

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Electric Reliability Organization (ERO) Compliance Analysis Report

Reliability Standard VAR-002 — Generator
Operation for Maintaining Network Voltage
Schedules

August 2010

to ensure
the reliability of the
bulk power system

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ERO Compliance Analysis Reports

The ERO is comprised of NERC and Regional Entities. Their compliance staffs are collaborating on analysis of the Top 10 violated standards, and publicly providing these integrated reports to facilitate compliance by providing information and guidance on the most violated standards. This is the fifth report where NERC and the Regional Entity compliance staffs have provided such a report. An addition for this report is the addition of recommendations to revise the standard based on compliance experience. With this addition this document further serves as a formal mechanism to provide feedback to the standards developers.

The ERO's next compliance analysis report is expected to be submitted to the BOTCC in September and cover PER-002. Subsequent to that, will be an analysis of CIP-006 and CIP-007.

Summary of Practical Information and Suggestions

This summary is intended to capture the analysis detailed below, by providing some essential elements of the requirements, and by offering some suggestions for consideration. It is not a complete list of all possible elements or actions. Evaluation or undertaking such actions or suggestions does not guarantee compliance and does not replace the NERC Reliability Standards language. “Suggested Enhancements” are included for informational purposes only.

After a thorough review of violation descriptions and potential impact statements submitted to NERC via the Regional Entities, the following recommendations can be made:

1. Entities need to use their Automatic Voltage Regulators (AVR) in Automatic mode at all times, unless specifically directed by their Transmission Operator. Entities are encouraged to modify systems to generate alarms when AVR mode changes occur. In addition, all attempts should be made to assure that consistent terminology is used between associated GOs and TOPs.
2. Entities need to establish robust communication procedures to ensure that the Transmission Operator is notified of **any and all changes** to elements critical in maintaining Reactive Power and voltage output. Generator Operators (GOPs) are encouraged to monitor and request a revised voltage schedule from their Transmission Operator (TOP) that is more consistent with the actual operating conditions at their site, or when the unit(s) is continually experiencing physical limitations when attempting to maintain the existing voltage schedule. TOPs can provide guidance and assistance to the GOPs in the development of the voltage schedules, in particular where GOPs must take into account their impact on neighboring GOPs and TOPs.
3. Entities need to notify their Transmission Operator within the specified time frame, 30 minutes, when taking the Automatic Voltage Regulator (AVR) offline or transferring the AVR into manual mode. Entities should develop a procedural framework to capture and clarify reporting requirements. In addition, a thorough review of AVR hardware/software systems has proven beneficial for many registered entities.

Analysis of VAR-002 Violations

Background

Since the beginning of the mandatory and enforceable standards on June 18, 2007, VAR-002 has been one of the Top 10 violated standards by registered entities, with it currently being ranked as the eighth all time most frequently violated reliability standard. This standard is of critical importance to the bulk power system (BPS), as it instructs generators to provide reactive and voltage control necessary to ensure that voltage levels, reactive flows, and reactive resources are maintained within applicable Facility Ratings to protect equipment and reliable operation of the Interconnection. Given the serious nature of these violations, NERC has analyzed active and closed violations of this standard looking to define the prevailing trends. As of July 28, 2010, there were 113 active or closed violations of VAR-002, with an additional 28 violations that were dismissed by the Regional Entities. This report focuses on the 113 active or closed violations of all revision levels of this standard. The current FERC-approved standard revision level is 1.1a, which became effective on May 13, 2009.

NERC focused on developing the following metrics of VAR-002:

1. Identifying how many violations were reported for each Region for the time period of June 18, 2007 to the present.
2. The prevailing method of discovery by the Regional Entity for each violation.
3. An analysis of violations by the date of violation to determine if violations were clustered around certain months or years.
4. A trending analysis of how many violations were submitted by month to determine if violation submission levels have reached a steady state, or if they are increasing or decreasing.
5. Key reasons for noncompliance cited by the Regional Entities, classified by a bucket structure that will be further described later in this paper.
6. An analysis of those buckets to determine if the violations contained within still pose a threat to the bulk power system.

The VAR-002 standard has five top level requirements and 10 sublevel requirements, with Violation Risk Factors (VRF) of medium and lower for all requirements. This reliability standard has predominately medium VRFs associated with it, and thus could have an impact on the reliability of the BPS.

NERC, its Members Representative Committee, and many other organizations have indicated a strong interest in examining the implementation of this standard, determining the reasons for the frequent violation of this standard, and identifying corrective actions to improve compliance with this standard, which result in overall better reliability of the BPS. Many of the entities affected are on a six-year audit cycle and may not be subject to an audit in the near term, which could result in continuing high violation levels at a time when the program is expected to be maturing.

Analysis

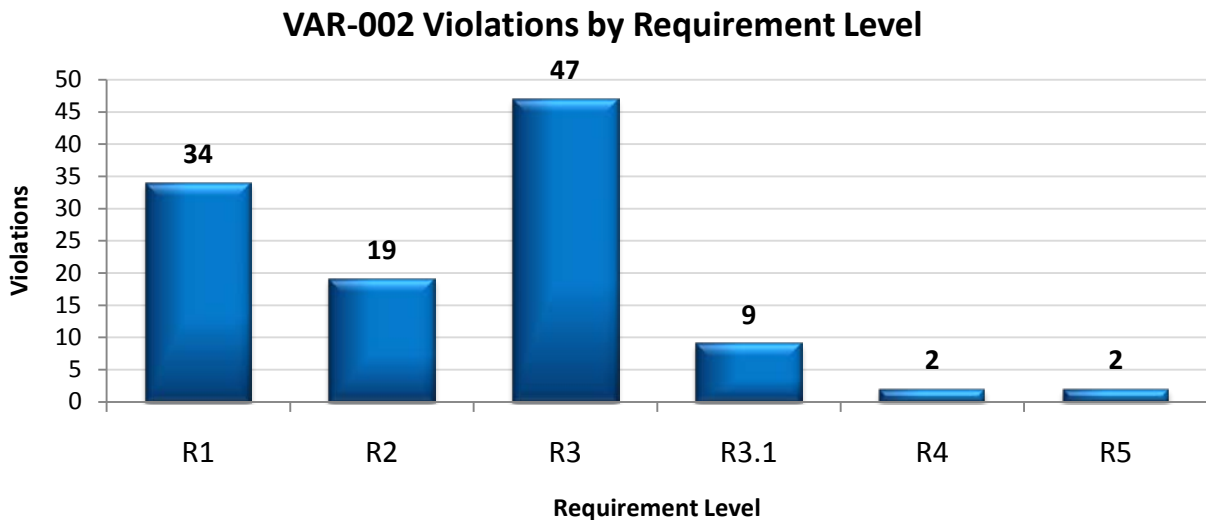
The first way to view the 113 violations of VAR-002 is by the requirement level violated by the registered entity. Table 1 below shows how the 113 violations have been submitted to NERC according to requirement. With the exception of Requirement 3, which concerns notifications of status or capability changes due to equipment, all other violations were filed at the requirement level, not the sub-requirement level.

Table 1

VAR-002 Analysis	Violations	Percentage
R1 – Operate AVR in Automatic Voltage Control Mode	34	30%
R2 – Maintenance of Generator Voltage or Reactive Power output	19	17%
R3 – Notify TOP of Status or Capability Change within 30 minutes	47	41%
R3.1 – Notify TOP of AVR or PSS Status or Capability change within 30 minutes	9	8%
R4 – GO provides TOP with info within 30 days of Request	2	2%
R5 – Make Tap Changes Requested by TOP	2	2%
Totals	113	100%

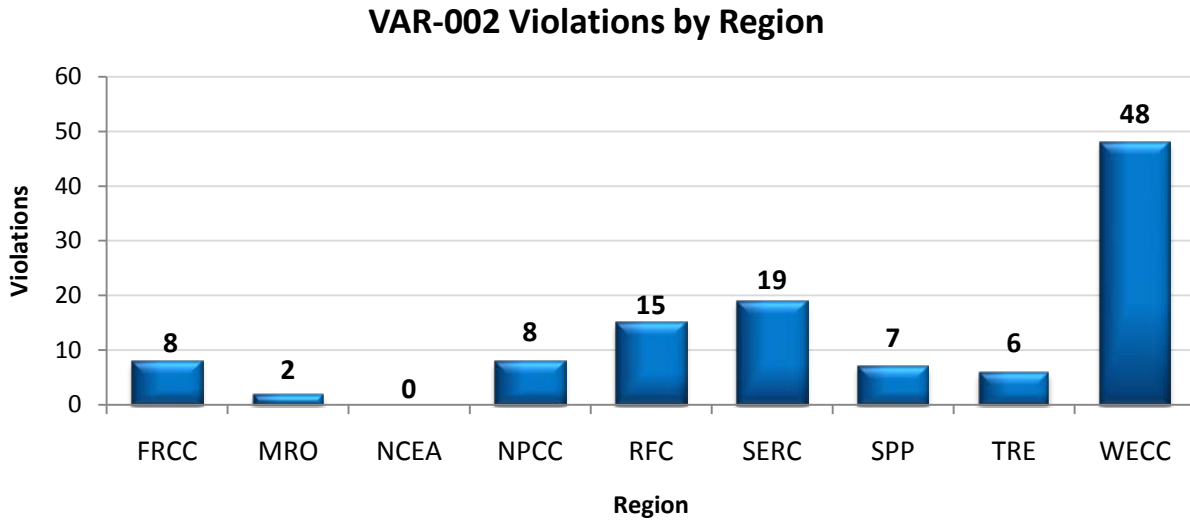
This table shows that a large percentage of violations were reported to NERC at the requirement level, and that these violations were not singularly focused on one specific requirement of VAR-002. A more visual representation of this analysis is shown below in Figure 1.

Figure 1



The second task was identifying how VAR-002 violations were spread across the Regional Entities. Figure 2 below illustrates the result of this process:

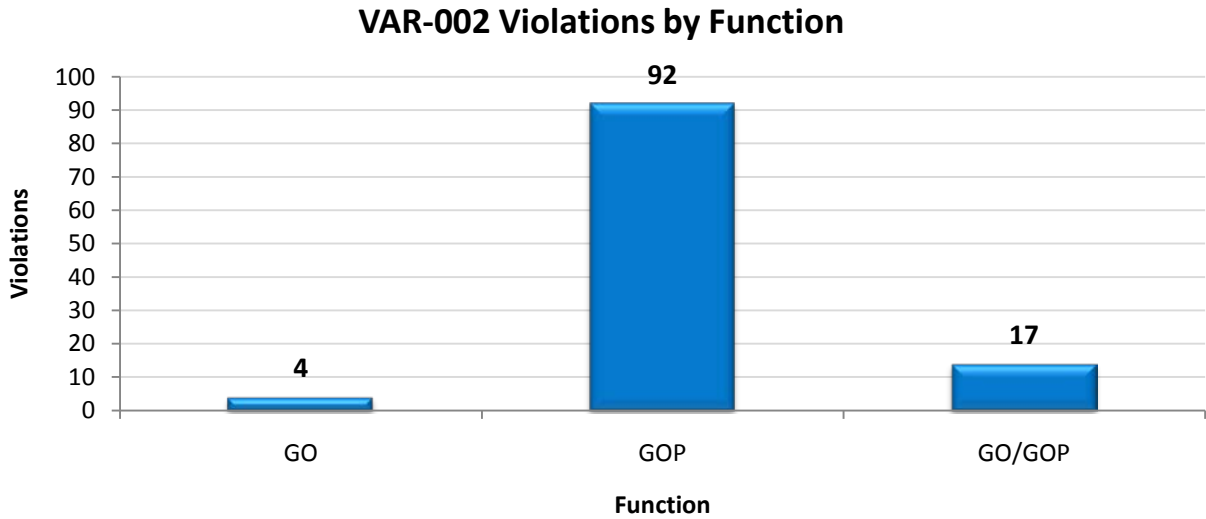
Figure 2



As of July 28, 2010, the WECC region continues to cover the largest geographic footprint of the Regional Entities. In its footprint, from the July 26, 2010 version of the NERC Compliance Registry, WECC monitors the largest number of GO, GOP, or GO/GOP registered entities (241 out of 980 GO, GOP, or GO/GOP total registered entities). However, the results of this analysis show that nearly 43% of the violations reported to NERC occurred in the WECC region, while the WECC region monitors only 24.6% of the total GO, GOP, or GO/GOP registered entities. Nearly 67% of the violations discovered by WECC were through self-reports (32 out of 48), while the other 16 violations were discovered through Compliance Audits (eight violations), exception reports (four violations) and self-certifications (four violations).

Another interesting way to view the VAR-002 violations is by the functional registration of the registered entity. Standard VAR-002 currently applies only to Generator Operators and Generator Owners. The results of this analysis are presented below in Figure 3.

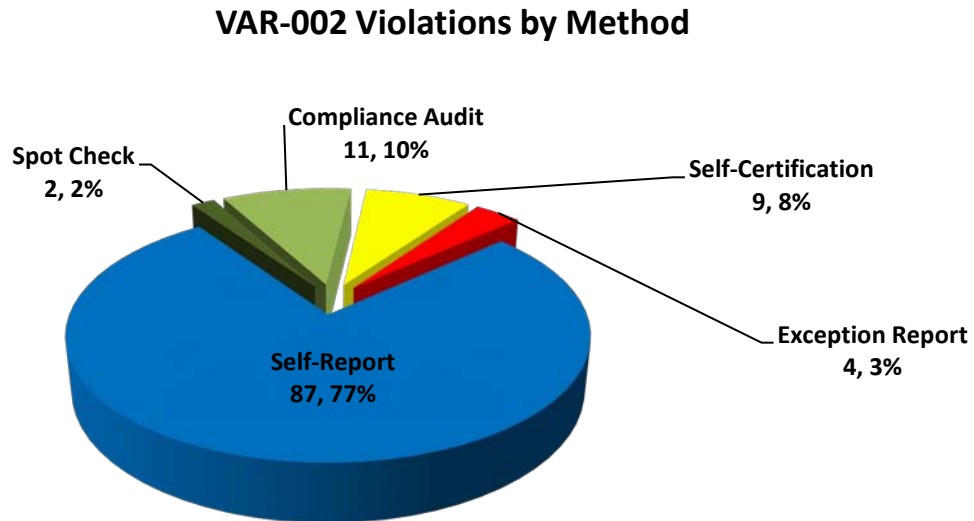
Figure 3



Since this standard focuses on Generator Operation, it is not a surprising result to discover that the violations are clustered towards operators rather than owners of generators.

The next analysis focused on determining the most frequent method of discovery for violations of VAR-002 that were reported to NERC from the Regional Entities. The results of this analysis are shown below in Figure 4.

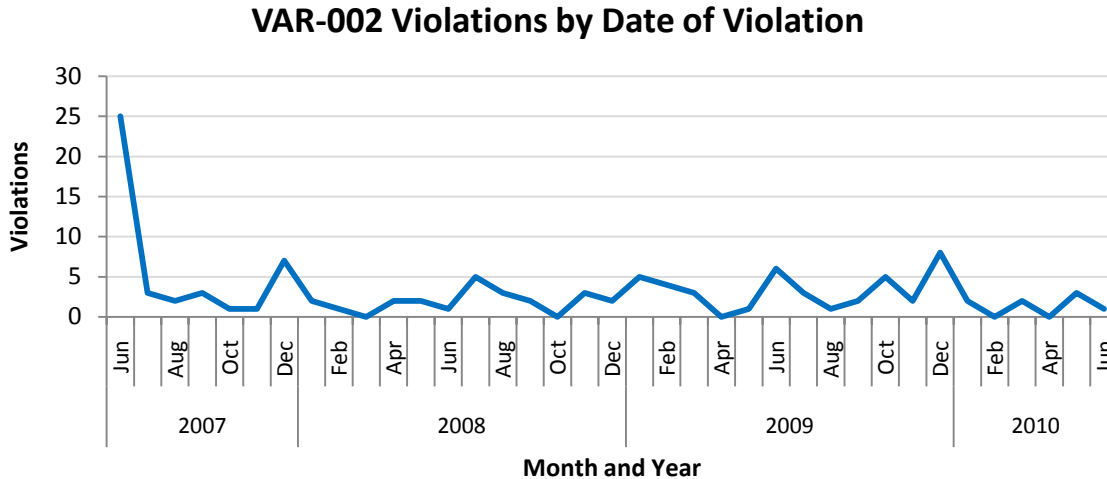
Figure 4



The result of the method of discovery analysis shows that a significant percentage of violations were discovered by the registered entities in the form of self-reporting. Registered entities are encouraged to self-report their violations, as soon as they are found to their respective Regional Entity.

The fifth analysis focused on determining the clustering effects of violations when analyzed by the date the violation occurred. Figure 5 below shows that a significant number of violations have a violation date clustered around June 2007. This is not an unexpected result with the initial wave of self-reported violations and as audits, self-certifications, and spot checks would identify Possible Violations that have not been self-reported and subsequently corrected or mitigated.

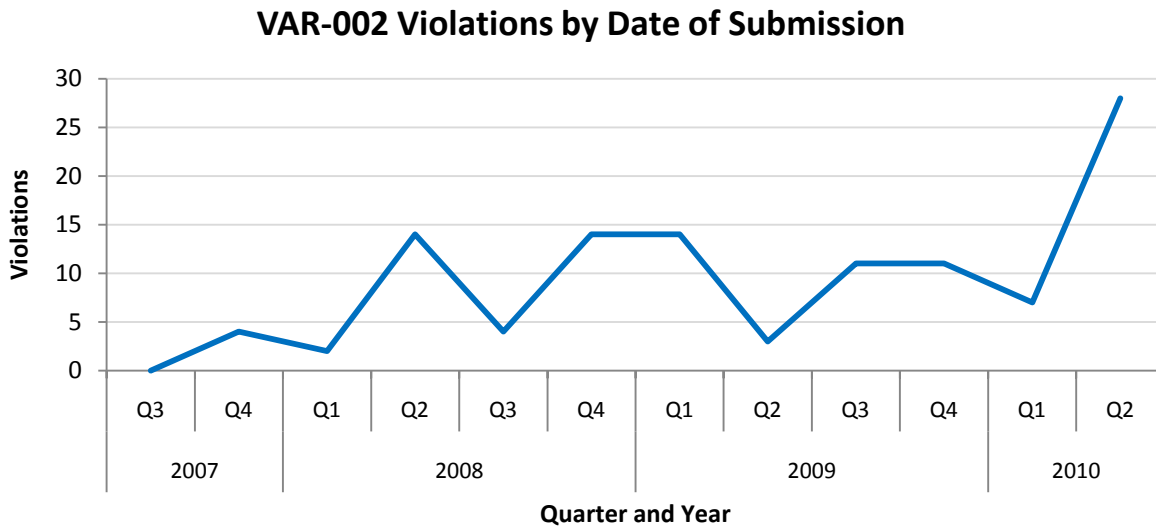
Figure 5



There are two significant spikes in violations totals that should be examined in further detail: December 2007 and December 2009. December 2007’s seven violations (rising above the trend of two to three violations per month), can be attributed to four violations coming from self-certifications, two violations were self-reported, and one violation was submitted via an exception report. December 2009’s eight violations, can be attributed to seven violations coming in the form of self-reports, with the last violation being in the form of exception reporting.

While there is some clustering of violations by the Date of Violation analysis, there is no discernable pattern when viewing the violations by their submission date to NERC, as Figure 6 shows.

Figure 6



The area of note is the spike during April and May of the second quarter in 2010. With a steady, fairly consistent number of violation submissions for the past three years, this spike is an outlier. This spike can be attributed to the NERC Lesson Learned published June 23, 2010, which is attached at the end of this report. The technical document mentioned in the NERC Lesson Learned contains erroneous information from the manufacturer concerning the indicators for the AVR.¹ The good news is that the industry appears to be paying attention to the NERC Lessons Learned and adjusting their compliance accordingly.

The only region not to submit a violation was NPCC, while WECC submitted nine, FRCC submitted six, and RFC submitted five. Of the 28 violations submitted during this quarter, 15 of them were self-reported, while eight of them were attributed to Compliance Audits, four to exception reporting, and one to a spot check.

Figure 5 and Figure 6 vary from each other because Regional Entities are required to identify the actual occurrence of a violation and such date may not be the date the violation was discovered. While Regional Entities may have only recently found or discovered a violation, the violation could have existed in the bulk power system for a significant period of time before discovery. This is the reason why Figure 5 and Figure 6 show different amounts of violations found and reported for each month.

Noncompliance Analysis

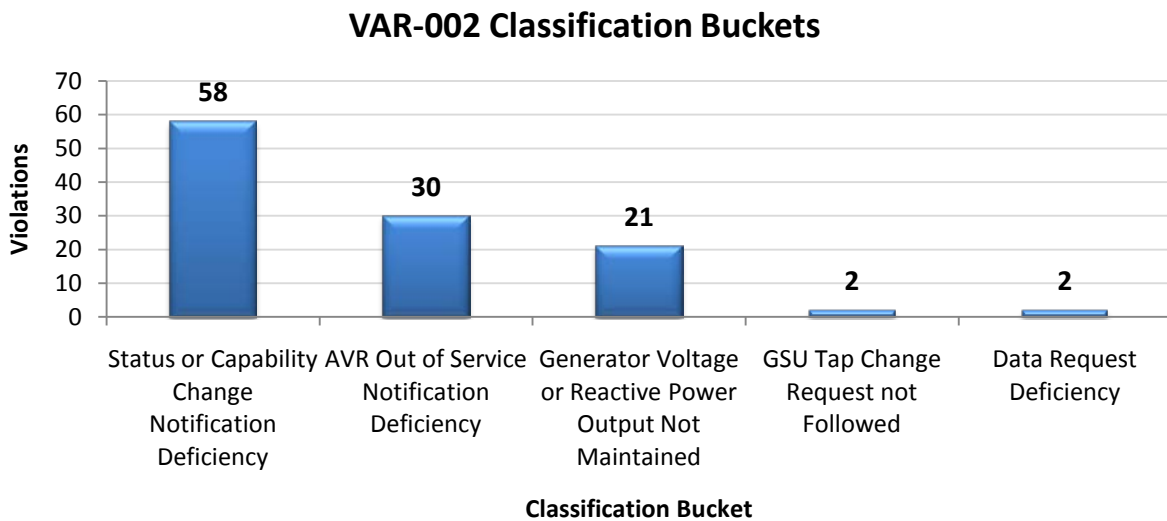
There are many forms of noncompliance by registered entities, from documentation issues to performance-related issues. NERC classified the 113 violations of VAR-002 by five different types of classifications given the information provided in the Violation Description and Potential Impact fields of the Regional Workbook submissions to NERC. The classifications are:

¹ GE Energy. *Technical Information Letter: Modification of HMI Screens – NERC Reliability Standard VAR-002-1*, 22 February 2010.

1. **AVR Out of Service Notification Deficiency** – Automatic Voltage Regulator taken out of service without appropriate notification to Transmission Operator.
2. **Generator Voltage or Reactive Power Output Not Maintained** – Generator voltage or Reactive Power output that deviates from Transmission Operator request.
3. **Status or Capability Change Notification Deficiency** – Status or Capability change on Automatic Voltage Regulator or Power System Stabilizer (R1) or other devices (R2) without proper notification to transmission operator.
4. **Data Request Deficiency** – Generator Operator cannot provide data to its Transmission Operator within 30 calendar days.
5. **GSU Tap Change Request Not Followed** – Generator Step-Up Tap change request from Transmission Operator is not followed by Generator Operator.

Figure 7 represents the results of this basic classification structure.

Figure 7



The results of this analysis show that most violations fall into one of three categories, and when Table 1 is taken into account, this result is not unexpected, as there was only one report of a Requirement 4 violation and one report of a Requirement 5 violation. The most prevalent trend was that a few R1 violations appeared to be Status or Capability Change Notification Deficiency violations, while a few R3 violations appeared to be AVR Out-of-Service Notification Deficiency violations based on the violation description and potential impact fields provided by the Regional Entities.

On closer examination, the Status or Capability Change notification deficiency classification bucket contains 58 violations, 48 of which were discovered through self-reports to the Regional Entity, with the other 10 violations split between self-certifications (2), exception reporting (4) and compliance audits (4).

Examination of the AVR Out-of-Service notification deficiency classification bucket, shows that out of the 30 violations reported, 25 were discovered through self-reports, with the other

violations being discovered through self-certifications (3), a spot check (1) and a Compliance Audit (1). The WECC region had the largest number of violations classified in this bucket (10 out of 30, 33%).

The third largest classification, Generator Voltage or Reactive Power Output Not Maintained, is comprised of violations that were self-reported to the Regional Entity (12 out of 21, 57%), with other forms of discovery accounting for the remaining percentage: self-certification (4 out of 21, 19%), spot check (1 out of 21, 5%), and Compliance Audit (4 out of 21, 19%). The largest number of these violations were reported in the WECC region (10 out of 21, 48%), with FRCC, MRO, and NPCC not reporting violations under this classification bucket.

Regional Entity Analysis

In addition to the Regional Entity contributions identified throughout the document, the following specific items warrant further discussion, with a summary of practical compliance information and suggestions provided at the end of this assessment.

Summary Info and Discussion

Most violations of VAR-002 are related to Requirements 1, 2 and 3. As in any dynamic complex process requiring constant monitoring and coordination, communication cannot be overemphasized. For the TOP this is clearly a significant effort, but GOPs can support the TOPs with improved monitoring and communication procedures followed by clear, concise and precise communication with the TOP.

Key Reasons for Noncompliance

The following information is organized by requirement. For each, typical facts surrounding violations are noted and suggestions for improvement are offered, based on the experience to date, of Regional compliance staff.

After reviewing the results of the information gathered, the following key reasons were identified by the RCIG as the primary reasons that registered entities were found to be noncompliant with VAR-002:

Common Violation Descriptions for Frequently Violated Requirements

1. Failure to operate each generator that is connected to the interconnected transmission system in the automatic voltage control mode.

R1. The Generator Operator 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.

A significant reason for violations was that GOPs were not operating their units in the automatic voltage control mode. This is considered a violation of VAR-002, Requirement 1. These results can be attributed to:

- a. The unit operator's lack of awareness possibly caused by defective or inoperative alarming sensors which results in no warning or alarm being generated when unit transfers out of AVR control;
- b. Control - labeling that is confusing, misleading, or wrong that has resulted in operators' mistaken belief that the unit is in AVR mode when in fact the unit is in Power Factor mode or not on at all.

Additionally, there were some cases documented where generating plants were operating their respective AVR in the NERC preferred mode of operation in voltage set point control instead of the mode that was communicated to them by the Transmission Operator as required by the standard. NERC staff issued an alert concerning labeling which can be found at:

<http://www.nerc.com/files/LL-Control-Labeling-Generator-Voltage-Regulators-0610.pdf>

Suggested Enhancements

- Those entities that have not already taken steps to modify systems to generate alarms when AVR mode changes occur are encouraged to do so. Plant/unit operators, as part of their normal daily duties, should be required to regularly check and/or document the status of the AVR and generator metered values (MW, MVAR, voltage, system and unit). The minimum recommended frequency of these checks should be at least every four hours. Shift turnover should include reporting the status of the AVR and logging all the metered values. In addition, entities which have not already added labeling to the controls to clarify the proper settings and provide notice that the TOP must be notified before and after any change in status should strive to do so. The plant/unit operators should be provided adequate training on any unusual labeling or designations of any generator controls. Signs/labels should be placed near the AVR controls which state that any status changes should be reported to the TOP. For AVRs controlled through screen displays, the control technicians should add this same type of message to the AVR display. In addition, all attempts should be made to assure that consistent terminology is used by the GO and the TOP and that each entity is aware of this consistent terminology.

2. Failure to maintain the generator voltage schedule or Reactive Power output as directed by the TOP.

R2. Unless exempted by the Transmission Operator, each Generator Operator shall maintain the generator voltage or Reactive Power output (within applicable Facility Ratings¹) as directed by the Transmission Operator.

Due to some narrow voltage schedule tolerances provided to the GOPs, especially those that may be operating in areas where system voltages may tend to frequently change (e.g. high or low) due to the dynamics of the system, the GOP in order to comply with the standard, must constantly monitor and adjust generator voltage or risk the possibly of violating the voltage schedule per Requirement 2. Another violation of this requirement occurs during the period when the plant/unit is considered in startup mode and/or any period when the unit is not stable. In order to adhere to the standard, GOPs are required to notify the TOP of the units' inability to maintain the voltage schedule as directed by the TOP until the unit is on-line, stable, or released for dispatch.

Suggested Enhancements

- The GOPs should safeguard against this type of violation by monitoring and requesting a revised voltage schedule from the TOP that is more consistent with the actual operating conditions at their site or when the unit(s) is continually experiencing physical limitations when attempting to maintain the existing voltage schedule. When the GOP is issued a voltage schedule, it should ensure that it is physically capable of meeting the schedule, or it should negotiate a more reasonable schedule, based upon the physical limitations of their unit/plant. The GOP might also request that the TOP define the allowable time period or voltage level when the voltage schedule would be considered violated (for example, instantaneous voltage values above the upper threshold or voltage averages over a specified time period). This would allow the operator time to make the necessary adjustments and still maintain the agreed- upon voltage schedule.
 - For some generator installations, the voltage schedule may be unattainable due to normally high system voltages in conjunction with an inherent deficiency of the generator leading reactive capability. Here again, the GOPs should guard against this type of violation by monitoring and requesting a revised voltage schedule from the TOP that is more consistent with the actual operating conditions at their site, and/or when the unit(s) is continually experiencing physical limitations when attempting to maintain the existing voltage schedule. If the generating plant/unit is interconnected near two neighboring TOPs, the TOPs should consider a coordinated and agreed-upon voltage schedule by taking into account the impact of the neighbor TOP/GOP prior to issuing the GOP a voltage schedule that will require the GOP to constantly chase the voltage. In some situations, the TO may also need to be involved in this process to help better define customer needs.
- 3. Failure to notify TOP within 30 minutes of a status or capability change of generator or other Reactive Power resource.**

R3. Each Generator Operator shall notify its associated Transmission Operator as soon as practical, but within 30 minutes:

- a. This appears to be the most prevalent reason for violations of standard VAR-002. The standard's requirement three (VAR-002-1, R3) is very clear in requiring that the GOP's notification to the TOP be made within 30 minutes of any change in status or capability regarding generator or any other Reactive Power resource. There seems to be multiple reasons for an entity violating this requirement. Below is a summary of those reasons that have been recorded to date:
 - i. the responsible reporting entity (e.g. GOP) not reporting the change in status;
 - ii. seeming confusion over whether the Reactive Power resource changing from automatic to manual requires the TOP to be notified; and
 - iii. failure to make the notification within the prescribed 30 minute time frame.

NOTE: Although the notification may occur after the AVR has been restored (e.g. for an AVR trip that lasted less than 30 minutes), this notification still needs to take place to ensure compliance to the standard.

- b. In general there seems to be an overall lack of procedural awareness by the responsible reporting entity regarding its obligation under this requirement to make proper notifications. This lack of awareness seems to be related to:
 - i. not knowing that any change in status has occurred;
 - ii. uncertainty that a pre-planned change in AVR status for the purpose of system testing or maintenance requires notification to the TOP. For example, power system stabilizers have been left in the "off" mode after maintenance and the TOP was not notified within 30 minutes of the status change. Instead, the change was not noticed for several days, but was corrected just before the stabilizer was to go online;
 - iii. not knowing who the appropriate party is that is required to be notified;
 - iv. the time limit provided in the standard within which the TOP is required to be notified; and
 - v. the types of unit limitations that constitute a status or capability change (i.e. unit reactive limits being reached, auxiliary bus voltage limits being reached, etc.) that would prohibit the unit(s) to perform beyond their current operating position.
- c. Regarding R3.1, status relates specifically to the AVR and PSS mode of operation, whereas capability refers to the generator's ability to function as a Reactive Power resource. This is not the capability of the AVR to maintain a voltage or a Reactive Power schedule. If a decrease in generator cooling occurred due to high cooling water temperatures, loss of a generator hydrogen cooler, and/or low generator gas pressure (hydrogen or air), then the TOP would need to be notified of the change in capability, i.e., reduction in MVAR capacity. In this case, the AVR and PSS may be fully functional.

Suggested Enhancements

- Registered entities should create a procedural framework that clarifies the reporting requirements and assists in the assurance of compliance, including:
 - a. well documented written instructions, procedures, and protocols;
 - b. adequate training for all appropriate personnel;
 - c. clear identification of responsible personnel and parties to be notified;
 - d. create AVR status date/time/notification tracking tool;
 - e. assign AVR notification single point accountability to appropriate management level; and
 - f. clearly identify all items that would constitute a unit's status or capability change including all items that would prohibit the unit's ability to perform beyond its current operating level/position.

- Conduct a thorough review of AVR hardware/software systems including:
 - a. The assurance that alarming sensors/systems are operable in all expected conditions. Alarming systems should not be the only key for operator awareness, since they can fail. Better education and training that would also help improve operator diligence to regularly monitor the generator metering/controls;
 - b. the verification, with or by manufacturer or vendor, of proper operation of equipment. Avoid the mistaken belief that the AVR is in Voltage Control Mode while unit is in fact in Power Factor Mode, VAR Mode, or No Control Mode;
 - c. verify and check to ensure that clarification of the labeling on all controls, switches, and displays is in place;
 - d. where possible, develop and implement visual and audible alarms, through EMS applications, from the generator to the Transmission Operator indicating the status of AVR; and
 - e. ensure that operators are properly trained in AVR/power factor operations.
- 4. Communications with the TOP was not documented as it related to the operation of the AVR.**

R4. The Generator Owner shall provide the following to its associated Transmission Operator and Transmission Planner within 30 calendar days of a request.

In some cases, where the responsible entity was aware of the requirements of the reliability standard, it failed to properly collect and document the evidence that would be needed to demonstrate compliance to the standard.

Suggested Enhancements

- This situation can be addressed by further emphasizing the requirements and responsibilities of the responsible entity, clearly explaining the requirements in such places as the operator's guidance documents and procedures and the RSAWs associated with the reliability standard and recommending enhanced training for responsible personnel that clearly identifies the functional responsibility of each of the registered entities.

Recommendations to Revise the Reliability Standard

Based on the experience gained from monitoring and enforcing this standard, the following recommendations will be provided to the NERC Standards Department to consider revisions to make the standard more clear and understandable. This would assist entities in complying with the standard and Regions in applying the standard.

1. Recommendations for Requirement 2:

- a. The SDT may want to consider whether the standard would benefit from including an exemption for periods after the generating unit is synchronized, in the startup process but not yet released for dispatch. Other exemptions may include:
 - i. periods when the generating unit is not stable,
 - ii. when a plant/unit has been dispatched under a directive by the RC, TOP or BA for the reliability of the bulk power system, or
 - iii. when the AVR is operating in Manual, Power Factor or VAR mode.
- b. When a GOP is unable to meet an agreed-upon voltage schedule and notifies the TOP, the GOP should request that the TOP take other controlling actions to adjust system voltage. This could be accomplished by contacting nearby generators, especially those connected at the same voltage level to allow all the units to maintain their agreed-upon voltage schedule. We recommend a requirement that if the system voltage is above the expected voltage schedule prior to generator synchronization, and the unit is unable to lower the voltage, the GOP should inform the TOP of the existing conditions and request an exemption.
- c. Another point of clarification needed in the standard is related to the following statement:

In most cases the Transmission Operator provides a voltage schedule for the generator to follow that includes a “deadband” range. A voltage schedule may be set to keep the voltage between 115 kV – 117 kV for all hours. A review of the standard’s measures section, the levels-of-noncompliance section, and the VSLs matrix show that a single instance of being outside the “deadband” or tolerance could be a violation, even if only for a moment. This can be a real challenge for smaller generators and in some case nuclear units, if the Transmission Operator has established too tight a “deadband.”

2. Recommendations for Requirement 3:

The industry and NERC should review the reliability standard, for the purposes of improving consistency and clarity, particularly:

- a. assuring that the 30 minute reporting requirement in the standard is truly necessary and implementable;
- b. adding a provision for responding to automatic switching to a non-voltage-control mode;
- c. allowing for short periods of time to place AVR in manual mode to correct a problem (switching to manual for less than 30 minutes should not be reportable);
- d. preventing the possible “double counting ” that could exist between Requirement 1 and Requirement 3, and Requirement 2 and Requirement 3 in the reliability standard; and
- e. reviewing the appropriateness of the current VSL designations.

Conclusion

The purpose of VAR-002 is to ensure generators provide Reactive Power and the voltage control necessary for voltage levels, Reactive Power flows, and reactive resources are maintained within applicable Facility Ratings to protect equipment and the reliable operation of the Interconnection. While registered entities have made significant strides in improving communication about changing equipment modes or taking services offline, this standard is still ranked as one the Top 10 most frequently violated reliability standards. NERC and the Regional Entities must remain vigilant in enforcing compliance with this standard to maintain the reliable operation of each Interconnection within the United States, Canada, and Mexico.

Compliance to the VAR-002 reliability standard is important to maintaining bulk power system reliability. It is imperative that clear information is provided by NERC and the Regional Entities to assure that the registered entities have the best opportunity to understand how they can effectively meet the standard. The technical requirements of the reliability standard should be explained by NERC and the Regional Entities as clearly as possible.

Finally, as the CMEP matures and registered entities, particularly those who have had little experience with formal compliance programs, become more familiar with the program, it is expected that compliance to the VAR-002 reliability standard will improve as long as the registered entities, NERC, and the Regional Entities are rigorous in their pursuit of an effective compliance program and the requirements clearly identify what is expected of the registered entities.

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Lesson Learned

Control Labeling of Generator Voltage Regulators

Primary Interest Groups

Generator Operators
Generator Owners

Problem Statement

A generator operator (GOP) discovered a certain manufacturer's generator automatic voltage regulators (AVRs) had been continuously operating in a constant Reactive Power output control mode instead of automatic voltage control mode (as desired) due to confusing control system labeling.

Details

During a routine review of standard operating procedures, the GOP noticed the voltage regulator on a generator appeared to be operating in a constant Reactive Power output mode (labeled "VAR" on the AVR control system) instead of automatic voltage control mode. Subsequently, the GOP confirmed that other entities with the same control system were operating in the same manner.

After further review, the GOP determined the labeling of the control modes was confusing on the AVR mode control screen. The voltage control screen had only three (3) modes of control: "OFF", "PF" (constant power factor), or "VAR" (constant Reactive Power output). During commissioning, technicians were trained by the manufacturer to operate in "VAR" mode. The technicians understood this to mean the units were operating in automatic voltage control when in "VAR" mode.

As a follow up to these concerns, the entity checked with the manufacturer and learned that in order to have the voltage regulator operate in automatic voltage control mode, the voltage control screen should be set to the position which was labeled the "OFF" position.

Corrective Actions

The entity removed the word "OFF" from the control panel and replaced it with "Voltage Control" to avoid confusion. The entity, in concert with the manufacturer, verified the units now operate in the automatic voltage control mode when that function has been selected on the control panel. Further, the manufacturer issued a technical information letter describing the corrective actions to be taken.

Lesson Learned

GOPs and GOs should review all manufacturer's technical information letters and verify the generator control systems are set in the correct mode for automatic voltage control operation. Generator equipment should be checked to make sure it is operating in the automatic voltage control mode. Incorrect labeling should be corrected as soon as possible. These generating units shall not be operated in other control modes (e.g., constant power factor control) unless authorized to do so by the host Balancing Area/Transmission Operator. The control mode of generating units shall be accurately represented in operating studies. Training for GOP and GO staff should clearly explain the meaning of each control mode as labeled on the voltage control screen. All user manuals and operator procedures should be modified to accurately describe the different modes and correct labeling.

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This document is designed to convey lessons learned from NERC's various activities. It is not intended to establish new requirements under NERC's Reliability Standards or to modify the requirements in any existing reliability standards. Compliance will continue to be determined based on language in the NERC Reliability Standards as they may be amended from time to time. Implementation of this lesson learned is not a substitute for compliance with requirements in NERC's Reliability Standards.