



# Operating Procedures

ISO New England Operating Procedure No. 12

*Voltage and Reactive Control*

Effective Date: June 4, 2010

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## VOLTAGE AND REACTIVE CONTROL

**Effective Date: June 4, 2010**

### References:

1. ISO New England Transmission Operating Guides - All Voltage/Reactive Guides
2. ISO New England Operating Procedure No. 4 - Action During a Capacity Deficiency (OP-4)
3. ISO New England Operating Procedure No. 7 - Action in an Emergency (OP-7)
4. ISO New England Operating Procedure No. 14 - Technical Requirements for Generation, Demand Resources and Asset Related Demands (OP-14)
5. ISO New England Operating Procedure No. 16 - Transmission System Data (OP-16)
6. ISO New England Operating Procedure No.19 - Transmission Operations (OP-19)
7. Master/Local Control Center Procedure No. 8 - Coordination of Generator Voltage Regulator and Power System stabilizer Outages (M/LCC 8)
8. Master/Local Control Center Procedure No. 9 - Operation of the Chester Static VAR Compensator (SVC) (M/LCC 9)
9. NERC Reliability Standard VAR-001 - Voltage and Reactive Control
10. NERC Reliability Standard IRO-005 - Reliability Coordinator Current Day Operations
11. NERC Reliability Standard VAR-002 - Generator Operations for Maintaining Network Voltage Schedules
12. NERC Reliability Standard MOD-025 - Verification of Generator Gross and Net Reactive Power Capability
13. NPCC Directory #10 - Verification of Generator Gross and Net Reactive Power Capability (NPCC D#10)
14. ISO New England Ancillary Service Schedule No. 2 Business Procedure

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- A. Voltage/Reactive Documents in the ISO New England Transmission Operating Guides
- B. Voltage and Reactive Survey

## I. INTRODUCTION

This procedure provides broad criteria, operating practices and responsibilities to help ensure that desired/reliable voltage and reactive conditions are maintained on the power system. It also includes general actions to control voltage/reactive conditions when deviations from normal occur or are needed to minimize adverse effects during abnormal conditions.

More specific criteria and actions may be required when the measures described in this procedure do not correct the abnormal voltage/reactive conditions. This information is contained in detailed voltage/reactive documents issued as part of the ISO New England (ISO) Transmission Operating Guides. Whereas these guides are referenced several times throughout this procedure, Appendix A lists the documents and indicates the types of information they contain. To facilitate references to Appendix A, its column numbering and headings are consistent with the format and order of this procedure.

## II. CRITERIA

### A. VOLTAGE SCHEDULES AND LIMITS FOR GENERATORS AND KEY TRANSMISSION STATIONS

Major generating stations throughout the New England Reliability Coordinator Area (RCA) have specified voltage schedules, which shall be maintained as closely as possible in system operations. These voltage schedules shall also be used by operators and planners in off-line studies of the power system. During certain conditions at a generating station or on the power system, sustained deviations from voltage schedules may be required/unavoidable and minimum and maximum voltages have been established that can be sustained at generating stations during these infrequent conditions.

In addition to voltage schedules, minimum and maximum voltage limits at several key generating or transmission stations have been established to promote system reliability during adverse voltage/reactive conditions. These reliability concerns can be based on the security of the transmission system or station service supplies to nuclear Generators. The key generating and transmission stations and the associated voltage limits are detailed in the area Voltage Guides issued as part of the ISO Transmission Operating Guides (refer to Appendix A, column 1).

### B. GENERATOR REACTIVE CAPABILITIES, COMMITMENTS AND REQUIRED REACTIVE RESERVES

Generator reactive capabilities available to regulate voltages shall be employed in system operations and analyses. Data collection methods [see ISO New England Operating Procedure No. 14 - Technical Requirements for Generation, Demand Resources and Asset Related Demands (OP-14)] have been designed such that these reactive capabilities shall be fully available except for occasional times when unique temporary problems occur at a particular generating station.

To promote security of the transmission system during adverse voltage/reactive conditions, required Generator commitments and levels of required reactive reserve from Generators within certain areas of the New England RCA have been established. System conditions that warrant the prescribed Generator commitments or reactive

reserves have also been identified. Details are provided in the ISO Transmission Operating Guides (see Appendix A columns 2 and 3).

### C. VERIFICATION OF GENERATOR REACTIVE POWER CAPABILITY

NPCC Directory #10 - Verification of Generator Gross and Net Reactive Power Capability (NPCC D#10) requires that each Transmission Operator establish and administer a Generator Reactive Power Capability Verification Program. It also requires each associated Generator Owner to comply with the Generator Reactive Power Capability Verification Program. The following language establishes the requirements of the ISO-NE Generator Reactive Power Capability Verification Program that each associated Generator Owner must meet to satisfy the NPCC D#10 Generator Owner compliance obligations.

ISO-NE Generator Reactive Power Capability Verification Program applies to Generators that satisfy both of the following conditions:

1. Located in the New England RCA
2. Connected at or above 100 kV and having a MVA capability greater than either one of the following:
  - 20 MVA for a single generator
  - 75 MVA for a generating station connected at a common transmission bus.

Each Generator Owner shall verify the Reactive Power Capability of their Generators that meet the above criterion in accordance with the requirements and processes contained within Sections 2.2.5 & 2.2.6 of ISO New England Ancillary Service Schedule No. 2 Business Procedure. The ISO New England Ancillary Service Schedule No. 2 Business Procedure can be located on the ISO-NE website.

The one exception to a Generator Owners adherence to the Sections 2.2.5 & 2.2.6 requirements is that the requirement for a Generator to first be recognized as a “Qualified Reactive Resource” does not apply. While Generators that are not recognized as a “Qualified Reactive Resource” do not receive Capacity Cost (CC) compensation under Ancillary Service Schedule 2 - Reactive Supply and Voltage Control from Qualified Reactive Resources Service (“Schedule 2”) under Section II of the ISO New England Tariff, they must still adhere to the Section 2.2.5 & 2.2.6 requirements.

If the results of a reactive capability test demonstrate that a Generator reactive capability is different than the reactive capability reported in the latest NX-12D, the Generator Owner must resolve the discrepancy in accordance with Section 3.9 of Part I and Schedules 22 or 23 of Part II of the ISO Tariff.

### **III. VOLTAGE/REACTIVE OPERATING PRACTICES**

#### **A. TRADITIONAL VOLTAGE/REACTIVE CONTROL**

Besides the use of Generator reactive capabilities, the proper dispatch of shunt capacitors/reactors combined with effective transformer voltage schedules or fixed tap settings are the most traditional means of achieving desired voltages and reactive conditions. Listings of switchable shunt devices installed to support the New England Transmission System (115 kV and above) and guides for switching them can be found in the area Voltage Guides (see Appendix A, column 4).

#### **B. TRANSMISSION INTERFACE TRANSFER LIMITS TO AVOID LOW VOLTAGE**

In some cases, custom software tools have been developed to calculate voltage based transfer limits for transmission interfaces. These limits ensure acceptable voltage response to contingencies. Appendix A column 5 notes the transmission operating guides that contain voltage based transfer limits for transmission interfaces.

#### **C. CIRCUIT SWITCHING TO CONTROL HIGH VOLTAGE**

In some areas, transmission circuit switching is a viable option for controlling high voltage/excessive charging conditions. Appendix A column 6 identifies the ISO New England Transmission Operating Guides that provide information for switching circuits in the Boston area to control high voltage.

#### **D. LOAD MANAGEMENT FOR VOLTAGE/REACTIVE RELIABILITY**

In severe cases of low voltage and/or inadequate reactive reserves, load management actions can be taken. Details on conditions when these actions can/shall be used and how they shall be implemented are provided in the Voltage Guides (as identified in Appendix A, column 7) and ISO New England Operating Procedure No. 4 - Action During a Capacity Deficiency (OP-4) and ISO New England Operating Procedure No. 7 - Action in an Emergency (OP-7).

## IV. RESPONSIBILITIES

This procedure is based on the principle that voltage control is best achieved when action is taken as close as possible to the affected area. Voltage schedules and other reactive conditions shall be supervised by the generating station operators, transmission station operators, Local Control Center (LCC) System Operators and ISO New England System Operators, each having a specific area of responsibility. Regardless of who requests or directs corrective measures, action must ultimately be taken by generating/transmission station operators or LCC System Operators depending on who has "hands on" control of the reactive resources.

### A. GENERATING AND TRANSMISSION STATIONS

Generating and transmission station operators are responsible for maintaining station service and other local voltage requirements and scheduled voltages at levels designated by individual Market Participants.

NERC Reliability Standard VAR-002 - Generator Operations for Maintaining Network Voltage Schedules requires each Generator equipped with an Automatic Voltage Regulator (AVR) to operate in the automatic voltage control mode. The Generator AVR will: (1.) be in service and controlling voltage, and (2.) remain in this configuration unless otherwise directed by the ISO or LCC System Operator. The Generator Operator shall promptly notify the ISO when AVR operation is temporarily unavailable.

Generating station operators are also responsible for maintaining voltage schedules set for the high side of the generator step-up transformers by the Voltage Task Force. Normally, automatic voltage regulation works off the low side of the step-up transformer (generator terminals). Thus, in order to maintain a high side voltage schedule, manual intervention can be required to offset varying power flows through and voltage drops across the step-up transformer.

When unable to maintain scheduled station and local voltages with the means under their control, the generating or transmission station operators must notify their respective LCC System Operator (and local dispatch authority if appropriate).

Generator station operators are responsible to comply with the reactive capability verification process defined in Section II.C.

## B. LCCs

LCCs are responsible for monitoring and supervising the following conditions within their territories:

1. Voltage schedules and limits,
2. Generator MVAR loadings, capabilities and reserves,
3. Shunt capacitor and reactor dispatches,
4. Transformer voltage schedules or fixed tap settings,
5. Synchronous condenser operation (requested via ISO by the LCC unless in emergency conditions),
6. MVAR flows between the AC system and HVDC facilities,
7. Static VAR Compensator operation (must be coordinated with ISO),
8. Line switching for voltage/reactive control (must be coordinated with ISO and, if warranted, with other LCCs),
9. ,Other predefined indicators of voltage/reactive security (e.g. a particular circuit flow, the status of specific Generators, area load level, etc.).

The LCCs are responsible for: 1) detecting and correcting deviations from normal scheduled voltage/reactive operations, 2) responding to notifications by generating or transmission station operators of difficulty in maintaining station or other local voltage or reactive schedules and, 3) responding to ISO requests to assist with inter-LCC or inter-Area problems.

The LCCs will notify/coordinate with ISO when there is a need to adjust the real power (MW) output of a Generator in order to adjust its MVAR output, and ISO will provide the direction to the Designated Entity/Generator Operator to adjust their Generator real power (MW) output. Unless an emergency condition warrants such action, the LCCs will not directly provide direction to the Generator Operator to adjust the real power output (MW) of their Generator in order to adjust its MVAR output.

The LCCs are authorized to exercise the following actions to correct voltage/reactive difficulties within their territories:

1. Direct voltage schedules and levels of reactive output and reserve on Generators, synchronous condensers and Static VAR Compensators,
2. Direct the use of shunt capacitors and reactors,
3. Direct the operation of LTC transformers.

When an LCC is unable to correct a voltage/reactive problem using the above actions or the LCC believes that the problem should be handled on a multi-LCC or inter-RCA basis, the LCC shall notify ISO and request assistance.

Before exercising any of the following voltage/reactive control actions, LCCs must notify ISO and coordinate their implementations:

1. Line switching,
2. Load management.

### C. ISO

ISO is responsible for general monitoring and supervision of voltage/reactive conditions in the New England RCA (115 KV and above). When system monitoring detects a problem within an LCC, ISO shall contact the LCC and request action.

When an LCC reports to ISO that it is not possible to correct an abnormal voltage/reactive-related operating condition at a station or LCC level, ISO shall assume direct responsibility for alleviating the problem. ISO is authorized to direct, through the appropriate LCC(s), all actions listed in the above LCC Section B and in addition any MW re-dispatching.

ISO is also responsible for monitoring and supervising voltage/reactive operations of inter-RCA ties. Abnormal voltage/reactive-related operating conditions may be noticed by ISO or appear in the form of requests from a neighboring Reliability Coordinator or companies for assistance. ISO shall inform the appropriate LCC (s) of the nature of the problem specifying; the pool or company involved, the location of the undesirable voltage/reactive condition and, general conditions aggravating the difficulty. ISO is authorized to work with/through the LCCs and use all Section B actions and MWh re-dispatching to eliminate the problem.

When abnormal voltage/reactive operating conditions materialize, ISO may initiate a survey of key system parameters to better assess the nature and expanse of the conditions. Appendix B contains the survey forms that ISO will use. The forms are broken down based on LCC territories.

ISO shall report annually to NPCC about the status of the ISO-NE Generator Reactive Power Capability Verification Program including any changes in the verification process and provide copies of any changes to the Generator Owners and NPCC within 30 days of issue. ISO shall also report annually to NPCC any discrepancies between published (NX-12D) and demonstrated reactive capability.

**OP 12 REVISION HISTORY**

**Document History** (This Document History documents action taken on the equivalent NEPOOL Procedure prior to the RTO Operations Date as well revisions made to the ISO New England Procedure subsequent to the RTO Operations Date.)

<b>Rev. No.</b>	<b>Date</b>	<b>Reason</b>
Rev 1	08/18/98	
Rev 2	02/01/05	Updated to conform to RTO terminology
Rev 3	05/06/05	Update References for NERC Version 0 Standards
Rev 4	06/04/10	Biennial Review by Procedure Owner. To the footer, added disclaimer on page 1 and added “uncontrolled to remaining pages; Corrected and added Reference titles. Minor clerical revisions (font format changed to Arial, grammar, etc..) Defined terms and approved acronyms for use in this document: ISO New England (ISO); Local Control Center (LCC); Reliability Coordinator Area (RCA) Inserted new language applicable to meeting requirements of NPCC Directory #10 & NERC Reliability Standard VAR-002 New Section II.C - Verification of Generator Reactive Power Capability. Section IV added related responsibilities to Generators and ISO.