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### **Purpose**

To provide a methodology for determining the System Operating Limits (SOL) for the Planning Horizon at the California ISO.

### **Applicable Reliability Standard(s)**


This methodology is based on the requirements and measures outlined in the North American Electric Reliability Corporation (NERC) Reliability Standard FAC-010 titled “System Operating Limits Methodology for the Planning Horizon” and other industry best practices applicable to a Planning Authority.

### **Applicability to California ISO**

The California ISO (ISO) has registered with NERC as a Planning Authority. This SOL methodology is applicable for determining System Operating Limits in the Planning Horizon within the ISO’s Planning Authority Area (R1). Since this methodology addresses the Planning Horizon (typically beyond one year to a maximum of ten years), it is assumed that the portfolio of facilities can be changed during that time to meet the SOLs developed (R1.1). Also the SOLs developed using this methodology shall not exceed associated Facility Ratings (i.e. Applicable Ratings) (R1.2).

### **SOLs and IROLs**

All operating limits, including path ratings and Interconnection Operating Transfer Capabilities (OTCs), are designated SOLs at the California ISO, in the planning horizon. A subset of the

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SOLs, which if exceeded, could cause severe impacts on the neighboring Balancing Authorities, is considered Interconnection Reliability Operating Limit (IROL). These severe impacts include: instability, uncontrolled separation(s), and cascading outages.

Since the Western Electric Coordinating Council (WECC) operating philosophy is to operate only in conditions that have been studied, there are no IROLs for normal operating conditions. An IROL condition may be created by the occurrence of one or more unanticipated contingencies. (R1.3)


### Study Methodology

In the planning horizon, the determination of SOLs generally follow the process and methodology outlined in the WECC Path Rating Process as detailed in Section 4.0 of the WECC document entitled “Overview of Policies and Procedures for Regional Planning Project Review, Project Rating Review, and Progress Reports”. Section 4.0, “The WECC Procedure for Project Rating Review” requires the California ISO and other planning authorities in the Western Interconnection to perform studies in a way that conforms to the following requirements, steps and processes: (R2)

1. Applicable reliability performance standards/criteria:
  - a) System should be transiently and dynamically stable
  - b) System should have adequate reactive margin to protect against voltage collapse
  - c) All transmission facilities should be within their applicable thermal ratings
2. Required Studies: Power flow, Transient Stability and Post-transient studies will be performed in accordance with the NERC/WECC Planning Standards (Planning Coordination Committee (PCC) handbook section XI Part1), this document, WECC Post-Transient Study Methodology and local utility criteria and guidelines. Transient Stability and Post-transient studies will be performed only as needed based on the results of Power flow study.
3. In the pre-contingency state and with all facilities in service, system performance shall have all facilities 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. (R2.1)
4. Following the single contingencies, system performance shall have all facilities within their Facility Ratings and within their thermal, voltage and stability limits, and cascading or uncontrolled separation shall not occur (R2.2). The BES response to a single contingency may include the following (R2.3):
  - 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. (R2.3.1)

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- System reconfiguration through manual or automatic control or protection actions. (R2.3.2)
5. 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. (R2.4). Contingencies will be evaluated as defined under the Regional Differences E1 of the FAC-010.
  6. The multiple contingencies shall meet or exceed the requirements of Regional Difference E1 (governed by R2.5 and R2.6) of FAC-010.
  7. In determining the system's response to any of the multiple contingencies, identified in Reliability Standard TPL-003 or Regional Difference E1 of FAC-010, the following shall be acceptable in addition to the responses allowed under item 4 above: (R2.6)
    - 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. (R2.6.1)
  8. Study Model: Select base cases from the most recent WECC cases available for the study time frame and conditions (summer, winter, spring, peak load, off-peak load, etc). Update the base cases to reflect the most accurate transmission system configuration, generation dispatch, and load level available for each appropriate transmission owner and / or individual Balancing Authority area for the study time period. (R3.5)  
The following are general guidelines for system representation in modeling:
    - Full loop representation is to be used with the entire WECC system modeled unless agreed to by the Project Review Group (working group comprising of California ISO, California Transmission owners, and interested neighboring entities) to use an ISO-wide model (to determine SOLs for local areas that do not have regional impacts). (R3.1)
    - All system elements will be in service in the study area for the assumed initial conditions.
    - System transfer levels for major WECC paths should be agreed upon and listed. Additional transfer paths should be included as appropriate.
    - Voltage criteria should be applied in accordance with existing practice by the respective utilities or the operating agents.
    - The phase shifter methodology to be followed for all applicable phase shifters should be identified.
    - A list of the series compensation assumptions for the major EHV lines should be provided.
    - A detailed system representation of the study area should be modeled when appropriate (R3.3 for bullets 2 through 7).
    - Special Protection Systems (SPS) or Remedial Action Schemes (RAS) required to obtain the Accepted Rating of a path should be described in detail and modeled as they will be

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applied in operation. (R3.4)

#### 9. Power Flow:

Power flow studies should be performed utilizing the following guidelines:


- **Contingencies**  
Single contingencies or multiple contingencies are defined as Category B and Category C contingencies in NERC Reliability Standards TPL-002 and TPL-003. A selected list of applicable contingencies is used in determining the SOLs. (R3.2)
- **Thermal Capacity Limits**  
No transmission element will be loaded above 100% of its continuous rating under normal conditions. Following a single contingency or a credible multiple contingency, no transmission element will be loaded above its applicable time-dependent emergency rating. A list of continuous and emergency ratings for applicable facilities should be developed by the Facility Owner and included in the study documentation.
- **System Voltage Limits**  
The NERC/WECC Planning Standards will govern voltage deviation for loss of a system element. All deviations from the WECC Reliability Criteria (PCC Handbook section XI) should be listed. Provide a list of bus voltages to be monitored. The Project Review Group should review and approve this list to ensure all meaningful buses are monitored.

#### 10. Transient Stability:

Transient stability studies should be performed as needed to establish the stability transfer limit. These studies would facilitate the development of the dynamic voltage support requirements.

Following single contingencies or probable multiple contingencies, the system shall demonstrate transient, dynamic and voltage stability. Stability runs should be carried out at least for 20 seconds to ensure adequate damping. All Facilities shall be within their Facility Ratings and within their thermal, voltage/stability limits, and uncontrolled separation shall not occur. (R2.2)

- System disturbances for stability studies should be initiated by a three-phase to ground fault on the EHV bus adjacent to the major Interconnection point and/or power plant of interest. A single line-to-ground fault should be studied as a sensitivity if requested by the Project Review Group.
- Faults on the transmission lines being evaluated will be cleared in accordance with guidelines provided by appropriate members of the Project Review Group. Backup clearing time for stuck breaker operation will also be provided by the appropriate members of the Project Review Group.

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- The system will be considered stable if it met the NERC/WECC Planning Standards.

#### 11. Post-transient Governor Power Flow

Post-transient power flow analysis shall be done when requested by the Project Review Group. This analysis should be consistent with WECC “Voltage Stability Assessment Methodology” and “Voltage Stability Criteria, Undervoltage Load Shedding and Reactive Reserve Monitoring Methodology” documents. The analysis should demonstrate conformance of the Plan of Service with the NERC/WECC Planning Standards.


#### 12. Documentation

The ISO shall issue its SOL Methodology, and any change to that methodology, to all of the following prior to the effectiveness of the change: (R4)

- Each adjacent Planning Authority and each Planning Authority that indicated it has a reliability-related need for the methodology. (R4.1)
- Each Reliability Coordinator and Transmission Operator that operates any portion of the ISO’s Planning Authority Area. (R4.2)
- Each Transmission Planner that works in the ISO’s Planning Authority Area. (R4.3)

#### 13. Response to Comments on SOL Methodology

If a recipient of the SOL Methodology provides documented technical comments on the methodology, the ISO shall provide a documented response to that recipient within 45 calendar days of receipt of those comments. The response shall indicate whether a change will be made to the SOL Methodology and, if no change will be made to that SOL Methodology, the reason why. (R5)

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## Supporting Information

### RESPONSIBILITIES

<b>M&amp;ID</b>	Market & Infrastructure Development Department
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### REFERENCES

<b>NERC Reliability Standards</b>	<b>FAC-010</b> - System Operating Limits Methodology for the Planning Horizon
	<b>TOP-002</b> - Normal Operations Planning – R10, R11
	<b>TPL-002</b> - System Performance following loss of a single Bulk Electric System element (Category B)
	<b>TPL-003</b> - System Performance following loss of two or more Bulk Electric System elements (Category C)
<b>WECC</b>	WECC Philosophy of SOL & IROL Conditions
<b>WECC</b>	Overview of Policies and Procedures for Regional Planning Project Review, Project Rating Review, and Progress Reports


### DEFINITIONS

NERC “Glossary of Terms used in Reliability Standards” was used for definitions on SOLs, IROLs, Bulk Electric System, etc.

In accordance with the NERC Reliability Functional Model – Version 5, the Functional Entity previously referred to as the Planning Authority has been changed to the Planning Coordinator.

### VERSION HISTORY

Version	Change	By	Date
1.0	1 <sup>st</sup> Draft		6/25/07
2.0	Updated for NERC Standard compliance		2/18/09
2.1	Updated to comply with the revised NERC Standard FAC-010-2.1 and to be consistent with the change in Functional Entity from the Planning Authority to the Planning Coordinator, as defined in the NERC Reliability Functional Model-Version 5.		8/3/10

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## Technical Review

Reviewed By Content Expert	Signature	Date
Operations Support		7/27/10
Regional Transmission		7/30/10
Grid Ops		7/30/10

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## Approval

Approved By	Signature	Date
Director of Regional Transmission		8/2/10
Director of System Operations		8/3/10