Transmission Strategy and Planning

SYSTEM OPERATING LIMITS METHODOLOGY FOR THE PLANNING HORIZON

Effective Date July 1, 2008

Prepared By:
Michael G. Toll, Principal Engineer

Approved By:

Brian Keith Yocum, Manager - Transmission Strategy and Planning **Date:** 6-26-08

Edwin R. Staton, Director - Transmission **Date:** 6/26/08

Current Revision Description

Date	Description
July 1, 2008	Initial Issue.

PURPOSE:

R1: This document describes the methodology included in E.ON's Transmission Planning Guidelines to determine System Operating Limits and Interconnection Reliability Operating Limits in E.ON's Planning Authority Area for the planning horizon in accordance with the Requirements of NERC Reliability Standard FAC-010-2.

DEFINITIONS:

The following definitions are extracted from the NERC Glossary of Terms May 2, 2007:

System Operating Limit (SOL): The value (such as MW, MVar, 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. System Operating Limits 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 Ratings (Applicable pre- and post-Contingency stability limits)
- Voltage Stability Ratings (Applicable pre- and post-Contingency voltage stability)
- System Voltage Limits (Applicable pre- and post-Contingency voltage limits)

Interconnection Reliability Operating Limit (IROL): A System Operating Limit that, if violated, could lead to instability, uncontrolled separation, or Cascading Outages that adversely impact the reliability of the Bulk Electric System.

Cascading: The uncontrolled successive loss of Bulk Electric System 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.

Facility Rating: The maximum or minimum voltage, current, frequency, or real or reactive power flow through a facility that does not violate the applicable equipment rating of any equipment comprising the facility.

Thermal Rating: The maximum amount of electrical current 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.

Normal Rating: The rating as defined by the equipment owner that specifies the level of electrical loading or output, usually expressed in megawatts (MW) or Mvar or other appropriate units, that a system, facility, or element can support, produce, or withstand through the daily demand cycles without loss of equipment life.

Emergency Rating: The rating as defined by the equipment owner that specifies the level of electrical loading or output, usually expressed in megawatts (MW) or Mvar or other appropriate units, that a system, facility, or element can support, produce, or withstand for a finite period. The rating assumes acceptable loss of equipment life or other physical or safety limitations for the equipment involved.

Stability Limit: 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.

DISTRIBUTION:

R4 and R5: This SOL Methodology, and any change to it, will be issued to the following entities prior to the effective date of the change.

1) Each adjacent Planning Authority (AEP, BREC, DEM, EEI, EKPC, OVEC, SIGE and TVA) and each Planning Authority that indicated it has a reliability-related need (none) for the methodology.
2) Each Reliability Coordinator (TVA) and Transmission Operator that operates any portion of the E.ON U.S. (E.ON) Planning Authority Area (none).
3) Each Transmission Planner that plans a portion of the E.ON Planning Authority Area (none).

If a recipient of this SOL Methodology provides documented technical comments on the methodology, the E.ON Planning Authority 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 the SOL Methodology and, if no change will be made, the reasoning behind the decision.

The E.ON Planning Authority will keep all superseded portions of its SOL Methodology for 12 months beyond the date of the change and will keep all documented comments and associated responses for three years.

PROCEDURE TO DETERMINE SOLs IN THE PLANNING HORIZON:

R1.1: E.ON's Transmission Planning group annually performs transmission expansion planning assessments and studies to ensure the reliability of the E.ON Planning Authority Area. The annual Assessment of Bulk Electric System (BES) performance will include evaluation of boundary conditions in the near-term planning horizon and the establishment of SOLs and IROLs, as necessary.

The annual Assessment will include pre-contingency, single contingency and multiple contingencies, indicated as NERC Categories A, B and C in Table 1. The steady-state analysis of system performance simulates single and multiple contingencies without implementation of manual or automatic system adjustments. Voltage Stability analysis will be performed if the BES contingency simulated in the steady-state analysis causes a BES voltage deviation greater than 8% or a post-contingency, pre-capacitor switching BES voltage less than 85%. Angular Stability analysis will be performed to assess the impact of the subsequent tripping of facilities with a post-contingency flow in excess of 110% of the emergency thermal limit.

Steady-state voltage stability analysis will be performed via V-Q analysis on summer and winter peak models. Transient voltage stability analysis will be performed on summer and winter peak models. Transient and dynamic angular stability will be performed on 1) summer peak models with all generators at maximum output and the necessary export split equally to the north and south and 2) summer models with E.ON load reduced such that all coal fired generators are at maximum output and an incremental 500 MW export split equally to the north and south.

The BES performance must meet the following reliability margins for stability:

- The voltage collapse point in the V-Q analysis shall not occur above 0.85 pu voltage.
- The study load level must be less than the maximum load operating point determined at 1) 5% below the load at the collapse point on the P-V curve for simulations of contingencies with a Required Performance Level of 1 or 2 or 2) 2.5% below the load at the collapse point on the P-V curve for simulations of contingencies with a Required Performance Level 3 or 4.
- All generators must remain stable. The BES voltages at generator interconnections must recover to 0.90 p.u. voltage within 1.0 seconds after the fault is cleared. All machine rotor angle oscillations will be positively damped.

R1.2: E.ON's procedure requires that SOLs shall not exceed associated facility ratings.

R1.3: The subset of SOLs identified through this procedure that qualify as IROLs are identified through the process described in section 3.6.

R2, R2.1, R2.2 and R2.5: 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 for pre-contingency, single contingency and multiple contingencies, indicated as NERC Categories A, B and C in Table 1:

Table 1
Transmission Contingencies and Measurements

NERC Cat	Contingency	Steady State Analysis	Dynamic Analysis	Required Performance Level
A	No Contingencies	Yes		1
B 1-3	Outage of a generator, transmission circuit, transformer or shunt device.	Yes	a,b	2
C3	Outage of two generators.	Yes	b	2
C3	Outage of a generator and a transmission circuit.	Yes	b	2
C3	Outage of a generator and a transformer.	Yes	b	2
	Outage of a transmission circuit or transformer with plant at maximum output.	Yes		2
C1	Outage of a bus section.	Yes	c	3
C2	Outage of a breaker.	Yes	c	3
C5	Outage of two circuits on a multiple circuit tower line. [more than 1 mile in length]	Yes	d	3
C3	Outage of two transmission circuits.	Yes	b	4
C3	Outage of a transmission circuit and a transformer.	Yes	b	4
C3	Outage of two transformers.	Yes	b	4
C6-8	Outage of a generator, transmission circuit or transformer.	No	e	2
C9	Outage of a bus section.	No	e	3

Fault Types:

a) None
b) Single Line Ground or 3-Phase, with Normal Clearing
c) Single Line Ground, with Normal Clearing
d) Non 3-Phase, with Normal Clearing
e) Single Line Ground, with Delayed Clearing

R2.3: The determination of SOLs, starting with all Facilities in service, may include the following actions in response to a single contingency:

- Planned or controlled interruption of 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.

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.

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 in R2.3, the following are acceptable:

- 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.

R3.1, R3.3 and R3.5: Study Model Detail and Transmission Configuration
The SOL evaluation will use the power flow and stability Base Case models developed annually to support the planning process.

Powerflow

Transmission base cases (Base Case(s)) for steady state analysis are developed on an annual basis to reflect the most current information and assumptions available concerning the modeling of future year's system load level and distribution of loads, generation and transmission expansion, firm transmission service obligations and representations of similar assumptions for other systems.

Base Case models are developed for each of the summer and winter peak periods included in the most recent NERC MMWG Base Case Series. Additionally, a Long-Term (10+ yr) winter peak Base Case is developed utilizing the last winter peak case in the series. Each Base Case contains a detailed representation of the LGEE and EKPC control areas from 69 kV through 500 kV. The NERC representation of all first-tier systems in the NERC models is incorporated into the Base Cases. Second-tier systems, and beyond are grouped considering geographic location and electrical interconnections and then equivalences are developed.

The generation in the LGEE control area is economically dispatched. The Transmission level voltage at the power plants will be regulated in the Base Case models.

Network Customers provide forecasts of the Network Load levels to include in the models. E.ON's load level is based on the Company 50/50 forecast with all interruptible, or curtailable, loads being served. The anticipated transmission configuration is based upon the most recent Transmission Expansion Plan submitted to the Independent Transmission Organization (ITO). Planned maintenance outages are not modeled. Existing and planned outages of generators and transmission facilities of more than 3 months in duration that are likely to occur at the time of peak of the Base Case season will be simulated.

Stability

The models available in the most recent NERC MMWG Base Case Series are used for stability simulations. The E.ON's BES is reviewed and modified, if necessary, to be consistent with the Transmission Expansion Plan.

R3.2: Contingency selection
The SOL evaluation will use the applicable contingency selection criteria used in the planning process.

Generator Contingency Selection - The Single Generator Contingency analysis will simulate an outage of the largest generator at each transmission bus. The Double Generator Contingency analysis will simulate an outage of the two largest generators at each plant and at each transmission bus. Smaller generators or combinations thereof will produce less severe results.

Transmission Contingency Selection - Category B analyses will simulate each Branch Contingency and each Multiple Branch Contingency in E.ON, each Branch Contingency in EKPC that would cause an E.ON transmission flow increase greater than 10% of the element Emergency rating and each 100 kV or higher Branch Contingency in other first-tier utilities that would cause an E.ON flow increase greater than 10% of the element Emergency rating. Category C2 and C3 contingencies will be tested by simulating all combinations of the Single Generator Contingencies and all Category B Transmission

Contingencies. All Category C bus and double circuit (>1 mi) contingencies and all Category D contingencies in the E.ON system will be simulated.

Branch Contingency - A Branch is a connection between busses with 3 or more network connections. When a branch has multiple segments with multiple loads and/or radial connections, the outage of the segments on each end of the branch will be simulated individually to create the worst case Branch contingency.

Multiple Branch Contingency - A single fault may outage multiple transmission components and Branches in the common zone of relay protection. Reclosure of the non-faulted components will be evaluated but reclosing is not required if violations occur as a result of the post-fault restoration. Procedures should be developed and documented if the component is not to be reclosed.

High Voltage Direct Current Contingencies – E.ON does not operate any HVDC facilities and is not aware of any HVDC facilities within the first-tiers utilities. Therefore, E.ON does not evaluate HVDC contingencies.

R3.4: E.ON does not use Special Protection Systems.

R3.6: IROL criteria

SOLs that result in uncontrolled tripping of EHV facilities in other areas or generators in other areas will be considered Interconnected Reliability Operating Limits (IROLs). The Tv for a IROL in the planning horizon is 30 minutes.