



***Facility Study
For
Generation Interconnection
Request
GEN-2006-044N02
GEN-2008-123N***

***SPP Generation
Interconnection
Studies***

March 2012

Summary

Nebraska Public Power District (NPPD) performed the following Study at the request of the Southwest Power Pool (SPP) for Generation Interconnection requests Gen-2006-044N02 and GEN-2008-123N. The requests for interconnection were 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.

Interconnection Customer Interconnection Facilities

Each Interconnection Customer will be responsible for its 115kV (GEN-2008-123N) or 230kV (GEN-2006-044N02) transmission facilities from its point of interconnection to its 115/34.5kV (GEN-2008-123N) or 230/34.5kV (GEN-2006-044N02) substation that will contain its step down transformers and wind turbine collector feeders. In addition, each Customer will be responsible for reactive power compensation equipment to maintain 95% lagging (providing vars) and 95% leading (absorbing vars) power factor at the point of interconnection.

Transmission Owner Interconnection Facilities and Non Shared Network Upgrades,

The interconnection customers were studied within the DISIS-2010-002 Impact Study. The Interconnection Customers are responsible for following non shared costs.

Gen 2006-044N02

Upgrade Description	Allocated Cost
Interconnection costs	\$2,100,000
Madison – Kelly 230kV. Upgrade conductor clearances to 100 ⁰ C. Includes substation upgrades at Kelly 230kV.	\$3,600,000
Total	\$5,700,000

Gen 2008-123N

Upgrade Description	Allocated Cost
Interconnection costs	\$4,400,000
Guide Rock 115kV Breaker Additions – Add breakers at Guide Rock for protection coordination issues.	\$2,300,000
Total	\$6,700,000

Contingent Upgrades

The interconnection requests were studied with the following network upgrades as Base Case upgrade facilities. For the customer to go in service before the in service date of the following facility will require further study.

- Addition of Madison County 230 kV substation on Ft. Randall – Kelly 230 kV line.
- Expansion of Petersburg North 115 kV substation.
- Upgrade of Neligh-Petersburg North – Petersburg – Albion 115 kV to 137 MVA facility rating
- Upgrade Ft. Randall – Kelly 230 kV line to 320 MVA facility rating.
- Upgrade of terminal at Broken Bow 115 kV substation
- Expansion of Broken Bow Wind 115 kV substation.

**DISIS-2010-001-4
GENERATION INTERCONNECTION
FACILITY RE-STUDY**

SPP GEN-2006-044N02 100.8 MW Wind Generation Facility at Madison Co. 230 kV
SPP GEN-2008-123N 89.7 MW Wind Generation Facility at Rosemont 115 kV

FEBRUARY 2012

**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

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DISIS-2010-001-4 Re-Study Summary

The *NPPD DISIS-2010-001-4 Facility Re-Study* was performed to document the reliability impacts of two new wind generation facilities interconnected to the NPPD transmission system. Three wind generation interconnection projects were studied in the original DISIS-2010-001 facility study and one of these wind generation projects have subsequently withdrawn from the SPP GI queue. As such, this prompted a re-study of the DISIS-2010-001 facility study and required interconnection facilities and network upgrades. The three wind generation projects in the DISIS-2010-001 are listed below:

Remaining DISIS-2010-001 Projects

<u>Project</u>	<u>MW</u>	<u>Point-of-Interconnection</u>	<u>Cluster</u>
GEN-2006-044N02	100.8	New Madison Co. Sub on Ft. Randall-Kelly 230 kV	9
GEN-2008-123N	<u>89.7</u> 190.5	New Rosemont Sub on Pauline-Guide Rock 115kV	15

This facility re-study re-evaluates the transmission interconnection plan developed to accommodate the interconnection of the two wind generation projects. This study report was prepared to document the assessment of 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. Due to the withdrawal of the single wind generation interconnection project in the DISIS-2010-001 study, the DISIS-2010-001 transmission interconnection plan has been modified by the re-evaluation of the DISIS-2010-001 system impact study. The following projects are the upgrades required for interconnection of the remaining two DISIS-2010-001 generation projects:

DISIS-2010-001 Transmission Additions

- Expansion of Madison County 230 kV Substation
- Upgrade Madison County – Kelly 230 kV line to 478 MVA facility rating
- Addition of Rosemont 115 kV Substation
- Breaker additions at Guide Rock 115 kV Substation

The DISIS-2010-001 Facility Re-Study includes a re-evaluation of the loadflow analysis and short circuit analysis performed in the original facility study. The same models were used in this re-study as in the original facility study. The DISIS-2010-001 Facility Re-Study included several wind generation interconnection project from the previous DISIS-2009-001 Re-Study. The prior queued generation projects and transmission upgrades associated with DISIS-2009-001 are listed on the following page:

Prior Queued DISIS-2009-001 Projects

<u>Project</u>	<u>MW</u>	<u>Point-of-Interconnection</u>	<u>Cluster</u>
GEN-2006-044N	40.5	Petersburg North 115 kV	9
GEN-2008-086N02	200.0	New Madison Co. Sub on Ft. Randall-Kelly 230 kV	9
GEN-2006-037N1	<u>75.0</u>	Broken Bow 115 kV	10
	315.5		

Prior Queued DISIS-2009-001 Transmission Additions

- Addition of Madison County 230 kV substation on Ft. Randall – Kelly 230 kV line.
- Expansion of Petersburg North 115 kV substation.
- Upgrade of Neligh-Petersburg North – Petersburg – Albion 115 kV to 137 MVA facility rating
- Upgrade Ft. Randall – Kelly 230 kV line to 320 MVA facility rating.
- Upgrade of terminal at Broken Bow 115 kV substation
- Expansion of Broken Bow Wind 115 kV substation.

This loadflow analysis documents the steady-state performance of the network following the two 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 contingency analysis revealed no additional facility overloads or voltage violations that would require mitigation due to TPL-001 and TPL-002 contingencies.

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 approximately 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 Phase 3 results indicate that the North Platte – Stockville 115 kV line was found to load to 102.3% of the facility rating for loss of the GGS – Red Willow 345 kV line. This limitation for the GGS – Red Willow 345 kV contingency is associated with the WNE_WKS PTDF flowgate and mitigation may be required to address the impact of the wind generation facilities on this constraint. Also, 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

worst-case N-1 contingency loading was 124.6% and 107.7% of the 120 MVA rating for the Gavins Point – Yankton Junction – Utica Junction 115 kV lines, respectively, for the loss of the Spirit Mound – Manning 115 kV line. The Gavins Point – Yankton Junction – Utica Junction 115 kV lines also overloaded for loss of Gavins Point – Hartington – Belden 115 kV, Manning – Beresford – Sioux Falls 115 kV, and Ft. Randall – Utica Junction 230 kV. The Phase 3 results also identified a list of two additional transmission facilities in the north central area that would need prior outage generation limits established to ensure system operating limits are maintained on NPPD transmission facilities for the potential loss of the next worst-case transmission facility. These new prior outage facilities are listed below.

New Prior Outage Limiting Facilities

Kelly 230/115 kV Transformer

Columbus East 230/115 kV Transformer

These transformers were identified as limiting facilities for the following prior outage conditions:

Prior Outage Facilities

Kelly – Columbus East 230 kV

Kelly – Shell Creek 230 kV

Kelly 230/115 kV Transformer

Shell Creek 345/230 kV Transformer

The list of 9 prior outage limiting facilities for the north central area in the DISIS-2009-001 re-study would also be an issue for the DISIS-2010-001 generation projects and would need further study to determine the appropriate prior outage limitations. Also, the list of 6 transmission facilities that was previously developed for the south central area would also need prior outage generation limits established to ensure system operating limits are maintained.

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 evaluate worst-case N-1 contingencies under these highly stressed transfer conditions. The Phase 4 results also identified several 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 110% of the 80 MVA facility rating for loss of the Crooked Creek – Riverdale 230 kV line. The North Platte – Stockville 115 kV lines were found to overload above 110% of the 137 MVA facility rating for loss of the GGS – Red Willow 345 kV line.

The short circuit analysis was performed to evaluate the fault interrupting capability of existing devices in the area and protection coordination issues following the interconnection of the proposed wind generation additions. The results of this analysis showed that the protection coordination issues associated with L-1171B and L-1172 would require additional 115 kV breakers at Guide Rock following the addition of the

new generation at the proposed Rosemont 115 kV substation. Also, existing relays and protection schemes for both new interconnection substations would need further review and coordination as the facilities are designed and engineered for construction. NPPD Telecom has reviewed the communication needs at the Rosemont substation site and is recommending microwave at this location. These additional telecom costs have been added to the list below.

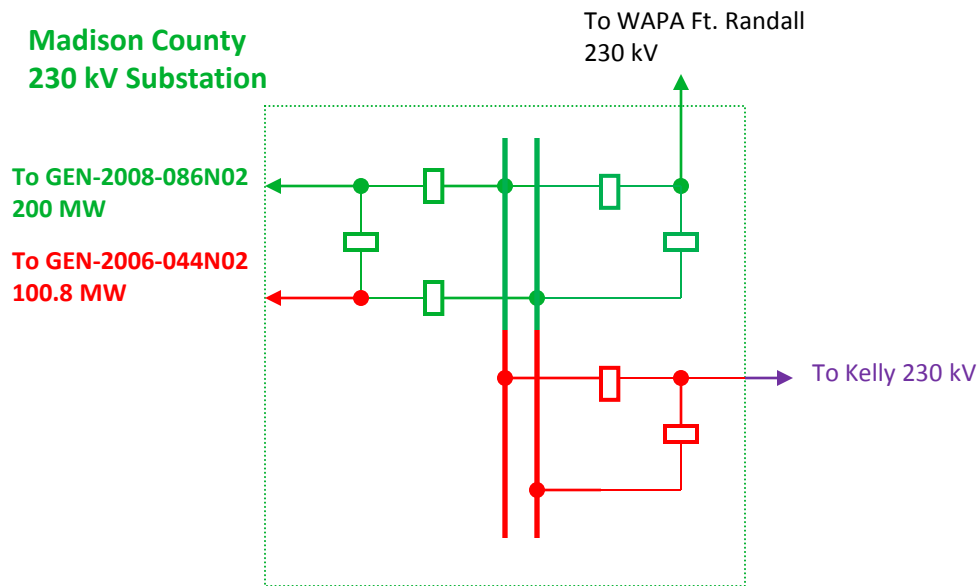
Overall, the *NPPD DISIS-2010-001-4 Facility Re-Study* documents the performance of the network following the addition of the two wind generation interconnection projects and associated transmission. The Facility Re-Study has documented the transmission plan required for interconnection to the NPPD transmission system and the details are listed below.

DISIS-2010-001-4 Generation Interconnection Plan

- GEN-2006-044N02 Interconnection Facilities – Madison County 230 kV substation expansion to accommodate new 230 kV interconnection. **\$ 2.1 Million**
- GEN-2008-123N Interconnection Facilities – Rosemont 115 kV substation addition on Pauline – Guide Rock 115 kV line to accommodate new 115 kV interconnection. **\$ 4.4 Million**
- Upgrade Madison County – Kelly 230 kV to 478 MVA rating – Upgrade conductor clearances to 100 Deg C and substation upgrades at Kelly 230 kV. **\$ 3.6 Million**
- Guide Rock 115 kV Breaker Additions – Add 115 kV breakers at Guide Rock due to protection coordination issues following the addition of Rosemont 115 kV substation as identified in DISIS-2010-001 Facility Study. **\$ 2.3 Million**

Total Interconnection & Network Upgrades: \$12.4 Million

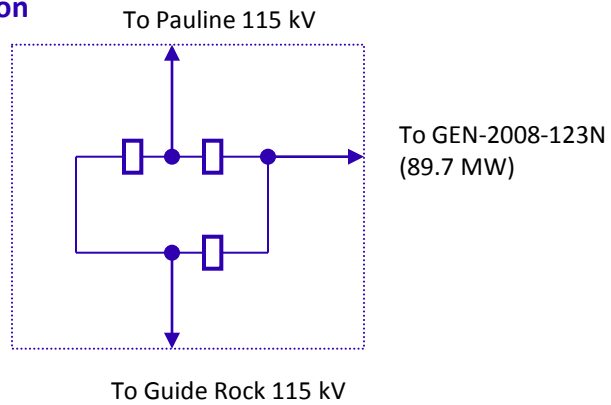
DISIS-2010-001 Interconnection Facilities & Network Upgrades



- Upgrades previously allocated to DISIS-2009-001 customers. \$9.3 Million Total for Madison County 230 kV sub (\$6.4 Million) & line upgrades (\$2.9 Million).
- GEN-2006-044N02 Interconnection Facility
- Network Upgrade: Upgrade Madison County – Kelly 230 kV to 478 MVA normal rating. Line upgrades to 100 Deg C and substation upgrades at Kelly to 1200 Amp.

DISIS-2010-001 Interconnection Facilities & Network Upgrades

Rosemont 115 kV Substation



- GEN-2008-123N Interconnection Facility (includes 115 kV breakers at Guide Rock)