SPP 2016 TPL-001-4 and FAC-014-2

Compliance Assessment Comprehensive Report

12/15/2016

Compliance and Advanced Studies

Southwest Power Pool

Revision History

Date	Author	Change Description
12/7/2016	SPP staff	Initial Draft to TWG
12/15/2016	SPP staff	Make changes based off feedback from TWG. TWG approved version.
12/30/2016	SPP staff	Corrected omission of two potential stability violations in Section 2.4. – non-material change
01/04/2017	SPP staff	Add Tri-State to list of entities involved in the study – non-material change

Executive Summary

This document includes NERC TPL-001-4 and FAC-014-2 Standard compliance assessments for the Southwest Power Pool (SPP) Planning Coordinator (PC). An objective of the 2016 Steady State, Stability, and Short Circuit Planning Assessments is to report findings from the 2016 Steady State, Stability, and Short Circuit Planning studies in support of SPP's compliance, as a PC, with NERC TPL-001-4 Reliability Standard.

To support SPP's compliance, as the PC, with the NERC FAC-014-2 Reliability Standard, an additional objective of this document is to ensure that System Operating Limits (SOLs) used in the reliable planning and operation of the Bulk Electric System (BES) are determined based on an established methodology in section 7.3.2 of the SPP Planning Criteria.[1]

This document is divided into three main sections for the Steady State (Section 1.) Stability (Section 2.), and Short Circuit (Section 3.) Assessments for NERC TPL-001-4. Each section is a stand-alone section that details the methodologies, results, and conclusions for each of the assessments. The Transmission Working Group approved study scopes for each of these assessments are appended to the end of this document (Sections 5-7).

For the TPL-001-4 Steady State, Stability, and Short Circuit Assessments, a number of potential violations were observed. Corrective Action Plans that satisfied all potential criteria violations were developed and tested by the Transmission Planners (TPs) and the SPP PC.

For adherence to FAC-014-2, SPP will post to Tru-Share a link to all System Operating Limits (SOLs). All facility ratings that were potentially violated in the TPL-001-4 Assessment were mitigated by Corrective Action Plans developed and tested by the SPP PC or SPP TPs. The TPL-001-4 Assessment did not identify any SOLs that should be lower than the applicable Facility Ratings as identified in SPP's Model Development Working Group (MDWG) powerflow models. Additionally, no Interconnection Reliability Operating Limits (IROLs) identified for the planning horizon.

[1] SPP Planning Criteria 7.3.2 page 87

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Section 1: **Steady State Planning Assessment**

The objective of the 2016 Steady State Planning Assessment (assessment) is to report findings from the 2016 TPL-001-4 steady state study in support of SPP's compliance, as a Planning Coordinator (PC), with the NERC TPL-001-4 Reliability Standard.

The goals of this Planning Assessment are:

1. To identify potential branch/transformer violations (>100% of rate A) under normal conditions. (TPL-001-4 Table 1 Planning Event P0)
2. To identify potential branch/transformer violations (>100% of rate B) due to the loss of a single element. (TPL-001-4 Table 1 Planning Event P1 and P2)
3. To identify potential branch/transformer violations (>100% of rate B) due to the loss of two or more elements. (TPL -001-4 Table 1 Planning Event P3, P4, P5, P6, and P7)
4. To identify potential branch/transformer violations (>100% of rate B) due to extreme events. (TPL-001-4 Table 1 Planning Event EE)
5. To identify potential voltage violations (0.95 p.u. - 1.05 p.u.)[2] under normal conditions. (TPL-001-4 Table 1 Planning Event P0)
6. To identify potential voltage violations (0.9 p.u. – 1.05 p.u.)[2] due to the loss of a single element. (TPL-001-4 Table 1 Planning Event P1 and P2)
7. To identify potential voltage violations (0.9 p.u. – 1.05 p.u.)[2] due to the loss of two or more elements. (TPL-001-4 Table 1 Planning Event P3, P4, P5, P6, and P7)
8. To identify potential voltage violations (0.9 p.u. – 1.05 p.u.)[2] due to extreme events. (TPL-001-4 Table 1 Planning Event EE)
9. To identify potential voltage deviations of 8% under normal conditions. (TPL-001-4 Table 1 Planning Event P0)
10. To identify potential voltage deviations of 8% due to the loss of a single element. (TPL-001-4 Table 1 Planning Event P1 and P2)
11. To identify potential voltage deviations of 8% due to the loss of two or more elements. (TPL-001-4 Table 1 Planning Event P3, P4, P5, P6, and P7)
12. To identify potential voltage deviations of 8% due to extreme events. (TPL-001-4 Table 1 Planning Event EE)

The focus of this assessment is the BES facilities in the SPP PC footprint. Potential criteria violations and Corrective Action Plans (CAPs) developed by Transmission Planners (TPs) and the SPP PC to address

[2] Applicable criteria that is more stringent than SPP Criteria was used if a TP provided their local criteria for planning purposes. If the TP has a criteria waiver on file with SPP, the conditions set forth in the waiver will be used during the analysis. SPP Criteria is listed in the 2016 Steady State TPL Scope as specified in the Appendix.

the potential criteria violations are summarized below. Voltage deviations were reported to the TPs for informational purposes only.

1.1: Models

The 2016 Series SPP Model Development Working Group (MDWG) power flow models reflect system conditions in accordance with MOD-010 and MOD-012 for selected years/seasons between year 2017 and year 2026. These models are updated by the MDWG modeling contacts to reflect the most current information using the Model On Demand (MOD) program. The SPP 2016 Series MDWG Final Powerflow Models were used in the 2016 TPL-001-4 planning studies.

Also included in the 2016 TPL-001-4 steady state study were sensitivity cases to comply with requirement R2.1.4. The sensitivity cases used were generated for the SPP Integrated Transmission Planning (ITP) Near Term. The specific models studied include a measurable change in the dispatch scenario of wind resources from the MDWG model. The complete list of models used during the TPL-001-4 steady state study are reflected in Table 1.1.

Model Scope	Description	Seasonal Assessment	Model Name	Model Released	Assessment Completed
Near Term	Year 1 peak	2017 Summer Peak	2016MDWGFinal-17S	April 2016	December 2016
Near Term	Year 1 off-peak	2017 Light Load	2016MDWGFinal-17L	April 2016	December 2016
Near Term	Year 5 peak	2021 Summer Peak	2016MDWGFinal-21S	April 2016	December 2016
Long Term	Year 10 peak	2026 Summer Peak	2016MDWGFinal-26S	April 2016	December 2016
Sensitivity Case	Year 1 peak	2017 Summer Peak	2017ITPP3-17S5	Aug 2016	December 2016
Sensitivity Case	Year 1 off-peak	2017 Light Load	2017ITPP3-17L5	Aug 2016	December 2016
Sensitivity Case	Year 5 peak	2021 Summer Peak	2017ITPP3-21S5	Aug 2016	December 2016

Table 1.1: TPL-001-4 Study Models

1.2: Basecase Analysis

Analysis on the models listed in Table 1.1 analyzed in the SPP PC steady state study did result in potential thermal and voltage violations under N-0, normal system conditions. These potential violations were mitigated by CAPs in the form of operating procedures, capital projects, or modeling corrections determined by the SPP PC and TPs. These mitigations were applied to the original model set and verified that all P0 voltage and thermal violations were alleviated. These updated models were then analyzed during the contingency analysis.

1.3: N-1 Contingency Analysis

The TPL-001-4 Table 1 Planning Event P1.2 and P2 (complex elements) considered for system evaluation were collected and compiled by the SPP PC with input from stakeholders and member entities. Additional software selected (N-1) elements were selected according to the conditions found in Table 1.2. Additional 1st tier contingencies to SPP were requested from 1st tier entities and analyzed in the Steady State analysis.

Element	Base kV	Source
Complex elements	---	SPP Staff and Member Entities
Branch	100 kV and above	Software Selection
Generator	All	Software Selection
Transformer	100 kV and above (low side)	Software Selection
Bus Shunts	100 kV and above	Software Selection
Switched Shunts	100 kV and above	Software Selection

Table 1.2: N-1 Elements Selected

1.4: N-k Contingency Analysis

The TPL-001-4 Table 1 Planning Event P4, P5, and P7 (complex elements) considered for system evaluation were collected and compiled by the SPP PC with input from stakeholders and member entities. The member submitted P1.1 contingencies were paired with member submitted P1.2, P1.3, P1.4, and P1.5 events in the same PSS/E modeling area in order to study P3 events. The member submitted P1.2, P1.3, P1.4, and P1.5 contingencies were paired with member submitted P1.2, P1.3, P1.4, and P1.5 events in the same PSS/E modeling area in order to study P6 events. The software selected (N-1) elements from Table 1.2 were paired to form software selected (N-1-1) contingencies. The pairs of software selected N-1 elements were chosen according to the conditions found in Table 1.3. Additional 1st tier contingencies to SPP were requested from 1st tier entities and analyzed in the Steady State analysis.

Element	Selection Rule	Source
Complex elements	---	SPP Staff and Member Entities
Branch*-Branch*	Same Zone	Software Selection
Branch*-Bus Shunt	Same Zone	Software Selection
Branch*-Switched Shunt	Same Zone	Software Selection
Generator-Branch*	Same Area	Software Selection

Generator-Bus Shunt	Same Zone	Software Selection
Generator-Switched Shunt	Same Zone	Software Selection
Generator-Generator	All	Software Selection
Switched Shunt-Switched Shunt	Same Zone	Software Selection
Switched Shunt-Bus Shunt	Same Zone	Software Selection
Bus Shunt-Bus Shunt	Same Zone	Software Selection

*Branch represents both branch and transformer elements.

Table 1.3: N-k Elements Selected

1.5: Extreme Events Contingency Analysis

The TPL-001-4 Table 1 Extreme Events considered for system evaluation were collected and compiled by the SPP PC with input from stakeholders and member entities as seen in Table 1.4. Additional 1st tier contingencies to SPP were requested from 1st tier entities and analyzed in the Steady State analysis.

Element	Selection Rule	Source
Extreme Events	---	SPP Staff, Stakeholders, Member Entities

Table 1.4: Extreme Events Selected

1.6: Simulation

Physical and Operational Margins (POM) software was used to perform an AC contingency analysis on the P1, P2, P3, P4, P5, P6, P7, and Extreme Events developed by SPP engineering staff and member entities in addition to software selected (N-k) contingencies based on the selection criteria described in the tables above.

Power System Simulation for Engineering (PSS/E) was used as a supplementary tool to verify potential criteria violations discovered in POM and for any additional analysis needed. The SPP PC provided all POM analysis potential violations along with proposed mitigations produced by the Optimal Mitigation Measures (OPM) module to the TPs for review. OPM is a tool used to automatically apply mitigation procedures based on system adjustments that can be used by SPP Operations in real-time.

POM Potential Cascading Modes (PCM) software was used to perform a cascading analysis on a subset of Planning Events that met the tripping threshold criteria, per the Steady State Scope[3], during the contingency analysis. As part of the data requested by SPP, each Transmission Owner submitted a list of equipment that, if lost, would require a year or longer to replace. During the TPL-001-4 assessment, analysis was performed to determine when an entity's spare equipment strategy could result in the

[3] See Appendix for the Scope document

unavailability of long lead time equipment. Standard Corrective Action Plans were developed to mitigate any potential violations found.

The potential violations observed in the analysis and the associated contingencies were provided to the TPs. The TPs reviewed the results for instances where generators would be tripped by a protection system with automatic controls for bus voltages or high side generation step up (GSU) voltages lower than 0.85 p.u.. The TP also reviewed the results for instances where Transmission elements would be tripped by a protection system with automatic controls due to relay loadability limits being exceeded. The TPs reviewed the results from the contingency analysis and concluded that no additional contingencies needed to be studied.

In the cases where TPL-001-4 models did not converge during the POM analysis, the SPP PC separately solved the cases and developed CAPs in conjunction with the TPs to address the potential violations that resulted from these previously non-converged cases. In cases where a CAP was unable to be developed prior to the need date, the contingency is to be evaluated as a potential System Operating Limit (SOL) in accordance with FAC-014-2.

1.7: Mitigations and Member Review

All of the potential criteria violations from the POM analysis were sent to the members for review. Each TP was asked to review their respective potential criteria violations identified during the simulations. OPM provided a mitigation plan for many of the potential criteria violations. TPs were asked to provide a Corrective Action Plan to any violation not covered by an OPM mitigation plan, and to provide an alternate mitigation to the OPM mitigation if desired.

This assessment summarizes potential violations discovered on the BES and does not address non-BES facilities. OPM generated mitigations were provided to the TPs for their validation and feedback.

1.8: Entities Involved

The following entities registered with the SPP Regional Entity were included in the TPL-001-4 studies.

Entity Name	Registered Function
American Electric Power (AEPW)	DP,GOP,GO,RP,TOP,TO,TP
East Texas Electric Cooperative (ETEC)	DP,GOP,GO, RP,TO,TP
Tex-La Electric Cooperative of Texas, Inc. (TEXL)	DP,RP,TO,TP
Board of Public Utilities (BPU)	DP,GO,GOP,RP,TO,TOP,TP
City Utilities of Springfield, MO (SPRM)	DP,GOP,GO,RP,TOP,TO,TP
Grand River Dam Authority (GRDA)	DP,GOP,GO,RP,TOP,TO,TP
Independence Power & Light (INDN)	DP,GOP,GO,RP,TOP,TO,TP
ITC Great Plains, LLC (ITCGP)	TOP,TO,TP
Kansas City Power & Light Company (KCPL)	DP,GOP,GO,RP,TOP,TO,TP
Lincoln Electric System (LES)*	DP,GOP,GO,RP,TOP,TO,TP
Midwest Energy, Inc (MIDW)	DP,TOP,TO,TP
Nebraska Public Power District (NPPD)*	DP,GOP,GO,RP,TOP,TO,TP
Oklahoma Gas & Electric Company (OKGE)	DP,GOP,GO,RP,TOP,TO,TP
Oklahoma Municipal Power Authority (OMPA)	DP,RP
Omaha Public Power District (OPPD)*	DP,GOP,GO,RP,TOP,TO,TP
Southwestern Power Administration (SWPA)	BA,RP,TOP,TO,TP
Southwestern Public Service Company (SPS)	DP,GOP,GO,RP,TOP,TO,TP

Sunflower Electric Power Corporation (SECI)	DP,GOP,GO,RP,TOP,TO,TP
The Empire District Electric Company (EDE)	DP,GOP,GO,RP,TOP,TO,TP
Tri-State Generation and Transmission Association Inc. – Transmission (TSGT)*	TO,TOP
Upper Missouri Zone (UMZ)*	DP,GOP,GO,RP,TOP,TO,TP
Basin Electric Power Cooperative (BEPC)	DP, GOP, GO, RP, TO, TP
Corn Belt Power Cooperative (CBPC)	DP, RP, TO, TOP, TP
Heartland Consumers Power District (HCPD)	RP, TO
Missouri River Energy Services (MRES)	GO, GOP, RP, TO
NorthWestern Energy (NWE)	DP, GOP, GO, RP, TO
Western Area Power Administration UGPR (WAPA UGPR)	TOP, TO, TP, RP
Western Area Power Administration RMR (WAPA RMR)	TO, TOP, TP
Westar Energy, Inc. (WR)	DP,GOP,GO,RP,TOP,TO,TP
Western Farmers Electric Cooperative (WFEC)	DP,GOP,GO,RP,TOP,TO,TP

Table 1.5: Entities Included in the study

DP : Distribution Provider
GOP: Generator Operator
GO: Generation Owner
RP: Resource Planner
TOP: Transmission Operator
TO: Transmission Owner
TP: Transmission Planner

*Midwest Reliability Organization (MRO) is the Regional Entity for these entities.

1.9: Results

The mitigations for the potential criteria violations include but are not limited to building new transmission facilities, upgrading existing transmission facilities, and implementing operating measures based on procedures used in real-time operations by the SPP RC. These operational measures include actions such as re-dispatching generation, changing system topology, capacitor bank switching, and removing load from the Transmission system[4].

1.10: TPL-001-4 P0 Planning Events Results (N-0)

The TPL-001-4 models analyzed for the steady state study did result in potential criteria violations under N-0, normal system conditions. Table 1.6 lists a summary of these potential violations.

Season	High Voltage	Low Voltage	Thermal Overloads	Total	Mitigated Findings	Remaining Violations
MDWG 2017 Summer	0	0	0	0	0	0
MDWG 2017 Light Load	7	0	0	7	7	0
MDWG 2021 Summer	0	1	0	1	1	0
MDWG 2026 Summer	0	4	1	5	5	0

[4] As allowed by Table 1 footnote 9 or 12 of the TPL Standard.

ITP 2017 Summer	0	2	1	3	3	0
ITP 2017 Light Load	10	0	0	10	10	0
ITP 2021 Summer	1	1	1	3	3	0

Table 1.6: P0 Potential Violations by Season

1.11: TPL-001-4 P1 and P2 Planning Events Results (N-1)

Table 1.7 displays a summary of potential criteria violations found using the TPL-001-4 Table 1 P1 and P2 Events provided by the TPs and the software selected N-1 contingencies created by POM. These numbers include the potential violations that were mitigated by the TPs and/or the SPP PC. The SPP PC verified the mitigations effectiveness in relieving the potential criteria violations.

Season	High Voltage	Low Voltage	Thermal Overloads	Total	Mitigated Findings	Remaining Violations
MDWG 2017 Summer	287	259	36	582	582	0
MDWG 2017 Light Load	1709	47	22	1778	1778	0
MDWG 2021 Summer	1182	655	39	1876	1876	0
MDWG 2026 Summer	910	648	82	1640	1640	0
ITP 2017 Summer	83	95	95	273	273	0
ITP 2017 Light Load	7	0	15	22	22	0
ITP 2021 Summer	8	58	61	127	127	0

Table 1.7: P1 and P2 (N-1) Potential Violations by Season

1.12: TPL-001-4 P3, P4, P5, P6, and P7 Planning Events Results

Table 1.8 displays a summary of potential criteria violations found using the TPL-001-4 Table 1 P3, P4, P5, P6, and P7 Events and the software selected N-1-1 contingencies created by POM. These numbers include the potential violations that were mitigated by the TPs in addition to the violations which were automatically mitigated by Optimal Mitigation Measures (OPM). The SPP PC verified the mitigations effectiveness in relieving the potential criteria violations.

Season	High Voltage	Low Voltage	Thermal Overloads	Total	Mitigated or Assessed Findings	Remaining Violations
MDWG 2017 Summer	742	1379	1018	3139	3139	0
MDWG 2017 Light Load	4103	190	288	4581	4581	0
MDWG 2021 Summer	2323	1653	698	4674	4674	0
MDWG 2026 Summer	1430	2387	1387	5204	5204	0
ITP 2017 Summer	118	552	568	1238	1238	0
ITP 2017 Light Load	214	35	132	381	381	0
ITP 2021 Summer	55	570	431	1056	1056	0

Table 1.8: TPL-001-4 Table 1 P3, P4, P5, P6, P7 (N-k) Potential Violations by Season

1.13: TPL-001-4 Extreme Events Results

Table 1.9 displays a summary of potential criteria violations found using the TPL-001-4 Table 1 Extreme Events. These numbers include the potential violations that were mitigated by the SPP TPs in addition to the violations that were software mitigated by Optimal Mitigation Measures (OPM). For the Extreme events, TPs reviewed the potential violations and were given the opportunity to review the automatically mitigated OPM mitigations. All events, including Extreme events, which led to potential cascading were mitigated.

Season	High Voltage	Low Voltage	Thermal Overloads	Total
MDWG 2017 Summer	10	85	98	193
MDWG 2017 Light Load	101	3	41	145
MDWG 2021 Summer	12	196	81	289
MDWG 2026 Summer	77	281	134	492
ITP 2017 Summer	0	36	50	86
ITP 2017 Light Load	3	0	23	26
ITP 2021 Summer	0	29	26	55

Table 1.9: TPL-001-4 Table 1 Extreme Events Potential Violations by Season

1.14: TPL-001-4 Cascading Results

Table 1.10 displays a summary of potential cascading violations found using the TPL-001-4 Table 1 Events. These numbers include the violations which were mitigated by the SPP TPs in addition to the violations that were software mitigated by Optimal Mitigation Measures (OPM). All events, including Extreme events, which led to potential cascading were mitigated.

Season	Potential for Cascading	Mitigated Findings	Remaining Violations
MDWG 2017 Summer	23	23	0
MDWG 2017 Light Load	10	10	0
MDWG 2021 Summer	24	24	0
MDWG 2026 Summer	35	35	0
ITP 2017 Summer	10	10	0
ITP 2017 Light Load	0	0	0
ITP 2021 Summer	7	7	0

Table 1.10: TPL Potential Cascading Results

1.15: TPL-001-4 Long Lead Time Results

Table 1.11 displays a summary of contingencies that simulate outages of equipment that has a long lead time for replacement. The contingencies are listed per season with potential violations found, and mitigations applied.

Season	Contingencies	Violations	Mitigated Findings	Remaining Violations
MDWG 2017 Summer	142	38	38	0
MDWG 2017 Light Load	142	226	226	0
MDWG 2021 Summer	142	30	30	0
MDWG 2026 Summer	142	29	29	0
ITP 2017 Summer	22	1	1	0
ITP 2017 Light Load	22	15	15	0
ITP 2021 Summer	22	0	0	0

Table 1.11: Long Lead Time Results

1.16: Totals by Modeling Area

Table 1.12 below summarizes the potential criteria violations by modeling control area. The results show additional detail based on the software selected contingencies in the POM software, which include P1, P2, P3, P4, P5, P6, and P7 events, and also the member submitted P1, P2, P3, P4, P5, P6, P7 and Extreme Events. Each entry below is separated by a "+" symbol. The value on the left of the "+" is a tabulation of the potential violations found in the MDWG cases while the value on the right of the "+" is a tabulation of the potential violations found in the sensitivity cases.

Note that several entities mentioned above in the Entities Involvement Section do not have unique modeled control areas as their facilities are embedded within other SPP member control areas.

Transmission Planner	Area Number	Software Selected	P1, P2 Events	P3, P4, P5, P6, P7 Events	Extreme Events	Total	Mitigated Findings	Remaining Violations
Southwestern Power Administration	515	111 + 22	6 + 0	19 + 1	15 + 0	174	174	0
American Electric Power	520	2747 + 1100	306 + 53	1885 + 492	81 + 4	6668	6668	0
Grand River Dam Authority	523	59 + 3	6 + 3	63 + 8	3 + 0	145	145	0
Oklahoma Gas & Electric Company	524	1072 + 338	40 + 16	255 + 39	20 + 1	1781	1781	0
Western Farmers Electric Cooperative	525	818 + 117	98 + 24	167 + 52	11 + 0	1287	1287	0
Southwestern Public Service Company	526	2431 + 670	514 + 169	4931 + 1135	601 + 81	10532	10532	0
Oklahoma Municipal Power Authority	527	73 + 42	0 + 0	2 + 2	0 + 0	119	119	0
Midwest Energy, Inc.	531	529 + 128	19 + 2	565 + 102	13 + 6	1364	1364	0
Sunflower Electric Power Corporation	534	1786 + 460	108 + 0	1596 + 248	23 + 9	4230	4230	0
Westar Energy, Inc.	536	1064 + 438	663 + 16	891 + 85	48 + 31	3236	3236	0

Transmission Planner	Area Number	Software Selected	P1, P2 Events	P3, P4, P5, P6, P7 Events	Extreme Events	Total	Mitigated Findings	Remaining Violations
Kansas City Power & Light Company	541	336 + 94	3 + 0	44 + 7	13 + 3	500	500	0
Kansas City Board of Public Utilities	542	0 + 0	0 + 0	0 + 0	0 + 0	0	0	0
The Empire District Electric Company	544	100 + 32	3 + 0	94 + 32	3 + 0	264	264	0
Independence Power and Light	545	11 + 0	0 + 0	0 + 0	2 + 0	13	13	0
City Utilities of Springfield, MO	546	20 + 11	4 + 2	8 + 4	0 + 0	49	49	0
Nebraska Public Power District	640	1860 + 260	322 + 15	1339 + 130	76 + 18	4020	4020	0
Western Area Power Administration Rocky Mountain Region	640	0 + 0	0 + 0	0 + 0	0 + 0	0	0	0
Omaha Public Power District	645	25 + 13	5 + 0	57 + 18	20 + 11	149	149	0
Lincoln Electric System	650	2 + 0	0 + 0	6 + 0	0 + 0	8	8	0
Upper Missouri Zone	652	1805 + 439	904 + 77	2946 + 320	96 + 2	6589	6589	0

Table 1.12: Potential Violation Totals by Model Area

1.17: Establishment of SOLs and IROLs

Any potential voltage instability conditions that cannot be adequately mitigated with a Corrective Action Plan were considered to be candidates for potential System Operating Limits (SOLs) that may have a lower rating than the Facility Rating as provided in the SPP MDWG models listed in Table 1.1. SPP did not identify any unstable contingencies that could not be mitigated with a Corrective Action Plan prior to the need date for that condition. Therefore, SPP did not identify any potential facility SOLs that would have ratings lower than the ratings listed in the SPP MDWG models.

In accordance with FAC-014-2, the PC shall identify the subset of SOLs that are also considered Interconnection Reliability Operating Limits (IROLs). SPP followed the process for determining IROLs as provided in the Steady State Scope and did not observe any conditions that warranted the need for an IROL. Therefore, no IROLs were identified.

1.18: Summary

The MDWG models and ITP sensitivity models developed by the SPP PC and member entities represent the power system for the SPP footprint in accordance with MOD-010 and MOD-012. These models did result in potential thermal and voltage violations for normal (N-0) operation under TPL-001-4 Table 1 P0 events. These potential violations were mitigated by operating procedures, capital projects, or modeling corrections determined by the SPP PC and TPs. Complex element lists were developed by the SPP PC and TPs to simulate selected TPL-001-4 Table 1 P1, P2, P3, P4, P5, P6, P7 and Extreme events. These events were studied by the SPP PC along with the software generated (N-1-1) contingency lists created by POM. All potential TPL-001-4 Table 1 P1, P2, P3, P4, P5, P6 and P7 event violations found during the studies were mitigated by operating procedures, capital projects, or modeling corrections determined by the SPP PC and TPs. All potential Extreme event violations were evaluated and reviewed by the SPP PC and TPs. All potential SPP TPL-001-4 violations identified through the TPL evaluation were mitigated as required through the TPL-001-4 Reliability standard.

Section 2: **Stability Planning Assessment**

The objective of this study is to report findings from the 2016 Stability Assessment to support compliance with NERC TPL-001-4 Reliability Standards for future years 2017 and 2026. This report, along with the Near-Term and Long-Term Steady State Assessment and the Near-Term Short Circuit Assessment, fulfills requirements of the TPL-001-4 Standards This report summarizes the potential stability violations anticipated by SPP and the applicable Corrective Action Plans (CAPs) developed by SPP Member Entities and SPP Engineering Staff.

The following terms are used in this report and are defined as follows:

Rotor Angle Stability – refers to the ability of synchronous machines of an interconnected power system to remain in synchronism after being subjected to a disturbance (also known as transient stability). It depends on the ability to maintain/restore equilibrium between electromagnetic torque and mechanical torque of each synchronous machine in the system. Instability that may result occurs in the form or increasing angular swings of some generators leading to their loss of synchronism with other generators.[5]

Oscillation Damping – is an influence within or upon an oscillating system that has the effect of reducing, restricting or preventing its oscillations. In the context of the present study, damping is the decay of disturbance induced rotor angle oscillations and is caused by mechanical energy loss in the generator rotor.

Transient Voltage Stability (Short-term voltage stability) – involves dynamics of fast-acting power system components such as induction motors, electronically controlled loads and HVDC converters. The study period of interest is in the order of several seconds, and analysis requires solutions of appropriate system differential equations; that is similar to the analysis of rotor angle stability. Dynamic modeling of loads is often essential. In contrast to rotor angle stability, short circuits near loads are important.

Cascading - The uncontrolled successive loss of system elements triggered by an incident at any location. Cascading results in widespread electric service interruption that cannot be restrained from sequentially spreading beyond an area predetermined by studies.[6] .[7] SPP uses a MW loss value of 1753 MWs as a set point to trigger additional study of a contingency not mitigated by a CAP. This MW loss value is based on the Reserve Sharing Group definition, which is the sum of the MW value of the largest unit and one half of the second largest unit in the SPP CBA.

2.1: Study Scope and Method

This section summarizes the scope of work performed by SPP, as Planning Coordinator (PC), for the 2016 NERC TPL-001-4 Stability Assessment. The full Scope of Work for the study was approved by the Transmission Working Group (TWG) on August 30, 2016.

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[5] IEEE/CIGRE Joint Task Force on Stability Terms and Definitions, *Definition and Classification of Power System Stability*, IEEE PES Trans. on Power Systems, Vol. 19, No. 2, May 2004.

[6] Glossary of Terms Used in NERC Reliability Standards. [Online], Available: http://www.nerc.com/pa/Stand/Glossary%20of%20Terms/Glossary_of_Terms.pdf

[7] Glossary of Terms Used in NERC Reliability Standards. [Online], Available: http://www.nerc.com/pa/Stand/Glossary%20of%20Terms/Glossary_of_Terms.pdf

The model set in Table 2.1 below establishes category P0 as the normal System condition in TPL-001-4 Table 1, and defines the models that are used for the 2016 TPL Stability analysis.

Description	Base Cases	Sensitivity Cases
Year 1 peak	MDWG 2017S	ITPNT 2017S5
Year 1 off-peak	MDWG 2017L	ITPNT 2017L5
Year 10 peak	MDWG 2026S	N/A

Table 2.1: Study Models

The generation dispatch in the base case models is derived from a member submitted merit order block dispatch. The ITPNT Scenario 5 models, which were chosen for the sensitivity cases, have as much of the firm transmission rights protected as load allows. The wind machines are dispatched considerably higher in the ITPNT Scenario 5 models.

TPL-001-4, Requirement 2.4.1, states that dynamic cases take into account the behavior of induction motors. SPP and their Member companies performed a sensitivity analysis using a generic PSSE load model in a summer peak case in late 2015. The results from this sensitivity analysis indicated the need for additional research regarding the use of a dynamic load models, load specific inputs, and the effects of the of the dynamic load models on the bulk electric system. The research has included partnering with Electric Power Research Institute (EPRI), leveraging their research on the subject matter, active participation in the NERC LMTF, and the formation of an SPP Dynamic Load Task Force (DLTF) in late 2015. The SPP DLTF has developed a set of industrial and agricultural composite load models and performed benchmark testing in PSSE version 32.2. Based on work performed by the DLTF and the LMTF, there were concerns about the performance of the first generation of the composite load model in PSSE version 32. SPP completed the build of its first cases in PSSE version 33.7 and has obtained a beta version of a second generation composite load model from Siemens-PTI to use in PSSE version 33.7. The benchmarking of this second generation composite load model and development of residential and commercial composite load models is an ongoing task for the DLTF. Once these items have been thoroughly vetted, SPP and it Members will have a composite model representation taking into account residential, commercial, agricultural, and industrial.

The SPP areas included in this assessment are shown below in Table 2.2:

Area Number	Entity Name
520	American Electric Power (AEPW)
542	Board of Public Utilities (BPU)
546	City Utilities of Springfield, MO (SPRM)
523	Grand River Dam Authority (GRDA)
545	Independence Power & Light (INDN)
NA	ITC Great Plains, LLC (ITCGP)
541	Kansas City Power & Light Company (KCPL)
540	KCPL - Greater Missouri Operations (KCPL-GMO)
650	Lincoln Electric System (LES)
531	Midwest Energy, Inc (MIDW)

Area Number	Entity Name
640	Nebraska Public Power District (NPPD)
524	Oklahoma Gas & Electric Company (OKGE)
527	Oklahoma Municipal Power Authority (OMPA)
645	Omaha Public Power District (OPPD)
515	Southwestern Power Administration (SWPA)
526	Southwestern Public Service Company (SPS)
534	Sunflower Electric Power Corporation (SECI)
544	The Empire District Electric Company (EDE)
652	Upper Missouri Zone (UMZ)
	Basin Electric Power Cooperative (BEPC)
	Corn Belt Power Cooperative (CBPC)
	Heartland Consumers Power District (HCPD)
	Missouri River Energy Services (MRES)
	NorthWestern Energy (NWE)
	Western Area Power Administration UGPR (WAPA UGPR)
536	Westar Energy, Inc. (WR)
525	Western Farmers Electric Cooperative (WFEC)

Table 2.2: SPP Assessment Areas

Fast Fault Screening: A Fast Fault Screening analysis of the SPP Transmission System was performed on all cases shown in Table 2.1. V&R Energy's Fast Fault Scan (FFS) tool was used to determine category P1 and P6 events above 100 kV. The screening produced a list of potential locations of concern, their ranking, and fault sequences for potential category P1 and P6 contingencies.

V&R Energy's FFS tool screens potential transmission fault locations for grid stability analysis and quickly identifies the most severe fault locations and ranks them in the order of severity. The tool begins by identifying the most severe fault locations, above 100 kV, which are considered the weaker points in the network. Faults at each of the identified locations are then ranked according to severity using a Ranking Index (RI) for the loss of lines, transformers, or generators according to TPL-001-4 at each ranked bus. SPP classifies fault severity according to the Ranking Index (RI) and the Critical Clearing Time (CCT).

Once the RI is known, the CCT is computed. The CCT is the maximum time during which a disturbance can be applied without generator units losing transient stability. The RI and CCT are used as metrics to determine fault locations that merit further examination.

Transient stability analysis was performed on ranked contingencies having a critical clearing time of less than nine (9) cycles using the ranked bus, CCT and the "outaged branch" identified in the FFS. The FFS identified the fault bus and associated "outaged branches;" however, the fault sequence was determined by SPP, as follows:

Category P1: Apply a three-phase fault at the ranked bus for a time span of CCT cycles, open the "outaged branch," and clear the fault.

Category P6: Open the first "outaged branch" and allow steady state system adjustments. Apply a three-phase fault at the ranked bus for a time span of CCT cycles, open the second "outaged branch," and clear the fault.

Dynamic Assessment of Member Specified Events: SPP members provided SPP Staff with reliability events for transient stability performance analysis. A transient stability analysis was performed for all member submitting events for all Table 2.1 cases. Some events required a change in generation differing from that amount in the powerflow models based on the member submitted contingency. In such cases, when possible, an offset amount was included within the member modeling area to balance generation prior to or during the event simulation. If sufficient generation was not available within the modeling area, any generation within 10 buses away from the outaged generator was used to make up the generation deficiency.

The contingency list provided by SPP members can be provided upon request.

Dynamic Assessment of Coordinated Events with Tier 1 Entities: Contingencies on systems adjacent to SPP may impact the SPP system and vice versa. Coordination with adjacent PCs must, therefore, be accomplished. SPP requested that adjacent systems provide events for the SPP study. A transient stability analysis was performed using PLI TSAT for all received events for all Table 2.1 cases.

A summary of contingencies provided by Tier 1 Entities can be provided upon request.

Dynamic Assessment of Breaker-to-breaker Contingencies: SPP Staff gathered system breaker-to-breaker data to formulate contingencies that emulate actual field responses to faults. Since faults on line segments between breakers normally cause the line-end terminal breakers to open all line sections, end-to-end de-energization is required during the simulation. The member submitted steady state P1.2 contingencies are representative of line section de-energization. A transient stability analysis was performed for all cases shown in Table 2.1 for the formulated breaker-to-breaker contingencies. Powertech Labs, Inc.'s DSATools TSAT was used for the analysis.

A list of breaker-to-breaker contingencies can be provided upon request

Assessment of Possible Cascading Due to Transient Instability: Category P1 through P7 and Extreme contingency events that produced the more severe system impacts were evaluated for cascading. A loss of synchronism as a result of an outaged element is the initiating mechanism for purposes of this assessment. A cascading analysis was performed on all cases shown in Table 2.1 using V&R Energy's Fast Fault Scan (FFS) and Potential Cascading Modes (PCM) tools. This analysis determined possible cascading due to transient instability within the SPP System.

The FFS tool was first used to determine the most severe category P1 fault locations (fault is placed near the bus on each branch to be outaged) within the system. The identified fault locations were ranked in order of decreasing severity (1 being the most severe) using a ranking index. The bus fault and associated outaged branch were then used as the initiating event in the PCM tool to determine possible cascading, meaning a criteria violation (loss of 1753 MW) had occurred. A criteria violation would merit further analysis.

Second, Category P2 through P7 and Extreme events were evaluated for potential cascading, as well. Any loss of MW due to generator instabilities for these events was evaluated against the 1753 MW criteria. A criteria violation would merit further analysis.

Mitigation of Unstable/Cascading Events: SPP Staff worked with SPP Members and adjacent entities to determine Corrective Action Plans (CAPS) for events found to be unstable or that resulted in cascading to ensure the proposed CAPS would, by implementation, provide system stability.

2.2: Performance Requirements

Twenty (20) second time domain simulations are performed for all events described in later sections of this report using Siemens' PTI's PSS/E Rev 33.7 and the PSSPLT plotting package and PowerTech Labs' DSATools TSAT (breaker-to-breaker events). As the simulations occur, the following are monitored and recorded to determine stability:

Rotor angle stability was monitored for all generators in the SPP PC footprint. Those units that exhibited signs of instability were marked for further analysis, and should CAPS be necessary, the member entity was engaged to determine the necessary CAP.

Rotor angle oscillation damping was monitored for those generators monitored for rotor angle stability. The damping curves were judged against the SPPR1 and SPPR5 criteria as described in the *SPP Disturbance Performance Requirements*. Those units that violated the criteria were identified for further analysis and, should CAPs be necessary, the member entity was engaged to determine the necessary CAP.

Transient voltage stability was monitored for BES buses up to ten (10) buses away from the disturbance (fault) location. The voltage responses were judged against the $.7 < V_{transient} < 1.2$ p.u. criteria, as described in the *SPP Disturbance Performance Requirements*. Those units that violate the transient voltage criteria were marked for further analysis and should CAPS be necessary, the member entity was engaged to determine the necessary CAP.

Generator Voltage Ride Through Capability was monitored for BES buses up to ten (10) buses away from the disturbance (fault) location. Assumed low voltage ride through capability is for all generators to comply with Attachment 2 of PRC-024-2. For generator points of interconnection that do not meet PRC-024-2 requirements, these generators are assumed to trip on low voltage. Simulations were performed again with the tripping of generators enabled. This meets the requirements of TPL-001-4 R4.3.1.2. PRC-024-2 requirements are listed below.

Generator Voltage Ride Through Duration	
Voltage (pu)	Time (S)
<0.45 pu	0.15
<0.65 pu	0.3
<0.75 pu	2.00
≥1.2 pu	Instantaneous trip
≥1.175 pu	0.20
≥1.15 pu	0.50
≥1.10 pu	1.00

Cascading - Potential cascading due to a fault event and subsequent rotor angle instability was determined for NERC category P1-P7 and Extreme events. The criteria for an event resulting in *potential* cascading is the loss of more than 1,753 MW of generation based on SPP operating reserve. Those events violating these criteria were identified as a possible cascading event for further analysis and, should CAPS be necessary, the member entity was engaged to determine the necessary CAP.

2.3: Results - Fast Fault Screening and Dynamic Assessment (Results)

The 29 locations (buses) of concern were identified and ranked according to their Ranking Index (RI) and Critical Clearing Time (CCT) for NERC P1 and P6 contingencies by using V&R Energy FFS tool. Those ranked locations with a CCT less than 9 cycles were identified for time domain analysis utilizing PSS/E. A list of the PSSE time domain analysis results for the locations identified were sent to the Members to verify the field clearing time. All of the potential issues identified by FFS were mitigated by verifying that the field clearing time was less than the CCT verified using PSSE, by utilizing an existing operating guide, or by utilizing member submitted corrective action plans (CAPs).

2.4: Results - Dynamic Assessment of Member Specified Events (Results)

Members provided a total of 2,349 events for study according in the following categories:

Category	Number of Events
P1	630
P2	108
P3	105
P4	582
P5	201
P6	303
P7	96
Extreme	324

Table 2.3: Member Submitted Events by Category

Transient stability analysis was performed on the above events using PSS/E's dynamics package. There were 7 events that did not meet "SPP Transient Stability Requirements" shown below in Table 2.4. All of these deficiencies were verified and addressed by CAPs submitted by the members and were verified using PSSE time domain simulations.

Event	Owner	Model	Criteria	Corrective Action Plan
FAULT__EMDE-All-37-P2_2-HOC4045	EMDE	2017S	Rotor Angle Stability	CAP received and verified by SPP
FAULT__GRDA-All-70-P5_5-CLARMR5	GRDA	2017S	Transient Voltage	CAP received and verified by SPP
FAULT__SPS-All-59-P5_5-DEAFSMITH6	SPS	2017S	Transient Voltage	CAP received and verified by SPP
FAULT__EMDE-All-37-P2_2-HOC4045	EMDE	2026S	Rotor Angle Stability	CAP received and verified by SPP
FAULT__GRDA-All-70-P5_5-CLARMR5	GRDA	2026S	Transient Voltage	CAP received and verified by SPP

FAULT__SPS-All-59-P5_5-DEAFSMITH6	SPS	2026S	Transient Voltage	CAP received and verified by SPP
FAULT__WFEC-All-72-P4-MOORLND4	WFEC	2026S	SPPR1/SPPR5	CAP received and verified by SPP

Table 2.4: Stability Results for Member-Submitted Events

2.5: Dynamic Assessment of Coordinated Events with Tier 1 Entities (Results)

A list of 1,564 Tier 1 contingencies were received from a neighboring Planning Coordinator. Theses contingences were simulated using TSAT. The TSAT simulation results were verified against the "SPP Transient Stability Requirements" and there were no deficiencies identified.

Entity Providing	Number
AECI-AEPW	82
SAS	232
CLECO	642
ETEC	19
GRDA	83
KCPL	10
MISO	124
ITCGP	21

Table 2.5: Tier 1 Entity provided contingency summary

2.6: Dynamic Assessment of Breaker to Breaker Contingencies (Results)

A list of 2,086 breaker-to-breaker contingencies were derived from the member submitted P1.2 Planning Events for the Steady State assessment. Transient stability analysis was performed using TSAT for all models shown in Table 2.1. The TSAT simulation results were verified against the "SPP Transient Stability Requirements" and there were no deficiencies identified.

2.7: Assessment of Possible Cascading Due to Transient Instability (Results)

Category P1 through P7 and Extreme contingency events that produced the more severe system impacts were evaluated for cascading. A loss of synchronism as a result of the outage of an element is the initiating mechanism for purposes of this assessment for an extreme contingency or P1 through P7 event not being mitigated through the use of a CAP. SPP received CAPs for all P1 through P7 contingencies, and therefore there were no initiating events of these types to be assessed for potential cascading. A cascading analysis was performed on the extreme contingency shown in Table 2.1 because the bus fault and associated branch outages were then used as the initiating event in a PSSE time domain simulation to determine possible cascading, meaning a criteria violation (loss of 1753 MW) had occurred. Due to the limitations V&R Energy's Potential Cascading Modes (PCM) tools simulating an extreme fault, SPP conducted additional sensitivities using PSSE to understand the extent of the loss of generation. This analysis determined possible cascading due to transient instability within the SPP System and this information was communicated to the member company. The member company has also performed a detailed analysis of the event and understands how the system will react to the extreme event.

Event	Owner	Model	Criteria	Remarks
FAULT__AEPW-All-21-Extreme_2_d-DIANA734500	AEP	2017S and 2026S	Cascading	SPP performed sensitivity runs to understand the extent of the loss of generation. This has been communicated to the Owner.

Table 2.6: Assessment of Potential Cascading Modes

2.8: Establishment of SOLs and IROLs

Any unstable conditions that cannot be adequately mitigated with a Corrective Action Plan were considered to be candidates for potential reduction of System Operating Limits (SOLs) from the MDWG models shown in Table 2.1. SPP did not identify any unstable contingencies that could not be mitigated with a Corrective Action Plan prior to the need date for that condition. Therefore, SPP did not identify any potential facility SOLs that would have ratings lower than the ratings listed in the SPP MDWG.

In accordance with FAC-014-2, SPP shall identify the subset of SOLs that are also considered Interconnection Reliability Operating Limits (IROLs). Since no potential reductions of SOLs were identified, no potential IROLs were found to be necessary.

2.9: Conclusion

SPP's TPL-001-4 Stability Assessment identified system deficiencies that were mitigated by applying and verifying that the member submitted CAPs corrected them. The potential issues found during the FFS scan were based on Critical Clearing Times (CCT) developed during the FFS simulation. All of the potential FFS issues were mitigated by ensuring that the field clearing time was less than the CCT verified using PSSE or by a member submitted corrective action plan (CAP). There were 18 member submitted contingencies that were deficient in meeting the "SPP Transient Stability Requirements". All of these deficiencies were verified and addressed by CAPs submitted by the members and were verified using PSSE time domain simulations. One Member submitted Extreme contingency met the potential cascading threshold of 1753 MWs of loss generation in the MDWG cases. All other P1-P7 contingencies did not result in the loss of more than 1753 MWs and were mitigated with member submitted CAPs. The breaker-to-breaker and tier run contingencies were simulated using TSAT. The TSAT results were verified against the "SPP Transient Stability Requirements" and there were no deficiencies identified.

Section 3: **Short Circuit Planning Assessment**

The objective of this section is to report findings from the 2016 Short Circuit Assessment to support compliance with NERC TPL-001-4 Reliability Standards for future year 2017. This report, along with the Near-Term and Long-Term Steady State Assessment and the Near-Term and Long-Term Stability Assessment, fulfills requirements of the TPL-001-4 Standards This report summarizes the potential short circuit violations anticipated by SPP and the applicable Corrective Action Plans (CAPS) developed by SPP Member Entities and SPP Engineering Staff.

The goals of this assessment are:

1. Determine whether circuit breakers have interrupting capability for Faults that they will be expected to interrupt. (R2.3)
2. Report Corrective Action Plans (CAPs) to address potential Equipment Rating violations. (R2.8)

This assessment focuses on transmission facilities in the SPP footprint, and summarizes potential criteria violations and the associated CAPs developed by Transmission Planners (TPs) and the SPP PC. Short Circuit analysis revealed thirty-four (34) potential violations in the model studied for the assessment. Corrective Action Plans were developed to mitigate any potential violations as detailed in this report.

3.1: Models

The 2016 SPP Model Development Working Group (MDWG) short circuit models reflect system conditions for the Near-Term Transmission Planning Horizon. These models are updated by TPs to reflect the most current information using the Model On Demand (MOD) program. The SPP 2016 Series MDWG Final Short Circuit Maximum Fault Models were used in the 2016 TPL-001-4 Planning Assessment as reflected in Table 3.1.

Model Scope	Seasonal Assessment	Model Used	Model Released	Assessment Completed
Near Term	2017 Summer Peak	2016MDWGFINALSC_Classical_MAX_FAULT-17S	April 2016	November 2016

Table 3.1: Models used in TPL-001-4 short circuit assessment

3.2: TPL-001-4 Short Circuit Study

Analysis results on the SPP 2016 MDWG Final Short Circuit Maximum Fault models used for the PC assessment were provided to TPs. The TPs were also provided the option to perform their own short circuit analysis in lieu of the PC provided results.

3.3: Simulation

Fault current values were determined for each bus modeled in SPP model areas using Power System Simulation for Engineering (PSS/E) activities Automatic Sequencing Fault Calculation (ASCC) and ANSI fault current calculation (ANSI) for Single Line to Ground and Three Phase faults. Results from both activities included system intact faults and activity ASCC also included Line Out faults.

3.4: Corrective Action Plans and Member Review

The TPs evaluated the applicable results and provided necessary CAPs to the PC. The PC verified validity of the TP submitted CAPs.

3.5: Entities Involved

The following entities registered with the SPP Regional Entity and Midwest Reliability Organization were included in the TPL-001-4 studies.

Entity Name	Registered Function
American Electric Power (AEPW)	DP,GO,GOP, RP,TO,TOP,TP
East Texas Electric Cooperative (ETEC)	DP,GO,GOP,RP,TO,TP
Tex-La Electric Cooperative of Texas, Inc. (TEXL)	DP,RP,TO,TP
Board of Public Utilities (BPU)	DP,GO,GOP,RP,TO,TOP,TP
City Utilities of Springfield, MO (SPRM)	DP,GO,GOP,RP,TO,TOP,TP
Grand River Dam Authority (GRDA)	DP,GO,GOP,RP,TO,TOP,TP
Independence Power & Light (INDN)	DP,GO,GOP,RP,TO,TOP,TP
ITC Great Plains, LLC (ITCGP)	TO,TOP,TP
Kansas City Power & Light Company (KCPL)	DP,GO,GOP,RP,TO,TOP,TP
Lincoln Electric System (LES)*	DP,GO,GOP,RP,TO,TOP,TP
Midwest Energy, Inc. (MIDW)	DP,LSE,TO,TOP,TP
Nebraska Public Power District (NPPD)*	DP,GO,GOP,RP,TO,TOP,TP
Oklahoma Gas & Electric Company (OKGE)	DP,GO,GOP,RP,TO,TOP,TP
Oklahoma Municipal Power Authority (OMPA)	DP,GO,GOP,RP
Omaha Public Power District (OPPD)*	DP,GO,GOP,RP,TO,TOP,TP
Southwestern Power Administration (SWPA)	BA,RP,TO,TOP,TP
Southwestern Public Service Company (SPS)	DP,GO,GOP,RP,TO,TOP,TP
Sunflower Electric Power Corporation (SECI)	DP,GO,GOP,RP,TO,TOP,TP
The Empire District Electric Company (EDE)	DP,GO,GOP,RP,TO,TOP,TP
Tri-State Generation and Transmission Association Inc. – Transmission (TSGT)*	TO,TOP
Western Area Power Administration UPGR (WAPA UPGR)*	DP,GO,GOP,RP,TO,TOP,TP
Upper Missouri Zone (UMZ)*	
Basin Electric Power Cooperative (BEPC)*	DP, GOP, GO, RP, TO, TP
Corn Belt Power Cooperative (CBPC)*	DP, RP, TO, TOP, TP
Heartland Consumers Power District (HCPD)*	RP, TO
Missouri River Energy Services (MRES)*	GO, GOP, RP, TO
NorthWestern Energy (NWE)*	DP, GOP, GO, RP, TO
Western Area Power Administration UGPR (WAPA UGPR)*	TOP, TO, TP, RP
Western Area Power Administration RMR (WAPA RMR)*	TO, TOP, TP
Westar Energy, Inc. (WR)	DP,GO,GOP,RP,TO,TOP,TP
Western Farmers Electric Cooperative (WFEC)	DP,GO,GOP,RP,TO,TOP,TP

Table 3.2: Entities included in the TPL-001-4 Short Circuit Assessment

DP : Distribution Provider
GO: Generation Owner
GOP: Generator Operator
RP: Resource Planner
TO: Transmission Owner
TOP: Transmission Operator
TP: Transmission Planner

*Midwest Reliability Organization (MRO) is the Regional Entity for these entities.

3.6: Study Results

CAPs to address potential violations consisted of the following:

- Replace circuit breakers in the course of normal budgeting and project planning.
- Temporarily relocate line terminal to higher rated transfer breaker until breaker replacement is complete.
- Add a trip from the relay which will isolate the equipment in the event of a fault.
- Add a block trip from the relay that will not allow the circuit switchers to open when the fault current is above their rating. The fault will be cleared by opening the breakers in the high voltage substation.

3.7: Potential Violations

The SPP 2016 MDWG Final Short Circuit Maximum Fault models used for the short circuit study did result in potential violations. Table 3.3 lists a summary of these potential violations.

Season	Total Violations	Mitigated Findings	Remaining Violations
2017 Summer	34	34	0

Table 3.3: TPL-001-4 Potential Violations

3.8: Totals by Modeling Area

Table 3.4 below summarizes the potential violations by modeling area. Note that several TPs do not have unique modeling areas as their transmission facilities are embedded within other SPP modeling areas.

Transmission Planner	Area Number	Total Violations	Mitigated Findings	Remaining Violations
Southwestern Power Administration	515	0	0	0
American Electric Power	520	0	0	0
Grand River Dam Authority	523	0	0	0
Oklahoma Gas & Electric Company	524	6	6	0

Transmission Planner	Area Numb er	Total Violations	Mitigated Findings	Remaining Violations
Western Farmers Electric Cooperative	525	0	0	0
Southwestern Public Service Company	526	12	12	0
Oklahoma Municipal Power Authority	527	0	0	0
Midwest Energy, Inc.	531	0	0	0
Sunflower Electric Power Corporation	534	0	0	0
Westar Energy, Inc.	536	2	2	0
Kansas City Power & Light Company	541	6	6	0
Kansas City Board of Public Utilities	542	0	0	0
The Empire District Electric Company	544	1	1	0
Independence Power and Light	545	0	0	0
City Utilities of Springfield, MO	546	0	0	0
Nebraska Public Power District	640	7	7	0
Western Area Power Administration Rocky Mountain Region	640	0	0	0
Omaha Public Power District	645	0	0	0

Transmission Planner	Area Number	Total Violations	Mitigated Findings	Remaining Violations
Lincoln Electric System	650	0	0	0
Upper Missouri Zone	652	0	0	0

Table 3.4: Potential Violation Totals by Model Area

3.9: Summary

The MDWG models developed by the SPP RTO and its Members represent the power system for the SPP PC. These models identified potential equipment rating violations. These potential equipment rating violations were mitigated by replacing fault current interrupting devices determined by the SPP PC and TPs. All SPP TPL-001-4 potential violations identified through the short circuit assessment were mitigated as required through the TPL-001-4 Reliability standard.

Section 4: **Conclusion**

This document includes NERC TPL-001-4 and FAC-014-2 Standard compliance assessments for the Southwest Power Pool (SPP) Planning Coordinator (PC). An objective of the 2016 Steady State, Stability, and Short Circuit Planning Assessments is to report findings from the 2016 Steady State, Stability, and Short Circuit Planning studies in support of SPP's compliance, as a PC, with NERC TPL-001-4 Reliability Standard.

For the TPL-001-4 Steady State, Stability, and Short Circuit Assessments, a number of potential violations were observed. Corrective Action Plans that satisfied all potential criteria violations were developed and tested by the Transmission Planners (TPs) and the SPP PC.

For adherence to FAC-014-2, SPP will post to Tru-Share a link to all System Operating Limits (SOLs). All facility ratings that were potentially violated in the TPL-001-4 Assessment were mitigated by Corrective Action Plans developed and tested by the SPP PC or SPP TPs. The TPL-001-4 Assessment did not identify any SOLs that should be lower than the applicable Facility Ratings as identified in SPP's Model Development Working Group (MDWG) powerflow models. Additionally, no Interconnection Reliability Operating Limits (IROLs) identified for the planning horizon.

Section 5: 2016 TPL-001-4 Steady State Scope

Section 6: **2016TPL-001-4 Stability Scope**

Section 7: **2016 TPL-001-4 Short Circuit Scope**