

NERC SPCTF Assessment of Standard PRC-001-0 — System Protection Coordination

December 7, 2006

A Technical Review of Standards

Prepared by the
System Protection and Controls Task Force
of the
NERC Planning Committee

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This report was approved by the Planning Committee on December 7, 2006, for forwarding to the Standards Committee.

Introduction

When the original scope for the System Protection and Control Task Force was developed, one of the assigned items was to review all of the existing PRC-series Reliability Standards, to advise the Planning Committee of our assessment, and to develop Standards Authorization Requests, as appropriate, to address any perceived deficiencies.

This report presents the SPCTF's assessment of PRC-001-0 – System Protection Coordination. The report includes the SPCTF's understanding of the intent of this standard and contains specific observations relative to the existing standard.

This standard was developed by translating the requirements of an earlier Phase I Planning Standard; thus it has not been previously subjected to a critical review of the Requirements.

Executive Summary

This reliability standard is intended to assure that system protection is coordinated between multiple transmission entities and between generation entities and transmission entities. It appears that this standard is intended to address coordination of protection functions and capabilities in both the operating time frame and the planning time frame. These time frames, as they apply to protective functions, are discussed, as are the various responsibilities to assure the related coordination.

The SPCTF concludes that the list of applicable entities in the existing standard is incomplete and that the assigned responsibilities do not reflect the activities of the identified functions. Significantly, the existing standard disregards the significant responsibilities and roles of the equipment owners; specifically, the Transmission Owners and Generator Owners.

The SPCTF also concludes that the Requirements of the existing standard are vague and ambiguous, and that, while Measures and Levels of Non-Compliance are defined, these are essentially unenforceable because of fundamental flaws within the requirements.

Assessment of PRC-001-0

General Comments

The SPCTF offers the following general comments:

1. None of the requirements within PRC-001-0 specifically indicate what protective systems are being addressed.
2. The phrase “protective relay or equipment” is a recurring phrase, and generally should be revised to “protective system” or “protective system equipment.”
3. The phrase “If a protective relay or equipment failure reduces system reliability” is ambiguous, and needs additional clarification. This phrase does not clearly state when failures must be reported.
4. Many of the requirements list the Balancing Authority as an applicable entity. It does not seem that the Balancing Authority has the direct responsibility for any of these activities, and only needs to respond to the various issues when directed by the Transmission Operator and/or Generator Operator.

Applicability

- 4.1. Balancing Authorities
- 4.2. Transmission Operators
- 4.3. Generator Operators

The remainder of the PRC-series standards rarely assigns any responsibility for protection systems to any of the above entities. Specifically, the responsibilities for disturbance monitoring (which includes some monitoring of protective systems) and for protective system maintenance apply to the equipment owners, specifically Transmission Owners and Generator Owners. The current applicable entities do, however, have a role in the functions of this standard. The SPCTF asserts that Transmission Owner, Generator Owner, and Distribution Provider should be added to the list of Applicable Entities.

R1

R1. Each Transmission Operator, Balancing Authority, and Generator Operator shall be familiar with the purpose and limitations of protective system schemes applied in its area.

This requirement is a statement of a highly laudable goal, but this is not specific and enforceable. In fact, the drafting team that was providing missing Measures and Compliance Elements was unable to assign either to this requirement.

It may be possible to restate this requirement in such a way to be measurable and enforceable. The protective system equipment owners (Transmission Owners, Generator Owners, and Distribution Providers) should be responsible to provide the necessary information to the Transmission Operator and Generator Operator to facilitate their familiarity with the relevant protective systems.

R2

R2. Each Generator Operator and Transmission Operator shall notify reliability entities of relay or equipment failures as follows:

R2.1. If a protective relay or equipment failure reduces system reliability, the Generator Operator shall notify its Transmission Operator and Host Balancing Authority. The Generator Operator shall take corrective action as soon as possible.

R2.2. If a protective relay or equipment failure reduces system reliability, the Transmission Operator shall notify its Reliability Coordinator and affected Transmission Operators and Balancing Authorities. The Transmission Operator shall take corrective action as soon as possible.

Requirement R2 addresses the operating horizon, but the equipment owner entities will be familiar with the condition of their protective system equipment.

Therefore, the responsibility for this requirement must originate with the owner entities: the Transmission Owner, Generator Owner, and Distribution Provider. These entities should inform the Transmission Operator, Generator Operator, and Balancing Authorities of equipment failures pertinent to this requirement. The Transmission Operators may need to have to coordinate with each other, similar to the existing requirement R4.

The requirement for corrective action, “as soon as possible”, is vague and ambiguous, and needs modification to be specific.

As evidenced by the lack of a related Measure (via the drafting team for missing Measures and Compliance Elements), this requirement is currently not measurable.

R3

Not only new protective systems and changes to protective systems should be coordinated. A

- R3.** A Generator Operator or Transmission Operator shall coordinate new protective systems and changes as follows.
- R3.1.** Each Generator Operator shall coordinate all new protective systems and all protective system changes with its Transmission Operator and Host Balancing Authority.
 - R3.2.** Each Transmission Operator shall coordinate all new protective systems and all protective system changes with neighboring Transmission Operators and Balancing Authorities.

requirement should be added to require coordination of all existing protective systems. Then, requirement R3 should require the coordination new protective systems and changes to protective systems with existing protective systems.

Requirement R3 addresses the planning horizon; therefore, this responsibility should be assigned to the Transmission Owner, Generator Owner, and Distribution Provider.

In addition, R3.1 should be bi-directional; the Transmission entity should provide similar coordination with the Generator entity.

R4

- R4.** Each Transmission Operator shall coordinate protection systems on major transmission lines and interconnections with neighboring Generator Operators, Transmission Operators, and Balancing Authorities.

It's unclear whether this requirement addresses the operations planning horizon or the planning horizon.

If Requirement R4 addresses the planning horizon, the responsibilities should be assigned similarly to the recommendations for R3, to the Transmission Owner, Generator Owner, and Distribution Provider. If Requirement R4 addresses the planning horizon, it seems to be redundant with R3 to some extent.

R5

- R5.** A Generator Operator or Transmission Operator shall coordinate changes in generation, transmission, load or operating conditions that could require changes in the protection systems of others:
- R5.1.** Each Generator Operator shall notify its Transmission Operator in advance of changes in generation or operating conditions that could require changes in the Transmission Operator's protection systems.
 - R5.2.** Each Transmission Operator shall notify neighboring Transmission Operators in advance of changes in generation, transmission, load, or operating conditions that could require changes in the other Transmission Operators' protection systems.

Requirement R5 addresses the both the planning horizon and operating planning horizon. It is essential to the reliability of the system that this activity occurs, and it must occur in advance of any changes to the system.

In the operations planning horizon, the Operator entities should coordinate these changes with the Owner entities, since the Owners have the tools to analyze the effects of these system changes on the protective systems and the access to the protective systems to make any needed changes to the protective system.

In the planning horizon, the owner entities should be responsible for this requirement, similarly to Requirement R3.

R6

R6. Each Transmission Operator and Balancing Authority shall monitor the status of each Special Protection System in their area, and shall notify affected Transmission Operators and Balancing Authorities of each change in status.

Requirement R6 addresses the operating horizon. The Owners have to monitor the status of Special Protection Systems and provide the status to the Operators. The Operators then should coordinate the availability of Special Protection Systems between each other, and take any necessary operating actions to address issues with Special Protection Systems.

This requirement needs to better define “status of ... Special Protection System...”

This requirement may be better moved to one of the PRC-series standards specifically addressing Special Protection Systems.

Related Standard

MOD-011-0 — Regional Steady-State Data Requirements and Reporting Procedures

Also, while reviewing PRC-001, the SPCTF noted that no existing NERC Standard requires that a consistent model be maintained for protection studies, such as that required by MOD-011-0 — Regional Steady-State Data Requirements and Reporting Procedures, for other steady-state studies. Without such a model, various Transmission Owners, Generator Owners, and Distribution Providers cannot accurately apply the protective relaying. To address this deficiency, the SPCTF recommends that MOD-011, Maintenance and Distribution of Steady-State Data Requirements and Reporting Procedures, be modified to include the essential data for wide-area fault studies. The specific MOD-011 requirements are listed below, together with suggested modifications.

R1.2 – Generators

Recommend including direct-axis synchronous reactance (X_d), transient reactance (X_d'), sub transient reactance (X_d''), and the associated time constants (T_{do} , T_{do}' , and T_{do}'') for synchronous generators. For induction and inverter generators, generically include the data necessary to model the equipment in short circuit models in the positive, negative, and zero sequence domains.

R1.3 – Transmission Lines

Recommend specifying the positive and zero sequence impedance, including mutual impedances

R1.5 – Transformers

Recommend specifying positive sequence and zero sequence impedance, including all grounding effects.

FERC Assessment of PRC-001-0

In the October 20, 2006, the Notice of Proposed Rulemaking for adoption of NERC Standards (Docket Number RM06-16-000), the Federal Energy Regulatory Commission, for the most part, considered the operating horizon impacts of PRC-001. FERC proposed that PRC-001-0 be approved as mandatory and enforceable. They did, however, propose that NERC be directed to make modifications to PRC-001. The modifications proposed in the NOPR are excerpted from the NOPR and repeated below:

“The Commission proposes to direct that NERC submit a modification to PRC-001-0 that: (1) includes Measures and Levels of Non-Compliance; (2) includes a requirement that relevant transmission operators and generator operators must be informed immediately upon the detection of failures in relays or protection system elements on the Bulk-Power System that would threaten reliable operation, so that these entities can carry out the appropriate corrective control actions consistent with those used in mitigating IROL violations; and (3) clarifies that, after being informed of failures in relays or protection system elements on the Bulk-Power System, transmission operators or generator operators shall carry out corrective control actions, i.e., returning the system to a stable state that respects system requirements as soon as possible and no longer than 30 minutes.”

Other Activities related to PRC-001-0

The Standard Drafting Team on Missing Measures and Compliance Elements modified PRC-001-0 as a part of their work, but the requirements were not changed. As this report is being prepared, the modified Standard is being balloted.

A draft SAR for the revision of PRC-001-0 is included in the “Draft Reliability Standards Development Plan: 2007–2009”, which was presented to the NERC Board of Trustees for their approval on November 1, 2006. This draft SAR is entitled, “System Protection Project (2009-01)”, and discusses many of the same deficiencies in PRC-001-1 that were identified by the SPCTF.

Conclusion and Recommendation

As it exists today, enforcement of PRC-001-0 will be very difficult. The applicable entities in the existing Standard are incorrect for many of the requirements, and the requirements themselves are vague and not measurable. In addressing the “operating horizon,” “operations planning horizon,” and “planning horizon” protection coordination issues, the deficiencies in the current standard are magnified.

The SPCTF recommends that the existing draft Standards Authorization Request that is included in the “Draft Reliability Standards Development Plan: 2007–2009” be modified to include the observations from the SPCTF assessment of PRC-001-0 and also include the modifications directed in the FERC NOPR on RM06-16-000. The SPCTF also recommends that the requirements for the operating horizon and planning horizon be clearly delineated and warrants consideration of dividing this standard into two standards.

In addition, it is not possible to effectively coordinate protective systems without having accurate short circuit models of neighboring systems. To address these modeling issues related to data for short circuit calculations, the SPCTF recommends that a Standards Authorization Request be developed to modify Standard MOD-013-1 — RRO Dynamics Data Requirements and Reporting Procedures, to address these issues. Data for short circuit calculations, as noted in this report, should be considered as additional requirements within MOD-013-1.

Appendices

Attachment A is not relevant to this SAR and was removed

Appendix B — SYSTEM PROTECTION AND CONTROL TASK FORCE

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Standard Review Guidelines

Applicability

Does this reliability standard clearly identify the functional classes of entities responsible for complying with the reliability standard, with any specific additions or exceptions noted? Where multiple functional classes are identified is there a clear line of responsibility for each requirement identifying the functional class and entity to be held accountable for compliance? Does the requirement allow overlapping responsibilities between Registered Entities possibly creating confusion for who is ultimately accountable for compliance?

Does this reliability standard identify the geographic applicability of the standard, such as the entire North American bulk power system, an interconnection, or within a regional entity area? If no geographic limitations are identified, the default is that the standard applies throughout North America.

Does this reliability standard identify any limitations on the applicability of the standard based on electric facility characteristics, such as generators with a nameplate rating of 20 MW or greater, or transmission facilities energized at 200 kV or greater or some other criteria? If no functional entity limitations are identified, the default is that the standard applies to all identified functional entities.

Purpose

Does this reliability standard have a clear statement of purpose that describes how the standard contributes to the reliability of the bulk power system? Each purpose statement should include a value statement.

Performance Requirements

Does this reliability standard state one or more performance requirements, which if achieved by the applicable entities, will provide for a reliable bulk power system, consistent with good utility practices and the public interest?

Does each requirement identify who shall do what under what conditions and to what outcome?

Measurability

Is each performance requirement stated so as to be objectively measurable by a third party with knowledge or expertise in the area addressed by that requirement?

Does each performance requirement have one or more associated measures used to objectively evaluate compliance with the requirement?

If performance results can be practically measured quantitatively, are metrics provided within the requirement to indicate satisfactory performance?

Technical Basis in Engineering and Operations

Is this reliability standard based upon sound engineering and operating judgment, analysis, or experience, as determined by expert practitioners in that particular field?

Completeness

Is this reliability standard complete and self-contained? Does the standard depend on external information to determine the required level of performance?

Consequences for Noncompliance

In combination with guidelines for penalties and sanctions, as well as other ERO and regional entity compliance documents, are the consequences of violating a standard clearly known to the responsible entities?

Clear Language

Is the reliability standard stated using clear and unambiguous language? Can responsible entities, using reasonable judgment and in keeping with good utility practices, arrive at a consistent interpretation of the required performance?

Practicality

Does this reliability standard establish requirements that can be practically implemented by the assigned responsible entities within the specified effective date and thereafter?

Capability Requirements versus Performance Requirements

In general, requirements for entities to have ‘capabilities’ (this would include facilities for communication, agreements with other entities, etc.) should be located in the standards for certification. The certification requirements should indicate that entities have a responsibility to ‘maintain’ their capabilities.

Consistent Terminology

To the extent possible, does this reliability standard use a set of standard terms and definitions that are approved through the NERC reliability standards development process?

If the standard uses terms that are included in the NERC Glossary of Terms Used in Reliability Standards, then the term must be capitalized when it is used in the standard. New terms should not be added unless they have a ‘unique’ definition when used in a NERC reliability standard. Common terms that could be found in a college dictionary should not be defined and added to the NERC Glossary.

Are the verbs on the ‘verb list’ from the DT Guidelines? If not – do new verbs need to be added to the guidelines or could you use one of the verbs from the verb list?

Violation Risk Factors (Risk Factor)

High Risk Requirement

A requirement that, if violated, could directly cause or contribute to bulk electric system instability, separation, or a cascading sequence of failures, or could place the bulk electric system at an unacceptable risk of instability, separation, or cascading failures;

or a requirement in a planning time frame that, if violated, could, under emergency, abnormal, or restorative conditions anticipated by the preparations, directly cause or contribute to bulk electric system instability, separation, or a cascading sequence of failures, or could place the bulk electric system at an unacceptable risk of instability, separation, or cascading failures, or could hinder restoration to a normal condition.

Medium Risk Requirement

A requirement that, if violated, could directly affect the electrical state or the capability of the bulk electric system, or the ability to effectively monitor and control the bulk electric system. However, violation of a medium risk requirement is unlikely to lead to bulk electric system instability, separation, or cascading failures;

or a requirement in a planning time frame that, if violated, could, under emergency, abnormal, or restorative conditions anticipated by the preparations, directly and adversely affect the electrical state or capability of the bulk electric system, or the ability to effectively monitor, control, or restore the bulk electric system. However, violation of a medium risk requirement is unlikely, under emergency, abnormal, or restoration conditions anticipated by the preparations, to lead to

bulk electric system instability, separation, or cascading failures, nor to hinder restoration to a normal condition.

Lower Risk Requirement

A requirement that, if violated, would not be expected to adversely affect the electrical state or capability of the bulk electric system, or the ability to effectively monitor and control the bulk electric system. A requirement that is administrative in nature;

or a requirement in a planning time frame that, if violated, would not, under the emergency, abnormal, or restorative conditions anticipated by the preparations, be expected to adversely affect the electrical state or capability of the bulk electric system, or the ability to effectively monitor, control, or restore the bulk electric system. A planning requirement that is administrative in nature.

Time Horizon

The drafting team should also indicate the time horizon available for mitigating a violation to the requirement using the following definitions:

- **Long-term Planning** — a planning horizon of one year or longer.
- **Operations Planning** — operating and resource plans from day-ahead up to and including seasonal.
- **Same-day Operations** — routine actions required within the timeframe of a day, but not real-time.
- **Real-time Operations** — actions required within one hour or less to preserve the reliability of the bulk electric system.
- **Operations Assessment** — follow-up evaluations and reporting of real time operations.

Violation Severity Levels

The drafting team should indicate a set of violation severity levels that can be applied for the requirements within a standard. ('Violation severity levels' replace existing 'levels of non-compliance.')

The violation severity levels must be applied for each requirement and may be combined to cover multiple requirements, as long as it is clear which requirements are included and that all requirements are included.

The violation severity levels should be based on the following definitions:

- **Lower: mostly compliant with minor exceptions** — The responsible entity is mostly compliant with and meets the intent of the requirement but is deficient with respect to one or more minor details. Equivalent score: more than 95% but less than 100% compliant.
- **Moderate: mostly compliant with significant exceptions** — The responsible entity is mostly compliant with and meets the intent of the requirement but is deficient with respect to one or more significant elements. Equivalent score: more than 85% but less than or equal to 95% compliant.
- **High: marginal performance or results** — The responsible entity has only partially achieved the reliability objective of the requirement and is missing one or more significant elements. Equivalent score: more than 70% but less than or equal to 85% compliant.
- **Severe: poor performance or results** — The responsible entity has failed to meet the reliability objective of the requirement. Equivalent score: 70% or less compliant.

Compliance Monitor

Replace, ‘Regional Reliability Organization’ with ‘Regional Entity’

Fill-in-the-blank Requirements

Do not include any ‘fill-in-the-blank’ requirements. These are requirements that assign one entity responsibility for developing some performance measures without requiring that the performance measures be included in the body of a standard – then require another entity to comply with those requirements.

Every reliability objective can be met, at least at a threshold level, by a North American standard. If we need regions to develop regional standards, such as in under-frequency load shedding, we can always write a uniform North American standard for the applicable functional entities as a means of encouraging development of the regional standards.

Requirements for Regional Reliability Organization

Do not write any requirements for the Regional Reliability Organization. Any requirements currently assigned to the RRO should be re-assigned to the applicable functional entity.

Effective Dates

Must be 1st day of 1st quarter after entities are expected to be compliant – must include time to file with regulatory authorities and provide notice to responsible entities of the obligation to comply. If the standard is to be actively monitored, time for the Compliance Monitoring and Enforcement Program to develop reporting instructions and modify the Compliance Data Management System(s) both at NERC and Regional Entities must be provided in the implementation plan. The effective date should be linked to the NERC BOT adoption date.

Associated Documents

If there are standards that are referenced within a standard, list the full name and number of the standard under the section called, ‘Associated Documents’.

Functional Model Version 3

Review the requirements against the latest descriptions of the responsibilities and tasks assigned to functional entities as provided in pages 13 through 53 of the draft Functional Model Version 3.