ISO New England Operating Procedure No. 12
Voltage and Reactive Control

Effective Date: December 10, 2018

References:

1. NERC Reliability Standard VAR-001 - Voltage and Reactive Control
2. NERC Reliability Standard IRO-005 - Reliability Coordination Current Day Operations
3. NERC Reliability Standard VAR-002 - Generator Operation for Maintaining Network Voltage Schedules
4. NPCC Directory #10 - Verification of Generator Gross and Net Reactive Power Capability (NPCC D#10)
5. ISO New England Ancillary Service Schedule No. 2 Business Procedure
6. ISO New England Operating Procedure No. 4 - Action During a Capacity Deficiency (OP-4)
7. ISO New England Operating Procedure No. 7 - Action in an Emergency (OP-7)
12. Master/Local Control Center Procedure No. 8 - Coordination of Generator Voltage Regulator and Power System Stabilizer Outages (M/LCC 8)
13. Master/Local Control Center Procedure No. 9 - Operation of the Chester Static VAR Compensator (SVC) (M/LCC 9)
# TABLE OF CONTENTS

I. INTRODUCTION ................................................................................................ 3

II. CRITERIA........................................................................................................... 4
   A. Voltage Schedules and Limits for Generators and Key Transmission Stations .............................................................. 4
   B. Generator Reactive Capabilities, Commitments and Required Reactive Reserves ........................................................... 5

III. VOLTAGE/REACTIVE OPERATING PRACTICES .............................................. 6
   A. Traditional Voltage/Reactive Control ................................................................. 6
   B. Transmission Interface Transfer Limits To Avoid Low Voltage ......................... 6
   C. Circuit Switching to Control High Voltage .......................................................... 6
   D. Load Management for Voltage/Reactive Reliability ............................................ 6

IV. RESPONSIBILITIES ........................................................................................... 7
   A. Generating and Transmission Stations .............................................................. 7
   B. LCCs ................................................................................................................ 9
   C. ISO ................................................................................................................. 11

OP-12 Revision History .............................................................................................. 12

APPENDICES

- Appendix A - Voltage/Reactive Documents in the ISO New England ODMS
- Appendix B - Voltage and Reactive Schedules
- Appendix C - Retired (12/10/18)
- Appendix D - Voltage Schedule Annual Transmittal Form
I. INTRODUCTION

This Operating Procedure (OP) establishes criteria, operating practices and responsibilities to maintain desired/reliable voltage and reactive conditions on the power system. It includes general actions to control voltage/reactive conditions when deviations from normal occur or are needed to minimize adverse effects during abnormal conditions.

Specific criteria and actions are contained in detailed voltage/reactive documents issued as part of the ISO New England (ISO) Transmission Operating Guides. OP-12, Appendix A - Voltage/Reactive Documents (OP-12A) lists the applicable Transmission Operating Guides and indicates the types of information they contain. Column numberings and headings in OP-12A are consistent with the format and order of this OP. OP-12A does not list temporary transmission operating guides that can contain additional criteria and actions required to correct abnormal voltage/reactive conditions. These temporary transmission operating guides can be found in the Operations Documents Management System (ODMS).
II. CRITERIA

A. Voltage Schedules and Limits for Generators and Key Transmission Stations

Voltage schedules and limits for NERC registered and/or transmission (69 kV or higher) connected Generators that can control transmission voltage and key transmission stations are specified by ISO in Appendix B - Voltage and Reactive Schedules (OP-12B) of this OP. OP-12B includes schedules for:

- Generators
- Transmission Static Synchronous Compensators (STATCOMs)
- Transmission Static VAR Compensators
- Synchronous Condensers
- Autotransformers with Load Tap Changers (LTCs)

OP-12B also includes size information for:

- Transmission Capacitors
- Transmission Reactors

Voltage schedules for Generators not listed in OP-12B are specified as follows:

- Generators listed in Master/Local Control Center Procedure No. 8 - Coordination of Generator Voltage Regulator and Power System Stabilizer Outages Attachment A - Generators Exempted from AVR Requirements (M/LCC 8A) are Generators that ISO has exempted from the requirement to have an automatic voltage regulator (AVR). As noted in M/LCC 8A, these Generators follow a reactive power schedule by operating near unity power factor.

- Generators not listed in OP-12B or M/LCC 8A will follow local voltage schedules specified by the applicable Local Control Center (LCC) in accordance with LCC requirements or as required in their interconnection agreements.

- Voltage schedules are not specified for Generators not modeled in the ISO Energy Management System (EMS)

The voltage schedule specified for a Generator in OP-12B is the prescribed normal voltage that a Generator shall maintain as measured at the high side of the Generator step-up transformer unless otherwise specified. This normal voltage schedule, which is specified for both on-peak and off-peak load periods, is represented by a kV schedule value with accompanying operational kV high and kV low values that establish the “voltage schedule tolerance band”. A Generator shall maintain voltage output within its normal voltage schedule tolerance band values in system operations at all times while one or more units at the generating station are online, unless otherwise directed by ISO or the LCC. These voltage schedules shall also be used by operators and planners in off-line studies of the power system.
During certain infrequent, atypical conditions at a generating station or on the power system, ISO or an LCC may issue an operating instruction to a Generator to deviate from its normal voltage schedule and to temporarily operate at a voltage output level outside of the normal voltage schedule tolerance band but within the wider minimum and maximum “acceptable” voltage schedule range, which is also listed in OP-12B. These minimum and maximum “acceptable” voltage schedule range values are based on data provided by the Generators on Form NX-12D in accordance with ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Response Resources, Asset Related Demands and Alternative Technology Regulation Resources (OP-14).

During these conditions, if ISO or the LCC issue an operating instruction to a generating station to operate to a temporary voltage schedule, it shall provide each applicable Generator operator with the following:

- The temporary voltage schedule to be maintained with the AVR in-service and controlling to a voltage setpoint
- The temporary voltage schedule tolerance band to be maintained
- The expected duration of this temporary voltage schedule change (if known, or “until further notice”)

If the Generator operator has been directed to deviate from the normal voltage schedule and tolerance band, the LCC shall contact the Generator operator at least once a shift to confirm the temporary voltage schedule and tolerance band. Once the temporary voltage schedule is no longer applicable, the ISO or LCC shall issue an operating instruction to the Generator operator to return to the normal voltage schedule and tolerance band.

B. Generator Reactive Capabilities, Commitments and Required Reactive Reserves

Generators’ reactive capabilities entered in the NX-12D Forms shall be used in system operations and analyses. These reactive capabilities shall be fully available when the Generator is on-line and any change to a Generator reactive capability shall be reported to the ISO and LCC in real time in accordance with Appendix B to OP-14 (OP-14B).

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 Reliability Coordinator Area (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 ODMS (see OP-12A columns 2 and 3).
III. VOLTAGE/REACTIVE OPERATING PRACTICES

A. Traditional Voltage/Reactive Control

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 while maintaining dynamic reactive reserve on Generators. Switchable shunt devices installed to support the New England Transmission System (115 kV and above) and guides for switching them can be found in OP-12B and in the ISO Transmission Operating Guides (see OP-12A, 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 provide acceptable voltage response to contingencies. OP-12A column 5 identifies the ISO 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. OP-12A column 6 identifies the ISO Transmission Operating Guides that provide information for switching circuits 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 described in the ISO Transmission Operating Guides (as identified in OP-12A, 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 OP 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 (or Generator operators), transmission station operators, LCC System Operators and ISO System Operators, each having a specific area of responsibility. Regardless of who issues an operating instruction for a corrective measure, action shall ultimately be taken by a generating/transmission station operator or LCC System Operator depending on who has "hands on" control of the reactive resource.

A. Generating and Transmission Stations

1. Generating Station and Transmission Station Operation to Maintain Voltage Schedule

Generator operators and transmission station operators are responsible for maintaining station service and other local voltage requirements and scheduled voltages at levels designated by ISO in OP-12B, or as otherwise specified through an operating instruction issued by ISO or an LCC.

Transmission station operators with control over dynamic reactive resources maintaining a voltage schedule within a voltage schedule tolerance band outlined in OP-12B shall comply with the requirements for Generator operators outlined in this Section IV.A.1.

Automatic voltage regulation normally works off the low side of the step-up transformer (generator terminals). 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.

The Generator operator shall maintain the high-side bus voltage within the normal voltage schedule tolerance band, as specified in the “kV High” and “kV Low” levels for the appropriate load period, as indicated in the “Operational Voltage Schedules” columns of OP-12B. If a Generator does not have high side bus-voltage visibility, a detailed description of the method used to monitor its high-side bus voltage shall be included in the unit’s NX-12D Form in accordance with OP-14B.

Excursions outside of the prescribed normal voltage schedule tolerance band shall be kept to a minimum. The Generator operator shall regularly check Generator high-side bus voltage against scheduled voltage and if the high-side voltage is outside the voltage schedule tolerance band, act to reestablish voltage within the tolerance band within 15 minutes. When a Generator operator or transmission station operator is unable to maintain the scheduled voltage within the voltage schedule tolerance band and local voltages with the means under its control, the Generator operator or transmission station operator shall notify its respective LCC System Operator (and local dispatch authority if appropriate). If a Generator high-side bus voltage drifts outside of its normal voltage schedule tolerance band, the Generator operator shall immediately notify the LCC when one of the following conditions is met:
(1) The Generator has been operating outside of its prescribed voltage schedule tolerance band for a continuous period of 15 minutes; or

(2) The Generator operator determines that the Generator will be unable to return to operating within its prescribed voltage schedule tolerance band within 15 minutes

A unit is not allowed to operate outside its normal voltage schedule tolerance band unless ISO or the LCC issues an operating instruction to do so. If a unit is not maintaining its voltage within the prescribed normal voltage schedule tolerance band for a period exceeding 15 minutes and has not notified the LCC (as described above), or is not closely following an alternative voltage schedule issued by ISO or the LCC, then the unit shall be considered to be in violation of this OP.

When a Generator is issued an operating instruction to deviate from its normal voltage schedule and tolerance band, the Generator shall operate within this temporary voltage schedule tolerance band until further notice.

2. Generator Operation in Automatic Voltage Control Mode

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. Whenever the AVR operation is available, the Generator AVR shall:

- Be in service and controlling voltage, and
- Remain in this configuration unless otherwise directed by the ISO or LCC System Operator.

When a Generator AVR is out-of-service, the Generator operator shall use an alternative method to control the Generator reactive output to meet the voltage or Reactive Power schedule. Actual or expected changes in AVR operating status shall be reported in accordance with this OP and with M/LCC 8 as follows:

- The Generator operator shall report changes to AVR status in Real-Time except for conditions that the Lead Market Participant has reported in advance on Form NX-12D, as described in the following paragraph. The Generator shall make those reports whenever the AVR is removed from or placed into service unless taking those actions is warranted by emergency plant conditions. The Generator operator shall also report any problems that could interfere with proper operation of an AVR. These reports shall be made to the following entities as soon as the AVR status change condition arises, as follows:
  - The Generator operator shall report to the applicable LCC; and
  - The Lead Market Participant shall report to ISO through its assigned Designated Entity (DE)

- When the Lead Market Participant describes expected changes to AVR status that occur during Real-Time conditions on Form NX-12D for the Generator in accordance with ISO OP-14 (i.e. periods of time when the Lead Market
participant routinely expects that its Generator will not operate with the AVR in service and controlling voltage, such as during start up or shut down) these changes shall not to be reported in Real-Time. When conditions that match the conditions described on Form NX-12D occur, the information on Form NX-12D shall serve as advance standing notification and Real-Time reporting shall not be required.

3. Generator Verification of Reactive Capability

Each Generator operator is responsible to comply with the reactive capability verification process detailed in ISO New England Operating Procedure No.23 - Generator Resource Auditing (OP-23).

B. LCCs

Each LCC is responsible for monitoring the following:

1. Generator, STATCOM, synchronous condenser, and static VAR compensator voltage schedules and limits,
2. Generator, STATCOM, synchronous condenser, and static VAR compensator MVAr loadings, capabilities and reserves,
3. Transformer voltage schedules,
4. MVAr flows between the AC system and HVDC facilities,
5. 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. Dispatching shunt capacitors and reactors,
2. Implementing transformer fixed and seasonal tap settings,
3. Line switching for voltage/reactive control (shall be coordinated with ISO and, if warranted, with other LCCs),
4. Detecting and correcting deviations from the voltage schedule tolerance band on a Generator, STATCOM, synchronous condenser, and/or static VAR compensator
5. Providing Real-Time voltage schedule changes to the operator of a Generator, STATCOM, synchronous condenser, or static VAR compensator, including the following information:
   - The temporary voltage schedule to maintain with AVR in-service and controlling voltage
   - The temporary voltage schedule tolerance band to maintain
   - The expected duration of this temporary voltage schedule change
6. Contacting the operator of a Generator, STATCOM, synchronous condenser,
or static VAR compensator that has been directed to deviate from the normal voltage schedule and tolerance band at least once per shift to confirm the temporary voltage schedule and tolerance band.

(7) Directing the operator of a Generator, STATCOM, synchronous condenser, or static VAR compensator to return to the normal voltage schedule and tolerance band once the temporary voltage schedule is no longer applicable.

(8) Responding to notifications from the operator of a Generator, STATCOM, synchronous condenser, or static VAR compensator of their difficulty in maintaining station or other local voltage or reactive schedules

(9) Responding to ISO requests to assist with inter-LCC or inter-area problems.

(10) Notifying/coordinating with ISO when there is a need to adjust the real power (MW) output of a Generator in order to adjust its MVAr output. ISO shall provide the direction to the DE to adjust its Generator real power (MW) output. Unless an emergency condition warrants such action, the LCCs shall not directly issue an operating instruction to the Generator operator to adjust the real power output (MW) of its Generator in order to adjust its MVAr output.

(11) Notifying/coordinating with ISO any of the following voltage/reactive control actions prior to implementation:
- Line switching
- Load management in response to voltage SOL exceedance/violation
- Generator, STATCOM, synchronous condenser, or static VAR compensator voltage schedule tolerance band (kV high and/or kV low) changes

If ISO and an LCC differ on what the voltage schedule should be for a given unit, then ISO and that LCC shall discuss and agree upon the appropriate voltage schedule to be communicated to the unit.

When an LCC is unable to correct a voltage/reactive problem using all available 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.

During the first quarter of each year, each LCC shall confirm the voltage control capability for each Generator within its operational footprint with the Lead Market Participant for that Generator and instruct each Generator (excluding those listed in M/LCC 8A) to comply with having the Generator AVR in service and controlling to the voltage schedule identified in the transmittal. Each LCC’s annual transmittals shall be sent to the following Generators:

(1) Those listed in OP-12B

(2) Those listed in M/LCC 8A

(3) All other Generators modeled in the ISO EMS

Each LCC shall use the template provided in OP-12, Appendix D - Voltage Schedule Annual Transmittal Form (OP-12D) for the transmittals. As the source of email
addresses for the Lead Market Participants, ISO shall use the DE Contact Information posted on the confidential satellite information website at:

https://smd.iso-ne.com/satellite/nx12_initialdisplay/

On each such transmittal, the LCC shall copy the chair of the Voltage Task Force at email address:

vtfcontact@iso-ne.com

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.

ISO is responsible for notifying the applicable LCC as soon as it becomes aware of an emergency or forced outage of a Generator AVR.

When an LCC reports to ISO that it is not possible to correct an abnormal voltage/reactive-related operating condition at a station or an 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 IV. B of this OP as well as any MW re-dispatching.

If ISO and an LCC differ on what the voltage schedule should be for a given unit, then ISO and that LCC shall discuss and agree upon the appropriate voltage schedule to be communicated to the unit.

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 actions under Section IV. B of this OP as well as MW 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. Online tools are utilized to conduct the surveys.
**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 as revisions made to the ISO New England Procedure subsequent to the RTO Operations Date.)

<table>
<thead>
<tr>
<th>Rev. No.</th>
<th>Date</th>
<th>Reason</th>
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<tbody>
<tr>
<td>Rev 1</td>
<td>08/18/98</td>
<td>Updated to conform to RTO terminology</td>
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<tr>
<td>Rev 2</td>
<td>02/01/05</td>
<td>Update References for NERC Version 0 Standards</td>
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<tr>
<td>Rev 3</td>
<td>05/06/05</td>
<td>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 &amp; NERC Reliability Standard VAR-002 New Section II.C - Verification of Generator Reactive Power Capability. Section IV added related responsibilities to Generators and ISO.</td>
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<tr>
<td>Rev 4</td>
<td>06/04/10</td>
<td>Biennial review performed by document owner References Section, deleted NERC Reliability Standard MOD-025, corrected titles of items 2 &amp; 8; Section I: clarified that only permanent operating guides are listed in Table 1 of OP-12, App A and pointed out that additional voltage/reactive instructions may reside in temporary operating guides; Section II.A: significant expansion to section, with added details on voltage schedule requirements for units; Section II.B: deleted name of OP-14 and added “Reliability Coordinator Area”; Section III.A: added phrase “OP-12, App B and in”; Section IV: removed “Local Control Center” name leaving the abbreviation and removed “station” reference in two locations; Section IV.A: significant enhancement describing the revised OP-12, App B document and the use of the information / voltage schedules found within OP-12, App B. Described AVR status change requirements in detail. Changed used of the word “station” in the 2nd to last paragraph.; Section IV.B: Changed used of the word “station” in the 2nd set of numbered items. Added requirement of the LCCs to annually contact and confirm the voltage schedule for units. Added provision to allow a 15-minute window for excursions outside of the prescribed voltage schedule tolerance band;</td>
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<td>5</td>
<td>04/13/12</td>
<td>Replaced page numbers in footers with Page X of Y format; References Section Item 7 replaced “…stabilizer…” with “…Stabilizer…”; Section II.A: defined voltage schedules and added reference to Appendix B Section II.C: in 1st paragraph, replaced “…satisfy both…” with “…satisfy all…” Section II.C: as new item II.C.3, added language to exempt units that are not NERC registered from testing requirements; Section II.C: as a new paragraph at the end of the section, added language to clarify testing requirements for units on extended outage; Section III. C. deleted “…in the Boston area…”; Section IV A: Inserted “Whenever AVR operation is available…” Section IV.B.9: deleted the comma (,) at the beginning of the item. Section IV.C. 3rd paragraph replaced “…MWh…” with “…MW…”</td>
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<td>6</td>
<td>01/23/14</td>
<td>Biennial review performed by document owner References Section, deleted NERC Reliability Standard MOD-025, corrected titles of items 2 &amp; 8; Section I: clarified that only permanent operating guides are listed in Table 1 of OP-12, App A and pointed out that additional voltage/reactive instructions may reside in temporary operating guides; Section II.A: significant expansion to section, with added details on voltage schedule requirements for units; Section II.B: deleted name of OP-14 and added “Reliability Coordinator Area”; Section III.A: added phrase “OP-12, App B and in”; Section IV: removed “Local Control Center” name leaving the abbreviation and removed “station” reference in two locations; Section IV.A: significant enhancement describing the revised OP-12, App B document and the use of the information / voltage schedules found within OP-12, App B. Described AVR status change requirements in detail. Changed used of the word “station” in the 2nd to last paragraph.; Section IV.B: Changed used of the word “station” in the 2nd set of numbered items. Added requirement of the LCCs to annually contact and confirm the voltage schedule for units. Added provision to allow a 15-minute window for excursions outside of the prescribed voltage schedule tolerance band;</td>
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<td>7</td>
<td>12/09/14</td>
<td>Section II.A: changed references to “Heavy” and “Light” to “On-Peak” and “Off-Peak”, respectively. Also added instructions for the LCC to provide voltage schedule and tolerance band, along with confirmation of these schedules at least once a shift, when in atypical conditions. Also removed language indicating that voltage schedules and acceptable voltage ranges are referenced in column 1 of OP12 Appendix A.; Section II.C. deleted the entire section content and moved applicable content to OP-23; Section IV.A. Added instructions for the LCCs to provide temporary voltage schedule and tolerance band, along with confirmation of these schedules at least once a shift, when in atypical conditions.; Section IV.B. added responsibilities on the LCCs to provide temporary voltage schedule and tolerance band, along with confirmation of these schedules at least once a shift, when in atypical conditions. Also clarified the language requiring the LCCs to confirm voltage control capability with all Generators within their footprint. Also added the third type of units (not in OP12B or MLCC8A) will be all other Generators modeled in the ISO EMS.; Section IV.C. added a responsibility on ISO to notify the applicable LCC when becoming aware of emergency or forced outage of a Generator AVR.</td>
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<td>7.1</td>
<td>10/21/16</td>
<td>Periodic review performed requiring no changes; Made administrative changes required to publish a Minor Revision (including adding required corporate document identity to all page footers);</td>
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<td>8</td>
<td>07/13/17</td>
<td>Biennial review performed by document owner; Sections I, II, &amp; III: made clarifying editorial changes; Section IV.A: added new paragraph extending requirements on Generators to Transmission station operators with dynamic reactive resources maintaining a voltage schedule per OP-12B; Section IV.B: modified, added, re-ordered, and clarified LCCs responsibilities. Modified the instructions to make it easier for the LCCs to find the DE Contact Information; Section IV.C: deleted obsolete reporting requirement on ISO to NPCC regarding ISO-NE Generator Reactive Power Capability Verification Program.</td>
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<tr>
<td>Rev 9</td>
<td>12/10/18</td>
<td>Globally used the term “operating instruction” is several places throughout the document to emphasize that the communication of a voltage schedule in real-time is an operating instruction (i.e., replaced terms such as “instruct” or “provide” or “communicate” with “issue an operating instruction”); Added sub-headings 1, 2 and 3 to Section IV.A to identify and differentiate different topics covered within the section; Moved certain provisions from one section of the document to another, where they are more appropriately placed (with some edits); Globally made other clarifying editorial and format changes; Retired Appendix C - Voltage and Reactive Surveys (12/10/18);</td>
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