

Technical Rationale for Reliability Standard

VAR-002-5

September 2023

VAR-002-5 – Generator Operation for Maintaining Network Voltage Schedules

Rationale for Applicability Section – Functional Entities

The purpose of the proposed VAR-002-5 Reliability Standard is to ensure generating resources provide reactive support and voltage control, within generating Facility capabilities, in order to protect equipment and maintain reliable operation of the Interconnection. There are two functional entities that play a role in proposed VAR-002-5 requirements and have an obligation to comply with them. These are:

- Generator Owner
- Generator Operator

The Generator Owner is responsible for maintaining the Generation Owner voltage control equipment, to include Generator Step-up and auxiliary Transformer if owned, defined by the Bulk Electric System as applicable to the generating resource(s). The Generator Owner will provide Transformer data as required in Requirement R5, communicating with the associated Transmission Operator regarding any requests or changes to generating resource(s) main step-up and auxiliary transformers with primary voltages equal to or greater than the generating resource(s) terminal voltage for conventional synchronous generators or at least one winding at a voltage of 100 kV or above for dispersed power producing resources. The Generator Owner maintaining the voltage control and reactive support equipment should provide the Generator Operator with any maintenance or planned and unplanned changes to the equipment that impacts the resource following the associated Transmission Operator instruction(s).

The Generator Operator is responsible for operation of the generating resource(s) voltage and reactive power control equipment to follow the NERC VAR-002 operation requirements and the specified Transmission Operator voltage or reactive power schedules and notifying the Transmission Operator as instructed to meet the conditions of notifications when deviating from schedule and where voltage control and reactive support change reporting expectations are provided. The Generator Operator will notify Transmission Operator of Reactive capability changes or automatic voltage regulator (AVR) status changes in real-time operations that meet the reporting expectations. If no additional reporting expectations have been provided by the Transmission Operator for generating resource(s) reactive capability changes or automatic voltage regulator (AVR) status changes, the Generator Operator shall report reactive capability changes or AVR status changes as stated in the VAR-002 requirements. The Generator Operator shall report to the Transmission Operator any equipment impacts associated with the Generator Operator following voltage or reactive power schedules or as instructed by Transmission Operator.

Degradation or restoration from degradation of voltage control and reactive support equipment and associated limits impacting the Generator Operating from following instruction at the desired generating resource(s) location(s) specified by the Transmission Operator for a specified voltage or reactive power

schedule shall be reported as required. The term degradation for this Standard is meant to for voltage control or reactive power support equipment not to perform as intended and unexpected lower performance to the reported capabilities. Operating of associated equipment to design characteristics and to operate as intended with changing the generating resource(s) voltage control or reactive support as expected should not be reported unless the Transmission Operator specifies.

The Generator Operator will normally have several communication methods available to voltage control status changes in real time such as telemetry or telecommunications. Clarity should be provided of desired communication method by the Transmission Operator.

Generating resource(s)

The generating resource(s), e.g., generator, dispersed power producing, will have met the NERC glossary of terms definition of inclusion to the Bulk Electric System and have capability to provide reactive support and voltage control to be required to follow the proposed VAR-002-5 NERC Reliability Standard. Unless exempted by the Transmission Operator, a generating resource(s) voltage or reactive power schedule is to be provided by the Transmission Operator with instruction for following the schedule or otherwise meet the conditions of notification for deviating from schedule. Each Generator Operator shall coordinate and cooperate with the Transmission Operator to provide necessary data, upon request, to determine proper reporting of the generating resource(s) voltage control and reactive capability changes for reliable real time system operations.

The generating resource(s) are a primary source of dynamic voltage control for the Transmission system. Generating resource(s) reactive resources within the plant's control are included in the Transmission system reactive support to be operated in a manner that maximizes stable control of the electric grid.

Each generating resource(s) facility may have a different methodology to ensure the facility has an automatic and dynamic response to changes in voltage to ensure the voltage schedule is maintained. It is implied, for example, in NERC VAR-001 that each GOP and TOP should understand capabilities of the generating resource(s) and the requirements of the transmission system to ensure a mutually agreeable solution and schedule is used.

Rationale for Requirement R1

This requirement has been maintained due to the importance of the Generator Operator running a unit with its automatic voltage regulator (AVR) in service and in either voltage controlling mode, or the mode instructed by the Transmission Operator. VAR-002-5 Standard footnote 1 is to bring attention to different types of control for the automatic voltage regulator (AVR) in regard to dispersed power producing resource inclusion defined by the Bulk Electric System within the NERC Glossary of Terms. Footnotes 2 and 3 are for defining start up and shut down for generating resource(s) to show output to resource that provides a sustainable output for continuous operation when connected to the grid, in which the AVR is to be in service and controlling voltage.

Rationale for Deletion of Requirement R2

This requirement has been maintained due to the importance of the Generator Operator maintaining the voltage or Reactive Power schedule provided by the Transmission Operator within each generating resource(s) capability. The voltage schedule is typically representing the desired voltage at or near the generating resource(s) point of interconnect to Transmission to account for any losses from the generating resource(s) source of voltage and reactive support location(s) to the Transmission point of interconnection location. If the voltage monitored by the Generator Operator is not at the desired voltage location specified in the Transmission voltage schedule, the Generator Operator will need to have a methodology for converting to voltage schedule to the Generator Operator monitored value accounting for differences in measurement values.

Typical dispersed power producing resources have a site automatic voltage regulator (AVR) or volt/VAR controller(s) that coordinates the voltage of the aggregated single generating resources to a common regulation point. If unexpected functionality changes occur to the site AVR or volt/VAR controller and associated equipment, e.g., communication path between site controllers to individual resource control, each individual resource may either continue to regulate at the last known set point or revert to unity power factor. These situations are accounted for in Requirement R2, Part 2.1, Generator Operator is to notify Transmission Operator when becoming aware of unexpected change.

Rationale for Deletion of Requirement R3

This requirement has been maintained due to the importance of the Generator Operator to communicate to the Transmission Operator in a mutually agreed communication method of impacts to the generating resource(s) ability to follow the Transmission Operator voltage instruction. Generating resource(s) voltage control statuses are changes that impact following the associated Transmission Operator instruction and specified voltage schedule either at the aggregated or single resource(s). Unexpected functionality changes in voltage control equipment are those that impact the ability to control voltage which degrades or restores from degradation and to exclude notifications that have change in status due to normal characteristics of operating the generating resource(s) or do not meet the Transmission Operator threshold for reporting where provided.

Each Generator Operator shall notify the associated Transmission Operator in a mutually agreed communication, e.g., phone call, telemetry, electronic, within 30 minutes of an AVR status change when the generating resource(s) are connected to the grid. An AVR responds to the generating resource(s) feedback to maintain the output voltage as close as possible to the scheduled voltage requested by the Transmission Operator. If AVR is not available for dynamic response to load changes the Transmission Operator would evaluate for system impacts in real time and may provide additional instruction(s) to generating resource(s) operating without automatic control of the AVR or in manual, such as coming off Automatic Generation Control (AGC) if available.

The power system stabilizer (PSS), if utilized, acts upon the AVR to dampen grid oscillations, and improve stability and would be treated as associated voltage control equipment when commissioned and enabled requiring Generator Operator to report to Transmission Operator when unexpected functionality changes or out of service and as stated in Requirement R3.

Rationale for Deletion of Requirement R4

This requirement has been maintained due to the importance of Generator Operator to communicate to the Transmission Operator in a mutually agreed communication, for required notifications when Generator controlled reactive resources change in Real-time operations and impact the reactive support of the generating resource(s) to impact Transmission Operator reactive resource schedule. VAR-001 R2 requires each Transmission Operator to schedule sufficient reactive resources to regulate voltage levels under normal and Contingency conditions. Transmission Operators are to use various means to provide sufficient reactive resources to include reactive generating resource(s) scheduling. VAR-002 R4 is a means for the Transmission Operator to be aware of changes to the reactive capability from generating resource(s) to be reported with the potential to system impacts. The reactive capability changes are to be reported that degrades or restores from degradation to the reported operating reactive resource capability. As reactive capability changes are not binary and may not be known as soon as they occur, the Generator Operator may not be aware of a change until operations is impacted by a generator equipment limit or monitored change. One fixed level of reactive capability changes for all generating resource(s) would trigger notifications without consideration of resource configurations, resource(s) geographical location, and connection to the Transmission System that may have varying impacts to the grid. However, if Transmission Operator remains neutral and does not provide needed clarity on reporting requirements to the Generator Operator, a 10% change in generating resource(s) reactive capability output is used for qualifying for a generating resource(s) reactive capability re-verification for modeling purposes. It is recommended that the Generator Operator may consider this reporting threshold, if practical, for changes in reactive capability real time operations and reporting.

Rationale for Deletion of Requirement R5

This requirement and corresponding measure have been maintained due to the importance of having accurate tap settings. If not properly set, then the VARs available from that unit can be affected. This requirement uses technology neutral language with respect to transformer modeling data when requested by the Transmission Operator. Dispersed power producing resource inclusion is for transformer in scope to have at least 1 winding at 100 kV or above.

VAR-002 is applicable to Generator Owner only and therefore will require applicable transformer data that are owned and maintained by the Generator Owner.

Rationale for Deletion of Requirement R6

This requirement and corresponding measure have been maintained due to the importance of having accurate tap settings. If not properly set, then the VARs available from that unit can be affected. Step-up transformers tap changes, according to the specifications provided by the Transmission Operator, will typically involve an outage of the transformer and is the culmination of a longer-term process to determine if a transformer tap change is appropriate. This requirement shows the importance of mutual understanding of changes and impacts to both operations and equipment, to communicate with technical justification to changes and rationale, allowing for collaboration to meet the objectives.