



**SYSTEM OPERATING LIMIT METHODOLOGY
FOR
THE OPERATIONS HORIZON**

Revised: September 29th, 2009

Effective Date: October 12th, 2009

SECTION 1 BACKGROUND

This document is the Operations Horizon Methodology for developing System Operating Limits (SOL), pursuant to the requirements of NERC Reliability Standards FAC-011 and FAC-014.

SECTION 2 DEFINITIONS

2.1 System Operating Limit (SOL): As stated in the NERC Glossary of Terms Used in Reliability Standards (http://www.nerc.com/files/Glossary_12Feb08.pdf), an SOL is defined as 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)

2.2 Interconnection Reliability Operating Limit (IROL): As stated in the NERC Glossary of Terms Used in Reliability Standards, an IROL is defined as 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.

2.2.1. IROL T_v : The maximum time that an IROL can be violated before the risk to the interconnection or other Reliability Coordinator Area(s) becomes greater than acceptable. Each IROL T_v shall be less than or equal to thirty (30) minutes.

2.3 Operations Horizon: This term is not explicitly defined in the NERC Glossary of Terms Used in Reliability Standards; however ERCOT ISO determines this to be the period from Real-Time Operations up to one year in the future. Refer to the NERC Reliability Concepts document posted on the NERC website (<http://www.nerc.com/page.php?cid=11151123>) for further information.

2.4 Power Generation Company: (ERCOT Protocols Section 2 “Definitions and Acronyms) An Entity registered by the PUCT that: (1) generates electricity that is intended to be sold at wholesale; (2) does not own a transmission or distribution Facility in this state other than an essential interconnecting Facility, a Facility not dedicated to public use, or a Facility otherwise excluded from the PURA definition of “electric utility;” and (3) does not have a certificated service area,

although its affiliated electric utility or transmission and distribution utility may have a certificated service area. This includes Non-Opt in Entities in the ERCOT Interconnection and generation companies that also own transmission level equipment from their resource to the point of interconnection.

- 2.5 Qualified Scheduling Entity: (ERCOT Protocols Section 2 “Definitions and Acronyms)
A Market Participant that is qualified by ERCOT in accordance with Section 16, Registration and Qualification of Market Participants, to submit Balanced Schedules and Ancillary Services bids and settle payments with ERCOT.
- 2.6 Transmission and/or Distribution Service Provider (TDSP): (ERCOT Protocols Section 2 “Definitions and Acronyms) An Entity that owns or operates for compensation in this state equipment or Facilities to transmit and/or distribute electricity, and whose rates for Transmission Service, distribution service, or both are set by a Governmental Authority.
- 2.7 Transmission Facilities: (ERCOT Protocols Section 2 “Definitions and Acronyms).The following Facilities are deemed to be Transmission Facilities:
(1) Power lines, substation, and associated Facilities, operated at 60 kV or above, including radial lines operated at or above 60 kV.
(2) Substation Facilities on the high side of the transformer, in a substation where power is transformed from a voltage higher than 60 kV to a voltage lower than 60 kV or is transformed from a voltage lower than 60 kV to a voltage higher than 60 kV.
(3) The direct current interconnections with the Southwest Power Pool (SPP), Western System Coordinating Council (WSCC), Comision Federal de Electricidad, or other interconnections.
- 2.8 Transfer Limit: The value, in MW, on a Zonal Interface identified as the limit to which free flow of energy across specified Congestion Zones is allowed. The Transfer Limit is calculated in the Day-Ahead process as indicated in the *Day-Ahead Limit Calculation and Enforcement Procedure*. The ERCOT ISO also utilizes a Real-Time Limit Calculator application to determine Transfer Limits on an hourly basis and upon request from an operator.
- 2.9 Commercial Model: (ERCOT Protocols Section 2 “Definitions and Acronyms). Transmission model developed by ERCOT that arranges groups of Generation Resource and Load busses into Congestion Zones that have similar impacts on Commercially Significant Constraints
1. Generating Facility Ratings: (ERCOT Operating Guide Section 3.1.4 “Power Generation Companies”). PGCs’ reporting QSEs shall, as a minimum, provide adequate modeling information, as follows:
- Machine impedance and characteristics;
 - Excitation system data, governor system constants;

- Transformer impedance; and
- Other relevant information.

This information is necessary to support ERCOT ISO and TDSP's ability to perform operational and planning studies such as:

- Transient and Dynamic Stability
- Short Circuit
- Load Flow
- Reliability Evaluations

The PGC's reporting QSE shall provide the following information to ERCOT ISO Control Area Authority at the times specified:

TIME	INFORMATION
Every 10 seconds	Generation net MW output Generation net MVAR Status of switching devices in switchyard Generating unit breaker status Generating unit High Operating Limit Generating unit Low Operating Limit
Daily	Planned unit status, Planned unit capability (both hourly and daily), Fuel limitations. The reporting Entity will promptly report this condition to ERCOT Control Area Authority
Annually	Seasonal capability where applicable, Planned maintenance schedules. This information shall be updated when it changes.
Upon request	Fuel capability as described in Section 6.2.7, Unit Alternative Fuel Capability Operating Guide Form, in conjunction with an Operating Condition Notice, Alert,

2.10 Transmission Facility Ratings: Pursuant to ERCOT ISO's Operating Guide Section 3.1.6 "Responsibility for Equipment Ratings", TDSPs are responsible for determining the rating of their facilities. TDSP's shall provide the ERCOT ISO with three (3) nominal Transmission Facility Ratings:

Continuous Rating

The continuous MVA rating of a Transmission Facility (including substation terminal equipment in series with a conductor or transformer) at the applicable ambient temperature. The Transmission Facility can operate at this rating indefinitely without damage, or violation of National Electrical Safety Code (NESC) clearances.

Emergency Rating

The two (2) hour MVA rating of a Transmission Facility (including substation terminal equipment in series with a conductor or transformer) at the applicable ambient temperature. The Transmission Facility can operate at this rating for two (2) hours without violation of NESC clearances or equipment failure.

Fifteen Minute Rating

The fifteen (15) minute MVA rating of a Transmission Facility (including substation terminal equipment in series with a conductor or transformer) at the applicable ambient temperature and with a step increase from a prior loading of ninety percent (90%) of the Continuous Rating. The Transmission Facility can operate at this rating for fifteen (15) minutes, assuming its pre-contingency loading was ninety percent (90%) of the Continuous Rating limit at the applicable ambient temperature, without violation of NESC clearances or equipment failure. This rating takes advantage of the time delay associated with heating of a conductor or transformer following a sudden increase in current.

SECTION 3 METHODOLOGY FOR DETERMINATION OF SOLS

- 3.1 This methodology is applicable for developing System Operating Limits (SOLs) to be used in the Operations Horizon.
- 3.2 The Network topology used in Real-Time has the most current and updated facility ratings. SOLs shall always equal facility ratings unless studies have established a lower limit based on operational conditions. Under no circumstance shall SOLs exceed their associated facility ratings. The Voltage SOLs are defined as 0.95 -1.05 PU for basecase and 0.90 – 1.10 PU for Post Contingency.
- 3.3 For the Operations Horizon, the ERCOT ISO uses study tools to identify IROLs that are subsets of SOLs. The identification of IROLs is performed using offline studies. IROLs are monitored in Real-Time using Real-Time applications and tools. The ERCOT ISO also has a *Monitoring SOL for Potential IROL and Reporting Criteria* procedure which details steps to identify SOLs in Real-Time that could potentially be IROLs.
- 3.4 The ERCOT ISO uses two types of study models for determining SOLs. The first is the Network Operations Model (or Operational Model, as defined in the ERCOT Protocols), which is used in all Energy Management System (EMS) applications. The second is the System Planning Model. Both the models have the entire topology modeled for the ERCOT Interconnection, including all non-radial facilities within the ERCOT Bulk Electric System (BES).

For the Operations Model, facilities that are rated at 60 kV and above (69, 138, & 345 kV Nominal) are modeled. This includes industrial and/or Private Area

Network facilities which have submitted topological modeling information to the ERCOT ISO. The System Planning Model consists of both Steady-State models and Dynamic models. The Steady-State System Planning Model is created and updated by the Reliability and Operations Subcommittee Steady-State Working Group (ROS SSWG) of which ERCOT ISO System Planning Department is a member. The Dynamic Planning Model is created based on the ROS SSWG Model, but also includes additional parameters for dynamic simulation studies. Both models are unequivalenced bus models. Operations Horizon studies are performed using the System Planning Models as required.

The Topology used in EMS applications, including the Study Network Analysis application, is capable of using dynamic ratings for transmission lines which ERCOT TOs have identified as dynamically rated. Real-Time applications and tools will use the dynamically rated lines rating based on actual temperatures. The dynamic ratings of these lines shall be the SOLs. Future studies which use the Operations Model use dynamic ratings based on expected temperatures.

The ERCOT Interconnection is a single Interconnection and is not connected synchronously with any other Reliability Coordinators or Balancing Authority.

- 3.5 The contingency list to be used in the Operations Horizon includes non-radial BES transmission lines and transformers greater than 100 kV, and all generators 10 MW and above. Two transmission lines sharing the same tower for longer than 0.5 mile shall be modeled as a double-circuit contingency. Transmission line contingencies are defined for all non-radial line segments that make up the circuit between two or more fault relaying breakers located at two or more switching stations. Similarly, contingencies for Autotransformers are defined for the Autos and their corresponding fault relaying breakers. The ERCOT ISO's procedure *Definitions and Maintenance of Contingencies* provides detailed step-by-step instructions for defining and modeling contingencies.
- 3.6 Stability Limits obtained from the ERCOT ISO's System Planning Department associated with multiple contingencies in accordance with the System Planning Department's "SOL Methodology for Planning Horizon" document. . The System Planning Department shall notify the Operations Planning Department whenever stability limits are evaluated. Any changes to the contingencies associated with the stability limit shall be provided to Operations Planning as per the System Planning Department's "SOL Methodology for Planning Horizon" document.

The Operations Planning Department will study the Stability Limits and associated multiple contingencies for Operations Horizon as per the procedure "Stability Limits for Operations Horizon". This procedure shall address the process to modify Stability Limits and the associated multiple contingencies for Operations Horizon.

Contingencies identified after conducting review for Operations Horizon shall be monitored in Real-Time using Real-Time applications and tools. ERCOT ISO uses Voltage Security Assessment Tool (VSAT) in Real-Time to monitor voltage stability limits. Reliability margins are established for these limits through off-line studies, and applied in Real-Time.

- 3.7 The ERCOT ISO's Operations Network Model consists of transmission lines, autotransformers, circuit breakers and switches, reactive devices, generation units and step-up transformers, loads, and other relevant electrical components. The System Planning Model consists of similar information as mentioned above as well as additional details and modeling information necessary to perform dynamic and transient stability studies. Both the Operations Network and System Planning Models are used to determine SOLs.
- 3.8 Special Protection Systems (SPSs) are designed to ensure grid reliability is maintained following a contingency or system disturbance by administering automatic corrective actions. The ERCOT ISO, in fulfilling its role as Reliability Coordinator, reviews all Special Protection System proposals, and approves or rejects them based on studies performed by both Operations Planning and System Planning. The Transmission Owner who operates and maintains a given SPS shall notify the ERCOT ISO when a given SPS is enabled or disabled.
- 3.9 Anticipated topology, generation dispatch and load levels are utilized in performing offline studies and near-Real-Time studies. Studies are conducted to investigate any thermal and voltage limit exceedances for the Operations Horizon. Dynamic Stability and Transient Stability studies are conducted offline as deemed necessary. Based on the results of these studies, changes may be made to the Operating Desk Procedure to mitigate potential SOL exceedances on case by case basis.
- 3.10 ERCOT evaluates all IROLs on an annual basis. ERCOT also reviews SOL exceedances in the Operations Horizon (Real-Time) to determine if they qualify as potential IROLs based on the following criteria:
 - a. Potential IROLs will be investigated when the Real-Time Contingency Analysis application indicates a thermal rating exceedance in excess of 125% of the SOL of the monitored facility rating (Emergency Rating).
 - b. Potential IROLs will also be investigated for base case exceedance greater than 100% of the normal facility ratings.
 - c. Potential IROLs will also be investigated when the Real-Time Contingency Analysis application indicates an under-voltage condition characterized by bus voltages of less than 90% across three or more related BES facilities or an over-voltage condition greater than 110% across three or more related BES facilities.
 - d. An unsolved or divergent contingency is present in RTCA.

If an SOL exceedance identified is validated (i.e. no bad SCADA or model data, etc), then an off-line study shall be performed for the contingency which identified the SOL exceedance. The element identified as having the SOL exceedance shall be opened, and the system response to the loss of this will be evaluated. If the results of this evaluation indicate cascading outages or voltage collapse which is not confined, then this SOL exceedance is considered to be an IROL.

IROLs identified in the annual studies will have the corresponding T_v assigned based on the Loss of Load Probability of one occurrence in ten years. If the resulting IROL T_v is greater than 30 minutes then IROL T_v shall be equal to 30 minutes. Under no circumstances shall the T_v be greater than 30 minutes. For SOLs that are identified as potential IROLs, T_v shall be assumed to be:

- I. If the post-contingency loading exceeds or equals the 15-minute Rating, the T_v shall be equal to 15 minutes.
- II. If the post-contingency loading is less than the 15-minute rating, the T_v shall be equal to 30 minutes.

3.11 The Contingency Analysis package in the EMS (RTCA in real-time, STCA in the study environment) is utilized to determine SOLs. When RTCA indicates a facility rating exceedance post-contingency for an element for a given contingency, congestion management techniques are employed per the *Transmission and Security Desk Procedure*. Once an RTCA potential post-contingency rating exceedance is confirmed as valid, the facility rating on the associated element becomes an SOL.

SECTION 4 SOL PROVISIONS

The ERCOT ISO is not synchronously connected to any other Balancing Authority or Reliability Coordinator. The ERCOT Interconnection does not have any intra-regional DC Transmission system within its footprint. When performing studies in the Operations Horizon, the following provisions shall be met:

- 4.1 In the pre-contingency state, 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. In determining SOLs, the BES condition used shall reflect current or expected system conditions and shall reflect changes to system topology such as Facility outages.
- 4.2 Following single contingencies as defined in (a) and (b) below, 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.
 - a) Single-Line-to-ground or three-phase fault (whichever is more severe), with normal clearing, on any faulted generator, line, transformer, or shunt device
 - b) Loss of any generator, line, transformer, or shunt without a Fault.

- 4.3 In determining the system's response to a single Contingency, the following shall be acceptable:
- a) 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.
 - b) Interruption of other network customers, only if the system has already been adjusted, or is being adjusted, following at least one prior outage, or if the real-time operating conditions are more adverse than anticipated in the corresponding studies, e.g., load greater than studied. System reconfiguration through manual or automatic control or protection actions.
- 4.4 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.

SECTION 5 DISSEMINATION OF THE ERCOT ISO SOL METHODOLOGY FOR THE OPERATIONS HORIZON

This Methodology document shall be provided to the following entities as applicable and where appropriate whenever this document is reviewed and updated. The document shall be distributed to the email distribution list ERCOT_TPANDTO@LISTS.ERCOT.COM. This Methodology shall also be posted on the ERCOT ISO website in a secure area. The entities are as follows:

- Any adjacent Reliability Coordinator (no synchronous ties, so none exist as of this revision)
- Any other Reliability Coordinator who has indicated a reliability-related need to have the methodology
- Each Planning Authority and Transmission Planner that models any portion of the ERCOT Interconnection
- Each Transmission Operator that operates in the ERCOT Interconnection

Any of the recipients indicated above may submit technical comments on this methodology via an email to comments@ercot.com or postal mail (physical address for postal mail is provided below). The ERCOT ISO shall respond to these technical comments within 45 calendar days of receipt of the comments. The response shall indicate whether or not this methodology shall be changed and the rationale used in making that determination. Copies of the technical comments and response shall be kept on file in the Operations Support Network drive. Copies of the communications with these entities shall be kept on file in the Operations Support Network Drive to verify that the SOL Methodology was provided.

Postal Address

Director System Operations
2705 West Lake Drive
Taylor, Texas 76574

ADDITIONAL RESOURCES

ERCOT Operating Guides

- <http://www.ercot.com/mktrules/guides/operating/index>

ERCOT Protocols

- <http://www.ercot.com/mktrules/protocols/>

ERCOT ISO Planning and Operations Information (secure site)

- <http://planning.ercot.com/login/login>

REVISION HISTORY

Previous versions of this Methodology shall be kept on file in the Operations Support Network drive. The most recent five (5) revisions to this Methodology shall be summarized in the table below.

REVISION	DESCRIPTION OF CHANGES	REVISION DATE	REVISION AUTHOR
0	New Methodology document	October 1 2008	Chad Thompson
1	Expand upon Rev 0 commentary; include additional definitions	January 1 2009	Chad Thompson
2	Include Implementation Date to meet FAC-011 R4.	March 6 2009	Chad Thompson
3	Restructuring the methodology, description on how to monitor potential IROLs etc.	April 23 2009	Sandip Sharma
4	Incorporate entity comments and other minor changes	July 15 2009	Sandip Sharma
5	Some minor changes and clarification on how to conduct studies for potential IROLs.	Sept 29 2009	Sandip Sharma