LIMITED OPERATION IMPACT STUDY REPORT

GEN-2015-023

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By SPP Generator Interconnections Dept.

REVISION HISTORY

Date	Author	Change Description
2/8/2019	SPP	Limited Operation Impact Study for GEN-2015-023 Issued

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EXECUTIVE SUMMARY

Interconnection Customer GEN-2015-023 has requested a Limited Operation System Impact Study (LOIS) consistent with Southwest Power Pool Open Access Transmission Tariff (OATT) for 300.72 MW of wind generation to be interconnected with 300.72 MW of Energy Resource interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS). The generator is planned to interconnect to the transmission system of Nebraska Public Power District (NPPD) in Antelope and Wheeler County, Nebraska.

As the R-Plan has currently been delayed until 1/1/2021, GEN-2015-023 has requested SPP to conduct a LOIS to determine the limited operation amount available to GEN-2015-023 under the following assumptions:

1. All planned transmission system improvements with ISD at the beginning of 2019 or earlier are included in the model
2. Gentleman – Thedford – Holt 345 kV ("R-Plan") Project **NOT** in-service after year end 2019.
3. SPP GEN-2015-023 Generation Interconnection Request (point of interconnection is at the proposed Holt Co. 345 kV substation) in-service at year end 2019 **WITHOUT** the planned Gentleman – Thedford – Holt 345 kV ("R-Plan").

For this LOIS, only power-flow analysis was conducted. The LOIS assumes that only the higher-queued projects listed within **TABLE 1** of this study will be in-service. If additional generation projects with queue priority equal-to or higher-than the study project, request to go into commercial operation, this LOIS may need to be restudied to ensure that interconnection service remains available for the customer's request.

Under the study assumptions outlined above, power-flow analysis from this LOIS has determined GEN-2015-023 can have full interconnection capacity at **300.72 MW ERIS** and **300.72 MW NRIS**. However, should any other projects, other than those listed within **TABLE 1** of this report come into service, an additional study may be required to determine if any new limit exists.

It should be noted that although this LOIS analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator may not be able to inject any power onto the Transmission System due to constraints that fall below the threshold of mitigation for a Generator Interconnection request. Because of this, the Customer may be required by the Transmission Provider to reduce their generation output to 0 MW under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Transient stability and short circuit analysis were not performed for this LOIS study.

Nothing in this study should be construed as a guarantee of delivery or transmission service within Southwest Power Pool's (SPP) transmission system. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.

INTRODUCTION

PURPOSE

The purpose of this study is to evaluate the impacts to the SPP system for a new interconnection request on the NPPD system and determine the amount of interconnection capacity available under the specified study assumptions.

STUDY ASSUMPTIONS

The Interconnection Customer has requested this LOIS be conducted under the following assumptions:

As the R-Plan has currently been delayed until 1/1/2021, GEN-2015-023 has requested SPP to determine the limited operation amount available to GEN-2015-023 under the following assumptions:

1. All planned transmission system improvements with ISD at the beginning of 2019 or earlier are included in the model
2. Gentleman – Thedford – Holt 345 kV ("R-Plan") Project **NOT** in-service after year end 2019.
3. SPP GEN-2015-023 Generation Interconnection Request (point of interconnection is at the proposed Holt Co. 345 kV substation) in-service at year end 2019 **WITHOUT** the planned Gentleman – Thedford – Holt 345 kV ("R-Plan").

Only power flow analysis was conducted for this Limited Operation Interconnection Study. Limited Operation Studies are conducted under GIA Section 5.9.

The LOIS considers the Base Case as well as all Generating Facilities (and with respect to any identified Network Upgrades associated with such higher-queued interconnection) that, on the date the LOIS is commenced:

a) are directly interconnected to the Transmission System;
b) are interconnected to Affected Systems and may have an impact on the Interconnection Request;
c) have pending higher-queued Interconnection Request(s) to interconnect to the Transmission System listed in **TABLE 1**; or
d) have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

Any changes to these assumptions, for example, one or more of the previously queued requests not included within this study execute an interconnection agreement and commencing commercial operation, may require a re-study of this LOIS at the expense of the Customer.

Nothing within this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service rights within Southwest Power Pool's (SPP) transmission system. Should the Customer require transmission service, those rights should be requested through SPP's Open Access Same-Time Information System (OASIS).

PRIOR-QUEUED REQUESTS

HIGHER QUEUED SPP REQUESTS INCLUDED IN THE ANALYSIS

Table 1 outlines the higher queued SPP requests included in this analysis. These requests have higher or equal queue priority to GEN-2015-023 and are assumed to have full or partial interconnection

service at the time GEN-2015-023 is in-service. As GEN-2015-023 is a Group 9 request, all higher queued Group 9 generation was included in the analysis.

Table 1: Higher Queued SPP Requests Included Within the LOIS

Generation Interconnection Number	MW MAX	Service	Group	Type	Status
GEN-2003-021N	75	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2004-023N	75	ER	09 NEB	Coal	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2006-020N	42	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2006-038N005	80	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2006-038N019	80	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2007-011N08	81	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2008-119O	60	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
NPPD Distributed (Broken Bow)	7.3	ER	09 NEB	Heat	
NPPD Distributed (Burwell)	3	ER	09 NEB	Heat	
NPPD Distributed (Ord)	10.8	ER	09 NEB	Heat	
NPPD Distributed (Stuart)	1.8	ER	09 NEB	Heat	
NPPD Distributed (Columbus Hydro)	45	ER	09 NEB	Hydro	
WAPA SEAMS (Gavins Pt Hydro)	102	ER	09 NEB	Hydro	
WAPA SEAMS (Ft Randle Hydro)	352	ER	09 NEB	Hydro	
WAPA SEAMS (Spirit Mound Heat)	120	ER	09 NEB	Heat	
NPPD Distributed (Burt County Wind)	12	ER	09 NEB	Wind	
NPPD Distributed (Buffalo County Solar)	10	ER	09 NEB	Solar	
GEN-2006-037N1	74.8	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2006-044N	40.5	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2008-086N02	201	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION

GEN-2008-123N	89.7	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2009-040	73.8	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2010-041	10.5	ER	09 NEB	Wind	IA FULLY EXECUTED/ON SCHEDULE
GEN-2010-051	200	ER	09 NEB	Wind	IA FULLY EXECUTED/ON SCHEDULE
GEN-2011-018	73.6	ER/NR	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2011-027	120	ER/NR	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
NPPD Distributed (North Platte - Lexington)	18	ER	09 NEB	Hydro	
NPPD Distributed (North Platte - Lexington)	18	ER	09 NEB	Hydro	
NPPD Distributed (North Platte - Lexington)	18	ER	09 NEB	Hydro	
GEN-2011-056	3.6	ER	09 NEB	Hydro	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2011-056A	3.6	ER	09 NEB	Hydro	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2011-056B	4.5	ER	09 NEB	Hydro	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2012-021	4.8	ER	09 NEB	Gas	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2013-002	50.6	ER/NR	09 NEB	Wind	IA FULLY EXECUTED/ON SUSPENSION
GEN-2013-008	1.2	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2013-019	73.6	ER/NR	09 NEB	Wind	IA FULLY EXECUTED/ON SUSPENSION
GEN-2013-032	204	ER	09 NEB	Wind	IA FULLY EXECUTED/ON SCHEDULE
GEN-2014-004	3.96	ER	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2014-013	73.5	ER/NR	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2014-031	35.8	ER/NR	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2014-032	10.22	ER/NR	09 NEB	Wind	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2014-039	73.39	ER/NR	09 NEB	Wind	IA FULLY EXECUTED/ON SCHEDULE
GEN-2007-017IS	200	ER/NR	09 NEB	Wind	On Schedule

GEN-2007-018IS	200	ER/NR	09 NEB	Wind	On Schedule
GEN-2015-007	160	ER	09 NEB	Wind	IA FULLY EXECUTED/ON SCHEDULE

CURRENT STUDY REQUESTS INCLUDED IN THE ANALYSIS

GEN-2015-023 was the only current study request evaluated in this LOIS.

Table 2: Current Study Requests Included in the LOIS

Generation Interconnection Number	MW MAX	Service	Group	Type	Status
GEN-2015-023	300.72	ER/NR	09 NEB	Wind	IA FULLY EXECUTED/ON SCHEDULE

HIGHER QUEUED NETWORK UPGRADES NOT INCLUDED IN THE ANALYSIS

Table 3: DISIS-2015-001 Network Upgrades Not Included in the Analysis

Upgrade Project	Type	Description	Previous Status	Study Assignment	Current Status
Gentleman – Thedford – Holt County 345kV ("R-Plan") Project	New line, transformer, and substation	Build approximately two hundred twenty seven (227) miles of new 345kV from Gentleman – Holt County. Install Thedford 345/115/13kV transformer, and built Holt County Substation	New ISD scheduled for 10/1/2019	2012 SPP Integrated Transmission Plan – 10 Year Assessment (ITP10)	Delayed – Estimated In-Service Date 1/1/2021

FACILITIES

GENERATING FACILITY

The Generation Facility is proposed to consist of one hundred sixty eight (168) 1.79 MW GE wind generators for a total generating nameplate capacity of 300.72 MW. The proposed in-service date is 12/31/2019.

INTERCONNECTION FACILITIES

The POI for GEN-2015-023 was through the proposed NPPD Holt County 345 kV substation. **Figure 1** depicts the one-line diagram of the local transmission system including the POI as well as the power flow model representing the requests.

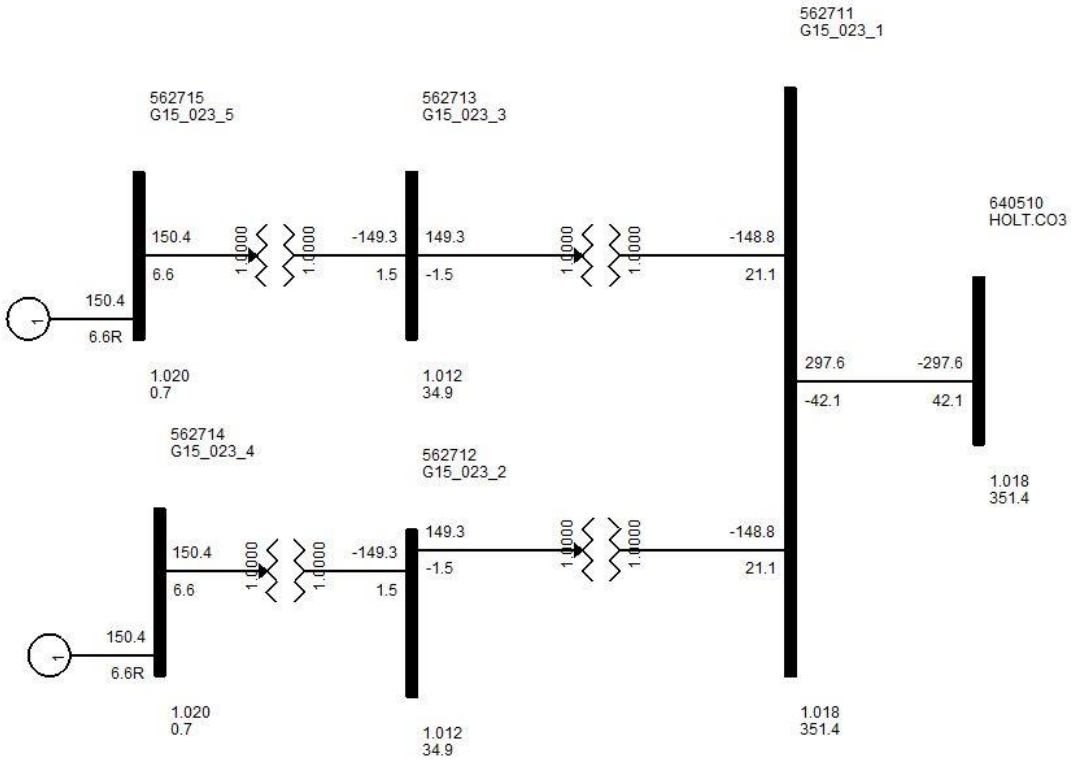

Figure 1: Power Flow representation of GEN-2015-023

BASE CASE NETWORK UPGRADES

Unless otherwise stated, the Network Upgrades included within this LOIS are facilities which are a part of the SPP Transmission Expansion Plan, Balanced Portfolio, or Integrated System (IS) Integration Study projects that have in-service dates prior to the customer's requested in-service date. These facilities have an approved Notification to Construct (NTC), or are in construction stages and expected to be in-service at the effective time of this study. No other SPP upgrades were included in this LOIS. If for some reason, construction on these projects is delayed or discontinued, a restudy may be needed to determine the interconnection service availability of the Customer.

POWER FLOW ANALYSIS

Power flow analysis is used to determine if the transmission system can accommodate the injection from the request without violating thermal or voltage transmission planning criteria.

MODEL PREPARATION

Power flow analysis was performed using modified versions of the 2016 series of 2017 ITP Near-Term study models including these seasonal models:

- Year 1 (2017) Winter Peak (17WP)
- Year 2 (2018) Spring (18G)
- Year 2 (2018) Summer Peak (18SP)
- Year 5 (2021) Light (21L)
- Year 5 (2021) Summer (SP)
- Year 5 (2021) Winter peak (WP)
- Year 10 (2026) Summer peak (SP)

DISPATCH OF SPP REQUESTS

Please refer to **Table 4** for an overview of SPP dispatch criteria.

Table 4: SPP GIR Power Flow Fuel Type Dispatch

Dispatch Type	Season	Service Type	Renewable (in group)	Renewable (out of group)	Conventional (in group)	Conventional (out of group)
ERIS HVER	All	All	100%	20%	N/A	N/A
ERIS LVER	Peak	All	20%	20%	100%	100%
NRIS HVER	Spring and Light Load	ERIS	80%	20%	N/A	N/A
		NRIS	100%	20%	100%	20%
NRIS LVER	Peak	ERIS	20%*	20%*	80%	80%
		NRIS	100%	100%	100%	100%

For Variable Energy Resources (VER) (solar/wind) in each power flow case, Energy Resource Interconnection Service (ERIS), is evaluated for the generating plants within a geographical area of the interconnection request(s) for the VERs dispatched at 100% nameplate of maximum generation. The VERs in the remote areas is dispatched at 20% nameplate of maximum generation. SPP projects are dispatched across the SPP footprint using load factor ratios.

Peaking units are not dispatched in the Year 2 spring and Year 5 light, or in the "High VER" summer and winter peaks. To study peaking units' impacts, the Year 1 winter peak, Year 2 summer peak, and Year 5 summer and winter peaks, models are developed with peaking units dispatched at 100% of the nameplate rating and VERs dispatched at 20% of the nameplate rating. Each interconnection request is also modeled separately at 100% nameplate for certain analyses.

All SPP generators (VER and peaking) that requested Network Resource Interconnection Service (NRIS) are dispatched in an additional analysis into the interconnecting Transmission Owner's (T.O.) area at 100% nameplate with Energy Resource Interconnection Service (ERIS) only requests at 80% nameplate. All MISO generators (VER and peaking) that requested Network Resource Interconnection Service (NRIS) are dispatched based on their respective NRIS amounts in an additional analysis into the MISO transmission system. This method allows for identification of network constraints that are

common between regional groupings to have affecting requests share the mitigating upgrade costs throughout the cluster.

STUDY METHODOLOGY AND CRITERIA

THERMAL OVERLOADS

Network constraints are found by using PSS/E AC Contingency Calculation (ACCC) analysis with PSS/E MUST First Contingency Incremental Transfer Capability (FCITC) analysis on the entire cluster grouping dispatched at the various levels previously mentioned.

For Energy Resource Interconnection Service (ERIS), thermal overloads are determined for system intact (n-0) (greater than 100% of Rate A - normal) and for contingency (n-1) (greater than 100% of Rate B – emergency) conditions.

The overloads are then screened to determine which generator interconnection requests have at least:

- 3% Distribution Factor (DF) for system intact conditions (n-0),
- 20% DF upon outage based conditions (n-1), or
- 3% DF on contingent elements that resulted in a non-converged solution.

Interconnection Requests that requested Network Resource Interconnection Service (NRIS) are also studied in a separate NRIS analysis to determine if any constraint measured greater than or equal to a 3% DF. If so, these constraints are also considered for transmission reinforcement under NRIS.
The contingency set includes all SPP control area branches and ties 69kV and above, first tier Non-SPP control area branches and ties 115 kV and above, any defined contingencies for these control areas, and generation unit outages for the SPP control areas with SPP reserve share program redispatch.

The monitored elements include all SPP control area branches, ties, and buses 69 kV and above, and all first tier Non-SPP control area branches and ties 69 kV and above. NERC Power Transfer Distribution Flowgates for SPP and first tier Non-SPP control area are monitored. Additional NERC Flowgates are monitored in second tier or greater Non-SPP control areas. Voltage monitoring was performed for SPP control area buses 69 kV and above.

Notwithstanding, should any facility be identified by MISO using MISO Constraint Identification Criteria as being affected by a study request, such as “Outlet” constraints or other specific criteria, review and mitigation of those constraints may also be required.

The SPP Permanent List of Flowgates are included within SPP Planning studies and can be reviewed on the SPP OASIS website. The direct link to the current Permanent Flowgate list is as follows:
https://www.oasis.oati.com/SWPP/SWPPdocs/Permanent_flowgates.xls

VOLTAGE

For non-converged power flow solutions that are determined to be caused by lack of voltage support, appropriate transmission support will be determined to mitigate the constraint.

After all thermal overload and voltage support mitigations are determined; a full ACCC analysis is then performed to determine voltage constraints. The following voltage performance guidelines are used in accordance with the Transmission Owner local planning criteria.

SPP Areas (69kV+):

Transmission Owner	Voltage Criteria (System Intact)	Voltage Criteria (Contingency)
AEPW	0.95 – 1.05 pu	0.92 – 1.05 pu
GRDA	0.95 – 1.05 pu	0.90 – 1.05 pu
SWPA	0.95 – 1.05 pu	0.90 – 1.05 pu
OKGE	0.95 – 1.05 pu	0.90 – 1.05 pu
OMPA	0.95 – 1.05 pu	0.90 – 1.05 pu
WFEC	0.95 – 1.05 pu	0.90 – 1.05 pu
SWPS	0.95 – 1.05 pu	0.90 – 1.05 pu
MIDW	0.95 – 1.05 pu	0.90 – 1.05 pu
SUNC	0.95 – 1.05 pu	0.90 – 1.05 pu
KCPL	0.95 – 1.05 pu	0.90 – 1.05 pu
INDN	0.95 – 1.05 pu	0.90 – 1.05 pu
SPRM	0.95 – 1.05 pu	0.90 – 1.05 pu
NPPD	0.95 – 1.05 pu	0.90 – 1.05 pu
WAPA	0.95 – 1.05 pu	0.90 – 1.05 pu
WERE L-V	0.95 – 1.05 pu	0.93 – 1.05 pu
WERE H-V	0.95 – 1.05 pu	0.95 – 1.05 pu
EMDE L-V	0.95 – 1.05 pu	0.90 – 1.05 pu
EMDE H-V	0.95 – 1.05 pu	0.92 – 1.05 pu
LES	0.95 – 1.05 pu	0.90 – 1.05 pu
OPPD	0.95 – 1.05 pu	0.90 – 1.05 pu

SPP Buses with more stringent voltage criteria:

Bus Name/Number	Voltage Criteria (System Intact)	Voltage Criteria (Contingency)
TUCO 230kV 525830	0.925 – 1.05 pu	0.925 – 1.05 pu
Wolf Creek 345kV 532797	0.985 – 1.03 pu	0.985 – 1.03 pu
FCS 646251	1.001 – 1.047 pu	1.001 – 1.047 pu

Affected System Areas (115kV+):

Transmission Owner	Voltage Criteria (System Intact)	Voltage Criteria (Contingency)
EES-EAI	0.95 – 1.05 pu	0.90 – 1.05 pu
LAGN	0.95 – 1.05 pu	0.90 – 1.05 pu
EES	0.95 – 1.05 pu	0.90 – 1.05 pu
AMMO	0.95 – 1.05 pu	0.90 – 1.05 pu
CLEC	0.95 – 1.05 pu	0.90 – 1.05 pu
LAFA	0.95 – 1.05 pu	0.90 – 1.05 pu
LEPA	0.95 – 1.05 pu	0.90 – 1.05 pu
XEL	0.95 – 1.05 pu	0.90 – 1.05 pu
MP	0.95 – 1.05 pu	0.90 – 1.05 pu
SMMPA	0.95 – 1.05 pu	0.90 – 1.05 pu
GRE	0.95 – 1.05 pu	0.90 – 1.10 pu
OTP	0.95 – 1.05 pu	0.90 – 1.05 pu
OTP-H (115kV+)	0.97 – 1.05 pu	0.92 – 1.10 pu
ALTW	0.95 – 1.05 pu	0.90 – 1.05 pu
MEC	0.95 – 1.05 pu	0.90 – 1.05 pu
MDU	0.95 – 1.05 pu	0.90 – 1.05 pu

SPC	0.95 – 1.05 pu	0.95 – 1.05 pu
DPC	0.95 – 1.05 pu	0.90 – 1.05 pu
ALTE	0.95 – 1.05 pu	0.90 – 1.05 pu

The constraints identified through the voltage scan are then screened for the following for each interconnection request. 1) 3% DF on the contingent element and 2) 2% change in pu voltage. In certain conditions, engineering judgement was used to determine whether or not a generator had impacts to voltage constraint

RESULTS

Power-flow analysis from this LOIS has determined GEN-2015-023 can interconnect **300.72 MW ERIS** and **300.72 MW NRIS** without the R-Plan in-service. However, should any other projects, other than those listed within **TABLE 1** of this report come into service, an additional study may be required to determine if any new limit exists.

ERIS THERMAL AND VOLTAGE CONSTRAINTS

No ERIS thermal or voltage constraints were observed for either the GEN-2015-023.

NRIS THERMAL AND VOLTAGE CONSTRAINTS

No NRIS thermal or voltage constraints were observed for either the GEN-2015-023.

CONCLUSION

Power-flow analysis from this LOIS has determined GEN-2015-023 can interconnect **300.72 MW ERIS** and **300.72 MW NRIS** without the R-Plan in-service. However, should any other projects, other than those listed within **TABLE 1** of this report come into service, an additional study may be required to determine if any new limit exists.

CURTAILMENT AND SYSTEM RELIABILITY

It should be noted that although this LOIS analyzed many of the most probable contingencies, it is not an all-inclusive list that can account for every operational situation. Additionally, the generator may not be able to inject any power onto the Transmission System due to constraints that fall below the threshold of mitigation for a Generator Interconnection request. Because of this, the Customer may be required by the Transmission Provider to reduce their generation output to 0 MW under certain system conditions to allow system operators to maintain the reliability of the transmission network.