



**SPP**

*Southwest  
Power Pool*

**Facility Study  
For  
Generator Interconnection  
Request  
GEN-2013-032  
(IFS-2013-002-006)**

*SPP Generator  
Interconnection Studies*

*(#GEN-2013-032)  
(#IFS-2013-002-006)*

**January 2015**

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## Revision History

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Date	Author	Change Description
06/25/2014	SPP	Facility Study Report Issued
01/20/2015	SPP	Final Facility Study Report Issued - Account for DISIS-2013-002-2 restudy results

## **Summary**

Nebraska Public Power District (NPPD), performed a detailed Facility Study at the request of Southwest Power Pool (SPP) for Generation Interconnection request GEN-2013-032/IFS-2013-002-6 (204.0 MW) located in Antelope County, Nebraska. Interconnection Customer, GEN-2013-032/IFS-2013-002-6 is an Energy Resource Interconnection Service (ERIS) only SPP GI Interconnection Request. SPP has proposed the in-service date will be after the assigned Interconnection Facilities and Non-Shared Network Upgrades are completed. Full Interconnection Service will require the Network Upgrades listed in the "Other Network Upgrades" section. The request for interconnection was placed with SPP in accordance with SPP's Open Access Transmission Tariff, which covers new generation interconnections on SPP's transmission system.

## **Phases of Interconnection Service**

It is not expected that interconnection service will require phases however, interconnection service will not be available until all interconnection facilities and network upgrades can be placed in service.

## **Interconnection Customer Interconnection Facilities**

The Interconnection Customer's generation facility consists of one hundred and twenty (120) 1.7 G.E. wind turbines for a total generation capacity of 204.0MW. The 34.5kV collector system for this wind farm is planned to be connect to one (1) 115/34.5kV Interconnection Customer owned and maintained transformer at the Interconnection Customer owned substation. An approximate ten (10) mile 115kV transmission circuit will connect the Interconnection Customer owned substation to the new NPPD owned 345/115kV Neligh East Substation. The Interconnection Customer will be responsible for all of the transmission facilities connecting the customer owned substation to the Point of Interconnection (POI), at NPPD owned 115 kV bus at the planned 345/115kV Neligh East Substation. The Interconnection Customer will also be responsible for any equipment located at the Customer substation necessary to maintain a power factor of 0.95 lagging to 0.95 leading at the POI.

## **Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades**

To allow interconnection the Transmission Owner will expand the proposed Neligh East substation 115 kV substation to allow for the addition of one (1) 115 kV line terminal to accept the Interconnection Customer's Interconnection Facilities. The required Network Upgrades include adding two (2) 115 kV breakers to the proposed Neligh East substation. NPPD has proposed a lead time of approximately twenty-four (24) to thirty-six (36) months for the completion of the Interconnection Facilities and all Non-Shared Network Upgrades.

Due to higher queued Interconnection Customers and the need for their assigned Network Upgrades withdrawing from the SPP GI Queue, a DISIS-2013-002 Re-study was conducted. NPPD has identified a Non-Shared Network Upgrade of replacing a Neligh 115kV breaker for short circuit analysis needs as part of the acceptance for the additional generation amount injected to the transmission system by GEN-2013-032. Additionally, results from the DISIS-2013-002-2 Impact Restudy show the GEN-2013-032/IFS-2013-002-6 generation injection causing thermal overload violations on the Battle Creek – County Line – Neligh East 115kV transmission circuit during contingency. A portion of this 115kV line section is being rebuilt per Hoskins – Neligh East

345/115kV Project<sup>1</sup>, while the rest of the line will be rebuilt to 125MVA at the \$4,000,000 estimated cost responsibility of GEN-2013-032/IFS-2013-002-6. At this time GEN-2013-032/IFS-2013-002-6 is responsible for \$7,000,000 of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades.

**Table 1: GEN-2013-032/IFS-2013-002-6 TOIF and Non-Shared Network Upgrades**

Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades Description	Allocated Cost (\$)	Allocated Percent (%)	Total Cost (\$)
Interconnection Substation - Transmission Owner Interconnection Facilities 115kV Substation work	\$700,000	100%	\$700,000
Interconnection Substation - Network Upgrades 115kV Substation work	\$1,800,000	100%	\$1,800,000
Neligh 115kV Substation – Non-Shared Network Upgrade for breaker replacement at Neligh 115kV Substation	\$500,000	100%	\$500,000
Battle Creek – County Line – Neligh East 115kV – Rebuild line sections to at least 125MVA	\$4,000,000	100%	\$4,000,000
<b>Total</b>	<b>\$7,000,000</b>	<b>100%</b>	<b>\$7,000,000</b>

**Shared Network Upgrades**

At this time, the Interconnection Customer is allocated \$0 for Shared Network Upgrades. If higher queued interconnection customers withdraw from the queue, suspend or terminate their GIA, restudies will have to be conducted to determine the Interconnection Customers’ allocation of Shared Network Upgrades. All studies have been conducted on the basis of higher queued interconnection requests and the upgrades associated with those higher queued interconnection requests being placed in service. At this time, the Interconnection Customer is allocated the following cost for Shared Network Upgrades.

**Table 2: GEN-2013-032/IFS-2013-002-6 Shared Network Upgrades**

Shared Network Upgrades Description	Allocated Cost (\$)	Allocated Percent (%)	Total Cost (\$)
Currently GEN-2013-032/IFS-2013-002-6 is not allocated Shared Network Upgrades	\$0	n/a	\$0
<b>Total</b>	<b>\$0</b>	<b>n/a</b>	<b>\$0</b>

**Other Network Upgrades**

Certain Other Network Upgrades are currently not the cost responsibility of the Customer but will be required for full Interconnection Service. Currently, the following Other Network Upgrades are required:

- Broken Bow Wind – Ord – North Loup 115 kV, assigned as a 2014 Integrated Transmission Plan Near Term (ITPNT) Reliability Upgrade with an on schedule in-service date of 6/1/2018<sup>2</sup>

<sup>1</sup> SPP-NTC-200253: <http://www.spp.org/publications/NTC%20NPPD%20200253.pdf>

<sup>2</sup> SPP-NTC-200294: <http://www.spp.org/publications/SPP%20NTC%20200294%20NPPD.pdf>

- Hoskins – Neligh East 345/115kV Project, assigned as a 2014 Integrated Transmission Plan Near Term (ITPNT) Reliability Upgrade with an on schedule in-service date of 6/1/2016<sup>3</sup>

Depending upon the status of higher or equally queued customers, the Interconnection Customer's in-service date is at risk of being delayed or their Interconnection Service is at risk of being reduced until the in-service date of these Other Network Upgrades.

**Conclusion**

Interconnection Service for GEN-2013-032/IFS-2013-002-6 will be delayed until the Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades are constructed. The Interconnection Customer is responsible for \$7,000,000 of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades. At this time, the Interconnection Customer is allocated \$0 for Shared Network Upgrades. After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 204.0 MW, as requested by GEN-2013-032/IFS-2013-002-6, can be allowed. At this time the total allocation of costs assigned to GEN-2013-032/IFS-2013-002-6 for Interconnection Service are estimated at \$7,000,000.

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<sup>3</sup> Please refer to footnote 1 for the SPP-NTC link.

**DISIS-2013-002-2  
GENERATION INTERCONNECTION  
FACILITY STUDY**

**SPP GEN-2013-032 204.0 MW at Neligh East (Antelope) 345-115 kV Substation**

**January 2015**

**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"*

## Executive Summary

The *NPPD DISIS-2013-002-2 Facility Study* was performed to document the reliability impacts of a generation project that is proposed to interconnect to the NPPD transmission system. This project has developed through the SPP Definitive Interconnection System Impact Study process and has advanced to the facility study stage. SPP has requested that NPPD perform the Facility Study associated with the generation interconnection project listed below:

<u>Project</u>	<u>MW</u>	<u>Type</u>	<u>Point-of-Interconnection</u>
GEN-2013-032	204.0	Wind	Neligh East 115 kV Substation (Antelope)

SPP entered into a facility study agreement with the generation interconnection customer and subsequently requested that NPPD perform the Facility Study for this GI request. The original facility study (DISIS-2013-002b) focused on the impacts of GEN-2013-032 and included a detailed loadflow analysis and short circuit analysis. Since the posting of DISIS-2013-002b Facility Study, GEN-2013-021 has subsequently withdrawn from the SPP GI queue and as such, DISIS-2013-002b will be considered DISIS-2013-002-1 Facility Study. The original Facility Study also included detailed cost estimates and estimated project schedules for the interconnection and network upgrades identified in the System Impact and Facility Study.

A list of interconnection and network upgrades identified in the original System Impact Study as required for this generation interconnection project is below:

- GEN-2013-032 Interconnection Facilities – Expansion of Neligh East 345-115 kV Substation (Antelope) for 115 kV terminal for GEN-2013-032 interconnection.
- Gavins Point – Yankton Junction 115 kV upgrade – This WAPA project was identified by SPP as a necessary third party upgrade for the interconnection of GEN-2013-032. SPP and WAPA will need to coordinate to complete this upgrade.
- Meadow Grove – Norfolk South 230 kV project – This previously-allocated DISIS-2013-001 project is required to provide generation interconnection capability for GEN-2013-032.
- Meadow Grove 230/115 kV & Meadow Grove – Petersburg North 115 kV – This previously-allocated DISIS-2013-001 project is required to provide generation interconnection capability for GEN-2013-032.
- Hoskins – Neligh East 345 kV project – This previously-allocated ITP10 project is required to provide generation interconnection capability for GEN-2013-032.

At the time of the original facility study, there were several active generation interconnection requests in the SPP GI queue in the Nebraska area. The previously

queued GI projects and network upgrades in the Nebraska area that were included in the original Facility Study were as follows:

Request	MW	Area	Point-Of-Interconnection	Status
GEN-2006-037N1	75	NPPD	Broken Bow 115kV	Under Development
GEN-2008-086N02	200	NPPD	Tap Ft Randall - Kelly 230kV (Meadow Grove)	Under Development
GEN-2008-123N	89.7	NPPD	Tap Guide Rock - Pauline 115kV	Under Development
GEN-2010-051	200	NPPD	Tap Twin Church - Hoskins 230kV	Under Development
GEN-2011-027	120	NPPD	Tap Twin Church - Hoskins 230kV	Under Development
GEN-2013-002	50.6	LES	Tap Sheldon - Folsom 115kV CKT 1	Facility Study
GEN-2010-041	10.5	OPPD	S 1399 161kV	IA Pending
GEN-2011-055	52.8	OPPD	South Sterling 69kV	IA Pending
GEN-2010-056	151	MIPU	Tap Cooper - St. Joe 345kV	Under Development
GEN-2012-005	81	NPPD	New 230 kV Sub on Ft. Randall – Meadow Grove 230 kV line	Facility Study
GEN-2013-004	6.5	NPPD	Prairie Breeze 230 kV Collector Substation	Facility Study
GEN-2013-005	73.5	NPPD	Prairie Breeze 230 kV Collector Substation	Facility Study
GEN-2013-006	50.6	NPPD	Meadow Grove 230 kV Substation	Facility Study
GEN-2013-008	1.2	NPPD	Steele Flats 115 kV Collector Substation	IA Pending
GEN-2013-014	25.5	NPPD	Rosemont 115 kV Substation	IA Pending
GEN-2013-015	125.8	NPPD	New 115 kV Sub on Pauline – Hildreth 115 kV line	IA Pending
GEN-2013-019	73.6	LES	Sheldon - Folsom & Pleasant Hill 115kV CKT 2	Facility Study

Previously allocated interconnection facilities & network upgrades

- Meadow Grove 230 kV substation (for GEN-2008-086N02)
- Upgrade Ft.Randall-MeadowGrove-Kelly 230kV line
- Rosemont 115 kV substation (for GEN-2008-123N)
- Dixon County 230 kV substation (for GEN-2010-051)
- Upgrade Twin Church-DixonCounty-Hoskins 230kV line
- Cooper-St. Joseph 345 kV substation (for GEN-2010-056)
- Knox County 230 kV substation (for GEN-2012-005)
- Bladen 115 kV substation (for GEN-2013-015)
- Norfolk South 345/230 kV substation
- Meadow Grove – Norfolk South 230 kV line
- Meadow Grove – Petersburg North 115 kV line
- Neligh 115 kV over-dutied breaker

Subsequently, a number of these GI requests were withdrawn through the SPP Generator Interconnection Procedures and SPP performed a new Definitive Interconnection System Impact Study (DISIS) to assess the impacts of the remaining GI requests. DISIS-2013-002-2 was posted in October of 2014. As a result of withdrawn GI requests, there were



also modifications to the required network upgrades which were previously identified in DISIS-2013-001 and DISIS-2013-002.

At the time of this DISIS-2013-002-2 Facility Study, there were several changes to the SPP GI queue and the table listed previously. The new updated table of queued GI projects and network upgrades in the Nebraska area that were included in the current DISIS-2013-002-2 Facility Study are as follows:

Request	MW	Area	Point-Of-Interconnection	Status
GEN-2006-037N1	75	NPPD	Broken Bow 115kV	In-Service
GEN-2008-086N02	200	NPPD	Tap Ft Randall - Kelly 230kV (Meadow Grove)	In-Service
GEN-2008-123N	89.7	NPPD	Tap Guide Rock - Pauline 115kV	Under Development
GEN-2010-051	200	NPPD	Tap Twin Church - Hoskins 230kV	On Suspension
GEN-2011-027	120	NPPD	Tap Twin Church - Hoskins 230kV	Under Development
GEN-2013-002	50.6	LES	Tap Sheldon - Folsom 115kV CKT 1	Facility Study
GEN-2010-041	10.5	OPPD	S 1399 161kV	Under Development
GEN-2011-055	52.8	OPPD	South Sterling 69kV	Withdrawn
GEN-2010-056	151	MIPU	Tap Cooper - St. Joe 345kV	Withdrawn
GEN-2012-005	81	NPPD	New 230 kV Sub on Ft. Randall – Meadow Grove 230 kV line	Withdrawn
GEN-2013-004	6.5	NPPD	Prairie Breeze 230 kV Collector Substation	Withdrawn
GEN-2013-005	73.5	NPPD	Prairie Breeze 230 kV Collector Substation	Withdrawn
GEN-2013-006	50.6	NPPD	Meadow Grove 230 kV Substation	Withdrawn
GEN-2013-008	1.2	NPPD	Steele Flats 115 kV Collector Substation	In-Service
GEN-2013-014	25.5	NPPD	Rosemont 115 kV Substation	On Suspension
GEN-2013-015	125.8	NPPD	New 115 kV Sub on Pauline – Hildreth 115 kV line	Withdrawn
GEN-2013-019	73.6	LES	Sheldon - Folsom & Pleasant Hill 115kV CKT 2	Facility Study

Previously allocated interconnection facilities & network upgrades

- Meadow Grove 230 kV substation (for GEN-2008-086N02)
- Upgrade Ft.Randall-MeadowGrove-Kelly 230kV line
- Rosemont 115 kV substation (for GEN-2008-123N)
- Dixon County 230 kV substation (for GEN-2010-051)
- Upgrade Twin Church-DixonCounty-Hoskins 230kV line
- Neligh 115 kV over-dutied breaker

As a result of all of the withdrawn GI requests, some significant network upgrades were also withdrawn. Most notably, the following network upgrades were removed from the SPP DISIS study efforts:

- Meadow Grove – Norfolk South 230 kV project – This previously-allocated DISIS-2013-001 project is required to provide generation interconnection capability for GEN-2013-032.
- Meadow Grove 230/115 kV & Meadow Grove – Petersburg North 115 kV – This previously-allocated DISIS-2013-001 project is required to provide generation interconnection capability for GEN-2013-032.

As a result of the removal of the previous network facility upgrades, there were previously identified overloads which must now be addressed by a different set of network upgrades. The SPP DISIS-2013-002-2 identified the following required network upgrades associated with GEN-2013-032:

- Rebuild / Upgrade Battle Creek – County Line 115 kV project – This DISIS-2013-002-2 project is required to provide generation interconnection capability for GEN-2013-032.
- Rebuild / Upgrade County Line – Neligh 115 kV project – This DISIS-2013-002-2 project is required to provide generation interconnection capability for GEN-2013-032.

The original DISIS-2013-002-1 Facility Study included a detailed loadflow analysis and short circuit analysis associated with GEN-2013-032. An updated summary of those results is included here as they are still valid for GEN-2013-032:

The Loadflow Analysis documents the steady-state performance of the network following the generation interconnection project. 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 Nebraska transmission system in accordance with NERC Standards TPL-001 and TPL-002. The Phase 1 screening identified the Petersburg North – Petersburg – Albion 115 kV line as limiting for two N-1 contingencies in the 2014 Summer Peak case. The 2014 ITP-NT project of the Broken Bow Wind – Ord 115 kV line was found to mitigate the loading issue to below 100% and this project is expected to be in-service by Summer 2018 and would be required for the GEN-2013-032 to interconnect. The Phase 1 screening did not discover any impacted bus voltages outside of limits for system intact or N-1 conditions (NERC Category A & B).

Phase 2 of the loadflow analysis involved a comprehensive multiple element contingency analysis of the Nebraska transmission system. The Neligh East – County Line – Battle Creek 115 kV line and Petersburg North – Petersburg 115 kV lines were found to overload for a number of Category C and Category D contingencies in the Phase 2 screening. No pre-contingency mitigation would be required for these contingencies; however, post-contingency mitigation would be required of the generation

interconnection to address these overload conditions. There were no impacted bus voltages outside of limits discovered in the Phase 2 screening for NERC Category C and D 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 off-peak 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 generation project. The results of the Phase 3 portion of the loadflow analysis revealed no additional facility overloads or voltage violations that would require mitigation due to TPL-001, TPL-002, TPL-003, and TPL-004 contingencies. This phase did identify several independent N-2 contingencies that would require prior outage generation limitations of the proposed generation interconnection projects. These prior outage limitations would be developed through an operational study and/or operational guides if the projects continue to be developed. The limiting prior outages are listed below:

Limiting Prior Outage Facilities

1. Neligh East – Hoskins 345 kV
2. Neligh East 345/115 kV Transformer
3. Bloomfield – Gavins Point 115 kV
4. Creighton – Neligh East 115 kV
5. Hartington – Gavins Point 115 kV
6. Hoskins 345/115 kV Transformer
7. Gavins Point – Yankton Junction 115 kV
8. Gavins Point – Spirit Mound 115 kV

Phase 4 of the loadflow analysis evaluated the transmission system with respect to worst-case north-to-south transfer conditions across Nebraska. The Phase 4 analysis was performed to evaluate worst-case N-1 contingencies under these highly stressed transfer conditions. Overall, there were several N-1 transmission facility overloads discovered in the Phase 4 screening that were associated with west-east and north-south transfer limitations in Nebraska.

The Short Circuit Analysis was performed to evaluate the fault interrupting capability of existing devices in the area and protection coordination issues following the generation interconnection projects and network upgrades. The results of this analysis showed that there was one protective device that would be subject to replacement with a breaker due to the proposed interconnection projects.

Overall, the *NPPD DISIS-2013-002-2 Facility Study* documents the performance of the network following the addition of the generation interconnection project and network upgrades. The Facility Study has documented the transmission plan required for interconnection to the NPPD transmission system and the details of this plan are listed on the following pages.

## DISIS-2013-002-2 Interconnection Plan

### Interconnection Facilities

- GEN-2013-032 Interconnection Facilities – Expansion of the planned Neligh East (Antelope) 345/115 kV substation to accommodate a new 115 kV interconnection to the GEN-2013-032 wind project.

**\$ 2.5 Million**

- Neligh 115 kV Breaker Replacement – The Short Circuit Analysis identified a 115 kV breaker at Neligh which was over-dutied due to the interconnection of GEN-2013-032.

**\$ 0.5 Million**

### Required Transmission Upgrades

- Rebuild / Upgrade Battle Creek – County Line – Neligh East (Antelope) 115 kV project – This DISIS-2013-002-2 project is required to provide generation interconnection capability for GEN-2013-032. The estimate for this project combines the previously identified two projects into one. A portion of these 115 kV line sections is being rebuilt as part of the ITP10 Hoskins – Neligh East project to re-terminate into the new 115 kV substation. This estimate is to upgrade the remaining line sections and substations to > 125 MVA capacity.

**\$ 4.0 Million**

- Hoskins – Neligh East 345 kV project – This previously-allocated ITP10 project is required to provide generation interconnection capability for GEN-2013-032.

### Required ITP-NT Upgrades

- Broken Bow Wind – Ord 115 kV project – This previously-identified 2014 ITP-NT project is required to provide generation interconnection capability for GEN-2013-032 due to N-1 issues identified on the Petersburg North – Petersburg – Albion 115 kV line in the facility study.

### Third-Party Required Transmission Upgrades

- Gavins Point – Yankton Junction 115 kV upgrade – This WAPA project was identified by SPP as a necessary third party upgrade for the interconnection of GEN-2013-032. SPP, WAPA and the developer will need to coordinate to complete this upgrade.