1x)
73002 AIRPORT	115.00	P4_BREAKER_FAILU	165.9%	
73433 WINDSORT	115.00 1	RE_001	253MVA (1x)	

AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

CONTINGENCY CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - WORST CASE VIOLATIONS
% LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES
THRESHOLD FOR THE COUNT OF CONTINGENCIES CAUSING OVERLOADING IS 100.0% OF RATING SET A

X--- MONITORED ELEMENT ----X	X-----LABEL----X	0-01 Benchmark.acc	1-01 Alt 1.acc
73095 KERSEYTP 115.00	P4_BREAKER_FAILU	103.7%	
73543 WILLOBY 115.00 1	RE_001	114MVA (1x)	
73197 THERMOPL 115.00	SINGL1 70005-703	107.5%	107.5%
73624 THERMOPL 34.500 1	97(1)	27MVA (760x)	27MVA (751x)
73211 WELD LM 115.00	SINGL1 70470-704	115.5%	
73212 WELD LM 230.00 1	71(T2)	173MVA (2x)	
73211 WELD LM 115.00	SINGL1 70470-704	111.5%	
73212 WELD LM 230.00 3	71(T2)	167MVA (2x)	
73211 WELD LM 115.00	P4_BREAKER_FAILU	104.0%	
73554 BOOMERNG 115.00 1	RE_003	124MVA (1x)	
73211 WELD LM 115.00	P4_BREAKER_FAILU	125.8%	
73558 WHITNEY 115.00 1	RE_001	187MVA (1x)	
73433 WINDSORT 115.00	P4_BREAKER_FAILU	152.7%	
73558 WHITNEY 115.00 1	RE_001	230MVA (1x)	
73502 DACONO 115.00	SINGL1 72107-730	101.7%	101.5%
73503 ERIE SW 115.00 1	48(1)	167MVA (1x)	167MVA (1x)

CONTINGENCY LEGEND:

<----- CONTINGENCY LABEL ------> EVENTS

SINGL1 70005-70397(1) : OPEN LINE FROM BUS 70005 [BRUSH_SS 115.00] TO BUS 70397 [B.CRK_PS 115.00] CKT 1
SINGL1 70023-70400(1) : OPEN LINE FROM BUS 70023 [ALLISON 115.00] TO BUS 70400 [SODALAKE 115.00] CKT 1
SINGL1 70037-70165(1) : OPEN LINE FROM BUS 70037 [ARAP_B 115.00] TO BUS 70165 [ENGLE3TP 115.00] CKT 1
SINGL1 70045-70242(1) : OPEN LINE FROM BUS 70045 [BANCROFT 115.00] TO BUS 70242 [KENDRICK 115.00] CKT 1
SINGL1 70108-70276(1) : OPEN LINE FROM BUS 70108 [CHEROKEE_S 115.00] TO BUS 70276 [MAPLETO1 115.00] CKT 1
SINGL1 70110-70175(1) : OPEN LINE FROM BUS 70110 [CHEROKEE_N 115.00] TO BUS 70175 [FEDERHT1 115.00] CKT 1
SINGL1 70244-70444(1) : OPEN LINE FROM BUS 70244 [LAFAYETT 115.00] TO BUS 70444 [VALMONT 115.00] CKT 1
SINGL1 70310-70311(U1) : OPEN LINE FROM BUS 70310 [PAWNEE 22.000] TO BUS 70311 [PAWNEE 230.00] CKT U1
SINGL1 70310-70311(U2) : OPEN LINE FROM BUS 70310 [PAWNEE 22.000] TO BUS 70311 [PAWNEE 230.00] CKT U2
SINGL1 70397-73020(1) : OPEN LINE FROM BUS 70397 [B.CRK_PS 115.00] TO BUS 73020 [BEAVERCK 115.00] CKT 1
SINGL1 70463-70483(1) : OPEN LINE FROM BUS 70463 [WATERTON 115.00] TO BUS 70483 [MARTN1TP 115.00] CKT 1

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.                                                                                                                    .
.                            AC CONTINGENCY REPORT FOR  2 AC CONTINGENCY CALCULATION RUNS                             .
.                                                                                                                    .
.           CONTINGENCY CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - WORST CASE VIOLATIONS           .
.               % LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES               .
.               THRESHOLD FOR THE COUNT OF CONTINGENCIES CAUSING OVERLOADING IS 100.0% OF RATING SET A               .
......................................................................................................................

CONTINGENCY LEGEND:
<----- CONTINGENCY LABEL ------>  EVENTS
SINGL1 70470-70471(T2)          : OPEN LINE FROM BUS 70470 [WELD_PS     115.00] TO BUS 70471 [WELD_PS     230.00] CKT T2
SINGL1 70537-70538(1)           : OPEN LINE FROM BUS 70537 [FITZSMNS    115.00] TO BUS 70538 [CHMBERS     115.00] CKT 1
SINGL1 72107-73048(1)           : OPEN LINE FROM BUS 72107 [SLATERTS    115.00] TO BUS 73048 [DEL CTAP    115.00] CKT 1
SINGL1 72142-72143(1)           : OPEN LINE FROM BUS 72142 [REDBOX      115.00] TO BUS 72143 [REDBOX      69.000] CKT 1
SINGL1 72142-72143(2)           : OPEN LINE FROM BUS 72142 [REDBOX      115.00] TO BUS 72143 [REDBOX      69.000] CKT 2
SINGL1 73502-73503(1)           : OPEN LINE FROM BUS 73502 [DACONO      115.00] TO BUS 73503 [ERIE SW     115.00] CKT 1
BUS_FAULT_001                   : OPEN LINE FROM BUS 73211 [WELD  LM    115.00] TO BUS 73554 [BOOMERNG    115.00] CKT 1
                                  OPEN LINE FROM BUS 73211 [WELD  LM    115.00] TO BUS 73558 [WHITNEY     115.00] CKT 1
                                  OPEN LINE FROM BUS 73211 [WELD  LM    115.00] TO BUS 73212 [WELD  LM    230.00] CKT 1
                                  OPEN LINE FROM BUS 73211 [WELD  LM    115.00] TO BUS 73212 [WELD  LM    230.00] CKT 3
                                  OPEN LINE FROM BUS 73211 [WELD  LM    115.00] TO BUS 70470 [WELD_PS     115.00] CKT 1
                                  OPEN LINE FROM BUS 73554 [BOOMERNG    115.00] TO BUS 70368 [ROSEDALE    115.00] CKT 1
P4_BREAKER_FAILURE_001          : OPEN BRANCH FROM BUS 70470 [WELD_PS     115.00] TO BUS 70471 [WELD_PS     230.00] CKT T2
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 70471 [WELD_PS     230.00] CKT 1
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73011 [AULT        230.00] CKT 1
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73011 [AULT        230.00] CKT 2
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73211 [WELD  LM    115.00] CKT 1
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73211 [WELD  LM    115.00] CKT 3
P4_BREAKER_FAILURE_003          : OPEN BRANCH FROM BUS 70209 [GREELEY     115.00] TO BUS 70470 [WELD_PS     115.00] CKT 1
                                  OPEN BRANCH FROM BUS 70209 [GREELEY     115.00] TO BUS 70202 [GODFRETP    115.00] CKT 1
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.                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     WED, SEP 21 2016  10:34             PAGE 29 .
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.                            AC CONTINGENCY REPORT FOR  2 AC CONTINGENCY CALCULATION RUNS                             .
.                                                                                                                    .
.                                 'NECO' BASE CASE BUSES WITH VOLTAGE GREATER  1.0500                                 .
......................................................................................................................

                          | 0-01 Ben | 1-01 Alt |
                          | chmark.a | 1.acc    |
X--------- BUS ---------X | cc       |          |
--------------------------|----------|----------|
 73324 POLEHILL    13.800 |  1.07390 |  1.07390 |
--------------------------|----------|----------|
 73356 KORTES1     6.9000 |  1.05332 |  1.05287 |
--------------------------|----------|----------|
 73357 KORTES2     6.9000 |  1.05318 |  1.05273 |
--------------------------|----------|----------|
 73358 KORTES3     6.9000 |  1.05338 |  1.05292 |
--------------------------|----------|----------|
 73631 COHIWND_G1  0.6900 |  1.05473 |  1.05466 |
--------------------------|----------|----------|
 73635 COHIWND_G2  0.6900 |  1.05724 |  1.05720 |
--------------------------|----------|----------|
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.                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     WED, SEP 21 2016  10:34             PAGE 30 .
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.                            AC CONTINGENCY REPORT FOR  2 AC CONTINGENCY CALCULATION RUNS                             .
.                                                                                                                    .
.                                 'NECO' BASE CASE BUSES WITH VOLTAGE LESS  0.9500                                    .
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                          | 0-01 Ben | 1-01 Alt |
                          | chmark.a | 1.acc    |
X--------- BUS ---------X | cc       |          |
--------------------------|----------|----------|
 73620 LARAMIE1    13.200 |  0.82209 |  0.82273 |
--------------------------|----------|----------|
 73621 LARAMIE2    13.200 |  0.86142 |  0.86202 |
--------------------------|----------|----------|
 79008 GRANGER     69.000 |  0.91223 |  0.91223 |
--------------------------|----------|----------|
 79009 LYMAN SW    69.000 |  0.88101 |  0.88101 |
--------------------------|----------|----------|
 79010 MANILA      69.000 |  0.94754 |  0.94754 |
--------------------------|----------|----------|
 79019 MORRO1-2    12.500 |  0.93119 |  0.93118 |
--------------------------|----------|----------|
 79030 FONTNLLE    69.000 |  0.94837 |  0.94837 |
--------------------------|----------|----------|
 79157 BMESA1-2    11.000 |  0.91124 |  0.91124 |
--------------------------|----------|----------|
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.                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     WED, SEP 21 2016  10:34             PAGE 31 .
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.                            AC CONTINGENCY REPORT FOR  2 AC CONTINGENCY CALCULATION RUNS                             .
.                                                                                                                    .
.              'NECO' CONTINGENCY CASE BUSES WITH VOLTAGE GREATER THAN  1.0500 - WORST CASE VIOLATIONS                .
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                          |                 | 0-01 Ben | 1-01 Alt |
                          |                 | chmark.a | 1.acc    |
X--------- BUS ---------X | X-----LABEL----X | cc       |          |
--------------------------|-----------------|----------|----------|
 72712 KITCARSN    34.500 | SINGL1 72713-727 |  1.09461 |  1.09473 |
                          | 14(1)            |     (4x) |     (4x) |
--------------------------|-----------------|----------|----------|
 72713 KITCAR_1    34.500 | SINGL1 72713-727 |  1.09491 |  1.09503 |
```

	14(1)	(2x)	(2x)
72714 KC_GEN 0.6900	UNIT 72714(G1)	1.09447 (1x)	1.09459 (1x)
72951 MONTROSE 230.00	UNIT 70310(C1)	1.05137 (2x)	1.05142 (2x)
72952 NUCLA 230.00	UNIT 70310(C1)	1.05230 (8x)	1.05234 (8x)
72953 CAHONE 230.00	UNIT 70310(C1)	1.05063 (1x)	1.05066 (1x)
73300 BIGTHOMP 13.800	P4_BREAKER_FAILURE_001	1.05752 (1x)	
73324 POLEHILL 13.800	SINGL1 73058-73155(1)	1.08160 (759x)	1.08160 (750x)
73332 ALCOVA1 6.9000	UNIT 70310(C1)	1.05244 (5x)	1.05231 (3x)
73356 KORTES1 6.9000	UNIT 70310(C1)	1.06799 (758x)	1.06801 (750x)
73357 KORTES2 6.9000	UNIT 70310(C1)	1.06777 (758x)	1.06779 (750x)
73358 KORTES3 6.9000	UNIT 70310(C1)	1.06807 (759x)	1.06810 (750x)
73438 ALCOVA2 6.9000	UNIT 70310(C1)	1.05250 (5x)	1.05237 (3x)
73627 COHIWND_1 34.500	SINGL1 70148-70208(1)	1.05000 (1x)	
73631 COHIWND_G1 0.6900	SINGL1 73150-73191(1)	1.05861 (755x)	1.05852 (746x)
73635 COHIWND_G2 0.6900	UNIT 73631(W)	1.06976 (755x)	1.06956 (746x)

AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

'NECO' CONTINGENCY CASE BUSES WITH VOLTAGE GREATER THAN 1.0500 - WORST CASE VIOLATIONS

X--------- BUS ---------X	X-----LABEL----X	0-01 Benchmark.acc	1-01 Alt 1.acc
79072 HESPERUS 345.00	UNIT 70310(C1)	1.05188 (9x)	1.05190 (9x)
79176 MCPHEE 2.4000	UNIT 70310(C1)	1.05459 (129x)	1.05460 (128x)
79177 MCPHEE 12.470	UNIT 70310(C1)	1.05188 (9x)	1.05189 (9x)
70844 MONFORT 46.000	SINGL1 70844-70845(1)	1.05295 (1x)	

CONTINGENCY LEGEND:

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<----- CONTINGENCY LABEL ------>  EVENTS
SINGL1 70148-70208(1)           : OPEN LINE FROM BUS 70148 [DENVTM      115.00] TO BUS 70208 [GRAY_ST.    115.00] CKT 1
SINGL1 70844-70845(1)           : OPEN LINE FROM BUS 70844 [MONFORT     46.000] TO BUS 70845 [MONFPACK    44.000] CKT 1
SINGL1 72713-72714(1)           : OPEN LINE FROM BUS 72713 [KITCAR_1    34.500] TO BUS 72714 [KC_GEN      0.6900] CKT 1
SINGL1 73058-73155(1)           : OPEN LINE FROM BUS 73058 [FLATIRON    115.00] TO BUS 73155 [POLEHILL    115.00] CKT 1
SINGL1 73150-73191(1)           : OPEN LINE FROM BUS 73150 [PEETZ       115.00] TO BUS 73191 [STERLING    115.00] CKT 1
UNIT 70310(C1)                  : REMOVE UNIT C1 FROM BUS 70310 [PAWNEE      22.000]
UNIT 72714(G1)                  : REMOVE UNIT G1 FROM BUS 72714 [KC_GEN      0.6900]
UNIT 73631(W)                   : REMOVE UNIT W FROM BUS 73631 [COHIWND_G1  0.6900]
P4_BREAKER_FAILURE_001          : OPEN BRANCH FROM BUS 70470 [WELD_PS     115.00] TO BUS 70471 [WELD_PS     230.00] CKT T2
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 70471 [WELD_PS     230.00] CKT 1
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73011 [AULT        230.00] CKT 1
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73011 [AULT        230.00] CKT 2
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73211 [WELD  LM    115.00] CKT 1
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73211 [WELD  LM    115.00] CKT 3
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X--------- BUS ---------X	X-----LABEL----X	0-01 Benchmark.acc	1-01 Alt 1.acc
70008 KELIM 115.00	P4_BREAKER_FAILURE_001	0.93491 (1x)	
70106 CHEROK4 22.000	UNIT 70106(C4)	0.94711 (1x)	0.94722 (1x)
70202 GODFRETP 115.00	P4_BREAKER_FAILURE_001	0.89296 (1x)	
70209 GREELEY 115.00	P4_BREAKER_FAILURE_001	0.89290 (1x)	
70210 GREELEY1 46.000	P4_BREAKER_FAILURE_001	0.89789 (1x)	
70240 JOHNSTN 115.00	P4_BREAKER_FAILURE_001	0.89263 (1x)	
70244 LAFAYETT 115.00	SINGL1 70244-704 44(1)	0.90844 (1x)	0.90587 (1x)
70246 JOHNSTN2 115.00	P4_BREAKER_FAILURE_001	0.89262 (1x)	
70263 LITTLET1 115.00	SINGL1 70463-704 83(1)	0.92714 (2x)	0.92735 (2x)
70279 MARTIN_1 115.00	SINGL1 70463-704 83(1)	0.91829 (1x)	0.91851 (1x)
70290 MONFORT 115.00	P4_BREAKER_FAILURE_001	0.88861 (1x)	
70368 ROSEDALE 115.00	P4_BREAKER_FAILURE_001	0.89429 (1x)	
70439 UNC 115.00	P4_BREAKER_FAILURE_001	0.89190 (1x)	
70469 WELD 46.000	P4_BREAKER_FAILURE_001	0.89742 (1x)	
70470 WELD_PS 115.00	P4_BREAKER_FAILURE_001	0.89779 (1x)	
70475 ARROWHLK 115.00	P4_BREAKER_FAILURE_001	0.89327 (1x)	

X--------- BUS ---------X	X-----LABEL----X	0-01 Benchmark.acc	1-01 Alt 1.acc
70483 MARTN1TP 115.00	SINGL1 70463-704 83(1)	0.91998 (1x)	0.92019 (1x)
70604 PARKWAY 115.00	SINGL1 70244-704 44(1)	0.92442 (1x)	0.92190 (1x)
70805 LEPRINO_PS 115.00	P4_BREAKER_FAILURE_001	0.89046 (1x)	
70899 LUCERENE 115.00	P4_BREAKER_FAILURE_001	0.88749 (1x)	
72107 SLATERTS 115.00	SINGL1 72107-730 48(1)	0.90463 (1x)	0.90650 (1x)
72142 REDBOX 115.00	SINGL1 72141-721 42(1)	0.94437 (2x)	0.94513 (2x)
72143 REDBOX 69.000	SINGL1 72141-721 42(1)	0.92209 (10x)	0.92287 (8x)
72144 REDTAIL 115.00	SINGL1 72141-721 42(1)	0.93953 (2x)	0.94029 (2x)
72222 RATTLSNK 115.00	P4_BREAKER_FAILURE_001	0.94513 (2x)	

72226 MILTON 115.00	P4_BREAKER_FAILU RE_001	0.92188 (1x)	
72403 S_KERSEY 115.00	P4_BREAKER_FAILU RE_001	0.91388 (1x)	
73002 AIRPORT 115.00	P4_BREAKER_FAILU RE_001	0.93491 (1x)	
73017 B.SANDY 115.00	SINGL1 73017-730 18(1)	0.94523 (1x)	0.94609 (1x)
73023 BIJOUTAP 115.00	SINGL1 73020-730 31(1)	0.91339 (2x)	0.92203 (2x)
73031 BRUSHTAP 115.00	SINGL1 73020-730 31(1)	0.89735 (1x)	0.90617 (1x)
73049 DELCAMIN 115.00	SINGL1 72107-730 48(1)	0.90776 (2x)	0.90962 (2x)

AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

'NECO' CONTINGENCY CASE BUSES WITH VOLTAGE LESS THAN 0.9500 - WORST CASE VIOLATIONS

X--------- BUS ---------X	X-----LABEL----X	0-01 Ben chmark.a cc	1-01 Alt 1.acc
73055 KERSEY_W 115.00	P4_BREAKER_FAILU RE_001	0.91036 (1x)	
73095 KERSEYTP 115.00	P4_BREAKER_FAILU RE_001	0.91306 (1x)	
73097 KIOWA CK 115.00	SINGL1 73020-730 31(1)	0.93358 (3x)	0.94198 (2x)
73098 KODAK 115.00	P4_BREAKER_FAILU RE_001	0.90657 (1x)	
73117 LOST CK 115.00	P4_BREAKER_FAILU RE_001	0.94827 (1x)	
73147 ORCHARD 115.00	SINGL1 73020-730 31(1)	0.93358 (3x)	0.94198 (2x)
73211 WELD LM 115.00	P4_BREAKER_FAILU RE_001	0.89788 (1x)	
73213 WIGGINS TAP 115.00	SINGL1 73020-730 31(1)	0.94144 (2x)	0.94910 (1x)
73218 WINDSOR 115.00	P4_BREAKER_FAILU RE_001	0.91683 (1x)	
73305 EFMORGTP 115.00	SINGL1 73020-730 31(1)	0.89736 (2x)	0.90618 (2x)
73309 HENDERSON 115.00	SINGL1 73020-730 31(1)	0.89700 (2x)	0.90582 (2x)
73310 FME 115.00	SINGL1 73020-730 31(1)	0.89582 (2x)	0.90465 (2x)
73311 FMS 115.00	SINGL1 73020-730 31(1)	0.89918 (2x)	0.90797 (2x)
73318 LIMON 115.00	SINGL1 73017-730 18(1)	0.94342 (1x)	0.94430 (1x)
73370 LOSTCKTP 115.00	P4_BREAKER_FAILU RE_001	0.94827 (1x)	
73377 EXCEL 115.00	SINGL1 73020-730 31(1)	0.89508 (2x)	0.90392 (2x)

AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

'NECO' CONTINGENCY CASE BUSES WITH VOLTAGE LESS THAN 0.9500 - WORST CASE VIOLATIONS

X--------- BUS ---------X	X-----LABEL----X	0-01 Ben chmark.a cc	1-01 Alt 1.acc
73378 FMN 115.00	SINGL1 73020-730 31(1)	0.89736 (2x)	0.90618 (2x)
73379 FMWEST 115.00	SINGL1 73020-730	0.89919	0.90798

	31(1)	(2x)	(2x)
73433 WINDSORT 115.00	P4_BREAKER_FAILURE_001	0.91792 (1x)	
73501 RINNVALL 115.00	SINGL1 72107-73048(1)	0.92317 (2x)	0.92499 (2x)
73502 DACONO 115.00	SINGL1 72107-73048(1)	0.93826 (1x)	0.94005 (1x)
73543 WILLOBY 115.00	P4_BREAKER_FAILURE_001	0.92994 (1x)	
73554 BOOMERNG 115.00	P4_BREAKER_FAILURE_001	0.89720 (1x)	
73555 BRACEWLL 115.00	P4_BREAKER_FAILURE_001	0.90630 (1x)	
73558 WHITNEY 115.00	P4_BREAKER_FAILURE_001	0.90659 (1x)	
73620 LARAMIE1 13.200	UNIT 70310(C1)	0.81487 (760x)	0.81563 (751x)
73621 LARAMIE2 13.200	UNIT 70310(C1)	0.85474 (760x)	0.85544 (751x)
79008 GRANGER 69.000	SINGL1 70005-70397(1)	0.91223 (760x)	0.91223 (751x)
79009 LYMAN SW 69.000	SINGL1 70005-70397(1)	0.88101 (760x)	0.88101 (751x)
79010 MANILA 69.000	SINGL1 70005-70397(1)	0.94754 (760x)	0.94754 (751x)
79019 MORRO1-2 12.500	UNIT 70310(C1)	0.91733 (760x)	0.91722 (751x)
79030 FONTNLLE 69.000	SINGL1 70005-70397(1)	0.94837 (760x)	0.94837 (751x)

AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

'NECO' CONTINGENCY CASE BUSES WITH VOLTAGE LESS THAN 0.9500 - WORST CASE VIOLATIONS

X--------- BUS ---------X	X-----LABEL----X	0-01 Benchmark.acc	1-01 Alt 1.acc
79157 BMESA1-2 11.000	SINGL1 70036-70384(1)	0.91084 (760x)	0.91084 (751x)
70801 16L003 44.000	P4_BREAKER_FAILURE_001	0.89742 (1x)	
70802 16L004 44.000	P4_BREAKER_FAILURE_001	0.89742 (1x)	
70803 CONTINTL 44.000	P4_BREAKER_FAILURE_001	0.82641 (45x)	
70804 CONTINTP 44.000	P4_BREAKER_FAILURE_001	0.83697 (2x)	
70808 AULT2 44.000	P4_BREAKER_FAILURE_001	0.83599 (2x)	
70810 AULT1 44.000	P4_BREAKER_FAILURE_001	0.84190 (4x)	
70812 AULT TAP 44.000	P4_BREAKER_FAILURE_001	0.84663 (4x)	
70817 EATON2 44.000	P4_BREAKER_FAILURE_001	0.83928 (5x)	
70819 EATON1 44.000	P4_BREAKER_FAILURE_001	0.84845 (1x)	
70818 EATONTAP 44.000	P4_BREAKER_FAILURE_001	0.84924 (1x)	
70827 BOYD JCT 44.000	P4_BREAKER_FAILURE_001	0.87211 (1x)	
70828 MUMPERHL 44.000	P4_BREAKER_FAILURE_001	0.87213 (1x)	
70831 COWHERD 44.000	P4_BREAKER_FAILURE_001	0.86728 (1x)	

70835 P.V. TAP 44.000	P4_BREAKER_FAILU RE_001	0.86322 (1x)	
70836 P.V. TAP 2 44.000	P4_BREAKER_FAILU RE_001	0.86322 (1x)	

X--------- BUS ---------X	X-----LABEL----X	0-01 Ben chmark.a cc	1-01 Alt 1.acc
70838 PLEASVAL 44.000	P4_BREAKER_FAILU RE_001	0.85789 (2x)	
70839 MONFORTP 44.000	P4_BREAKER_FAILU RE_001	0.87302 (1x)	
70844 MONFORT 46.000	P4_BREAKER_FAILU RE_001	0.87724 (1x)	
70845 MONFPACK 44.000	P4_BREAKER_FAILU RE_001	0.87073 (1x)	
70846 WEBERTAP 44.000	P4_BREAKER_FAILU RE_001	0.87923 (1x)	
70849 EVANSTAP 44.000	P4_BREAKER_FAILU RE_001	0.87919 (1x)	
70852 GREELYTP 44.000	P4_BREAKER_FAILU RE_001	0.88280 (1x)	
70857 BRANTNER 44.000	P4_BREAKER_FAILU RE_001	0.87821 (1x)	
70861 LASALLTP 44.000	P4_BREAKER_FAILU RE_001	0.87432 (1x)	
70865 LASALLE 44.000	P4_BREAKER_FAILU RE_001	0.87432 (1x)	
70866 MCMILLEN 44.000	P4_BREAKER_FAILU RE_001	0.86578 (2x)	0.94890 (1x)
70870 BOXELDER 44.000	P4_BREAKER_FAILU RE_001	0.84481 (4x)	0.92988 (1x)
70871 HIGHLDTP 44.000	P4_BREAKER_FAILU RE_001	0.88750 (1x)	
70875 HIGHLAND 44.000	P4_BREAKER_FAILU RE_001	0.88536 (1x)	
70877 EVANS 44.000	P4_BREAKER_FAILU RE_001	0.87696 (1x)	
70903 CLOVERLY 115.00	P4_BREAKER_FAILU RE_001	0.88662 (1x)	

X--------- BUS ---------X	X-----LABEL----X	0-01 Ben chmark.a cc	1-01 Alt 1.acc
72227 NERESCAN 115.00	P4_BREAKER_FAILU RE_001	0.92185 (1x)	
72208 DELCAMIN 69.000	SINGL1 72107-730 48(1)	0.92450 (2x)	0.92647 (2x)

CONTINGENCY LEGEND:

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<----- CONTINGENCY LABEL ------>  EVENTS
SINGL1 70005-70397(1)           : OPEN LINE FROM BUS 70005 [BRUSH_SS    115.00] TO BUS 70397 [B.CRK_PS    115.00] CKT 1
SINGL1 70036-70384(1)           : OPEN LINE FROM BUS 70036 [ARAP_A      115.00] TO BUS 70384 [SHERIDAN    115.00] CKT 1
SINGL1 70244-70444(1)           : OPEN LINE FROM BUS 70244 [LAFAYETT    115.00] TO BUS 70444 [VALMONT     115.00] CKT 1
SINGL1 70463-70483(1)           : OPEN LINE FROM BUS 70463 [WATERTON    115.00] TO BUS 70483 [MARTN1TP    115.00] CKT 1
SINGL1 72107-73048(1)           : OPEN LINE FROM BUS 72107 [SLATERTS    115.00] TO BUS 73048 [DEL CTAP    115.00] CKT 1
SINGL1 72141-72142(1)           : OPEN LINE FROM BUS 72141 [KEOTA       115.00] TO BUS 72142 [REDBOX      115.00] CKT 1
SINGL1 73017-73018(1)           : OPEN LINE FROM BUS 73017 [B.SANDY     115.00] TO BUS 73018 [B.SANDY     230.00] CKT 1
SINGL1 73020-73031(1)           : OPEN LINE FROM BUS 73020 [BEAVERCK    115.00] TO BUS 73031 [BRUSHTAP    115.00] CKT 1
UNIT 70106(C4)                  : REMOVE UNIT C4 FROM BUS 70106 [CHEROK4     22.000]
UNIT 70310(C1)                  : REMOVE UNIT C1 FROM BUS 70310 [PAWNEE      22.000]
P4_BREAKER_FAILURE_001          : OPEN BRANCH FROM BUS 70470 [WELD_PS     115.00] TO BUS 70471 [WELD_PS     230.00] CKT T2
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                                OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 70471 [WELD_PS     230.00] CKT 1
                                OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73011 [AULT        230.00] CKT 1
                                OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73011 [AULT        230.00] CKT 2
                                OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73211 [WELD  LM    115.00] CKT 1
                                OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73211 [WELD  LM    115.00] CKT 3
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.                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     WED, SEP 21 2016  10:34            PAGE 40 .
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.                           AC CONTINGENCY REPORT FOR  2 AC CONTINGENCY CALCULATION RUNS                            .
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.               'NECO' CONTINGENCY CASE BUSES WITH VOLTAGE DROP BEYOND  0.0800 - WORST CASE VIOLATIONS               .
.....................................................................................................................

                          |                  | 0-01 Ben | 1-01 Alt |
                          |                  | chmark.a | 1.acc    |
X--------- BUS ---------X | X-----LABEL----X | cc       |          |
--------------------------|------------------|----------|----------|
 70202 GODFRETP    115.00 | P4_BREAKER_FAILU |  0.89296 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70209 GREELEY     115.00 | P4_BREAKER_FAILU |  0.89290 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70210 GREELEY1    46.000 | P4_BREAKER_FAILU |  0.89789 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70240 JOHNSTN     115.00 | P4_BREAKER_FAILU |  0.89263 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70244 LAFAYETT    115.00 | SINGL1 70244-704 |  0.90844 |  0.90587 |
                          | 44(1)            |     (1x) |     (1x) |
--------------------------|------------------|----------|----------|
 70246 JOHNSTN2    115.00 | P4_BREAKER_FAILU |  0.89262 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70279 MARTIN_1    115.00 | SINGL1 70463-704 |  0.91829 |  0.91851 |
                          | 83(1)            |     (1x) |     (1x) |
--------------------------|------------------|----------|----------|
 70290 MONFORT     115.00 | P4_BREAKER_FAILU |  0.88861 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70368 ROSEDALE    115.00 | P4_BREAKER_FAILU |  0.89429 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70439 UNC         115.00 | P4_BREAKER_FAILU |  0.89190 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70469 WELD        46.000 | P4_BREAKER_FAILU |  0.89742 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70470 WELD_PS     115.00 | P4_BREAKER_FAILU |  0.89779 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70475 ARROWHLK    115.00 | P4_BREAKER_FAILU |  0.89327 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 70483 MARTN1TP    115.00 | SINGL1 70463-704 |  0.91998 |  0.92019 |
                          | 83(1)            |     (1x) |     (1x) |
--------------------------|------------------|----------|----------|
 70604 PARKWAY     115.00 | SINGL1 70244-704 |  0.92442 |  0.92190 |
                          | 44(1)            |     (1x) |     (1x) |
--------------------------|------------------|----------|----------|
 70805 LEPRINO_PS  115.00 | P4_BREAKER_FAILU |  0.89046 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
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.                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     WED, SEP 21 2016  10:34            PAGE 41 .
.                                                                                                                   .
.                           AC CONTINGENCY REPORT FOR  2 AC CONTINGENCY CALCULATION RUNS                            .
.                                                                                                                   .
.               'NECO' CONTINGENCY CASE BUSES WITH VOLTAGE DROP BEYOND  0.0800 - WORST CASE VIOLATIONS               .
.....................................................................................................................

                          |                  | 0-01 Ben | 1-01 Alt |
                          |                  | chmark.a | 1.acc    |
X--------- BUS ---------X | X-----LABEL----X | cc       |          |
--------------------------|------------------|----------|----------|
 70899 LUCERENE    115.00 | P4_BREAKER_FAILU |  0.88749 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 72107 SLATERTS    115.00 | SINGL1 72107-730 |  0.90463 |  0.90650 |
                          | 48(1)            |     (1x) |     (1x) |
--------------------------|------------------|----------|----------|
 73031 BRUSHTAP    115.00 | SINGL1 73020-730 |  0.89735 |  0.90617 |
                          | 31(1)            |     (1x) |     (1x) |
--------------------------|------------------|----------|----------|
 73049 DELCAMIN    115.00 | SINGL1 72107-730 |  0.90776 |  0.90962 |
                          | 48(1)            |     (1x) |     (1x) |
--------------------------|------------------|----------|----------|
 73098 KODAK       115.00 | P4_BREAKER_FAILU |  0.90657 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 73211 WELD  LM    115.00 | P4_BREAKER_FAILU |  0.89788 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
 73218 WINDSOR     115.00 | P4_BREAKER_FAILU |  0.91683 |          |
                          | RE_001           |     (1x) |          |
--------------------------|------------------|----------|----------|
```

73305 EFMORGTP 115.00	SINGL1 73020-730 31(1)	0.89736 (2x)	0.90618 (2x)
73309 HENDERSON 115.00	SINGL1 73020-730 31(1)	0.89700 (2x)	0.90582 (2x)
73310 FME 115.00	SINGL1 73020-730 31(1)	0.89582 (2x)	0.90465 (2x)
73311 FMS 115.00	SINGL1 73020-730 31(1)	0.89918 (2x)	0.90797 (2x)
73377 EXCEL 115.00	SINGL1 73020-730 31(1)	0.89508 (2x)	0.90392 (2x)
73378 FMN 115.00	SINGL1 73020-730 31(1)	0.89736 (2x)	0.90618 (2x)
73379 FMWEST 115.00	SINGL1 73020-730 31(1)	0.89919 (2x)	0.90798 (2x)
73433 WINDSORT 115.00	P4_BREAKER_FAILU RE_001	0.91792 (1x)	
73554 BOOMERNG 115.00	P4_BREAKER_FAILU RE_001	0.89720 (1x)	

BUS	LABEL	0-01 Ben chmark.a cc	1-01 Alt 1.acc
73555 BRACEWLL 115.00	P4_BREAKER_FAILU RE_001	0.90630 (1x)	
73558 WHITNEY 115.00	P4_BREAKER_FAILU RE_001	0.90659 (1x)	
70801 16L003 44.000	P4_BREAKER_FAILU RE_001	0.89742 (1x)	
70802 16L004 44.000	P4_BREAKER_FAILU RE_001	0.89742 (1x)	
70803 CONTINTL 44.000	P4_BREAKER_FAILU RE_001	0.82641 (1x)	
70804 CONTINTP 44.000	P4_BREAKER_FAILU RE_001	0.83697 (1x)	
70808 AULT2 44.000	P4_BREAKER_FAILU RE_001	0.83599 (1x)	
70810 AULT1 44.000	P4_BREAKER_FAILU RE_001	0.84190 (1x)	
70812 AULT TAP 44.000	P4_BREAKER_FAILU RE_001	0.84663 (1x)	
70817 EATON2 44.000	P4_BREAKER_FAILU RE_001	0.83928 (1x)	
70819 EATON1 44.000	P4_BREAKER_FAILU RE_001	0.84845 (1x)	
70818 EATONTAP 44.000	P4_BREAKER_FAILU RE_001	0.84924 (1x)	
70827 BOYD JCT 44.000	P4_BREAKER_FAILU RE_001	0.87211 (1x)	
70828 MUMPERHL 44.000	P4_BREAKER_FAILU RE_001	0.87213 (1x)	
70831 COWHERD 44.000	P4_BREAKER_FAILU RE_001	0.86728 (1x)	
70835 P.V. TAP 44.000	P4_BREAKER_FAILU RE_001	0.86322 (1x)	

BUS	LABEL	0-01 Ben chmark.a cc	1-01 Alt 1.acc

70836 P.V. TAP 2 44.000	P4_BREAKER_FAILU RE_001	0.86322 (1x)	
70838 PLEASVAL 44.000	P4_BREAKER_FAILU RE_001	0.85789 (1x)	
70839 MONFORTP 44.000	P4_BREAKER_FAILU RE_001	0.87302 (1x)	
70844 MONFORT 46.000	P4_BREAKER_FAILU RE_001	0.87724 (1x)	
70845 MONFPACK 44.000	P4_BREAKER_FAILU RE_001	0.87073 (1x)	
70846 WEBERTAP 44.000	P4_BREAKER_FAILU RE_001	0.87923 (1x)	
70849 EVANSTAP 44.000	P4_BREAKER_FAILU RE_001	0.87919 (1x)	
70852 GREELYTP 44.000	P4_BREAKER_FAILU RE_001	0.88280 (1x)	
70857 BRANTNER 44.000	P4_BREAKER_FAILU RE_001	0.87821 (1x)	
70861 LASALLTP 44.000	P4_BREAKER_FAILU RE_001	0.87432 (1x)	
70865 LASALLE 44.000	P4_BREAKER_FAILU RE_001	0.87432 (1x)	
70866 MCMILLEN 44.000	P4_BREAKER_FAILU RE_001	0.86578 (1x)	
70870 BOXELDER 44.000	P4_BREAKER_FAILU RE_001	0.84481 (1x)	
70871 HIGHLDTP 44.000	P4_BREAKER_FAILU RE_001	0.88750 (1x)	
70875 HIGHLAND 44.000	P4_BREAKER_FAILU RE_001	0.88536 (1x)	
70877 EVANS 44.000	P4_BREAKER_FAILU RE_001	0.87696 (1x)	

. AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS .

. 'NECO' CONTINGENCY CASE BUSES WITH VOLTAGE DROP BEYOND 0.0800 - WORST CASE VIOLATIONS .

X--------- BUS ---------X	X-----LABEL----X	0-01 Ben chmark.a cc	1-01 Alt 1.acc
70903 CLOVERLY 115.00	P4_BREAKER_FAILU RE_001	0.88662 (1x)	
72208 DELCAMIN 69.000	SINGL1 72107-730 48(1)	0.92450 (1x)	0.92647 (1x)

CONTINGENCY LEGEND:

```
<----- CONTINGENCY LABEL ------>  EVENTS
SINGL1 70244-70444(1)           : OPEN LINE FROM BUS 70244 [LAFAYETT    115.00] TO BUS 70444 [VALMONT     115.00] CKT 1
SINGL1 70463-70483(1)           : OPEN LINE FROM BUS 70463 [WATERTON    115.00] TO BUS 70483 [MARTN1TP    115.00] CKT 1
SINGL1 72107-73048(1)           : OPEN LINE FROM BUS 72107 [SLATERTS    115.00] TO BUS 73048 [DEL CTAP    115.00] CKT 1
SINGL1 73020-73031(1)           : OPEN LINE FROM BUS 73020 [BEAVERCK    115.00] TO BUS 73031 [BRUSHTAP    115.00] CKT 1
P4_BREAKER_FAILURE_001          : OPEN BRANCH FROM BUS 70470 [WELD_PS     115.00] TO BUS 70471 [WELD_PS     230.00] CKT T2
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 70471 [WELD_PS     230.00] CKT 1
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73011 [AULT        230.00] CKT 1
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73011 [AULT        230.00] CKT 2
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73211 [WELD  LM    115.00] CKT 1
                                  OPEN LINE FROM BUS 73212 [WELD  LM    230.00] TO BUS 73211 [WELD  LM    115.00] CKT 3
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