



SPP 2019 TPL-001-4 Planning Assessment Scope

Compliance and Advanced Studies

Revision History

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|------------------------|-----------|--------------------|
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1. Overview

This document presents the scope and schedule of work for the NERC TPL-001-4 (TPL) Annual Planning Assessment. This document will be reviewed by the Transmission Working Group (TWG) and the applicable functional entities as described in NERC TPL-001-4 (Standard), A.4.1. Southwest Power Pool (SPP), as the Planning Coordinator (PC), will coordinate with the Transmission Planners (TP) to exchange data. The assessment will be completed on an annual basis which will not exceed 15 months from the completion of the previous assessment.

1.1. Relationship between the 2019 TPL-001-4 Planning Assessment and the 2019 ITP

In accordance with the SPP Board of Directors approval of the Transmission Planning Improvement Task Force (TPITF) Whitepaper and the subsequent Markets and Operations Committee (MOPC) approval of the Integrated Transmission Planning Manual (ITP Manual), the SPP Planning Coordinator will use a common analysis with the 2019 Integrated Transmission Planning Study (2019 ITP) to meet portions of the 2019 Annual Planning Assessment. Portions of the TPL Steady State Assessment and the Short Circuit Assessment are performed in accordance with processes addressed in the ITP Manual¹ and the 2019 ITP Study Scope². This will be noticed throughout this scope document in appropriate sections that reference ITP processes. However, the study report for the 2019 TPL Annual Planning Assessment will be an all inclusive report that documents the compliance with all requirements of the TPL-001-4 NERC planning standard.

¹ <https://www.spp.org/Documents/22887/ITP%20Manual%20version%202.2.docx>

² <https://www.spp.org/Documents/56206/2019%20itp%20scope%20final-3.docx>

2. Data inputs

2.1. Modeling data

Modeling data required in the TPL steady state study is incorporated through the annual SPP Model Development Working Group (MDWG) model building process. The MDWG model building process is performed in accordance with the applicable NERC Modeling, Data, and Analysis (MOD) Standards as described in the Model Development Procedure Manual³ and ITP Manual⁴. In order to meet the R1 requirements⁵, the models will represent the following:

- Existing Facilities
- Known outage(s) of generation or Transmission Facility (ies) with a duration of at least six months⁶.
- New planned Facilities and changes to existing Facilities (including the following as applicable)
 - SPP upgrades that have been approved for construction
 - SPP Transmission Owner's planned (zonal sponsored) upgrades
 - First-tier entities' planned upgrades
- Real and reactive Load forecasts
- Known commitments for Firm Transmission Service and Interchange
- Resources (supply or demand side) required for Load

The model sets in Table 1, Table 2, and Table 3 below establish category P0 as the normal System condition in TPL-001-4 Table 1 and defines the models that will be used for the 2019 TPL-001-4 analyses.

2.1.1. Steady State Models

The models in Table 1 were chosen to comply with requirement R2.1.1, R2.1.2, R2.2.1 (Base case) and R2.1.4 (Sensitivity case). The PC interprets Year two as the current year of the study plus two years. For example, for a study that is performed during the 2019 calendar year, the Year Two model would include the forecasted peak Load period for 2021⁷. The base reliability model (BR models) set will contain an indicative representation of how load responsible entities within the SPP PC footprint will serve network load by utilizing network resources. These base reliability models will consist of non-coincident peak load forecasts, assumed long-term firm transmission service usage levels, and expected conventional and renewable resource output levels. The sensitivity models⁸ (BA models) represent a specific one-hour snapshot of a centralized dispatch with SPP acting as the balancing authority to serve load within the PC footprint in the most economical manner. The hours represented will be the SPP coincident peak hour (peak) and the hour with the highest wind penetration between April and May between the hours of 12 a.m. – 6 a.m. (off-peak). The models will be developed by matching the dispatch in each powerflow model to the dispatch in an economic model simulation representing the same hour.

³ <https://www.spp.org/Documents/12959/spp%20model%20development%20procedure%20manual%202018%20v1.1.docx>

⁴ <https://www.spp.org/Documents/22887/ITP%20Manual%20version%202.2.docx>

⁵ TPL-001-4 Requirements R1-R1.1.6

⁶ Known outages of six month or longer will be obtained from the submission provided by the data submitters in the MDWG model building process via the SPP Engineering database.

⁷ NERC Glossary of Terms Year One definition

⁸ The BA models are derived from the Future 1 economic models build per the ITP Manual/Scope documents.

| Requirement | Description | Base case | Sensitivity case |
|-------------|-----------------|--------------|------------------|
| R2.1.1 | Year 2 peak | ITP 2021S BR | ITP 2021S BA |
| R2.1.1 | Year 5 peak | ITP 2024S BR | ITP 2024S BA |
| R2.1.2 | Year 2 off-peak | ITP 2021L BR | ITP 2021L BA |
| R2.2.1 | Year 10 peak | ITP 2029S BR | N/A |

Table 1. Steady State Analysis Study Models

2.1.2. Stability Models

The models in Table 2 were chosen to comply with requirement R2.4.1, R2.4.2, R2.4.1 (Base case), R2.4.1 (Sensitivity case), and R2.5. To align with the ITP steady state and short circuit processes, Year Two models will be used in the stability assessment. The study case model set will contain an indicative representation of how load responsible entities within the SPP PC footprint will serve network load by utilizing network resources. These base reliability models will consist of non-coincident peak load forecasts, assumed long-term firm transmission service usage levels, and expected conventional and renewable resource output levels. The SPP PC will add the ITP “Notifications to Construct” (NTC) for transmission reinforcements that have been approved through the ITP process to be added to the study case model case set. The addition of the NTC projects will better align the steady-state and dynamic assessments performed with ITP BR and stability case sets. The sensitivity models will have an alternate dispatch scenario that takes into account wind resources that have firm service. In the sensitivity models, all wind resources that have firm service will be dispatched to represent all firm service sold out of those machines therefore the aggregated wind dispatch will generally be higher.

| Requirement | Description | Base case | Sensitivity case |
|-------------|-----------------|------------|---------------------------------|
| R2.4.1 | Year 2 peak | MDWG 2021S | MDWG 2021S (high wind dispatch) |
| R2.4.2 | Year 2 off-peak | MDWG 2021L | MDWG 2021L (high wind dispatch) |
| R2.2.5 | Year 10 peak | MDWG 2029S | N/A |

Table 2. Stability Analysis Study Models

TPL-001-4, Requirement 2.4.1, states that dynamic cases take into account the behavior of induction motors. SPP and its Member companies formed a task force called the Dynamic Load Task Forces (DLTF) to address the use of composite load models (dyre files) to account for the behavior of induction motors. SPP and its Members developed and approved a set of industrial and agricultural composite load model representations for the dynamic case set. A requirement to apply the CMLD (composite load model) dyre file models to the industrial agricultural loads greater than 10 MWs has been placed in the MDWG Manual for the 2018 MDWG Build case set. Once the additional CMLD representations for the residential and commercial have been thoroughly vetted by the DLTF, SPP and its Members will have a composite model representation taking into account residential, commercial, agricultural, and industrial.

2.1.3. Short Circuit Model

The model in Table 3 was chosen to comply with requirements of R2.3. The short circuit study model is modified from the Year 2 Peak model in Table 1 and Table 2 to accommodate the maximum available fault current that interrupting devices will be expected to interrupt by making the following modifications:

- Place all available facilities in-service:
 - Generation
 - Transmission lines (Out for maintenance)
 - Transformers
 - Buses

| Requirement | Description | Base case | Sensitivity case |
|-------------|-------------|--|------------------|
| R2.3 | Year 2 peak | MDWG 2021S Maximum Fault Short Circuit | N/A |

Table 3. Short Circuit Analysis Study Model

2.2. Data required by the PC for Steady State Analysis

2.2.1. Initial Data Request

The initial data request focuses on collecting contingencies that will be used during the steady state analysis performed by the PC.

Prior to beginning the 2019 ITP study process, the PC sent a data request to each applicable stakeholder requesting the TP supply contingency definitions for each planning events as defined in Table 1 of the Standard. The PC requires the TPs follow the SPP contingency naming convention⁹ when deriving names for each contingency definition. The SPP contingency naming convention will be embedded in the annual data request.

The list below summarizes the type of contingency data the PC expects to receive during the annual contingency request.

1. A data request will go out to the current TPL contacts for any contact information that needs to be updated.
2. A list of NERC TPL-001-4, Table 1 contingencies that are expected to produce more severe System impacts and the rationale for each event.
 - a. Planning events (P2, P4, P5, and P7)¹⁰
 - b. Extreme events (EE.SS.1 – EE.SS.3b)¹¹
3. A list of contingencies on systems adjacent to the TP and PCs Systems which may impact their Systems and a rationale for each event.¹²

The SPP PC will coordinate with adjacent PCs to ensure contingencies on adjacent PC and TP Systems which may impact the SPP PC System will be included in the contingency list. This is an addition to the SPP TP submitted contingencies list. The PC will communicate with the adjacent PCs to resolve any contingency issues.

⁹ Appendix B

¹⁰ R3.4, The PC will use combinations of P1 events to create P3 and P6 events

¹¹ R3.5

¹² R3.4.1

2.2.2. Subsequent Data Requests

The subsequent data requests will focus on collecting the applicable contact information, monitored elements of the BES, long lead time facilities, Protection System contingencies, and the Corrective Action Plans (CAPs) that are not addressed by the 2019 ITP study process for potential TPL-001-4, R5 voltage and SPP Criteria thermal violations (violations) found during the steady state study performed by the PC. The PC may request additional data to support the study and assessment as needed.

The list below summarizes the type of data that will be collected during scheduled Subsequent Data requests.

1. A Bulk Electric System (BES) inclusion/exclusion list to be monitored in addition to 100 kV and above facilities in the PC footprint.
2. A Spare Equipment strategy facility list.¹³
 - A list of equipment that if lost would result in a year or longer to replace and is not currently associated with a spare equipment strategy.
3. CAPs to address potential violations found while analyzing the contingency lists studied by the PC.¹⁴
 - An ITP solution to address a contingency event identified during the 2019 ITP analysis will be evaluated in the 2019 ITP Study process
 - For the remaining contingency events -
 - A CAP can include but is not limited to model corrections, system adjustments or transmission projects.
 - An ideo or Python file will be required to represent the changes/adjustments made to the powerflow in order for the PC to verify the effectiveness of the CAP.
4. A list of Protection System contingencies¹⁵.

2.3. Data required by the PC for Stability Analysis

2.3.1. Initial Data Request

The initial data request focuses on collecting contingencies that will be used during the stability analysis performed by the PC.

Member-Submitted Events

The PC will request contingencies from the TPs for analysis. The TP will provide the PC with contingencies as per the PC's requested *Member-Submitted Contingency Spreadsheet* format. The PC will generate and validate the submitted contingencies and resolve any discrepancies with the submitting TP.

The list below summarizes the type of contingency data the PC expects to receive during the annual contingency request for Planning Events P1-P7 and Extreme Events as defined in Table 1 of the Standard.

¹³ R2.1.5

¹⁴ R2.7

¹⁵ R3.3.1

1. A list of NERC TPL-001-4, Table 1 contingencies that are expected to produce more severe System impacts.
 - a. Planning events (P1-P7) and Extreme events
 - b. A maximum of 200 member-submitted events per TP per model.
 - c. Rationale for Event Selection
2. Relay models
 - a. PSS/E Dynamic Relay Models for DYRE file, and/or
 - b. Description of time domain relay actions that replicate the expected removal of elements
3. Description of successful and unsuccessful high speed (less than one (1) second) reclosing into a Fault where high speed reclosing is utilized.
4. Tripping of generators where simulations show generator bus voltages or high side of the GSU voltages are less than known or assumed generator low voltage ride through capability. Include in the assessment any assumptions made or a description of generator low voltage ride through characteristics if not already contained in DYRE file.
 - a. If the TP does not provide generator low voltage ride through characteristics, the PC will assume low voltage ride through characteristics adhere to PRC-024-2 requirements. Those requirements are given in the Stability Analysis section.
5. Remedial Action Schemes
6. Generic or actual relay models for tripping of transmission lines and transformers where transient swings cause protection system operations.
 - a. If the TP does not provide relay models, PSS/E function “RELSCN” will be used to represent transmission line relays.
7. Specific generator scaling that will be required to balance generation/load when generation is removed as a “prior outage” for a contingency.
 - a. Contingencies that specify a new operating condition prior to evaluation (e.g. Ramp up or down of a certain generating plant) will not be evaluated on the stability sensitivity cases. Instead the contingency will first be evaluated on the base case without the new operating condition. Then the new operating condition will be applied to the base case (in effect creating a sensitivity case) and the contingency will be evaluated again. The second evaluation will serve as the “sensitivity” evaluation. ¹⁶

Tier 1 Coordinated Events

The TPs and PC will coordinate with adjacent PCs and TPs to ensure Contingencies on adjacent Systems which may impact the SPP system are included in the Contingency list. The PC will communicate with the adjacent PCs to resolve any contingency issues.

2.3.2. Subsequent Data Requests

The subsequent data requests will focus on collecting the appropriate system adjustments or Corrective Action Plans (CAPs) for system events exhibiting transient (rotor angle) instability, transient voltage response violations, machine damping violations, voltage stability violations, or potential Cascading. The PC may request additional data to support the assessment, as needed. A CAP is a list of actions and an associated timetable for implementation to remedy a specific problem.

¹⁶ SPP Staff will work with Transmission Planners on the necessary edits to the stability contingency spreadsheet for the applicable “PX” events events.

2.4. Data required by the PC for Short Circuit Analysis

2.4.1. Initial Data Request

The initial data request only applies to TPs that require ANSI Fault Current calculation. The TP will provide a listing of each bus number for which a line-out analysis is required for Activity ANSI to be performed by the PC. Each TP who requires ANSI calculations will provide to the PC the following ANSI Fault Current Calculation parameters to be used for each bus within the TP area:

- Divisors
 - For branches in positive sequence
 - For machines in positive sequence
 - For branches in zero sequence
 - For machines in zero sequence
- Fault multiplying factors
 - DC decrement only or AC and DC decrement
- Max operating voltage, in PU
- Contact parting times, in seconds

There is not an initial data request for ASCC results. The PC will run ASCC analysis on all buses in the short circuit model within the PC footprint.

2.4.2. Subsequent Data Requests

The PC will require the TPs to provide a list of equipment determined to be overdutied and the rating of the equipment that is exceeded. Corrective Action Plans will be submitted via ITP processes for instances where the short circuit current interrupting duty exceeds the equipment rating.¹⁷

2.5. Assessment Area

At a minimum the PC will monitor the below facilities for the assessment:

- All BES facilities provided by the TP for TPL compliance
- Any non-BES facilities provided by the TP for informational purposes
- All Tie-lines between SPP TPs and in Tier 1 areas

The PC will also monitor all 100 kV and above facilities in the PC footprint. The PC footprint includes the areas listed in the table below.

¹⁷ R2.8

| Area Number | Entity Name |
|-------------|--|
| 515 | Southwestern Power Administration (SWPA) |
| 520 | American Electric Power (AEPW) |
| 523 | Grand River Dam Authority (GRDA) |
| 524 | Oklahoma Gas & Electric Company (OKGE) |
| 525 | Western Farmers Electric Cooperative (WFEC) |
| 526 | Southwestern Public Service Company (SPS) |
| 527 | Oklahoma Municipal Power Authority (OMPA) |
| 534 | Sunflower Electric Power Corporation (SECI) |
| 536 | Westar Energy, Inc. (WR) |
| 541 | Kansas City Power & Light Company (KCPL) |
| 542 | Board of Public Utilities (BPU) |
| 544 | The Empire District Electric Company (EDE) |
| 545 | Independence Power & Light (INDN) |
| 546 | City Utilities of Springfield, MO (SPRM) |
| 640 | Nebraska Public Power District (NPPD) |
| 640 | Western Area Power Administration (WAPA-RMR) |
| 641 | City of Hastings, Nebraska (HAST) |
| 642 | City of Grand Island, Nebraska (GRIS) |
| 645 | Omaha Public Power District (OPPD) |
| 652 | Western Area Power Administration (WAPA) |
| 659 | Basin Electric Power Cooperative (BEPC) |
| N/A | ITC Great Plains, LLC (ITCGP) |
| N/A | East Texas Electric Cooperative (ETEC) |

Table 4. Assessment Area

3. Steady State Analysis

3.1. Software

The software that will be used for the steady state analysis is V&R Energy's Physical and Operational Margins (POM) suite and PTI's PSS/E power flow software.

3.2. Software parameters¹⁸

In order to simulate the expected automatic operation of existing and planned devices designed to provide steady state control of the electric system the POM powerflow solution settings will be used:

- Full Newton Power Flow Solution
- Area Interchange Disabled
- Phase Shift Adjustment Enabled
- Transformer Tap Stepping Enabled
- DC Tap Adjustment Enabled
- Switched Shunt Adjustment Enabled

The PSS/E powerflow software will also be utilized during the assessment and in order to simulate the expected automatic operation of existing and planned devices designed to provide steady state control of the electric system the PSS/E powerflow solution settings will be used:

- Fixed Slope Decoupled Newton-Raphson Power Flow Solution (FDNS)
- Area Interchange Disabled
- Phase Shift Adjustment Enabled
- Transformer Tap Stepping Enabled
- DC Tap Adjustment Enabled
- Switched Shunt Adjustment Enabled
- Non-Divergent Solution Flag Disabled

3.3. Monitored facilities

At a minimum, the PC will monitor the below facilities during the contingency analysis:

- All BES facilities provided by the TP for TPL compliance
- Any non-BES facilities provided by the TP for informational purposes
- All Tie-lines between SPP TPs and in Tier 1 areas

The PC will also monitor all 100 kV and above facilities in the PC footprint.

3.4. Basecase Analysis¹⁹

After the 2019 ITP model building process is complete and approved by the appropriate SPP Working Groups, the study models will be evaluated for TPL Table 1 planning event P0, system intact, violations. A P0, TPL requirement R5 voltage violation in the steady state occurs when the per unit (pu) voltage of any bus

¹⁸ R3.3.2

¹⁹ R3.1

is outside the range of 0.95 pu to 1.05 pu or if a TP has a more or less²⁰ stringent local criteria. A PO thermal violation occurs when a branch or transformer exceeds 100% of rate A.

Any violation found during the basecase analysis must have a Corrective Action Plan (CAP) that will be developed as part of the 2019 ITP Study process.

3.5. Basecase Contingency Analysis

The PC will gather contingencies from the TPs and other PCs per its Annual Data Request. In addition to the TP submitted contingencies, the PSS/E ACCC function will be utilized to analyze all single (N-1) contingencies. POM will be used to analyze combinations of TP submitted contingencies and single contingencies (N-1-1). After all contingencies are collected per the schedule, the PC will use the applicable software to analyze all the contingencies to determine whether the BES meets the performance requirements. Non-converged contingencies will be further analyzed and potential violations will either require the TP to submit a CAP to the PC or a project will be developed through the 2019 ITP process.

A steady state TPL-001-4 requirement R5 voltage limit violation occurs when after a contingency, the pu voltage of any BES or load serving bus is outside the SPP Criteria range of 0.90 pu to 1.05 pu or a more or less²¹ stringent local criteria. A steady state TPL-001-4 requirement R5 post-Contingency voltage deviation greater than 0.10 pu on any BES facility shall be flagged and serve as informational purpose only.

After a contingency, a thermal violation occurs when a branch or transformer exceeds 100% of rate B.²² Any exceedances of Rate A shall be mitigated by the Transmission Owner's facility rating methodology to return the loading below Rate A prior to the end of the emergency rating time limit.

The violations derived from the POM software will be verified through PSS/E[®] to validate the POM results. If a discrepancy is found between the two solutions engines, the results from PSS/E will be used in the violations workbook.

3.5.1. Auto N-1 analysis

In the ITP powerflow analysis, the N-1 analysis will be performed in PSS/E by taking a contingent element out of service, solving the power flow using Fixed Decoupled Newton Power Flow Solution, and scanning the monitored elements for potential violations. Any potential violations found will be reported in spreadsheet format. The auto N-1 contingencies that will be evaluated by the software include:

1. Generator
2. Shunt device
3. Single Pole of a DC line
4. Transformer
5. Transmission line segment

²⁰ With criteria waiver

²¹ With criteria waiver

²² R5

3.5.2. Auto N-1-1 analysis

The N-1-1 analysis will be performed in the POM power flow software by taking a contingent element out of service, solving the power flow using a Full Newton power flow solution, and scanning the monitored elements for potential violations. If no potential violation occurs, a second contingent element will be taken out of service, the power flow will be solved using a Full Newton power flow solution, and the monitored elements will be scanned for potential violations. Any potential violations found will be reported in spreadsheet format. Some of these contingency analyses [P3 events (G-1; N-1 events)] will be performed in concert with the 2019 ITP analysis. The N-1-1 contingencies will be generated in the POM and custom software using the following conditions:

1. All Generators – All Generators $\geq 5\%$ on same facilities [performed as part of the 2019 ITP]
2. All Generators – Transmission branch²³ with $\geq 5\%$ GSF [performed as part of the 2019 ITP]
3. All Generators – Shunt device within 10 buses [performed as part of the 2019 ITP]
4. Transmission branch – Transmission branch in same Zone
5. Transmission branch – Shunt device in same Zone
6. Shunt device – Shunt device in same Zone

3.5.3. Long lead time analysis

An additional study must be performed when an entity's spare equipment strategy could result in the unavailability of long lead time equipment.²⁴ If the first element of a P6 event has a long lead time and is not covered in its spare equipment strategy, it will be categorized as being studied for R2.1.5 and will not be studied as a P6 event. A P6 event categorized as R2.1.5 will be studied in accordance with the following steps:

1. Perform a basecase analysis treating each element classified as having long lead time as outaged
2. Check for system intact violations; if any exist report and request CAPs to mitigate
3. With the long lead time element out of service, take additional P1 and P2 elements out of service
4. Check for violations; if any exist report and request CAPs to mitigate
5. Repeat steps 1 through 4 for every R2.1.5 long lead time equipment

If a violation occurs in step 2 or 4, the Corrective Action Plan (CAP) must abide with P0, P1, or P2 as applicable.

3.5.4. Impact Analysis of Planned Outages

To comply with IRO-017-1, an evaluation of whether planned outages are the sole cause of, or whether they contribute to the impact of identified issues. The list of identified issues is compared with planned outages. If necessary, additional steady state assessment simulations will be performed with the planned outaged facilities in service to determine if the issues are caused by the planned outage.

3.5.5. Cascading analysis

For TPL-001-4 Table 1 planning events, if the CAP is able to mitigate the violation the POM-PCM (Potential Cascading Modes) module will not be used since cascading will be prevented by the CAP. The POM-PCM module will be used to detect cascading in the steady state. Contingencies identified during the Table 1

²³ Transmission Branch = Transformer or Transmission line segment

²⁴ R2.1.5

event analysis that yielded monitored elements with thermal loadings over 120% of Rate B and/or pu voltages below 0.90 pu at three (3) or more buses (tripping threshold), are documented and analyzed with POM-PCM. The POM-PCM module will simulate the initial contingency and then take any monitored element out of service if the tripping threshold is exceeded. The powerflow is solved and the system is scanned for elements meeting the tripping threshold again. This tripping, solving, and documenting pattern (tier) is continued until the system becomes stable or cascading occurs.

In order to reduce the likelihood of cascading, the OPM module will be used to generate a CAP after each violation is discovered but before the elements are tripped offline. The PC will identify potential instances of cascading and send to the TP for verification. If the TP confirms the potential cascading event and the TP provides a CAP to mitigate any of the tripping threshold events, cascading will not occur. If the potential instance of cascading is determined invalid by the TP, the TP will provide justification stating the reason for invalidation. The PC will report on cascading when the simulation results in 3 or more tiers of cascading.²⁵ If the analysis above concludes there is Cascading, and the Cascading is initiated by the occurrence of an extreme event, then an evaluation of possible actions designed to reduce the likelihood or mitigate the consequences and adverse impacts of the event(s) will be conducted.²⁶ The PC will require the possible actions designed to reduce the likelihood or mitigate the consequences and adverse impacts of the event(s).

3.5.6. Protection System analysis

Once the potential violation results are provided to the TPs due to the auto N-1, auto N-1-1, and TP submitted contingencies, the TPs will review 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 pu.²⁷ The TP will also review the results for instances where Transmission elements would be tripped by a protection system with automatic controls due to relay loadability limits being exceeded.²⁸

After reviewing the results for the above mentioned conditions, the TP will submit to the PC a set of contingencies which include elements that the Protection System will trip offline along with any assumptions made. The PC will analyze the contingencies and report back to the TP any violations found. A CAP will be submitted by the TP to the PC for validation.

3.6. Sensitivity-case Analysis

In order to demonstrate a measurable change in System response between the basecase models and the sensitivity models²⁹, a Near-Term Planning Horizon study identical to the analysis described in the Basecase Analysis and Basecase Contingency Analysis sections above shall be performed on the sensitivity models listed in Table 1.

While the PC will evaluate all contingencies on the sensitivity cases, it is important to note that Corrective Action Plan(s) do not need to be developed solely to meet the performance requirements for a single sensitivity case analyzed in accordance with Requirement R2, Part 2.1.4.

²⁵ R6

²⁶ R3.5

²⁷ R3.3.1.1

²⁸ R3.3.1.2

²⁹ R2.1.4

3.7. Corrective Action Plan (CAP)

A Corrective Action Plan is a list of actions and an associated timetable for implementation to remedy a specific problem³⁰. When the analysis for planning events indicates an inability of the System to meet the performance requirements in NERC TPL-001-4 Table 1, the Planning Assessment shall include system adjustments, model corrections, or CAPs addressing how the performance requirements will be met.

The PC will provide two different workbooks to the TPs to coordinate CAPs for the 2019 TPL Assessment. The first workbook will be provided in accordance with the 2019 ITP process. The first workbook will contain and identify potential Planning Assessment violations associated with P1 events, P3 events, and EHV facility related P2, P4, and P5 events for facilities included in the Monitored facilities section.

The second workbook provided will contain the potential violations for the monitored facilities listed in the Monitored facilities section above for all other planning and extreme events. The workbook(s) will contain the model year, season, monitored element, contingent element(s), loading/pu voltage, OPM mitigation if available, and a column for the TP to provide system adjustments, model corrections, or a CAP. If an op-guide is used as a mitigation, the TP will provide the op-guide to the PC for review.

Corrective Action Plan(s) do not need to be developed solely to meet the performance requirements for a single sensitivity case analyzed in accordance with Requirements R2, Parts 2.1.4 and 2.4.3.

3.7.1. ITP Solutions

For contingency events that are analyzed in the 2019 ITP assessment, SPP stakeholders (including SPP TPs) will provide potential solutions for potential violations observed. SPP will follow all applicable ITP processes (including those for FERC Order 1000) to determine the optimum solution for any contingency event that is applicable to the SPP ITP process.

3.7.2. Transmission Planner CAP

For potential violations that are not subject to the 2019 ITP process, SPP Transmission Planners will be requested to submit a CAP(s) for potential violations on their respective systems. A CAP can be many actions over varying timeframes. Some example include: line switching, capacitor adjustments, transformer tap adjustments, generation re-dispatch, etc. A CAP can also be a transmission upgrade as long as the earliest in-service date of the project is prior to the need date of the violation. At a minimum, the project plan should include: project description, schedule of implementation, in-service dates, and lead times.

An example of a project plan:

Project: Rebuild and re-conductor x.x miles of abc-def 138 kV line

Reason(s): Overloads the 101 MVA RATE B for loss of ghi-jkl 138 kV and several other contingencies in 2024 summer.

In-Service Date: 6/1/2024

Lead Time: 24 months

Line Rating: 225/315 MVA

Other information: This is other pertinent information about the project.

³⁰ http://www.nerc.com/files/glossary_of_terms.pdf

Along with a description of system adjustments or project plans for transmission upgrades, an idev or Python file must be submitted to the PC for use in the verification process when applicable.

3.7.3. Optimal Mitigation Measures (OPM) CAPs

The POM software suite Optimal Mitigation Measures (OPM) module will be utilized to aid in generating CAPs. OPM is a tool used to automatically apply mitigation procedures based on operating measures, system adjustments, used by SPP Operations in real-time. CAPs produced by OPM will be presented to the TPs for their review in the violation workbook. In the case when OPM is not able to generate a CAP, TPs will be required to provide a CAP. TPs will also be able to provide an alternate CAP to the OPM CAP if desired. OPM will not be used during N-1 conditions to re-dispatch MW or MVAR in order to protect firm service.

OPM applies a minimum number of remedial actions based on a priority schedule. The PC will use the following measures when generating OPM CAPs:

- MW Dispatch – except during N-1 conditions
- MVAR Dispatch – except during N-1 conditions
- Capacitor and Reactor Switching
- ULTC Transformer Tap Change
- PAR Transformer Phase Angle Change
- Line Switching (In and Out)

3.7.4. Joint Solution Development with Reliability Coordinator

As required by IRO-017-1 R4, analysis of issues caused by planned outages will be identified. The PC will coordinate with the impacted TPs and the RC to develop joint solutions for these identified issues.

3.8. Establishment of System Operating Limits (SOLs) and Interconnection Reliability Operating Limits (IROLs)

Any potential voltage instability conditions that cannot be adequately mitigated with a Corrective Action Plan will be considered to be candidates for potential System Operating Limits (SOLs) that may have a lower rating than the Facility Rating as provided in the study models. For purposes of steady state analysis, contingencies that do not converge will be considered to be potentially unstable³¹.

CAPs can be applied to mitigate potential IROLs. If the TPL-001-4 Steady State results identifies a potential IROL through application of SPP Planning Criteria 7.3.2, then the CAP, in the form of a system adjustment used to mitigate the potential IROL, must be performed within SPP's IROL Tv. SPP Planning Criteria states that the Planning Horizon IROL Tv is 30 minutes.

3.9. Deliverables

After a contingency analysis is complete, the potential violation workbook will be provided to the TPs for their review of the violations, OPM CAPs, and documenting any Transmission Planner CAPs.

³¹ TPL-001-4 R6

4. Stability Analysis

4.1. Software

The software used for the stability analysis includes PTI's PSS/E Powerflow and Dynamics modules, PLI's DSA Tools Transient Security Assessment Tool ("TSAT"), and V&R Energy's POM Fast Fault Screening ("FFS") module.

4.2. Performance Requirements

A twenty (20) second time domain simulation will be performed for all events using Siemens' PTI's PSS/E Rev 33.10 and the PSSPLT plotting package or PowerTech Labs' DSATools TSAT (breaker-to-breaker or Tier 1 events). As the simulations occur, the following are monitored and recorded to determine stability:

Rotor angle stability will be monitored for all generators in the SPP PC footprint. Those units that exhibit signs of instability will be marked for further analysis, and should system adjustments or CAPs be necessary, the applicable TP will be coordinated with to determine the necessary system adjustments or CAP.

Machines with rotor angle deviations greater than or equal to 16 degrees (measured as absolute maximum peak to absolute minimum peak) shall be evaluated against SPPR1 or SPPR5 requirements below. Machines with rotor angle deviations less than 16 degrees which do not exhibit convergence shall be evaluated on an individual basis. Rotor angle deviations will be calculated relative to the system swing machine. The damping curves will be judged against the SPPR1 and SPPR5 criteria as described in the *SPP Disturbance Performance Requirements*. Those units that violate the criteria will be identified for further analysis and, should CAPs be necessary, the TP will be engaged to determine the necessary CAP.

Transient voltage stability will be monitored for BES buses up to ten (10) buses away from the disturbance (fault) location. The voltage responses shall recover above 0.70 per unit, 2.5 seconds after the fault is cleared. Bus voltages shall not swing above 1.20 per unit after the fault is cleared, unless affected transmission system elements are designed to handle the rise above 1.2 per unit. Those units that violate the transient voltage criteria will be marked for further analysis and should CAPS be necessary, the TP will be engaged to determine the necessary CAP.

Generator Voltage Ride-Through Capability³² will be monitored for BES buses up to ten (10) buses away from the disturbance (fault) location. If low voltage ride through capability is not provided by the TP, the PC will assume low voltage ride through capability 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. PRC-024-2 requirements are listed in Table 5.

³² R4.3.1.2

| PRC-024-2 Generator Voltage Ride Through Duration | |
|---|--------------------|
| Voltage (pu) | Time (S) |
| <0.45 pu | 0.15 |
| <0.65 pu | 0.3 |
| <0.75 pu | 2.00 |
| <0.90 pu | 3.00 |
| ≥1.2 pu | Instantaneous trip |
| ≥1.175 pu | 0.20 |
| ≥1.15 pu | 0.50 |
| ≥1.10 pu | 1.00 |

Table 5. PRC-024-2 Requirements

Tripping of Transmission lines³³ – Scanning for potential tripping of transmission lines not cleared by the fault clearing action will be accomplished by use of PSS/E command, “RELSCN”.

Cascading - Potential cascading due to a fault event and subsequent rotor angle instability will be determined for NERC category P1-P7 and Extreme events. The criteria for an event resulting in *potential* cascading is the loss of more than 3,000 MW of generation based on SPP’s largest plant output plus 50 percent of the largest unit. Those events violating these criteria were identified as a possible cascading event for further analysis and, should CAPs be necessary, the member entity will be engaged to determine the necessary CAP.

4.3. System Intact Analysis

Category ‘P0’ is considered system intact for the base and the sensitivity cases. The ‘P0’ analysis will consist of a 20-second no-fault and a 60-second ring-down simulation to test the integrity of the base and the sensitivity cases.

4.4. Contingency Analysis

Stability analysis for disturbance events will be completed using Siemens PTI’s PSS/E or PLI’s DSATools TSAT. Stability performance will be determined for four (4) groups of events:

- 1. Dynamic Assessment of Member Specified Events:** TPs will be requested to provide the PC with reliability contingencies for transient stability analysis. A transient stability analysis will be performed for all member submitted events utilizing PSS/E. The events will be simulated on both the MDWG base case models and sensitivity models³⁴.
- 2. Dynamic Assessment of Breaker-to-breaker Contingencies:** The PC will gather system breaker-to-breaker data to formulate contingencies that emulate actual field responses to faults. Because 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 will be performed for the formulated breaker-to-breaker contingencies. Powertech Labs, Inc.’s DSATools TSAT will be used for the analysis³⁵. The PC will then verify in PSS/E time domain simulation any events that do not meet the “SPP Transient Stability Requirements”. The TP will be contacted to verify the exact event definition, including fault clearing times to determine if a potential violation exists.

³³ R4.3.1.3

³⁴ Except as noted in Section 2.3.1 (7) of this scope document

³⁵ PSS/E may be used for this analysis if conditions warrant

3. Fast Fault Screening Events - V&R Energy’s Fast Fault Scan (FFS) tool will be used to screen for potential category P1 and P6 events at each bus greater than 100kV to determine the more severe fault locations (buses) in the SPP region for each case. These locations will be ranked according to Critical Clearing Times (CCTs). The PC will then verify in PSS/E time domain simulation that critical clearing times are less than 9 cycles. The TP will be contacted to verify the exact event definition, including fault clearing times to determine if a potential violation exists.

4. Dynamic Assessment of Coordinated Events with Tier 1 Entities: Coordination with adjacent PCs will be accomplished. A transient stability analysis will be performed using PLI TSAT for all received events³⁶. The PC will then verify in PSS/E time domain simulation any events that do not meet the “SPP Transient Stability Requirements”. The Tier 1 Entity will be contacted to verify the exact event definition, including fault clearing times to determine if a potential violation exists.

4.4.1. Impact Analysis of Planned Outages

To comply with new standard IRO-017-1, an evaluation of whether planned outages are the sole cause of, or whether they contribute to the impact of identified issues. The list of identified issues is compared with planned outages. If necessary, additional stability assessment simulations will be performed with the planned outaged facilities in service to determine if the issues are caused by the planned outage.

4.5. Monitored Quantities

During the stability simulations, monitored parameters in the assessment area will include

1. Rotor Angle and Speed (The system swing machine at Brown’s Ferry, TVA, will be used as the reference for rotor angle)
2. Real and Reactive Power
3. Generator bus voltages of any voltage level and non-generator buses with voltages greater than 100kV in the disturbance Area(s). More than one (1) area may be monitored depending on proximity to the disturbance.
4. Transient voltage response and machine rotor angle damping will be monitored and compared with the latest version of the *SPP Disturbance Performance Requirements*. For certain instances in which the waveforms may not conform with the latest version of the performance requirements, engineering judgement will be allowed to determine whether rotor angles have adequate damping and voltages adequately recover from a fault.

4.6. Cascading Analysis

Contingency events that produce the more severe system impacts will be evaluated for cascading. Those extreme events where a loss of 3000 MW of generation due to generator instabilities will merit further evaluation and study by the SPP PC and the member entity. CAP’s will be required for those determined to cause cascading.

³⁶ PSS/E may be used for this analysis if conditions warrant.

4.7. Corrective Action Plans

For any planning events (P0-P7), any observed potential violation of stability, damping or transient voltage criteria will be further evaluated to determine if system adjustments are allowed, or if not allowed, the development of a Corrective Action Plan. For those events that are determined to cause cascading, CAPs will be required to mitigate the impact of the cascading. The PC will coordinate with the TP on the development of any system adjustments or CAPs.

While the PC will evaluate all contingencies in the sensitivity cases³⁷, it is important to note that Corrective Action Plan(s) do not need to be developed solely to meet the performance requirements for a single sensitivity case analyzed in accordance with Requirement R2, Part 2.4.3.

4.7.1. Joint Solution Development with Reliability Coordinator (RC)

As required by IRO-017-1 R4, analysis of issues caused by planned outages will be identified. The PC will coordinate with the impacted TPs and the RC to develop joint solutions for these identified issues.

4.8. Establishment of System Operating Limits (SOLs) and Interconnection Reliability Operating Limits (IROLs)

Any potential voltage instability conditions that cannot be adequately mitigated with a Corrective Action Plan will be considered to be candidates for potential System Operating Limits (SOLs) that may have a lower rating than the Facility Rating as provided in the study models.

CAPs can be applied to mitigate potential IROLs. If the TPL-001-4 results identifies a potential IROL through application of SPP Planning Criteria 7.3.2, then the CAP, in the form of a system adjustment used to mitigate the potential IROL, must be performed within SPP's IROL Tv. SPP Planning Criteria states that the Planning Horizon IROL Tv is 30 minutes.

4.9. Deliverables

As each contingency analysis is performed, a workbook of results, including potential violations will be provided to the TPs for their review of the violations, CAPs, and documenting of any CAPs.

³⁷ Except as noted in Section 2.3.1 (7) of this scope document

5. Short Circuit Analysis

5.1. Software

The software used for the short circuit analysis is PTI PSS/E.

5.2. Analysis

In accordance with the ITP Manual Section 2.7, the PC will send out the total Bus fault current study results for SLG and 3 phase faults to the TPs. The results will include the following:

- Full bus-fault current and line-out results using ASCC
- Full bus-fault current using ANSI (if applicable for the respective TP)
 - Line-out results for buses provided in data request

The TPs will be required to evaluate the results provided by the PC and responds if any fault-interrupting equipment will have its duty ratings exceeded by the maximum available fault current. For equipment that is seen to have its duty ratings exceeded, the TP will provide the PC with the applicable duty rating of the equipment.

The TPs can perform their own short circuit analysis to meet the requirements of TPL-001-4. However, any CAPs that may result in the eventual issuance of a Notice to Construct (NTC) will be based on the PC short circuit analysis.

5.3. Software parameters

PSS/E settings:

- Run activity FLAT
 - Set classical Short Circuit Assumptions (activity FLAT,CL)
 - Set Tap Ratios to unity (1.0)
 - Set Charging to zero (0.0)
 - Set Shunts to zero (0.0) in all sequences³⁸
- Use Automatic Sequence Fault Calculation (ASCC_3) function
 - Three phase fault
 - Line to Ground (LG) fault
 - Line Out (LOUT) fault
 - Impose flat conditions
 - I²k contributions to “N” levels away
 - N=0
- Use ANSI_2 Fault Current Calculation (with defaults below unless alternate provided by TP)
 - Divisors
 - For branches in positive sequence = 40.0
 - For machines in positive sequence = 80.0
 - For branches in zero sequence = 40.0
 - For machines in zero sequence = 80.0

³⁸ Set line shunts to 0.0 in the positive (and hence negative) sequence, and fixed and switched shunts to 0.0 in all three sequence networks.

- Fault multiplying factors = DC decrement only
- Output Format = Summary output using ANSI R and X
- Max operating voltage, in PU = 1.05
- Contact parting times, in seconds = 0.033
- Short Circuit Output = Physical
- Short Circuit Coordinates = Polar

Short Circuit Parameters = 3 Phase

5.4. Corrective Action Plans

For any observed potential violation of interrupting duties of circuit breakers or other interrupting devices, the development of a Corrective Action Plan will be required. For potential violations of tariff facilities, the CAP will be determined through the ITP process as described in Section 5.4.1. The PC will coordinate with the TP on the development of any additional CAPs that are not addressed through the ITP process.

5.4.1. ITP Solutions

For contingency events that are analyzed in the 2019 ITP assessment, SPP stakeholders (including SPP TPs) will provide potential solutions for potential violations observed. SPP will follow all applicable ITP processes (including those for FERC Order 1000) to determine the optimum solution for any contingency event that is applicable to the SPP ITP process.

5.5. Deliverables

The following deliverables will be provided for the Short Circuit Assessment –

- Initial submittal of total Bus Fault Currents from PC to TPs in an Excel format
 - Full bus-fault current and line-out results using ASCC and ANSI

6. Draft Assessment

A draft assessment will be provided to the TWG for a feedback and review period.

After incorporating any feedback from the TWG's review, a final assessment will be presented for TWG approval.

7. Assessment Distribution

Each Planning Coordinator and Transmission Planner shall distribute its Planning Assessment results to adjacent Planning Coordinators, adjacent Transmission Planners, and its Reliability Coordinator within 90 calendar days of completing its Planning Assessment, and to any functional entity that has a reliability related need and submits a written request for the information within 30 days of such a request.³⁹

If a recipient of the Planning Assessment results provides documented comments on the results, the respective Planning Coordinator or Transmission Planner shall provide a documented response to that recipient within 90 calendar days of receipt of those comments.⁴⁰

³⁹ R8

⁴⁰ R8.1

8. Proposed Schedule for Steady State Analysis

| Owner | Scheduled Activities | Dates |
|--------------|---|--------------------|
| PC | Begin Steady State Scope Development | September 1, 2018 |
| MDWG | Contingency data request | July 26, 2018 |
| PC | Spare equipment data request | November 19, 2018 |
| TWG | Scope Approval | November 13, 2018 |
| | | |
| | Analysis | |
| TWG | 2019 ITP BR powerflow model set approval | September 12, 2018 |
| TWG | 2019 ITP BA powerflow model set approval | October 31, 2018 |
| TP | Deadline for providing Contingency data (P1,P2,P4,P5,P7, EE) | August 1, 2018 |
| TP | Deadline for providing Local Planning Criteria per Tariff | April 1, 2018 |
| TP | Deadline for providing spare equipment list | December 3, 2018 |
| | | |
| | Corrective Action Plans | |
| PC | Send initial potential violations to TPs/RC and request DPPs (ITP/TPL potential violations via ITP Needs posting) | January 1, 2019 |
| TP | Deadline for providing DPPs | February 6, 2019 |
| PC | Send initial potential violations to TPs/RC and request CAPs (ITP/TPL and TPL only violations) | February 28, 2019 |
| TP | Deadline for providing Protection Scheme Contingencies | March 29, 2019 |
| TP, RC | Deadline for providing CAPs | April 29, 2019 |
| PC | Complete Testing of CAPs | August 30, 2019 |

9. Proposed Schedule for Stability Analysis

| Owner | Scheduled Activities | Dates |
|--------------|---|-------------------|
| TWG | Scope Approval | November 13, 2018 |
| PC | Contingency data request (TP and Tier 1 contingencies) | February 15 |
| TP | Deadline for providing Contingency Data | March 15 |
| | | |
| | MDWG Case Analysis | |
| MDWG | MDWG Dynamic model set approval | February 1 |
| PC | Provide Fast Fault Scans Results to TPs | June 3 |
| PC | Provide Member Submitted Contingency Results to TP/RC for MDWG models | June 3 |
| PC | Provide Breaker to Breaker and Tier 1 Contingency Results to TP/RC for MDWG models | June 3 |
| TP | Provide input to PC on Fast Fault Scan Results including Corrective Action Plans if necessary | July 1 |
| TP, RC | Provide input to PC on Member Submitted Contingency results for MDWG models including Corrective Action Plans if necessary | July 1 |
| TP, RC | Provide input to PC on Breaker to Breaker Contingency results for MDWG models including Corrective Action Plans if necessary | July 1 |
| PC | Complete testing of CAPs | August 30 |
| | | |
| | Sensitivity Case Analysis | |
| PC | Complete development of Sensitivity models | March 15 |
| PC | Provide Member Submitted Contingency Results to TP/RC for Sensitivity models | June 3 |
| PC | Provide Breaker to Breaker and Tier 1 Contingency Results to TP/RC for Sensitivity models | June 3 |
| TP, RC | Provide input to PC on Member Submitted Contingency results for Sensitivity models including Corrective Action Plans if necessary | July 1 |
| TP, RC | Provide input to PC on Breaker to Breaker Contingency results for Sensitivity models including Corrective Action Plans if necessary | July 1 |
| PC | Complete testing of CAPs | August 30 |

10. Proposed Schedule for Short Circuit Analysis

| Owner | Scheduled Activities | Dates |
|--------------|---|--------------------|
| PC | Short Circuit Scope Development | September 1, 2018 |
| MDWG | MDWG Short circuit model set approval | September 12, 2018 |
| PC | Request ANSI parameters and listing of buses for line-out analysis using ANSI | October 2, 2018 |
| TWG | TWG Scope Approval | November 13, 2018 |
| TP | Deadline for providing ANSI parameters and listing of buses for line-out analysis using ANSI | October 18, 2018 |
| PC | Perform Short Circuit simulation | October 22, 2018 |
| PC | Send Short Circuit results to TPs and request equipment ratings | November 19, 2018 |
| TP | Deadline for providing equipment ratings | November 29, 2018 |
| PC | Send initial potential violations to TPs/RC and request DPPs (ITP/TPL potential violations via ITP Needs posting) | January 1, 2019 |
| TP | Deadline for providing DPPs | February 6, 2019 |
| PC | Complete verification of TP submitted Short Circuit DPPs | March 20, 2019 |

11. Proposed Schedule for Draft Assessment

| Owner | Scheduled Activities | Dates |
|--------------|---|--------------|
| PC | Provide Draft Assessment to TWG for review | October 15 |
| TWG | Provide feedback to PC pertaining to Draft Assessment | October 31 |
| PC | Provide Final Assessment for TWG approval | November 5 |
| TWG | Approval of Final Assessment | November 12 |

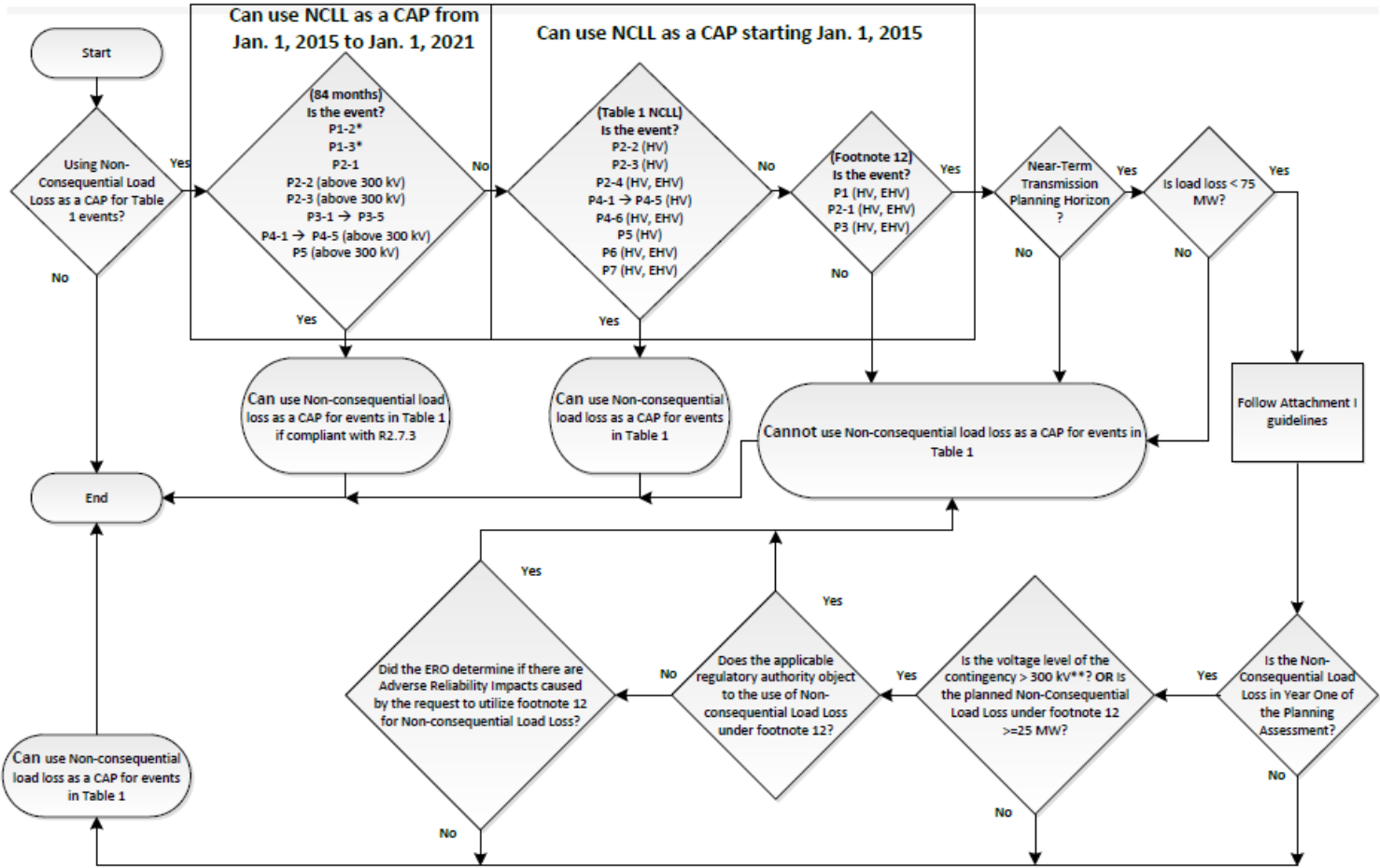
12. Changes in Process and Assumptions

In order to protect against changes in process and assumptions that could present a significant risk to the completion of the TPL study, any such changes must be vetted. If TWG votes on any process steps or assumptions to be used in the study, those assumptions will be used for the 2019 TPL study. Changes to process or assumptions recommended by stakeholders must be approved by the TWG. This process will allow for changes if they are deemed necessary and critical to the TPL study, while also ensuring that changes, and the risks and benefits of those changes, will be fully vetted and discussed.

Appendix A

TPL-001-4 Non-Consequential Load Loss decision flowchart

SPP TPL Task Force



*for controlled interruption of electric supply to local network customers connected to or supplied by the Faulted element
 **Check TPL-001-4 Attachment I, Section III.1.a & Section III.1.b for qualification information

Appendix B

SPP Contingency Naming Convention

https://www.spp.org/documents/53546/spp%20contingency%20naming%20convention_2016.pdf