

March 22, 2017

**VIA OVERNIGHT MAIL**

Sheri Young, Secretary of the Board  
National Energy Board  
517 – 10<sup>th</sup> Avenue SW  
Calgary, Alberta  
T2R 0A8

Re: *North American Electric Reliability Corporation*

Dear Ms. Young:

The North American Electric Reliability Corporation hereby submits Notice of Filing of the North American Electric Reliability Corporation of Proposed Reliability Standard VAR-501-WECC-3. NERC requests, to the extent necessary, a waiver of any applicable filing requirements with respect to this filing.

Please contact the undersigned if you have any questions concerning this filing.

Respectfully submitted,

/s/ Shamai Elstein

Shamai Elstein  
*Senior Counsel for the North American Electric  
Reliability Corporation*

Enclosure

3353 Peachtree Road NE  
Suite 600, North Tower  
Atlanta, GA 30326  
404-446-2560 | [www.nerc.com](http://www.nerc.com)

---

**BEFORE THE  
NATIONAL ENERGY BOARD**

**NORTH AMERICAN ELECTRIC )  
RELIABILITY CORPORATION )**

**NOTICE OF FILING OF THE  
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION OF PROPOSED  
REGIONAL RELIABILITY STANDARD VAR-501-WECC-3**

Shamai Elstein  
Senior Counsel  
Marisa Hecht  
Counsel  
North American Electric Reliability Corporation  
1325 G Street, N.W., Suite 600  
Washington, D.C. 20005  
(202) 400-3000  
shamai.elstein@nerc.net  
marisa.hecht@nerc.net

*Counsel for the North American Electric  
Reliability Corporation*

March 22, 2017

---

## TABLE OF CONTENTS

I.	EXECUTIVE SUMMARY .....	2
II.	NOTICES AND COMMUNICATIONS.....	3
III.	BACKGROUND .....	4
A.	WECC Regional Reliability Standards Development Process .....	4
B.	Need for Power System Stabilizers in the Western Interconnection .....	4
C.	Development of Proposed Regional Reliability Standard.....	6
IV.	JUSTIFICATION .....	6
A.	Justification for the Need for the Proposed Regional Reliability Standard .....	7
B.	WECC Policy Statement on Power System Stabilizers .....	8
C.	Applicability of Proposed Regional Reliability Standard VAR-501-WECC-3 – Power System Stabilizers.....	9
D.	Description and Technical Basis of Proposed Requirements.....	12
1.	Requirement R1 .....	12
2.	Requirement R2.....	13
3.	Requirement R3 .....	15
4.	Requirement R4.....	16
5.	Requirement R5 .....	17
E.	Enforceability of Proposed Regional Reliability Standard VAR-501-WECC-3 .....	18
V.	EFFECTIVE DATE.....	18

<b>Exhibit A</b>	Proposed Regional Reliability Standard, VAR-501-WECC-3 – Power System Stabilizer
<b>Exhibit B</b>	Implementation Plan for Proposed Regional Reliability Standard VAR-501-WECC-3
<b>Exhibit C</b>	Reliability Standards Criteria for Proposed Regional Reliability Standard VAR-501-WECC-3
<b>Exhibit D</b>	Mapping Document
<b>Exhibit E</b>	Analysis of Violation Risk Factors and Violation Severity Levels
<b>Exhibit F</b>	Summary of Development History and Complete Record of Development
<b>Exhibit G</b>	Technical Justification White Papers

## TABLE OF CONTENTS

**Exhibit G-1** Power System Stabilizer Applicability in the WECC System: Study Progress Report to WECC-0107 Drafting Team

**Exhibit G-2** Technical Justification WECC-0107 Power System Stabilizer Requirement R3

**Exhibit H** Western Electricity Coordinating Council Policies and Guidelines on Power System Stabilizers

**Exhibit H-1** Western Electricity Coordinating Council Policy Statement on Power System Stabilizers

**Exhibit H-2** Western Electricity Coordinating Council Power System Stabilizer Tuning Guidelines

**Exhibit H-3** Criteria to Determine Excitation System Suitability for Power System Stabilizers in Western Systems Coordinating Council System

**Exhibit I** Standard Drafting Team Roster for Project WECC-0107 Power System Stabilizer Design and Performance

**BEFORE THE  
NATIONAL ENERGY BOARD**

**NORTH AMERICAN ELECTRIC** )  
**RELIABILITY CORPORATION** )

**NOTICE OF FILING OF THE  
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION OF PROPOSED  
REGIONAL RELIABILITY STANDARD VAR-501-WECC-3**

The North American Electric Reliability Corporation (“NERC”) hereby submits proposed Regional Reliability Standard VAR-501-WECC-3 – Power System Stabilizers. Regional Reliability Standard VAR-501-WECC-3 establishes the performance criteria for power system stabilizers to help ensure the Western Interconnection is operated in a coordinated manner under normal and abnormal conditions.

Proposed Regional Reliability Standard VAR-501-WECC-3 (**Exhibit A**) is just, reasonable, not unduly discriminatory or preferential, and in the public interest.<sup>1</sup> NERC also provides notice of: (i) the associated Implementation Plan (**Exhibit B**) for the proposed Regional Reliability Standard; (ii) the associated Violation Risk Factors (“VRFs”) and Violation Severity Levels (“VSLs”) (**Exhibits A and E**); and (iii) the retirement of Regional Reliability Standard VAR-501-WECC-2. The NERC Board of Trustees adopted proposed Regional Reliability Standard VAR-501-WECC-3 on February 9, 2017.

This filing presents the technical basis and purpose of proposed Regional Reliability Standard VAR-501-WECC-3, including supporting technical documentation (**Exhibits G and H**); a demonstration that the proposed Regional Reliability Standard meets the Reliability Standards

---

<sup>1</sup> Unless otherwise designated, all capitalized terms shall have the meaning set forth in the *Glossary of Terms Used in NERC Reliability Standards*, available at [http://www.nerc.com/files/Glossary\\_of\\_Terms.pdf](http://www.nerc.com/files/Glossary_of_Terms.pdf).

criteria (**Exhibit C**); a mapping document illustrating how requirements from VAR-501-WECC-2 map to the proposed requirements from VAR-501-WECC-2 (**Exhibit D**); and a summary of the development history (**Exhibit F**).

## **I. EXECUTIVE SUMMARY**

Power System Stabilizers damp oscillations that can occur between geographic areas within the Western Interconnection and have played an important role in the stability of the Western Interconnection. Over the past several decades, WECC and related working groups have developed policies and guidelines, conducted studies, and approved a Regional Reliability Standard to help manage power system stabilizer use in the Western Interconnection. With the development of proposed Regional Reliability Standard VAR-501-WECC-3, WECC seeks to incorporate elements from its policies, guidelines, and lessons learned from studies into clarified, mandatory requirements.

The purpose of proposed Regional Reliability Standard VAR-501-WECC-3 is to ensure the Western Interconnection is operated in a coordinated manner under normal and abnormal conditions by establishing the performance criteria for power system stabilizers. Proposed Regional Reliability Standard VAR-501-WECC-3 includes requirements that address the following: (1) providing Transmission Operators with procedures or other documents that inform the Transmission Operator of when a power system stabilizer will be out of service; (2) having the power system stabilizer in service at all times except during specific circumstances; (3) tuning power system stabilizers to stated criteria; (4) installing and completing start-up testing of a power system stabilizer; and (5) repairing or replacing a power system stabilizer within a specified time period.

Proposed Regional Reliability Standard VAR-501-WECC-3 improves upon the existing standard by (1) focusing the in-service requirement on performance of the power system stabilizers rather than counting the hours they are online, (2) incorporating the power system stabilizer policies and guidelines into a mandatory standard, and (3) reducing administrative requirements with little benefit to reliability. Development of the proposed standard followed standards development processes and included subject matter experts with experience in power system stabilizers in the Western Interconnection. As a result, WECC draws upon its long history with power system stabilizers in the Western Interconnection to present an improved standard.

This filing contains proposed Regional Reliability Standard VAR-501-WECC-3, the associated VRFs and VSLs, the associated Implementation Plan, and the retirement of the existing Regional Reliability Standard VAR-501-WECC-2. The following filing presents the justification for the proposed standard and supporting documentation.

## **II. NOTICES AND COMMUNICATIONS**

Notices and communications with respect to this filing may be addressed to the following:

Shamai Elstein  
Senior Counsel  
Marisa Hecht  
Counsel  
North American Electric Reliability Corporation  
1325 G Street, N.W., Suite 600  
Washington, D.C. 20005  
(202) 400-3000  
shamai.elstein@nerc.net  
marisa.hecht@nerc.net

*Counsel for the North American Electric  
Reliability Corporation*

### **III. BACKGROUND**

The following background information is provided below: (a) an explanation of the WECC Regional Reliability Standards development process; (b) a discussion of the need for power system stabilizers in the Western Interconnection; and (c) the history of Project WECC-0107 Power System Stabilizer Design and Performance.

#### **A. WECC Regional Reliability Standards Development Process**

The proposed Regional Reliability Standard was developed in an open and fair manner and in accordance with the WECC Reliability Standards Development Procedures.<sup>2</sup> NERC's proposed common attributes for Regional Reliability Standard development and WECC's Reliability Standards Development process provide for reasonable notice and opportunity for public comment, due process, openness, and a balance of interests in developing Reliability Standards and thus addresses certain of the criteria for approving Reliability Standards. The development process is open to any person or entity that is an interested stakeholder. WECC considers the comments of all stakeholders, and a vote of stakeholders and the WECC Board of Directors is required to approve a Regional Reliability Standard. Once the standard is approved by the WECC Board of Directors, NERC posts the approved Regional Reliability Standard for an additional comment period. Then the NERC Board of Trustees must adopt the Regional Reliability Standard before the Regional Reliability Standard is submitted to the applicable governmental authorities.

#### **B. Need for Power System Stabilizers in the Western Interconnection**

Power system stabilizers play an important role in the stability of the Western Interconnection. Power system stabilizers are part of the automatic voltage regulation system of a

---

<sup>2</sup> The WECC Reliability Standards Development Procedures are available at <https://www.wecc.biz/Reliability/Reliability%20Standards%20Development%20Procedures%20-%20FERC%20Approved%20Dec%202023%202014.pdf>.



generator and are designed to add or subtract torque to a generator with the goal of damping oscillations on the Western Interconnection’s Bulk Electric System (“BES”) that otherwise would be amplified if the automatic voltage regulator is operated alone. Power system stabilizers within WECC were developed in the 1960s in response to power system oscillations on the Pacific Intertie within the Western Interconnection. These oscillations occur at very low frequencies (<1 Hertz), are very lightly dampened, and became known as “inter-area modes” of oscillation because they occur when real power is transferred from one Western Interconnection geographic region to another (such as between the Pacific Northwest and the Southwest). These modal oscillations are the result of a combination of many machines on one part of the Western Interconnection BES whose voltage support response to system fluctuations is not in phase with the response of machines on another part of the Western Interconnection BES.

Moreover, as the Federal Energy Regulatory Commission (“FERC”) recognized, the Western Interconnection possesses particular physical characteristics that justify interconnection-specific requirements.<sup>3</sup> In Order No. 740, FERC stated:

[I]n the Western Interconnection a significant number of transmission paths are voltage or frequency stability-limited, in contrast to other regions of the [BES] where transmission paths more often are thermally-limited. Disturbances resulting in a stability-limited transmission path overload, generally, must be responded to in a shorter time frame than a disturbance that results in a thermally-limited transmission path overload. [FERC has also noted] its understanding that this physical difference is one of the reasons for the need for certain provisions of regional Reliability Standards in the Western Interconnection.<sup>4</sup>

As a result of the Western Interconnection physical characteristics, WECC developed a Regional Reliability Standard, policies, and guidelines that address power system stabilizers. With the development of proposed Regional Reliability Standard VAR-501-WECC-3, WECC provided

---

<sup>3</sup> *Version One Regional Reliability Standard for Resource and Demand Balancing*, Order No. 740, 133 FERC ¶ 61,063 (2010) at P 23.

<sup>4</sup> *Id.*

additional clarity and incorporated the power system stabilizer policies and guidelines into one Regional Reliability Standard. Proposed Regional Reliability Standard VAR-501-WECC-3 addresses the unique characteristics of the Western Interconnection in one set of requirements that incorporate WECC's long history with power system stabilizers.

### **C. Development of Proposed Regional Reliability Standard**

As further described in Exhibit F hereto, proposed Regional Reliability Standard VAR-501-WECC-3 was developed as part of Project WECC-0107 Power System Stabilizer Design and Performance to improve upon Regional Reliability Standard VAR-501-WECC-2. On May 2, 2016, the ninth draft of proposed Regional Reliability Standard VAR-501-WECC-3 received the requisite approval from the registered ballot body, with a weighted approval of 66.0 percent. The WECC Board of Directors approved the standard on June 14, 2016 and subsequently approved the standard to be submitted to the NERC Board of Trustees for adoption on September 21, 2016. NERC posted the standard for a 45-day comment period concluding on January 25, 2017. There were no additional changes after this comment period. The NERC Board of Trustees adopted the standard on February 9, 2017.

## **IV. JUSTIFICATION**

As discussed in detail in Exhibit C, proposed Regional Reliability Standard VAR-501-WECC-3 – Power System Stabilizers is just, reasonable, not unduly discriminatory or preferential, and in the public interest. As described more fully herein and in Exhibit C, the proposed Regional Reliability Standard provides reliability benefits for the Bulk-Power System in the WECC region.

The purpose of proposed Regional Reliability Standard VAR-501-WECC-3 is to ensure the Western Interconnection is operated in a coordinated manner under normal and abnormal conditions by establishing the performance criteria for power system stabilizers. The provisions

of the proposed standard provide mandatory performance requirements for power system stabilizers in the Western Interconnection based on long-held policy in the WECC region. The codification of this policy increases reliability by providing certainty around operating practices for power system stabilizers.

The proposed standard includes requirements for providing power system stabilizer operating specifications to Transmission Operators (Requirement R1), having power system stabilizers in service during all hours unless specifically exempted (Requirement R2), tuning power system stabilizers to meet certain inter-area mode criteria (Requirement R3), installing power system stabilizers under specified circumstances occurring after the effective date of the standard (Requirement R4), and repairing or replacing an existing power system stabilizer within 24 months of the power system stabilizer becoming non-operational (Requirement R5).

This section of the filing addresses: (i) the justification of the need for the Proposed Regional Reliability Standard; (ii) the existing WECC policies and guidelines on power system stabilizers on which the revised VAR-501-WECC-3 is based; (iii) the applicability of proposed Regional Reliability Standard VAR-501-WECC-3; (iv) the description and technical basis of the proposed requirements; and (v) the enforceability of the proposed standard.

**A. Justification for the Need for the Proposed Regional Reliability Standard**

In addition to the physical characteristics of the Western Interconnection that necessitate a Regional Reliability Standard addressing power system stabilizers, discussed above, proposed Regional Reliability Standard VAR-501-WECC-3 meets the criteria to justify the need for a Regional Reliability Standard as it is more stringent than the related continent-wide NERC Reliability Standard VAR-002-4. Whereas NERC Reliability Standard VAR-002-4 only requires that a Generator Operator notify its Transmission Operator when it removes a power system stabilizer from service and does not limit the amount of time for operating generators without a

power system stabilizer in service, proposed Regional Reliability Standard VAR-501-WECC-3 requires power system stabilizers to be in service except for specific circumstances and for a limited time. In addition, the proposed standard requires applicable entities to install power system stabilizers on generators following certain triggering events, which is not required by any continent-wide NERC Reliability Standard. As power system stabilizers provide an additional stability support beyond that of an automatic voltage regulator alone, the proposed Regional Reliability Standard VAR-501-WECC-3 is more stringent than continent-wide standards by requiring the extra level of support. Therefore, the proposed Regional Reliability Standard VAR-501-WECC-3 is justified because it meets the Reliability Standards criteria to be more stringent than continent-wide Reliability Standards. Entities that perform the functions to which the continent-wide standards and the proposed Regional Reliability Standard apply need to comply with all applicable standards, so the proposed Regional Reliability Standard provides a level of support to the Western Interconnection in addition to the continent-wide standards.

**B. WECC Policy Statement on Power System Stabilizers**

The standard drafting team based the requirements in proposed Regional Reliability Standard VAR-501-WECC-3 on long-held policy in the Western Interconnection. This includes the WECC Policy Statement on Power System Stabilizers, the WECC Power System Stabilizer Tuning Guidelines, and the Criteria to Determine Excitation System Suitability for Power System Stabilizers in the Western Systems Coordinating Council (“WSCC”) System (**Exhibit H**).<sup>5</sup>

Approved by the WECC Board of Directors on April 18, 2002, the WECC Policy Statement on Power System Stabilizers provides guidance on the types of generators that should have power system stabilizers, citing the December 1992 Criteria to Determine Excitation System

---

<sup>5</sup> WSCC became WECC in 2002 after merging with other regional transmission associations.

Suitability for Power System Stabilizers in the WSCC System. In addition, the WECC Policy Statement on Power System Stabilizers includes a reference to the WECC Power System Stabilizer Tuning Guidelines, which suggests minimum criteria needed to tune a power system stabilizer. Although not mandatory, the policy and referenced guidelines provided some direction to applicable entities in the Western Interconnection as to who should install power system stabilizers, how they should be tuned, and under what circumstances power system stabilizers could be out of operation. In developing proposed Regional Reliability Standard VAR-501-WECC-3, WECC expanded on the current Regional Reliability Standard VAR-501-WECC-2 to incorporate concepts from the WECC policies and guidelines, including applicability, installation, and tuning. By incorporating the policies and guidelines into a mandatory standard, WECC will help to ensure that the concepts from the policies and guidelines are consistently implemented. In doing so, the Western Interconnection can derive the benefits of more broadly-installed power system stabilizers and bolster the reliability of the system.

**C. Applicability of Proposed Regional Reliability Standard VAR-501-WECC-3 – Power System Stabilizers**

Proposed Regional Reliability Standard VAR-501-WECC-3 is applicable to: (1) Generator Operators in the Western Interconnection that operate synchronous generators, connected to the BES, that meet the definition of Commercial Operation; and (2) Generator Owners in the Western Interconnection that own synchronous generators, connected to the BES, that meet the definition of Commercial Operation.<sup>6</sup> In determining which generators should be subject to the proposed standard, the standard drafting team considered the WECC Policy Statement on Power System

---

<sup>6</sup> “Commercial Operation” is a WECC Regional Term and is defined as “[a]chievement of this designation indicates that the Generator Operator or Transmission Operator of the synchronous generator or synchronous condenser has received all approvals necessary for operation after completion of initial start-up testing.”

Stabilizers, included in Exhibit H hereto, and studies performed in the Western Interconnection on the applicability of power system stabilizers (“Applicability Study”), included in Exhibit G hereto.

The WECC Policy Statement on Power System Stabilizers recommended that power system stabilizers be applied to units greater than 30 Mega Volt Amps (“MVAs”). This threshold was based on a 1992 study, Criteria to Determine Excitation System Suitability for Power System Stabilizers in WSCC System, included in Exhibit H hereto. The results of the Applicability Study indicated, however, that generating unit MVA rating is not directly proportional to its impact on damping of particular modes of oscillation and, as a result, did not specify a MVA rating that could be used in the proposed standard. As discussed below, the standards drafting team ultimately decided to rely on a generator’s connection to the BES to determine applicability.

More specifically, the Applicability Study found that several factors influence the effectiveness of power system stabilizers at any single point in time, and it is nearly impossible to determine the impact of a single unit. As noted in the Applicability Study, the nature of system-wide modes of oscillation and the effectiveness of individual generating units on these modes varies with the system topology and the instantaneous operating point conditions. In some cases, the response of a particular unit may be of great importance to the overall system behavior, but in another case, have no impact. As a result, entities in the Western Interconnection have installed power system stabilizers on synchronous generators across the system to provide sufficient stability support at any one time.

Recognizing that broad use of power system stabilizers across the system provide stability support, the Applicability Study further looked into whether there was a MVA rating at which the damping effects of the power system stabilizer no longer benefited the system (**Exhibit G**). The study concluded, as noted above, that generating unit MVA rating is not directly proportional to its impact on damping of particular modes of oscillation. Stated simply, the Applicability Study

concluded that there is no clear MVA rating threshold below which a power system stabilizer does not provide a benefit based on the data available. However, the Applicability Study did note that a majority of power system stabilizers in the Western Interconnection are on synchronous generators greater than 75 MVA.

Based on this study and the WECC policy, the standard drafting team determined that the standard should apply to any synchronous generator that connects to the BES and meets the definition of Commercial Operation. Under the BES definition, a generating resource is considered part of the BES if it is connected at a voltage of 100 kilovolts or above with: (1) gross individual nameplate rating greater than 20 MVA; or (2) gross plant/facility aggregate nameplate rating greater than 75 MVA, unless excluded or exempted.<sup>7</sup> In the absence of a clear MVA rating threshold for the benefits of power system stabilizers, using the BES definition as a bright line of applicability would help to ensure an appropriate number of synchronous generators would have power system stabilizers installed. In fact, by using the BES definition as a threshold, the standard drafting team recognized that some generators previously excluded under the existing standard would be brought into scope because some generators that fell under the existing five percent operating hours exclusion would come in under the BES definition. In addition, the BES definition is a natural cut off for applicability of NERC Reliability Standards as it represents the threshold for determining whether a facility could impact the reliable operation of the Bulk-Power System. Therefore, the applicability of the proposed Regional Reliability Standard supports reliability by providing a clear applicability threshold for generators, which helps to ensure that there is sufficient stability support in the Western Interconnection.

---

<sup>7</sup> The entire Bulk Electric Definition is in the *Glossary of Terms Used in NERC Reliability Standards*, available at [http://www.nerc.com/pa/Stand/Glossary%20of%20Terms/Glossary\\_of\\_Terms.pdf](http://www.nerc.com/pa/Stand/Glossary%20of%20Terms/Glossary_of_Terms.pdf).

#### **D. Description and Technical Basis of Proposed Requirements**

Proposed Regional Reliability Standard VAR-501-WECC-3 revises the existing requirements in Regional Reliability Standard VAR-501-WECC-2 to incorporate existing WECC policies and guidelines on power system stabilizers, provide improved clarity on installation and tuning of power system stabilizers, and reduce administrative burdens that have little benefit to reliability. The existing Regional Reliability Standard VAR-501-WECC-2 requires applicable entities to run power system stabilizers for 98 percent of operating hours, except under 12 specified conditions, obligating entities to log the number of operating hours of the synchronous generator. In contrast, the proposed Regional Reliability Standard VAR-501-WECC-3 requires applicable entities to have the power system stabilizer in service during all hours, unless specifically exempted under Requirement R2, without the burdensome expectation that all operating hours must be logged. In addition, Regional Reliability Standard VAR-501-WECC-3 added requirements to (1) notify Transmission Operators as to known circumstances when a power system stabilizer will be out of service; (2) tune the power system stabilizer to stated specifications; and (3) install and service power system stabilizers.

The following sections discuss the proposed Requirements R1, R2, R3, R4, and R5.

##### **1. Requirement R1**

Proposed Requirement R1 requires a Generator Owner to provide to its Transmission Operator the Generator Owner's written Operating Procedure or other document(s) describing those known circumstances during which the Generator Owner's power system stabilizer will not be providing an active signal to the automatic voltage regulator. Such procedures or documents must be provided within 180 days of any of the following events: (1) the effective date of VAR-501-WECC-3; (2) the power system stabilizer's Commercial Operation date; or (3) any changes to the power system stabilizer operating specifications. The intent of Requirement R1 is to provide



the Transmission Operator awareness of the varying states of the power system stabilizer in a planning horizon, particularly to help ensure the Transmission Operator knows when the power system stabilizer is active and providing damping to the system.

The standard drafting team selected 180 days to give time to develop the appropriate documents, if necessary, after the triggering factors. For instance, if an entity just installed a power system stabilizer on a generator, the 180 days gives the Generator Owner time to complete start-up testing and incorporate any operating specifications into the document that resulted from start-up testing. In addition, the Generator Operator must already provide more real-time status updates of the power system stabilizer to the Transmission Operator under Reliability Standard VAR-002-4, Requirement R3, so the Transmission Operator would receive any status change notifications while waiting to receive any operating documents required under proposed Requirement R1. For purposes of notifying the Transmission Operator, the various states of the power system stabilizer, such as on, off, active, and non-active, would not constitute changes to the operating specifications as long as the power system stabilizer is operating according to the documentation provided to the Transmission Operator. Proposed Requirement R1 provides a reliability benefit by incorporating a requirement in the planning horizon into the power system stabilizer standard. By providing operating procedures or documents, proposed Requirement R1 improves reliability by supplementing the real-time reporting obligations of Reliability Standard VAR-002-4, Requirement R3 with planning horizon documents.

## **2. Requirement R2**

Whereas proposed Requirement R1 addresses normal operating conditions, proposed Requirement R2 addresses exceptions to normal operation of power system stabilizers. Proposed Requirement R2 requires Generator Operators to have their power system stabilizers in service while synchronized, except during any of the following: (1) component failure; (2) testing of a

BES Element affecting or affected by the power system stabilizer; (3) maintenance, or (4) as agreed upon by the Generator Operator and the Transmission Operator. This requirement only applies when the power system stabilizer has been out of service for a period greater than 30 minutes as such short-term incidents are unlikely to have any negative impact on the reliability of the BES. For instance, there is no reliability concern if there is a lag in the power system stabilizer becoming active the instant the generator is synchronized. With the 30-minute allowance, there is time for synchronization and subsequent activation of the power system stabilizer. To that end, a power system stabilizer may be out of service for 30 minutes or less, regardless of cause, without risking noncompliance with Requirement R2.

The intent of proposed Requirement R2 is to shift the focus from counting operating hours to requiring performance of power system stabilizers. Under the existing standard, power system stabilizers can be out of service for two percent of the time for any reason. In addition, under the existing version of the standard, there are twelve instances in which certain hours may be excluded from the in-service requirement beyond the two percent downtime. The proposed Regional Reliability Standard narrows those exceptions. Under Requirement R2, power system stabilizers may be out of service for 30 minutes or longer only in the following circumstances: component failure, testing of certain Elements, maintenance, or when agreed upon by the Generator Operator and Transmission Operator.

Proposed Requirement R2 improves upon the existing Requirement R2 by requiring power system stabilizers to be in service for 100 percent of the time except for the circumstances stated in the standards, whereas the existing standard only requires power system stabilizers to be in service 98 percent of operating hours except for the circumstances stated in the standard and for two percent of operating hours for any reason. As a result, proposed Requirement R2 promotes reliability by allowing Generator Operators to focus on keeping the power system stabilizer in

service, except for the stated reasons or by agreement, rather than counting the hours it is out of service and by increasing the amount of time required to be in service. In addition, proposed Requirement R2 decreases an administrative burden that does little to promote reliability through eliminating the expectation to log hours of synchronous generator operation.

### **3. Requirement R3**

Proposed Requirement R3 specifies inter-area mode criteria for tuning power system stabilizers. The proposed requirement reads as follows:

- R3.** Each Generator Owner shall tune its PSS to meet the following inter-area mode criteria, except as specified in Requirement R3, Part 3.5 below: [Violation Risk Factor: Medium] [Time Horizon: Operating Assessment]
- 3.1.** PSS shall be set to provide the measured, simulated, or calculated compensated  $V_t/V_{ref}$  frequency response of the excitation system and synchronous machine such that the phase angle will not exceed  $\pm 30$  degrees through the frequency range from 0.2 Hertz to the lesser of 1.0 Hertz or the highest frequency at which the phase of the  $V_t/V_{ref}$  frequency response does not exceed 90 degrees.
  - 3.2.** PSS output limits shall be set to provide at least  $\pm 5\%$  of the synchronous machine's nominal terminal voltage.
  - 3.3.** PSS gain shall be set to between  $1/3$  and  $1/2$  of maximum practical gain.
  - 3.4.** PSS washout time constant shall be no greater than 30 seconds.
  - 3.5.** Units that have an excitation system or PSS that is incapable of meeting the tuning requirements of Requirement R3 are exempt from Requirement R3 until the voltage regulator is either replaced or retrofitted such that the PSS becomes capable of meeting the tuning requirements.

Proposed Requirement R3 drew from the WECC Power System Stabilizer Tuning Guidelines to determine tuning output criteria (**Exhibit H**). In addition, the standard drafting team took a practical approach to setting the parameters in proposed Requirement R3. Recognizing that proper tuning is important to power system stabilizer performance, the standard drafting team also considered how best to construct the criteria based on practical limitations and past experience.

For instance, the standard drafting team noted in the Guideline and Technical Basis section that the proposed .2 Hertz to the lesser of 1 Hertz frequency range more closely aligns with observed oscillation frequencies in the Western Interconnection than the .1 Hertz included in the WECC Power System Stabilizer Tuning Guidelines. Additionally, the standard drafting team considered real operating conditions when determining that the power system stabilizer gain is to be 1/3 and 1/2 of the maximum practical gain that could be achieved during commissioning. As detailed more fully in Exhibit G hereto, by using maximum practical gain that was achieved during commissioning as a measure, the standard drafting team took limiting factors that could occur in actual operations, such as noise, into account that may not be represented in simulations. Therefore, proposed Requirement R3 promotes reliability by requiring tuning parameters that take practical considerations and unit variations into account.

#### **4. Requirement R4**

Proposed Requirement R4 requires Generator Owners to install and complete start-up testing of a power system stabilizer on a generator within 180 days of either of the following: (1) the Generator Owner connects a generator to the BES, after achieving Commercial Operation, and after the effective date of VAR-501-WECC-3; or (2) the Generator Owner replaces the voltage regulator on its existing excitation system after achieving Commercial Operation for its generator that is connected to the BES and after the effective date of VAR-501-WECC-3.

The intent behind proposed Requirement R4 was to provide specificity as to when a power system stabilizer should be installed and to provide a reasonable amount of time for commissioning. As detailed in the mapping document in Exhibit D hereto, the standard drafting team concluded 180 days is a reasonable time for commissioning based on comments received and consultation with compliance staff. The 180 days allows the Generator Owner to address some unforeseen circumstances that may delay commissioning, although the drafting team recognized

that there may be other circumstances out of the entity's control that may extend commissioning beyond 180 days. The standard drafting team determined that it could not accommodate all unforeseen circumstances in a requirement and that 180 days was an appropriate balance of allowing some time for unforeseen circumstances while providing a clear timeframe. All new synchronous generators connected to the BES are required to install power system stabilizers, but existing synchronous generators do not need to install a power system stabilizer until one of the triggering events listed in proposed Requirement R4. In addition, the first bullet of proposed Requirement R4 is intended to only apply to initial connection to the BES.

## **5. Requirement R5**

Proposed Requirement R5 requires each Generator Owner to repair or replace a power system stabilizer within 24 months of that power system stabilizer becoming incapable of meeting the tuning specifications in Requirement R3. The intent of proposed Requirement R5 is to address units that previously were working but no longer are capable. In addition, the standard drafting team streamlined the approach towards repairs or replacements. In the existing Regional Reliability Standard VAR-501-WECC-2, Requirement R1, Parts 1.8, 1.9, and 1.10 provide incremental repair timeframes, depending on the type of maintenance and documentation submitted, up to 24 months. The 24-month timeframe originally was intended to accommodate procurement periods for replacing a power system stabilizer, which was based on entity experiences in WECC, and FERC recognized the need for this timeframe.<sup>8</sup> The proposed Requirement R5 simply allows 24 months for repair or replacement, regardless of cause or documentation. Therefore proposed Requirement R5 retains the maximum time period to

---

<sup>8</sup> *Version One Regional Reliability Standards for Facilities Design, Connections, and Maintenance; Protection and Control; and Voltage and Reactive*, 135 FERC ¶ 61,061 (2011) at P 104.

accommodate procurement periods and eliminates the tiered approach from the current standard to streamline the requirement and reduce excess documentation needs.

**E.     **Enforceability of Proposed Regional Reliability Standard VAR-501-WECC-3****

The proposed Regional Reliability Standard includes VRFs and VSLs. The VSLs provide guidance on the way that NERC will enforce the requirements of the proposed Regional Reliability Standard. The VRFs are one of several elements used to determine an appropriate sanction when the associated requirement is violated. The VRFs assess the impact to reliability of violating a specific requirement. The VRFs and VSLs for the proposed Regional Reliability Standard comport with NERC and FERC guidelines related to their assignment. For a detailed review of the VRFs, the VSLs, and the analysis of how the VRFs and VSLs were determined using these guidelines, please see Exhibit E.

The proposed Regional Reliability Standard also includes measures that support each requirement by clearly identifying what is required and how the requirement will be enforced. These measures help ensure that the requirements will be enforced in a clear, consistent, and non-preferential manner and without prejudice to any party.

**V.     **EFFECTIVE DATE****

Proposed Regional Reliability Standard VAR-501-WECC-3 and the retirement of VAR-501-WECC-2 will become effective as set forth in the proposed Implementation Plan, provided in Exhibit B hereto. The proposed effective date of the proposed Regional Reliability Standard is the first day of the first calendar quarter after the effective date of the applicable governmental authority's order approving the standard, or as otherwise provided for in the Implementation Plan. The implementation plan provides, however, that for units placed in service prior to final regulatory or NERC Board of Trustees approval of the standard, Requirement R3 becomes

effective five years after the effective date of the standard. The drafting team determined that the additional time for certain units to comply with Requirement R3 is necessary as changing the tuning parameters on power system stabilizers does not need to occur for currently-operating units and could place a moderate to severe burden on the entity depending on its practices. Units placed into service for the first time after the effective date of the standard can tune the power system stabilizers to the parameters in proposed Requirement R3 during initial testing and start-up.

Respectfully submitted,

/s/ Marisa Hecht

Shamai Elstein  
Senior Counsel  
Marisa Hecht  
Counsel  
North American Electric Reliability Corporation  
1325 G Street, N.W., Suite 600  
Washington, D.C. 20005  
(202) 400-3000  
shamai.elstein@nerc.net  
marisa.hecht@nerc.net

*Counsel for the North American Electric  
Reliability Corporation*

Date: March 22, 2017



EXHIBITS A-B AND D-I

NERC is responsible for ensuring that the Reliability Standards, Violation Risk Factors (VRF), Violation Severity Levels (VSL), definitions, Variances, and Interpretations developed by drafting teams are developed in accordance with NERC processes. They must also meet NERC's benchmarks for Reliability Standards, as well as criteria for governmental approval.

The discussion below explains how the proposed Regional Reliability Standard has met or exceeded the Reliability Standards criteria:

**1. Proposed reliability standards must be designed to achieve a specified reliability goal.**

NERC Reliability Principles - "NERC Reliability Standards are based on certain reliability principles that define the foundation of reliability for North American bulk power systems. Each reliability standard shall enable or support one or more of the reliability principles, thereby ensuring that each standard serves a purpose in support of reliability of the North American bulk power systems."

NERC Reliability Principle 1 states: "Interconnected bulk power systems shall be planned and operated in a coordinated manner to perform reliably under normal and abnormal conditions as defined in the NERC Standards."<sup>1</sup>

The Purpose of VAR-501-WECC-3 is "to ensure the Western Interconnection is operated in a coordinated manner under normal and abnormal conditions by establishing the performance criteria for WECC power system stabilizers."

**2. Proposed reliability standards must contain a technically sound method to achieve the goal.**

Standard Development

The proposed standard was developed using the NERC and WECC Standards development processes in effect at each point in the process. Among other things, these processes include drafting of the standard by a drafting team composed of subject matter experts (SME). Biographies of those SMEs are provided with this filing.

---

<sup>1</sup> [http://www.nerc.com/files/Reliability\\_Principles.pdf](http://www.nerc.com/files/Reliability_Principles.pdf)

These processes also include repeated public iterative comment/response cycles whereby comments are received from the industry and responses to those comments are provided by the drafting team.

#### Technically Sound

A technical review of the PSS tuning specifications is provided in Attachment F of this filing, *WECC-0107 VAR-501-WECC-3 Power System Stabilizers, Use of Minimum-Load for Tuning In Proposed Requirement R3, WECC-0107 Drafting Team (DT), Kestrel Consulting, Mr. Leo Lima, Kestrel Consulting, July 2, 2015.*

A technical review of the applicability threshold is addressed in Attachment F1 of this filing, *Power System Stabilizer Applicability in the WECC System, Study Progress Report to WECC-0107 Drafting Team, Shawn Patterson of the United States Bureau of Reclamation, April 2014.*

#### Lessons Learned

PSSs are part of the Automatic Voltage Regulation (AVR) system of a generator and are designed to add or subtract torque to a generator with the goal of damping oscillations on the WECC Interconnection's Bulk Electric System (BES) that otherwise would be amplified if the AVR is operated by itself.

PSSs within WECC (originally called Supplementary Control Systems) were developed in the 1960s in response to power system oscillations on the Pacific Intertie within the Western Interconnection. These oscillations occur at very low frequencies (<1 hertz), are very lightly dampened, and became known as "inter-area modes" (modes) of oscillation because they occurred when real power was transferred from one Western Interconnection geographic region to another (such as between the Pacific Northwest and the Southwest).

These modal oscillations are the result of a combination of many machines on one part of the Western Interconnection BES whose voltage support response to system fluctuations is not in phase with the response of machines on another part of the Interconnection's BES.

#### WECC Physical Characteristics

The Federal Energy Regulatory Commission (FERC) Order 740, Docket No. RM09-15-000, P23, noted that “in the Western Interconnection a significant number of transmission paths are voltage or frequency stability-limited, in contrast to other regions of the [BES] where transmission paths more often are thermally-limited. Disturbances resulting in a stability-limited transmission path overload, generally, must be responded to in a shorter time frame than a disturbance that results in a thermally-limited transmission path overload. [FERC has also noted] its understanding that this physical difference is one of the reasons for the need for certain provisions of regional Reliability Standards in the Western Interconnection.”

When coupled with generator operations within WECC, these physical characteristics create modal oscillations, that when not corrected by the installation and accurate operation of PSS, could contribute to instability within the WECC Interconnection.

**3. Proposed reliability standards must be applicable to users, owners, and operators of the bulk power system, and not others.**

VAR-501-WECC-3 complies with the Reliability Standards criteria in that it applies to the Generator Operator and the Generator Owner.

**4. Proposed reliability standards must be clear and unambiguous as to what is required and who is required to comply.**

VAR-501-WECC-3 complies with the Reliability Standards criteria in that it applies to the Generator Operator and the Generator Owner and specifically states the task(s) each of those entities is required to perform.

The proposed standard requires the Generator Owner to: 1) inform the applicable entities as to the known circumstances when a power system stabilizer (PSS) will be out-of-service (R1), 2) tune the PSS to stated specifications (R3), and 3) establish installation (R4) and servicing criteria (R5) for the PSS.

The proposed standard requires the Generator Operator to have the PSS in-service unless otherwise specified (R2).

**5. Proposed reliability standards must include clear and understandable consequences and a range of penalties (monetary and/or non-monetary) for a violation.**

Violation Risk Factors

The WECC-0107 VAR-501-WECC-3 - Power System Stabilizer Drafting Team (DT) used the NERC-provided guidance document for Violation Risk Factors (VRF) to determine the VRF for each requirement. Based on the guidance document, the DT assigned a low VRF to Requirement R1 because the requirement is administrative in nature addressing the planning horizon. A violation of the requirement would not—under the emergency, abnormal, or restorative conditions anticipated by the preparations—be expected to adversely affect the electrical state or capability of the Bulk Electric System (BES), or the ability to effectively monitor, control, or restore the BES.

All other requirements were assigned a medium VRF.

The remaining requirements address the operational horizon. If violated, they could directly affect the electrical state or the capability of the BES, or the ability to effectively monitor and control the BES. However, violation of these medium-risk requirements is unlikely to lead to BES instability, separation, or cascading failures.

Violation Severity Level (VSL)

The DT used the NERC-provided guidance document for VSLs to determine the VSL for each requirement. Based on the guidance document, the DT assigned a severe VSL to Requirements R1, R4 and R5, because the requirements are binary in nature, that is a “pass or fail” type requirement where any degree of noncompliant performance would result in totally or mostly missing the reliability intent of the Requirements.

For each of the remaining Requirements, the DT assigned a graded performance schedule with each requirement being assigned four increasing tiers for non-compliance. In each case the DT concluded that partial performance would have some reliability-related value.

The VSL for Requirement R2 is based on the passage of time. The longer a Generator Operator leaves its power system stabilizer out of service, the greater the VSL becomes.

The VSL for Requirement R3 is based on the cumulative number of times the Generator Owner failed to meet the prescribed performance. Each piece of the prescribed performance contributes equally to the reliability-related objective; therefore, the VSL was uniformly applied for each piece.

**6. Proposed reliability standards must identify clear and objective criterion or measure for compliance, so that it can be enforced in a consistent and non-preferential manner.**

Each proposed requirement has a corresponding measure stating the objective evidence required to illustrate compliance.

**7. Proposed reliability standards should achieve a reliability goal effectively and efficiently - but does not necessarily have to reflect “best practices” without regard to implementation cost.**

The proposed standard was posted eight times for comment. Each time, the industry was invited to provide comments on all aspects of the document. Cost concerns were raised by PPL Montana in Posting 1. In response, the DT reassured PPL that the standard would not apply to all units; it would only apply to those impacting the BES. In the following seven postings the DT received no comments regarding costs.

**8. Proposed reliability standards cannot be “lowest common denominator,” i.e., cannot reflect a compromise that does not adequately protect bulk power system reliability.**

The proposed standard takes the existing standard and builds on its strengths. The existing standard has but one requirement calling for a PSS to be in-service for 98% of the time. The spirit of the requirement is retained but redrafted so the applicable entities no longer have to count each hour but are still required to keep the PSS in-service.

In addition to retention of the in-service requirement, the proposed standard adds requirements to install, tune, repair and document the operations of its PSS.

**9. Proposed reliability standards may consider costs to implement for smaller entities but not at consequence of less than excellence in operating system reliability.**

See response to Question 7.

**10. Proposed reliability standards must be designed to apply throughout North America to the maximum extent achievable with a single reliability standard while not favoring one area or approach.**

Matters not Covered Elsewhere

Regional Entity Standards or Regional Variances to a NERC Reliability Standard (Standard) are permissible if:

- they set more stringent reliability requirements than the NERC Reliability Standard;
- cover matters not covered by an existing NERC Reliability Standard; or
- are necessitated by a physical difference in the Bulk-Power System (BES).<sup>2</sup>

As mentioned in Question 8, the proposed standard adds requirements not otherwise addressed in existing NERC Standards.

WECC Physical Characteristics

The Federal Energy Regulatory Commission (FERC) Order 740, Docket No. RM09-15-000, P23, noted that “in the Western Interconnection a significant number of transmission paths are voltage or frequency stability-limited, in contrast to other regions of the [BES] where transmission paths more often are thermally-limited. Disturbances resulting in a stability-limited transmission path overload, generally, must be responded to in a shorter time frame than a disturbance that results in a thermally-limited transmission path overload. [FERC has also noted] its understanding that this physical difference is one of the reasons for the need for certain provisions of regional Reliability Standards in the Western Interconnection.”

When coupled with generator operations within WECC, these physical characteristics create modal oscillations, that when not corrected by the

---

<sup>2</sup> See NERC Functional Model, Version 5, “2. Reliability Standards,” page 36.

installation and accurate operation of PSS, could contribute to instability within the Western Interconnection.

**11. Proposed reliability standards should cause no undue negative effect on competition or restriction of the grid.**

The proposed standard is not anticipated to have any negative impact on competition.

**12. The implementation time for the proposed reliability standards must be reasonable.**

Implementation

For more detail please refer to Attachment E of this filing.

With the exception of Requirement R3, VAR-501-WECC-3 has a standardized Effective Date.

Use of this separate Effective Date for Requirement R3 highlights the fact that the reliability-related tasks included in Requirement R3 are a change from existing tuning parameters and could impose an entity-specific burden that is moderate to severe, depending on the existing practices of each entity. The tiered implementation of Requirement R3 reduces the burden by allowing entities to address the Requirement over a longer period of time.

Units placed into first-time service after regulatory approval will require initial testing, tuning, and set-up. As such, immediate compliance with Requirement R3 for new units should impose no undue burden. Many of the units already in service are currently and adequately tuned to pre-Requirement R3 parameters and need not be immediately revisited. The five-year applicability date for those units already in service lessens the burden while targeting a uniform tuning across the Western Interconnection.

Consideration of Early Compliance

Early compliance should impose no negative impacts. Because many of the Requirements are based on existing WECC guidelines, many Applicable Entities within WECC will already be in voluntary compliance.



**13. The reliability standard development process must be open and fair.**

WECC followed the standard development process in effect at the time of each step in the process.

In accordance with the WECC Reliability Standards Development Procedures, all drafting team meetings are open to the public.

This drafting team met in excess of 35 times.

Notice of the meetings was provided to NERC, posted on the WECC website and embedded in the minutes of each meeting. Meeting minutes are posted on the WECC website and accessible by the public.

All meetings were supported by a telephone conference bridge associated with an online internet visual capability allowing all participants to see the document(s) as they were being developed. Further, this team held an open-mic standards briefing prior to balloting affording the industry an additional opportunity to have its questions addressed.

The project was posted for comment on eight occasions. On each occasion comments were received, considered, and addressed.

In addition, the project was posted at NERC for a 45-day comment period.

Comments and their responses are currently posted on the WECC website at the WECC-0107 Project Page on the Submit and Review Comments accordion and have been provided with this filing.

**14. Proposed reliability standards must balance with other vital public interests.**

WECC is not aware of any other vital public interests. No such balancing concerns were raised or noted.

**15. Proposed reliability standards must consider any other relevant factors.**

Inter alia, the DT considered and addressed the following issues:

- 1) cost allocation,
- 2) operational impact to smaller entities, and
- 3) inclusion / exclusion of units based on size.

Although not all suggested changes were adopted by the DT, the DT is confident that each voiced concern was heard, considered and addressed.