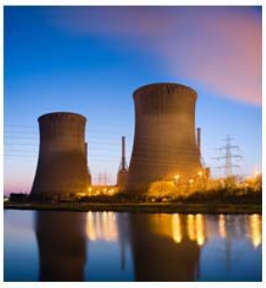
NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Project 2015-09 System Operating Limits

Technical Conference Background Materials

These background materials were prepared by members of the Standard Drafting Team solely for use in conjunction with the Project 2015-09 SOL Technical Conference.

RELIABILITY | ACCOUNTABILITY

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Background Information Regarding Project 2015-09

The Facilities Design, Connections, and Maintenance (FAC) Reliability Standards fulfill an important reliability objective for determining and communicating System Operating Limits (SOLs) and Interconnection Reliability Operating Limits (IROLs) used in the reliable planning and operation of the Bulk Electric System (BES). SOLs and IROLs are vital concepts in NERC's Reliability Standards as they establish acceptable performance criteria both pre- and post-contingency to maintain reliable BES operations.

The purpose of Project 2015-09 - System Operating Limits is to revise the requirements for determining and communicating SOLs and IROLs used in the reliable planning and operation of the BES. Revisions are necessary to improve the requirements by eliminating overlap with approved Transmission Planning (TPL) requirements, enhancing consistency with Transmission Operations (TOP) and Interconnection Reliability Operations (IRO) standards, and addressing issues with determining and communicating SOLs and IROLs.

As outlined in the Standards Authorization Request (SAR), the scope of the standards development project includes the development of new or revised requirements and/or NERC Glossary definitions to provide additional clarity and consistency for establishing SOLs and IROLs, and to address potential reliability issues resulting from application of the current NERC Glossary definitions for SOL and IROL. The SAR was sponsored and submitted by the Project 2015-03 -Periodic Review of System Operating Limit Standards periodic review team (PRT).[1] The standard drafting team (SDT) will address the issues identified by the Project 2015-03 PRT including, but not limited to:

- Clarify acceptable System performance criteria for the operations time horizon. The SDT will develop revisions to the continent-wide standards for system performance that specify acceptable system performance through the Reliability Coordinator (RC) SOL methodology.
- Revise or develop new NERC Glossary definitions to provide clarity and alignment with how SOLs are treated in the TOP and IRO Reliability Standards. The TOP and IRO Reliability Standards promote reliability by, among other things, clearly specifying requirements for RCs and Transmission Operators (TOPs) to monitor and operate the BES within SOLs and IROLs, and to resolve violations of operating limits within specified timeframes. The TOP and IRO Reliability Standards, however, do not address the methods for the development and identification of SOLs and IROLs. Requirements governing the development and identification of SOLs and IROLs are included in the FAC Reliability Standards. The SDT will address the issues with the definition of SOL, including possible development of a new definition ("SOL Exceedance"). The SDT will also address issues identified by the PRT related to application of the IROL definition. The revised definitions will provide clarity and consistency to allow for establishment and "exceedance" of SOLs and IROLs.
- Retirement of FAC-010-3. BES planning is covered under approved TPL-001-4 which provides comprehensive requirements for a variety of contingencies. The SDT will consider whether to propose retirement of FAC-010-3 given the redundancy and/or overlap with TPL-001-4.
- Develop revised or new requirement(s) that facilitate transfer of necessary reliability information between the planning and operating entities for establishing and communicating System Operating Limits.
- Propose requirements to address identified reliability issues. Requirement(s) will be developed to address FERC Order No. 777 directive for the communication of IROL information to Transmission Owners (see, Paragraph 6 and Paragraph 41).[2]

[1] For more information regarding Project 2015-03, click here.

[2] See, FERC Order No. 777, Paragraph 6 ("As discussed below, we also direct NERC to develop a means to assure that IROLs are communicated to transmission owners.") and Paragraph 41 ("NERC should establish a clearly defined communication

- Clarify responsibilities for establishing and communicating SOLs. The project will propose requirements to clearly delineate the functional entity responsibilities for determining and communicating each type of SOL (Facility Ratings, System voltage limits, voltage stability limits, and transient stability limits) where not already addressed in existing standards (*e.g.*, FAC-008).

In revising the requirements for the development and identification of SOLs and IROLs, the SDT will take into consideration the comments included as part of the FERC Order approving revisions to the TOP/IRO Reliability Standards. Specifically, FERC Order No. 817, provides: "[W]e conclude that NERC's explanation, that the Project 2015-09 standard drafting team will address the clarity and consistency of the requirements for establishing both SOLs and IROLs, is reasonable. Therefore, we will not direct further action on IROLs in the immediate TOP and IRO standard-related rulemaking. However, when this issue is considered in Project 2015-19, the specific regional difference of WECC's 1,000 MW threshold in IROLs should be evaluated in light of the Commission's directive in Order No. 802 (approving Reliability Standard CIP-014) to eliminate or clarify the "widespread" qualifier on "instability" as well as our statement in the Remand NOPR that "operators do not always foresee the consequences of exceeding such SOLs and thus cannot be sure of preventing harm to reliability." See, Paragraph 27.

structure to assure that IROLs and changes to IROL status are timely communicated to transmission owners...One way to achieve this objective...is to modify FAC-014 to require the provision of IROLs to transmission owners. However, we leave it to NERC to determine the most appropriate means for communicating IROL status to transmission owners.")

Review of Relevant TOP and IRO Reliability Standards

The SDT will develop revisions to the FAC requirements and definitions related to SOL and IROL, and in doing so, will seek to align the definitions with how SOLs and IROLs are treated in the newly revised TOP and IRO Reliability Standards.

Below are highlights of the relevant TOP and IRO Reliability Standards and the white paper developed by Project 2014-03 – Revisions to TOP and IRO Standards (click here for the SOL white paper: "System Operating Limit Definition and Exceedance Clarification"). These serve as a basis for the direction of the current SDT work in revising the FAC Reliability Standards.

"SOL Definition and Exceedance Clarification" White Paper

The "SOL Definition and Exceedance Clarification" developed by the TOP/IRO SDT (hereinafter referred to as the "SOL white paper") served as a context and a foundation for the revisions to the TOP/IRO Reliability Standards. The SOL white paper points out that the NERC Glossary definition of SOL is used extensively throughout the Reliability Standards. The white paper takes the position that there is much confusion with – and many widely varied interpretations and applications of – the definition of SOL.

Key excerpts from the SOL white paper relevant to the current SDT work:

- Page 3, paragraph 1: "Some have interpreted the language in approved FAC-011-2, Requirement R2 to imply that the objective is to perform prior studies to determine a specific MW flow value (SOL) that ensures operation within the criteria specified in approved FAC-011-2, Requirement R2 sub-requirements, the assumption being that if the system is operated within this pre-determined SOL value, then all of the pre- and post-Contingency requirements described in approved FAC-011-2, Requirement R2 will be met. The SDT believes this approach may not capture the complete intent of the SOL concept within approved FAC-011-2, which is both:
    1. Know the Facility Ratings, voltage limits, transient Stability limits, and voltage Stability limits, and
    2. Ensure that they are all observed in both the pre- and post-Contingency state by performing a Real-time Assessment."
- Page 3, paragraph 2: "It is important to distinguish operating practices and strategies from the SOL itself. As stated earlier, the SOL is based on the actual set of Facility Ratings, voltage limits, or Stability limits that are to be monitored for the pre- and post-Contingency state. How an entity remains within these SOLs can vary depending on the planning strategies, operating practices, and mechanisms employed by that entity. For example, one Transmission Operator may utilize line outage distribution factors or other similar calculations as a mechanism to ensure SOLs are not exceeded, while another may utilize advanced network applications to achieve the same reliability objective."
- Page 7, paragraph 1: "SOL exceedance occurs when acceptable system performance as described in approved FAC-011-2 is not occurring in Real-time operations as determined by Real-time Assessments. In other words, unacceptable system performance as indicated by Real-time Assessments equates to SOL exceedance."

TOP and IRO Reliability Standards

The revised TOP and IRO Reliability Standards often refer to "SOL exceedance" or "exceeding an SOL." In fact, with only one exception[3], every time that the term SOL is used, it is accompanied by the word "exceed" or "exceedance." The revised TOP and IRO Reliability Standards also use the defined terms Operational Planning

[3] See, TOP-001-3 Requirement R18

Analysis (OPA) and Real-time Assessment (RTA). Of note, both definitions address pre-Contingency and post-Contingency operations. The Glossary definitions are as follows:

- Operational Planning Analysis – An evaluation of projected system conditions to assess anticipated (pre-Contingency) and potential (post-Contingency) conditions for next-day operations. The evaluation shall reflect applicable inputs including, but not limited to, load forecasts; generation output levels; Interchange; known Protection System and Special Protection System status or degradation; Transmission outages; generator outages; Facility Ratings; and identified phase angle and equipment limitations. (Operational Planning Analysis may be provided through internal systems or through third-party services.)
- Real-time Assessment – An evaluation of system conditions using Real-time data to assess existing (pre-Contingency) and potential (post-Contingency) operating conditions. The assessment shall reflect applicable inputs including, but not limited to: load, generation output levels, known Protection System and Special Protection System status or degradation, Transmission outages, generator outages, Interchange, Facility Ratings, and identified phase angle and equipment limitations. (Real-time Assessment may be provided through internal systems or through third-party services.)

The following Reliability Standards address the responsibilities of the TOP and RC related to SOL management:

Operations planning time horizon:

1. IRO-017-1 requires PCs and TPs to share annual Planning Assessments with RCs (Requirement R3) and work with the RC to resolve conflicts (Requirement R4). These requirements facilitate a handshake from planning to operations with regard to outage planning.
2. IRO-017-1 requires RCs to implement an outage coordination process (Requirement R1), and TOPs and BAs to follow the process (Requirement R2). These requirements improve outage coordination within the operations planning time horizon leading up to real-time operations.
3. TOP-002-4 Requirement R1 and IRO-008-2 Requirement R1 require that the TOP and RC have an OPA to identify SOL exceedances.
4. TOP-002-4 Requirement R2 and IRO-008-2 Requirement R2 require that the TOP and RC have Operating Plan(s) to address potential SOL exceedances identified in the OPA.
5. TOP-002-4 Requirement R3 and IRO-008-2 Requirement R3 require that the TOP and RC notify entities identified in the Operating Plan(s) as to their role in those plan(s).
6. TOP-002-4 Requirement R6 requires that the TOP provide its Operating Plan(s) for next-day operations to its RC.

Same day and Real-time time horizons:

1. TOP-001-3 Requirement R13 and IRO-008-2 Requirement R4 require that the TOP and RC ensure that a RTA is performed at least once every 30 minutes.
2. TOP-001-3 Requirement R14 and IRO-008-2 Requirement R5 require that the TOP and RC initiate its Operating Plan to mitigate an SOL exceedance identified as part of its Real-time monitoring or RTA; the RC is required to notify BAs and TOPs.

In these requirements, pre- and post-Contingency reliability with regard to SOL exceedance is addressed through outage coordination, the performance of OPAs, the performance of RTAs, and the development, communication and implementation of Operating Plans. The SDT intends to propose revisions in alignment with these principles and concepts.

Topic 1 – Definitions: System Operating Limits and SOL Exceedance

The SDT believes revisions are needed to the existing definition of SOL in order to provide clarity in meaning, improve consistency in application of the definition, and to align the definition with the revised TOP and IRO Reliability Standards and SOL white paper. Also, the SDT is considering whether to create a new NERC Glossary term: "SOL exceedance."

Issue Statements

1. The Glossary term "SOL" is used extensively throughout the NERC Reliability Standards; however, the SDT believes there is industry confusion regarding application of the definition. A widely varied application of the definition of SOL can have an adverse impact on reliability.
2. The TOP/IRO Reliability Standards refer to "SOL exceedance" and "exceeding an SOL"; however, the SDT believes there are various understandings within the industry regarding what it means to "exceed" an SOL.

Background Information

Relevant Glossary definition(s):

- **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)

Relevant Reliability Standard(s):

- **FAC-011 Requirement R2**

Drafting Team Perspective

The definition of SOL and the associated FAC-011-0 and FAC-014-0 Reliability Standards were approved in 2006, and minimal changes have occurred in subsequent revisions. It is the understanding of the SDT that both the definition of SOL and the use of the term in the FAC standards presumed an operations paradigm characterized by the following:

1. A study, assessment, or analysis needs to be performed ahead of time to establish an SOL (and IROL as needed) that achieves acceptable BES system performance (pursuant to FAC-011-3 Requirement R2).
2. The established SOL is then communicated and coordinated with operators and other impacted entities prior to implementation.
3. TOPs are then given Operating Plans to operate below the SOL with the presumption that doing so will result in acceptable pre- and post-Contingency system performance in Real-time operations.

Advanced applications, such as state estimation and Real-time contingency analysis (which are widely used in the industry today), allow entities to assess pre- and post-Contingency performance and identify potential Cascading events in Real-time, based on actual operating conditions. The TOP and IRO Reliability Standards require that TOPs and RCs have OPAs and RTAs to assess actual and expected System conditions for the pre- and post-Contingency states. The SDT believes that the use of these technologies today, along with the TOP and IRO Reliability Standards

and definitions of OPA and RTA, suggest that reliability can be maintained and operating efficiencies can be gained by revising the defintion of SOL.

Some or all of the SDT members believe the following issues should be addressed:

1. The definition of SOL and FAC-011-3 requirements presume an operating paradigm that may not be aligned with today's environment.
2. The definition of SOL and concept as used in FAC-011-3 may not align with the TOP and IRO Reliability Standards, or the definitions of OPA and RTA. The definition of SOL contains pre- and post-Contingency language, as do the revised definitions of OPA and RTA, which is redundant and may cause industry confusion.
3. It is unclear whether the SOL is the actual operating parameter or if it is a value that is calculated ahead of time to provide for acceptable system performance (as described in FAC-010-2 Requirement R2).
4. It is unclear whether every BES Facility is required to have an SOL. Some entities may interpret and apply the approved SOL definition in such a way to limit the number SOLs on their system. This poses risks to reliability.
5. SOLs may be confused with mechanisms for ensuring acceptable system performance (see, the SOL white paper).
6. It is unclear in Real-time operations when an SOL ceases to be an SOL because it is no longer the most limiting criteria (according to the SOL definition). The end result may be "chasing" the SOL as system conditions change or are expected to change.
7. The definition of SOL combined with the use the term in FAC-011-3 intermingles "what the limits are" and "how the system should be operated."

The SDT is considering revising the definition of SOL as follows:

Reliability limits used for operations, to include Facility Ratings, System voltage limits, and any identified stability limitations. ~~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)~~

Additionally, the SDT is considering whether to propose creation of a new NERC Glossary term for "SOL Exceedance," which would be defined as follows:

When any of the following occur or are observed as part of Real-time monitoring or a Real-time Assessment:

- actual flow on a Facility is above the Normal Rating
- calculated post-Contingency flow on a Facility is above the Emergency Rating(s)
- actual bus voltage is outside normal System voltage limits
- calculated post-Contingency bus voltage is outside emergency System voltage limits
- operating parameters are beyond identified stability limitations

Discussion Items and Questions

1. Do the proposed revisions to the definition of SOL and the new defined term "SOL Exceedance" help to provide clarity regarding the meaning of a SOL, and what it means to exceed one?
2. Does every BES Facility "have" an SOL? If so, do the revised definitions help provide clarity on this issue?

3. Is the “the most limiting criteria” language included in the definition of SOL necessary for reliability, or should it be removed from the definition? If the definition of SOL is revised in the manner outlined above, then Facility Ratings, System voltage limits, and stability limitations are SOLs, all of the time, regardless of which one is the most limiting. Any “SOL Exceedance,” as defined above, would be addressed as required by the TOP and IRO Reliability Standards.
4. Do you believe there is a redundancy with including the language “pre-Contingency and post-Contingency” in both the definition of SOL and the definitions of OPA and RTA?
5. Do you believe the suggested revisions to the definition of SOL clearly distinguish between “what the limits are” and “how the system should be operated”? The suggested revisions would mean that the Facility Ratings, system voltage limits, and stability limitations are the actual SOLs. OPAs and RTAs are performed to determine whether these SOLs are expected to be exceeded (OPA) or are actually exceeded (RTA). Operating Plans are developed to address SOL exceedances.
6. Do you believe that the suggested revisions to the definition of SOL and (new) definition of SOL Exceedance are in alignment with the TOP and IRO Reliability Standards?
7. Do you believe the “specified system configuration” language in the definition of SOL should be removed because it creates industry confusion given that it is inherent to the definition of some SOLs, and yet may not be applicable to others? Do you agree that many SOLs are not dependent upon system configuration (such as the majority of Facility Ratings and voltage limits), while other SOLs (such as stability limitations) are dependent on system configuration.
8. Do you believe that issues associated with addressing “SOL exceedance” amidst changing system configurations are more appropriately addressed in the Operating Plan required by TOP-002-4 and IRO-008-2?
9. Do you believe that the suggested revisions to the definition of SOL and new definition for SOL Exceedance help provide clarity regarding the use of proxies as SOLs?

Topic 2 – Establishing SOLs in the Operations Horizon

The SDT is considering what revisions are needed to the FAC standards to: (1) ensure that RCs and TOPs use the same Facility Ratings for a given BES Facility; (2) clarify responsibilities for establishing and communicating System voltage limits; (3) address the level of flexibility appropriate for establishing stability limitations; and, (4) address potential overlap issues with the proposed definition of "SOL Exceedance."

Issue statement(s)

1. Acceptable performance criteria: The performance requirements in FAC-011-3 Requirement R2 includes both operational performance requirements and SOL establishment requirements. How and where should acceptable system performance requirements both for operations and for SOL establishment be addressed?
2. System stability limitations: Currently, there are no continent-wide stability limit criteria, provided the system performance requirements in FAC-011-3 Requirement R2 are met. FAC-011-3 provides RCs with full flexibility in establishing stability limits within their methodology. Is greater specificity needed? What degree of flexibility is appropriate for reliability?
3. System voltage limits: There is no Reliability Standard that specifically requires establishment and communication of System voltage limits for use in operations; however, System voltage limits are included in the approved (and proposed) definition of SOL and are important for reliable operations. Furthermore, system voltage limits are inconsistently used in operations.
4. Facility Ratings: FAC-008-3 requires Transmission Owners (TO) and Generation Owners (GO) to establish and communicate Facility Ratings consistent with their Facility Ratings methodology. Because each TO and GO may have a different methodology for establishing Facility Ratings, these Facility Ratings may not directly translate to a consistent set of limits used in operations by TOPs and RCs.

Background Information

Relevant NERC Glossary definition(s)

- 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.
- Equipment Rating – The maximum and minimum voltage, current, frequency, real and reactive power flows on individual equipment under steady state, short-circuit and transient conditions, as permitted or assigned by the equipment owner.
- Stability – The ability of an electric system to maintain a state of equilibrium during normal and abnormal conditions or disturbances.
- 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.

Relevant Reliability Standard(s)

- FAC-008-3
    - Requirements R2 and R3 require TOs and GOs to have a methodology for the development of Facility Ratings.
    - Requirement R6 requires TOs and GOs to have Facility Ratings that are consistent with their methodology.
    - Requirements R7 and R8 require GOs and TOs to provide Facility Ratings information to associated PCs, TPs, RCs, TOs, and TOPs upon request. (The obligation to provide Facility Rating information exists only when the information is specifically requested.)

- Requirement R2, Part 2.3 and Requirement R3, Part 3.3 require Facility Ratings to respect the most limiting applicable Equipment Rating of the individual equipment that comprises the Facility.
- Requirement R2, Part 2.4.2 and Requirement R3, Part 3.4.2 require Facility Ratings to include, at a minimum, Normal and Emergency Ratings.

- FAC-011-3
- TPL-001-4

Drafting Team Perspective

Issue 1: Clarity and consistency for establishing system performance requirements

The approved set of performance requirements in FAC-011-3 Requirement R2 and portions of Requirement R3 include both operational performance requirements and SOL establishment requirements. How and where should acceptable system performance requirements for operations, and for SOL establishment, be addressed?

The suggested revisions to the definition of SOL provide that SOLs are the Facility Ratings, the system voltage limits, and the identified stability limitations. In Issues 2, 3 and 4, there is discussion regarding whether to address the establishment, communication, and use of Facility Ratings and System Voltage limits in operations outside the RCs SOL Methodology. However, SDT members believe that the establishment of stability limitations may best be addressed by the RCs SOL Methodology. Facility Ratings and system voltage limits are for the most part direct inputs into tools for operating reliably. However, stability limitations must be "established" through further analysis, before becoming an input into reliability tools. This approach integrates seamlessly into the TOP and IRO Reliability Standards that address:

- Performing OPAs
- Developing and communicating Operating Plans for SOL exceedances identified in OPAs
- Performing RTAs
- Implementing Operating Plans when SOL exceedance is observed in real-time monitoring and RTAs.

SDT members believe that the suggested revisions to the definition of SOL and new definition for SOL Exceedance would eliminate any confusion with SOLs and provide greater distinction regarding:

- What the limits are
- What it means to exceed them
- How SOL exceedances are expected to be addressed in operations planning and real-time operations

Issue 1 Discussion Items and Questions:

1. Performance requirement: Do you believe that the current requirements in FAC-011-3 Requirement R2 (and portions of Requirement R3) mix performance requirements that are operations centric with those that exist for the purpose of establishing stability limitations? The SDT takes this position and believes that some of the performance requirements in FAC-011-3 Requirement R2 are addressed through the suggested new definition for "SOL Exceedance." However, many operations centric requirements under Requirements R2 and R3 are not addressed by the suggested definitions or through the TOP and IRO Reliability Standards. For example, neither the suggested definition of SOL Exceedance nor the TOP and IRO Reliability Standards specify which Contingencies (single or multiple) are expected to be observed when performing OPAs and RTAs in order to determine SOL exceedance, or are expected to be used when deriving stability limitations.
2. Currently, the definition does not describe the difference between acceptable system performance for single Contingencies versus that of multiple element Contingencies. For example, single Contingencies should not result in exceeding Emergency Facility Ratings. Do you think it is acceptable for multiple Contingencies to result in exceeding Emergency Facility Ratings, so long as they don't result in instability, uncontrolled separation, or Cascading? Who should make this decision? Where should it be specified?

3. Several of the requirements in FAC-011-3 (see, Requirement R2, Parts 2.3 and 2.4 and Requirement R3 Part 3.5) address what is acceptable from a system response perspective. The requirements establish what must occur when developing Operating Plans, and in actual operation of the system. The SDT is considering revising requirements that pertain to how the system should be operated, and is considering whether to propose the requirements be moved outside the family of FAC standards. While the SDT agrees that stability limitations should be addressed in the RCs SOL methodology, other aspects of System performance could be specified elsewhere. Do you agree with this position? The SDT has discussed a number of possible options, including: (1) remove performance requirements in FAC-011-3 R2 and R3 that are already covered by definitions and in other standards; (2) develop a baseline set of requirements for establishing stability limitations for FAC-011 and/or develop performance criteria for establishing stability limitations for the FAC-011 guideline section; or (3) determine a baseline set of operations centric performance requirements applicable to developing Operating Plans to be placed in either a TOP standard; or criteria to be used in a TOP guideline
4. Do you believe that sufficient flexibility should be retained in the standard to allow for determining specific performance requirements that are unique to operational areas? For example, should RCs and TOPs have flexibility to determine which multiple element Contingencies should be respected in operations such that SOLs are not exceeded?
5. Do you agree with the SDT position that currently different practices for determining and applying stability limits for multiple element Contingencies are in use? Do you agree that since the system design, probability, and impact of such Contingencies varies widely across North America, a "one size fits all" requirement would not support or improve reliability?

Issue 2: No Continent-Wide Stability Limit Criteria

Currently, there are no continent-wide stability limit criteria, provided the system performance requirements in FAC-011-3 Requirement R2 are met. FAC-011-3 provides RCs with full flexibility in establishing stability limits within their methodology. Is greater specificity needed? What degree of flexibility is appropriate for reliability?

Issue 2 Discussion Items and Questions:

1. Should FAC-011-3 include a table of applicable contingencies and acceptable system performance requirements (similar to TPL-001-4)? The SDT is considering using a table to list the Contingencies, and seeks industry input on whether the current list should not be expanded. This leaves the flexibility for entities to adopt more stringent Contingencies depending on their individual needs and circumstances.
2. How are studied contingencies different between Planning and Operations time horizons? Do the differences impact reliability? The SDT has discussed that the planning time horizon commonly focuses on a limited set of load levels, transfer conditions, and facility out states. This differs from the operations time horizon, which examines system performance during the full range of system load, transfers, generating operating states, and all approved and forced outage conditions. As a consequence, planning commonly examines a wider array of stability contingencies, to design and build a robust system for operations. Operations utilizes the regional experience and risk assessment to identify what subset of contingencies will be respected in operations for stability considerations/criteria.
3. Currently, there are no industry-wide stability limit criteria. Is greater specificity needed? The SDT discussed the current practices in place among the various SDT members (and their respective entities), and as a result, the team is considering whether to develop criteria to promote consistency. The SDT seeks input on the criteria and means for promoting consistency within the industry, such as whether a guideline would be helpful to compliment the revised standard?
4. Currently, FAC-011-3 gives the RC flexibility to define what acceptable stability performance is for its particular RC Area. Does this flexibility support reliability? The SDT believes this flexibility does support reliability. Each RC has its own unique issues and considerations, and the SDT members believe that there is no "one size fits all" set of performance criteria for use by all.

5. What is the best way to maintain RC flexibility, but yet create some uniformity or minimum criteria that must be identified by the RC? The SDT did not reach consensus on this item, but considered ideas such as a minimum set of criteria that could be the foundation on which each RC bases their set of stability performance criteria.
6. How are stability limitations communicated? Commonly the limitations are communicated from the entity that "created" the limit (either TOP or RC), to all of the other entities that have a need for receiving the limit information (if it is not monitored/calculated in real-time).

Issue 3: Establishment and Communication of System Voltage Limits

There is no Reliability Standard that specifically requires establishment and communication of System voltage limits; however, System voltage limits are used in the approved (and proposed) definition of SOL and are an important aspect of reliable operations. Furthermore, some or all of the SDT members believe that system voltage limits are inconsistently used in operations.

The SDT believes it is important for the Reliability Standards to assign responsibility for the establishment and communication of System voltage limits. Like Facility Ratings, System voltage limits should be consistent between TOPs and RCs throughout all operations processes. The SDT believes establishing and communicating System voltage limits may be better addressed by TOPs outside of the RC SOL Methodology. This could be accomplished by requiring TOPs to:

- Establish System voltage limits for use in operations and to implement those limits into their tools and processes.
- Communicate the System voltage limits they are using in operations to the RC.
- Update System voltage limits in their tools and communicate those updates to the RC.

In turn, the RC would use the System voltage limits provided by TOPs in the RC operations tools and processes. There may be value in having a requirement that TOP-established System voltage limits respect equipment voltage ratings. There also may be value in defining "System Voltage Limits."

Issue 3 Discussion Items and Questions:

1. Who is responsible for establishing and communicating System voltage limits, unless it is specifically addressed in the RC SOL methodology?
2. Is there potential for confusion between System voltage limits used in planning versus System voltage limits used in operations?
3. Is there confusion regarding the difference between System voltage limits and voltage schedules (VAR standards)?
4. Is it unclear whether System voltage limits must respect equipment voltage ratings?
5. Is it unclear whether System voltage limits are considered SOLs, especially high voltage limits?
6. Is it unclear whether every bus has a System voltage limit, or if only certain buses have System voltage limits?

Issue 4: Consistent Use of Facility Ratings between TOPs and RCs

Under FAC-008-3, Facility Ratings are established by TOs and GOs consistent with their own Facility Ratings methodology and are communicated to TOPs and to RCs upon request. TOPs and RCs interpret those Facility Ratings and implement them into their tools and processes. Because each TO and GO may have a different methodology for establishing Facility Ratings, these Facility Ratings may not directly translate to a consistent set of limits used in operations by TOPs and RCs, thus there is a risk that TOPs and RCs may be using differing sets of Facility Ratings in outage coordination studies, OPAs, and RTAs (depending on how these entities interpret the Facility Ratings provided by the TO and GO).

Some or all of the SDT members believe it is important for TOPs and RCs to use the same set of Facility Ratings throughout all operations processes. This could be addressed by requiring TOPs to:

- Implement Facility Ratings for use in operations into their tools and processes as provided by TOs and GOs. This would oblige the TOP to request the Facility Rating information from the TO and GO and to interpret the Facility Ratings as provided by the TO and GO and to translate them into their tools and processes.
- Communicate the Facility Ratings they are using in operations to their associated RCs.
- Update Facility Ratings in their tools and processes upon receipt of communication by the TO and GO and communicate those updates to their associated RCs.

In turn, the RC would use the Facility Ratings provided by TOPs in the RC operations tools and processes. Facility Ratings should be consistent between TOPs and RCs throughout all operations processes. Some or all of the SDT members believe that TOPs should be responsible for communicating the Facility Ratings that they are using for operations with RCs, and there is no need for Facility Ratings to be addressed by the RC SOL methodology.

Topic 3 – Establishing IROLs

Issue Statement(s)

1. The approved definition of IROL (in isolation of FAC-011-3), could be construed to mean that any instability would require the establishment of an IROL to prevent that instability from occurring. Whereas, FAC-011-3 Requirement R1 and Requirement R3 allow the RC to identify in its SOL Methodology which specific SOLs qualify as IROLs, an approach which is in practice throughout industry.
2. Regional differences exist in the criteria for determining which subset of SOLs are IROLs. In Order No. 817, FERC noted the regional differences and requested that the SDT consider the potential reliability impacts of those differences. Specifically, FERC provided, "[t]he specific regional difference of WECC's 1,000 MW threshold in IROLs should be evaluated in light of the Commission's directive in Order No. 802 (approving Reliability Standard CIP-014) to eliminate or clarify the "widespread" qualifier on "instability" as well as our statement in the Remand NOPR that "operators do not always foresee the consequences of exceeding such SOLs and thus cannot be sure of preventing harm to reliability."
3. In response to forced outages or similar unforeseen events, real-time operating conditions can occur such that an RTA identifies an operating state (not a pre-defined IROL exceedance) where the next worst Contingency could result in instability, uncontrolled separation or cascading outages. When these types of operating conditions occur in Real-time operations, it is clear that System Operators are expected to take urgent action to get out of the potentially N-1 insecure operating state as soon as possible; however, it is unclear whether these conditions constitute an IROL exceedance where IROL-related Reliability Standards would apply.

Background Information

Relevant NERC Glossary definition(s)

- **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.

Relevant Reliability Standard(s)

- **FAC-011-2 Requirement R1, Part 1.3**
- **FAC-011-2 Requirement R3, Part 3.7**

Drafting Team Perspective

Issue: Instability and IROL Determination

Some or all of the SDT members believe that the definition of IROL (in isolation of FAC-011-3) could be construed to mean that any instability would require the establishment of an IROL to prevent that instability from occurring. Whereas, FAC-011-3 Requirement R1 and Requirement R3 allow the RC to identify in its SOL methodology which specific SOLs qualify as IROLs, an approach which is in practice throughout industry. The SDT considered several examples of stability limits (SOLs) that may not qualify for IROL designation under a specific RC methodology. Some examples are listed below, which could typically result after planned or forced outages:

- Import voltage stability limit of 100 MW where a localized load pocket is lost as a result of voltage collapse;
- Export angular stability limit with a consequence of the loss of 100 MW of aggregated generation; and
- Small Island would be created with next contingency after forced outages on a small localized 100 MW load pocket.

The SDT believes there may be potential negative consequences of defining *any* instability as an IROL, such as:

- Mandatory pre-contingency load shedding or removal of generation.

- Operational misalignment of risk (*e.g.*, 100 MW given the same priority as 5000 MW)

Because there may be potential negative impacts to reliability, the SDT believes that not every instance of instability should be treated as an IROL (*i.e.*, not every instance of instability warrants establishment of an IROL to prevent that instability from occurring). Instead, the SDT believes that RCs should establish criteria that clearly identify the severity and extent of instability that warrants the establishment of an IROL in its RC Area, consistent with FAC-011-3. The SDT has discussed a number of various options to address the issue, including:

- Define "Instability" and "Uncontrolled Separation" similar to Cascading.
- Include a clause in the IROL definition to clearly identify it is not *any* instability (*e.g.*, local, contained area) that qualifies as an IROL.
- Link the definition to the standard requirements by including a statement or phrase to prevent interpreting in isolation of the criteria identified in the SOL methodology.
- Modify the definition of IROL to address the issue
- No definition change, but provide guidance elsewhere (*e.g.*, in a guideline in the revised FAC-011 Reliability Standard).

Possible suggested modifications to the definition of IROL under consideration by the SDT include:

- A System Operating Limit that~~,~~ if exceeded~~violated,~~ could lead to instability that cannot be restrained from spreading beyond an area predetermined by studies, uncontrolled separation, or Cascading ~~outages that adversely impact the reliability of the Bulk Electric System~~.
- A System Operating Limit that~~,~~ if exceeded ~~violated,~~ has been demonstrated to result in ~~could lead to~~ instability that cannot be restrained from spreading beyond an area predetermined by studies, uncontrolled separation, or Cascading ~~outages that adversely impact the reliability of the Bulk Electric System~~.
- A System Operating Limit that, if exceeded~~violated~~, has been demonstrated by studies ~~could lead~~ to result in ~~instability,~~ uncontrolled separation, ~~or~~ Cascading~~,~~ ~~outages~~ or instability that cannot be restrained from spreading beyond a predetermined area. ~~that adversely impact the reliability of the Bulk Electric System.~~

Discussion Items and Questions:

1. Do you believe that the definition of IROL is ambiguous in that it could be construed to mean that any instability would require the establishment of an IROL to prevent that instability from occurring?
2. Do you believe that RCs should establish criteria that clearly identify the severity and extent of instability that warrants the establishment of an IROL in its RC Area, consistent with FAC-011-3?

Issue 2: Regional Differences

Regional differences exist in the criteria for determining the subset of SOLs that qualify as IROLs. The SDT discussed regional differences in IROL determination among the RC Areas represented by the SDT members. Several similarities and differences emerged:

- Similarities:
  - Loss of Load criteria
  - Loss of generation criteria
  - Non-localized/uncontained instability
  - Affects neighboring RC Area
- Differences:
  - Static (# MW) vs. dynamic (% of Load/generation)
  - Quantities of MW Load/generation criteria
  - Single RC/BA Interconnection vs. multi-RC Interconnection
  - Various stability criteria

The SDT evaluated whether a uniform criteria approach would provide a reliability benefit (*i.e.*, use the same thresholds/values and considered elements for every RC).

- Pros:
  - Improved consistency and transparency
  - More conservative approach for those RCs who move from a less conservative criteria
- Cons:
  - Unnecessary pre-contingency load shedding
  - Less conservative approach for those RCs who move to a less conservative criteria
  - Lack of flexibility to address risks unique to RC Area

The SDT is considering a "hybrid" approach: RC specify criteria with minimum elements for consideration (flexibility with thresholds; but consistency in what elements are considered)

- Pros:
  - Improved consistency and transparency
  - Flexibility to address risks unique to RC Area
  - Pre-contingency load shedding better aligned with RC Area risks
  - More conservative approach for those RCs who move from a less conservative criteria
- Cons:
  - Thresholds/values will still vary between RC (*e.g.*, loss of Load threshold)

The SDT has considered whether the development of IROL criteria will provide consistency and clarity in identifying IROLs. The team believes that it may be beneficial to survey RCs to obtain their respective IROL criteria, which would allow the SDT to develop a minimum set of criteria and elements for the RC to consider when identifying its criteria. Further, SDT may identify a minimum set of elements that must be considered and thresholds identified by the RC when determining its specific IROL criteria. For example:

- Loss of Load threshold (*e.g.*, XXXX MW or X% of system load)
- Loss of generation threshold (*e.g.*, XXXX MW or (x)percent of system generation, or most severe single Contingency multiplier)
- Non-local stability criteria (*e.g.*, (x)percent damping with a mode greater than (x))
- Neighboring RC criteria in an Interconnection with multiple RCs

Issue 3: Limits identified in Real-time

In response to forced outages or similar unforeseen events, real-time operating conditions can occur such that an RTA identifies an operating state (not a pre-defined IROL exceedance) where the next worst Contingency could result in instability, uncontrolled separation or cascading outages. When these types of operating conditions occur in Real-time operations, it is clear that System Operators are expected to take urgent action to get out of the potentially N-1 insecure operating state as soon as possible. However, it is unclear whether these conditions constitute an IROL exceedance where IROL-related Reliability Standards would apply.

Discussion Items and Questions:

1. Do you believe that this is an issue that needs to be addressed? If yes, how should the Reliability Standards be modified to address the reliability risks associated with unforeseen N-1 insecure operating states identified in RTAs, other than designation as an "IROL exceedance"?
2. Do you believe that these operating conditions constitute an "IROL exceedance" where IROL-related Reliability Standards would apply? If yes, when do you believe T_V begins?

3. What is your process for assessing current operating conditions in order to determine whether the system has entered a potential N-1 insecure state (*i.e.*, in an operating state where the next worst single Contingency could result in instability, uncontrolled separation, or Cascading)?
4. Would you consider this type of operating condition to be an Emergency condition?

Topic 4 – Establishing SOLs in the Planning Horizon

Issue Statement(s)

1. In light of the requirements in various existing Reliability Standards (*i.e.*, TPL, TOP and IRO), is there a reliability-related need for the requirements in FAC-010-3 and (related requirements in FAC-014-2), which relate to establishing SOLs in the planning horizon?

Background Information

Relevant Reliability Standard(s)

- **FAC-010-3**
  - requires Planning Coordinators to document and communicate a methodology for developing SOLs, including IROLs, in the planning horizon
- **FAC-014-2**
  - Requirements R3, R4 and R5 require Planning Coordinators and Transmission Planners to establish SOLs, including IROLs, consistent with their methodologies and appropriately communicate them
  - Requirement R6 requires Planning Coordinators to determine a subset of multiple contingencies (if any) from TPL-003 that result in stability limits
- **TPL-001-4**
  - requires development of a Corrective Action Plan for extreme events that result in an inability to meet performance requirements
  - Requirements R5 and R6 require Transmission Planners and Planning Coordinators to document, within a Planning Assessment, the criteria, methodology and the assessment results
  - Requirement R8 provides for the distribution of the Planning Assessment to the adjacent PCs and TPs and "any functional entity that has a reliability related need and submits a written request…" for the information

Relevant Project 2015-03 Periodic Review Team (PRT) Recommendations

The PRT concluded that the requirements in FAC-010-3 are not necessary inputs to the BES planning process. BES planning is covered under TPL-001-4, which provides comprehensive requirements for a variety of contingencies. For these reasons, the PRT recommended retirement of FAC-010-3 (and associated requirements in FAC-014-2).

Drafting Team Perspective

Based on the recommendations of the Project 2015-03 PRT, the SDT is considering whether to propose retirement of FAC-010-3. The SDT believes that TPL-001-4 adequately covers the BES planning process for the planning horizon studies, and the communication of planning study results to the appropriate entities in order to ensure reliability of the BES is maintained. An issue under consideration by the SDT is whether there should be a requirement to ensure that the necessary operational information in the planning horizon is properly identified and provided to the appropriate reliability entities for use in the operations horizon.

Appendix A
Project 2015-09 SOL - Drafting Team Roster

Role	Name	Entity
Chair	Vic Howell	Peak Reliability
Vice-chair	Hari Singh	Xcel Energy
Member	David Bueche	CenterPoint Energy Houston Electric
Member	David Hislop	PJM Interconnection
Member	Samuel Jager	Independent Electricity System Operator
Member	Dean LaForest	ISO New England
Member	Thomas Leslie	Georgia Transmission Corp
Member	Jason Smith	Southwest Power Pool
Member	Stephen Solis	Electric Reliability Council of Texas
Member	Aaron Staley	Orlando Utilities Commission
Member	Dede Subakti	California ISO
NERC Staff	Lacey Ourso – Standards Developer	North American Electric Reliability Corporation
NERC Staff	Mark Olson – Standards Developer	North American Electric Reliability Corporation
NERC Staff	Shamai Elstein – Senior Counsel	North American Electric Reliability Corporation