


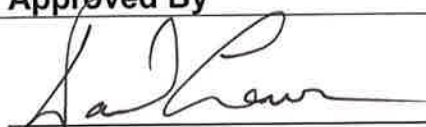


East Kentucky Power Cooperative
System Operating Limits Methodology for the Planning Horizon

Revision:
0002

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Revision Log

Revision	Effective Date	Description of Revision/Change
0	July 1, 2008	Initial Publication
1	August 1, 2010	Various changes to clarify the methodology, include language from the NERC Standard FAC-010-2, and also include language to address compliance with NERC Standard FAC-014-2.
2	August 1, 2011	Various formatting changes; added statements that any potential SOL violations will be documented; included explanation of process for identifying IROLs; clarified in section 5.0 that SOLs will be provided to those entities that make a written request

TABLE OF CONTENTS

1.0	PURPOSE	4
2.0	DEFINITIONS.....	4
3.0	SOL METHODOLOGY.....	5
4.0	DOCUMENT COMMUNICATION AND MAINTENANCE.....	8
5.0	ESTABLISHMENT AND COMMUNICATION OF SYSTEM OPERATING LIMITS.....	9

1.0 PURPOSE

The purpose of this document is to describe East Kentucky Power Cooperative's methodology used to determine System Operating Limits for the Planning Horizon (years 1 through 10) in accordance with NERC Reliability Standard FAC-010-2, as well as the procedure to establish and communicate those System Operating Limits in accordance with NERC Reliability Standard FAC-014-2.

2.0 DEFINITIONS

A **System Operating Limit (SOL)** for the Planning Horizon is defined as a value (such as MW, MVAR, MVA, Amperes, Frequency, or Volts) that satisfies the most limiting of the prescribed operating criteria for a specified system configuration to ensure operation within acceptable reliability criteria. SOLs are based upon certain operating criteria. These include but are not limited to:

- Facility Ratings (applicable pre- and post-contingency equipment or facility ratings)
- Transient Stability Limits (applicable pre- and post-contingency stability limits)
- Voltage Stability Limits (applicable pre- and post-contingency voltage stability)
- System Voltage Limits (applicable pre- and post-contingency voltage limits)

An **Interconnection Reliability Operating Limit (IROL)** for the Planning Horizon is defined as a limit which, if exceeded and then a contingency occurs, results in instability, uncontrolled separation, and/or cascading outages that impact the electrical grid beyond the EKPC Planning Authority area.

The EKPC **Bulk Electric System (BES)** is the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment operated at voltages of 100 kV or higher. Radial transmission facilities serving only load with one transmission source are not included in this definition.

Cascading is the uncontrolled successive loss of BES facilities 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.

A **Facility** is a set of electrical equipment that operates as a single BES Element (e.g., a line, a generator, a shunt compensator, transformer, etc.)

A **Facility Rating** is the maximum or minimum voltage, current, frequency, or power flow (real, reactive, or total) through a facility that does not violate the applicable equipment rating of any equipment comprising the Facility.

Stability is the ability of an electric system to maintain a state of equilibrium during normal and abnormal conditions or disturbances.

A **Stability Limit** is the maximum power flow possible through some particular point in the system while maintaining stability in the entire system or the part of the system to which the Stability Limit refers.

A **Thermal Rating** is the maximum amount of electrical current or power that a transmission line or electrical facility can conduct over a specified time period before it sustains permanent damage by overheating or before it sags to the point that it violates public safety requirements.

3.0 SOL METHODOLOGY

This methodology shall be used for developing SOLs in the planning horizon.

The Facility Ratings for EKPC's BES Facilities form the basis for defining the base set of SOLs for the EKPC system. The SOLs shall not exceed the associated Facility Ratings of EKPC's BES Facilities. The SOL for a Facility will equal the Facility Rating of that Facility unless a lower limit is identified for reasons such as the following:

- System instability
- An oscillatory or negatively damped system response
- Voltage collapse
- Potential separation of the system (islanding)

As part of the annual transmission assessment process, all studies (power flow, stability, voltage, transfer, etc.) should be reviewed to determine if any SOLs other than those based strictly on facility ratings should be established.

The following types of studies will be performed as necessary to determine the SOLs for the EKPC BES:

- o Steady State Power Flow Analysis
- o Voltage Stability Analysis

- o Transient and Dynamic Stability Analysis
- o Incremental Transfer Analysis

The models to be used to determine the SOLs for the EKPC BES will be the power flow and stability base cases from EKPC's current library of cases. These cases are developed from the NERC MMWG models developed annually. A full detailed representation is inserted for EKPC and LG&E/KU. The representation of the remaining neighboring areas is that contained in the NERC MMWG cases. The other control areas in the cases may be reduced to help improve solution performance. These base cases will be updated as necessary to represent the most accurate transmission system topology, generation dispatch, load representation, and area interchange for the study period of interest. For instance, if planned outages of transmission facilities within the study period of interest are known, these outages will be included in the assessment. Generation dispatch in the models will be based on economic dispatch. The load level in the models is generally peak load levels for the winter and summer season. EKPC will evaluate varying generation dispatch and load levels as necessary in the identification of SOLs.

Pre-Contingency State: All Facilities in Service for the Planning Horizon

For the pre-contingency state (all Facilities in service), the EKPC BES shall demonstrate transient, dynamic, and voltage stability; all Facilities shall be within their Facility Ratings and within their thermal, voltage, and stability limits. Any potential SOL violations shall be documented. In the determination of SOLs, the BES condition used shall reflect expected system conditions and shall reflect changes to system topology, such as Facility outages. EKPC analyzes SOLs for the pre-contingency state as part of its annual assessment required for NERC Reliability Standard TPL-001.

Single Contingency Outages for the Planning Horizon

The following types of single Contingencies on the EKPC BES will be simulated, if applicable:

- Single line to ground or three-phase Fault (whichever is more severe) with Normal Clearing, on any Faulted generator, line, transformer, or shunt device.
- Loss of any generator, line, transformer, or shunt device without a Fault.
- Single pole block, with Normal Clearing, in a monopolar or bipolar high voltage direct current system (EKPC currently has no such Facilities).

For these Contingencies, the EKPC BES shall perform as follows:

- Demonstrate transient, dynamic, and voltage stability

- All Facilities shall operate within their Facility Ratings and within their thermal, voltage, and stability limits
- Cascading Outages and/or uncontrolled separation shall not occur

Starting with all Facilities in service, the system's response to a single Contingency may include any of the following:

- 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.
- System reconfiguration through manual or automatic control or protection actions.
- 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.

EKPC analyzes SOLs for the single-contingency state as part of its annual assessment required for NERC Reliability Standard TPL-002. Any potential SOL violations shall be documented.

Multiple Contingency Outages for the Planning Horizon

The multiple Contingencies identified in Reliability Standard TPL-003 will also be simulated to determine SOLs on the EKPC BES. For these multiple Contingencies, the EKPC BES shall perform as follows:

- Demonstrate transient, dynamic, and voltage stability
- All Facilities shall operate within their Facility Ratings and within their thermal, voltage, and stability limits
- Cascading Outages and/or uncontrolled separation shall not occur

The EKPC system's response to any of these multiple Contingencies may include any of the following:

- 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.
- System reconfiguration through manual or automatic control or protection actions.
- 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.

Any potential SOL violations shall be documented.

Contingencies Simulated

The Contingencies to be simulated are those described in the Reliability Standards TPL-002 and TPL-003, and include those simulated in EKPC's annual transmission assessment to ensure compliance with the NERC Transmission Planning (TPL) Reliability Standards. When performing this assessment, any Facilities identified as violating their Facility Limits or any violations of EKPC planning criteria must have a corrective action planned to address the issue prior to reaching the operating horizon.

Special Protection Systems/Remedial Action Plans

EKPC does not presently use Special Protection Systems (SPS) or Remedial Action Plans (RAP). If these are installed on the EKPC system at some future date, the system will be assessed with the SPS or RAP active.

Identification of IROLs

If an SOL is exceeded and a contingency then occurs that results in instability, uncontrolled separation, and/or cascading outages that impact the electrical grid beyond the EKPC Planning Authority area, then this SOL will be defined as an Interconnection Reliability Operating Limit (IROL). The T_v for an IROL for the Planning Horizon shall be defined as 30 minutes.

EKPC will evaluate the system to determine if adequate resources and operational actions are available to reposition the system within 30 minutes to a new operating state that allows continued reliable operation in the event that a second contingency (n-1-1) occurs. This type of analysis ensures that the system can both withstand a first contingency and then be repositioned to withstand the second contingency within 30 minutes without resulting in an IROL violation.

Thermal overloads greater than 125% of an SOL will be tested for potential instability. These are tested for potential cascading by tripping the overloaded branch and checking for subsequent overloads greater than 125% of an SOL. This process continues until all flows are with 125% of applicable SOLs or until the case fails to converge. Additionally, non-converged contingencies are tested for potential instability.

4.0 DOCUMENT COMMUNICATION AND MAINTENANCE

EKPC will issue this SOL methodology to the following entities:

- Each adjacent Planning Authority (PA)/Transmission Planner (TP) and each PA/TP that indicates it has a reliability-related need for the methodology. The adjacent Planning Authorities/Transmission

Planners to be provided this methodology are presently identified as AEP, Dayton Power & Light, Duke Energy-Ohio, LG&E/KU, MISO, PJM, and TVA. Presently, no other PA/TP has identified a need for the methodology.

- Each Reliability Coordinator (RC) and Transmission Operator (TOP) that operates any portion of EKPC's PA Area. TVA is the only RC presently operating in EKPC's PA Area. EKPC is the only TOP presently operating in the EKPC PA Area.
- Each Transmission Planner that works in EKPC's PA Area. EKPC is the only Transmission Planner presently operating in the EKPC PA Area.

If a recipient of this SOL methodology provides documented technical comments on the methodology, EKPC will provide a documented response to that recipient within 45 calendar days of receipt of those comments. The response will indicate whether a change will be made to this SOL methodology and, if no change will be made to this SOL methodology, the reason will be given.

EKPC will review this SOL methodology periodically to determine if any revisions should be made. EKPC will issue any revisions to this document to the above entities within five business days of completion of the revisions.

5.0 ESTABLISHMENT AND COMMUNICATION OF SYSTEM OPERATING LIMITS

EKPC, as a Planning Authority/Transmission Planner, will establish SOLs, including IROLs, for its Planning Authority/Transmission Planner Area that are consistent with its SOL methodology.

EKPC, as a Planning Authority/Transmission Planner, will issue its SOLs (including the subset of SOLs that are IROLs) to the following 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:

- Each adjacent Planning Authority (PA)/Transmission Planner. No adjacent Planning Authorities or Transmission Planners have yet made such a request for EKPC's SOLs.
- Each Reliability Coordinator (RC), Transmission Service Provider (TSP), and Transmission Operator (TOP) that operates any portion of EKPC's PA Area. TVA is the only RC presently operating in EKPC's PA Area. EKPC is the only TSP and TOP presently operating in the EKPC PA Area. No requests have been made for EKPC's SOLs by these entities.

- Each Transmission Planner that works in EKPC's PA Area. EKPC is the only Transmission Planner presently operating in the EKPC PA Area.

EKPC will identify the subset of multiple contingencies (if any), from Reliability Standard TPL-003 which results in stability limits. EKPC will provide this list of multiple contingencies and the associated stability limits to the Reliability Coordinators that monitor the facilities associated with these contingencies and limits. If EKPC does not identify any stability-related multiple contingencies, the Reliability Coordinator shall be notified that none have been identified.