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## Revision History

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Date	Author	Change Description
11/11/2014	SPP staff	Initial Draft
12/3/2014	SPP staff	Updated formatting and numbers in embedded tables.
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## Section 1: Purpose

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The objective of the 2014 Steady State Planning Assessment (assessment) is to report findings from the 2014 TPL steady state planning studies in support of SPP's compliance, as a Planning Coordinator (PC), with NERC TPL-001-0, TPL-002-0, TPL-003-0, and TPL-004-0 Reliability Standards.

The goals of this Planning Assessment are:

1. To identify overloaded branches/transformers (>100% of rate A) under normal conditions. (NERC Category A)
2. To identify potential branch/transformer violations (>100% of rate B) due to the loss of a single element. (NERC Category B)
3. To identify potential branch/transformer violations (>100% of rate B) due to the loss of two elements. (NERC Category C)
4. To identify potential branch/transformer violations (>100% of rate B) due to extreme events. (NERC Category D)
5. To identify voltage performance (0.95 pu - 1.05 pu)<sup>1</sup> under normal conditions. (NERC Category A)
6. To identify potential voltage violations (0.9 pu – 1.05 pu)<sup>1</sup> due to the loss of a single element. (NERC Category B)
7. To identify potential voltage violations (0.9 pu – 1.05 pu)<sup>1</sup> due to the loss of two elements. (NERC Category C)
8. To identify potential voltage violations (0.9 pu – 1.05 pu)<sup>1</sup> due to extreme events. (NERC Category D)

This assessment focuses on facilities 100 kV and above in the SPP footprint, and summarizes potential criteria violations anticipated by the SPP PC and the mitigation plans developed by Transmission Planners (TPs) and the SPP PC to address the aforementioned potential criteria violations.

The SPP PC monitored the 69 kV system in the SPP footprint; however, the assessment did not require mitigations for violations found on the 69 kV system.

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<sup>1</sup> SPP Criteria 3.3

## Section 2: Models

The 2014 SPP Model Development Working Group (MDWG) power flow models reflect system conditions for selected years/seasons between year 2014 and year 2025. These models are updated by TPs to reflect the most current information using the Model On Demand (MOD) program. The SPP 2014 Series MDWG Final Powerflow Models were used in the 2014 TPL planning studies as reflected in Table 2.1.

Model Scope	Seasonal Assessment	Model Used	Model Released	Assessment Completed
Near Term	2015 Summer Peak	2014MDWG_FINAL-15S	April 2014	December 2014
Near Term	2015 Fall	2014MDWG_FINAL-15F	April 2014	December 2014
Near Term	2015 Winter	2014MDWG_FINAL-15W	April 2014	December 2014
Near Term	2016 Spring	2014MDWG_FINAL-16G	April 2014	December 2014
Near Term	2016 Summer Peak	2014MDWG_FINAL-16S	April 2014	December 2014
Near Term	2020 Summer Peak	2014MDWG_FINAL-20S	April 2014	December 2014
Long Term	2025 Summer Peak	2014MDWG_FINAL-25S	April 2014	December 2014
Long Term	2025 Winter	2014MDWG_FINAL-25W	April 2014	December 2014

*Table 2.1: Models used in TPL studies*

## Section 3: Studies

### **3.1: TPL-001-0 Study (N-0)**

Analysis on the SPP 2014 MDWG Final models used for the SPP PC Planning Assessment did result in potential thermal and voltage violations under N-0, normal system conditions. These potential violations were mitigated by operating procedures, capital projects, or modeling corrections determined by the SPP PC and TPs.

### **3.2: TPL-002-0 Study (N-1)**

The multi-terminal outages (i.e. complex elements) considered for system evaluation under Category B were compiled by the SPP RTO with input from stakeholders and member entities. Additional automatically selected (N-1) elements were programmatically selected according to the conditions found in Table 3.1.

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

*Table 3.1: N-1 Elements Selected*

### **3.3: TPL-003-0 Study (N-2)**

The complex elements considered for system evaluation under Category C were compiled by the SPP RTO with input from stakeholders and member entities. Additionally, the automatically selected (N-1) elements studied for TPL-002-0 were paired to form automatically selected (N-2) contingencies for the TPL-003-0 study. The pairs of automatically selected N-1 elements were chosen according to the conditions found in Table 3.2. *\*Branch represents both branch and transformer elements.*

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

*Table 3.2: N-2 Elements Selected*

### **3.4: TPL-004-0 Study (Extreme Events)**

The complex elements considered for system evaluation under Category D were compiled by the SPP RTO with input from stakeholders and member entities as seen in Table 3.3.

Element	Selection Rule	Source
Extreme Events	---	SPP Staff and Member Entities

*Table 3.3: Extreme Events Selected*

### **3.5: Simulation**

Physical and Operational Margins (POM) software was used to perform an AC contingency analysis on the Category B, C, and D contingencies developed by SPP engineering staff and member entities in addition to automatically 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 for potential criteria violation verification and any additional analysis needed. The SPP PC presented to the TPs, for review, all the potential criteria violations along with proposed mitigations produced by the Optimal Mitigation Measures (OPM) module. OPM is a tool used to automatically apply mitigation procedures based on operating measures, system adjustments, used by SPP Operations in real-time.

### **3.6: Mitigations and Member Review**

All of the potential SPP criteria violations 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 mitigation plan to any violation not covered by an OPM mitigation plan, and to provide an alternate mitigation to the OPM mitigation if desired.

While the SPP PC simulations monitored the SPP footprint for 69 kV and above, this assessment only summarizes potential violations on 100 kV and above buses. TPs were given the opportunity to provide mitigations for 60 kV – 100 kV potential criteria violations. OPM generated mitigations were also provided to the TPs for their validation and feedback.



## Section 4: Entities Involved

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

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

*Table 4.1: Entities Included in the study*

DP : Distribution Provider

GOP: Generator Operator

GO: Generation Owner

LSE: Load Serving Entity

PSE: Purchasing-Selling Entity

TOP: Transmission Operator

TO: Transmission Owner

TP: Transmission Planner

RP: Resource Planner

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

## Section 5: 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<sup>2</sup>.

### 5.1: TPL-001-0 Study (N-0)

The SPP 2014 MDWG Final models used for the steady state study did result in potential criteria violations under N-0, normal system conditions. Table 5.1 lists a summary of these potential violations.

Season	High Voltage	Low Voltage	Thermal Overloads	Total	Mitigated Findings	Remaining Violations
2015 Summer	0	3	0	3	3	0
2015 Fall	1	0	0	1	1	0
2015 Winter	0	1	0	1	1	0
2016 Spring	0	1	0	1	1	0
2016 Summer	0	12	0	12	12	0
2020 Summer	0	2	0	2	2	0
2025 Summer	0	11	4	15	15	0
2025 Winter	0	7	0	7	7	0

Table 5.1: TPL 001 Potential Violations by Season

### 5.2: TPL-002-0 Study (N-1)

Table 5.2 lists a summary of potential criteria violations found using the Category B complex element list provided by the TPs and the automatically selected N-1 list by POM. These numbers include the violations which were mitigated by the TPs and/or the SPP PC. The SPP PC verified the mitigations effectiveness in relieving the potential criteria violations. *\*automatically selected + TP submitted*

Season	High Voltage	Low Voltage	Thermal Overloads	Total	Mitigated Findings	Remaining Violations
2015 Summer	79+5	105+42	19+3	253	253	0
2015 Fall	75+31	76+17	6	205	205	0
2015 Winter	96+9	46+1	4	156	156	0
2016 Spring	94+10	47+12	7	170	170	0
2016 Summer	105+22	48+15	26+6	222	222	0

<sup>2</sup> As allowed under TPL Standards under Table 1 footnote b.

2020 Summer	54+5	128+34	68+6	295	295	0
2025 Summer	56+4	236+42	164+12	514	514	0
2025 Winter	84+9	293+20	29+1	436	436	0

Table 5.2: TPL 002 (N-1) Potential Violations by Season

### **5.3: TPL-003-0 Study (N-2)**

Table 5.3 displays a summary of potential criteria violations found using the Category C complex element list and the automatically selected N-2 list created by POM. These numbers include the violations which 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. *\*automatically selected + TP submitted*

Season	High Voltage	Low Voltage	Thermal Overloads	Total	Mitigated or Assessed Findings	Remaining Violations
2015 Summer	402+9	3046+64	1482+26	5029	5029	0
2015 Fall	531+67	2110+8	278+3	2997	2997	0
2015 Winter	485+20	2294+3	279+3	3084	3084	0
2016 Spring	414+2	2038+6	510+7	2977	2977	0
2016 Summer	372+6	2650+60	1462+29	4579	4579	0
2020 Summer	748+8	2419+58	1793+23	5049	5049	0
2025 Summer	1233+15	2810+67	2427+91	6643	6643	0
2025 Winter	1386+16	2225+22	320+3	3972	3972	0

Table 5.3: TPL 003 (N-2) Potential Violations by Season

### **5.4: TPL-004-0 Study (Extreme Events)**

Table 5.4 displays a summary of potential criteria violations found using the Category D complex element list compiled by the SPP RTO with input from stakeholders and member entities. These numbers include the violations which were mitigated by the SPP TPs in addition to the violations that were automatically mitigated by Optimal Mitigation Measures (OPM). For the Category D events, TPs reviewed the potential violations and were given the opportunity to review the automatically mitigated OPM mitigations. It should be noted that Category D events are only for assessment purposes and do not require mitigation.

Season	High Voltage	Low Voltage	Thermal Overloads	Total
2015 Summer	2	73	31	106
2015 Fall	18	7	7	32
2015 Winter	17	15	10	42
2016 Spring	3	8	8	19
2016 Summer	3	59	42	104

2020 Summer	6	51	38	95
2025 Summer	8	63	51	122
2025 Winter	5	11	13	29

*Table 5.4: TPL 004 Potential Violations by Season*

### **5.5: Totals by Model Area**

Table 5.5 below summarizes the potential criteria violations by modeling control area. The results show the breakout based on the automatically selected contingencies in the POM software, which include Category B and C events, and also the member submitted Category B, Category C, and D events.

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.

<b>Transmission Planner</b>	<b>Area Number</b>	<b>Automatically Selected</b>	<b>Category B</b>	<b>Category C</b>	<b>Category D</b>	<b>Total</b>	<b>Mitigated Findings</b>	<b>Remaining Violations</b>
Southwestern Power Administration	515	310	3	1	0	314	314	0
American Electric Power	520	8361	54	128	34	8577	8577	0
Grand River Dam Authority	523	239	0	25	15	279	279	0
Oklahoma Gas & Electric Company	524	2828	3	113	6	2950	2950	0
Western Farmers Electric Cooperative	525	296	0	10	1	307	307	0
Southwestern Public Service Company	526	8292	55	19	0	8366	8366	0
Oklahoma Municipal Power Authority	527	84	0	0	0	84	84	0
Midwest Energy, Inc.	531	812	19	7	25	863	863	0
Sunflower Electric Power Corporation	534	3347	92	36	102	3577	3577	0
Westar Energy, Inc.	536	3474	11	130	244	3859	3859	0

Transmission Planner	Area Number	Automatically Selected	Category B	Category C	Category D	Total	Mitigated Findings	Remaining Violations
KCPL - Greater Missouri Operations	540	237	0	6	7	250	250	0
Kansas City Power & Light Company	541	523	0	0	21	544	544	0
Kansas City Board of Public Utilities	542	0	0	0	0	0	0	0
The Empire District Electric Company	544	381	8	4	0	393	393	0
Independence Power and Light	545	160	0	0	0	160	160	0
City Utilities of Springfield, MO	546	33	0	12	0	45	45	0
Nebraska Public Power District	640	6298	66	111	98	6573	6573	0
Omaha Public Power District	645	231	0	29	7	267	267	0
Lincoln Electric System	650	9	0	0	0	9	9	0

*Table 5.5: Potential Violation Totals by Model Area*

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## Section 6: Summary

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The MDWG models developed by the SPP RTO and member entities represent the power system for the SPP footprint. These models did result in potential thermal and voltage violations for normal (N-0) operation under Category A. 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 Category B, C, and D events. These events were studied by the SPP PC along with the automatically generated (N-k) contingency lists created by POM. All potential Category B and C violations found during the studies were mitigated by operating procedures, capital projects, or modeling corrections determined by the SPP PC and TPs. All potential Category D violations were evaluated and reviewed by the SPP PC and TPs. All potential SPP TPL violations identified through the four TPL evaluations were mitigated as required through the TPL Reliability standards.