Master/Local Control Center Procedure No. 15

(M/LCC 15)

System Operating Limits Methodology

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References

NERC FAC Standards - System Operating Limits Methodology for the Planning/Operations Horizon

NERC TPL, TOP and IRO Standards - Transmission Planning and Operations Standards

NPCC A-2 Basic Criteria for Design and Operation of Interconnected Power Systems

ISO New England Transmission Operating Guides:

- Procedure for Loss of Phase II Imports Guide - Text Document
- Joint NYISO/ISO-NE Protocol for Restricting NE Single Source Contingencies > 1200 MW Net Guide

ISO New England Operating Procedure No. 1 - Central Dispatch Operating Responsibility and Authority of ISO New England, the Local Control Centers and Market Participants (OP-1)

ISO New England Operating Procedure No. 3 - Transmission Outage Scheduling (OP-3)

ISO New England Operating Procedure No. 8 - Operating Reserve and Regulation (OP-8)

ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Resources and Asset Related Demands (OP-14)

ISO New England Operating Procedure No. 16 - Transmission System data (OP-16)

ISO New England Operating Procedure No. 19 - Transmission Operations (OP-19)

ISO New England Planning Procedure No. 3 - Reliability Standards for the New England Area Bulk Power Supply System (PP 3)

ISO New England Planning Procedure No. 7 - Procedures for Determining and Implementing

Transmission Facility Ratings in New England (PP 7)

1. Background

The purpose of this Master/Local Control Center (M/LCC) Procedure is to describe the reliability methodology for the planning and operation of the New England Transmission System[1]. The requirement to detail the methodology for use in developing SOLs within the Reliability Coordinator (RC) Area is specified in NERC FAC-010, FAC-011 and other related NERC Standards. The provisions contained herein are in accordance with North American Electric Reliability Corporation (NERC) Standards, Northeast Power Coordinating Council, Inc. (NPCC) Criteria and ISO New England (ISO) Operating Procedures listed as references to this document. Prescribed operator actions are further detailed in several ISO Transmission Operating Guides (TOGs), ISO System Operating Procedures (SOPs), and M/LCC Procedures.

NERC Standards and NPCC Criteria documents define specific requirements applicable to the design, planning and operation of the New England Transmission System. The provisions in this document are used to determine data, methodology and System Operating Limits (SOLs), and the subset of SOLs classified as Interconnection Reliability Operating Limits (IROLs), for the planning and operation of the New England Transmission System.

2. Responsibilities

ISO is responsible for performing the Reliability Coordinator (RC), Transmission Operator (TOP), Balancing Authority (BA), and Planning Authority (PA) functions for the New England Control Area (CA). Local Control Centers (LCCs) are responsible for performing the TOP function. ISO and the LCCs are responsible for ensuring their respective network models use the same Facility Rating limits as recorded in the NX-9 database unless temporary ratings have been implemented or the NX-9 data has been determined to be erroneous; in this case, the NX-9 data shall be updated as soon as possible. ISO and the LCCs are responsible for ensuring that their respective network models use the same generator technical characteristics as recorded in the NX-12 database. The NX-12 form contains data on the technical characteristics of the generator units (response rates, MW and MVAr operating limits, etc.) that will be used in the network study models.

ISO is responsible for identifying the subset of SOLs that qualify as IROLs.

ISO and the LCCs are jointly responsible for monitoring and mitigating SOLs and IROLs in real time.

ISO and the LCCs work together in accordance with OP-1. In real-time, ISO will monitor and ensure New England Single Source Contingencies remain within the calculated limits, as documented in the relevant TOGs, to ensure that they do not pose an IROL risk to either the PJM or NYISO systems.

[1] New England Transmission System is the system of transmission facilities within the New England Control Area under the ISO's operational jurisdiction.

3. Network Study Model Inputs

3.1 Network Study Model

The ISO network study model used in the real-time operations horizon is contained in the ISO Energy Management System (EMS) and includes all generators and transmission facilitates and an equivalence model for non-BPS 69 kV and radial 115 kV facilities within New England. In addition, ISO explicitly models all key generators and transmission above 230 kV as well as an equivalence model for the 115 kV and 138 kV in both the neighboring RC areas of New Brunswick and New York. The Quebec transmission system is asynchronously interconnected to New England via HVDC and is therefore not explicitly modeled; instead, it is modeled as a generation or load. For the planning horizon, transient, dynamic stability and voltage stability analysis, ISO uses an off-line network study model contained in the Siemens Power Technology International (PTI) PSS/E to identify those contingencies that may be identified as an SOL or IROL. This off-line network model originates from the NERC Multiregional Modeling Working Group (MMWG) series of network models. The level of modeling detail meets or exceeds the NERC MMWG modeling requirements and the requirements of NERC Modeling Standards.

For real-time and near real-time, the EMS network study model Powerflow is used and includes the applicable approved transmission outages, generation outages, load forecast, estimated external transaction schedules and generation schedule. ISO also uses the EMS applications Study-time and Real-time Contingency Analysis (STCA and RTCA) and Interface Limit Calculator (ILC) to model all identified contingencies.

The ISO network study model also includes the modeling and operation of approved Special Protection Systems (SPSs) where appropriate.

3.2 Facility Rating Limits

The calculation of Facility Ratings is first determined based on the requirements of ISO New England Planning Procedure No. 7 (PP 7).

Transmission Facility Ratings are required to be supplied by the Transmission Owners to ISO per Operating Procedure No. (OP-16) using the NX-9 data form. Annually, ISO initiates an NX9 certification process. This process will requires Market Participants to certify that all transmission equipment identified in OP-16 is accurately represented on the appropriate NX9 form. The Facility Ratings are the foundation for the calculation of thermal or voltage based SOLs. The NX-9 form contains data on the transmission element (transformer, line, reactor, capacitor etc.) and the limiting component (relay, disconnect switch etc.) as well as the Summer/Winter; Normal, Long-Time Emergency (LTE), Short-Time Emergency (STE) and Drastic Action Limit (DAL) ratings. The basis for the calculation of any SOL first starts with a comprehensive model of the facilities comprising the New England Transmission System and adjacent AC systems.

3.2.1 Normal Rating

This is a continuous twenty-four (24) hour rating. Transmission facility loadings up to this rating can be experienced without incurring loss of life above design criteria.

3.2.2 Long-Time Emergency (LTE) Rating

This rating is intended to fit a daily load cycle (12 hours summer, 4 hours winter). A facility may operate up to this rating provided that its loading is returned to or below the Normal rating during off-peak hours.

3.2.3 Short-Time Emergency (STE) Rating

This is a fifteen (15) minute rating. If a facility operates at this rating for more than fifteen minutes, equipment will suffer thermal damage. Facility loadings above the LTE rating but at or below the STE rating shall be reduced to at or below the LTE rating within 15 minutes.

3.2.4 Drastic Action Limit (DAL)

This is an extreme emergency five (5) minute rating. If a facility operates at this rating for more than five minutes, equipment will suffer thermal damage. Facility loadings above the STE rating but at or below the DAL shall be reduced to at or below the LTE rating within 5 minutes.

3.2.5 Standard Seasonal (Summer and Winter) Facility Rating Periods

Summer ratings shall be used from April 1 through October 31. Winter ratings shall be used from November 1 through March 31.

There are times when the weather forecast or actual ambient conditions (temperature and wind) are significantly different from those used to establish standard seasonal Facility Ratings. During those times, the use of temporary Facility Ratings based on the forecast or actual ambient conditions may be warranted. Depending on the forecast or actual ambient conditions, the temporary Facility Ratings may be higher or lower than the standard seasonal Facility Ratings. When such weather conditions exist and a transmission facility is limiting, ISO, the appropriate LCC or appropriate Transmission Owner will identify the need for a temporary transmission Facility Rating based on actual weather conditions. In cases where the Transmission Owner has supplied pre-defined weather sensitive ratings, such ratings will be used by ISO and the LCC after the LCC and/or Transmission Owner has confirmed the actual weather conditions. If pre-defined weather sensitive Facility Ratings are not available, the involved Transmission Owner will be informed of the circumstances. That Transmission Owner may elect to provide the appropriate LCC with temporary Facility Ratings along with any pertinent qualifications for their use. The LCC will forward all temporary Facility Rating information electronically (fax or email) to ISO. Such temporary Facility Ratings will then be used in real-time for the time period specified by the Transmission Owner or until rescinded by the Transmission Owner.

3.3 Generator Technical Characteristics

Generator technical characteristics are required to be supplied by the Designated Entity to ISO per Operating Procedure No. 14 (OP-14) using the NX-12 data form. The NX-12 form contains data on the technical characteristics of the generator units (response rates, MW and MVAr operating limits etc.) that will be used in the network study model.

4. Determining SOLs and IROLs

The New England Transmission System is operated so that, in the pre-contingent state, it shall demonstrate transient dynamic and voltage stability and all facilities shall be within their Facility Rating. The New England Transmission System shall continue to demonstrate transient, dynamic and voltage stability and all facilities shall be within their thermal, voltage and stability limits in the post-contingency state.

The Facility Ratings determined from section 3.2 of this procedure form the basis for defining the base set of SOLs in the network model. Under no circumstances will an SOL exceed the associated Facility Rating.[2]

Determination of the subset of SOLs that are considered IROLs can result from identification of a significant adverse impact outside the local (studied) area, such as:

1. System instability.
2. An oscillatory or negatively damped system response.
3. A discrete bounded sub-area of the system that is susceptible to voltage collapse or separation from the rest of the system cannot be determined.
4. Analysis results in isolation of a sub-area, the net load and/or generation in that sub-area must be quantified. If the sub-area is supplying more than 1,300 MW to the rest of the system, or if it is absorbing more than 1,200 MW of power.
5. Uncontrolled islanding of the Bangor Hydro and/or Maritimes systems would require consultation with New Brunswick System Operator (NBSO) to determine whether the event is classified as an IROL. When the islanding is a result of proper operation of an SPS to a disturbance that the SPS is designed to operate, the islanding would be controlled and not considered an IROL.
6. A discrete bounded sub-area of the system that is susceptible to voltage collapse included portions of another RC Area, or if the facilities of another RC Area exceed their LTE ratings, then the results will be coordinated with that RC to determine whether the event is classified as an IROL.

[2] Planned or controlled interruption of electric supply to radial customers or some local Network customers, connected to or supplied by the Faulted element or by the affected area, may occur in certain areas without impacting the overall reliability of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted Firm (non-recallable reserved) electric power Transfers.

4.1 Thermal System Operating Limits

ISO performs studies in order to establish seasonal and operational planning transmission interface limits to prevent thermal overloads or cascading thermal overloads. ISO establishes these limits by evaluating system response to all normal contingencies: NERC TPL Standards Category A, B and a subset of the Category C contingencies where the occurrence of the contingency could result in an IROL. SOLs not classified as IROLs do not need to adhere to Category C contingencies. These studies therefore include: (a) the anticipated system conditions, (b) a range of generator unit availability and transmission outage scenarios, (c) various peak load assumptions, and (d) simulation of SPS actions when appropriate.

The limits are determined to ensure no facility ratings are exceeded under a base-case set of assumptions. Then, ISO evaluates system performance assuming first (N-1) contingency in order to ensure that the post-contingency loadings do not result in an SOL. Additionally, for IROLs, ISO evaluates the system to determine if adequate resources and operational actions are available to reposition the system within 30 minutes to a new operating state that allows continued reliable operation *in the event that* a second contingency (N-1-1) occurs. This type of analysis ensures the system can both: (a) withstand a first contingency and (b) be repositioned to withstand the second contingency within 30 minutes, without resulting in an IROL violation.

4.2 Voltage and Reactive System Operating Limits

ISO performs studies to establish transmission interface limits to prevent cascading voltage collapse by testing NERC TPL Standards Category A, B and a subset of the Category C contingencies where the occurrence of the contingency could result in an IROL. SOLs not classified as IROLs do not need to adhere to Category C contingencies. Where appropriate, simulations of SPS actions are included in the studies. These analyses are conducted prior to real-time operations and use a set of stressed system conditions, such as: (a) a range of high-load levels to aggravate low voltage problems; (b) a range of low load levels to aggravate high voltage problems; (c) a range of generator unit availability to quantify the impact on the voltage problem; (d) and inclusion of generator and transmission maintenance conditions.

These analyses are conducted using standard load-flow techniques. The analyses identify limits by either: detecting a violation of acceptable minimum/maximum voltage levels on transmission buses or detecting the failure of simulations to converge – an event which signals a voltage collapse. Once a maximum transfer limit is determined by a convergent solution containing acceptable voltage profiles, ISO will then reduce the transmission interface limit by an engineering safety margin. The magnitude of the margin is based on reviewing the P-V system response and maintaining sufficient gradients between the pre-contingency voltages and the limiting post-contingency voltages. Typically these engineering safety margins are approximately 50 MW to 100 MW. Utilizing the stressed study assumptions and operating at this reduced transfer limit provides a safety margin to protect against wide spread voltage instability or collapse and prevent an IROL violation.

4.3 Transient and Dynamic Stability System Operating Limits

ISO performs studies to establish transmission interface limits to prevent unit/area instability, insufficiently damped system response, or unacceptable transient low voltage conditions. To do this, ISO conducts testing under a range of system conditions, including testing the system at light load conditions due to the reduced system damping available from load and inertia from limited online resources. Significant sensitivities to generator dispatch, reactive equipment availability, bus/breaker configurations, line/breaker out conditions, SPS action/in-action, etc., are all considered in the testing. ISO New England Planning Procedure No. 3 (PP 3), Appendix C, details the damping criterion for stability analysis.

The transmission interface limits are determined using standard transient stability simulations of NERC TPL Standards Category A, B and C contingency faults and are limited by unit/area instability, insufficiently damped system response, or unacceptable transient low voltage conditions. Once the transfer limit is determined with acceptable dynamic performance through the analysis, ISO will reduce the transmission interface limit by an engineering safety margin of approximately 50 MW to 100 MW. At this limit, damping is evaluated to determine if the dampening criteria is met. If so, no additional buffer is included; if not, transfers are continually reduced and re-evaluated until the dampening criterion is met. Just like with voltage or reactive limit exceedences, it is necessary to operate at this reduced transfer limit to protect against unit/area instability, insufficiently damped system response, an unacceptable transient low voltage condition, and to prevent an IROL violation.

Finally, ISO evaluates system operations in response to the extreme contingency three-phase fault with delayed clearing as is identified in NERC TPL Standards Category D in order to:

a) measure system strength;

b) determine the extent of a widespread system disturbance; and

c) depending on the system impact, impose an additional reduction in the transmission interface limit.

4.4 Transmission Interfaces and ILC

ISO determines N-1-1 transmission interface limits for importing areas identified as having the potential to be an IROL within the New England Reliability Coordinator Area. This is done in order to ensure there are adequate post "first contingency" actions available to redispatch the New England Transmission System within 30 minutes of the "first contingency" so that ISO is prepared for the next contingency. ISO communicates these limits to all LCCs. ISO continually refines and updates study assumptions for identifying transmission interface limits up to and including the real-time operational timeframe.

In real-time, ISO and LCC software is configured to alert the ISO and LCC System Operators when there is the potential for exceeding an SOL or IROL associated with an interface due to real-time system conditions. System Operators will pre-posture resources (e.g., generation) or take other pre-contingent actions when system flows indicate that an IROL violation may occur if a system contingency were to take place or, in the case of N-1-1 interface limits, if there would be inadequate actions available to redispatch the system within 30 minutes in preparation for the next contingency. In addition, ISO and LCC RTCA applications will identify stuck breaker, bus fault or double circuit tower contingencies to ensure that they do not pose a potential IROL.

4.5 Single Source Contingencies

Joint RC (PJM/NYISO/ISO) studies have concluded that the loss of a supply source at high levels of imports (greater than 1,200 MW) could have a worse effect on NYISO and PJM than the worst internal contingency that these individual systems normally protect against. ISO monitors and will dispatch its large Single Source Contingencies against the PJM and NYISO limiting interfaces to ensure that the New England system does not impose an IROL on another area in real-time.

5. $IROL_t$ time limit

The NERC Standard IRO-005 states that for any identified IROL that is exceeded, the Reliability Coordinator in conjunction with the Transmission Operator and Balancing Authority will return its transmission system within the IROL limit without delay, and no longer than 30 minutes. The subscript term for time to return the transmission system to within limits for an IROL is $IROL_t$ (subscript variable time = 't').

The subscript 't' criteria in New England shall be 30 minutes for all interfaces and contingency pairs that ISO identifies as meeting the IROL determination requirements detailed above. In all instances regardless of the subscript 't' criteria time limit, ISO will develop an action plan as soon as possible to deal with the next worst contingency on the system.

ISO will commit and dispatch resources if available in order to meet both N-1, and N-1-1 contingency coverage for an IROL to prevent the need for firm load-shedding except as explicitly permitted in the ISO TOGs and SOPs.

6. Revision History

Rev. No.	Date	Reason	Contact
Rev 0	04/16/09	New M/LCC version	Mike Taniwha
Rev 1	4/15/11	Biennial review completed by procedure owner, no changes required at this time	John Norden