Interconnection Feasibility Study Report
Request # GI-2016-10

8.4 MW Waste Heat Recovery Generation Facility
Vasquez Substation
Weld County, Colorado

Public Service Company of Colorado
Transmission Planning
September 29, 2016

Contents

Executive Summary

On August 26th, 2016, Public Service Company of Colorado (PSCo) Transmission received a small generator interconnection request (GI-2016-10) to determine the feasibility of interconnecting a new 8.4 MW waste heat recovery generation facility, located approximately 3.5 miles north and east of the existing PSCo owned Vasquez Substation in Weld County, Colorado. The Customer requested a primary Point of Interconnection (POI) at the Vasquez Substation. A requested alternative POI involves tapping the 115 kV line between the Vasquez and Gilcrest Substations. The generation facility will connect to the POI via a Customer owned 115 kV line. Generation from the new facility will be supplied to PSCo native load Customers. The Customer has proposed a commercial operation date of September 1, 2018, with an assumed back-feed (for site energization) date of March 1, 2018.

This small generator interconnection request was studied as a stand-alone project only. All generation interconnection requests at a higher position in PSCo's "Generation Interconnection Requests" Queue on the PSCO Home OASIS, other than those generator interconnection projects that are already planned to be in service by September, 2018, were not modeled.

The main purpose of this Feasibility Study was to evaluate the potential impact of this proposed project on the reliability of the PSCo transmission infrastructure as well as that of neighboring utilities, when injecting the new 8.4 MW of generation at the Customer requested POI, and delivering the additional generation to PSCo native loads and determine whether or not the interconnection is feasible.

This study included a steady-state power flow and short-circuit analysis. Benchmarking was accomplished using a 2024 Heavy Summer (HS) Colorado Coordinated Planning Group (CCPG) case based on the 2024 HS WestConnect case. The study compared the impacts when adding GI-2016-10 to the benchmark case at the Customer requested POI. The generation sink was set to Comanche Unit 2 (area swing). Single (N-1) and select multiple contingency outages were applied.

As a result of the addition of the generation facility GI-2016-10 at both the primary POI and the alternate POI, no transmission elements were overloaded, and no voltage issues were observed other than those that were already present in the benchmark case. Additionally, results of the short circuit analysis showed no over-duty on circuit breakers due to the addition of the new generation facility.

This study indicates interconnection to the PSCo network is feasible.

Estimates were only developed for the primary POI. The total estimated cost of the recommended system upgrades to interconnect GI-2016-10 to the transmission system at the primary POI is approximately **$ 6,730,000** and includes:

- $ 840,000 for PSCo Owned, Customer Funded Interconnection Facilities
- $ 5,890,000 for PSCo Owned, PSCo Funded Network Upgrades for Interconnection
- $ 0 for Non PSCo Network Upgrades for Delivery

A preliminary one-line of the new GI-2016-10 primary POI at the Vasquez Substation detailing the Interconnection and Delivery is shown below in Figure 1.

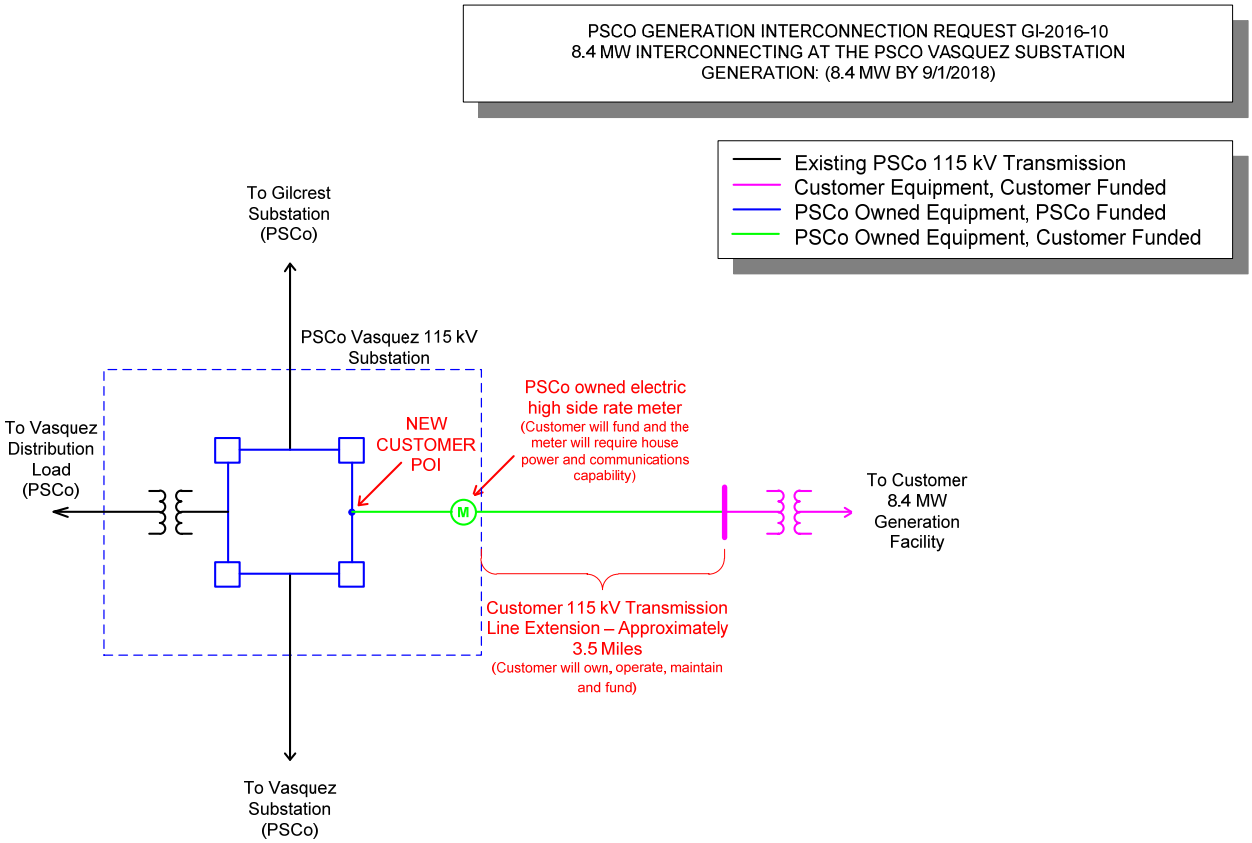

Figure 1: Preliminary One-Line of the Primary POI

I. Introduction

Public Service Company of Colorado (PSCo) Transmission received a small generator interconnection request on August 26th, 2016, to determine the feasibility of interconnecting a new 8.4 MW waste heat recovery generation facility which is planned to be located approximately 3.5 miles north and east of the existing PSCo owned Vasquez Substation in Weld County, Colorado. Because this generation facility is less than 20 MW, it is classified as a small generator interconnection.

The Customer's project facility is assumed to consist of a single 8.4 MW (9.125 MVA) waste heat recovery generator and is located near the intersection of County Road 38 and County Road 35 in Weld County, Colorado. The generator is assumed to operate between a +/- 0.90 power factor (+4/-4 MVAr). The Customer requested a primary Point of Interconnection (POI) at the Vasquez Substation. A requested alternative POI involves tapping the 115 kV line between the Vasquez and Gilcrest substations. The generation facility will connect to the POI from the Customer's facility via an approximately 3.5 mile, Customer owned, 115 kV line. It is assumed the new 115 kV transmission line will be constructed utilizing a standard, single-circuit, wooden H-frame design, with 336 kcmil ACSR "Linnet" conductor. Generation from the facility will be supplied to PSCo native load Customers. The Customer has proposed a commercial operation date of September 1, 2018, with an assumed back-feed (for site energization) date of March 1, 2018.

This small generator interconnection request was studied as a stand-alone project only. All generation interconnection requests at a higher position in PSCo's "Generation Interconnection Request" Queue, other than those Generator Interconnection projects that are already planned to be in service by September, 2018, were not modeled.

II. Study Scope and Analysis

The main purpose of this Feasibility Study is to evaluate the potential impact on the PSCo transmission infrastructure as well as that of neighboring utilities, when injecting the new 8.4 MW of generation at the Customer requested POI, and delivering the additional generation to PSCo native loads. Results of the study analysis will determine whether or not the interconnection of GI-2016-10 to the transmission system is feasible, and if deemed feasible, the good faith estimate of the costs necessary for interconnection.

PSCo conducted a Feasibility Study analysis for the interconnection of the 8.4 MW waste heat generation facility. Both a steady-state power flow and short-circuit analysis were performed. The power flow analysis provided a preliminary identification of thermal and/or voltage limit violations resulting from the interconnection, while the short-circuit analysis identified any circuit breaker and other system protection element capability limitations.

PSCo adheres to NERC / WECC Reliability Criteria, as well as internal Company criteria for planning studies. During system intact conditions, transmission system bus voltages are to be maintained between 0.95 and 1.05 per-unit of system nominal / normal conditions, and steady state power flows within 1.0 per-unit (100%) of all elements thermal (continuous current or

MVA) ratings. Operationally, PSCo tries to maintain a transmission system voltage profile ranging from 1.02 per-unit or higher at generation buses, to 1.0 per-unit or higher at transmission load buses. Following contingency element outages, transmission system steady state bus voltages must remain within 0.90 per-unit to 1.10 per-unit, and power flows within 1.0 per-unit (100%) of the element's continuous thermal ratings.

For this project no potential affected parties have been identified.

III. Power Flow Study Models

A 2024 Heavy Summer (HS) Colorado Coordinated Planning Group (CCPG) case that was based on a 2024 HS WestConnect case was used to simulate the benchmark case. This benchmark case scenario was used to analyze the impacts when adding GI-2016-10 to the transmission system at the existing Vasquez Substation.

The generation facility was connected to the POI from the Customer's facility via an approximately 3.5 mile, Customer owned, 115 kV line. It is assumed the new 115 kV transmission line will be constructed utilizing a standard, single-circuit, wooden H-frame design, with 336 kcmil ASCR "Linnet" conductor. Generation from the facility was supplied to PSCo native load Customers. The generation sink was set to Comanche Unit 2 (area swing).

The proposed generation project was modeled as a single, lumped, generation unit representing the 8.4 MW waste heat recovery generator. The generator was assumed to have a maximum output of 9.125 MW (9.125 MVA) with a reactive capability between -4.0 and 4.0 MVAr, assuming a 0.90 power factor. The generator was modeled with a terminal voltage of 115 kV and was connected directly to the 115 kV transmission system. No step-up transformation was used in the power flow model. For modeling purposes, the generator was set to control the interconnecting bus voltage on the 115 kV system to 1.00 per-unit.

A one-line diagram of the primary POI is shown below in Figure 2.

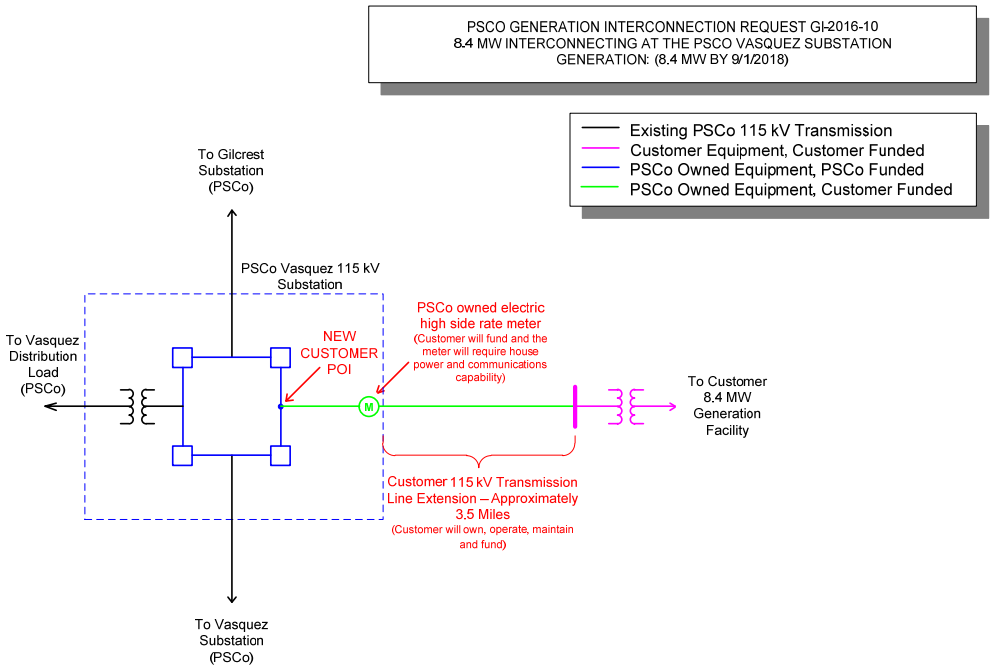

Figure 2: Preliminary One-Line Diagram of the Primary POI

Figure 3 shows the one-line diagram of the alternate POI.

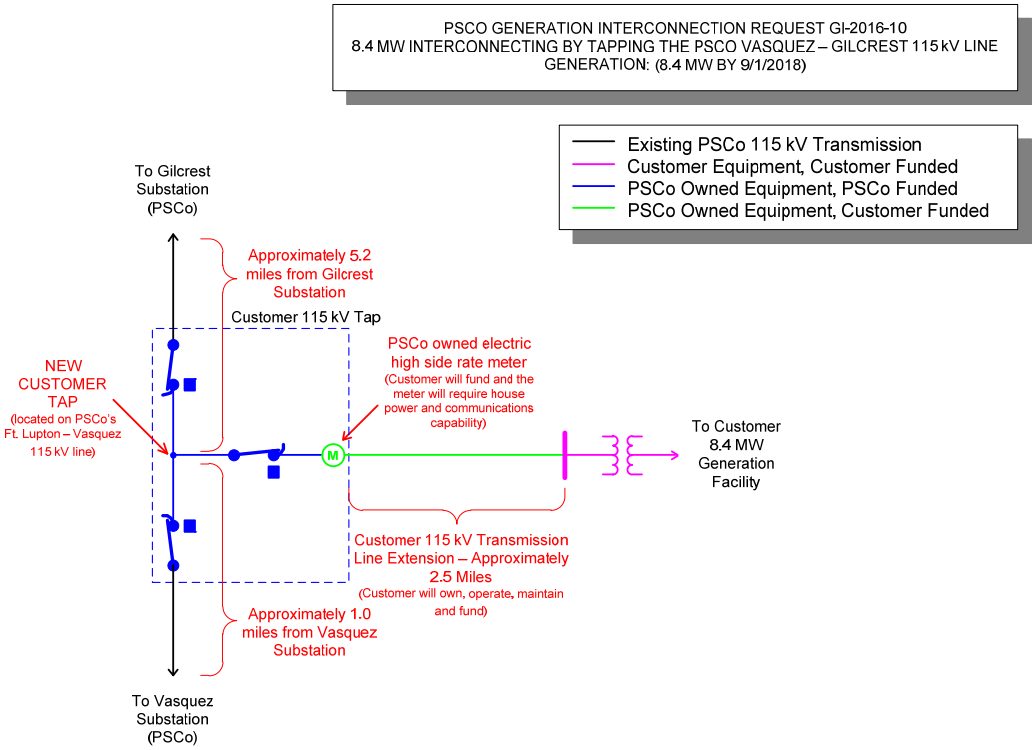

Figure 3: Preliminary One-Line Diagram of the Alternate POI

Automated single contingency power flow studies were completed on the benchmark and GI-2016-10 addition case models, switching out single elements (lines, transformers and generation units) one at a time in the study area. In addition, some select multiple contingency outages were simulated for this area of the system. The study results from the contingency analyses were compared to identify thermal or voltage limit violations resulting from the addition of GI-2016-10.

IV. Stand Alone Study Results (PSCo)

Power Flow Analysis

As a result of the addition of the generation facility GI-2016-10 at both the primary and alternate POI, no transmission elements were overloaded, and no voltage issues were observed other than those that were already present in the benchmark case. Therefore, this study indicates that the interconnection of GI-2016-10 to the PSCo transmission network is feasible.

Appendix A shows a complete comparison table of the system intact (N-0), single contingency (N-1) and select multiple contingency overloads.

Similarly, Appendix B shows a complete comparison table of the bus voltage violations.

Short Circuit Analysis Results

A short circuit analysis was performed by simulating both a single line to ground and bolted three phase fault. The short circuit analysis assumed a 3.5 mile 115 kV line from the Vasquez Substation to the Customer's facility, a 10 MVA step-down transformer at the Customer's facility with a wye-connected high-side, delta-connected low-side, and impedance of 10%, with an X/R ratio of 20.

Results of the short circuit analysis showed no over-duty on circuit breakers due to the addition of the new generation facility. Table 1 below shows the estimated fault currents at the Vasquez Substation due to the addition of GI-2016-10.

Table 1: Results of Short Circuit Analysis

	Benchmark Case	Case with GI-2016-10
Three Phase Current	5796A	5886A
Single Line to Ground Current	4182A	4267A
Positive Sequence Impedance	2.17+j11.25 ohms	2.12+j11.08 ohms
Negative Sequence Impedance	2.18+j11.25 ohms	2.13+j11.08 ohms
Zero Sequence Impedance	5.26+j24.15 ohms	5.19+j23.56 ohms

V. Costs Estimates and Assumptions

Indicative level cost estimates (with no implied accuracy) were developed only for the primary POI. These estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery were developed by Public Service Company of Colorado (PSCo) / Xcel Energy (Xcel) Engineering. The cost estimates are in 2016 dollars with escalation and contingency factors included. AFUDC is not included in the estimates. Estimates are developed assuming typical construction costs for previously completed projects. These estimates include all applicable labor and overheads associated with the siting support, engineering, design, material/equipment procurement, construction, testing and commissioning of these new substation and transmission line facilities. This estimate does not include the cost for any other Customer owned equipment and associated design and engineering.

The estimated total cost for the required upgrades for GI-2016-10 is **$6,730,000**. Figure 2, located on page 7, represents a conceptual one-line of the proposed interconnection into the 115 kV bus at the Vasquez 115 kV Transmission Substation. These estimates do not include costs for any other Customer owned equipment and associated design and engineering. The following tables list the improvements required to accommodate the interconnection and the delivery of the Project generation output. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon a more detailed and refined design.

Table 2: PSCo Owned; Customer Funded, Transmission Provider Interconnection Facilities

Element	Description	Cost Est. (Millions)
Vasquez 115kV Transmission Substation	Interconnect Customer to tap at the Vasquez 115 kV Transmission Substation (into the 115 kV bus). The new equipment includes: • Two 115 kV disconnect switches • Three 115 kV arresters • One set 115 kV CT/PT metering units • Station controls • Instrument transformers • Associated bus, wiring and equipment • Associated site development, grounding, foundations and structures • Associated transmission line communications, relaying and testing	**$0.470**
	Transmission line relocation and tap into substation. Three spans, structures, conductor, insulators, hardware and labor.	**$0.200**
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction.	**$0.020**
	Total Cost Estimate for PSCo Owned, Customer Funded Interconnection Facilities	**$0.690**

Time Frame	**Site, design, procure and construct**	**18 Months**

Table 3: PSCo Owned; Customer Funded, Transmission Provider Interconnection Facilities

Element	Description	Cost Est. (Millions)
Customer's 115kV Transmission Substation	Interconnect Customer to tap at the Vasquez 115 kV Transmission Substation (into the 115 kV bus). The new equipment includes: • Load Frequency/Automated Generation Control (LF/AGC) RTU	**$0.150**
	Total Cost Estimate for PSCo Owned, Customer Funded Interconnection Facilities	**$0.150**
Time Frame	**Design, procure and construct**	**18 Months**

Table 4: PSCo Owned; PSCo Funded, Interconnection Network Facilities

Element	Description	Cost Estimate (Millions)
Vasquez 115kV Transmission and Distribution Substation	Interconnect Customer to tap at Vasquez 115 kV Transmission and Distribution Substation (into the 115 kV bus). The new equipment includes: • Four 115 kV circuit breakers • Ten 115 kV disconnect switches • 115 kV arresters • Station battery system upgrades • Station controls • Associated communications, supervisory and SCADA equipment • Associated line relaying and testing • Associated bus, miscellaneous electrical equipment, cabling and wiring • Associated foundations and structures • Associated road and site development, fencing and grounding	**$5.840**
	Siting and Land Rights support for substation land acquisition and construction. 5 acres @ $8,000/acre.	**$0.050**
	Total Cost Estimate for PSCo Owned, PSCo Funded Interconnection Facilities	**$5.890**
Time Frame	**Site, design, procure and construct**	**18 Months**

Table 5: PSCo Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
	N/A	**$0.000**
	Total Cost Estimate for PSCo Network Upgrades for Delivery Facilities	**$0.000**
Time Frame	**Design, procure and construct**	**N/A**

Assumptions for Alternatives

- Indicative level project estimates for Interconnection Facilities and Infrastructure Upgrades for Delivery, PSCo Funded Network Upgrades for Delivery (no level of accuracy) were developed by PSCo Engineering

- Estimates are based on 2016 and similar type projects
- AFUDC has been excluded
- Labor is estimated for straight time only – no overtime included
- Lead times for materials were considered for the schedule
- The Generation Facility is in PSCo's retail service territory. Therefore, costs for retail load (distribution) facilities and metering required for station service are included in these estimates
- Assuming an additional 5 acres of substation land needs to be acquired for the expansion (@$8,000/acre)
- Assuming a 4-breaker ring installation with required relaying, interconnection and communications facilities
- PSCo (or our Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities
- A CPCN will not be required for the Interconnection Facilities and Infrastructure Upgrades for Delivery and network delivery facilities construction
- The Customer will be required to design, procure, install, own, operate and maintain a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer Substation. PSCo / Xcel will need indications, readings and data from the LFAGC RTU
- Customer will string OPGW fiber into substation as part of the transmission line construction scope
- Breaker duty study determined that no breaker replacements are needed in neighboring substations

Appendix A: Thermal Overloads

System Intact (N-0) Overloads

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.                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     WED, AUG 24 2016  12:27            PAGE 23 .
.                                                                                                                 .
.                           AC CONTINGENCY REPORT FOR  2 AC CONTINGENCY CALCULATION RUNS                           .
.                                                                                                                 .
.                  BASE CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - ALL VIOLATIONS               .
.               % LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES             .
.................................................................................................................
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X--- MONITORED ELEMENT ----X	Benchmark ACCC.ac	Mewborne ACCC.ac
70290 MONFORT 115.00	105.4%	105.4%
70844 MONFORT 46.000 T1	63MVA	63MVA

Contingency Overloads

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.                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     WED, AUG 24 2016  12:27            PAGE 24 .
.                                                                                                                 .
.                           AC CONTINGENCY REPORT FOR  2 AC CONTINGENCY CALCULATION RUNS                           .
.                                                                                                                 .
.           CONTINGENCY CASE MONITORED BRANCHES LOADED ABOVE 100.0% OF RATING SET A - WORST CASE VIOLATIONS        .
.               % LOADING VALUES ARE % MVA FOR TRANSFORMERS AND % CURRENT FOR NON-TRANSFORMER BRANCHES             .
.               THRESHOLD FOR THE COUNT OF CONTINGENCIES CAUSING OVERLOADING IS 100.0% OF RATING SET A             .
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X--- MONITORED ELEMENT ----X	X-----LABEL----X	Benchmark ACCC.ac	Mewborne ACCC.ac
70023 ALLISON 115.00	SINGL1 70045-702	102.6%	102.6%
70400 SODALAKE 115.00 1	42(1)	159MVA (1x)	159MVA (1x)
70037 ARAP_B 115.00	SINGL1 70463-704	142.8%	142.8%
70165 ENGLE3TP 115.00 1	83(1)	169MVA (2x)	169MVA (2x)
70045 BANCROFT 115.00	SINGL1 70023-704	103.0%	103.0%
70242 KENDRICK 115.00 1	00(1)	159MVA (1x)	159MVA (1x)
70065 BROOMFLD 115.00	SINGL1 70110-701	114.7%	114.7%
70382 SEMPER 115.00 1	75(1)	135MVA (1x)	135MVA (1x)
70073 CALIFOR 115.00	SINGL1 70108-702	106.9%	107.0%
70108 CHEROKEE_S 115.00 1	76(1)	150MVA (2x)	150MVA (2x)
70127 COORSREC 115.00	SINGL1 70244-704	129.0%	129.1%
70191 FTLUPTON 115.00 1	44(1)	155MVA (1x)	155MVA (1x)
70162 EAST 115.00	SINGL1 70537-705	120.0%	120.1%
70538 CHMBERS 115.00 1	38(1)	148MVA (1x)	148MVA (1x)
70290 MONFORT 115.00	P4_BREAKER_FAILU	107.4%	107.4%
70805 LEPRINO_PS 115.00 1	RE_003	188MVA (1x)	188MVA (1x)
70290 MONFORT 115.00	P4_BREAKER_FAILU	107.8%	107.8%
70844 MONFORT 46.000 T1	RE_001	65MVA (752x)	65MVA (753x)
70310 PAWNEE 22.000	SINGL1 70310-703	131.5%	131.5%
70311 PAWNEE 230.00 U1	11(U2)	478MVA (1x)	479MVA (1x)
70310 PAWNEE 22.000	SINGL1 70310-703	131.4%	131.4%
70311 PAWNEE 230.00 U2	11(U1)	478MVA (1x)	478MVA (1x)
70368 ROSEDALE 115.00	P4_BREAKER_FAILU	115.9%	115.9%
70439 UNC 115.00 1	RE_003	203MVA (1x)	203MVA (1x)

70368 ROSEDALE	115.00	P4_BREAKER_FAILU	130.2%	130.3%
73055 KERSEY_W	115.00 1	RE_001	140MVA	140MVA
			(1x)	(1x)
70397 B.CRK_PS	115.00	SINGL1 70397-730	100.4%	100.4%
70399 B.CRK_PS	230.00 T1	20(1)	222MVA	222MVA
			(1x)	(1x)
70439 UNC	115.00	P4_BREAKER_FAILU	115.8%	115.8%
70805 LEPRINO_PS	115.00 1	RE_003	203MVA	203MVA
			(1x)	(1x)
70463 WATERTON	115.00	SINGL1 70037-701	120.5%	120.5%
70483 MARTN1TP	115.00 1	65(1)	168MVA	168MVA
			(1x)	(1x)
70470 WELD_PS	115.00	BUS_FAULT_001	108.1%	108.1%
70471 WELD_PS	230.00 T2		303MVA	303MVA
			(1x)	(1x)
72107 SLATERTS	115.00	SINGL1 73502-735	110.8%	110.8%
73049 DELCAMIN	115.00 1	03(1)	141MVA	141MVA
			(1x)	(1x)
72142 REDBOX	115.00	SINGL1 72142-721	125.4%	125.4%
72143 REDBOX	69.000 1	43(2)	63MVA	63MVA
			(1x)	(1x)
72142 REDBOX	115.00	SINGL1 72142-721	125.4%	125.4%
72143 REDBOX	69.000 2	43(1)	63MVA	63MVA
			(1x)	(1x)
73002 AIRPORT	115.00	P4_BREAKER_FAILU	203.5%	203.5%
73026 BOYD	115.00 1	RE_001	316MVA	316MVA
			(1x)	(1x)
73002 AIRPORT	115.00	P4_BREAKER_FAILU	165.9%	165.8%
73433 WINDSORT	115.00 1	RE_001	253MVA	253MVA
			(1x)	(1x)
73095 KERSEYTP	115.00	P4_BREAKER_FAILU	103.7%	103.5%
73543 WILLOBY	115.00 1	RE_001	114MVA	113MVA
			(1x)	(1x)
73211 WELD LM	115.00	SINGL1 70470-704	115.5%	115.5%
73212 WELD LM	230.00 1	71(T2)	173MVA	173MVA
			(2x)	(2x)
73211 WELD LM	115.00	SINGL1 70470-704	111.5%	111.4%
73212 WELD LM	230.00 3	71(T2)	167MVA	167MVA
			(2x)	(1x)
73211 WELD LM	115.00	P4_BREAKER_FAILU	104.0%	103.9%
73554 BOOMERNG	115.00 1	RE_003	124MVA	124MVA
			(1x)	(1x)
73211 WELD LM	115.00	P4_BREAKER_FAILU	125.8%	125.7%
73558 WHITNEY	115.00 1	RE_001	187MVA	187MVA
			(1x)	(1x)
73433 WINDSORT	115.00	P4_BREAKER_FAILU	152.7%	152.7%
73558 WHITNEY	115.00 1	RE_001	230MVA	230MVA
			(1x)	(1x)
73502 DACONO	115.00	SINGL1 72107-730	101.7%	101.7%
73503 ERIE SW	115.00 1	48(1)	167MVA	167MVA
			(1x)	(1x)

Contingency Legend

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CONTINGENCY LEGEND:
<----- CONTINGENCY LABEL ------>  EVENTS
SINGL1 70023-70400(1)          : OPEN LINE FROM BUS 70023 [ALLISON     115.00] TO BUS 70400 [SODALAKE    115.00] CKT 1
SINGL1 70037-70165(1)          : OPEN LINE FROM BUS 70037 [ARAP_B      115.00] TO BUS 70165 [ENGLE3TP    115.00] CKT 1
SINGL1 70045-70242(1)          : OPEN LINE FROM BUS 70045 [BANCROFT    115.00] TO BUS 70242 [KENDRICK    115.00] CKT 1
SINGL1 70108-70276(1)          : OPEN LINE FROM BUS 70108 [CHEROKEE_S  115.00] TO BUS 70276 [MAPLETO1    115.00] CKT 1
SINGL1 70110-70175(1)          : OPEN LINE FROM BUS 70110 [CHEROKEE_N  115.00] TO BUS 70175 [FEDERHT1    115.00] CKT 1
SINGL1 70244-70444(1)          : OPEN LINE FROM BUS 70244 [LAFAYETT    115.00] TO BUS 70444 [VALMONT     115.00] CKT 1
SINGL1 70310-70311(U1)         : OPEN LINE FROM BUS 70310 [PAWNEE      22.000] TO BUS 70311 [PAWNEE      230.00] CKT U1
SINGL1 70310-70311(U2)         : OPEN LINE FROM BUS 70310 [PAWNEE      22.000] TO BUS 70311 [PAWNEE      230.00] CKT U2
SINGL1 70397-73020(1)          : OPEN LINE FROM BUS 70397 [B.CRK_PS    115.00] TO BUS 73020 [BEAVERCK    115.00] CKT 1
SINGL1 70463-70483(1)          : OPEN LINE FROM BUS 70463 [WATERTON    115.00] TO BUS 70483 [MARTN1TP    115.00] CKT 1
SINGL1 70470-70471(T2)         : OPEN LINE FROM BUS 70470 [WELD_PS     115.00] TO BUS 70471 [WELD_PS     230.00] CKT T2
SINGL1 70537-70538(1)          : OPEN LINE FROM BUS 70537 [FITZSMNS    115.00] TO BUS 70538 [CHMBERS     115.00] CKT 1
SINGL1 72107-73048(1)          : OPEN LINE FROM BUS 72107 [SLATERTS    115.00] TO BUS 73048 [DEL CTAP    115.00] CKT 1
SINGL1 72142-72143(1)          : OPEN LINE FROM BUS 72142 [REDBOX      115.00] TO BUS 72143 [REDBOX      69.000] CKT 1
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SINGL1 72142-72143(2) : OPEN LINE FROM BUS 72142 [REDBOX 115.00] TO BUS 72143 [REDBOX 69.000] CKT 2

Appendix B: Voltage Violations

Low Voltage Violations

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AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

'GREELEY' CONTINGENCY CASE BUSES WITH VOLTAGE LESS THAN 0.9000 - WORST CASE VIOLATIONS

X--------- BUS ---------X	X-----LABEL----X	Benchmark ACCC.acc	Mewborne ACCC.acc
70202 GODFRETP 115.00	P4_BREAKER_FAILURE_001	0.89296 (1x)	0.89284 (1x)
70209 GREELEY 115.00	P4_BREAKER_FAILURE_001	0.89290 (1x)	0.89277 (1x)
70210 GREELEY1 46.000	P4_BREAKER_FAILURE_001	0.89789 (1x)	0.89776 (1x)
70240 JOHNSTN 115.00	P4_BREAKER_FAILURE_001	0.89263 (1x)	0.89251 (1x)
70246 JOHNSTN2 115.00	P4_BREAKER_FAILURE_001	0.89262 (1x)	0.89250 (1x)
70290 MONFORT 115.00	P4_BREAKER_FAILURE_001	0.88861 (1x)	0.88848 (1x)
70368 ROSEDALE 115.00	P4_BREAKER_FAILURE_001	0.89429 (1x)	0.89415 (1x)
70439 UNC 115.00	P4_BREAKER_FAILURE_001	0.89190 (1x)	0.89176 (1x)
70469 WELD 46.000	P4_BREAKER_FAILURE_001	0.89742 (1x)	0.89731 (1x)
70470 WELD_PS 115.00	P4_BREAKER_FAILURE_001	0.89779 (1x)	0.89768 (1x)
70475 ARROWHLK 115.00	P4_BREAKER_FAILURE_001	0.89327 (1x)	0.89314 (1x)
70805 LEPRINO_PS 115.00	P4_BREAKER_FAILURE_001	0.89046 (1x)	0.89032 (1x)
70899 LUCERENE 115.00	P4_BREAKER_FAILURE_001	0.88749 (1x)	0.88735 (1x)
73031 BRUSHTAP 115.00	SINGL1 73020-730 31(1)	0.89735 (1x)	0.89732 (1x)
73211 WELD LM 115.00	P4_BREAKER_FAILURE_001	0.89788 (1x)	0.89777 (1x)
73305 EFMORGTP 115.00	SINGL1 73020-730 31(1)	0.89736 (2x)	0.89734 (2x)
73309 HENDERSON 115.00	SINGL1 73020-730 31(1)	0.89700 (2x)	0.89698 (2x)
73310 FME 115.00	SINGL1 73020-730 31(1)	0.89582 (2x)	0.89579 (2x)
73311 FMS 115.00	SINGL1 73020-730 31(1)	0.89918 (1x)	0.89915 (1x)
73377 EXCEL 115.00	SINGL1 73020-730 31(1)	0.89508 (2x)	0.89506 (2x)
73378 FMN 115.00	SINGL1 73020-730 31(1)	0.89736 (2x)	0.89734 (2x)
73379 FMWEST 115.00	SINGL1 73020-730 31(1)	0.89919 (1x)	0.89917 (1x)
73554 BOOMERNG 115.00	P4_BREAKER_FAILU	0.89720	0.89709

		RE_001	(1x)	(1x)
70801 16L003	44.000	P4_BREAKER_FAILU	0.89742	0.89731
		RE_001	(1x)	(1x)
70802 16L004	44.000	P4_BREAKER_FAILU	0.89742	0.89731
		RE_001	(1x)	(1x)
70803 CONTINTL	44.000	P4_BREAKER_FAILU	0.82641	0.82628
		RE_001	(1x)	(1x)
70804 CONTINTP	44.000	P4_BREAKER_FAILU	0.83697	0.83684
		RE_001	(1x)	(1x)
70808 AULT2	44.000	P4_BREAKER_FAILU	0.83599	0.83587
		RE_001	(1x)	(1x)
70810 AULT1	44.000	P4_BREAKER_FAILU	0.84190	0.84174
		RE_001	(1x)	(1x)
70812 AULT TAP	44.000	P4_BREAKER_FAILU	0.84663	0.84647
		RE_001	(1x)	(1x)
70817 EATON2	44.000	P4_BREAKER_FAILU	0.83928	0.83911
		RE_001	(1x)	(1x)
70819 EATON1	44.000	P4_BREAKER_FAILU	0.84845	0.84833
		RE_001	(1x)	(1x)
70818 EATONTAP	44.000	P4_BREAKER_FAILU	0.84924	0.84912
		RE_001	(1x)	(1x)
70827 BOYD JCT	44.000	P4_BREAKER_FAILU	0.87211	0.87199
		RE_001	(1x)	(1x)
70828 MUMPERHL	44.000	P4_BREAKER_FAILU	0.87213	0.87201
		RE_001	(1x)	(1x)
70831 COWHERD	44.000	P4_BREAKER_FAILU	0.86728	0.86711
		RE_001	(1x)	(1x)
70835 P.V. TAP	44.000	P4_BREAKER_FAILU	0.86322	0.86306
		RE_001	(1x)	(1x)
70836 P.V. TAP 2	44.000	P4_BREAKER_FAILU	0.86322	0.86306
		RE_001	(1x)	(1x)
70838 PLEASVAL	44.000	P4_BREAKER_FAILU	0.85789	0.85773
		RE_001	(1x)	(1x)
70839 MONFORTP	44.000	P4_BREAKER_FAILU	0.87302	0.87286
		RE_001	(1x)	(1x)
70844 MONFORT	46.000	P4_BREAKER_FAILU	0.87724	0.87708
		RE_001	(1x)	(1x)
70845 MONFPACK	44.000	P4_BREAKER_FAILU	0.87073	0.87057
		RE_001	(1x)	(1x)
70846 WEBERTAP	44.000	P4_BREAKER_FAILU	0.87923	0.87909
		RE_001	(1x)	(1x)
70849 EVANSTAP	44.000	P4_BREAKER_FAILU	0.87919	0.87906
		RE_001	(1x)	(1x)
70852 GREELYTP	44.000	P4_BREAKER_FAILU	0.88280	0.88267
		RE_001	(1x)	(1x)
70857 BRANTNER	44.000	P4_BREAKER_FAILU	0.87821	0.87807
		RE_001	(1x)	(1x)
70861 LASALLTP	44.000	P4_BREAKER_FAILU	0.87432	0.87419
		RE_001	(1x)	(1x)
70865 LASALLE	44.000	P4_BREAKER_FAILU	0.87432	0.87419
		RE_001	(1x)	(1x)
70866 MCMILLEN	44.000	P4_BREAKER_FAILU	0.86578	0.86565
		RE_001	(1x)	(1x)
70870 BOXELDER	44.000	P4_BREAKER_FAILU	0.84481	0.84467
		RE_001	(1x)	(1x)
70871 HIGHLDTP	44.000	P4_BREAKER_FAILU	0.88750	0.88739
		RE_001	(1x)	(1x)
70875 HIGHLAND	44.000	P4_BREAKER_FAILU	0.88536	0.88524
		RE_001	(1x)	(1x)
70877 EVANS	44.000	P4_BREAKER_FAILU	0.87696	0.87683
		RE_001	(1x)	(1x)

70903 CLOVERLY 115.00	P4_BREAKER_FAILU RE_001	0.88662 (1x)	0.88649 (1x)

CONTINGENCY LEGEND:

<----- CONTINGENCY LABEL ------>	EVENTS
SINGL1 73020-73031(1)	: OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1
P4_BREAKER_FAILURE_001	: OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3

Voltage Drop Violations

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AC CONTINGENCY REPORT FOR 2 AC CONTINGENCY CALCULATION RUNS

'GREELEY' CONTINGENCY CASE BUSES WITH VOLTAGE DROP BEYOND 0.0500 - WORST CASE VIOLATIONS

X--------- BUS ---------X	X-----LABEL----X	Benchmark ACCC.acc	Mewborne ACCC.acc
70008 KELIM 115.00	P4_BREAKER_FAILU RE_001	0.93491 (1x)	0.93485 (1x)
70127 COORSREC 115.00	SINGL1 70191-701 92(T1)	0.97539 (1x)	
70191 FTLUPTON 115.00	SINGL1 70191-701 92(T1)	0.97503 (1x)	0.97827 (1x)
70198 GILCREST 115.00	SINGL1 70191-701 92(T1)	0.97094 (1x)	
70202 GODFRETP 115.00	P4_BREAKER_FAILU RE_001	0.89296 (1x)	0.89284 (1x)
70209 GREELEY 115.00	P4_BREAKER_FAILU RE_001	0.89290 (1x)	0.89277 (1x)
70210 GREELEY1 46.000	P4_BREAKER_FAILU RE_001	0.89789 (1x)	0.89776 (1x)
70240 JOHNSTN 115.00	P4_BREAKER_FAILU RE_001	0.89263 (1x)	0.89251 (1x)
70244 LAFAYETT 115.00	SINGL1 70244-704 44(1)	0.90844 (1x)	0.90751 (1x)
70246 JOHNSTN2 115.00	P4_BREAKER_FAILU RE_001	0.89262 (1x)	0.89250 (1x)
70263 LITTLET1 115.00	SINGL1 70463-704 83(1)	0.92714 (1x)	0.92712 (1x)
70279 MARTIN_1 115.00	SINGL1 70463-704 83(1)	0.91829 (1x)	0.91828 (1x)
70290 MONFORT 115.00	P4_BREAKER_FAILU RE_001	0.88861 (1x)	0.88848 (1x)
70368 ROSEDALE 115.00	P4_BREAKER_FAILU RE_001	0.89429 (1x)	0.89415 (1x)
70439 UNC 115.00	P4_BREAKER_FAILU RE_001	0.89190 (1x)	0.89176 (1x)
70450 VASQUEZ 115.00	SINGL1 70191-701 92(T1)	0.97145 (1x)	
70469 WELD 46.000	P4_BREAKER_FAILU RE_001	0.89742 (1x)	0.89731 (1x)
70470 WELD_PS 115.00	P4_BREAKER_FAILU RE_001	0.89779 (1x)	0.89768 (1x)
70475 ARROWHLK 115.00	P4_BREAKER_FAILU RE_001	0.89327 (1x)	0.89314 (1x)
70483 MARTN1TP 115.00	SINGL1 70463-704 83(1)	0.91998 (1x)	0.91996 (1x)
70604 PARKWAY 115.00	SINGL1 70244-704	0.92442	0.92351

		44(1)	(1x)	(1x)
70805 LEPRINO_PS	115.00	P4_BREAKER_FAILURE_001	0.89046 (1x)	0.89032 (1x)
70899 LUCERENE	115.00	P4_BREAKER_FAILURE_001	0.88749 (1x)	0.88735 (1x)
72107 SLATERTS	115.00	SINGL1 72107-730 48(1)	0.90463 (1x)	0.90457 (1x)
72226 MILTON	115.00	P4_BREAKER_FAILURE_001	0.92188 (1x)	0.92165 (1x)
72403 S_KERSEY	115.00	P4_BREAKER_FAILURE_001	0.91388 (1x)	0.91370 (1x)
73002 AIRPORT	115.00	P4_BREAKER_FAILURE_001	0.93491 (1x)	0.93486 (1x)
73017 B.SANDY	115.00	SINGL1 73017-730 18(1)	0.94523 (1x)	0.94522 (1x)
73023 BIJOUTAP	115.00	SINGL1 73020-730 31(1)	0.91339 (2x)	0.91336 (2x)
73031 BRUSHTAP	115.00	SINGL1 73020-730 31(1)	0.89735 (1x)	0.89732 (1x)
73049 DELCAMIN	115.00	SINGL1 72107-730 48(1)	0.90776 (2x)	0.90770 (2x)
73055 KERSEY_W	115.00	P4_BREAKER_FAILURE_001	0.91036 (1x)	0.91020 (1x)
73095 KERSEYTP	115.00	P4_BREAKER_FAILURE_001	0.91306 (1x)	0.91292 (1x)
73097 KIOWA CK	115.00	SINGL1 73020-730 31(1)	0.93358 (2x)	0.93356 (2x)
73098 KODAK	115.00	P4_BREAKER_FAILURE_001	0.90657 (1x)	0.90649 (1x)
73147 ORCHARD	115.00	SINGL1 73020-730 31(1)	0.93358 (2x)	0.93356 (2x)
73211 WELD LM	115.00	P4_BREAKER_FAILURE_001	0.89788 (1x)	0.89777 (1x)
73213 WIGGINS TAP	115.00	SINGL1 73020-730 31(1)	0.94144 (2x)	0.94143 (2x)
73218 WINDSOR	115.00	P4_BREAKER_FAILURE_001	0.91683 (1x)	0.91675 (1x)
73305 EFMORGTP	115.00	SINGL1 73020-730 31(1)	0.89736 (2x)	0.89734 (2x)
73309 HENDERSON	115.00	SINGL1 73020-730 31(1)	0.89700 (2x)	0.89698 (2x)
73310 FME	115.00	SINGL1 73020-730 31(1)	0.89582 (2x)	0.89579 (2x)
73311 FMS	115.00	SINGL1 73020-730 31(1)	0.89918 (2x)	0.89915 (2x)
73318 LIMON	115.00	SINGL1 73017-730 18(1)	0.94342 (1x)	0.94342 (1x)
73377 EXCEL	115.00	SINGL1 73020-730 31(1)	0.89508 (2x)	0.89506 (2x)
73378 FMN	115.00	SINGL1 73020-730 31(1)	0.89736 (2x)	0.89734 (2x)
73379 FMWEST	115.00	SINGL1 73020-730 31(1)	0.89919 (2x)	0.89917 (2x)
73433 WINDSORT	115.00	P4_BREAKER_FAILURE_001	0.91792 (1x)	0.91784 (1x)
73501 RINNVALL	115.00	SINGL1 72107-730 48(1)	0.92317 (1x)	0.92311 (1x)
73543 WILLOBY	115.00	P4_BREAKER_FAILURE_001	0.92994 (1x)	0.92985 (1x)
73554 BOOMERNG	115.00	P4_BREAKER_FAILURE_001	0.89720 (1x)	0.89709 (1x)

73555 BRACEWLL 115.00	P4_BREAKER_FAILURE_001	0.90630 (1x)	0.90621 (1x)
73558 WHITNEY 115.00	P4_BREAKER_FAILURE_001	0.90659 (1x)	0.90650 (1x)
70801 16L003 44.000	P4_BREAKER_FAILURE_001	0.89742 (1x)	0.89731 (1x)
70802 16L004 44.000	P4_BREAKER_FAILURE_001	0.89742 (1x)	0.89731 (1x)
70803 CONTINTL 44.000	P4_BREAKER_FAILURE_001	0.82641 (1x)	0.82628 (1x)
70804 CONTINTP 44.000	P4_BREAKER_FAILURE_001	0.83697 (1x)	0.83684 (1x)
70808 AULT2 44.000	P4_BREAKER_FAILURE_001	0.83599 (1x)	0.83587 (1x)
70810 AULT1 44.000	P4_BREAKER_FAILURE_001	0.84190 (1x)	0.84174 (1x)
70812 AULT TAP 44.000	P4_BREAKER_FAILURE_001	0.84663 (1x)	0.84647 (1x)
70817 EATON2 44.000	P4_BREAKER_FAILURE_001	0.83928 (1x)	0.83911 (1x)
70819 EATON1 44.000	P4_BREAKER_FAILURE_001	0.84845 (1x)	0.84833 (1x)
70818 EATONTAP 44.000	P4_BREAKER_FAILURE_001	0.84924 (1x)	0.84912 (1x)
70827 BOYD JCT 44.000	P4_BREAKER_FAILURE_001	0.87211 (1x)	0.87199 (1x)
70828 MUMPERHL 44.000	P4_BREAKER_FAILURE_001	0.87213 (1x)	0.87201 (1x)
70831 COWHERD 44.000	P4_BREAKER_FAILURE_001	0.86728 (1x)	0.86711 (1x)
70835 P.V. TAP 44.000	P4_BREAKER_FAILURE_001	0.86322 (1x)	0.86306 (1x)
70836 P.V. TAP 2 44.000	P4_BREAKER_FAILURE_001	0.86322 (1x)	0.86306 (1x)
70838 PLEASVAL 44.000	P4_BREAKER_FAILURE_001	0.85789 (1x)	0.85773 (1x)
70839 MONFORTP 44.000	P4_BREAKER_FAILURE_001	0.87302 (1x)	0.87286 (1x)
70844 MONFORT 46.000	P4_BREAKER_FAILURE_001	0.87724 (1x)	0.87708 (1x)
70845 MONFPACK 44.000	P4_BREAKER_FAILURE_001	0.87073 (1x)	0.87057 (1x)
70846 WEBERTAP 44.000	P4_BREAKER_FAILURE_001	0.87923 (1x)	0.87909 (1x)
70849 EVANSTAP 44.000	P4_BREAKER_FAILURE_001	0.87919 (1x)	0.87906 (1x)
70852 GREELYTP 44.000	P4_BREAKER_FAILURE_001	0.88280 (1x)	0.88267 (1x)
70857 BRANTNER 44.000	P4_BREAKER_FAILURE_001	0.87821 (1x)	0.87807 (1x)
70861 LASALLTP 44.000	P4_BREAKER_FAILURE_001	0.87432 (1x)	0.87419 (1x)
70865 LASALLE 44.000	P4_BREAKER_FAILURE_001	0.87432 (1x)	0.87419 (1x)
70866 MCMILLEN 44.000	P4_BREAKER_FAILURE_001	0.86578 (1x)	0.86565 (1x)
70870 BOXELDER 44.000	P4_BREAKER_FAILURE_001	0.84481 (1x)	0.84467 (1x)
70871 HIGHLDTP 44.000	P4_BREAKER_FAILURE_001	0.88750 (1x)	0.88739 (1x)

70875 HIGHLAND	44.000	P4_BREAKER_FAILU RE_001	0.88536 (1x)	0.88524 (1x)
70877 EVANS	44.000	P4_BREAKER_FAILU RE_001	0.87696 (1x)	0.87683 (1x)
70903 CLOVERLY	115.00	P4_BREAKER_FAILU RE_001	0.88662 (1x)	0.88649 (1x)
72227 NERESCAN	115.00	P4_BREAKER_FAILU RE_001	0.92185 (1x)	0.92162 (1x)
72208 DELCAMIN	69.000	SINGL1 72107-730 48(1)	0.92450 (2x)	0.92443 (2x)

CONTINGENCY LEGEND:

<----- CONTINGENCY LABEL ------>	EVENTS
SINGL1 70191-70192(T1)	OPEN LINE FROM BUS 70191 [FTLUPTON 115.00] TO BUS 70192 [FTLUPTON 230.00] CKT T1
SINGL1 70244-70444(1)	OPEN LINE FROM BUS 70244 [LAFAYETT 115.00] TO BUS 70444 [VALMONT 115.00] CKT 1
SINGL1 70463-70483(1)	OPEN LINE FROM BUS 70463 [WATERTON 115.00] TO BUS 70483 [MARTN1TP 115.00] CKT 1
SINGL1 72107-73048(1)	OPEN LINE FROM BUS 72107 [SLATERTS 115.00] TO BUS 73048 [DEL CTAP 115.00] CKT 1
SINGL1 73017-73018(1)	OPEN LINE FROM BUS 73017 [B.SANDY 115.00] TO BUS 73018 [B.SANDY 230.00] CKT 1
SINGL1 73020-73031(1)	OPEN LINE FROM BUS 73020 [BEAVERCK 115.00] TO BUS 73031 [BRUSHTAP 115.00] CKT 1
P4_BREAKER_FAILURE_001	OPEN BRANCH FROM BUS 70470 [WELD_PS 115.00] TO BUS 70471 [WELD_PS 230.00] CKT T2
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 70471 [WELD_PS 230.00] CKT 1
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 1
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73011 [AULT 230.00] CKT 2
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 1
	OPEN LINE FROM BUS 73212 [WELD LM 230.00] TO BUS 73211 [WELD LM 115.00] CKT 3

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