

Standard VAR-001-2 — Voltage and Reactive Control

Regional Variance Development Roadmap

This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.

Development Steps Completed:

Completed Actions	Completion Date
1. Post draft standard for initial industry comments	December 14, 2009
2. Receive Initial industry comments from First Posting	January 29, 2010
3. Drafting Team to review and respond to initial industry comments	March 4, 2010
4. Post second draft standard for industry comments	May 6, 2010
5. Second draft comment period ended	July 12, 2010
6. Drafting Team to review and respond to industry comments	August 11, 2010
7. Post third draft standard for industry comments	September 24, 2010
8. Industry comments for third draft standard are due	October 25, 2010
9. Drafting Team to review and respond to industry comments	November 24, 2010
10. Post fourth draft as a regional variance to NERC VAR-001-2 Requirements R3 and R4	December 7, 2010
11. Comments from fourth posting are due	January 7, 2011
12. Post draft standard for Operating Committee approval	January 26, 2011
13. Operating Committee approved proposed standard	March 2-4, 2011
14. Posted draft standard for WECC Board approval	May 2011
15. WECC Board approved proposed standard	June 22, 2011

Description of Current Draft:

The current draft has been converted from a regional reliability standard into a regional variance to the NERC VAR-001-2 Standard. The format incorporates the WECC Regional Variance into the NERC Standard with minor additions to address the scope of the variance. The regional variance specifics are included as Section E and in this case are intended to replace NERC VAR-001-2 Requirements R3 and R4 as noted at the beginning of Section E. The redline version of Section E identifies what was changed from the last posting.

The purpose of this regional variance to a NERC Reliability Standard is to ensure that voltage levels are within limits in real time to protect equipment and the reliable operation of the Western Interconnection. The “Rules of Procedure of the North American Electric Reliability Corporation” (Appendix 3A, page 32) permit the development of a regional variance to a NERC Reliability Standard on an Interconnection-wide basis when the Regional Reliability Organization has valid justification, and when the variance is not inconsistent with or less

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stringent than the NERC Reliability Standard. The variance is an alternative method for obtaining the same reliability objective as the continent-wide standard and is typically necessitated by a physical difference. A variance is embodied within a reliability standard and as such, if adopted by NERC and approved by the electric reliability organization governmental authority, shall be enforced within the applicable regional entity or regional entities pursuant to delegated authority.

Analysis of disturbances in the Western Interconnection have demonstrated that during and immediately following a disturbance, the generator's Automatic Voltage Regulator (AVR) — operating in automatic voltage control mode — is needed to stabilize the Bulk Electric System's voltage. Transmission Operators are responsible for determining the voltage levels required to maintain reliable operation of the Interconnection and convey the required voltage level information to Generator Operators.

The NERC VAR-001-2 Requirement R3 allows Transmission Operators the option of specifying criteria that exempt generators from compliance with the requirements defined in NERC Standard VAR-001-2 Requirement 4 and Requirement 6.1. The drafting team and WECC stakeholders believe that permitting such exemptions reduces the proper voltage support when generation and transmission outages occur, adversely impacting the reliability of the Western Interconnection.

The NERC VAR-001-2 Requirement R4 allows Transmission Operators the option of providing reactive power schedules rather than voltage schedules; however, operating against a reactive power schedule will not enhance reliability in the Western Interconnection by ensuring that generators provide the proper voltage support when generation and transmission outages occur. This conclusion is based on the interpretation that generator operators given reactive schedules under NERC VAR-001-2 are required to maintain the reactive output defined in the schedule at all times. This will require generator operators to modify the AVR set point as system conditions change to maintain the specified reactive output of the schedule.

This variance to a NERC Standard restricts the Transmission Operator to providing only a voltage schedule, but allows the schedule to be conveyed through a reactive power level, provided that the reactive power level is converted to a voltage level for the AVR's automatic voltage control mode setting. Once a reactive power level is converted to a voltage level, that voltage level defines the schedule until a new voltage schedule — which may be in reactive power terms — is provided by the Transmission Operator.

In the Western Interconnection, System Operating Limits for transmission paths in the Bulk Electric System assume that the AVRs are in service to control voltage to support the transfer capabilities. As noted below the previous approvals and rulings regarding VAR-002-WECC-1 have directed Generator Operators to operate AVRs in voltage control mode controlling voltage to support transfer capabilities in the Western Interconnection.

- April 16, 2008: the WECC Board of Directors approved VAR-002-WECC-1 to ensure that the AVRs are in service and controlling voltage so that generators provide the proper voltage support when generation and transmission outages occur.
- October 29, 2008: the NERC Board of Trustees approved VAR-002-WECC-1.
- April 21, 2011: FERC issued an Order approving VAR-002-WECC-1.

The NERC Rules of Procedure allow that WECC regional reliability standard requirements may be more, but not less, stringent than NERC requirements. NERC VAR-002-1.1b requires Generator

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Operators to maintain the voltage or Reactive Power output as directed by the Transmission Operators. VAR-002-WECC-1 requires that Generators Operators maintain the AVRs in service operating in automatic voltage control mode with some defined exceptions. This proposed variance to VAR-001-2 does not allow AVR operation to be defined by a reactive power schedule.

If the Transmission Operator provides a schedule of voltages to the Generator Operator, the Generator Operator can more easily maintain compliance with the requirement. If the Transmission Operator provides voltage schedule information in another format, such as in reactive power terms, compliance with the proposed requirements require conversion of the operating instruction to a voltage value by the Generator Operator. The Generator Operator uses the converted value to set the automatic voltage control. The resulting voltage needs to be monitored by the Transmission Operator to ensure the desired outcome is achieved or the Transmission Operator needs to issue additional schedules.

During the VAR-002-WECC-1 standard development process, the industry comments noted that not all WECC Transmission Operators provide voltage schedules to their Generator Operators. Providing reactive power schedules (instead of specific voltage levels) forces Generator Operators to manually adjust their AVR voltage setting to a setting that will provide the exact amount of reactive power in the schedule.

It is recognized that during the course of a day, system dynamics may result in changes in reactive output such that the generator will no longer produce the amount of reactive power specified by the Transmission Operator's reactive power schedule. If the Generator Operator alters the amount of reactive power provided by the generator to return it to the schedule, there is higher risk that such action will result in the generator doing the exact opposite of what is needed to maintain system reliability: ensuring that generators provide the proper voltage support when generation and transmission outages occur.

The drafting team surveyed Transmission Operators and Generator Operators to identify scheduling practices that are causing confusion. The survey results identified a rationale that will accommodate the continued practice of providing direction in reactive power terms rather than requiring all Transmission Operators to define the stable system voltage with the exclusive use of a voltage schedule.

WECC is requesting NERC Board of Trustee approval of the draft regional variance to the NERC VAR-001-2 Standard. The WECC Regional Variance requires Transmission Operators to issue schedules but identifies the methodologies to be used by Generator Owners for implementing the schedules so as to maintain compliance without burdensome manual intervention by operating personnel.

The WECC Variance to VAR-001-2 is an alternative approach to meeting the same reliability objective as the NERC VAR-001-2 Reliability Standard. The proposed regional variance in Section E contains requirements that are more stringent than the continent-wide Requirements R3 and R4 of VAR-001-2 or provides a specific alternative approach to meeting the same reliability objective.

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Future Development Plan:

Anticipated Actions	Anticipated Date
1. Request NERC 45-day Posting	October 2011
2. Post draft standard for 45-day NERC comment period	To be determined
3. NERC comment period ends	To be determined
4. Drafting Team completes review and consideration of industry comments to NERC posting	To be determined
5. Submit NERC Board approval request	To be determined
6. Receive NERC Board approval	To be determined
7. Request FERC approval	To be determined

Definitions of Terms Used in Standard

This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved. When the standard becomes effective, these definitions will be removed from the standard and added to the Glossary.

None

A. Introduction

1. **Title:** Voltage and Reactive Control
2. **Number:** VAR-001-2
3. **Purpose:** To ensure that voltage levels, reactive flows, and reactive resources are monitored, controlled, and maintained within limits in real time to protect equipment and the reliable operation of the Interconnection.
4. **Applicability:**
 - 4.1. Transmission Operators.
 - 4.2. Purchasing-Selling Entities.
 - 4.3. Load Serving Entities.
 - 4.4. Generator Operators within the Western Interconnection.
5. **(Proposed) Effective Date:** The first day of the first calendar quarter six months after applicable regulatory approval; or in those jurisdictions where no regulatory approval is required, the first day of the first calendar quarter six months after Board of Trustees' adoption.

B. Requirements

- R1. Each Transmission Operator, individually and jointly with other Transmission Operators, shall ensure that formal policies and procedures are developed, maintained, and implemented for monitoring and controlling voltage levels and Mvar flows within their individual areas and with the areas of neighboring Transmission Operators.
- R2. Each Transmission Operator shall acquire sufficient reactive resources – which may include, but is not limited to, reactive generation scheduling; transmission line and reactive resource switching;, and controllable load – within its area to protect the voltage levels under normal and Contingency conditions. This includes the Transmission Operator's share of the reactive requirements of interconnecting transmission circuits.
- R3. The Transmission Operator shall specify criteria that exempts generators from compliance with the requirements defined in Requirement 4, and Requirement 6.1.
 - R3.1. Each Transmission Operator shall maintain a list of generators in its area that are exempt from following a voltage or Reactive Power schedule.
 - R3.2. For each generator that is on this exemption list, the Transmission Operator shall notify the associated Generator Owner.
- R4. Each Transmission Operator shall specify a voltage or Reactive Power schedule ¹ at the interconnection between the generator facility and the Transmission Owner's facilities to be maintained by each generator. The Transmission Operator shall provide the voltage or Reactive Power schedule to the associated Generator Operator and direct the Generator Operator to comply with the schedule in automatic voltage control mode (AVR in service and controlling voltage).
- R5. Each Purchasing-Selling Entity and Load Serving Entity shall arrange for (self-provide or purchase) reactive resources – which may include, but is not limited to, reactive generation

¹ The voltage schedule is a target voltage to be maintained within a tolerance band during a specified period.

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scheduling; transmission line and reactive resource switching;, and controllable load– to satisfy its reactive requirements identified by its Transmission Service Provider.

- R6.** The Transmission Operator shall know the status of all transmission Reactive Power resources, including the status of voltage regulators and power system stabilizers.
 - R6.1.** When notified of the loss of an automatic voltage regulator control, the Transmission Operator shall direct the Generator Operator to maintain or change either its voltage schedule or its Reactive Power schedule.
- R7.** The Transmission Operator shall be able to operate or direct the operation of devices necessary to regulate transmission voltage and reactive flow.
- R8.** Each Transmission Operator shall operate or direct the operation of capacitive and inductive reactive resources within its area – which may include, but is not limited to, reactive generation scheduling; transmission line and reactive resource switching; controllable load; and, if necessary, load shedding – to maintain system and Interconnection voltages within established limits.
- R9.** Each Transmission Operator shall maintain reactive resources – which may include, but is not limited to, reactive generation scheduling; transmission line and reactive resource switching;, and controllable load– to support its voltage under first Contingency conditions.
 - R9.1.** Each Transmission Operator shall disperse and locate the reactive resources so that the resources can be applied effectively and quickly when Contingencies occur.
- R10.** Each Transmission Operator shall correct IROL or SOL violations resulting from reactive resource deficiencies (IROL violations must be corrected within 30 minutes) and complete the required IROL or SOL violation reporting.
- R11.** After consultation with the Generator Owner regarding necessary step-up transformer tap changes, the Transmission Operator shall provide documentation to the Generator Owner specifying the required tap changes, a timeframe for making the changes, and technical justification for these changes.
- R12.** The Transmission Operator shall direct corrective action, including load reduction, necessary to prevent voltage collapse when reactive resources are insufficient.

C. Measures

- M1.** The Transmission Operator shall have evidence it provided a voltage or Reactive Power schedule as specified in Requirement 4 to each Generator Operator it requires to follow such a schedule.
- M2.** The Transmission Operator shall have evidence to show that, for each generating unit in its area that is exempt from following a voltage or Reactive Power schedule, the associated Generator Owner was notified of this exemption in accordance with Requirement 3.2.
- M3.** The Transmission Operator shall have evidence to show that it issued directives as specified in Requirement 6.1 when notified by a Generator Operator of the loss of an automatic voltage regulator control.
- M4.** The Transmission Operator shall have evidence that it provided documentation to the Generator Owner when a change was needed to a generating unit’s step-up transformer tap in accordance with Requirement 11.

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

Regional Entity.

1.2. Compliance Monitoring Period and Reset Time Frame

One calendar year.

1.3. Compliance Monitoring and Enforcement Processes:

Compliance Audits

Self-Certifications

Spot Checking

Compliance Violation Investigations

Self-Reporting

Complaints

1.4. Data Retention

The Transmission Operator shall retain evidence for Measures 1 through 4 for 12 months.

The Compliance Monitor shall retain any audit data for three years.

1.5. Additional Compliance Information

The Transmission Operator shall demonstrate compliance through self-certification or audit (periodic, as part of targeted monitoring or initiated by complaint or event), as determined by the Compliance Monitor.

2. Violation Severity Levels (no changes)

E. Regional Variances

E.A. Regional Variance for the Western Electricity Coordinating Council

The following Interconnection-wide variance shall be applicable in the Western Electricity Coordinating Council (WECC) and replaces, in their entirety, Requirements R3 and R4. Please note that Requirement R3 is deleted and R4 is replaced with the following requirements.

Requirements

E.A.13. Each Transmission Operator shall issue any one of the following types of voltage schedules to the Generator Operators for each of their generation resources that are on-line and part of the Bulk Electric System within the Transmission Operator Area: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning and Same-day Operations]*

- A voltage set point with a voltage tolerance band and a specified period.
- An initial volt-ampere reactive output or initial power factor output with a voltage tolerance band for a specified period that the Generator Operator uses to establish a generator bus voltage set point.

- A voltage band for a specified period.
- E.A.14.** Each Transmission Operator shall provide one of the following voltage schedule reference points for each generation resource in its Area to the Generator Operator. *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning and Same-day Operations]:*
- The generator terminals.
 - The high side of the generator step-up transformer.
 - The point of interconnection.
 - A location designated by mutual agreement between the Transmission Operator and Generator Operator.
- E.A.15.** Each Generator Operator shall convert each voltage schedule specified in Requirement E.A.13 into the voltage set point for the generator excitation system. *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning and Same-day Operations]*
- E.A.16.** Each Generator Operator shall provide its voltage set point conversion methodology from the point in Requirement E.A.14 to the generator terminals within 30 calendar days of request by its Transmission Operator. *[Violation Risk Factor: Lower] [Time Horizon: Operations Planning]*
- E.A.17.** Each Transmission Operator shall provide to the Generator Operator, within 30 calendar days of a request for data by the Generator Operator, its transmission equipment data and operating data that supports development of the voltage set point conversion methodology. *[Violation Risk Factor: Lower] [Time Horizon: Operations Planning]*
- E.A.18.** Each Generator Operator shall meet the following control loop specifications if the Generator Operator uses control loops external to the Automatic Voltage Regulators (AVR) to manage MVar loading: *[Violation Risk Factor: Medium] [Time Horizon: Real-time Operations]*
- E.A.18.1.** Each control loop's design incorporates the AVR's automatic voltage controlled response to voltage deviations during System Disturbances.
 - E.A.18.2.** Each control loop is only used by mutual agreement between the Generator Operator and the Transmission Operator affected by the control loop.

Measures²

- M.E.A.13.** Each Transmission Operator shall have and provide upon request, evidence that it provided the voltage schedules to the Generator Operator. Dated spreadsheets,

² The number for each measure corresponds with the number for each requirement, i.e. M.E.A.13 means the measure for Requirement E.A.13.

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reports, voice recordings, or other documentation containing the voltage schedule including set points, tolerance bands, and specified periods as required in Requirement E.A.13 are acceptable as evidence.

- M.E.A.14.** The Transmission Operator shall have and provide upon request, evidence that it provided one of the voltage schedule reference points in Requirement E.A.14 for each generation resource in its Area to the Generator Operator. Dated letters, e-mail, or other documentation that contains notification to the Generator Operator of the voltage schedule reference point for each generation resource are acceptable as evidence.
- M.E.A.15.** Each Generator Operator shall have and provide upon request, evidence that it converted a voltage schedule as described in Requirement E.A.13 into a voltage set point for the AVR. Dated spreadsheets, logs, reports, or other documentation are acceptable as evidence.
- M.E.A.16.** The Generator Operator shall have and provide upon request, evidence that within 30 calendar days of request by its Transmission Operator it provided its voltage set point conversion methodology from the point in Requirement E.A.14 to the generator terminals. Dated reports, spreadsheets, or other documentation are acceptable as evidence.
- M.E.A.17.** The Transmission Operator shall have and provide upon request, evidence that within 30 calendar days of request by its Generator Operator it provided data to support development of the voltage set point conversion methodology. Dated reports, spreadsheets, or other documentation are acceptable as evidence.
- M.E.A.18.** If the Generator Operator uses outside control loops to manage MVar loading, the Generator Operator shall have and provide upon request, evidence that it met the control loop specifications in sub-parts E.A.18.1 through E.A.18.2. Design specifications with identified agreed-upon control loops, system reports, or other dated documentation are acceptable as evidence.

Violation Severity Levels

E #	Lower VSL	Moderate VSL	High VSL	Severe VSL
E.A.13	For the specified period, the Transmission Operator did not issue one of the voltage schedules listed in E.A.13 to at least one generation resource but less than or equal to 5% of the generation resources that are on-line and part of	For the specified period, the Transmission Operator did not issue one of the voltage schedules listed in E.A.13 to more than 5% but less than or equal to 10% of the generation resources that are on-line and part of	For the specified period, the Transmission Operator did not issue one of the voltage schedules listed in E.A.13 to more than 10% but less than or equal to 15% of the generation resources that are on-line and part of	For the specified period, the Transmission Operator did not issue one of the voltage schedules listed in E.A.13 to more than 15% of the generation resources that are on-line and part of the BES in the Transmission

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E #	Lower VSL	Moderate VSL	High VSL	Severe VSL
	the BES in the Transmission Operator Area.	the BES in the Transmission Operator Area.	the BES in the Transmission Operator Area.	Operator Area.
E.A.14	The Transmission Operator did not provide a voltage schedule reference point for at least one but less than or equal to 5% of the generation resources in the Transmission Operator area.	The Transmission Operator did not provide a voltage schedule reference point for more than 5% but less than or equal to 10% of the generation resources in the Transmission Operator Area.	The Transmission Operator did not a voltage schedule reference point for more than 10% but less than or equal to 15% of the generation resources in the Transmission Operator Area.	The Transmission Operator did not provide a voltage schedule reference point for more than 15% of the generation resources in the Transmission Operator Area.
E.A.15	The Generator Operator failed to convert at least one voltage schedule in Requirement E.A.13 into the voltage set point for the AVR for less than 25% of the voltage schedules.	The Generator Operator failed to convert the voltage schedules in Requirement E.A.13 into the voltage set point for the AVR for 25% or more but less than 50% of the voltage schedules.	The Generator Operator failed to convert the voltage schedules in Requirement E.A.13 into the voltage set point for the AVR for 50% or more but less than 75% of the voltage schedules.	The Generator Operator failed to convert the voltage schedules in Requirement E.A.13 into the voltage set point for the AVR for 75% or more of the voltage schedules.
E.A.16	The Generator Operator provided its voltage set point conversion methodology greater than 30 days but less than or equal to 60 days of a request by the Transmission Operator.	The Generator Operator provided its voltage set point conversion methodology greater than 60 days but less than or equal to 90 days of a request by the Transmission Operator.	The Generator Operator provided its voltage set point conversion methodology greater than 90 days but less than or equal to 120 days of a request by the Transmission Operator.	The Generator Operator did not provide its voltage set point conversion methodology within 120 days of a request by the Transmission Operator.
E.A.17	The Transmission Operator provided its data to support development of the voltage set point conversion methodology than 30 days but less than or equal to 60 days of a request by the Generator	The Transmission Operator provided its data to support development of the voltage set point conversion methodology greater than 60 days but less than or equal to 90 days of a request by the Generator.	The Transmission Operator provided its data to support development of the voltage set point conversion methodology greater than 90 days but less than or equal to 120 days of a request by the Generator.	The Transmission Operator did not provide its data to support development of the voltage set point conversion methodology within 120 days of a request by the Generator Operator.

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E #	Lower VSL	Moderate VSL	High VSL	Severe VSL
	Operator.	Operator.	Operator.	
E.A.18	N/A	The Generator Operator did not meet the control loop specifications in EA18.2 when the Generator Operator uses control loop external to the AVR to manage Mvar loading.	The Generator Operator did not meet the control loop specifications in EA18.1 when the Generator Operator uses control loop external to the AVR to manage Mvar loading.	The Generator Operator did not meet the control loop specifications in EA18.1 through EA18.2 when the Generator Operator uses control loop external to the AVR to manage Mvar loading.

Version History

Version	Date	Action	Change Tracking
0	April 1, 2005	Effective Date	New
1	August 2, 2006	BOT Adoption	Revised
1	July 3, 2007	Added “Generator Owners” and “Generator Operators” to Applicability section.	Errata
1	August 23, 2007	Removed “Generator Owners” and “Generator Operators” to Applicability section.	Errata
2	TBD	Modified to address Order No. 693 Directives contained in paragraphs 1858 and 1879.	Revised.
2		Modified to add a WECC region variance	