Standard Development Timeline

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

1. Draft 1 of SAR posted for comment August 17 – September 17, 2009.
2. Draft 2 of SAR posted for comment February 24 – March 26, 2010.
3. SC authorized moving the SAR forward to standard development May 13, 2010.
4. SC appoints SDT July 14, 2010.

Description of Current Draft

The VRPC SDT is requesting comments on the draft standard under a 30-day informal comment period.

Anticipated Actions	Anticipated Date
30-day Formal Comment Period	June 2011
45-day Formal Comment Period with Parallel Initial Ballot	
30-day Formal Comment Period with Parallel Successive Ballot	
Recirculation ballot	
BOT adoption	

Effective Dates

Version History

Version	Date	Action	Change Tracking

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 defined terms will be removed from the individual standard and added to the Glossary.

Term: Reactive Power The component of the alternating current power system which balances the inductive and capacitive load to control the power system voltage. The power system Reactive Power is balanced dynamically with generators, synchronous condensers, static var compensators (SVC's), flexible alternating current transmission system (FACTS) devices and balanced statically with transformers, capacitors, and shunt reactors. Reactive power is expressed in kilovars (kVAR) or megavars (mVAR).

Rationale: The VAR drafting team recommends to change the NERC Reactive Power definition because (i) it does not state that reactive power controls voltage by balancing inductive and capacitive load but instead, uses the words "directly influences" and (ii) does not specifically state that there are dynamic and static reactive supplies used to control voltage for Contingency and Steady State conditions respectively. This change is required to support VAR-001 requirements and FERC directives to address transmission system voltage control. The present NERC definition of Reactive Power is:

- **The portion of electricity that establishes and sustains the electric and magnetic fields of alternating-current equipment. Reactive power must be supplied to most types of magnetic equipment, such as motors and transformers. It also must supply the reactive losses on transmission facilities. Reactive power is provided by generators, synchronous condensers, or electrostatic equipment such as capacitors and directly influences electric system voltage. It is usually expressed in kilovars (kvar) or megavars (Mvar).**

Term: **Reactive Margin** The margin of additional reactive power required to maintain acceptable voltage in response to changes in system conditions such as a Contingency.

When this standard has received ballot approval, the text boxes will be moved to the Application Guidelines Section of the Standard.

A. Introduction

1. **Title:** **Voltage and Reactive Control**
2. **Number:** **VAR-001-3**

Purpose:

To reliably operate the BES to ensure that real time voltages are controlled by operating and monitoring Reactive Power resources.

3.
4. **Applicability:**

   4.1. Functional Entities:

   4.1.1 RC, TOP

   4.2. Facilities:

   4.2.1 (Subset of Facilities)

5. **Background:**

In August 2008 the Transmission Issues Subcommittee formed the Reactive Support/Control Subteam (RSCS) to develop a report to address the fundamental issues of Standards Committee Project 2008-01. The report *Reactive Support & Control Whitepaper* dated 05/18/2009 identifies what technical requirements are needed to determine the reactive resources required under different system. The report provides the reliability concepts and foundation for the Standards Authorization Request (SAR) and subsequent work by the Standards Drafting Team (SDT) and includes the directives contained in FERC Order 693. In August of 2008 NERC established a SAR Team to investigate revisions to VAR Reliability Standards and address directives in FERC order 693. Review and modifications to the existing VAR standards considered the Transmission Issues Subcommittee's "Reactive Support & Control Whitepaper" dated 05/18/2009. The review addressed the technical requirements needed to determine the reactive resources required under each system state. The Voltage and Reactive Planning and Control (VRPC) SDT also relied on the *Electric Reliability Organization Compliance Analysis Report Reliability Standard VAR-002, August 2010*, which characterized compliance issues with the existing standards and listed recommendations addressing the violations.

The VRPC SDT developed a framework for the requirements based on the new results based standard development process. The VRPC SDT developed a Need statement and Goals that supported the Need. This was followed by the development of objectives of how to implement the goal. The requirements in the standard were developed from this outline which is listed below.

Summary of Concepts

- Goal: Control the voltage levels under normal and contingency conditions
  - Objective: schedule sufficient reactive resources in real time
- Goal: Monitor voltage levels in real time
  - Objective: Operate a real time EMS state estimator and contingency analysis along with SCADA alarming
- Goal: Maintain voltage levels in real time
  - Objective: Do not exceed applicable Facility Ratings, voltage criteria, and maintain voltage stability and reactive margins
  - Objective: Implement corrective action for insufficient reactive reserves that impact SOL and IROLs, and shedding load

B. Requirements and Measures

R1. Each Reliability Coordinator and Transmission Operator, individually and jointly with neighboring Transmission Operators, shall annually ensure that formal policies and/or procedures are developed, maintained, and implemented for monitoring and controlling voltage and Reactive Power flows within their Transmission Operator Area.~~.~~ *[Violation Risk Factor:] [Time Horizon:]*

Rationale for R1: Document and coordinate voltage schedules and Reactive Power flows between Transmission Operators to ensure system voltage Stability during normal and Contingency conditions – added RC – see FERC 693 – paragraph 1855

~~**M1.**~~ The Transmission Operator has a documented policy and/or procedure that is reviewed and coordinated annually with its neighboring Transmission Operator. ~~Add measure for 1.1~~

~~**M2.**~~**M1.**

R2. The Transmission Operator shall monitor and operate Reactive Power resources within its area to control system voltages, to maintain voltage Stability, and to maintain Reactive Margins. *[Violation Risk Factor:] [Time Horizon:]*

Rationale for R2: Sufficient Reactive Power resources need to be available to control voltages.

2.1. The Transmission Operator shall perform AC Contingency A~~a~~nalysis using on-line or off-line techniques in the operations horizon.

2.2. The TOP shall define operational requirements for acceptable voltage limits and/or Reactive Margin requirements. Ties to FAC-011, R1, R3 and R4.3

2.3. The TOP shall identify sufficient reactive resources including TOP or BA controllable load (if any) to satisfy reactive requirements.

2.4. This is not a reliability requirement. ~~The TOP shall monitor and record the power factor at TOP defined Bulk Power System load serving interfaces. Over time the range of power factor at these interfaces shall be documented by the TOP tofor validate seasonal On-Peak and Off-Peak study modelsies. (Does this tie to another standard?)~~ [A1]

~~R3.~~ (remove - The Reliability Coordinator shall monitor that sufficient R~~r~~eactive Power resources are available for reliable system operations and take appropriate corrective action in coordination with the Transmission Operators if reliable system operation is jeopardized.) (This is ~~may be~~ covered by IRO-005-2, R1.4)

~~M3.~~**M2.** The Transmission Operator has a procedure to schedule and operate Reactive Power resources.

R3. The Transmission Operator shall instruct the Generator Operator to comply with the voltage requirement in automatic voltage control mode (AVR in service and controlling voltage).

R3.1 The TOP shall provide a voltage requirement **or reactive power requirement** to the GOP for each generator in its area**. These requirements shall** include the following: *[Violation Risk Factor:] [Time Horizon:]*

R3.1.1 The voltage or reactive set point and tolerance band, as well as the operating time frame for which the requirement is applicable and the reference point at which this set point is specified. The reference point shall be designated by mutual agreement between the Transmission Operator and Generator Operator

Rationale for R3: The generator automatic voltage regulator (AVR) is required to be in service to respond dynamically to system contingencies. Manual switching of Reactive Power resources is insufficient to respond to these contingencies. **The TOP shall direct the GOP to follow a voltage or reactive power schedule to control system voltages.**

M3. The Transmission Operator has evidence that the Generator Operator has been informed of how to operate the generator using procedures, policies, emails, documents, operator log and voice recordings.

R4. When the Transmission Operator is notified of the loss of ~~an AVR~~automatic voltage control, the Transmission Operator shall instruct the Generator Operator to manually control voltage by providing specific voltage or reactive output instructions.

R4.1 The Transmission Operator shall evaluate the impact to system voltage and take corrective actions if required.

Rationale for R4: Sufficient dynamic Reactive Power resources are required to respond to system Contingencies to be compliant with R1 and R2.

M4. The Transmission Operator shall have a documented process to evaluate the loss of the generator AVR.

Should the entire standard apply to non-synchronous generation types (e.g., wind farms, etc.)? What type of requirements should be applicable to non-synchronous generation types?

R5. Each Transmission Operator shall, when notified of the loss of a power system stabilizer, evaluate the impact and take corrective actions if required.

R5. The Transmission Operator shall evaluate the GSU transformer in order to maximize the generator Reactive Power capability for both high load and low load system conditions as required. This evaluation shall result in a recommended GSU fixed tap position. For GSU transformers with movable load taps, this evaluation is not required.

Rationale for R6: The generator Reactive Power output should be maximized to provide reliable voltage control for normal and contingency conditions.

M5. The Transmission Operator shall have evidence that it provided documentation to the Generator Owner when a change to the GSU transformer is recommended.

R6. Recommend deleting: This is covered by Requirement R2.1 – In addition – commercially available reference should be removed because a TOP may develop in house tools or perform off-line analysis. ~~The TOP shall Pperform voltage stability analysis periodically, using online techniques where commercially available and offline techniques where online techniques are not available, to assist real-time operations, for areas susceptible to voltage instability; . The Reliability Coordinator shall monitor that sufficient reactive resources are available for reliable system operations and take appropriate corrective action in coordination with the TOPs if reliable system operation is jeopardized. ; [portion of paragraph 1880 and 1875]~~

Rationale for R8:

The VAR Standards should provide a high level of confidence that the system's reactive power needs can be met satisfactorily across a broad range of contingencies that planners and operators might reasonably anticipate. Reactive power evaluations should be conducted within a process that is documented in detail and includes a range of contingencies that might be reasonably anticipated, because this would avoid the 'one size fits all' problem, where a prescriptive analytical methodology does not fit with a particular system configuration. This flexible approach would provide a more effective planning and operating tool for the industry, while satisfying concerns over potentially inadequate reactive reserves. The need for, and method of providing for, reactive resources varies greatly.~~,~~ All entities should not be required to follow the same methodology to accomplish the goal of a reliable system. [summary of paragraphs 1864 & 1867].

VAR-001-1 shall include more detailed and definitive requirements on "established limits" and "sufficient reactive resources" and identify acceptable margins (i.e. voltage and/or reactive power margins) above voltage instability points to prevent voltage instability and to ensure reliable operations. It is recognized that this modification does not identify what definitive requirements the ~~Reliability~~ Standard should use for "established limits" and "sufficient reactive resources. Regarding concerns about a prescriptive analytical methodology, the Standard should not- dictate what methodology must be used to determine reactive power needs. Rather, the Standard would benefit from having more defined requirements that clearly define what voltage limits are used and how much reactive resources are needed to ensure voltage instability will not occur under normal and emergency conditions. For example, the methodology chosen by the TOP should consider WECC's Reliability Criteria, which contain specific and definitive technical requirements on voltage and margin application. While this is not a directive that the WECC reliability criteria be adopted, it represents a good example of clearly-defined requirements for voltage and reactive margins. [summary of paragraph 1868-1870]. Detailed and definitive requirements on "established limits" and "sufficient reactive resources" and identification of acceptable margins above the voltage instability points shall be defined. Controllable load should be included among the reactive resources to satisfy reactive requirements. [summary of paragraph 1880].

R8. This covered in Requirement 2.2 - ~~The TOP shall define operational detailed and definitive requirements on "established limits" and "sufficient reactive resources" and shall identifyication of acceptable margins above the voltage instability points.clearly define operational voltage levels and reactive resource requirements by documenting detailed operational voltage limits, voltage stabiltity margin expectations, and Reactive Power resources. The operational locations and scheduled amount of sufficient reactive resources shall be identified by the TOP including RC, TOP, or BA controllable load (if any) among the reactive resources to satisfy reactive requirements. .~~

~~**Team 1 comment (Bill and Ed): We had discussed this point. The DT agreed that the voltage instability points would not be identified, but that the system will have acceptable voltage ranges and Reactive recourses to response to a Contingency. Using the terms "detailed and definitive" should not be part of a NERC Standard.**~~

~~**M8.** The TOP shall have evidence that the above were defined and identified.~~

Rationale for R9~~ and R10~~:

If the power factor at various Bulk Power System load serving ~~locations~~interfaces is so low as to result in low voltages at key busses on the Bulk-Power System, then there is risk for voltage collapse. VAR-001-1 is an appropriate place to take steps to address these concerns by setting out requirements for users and facility owners to maintain an appropriate power factor range at such interfaces. VAR-001-1 should include appropriate modifications to address the power factor range at such load serving interfaces on the Bulk-Power System. Transmission operators currently have access to data through their energy management systems to determine a range of power factors at which load operates during various conditions, and this type of data should be used as a starting point for developing this modification. The appropriate power factor range developed from VAR-001-1 should be used as an input to ~~the~~ transmission and operations planning. The range of power factors developed should also provide the input to the range of power factors identified in the modifications to the TPL Reliability Standards. Sensitivity studies for the TPL Reliability Standards should consider the range of load power factors. [-summary of paragraphs 1861 to 1863].

~~7~~

~~Address the power factor range at the interface between LSEs and the transmission grid.~~

~~Determination:~~

~~Paragraph 1861.~~

~~Rationale for R9 and R10:~~

~~If the power factor at various Bulk Power System load serving locations is so low as to result in low voltages at key busses on the Bulk-Power System, then there is risk for voltage collapse. VAR-001-1 is an appropriate place to take steps to address these concerns by setting out requirements for users and facility owners to maintain an appropriate power factor range at suchtheir interfaces. VAR-001-1 should include appropriate modifications to address the power factor range at such load serving interfaces on the Bulk-Power System.~~

~~1862. We direct the ERO to include APPA's concern in the Reliability Standards development process. We note that tTransmission operators currently have access to data through their energy management systems to determine a range of power factors at which load operates during various conditions, and we suggest that the ERO use this type of data should be used as a starting point for developing this modification.~~

~~1863. The Commission expects that tThe appropriate power factor range developed for the interface between the bulk electric system and the LSE from VAR-001-1 would should be used as an input to the transmission and operations planning. Reliability Standards. The range of power factors developed in this Reliability Standard should also provides the input to the range of power factors identified in the modifications to the TPL Reliability Standards. In the NOPR, the Commission suggested that sSensitivity studies for the TPL Reliability Standards should consider the range of load power factors." [summary of paragraphs 1861 to 1863].~~

R9. This is a reporting requirement – delete ~~The power factor at TOP defined Bulk Power System load serving locationsinterfaces shall be monitored and recorded. Overtime the range of power factor as these locationsinterfaces shallwill be documented by the TOP for On-Peak~~

~~and Off-Peak studies. In real time operations the TOP shallwill monitor and alarm these power factor locationsinterfaces to identify unexpected deviations outside the On-Peak and Off-Peak study assumptions. When such an alarm occurs, the TOP shall take appropriate action (if any) as deemed appropriate by the TOP or RC.~~

~~**Team 1 comments (Bill and Ed): The Power Factor range needs to be addressed in FERC order 693. We need t discuss whether this Reliability Requirement is not already addressed in the TPL standards.**~~

~~**M9.** The TOP shall have evidence that the above were monitored, recorded, and an expected power factor range established for On-Peak and Off-Peak studies. The TOP shall also have evidence that in real time operations deviations outside the On-Peak and Off-Peak study assumptions were identified and alarmed for further action (if any) as deemed appropriate by the TOP or RC.~~

~~**R10.**~~

~~The RC shall take such action as necessary to maintain voltage stability when the TOP or BA are is not able to directly or indirectly control BPS load serving location Power Factor range within TOP pre-established expectations.~~

~~**M10.**~~

C. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

Regional Entity

1.2. Evidence Retention

Text

1.3. Compliance Monitoring and Assessment Processes:

Compliance Audits

Self-Certifications

Spot Checking

Compliance Violation Investigations

Self-Reporting

Complaints Text

1.4. Additional Compliance Information

None

Table of Compliance Elements

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R1						
R2						
R3						

D. Regional Variances

None.

E. Interpretations

None.

F. Associated Documents

None.

Guidelines and Technical Basis

Requirement R1:

Requirement R2:

Requirement R3: