TE-TP Standard Programs and Processes	**Methodology for Determining and Communicating System Operating Limits for the Planning Horizon (FAC-010 & -014)**	**TE-TP-SPP-30.304** **Rev. 0000** **Page 1 of 13**
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Responsible Executive Organization: Transmission Engineering - Planning

Approved by: Timothy L. Smith, General Manager of TE-Planning — 03-18-2016 Date

Revision Log

Revision or Change Number	Effective Date	Affected Page Numbers	Description of Revision/Change
0000	03-24-2016	All	This procedure supersedes TREC-SPP-30.010 Revision 0003 with the same name. The SPP has been downgraded to a TE-Planning level. Removed the Appendix A and addressed its contents more generically. Added wording on steady state analysis.

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NOTE

Throughout this procedure, North American Electric Reliability Corporations (NERC) Reliability Standard requirements are referenced before the statements that are applicable to the requirements.

1.0 PURPOSE

(FAC-010 R1) (C1). This document describes the methodology used to determine System Operating Limits (SOLs) and Interconnection Reliability Operating Limits (IROLs) in the planning horizon for the TVA Planning Authority Area in accordance with the Requirements of NERC Reliability Standard FAC-010. **(FAC-014 R3) (C2).** This document also describes the process for establishing and communicating SOLs in accordance with Requirements of NERC Reliability Standard FAC-014 pertaining to the Planning Coordinator and Transmission Planner.

2.0 SCOPE

This Standard Programs and Processes (SPP) applies to the TVA Planning Coordinator (PC) and the Transmission Planner (TP).

(FAC-010 R1.1) At the request of the PC, TVA's Transmission Engineering - Planning Department acting as the TP annually performs transmission expansion planning studies to ensure the continued reliability of the TVA PC Area. These studies provide the basis for determination of SOLs in the planning horizon, which are then communicated to TVA's Reliability Coordinator (RC) for use in operations.

Review Cadence: This document will be reviewed every three (3) years or as needed by the PC and documented in the revision log.

3.0 PROCESS

3.1 Roles and Responsibilities

3.1.1 General Manager, Transmission Engineering - Planning

The General Manager of Transmission Engineering - Planning is the owner and approval authority for this procedure and has TPS SPP program oversight. Approval of this procedure is indicated by the signature on the cover page.

3.1.2 Planning Coordinator (PC)

The PC ensures the future reliability of the Bulk Electric System (BES) by the coordination, facilitation, integration, and evaluation of long term transmission and resource plans within TVA's PC area and by coordinating with adjoining PC areas. The PC is responsible for the communication of SOLs and IROLs to adjacent PCs as well as coordinating and communicating neighboring systems' SOLs and IROLs to those with a reliability reason to know within the PC footprint. The PC has TPS SPP program oversight, execution, and support.

3.1.3 Transmission Planner (TP)

TVA's TP annually performs transmission expansion planning studies to ensure the continued reliability of the TVA PC Area. These studies provide the basis for determination of SOLs in the planning horizon, which are then communicated to TVA's RC for use iin operations. The TP has TPS SPP program execution and support.

3.2 Program Elements

SOL Methodology

(FAC-010 R4) This SOL Methodology and any subsequent change to it will be issued to the following entities prior to the effective date of the change.

A. **(FAC-010 R4.1)** Each adjacent PC and each PC that indicated it has a reliability-related need for the methodology.

B. **(FAC-010 R4.2)** Each Reliability Coordinator and Transmission Operator that operates any portion of the TVA PC Area. Presently the PC Area includes TVA, Nashville Electric System (NES), Memphis Light, Gas, and Water Division (MLG&W), and Smoky Mountain Transmission (SMT).

C. **(FAC-010 R4.3)** Each TP that plans a portion of the TVA PC Area. Presently the PC Area includes TVA, NES, MLG&W, and SMT.

(FAC-010 R5) If one of the recipients of this SOL Methodology provides documented technical comments on the methodology, the TVA PC will provide a documented response within 45 calendar days indicating whether a change will be made and the reasoning behind the decision.

3.3 Instructions

Studies performed to determine SOLs/IROLs in the Planning Horizon for Steady State and Stability are shown below.

Steady State

SOLs within the planning horizon in the TVA PC area are determined by steady state analysis performed on the BES based on NERC TPL Reliability Standards. Determination of steady state SOLs include any facility that operates outside the TVA Planning Criteria in our steady state analysis using the FAC-010 R2 BES performance parameters for contingency analysis and system response including but not limited to generation re-dispatch and load curtailment as appropriate.

Stability

3.3 Instructions (continued)

SOLs within the planning horizon in the TVA Planning Authority Area are obtained from four types of analyses for stability. These studies are performed over a range of system demand levels as appropriate to identify worst-case conditions. The following procedures are used to determine these limits:

3.3 Instructions (continued)

A. Studies of limits related to NERC Category P0 system conditions

NERC Category P0 system conditions consist of a normal system considering all lines and protection schemes in service.

If thermal limits are exceeded, instability is found, or loads are tripped, then determine the amount of allowable generation which would relieve the overload and maintain stability. Consideration will be given to reducing generation in the area to eliminate an overload or keep the system stable. The SOL for stability could be a total generation limit in the area, a limit on the total export of power from the area, or a limit of power flowing on a set of lines in the area (i.e. a flowgate). This amount of generation becomes the SOL during the transmission outage. If the instability extends outside the TVA area then an IROL may be identified.

B. Studies of limits related to NERC Category P1 and P2 (E1) events

NERC Category P1 events include events consisting of the failure or tripping of a single transmission element with or without a fault. NERC Category P2 E1 includes the opening of a line section without a fault.

Various contingencies are simulated in the area of the system including three-phase, normally cleared faults, or the tripping of an element without a fault due to protection system or control system failure. The contingencies studied are listed in Sections 2 below. If thermal limits are exceeded, voltage criteria are not met, instability is found, or loads are tripped, then the amount of allowable generation is determined which would relieve the overload and maintain stability. Consideration will be given to reducing generation in the area to eliminate an overload or keep the system stable. The SOL for thermal overload or stability could be a total generation limit in the area, a limit on the total export of power from the area, or a limit of power flowing on a set of lines in the area (i.e. a flowgate). This amount of generation becomes the SOL during the transmission outage. If the instability extends outside the TVA area then an IROL may be identified.

3.3 Instructions (continued)

C. Studies of limits related to NERC Category P2 (E2-E4) and P3-P7 events

NERC Category P2 (E2-E4)events are single contingency events such as a bus section fault or internal breaker fault. NERC Category P3-P7 events are multiple contingency events such as a double contingency or single-line-to-ground fault with a stuck breaker.

Various contingencies are simulated in the area of the system including double contingencies consisting of two three-phase, normally cleared faults or a single-line-to-ground fault with delayed clearing due to a stuck breaker or other protection system or control system failure. The contingencies studied are listed in Section 2 below. If thermal limits are exceeded, voltage criteria are not met, instability is found, or loads are tripped (beyond applicable TPL criteria), then determine the amount of allowable generation which would relieve the overload and maintain stability. Consideration will be given to reducing generation in the area to eliminate an overload or keep the system stable. The SOL for thermal overload or stability could be a total generation limit in the area, a limit on the total export of power from the area, or a limit of power flowing on a set of lines in the area (i.e. a flowgate). This amount of generation becomes the SOL during the transmission outage. If the instability extends outside the TVA area then an IROL may be identified.

D. Studies of limits related to NERC Extreme events

NERC Extreme events include multiple events such as the loss of a whole substation or a three-phase-to-ground fault with a stuck breaker.

Various extreme contingencies are simulated in the area of the system identified in Reliability Standard TPL-001-4. The results of the simulations are documented and risks weighed when appropriate. If thermal limits are exceeded, voltage criteria are not met, instability is found, or loads are tripped (beyond acceptable limits), then determine the amount of allowable generation which would relieve the overload and maintain stability or determine other system changes that would mitigate the instability or overloads. Consideration will be given to reducing generation in the area to eliminate an overload or keep the system stable. The SOL for thermal overload or stability could be a total generation limit in the area, a limit on the total export of power from the area, or a limit of power flowing on a set of lines in the area (i.e. a flowgate). This amount of generation becomes the SOL during the transmission outage. If the instability extends outside the TVA area then an IROL may be identified.

3.3 Instructions (continued)

1. **(FAC-010 R1 and R1.1)** This methodology is used to determine SOLs and IROLs in TVA's PC Area for the planning horizon in accordance with the Requirements of NERC Reliability Standard.

   a. **(FAC-010 R1.2)** This procedure states that SOLs shall not exceed associated Facility Ratings.

   b. **(FAC-010 R1.3)** The subset of SOLs identified through this procedure that qualify as IROLs are identified through the process described in section 3F (for requirement FAC-010 R3.6).

2. **(FAC-010 R2)** SOLs shall provide BES performance consistent with the following:

   a. **(FAC-010 R2.1)** In the pre-contingency state and with all Facilities in service, the BES shall demonstrate transient, dynamic and voltage stability; all facilities shall be within their Facility Ratings and within their thermal, voltage and stability limits; the BES condition used shall reflect expected system conditions and shall reflect changes to system topology such as Facility outages.

   b. **(FAC-010 R2.2)** Following the single Contingencies identified for R2.2.1 through R2.2.3 below (which are the minimum contingencies that must be considered but do not exclude evaluating other appropriate contingencies), the system shall demonstrate transient, dynamic and voltage stability; all Facilities shall be operating within their Facility Ratings and within their thermal, voltage and stability limits; and Cascading Outages or uncontrolled separation shall not occur.

      (1) **(FAC-010 R2.2.1)** Single line to ground or three-phase Fault (whichever is more severe), with Normal Clearing, on any Faulted generator, line, transformer, or shunt device.

      (2) **(FAC-010 R2.2.2)** Loss of any generator, line, transformer, or shunt device without a Fault.

      (3) **(FAC-010 R2.2.3)** Single pole block, with Normal Clearing, in a monopolar or bipolar high voltage direct current system. Note that TVA presently has no HVDC equipment in its BES.

   c. **(FAC-010 R2.3)** Starting with all Facilities in service, the system's response to a single Contingency may include any of the following:

      (1) **(FAC-010 R2.3.1)** Planned or controlled interruption of electric supply to radial customers or some local network customers connected to or supplied by the Faulted Facility or by the affected area.

      (2) **(FAC-010 R2.3.2)** System reconfiguration through manual or automatic control or protection actions.

3.3 Instructions (continued)

d. **(FAC-010 R2.4)** To prepare for the next Contingency, system adjustments may be made including changes to generation, uses of the transmission system, and the transmission system topology.

e. (**FAC-010 R2.5)** Starting with all Facilities in service and following any of the multiple Contingencies identified in Reliability Standard TPL-003, the system shall demonstrate transient, dynamic and voltage stability; all facilities shall be operating within their Facility Ratings and within their thermal, voltage and stability limits; and Cascading Outages or uncontrolled separation shall not occur.

f. **(FAC-010 R2.6)** In determining the system's response to any of the multiple Contingencies identified in Reliability Standard TPL-003, in addition to the actions identified for R2.3.1 and R2.3.2, the following are acceptable:

(1) **(FAC-010 R2.6.1)** Planned or controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or the curtailment of contracted Firm (non-recallable reserved) electric power Transfers.

3. **(FAC-010 R3)** The Planning Authority's methodology for determining SOLs includes the following:

a. **(FAC-010 R3.1)** The study model used for determining SOLs are consistent with the steady state and dynamic models used for the NERC TPL Reliability Standards assessment. These models include the entire TVA PC Area as well as critical modeling details from other Planning Authority Areas that may impact the Facilities under study.

b. **(FAC-010 R3.2)** Contingency selection is consistent with that of the NERC TPL Reliability Standards assessment performed by TVA.

c. **(FAC-010 R3.3)** The level of detail included in the model encompasses all BES Facilities that could have an impact on the Facilities under study. The study year for items above considers the appropriate system enhancements for the time period that the SOL is expected to be in force.

d. **(FAC-010 R3.4)** Where appropriate, simulations of Special Protection Systems (SPS) or Remedial Action Schemes (RAS) shall be included in the model. Note that in the future, an SPS will be called a Remedial Action Scheme (RAS).

e. **(FAC-010 R3.5)** The configuration of the BES Transmission system used in the studies shall reflect expected system conditions, anticipated transmission system configuration, and changes to system topology such as Facility outages. Generating plants shall be modeled at expected output. The studies shall be performed over a range of system demand levels as appropriate, to identify worst-case conditions.

f. **(FAC-010 R3.6)** An IROL is defined as a subset of a SOL that, if violated, could lead to instability, uncontrolled separation, or Cascading outages that adversely impact the reliability of the Bulk Electric System beyond the TVA PC Area. The time constant, $T_{v,}$ for an IROL for the planning horizon is defined as 30 minutes.

Coordination and Communication of SOLs and IROLs in the Planning Horizon

The remainder of the Instructions section refers to FAC-014 for Requirements specific to the TP and PC. The other FAC-014 requirements are addressed in TRO-RC-SPP-30.238, SOLs Methodology for Operations Horizon.

Once the SOLs and IROLs are determined as described above, the PC communicates these with the adjacent PCs and those with a reliability-related need for those limits with an email stating the SOLs or IROLs if any.

(FAC-014 R1 & R2) These requirements apply to the RC and TP respectively and are addressed by TRO-RC-SPP-30.238.

(FAC-014 R3 & R4) The TVA PC/TP establishes SOLs, including IROLs, determined as described above for its PC Area as required by NERC Standard FAC-014-1 - Establish and Communicate System Operating limits.

4. **(FAC-014 R5)** The PC/TP provides SOLs and IROLs to those entities that have a reliability-related need for those limits and provide a written request that includes a schedule for delivery of those limits as follows:

   a. **(FAC-014 R5.1 and 5.2)** These requirements apply to the RC and TOP respectively and are address by TRO-RC-SPP-30.238.

   b. **(FAC-014 R5.3 & 5.4)** The PC/TP provides its SOLs (including the subset of SOLs that are IROLs) to adjacent PC and TP, and to TP, Transmission Service Providers, Transmission Operators and RC that work within its PC Area.

5. **(FAC-014 R6)** The PC/TP identifies the subset of multiple contingencies (if any), from Reliability Standard TPL-003 which result in stability limits.

   a. **(FAC-014 R6.1)** The PC/TP provides this list of multiple contingencies and the associated stability limits to the RC that monitor the Facilities associated with these Contingencies and limits.

   b. **(FAC-014 R6.2)** If the PC/TP does not identify any stability-related multiple Contingencies, the PC/TP so notifies the RC.

4.0 RECORDS

4.1 QA Records

None

4.2 Non-QA Records

None

NOTE

Terms referred to in this document that are defined in the NERC Glossary will not be defined here.

5.0 DEFINITIONS

Cascading outages - The uncontrolled successive loss of Bulk Electric System Facilities triggered by an incident (or condition) at any location resulting in the interruption of electric service that cannot be restrained from spreading beyond a predetermined area.

Source Notes
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Requirements Statement	Source Document	Implementing Statement
The purpose of this standard is to ensure that SOLs used in the reliable planning of the Bulk Electric System are determined based on an established methodology.	NERC FAC-010	C1
The purpose of this standard is to ensure that SOLs used in the reliable planning of the Bulk Electric System are determined based on an established methodology and are communicated as appropriate.	NERC FAC-014	C2