Interim Availability Interconnection System Impact Study for Generator Interconnection Request

GEN-2019-001

December 2018
Generator Interconnection

SPP Southwest Power Pool

Revision History

Date	Author	Change Description
12/21/2018	SPP	Interim Availability Interconnection System Impact Study (IAISIS) for Generator Interconnection Request GEN-2019-001 Report Issued

Executive Summary

GEN-2019-001 (Interconnection Customer) has requested an Interim Availability Interconnection System Impact Study (IAISIS) under Section 11A of Attachment V (Generator Interconnection Procedures - GIP) to the Southwest Power Pool Open Access Transmission Tariff (OATT) for 25.0 MW of wind generation to be interconnected with Energy Resource Interconnection Service (ERIS) into the transmission system of Westar Energy, Inc (WERE) in Pratt County, Kansas. GEN-2019-001 has requested this IAISIS to determine the impacts of interconnecting to the transmission system before all required Network Upgrades identified in the DISIS-2019-001 (or most recent iteration) Impact Study can be placed into service.

This IAISIS addresses the effects of interconnecting the generator to the rest of the transmission system for the system topology and conditions as expected on December 31, 2018. Interconnection requests GEN-2015-024, GEN-2015-025, GEN-2015-090, and GEN-2019-001 each share a portion of interconnection facilities including a generator lead to a common Point of Interconnection at Buffalo Flats 345 kV.

- GEN-2015-024 is comprised of one-hundred eleven (111) GE 1.715 MW and ten (10) GE 1.79 MW wind turbine generators for a total nameplate capacity of 208.265 MW.
- GEN-2015-025 is comprised of one-hundred ten (110) GE 1.715 MW and ten (10) GE 1.79 MW wind turbine generators for a total nameplate capacity of 206.55 MW.
- GEN-2015-090 is comprised of eighty-eight (88) Siemens 2.3 MW, six (6) GE 2.3 MW, and one (1) GE 2.2 MW wind turbine generators for a total nameplate capacity of 218.4 MW.
- GEN-2019-001 is requesting the interconnection of ten (10) Siemens 2.3 MW and one (1) GE 2.0 MW wind turbine generators for a total nameplate capacity of 25.0 MW.

The total generator nameplate evaluated on the GEN-2019-001 shared generator lead is 658.215 MW which is within the 660 MW ERIS service amount studied for GEN-2015-024, GEN-2015-025, GEN-2015-090.

For this IAISIS power flow, stability, reduced wind generation analysis, and short circuit analysis was conducted. The IAISIS assumes that only the higher queued projects listed within Table 1 of this study might go into service before the completion of all Network Upgrades identified within Table *2* of this report. If additional generation projects, listed within Table 3, with queue priority equal to or higher than the study project request rights to go into commercial operation before all associated Network Upgrades identified within *Table 2* of this report are completed, this IAISIS may need to be restudied to ensure that interconnection service remains for the customer's request.

Power flow and stability analysis from this IAISIS has determined that the GEN-2019-001 request can interconnect 25.0 MW of generation with Energy Resource Interconnection Service (ERIS) on 12/31/2018 prior to the completion of the required Network Upgrades, listed within *Table 2* of this report. 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 limited operation service is available. It should be noted that although this IAISIS 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, it is likely that the Customers may be required 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 analysis for this IAISIS has determined that GEN-2019-001 request will be limited to a maximum of 25.0 MW output. No transient stability issues were observed for the transmission system for the previous analysis and the additional twelve (12) selected faults for the IAISIS of GEN-2019-001. The analysis shows that the generator will meet Low Voltage Ride-Through (LVRT) requirements of FERC Order #661A.

Power Factor analysis was not conducted. In accordance with FERC Order 827 GEN-2019-001 will be required to provide dynamic reactive power within the power factor range of 0.95 leading (absorbing Vars from the network) to 0.95 lagging (providing Vars to the network) at continuous rated power output at the high side of the generator substation.

Reduced Wind analysis has identified a need for approximately 2.3 MVAR of switched shunt reactors to compensate for capacitive charging current resultant from the addition of the Interconnection Request facilities. This amount is in addition to the approximate 102.1 MVAR of switched shunt reactors identified for GEN-2015-024, GEN-2015-025, and GEN-2015-090. It is the interconnection customer's responsibility to design and install the reactive compensation equipment necessary to control the reactive power injection at the POI.

Nothing in this study should be construed as a guarantee of delivery or transmission service. 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.

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Purpose

GEN-2019-001 (Interconnection Customer) has requested an Interim Availability Interconnection System Impact Study (IAISIS) under the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT) Attachment V (GIP) Section 11A for an interconnection request into the transmission system of Westar Energy, Inc. (WERE).

The purpose of this study is to evaluate the impacts of interconnecting GEN-2019-001 request with a total of 25.0 MW comprised of ten (10) Siemens 2.3MW and one (1) GE 2.0MW wind turbine generators and associated facilities interconnecting at the Buffalo Flats 345 kV substation. The Interconnection Customer has requested this amount to be studied with Energy Resource Interconnection Service (ERIS) to commence on or around December 31, 2018.

Interconnection requests GEN-2015-024, GEN-2015-025, GEN-2015-090, and GEN-2019-001 each share a portion of interconnection facilities including a generator lead to a common Point of Interconnection (POI) at Buffalo Flats 345 kV. The combined nameplate capacity requested, studied through DISIS, and the ERIS amounts included in the currently executed GIAs for GEN-2015-024 (220 MW), GEN-2015-025 (220 MW), and GEN-2015-090 (220 MW) is 660 MW.

Interconnection Customer has requested this IAISIS analysis be conducted with the following configuration for these higher queued requests:

- GEN-2015-024 is comprised of one-hundred eleven (111) GE 1.715 MW and ten (10) GE 1.79 MW wind turbine generators for a total nameplate capacity of 208.265 MW.
- GEN-2015-025 is comprised of one-hundred ten (110) GE 1.715 MW and ten (10) GE 1.79 MW wind turbine generators for a total nameplate capacity of 206.55 MW.
- GEN-2015-090 is comprised of eighty-eight (88) Siemens 2.3 MW, six (6) GE 2.3 MW, and one (1) GE 2.2 MW wind turbine generators for a total nameplate capacity of 218.4 MW.

With the above configuration, the combined nameplate for these higher queued requests is 633.215 MW. The requested 25.0 MW expansion results in a combined nameplate including GEN-2019-001 at 658.215 MW which is within the 660 MW ERIS service amount studied in DISIS-2015-002-4, DISIS-2016-001-2, and DISIS-2016-002.

Additional power flow analysis is not required at this time as the requested service type and amount has been evaluated previously in DISIS-2015-002-5, DISIS-2016-001-1, and DISIS-2016-002 under the combination of GEN-2015-024, GEN-2015-025, and GEN-2015-090.

Transient stability and reduced wind analysis were conducted for this IAISIS.

The IAISIS considers the Base Case as well as all Generating Facilities (and with respect to (b) below, any identified Network Upgrades associated with such higher queued interconnection) that, on the date the IAISIS 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 a pending higher queued Interconnection Request 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 executing an interconnection agreement and commencing commercial operation, may require a re-study of this IAISIS 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. Should the Customer require transmission service, those rights should be requested through SPP's Open Access Same-Time Information System (OASIS).

This IAISIS study included prior queued generation interconnection requests. Those listed within Table 1 are the generation interconnection requests that are assumed to have rights to either full or partial interconnection service prior to the requested December 2018 in-service for this IAISIS. Also listed in Table 1 are both the amount of MWs of interconnection service expected at the effective time of this study and the total MWs requested of interconnection service, the fuel type, the point of interconnection (POI), and the current status of each particular prior queued request.

Table 1: Generation Requests Included within IAISIS

Project	MW	Total MW	Fuel Source	POI	Status
ASGI-2010-006 (AECI GIA-27)	150.00	150.00	Wind	Remington 138kV	GIA Executed
ASGI-2014-014	56.40	56.40	Gas	Ferguson 69kV	Under Study (DISIS-2014-002)
ASGI-2015-004	56.36	56.36	Gas	Coffeyville City 69kV	Under Study (DISIS-2015-001)
ASGI-2017-008 (AECI GIA-059)	158.60	158.60	Wind	Remington to Shidler 138 kV	Withdrawn
GEN-2002-004	200.00	200.00	Wind	Latham 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2005-013	201.00	201.00	Wind	Caney River 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2007-025	300.00	300.00	Wind	Viola 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2008-013	300.00	300.00	Wind	Hunter 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2008-021	42.00	42.00	Nuclear	Wolf Creek 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2008-098	100.80	100.80	Wind	Waverly 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2009-025	59.80	59.80	Wind	Nardins 69kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2010-003	100.80	100.80	Wind	Waverly 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2010-005	299.20	299.20	Wind	Viola 345kV	IA FULLY EXECUTED/ON SCHEDULE

Table 1: Generation Requests Included within IAISIS

Project	MW	Total MW	Fuel Source	POI	Status
GEN-2010-055	4.50	4.50	Gas	Wekiwa 138kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2011-057	150.40	150.40	Wind	Creswell 138kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2012-032	300.00	300.00	Wind	Open Sky 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2012-033	98.10	98.10	Wind	Tap and Tie South 4th - Bunch Creek & Enid Tap - Fairmont (GEN-2012-033T) 138kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2012-041	121.50	121.50	CT	Ranch Road 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2013-012	147.00	147.00	Gas	Redbud 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2013-028	559.50	559.50	Gas	Tap N Tulsa - GRDA 1 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2013-029	300.00	300.00	Wind	Renfrow 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2014-001	200.60	200.60	Wind	Tap Wichita - Emporia Energy Center (GEN-2014-001 Tap) 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2014-028	35.00	35.00	CC	Riverton 161kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2014-064	248.40	248.40	Wind	Otter 138kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2015-001	200.00	200.00	Wind	Ranch Road 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2015-015	154.60	154.60	Wind	Road Runner 138kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2015-016	200.00	200.00	Wind	Tap Marmaton - Centerville 161kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2015-024	220.00	220.00	Wind	Tap Thistle - Wichita 345kV Dbl CKT	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2015-025	220.00	220.00	Wind	Tap Thistle - Wichita 345kV Dbl CKT	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2015-030	200.10	200.10	Wind	Sooner 345kV	WITHDRAWN
GEN-2015-034	200.00	200.00	Wind	Ranch Road 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2015-047	300.00	300.00	Wind	Sooner 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2015-052	300.00	300.00	Wind	Tap Open Sky - Rose Hill 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2015-062	4.50	4.50	Wind	Tap and Tie South 4th - Bunch Creek & Enid Tap - Fairmont (GEN-2012-033T) 138kV	IA PENDING
GEN-2015-063	300.00	300.00	Wind	Tap Woodring - Mathewson 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2015-066	248.40	248.40	Wind	Tap Cleveland - Sooner 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2015-069	300.00	300.00	Wind	Union Ridge 230kV	IA FULLY EXECUTED/COMMERCIAL OPERATION
GEN-2015-073	200.10	200.10	Wind	Emporia Energy Center 345kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2015-083	125.00	125.00	Wind	Belle Plain 138kV	WITHDRAWN
GEN-2015-090	220.00	220.00	Wind	Tap Thistle - Wichita 345kV Dbl CKT	IA FULLY EXECUTED/ON SCHEDULE
GEN-2016-009	29.00	29.00	Steam	Osage 69kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2016-022	151.80	151.80	Wind	Ranch Road 345kV	FACILITY STUDY STAGE
GEN-2016-031	1.50	1.50	Wind	Ranch Road 345kV	IA FULLY EXECUTED/COMMERCIAL OPERATION

Table 1: Generation Requests Included within IAISIS

Project	MW	Total MW	Fuel Source	POI	Status
GEN-2016-032	200.00	200.00	Wind	Tap Marshall - Cottonwood Creek 138kV	IA FULLY EXECUTED/ON SCHEDULE
GEN-2016-060	25.30	25.30	Wind	Belle Plain 138kV	WITHDRAWN
GEN-2016-061	250.70	250.70	Wind	Tap Woodring - Sooner 345kV	FACILITY STUDY STAGE
GEN-2016-068	250.00	250.00	Wind	Woodring 345kV	FACILITY STUDY STAGE
GEN-2016-071	200.10	200.10	Wind	Chilocco 138kV	FACILITY STUDY STAGE
GEN-2016-073	220.00	220.00	Wind	Tap Thistle – Wichita 345kV Dbl CKT	FACILITY STUDY STAGE
GEN-2016-100	100.00	100.00	Wind	Tap Sooner-Spring Creek 345kV	FACILITY STUDY STAGE
GEN-2016-101	195.00	195.00	Wind	Tap Sooner-Spring Creek 345kV	FACILITY STUDY STAGE
GEN-2016-119	600.00	600.00	Wind	Tap Spring Creek-Sooner 345 kV	FACILITY STUDY STAGE
GEN-2016-128	176.00	176.00	Wind	Woodring 345kV Substation	FACILITY STUDY STAGE
GEN-2016-133	187.50	187.50	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-134	187.50	187.50	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-135	100.00	100.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-136	75.00	75.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-137	187.50	187.50	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-138	187.50	187.50	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-139	100.00	100.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-140	75.00	75.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-141	350.00	350.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-142	350.00	350.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-143	175.00	175.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-144	175.00	175.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-145	175.00	175.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-146	175.00	175.00	Wind	Tulsa North 345kV Substation	FACILITY STUDY STAGE
GEN-2016-148	150.00	150.00	Wind	Hardy 138kV Substation	WITHDRAWN
GEN-2016-153	134.00	134.00	Wind	Viola 345kV Substation	FACILITY STUDY STAGE
GEN-2016-162	252.00	252.00	Wind	Benton 345kV	FACILITY STUDY STAGE
GEN-2016-163	252.00	252.00	Wind	Benton 345kV	FACILITY STUDY STAGE
GEN-2016-024	55.90	55.90	Solar	Midian 138kV	DISIS STAGE
GEN-2016-072	300.00	300.00	Wind	Renfrow 345kV	DISIS STAGE
GEN-2016-127	200.10	200.10	Wind	Shidler 138kV Substation	DISIS STAGE
GEN-2016-173	42.00	42.00	Solar	Creswell 69kV Sub	DISIS STAGE

Note: the projects listed in *Table 1* with a status of "WITHDRAWN" or "DISIS STAGE" were included in DISIS-2016-002 which began prior to each withdrawal or lowering of queue priority. The DISIS-2016-002-1 restudy will re-evaluate the upgrades assigned to the remaining requests within DISIS-2016-002.

This IAISIS was required because the Interconnection Customer is requesting interconnection prior to the completion of all of their required upgrades listed within the latest iteration of their Definitive Interconnection System Impact Study (DISIS). Table *2* below lists the required upgrade projects for which equally or higher queued requests have cost responsibility. GEN-2019-001 is included within the DISIS-2019-001 which will be studied following DISIS-2018-001 with an estimated posting in fourth quarter, 2020 and also following the subsequent posting of DISIS-2018-002. Once posted these reports will be located at the following Generation Interconnection Study URL:

http://opsportal.spp.org/Studies/Gen (studies posting main page)
http://opsportal.spp.org/Studies/GenList?yearTypeId=165 (2018 Impact Studies)

Table 2: Upgrade Projects not included but Required for Full Interconnection Service

Upgrade Project	Type	Description	Status	Study Assignment
Lacygne - Waverly 345kV CKT 1	ERIS	Upgrade terminal equipment	Facility Study	DISIS-2016-001
DISIS-2016-002-1 upgrades	ERIS	Various	Re-evaluation	DISIS-2016-002
DISIS-2017-001 upgrades	ERIS	Various	TBD	DISIS-2017-001
DISIS-2017-002 upgrades	ERIS	Various	TBD	DISIS-2017-002
DISIS-2018-001 upgrades	ERIS	Various	TBD	DISIS-2018-001
DISIS-2018-002 upgrades	ERIS	Various	TBD	DISIS-2018-002
DISIS-2019-001 upgrades	ERIS	Various	TBD	DISIS-2019-001

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

The higher or equally queued projects that were not included in this study are listed in Table 3. While this list is not all-inclusive, it is a list of the most probable and affecting prior-queued requests that were not included within this IAISIS, either because no request for an IAISIS has been made or the request is on suspension, etc.

Table 3: Higher or Equally Queued GI Requests and projects not included within IAISIS

Project	MW	Total MW	Fuel Source	POI	Status
ASGI-2018-003 (AECI GIA-63)	200	200	Wind	Remington 138 kV Substation	Interconnection Facility Study in progress
AECI GIA-64	77.5	77.5	Wind	Humphreys Substation	Interconnection Facility Study in progress
AECI GIA-65	500	500	Wind	Sportsman 345 kV	System Impact Study in progress
AECI GIA-67	250	250	Wind	Maryville Substation	System Impact Study in progress
AECI GIA-68	400	400	Solar	Blackberry 345 kV	System Impact Study in progress
AECI GIA-69	250	250	Wind	Luther 138 kV	System Impact Study in progress
Limited Operation of DISIS-2016-001 equally or later queued requests	TBD	TBD	Various	Various	TBD
DISIS-2017-001 requests	TBD	TBD	Various	Various	DISIS Study in progress
DISIS-2017-002 requests	TBD	TBD	Various	Various	DISIS Study in progress
DISIS-2018-001 requests	TBD	TBD	Various	Various	DISIS Study in progress
DISIS-2018-002 requests	TBD	TBD	Various	Various	DISIS Study in progress
DISIS-2019-001 requests	TBD	TBD	Various	Various	DISIS Study in progress

Nothing in this System Impact Study constitutes a request for transmission service or grants the Interconnection Customer any rights to transmission service.

Facilities

Generating Facility

The Interconnection Customer's request to interconnect a total of 25.0 MW is comprised of ten (10) Siemens 2.3 MW and one (1) GE 2.0 MW wind turbine generators and associated facilities.

Interconnection Facilities

The POI for GEN-2019-001 Interconnection Customer is the Buffalo Flats 345kV 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 GEN-2015-024, GEN-2015-025, GEN-2015-090, GEN-2016-073 and GEN-2019-001 requests.

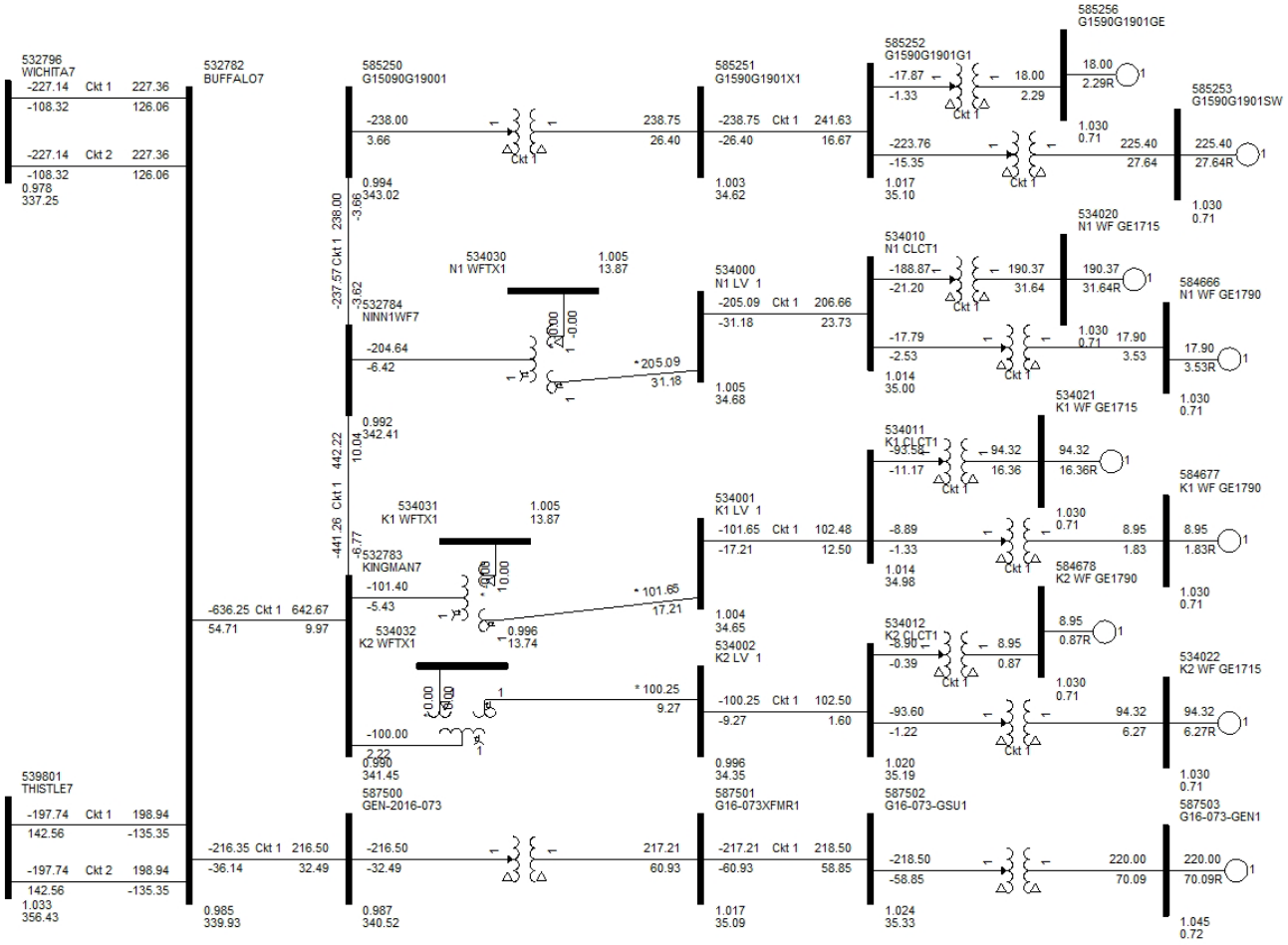

Figure 1: Proposed POI Configuration and Request Power Flow Model

Base Case Network Upgrades

The Network Upgrades included within the cases used for this IAISIS study are those facilities that 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 GEN-2019-001 requested in-service date of December 31, 2018. 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 upgrades were included for this IAISIS. 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 for DISIS-2015-002-4 was performed using modified versions of the 2015 series of transmission service request study models including the 2016 Winter Peak (16WP), 2017 Spring (17G), 2017 Summer Peak (17SP), 2020 Light (20L), 2020 Summer Peak (SP), 2020 Winter Peak (20WP), and 2025 Summer Peak (25SP) seasonal models.

Power flow analysis for DISIS-2016-001-2 and DISIS-2016-002 was performed using modified versions of the 2016-series Integrated Transmission Planning models used for the 2017 ITP-Near Term analysis including the 2017 Winter Peak (17WP), 2018 Spring (18G), 2018 Summer Peak (18SP), 2021 Light (21L), 2021 Summer Peak (21SP), 2021 Winter Peak (WP), and 2026 Summer Peak seasonal models.

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% (except in the DISIS-2016-002 21L case which is reduced to 10%) nameplate of maximum generation. These projects are dispatched across the SPP footprint using load factor ratios.

Peaking units are not dispatched in the spring, light, or in the “High VER” summer and winter peaks. To study peaking units’ impacts, the summer and winter peak 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 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. 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.

For this IAISIS, only the previous queued requests listed in Table 1 were assumed to be in-service at 100% dispatch.

Study Methodology and Criteria

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 of 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.

To evaluate the GEN-2019-001 request, the unused interconnection service from GEN-2015-024, GEN-2015-025, and GEN-2015-090 was allocated to GEN-2019-001 for evaluation with the DISIS-2015-002-4, DISIS-2016-001-2, and DISIS-2016-002 powerflow results.

Results

The IAISIS ACCC analysis indicates that the Interconnection Customer can interconnect its generation into the WERE transmission system before all required upgrades listed within the DISIS-2019-001 study or latest iteration can be placed into service. Should any other GI projects, other than those listed within Table 1 of this report, come into service including DISIS-2016-001 and any later queued requests through DISIS-2019-001 under limited operation, an additional study may be required to determine if any limited operation service is available.

DISIS-2015-002-4 and DISIS-2016-001-2 ACCC results provide adequate ERIS for the studied combined configuration for GEN-2015-024, GEN-2015-025, GEN-2015-090, and GEN-2019-001 for

system conditions as of December 31, 2018. No additional powerflow analysis is required at this time.

In the event that GEN-2016-073 requests limited operation prior to the completion of DISIS-2016-001-2 assigned Lacygne - Waverly 345 kV terminal equipment upgrade, or any other request equally or lower queued to DISIS-2016-001 requests limited operation this IAISIS will be invalid and will require a restudy and revision or termination of an Interim GIA for GEN-2019-001.

Curtailment and System Reliability

In no way does this study guarantee operation for all periods of time. It should be noted that although this study analyzed many of the most probable contingencies, it is not an all-inclusive list and cannot account for every operational situation. Because of this, it is likely that the Customer may be required to reduce their generation output to **0 MW** under certain system conditions to allow system operators to maintain the reliability of the transmission network.

Stability Analysis

Transient stability analysis is used to determine if the transmission system can maintain angular stability and ensure bus voltages stay within planning criteria bandwidth during and after a disturbance while considering the addition of a generator interconnection request.

Model Preparation

Transient stability analysis was performed using modified versions of the 2016 series of Model Development Working Group (MDWG) dynamic study models including the 2017 winter, 2018 summer peak, and 2025 summer peak dynamic cases. The cases were adapted to resemble the power flow study cases with regards to prior queued generation requests and topology. Finally, the prior queued and study generation was dispatched into the SPP footprint. Initial simulations are then carried out for a no-disturbance run of twenty (20) seconds to verify the numerical stability of the model.

DISIS-2016-002 and GEN-2015-090 material modification evaluation results are valid for faults distant from the POI. Requests through DISIS-2016-002-1 and upgrades through DISIS-2016-001-1 were included in the IAISIS stability analysis for faults near the POI.

Disturbances

As the configuration of generators on the shared generator lead have changed since the previous evaluation for the modification evaluation of GEN-2015-090, twelve (12) contingencies near the POI were identified for this study. These faults are listed within Table 4.

These contingencies included three-phase faults and single-phase line faults at locations defined by SPP. Single-phase line faults were simulated by applying fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice.

With exception to transformers, the typical sequence of events for a three-phase and single-phase fault is as follows:

1. apply fault at particular location
2. continue fault for five (5) cycles, clear the fault by tripping the faulted facility
3. after an additional twenty (20) cycles, re-close the previous facility back into the fault
4. continue fault for five (5) additional cycles
5. trip the faulted facility and remove the fault

Transformer faults are typically only performed for three-phase faults, unless otherwise noted. Additionally the sequence of events for a transformer is to 1) apply a three-phase fault for five (5) cycles and 2) clear the fault by tripping the affected transformer facility. Unless otherwise noted there will be no re-closing into a transformer fault.

Table 4*: Contingencies Evaluated for IAISIS*

Contingency Number and Name		Description
1	FLT01-3PH	3 phase fault on Buffalo Flats (532782) to Wichita (532796) 345kV Ckt 1, near Buffalo Flats. a. Apply fault near Buffalo Flats 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
2	FLT02-3PH	3 phase fault on Buffalo Flats (532782) to Thistle (539801) 345kV Ckt 1, near Buffalo Flats. a. Apply fault near Buffalo Flats 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
3	FLT03-3PH	3 phase fault on Thistle (539801) to Woodward (515375) 345kV Ckt 1, near Thistle. a. Apply fault near Thistle 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
4	FLT04-3PH	3 phase fault on Thistle (539801) to GEN-2016-005 Tap (560072) 345kV Ckt 1, near Thistle. a. Apply fault near Thistle 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
5	FLT05-3PH	3 phase fault on GEN-2016-005 Tap (560072) to Clark County (539800) 345kV Ckt 1, near GEN-2016-005 Tap. a. Apply fault near GEN-2016-005 Tap 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
6	FLT06-3PH	3 phase fault on Wichita (532796) to Reno (532771) 345kV Ckt 1, near Wichita. a. Apply fault near Wichita 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
7	FLT07-3PH	3 phase fault on Wichita (532796) to Benton (532791) 345kV Ckt 1, near Wichita. a. Apply fault near Wichita 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
8	FLT08-3PH	3 phase fault on Wichita (532796) to Viola (532798) 345kV Ckt 1, near Wichita. a. Apply fault near Wichita 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.

Contingency Number and Name		Description
9	FLT09-3PH	3 phase fault on GEN-2014-001 Tap (562476) to Emporia Energy Center (532768) 345kV Ckt 1, near GEN-2014-001 Tap. a. Apply fault near GEN-2014-001 Tap 345kV bus. b. Clear fault after 5 cycles and trip the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
10	FLT01-SLG	Single line to ground fault on Buffalo Flats (532782) to Wichita (532796) 345kV Ckt 1, near Buffalo Flats. a. Apply fault near Buffalo Flats 345kV bus. b. Clear fault after 16 cycles and trip the faulted line and Buffalo Flats (532782) to Thistle (539801) 345kV Ckt 1.
11	FLT03-SLG	Single line to ground fault on Thistle (539801) to Buffalo Flats (532782) 345kV Ckt 1, near Thistle. a. Apply fault near Thistle 345kV bus. b. Clear fault after 16 cycles and trip the faulted line and Thistle (539801) to Woodward (515375) 345kV Ckt 1.
12	FLT08-SLG	Single line to ground fault on Wichita (532796) to Viola (532798) 345kV Ckt 1, near Wichita. a. Apply fault near Wichita 345kV bus. b. Clear fault after 16 cycles and trip the faulted line and Wichita (532796) to Buffalo Flats (532782) 345kV Ckt 1.

Results

Results of the additional stability analysis are summarized in Table 5. These results are valid for GEN-2019-001 interconnecting with a generation amount up to 25.0 MW and the total generator nameplate evaluated on the GEN-2019-001 shared generator lead at 658.215 MW with the previously described wind turbine generator configuration. Beyond the note below and the DISIS-2015-002-4, DISIS-2016-001-2, DISIS-2016-002, and GEN-2015-090 material modification evaluation study results, no system stability issues were observed during the analysis.

Note: In all seasons, the protection relays and generator "Fast Stop" logic were disabled for the GEN-2016-133 through GEN-2016-146 requests consistent with the DISIS-2016-002 Group 8 stability report.

Table 5*: Fault Analysis Results for IAISIS*

Contingency Number and Name		2017SP	2016WP	2025SP
1	FLT01-3PH	Stable	Stable	Stable
2	FLT02-3PH	Stable	Stable	Stable
3	FLT03-3PH	Stable	Stable	Stable
4	FLT04-3PH	Stable	Stable	Stable
5	FLT05-3PH	Stable	Stable	Stable
6	FLT06-3PH	Stable	Stable	Stable
7	FLT07-3PH	Stable	Stable	Stable
8	FLT08-3PH	Stable	Stable	Stable
9	FLT09-3PH	Stable	Stable	Stable
10	FLT01-SLG	Stable	Stable	Stable
11	FLT03-SLG	Stable	Stable	Stable
12	FLT08-SLG	Stable	Stable	Stable

FERC LVRT Compliance

FERC Order #661A places specific requirements on wind farms through its Low Voltage Ride Through (LVRT) provisions. For Interconnection Agreements signed after December 31, 2006, wind farms shall stay on line for faults at the POI that draw the voltage down at the POI to 0.0 pu.

Fault contingencies were developed to verify that wind farms remain on line when the POI voltage is drawn down to 0.0 pu. These contingencies are shown in Table 6.

Table 6*: LVRT Contingencies*

Contingency Number and Name		Description
1	FLT01-3PH	3 phase fault on Buffalo Flats (532782) to Wichita (532796) 345kV Ckt 1, near Buffalo Flats.
2	FLT02-3PH	3 phase fault on Buffalo Flats (532782) to Thistle (539801) 345kV Ckt 1, near Buffalo Flats.

The required prior queued project wind farms remained online for the fault contingencies described in this section as well as the fault contingencies described in the Disturbances section of this report. GEN-2019-001 is found to be in compliance with FERC Order #661A.

Power Factor Analysis

In accordance with FERC Order 827 GEN-2019-001 will be required to provide dynamic reactive power within the power factor range of 0.95 leading (absorbing Vars from the network) to 0.95 lagging (providing Vars to the network) at continuous rated power output at the high side of the generator substation.

Reduced Wind Generation Analysis

A low wind analysis has been performed for the GEN-2019-001 Interconnection Request. SPP performed this low wind analysis for excessive capacitive charging current for the addition of the Interconnection Request facilities. The high side of the each Interconnection Customer's transformer will interconnect to The Point of Interconnection (POI).

The project generators and capacitors (if any) were turned off in the base case. The resulting reactive power injection into the transmission network comes from the capacitance of the project's transmission lines and collector cables.

Final shunt reactor requirement for each project with the model information provided to SPP is shown in Table 7. It is the interconnection customer's responsibility to design and install the reactive compensation equipment necessary to control the reactive power injection at the POI. The reactive equipment required may vary with system conditions (e.g. a higher compensation amount is required for voltages above unity at the POI and a lower compensation amount is required for voltages below unity at the POI) thus the values calculated by SPP may not be adequate under all normal operating conditions.

Table 7*:* Summary of Reduced Wind Generation Analysis

Request	Point of Interconnection (POI)	Reactor Size (Mvar)
GEN-2015-024	Buffalo Flats 345 kV (532782)	41.5
GEN-2015-025	Buffalo Flats 345 kV (532782)	36.5
GEN-2015-090	Buffalo Flats 345 kV (532782)	24.1
GEN-2019-001	Buffalo Flats 345 kV (532782)	2.3

Short Circuit Analysis

The short circuit analysis was performed on the 2018 & 2026 Summer Peak stability analysis power flow cases using the PSS/E ASCC program. Since the power flow model does not contain negative and zero sequence data, only three-phase symmetrical fault current levels were calculated at the point of interconnection up to and including five levels away.

Short Circuit Analysis was conducting using flat conditions with the following PSS/E ASCCC program settings:

- BUS VOLTAGES SET TO 1 PU AT 0 PHASE ANGLE
- GENERATOR P=0, Q=0
- TRANSFORMER TAP RATIOS=1.0 PU and PHASE ANGLES=0.0
- LINE CHARGING=0.0 IN +/-/0 SEQUENCE
- LOAD=0.0 IN +/- SEQUENCE, CONSIDERED IN ZERO SEQUENCE
- LINE/FIXED/SWITCHED SHUNTS=0.0 AND MAGNETIZING ADMITTANCE=0.0 IN +/-/0 SEQUENCE
- DC LINES AND FACTS DEVICES BLOCKED
- TRANSFORMER ZERO SEQUENCE IMPEDANCE CORRECTIONS IGNORED

Results

The results of the short circuit analysis are shown in Appendix D.

Conclusion

Powerflow and stability analysis have demonstrated that GEN-2019-001 may reliably interconnect on an interim basis ten (10) Siemens 2.3 MW and one (1) GE 2.0 MW wind turbine generators for a total nameplate capacity of 25.0 MW with ERIS at a POI on the WERE Buffalo Flats 345 kV substation for system conditions as of December 31, 2018.

GEN-2019-001 was found to be in compliance with FERC Order #661A when studied as listed within this report. GEN-2019-001 must design and install approximately 2.3 MVAR of reactive compensation equipment, which may include wind turbine manufacturer options, necessary to control the reactive power injection at the POI. The Interconnection Customer will be required to provide documentation and design specifications demonstrating how the requirements are met.

In the event that any interconnection request, equally or lower queued to DISIS-2016-001, requests limited operation or if any of the requests with a shared generator lead to the POI (GEN-2015-024, GEN-2015-025, and GEN-2015-090) reduce their unused interconnection service (i.e. GIA revision or construction of additional generators) this IAISIS will be invalid and will require a restudy and revision or termination of an Interim GIA for GEN-2019-001.

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 IAISIS at the expense of the Customer.

Nothing in this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service.

Appendices

A: Reduced Wind Generation Analysis Results

Below figures are from the DISIS-2016-002-1 stability analysis 2017 WP model without current study upgrades.

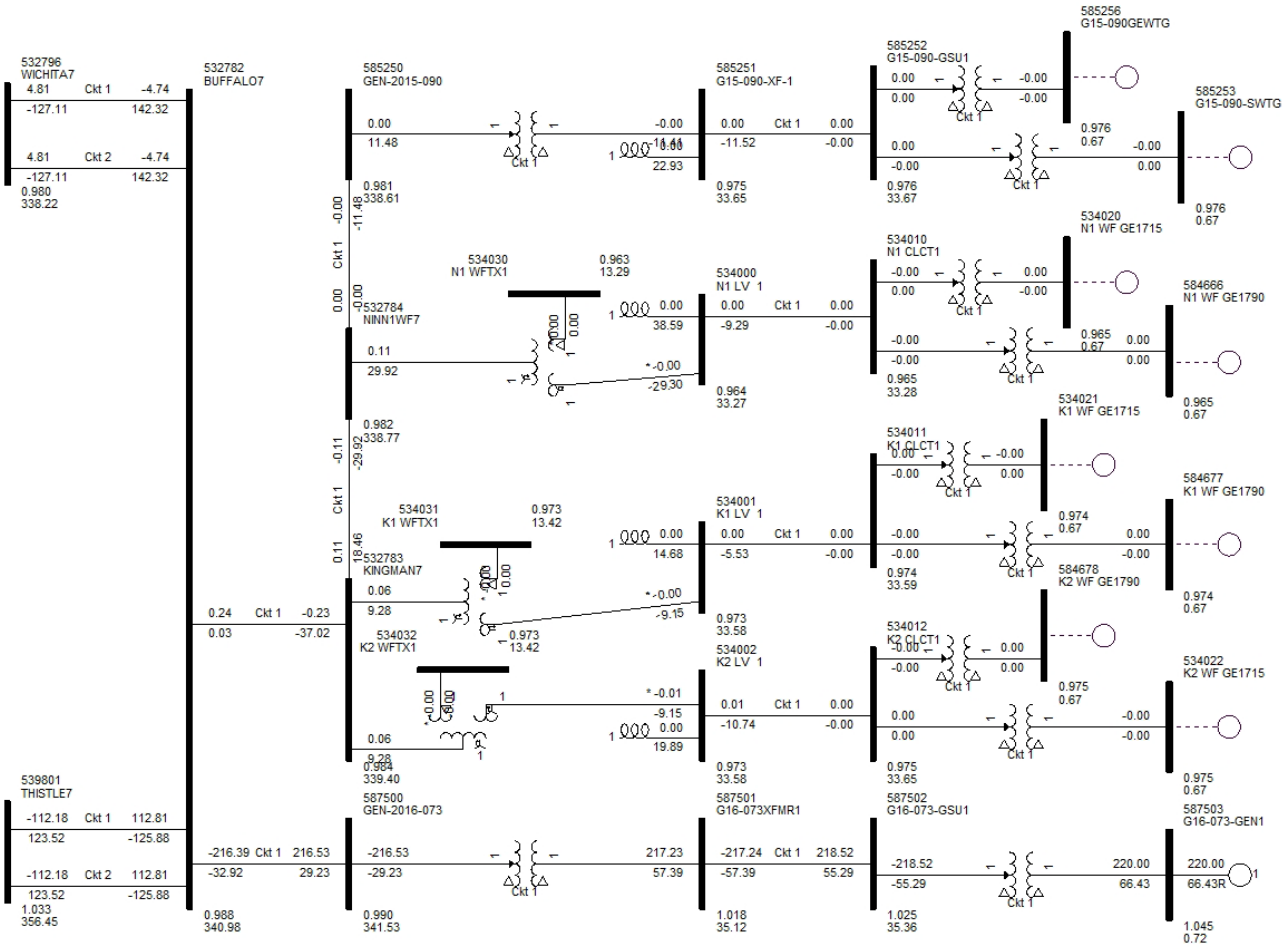

Figure 2: GEN-2015-024, GEN-2015-025, and GEN-2015-090 without GEN-2019-001

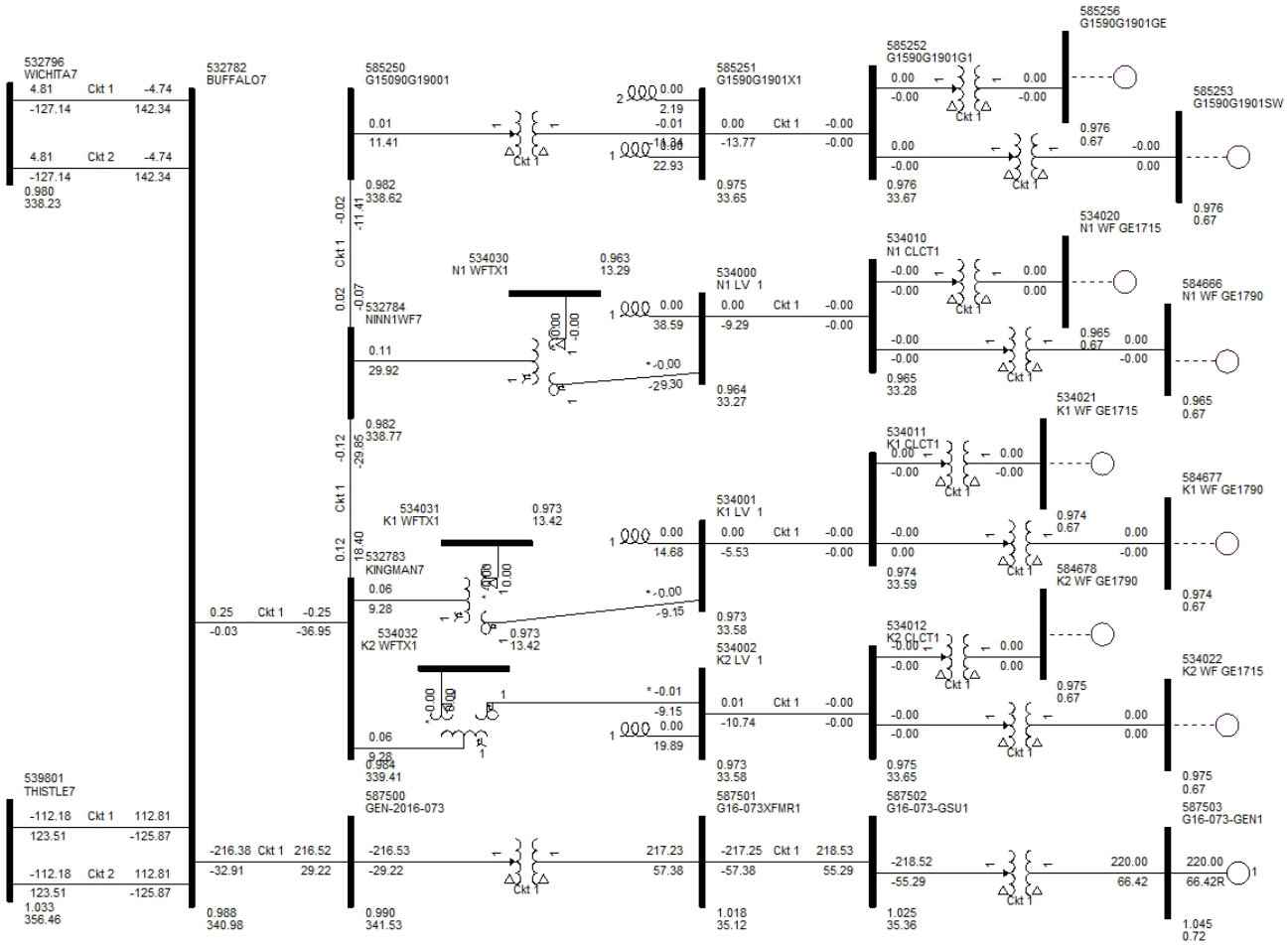

Figure 3: GEN-2015-024, GEN-2015-025, and GEN-2015-090 with GEN-2019-001 and identified switched shunt reactors located at the 34.5kV customer substation.

B: Short Circuit Analysis Results

18SP

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                              PSS(R)E-33.7.0 ASCC SHORT CIRCUIT CURRENTS          THU, DEC 20 2018
18:56
2016 MDWG FINAL WITH 2015 SERIES MMWG FINAL
MDWG 2018S WITH MMWG 2017S

OPTIONS USED:
    - SET PRE-FAULT VOLTAGE ON ALL BUSES TO  1.00 PU AT 0 PHASE SHIFT ANGLE
    - SET SYNCHRONOUS/ASYNCHRONOUS MACHINE POWER OUTPUTS TO P=0.0, Q=0.0
    - SET GENERATOR POSITIVE SEQUENCE REACTANCES TO SUBTRANSIENT
    - SET TRANSFORMER TAP RATIOS=1.0 PU AND PHASE SHIFT ANGLES=0.0
    - SET LINE CHARGING=0.0 IN +/-/0 SEQUENCES
    - SET LINE/FIXED/SWITCHED SHUNTS=0.0 AND TRANSFORMER MAGNETIZING ADMITTANCE=0.0 IN +/-/0
SEQUENCES
    - SET LOAD=0.0 IN +/- SEQUENCES
    - DC LINES AND FACTS DEVICES BLOCKED
    - IMPEDANCE CORRECTIONS APPLIED TO TRANSFORMER ZERO SEQUENCE IMPEDANCES

                                 THREE PHASE FAULT
X---------- BUS ----------X          /I+/    AN(I+)
511456 [O.K.U.-7    345.00] AMP     5096.3   -84.34
514715 [WOODRNG7    345.00] AMP    18759.7   -85.05
514785 [WOODWRD4    138.00] AMP    12782.7   -81.25
514787 [DEWEY  4    138.00] AMP     7414.7   -77.29
514796 [IODINE-4    138.00] AMP     7221.0   -79.85
514880 [NORTWST7    345.00] AMP    32393.4   -86.10
514901 [CIMARON7    345.00] AMP    32794.4   -85.94
515375 [WWRDEHV7    345.00] AMP    18759.3   -86.04
515376 [WWRDEHV4    138.00] AMP    22548.3   -85.98
515394 [KEENAN 4    138.00] AMP     7966.0   -84.86
515398 [OUSPRT 4    138.00] AMP     8744.8   -82.11
515407 [TATONGA7    345.00] AMP    15751.4   -86.53
515425 [WWDPST 4    138.00] AMP    16801.8   -83.94
515448 [CRSRDSW7    345.00] AMP    11016.3   -85.54
515458 [BORDER     7345.00] AMP     5022.4   -86.23
515476 [HUNTERS7    345.00] AMP    13270.5   -84.79
515477 [CHSHLMV7    345.00] AMP    13251.1   -84.79
515497 [MATHWSN7    345.00] AMP    31777.2   -86.11
515543 [RENFROW7    345.00] AMP    12651.8   -84.74
515544 [RENFROW4    138.00] AMP    13987.2   -85.02
515546 [GRANTCO4    138.00] AMP     6354.7   -81.17
515554 [BVRCNTY7    345.00] AMP    14235.8   -86.42
515569 [MDFRDTP4    138.00] AMP    11224.8   -83.53
515582 [SLNGWND7    345.00] AMP     7196.4   -85.23
515585 [MAMTHPW7    345.00] AMP    12472.4   -85.99
515599 [G07621119-20345.00] AMP    12777.9   -85.54
515621 [OPENSKY7    345.00] AMP    12229.9   -86.78
515646 [GRNTWD 7    345.00] AMP    11086.8   -84.67
515677 [BADGER 7    345.00] AMP    13369.2   -86.45
515686 [GEN-2011-014345.00] AMP    11980.8   -86.21
515875 [REDNGTN7    345.00] AMP    17971.5   -84.96
520409 [RENFROW4    138.00] AMP    10171.9   -83.19
525830 [TUCO_INT   6230.00] AMP    20025.9   -84.53
525832 [TUCO_INT   7345.00] AMP    10071.2   -85.98
525850 [ELK_CT1     345.00] AMP     9991.4   -85.96
531469 [SPERVIL7    345.00] AMP    13610.6   -83.05
532766 [JEC N  7    345.00] AMP    23698.0   -87.42
532768 [EMPEC 7     345.00] AMP    17346.0   -86.14
532769 [LANG   7    345.00] AMP    17133.6   -86.13
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532770 [MORRIS 7    345.00] AMP    12801.3   -85.50
532771 [RENO   7    345.00] AMP    11941.5   -85.92
532773 [SUMMIT 7    345.00] AMP    11291.5   -85.98
532774 [SWISVAL7    345.00] AMP    16434.2   -85.26
532780 [CANEYRV7    345.00] AMP     9950.4   -85.49
532782 [BUFFALO7    345.00] AMP    21403.7   -86.38
532783 [KINGMAN7    345.00] AMP     6304.9   -86.76
532784 [NINN1WF7    345.00] AMP     5220.8   -86.82
532791 [BENTON 7    345.00] AMP    20355.3   -85.85
532792 [FR2EAST7    345.00] AMP     7046.8   -85.69
532794 [ROSEHIL7    345.00] AMP    19411.6   -85.85
532795 [FR2WEST7    345.00] AMP     5726.3   -85.72
532796 [WICHITA7    345.00] AMP    25714.3   -86.25
532797 [WOLFCRK7    345.00] AMP    15918.7   -86.64
532798 [VIOLA   7   345.00] AMP    13910.7   -85.31
532799 [WAVERLY7    345.00] AMP    14603.2   -86.29
532800 [LATHAMS7    345.00] AMP    10550.0   -85.56
532801 [ELKRVR17    345.00] AMP     9305.7   -85.46
532802 [WAVERTX7    345.00] AMP    12415.6   -85.77
532856 [SWISVAL6    230.00] AMP    21421.5   -85.32
532863 [MORRIS 6    230.00] AMP    13856.1   -85.28
532871 [CIRCLE 6    230.00] AMP     8973.0   -84.39
532986 [BENTON 4    138.00] AMP    28918.8   -85.91
532987 [BUTLER 4    138.00] AMP     9950.1   -79.40
532988 [BELAIRE4    138.00] AMP    19088.3   -84.80
532990 [MIDIAN 4    138.00] AMP    10144.1   -80.45
532991 [WEAVER 4    138.00] AMP    22241.8   -83.97
533011 [HALSTD 4    138.00] AMP     4247.3   -85.35
533013 [MOUND  4    138.00] AMP     4846.0   -84.78
533015 [BENTLEY4    138.00] AMP    10052.2   -85.10
533016 [WWUPLNT4    138.00] AMP     7716.2   -84.69
533024 [29TH   4    138.00] AMP    19888.0   -85.13
533035 [CHISHLM4    138.00] AMP    22582.4   -84.80
533036 [CLEARWT4    138.00] AMP    14410.6   -85.32
533037 [COMOTAR4    138.00] AMP    18838.4   -84.63
533038 [COWSKIN4    138.00] AMP    19279.5   -84.75
533039 [ELPASO 4    138.00] AMP    25138.2   -84.17
533040 [EVANS N4    138.00] AMP    40713.8   -87.36
533041 [EVANS S4    138.00] AMP    40713.8   -87.36
533045 [GILL W 4    138.00] AMP    25877.2   -85.24
533046 [GILL S 4    138.00] AMP    25877.2   -85.24
533047 [GILL   4    138.00] AMP    25877.2   -85.24
533049 [HOOVERN4    138.00] AMP    18757.2   -85.05
533053 [LAKERDG4    138.00] AMP    18938.6   -85.63
533054 [MAIZE  4    138.00] AMP    23262.6   -85.18
533060 [NOEASTE4    138.00] AMP    20833.5   -84.77
533062 [ROSEHIL4    138.00] AMP    31847.0   -86.17
533064 [17TH   4    138.00] AMP    18048.0   -84.52
533065 [SG12COL4    138.00] AMP    21162.3   -85.78
533068 [STEARMN4    138.00] AMP    19842.2   -84.18
533074 [45TH ST4    138.00] AMP    27709.4   -85.74
533075 [VIOLA  4    138.00] AMP    18594.2   -85.90
533304 [LANG   3    115.00] AMP    14451.0   -85.15
533380 [SPRGCRK3    115.00] AMP     3606.1   -72.58
533390 [MAIZEW 4    138.00] AMP    27520.1   -85.54
533391 [MAIZEE 4    138.00] AMP    21845.2   -84.99
533394 [CORONAD3    115.00] AMP     7177.3   -84.31
533412 [ARKVALJ3    115.00] AMP     9859.7   -83.35
533413 [CIRCLE 3    115.00] AMP    19060.0   -85.26
533414 [CITIES 3    115.00] AMP     8299.6   -82.23
533415 [DAVIS  3    115.00] AMP     8299.8   -82.43
533416 [RENO   3    115.00] AMP    23004.8   -85.87
533419 [HEC    3    115.00] AMP    17781.9   -85.13
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533421 [HEC GT 3    115.00] AMP    18511.3   -85.27
533426 [MANVILE3    115.00] AMP    10090.0   -83.82
533428 [MCPHER 3    115.00] AMP    11755.8   -84.71
533429 [MOUNDRG3    115.00] AMP     7100.7   -83.10
533438 [WMCPHER3    115.00] AMP    12217.2   -84.74
533439 [WHEATLD3    115.00] AMP     7100.7   -83.80
533506 [DAVIS  2    69.000] AMP     7326.5   -82.33
533597 [MIDIAN 2    69.000] AMP    12222.5   -81.91
533626 [BURLJCT2    69.000] AMP     4774.9   -85.77
533629 [CC2SHAR2    69.000] AMP     4514.7   -81.43
533653 [WOLFCRK2    69.000] AMP     5807.9   -87.17
533786 [CHISHLM2    69.000] AMP    18968.8   -85.42
539000 [RAGO   4    138.00] AMP     3929.3   -81.45
539001 [ANTHONY4    138.00] AMP     4376.5   -82.40
539004 [MAYFLD 4    138.00] AMP     7101.6   -80.61
539008 [MILAN_GOAB  138.00] AMP    10391.1   -77.98
539009 [CONWAY      138.00] AMP    11164.9   -77.58
539631 [FLATRWD4    138.00] AMP    10296.6   -83.98
539638 [FLATRDG4    138.00] AMP    15368.3   -85.70
539668 [HARPER 4    138.00] AMP     6900.6   -79.55
539674 [BARBER 4    138.00] AMP     8169.9   -83.81
539675 [MILANTP4    138.00] AMP     9034.8   -75.14
539676 [MILAN 4     138.00] AMP     9317.1   -76.65
539760 [BARBER 3    115.00] AMP     8009.1   -83.52
539800 [CLARKCOUNTY7345.00] AMP    13429.5   -83.15
539801 [THISTLE7    345.00] AMP    16107.6   -85.72
539803 [IRONWOOD7   345.00] AMP    13037.8   -83.05
539804 [THISTLE4    138.00] AMP    17326.2   -86.46
542965 [W.GRDNR7    345.00] AMP    26412.8   -85.84
542981 [LACYGNE7    345.00] AMP    25393.4   -86.90
560002 [IRONWOOD2  7345.00] AMP    13193.0   -82.29
560053 [G15-052T    345.00] AMP    13034.6   -86.52
560071 [G16-003-TAP 345.00] AMP    14607.9   -86.29
560072 [G16-005-TAP 345.00] AMP    12705.9   -84.25
560080 [G16-046-TAP 345.00] AMP    11478.1   -79.31
562476 [G14-001-TAP 345.00] AMP    11126.4   -85.03
582008 [GEN-2011-008345.00] AMP    10960.8   -83.17
582016 [GEN-2011-016345.00] AMP     7378.3   -80.00
582708 [G-2011-008-1345.00] AMP     9159.0   -83.13
583090 [G1149&G1504 345.00] AMP     4596.3   -86.08
583370 [GEN-2012-024345.00] AMP    11433.1   -83.30
583850 [GEN-2014-001345.00] AMP     7581.8   -84.75
584700 [GEN-2015-029345.00] AMP     9539.8   -84.61
584900 [GEN-2015-052345.00] AMP    12985.1   -86.50
585060 [GEN-2015-068345.00] AMP     8486.2   -85.80
585100 [GEN-2015-073345.00] AMP    13055.6   -85.50
585190 [GEN-2015-082345.00] AMP     6947.3   -85.59
585250 [G15090G19001345.00] AMP     4339.0   -86.51
585410 [GREAT_WESTRN345.00] AMP     9722.9   -85.26
585420 [COWBOY_RIDGE345.00] AMP     7544.6   -85.01
585430 [PRSIMN_CRK1 345.00] AMP    11292.6   -85.42
585440 [PRSIMN_CRK2 345.00] AMP    10338.4   -85.32
587020 [GEN-2016-003345.00] AMP    14607.9   -86.29
587040 [GEN-2016-005345.00] AMP    10489.7   -84.29
587300 [G16-045-SUB1345.00] AMP     1557.0   -85.29
587304 [G16-045-SUB2345.00] AMP     1517.6   -85.34
587310 [GEN-2016-046345.00] AMP     9877.3   -80.01
587380 [G16-057-SUB1345.00] AMP     1533.9   -85.31
587384 [G16-057-SUB2345.00] AMP     1465.5   -85.40
587500 [GEN-2016-073345.00] AMP    15563.0   -85.93
587880 [GEN-2016-111345.00] AMP     6925.7   -85.69
587884 [G16-111-TAP 345.00] AMP    10846.7   -86.17
587894 [G16-112-TAP 345.00] AMP    10609.8   -86.13
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587910 [GEN-2016-114345.00] AMP     9728.4   -86.01
587980 [GEN-2016-122345.00] AMP     5104.5   -84.71
588320 [GEN-2016-162345.00] AMP     9908.6   -85.38
588330 [GEN-2016-163345.00] AMP     8739.8   -85.31
588360 [GEN-2016-153345.00] AMP     7398.7   -85.04
588364 [G16-153-TAP 345.00] AMP     7742.3   -85.64
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26SP

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                              PSS(R)E-33.7.0 ASCC SHORT CIRCUIT CURRENTS          THU, DEC 20 2018
18:56
2016 MDWG FINAL WITH 2015 SERIES MMWG FINAL
MDWG 2026S WITH MMWG 2026S

OPTIONS USED:
    - SET PRE-FAULT VOLTAGE ON ALL BUSES TO  1.00 PU AT 0 PHASE SHIFT ANGLE
    - SET SYNCHRONOUS/ASYNCHRONOUS MACHINE POWER OUTPUTS TO P=0.0, Q=0.0
    - SET GENERATOR POSITIVE SEQUENCE REACTANCES TO SUBTRANSIENT
    - SET TRANSFORMER TAP RATIOS=1.0 PU AND PHASE SHIFT ANGLES=0.0
    - SET LINE CHARGING=0.0 IN +/-/0 SEQUENCES
    - SET LINE/FIXED/SWITCHED SHUNTS=0.0 AND TRANSFORMER MAGNETIZING ADMITTANCE=0.0 IN +/-/0
SEQUENCES
    - SET LOAD=0.0 IN +/- SEQUENCES
    - DC LINES AND FACTS DEVICES BLOCKED
    - IMPEDANCE CORRECTIONS APPLIED TO TRANSFORMER ZERO SEQUENCE IMPEDANCES

                                 THREE PHASE FAULT
X---------- BUS ----------X          /I+/    AN(I+)
511456 [O.K.U.-7    345.00] AMP     5167.5   -84.33
514715 [WOODRNG7    345.00] AMP    18783.0   -85.05
514785 [WOODWRD4    138.00] AMP    12933.1   -81.11
514787 [DEWEY  4    138.00] AMP     7450.2   -77.27
514796 [IODINE-4    138.00] AMP     7239.4   -79.82
514880 [NORTWST7    345.00] AMP    32290.5   -86.09
514901 [CIMARON7    345.00] AMP    32724.3   -85.93
515375 [WWRDEHV7    345.00] AMP    18818.4   -86.03
515376 [WWRDEHV4    138.00] AMP    22648.3   -85.95
515394 [KEENAN 4    138.00] AMP     7978.5   -84.85
515398 [OUSPRT 4    138.00] AMP     8759.7   -82.09
515407 [TATONGA7    345.00] AMP    15764.2   -86.53
515425 [WWDPST 4    138.00] AMP    16898.5   -83.90
515448 [CRSRDSW7    345.00] AMP    11022.6   -85.53
515458 [BORDER     7345.00] AMP     5069.7   -86.21
515476 [HUNTERS7    345.00] AMP    13305.0   -84.79
515477 [CHSHLMV7    345.00] AMP    13285.5   -84.79
515497 [MATHWSN7    345.00] AMP    31724.5   -86.10
515543 [RENFROW7    345.00] AMP    12706.2   -84.74
515544 [RENFROW4    138.00] AMP    14021.1   -84.99
515546 [GRANTCO4    138.00] AMP     6363.9   -81.14
515554 [BVRCNTY7    345.00] AMP    14252.7   -86.41
515569 [MDFRDTP4    138.00] AMP    11254.3   -83.49
515582 [SLNGWND7    345.00] AMP     7198.8   -85.23
515585 [MAMTHPW7    345.00] AMP    12480.3   -85.99
515599 [G07621119-20345.00] AMP    12802.1   -85.54
515621 [OPENSKY7    345.00] AMP    12232.0   -86.78
515646 [GRNTWD 7    345.00] AMP    11128.0   -84.67
515677 [BADGER 7    345.00] AMP    13385.1   -86.45
515686 [GEN-2011-014345.00] AMP    11993.5   -86.20
515875 [REDNGTN7    345.00] AMP    17971.9   -84.96
520409 [RENFROW4    138.00] AMP    10190.0   -83.17
525830 [TUCO_INT   6230.00] AMP    22446.6   -84.97
525832 [TUCO_INT   7345.00] AMP    12110.5   -86.09
525850 [ELK_CT1     345.00] AMP    11994.5   -86.07
526936 [YOAKUM_345  345.00] AMP     8845.8   -86.45
531469 [SPERVIL7    345.00] AMP    13661.6   -83.04
532766 [JEC N  7    345.00] AMP    23750.3   -87.42
532768 [EMPEC 7     345.00] AMP    17373.5   -86.14
532769 [LANG   7    345.00] AMP    17160.5   -86.12
532770 [MORRIS 7    345.00] AMP    12825.1   -85.49
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532771 [RENO   7    345.00] AMP    12440.4   -86.13
532773 [SUMMIT 7    345.00] AMP    11537.9   -86.08
532774 [SWISVAL7    345.00] AMP    16448.4   -85.26
532780 [CANEYRV7    345.00] AMP     9944.4   -85.49
532782 [BUFFALO7    345.00] AMP    21552.1   -86.39
532783 [KINGMAN7    345.00] AMP     6314.4   -86.77
532784 [NINN1WF7    345.00] AMP     5226.9   -86.82
532791 [BENTON 7    345.00] AMP    20412.3   -85.85
532792 [FR2EAST7    345.00] AMP     7088.3   -85.71
532794 [ROSEHIL7    345.00] AMP    19455.8   -85.85
532795 [FR2WEST7    345.00] AMP     5751.4   -85.73
532796 [WICHITA7    345.00] AMP    25955.0   -86.27
532797 [WOLFCRK7    345.00] AMP    15921.5   -86.64
532798 [VIOLA   7   345.00] AMP    14138.5   -85.36
532799 [WAVERLY7    345.00] AMP    14604.6   -86.28
532800 [LATHAMS7    345.00] AMP    10547.7   -85.56
532801 [ELKRVR17    345.00] AMP     9304.0   -85.46
532802 [WAVERTX7    345.00] AMP    12416.6   -85.77
532856 [SWISVAL6    230.00] AMP    21439.3   -85.33
532863 [MORRIS 6    230.00] AMP    13894.7   -85.28
532871 [CIRCLE 6    230.00] AMP     9683.4   -84.76
532982 [OXFORD 4    138.00] AMP     9379.0   -82.93
532984 [SUMNER 4    138.00] AMP    10237.2   -82.82
532986 [BENTON 4    138.00] AMP    28980.7   -85.91
532987 [BUTLER 4    138.00] AMP     9964.6   -79.39
532988 [BELAIRE4    138.00] AMP    19120.5   -84.80
532990 [MIDIAN 4    138.00] AMP    10158.2   -80.44
532991 [WEAVER 4    138.00] AMP    22369.8   -83.97
532992 [TIMBJCT4    138.00] AMP     5867.1   -83.23
533011 [HALSTD 4    138.00] AMP     4270.7   -85.38
533013 [MOUND  4    138.00] AMP     4886.8   -84.82
533015 [BENTLEY4    138.00] AMP    10066.7   -85.11
533016 [WWUPLNT4    138.00] AMP     7724.7   -84.70
533024 [29TH   4    138.00] AMP    19922.7   -85.13
533035 [CHISHLM4    138.00] AMP    22616.9   -84.80
533036 [CLEARWT4    138.00] AMP    14620.8   -85.27
533037 [COMOTAR4    138.00] AMP    18872.4   -84.63
533038 [COWSKIN4    138.00] AMP    19313.8   -84.75
533039 [ELPASO 4    138.00] AMP    25469.6   -84.18
533040 [EVANS N4    138.00] AMP    40845.0   -87.38
533041 [EVANS S4    138.00] AMP    40845.0   -87.38
533045 [GILL W 4    138.00] AMP    26021.4   -85.24
533046 [GILL S 4    138.00] AMP    26021.4   -85.24
533047 [GILL   4    138.00] AMP    26021.4   -85.24
533049 [HOOVERN4    138.00] AMP    18789.3   -85.05
533053 [LAKERDG4    138.00] AMP    18968.9   -85.64
533054 [MAIZE  4    138.00] AMP    23298.2   -85.18
533060 [NOEASTE4    138.00] AMP    20879.6   -84.77
533062 [ROSEHIL4    138.00] AMP    32010.6   -86.17
533063 [SC10BEL4    138.00] AMP     9766.0   -81.64
533064 [17TH   4    138.00] AMP    18073.7   -84.52
533065 [SG12COL4    138.00] AMP    21204.9   -85.79
533068 [STEARMN4    138.00] AMP    19937.2   -84.17
533074 [45TH ST4    138.00] AMP    27772.4   -85.75
533075 [VIOLA  4    138.00] AMP    20389.2   -85.72
533304 [LANG   3    115.00] AMP    14462.6   -85.14
533380 [SPRGCRK3    115.00] AMP     3622.3   -72.54
533390 [MAIZEW 4    138.00] AMP    27573.4   -85.54
533391 [MAIZEE 4    138.00] AMP    21875.8   -85.00
533394 [CORONAD3    115.00] AMP     7520.8   -84.45
533412 [ARKVALJ3    115.00] AMP    10503.5   -83.51
533413 [CIRCLE 3    115.00] AMP    21933.8   -85.74
533414 [CITIES 3    115.00] AMP     8743.5   -82.23
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533415 [DAVIS  3    115.00] AMP     8683.8   -82.43
533416 [RENO   3    115.00] AMP    25327.8   -86.18
533419 [HEC    3    115.00] AMP    20452.8   -85.61
533421 [HEC GT 3    115.00] AMP    21281.3   -85.75
533426 [MANVILE3    115.00] AMP    11237.6   -83.98
533428 [MCPHER 3    115.00] AMP    14485.8   -85.68
533429 [MOUNDRG3    115.00] AMP     7200.9   -83.14
533438 [WMCPHER3    115.00] AMP    14669.6   -85.51
533439 [WHEATLD3    115.00] AMP     7707.2   -84.08
533506 [DAVIS  2    69.000] AMP     7514.7   -82.31
533597 [MIDIAN 2    69.000] AMP    12237.7   -81.90
533626 [BURLJCT2    69.000] AMP     4774.8   -85.77
533629 [CC2SHAR2    69.000] AMP     4514.7   -81.43
533653 [WOLFCRK2    69.000] AMP     5807.8   -87.17
533786 [CHISHLM2    69.000] AMP    18983.4   -85.42
539000 [RAGO   4    138.00] AMP     3952.9   -81.35
539001 [ANTHONY4    138.00] AMP     4419.2   -82.28
539004 [MAYFLD 4    138.00] AMP     7313.9   -80.34
539008 [MILAN_GOAB  138.00] AMP    10887.0   -77.44
539009 [CONWAY      138.00] AMP    11699.9   -77.05
539631 [FLATRWD4    138.00] AMP    10317.3   -83.96
539638 [FLATRDG4    138.00] AMP    15416.4   -85.67
539668 [HARPER 4    138.00] AMP     6973.1   -79.34
539674 [BARBER 4    138.00] AMP     8184.4   -83.80
539675 [MILANTP4    138.00] AMP     9345.5   -74.64
539676 [MILAN 4     138.00] AMP     9711.7   -76.11
539760 [BARBER 3    115.00] AMP     8021.7   -83.50
539800 [CLARKCOUNTY7345.00] AMP    13462.8   -83.12
539801 [THISTLE7    345.00] AMP    16165.5   -85.71
539803 [IRONWOOD7   345.00] AMP    13083.3   -83.04
539804 [THISTLE4    138.00] AMP    17377.1   -86.43
542965 [W.GRDNR7    345.00] AMP    26432.0   -85.83
542981 [LACYGNE7    345.00] AMP    25366.7   -86.89
560002 [IRONWOOD2  7345.00] AMP    13240.0   -82.28
560053 [G15-052T    345.00] AMP    13043.3   -86.52
560071 [G16-003-TAP 345.00] AMP    14635.8   -86.28
560072 [G16-005-TAP 345.00] AMP    12735.1   -84.23
560080 [G16-046-TAP 345.00] AMP    11505.1   -79.28
562476 [G14-001-TAP 345.00] AMP    11151.7   -85.03
582008 [GEN-2011-008345.00] AMP    10980.4   -83.15
582016 [GEN-2011-016345.00] AMP     7392.2   -79.98
582708 [G-2011-008-1345.00] AMP     9171.6   -83.11
583090 [G1149&G1504 345.00] AMP     4634.8   -86.06
583370 [GEN-2012-024345.00] AMP    11457.0   -83.27
583850 [GEN-2014-001345.00] AMP     7592.6   -84.75
584700 [GEN-2015-029345.00] AMP     9544.4   -84.60
584900 [GEN-2015-052345.00] AMP    12993.8   -86.50
585060 [GEN-2015-068345.00] AMP     9853.9   -85.84
585100 [GEN-2015-073345.00] AMP    13071.0   -85.50
585190 [GEN-2015-082345.00] AMP     6951.4   -85.59
585250 [G15090G19001345.00] AMP     4343.0   -86.51
585410 [GREAT_WESTRN345.00] AMP     9735.8   -85.25
585420 [COWBOY_RIDGE345.00] AMP     7551.9   -85.00
585430 [PRSIMN_CRK1 345.00] AMP    11311.2   -85.41
585440 [PRSIMN_CRK2 345.00] AMP    10353.9   -85.31
587020 [GEN-2016-003345.00] AMP    14635.8   -86.28
587040 [GEN-2016-005345.00] AMP    10509.2   -84.28
587300 [G16-045-SUB1345.00] AMP     1556.9   -85.29
587304 [G16-045-SUB2345.00] AMP     1517.5   -85.34
587310 [GEN-2016-046345.00] AMP     9897.0   -79.99
587380 [G16-057-SUB1345.00] AMP     1533.8   -85.31
587384 [G16-057-SUB2345.00] AMP     1465.5   -85.40
587500 [GEN-2016-073345.00] AMP    15640.2   -85.94
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587880 [GEN-2016-111345.00] AMP     7038.2   -85.76
587884 [G16-111-TAP 345.00] AMP    11144.2   -86.30
587894 [G16-112-TAP 345.00] AMP    10852.9   -86.23
587910 [GEN-2016-114345.00] AMP     9963.8   -86.12
587980 [GEN-2016-122345.00] AMP     5150.3   -84.72
588320 [GEN-2016-162345.00] AMP     9920.7   -85.38
588330 [GEN-2016-163345.00] AMP     8749.1   -85.31
588360 [GEN-2016-153345.00] AMP     7446.4   -85.05
588364 [G16-153-TAP 345.00] AMP     7795.0   -85.65
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