

# NERC

NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

## Compliance Analysis Report Reliability Standard PRC-005-1—System Protection Maintenance and Testing

to ensure  
the reliability of the  
bulk power system

August 31, 2009

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# Analysis of PRC-005-1 Violations

## 1. Background

Since the beginning of the mandatory and enforceable standards on June 18, 2007, PRC-005-1 has been one of the standards reported to be most frequently violated by Registered Entities, and it has a critical impact on the bulk electric system. Many system events analyzed have some element of protection system problems involved in as causal or contributing to the event. Given the serious nature of these protection-based violations, NERC and the Regional Entities analyzed active and closed violations of this standard looking to define trends. As of July 22, 2009, there are 360 active and closed violations of PRC-005-1, with an additional 57 violations that were dismissed by the Regions. This report will focus on the 360 active and closed violations. A separate white paper developed by the Regional Entities at the request of the BOTCC was a key component of the analysis.

NERC focused on developing the following metrics:

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

## 2. Analysis

The first way to view the 360 violations of PRC-005-1 is by requirement level violated by the Registered Entity. Table 1 below shows how the 360 violations have been submitted to NERC according to requirement.

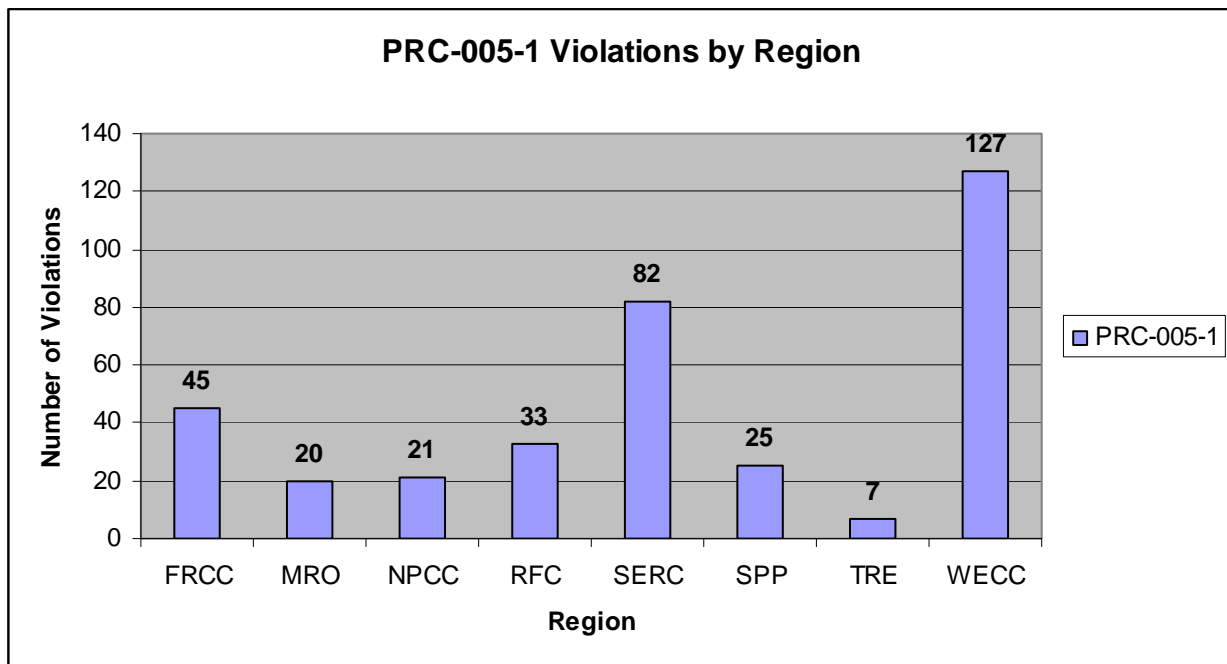
**Table 1**

<b>PRC-005-1 Analysis</b>	<b>Violations</b>	<b>Percentage</b>
R1 – Maintenance and Testing program	156	43 %
R1.1 – Maintenance and Testing Intervals	3	< 1 %
R1.2 – Maintenance and Testing Procedures	2	< 1 %
R2 – Documentation Provided on Request	129	36 %
R2.1 – Evidence of Testing within Intervals	68	19 %
R2.2 – Date of last test / maintenance op	2	< 1%
<b>Grand Total</b>	<b>360</b>	<b>100%</b>

This table shows that large percentages (nearly 80 percent) of violations have been reported by the Regional Entities to NERC at the requirement level, and that these violations were not singularly focused on one specific requirement of PRC-005-1.

The second task was identifying how PRC-005-1 violations were spread across the Regional Entities. Figure 1 below illustrates the result of this process:

**Figure 1**



With the WECC Region covering not only the largest geographical area, but also monitoring the largest number of Registered Entities (467 out of 1,834 total Registered Entities), finding the largest number of reported violations occurring in the WECC region is not surprising.

Another way to view the PRC-005-1 violations is by the registered functions of the entities that committed the violations. Standard PRC-005-1 applies to Transmission Owners, Generator Owners, and Distribution Providers that own a Transmission Protection System. The results of this analysis are shown below in Figure 2. Since most entities are registered by the Regional Entities and NERC under multiple functions, the following graph will sum to more than the 360 total violations that this report is covering.

The registered function data reported across the Regions was inconsistent, as different Regional Entities reported the data to NERC in different patterns. Some Regional Entities reported only the registered functions that an entity violated, while other Regional Entities reported every registered function of an entity when reporting a violation. This leads to a lack in overall confidence of the numbers presented by registered function in the figure below.

Figure 2

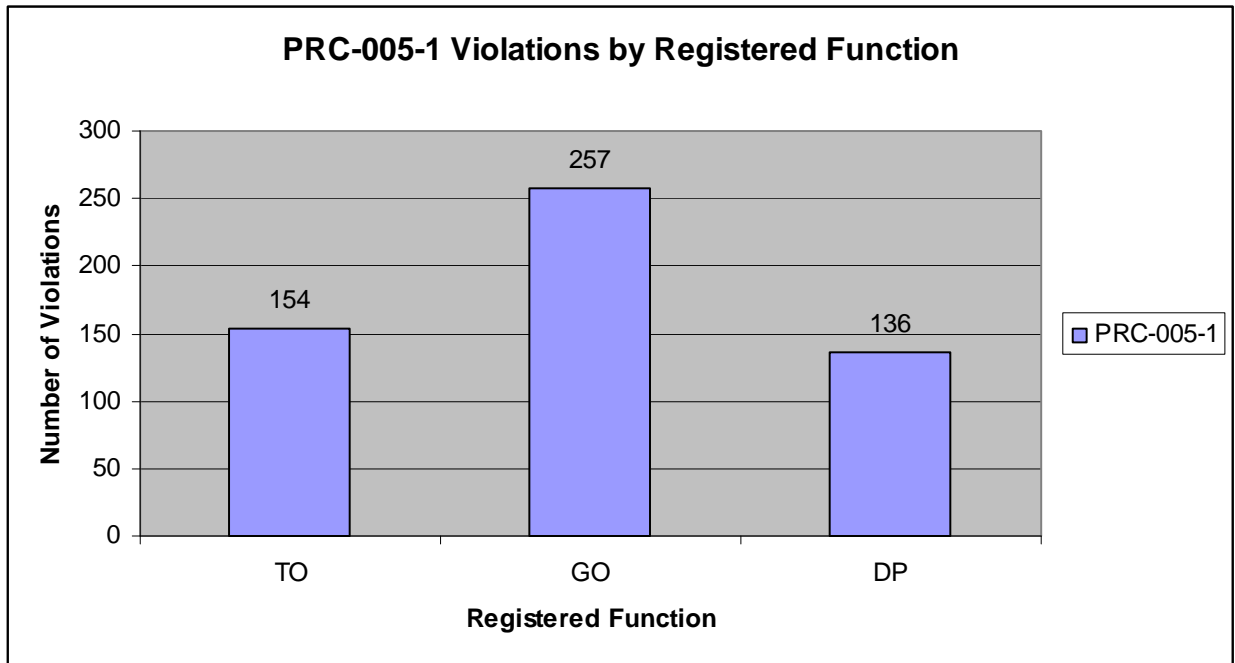
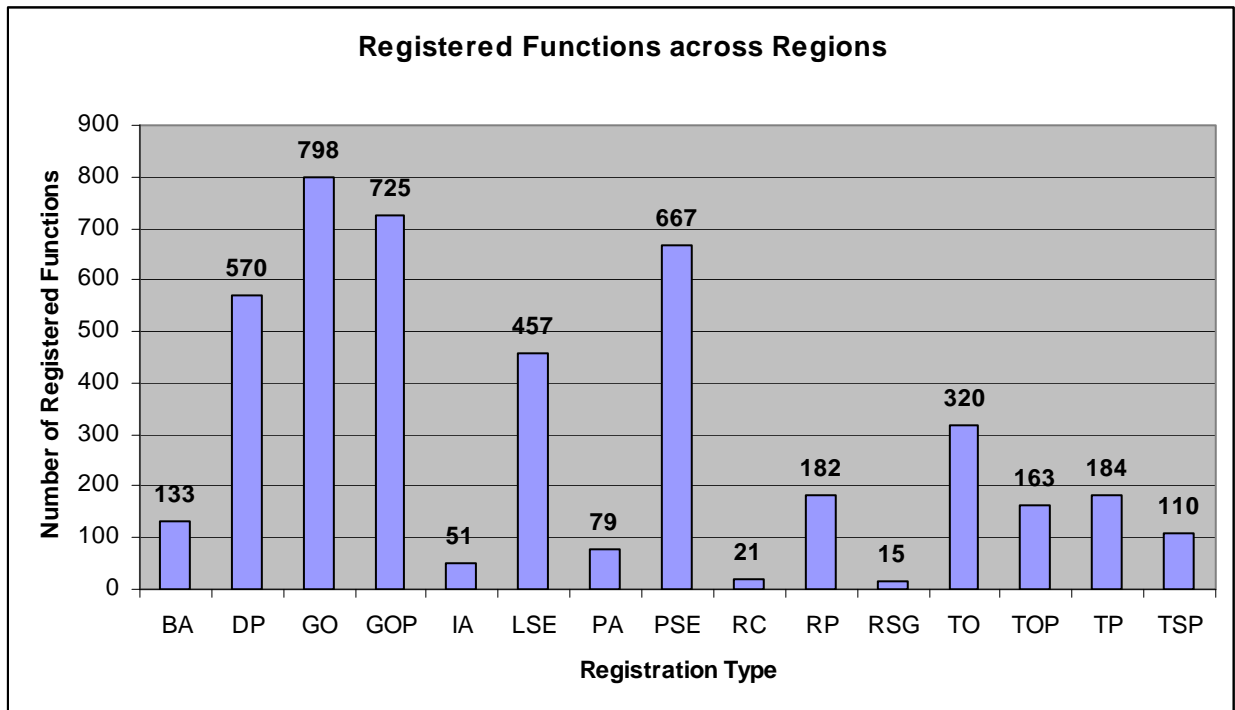


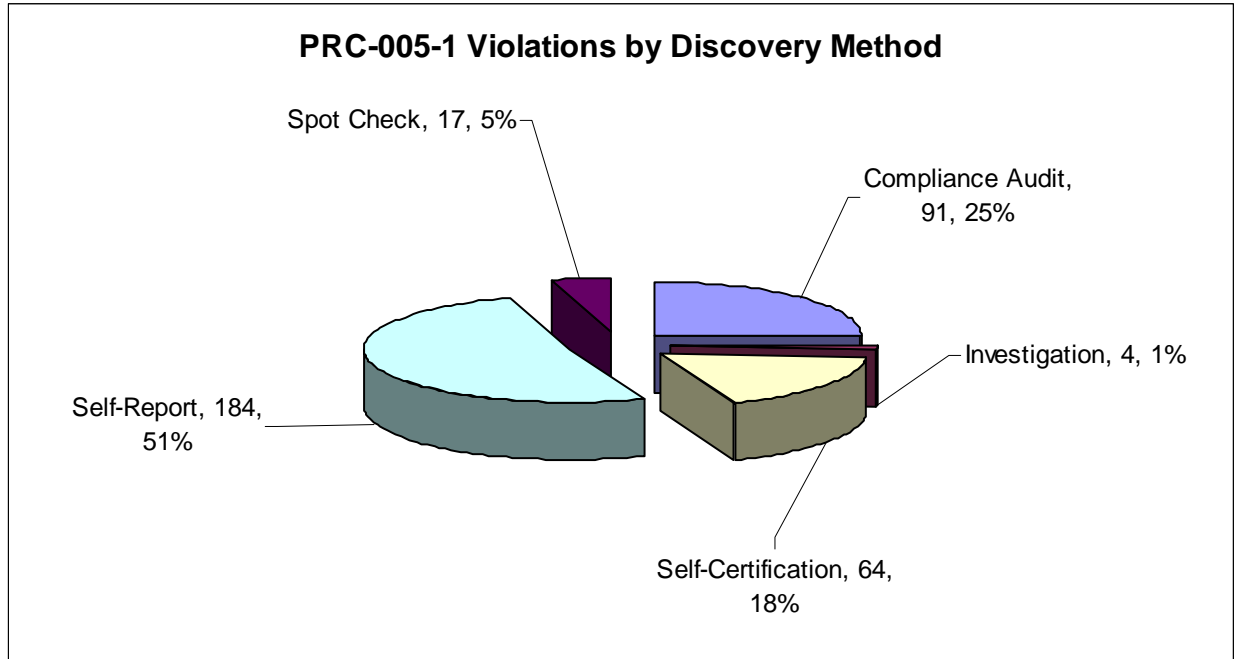
Figure 3 shows the total number of registered functions across the Regions that are currently listed as active in the NERC Registration database.

Figure 3



The most prevalent method of discovery for the 360 active and closed violations is through self-reports submitted to the Regional Entities. Figure 4 below graphically demonstrates the distribution of the methods of discovery for the 360 violations across the Regional Entities.

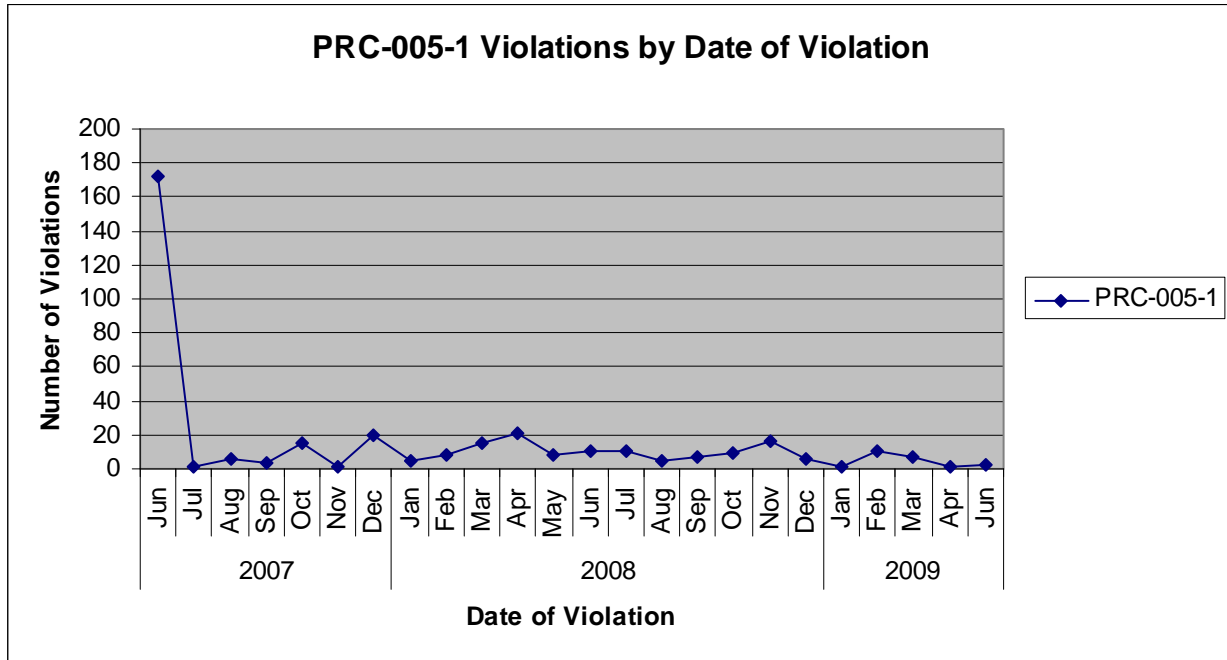
**Figure 4**



The results of the method of discovery are to be expected, as Registered Entities are encouraged to self-report their violations, even if those violations are dismissed at a later date by the Regional Entity.

Figure 5 shows how a significant number of violations have a violation date clustered around June 2007. This is not unexpected with the initial wave of self-reported violations and as audits, investigations, and self-certifications would identify potential violations that have not been self-reported and subsequently corrected or mitigated.

Figure 5



Violations for this standard drop off precipitously after June 2007. However, a more steady number of violations may be emerging. The chart reveals some ongoing level of violations with no month exceeding more than 21 violations of this standard.

While there is clustering of the violations by date of the violation, there is no discernable pattern when viewing the violations by their submission date to NERC, as the following chart demonstrates.

Figure 6

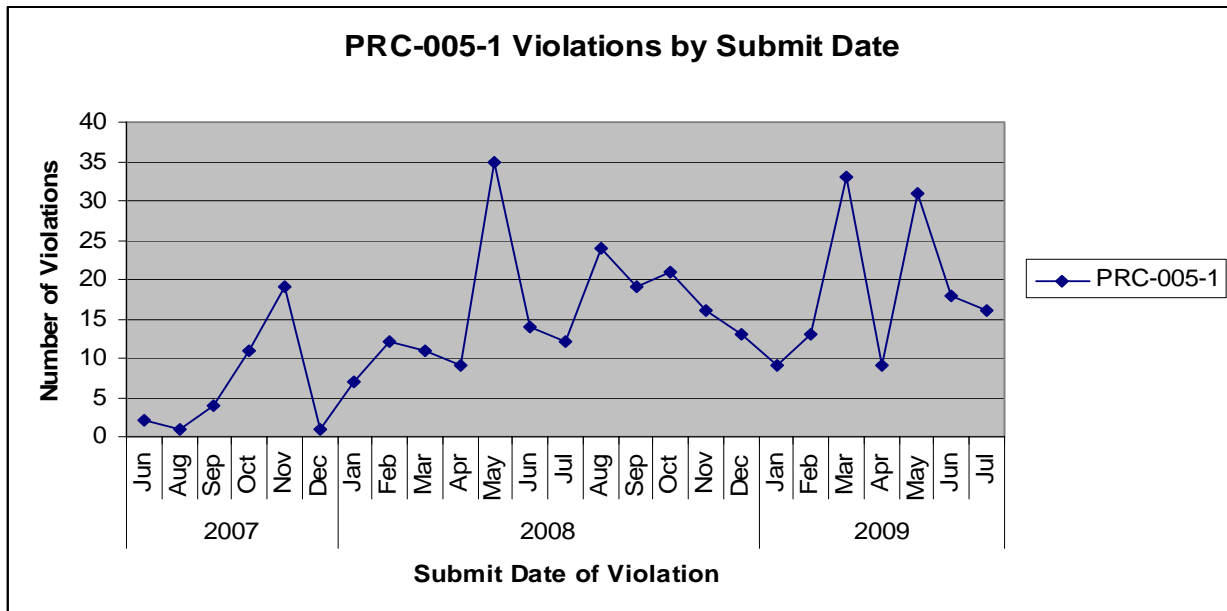


Figure 5 and Figure 6 vary from each other because Regional Entities are required to identify the actual occurrence of a violation and such date may not be the date the violation was discovered. While Regional Entities may have only recently found or discovered a violation, the violation could have existed in the bulk electric 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.

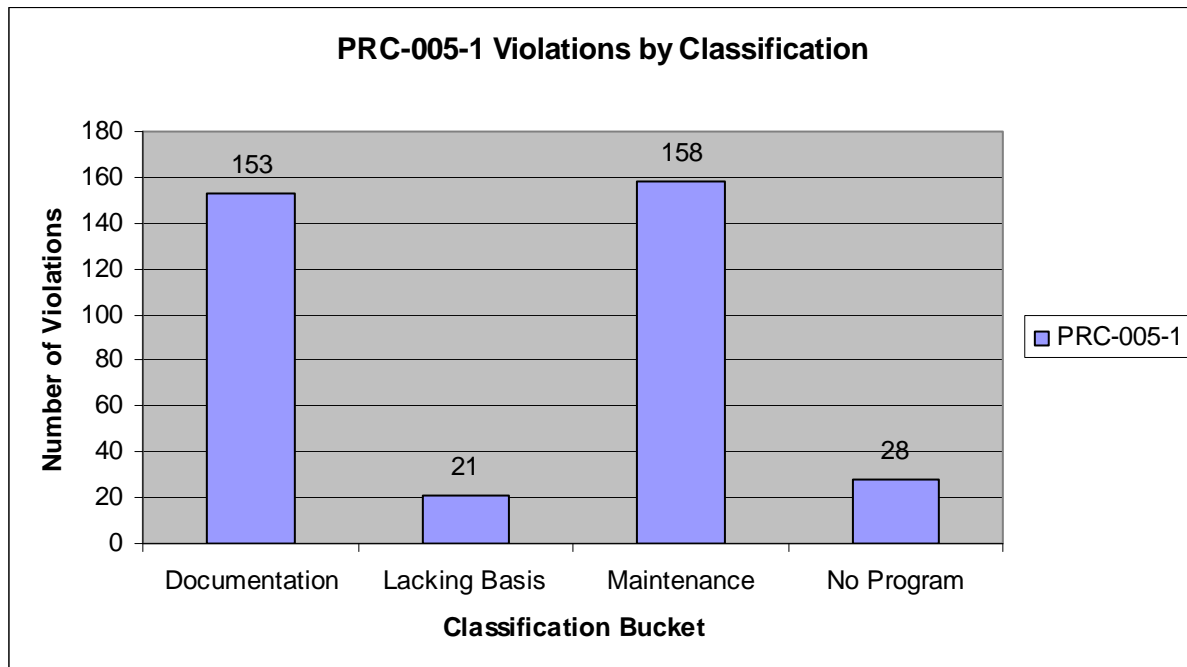
### 3. Non-Compliance Analysis

There are many forms of non-compliance by Registered Entities, from documentation issues to performance related-issues. NERC classified the 360 violations of PRC-005-1 by four different types of violations given the information provided in the Violation Description and Potential Impact fields of the Regional workbook submissions to NERC. The classifications are:

1. *Documentation* – a lack of records to demonstrate compliance with the standard where the Regional Entity could determine maintenance was being performed;
2. *Maintenance* – failure to perform maintenance and testing in prescribed intervals;
3. *Lacking Basis* – no basis to determine the appropriate testing intervals; and
4. *No Program* – no maintenance or testing program exists, no documentation, and no testing of elements in a prescribed manner.

The following figure represents the results of this basic classification structure.

**Figure 7**



The classification of violations with the greatest reliability impact are those where no system protection system maintenance program exists shown as “No Program” on the chart for the 28 PRC-005-1 violations. To gauge the risk to the reliability of the bulk electric system, NERC

analyzed the functions reporting “No Program”. The most prevalent registered function of the “No Program” violations is related to Distribution Providers (19), but there are also violations of Generator Owners (11), and Transmission Owners (10). From the violation descriptions submitted by the Regional Entities to NERC, the commonly cited terminology is that the Registered Entity in question had no documented maintenance or testing program for the elements required by the standard. The entities in question with “No Program” classification appeared to be smaller entities mostly located in the WECC and FRCC regions, and most did not appear to pose a significant or substantial risk to the reliability of the bulk electric system given the Potential Impact statements prepared by the Regional Entities.

The other issue of critical importance is 158 violations that have been classified as having “Maintenance” issues. The most prevalent registered function of the “Maintenance” violations is Generation Owners (124), with the second most being attributed to Transmission Owners (75), and the least most prevalent being Distribution Providers (61). From the violation descriptions submitted by the Regional Entities, the most commonly cited reason is that Maintenance and Testing were not performed according to pre-defined intervals. Other most commonly cited reasons include overlooking critical elements for testing, such as relays and batteries, or being behind schedule on testing. The potential impact of these maintenance violations ranged from minimal to moderate, with a few specific violations registering as severe, and the types of entities cited in the “Maintenance” bucket ranged from small entities that have no impact on the bulk electric system, to medium and moderate-sized entities that could have an impact on the bulk electric system if their violations were not mitigated.

#### **4. Regional Entity Analysis**

The RCIG assessment (see Attachment A), presented to the BOTCC at their meeting on June 10, 2009, identifies five critical issues surrounding violations of PRC-005-1 to be the following:

1. Not all components of the protection systems were identified or tested;
2. Documentation of testing and maintenance results is missing or inadequate;
3. Failure to complete maintenance and testing activities on time;
4. Lack of complete and thorough monitoring of testing and maintenance programs; and
5. Inventory lists of applicable devices are incomplete and therefore, devices are not scheduled appropriately

While the NERC classification system differs slightly from the Regional Entities, the same common themes of non-compliance can be found in both analyses of PRC-005-1. Maintenance and documentation issues were the most relevant issues in the RCIG analysis, and they were highest ranking classification problems identified by the analysis at NERC. The conclusion of the RCIG group is similar to NERC’s, in that, NERC Reliability Standard PRC-005-1 is critical to maintaining bulk electric system reliability.

#### **5. Conclusion**

The goal of PRC-005-1 is to ensure all transmission and generation protection systems affecting the reliability of the bulk electric system are maintained and tested according to schedule and

procedure. While Registered Entities have made strides in implementing this standard, this standard still shows up as the most frequently violated standard each month in the BOTCC reports, indicating that there is still a reliability threat to the bulk electric system. Until there is a precipitous decline in frequency and number of violations attributed to this standard and its multiple requirements, Regional Entities and NERC have to remain vigilant in enforcing to ensure that a large-scale blackout does not occur again.

## 6. Recommendations

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 subject to standard PRC-005 need to have a documented maintenance and testing plan in place for devices that qualify as protection systems
2. Entities shall ensure that all devices that qualify as protection systems are included in their maintenance and testing program, i.e., batteries are a common item which is missed on an entities maintenance and testing program
3. Entities need to strive to complete their maintenance and testing programs on schedule and within defined intervals
4. Entities need to verify that their testing programs include the appropriate basis of testing to ensure the reliability of the Bulk Electric System

These recommendations are based off of violation descriptions submitted by the Regional Entities which included:

*“Evidence did not confirm that all Protection System devices were maintained and testing within the defined intervals.”*

*“The entity's Protection System program for the audit period did not have all the components identified. The station batteries for the generation batteries were not in the program for the audit period.”*

*“Entity has no documented protection system maintenance & testing program.”*

*“The entity did not provide sufficient evidence to demonstrate that the entity's maintenance and testing program for Protection System included a basis, interval and summary of maintenance and testing procedures for the associated communication systems, DC control circuitry, station batteries, and voltage current sensing devices.”*

**RCIG Assessment**  
**on**  
**Monitoring and Implementation**  
**of**  
**Reliability Standard PRC-005-1**  
**Transmission and Generation Protection System**  
**Maintenance and Testing**

Prepared by: Regional Compliance Implementation Group  
May 27, 2009

RCIG - A - 001

## **1. Introduction**

During the monitoring and implementation of the Compliance Monitoring and Enforcement Program (CMEP) to date, the PRC-005-1 Reliability Standard has been identified as one of the most frequently violated Reliability Standards. Since this Reliability Standard is a high Violation Risk Factor (VRF) and thus could have significant impact on the reliability of the bulk electric system, NERC, the 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 suggested process enhancements to improve compliance with this standard. 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.

In response, the Regional Compliance Implementation Group (RCIG) took on the responsibility of reviewing this issue. The RCIG developed a Regional Report Template that was distributed to each Region. This template requested the following information:

- Identification of the frequency of standard implementation, including the number of times the standard was monitored by the Regions
- The number of times the entity monitored was compliant/non-compliant
- An identification of the method of discovery
- Identification of both primary and secondary issues related to the reason for the non-compliance
- Identification of suggested process enhancements

After review of the information received from the data returned via the template, the RCIG agreed to issue this whitepaper identifying key reasons for non-compliance and suggested process enhancements.

## **2. Key Reasons for Non-Compliance and Suggested Process Enhancements**

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 non-compliant:

### **1. Not all components of the protection systems were identified or tested.**

Data presented demonstrated that in many cases of non-compliance the entity did not test nor maintain all of the defined components of the protection system as defined by the NERC Glossary. These components include protective relays (i.e. electro-mechanical and microprocessor); associated communication systems; DC control circuitry; voltage and current sensing devices (PTs and CTs), and station batteries.

*Suggested Process Enhancements*

Clarify the definition of a protection system by defining all of the components of the protection system. In addition, reinforce this concept by including the definition in the RSAW for PRC-005, at the Regional Entities' (RE) compliance workshops, other methods of communication that NERC and the RE's have with the applicable Registered Entities, and provide a review of the definition and review the findings of this whitepaper. Present drafting team activities for this standard are expected to address the specific maintenance activities for components in the Protection System definition. Expectations on the use of the glossary may need to be promulgated to the industry, and the process of establishing and changing definitions.

**2. Documentation of testing and maintenance results is missing or inadequate.**

In many cases the Registered Entity had missing or incomplete documentation. Testing and maintenance may have been done as a long standing practice by the entity, but recordkeeping was insufficient leading to a non-compliance finding. Lack of experience with a true culture of compliance and interaction with a comprehensive compliance monitoring and enforcement program was also identified as a reason for the insufficient documentation. The industry continues to struggle with the level of documentation that is necessary to adequately institute the requirements of the standard. A "zero tolerance" approach of violations to this standard, for which there could be thousands of pieces of applicable equipment, has also contributed to the visibility of this issue.

*Suggested Process Enhancements*

Registered Entities have to be given further guidance and explicit direction that: a) there needs to be thorough and rigorous documentation of applicable testing and maintenance practices; b) that the documentation is kept current; c) data should be retained for 3 years or the last date maintenance and testing was performed if it is greater than 3 years; and d) the entity has the ability to produce data associated with the Standard requirements. Doing the above is critical to meeting the standard as it is currently written.

On a longer term basis, future consideration should be given to having the requirements of the standard focus not only on documentation, but also on the quality of the maintenance and testing program and the operability of the equipment. Emphasis in the standard should be on the performance of the maintenance and testing and the quality of that performance rather than on the maintenance of documentation. It will be a self-correcting process as the entity will only be able to adequately demonstrate effective testing and maintenance if they can produce evidence and documentation that they have met the parameters of the maintenance and testing program.

### **3. Failure to complete maintenance and testing activities on time.**

Many Regions reported that while the Registered Entities may have conducted their maintenance and testing programs they did not complete them in the time intervals specified in their plan due to many reasons. Entities have had to divert resources to support events such as natural disasters, system emergencies or equipment failures, or may have difficulty in obtaining transmission line or generating plant outages. Their program must identify the management of these issues.

#### *Suggested Process Enhancement*

Emphasis on the urgency to meet the specified time intervals must be made explicitly clear. The Registered Entity needs to recognize that the program it establishes is not viewed as a target, but is a minimum that must be achieved, regardless of what situations the company may encounter that interfere with planned maintenance. The entities need to clearly define how they manage the intervals and their schedule. The intervals and the schedule need to be managed to allow an appropriate grace period that each entity can support and justify technically. If tested outside of a scheduled interval, and the operability is deemed to have not been effected, a lower violation should be effectuated. As mentioned above, this point needs to be reinforced with the Registered Entity via all communications methods available to the RE (compliance workshops, Reliability Standard Audit Worksheet (RSAW), Compliance Guidance Document (CGD), etc.). Entities must be made aware of the need to adequately budget and plan their maintenance and testing programs to assure that they are in the best position to meet the requirements of the program, all in the interest to enhance overall system reliability.

### **4. Lack of complete and thorough monitoring of testing and maintenance programs.**

Regions reported that some Registered Entities did not have complete programs. Typically, this involved failure to include items in the definition other than protective relays themselves. This non-compliance issue could be due to unfamiliarity with a formal compliance program, inexperience, or less than diligent implementation.

In particular some smaller companies do not use an oversight approach to their programs. These companies go through all their devices on a cycle but they do not necessarily have them scheduled. Some have maps showing which stations have been completed and when, but there are no summary type worksheets tracking the work. The idea of summary type of worksheets is new to these companies. The reason the smaller companies have been doing it this way is because they contract a lot of this work out. They write contracts to cover their stations within their time cycle and they believe they are done, when in fact that is just part of the tracking that needs to take place.

*Suggested Process Enhancements*

Where possible, examples of acceptable maintenance and testing programs should be given to the Registered Entities that are deficient. This could occur at a Region's compliance workshop, or through a compliance guidance statement that is posted on the RCIG website, or other means.

**5. Inventory lists of applicable devices are incomplete and therefore devices are not scheduled appropriately.**

In some instances, Registered Entities did not ensure that all devices were properly transferred from legacy paper or spreadsheet systems to advanced database software management packages in common usage today. In addition, Registered Entities were not ensuring that recently installed devices were added to their active inventory list of devices and therefore not added to maintenance schedules. Inadequate configuration controls can contribute to this issue.

*Suggested Process Enhancement*

Registered Entities should perform periodic physical inventories, including walkthroughs where needed, to ensure that the active device inventory list is complete and accurate, and that all pertinent devices appear on maintenance and testing schedules.

**3. Conclusion**

Compliance to the PRC-005-1 Reliability Standard is critical to maintaining bulk electric system reliability. It is imperative that clear information is provided to assure that the Registered Entities have the best opportunity to understand how they can effectively meet the standard. The standard drafting team is presently addressing some of these issues. The RCIG should review and comment on the posted drafts of PRC-005 and provide observations from a compliance perspective. Registered Entities should be given this guidance and information via all methods available as discussed in this whitepaper.

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 PRC-005-1 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 culture.