Resource Planning Power Flow & Feasibility Study

A Proposal to

Portland General Electric
121 SW Salmon Street
Portland, Oregon 97204

by

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1. Introduction

The OSU Motor Systems Resource Facility (MSRF), co-directed by the Principal Investigators (PI's, bios included), is an Energy Systems Laboratory with operating capabilities up to 750kVA, testbeds up to 300hp, a 120kVA fully programmable source, and a bi-directional grid interface enabling regeneration back onto the grid. The MSRF was developed at OSU for the research and testing of current and emerging technologies involving electric energy generation and renewables, machines, power electronics, industrial systems and power quality, and the hands-on training of students to prepare them for their transition into industry. The laboratory is unique in that it serves both students and industry through contracted projects, demonstrations and courses, including two short courses offered to PGE on Adjustable Speed Drives and Utility Application Issues in 2000. Example research that the MSRF has conducted includes ocean wave and wind generation work, research with the Navy on the "all-electric ship" and their Landing Craft, Air Cushion (LCAC) hovercraft and hybrid electric vehicles including sport utility vehicles and military tanks. At this time the MSRF has the highest power ratings and is the best-equipped Energy Systems Laboratory in any university in the nation.

2. Resource Planning Power Flow Feasibility Study

New potential electrical generation in Oregon and Washington (2000 – 5000 MW of Wind & Gas) offers significant opportunities for PGE. For optimum Resource Planning and Integration with existing resources, the PI's propose to work with two graduate students to model regional Power Flow transmission options in order to provide input to an overall Feasibility Study. The PowerWorld simulator will be employed as the primary power flow platform, and Matlab will be considered if more detailed low level modeling is required. Contingency/outage analysis will be conducted at strategic locations. The OSU Power Flow team will work closely with PGE Transmission Engineers, namely Mr. James (Jim) Eden, to obtain all of the necessary system information, and for weekly input to the power flow and feasibility study development process.

3. Period of Performance: July 1st, 2005 through September 30th, 2005

4. Scope of Work

There are three primary feasibility studies that are required.

A. The first study will be an examination of the transmission system north of the Portland area. This transmission path, South of Allston (SoA), is a system constraint that limits PGE's ability to secure adequate long-term firm transmission in other parts of the Pacific Northwest grid. PGE will complete the Port Westward combined-cycle gas project in May 2007. This project will interconnect at the decommissioned Trojan Nuclear Plant site, which is located in the middle of the SoA path. Analysis on the post-Port Westward system will include several potential topology changes including: effects/impacts of opening the Allston-Trojan lines; a parametric study of adding phase-shifting transformers at Trojan on the Allston lines; adding a third 230 kV line from Trojan to Portland; and other potential upgrades of other facilities in the path.

B. The second study will examine a PGE proposal to assess the Southern Crossing. This study will investigate the feasibility of upgrading the Bethel-Round Butte 230 kV line to 500 kV and extending PGE's transmission from Round Butte to the Boardman/Coyote Springs/McNary area. PGE's objective is to provide it's own transmission path from the McNary area directly to Portland and maximize the economic transfer of PGE's existing resources located in the McNary area, as well as, integrating new resource developments in the area. This plan may require HVDC, series compensation, phase-shifting transformers, or other possible technologies to optimize the transfer. New resources include renewable projects between John Day and Walla Walla and gasification or conventional coal technologies at Boardman.

C. The third study will build upon the results of the second study and examine the synergies between the Southern Crossing options and other potential large-scale regional projects that currently include several AC and DC Canada to California grid expansion alternatives. The Montana/Wyoming to PNW regional projects will not have been developed in sufficient detail to be included in this study. PGE's objective is to leverage the Southern Crossing transmission expansion with the new transmission from Canada. There are significant new potential resources being considered in Canada, and they are looking at potential markets for these resources. The new resources include hydro, renewable, gas and coal projects proposed in BC and Alberta. The Southern Crossing would enable PGE to tap into these developments.

To accomplish the feasibility studies, PGE proposes to use the WECC 2007 HS2 base case. This case is also being used in the region to assess the Canada to California grid expansions. Each study will require one or more power flow maps to be constructed. Contingency studies will mainly be limited to critical outages using a power flow program, although some transient stability benchmarking may be necessary. New facility additions will need to be properly modeled. Each study will be documented and include assumptions, methodology, system analysis of options, cost estimates, and conclusions. PGE will provide generic cost information for these studies.

PGE has received permission from PowerWorld to extend PGE's site license to OSU for the purposes of completing this study. To allow this, OSU will be required to sign an agreement with PowerWorld. In addition, OSU may be required to sign a non-disclosure agreement with PGE to protect certain information that is considered sensitive for national security reasons.

South of Allston

Summer 2004 Study Report

1) Introduction

This report summarizes the studies used to determine safe and reliable operation of the South of Allston path. The South of Allston path is typically loaded heavily only during the summer season when there is high north-to-south power flow across the Northwest system. The generation sources for this pattern include: Upper Columbia generation, Mid Columbia generation, BC Hydro generation, generation in the Puget Sound area and along the I-5 Corridor. The following transmission lines define the South of Allston path.

Allston – Keeler 500 kV (BPA)
Trojan – St. Marys 230 kV (PGE)
Trojan – Rivergate 230 kV (PGE)
Lexington – Ross 230 kV (BPA)
Allston – St. Helens 115 kV (BPA)
Merwin – St. Johns 115 kV (PACW)
Astoria – Seaside 115 kV (PACW)
Lewis & Clark – Astoria Tap 115 kV (PACW)

Note: The "from" and "to" substations are listed in the direction of positive flow on the South of Allston path. The underlined substation is where the flow is metered.

This path is thermally limited and the worst contingencies were found to be the following list of facilities.
N-1: Allston – Keeler 500 kV line
BFR: 4394 Keeler 500 kV (loss of Allston-Keeler and Keeler-Pearl 500 kV lines)
BFR: 4283 Pearl 500 kV (loss of Keeler-Pearl and Pearl-Ostrander 500 kV lines)
N-2: Allston – Trojan 1&2 230 kV lines
N-2: Keeler – St. Marys / Trojan – St. Marys 230 kV lines

The above contingencies typically overload the following listed elements depending on the generation pattern and transfer level. The limiting elements include: Merwin – View Tap 115 kV line section, Woodland – Ross 230 kV line section, Lexington – Longview 230 kV line, Keeler – St. Marys 230 kV line, Trojan – St. Marys 230 kV line, and Keeler – Forest Grove #2 115 kV line.

The reactive margins were determined for the critical contingencies at the Operating Transfer Capability (OTC) limit and at a level that is 5% higher than the OTC to confirm that there are no potential voltage stability issues. All contingencies studied included RAS if applicable.

2) Purpose

The procedures outlined in BPA's Dispatcher Standing Order (DSO) 309 are what is used to operate the system in real-time for the South of Allston path. These procedures identify the transfer levels where RAS is to be armed. The RAS arming is triggered off the north-to-south loading of the Allston – Keeler 500 kV line for the loss of the Allston – Keeler 500 kV line, as it is the worst outage in the local area without RAS. Any contingency involving the loss of the Allston – Keeler 500 kV line would also trigger the same RAS actions.

The DSO currently specifies four levels where actions are taken based on Allston - Keeler loading. The first three arm some type of RAS and the fourth level is the OTC limit where real-time schedule cuts are made to maintain reliable transfers. The Level 1 RAS arms 1200 MW of gen drop. The Level 2 RAS specifies to arm the PACW automatic runback of generation at its Swift and Yale plants. The Swift plant is runback to 170 MW (from a typical output of 200 MW) and the Yale plant is runback to 70 MW (from a typical output of 150 MW). This reduces the flows on the limiting elements stated earlier and is in addition to the Level 1 RAS. The Level 3 RAS arms a total of 2700 MW of gen drop that includes the PACW automatic runback scheme. The RAS gen drop sites include the Fredrickson LLP units at South Tacoma substation, TransAlta Big Hanaford project, Chehalis Power Partners generation at Napavine substation, Upper Columbia generation (Chief Joe and Grand Coulee) as well as generation in BC Hydro's system if loading on the Custer-Ingledow lines is above 800 MW north-to-south.

There is also RAS used for the loss of the Keeler – Pearl 500 kV line to protect the parallel transmission lines in its area. The Keeler – Pearl RAS is armed based on the Keeler – Pearl 500 kV line loading. It only has two levels where Gen Drop is armed. The first is at a Keeler – Pearl loading of 700 MW where 1200 MW is armed and the second is at a loading of 1000 MW where 2700 MW is armed. When 2700 MW of Gen Drop is armed then the Allston – Keeler loading will be limiting before Pearl – Keeler ever hits a limit.

3) Assumptions

The studies were performed using the Heavy Summer 2004 WECC case, as the summer is when this path is most heavily loaded. Figure #1 shows a loading distribution curve of the Allston – Keeler line for Summer (May – September) and Non-Summer (October – April) seasons. It can be seen during the Non-Summer seasons that the path is not stressed high enough to result in any thermal problems, as the loading never reaches the Level 1 arming point. Also, the summer case uses 30 deg C ratings for transmission lines resulting in conservative arming levels and limits during the Non-Summer period. Figure #2 shows a similar loading distribution curve for the Keeler – Pearl 500 kV line.

It is important to note that the Merwin – View Tap 115 kV line section overloads first and is the most limiting element for the South of Allston path. PACW monitors and protects this line by manually running back generation at its Merwin and Yale hydro plants that each integrate into the Merwin 115 kV substation. The studies used the same option that was applied in previous summer studies to model the manual runback scheme when determining the RAS arming levels. This was to see how far back from 250 MW the Merwin and Yale generators (150 MW at Yale and 100 MW at Merwin) would need to be set to in order to alleviate the overloaded Merwin – View Tap 115 kV line section for an outage of the Merwin – Cardwell 115 kV line. It was found that if the combined output was limited to 170 MW then the overload was eliminated. The studies were then conducted by setting the combined generation to 170 MW (100 MW at Yale and 70 MW at Merwin) to mimic what PACW would at least have to do for an outage on their system. By setting the Yale generator to 100 MW the effectiveness of the automatic runback scheme was reduced as the Yale generator is still only ramped back to 70 MW when this scheme is implemented.

When determining the OTC of the South of Allston path it was then assumed that PACW would mitigate any overload experienced on the Merwin – View Tap 115 kV line section with its manual (Merwin and Yale) runback scheme. Also, the PACW Holladay – Knott 115 kV line was allowed to go to 125 percent of its rating (1125 A from 900 A) to account for the time, after a contingency, to manually reduce loadings before a sag violation actually occurs. These assumptions were agreed to by PACW.

4) System Changes

There are a few significant changes in the area since the Summer 2003 studies were performed. There was a second Pearl 500/230 kV transformer bank installed. The Swift #2 generation is gone. The DSI load at Longview is reduced and the DSI load at Pennwalt has been removed. Also, comparing the load levels between 2003 and 2004 indicates that the total amount of load is the same, but the load distribution is different.

5) Methodology

The studies were performed by increasing the north-to-south transfer across the South of Allston path while applying the surrounding area's N-1 and N-2 contingencies until some limiting element was loaded up to 100 percent of its rating in the post-contingent state. Then Level 1 RAS is applied, as described in the DSO, to allow transfers to go higher. When a new limit is found by modeling the Level 1 RAS then the Level 2 RAS is applied. This process continues until the Level 3 RAS has been modeled and no more mitigating actions are available. This point identifies the OTC for the path. Generation at the Beaver, Swift, River Road and Chehalis Power Partners plants were also varied to check their impact on transfers. A list of all the contingencies considered in this study can be found in Table #4.

6) Results

A. Thermal Limitations

The results of the thermal study for Allston – Keeler loadings are found in Table #1. The studies began with no RAS being applied. For this scenario the worst contingency was the Keeler 500 kV breaker failure losing the Allston – Keeler and Keeler – Pearl 500 kV lines. This contingency was limited by overloads on the Merwin – View Tap 115 kV line section at a transfer level of 1678 MW on the South of Allston path. The Allston – Keeler loading to identify the Level 1 arming point in the DSO would be 940 MW.

Next, the Level 1 RAS (1200 MW of gen drop) was modeled for any contingency involving the loss of the Allston – Keeler 500 kV line and the transfers increased again. The worst contingency was again the Keeler 500 kV breaker failure that would overload the Merwin – View Tap 115 kV line section. The South of Allston transfer level at this point was found to be 1982 MW. The Allston – Keeler loading to identify the Level 2 arming point in the DSO is 1136 MW.

Then the Level 2 RAS (Swift and Yale automatic runback) was modeled, in addition to the Level 1 RAS, for any contingency involving the loss of the Allston – Keeler 500 kV line and the transfers increased further. The worst contingency was either the loss of the Allston – Keeler 500 kV line, the Keeler 500 kV breaker failure both of which would overload the Merwin – View Tap 115 kV line section. The South of Allston transfer level at this point was found to be 2341 MW. The Allston – Keeler loading to identify the Level 3 arming point in the DSO was found to be 1385 MW.

Finally, the Level 3 RAS (2700 MW of total gen drop) was modeled, which included the Swift and Yale automatic runback schemes, for any contingency involving the loss of the Allston – Keeler 500 kV line and the transfers increased higher. The worst contingency was the simultaneous loss of the Allston – Trojan 1&2 230 kV lines. There were several limiting elements identified depending on the generation pattern, but the most restrictive was on the Woodland – Ross 230 kV line section. The South of Allston transfer level at which this occurred was 3050 MW and the Allston – Keeler loading was 1741 MW. This identifies the Level 4 OTC limit. Beyond this loading level real-time schedule cuts are made to stay at or below this maximum transfer.

The results of the thermal study for Keeler – Pearl loadings are found in Table #2. The Level 1 Keeler – Pearl RAS (1200 MW of gen drop) is needed when the Keeler – Pearl 500 kV line loading exceeds 700 MW. The Merwin – View Tap 115 kV line section would overload for the loss of the Keeler – Pearl 500 kV line at loadings above 700 MW if no RAS was applied.

The Level 2 Keeler – Pearl RAS (2700 MW of gen drop) is needed when the Keeler – Pearl 500 kV line loading exceeds 1000 MW. It was also found that no additional RAS was needed for Keeler – Pearl through the OTC loading level found for South of Allston. This Gen Drop is separate from the Gen Drop used for the Allston – Keeler outage, but the same points are armed to prevent overarming issues.

B. Voltage Stability Checks

Reactive margin was checked for the worst contingencies at the OTC level identified through the thermal study. All major 500 kV and 230 kV busses in the area were studied. The results are found in Table #3.

It can be seen from Table #3 that each bus studied has adequate margin at the path OTC and at a transfer level that is 5% higher than the OTC. Also, it can be seen that there is no significant decrease in margin as the transfer level is increased. These findings indicate that transfers on the South of Allston path are not voltage stability limited at least through the current OTC limits found in the thermal study.

The minimum reactive margin for any 500 kV bus was 1736 MVAR and for any 230 kV bus was 745 MVAR. The collapse point voltage was always less than 0.85 p.u. at any bus for all transfer levels.

C. Transient Stability Checks

Transient stability simulations were run at the path OTC as identified through the thermal studies. The contingencies studied were the Allston – Keeler 500 kV line outage and the simultaneous loss of both Allston – Trojan 230 kV lines.

The Allston – Keeler 500 kV line outage included the RAS of 2700 MW of gen drop.

All load bus voltage dips did not exceed 25%.
All load bus voltage dips did not exceed 20% for more than 20 cycles.
All generator bus voltage dips did not exceed 30%.
All other bus voltage dips did not exceed 30%

The simultaneous loss of both Allston – Trojan 230 kV lines did not have any violations of the NERC/WECC performance Level C criteria.

All load bus voltage dips did not exceed 30%.
All load bus voltage dips did not exceed 20% for more than 40 cycles.
All generator bus voltage dips did not exceed 30%.
All other bus voltage dips did not exceed 30%

7) Outage History

The following is a list of the outage history for the critical contingencies identified in the studies. The outage history was compiled from data back through July 1, 1996.

Allston – Keeler #1 500 kV

Date	Time	Duration (min.)	Reason
8/10/96	3:42 PM	315	Tree
4/18/98	3:10 PM	0	Lightning
7/14/98	8:45 PM	0	Unknown
7/22/00	5:29 AM	0	Lightning

Allston – Trojan #1 230 kV

Date	Time	Duration (min.)	Reason
5/1/98	6:43 PM	0	Lightning
10/19/99	7:24 AM	83	Improper Relaying
3/18/03	10:35 AM	8	Maintenance Error

Allston – Trojan #2 230 kV

Date	Time	Duration (min.)	Reason

No outages since 7/1/96.

Keeler – Pearl 500 kV

Date	Time	Duration (min.)	Reason
7/13/96	2:36 PM	427	Tree
8/10/96	3:42 PM	315	Forced
6/24/02	8:58 AM	0	Insulator
11/6/02	6:43 AM	0	Weather

Table #4: Contingencies Studied

BFR: (Allston 4502) Allston-Keeler/Napavine-Allston
BFR: (Allston 4690) Paul-Allston #2/Allston Bank #2
BFR: Keeler 500 kV
N-2: Allston-Trojan 1&2 230 kV
N-2: Paul-Allston#2/Napavine-Allston 500 kV
N-2: Trojan-Harborton/Trojan-St. Marys 230 kV
N-2: Keeler- St. Marys/Trojan-St. Marys 230 kV
N-2: Longview-Allston 1&2 230 kV
N-2: Longview-Allston 1&3 230 kV
N-2: Longview-Allston 2&3 230 kV
N-1: Keeler-Pearl 500 kV
N-1: Paul-Allston #2 500 kV
N-1: Napavine-Allston 500 kV
N-1: Pearl-Ostrander 500 kV
N-1: Ostrander-Troutdale 500 kV
N-1: Ostrander-McLoughlin 500 kV
N-1: Allston-Trojan #1 230 kV
N-1: Allston-Trojan #2 230 kV
N-1: 119THST115-HOKINSN115C1
N-1: 119THST115-SW51115C1
N-1: 4THPLN115-SIFTTP115C1
N-1: 4THPLN115-SW51115C1
N-1: 72NDCC115-99THTP115C1
N-1: 72NDCC115-MANOR115C1
N-1: 72NDPPL115-CHERYPPL115C1
N-1: 72NDPPL115-HZLDLPPL115C1
N-1: 99THTP115-BABERTN115C1
N-1: 99THTP115-SW35115C1
N-1: ABRNATHY115-ABRNTHY1115C1
N-1: ABRNTHY#115-CANEMAH115C1
N-1: ABRNTHY#115-MTPLSN2115C1
N-1: ABRNTHY1115-JENGSLD2115C1
N-1: ABRNTHY1115-MCLGHLNA115C1
N-1: ALBINA115-DELAWARE115C1
N-1: ALBINA115-KNOTT115C1
N-1: ALCOA115-PORT115C1
N-1: ALCOA115-ROSALC48115C1
N-1: ALCOA115-STEVNTP115C1
N-1: ALCOA230-ROSS230C1
N-1: ALCOTI115-ALCOA115C1
N-1: ALCOTI115-SW48115C1
N-1: ALDERCRT115-GLENCOE115C1
N-1: ALDERCRT115-HARSNPGE115C1
N-1: ALLSTON115-DELENA115C1
N-1: ALLSTON115-NYSTAP115C4-MS
N-1: ALLSTON115-RAINIER#115C1-MS
N-1: ALLSTON230-BEAVER230C1
N-1: ALLSTON230-DRISCOLL230C1
N-1: ALLSTON230-DRISCOLT230C1
N-1: ALLSTON230-LONGVIEW230C1
N-1: ALLSTON230-LONGVIEW230C2
N-1: ALLSTON230-LONGVIEW230C3
N-1: ARCHERCC115-SW52115C1
N-1: ARIEL115-CARDWELL115C1
N-1: ARIEL115-MERWIN115C1
N-1: ASTORIA115-FERNHIL115C1
N-1: ASTORTP115-ASTORIA115C1
N-1: ASTORTP115-SEASIDE115C1
N-1: AXFORD115-CHERYCC115C1
N-1: AXFORD115-HEYEMYR115C1
N-1: BABERTN115-BRBTNSW115C1
N-1: BAKERCR115-WALNCTY115C1
N-1: BAKERCR115-WALNTAP115C1
N-1: BATLGRD115-CHERYCC115C1
N-1: BATLGRD115-SW6115C1
N-1: BEAVRTON115-BEAVTN#115C1
N-1: BEAVRTON115-DENNY115C1
N-1: BEAVTN#115-TEK1115C1
N-1: BELL115-LENTS115C1
N-1: BELL115-SELLWOOD115C1
N-1: BETHANY115-CEDARHL#115C1
N-1: BETHANY115-WILBRDG#115C1
N-1: Allston – Keeler 500 kV
N-1: BLOSS115-COLUMPG115C1
N-1: BLOSS115-STJOHNT115C1
N-1: BLUELAKE115-FAIRVWP115C1
N-1: BLUELAKE115-ROCKWD2115C1
N-1: BLUELAKE230-TROUTDAL230C1
N-1: BOCGASES115-ELMGRN115C1
N-1: BOISECSC115-STHELENS115C1
N-1: BOONESFR115-OSWEGO115C1
N-1: BOONESFR115-WSTPRTLD115C1
N-1: BOOTHBD115-MCMINVIL115C1
N-1: BOOTHBD115-WALNCTY115C1
N-1: BRBTNSW115-ELMGTI115C1
N-1: BURNT115-BURTON115C1
N-1: BURNT115-CAPLES115C1
N-1: BURTON115-SW100115C1
N-1: BURTON115-SW105115C1
N-1: CAMAS115-FIBERWEB115C1
N-1: CAMAS115-NCAMAS115C1
N-1: CANEMAH115-MTPLSN1115C1
N-1: CANEMAH115-SULIVAN115C1
N-1: CANNONB115-NEHALTP115C1
N-1: CANNONB115-SEASIDE115C1
N-1: CANYON115-SULZER#115C1
N-1: CANYON115-SYLVAN#115C1
N-1: CANYON115-URBAN115C1
N-1: CARBNDM115-ROSS115C1
N-1: CARDWELL115-CARROLLS115C1
N-1: CARDWELL115-COWLCCP115C1
N-1: CARLTON115-CARLTONT115C1
N-1: CARLTON115-WINDSHAR115C1
N-1: CARLTON230-CASCADTP230C1
N-1: CARLTON230-TILLAMOK230C1
N-1: CARLTONT115-FILBRTT115C1
N-1: CARLTONT115-WALNTAP115C1
N-1: CARROLLS115-SKELSO115C1
N-1: CARVER115-CLACKMAS115C1
N-1: CARVER115-PLSNTVLY115C1
N-1: CARVER115-TOWNCNTR115C1
N-1: CARVER230-GRESHAM230C1
N-1: CARVER230-MCLOUGLN230C1
N-1: CASCADTP230-SHERWOOD230C1
N-1: CASCADTP230-WINDSHAR230C1-MS
N-1: CASCDLK115-HOODRVR115C1
N-1: CASCDPK115-JOEAST115C1
N-1: CASCDPK115-SW117115C1
N-1: CATHLAMT115-GRAYSRV115C1
N-1: CATHTAP115-CATHLAMT115C1
N-1: CATHTAP115-KNAPPA115C1
N-1: CATHTAP115-MIST115C1
N-1: CEDARHIL115-CEDARHL#115C1
N-1: CEDARHL#115-STMARYE1115C1
N-1: CHERYCC115-CHERYPPL115C1
N-1: CHERYPPL115-VIEWTAP115C1
N-1: CLACKMA#115-CLACKMAS115C1
N-1: CLACKMA#115-JENGSL#115C1
N-1: CLACKMA#115-MCLGHLNB115C1
N-1: CLARK115-SARA115C1
N-1: CLARK115-SW7115C1
N-1: CLATSKAN115-DELENA115C1
N-1: CLATSKAN115-MIST115C1
N-1: CLATSOP230-DRISCOLT230C1
N-1: CNTENIAL115-CNTENL1115C1
N-1: CNTENL1115-ESTPORT#115C1
N-1: CNTENL1115-MIDWAY1115C1
N-1: CNTENL2115-GLNDOVER115C1
N-1: CNTENL2115-GRESHAMA115C1
N-1: COLUMPG115-MALLORY115C1
N-1: CORNELUS115-FORGROV115C1
N-1: COWLCCP115-LONGVIEW115C1
N-1: CULLY115-HOLLYWOD115C1
N-1: CULLY115-TROUTDAL115C1
N-1: CURTIS#115-DELAWARE115C1

N-1: CURTIS#115-PORTSMTH115C1
N-1: CURTIS115-CURTIS#115C1
N-1: DAYTON115-MCMINVIL115C1
N-1: DENNY115-PROGRESS115C1
N-1: DRISCOLL230-DRISCOLT230C1
N-1: DRISCOLL230-WAUNA230C1
N-1: DURHAM1115-MERIDIAN115C1
N-1: DURHAM1115-TUALATIN115C1
N-1: DURHAM115-DURHAM1115C1
N-1: DURHAM2115-TIGARD1115C1
N-1: DURHAM2115-WSTPRTLD115C1
N-1: DUTCHCAN115-STJOHNS115C1
N-1: DUTCHCAN115-WARREN115C1
N-1: EASTPORT115-ESTPORT#115C1
N-1: EKELSO115-SHAWNCC115C1
N-1: EKELSO115-SKELSO115C1
N-1: ELMGRN115-SW52115C1
N-1: ELMGTI115-ELMGRN115C1
N-1: ELMGTI115-SW119115C1
N-1: ELSWORT115-SW100115C1
N-1: ELSWORT115-SW117115C1
N-1: ESTPORT#115-LINNEMAN115C1
N-1: ESUBSTA115-SULZER#115C1
N-1: ESUBSTA115-WILBRDG#115C1
N-1: ESUBSTA115-WILLPENN115C1
N-1: EVANSC115-EVANSCLK115C1
N-1: EVANSC115-FIBERWEB115C1
N-1: EVANSCLK115-NCAMAS115C1
N-1: EVERGRN115-SEHSILCA115C1
N-1: EVERGRN115-SIFTON115C1
N-1: EVERGRN115-SW62115C1
N-1: F.VALLEY115-HZLDLPPL115C1
N-1: F.VALLEY115-RVRRDC115C1
N-1: FAIRVWP115-FUJITSU115C1
N-1: FARGO115-ORECITY115C1
N-1: FELIDA115-SARA115C1
N-1: FELIDA115-SW48115C1
N-1: FERNHIL115-KNAPPA115C1
N-1: FILBRTT115-FORGROV115C1
N-1: FISHERS115-JOEAST115C1
N-1: FISHERS115-SIFTON115C1
N-1: FORGROV115-KEELER115C2
N-1: FORGRT115-KEELER115C1
N-1: FORGRT115-THATCHJ115C1
N-1: FUJITSU#115-GRESHAMB115C1
N-1: FUJITSU#115-ROCKWD115C1
N-1: FUJITSU115-FUJITSU#115C1
N-1: FUJITSU115-MCGILL115C1
N-1: GARIBALD115-MOHLER115C1
N-1: GARIBALD115-TILLAMOK115C1
N-1: GLENCOE#115-TABOR115C1
N-1: GLENCOE115-GLENCOE#115C1
N-1: GLENCULN115-GRDNHOM1115C1
N-1: GLENCULN115-SYLVAN#115C1
N-1: GLNDOVER115-HEMLOCK#115C1
N-1: GLNDOVER115-RUSSELLV115C1
N-1: GOBLE#115-RAINIER#115C1
N-1: GOBLE#115-TWR22-4N115C1
N-1: GRAND115-MILLPLN115C1
N-1: GRAND115-ROSS115C1
N-1: GRAYSRV115-NASELLE115C1
N-1: GRDNHOM1115-WSTPRTLD115C1
N-1: GRDNHOM2115-GRDNHOME115C1
N-1: GRDNHOM2115-RALGHHIL115C1
N-1: GRDNHOM2115-WSTPRTLD115C1
N-1: GRESHAM230-LINNEMAN230C1
N-1: GRESHAM230-TROUTPP2230C1
N-1: GRESHAMA115-RAMAPO#115C1
N-1: GRESHAMB115-HOGAN115C1
N-1: GRESHAMB115-PLSNTVLY115C1
N-1: HAGENTP115-NASELLE115C1
N-1: HAGENTP115-TARLETT115C1
N-1: HARBLOAD115-HARBTN2115C1
N-1: HARBORTN115-HARBTN1115C1
N-1: HARBORTN115-SCAPPOSE115C1
N-1: HARBORTN230-RIVRGATE230C1
N-1: HARBORTN230-TROJAN2230C1
N-1: HARBTN1115-RVGTSO#115C1
N-1: HARBTN2115-STMARYSC115C1
N-1: HARBTN2115-WACKER115C1
N-1: HARMONY115-JENGSL#115C1
N-1: HARRISON115-HARSNPGE115C1
N-1: HARRISON115-HOLLADAY115C1
N-1: HARRISON115-LINCOLN115C1
N-1: HEMLCK115-HEMLOCK#115C1
N-1: HEMLOCK#115-ROCKWD2115C1
N-1: HEYEMYR115-HEYESW115C1
N-1: HEYEMYR115-HOKINSN115C1
N-1: HEYESW115-UNIONCC115C1
N-1: HOGAN115-MCGILL115C1
N-1: HOLCOMB115-VALLEYT115C1
N-1: HOLLADAY115-KNOTT115C1
N-1: HOLLYWOD115-KNOTT115C1
N-1: HUBER1115-MURRAYH115C1
N-1: HUBER1115-REEDVILE115C1
N-1: HUBER115-HUBER1115C1
N-1: HUBER2115-STMARYSB115C1
N-1: HUBER2115-TEK1115C1
N-1: HYDNISL115-KELLEY1115C1
N-1: HZLDLCC115-HZLDLPPL115C1
N-1: HZLDLCC115-ROSS115C1
N-1: HZLDLCC115-SW1115C1
N-1: ISLAND115-JENGSLD2115C1
N-1: ISLAND115-SELLWOOD115C1
N-1: JENGSL#115-JENGSLDG115C1
N-1: JNSP1115-JNSP2115C1
N-1: JNSP1115-SW8115C1
N-1: JNSP2115-LMJNS115C1
N-1: JOEAST115-RUNYAN115C1
N-1: KEELER115-ORECITY115C2
N-1: KEELER115-PENNWALT115C1
N-1: KEELER115-STJOHNS115C2
N-1: KEELER230-RIVRGATE230C1
N-1: KEELER230-STMARYS230C1
N-1: KELLEY1115-KELLEYPT115C1
N-1: KELLEY1115-RIVRGTA115C1
N-1: KELYBUTE115-MIDWAY1115C1
N-1: KELYBUTE115-TABOR115C1
N-1: KINGCITY115-SHERWDB115C1
N-1: KINGCITY115-TIGARD1115C1
N-1: KNOTT115-MALLORY115C1
N-1: LENTS115-RAMAPO#115C1
N-1: LEXINGTN115-PACIFWY115C1
N-1: LEXINGTN115-SHAWNCC115C1
N-1: LEXINGTN230-LONGVIEW230C2
N-1: LEXINGTN230-WOODLAND230C1
N-1: LINCOLN115-URBAN115C1
N-1: LINNEMAN230-TROUTPP1230C1
N-1: LKSHORE115-SW1115C1
N-1: LKSHORE115-SW48115C1
N-1: LMJNS115-STKFRD115C1
N-1: LONGVIEW115-NYSTAP115C4-MS
N-1: LONGVIEW115-PACIFWY115C1
N-1: MCLOUGLN230-PEARL#230C1
N-1: MCMINVIL115-WALNTAP115C1
N-1: MCMINVIL115-WINDSHAR115C1
N-1: MERIDIAN115-ROSEMONT115C1
N-1: MERWIN115-VIEWTAP115C1
N-1: MIDWAYPG115-RAMAPO115C1
N-1: MILLPLN115-SHPYRD115C1

N-1: MINHAHA115-SW119115C1
N-1: MOHLER115-NEHALTP115C1
N-1: MTPLSN1115-MTPLSNT115C1
N-1: MULTNM2#115-MULTNMAH115C1
N-1: MULTNM2#115-RALGHHL#115C1
N-1: MULTNM2#115-RIVRVW1115C1
N-1: MULTNMA#115-URBAN#115C1
N-1: MULTNMA#115-WSTPRTLD115C1
N-1: MURRAYH115-BEAVRTON115C1
N-1: MURRAYH230-SHERWOOD230Cr1
N-1: MURRAYH230-STMARYS230C1
N-1: NASELLE115-TARLETT115C1
N-1: NASELLE115-VALLEYT115C1
N-1: NCAMAS115-SIFTON115C1
N-1: NEHALTP115-NEHALEM115C1
N-1: NEWBERG115-SHERWDA115C1
N-1: OAKHILL2115-OAKHILLS115C1
N-1: OAKHILL2115-STMARYSA115C1
N-1: OAKHILL2115-SUNSETPG115C1
N-1: ORCHRDS115-SW35115C1
N-1: ORCHRDS115-SW62115C1
N-1: ORENCO1115-REEDVILE115C1
N-1: ORENCO1115-STMARYSB115C1
N-1: ORENCO1115-STMARYSC115C1
N-1: ORENCO1115-SUNSETPG115C1
N-1: ORENCO115-ORENCO1115C1
N-1: ORENCO115-ROSEWAY115Cr1
N-1: ORESTEEL115-RIVRGTB115C1
N-1: OSWEGO115-ROSEMONT115C1
N-1: OWENSCR#115-SCAPPOSE115C1
N-1: OWENSCR#115-STHELENS115C1
N-1: OWENSCR115-OWENSCR#115C1
N-1: PARKDALE230-TROUTDAL230C1
N-1: PEARL#230-SHERWOOD230C1
N-1: PEARL230-PEARL#230C1
N-1: PEARL230-SHERWOOD230C1
N-1: PORTSMTH115-RIVRGTA115C1
N-1: PROGRESS115-TIGARD2115C1
N-1: RAINIER115-RAINIER#115C1
N-1: RALGHHL#115-SYLVAN2115C1
N-1: RAMAPO115-RAMAPO#115C1
N-1: REEDVILE115-ROSEWAY115Cr1
N-1: RIVRGATE230-ROSS230C1
N-1: RIVRGTA115-RVGTSO#115C1
N-1: RIVRGTA115-RVGTSO115C1
N-1: RIVRVIEW115-RIVRVW1115C1
N-1: RIVRVW1115-SELLWOOD115C1
N-1: RIVRVW2115-SELLWOOD115C1
N-1: RIVRVW2115-URBAN#115C1
N-1: ROSALC11115-ROSALC48115C2-MS
N-1: ROSALC11115-ROSALC48115C4
N-1: ROSALC11115-ROSS115C1
N-1: ROSEMONT115-SULIVAN115C1
N-1: ROSS115-SIFTON115C1
N-1: ROSS115-SW52115C1
N-1: ROSS230-SIFTTP1230C1
N-1: ROSS230-SIFTTP2230C2
N-1: ROSS230-STJOHNS230C1
N-1: ROSS230-WOODLAND230C1
N-1: RUNYAN115-TROUTDAL115C1
N-1: RUNYAN115-WAFERTEC115C1
N-1: RUSSELLV115-TABOR115C1
N-1: SEHSILCA115-SW105115C1
N-1: SELLWOOD115-TOWNCNT#115C1
N-1: SHERWDA115-TUALATIN115C1
N-1: SHERWDB115-SIXCRNRS115C1
N-1: SIFTON115-SW100115C1
N-1: SIFTON115-WAFERTEC115C1-MS
N-1: SIFTTP115-SIFTON115C1
N-1: SIFTTP1230-SIFTON1230C1
N-1: SIFTTP2230-SIFTON2230C1
N-1: SOUFORK115-TILLAMOK115C1
N-1: SOUFORK115-TIMBER115C1
N-1: STEVNTP115-STEVNSON115C1
N-1: STHELENS115-TWR22-4N115C1
N-1: STHELENS115-TWR22-4S115C1
N-1: STHELN115-SW117115C1
N-1: STJOHNS115-STJOHNT115C1
N-1: STKFRD115-SW1115C1
N-1: STMARYE1115-STMARYSA115C1
N-1: STMARYE2115-STMARYES115C1
N-1: STMARYE2115-STMARYSB115C1
N-1: STMARYE2115-TEKTRONX115C1
N-1: STMARYS230-TROJAN1230C1
N-1: STMARYSC115-SUNSETPG115Cr1
N-1: SULZER115-SULZER#115C1
N-1: SW105115-WALNUT115C1
N-1: SW119115-WALNUT115C1
N-1: SW35115-UNIONCC115C1
N-1: SW50115-SW51115C1
N-1: SW50115-SW62115C1
N-1: SW6115-SW7115C1
N-1: SW7115-SW8115C1
N-1: SWIFT230-WOODLAND230C1
N-1: SYLVAN115-SYLVAN#115C1
N-1: THATCHJ115-TIMBER115C1
N-1: TIGARD115-TIGARD1115C1
N-1: TIGARD2115-WSTPRTLD115C1
N-1: TILLAMOK115-TRASKRV115C1
N-1: TOWNCNT#115-TOWNCNTR115C1
N-1: TROJAN230-TROJAN1230C1
N-1: TROJAN230-TROJAN2230C1
N-1: TROUTDAL230-TROUTPP1230C1
N-1: TROUTDAL230-TROUTPP2230C1
N-1: TWR22-4S115-WARREN115C1
N-1: URBAN115-URBAN#115C1
N-1: WACKER115-WILLPENN115C1
N-1: WILBRDG#115-WILLBRDG115C1
T-1: ALCOA230-ALCOA115C1
T-1: ALLSTON500-ALLSTON230C1
T-1: ALLSTON500-ALLSTON230C2
T-1: BLUELAKE230-BLUELAKE115C1
T-1: CARLTON230-CARLTON115C1
T-1: CARVER230-CARVER115C1
T-1: CLATSOP230-ASTORTP115C1
T-1: GRESHAM230-GRESHAMA115C1
T-1: GRESHAM230-GRESHAMB115C1
T-1: KEELER230-KEELER115C1
T-1: KEELER230-KEELER115C2
T-1: KEELER500-KEELER230C1
T-1: LEXINGTN230-LEXINGTN115C1
T-1: LINNEMAN115-LINNEMAN230C1
T-1: LONGVIEW230-LONGVIEW115C1
T-1: MCLOUGLN230-MCLGHLNA115C1
T-1: MCLOUGLN230-MCLGHLNB115C1
T-1: MCLOUGLN500-MCLOUGLN230C1
T-1: MURRAYH115-MURRAYH230C1
T-1: PEARL500-PEARL230C1
T-1: RIVRGATE230-RIVRGTA115C1
T-1: RIVRGATE230-RIVRGTB115C1
T-1: ROSS230-ROSS115C1
T-1: ROSS230-ROSS115C2
T-1: SHERWOOD230-SHERWDA115C1
T-1: SHERWOOD230-SHERWDB115C1
T-1: SIFTON1230-SIFTON115C1
T-1: SIFTON2230-SIFTON115C1
T-1: STJOHNS230-STJOHNS115C1
T-1: TILLAMOK230-TILLAMOK115C1
T-1: TROUTDAL115-TROUTPP2230C1
T-1: TROUTDAL500-TROUTDAL230C1

2005 Summer
Operational Transfer Capability
Study Report for the

South of Allston Path

Submitted to:

Northwest Operational Planning Study Group (NOPSG)
&
Operating Transfer Capability Policy Committee (OTCPC)

Submitted by:

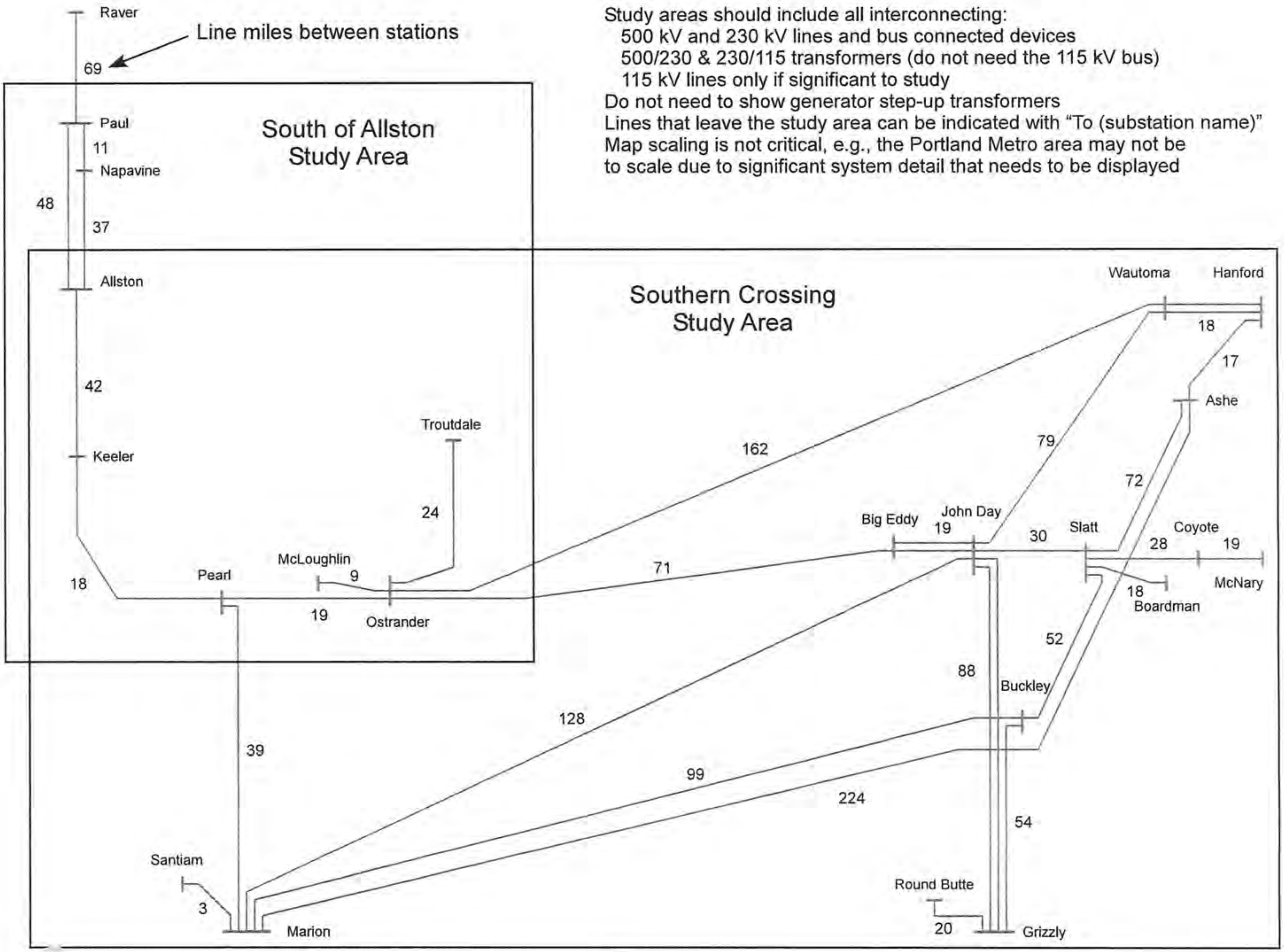
Bonneville Power Administration

James L. Randall, P.E.

March 29, 2005

Study areas should include all interconnecting:
- 500 kV and 230 kV lines and bus connected devices
- 500/230 & 230/115 transformers (do not need the 115 kV bus)
- 115 kV lines only if significant to study

Do not need to show generator step-up transformers
Lines that leave the study area can be indicated with "To (substation name)"
Map scaling is not critical, e.g., the Portland Metro area may not be
to scale due to significant system detail that needs to be displayed



South of Allston

Summer 2005 Study Report

1) Introduction

This report summarizes the studies used to determine safe and reliable operation of the South of Allston path. The South of Allston path is typically loaded heavily only during the summer season when there is high north-to-south power flow across the Northwest system. The generation sources for this pattern include: Upper Columbia generation, Mid Columbia generation, BC Hydro generation, generation in the Puget Sound area and along the I-5 Corridor. The following transmission lines define the South of Allston path.

<u>Allston</u> – Keeler 500 kV (BPA)
<u>Trojan</u> – St. Marys 230 kV (PGE)
<u>Trojan</u> – Rivergate 230 kV (PGE)
Lexington – <u>Ross</u> 230 kV (BPA)
<u>Allston</u> – St. Helens 115 kV (BPA)
<u>Merwin</u> – St. Johns 115 kV (PACW)
<u>Astoria</u> – Seaside 115 kV (PACW)
<u>Lewis & Clark</u> – Astoria Tap 115 kV (PACW)

Note: The "from" and "to" substations are listed in the direction of positive flow on the South of Allston path. The underlined substation is where the flow is metered.

This path is thermally limited and the worst contingencies were found to be the following list of facilities.
N-1: Allston – Keeler 500 kV line
BFR: 4322, 4324, 4394 Keeler 500 kV (loss of Keeler 500 kV bus)
BFR: 4280 Pearl 500 kV (loss of Pearl-Keeler and Pearl Bank #2)
BFR: 4283 Pearl 500 kV (loss of Pearl-Keeler and Pearl-Ostrander 500 kV lines)
N-2: Pearl – Keeler 500 kV and Pearl – Sherwood 230 kV lines
N-2: Keeler – St. Marys / Trojan – St. Marys 230 kV lines
N-1: Lexington – Longview 230 kV

The above contingencies typically overload the following elements depending on the generation pattern and transfer level. The limiting elements include: Merwin – View Tap 115 kV line section, Woodland – Ross 230 kV line section, Lexington – Longview 230 kV line, Keeler – St. Marys 230 kV line, Trojan – St. Marys 230 kV line, Keeler – Forest Grove #2 115 kV line, and the Longview 230/115 kV Bank.

The reactive margins were determined for the critical contingencies at the Operating Transfer Capability (OTC) limit and at a level that is 5% higher than the OTC to confirm that there are no potential voltage stability issues. All contingencies studied included RAS if applicable.

2) Purpose

The procedures outlined in BPA's Dispatcher Standing Order (DSO) 309 are what is used to operate the system in real-time for the South of Allston path. These procedures identify the transfer levels where RAS is to be armed. The RAS arming is triggered off the north-to-south loading of the Allston – Keeler 500 kV line. This is because the Allston – Keeler 500 kV line is a very good measure of the relative stress through the area. Also the Allston – Keeler 500 kV line is the worst single line outage in the local area without RAS. Any contingency involving the loss of the Allston – Keeler 500 kV line would also trigger the same RAS actions.

The DSO specifies three levels where actions are taken based on Allston – Keeler loading. The first two arm some type of RAS and the third level is the OTC limit where real-time schedule cuts are made to maintain reliable transfers. The Level 1 RAS arms 1200 MW of gen drop. The Level 2 RAS specifies to arm the PACW automatic runback of generation at its Swift and Yale plants. The Swift plant is runback to 170 MW and the Yale plant is runback to 70 MW. This reduces the flows on the limiting elements stated earlier and is in addition to the Level 1 RAS. The Level 2 RAS also arms a total of 2700 MW of gen drop that includes the PACW automatic runback scheme. The RAS gen drop sites include the Fredrickson LLP units at South Tacoma substation, TransAlta Big Hanaford project, Chehalis Power Partners generation at Napavine substation, Upper Columbia generation (Chief Joe and Grand Coulee) as well as generation in BC Hydro's system if loading on the Custer-Ingledow lines is above 800 MW north-to-south.

There is also RAS used for the loss of the Keeler – Pearl 500 kV line to protect the parallel transmission lines in its area. The Keeler – Pearl RAS is armed based on the Keeler – Pearl 500 kV line loading. It only has two levels where Gen Drop is armed. The first is at a Keeler – Pearl loading of 700 MW where 1200 MW is armed and the second is at a loading of 1000 MW where 2700 MW is armed.

3) Assumptions

The studies were performed using the Heavy Summer 2005 WECC operating case, as the summer is when this path is most heavily loaded. Loads and generation at many local busses were modified to accurately model what was measured from recent summer historical SCADA data. These changes were implemented for the northern Oregon and southern Washington coastal areas as well as in Lewis and Cowlitz County PUD systems.

Figure #1 shows a loading distribution curve of the Allston – Keeler line for Summer (June – September) and Non-Summer (October – May) seasons. It can be seen during the Non-Summer seasons that the path is not stressed enough to result in significant thermal problems. The loading has only exceeded the Level 1 arming point for a few hours throughout its history. Also, the summer case uses 30 deg C ratings for transmission lines resulting in conservative arming levels and limits during the Non-Summer period. Figure #2 shows a similar loading distribution curve for the Keeler – Pearl 500 kV line.

It is important to note that the Merwin – View Tap 115 kV line section overloads first and is the most limiting element for the South of Allston path when the Merwin and Yale generators are up. PACW monitors and protects this line by manually running back generation at its Merwin and Yale hydro plants that each integrate into the Merwin 115 kV substation. The studies used the same option that was applied in previous summer studies to model the manual runback scheme when determining the RAS arming levels. This was to see how far back the Merwin and Yale generators would need to be set to in order to alleviate the overloaded Merwin – View Tap 115 kV line section for an outage of the Merwin – Cardwell 115 kV line. It was found that if the combined output was limited to 145 MW then the overload was eliminated. The studies were then conducted by setting the combined generation to 170 MW (70 MW at Yale and 75 MW at Merwin) to mimic what PACW would at least have to do for an outage on their system. By setting the Yale generator to 70 MW the effectiveness of the automatic runback scheme was not apparent as the Yale generator is still only ramped back to 70 MW when this scheme is implemented.

When determining the OTC of the South of Allston path it was then assumed that PACW would mitigate any overload experienced on the Merwin – View Tap 115 kV line section with its manual (Merwin and Yale) runback scheme. This assumption was agreed to by PACW.

4) System Changes

There are a few significant changes in the area since the Summer 2004 studies were performed. There was a change in the generation assumption at the Longview Fiber plant integrating into the Cowlitz 115 kV bus. The 2004 case had 130 MW of generation while the 2005 case used only 35 MW of generation. Also, comparing the load levels between the 2004 and 2005 cases indicates that there were many changes in the South of Allston area. The following table summarizes the load differences based on ownership.

Owner	2005 Load	2004 Load	% Change
Clark PUD	632 MW	564 MW	+12.0 %
Cowlitz PUD	552 MW	586 MW	-5.8 %
Tillamook PUD	69.3 MW	72.8 MW	-4.8 %
PACW (PTLD+CLTP)	462 MW	488 MW	-5.3 %
PGE (East + West)	3323 MW	3158 MW	+5.2 %

5) Methodology

The studies were performed by increasing the north-to-south transfer across the South of Allston path while applying the surrounding area's N-1 and N-2 contingencies until some limiting element was loaded up to 100 percent of its emergency rating in the post-contingent state. Then the Level 1 RAS is applied, as described in the DSO, to allow transfers to go higher. When a new limit is found by modeling the Level 1 RAS then the Level 2 RAS is applied and transfers are again increased. Once the Level 2 RAS has been modeled then transfers are further increased until the next limit is found. This point describes when the Level 3 RAS becomes necessary. Finally, when the Level 3 RAS is modeled then transfers are increased again. At this point no more mitigating actions are available and this point identifies the OTC for the path.

Generation outputs at local sites were varied to check their impact on transfers. The generators were varied from an output of 0 MW (off-line) to their recent historical summer maximums as measured by SCADA. The generation sites include: Beaver, River Road, Swift, Merwin+Yale and Chehalis Power Partners plants. Peak summer output amounts for these generators are: Chehalis = 525 MW, Beaver = 500 MW, River Road = 255 MW and Swift = 225 MW. The combined output of Merwin and Yale had a peak of 200 MW but was capped at 145 MW as described in the Assumptions section earlier.

As there were five local generation sites toggled between 0 MW and historical peak values this gave 32 combinations to study at each arming level. The arming levels in the DSO use the worst-case scenario for each arming level.

A list of all the contingencies considered in this study can be found in Table #4 at the end of this report.

6) Results

A. Thermal Limitations

The results of the thermal study for Allston – Keeler loadings are found in Table #1. The studies began with no RAS being applied. For this scenario the worst contingency was the Keeler 500 kV breaker failure losing the Allston – Keeler and Keeler – Pearl 500 kV lines. This contingency was limited by overloads on the Merwin – View Tap 115 kV line section at a transfer level of 1780 MW on the South of Allston path. The Allston – Keeler loading to identify the Level 1 arming point in the DSO would be 1030 MW.

Next, the Level 1 RAS (1200 MW of gen drop) was modeled for any contingency involving the loss of the Allston – Keeler 500 kV line and the transfers increased again. The worst contingency was again the Keeler 500 kV breaker failure that would overload the Merwin – View Tap 115 kV line section. The South of Allston transfer level at this point was found to be 2090 MW. The Allston – Keeler loading to identify the Level 2 arming point in the DSO is 1250 MW.

Then the Level 2 RAS (Swift and Yale automatic runback) was modeled, in addition to the Level 1 RAS, for any contingency involving the loss of the Allston – Keeler 500 kV line and the transfers increased further. The most limiting scenario for this case was found to be nearly identical as when just the Level 1 RAS was modeled. This is because the most limiting case had Swift generation off-line and therefore no benefit was noticed for this RAS action. However, it is important to note that other scenarios where Swift generation was on-line showed a benefit for having the automatic runback scheme. The previous RAS arming point will therefore designate when the Swift/Yale runback becomes armed as well as the 2700 MW of total generation drop.

Finally, the Level 3 RAS (2700 MW of total gen drop) was modeled, which included the Swift and Yale automatic runback schemes, for any contingency involving the loss of the Allston – Keeler 500 kV line and the transfers increased higher. The worst contingency was the loss of the Keeler-St. Marys/Trojan-St. Marys 230 kV lines which would overload the Keeler – Forest Grove #2 115 kV line. Other outages and limiting element pairs were almost as restrictive on transfers as this one. Outages of note include: Pearl BFR 4280, Pearl BFR 4283, Keeler BFR, Pearl-Keeler/Pearl-Sherwood, and Lexington-Longview 230 kV. Other limiting facilities include: Keeler-St. Marys 230 kV line, Trojan-St. Marys 230 kV line, and Longview 230/115 kV Bank. The South of Allston transfer level was 2630 MW and the Allston – Keeler loading was 1670 MW. This identifies the Level 4 OTC limit. Beyond this loading level real-time schedule cuts are made to stay at or below this maximum transfer.

The results of the thermal study for Keeler – Pearl loadings are found in Table #2. The Level 1 Keeler – Pearl RAS (1200 MW of gen drop) is needed when the Keeler – Pearl 500 kV line loading exceeds 700 MW. The Keeler – St. Marys 230 kV line section would overload for the loss of the Keeler – Pearl 500 kV line at loadings above 700 MW if no RAS was applied.

The Level 2 Keeler – Pearl RAS (2700 MW of gen drop) is needed when the Keeler – Pearl 500 kV line loading exceeds 1000 MW. It was also found that no additional RAS was needed for Keeler – Pearl through the OTC loading level found for South of Allston. This Gen Drop is separate from the Gen Drop used for the Allston – Keeler outage, but the same points are armed to prevent overarming issues.

B. Voltage Stability Checks

Reactive margin was checked for the worst contingencies at the OTC level identified through the thermal study. All major 500 kV busses in the area were studied. The results are found in Table #3. It can be seen from Table #3 that each bus studied has adequate margin at the path OTC and at a transfer level that is 5% higher than the OTC. Also, it can be seen that there is no significant decrease in margin as the transfer level is increased. These findings indicate that transfers on the South of Allston path are not voltage stability limited at least through the current OTC limits found in the thermal study. The minimum reactive margin for any 500 kV bus was 1742 MVAR and the collapse point voltage was always less than 0.85 p.u. at any bus for all transfer levels.

C. Transient Stability Checks

Transient stability simulations were run at the path OTC as identified through the thermal studies. The contingencies studied were the N-1: Allston – Keeler 500 kV outage, the Keeler 500 kV BFR and the Pearl 500 kV BFR of 4283.

The Allston - Keeler 500 kV line outage included the RAS of 2700 MW of gen drop.

All load bus voltage dips did not exceed 25%.
All load bus voltage dips did not exceed 20% for more than 20 cycles.
All generator bus voltage dips did not exceed 30%.
All other bus voltage dips did not exceed 30%

Each of the 500 kV BFRs did not have any violations of the NERC/WECC performance Level C criteria.

All load bus voltage dips did not exceed 30%.
All load bus voltage dips did not exceed 20% for more than 40 cycles.
All generator bus voltage dips did not exceed 30%.
All other bus voltage dips did not exceed 30%

7) Outage History

The following is a list of the outage history for the critical contingencies identified in the studies. The outage history was compiled from data back through July 1, 1996.

Allston – Keeler #1 500 kV

Date	Time	Duration (min.)	Reason	Pre-Flow
8/10/96	3:42 PM	315	Tree	1298 MW
4/18/98	3:10 PM	0	Lightning	-53 MW
7/14/98	8:45 PM	0	Unknown	876 MW
7/22/00	5:29 AM	0	Lightning	-170 MW
6/18/04	6:33 PM	0	Lightning	630 MW

Allston – Trojan #1 230 kV

Date	Time	Duration (min.)	Reason
5/1/98	6:43 PM	0	Lightning
10/19/99	7:24 AM	83	Improper Relaying
3/18/03	10:35 AM	8	Maintenance Error

Allston – Trojan #2 230 kV

Date	Time	Duration (min.)	Reason

No outages since 7/1/96.

Keeler – Pearl 500 kV

Date	Time	Duration (min.)	Reason
7/13/96	2:36 PM	427	Tree
8/10/96	3:42 PM	315	Forced
6/24/02	8:58 AM	0	Insulator
11/6/02	6:43 AM	0	Weather

8) Conclusion

The studies identified nearly identical transfers for the Level 2 and Level 3 arming. This was due to the generation assumptions for the Swift and Yale plants as well as the limiting scenario identified. Therefore, the Level 2 arming point will indicate when both the Level 2 (Siwft+Yale runback) and Level 3 RAS (2700 MW total gen drop) needs to be armed.

The proposed OTC for the South of Allston path is 2640 MW with the Allston-Keeler proxy, used to monitor the path for real-time operations, to have a limit of 1670 MW.

Table #4: Contingencies Studied

N-1: Keeler-Allston 500 kV
BFR 4502 Napavine-Allston/Keeler-Allston
BFR 4322 (or 4324, 4394) Keeler 500 Clear
N-1: Keeler-Pearl 500 kV
BFR 4280 Pearl-Keeler (+Pearl Bank #2)
BFR 4283 Pearl-Keeler/Ostrander-Pearl
N-2: Pearl-Keeler 500 and Pearl-Sherwood 230
N-2: Pearl-Keeler 500 and Sherwood-Carlton 230
BFR 4287 Ostrander-Pearl (+Pearl Bank #1 and Pearl Caps)
BFR 4432 Ostrander-Troutdale (+Ostrander Caps) (need two OST busses)
BFR 4439 Big Eddy-Ostrander/Ostrander-Troutdale
BFR 4442 Big Eddy-Ostrander/Ostrander-McLoughlin
BFR 4445 Ostrander-McLoughlin (+Ostrander Caps)
BFR 4448 Hanford-Ostrander/Ostrander-Troutdale
BFR 4450 Hanford-Ostrander/Ostrander-Pearl
BFR 4453 Ostrander-Pearl (+Ostrander Caps)
BFR 4475 Pearl-Marion (+Pearl Bank #2)
BFR 4510 Pearl-Marion (+Pearl Bank #1 and Pearl Caps)
BFR 4690 Paul-Allston #2 (+Allston Bank #2)
BFR 5134 Ostrander-Pearl (+Ostrander Caps)
N-2: Hanford-John Day and McNary-Ross 345
N-2: Hanford-Ostrander 500 and McNary-Ross 345
N-2: Hanford-Ostrander 500 and Midway-North Bonneville 230
N-2: Ostrander-McLoughlin 500 and Big Eddy-McLoughlin 230
N-2: Pearl-Ostrander 500 and Big Eddy-McLoughlin 230
N-2: Pearl-Ostrander/Ostrander-McLoughlin
G-1: Beaver Gen (PGE)
G-1: River Road Gen (CPUD)
G-1: Swift Gen (PACW)
G-1: Yale Gen (PACW)
G-1: Wauna Gen
N-1: Napavine-Allston 500 kV
N-1: Paul-Allston #2 500 kV
N-1: Ostrander-Pearl 500 kV
BF A213 LEXINGTN 230 - FAULT ANY LINE
L/D ALLSTON-ASTORIA-NASELLE 115
L/D ALLSTON-DRSCOLL TAP/ALLSTON-DRISCOLL (74)
L/D ALLSTON-LONGVIEW 1 & 2 (101)
L/D ALLSTON-TROJAN 1 & ALLSTON-TROJAN 2 (91)
L/D CARLTON-SHERWOOD 230 3 TERMINAL LINE
L/D CHEHALIS-LONGVIEW,LEXINGTON-LONGVIEW (84)
L/D CHEMAWA-BIG EDDY-MCLOUGHLIN (18)
L/D FOREST GROVE-MCMINNVILLE & MCMINNVILLE-CARLTON M-A (161)
L/D GRESHAM-TROUTDALE-TROUTDALE,LINNEMAN-TROUTDALE (82)
L/D KEELER-ST MARYS ST MARYS-TROJAN 1 (221)
L/D MCLOUGHLIN-PEARL #-SHERWOOD
L/D NORTH BONNEVILE-SIFTON TAP 2-ROSS,MCNARY-ROSS M-89 A (128)
L/D NORTH BONNEVILLE-SIFTON & NORTH BONNEVILL-ALCOA 115 M-181 (39)
L/D NORTH BONNEVILLE-SIFTON TAP-ROSS 1 & 2 (24)

L/D NORTH BONNEVILLE-TROUTDALE #1&2 (42)
L/D NORTH BONNEVILLE-TROUTDALE 2,NORTH BONNEVILLE-SIFTON TA
L/D PEARL-SHERWOOD 1 & 2 (111)
L/D ROSS-RIVERGATE & ROSS-ST JOHNS (101)
L/D ST MARY'S-TROJAN 1,RIVERGATE-TROJAN 2 (9)
L/D WENDSON-LANE 230 & 115 M-149 4 XING (22)
L/D WENDSON-TAHKENICH 230 & 115 M-149 1 XING (43)
N-1: 119THST115-HOKINSN115C1
N-1: 119THST115-SW51115C1
N-1: 4THPLN115-SIFTTP115C1
N-1: 4THPLN115-SW51115C1
N-1: 72NDCC115-99THTP115C1
N-1: 72NDCC115-MANOR115C1
N-1: 72NDPPL115-CHERYPPL115C1
N-1: 72NDPPL115-HZLDLPPL115C1
N-1: 99THTP115-BABERTN115C1
N-1: 99THTP115-SW35115C1
N-1: ABRNATHY115-ABRNTHY#115C1
N-1: ABRNATHY115-ABRNTHY1115C1
N-1: ABRNTHY#115-CANEMAH115C1
N-1: ABRNTHY#115-MTPLSN2115C1
N-1: ABRNTHY1115-JENGSLD2115C1
N-1: ABRNTHY1115-MCLGHLNA115C1
N-1: ACTON115-BONNVILE115C1
N-1: ACTON115-CASCDLK115C1
N-1: ALBINA115-KNOTT115C1
N-1: ALBINA115-SWANTP115C1
N-1: ALCOA115-PORT115C1
N-1: ALCOA115-ROSALC48115C1
N-1: ALCOA115-STEVNTP115C1
N-1: ALCOA230-ROSS230C1
N-1: ALCOTI115-ALCOA115C1
N-1: ALCOTI115-SW48115C1
N-1: ALDERCRT115-GLENCOE115C1
N-1: ALDERCRT115-HARSNPGE115C1
N-1: ALFALFA230-BONNVILE230C1-MS
N-1: ALLSTON115-DELENA115C1
N-1: ALLSTON115-NYSTAP115C4-MS
N-1: ALLSTON115-RAINIER#115C1-MS
N-1: ALLSTON230-DRISCOLL230C1
N-1: ALLSTON230-DRISCOLT230C1
N-1: ALLSTON230-LONGVANX230C3
N-1: ALLSTON230-LONGVIEW230C1
N-1: ALLSTON230-LONGVIEW230C2
N-1: ALLSTON230-TROJAN1230C1
N-1: ALLSTON230-TROJAN2230C1
N-1: ARCHERCC115-SW52115C1
N-1: ARIEL115-CARDWELL115C1
N-1: ARIEL115-MERWIN115C1

N-1: ASTORIA115-FERNHIL115C1
N-1: ASTORIA115-YUNGSBAY115C1
N-1: ASTORTP115-ASTORIA115C1
N-1: ASTORTP115-LWSCLARK115C1
N-1: ASTORTP115-SEASIDE115C1
N-1: AXFORD115-CHERYCC115C1
N-1: AXFORD115-HEISSON115C1
N-1: AXFORD115-HEYEMYR115C1
N-1: BABERTN115-BRBTNSW115C1
N-1: BAKERCR115-WALNCTY115C1
N-1: BAKERCR115-WALNTAP115C1
N-1: BALDMT115-CARSON115C1
N-1: BASINAV115-SWANTP1115C1
N-1: BATLGRD115-CHERYCC115C1
N-1: BATLGRD115-SW6115C1
N-1: BEAVER115-TILLAMOK115C1-MS
N-1: BEAVRTON115-BEAVTN#115C1
N-1: BEAVRTON115-DENNY115C1
N-1: BEAVRTON115-MURRAY#2115C1
N-1: BEAVTN#115-RALGHHL#115C1
N-1: BEAVTN#115-TEK1115C1
N-1: BELL115-LENTS115C1
N-1: BELL115-SELLWOOD115C1
N-1: BETHANY115-STMARYE1115C1
N-1: BETHANY115-WILBRDG#115C1
N-1: BIGEDDY1230-PARKDALE230C1
N-1: BIGEDDY3230-MCLOUGLN230C1-MS
N-1: BLOSS115-COLUMPG115C1
N-1: BLOSS115-STJOHNSS115C1
N-1: BLUELAKE115-FAIRVWP115C1
N-1: BLUELAKE115-ROCKWD2115C1
N-1: BLUELAKE230-TROUTDAL230C1
N-1: BOCGASES115-ELMGRN115C1
N-1: BOISE#115-BOISECSC115C1
N-1: BOISE#115-OWENSCR115C1
N-1: BOISE#115-STHELENS115C1
N-1: BONNVILE115-STEVNT2115C1
N-1: BONNVILE115-STEVNTP115C1
N-1: BONNVILE230-SIFTTP1230C1
N-1: BONNVILE230-SIFTTP2230C2
N-1: BONNVILE230-TROUTDAL230C1
N-1: BONNVILE230-TROUTDAL230C2
N-1: BOONESFR115-OSWEGO115C1
N-1: BOONESFR115-WSTPRT115C1
N-1: BOOTHBD115-MCMINVIL115C1
N-1: BOOTHBD115-WALNCTY115C1
N-1: BRBTNSW115-ELMGTI115C1
N-1: BURNT115-BURTON115C1
N-1: BURNT115-CAPLES115C1
N-1: BURTON115-SW100115C1
N-1: BURTON115-SW105115C1
N-1: CAMAS115-FIBERWEB115C1
N-1: CAMAS115-NCAMAS115C1
N-1: CANEMAH115-MTPLSN1115C1
N-1: CANEMAH115-SULIVAN115C1
N-1: CANNONB115-SEASIDE115C1
N-1: CANYON115-SULZER#115C1
N-1: CANYON115-SYLVAN#115C1
N-1: CANYON115-URBAN115C1
N-1: CAPEHORN115-EVANSCLK115C1
N-1: CAPEHORN115-STEVNT2115C1
N-1: CARBNDM115-ROSS115C1
N-1: CARDWELL115-CARROLLS115C1
N-1: CARDWELL115-COWLCCP115C1
N-1: CARLTON115-CARLTONT115C1
N-1: CARLTON115-WINDSHAR115C1
N-1: CARLTON230-CASCADTP230C1
N-1: CARLTON230-TILLAMOK230C1
N-1: CARLTONT115-FILBRTT115C1
N-1: CARLTONT115-WALNTAP115C1
N-1: CARROLLS115-SKELSO115C1
N-1: CARSON115-STEVNSON115C1
N-1: CARVER1115-CARVERLD115C1
N-1: CARVER1115-TOWNCNTR115C1
N-1: CARVER115-CARVER1115C1
N-1: CARVER115-CARVER2115C1
N-1: CARVER115-CLACKMAS115C1
N-1: CARVER2115-CARVERLD115C1
N-1: CARVER2115-PLSNTVLY115C1
N-1: CARVER230-GRESHAM230C1
N-1: CARVER230-MCLOUGLN230C1
N-1: CASCADTP230-SHERWOOD230C1
N-1: CASCADTP230-WINDSHAR230C1-MS
N-1: CASCDLK115-HOODRVR115C1
N-1: CASCDPK115-JOEAST115C1
N-1: CASCDPK115-SW117115C1
N-1: CATHLAMT115-GRAYSRV115C1
N-1: CATHTAP115-CATHLAMT115C1
N-1: CATHTAP115-KNAPPA115C1
N-1: CATHTAP115-MIST115C1
N-1: CEDARHIL115-CEDARHL#115C1
N-1: CEDARHIL115-SYLVAN2115C1
N-1: CEDARHL#115-HARBTN2115C1
N-1: CEDARHL#115-STMARYSC115C1
N-1: CHEHALIS230-LONGVWT230C1
N-1: CHEHALIS230-LONGVWT230C2

N-1: CHELATT115-MERWIN115C1
N-1: CHERYCC115-CHERYPPL115C1
N-1: CHERYPPL115-VIEWTAP115C1
N-1: CLACKMA#115-CLACKMAS115C1
N-1: CLACKMA#115-JENGSL#115C1
N-1: CLACKMA#115-MCLGHLNB115C1
N-1: CLARK115-SARA115C1
N-1: CLARK115-SW7115C1
N-1: CLATSKAN115-DELENA115C1
N-1: CLATSKAN115-MIST115C1
N-1: CLATSOP230-DRISCOLT230C1
N-1: CNTENIAL115-CNTENL1115C1
N-1: CNTENIAL115-CNTENL2115C1
N-1: CNTENL1115-ESTPORT#115C1
N-1: CNTENL1115-MIDWAY1115C1
N-1: CNTENL2115-GLNDOVER115C1
N-1: CNTENL2115-GRESHAMA115C1
N-1: COLUMPG115-MALLORY115C1
N-1: CORNELUS115-FORGROV115C1
N-1: COWLCCP115-LONGVIEW115C1
N-1: CULLY115-HLLYWOOD115C1
N-1: CULLY115-TROUTDAL115C1
N-1: CURTIS#115-CURTISPG115C1
N-1: CURTIS#115-DELAWARE115C1
N-1: CURTIS#115-PORTSMTH115C1
N-1: DAYTON115-MCMINVIL115C1
N-1: DELAWARE115-SWANTP115C1
N-1: DENNY115-PROGRESS115C1
N-1: DRISCOLL230-DRISCOLT230C1
N-1: DRISCOLL230-WAUNA230C1
N-1: DURHAM1115-MERIDIAN115C1
N-1: DURHAM1115-TUALATIN115C1
N-1: DURHAM115-DURHAM1115C1
N-1: DURHAM2115-DURHAM115C1
N-1: DURHAM2115-TIGARD1115C1
N-1: DURHAM2115-WSTPRT115C1
N-1: DUTCHCAN115-STJOHNS115C1
N-1: DUTCHCAN115-WARREN115C1
N-1: EASTPORT115-ESTPORT#115C1
N-1: EASTPORT115-HARRISON115C1
N-1: EKELSO115-SHAWNCC115C1
N-1: EKELSO115-SKELSO115C1
N-1: ELMGRN115-SW52115C1
N-1: ELMGTI115-ELMGRN115C1
N-1: ELMGTI115-SW119115C1
N-1: ELSWORT115-SW100115C1
N-1: ELSWORT115-SW117115C1
N-1: ESTPORT#115-LINNEMAN115C1
N-1: ESUBSTA115-SULZER#115C1
N-1: ESUBSTA115-WILBRDG#115C1
N-1: ESUBSTA115-WILLPENN115C1
N-1: EVANSC115-EVANSCLK115C1
N-1: EVANSC115-FIBERWEB115C1
N-1: EVANSCLK115-NCAMAS115C1
N-1: EVERGRN115-SEHSILCA115C1
N-1: EVERGRN115-SIFTON115C1
N-1: EVERGRN115-SW62115C1
N-1: F.VALLEY115-HAYDENT115C1
N-1: F.VALLEY115-HZLDLPPL115C1
N-1: FAIRVWP115-GLISAN115C1
N-1: FARGO115-ORECITY115C1
N-1: FELIDA115-SARA115C1
N-1: FELIDA115-SW48115C1
N-1: FERNHIL115-KNAPPA115C1
N-1: FILBRTT115-FORGROV115C1
N-1: FISHERS115-JOEAST115C1
N-1: FISHERS115-SIFTON115C1
N-1: FORGROV115-KEELER115C2
N-1: FORGRT115-KEELER115C1
N-1: FORGRT115-THATCHJ115C1
N-1: GARIBALD115-MOHLER115C1
N-1: GARIBALD115-TILLAMOK115C1
N-1: GLENCOE#115-HLLYWOOD115C1
N-1: GLENCOE#115-TABOR115C1
N-1: GLENCOE115-GLENCOE#115C1
N-1: GLENCULN115-GRDNHOM1115C1
N-1: GLENCULN115-SYLVAN#115C1
N-1: GLISAN#115-GRESHAMB115C1
N-1: GLISAN#115-ROCKWD115C1
N-1: GLISAN115-GLISAN#115C1
N-1: GLISAN115-MCGILL115C1
N-1: GLNDOVER115-HEMLOCK#115C1
N-1: GLNDOVER115-RUSSELLV115C1
N-1: GOBLE#115-RAINIER#115C1
N-1: GOBLE#115-TWR22-4N115C1
N-1: GRAND115-MILLPLN115C1
N-1: GRAND115-ROSS115C1
N-1: GRAYSRV115-NASELLE115C1
N-1: GRDNHOM1115-GRDNHOME115C1
N-1: GRDNHOM1115-WSTPRT115C1
N-1: GRDNHOM2115-GRDNHOME115C1
N-1: GRDNHOM2115-RALGHHIL115C1
N-1: GRDNHOM2115-WSTPRT1115C1
N-1: GRESHAM230-LINNEMAN230C1
N-1: GRESHAM230-TROUTPP2230C1
N-1: GRESHAMA115-RAMAPO#115C1

N-1: GRESHAMB115-HOGAN#1115C1
N-1: GRESHAMB115-PLSNTVLY115C1
N-1: HAGENTP115-NASELLE115C1
N-1: HAGENTP115-TARLETT115C1
N-1: HARBLOAD115-HARBTN1115C1
N-1: HARBLOAD115-HARBTN2115C1
N-1: HARBORTN115-HARBTN1115C1
N-1: HARBORTN115-SCAPPOSE115C1
N-1: HARBORTN230-RIVRGATE230C1
N-1: HARBORTN230-TROJAN2230C1
N-1: HARBTN1115-RVGTSO#115C1
N-1: HARBTN2115-WACKER115C1
N-1: HARMONY115-JENGSL#115C1
N-1: HARMONY115-TOWNCNT#115C1
N-1: HARRISON115-HARSNPGE115C1
N-1: HARRISON115-HOLLADAY115C1-MS
N-1: HARRISON115-LINCOLN115C1
N-1: HAYDENT115-STJOHNSS115C1
N-1: HEMLCK115-HEMLOCK#115C1
N-1: HEMLOCK#115-ROCKWD2115C1
N-1: HEYEMYR115-HEYESW115C1
N-1: HEYEMYR115-HOKINSN115C1
N-1: HEYESW115-UNIONCC115C1
N-1: HLLYWOOD115-KNOTT115C1
N-1: HOGAN#1115-HOGANN115C1
N-1: HOGAN#2115-MCGILL115C1
N-1: HOGAN115-HOGAN#1115C1
N-1: HOGAN115-HOGAN#2115C1
N-1: HOGANN115-HOGAN#2115C1
N-1: HOLCOMB115-VALLEYT115C1
N-1: HOLLADAY115-KNOTT115C1
N-1: HUBER1115-MURRAY#1115C1
N-1: HUBER1115-REEDVILE115C1
N-1: HUBER115-HUBER1115C1
N-1: HUBER115-HUBER2115C1
N-1: HUBER2115-STMARYSB115C1
N-1: HUBER2115-TEK1115C1
N-1: HYDNISL115-KELLEY1115C1
N-1: HZLDLCC115-HZLDLPPL115C1
N-1: HZLDLCC115-ROSS115C1
N-1: HZLDLCC115-SW1115C1
N-1: ISLAND115-JENGSLD2115C1
N-1: ISLAND115-SELLWOOD115C1
N-1: JENGSL#115-JENGSLDG115C1
N-1: JENGSLD2115-JENGSLDG115C1
N-1: JNSP1115-JNSP2115C1
N-1: JNSP1115-SW8115C1
N-1: JNSP2115-LMJNS115C1
N-1: JOEAST115-RUNYAN115C1
N-1: KEELER115-ORECITY115C2
N-1: KEELER115-STJOHNS115C2
N-1: KEELER230-RIVRGATE230C1
N-1: KEELER230-STMARYS230C1
N-1: KEEL-SVC230-KEELER230C1
N-1: KELLEY1115-KELLEYPT115C1
N-1: KELLEY1115-SWANTAP115C1
N-1: KELLEYPT115-POTASH1115C1
N-1: KELYBUTE115-MIDWAY1115C1
N-1: KELYBUTE115-TABOR115C1
N-1: KINGCITY115-SHERWDB115C1
N-1: KINGCITY115-TIGARD1115C1
N-1: KNOTT115-MALLORY115C1
N-1: LENTS115-RAMAPO#115C1
N-1: LEXINGTN115-PACIFWY115C1
N-1: LEXINGTN115-SHAWNCC115C1
N-1: LEXINGTN230-LONGVIEW230C2
N-1: LEXINGTN230-WOODLAND230C1
N-1: LINNEMAN230-TROUTPP1230C1
N-1: LMJNS115-STKFRD115C1
N-1: LONGVIEW115-NYSTAP115C4-MS
N-1: LONGVIEW115-PACIFWY115C1
N-1: LONGVIEW230-LONGVANX230C1
N-1: LONGVIEW230-LONGVWT230C1
N-1: Longview-Chehalis 1&3 230 kV
N-1: LWSCLARK115-WARRNTON115C1
N-1: MAXIM115-STMARYE2115C1
N-1: MAXIM115-TEKTRONX115C1
N-1: MCLGHLNA115-MTPLSN2115C1
N-1: MCLGHLNA115-REDLAND1115C1
N-1: MCLGHLNB115-MTPLSN1115C1
N-1: MCLGHLNB115-REDLAND2115C1
N-1: MCLOUGLN230-MONITOR230C1
N-1: MCLOUGLN230-PEARL#230C1
N-1: MCMINVIL115-WALNTAP115C1
N-1: MCMINVIL115-WINDSHAR115C1
N-1: MERIDIAN115-ROSEMONT115C1
N-1: MIDWAY1115-MIDWAYPG115C1
N-1: MIDWAYPG115-RAMAPO115C1
N-1: MILLPLN115-SHPYRD115C1
N-1: MINHAHA115-SW119115C1
N-1: MOHLER115-NEHALTP115C1
N-1: MTPLSN1115-MTPLSNT115C1
N-1: MTPLSN2115-MTPLSNT115C1
N-1: MULTNM2#115-MULTNMAH115C1
N-1: MULTNM2#115-RALGHHL#115C1
N-1: MULTNM2#115-RIVRVW1115C1

N-1: MULTNMA#115-MULTNMAH115C1
N-1: MULTNMA#115-URBAN#115C1
N-1: MULTNMA#115-WSTPRT115C1
N-1: MURAYLD115-MURRAY#1115C1
N-1: MURAYLD115-MURRAY#2115C1
N-1: MURRAYH115-MURRAY#1115C1
N-1: MURRAYH115-MURRAY#2115C1
N-1: MURRAYH230-SHERWOOD230C1
N-1: MURRAYH230-STMARYS230C1
N-1: NASELLE115-TARLETT115C1
N-1: NASELLE115-VALLEYT115C1
N-1: NCAMAS115-SIFTON115C1
N-1: NEHALTP115-CANNONB115C1
N-1: NEHALTP115-NEHALEM115C1
N-1: NEWBERG115-SHERWDA115C1
N-1: OAKHILL1115-OAKHILLS115C1
N-1: OAKHILL1115-STMARYSC115C1
N-1: OAKHILL1115-SUNSETPG115C1
N-1: OAKHILL2115-OAKHILLS115C1
N-1: OAKHILL2115-STMARYSA115C1
N-1: OAKHILL2115-SUNSETPG115C1
N-1: ORCHRDS115-SW35115C1
N-1: ORCHRDS115-SW62115C1
N-1: ORENCO1115-ORENCOLD115C1
N-1: ORENCO1115-STMARYSB115C1
N-1: ORENCO115-ORENCO1115C1
N-1: ORENCO115-ORENCO2115C1
N-1: ORENCO115-ROSEWAY115C1
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N-1: SW48115-VANDYKE115C1
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N-1: SW6115-URIDGE115C1
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Western Electricity Coordinating Council

WECC 2005 PATH RATING CATALOG

February 2005

Prepared By:
TECHNICAL STUDIES SUBCOMMITTEE

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- Provide a resource for discussion of simultaneous interactions between major transmission paths.

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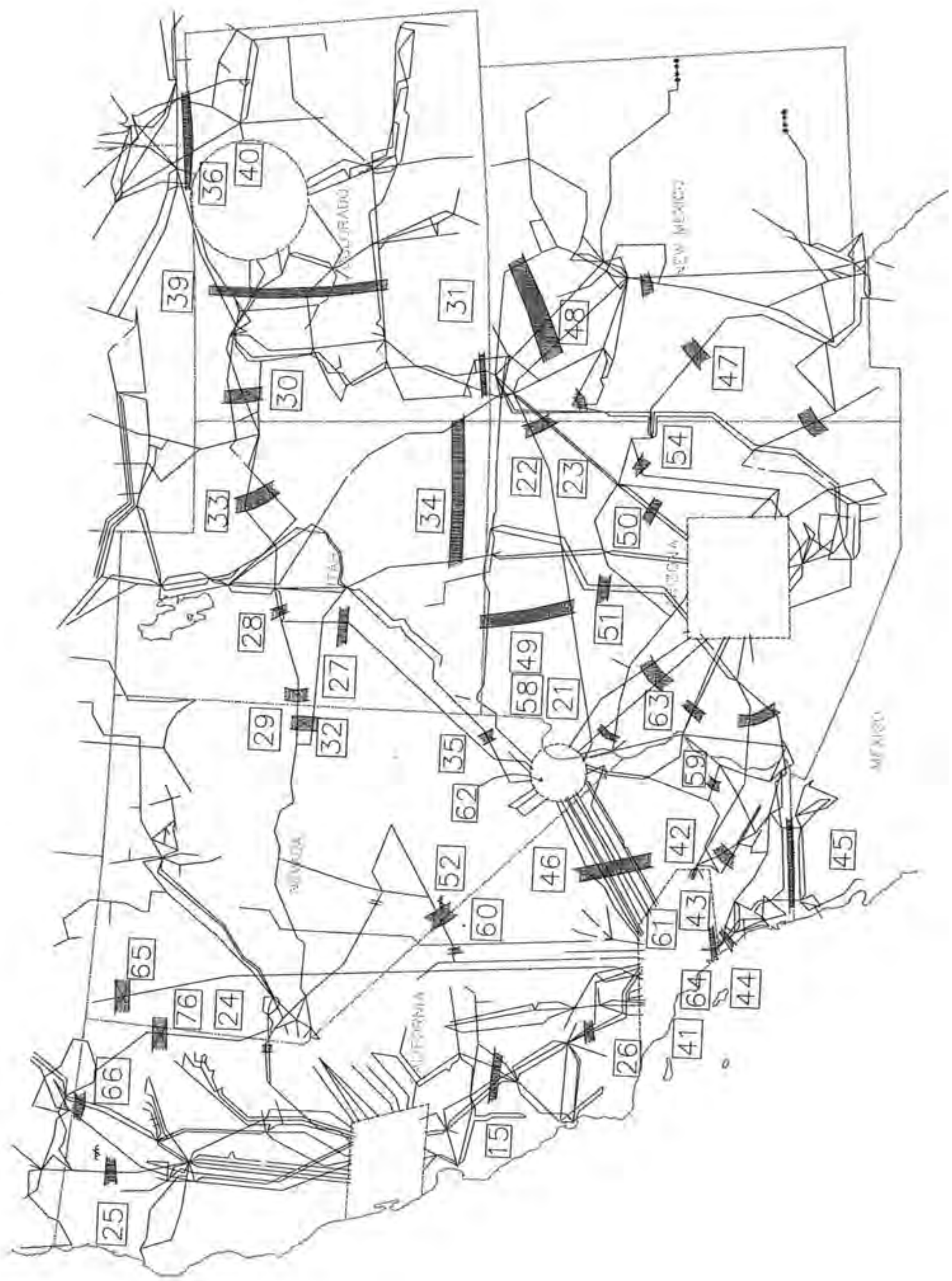
EXISTING PATHS

WECC Transfer Paths



WECC PATH RATING CATALOG

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This catalog contains descriptions of path components and describes path ratings as provided by individual WECC members. The path ratings in this catalog are "Maximum Path Transfer Capabilities" and not "First Contingency Incremental Transfer Capabilities" (the method used by other NERC councils). Most of the ratings reflect capabilities based on technical limits determined from system studies. They do not represent Available Transmission Capacity because they do not indicate the degree to which the path transfer capability has been committed with existing transactions.

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Among other things, this Path Rating Catalog is not intended to:

- Ascertain if WECC Procedures were followed to determine a path rating,
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- Imply WECC approval of the rating, although a path can receive an "Accepted Rating" via the Three Phase Rating Process,

- Provide OASIS information or Available Transfer Capability (ATC) or the most current operating limits,
- Serve as a complete list of all path information, or
- Enforce, support or implement any WECC Policy.

Contents

This Path Rating Catalog should include:
- All significant paths (i.e., Loop Flow Qualified paths, OTC Policy Group paths and constrained paths),
- A compilation of best available path rating information consisting of accepted ratings, Phases 2 and 3 ratings, existing ratings and other ratings,
- The names of contact persons of the appropriate WECC members (single point of contact),
- "Maximum Path Transfer Capabilities," not "First Contingency Incremental Transfer Capabilities" and reflects technical transfer capabilities based on technical limits from system planning studies.

Path Descriptions

The minimum specific content of each path description should include:
- A specific identification of the facilities that make up the transmission path,
- A discussion of the non-simultaneous path rating and the conditions used to achieve the path rating,
- Any necessary Remedial Action Schemes to achieve the path rating,
- An identification of interactions or relationships with other paths including applicable nomograms (Information should be provided on where a "current" nomogram can be located),
- Ownership and allocation or rights on the path,
- Date of submittal or update and contact person.

Additional explanatory information supporting transfer path ratings is welcome such as identification of internal paths that are considered to have no significant regional impact.

Document Update Policy

Changes to an "accepted" or "existing" path rating must follow the *WECC Procedures for Regional Planning Project Review and Rating Transmission Facilities (WECC Procedures).* Minor changes to a path rating (such as moving a metering location) should be submitted as part of the 60-day Expedited Process defined in Part 2B, Section 3.0 of the WECC Procedures (assuming no comments require reissuing a study report). Changes to a path with an "other" path rating do not need to follow the WECC Procedures; however, the path will retain the "other" status. Changes to an "accepted" or "existing" path rating that do not follow the WECC procedures will be reclassified to "other" status. Although updated entries to the *WECC Path Rating Catalog* may be submitted to the WECC staff at any time, the catalog will be published once annually. Each path rating narrative shall indicate the date it was added to the catalog. When a path rating narrative is revised, the word "Revised" will be added followed by the revision date. Paths can be deleted if superseded by another path with newly defined accepted rating or with notification and explanation to TSS.

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EXPLANATION OF TERMS

Path Name

Accepted Rating ☐
Existing Rating ☐
Other ☐

Location:	Where the path is located, physically and geographically
Definition:	A description of the path in terms of the transmission lines comprising the path, the area interconnected by the path, and any project or operations name given to the path.
Transfer Limit:	The rating of the path. This can be a single maximum rating or a range of operation dependent on system conditions. If the path is rated bidirectionally, then information for each direction is given.
Critical Disturbance that limits the transfer capability:	What was the critical disturbance(s) that limits the path rating? What was the limitation (steady-state thermal, transient or dynamic stability, post-transient voltage or thermal)?
When:	The date the path rating was defined and in which forum.
System Conditions:	Under what system conditions were the path rating determined (transmission system, area load level, generation pattern, transfer direction, time of year, etc.). Describe any fictitious transmission devices, generation, or power scheduling that was utilized to achieve transfer levels, voltage levels, or generation resources.
Study Criteria:	The planning and operating reliability criteria that was met in defining this path rating (WECC, internal company).
Remedial Actions Required:	A description of any remedial actions (both external and internal) required to achieve the path rating.
Formal Operating Procedure:	The formal operating procedures utilized to achieve the path rating and meet applicable reliability criteria.
Allocation:	Allocation of the path rating among the owners and major users of the path (be specific by participant and percent allocation).
Interaction w/Other Transfer Paths:	Under what conditions and operating procedures would the path rating be reduced?
Contact Person:	Person(s) who can be contacted for additional information on this path rating (include address).

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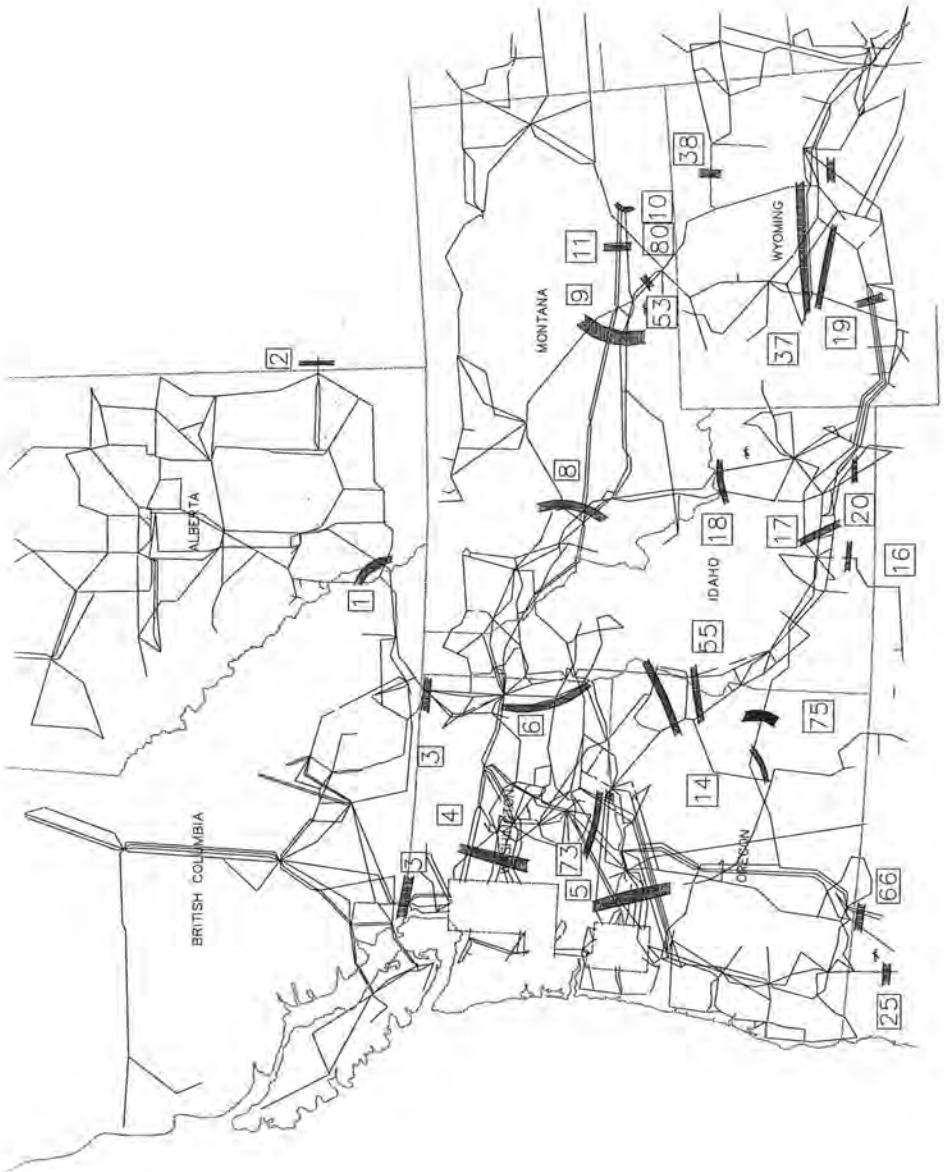
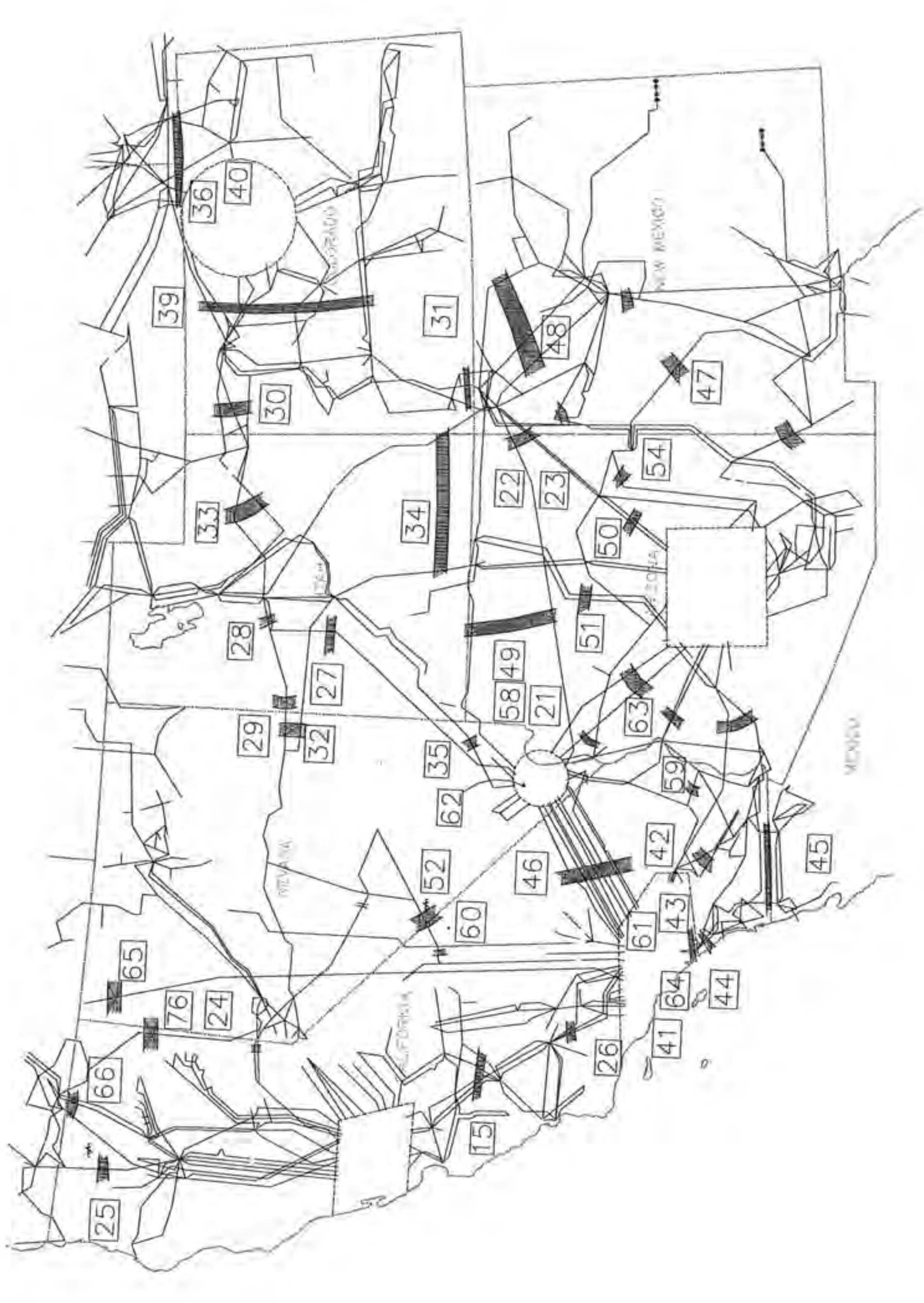
EXISTING PATHS

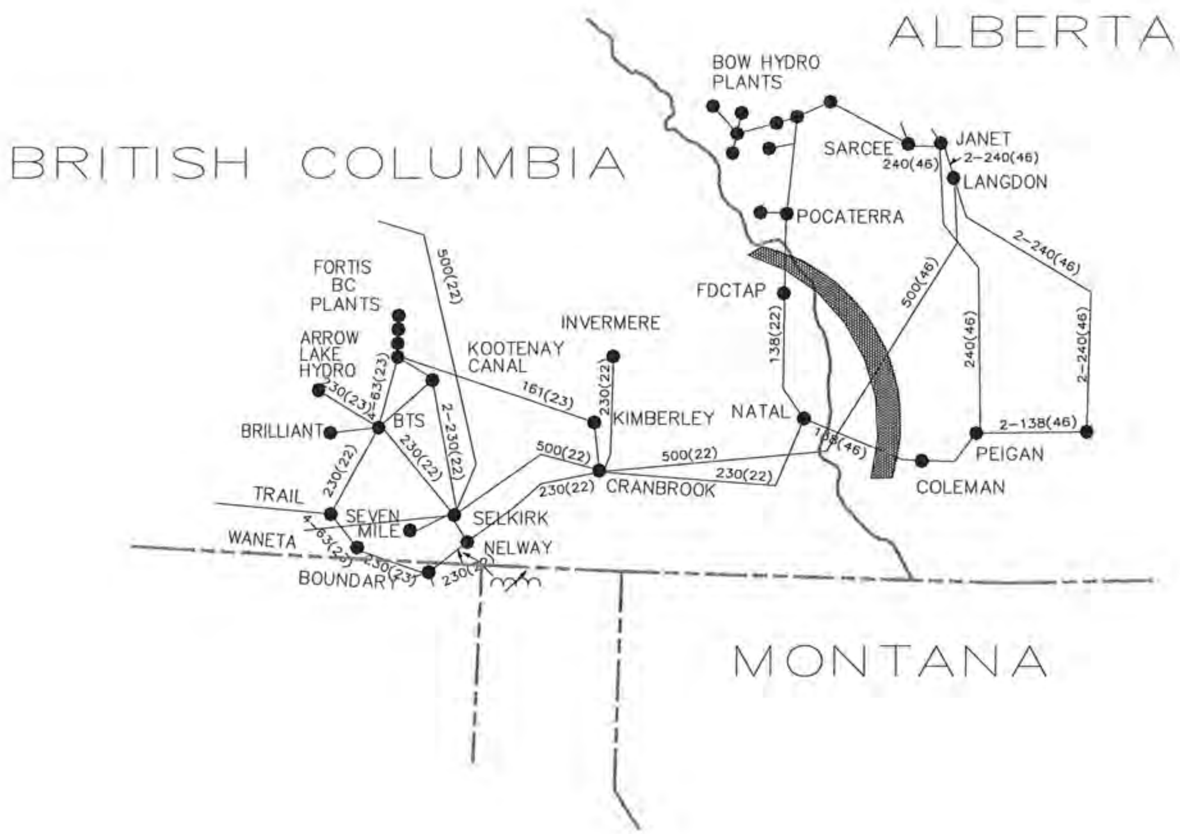
WECC Transfer Paths



WECC Transfer Paths



1. Alberta - British Columbia



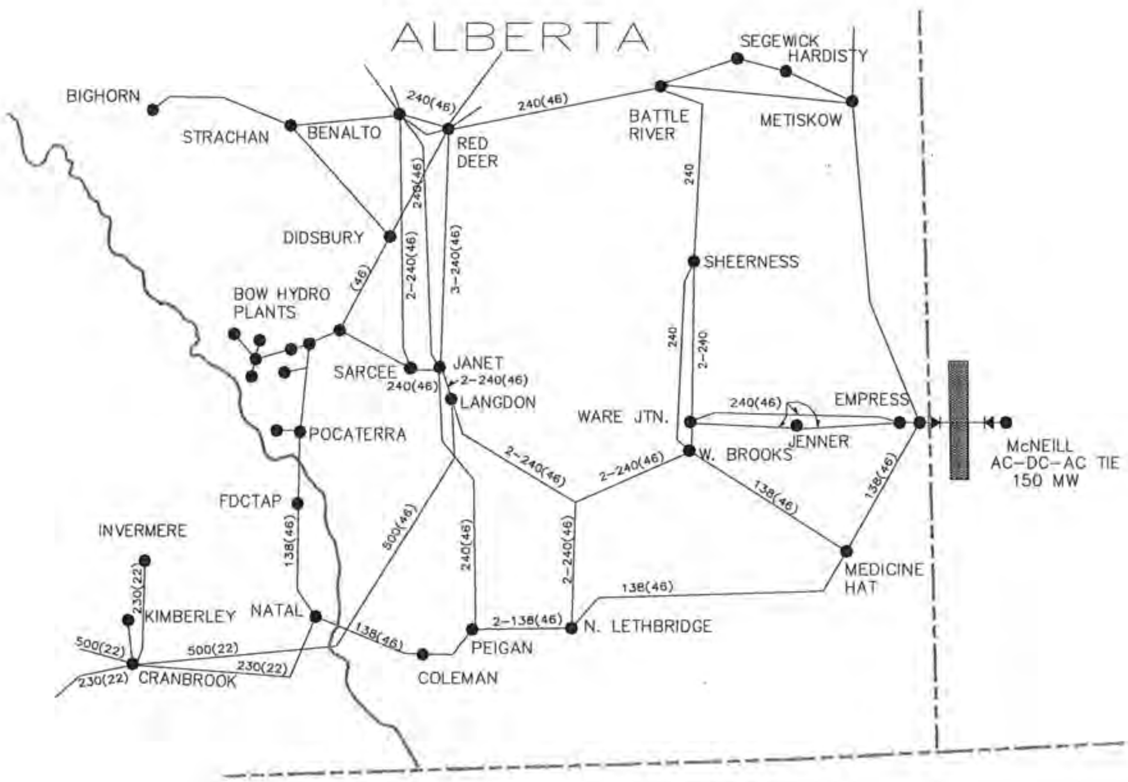
1. Alberta - British Columbia

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southern Alberta and Southern British Columbia
Definition:	Sum of the flows on the following lines: Line — Metered End Langdon-Cranbrook 500 kV — Langdon (Alta Link) Pocaterra-Fording Coal Tap 138 kV — Pocaterra (Alta Link) Coleman-Natal 138 kV — Natal (BCTC)
Transfer Limit:	East to West: 1000 MW West to East: 1200 MW
Critical Disturbance That limits the transfer capability:	West to East: Loss of the Langdon-Cranbrook 500 kV line.
When:	The 1000 MW bidirectional path rating was established in Progress Reports during the period from 1978 to 1985. Studies were conducted jointly by B.C. Hydro and Power Authority (BCH) and TransAlta Utilities Corp. (TAUC). East to West: Studies conducted since that time, show that loss of the PDCI dipole at high transfers could cause separation between Alberta and BC during high Alberta to BC transfer. Subsequent studies done by BPA in 1994 show that separation still occurs with the COTP in service. Alberta accepts separation for loss of PDCI or for any N-1 outage. West to East: Internal studies conducted since the 1985 Progress Report indicate the transfer capability is 1200 MW.
System Conditions:	East to West: Typical flows are 0 to 400 MW and usually occur during light load hours. West to East: Typical flows are 0 to 400 MW although they can be as high as 800 MW and usually occur during peak load hours.
Study Criteria:	All facilities loaded within normal ratings under normal system conditions. All facilities loaded within emergency ratings under outage conditions. The maximum acceptable transient voltage is 0.85 p.u. for 0.5 seconds on the 500 kV system.
Remedial Actions Required:	Remedial actions are required to achieve the rated transfer capability. Most involve tripping the tie line for outages in the B.C. Hydro system. East to West: For high transfers, one of the units at Keephills may be tripped (up to 370 MW). West to East: For transfer 400 MW or greater, interruptible load is armed based on system load.
Formal Operating Procedure:	BC Transmission Corporation System Operating Order 7T-17. Alberta Electric System Operator (AESO) OPP 303, 304 and 312.

Allocation:	BC Hydro owns but BC Transmission Corporation plans, operates, and manages the lines and associated facilities in British Columbia. Alta Link owns the lines and associated facilities in Alberta. The Alberta Electric System Operator (AESO) plans and administers operation of the lines and associated facilities in Alberta.
Interaction w/Other Transfer Paths:	A nomogram showing the relationship between the transfers on the BC-Alberta Intertie and the PDCI were developed prior to the completion of COTP. Since Alberta now accepts separation of their intertie with B.C. Hydro for loss of PDCI or any N-1 outage, no nomogram is required.
Contact Person:	Eric Tse British Columbia Transmission Corporation Suite 1100, Four Bentall Centre 1055 Dunsmuir Street P. O. Box 49260 Vancouver, BC. Canada, V7X1V5 (604) 699-7365 (604) 699-7538 - fax eric.tse@bctc.com Neil J. Brausen Alberta Electric System Operator 2500, 330 – 5th Ave. S.W. Calgary, Alberta, CANADA T2P 0L4 (403) 539-2533 (403) 539-2612 - fax neil.brausen@aeso.ca

2. Alberta - Saskatchewan



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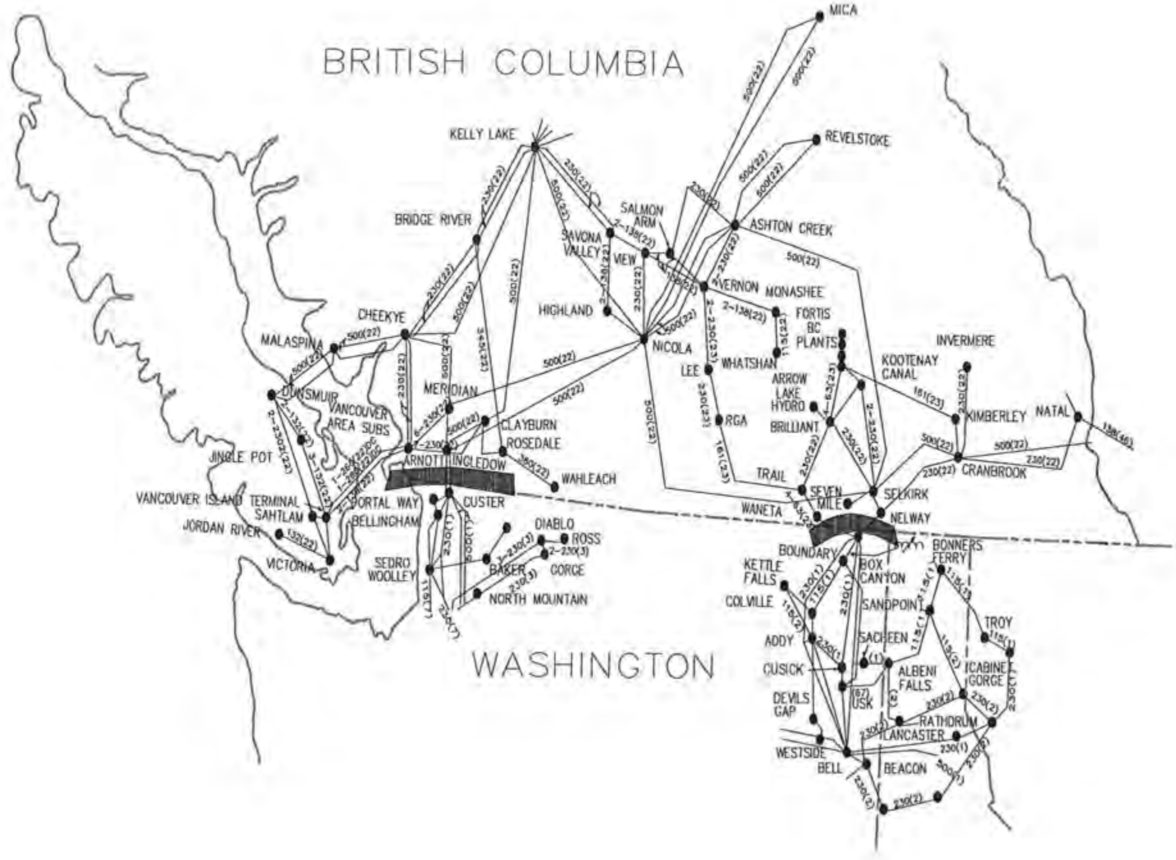
2. Alberta - Saskatchewan

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southern Alberta and Southern Saskatchewan
Definition:	This interconnection consists of the McNeill AC-DC-AC tie. This back-to-back DC converter station is operated at 42.2 kV.
Transfer Limit:	East to West: 150 MW West to East: 150 MW
Critical Disturbance that limits the transfer capability:	The capacity of this path is currently limited by the DC converter rating.
When:	
System Conditions:	This rating is independent of transfer levels between major areas of WECC. The transfer limit is impacted by local conditions.
Study Criteria:	
Remedial Actions Required:	None
Formal Operating Procedure:	Transmission Administrator of Alberta Ltd. TAOP 324 (draft) operating procedure under development.
Allocation:	ATCO Electric owns the converter facilities in Alberta, and SaskPower Ltd. owns and operates the converter facilities in Saskatchewan. The Transmission Administrator of Alberta Ltd. plans and administers operation of the facilities in Alberta.
Interaction w/Other Transfer Paths:	None
Contact Person:	Neil J. Brausen, P. Eng. Director, System Planning Alberta Electric System Operator 2500, 330 - 5th. Ave. S. W. Calgary, Alberta, CANADA T2P OL4 (403) 539-2533 (403) 539-2612 - fax neil.brausen@aeso.ca

3. Northwest - Canada



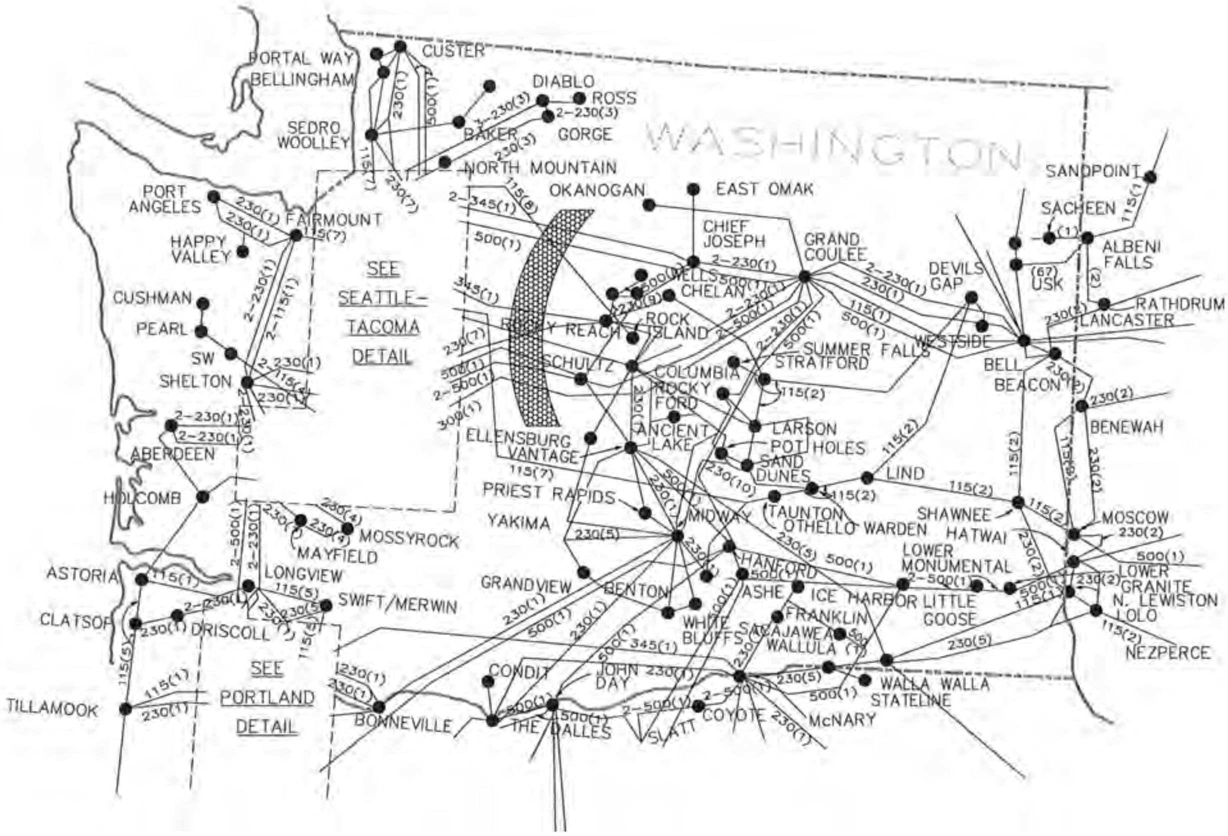
3. Northwest - Canada

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Washington and southern British Columbia
Definition:	BC Transmission Corporation now plans, operates, and manages all transmission equipment owned by BC Hydro in British Columbia. Sum of the flows on the following lines: Line / Owner / Metered End Custer (BPA)-Ingledow (BCTC) 500 kV lines 1&2 (Westside Intertie) — Joint — Ingledow (North end) Boundary (BPA)-Waneta (Fortis BC) 230 kV (Eastside Intertie) — Joint — Boundary (South end) Boundary (BPA)-Nelway (BCTC) 230 kV (Eastside Intertie) — Joint — Boundary (South end)
Transfer Limit:	North to South: Up to 3150 MW (all ties). Flow cannot exceed 2850 MW on both Custer-Ingledow lines 1&2 (Westside Intertie) or 400 MW on the Boundary-Nelway line (one of the two Eastside Interties). South to North: Up to 2000 MW (all ties). Flow cannot exceed 2000 MW on both Custer-Ingledow lines 1&2 (Westside Intertie) or 400 MW on the Boundary-Nelway line (one of the two Eastside Interties).
Critical Disturbance that limits the transfer capability:	Depending on the season, load level, direction of transfer and the pattern of generation in the local area, different outages will limit the transfer capability. Typically the most severe outages are on the 500, 345 and 230 kV grid in the Puget Sound area. Typically the limiting facilities are on the 230 and 115 kV system. Recent study work addressing the N-2 common mode outages (breaker failures, common ROW, etc.) has identified the limiting contingencies. Addition of new sectionalizing breakers, reconfiguration of the 230 kV system and uprating of existing lines has improved the operating capability of the Northern Intertie. Work is continuing on further system improvements.
When:	North to South: The 2300 MW path rating was established in January 1989 with the publication of "Facility Rating Studies for Joint BPA-BCH 2300 MW Intertie Uprate Report." The 3150 MW path rating was established with the completion of the 2850 MW Westside BCH-BPA Intertie Project. The Westside BCH-BPA 2850 MW Intertie Uprate WECC Ad Hoc Review Group issued a final report titled "Report On the Accepted Rating Study of the Westside BCH-BPA 2850 MW Intertie Uprate" in May 1994.

System Conditions:	North to South: The two Custer-Ingledow tielines can transmit 2850 MW from Canada to the Northwest when B.C. Transmission Corporation's load (Canada) is between approximately 40% and 70% of its annual peak load. South to North: Restrictions occur during winter peak demand periods due to voltage stability concerns in the Northwest and B.C. Transmission Corporation. However, predominant transfers occur during spring months when voltage stability limitations are not a concern in northwest Washington.
Study Criteria:	All applicable B. C. Transmission Corporation, Bonneville Power Administration, and WECC Criteria.
Remedial Actions Required:	North to South: The maximum amount of generator tripping in Canada (B.C. Transmission Corporation) is about 110% of the scheduled export from Canada to the Northwest. Reactive power equipment switching scheme is used in B.C. Transmission Corporation (Canada) to control voltages when the transfer on the Ingledow-Custer tielines is between 2300 and 2850 MW. South to North: The 230 kV tielines are directly tripped after outages of both 500 kV Ingledow-Custer ties when the South to North total transfer exceeds 400 MW, thus separating the Northwest from Canada.
Formal Operating Procedure:	B.C. Transmission Corporation's System Operating Order #7T-18 "Custer-Ingledow 500 kV Interconnection," BPA Dispatcher Standing Order #320 "Operation of the Northern Intertie" and Standing Order #323 "Bellingham Area-Intalco Load Tripping."
Allocation:	North to South: All of the capacity is allocated to B. C. Transmission Corporation, BPA, and PSE. South to North: All of the capacity is allocated to B.C. Transmission Corporation, BPA, and PSE.
Interaction w/Other Transfer Paths:	North to South: For the Ingledow-Custer intertie 2850 MW accepted rating, there is a potential interaction with the Raver-Paul loading.
Contact Person:	Eric Tse British Columbia Transmission Corporation Suite 1100, Four Bentall Centre 1055 Dunsmuir Street P.O. Box 49260 Vancouver, British Columbia Canada V7X 1V5 (604) 699-7365 (604) 699-7538 - fax eric.tse@bctc.com Mike Kreipe (TOP-PPOC2-2) Bonneville Power Administration 8100 NE Parkway Dr. #50 Vancouver, WA 98662-1409 (360) 619-6686 (360) 619-6945 - fax mjkreipe@bpa.gov

4. West of Cascades - North



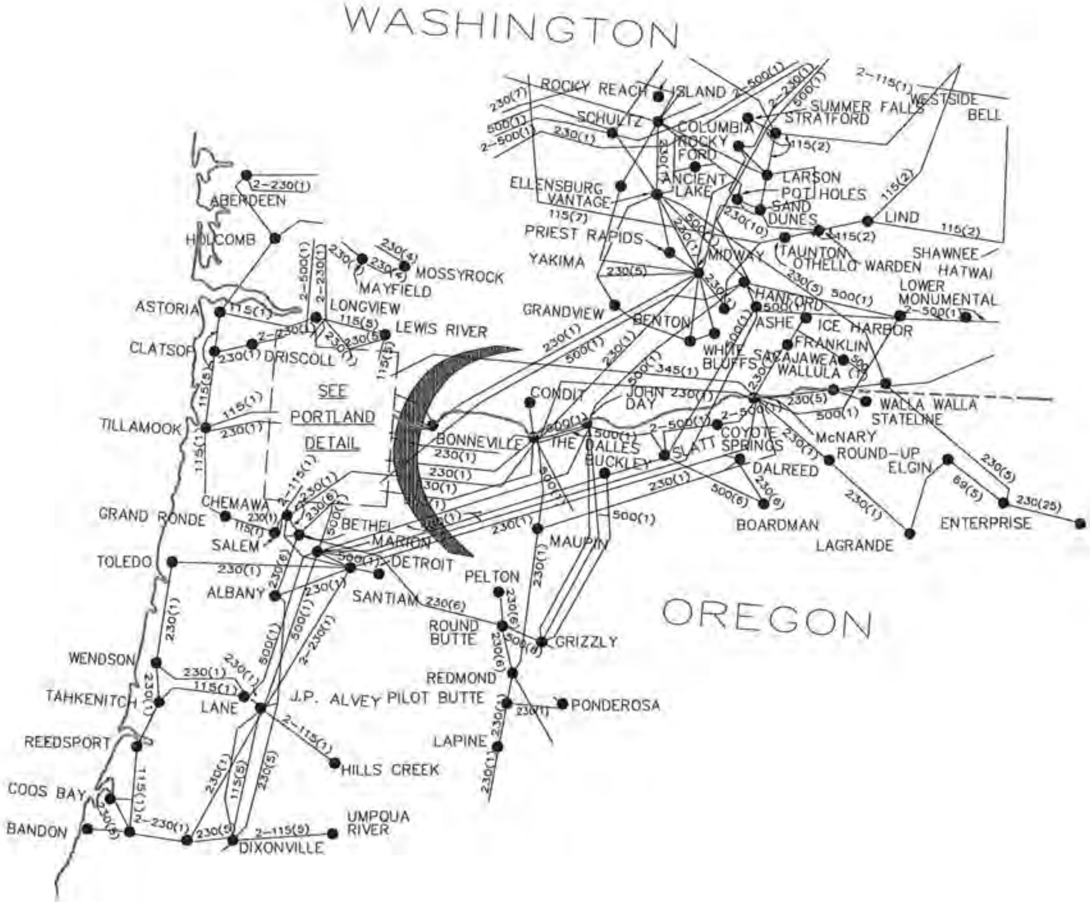
Revised February 2004

4. West of Cascades - North

Accepted Rating ☐
Existing Rating ☐
Other ☒

Location:	Central Washington
Definition:	Sum of the flows on the following lines: Line — Metered End Chief Joseph-Monroe 500 kV — Chief Joseph Schultz-Raver 1, 3, 4 500 kV — Schultz Chief Joe-Snohomish 345 kV lines 3&4 — Chief Joseph Rocky Reach-Maple Valley 345 kV — Rocky Reach Coulee-Olympia 300 kV — Coulee Rocky Reach-White River 230 kV — Rocky Reach Columbia-Covington 230 kV — Columbia Schultz-Echo Lake 500 kV — Schultz
Transfer Limit:	The transfer limit is approximately 10,200 MW and is voltage stability limited. The increase of 400 MW is due to the added series capacitors in the Schultz-Raver No 1 (45%) and Schultz-Echo Lake 500 kV (42%) lines in late 2003.
Critical Disturbance that limits the transfer capability:	The two critical outages include the single line outage of the Chief Joseph-Monroe 500 kV line under "extra heavy" winter peak load levels and the double outage of the Raver-Schultz 500 kV lines 1&2 under normal winter peak load levels.
When:	The most recent studies were published on October 9, 1992 and are reviewed each year. The studies are coordinated with the Northwest Power Pool.
System Conditions:	Generally, to achieve high west of Cascades north flows, the Northwest region must experience an "extra heavy" winter load condition. These unusual "Arctic storm" conditions have occurred on several occasions in the past.
Study Criteria:	All applicable BPA and WECC criteria.
Remedial Actions Required:	None. Automatic under-voltage load tripping is in place to trip up to 15% of load in the Puget Sound Area for multiple contingencies.
Formal Operating Procedure:	BPA Dispatch Standing Order 322, "Voltage Collapse Mitigation Procedures for the Puget Sound Area."
Allocation:	100% BPA
Interaction w/Other Transfer Paths:	None
Contact Person:	Mike Kreipe (TOP-PPOC2-2) Bonneville Power Administration 8100 NE Parkway Dr. #50 Vancouver, WA 98662-1409 (360) 619-6686 (360) 619-6945 - fax mjkreipe@bpa.gov

5. West of Cascades - South



Revised February 2003

5. West of Cascades - South

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Northwestern Oregon and Southwestern Washington
Definition:	Sum of the flows on the following lines: Line — Metered End Big Eddy-Ostrander 500 kV — Big Eddy Ashe-Marion 500 kV — Ashe Buckley-Marion 500 kV — Buckley Hanford-Ostrander 500 kV — Hanford John Day-Marion 500 kV — John Day McNary-Ross 345 kV — McNary Big Eddy-McLoughlin 230 kV — Big Eddy Big Eddy-Chemawa 230 kV — Big Eddy Midway-N. Bonneville 230 kV — N. Bonneville McNary-Santiam 230 kV — McNary Big Eddy-Troutdale 230 kV — Big Eddy Round Butte-Bethel 230 kV — Bethel
Transfer Limit:	The transfer limit is 7000 MW and is voltage stability limited.
Critical Disturbance that limits the transfer capability:	Big Eddy-Ostrander 500 kV or Pearl breaker failure causing loss of the Keeler-Pearl and Pearl-Marion 500 kV lines.
When:	The most recent studies were posted on BPA's transmission web site for 2000/2001 studies. The studies are coordinated with the Northwest Power Pool.
System Conditions:	Generally, to achieve high west of Cascades south flows, the Northwest region must experience an "extra heavy" winter load condition. These unusual "Arctic storm" conditions have occurred on several occasions in the past.
Study Criteria:	All applicable BPA and WECC criteria.
Remedial Actions Required:	None. Automatic under-voltage load tripping is in place to trip up to 15% of load in the Williamette Valley/Southwest Washington area for multiple contingencies.
Formal Operating Procedure:	BPA Dispatch Standing Order 324 "Voltage collapse mitigation procedures for the Willamette Valley/Southwest Washington area."
Allocation:	100% BPA
Interaction w/Other Transfer Paths:	None.

Contact Person:	Mike Kreipe (TOP-PPOC2-2) Bonneville Power Administration 8100 NE Parkway Dr. #50 Vancouver, WA 98662-1409 (360) 619-6686 (360) 619-6945 - fax mjkreipe@bpa.gov

6. West of Hatwai

6. West of Hatwai

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Eastern Washington
Definition:	Sum of the flows on the following line sections: Line — Metered End Hatwai (BPA)-Lower Granite (BPA) 500 kV — Hatwai Bell (BPA)-Coulee (USBR) 230 kV lines 3&5 — Bell Westside (AVA)-Coulee (BPA) 230 kV — Westside Hatwai (BPA)-Lolo (AVA) 230 kV — Hatwai Lolo (AVA) 230/115 kV transformers 1&2 — 115 kV North Lewiston (AVA)-Walla Walla (PAC) 230 kV — North Lewiston Bell (BPA)-Creston (BPA) 115 kV — Bell N. Lewiston (AVA)-Clarkston (BPA) 115 kV — North Lewiston Harrington (AVA)-Odessa (AVA) 115 kV — Harrington Lind (AVA)-Roxboro (AVA) 115 kV — Lind Dry Gulch (AVA) 115/69 kV (PAC) transformer — 115 kV Grand Coulee (USBR)-Bell (BPA) 500 kV — Bell Note: BPA and Avista are proposing through the current WOH Review Group to change the WOH definition when the new WOH rating takes effect in the spring of 2005. The new definition will remove the Hatwai-Lolo 230 kV line, the Lolo 230/115 kV transformer, and changes the termination of the North Lewiston-Walla Walla 230 kV line from North Lewiston to Dry Creek 230 kV to form a Dry Creek-Walla Walla 230 kV line with metering changed to Dry Creek.
Transfer Limit:	East to West: 2800 MW West to East: Not defined In the Spring of 2005, it is expected that the East to West WOH rating will increase to about 4300 MW as a result of the completion of the new BPA and Avista WOH facility additions. This rating is presently being reviewed by the WOH Review Group.
Critical Disturbance that limits the transfer capability:	Loss of 500 kV facilities in Eastern Washington
When:	The WOH path is currently undergoing a re-rating of the WOH path with a new rating expected by April 2005.
System Conditions:	Cut-plane rating based upon spring load conditions with high Western Montana hydro and Colstrip generation levels.
Study Criteria:	All applicable AVA, BPA, and WECC criteria.
Remedial Actions Required:	Generator dropping (Libby, Dworshak, Lancaster, and Colstrip) Reactor tripping (Garrison) Tripping of Miles City DC link

Formal Operating Procedure:	WECC Operating Procedure BPA-16 BPA dispatcher standing order 325
Allocation:	BPA: 2200 MW AVA: 600 MW
Interaction w/Other Transfer Paths:	To be determined
Contact Person:	Scott Waples Avista Corp. 1411 East Mission P. O. Box 3727 Spokane, WA 99220-3727 (509) 495-4462 (509) 495-8542 - fax scott.waples@avistacorp.com Mike Kreipe (TOP-PPOC2-2) Bonneville Power Administration 8100 NE Parkway Dr. #50 Vancouver, WA 98662-1409 (360) 619-6686 (360) 619-6945 - fax mjkreipe@bpa.gov

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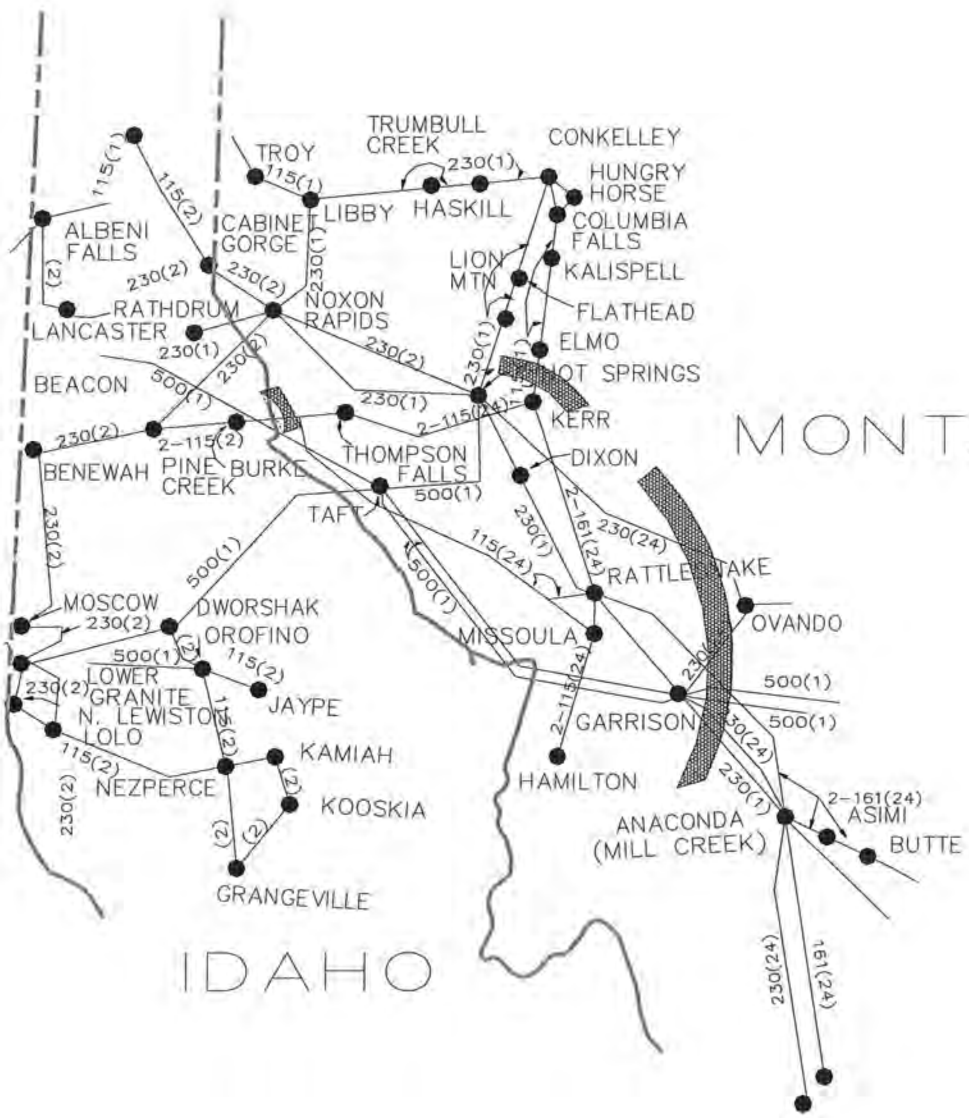
8. Montana to Northwest



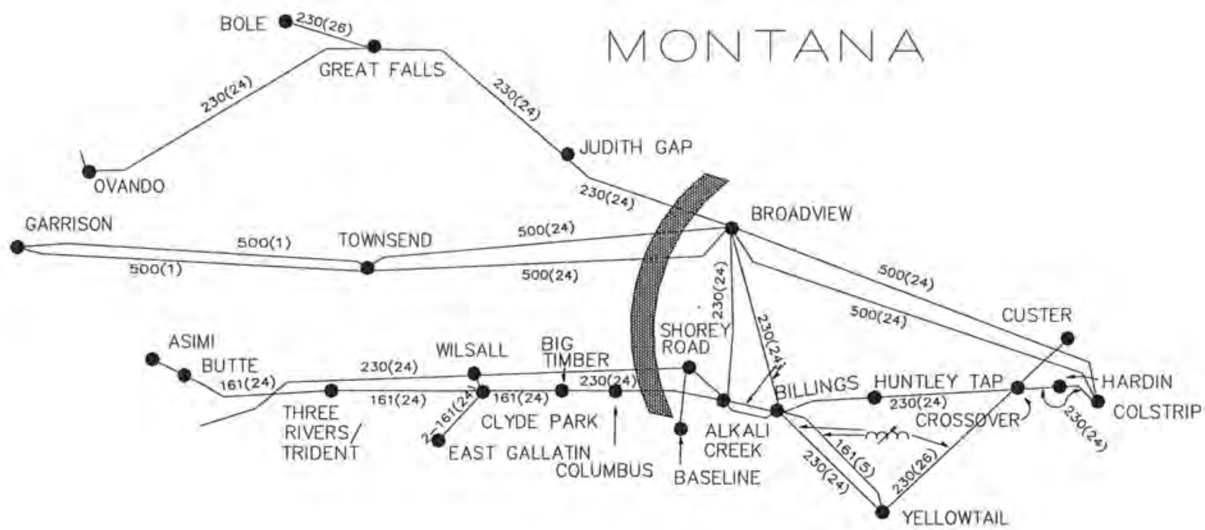
8. Montana to Northwest

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	The lines between western Montana and the Northwest US
Definition:	The lines involved in this path are the metered tie lines between NorthWestern Energy (NWMT) and Bonneville Power Administration (BPA), plus the metered tie lines between NWMT and Avista Corp. (AVA). Metered End Broadview-Garrison #1 & #2 500 kV lines — Garrison Anaconda-Garrison #1 & #2 230 kV lines — Anaconda Ovando-Garrison 230 kV — Garrison Ovando-Hot Springs 230 kV — Hot Springs Rattlesnake 230/161 kV transformer — 161 kV Kerr-Elmo 115 kV — Kerr Thompson Falls-Burke 115 kV — Burke Crow Creek-Burke 115 kV — Burke
Transfer Limit:	East to West: 2200 MW West to East: 1350 MW
Critical Disturbance that limits the transfer capability:	The constraint that sets the East-to-West rating is pre-outage steady-state voltage performance. The West-to-East rating is set by post-transient voltage performance for the loss of both Garrison-Taft 500 kV lines. The ratings of the series capacitor bank lines between Garrison and Taft were increased to 2000 A in 2004.
When:	This rating is based on studies conducted by the Montana Power Company (dba NWMT) and the Bonneville Power Administration in 1993. This study was reviewed by an Ad Hoc Review Group under the auspices of the WECC. The West to East rating of 1350 MW was studied and approved by the three-phase rating process. This is an accepted rating.
System Conditions:	
Study Criteria:	
Remedial Actions Required:	The east to west stability limit is higher than the thermal limit. This limit has been enhanced by the application of remedial action schemes. Without the remedial action schemes stability performance would be the limiting constraint for this path. The remedial actions which are used to enhance stability performance are as follows: 1. Switching shunt reactors at the Garrison 500 kV bus for the loss of critical 500 kV lines. 2. Tripping the back-to-back DC tie at Miles City. 3. Tripping Colstrip generation. 4. Tripping Libby and Noxon generation.
Formal Operating Procedure:	None

Allocation:	East-West NWMT/AVA 250 MW NWMT/AVA 132 MW NWMT/BPA 1818 MW West-East NWMT/AVA 382 MW NWMT/BPA 968 MW	 Ovando-Hot Springs 230 kV Thompson Falls-Burke 115 kV Kerr-Kalispell 115 kV, Garrison-Taft 500 kV, Garrison-Hot Springs 230 kV Ovando-Hot Springs 230 kV, Thompson Falls-Burke 115kV Kerr-Kalispell 115 kV, Garrison-Taft 500 kV, Garrison-Hot Springs 230 kV
Interaction w/Other Transfer Paths:	None	
Contact Person:	Charles A. Stigers NorthWestern Energy 40 East Broadway Butte, MT 59701 (406) 497-4538 (406) 497-3393 - fax Chuck.Stigers@northwestern.com Scott Waples Avista Corp. 1411 East Mission P. O. Box 3727 Spokane, WA 99220-3727 (509) 495-4462 (509) 495-8542 - fax scott.waples@avistacorp.com	

9. West of Broadview

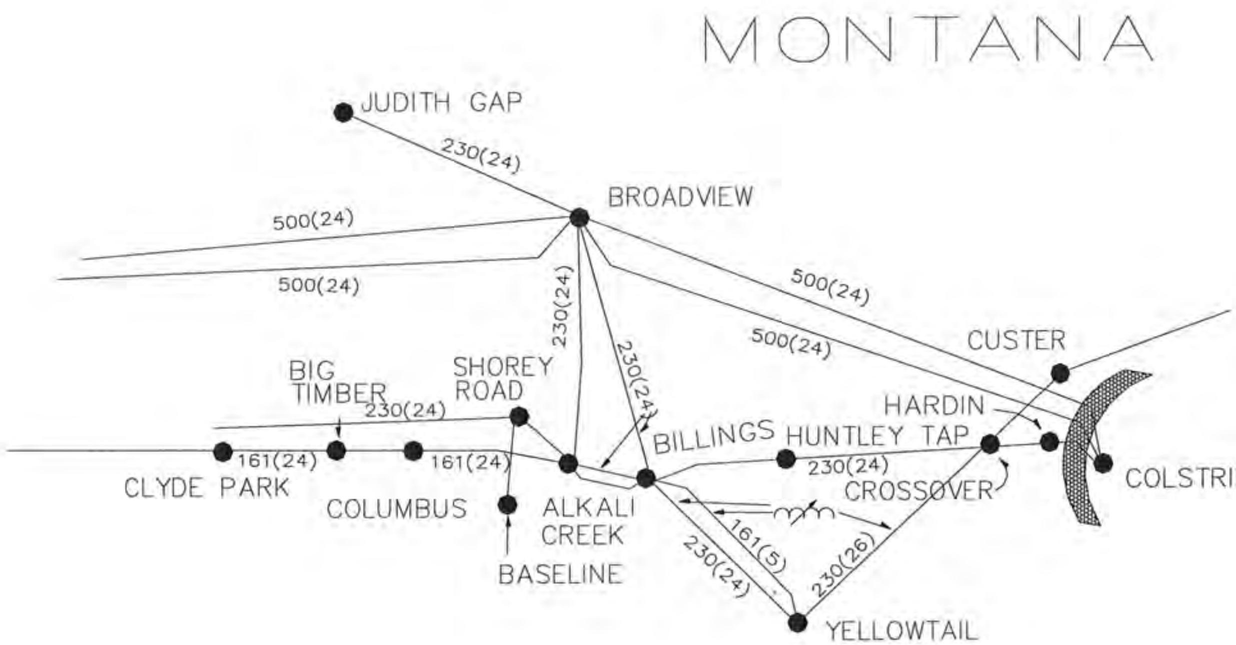


9. West of Broadview

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	South Central Montana
Definition:	The West of Broadview path consists of the following transmission lines: Line — Metered End Broadview-Garrison 500 kV #1 & #2 — Broadview Broadview-Judith Gap 230 kV — Broadview Shorey Road-Wilsall 230 kV — Shorey Road Alkali-Columbus/Rapleje 161 kV — Alkali Broadview 2-230/100 kV auto transformers — Broadview This path includes all lines which proceed west from the Billings area.
Transfer Limit:	East to West: 2573 MW Since the flow on this path is almost always east to west, and is never large when it is west to east, no effort has been made to determine the west to east capacity.
Critical Disturbance that limits the transfer capability:	The capacity rating is based on the maximum flow for which a two-phase-ground fault at the Broadview end of a Broadview-Garrison line when cleared normally will result in a worst case voltage dip after the fault has cleared no more than 20% of the starting voltage on any load bus with no generator tripping at Colstrip.
When:	This capacity rating is based on studies done in 1980 for the Colstrip participants.
System Conditions:	
Study Criteria:	
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	
Interaction w/Other Transfer Paths:	
Contact Person:	Charles A. Stigers NorthWestern Energy 40 East Broadway Butte MT 59701 (406) 497-4538 (406) 497-3393 - fax Chuck.Stigers@northwestern.com

10. West of Colstrip



10. West of Colstrip

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southeastern Montana
Definition:	The West of Colstrip path consists of the following transmission lines: Line — Metered End Colstrip-Broadview 500 kV lines #1 & #2 — Colstrip Colstrip-Hardin 230 kV — Colstrip Colstrip-Hardin 115 kV — Colstrip
Transfer Limit:	East to West: 2598 MW Since this path was constructed to integrate the Colstrip generation project into the Montana system, no effort has been made to determine the west to east capacity.
Critical Disturbance that limits the transfer capability:	
When:	The path capacity is based on studies done in 1980 for the Colstrip participants. This study result must be regarded as only approximate, since the transmission system model used in the study did not include significant changes which have occurred since 1980. These include: 1. The insertion of the Crossover bus in the Colstrip-Billings 230 kV line connecting this NWMT line to the Miles City-Yellowtail 230 kV Western Area Power Administration (WAPA) line at the location where the two lines intersect. 2. The addition of the Miles City back-to-back DC tie. 3. The insertion of the Hardin bus in the Colstrip-Crossover 230 kV line. 4. The addition of the Montana 1 power station on the 115 kV line between Colstrip and the Nichols pumping station. 5. The 230/115 kV transformer at Hardin. 6. Closing through the 115 kV line between Colstrip and Hardin. 7. A load tap has been placed between Crossover and Billings to serve the Huntley area. It is not likely that any of these changes has a significant impact on the capacity of this path.
System Conditions:	
Study Criteria:	
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	

Interaction w/Other Transfer Paths:	
Contact Person:	Charles A. Stigers NorthWestern Energy 40 East Broadway Butte, MT 59701 (406) 497-4538 (406) 497-3393 - fax Chuck.Stigers@northwestern.com

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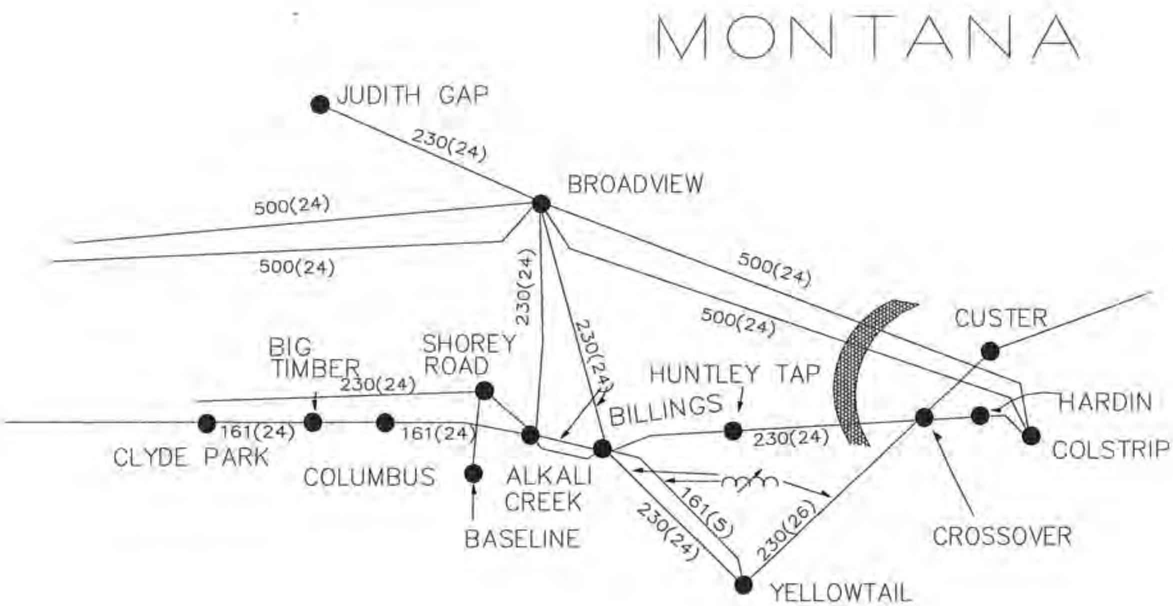
11. West of Crossover



Revised February 2004

11. West of Crossover

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southeastern Montana
Definition:	The branches included in this path are: Line — Metered End Colstrip-Broadview #1 & #2 500 kV lines — Colstrip Crossover-Huntley 230 kV line — Crossover
Transfer Limit:	East to West: 2598 MW Since this path integrates the Colstrip generation and the Miles City DC tie into the system, no effort has been made to determine the west to east capacity.
Critical Disturbance that limits the transfer capability:	
When:	The path capacity is based on studies done in 1980 for the Colstrip participants. The original purpose of the study was to determine the transfer capacity west of Colstrip. This study result must be regarded as only approximate, since the transmission system model used in the study did not include significant changes which have occurred since 1980. These include: 1. The insertion of the Crossover bus in the Colstrip-Billings 230 kV line connecting this line to the Miles City-Yellowtail 230 kV Western Area Power Administration (WAPA) line at the location where the two lines intersect. 2. The addition of the Miles City back-to-back DC tie. 3. The insertion of the Hardin bus in the Colstrip-Crossover 230 kV line. 4. The addition of the Montana 1 power station on the 115 kV line between Colstrip and the Nichols pumping station. 5. The 230/115 kV transformer at Hardin. 6. Closing through the 115 kV line between Colstrip and Hardin. 7. A load tap has been placed between Crossover and Billings to serve the Huntley area. It is not likely that any of these changes has a significant impact on the capacity of this path.
System Conditions:	
Study Criteria:	
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	

Interaction w/Other Transfer Paths:	
Contact Person:	Charles A. Stigers NorthWestern Energy 40 East Broadway Butte, MT 59701 (406) 497-4538 (406) 497-3393 - fax chuck.stigers@northwestern.com

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13.

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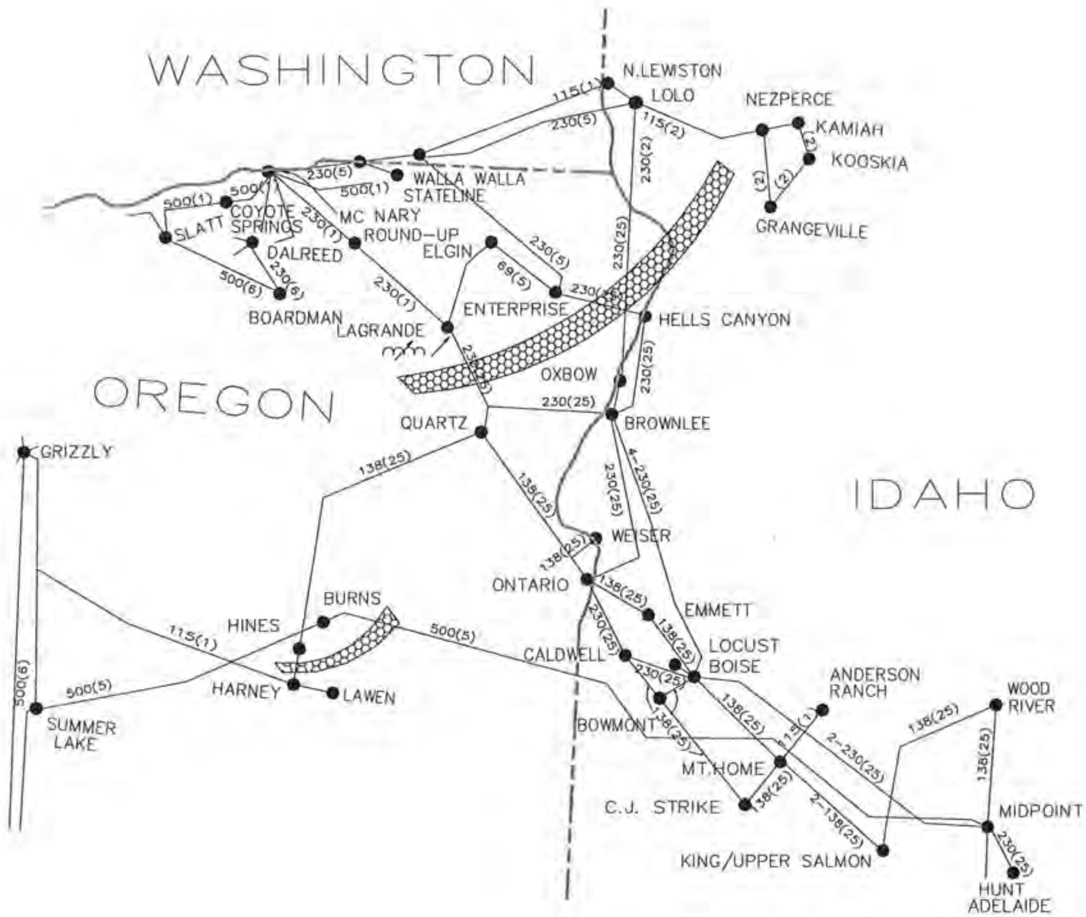
14. Idaho to Northwest



14. Idaho to Northwest

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southwest Idaho and Eastern Oregon/Washington and Northern Idaho
Definition:	Sum of the flows on the following lines: <u>500 kV system</u>: — <u>Metered End</u> Midpoint-Summer Lake 500 kV — Midpoint <u>230 kV and 115 kV system</u>: Imnaha-Lolo 230 kV — Imnaha Hells Canyon-Enterprise 230 kV — Enterprise Quartz Tap-LaGrande 230 kV — LaGrande Hines-Harney 138/115 kV tie — Harney
Transfer Limit:	<u>Combined Ratings</u> East to West: 2400 MW West to East: 1200 MW <u>Individual Systems Ratings</u>: 500 kV system — East to West: 1500 MW; West to East: unallocated 230 kV and 115 kV system — East to West: 1200 MW; West to East: 1200 MW <u>Current OTC Seasonal Transfer Limits</u>: East to West: 2304 NW* West to East: 1200 MW Winter 1150 MW Spring/Fall** 1090 MW Summer** * The East to West OTC transfer capability is limited due to network changes, which consisted of the removal of the Copperfield series capacitor and thermal limitations on the Imnaha-Lolo 230 kV line section. ** The West to East OTC transfer capability is limited in the spring, summer, and fall seasons due to thermal limitations on the Imnaha-Lolo 230 kV line section.
Critical Disturbance that limits the transfer capability:	<u>East to West</u>: Transient voltage dip at LaGrande, post-transient voltages at LaGrande, Hines, and West John Day, and the thermal overload on the Walla Walla series capacitor following the loss of the Midpoint-Summer Lake 500 kV line. <u>West to East</u>: The transfer capacity on the three 230 kV and one 115 kV tie lines is based on steady state thermal limits. The 1200 MW transfer capacity assumes no allocation on the Midpoint-Summer Lake line during normal system conditions.

When:	The 2400 MW east to west rating was established in August, 1989 with the publication of Idaho Power Company to Pacific Northwest Intertie Capacity Study. The WECC Notification Procedures for Changes in Facility Ratings and/or Operating Procedures was followed. The 1200 MW west to east rating was established in 1981 and reconfirmed in 1986. The 2400 MW east to west rating was conducted jointly by: Bonneville Power Administration (BPA) Idaho Power Company (IPC) PacifiCorp (PAC) Avista Corp. (AVA) The 500 kV system east to west capability was demonstrated at the time of 2400 MW east to west study in 1989. The 230 kV and 115 kV system east to west capability was established in 1976 and redemonstrated with the 1989 study. The 1200 MW west to east rating was established in 1981 and reconfirmed in 1986 without allocation of capacity to the Midpoint-Summer Lake 500 kV line. The studies were conducted by Idaho Power Company.
System Conditions:	The 2400 MW east to west transfer rating was studied with light load conditions in Idaho with heavy eastern thermal resources, and moderate generation on the remaining hydro plants in Idaho. Studies were performed with both north to south and south to north on the PACI and near maximum transfers on parallel paths; i.e. transfers to Northwest and Arizona to California. The 1200 MW west to east transfer rating was studied with high hydro conditions in the Northwest with low to moderate eastern thermal resources. In addition, the 1200 MW west to east rating cannot be fully utilized simultaneous with heavy Hells Canyon complex generation because of steady state thermal overloads and/or post disturbance voltage change in Idaho Power's internal transmission system.
Study Criteria:	WECC Reliability Criteria For Transmission System Planning
Remedial Actions Required:	Remedial action schemes are required to achieve the 2400 MW east to west transfer capability. An outage of any one of the three 230 kV tie lines will initiate the generator runback remedial action scheme at Idaho Power Company's Hells Canyon plants to automatically reduce the thermal overloads on the remaining tie lines. Outage of the Midpoint-Summer Lake 500 kV line requires Jim Bridger unit(s) tripping. Remedial actions are not required to achieve the 1200 MW west to east transfer capability.
Formal Operating Procedure:	Under certain generation and load conditions, 2400 MW Idaho to Northwest transfer simultaneous with heavy Northwest to California transfers may cause overloading of the Midpoint-Summer Lake line. During these conditions, one-half of the Burns series capacitor can be bypassed to reduce Midpoint-Summer Lake loading but it results in reduced Bridger West capacity.

Allocation:	The transfer capability of the path is allocated among the interconnections as follows: • <u>2400 MW East to West</u>: 1587 MW IPC - PacifiCorp interconnection 413 MW IPC - BPA interconnection 400 MW IPC - AVA interconnection • <u>1200 MW West to East</u>: 350 MW BPA - IPC interconnection 400 MW PacifiCorp - IPC interconnection 450 MW AVA - IPC interconnection
Interaction w/Other Transfer Paths:	
Contact Person:	Mark D. Hanson Idaho Power Company P. O. Box 70 Boise, ID 83707 (208) 388-2253 (208) 388-6647 - fax mhanson@idahopower.com Scott Waples Avista Corp. 1411 East Mission P. O. Box 3727, MSC-16 Spokane, WA. 99220-3727 (509) 495-4462 (509)-495-8542 - fax scott.waples@avistacorp.com Don Johnson PacifiCorp, 9951 S.E. Ankeny Street, 2nd Floor Portland, OR 97216-2315 (503) 251-5283 (503) 251-5228 - fax don.johnson@pacificorp.com Mike Kreipe (TOP-PPOC2-2) Bonneville Power Administration 8100 NE Parkway Dr. #50 Vancouver, WA 98662-1409 (360) 619-6686 (360) 619-6945 - fax mjkreipe@bpa.gov

15. Midway - Los Banos

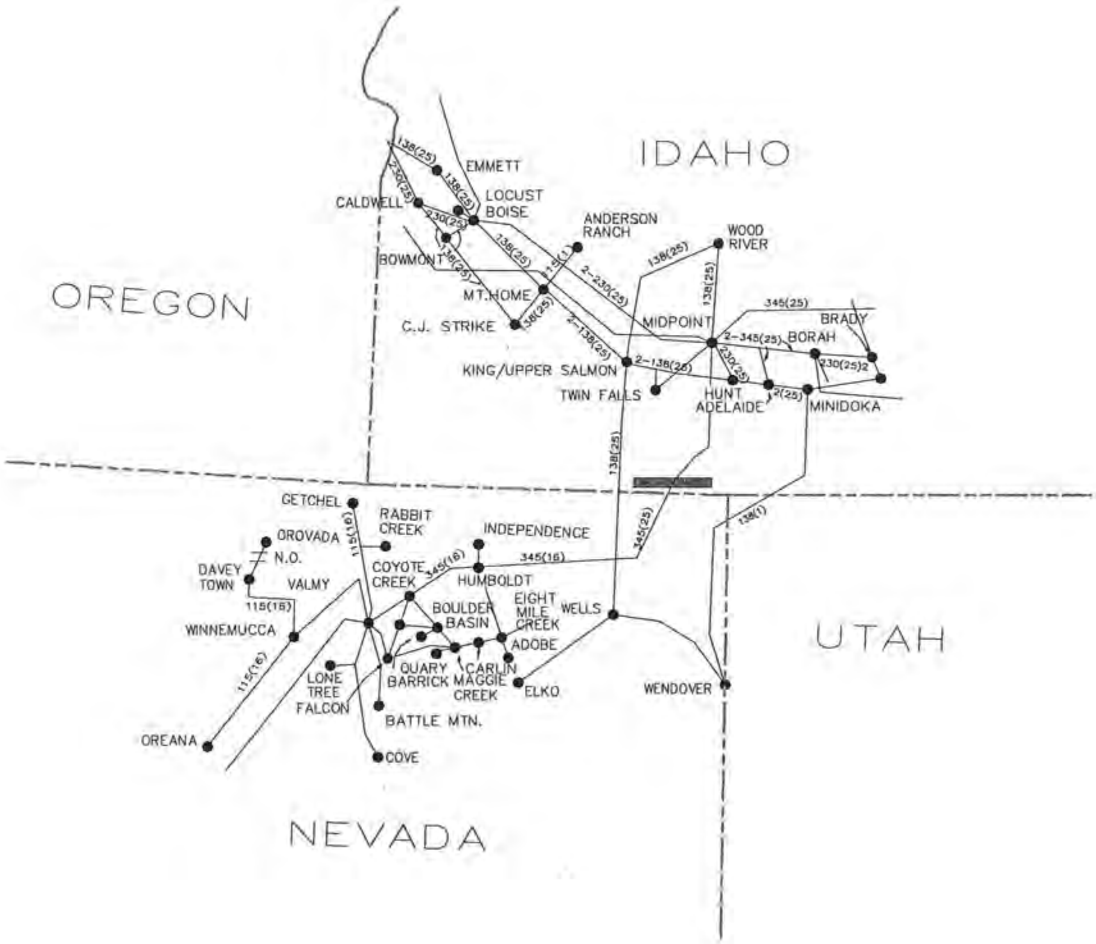
15. Midway - Los Banos

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Between central and southern California within the PG&E system and south of Los Banos substation (PG&E internal Path 15).
Definition:	Midway-Los Banos 500 kV line Los Banos-Gates # 1 and #3 500 kV lines Gates-Panoche #1 & #2 230 kV lines Gates-Gregg 230 kV line Gates-McCall 230 kV line
Transfer Limit:	The transfer limit ranges from 2000-3265 MW from north to south. The transfer limit ranges from 4800-5400 MW from south to north.
Critical Disturbance that limits the transfer capability:	From north to south: Midway-Gates and Midway-Los Banos 500 kV double line outage. Double Palo Verde unit outage. Los Banos-Tesla and Los Banos-Tracy 500 kV double line outage. From south to north: Double line 500 kV outages between Tesla and Midway.
When:	The 3265 MW north-to-south rating was established in the August 5, 2002 Path 15 Upgrade north-to-south Project Comprehensive Progress Report. Phase III Status granted on October 23, 2003. The 5400 MW south-to-north rating was established in the September 18, 2001 Path 15 Upgrade Project Comprehensive Progress Report. A letter from the PCC chair indicating the Phase II report was accepted and granting Phase III status was distributed on February 5, 2003.
System Conditions:	The north-to-south path rating was based on north-to-south transfers under heavy summer (high temperature) operating conditions. The south-to-north path rating was based on south-to-north transfers under light winter operating conditions.
Study Criteria:	NERC/WECC Planning Standards.
Remedial Actions Required:	Remedial actions are employed on an as needed basis for double line outages between Tesla and Midway.
Formal Operating Procedure:	CISO T-122 and PG&E O-51 operating procedures which are periodically updated.
Allocation:	PG&E, SCE, SDG&E, CDWR, and various new owners.
Interaction w/Other Transfer Paths:	For high north-to-south flows on Path 15 and high north-to-south flows on COI and/or PDCI it is necessary to operate based on a nomogram. Path 15 north-to-south transfer limit can be significantly less with high generation levels in the Midway area because of Path 26 limitations. For high south-to-north flows on Path 15 and high east-to-west flows on West of Borah it is necessary to operate based on a nomogram.

Contact Person:	Jon Eric Thalman Pacific Gas and Electric Company 77 Beale St. B15A San Francisco, CA 94105 (415) 973-7691 (415) 973-8804 - fax jetg@pge.com

16. Idaho - Sierra



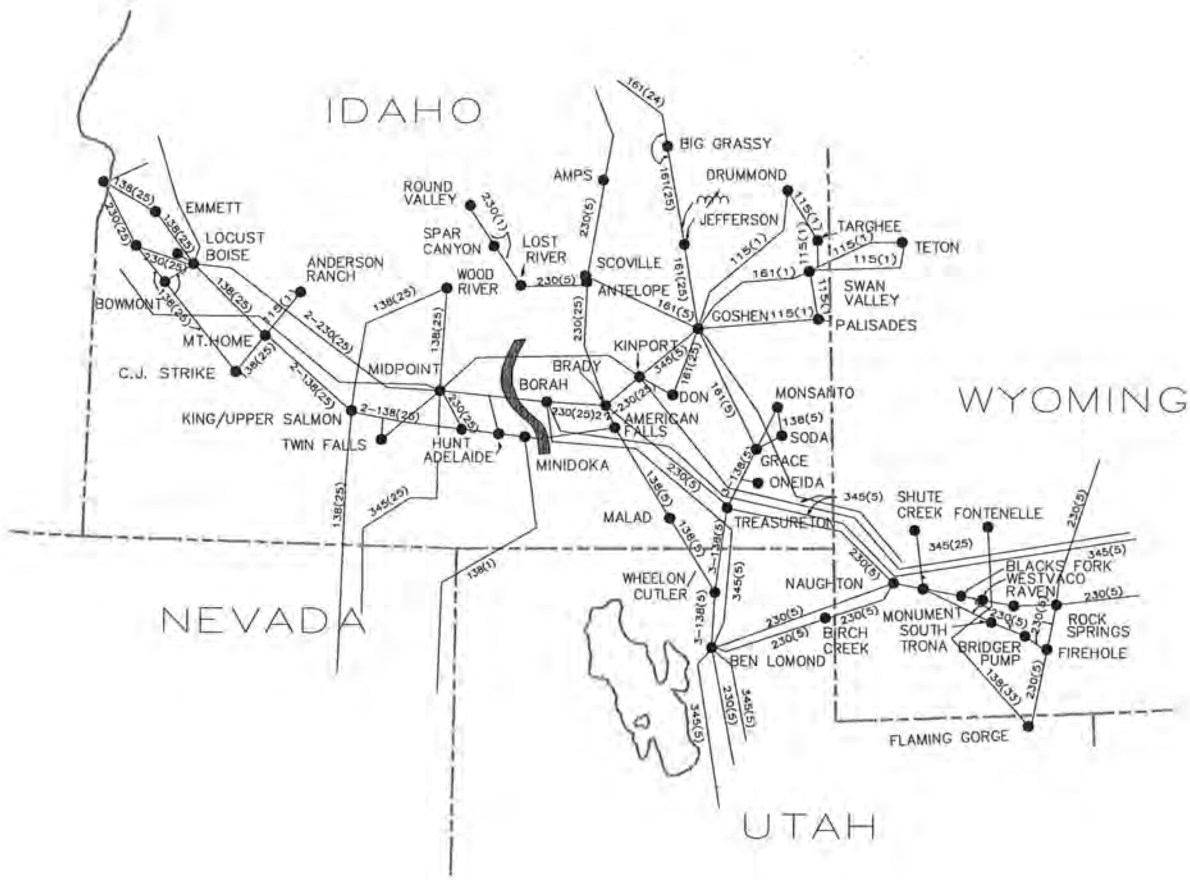
16. Idaho - Sierra

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Border between southern Idaho and northern Nevada
Definition:	Midpoint-Valmy 345 kV (3 line sections make up this path) Point of interconnection between Idaho Power Co. (Idaho) and Sierra Pacific Power Co. (Sierra) is the Idaho-Nevada state line border.
Transfer Limit:	North to South: 500 MW South to North: 360 MW The capacities listed above are non-simultaneous ratings of the line. Simultaneous ratings are dependent on Sierra's net control area operations. Seasonal OTC limits may be more restrictive for operating South to North.
Critical Disturbance that limits the transfer capability:	Outage of the Midpoint-Humboldt 345 kV line is a critical disturbance which determines Sierra's net system import limit. The net system export limit is determined by the outage of the Coyote Creek-Valmy 345 kV line.
When:	Initial non-simultaneous transfer studies were performed jointly by Sierra Pacific Power Company and Idaho Power Company in 1980. Periodically, Sierra updates their net system import limit studies to quantify simultaneous limits.
System Conditions:	Studies of the Sierra net system import limit have been conducted for all seasons and at various load levels.
Study Criteria:	Criteria used in determining Sierra's net import and export limits: • The post disturbance steady state voltages on the Ft. Churchill-Pavant 230 kV load buses must recover to 90% of pre-disturbance voltage and no less than 0.90 p.u. Automatic reactor switching allowed. • The post disturbance net flow on the Sierra-PG&E 120 kV and 60 kV interties must not exceed the limitations on that intertie (nominally 180 MW).
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	The transfer capability of the path is allocated as follows: Ownership — Allocation 50% Idaho — 100% North-bound capacity 50% Sierra — 100% South-bound capacity
Interaction w/Other Transfer Paths:	Sierra's system import and export limits and the flows on their other tie lines affect the scheduling capability of this intertie.

Contact Person:	Joe Tarantino Sierra Pacific Power Company P. O. Box 10100 Reno, NV 89520-0026 (775) 834-3348 (775) 834-3047 - fax jtarantino@sppc.com

17. Borah West



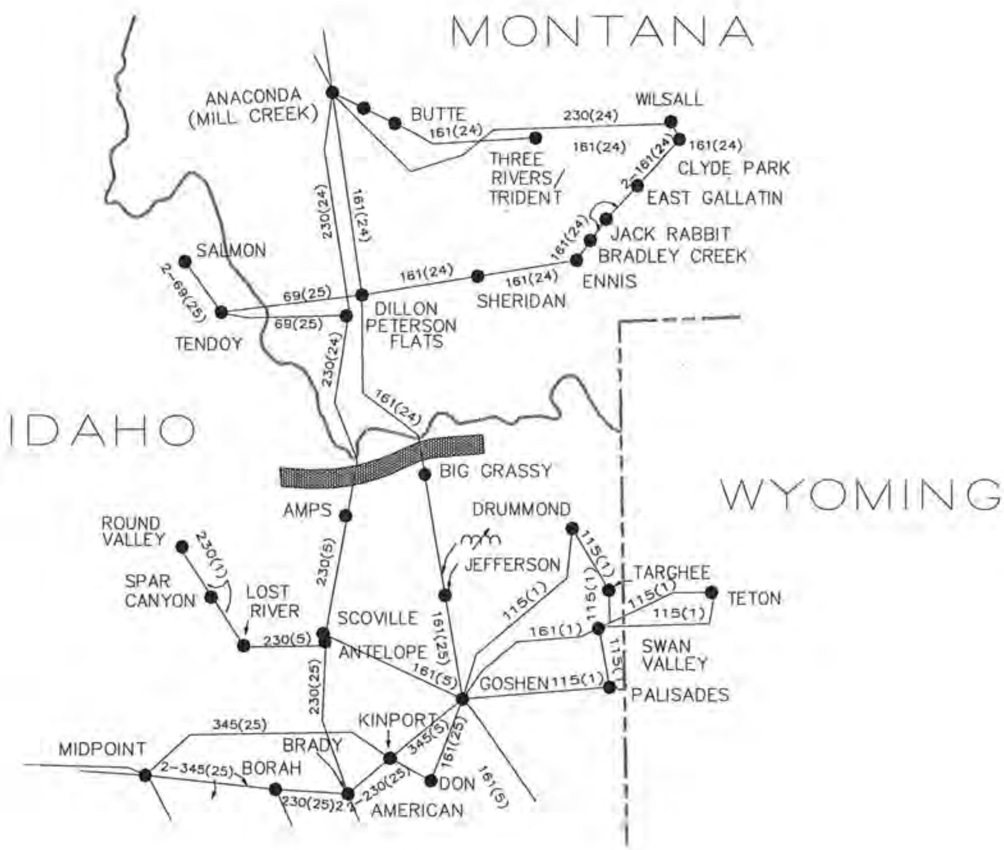
17. Borah West

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southeast Idaho
Definition:	Sum of the flows on the following lines: Line — Metered End Kinport-Midpoint 345 kV — Kinport Borah-Adelaide-Midpoint #1 345 kV — Borah Borah-Adelaide-Midpoint #2 345 kV — Borah AmFalls-Pleasant Valley-Adelaide 138 kV — American Falls AmFalls-Raft River-Minidoka 138 kV — American Falls
Transfer Limit:	East to West: 2307 MW West to East: Not defined The transfer capacity listed above is the non-simultaneous rating. The simultaneous rating for all seasons except summer is also 2307 MW. This rating may be derated in the summer depending on local irrigation load served by the underlying 138 kV transmission system.
Critical Disturbance that limits the transfer capability:	The Borah West transfer capacity is limited by transient voltage dips for SLG line faults with delayed clearing (breaker failure), and thermal overloads on the 345 kV lines West of Borah following an outage of one of the Borah West 345 kV lines. During the summer, the thermal overloads on the underlying 138 kV system is more restrictive for an outage of one of the Borah West 345 kV lines due to increased initial loadings caused by local irrigation load.
When:	The Borah West non-simultaneous transfer rating was established in 1988. The simultaneous transfer rating was established in June, 1991 and reconfirmed in early 1994 by Idaho Power Company. The Borah West simultaneous transfer capacity studies were redone due to the addition of the Kinport 175 MVAR and the Jim Bridger 200 MVAR shunt capacitor banks in late 1992 and early 1993.
System Conditions:	The Borah West transfer rating was determined with simultaneous heavy transfers on series path consistent with heavy transfers of eastern thermal resources to the west. The studies were performed with simultaneous flows on Path C (south to north) at 700 MW, Bridger West at 2200 MW, and Idaho-Northwest at 1850 MW. During moderate to heavy load periods, high Borah West flows may not be achievable due to eastern Idaho load and the inability to import more resources due to capacity limitations on Bridger West and Path C.
Study Criteria:	WECC Reliability Criteria for Transmission System Planning
Remedial Actions Required:	The loss of two of the 345 kV lines simultaneously or one line initially out-of-service and loss of another line will initiate a trip of one Jim Bridger unit if the flow from the east on the three 345 kV lines into Midpoint exceeds 1050 MW. For the special contingency of the loss of the Kinport-Midpoint 345 kV line with one of the Borah-Adelaide-Midpoint 345 kV lines under high flow conditions, a trip of two Jim Bridger units may be required.

Formal Operating Procedure:	For PDCI south to north operation, a nomogram exists for flows on the PDCI, COI, Borah West and available load dropping in the Northwest. California ISO T-122 (West of Borah versus Path 15 nomogram).
Allocation:	The Borah West transfer path and capacity is owned by Idaho Power Company (IPC). IPC has long term agreements to provide transmission services on this path to PacifiCorp for up to 1600 MW.
Interaction w/Other Transfer Paths:	There is a known interaction for south to north transfers on PDCI and transfers on COI and Borah West. Also, there is a known interaction for south to north transfers on Path 15 and Borah West.
Contact Person:	Mark D. Hanson Idaho Power Company P. O. Box 70 Boise, ID 83707 (208) 388-2253 (208) 388-6647 - fax mhanson@idahopower.com

18. Idaho - Montana



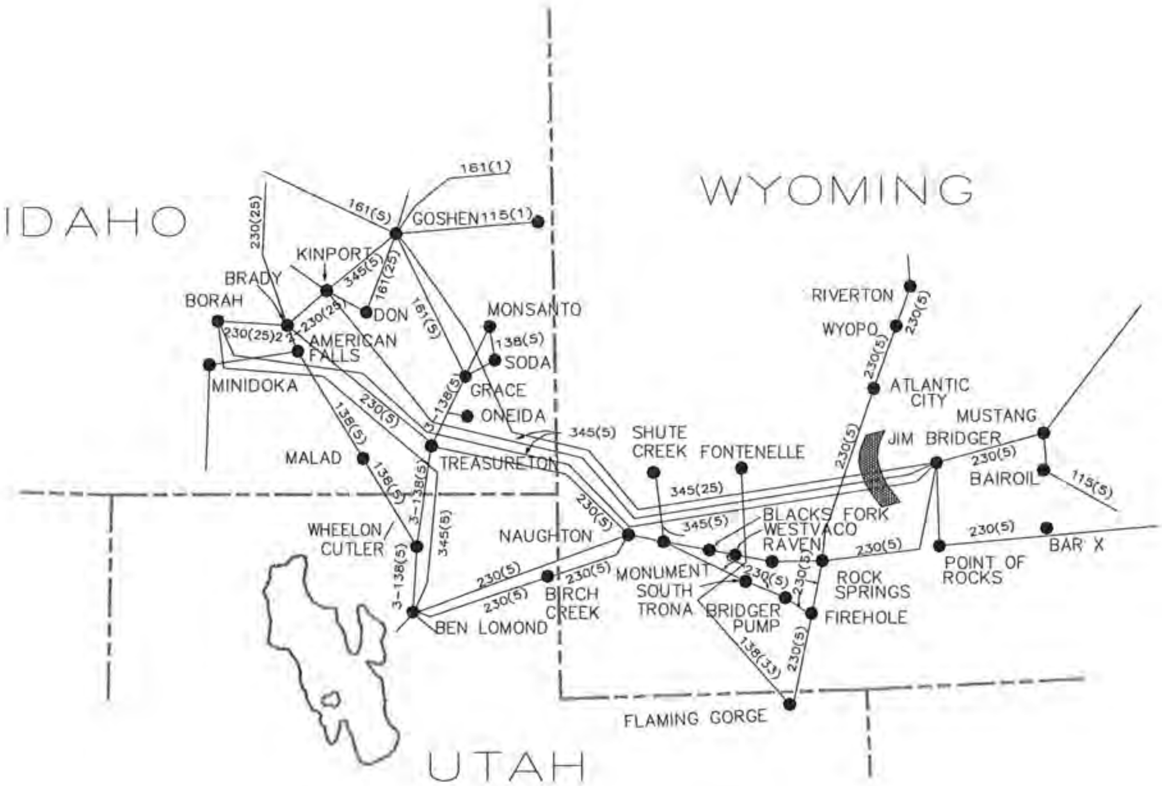
18. Idaho - Montana

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Eastern Idaho and Western Montana
Definition:	Sum of the flows on the following lines: Meter Location Big Grassy-Dillon Salmon 161 kV Big Grassy Peterson Flats-AMPS 230 kV Amps
Transfer Limit:	North to South: 337 MW South to North: 337 MW
Critical Disturbance that limits the transfer capability:	Outage of the Anaconda-Antelope 230 kV line. Outage of the Big Grassy-Dillon Salmon 161 kV Line. Outage of the Bridger-Goshen and Bridger-Kinport 345 kV lines with RAS tripping two Bridger units.
When:	The 230 kV capability of 250 MW and the 161 kV capability of 87 MW was established by AMPS participants (PacifiCorp, NorthWestern Energy, Idaho Power and Avista Corp.) in 1978.
System Conditions:	North to south flows achieved with high Montana hydro and thermal generation and low Idaho generation patterns.
Study Criteria:	Steady state voltage limit of .90 p.u. on the 161 kV busses at Dillon, Big Grassy, and Jefferson after the loss of the 230 kV line from Anaconda to Antelope.
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	Based upon Hot Springs to Brady: <table><tr><td></td><td></td><td><u>Ownership approx.</u> (varies year to year)</td><td></td><td><u>Allocation</u></td></tr><tr><td>230 kV</td><td></td><td>IPC</td><td>31.9%</td><td>31.9% (80 MW)</td></tr><tr><td></td><td></td><td>NWMT</td><td>31.9%</td><td>31.9% (80 MW)</td></tr><tr><td></td><td></td><td>PAC</td><td>36.2%</td><td>36.2% (90 MW)</td></tr><tr><td>161 kV</td><td>Goshen-Stateline</td><td>IPC</td><td>100.0%</td><td>100.0% (87 MW)</td></tr><tr><td></td><td>Stateline-Dillon</td><td>NWMT</td><td>100.0%</td><td>100.0% (87 MW)</td></tr></table>
Interaction w/Other Transfer Paths:	None

Contact Person:	Mark D. Hanson Idaho Power Company P. O. Box 70 Boise, ID 83707 (208) 388-2253 (208) 388-6647 - fax mhanson@idahopower.com Don Johnson PacifiCorp, 9951 S.E. Ankeny Street, 2nd Floor Portland, OR 97216-2315 (503) 251-5283 (503) 251-5228 - fax don.johnson@pacificorp.com	Charles A. Stigers Northwestern Energy 40 East Broadway Butte, MT 59701 (406) 497-4538 (406) 497-3393 - fax chuck.stigers@northwestern.com

19. Bridger West



Revised February 2002

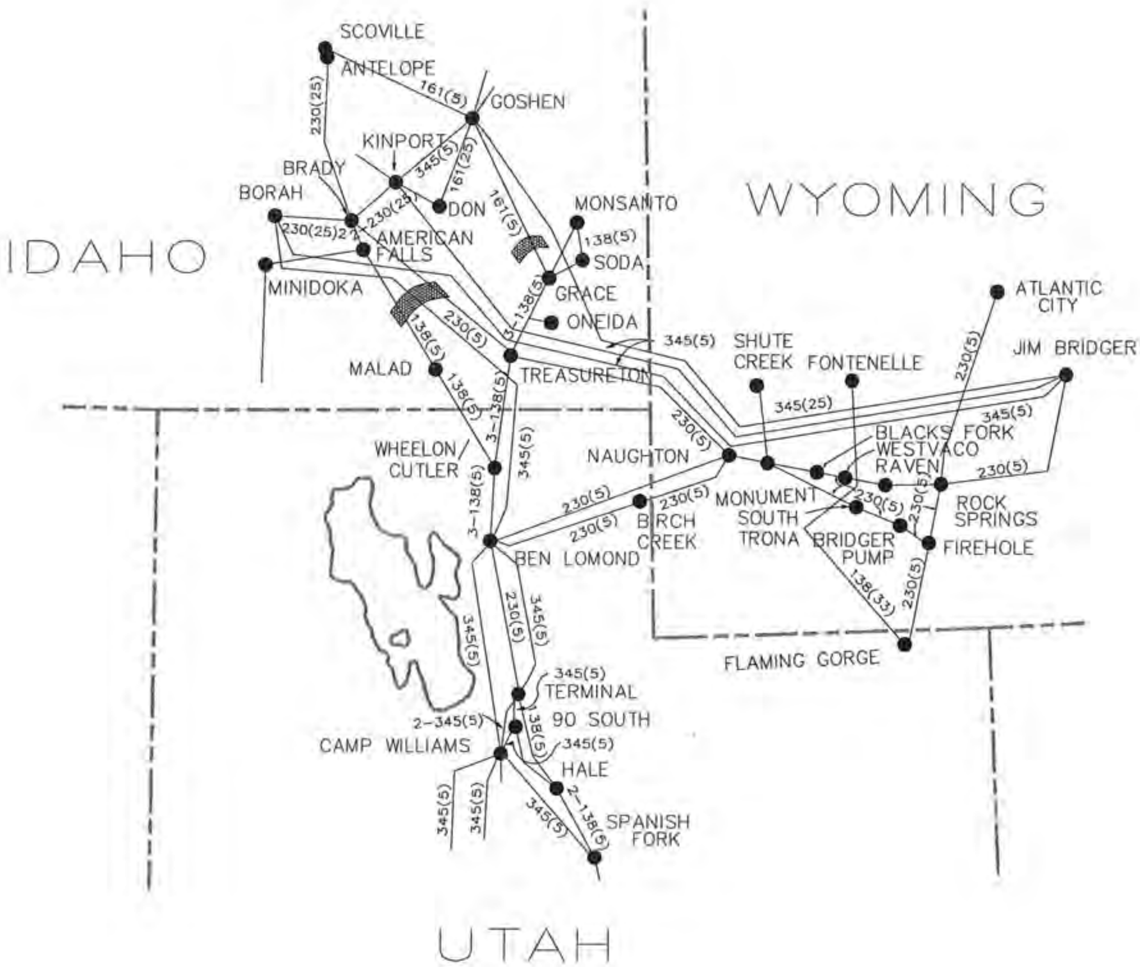
19. Bridger West

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Border between Southeast Idaho and Southwest Wyoming
Definition:	Sum of the flows on the following lines: Line — Metered End Jim Bridger-Borah 345 kV — Jim Bridger Jim Bridger-Goshen 345 kV — Jim Bridger Jim Bridger-Kinport 345 kV — Jim Bridger
Transfer Limit:	East to West: 2200 MW West to East: Not defined
Critical Disturbance that limits the transfer capability:	Transient voltage dips and post transient voltage stability are the limiting conditions for outages of the Jim Bridger system 345 kV lines. Generally, the most critical single line outage is the loss of the Jim Bridger-Borah 345 kV line.
When:	The 2200 MW rating was established in 1982 and reconfirmed in 1990 and 1992. The studies were conducted jointly by Idaho Power Company (IPC) and PacifiCorp. Since the transfer capability did not increase, the WECC "Notification Procedure for Changes in Facility Ratings and/or Operating Procedures" were not implemented.
System Conditions:	The Bridger West transfer rating was determined with simultaneous heavy transfers on series and parallel paths consistent with heavy transfers of eastern thermal resources to the west. The original transfer studies were performed with simultaneous flows on Montana-Northwest at 1800-1900 MW, TOT 4A at 600 MW, Path C (Utah North) at 700 MW, and high West of Borah and Idaho-Northwest flows (actual flow dependent on load conditions assumed in Idaho). Subsequently, transfer studies have been performed with simultaneous flows on Path C at 850 MW-950 MW depending on seasonal conditions.
Study Criteria:	**Initial Conditions:** • Per unit bus voltages within PacifiCorp and IPC systems between 0.95 p.u. and 1.05 p.u. • All line and transformer loadings maintained within allowable continuous ratings. • Synchronous condensers at Kinport, Goshen, and American Falls operating in the middle of their boost-buck range. The Jim Bridger 200 MVAR shunt capacitor bank in service. • The Treasureton 2 x 50 MVAR 138 kV shunt capacitor banks will be switched in service when the flows exceed either 1750 MW on Bridger West or 700 MW on Path C. **Transient:** WECC Reliability Criteria for Transmission System Planning. **Post Transient:** For single contingencies (N-1), a 250 MVAR reactive margin will be maintained from the point of voltage instability (nose of the QV curve) at the critical bus for an outage of the critical line with successful operation of remedial action scheme. For double contingencies (N-2), a 200 MVAR reactive margin will be maintained at the critical bus.

Remedial Actions Required:	A remedial action scheme is required to achieve the 2200 MW east to west rating. Multi-phase faults, SLG faults with delayed clearing, and multi-line outages on the Jim Bridger 345 kV lines require Jim Bridger unit(s) tripping. The addition of the Jim Bridger 200 MVAR 345 kV, Kinport 175 MVAR 345 kV, and Goshen 100 MVAR 161 kV shunt capacitor banks, along with the bypassing of Burns 500 kV series capacitor bank, has eliminated Jim Bridger unit tripping for SLG faults. The Jim Bridger shunt capacitor is normally on to reduce the reactive output of the Jim Bridger units so more reactive support can be provided during a disturbance. The Kinport and Goshen shunt capacitors are normally off and held in reserve to be switched at the time of a disturbance for additional reactive support.
Formal Operating Procedure:	Bridger West vs Path C South – North seasonal nomograms (Operating Procedure: PCC-005 Path C, South to North)
Allocation:	The transfer capability of the path is allocated as follows: 2200 MW East to West: Ownership Allocation 733 MW (1/3) IPC 707 MW (1/3 Max Jim Bridger Generation) 1467 MW (2/3) PacifiCorp 1493 MW (Remainder)
Interaction w/Other Transfer Paths:	The Bridger West Path has a nomogram identifying simultaneous operating constraints between this path and Path C in the south to north direction during light load conditions. The intersection exists for Bridger West flows in excess of 2100 MW.
Contact Person:	Mark D. Hanson Idaho Power Company P. O. Box 70 Boise, ID 83707 (208) 388-2253 (208) 388-6647 - fax mhanson@idahopower.com Don Johnson Pacificorp 9951 S.E. Ankeny Street, 2nd Floor Portland, OR 97216-2315 (503) 251-5283 (503) 251-5228 - fax don.johnson@pacificorp.com

20. Path C



IDAHO
WYOMING
UTAH
SCOVILLE
ANTELOPE
GOSHEN
KINPORT
BRADY
BORAH
DON
AMERICAN FALLS
MINIDOKA
MONSANTO
SODA
GRACE
ONEIDA
MALAD
TREASURETON
SHUTE CREEK
FONTENELLE
JIM BRIDGER
ATLANTIC CITY
WHEELON/ CUTLER
NAUGHTON
BLACKS FORK
WESTVACO
RAVEN
MONUMENT
SOUTH TRONA
BRIDGER PUMP
ROCK SPRINGS
FIREHOLE
BIRCH CREEK
BEN LOMOND
FLAMING GORGE
TERMINAL
90 SOUTH
CAMP WILLIAMS
HALE
SPANISH FORK
230(25)
161(5)
345(5)
161(25)
230(25)
138(5)
3-138(5)
230(5)
345(25)
138(33)
2-345(5)
2-138(5)

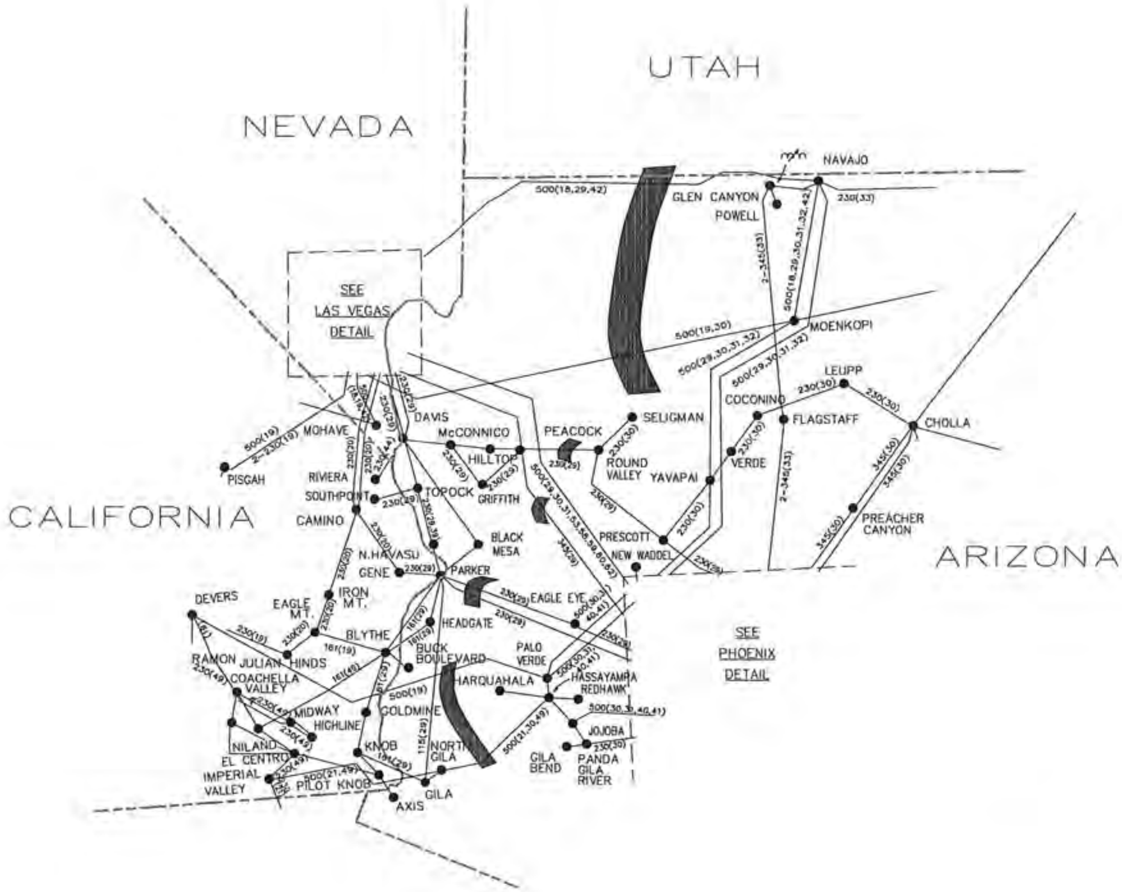
20. Path C

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Northern Utah/Southern Idaho
Definition:	Sum of the flows on the following transmission lines: Line Ben Lomond-Borah 345 kV Treasureton-Brady 230 kV Grace-Goshen 161 kV Malad-American Falls 138 kV
Transfer Limit:	North to South: 1000 MW (nominal) South to North: 1000 MW (nominal) Operating limits are based on OTC studies.
Critical Disturbance that limits the transfer capability:	The limiting outage in the south to north and north to south direction is loss of the Ben Lomond-Borah 345 kV line.
When:	Studies conducted by PacifiCorp in 1982 established the 1000 MW rating. The most current south to north studies were conducted in 1992. These studies developed the relationship between rating, ambient temperature, and load levels.
System Conditions:	The stated ratings are a function of load and generation in the northern Utah and southeastern Idaho area. As ratings are limited by thermal line ratings, they also depend on ambient temperatures.
Study Criteria:	• Steady state pre disturbance voltages between .95 p.u. and 1.05 p.u. • Post-disturbance voltages between .90 p.u. and 1.10 p.u. • Post-disturbance line loadings less than "emergency ratings." • First-swing transient voltage dips not to exceed .80 p.u.
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	PacifiCorp

Interaction w/Other Transfer Paths:	For north to south transfers, there is a nomogram relationship with the Rocksprings-Monument and Firehole-Monument 230 kV lines. For south to north transfers, there is a nomogram relationship with the Bridger West transmission path. Operating limits are based on OTC studies.
Contact Person:	Bill Hall PacifiCorp 1407 W. North Temple - Suite 275 Salt Lake City, UT 84140 (801) 220-4274 (801) 220-2842 - fax bill.hall@pacificorp.com

21. Arizona to California (Unscheduled Flow Qualified Path)



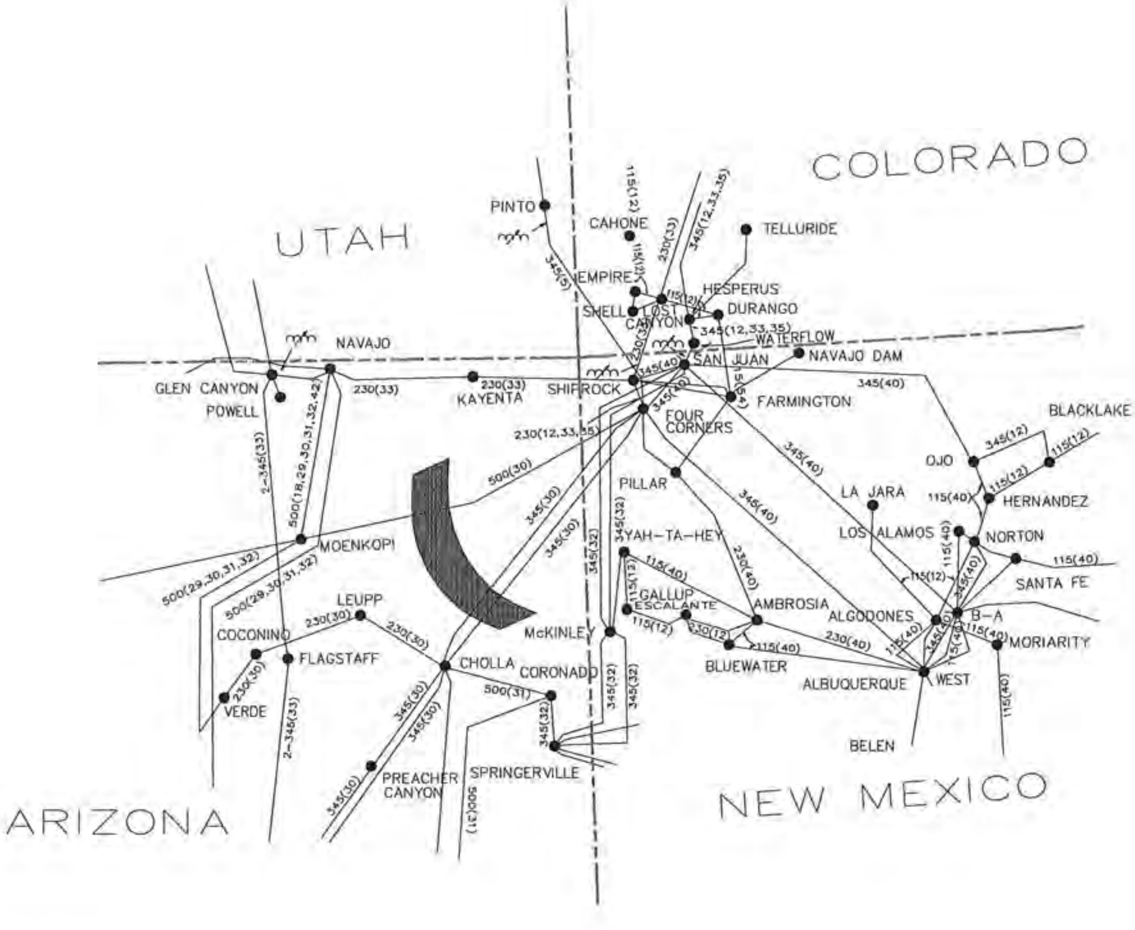
21. Arizona to California (Unscheduled Flow Qualified Path)

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Western Arizona
Definition:	A WECC unscheduled flow qualified path which is the sum of the flows on the following transmission lines: Line — Metered End Navajo-Crystal-McCullough 500 kV — Navajo Moenkopi-Eldorado 500 kV — Eldorado Liberty-Peacock-Mead — Liberty Palo Verde-Devers 500 kV — Palo Verde Hassayampa-North Gila 500 kV — Hassayampa Round Valley-Peacock 230 kV — Peacock Liberty-Parker #1 230 kV — Parker Liberty-Parker #2 230 kV — Parker
Transfer Limit:	East to West: 5700 MW (Non-simultaneous) West to East: Not rated The present east to west, non-simultaneous path rating is 5700 MW and assumes a "normal" operating system with all lines in service and full series compensation levels in the Navajo, Palo Verde and Liberty-Mead transmission systems. Path 21 was initially qualified in the late 1980's. Since the study determining the rating of 5700 MW was performed, system upgrades and a parallel 500 kV transmission line have been added. No re-rating studies have been performed since the unscheduled flow curtailment procedure was installed in 1994.
Critical Disturbance that limits the transfer capability:	The 5700 MW non-simultaneous limit is due to the continuous rating of the series capacitors at the Palo Verde end of the Palo Verde-Devers 500 kV line. The transfer capability is limited under normal (all-lines-in-service) conditions. However, various East of the Colorado River (EOR) line outages may result in 97-99% loading of emergency ratings on various EOR lines.
When:	The non-simultaneous transfer rating was established in 1987 by the Western Arizona Transmission Systems (WATS) Task Force. The Task Force was comprised of members from the following companies: Arizona Public Service Company El Paso Electric Company DOE-Western Area Power Administration Imperial Irrigation District Los Angeles Department of Water & Power Nevada Power Company Public Service Company of New Mexico Salt River Project San Diego Gas & Electric Company Southern California Edison Company Southern California Public Power Authority Tucson Electric Power Company

System Conditions:	Flows on the transfer path have historically been east to west due to the large amount of joint participation plants located in Arizona and New Mexico which are partly owned by southern California and Nevada entities.
Study Criteria:	WECC Reliability Criteria for Transmission System Planning
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	The 5700 MW transfer capability is divided among the following entities: Southern California Edison Company 2232 MW Los Angeles Department of Water & Power 1229 MW Western Area Power Administration 527 MW Nevada Power Company 353 MW San Diego Gas & Electric Company 914 MW Salt River Project 160 MW Imperial Irrigation District 153 MW Arizona Public Service Company 132 MW 5700 MW
Interaction w/Other Transfer Paths:	The simultaneous transfer limit into southern California is governed by the Southern California Import Transmission (SCIT) Nomogram and is a function of the EOR (Path 49) flow of which this path is a subset.
Contact Person:	Tom Isham Arizona Public Service Company P. O. Box 53999, Station 2260 Phoenix AZ 85072-3999 (602) 250-1499 (602) 250-1674 - fax tommy.isham@aps.com

22. Southwest of Four Corners (Unscheduled Flow Qualified Path)



22. Southwest of Four Corners (Unscheduled Flow Qualified Path)

Accepted Rating ☐
Existing Rating ☒
Other ☐

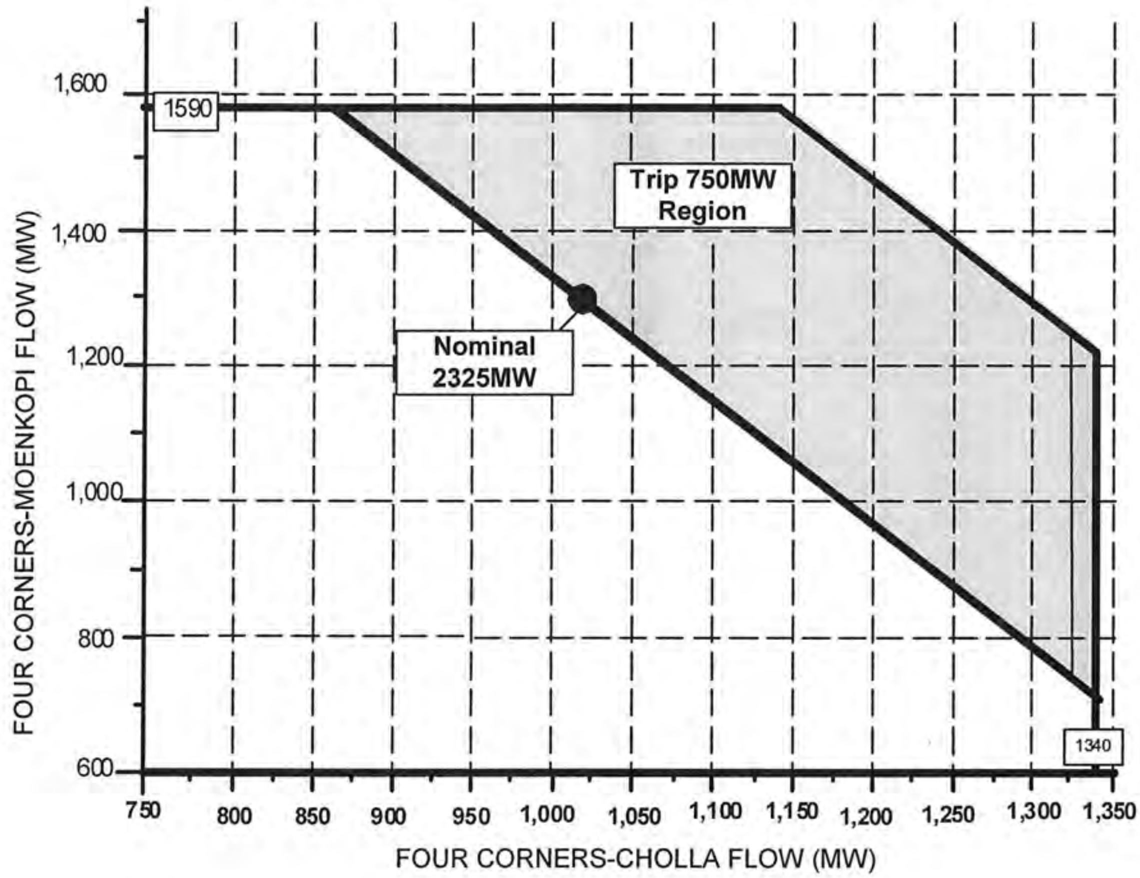
Location:	Northeastern Arizona
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Four Corners-Moenkopi 500 kV — Four Corners Four Corners-Cholla 345 kV #1 — Four Corners Four Corners-Cholla 345 kV #2 — Four Corners
Transfer Limit:	East-West: 2325 MW nominal West-East: Not rated The 2325 MW nominal operating limit is limited by the thermal rating of the Four Corners-Cholla 345 kV lines and voltage deviation at Pinnacle Peak following the critical disturbance. The actual rating is defined by the diagonal on the attached nomogram.
Critical Disturbance that limits the transfer capability:	The critical disturbance is loss of the Four Corners-Moenkopi 500 kV line.
When:	The transfer rating was established in the mid 1980's by the Four Corners Technical Studies Task Force. The task force is comprised of members from the following companies: Arizona Public Service Company El Paso Electric Company Public Service Company of New Mexico Salt River Project Southern California Edison Company Tucson Electric Power Company Verified by 2004 OTC studies.
System Conditions:	Flows on this transfer path have historically been east to west due to the large amount of generation located in northwestern New Mexico. This generation is partly owned by entities west of the Arizona - New Mexico border. The 2325 MW nominal limit was determined due to voltage deviation, and thermal constraints.
Study Criteria:	Same as WECC Reliability Criteria for Transmission System Planning.
Remedial Actions Required:	None
Formal Operating Procedure:	None

Allocation:	The transfer capability is divided among the following utilities: Arizona Public Service Company owns all rights on the Four Corners-Cholla 345 kV lines. Southern California Edison Company owns all the rights on the Four Corners-Moenkopi 500 kV line.
Interaction w/Other Transfer Paths:	None
Contact Person:	Tom Isham Arizona Public Service Company P. O. Box 53999, Station 2260 Phoenix AZ 85072-3999 (602) 250-1499 (602) 250-1674 - fax tommy.isham@aps.com

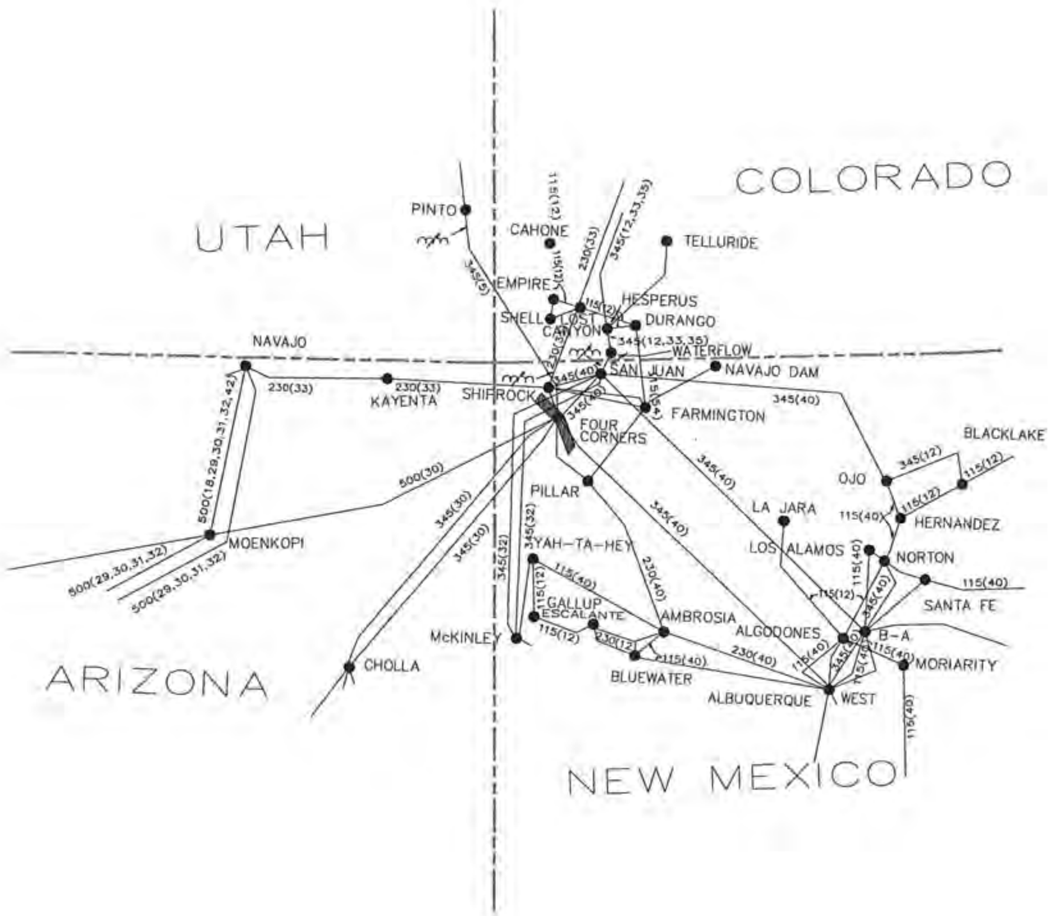
2004 PATH 22 OPERATING NOMOGRAM

FOUR CORNERS SYSTEM LIMITS

FOUR CORNERS-CHOLLA SERIES COMPENSATION - 25%
FOUR CORNERS-MOENKOPI SERIES COMPENSATION 0 - 24%



23. Four Corners 345/500 Qualified Path

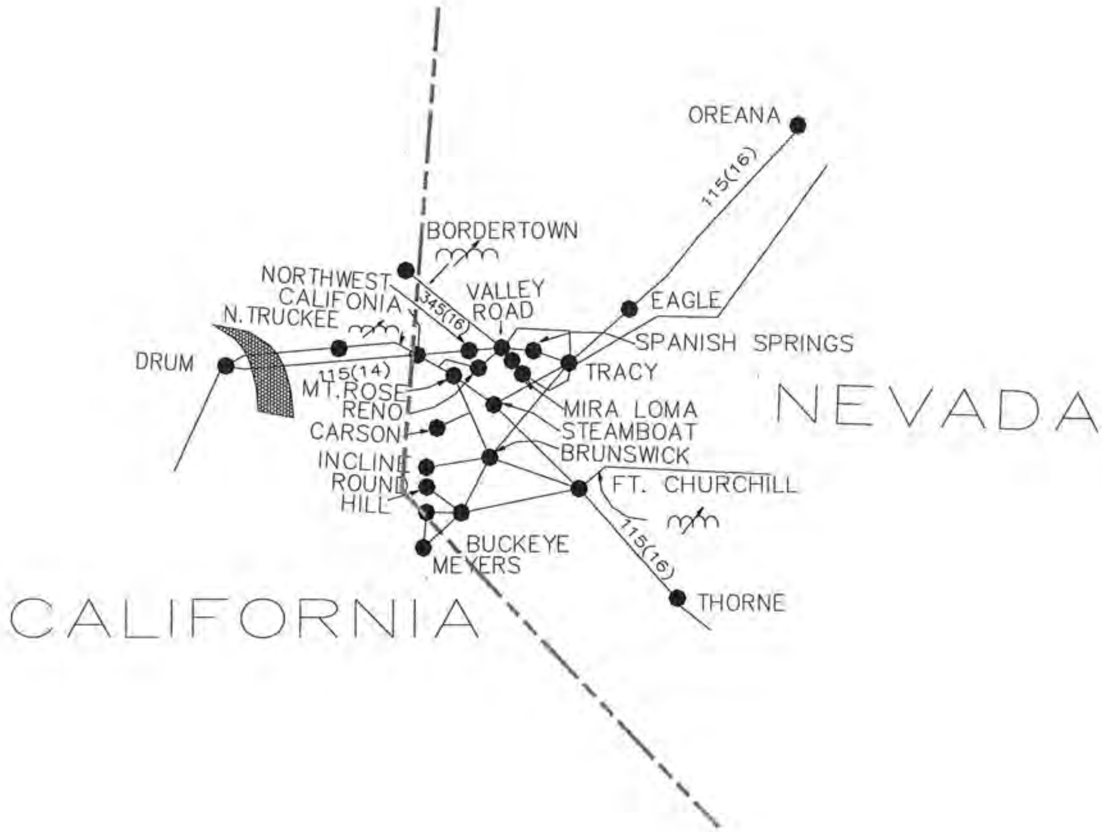


23. Four Corners 345/500 Qualified Path

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Northeastern Arizona
Definition:	Flow on 345/500 kV transformer
Transfer Limit:	345 to 500 kV: 840 MVA (top FOA) 500 to 345 kV: 840 MVA (top FOA)
Critical Disturbance that limits the transfer capability:	1) Loss of Four Corners #5 (750 MVA); or 2) with Four Corners #5 off line, base case loading may approach the continuous rating; or 3) with Four Corners #5 off line, any of several single contingencies, may exceed continuous rating.
When:	Certified as a qualified path in mid 1980s.
System Conditions:	Flows in this area are from east to west due to the large amount of generation in the area. The 345/500 kV transformer is in series with the 500 kV line and is the limiting element when Four Corners #5 is off line.
Study Criteria:	Base case loading not to exceed 100% of continuous rating. Single contingency load may not exceed 100% of continuous rating for more than 30 minutes.
Remedial Actions Required:	Schedules to be reduced when necessary.
Formal Operating Procedure:	None
Allocation:	Owners of the transformer are: Southern California Edison Company 48% Arizona Public Service Company 15% Public Service Company of New Mexico 13% Salt River Project 10% El Paso Electric Company 7% Tucson Electric Power Company 7% 100%
Interaction w/Other Transfer Paths:	None
Contact Person:	Tom Isham Arizona Public Service Company P. O. Box 53999, Station 2260 Phoenix AZ 85072-3999 (602) 250-1499 (602) 250-1674 - fax tommy.isham@aps.com

24. PG&E - Sierra



Revised February 2001

24. PG&E - Sierra

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Between Northern California and Nevada
Definition:	Drum-Summit (2-115 kV lines) Spaulding-Summit (1-60 kV line) Sum of the flows on the following transmission lines: Line — Metered Point Drum-Summit 1 115 kV — Summit 1 115 kV bus Drum-Summit 2 115 kV — Summit 2 115 kV bus Drum-Summit 60 kV — Summit 60 kV bus
Transfer Limit:	160 MW West to East 150 MW East to West Transfer limit may vary from 0-160 MW depending on generation and load in the Drum-Rio Oso-Goldhill area. East to west limit based on N. Tahoe loads and Cal Sub phase shifter.
Critical Disturbance that limits the transfer capability:	Loss of the Drum powerhouse Loss of Drum-Rio Oso #1 (115 kV) Loss of Drum-Summit 1&2 Goldhill-Placer #2 (115 kV) Halsey Jct-Newark #1 & #2 (between Drum and Placer)
When:	
System Conditions:	Heavy Summer Heavy Winter
Study Criteria:	All facilities loaded within normal ratings under normal system conditions. All facilities loaded within emergency ratings under outage conditions. Fully meets WECC Reliability Criteria in effect at time rating was established.
Remedial Actions Required:	Open Drum-Summit lines. For NE/SE separation, opening of the PG&E-Sierra tie lines is required. Open Drum-Atlantic 60 kV line at Weimer.
Formal Operating Procedure:	
Allocation:	Sierra, PG&E
Interaction w/Other Transfer Paths:	Affected by flow at California-Oregon border. The flow on the Midpoint-Humboldt line affects the scheduling capability of this path.

Contact Person:	Eric Law Pacific Gas & Electric Company P. O. Box 770000 - MC B15A San Francisco, CA 94177 (415) 973-7628 (415) 973-8804 - fax etl1@pge.com	Joe Tarantino Sierra Pacific Power Company P. O. Box 10100 Reno, NV 89520-0026 (775) 834-3348 (775) 834-3047 - fax jtarantino@sppc.com

25. PacifiCorp/PG&E 115 kV Interconnection

25. PacifiCorp/PG&E 115 kV Interconnection

Accepted Rating ☐
Existing Rating ☐
Other ☒

Location:	Southern Oregon/Northern California (Line 14)
Definition:	Sum of flow on Line 14, measured at Cascade.
Transfer Limit:	<u>Winter</u> <u>Summer</u> North to South: 100 MW * 80 MW South to North: 45 MW ** 45 MW ** The thermal rating of this 115 kV line is 100/149 MVA Summer/Winter (397.5 ACSR conductor). * Due to load growth in the area, there are periods when the winter transfer limit may be reduced below 100 MW, sometimes as low as 80 MW. ** The south to north non-simultaneous rating listed in the WECC Transfer Capability Diagram is 45 MW. This capability is rated under tie-line open south of phase shifter and is equivalent to the magnitude of PacifiCorp's local area load.
Critical Disturbance that limits the transfer capability:	
When:	Path rating was established on April 19, 1984 with the publishing of the WECC progress report, by project owners. The powerflow and stability studies deriving the path rating, above, were conducted by PacifiCorp and PG&E.
System Conditions:	This interconnection operates in parallel with the California-Oregon Intertie (COI). In order to direct flow of the 100 MW south on Line 14, a 75/100/125 MVA, 118 kV 0-60 degrees compensated phase shifter is installed at PacifiCorp's Weed Junction substation, Weed Junction, California. This phase-shifting transformer regulates the flow of power, preventing power scheduled over it from flowing on the COI.
Study Criteria	The following stability simulations were made: A. <u>Islanding Without the Line 14, 115 kV Tie</u> This simulation assumes 3200 MW on the COI as well as 4163 MW on the Arizona to southern California path and indicates that minimum standards for stable operation can be achieved, complying with WECC criteria. Stability plot of the Devers 500 kV bus shows oscillations of increasing amplitude through the first 7-8 seconds, with decreasing amplitude thereafter. The minimum transient swing voltage was at the Devers 230 kV bus with 81.7%. Use of the SDG&E's Damping Coefficient Method demonstrates a 7.6% damping on this bus. Frequencies drop to 58.84 Hz minimum in California causing some under-frequency load shedding.

Study Criteria (*continued*)	B. Islanding With the PAC-PG&E 115 kV Tie This simulation assumes the addition of 100 MW on the existing Line 14, 115 kV Tie. This increase indicates that the minimum transient swing voltage at Devers would drop from 81.7% to 79.5% or a 2.2% reduction.
Remedial Actions Required:	In addition to standard protection, a thermal relay is installed at Cascade and out-of-step indication is installed at Weed Junction. In the event of islanding, Line 14 is tied into the relaying and communication of the WECC "islanding" scheme. It is to be tripped approximately six cycles after the 3-line loss of the COI.
Formal Operating Procedure:	PacifiCorp is the operating agent and uses real-time flows to monitor this path.
Allocation:	The entire path transfer capability is owned by PacifiCorp.
Interaction w/Other Transfer Paths:	No interaction with other WECC paths. However, transfer capability could be limited at times due to local loads.
Contact Person:	Don Johnson PacifiCorp 9951 S.E. Ankeny Street, 2nd Floor Portland, OR 972216 - 2315 (503) 251-5283 (503) 251-5228 - fax don.johnson@pacificorp.com Eric Law Pacific Gas & Electric Mail Code B15A P. O. Box 770000 San Francisco, CA 94177 (415) 973-7628 (415) 973-8804 - fax etl1@pge.com

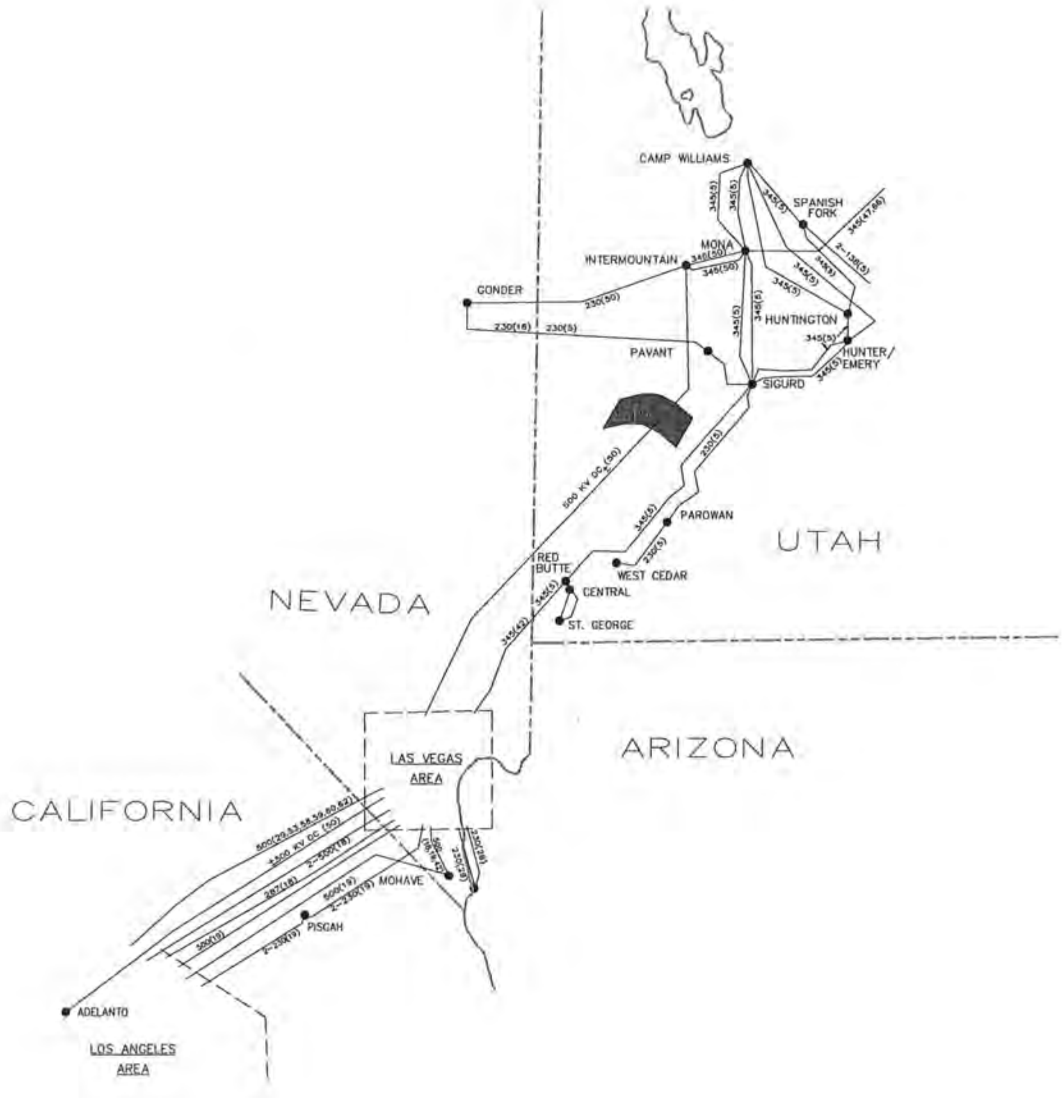
26. Northern - Southern California

26. Northern - Southern California

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Between PG&E and Southern California Edison (Midway-Vincent)
Definition:	Midway-Vincent (3-500 kV lines)
Transfer Limit:	North to South: 3400 MW (Accepted Rating) South to North: 3000 MW (Existing Rating) Transfer limits are affected by generation and load levels between Path 15 and Midway. North to south seasonal limits can vary from 900 to 3400 MW and south to north from 1400 to 2400 MW.
Critical Disturbance that limits the transfer capability:	Midway-Vincent #1 and #2 500 kV double-line outage can overload the Midway-Vincent #3 500 kV line and/or cause voltage criteria violation.
When:	North to south rating of 3400 MW was approved by WECC on July 17, 2003. A Path 26 RAS was operational on May 18, 2004 to support the north to south rating.
System Conditions:	North to south transfer was based on heavy summer and light spring conditions. South to north transfer was based on light winter conditions.
Study Criteria:	All facilities loaded within normal ratings under normal system conditions. All facilities loaded within emergency ratings under outage conditions. The system meets the post transient voltage criteria. Fully meets NERC/WECC Planning Standards.
Remedial Actions Required:	Based on the nomogram curve designed for north to south flow between 3000 and 3400 MW, a Path 26 RAS would trip Midway area generation for loss of any two of the Midway-Vincent #1, #2, and #3 500 kV lines.
Formal Operating Procedure:	California ISO T-103, T-118A, T-120 and T-122.
Allocation:	PG&E, SCE, SDG&E, CDWR
Interaction w/Other Transfer Paths:	South to north flows on Path 26 are typically limited by Path 15 capability. North to south flows on Path 26, during peak load and heavy transfer conditions, may be limited by the Southern California Import Transmission (SCIT) nomogram. (See entry to "Formal Operating Procedure" above.) Under light load and heavy transfer conditions in Northern California, the north to south flows may be limited by Midway area reactive margin.
Contact Person:	Kang Ling Ching Pacific Gas & Electric 77 Beale St. B15A San Francisco, CA 94105 (415) 973-7637 (415) 973-8804 - fax kxc5@pge.com Patricia L. Arons Southern California Edison P. O. Box 800 2131 Walnut Grove Avenue Rosemead, CA 91770 (626) 302-9644 (626) 302-9647 - fax patricia.arons@sce.com

27. Intermountain Power Project DC Line



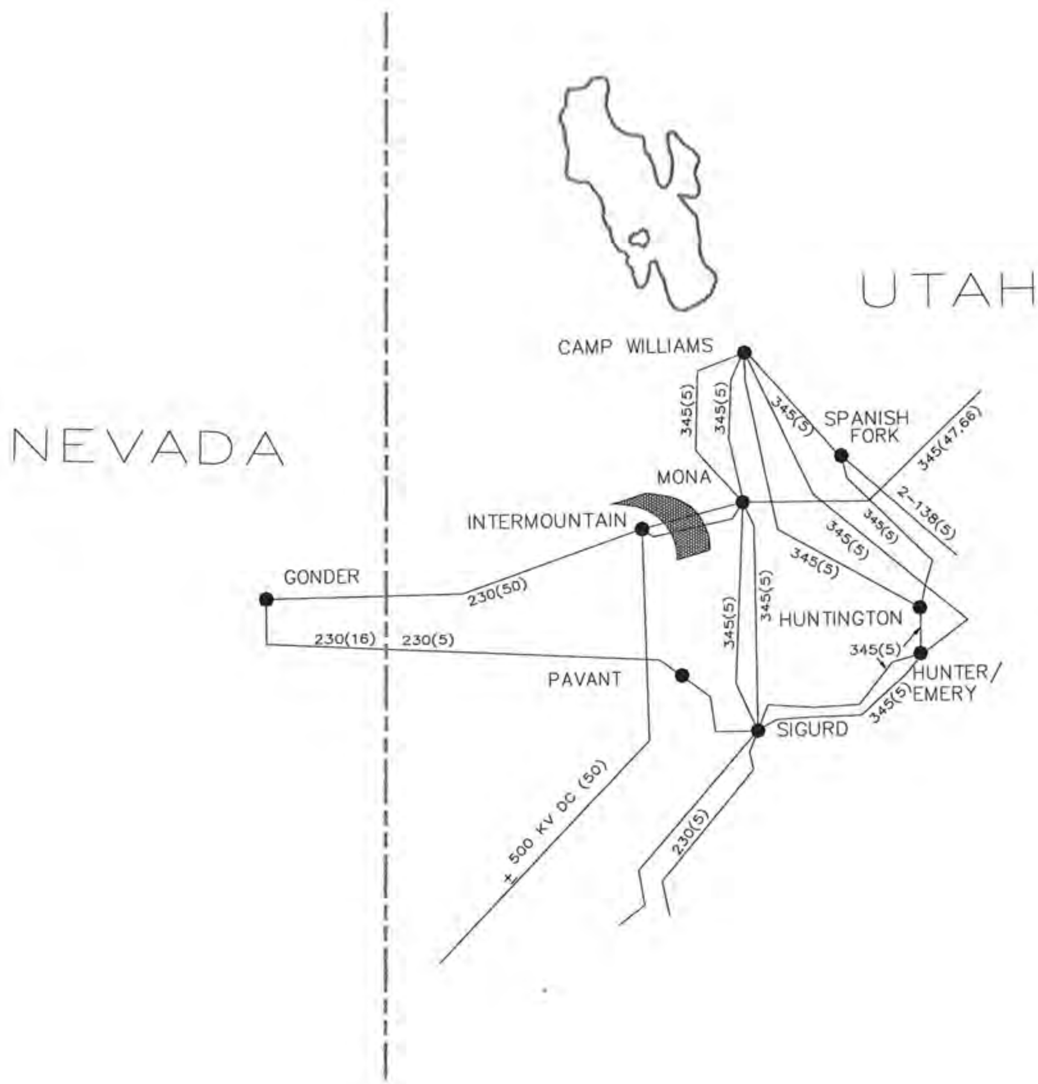
27. Intermountain Power Project DC Line

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Line from Intermountain station in central Utah to Adelanto station in southern California (IPPDC)
Definition:	The IPPDC line is a ∀500 kV DC bipole system. Power flow on the DC line is measured at the Intermountain end.
Transfer Limit:	Intermountain to Adelanto (NE-SW): 1920 MW Adelanto to Intermountain (SW-NE): 1400 MW
Critical Disturbance that limits the transfer capability:	Loss of the IPPDC bipole line.
When:	The NE-SW rating was established in May 1987 with the publication of the "Intermountain Power Project WECC Progress Report No. 9." The SW-NE rating established in conjunction with the DOE Form IE-411 reporting in 1989. The NE-SW rating was established by the Los Angeles Department of Water and Power (LADWP), operating agent of the IPPDC. The SW-NE rating was established jointly by LADWP and PacifiCorp-Utah Power.
System Conditions:	IPPDC line NE-SW rating, when established, was dependent on the power flows on the NE/SE and the PACI paths. IPPDC line was most sensitive to the Pinto-Four Corners 345 kV and the Sigurd-Glen Canyon 230 kV line flows. Flows on the Sigurd-Red Butte-Harry Allen 345 kV line, which was built subsequent to the IPPDC line, has similar impact as the other two lines. The NE-SW rating studies assumed established maximum non-simultaneous flow capability of the NE/SE lines. IPPDC line SW-NE rating is dependent on the AC ties to the Utah system. The Intermountain-Mona 345 kV line transfer limitation is 1400 MW line thermal rating based on N-1 contingency, i.e., one of the Intermountain-Mona 345 kV lines being out.
Study Criteria:	(Summary) System intact: • Pre-disturbance voltage between 0.98 p.u. and 1.05 p.u. in Utah Single contingency outage conditions: • Transient voltage swing minimum of 0.85 p.u. in Utah • Post-disturbance voltage minimum of 0.95 p.u. in Utah Double contingency outage conditions: • Transient voltage swing minimum of 0.80 p.u. in Utah • Post-disturbance voltage minimum of 0.90 p.u. in Utah

Remedial Actions Required:	The Intermountain Power Project (IPP) Contingency Arming System (CAS) has been implemented to mitigate IPPDC disturbances by tripping one or two IPP generating units. The IPP CAS has been in operation since 1986. The design and operations of this RAS has been reported to WECC on April 1986 with a report entitled "Intermountain Power Project Contingency Arming System: One Unit Operation" and on August 1992, with a report entitled "Intermountain Power Project Contingency Arming System: Non-Credibility of Remedial Action Scheme Failure."
Formal Operating Procedure:	The IPP CAS consists of arming charts where real-time power output of the IPP generating units and the IPPDC line flows are used to select the no-unit, one-unit or two-unit arming of remedial actions. The IPP CAS and associated operating procedures are included with the LADWP's Energy Control Center Energy Management System (ECC-EMS) computers.
Allocation:	LADWP 59.5% Anaheim 17.7% Riverside 10.2% Pasadena 5.9% Burbank 4.5% Glendale 2.3%
Interaction w/Other Transfer Paths:	Originally, there were simultaneous transfers for the IPPDC vs. PACI which were developed under Pacific and Southwest Transfer (PAST) studies. The need for IPPDC/PACI nomogram operation was determined to be unnecessary in 1991.
Contact Person:	Ly Le Los Angeles Department of Water and Power P. O. Box 111, Room 1246 111 North Hope Street Los Angeles, CA 90051 (213) 367-0302 (213) 367-3829 - fax ly.le@ladwp.com

28. Intermountain - Mona 345 kV



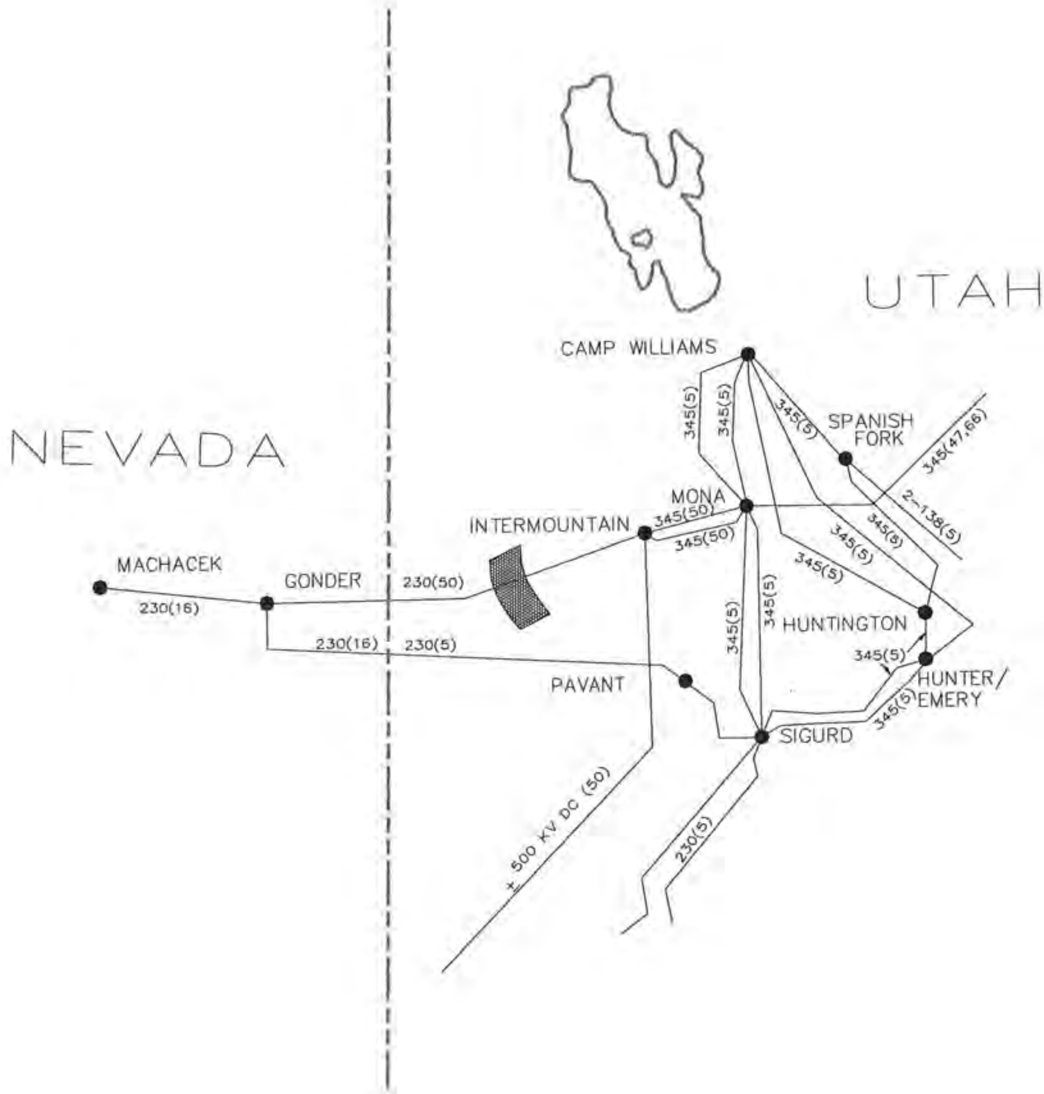
28. Intermountain - Mona 345 kV

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Transmission line from Intermountain Power Facility (IPF) at Delta, Utah to Mona station in central Utah
Definition:	Two 50-mile 345 kV transmission lines from the 345 kV IPF station to the 345 kV Mona station. The IPF 345 kV station is in the Los Angeles Department of Water and Power (LADWP) control area, while the Mona 345 kV station is in the PacifiCorp control area.
Transfer Limit:	East to West: 1200 MW West to East: 1400 MW
Critical Disturbance that limits transfer capability:	N-1 load flow studies
When:	These ratings were established in 1987, when the IPF was first put into service. These ratings have been documented in the WECC Operations Committee's Non-Simultaneous Transfer Capability Diagram as well as in the NERC Form OE-411, Item 5A reportings.
System Conditions:	East to West: Sum of a) 200 MW: Intermountain-Gonder line non-simultaneous capability, and b) 1000 MW: IPPDC capability with the two IPF units at minimum generation output (1920 - (2*460 MW)). This is N-1 rating since each line's thermal capability is above 1400 MW. West to East: Based on N-1 load flow with two IPF generating units on line. The thermal capability of the IPF-Mona 345 kV lines is above 1400 MW.
Study Criteria:	WECC Reliability Criteria for System Design. (The applicable WECC reliability criteria at that time.)
Remedial Actions Required:	A back-up protection to the IPF unit tripping RAS (the IPP Contingency Arming System) trips the IPF-Mona 345 kV line for failure of the IPF RAS. The relay protection, which is based on power surge measurement on the lines, trips the lines if the power surge exceeds a pre-selected power level. The power surge on these lines is expected to exceed the relay tripping level only when there are IPF bipole outages or two unit IPF tripping, and failure of the IPF RAS.
Formal Operating Procedure:	There are automatic and operating procedures to fast-reclose the Mona lines whenever the lines are tripped due to the power-surge relay protection or other causes.
Allocation:	The following utilities have entitlements on these lines: LADWP, Anaheim, Riverside, Pasadena, Burbank, Glendale, and PacifiCorp.
Interaction w/Other Transfer Paths:	

Contact Person:	Ly Le Los Angeles Department of Water and Power P. O. Box 111, Room 1246 111 North Hope Street Los Angeles, CA 90051 (213) 367-0302 (213) 367-3829 - fax ly.le@ladwp.com Gil Coulam PacifiCorp 1407 West North Temple Suite 110 Salt Lake City, UT 84140 (801) 220-2954 (801) 220-2842 - fax gilbert.coulam@pacificorp.com

29. Intermountain - Gonder 230 kV



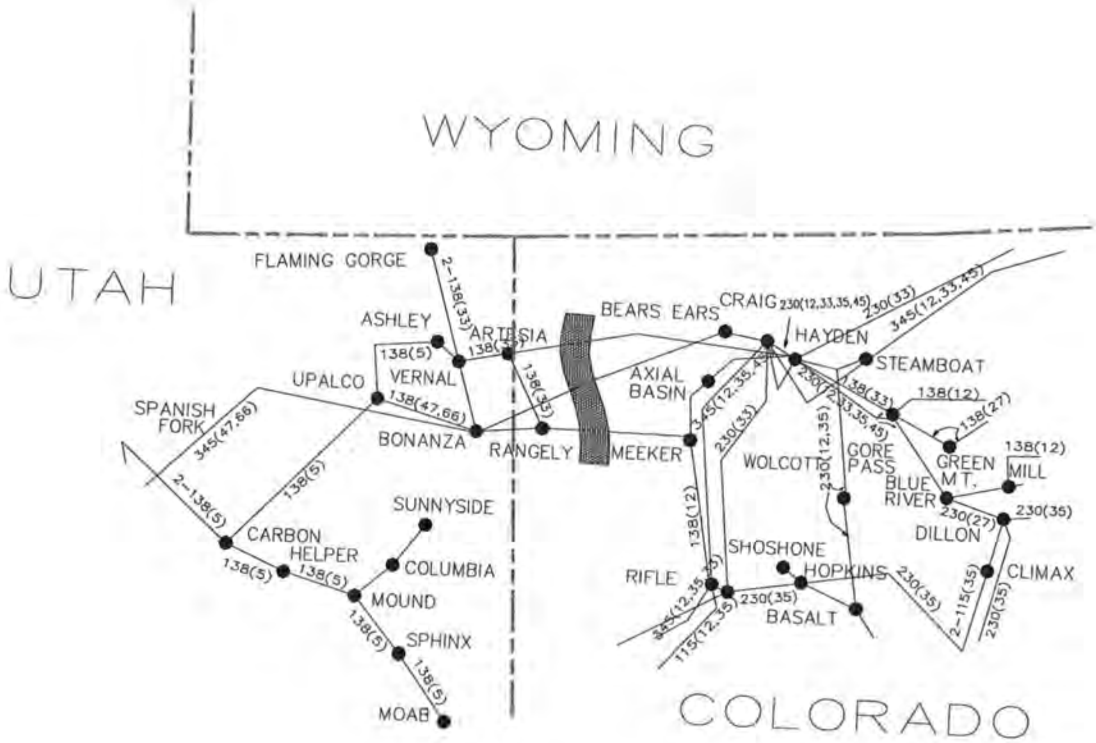
29. Intermountain - Gonder 230 kV

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Transmission line from Intermountain Power Facility (IPF) at Delta, Utah to Gonder station in eastern central Nevada
Definition:	A 144-mile 230 kV transmission line from the 230 kV IPF station to the Mt. Wheeler Power Cooperative's Gonder 230 kV station. The IPF 230 kV station is connected to the IPF 345 kV station through a 300 MVA regulating transformer. The IPF 345 and 230 kV stations are in the Los Angeles Department of Water and Power (LADWP) control area, while the Gonder 230 kV station is in the Sierra Pacific Power Company's control area.
Transfer Limit:	East to West: 200 MW (non-simultaneous) Studies to determine the simultaneous rating of this line with the Pavant-Gonder 230 kV line are presently on-going.
Critical Disturbance that limits the transfer capability:	The non-simultaneous rating is based on the rule-of-thumb criterion of 30 degree power angle difference between the sending and the receiving end, and on N-0 load flow studies.
When:	The 200 MW bidirectional non-simultaneous rating was established in 1987, when the IPF was first put into service. This rating has been documented in the WECC Operations Committee's Non-Simultaneous Transfer Capability Diagram as well as in the NERC Form OE-411, Item 5A reportings.
System Conditions:	The non-simultaneous rating is based on the rule-of-thumb criterion of 30 degree power angle difference between the sending and the receiving end, and on N-0 load flow studies.
Study Criteria:	WECC Reliability Criteria for System Design. (The applicable WECC reliability criteria at that time.)
Remedial Actions Required:	For disturbances where both of the IPF-Mona 345 kV lines are tripped, a transfer trip protection trips the IPF-Gonder 230 kV line.
Formal Operating Procedure:	There is an established energization/synchronization procedure for the line to control overvoltage conditions on the line. The IPF 230/345 kV regulating transformer (ULTC) is under the LADWP SCADA system.
Allocation:	The following utilities have entitlements on this line: LADWP, Anaheim, Riverside, Pasadena, Burbank and Glendale.
Interaction w/Other Transfer Paths:	At the maximum flow conditions, the transfer capability of the line is sensitive to the flows on the Pavant-Gonder 230 kV line. Simultaneous flow capability of these two lines at the Gonder station cut-plane is presently under going a study.

Contact Person:	John (Gang-Kung) Hu Los Angeles Department of Water and Power P. O. Box 111, Room 1246 111 North Hope Street Los Angeles, CA 90051 (213) 367-0506 (213) 367-0457 - fax gang-kung.hu@ladwp.com

30. TOT 1A


WYOMING
UTAH
COLORADO
FLAMING GORGE
2-138(33)
ASHLEY
138(5)
VERNAL
ARTESIA
138(33)
UPALCO
138(47,66)
SPANISH FORK
345(47,66)
BONANZA
RANGELY
138(5)
2-138(5)
CARBON
HELPER
138(5)
138(5)
MOUND
SUNNYSIDE
COLUMBIA
SPHINX
138(5)
138(5)
MOAB
BEARS EARS
CRAIG
230(12,33,35,45)
230(33)
345(12,33,45)
HAYDEN
STEAMBOAT
AXIAL BASIN
MEEKER
345(12,35,45)
230(33)
138(33)
230(12,33,35,45)
138(12)
138(27)
WOLCOTT
GORE PASS
230(12,35)
GREEN MT.
138(12)
MILL
BLUE RIVER
230(27)
230(35)
DILLON
138(12)
SHOSHONE
HOPKINS
230(35)
CLIMAX
RIFLE
230(35)
BASALT
345(12,35,45)
115(12,35)
2-115(35)
230(35)

30. TOT 1A

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Extreme Northwest Colorado
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Bears Ears-Bonanza 345 kV — Bears Ears Hayden-Artesia 138 kV — Hayden Meeker-Rangely 138 kV — Rangely
Transfer Limit:	East to West: 650 MW (maximum) West to East: Not defined Depending on local generation levels and the flows on underlying 115 kV and 138 kV facilities, the real-time rating can range between a minimum of 230 MW and a maximum of 650 MW (see attachment). Typically, the real-time rating centers around 550 MW.
Critical Disturbance that limits the transfer capability:	Outage of the Bears Ears-Bonanza 345 kV line. The limiting element can be the emergency overload on the Upalco-Carbon 138 kV line, the Flaming Gorge 230/138 kV transformer, the Hayden-Artesia 138 kV line, or the Meeker-Rangely 138 kV line (see attachment).
When:	Rating established in March 1990 with the publication of "Bears Ears-Bonanza 345 kV Line Operating Study Report." The operating study was conducted jointly by: Western Area Power Administration - Salt Lake, Golden, Montrose Tri-State Generation & Transmission Association, Inc. (TSGT) Utah Associated Municipal Power System Platte River Power Authority Deseret Generation and Transmission Co-operative Salt River Project Utah Power & Light Co. (now PacifiCorp) Colorado-Ute Electric Association (now TSGT and Public Service Company of Colorado)
System Conditions:	This rating is independent of transfer levels between major areas of WECC, although the actual flow is heavily impacted by east to west inadvertent. The transfer limit is impacted by local area generation and load levels. Historically, the flows have all been east to west across the path.

Study Criteria:	(Summary) System intact: • Per unit voltages between 0.95 p.u. and 1.05 p.u. • All lines and transformers loaded to less than continuous rating. Single contingency outage conditions: • Per unit voltages between 0.90 p.u. and 1.10 p.u. • All lines loaded to less than 15-minute emergency ratings. • All transformers loaded to less than 30-minute emergency ratings. • Transient voltage swings down to 0.7 p.u. permitted, except PacifiCorp which is limited to 0.85 p.u. and DG&T Rangely bus which is limited to 0.75 p.u.
Remedial Actions Required:	Remedial action schemes are required to achieve the rated transfer capability. Following an outage, all overloaded lines and transformers must have their loadings reduced to continuous ratings within 15 minutes. This is accomplished by reducing schedules or lowering local generation. Unit trip schemes are implemented for Bonanza and Flaming Gorge generation for outages of the Bonanza-Mona 345 kV line. Remedial action schemes are required to achieve the rated transfer capability.
Formal Operating Procedure:	There is a formal operating procedure dated July 26, 1990. WAPA-Montrose is the operating agent and uses real-time flows to monitor the path.
Allocation:	The transfer capability of the path is divided between WAPA, PRPA, TSGT and UAMPS.
Interaction w/Other Transfer Paths:	None
Contact Person:	Brent Vossler Western Area Power Administration Rocky Mountain Region P. O. Box 3700 Loveland, CO 80539-3003 (970) 461-7482 (970) 461-7213 - fax avossler@wapa.gov

TRANSFER CAPABILITY ALGEBRAIC EXPRESSIONS

TOT 1A transfer (schedule) limit is equal to

The lesser of

1 - TOT 1A limit based on Upalco-Carbon limit due to Bonanza-Mona outage

TOT 1A = UPC>CBNlf + 5.4(145 - UPC>CBNlf) + .886(BNZg) + .52(FGg) + NET INTERCHANGE + VNL>FGlf

2 - TOT 1A limit based on Flaming Gorge 138/230 Transformer limit due to Bonanza-Mona outage

TOT 1A = UPC>CBNlf + 4.5(200 - FGxf) + 1.13(BNZg) + 2.74(FGg) + NET INTERCHANGE + VNL>FGlf

3 - TOT 1A limit based on Hayden-Artesia or Meeker-Rangely limit due to a Bears Ears-Bonanza outage

Hayden-Artesia

TOT 1A = MKR>SWRlf + HDN>ARTlf + 7.0(140 - HDN>ARTlf)

Meeker-Rangely

TOT 1A = MKR>SWRlf + HDN>ARTlf + 4.9(160 - MRK>SWRlf)

Where

BNZg	= Droppable Bonanza generation
FGg	= Droppable Flaming Gorge generation
MRK>SWRlf	= Meeker-Southwest Rangely line flow
HDN>ARTlf	= Hayden-Artesia line flow
VNL>FGlf	= Vernal-Flaming Gorge 1 & 2 line flows
UPC>CBNlf	= Upalco-Carbon line flow
FGxf	= Flaming Gorge 138/230 1 & 2 transformer flows
140	= Hayden-Artesia emergency rating
160	= Meeker-Rangely emergency rating
250	= Flaming Gorge transformers emergency rating
145	= Upalco-Carbon emergency rating

31. TOT 2A


UTAH
COLORADO
ARIZONA
NEW MEXICO
MORROW POINT
BLUE MESA
CRYSTAL
MONTROSE
CURECANTI
NUCLA
PINTO
CAHONE
TELLURIDE
EMPIRE
HESPERUS
SHELL
LOST CANYON
DURANGO
WATERFLOW
SAN JUAN
NAVAJO DAM
SHIPROCK
FARMINGTON
FOUR CORNERS
PILLAR
115(12)
345(12,33,35)
230(33)
115(33)
345(12,33,35)
345(5)
345(40)
345(32)
115(54)

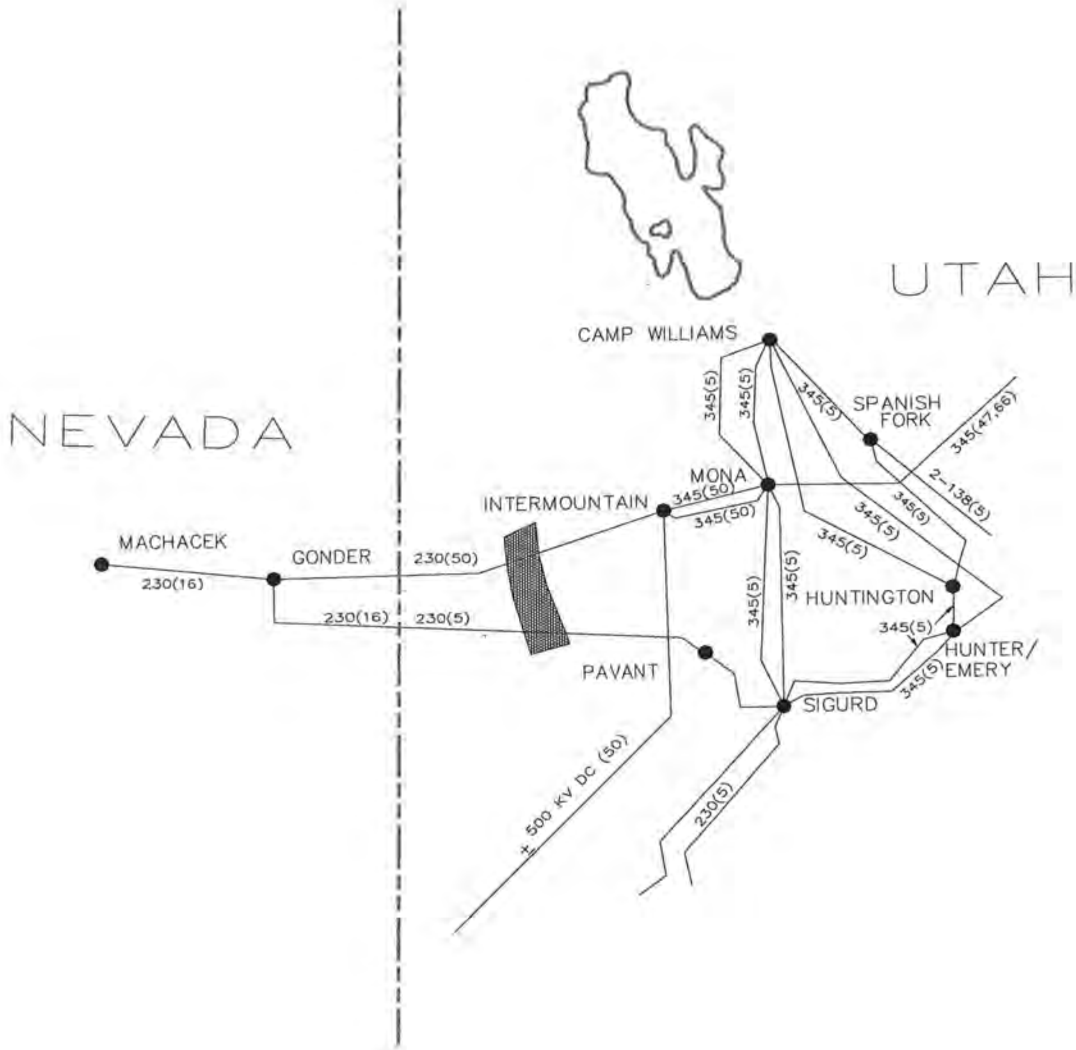
31. TOT 2A

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Extreme Southwest Colorado
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Hesperus-San Juan 345 kV — San Juan Durango-Glade Tap 115 kV — Glade Tap Lost Canyon-Shiprock 230 kV — Shiprock
Transfer Limit:	North to South: 690 MW minus net load in the Montrose-Curecanti-San Juan-Shiprock area of southwest Colorado. The load itself ranges 110-220 MW, and internal thermal generation can be 100 MW and hydro generation can be 15 MW. However, the maximum rating is 690 MW. South to North: Not defined Depending on local load and generation levels, the real-time rating ranges between a maximum of 690 MW and a minimum of 550 MW. Typically, the real-time rating centers around 650 MW.
Critical Disturbance that limits the transfer capability:	The critical disturbance is the outage of the 345 kV system between Montrose and San Juan. The limiting elements are low voltages or emergency overloads on the local 115 kV system, or emergency overloads on local 230/115 kV or 345/115 kV transformers. The specific outage and limiting element depend on load levels and generation patterns.
When:	The rating was established jointly by Colorado-Ute Electric Association (CUEA) and Western Area Power Administration (WAPA)-Montrose, in 1989.
System Conditions:	This rating is independent of transfer levels between major areas of WECC although the actual flow is heavily impacted by inadvertent. The transfer limit is impacted by local area generation and load levels. Historically, the flows have been predominately north to south across the path, although flows south to north have been recently experienced.
Study Criteria:	(Summary) System intact: • Per unit voltages between 0.95 p.u. and 1.05 p.u. • All lines and transformers loaded to less than continuous rating. Single contingency outage conditions: • Per unit voltages between 0.90 p.u. and 1.10 p.u. • All lines loaded to less than 15-minute emergency ratings. • All transformers loaded to less than 30-minute emergency ratings. • Transient voltage swings down to 0.7 p.u. permitted.

Remedial Actions Required:	Remedial action schemes are required to achieve the rated transfer capability. Following an outage, all overloaded lines and transformers must have their loadings reduced to continuous ratings within 15 minutes. This is accomplished by reducing schedules, lowering local generation or manually tripping a lower voltage parallel path. For the Montrose-Hesperus 345 kV line outage with generation at Nucla above 60 MW, the parallel Montrose-Nucla 115 kV line can be automatically transfer tripped. This automatic transfer trip scheme is normally enabled. If it is disabled, then real-time transfer capability limits are calculated using local load and local generation as input variables.
Formal Operating Procedure:	There is a formal operating procedure, in the form of a letter agreement between CUEA and WAPA, dated June 1, 1989. WAPA-Montrose is the operating agent and uses real-time flows to monitor the path.
Allocation:	The transfer capability of the path is divided between WAPA, Public Service Company of Colorado and Tri-State G&T.
Interaction w/Other Transfer Paths:	None
Contact Person:	Brent Vossler Western Area Power Administration Rocky Mountain Region P. O. Box 3700 Loveland, CO 80539-3003 (970) 461-7482 (970) 461-7213 - fax avossler@wapa.gov

32. Pavant - Gonder 230 kV
Intermountain - Gonder 230 kV

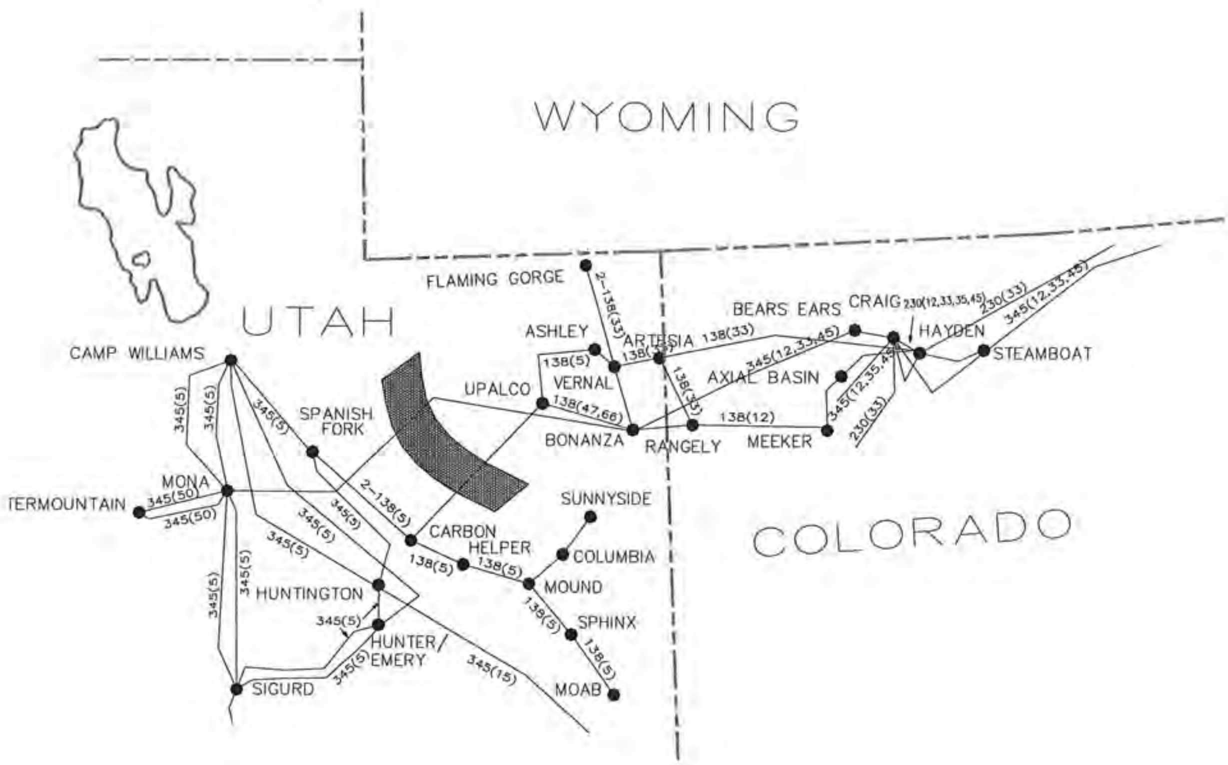


32. Pavant - Gonder 230 kV
Intermountain - Gonder 230 kV

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Central Eastern Nevada/Central Western Utah
Definition:	Sum of the flows on the following transmission lines: Line — Metered Point Gonder-Pavant 230 kV — NV-UT stateline Gonder-Intermountain 230 kV — Gonder
Transfer Limit:	East to West: 440 MW West to East: 235 MW
Critical Disturbance that limits the transfer capability:	East to West: Pavant 230 kV bus voltage for loss of the IPP-Gonder 230 kV line. West to East: Falcon 345/230 XFMR thermal overload for loss of the Valmy-Coyote Crk 345 kV line. Also, Ft. Churchill 230/120 kV XFMR thermal overload for loss of the Falcon-Gonder 345 kV line.
When:	A comprehensive progress report was accepted on August 27, 1999. A Phase II report was approved by the PCC chairman on 12/19/00.
System Conditions:	East to west transfers were studied on light winter and heavy summer conditions. West to east transfers were studied on heavy summer conditions.
Study Criteria:	Both WECC and Sierra Pacific reliability criteria were used in the comprehensive progress report and the Phase II report.
Remedial Actions Required:	None.
Formal Operating Procedure:	
Allocation:	Mt. Wheeler is allocated 40 MW during the summer and 22 MW during the winter on the Gonder-Pavant 230 kV line.
Interaction w/Other Transfer Paths:	None.
Contact Person:	Joe Tarantino Sierra Pacific Power Company P. O. Box 10100 Reno, NV 89520-0026 (775) 834-3348 (775) 834-3047 - fax jtarantino@sppc.com

33. Bonanza West



33. Bonanza West

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Northeast Utah to Central Utah
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Bonanza-Mona 345 kV — Mona Upalco-Carbon 138 kV — Carbon
Transfer Limit:	East to West: 785 MW West to East: Not defined Depending on local generation levels and the flows on underlying 138 kV facilities, the real-time rating can vary up to 785 MW. Typically the real-time rating is about 735 MW.
Critical Disturbance that limits the transfer capability:	Bonanza-Mona 345 kV outage. Based on modeled system conditions, outage results in post-transient overload on Upalco-Carbon 138 kV.
When:	December 1990. The rating was established with the publication of the "Bears Ears-Bonanza 345 kV Line Operating Study Report," March 1990, and with the upgrading of current transformers at Mona. The operating study was conducted jointly by the following entities: Western Area Power Administration - Salt Lake City, Golden, Montrose Tri-State Generation & Transmission Association, Inc. Utah Associated Municipal Power Systems Deseret Generation & Transmission Co-operative Platte River Power Authority Salt River Project PacifiCorp Colorado-Ute Electric Association
System Conditions:	The rating is independent of transfer levels between major areas of WECC, although the actual flow is heavily impacted by inadvertent flows. The transfer limit is impacted by local area generation and load levels. Historically, flows have been east to west across the path.
Study Criteria:	• Steady-state pre-disturbance voltages between 0.95 p.u. and 1.05 p.u. • All lines and transformers loaded to less than continuous rating. • Post-disturbance voltages between 0.90 p.u. and 1.10 p.u. • All lines loaded to less than 15-minute emergency ratings. • All transformers loaded to less than 110% of maximum continuous ratings. • Transient voltage swings down to 0.70 p.u. permitted, except for Utah Power facilities which were limited to 0.80 p.u. and Deseret G&T's Rangely bus which is limited to 0.75 p.u.

Remedial Actions Required:	Unit tripping schemes are implemented for Bonanza Unit 1 and for Flaming Gorge generation, as required, for an outage of the Bonanza-Mona 345 kV line in order to achieve the rated transfer capability.
Formal Operating Procedure:	None, although the operating procedures for TOT1A are based, in part, on the line loadings and implementation of the remedial action schemes for Bonanza West path. Western Area Power Administration and the control area operator, PacifiCorp East, monitor real-time power flows on the Bonanza West path.
Allocation:	The transfer capability of the path is divided among the following entities: Utah Associated Municipal Power Systems Utah Municipal Power Agency Deseret Generation & Transmission Co-operative PacifiCorp
Interaction w/Other Transfer Paths:	None, however, implementation of remedial action schemes and Bonanza West loading affect scheduling limits on TOT1A.
Contact Person:	Curt Winterfeld Deseret Generation & Transmission Co-opative 10714 South Jordan Gateway, Suite 300 South Jordan, Utah 84095 (801) 619-6511 (801) 619-6599 - fax ckwinter@desgt.com

34.

SEE PATHS 78 AND 79

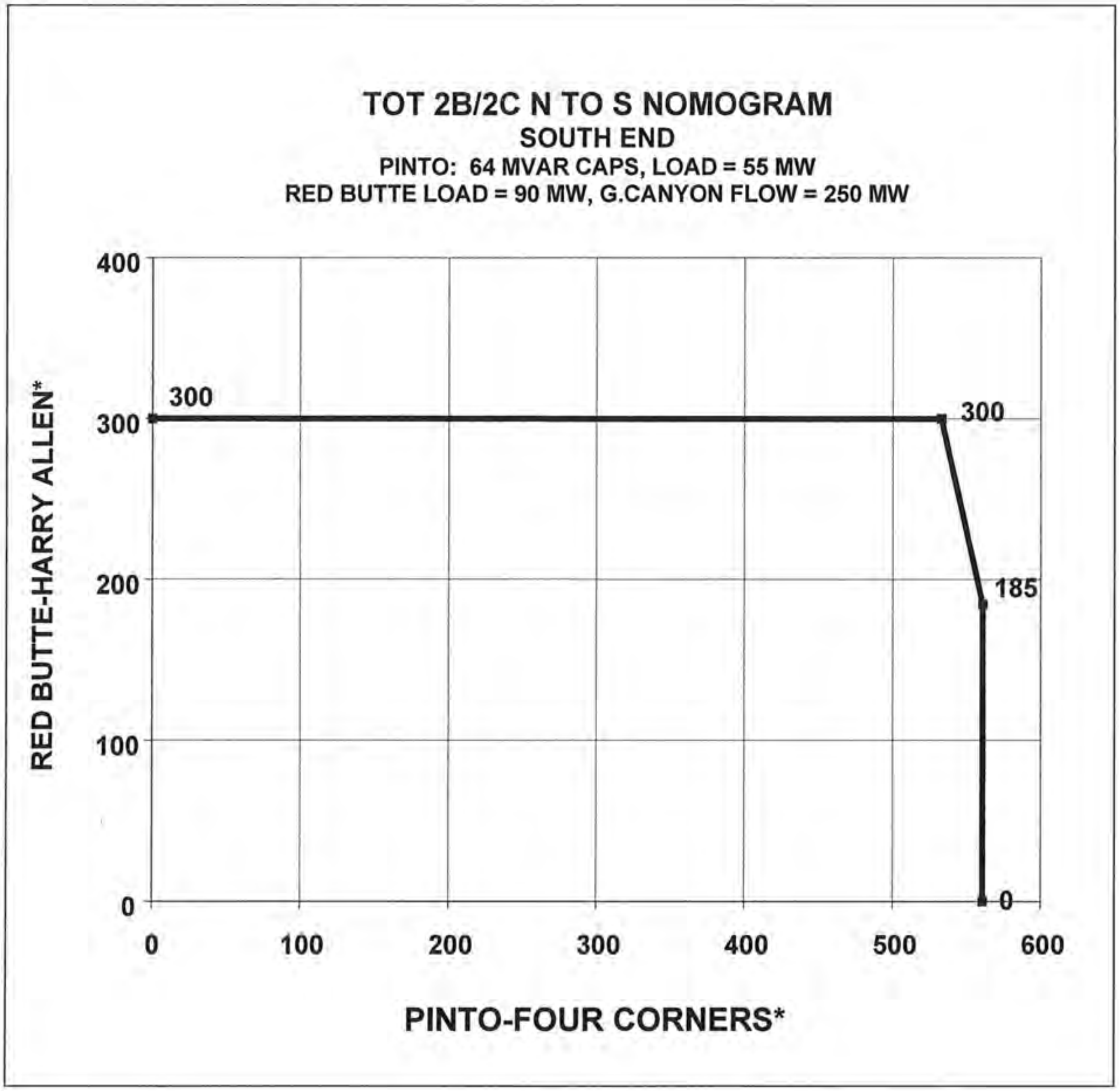
35. TOT 2C

Revised February 2003

35. TOT 2C

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southwestern Utah to South-East Nevada
Definition:	Red Butte-Harry Allen 345 kV Line
Transfer Limit:	North to South: 300 MW South to North: 300 MW
Critical Disturbance that limits the transfer capability:	Non-simultaneous: Limited by pre-disturbance voltages in the Red Butte area and/or Harry Allen 345/230 transformer normal thermal rating. Simultaneous: Sigurd-Red Butte-Harry Allen 345 line outage, Huntington-Pinto-Four Corners 345 line outage.
When:	These ratings were established prior to January 1994.
System Conditions:	Non-simultaneous capability is a function of Red Butte load and/or Harry Allen 345/230 kV transformer thermal rating. Moderate flow levels on parallel lines.
Study Criteria:	WECC Reliability Criteria for System Design PacifiCorp Internal Reliability Criteria Nevada Power Internal Reliability Criteria
Remedial Actions Required:	None
Formal Operating Procedure:	TOT 2B/2C Nomogram (see attachment) TOT2 OTC limits
Allocation:	PacifiCorp/Nevada Power
Interaction w/Other Transfer Paths:	TOT 2A, TOT 2B1, TOT 2B2, IPPDC, PDCI, COI
Contact Person:	Gil Coulam PacifiCorp 1407 W. North Temple - Suite 210 Salt Lake City, UT 84140 (801) 220-2954 (801) 220-2842 - fax gilbert.coulam@pacificorp.com Hamilton Avery Nevada Power Company MS#57 6226 West Sahara Avenue Las Vegas, Nevada 89151 (702) 862-7174 (702) 862-7113 - fax HAvery@nevp.com

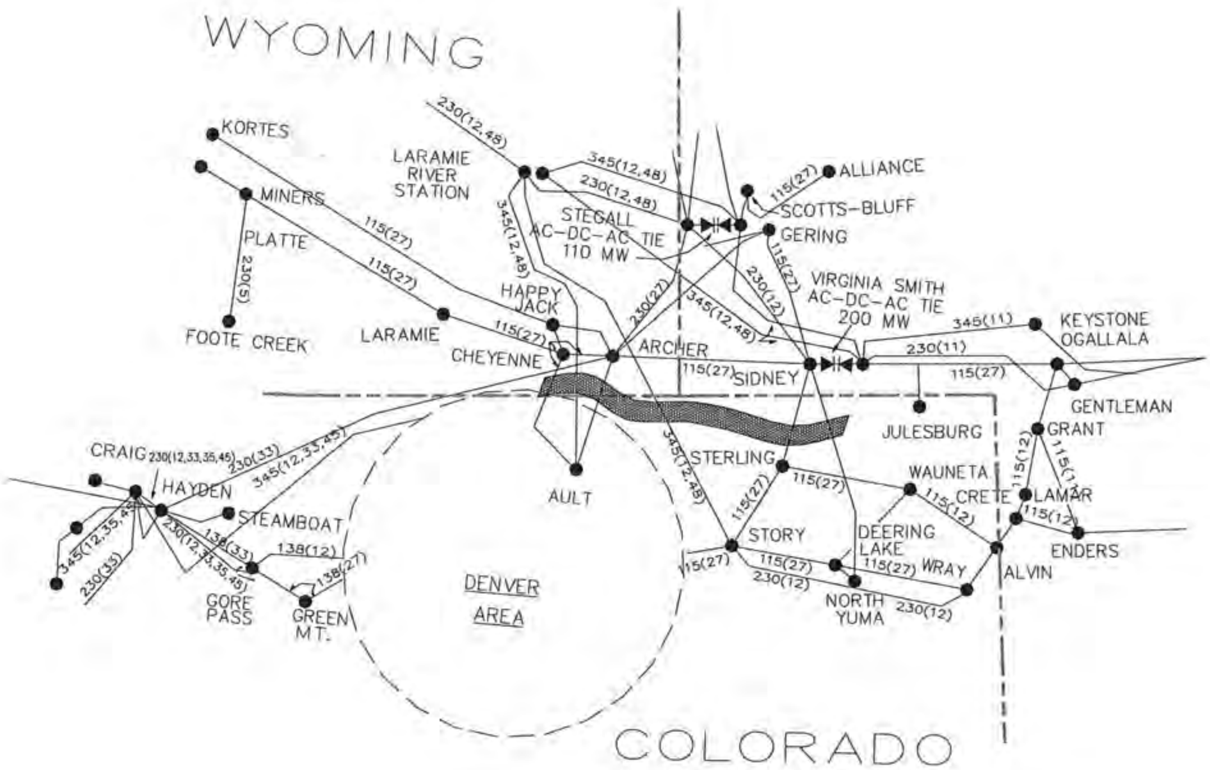


TOT 2B:	Pinto-Four Corners* 345
	Sigurd-Gcanyon* 230
TOT 2C:	Red Butte-Harry Allen* 345

*metered end

Note: This is a representative nomogram.
Red Butte load varies from 60 to 210 MW, affecting TOT 2C capability.

36. TOT 3


WYOMING
COLORADO
KORTES
MINERS
PLATTE
FOOTE CREEK
LARAMIE
LARAMIE RIVER STATION
HAPPY JACK
CHEYENNE
ARCHER
STEGALL AC-DC-AC TIE 110 MW
ALLIANCE
SCOTTS-BLUFF
GERING
VIRGINIA SMITH AC-DC-AC TIE 200 MW
SIDNEY
KEYSTONE
OGALLALA
GENTLEMAN
JULESBURG
GRANT
STERLING
WAUNETA
CRETE
LAMAR
ENDERS
STORY
DEERING LAKE
WRAY
ALVIN
NORTH YUMA
AULT
DENVER AREA
CRAIG
HAYDEN
STEAMBOAT
GORE PASS
GREEN MT.
230(12,48)
345(12,48)
115(27)
230(5)
230(27)
230(12)
345(11)
230(11)
115(12)
138(12)
138(27)
138(33)
230(33)
345(12,33,45)
230(12,33,35,45)
345(12,35,45)

36. TOT 3

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Border between Northeast Colorado and Southeast Wyoming
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Archer-Ault 230 kV — Archer Laramie River-Ault 345 kV — Laramie River Laramie River-Story 345 kV — Laramie River Cheyenne-Ault 115 kV — Cheyenne Sidney-Sterling 115 kV — Sidney Sidney-N. Yuma 230 kV — Sidney
Transfer Limit:	North to South: 1605 MW (Maximum) South to North: Not defined Depending on local generation levels, DC tie levels and direction, the real-time rating can range between a maximum of 1605 W and a minimum of 843 MW. Typically, the real-time rating is calculated dynamically and updated every minute based on Table 1B.
Critical Disturbance that limits the transfer capability:	The critical disturbances and limiting elements vary with the various scenarios. Reference Table 1B for further information.
When:	Rating was first established in 1981. The current rating was established in July 1999 with publication of the "Comprehensive Progress Report for the Revised Rating of the TOT 3 Transfer Path." The study was conducted by Western and the revised rating was jointly proposed by: Western Area Power Administration (WAPA) - Loveland Tri-State Generation & Transmission Association, Inc. (TSGT) Public Service Company of Colorado (PSC) Basin Electric Power Cooperative (BEPC)
System Conditions:	This rating is independent of transfer levels between major areas of WECC. The transfer limit is impacted by local area generation and the direction and magnitude of DC tie flows. Historically, the flows have all been north to south across the path. Under certain operating conditions when TOT 3 is loaded to its limit, the TOT 5 capability cannot be used since additional schedule on TOT 5 will overload TOT 3.

Study Criteria:	(Summary) System intact: • Per unit voltages between 0.95 p.u. and 1.05 p.u. • All lines and transformers loaded to less than continuous rating. Single contingency outage conditions: • Per unit voltages between 0.90 p.u. and 1.10 p.u. • All lines loaded to less than 15-minute emergency ratings. • All transformers loaded to less than 30-minute emergency ratings. • Transient voltage swings down to 0.7 p.u. permitted.
Remedial Actions Required:	Remedial actions are required to achieve the rated transfer capability. Following an outage, all overloaded lines and transformers must have their loadings reduced to continuous ratings within 15 minutes. This is accomplished by reducing schedules and adjusting generation.
Formal Operating Procedure:	There is a formal operating procedure dated November 1999. WAPA-Loveland is the operating agent and uses real-time flows to monitor the path.
Allocation:	The transfer capability of the path is divided between WAPA, Missouri Basin Power Project (MBPP), Public Service Company of Colorado (PSC), and Tri-State Generation & Transmission (TSGT). TSGT and BEPC are members of MBPP.
Interaction w/Other Transfer Paths:	None
Contact Person:	Brent Vossler Western Area Power Administration Rocky Mountain Region P. O. Box 3700 Loveland, CO 80539-3003 (970) 461-7482 (970) 461-7213 - fax avossler@wapa.gov

TABLE 1B
TOT3 PRIOR SYSTEM INTACT LIMITS
2001-2002 Heavy Winter
CPP: 68 MW

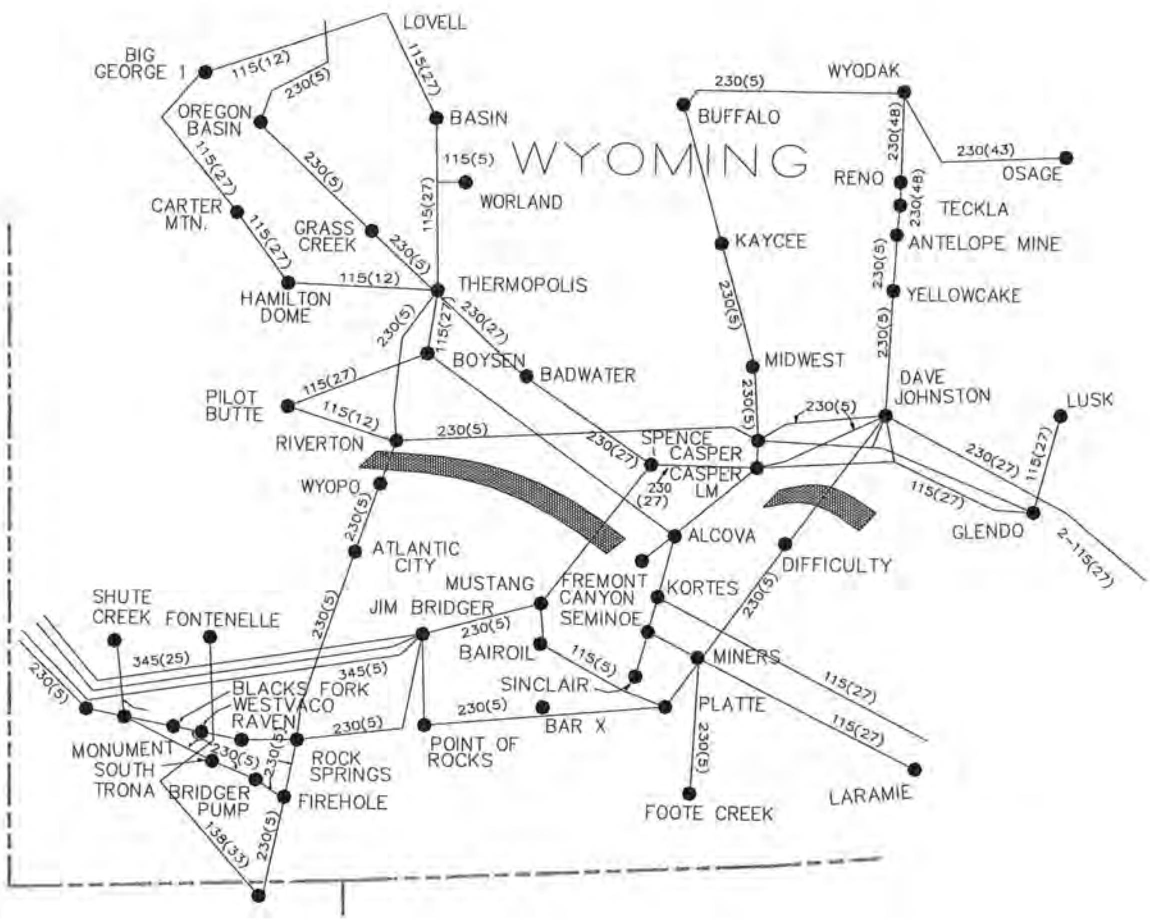
System Intact
DC TIES

Gen Level	300 MW East to West	0 MW	300 MW West to East
LRS 1100 MW (Net) Pawnee 805 MW (Net)	**TOT3 = 1505 MW** (Outage LRS-Story 345-kV loaded LRS-Ault 345-kV to 100% of 956 MVA normal rating)	**TOT3 = 1321 MW** (Laramie bus at 0.90 p.u. for outage of LRS-Ault 345-kV line)	**TOT3 = 1245 MW** (Laramie bus at 0.90 p.u. for outage of LRS-Ault 345-kV line)
LRS 550 MW (Net) Pawnee 805 MW (Net)	**TOT3 = 1256 MW** (Laramie bus at 0.90 p.u. for outage of LRS-Ault 345-kV line)	**TOT3 = 1058 MW** (Laramie bus at 0.90 p.u. for outage of LRS-Ault 345-kV line)	**TOT3 = 901 MW** (Outage Stegall-DaveJohn 230-kV loaded DaveJohn-Lar.Rivr 230-kV to 100% of 442 MVA normal rating)
LRS 1100 MW (Net) Pawnee 300 MW (Net)	**TOT3 = 1605 MW** (Outage LRS-Story 345-kV loaded LRS-Ault 345-kV to 100% of 956 MVA normal rating)	**TOT3 = 1391 MW** (Laramie bus at 0.90 p.u. for outage of LRS-Ault 345-kV line)	**TOT3 = 1304 MW** (Outage LRS-Story 345-kV loaded Sidney-Stegall 230-kV to 100% of 319 MVA normal rating)
LRS 550 MW (Net) Pawnee 300 MW (Net)	**TOT3 = 1316 MW** (Outage Sidney-N.Yuma 230-kV loaded Sidney-Peetz 115-kV line to 100% of 109 MVA rating)	**TOT3 = 1134 MW** (May 115-kV voltage at .90 pu for outage LRS-DaveJohn 230-kV line)	**TOT3 = 927 MW** (Outage Stegall-DaveJohn 230-kV loaded DaveJohn-Lar.Rivr 230-kV to 104% of 442 MVA normal rating)

Case Summary Report
avossler@wapa.gov

WECC "Accepted Rating" is <= 1605 MW

37. TOT 4A


WYOMING
LOVELL
BIG GEORGE 1
OREGON BASIN
BASIN
WORLAND
CARTER MTN.
GRASS CREEK
HAMILTON DOME
THERMOPOLIS
BOYSEN
BADWATER
PILOT BUTTE
RIVERTON
WYOPO
ATLANTIC CITY
SHUTE CREEK
FONTENELLE
JIM BRIDGER
MUSTANG
FREMONT CANYON
SEMINOE
BAIROIL
SINCLAIR
BLACKS FORK
WESTVACO
RAVEN
MONUMENT
SOUTH TRONA
BRIDGER PUMP
ROCK SPRINGS
FIREHOLE
POINT OF ROCKS
BAR X
BUFFALO
WYODAK
RENO
OSAGE
TECKLA
ANTELOPE MINE
KAYCEE
YELLOWCAKE
MIDWEST
DAVE JOHNSTON
LUSK
SPENCE
CASPER
CASPER LM
ALCOVA
KORTES
DIFFICULTY
GLENDO
MINERS
PLATTE
FOOTE CREEK
LARAMIE

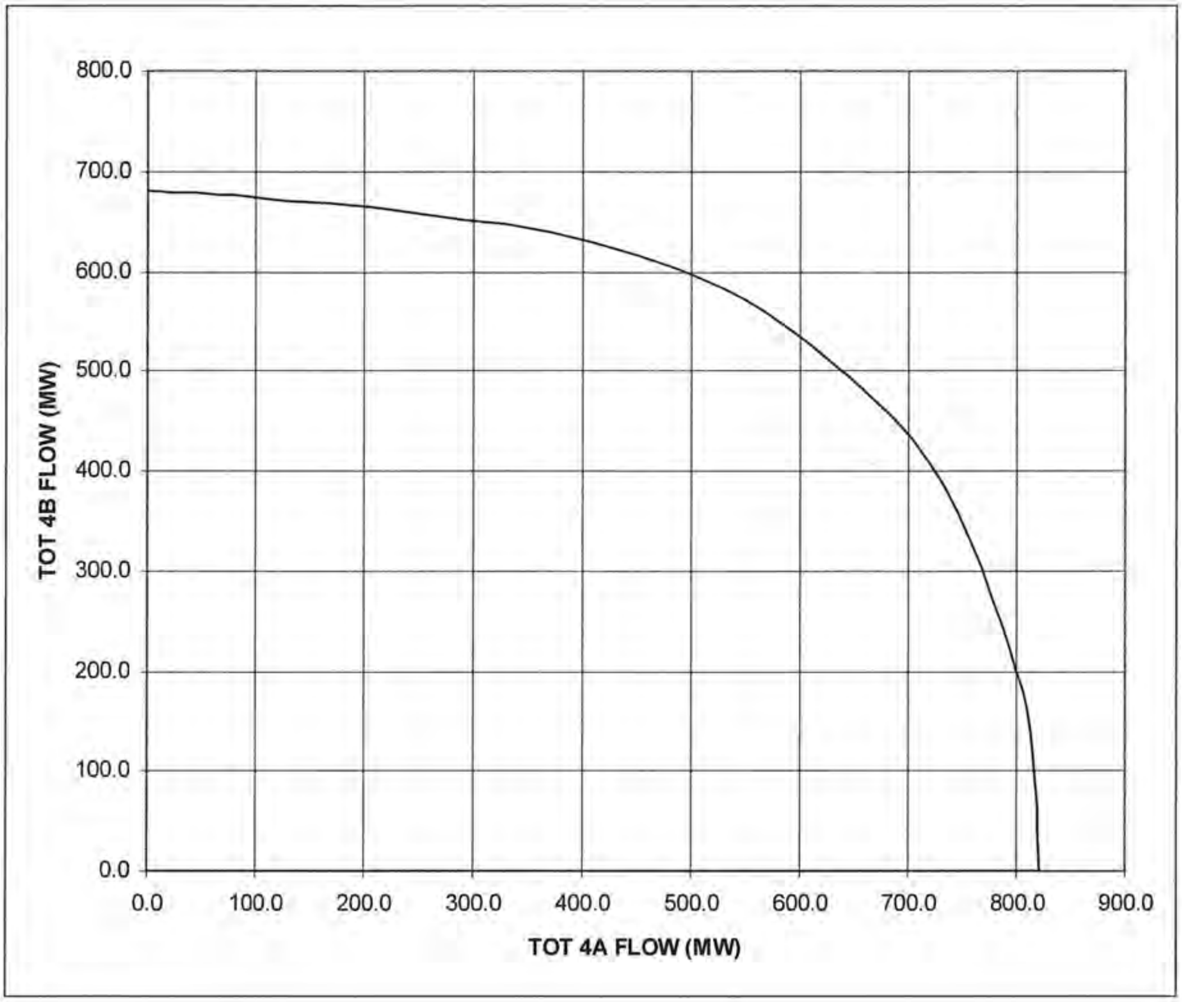
37. TOT 4A

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southwest Wyoming
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Riverton-Wyopo 230 kV — Riverton Dave Johnston-Difficulty 230 kV — Dave Johnston Spence-Mustang 230 kV — Spence
Transfer Limit:	Northeast to Southwest: 810 MW (Non-simultaneous) Southwest to Northeast: Not defined Depending on flows on the adjacent TOT 4B path, the real-time rating can range between a minimum of 0 MW and a maximum of 810 MW (Reference attachment). Typically, the real-time rating centers around 650 MW.
Critical Disturbance that limits the transfer capability:	The critical disturbances and limiting elements vary with the various points on the nomogram. Reference attachment for further information.
When:	Rating was first established in March 1991 with the publication of "1990 Update of the TOT 4B vs. 4A Nomograms." The operating study was conducted jointly by: PacifiCorp (PAC) Western Area Power Administration (WAPA) - Loveland
System Conditions:	This rating is independent of transfer levels between major areas of WECC. Historically, the flows have all been northeast to southwest across the path.
Study Criteria:	(Summary) System intact: • Per unit voltages between 0.95 p.u. and 1.05 p.u. • All lines and transformers loaded to less than continuous rating. Single contingency outage conditions: • Per unit voltages between 0.90 p.u. and 1.10 p.u. • All facilities loaded to less than 100% of emergency ratings.
Remedial Actions Required:	Remedial actions are required to achieve the rated transfer capability. Following an outage, all overloaded lines and transformers must have their loading reduced to continuous ratings within 15 minutes. This is accomplished by reducing schedules and adjusting generation.
Formal Operating Procedure:	There is a formal operating procedure dated April 12, 1991. PAC is the operating agent and uses real-time flows to monitor the path.
Allocation:	PAC has the entire transfer capability of the path.
Interaction w/Other Transfer Paths:	See attachment

Contact Person:	Gil Coulam PacifiCorp 1407 W. North Temple - Suite 100 Salt Lake City, UT 84140 (801) 220-2954 (801) 220-2842 - fax gilbert.coulam@pacificorp.com

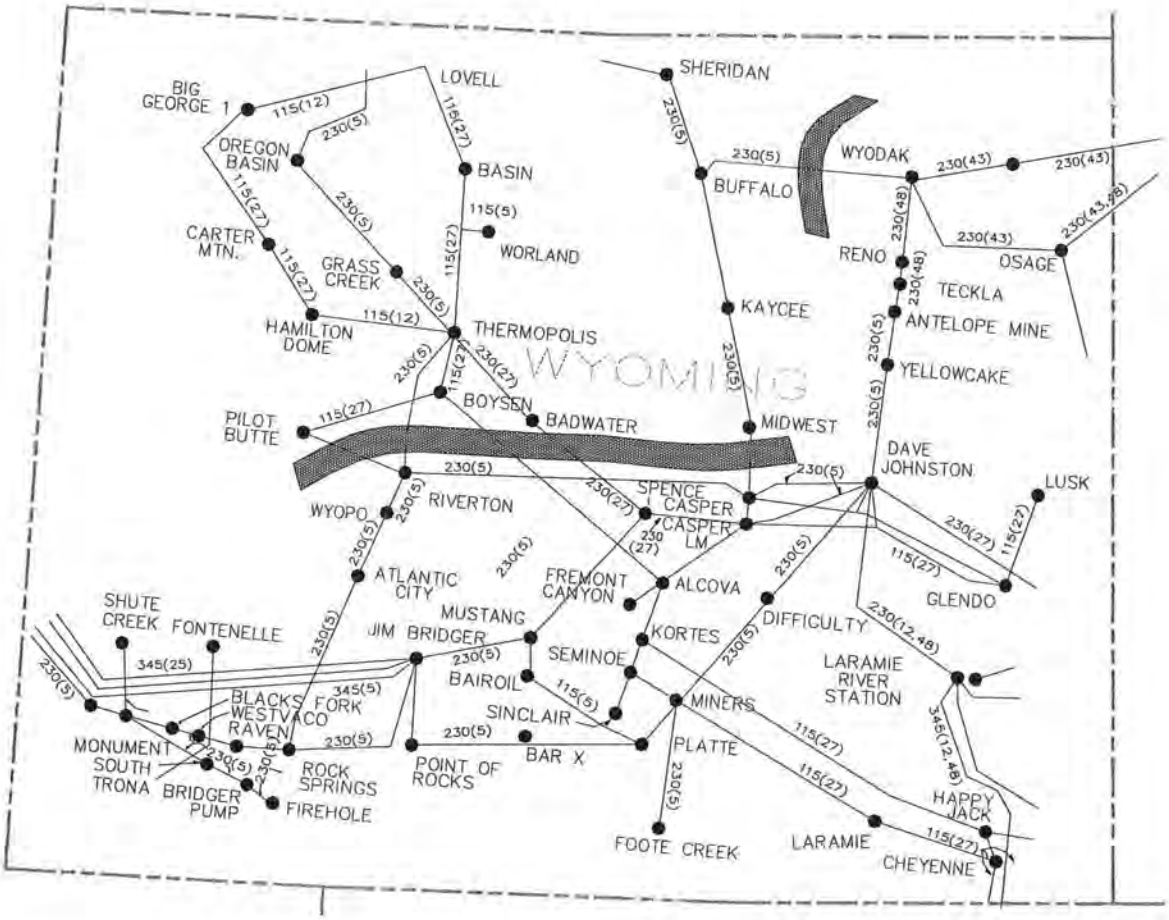
WYOMING SYSTEM OPERATING CURVE
SYSTEM NORMAL
(1990 STUDIES)



SYSTEM NORMAL

POWERFLOW CASE	TOT FLOWS (MW) 4A	4B	LIMITING OUTAGE LINE	KV	LIMITING CONDITION BUS/LINE KV	LIMIT
	0.0	680.0	ESTIMATED			
92LW206	94.1	675.0	NONE		BUF SHR 230	99.70%
92LW205	251.1	657.0	BUF - WYD	230	CSP DJ 230	99.90%
92LW204	411.1	628.2	BUF - SHR	230	CART MT 115	0.9005
92LW203	568.2	558.3	BUF - WYD	230	CSP DJ 230	99.60%
92LW202	719.1	407.8	DJ - DIF	230	SPENCE 230	0.9008
	800.0	200.0	ESTIMATED			
92LW201	817.0	87.2	DJ - DIF	230	SPENCE 230	0.9000
	820.0	0.0	ESTIMATED			

38. TOT 4B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SHERIDAN
BUFFALO
WYODAK
KAYCEE
MIDWEST
RENO
TECKLA
ANTELOPE MINE
YELLOWCAKE
OSAGE
DAVE JOHNSTON
LUSK
GLENDO
BIG GEORGE 1
LOVELL
OREGON BASIN
BASIN
WORLAND
CARTER MTN.
GRASS CREEK
HAMILTON DOME
THERMOPOLIS
BOYSEN
BADWATER
PILOT BUTTE
RIVERTON
WYOPO
SPENCE
CASPER
CASPER LM
ATLANTIC CITY
FREMONT CANYON
ALCOVA
MUSTANG
JIM BRIDGER
SEMINOE
KORTES
DIFFICULTY
BAIROIL
SINCLAIR
MINERS
PLATTE
BAR X
POINT OF ROCKS
LARAMIE RIVER STATION
SHUTE CREEK
FONTENELLE
BLACKS FORK
WESTVACO
RAVEN
MONUMENT
SOUTH TRONA
BRIDGER PUMP
ROCK SPRINGS
FIREHOLE
FOOTE CREEK
LARAMIE
HAPPY JACK
CHEYENNE

38. TOT 4B

Accepted Rating ☐
Existing Rating ☒
Other ☐

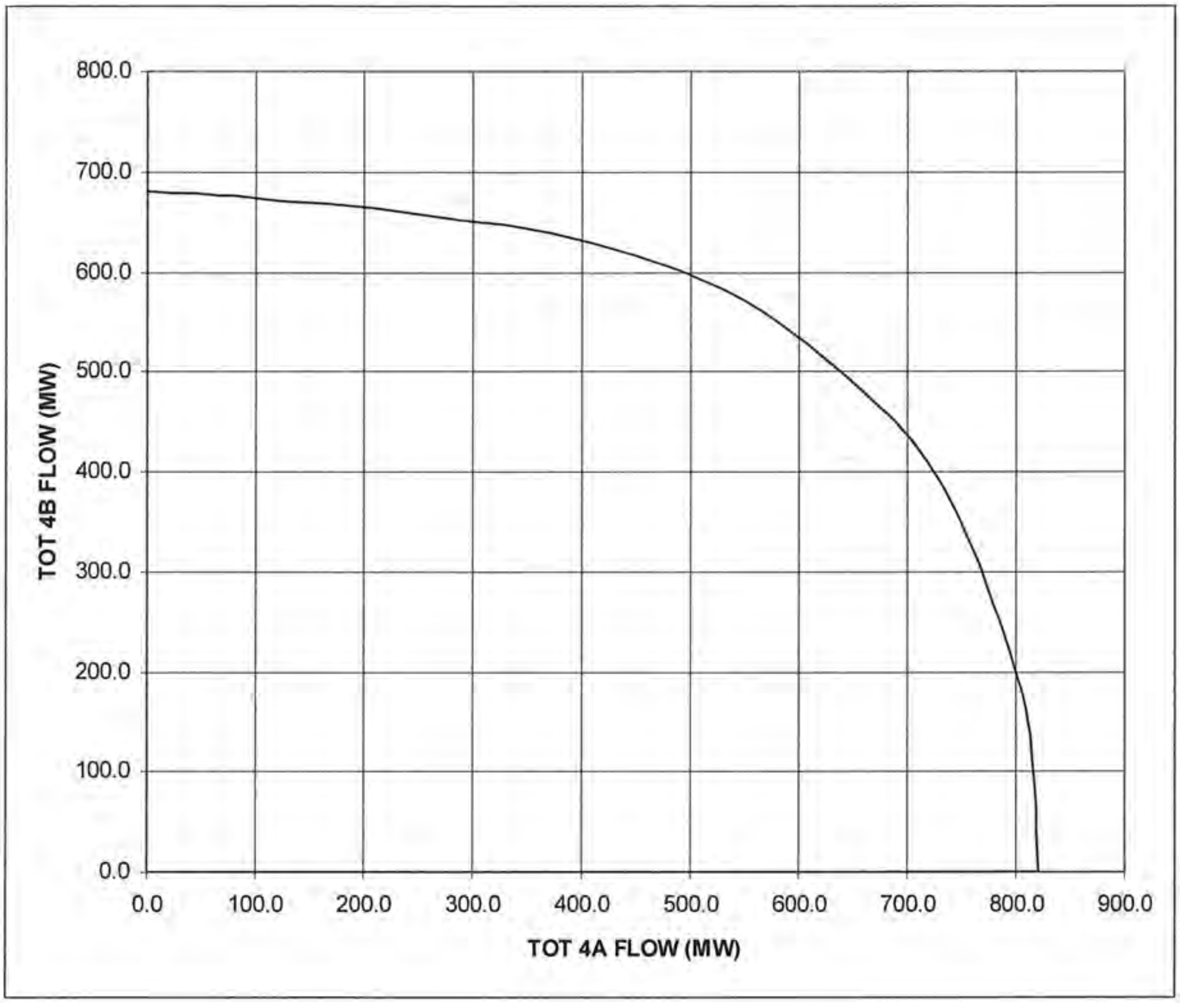
Location:	Northwest Wyoming
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Wyodak-Buffalo 230 kV — Wyodak Spence-Thermopolis 230 kV — Spence Alcova-Raderville 115 kV — Alcova Casper-Midwest 230 kV — Casper Riverton-Thermopolis 230 kV — Riverton Riverton-230/115 kV transformers — Riverton 230 kV
Transfer Limit:	Southeast to Northwest: 680 MW (Non-simultaneous) Northwest to Southeast: Not defined Depending on flows on the adjacent TOT 4A path, the real-time rating can range between a minimum of 0 MW and a maximum of 680 MW (Reference attachment). Typically, the real-time rating centers around 475 MW.
Critical Disturbance that limits the transfer capability:	The critical disturbances and limiting elements vary with the various points on the nomogram. Reference attachment for further information.
When:	Rating was established in March 1991 with the publication of "1990 Update of the TOT 4B vs. 4A Nomograms." The operating study was conducted jointly by: PacifiCorp (PAC) Western Area Power Administration (WAPA) - Loveland
System Conditions:	This rating is independent of transfer levels between major areas of WECC. Historically, the flows have all been southeast to northwest across the path.
Study Criteria:	(Summary) System intact: • Per unit voltages between 0.95 p.u. and 1.05 p.u. • All lines and transformers loaded to less than continuous rating. Single contingency outage conditions: • Per unit voltages between 0.90 p.u. and 1.10 p.u. • All facilities loaded to less than 100% of emergency ratings.
Remedial Actions Required:	Remedial actions are required to achieve the rated transfer capability. Following an outage, all overloaded lines and transformers must have their loading reduced to continuous ratings within 15 minutes. This is accomplished by reducing schedules or lowering local generation.
Formal Operating Procedure:	There is a formal operating procedure dated April 12, 1991. PAC is the operating agent and uses real-time flows to monitor the path.
Allocation:	PAC and WAPA share the transfer capability of the path.

Interaction w/Other Transfer Paths:	See attachment
Contact Person:	Gil Coulam PacifiCorp 1407 W. North Temple - Suite 110 Salt Lake City, UT 84140 (801) 220-2954 (801) 220-2842 - fax gilbert.coulam@pacificorp.com

WYOMING SYSTEM OPERATING CURVE

SYSTEM NORMAL

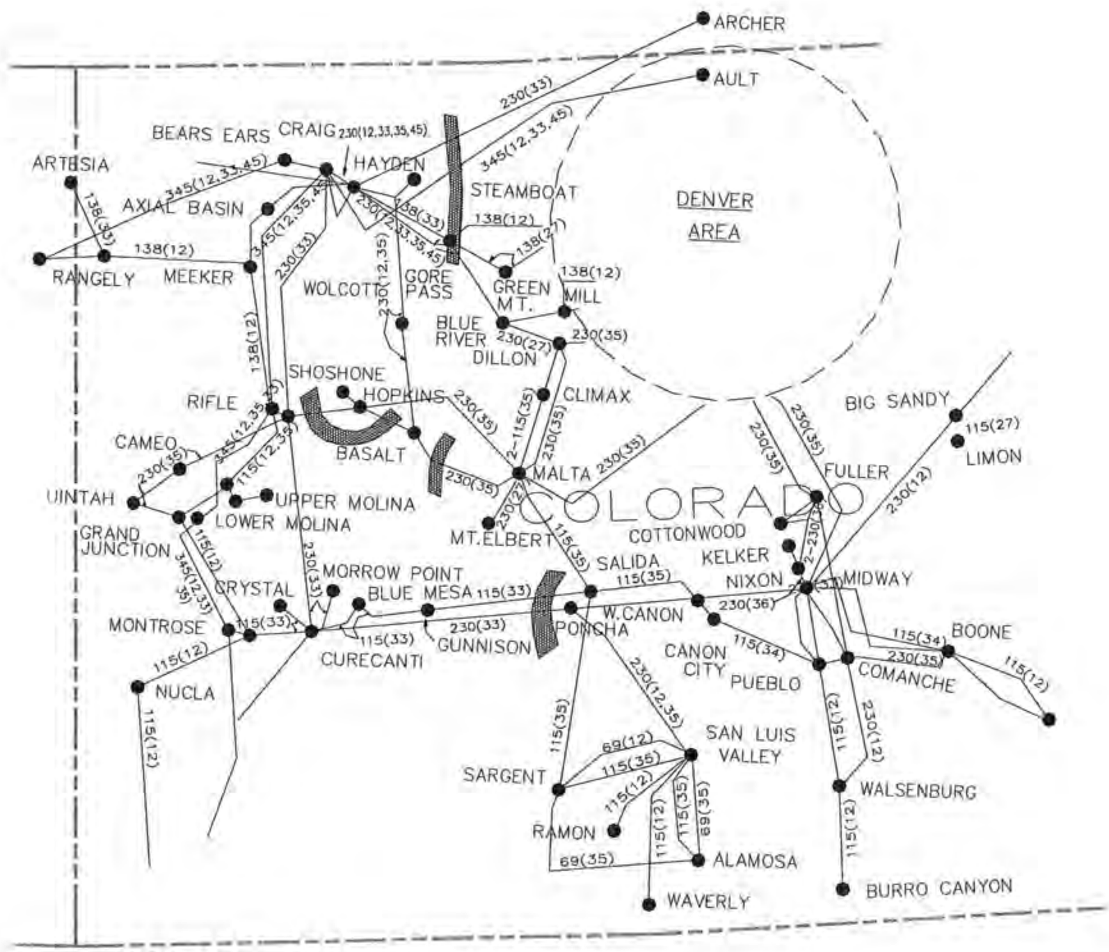
(1990 STUDIES)



SYSTEM NORMAL

POWERFLOW	TOT FLOWS (MW)		LIMITING OUTAGE		LIMITING CONDITION	
CASE	4A	4B	LINE	KV	BUS/LINE KV	LIMIT
	0.0	680.0	ESTIMATED			
92LW206	94.1	675.0	NONE		BUF SHR 230	99.70%
92LW205	251.1	657.0	BUF - WYD	230	CSP DJ 230	99.90%
92LW204	411.1	628.2	BUF - SHR	230	CART MT 115	0.9005
92LW203	568.2	558.3	BUF - WYD	230	CSP DJ 230	99.60%
92LW202	719.1	407.8	DJ - DIF	230	SPENCE 230	0.9008
	800.0	200.0	ESTIMATED			
92LW201	817.0	87.2	DJ - DIF	230	SPENCE 230	0.9000
	820.0	0.0	ESTIMATED			

39. TOT 5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AULT
DENVER AREA
BEARS EARS
CRAIG
HAYDEN
ARTESIA
AXIAL BASIN
STEAMBOAT
RANGELY
MEEKER
WOLCOTT
GORE PASS
GREEN MT.
MILL
BLUE RIVER
DILLON
SHOSHONE
HOPKINS
CLIMAX
RIFLE
BASALT
CAMEO
MALTA
UINTAH
UPPER MOLINA
LOWER MOLINA
GRAND JUNCTION
MT.ELBERT
COLORADO
COTTONWOOD
KELKER
NIXON
MIDWAY
SALIDA
MORROW POINT
CRYSTAL
BLUE MESA
W.CANON
MONTROSE
PONCHA
CURECANTI
GUNNISON
CANON CITY
PUEBLO
COMANCHE
BOONE
NUCLA
BIG SANDY
LIMON
FULLER
SAN LUIS VALLEY
SARGENT
RAMON
ALAMOSA
WAVERLY
WALSENBURG
BURRO CANYON

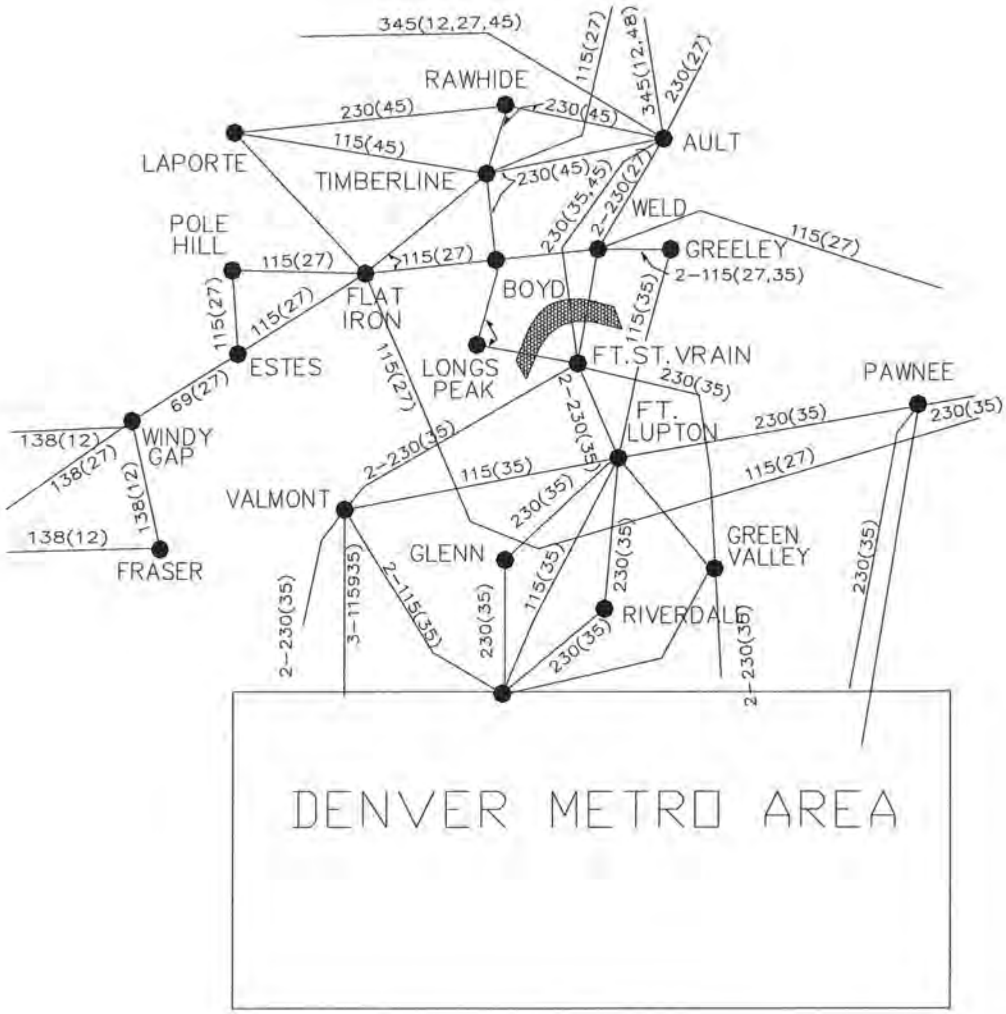
39. TOT 5

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	West-Central Colorado
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Hayden-Archer 230 kV — Archer Craig-Ault 345 kV — Craig Gore Pass-Blue River 230 kV — Blue River Hayden-Gore Pass 138 kV — Gore Pass Gore Pass 230/138 kV transformer — Gore Pass 230 Gunnison-Salida (Poncha Jct.) 115 kV — Poncha Curecanti-Poncha 230 kV — Curecanti Basalt-Malta 230 kV — Basalt Basalt-Hopkins 115 kV — Basalt Rifle-Hopkins 230 kV — Rifle
Transfer Limit:	West to East: 1675 MW East to West: Not defined
Critical Disturbance that limits the transfer capability:	The critical disturbance is the outage of the Hayden-Gore Pass 230 kV line and the remedial action of opening the parallel Hayden-Gore Pass 138 kV line. The limiting elements are the overload of the Craig-Ault 345 kV and Rifle-Malta 230 kV lines.
When:	Rating established in "Hayden-Blue River 230 kV Transmission Line Operating Study, Phase 1 Report - System Normal Operation" dated October 1987; and "Phase 2 Report - Line Outage Conditions" dated May 1988. The operating study was conducted jointly by: Colorado-Ute Electric Association (CUEA) (now PSCO and TSGT) Platte River Power Authority (PRPA) Public Service Company of Colorado (PSC) Tri-State Generation & Transmission Association, Inc. (TSGT) Western Area Power Administration (WAPA) - Salt Lake, Golden, Montrose, Loveland Salt River Project (SRP)
System Conditions:	This rating is independent of peak load/light load assumptions or transfer levels between major areas of WECC. This path is affected primarily by power exchanges within Colorado, and historically the flows have all been west to east across the path.

Remedial Actions Required:	Remedial actions are required to achieve the rated transfer capability. Following an outage, all overloaded lines and transformers must have their loadings reduced to continuous ratings within 15 minutes. This is accomplished by reducing schedules, lowering local generation or manually tripping a lower voltage parallel path for an outage of the Hayden-Gore Pass 230 kV line.
Formal Operating Procedure:	There is a formal operating procedure, the most current one dated April 10, 1997. WAPA-Rocky Mountain Region is the operating agent and uses real-time flows to monitor the path.
Formal Operating Procedure:	There is a formal operating procedure, the most current one dated April 10, 1997. WAPA-Rocky Mountain Region is the operating agent and uses real-time flows to monitor the path.
Allocation:	The transfer capability of the path is divided between WAPA, PRPA, TSGT and PSC.
Interaction w/Other Transfer Paths:	None
Contact Person:	Brent Vossler Western Area Power Administration Rocky Mountain Region 5555 East Crossroads Boulevard Loveland, CO 80538-8986 (970) 461-7482 (970) 461-7213 - fax avossler@wapa.gov

40. TOT 7



345(12,27,45)
115(27)
345(12,48)
230(27)
RAWHIDE
230(45)
230(45)
AULT
LAPORTE
115(45)
TIMBERLINE
230(45)
WELD
230(35,45)
2-230(27)
POLE HILL
115(27)
115(27)
GREELEY
115(27)
2-115(27,35)
FLAT IRON
BOYD
115(27)
115(27)
115(35)
ESTES
LONGS PEAK
FT.ST.VRAIN
115(27)
230(35)
PAWNEE
69(27)
2-230(35)
FT. LUPTON
230(35)
230(35)
138(12)
WINDY GAP
2-230(35)
138(27)
138(12)
115(35)
115(27)
VALMONT
230(35)
138(12)
FRASER
GLENN
GREEN VALLEY
230(35)
2-230(35)
3-115935
2-115(35)
230(35)
115(35)
230(35)
RIVERDALE
230(35)
2-230(35)
DENVER METRO AREA

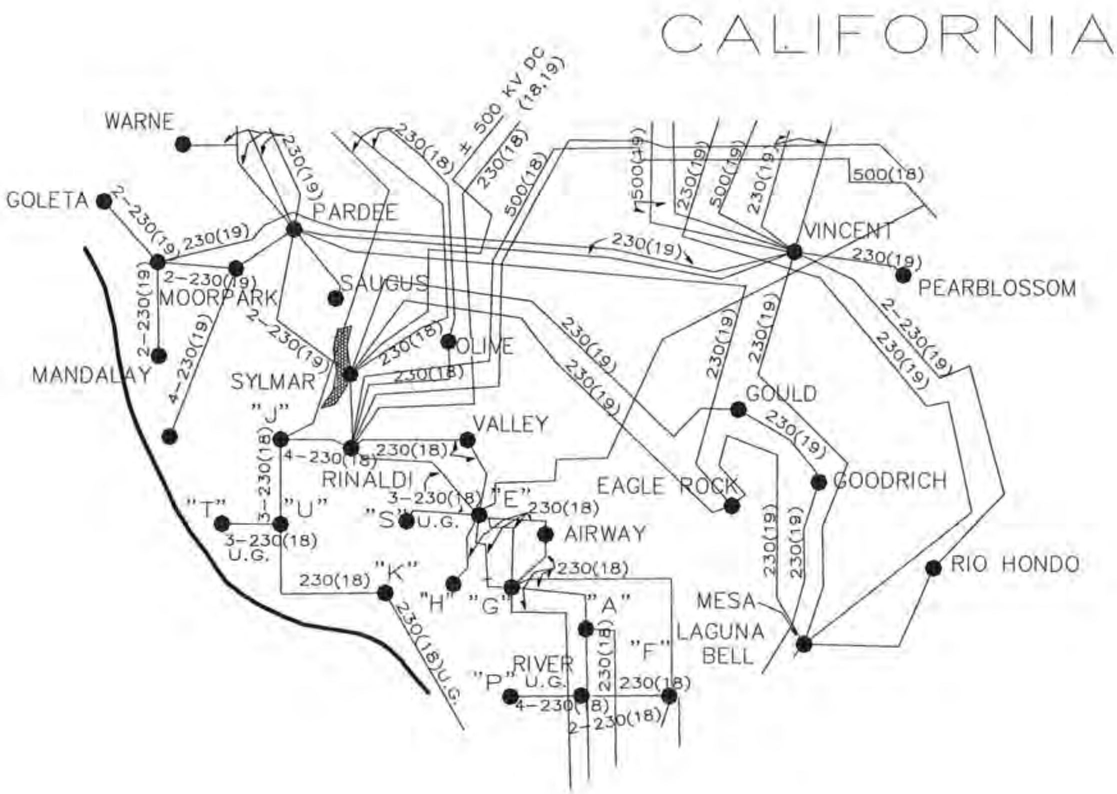
40. TOT 7

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	North Central Colorado
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Ault-Fort St. Vrain 230 kV — Ault Weld-Fort St. Vrain 230 kV — Weld Longs Peak-Fort St. Vrain 230 kV — Fort St. Vrain
Transfer Limit:	North to South: 890 MW South to North: Not defined
Critical Disturbance that limits the transfer capability:	The critical disturbance is the outage of the Ault-Windsor-Fort St. Vrain 230 kV line. The limiting element is the emergency overload on the Weld-Fort St. Vrain 230 kV line.
When:	Rating established in December 1995 with publication of "Foothills Planning Group TOT 7 Operating Study Report." The operating study was conducted jointly by: Public Service Company of Colorado (PSC) Western Area Power Administration (WAPA) - Loveland Tri-State Generation & Transmission Association, Inc. (TSGT) Platte River Power Authority (PRPA)
System Conditions:	This rating is independent of peak load/light load assumptions or transfer levels between major areas of WECC. This path is affected primarily by Colorado/Wyoming power exchanges, and historically the flows have all been north to south across the path.
Study Criteria:	(Summary) System intact: • Per unit voltages between 0.95 p.u. and 1.05 p.u. • All lines and transformers loaded to less than continuous rating. Single contingency outage conditions: • Per unit voltages between 0.92 p.u. and 1.10 p.u. • All lines loaded to less than 15-minute emergency ratings. • All transformers loaded to less than their continuous ratings.
Remedial Actions Required:	Remedial actions schemes are required to achieve the rated transfer capability. Following an outage, all overloaded lines and transformers must have their loadings reduced to continuous ratings within 15 minutes. This is accomplished by reducing schedules or lowering local generation.
Formal Operating Procedure:	There is a formal operating procedure, the most current one dated June 1, 2002. Public Service Company of Colorado is the operating agent and uses real-time flows to monitor the path.
Allocation:	The transfer capability of the path is divided between Public Service Company of Colorado and Platte River Power Authority.

Interaction w/Other Transfer Paths:	None
Contact Person:	Thomas W. Green Public Service Company of Colorado Technical Services Building 550 15th Street, Suite 700 Denver, CO 80202-4256 (303) 571-7223 (303) 571-7877 - fax thomas.green@xcelenergy.com

41. Sylmar to SCE



41. Sylmar to SCE

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Los Angeles County, California
Definition:	Flows on the three 220/230 kV transformer banks at Sylmar switching station.
Transfer Limit:	North to South: 1600 MW (non-simultaneous) South to North: 1600 MW (non-simultaneous)
Critical Disturbance that limits the transfer capability:	Transfer limit based on the emergency thermal rating of the two existing transformers (800 MW each) for the loss of the third transformer.
When:	The rating was approved by letter dated May 24, 2004 subsequent to WECC approval of the Comprehensive Progress Report titled Sylmar to SCE – Path 41 Upgrade Rating Report submitted on April 23, 2004.
System Conditions:	North to South flows (LADWP to SCE) are typical during heavy summer conditions with imports from the Northwest into southern California through the Pacific DC intertie. South to North flows (SCE to LADWP) occur during light winter, South to North PDCI flows.
Study Criteria:	WECC, LADWP, SCE
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	The transformer capability of the path is divided between: PG&E CDWR City of Anaheim SCE LADWP City of Riverside SDG&E City of Pasadena
Interaction w/Other Transfer Paths:	None
Contact Person:	Patricia L. Arons Southern California Edison P. O. Box 800, Room 460 2131 Walnut Grove Avenue Rosemead, CA 91770 (626) 302-9644 (626) 302-9647 - fax patricia.arons@sce.com Ly Le Los Angeles Department of Water and Power P. O. Box 111, Room 1246 111 North Hope Street Los Angeles, CA 90051 (213) 367-0302 (213) 367-3829 - fax ly.le@ladwp.com

42. IID - SCE

CALIFORNIA
ARIZONA
MEXICO
DEVERS
EAGLE MT.
EAGLE EYE
HEADGATE
BLYTHE
BUCK BOULEVARD
PALO VERDE
MIRAGE
JULIAN HINDS
RAMON
COACHELLA VALLEY
TALEGA
SAN ONOFRE
SAN LUIS
ENCINA
ESCONDIDO
SYCAMORE
MIDWAY
HIGHLINE
GOLDMINE
PENASQUITOS
AVE 58
MISSION
LOS COCHES
NILAND
KNOB
OLD TOWN
EL CENTRO
N.GILA
MIGUEL
IMPERIAL
PILOT KNOB
GILA
SOUTH BAY
VALLEY
AXIS
TIJUANA I
SEMPRA (TDM)
INTERGEN (LA ROSITA)
PANAMERICANA
RUMOROSA
METROPOLI
MEXICALI I
CENTRAL
LA ROSITA
RUIZ CORTINEZ
PRESIDNETE JUAREZ
LOMAS
HIDALGO
CIPRES
CERRO PRIETO
P. IND. SAN LUIS
CHAPULTEPEC

Revised February 2004

42. IID - SCE

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Riverside County, California
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Ramon-Mirage 230kV — Mirage 230 kV Coachella-Devers 230 kV — Devers 230 kV
Transfer Limit:	East to West: 600 MW West to East: Not rated
Critical Disturbance that limits the transfer capability:	The limiting N-1 condition is an outage of Devers-Coachella line which results in power flow equaling the N-1 thermal rating of the Mirage-Coachella line.
When:	The 600 MW rating was established in 1990.
System Conditions:	The 600 MW rating is valid at all times. Flows on this transfer path have historically been east to west due to the presence of a number of QFs in the IID service territory delivering power to SCE.
Study Criteria:	WECC, SCE
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	SCE, IID
Interaction w/Other Transfer Paths:	None
Contact Person:	Patricia L. Arons Southern California Edison P. O. Box 800, Room 460 2131 Walnut Grove Avenue Rosemead, CA 91770 (626) 302-9644 (626) 302-9647 - fax patricia.arons@sce.com David L. Barajas Imperial Irrigation District P. O. Box 937 333 E. Barioni Blvd. Imperial, CA 92251-0937 (760) 339-9093 (760) 339-0525 - fax georgeb@thegrid.net

43. North of San Onofre

43. North of San Onofre

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	North of San Onofre Nuclear Generating Station (SONGS) San Onofre Interconnection San Diego County, California
Definition:	<u>North of SONGS Lines</u> — <u>Metered End</u> SONGS-Santiago #1 230 kV — SONGS SONGS-Santiago #2 230 kV — SONGS SONGS-Serrano 230 kV — SONGS SONGS-Chino 230 kV — SONGS
Transfer Limit:	South to North: 2440 MW
Critical Disturbance that limits the transfer capability:	Transient instability can occur for N-2 loss of both SONGS-Santiago #1 and #2 230 kV lines.
When:	The stability limit was established in 1988. The north to south transfer limit designation was removed per PCC chair's May 19, 1999 letter addressing this issue.
System Conditions:	The ratings given above are used under all system conditions. The stability rating was established based on light load conditions.
Study Criteria:	WECC and SCE
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	Southern California Edison owns and operates the lines as defined above.
Interaction w/Other Transfer Paths:	
Contact Person:	Patricia L. Arons Southern California Edison P. O. Box 800, Room 460 2131 Walnut Grove Avenue Rosemead, CA 91770 (626) 302-9644 (626) 302-9647 - fax patricia.arons@sce.com

44. South of San Onofre

Revised February 2005

44. South of San Onofre

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	South of San Onofre Nuclear Generating Station (SONGS) San Onofre Interconnection, San Diego County, California
Definition:	South of SONGS Lines — Metered End SONGS-San Luis Rey — SONGS SONGS-San Luis Rey — SONGS SONGS- San Luis Rey — SONGS SONGS-Talega #1 — SONGS SONGS-Talega #2 — SONGS
Transfer Limit:	North to South: 2200/2500 MW (see System Conditions below) South to North: No longer required based on determination made in 1999 through WECC review. (See letter from PCC Chairman to PCC, OC, and TSS dated June 26, 2001)
Critical Disturbance that limits the transfer capability:	The 2200 MW north to south rating is based on flowability on the path under normal conditions. During critical contingency operating conditions with a 2500 MW north to south flow, outage of SCE's Del Amo-Ellis 230 kV line loads the Barre-Ellis 230 kV line to 99.8% of its N-1 contingency "A" rating of 2850 amps.
When:	Accepted dual ratings were approved by PCC on February 11, 2000.
System Conditions:	For north to south flow, the 2200 MW rating is applicable under normal conditions. The 2500 MW rating is applicable only for times when any segment of the Southwest PowerLink is out of service for any reason.
Study Criteria:	WECC, SDG&E, and the California ISO.
Remedial Actions Required:	The need for arming RAS for local load shedding will be determined by the California ISO and SDG&E during seasonal operating studies, however, no load shedding requirement has been identified at this time.
Formal Operating Procedure:	None
Allocation:	San Diego Gas & Electric owns lines as defined above. The California ISO exercises operational control of the lines and associated facilities.
Interaction w/Other Transfer Paths:	None
Contact Person:	Linda P. Brown San Diego Gas & Electric 8316 Century Park Court, CP52A San Diego, CA 92123-1582 (858) 654-6477 (858) 654-1692 - fax lpbrown@semprautilities.com

45. SDG&E - CFE


CALIFORNIA
ARIZONA
MEXICO
DEVERS
EAGLE MT.
EAGLE EYE
HEADGATE
BLYTHE
BUCK BOULEVARD
PALO VERDE
MIRAGE
RAMON
JULIAN HINDS
COACHELLA VALLEY
TALEGA
SAN ONOFRE
SAN LUIS
ENCINA
ESCONDIDO
SYCAMORE
PENASQUITOS
MISSION
OLD TOWN
LOS COCHES
AVE 58
MIDWAY
HIGHLINE
GOLDMINE
NILAND
EL CENTRO
KNOB
N.GILA
MIGUEL
IMPERIAL VALLEY
PILOT KNOB
GILA
AXIS
SOUTH BAY
SEMPRA (TDM)
INTERGEN (LA ROSITA)
TIJUANA I
PANAMERICANA
RUMOROSA
METROPOLI
CENTRAL
MEXICALI
LA ROSITA
RUIZ CORTINEZ
HIDALGO
PRESIDNETE JUAREZ
LOMAS
CIPRES
CERRO PRIETO
P. IND. SAN LUIS
CHAPULTEPEC

45. SDG&E - CFE

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	San Diego County - Baja California Norte (Mexico)
Definition:	Tijuana Interconnection — Metered End Tijuana I-Miguel — Tijuana I La Rosita Interconnection — Metered End La Rosita-Imperial Valley — La Rosita
Transfer Limit:	North to South: 408 MW South to North: 800 MW per letters from PCC Chairman to PCC, OC, and TSS dated July 17, 2003, and from SDG&E to PCC, OC, TSS, CMOPS and TOC dated June 11, 2003).
Critical Disturbance that limits the transfer capability:	The South to North path is collectively rated 800 MW to allow for loss of Imperial Valley-Miguel 500 kV line without overloading the Miguel-Tijuana 230kV line. Note that the North to South rating has not been changed and was established based on the old thermal rating of the La Rosita-Imperial Valley 230 kV line, which was 408 MW.
When:	
System Conditions:	The North to South ratings given above are used under all pre-contingency system conditions. The thermal ratings were established based on heavy load conditions. The South to North ratings given above were established based on winter and summer conditions, respectively, and maximum available generation in the CFE system.
Study Criteria:	WECC, SDG&E and CFE
Remedial Actions Required:	None required at this time.
Formal Operating Procedure:	None
Allocation:	SDG&E owns the lines and associated facilities in the United States, and CFE owns and operates the lines and associated facilities in Mexico. The California ISO exercises operational control of the lines and associated facilities in the United States.

Contact Person:	Ing. Jesús Moya Jefe del Area de Control BCN Comision Federal de Electricidad PMB-42-023 120-A Rockwood Ave. Calexico, CA 92231 (USA address) 011-52(686)-558-1501 011-52(686)-558-1508 011 52(686)-558-1543 - fax 011-52(686)-558-1533 - fax jesus.moya@cfe.gob.mx	Linda P. Brown San Diego Gas & Electric 8316 Century Park Court, CP52A San Diego, CA 92123-1582 (858) 654-6477 (858) 654-1692 - fax lprown@ semprautilities.com

46. West of Colorado River (WOR)

46. West of Colorado River (WOR)

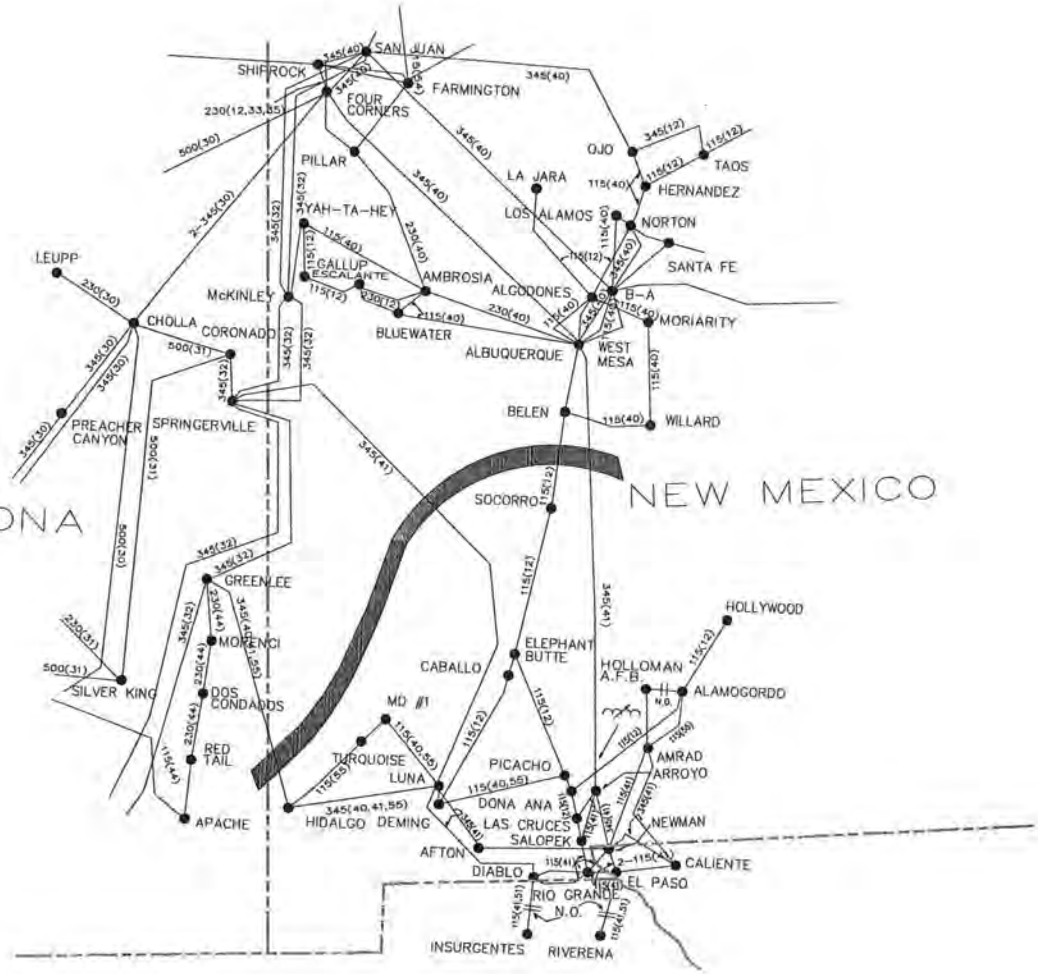
Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	The WOR lines interconnect southern Nevada and Arizona to southern California
Definition:	The sum of the flows on the following transmission lines: (Northern System) Eldorado-Lugo 500 kV Eldorado-Lugo 230 kV lines 1 & 2 Mohave-Lugo 500 kV Julian Hinds-Mirage 230 kV (metered at Mirage) McCullough-Victorville 500 kV lines 1 & 2 Hoover-Victorville 287 kV Marketplace-Adelanto 500 kV (Southern System) North Gila-Imperial Valley 500 kV Palo Verde-Devers 500 kV (metered at Devers) (Underlying System) El Centro-Imperial Valley 230 kV (metered at IV) Ramon-Mirage 230 kV Coachella-Devers 230 kV
Transfer Limit:	10,118 MW
Critical Disturbance that limits the transfer capability:	Loss of the Palo Verde-North Gila or Palo Verde-Devers 500 kV lines.
When:	The rating increase from 8,206 MW to 10,118 MW was approved by letter dated March 4, 1996, subsequent to WECC approval of the report titled "Comprehensive Progress Report On The Accepted Rating Study Of The Arizona-California West-of-the-River (WOR) Path" in December 7, 1995.
System Conditions:	Rating valid under all system conditions.
Study Criteria:	WECC
Remedial Actions Required:	None
Formal Operating Procedure:	Operation is maintained within the boundaries of the Southern California Import Transmission (SCIT) nomogram.

<table>
<tr><td>Allocation:</td><td>
<table>
<tr><td>Northern System:
Lines</td><td>Net WOR Line
Allocation</td><td colspan="2">Entitlements</td></tr>
<tr><td>McCullough-Victorville 500 1&2
+Hoover-Victorville 287</td><td>2592 MW</td><td>LADWP</td><td>2592 MW</td></tr>
<tr><td>Marketplace-Adelanto 500</td><td>1291 MW</td><td>LADWP
SCE
Cities</td><td>313 MW
60 MW
918 MW</td></tr>
<tr><td>Eldorado-Lugo 500
+Eldorado-Lugo 230 1&2
+Mohave-Lugo 500
+J. Hinds-Mirage 230</td><td>2754 MW</td><td>SCE
CDWR
ANZA</td><td>2509 MW
235 MW
10 MW</td></tr>
<tr><td>Northern Subtotal</td><td>6637 MW</td><td></td><td></td></tr>
<tr><td>Southern System:
Lines</td><td>Net WOR Line
Allocation</td><td colspan="2">Entitlements</td></tr>
<tr><td>Palo Verde-Devers 500</td><td>1550 MW</td><td>SCE
LADWP</td><td>1082 MW
468 MW</td></tr>
<tr><td>Ramon-Mirage 230
+Coachella-Devers 230</td><td>600 MW</td><td>SCE</td><td>600 MW</td></tr>
<tr><td>N. Gila-Imperial Valley 500
+El Centro-Imperial Valley 230</td><td>1331 MW</td><td>SDGE
IID</td><td>1168 MW
163 MW</td></tr>
<tr><td>Southern Subtotal</td><td>3481 MW</td><td></td><td></td></tr>
<tr><td>Total System:</td><td>10118 MW</td><td></td><td></td></tr>
</table>
Since IID's system is east of the WOR cut-plane, any schedules made by IID on the North Gila-Imperial Valley line are equal in magnitude and opposite in direction to IID's schedules on the El Centro-Imperial Valley line; thus, IID's schedules on the North Gila-Imperial Valley line and El Centro-Imperial Valley line are not added to the WOR flow total nor is IID required to curtail schedules for WOR or SCIT limitations.
</td></tr>
<tr><td>Interaction w/Other Transfer Paths:</td><td>The maximum capability of the WOR path is influenced by the flows on the other paths bringing power into southern California. Real-time power flows are monitored for all of the paths defining the SCIT nomogram, including WOR, Midway-Vincent, PDCI, IPP DC and North of Lugo.</td></tr>
<tr><td>Contact Person:</td><td>Patricia L. Arons
Southern California Edison Company
P. O. Box 800, Room 460
2131 Walnut Grove Avenue
Rosemead, CA 91770
(626) 302-9644
(626) 302-9647 - fax
patricia.arons@sce.com</td></tr>
</table>

Revised February 2005

47. Southern New Mexico (NM1)



47. Southern New Mexico (NM1)

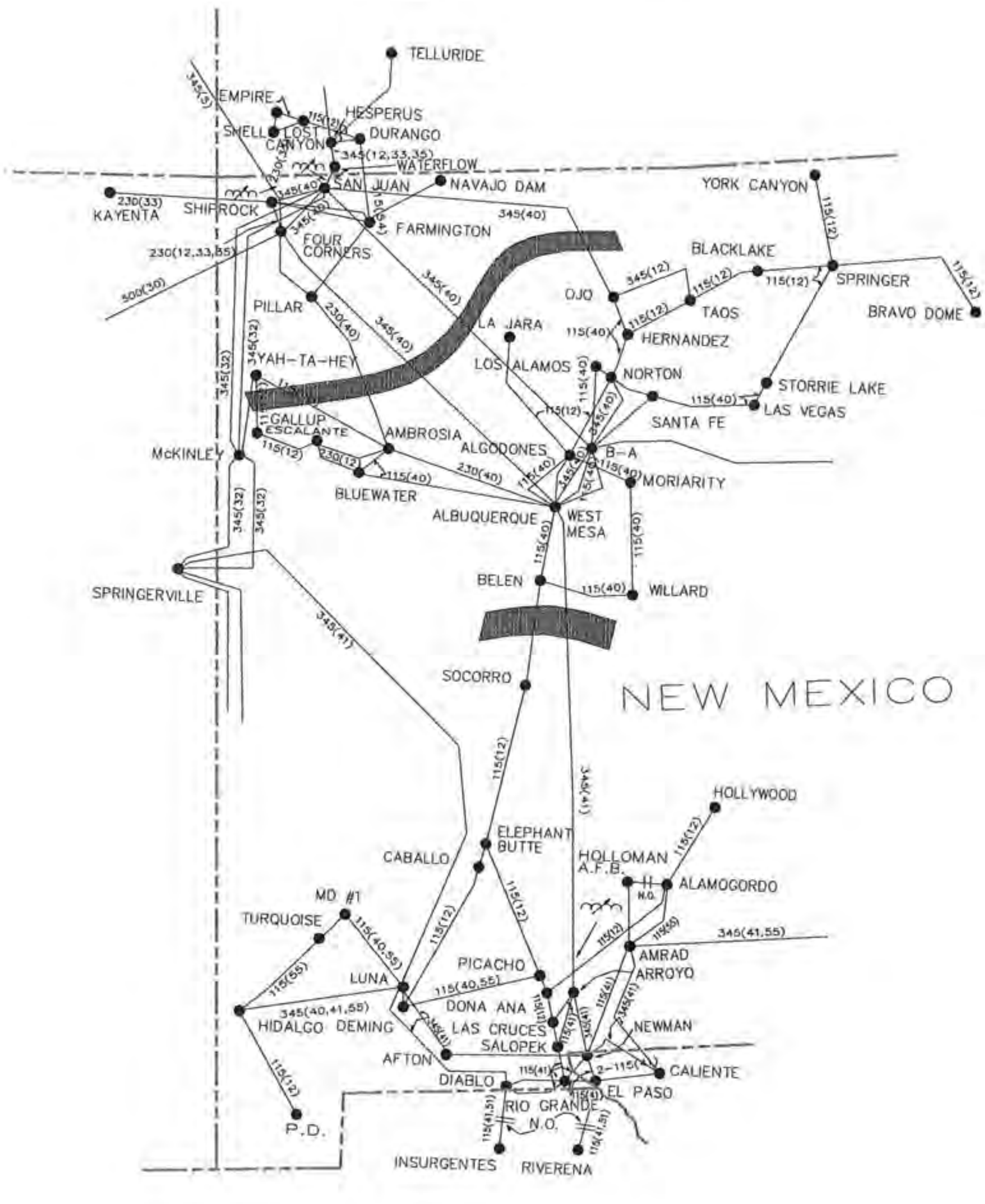
Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Southern New Mexico
Definition:	Sum of the flows on the following transmission lines: Line — Metered End West Mesa-Arroyo 345 kV — West Mesa 345 kV Springerville-Luna 345 kV — Springerville 345 kV Greenlee-Hidalgo 345 kV — Greenlee 345 kV Belen-Bernardo 115 kV — Belen 115 kV The definition of Path 47 has been changed to replace the West Mesa-Belen 115 kV line with the Belen-Bernardo 115 kV line, metered at Belen. This does not result in a change in the path rating. In 2004, this change was put through the expedited process to preserve the accepted rating status.
Transfer Limit:	Simultaneous firm: 925 MW Non-simultaneous: 1048 MW
Critical Disturbance that limits the transfer capability:	Either the Springerville-Luna 345 kV or Greenlee-Hidalgo 345 kV lines.
When:	Simultaneous firm accepted rating established by New Mexico Transmission Operating Procedure 1999 and non-simultaneous accepted rating established by WECC Peer Review Group in 1995.
System Conditions:	Ratings are independent of transfer levels between major WECC areas. Ratings were established for a heavy summer system and are dependent upon Arroyo phase shifter schedules, generation levels, area power factors and reactor levels in southern New Mexico.
Study Criteria:	Local New Mexico pre-disturbance voltage levels between 0.95 p.u. and 1.05 p.u. Post-transient voltage deviation no greater than 7% from base case levels on southern New Mexico 345 kV buses and 6% on northern New Mexico 345 kV buses. WECC criteria applied for systems outside New Mexico area.
Remedial Actions Required:	For double contingencies on the 345 kV lines defined above, WECC Operating Procedure EPE-1 is implemented.
Formal Operating Procedure:	New Mexico Transmission Operating Procedure, effective 6/1/99.
Allocation:	EPE, Tri-State G&T, PNM, TNP
Interaction w/Other Transfer Paths:	Interaction with Northern New Mexico Transfer Path (NM2) is controlled with the Arroyo phase shifter.

Contact Person:	Dennis Malone El Paso Electric Company P. O. Box 982 El Paso, TX 79960 (915) 543-5757 (915) 521-4763 - fax dmalone@epelectric.com

48. Northern New Mexico (NM2)

Revised February 2003



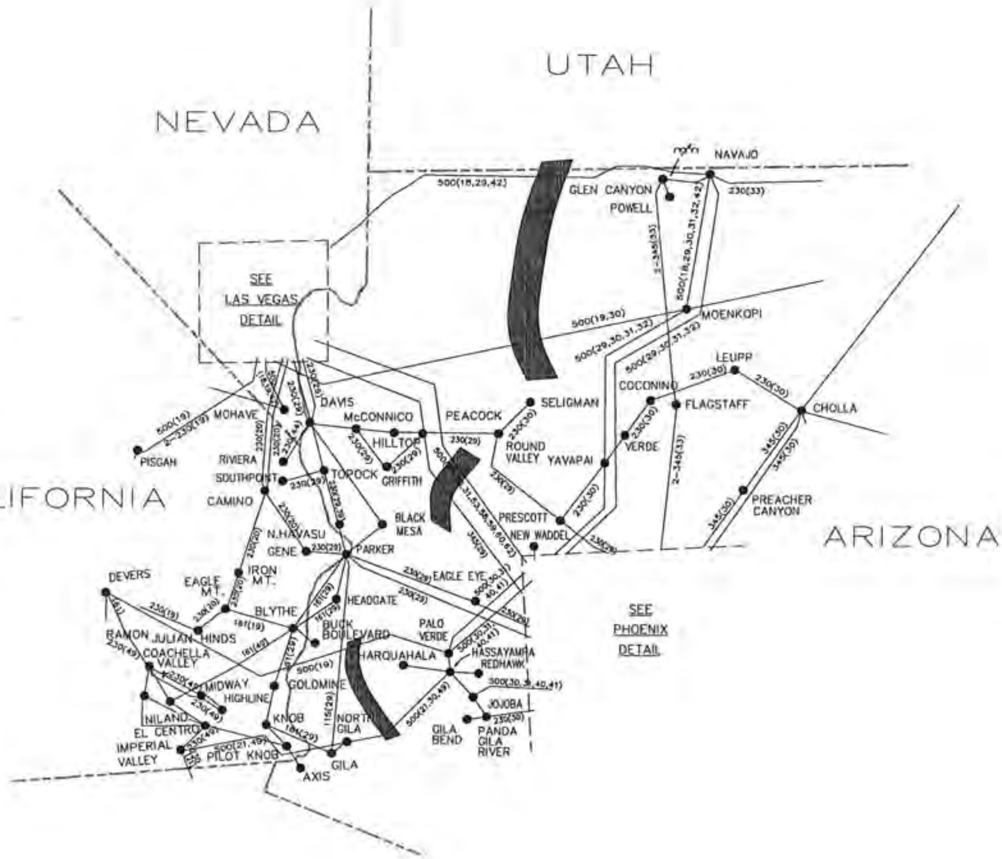
48. Northern New Mexico (NM2)

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Northern New Mexico
Definition:	Sum of flows on the following transmission elements: Element — Metered End Four Corners-West Mesa 345 kV line — Four Corners San Juan-BA 345 kV line — San Juan San Juan-Ojo 345 kV line — San Juan McKinley/Yah-Ta-Hey 345/115 kV trans — Yah-Ta-Hey Bisti-Ambrosia 230 kV line — Bisti Less the following flows: Belen-Bernardo 115 kV line — Belen West Mesa-Arroyo 345 kV line — West Mesa
Transfer Limit:	Simultaneous firm: 1800 MW Non-simultaneous: 1947 MW
Critical Disturbance that limits the transfer capability:	Four Corners-West Mesa or San Juan-BA 345 kV lines.
When:	The rating was approved by letter dated May 6, 2002, subsequent to WECC approval of the revised Comprehensive Progress Report titled Bluewater-West Mesa (BW) and Norton-Hernandez (NH) 115 kV line Upgrades for Path 48 (NM2) submitted April 16, 2002.
System Conditions:	The operating transfer limit on Path 48 uses independent real-time nomogram equations that are incorporated in PNM's Energy Management System. These nomogram equations utilize metered real-time system conditions (e.g., real/reactive power flows, status of shunt capacitors/reactors, etc.) to determine the Path 48 limits on a one-minute basis. The nomogram equation variables included in the Path 48 calculations are therefore dependent upon system conditions and take into account seasonal and time-of-day variations.
Study Criteria:	Local New Mexico criteria include pre-disturbance voltage levels between 0.95 and 1.05 p.u., post transient voltage deviation no greater than 6% in northern New Mexico and 7% in southern New Mexico, or not less than a 5% voltage stability margin. PNM operates Path 48 based on the lower of the voltage or thermal limits.
Remedial Actions Required:	
Formal Operating Procedure:	Post-PST New Mexico Transmission Operating Procedure, effective June 18, 1999.

Allocation:	PNM owns and operates Path 48. Several entities have the rights to use the transfer capability on this path.
Interaction w/Other Transfer Paths:	Interacts with transfers over path NM1, but is controlled by the Arroyo phase-shifting transformer.
Contact Person:	Gregory C. Miller Public Service Company of New Mexico Alvarado Square, MS 0604 Albuquerque, NM 87158 (505) 241-4570 (505) 241-4363 - fax gmiller@mail.pnm.com

49. East of the Colorado River (EOR)



49. East of the Colorado River (EOR)

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Western Arizona
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Navajo-Crystal-McCullough 500 kV — Navajo Moenkopi-Eldorado 500 kV — Eldorado Liberty-Peacock-Mead 345 kV — Liberty Palo Verde-Devers 500 kV — Palo Verde Hassayampa-North Gila 500 kV — Hassayampa Perkins-Mead 500 kV — Perkins
Transfer Limit:	East to West: 7550 MW (Non-simultaneous) West to East: Not rated The present east to west, non-simultaneous EOR rating is 7550 MW and assumes a 'normal' operating system with all lines in service and full series compensation levels in the Navajo, Palo Verde, and Mead-Phoenix Project (MPP) transmission systems.
Critical Disturbance that limits the transfer capability:	The 7550 MW non-simultaneous limit is due to the continuous rating of the series capacitors at the Palo Verde end of the Palo Verde-Devers and Hassayampa-N.Gila 500 kV lines. The transfer capability is limited under normal (all-lines-in-service) conditions. However, various EOR line outages may result in 97-99% loading of emergency ratings on various EOR lines.
When:	The non-simultaneous transfer rating was established in 1996 by the Western Arizona Transmission Systems (WATS) Task Force. The Task Force was comprised of members from the following companies: Arizona Public Service Company El Paso Electric Company DOE-Western Area Power Administration Imperial Irrigation District Los Angeles Department of Water and Power Nevada Power Company Public Service Company of New Mexico Salt River Project San Diego Gas and Electric Company Southern California Edison Company Southern California Public Power Authority Tucson Electric Power Company SDG&E sponsored studies conducted within a WECC Review Group that led to approval of the Accepted Rating Report, and was granted Accepted Rating Status by the August 5, 1996 letter from the PCC Chairman.

System Conditions:	Flows on this transfer path have historically been east to west due to the large amount of joint participation plants located in Arizona and New Mexico which are partly owned by southern California and Nevada entities.
Study Criteria:	WECC Reliability Criteria for Transmission System Planning
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	The presently used allocation is as follows: Southern California Edison Co. 3105 MW Los Angeles Dept. of Water & Power 695 MW Western Area Power Administration 1218 MW Nevada Power Company 371 MW San Diego Gas & Electric Co. 970 MW Imperial Irrigation Project 163 MW Arizona Public Service Co. 376 MW Southern California Public Power Authority 238 MW Salt River Project 236 MW Modesto-Santa Clara-Redding 150 MW Vernon 28 MW 7550 MW
Interaction w/Other Transfer Paths:	The simultaneous transfer limit into southern California is governed by the Southern California Import Transmission (SCIT) Nomogram, and is partly a function of the EOR flow. The SCIT Nomogram varies seasonally and is limited by post transient and transient conditions.
Contact Person:	Tom Isham Arizona Public Service Company P. O. Box 53999, Station 2260 Phoenix AZ 85072-3999 (602) 250-1499 (602) 250-1674 - fax tommy.isham@aps.com

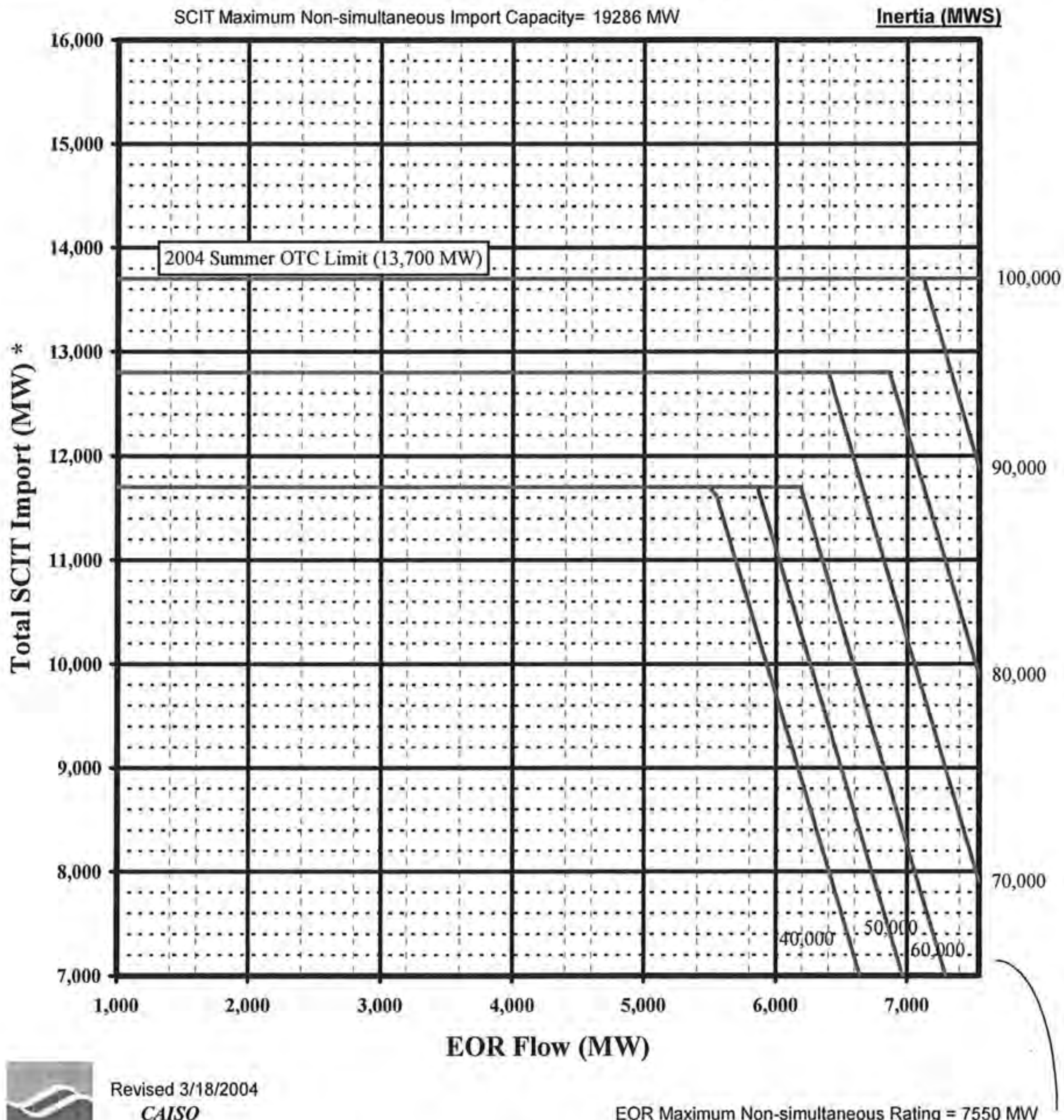
East-of-River/Southern California Import Transmission Nomogram

Based upon:
Three Palo Verde units
All transmission facilities in service

Reduction in SCIT Import Limit
For Palo Verde Status:

3 units on Line	0 MW
2 units on Line	200 MW
1 unit on Line	400 MW
0 unit on Line	700 MW

500 MW Operating Margin Taken Normal to the Limits

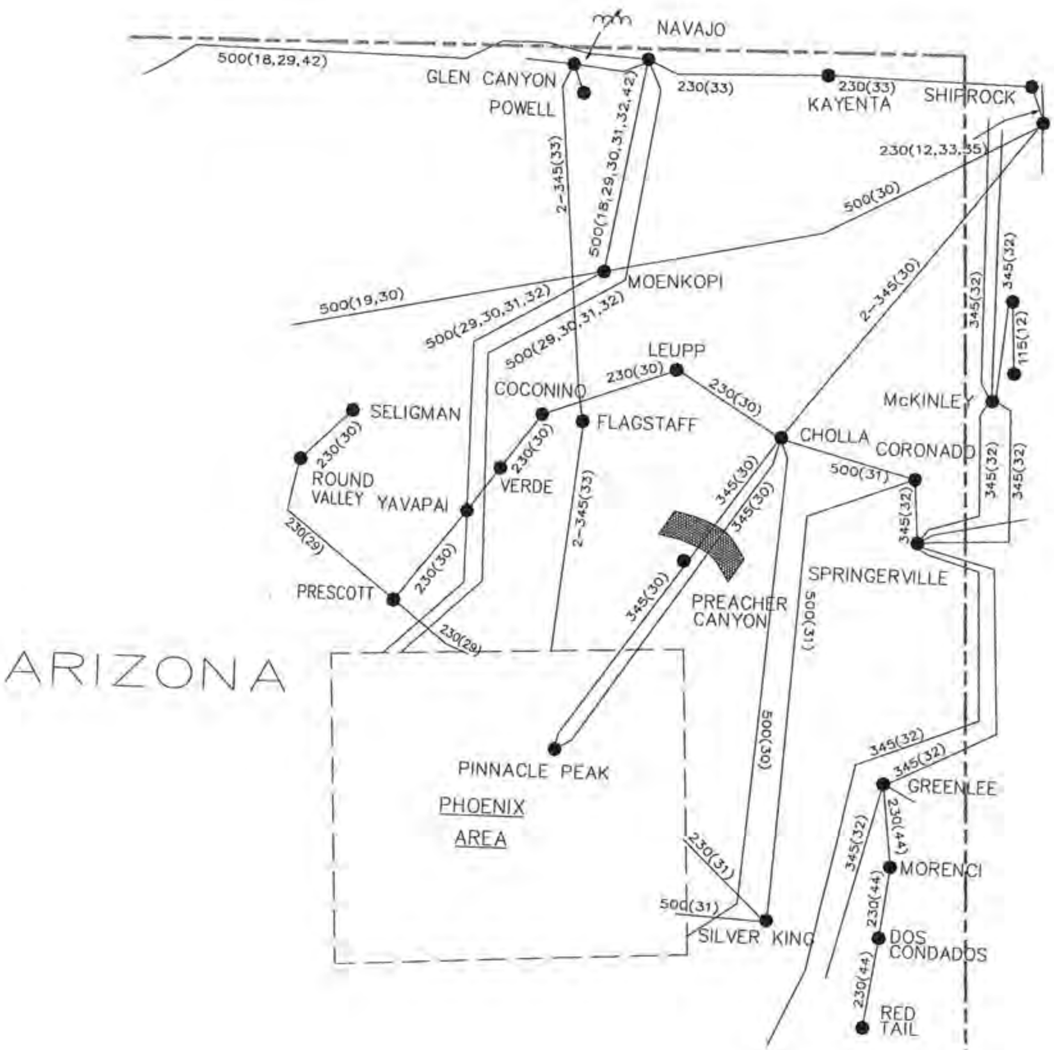


Revised 3/18/2004
CAISO

*Sum of flows on Midway-Vincent, PDCI, IPP, North of Lugo, and WOR.

50. Cholla - Pinnacle Peak

Revised February 2003

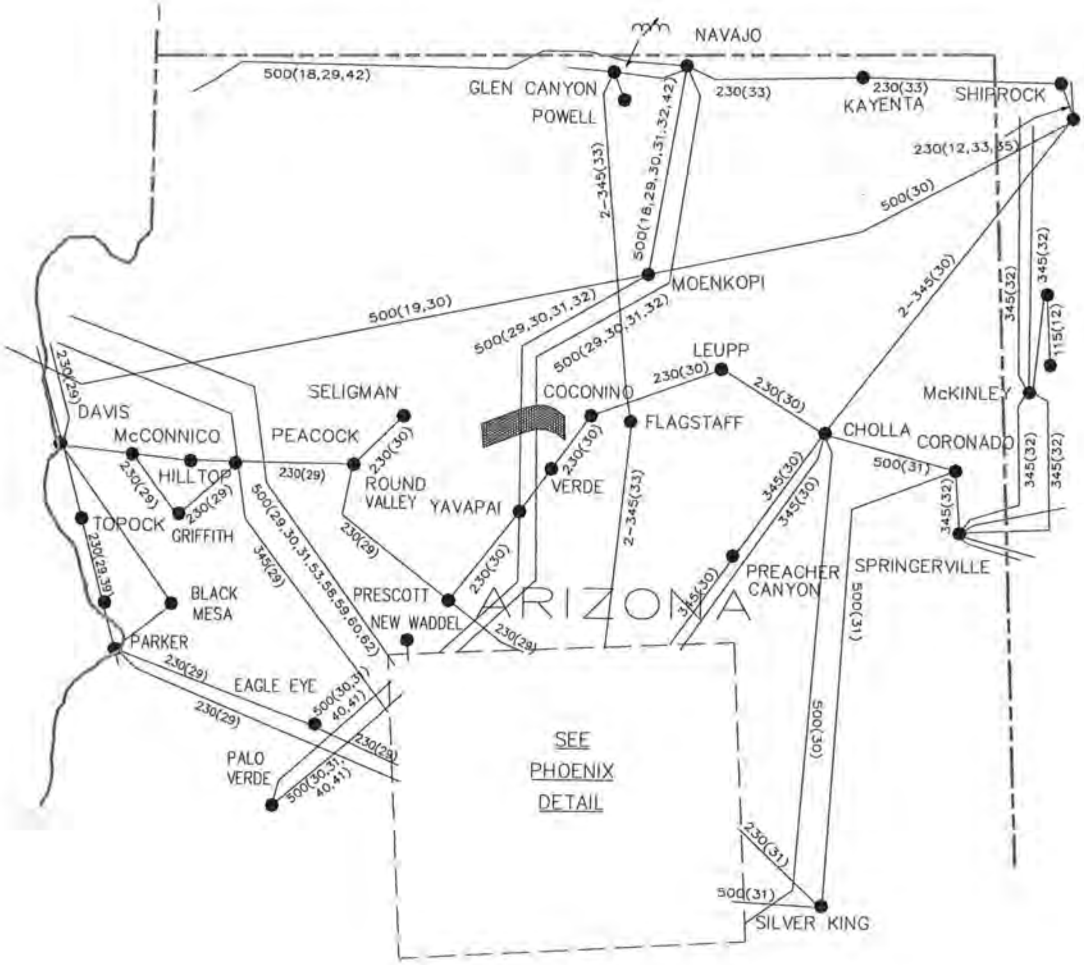


50. Cholla - Pinnacle Peak

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Northern Arizona
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Cholla-Pinnacle Peak 345 kV #1 — Cholla Cholla-Pinnacle Peak 345 kV #2 — Cholla
Transfer Limit:	East to West: 1200 MW West to East: Not rated
Critical Disturbance that limits the transfer capability:	The critical disturbance is loss of one of the Cholla-Pinnacle Peak 345 kV lines which causes the remaining Cholla-Pinnacle Peak 345 kV line to reach the emergency rating.
When:	The 1200 MW rating was established in the early 1980's by the Four Corners Technical Studies Task Force. The task force is comprised of members from the following companies: Arizona Public Service Company El Paso Electric Company Public Service Company of New Mexico Salt River Project Southern California Edison Company Tucson Electric Power Company Verified by 2004 OTC studies.
System Conditions:	Flows on this transfer path have historically been east to west due to the large amount of generation located in northwestern New Mexico and Cholla.
Study Criteria:	Same as the WECC Reliability Criteria for Transmission System Planning.
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	The transfer capability is wholly owned by APS.
Interaction w/Other Transfer Paths:	None
Contact Person:	Tom Isham Arizona Public Service Company P. O. Box 53999, Station 2260 Phoenix AZ 85072-3999 (602) 250-1499 (602) 250-1674 - fax tommy.isham@aps.com

51. Southern Navajo



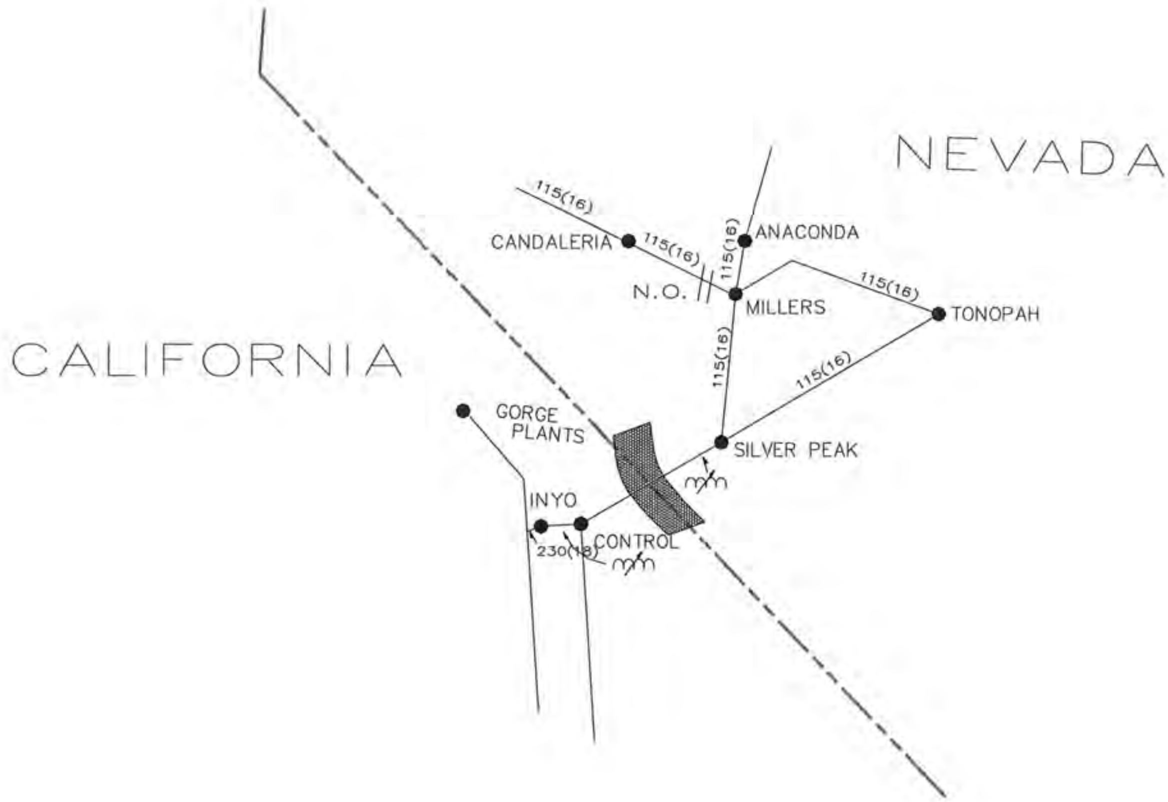
Revised February 2005

51. Southern Navajo

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Northern Arizona
Definition:	Sum of the flows on the following transmission lines: Line — Metered End Moenkopi-Yavapai 500 kV — Moenkopi Navajo-Westwing 500 kV — Navajo
Transfer Limit:	North to South: 2264 MW South to North: Not rated.
Critical Disturbance that limits the transfer capability:	The 2264 MW operating limit is limited by the continuous thermal rating of the series capacitors at the Moenkopi end of the Moenkopi-Yavapai line prior to any line outages.
When:	The transfer rating was established in 1994 in a study performed by APS Transmission Planning. Detailed report mailed August 5, 1994. Verified by 1999 OTC studies.
System Conditions:	Flows on this transfer path have historically been north to south due to the generation at the Navajo power plant. Flows approaching these limiting levels can only be realized when the Palo Verde Nuclear Generating Plant is off line.
Study Criteria:	Same as the WECC Reliability Criteria for Transmission System Planning.
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	The transfer capability is divided among the following entities: APS 24.7% TEP 13.3% SRP 38.3% DOE 23.7%
Interaction w/Other Transfer Paths:	None
Contact Person:	Tom Isham Arizona Public Service Company P. O. Box 53999, Station 2260 Phoenix AZ 85072-3999 (602) 250-1499 (602) 250-1674 - fax tommy.isham@aps.com

52. Silver Peak - Control 55 kV



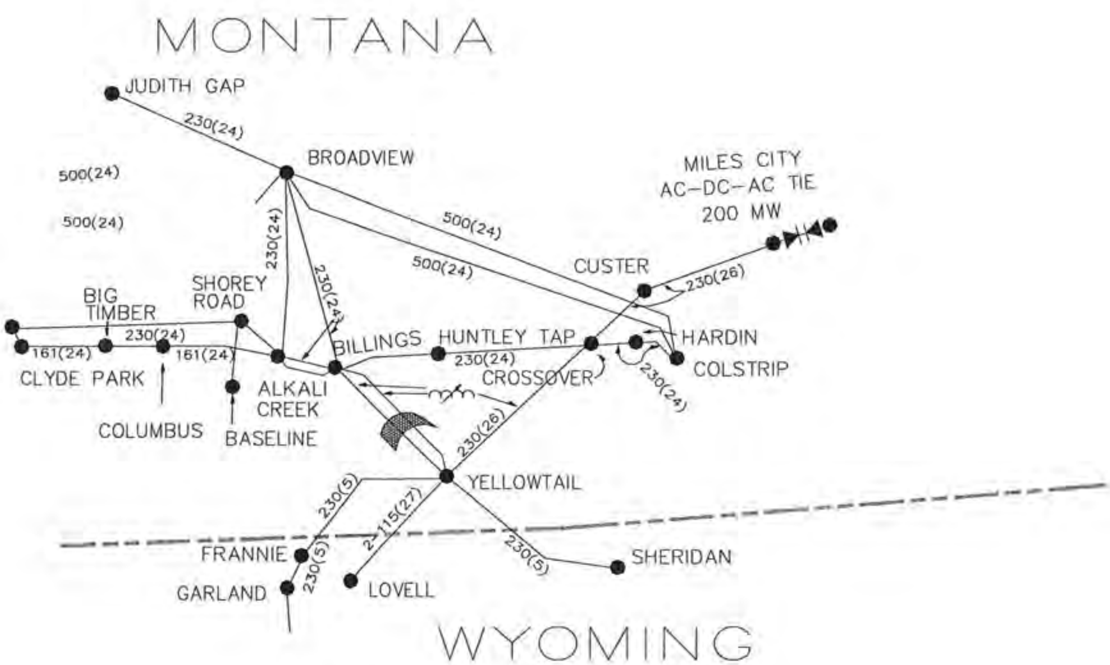
Revised February 2002

52. Silver Peak - Control 55 kV

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southwestern Nevada/Central Eastern California
Definition:	Sum of flows: Line — Metered End Silver Peak-Control 55 kV — California-Nevada border
Transfer Limit:	Direction — Limit Silver Peak to Control — 17 MW Control to Silver Peak — 17 MW
Critical Disturbance that limits the transfer capability:	Limited by pre-disturbance voltage on the intertie caused by surge impedance loading of the line.
When:	Studies were performed in 1985 to establish this line rating.
System Conditions:	Historically, during peak loading conditions, flows on the intertie have been limited to 14 MW.
Study Criteria:	
Remedial Actions Required:	
Formal Operating Procedure:	
Allocation:	
Interaction w/Other Transfer Paths:	
Contact Person:	Joe Tarantino Sierra Pacific Power Company P. O. Box 10100 Reno, NV 89520-0026 (775) 834-3348 (775) 834-3047 - fax jtarantino@sppc.com

53. Billings – Yellowtail (obsolete, see Path 80)



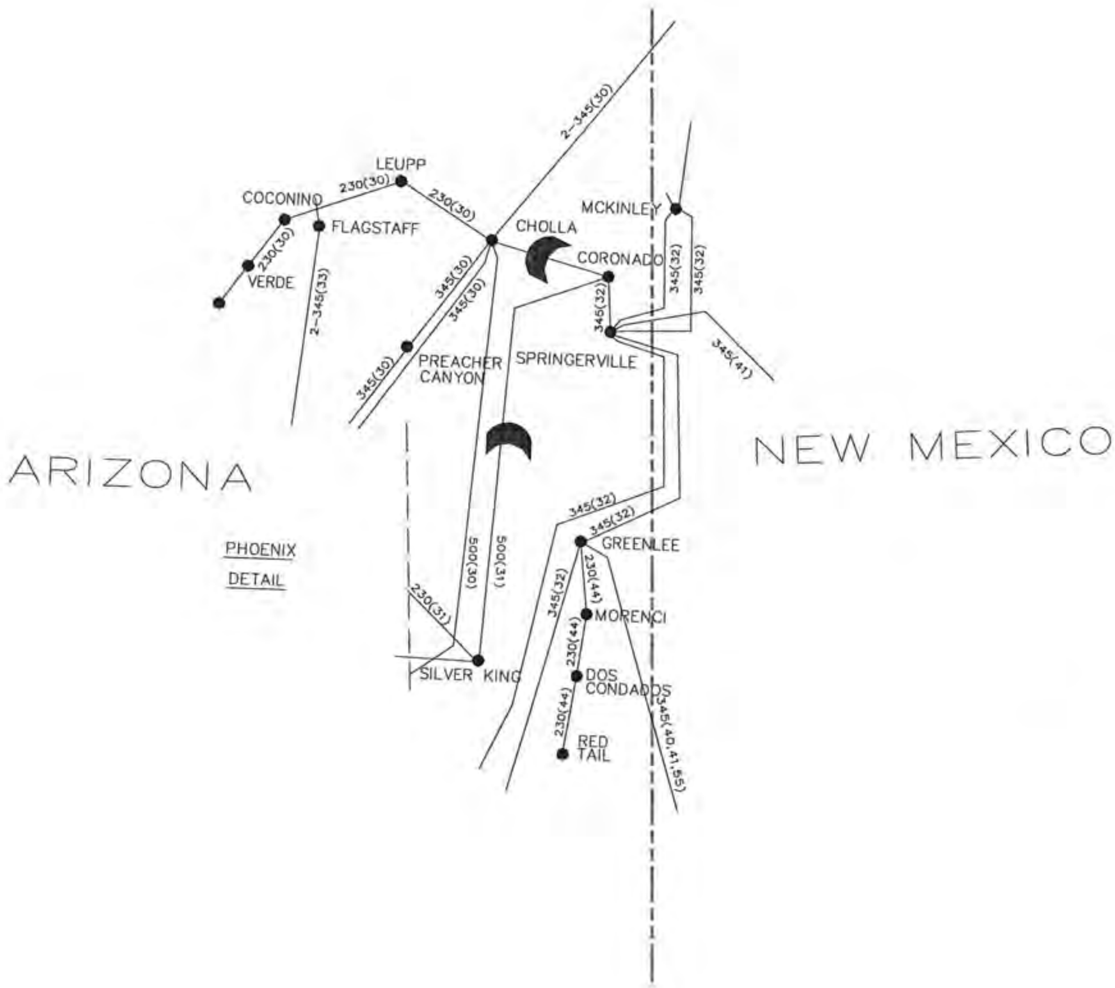
53. Billings – Yellowtail (obsolete, see Path 80)

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	South Central Montana
Definition:	This path consists of the following two lines: Line / Metered End Billings-Yellowtail 230 kV line Rimrock-Yellowtail 161 kV line (Rimrock is another substation in Billings.)
Transfer Limit:	Each of these lines is in series with a phase-shifting transformer at the Billings end. These are rated 300 MVA and 100 MVA respectively. Thus the path rating is 400 MVA.
Critical Disturbance that limits the transfer capability:	
When:	
System Conditions:	
Study Criteria:	
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	
Interaction w/Other Transfer Paths:	
Contact Person:	Charles A. Stigers NorthWestern Energy 40 East Broadway Butte, MT 59701 (406) 497-4538 (406) 497-3393 - fax chuck.stigers@northwestern.com

54. Coronado West

Revised February 2003



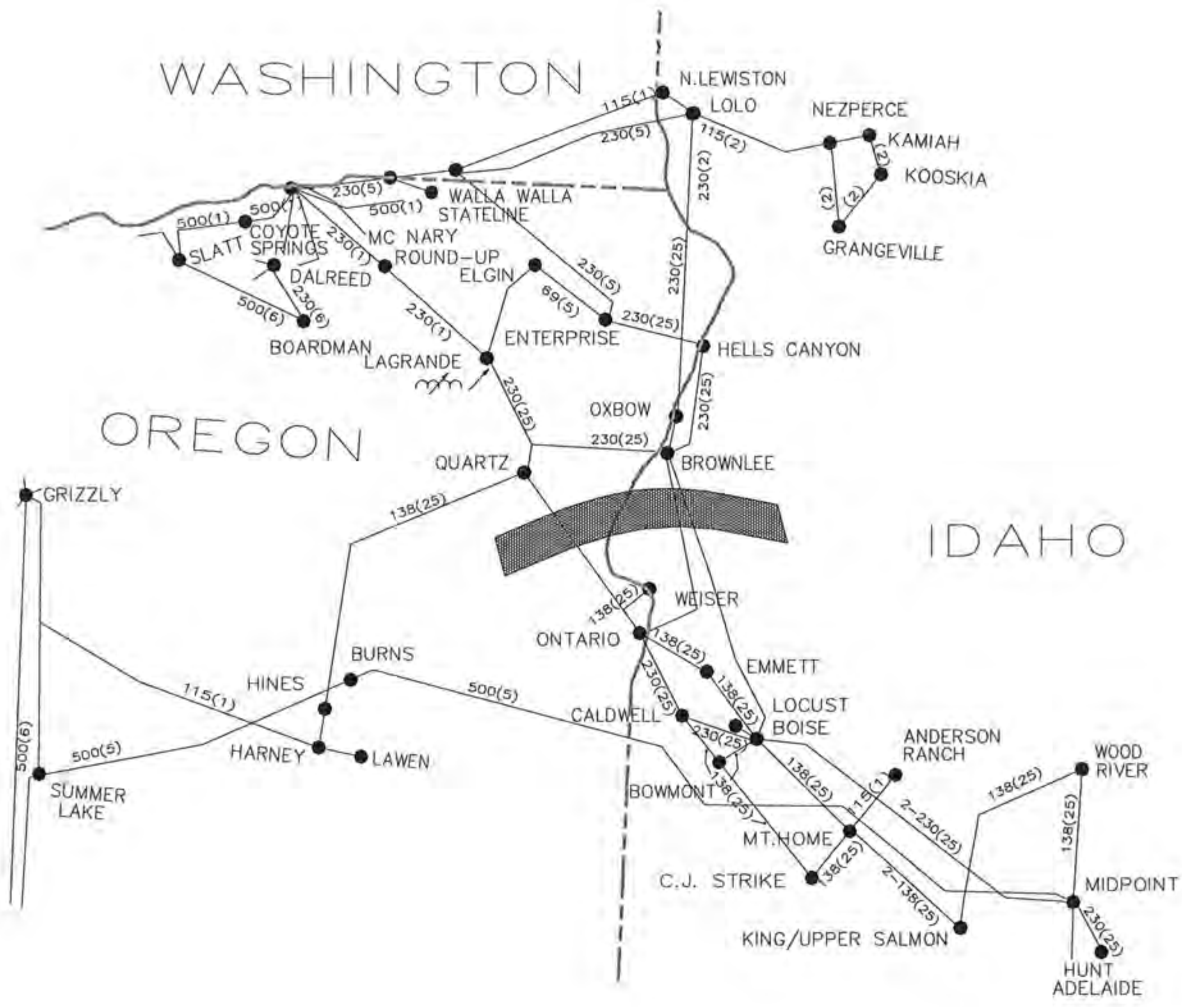
Revised February 2005

54. Coronado West

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Eastern Arizona
Definition:	Sum of flows on the following transmission lines: Line / Metered End Coronado-Silver King 500 kV — Coronado Coronado-Cholla 500 kV — Coronado
Transfer Limit:	East to West: 1100 MW West to East: Not rated
Critical Disturbance that limits the transfer capability:	The critical disturbance is loss of the Four Corners-Moenkopi 500 kV line.
When:	The capacity rating is based on studies performed in 1986 by SRP for the Coronado Transmission System.
System Conditions:	Flows on this transfer path have historically been east to west due to generation at Coronado. Based on two Coronado units in service.
Study Criteria:	WECC Reliability Criteria For Transmission System Planning
Remedial Actions Required:	None
Formal Operating Procedure:	Coronado-Silver King line operating procedure #45407.
Allocation:	Salt River Project
Interaction w/Other Transfer Paths:	None
Contact Person:	James Hsu Salt River Project P.O. Box 52025 Phoenix, AZ 85072-2025 (602) 236-0969 (602) 236-3896 - fax e-mail address: jchsu@srpnet.com

55. Brownlee East



Revised February 2005

55. Brownlee East

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Southwest Idaho
Definition:	The transfer path is comprised of the following lines: Brownlee-Boise Bench #1 230 kV Brownlee-Boise Bench #2 230 kV Brownlee-Boise Bench #3 230 kV Brownlee-Boise Bench #4 230 kV Brownlee-Ontario 230kV Oxbow-McCall 138 kV Quartz-Ontario 138 kV
Transfer Limit:	West to East: 1850 MW East to West: Not defined. However, this transfer path does not restrict east to west transfers through Idaho.
Critical Disturbance that limits the transfer capability:	Post transient reactive margin at the Boise Bench 230 kV following the loss of the Midpoint-Summer Lake 500 kV line, or the loss of two Jim Bridger lines with tripping of two Jim Bridger units, or the loss of two Brownlee-Boise Bench 230 kV lines. Thermal limits on the remaining two Brownlee-Boise Bench 230 kV lines for loss of the other two lines.
When:	In 1983, the Brownlee East transfer limit was established by Idaho Power Company and was revised in 1986 when the Northwest to Idaho transfer limit was restudied. After the July 2 and 3, 1996 disturbances, the Brownlee East transfer limit was restricted to 1560 MW. After the completion of the Brownlee-Boise Bench 230kV Project in 2001, the Brownlee East transmission path attained an Accepted Rating of 1750 MW West to East. The accepted rating was increased to 1850 MW West to East for the summer of 2004 when the final phase of the project, which included the 2nd Brownlee-Oxbow 230 kV circuit, was completed.
System Conditions:	The Brownlee East transfer limit was developed with high Northwest to Idaho imports and T E Roach Complex generation with low eastern thermal resources, and with heavy summer loads.
Study Criteria:	The WECC Reliability Criteria for Transmission System Planning and Idaho Power's post transient reactive margin criteria for N-1 and N-2 disturbances.
Remedial Actions Required:	At high flows East of Brownlee, the loss of two Brownlee-Boise Bench 230 kV lines requires overload mitigation measure of bypassing ½ series compensation in the remaining two Brownlee-Boise Bench 230 kV lines, and in the Brownlee-Ontario 230kV line.

Formal Operating Procedure:	None
Allocation:	The transfer path is an internal path and is 100% owned by Idaho Power Company.
Interaction w/Other Transfer Paths:	None
Contact Person:	Mark D. Hanson Idaho Power Company P.O. Box 70 Boise, ID 83707 (208) 388-2253 (208) 388-6647 - fax mhanson@idahopower.com

56.

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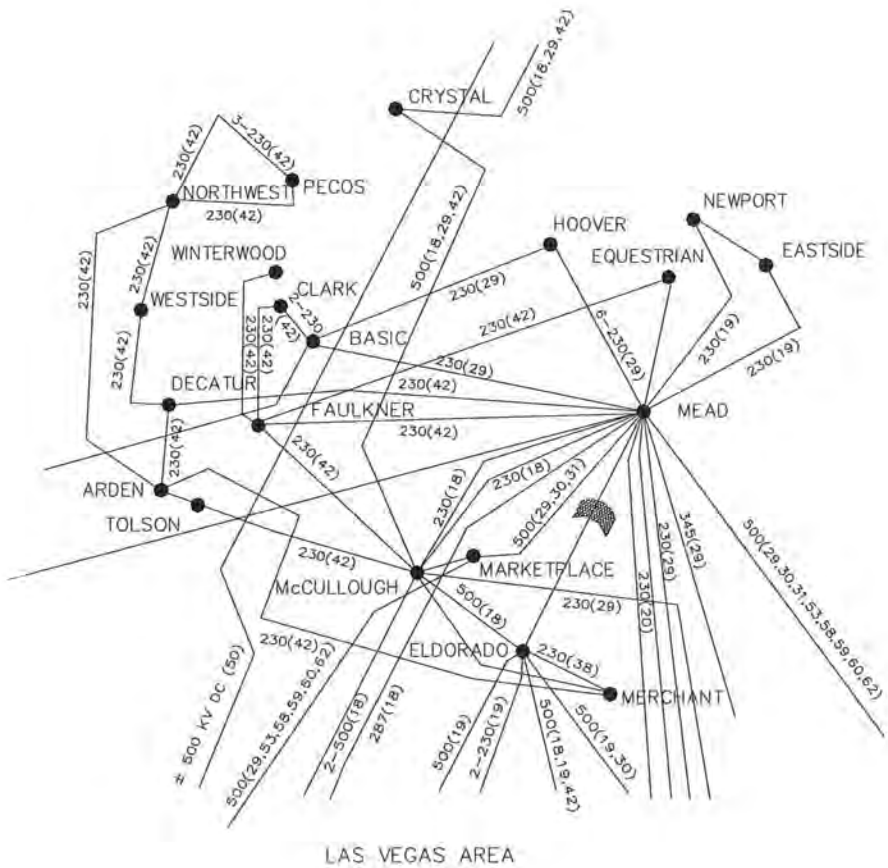
58. Eldorado - Mead 230 kV Lines



58. Eldorado - Mead 230 kV Lines

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Near Boulder City in southern Nevada
Definition:	Flows on the Eldorado-Mead 230 kV transmission lines 1 and 2.
Transfer Limit:	1140 MW
Critical Disturbance that limits the transfer capability:	The 1140 MW rating is limited by the likely contingency (emergency) thermal rating of the conductor. The critical disturbance for which the 1140 MW rating is established, is outage of one of the two Eldorado-Mead 230 kV lines.
When:	The 1140 MW rating was established in 1969.
System Conditions:	Power may flow westbound or eastbound in varying levels throughout the year primarily due to Mohave and Hoover power deliveries.
Study Criteria:	WECC, SCE
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	Jointly owned by SCE (54.700%), NEVP (26.425%) and SRP (18.875%).
Interaction w/Other Transfer Paths:	None
Contact Person:	Patricia L. Arons Southern California Edison P. O. Box 800, Room 460 2131 Walnut Grove Avenue Rosemead, CA 91770 (626) 302-9644 (626) 302-9647 - fax patricia.arons@sce.com

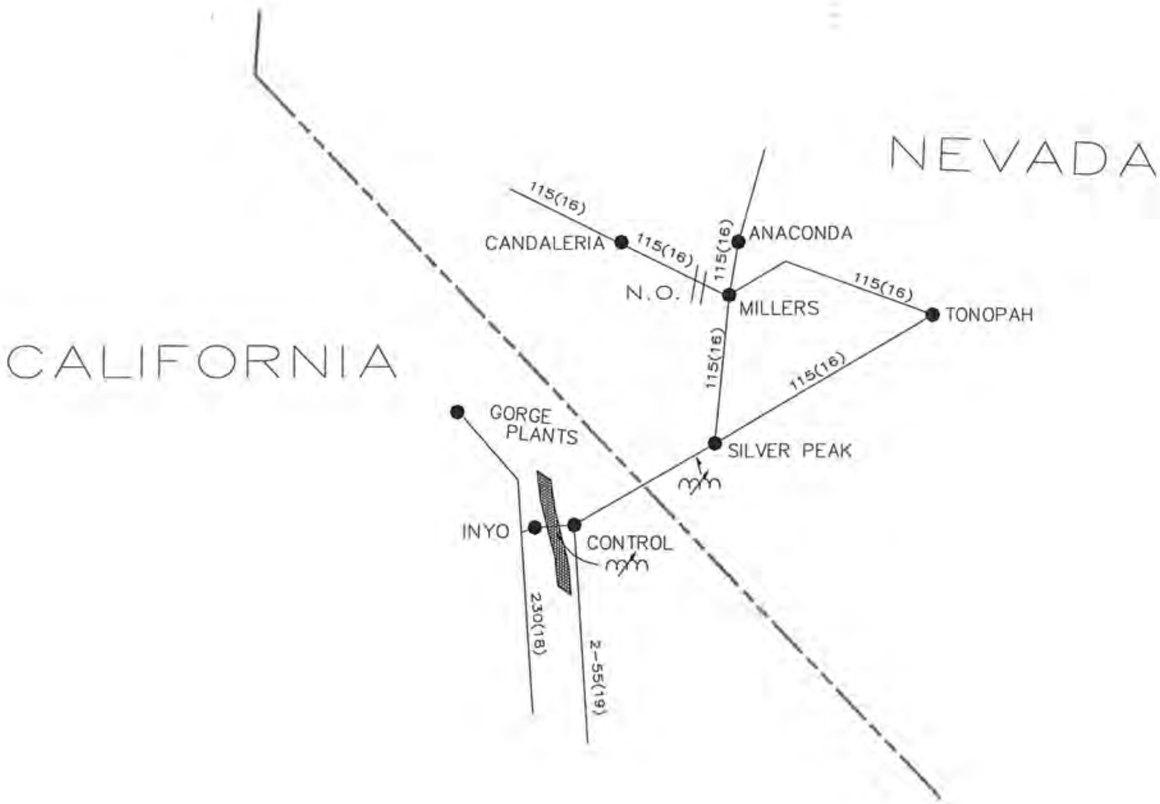
59. WALC Blythe 161 kV Substation - SCE Blythe 161 kV Substation

59. WALC Blythe 161 kV Substation - SCE Blythe 161 kV Substation

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Blythe substation is 5 miles west of the city of Blythe in Riverside County
Definition:	The bus tie-line between WALC Blythe 161 kV substation and SCE Blythe 161 kV substation.
Transfer Limit:	East to West: 218MW -- The E-W transfer capacity of the path is limited by the continuous 168 MVA rating of the Eagle Mountain-Blythe (SCE) 161 kV line. The E-W flow across the bus tie-line between SCE Blythe 161 kV substation and WALC is partially consumed by the load on the Blythe (SCE) 161 kV bus first, and then, goes onto the Eagle Mountain-Blythe (SCE) 161 kV line.
Critical Disturbance that limits the transfer capability:	The path rating is limited by the continuous 168 MVA rating of the Eagle Mountain-Blythe (SCE) 161 kV line.
When:	In 1965, the path rating was established by SCE. In 2002, the path rating was increased due to the replacement of the 230/161 kV transformer at Eagle Mountain and upgrades to the Eagle Mountain-Blythe (SCE) 161 kV line. A letter from the PCC chair dated September 24, 2002 was distributed granting Phase III status and an accepted rating. At the January 2004 TSS meeting, the elimination of the path rating in the west to east direction was approved.
System Conditions:	
Study Criteria:	WECC, SCE, CISO
Remedial Actions Required:	None
Formal Operating Procedure:	Path 59 - WALC Blythe 161 kV Substation - SCE Blythe 161 kV Substation Tie vs. Blythe load east to west.
Allocation:	The transfer is allocated 100% to SCE
Interaction w/Other Transfer Paths:	None
Contact Person:	Patricia L. Arons Southern California Edison P. O. Box 800, Room 460 2131 Walnut Grove Avenue Rosemead, CA 91770 (626) 302-9644 (626) 302-9647 - fax patricia.arons@sce.com

60. Inyo - Control 115 kV Tie



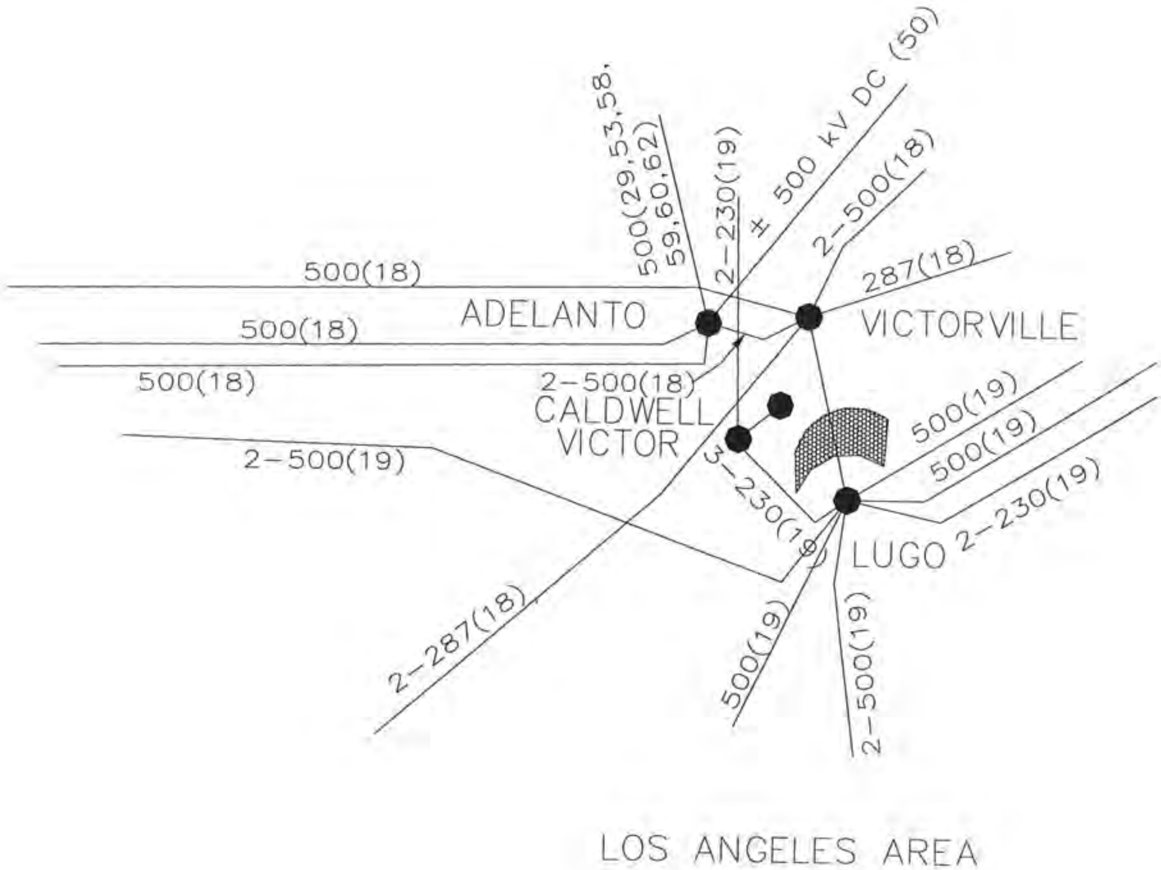
Revised February 2005

60. Inyo - Control 115 kV Tie

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Inyo substation is located 2 miles southwest of the town of Bishop	
Definition:	The 115 kV phase shifter between SCE and LADWP.	
Transfer Limit:	56 MW	
Critical Disturbance that limits the transfer capability:	The path rating is limited by the continuous rating of the 56 MVA phase shifter.	
When:	1976	
System Conditions:		
Study Criteria:	WECC, SCE, LADWP	
Remedial Actions Required:	None	
Formal Operating Procedure:	None	
Allocation:	The transfer is allocated between SCE and LADWP.	
Interaction w/Other Transfer Paths:	None	
Contact Person:	Patricia L. Arons Southern California Edison P. O. Box 800, Room 460 2131 Walnut Grove Avenue Rosemead, CA 91770 (626) 302-9644 (626) 302-9647 - fax patricia.arons@sce.com	Ly Le Los Angeles Dept. Of Water & Power P. O. Box 111, Room 1246 111 N. Hope Street Los Angeles, CA 90051 (213) 367-0302 (213) 367-3829 - fax ly.le@ladwp.com

61. Lugo - Victorville 500 kV Line

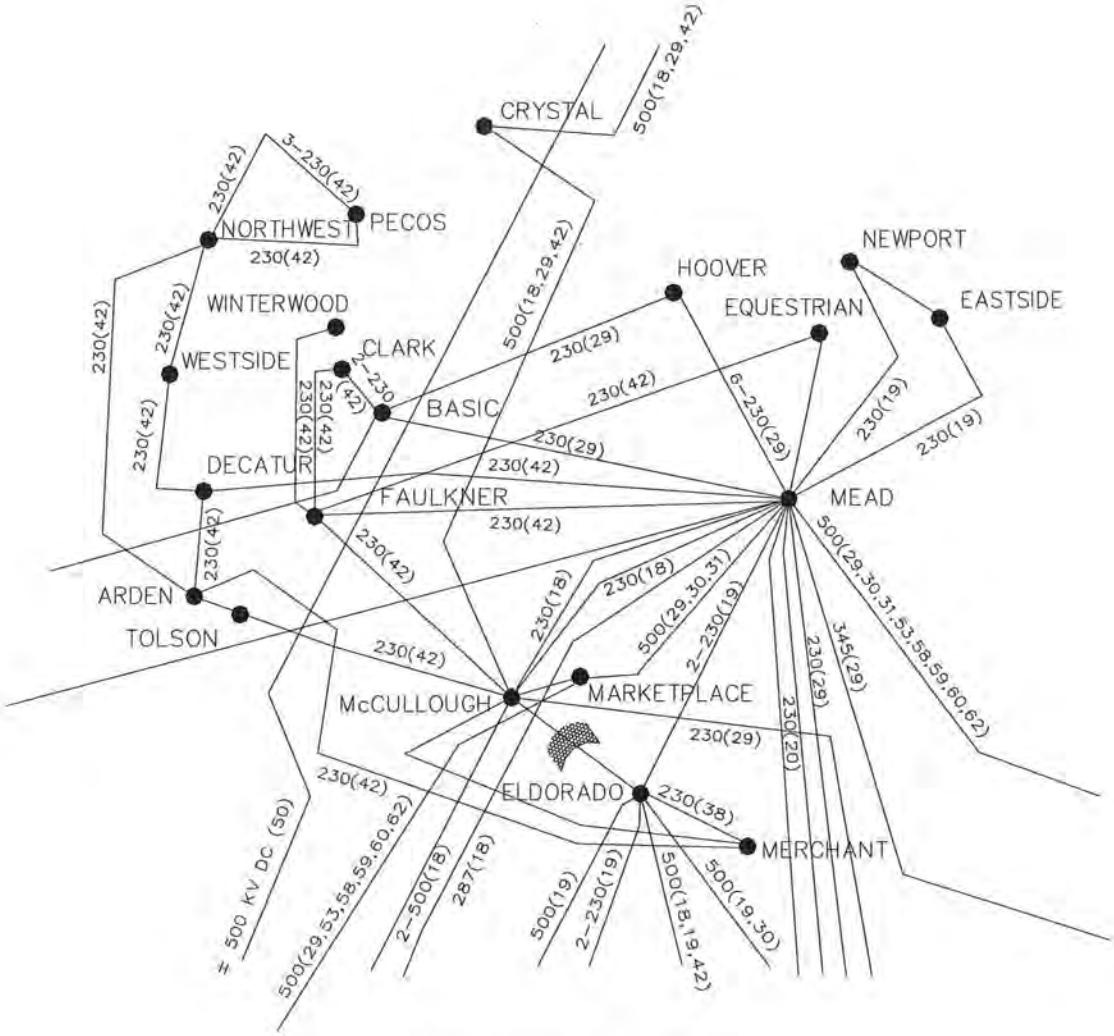


61. Lugo - Victorville 500 kV Line

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	500 kV transmission line from Victorville substation in LADWP's service area to Lugo substation in SCE's service area
Definition:	Line is owned independently from the midpoint of the line to the respective service areas of SCE and LADWP.
Transfer Limit:	Victorville to Lugo: 2400 MW Lugo to Victorville: 900 MW
Critical Disturbance that limits the transfer capability:	The 2400 MW rating is limited by the loss of the Mohave-Lugo or Eldorado-Lugo 500 kV lines in SCE's service territory. The 900 MW rating is limited due to thermal limitations on Inyokern-Searles 115 kV line under N-0 conditions.
When:	The Victorville-Lugo rating was established in 2001 and the Lugo-Victorville rating was established in 1995.
System Conditions:	Victorville to Lugo flows are high during high IPPDC and high EOR/WOR flows. Lugo to Victorville flows are high with low flows on EOR/WOR and low flows on the IPPDC.
Study Criteria:	WECC Reliability Criteria
Remedial Actions Required:	None
Formal Operating Procedure:	Flows on Victorville-Lugo may be limited depending on flows across the Sylmar auto-transformer banks. A dynamic nomogram has also been put in-place to monitor the actual flows on Eldorado-Lugo, Mohave-Lugo, Palo Verde-Devers and Palo Verde-N. Gila lines such that the outage of any one of these lines will not load the Victorville-Lugo line above the emergency rating of 2600 MVA.
Allocation:	The flows are allocated between LADWP, SCE, Anaheim and Riverside.
Interaction w/Other Transfer Paths:	Flow on this path is dependent on internal generation in SCE, and flows on IPPDC, EOR/WOR, Midway-Vincent 500 kV lines and north of Lugo paths.
Contact Person:	Ly Le Los Angeles Dept. Of Water and Power P. O. Box 111, Room 1246 111 N. Hope Street Los Angeles, CA 90051 (213) 367-0302 (213) 367-3829 - fax ly.le@ladwp.com Patricia L. Arons Southern California Edison P. O. Box 800, Room 460 2131 Walnut Grove Avenue Rosemead, CA 91770 (626) 302-9644 (626) 302-9647 - fax patricia.arons@sce.com

62. Eldorado - McCullough 500 kV Line



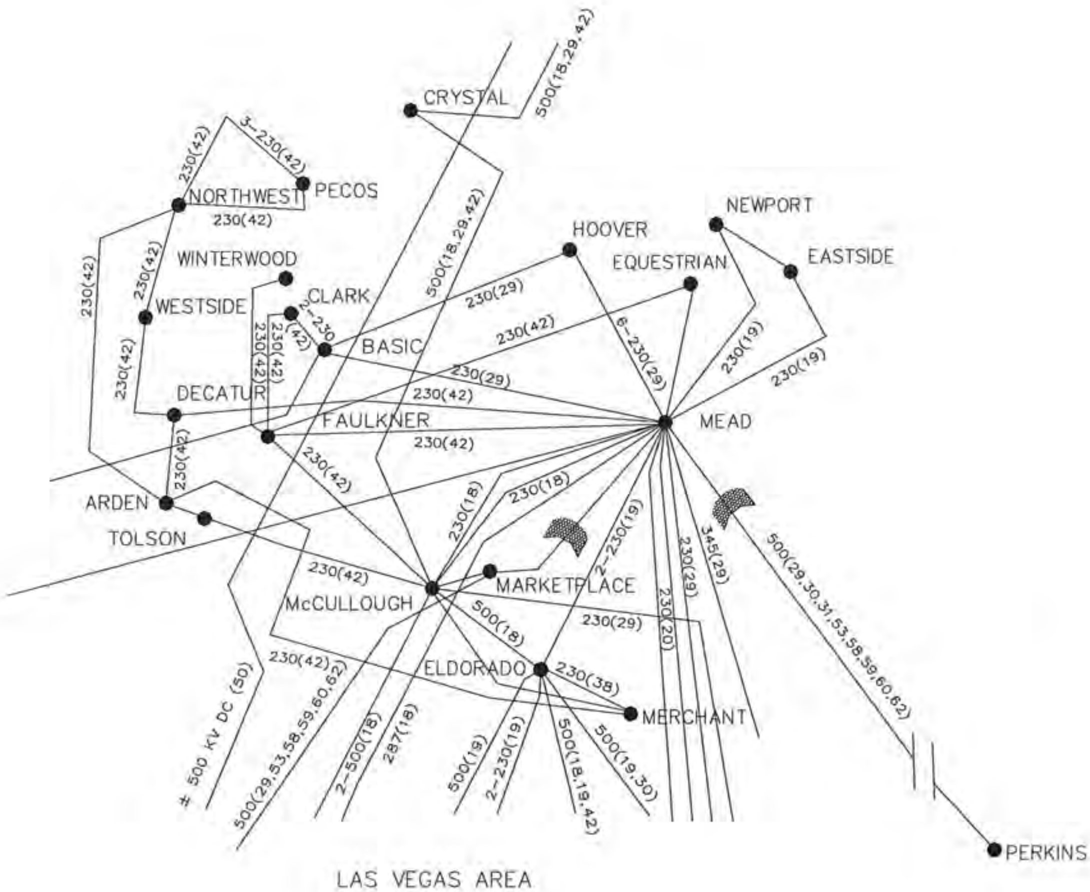
LAS VEGAS AREA

62. Eldorado - McCullough 500 kV Line

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	It is a 0.6 mile long 500 kV transmission line from McCullough substation in LADWP'S service area to Eldorado substation in SCE's service territory
Definition:	The line is owned by LADWP for the purpose of mutual support between LADWP and SCE.
Transfer Limit:	The line is limited to 2598 MVA (3000 Amperes) in either direction.
Critical Disturbance that limits the transfer capability:	The transfer is limited by the continuous rating of circuit breakers at the two substations.
When:	The rating was established in 1970.
System Conditions:	The power flows from McCullough to Eldorado almost all the time. The level of the flow is dependent on generation commitment, EOR/WOR schedules and the lines in service.
Study Criteria:	WECC, LADWP and SCE
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	The flows on the line are allocated between: LADWP, SCE, and cities of Burbank, Glendale, Pasadena, Azusa, Banning, Colton, Vernon, and Riverside.
Interaction w/Other Transfer Paths:	Flow across this line is dependent on unit commitment in southern California, southern Nevada and Arizona and flows across the EOR and the WOR paths.
Contact Person:	Ly Le Los Angeles Dept. Of Water and Power P. O. Box 111, Room 1246 111 N. Hope Street Los Angeles, CA 90051 (213) 367-0302 (213) 367-3829 - fax ly.le@ladwp.com Patricia L. Arons Southern California Edison P. O. Box 800, Room 460 2131 Walnut Grove Avenue Rosemead, CA 91770 (626) 302-9644 (626) 302-9647 - fax patricia.arons@sce.com

63. Perkins - Mead - Marketplace 500 kV Line



63. Perkins - Mead - Marketplace 500 kV Line

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Line from Perkins (Phoenix, AZ area) to Mead substation and Marketplace station (Las Vegas area)
Definition:	The Perkins-Mead-Marketplace 500 kV AC line (Mead-Phoenix Project or MPP) is 260 miles long with 70% series compensation of the line impedance between Perkins and Mead (35% at Perkins and 35% at Mead), one 500/230 kV transformer at Mead, two 650 MVA 500 kV phase shifters installed, in parallel, at Perkins. A tie line between Marketplace and McCullough and two 387.5 MVAR static var compensators located at Marketplace and Adelanto are jointly owned with the Mead-Adelanto Project (MAP). The Perkins-Mead portion of the line, according to the existing system interconnections, is considered part of the East-of-the-River (EOR) path.
Transfer Limit:	East to West: Rating of 1300 MW West to East: Not rated The MPP is part of the EOR transmission path. The WECC Accepted Rating of the EOR path is: East to West: 7550 MW West to East: Not rated (See "East of the Colorado River (EOR)" for additional path rating information.)
Critical Disturbance That limits the Transfer Capability:	Loss of the Palo Verde-North Gila 500 kV line following a three-phase fault at Palo Verde 500 kV station.
When:	The 1300 MW MPP rating, in conjunction with the 1200 MW MAP rating, was established through the WECC Project Planning Project according with the WECC Interim Procedures for Regional Planning Project Review and Rating Transmission facilities. In accordance with these Interim Procedures, the Mead-Phoenix/Mead-Adelanto WECC Review Group was established in July, 1992 to facilitate peer review of the projects by WECC membership. The Review Group issued a final report on July 8, 1993. The WECC Planning Coordination Committee (PCC) accepted the Review Group's report on July 15, 1993. The PCC's acceptance of the report completed Phase II of the WECC Project Planning Process and established a WECC Accepted Rating for the EOR path of 7000 MW. The 1300 MW incremental increase in the EOR rating is allocated to the MPP owners.
System Conditions:	1995/96 Heavy Summer and Heavy Winter conditions. Pre and Post Project benchmark cases were developed in which the EOR and Southern California Import Transmission (SCIT) Nomogram paths were stressed separately until a stability limit was reached. See "East of the Colorado River (EOR)" for additional information on SCIT.

Study Criteria:	WECC Reliability Criteria for Transmission System Planning
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	Southern California Public Power Authority Anaheim 47 Azusa 3 Banning 3 Burbank 35 Colton 3 Glendale 28 LADWP 74 Pasadena 33 Riverside 12 Salt River Project 236 Arizona Public Service 236 Modesto-Redding-Santa Clara 150 Vernon 28 <u>Western</u> <u>412</u> Total 1300 MW
Interaction w/Other Transfer Paths:	See "East of the Colorado River (EOR)."
Contact Person:	James Hsu Salt River Project P. O. Box 52025 Phoenix, AZ 85072-2025 (602) 236-0969 (602) 302-3896 - fax jchsu@srpnet.com

64. Marketplace - Adelanto

Revised February 1998

64. Marketplace - Adelanto

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Line from Marketplace station near McCullough to Adelanto station in southern California
Definition:	The Mead-Adelanto Project (MAP) consists of a 45% series compensated 500 kV transmission line, a tie line between Marketplace and McCullough, and two 387.5 MVAR static var compensators (SVCs) located at the termination points. (The SVCs and the tie line are jointly owned with the Mead-Phoenix Project (MPP)). The MAP line, according to the physical system interconnections, is considered part of the West-of-the-(Colorado) River (WOR) path. The MAP was put in-service on January 1996.
Transfer Limit:	Accepted rating of 1200 MW
Critical Disturbance that limits the transfer capability:	Loss of Palo Verde-North Gila line following three-phase fault at Palo Verde 500 kV station.
When:	The 1200 MW MAP accepted rating, in conjunction with the 1300 MW MPP accepted rating, was established through the WECC Project Planning Process in accordance with the WECC Policies and Procedures for Rating Transmission Facilities. A WECC Ad Hoc Review Group on the Accepted Rating of the MAP/MPP was established in July 1992. The Review Group issued a final report on July 8, 1993. The WECC PCC accepted the Accepted Rating Report on July 15, 1993.
System Conditions:	The MAP line transfer capability is sensitive to the flows on the other West of River (WOR) lines. The MAP accepted rating of 1200 MW is based on the WOR transfer rating of 8206 MW. The MAP rating assumes that 250 MW of the 1200 MW is scheduled to the project participants in northern California. Thus, the SCIT import capability will be increased by 1300 MW on the EOR axis and approximately 950 MW on the SCIT axis for 1995 heavy winter conditions. Two 387.5 MVAR SVCs are included at the Marketplace and Adelanto stations for dynamic support. The MPP line with 1300 MW schedule is also considered to be in service in the MAP rating studies.
Study Criteria:	WECC Reliability Criteria for Transmission System Planning
Remedial Actions Required:	None
Formal Operating Procedure:	None

Allocation:		Percentage	MW
	Southern California Public Power Authority (SCPPA)	67.9167	815
	Anaheim	9.1666	110
	Azusa	1.5000	18
	Banning	0.9167	11
	Burbank	7.8334	94
	Colton	1.7500	21
	Glendale	7.5000	90
	LADWP	24.2500	291
	Pasadena	5.8334	70
	Riverside	9.1666	110
	Modesto-Redding-Santa Clara	17.5000	210
	Vernon	6.2500	75
	Western	8.3333	100
Interaction w/Other Transfer Paths:	Because this line is considered part of the WOR path, the loading on the other WOR lines will have influence on the MAP line power transfer capability. Currently, the WOR path flow is one of the components of the Southern California Import Transmission (SCIT) nomogram. Therefore, the other components of the SCIT-Midway-Vincent, PDCI, IPPDC, North of Lugo and East-of-the-River (EOR) will also have influence on the MAP line transfer flow capability.		
Contact Person:	Ly Le Los Angeles Department of Water and Power P. O. Box 111, Room 1246 111 North Hope Street Los Angeles, CA 90051 (213) 367-0302 (213) 367-3829 - fax ly.le@ladwp.com		

65. Pacific DC Intertie (PDCI)

65. Pacific DC Intertie (PDCI)

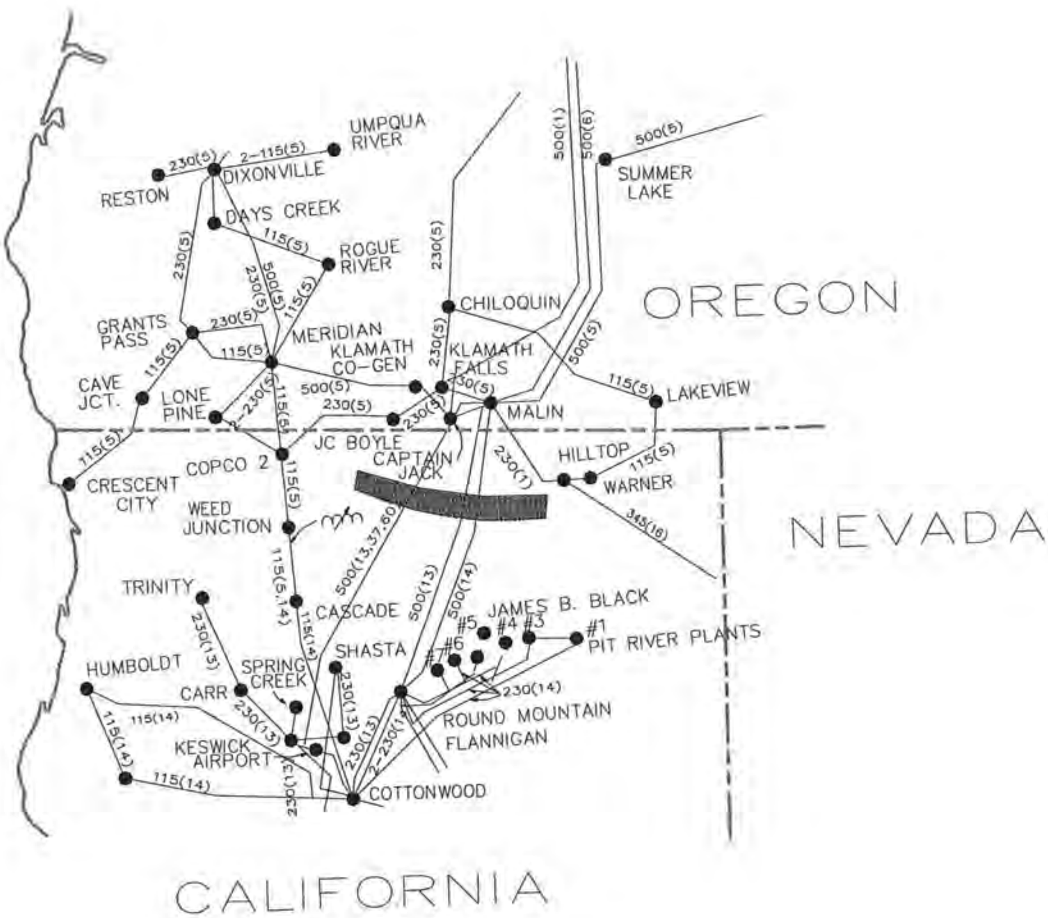
Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Line from Celilo station (Big Eddy area) in northern Oregon to Sylmar station in southern California
Definition:	The PDCI line is a ∀500 kV DC multi-terminal system. This system is divided into the northern and southern systems, the demarcation point is the Nevada-Oregon state line border (NOB).
Transfer Limit:	Based on the sending end measured power: Celilo to Sylmar (North to South): 3100 MW Sylmar to Celilo (South to North): 3100 MW
Critical Disturbance that limits the transfer capability:	Loss of the PDCI bipole line.
When:	<u>North to South</u>: The rating upgrade from 2000 MW to 3100 MW was through the DC Expansion Review Group studies performed in 1985-1988 and the 1100 MW Expansion Project progress reports of March 25, 1985 and September 26, 1985. The DC Expansion Review Group was established by a letter to PCC on March 28, 1984. The Expansion Project was put in commercial operation on May 4, 1989. The rating was established by the Los Angeles Department of Water and Power, and the Bonneville Power Administration. <u>South to North</u>: The 3100 MW rating was based on the publication of the "3100 MW South-to-North Pacific DC Intertie Rating" report of July 1992. The rating was established by the Los Angeles Department of Water and Power, and the Bonneville Power Administration, in conjunction with the California Power Pool.
System Conditions:	<u>North to South</u>: The system transfer capability is most sensitive to the power flow level on the COI. High level of northern California hydro on line is also important for voltage support of 3100 MW bipole outage if the static VAR devices in the Northwest and PG&E areas are out of service. <u>South to North</u>: The system transfer capability is sensitive to the south to north power flow levels on the COI, the Midway-Vincent lines, and the east to west transfer levels on the Idaho-Northwest lines (West-of-Borah flows).

Study Criteria:	North to South: System intact: • Series capacitor loading within normal continuous rating on the PG&E's South-of-Tesla lines. Single contingency outage conditions: (bipole outage) • VAR margin of 300 MVAR (subsequently changed to 400 MVAR) and minimum 500 kV voltage of 480 kV in PG&E's system for post-transient conditions. • General WECC reliability criteria. South to North: System intact: • Series capacitor loading within normal continuous rating on the PG&E's South-of-Tesla lines. Single contingency outage conditions: (bipole outage) • With minimum operating voltage profile in Idaho & Northwest areas, VAR margin of 250 MVAR at Idaho's critical bus (generally Midpoint, Borah or Kinport) for post-transient conditions. • Series capacitor loading within emergency thermal rating on the PG&E's South-of-Tesla lines. • WECC reliability criteria. (8/11/87 version)
Remedial Actions Required:	North to South: Generator dropping in the Northwest, and series capacitor fast insertion on the Pacific Intertie AC lines are remedial actions used for partial and full loss of the PDCI intertie. Mechanically switched capacitors (MSC) have been installed in the Northwest and COI systems for post-transient voltage support for loss of the 3100 MW PDCI bipole system. South to North: Load dropping remedial action scheme in the Northwest is implemented for loss of the 3100 MW PDCI bipole system. The Northwest and COI MSCs will also be activated for post-transient voltage support.
Formal Operating Procedure:	North to South: Arming of the generation dropping is performed by Northwest (BPA) by monitoring the actual power flow on the DC line and the available generation for dropping. South to North: Load-dropping in the Northwest is implemented. PDCI power flow monitoring and load dropping arming is performed by the Northwest (BPA).
Allocation:	The percentage ownership and scheduling allocations of the line is as follows: <table><tr><td></td><td><u>Ownership</u></td><td><u>Scheduling</u></td></tr><tr><td>SCE</td><td>50.00</td><td>38.22</td></tr><tr><td>LADWP</td><td>40.00</td><td>23.28</td></tr><tr><td>San Diego</td><td></td><td>3.5</td></tr><tr><td>PG&E</td><td></td><td>21.6</td></tr><tr><td>Glendale</td><td>3.85</td><td>3.85</td></tr><tr><td>Burbank</td><td>3.85</td><td>3.85</td></tr><tr><td>Pasadena</td><td>2.30</td><td>2.30</td></tr><tr><td>Vernon</td><td></td><td>3.4</td></tr></table>

Interaction w/Other Transfer Paths:	North to South: A nomogram showing the relationship between the transfers on the BC Hydro-TransAlta Intertie and the PDCI was developed prior to the completion of COTP. Studies now conducted by BPA indicate that with the COTP in service, no nomogram is required. These new results are in the process of being reviewed. South to North: There is close dependence with the transfer on the Pacific AC Intertie (between Los Banos and Midway) and the Idaho transfer to the Northwest (West-of-Borah).
Contact Person:	Ly Le Los Angeles Department of Water and Power P. O. Box 111, Room 1246 111 North Hope Street Los Angeles, CA 90051 (213) 367-0302 (213) 367-3829 - fax ly.le@ladwp.com

66. COI


UMPQUA RIVER
RESTON
DIXONVILLE
DAYS CREEK
ROGUE RIVER
GRANTS PASS
MERIDIAN
KLAMATH CO-GEN
KLAMATH FALLS
CHILOQUIN
SUMMER LAKE
OREGON
LAKEVIEW
CAVE JCT.
LONE PINE
JC BOYLE
MALIN
CAPTAIN JACK
COPCO 2
HILLTOP
WARNER
CRESCENT CITY
WEED JUNCTION
NEVADA
TRINITY
CASCADE
JAMES B. BLACK
PIT RIVER PLANTS
HUMBOLDT
SPRING CREEK
SHASTA
CARR
ROUND MOUNTAIN
FLANNIGAN
KESWICK
AIRPORT
COTTONWOOD
CALIFORNIA

Revised February 2001

66. COI

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Between Oregon and northern California
Definition:	Malin to Round Mt. 500 kV (2 lines) (Pacific AC Intertie) Captain Jack-Olinda 500 kV line (COTP)
Transfer Limit:	4800 MW North to South 3675 MW South to North
Critical Disturbance that limits the transfer capability:	With north to south transfers, the critical outage is the loss of two Palo Verde units or the DC Bipole outage. The outage of the Coulee-Hanford 500 kV line is critical with high North of John Day flows. The critical outage for the California portion of the COI when transfers are north to south is the south of Table Mt. 500 kV outage (Table Mt. To Tesla and Table Mt. To Vaca-Dixon). With south to north transfers, the critical outages are (1) single line outage of the Captain Jack-Meridian 500 kV line and the PDCI, (2) a double line outage of the Malin-Round Mt. 500 kV lines, and (3) a double line outage of the Ashe-Marion and Buckley-Marion 500 kV lines (this latter outage is limiting with high west-side loads in Oregon). Most of these critical outages were limiting due to voltage stability margin.
When:	The 4800 MW north to south rating was established in 1986 through the WECC Annual Progress Report Procedure. Update reports were submitted each year since through 1992. The 3675 MW south to north limit was established in November 1992.
System Conditions:	Six cases were studied (Heavy Summer; Heavy Spring; Light Winter; PG&E importing; PG&E exporting; BPA spring). • The PDCI is 3100 MW (n-s) in the N-S cases, 2000 MW (n-s) in the PG&E import case and 2000 MW (s-n) in the S-N cases. • Northern California hydro is at 60% in the BPA spring case and 90% in other cases. • Cases were developed showing both 1 and 2 units on line at Diablo for the Spring and Summer. The light winter case had 2 units on line as does the PG&E import case. The PG&E export case has 1 Diablo unit on line.
Study Criteria:	All facilities loaded within normal ratings under normal system conditions. All facilities loaded within emergency ratings under outage conditions. The system meets the WECC voltage stability criteria recommended by TSS. Fully meets WECC reliability criteria in effect at time rating was established. The study's results meet the reliability criteria of all utilities in the Northwest and northern California.

Remedial Actions Required:	Depending on the outage and the magnitude and direction of flow, one or more of the following remedial actions may be used: Northwest generator dropping Chief Jo Brake insertion Fort Rock Series Capacitor insertion Northwest load dropping Feather River generator dropping Northern and central California pump dropping Round Mt 500/230 kV transformer bank opening Series capacitor bypassing on the Olinda-Tracy 500 kV line Series capacitor bypassing on the Malin-Round Mt. #1 and #2 500 kV lines MSC insertion at Malin, Table Mt, Olinda, and/or Tracy 500 kV stations Shunt reactors at Olinda and Tracy NE/SE Separation Scheme Northwest Shunt Reactive Switching
Formal Operating Procedure:	WECC operating procedure #1 BPA Standing Order 306 and California ISO T-102 (COI/PDCI/North of John Day Nomogram Operation) California ISO T-120 (Adverse Operating Conditions)
Allocation:	Northwest: BPA (58.8%), PacifiCorp (8.3%), PGE (17.7%), NW capacity Owners (15.1%) California: PACI participants (2/3), COTP Participants (1/3)
Interaction w/Other Transfer Paths:	Nomograms are routinely developed to identify simultaneous operating constraints between this path and other paths including: the Pacific DC Intertie, North of John Day, Montana, Idaho, and Reno-Alturas path. (Please see entry to Formal Operating Procedure above.)
Contact Person:	California: Eric Law PG&E 77 Beale St. B15A San Francisco, CA 94105 (415) 973-7628 (415) 973-8804 - fax etl1@pge.com Morteza Sabet WAPA, N4400 114 Parkshore Drive Folsom, CA 95630 (916) 353-4489 (916) 985-1935 - fax sabet@wapa.gov Dilip Mahendra SMUD, MS D113 P. O. Box 15830 Sacramento, CA 95852 (916) 732-6180 (916) 732-7517 - fax dmahend@smud.org Northwest: Mike Kreipe (TOP-PPOC2-2) BPA 8100 NE Parkway Dr. #50 Vancouver, WA 98662-1409 (360) 619-6686 (360) 619-6945 - fax mjkreipe@bpa.gov George Hutcherson PGE 121 S. W. Salmon Street 3WTC0506 Portland, OR 97204 (503) 464-8027 (503) 464-8178 - fax george.hutcherson@pgn.com Don Johnson PacifiCorp 9951 S.E. Ankeny Street Second Floor Portland, OR 97216-2315 (503) 251-5283 (503) 251-5228 - fax don.johnson@pacificorp.com

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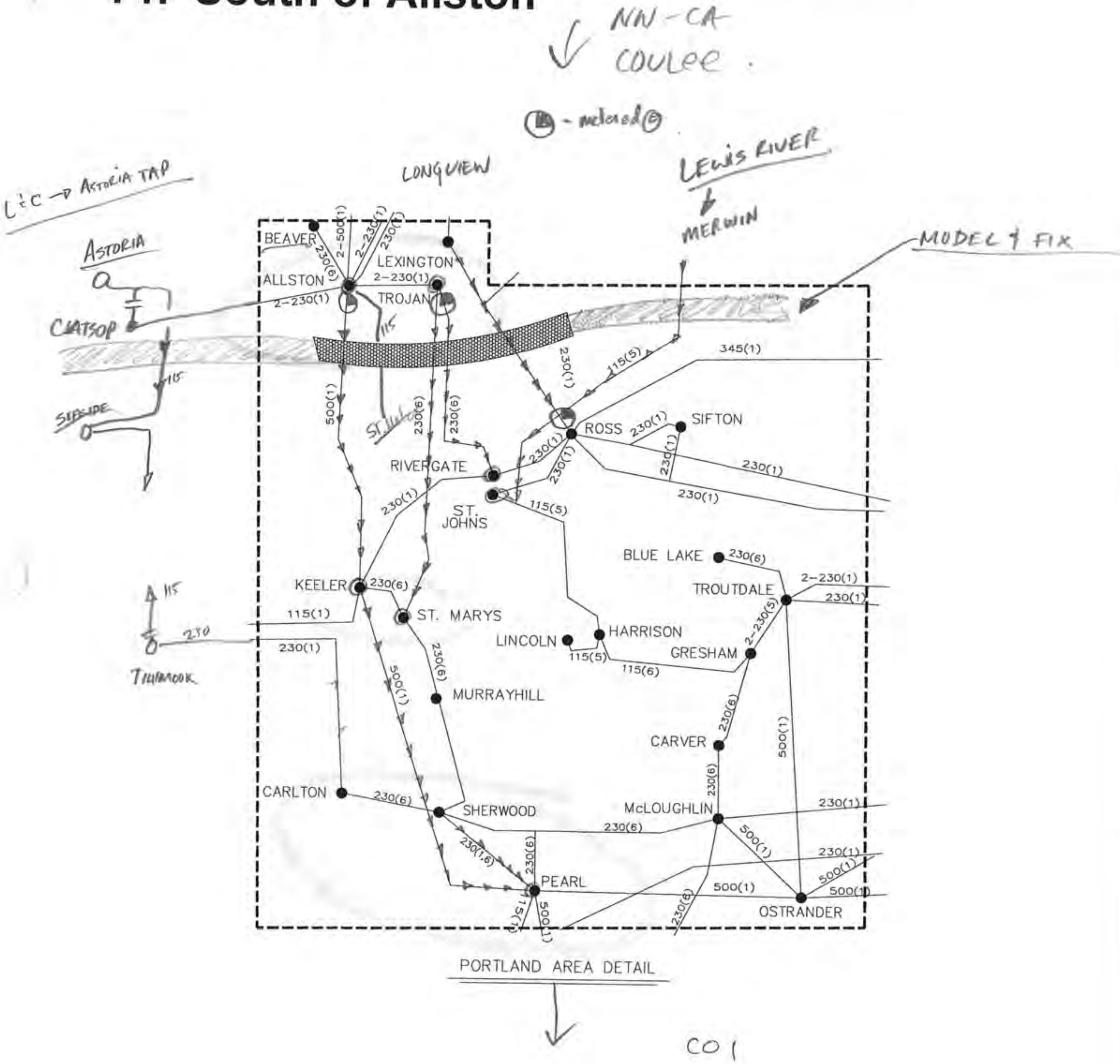
71. South of Allston



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Reinstated February 2004

71. South of Allston

Accepted Rating ☐
Existing Rating ☐
Other ☒

Location:	Southwestern Washington/Northwestern Oregon
Definition:	Sum of the flows on the following lines: Line — Metered End Allston-Keeler 500 kV — Allston Allston-Rainier 115 kV — Allston Astoria Tap-Seaside 115 kV — Astoria Tap Merwin-View 115 kV — Merwin Trojan-Rivergate 230 kV — Trojan Trojan-St Marys 230 kV — Trojan Woodland Tap-Ross 230 kV — Woodland Tap
Transfer Limit:	Path limit yet to be determined. RAS armed over a range of 1030-1620 MW loading on the Allston-Keeler 500 kV line, depending on system conditions (all lines in service). Maximum Allston - Keeler 500 kV line loading 1620 MW, based on OTC studies.
Critical Disturbance that limits the transfer capability:	Allston-Keeler 500 kV line
When:	
System Conditions:	Heavy summer loadings Canada - NW – high north to south flow California - Oregon Intertie – high north to south flow Pacific DC Intertie – high north to south flow Upper Columbia generation high Lower Columbia generation low I-5 Corridor generation high
Study Criteria:	BPA, PGE, PAC and WECC
Remedial Actions Required:	Generation dropping on available I-5 corridor thermal generation (Chehalis, Big Hanaford and Fredrickson) Generation ramping on Lewis River (Swift and Yale) Generation dropping in B.C. Hydro Generation dropping on Upper Columbia (Coulee and Chief Joseph)
Formal Operating Procedure:	BPA Dispatcher Standing Order No. 309 dated 6-6-03
Allocation:	Yet to be determined.
Interaction w/Other Transfer Paths:	None

Contact Person:	Mike J. Kreipe (TOP-PPOC2-2) Bonneville Power Administration 8100 NE Parkway Drive #50 Vancouver, WA 98662-1409 (360) 619-6686 (360) 619-3945 –fax mjkreipe@bpa.gov George Hutcherson Portland General Electric 121 S. W. Salmon Street, 3WTC0506 Portland, OR 97204 (503)464-8027 (503) 464-8178 – fax george.hutcherson@pgn.com Don Johnson PacifiCorp 9951 S.E. Ankeny Street, 2nd Floor Portland, OR 97216-2315 (503) 251-5283 (503) 251-5228 – fax don.johnson@pacificorp.com

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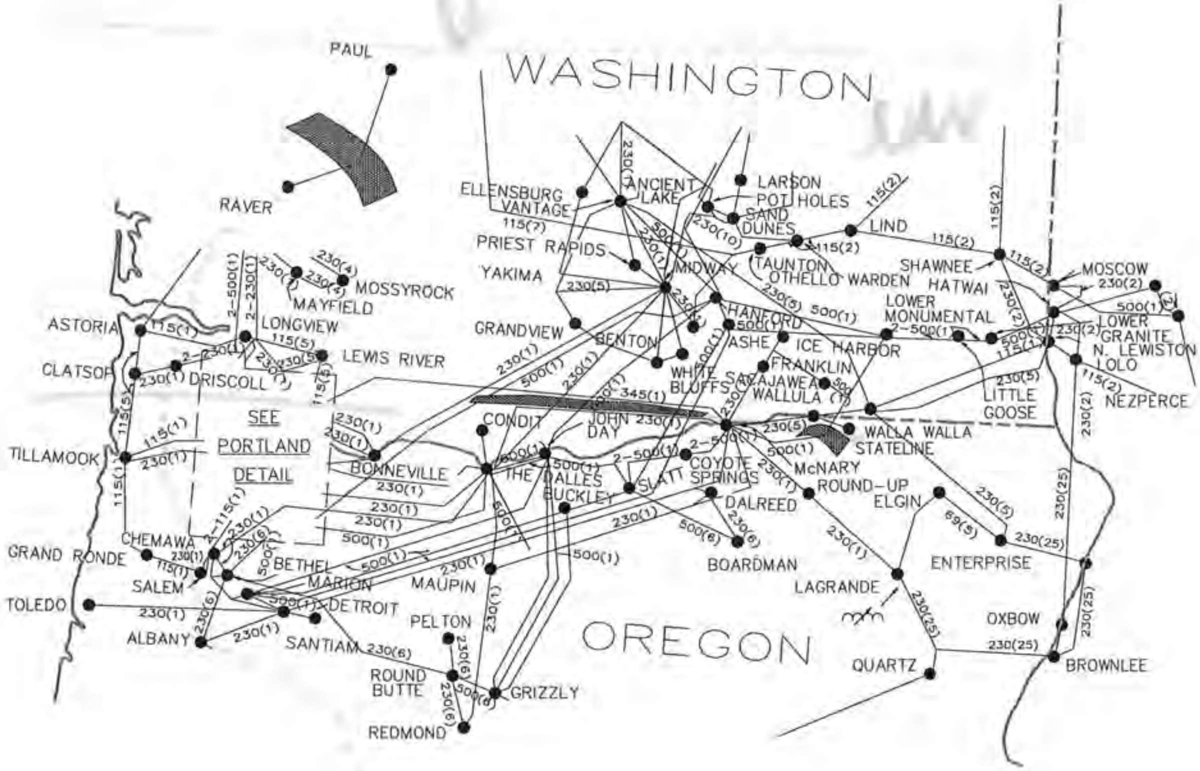
73. North of John Day



73. North of John Day

Accepted Rating ☐
Existing Rating ☐
Other ☒

Location:	Southern Washington/Northern Oregon
Definition:	Sum of the flows on the following lines: Line — Metered End Raver-Paul 500 kV — Raver Hanford-Ostrander 500 kV — Hanford Hanford-John Day 500 kV — Hanford Ashe-Marion 500 kV — Ashe Ashe-Slatt 500 kV — Ashe Lower Monumental-McNary 500 kV — McNary
Transfer Limit:	8400 MW established in OTC studies
Critical Disturbance that limits the transfer capability:	Two Palo Verde unit loss/Coulee-Hanford 500 kV line/PDCI Bipole
When:	OTC studies done 2002
System Conditions:	Light winter, heavy spring and summer loadings California-Oregon Intertie (north to south) - 4800 Pacific DC Intertie (north to south) - 3100 MW Coulee generation - 5600 MW - 7000 MW Lower Columbia generation low (spring and summer fish flush levels)
Study Criteria:	All applicable BPA and WECC criteria.
Remedial Actions Required:	Third AC RAS - Gen Drop at Chief Jo, Coulee, John Day, McNary/Chief Jo Brake. RAS Reactive Switching in the Northwest. FACRI - Fort Rock series capacitors and Malin MSC.
Formal Operating Procedure:	Accepted COI vs NJD seasonal operating nomograms developed by NOPSG for winter, spring, and summer. Refer to NOPSG reports for COI+Alturas/PDCI vs NJD nomograms.
Allocation:	
Interaction w/Other Transfer Paths:	COI/PDCI
Contact Person:	Mike Kreipe (TOP-PPOC2-2) Bonneville Power Administration 8100 NE Parkway Dr. #50 Vancouver, WA 98662-1409 (360) 619-6686 (360) 619-6945 - fax mjkreipe@bpa.gov

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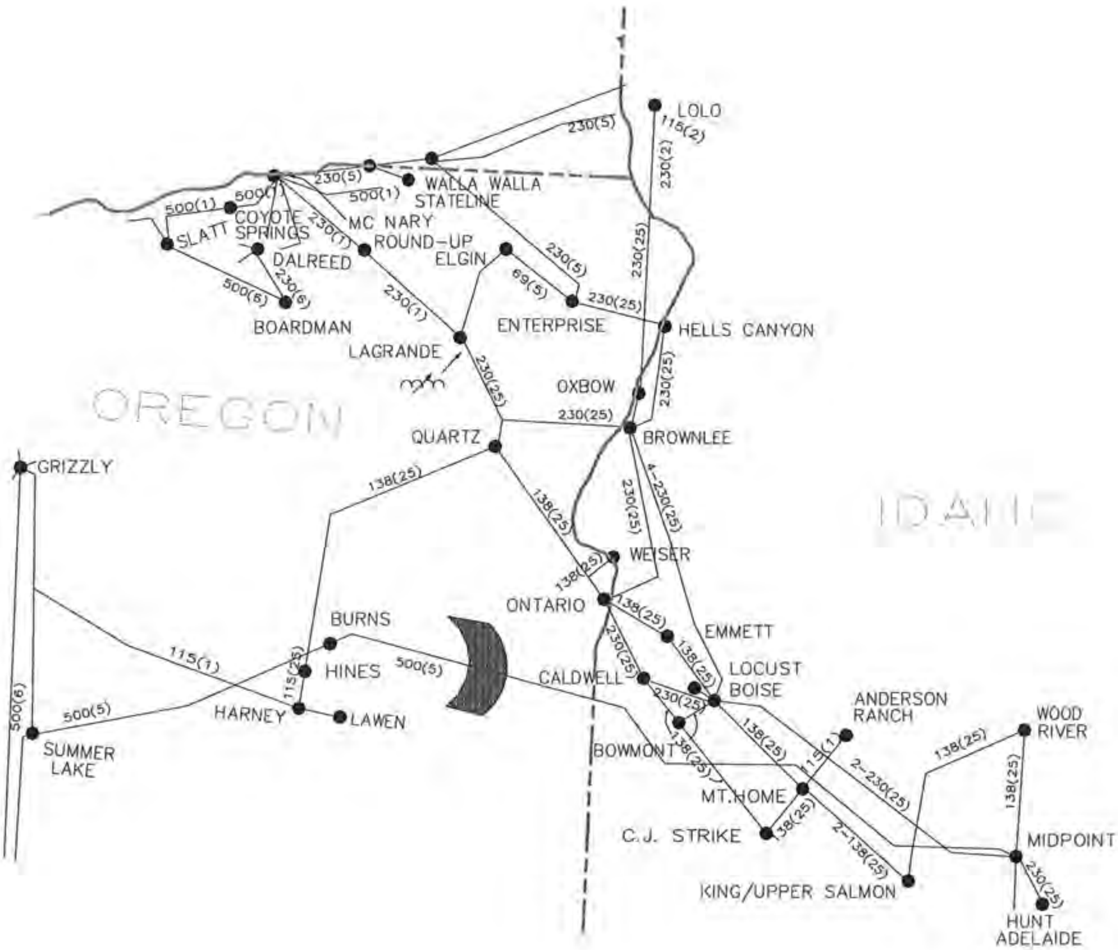
75. Midpoint - Summer Lake



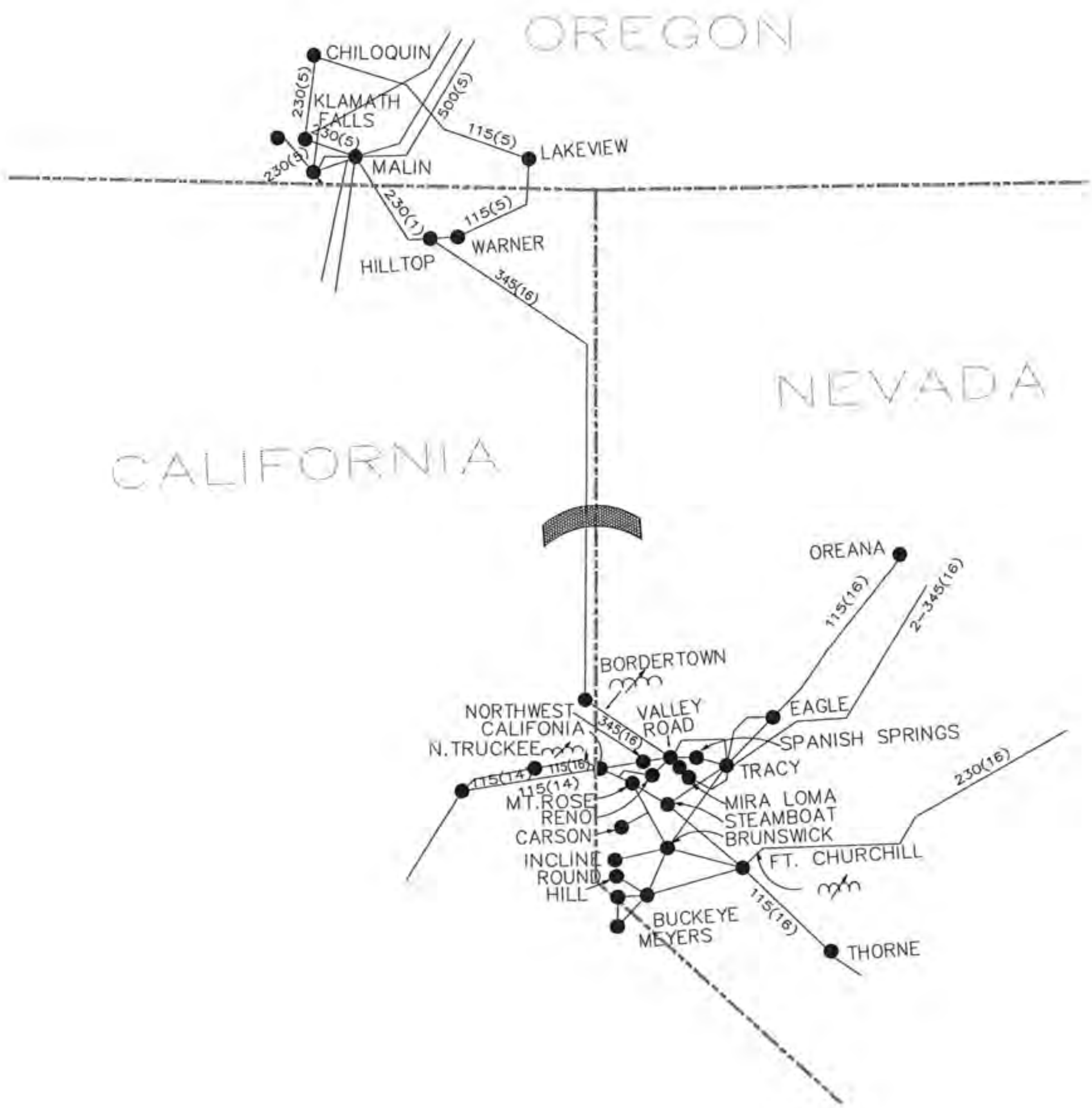
75. Midpoint - Summer Lake

Accepted Rating ☐
Existing Rating ☐
Other ☒

Location:	Southwest Idaho and eastern Oregon
Definition:	Midpoint-Summer Lake 500 kV metered at the Midpoint 500 kV. Note: The path is also within the Idaho-Northwest Path.
Transfer Limit:	East to West: 1500 MW West to East: 400 MW
Critical Disturbance that limits the transfer capability:	<u>East to West</u>: Transient voltage dip at LaGrande, and post-transient voltage at LaGrande and Hines following the loss of the Midpoint-Summer Lake 500 kV line. <u>West to East</u>: The thermal overload of the Lolo-Oxbow 230 kV line is the limiting condition for an outage of the Midpoint-Summer Lake 500 kV line. Under heavy Brownlee to Boise Bench 230 kV line flow, post transient reactive margin at Boise Bench may be more constraining for the loss of the Midpoint-Summer Lake 500 kV line.
When:	The east to west rating is limited by thermal ratings of Midpoint 345/500 kV transformer and series capacitor in the line. It was established along with the 2400 MW east to west rating of Idaho to Northwest path in August, 1989 with the publication of Idaho Power Company to Pacific Northwest Intertie Capacity Study. The WECC Notification Procedures for Changes in Facility Rating and/or Operating Procedures was followed. The east to west rating was conducted jointly by: Bonneville Power Administration (BPA) Idaho Power Company (IPC) PacifiCorp (PAC) Avista Corp. (AVA) The west to east rating is based on the 1998-2002 OTC (formerly OCSG) Spring Operating Studies.
System Conditions:	The east to west transfer rating was studied with light load conditions in Idaho with heavy eastern thermal resources, and moderate generation on the remaining hydro plants in Idaho. Studies were performed with both north to south and south to north on the PACI and near maximum transfers on parallel paths; i.e., transfers to Northwest and Arizona to California. The west to east transfer rating was studied with high hydro conditions in the Northwest with low to moderate eastern thermal resources. In addition, the west to east rating may not be fully utilized simultaneous with heavy Hells Canyon Complex generation because of steady state thermal overloads and/or post disturbance voltage change in Idaho Power's internal transmission system.
Study Criteria:	WECC Reliability Criteria for Transmission System Planning.

Remedial Actions Required:	Remedial action schemes are required to achieve the 2400 MW east to west transfer capability on the Idaho-Northwest path under which this path is operated. An outage of the Midpoint-Summer Lake 500 kV line requires Jim Bridger unit(s) tripping. Bridger tripping is only needed for the Midpoint-Summer Lake 500kV outage for East-West transfers. No RAS is required for West-East transfers.
Formal Operating Procedure:	Under certain generation and load conditions, 2400 MW Idaho to Northwest transfers, simultaneous with heavy Northwest to California transfers, may cause overloading of the Midpoint-Summer Lake line. During these conditions, one-half of the Burns series capacitors can be bypassed to reduce Midpoint-Summer Lake loading but it results in reduced Bridger West capacity.
Allocation:	The transfer capability of the path is allocated among the interconnections as follows: • <u>1500 MW East to West</u> 1187 MW PacifiCorp - IPC Interconnection • <u>400 MW West to East</u> PacifiCorp
Interaction w/Other Transfer Paths:	Path 75 has an interaction with the Idaho-NW path (Path #14), as the Midpoint-Summer Lake line is part of Path 14. Path 75 also has an interaction with COI, as illustrated by the COI Nomogram which is dependent upon flows on the Midpoint-Summer Lake 500 kV line.
Contact Person:	Don Johnson PacifiCorp 9951 S.E. Ankeny Street, 2nd Floor Portland, OR 97216-2315 (503) 251-5283 (503) 251-5228 - fax don.johnson@pacificorp.com

76. Alturas Project



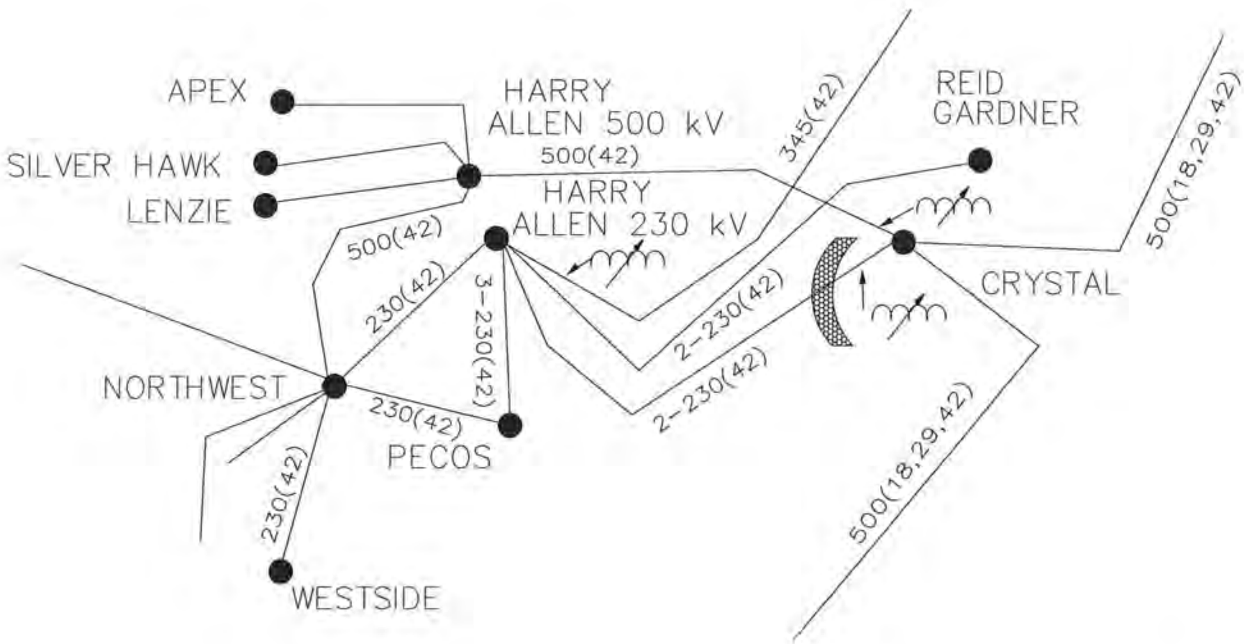
76. Alturas Project

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Line between northeastern California and western Nevada
Definition:	Hilltop (near existing Warner Substation) 230/345 kV-Bordertown 345 kV and Bordertown-N. Valley Road 345 kV. Point of interconnection between Bonneville Power Authority (BPA) and Sierra Pacific Power Company (Sierra) is the Hilltop 230 kV.
Transfer Limit:	North to South: 300 MW South to North: 300 MW
Critical Disturbance that limits the transfer capability:	North to South: Post-disturbance voltage deviation on the Malin-Hill top 230kV system and/or the Warner-Chiloquin 115kV system for a midpoint-Humboldt 345kV outage or an outage of the Malin-Hill Top 230kV line. South to North: Post-disturbance line flows in the Reno 120kV system following a Tracy-Valley Road 345kV outage.
When:	The February 1995 Alturas Project Phase II rating report established the ratings for this project. PCC formally approved these ratings in July of 1995. A Phase II review group was formed in August of 1997 to amend the report's North to South rating due to events that demonstrated limits in transfers in from the Pacific Northwest. This amendment was accepted and approved by PCC in June 1998.
System Conditions:	North to South: The 300 MW rating was determined with heavy Northwest exports to California and heavy loads in the southern Oregon and Sierra areas. South to North: The 300 MW rating was determined with simultaneous heavy transfers consistent with high Pacific Northwest imports for winter loads.
Study Criteria:	WECC Reliability Criteria for Transmission System Planning
Remedial Actions Required:	Direct transfer tripping of the Hilltop-Bordertown 345kV line for loss of the Malin-Hilltop 230kV under certain transfer conditions.
Formal Operating Procedure:	None
Allocation:	Sierra 100%
Interaction w/Other Transfer Paths:	An operating nomogram was developed in the amendment for the Phase II Report that shows safe areas of simultaneous operation between this path and COI. The loads in the Alturas-Chiloquin 115 kV loop affect the north to south capability of this intertie.

Contact Person:	Joe Tarantino Sierra Pacific Power Company P. O. Box 10100 Reno, NV 89520-0026 (775) 834-3348 (775) 834-3047 - fax jtarantino@sppc.com

77. Crystal - Allen



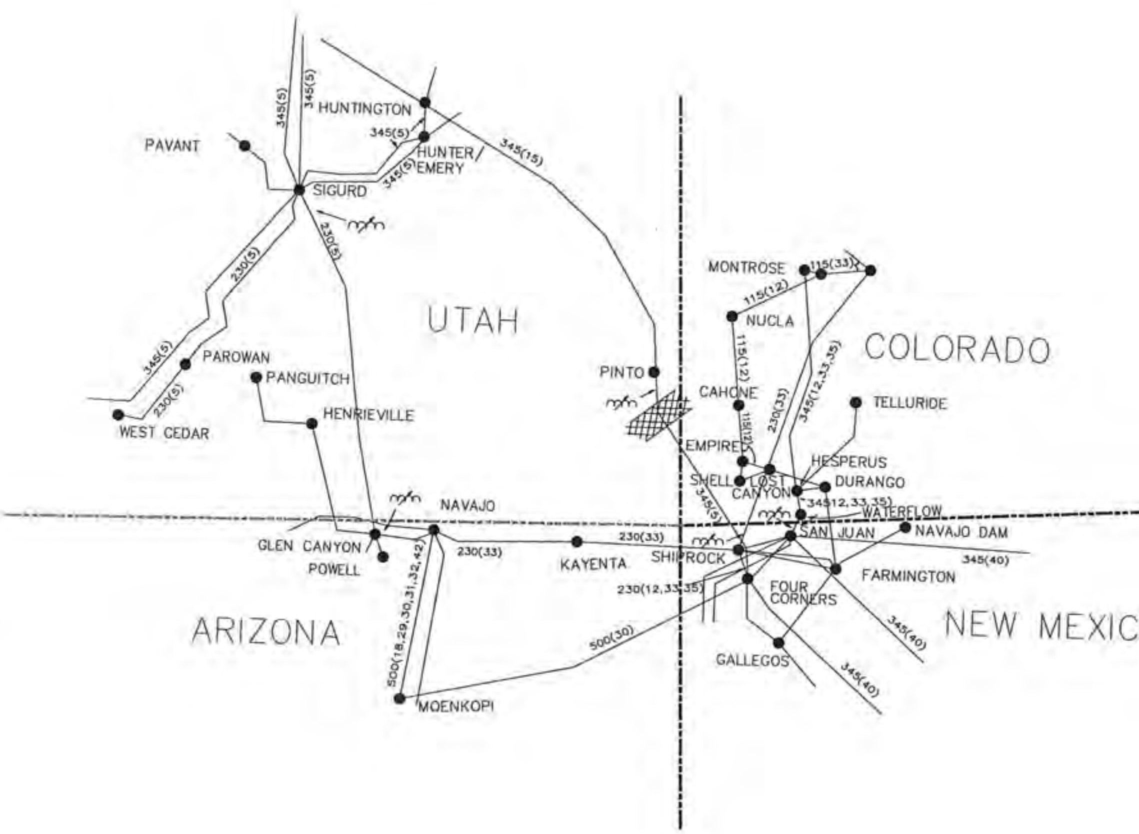
77. Crystal - Allen

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Southern Nevada
Definition:	Sum of the flows on the two 500/230 kV transformer banks at Crystal switching station, metered at the 500 kV bus.
Transfer Limit:	Crystal to Harry Allen: 950 MW Harry Allen to Crystal: Not defined
Critical Disturbance that limits the transfer capability:	Under conditions of maximum transfers from Harry Allen into the Las Vegas Valley (i.e., all resources feeding into the Harry Allen substation at rated capacity - Reid Gardner 1-4, H. Allen 3, Red Butte-Harry Allen 345 kV and Crystal at 950 MW) the Pecos 230/138 kV autotransformers will be loaded to a level where loss of the #3 or #4 bank will load the #1 bank to its emergency rating (275.1 MVA).
When:	The *Crystal Transmission Project Phase 2 Review Group Report* published in February 1999 established the rating for the project. PCC formally approved this rating in April 1999.
System Conditions:	The Crystal-Allen 950 MW rating has been evaluated under peak summer load conditions under maximum southern Nevada imports, and under heavy autumn conditions with maximum EOR or WOR path flows.
Study Criteria:	WECC and Nevada Power Company Reliability Criteria for System Design
Remedial Actions Required:	None
Formal Operating Procedure:	Operating and Clearance Procedures, Nevada Power Company - Crystal Substation 500/230 kV, dated December 7, 1998.
Allocation:	The transfer capability is wholly owned by Nevada Power Company.
Interaction w/Other Transfer Paths:	The Crystal progress report identified an interaction between the EOR and WOR transfer paths. There is also an interaction with the Red Butte-H. Allen 345 kV line (TOT2C path) due to the Crystal and H. Allen phase shifter interrelationship.
Contact Person:	Hamilton Avery Nevada Power Company MS#57 6226 West Sahara Avenue Las Vegas, Nevada 89151 (702) 862-7174 - office (702) 862-7113 - fax HAvery@nevp.com

78. TOT 2B1

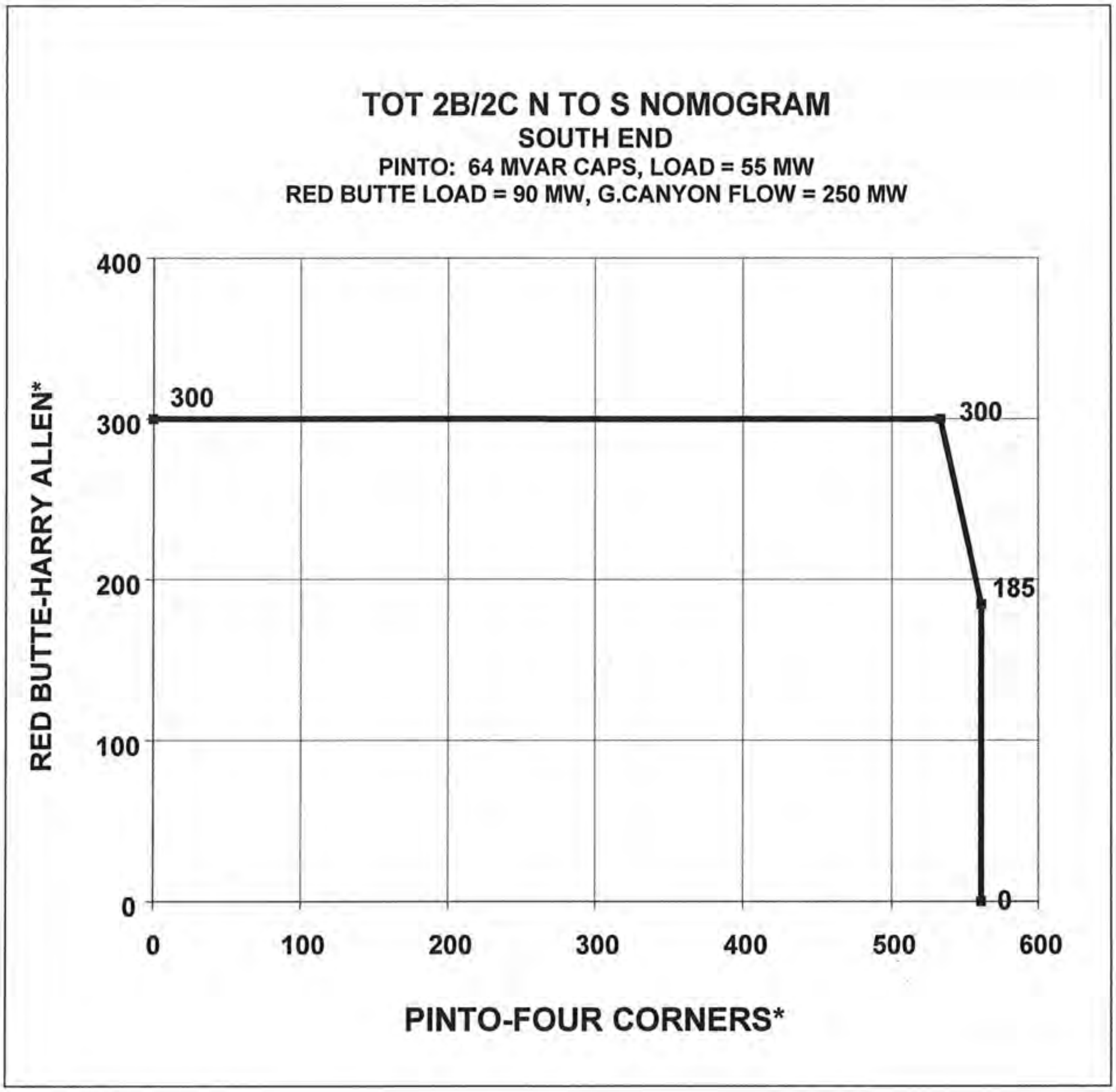
Revised February 2000



78. TOT 2B1

Accepted Rating ☐
Existing Rating ☒
Other ☐

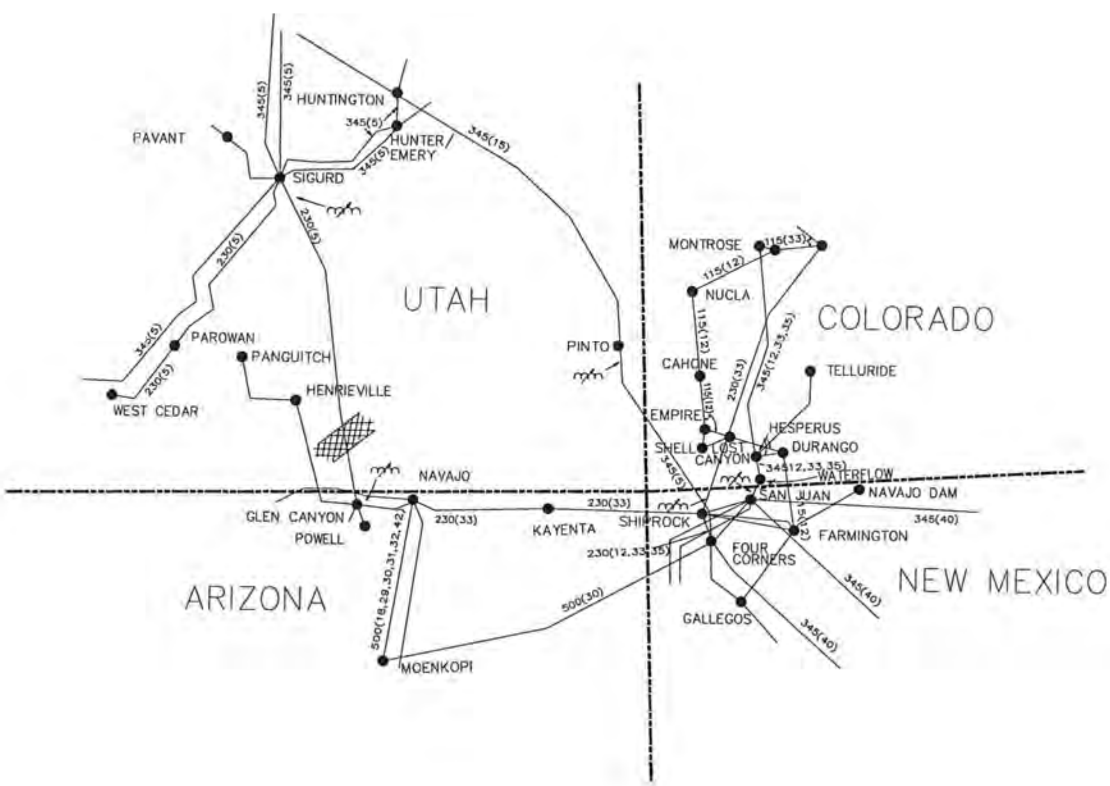
Location:	Southern Utah to N. Arizona/W. New Mexico
Definition:	Pinto-Four Corners 345 kV Line. This line, combined with the Sigurd-Glen Canyon 230 Line, make up the TOT 2B Path. Formerly reported as the combined TOT 2B Path.
Transfer Limit:	North to South (so. end): 560 MW (up to 600 MW with PST bypassed, low Pinto load South to North (so. end): 600 MW
Critical Disturbance that limits the transfer capability:	Non-simultaneous: Pre-disturbance voltage at Pinto 345 bus, normal thermal limit of the Pinto phase-shifting transformers. Simultaneous: Huntington-Pinto-Four Corners 345 line outage, Sigurd-Red Butte-Harry Allen 345 line outage.
When:	Ratings established prior to January 1994. Two 32 MVAR capacitor banks added at Pinto 138 bus in 1999 to compensate for Pinto area load growth.
System Conditions:	Non-simultaneous capability is a function of Pinto load and/or Pinto phase shifter thermal rating. Moderate flow levels on parallel lines.
Study Criteria:	WECC Reliability Criteria for System Design PacifiCorp Internal Reliability Criteria
Remedial Actions Required:	North to South: Trip Huntington generation for loss of the Huntington-Pinto-Four Corners line when parallel lines are heavily loaded.
Formal Operating Procedure:	TOT 2B/2C Nomogram (see attachment) TOT 2 OTC limits.
Allocation:	PacifiCorp
Interaction w/Other Transfer Paths:	TOT 2A, TOT 2B2, TOT 2C, IPPDC, PDCI, COI
Contact Person:	Gil Coulam PacifiCorp 1407 W. North Temple - Suite 210 Salt Lake City, UT 84140 (801) 220-2954 (801) 220-2842 - fax gilbert.coulam@pacificorp.com



TOT 2B:	Pinto-Four Corners* 345	Note:	This is a representative nomogram.
	Sigurd-GCanyon* 230		Red Butte load varies from 60 to 210 MW,
TOT 2C:	Red Butte-Harry Allen* 345		affecting TOT 2C capability.

*metered end

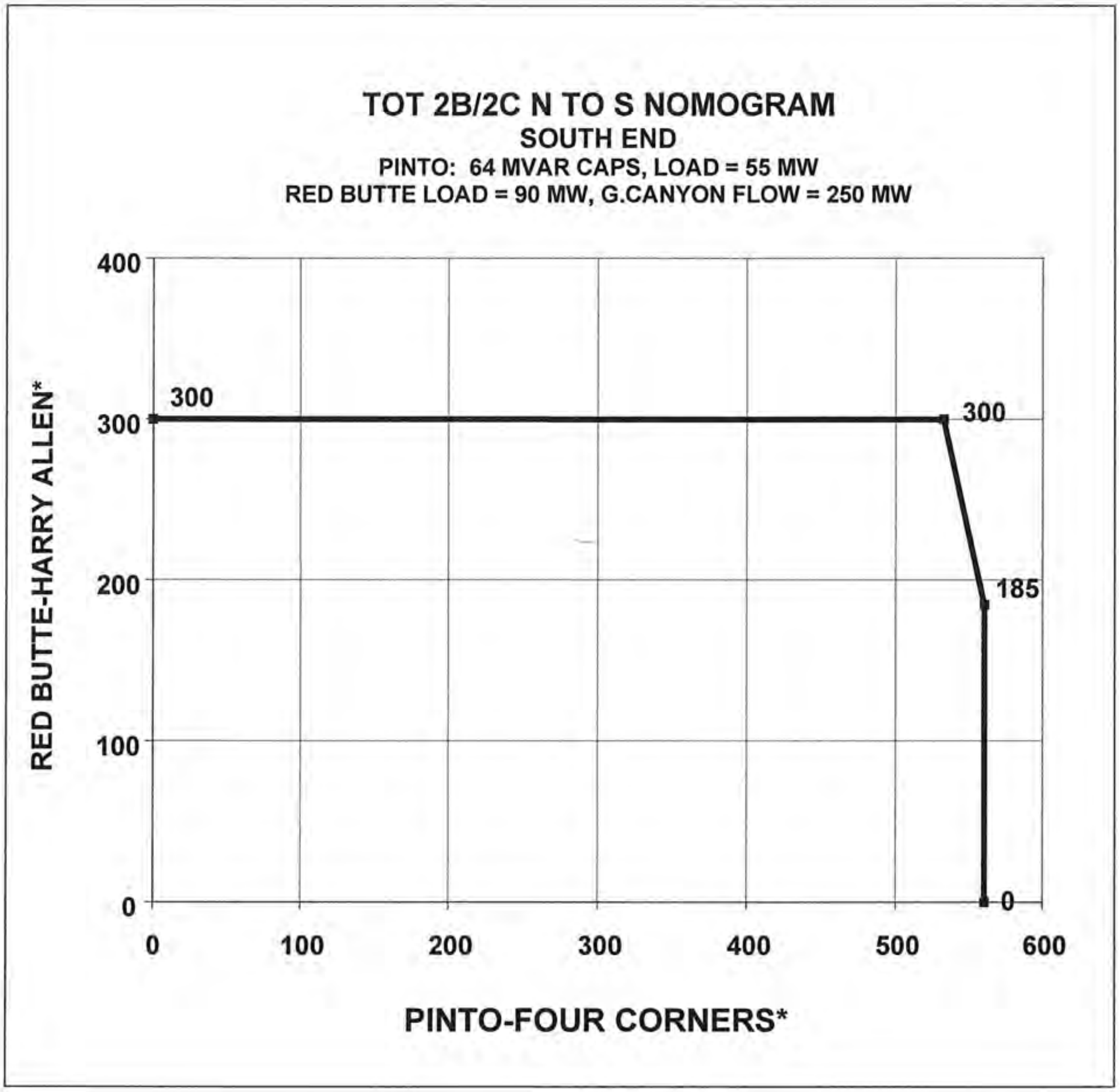
79. TOT 2B2


HUNTINGTON
345(5)
345(5)
PAVANT
345(5)
HUNTER/
EMERY
345(5)
345(15)
SIGURD
230(5)
230(5)
UTAH
345(5)
PAROWAN
PANGUITCH
230(5)
WEST CEDAR
HENRIEVILLE
NAVAJO
GLEN CANYON
POWELL
230(33)
KAYENTA
230(33)
500(18,28,30,31,32,42)
ARIZONA
500(30)
MOENKOPI
PINTO
MONTROSE
115(33)
115(12)
NUCLA
COLORADO
115(12)
CAHONE
230(33)
345(12,33,35)
TELLURIDE
EMPIRE
115(12)
HESPERUS
SHELL
LOST CANYON
DURANGO
345(5)
345(12,33,35)
WATERFLOW
SAN JUAN
NAVAJO DAM
SHIPROCK
345(40)
FARMINGTON
230(12,33,35)
FOUR CORNERS
NEW MEXICO
345(40)
GALLEGOS
345(40)

79. TOT 2B2

Accepted Rating ☐
Existing Rating ☒
Other ☐

Location:	Southern Utah to N. Arizona
Definition:	Sigurd-Glen Canyon 230 kV Line. This line, combined with the Pinto-Four Corners 345 kV Line, make up the TOT 2B Path. Formerly reported as the combined TOT 2B Path.
Transfer Limit:	North to South (so. end): 265 MW South to North (so. end): 300 MW
Critical Disturbance that limits the transfer capability:	Non-simultaneous: Normal thermal limit of Sigurd phase-shifting transformer. Simultaneous: Huntington-Pinto-Four Corners 345 line outage, Sigurd-Red Butte-Harry Allen 345 line outage.
When:	Ratings were established prior to January 1994.
System Conditions:	Parallel lines are at moderate levels. This line is limited to 250 MW when parallel lines are heavy.
Study Criteria:	WECC Reliability Criteria for System Design PacifiCorp Internal Reliability Criteria
Remedial Actions Required:	None
Formal Operating Procedure:	TOT 2B/2C Nomogram (see attachment) TOT2 OTC limits.
Allocation:	PacifiCorp
Interaction w/Other Transfer Paths:	TOT 2A, TOT 2B1, TOT 2C, IPPDC, PDCI, COI
Contact Person:	Gil Coulam PacifiCorp 1407 W. North Temple - Suite 210 Salt Lake City, UT 84140 (801) 220-2954 (801) 220-2842 - fax gilbert.coulam@pacificorp.com



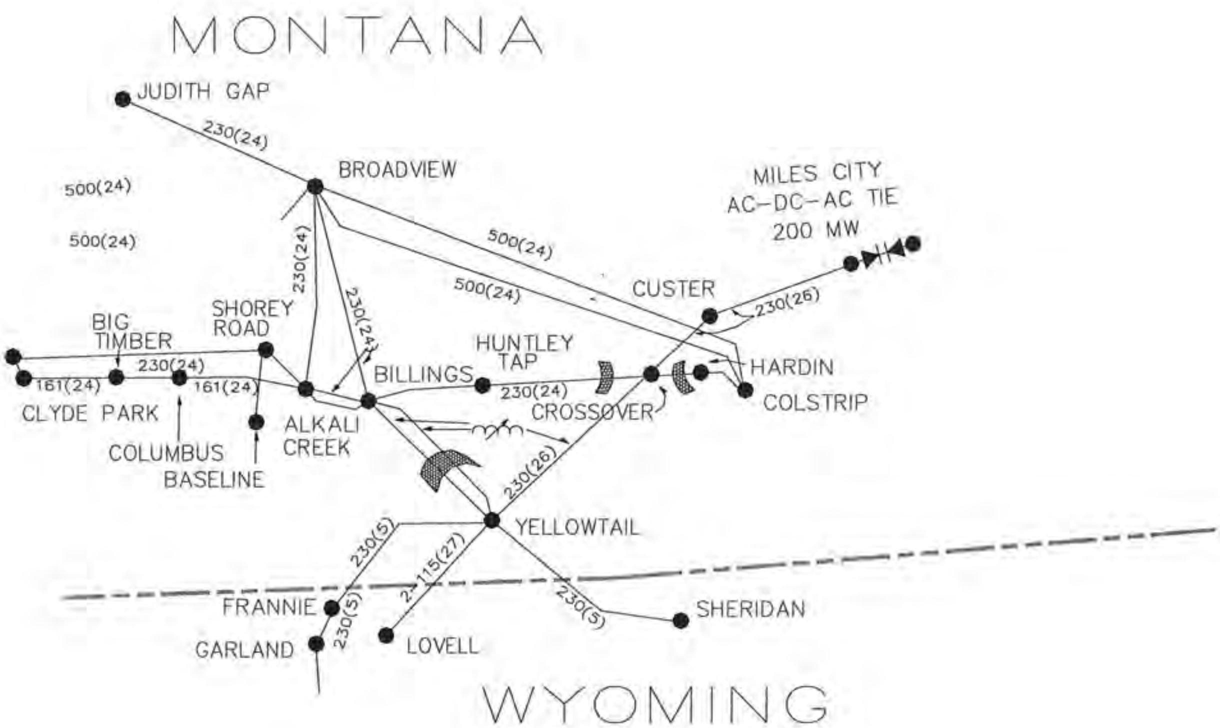
TOT 2B:	Pinto-Four Corners* 345	
	Sigurd-GCanyon* 230	
TOT 2C:	Red Butte-Harry Allen* 345	

*metered end

Note: This is a representative nomogram. Red Butte load varies from 60 to 210 MW, affecting TOT 2C capability.

Added February 2005

80. Montana Southeast



Added February 2005

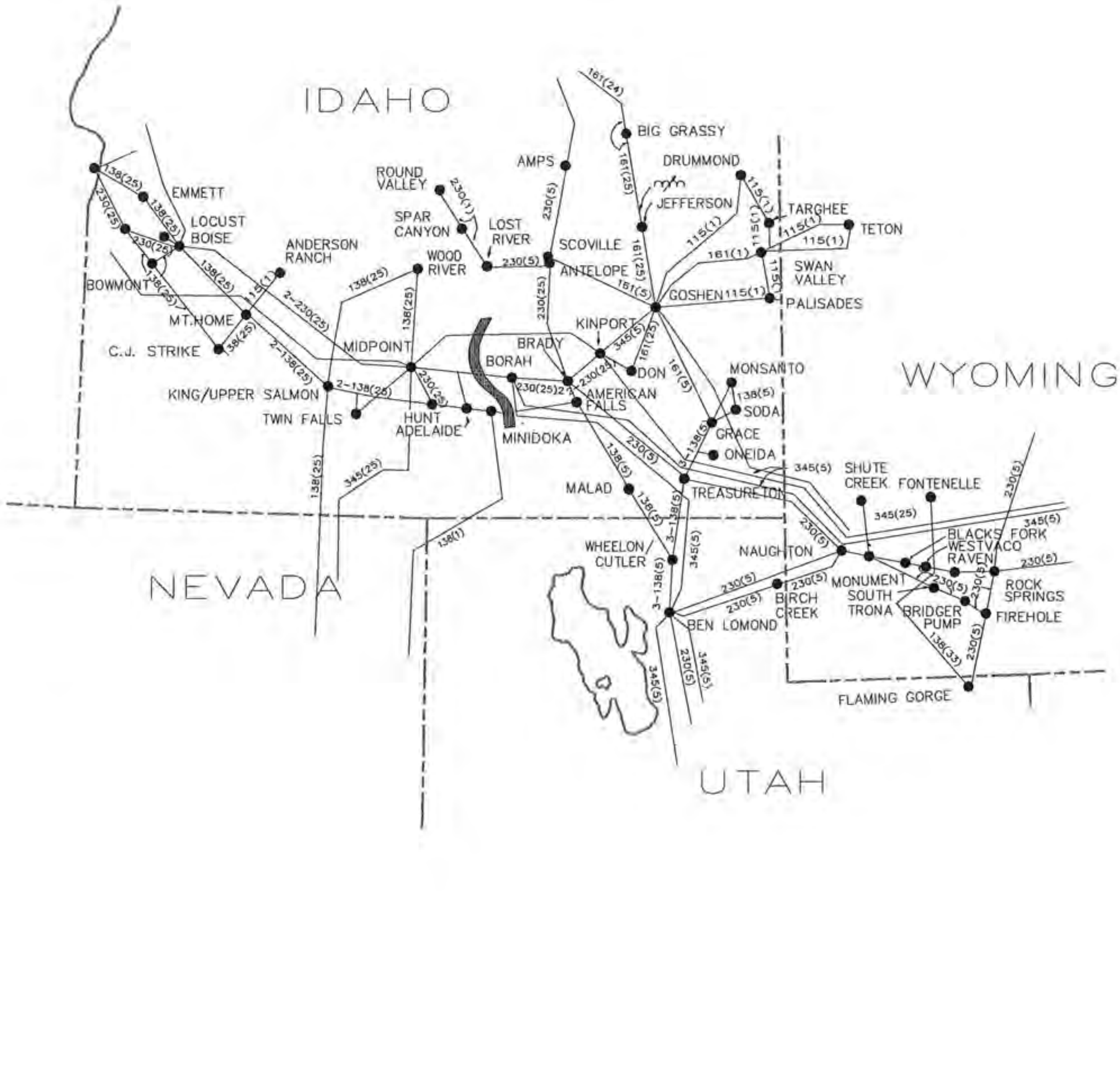
80. Montana Southeast

Accepted Rating ☐
Existing Rating ☐
Other ☒

Location:	Southeast Montana
Definition:	1. Billings-Yellowtail 230 kV 2. Rimrock-Yellowtail 161 kV 3. Hardin-Crossover 230 kV 4. Huntley-Crossover 230 kV Note: The metered end is underscored.
Transfer Limit:	The path has a rating of 600 MW for both imports and exports from the Montana Control area. The OTC for imports may be much lower depending on Yellowtail generation, Miles City DC tie flow, and loads in Northern Wyoming. The OTC nomogram is published through NOPSG.
Critical Disturbance that limits the transfer capability:	The critical disturbance for imports is a three-phase fault at the Broadview 500 kV bus followed by the loss of both Broadview-Garrison 500 kV lines.
When:	This path rating is based primarily on OTC study work that has been performed since 1999 through the NOPSG committee.
System Conditions:	This path has been studied for all seasons and load conditions. The most important parameters that govern the OTC are Yellowtail generation, Miles City DC tie flow, and loads in Northern Wyoming. There is an operational nomogram for imports.
Study Criteria:	WECC performance criteria are met when the path is operated below the OTC nomogram. The principal criterion that governs the OTC for import is the transient voltage dip criterion.
Remedial Actions Required:	The ATR is in service at all times. This RAS protects for the critical contingency.
Formal Operating Procedure:	NWE (NWMT) operators monitor the MTSE path to assure that it is operated below the OTC nomogram on a real-time basis.
Allocation:	
Interaction w/Other Transfer Paths:	The flow on this path may be constrained by reaching limits on other paths first. Examples of such paths are South of Yellowtail and West of Broadview.
Contact Person:	Charles A. Stigers Northwestern Energy 40 East Broadway Butte, MT 59701 (406) 497-4538 (406) 497-3393 - fax chuck.stigers@northwestern.com

Phase III Projects

III-1 Borah West (Path 17 250 MW Uprate)



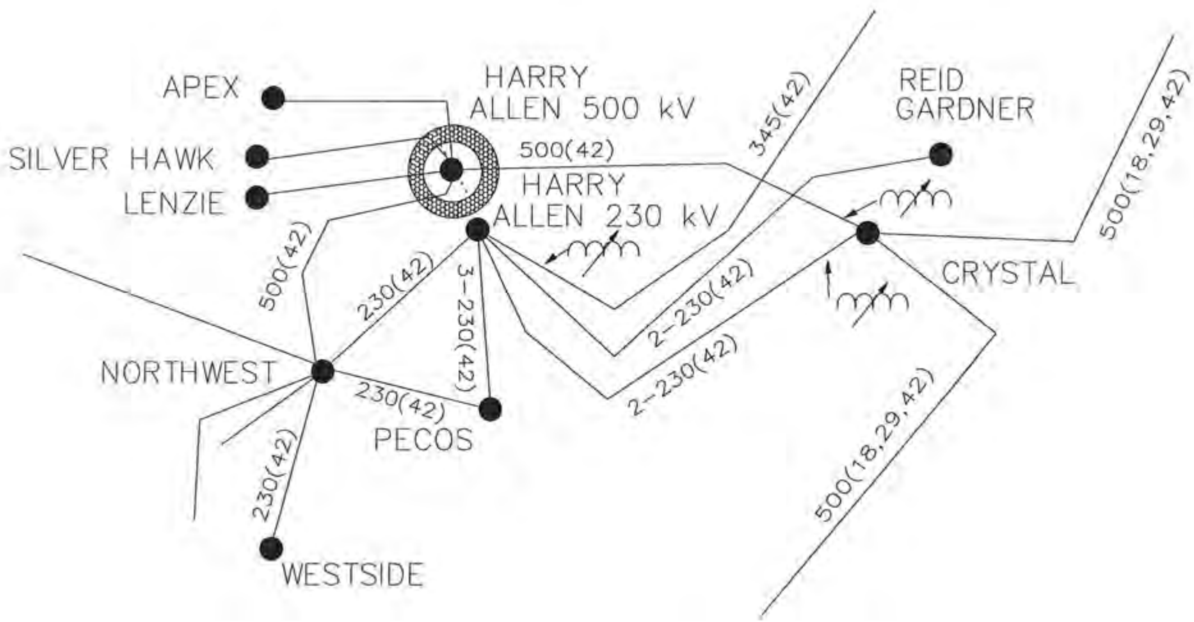
III-1 Borah West (Path 17 250 MW Uprate)

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Southeast Idaho
Definition:	Sum of the flows on the following lines: Line — Metered End Kinport-Midpoint 345 kV — Kinport Borah-Adelaide-Midpoint #1 345 kV — Borah Borah-Adelaide-Midpoint #2 345 kV — Borah Am Falls-Pleasant Valley-Adelaide 138 kV — American Falls AmFalls-Raft River-Minidoka 138 kV — American Falls
Transfer Limit:	East to West: 2557 MW West to East: Not defined The transfer capacity listed above is the accepted rating following the completion of the Borah West 250 MW uprate project.
Critical Disturbance that limits the transfer capability:	The double line loss of the Kinport-Midpoint 345 kV line and one of the Borah-Adelaide-Midpoint 345 kV lines.
When:	The 2557 MW Borah West rating was established in the Phase II comprehensive progress report, which was issued September 10, 2002. The Borah West Uprate project was granted Phase III status on March 24, 2003.
System Conditions:	The Borah West transfer rating was determined with simultaneous heavy transfers on series path (Path C south to north, and Bridger West) consistent with the transfer of eastern thermal resources to the west.
Study Criteria:	WECC Reliability Criteria for Transmission System Planning
Remedial Actions Required:	The loss of two of the 345 kV lines simultaneously or one line initially out-of-service and loss of another line will initiate a trip of one Jim Bridger unit if the flow from the east on the three 345 kV lines into Midpoint exceeds 1050 MW. For the special contingency of the loss of the Kinport-Midpoint 345 kV line with one of the Borah-Adelaide-Midpoint 345 kV lines under high flow conditions, a trip of two Jim Bridger units may be required.
Formal Operating Procedure:	For PDCI south to north operation, a nomogram exists for flows on the PDCI, COI, Borah West and available load dropping in the Northwest. California ISO T-122 (West of Borah versus Path 15 nomogram).
Allocation:	Idaho Power Company (IPC) owns the Borah West transfer path and capacity. IPC has long-term agreements to provide transmission services on this path to PacifiCorp for up to 1600 MW and has received requests for 250 MW of additional firm transmission service.

Interaction w/Other Transfer Paths:	There is a known interaction for south to north transfers on PDCI and COI and Borah West. Also, there is a known interaction for high south to north transfer on Path 15 and Path 26 (under outage conditions) and high east-to-west transfers on Borah West that requires operation based on a nomogram. A potential interaction under maximum simultaneous imports into the northwest with high north-to-south transfers on Canada-Northwest and high east-to-west transfers on Borah West is being studied.
Contact Person:	Mark D. Hanson Idaho Power Company P. O. Box 70 Boise, ID 83707 (208) 288-2253 (208) 388-6647 - fax mhanson@idahopower.com

III-2 Centennial



Added February 2005

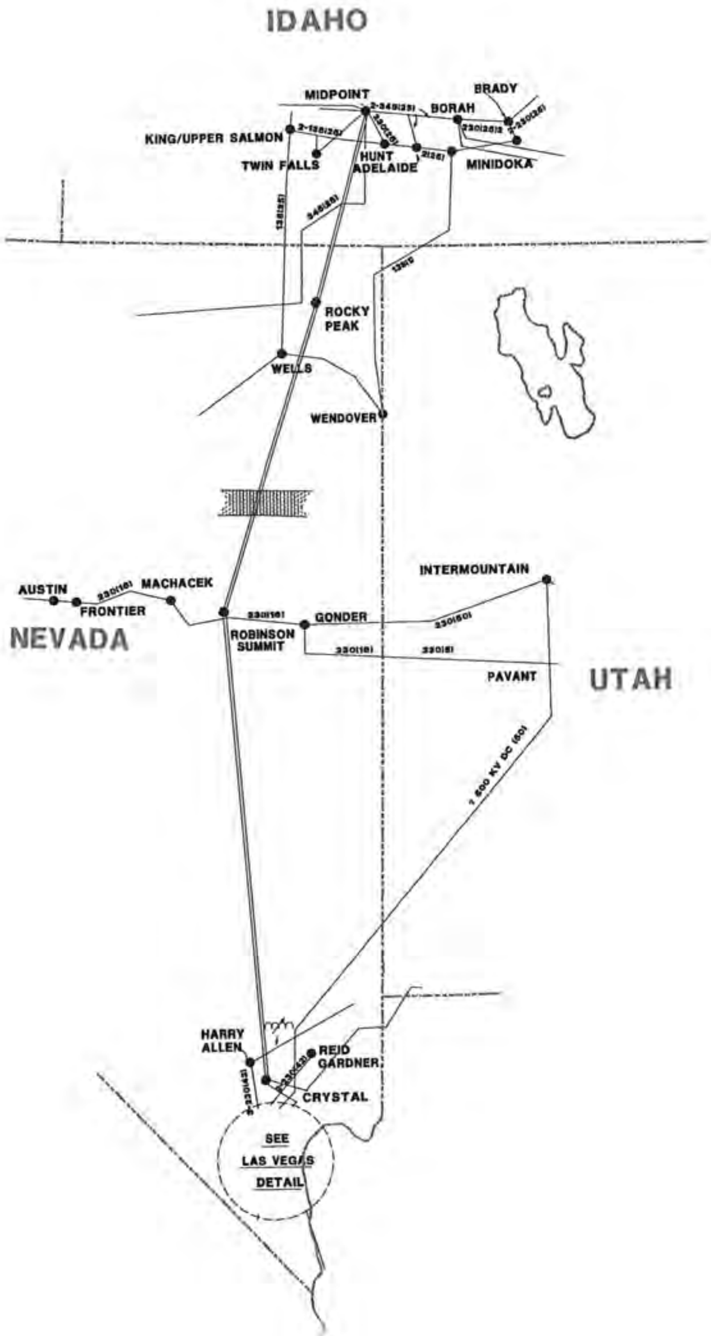
III-2 Centennial

Accepted Rating ☒
Existing Rating ☐
Other ☐

Location:	Southern Nevada
Definition:	Sum of the flows on the three 500 kV system lines interconnected at Harry Allen 500 kV substation.
Transfer Limit:	3000 MW
Critical Disturbance that limits the transfer capability:	The Northwest 500/230 kV autotransformer and/or Crystal 500 kV phase shifters reach their emergency limit during loss of Harry Allen-Mead 500 kV line.
When:	The path was defined with *The Centennial Plan: Western Arizona Transmission Studies Task Force Report*, which was approved by WATS in April 2004. PCC approved study work in April 2004 and was given a Phase 3 path rating in May 2004.
System Conditions:	The path rating was evaluated during peak summer loading conditions and light winter loading conditions. In addition, it was also evaluated under heavy autumn conditions with maximum EOR flows, SCIT imports, and southern Navajo flows. For rating acceptance, 3000 MW of generation was modeled at Harry Allen.
Study Criteria:	WECC and Nevada Power Company Reliability Criteria for System Design
Remedial Actions Required:	None
Formal Operating Procedure:	They are under development.
Allocation:	Nevada Power Company: 100%.
Interaction w/Other Transfer Paths:	The Centennial progress report identifies an interaction with the EOR and southern Navajo transfer paths.
Contact Person:	Rahn Sorensen Nevada Power Company, MS # 26 6226 West Sahara Avenue P.O. Box 98910 Las Vegas, NV 89151-0001 (702) 367-5447 (702) 227-2250 - fax rsorensen@nevp.com

Phase II Projects

II-1 Southwest Intertie Project (SWIP)



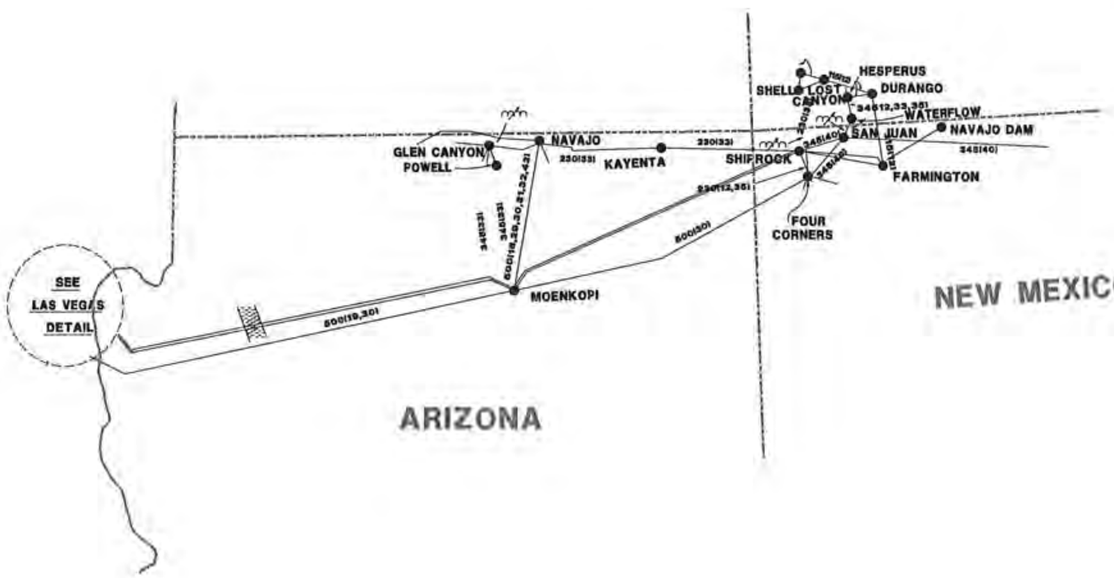
II-1 Southwest Intertie Project (SWIP)

Accepted Rating ☐
Existing Rating ☐
Other ☒

Location:	Between southern Idaho and southern Nevada (Las Vegas area)
Definition:	Midpoint-Robinson Summit-Crystal 500 kV
Transfer Limit:	North to South: 1200 MW South to North: 1200 MW
Critical Disturbance that limits the transfer capability:	1200 MW North to South: Transient voltage dips in northern California and post-transient voltage dips at Red Butte 345 kV and in northern California are the limiting conditions for outages of the Midpoint-Robinson Summit-Crystal 500 kV line. 1200 MW South to North: The south to north transfer capability is limited by flowability due to line loadings on the parallel path of Midway-Vincent/South of Los Banos. Transient and post-transient results at 1200 MW transfer capability were non-limiting.
When:	The 1200 MW north to south rating was established in July, 1990 with the publication of the Southwest Intertie Project (SWIP) comprehensive progress report. The July, 1992 SWIP comprehensive progress report established the 1200 MW south to north rating.
System Conditions:	North to South: The 1200 MW north to south rating was determined with simultaneous heavy transfers on significant parallel paths consistent with heavy transfers of hydro resources in the spring from the Pacific Northwest to the Southwest. The transfer studies were performed with simultaneous flows on PACI/COTP at 4880 MW, PDCI at 3100 MW, Midway-Vincent at 2000 MW, and TOT2 at 625 MW (Red Butte-Harry Allen 345 kV line flow at 250 MW). The east side phase shifters were operated to hold path schedule. South to North: The 1200 MW south to north rating was determined with simultaneous heavy transfers on significant parallel paths consistent with high Pacific Northwest imports for peak winter loads. The transfer studies were performed with simultaneous flows on PACI/COTP at -3682 MW, PDCI at -2000 MW, Midway-Vincent at -1000 MW, South of Los Banos at -2690 MW, and TOT2 at -300 MW. The east side phase shifters were operated to hold path schedule.
Study Criteria:	WECC Reliability Criteria for Transmission System Planning
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	To be determined.

Interaction w/Other Transfer Paths:	
Contact Person:	Mark D. Hanson Idaho Power Company P. O. Box 70 Boise ID 83707 (208) 388-2253 (208) 388-6647 - fax mhanson@idahopower.com

II-2 Navajo Transmission Project

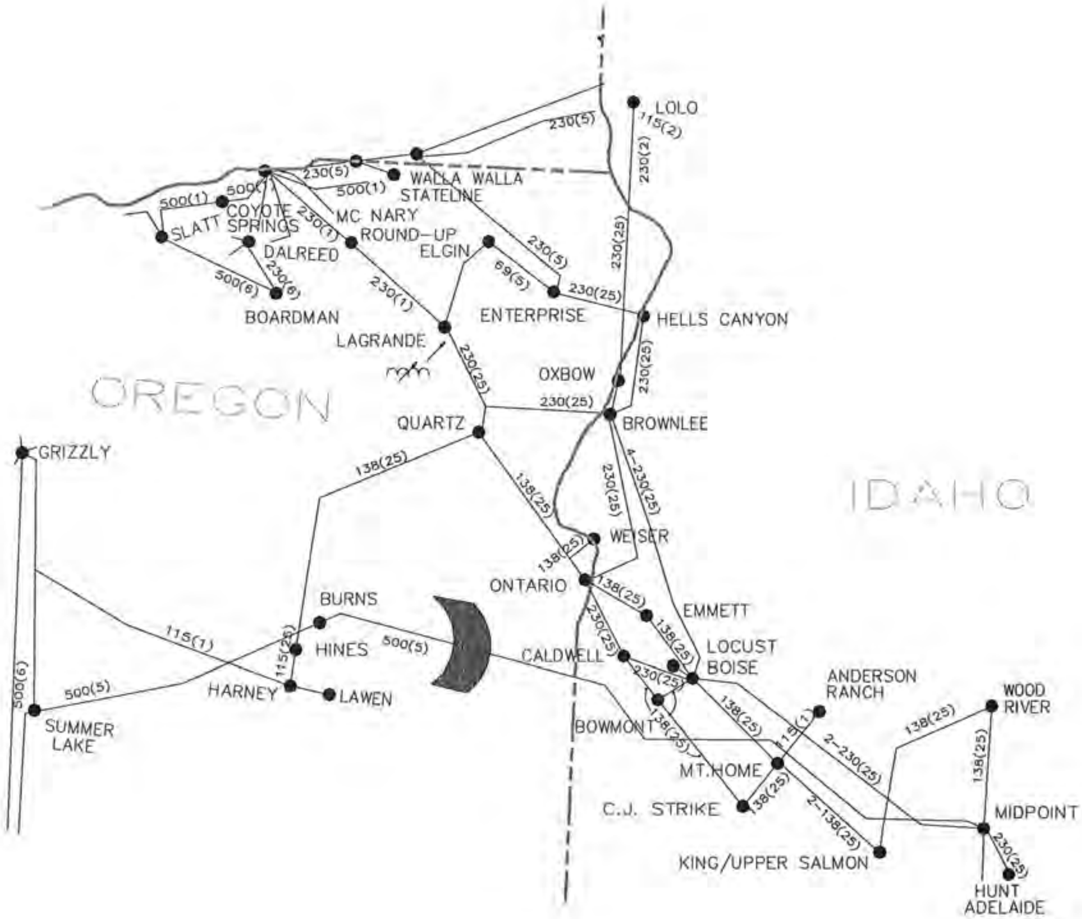


II-2 Navajo Transmission Project

Accepted Rating ☐
Existing Rating ☐
Other ☒

Location:	Line between the Four Corners area of New Mexico and southern Nevada
Definition:	Shiprock-Moenkopi-Marketplace 500 kV
Transfer Limit:	Shiprock-Moenkopi: 1189 MW Moenkopi-Marketplace: 1339 MW
Critical Disturbance that limits the transfer capability:	Continuous rating of the Palo Verde-Devers 500 kV line and the emergency loading on the Palo Verde-N. Gila 500 kV line following an outage of the Palo Verde-Devers 500 kV line.
When:	The planned rating was established in August, 1993 with the completion of the WECC Annual Progress Report for the Navajo Transmission Project. The Phase 2 Ad-Hoc Review Group has been formed and Phase 2 studies are being actively developed.
System Conditions:	A 1997 heavy summer benchmark case established simultaneous maximums for the FCWest and EOR to be 2419 MW and 7104 MW respectively. With NTP added and schedules increased, the resulting path flows were 3608 MW for FCWest and 8443 MW for EOR.
Study Criteria:	WECC Reliability Criteria For Transmission System Planning.
Remedial Actions Required:	None
Formal Operating Procedure:	None
Allocation:	Navajo Tribal Utility Authority and Western Area Power Administration are cosponsors.
Interaction w/Other Transfer Paths:	
Contact Person:	Steven Begay, General Manager Diné Power Authority P. O. Box 3239 Window Rock, AZ 86515 (928) 871-2133 (928) 871-4046 - fax dpasteve@citlink.net

II-3 Midpoint - Summer Lake (Path 75 Re-rate)



II-3 Midpoint - Summer Lake (Path 75 Re-rate)

Accepted Rating ☐
Existing Rating ☐
Other ☒

Location:	Southwest Idaho and eastern Oregon
Definition:	Midpoint-Summer Lake 500 kV metered at the Midpoint 500 kV. Note: The path is also within the Idaho-Northwest Path.
Transfer Limit:	East to West:1500 MW West to East: 600 MW Studies are currently underway and have achieved Phase II status, to raise the W-E non-simultaneous rating to 600 MW.
Critical Disturbance that limits the transfer capability:	East to West: Transient voltage dip at LaGrande, and post-transient voltage at LaGrande and Hines following the loss of the Midpoint-Summer Lake 500 kV line. West to East: The thermal overload of the Lolo-Oxbow 230 kV line is the limiting condition for an outage of the Midpoint-Summer Lake 500 kV line. Under heavy Brownlee to Boise Bench 230 kV line flow, post transient reactive margin at Boise Bench may be more constraining for the loss of the Midpoint-Summer Lake 500 kV line.
When:	The east to west rating is limited by thermal ratings of Midpoint 345/500 kV transformer and series capacitor in the line. It was established along with the 2400 MW east to west rating of Idaho to Northwest path in August, 1989 with the publication of Idaho Power Company to Pacific Northwest Intertie Capacity Study. The WECC Notification Procedures for Changes in Facility Rating and/or Operating Procedures was followed. The east to west rating was conducted jointly by: Bonneville Power Administration (BPA) Idaho Power Company (IPC) PacifiCorp (PAC) Avista Corp. (AVA) The west to east rating is based on the 1998 OCSG Spring Operating Study.
System Conditions:	The east to west transfer rating was studied with light load conditions in Idaho with heavy eastern thermal resources, and moderate generation on the remaining hydro plants in Idaho. Studies were performed with both north to south and south to north on the PACI and near maximum transfers on parallel paths; i.e., transfers to Northwest and Arizona to California. The west to east transfer rating was studied with high hydro conditions in the Northwest with low to moderate eastern thermal resources. In addition, the west to east rating may not be fully utilized simultaneous with heavy Hells Canyon Complex generation because of steady state thermal overloads and/or post disturbance voltage change in Idaho Power's internal transmission system.
Study Criteria:	WECC Reliability Criteria for Transmission System Planning

Remedial Actions Required:	Remedial action schemes are required to achieve the 2400 MW east to west transfer capability on the Idaho-Northwest path under which this path is operated. An outage of the Midpoint-Summer Lake 500 kV line requires Jim Bridger unit(s) tripping. No Bridger unit tripping is required for West-East transfers.
Formal Operating Procedure:	Under certain generation and load conditions, 2400 MW Idaho to Northwest transfers, simultaneous with heavy Northwest to California transfers, may cause overloading of the Midpoint-Summer Lake line. During these conditions, one-half of the Burns series capacitors can be bypassed to reduce Midpoint-Summer Lake loading but it results in reduced Bridger West capacity.
Allocation:	The transfer capability of the path is allocated among the interconnections as follows: • 1500 MW East to West 1187 MW PacifiCorp – IPC Interconnection • 600 MW West to East PacifiCorp
Interaction w/Other Transfer Paths:	
Contact Person:	Don Johnson PacifiCorp 9951 S.E. Ankeny Street, 2nd Floor Portland, OR 97216-2315 (503) 251-5283 (503) 251-5228 - fax don.johnson@pacificorp.com

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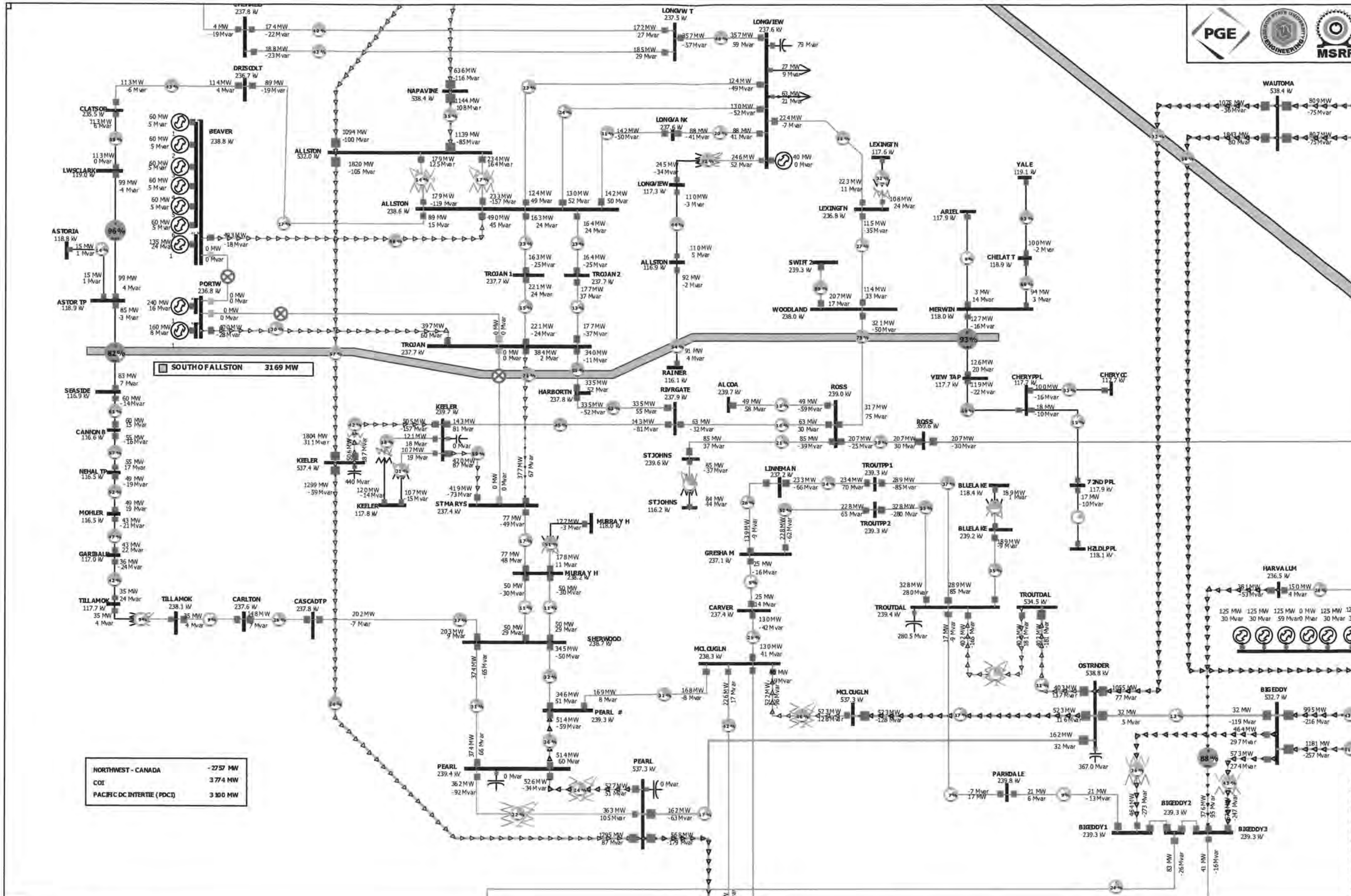


OREGON STATE UNIVERSITY ELECTRICAL ENGINEERING MOTOR SYSTEMS RESOURCE FACILITY	INTIAL CASE	CASE 0 0 8/8/2005

Portland General Electric
One World Trade Center
121 SW Salmon Street
Portland OR 97204

FAX COVER SHEET

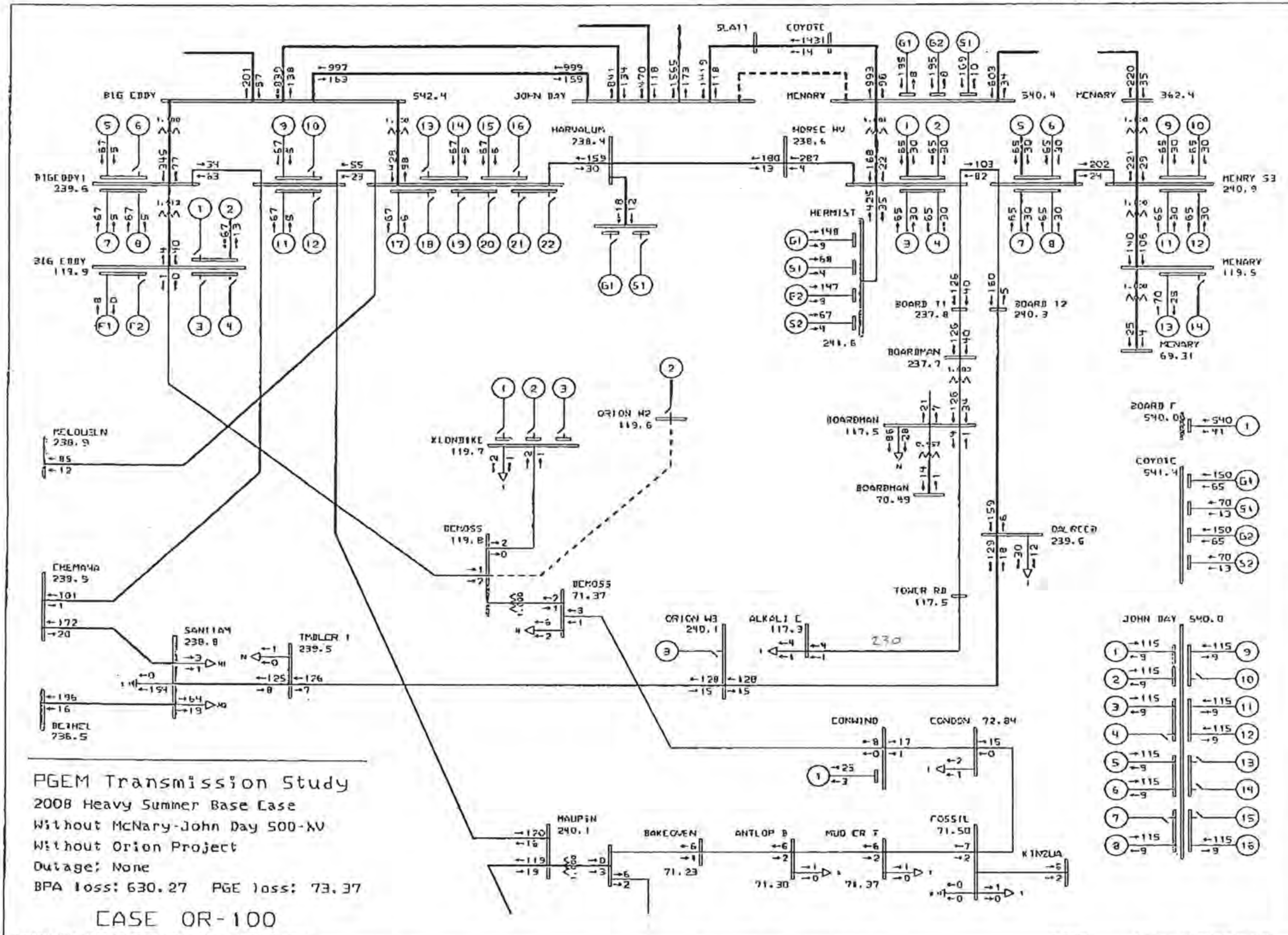
Date: June 30, 2005			
To: Annette von Jouanne			
At: OSU			
Receiver's Phone No.:	(541) 737-0831	Receiver's Fax No.:	(541) 737-1300
From: Jim Eden			
Sender's Phone No.:	(503) 464-7031	Sender's Fax No.:	(503) 464-2605
Number of Pages (including cover sheet): 3			

Remarks:

Attached are two drawings (from the GE program) that may be useful. They generally convey my style/conventions. They may also be useful as a guide for the study areas. They are from a different base case, an older WECC 2008 HS case. The topology may be slightly different, due to change in future plans, as well as, I may have added facilities that are under study. Understand that the GE program, at the time these were made, had less than stellar drawing capability, and each page was a separate document file. You can tell that sometimes things had to get squeezed in. I don't know enough about the PowerWorld mapping capabilities to be explicit in how to show things, so I'll leave that to your creativity. The first plot shows the Portland area with the detail I'm looking for. The South of Allston (SoA) path is not fully included in this map and I would like to see it. I think you have the ability to mark the path like what is done on page 181 from the Path Catalog, and put a total path flow on the marking. I would like to see that done for the West of Cascades-South (p. 13), the North of John Day (p. 185, this may be tricky), the West of Slatt (WoS), and the West of McNary (WoM). I'll get the line listings for those. I would like the following paths totaled and placed on the drawing in a suitable location: The BCHw (p. 8), the COI (p. 174), the PDCI (p. 170), and the IdaNW (p. 33), like I have done on the Portland drawing. The other drawing was used for transmission analysis for wind projects that happens to be in our Southern Crossing study. It shows some of the same facilities that you will also be mapping, and the challenge to get all the hydo machines shown. Now you know why I don't detail generator step-ups.

Jim

SOUTHERN: USE AS EXAMPLE.



PGEM Transmission Study

2008 Heavy Summer Base Case

Without McNary-John Day 500-kV

Without Orion Project

Outage: None

BPA loss: 630.27 PGE loss: 73.37

CASE OR-100

General Electric International, Inc. PSLF Program MR/MVAR Tue Sep 14 09:21:14 2004

	PGEM Orion Project Study 2008 Heavy Summer Without 2nd John Day-McNary 500-kV line Without Orion Project	Base Case (All lines in-service)	orion100.drw orion_ko. ...v Rating ...

ATE = 06-27-2001 PORTLAND GENERAL ELECTRIC CO. TRANSMISSION LINE DATA

LINE DESCRIPTION	NOM KV	LENGTH MILES	CONDUCTOR	CONF	EQUIV SP FT	POS SEQ OHMS R1	X1	Z1	ANG	B	ZERO SEQ OHMS R0	X0	Z0	POS SEQ P.U. R1P	X1P	ZERO SEQ P.U. AT 100 MVA R0P	X0P	BP
MARYS-TROJAN	230.00													R	X			B
ST MARYS-SPRINGVILLE JCT		3.78	1272 AAC 61	D2	22.89	0.319	2.892			21.073	1.400	9.501		0.00060	0.00547	0.00265	0.01796	0.01115
SPRING JCT-SKYLINE		2.86	1590 AAC 61		23.49	0.197	2.159			16.172	1.015	7.132		0.00037	0.00408	0.00192	0.01348	0.00856 × 1/2
SKYLINE-TWR 1/3 (HAR)		1.35	1780 ACSR 84/19		26.48	0.082	1.016			7.580	0.468	3.305		0.00016	0.00192	0.00089	0.00625	0.00401
SUBTOTAL		7.99				0.598	6.067	6.097	84.368	44.825	2.883	19.938	20.145	0.00113	0.01147	0.00545	0.03769	0.02371
TWR 1/3 - CORNER (37/1)		32.65	1590 AAC 61		23.49	2.253	24.645			184.625	11.591	81.421		0.00426	0.04659	0.02191	0.15391	0.09767
TWR-37/1 TROJ HTS		0.10	1780 ACSR 84/19		25.49	0.006	0.075			0.565	0.035	0.246		0.00001	0.00014	0.00007	0.00046	0.00030
TROJ HTS- TROJAN		0.52	1780 ACSR 84/19	H3	34.02	0.032	0.407			2.803	0.180	1.241		0.00006	0.00077	0.00034	0.00235	0.00148
SUBTOTAL		33.27				2.291	25.127	25.231	84.791	187.993	11.806	82.908	83.744	0.00433	0.04750	0.02232	0.15673	0.09945
TOTAL		41.26				2.889	31.194	31.328	84.709	232.818	14.689	102.846	103.890	0.00546	0.05897	0.02777	0.19442	0.12316
OJAN SW. STA.-TROJAN PL	230.00																	
TROJAN SW. STA.-TROJAN PL		0.16	2-1780 ACSR	S7	-1.00	0.005	0.087			2.600	0.051	0.361		0.00001	0.00016	0.00010	0.00068	0.00138
TOTAL		0.16				0.005	0.087	0.087	86.844	2.600	0.051	0.361	0.365	0.00001	0.00016	0.00010	0.00068	0.00138

ST MARYS - TROJAN #2

5.21 mi

SPRBRULE

36.05 mi.

41.26 mil

R = .00530

X = 0.05761

B = 0.1255

per mi

0.0001285

0.001396

0.003042

R	X	B
0.0006695	0.007273	0.01585
0.004632	0.05033	0.10966
0.000785	0.00751	0.01543
0.004675	0.05146	0.10773

ST. MARYS - TROJAN #1

5.21

36.05

R/2 .000185

X/2 0.00204

B/2 .00428

511[illegible]1 MYRTLE ST
FORT COLLINS CO 80521

DATE = 09-03-1992 PORTLAND GENERAL ELECTRIC CO. MISSION LINE DATA

LINE DESCRIPTION	NOM KV	LENGTH MILES	CONDUCTOR	CONF	EQUIV SP FT	POS SEQ OHMS R1	X1	Z1	ANG	B	ZERO SEQ OHMS R0	X0	Z0	POS SEQ P.U. R1P	X1P	ZERO SEQ P.U. AT 100 MVA R0P	X0P	BP
KEELER BPA-RIVERGATE																		
- BPA LINE	230.00													R	X			B
KEELER BPA-TWR 2/3		6.63	1272 ACSR 54/19	J3*	34.02	0.564	5.304			35.018	2.460	15.939		0.00107	0.01003	0.00465	0.03013	0.01852
TWR 2/3-TWR 1/5		1.01	556 ACSR PAR.EQ.	S9	-1.00	0.094	0.412			10.416	0.383	2.061		0.00018	0.00078	0.00072	0.00390	0.00551
TWR 1/5-DE TWR (BPA)		0.74	1272 ACSR 54/19	J2*	27.68	0.063	0.573			4.039	0.275	1.816		0.00012	0.00108	0.00052	0.00343	0.00214
SUBTOTAL		8.38				0.721	6.289	6.331	83.459	49.473	3.118	19.816	20.060	0.00136	0.01189	0.00589	0.03746	0.02617
DE TWR (PGE)-RIVERGATE		0.09	1272 AAC 61	J2*	27.68	0.008	0.071			0.486	0.033	0.222		0.00001	0.00013	0.00006	0.00042	0.00026
SUBTOTAL		0.09				0.008	0.071	0.071	83.896	0.486	0.033	0.222	0.225	0.00001	0.00013	0.00006	0.00042	0.00026
TOTAL		8.47				0.729	6.360	6.402	83.464	49.959	3.151	20.038	20.285	0.00138	0.01202	0.00596	0.03788	0.02643
KEELER BPA-ST MARYS	230.00	PM-107, M132																
KEELER-SPRINGVILLE JCT		2.89	1590 ACSR TWD	H2	25.20	0.159	2.182			16.316	0.985	7.133		0.00030	0.00412	0.00186	0.01348	0.00863
SPRINGVILLE JCT-ST MARYS		3.78	1590 ACSR TWD	D2	22.89	0.208	2.809			21.690	1.289	9.418		0.00039	0.00531	0.00244	0.01780	0.01147
TOTAL		6.67				0.367	4.991	5.004	85.796	38.005	2.274	16.551	16.707	0.00069	0.00943	0.00430	0.03129	0.02010
														ASPen 7/27/93				
LINNEMAN PP&L -																		
-TROUTDATE BPA(PP&L LINE)	230.00																	
LINNEMAN PP&L - CHANGE 1		6.33	900 SSAC 54/7	PP&L	25.12	0.676	4.968			34.284	2.486	15.820		0.00128	0.00939	0.00470	0.02991	0.01814
CHANGE 1 - TROUTDALE BPA		0.11	1272 ACSR 36/1	PP&L	25.12	0.009	0.085			0.605	0.041	0.274		0.00002	0.00016	0.00008	0.00052	0.00032
TOTAL		6.44				0.685	5.053	5.099	82.276	34.889	2.527	16.094	16.291	0.00130	0.00955	0.00478	0.03042	0.01846
														ASPen 7/27/93				

KEELER R X B

$3.4\ mi \times \left(\frac{0.00107}{6.63\ m}\right)$ $\left(\frac{0.01003}{6.63}\right)$ $\left(\frac{0.01852}{6.63}\right)$

$R_1 = 0.0005487$ $X_1 = 0.005144$ $B_1 = 0.009497$

SPRGRVLE

$(0.00138 - R_1)$ $(0.01202 - X_1)$ $(0.02643 - B_1)$

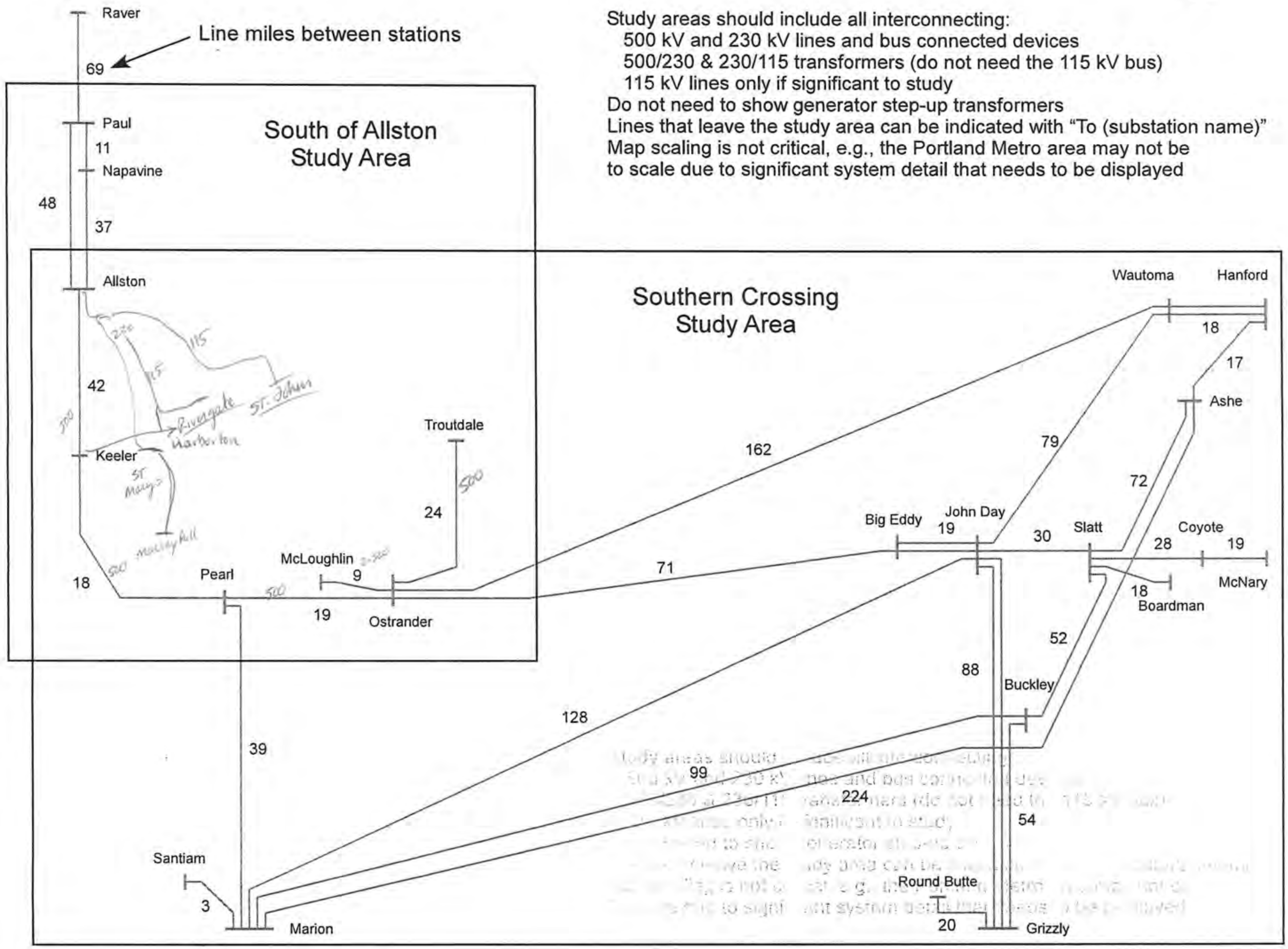
5.07 $= 0.0008313$ $= 0.006876$ $= 0.016933$

RIVERGATE

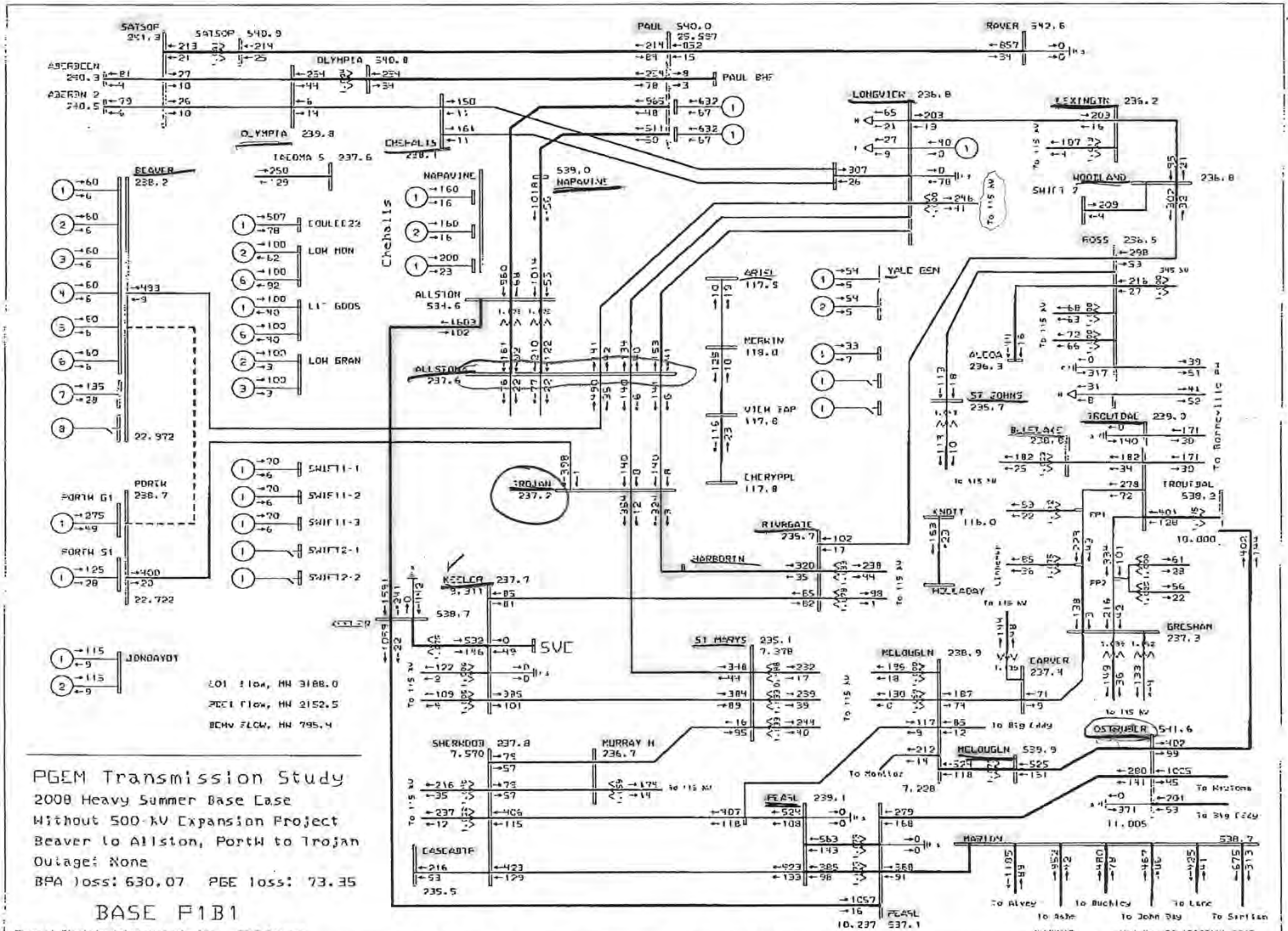
5.07

Study areas should include all interconnecting:
- 500 kV and 230 kV lines and bus connected devices
- 500/230 & 230/115 transformers (do not need the 115 kV bus)
- 115 kV lines only if significant to study

Do not need to show generator step-up transformers
Lines that leave the study area can be indicated with "To (substation name)"
Map scaling is not critical, e.g., the Portland Metro area may not be to scale due to significant system detail that needs to be displayed



40%



General Electric International, Inc. PSLF Program

PGEM PortWestward/Beaver Project Study 2008 Heavy Summer
PortW at 400 MW, Beaver at 495 MW to Allston CASE F1B1
Displace: 90 MW Coulee, 100 MW J Day, 210 MW Snake R.

Base Case (All lines in-service)

PH/MWAR Wed Mar 09 15:23:46 2005

p1b1.drw
p1b1.sav
Rating = 1

Portland General Electric
One World Trade Center
121 SW Salmon Street
Portland OR 97204

FAX COVER SHEET

Date: July 25, 2005	
To: Alan Wallace	
At: OSU	
Receiver's Phone No.: (541) 737-2995	Receiver's Fax No.: (541) 737-1300
From: Jim Eden	
Sender's Phone No.: (503) 464-7031	Sender's Fax No.: (503) 464-2605
Number of Pages (including cover sheet): 3	

Remarks:

Attached are two drawings (from the GE program) that represent Case 0 (the case I sent you) and Case 1 (Beaver switched to Trojan and the St Marys/Rivergate lines switched to Trojan).

Comparing my Case 1 with the picture that Joe sent on 7-21-05, which I think are the same cases, I'm puzzled by a number of differences. The cases should be more similar. Also, the COI flow is off by 90 MW. My plot only shows the BC(west)-NW, i.e., just the Ingledow-Custer lines. Voltage and reactive flows in and around Beaver, Port Westward and Trojan seem to be quite different. I'm wondering if we need to double-check what controls are used in the PW solution.

Looking at your figure, I see we still have some items missing. There are three lines from Allston to Longview (you show only one) and you are missing the SVC at Keeler 230. There is also a capacitor bank at Keeler 500 and two 230/115 xfmrs. We will want to show the 230/115 xfmrs at Longview and Lexington. That's just from looking at the one small picture you sent. I do need to look over the full drawing, I'll do that as soon as possible.

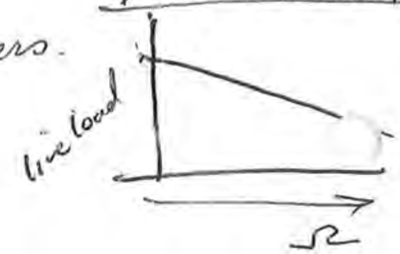
Let's talk today, if we can, about the solved differences.

Jim

PLOTS — EXCEL

1. ↑ Ω's ; ↓ line loading ;
2. SOA - transfer reduce to to equivalent overloading for outages.

BASE OVER MATCH



CASES   BASE CASE = ?

$\boxed{5 - 25\,\Omega}$

↓ (5) → A-K out → reduce SOA stress COI, BC-NW, DCPI → back to base case.
(10)

replace line (2) PHASE SHIFTING X-FMR.

EXCEL FILE

	OUTS BASE			REDUCED FLOW		
Ωs	1	2	3	BC→ NW → CA		①c AK
5	SOA - ① ② ③					
10						
15						
20						
25						
				BASE	REDUCED	

O

over loaded lines.

$\boxed{> 100\%\ \text{B RATING}}$

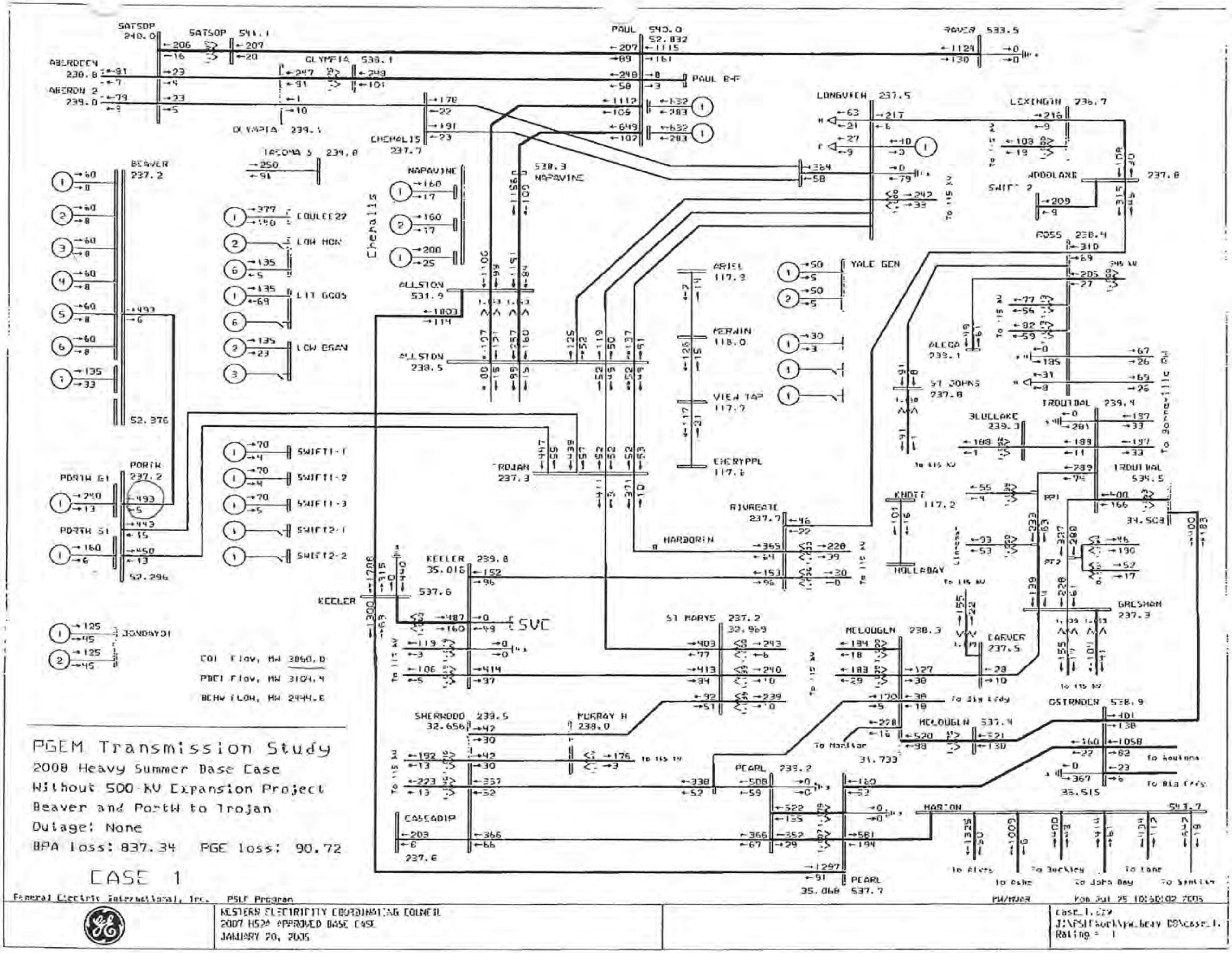
Reduced.
Overloaded to near BASE.

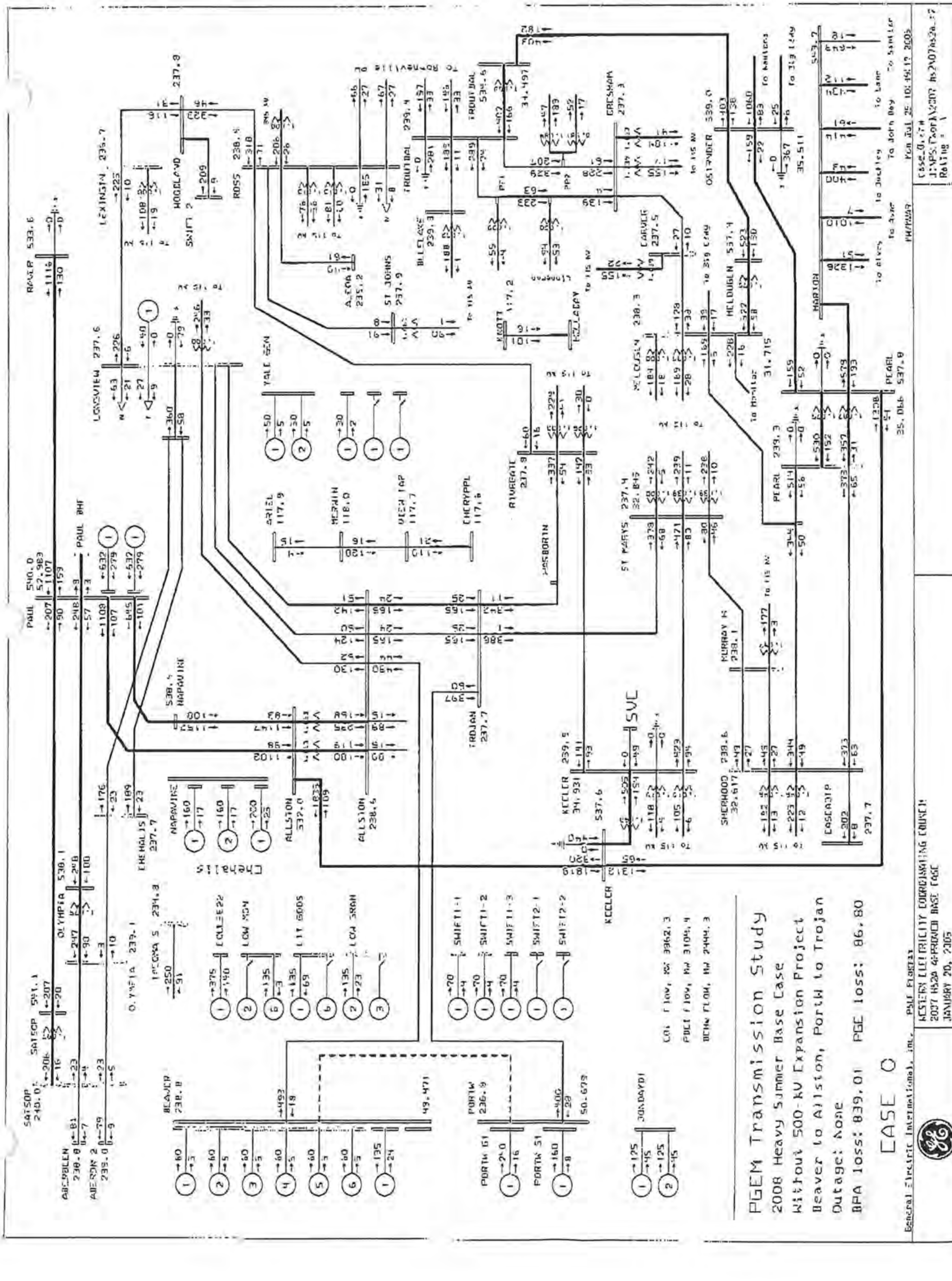
EMERGENCY A - nominal - All lines services
↳ B - Contigency - summer. case. — Winter C, D

REPORT

Intro — SOA Transmission system.

SECTIONS: RESULTS.
EACH CASE — BASE CASE.
TO NEW BASE CASE → w/ PICTURES & GRAPHS. (BEAVER)
→ TABLE OUT PUT — EXCEL SHEET.
→ TEMPLATE BOX
↳ APPENDIX W/ KEY TABLES.
↳ DOCUMENT. ONELINES & TABLES
w/ ALL CHANGES w/R/T BASE CASE


SATSOP 240.0
SATSOP 541.1
ABERDEEN 238.8
ABERDN 2 239.0
GLYMPIA 538.1
OLYMPIA 239.1
PAUL 540.0
52.832
PAUL B-F
RAVER 533.5
LONGVIEW 237.5
LEXINGTN 236.7
CHEHALIS 237.7
TACOMA S 239.0
BEAVER 237.2
52.376
NAPAVINE
538.3 NAPAVINE
Chehalis
COULEE22
LOW MON
LIT GOOS
LOW GRAN
ALLSTON 531.9
ALLSTON 238.5
WOODLAND 237.8
SWIFT 2
ROSS 238.4
YALE GEN
ARIEL 117.9
MERWIN 118.0
VIEW TAP 117.7
CHERYPPL 117.6
ALCOA 233.1
ST JOHNS 237.8
TROUTDAL 239.4
BLUELAKE 239.3
TROUTDAL 534.5
34.503
To Bonneville PH
PORTW 237.2
PORTW G1
PORTW S1
52.296
SWIFT1-1
SWIFT1-2
SWIFT1-3
SWIFT2-1
SWIFT2-2
TROJAN 237.3
KNOTT 117.2
RIVRGATE 237.7
HARBORTN
HOLLADAY
KEELER 239.8
35.016
537.6
KEELER
SVC
BOARDMAN
COI Flow, MW 3850.0
PDCI Flow, MW 3104.4
BCHW FLOW, MW 2444.6
ST MARYS 237.2
32.969
MCLOUGLN 238.3
CARVER 237.5
GRESHAM 237.3
OSTRNDER 538.9
MCLOUGLN 537.4
31.733
SHERWOOD 239.5
32.656
MURRAY H 238.0
PEARL 239.2
CASCADIP 237.6
MARION 543.7
35.515
PEARL
35.068 537.7
To Alvey
To Buckley
To Lane
To Santiam
To Pehe
To John Day
To Keeler
To Big Eddy
To Hanford
To 115 kV
PGEM Transmission Study
2008 Heavy Summer Base Case
Without 500 KV Expansion Project
Beaver and PortW to Trojan
Outage: None
BPA loss: 837.34 PGE loss: 90.72
CASE 1
General Electric International, Inc. PSLF Program
WESTERN ELECTRICITY COORDINATING COUNCIL
2007 HS2A APPROVED BASE CASE
JANUARY 20, 2005
MW/MVAR
Mon Jul 25 10:50:02 2005
case_1.drw
J:\PSLF\work\pw_heav CB\case_1.
Rating = 1


PGEM Transmission Study
2008 Heavy Summer Base Case
Without 500-kV Expansion Project
Beaver to Allston, PortW to Trojan
Outage: None
BPA loss: 839.01 PGE loss: 86.80
CASE 0

EDIT: 9/22/05
JIM Eden

South of Allston
Summer 2005 Study Report

1) Introduction

This report summarizes the studies conducted by OSU for PGE on the South of Allston path. The South of Allston path is typically loaded heavily only during the summer season when there is high north-to-south power flow across the Northwest system. The generation sources for this pattern include: Upper Columbia generation, Mid Columbia generation, BC Hydro generation, generation in the Puget Sound area and along the I-5 Corridor. The following transmission lines define the South of Allston path.

Allston – Keeler 500 kV (BPA)
Trojan – St. Marys 230 kV (PGE)
Trojan – Rivergate 230 kV (PGE)
Lexington – Ross 230 kV (BPA)
Allston – St. Helens 115 kV (BPA)
Merwin – St. Johns 115 kV (PACW)
Astoria – Seaside 115 kV (PACW)
Lewis & Clark – Astoria Tap 115 kV (PACW)

Note: The "from" and "to" substations are listed in the direction of positive flow on the South of Allston path. The underlined substation is where the flow is metered.

This path is thermally limited and the worst contingencies ~~were found~~ are known to be the following list of facilities.
N-1: Allston – Keeler 500 kV line
BFR: 4322, 4324, 4394 Keeler 500 kV (loss of Keeler 500 kV bus)
BFR: 4280 Pearl 500 kV (loss of Pearl-Keeler and Pearl Bank #2)
BFR: 4283 Pearl 500 kV (loss of Pearl-Keeler and Pearl-Ostrander 500 kV lines)
N-2: Pearl – Keeler 500 kV and Pearl – Sherwood 230 kV lines
N-2: Keeler – St. Marys / Trojan – St. Marys 230 kV lines
N-1: Lexington – Longview 230 kV

The above contingencies typically overload the following elements depending on the generation pattern and transfer level. The limiting elements include: Merwin – View Tap 115 kV line section, Woodland – Ross 230 kV line section, Lexington – Longview 230 kV line, Keeler – St. Marys 230 kV line, Trojan – St. Marys 230 kV line, Keeler – Forest Grove #2 115 kV line, and the Longview 230/115 kV Bank.

2) Purpose

The purpose of these studies are to assess the impacts of PGE's re-termination of its Beaver Plant, the relative contribution of PGE's Trojan lines to the SOA transfer capacity, the effects of controlling the Trojan line flows by using series reactors and phase-shifters, and finally, to assess the relative effects of reconductoring several critically limiting facilities and the addiction of a third Trojan line. The studies were performed using the Heavy Summer 2007 WECC base case, as the summer is when the path is most heavily loaded. The SOA North-to-South stress level~~s~~ is ~~are at or~~ beyond the present simultaneous operating limits as established by BPA for the 2005 operating season.

	flow MW	2005 rating
Northern Intertie	2757	3100
COI	3772	4800
PDCI	3100	3100
SOA Path	3168	2630
A-K line ~~Path~~	1821	1670

Table.1 The North-to South stress levels

3) System Changes and Base Case Stress

The base case (Case 1) was developed from the Heavy Summer 2007 WECC base case (Case 0) by the following re-terminations.

(a) Open Beaver-Allston 230kV, and reconnect Beaver stations to the system through Beaver-PORTW-Trojan 230kV lines.

(b) Change the internal connections at Trojan Switching Station. Allston 230kV bus is connected to the Trojan 230kV bus through Trojan 1 & 2. For the flow control studies the Reactors or the Phase Shifting Transformers will be inserted to manage the power flow between Allston 230kV and Trojan 230kV buses.

4) Methodology

There are totally 18 cases in these studies (Appendix A). All the cases were tested by only running four representative outages. These outages were identified by BPA as the most critical outages in limiting and setting the SOA transfer capacity. The following outages were used for this study.

N-1: Allston – Keeler 500 kV line (AK)

N-1 N-~~2~~: Pearl – Keeler 500 kV ~~and Pearl – Sherwood 230 kV lines~~ (KP)

N-2: Keeler – St. Marys / Trojan – St. Marys 230 kV lines (KTS)

N-1: Lexington – Longview 230 kV (LL)

first series of (cases 3-8)

For the first series of flow control cases, one series reactor is inserted in each Allston-Trojan line at Trojan, with ~~the~~ impedance values of 5, 10, 15, 20, and 25 ohms. For reference, 5 ohms is equal to about 10 miles of 230 line, which is also equal the reactance of each Allston-Trojan line. Thus a 5 ohms rector will double the line impedance, 10 ohms will triple, and so on. For the second series of flow control cases, one ~~Next the Rectors are replaced with~~ Phase Shift ~~Transformers~~ Transformer is inserted in each Allston-Trojan line at Trojan, which are the same type as the one used at Nelway on the Boundary line. Phase shift angles of 0, 2, 4, 6, 8, and 10 degrees were used (Cases 9-14). The power flows from BC Hydro to the Northwest, and from Northwest to LA (PDCI) and PG&E (COI) are kept the same levels in all above scenarios. The phase-shifters were to block the contingency flows on the Trojan lines. Thus, as the angle is increased, the base flows from Trojan to Allston are increased. X

~~Since~~ The Allston-Keeler 500kV line is the worst single line outage in the South of Allston Path. For this outage, an additional case was run and is referred to as the reduced stress case. The North to South stress level is reduced by decreasing northern generation (BC imports and Coulee generation equally) and decreasing southern exports (AC & DC Interties equally). This was done to get a measure of how a system change affects the SOA transfer capacity. The stress is reduced until the overload ratios of Non-PGE facilities in the study area recovered to the original values as shown in the no flow control base case.

An ~~Additional cases~~ additional case (Case 15~~/16~~) was ~~were~~ run to determine the relative benefits of reconductoring several limiting facilities in the SOA Path with ACSS equivalent conductor. For ~~these cases~~ this case, the system topology and line impedances were unchanged and overloads should be greatly reduced or eliminated. Two ~~Another~~ cases (Case 16-17) were ~~was~~ studied that includes a new third 230kV line south of Trojan. This line was terminated at St. Marys. A final case (case 18) was studied that included this new third Trojan line and a new substation in the Springville area, about 5 miles north of St. Marys. Both Trojan-St. Marys lines and the Rivergate-Keeler lines were looped through this new station.

5) Results

5.1 Case 1: Beaver Re-termination

South of Allston is operationally monitored by tracking the Allston-Keeler (500KV) loading. The RAS levels are armed according to the Allston-Keeler line loading. sp Form the base case incorporated into this Power World simulator study, the cases studied are over-scheduled according to limits established by BPA, ~~annual scheduled flows~~ as shown below:

Scheduled Loading		
YEAR	South of Allston (SOA) [MW]	Allston-Keeler (A-K) [MW]
2004	3050	~~2630~~ 1740
2005	~~1741~~ 2630	1670

Table.2 Scheduled loading for Year 2004 and 2005

estward, and a second PortWestward to Trojan 230 kV line is added.

For case study 1, Beaver is re-terminated at Port W. to Trojan through a second~~ary~~ Port W.-Trojan 230 ~~KV Line~~. The South of Allston flow comparison for case 0 to case 1:

Case Comparison: CASE 0 and CASE 1 for SOA MW Flows						
CASE	South of Allston (SOA)	Allston-Keeler (A-K)	Merwin-View Tap	Trojan-South (PGE Lines)	Woodland-Ross	Allston-Rainer
0	3168	1821	127	712	322	91
1	3180	1791	124	767	315	88
Delta Δ	**12**	-30	-3	**55**	-7	-3

Table.3 The South of Allston flow comparison

The Beaver re-termination at Port W. to Trojan increases South of Allston flow by a total of 12 MW. All increased loading from this re-termination of Beaver is placed upon the Trojan-South PGE lines which include Trojan-St. Marys and Trojan- Rivergate ~~Harborton~~. The total Allston-Keeler line flow reduction is 30 MW. Consequently the critical outage~~s~~ ~~are~~ is reduced in magnitude while critical facilities that overload are all reduced in the base case loading.

For the Allston-Keeler 500 KV outage (A-K) all non-PGE overloads are reduced, one is eliminated and one is marginal (May be eliminated if SOA reduced to pre-2005 levels). ~~For~~ The Keeler-Pearl 500 KV outage (K-P) experiences little change due to the Beaver re-termination with a slight improvement overall. The Keeler-St. Marys and Trojan-St. Marys 230 KV outage (KTS) also experiences little change due to the re-termination of Beaver, and also has little effect on the limiting Keeler-Forest Grove 115 KV line. For the Longview-Lexington 230KV outage there is a slight improvement on the critical facility. (Reference to index case 0 and 1 tables and onelines)

Based on these results, the Beaver re-termination at Port W. to Trojan, is a positive benefit to the South of Allston transfer capacity based upon the review of these most critical outages.

5.2 Case 2: Allston-Trojan "Open"

CASE 2: South of Allston MW Flow			
	CASE 1	CASE 2	
South of Allston [MW]	3180	3206	
Trojan-South [MW]	767	867	Δ
new South of Allston [MW]	2413	2339	- 74 MW

Table.4 Power flow comparison for Trojan-South and New South of Allston Path

~~From these Trojan 1 and 2 open-circuits~~, no initial overloads are created and

Case 2, with the Allston-Trojan lines open, This is due to small flows on the Allston-Trojan lines towards Allston that are now carried on the Trojan south lines when the Allston lines are opened.

over-all non-PGE line loading is reduced slightly. However for the Allston-Keeler 500 KV outage there are significantly worse overloads. The only exception is BPA's Keeler-Rivergate. This line is now less tightly coupled to the main-grid and therefore experiences a significant reduction in overload. Consequently, all PGE overloads normally experienced during an Allston-Keeler 500KV outage [are] eliminated.

For ~~this~~ [the] Allston-Keeler outage, the reduced ~~South of Allston~~ [stress case], ~~study~~ ~~proves~~ [indicates] that SOA must be reduced by approximately 200MW to reach initial ~~Allston-Keeler~~ case 1 outage overload values on non-PGE lines. [Specifically,] ~~This~~ [at] would require a [inter-regional flow reduction from] BC/Coulee to N/S California ~~reduction~~ of approximately 1800 MW. This is the most drastic of the flow reductions necessary to reach ~~base~~ case 1 values.

For the Keeler-Pearl 500 KV Outage, there is little change due [to] the Allston-Trojan lines being open. However, for the N-2 Keeler-St. Marys and Trojan-St. Marys 230 KV outage, there is significant overloads on the PGE lines from Trojan to Rivergate which would require generator tripping [at Beaver or Port Westward] in the order of 300 MW total. There are no non-PGE overloads. Heavily overloaded facilities are reduced by Allston-Trojan lines being open. For the Longview-Lexington 230 KV outage, the heavily loaded facilities are also reduced by the Allston-Trojan lines being open.

Based on these observations, the South of Allston path is severely impacted by the opening of the Allston-Trojan lines 1 and 2. The north to south stress across the Pacific Northwest must be reduced by nearly 2000 MW to achieve comparable results as to the base case. [for the A-K outage] ~~Non-PGE contingencies appear to be less severe~~, while PGE requires a 300 MW generator trip in the case a Keeler-Trojan-St. Marys (KTS) 230KV outage. ~~Equivalently~~ [Alternatively], the Allston-Trojan connection is worth (or supports) approximately 2000 MW of N-S inter-regional flows [at Trojan] Allston and Trojan (Trojan 1 and 2)

5.3 Case 3-8: Series Reactor Parametric Study

[Series] ~~Two~~ Reactors were inserted between ~~Trojan 1 & 2 to Trojan bus~~ and the reactor impedance ~~varies from~~ [was studied at] 0, 5,10,15,20 [and] to 25 ohms. Each case was studied under all [four] 4 outages. The area power transaction levels are kept the same as the basic Case 1. Six critical transmission lines were selected to evaluate the ~~interferences~~ [impacts] of the Trojan power flow control to the South of Allston Path, which are as follows:

- [Astoria] Astor-LWSCLAR [Lewis&Clark] 115 kV line
- Trojan – St. Marys 230 kV line,
- Keeler –Rivergate 230 kV line,
- Longview 230/115 kV Bank.
- Woodland – Ross 230 kV line
- Merwin – View Tap 115 kV line [Section]

[The] Astor- LWSCLAR 115 kV line is the most heavily loaded line in the coastal area. Trojan – St. Marys 230 kV line and Keeler –Rivergate 230 kV line are good indictors for the power flows [south] of Trojan. Longview 230/115 kV Bank and Woodland – Ross 230 kV line are always the first overloaded lines/transformers ~~cased~~ [caused] by the power flow from the Longview bus. The Merwin – View Tap 115 kV ~~load ratio~~ ~~is always~~ [line loading]

~~more than 80%, and~~ can be as high as 159% which made it the most critical bottleneck for the whole South of Allston.

The cross comparison for each critical line during all 4 outages are summarized using tables and plots in Appendix B. When the reactor impedances between Trojan 1 &2 to Trojan were increased, more and more Trojan-South contingency flow was blocked. As ~~the~~ a result, almost all transmission lines increased their contingency loadings ~~level~~ except for the Trojan-South PGE lines, ~~while maintaining~~ the MW transactions among BC Hydro generation, Northwest, LA and PGE areas. were maintained for all cases.

For most critical lines the loading variation caused by the changing of the Trojan Reactors are within 20%. The largest variation happened on Keeler-Rivergate 230 KV line during the KTS outage. But this would be reasonable considering the close distance of KTS outage to this transmission line. The interfere from the Trojan-South flow control utilizing the Reactors to the South of Allston Path is very limited. benefits

The series reactors do block contingency flows S of Trojan but at the expense of inter regional capability.

5.4 Case9-14: Phase-Shifter Parametric Study

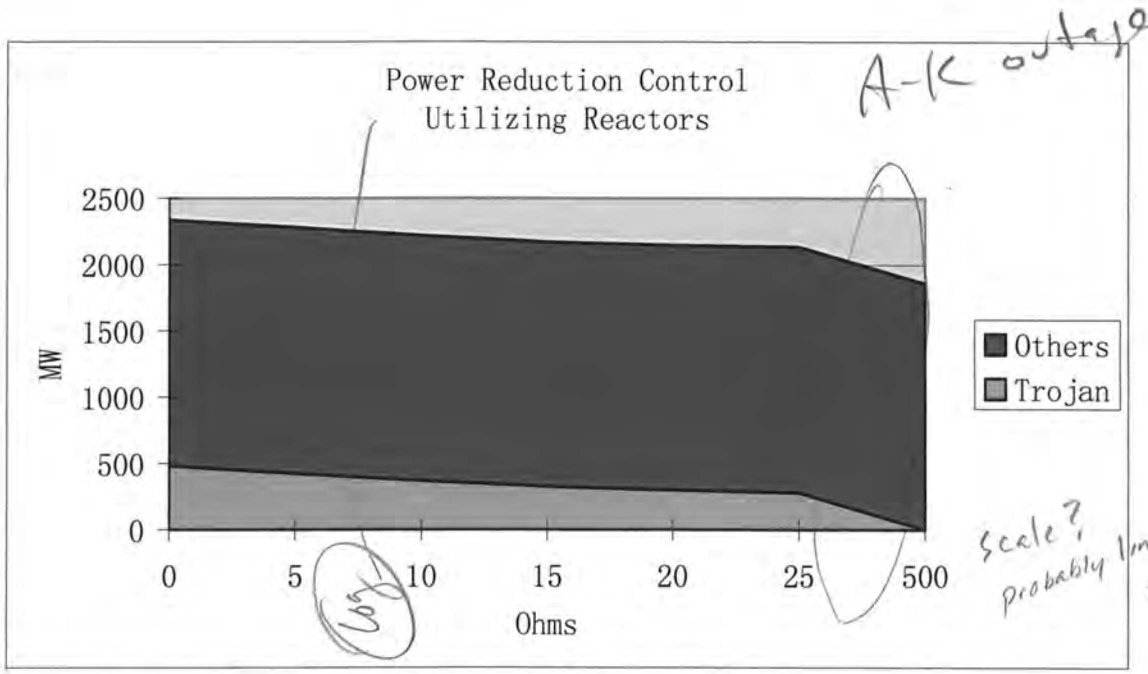
Instead of blocking the Trojan-South flow with Reactors, two Phase Shift Transformers were used to compensate the North to South power flow between Allston 230 kV bus and Trojan 230 kV. The six critical transmission lines in Case 3-8 were still used in these cases. The Phase Shift Transformer has different impedance at 0 degree compared with the 0 ohm Reactor impedance in Case 3, so there is a little ~~bit~~ difference between Case 3 and Case 9. During the AK outage, there is not much difference in the overload scenarios between Reactor control and Phase Shift Transformer control. The Phase Shift Transformer control removed the overload of Keeler-Rivergate 230kV line during the KTS outage. The Phase-Shifter control reduced the burden on Woodland – Ross 230 kV line, but distributed more power flow to Longview 230/115 kV Bank, and Merwin – View Tap 115 kV line.

5.5 Case 3-14: Power reduction control

As shown in Fig. 1, the power flow of South of Allston was controlled from 2336MW down to 1859 MW during the AK outage with the Reactor control. And the power flow though Trojan is 480 MW to 0 MW. The difference between these two flows is very close to a constant value of 1850 MW, which may be a good indicator of the loose interferences of Trojan to other transmission lines. The 500 ohms in Fig. 1 in fact refers to the Trojan 1 & 2 to Trojan open case (Case 2). A big Reactor will be needed for a wide operational range due to the saturation effect. As a passive device, the series reactor is very reliable and needn't any additional control circuit. Unfortunately ~~its~~ bidirectional blocking ~~function~~ capability ~~limits~~ is effective for both North-to-South and South-to-North power flows.

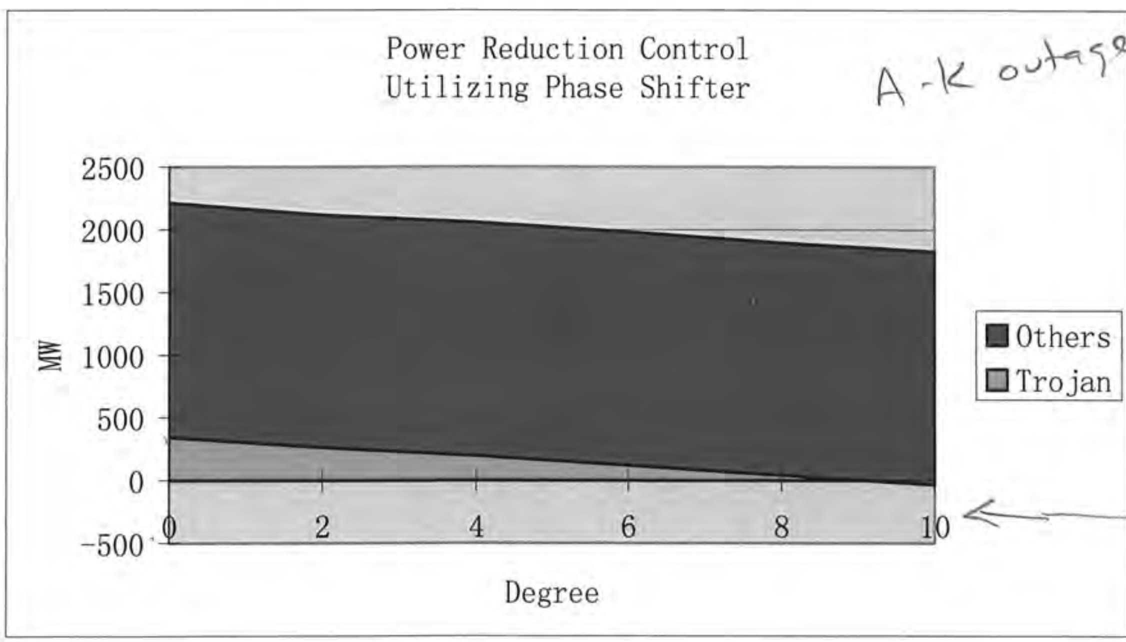
As a contingency blocking device, its

→ This effect is also similiar to minimizing power transfer, both pre- & post- contingency between Allston and Trojan.



scale? probably linear is scale is adjusted.

Fig.1 Power transaction control of the Trojan lines and the whole South of Allston Path utilizing the Reactors



fix?

Fig.2 Power transaction control of the Trojan lines and the whole South of Allston Path utilizing the Phase Shifting Transformers

The Phase-Shifter has similar power flow control functions as the series reactor, also with a nearly constant difference of 1850MW between the whole capacity of SOA and Trojan shown in Fig.2. ~~Note its bidirectional characteristic on the flow control, the~~

for the A-K outage.

As a contingency blocking device, its directional blocking is effective for N-S power flows, but has undesirable pre-contingency loading by increasing pre-outage flows to Allston.

~~Phase shifter can even compensate the South to North power flow.~~ ~~Another good thing of~~ the phase-shifter ~~is the~~ exhibits a linear~~ity of the~~ operationaling curve. As an active equipment, the phase-shifter requires additional control and high maintenance.

5.5 Case 15

In this case we ~~installed~~ assumed new conductors in transmission lines which were known to overload heavily in the case of a major outage. These lines are Merwin-View Tap-Cherryppl, LwsClark-Astor Tap, Woodland-Ross, and Rivergate-Keeler. The Merwin-View Tap line~~s~~ (4.2 miles) and the View Tap-Cherryppl line~~s~~ (6.69 miles) 6.7 are currently 636 ACSR Rook. by using ~~a~~ 636 ACSS Rook, the summer ~~nominal~~ emergency rating can by increased from 134.0 MVA to 292.6 MVA ~~and the winter nominal emergency can be increased from 210.0 MVA to 323.3 MVA.~~ ~~The lines are currently owned by PacifiCorp-West.~~ The LwsClark-Astor Tap line~~s~~ (0.7 miles) ~~are~~ is currently 397.5 ACSR Ibis, and by using 397.5 ACSS Ibis, the summer emergency rating can be increased ~~to~~ from 100 MVA to 216.9 MVA. The line from Astor Tap to Seaside is 12.8 miles long and is less critically loaded, however installing new conductor on these lines is a consideration for future study. All of the above line sections ~~The lines~~ are currently owned by PacifiCorp-West. The Woodland-Ross lines (19.85 miles) ~~are~~ is currently 795 ACSR Drake, and by using 795 ACSS Drake the summer emergency rating can be increased from 426.3 MVA to 682 MVA. These lines are currently owned by Bonneville Power Administration. The Rivergate-Keeler line~~s~~ (8.47 8.5 miles) ~~are~~ is currently limited by a 0.73 mile section of 1.01 miles of 556 ACSR Eagle. By installing new 1272 AAC Narcissus, the summer emergency rating for the Rivergate-Keeler lines can be increased from 346.6 MVA to 523.8 MVA. move this sentence to end.

Installing new conductors on these lines eliminates the three top overloads which occur during an N-1 Allston-Keeler 500KV Outage. (Refer to onelines and tables for Case 15) Th~~e top overloads are now reduced to the limiting lines in the transmission area of~~ Trojan-St. Marys, Trojan-Harborton, and Harborton-Rivergate. Case 16 addresses this limitation. remaining overloaded facilities are PGE's Trojan south lines.

5.6 Case 16

In this case, we used case 15 with all the new conductors and then increased the capacity South of Allston by installing an entire new circuit from Trojan to St. Marys. The new circuit Trojan-St. Marys #2 has an assumed summer ~~nominal~~ emergency rating of 641.0 MVA and winter ~~nominal~~ emergency ~~is~~ of 844.5 MVA.

Describe the base case effects before addressing the contingencies.

From the installation of this new Trojan-St. Marys circuit, the flow South of Allston during an N-1 Allston-Keeler Outage is increased 165MW, from 2337MW to 2502MW. The flow during normal operation is increased 47MW, from 3180MW to 3227MW. The significant overloads above 100% of the summer ~~nominal~~ emergency rating during an N-1 Allston-Keeler outage are limited to Astor-Tap-Seaside and

Trojan-St. Marys #1. These overloads are significantly reduced, the seaside loading is reduced 13% and the St Marys line is reduced 31%.

5.7 Case 17

In this case the advantage of having Trojan-St. Marys was realized while only installing new conductors on two of the most critical lines. Therefore we installed new conductors only on the Merwin-View Tap-Cherryppl and LwsClark-Astor Tap lines as described in case 15, and installed the new Trojan-St. Marys circuit. This case provides more South of Allston capacity while only fixing ~~more~~ the most critical lines. (Refer to onelines and tables for cases 16 and 17)

TABLES

5.8 Case 18: New Springerville Station

In this case, we took case 17 and created a new substation at Springerville which is located between Trojan and St. Marys and Rivergate and Keeler. The substation is a 230KV bus as shown below:

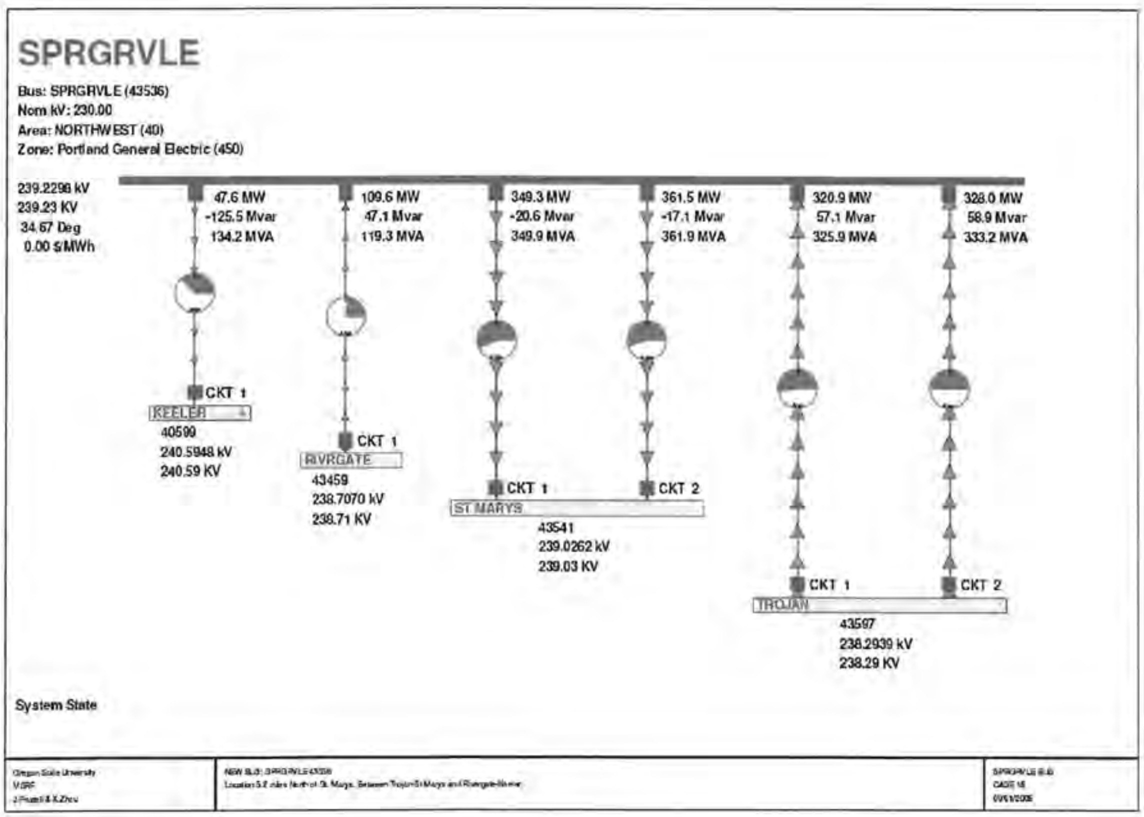


Fig.3 New Springerville Station

By calculating the geographical position of the substation and using known distances and line parameters, we modeled the 230Kv transmission lines using the existing Rivergate-Keeler and Trojan-St. Marys #1 & #2.

For the model simulation we changed the Keeler-St. Marys and Trojan-Marys

outage (KTS Outage) to a Keeler-~~Sprgrvle~~ St Marys and Sprgrvle-St. Marys 230Kv Outage (KSS Outage) The N-1 Allston-Keeler 500Kv Outage creates a 152% overload on the Keeler-Sprgrvle lines followed by Astor Tap-Seaside at 111%. However a N-1 Keeler Pearl 500KV Outage shifts the overload to St. Marys-Murray H. at 118% followed by a Forest Grove-Keeler at 104%. Further detailed results are shown in the case 18 onelines and tables. The limiting factor to be addressed ~~in the case of creating a new substation at this location~~ for this configuration would be the 3.4 miles of 1272 ACSR Pheasant between Keeler and Springerville. due to significant ~~loadings~~ contingency loadings as a result of the A-K outage.

instead: address the option of reconducting with ACSS

6) Conclusion

These studies evaluated the influence of the Trojan reconstruction on the transfer capacity of the South of Allston Path. Any power transaction reduced through the Trojan lines would cause almost the same amount of loss for the whole South of Allston Path. Due to the related loose connection of the Trojan lines to the other transfer channels, the re-termination would keep the power distribution in other transmission lines at reasonable levels, and would not generate new problems for the whole path. The update of the transmission lines including Merwin-View Tap-Cherryppl, LwsClark-Astor Tap, Woodland-Ross, and Rivergate-Keeler will also reduce the overloading problem of South of Allston will reduce the system overloading problem and improve the capacity of the South of Allston Path. A new substation at Spingerville could also be a good option.

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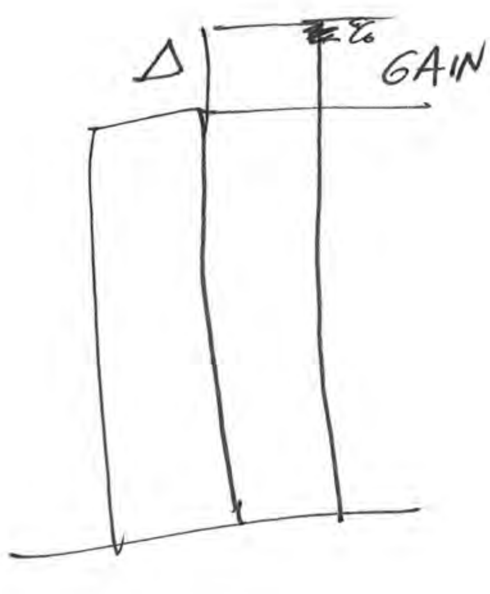

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South of Allston
Summer 2005 Study Report

FINAL DRAFT 8
9/23/05

NAMES

1) Introduction

This report summarizes the studies conducted by OSU for PGE on the South of Allston path. The South of Allston path is typically loaded heavily only during the summer season when there is high north-to-south power flow across the Northwest system. The generation sources for this pattern include: Upper Columbia generation, Mid Columbia generation, BC Hydro generation, generation in the Puget Sound area and along the I-5 Corridor. The following transmission lines define the South of Allston path.

Allston – Keeler 500 kV (BPA)
Trojan – St. Marys 230 kV (PGE)
Trojan – Rivergate 230 kV (PGE)
Lexington – Ross 230 kV (BPA)
Allston – St. Helens 115 kV (BPA)
Merwin – St. Johns 115 kV (PACW)
Astoria – Seaside 115 kV (PACW)
Lewis & Clark – Astoria Tap 115 kV (PACW)

Note: The "from" and "to" substations are listed in the direction of positive flow on the South of Allston path. The underlined substation is where the flow is metered.

This path is thermally limited and the worst contingencies are known to be the following list of facilities.
N-1: Allston – Keeler 500 kV line
BFR: 4322, 4324, 4394 Keeler 500 kV (loss of Keeler 500 kV bus)
BFR: 4280 Pearl 500 kV (loss of Pearl-Keeler and Pearl Bank #2)
BFR: 4283 Pearl 500 kV (loss of Pearl-Keeler and Pearl-Ostrander 500 kV lines)
N-2: Pearl – Keeler 500 kV and Pearl – Sherwood 230 kV lines
N-2: Keeler – St. Marys / Trojan – St. Marys 230 kV lines
N-1: Lexington – Longview 230 kV

The above contingencies typically overload the following elements depending on the generation pattern and transfer level. The limiting elements include: Merwin – View Tap 115 kV line section, Woodland – Ross 230 kV line section, Lexington – Longview 230 kV line, Keeler – St. Marys 230 kV line, Trojan – St. Marys 230 kV line, Keeler – Forest Grove #2 115 kV line, and the Longview 230/115 kV Bank.

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2) Purpose

The purpose of these studies are to assess the impacts of PGE's re-termination of its Beaver Plant, the relative contribution of PGE's Trojan lines to the SOA transfer capacity, the effects of controlling the Trojan line flows by using series reactors and phase-shifters, and finally, to assess the relative effects of reconductoring several critically limiting facilities and the addition of a third Trojan line. The studies were performed using the Heavy Summer 2007 WECC base case, as the summer is when the path is most heavily loaded. The SOA North-to-South stress level is beyond the present simultaneous operating limits as established by BPA for the 2005 operating season.

	flow MW	2005 rating
Northern Intertie	2757	3100
COI	3772	4800
PDCI	3100	3100
SOA Path	3168	2630
A-K Line	1821	1670

Table.1 The North-to South stress levels

3) System Changes and Base Case Stress

The base case (Case 1) was developed from the Heavy Summer 2007 WECC base case (Case 0) by the following re-terminations.

(a) Open Beaver-Allston 230kV, and reconnect Beaver stations to the system through Beaver-PORTW-Trojan 230kV lines.

(b) Change the internal connections at Trojan Switching Station. Allston 230kV bus is connected to the Trojan 230kV bus through Trojan 1 & 2. For the flow control studies the Reactors or the Phase Shifting Transformers will be inserted to manage the power flow between Allston 230kV and Trojan 230kV buses. clarify

4) Methodology

There are totally 18 cases in these studies (Appendix A). All the cases were tested by only running four representative outages. These outages were identified by BPA as the most critical outages in limiting and setting the SOA transfer capacity. The following outages were used for this study.

N-1: Allston – Keeler 500 kV line (AK)

N-1: Keeler– Pearl 500 kV line (KP) FORMAT?

N-2: Keeler – St. Marys / Trojan – St. Marys 230 kV lines (KTS)

N-1: Lexington – Longview 230 kV (LL)

For the first series of flow control cases, one series reactor is inserted in (Cases 3-8) Allston-Trojan line at Trojan, with the impedance values of 5, 10, 15, 20 and 25 ohms.

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For reference, 5 ohms is equal to about 10 miles of 230 line, which is also equal to the reactance of each Allston-Trojan line. Thus, a 5 ohms rector will double the line impedance, 10 ohms will triple, and so on. For the second series of flow control cases, one Phase Shift Transformer is inserted in each Allston–Trojan line at Trojan, which is the same type as the one used at Nelway on the Boundary line. Phase shift angles of 0, 2, 4, 6, 8, and 10 degrees were used (Cases 9-14). The power flows from BC Hydro to the Northwest, and from Northwest to LA (PDCI) and PG&E (COI) are kept the same levels in all above scenarios. The phase-shifters were to block the contingency flows on the Trojan lines. Thus, as the angle is increased, the base flows from Trojan to Allston are increased.

Lower case

The Allston-Keeler 500kV line is the worst single line outage in the South of Allston Path. For this outage, an additional case was run and is referred to as the reduced stress case. The North to South stress level is reduced by decreasing northern generation (BC imports and Coulee generation equally) and decreasing southern exports (AC & DC Interties equally). This was done to get a measure of how a system change affects the SOA transfer capacity. The stress is reduced until the overload ratios of Non-PGE facilities in the study area recovered to the original values as shown in the no flow control base case.

An additional case(Case 15) was run to determine the relative benefits of reconductoring several limiting facilities in the SOA Path with ACSS equivalent conductor. For this case, the system topology and line impedances were unchanged and overloads should be greatly reduced or eliminated. Two other cases (Cases 16-17) were studied that includes a new third 230kV line south of Trojan. This line was terminated at St. Marys. A final case (case 18) was studied that included this new third Trojan line and a new substation in the Springville area, about 5 miles north of St. Marys. Both Trojan-St. Marys lines and the Rivergate-Keeler lines were looped through this new station.

5) Results

5.1 Case 1: Beaver Re-termination

South of Allston is operationally monitored by tracking the Allston-Keeler (500KV) loading. The RAS levels are armed according to the Allston-Keeler line loading.

From the base case incorporated into this Power World simulator study, the cases studied are over-scheduled according to limits established, as shown below:

Scheduled Loading		
YEAR	South of Allston (SOA) [MW]	Allston-Keeler (A-K) [MW]
2004	3050	1740
2005	2630	1670

Table.2 Scheduled loading for Year 2004 and 2005

center

① = comma

A flow comparison between case 0 and case 1 for the South of Allston case is shown in table 3 below

Clarity ?

For case study 1, Beaver is re-terminated at Port Westward and a second Port Westward to Trojan 230kV line is added. The South of Allston flow comparison for case 0 to case 1:

Case Comparison: CASE 0 and CASE 1 for SOA MW Flows						
CASE	South of Allston (SOA)	Allston-Keeler (A-K)	Merwin-View Tap	Trojan-South (PGE Lines)	Woodland-Ross	Allston-Rainer
0	3168	1821	127	712	322	91
1	3180	1791	124	767	315	88
Delta Δ	**12**	-30	-3	**55**	-7	-3

Table.3 The South of Allston flow comparison

The Beaver re-termination at Port Westward. to Trojan increases South of Allston flow by a total of 12 MW. All increased loading from this re-termination of Beaver is placed upon the Trojan-South PGE lines which include Trojan-St. Marys and Trojan-Rivergate. The total Allston-Keeler line flow reduction is 30 MW. Consequently the critical outage is reduced in magnitude while critical facilities that overload are all reduced in the base case loading.

For the Allston-Keeler 500 KV outage (A-K) all non-PGE overloads are reduced, one is eliminated and one is marginal (May be eliminated if SOA reduced to pre-2005 levels). The Keeler-Pearl 500 KV outage (K-P) experiences little change due to the Beaver re-termination with a slight improvement overall. The Keeler-St. Marys and Trojan-St. Marys 230 KV outage (KTS) also experiences little change due to the re-termination of Beaver, and also has little effect on the limiting Keeler-Forest Grove 115 KV line. For the Longview-Lexington 230KV outage there is a slight improvement on the critical facility. (Reference to index case 0 and 1 tables and onelines)

Based on these results, the Beaver re-termination at Port W. to Trojan, is a positive benefit to the South of Allston transfer capacity based upon the review of these most critical outages.

5.2 Case 2: Allston-Trojan "Open"

CASE 2: South of Allston MW Flow			
	CASE 1	CASE 2	
South of Allston [MW]	3180	3206	
Trojan-South [MW]	767	867	Δ
new South of Allston [MW]	2413	2339	- 74

Table.4 Power flow comparison for Trojan-South and New South of Allston Path

Case 2, with the Allston-Trojan lines open, no initial overloads are created and over-all non-PGE line loading is reduced slightly. This is due to small flows on the Allston-Trojan lines towards Allston that are now carried on the Trojan South line when the Allston lines are opened. However for the Allston-Keeler 500 KV outage there are significantly worse overloads. The only exception is BPA's Keeler-Rivergate. This line is now less tightly coupled to the main-grid and therefore experiences a significant reduction in overload. Consequently, all PGE overloads normally experienced during an Allston-Keeler 500KV outage are eliminated.

clarity

For the Allston-Keeler outage the reduced stress case indicates that SOA must be reduced by approximately 200MW to reach initial case 1 outage overload values on non-PGE lines. Specifically, this would require a inter-regional flow reduction from BC/Coulee to N/S California of approximately 1800 MW. This is the most drastic of the flow reductions necessary to reach case 1 values. flip

For the Keeler-Pearl 500 KV Outage, there is little change due to the Allston-Trojan lines being open. However, for the N-2 Keeler-St.Marys and Trojan-St. Marys 230 KV outage, there are significant overloads on the PGE lines from Trojan to Rivergate which would require generator tripping at Beaver or Post Westward in the order of 300 MW total. There are no non-PGE overloads. Heavily overloaded facilities are reduced by Allston-Trojan lines being open. For the Longview-Lexington 230 KV outage, the heavily loaded facilities are also reduced by the Allston-Trojan lines being open.

Based on these observations, the South of Allston path is severely impacted by the opening of the Allston-Trojan lines 1 and 2. The north to south stress across the Pacific Northwest must be reduced by nearly 2000 MW to achieve comparable results as to the base case for the A-K outage. While PGE requires a 300 MW generator trip in the case a Keeler-Trojan-St. Marys (KTS) 230KV outage, alternatively, the Allston-Trojan connection is worth (or supports) approximately 2000 MW of N-S inter-regional flows. (during a contingency?)

5.3 Case 3-8: Series Reactor Parametric Study

spacing

Series Reactors were inserted between Allston and Trojan (Trojan 1 and 2) and the reactor impedance was studied at 0, 5,10,15,20 and 25 ohms. Each case was studied under all four outages. The area power transaction levels are kept the same as the base Case 1. Six critical transmission lines were selected to evaluate the ~~interferences~~ impact of the Trojan power flow control ~~to~~ on the South of Allston Path, ~~which are~~ as follows: The critical transmission lines are

Astoria- Lewis & Clark 115 kV line
Trojan – St. Marys 230 kV line,
Keeler –Rivergate 230 kV line,
Longview 230/115 kV Bank.
Woodland – Ross 230 kV line
Merwin – View Tap 115 kV line

the Astoria- Lewis & Clark 115 kV line section is the most heavily loaded line in the coastal area. Trojan – St. Marys 230 kV line and Keeler –Rivergate 230 kV line are good indictors for the power flow~~s~~ south of Trojan. Longview 230/115 kV Bank and Woodland – Ross 230 kV line are always the first overloaded lines/transformers caused by the power flow from the Longview bus. The Merwin – View Tap 115 kV line loading can be as high as 159% which made it the most critical bottleneck for the whole South of Allston.

The cross comparison for each critical line during all Four ~~4~~ outages are summarized using tables and plots in Appendix B. When the reactor impedances between Trojan 1 &2 to Trojan were increased, more and more Trojan-South contingency flow was blocked. As a result, almost all transmission lines increased their contingency loadings except for the Trojan-South PGE lines. The MW transactions among BC Hydro generation, Northwest, LA and PGE areas were maintained for all cases.

space

For most critical lines the loading variation caused by the changing of the Trojan Reactors are within 20%. The largest variation happened on Keeler-Rivergate 230 KV line during the KTS outage. But this is ~~this would be~~ reasonable considering the close distance ~~of~~ the Keeler-Rivergate line to KTS outage ~~to this transmission~~ line. The series reactors do block contingency flows south of Trojan but at the expense of inter-regional capability. proximity

5.4 Case9-14: Phase-Shifter Parametric Study

Instead of blocking the Trojan-South flow with Reactors, two Phase Shift Transformers were used to compensate the North to South power flow between Allston 230 kV bus and Trojan 230 kV. The six critical transmission lines in Case 3-8 were still used in these cases. The Phase Shift Transformer has different impedance at 0 degree compared with the 0 ohm Reactor impedance in Case 3, so there is a little difference between Case 3 and Case 9. During the AK outage, there is not much difference in the overload scenarios between Reactor control and Phase Shift Transformer control. The Phase Shift Transformer control removed the overload of Keeler-Rivergate 230kV line during the KTS outage. The Phase-Shifter control reduced the burden on Woodland – Ross 230 kV line, but distributed more power flow to Longview 230/115 kV Bank, and Merwin – View Tap 115 kV line.

5.5 Case 3-14: Power reduction control

As shown in Fig. 1, the power flow of South of Allston was controlled from 2336MW down to 1859 MW during the AK outage with the Reactor control. And the power flow though Trojan is 480 MW to 0 MW. The difference between these two flows is very close to a constant value of 1850 MW, which may be a good indicator of the loose interferences of Trojan to other transmission lines. The 500 ohms in Fig. 1 in fact refers to the Trojan 1 & 2 to Trojan open case (Case 2). A big Reactor will be needed for a wide operational range due to the saturation effect. As a passive device, the series reactor is very reliable and needn't any additional control circuit. As a contingency blocking device, its bidirectional blocking capability is effective for both North-to-South and South-to-North power flows. This effect is also similar to minimizing power transfer, both pre- & post-contingency between Allston and Trojan.

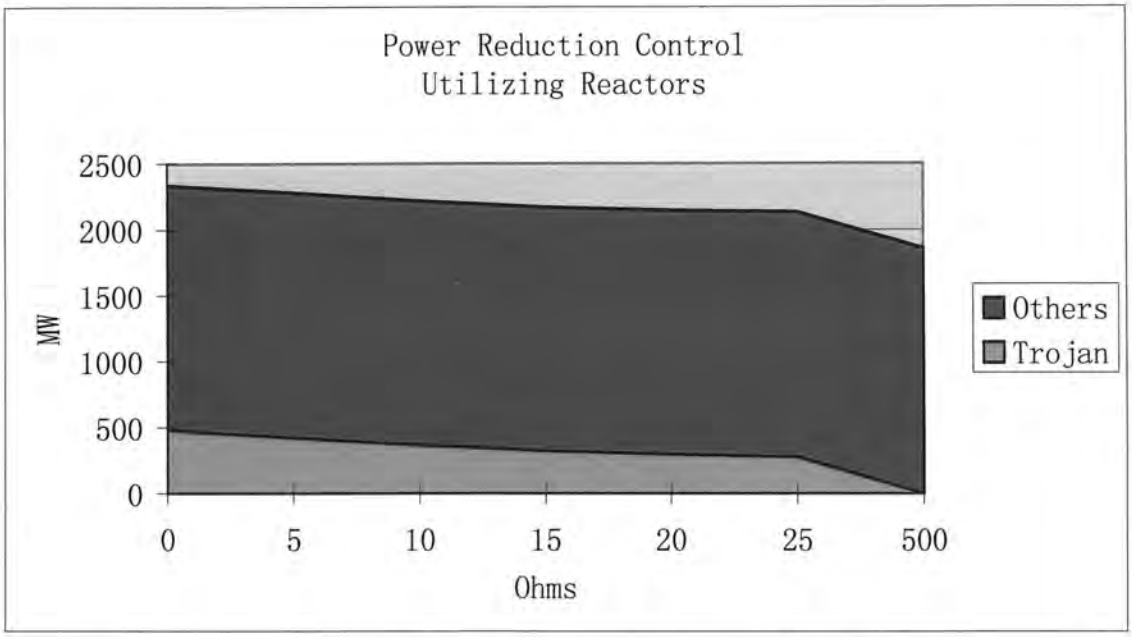

Fig.1 Power transaction control of the Trojan lines and the whole South of Allston Path utilizing the Reactors

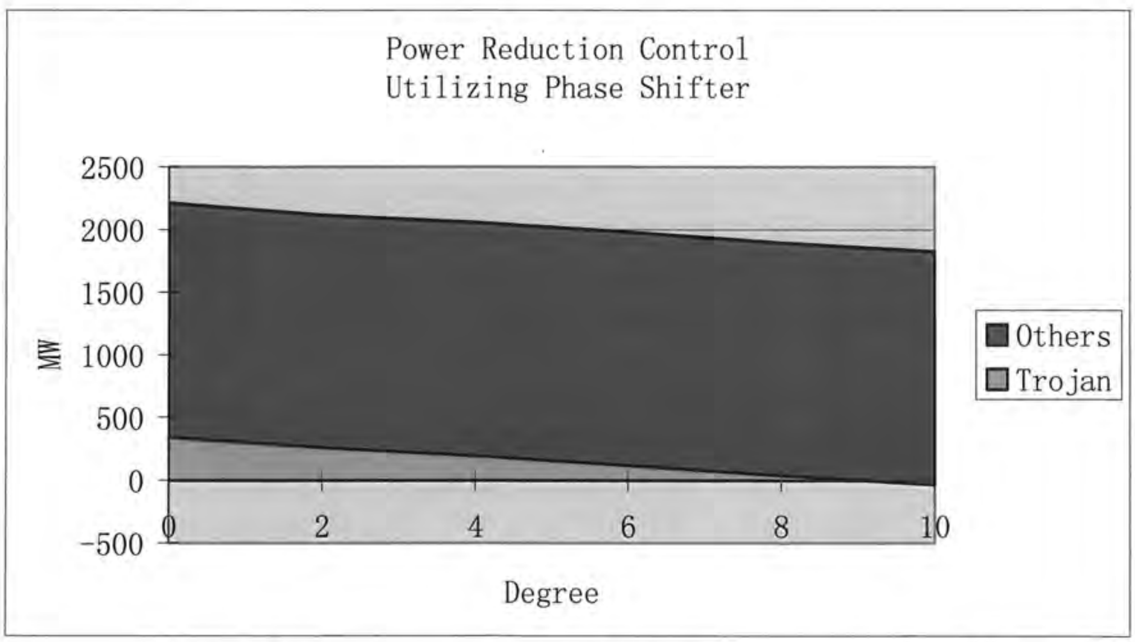

Fig.2 Power transaction control of the Trojan lines and the whole South of Allston Path utilizing the Phase Shifting Transformers

The Phase-Shifter has similar power flow control functions as the series reactor, also with a nearly constant difference of 1850MW between the whole capacity of SOA and Trojan shown in Fig.2 for the A-K outage. As a contingency blocking device, its directional blocking is effective for N-S power flows, but the undesirable pre-contingency loading by increasing pre-outage flows to Allston. The phase-shifter exhibits a linear operating curve. As an active equipment, the phase-shifter requires additional control and high maintenance.

5.5 Case 15

In this case we assumed new conductors in transmission lines which were known to overload heavily in the case of a major outage. These lines are Merwin-View Tap-Cherryppl, LwsClark-Astor Tap, Woodland-Ross, and Rivergate-Keeler. The Merwin-View Tap line (4.2 miles) and the View Tap-Cherryppl line (6.7 miles) are currently 636 ACSR Rook by using 636 ACSS Rook, the summer emergency rating can by increased from 134.0 MVA to 292.6 MVA. The LwsClark-Astor Tap line (0.7 miles) is currently 397.5 ACSR Ibis, and by using 397.5 ACSS Ibis, the summer emergency rating can be increased from 100 MVA to 216.9 MVA. The line from Astor Tap to Seaside is 12.8 miles long and is less critically loaded, however installing new conductor on these lines is a consideration for future study. All of the above line sections are currently owned by PacifiCorp-West.

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Installing new conductors on these lines eliminates the three top overloads which occur during an N-1 Allston-Keeler 500KV Outage. (Refer to onelines and tables for Case 15). The remaining overloaded facilities are PGE's Trojan South lines. Case 16 addresses this limitation.

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In this case, we used case 15 with all the new conductors and then increased the capacity South of Allston by installing an entire new circuit from Trojan to St. Marys. The new circuit Trojan-St. Marys #2 has an assumed summer emergency rating of 641.0 MVA and winter emergency of 844.5 MVA.

From the installation of this new Trojan-St. Marys circuit, The flow during normal operation is increased 47MW, from 3180MW to 3227MW, and the flow South of Allston during an N-1 Allston-Keeler Outage is increased 165MW, from 2337MW to

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		Case 1 (MW)	Case 16 (MW)	Δ (MW)
soa TOTAL		3180	3227	47
South of Trojan		767	965	198
Allston-Keeler		1791	1673	-118
Woodland-Ross		315	295	-20
Merwin-ViewTp		124	118	-6
AstrTp-h&C		97	92	-5
Allston-Raineer		88	82	-6

Table. Power flow distribution in case 16 compared with base Case 1

15

5.7 Case 17

In this case the advantage of having Trojan-St. Marys was realized while only installing new conductors on two of the most critical lines. Therefore we installed new conductors only on the Merwin-View Tap-Cherryppl and LwsClark-Astor Tap lines as described in case 15, and installed the new Trojan-St. Marys circuit. This case provides more South of Allston capacity while only fixing the most critical lines. (Refer to onelines and tables for cases 16 and 17)

	Case 1			Case 17			Δ	
	(MW)	(%rating)	(% of Base SOA)	(MW)	(%rating)	(% of Base SOA)	(MW)	(% of Base SOA)
SOA total	2337		73.5%	2502		77.5%	165	4.0%
South of Trojan	1320	132%	41.5%	1589	101%	49.2%	269	7.7%
Woodland-Ross	513	118%	16.1%	459	105%	14.2%	-54	-1.9%
Merwin-ViewTp	185	135%	5.8%	168	56%	5.2%	-17	-0.6%
AstrTp-h&c	140	137%	4.4%	127	56%	3.9%	-13	-0.5%
AstrTp-Seaside	147	86%	4.6%	131	76%	4.1%	-16	-0.6%
Allston-Raineer	533	159%	16.8%	394	116%	12.2%	-139	-4.6%
Rivergate	126	124%	4.0%	114	111%	3.5%	-12	-0.4%

Table Power flow distribution in case 17 compared with base Case 1

16

5.8 Case 18: New Springerville Station

In this case, we took case 17 and created a new substation at Springerville which is located between Trojan and St. Marys and Rivergate and Keeler. The substation is a 230KV bus as shown below:

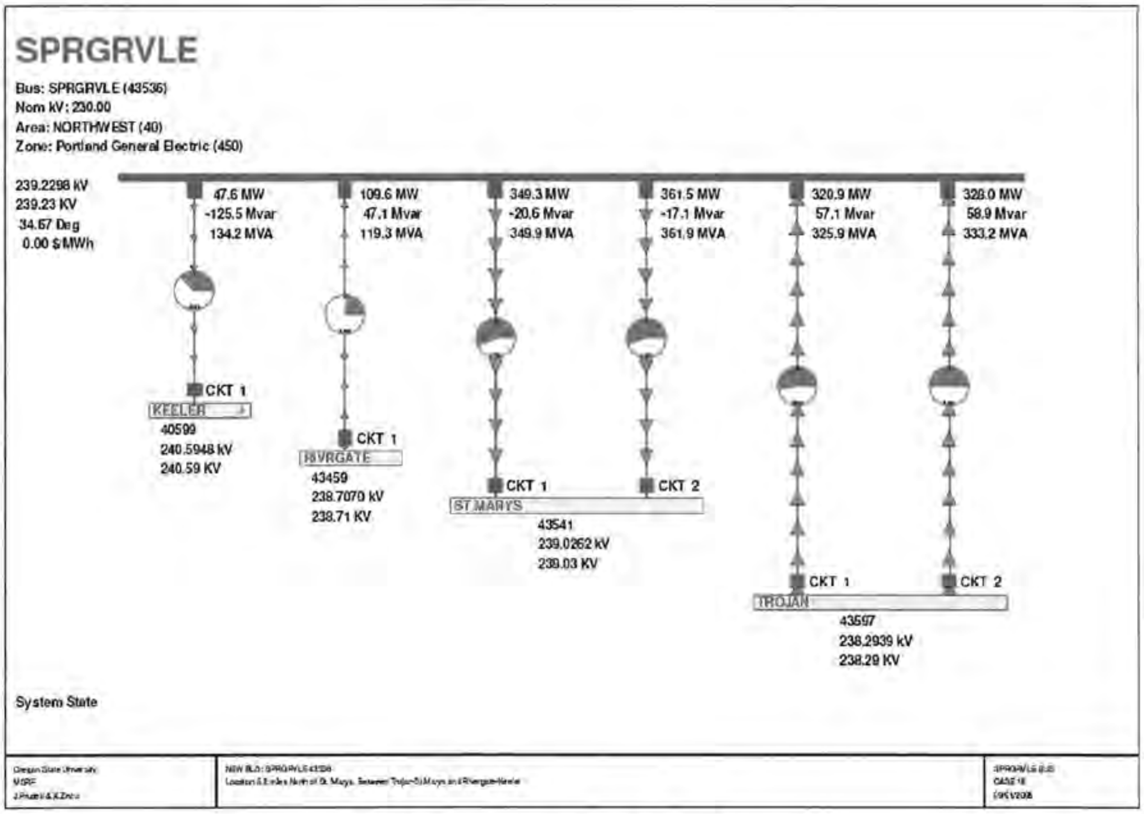


Fig.3 New Springerville Station

By calculating the geographical position of the substation and using known distances and line parameters, we modeled the 230Kv transmission lines using the existing Rivergate-Keeler and Trojan-St. Marys #1 & #2.

For the model simulation we changed the Keeler-St. Marys and Trojan-Marys outage (KTS Outage) to a Keeler-St. Marys and Sprgrvle-St. Marys 230Kv Outage (KSS Outage) The N-1 Allston-Keeler 500Kv Outage creates a 152% overload on the Keeler-Sprgrvle lines followed by Astor Tap-Seaside at 111%. However a N-1 Keeler Pearl 500KV Outage shifts the overload to St. Marys-Murray H. at 118% followed by a Forest Grove-Keeler at 104%. Further detailed results are shown in the case 18 onelines and tables.The limiting factor to be addressed for this configuration would be the 3.4 miles of 1272 ACSR Pheasant between Keeler and Springerville, due to significant contingency loadings as a result of the A-K outage

6) Conclusion

These studies evaluated the influence of the Trojan reconstruction on the transfer capacity of the South of Allston Path. Any power transaction reduced through the Trojan lines would cause almost the same amount of loss for the whole South of Allston Path. Due to the related loose connection of the Trojan lines to the other transfer channels, the re-termination would keep the power distribution in other transmission lines at reasonable levels, and would not generate new problems for the whole path. The update of the transmission lines including Merwin-View Tap-Cherryppl, LwsClark-Astor Tap, Woodland-Ross, and Rivergate-Keeler will also reduce the overloading problem of South of Allston will reduce the system overloading problem and improve the capacity of the South of Allston Path. A new substation at Spingerville could also be a good option.

South of Allston
Summer 2005 Study Report

1) Introduction

This report summarizes the studies used to determine safe and reliable operation of the South of Allston path. The South of Allston path is typically loaded heavily only during the summer season when there is high north-to-south power flow across the Northwest system. The generation sources for this pattern include: Upper Columbia generation, Mid Columbia generation, BC Hydro generation, generation in the Puget Sound area and along the I-5 Corridor. The following transmission lines define the South of Allston path.

<u>Allston</u> – Keeler 500 kV (BPA)
<u>Trojan</u> – St. Marys 230 kV (PGE)
<u>Trojan</u> – Rivergate 230 kV (PGE)
Lexington – <u>Ross</u> 230 kV (BPA)
<u>Allston</u> – St. Helens 115 kV (BPA)
<u>Merwin</u> – St. Johns 115 kV (PACW)
<u>Astoria</u> – Seaside 115 kV (PACW)
<u>Lewis & Clark</u> – Astoria Tap 115 kV (PACW)

Note: The "from" and "to" substations are listed in the direction of positive flow on the South of Allston path. The underlined substation is where the flow is metered.

This path is thermally limited and the worst contingencies were found to be the following list of facilities.
N-1: Allston – Keeler 500 kV line
BFR: 4322, 4324, 4394 Keeler 500 kV (loss of Keeler 500 kV bus)
BFR: 4280 Pearl 500 kV (loss of Pearl-Keeler and Pearl Bank #2)
BFR: 4283 Pearl 500 kV (loss of Pearl-Keeler and Pearl-Ostrander 500 kV lines)
N-2: Pearl – Keeler 500 kV and Pearl – Sherwood 230 kV lines
N-2: Keeler – St. Marys / Trojan – St. Marys 230 kV lines
N-1: Lexington – Longview 230 kV

The above contingencies typically overload the following elements depending on the generation pattern and transfer level. The limiting elements include: Merwin – View Tap 115 kV line section, Woodland – Ross 230 kV line section, Lexington – Longview 230 kV line, Keeler – St. Marys 230 kV line, Trojan – St. Marys 230 kV line, Keeler – Forest Grove #2 115 kV line, and the Longview 230/115 kV Bank.

2) Purpose

Among all the transmission lines defined in South of Allston path, Trojan – St. Marys 230 kV and Trojan – Rivergate 230 kV share a common point (Trojan, Trojan 1 and Trojan 2 buses). The power flow through both transmission lines could be managed by just controlling the Trojan connection. The objective of these studies is to explore the contribution of the Trojan transmission lines to the whole capacity of the South of Allston Path and the influence of the Trojan reconstruction on other lines during different outages.

The studies were performed using the Heavy Summer 2005 WECC operating case, as the summer is when the path is most heavily loaded. Loads and generation at many local busses were modified to accurately model what was measured from recent summer historical SCADA data. These changes were implemented for the northern Oregon and southern Washington coastal areas as well as in Lewis and Cowlitz County PUD systems.

3) System Changes

The base case was developed from the Heavy Summer 2005 WECC operating case by the following re-terminations.

a) Open Beaver-Allston 230kV, and reconnect Beaver stations to the system through Beaver-PORTW-Trojan 230kV lines.
b) Change the internal connections at Trojan common point. Allston 230kV bus is connected to the Trojan 230kV bus through Trojan 1 & 2. And either the Reactors or the Phase Shifting Transformers will be used to manage the power flow between Allston 230kV and Trojan 230kV.

4) Methodology

The studies were first performed by directly connecting Trojan 1 & 2 buses to Trojan bus, and later opening Trojan 1 & 2 to Trojan. Then two Reactors are inserted between Trojan 1 & 2 to Trojan, with the impedance value of 5, 10, 15, 20, 25 ohms. Each case was tested with the following 4 outages:

N-1: Allston – Keeler 500 kV line (AK)
N-2: Pearl – Keeler 500 kV and Pearl – Sherwood 230 kV lines (KP)
N-2: Keeler – St. Marys / Trojan – St. Marys 230 kV lines (KTS)
N-1: Lexington – Longview 230 kV (LL)

Next the Rectors are replaced with Phase Shifting Transformers, which are the same type as the one used between NLY230(??). Phase shift angles of 2, 4, 6, 8, and 10 degrees were used. Again every case was investigated under all 4 outages (AK, KP, KTS and LL). The power transactions from BC Hydro generation to Northwest, and from Northwest to LA and PGE are kept the same levels in all above scenarios.
Since the Allston-Keeler 500kV line is the worst single line outage in the South of Allston, a series of power reduction studies are repeated for each case only with the

AK outage. The power transactions including BC Hydro generation -Northwest, Northwest-LA, Northwest –PGE and ??DC lines are reduced until the overload ratios of Lexington – Longview 230 kV line and the Longview 230/115 kV Bank recovered to the original values as shown in the case of direct connection between Trojan 1 & 2 to Trojan with AK outage.

New conductors were installed in heavily overloaded transmission lines in the major outage, including the Merwin-View Tap lines (4.2miles), LwsClark –Astor Tap lines (0.7 mile), Woodland-Ross lines (19.85 miles) and the Keeler-Rivergate lines(8.47 miles). The improvements are evaluated during both normal operation and the Allston-Keeler outage.

Between Trojan-St. Marys 230kV lines and Keeler-Rivergate 230kV lines, a new substation at Springerville was added to investigate its effect on the power flow distribution among these buses.

5) Results

A) Power reduction control

As shown in Fig. 1, the power flow of South of Allston can be controlled from 2336MW down to 1859 MW during the AK outage with the Reactor control. And the power flow though Trojan is 480 MW to 0 MW. The difference between these two flows is very close to a constant value of 1850 MW, which may be a good indicator of the loose interferences of Trojan to other transmission lines. The 500 ohms in Fig. 1 in fact refers to the Trojan 1 & 2 to Trojan open case (case 2). A big Reactor will be needed for a wide operational range due to the saturation effect.

The Phase Shifting Transformer has similar power flow control functions, also with a nearly constant difference of 1850MW between the whole capacity of SOA and Trojan shown in Fig.2. Note the linearity of the operational curve. The Phase shifter can even compensate the South to North power flow.

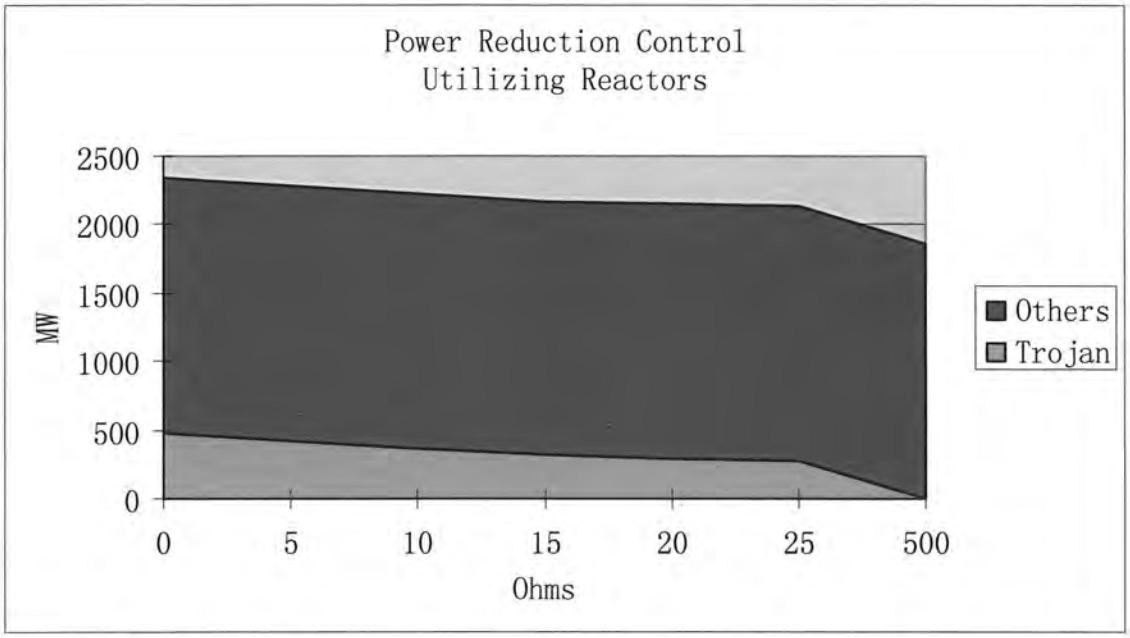


Fig.1 Power transaction control of the Trojan lines and the whole South of Allston Path utilizing the Reactors

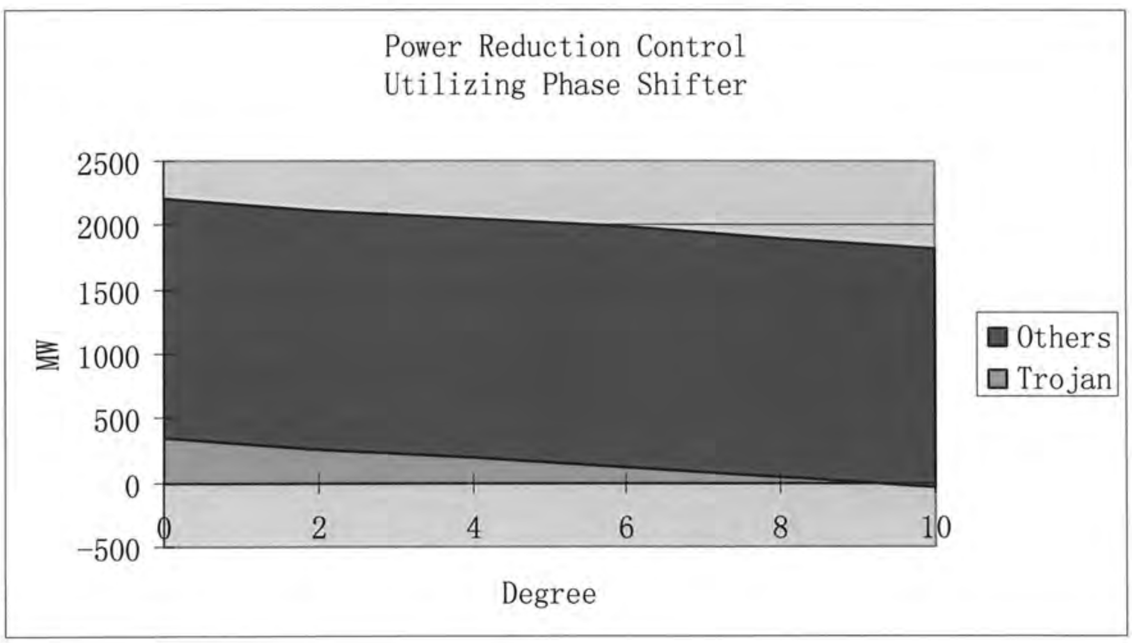


Fig.2 Power transaction control of the Trojan lines and the whole South of Allston Path utilizing the Phase Shifting Transformers

B) The interferences of Trojan to the SOA

As shown in Appendix A(Fig.4 –Fig.9), six critical transmission lines were selected to evaluate the interferences of the Trojan power flow control to the South of Allston system, which are as follows:

Astor- LWSCLAR 115 kV line
Trojan – St. Marys 230 kV line,
Keeler –Rivergate 230 kV line,
Longview 230/115 kV Bank.
Woodland – Ross 230 kV line
Merwin – View Tap 115 kV line

Astor- LWSCLAR 115 kV line is the most heavily loaded line in the coastal area. Trojan – St. Marys 230 kV line and Keeler –Rivergate 230 kV line are good indictors for the power flows of Trojan. Longview 230/115 kV Bank and Woodland – Ross 230 kV line are always the first overloaded lines/transformers cased by the power flow from the Longview bus. The Merwin – View Tap 115 kV load ratio is always more than 80%, and can be as high as 159% which made it the most critical bottleneck for the whole South of Allston.

For both the Reactor control and the Phase Shifting Transformer control scenarios, all of the selected transmission line power flow changes due to the variation of the control parameters are pretty limited (most of them are less than 30%). The biggest variation from about 40% to 104% happened on Keeler –Rivergate 230 kV line with the KP outage using Reactor control, which could be quite reasonable considering the KP outage is so close to this transmission line. Thus the interference from the Trojan reconstruction is limited.

C) Overload mitigation by utilizing new conductors

FONT

New conductors were installed in transmission lines which were known to overload heavily in the case of a major outage. These lines are Merwin-View Tap-Cherryppl, LwsClark-Astor Tap, Woodland-Ross, and Rivergate-Keeler.

The Merwin-View Tap lines (4.2 miles) and the View Tap-Cherryppl lines (6.69 miles) are currently 636 ACSR Rook, by using a 636 ACSS Rook the summer nominal emergency rating can by increased from 134.0 MVA to 292.6 MVA and the winter nominal emergency can be increased from 210.0 MVA to 323.3 MVA. The lines are currently owned by PacifiCorp-West.

The LwsClark-Astor Tap lines (0.7 miles) are currently 397.5 ACSR Ibis, by using 397.5 ACSS Ibis the summer emergency rating can be increased to from 100 MVA to 216.9 MVA. The line from Astor Tap to Seaside is 12.8 miles long and is less critically loaded, however installing new conductor on these lines is a consideration for future study. The lines are currently owned by PacifiCorp-West.

The Woodland-Ross lines (19.85 miles) are currently 795 ACSR Drake, by using 795 ACSS Drake the summer emergency rating can be increased from 426.3 MVA to 682 MVA. These lines are currently owned by Bonneville Power Administration.

The Rivergate-Keeler lines (8.47 miles) are currently limited by a 0.73 mile section of 1.01 miles of 556 ACSR Eagle. By installing new 1272 AAC Narcissus, the summer emergency rating for the Rivergate-Keeler lines can be increased from 346.6 MVA to 523.8 MVA. Installing new conductors on these lines eliminates the three top overloads which occur during the Allston-Keeler 500KV Outage. (Refer to onelines and tables for CASE 15) The top overloads are now reduced to the limiting lines in the transmission area of Trojan-St. Mary's, Trojan-Harborton, and Harborton-Rivergate.

By installing an entire new circuit from Trojan to St. Mary's, case 15 with all the new conductor was developed into a new case 16. The new circuit Trojan-St. Mary's #2 has a summer nominal emergency rating 641.0 MVA and winter nominal emergency is 844.5 MVA. From the installation of this new Trojan-St. Mary's circuit, the flow South of Allston during an N-1 Allston-Keeler Outage is increased 165MW, from 2337MW to 2502MW. The flow during normal operation is increased 47MW, from 3180MW to 3227MW. The significant overloads above 100% the summer nominal emergency rating during an N-1 Allston-Keeler outage are limited to Astor-Tap-Seaside and Trojan-St. Mary's #1. Further study was done by keeping the advantage of having Trojan-St. Mary's while only installing new conductors on two of the most critical lines, which include the Merwin-View Tap-Cherryppl and LwsClark-Astor Tap lines.This case provides more South of Allston capacity while only fixing more critical lines. (Refer to cases 16 and 17).

D) Constructing new substation at Springerville

Based on case 17, a new substation at Springerville was added between Trojan-St. Mary's and Keeler -Rivergate. The substation is a 230KV bus as shown in Fig.3

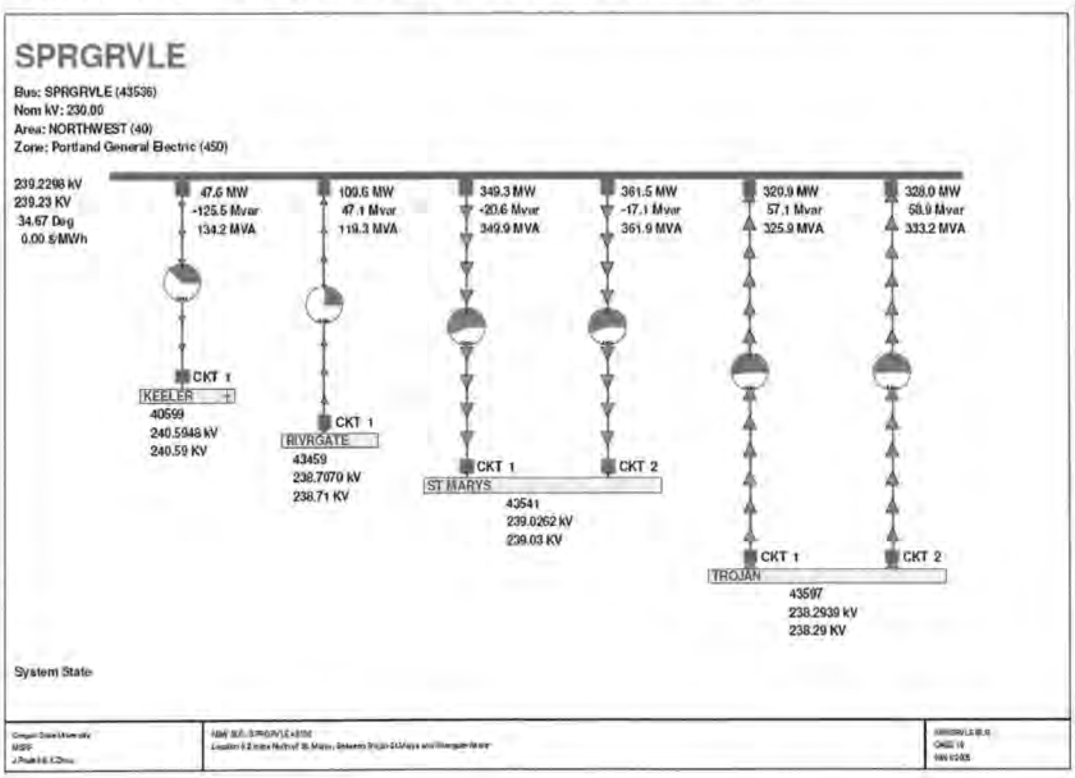


Fig.3

By calculating the geographical position of the substation and using know distances and line parameters, we modeled the 230Kv transmission lines using the existing Rivergate-Keeler and Trojan-St. Mary's #1 & #2.

For the model simulation we changed the Keeler-St. Mary's and Trojan-Mary's outage (KTS Outage) to a Keeler-Sprgrvle and Sprgrvle-St. Mary's 230Kv Outage (KSS Outage) The N-1 Allston-Keeler 500Kv Outage creates a 152% overload on the Keeler-Sprgrvle lines followed by Astor Tap-Seaside at 111%. However a N-1 Keeler Pearl 500KV Outage shifts the overload to St.Mary's-Murray H. at 118% followed by a Forest Grove-Keeler at 104%. Further detailed results are shown in the case 18 onelines and tables. The limiting factor to be addressed in the case of creating a new substation at this location would be the 3.4 miles of 1272 ACSR Pheasant between Keeler and Springerville.

6) Conclusion

These studies evaluated the influence of the Trojan reconstruction on the transfer capacity of the South of Allston Path. Any power transaction reduced through the Trojan lines would cause almost the same amount of loss for the whole South of Allston Path. Due to the related loose connection of the Trojan lines to the other transfer channels, the re-termination would keep the power distribution in other transmission lines at reasonable levels, and would not generate new problems for the whole path. The update of the transmission lines including Merwin-View Tap-Cherryppl, LwsClark-Astor Tap, Woodland-Ross, and Rivergate-Keeler will also reduce the overloading problem of South of Allston will reduce the system overloading problem and improve the capacity of the South of Allston Path. A new substation at Spingerville could also be a good option.

Appendix A: Power Reduction control

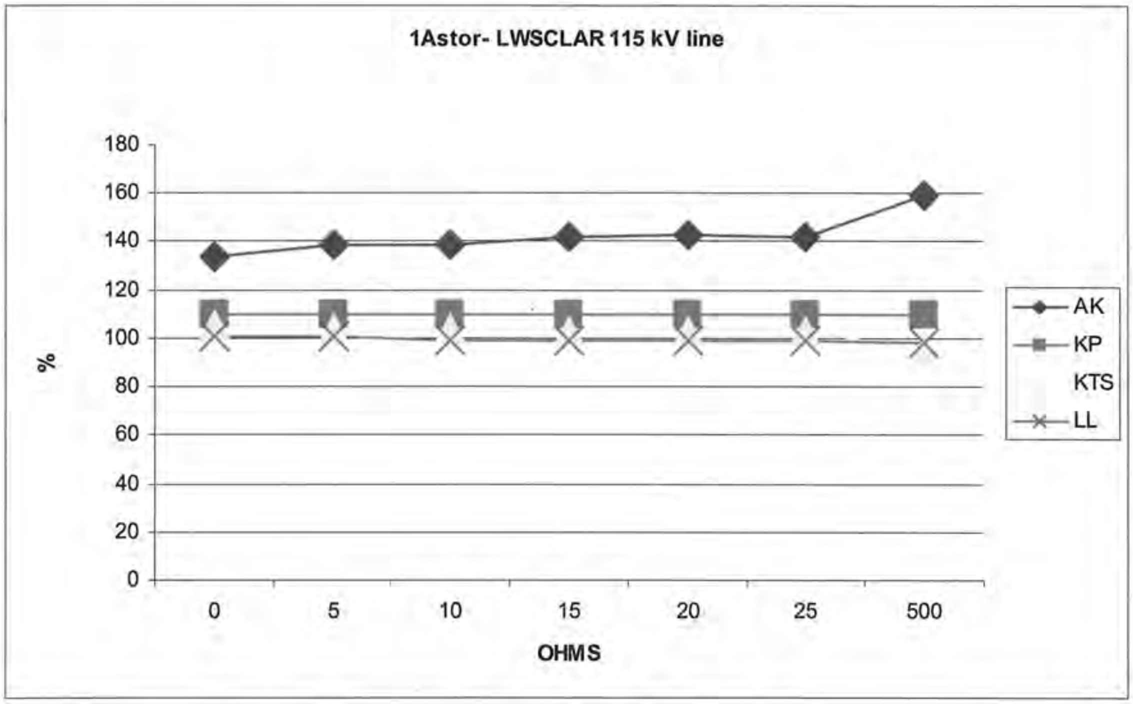


Fig.4a Astor- LWSCLAR 115 kV line in different outages
with Reactor control

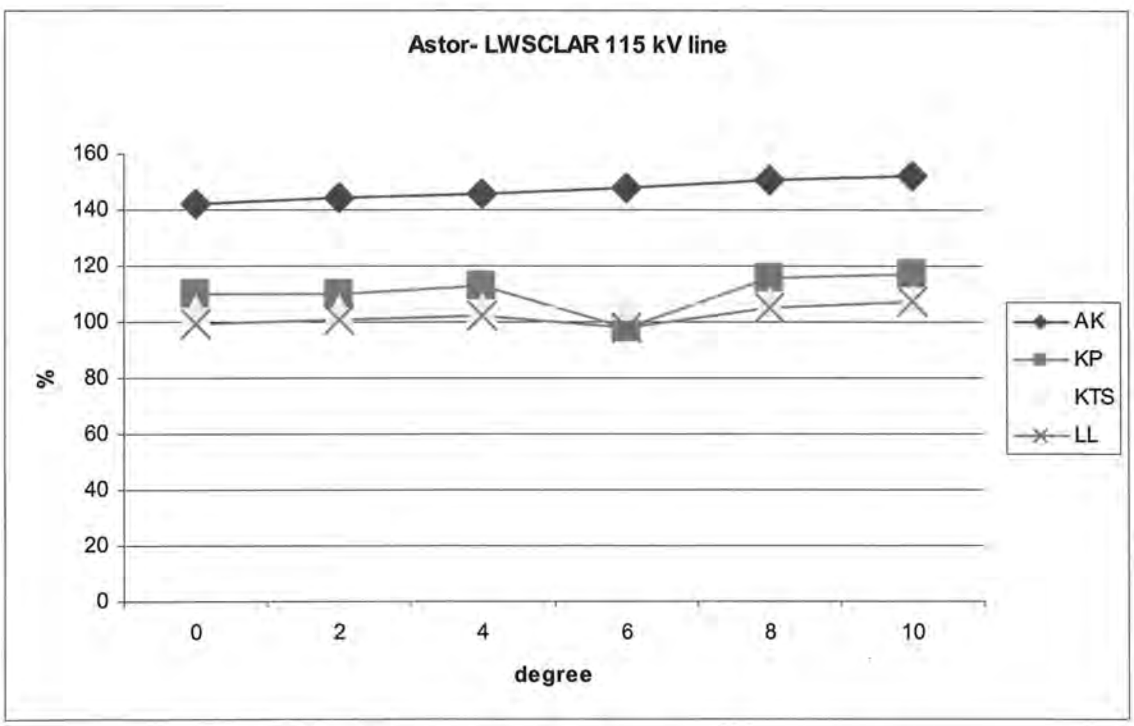


Fig.4b Astor- LWSCLAR 115 kV line in different outages
with Phase Shift Transformer control

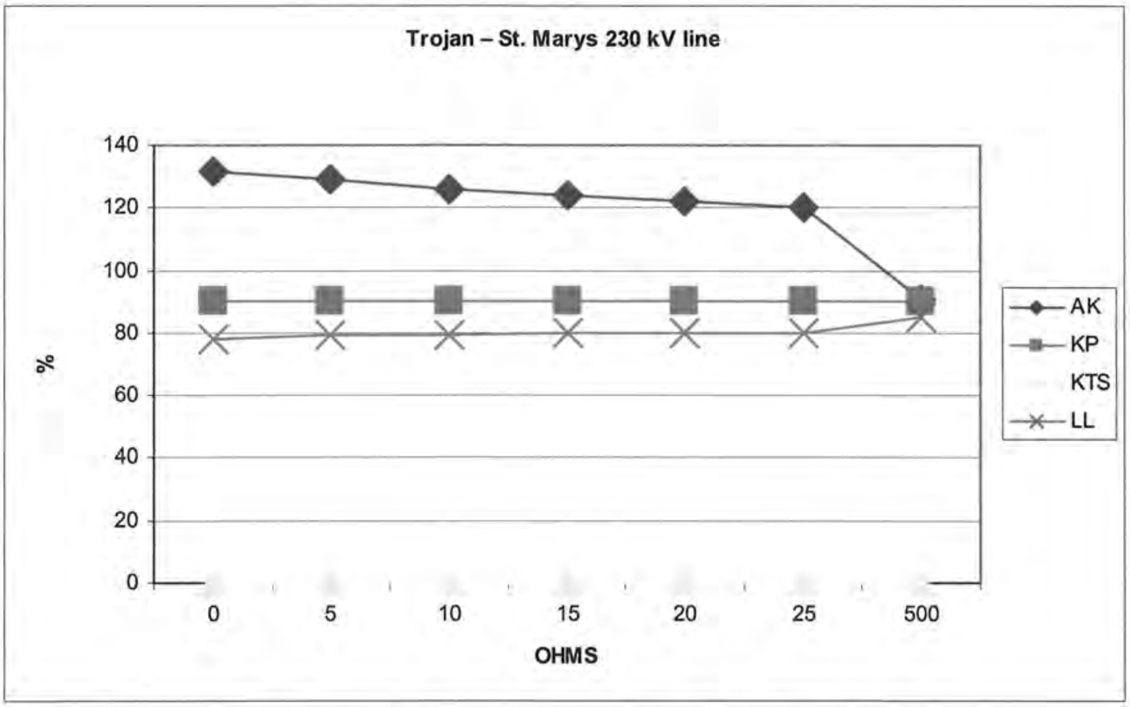


Fig.5a Trojan – St. Marys 230 kV line in different outages
with Reactor control

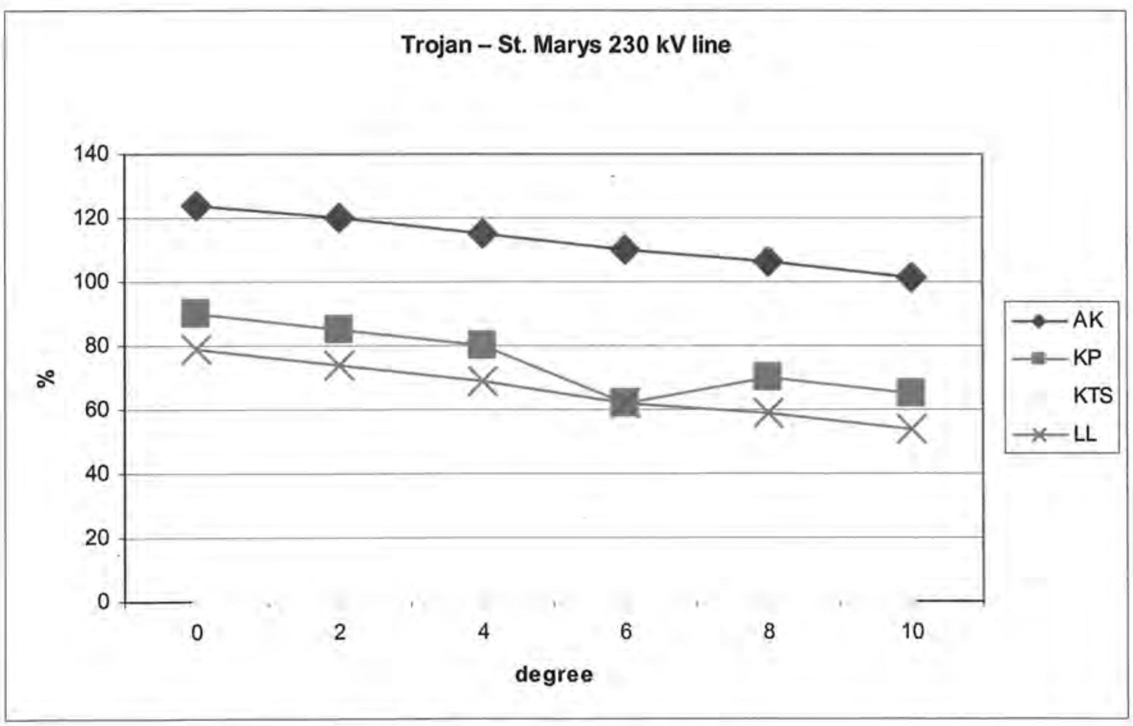


Fig.5b Trojan – St. Marys 230 kV line in different outages
with Phase Shift Transformer control

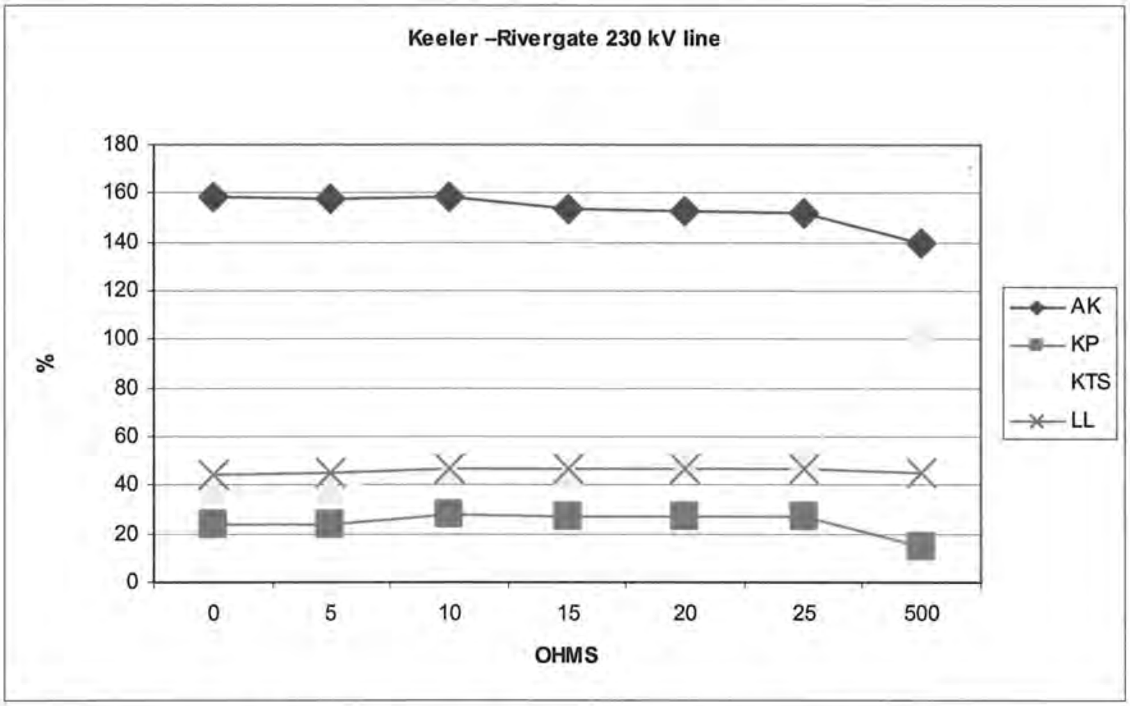


Fig.6a Keeler –Rivergate 230 kV line in different outages
with Reactor control

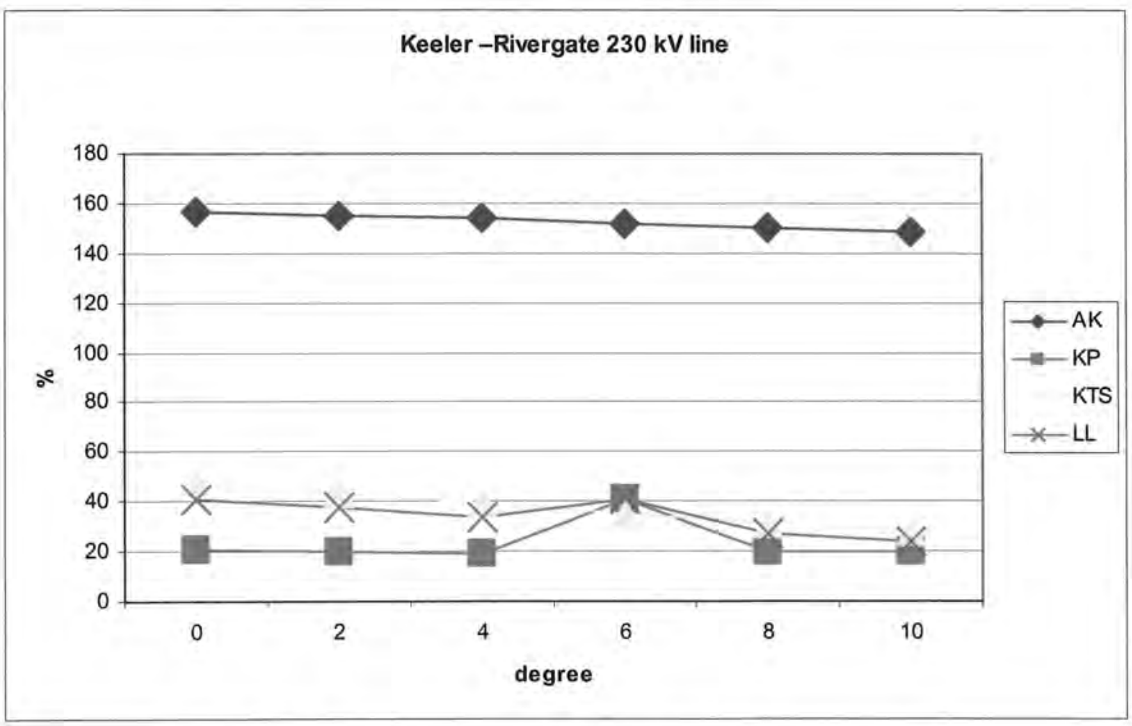


Fig.6b Keeler –Rivergate 230 kV line in different outages
with Phase Shift Transformer control

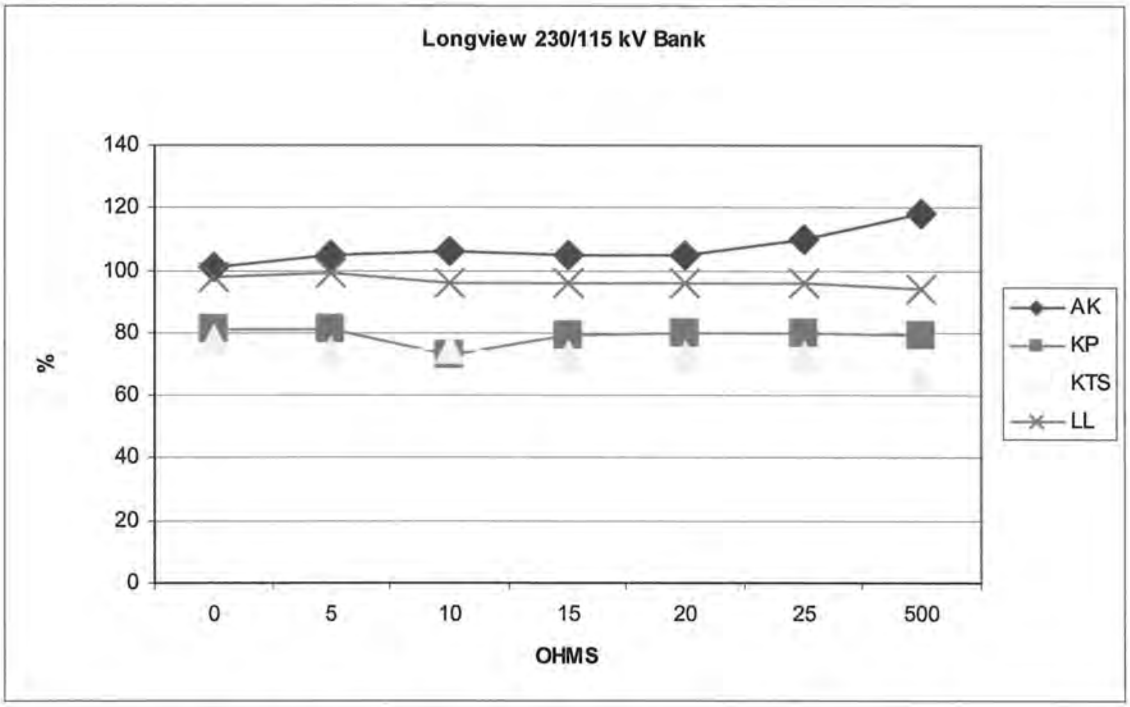


Fig.7a Longview 230/115 kV Bank in different outages
with Reactor control

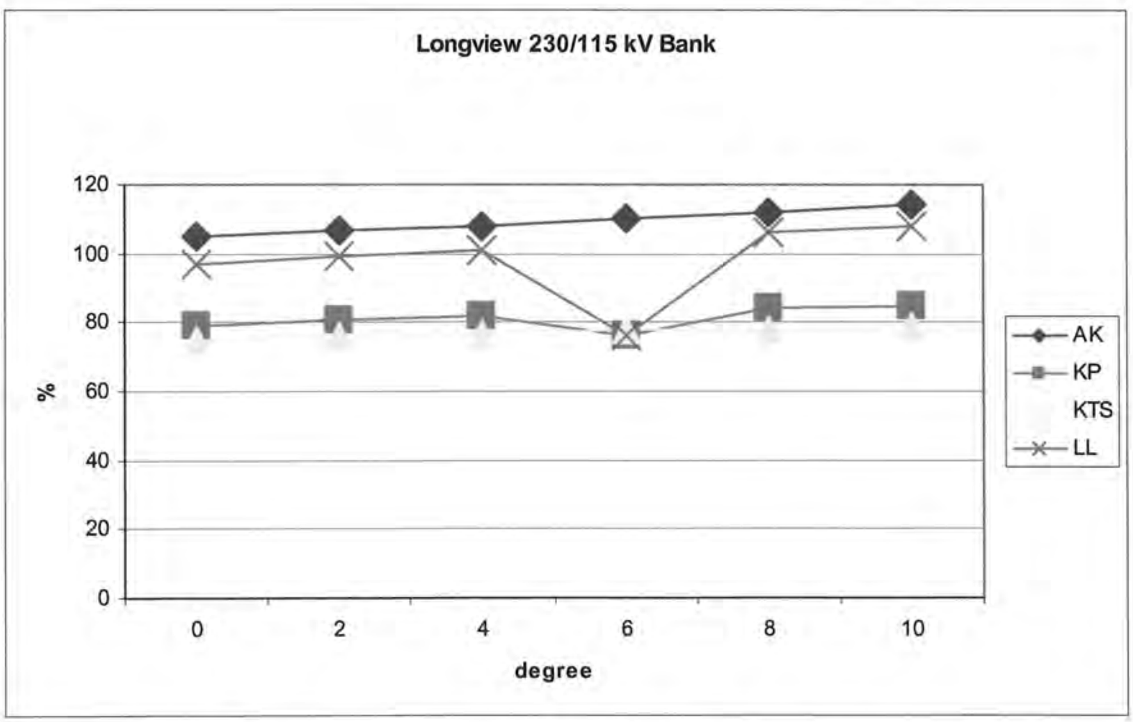


Fig.7b Longview 230/115 kV Bank in different outages
with Phase Shift Transformer control

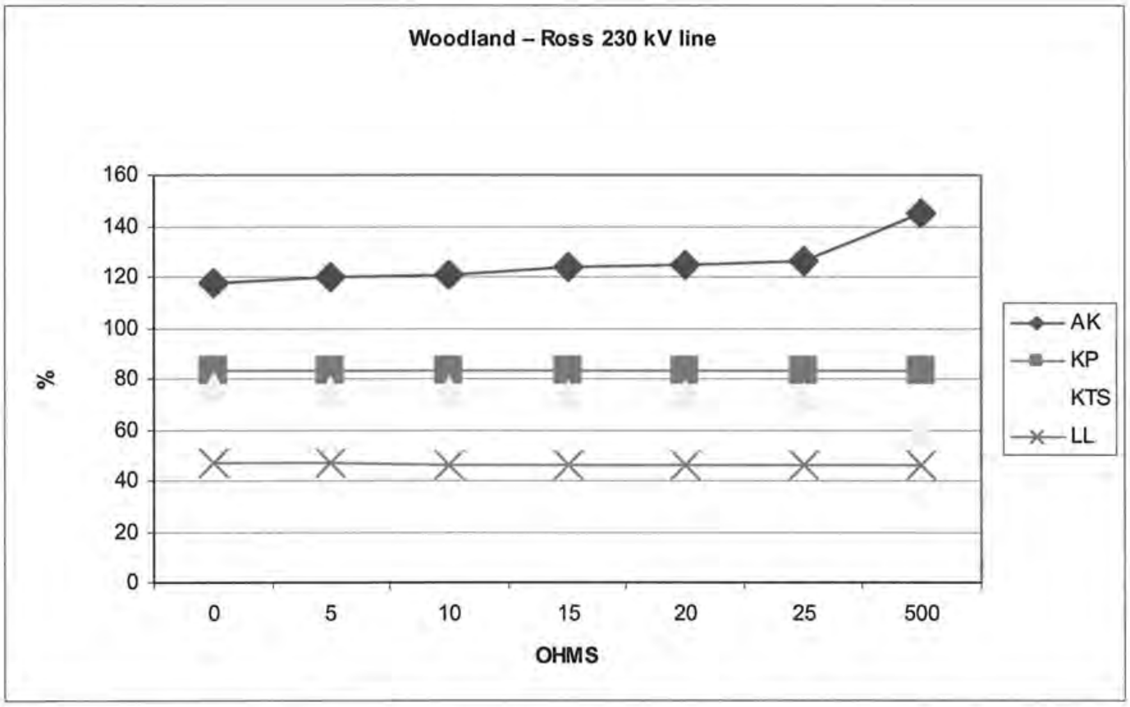


Fig.8a Woodland – Ross 230 kV line in different outages
with Reactor control

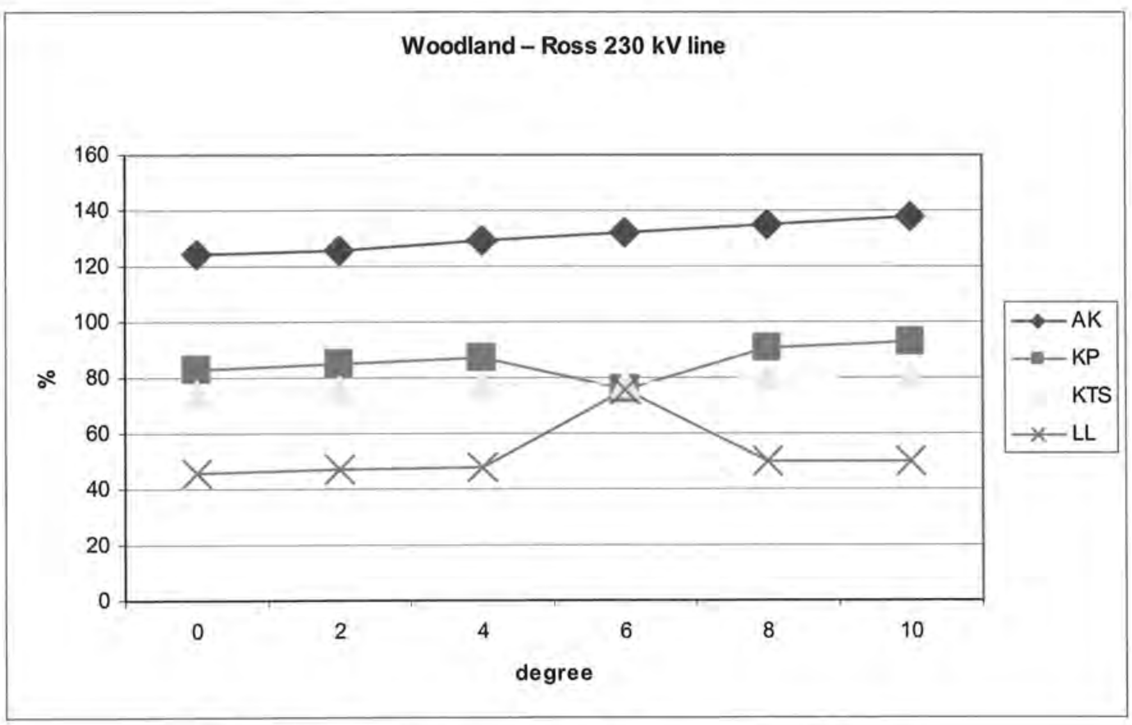


Fig.8b Woodland – Ross 230 kV line in different outages
with Phase Shift Transformer control

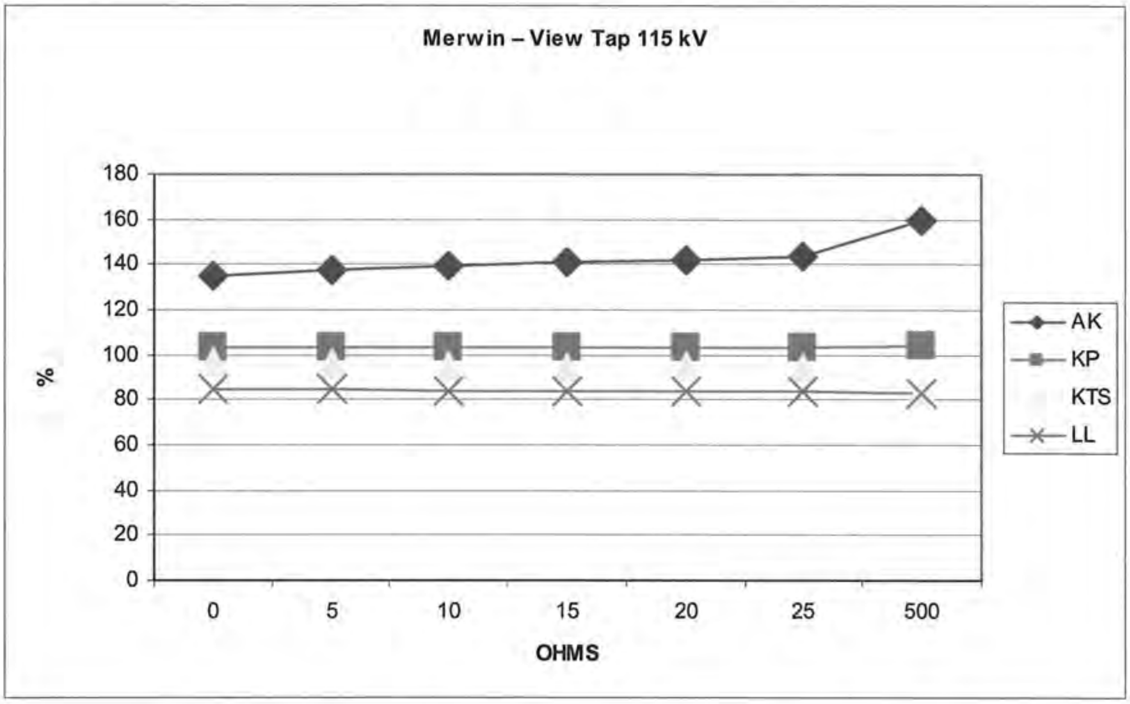


Fig.9a Merwin – View Tap 115 kV line in different outages
with Reactor control

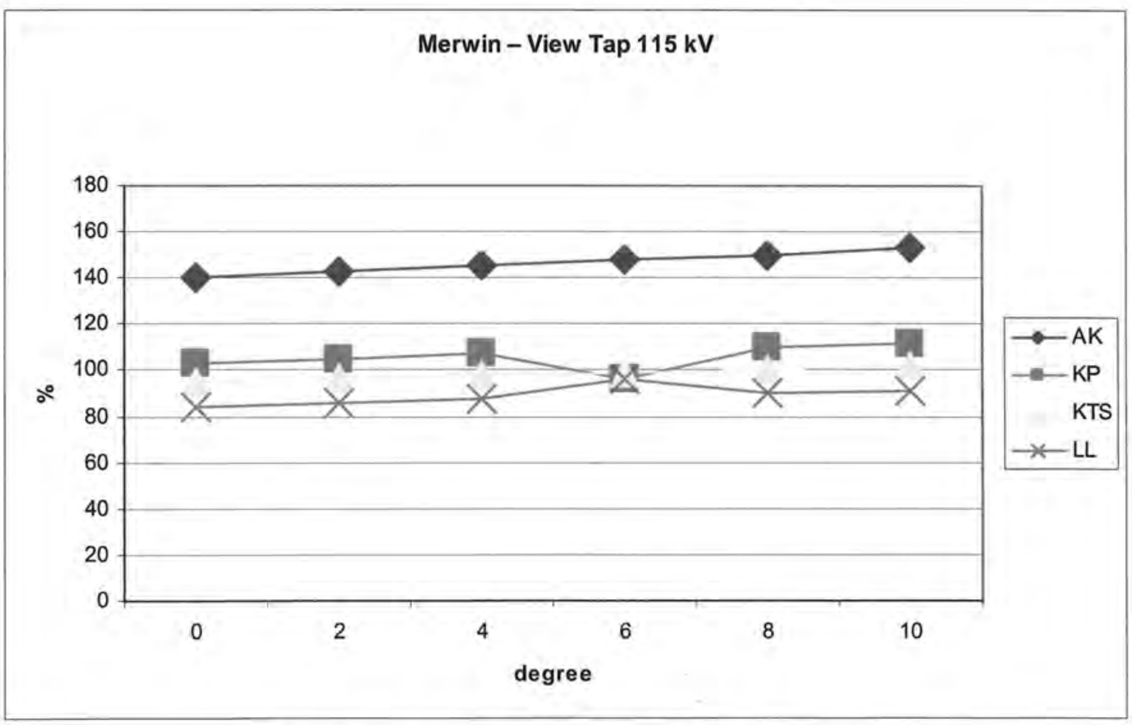
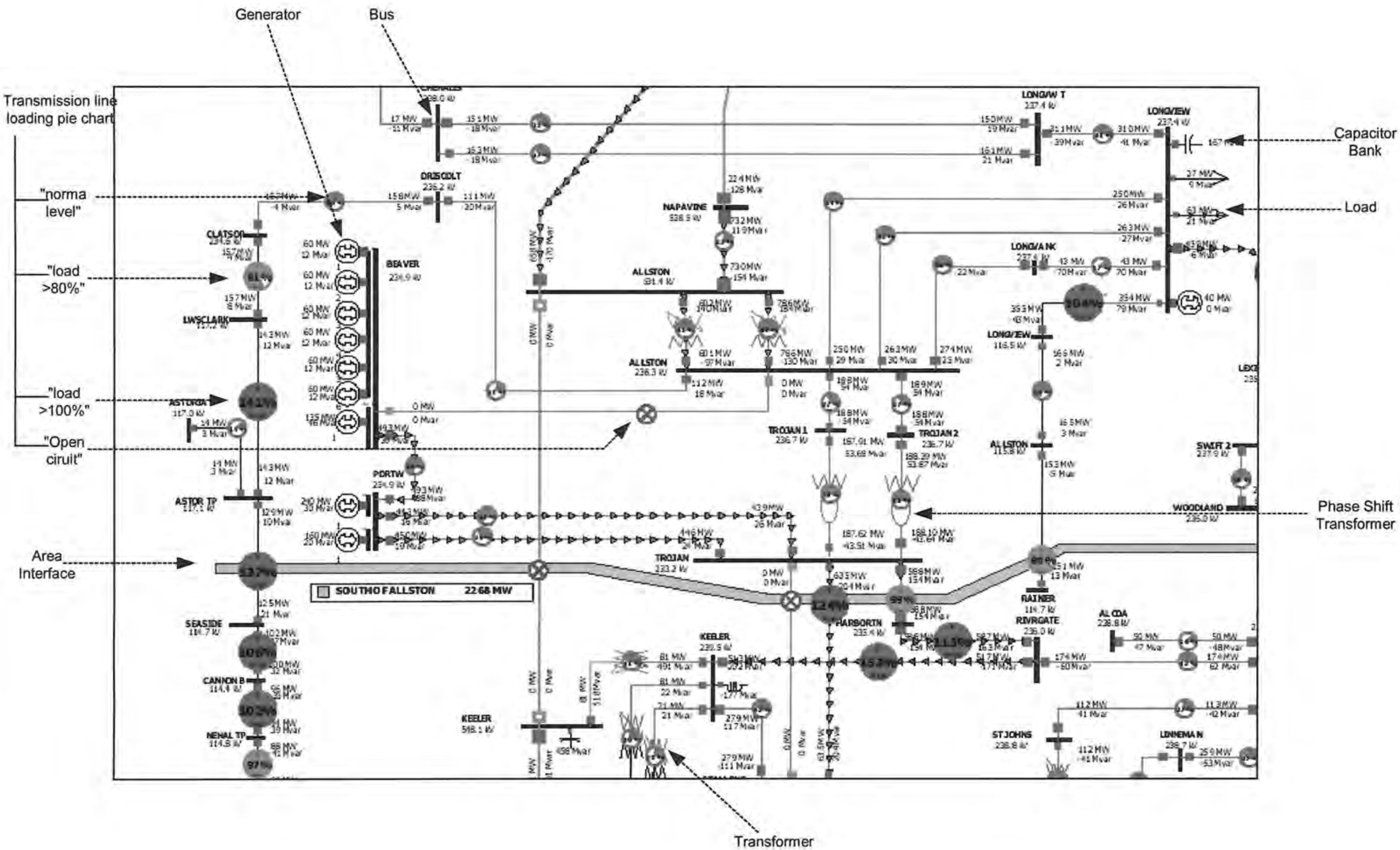


Fig.9b Merwin – View Tap 115 kV line in different outages
with Phase Shift Transformer control

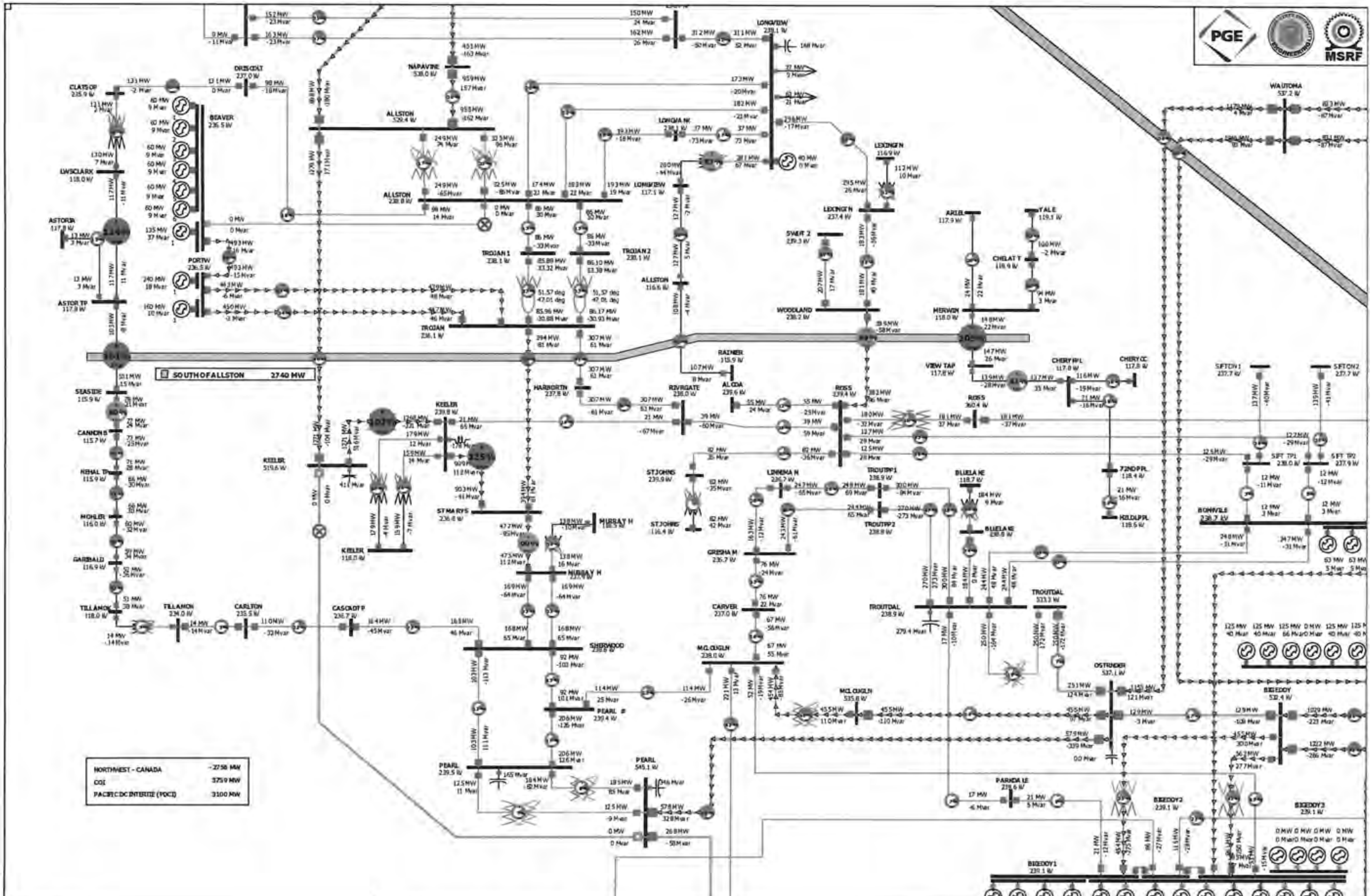
Appendix B: the list of all studies

Case #	Comments	Testing Scenarios
Case_0	Initial Base	All 4 outages
Case_1	1) New base by Open Beaver-Allston 230kV, and reconnect Beaver stations to the system through Beaver-PORTW-Trojan 230kV lines. 2) Allston 230kV bus connects to the Trojan 230kV bus through Trojan 1 & 2	All 4 outages
Case_2	Trojan 1 & 2 to Trojan lines open circuit	All 4 outages Power reduction in AK outage
Case_3	Power flow control with 0 ohm reactors	All 4 outages Power reduction in AK outage
Case_4	Power flow control with 5 ohm reactors	All 4 outages Power reduction in AK outage
Case_5	Power flow control with 10 ohm reactors	All 4 outages Power reduction in AK outage
Case_6	Power flow control with 15 ohm reactors	All 4 outages Power reduction in AK outage
Case_7	Power flow control with 20 ohm reactors	All 4 outages Power reduction in AK outage
Case_8	Power flow control with 25 ohm reactors	All 4 outages Power reduction in AK outage
Case_9	Power flow control using Phase Shift Transformers with 0 degree shifting angle	All 4 outages Power reduction in AK outage
Case_10	Power flow control using Phase Shift Transformers with 2 degree shifting angle	All 4 outages Power reduction in AK outage
Case_11	Power flow control using Phase Shift Transformers with 4 degree shifting angle	All 4 outages Power reduction in AK outage
Case_12	Power flow control using Phase Shift Transformers with 6 degree shifting angle	All 4 outages Power reduction in AK outage
Case_13	Power flow control using Phase Shift Transformers with 8 degree shifting angle	All 4 outages Power reduction in AK outage
Case_14	Power flow control using Phase Shift Transformers with 10 degree shifting angle	All 4 outages Power reduction in AK outage
Case_15		
Case_16		
Case_17		
Case_18		

LEGEND

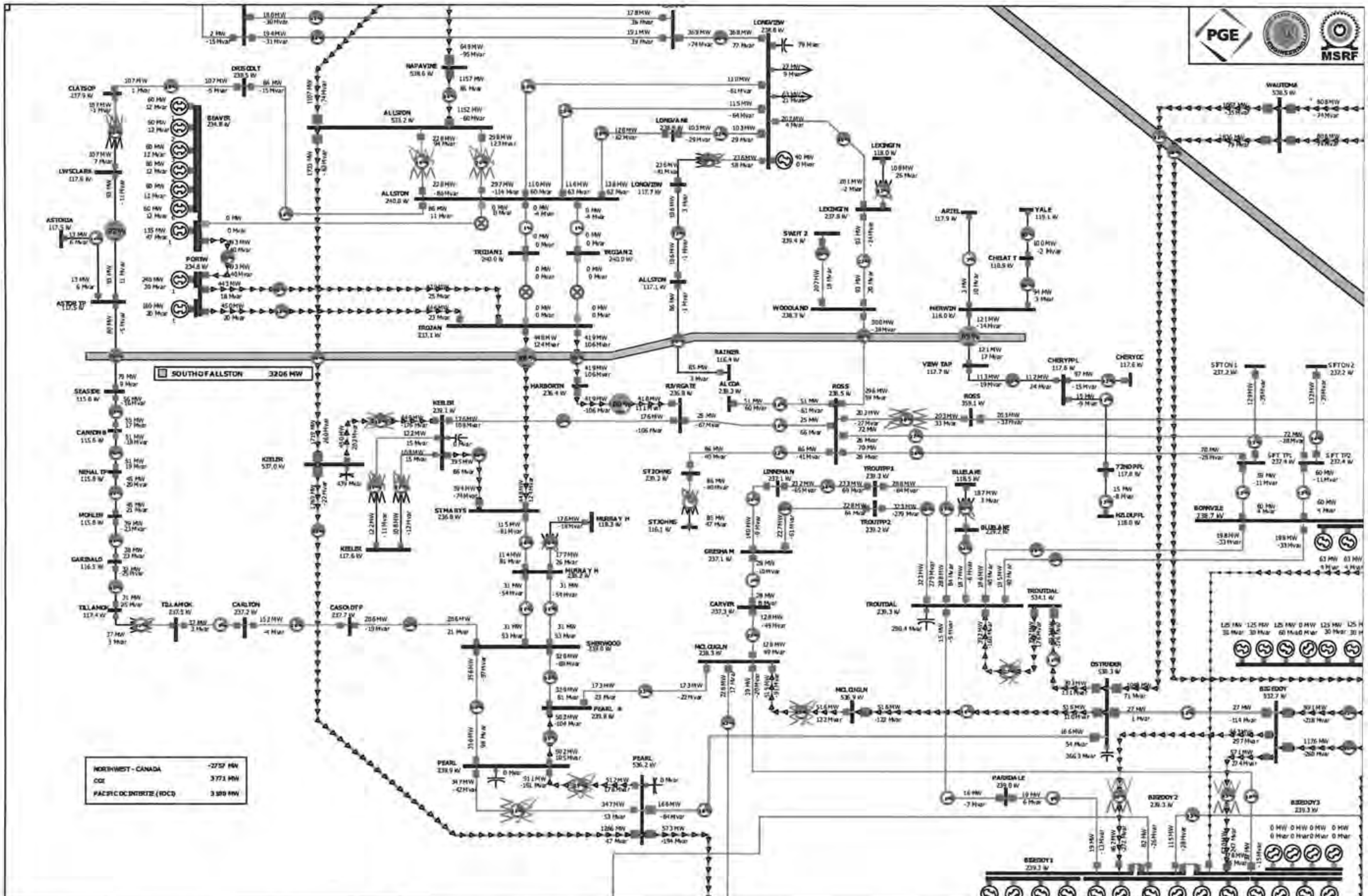


Generator
Bus
Transmission line loading pie chart
"norma level"
"load >80%"
"load >100%"
"Open ciruit"
Area Interface
Capacitor Bank
Load
Phase Shift Transformer
Transformer
SOUTH OF ALLSTON 2268 MW
BEAVER
ALLSTON
NAPAVINE
DRISCOLL
LONGVIEW
TROJAN
TROJAN 1
TROJAN 2
KEELER
ASTORIA
SEASIDE
PORTW
RAINIER
RIVRGATE
ALCOA
ST JOHNS
WOODLAND

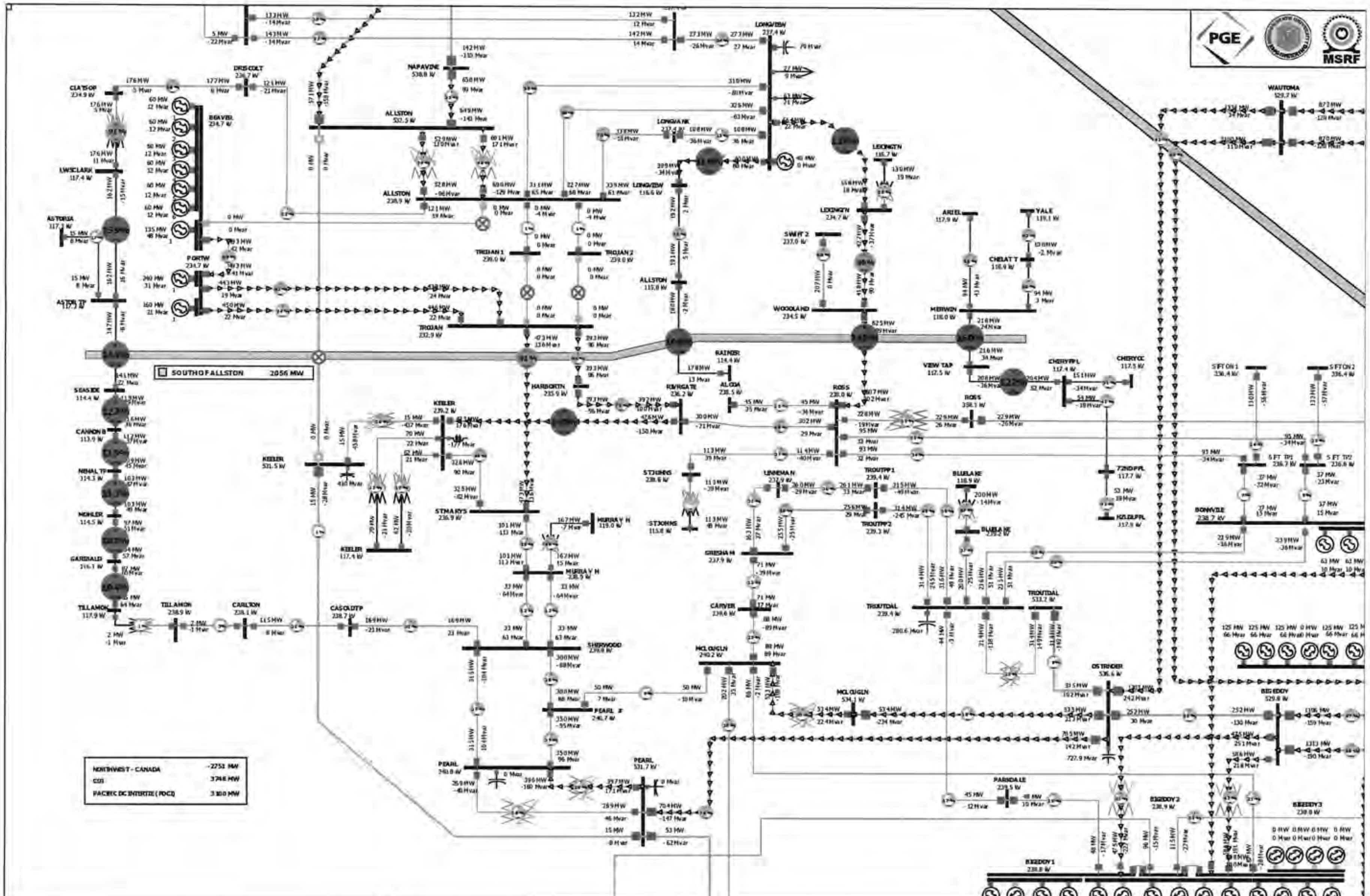


Oregon State University MSRF X.Zhou & J.Prudell	SOA- Beaver re-terminated at PortW. to Trojan Phase shifters at Trojan to Trojan 1 & 2 ; 6 degrees N-1 Keeler-Pearl 500KV Outage	K-P Outage CASE 12 9/2/2005

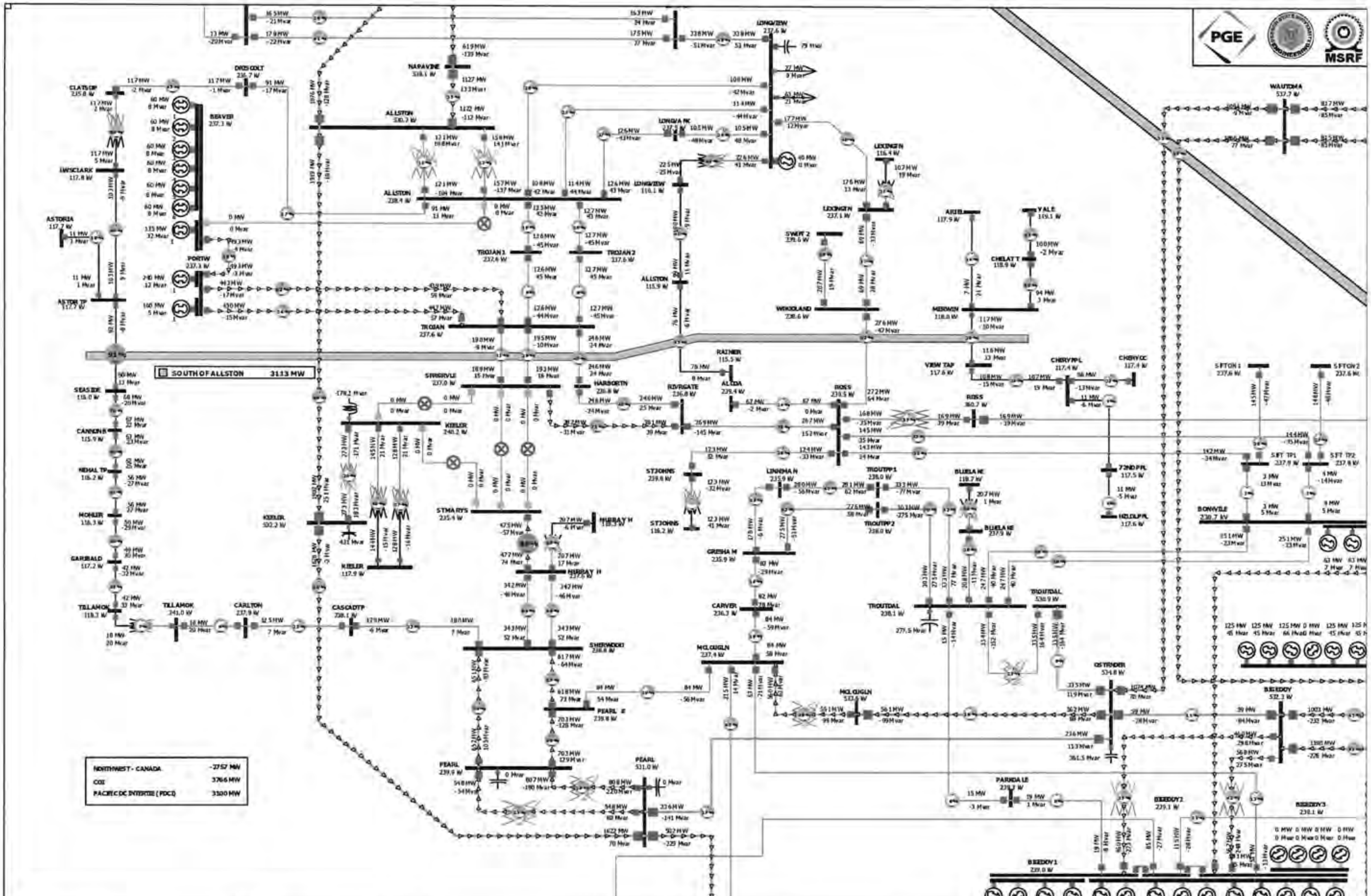
new



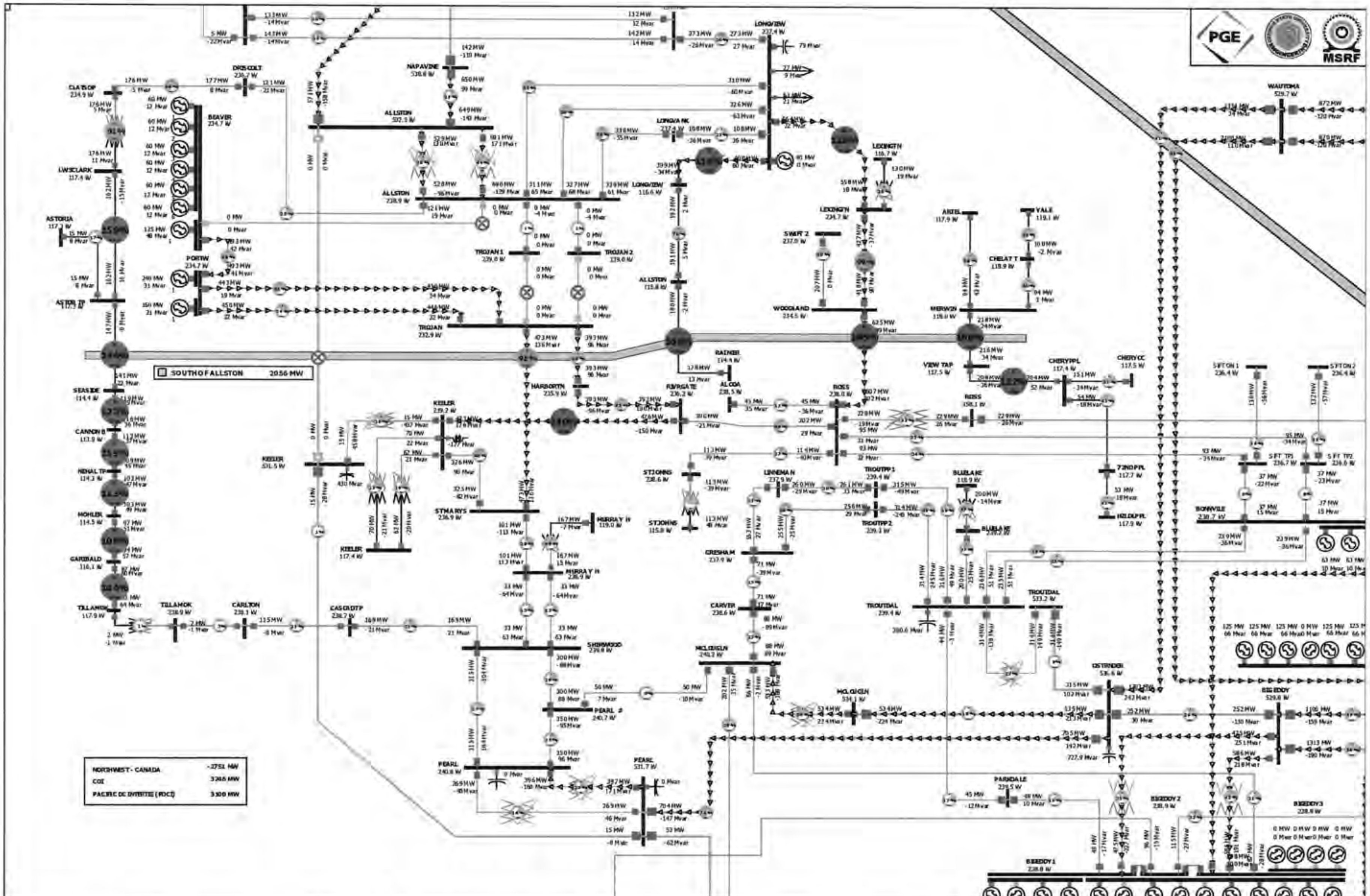
Oregon State University MSRF X.Zhou & J. Rudell	SOA - Beaver re-terminated to Port W. to Trojan Trojan 1 and Trojan 2 are OPEN	BASE CASE 2 8/23/2005



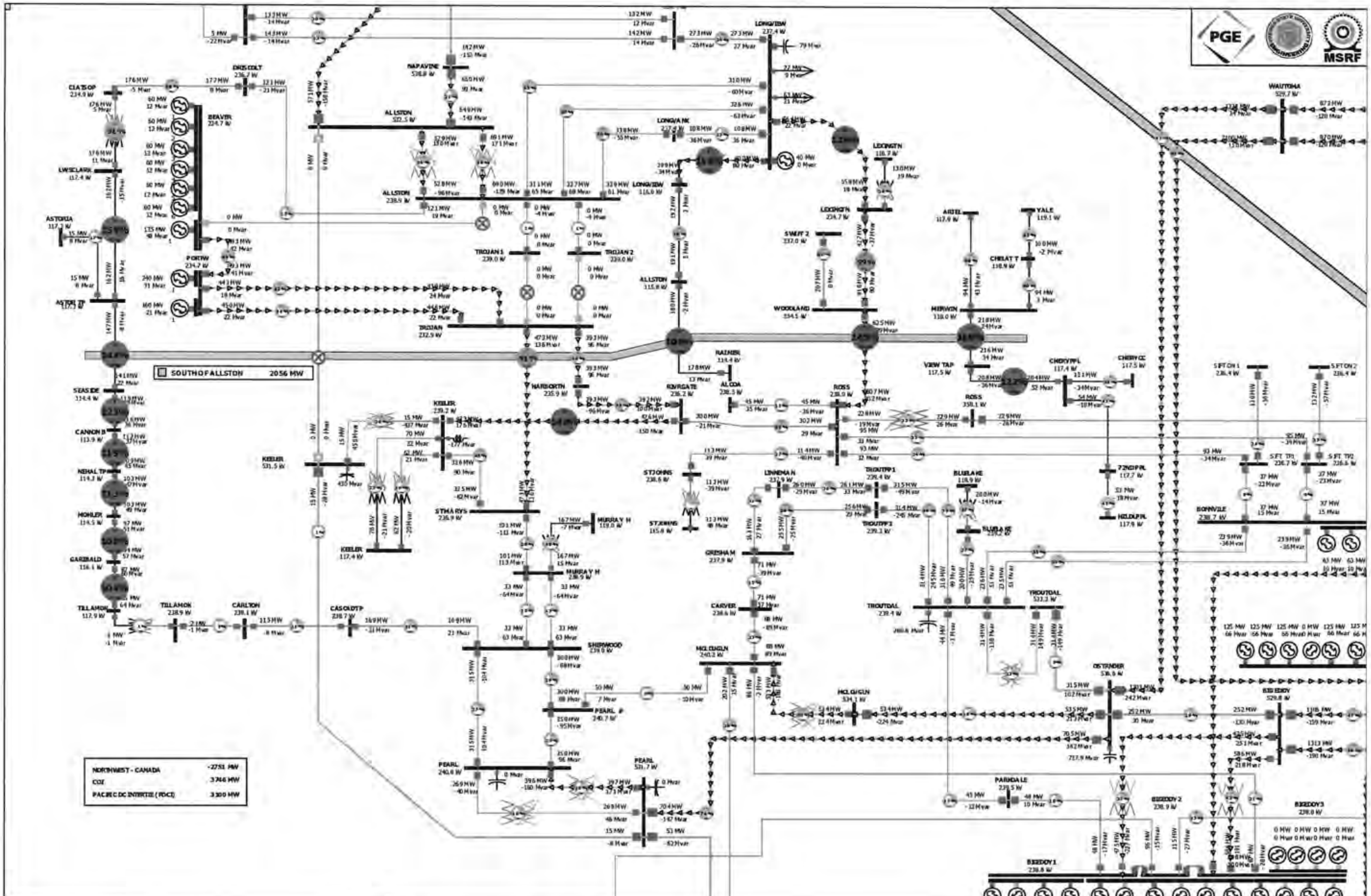
Oregon State University MSRF X.Zhou & J.Prudell	SOA - Beaver re-terminated to Port W. to Trojan Trojan 1 and Trojan 2 are OPEN N-1 Allston-Keeler 500KV Outage	A-K Outage CASE 2 8/23/2005



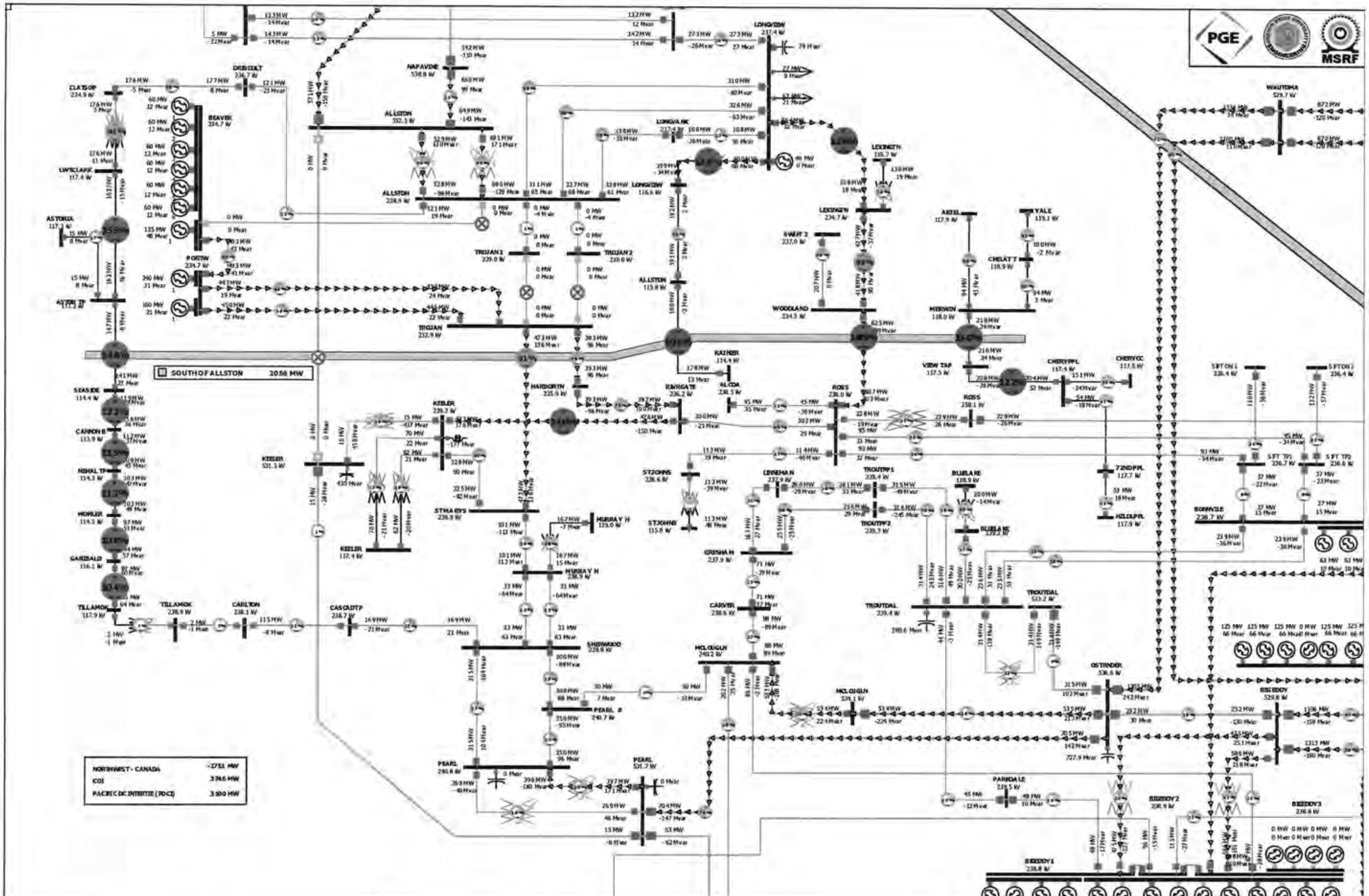
Oregon State University MSRF X.Zhou & J. Prudell	SOA- Beaver re-terminated at PortW. to Trojan SPRGRVLE 230KV bus created, Merwin-ViewTap-Cherrypl and LwsClark-Astortap re-conductored N-4 Keeler-Sprgrvle, Keeler-St.Marys, St.Marys-Sprgrvle 1&2, 230KV Outage	KSS Outage CASE 18 8/30/2005



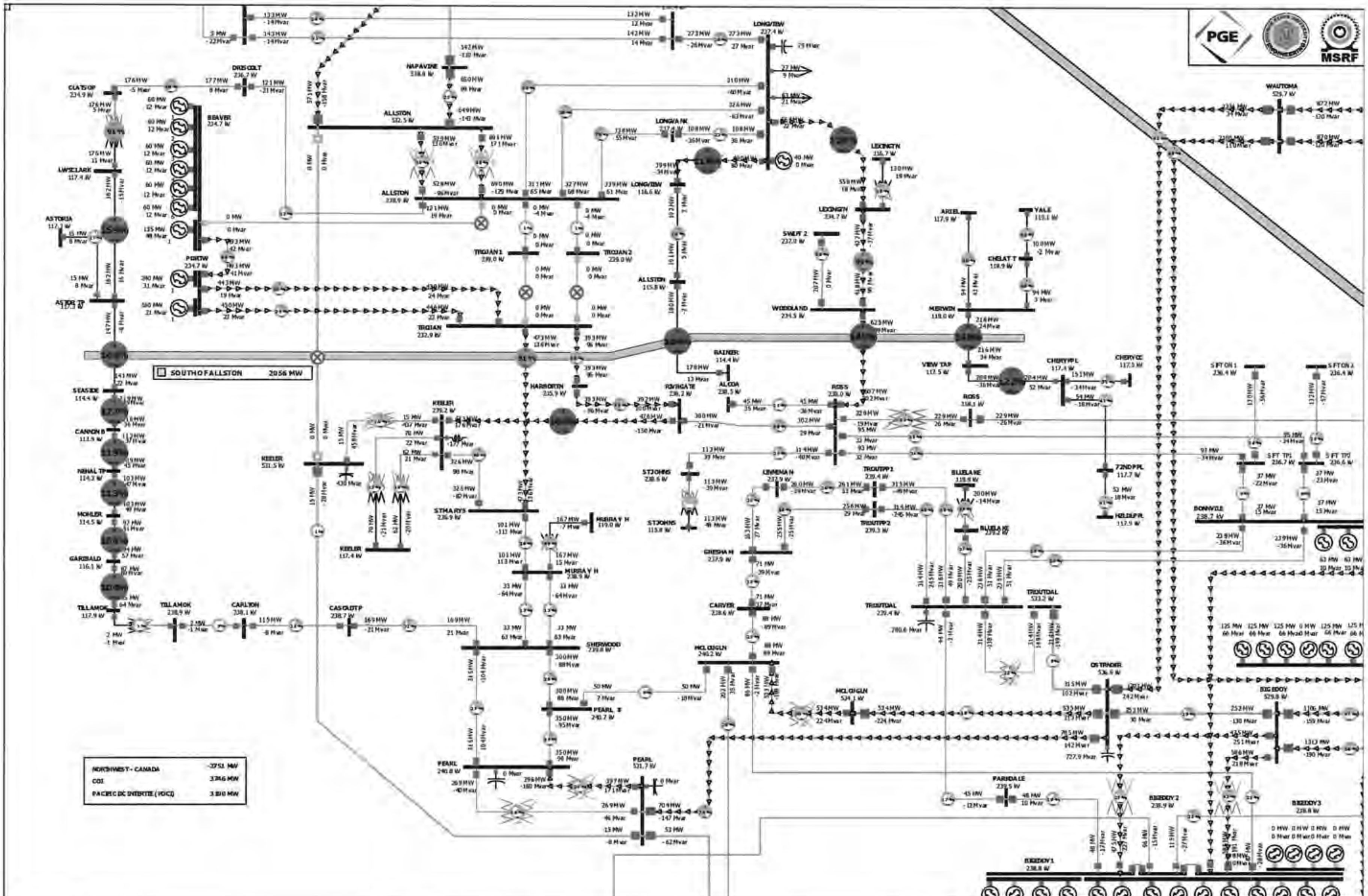
Oregon State University MSRF X.Zhou & J.Prudel	SOA - Beaver re-terminated to Port W. to Trojan Trojan 1 and Trojan 2 are OPEN N-1 Allston-Keeler 500KV Outage	A-K Outage CASE 2 8/23/2005



Oregon State University MSRF X.Zhou & J. Prudell	SOA - Beaver re-terminated to Port W. to Trojan Trojan 1 and Trojan 2 are OPEN N-1 Allston-Keeler 500KV Outage	A-K Outage CASE 2 8/23/2005



Oregon State University	SOA - Beaver re-terminated to Port W. to Trojan	A-K Outage
MSRF	Trojan 1 and Trojan 2 are OPEN	CASE 2
X.Zhou & J.Prudell	N-1 Allston-Keeler 500KV Outage	8/23/2005



Oregon State University MSRF X.Zhou & J.Prudel	SOA - Beaver re-terminated to Port W. to Trojan Trojan 1 and Trojan 2 are OPEN N-1 Allston-Keeler 500KV Outage	A-K Outage CASE 2 8/23/2005

$X = 0.01071$

EXCEL FILE

ADD KV BUS LEVEL (230, 115, 500 etc) <50KV!

☐ LINES → CURRENT

☐ PRINT ⇒ Call POWER WORLD ⇒ SET PRINT OPTION? –

☐ PRINT w/ OVERLOAD

- Decryption – / contingence / ie Beaver Allston vs Beaver – Port.W.
- S. Allston Cut Plane FLOW – IN DOCUMENT; (ADD Interface)!
-

0.4

.~~86~~

☐ CUT PLANE

ADD – ☐ ALLSTON – RAINER
☐ ASTORIA Tap – Seaside.

$\frac{9.5}{.596}$

$5\,\Omega$

CASES

① OPEN: – Reduce as explained –

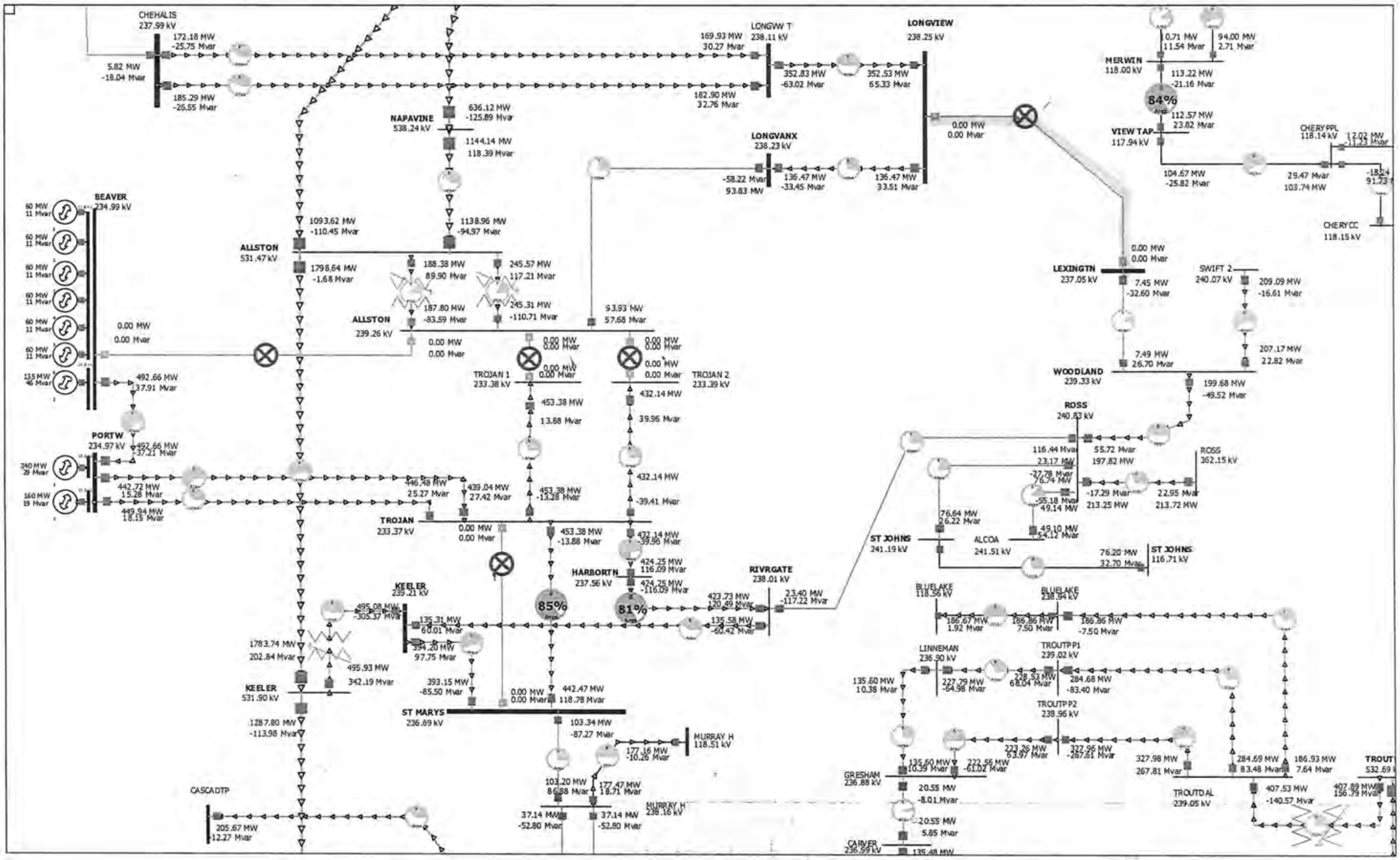
9.5×0.596416

$\boxed{5.66\,\Omega}$

② Line Reactors: → ⓪ ZERO Reactor I Base Case – no outages –
Z = 0,

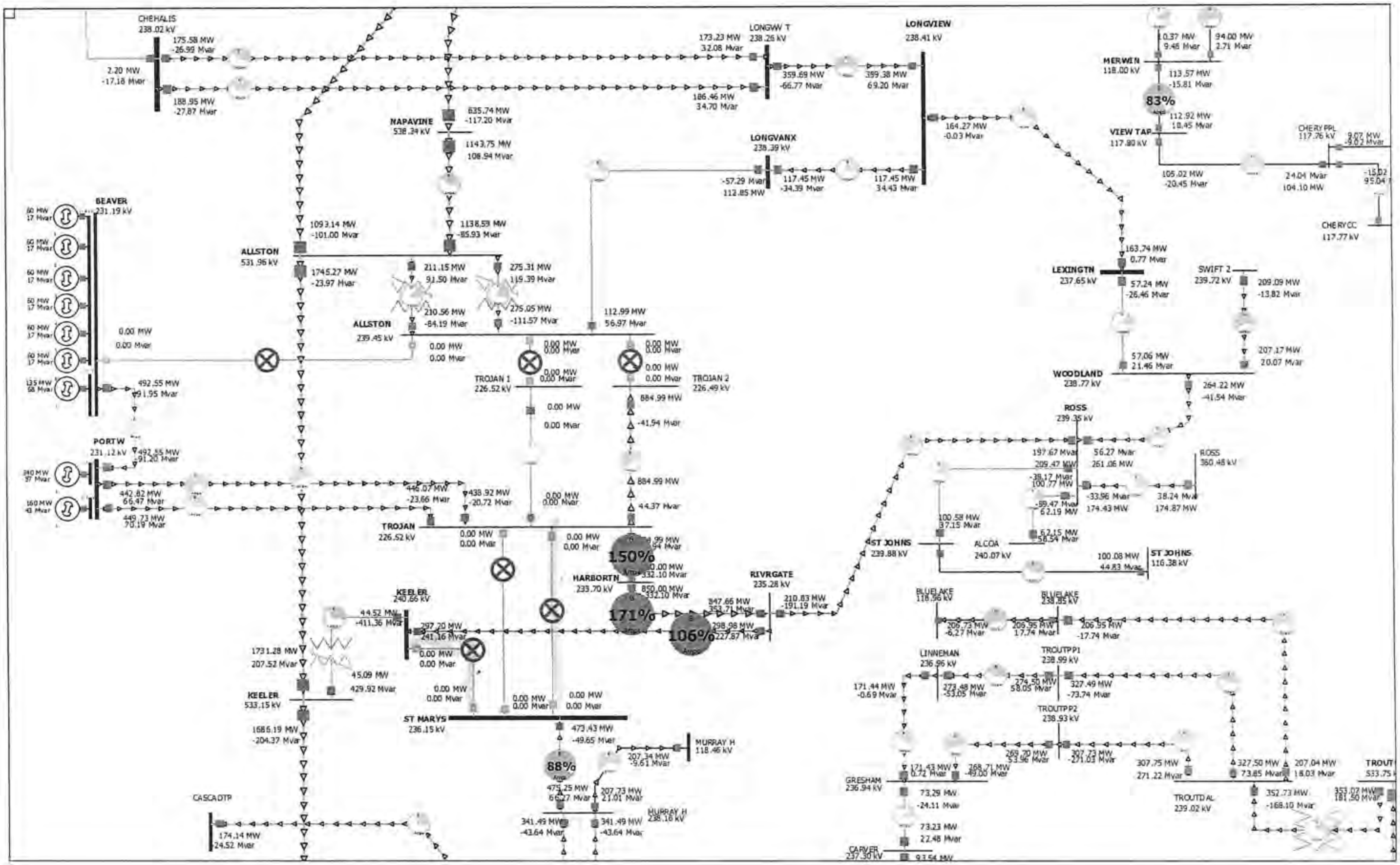
③ Phase-shifter:

CASE 3



CHEHALIS
237.99 kV
172.18 MW
-25.75 Mvar
5.82 MW
-18.04 Mvar
185.29 MW
-26.55 Mvar
169.93 MW
30.27 Mvar
LONGVW T
238.11 kV
182.90 MW
32.76 Mvar
352.83 MW
-63.02 Mvar
352.53 MW
65.33 Mvar
LONGVIEW
238.25 kV
0.00 MW
0.00 Mvar
LONGVANX
238.23 kV
-58.22 Mvar
93.83 MW
136.47 MW
-33.45 Mvar
136.47 MW
33.51 Mvar
MERWIN
118.00 kV
0.71 MW
11.54 Mvar
94.00 MW
2.71 Mvar
113.22 MW
-21.16 Mvar
84%
112.57 MW
23.82 Mvar
VIEW TAP
117.94 kV
104.67 MW
-25.82 Mvar
29.47 Mvar
103.74 MW
CHERYPPL
118.14 kV
12.02 MW
-11.23 Mvar
CHERYCC
118.15 kV
NAPAVINE
538.24 kV
636.12 MW
-125.89 Mvar
1144.14 MW
118.39 Mvar
1093.62 MW
-110.45 Mvar
1138.96 MW
-94.97 Mvar
ALLSTON
531.47 kV
1798.64 MW
-1.68 Mvar
188.38 MW
89.90 Mvar
245.57 MW
117.21 Mvar
187.80 MW
-83.59 Mvar
245.31 MW
-110.71 Mvar
ALLSTON
239.26 kV
93.93 MW
57.68 Mvar
BEAVER
234.99 kV
0.00 MW
0.00 Mvar
492.66 MW
37.91 Mvar
TROJAN 1
233.38 kV
TROJAN 2
233.39 kV
453.38 MW
13.88 Mvar
432.14 MW
39.96 Mvar
PORTW
234.97 kV
492.66 MW
-37.21 Mvar
442.72 MW
15.28 Mvar
449.94 MW
18.15 Mvar
446.48 MW
25.27 Mvar
439.04 MW
27.42 Mvar
453.38 MW
-13.28 Mvar
432.14 MW
-39.41 Mvar
TROJAN
233.37 kV
0.00 MW
0.00 Mvar
453.38 MW
-13.88 Mvar
432.14 MW
-39.96 Mvar
424.25 MW
116.09 Mvar
HARBORTN
237.56 kV
424.25 MW
-116.09 Mvar
85%
81%
RIVRGATE
238.01 kV
423.73 MW
120.49 Mvar
23.40 MW
-117.22 Mvar
135.58 MW
-60.42 Mvar
KEELER
239.21 kV
495.08 MW
-305.37 Mvar
135.31 MW
60.01 Mvar
394.20 MW
97.75 Mvar
495.93 MW
342.19 Mvar
1783.74 MW
202.84 Mvar
KEELER
531.90 kV
1287.80 MW
-113.98 Mvar
393.15 MW
-85.50 Mvar
0.00 MW
0.00 Mvar
442.47 MW
118.78 Mvar
ST MARYS
236.69 kV
103.34 MW
-87.27 Mvar
MURRAY H
118.51 kV
177.16 MW
-10.26 Mvar
103.20 MW
86.88 Mvar
177.47 MW
18.71 Mvar
MURRAY H
238.16 kV
37.14 MW
-52.80 Mvar
37.14 MW
-52.80 Mvar
CASCADTP
205.67 MW
12.27 Mvar
LEXINGTN
237.05 kV
0.00 MW
0.00 Mvar
7.45 MW
-32.60 Mvar
SWIFT 2
240.07 kV
209.09 MW
-16.61 Mvar
7.49 MW
26.70 Mvar
207.17 MW
22.82 Mvar
WOODLAND
239.33 kV
199.68 MW
-49.52 Mvar
ROSS
240.83 kV
116.44 Mvar
55.72 Mvar
197.82 MW
ROSS
362.15 kV
-17.29 Mvar
213.25 MW
22.95 Mvar
213.72 MW
49.14 MW
49.10 MW
-54.12 Mvar
76.64 MW
26.22 Mvar
ST JOHNS
241.19 kV
ALCOA
241.51 kV
76.20 MW
32.70 Mvar
ST JOHNS
116.71 kV
BLUELAKE
118.56 kV
BLUELAKE
238.94 kV
186.67 MW
1.92 Mvar
186.86 MW
7.50 Mvar
186.86 MW
-7.50 Mvar
LINNEMAN
236.90 kV
TROUTPP1
239.02 kV
135.60 MW
10.38 Mvar
227.79 MW
-64.98 Mvar
228.93 MW
68.04 Mvar
284.68 MW
-83.40 Mvar
TROUTPP2
238.96 kV
223.26 MW
63.97 Mvar
327.96 MW
-267.81 Mvar
135.60 MW
10.39 Mvar
222.56 MW
-61.02 Mvar
327.98 MW
267.81 Mvar
284.69 MW
83.48 Mvar
186.93 MW
7.64 Mvar
GRESHAM
236.88 kV
20.55 MW
-8.01 Mvar
20.55 MW
5.85 Mvar
TROUTDAL
239.05 kV
407.53 MW
-140.57 Mvar
407.89 MW
156.79 Mvar
CARVER
236.59 kV
135.48 MW

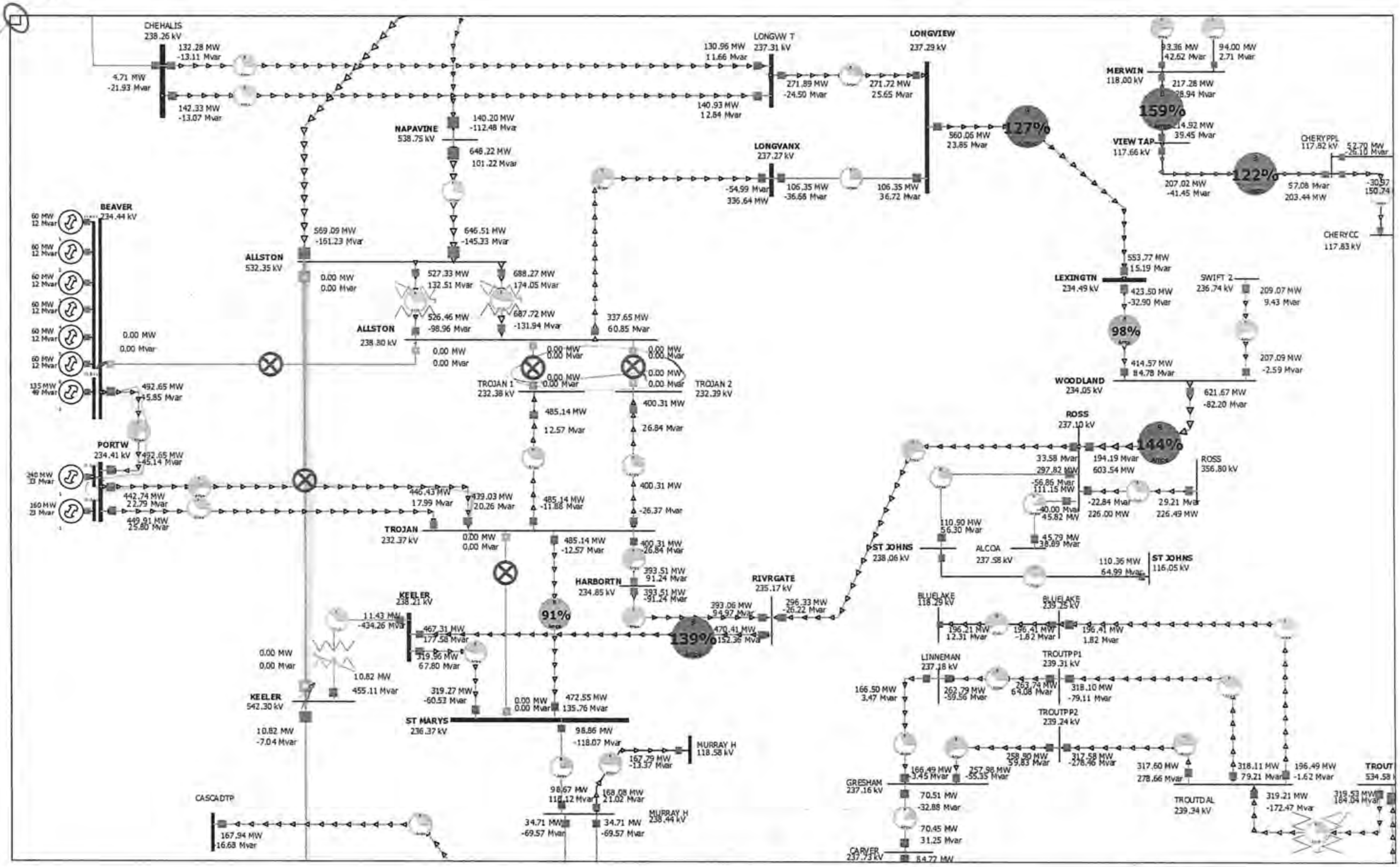
CASE 2


CHEHALIS
238.02 kV
LONGW T
238.26 kV
LONGVIEW
238.41 kV
MERWIN
118.00 kV
83%
VIEW TAP
117.80 kV
CHERY PPL
117.76 kV
CHERY CC
117.77 kV
NAPAVINE
538.34 kV
LONGVANX
238.39 kV
BEAVER
231.19 kV
ALLSTON
531.96 kV
ALLSTON
239.45 kV
LEXINGTN
237.65 kV
SWIFT 2
239.72 kV
WOODLAND
238.77 kV
TROJAN 1
226.52 kV
TROJAN 2
226.49 kV
ROSS
239.35 kV
ROSS
360.48 kV
PORTW
231.12 kV
TROJAN
226.52 kV
150%
HARBORTN
233.70 kV
171%
106%
RIVRGATE
235.28 kV
ST JOHNS
239.88 kV
ALCOA
240.07 kV
ST JOHNS
116.38 kV
KEELER
240.66 kV
BLUELAKE
BLUELAKE
LINNEMAN
236.96 kV
TROUTPP1
238.99 kV
TROUTPP2
238.93 kV
KEELER
533.15 kV
ST MARYS
236.15 kV
88%
MURRAY H
118.46 kV
MURRAY H
238.16 kV
GRESHAM
236.94 kV
TROUTDAL
239.02 kV
CARVER
237.30 kV
CASCADTP

FIND - BC → CLUSTER
INGLEPOOL →

CASE ①

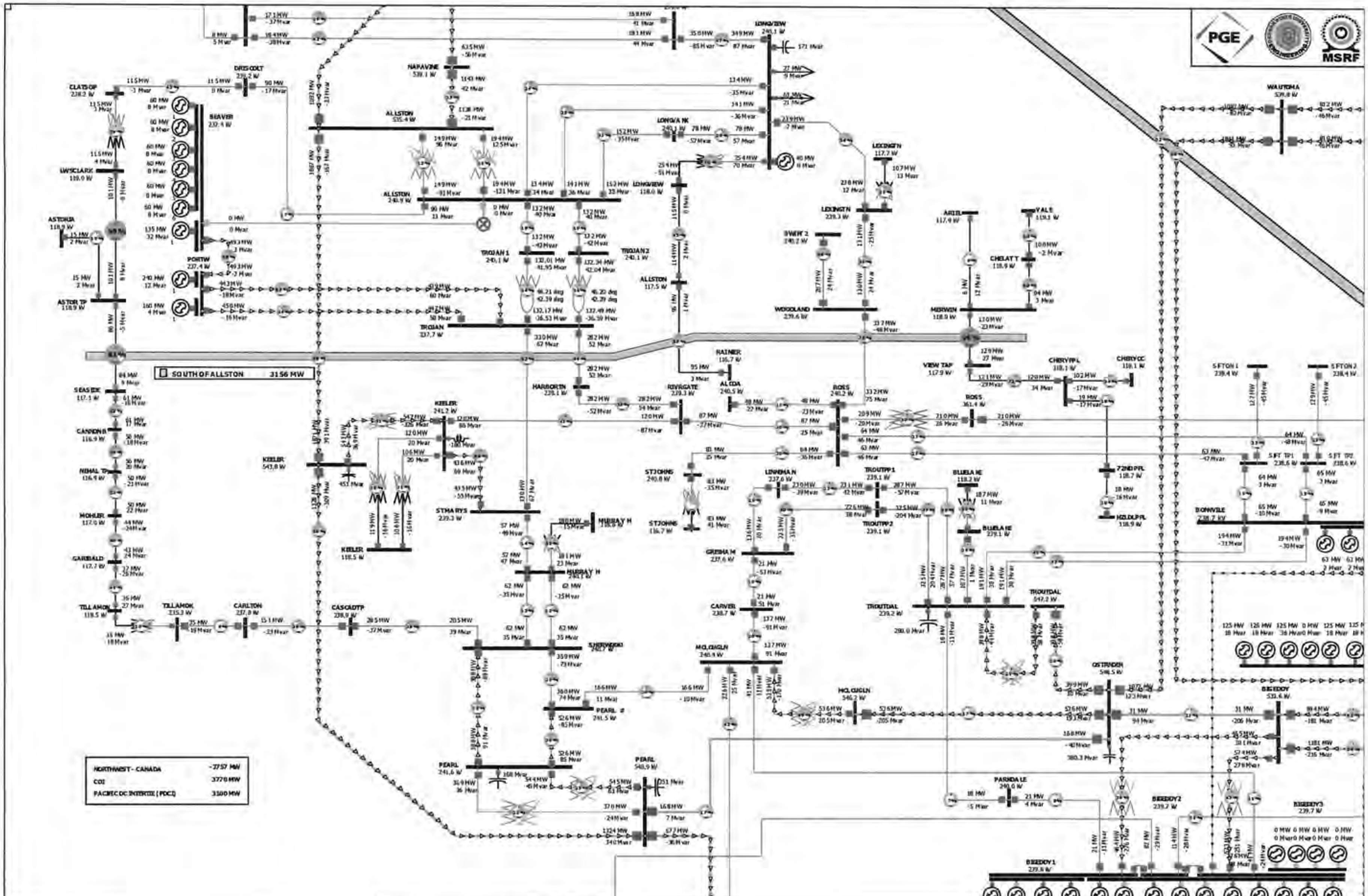
PRINT CORNER.



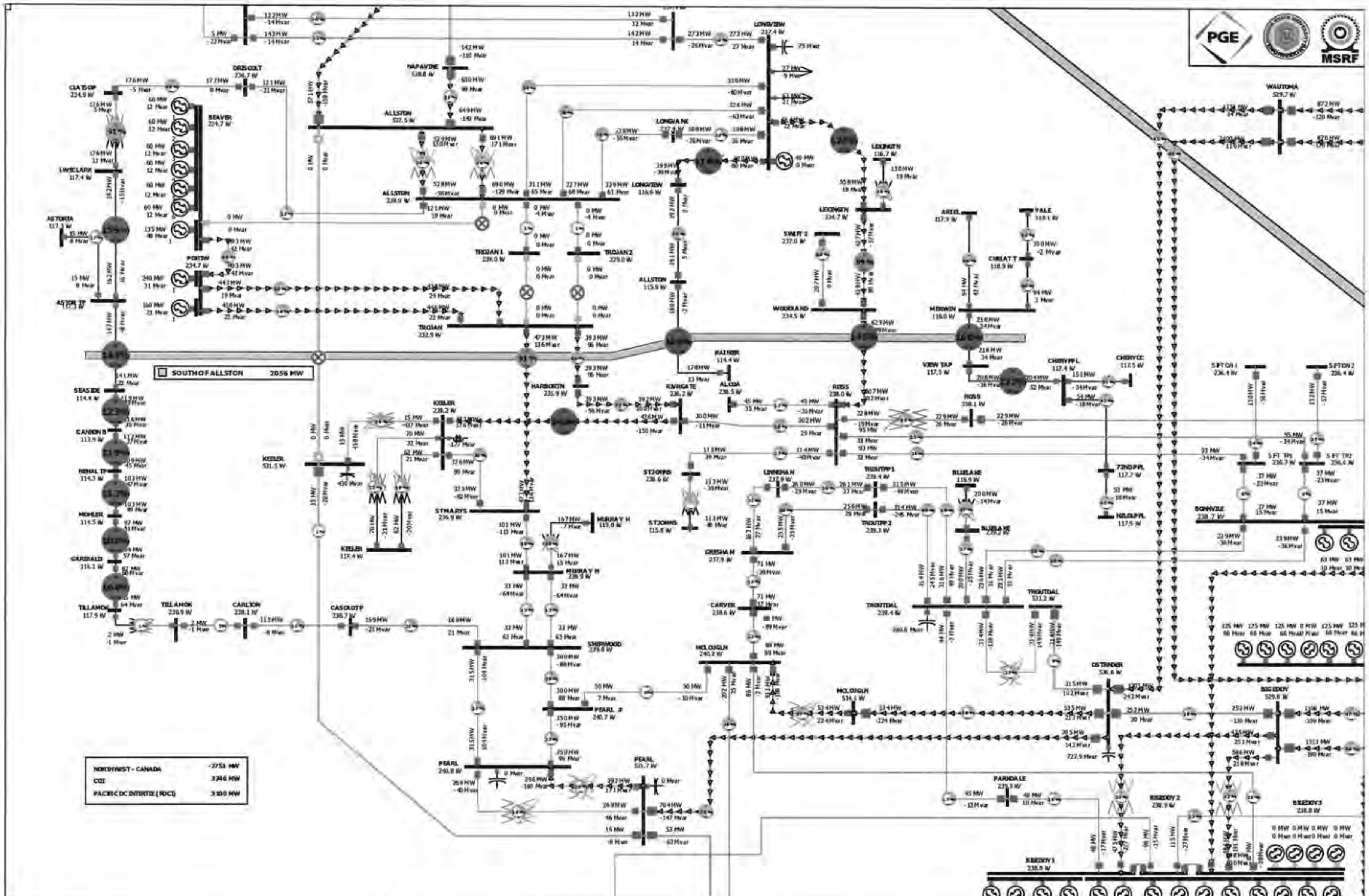
① Bring transfer's down to close to normal. (500-750 MW STEPS) + DOWN.

BCNW =
COI =
PDCI =

WATCH FOR SWING.



Oregon State University MSRF X.Zhou & J.Prudell	SOA-Beaver re-terminated to PortW. to Trojan Phase shifters at Trojan to Trojan 1&2 ; 6 degrees N-1 Keeler-Pearl 500KV Outage	K-P Outage CASE 12 8/29/2005



Oregon State University	SOA - Beaver re-terminated to Port W. to Trojan	A-K Outage
MSRF	Trojan 1 and Trojan 2 are OPEN	CASE 2
X.Zhou & J.Prudell	N-1 Allston-Keeler 500KV Outage	8/23/2005

R

PU

17.83 mi

$.553\ \Omega \Rightarrow .031015\ \Omega/mi \quad \frac{100}{500^2} \Rightarrow .00001241$ per mi

X

$10.52\ \Omega \Rightarrow 0.590017\ \Omega/mi \quad \frac{100}{500^2} \Rightarrow .00023601$ per mi

B

$126.95\ \mu\mho \Rightarrow .00000712\ \mho/mi \quad \frac{500^2}{100} \Rightarrow .0178$ per mi

500 KV

2 - 1780 ACSR Chukar

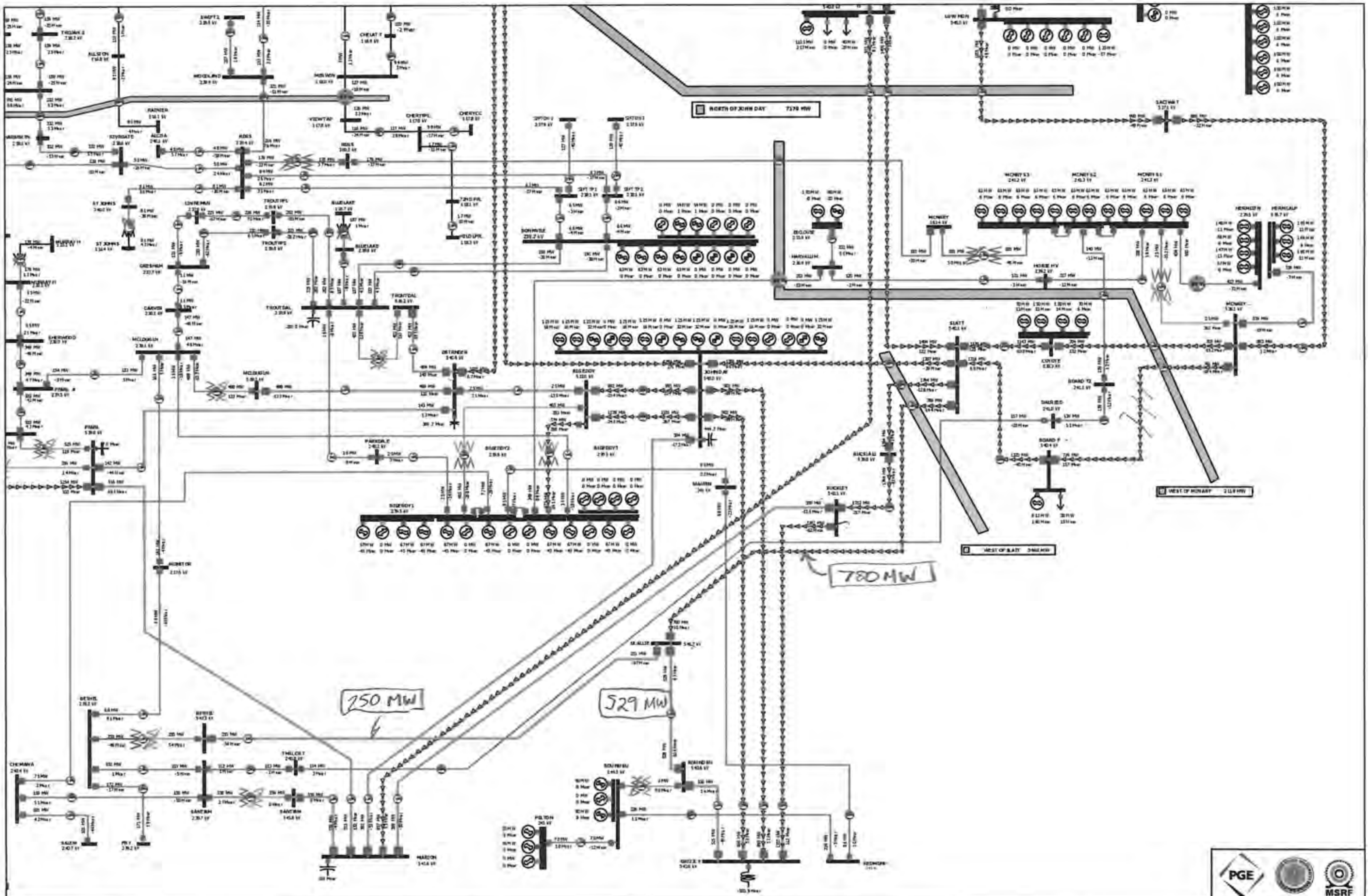
M3

35.99 GMD

18" sub spacing

CASE 31

WoM 2119 MW
WoS 3940 MW



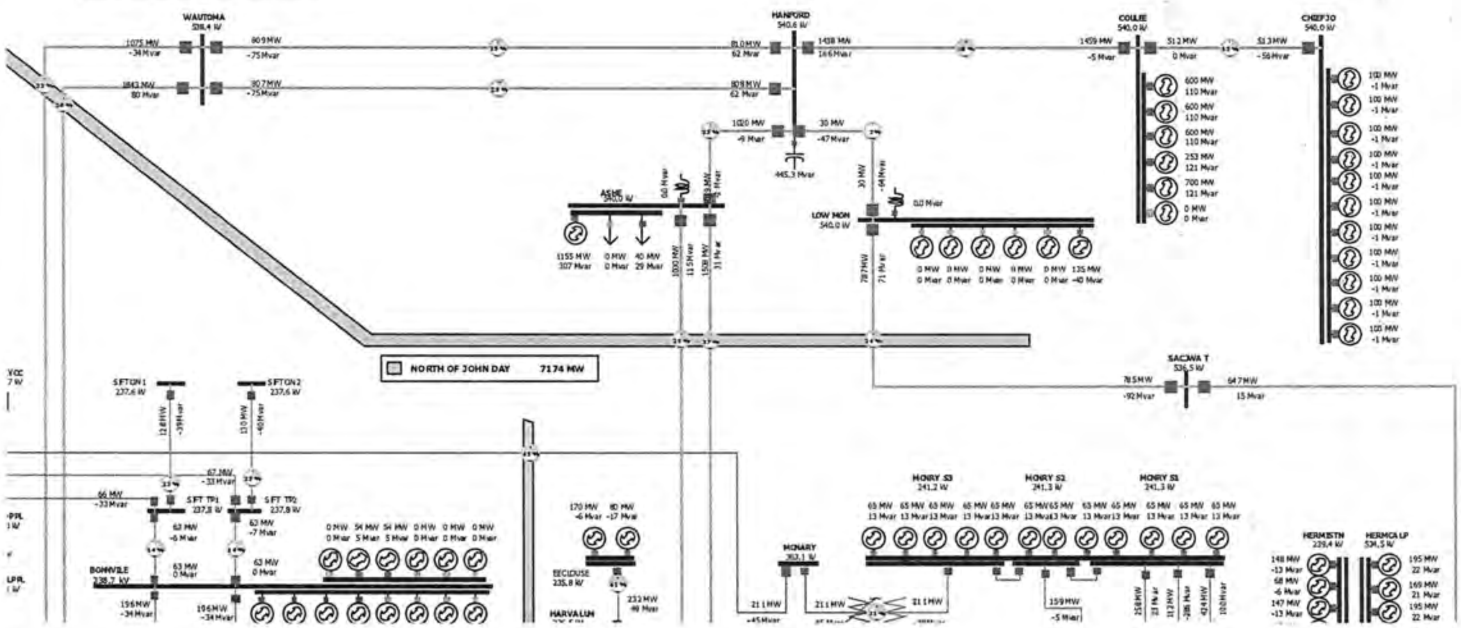
Oregon State University MSRF J. Prudell & X. Zhou	New station OLALLIE and BETHEL 500KV New 500KV Chuker lines from Bethel-Olallie-Slatt-McNary & Round Bu	BASE CASE 31 9/8/2005

$\boxed{17}$ — send .pwd .pwb

$\boxed{1}$ — send .pwd .pwb

$\boxed{21}$

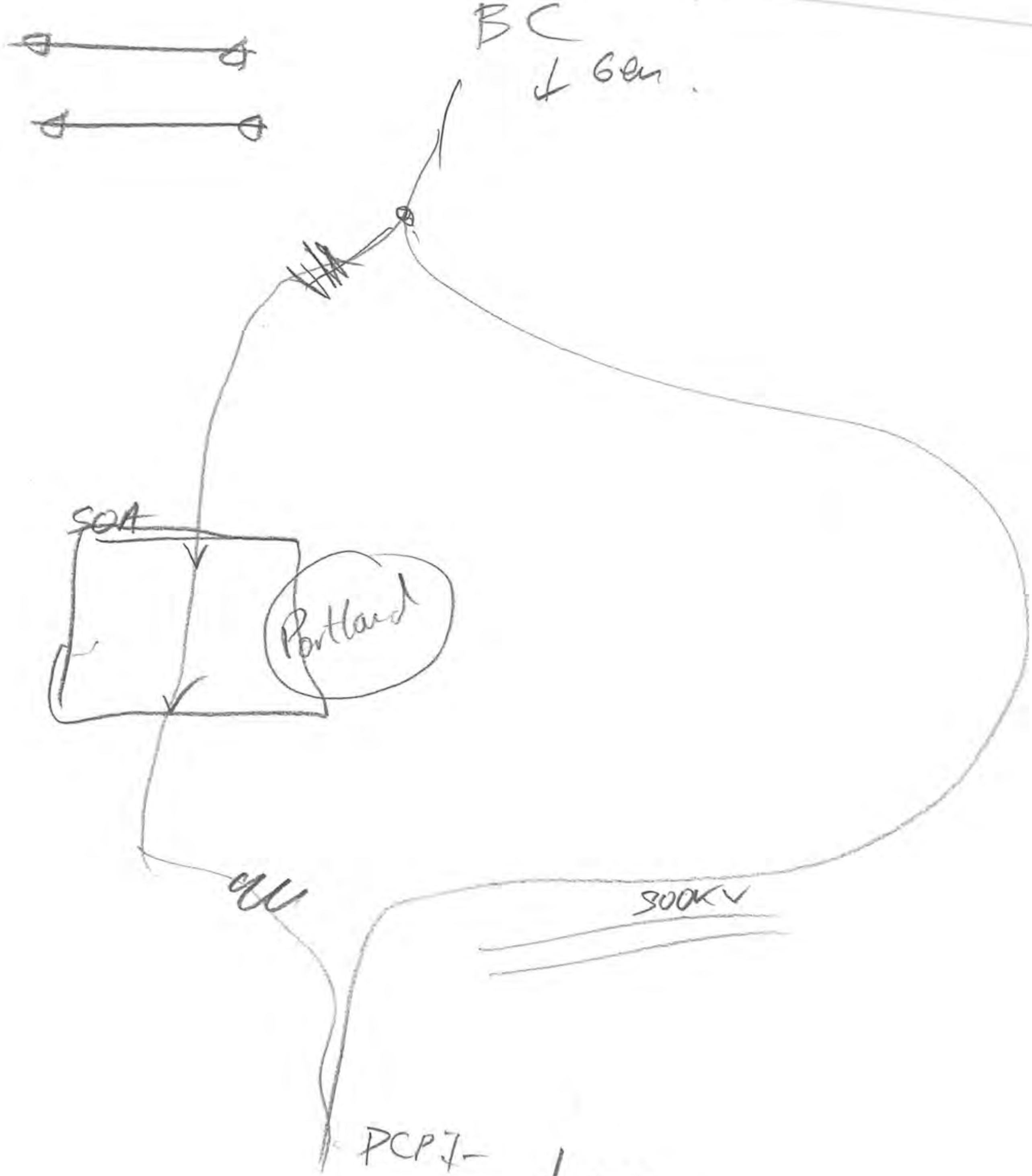
SOUTHERN


WAUTOMA
HANFORD
COULEE
CHIEFJO
ASHE
LOW MON
NORTH OF JOHN DAY 7174 MW
SACJWA T
SIFTON1
SIFTON2
MCNARY
MCNRY S3
MCNRY S2
MCNRY S1
HERMISTN
HERMCALP
BONNVILE
HARVALUM

NEW BUS
$\boxed{\text{CASE 18}}$: Springville: [Trojan - ST Marys (2x) + Rivergate + Keller]
↳ Use map and data base line information printout to define LINE LENGTHS
↳ X + R & B. values.
↳ Watch for B/2 values in power world.

☐ Send Jim - CASE_2_oneline.
CASE_12_KP_oneline
CASE_18_KSS_oneline.

$\boxed{\text{Phase angle.}}$



BC
↓ Gen.
SOA
Portland
500KV
PCPJ-
↓ LOAD

Date: Mon, 01 Aug 2005 12:16:51 -0700
From: Jim Eden <Jim.Eden@pgn.com>
To: prudell@engr.orst.edu
Cc: avj@eecs.oregonstate.edu, wallace@eecs.oregonstate.edu, zhouxi@engr.orst.edu
Subject: Re: North of John Day

2 HTML text/html 3.76 KB

Looking good ! ! !

Looks like you have analysis and mapping going on together. Teamwork!

Mapping suggestions:

On the SoA maps, it would be nice to extend the bottom and right side a bit. Can you set the lower right page marker out a bit, so that the Pearl 500 bus and the Ostrander 500 bus are included? As sent, and printed in color, the picture looks real nice. Extending the page will shrink the size down a bit, maybe getting to small. However, I printed the picture on tabloid (11x17) and everything grows. So, enlarging the view, when printed on tabloid, should be a wash. I will bring a sample for you. I envision that these pages can fold out (11X17 trifolds to 11X8.5).

On the Southern maps, we need to move things around a bit. Note that even John Day is "north" of Portland. We can generally shift the 500 system up and right. My suggestions are:

At Pearl, keep the three lines equal spaced, so, the Keeler line moves down the bus and equal with the Pearl line, the cap moves up to the "top" xfmer and the Ostrander line lines up with the "middle" xfmr.

Move Ostrander up, equal with McLoughlin. Move Wautoma up, below the logos. Put Hanford above the logos, and more to the right. Move Big Eddy well to the right and "higher" than Ostrander. Move John Day even more right and equal with Big Eddy. Grizzly will move right, as with all the rest of the east side 500 (Buckley, Slatt, McNary, etc).

Move Marion down a little, equal to Grizzly. I think the NoJD cutplane will line up nicely.

I know you are not done adding the 230 elements. To be sure, we will need the 230 from Portland to Salem (Big Eddy-Chemawa and the Mcloughlin-Monitor-Bethel line) and the 230 "Salem" system. Not much there, you can end at Fry. We will need the 230 from Portland/Salem up to the John Day area. It would include the couple lines to Bonneville, the Bethel-Round Butte line (remember, this line will be prime upgrading to 500, so leave some working room), and the 230 lines from Santiam all the way back to McNary (they will also be important, as this right-of way will get us to McNary.

You can move Boardman south of Coyote a little more, it may be a key station, so we'll need some working room there too.

I was out Thursday and Friday, so this note is not real timely, sorry. Keep sending stuff,

Looks good folks ! ! !

Jim

- [ ] LOAD FLOWS
- [ ] GENERATE REPORTS
- [ ] COLORED PENS

>>> "Joseph H. Prudell" <prudell@engr.orst.edu> 07/29/2005 11:50 AM >>>
Hello,

Included in the attached files is the latest version of the oneline which includes the 500KV lines and a N. of John Day interface.
The PDF's are of the initial case, base case 1 with Beaver moved, and faults.

Regards,

Joseph H. Prudell
Oregon State University
Energy Systems and Power Electronics
School of Electrical Engineering and Computer Science

Date: Thu, 04 Aug 2005 15:24:29 -0700
From: Jim Eden <Jim.Eden@pgn.com>
To: prudell@engr.orst.edu
Cc: avj@eecs.oregonstate.edu, wallace@eecs.oregonstate.edu, zhouxi@engr.orst.edu
Subject: Re: Southern Crossing

2 HTML text/html 3.65 KB

The drawing looks real good. And now that you have mapped many of the 500 kV lines it is obvious that all the multi-section lines have dummy busses added. These dummies don't exist in the GE data, but PW adds these when it reads in multi-section lines. This is an option that a user selects when reading in an .epe file (I just confirmed this).

This has increased your mapping items because the dummy busses in PW are not modeled as busses in GE. When I saw this initially on the earlier one-lines I didn't know what was going on, as there were only a few. But now that you did the 500 lines, and there are so many, I had to figure out what was going on. . .

I'm not sure how I want to proceed. If you read in the .epc base case, and choose not to use dummy busses (except for lines that the sections are caps or xfmrs, then the dummies are always used), you will need to re-map the lines that had multi-sections. And will have to recreate any new interfaces, like SoA. This is confirmed by selecting this option and then opening the brand new one-line. I get a purple shading around all multi-section one-line items that no longer exist.

I would prefer to do this, but it means more work for you. In the long run, PW will have to adapt to the rest of the world, just a matter of time. I would rather have this for future use, without the dummy busses.

If you print the one-line showing which facilities are missing, you will know which lines are affected and how to redraw them. The good news is, you won't have to plot the dummy busses or the multiple lines. This will also help clean up the one-line quite a bit.

As for other suggestions, I would stretch the Marion bus to the right and separate the lines a little more, and separate the 230 lines from the 500 lines a little more. Also, may as well add the Round Butte - Redmond 230 line, Redmond would be to the right of Grizzly. You can eliminate the Celilo 1 and 2 busses, as you have only shown part of the PDCI (the two-pole 1100 MW part, not the 2000 MW part). We don't need the DC line anyway.

Other than that it looks real good! When the dummy busses go away, it will actually look a lot cleaner.
I'm real sorry I didn't figure this out sooner. You guys are working real hard and I appreciate you efforts!

You were sitting down when you read this, right?

Jim

>>> "Joseph H. Prudell" <prudell@engr.orst.edu> 08/04/2005 1:41 PM >>>
Hello Jim,

Attached is a newer one-line ready for comments and a sample print of the
souther crossing with wider margins. Please comment! on what we have so far.
I tired to follow the drawing you made yesterday.

take care
-Joe

Regards,

Joseph H. Prudell
Oregon State University
Energy Systems and Power Electronics
School of Electrical Engineering and Computer Science

http://engr.oregonstate.edu/~prudell

Date: Tue, 06 Sep 2005 13:47:51 -0700
From: Jim Eden <Jim.Eden@pgn.com>
To: avj@eecs.oregonstate.edu, wallace@eecs.oregonstate.edu
Cc: prudell@engr.orst.edu, zhouxi@engr.orst.edu
Subject: Next visit, Thursday?

2 HTML text/html 0.91 KB

I'm leaving shortly for a trip to Salt Lake City. This Thursday is open for a visit. Will that work?

I think I still need all six one-lines for Case 12 (6 degree).

I messed up printing Case 2 base one-line. I will bring the replacements.

You mis-labeled Case 4 base one-line, says "3 ohns", should be "5 ohms". It is just that one plot, and I indicated that we can just hand correct that page.

I will be looking over the write-up. Maybe you should send the electronic version.

Jim

ECE 499/599 WINTER TERM 2004

TERM PAPER PRESENTATIONS

PEER EVALUATIONS

Score up to 5 points for each question (0—poor; 5—excellent)

Date: 3/2/04 **Group #** 8
Title of Paper: HEV Safety Issues

	Score
1. CONTENT	
1.1 Did the presentation address the topic?	5
1.2 Was the topic addressed in sufficient depth?	4
1.3 Were the broader implications for electric and HE vehicles addressed?	5
1.4 Did you learn from this presentation?	4
2. TECHNIQUE	
2.1 Did the presenters communicate well? (clear; responsive to audience; eye contact)	3
2.2 Were the presenters well prepared? (good visuals; coherent theme)	5
2.3 Had the topic been sufficiently researched? (did the presenter convince you?)	5
2.4 Were questions answered well?	5

TOTAL: 36

Reviewer's signature:

[signature]

Patrick Gilman

Date: Wed, 07 Sep 2005 06:55:04 -0700
From: Jim Eden <Jim.Eden@pgn.com>
To: prudell@engr.orst.edu
Cc: avj@eecs.oregonstate.edu, wallace@eecs.oregonstate.edu, zhouxi@engr.orst.edu
Subject: Re: Southern Crossing

2 HTML text/html 5.22 KB

I should be looking at the report, but couldn't help inspecting the Southern Crossing plot. What happened to the Tumble Creek-Dalreed 230 line? We were only replacing the Bethel-Round Butte 230 with a new 500 line. I may have confused you earlier, the McNary-Santiam is double-circuit towers, but one side is idle. Our Round Butte line is single-circuit lattice towers.

I have a few mapping suggestions. Move (rotate) the cap bank at John Day to be opposite the Marion line position. Then you will have room to move the Maupin substation to the area just below John Day sub. Keep Maupin oriented like it is so that the line that goes through it is north-south.

The Tumble Creek line, after it crosses the 500 lines, will head northeast (and move it closer to the 500 lines, I know I said to separate it earlier, but it turns out that all of these lines are roughly in the same corridor) and cross the Maupin-Redmond line, then head east to cross the 500 lines.

Now you will have more room for the new 500 sub. Lets call it Olallie (since the lake is nearby), but make sure we don't already have a sub with that name!

40723

The Boardman generator may have to rotate downward, to allow a line to continue on to McNary. We will also look at a second Boardman unit, but will do this later.

43049

You still have some decimals on flows and volts in the Round Butte/Grizzly area.

I like these results. I studied this 10-15 years ago, just a conversion of Bethel-Round Butte 230 to 500, and I had trouble getting it to load. I had to use large amounts of compensation to get medium flows. It looks like without compensation, you are getting nearly 900 MW out of Boardman (wow), and nearly 300 MW to Bethel (wow again). This is real encouraging! Lets call this case 20 (don't want to get confused with our earlier work). We can comp the Bethel leg, say 50%, just to see what happens. This would not be case for now, let's play with it before we give the case a label.

Another option is to take the new line from Olallie to Slatt, this would be case 30 (the 20's will be for various options at Boardman, the 30's will be options at Slatt). For both of these, a new case, say 21 and 31, will add a new line from Boardman to McNary. 40789

The West of Slatt cut-plane will include any new 500 line, whether it starts from Slatt or Boardman. Do not include the 230 (Dalreed line) as it is already in the West of McNary cut-plane. Any new 500 line from McNary will be included in the West of McNary cut-plane.

We will also need a one-line for the Southern Crossing that originates from Case 1, our base case starting point.

We will also need to test each "good plan" with a growth test. Since this won't be built for several years, we will need to add 350 MW of load to PGE's Area (we will scale up the area load, 70 MW x 5 yrs = 350 MW). When we do this, we will add "L" on the case number, eg 20L, to indicate a higher load test. At the same time we will also add 350 MW (or more) of new generation in the Boardman area, like new wind or Boardman #2. We worry about that later.

I realize that we are running out of time, but we can still make good headway on the Southern Crossing. I was talking internally about maybe needing more help from OSU if the results were looking good. If we demonstrate that this looks feasible (defined as not needing phase-shifters to achieve high flows), we will want to do more studies, maybe later this year!

I like this! See you tomorrow.

Jim

>>> "Joseph H. Prudell" <prudell@engr.orst.edu> 09/06/2005 9:07:32 PM >>>
Hello Jim,

I wanted to get ahead on the Southern Crossing so I created a BASE CASE 1 which we can later input more accurate impedances and distances for the 500Kv lines.

ECE 499/599 WINTER TERM 2004

TERM PAPER PRESENTATIONS

PEER EVALUATIONS

Score up to 5 points for each question (0—poor; 5—excellent)

Date: 3/9/04 **Group #** 2
Title of Paper: State of the Art PMM in HEV

1. CONTENT	**Score**
1.1 Did the presentation address the topic?	5
1.2 Was the topic addressed in sufficient depth?	5
1.3 Were the broader implications for electric and HE vehicles addressed?	5
1.4 Did you learn from this presentation?	4

2. TECHNIQUE	
2.1 Did the presenters communicate well? (clear; responsive to audience; eye contact)	4
2.2 Were the presenters well prepared? (good visuals; coherent theme)	5
2.3 Had the topic been sufficiently researched? (did the presenter convince you?)	5
2.4 Were questions answered well?	5

TOTAL: 38

Reviewer's signature: Bobby G. Lee

Date: Tue, 13 Sep 2005 08:46:48 -0700
From: Jim Eden <Jim.Eden@pgn.com>
To: prudell@engr.orst.edu, zhouxi@engr.orst.edu
Cc: avj@eecs.oregonstate.edu, wallace@eecs.oregonstate.edu
Subject: New cases

2 HTML text/html 2.86 KB

I've looked over the cases, and have a few comments.

We need to maintain about 540 kV at 500 stations, and from Case 1, we are holding Boardman at 541 kV and looking at Case 21 and 31, the machine is nearly at maximum. Lets assume for 21 and 31, the addition of a 150 MVAr cap (550 kV base). Rest the volatge control at Boardman to 540 kV for all new cases.

Marion is at 542 kV in Case 1, this is okay, but in Case 21 and 31, it climbs to 546 kV. There should be reactors at Marion, and they should be coming on, can you look to see if they are on, and we may need to show this on the one-line.

Olallie may need a reactor, let's assume a 150 MVAr reactor (500 kV base). Bethel is a little high, but the Olallie reactor will help.

The Bethel 500/230 is not loading high enough, so let's look at termination options at Bethel. Let's set up a NEW case where we loop the Olallie-Bethel line into Santiam. The Bethel-Santiam 230 line is about 20 miles long and along the R/W somewhere, so let's loop the Olallie line into Santiam 500 with no additional line length. So, the Bethel-Santiam 500 is 20 miles and the Santiam-Olallie is 20 miles less. Let's change the Bethel 500/230 transformer for all cases to match the Allston 500/230 #2 bank (1300 MVA).

For outages, we should look at heavily loaded lines, I'm thinking:
WJD outage CS outage SB outage SS outage.
Wautoma-John Day 500, Coyote-Slatt 500, the Slatt-Buckley 500, and the Santiam 500/230. Trying to keep this to a small list.
Ash - Marion - Buckley - Marion. / Ash-SLATT Ash Marion

I have to run to the airport, but wanted to make sure you had stuff to work on. I may e-mail you from the airport meeting.

Jim

>>> "Joseph H. Prudell" <prudell@engr.orst.edu> 09/09/2005 1:58:49 PM >>>
Hello Jim,

I just sent you cases 21, 31 , 17 and 1 as requested.
Have a good weekend..
Remember I'll be out of town.. Wednesday 16th (Afternoon)..until Tuesday 20th (afternoon).
I'll be here sunday to work.. let me know...I plan working long days monday, tuesday..

take care
Joe

Regards,

Joseph H. Prudell
Oregon State University
Energy Systems and Power Electronics
School of Electrical Engineering and Computer Science

http://engr.oregonstate.edu/~prudell

CASE 15

In this case we installed new conductors in transmission lines which were known to overload heavily in the case of a major outage. These lines are Merwin-View Tap-Cherryppl, LwsClark-Astor Tap, Woodland-Ross, and Rivergate-Keeler.

The Merwin-View Tap lines (4.2 miles) and the View Tap-Cherryppl lines (6.69 miles) are currently 636 ACSR Rook, by using a 636 ACSS Rook the summer nominal emergency rating can by increased from 134.0 MVA to 292.6 MVA and the winter nominal emergency can be increased from 210.0 MVA to 323.3 MVA. The lines are currently owned by PacifiCorp-West.

The LwsClark-Astor Tap lines (0.7 miles) are currently 397.5 ACSR Ibis, by using 397.5 ACSS Ibis the summer emergency rating can be increased to from 100 MVA to 216.9 MVA. The line from Astor Tap to Seaside is 12.8 miles long and is less critically loaded, however installing new conductor on these lines is a consideration for future study. The lines are currently owned by PacifiCorp-West.

The Woodland-Ross lines (19.85 miles) are currently 795 ACSR Drake, by using 795 ACSS Drake the summer emergency rating can be increased from 426.3 MVA to 682 MVA. These lines are currently owned by Bonneville Power Administration.

The Rivergate-Keeler lines (8.47 miles) are currently limited by a 0.73 mile section of 1.01 miles of 556 ACSR Eagle. By installing new 1272 AAC Narcissus, the summer emergency rating for the Rivergate-Keeler lines can be increased from 346.6 MVA to 523.8 MVA.

Installing new conductors on these lines eliminates the three top overloads which occur during an N-1 Allston-Keeler 500KV Outage. (Refer to onelines and tables for CASE 15) The top overloads are now reduced to the limiting lines in the transmission area of Trojan-St. Mary's, Trojan-Harborton, and Harborton-Rivergate. Case 16 addresses this limitation.

CASE 16

In this case, we used case 15 with all the new conductors and then increased the capacity South of Allston by installing an entire new circuit from Trojan to St. Mary's. The new circuit Trojan-St. Mary's #2 has a summer nominal emergency rating 641.0 MVA and winter nominal emergency is 844.5 MVA.

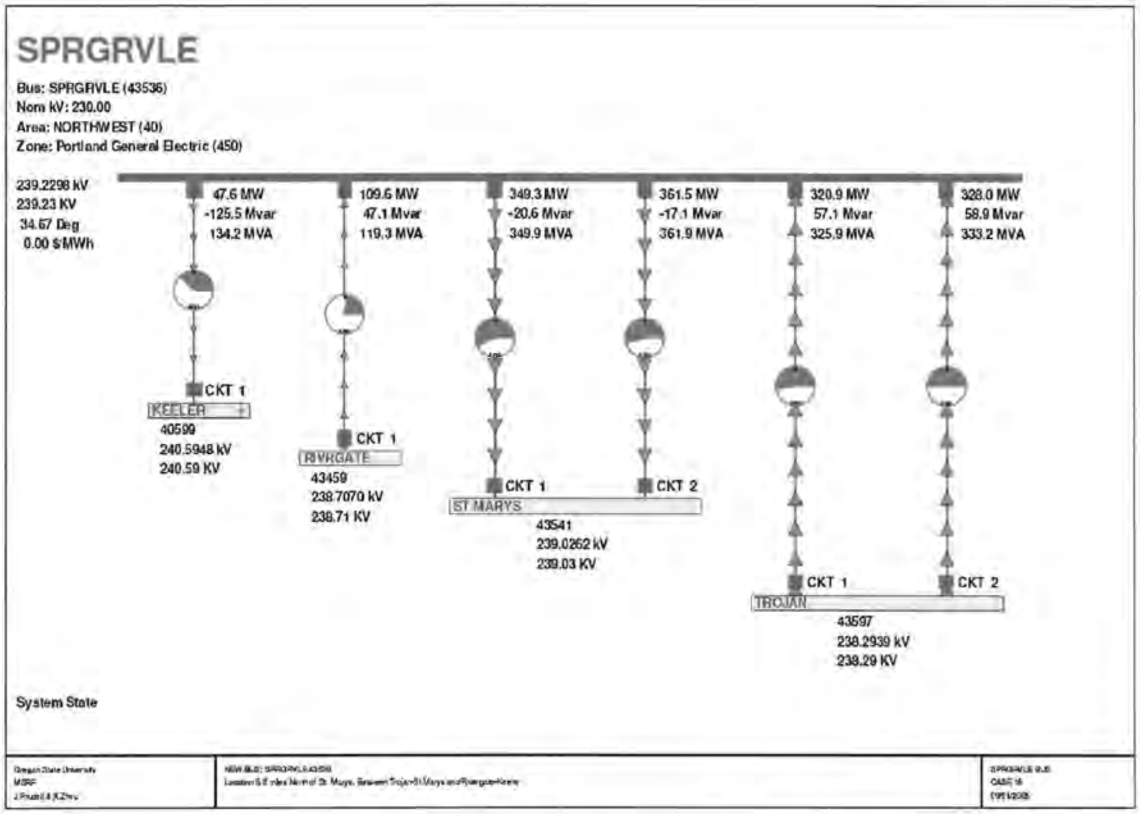
From the installation of this new Trojan-St. Mary's circuit, the flow South of Allston during an N-1 Allston-Keeler Outage is increased 165MW, from 2337MW to 2502MW. The flow during normal operation is increased 47MW, from 3180MW to 3227MW. The significant overloads above 100% the summer nominal emergency rating during an N-1 Allston-Keeler outage are limited to Astor-Tap-Seaside and Trojan-St. Mary's #1.

CASE 17

In this case the advantage of having Trojan-St. Mary's was realized while only installing new conductors on two of the most critical lines. Therefore we installed new conductors only on the Merwin-View Tap-Cherryppl and LwsClark-Astor Tap lines as described in case 15, and installed the new Trojan-St. Mary's circuit. This case provides more South of Allston capacity while only fixing more critical lines. (Refer to onelines and tables for cases 16 and 17)

CASE 18

In this case, we took case 17 and created a new substation at Springerville which is located between Trojan and St. Mary's and Rivergate and Keeler. The substation is a 230KV bus as shown below:



By calculating the geographical position of the substation and using know distances and line parameters, we modeled the 230Kv transmission lines using the existing Rivergate-Keeler and Trojan-St. Mary's #1 & #2.

For the model simulation we changed the Keeler-St. Mary's and Trojan-Mary's outage (KTS Outage) to a Keeler-Sprgrvle and Sprgrvle-St. Mary's 230Kv Outage (KSS Outage) The N-1 Allston-Keeler 500Kv Outage creates a 152% overload on the Keeler-Sprgrvle lines followed by Astor Tap-Seaside at 111%. However a N-1 Keeler Pearl 500KV Outage shifts the overload to St. Mary's-Murray H. at 118% followed by a Forest Grove-Keeler at 104%. Further detailed results are shown in the case 18 onelines and tables. The limiting factor to be addressed in the case of creating a new substation at this location would be the 3.4 miles of 1272 ACSR Pheasant between Keeler and Springerville.

System Swing

PGE	off AGC

SOA - 3177	- 140 MW
BC - 2757	- -
C01 3772	
3100	

MATRIX

TARGET	TOTAL scheduled	- 300	-300	
BC - 300 = 2457	3375	3075	2538	
NW - =				
C01 + 300 (North CA)				
DC + 300 (L.A)				

	Bus	GEN.
(40) PGE - PTSB 7	30,000	~~95~~ 508 MW
(24) SO-CAL_ALAMT4.4	24004	253. MW
(50) BC_ GMS_G5	50499	7388 - 267
NW _COULEE22	40276	258. - 130

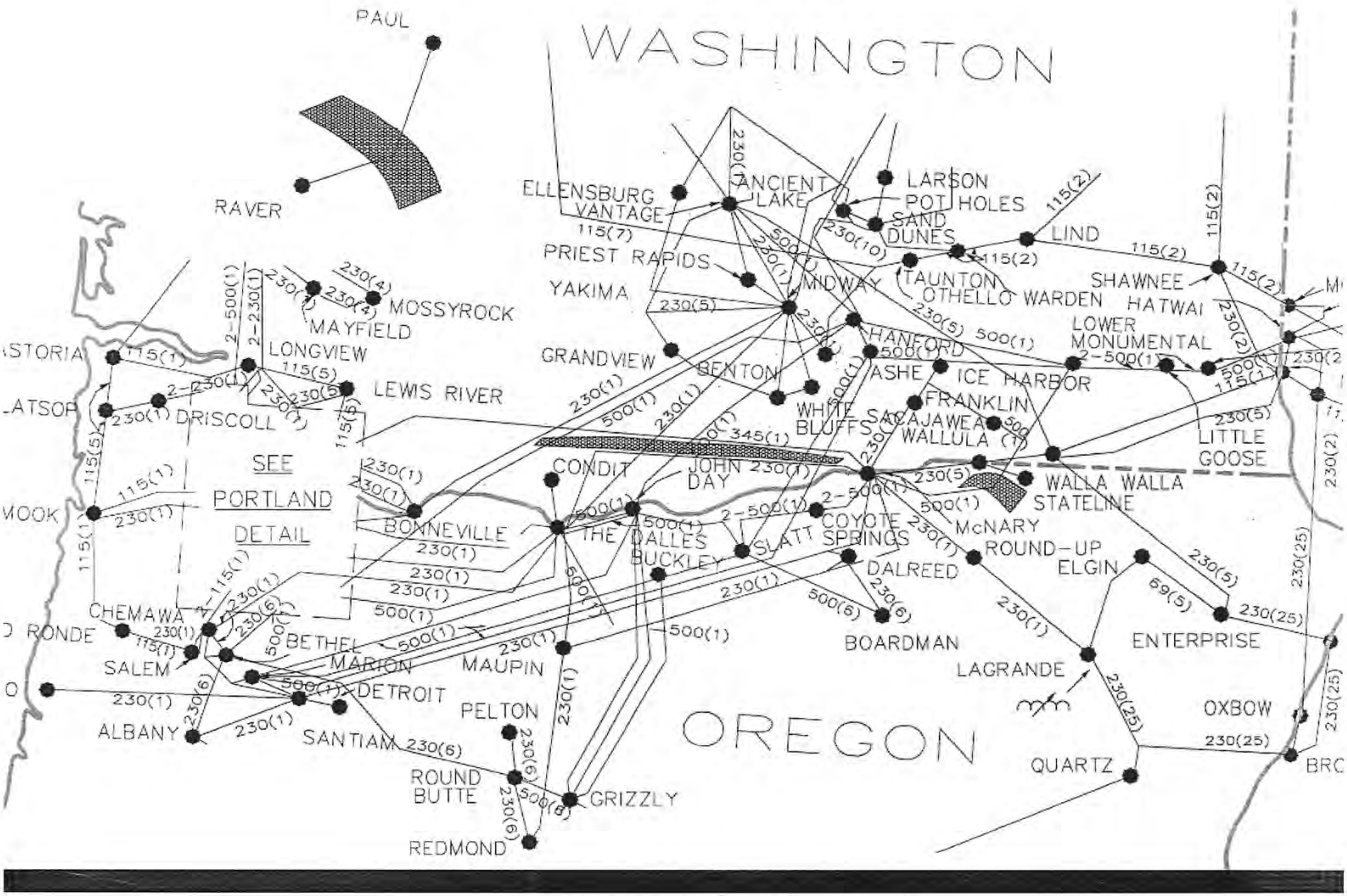
Area → show dialog.

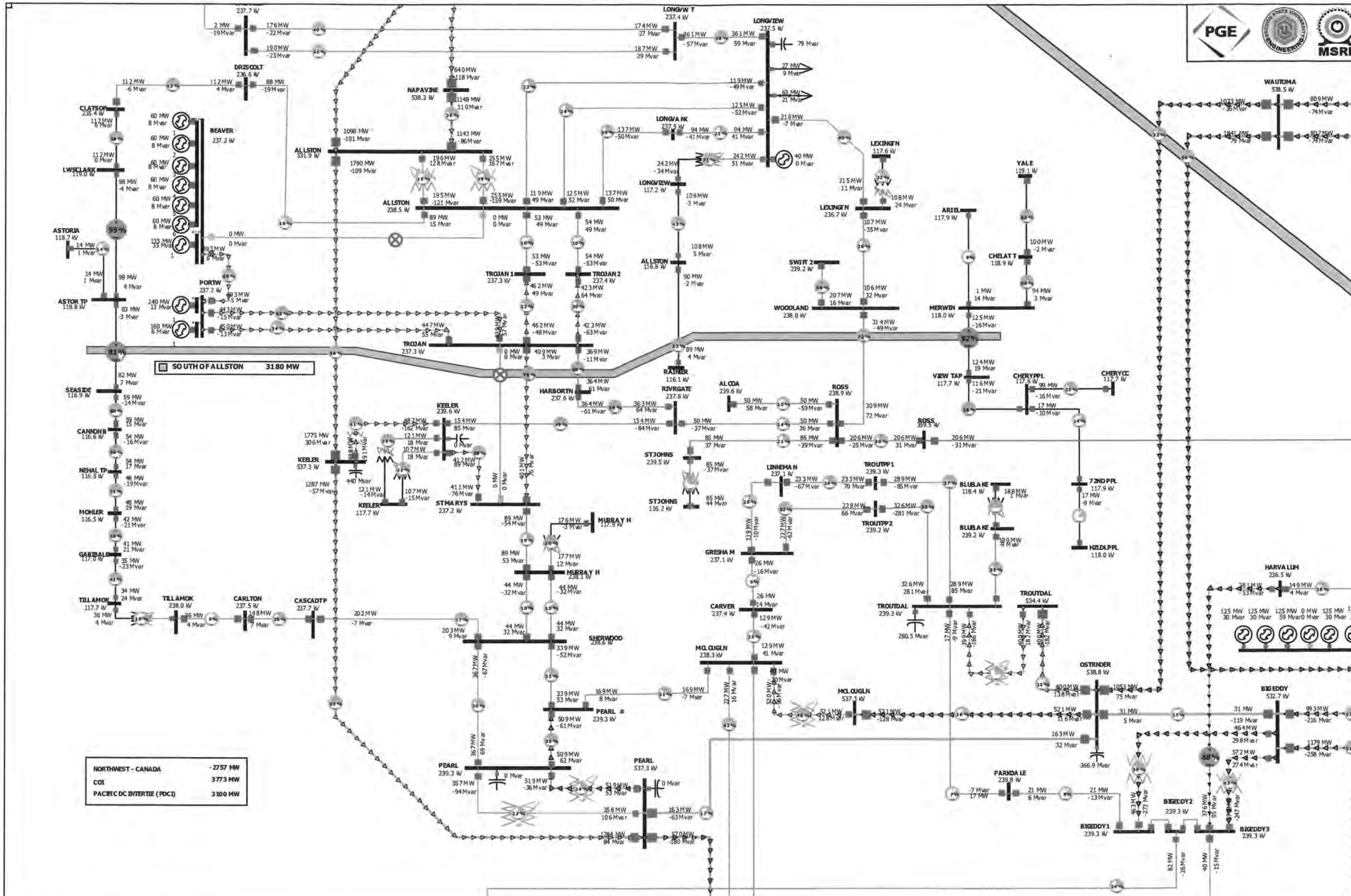
① Do AREA MATRIX Adjustment _ (MW_transactions)

② DC_Lines ⇒ DC - converters ⇒ setpoint ⇒

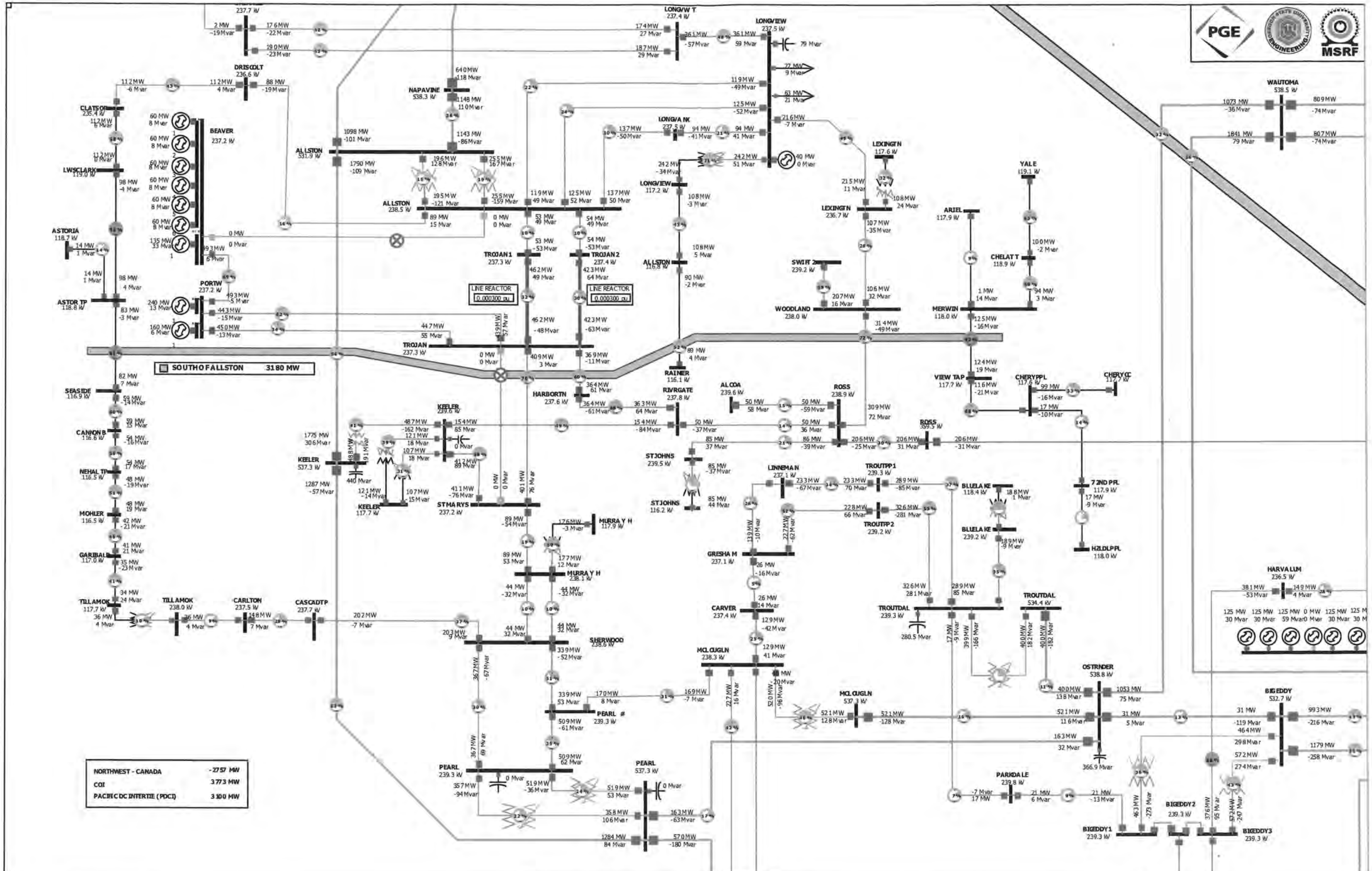
	Setpoints
Celilo 1	1100 → 1000
Celilo 3	1984 → 1784

BASE	5 — 25

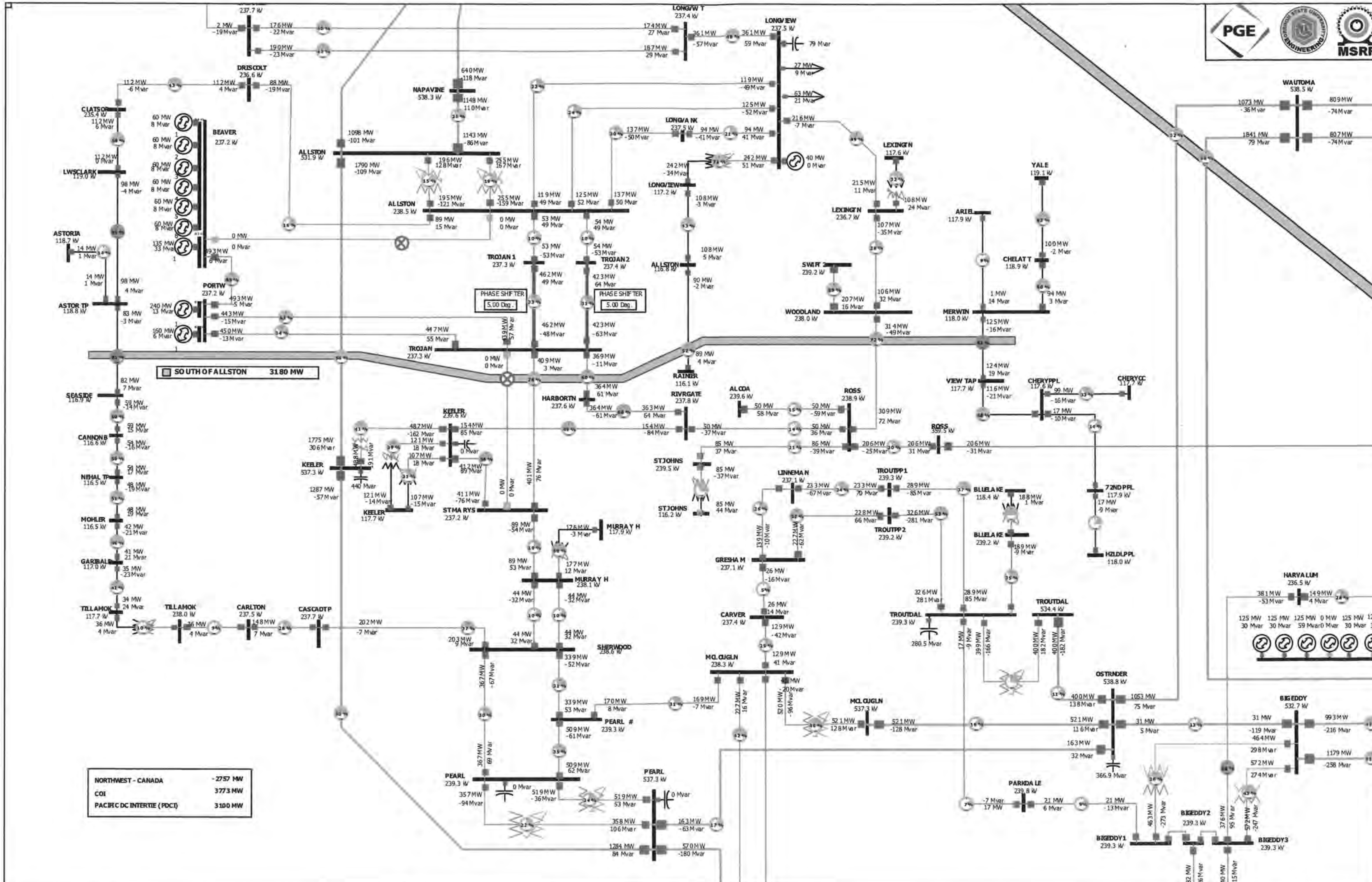

WASHINGTON
OREGON
PAUL
RAVER
ELLENSBURG
VANTAGE
ANCIENT LAKE
LARSON
POT HOLES
SAND DUNES
LIND
PRIEST RAPIDS
YAKIMA
MIDWAY
TAUNTON
OTHELLO
WARDEN
SHAWNEE
HATWAI
MOSSYROCK
MAYFIELD
LONGVIEW
LEWIS RIVER
DRISCOLL
GRANDVIEW
BENTON
HANFORD
ASHE
ICE HARBOR
LOWER MONUMENTAL
FRANKLIN
WHITE BLUFFS
SACAJAWEA
WALLULA
LITTLE GOOSE
SEE PORTLAND DETAIL
CONDIT
JOHN DAY
WALLA WALLA
STATELINE
BONNEVILLE
THE DALLES
BUCKLEY
SLATT
COYOTE SPRINGS
McNARY
DALREED
ROUND-UP
ELGIN
ENTERPRISE
BOARDMAN
LAGRANDE
CHEMAWA
SALEM
BETHEL
MARION
DETROIT
MAUPIN
ALBANY
SANTIAM
PELTON
ROUND BUTTE
GRIZZLY
REDMOND
QUARTZ
OXBOW



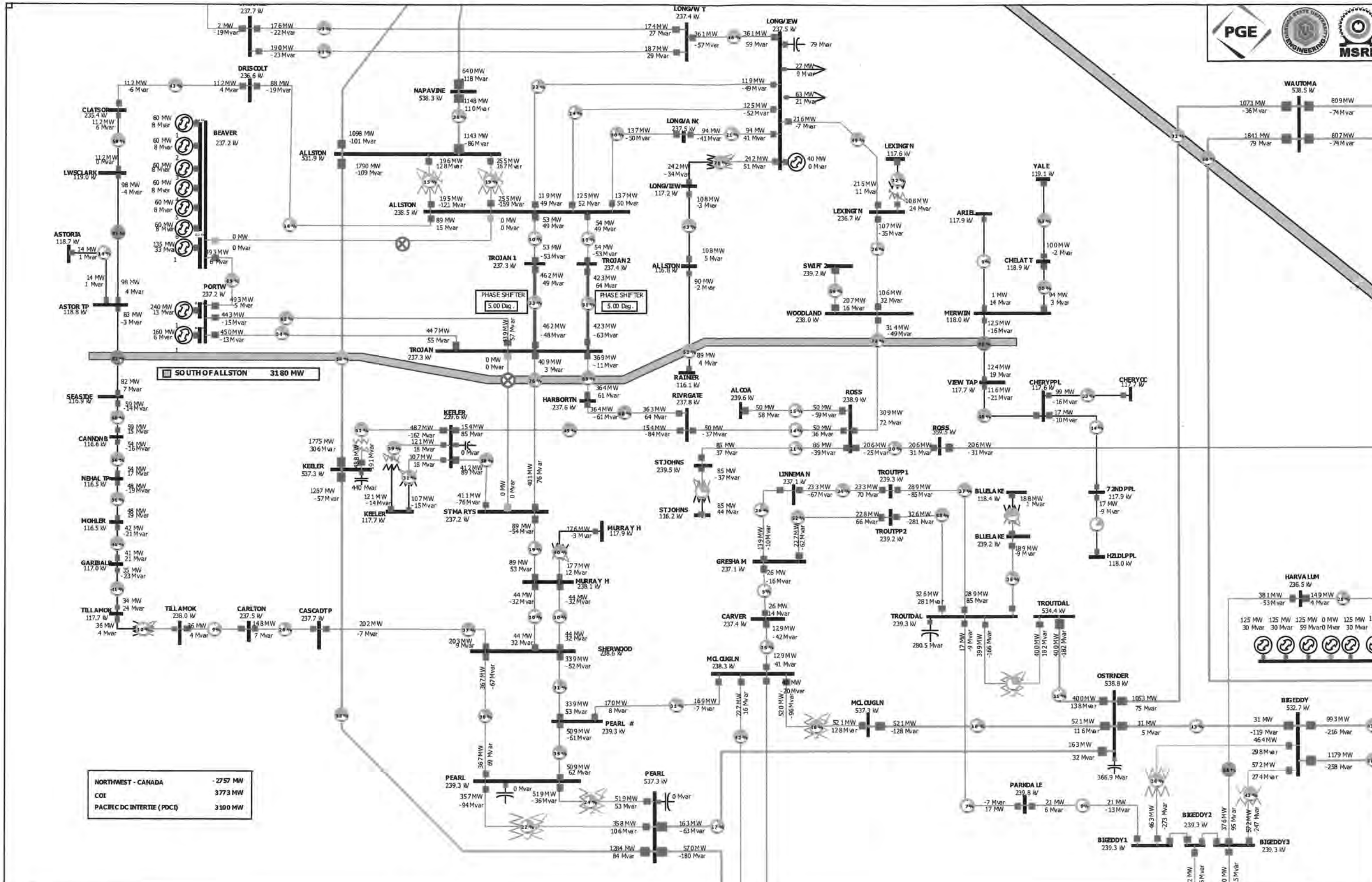
OREGON STATE UNIVERSITY ELECTRICAL ENGINEERING MOTOR SYSTEMS RESOURCE FACILITY	BEAVER SWITHCED OVER TO PORT W.	CASE 1 1 8/8/2005



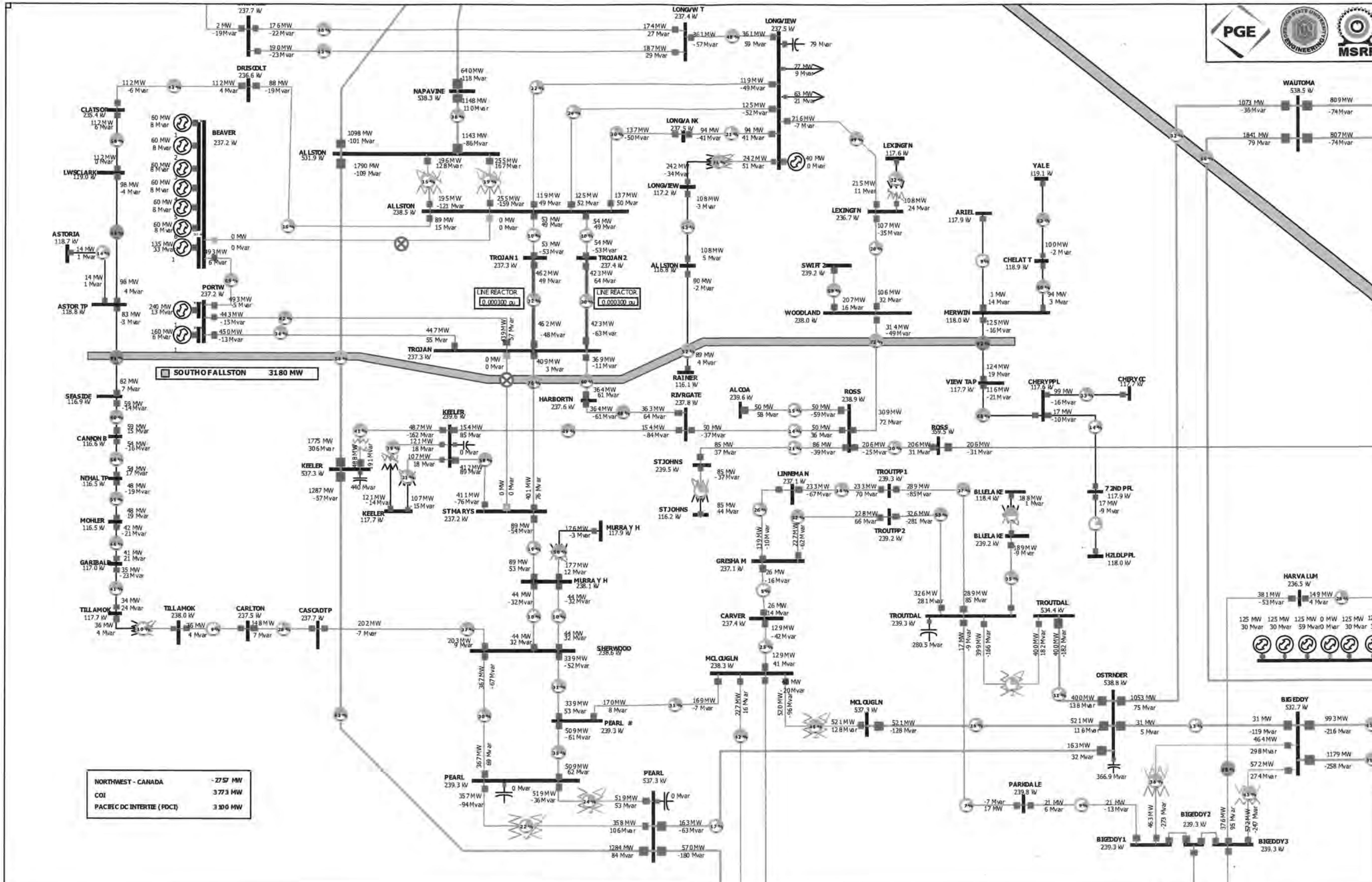
OREGON STATE UNIVERSITY ELECTRICAL ENGINEERING MOTOR SYSTEMS RESOURCE FACILITY	BEAVER SWITCHED OVER TO PORT W. LINE REACTOR VALUES SHOWN AND ENTERED	CASE 2 EXAMPLE 2 8/8/2005



OREGON STATE UNIVERSITY ELECTRICAL ENGINEERING MOTOR SYSTEMS RESOURCE FACILITY	BEAVER SWITCHED OVER TO PORT W. PHASE SHIFTING TRANSFORMERS ENTERED AND PHASE ANGLE DISPLAYED IN DEGREES	CASE 3 3 8/8/2005



OREGON STATE UNIVERSITY ELECTRICAL ENGINEERING MOTOR SYSTEMS RESOURCE FACILITY	BEAVER SWITCHED OVER TO PORT W. PHASE SHIFTING TRANSFORMERS ENTERED AND PHASE ANGLE DISPLAYED IN DEGREES	CASE 3 3 8/8/2005



OREGON STATE UNIVERSITY
ELECTRICAL ENGINEERING
MOTOR SYSTEMS RESOURCE FACILITY

BEAVER SWITCHED OVER TO PORT W.
LINE REACTOR VALUES SHOWN AND ENTERED

CASE 2 EXAMPLE
2
8/8/2005