

**Comparison between NERC VAR-002-1.1b and Alberta VAR-002-AB-1.1b  
Generator Operation for Maintaining Network Voltages**

Section	NERC VAR-002-1.1b	Alberta VAR-002-AB-1.1b	Reason for Difference <sup>1</sup>
<b>Purpose</b>	To ensure generators provide reactive and voltage control necessary to ensure voltage levels, reactive flows, and reactive resources are maintained within applicable Facility Ratings to protect equipment and the reliable operation of the Interconnection.	The purpose of this reliability standard is to ensure generating units provide reactive and voltage control necessary to ensure voltage levels, reactive flows, and reactive resources are maintained within applicable facility ratings to protect equipment and the reliable operation of the Interconnection.	
<b>Applicability</b>	<p><b>4.1.</b> Generator Operator.</p> <p><b>4.2.</b> Generator Owner.</p>	<p>This reliability standard applies to:</p> <ul style="list-style-type: none"> <li>• Operators of synchronous generating units and wind aggregated generating facilities equipped with voltage regulating systems connected to the transmission system;</li> <li>• GFOs of synchronous generating units and wind aggregated generating facilities equipped with a voltage regulating system connected to the transmission system.</li> </ul>	Added that this standard also applies to voltage regulating systems at wind aggregated generating facilities.
<b>Effective Date</b>	Immediately after approval of applicable regulatory authorities.	Ninety calendar days after the date of approval by the Commission.	
<b>Requirement</b>	<b>R1.</b> The Generator Operator shall operate each generator connected to the	<b>R1.</b> Each operator of a generating unit, subject to requirement R3 and the ISO's	Added to requirements R1 and R2 that consent from the ISO is required

<sup>1</sup> The following revisions have been made throughout this proposed reliability standard:

- Identified the responsible entities in Alberta.
- Applied a consistent writing style and added clarity.
- Changed passive terms such as "shall" to "must".
- Developed measures specific to the requirements.

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	<p>interconnected transmission system in the automatic voltage control mode (automatic voltage regulator in service and controlling voltage) unless the Generator Operator has notified the Transmission Operator.</p>	<p>consent to operate otherwise, must operate such generating unit with the automatic voltage regulator in service and in voltage control mode and must not operate in any other mode including without limitation,</p> <ul style="list-style-type: none"> <li>• power factor control mode</li> <li>• VAR control mode</li> </ul> <p><b>R2.</b> Each operator of a wind aggregated generating facility, subject to requirement R3 and the ISO's consent to operate otherwise, must operate such wind aggregated generating facility with the voltage regulating system in service and in voltage control mode and must not operate in any other mode including without limitation,</p> <ul style="list-style-type: none"> <li>• power factor control mode</li> <li>• VAR control mode</li> </ul> <p><b>R3.</b> Each operator of a generating unit or wind aggregated generating facility must notify the ISO as soon as practical when the automatic voltage regulator or voltage regulating system is out of service.</p>	<p>in order to operate without the automatic voltage regulator in service.</p>

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Section	NERC VAR-002-1.1b	Alberta VAR-002-AB-1.1b	Reason for Difference <sup>1</sup>
<b>Measure</b>	<b>M1.</b> The Generator Operator shall have evidence to show that it notified its associated Transmission Operator any time it failed to operate a generator in the automatic voltage control mode as specified in Requirement 1.	<p><b>MR1.</b> Evidence exists that the automatic voltage regulator was in service and in voltage control mode as specified in requirement R1.</p> <p><b>MR2.</b> Evidence exists that the voltage regulating system was in service and in voltage control mode as specified in requirement R2.</p> <p><b>MR3.</b> Electronic logs, operator logs, and/or voice recordings show that notifications were provided, as specified in requirement R3.</p>	
<b>Requirement</b>	<b>R2.</b> Unless exempted by the Transmission Operator, each Generator Operator shall maintain the generator voltage or Reactive Power output (within applicable Facility Ratings <sup>1</sup> ) as directed by the Transmission Operator.	<p><b>R4.</b> The operator of a generating unit or wind aggregated generating facility unless exempted by the ISO must comply with directives from the ISO that specify the following:</p> <ul style="list-style-type: none"> <li>a) voltage level on the high voltage side of the transformer(s) at the point of connection between each generating unit or wind aggregated generating facility and the TFO's facilities; or</li> <li>b) the reactive power to be achieved by the generating unit or wind aggregated generating facility.</li> </ul>	Provided additional detail on how voltage level directives are to be achieved.

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		<p><b>R4.1</b> Each operator of a generating unit or wind aggregated generating facility pursuant to requirement R4 must comply by adjusting the:</p> <ul style="list-style-type: none"> <li>a) set point of the automatic voltage regulator or voltage regulation system; or</li> <li>b) on-load tap changer.</li> </ul> <p><b>R4.2</b> The operator of a generating unit or wind aggregated generating facility, subsequent to complying pursuant to requirement R4, must not adjust either of the following:</p> <ul style="list-style-type: none"> <li>a) set point of the automatic voltage regulator or voltage regulating system; or</li> <li>b) on-load tap changer.</li> </ul>	

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<b>Measure</b>	<b>M2.</b> The Generator Operator shall have evidence to show that it controlled its generator voltage and reactive output to meet the voltage or Reactive Power schedule provided by its associated Transmission Operator as specified in Requirement 2.	<p><b>MR4</b> Evidence such as electronic logs or operator logs, show that directives as specified in requirement R4 were followed.</p> <p><b>MR4.1</b> Evidence shows that setpoints and tapchanger position were changed as specified in requirement R4.1.</p> <p><b>MR4.2</b> Evidence shows that setpoints and tapchanger position have not changed without directives, as specified in requirement R4.2.</p>	
<b>Requirement</b>	<b>R2.1.</b> When a generator's automatic voltage regulator is out of service, the Generator Operator shall use an alternative method to control the generator voltage and reactive output to meet the voltage or Reactive Power schedule directed by the Transmission Operator.	<b>R5</b> Each operator of a generating unit or wind aggregated generating facility must use an alternative method to control voltage and reactive power output to meet the voltage level directive, or reactive power level directive issued by the ISO when the automatic voltage regulator or voltage regulating system is out of service.	Reworded for clarity and consistency.
<b>Measure</b>	<b>M3.</b> The Generator Operator shall have evidence to show that it responded to the Transmission Operator's directives as identified in Requirement 2.1 and Requirement 2.2.	<b>MR5</b> Evidence shows that voltage levels are within tolerances specified in requirement R5.	

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<b>Requirement</b>	<b>R2.2.</b> When directed to modify voltage, the Generator Operator shall comply or provide an explanation of why the schedule cannot be met.	<b>R6.</b> Each operator of a generating unit or wind aggregated generating facilities who cannot comply with a directive pursuant to requirement R5 must notify the ISO with its explanation for not complying with a voltage level directive within 30 minutes.	Added that the ISO is to be notified within 30 minutes to maintain reliable operations.
<b>Measure</b>	<b>M3.</b> The Generator Operator shall have evidence to show that it responded to the Transmission Operator's directives as identified in Requirement 2.1 and Requirement 2.2.	<b>MR6.</b> Electronic logs, operator logs, and/or voice recordings explain conditions specified in requirement R6.	
<b>Requirement</b>	<b>R3.</b> Each Generator Operator shall notify its associated Transmission Operator as soon as practical, but within 30 minutes of any of the following:	<b>R7.</b> Each operator of a generating unit or wind aggregated generating facility must notify the ISO as soon as practical, but within 30 minutes of any of the following:	Reworded for clarity and consistency.
<b>Measure</b>	<b>M4.</b> The Generator Operator shall have evidence it notified its associated Transmission Operator within 30 minutes of any of the changes identified in Requirement 3.	<b>MR7</b> Electronic logs, operator logs, and/or voice recordings showing that notifications were provided within the timelines specified in each of the sub-requirements of R7.	

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<b>Requirement</b>	<b>R3.1.</b> A status or capability change on any generator Reactive Power resource, including the status of each automatic voltage regulator and power system stabilizer and the expected duration of the change in status or capability.	<b>R7.1.</b> A status or capability change on any generating unit or wind aggregated generating facility reactive power resource in excess of 2.5 MVar or 1% (which ever is greater) of its reactive power obligation, including the status of each automatic voltage regulator, voltage regulating system and power system stabilizer, and the expected duration of the change in status or capability.	Identified the tolerance for reporting changes in reactive power capability.
<b>Measure</b>		<b>MR7.1</b> Electronic logs, operator logs, and/or voice recordings show that notifications were provided as specified in requirement R7.1	
<b>Requirement</b>	<b>R3.2.</b> A status or capability change on any other Reactive Power resources under the Generator Operator's control and the expected duration of the change in status or capability.	<p><b>R7.2</b> A status or capability change on any other reactive power resource in excess of 2.5 MVar or 1% (which ever is greater) of the reactive power obligation under the control of each operator of a generating unit or operator of a wind aggregated generating facility , and the expected duration of the change in status or capability.</p> <p><b>R7.3</b> A status or capability change of the reactive power resource of an unknown value. Once the value is known then operator of generating unit must report the value to the</p>	<p>Identified the tolerance for reporting changes in reactive power capability.</p> <p>Added that the ISO is to be notified of any change of the reactive power resource within 30 minutes in order to maintain reliable operations</p>

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		ISO as soon as practical, but within 30 minutes.	
<b>Measure</b>		<p><b>MR7.2</b> Electronic logs, operator logs, and/or voice recordings show that notifications were provided as specified in requirement R7.2</p> <p><b>MR7.3</b> Electronic logs, operator logs, and/or voice recordings show that notifications were provided as specified in requirement R7.3</p>	
<b>Requirement</b>	<b>R4.</b> The Generator Owner shall provide the following to its associated Transmission Operator and Transmission Planner within 30 calendar days of a request.	<b>R8.</b> Each GFO with generating unit step-up and auxiliary transformers with primary voltages equal to or greater than the generating unit terminal voltage must provide the ISO any one or more of the following within 30 days of a request:	Reworded for clarity and consistency.
<b>Measure</b>		<b>MR8</b> – Confirmation that the information was provided in the timeline specified in requirement R8.	
<b>Requirement</b>	<p><b>R4.1.</b> For generator step-up transformers and auxiliary transformers with primary voltages equal to or greater than the generator terminal voltage:</p> <p><b>R4.1.1.</b> Tap settings.</p> <p><b>R4.1.2.</b> Available fixed tap ranges.</p> <p><b>R4.1.3.</b> Impedance data.</p>	<p><b>R8.1</b> Tap settings.</p> <p><b>R8.2</b> Available fixed tap ranges.</p> <p><b>R8.3</b> Impedance data.</p> <p><b>R8.4</b> The +/- voltage range with step-change in % for on-load tap changing transformers.</p>	Moved the NERC requirement R4.1 into the Alberta requirement R8.

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	<b>R4.1.4.</b> The +/- voltage range with step-change in % for load-tap changing transformers.		
<b>Measure</b>	<b>M5.</b> The Generator Owner shall have evidence it provided its associated Transmission Operator and Transmission Planner with information on its step-up transformers and auxiliary transformers as required in Requirements 4.1.1 through 4.1.4.	<b>MR8.1</b> Documentation exists that shows the information in requirement R8.1 has been provided. <b>MR8.2</b> Documentation exists that shows the information in requirement R8.2 has been provided. <b>MR8.3</b> Documentation exists that shows the information in requirement R8.3 has been provided. <b>MR8.4</b> Documentation exists that shows the information in requirement R8.4 has been provided.	
<b>Requirement</b>	<b>R5.</b> After consultation with the Transmission Operator regarding necessary step-up transformer tap changes, the Generator Owner shall ensure that transformer tap positions are changed according to the specifications provided by the Transmission Operator, unless such action would violate safety, an equipment rating, a regulatory requirement, or a statutory requirement.	<b>R9.</b> Each GFO with step-up transformer off-load taps, after reviewing with the ISO, must ensure that transformer tap positions are changed according to the specifications provided by the ISO.	Reworded for clarity and consistency.
<b>Measure</b>	<b>M6.</b> The Generator Owner shall have evidence that its step-up transformer taps	<b>MR9.</b> Evidence or records show that settings were made and conform to technical	

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	were modified per the Transmission Operator's documentation as identified in Requirement 5.	requirement specified in requirement R9.	
<b>Requirement</b>	<b>R5.1.</b> If the Generator Operator can't comply with the Transmission Operator's specifications, the Generator Operator shall notify the Transmission Operator and shall provide the technical justification.	<b>R10.</b> Each GFO must notify the ISO within 30 days of the ISO providing the specifications pursuant to requirement R9 if the GFO cannot comply and must include the technical justification in such notice.	Added that the required notification is done within 30 days in order to maintain reliable operations and to have a reasonable measure for compliance.
<b>Measure</b>	<b>M7.</b> The Generator Operator shall have evidence that it notified its associated Transmission Operator when it couldn't comply with the Transmission Operator's step-up transformer tap specifications as identified in Requirement 5.1.	<b>MR10</b> Documentation exists and shows that an acceptable explanation was provided within the timelines specified in requirement R10.	
<b>Compliance</b>	To view the compliance section D of the NERC reliability standard follow this link: <a href="http://www.nerc.com/files/VAR-002-1_1b.pdf">http://www.nerc.com/files/VAR-002-1_1b.pdf</a>		There is no compliance section currently proposed in the Alberta Reliability Standards. A compliance program for Alberta Reliability Standards is under development that recognizes the compliance monitoring and enforcement structure in Alberta. This approach is deemed consistent with the existing ISO Rules.

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<b>Regional Differences</b>	None identified.		Not applicable in Alberta

**Associated Documents**

1. Appendix 1 – Interpretation of Requirements R1 and R2 (August 1, 2007).

**Appendix 1<sup>2</sup>**

**Interpretation of Requirements R1 and R2  
Request:**

Requirement R1 of Standard VAR-002-1 states that Generation Operators shall operate each generator connected to the interconnected transmission system in the automatic voltage control mode (~~*automatic voltage regulator in service and controlling voltage*~~) unless the Generator Operator has notified the Transmission Operator.

Requirement R2 goes on to state that each Generation Operator shall maintain the generator voltage ~~or *Reactive Power output*~~ as directed by the Transmission Operator. The two underlined phrases are the reasons for this interpretation request. Most generation excitation controls include a device known as the Automatic Voltage Regulator, or AVR. This is the device which is referred to by the R1 requirement above. Most AVR's have the option of being set in various operating modes, such as constant voltage, constant power factor, and constant Mvar. In the course of helping members of the WECC insure that they are in full compliance with NERC Reliability Standards, I have discovered both Transmission Operators and Generation Operators who have interpreted this standard to mean that AVR operation in the constant power factor or constant Mvar modes complies with the R1 and R2 requirements cited above. Their rationale is as follows:

The AVR is clearly in service because it is operating in one of its operating modes

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<sup>2</sup> Interpretations have been included by providing clarification in requirement R1. It was determined that no further clarification is required in requirement R4 that corresponds to NERC R2.



The AVR is clearly controlling voltage because to maintain constant PF or constant Mvar, it controls the generator terminal voltage

R2 clearly gives the Transmission Operator the option of directing the Generation Operator to maintain a constant reactive power output rather than a constant voltage. Other parties have interpreted this standard to require operation in the constant voltage mode only. Their rationale stems from the belief that the purpose of the VAR-002-1 standard is to insure the automatic delivery of additional reactive to the system whenever a voltage decline begins to occur. The material impact of misinterpretation of these standards is twofold.

First, misinterpretation may result in reduced reactive response during system disturbances, which in turn may contribute to voltage collapse.

Second, misinterpretation may result in substantial financial penalties imposed on generation operators and transmission operators who believe that they are in full compliance with the standard.

In accordance with the NERC Reliability Standards Development Procedure, I am requesting that a formal interpretation of the VAR-002-1 standard be provided. Two specific questions need to be answered:

First, does AVR operation in the constant PF or constant Mvar modes comply with R1?

Second, does R2 give the Transmission Operator the option of directing the Generation Owner to operate the AVR in the constant Pf or constant Mvar modes rather than the constant voltage mode?

**Interpretation:**

1. First, does AVR operation in the constant PF or constant Mvar modes comply with R1?

**Interpretation:** No, only operation in constant voltage mode meets this requirement. This answer is predicated on the assumption that the generator has the physical equipment that will allow such operation and that the Transmission Operator has not directed the generator to run in a mode other than constant voltage.

2. Second, does R2 give the Transmission Operator the option of directing the Generation Owner (sic) to operate the AVR in the constant Pf or constant Mvar modes rather than the constant voltage mode?

**Interpretation:** Yes, if the Transmission Operator specifically directs a Generator Operator to operate the AVR in a mode other than constant voltage mode, then that directed mode of AVR operation is allowed.

## Appendix 2<sup>3</sup>

### Interpretation of VAR-002-1a

#### **Request:**

~~VAR-002—Generator Operation for Maintaining Network Voltage Schedules, addresses the generator’s provision of voltage and VAR control. Confusion exists in the industry and regions as to which requirements in this standard apply to Generator Operators that operate generators that do not have automatic voltage regulation capability.~~

~~The Standard’s requirements do not identify the subset of generator operators that need to comply—forcing some generator operators that do not have any automatic voltage regulation capability to demonstrate how they complied with the requirements, even when they aren’t physically able to comply with the requirements. Generator owners want clarification to verify that they are not expected to acquire AVR devices to comply with the requirements in this standard.~~

~~Many generators do not have automatic voltage regulators and do not receive voltage schedules. These entities are at a loss as to how to comply with these requirements and are expending resources attempting to demonstrate compliance with these requirements. A clarification will avoid challenges and potential litigation stemming from sanctions and penalties applied to entities that are being audited for compliance with this standard, but who do not fall within the scope or intent of the standard itself.~~

~~Please identify which requirements apply to generators that do not operate generators equipped with AVRs.~~

~~**Response:** All the requirements and associated subrequirements in VAR-002-1a apply to Generator Owners and Generator Operators that own or operate generators whether equipped with an automatic voltage regulator or not. The standard is predicated on the assumption that the generator has the physical equipment (automatic voltage regulator) that is capable of automatic operation. A generator that is not equipped with an automatic voltage regulator results in a functionally equivalent condition to a generator equipped with an automatic voltage regulator that is out of service due to maintenance or failure.~~

~~There are no requirements in the standard that require a generator to have an automatic voltage regulator, nor are there any requirements for a Generator Owner to modify its generator to add an automatic voltage regulator. Unless exempted by the Transmission Operator, each Generator Operator shall maintain the generator voltage or Reactive Power output (within applicable Facility Ratings) as directed by the Transmission Operator.~~

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<sup>3</sup> Interpretation did not require clarification to the requirements.



### **Proposed Terms for the Consolidated Authoritative Document Glossary<sup>4</sup>:**

“**aggregated generating facilities**” means an aggregation of **generating units**, including any **reactive power** resources, which are:

- (i) designated by the **ISO**; and
- (ii) situated in the same proximate location at one or more **point of connections**.

“**voltage regulating system**” means the equipment that automatically controls the **reactive power** resources to regulate the voltage level at any **collector bus**.

### **Existing Defined Terms Used in this Standard:**

(As included in the Consolidated Authoritative Document Glossary)

- automatic voltage regulator
- Commission
- day
- facility
- facility rating
- generating facility owner (GFO)
- Interconnection
- interconnection reliability operating limits
- ISO
- MVar
- power factor
- reactive power
- reliability standards

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<sup>4</sup> These proposed defined terms are also being consulted on as part of the ISO rules consultation on Section G1 Definitions (Package 4).