

NESCOE Criteria Discussion

Brent Oberlin
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Presentation Overview

- Historical Context for Reliability Standards
- Overview of Reliability Standards
- Transmission Planning Reliability Standards with No Discretion: Contingencies
- Transmission Planning Reliability Standards where ISO has Discretion: System Conditions

Historical Context for Reliability Standards

Historical Context for Reliability Standards

- Prior to 2007, reliability standards were voluntary and penalties for violations were non-monetary
- The blackout of 2003 prompted Congress to act, and it amends the Federal Power Act
- March 2007 FERC adopts Order 693 establishing mandatory reliability standards
 - NERC is responsible for developing and enforcing reliability standards
 - FERC approves and adopts NERC's reliability standards

Historical Context for Reliability Standards, *cont.*

- Reliability Standards collectively define overall acceptable performance with regard to operation, planning and design of the North American Bulk Electric System

Historical Context for Reliability Standards, *cont.*

- Reliability standards cover the following areas
 - BAL: Resource and Demand Balancing
 - CIP: Critical Infrastructure Protection
 - COM: Communications
 - EOP: Emergency Preparedness and Operations
 - FAC: Facilities Design, Connections, Maintenance, and Transfer Capabilities
 - INT: Interchange Scheduling and Coordination
 - IRO: Interconnection Reliability Operations and Coordination
 - MOD: Modeling, Data, and Analysis
 - PER: Personnel Performance, Training and Qualifications
 - PRC: Protection and Control
 - TOP: Transmission Operations
 - TPL: Transmission Planning
 - VAR: Voltage and Reactive Control

Historical Context for Reliability Standards, *cont.*

- Factors that FERC considers when adopting reliability standards include:
 - Reliability Standard must provide for the reliable operation of Bulk Electric System facilities and may impose a requirement on any user, owner or operator of such facilities
 - It must be designed to achieve a specified reliability goal and must contain a technically sound means to achieve this goal
 - It does not necessarily need to reflect the optimal method for achieving its reliability goal
 - It should be applicable across North America to the extent possible, but can account for regional variations due to physical characteristics of grids

Violations of Mandatory Reliability Standards Carry Consequences

- Entities Subject to Financial Penalties for noncompliance

- Florida Power & Light (FPL)
 - FPL is registered as a Balancing & Planning Authority and is responsible for compliance with the Reliability Standards
 - On February 28, 2008, load loss occurred and attributed to possible violations of Reliability Standards
 - Loss of 22 transmission lines, 4,300 MW of generation, and 3,650 MW of customer service or load
 - As a result of a FERC/NERC enforcement action, FPL agreed to pay a civil penalty of \$25 million as well as adopt numerous reliability enhancement measures

Overview of Reliability Standards: Transmission Planning Standards

What is the Purpose of Transmission Planning Standards and Criteria?

- NERC describes the Intent of Transmission Planning Standards (TPLs) as follows:
 - “Purpose: System simulations and associated assessments are needed periodically to ensure that reliable systems are developed that meet specified performance requirements with sufficient lead time, and continue to be modified or upgraded as necessary to meet present and future system needs.”
- NPCC Describes the Intent of Criteria as follows:
 - “The objective of these criteria is to provide a “design-based approach” to ensure the bulk power system is designed and operated to a level of reliability such that the loss of a major portion of the system, or unintentional separation of a major portion of the system, will not result from any design contingencies referenced in Sections 5.4.1 and 5.4.2. In NPCC the technique for assuring the reliability of the bulk power system is to require that it be designed and operated to withstand representative contingencies as specified in this Directory.”

What is the Purpose of Transmission Planning Standards and Criteria? *cont.*

- ISO-NE Describes the Purpose Planning Standards in Planning Procedure No. 3 (PP-3)
 - “The purpose of these New England Reliability Standards is to assure the reliability and efficiency of the New England bulk power supply system through coordination of system planning, design and operation.”

Overview of Transmission Planning Standards

TPL Reliability Standards address:

- (1) the types of simulations and assessments that must be performed to ensure that reliable systems are developed to meet present and future system needs; and
- (2) the information required to assess regional compliance with planning criteria and for self-assessment of regional reliability

Primary Transmission Planning Standards Applicable to the ISO

- NERC Transmission Planning Standards
 - TPL-001, TPL-002, TPL-003, and TPL-004
 - TPL-004 is focused on extreme contingency testing which is not discussed in this presentation
 - National reliability standards
 - The current standards are undergoing a major revision to add clarity and consistency between parts of the country
- NPCC Regional Reliability Reference Directory #1 “Design and Operation of the Bulk Power System”
 - Applies to Ontario, Quebec, Canadian Maritimes, New York and New England
 - Currently being redrafted to clearly define enforcement requirements and to remove duplication with NERC criteria

Primary Transmission Planning Standards Applicable to the ISO, *cont.*

- ISO New England PP-3: Reliability Standards for the New England Bulk Power Supply System
 - Requirements are largely a mirror image of those in NPCC Directory 1
 - To be updated once NERC and NPCC documents have been finalized

Transmission Planning Reliability Standards with No Discretion: Contingencies

Transmission Planning Reliability Standards

- *Contingencies: No Interpretation by ISO*
- NERC, NPCC and ISO-NE transmission planning standards/criteria on contingencies generally have similar levels of detail
 - There are specific contingencies which **must** be simulated to determine the impact on the system – no interpretation done by ISO
 - System performance must remain within emergency limits following a given contingency
 - The required contingencies include second contingency testing

Standards for Multiple Element Contingency Testing

- NERC, NPCC, and ISO-NE criteria require multiple element contingency testing – wording is slightly different, but they cover either identical or similar events
 - Loss of multiple elements due the failure of a circuit breaker
 - Loss of any two circuits on a multiple circuit tower line

Standards for Second Contingency Testing (N-1-1)

- Loss of a generator, transmission circuit, or transformer with system adjustments followed by the loss of a generator, transmission circuit, or transformer
- NERC provides no guidance on the actions available between contingencies
 - NPCC and ISO-NE provide restrictions to ensure a realistically operable system – use of 10 minute resources, HVDC and phase angle regulator adjustment
- NPCC and ISO-NE criteria are more stringent – both require all contingencies, both single and multiple element, to be tested as the second contingency

Multiple Lines Out of Service

– *Examples*

- Transmission outages are not common but have high impact when they occur
- TPL standards are designed to capture the type of outages that are experienced in the course of operating the system over a long period of time
- An example of what can happen occurred on March 18, 2011
 - Loss of two 345 kV cables in downtown Boston from Mystic to Kingston St within seconds resulting in N-2 [more severe than N-1-1 criteria]
 - Loss of both HQ Phase II and the Cross Sound Cable within seconds of each other
 - Loss of two lines in the Burlington area serving the IBM load

Transmission Planning Reliability Standards Where ISO has Discretion: System Conditions

Transmission Planning Reliability Standards

- System Conditions: *Interpretation by ISO*
- The standards/criteria include general descriptions of the system conditions which should be simulated when applying the specified contingencies
 - NERC – “cover critical system conditions”
 - NPCC – “Design studies shall assume power flow conditions utilizing transfers, load and generation conditions which stress the system”
 - ISO New England – “With due allowance for generator maintenance and forced outages, design studies will assume power flow conditions with applicable transfers, load and resource conditions that reasonably stress the system”
- Here, ISO is responsible for interpreting these general descriptions

Overview of Needs Assessments

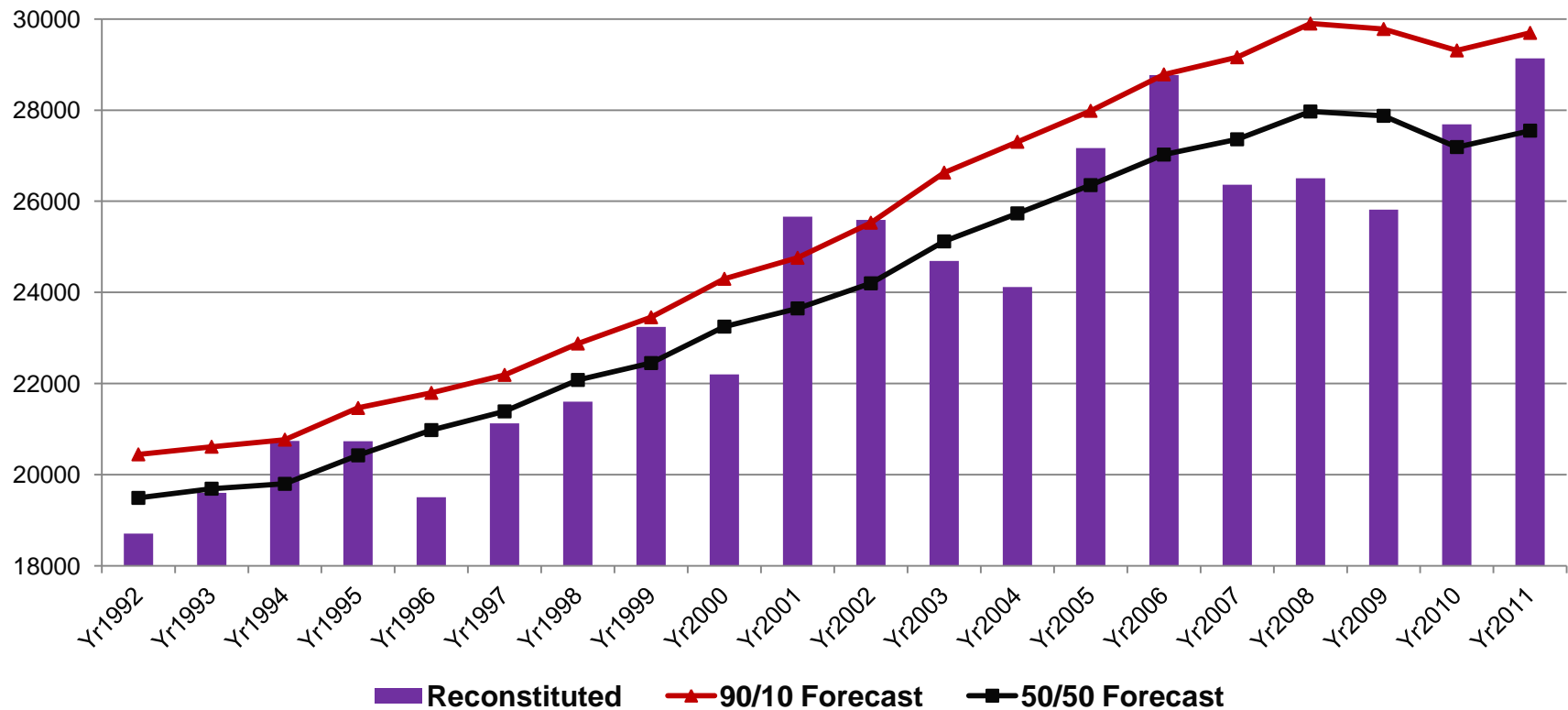
- Provide a 10-year look ahead so that system concerns are anticipated and resolved prior to being experienced in real time operations
 - Solutions may be in the form of modifications to the transmission system and also with the addition of a new resource(s) in the proper location(s)
- The conditions evaluated in the assessments serve as a proxy for the multitude of potential system conditions which can occur
 - The exact system conditions evaluated may never occur, but they need to yield a system robust enough that it can be operated reliably under most circumstances

System Conditions – Load Level

- The New England transmission system had historically been planned using a 50/50 load forecast
 - A 50/50 load forecast is one that has a 50% chance of exceeding the peak load forecast
- After a number of hot summers and extreme seasonal peak loads, ISO and many stakeholders began questioning the appropriateness of this assumption – is it reasonable to have a 50% chance of the operator facing a peak load which the system was never designed to accommodate?
 - October 8, 2002 NEPOOL Reliability Committee concluded: “That the Reliability Committee urges that a higher load forecast, such as the 90th percentile load, should be reviewed by the TTF for use when performing deterministic analysis. This would include transmission planning needs assessments and capacity adequacy analyses and presentations.”

System Conditions – Load Level, *cont.*

ISO-NE Summer Peaks (MW) Actual and 50/50 & 90/10 Forecasts



Note - YR2011 data is preliminary and subject to revision

System Conditions – Load Level, *cont.*

- ISO assumptions
 - 100% of FCM energy efficiency
 - 75% of active demand resources
 - Performance factors vary over time based on audit results
- ISO working to develop a long-range forecast for state-sponsored energy efficiency
 - Meetings with program administrators from all six states have been completed
 - Methods used by other ISO's/RTO's have been reviewed
 - ISO to soon present proposed methodology to stakeholders

System Conditions – Generation Outages

- NERC TPLs
 - In response to Requests for Interpretation of TPL-002 and 3 from Ameren and MISO, NERC responded:
 - The selection of a credible generation dispatch for the modeling of critical system conditions is within the discretion of the Planning Authority
 - The Planning Authority was renamed “Planning Coordinator” (PC) in the Functional Model dated February 13, 2007
 - Consistent with this interpretation, a Planning Coordinator would formulate critical system conditions that may involve a range of critical generator unit outages as part of the possible generator dispatch scenarios

System Conditions – Generation Outages, *cont.*

- Why contemplate any generator outages prior to applying contingencies in the model?
 - Generator outages occur with a greater frequency than transmission outages
 - Generators generally have between a 5-10% forced outage rate
 - Caution must be used when evaluating recent forced outage data
 - Even if the generation is available, there are quite often simultaneous limitations on generator output due to cooling water temperatures, internal plant concerns (tube leaks), emissions limitations –both air and water
 - Generating plants tend to experience more problems as they are stressed while operating during a heat wave
 - Many units have long start-up times and slow ramp rates, presenting operating challenges for unanticipated changes in load or resources

System Conditions – Generation Outages, *cont.*

- Why is a second generator out of service?
 - Having the second generator out of service provides some margin for the unexpected
 - New England's daily generator outages during the peak day of June, July, and August over the past ten years has been approximately 2500 MW or greater 5 times and had reached a high of 3160 MW
 - During the top ten peak load days of June, July and August over the past ten years New England's generator outages reached a high of 4270 MW

System Conditions – Generation Outages, *cont.*

- Significant generator outages have occurred which are well beyond criteria. Some notable examples:
 - Shut down of four nuclear units in Connecticut for multiple years
 - Retirement of New Boston 1 followed by a fire on New Boston 2 which destroyed the unit
 - Explosion at Salem Harbor which shut down all four generators
 - Extended outage of all four Northfield Mountain generators
- Due to industry restructuring, there are new threats to the availability of generators
 - Financial concerns have caused owners to make units unavailable without advanced notice

System Conditions – Generation Outages, *cont.*

- Why is a second generator out of service?
 - Having the second generator out of service provides some margin for:
 - Maintenance conditions
 - Maintenance is generally confined to the Spring and Fall
 - Multiple transmission lines are simultaneously removed from service
 - Multiple generating plants are simultaneously removed from service
 - Quite often, while demand is lower, the system is more stressed under these conditions than at peak load
 - If maintenance is postponed, the risk of multiple forced outages during heavy demand conditions increases
 - High demand can occur, and has occurred, during maintenance periods. As an example, all time peaks for the months of May and September occurred in 2010 during the heart of the annual maintenance season

System Conditions – Generation Outages, *cont.*

- Why is a second generator out of service?
 - Impacts on stakeholders – stakeholder feedback
 - Reliability reviews to determine if the system can be operated reliably without a particular generator (referred to as Retirement or Deactivation Determinations, Reliability Must Run or Reliability Agreement Determinations, De-list Bid or Non-Price Retirement Analysis depending upon the time period) are tested with the subject generator out of service, in addition to one other generator – 2 generators are out of service
 - If the system is designed to accommodate only one generator out of service, it is quite likely that reliability concerns will be revealed as a result of this testing
 - End result is likely a determination that the generator is needed to ensure system reliability, resulting in additional out of market compensation

System Conditions – Generation Outages, *cont.*

- Why is a second generator out of service?
 - Impacts on stakeholders – stakeholder feedback
 - A determination of need often provides an avenue for a generator(s) to receive costly out of market payments
 - Change in fuel prices may drive up costs when the reliability of the system is dependent upon specific resources
 - Lower SEMA is an area which was dependent upon the operation of generation at Canal
 - Due to the rise in oil prices, generation was dispatched out of merit to ensure system reliability
 - Out of merit costs were above \$100M per year, which was funded locally due to the nature of the reliability concern

System Conditions – Generation Outages, *cont.*

- Why is a second generator out of service?
 - Retirements can occur with limited notice
 - Example – Salem Harbor 3 and 4
 - In February, 2011, Dominion Energy Marketing submitted a Non-Price Retirement Request to retire Salem 1- 4 as of June 1, 2014
 - May 10, 2011, the ISO issued a determination letter stating that Salem Harbor 3 and 4 were needed for reliability in the 2014-2015 period
 - Dominion Energy Marketing has notified the ISO that they will be retiring the units June 1, 2014
 - This provides limited time, approximately 3 years, to develop and install the necessary system modifications to ensure continued system reliability
 - Large transmission projects often require 5-8 years to develop/install
 - Under the normal planning process, this was already under study as part of the on-going Greater Boston Study and this scenario was being analyzed

System Conditions – July 22, 2011

- For New England as a whole, peak hour forced outages and reductions totaled 3,403 MW, against 1,960 MW listed in the Morning Report
- Significant Connecticut Events
 - All events below occurred over the course of the day on July 22, 2011 and are in addition to what was already out of service at the beginning of the day
 - Large generator reduced output due to condenser issues
 - Loss of a large generator
 - Loss of a second large generator
 - Multiple large generators found to be in constant MVAR mode rather than maintaining scheduled voltages
 - Loss of a 345 kV transmission line
 - Many of these events occurred within a few hours of each other and overlap

System Conditions – Stressed Transfers

- The system must be designed to preserve existing transfer capability
- There may be a need to increase transfer capability as the generation pattern shifts
 - General system trends in the direction of flow and magnitude change dramatically over the years
 - Examples
 - Connecticut used to export many hours, but significant load growth and the outage of the nuclear units changed this to an import
 - New Brunswick was often an exporter to New England. The hours of export decreased due to the extended outage of Point Lepreau
 - Studies associated with the New England East West Solution – in the past these studies focused on the need to move power from East to West. The most recent update of this analysis shows the need to move power West to East, even prior to consideration of the retirement of Salem Harbor station in 2014

Appendix B

Transmission Planning Reliability Standards -- Contingencies

NERC TPL-001-003 Contingencies

Table I. Transmission System Standards — Normal and Emergency Conditions

Category	Contingencies	System Limits or Impacts		
	Initiating Event(s) and Contingency Element(s)	System Stable and both Thermal and Voltage Limits within Applicable Rating ^a	Loss of Demand or Curtailed Firm Transfers	Cascading Outages
A No Contingencies	All Facilities in Service	Yes	No	No
B Event resulting in the loss of a single element.	Single Line Ground (SLG) or 3-Phase (3Ø) Fault, with Normal Clearing: 1. Generator 2. Transmission Circuit 3. Transformer Loss of an Element without a Fault.	Yes Yes Yes Yes	No ^b No ^b No ^b No ^b	No No No No
	Single Pole Block, Normal Clearing ^e : 4. Single Pole (dc) Line	Yes	No ^b	No
C Event(s) resulting in the loss of two or more (multiple) elements.	SLG Fault, with Normal Clearing ^e : 1. Bus Section 2. Breaker (failure or internal Fault)	Yes Yes	Planned/ Controlled ^f Planned/ Controlled ^f	No No
	SLG or 3Ø Fault, with Normal Clearing ^e , Manual System Adjustments, followed by another SLG or 3Ø Fault, with Normal Clearing ^e : 3. Category B (B1, B2, B3, or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3, or B4) contingency	Yes	Planned/ Controlled ^f	No
	Bipolar Block, with Normal Clearing ^e : 4. Bipolar (dc) Line Fault (non 3Ø), with Normal Clearing ^e : 5. Any two circuits of a multiple circuit towerline ^g	Yes Yes	Planned/ Controlled ^f Planned/ Controlled ^f	No No
	SLG Fault, with Delayed Clearing ^e (stuck breaker or protection system failure): 6. Generator 7. Transformer 8. Transmission Circuit 9. Bus Section	Yes Yes Yes Yes	Planned/ Controlled ^f Planned/ Controlled ^f Planned/ Controlled ^f	No No No No

NPCC Directory 1 - Contingencies

- a. A permanent three-phase fault on any generator, transmission circuit, transformer or bus section with normal fault clearing.
- b. Simultaneous permanent phase to ground faults on different phases of each of two adjacent transmission circuits on a multiple circuit tower, with normal fault clearing. If multiple circuit towers are used only for station entrance and exit purposes, and if they do not exceed five towers at each station, then this condition is an acceptable risk and therefore can be excluded. Other similar situations can be excluded on the basis of acceptable risk, provided that the Reliability Coordinating Committee specifically accepts each request for exclusion.
- c. A permanent phase to ground fault on any transmission circuit, transformer, or bus section with delayed fault clearing.
- d. Loss of any element without a fault.
- e. A permanent phase to ground fault on a circuit breaker with normal fault clearing. (Normal fault clearing time for this condition may not always be high speed.)
- f. Simultaneous permanent loss of both poles of a direct current bipolar facility without an ac fault.
- g. The failure of a circuit breaker to operate when initiated by a SPS following: loss of any element without a fault; or a permanent phase to ground fault, with normal fault clearing, on any transmission circuit, transformer or bus section.

NPCC Second Contingency Testing

- These criteria will also apply after any critical generator, transmission circuit, transformer, series or shunt compensating device or HVDC pole has already been lost, assuming that the Planning Coordinator Area generation and power flows are adjusted between outages by the use of ten-minute reserve and where available, phase angle regulator control and HVDC control.

ISO-NE PP-3 Contingencies

- a. A permanent three-phase fault on any generator, transmission circuit, transformer, or bus section with normal fault clearing.
- b. Simultaneous permanent phase-to-ground faults on different phases of each of two adjacent transmission circuits on a multiple circuit transmission tower, with normal fault clearing. If multiple circuit towers are used only for station entrance and exit purposes, and if they do not exceed five towers at each station, then this condition and other similar situations can be excluded on the basis of acceptable risk, provided that the ISO specifically approves each request for exclusion. Similar approval must be granted by the NPCC Reliability Coordinating Committee.
- c. A permanent phase-to-ground fault on any transmission circuit, transformer or bus section with delayed fault clearing. This delayed fault clearing could be due to circuit breaker, relay system or signal channel malfunction.
- d. Loss of any element without a fault.
- e. A permanent phase-to-ground fault in a circuit breaker, with normal fault clearing. (Normal fault clearing time for this condition may not be high speed.)
- f. Simultaneous permanent loss of both poles of a direct current bipolar facility without an ac fault.
- g. The failure of any SPS which is not functionally redundant to operate properly when required following the contingencies listed in "a" through "f" above.
- h. The failure of a circuit breaker to operate when initiated by an SPS following: loss of any element without a fault; or a permanent phase to ground fault, with normal fault clearing, on any transmission circuit, transformer, or bus section.

ISO-NE PP-3 Second Contingency Testing

- These requirements will also apply after any critical generator, transmission circuit, transformer, phase angle regulating transformer, HVDC pole, series or shunt compensating device has already been lost, assuming that the area resources and power flows are adjusted between outages, using all appropriate reserve resources available in ten minutes and where applicable, any phase angle regulator control, and HVDC control