Facility Study For Generation Interconnection Request GEN-2006-037N01 GEN-2006-044N GEN-2007-011N06 GEN-2007-011N09 GEN-2008-086N02

SPP Generation Interconnection Studies

August 2010
Revised – November 2010

Summary

Nebraska Public Power District (NPPD) performed the following Study at the request of the Southwest Power Pool (SPP) for Generation Interconnection request Gen-2006-037N01, GEN-2006-044N, GEN-2007-011N06, GEN-2007-011N09, and GEN-2008-086N02. The request for interconnection was placed with SPP in accordance SPP's Open Access Transmission Tariff, which covers new generation interconnections on SPP's transmission system.

Pursuant to the tariff, NPPD was asked to perform a detailed Facility Study of the generation interconnection request to satisfy the Facility Study Agreement executed by the requesting customers and SPP.

This study has been revised to account for

- Adjustment of costs to GEN-2006-044N to account for a requested in service date ahead of the completion date for previously identified network upgrades
- Adjustment of costs attributable to GEN-2008-086N2
- Account for previously identified WAPA constraints.

Interconnection Customer Interconnection Facilities

The Interconnection Customers will be responsible for the 115kV/230kV transmission facilities from the respective points of interconnection to its 230/34.5kV or 115/34.5kV substation that will contain its step down transformers and wind turbine collector feeders. In addition, the Customer will be required to maintain the power factor requirements as detailed in the DISIS-2009-001 Impact Study at their respective points of interconnection.

Transmission Owner Interconnection Facilities and Non Shared Network Upgrades

The interconnection customers were studied within the DISIS-2009-001 Impact Study. The Interconnection Customers are responsible for the costs shown on the next page. If a customer is not assigned the entire cost of a particular upgrade, that upgrade is considered a "shared upgrade". If higher queued interconnection customers withdraw from the queue, suspend or terminate their LGIA, restudies will have to be conducted to determine the Interconnection Customers' allocation of shared network upgrades.

Affected System Facilities

A possible Affected System Facility was identified in the Facility Study. The Facility is the WAPA Utica Jct-Yankton Jct 115kV line. Sensitivity analysis has shown that GEN-2007-011N09 affects this facility. WAPA was contacted and responded that the Utica Jct-Yankton Jct 115kV line has been uprated to 120/128 MVA (summer) and 120/132 MVA (winter) which alleviates constraints on this facility.

Cost Allocation Per Request (Revised)

Interconnection Request	Upgrade Type	Allocated Costs	E + C Costs
GEN-2006-037N01			
GEN-2006-037N1 Interconnection Costs See Oneline Diagram	Current Study Allocation	$10,000,000.00	$10,000,000.00
	Current Study Total	**$10,000,000.00**	
GEN-2006-044N			
GEN-2006-044N Interconnection Costs See Oneline Diagram - Costs includes the cost of increasing clearances replacing conductor and substatoin equipment to re-rate the Albion - Neligh 115kV line at 100 C.	Current Study Allocation	$2,200,000.00	$2,200,000.00
Petersburg - Madison 115KV CKT 1 Construct approximately 35 miles of new 115kV	Current Study Allocation	$7,205,988.61	$22,400,000.00
Belden - Bloomfield 115KV CKT 1 Construct approximately 45 miles of new 115kV including breaker replacements at Belden and Creighton	Current Study Allocation	$1,493,498.04	$23,200,000.00
	Current Study Total	**$10,899,486.65**	
GEN-2007-011N06			
GEN-2007-011N06 Interconnection Costs See Oneline Diagram	Current Study Allocation	$500,000.00	$500,000.00
Petersburg - Madison 115KV CKT 1 Construct approximately 35 miles of new 115kV	Current Study Allocation	$13,181,686.47	$22,400,000.00
Belden - Bloomfield 115KV CKT 1 Construct approximately 45 miles of new 115kV including breaker replacements at Belden and Creighton	Current Study Allocation	$2,732,008.61	$23,200,000.00
	Current Study Total	**$16,413,695.08**	
GEN-2007-011N09			
GEN-2007-011N09 Interconnection Costs See Oneline Diagram	Current Study Allocation	$500,000.00	$500,000.00
Belden - Bloomfield 115KV CKT 1 Construct approximately 45 miles of new 115kV including breaker replacements at Belden and Creighton	Current Study Allocation	$18,974,493.35	$23,200,000.00
Petersburg - Madison 115KV CKT 1 Construct approximately 35 miles of new 115kV	Current Study Allocation	$2,012,324.92	$22,400,000.00
	Current Study Total	**$21,486,818.27**	
GEN-2008-086N02			
GEN-2008-086N02 Interconnection Costs See Oneline Diagram	Current Study Allocation	$9,300,000.00	$9,300,000.00
	Current Study Total	**$9,300,000.00**	

* Current Study Requests' Costs of Previously Allocated Network Upgrades will be determined by a restudy, if neccesary.

DISIS-2009-01
GENERATION INTERCONNECTION FACILITY STUDY

SPP GEN-2007-011N09	**75.0 MW Wind Generation Facility at Bloomfield 115 kV**
SPP GEN-2006-044N	**40.5 MW Wind Generation Facility at Petersburg N. 115 kV**
SPP GEN-2007-011N06	**75.0 MW Wind Generation Facility at Petersburg N. 115 kV**
SPP GEN-2006-037N1	**75.0 MW Wind Generation Facility at Broken Bow 115 kV**
SPP GEN-2008-086N02	**200.0 MW Wind Generation Facility at Madison Co. 230 kV**

JUNE 2010

[REVISED OCTOBER 2010]
[REVISED NOVEMBER 2010]

PREPARED FOR:
SOUTHWEST POWER POOL

PREPARED BY:
NEBRASKA PUBLIC POWER DISTRICT OPERATIONS
TRANSMISSION ASSET PLANNING
T&D ASSET MANAGEMENT
T&D ENGINEERING

Nebraska Public Power District
"Always there when you need us"

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Executive Summary

The *NPPD DISIS-2009-001 Facility Study* was performed to document the reliability impacts of five new wind generation facilities interconnected to the NPPD transmission system. These five wind generation projects have developed through the SPP Definitive Interconnection System Impact Study process and have advanced to the facility study stage. SPP has requested that NPPD perform the Facility Study associated with the five generation interconnection projects listed below:

Project	MW	Point-of-Interconnection	Cluster
GEN-2006-044N	40.5	New Sub on Neligh-Petersburg 115kV	9
GEN-2007-011N06	75.0	New Sub on Neligh-Petersburg 115kV	9
GEN-2007-011N09	75.0	Bloomfield 115 kV	9
GEN-2008-086N02	200.0	New Sub on Ft. Randall-Kelly 230 kV	9
GEN-2006-037N1	75.0	Broken Bow 115 kV	10
	465.5		

This facility study provides the transmission interconnection plan to accommodate the interconnection of the five wind generation projects. This study report was performed to assess the future system state in accordance with NERC TPL standards and NPPD's Facility Connection Requirements Document. This study was performed in multiple phases to address a wide range of operating conditions to adequately assess the future system state with the proposed wind generation interconnection projects and associated transmission. SPP evaluated these five wind generation interconnection projects as two separate clusters in the DISIS-2009-001 system impact study and developed a list of transmission projects required to interconnect these generation facilities to the NPPD transmission system at the requested points of interconnection. The required transmission upgrade projects identified in the DISIS-2009-001 are listed below:

- New 35-mile Petersburg North – Madison 115 kV line
- New 45-mile Bloomfield – Belden 115 kV line

The Facility Study includes a loadflow analysis, short circuit analysis, and regional flowgate impact analysis.

The loadflow analysis documents the steady-state performance of the network following the wind generation facility additions and the associated transmission facility upgrades. The loadflow analysis was split into four phases.

Phase 1 of the loadflow analysis was a system intact and N-1 contingency analysis of the expected system state following the wind generation & transmission additions performed in accordance with NERC Standards TPL-001 and TPL-002. The results of the Phase 1 portion of the loadflow analysis revealed two facilities (Gavins Point – Yankton Junction 115 kV and Yankton Junction – Utica Junction 115 kV) outside of the NPPD system that would need further coordination with external entities. The Phase 1 analysis also identified two facilities on the NPPD system that would need mitigation. The Petersburg

North – Petersburg – Albion 115 kV lines were flagged as loaded above the normal rating, but less than the 30-minute short-term emergency rating for several N-1 contingencies. Post-contingency generation reductions would be required to mitigate this issue and prepare for the next worst-case contingency.

Phase 2 of the loadflow analysis involved a comprehensive multiple element contingency analysis of the Nebraska transmission system. The results of the Phase 2 contingency analysis revealed no additional facility overloads or voltage violations that would require mitigation due to TPL-003 and TPL-004 contingencies.

Phase 3 of the loadflow analysis evaluated the local area transmission capacity with respect to delivering the fully accredited generating capability out of the area at 60% load levels. The Phase 3 loadflow analysis was performed to evaluate the system state for the worst-case N-1, stuck breaker, and N-2 contingencies in the area of the wind projects. The results of the Phase 3 portion of the loadflow analysis revealed two facilities (Gavins Point – Yankton Junction 115 kV and Yankton Junction – Utica Junction 115 kV) outside of the NPPD system that would need further coordination with external entities. The Phase 3 results also identified a list of 20 transmission facilities that would need prior outage generation limits established to ensure system operating limits are maintained for the potential loss of the next worst-case transmission facility.

Phase 4 of the loadflow analysis evaluated the transmission system with respect to worst-case west-to-east transfer conditions across Nebraska. The Phase 4 analysis was performed to evaluated worst-case N-1 contignencies under these highly stressed transfer conditions. The results of the Phase 4 portion of the loadflow analysis revealed two facilities (Gavins Point – Yankton Junction 115 kV and Yankton Junction – Utica Junction 115 kV) outside of the NPPD system that would need further coordination with external entities. The Phase 4 results also identified two facilities on the NPPD system that may require further mitigation. The Canaday – Elm Creek 115 kV and Canaday – Lexington 115 kV lines were found to overload above the 30-minute short-term emergency rating for loss of the Crooked Creek – Riverdale 230 kV line.

The short circuit analysis was performed to evaluate the fault interrupting capability of existing devices in the area following the interconnection of the proposed wind generation additions. The results of this analysis showed that Belden PCB1112 and Creighton 607-D2 would be required network upgrades for interconnection of the new generation facilities and associated transmission.

The regional flowgate impact analysis was performed to determine if flows on any defined flowgates in Nebraska would be significantly affected by the wind generation facilities. Overall, the results showed that four PTDF flowgates, COOPER_S, GRIS_LNC, FTCAL_S and WNE_WKS, were significantly impacted by the wind projects. Two OTDF flowgates, the Council Bluffs – River Bend 161 kV FLO Cooper – St. Joe 345 kV and Kelly – Tecumsah Hill 161 kV FLO Cooper – St. Joe 345 kV flowgates were significantly impacted by the wind projects. Regional flowgate impacts

due to the wind projects will be further addressed in the delivery study following a request for transmission service.

Overall, the *NPPD DISIS-2009-001 Facility Study* documents the performance of the network following the addition of the five wind generation interconnection projects and associated transmission. The Facility Study has documented the transmission plan required for interconnection to the NPPD transmission system and the details are listed below.

DISIS-2009-001 Generation Interconnection Plan

- GEN-2006-044N Interconnection Facilities – Petersburg North 115 kV substation expansion to accommodate new 115 kV interconnection. **$ 1.3 Million**

- GEN-2007-011N06 Interconnection Facilities – Petersburg North 115 kV substation expansion to accommodate new 115 kV interconnection. **$ 0.5 Million**

- GEN-2007-011N09 Interconnection Facilities – Bloomfield 115 kV substation expansion to accommodate new 115 kV interconnection. **$ 0.5 Million**

- GEN-2008-086N02 Interconnection Facilities – Development of new Madison County 230 kV substation to accommodate new 230 kV interconnection. Detailed engineering review of the Ft. Randall – Kelly 230 kV line conductor clearances indicates additional line work would be required for interconnection to accommodate the increased loading on this facility. **$ 9.3 Million**

- GEN-2006-037N1 Interconnection Facilities – Broken Bow South 115 kV substation addition. The existing Broken Bow 115 kV substation is fully built out with no room or possibility of expansion at the existing site. To accommodate the request for interconnection, a Broken Bow South 115 kV substation would be built on land near the existing Broken Bow 115 kV substation and the existing transmission facilities would be re-terminated to the new substation. **$ 10.0 Million**

- Petersburg North – Madison 115 kV Line – New 35-mile 115 kV line from Petersburg North to Madison and associated substation additions. **$ 22.4 Million**

- Bloomfield – Belden 115 kV Line – New 45-mile 115 kV line from Bloomfield to Belden and associated substation additions. **$ 22.7 Million**

- Belden PCB 1112 & Creighton 607-D2 Replacement – Replace PCB 1112 at Belden and 607-D2 fuse at Creighton due to increased fault duty. **$ 0.5 Million**

- Albion – Petersburg – Petersburg North – Neligh 115 kV line uprate – Per the request of GEN-2006-044N, NPPD performed a facility study to evaluate the necessary upgrades to the Albion – Petersburg – Petersburg North – Neligh 115 kV lines to accommodate a 100 Deg C facility rating. The work required to upgrade these facilities to 100 Deg C include increasing line clearances, replacing bus conductor, miscellaneous substation upgrades and protection system modifications.

  $ 0.9 Million

Total Interconnection & Network Upgrades: $68.1 Million

1.0 Introduction

In March/April 2010, NPPD was notified that five generation interconnection requests in the SPP generation interconnection queue had advanced to the facility study stage. Each of the five generation interconnection requests were evaluated by SPP in the Definitive Interconnection System Impact Study (DISIS-2009-001) as clusters in Group 9 and Group 10. The five generation interconnection requests are listed below:

Project	MW	Point-of-Interconnection	Cluster
GEN-2006-044N	40.5	New Sub on Neligh-Petersburg 115kV	9
GEN-2007-011N06	75.0	New Sub on Neligh-Petersburg 115kV	9
GEN-2007-011N09	75.0	Bloomfield 115 kV	9
GEN-2008-086N02	200.0	New Sub on Ft. Randall-Kelly 230 kV	9
GEN-2006-037N1	75.0	Broken Bow 115 kV	10
	465.5		

SPP entered into a facility study agreement with each of the five generation interconnection customers and subsequently requested that NPPD perform the Facility Study for each request. In response to the SPP request, NPPD has performed a Facility Study for all of the generation interconnection requests which included a detailed loadflow analysis, short circuit analysis and regional flowgate impact analysis. The Facility Study also includes detailed cost estimates and estimated project schedules for the interconnection and network upgrades identified in the System Impact Study and Facility Study. A list of interconnection and network upgrades identified in the System Impact Study as required for these five generation interconnection projects is below:

- GEN-2006-044N Interconnection Facilities – Petersburg North 115 kV substation expansion to accommodate new 115 kV interconnection.

- GEN-2007-011N06 Interconnection Facilities – Petersburg North 115 kV substation expansion to accommodate new 115 kV interconnection.

- GEN-2007-011N09 Interconnection Facilities – Bloomfield 115 kV substation expansion to accommodate new 115 kV interconnection.

- GEN-2008-086N02 Interconnection Facilities – Development of new Madison County 230 kV substation to accommodate new 230 kV interconnection.

- GEN-2006-037N1 Interconnection Facilities – Broken Bow South 115 kV substation addition. The existing Broken Bow 115 kV substation is fully built out with no room or possibility of expansion at the existing site. To accommodate the request for interconnection, a Broken Bow South 115 kV substation would be

built on land near the existing Broken Bow 115 kV substation and the existing transmission facilities would be re-terminated to the new substation.

- Petersburg North – Madison 115 kV Line – New 35-mile 115 kV line from Petersburg North to Madison and associated substation additions.

- Bloomfield – Belden 115 kV Line – New 45-mile 115 kV line from Bloomfield to Belden and associated substation additions.

2.0 Study Scope

2.1 Overview

This Facility Study will evaluate five proposed wind generator interconnection projects on the NPPD transmission system. This study will evaluate five generator interconnection requests in the SPP Generator Interconnection Queue which were studied in Group 9 & 10 of the SPP Definitive Interconnection System Impact Study, SPP DISIS-2009-001, and progressed to the facility study stage. The five GI projects on the NPPD transmission system included in Group 9 & 10 of the DISIS-2009-001 study are as follows:

Project	MW	Point-of-Interconnection	Cluster
GEN-2006-044N	40.5	New Sub on Neligh-Petersburg 115kV	9
GEN-2007-011N06	75.0	New Sub on Neligh-Petersburg 115kV	9
GEN-2007-011N09	75.0	Bloomfield 115 kV	9
GEN-2008-086N02	200.0	New Sub on Ft. Randall-Kelly 230 kV	9
GEN-2006-037N1	75.0	Broken Bow 115 kV	10
	465.5		

This Facility Study will focus on the five projects requesting interconnection to the NPPD transmission system. The SPP DISIS-2009-001 study did identify several transmission upgrades that would be required to interconnect the five proposed generation facilities. These transmission upgrades were required to mitigate impacts of the proposed generation projects on the existing transmission system as identified in the DISIS-2009-001 study. These transmission upgrades are listed below:

- New 35 Mile 115 kV line from Petersburg to Madison
- New 45 Mile 115 kV line from Bloomfield to Belden

Also, the SPP DISIS-2009-001 study did identify several additional transmission upgrades that would be required to interconnect the Group 10 proposed generation facilities. These transmission upgrades were required to mitigate impacts of the proposed Group 10 generation projects on the existing transmission system as identified in the DISIS-2009-001 study. These transmission upgrades are a new 35 Mile 115 kV line from Stuart to O'Neill and a new 100 Mile 115 kV line from Valentine to Stuart. In the original Group 10 of the DISIS-2009-001 study, there was an additional generation interconnection request at Valentine (GEN-2006-037N) that decided to not continue to the facility study stage. The generation interconnection request at Valentine was the primary driver for the transmission upgrades listed above and SPP is currently performing a re-study of DISIS-2009-001 to determine if these upgrades are no longer required. For this Facility Study, these transmission upgrades will not be considered in the facility study evaluation of the remaining generation interconnection request at Broken Bow. These transmission upgrades are fairly remote from the proposed point of

interconnection and are very likely to no longer be required for interconnection as a result of the SPP re-study of the Group 10 cluster of DISIS-2009-001.

The Facility Study will assess the new system state with the proposed wind facilities and associated transmission upgrades. The Facility Study will also identify any additional transmission issues that would require mitigation to meet mandatory NERC reliability standards following the addition of the new generation facilities and associated transmission projects. The Facility Study will include the following study phases:

1. Loadflow Analysis
2. Short Circuit Analysis
3. Regional Flowgate Impact Analysis

The loadflow analysis will be an assessment of the transmission system following the addition of the proposed generation requests and associated transmission projects. The loadflow analysis will evaluate the transmission system for compliance with NERC Reliability Standards and identify any thermal and voltage issues that could require mitigation. The short circuit analysis will evaluate the impacts of the wind facilities and associated transmission on existing fault currents in the area and determine if the capability of existing fault interrupting devices are adequate. A regional flowgate impact analysis will also be included to identify any regional flowgates impacted by the proposed generator interconnections.

The intent of the Facility Study is to perform a detailed assessment of the proposed generation interconnection facilities and associated transmission and validate adherence to system reliability criteria. This study will be performed in accordance with NERC Reliability Standards and the criteria set forth under those standards. This Facility Study will document the required transmission facility interconnection plan for the five proposed generation interconnection facilities and be performed in accordance with the methodologies described in NPPD's Facility Connection Requirements Document.

2.2 Loadflow Analysis

NPPD Transmission Planning will perform a loadflow analysis to screen the steady state performance of the network following the addition of the wind facilities and associated transmission. The powerflow models used for the loadflow analysis will be 2010 Series SPP MDWG models (Build 1). These models will represent system conditions close to the expected in-service dates of the proposed wind projects and will adequately represent a variety of worst-case seasonal conditions. The powerflow models utilized for the analysis will be:

2010 Spring Peak Load Case
2016 Spring Light Load Case
2016 Summer 100% Peak Load Case
2016 Winter 100% Peak Load Case

The base SPP MDWG powerflow models will be updated with planned transmission facility additions in the 2010 – 2016 timeframe and other system changes consistent with the latest SPP / MAPP Regional Plan.

The loadflow study will be split into three phases:

Phase 1 : System-wide Single Contingency N-1 Analysis

Phase 2 : System-wide Multiple Element Contingency N-2 Analysis

Phase 3 : Local Area Full Accredited Generation Capacity N-1 & N-2 Contingency Analysis

Phase 4 : System-wide Single Contingency N-1 Analysis under heavy transfer conditions.

PHASE 1: This Phase is considered a comprehensive single contingency analysis of the entire Nebraska subregion. Every single element rated from 115 kV – 345 kV in the NPPD, OPPD, LES, MEC and WAPA areas will be outaged and monitored through activity ACCC. The results of the contingency screening will be assessed and documented. Phase 1 will also further investigate all critical contingencies identified from the ACCC contingency screening. Phase 1 will be utilized to document the performance characteristics of the system in accordance with NERC Reliability Standards, TPL-001 and TPL-002.

PHASE 2: This Phase is considered a comprehensive multiple element contingency analysis of the entire Nebraska region. Multiple element contingencies rated from 115 kV – 345 kV will be outaged and monitored through activity ACCC. The multiple element contingencies consist of stuck breaker contingencies and double circuit tower contingencies identified by Nebraska transmission owners and utilized during MRO and SPP screening processes. The results of the contingency screening will be assessed and documented. Phase 2 will also further investigate all critical contingencies identified from the ACCC contingency screening comparison. Phase 2 will be utilized to document the performance characteristics of the system in accordance with NERC Reliability Standards, TPL-003 and TPL-004.

PHASE 3: This Phase will evaluate the impacts of worst case N-1 single contingency and independent N-2 double contingency conditions for the local area transmission outlet

paths associated with the wind projects. The 2010 Series 2010 Spring Peak load case will be utilized to show the impacts of the worst case local area contingencies. All of the local area generation including the wind additions will be redispatched off-system. The purpose of this Phase will be to document sufficient generator outlet transmission capacity for the new wind generators concurrent with the existing approved accredited generation in the area.

This Phase will be used to evaluate the Nebraska area transmission capacity with respect to delivering the fully accredited generating capability out of the local area resources for load levels at and above 70% of peak. The Spring Peak Load case is approximately 60% of summer peak for the Nebraska region. To stress the generation outlet capacity, the maximum accredited generation is modeled in the north central area and exported into the surrounding SPP region. The following maximum accredited net generation levels will be modeled in the area:

GEN-2006-044N (Petersburg.N)	=	40.5 MW
GEN-2007-011N06 (Petersburg.N)	=	75.0 MW
GEN-2007-011N09 (Bloomfield)	=	75.0 MW
GEN-2008-086N02 (Madison.Co)	=	200.0 MW
GEN-2006-037N1 (BrokenBow)	=	75.0 MW
Petersburg Wind	=	80.0 MW
Broken Bow Wind	=	80.0 MW
Bloomfield Crofton Hills Wind	=	42.0 MW
Bloomfield Elkhorn Ridge Wind	=	81.0 MW
Ainsworth Wind	=	75.0 MW
Broken Bow #1-6	=	8.3 MW
Burwell #2-5	=	3.0 MW
Ord #1-5	=	10.8 MW
Stuart #1	=	2.1 MW
Spencer #1	=	1.8 MW
Monroe #1-3	=	2.7 MW
Gavins Point #1-3	=	92.0 MW
Ft. Randall #1-6	=	347.0 MW
Spirit Mound #1-2	=	104.0 MW
Columbus Hydro #1-3	=	45.0 MW
Columbus ADM Co-Gen #1	=	75.0 MW

All of the incremental generation adjustments were made to external Nebraska resources to effect these schedules. Additional non-firm schedules into the SPP region made up the transfers. This type of operational mode is highly unlikely, but was utilized to demonstrate the transmission capacity available to deliver the fully accredited generation out of the Nebraska area under emergency conditions.

This Phase will include one-line powerflow plots showing flows and voltages in the area for system intact and N-1 conditions. This Phase will also evaluate critical stuck breaker

outages, double circuit transmission line outages and independent N-2 contingencies which could be affected by the wind projects. Powerflow plots will be included and any required operating limitations will be documented.

PHASE 4: This Phase is considered a comprehensive single contingency analysis of the entire Nebraska subregion under transfer conditions. This Phase will assess the performance of the NPPD transmission system under heavy west-to-east transfer conditions. Transfer cases will be established to evaluate west-to-east transfer limits with the wind generation interconnection projects at maximum output levels. Every single element rated from 115 kV – 345 kV in the NPPD, OPPD, LES, MEC and WAPA areas will be outaged and monitored through activity ACCC. The results of the contingency screening will be assessed and documented. Phase 1 will also further investigate all critical contingencies identified from the ACCC contingency screening. Phase 1 will be utilized to document the performance characteristics of the system in accordance with NERC Reliability Standards, TPL-001 and TPL-002.

2.3 Short Circuit Analysis

The purpose of the Short Circuit Analysis will be to evaluate the five proposed generation interconnection projects and associated transmission on the existing substation equipment fault duty ratings in the area. The substations to be evaluated are those electrically close to the interconnection points (Petersburg 115 kV, Bloomfield 115 kV, Broken Bow 115 kV, and Ft-Randall-Kelly 230 kV Sub) of the wind projects.

The Short Circuit Analysis will include short circuit calculations, an evaluation of the adequacy of existing circuit breaker interrupting ratings and an evaluation of the adequacy of the fault withstand capability of other substation equipment located at the monitored substations. The Short Circuit Analysis will be performed by NPPD Engineering Protection & Control personnel.

2.4 Regional Flowgate Impact Analysis

A Regional Flowgate Impact Analysis (DF Analysis) will be performed to assess the impacts of the five wind projects on Nebraska flowgates. Distribution Factor (PTDF and OTDF) calculations will be performed to examine the incremental impacts of the wind projects on currently defined constrained interfaces in the Nebraska area transmission system. The results of the DF screening will flag any impacts on Nebraska area flowgates for delivery of the wind projects outside of the Nebraska subregion. Any constrained interfaces identified as being impacted by greater than the allowable thresholds will be noted.

2.5 Detailed Cost Estimates & Project Schedule

NPPD Engineering, Asset Management, and Project Management departments will review the transmission upgrades identified in the SPP DISIS-2009-001 study. Detailed cost estimates and project schedules will be developed by these groups to implement the proposed transmission upgrades using standard NPPD construction and procurement practices. If any additional transmission upgrades are identified in this facility study, a detailed cost estimate and project schedule for these additional upgrades will also be developed and provided as required.

3.0 Model Development

This study was conducted using Rev 30.3.3 of Power Technology Inc.'s (PTI's) Power System Simulator (PSS/E) software package and the following SPP MDWG 2010 series build 1 powerflow models:

2010 Spring Peak Load Case
2016 Spring Light Load Case
2016 Summer 100% Peak Load Case
2016 Winter 100% Peak Load Case

The powerflow models were updated based on previously approved generation interconnection projects in the area. The following generation interconnection projects were included in the base powerflow models:

Petersburg Wind	=	80.0 MW
Broken Bow Wind	=	80.0 MW
Bloomfield Crofton Hills Wind	=	42.0 MW
Bloomfield Elkhorn Ridge Wind	=	81.0 MW
Ainsworth Wind	=	75.0 MW
Gavins Point #1-3	=	92.0 MW
Ft. Randall #1-6	=	347.0 MW
Columbus Hydro #1-3	=	45.0 MW
Columbus ADM Co-Gen #1	=	75.0 MW

The previously approved generation resources listed above were dispatched at 100% and other generation resources in the same balancing authority (BA) were reduced to account for the increased generation. The five new generation interconnection projects listed below were then added to the models and dispatched at 100%. The total output (465.5 MW) from the new generation interconnection projects was dispatched off-system to all other balancing authorities within the SPP footprint on a pro rata basis.

GEN-2006-044N (Petersburg.N)	=	40.5 MW
GEN-2007-011N06 (Petersburg.N)	=	75.0 MW
GEN-2007-011N09 (Bloomfield)	=	75.0 MW
GEN-2008-086N02 (Madison.Co)	=	200.0 MW
GEN-2006-037N1 (BrokenBow)	=	75.0 MW

Wind Generation Models

Each of the new wind generation interconnection projects were modeled with a +/- 0.95 power factor range with voltage control capability at the designated point-of-interconnection. Some of the new projects may have a larger reactive power range

available, but the reactive capability of each generation interconnection project was limited to +/- 0.95 power factor to be conservative in this study.

Base Transmission Upgrades

The SPP definitive generation interconnection study (DISIS-2009-001) identified two significant transmission additions that were required to accommodate the interconnection of the wind generation interconnection projects on the NPPD system. These transmission upgrade projects were modeled as base transmission upgrades in this facility study. The impedance characteristics and facility ratings modeled for these projects in this facility study are documented below:

Petersburg North – Madison 115 kV (35 miles)
R: 0.02558
X: 0.18086
B: 0.02850
RateA: 240 MVA (Normal)
RateB: 240 MVA (Long-term Emergency)
RateC: 264 MVA (Short-term Emergency)

Bloomfield – Belden 115 kV (45 miles)
R: 0.03289
X: 0.23254
B: 0.03664
RateA: 240 MVA (Normal)
RateB: 240 MVA (Long-term Emergency)
RateC: 264 MVA (Short-term Emergency)

4.0 Study Criteria

Facility Loading Criteria

Overloads of equipment are defined as greater than 100% of the normal continuous rating (Rate A). An emergency rating (Rate C) may be utilized for a period of less than 30 minutes during which the facility must be returned to normal operating limits. This emergency rating is defined as 110% for transmission line equipment and 125% for transformers.

Voltage Criteria

Normal steady-state voltage levels are defined as 0.95 to 1.05 pu. Emergency steady-state voltage levels are defined as 0.90 – 1.10 pu and may be utilized for less than 30 minutes.

5.0 Loadflow Analysis

5.1 Phase 1 Results (System-wide N-1 Screening)

PSS/E activity ACCC was used as a screening tool on each of the base cases to identify those contingencies which deserve closer study. ACCC analyzed the system by sequentially taking each transmission element greater than 100kV in the NPPD, OPPD, LES, MEC, and WAPA control areas out of service. Transmission facilities in the NPPD, OPPD, LES, MEC, and WAPA control areas were then monitored for violations of loading or bus voltage criteria. The results of the contingency analysis are shown in the ACCC summaries included in Appendix A. Contingencies which resulted in facility loadings or bus voltages outside of acceptable limits will be discussed in the summary of each case. The Phase 1 ACCC analysis is performed to assess the performance of the transmission system following the addition of the wind generation interconnection projects according to TPL-001 and TPL-002 standards.

Phase 1 analysis further addressed contingencies flagged in the screened ACCC run with additional AC powerflow analysis as required. In the NPPD area, there are loadflow solution issues associated with voltage regulation bandwidths. Consequently, most of the capacitors and reactors are modeled as fixed mode switched shunts, which must be manually switched to achieve optimal voltage profiles.

Powerflow activities VCHK and RATE were used to identify voltage and loading issues in the NPPD, OPPD, LES, WAPA, and MEC control areas for the full AC solution contingency runs. Activity VCHK produced a listing of those buses whose voltage magnitude was greater than 1.10 PU, followed by a listing of buses whose voltage was less than 0.90 PU. Activity RATE reported any branch whose current loading, including line charging and line connected shunt components, exceeded the specified percentage of RATE A.

<u>Phase 1 – 2010 Spring Peak</u>

System Intact Results (TPL-001):

One transmission facility was found to be loaded above its normal facility rating under system intact conditions. The Yankton Junction – Utica Junction 115 kV line in the WAPA system was loaded to 115.1% of the 60 MVA normal rating. Without the five new wind projects, the Yankton Junction – Utica Junction 115 kV line was loaded to 81.6% of the 60 MVA rating. The high loading on the Yankton Junction – Utica Junction 115 kV line will need to be coordinated with WAPA due to relatively close proximity of the overloaded line to the proposed wind interconnection projects.

N-1 Contingency Results (TPL-002):

Five overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2010 Spring Peak case with the wind facility additions. The full ACCC results are summarized in Appendix A. The post-contingency facility overloads that were discovered are summarized in Table 1 below.

Table 1. 2010 Spring Peak: N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	SINGLE 252	120	110
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	SINGLE 270	100	104.2
640183	GENTLMN3 345.00	640184	GENTLMN4 230.00	2	TRF-GENTLMN	336	107.4
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 769	60	169.4
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 771	60	166.6
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 810	60	166.6
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 789	60	156.2
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 742	60	145.8
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 370	60	137
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 258	60	135.1
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 255	60	134
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 252	60	131.1
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 253*	60	127.8
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 861	250	128.3
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 861	250	128.3

**Only the top ten contingency overloads were summarized in Table 1.*

The Gavins Point – Bloomfield 115 kV line was overloaded for loss of the proposed Bloomfield – Belden 115 kV line. The facility rating for the Gavins Point – Bloomfield 115 kV line is planned to be increased to 159 MVA to accommodate the addition of the prior queued Crofton Hills wind project. The facility rating increase is dependent on substation upgrades at the Gavins Point 115 kV substation and these upgrades are scheduled to be completed prior to the interconnection of the Crofton Hills project.

The Canaday 230 / 115 kV transformer was overloaded for loss of the Crooked Creek – Riverdale 230 kV line. The facility rating for the Canaday 230 /115 kV transformer is 100 MVA and is planned to be increased to 336 MVA by Fall 2010. The loading on this facility would not be an issue once the work to replace the existing transformer with the new 336 MVA unit is complete.

The Gentleman 345/230 kV transformer was overloaded for loss of the parallel Gentleman 345/230 kV transformer. In the 2010 Spring Peak case, the GGS Unit #2 is modeled offline due to a planned maintenance outage. This constraint is a known

limitation and the dispatch of GGS Unit #1 can be adjusted within 30 minutes to reduce the loading on this transformer to within normal limits. The overload does not exceed the 30-minute emergency rating of 420 MVA.

The Utica Junction – Yankton Junction 115 kV line was found to load above its 60 MVA rating for a number of N-1 contingencies. The Utica Junction – Yankton Junction 115 kV line is just north of Gavins Point in South Dakota. The high post-contingency loading on this line warrants additional evaluation and coordination with the transmission owner (Northwest Public Service) and the transmission planner (WAPA UGP) for this facility.

The Leland Olds 345/230 kV transformer was found to load above its 250 MVA rating for loss of the parallel 345/230 kV transformer. The post-contingency loading of this facility would need further review and coordination by the facility owner (BEPC) and the transmission planner (WAPA UGP) for this facility.

There were eleven bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis. The post-contingency bus voltage violations that were discovered are summarized in Appendix A. Only one contingency (SINGLE 336: Firth – Sheldon 115 kV) was found the NPPD area. The bus voltage violation is a modeling issue and can easily be addressed by adjusting the 115/69 kV transformer taps at the Sterling 115 kV substation. The remaining ten bus voltage violation issues would need to be coordinated with external entities for further review.

Phase 1 – 2016 Summer Peak

System Intact Results (TPL-001):

There were no transmission facility overloads or bus voltages outside of limits under system intact or base case conditions for the 2016 Summer Peak model.

N-1 Contingency Results (TPL-002):

Thirty-five overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2016 Summer Peak case with the wind generation additions. The full ACCC results are summarized in Appendix A. Four of the facility overloads were on the NPPD transmission system. The post-contingency facility overloads that were discovered are summarized in Table 2 below.

Table 2. 2016 Summer Peak: N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 894	120	100.5
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 918	120	100.5
640054	ALBION 7 115.00	640318	PETRSBG7 115.00	1	SINGLE 415	113	105.4
640318	PETRSBG7 115.00	640444	PETERSBRG.N7115.00	1	SINGLE 415	113	109.1
640318	PETRSBG7 115.00	640444	PETERSBRG.N7115.00	1	SINGLE 420	113	103
640318	PETRSBG7 115.00	640444	PETERSBRG.N7115.00	1	SINGLE 443	113	102.3
652405	FTPECK 4 230.00	652406	FTPECK 7 115.00	1	SINGLE 654	67	144.7
652426	BISMARK4 230.00	652427	BISMARK7 115.00	1	SINGLE 678	100	115.9
652426	BISMARK4 230.00	652427	BISMARK7 115.00	2	SINGLE 677	100	111.3
652476	EAGLEBT7 115.00	652520	OAHE 7 115.00	1	SINGLE 755	60	105.2
652481	MIDLAND7 115.00	652491	IRVSIMM7 115.00	1	SINGLE 755	77	138.6
652481	MIDLAND7 115.00	652491	IRVSIMM7 115.00	1	SINGLE 753	77	103.5
652481	MIDLAND7 115.00	652491	IRVSIMM7 115.00	1	SINGLE 752	77	103.4
652481	MIDLAND7 115.00	652487	PHILIP 7 115.00	1	SINGLE 755	77	103.3
652482	MISSION7 115.00	652495	WITTEN 7 115.00	1	SINGLE 785	80	158.8
652486	PHILIP 4 230.00	652487	PHILIP 7 115.00	1	SINGLE 747	100	115.1
652486	PHILIP 4 230.00	652488	PHILTAP4 230.00	1	SINGLE 747	100	111.9
652486	PHILIP 4 230.00	652487	PHILIP 7 115.00	1	SINGLE 744	100	101.9
652487	PHILIP 7 115.00	652492	WALL 7 115.00	1	SINGLE 747	77	104.6
652488	PHILTAP4 230.00	652519	OAHE 4 230.00	1	SINGLE 853	240	114.1
652488	PHILTAP4 230.00	652519	OAHE 4 230.00	1	TRF-STEGALL	240	114.1
652491	IRVSIMM7 115.00	652520	OAHE 7 115.00	1	SINGLE 818	120	103.9
652512	GROTON 7 115.00	652533	BRISTOL7 115.00	1	SINGLE 831	60	108.5
652515	HURON 7 115.00	660009	BTAP WP7 115.00	1	SINGLE 812	80	116.9
652515	HURON 7 115.00	660009	BTAP WP7 115.00	1	SINGLE 804	80	101.6
652519	OAHE 4 230.00	652520	OAHE 7 115.00	1	SINGLE 755	107	116.9
652520	OAHE 7 115.00	652600	ASH TAP 115.00	1	SINGLE 760	120	104.6
652626	UTICAJC7 115.00	660007	MENNOJT7 115.00	1	SINGLE 975	60	117.1
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 888	250	174.6
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 892	250	174.6
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 881	250	105.9
659105	LELANDO3 345.00	659202	LELND2TY 345.00	1	SINGLE 881	500	100.5
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 888	250	174.6
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 892	250	174.6
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 881	250	105.9
659106	LELANDO4 230.00	659202	LELND2TY 345.00	1	SINGLE 881	500	100.3

Three contingencies were found which could potentially result in the overload of the Petersburg North – Petersburg 115 kV or Petersburg – Albion 115 kV line sections. These N-1 contingencies are Petersburg North – Madison 115 kV, Petersburg North – Neligh 115 kV, and North Loup – Loup City 115 kV. These N-1 contingencies and post-contingency loading issues are all local area generation outlet issues for the wind projects interconnected at the Petersburg North 115 kV substation. None of these N-1 contingencies / facility overload combinations were an issue prior to the interconnection of the new wind generation facilities. The facility overloads do not exceed short-term 30-minute emergency ratings and generation reductions would be required to mitigate the overload condition and prepare for the potential loss of the next worst-case facility.

There were thirty-one additional facility overloads discovered during the ACCC analysis of the 2016 Summer Peak model with the wind generation additions. The thirty-one facility overloads are all located in the WAPA area and this would require further coordination with WAPA to determine if any mitigation is required of the proposed wind generation facility additions.

There were 70 bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis of the 2016 Summer Peak model with the wind additions. The post-contingency bus voltage violations that were discovered are summarized in Appendix A. Only two contingencies and three subsequent bus voltage violations were located in the NPPD area. The Firth – Sheldon 115 kV and Firth – Sterling 115 kV contingencies were flagged for post-contingency voltage violations at Firth 115 kV and Sterling 115 kV in the NPPD area. These bus voltage violations are a PSS/E modeling issue and can easily be addressed by adjusting the 115/69 kV transformer taps at the Sterling 115 kV substation. The remaining sixty-seven bus voltage violation issues are outside of the NPPD system and would need to be coordinated with external entities (WAPA) for further review.

Phase 1 – 2016 Winter Peak

System Intact Results (TPL-001):

There were no transmission facility overloads or bus voltages outside of limits under system intact or base case conditions for the 2016 Winter Peak model.

N-1 Contingency Results (TPL-002):

Forty overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2016 Winter Peak case with the wind generation additions and reported in the table. The full ACCC results are summarized in Appendix A. Only one of the facility overloads were on the NPPD transmission system. The post-contingency facility overloads that were discovered are summarized in Table 3 below.

Table 3. 2016 Winter Peak: N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 889	120	141.1
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 894	120	117.5
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 918	120	117.5
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 8	120	113.7
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 707*	120	110.7
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	SINGLE 259	120	106.7
652442	GARRISN7 115.00	652449	MAX 7 115.00	1	SINGLE 889	120	113.3
652449	MAX 7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 889	120	106.2
652476	EAGLEBT7 115.00	652520	OAHE 7 115.00	1	SINGLE 748	60	113.3
652476	EAGLEBT7 115.00	652520	OAHE 7 115.00	1	SINGLE 939	60	107.3
652476	EAGLEBT7 115.00	652520	OAHE 7 115.00	1	SINGLE 486	60	102.4
652476	EAGLEBT7 115.00	652520	OAHE 7 115.00	1	SINGLE 747	60	101.3
652481	MIDLAND7 115.00	652491	IRVSIMM7 115.00	1	SINGLE 753	77	101.2
652481	MIDLAND7 115.00	652491	IRVSIMM7 115.00	1	SINGLE 752	77	101.1
652482	MISSION7 115.00	652495	WITTEN 7 115.00	1	SINGLE 785	80	149.3
652486	PHILIP 4 230.00	652487	PHILIP 7 115.00	1	SINGLE 747	100	103.4
652488	PHILTAP4 230.00	652519	OAHE 4 230.00	1	SINGLE 939	240	112
652515	HURON 7 115.00	660009	BTAP WP7 115.00	1	SINGLE 812	80	114.6
652515	HURON 7 115.00	660009	BTAP WP7 115.00	1	SINGLE 802	80	103.3
652515	HURON 7 115.00	660009	BTAP WP7 115.00	1	SINGLE 921	80	103.3
652554	MORRIS 4 230.00	652555	MORRIS 7 115.00	1	SINGLE 839	100	118.6
652554	MORRIS 4 230.00	652555	MORRIS 7 115.00	1	SINGLE 695	100	103.8
652554	MORRIS 4 230.00	652555	MORRIS 7 115.00	1	SINGLE 708	100	102.0
652554	MORRIS 4 230.00	652555	MORRIS 7 115.00	1	SINGLE 698	100	101.3
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 888	250	208.5
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 892	250	208.5
659105	LELANDO3 345.00	659202	LELND2TY 345.00	1	SINGLE 887	500	116.3
659105	LELANDO3 345.00	659202	LELND2TY 345.00	1	SINGLE 891	500	116.3
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 886	250	101.2
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 888	250	208.5
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 892	250	208.5
659106	LELANDO4 230.00	659202	LELND2TY 345.00	1	SINGLE 887	500	115.9
659106	LELANDO4 230.00	659202	LELND2TY 345.00	1	SINGLE 891	500	115.9
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 886	250	101.2
659106	LELANDO4 230.00	659108	LOGAN 4 230.00	1	SINGLE 633	319	100.5
659106	LELANDO4 230.00	659108	LOGAN 4 230.00	1	SINGLE 930	319	100.1
659108	LOGAN 4 230.00	659143	BLAISDELL 4230.00	1	SINGLE 633	239	102.3
659108	LOGAN 4 230.00	659143	BLAISDELL 4230.00	1	SINGLE 930	239	101.7
659182	CHAR.CK7 115.00	659184	R.RIDER7 115.00	1	SINGLE 633	120	100.9
659182	CHAR.CK7 115.00	659184	R.RIDER7 115.00	1	SINGLE 930	120	100.6

**Only the top five contingency overloads reported in Table 3.*

The Gavins Point – Bloomfield 115 kV line was overloaded for loss of the proposed Bloomfield – Belden 115 kV line. The facility rating for the Gavins Point – Bloomfield 115 kV line is planned to be increased to 159 MVA to accommodate the addition of the prior queued Crofton Hills wind project. The facility rating increase is dependent on substation upgrades at the Gavins Point 115 kV substation and these upgrades are scheduled to be completed prior to the interconnection of the Crofton Hills project.

There were thirty-nine additional facility overloads discovered during the ACCC analysis of the 2016 Winter Peak model with the wind generation additions. The thirty-nine facility overloads are located in the WAPA area and this would require further coordination with WAPA to determine if any mitigation is required of the proposed wind generation facility additions.

There were 267 bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis of the 2016 Winter Peak model with the wind additions. The post-contingency bus voltage violations that were discovered are summarized in Appendix A. Only two contingencies and three subsequent bus voltage violations were located in the NPPD area. The Firth – Sheldon 115 kV and Firth – Sterling 115 kV contingencies were flagged for post-contingency voltage violations at Firth 115 kV and Sterling 115 kV in the NPPD area. These bus voltage violations are a PSS/E modeling issue and can easily be addressed by adjusting the 115/69 kV transformer taps at the Sterling 115 kV substation. The remaining 264 bus voltage violation issues are outside of the NPPD system and would need to be coordinated with external entities (WAPA) for further review.

Phase 1 – 2016 Spring Light Load

System Intact Results (TPL-001):

One transmission facility was found to be loaded above the normal facility rating under system intact conditions. The Yankton Junction – Utica Junction 115 kV line in the WAPA system was loaded to 127.2% of the 60 MVA normal rating. Without the five new wind projects, the Yankton Junction – Utica Junction 115 kV line was loaded to 92% of the 60 MVA rating. The high loading on the Yankton Junction – Utica Junction 115 kV line will need to be coordinated with WAPA due to relatively close proximity of the overloaded line to the proposed wind interconnection projects.

N-1 Contingency Results (TPL-002):

Forty-eight overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2016 Spring Light Load case with the wind generation additions and reported in the table. The full ACCC results are summarized in Appendix A. Only two of the facility overloads were on the NPPD transmission system. The post-contingency facility overloads that were discovered are summarized in Table 4 below.

Table 4. 2016 Spring Light Load: N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 889	120	125.3
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 894	120	102.3
603023	MALLARD7 115.00	659190	NDPRAIRWND 7115.00	1	SINGLE 918	120	102.3
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	SINGLE 259	120	125.2
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	SINGLE 265	120	100.6
652405	FTPECK 4 230.00	652406	FTPECK 7 115.00	1	SINGLE 654	67	144.3
652441	GARRISN4 230.00	652442	GARRISN7 115.00	1	SINGLE 889	133	141.2
652441	GARRISN4 230.00	652442	GARRISN7 115.00	1	SINGLE 881	133	128.9
652441	GARRISN4 230.00	652442	GARRISN7 115.00	1	SINGLE 703	133	118
652441	GARRISN4 230.00	652442	GARRISN7 115.00	1	SINGLE 681	133	116.4
652441	GARRISN4 230.00	652442	GARRISN7 115.00	1	SINGLE 894*	133	115.9
652476	EAGLEBT7 115.00	652520	OAHE 7 115.00	1	SINGLE 755	60	103.4
652481	MIDLAND7 115.00	652491	IRVSIMM7 115.00	1	SINGLE 755	77	117.2
652486	PHILIP 4 230.00	652487	PHILIP 7 115.00	1	SINGLE 747	100	100.4
652488	PHILTAP4 230.00	652519	OAHE 4 230.00	1	SINGLE 939	240	101.7
652488	PHILTAP4 230.00	652519	OAHE 4 230.00	1	SINGLE 853	240	101.6
652488	PHILTAP4 230.00	652519	OAHE 4 230.00	1	TRF-STEGALL	240	101.6
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 796	120	115.4
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 836	120	115.4
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 814	120	107.7
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 767	120	101.9
652515	HURON 7 115.00	660009	BTAP WP7 115.00	1	SINGLE 812	80	102.8
652519	OAHE 4 230.00	652520	OAHE 7 115.00	1	SINGLE 755	107	107.3
652554	MORRIS 4 230.00	652555	MORRIS 7 115.00	1	SINGLE 839	100	122.0
652554	MORRIS 4 230.00	652555	MORRIS 7 115.00	1	SINGLE 695	100	105.7
652554	MORRIS 4 230.00	652555	MORRIS 7 115.00	1	SINGLE 708	100	102.5
652554	MORRIS 4 230.00	652555	MORRIS 7 115.00	1	SINGLE 698	100	101.8
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 794	60	192.1
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 796	60	184.8
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 836	60	184.8
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 814	60	171.9
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 767*	60	162.2
652626	UTICAJC7 115.00	660007	MENNOJT7 115.00	1	SINGLE 975	60	109
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 888	250	228.2
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 881	250	129.2
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 886	250	106.9
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 920	250	106.2
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 633	250	103.7
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 930*	250	103.6
659105	LELANDO3 345.00	659202	LELND2TY 345.00	1	SINGLE 887	500	127.1
659105	LELANDO3 345.00	659202	LELND2TY 345.00	1	SINGLE 881	500	122.6
659105	LELANDO3 345.00	659202	LELND2TY 345.00	1	SINGLE 886	500	101.5
659105	LELANDO3 345.00	659202	LELND2TY 345.00	1	SINGLE 920*	500	100.8
659108	LOGAN 4 230.00	659143	BLAISDELL 4230.00	1	SINGLE 881	239	102
659108	LOGAN 4 230.00	659143	BLAISDELL 4230.00	1	SINGLE 633	239	101.9
659108	LOGAN 4 230.00	659143	BLAISDELL 4230.00	1	SINGLE 930	239	101.3
659182	CHAR.CK7 115.00	659184	R.RIDER7 115.00	1	SINGLE 633	120	101.6
659182	CHAR.CK7 115.00	659184	R.RIDER7 115.00	1	SINGLE 930	120	101.2

**Only the top five contingency overloads reported in Table 4.*

The Gavins Point – Bloomfield 115 kV line was overloaded for loss of the proposed Bloomfield – Belden 115 kV line or Bloomfield – Creighton 115 kV line. The facility rating for the Gavins Point – Bloomfield 115 kV line is planned to be increased to 159 MVA to accommodate the addition of the prior queued Crofton Hills wind project. The facility rating increase is dependent on substation upgrades at the Gavins Point 115 kV substation and these upgrades are scheduled to be completed prior to the interconnection of the Crofton Hills project.

The remaining facility overloads discovered during the ACCC analysis are on the WAPA system and would require further coordination with WAPA to determine if any mitigation is required of the proposed wind generation facility additions. Two of the facility overloads are in relatively close proximity of the wind generation interconnection projects and would require further detailed investigation. The Gavins Point – Yankton Junction 115 kV and Yankton Junction – Utica Junction 115 kV lines were found to load over the posted facility ratings. Gavins Point – Yankton 115 kV is one of several worst-case N-1 contingencies for these particular facilities. This contingency would result in the 115% overload of the 120 MVA rating on the Gavins Point – Yankton Junction 115 kV and the 192% overload of the 60 MVA rating on the Yankton Junction – Utica Junction 115 kV line. More coordination with WAPA will be required to determine how to address these issues.

There were 234 bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis. Only one contingency and subsequent bus voltage violation was located in the NPPD area. The Firth – Sterling 115 kV contingency was flagged for post-contingency voltage violations at Sterling 115 kV in the NPPD area. These bus voltage violations are a PSS/E modeling issue and can easily be addressed by adjusting the 115/69 kV transformer taps at the Sterling 115 kV substation. The remaining 233 bus voltage violation issues are outside of the NPPD system and would need to be coordinated with external entities (MEC and WAPA) for further review.

Phase 1 Results Summary

Overall, there were five transmission facility overloads discovered in the Phase 1 screening that were in the immediate vicinity of the proposed generation interconnection projects. Two of the five transmission facility overloads were found on an external system and would need further coordination and investigation with the affected party (WAPA). These external system transmission facility overloads are listed below:

- Gavins Point – Yankton Junction 115 kV
- Yankton Junction – Utica Junction 115 kV

Three of the five transmission facility overloads were found on the NPPD transmission system and would need mitigation in order to maintain compliance with NERC TPL standards. These facility overloads are summarized below:

Gavins Point – Bloomfield 115 kV: This facility loaded to above the 120 MVA facility rating for loss of the Bloomfield – Belden 115 kV or Bloomfield – Creighton 115 kV lines. This facility is planned to be upgraded to 159 MVA due to the Crofton Hills wind generation project and no further upgrade is required.

Petersburg North – Petersburg – Albion 115 kV: These two facilities loaded to above the 113 MVA normal facility rating for loss of the new Petersburg North – Madison 115 kV line, North Loup – Loup City 115 kV, and Petersburg North – Neligh 115 kV lines. The 30-minute short-term emergency rating is not exceeded for any of these contingencies and generation reductions would be required at the new proposed wind generation sites to mitigate the overload condition and prepare for the loss of the next worst-case facility.

5.2 Phase 2 Results (System-wide Multiple Element Screening)

PSS/E activity ACCC was used as a screening tool on each of the base cases to identify those multiple element contingencies which deserve closer study. ACCC analyzed the system by sequentially taking select multiple element contingencies in the Nebraska area out-of-service. Transmission facilities in the NPPD, OPPD, LES, WAPA and MEC control areas were then monitored for violations of loading or bus voltage criteria. The results of the Phase 2 contingency analysis are shown in the ACCC summary printouts included in Appendix B. The Phase 2 ACCC analysis is performed to assess the performance of the transmission system following the addition of the wind generation interconnection projects according to TPL-003 and TPL-004 standards.

Phase 2 – 2010 Spring Peak

Category C Results (TPL-003):

There were seven facility overloads discovered in the Category C ACCC analysis of the 2010 Spring Peak case with the wind generation interconnection facilities and reported in the table. Only one of the facility overloads was within the NPPD area. The post-contingency facility overloads that were discovered are summarized in Table 5 below.

Table 5. 2010 Spring Peak: Category C Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	BUS-RIVERDAL	100	105.1
640183	GENTLMN3 345.00	640184	GENTLMN4 230.00	2	BKR-GGS-3304	336	107.4
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	BUS-HOSKINS	60	119.7
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	BKR-WAY-186	60	119.3
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	BKR-CPR-3304	60	117.7
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	BKR-TEK-1604	60	113.5
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	CBTEK-BUS*	60	113.5

**Only the top five contingency overloads reported in Table 5.*

The Canaday 230 / 115 kV transformer was overloaded for loss of the Riverdale 230 kV bus (stuck breaker or bus section outage). The facility rating for the Canaday 230 /115 kV transformer is 100 MVA and is planned to be increased to 336 MVA by Fall 2010. The loading on this facility would not be an issue once the work to replace the existing transformer with the new 336 MVA unit is complete.

The Gentleman 345/230 kV transformer was overloaded for loss of the parallel Gentleman 345/230 kV transformer and GGS Unit #2 GSU for a stuck breaker outage. This constraint is a known limitation and the dispatch of GGS Unit #1 can be adjusted

within 30 minutes to reduce the loading on this transformer to within normal limits. The overload does not exceed the 30-minute emergency rating of 420 MVA.

The Utica Junction – Yankton Junction 115 kV line was found to load above its 60 MVA rating for a number of contingencies. The Utica Junction – Yankton Junction 115 kV line is just north of Gavins Point in South Dakota. The high post-contingency loading on this line warrants additional evaluation and coordination with the transmission owner (Northwest Public Service) and the transmission planner (WAPA UGP) for this facility.

There were no post-contingency voltage violations discovered in the Category C multiple element ACCC analysis of the 2010 Spring Peak case.

Category D Results (TPL-004):

There were thirteen facility overloads discovered in the Category D ACCC analysis of the 2010 Spring Peak case with the wind generation interconnection facilities as a result of three Category D contingencies. The post-contingency facility overloads that were discovered are summarized in Table 6 below.

Table 6. 2010 Spring Peak: Category D Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	CSPT-SA-CCR	100	118.1
640068	B.SPRGS7 115.00	640091	BRULE 7 115.00	1	CSPT-SK-SO	120	126.5
640068	B.SPRGS7 115.00	640246	JULSTAP7 115.00	1	CSPT-SK-SO	120	106.2
640091	BRULE 7 115.00	659132	OGALALA7 115.00	1	CSPT-SK-SO	120	125
640246	JULSTAP7 115.00	652300	CHAPPEL7 115.00	1	CSPT-SK-SO	120	124.1
652300	CHAPPEL7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	127.6
652572	SIDNEY 7 115.00	659136	SIDNEY*4 230.00	1	CSPT-SK-SO	112	141
652572	SIDNEY 7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	128.6
652573	STEGALL4 230.00	659206	STGXFMR4 230.00	1	CSPT-SK-SO	400	108
659134	SIDNEY 4 230.00	659136	SIDNEY*4 230.00	1	CSPT-SK-SO	112	144
659135	STEGALL3 345.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	108.7
659206	STGXFMR4 230.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	105
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	INT-CF-CSJ	60	118.7
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	CSPT-HR-HTC	60	117.4
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	OPPD CATD 10	60	112.9
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	OPPD_CIP5	60	112.9
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SUB-68TH-HLD*	60	112.7

**Only the top five contingency overloads reported in Table 6.*

The Canaday 230 / 115 kV transformer was overloaded for loss of the Sweetwater – Axtell 345 kV and Crooked Creek – Riverdale 230 kV cross point. The facility rating for the Canaday 230 /115 kV transformer is 100 MVA and is planned to be increased to 336 MVA by Fall 2010. The loading on this facility would not be an issue once the work to replace the existing transformer with the new 336 MVA unit is complete.

The Utica Junction – Yankton Junction 115 kV line was found to load above its 60 MVA rating for a number of contingencies. The Utica Junction – Yankton Junction 115 kV line is just north of Gavins Point in South Dakota. The high post-contingency loading on this line warrants additional evaluation and coordination with the transmission owner (Northwest Public Service) and the transmission planner (WAPA UGP) for this facility.

There was a single bus voltage violation discovered in the Category D ACCC analysis of the 2010 Spring Peak case. The Wayside 230 kV bus voltage was found below criteria for the CSPT-SK-SO (Sidney – Keystone 345 kV & Sidney – Ogallala 230 kV) contingency.

Phase 2 – 2016 Summer Peak

Category C Results (TPL-003):

There were no facility overloads discovered in the Category C ACCC analysis of the 2016 Summer Peak case with the wind generation interconnection facilities. There were also no bus voltage violations discovered in the Category C ACCC analysis of the 2016 Summer Peak case.

Category D Results (TPL-004):

There were fifteen facility overloads discovered in the Category D ACCC analysis of the 2016 Summer Peak case with the wind generation interconnection facilities. There were also no bus voltage violations discovered in the Category D ACCC analysis of the 2016 Summer Peak case. The post-contingency facility overloads that were discovered are summarized in Table 7 below.

Table 7. 2016 Summer Peak: Category D Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
659134	SIDNEY 4 230.00	659136	SIDNEY*4 230.00	1	CSPT-SK-SO	112	146.7
652572	SIDNEY 7 115.00	659136	SIDNEY*4 230.00	1	CSPT-SK-SO	112	143.2
652572	SIDNEY 7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	130.8
652300	CHAPPEL7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	127.9
640246	JULSTAP7 115.00	652300	CHAPPEL7 115.00	1	CSPT-SK-SO	120	120
659135	STEGALL3 345.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	105.7
652573	STEGALL4 230.00	659206	STGXFMR4 230.00	1	CSPT-SK-SO	400	104.4
659206	STGXFMR4 230.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	103.6
640318	PETRSBG7 115.00	640444	PETERSBRG.N7115.00	1	GEN-GGS-ALL	113	101.2
640139	COOPER 3 345.00	645458	S3458 3 345.00	1	OPPD CATD 10	1195	105.5
646227	S1227 5 161.00	646231	S1231 5 161.00	1	OPPD_CIP14	335	100.7
646201	S1201 5 161.00	646206	S1206 5 161.00	1	OPPD CIP21	221	103.4
646201	S1201 5 161.00	646206	S1206 5 161.00	1	OPPD_CIP21	221	103.4
640139	COOPER 3 345.00	645458	S3458 3 345.00	1	OPPD CIP5	1195	105.5

One contingency (Loss of all GGS generation) was found which could potentially result in the overload of the Petersburg North – Petersburg 115 kV line sections. This contingency / facility overload combination was not an issue prior to the interconnection of the new wind generation facilities. The post-contingency loading did not exceed the 30-minute short-term emergency rating.

Phase 2 – 2016 Winter Peak

Category C Results (TPL-003):

There was one facility overload discovered in the Category C ACCC analysis of the 2016 Winter Peak case with the wind generation interconnection facilities. The overload was not in the NPPD area. The post-contingency facility overloads that were discovered are summarized in Table 8 below.

Table 8. 2016 Winter Peak: Category C Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
652476	EAGLEBT7 115.00	652520	OAHE 7 115.00	1	BKR-WAY-186	60	102.8

There were also no bus voltage violations discovered in the Category C ACCC analysis of the 2016 Winter Peak case.

Category D Results (TPL-004):

There were ten facility overloads discovered in the Category D ACCC analysis of the 2016 Winter Peak case with the wind generation interconnection facilities. Three Category D contingencies were identified that resulted in the facility overloads. The post-contingency facility overloads that were discovered are summarized in Table 9 below.

Table 9. 2016 Winter Peak: Category D Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640139	COOPER 3 345.00	645458	S3458 3 345.00	1	OPPD CATD 10	1195	105.8
640139	COOPER 3 345.00	645458	S3458 3 345.00	1	OPPD CIP5	1195	105.8
659206	STGXFMR4 230.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	108.6
640246	JULSTAP7 115.00	652300	CHAPPEL7 115.00	1	CSPT-SK-SO	120	108.8
652573	STEGALL4 230.00	659206	STGXFMR4 230.00	1	CSPT-SK-SO	400	111.7
659135	STEGALL3 345.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	112.3
652300	CHAPPEL7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	113.1
652572	SIDNEY 7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	114.7
652572	SIDNEY 7 115.00	659136	SIDNEY*4 230.00	1	CSPT-SK-SO	112	127.4
659134	SIDNEY 4 230.00	659136	SIDNEY*4 230.00	1	CSPT-SK-SO	112	128.8

There were three bus voltage violations discovered in the Category D ACCC analysis of the 2016 Winter Peak case. The Wayside 230 kV, Rapid City 230 kV and Rushmore 115 kV bus voltages were found below criteria for the CSPT-SK-SO (Sidney – Keystone 345 kV & Sidney – Ogallala 230 kV) contingency.

Phase 2 – 2016 Spring Light Load

Category C Results (TPL-003):

There was one facility overload discovered in the Category C ACCC analysis of the 2016 Spring Light Load case with the wind generation interconnection facilities and reported in the table. The overload was not in the NPPD area, but was in the immediate vicinity of the wind generation interconnection projects. The post-contingency facility overloads that were discovered are summarized in Table 10 below.

Table 10. 2016 Spring Light Load: Category C Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	BUS-HOSKINS	60	133
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	BKR-WAY-186	60	131.7
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	BUS-TWNCRH-N	60	130.7
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	BKR-HOS-3312	60	129.4
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	BKR-CPR-3304*	60	129.3

**Only the top five contingency overloads reported in Table 10.*

There were also no bus voltage violations discovered in the Category C ACCC analysis of the 2016 Spring Light Load case.

Category D Results (TPL-004):

There were sixteen facility overloads discovered in the Category D ACCC analysis of the 2016 Spring Light Load case with the wind generation interconnection facilities and reported in the table. None of the overloads were in the NPPD area, but one facility was in the immediate vicinity of the wind generation interconnection projects. The post-contingency facility overloads that were discovered are summarized in Table 11 below.

Table 11. 2016 Spring Light Load: Category D Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640068	B.SPRGS7 115.00	640091	BRULE 7 115.00	1	CSPT-SK-SO	120	133.8
640068	B.SPRGS7 115.00	640246	JULSTAP7 115.00	1	CSPT-SK-SO	120	110
640091	BRULE 7 115.00	659132	OGALALA7 115.00	1	CSPT-SK-SO	120	132.6
640246	JULSTAP7 115.00	652300	CHAPPEL7 115.00	1	CSPT-SK-SO	120	126.7
652300	CHAPPEL7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	129.4
659134	SIDNEY 4 230.00	659136	SIDNEY*4 230.00	1	CSPT-SK-SO	112	145.8
659135	STEGALL3 345.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	109.6
659206	STGXFMR4 230.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	104.9
652572	SIDNEY 7 115.00	659136	SIDNEY*4 230.00	1	CSPT-SK-SO	112	142.6
652572	SIDNEY 7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	130.3
652573	STEGALL4 230.00	659206	STGXFMR4 230.00	1	CSPT-SK-SO	400	109.3
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	CSPT-HR-HTC	60	134.3
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	GEN-EC-ALL	60	125.4
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	GEN-GGS-ALL	60	124.9
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	OPPD CIP1	60	124.2
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	OPPD CATD 13	60	124.1

**Only the top five contingency overloads reported in Table 11.*

There were ten bus voltage violations discovered in the Category D ACCC analysis of the 2016 Spring Light Load case. The bus voltage violations were found in the Wayside / New Underwood / Rapid City area below criteria for the CSPT-SK-SO (Sidney – Keystone 345 kV & Sidney – Ogallala 230 kV) contingency.

Phase 2 Results Summary

Overall, there were three transmission facility overloads discovered in the Phase 2 screening that were in the immediate vicinity of the proposed generation interconnection projects. One of the three transmission facility overloads (Yankton Junction – Utica Junction 115 kV) were found on an external system and would need further coordination and investigation with the affected party (WAPA). The Yankton Junction – Utica Junction 115 kV facility overload was discovered for both Category C and Category D contingencies.

Two of the three transmission facility overloads (Petersburg North – Petersburg 115 kV & Canaday 230/115 kV) were found on the NPPD transmission system and in the immediate vicinity of the wind generation interconnection projects. The Petersburg North – Petersburg 115 kV facility overload was found only for a Category D disturbance (Loss of both GGS units) and did not exceed the short-term emergency rating of the facilities. The Canaday 230/115 kV facility overload was for both Category C and D contingencies, but

this transformer is scheduled to be replaced in Fall 2010 with a larger unit that would accommodate the post-contingency loadings discovered in this analysis.

5.3 Phase 3 Results (Local Area Full Accredited Generation Capacity N-1 & N-2 Contingency Analysis)

5.3.1 Phase 3 – N-1 Contingency Screening Analysis Results

PSS/E activity ACCC was used as a screening tool on the maximum generation powerflow model to identify those contingencies which deserve closer study. It should be noted that the powerflow models utilized in this phase of the loadflow study represent extreme worst-case generation outlet conditions. The powerflow models represent a highly unlikely maximum simultaneous generation dispatch scenario of generation facilities in the area. ACCC analyzed the system by sequentially taking contingencies in the NPPD, LES, OPPD, WAPA, and MEC areas out-of-service and monitoring facilities in the NPPD, LES, OPPD, WAPA and MEC areas for violations of loading or bus voltage criteria. The results of the contingency analysis are shown in the ACCC summary printouts included in Appendix C.

Phase 3 – 2010 Spring Peak (N-1)

System Intact Results (TPL-001):

One transmission facility was found to be loaded above its normal facility rating under system intact conditions. The Yankton Junction – Utica Junction 115 kV line in the WAPA system was loaded to 171.0% of the 60 MVA normal rating. The high loading on the Yankton Junction – Utica Junction 115 kV line will need to be coordinated with WAPA due to relatively close proximity of the overloaded line to the proposed wind interconnection projects.

N-1 Contingency Results (TPL-002):

Six overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2010 Spring Peak case with the wind facility additions. The full ACCC results are summarized in Appendix C. The post-contingency facility overloads that were discovered are summarized in Table 12 below.

Table 12. 2010 Spring Peak (max gen): N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	SINGLE 252	120	106.0
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	SINGLE 270	100	139.2
640287	N.PLATT7 115.00	640365	STOCKVL7 115.00	1	SINGLE 347	137	104.0
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 789	120	141.2
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 742	120	135.5
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 743	120	123.4
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 370	120	117.6
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 255*	120	113.2
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 789	60	240.9
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 742	60	231.6
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 769	60	227.7
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 743	60	211.9
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 370*	60	201.9
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 861	250	135.7
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 865	250	135.7
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 861	250	135.7
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 865	250	135.7

**Only the top five contingency overloads reported in Table 12.*

The Gavins Point – Bloomfield 115 kV line was overloaded for loss of the proposed Bloomfield – Belden 115 kV line. The facility rating for the Gavins Point – Bloomfield 115 kV line is planned to be increased to 159 MVA to accommodate the addition of the prior queued Crofton Hills wind project. The facility rating increase is dependent on substation upgrades at the Gavins Point 115 kV substation and these upgrades are scheduled to be completed prior to the interconnection of the Crofton Hills project.

The Canaday 230 / 115 kV transformer was overloaded for loss of the Crooked Creek – Riverdale 230 kV line. The facility rating for the Canaday 230 /115 kV transformer is 100 MVA and is planned to be increased to 336 MVA by Fall 2010. The loading on this facility would not be an issue once the work to replace the existing transformer with the new 336 MVA unit is complete.

The North Platte – Stockville 115 kV line was overloaded for loss of the GGS – Red Willow 345 kV line. This contingency / monitored element pair are the limiting elements associated with the WNE_WKS PTDF flowgate. The post-contingency loading on the North Platte – Stockville 115 kV line is less than the 30-minute short-term emergency rating of 151 MVA.

The Gavins Point – Yankton Junction 115 kV line was found to load above its 120 MVA rating for a number of N-1 contingencies. The Gavins Point – Yankton Junction 115 kV line is just north of Gavins Point in South Dakota. The high post-contingency loading on

this line warrants additional evaluation and coordination with the transmission owner and the transmission planner (WAPA UGP) for this facility.

The Utica Junction – Yankton Junction 115 kV line was found to load above its 60 MVA rating for a number of N-1 contingencies. The Utica Junction – Yankton Junction 115 kV line is just north of Gavins Point in South Dakota. The high post-contingency loading on this line warrants additional evaluation and coordination with the transmission owner (Northwest Public Service) and the transmission planner (WAPA UGP) for this facility.

The Leland Olds 345/230 kV transformer was found to load above its 250 MVA rating for loss of the parallel 345/230 kV transformer. The post-contingency loading of this facility would need further review and coordination by the facility owner (BEPC) and the transmission planner (WAPA UGP) for this facility.

There were eleven bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis. The post-contingency bus voltage violations that were discovered are summarized in Appendix C. Only one contingency (SINGLE 336: Firth – Sheldon 115 kV) was found the NPPD area. The bus voltage violation is a modeling issue and can easily be addressed by adjusting the 115/69 kV transformer taps at the Sterling 115 kV substation. The remaining bus voltage violation issues would need to be coordinated with external entities for further review.

Phase 3 – Powerflow One-Line Diagrams (N-1)

Several powerflow one-line diagrams are provided to show system flows and voltages in the area for several worst-case system intact and N-1 contingency conditions. The 2010 Spring Peak Maximum Generation cases were utilized for this analysis. The worst-case system conditions that are provided via powerflow one-line diagrams are listed below.

1. System Intact
2. Loss of Petersburg North – Neligh 115 kV
3. Loss of Petersburg North – Madison 115 kV
4. Loss of Petersburg North – Petersburg 115 kV
5. Loss of Bloomfield – Creighton 115 kV
6. Loss of Bloomfield – Gavins Point 115 kV
7. Loss of Bloomfield – Belden 115 kV
8. Loss of Spirit Mound – Manning 115 kV
9. Loss of Madison County – Ft. Randall 230 kV
10. Loss of Madison County – Kelly 230 kV
11. Loss of Broken Bow – Callaway 115 kV
12. Loss of Broken Bow – Crooked Creek 115 kV
13. Loss of Broken Bow – Loup City 115 kV
14. Loss of Crooked Creek – Riverdale 230 kV

The powerflow one-line diagrams for the Phase 3 2010 Spring Peak Maximum Generation models are in Section 5.3.4.

5.3.2 Phase 3 – Multiple Element Contingency Analysis Results

This phase of the analysis evaluated all worst-case stuck breaker and double circuit contingencies in the local areas with the wind facility additions. PSS/E activity ACCC was used as a screening tool on each of the maximum generation base cases with the additions to identify those contingencies which deserve closer study. ACCC analyzed the system by sequentially taking stuck breaker and double circuit contingencies in the areas near the wind generation additions and monitoring facilities in the NPPD, OPPD, LES, MEC, and WAPA areas for violations of loading or bus voltage criteria. The results of the contingency analysis are shown in the ACCC summary printouts included in Appendix C.

The stuck breaker and double circuit contingencies that were evaluated in this analysis are listed below.

Stuck PCB at Petersburg North 115 kV
Stuck PCB at Albion 115 kV
Stuck PCB at Genoa 115 kV
Stuck PCB at Spalding 115 kV
Stuck PCB at North Loup 115 kV
Stuck PCB at Neligh 115 kV
Stuck PCB at Creighton 115 kV
Stuck PCB 1104 at Bloomfield 115 kV
Stuck PCB 1102 at Bloomfield 115 kV
Stuck PCB at Gavins Point 115 kV
Stuck PCB at Kelly 230 kV
Stuck PCB at Broken Bow 115 kV
Stuck PCB at Callaway 115 kV
Stuck PCB at Maxwell 115 kV
Stuck PCB at Loup City 115 kV
Stuck PCB at Crooked Creek 230 kV
DOUBLE CIRCUIT: KELLY-SHELL CREEK 230 KV & COLUMBUS-CRESTON 115 KV
DOUBLE CIRCUIT: SHELL CREEK-HOSKINS 345 KV & COLUMBUS-CRESTON 115 KV
DOUBLE CIRCUIT: SHELL CREEK-HOSKINS 345 KV & CRESTON-MADISON 115 KV
DOUBLE CIRCUIT: SHELL CREEK-HOSKINS 345 KV & MADISON-NORFOLK 115 KV
DOUBLE CIRCUIT: SHELL CREEK-HOSKINS 345 KV & NORFOLK-HOSKINS 115 KV

Phase 3 – 2010 Spring Peak (Stuck PCB / Double Circuit)

There were six stuck breaker contingency overloads identified in the monitored study areas during the ACCC runs of the 2010 Spring Peak Maximum Generation case with the proposed wind facilities. The post-contingency overloads are summarized in Appendix C. These contingency overloads are summarized in Table 13 below:

Table 13. 2010 Spring Peak (max gen): Multiple Element Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	BKR-CC-2202	100	126.4
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	CREIGHTON	120	112.8
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	NELIGH	120	106.5
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	ALBION	120	102
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	GENOA	120	100.5
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	CREIGHTON	60	193.5
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	NELIGH	60	183.9
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	ALBION	60	177.5
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	GENOA	60	174.8
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	NLOUP*	60	169.1

**Only the top five contingency overloads reported in Table 13.*

The Canaday 230 / 115 kV transformer was overloaded for loss of the Crooked Creek – Riverdale 230 kV line. The facility rating for the Canaday 230 /115 kV transformer is 100 MVA and is planned to be increased to 336 MVA by Fall 2010. The loading on this facility would not be an issue once the work to replace the existing transformer with the new 336 MVA unit is complete.

The Gavins Point – Yankton Junction 115 kV line was found to load above its 120 MVA rating for a number of multiple element contingencies. The Gavins Point – Yankton Junction 115 kV line is just north of Gavins Point in South Dakota. The high post-contingency loading on this line warrants additional evaluation and coordination with the transmission owner and the transmission planner (WAPA UGP) for this facility.

The Utica Junction – Yankton Junction 115 kV line was found to load above its 60 MVA rating for a number of multiple element contingencies. The Utica Junction – Yankton Junction 115 kV line is just north of Gavins Point in South Dakota. The high post-contingency loading on this line warrants additional evaluation and coordination with the transmission owner (Northwest Public Service) and the transmission planner (WAPA UGP) for this facility.

There were no bus voltage violations identified in the monitored study areas in the ACCC screening of the 2010 Spring Peak Maximum Generation case with the proposed wind facilities.

5.3.3 Phase 3 – Independent N-2 Contingency Analysis Results

This phase of the analysis evaluated all independent N-2 contingencies in the areas with the wind facility additions. PSS/E activity ACCC was used as a screening tool on the 2010 Spring Peak Maximum Generation powerflow model with the wind facility

additions to identify those contingencies which deserve closer study. ACCC analyzed the system by sequentially taking out all independent N-2 contingencies in the area and monitoring facilities in the NPPD, OPPD, LES, WAPA, and MEC areas for violations of loading or bus voltage criteria. A total of 1653 independent N-2 contingencies were evaluated in this analysis. The results of the contingency analysis are shown in the ACCC summary printouts included in Appendix C.

Phase 3 – 2010 Spring Peak (Independent N-2)

There were a number of overloaded transmission facilities discovered in the monitored study areas in the independent N-2 ACCC analysis of the 2010 Spring Peak cases with the wind facility additions. The worst-case facility overloads identified in the ACCC analysis are summarized in Table 14 below. Prior outage generation restrictions would be required to ensure the transmission system is able to be operated reliability when certain transmission lines are taken out-of-service. The wind project curtailments will be subject to "first on, last off" curtailment priorities and operating guides will need to be developed to ensure the transmission system is operated in accordance with mandatory reliability standards. Based on a review of the N-2 contingencies that were flagged in the ACCC analysis, the following list was prepared of transmission facilities that would need detailed prior outage review or operating guides established. These transmission facilities were found to be part of an N-2 contingency pairing that resulted in a facility overload on the NPPD transmission system.

Limiting Prior Outage Facilities

1. Petersburg North – Madison 115 kV
2. Petersburg North – Petersburg 115 kV
3. Petersburg North – Neligh 115 kV
4. Petersburg – Albion 115 kV
5. Albion – Genoa 115 kV
6. Neligh – County Line 115 kV
7. Creighton – Neligh 115 kV
8. Bloomfield – Creighton 115 kV
9. Bloomfield – Gavins Point 115 kV
10. Bloomfield – Belden 115 kV
11. Belden – Twin Church 115 kV
12. Belden – Hoskins 115 kV
13. Gavins Point – Yankton Junction 115 kV
14. Yankton Junction – Utica Junction 115 kV
15. Spirit Mound – Manning 115 kV
16. Broken Bow – Callaway 115 kV
17. Broken Bow – Loup City 115 kV
18. Broken Bow – Crooked Creek 115 kV
19. Crooked Creek 230/115 kV
20. Callaway – Maxwell 115 kV

There were a number of other N-2 contingencies that would result in facility overloads on the WAPA transmission system. The limiting facility overloads on the WAPA system are included in Table 14 below and highlighted in blue. These facility overloads and potential prior outage limitations would need to be coordinated with WAPA.

There were no bus voltage violations identified in the monitored study areas in the Phase 3 Independent N-2 ACCC screening analysis of the 2010 Spring Peak Maximum Generation model.

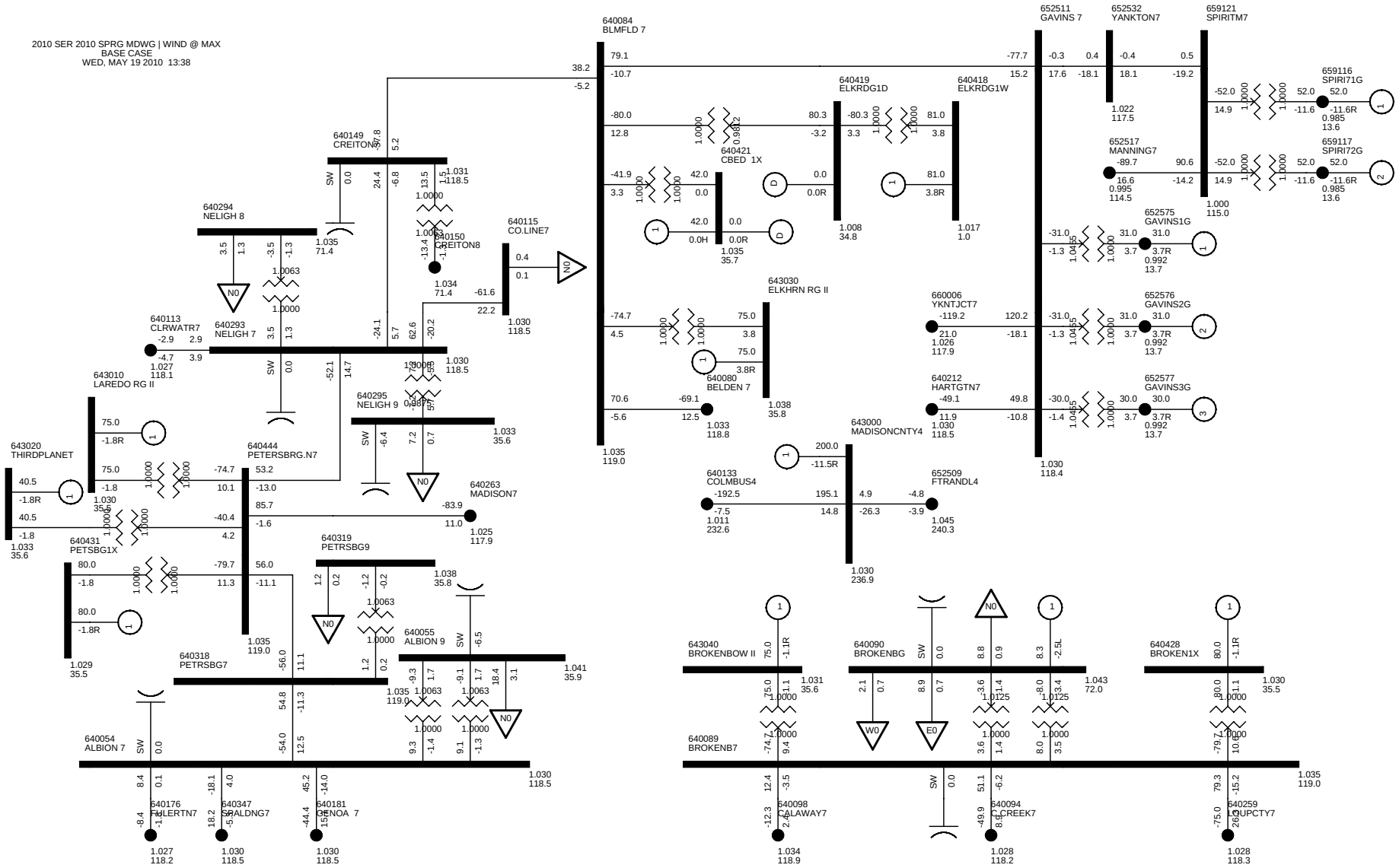
Table 14. 2010 Spring Peak (max gen): Independent N-2 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640054	ALBION 7 115.00	640318	PETRSBG7 115.00	1	DOUBLE 1427	113	166.4
640054	ALBION 7 115.00	640318	PETRSBG7 115.00	1	DOUBLE 1071	113	111
640054	ALBION 7 115.00	640181	GENOA 7 115.00	1	DOUBLE 1427	113	122.5
640072	BATTLCR7 115.00	640115	CO.LINE7 115.00	1	DOUBLE 1428	120	109.6
640072	BATTLCR7 115.00	640115	CO.LINE7 115.00	1	DOUBLE 306	120	109.1
640072	BATTLCR7 115.00	640296	NORFK.N7 115.00	1	DOUBLE 1428	120	106
640072	BATTLCR7 115.00	640296	NORFK.N7 115.00	1	DOUBLE 306	120	105.6
640080	BELDEN 7 115.00	640387	TWIN CH7 115.00	1	DOUBLE 520	99	120.5
640080	BELDEN 7 115.00	640387	TWIN CH7 115.00	1	DOUBLE 1639	99	114.9
640080	BELDEN 7 115.00	640387	TWIN CH7 115.00	1	DOUBLE 613	99	100.8
640080	BELDEN 7 115.00	640387	TWIN CH7 115.00	1	DOUBLE 524	99	100.6
640080	BELDEN 7 115.00	640228	HOSKINS7 115.00	1	DOUBLE 567	113	109.2
640080	BELDEN 7 115.00	640228	HOSKINS7 115.00	1	DOUBLE 1639	113	100.8
640080	BELDEN 7 115.00	640212	HARTGTN7 115.00	1	DOUBLE 1639	120	113.1
640080	BELDEN 7 115.00	640212	HARTGTN7 115.00	1	DOUBLE 423	120	106.1
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	DOUBLE 382	120	152.3
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	DOUBLE 400	120	141.4
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	DOUBLE 394**	120	122
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	DOUBLE 407**	120	115
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	DOUBLE 413**	120	112.6
640084	BLMFLD 7 115.00	640149	CREITON7 115.00	1	DOUBLE 383	159	114.3
640089	BROKENB7 115.00	640098	CALAWAY7 115.00	1	DOUBLE 665	120	115.2
640089	BROKENB7 115.00	640098	CALAWAY7 115.00	1	DOUBLE 751	120	115.2
640089	BROKENB7 115.00	640259	LOUPCTY7 115.00	1	DOUBLE 664	120	115.2
640089	BROKENB7 115.00	640259	LOUPCTY7 115.00	1	DOUBLE 709	120	115.2
640089	BROKENB7 115.00	640259	LOUPCTY7 115.00	1	DOUBLE 671	120	109.5
640089	BROKENB7 115.00	640259	LOUPCTY7 115.00	1	DOUBLE 797	120	109.5
640098	CALAWAY7 115.00	640267	MAXWELS7 115.00	1	DOUBLE 665	120	109.6
640098	CALAWAY7 115.00	640267	MAXWELS7 115.00	1	DOUBLE 751	120	109.6
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	DOUBLE 754***	100	163.9
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	DOUBLE 927***	100	146.3
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	DOUBLE 19***	100	145.7
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	DOUBLE 926***	100	144.3
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	DOUBLE 932*,***	100	142.8
640115	CO.LINE7 115.00	640293	NELIGH 7 115.00	1	DOUBLE 1428	120	110.1
640115	CO.LINE7 115.00	640293	NELIGH 7 115.00	1	DOUBLE 306	120	109.6
640115	CO.LINE7 115.00	640293	NELIGH 7 115.00	1	DOUBLE 383	120	100.3
640149	CREITON7 115.00	640293	NELIGH 7 115.00	1	DOUBLE 383	143	117.9
640212	HARTGTN7 115.00	652511	GAVINS 7 115.00	1	DOUBLE 1639	120	124.9
640212	HARTGTN7 115.00	652511	GAVINS 7 115.00	1	DOUBLE 423	120	117.9
640293	NELIGH 7 115.00	640444	PETERSBRG.N7115.00	1	DOUBLE 1428	113	167.9
640293	NELIGH 7 115.00	640444	PETERSBRG.N7115.00	1	DOUBLE 306	113	166.9
640293	NELIGH 7 115.00	640444	PETERSBRG.N7115.00	1	DOUBLE 254	113	129
640318	PETRSBG7 115.00	640444	PETERSBRG.N7115.00	1	DOUBLE 1427	113	167.4
640318	PETRSBG7 115.00	640444	PETERSBRG.N7115.00	1	DOUBLE 1071	113	112
652502	BERSFRD7 115.00	652517	MANNING7 115.00	1	DOUBLE 1323	120	107.3
652502	BERSFRD7 115.00	652517	MANNING7 115.00	1	DOUBLE 472	120	104.4
652502	BERSFRD7 115.00	652517	MANNING7 115.00	1	DOUBLE 613	120	100.3
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 1324	120	170.4
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 473	120	164
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 614	120	161.5
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 568	120	160.9
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 521*	120	157.3
652517	MANNING7 115.00	659121	SPIRITM7 115.00	1	DOUBLE 1323	120	118.1
652517	MANNING7 115.00	659121	SPIRITM7 115.00	1	DOUBLE 472	120	115.3
652517	MANNING7 115.00	659121	SPIRITM7 115.00	1	DOUBLE 613	120	111.2
652517	MANNING7 115.00	659121	SPIRITM7 115.00	1	DOUBLE 567	120	109.3
652517	MANNING7 115.00	659121	SPIRITM7 115.00	1	DOUBLE 520*	120	109
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 1621	60	292.8
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 1324	60	287.8
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 473	60	277.4
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 568	60	273.1
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	DOUBLE 614*	60	272.3

**Only the top five contingency overloads reported in Table 14.*
***Would be mitigated by increasing facility rating to conductor limit due to Crofton Hills project.*
****Would be mitigated by increasing facility rating to 336 MVA due to transformer replacement project (Fall 2010)*

Section 5.3.4

Phase 3 – Powerflow One-Line Diagrams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SPIRI72G
652517
MANNING7
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GAVINS1G
652576
GAVINS2G
652577
GAVINS3G
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640418
ELKRDG1W
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CBED 1X
643030
ELKHRN RG II
660006
YKNTJCT7
640080
BELDEN 7
640212
HARTGTN7
643000
MADISONCNTY4
640133
COLUMBUS4
652509
FTRANDL4
640149
CREITON7
640150
CREITON8
640294
NELIGH 8
640115
CO.LINE7
640113
CLRWATR7
640293
NELIGH 7
643010
LAREDO RG II
640295
NELIGH 9
643020
THIRDPLANET
640444
PETERSBRG.N7
640263
MADISON7
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PETSBG1X
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PETRSBG9
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PETRSBG7
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ALBION 9
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ALBION 7
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SPALDNG7
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GENOA 7
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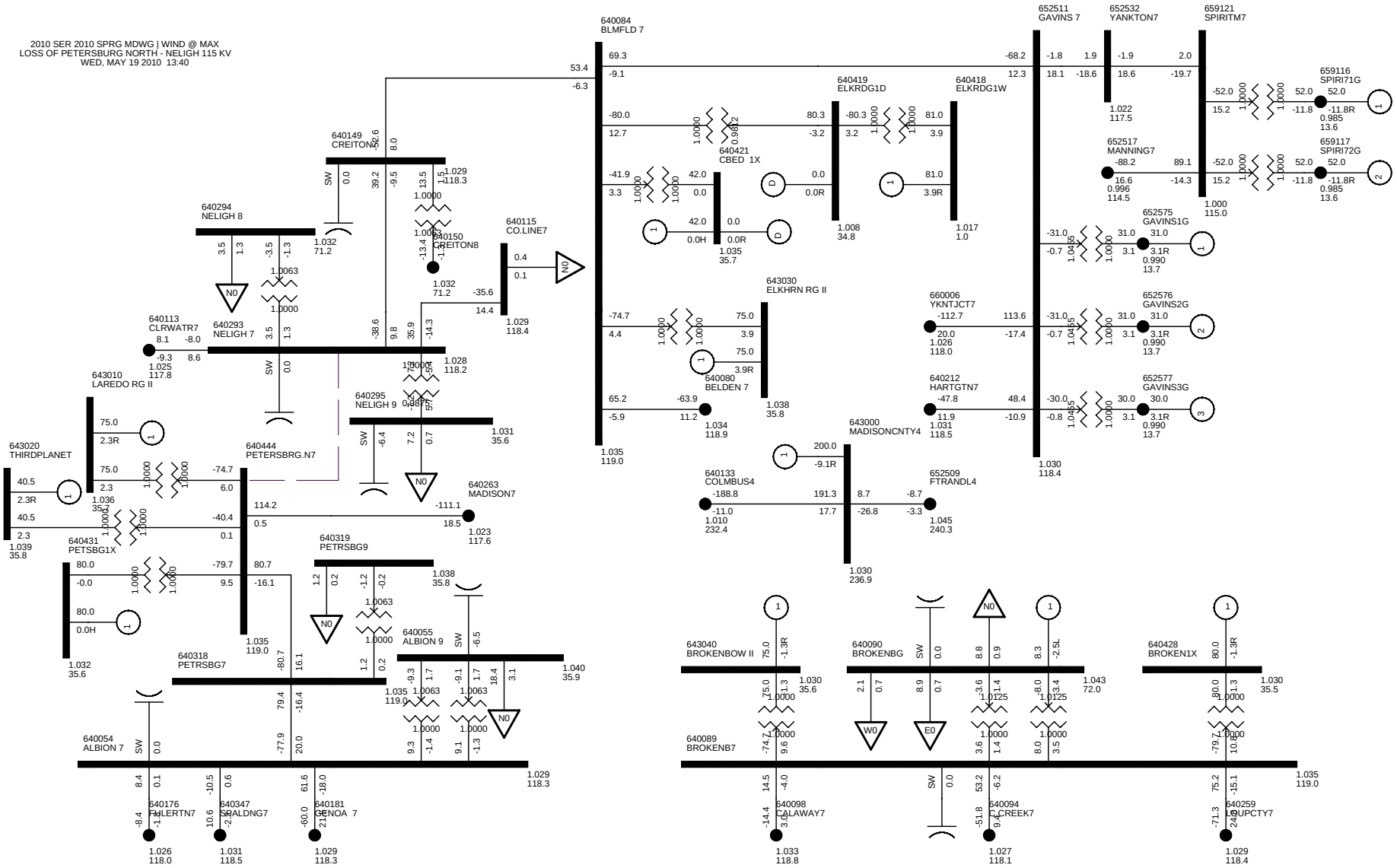
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BELDEN 7
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FTRANDL4
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CREITON7
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CREITON8
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CO.LINE7
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NELIGH 8
640293
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CLRWATR7
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LAREDO RG II
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THIRDPLANET
640444
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MADISON7
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ALBION 7
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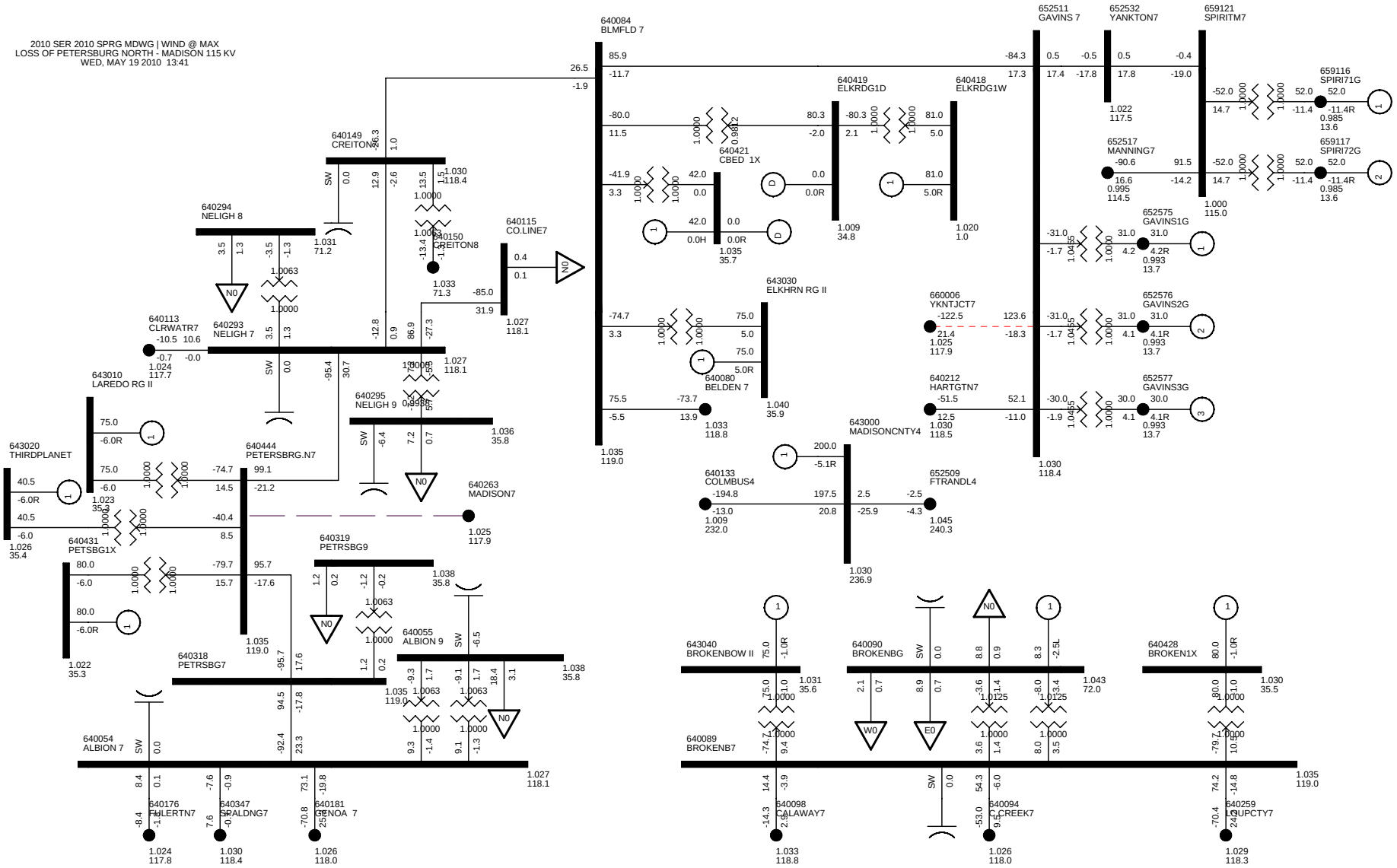
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652577 GAVINS3G
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640150 CREITON8
640294 NELIGH 8
640293 NELIGH 7
640295 NELIGH 9
640115 CO.LINE7
640113 CLRWATR7
643010 LAREDO RG II
643020 THIRDPLANET
640444 PETERSBRG.N7
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640055 ALBION 9
640054 ALBION 7
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640347 SPALDNG7
640181 GENOA 7
643030 ELKHRN RG II
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660006 YKNTJCT7
640212 HARTGTN7
643000 MADISONCNTY4
640133 COLUMBUS4
652509 FTRANDL4
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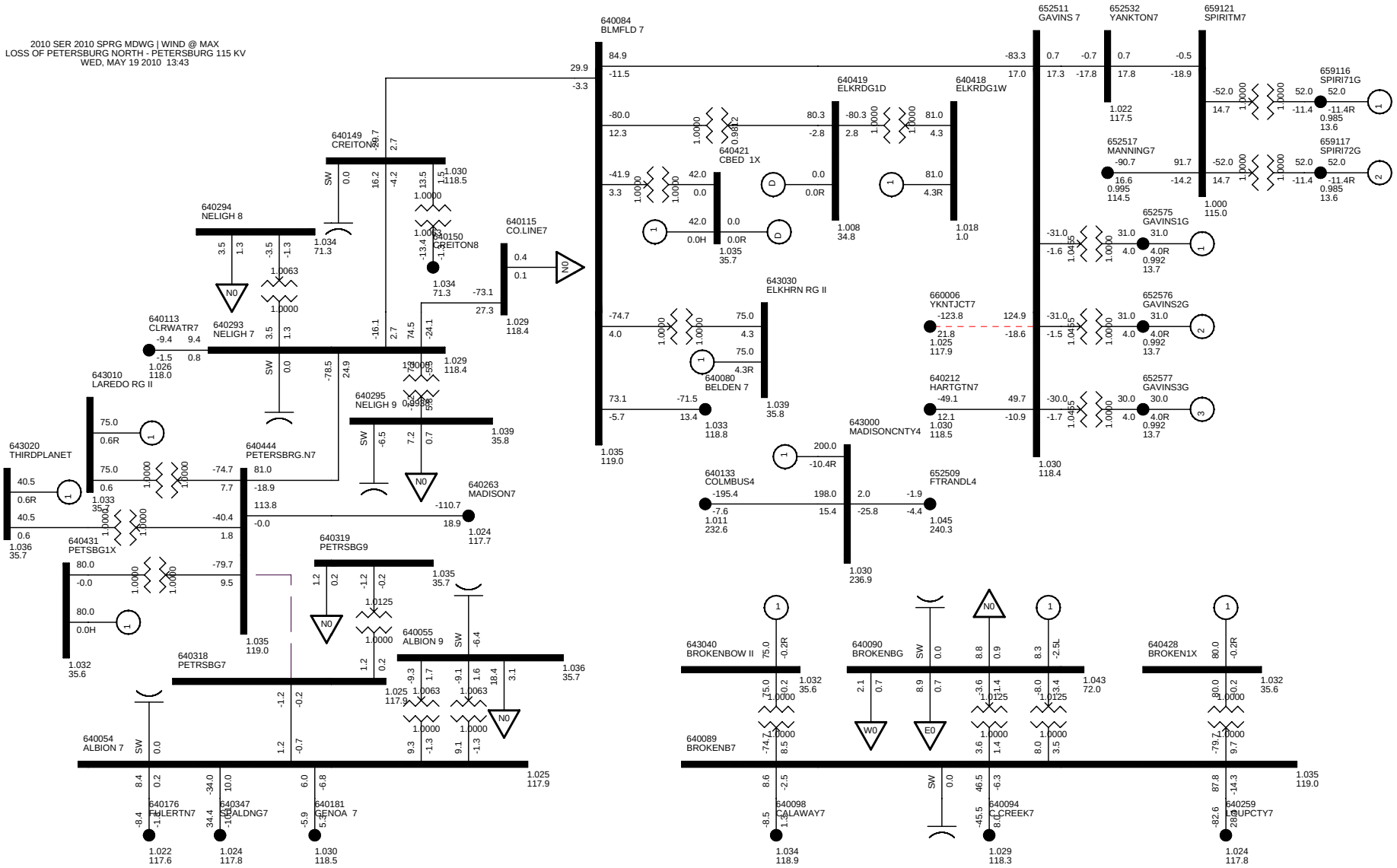
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BELDEN 7
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COLUMBUS4
652509
FTRANDL4
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CREITON7
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CREITON8
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NELIGH 8
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CLRWATR7
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NELIGH 7
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LAREDO RG II
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NELIGH 9
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THIRDPLANET
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PETERSBRG.N7
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MADISON7
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ALBION 9
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PETRSBG7
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SCALDNG7
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GENOA 7
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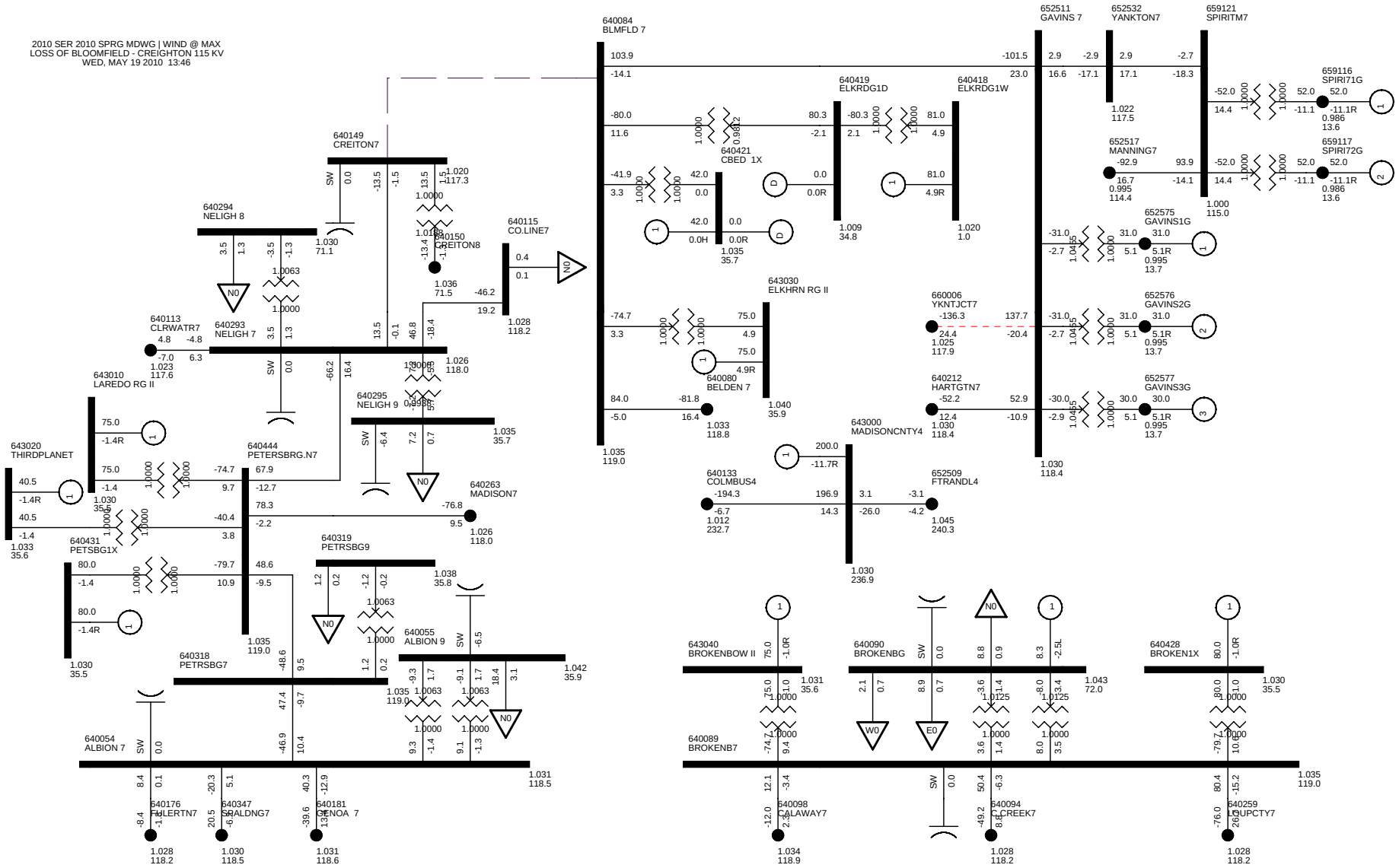
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GAVINS2G
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GAVINS3G
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CREITON7
640294
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CREITON8
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CO.LINE7
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CLRWATR7
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BELDEN 7
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HARTGTN7
643010
LAREDO RG II
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NELIGH 9
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MADISONCNTY4
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THIRDPLANET
640444
PETERSBRG.N7
640263
MADISON7
640133
COLUMBUS4
652509
FTRANDL4
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PETSBG1X
640319
PETRSBG9
640318
PETRSBG7
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ALBION 9
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BROKEN1X
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ALBION 7
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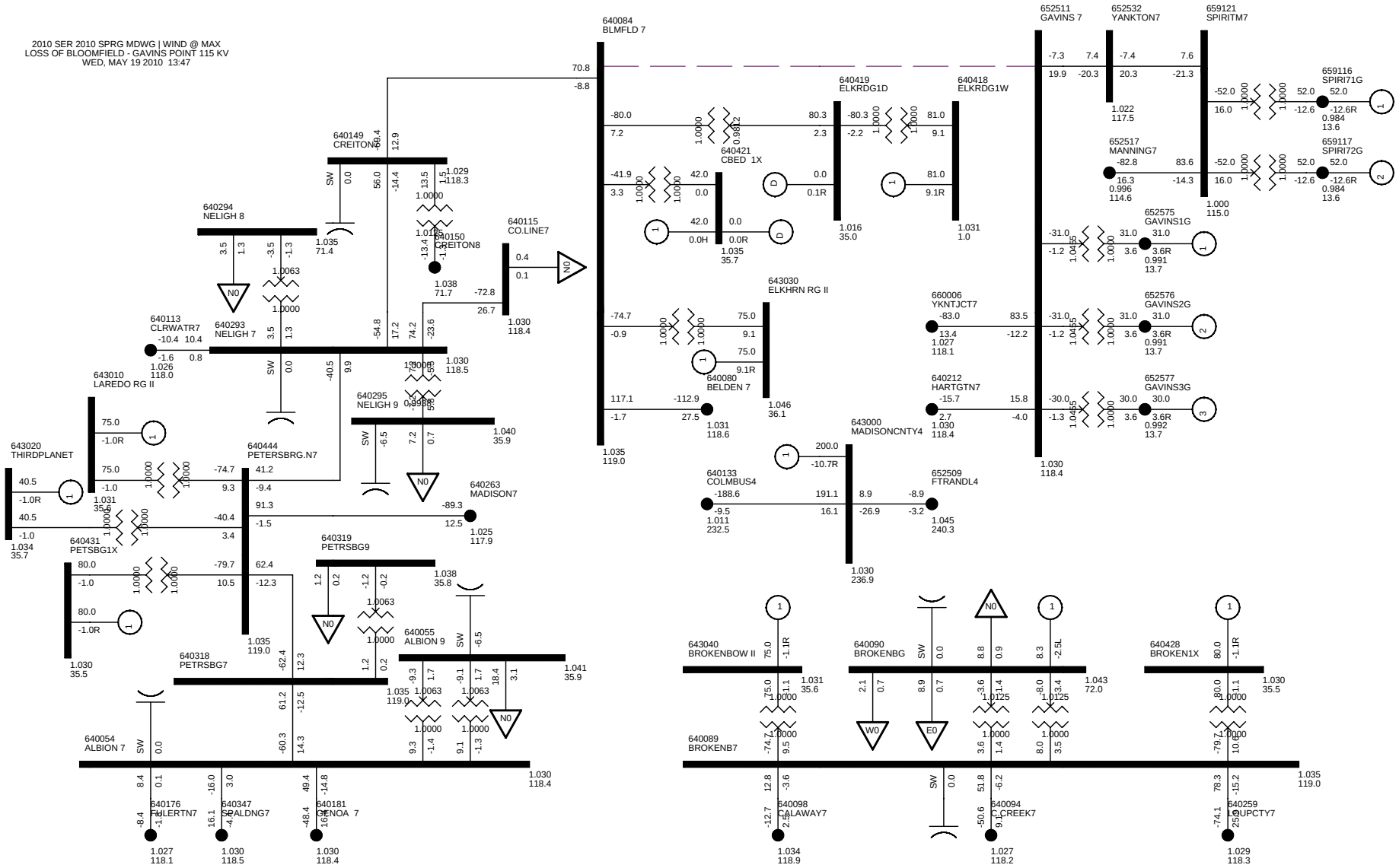
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659117 SPIRI72G
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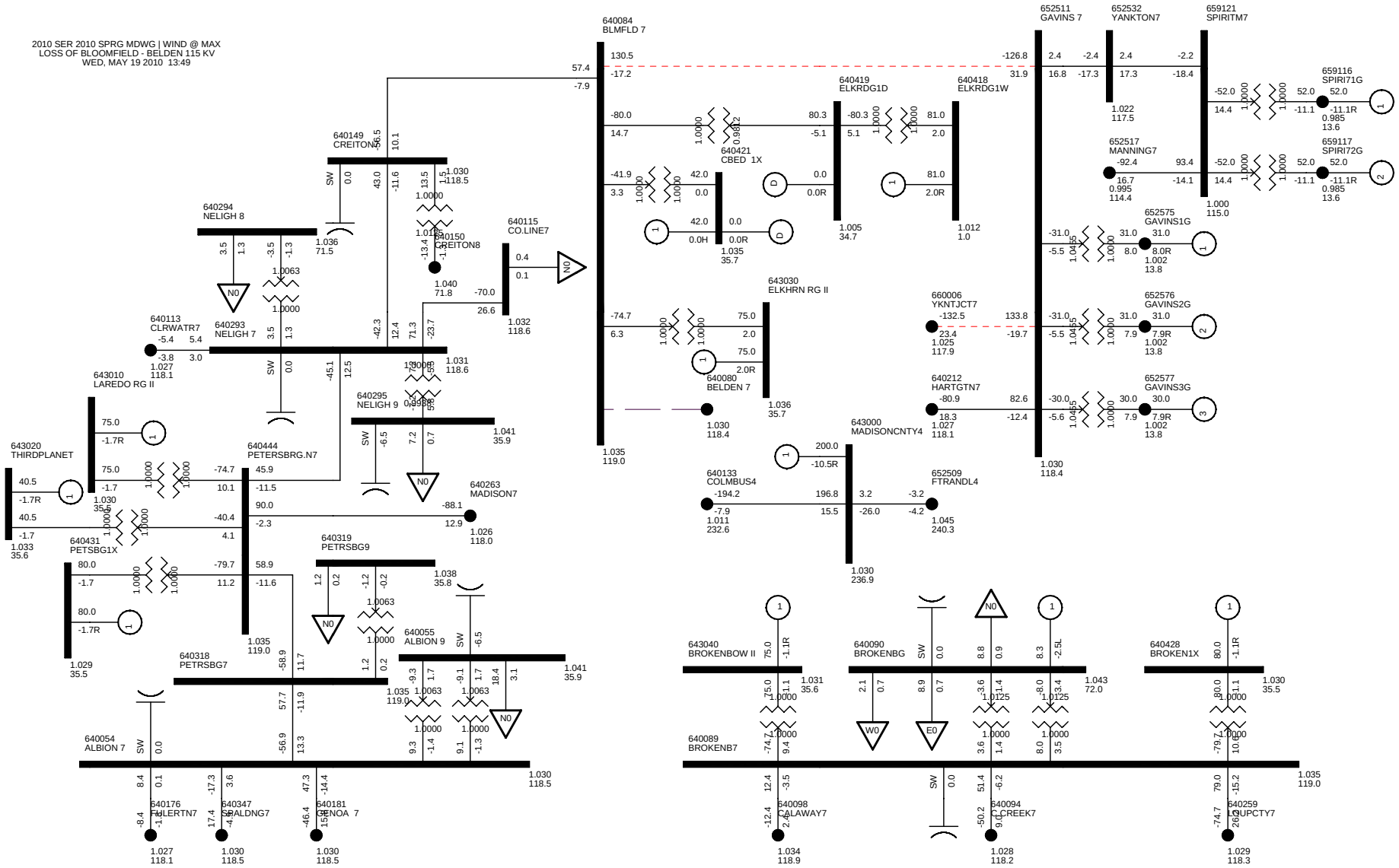
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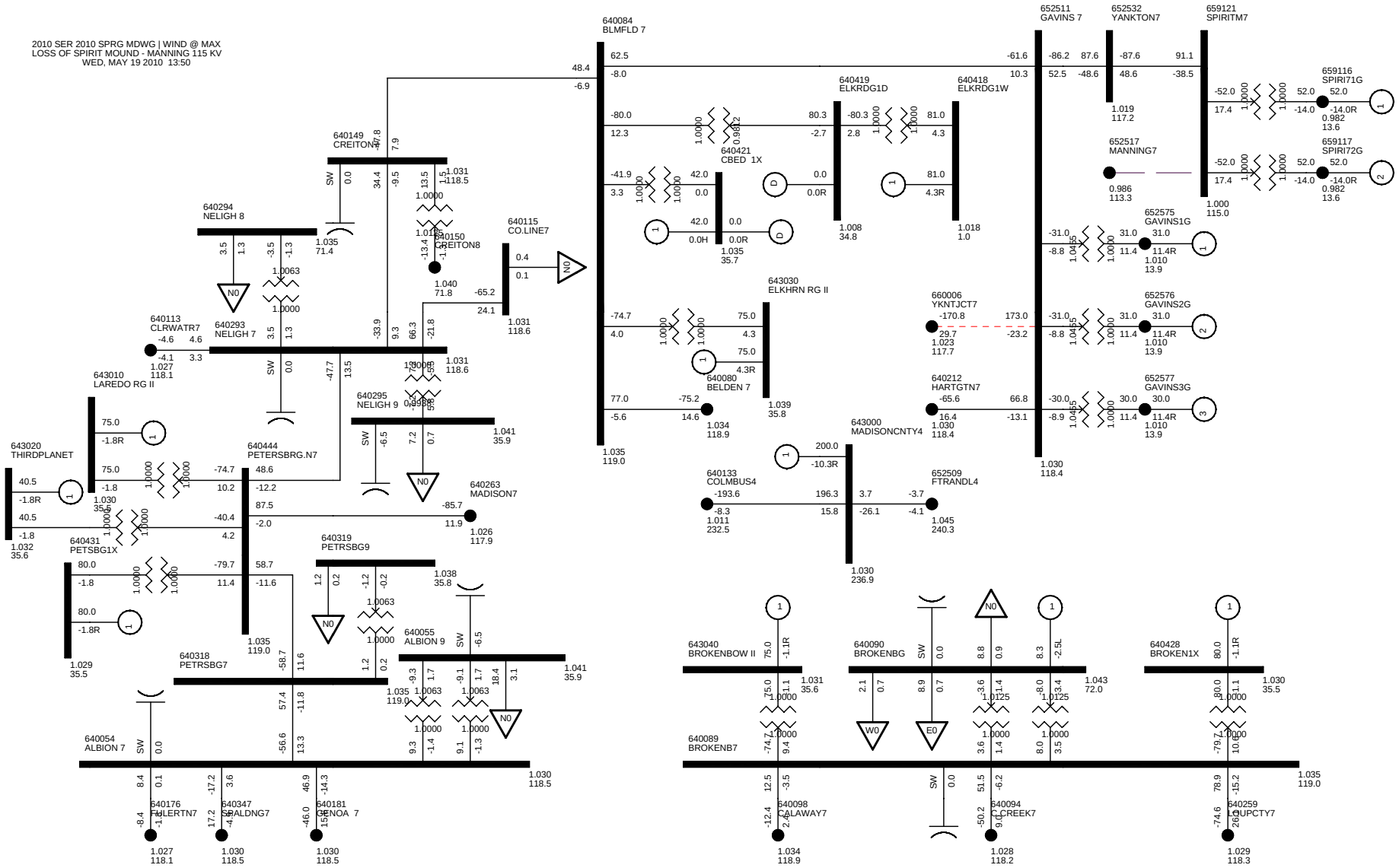
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CREITON8
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CO.LINE7
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NELIGH 9
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MADISON7
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PETSBG1X
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PETRSBG9
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PETRSBG7
640055
ALBION 9
640054
ALBION 7
640176
HLERTN7
640347
SPALDNG7
640181
GENOA 7
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ELKRDG1D
640418
ELKRDG1W
640421
CBED 1X
643030
ELKHRN RG II
640080
BELDEN 7
660006
YKNTJCT7
640212
HARTGTN7
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MADISONCNTY4
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COLUMBUS4
652509
FTRANDL4
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MANNING7
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GAVINS1G
652576
GAVINS2G
652577
GAVINS3G
659116
SPIRI71G
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SPIRI72G
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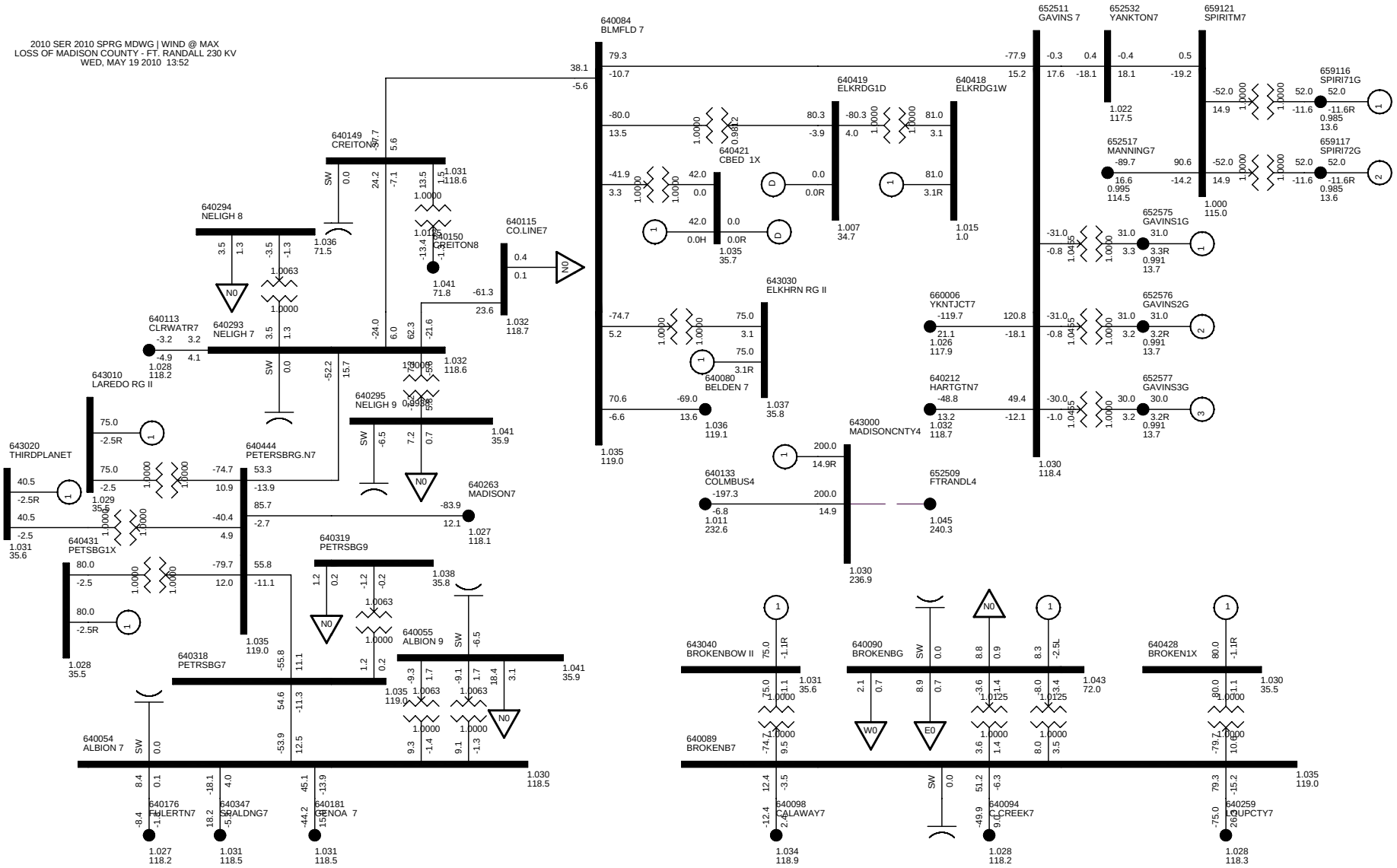
CUPCTY7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652577 GAVINS3G
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640418 ELKRDG1W
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640294 NELIGH 8
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643020 THIRDPLANET
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640263 MADISON7
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640055 ALBION 9
640054 ALBION 7
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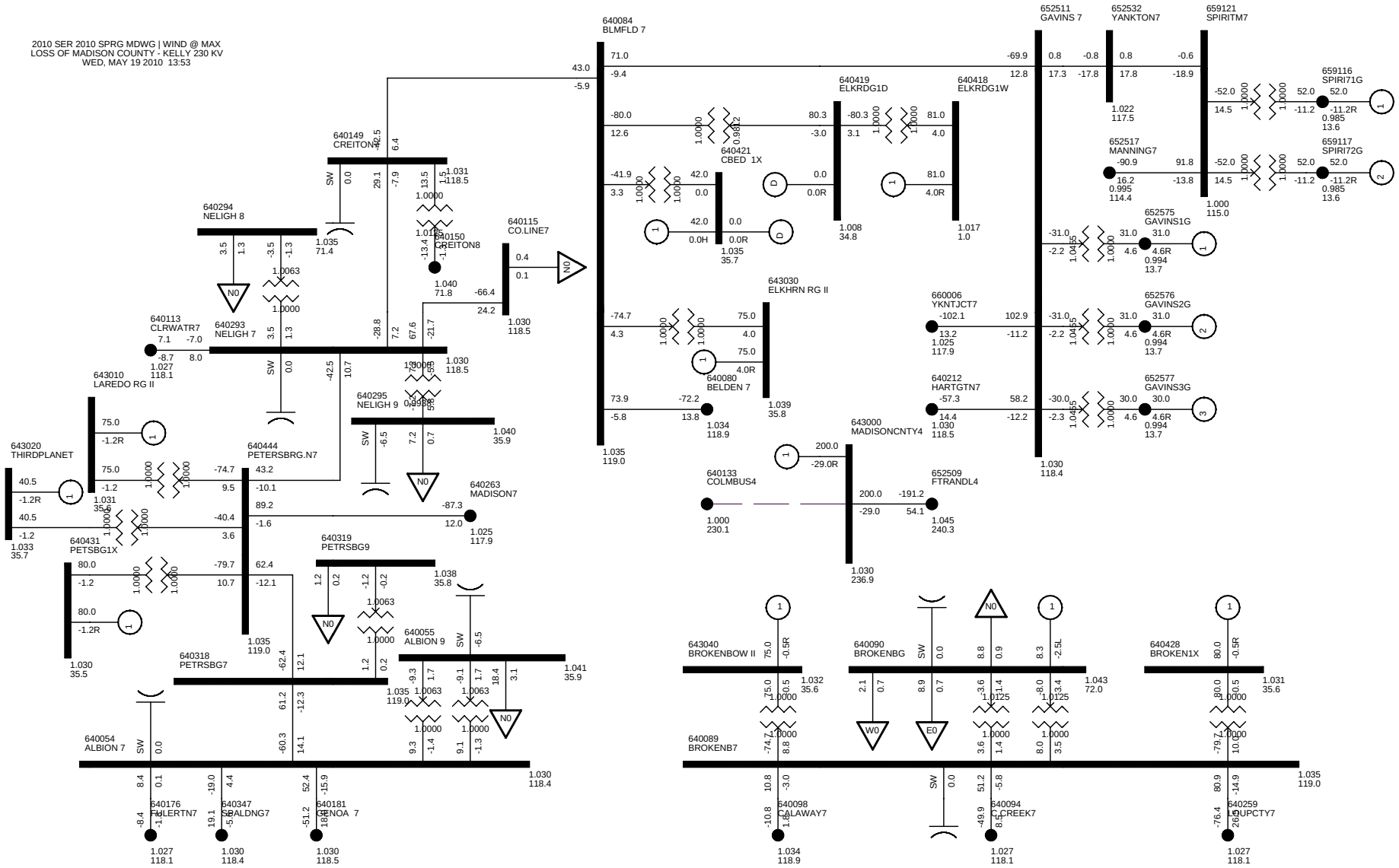
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640444 PETERSBRG.N7
640295 NELIGH 9
640263 MADISON7
640431 PETSBG1X
640319 PETRSBG9
640318 PETRSBG7
640055 ALBION 9
640054 ALBION 7
640176 HLERTN7
640347 SEALDNG7
640181 GENOA 7
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640418 ELKRDG1W
640421 CBED 1X
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640080 BELDEN 7
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652509 FTRANDL4
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640212 HARTGTN7
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659121 SPIRITM7
659116 SPIRI71G
659117 SPIRI72G
652517 MANNING7
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652576 GAVINS2G
652577 GAVINS3G
643040 BROKENBOW II
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640089 BROKENB7
640098 CALAWAY7
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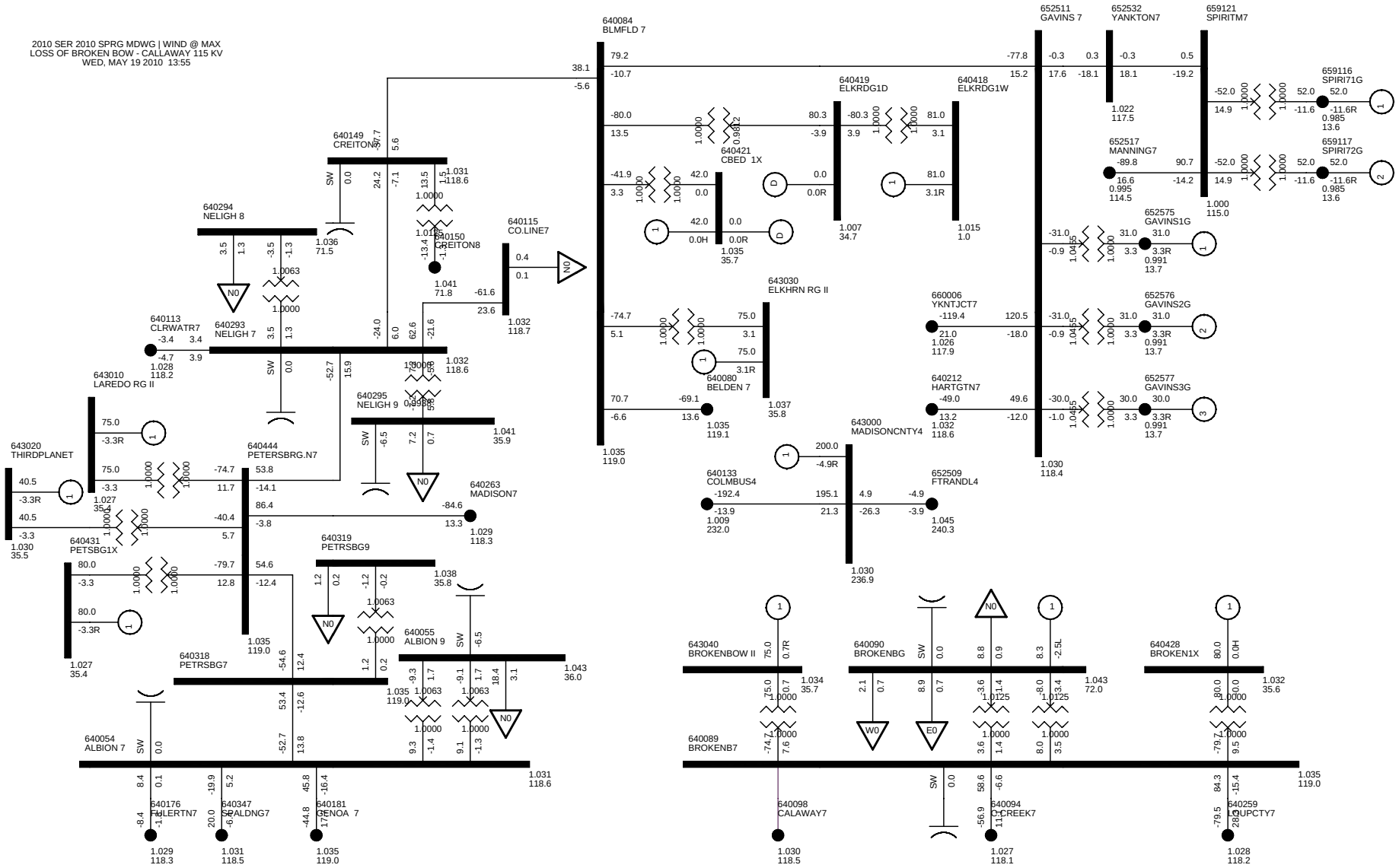
640259 LOUPCTY7


2010 SER 2010 SPRG MDWG | WIND @ MAX
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652532 YANKTON7
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659116 SPIRI71G
659117 SPIRI72G
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652576 GAVINS2G
652577 GAVINS3G
660006 YKNTJCT7
640212 HARTGTN7
640419 ELKRDG1D
640418 ELKRDG1W
640421 CBED 1X
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640080 BELDEN 7
643000 MADISONCNTY4
640133 COLUMBUS4
652509 FTRANDL4
640149 CREITON7
640150 CREITON8
640115 CO.LINE7
640294 NELIGH 8
640293 NELIGH 7
640295 NELIGH 9
640113 CLRWATR7
643010 LAREDO RG II
643020 THIRDPLANET
640444 PETERSBRG.N7
640263 MADISON7
640431 PETSBG1X
640319 PETRSBG9
640318 PETRSBG7
640055 ALBION 9
640054 ALBION 7
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640347 SPALDNG7
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643040 BROKENBOW II
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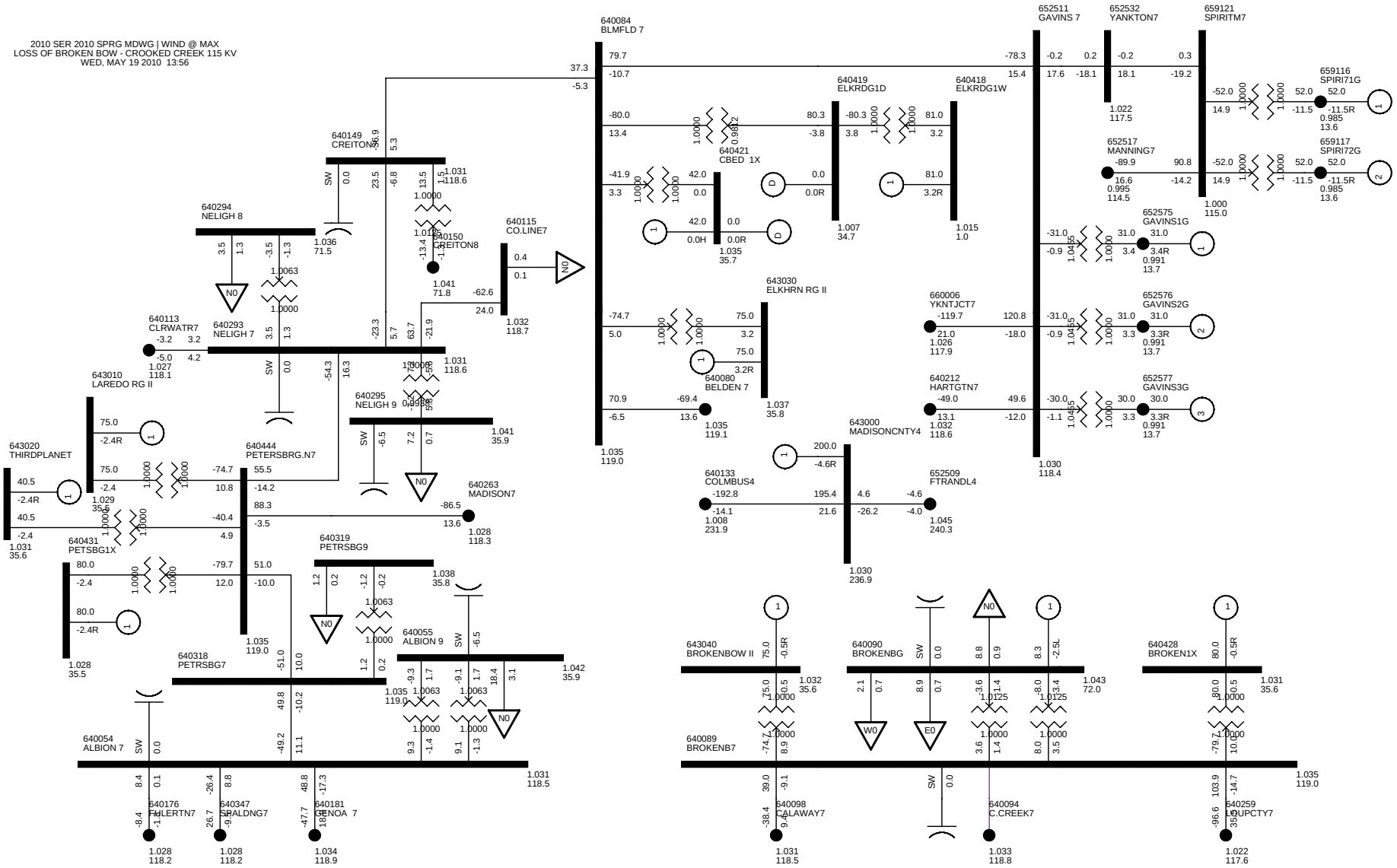
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LOSS OF BROKEN BOW - CROOKED CREEK 115 KV
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652576 GAVINS2G
652577 GAVINS3G
640419 ELKRDG1D
640418 ELKRDG1W
640421 CBED 1X
643030 ELKHRN RG II
660006 YKNTJCT7
640080 BELDEN 7
640212 HARTGTN7
643000 MADISONCNTY4
640133 COLUMBUS4
652509 FTRANDL4
640149 CREITON7
640150 CREITON8
640294 NELIGH 8
640115 CO.LINE7
640113 CLRWATR7
640293 NELIGH 7
643010 LAREDO RG II
640295 NELIGH 9
643020 THIRDPLANET
640444 PETERSBRG.N7
640263 MADISON7
640431 PETSBG1X
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640054 ALBION 7
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643040 BROKENBOW II
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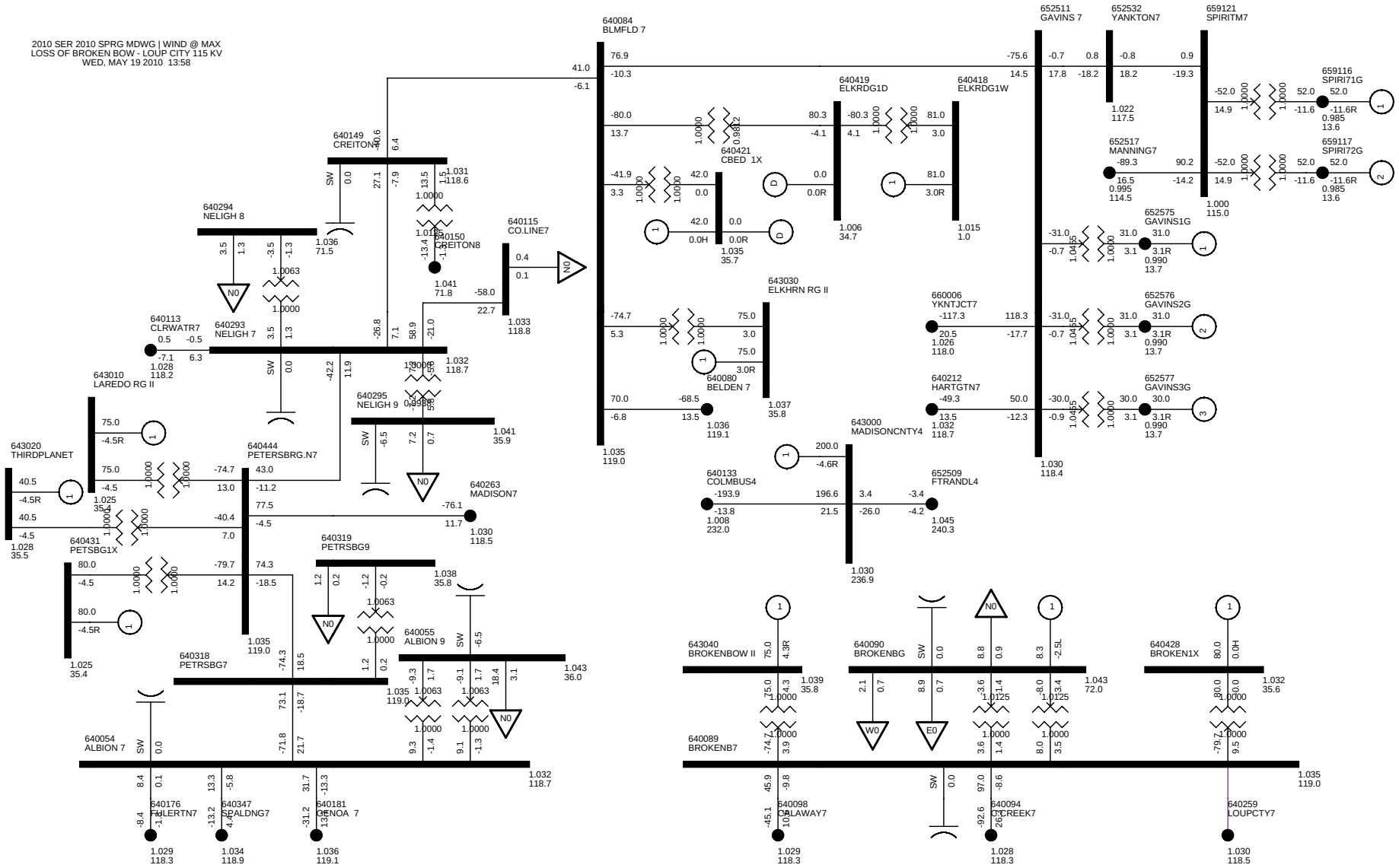
640094 C.CREEK7
640259 LOUPCTY7


2010 SER 2010 SPRG MDWG | WIND @ MAX
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CREITON7
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NELIGH 8
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CREITON8
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CO.LINE7
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CLRWATR7
640293
NELIGH 7
643010
LAREDO RG II
643020
THIRDPLANET
640444
PETERSBRG.N7
640295
NELIGH 9
640263
MADISON7
640431
PETSBG1X
640319
PETRSBG9
640318
PETRSBG7
640055
ALBION 9
640054
ALBION 7
640176
HLERTN7
640347
SPALDNG7
640181
GENOA 7
640419
ELKRDG1D
640418
ELKRDG1W
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CBED 1X
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BELDEN 7
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YKNTJCT7
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HARTGTN7
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COLUMBUS4
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GAVINS3G
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BROKENBOW II
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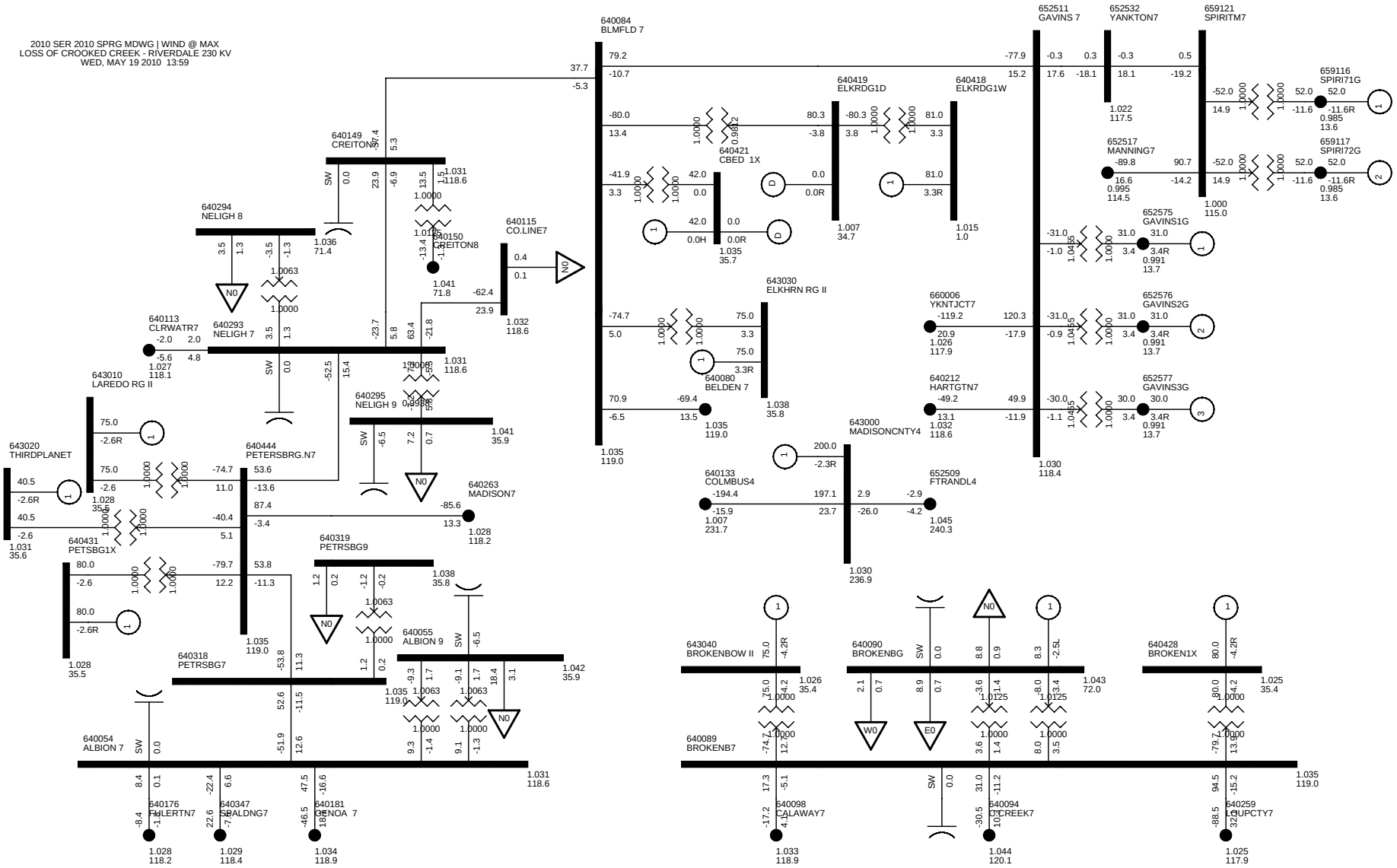
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WED, MAY 19 2010 13:59
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652576 GAVINS2G
652577 GAVINS3G
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640150 CREITON8
640294 NELIGH 8
640293 NELIGH 7
640295 NELIGH 9
640115 CO.LINE7
640113 CLRWATR7
643010 LAREDO RG II
643020 THIRDPLANET
640444 PETERSBRG.N7
640263 MADISON7
640431 PETSBG1X
640319 PETRSBG9
640318 PETRSBG7
640055 ALBION 9
640054 ALBION 7
640176 HLERTN7
640347 SEALDNG7
640181 GENOA 7
640419 ELKRDG1D
640418 ELKRDG1W
640421 CBED 1X
643030 ELKHRN RG II
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640090 BROKENBG
640428 BROKEN1X
640089 BROKENB7
640098 CALAWAY7
640094 CTCREEK7
640259 LOUPCTY7

5.4 Phase 4 Results (System-wide N-1 Screening w/ transfer conditions)

The Phase 4 ACCC analysis is performed to assess the performance of the transmission system under stressed heavy transfer conditions following the addition of the wind generation interconnection projects according to TPL-001 and TPL-002 standards. This phase utilized the 2010 Spring Peak case as the base system topology. The proposed wind generation interconnection projects (465 MW total) and associated transmission upgrades were added to the case. The new wind generation was exported off-system to other modeling areas in SPP on a pro rata basis. Generation and DC tie schedules in western Nebraska were then increased to stress the existing flowgates (GGS & WNE_WKS) in western Nebraska to existing transfer limits. PSS/E activity ACCC was then used as a screening tool on the base case to identify those contingencies which deserve closer study. ACCC analyzed the system by sequentially taking each transmission element greater than 100kV in the NPPD, OPPD, LES, MEC, and WAPA control areas out of service. Transmission facilities in the NPPD, OPPD, LES, MEC, and WAPA control areas were then monitored for violations of loading or bus voltage criteria. The results of the contingency analysis are shown in the ACCC summaries included in Appendix D. Contingencies which resulted in facility loadings or bus voltages outside of acceptable limits will be discussed in the summary of each case.

System Intact Results (TPL-001):

One transmission facility was found to be loaded above its normal facility rating under system intact conditions. The Yankton Junction – Utica Junction 115 kV line in the WAPA system was loaded to 131.0% of the 60 MVA normal rating. The high loading on the Yankton Junction – Utica Junction 115 kV line will need to be coordinated with WAPA due to relatively close proximity of the overloaded line to the proposed wind interconnection projects.

N-1 Contingency Results (TPL-002):

Twenty-two overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2010 Spring Peak case with transfers and the wind facility additions and reported in the table. The full ACCC results are summarized in Appendix D. The post-contingency facility overloads that were discovered are summarized in Table 15 below.

Table 15. 2010 Spring Peak (w/ transfers): N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640089	BROKENB7 115.00	640259	LOUPCTY7 115.00	1	SINGLE 3	120	101.3
640374	SWEET W3 345.00	652571	GR ISLD3 345.00	1	SINGLE 3	717	100.6
640374	SWEET W3 345.00	652571	GR ISLD3 345.00	1	SINGLE 234	717	104.2
640084	BLMFLD 7 115.00	652511	GAVINS 7 115.00	1	SINGLE 252	120	119.1
640102	CANADAY4 230.00	640103	CANADAY7 115.00	1	SINGLE 270	100	131.7
640103	CANADAY7 115.00	640256	LXNGTN 7 115.00	1	SINGLE 270	80	114.7
640103	CANADAY7 115.00	640161	ELMCRK_7 115.00	1	SINGLE 270	80	111.7
640161	ELMCRK_7 115.00	640250	KEARNEY7 115.00	1	SINGLE 270	80	106.4
640256	LXNGTN 7 115.00	640331	RIVERDL7 115.00	1	SINGLE 270	80	101
640287	N.PLATT7 115.00	640365	STOCKVL7 115.00	1	SINGLE 347	137	107.6
640302	OGALALA4 230.00	659134	SIDNEY 4 230.00	1	SINGLE 402	320	119
652473	ELKCRK 7 115.00	652490	RAPIDCY7 115.00	1	SINGLE 723	60	100.5
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 771	120	105.9
652511	GAVINS 7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 810	120	105.9
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 769	60	197
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 810	60	189.7
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 771	60	189.7
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 789	60	179.2
652626	UTICAJC7 115.00	660006	YKNTJCT7 115.00	1	SINGLE 742*	60	168.7
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 861	250	109.7
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 861	250	109.7
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 865	250	109.7
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 865	250	109.7

**Only the top five contingency overloads reported in Table 15.*

The Broken Bow – Loup City 115 kV line and Sweetwater – Grand Island 345 kV line were both loaded above the normal facility ratings for loss of the Red Willow – Mingo 345 kV line. There are prior outage limits associated with the GGS stability flowgate for this contingency that would consequently relieve the loading on the Broken Bow – Loup City 115 kV line and Sweetwater – Grand Island 345 kV line in 30 minutes. The loading on both facilities does not exceed the 30-minute short-term emergency rating and the wind generation may be required to reduce its output to mitigate the loading on these facilities for this contingency.

The Sweetwater – Grand Island 345 kV line loaded above the normal facility rating for loss of the Sweetwater – Axtell 345 kV line. There are prior outage limits associated with the GGS stability flowgate for this contingency that would consequently relieve the loading on the Sweetwater – Grand Island 345 kV line in 30 minutes. The loading does not exceed the 30-minute short-term emergency rating and the wind generation may be required to reduce its output to mitigate the loading on this facility for this contingency.

The Gavins Point – Bloomfield 115 kV line was overloaded for loss of the proposed Bloomfield – Belden 115 kV line. The facility rating for the Gavins Point – Bloomfield 115 kV line is planned to be increased to 159 MVA to accommodate the addition of the prior queued Crofton Hills wind project. The facility rating increase is dependent on substation upgrades at the Gavins Point 115 kV substation and these upgrades are scheduled to be completed prior to the interconnection of the Crofton Hills project.

The Canaday 230 / 115 kV transformer, Canaday – Lexington – Riverdale 115 kV line, and Canaday – Elm Creek – Kearney 115 kV line was overloaded for loss of the Crooked Creek – Riverdale 230 kV line. The facility rating for the Canaday 230 /115 kV transformer is 100 MVA and is planned to be increased to 336 MVA by Fall 2010. The loading on the Canaday transformer would not be an issue once the work to replace the existing transformer with the new 336 MVA unit is complete. The loading on the Canaday – Lexington 115 kV and Canaday – Elm Creek 115 kV lines exceed the short-term 30-minute emergency ratings for loss of the Crooked Creek – Riverdale 230 kV line. Terminal upgrades and/or conductor clearance corrections would be required to increase the facility ratings on these transmission facilities.

The North Platte – Stockville 115 kV line was overloaded for loss of the GGS – Red Willow 345 kV line. This contingency / monitored element pair are the limiting elements associated with the WNE_WKS PTDF flowgate. The post-contingency loading on the North Platte – Stockville 115 kV line is less than the 30-minute short-term emergency rating of 151 MVA.

The Ogallala – Sidney 230 kV line was overloaded for loss of the Sidney – Keystone 345 kV line. In this case, the Sidney DC tie is scheduled at 200 MW west to east. Loss of the Sidney – Keystone 345 kV line under these transfer conditions would result in the trip of the Sidney DC tie and automatically mitigate the Ogallala – Sidney 230 kV line overload that was discovered.

The Rapid City – Elk Creek 115 kV line overloaded for loss of the New Underwood – Maurine 230 kV line. The post-contingency loading of this facility would need further review and coordination by the facility owner (BEPC) and the transmission planner (WAPA UGP) for this facility.

The Gavins Point – Yankton Junction 115 kV line was found to load above its 120 MVA rating for a number of N-1 contingencies. The Gavins Point – Yankton Junction 115 kV line is just north of Gavins Point in South Dakota. The high post-contingency loading on this line warrants additional evaluation and coordination with the transmission owner and the transmission planner (WAPA UGP) for this facility.

The Utica Junction – Yankton Junction 115 kV line was found to load above its 60 MVA rating for a number of N-1 contingencies. The Utica Junction – Yankton Junction 115 kV line is just north of Gavins Point in South Dakota. The high post-contingency loading on this line warrants additional evaluation and coordination with the transmission owner (Northwest Public Service) and the transmission planner (WAPA UGP) for this facility.

The Leland Olds 345/230 kV transformer was found to load above its 250 MVA rating for loss of the parallel 345/230 kV transformer. The post-contingency loading of this facility would need further review and coordination by the facility owner (BEPC) and the transmission planner (WAPA UGP) for this facility.

There were seventy-two bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis. The post-contingency bus voltage violations that were discovered are summarized in Appendix D. Three contingencies were found the NPPD area. The first contingency (Sheldon – Firth 115 kV) is a modeling issue and can easily be addressed by adjusting the 115/69 kV transformer taps at the Sterling 115 kV substation. The second contingency (Sidney – Keystone 345 kV) would be mitigated by the post-contingency tripping of the Sidney DC tie due to its remedial action scheme. The third contingency (Stegall 345/230 kV transformer) would be mitigated by the post-contingency tripping of both the Stegall and Rapid City DC ties. The remaining bus voltage violation issues were outside of the NPPD system and would need to be coordinated with external entities for further review.

Phase 4 Results Summary

Overall, there were five transmission facility overloads discovered in the Phase 4 screening that were in the immediate vicinity of the proposed generation interconnection projects. Two of the five transmission facility overloads were found on an external system and would need further coordination and investigation with the affected party (WAPA). These external system transmission facility overloads are listed below:

- Gavins Point – Yankton Junction 115 kV
- Yankton Junction – Utica Junction 115 kV

Three of the five transmission facility overloads were found on the NPPD transmission system. These facility overloads are summarized below:

Gavins Point – Bloomfield 115 kV: This facility loaded to above the 120 MVA facility rating for loss of the Bloomfield – Belden 115 kV or Bloomfield – Creighton 115 kV lines. This facility is planned to be upgraded to 159 MVA due to the Crofton Hills wind generation project and no further upgrade is required.

Canaday 230/115 kV & Canaday – Elm Creek 115 kV & Canaday – Lexington 115 kV: These facilities loaded to above the 30-minute short-term emergency facility ratings for loss of the Crooked Creek – Riverdale 230 kV line. The Canaday 230/115 kV transformer is scheduled to be replaced with a larger 336 MVA unit in the Fall 2010. The loading on the Canaday – Elm Creek 115 kV and Canaday – Lexington 115 kV lines will need to be further assessed and monitored through the regional planning processes to determine if upgrades are required.

6.0 Short Circuit Analysis

6.1 Model Development

Computer Programs

The Aspen One-liner software program (V10.12 September 2008) was utilized to perform short circuit simulations and studies on the transmission system. The data files (transmission lines/transformer/generator constants) for the Aspen One-liner program are updated by NPPD numerous times per year as transmission system changes and additions occur across Nebraska. The short circuit data information (system equivalent impedances) for transmission system interconnections to non-Nebraska utilities was updated in 2005. The Aspen One-liner software program calculates the symmetrical (alternating current component) short circuit currents in physical amps or per unit values. If asymmetrical currents (alternating current component plus direct current component) are required, these values have to be separately calculated and based on the X/R ratio at the fault location and the protective device operating time.

Due to the numerous short circuit models being performed for future conditions, the Aspen One-liner software is configured to calculate short circuit magnitudes based on all generator source voltages being at 1.0 per unit (Flat conditions). The Aspen One-liner short circuit program has the ability to solve a load flow (generator voltages not set at 1.0 per unit) prior to performing short circuit calculations; however this option will not be utilized due to the time requirements to convert data from the load flow software (PSS/E) to Aspen One-liner. The program is configured to utilize the generator subtransient impedance (X”d) for short circuit calculations. This is standard for conducting short circuit studies on the transmission system. When conducting short circuit studies for buses where generators are directly connected, the generator transient impedance (X’d) is typically utilized.

The Aspen One-liner short circuit program does not have a specific induction generator module to model the wind generation transient short circuit current contributions for short circuits on the transmission system. Turbine, distribution transformer, and step up transformer data have not been provided by the developers to date. To model the induction generator short circuit contributions, the Vestas V90 induction generator constants have been converted by Vestas to equivalent synchronous generator constants for the Bloomfield 80MW wind farm. An equivalent synchronous generator was used in the modeling of future wind farms. Equivalent transformers to those installed at Bloomfield (80MW wind farm) will be used to simulate symmetrical fault contributions from these various new wind farm additions unless specific transformer information is currently available.

Two new 115kV lines were identified as being necessary system additions due to the additional wind farm generation. Line routing, length, and design have not been

completed and thus have been estimated based on NPPD minimum line construction standards.

Base System Model Additions

The 2010 base short circuit data file was updated with planned work (NPPD and other) through 2012 that may have an effect on interrupting capabilities of equipment near the proposed wind farm locations. Below is the list of additions including the proposed wind generation.

1.) The addition of a 115/34.5 kV 30/50/56 MVA transformer at the Bloomfield 115 kV Substation with 40MW of Vestas V90 wind generation modeled as synchronous generators with 3.16MVA turbine step up transformers. The VAR control system details are estimated based on the Ainsworth wind farm design. The grounding transformer details are estimated based on the Elkhorn Ridge wind farm. This is the future Crofton Hills Wind Farm.

2.) The addition of a 115/34.5 kV 57/76/95 MVA transformer at Petersburg 115kV Substation (impedances modeled after Elkhorn Ridge Main GSU) with 80MW of Vestas V90 wind generation modeled as synchronous generators (lumped equivalent impedance of Elkhorn Ridge collector system). This is the future Laredo Ridge Wind Farm.

3.) The addition of a 115/34.5 kV 57/76/95 MVA transformer 9 miles from the Broken Bow 115kV Substation (impedances modeled after Elkhorn Ridge Main GSU) with 80MW of Vestas V90 wind generation modeled as (lumped equivalent impedance of Elkhorn Ridge collector system). This is connected to the Broken Bow 115kV bus by 9 miles of H Frame, 477 ACSR with 7/16 EHS neutral.

4.) The addition of a 115/34.5kV Delta/Wye 50/67/84 MVA transformer at Petersburg 115kV Substation (impedances from proposed Laredo Ridge Wind II) with 75MW of Vestas V90 wind generation modeled as synchronous generators with 87.5MVA turbine step up transformers (impedances from proposed Laredo Ridge Wind II) connected through a collector equivalent impedance to the 50/67/84MVA transformer. This is the future Laredo Ridge Wind II Farm (GEN-2007-011N06).

5.) The addition of a 115/34.5kV Wye/Delta/Wye 27/36/45 MVA transformer at Petersburg 115kV Substation (impedances modeled after Elkhorn Ridge Main GSU and scaled to 10% at 27MVA) with 40MW of Vestas V90 wind generation modeled as synchronous generators (impedance estimated as 200% of impedance of Elkhorn Ridge collector system). This is the future White Horse Wind Farm (GEN-2006-044N).

6.) The addition of a 115/34.5 kV 57/76/95 MVA transformer at Bloomfield 115kV Substation (impedances modeled after Elkhorn Ridge Main GSU) with 75MW of

Vestas V90 wind generation modeled as synchronous generators (lumped equivalent impedance of Elkhorn Ridge collector system less two turbines). This is the future GEN-2007-011N09 Wind Farm.

7.) The addition of a 115/34.5 kV 57/76/95 MVA transformer at Broken Bow 115kV Substation (impedances modeled after Elkhorn Ridge Main GSU) with 75MW of Vestas V90 wind generation modeled as synchronous generators (lumped equivalent impedance of Elkhorn Ridge collector system less two turbines). This is the GEN-2006-037N1 Wind Farm.

8.) The addition of 35 miles of 115kV line connecting Petersburg North and Madison substations. This line was modeled as H frame, 477 ACSR, with 7/16 EHS neutral.

9.) The addition of 45 miles of 115kV line connecting Bloomfield and Belden substations. This line was modeled as H frame, 477 ACSR, with 7/16 EHS neutral.

10.) The addition of a new 230kV substation on the Kelly – Ft. Randall existing line (L-2301). This was modeled at 28.95 miles from Kelly, 99.15 miles from Ft. Randall (at the approximate intersection of the future Petersburg North – Madison line).

11.) The addition of a 230/34.5kV 140/233MVA 9.5% impedance transformer at the new 230kV substation on the Kelly – Ft. Randall line with 200MW of Vestas V90 wind generation modeled as synchronous generators (lumped equivalent impedance of Elkorn Ridge collector system scaled by 250%). This is the GEN-2008-086N02 Wind Farm.

12.) The addition of a 230/34.5kV 30/56MVA transformer at Columbus West 230kV Substation. This transformer is currently at the substation (not energized).

13.) The addition of a 115/34.5kV 15/28MVA transformer at Spalding 115kV Substation. The scheduled in-service for this transformer is June 2012.

14.) The addition of a 115/34.5kV 30/56MVA transformer at North Norfolk 115kV Substation. The scheduled in-service for this transformer is June 2010.

15.) The addition ADM Cogen Unit #1. An in-service date is 2010.

16.) The addition of a 230/115 kV 180/300/336 MVA transformer at North Platte 230 kV Substation. This will replace the existing 100/167/187 MVA T-9 transformer at North Platte. This is scheduled for a June 2010 In-service date.

17.) The addition of a 230/115kV 180/300/336 MVA transformer at Canaday 230kV Substation. This will replace the existing 100/167/187 MVA T-1 transformer. The installation of this transformer is dependent on several approved wind farms (previous to this review).

18.) The addition of 136 miles of 345kV line from Axtell 345kV substation to Post Rock 345kV substation in Kansas.

The Aspen One-liner data file for this configuration is "NPPD 2009 Aug 07 plus wind farm additions.olr". Other system additions necessary for the transmission of power due to the addition of these wind farms may be identified and have not been included in this short circuit study.

6.2 Study Methodology

The interrupting rating of protective devices (breakers, circuit switchers, fuses, etc) is being reviewed at selected buses where the additional wind facilities and lines may have a significant affect on the available short circuit currents. The Aspen One-liner software program is being utilized to determine the maximum short circuit current magnitudes.

This short circuit study will evaluate the adequacy of the individual protective device interrupting ratings for NPPD transmission and tap substations adjacent to the new wind facilities and lines and corresponding remote buses.

For single breaker/single bus configurations, the maximum bus short circuit current (three phase fault or single line to ground fault) will be utilized to evaluate whether the existing protective device interrupting rating is adequate. If the breaker is over 75% of the interrupting rating, a more detail fault study will be performed to individually review the specific fault current through the breaker/fuse in question.

An equivalent symmetrical rating will be calculated for Oil Circuit breakers manufactured prior to 1971 that have only an asymmetrical interrupting rating. For asymmetrical rated breakers, the interrupting rating is based on the number of faults the breaker is subjected to over a 15 minute period. Reference C37.07-1969 for the derating factors used on breakers with an asymmetrical rating in the interrupting study.

The breaker interrupting ratings will be evaluated for future system configuration with all known future changes through 2012 in-service, and future system configuration with all known future changes plus estimations of the studied wind farms and lines in-service for comparison.

The accuracy of the short circuit study for future conditions will have a possible error factor due to utilizing estimated line constants/lengths as well as estimated transformer/generator impedance values. Utilizing flat case short circuit study without solving a load flow case with the generators voltages at 1.0 per unit also introduces an additional error factor. To accommodate for these errors all protective devices within 90% of their interrupting rating will be identified. It is recommended that all breakers/fuses within 95% of the nameplate interrupting rating be replaced unless otherwise noted.

6.3 Results

The interrupting rating for over 300 protective devices was reviewed in twenty eight (28) substations which NPPD owns protective devices in. The Aspen One-liner short circuit software was utilized to determine the maximum short circuit currents for the future case without the studied wind farms and lines, and with the studied wind farms and lines. For a complete list of future additions that were put in-service for analysis, see 6.1 "Base System Model Additions". Table 16 lists all devices that were found to be above 95% of their interrupting rating, and the effective change in duty due to the wind farms, and lines to support the wind farms being added to the system.

Table 16. Short Circuit Analysis Results

Substation	Device Number	Circuit	% of Rating	Δ
Battle Creek	619-D	Bus PT fuse	112%	3%
Hartington	T-2 Fuse	604-D2	106%	2%
Hoskins	North Bus Fuse	329-D	154%	1%
Hoskins	T-5 Fuse	322-D	154%	1%
Hoskins	South Bus Fuse	315-D	154%	1%
Belden	PCB1112	T1 Primary	99%	17%
Creighton	607-D2	L-66393 fuse	98%	4%

**At this time, CS1112, PCB320, and 314-D at Creston have not been identified (LPPD owned equipment). Data has been requested.*

Hoskins fusing is a known issue. Normal operation procedure is to keep the bus tie open which limits fault current to below the fuse ratings (87%).

For more details on the specific breakers that were reviewed, please refer to section 6.5 which contains the details of the short circuit analysis.

6.4 Conclusions

The Short Circuit Analysis found seven interrupting devices where the available short circuit current will be above or near the interrupting rating as listed in Table 16. The replacement of the first five interrupting devices should not be charged to the transmission system changes required to serve the new wind farms to be constructed since they are currently above the 95% suggested replacement level. The Belden PCB1112 and Creighton 607-D2 replacements would be required network upgrades for interconnection of the new generation facilities and associated transmission. Replacement of these two devices will be included in the interconnection plan for the proposed wind generation projects.

6.5 Detailed Short Circuit Analysis Results

SPP Wind Farm Analysis
Models: SPP Wind Farm \ NPPD 2009 Aug 07 plus wind farm additions.olr, NPPD 2009 Aug 07 system today.olr

This document evaluates the regional area interupting device ratings due to:
-New Wind Farms at Petersbug - GEN2006-044N (White Horse), GEN2007-011N06
-New Wind Generation at Bloomfield - GEN-2007-011N09
-New line from Petersburg North to Madison (35 miles)
-New line from Bloomfield to Belden (45 miles)
-New 230kV substation on Kelly - Ft. Randall line (Near Pet. N. to Madison line bisection)
-New 200MW wind farm at new 230kV substation - GEN-2088-086N02
-New 75MW Wind Farm at Broken Bow

Planning area will need to provide updated load capabilities that are required in the regional area so the lines and subs area can review equipment load ratings and the protection area can review CT and breaker load ratings as needed.

Current interrupting capabilities were verified for substations 2 buses out, or where fault currents rose by more than 10% due to the installation of the system upgrades.

NOTES -faults taken on the bus unless interrupting rating is found to be close to or below the bus fault value

Issues or possible issues in red unknown loading capacity requirements in green Not owned by NPPD

	Faults % of Rating	Δ	System Today	SPP Upgrades	Interupting Rating	Derate Value	Data Interupt	CT Ratio Set	Required Load Capacity	CT Sec Current	CT Max Available	Amp Rating	Speed	Reclose	Year	PO Cont	Interupting Device
Albion																	
PCB1102 to Spalding	27%	14 %	4810	5490	19982	80%	5000 Asym	80	80?	69	1200/5	1200	3	1	1962	613	GE FK-115-5000
PCB1104 to Fullerton	25%	14 %	4810	5490	22000		22kA	120	120?	46	1200/5	1200	3		1971	N70-11	GE FK-121-22000-2
PCB1106 to Petersburg	25%	14 %	4810	5490	22000		22kA	120	120?	46	1200/5	1200	3		1972	E71-19	GE FK-121-22000-2
PCB1108 to Genoa	25%	14 %	4810	5490	22000		22kA	160	160?	34	1200/5	1200	3		1972	E71-19	GE FK-121-22000-2
PCB1116	14%	14 %	4810	5490	40000		40kA	100	20	55	1200/5	2000	3		2007		ABB 121 PMI 40-20
CS1110 - Loup	22%	14 %	4810	5490	25000		25000	60	40	92	no T1 CT data	1200		0	2006		S&C2030
CS1112 - Loup	92%	14 %	4810	5490	6000		6kA	60	40	92	1200/5	1200			1974		S&C Mark III
CS1114												1200			1977		S&C Mark IV
CS1114-D2	52%	14 %	4810	5490	10500		10.5kA										SMD-2B
PCB302 - Loup	32%	4%	6230	6500	20007	80%	1500 Asym	60	60?	108	1200/5	1200	5	3	1971	N70-16	McGraw Edison CF-37-34.5-1500
PCB306 - Loup	21%	4%	6230	6500	31500		31.5kA	120	120?	54		1200			1998		Siemens SPS2-38-31.5-1200
PCB308 - Loup	85%	4%	6230	6500	7623	91%	500 Asym	120	120?	54		600	8				GE FK-339-345-500-3
PCB310 - Loup	21%	4%	6230	6500	31500		31.5kA	120	100	54		1200			1998		Siemens SPS2-38-31.5-1200
PCB312 - Loup	16%	4%	6230	6500	40000		40kA	120	100	54		1200			2003		Siemens SPS2-38-40-2
PCB316 - Loup	32%	4%	6230	6500	20007	80%	1500 Asym	100	100?	65	1200/5	1200	5	3		439-B	McGraw Edison CF-37-34.5-1500
304 (fuse) - Loup	37%	4%	6230	6500	17500		17.5kA										SMD-1A

314-D - Loup	65%	4%	6230	6500	10000		10kA									SMD-20
317-D - Loup	65%	4%	6230	6500	10000		10kA									SMD-20
318-D - Loup	54%	4%	6230	6500	12000		12kA									LBU-11
321-D - Loup	65%	4%	6230	6500	10000		10kA									SMD-20
Battle Creek																
CS1110	76%	1%	6000	6080	8000		8kA					1200			1977	S&C Mark V
PCB602	19%	3%	3650	3760	20000		20kA	80	80	47	1200/5	1200	5	3	1980	80-20	McGraw Edison CG-48-72.5-20
PCB604	19%	3%	3650	3760	20000		20kA	80	80	47	1200/5	1200	5	3	1980	80-20	McGraw Edison CG-48-72.5-20
619-D	112%	3%	3650	3760	3350												SMD-50
Belden - building may not be large enough for another panel																
PCB1104	31%	17%	5800	6780	22091	88%	3500 Asym	120	?	57	600/5	1200	5	1	1952	580	GE FK-439-115-3500-3
PCB1106 (WAPA)	17%	17%	5800	6780	40000		40kA	120	?	57	1200/5	1200	3	1	2002		Mistsubishi 100-SFMT-40HE
PCB1108	31%	17%	5800	6780	22000		22kA	120	?	57	1200/5	1200	3	1	1969	738	ITE 115-KM-5000-12B
PCB1112 T1 Pri	99%	17%	5800	6780	6853	91%	1500 Asym	80		85	600/5 and 1200/5	800	5	0	1957	923	GE FK-439-115-1500-3
PCB602	10%	6%	3710	3950	40000		40kA	240		16	2000/5	2000	3	3	2007		Siemens SPS2-72.5-40-20
PCB606	10%	6%	3710	3950	40000		40kA				1200/5	2000	5	3	2004		ABB 72-PM-40-20
PCB608	17%	6%	3710	3950	23000		23kA				1200/5	1200	3	3	1995	95-34	Siemens SPS-72.5-23-1
PCB610	10%	6%	3710	3950	40000		40kA				2000/5	2000	3	1	2007		Siemens SPS2-72.5-40-2
CS614	99%	6%	3710	3950	4000		4000					1200		0	1967		S & C CS-10
614-D	45%	6%	3710	3950	8750												SMD-1A
619-D	45%	6%	3710	3950	8750												SMD-1A
627-D	45%	6%	3710	3950	8750												SMD-1A
Bloomfield																
PCB1102	18%	36%	5380	7330	40000		40kA	160	160?	46	2000/5	2000	3	1	2007		Mistsubishi 100-SFMT-40HE
PCB1104	18%	36%	5380	7330	40000		40kA	160	160?	46	2000/5	2000	3	1	2007		Mistsubishi 100-SFMT-40HE
PCB1120	35%	36%	5380	7330	20835	83%	5000 Asym	240	160?	31	1200/5	1200	3	0	1967	963	GE FK-115-5000-2
CS1110 T1 Pri	18%	36%	5380	7330	40000		40kA	120		61		1200	6	0	2002		S&C 2030
PCB610	15%	9%	2560	2790	19036	91%	2500 Asym	60		47	1200/5	1200	5	1	1967	963	PENN CF-48-69-2500
PCB602	16%	9%	2560	2790	17384	83%	2500 Asym	60		47	1200/5	1200	5	3	1967	963	PENN CF-48-69-2500
614-D	83%	9%	2560	2790	3350												SMD-50
619-D	83%	9%	2560	2790	3350												SMD-50
115-D		2%	3530	3600													

Broken Bow																
PCB1102	15%	62 %	3610	5840	40000		40kA	120	120?	49	2000/5	2000	3		2008	Mistsubishi 100-SFMT-40HE
PCB1104	29%	62 %	3610	5840	20000		20kA	120	120?	49	1200/5	1200	3		1985	84-61	Westinghouse 121-DWE-20
PCB1106	15%	62 %	3610	5840	40000		40kA	160	160?	37	2000/5	2000	3		2002	Mistsubishi 100-SFMT-40HE
CS1110 T1 Pri	29%	62 %	3610	5840	20000		20kA	80	60	73	600/5	1200			1998	95-78	S&C 2030
CS1112 T2 Diff	23%	62 %	3610	5840	25000		25kA	40	40	146	1200/5	1200			2003	4.5E+09	S&C 2030
CS614	64%	27 %	4010	5110	8000		8kA					1200			1981	184942	S&C V-1
PCB602	31%	27 %	4010	5110	16735	80%	2500 Asym	80	80?	64	1200/5	1200	5	3	1961	259	GE FK-69-2500-5
PCB604	31%	27 %	4010	5110	16735	80%	2500 Asym	80	80?	64	1200/5	1200	5	3	1964	712	PENN CF-48-69-2500
PCB606	26%	27 %	4010	5110	20000		20kA	80	80?	64	1200/5	1200	5		1980	80-20	McGraw Edison CG-48-72.5-20
PCB608	26%	27 %	4010	5110	20000		20kA	80	80?	64	1200/5	1200	5		1981	81-6	McGraw Edison CG-48-72.5-20
PCB610	19%	27 %	4010	5110	27000		27kA	120	120	43	1200/5	1200	3		1974	73-45	GE FKA-72.5-27000-3
PCB612	26%	27 %	4010	5110	20000		20kA	60	60	85	1200/5	1200	3		1999	E19979	Siemens SPS2-72.5-20-1
615-D (69kV East Bus PT)	58%	27 %	4010	5110	8750		8.75kA										SMD-1A
619-D (69kV West Bus PT)	58%	27 %	4010	5110	8750		8.75kA										SMD-1A
618-D2	58%	27 %	4010	5110	8750		8.75kA										SMD-1A, 150E
614-D	58%	27 %	4010	5110	8750		8.75kA										SMD-1A, 125E
115-D	53%	8%	6920	7450	14000		14kA										SMD-20
117-D	53%	8%	6920	7450	14000		14kA										SMD-20
Callaway																
PCB1102	61%	20 %	3120	3730	6100	81%	1500 Asym	120	120?	31	1200/5	800	5	1	1947		GE FK-439-115-1500
CS1110 T1 Pri	15%	20 %	3120	3730	25000		25kA	80	60	47	1200/5	1200			2004	4.5E+09	S&C 2030
PCB610	17%	8%	2830	3060	18200	87%	2500 Asym	120	120?	26	1200/5	1200	5	1	1964	712	PENN CF-48-69-2500
PCB602	16%	8%	2830	3060	19000		19kA	60	60?	51	1200/5	1200	5	3	1969		GE FK-72.5-19000-7
PCB604	8%	8%	2830	3060	40000		40kA	40	40?	77	1200/5	1200	3	3	2003	450003068 1, 02-37	Siemens SPS2-72.5-20-1
PCB606	16%	8%	2830	3060	19000		19kA	60	60?	51	1200/5	1200	5	3	1969		GE FK-72.5-19000-7
CS614												1200			1978	77-13	Mark VI-1
CS616															1998	E14568	Joslyn VBB
618-D2	35%	8%	2830	3060	8750		8.75kA										SMD-1A
117-D	28%	2%	3770	3850	14000		14kA										SMD-20
621-D	91%	8%	2830	3060	3350		3.35kA										SMD-50
622-D2		8%	2830	3060													
Clearwater																

71-0910 (fuse to T-1 - Elkorn RPPD)	83%	4%	4010	4170	5000		5kA										SMD-1A
Columbus Hydro																	
PCB1102 to Schuyler	48%	3%	18790	19320	40000		40kA	240	81	2000/5	2000	3		2008			Mitsubishi 100-SFMT-40HE-1
PCB1104 to Columbus SE	48%	3%	18790	19320	40000		40kA	240	81	2000/5	2000	3		2007	07-38A		Mitsubishi 100-SFMT-40HE
PCB1106 to Creston	48%	3%	18790	19320	40000		40kA	240	81	2000/5	2000	3		2007	07-38		Mitsubishi 100-SFMT-40HE
PCB1110 to Silver Creek	48%	3%	18790	19320	40000		40kA	240	81	2000/5	2000	3		2008			Mitsubishi 100-SFMT-40HE-1
PCB1112 to G1	48%	3%	18790	19320	40000		40kA	80	242	2000/5	2000	3		2001	00-10		Mitsubishi 100-SFMT-40HE
PCB1114 to G2	48%	3%	18790	19320	40000		40kA	80	242	2000/5	2000	3		2001	00-10		Mitsubishi 100-SFMT-40HE
PCB1116 to G3	48%	3%	18790	19320	40000		40kA	80	242	2000/5	2000	3		2001	00-10		Mitsubishi 100-SFMT-40HE
PCB1118 to T-5	48%	3%	18790	19320	40000		40kA	240	81		2000	3		2001			Mitsubishi 100-SFMT-40HE
PCB1120 to Genoa	48%	3%	18790	19320	40000		40kA	240	81	2000/5	2000	3		2007	07-38A		Mitsubishi 100-SFMT-40HE
PCB1122 (bus tie)	48%	3%	18790	19320	40000		40kA	240	81	2000/5	2000	3		1980	80-20		McGraw Edison ALP-54
PCB1124 to Kelly	48%	3%	18790	19320	40000		40kA	240	81	2000/5	2000	3		2008			Mitsubishi 100-SFMT-40HE-1
PCB1126 (bus tie)	79%	1%	16200	16440	20835	83%	5000 Asym	240	69	1200/5	1200	3	0	1962	320		GE FK-115-5000
PCB1128 to Columbus East	48%	3%	18790	19320	40000		40kA	240	81	2000/5	2000	3		2008			Mitsubishi 100-SFMT-40HE-1
PCB1130 (Cap Bank #1)	48%	3%	18790	19320	40000		40kA	240	81	1200/5	2000	3		1995	94-96		ABB 121-PMI-40-20
PCB1132 to T-6	48%	3%	18790	19320	40000		40kA	80	242		2000	3		2001			Mitsubishi 100-SFMT-40HE
PCB302	59%	0%	11750	11800	20000		20kA		#DIV/0!		1200						McGraw Edison CG-38
PCB306	59%	0%	11750	11800	20000		20kA		#DIV/0!		1200				2679		McGraw Edison CG-38
PCB308	59%	0%	11750	11800	20000		20kA		#DIV/0!		1200						McGraw Edison CG-38
PCB310	47%	0%	11750	11800	25103	100%	1500 Asym		#DIV/0!		1200	8	1				Westinghouse 345-GS-1500
PCB312	47%	0%	11750	11800	25103	100%	1500 Asym		#DIV/0!		1200	8	1				Westinghouse 345-GS-1500
PCB318	59%	0%	11750	11800	20000		20kA		#DIV/0!		1200						McGraw Edison CG-38
PCB320	47%	0%	11750	11800	25103	100%	1500 Asym		#DIV/0!		1200	8	0				Westinghouse 345-GS-

PCB322		59%	0%	11750	11800	20000		20kA				1200					1500 McGraw Edison CG-38
Creighton																	
PCB1102 to Neligh		11%	10%	3920	4330	40000		40kA	160	160	27	2000/5	2000	3		2008	4.5E+09	Mistubishi 100-SFMT-40HE
PCB1104 to Bloomfield		11%	10%	3920	4330	40000		40kA	160	160	27	2000/5	2000	3		2008	4.5E+09	Mistubishi 100-SFMT-40HE
PCB1114		11%	10%	3920	4330	40000		40kA	100	20	43	1200/5	2000	3		2007	4.5E+09	ABB 121 PMI 40-20
CS1110		22%	10%	3920	4330	20000		40kA	60	60	72	1200/5	1200	8		2008	4.5E+09	S&C 2030
PCB602		8%	4%	3150	3280	40000		40kA	80	80	41	1200/5	1200	3		2004		SPS2-72.5-40-2
PCB604		29%	4%	3150	3280	11434	91%	1500 Asym	80	80	41	600/5	1200	8	3	1961	260	GE FK-69-1500-4
PCB606		43%	4%	3150	3280	7623	91%	1000 Asym	80	80	41	600/5	600	8	3	1961		GE FK-439-69-1000-4
PCB610		26%	4%	3150	3280	12551	100%	1500 Asym	120	120	27	600/5	1200	8	1	1961	260	GE FK-69-1500-4
614-D		37%	4%	3150	3280	8750		8.75kA										SMD-1A
607-D2		98%	4%	3150	3280	3350		3.35kA										SMD-50
619-D		37%	4%	3150	3280	8750		8.75kA										SMD-1A
Creston																	
PCB1102		49%	2%	3290	3370	6853	91%	1500Asym				600/5	800	5	2	1957	923	GE FK-439-115-1500-3
PCB1104		56%	14%	3360	3820	6853	91%	1500Asym				600/5	800	5	2	1957	923	GE FK-439-115-1500-3
SW1110		33%	13%	5790	6520	20000		20kA					1200	6				Siemens CPV
SW1112		#DIV/0!	13%	5790	6520													
PCB302		28%	3%	6070	6230	22000		22kA					1200					GE FKA-38-22000-6
PCB304		28%	3%	6070	6230	22000		22kA					1200					GE FKA-38-22000-6
PCB320		#DIV/0!	3%	6070	6230													Westinghouse GS1500
315-D		#DIV/0!	3%	6070	6230													
317-D		62%	3%	6070	6230	10000		10kA										SMD-20
321-D		62%	3%	6070	6230	10000		10kA										SMD-20
115-D		45%	1%	6210	6300	14000		14kA										SMD-20
117-D		45%	1%	6210	6300	14000		14kA										SMD-20
Crooked Creek																	
PCB1102		21%	5%	7820	8200	40000		40kA	160	160?	51	2000/5	2000	3		2002	4.3E+09	Mitsubishi 100-SFMT-40HE
PCB2202		16%	3%	6040	6200	40000		40kA	240	160?	26	2000/5	2000	3		1977	76-39	McGraw Edison RHF-84-242-40
PCB2204		16%	3%	6040	6200	40000		40kA	160	160?	39	2000/5	2000	3		1977	76-39	McGraw Edison RHF-84-242-40
PCB2206		16%	3%	6040	6200	40000		40kA	160	160?	39	2000/5	2000	3		1977	76-39	McGraw Edison RHF-84-242-40
PCB2208		16%	3%	6040	6200	40000		40kA	240	160?	26	2000/5	2000	3		2002	4.5E+09	ABB 242-PMR-40-20
Ericson Pumping	New substation - equipment will be rated high enough (40kA)		9%	1610	1750													

Station																	
Ft Randall 230kV (Wapa)	WAPA owns		1%	10330	10440												
Fullerton																	
CS1110 - Loup		13%	7%	2480	2650	20000		20kA	40	30	66	600/5	1200				S&C 2030
Gavins Pt (WAPA)	WAPA will need to review (said it should be OK with such a small change - reference emails)		4%	8700	9050												
Genoa																	
PCB1102 to Columbus		13%	4%	4900	5090	40000		40kA	160	160	32	1200/5	2000	3	1	2007	4.5E+09	Mitsubishi 100-SFMT-40HE
PCB1104 to Albion		13%	4%	4900	5090	40000		40kA	160	160	32	1200/5	2000	3	1	2007	4.5E+09	Mitsubishi 100-SFMT-40HE
PCB1114		13%	4%	4900	5090	40000		40kA	100	100	51	1200/5	2000	3	0	2009	4.5E+09	ABB 121-PMI-40-20
CS1110 - Loup		25%	4%	4900	5090	20000							1200					S&C 2030
CS1112 - Loup		25%	4%	4900	5090	20000							1200					S&C 2030
PCB302		17%	1%	5420	5480	31500		31.5kA				1200/5	1200	3	3	1996		Siemens SPS-38-31.5-1200
PCB304		30%	1%	5420	5480	18250	73%	1500 Asym				1200/5	1200	5	3		N70-6	Westinghouse AA-7 645-GS-1500
PCB306		17%	1%	5420	5480	31500		31.5kA				1200/5	1200	3	3	1996		Siemens SPS-38-31.5-1200
PCB320		14%	1%	5420	5480	40000		40kA										Seimens 72.5-40-2
Hartington																	
PCB162		13%	5%	5040	5310	40000		40kA				2000/5	2000	3		2008		Mitsubishi 100-SFMT-40HE-1
PCB262		13%	5%	5040	5310	40000		40kA				2000/5	2000	3		2008		Mitsubishi 100-SFMT-40HE-1
CS362			5%	5040	5310	25000		25kA								2007		S & C 2030
PCB602		15%	2%	3470	3540	23000		23kA				1200/5	1200	3		1995	E01167	Siemens SPS-72.5-23-1
619-D		40%	2%	3470	3540	8750												SMD-1A
604-D2 - Cedar Knox PPD		106%	2%	3470	3540	3350		3.35kA										SMD-50
115-D		25%	2%	3470	3540	14000												SMD-20
Hoskins																	
PCB3302		23%	3%	8920	9150	40000		40kA				2000/5	3000	2		2007	07-15	ABB 362-PMI-40-30
PCB3308		23%	3%	8920	9150	40000		40kA				2000/5	3000	2		2007	07-15	ABB 362-PMI-40-30
PCB3310		23%	3%	8920	9150	40000		40kA				2000/5	3000	2		2007	07-15	ABB 362-PMI-40-30
PCB3312		23%	3%	8920	9150	40000		40kA				2000/5	3000	2		2007	?	ABB 362-PMI-40-30
PCB2202		30%	2%	9210	9350	31500		31.5kA				2000/5	1600	3		1973	E72-20	McGraw Edison RHE-

														84-242-31.5
PCB2210	23%	2%	9210	9350	40000		40kA	2000/5	3000	2		2007	07-15A	Mitsubishi 200-SFMT-40HF
PCB2212	23%	2%	9210	9350	40000		40kA	2000/5	3000	2		2007	07-15A	Mitsubishi 200-SFMT-40HF
SW2218	47%	2%	9210	9350	20000		20kA/4kA secondary					1997	E12170	S & C 2030
PCB1102	45%	3%	17270	17800	40000		40kA	2000/5	2000	3		2008	4500088135	Mitsubishi 100SFMT-40HE-1
PCB1104	45%	3%	17270	17800	40000		40kA	2000/5	2000	3		2009	460000071	Mitsubishi 100SFMT-40HE-1
PCB1106	45%	3%	17270	17800	40000		40kA	2000/5	2000	3		2008	4500091256	Mitsubishi 100SFMT-40HE-1
PCB1108	45%	3%	17270	17800	40000		40kA	2000/5	2000	3		2009	460000071	Mitsubishi 100SFMT-40HE-1
PCB1110	45%	3%	17270	17800	40000		40kA	2000/5	2000	3		2009	460000071	Mitsubishi 100SFMT-40HE-1
PCB1112	45%	3%	17270	17800	40000		40kA	2000/5	2000	3		2009	4500091256	Mitsubishi 100SFMT-40HE-1
PCB1118	45%	3%	17270	17800	40000		40kA	2000/5	2000	3		2009	4500091256	Mitsubishi 100SFMT-40HE-1
PCB1120	45%	3%	17270	17800	40000		40kA	2000/5	2000	3		2007	07-38	Mitsubishi 100SFMT-40HE
PCB1122	45%	3%	17270	17800	40000		40kA	2000/5	2000	3		2009	460000071	Mitsubishi 100SFMT-40HE-1
PCB302	39%	1%	15330	15440	40000		40kA	1200/5	1200	3		2006	4500053994	Siemens SPS-72.5-40-2
PCB304	39%	1%	15330	15440	40000		40kA	1200/5	1200	3		2006	4500055794	Siemens SPS-72.5-40-2
PCB320	39%	1%	15330	15440	40000		40kA	1200/5	1200	3		2006	4500053994	Siemens SPS-72.5-40-2
PCB322	30%	0%	9530	9560	31500		31.5kA	2000/5	2000	3		1997	58635	ABB 72-PM-31-20
PCB324	30%	0%	9530	9560	31500		31.5kA	2000/5	2000	3		1997	58635	ABB 72-PM-31-20
PCB326	30%	0%	9530	9560	31500		31.5kA	2000/5	2000	3		1997	58635	ABB 72-PM-31-20
PCB328	30%	0%	9530	9560	31500		31.5kA	2000/5	2000	3		1997	58635	ABB 72-PM-31-20
PCB330	30%	0%	9530	9560	31500		31.5kA	2000/5	2000	3		1997	58635	ABB 72-PM-31-20
PCB332	30%	0%	9530	9560	31500		31.5kA	2000/5	2000	3		1997	58635	ABB 72-PM-31-20
ACB102	59%	0%	16840	16900	28555	91%	750 Asym		2000	5	0	1978	78-36	Westinghouse DHP
SW104	68%	0%	16840	16900	25000		25kA	1200/5	2000	3		2009	4500102705	ABB RMAG
SW106	68%	0%	16840	16900	25000		25kA	1200/5	2000	3		2009	4500102705	ABB RMAG
329-D	154%	1%	15330	15440	10000		10kA							SMD-20
322-D	154%	1%	15330	15440	10000		10kA							SMD-20

315-D	154%	1%	15330	15440	10000		10kA									SMD-20
Kelly																
PCB2202 to Wind Farm	55%	8%	10190	10990	19957	80%	10,000 Asym	160	240?	69	1200/5	1600	3	1	1959	104A	FP RHE -84-230-100000 GE HVB-
PCB2204 to Columbus East	27%	8%	10190	10990	40000		40kA	160	120	69	2000/5	2000	3		1988	88-12	242-400000-1 PENN RHE-
PCB2206 to Columbus West	55%	8%	10190	10990	19957	80%	10,000 Asym	160	240?	69	1200/5	1600	3	1	1965	691A	84-230-10000 ABB 242-
PCB2208 to Shell Creek	27%	8%	10190	10990	40000		40kA	240	240	46	2000/5	2000	3		2000	4.5E+09	PMR-40-20
CS2210	55%	8%	10190	10990	20000		20kA					1200			2002		S & C 2030 GE VB1-
PCB102	87%	1%	24340	24480	28000		28kA	320	240	77	2000	2000	5		1992		13.8-750-2000
Loup City																
PCB1102	18%	9%	3340	3640	20000		20kA	120	120?	30	1200/5	1200	3		1979	79-7	GE FK-121-20000-3
PCB1104	34%	9%	3340	3640	10794	86%	2500 Asym	120	120?	30	600/5	600	5	1	1945		Westinghouse GM-2
PCB1106	59%	4%	2390	2480	4202	84%	1000 Asym	120	120?	21	600/5	600	5	2	1946	319	GE FK-339-1000
CS1110 T1 Pri	18%	9%	3340	3640	20000		20kA								2008		S & C 2030
CS1114 1114-D2	35%	7%	3400	3640	10500		10.5kA					1200			1972	71-41 II	S&C II-2 SMD-2B
PCB302	45%	2%	3400	3460	7615	91%	500 Asym	80	80?	43	600/5	600	8	3	1951	824	GE FK-339-34.5-500-3
PCB304	45%	2%	3400	3460	7615	91%	500 Asym	40	40?	87	600/5	600	8	3	1951	824	GE FK-339-34.5-500-3
PCB306	45%	2%	3400	3460	7615	91%	500 Asym	40	40?	87	600/5	600	8	3	1951	824	GE FK-339-34.5-500-3
PCB310	45%	2%	3400	3460	7615	91%	500 Asym	120	60	29	600/5	600	8	1	1951	824	GE FK-339-34.5-500-3
307-L	35%	2%	3400	3460	10000		10kA										SMU-20
319-D	35%	2%	3400	3460	10000		10kA										SMD-20
115-D	23%	1%	3190	3220	14000		14kA										SMD-20
Madison - building may not be large enough for another panel																
CS1110	29%	24%	5920	7330	25000		25kA/4kA Secondary					1200			1996		S & C 2030
PCB302	10%	3%	3970	4100	40000		40kA				1200/5	1200	3		2005	4500052917	Siemens SPS2-72.5-40-2
115-D	25%	1%	3430	3480	14000		14kA										SMD-20
319-D	41%	3%	3970	4100	10000		10kA										SMD-20
Maxwell																
PCB1102	29%	4%	5640	5850	20000		20kA	120	120?	49	1200/5	1200	3		1978	78-1	McGraw Edison AHF-48-121-20
PCB1104	29%	4%	5640	5850	20000		20kA	160	160?	37	1200/5	1200	3		1978	78-1	McGraw Edison AHF-48-121-20
PCB1106	31%	4%	5640	5850	18576	74%	5000 Asym	160	160?	37	1200/5	1200	3	2	1964	691B	Westinghouse 1150-GM-5000
Neligh																
PCB1102 to Tilden	42%	9%	5860	6360	15024	86%	3500 Asym	120	120?	53	600/5	1200	5	1	1952	580	GE FK-439-115-3500-3
PCB1104 to	41%	9%	5860	6360	15516	88%	3500	120	120?	53	600/5	1200	5	1	195	580	GE FK-439-

Clearwater PCB1106 to Petersburg North	61%	0%	4060	4070	6650	88%	Asym 1500 Asym	120	120?	34	600/5	800	5	1	3 195 7	278	115-3500-3 GE FK-439-115-1500-3
PCB1108 to Creighton	16%	9%	5860	6360	40000		40kA	160	160?	40	2000/5	2000	3	1	200 8		Mistubishi 100-SFMT-40HE
PCB1110 T1 Pri	31%	9%	5860	6360	20835	83%	5000 Asym	80	40	80	1200/5	1200	3	0	197 1	N70-3	Westinghouse 1150-GM-5000
PCB1116	16%	9%	5860	6360	40000		40kA	100	20	64	1200/5	2000		0	200 7	4.5E+09	ABB 121 PMI 40-20
CS1112 T2 Pri	32%	9%	5860	6360	20000		20kA pri/ 4kA sec	80	60	80	1200/5	1200		1	198 9	352599	S&C 2030
CS1114												1200			197 4	62891	S&C II
1114-D2	61%	9%	5860	6360	10500		10.5kA								197 4		SMD-2B
619-D	45%	4%	3790	3930	8750		8.75kA								197 1		SMD-1A
308-D (fuse to T-3 - Elkorn RPPD)	46%	2%	4510	4590	10000		10kA										SMD-20
314-D	46%	2%	4510	4590	10000		10kA					1200			197 4		SMD-20
PCB602	17%	4%	3790	3930	23000		23kA	120	120?	33	1200/5	1200		3	199 5	95-34	Siemens SPS-72.5-23-1
PCB604	11%	2%	4510	4590	40000		40kA				1200/5	2000	3		200 8		Siemens SPS2-72.5-40-2
PCB310	11%	2%	4510	4590	40000		40kA	120	120	38	1200/5	2000	3	1	200 9	08-32	Areva DT1-72.4-F1FK
PCB302	11%	2%	4510	4590	40000		40kA	80	80	57	1200/5	2000	3	3	200 9	08-32	Areva DT1-72.4-F1FK
PCB304	11%	2%	4510	4590	40000		40kA	80	80	57	1200/5	2000	3	3	200 9	08-32	Areva DT1-72.4-F1FK
PCB306	11%	2%	4510	4590	40000		40kA	80	80	57	1200/5	2000	3	3	200 9	08-32	Areva DT1-72.4-F1FK
Norfolk																	
PCB1102	76%	5%	11190	11700	15463	88%	3500 Asym				1200/5	1200	5	1	195 6	409	Westinghouse GM-5A
PCB1104	53%	5%	11190	11700	22000		22kA				2000/5	1600	3		196 9		ITE 115-KM-10000-16B
PCB1106	59%	5%	11190	11700	20000		20kA				1200/5	1200	3		197 7	76-36	Allis Chalmers BZO-121-20-7
PCB1114	59%	5%	11190	11700	20000		20kA				1200/5	1200	3		197 7	76-36	Allis Chalmers BZO-121-20-7
PCB1116	56%	5%	11190	11700	20835	83%	5000 Asym				1200/5	1200	3	0	196 2	320	GE FK-115-5000
PCB1118	29%	5%	11190	11700	40000		40kA				1200/5	2000	3		200 0	99-40	ABB 121-PMI-40-20
PCB1120	29%	5%	11190	11700	40000		40kA				1200/5	2000	3		200 0	99-40	ABB 121-PMI-40-20
PCB302	35%	1%	13930	14100	40000		40kA				1200/5	1200	3		200 3		Siemens SPS2-72.5-40-2
PCB304	64%	1%	13930	14100	22000		22kA				2000/5	1200	5		197 4	73-45	GE FKA-38-22000-6
PCB306	61%	1%	13930	14100	23000		23kA				1200/5	1200	3		199 6	E12831	Siemens SPS-72.5-23-1
PCB310	61%	1%	13930	14100	23000		23kA				1200/5	1200	3		199 6	E12831	Siemens SPS-72.5-23-1

PCB312	61%	1%	13930	14100	23000		23kA				1200/5	1200	3		1996	E12831	Siemens SPS-72.5-23-1
PCB314	61%	1%	13930	14100	23000		23kA				1200/5	1200	3		1993	369400	Siemens SP-38-23-3
PCB316	64%	1%	13930	14100	22000		22kA				2000/5	1200	5		1974	73-45	GE FKA-38-22000-6
PCB320	70%	1%	13930	14100	20007	80%	1500 Asym				1200/5	1200	5	3	1970	N70-6	Westinghouse 345-GS-1500
PCB322	70%	1%	13930	14100	20007	80%	1500 Asym				1200/5	1200	5	3	1972	E71-20	Westinghouse 345-GS-1500
318-D	81%	1%	13930	14100	17500		17.5kA										SMD-1A
T-3 fuse	81%	1%	13930	14100	17500		17.5kA										SM-5
327-D	81%	1%	13930	14100	17500		17.5kA										SMD-1A
331-D	81%	1%	13930	14100	17500		17.5kA										SMD-1A
21-D	61%	0%	8520	8560	14000		14kA										SMD-20
Norfolk North																	
PCB1102	60%	2%	11790	12070	20000		20kA	160		75	1200/5	1200	3	1	1981	81-6	McGraw Edison AHF-48-121-20
PCB1104	60%	2%	11790	12070	19957	80%	5000 Asym	240		50	1200/5	1200	3	1	1960	E58-37	Westinghouse GM-6B
PCB1106	60%	2%	11790	12070	19957	80%	5000 Asym	240		50	1200/5	1200	3	1	1960	E58-37	Westinghouse GM-6B
PCB1110	60%	2%	11790	12070	20000		20kA				1200/5	1200	3	1	1978	78-1	McGrawEdison AHF-48-121-20
PCB1112 (new)	30%	2%	11790	12070	40000		40kA					2000	3		2010		Areva DT1-123 F1 FK
PCB302	69%	1%	13610	13710	20007	80%	1500 Asym				1200/5	1200	5	3	1972	E71-20	Westinghouse 345-GS-1500
PCB304	62%	1%	13610	13710	22000		22kA				1200/5	1200	5	3	1974	73-45	GE FKA-38-22000-6
PCB306	69%	1%	13610	13710	20007	80%	1500 Asym				1200/5	1200	5	3	1972	E71-20	Westinghouse 345-GS-1500
PCB310	34%	1%	13610	13710	40000		40kA				1200/5	2000	3	3	2008		Siemens SPS-72.5-40-2
PCB312 (new)	34%	1%	13610	13710	40000		40kA				1200/5	2000	3		2009		Areva DT1-123 F1 FK
PCB314	44%	1%	13610	13710	31500		31.5kA				1200/5	2000	3	0	2008		ABB 72-PMI-32-20
PCB320 (new)	34%	1%	13610	13710	40000		40kA				1200/5	2000	3		2009		Areva DT1-123 F1 FK
315-D	78%	1%	13610	13710	17500		17.5kA										SMD-1A
319-D	78%	1%	13610	13710	17500		17.5kA										SMD-1A
327-D	78%	1%	13610	13710	17500		17.5kA										SMD-1A
329-D	78%	1%	13610	13710	17500		17.5kA										SMD-1A
North Loup																	
PCB1102	13%	5%	2750	2900	22000		22kA	120	80?	24	1200/5	1200	3		1972	E71-19	GE FK-121-22000-2
PCB1104	13%	5%	2750	2900	22000		22kA	80	80?	36	1200/5	1200	3		1972	E71-19	GE FK-121-22000-2
PCB1106	13%	5%	2750	2900	22000		22kA	160	120?	18	1200/5	1200	3		1972	E71-19	GE FK-121-22000-2
CS1110 T1 Diff	73%	5%	2750	2900	4000		4kA	40	40	73	1200/5	1200			2005	4.5E+09	S&C 2030
CS1114 1114-D2	28%	5%	2750	2900	10500		10.5kA					1200			1977	77-13	S&C IV-2 SMD-2B

North Platte																	
PCB1102	46%	1%	18300	18540	40000		40kA	240	120?	77	2000/5	2000	3	1	2010		
PCB1104	46%	1%	18300	18540	40000		40kA	240	160?	77	2000/5	2000	3	1	2009		
PCB1106	84%	1%	18300	18540	22000		22kA	160	160?	116	1200/5	1200	3		1971	N70-11	GE FK-121-22000-2
PCB1108	46%	1%	18300	18540	40000		40kA	240	60	77	1200/5	2000	3		2007	00-10	Mitsubishi 100-SFMT-40HE
PCB1110	86%	1%	17110	17340	20082	80%	5000 Asym	240	120?	72	1200/5	1200	3	1	1966	E66-22	Westinghouse 1150-GM-5000
PCB1112 T1 Diff	79%	1%	17300	17410	22000		22kA	160	40	109	1200/5	1200	3		1971	N70-11	GE FK-121-22000-2
PCB1116	46%	1%	18300	18540	40000		40kA	240	400	77	1200/5	2000	3		2006	00-10	Mitsubishi 100-SFMT-40HE
PCB1118	46%	1%	18300	18540	40000	83%	40kA	400	400	46	2000/5	2000	3	0	2009		
PCB1120	46%	1%	18300	18540	40000		40kA	240	240?	77	2000/5	2000	3		2004	00-10	Mitsubishi 100-SFMT-40HE
PCB1122	90%	1%	17810	18050	20000		20kA	240	60	75	1200/5	1200	3		1977	76-36	Allis Chalmers BZO-121-20-7
PCB2202	30%	2%	11660	11850	40000		40kA	160	160?	74	2000/5	2000	3		1977	76-39	McGraw Edison RHF-84-242-40
PCB2204	40%	2%	11660	11850	29370	78%	15000 Asym	160	160?	74	2000/5	1600	3	4	1966	E65-9	Westinghouse 2300-GW-15000
PCB2206	30%	2%	11660	11850	40000		40kA	160	160?	74	2000/5	2000	3		1977	76-39	McGraw Edison RHF-84-242-40
PCB2208	36%	2%	11660	11850	33000		33kA	240	240?	49	2000/5	1600	3		1971	751	McGraw Edison RHE-84-230-15000
PCB2210	30%	2%	11660	11850	40000		40kA	240	240?	49	2000/5	2000	3		1977	76-39	McGraw Edison RHF-84-242-40
PCB2212	30%	2%	11660	11850	40000		40kA	240	240?	49	2000/5	2000	3		1977	76-39	McGraw Edison RHF-84-242-40
PCB102	25%	0%	23810	23890	97000		97kA	1000		24		2000	5		2007	4.5E+09	Cutler Hammer 150VCP-W750
PCB104	25%	0%	23810	23890	97000		97kA	1000		24		2000	5		2007		Cutler Hammer 150VCP-W750
115-D	70%	0%	23810	23890	34000		34kA										SM-5
117-D	70%	0%	23810	23890	34000		34kA										SM-5
O'Neil																	
PCB1102 to Emmet	23%	0%	3520	3530	15674	89%	3500 Asym	120	120?	29	600/5	1200	5	1	1952	580	GE FK-439-115-3500-3
PCB1104 to Clearwater	23%	0%	3520	3530	15516	88%	3500 Asym	120	120?	29	600/5	1200	5	1	1952	580	GE FK-439-115-3500-3
PCB1106 to Spencer	18%	0%	3520	3530	20000		20kA	120	120?	29	1200/5	1200					McED AHF-48-121-20ka 1200A
PCB1110	52%	0%	3520	3530	6853	91%	1500	80	60	44	600/5	800	5	1	194	918	GE FK-339-

						Asym							2		115-1500
CS1112	9%	0%	3520	3530	40000	40kA	120	60	29	600/5	1200		2008		S&C 2030
CS1114											1200		1972		S&C MKII
1114-D2	34%	0%	3520	3530	10500	10.5kA									SMD-2B 125E
Petersburg															
1110-D (Loup)	71%	38%	5420	7460	10500	10.5kA									SMD-2B
PCB302 (Loup)	8%	3%	1550	1590	20000	20kA	80	80?	20	?	1200	3			McGraw Edison CG-38
319-D (Loup)	16%	3%	1550	1590	10000	10kA									SMD-20
115-D (Loup)	15%	1%	2010	2040	14000	14kA									SMD-20
Petersburg North	New substation - equipment will be rated high enough (40kA)	38%	5440	7480											
Spalding															
PCB1102 to North Loup	8%	6%	2980	3170	40000	40kA	160	80?	20	2000/5	2000	3	2008	4.5E+09	Mistubishi 100-SFMT-40HE
PCB1104 to Albion	8%	6%	2980	3170	40000	40kA	160	80?	20	2000/5	2000	3	2009	4.5E+09	Mistubishi 100-SFMT-40HE
PCB1114	8%	6%	2980	3170	40000	40kA	100	20	32	1200/5	2000	3	2007	4.5E+09	ABB 121 PMI 40-20
CS1110	16%	6%	2980	3170	20000	20kA	40	30	79		1200		1998	E16004	S&C 2030
Tilden															
1110-D (fuse to T-1 - Elkorn RPPD)	50%	3%	5060	5220	10500	10.5kA									SMD-2B
Twin Church 115	Substation is being rebuilt; will tap 345kV eventually; SPP wind farm impacts appear negligable	1%	11370	11510											

7.0 Regional Flowgate Impact Analysis

7.1 Overview

Power Transfer Distribution Factors (PTDF)s and Outage Transfer Distribution Factors (OTDF)s were calculated for all flowgates in the Nebraska area utilizing the DFCALC IPLAN program. MAPP DRS criteria were utilized to determine if a defined flowgate was significantly affected by the addition of the wind facilities and potential deliveries. If a PTDF flowgate was impacted by greater than 5.0% and 1 MW or an OTDF flowgate was impacted by greater than 3.0% and 1 MW, the flowgate was considered significantly affected by the addition and mitigation may be required for firm transmission service if AFC is unavailable. The 2010 Spring Peak and 2016 Summer Peak cases were utilized as the base case models for this analysis. A GEN-to-GEN dispatch was evaluated for each of the wind facilities.

For the GEN-to-GEN evaluation, the incremental generation associated with the new wind generation facilities was dispatched to all other online generation in all other SPP areas. Dispatching the units in this manner best shows the overall impact of dispatching the wind facilities to the entire SPP footprint. The dispatch utilized in the DF analysis was the same dispatch that was utilized in the loadflow analysis portion of the study.

7.2 Results

Utilizing the DFCALC IPLAN routine, PTDF and OTDF calculations were performed on each of the generation re-dispatch cases. Table 17 below summarizes the DF results (%) for each flowgate in the Nebraska area. The full DF outputs are contained in Appendix D.

Overall, the results were fairly consistent for each of the five generation interconnection projects. Four PTDF flowgates, COOPER_S, GRIS_LNC, FTCAL_S and WNE_WKS, were significantly impacted by each of the wind projects. COOPER_S was the highest impacted flowgate at over 30% DF for each of the wind projects. FTCAL_S and WNE_WKS were both impacted at roughly 10% DF for each of the wind projects. GRIS_LNC was impacted by roughly 35% DF for only the Broken Bow wind project. The Council Bluffs – River Bend 161 kV FLO Cooper – St. Joe 345 kV and Kelly – Tecumsah Hill 161 kV FLO Cooper – St. Joe 345 kV OTDF flowgates were impacted by roughly 3% by each of the wind projects. Regional flowgate impacts due to the wind projects will be further addressed in the Delivery study. This DF analysis evaluates the impacts on regional flowgates to understand the potential impacts of these future resources on known regional constraints. Ultimately, the transmission service or delivery study will evaluate the final impacts of any deliveries from the wind projects on the regional flowgates. The delivery study will determine if sufficient AFC is available or if any mitigation is required on the regional flowgates due to the impact of the wind projects.

Table 17. DFCALC Results

		2010 Spring Peak					
		40.5 MW TPW	75 MW Laredo Ridge II	75 MW Elkhorn Ridge II	200 MW Madison County	75 MW Broken Bow	ALL (465.5 MW)
Type	Interface	GEN-to-GEN (MW)	GEN-to-GEN (MW)	GEN-to-GEN (MW)	GEN-to-GEN (MW)	GEN-to-GEN (MW)	GEN-to-GEN (MW)
PTDF	COOPER_S	**33.4% (13.5 MW)**	**33.7% (25.3 MW)**	**31.6% (23.7 MW)**	**34.9% (69.8 MW)**	**31.0% (23.3 MW)**	**33.4% (155.5 MW)**
	FTCAL_S	**10.2% (4.1 MW)**	**10.5% (7.9 MW)**	**15.0% (11.3 MW)**	**8.5% (17.1 MW)**	2.1%	**9.0% (41.9 MW)**
	GGS	0.4%	0.7%	1.9%	0.9%	-1.8%	0.5%
	GRIS_LNC	0.8%	1.7%	0.0%	-7.7%	**40.7% (30.5 MW)**	3.6%
	WNE_WKS	**10.8% (4.4 MW)**	**10.9% (8.2 MW)**	**10.0% (7.5 MW)**	**11.0% (22.1 MW)**	**14.5% (10.9 MW)**	**11.4% (53.1 MW)**
OTDF	S1226TEKAMAH	-5.5%	-5.6%	-7.1%	-4.3%	-1.7%	-4.7%
	RIVERBEND	**3.0% (1.2 MW)**	**3.1% (2.3 MW)**	2.8%	**3.2% (6.4 MW)**	2.8%	**3.0% (14.1 MW)**
	KELLYTECH	**3.5% (1.4 MW)**	**3.6% (2.7 MW)**	**3.4% (2.5 MW)**	**3.7% (7.4 MW)**	**3.2% (7.4 MW)**	**3.5% (16.4 MW)**
	TEKRNS3451RN	-1.5%	-1.6%	-3.2%	-1.7%	-0.4%	-1.7%
		2016 Summer Peak					
		40.5 MW TPW	75 MW Laredo Ridge II	75 MW Elkhorn Ridge II	200 MW Madison County	75 MW Broken Bow	ALL (465.5 MW)
Type	Interface	GEN-to-GEN (MW)	GEN-to-GEN (MW)	GEN-to-GEN (MW)	GEN-to-GEN (MW)	GEN-to-GEN (MW)	GEN-to-GEN (MW)
PTDF	COOPER_S	**30.4% (12.3 MW)**	**30.3% (22.7 MW)**	**27.8% (20.8 MW)**	**29.8% (59.5 MW)**	**26.6% (19.9 MW)**	**29.1% (135.3 MW)**
	FTCAL_S	**10.8% (4.4 MW)**	**10.9% (8.2 MW)**	**15.3% (11.5 MW)**	**8.5% (17.0 MW)**	1.9%	**9.1% (42.5 MW)**
	GGS	0.9%	1.0%	2.1%	1.1%	-1.9%	0.8%
	GRIS_LNC	-3.8%	-3.6%	-5.3%	-13.7%	**35.8% (26.9 MW)**	-1.9%
	WNE_WKS	**7.6% (3.1 MW)**	**7.4% (5.6 MW)**	**6.8% (5.1 MW)**	**7.2% (14.5 MW)**	**11.0% (8.2 MW)**	**7.8% (36.4 MW)**
OTDF	S1226TEKAMAH	-5.7%	-5.6%	-7.0%	-4.1%	-1.5%	-4.5%
	RIVERBEND	2.7%	2.7%	2.4%	2.6%	2.3%	2.6%
	KELLYTECH	**3.0% (1.2 MW)**	**3.0% (2.3 MW)**	2.8%	**3.0% (5.9 MW)**	2.7%	2.9%
	TEKRNS3451RN	-1.4%	-1.5%	-3.2%	-1.7%	-0.3%	-1.6%

** Significant Impacts greater than 5% PTDF or 3% OTDF and greater than 1 MW are highlighted in **BOLD**.*

8.0 Detailed Cost Estimates & Project Schedule

NPPD's Engineering, Asset Management, and Project Management groups have reviewed the list of interconnection facilities and network upgrades that are required for interconnection of the five wind generation projects. Detailed cost estimates have been prepared for each of the interconnection facilities and network upgrades that were identified in the SPP DISIS-2009-1 system impact study and the facility study. The prepared cost estimates are budgetary level estimates (+75%/-25%) and assume implementation of standard NPPD construction and procurement practices. The costs estimates for the interconnection facilities and network upgrades are below:

- GEN-2006-044N Interconnection Facilities – Petersburg North 115 kV substation expansion to accommodate new 115 kV interconnection. **$ 1.3 Million**

- GEN-2007-011N06 Interconnection Facilities – Petersburg North 115 kV substation expansion to accommodate new 115 kV interconnection. **$ 0.5 Million**

- GEN-2007-011N09 Interconnection Facilities – Bloomfield 115 kV substation expansion to accommodate new 115 kV interconnection. **$ 0.5 Million**

- GEN-2008-086N02 Interconnection Facilities – Development of new Madison County 230 kV substation to accommodate new 230 kV interconnection. Detailed engineering review of the Ft. Randall – Kelly 230 kV line conductor clearances indicates additional line work would be required for interconnection to accommodate the increased loading on this facility. **$ 9.3 Million**

- GEN-2006-037N1 Interconnection Facilities – Broken Bow South 115 kV substation addition. The existing Broken Bow 115 kV substation is fully built out with no room or possibility of expansion at the existing site. To accommodate the request for interconnection, a Broken Bow South 115 kV substation would be built on land near the existing Broken Bow 115 kV substation and the existing transmission facilities would be re-terminated to the new substation. **$ 10.0 Million**

- Petersburg North – Madison 115 kV Line – New 35-mile 115 kV line from Petersburg North to Madison and associated substation additions. **$ 22.4 Million**

- Bloomfield – Belden 115 kV Line – New 45-mile 115 kV line from Bloomfield to Belden and associated substation additions. **$ 22.7 Million**

- Belden PCB 1112 & Creighton 607-D2 Replacement – Replace PCB 1112 at Belden and 607-D2 fuse at Creighton due to increased fault duty. **$ 0.5 Million**

- Albion – Petersburg – Petersburg North – Neligh 115 kV line uprate – Per the request of GEN-2006-044N, NPPD performed a facility study to evaluate the necessary upgrades to the Albion – Petersburg – Petersburg North – Neligh 115 kV lines to accommodate a 100 Deg C facility rating. The work required to upgrade these facilities to 100 Deg C include increasing line clearances, replacing bus conductor, miscellaneous substation upgrades and protection system modifications.

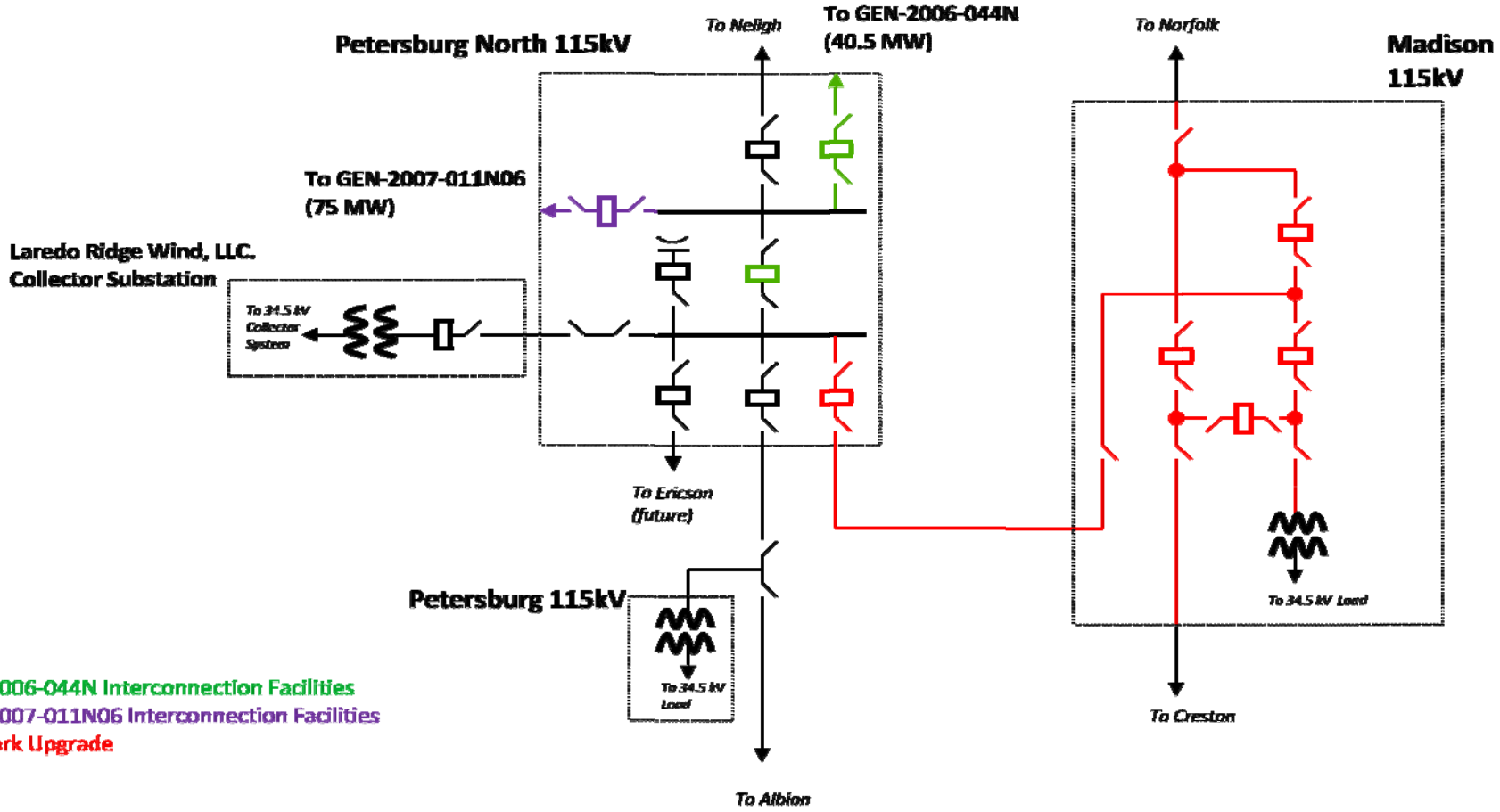
  $ 0.9 Million

Total Interconnection & Network Upgrades: $68.1 Million

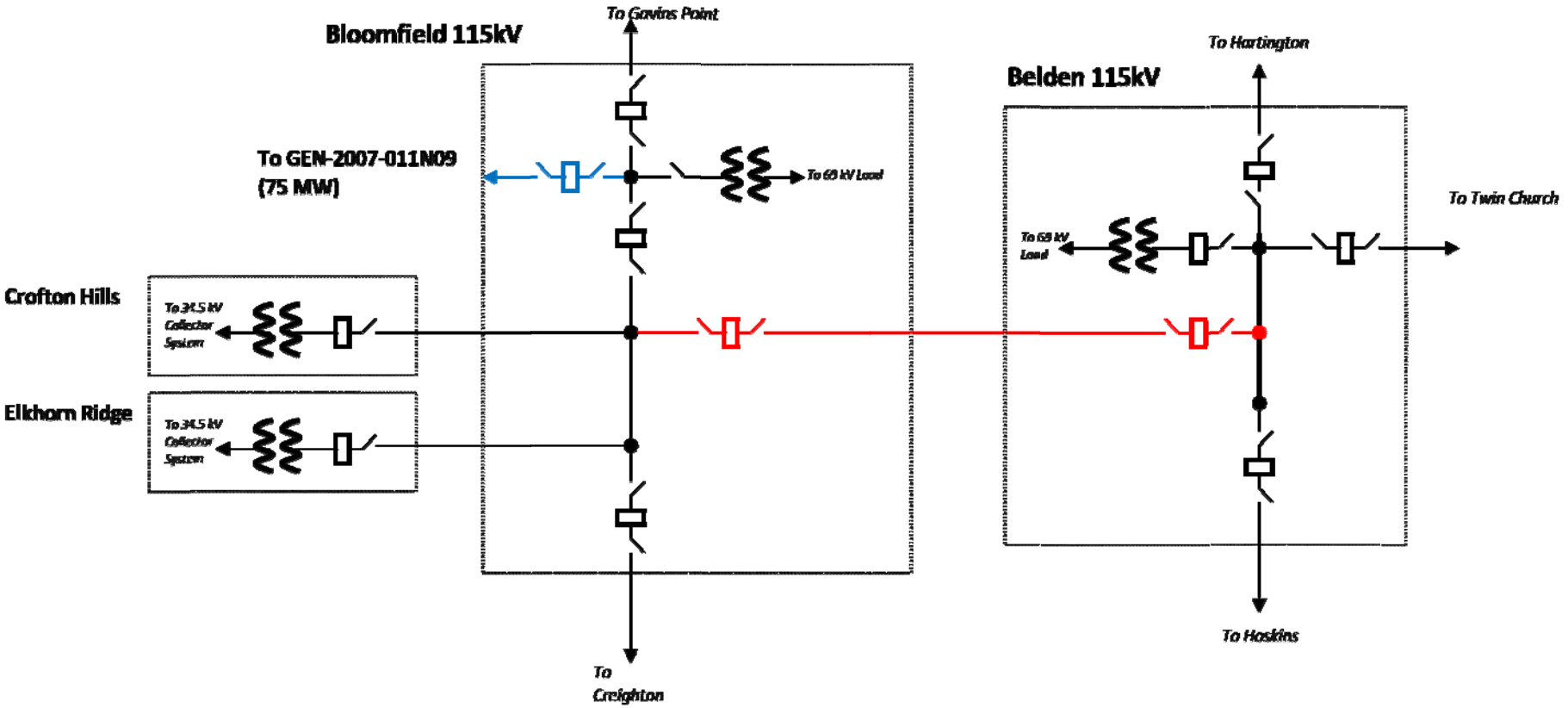
Proposed one-line diagrams of the interconnection and network upgrades are on the following pages. NPPD will work with the wind generation facility projects to develop project schedules for the interconnection facilities and network upgrade projects listed above. Typical implementation schedules for new transmission lines (>115 kV) are roughly 4 years to accommodate the public routing process and construction schedules. Substation additions require less land acquisition and typically can be implemented in less time or approximately 2 years. Project schedule details will be further discussed in the development of the generator interconnection agreement (GIA) and the milestones associated with the generation interconnection projects.

It should be noted that the projects listed above do not include any third party facilities (Yankton Junction – Utica Junction 115 kV & Gavins Point – Yankton Junction 115 kV) that were identified in the facility study. SPP will need to coordinate the results of this facilities study with these external entities to determine the appropriate mitigations and necessary transmission upgrades. Detailed costs and project schedules would then be developed by SPP and the external entity and communicated to the wind generation interconnection customers.

GEN-2006-044N Interconnection Facilities
GEN-2007-011N06 Interconnection Facilities
Petersburg North – Madison 115 kV Line & Substation Additions

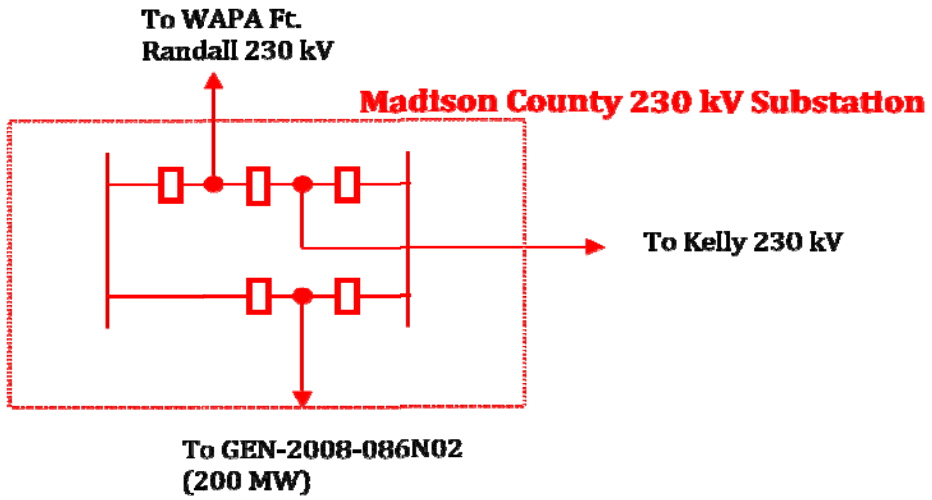


GEN-2007-011N09 Interconnection Facilities
Bloomfield – Belden 115 kV Line & Substation Additions



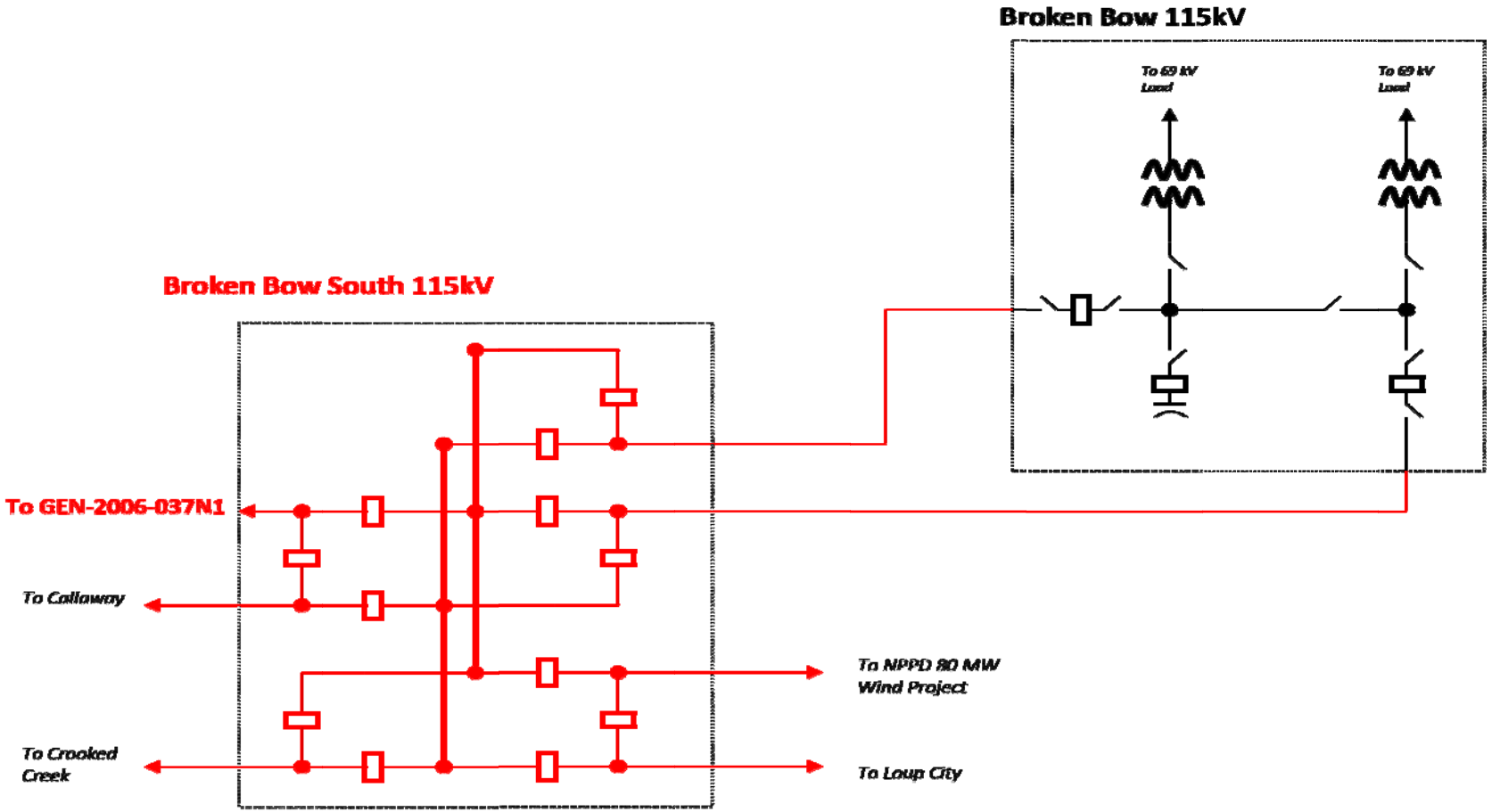
- GEN-2007-011N09 Interconnection Facilities
- Network Upgrade

GEN-2008-086N02 Interconnection Facilities



- GEN-2008-086N02 Interconnection Facilities

GEN-2006-037N1 Interconnection Facilities



• GEN-2006-037N1 Interconnection Facilities