

SYSTEM OPERATING LIMITS IN THE PLANNING HORIZON FAC-010 COMPLIANCE

System Operating Limits (SOLs) in the planning horizon are required to be identified by FAC-010. This guideline describes how Duke Energy Carolinas (DEC) meets the requirements of FAC-010 and is applicable for the 1 through 10 year planning horizon **(R1.1)**. Relevant definitions applicable to the standard are:

SOLs are 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 Ratings 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)

Facility Ratings are defined by NERC as:

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.

Facility ratings determine the fundamental limits of transmission system equipment. SOLs shall not exceed the facility ratings **(R1.2)**.

Interconnected Reliability Operating Limits are defined as:

A System Operating Limit that, if violated, could lead to instability, uncontrolled separation, or Cascading that adversely impact the reliability of the Bulk Electric System.

SOLs that can result in system instability, uncontrolled cascading outages beyond an acceptable range must be identified as IROL's and communicated to System Operations Engineering **(R1.3)**.

The transmission system must be planned to meet FAC-010 standards such that:

R2.1. In the pre-contingency state and with all Facilities in service, 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 the determination of SOLs, the BES condition used shall reflect expected system conditions and shall reflect changes to system topology such as Facility outages.

R2.2. Following the single Contingencies¹ identified in Requirement 2.2.1 through Requirement 2.2.3, 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 or uncontrolled separation shall not occur.

R2.2.1. Single line to ground or three-phase Fault (whichever is more severe), with Normal Clearing, on any Faulted generator, line, transformer, or shunt device.

R2.2.2. Loss of any generator, line, transformer, or shunt device without a Fault.

R2.2.3. Single pole block, with Normal Clearing, in a monopolar or bipolar high voltage direct current system.

R2.3. Starting with all Facilities in service, the system's response to a single Contingency, may include any of the following:

R2.3.1. 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.

R2.3.2. 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.

¹ The Contingencies identified in R2.2.1 through R2.2.3 are the minimum contingencies that must be studied but are not necessarily the only Contingencies that should be studied.

R2.5. Starting with all facilities in service and following any of the multiple Contingencies identified in Reliability Standard TPL-003 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 or uncontrolled separation shall not occur.

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 R2.3.1 and R2.3.2, the following shall be acceptable:

R2.6.1. 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.

DEC's planning practices, in accordance with the TPL standards, assess DEC control area transmission system performance to the requirements of R2.1 through 2.6. Detailed internal models of the DEC control area from 44 kV to 500 kV are utilized. Models are available for the next 10 years summer and winter peak period, as well as near term light load cases. The latest SERC LTSG or MMWG models are used to represent the world outside of DEC to provide the critical modeling details of other control areas **(R3.1)**. Each year/season's model contains the expected system topology, interchange, generation, and load level **(R3.3 & 3.5)**. ECDI files to correctly economically dispatch are available for each model. The contingencies studied include all internal transmission and generation elements as well as external transmission elements that may have significant impact on the DEC system **(R3.2)**. When performing the TPL assessments, any facilities identified as reaching their facility ratings limit or violating planning guidelines limits must have a corrective action planned to eliminate the concern prior to reaching the operating horizon. Remedial Action Schemes are acceptable corrective actions **(R3.4)**.

These practices preclude the possibility of reaching the operating horizon with SOLs and IROLs **(R3.6)**. The exception may be where transmission planning and operations have agreed on an operating guide that will be instituted to preclude exceeding a facility's rating. These operating guides must be agreed to prior to entering the operating horizon and be tested for acceptability during the planning process.

Distribution

Prior to the effective date of any changes, this document will be provided to all adjacent Planning Authorities and any that request it due to a reliability need **(R4.1)**. It will also be provided to the VACAR-South Reliability Coordinator and the System Operations Engineering group **(R4.2)**. The document is to be reviewed and understood by all Transmission Planning transmission planners **(R4.3)**.

In order to ensure compliance with the FAC-010 standard the following measures must be met:

C. Measures

M1. The Planning Authority's SOL Methodology shall address all of the items listed in Requirement 1 through Requirement 3.

M2. The Planning Authority shall have evidence it issued its SOL Methodology and any changes to that methodology, including the date they were issued, in accordance with Requirement 4.

In order to meet these requirements, any emails involving the issuance of this document or as a response to comments on the document should be retained for a period of 3 years.

REVISIONS

REVISION NUMBER	DATE	REASON FOR REVISION
0	6/29/07	
1	10/01/09	Modify text copied from original FAC-010-1 standard to agree with FAC-010-2 revision and update organizational name changes. Revision to be effective 11/1/09.
2	4/15/10	Update revision to agree with FAC-010.2. Effective 4/15/10.
3	5/01/16	Update definitions, distribution information and group names that provide the outside area modeling information. Effective 7/1/16.
4	12/01/16	Remove term Special Protection Scheme from R3.4 related statement.
5	8/7/17	Updated after review of FAC-010-3 and removed reference to version # of the standard. Effective 9/1/17

Prepared By	Robert Pierce, Principal Engineer
Date Created	August 7, 2017
Approved By	Edgar Bell - Director – Transmission Planning