

## Meeting Notes

### Project 2007-06 System Protection Coordination Standard Drafting Team

March 20-21, 2012

NERC Headquarters  
Atlanta, GA

#### Administrative

##### 1. Introductions

The meeting was brought to order by Chair, Phil Winston, at 8:00 a.m. ET on Tuesday, March 20, 2012. Building and safety information/logistics were provided by Al McMeekin. Each participant was introduced; those in attendance were:

Name	Company	Member/ Observer	In Person	Conference Call/Web
Philip Winston, Chair	Southern Company	Member	X	
Bill Middaugh, Vice Chair	Tri-State G & T Association, Inc.	Member	X	
Forrest Brock	Western Farmers Electric Cooperative	Member	X	
David Cirka	National Grid	Member		X
Samuel Francis	Oncor	Member	X	
Jeffery Iler	American Electric Power	Member	X	
William Waudby	Consumers Energy	Member	X	
Kevin Wempe	Kansas City Power & Light	Member		X
Amelia Lewis	FERC	Observer	X	
Al McMeekin	NERC Staff	Member	X	

## 2. Determination of Quorum

The rule for NERC Standard Drafting Team (SDT or team) states that a quorum requires two-thirds of the voting members of the SDT. Quorum was achieved as 8 of the 9 members were present.

## 3. NERC Antitrust Compliance Guidelines and Public Announcement

The NERC Antitrust Compliance Guidelines and public announcement were delivered.

## 4. Review Team Roster

The team reviewed the team roster and confirmed that it was accurate and up to date.

## Agenda

### 1. Discuss Developments Since Last Meeting

Al McMeekin reported that the Project 2007-03 Real-time Operations drafting team had included the reliability intent of Requirements R2, R5, and R6 of PRC-001-1 be retired due to the fact that those requirements deal with data and data requirements and would be covered in the proposed TOP-003-2.

Mr. McMeekin reviewed the transition from revising PRC-001-1 to developing the new results-based standard PRC-027-1, including the responses to the Quality Review (QR) performed in January.

Mr. Winston reported that he had sent a concepts paper to each of the region's Protection and Control working groups requesting feedback on the new standard PRC-027-1 Protection System Coordination for Performance During Faults but the feedback was sparse at this point.

### 2. Revise standard and associated documents

The team made numerous revisions to the standard and other documents, please refer to the attached documents.

### 3. Action Items

Mr. McMeekin will prepare all documents for next QR.

### 4. Future Meeting(s)

Conference calls will be scheduled as required to address the QR issues.

No face-to-face meetings scheduled until after the next posting.

### 5. Adjourn

The meeting adjourned at 5:00 p.m. ET on Wednesday, March 21, 2012.

## Standard Development Timeline

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*This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.*

### Development Steps Completed

1. Draft 1 of SAR posted for comment June 11, 2007 – July 10, 2007.
2. SAR approved on August 13, 2007.
3. First posting of revised standard PRC-001-2 on September 11, 2009
4. Transitioned from a revision of PRC-001-1 to development of PRC-027-1 based on industry comments, Quality Review feedback, and consideration of FERC directives relative to the existing requirements of PRC-001-1.

### Description of Current Draft

The SPC SDT created a new results-based standard PRC-027-1 to coordinate Protection Systems utilized to protect interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those that are actually required to isolate Faults and maintain reliability, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards. This standard incorporates and enhances the coordination aspects of Requirements R3 and R4 from PRC-001-1. The SPC SDT is requesting a posting for stakeholder comments under a 30-day formal comment period.

Anticipated Actions	Anticipated Date
Post first draft of standard for 30-day Formal Comment Period.	May 2012
45-day Formal Comment Period with Parallel Initial Ballot	August 2012
30-day Formal Comment Period with Parallel Successive Ballot	November 2012

**Effective Dates:**

PRC-027-1 shall become effective on the first day of the first calendar quarter that is twelve months beyond the date that this standard is approved by applicable regulatory authorities. In those jurisdictions where regulatory approval is not required, this standard shall become effective on the first day of the first calendar quarter that is twelve months beyond the date that this standard is approved by the NERC Board of Trustees, or as otherwise made effective pursuant to the laws applicable to such ERO governmental authorities.

**Version History**

Version	Date	Action	Change Tracking
1	TBD	Project 2007-06 – PRC-027-1	New

**Definitions of Terms Used in Standard**

*This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved. When the standard becomes effective, these defined terms will be removed from the individual standard and added to the Glossary.*

**Terms:**

**Interconnected Facility:** Facilities that are electrically joined by one or more Element(s) and are owned by different functional entities.

**Protection System Study:** A study that demonstrates existing or proposed Protection Systems operate in the desired sequence for clearing Faults.

*When this standard has received ballot approval, the text boxes will be moved to the Application Guidelines Section of the Standard.*

## A. Introduction

1. **Title:** Protection System Coordination for Performance During Faults
2. **Number:** PRC-027-1
3. **Purpose:** To coordinate Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those required to isolate Faults, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards.
4. **Applicability:**
  - 4.1. **Functional Entities:**
    - 4.1.1 Transmission Owner
    - 4.1.2 Generator Owner
    - 4.1.3 Distribution Provider
  - 4.2 **Facilities:**

Protection Systems installed at Interconnected Facilities.
5. **Background:**

On December 7, 2006, the NERC Planning Committee approved the assessment of Reliability Standard PRC-001 – System Protection Coordination prepared by the NERC System Protection and Control Task Force (SPCTF). The SPCTF noted problems with the applicability to entities and vagueness of requirements in the existing PRC-001-1 Reliability Standard. The SPCTF concluded that the deficiencies of Reliability Standard PRC-001-1 were magnified by having requirements that addressed protection coordination of protection functions and capabilities in the operating and planning timeframes.

The NERC Standards Committee approved a Standard Authorization Request that included the modifications noted by the SPCTF for posting on June 5, 2007. The SAR was posted for comment from June 11, 2007 – July 10, 2007 and was subsequently approved.

The Project 2007-06 – System Protection Coordination Standard Drafting Team (SPC SDT) posted an initial draft of Reliability Standard PRC-001-2 on September 11, 2009 for comments. In that draft, the SPC SDT addressed the planning and non-operational issues identified by the SPCTF assessment for PRC-001-1 as well as the operating time frame issues identified in FERC Order 693. These operating time frame requirements involved detecting Protection System failures, informing operators, and taking quick corrective actions; consequently, the SPC SDT transferred the Order 693 directives associated with Reliability Standard PRC-001-1, Requirements R2, R5, and R6 to Project 2007-03 Real-time Operations for inclusion in the revisions of the appropriate operating standards associated within that project. Additionally, the SPC SDT determined that the training aspects of PRC-001-1, Requirement R1 are more appropriately addressed by Reliability Standard PER-005-1 with revision to its Applicability section to include the Generator Operator. The two remaining requirements, Requirements R3 and R4 of PRC-001-1 address the coordination of new and existing protective systems. These aspects of coordination are

incorporated and enhanced in the proposed Reliability Standard PRC-027-1 – Protection System Coordination for Performance During Faults.

The SPC SDT responded to the comments from the initial posting of PRC-001-2 and incorporated pertinent suggestions into the second draft of the standard in the first quarter of 2010. This second draft went through a NERC Quality Review in December 2010, which resulted in substantial changes to the standard. After informal consultations with industry stakeholders, as well as NERC and FERC staffs, the drafting team decided to focus their knowledge and expertise on developing a standard with the stated purpose: To coordinate Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those required to isolate Faults, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards. The SPC SDT is presenting this first draft of PRC-027-1 for stakeholder review and comment.

Additionally, the requirements in PRC-027-1 take into account Recommendation 21 C of the Final Report on the August 14, 2003 Blackout in the United States and Canada written by the U.S.-Canada Power System Task Force which identified the need to address “the appropriate use of time delays in relays”, by requiring that individual interconnected entities cooperate in designing and setting their Protection Systems to achieve coordination.

**Other Aspects of coordination of Protection Systems addressed by other Projects:**

Fault clearing is the only aspect of protection coordination that is addressed by Reliability Standard PRC-027-1. Other items such as over/under frequency, over/under voltage, coordination of generating unit or plant voltage regulating controls, and relay loadability are addressed by the following existing standards or current projects.

- Underfrequency load shedding programs are addressed by PRC-006-1 (Project 2007-01 Underfrequency Load Shedding) and generator performance during frequency excursions is addressed by PRC-024-1 (Project 2007-09 Generator Verification).
- Undervoltage Load shedding programs are addressed by PRC-010-0 and will be improved by Project 2008-02 Undervoltage Load Shedding. Generator performance during voltage excursions is addressed by PRC-024-1x (Project 2007-09 Generator Verification).
- Coordination of Generating Unit or Plant Voltage Regulating Controls with Generating Unit or Plant Capabilities and Protection is addressed in PRC-019-1 (Project 2007-09).
- Transmission relay loadability is addressed in PRC-023-2.
- Generator relay loadability will be addressed in Phase 2 of Project 2010-13 Relay Loadability Order.
- Protective relay response during power swings will be addressed in Phase 3 of Project 2010-13 Relay Loadability Order.

- Misoperations identified as coordination issues are investigated and have Corrective Action Plans created in accordance with PRC-003-0 and PRC-004-2 (Project 2010-05.1).

The SPC SDT believes that including these other aspects of protection coordination within PRC-027-1 would cause duplication or conflict with requirements and compliance measurements of other standards.

## B. Requirements and Measures

**R1.** Each Transmission Owner, Generator Owner, and Distribution Provider shall:  
*[Violation Risk Factor: Medium] [Time Horizon: Operations Planning, Long-term Planning]*

**1.1.** Perform a Protection System Study for each Interconnected Facility to verify that Protection Systems do not remove power system Elements from service except for those required to isolate Faults as follows:

**1.1.1** Within 36 calendar months after the effective date of this standard, if no Protection System Study for that Interconnected Facility exists that was performed on or subsequent to June 18, 2007.

**1.1.2** Within 6 calendar months after determining, or being notified of, a 10% or greater change in Fault current for that Interconnected Facility, as described in Requirement R2, unless the entity can demonstrate such a study is not required.

**1.1.3** When proposing or being notified of a change at the Interconnected Facility as described in Requirement R3, Part 3.1 or Part 3.3 unless the entity can demonstrate such a study is not required.

**1.2.** Provide to each affected Interconnected Facility owner, a summary of the results of each Protection System Study performed pursuant to this requirement, including at a minimum, the Protection System(s) reviewed, any issues identified, and any revisions proposed within 90 calendar days after the completion of each Protection System Study.

### Rationale for R1:

Part 1.1-This requires a Protection System study has been performed for every Interconnected Facility to verify coordination of existing Protection Systems. The SDT uses the term “Interconnected Facilities” to identify those Facilities that are electrically joined by a single Element and are owned by different entities. (Note: This also applies to a single owner with multiple functional registrations.)

Part 1.1.1 Protection System studies performed after June 18, 2007 (the effective date of PRC-001-1) and in accordance with PRC-001-1, are sufficient to meet Requirement R1, Part 1.1.1. The SDT believes that 36 months is an appropriate period of time for entities to perform the studies required where no study exists. The SDT has no evidence there is widespread miscoordination between Interconnected Facilities that warrants a shorter time-frame.

Part 1.1.2 The SDT believes that 6 months is an appropriate period of time for entities to perform the studies required when determining, or being notified of, a 10% or greater fault current deviation, where such conditions may warrant a new Protection System Study, or to justify why no such study is needed, i.e., when a line is protected by dual current differential systems with no backup elements set that are dependent upon fault current.

Part 1.1.3 The SDT believes that entities must perform the studies required when proposing or being notified of changes identified in Requirement R3 or to justify why no such study is needed. The SDT believes that no time frame is required for studies associated with Requirement R3 because notification of such a change may occur weeks or years prior to the change. The initiating entity has the incentive to provide the identified information as soon as possible to ensure timely implementations.

Part 1.2 This requirement provides for the communication of the results of a Protection System Study to allow the interconnected owner to review the results. The SDT believes to properly ensure coordination of Protection Systems of Interconnected Facilities; all entities need to assess the study results. The SDT believes that 90 calendar days is a reasonable time for the entity to provide the results of the Protection System Study performed in accordance with Requirement R1 to the Interconnected Facility owner.



- M1.** Acceptable evidence for Requirement R1, Part 1.1 is dated documentation indicating a Protection System Study was performed such as a dated summary of the results of the Protection System Study.
- M2.** Acceptable evidence for Requirement R1, Part 1.2. is dated documentation which may include emails, electronic files, or hard copy records demonstrating transmittal and receipt of the summary of results of each Protection System Study within the specified time frame.
- R2.** For each Interconnected Facility, each Transmission Owner shall: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning, Long-term Planning*]
- 2.1.** Not less than once every twenty-four months, perform a short-circuit study to determine the present Fault current values.
  - 2.2.** Calculate the percent deviation between the Fault current values (Single Line to Ground and 3-Phase for the Bus(s) or Element(s) under consideration) used in the most recent Protection System Study and the Fault current values determined pursuant to Requirement R2, Part 2.1 using the following equation:
 
$$\% \text{ Deviation} = \left( \frac{V_{scs} - V_{pss}}{V_{pss}} \right) \times 100$$

Where:  $V_{scs}$  = Fault current value from present short-circuit study

And:  $V_{pss}$  = Fault current value from most recent Protection System Study
  - 2.3.** Within 30 calendar days after identification of any deviation in Fault current values found to be 10% or greater, notify each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility.
- M3.** Acceptable evidence for R2, Part 2.1 is dated documentation or an electronic file containing the output(s) of the percent deviation calculation(s) including the Facilities analyzed.
- M4.** Acceptable evidence for R2, Part 2.2 is dated documentation or an electronic file that verifies the formula used in the analysis pursuant to Part 2.1.
- M5.** Acceptable evidence for R2, Part 2.3 is documentation demonstrating the transmittal and receipt of the notification to each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility.

**Rationale for R2:** This requires a periodic review of Fault currents and notification to the applicable entities when deviations occur that meet the Requirement R2 criteria. It is important that Interconnected Facility owners are kept aware of changes that could affect proper performance of their Protection Systems. The Transmission Owner is identified as the entity responsible for performing the Fault current studies because they maintain the data necessary to perform the studies. The SDT determined that 10% was an appropriate point at which to require notification based on the fact that Protection System elements that can be affected by Fault current are typically set with margins well above 10%.

Part 2.1 Short-circuit databases are customarily updated annually, so the SDT believes 24 months provides the entities flexibility to schedule and perform the new short-circuit studies and calculate the percent deviation. The SDT believes studies associated with changes that would affect the coordination in less time would be triggered by other requirements in this standard.

Part 2.2 The SDT is requiring this formula to assure a consistent approach is used by each Transmission Owner when calculating the percent deviation in Fault current vales.

Part 2.3 The SDT believes the 30-day time frame is reasonable for sending notification(s) to the interconnected entity(s).

**R3.** Each Transmission Owner, Generator Owner, and Distribution Provider shall provide to each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility, the details (e.g., project schedule, protective relaying scheme types and settings, etc.) as follows: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*]

**3.1.** For any change or additions listed below; either, at an existing or new Interconnected Facility, or at other Facilities when the proposed change modifies the conditions used in the coordination of Protection Systems of the Interconnected Facilities.

- New installation, replacement with different types, or modification of: protective relays or protective function settings, communication systems, current transformer ratios and voltage transformer ratios.
- Changes to line lengths and/or conductor size or spacing.
- Additions, removals, and/or replacements of transmission system Element(s).
- Changes to generator unit(s) including replacements, re-ratings, and impedances.
- Replacement of the generator step-up transformer(s).

**3.2.** According to an agreed upon schedule with a Transmission Owner, Generator Owner, or Distribution Provider; or absent such an agreement, within 30 calendar days of receiving a request for information.

**3.3.** Within 30 calendar days after:

- 3.3.1** Corrections are made when Protection System errors are found during misoperation investigations, commissioning, or maintenance activities.
- 3.3.2** Emergency replacements are made due to failures of Protection System components.

**M6.** Acceptable evidence for R3, Part 3.1 is documentation which may include emails, electronic files, or hard copy records demonstrating transmittal and receipt of project information.

**Rationale for R3:** This requires the transfer of appropriate information to the entities connected at each interconnection due circumstances identified in Parts 3.1 3.2, and 3.3

**Part 3.1** The reliability objective of this requirement is to enable the process of conducting Protection System Studies by ensuring that the information is provided to the Interconnected Facility owner(s) in a timely manner. The SDT believes that no single time frame is appropriate for the wide variety of conditions that will need to be evaluated. The list in the requirement is inclusive as it comprises either the protective equipment itself or the power system Elements that affect the coordination of Protection Systems. This requirement would also pertain to changes identified as a result of studies performed in Part 1.1.

**Part 3.2** The purpose of this requirement is to provide a means for an entity to receive requested information from an interconnected owner in a timely manner in order to perform a Protection System Study as required in Parts 1.1.1, 1.1.2, 1.1.3 The SDT believes 30 calendar days after receipt of the request is a sufficient time to provide this information. The requirement also provides some flexibility for the parties involved to determine an otherwise agreed to schedule, if appropriate.

**Part 3.3** The SDT believes 30 calendar days after the conditions noted in Parts 3.3.1 and 3.3.2 is sufficient time to provide the information.

Evidence may include, but is not limited to, a summary of the future project or technical specifications of the proposed changes.

- M7.** Acceptable evidence for R3, Part 3.2 is dated documentation demonstrating the requested information was delivered according to the agreed upon schedule or within 30 calendar days absent such an agreement.
- M8.** Acceptable evidence for R3, Part 3.3 is dated documentation demonstrating the information was delivered within 30 calendar days.
- R4.** Each Transmission Owner, Generator Owner, and Distribution Provider shall: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*]
- 4.1.** Within 90 calendar days after receipt, confirm agreement with the summary results of a Protection System Study, as described in Requirement R1, Part 1.2, or absent such agreement propose revisions to achieve acceptable results.
  - 4.2.** Prior to the in-service date of any planned change at the Interconnected Facility, confirm the Protection System(s) changes as described in Requirement R3, Part 3.1, are acceptable.
  - 4.3.** Within 30 calendar days after receipt:
    - 4.3.1** Confirm the Protection System(s) changes are acceptable pursuant to notification received per Requirement R3, Part 3.3.1.
    - 4.3.2** Confirm the Protection System(s) changes are acceptable pursuant to notification received per Requirement R3, Part 3.3.2.
- M9.** Acceptable evidence for R4, Parts 4.1, 4.2, and 4.3 is dated documentation (electronic or hard copy) demonstrating confirmation was achieved in accordance with the respective timeframe.

**Rationale for R4:** This requirement ensures owners of Interconnected Facilities confirm that the each Protection System(s) applied on each of its Interconnected Facilities is acceptable per the conditions identified in Parts 4.1, 4.2, and 4.3.

**Part 4.1** The SDT believes ninety (90) calendar days is a reasonable time for the owners of existing Interconnected Facilities to resolve differences and reach agreement.

**Part 4.2** The SDT believes that proposed modifications (including implementation schedules) to Interconnected Facilities as described in Requirement R3, Part 3.1 must be communicated and agreed to prior to the in-service date. Agreement assures that the coordination of Protection Systems for Interconnected Facilities is achieved.

**Part 4.3** The SDT believes thirty (30) calendar days is a reasonable time for the owners of existing Interconnected Facilities to resolve differences and reach agreement for the conditions noted in Parts 4.3.1 and 4.3.2

## C. Compliance

### 1. Compliance Monitoring Process

#### 1.1. Compliance Enforcement Authority

Regional Entity

#### 1.2. Evidence Retention

The following evidence retention periods identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full time period since the last audit.

**1.2.1** Each Responsible Entity shall retain data or evidence for three calendar years unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

**1.2.2** If a Registered Entity is found non-compliant, it shall keep information related to the non-compliance until mitigation is complete and approved or for the time specified above, whichever is longer.

**1.2.3** The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent audit records.

#### 1.3. Compliance Monitoring and Assessment Processes:

Compliance Audit

Self-Certification

Spot Checking

Compliance Investigation

Self-Reporting

Complaint

#### 1.4. Additional Compliance Information

None

Table of Compliance Elements

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R1	Operations Planning, Long-term Planning	Medium	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.1 but was late by less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.2 or documented why a study was not required but was late by less than or equal to 10 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible</p>	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.1 but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.2 or documented why a study was not required but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible</p>	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.2 or documented why a study was not required but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible</p>	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.2 or documented why a study was not required but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			entity provided the Protection System Study results in accordance with R1, Part 1.2 but was late by 10 calendar days or less.	entity provided the Protection System Study results in accordance with R1, Part 1.2 but was late by more than 10 calendar days but less than or equal to 20 calendar days.	entity provided the Protection System Study results in accordance with R1, Part 1.2 but was late by more than 20 calendar days but less than or equal to 30 calendar days.	entity provided the Protection System Study results in accordance with R1, Part 1.2 but was late by more than 30 calendar days.  OR  The responsible entity failed to perform a Protection System Study on an Interconnected Facility per R1, Parts 1.1.1, 1.1.2, or 1.1.3, or document why a study was not required.  OR  The responsible entity failed to provide Protection System Study results in accordance with R1, Part 1.2.
<b>R2</b>	<b>Long-term Planning</b>	<b>Medium</b>	The Transmission Owner performed a short-circuit study as described in R2,	The Transmission Owner performed a short-circuit study as described in R2,	The Transmission Owner performed a short-circuit study as described in R2,	The Transmission Owner performed a short-circuit study as described in R2,

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			<p>Part 2.1 but was late by less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner notified the Interconnected Facility owner of the changes in Fault currents but was late by less than or equal to 10 calendar days.</p>	<p>Part 2.1 but was late by more than 30 calendar days but less than or equal to 40 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner notified the Interconnected Facility owner of the changes in Fault currents but was late by more than 10 calendar days but less than or equal to</p>	<p>Part 2.1 but was late by more than 40 calendar days but less than or equal to 50 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner notified the Interconnected Facility owner of the changes in Fault currents but was late by more than 20 calendar days but less than or equal to</p>	<p>Part 2.1 but was late by more than 50 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner failed to perform a short-circuit study as described in R2, Part 2.1.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner failed to calculate the percent deviation between the Fault currents according to the formula designated in R2, Part 2.2.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner notified the Interconnected Facility owner of the changes in Fault currents but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
				20 calendar days.	30 calendar days.	The Transmission Owner failed to notify the Interconnected Facility owner of the changes in Fault currents.
<b>R3</b>	<b>Operations Planning</b>	<b>Medium</b>	<p>The responsible entity provided the requested information per R3, Part 3.2 but was late by 10 calendar days or less.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the</p>	<p>The responsible entity provided the requested information per R3, Part 3.2 but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the</p>	<p>The responsible entity provided the requested information per R3, Part 3.2 but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the</p>	<p>The responsible entity failed to provide information to the owners of the interconnected Facilities for any proposed change identified in R3.1.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the requested information per R3, Part 3.2 but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the</p>



R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			required information identified in R3, Part 3.3 but was late by 10 calendar days or less.	required information identified in R3, Part 3.3 but was late by more than 10 calendar days but less than or equal to 20 calendar days.	required information identified in R3, Part 3.3 but was late by more than 20 calendar days but less than or equal to 30 calendar days	required information identified in R3, Part 3.3 but was late by more than 30 calendar days.  OR The responsible entity failed to provide the requested information.
<b>R4</b>	<b>Operations Planning</b>	<b>Medium</b>	The responsible entity confirmed agreement with the summary results of the Protection System Study per R4, Part 4.1 but was late by 10 calendar days or less.	The responsible entity confirmed agreement with the summary results of the Protection System Study per R4, Part 4.1 but was late by more than 10 calendar days but less than or equal to 20 calendar days.	The responsible entity confirmed agreement with the summary results of the Protection System Study per R4, Part 4.1 but was late by more than 20 calendar days but less than or equal to 30 calendar days.	The responsible entity confirmed agreement with the summary results of the Protection System Study per R4, Part 4.1 but was late by more than 30 calendar days.  OR The responsible entity failed to confirm agreement with the summary results of the Protection System Study per R4, Part 4.1.

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			<p>OR</p> <p>The responsible responded to the confirmation request per R4, Part 4.3, but was late by 10 calendar days or less.</p>	<p>OR</p> <p>The responsible responded to the confirmation request per R4, Part 4.3, but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p>	<p>OR</p> <p>The responsible responded to the confirmation request per R4, Part 4.3, but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p>	<p>OR</p> <p>The responsible entity failed to confirm acceptance of the planned changes pursuant to R4, Part 4.2 prior to implementation of those changes.</p> <p>OR</p> <p>The responsible responded to the confirmation request per R4, Part 4.3, but was late by more than 30 calendar days.</p> <p>OR</p> <p>The responsible entity failed to respond to the confirmation request per R4, Part 4.3.</p>

**D. Regional Variances**

None.

**E. Interpretations**

None.

**F. Associated Documents**

None.

### Guidelines and Technical Basis

#### Requirement R1:

This requirement directs the performance of Protection System Studies for every interconnected Facility to verify coordination of existing Protection Systems where no recent study exists or when Facility configuration or Fault current deviations of 10% or more have occurred. In developing the language to define Protection System Study, the SDT considered various reference books discussing protective relaying theory and application along with the following description of “coordination of protection” from the pending revision of IEEE C37.113 Guide for Protective Relay Applications to Transmission Lines:

*“The process of choosing current or voltage settings, or time delay characteristics of protective relays such that their operation occurs in a specified sequence so that interruption to customers is minimized and least number of power system elements are isolated following a system Fault.”*

Using the reference material cited above as guidance, the SDT defined the term Protection System Study for use within the PRC-027-1 Reliability Standard as:

“A study that demonstrates existing or proposed Protection Systems operate in the desired sequence for clearing Faults.”

Protection System Studies comprise a variety of assessments and underlying database activities that cumulatively serve to provide verification that Protection Systems will function as designed. Typical database activities performed during these studies include assembling impedance data for Fault studies and modeling Protection Systems. Ultimately, the particular studies performed depend on the protective relays installed, their application, and the Protection System philosophies of each Transmission Owner, Generator Owner, and Distribution Provider. These studies may include graphical coordination of protection characteristics on time-current or impedance graphs; relay scheme simulation studies using sequence of operations during pre-defined Faults; and sensitivity studies to confirm effective reaches, sufficient operating parameters (energy or operating torque), and adequate directional polarizing quantities.

The SDT believes applicable entities should have a documented Protection System Study for each interconnected Facility to validate the Protection Systems perform in a manner consistent with the purpose of this Standard. Additionally, the SDT believes that 36 months is an appropriate amount of time for entities to perform the initial studies expected under this requirement. This period considers the time some entities may require to create project scopes, acquire proposals, and secure contracts to hire external resources that may be needed to perform the studies. The SDT also has no evidence there is widespread miscoordination between interconnected Facilities that might warrant a shorter time-frame for the studies to be performed. Protection Systems are continually challenged by Faults on the BES but records collected for Reliability Standard PRC-004 do not indicate that lack of coordination was the predominate root cause of reported Misoperations.

It should be noted that Protection System studies performed after June 18, 2007 (the effective date of PRC-001-1) are sufficient to meet Requirement R1.

## Application Guidelines

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Parts 1.1.2 and 1.1.3 further direct that Protection System Studies must be completed under the following two circumstances:

1. After notification of an identified 10% or greater deviation in Fault current, the notified entities must perform a new Protection System study of the Interconnected Facility or document why a study is not required. The SDT recognizes that, based on the Protection Systems installed (e.g., current differential), a 10% or greater deviation in Fault current may not necessitate a new Protection System Study be performed; therefore this part of the requirement includes the statement, “unless the entity can demonstrate that such a study is not required”. The SDT believes the 6-month time frame associated with this requirement represents is a reasonable period to perform the studies that are required after identification by the 24-month Fault current review.
2. After proposing or being notified of a change at an Interconnected Facility, entities must perform a new Protection System study or document why a study is not required. The SDT recognizes that, based on the scope of the proposed change and/or the Protection Systems installed (e.g., current differential), the change may not necessitate a new Protection System Study be performed; therefore this part of the requirement includes the statement, “unless the entity can demonstrate that such a study is not required”. The SDT believes that specifying a single time frame for evaluation of the wide variety of conditions that may be associated with a particular change is not appropriate. This is because the SDT sees the entity initiating any change as having the incentive to move this along in a timely fashion in order to both keep the associated project on schedule and confirm the changes are acceptable “prior to the in-service date” as stipulated by Requirement R4, Part 4.2.

Requirement R1, Part 1.2 requires that the entity performing the Protection System Study to provide a summary of the study results to the affected owners of Protection Systems applied at interconnected Facilities. As guidance, the SDT lists the following inputs and results of a Protection System Study that may be included in the summary provided pursuant to this requirement:

1. Data used to determine Fault currents in performing the study along with a listing of the single-line-to-ground and 3-phase Fault currents for the Bus or Element at the Interconnected Facility under study.
2. A listing of the Protection System(s) owned by the entity performing the study that are adjacent to the Bus or Element at the Interconnected Facility and were reviewed for coordination of protective relays as part of the study.
3. A listing of any issues associated with the relay settings of the other owner(s) at the Interconnected Facility that were identified by the study.
4. Any proposed revisions to a Protection System or its protective relay settings that were identified by the study.

### Requirement R2:

The SDT investigated various inputs that would trigger a review of the existing Protection System Studies, and determined through the experience of the SDT members, along with informal surveys of several regional protection and control committees, that variations in Fault currents of 10% or more are an appropriate indicator that an updated Protection System Study may be necessary. These variations could have resulted from the accumulation of incremental changes over time. This requires a periodic review of Fault currents and includes the calculation of the percent deviation between the Fault current values used in the most recent Protection System Study and the present Fault current values indicated by the short-circuit study performed pursuant to this requirement. This calculation is necessary to identify Fault current changes that must be communicated in accordance with Requirement R2, Part 2.3.

Polling of SDT membership and various protection engineering committees indicates that short-circuit databases are customarily updated annually. Based on this information, the SDT believes that requiring a 24-month periodic review of Fault currents provides entities additional flexibility to schedule and perform these studies and calculate the percent deviation as described in Requirement R2, Part 2.2. The SDT believes studies associated with changes that would affect the coordination in less than 24-months would be triggered by other requirements in this standard.

Requirement R2, Part 2.3 further directs the Transmission Owner to, within 30 calendar days, inform interconnected Facility owners when short-circuit studies indicate that 10% deviations in Fault current have occurred at the Interconnected Facility. The SDT believes the 30-day time frame associated with this requirement is reasonable for sending notification to the interconnected entity(s) and is consistent with other NERC Reliability Standards.

In Requirement R2, the Transmission Owner is identified as the functional entity responsible for performing the Fault current studies because they maintain the data required to perform the studies. Generator data (including data provided by Distribution Providers) is incorporated into the Transmission Owners' short circuit models.

### Requirement R3:

This requires the Interconnected Facility owners to evaluate the impact to their Protection Systems due to proposed changes by requiring the registered functional entity initiating the changes to provide the details to the other affected entities of the Interconnected Facility. Documentation provided to these other owners may include, but is not limited to: power system configurations; protection schemes; schematics; instrument transformer ratios; type of relay(s); communication equipment applied for protection; and Protection System settings. The recipient will incorporate the applicable information into its Protection System Studies to evaluate whether changes are required.

The list of applicable changes provided in Requirement R3, Part 3.1 is inclusive, as it comprises either the protective equipment itself or the power system Elements that

affect the coordination of Protection Systems. The SDT recognizes that other Facility changes not directly associated with the interconnection can impact the Protection System Study of the interconnected Facilities; e.g., the addition of a large autotransformer bank or generator not directly associated with the interconnected Facilities. The SDT believes that it is not appropriate to specify a single time frame for providing the details of the wide variety of conditions listed in Requirement R3, Part 3.1 that may be associated with a particular change. This is because the SDT sees the entity initiating any change as having the incentive to move the process along in a timely fashion in order to both keep the associated project on schedule and confirm the changes are acceptable “prior to the in-service date” as stipulated by Requirement R4, Part 4.2.

Requirement R3, Part 3.2 allows for entities to agree upon a schedule, appropriate to the circumstances, for providing the details needed to conduct a Protection System Study or, absent such agreement, within 30 days of a request for this information. This requirement provides a means for entities to receive requested information in a timely manner. In consideration of circumstances where the information may not be readily available or may be incomplete due the retirement of personnel, the purging of records, change of ownership, etc., it also provides the flexibility of mutually agreeing to a schedule for exchanging information. The SDT believes 30 calendar days after receipt of the request is a sufficient time to provide the requested information where no other agreement exists.

Additionally, this requirement includes a provision for providing details associated with changes to the previously agreed upon coordination when: (1) Protection System errors are found during misoperation investigations, commissioning, or maintenance activities; (2) emergency replacements are made due to failures of Protection System components. Based upon the limited number of instances that would occur under such circumstances, the SDT believes 30 calendar days after determining that changes are required is an appropriate time frame for providing the associated details to affected entities.

### **Requirement R4:**

The reliability objective of this requirement is to bring the process of Protection System coordination full-circle by gaining the confirmation of interconnected entities that their Protection Systems are coordinated consistent with the purpose of this standard. Cooperative participation of Interconnected Facility owners in communicating Protection System(s) design and study results will achieve coordination of Protection Systems for reliable operation of the BES during Faults.

Requirement R4, Part 4.1 directs applicable entities to confirm agreement within 90 days of receiving a summary of results from an entity performing the Protection System Study that the results indicate, and/or follow-up revisions achieve coordination of the entities’ associated Protection Systems. The SDT believes 90 calendar days after receipt of the results of a Protection System Study provides a reasonable time for the owners of Interconnected Facilities to resolve differences and reach agreement that their Protection Systems are coordinated.

## Application Guidelines

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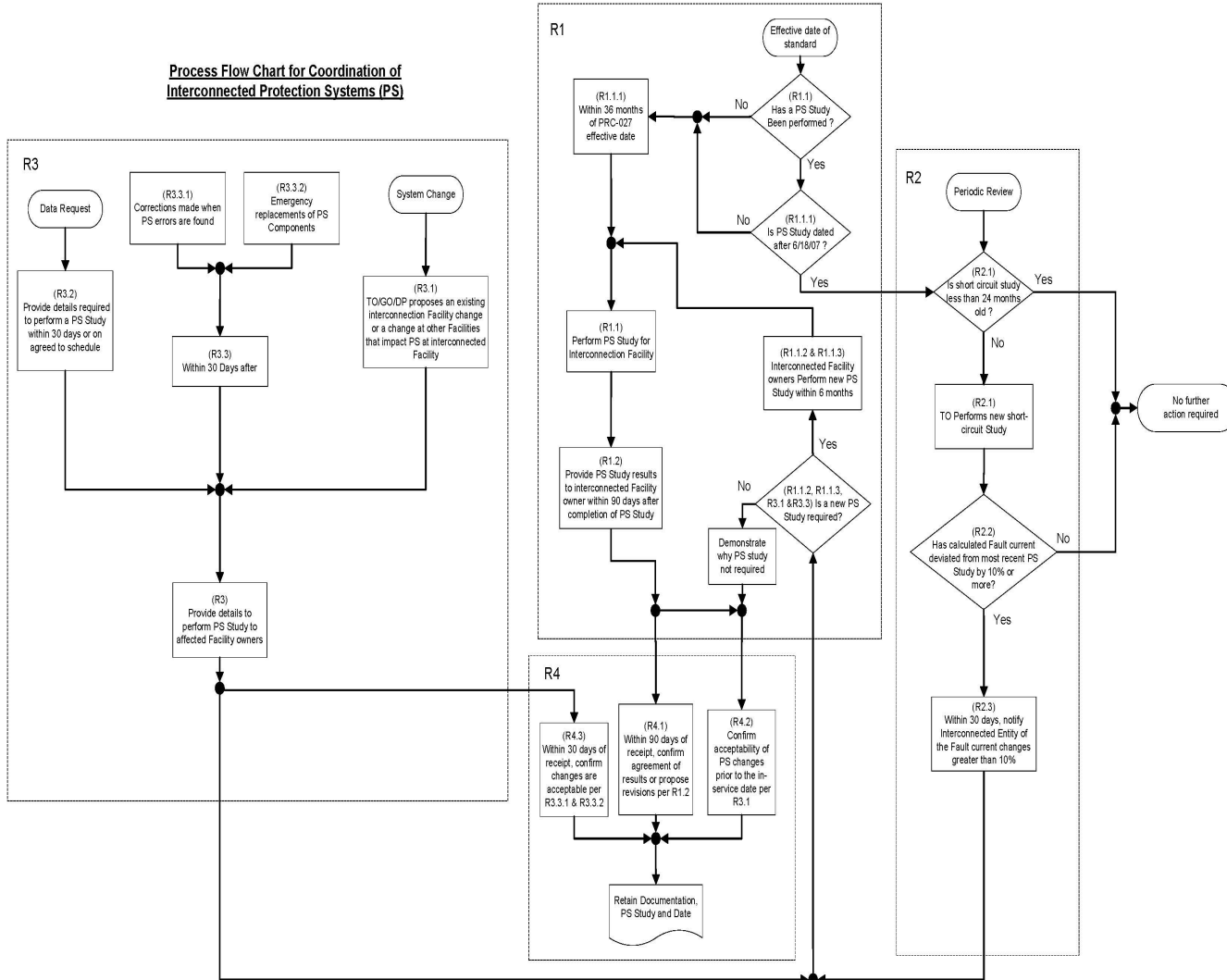
Requirement R4, Part 4.2 directs entities to confirm that planned changes described in Requirement 3.1 are acceptable prior to the in-service date of those changes. The purpose of this requirement is to assure the effects that planned changes have on Protection Systems at Interconnected Facilities have been considered by all affected entities.

Requirement R4, Parts 4.3.1 and 4.3.2 direct confirmation within 30 calendar days that changes are acceptable when corrections are made due to Protection System errors found during misoperation investigations, commissioning, or maintenance activities, or when emergency replacements are made due to failures of Protection System components. Based upon the limited number of instances that would occur under such circumstances, the SDT believes 30 calendar days provides adequate time for achieving such agreement.



## Process Flow Chart

Below is a complete representation of the process including the relationships between requirements:



## **Application Guidelines**

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### **Example Process**

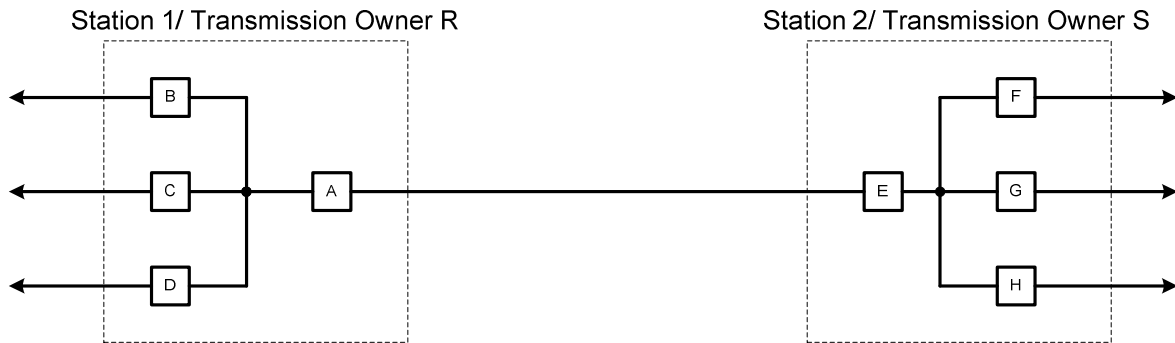
An example of the interaction between entities required to gather the information to perform an accurate study is below.

- The initiating entity (Entity A) will contact the interconnected entity (Entity B) and request up-to-date Protection System information.
- Upon receipt of the above request for information, Entity B will provide the information within 30 calendar days or an agreed upon time frame.
- Entity A will perform a Protection System Study using the information received.
- Entity A will provide a summary of the results of the study to Entity B within 90 calendar days of completing the Protection System Study.
- Entity B will review the summary information and confirm agreement within 90 calendar days of receiving the study results from Entity A that coordination is achieved.
  - In cases where the study reveals that changes to Protection Systems are needed, Entity B would propose to Entity A revisions that achieve acceptable results.
- Documentation of the final agreement is required prior to implementation of planned changes.

### Diagrams

Introduction: The diagrams below are intended to provide guidance related to the responsibilities associated with the Purpose of this Standard between Owners of interconnected Facilities. After the reviews and prior to implementation of the changes, the owners must reach agreement on the final settings to achieve coordination of the Protection Systems.

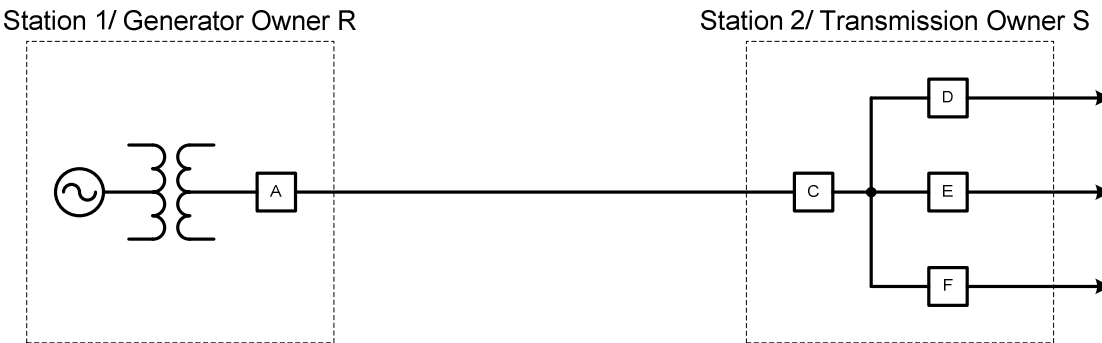
**Figure 1**



In Figure 1 above, the interconnecting Element between the Transmission interconnected Facilities (Station 1 – Transmission Owner R and Station 2 – Transmission Owner S) is the transmission line between Breakers A and E.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 1, the responsibility for Owner S is to verify that the Protection System settings associated with Breaker A (provided by Owner R) do not result in coordination issues with the Protection System settings associated with Breakers E, F, G, and H. Likewise, the responsibility for Owner R is to verify that the Protection System settings associated with Breaker E provided by Owner S do not result in coordination issues with the Protection System settings associated with Breakers A, B, C, and D.

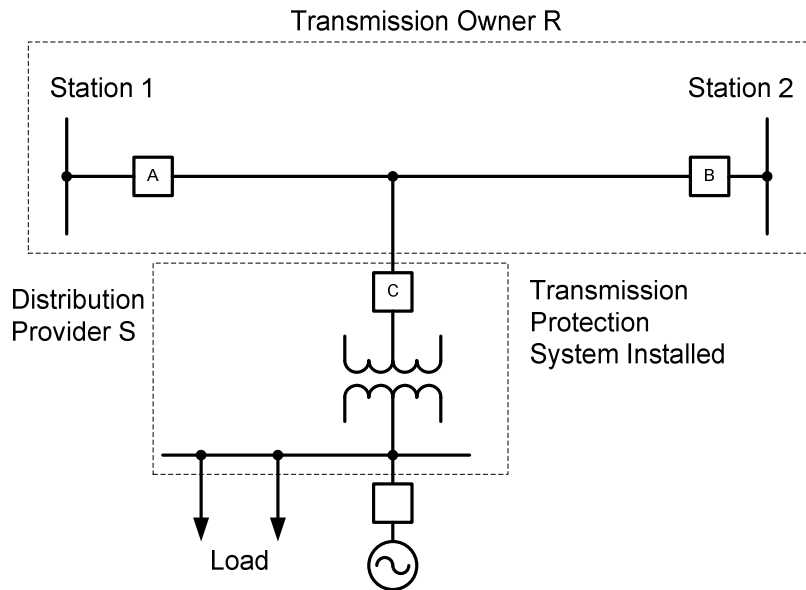
**Figure 2**



In Figure 2 above, the interconnecting Element between the Transmission to Generation Interconnected Facilities (Station 1 – Generation Owner R and Station 2 – Transmission Owner S) is the transmission line or bus between Breakers A and C.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 2, the responsibility for Transmission Owner S is to verify that the Protection System settings associated with Breaker A (provided by Owner R) and the generator Protection Systems do not result in coordination issues with the Protection System settings associated with Breakers C, D, E, and F. Likewise, the responsibility for Generation Owner R is to verify that the Protection System settings associated with Breaker C (provided by Owner S) do not result in coordination issues with the Protection System settings associated with Breaker A or the generator Protection Systems.

**Figure 3**

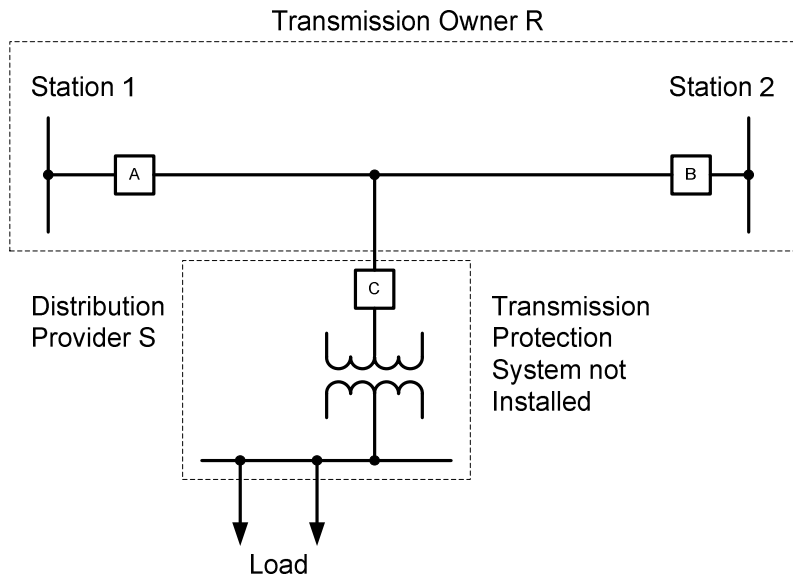


In Figure 3 above, the interconnecting Element between the Transmission Owner to Distribution Provider (with a generator) interconnected Facilities (Transmission Owner R line between Breakers A and B – Distribution Provider S) is the transmission line or tap between the line and Breaker C.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 3, the responsibility for Transmission Owner R is to verify that the Protection System settings associated with Line Breaker C (provided by Distribution Provider S) and the generator Protection Systems do not result in coordination issues with the Protection System settings associated with Breakers A and B and other Protection Systems at stations 1 and 2. Likewise, the responsibility for Distribution Provider S is to verify that the Protection System settings associated with Breakers A and B provided by Owner R do not result in coordination issues with the Protection System settings associated with Breaker C and the generator Protection Systems. In order to perform this verification, it will be necessary that the Generator Owner provide Distribution Provider S with its generator Protection System settings.

**Note:** A Protection System Study is required per this Standard for this example if a Protection System at the Distribution Provider's substation is designed to protect transmission Elements.

**Figure 4**

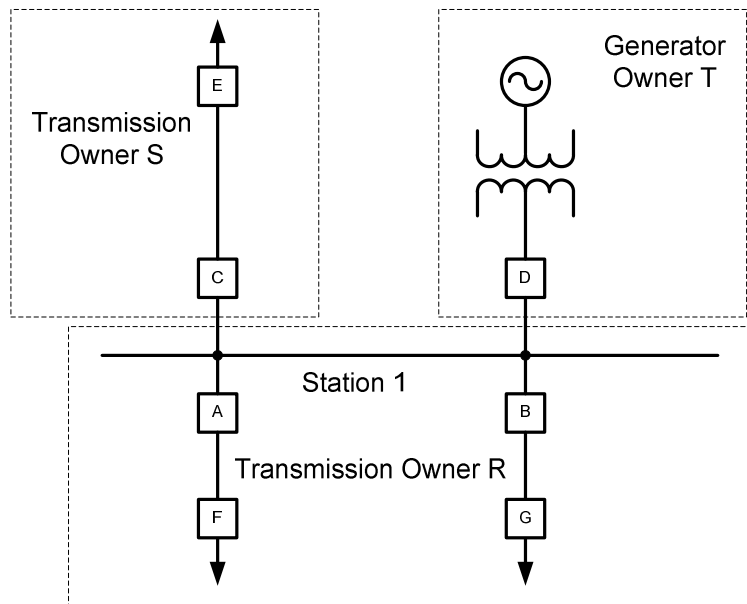


In Figure 4 above, the interconnecting Element between the Transmission Owner to Distribution Provider interconnected Facilities (Transmission Owner R line between Breakers A and B – Distribution Provider S) is the transmission line or tap between the line and Breaker C.

**Note:** No specific Protection System Study is required per this Standard for this example since the Protection System at the Distribution Provider’s substation is not designed to protect transmission Elements.

**Figure 5**

Transmission/Generation Facility with Multiple Owners



In Figure 5 above, the interconnecting Element between the Transmission Owners R and S and the Generation Owner T is the common Transmission bus. In this example, Transmission Owner S and Generator Owner T are not directly interconnected to each other at Transmission Station 1 and all direct interconnections are between Owner R and each of the other Owners connected to the bus.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 5:

The responsibility for Owner R is to verify that the Protection System settings associated with Breaker C, E, D, and the generator Protection System (provided by Owners S or T) do not result in coordination issues with the Protection System settings associated with Breakers A, B.

The responsibility for Owner S is to verify that the Protection System settings associated with Breakers A, F, B, G, D, and the generator Protection System (provided by Owners R or T) do not result in coordination issues with the Protection System settings associated with Breaker C. To perform this verification, it will be necessary that Transmission Owner R provide Owner S with its settings for Breakers A, F, B, and G as well as the settings for Breaker D and generator Protection System settings provided to Owner R by Generator Owner T.

The responsibility for Owner T is to verify that the Protection System settings associated with Breakers A, F, B, G, C, and E (provided by Owners R or S) do not result in coordination issues with the Protection System settings associated with Breaker D or the Protection Systems associated with generator Protection Systems. In order to perform this verification, it will be necessary that Transmission Owner R provide Generator Owner T with its settings for Breakers A, F, G, and B as well as the settings for Breaker C and E provided to Owner R by Transmission Owner S.

## Standard Development Timeline

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*This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.*

### Development Steps Completed

1. Draft 1 of SAR posted for comment June 11, 2007 – July 10, 2007.
2. SAR approved on August 13, 2007.
3. First posting of revised standard PRC-001-2 on September 11, 2009
4. Transitioned from a revision of PRC-001-1 to development of PRC-027-1 based on industry comments, Quality Review feedback, and consideration of FERC directives relative to the existing requirements of PRC-001-1.

### Description of Current Draft

The SPC SDT created a new Results-based standard PRC-027-1 to coordinate Protection Systems utilized to protect interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those that are actually required to isolate Faults and maintain reliability, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards. This standard incorporates and enhances the coordination aspects of Requirements R3 and R4 from PRC-001-1. The SPC SDT is requesting a posting for stakeholder comments under a 30-day formal comment period.

Anticipated Actions	Anticipated Date
Post first draft of standard for 30-day Formal Comment Period.	May 2012
45-day Formal Comment Period with Parallel Initial Ballot	August 2012
30-day Formal Comment Period with Parallel Successive Ballot	November 2012



### Effective Dates:

PRC-027-1 shall become effective on the first day of the first calendar quarter that is twelve months beyond the date that this standard is approved by applicable regulatory authorities. In those jurisdictions where regulatory approval is not required, this standard shall become effective on the first day of the first calendar quarter that is twelve months beyond the date that this standard is approved by the NERC Board of Trustees, or as otherwise made effective pursuant to the laws applicable to such ERO governmental authorities.

### Version History

Version	Date	Action	Change Tracking
1	TBD	Project 2007-06 – PRC-027-1	New

### Definitions of Terms Used in Standard

*This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved. When the standard becomes effective, these defined terms will be removed from the individual standard and added to the Glossary.*

#### Terms:

**Interconnected Facility:** Facilities that are electrically joined by one or more Elements and are owned by different functional entities.

**Protection System Study:** A study that demonstrates existing or proposed Protection Systems operate in the desired sequence for clearing Faults.

*When this standard has received ballot approval, the text boxes will be moved to the Application Guidelines Section of the Standard.*

## A. Introduction

1. **Title:** Protection System Coordination for Performance During Faults
2. **Number:** PRC-027-1
3. **Purpose:** To coordinate Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those required to isolate Faults, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards.
4. **Applicability:**
  - 4.1. **Functional Entities:**
    - 4.1.1 Transmission Owner
    - 4.1.2 Generator Owner
    - 4.1.3 Distribution Provider
  - 4.2 **Facilities:**

Protection Systems installed at Interconnected Facilities.

### 5. Background:

On December 7, 2006, the NERC Planning Committee approved the assessment of Reliability Standard PRC-001 – System Protection Coordination prepared by the NERC System Protection and Control Task Force (SPCTF). The SPCTF noted problems with the applicability to entities and vagueness of requirements in the existing PRC-001-1 Reliability Standard. The SPCTF concluded that the deficiencies of Reliability Standard PRC-001-1 were magnified by having requirements that addressed protection coordination of protection functions and capabilities in the operating and planning timeframes.

The NERC Standards Committee approved a Standard Authorization Request that included the modifications noted by the SPCTF for posting on June 5, 2007. The SAR was posted for comment from June 11, 2007 – July 10, 2007 and was subsequently approved.

The Project 2007-06 – System Protection Coordination Standard Drafting Team (SPC SDT) posted an initial draft of Reliability Standard PRC-001-2 on September 11, 2009 for comments. In that draft, the SPC SDT addressed the planning and non-operational issues identified by the SPCTF assessment for PRC-001-1 as well as the operating time frame issues identified in FERC Order 693. These operating time frame requirements involved detecting Protection System failures, informing operators, and taking quick corrective actions; consequently, the SPC SDT transferred the Order 693 directives associated with Reliability Standard PRC-001-1, Requirements R2, R5, and R6 to Project 2007-03 Real-time Operations for inclusion in the revisions of the appropriate operating standards associated within that project. Additionally, the SPC SDT determined that the training aspects of PRC-001-1, Requirement R1 are more appropriately addressed by Reliability Standard PER-005-1 with revision to its Applicability section to include the Generator Operator. The two remaining requirements, Requirements R3 and R4 of PRC-001-1 address the coordination of new and existing protective systems. These aspects of coordination are

incorporated and enhanced in the proposed Reliability Standard PRC-027-1 – Protection System Coordination for Performance During Faults.

The SPC SDT responded to the comments from the initial posting of PRC-001-2 and incorporated pertinent suggestions into the second draft of the standard in the first quarter of 2010. This second draft went through a NERC Quality Review in December 2010, which resulted in substantial changes to the standard. After informal consultations with industry stakeholders, as well as NERC and FERC staffs, the drafting team decided to focus their knowledge and expertise on developing a standard with the stated purpose: To coordinate Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those that are actually required to isolate Faults and maintain reliability, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards. The SPC SDT is presenting this first draft of PRC-027-1 for stakeholder review and comment.

Additionally, the requirements in PRC-027-1 take into account Recommendation 21 C of the Final Report on the August 14, 2003 Blackout in the United States and Canada written by the U.S.-Canada Power System Task Force which identified the need to address “the appropriate use of time delays in relays”, by requiring that individual interconnected entities cooperate in designing and setting their Protection Systems to achieve coordination.

**Other Aspects of coordination of Protection Systems addressed by other Projects:**

Fault clearing is the only aspect of protection coordination that is addressed by Reliability Standard PRC-027-1. Other items such as over/under frequency, over/under voltage, coordination of generating unit or plant voltage regulating controls, and relay loadability are addressed by the following existing standards or current projects.

- Underfrequency load shedding programs are addressed by PRC-006-1 (Project 2007-01 Underfrequency Load Shedding) and generator performance during frequency excursions is addressed by PRC-024-1 (Project 2007-09 Generator Verification).
- Undervoltage Load shedding programs are addressed by PRC-010-0 and will be improved by Project 2008-02 Undervoltage Load Shedding. Generator performance during voltage excursions is addressed by PRC-024-1x (Project 2007-09 Generator Verification).
- Coordination of Generating Unit or Plant Voltage Regulating Controls with Generating Unit or Plant Capabilities and Protection is addressed in PRC-019-1 (Project 2007-09).
- Transmission relay loadability is addressed in PRC-023-2.
- Generator relay loadability will be addressed in Phase 2 of Project 2010-13 Relay Loadability Order.
- Protective relay response during power swings will be addressed in Phase 3 of Project 2010-13 Relay Loadability Order.
- Misoperations identified as coordination issues are investigated and have Corrective Action Plans created in accordance with PRC-003-0 and PRC-004-2 (Project 2010-05.1).

The SPC SDT believes that including these other aspects of protection coordination within PRC-027-1 would cause duplication or conflict with requirements and compliance measurements of other standards.

## B. Requirements and Measures

- R1.** Each Transmission Owner, Generator Owner, and Distribution Provider shall: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning, Long-term Planning]*
- 1.1.** Perform a Protection System Study for each Interconnected Facility to verify that Protection Systems do not remove power system Elements from service except for those required to isolate Faults as follows:
    - 1.1.1** Within 36 calendar months after the effective date of this standard, if no Protection System Study for that Interconnected Facility exists that was performed on or subsequent to June 18, 2007.
    - 1.1.2** Within 6 calendar months after determining, or being notified of, a 10% or greater change in Fault current for that Interconnected Facility, as described in Requirement R2, unless the entity can demonstrate such a study is not required.
    - 1.1.3** When proposing or being notified of a change at the Interconnected Facility as described in Requirement R3, part 3.1 or part 3.3 unless the entity can demonstrate such a study is not required.
  - 1.2.** Provide to each affected Interconnected Facility owner, a summary of the results of each Protection System Study performed pursuant to this requirement, including at a minimum, the

**Rationale for R1** R1.1-This requirement ensures a Protection System study has been performed for every Interconnected Facility to verify coordination of existing Protection Systems. The SDT uses the term “Interconnected Facilities” to identify those Facilities that are electrically joined by a single Element and are owned by different entities. (Note: This also applies to a single owner with multiple functional registrations.)

R1.1.1 Protection System studies performed after June 18, 2007 (the effective date of PRC-001-1) and in accordance with PRC-001-1, are sufficient to meet Requirement R1, 1.1.1. The SDT believes that 36 months is an appropriate period of time for entities to perform the studies required where no study exists. The SDT has no evidence there is widespread miscoordination between Interconnected Facilities that warrants a shorter time-frame.

R1.1.2 The SDT believes that 6 months is an appropriate period of time for entities to perform the studies required when determining, or being notified of, a 10% or greater fault current deviation, where such conditions may warrant a new Protection System Study, or to justify why no such study is needed, i.e., when a line is protected by dual current differential systems with no backup elements set that are dependent upon fault current.

R1.1.3 The SDT believes that entities must perform the studies required when proposing or being notified of changes identified in Requirement R3 or to justify why no such study is needed. The SDT believes that no time frame is required for studies associated with Requirement R3 because notification of such a change may occur weeks or years prior to the change. The initiating entity has the incentive to provide the identified information as soon as possible to ensure timely implementations.

R1.2 This requirement provides for the communication of the results of a Protection System Study to allow the interconnected owner to review the results. The SDT believes to properly ensure coordination of Protection Systems of Interconnected Facilities; all entities need to assess the study results. The SDT believes that 90 calendar days is a reasonable time for the entity to provide the results of the Protection System Study performed in accordance with Requirement R1 to the interconnected Facility owner.

Protection System(s) reviewed, any issues identified, and any revisions proposed within 90 calendar days after the completion of each Protection System Study.

- M1.** Acceptable evidence for Requirement R1, part 1.1 is dated documentation indicating a Protection System Study was performed such as a dated summary of the results of the Protection System Study.
- M2.** Acceptable evidence for Requirement R1, part 1.2. is dated documentation which may include emails, electronic files, or hard copy records demonstrating transmittal and receipt of the summary of results of each Protection System Study within the specified time frame.
- R2.** For each Interconnected Facility, each Transmission Owner shall: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning, Long-term Planning]*
  - 2.1.** Not less than once every twenty-four months, perform a short-circuit study and analyze the percent deviation between the Fault current values used in the most recent Protection System Study (Single Line to Ground and 3-Phase for Bus or Element under consideration) and the present Fault current values indicated by the short-circuit study.
  - 2.2.** Calculate the percent deviation between the Fault current values analyzed pursuant to Requirement R2, part 2.1 using the following equation:
 
$$\% \text{ Deviation} = \left( \frac{V_{scs} - V_{pss}}{V_{pss}} \right) \times 100$$

Where:  $V_{scs}$  = Fault current value from present short-circuit study

And:  $V_{pss}$  = Fault current value from most recent Protection System Study
  - 2.3.** Within 30 calendar days after identification of any deviation in Fault current values found to be 10% or greater, notify each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility.
- M3.** Acceptable evidence for Requirement R2, part 2.1 is dated documentation or an electronic file containing the output(s) of the percent deviation calculation(s) including the Facilities analyzed.
- M4.** Acceptable evidence for Requirement R2, part 2.2 is dated documentation or an electronic file that verifies the formula used in the analysis pursuant to Requirement 2.1.

**Rationale for R2:** This requires a periodic review of Fault currents and notification to the applicable entities when deviations occur that meet the Requirement R2 criteria. It is important that Interconnected Facility owners are kept aware of changes that could affect proper performance of their Protection Systems. The Transmission Owner is identified as the entity responsible for performing the Fault current studies because they maintain the data necessary to perform the studies. The SDT determined that 10% was an appropriate point at which to require notification based on the fact that Protection System elements that can be affected by Fault current are typically set with margins well above 10%.

2.1 This requirement identifies which facilities must be analyzed and when. Short circuit databases are customarily updated annually, so the SDT believes 24 months provides the entities flexibility to schedule and perform the new short-circuit studies and calculation of percent deviation. The SDT believes studies associated with changes that would affect the coordination in less time would be triggered by other requirements in this standard.

2.2. This Part provides the formula to be used in the calculation for the facility under consideration.

2.3 The SDT believes the 30-day time frame is reasonable for sending notification(s) to the interconnected entity(s).

**M5.** Acceptable evidence for Requirement R2, part 2.3 is documentation demonstrating the transmittal and receipt of the notification to each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility

**R3.** Each Transmission Owner, Generator Owner, and Distribution Provider shall provide to each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility, the details (e.g., project schedule, protective relaying scheme types and settings, etc.) as follows: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning]*

**3.1.** For any change or additions listed below; either, at an existing or new Interconnected Facility, or at other Facilities when the proposed change modifies the conditions used in the coordination of Protection Systems of the Interconnected Facilities.

- New installation, replacement with different types, or modification of: protective relays or protective function settings, communication systems, current transformer ratios and voltage transformer ratios.
- Changes to line lengths and/or conductor size or spacing.
- Additions, removals, and/or replacements of transmission system Element(s).
- Changes to generator unit(s) including replacements, re-ratings, and impedances.
- Replacement of the generator step-up transformer(s).

**3.2.** According to an agreed upon schedule with a Transmission Owner, Generator Owner, or Distribution Provider; or absent such an agreement, within 30 calendar days of receiving a request for information.

**3.3.** Within 30 calendar days after:

**3.3.1** Corrections are made when Protection System errors are found during misoperation investigations, commissioning, or maintenance activities.

**3.3.2** Emergency replacements are made due to failures of Protection System components.

**Rationale for R3:** This requires the transfer of appropriate information to the entities connected at each interconnection due circumstances identified in R3.1 R3.2, and R3.3

3.1 The reliability objective of this requirement is to enable the process of conducting Protection System Studies by ensuring that the information is provided to the Interconnected Facility owner(s) in a timely manner. The SDT believes that no single time frame is appropriate for the wide variety of conditions that will need to be evaluated. The list in the requirement is inclusive as it comprises either the protective equipment itself or the power system Elements that affect the coordination of Protection Systems. This requirement would also pertain to changes identified as a result of studies performed in R1.1.

R3.2 The purpose of this requirement is to provide a means for an entity to receive requested information from an interconnected owner in a timely manner in order to perform a Protection System Study as required by R1.1.1, R1.1.2, R1.1.3 The SDT believes 30 calendar days after receipt of the request is a sufficient time to provide this information. The requirement also provides some flexibility for the parties involved to determine an otherwise agreed to schedule, if appropriate.

R3.3 The SDT believes 30 calendar days after the conditions noted in Part 3.3.1 and Part 3.3.2 is a sufficient time to provide the information.

- M6. Acceptable evidence for Requirement R3, part 3.1 is documentation which may include emails, electronic files, or hard copy records demonstrating transmittal and receipt of project information. Evidence may include, but is not limited to, a summary of the future project or technical specifications of the proposed changes.
- M7. Acceptable evidence for Requirement R3, part 3.2 is dated documentation demonstrating the requested information was delivered according to the agreed upon schedule or within 30 calendar days absent such an agreement.
- M8. Acceptable evidence for Requirement R3, part 3.3 is dated documentation demonstrating the information was delivered within 30 calendar days.

**R4.** Each Transmission Owner, Generator Owner, and Distribution Provider shall: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*]

- 4.1. Within 90 calendar days after receipt, confirm agreement with the results of the summary of a Protection System Study, as described in Requirement R1, part 1.2, or absent such agreement propose revisions to achieve acceptable results.
- 4.2. Prior to the in-service date of any planned change at the Interconnected Facility, confirm the Protection System(s) changes as described in Requirement R3, part 3.1, are acceptable.
- 4.3. Within 30 calendar days after:
  - 4.3.1 Confirm the Protection System(s) changes are acceptable pursuant to notification received per Requirement R3, part 3.3.1.
  - 4.3.2 Confirm the Protection System(s) changes are acceptable pursuant to notification received per Requirement R3, part 3.3.2.

**Rationale for R4:** This requirement ensures owners of Interconnected Facilities confirm that the each Protection System(s) applied on each of its Interconnected Facilities is acceptable per the conditions identified in parts R4.1, R4.2, and R4.3.

R4.1 The SDT believes ninety (90) calendar days is a reasonable time for the owners of existing Interconnected Facilities to resolve differences and reach agreement.

R4.2. The purpose of this requirement is to assure that entities achieve agreement(s) prior to implementing modifications to Interconnected Facilities assures that proposals are properly communicated and implementations are appropriately scheduled. The SDT believes the agreements reached through these efforts provide assurance that coordination of Protection Systems for Interconnected Facilities is achieved.

R4.3 The SDT believes thirty (30) calendar days is a reasonable time for the owners of existing Interconnected Facilities to resolve differences and reach agreement for the conditions noted in part 4.3.1 and Part 4.3.2

- M9. Acceptable evidence for Requirement R4 is dated documentation (electronic or hard copy) demonstrating confirmation was achieved in accordance with the respective timeframe.

## C. Compliance

### 1. Compliance Monitoring Process

#### 1.1. Compliance Enforcement Authority

Regional Entity

#### 1.2. Evidence Retention



The following evidence retention periods identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full time period since the last audit.

- 1.2.1** Each Responsible Entity shall retain data or evidence for three calendar years unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.
- 1.2.2** If a Registered Entity is found non-compliant, it shall keep information related to the non-compliance until mitigation is complete and approved or for the time specified above, whichever is longer.
- 1.2.3** The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent audit records.

**1.3. Compliance Monitoring and Assessment Processes:**

- Compliance Audit
- Self-Certification
- Spot Checking
- Compliance Investigation
- Self-Reporting
- Complaint

**1.4. Additional Compliance Information**

- None

Table of Compliance Elements

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R1	Operations Planning, Long-term Planning	Medium	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per R.1.1.1 but was late by less than or equal to 30 calendar days.</p> <p>OR</p> <p>The responsible entity performed a Protection System Study on an interconnected Facility per R.1.1.2 or documented why a study was not required but was late by less than or equal to 10 calendar days.</p> <p>OR</p> <p>The responsible entity provided the Protection System Study results in accordance with R.1.2 but was late</p>	<p>The responsible entity performed a Protection System Study on an interconnected Facility per R.1.1.1 but was late by more than 30 calendar days.</p> <p>OR</p> <p>The responsible entity performed a Protection System Study on an interconnected Facility per R.1.1.2 or documented why a study was not required but was late by more than 10 calendar days but less than or equal to 20 calendar days</p> <p>OR</p> <p>The responsible entity provided the Protection System Study results in accordance R1.2</p>	<p>The responsible entity performed a Protection System Study on an interconnected Facility per R.1.1.2 or documented why a study was not required but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p> <p>OR</p> <p>The responsible entity provided the Protection System Study results in accordance with R1.2 but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p>	<p>The responsible entity performed a Protection System Study on an interconnected Facility per R.1.1.2 or documented why a study was not required but was late by more than 30 calendar days.</p> <p>OR</p> <p>The responsible entity failed to perform a Protection System Study on an interconnected Facility per R.1.1.1, R1.1.2, or R1.1.3, or document why a study was not required</p> <p>OR</p> <p>The responsible entity provided the Protection System Study results in accordance with R1.2 but was late by</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			by 10 calendar days or less.	but was late by more than 10 calendar days but less than or equal to 20 calendar days.		more than 30 calendar days. OR The responsible entity failed to provide Protection System Study results in accordance with R1.2.
<b>R2</b>	<b>Long-term Planning</b>	<b>Medium</b>	<p>The Transmission Owner calculated the percent deviation between the Fault currents on an interconnected Bus or Element but was late by less than or equal to 30 calendar days.</p> <p>OR</p> <p>The Transmission Owner notified the interconnected Facility owner of the changes in Fault currents but was late by less than or equal to 10 calendar days.</p>	<p>The Transmission Owner calculated the percent deviation between the Fault currents on an interconnected Bus or Element but was late by more than 30 calendar days but less than or equal to 60 calendar days.</p> <p>OR</p> <p>The Transmission Owner notified the interconnected Facility owner of the changes in Fault currents but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p>	<p>The Transmission Owner calculated the percent deviation between the Fault currents on an interconnected Bus or Element but was late by more than 60 calendar days but less than or equal to 90 calendar days.</p> <p>OR</p> <p>The Transmission Owner notified the interconnected Facility owner of the changes in Fault currents but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p>	<p>The Transmission Owner calculated the percent deviation between the Fault currents on an interconnected Bus or Element but was late by more than 90 calendar days.</p> <p>OR</p> <p>The Transmission Owner failed to calculate the percent deviation between the Fault currents on an interconnected Bus or Element.</p> <p>OR</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			days.	calendar days but less than or equal to 20 calendar days.	calendar days but less than or equal to 30 calendar days.	<p>The Transmission Owner notified the interconnected Facility owner of the changes in Fault currents but was late by more than 30 calendar days.</p> <p>OR</p> <p>The Transmission Owner failed to notify the interconnected Facility owner of the changes in Fault currents.</p> <p>OR</p> <p>The Transmission Owner failed to calculate the percent deviation between the Fault currents on an interconnected Bus or Element according to the formula Designated in R2.2.</p>
<b>R3</b>	<b>Operations Planning</b>	<b>Medium</b>	The responsible entity provided the requested	The responsible entity provided the requested	The responsible entity provided the requested	The responsible entity failed to provide information

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			information per R.3.2 but was late by 10 calendar days or less.  OR  The responsible entity provided the required information identified in R3.3 but was late by 10 calendar days or less.	information per R.3.2 but was late by more than 10 calendar days but less than or equal to 20 calendar days.  OR  The responsible entity provided the required information identified in R3.3 but was late by more than 10 calendar days but less than or equal to 20 calendar days.	information per R.3.2 but was late by more than 20 calendar days but less than or equal to 30 calendar days.  OR  The responsible entity provided the required information identified in R3.3 but was late by more than 20 calendar days but less than or equal to 30 calendar days	to the owners of the interconnected Facilities for any proposed change identified in R3.1.  OR  The responsible entity provided the requested information per R.3.2 but was late by more than 30 calendar days.  OR  The responsible entity provided the required information identified in R3.3 but was late by more than 30 calendar days.  OR  The responsible entity failed to provide the requested information.
<b>R4</b>	<b>Operations</b>	<b>Medium</b>	The responsible entity agreed to the	The responsible entity agreed to the	The responsible entity agreed to the	The responsible entity agreed to the

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
	<b>Planning</b>		<p>results of the Protection System Study on an interconnected Facility per R.4.1 but was late by 10 calendar days or less.</p> <p style="text-align: center;">OR</p> <p>The responsible responded to the confirmation request per R.4.3, but was late by 10 calendar days or less.</p>	<p>results of the Protection System Study on an interconnected Facility per R.4.1 but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible responded to the confirmation request per R.4.3, but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p>	<p>results of the Protection System Study on an interconnected Facility per R.4.1 but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible responded to the confirmation request per R.4.3, but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p>	<p>results of the Protection System Study on an interconnected Facility per R.4.1 but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity failed to agree to the results of the Protection System Study on an interconnected Facility per R.4.1.</p> <p style="text-align: center;">OR</p> <p>The responsible entity failed to agree to the changes proposed in R.4.2 prior to implementation of those changes.</p> <p style="text-align: center;">OR</p> <p>The responsible responded to the confirmation request per R.4.3, but was late by more than 30</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
						calendar days. OR OR The responsible entity failed to The responsible responded to the confirmation request per R.4.3.

**D. Regional Variances**

None.

**E. Interpretations**

None.

**F. Associated Documents**

None.

### Guidelines and Technical Basis

#### Requirement R1:

This requirement directs the performance of Protection System Studies for every interconnected Facility to verify coordination of existing Protection Systems where no recent study exists or when Facility configuration or Fault current deviations of 10% or more have occurred. In developing the language to define Protection System Study, the SDT considered various reference books discussing protective relaying theory and application along with the following description of “coordination of protection” from the pending revision of IEEE C37.113 Guide for Protective Relay Applications to Transmission Lines:

*“The process of choosing current or voltage settings, or time delay characteristics of protective relays such that their operation occurs in a specified sequence so that interruption to customers is minimized and least number of power system elements are isolated following a system Fault.”*

Using the reference material cited above as guidance, the SDT defined the term Protection System Study for use within the PRC-027-1 Reliability Standard as:

“A study that demonstrates existing or proposed Protection Systems operate in the desired sequence for clearing Faults.”

Protection System Studies comprise a variety of assessments and underlying database activities that cumulatively serve to provide verification that Protection Systems will function as designed. Typical database activities performed during these studies include assembling impedance data for Fault studies and modeling Protection Systems. Ultimately, the particular studies performed depend on the protective relays installed, their application, and the Protection System philosophies of each Transmission Owner, Generator Owner, and Distribution Provider. These studies may include graphical coordination of protection characteristics on time-current or impedance graphs; relay scheme simulation studies using sequence of operations during pre-defined Faults; and sensitivity studies to confirm effective reaches, sufficient operating parameters (energy or operating torque), and adequate directional polarizing quantities.

The SDT believes applicable entities should have a documented Protection System Study for each interconnected Facility to validate the Protection Systems perform in a manner consistent with the purpose of this Standard. Additionally, the SDT believes that 36 months is an appropriate amount of time for entities to perform the initial studies expected under this requirement. This period considers the time some entities may require to create project scopes, acquire proposals, and secure contracts to hire external resources that may be needed to perform the studies. The SDT also has no evidence there is widespread miscoordination between interconnected Facilities that might warrant a shorter time-frame for the studies to be performed. Protection Systems are continually challenged by Faults on the BES but records collected for Reliability Standard PRC-004 do not indicate that lack of coordination was the predominate root cause of reported Misoperations.



## Application Guidelines

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It should be noted that Protection System studies performed after June 18, 2007 (the effective date of PRC-001-1) are sufficient to meet Requirement R1.

Sub requirements 1.1.2 and 1.1.3 further direct that Protection System studies must be completed under the following two circumstances:

1. After notification of an identified 10% or greater deviation in Fault current, the notified entities must perform a new Protection System study of the Interconnected Facility or document why a study is not required. The SDT recognizes that, based on the Protection Systems installed (e.g., current differential), a 10% or greater deviation in Fault current may not necessitate a new Protection System Study be performed; therefore this part of the requirement includes the statement, “unless the entity can demonstrate that such a study is not required”. The SDT believes the 6-month time frame associated with this requirement represents is a reasonable period to perform the studies that are required after identification by the 24-month Fault current review.
2. After proposing or being notified of a change at an Interconnected Facility, entities must perform a new Protection System study or document why a study is not required. The SDT recognizes that, based on the scope of the proposed change and/or the Protection Systems installed (e.g., current differential), the change may not necessitate a new Protection System Study be performed; therefore this part of the requirement includes the statement, “unless the entity can demonstrate that such a study is not required”. The SDT believes that specifying a single time frame for evaluation of the wide variety of conditions that may be associated with a particular change is not appropriate. This is because the SDT sees the entity initiating any change as having the incentive to move this along in a timely fashion in order to both keep the associated project on schedule and confirm the changes are acceptable “prior to the in-service date” as stipulated by Requirement R4, part 4.2.

Requirement R1, part 1.2 requires that the entity performing the Protection System Study to provide a summary of the study results to the affected owners of Protection Systems applied at interconnected Facilities. As guidance, the SDT lists the following inputs and results of a Protection System Study that may be included in the summary provided pursuant to this requirement:

1. Data used to determine Fault currents in performing the study along with a listing of the single-line-to-ground and 3-phase Fault currents for the Bus or Element at the Interconnected Facility under study.
2. A listing of the Protection System(s) owned by the entity performing the study that are adjacent to the Bus or Element at the Interconnected Facility and were reviewed for coordination of protective relays as part of the study.
3. A listing of any issues associated with the relay settings of the other owner(s) at the Interconnected Facility that were identified by the study.

## Application Guidelines

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4. Any proposed revisions to a Protection System or its protective relay settings that were identified by the study.

### Requirement R2:

The SDT investigated various inputs that would trigger a review of the existing Protection System Studies, and determined through the experience of the SDT members, along with informal surveys of several regional protection and control committees, that variations in Fault currents of 10% or more are an appropriate indicator that an updated Protection System Study may be necessary. These variations could have resulted from the accumulation of incremental changes over time. This requires a periodic review of Fault currents and includes the calculation of the percent deviation between the Fault current values used in the most recent Protection System Study and the present Fault current values indicated by the short-circuit study performed pursuant to this requirement. This calculation is necessary to identify Fault current changes that must be communicated in accordance with Requirement R2, part 2.3.

Polling of SDT membership and various protection engineering committees indicates that short-circuit databases are customarily updated annually. Based on this information, the SDT believes that requiring a 24-month periodic review of Fault currents provides entities additional flexibility to schedule and perform these studies and calculate the percent deviation as described in Requirement R2, part 2.2. The SDT believes studies associated with changes that would affect the coordination in less than 24-months would be triggered by other requirements in this standard.

Requirement R2, part 2.3 further directs the Transmission Owner to, within 30 calendar days, inform interconnected Facility owners when short-circuit studies indicate that 10% deviations in Fault current have occurred at the Interconnected Facility. The SDT believes the 30-day time frame associated with this requirement is reasonable for sending notification to the interconnected entity(s) and is consistent with other NERC Reliability Standards.

In Requirement R2, the Transmission Owner is identified as the functional entity responsible for performing the Fault current studies because they maintain the data required to perform the studies. Generator data (including data provided by Distribution Providers) is incorporated into the Transmission Owners' short circuit models.

### Requirement R3:

This requires the Interconnected Facility owners to evaluate the impact to their Protection Systems due to proposed changes by requiring the registered functional entity initiating the changes to provide the details to the other affected entities of the Interconnected Facility. Documentation provided to these other owners may include, but is not limited to: power system configurations; protection schemes; schematics; instrument transformer ratios; type of relay(s); communication equipment applied for protection; and Protection System settings. The recipient will incorporate the applicable

information into its Protection System Studies to evaluate whether changes are required.

The list of applicable changes provided in Requirement R3, part 3.1 is inclusive, as it comprises either the protective equipment itself or the power system Elements that affect the coordination of Protection Systems. The SDT recognizes that other Facility changes not directly associated with the interconnection can impact the Protection System Study of the interconnected Facilities; e.g., the addition of a large autotransformer bank or generator not directly associated with the interconnected Facilities. The SDT believes that it is not appropriate to specify a single time frame for providing the details of the wide variety of conditions listed in Requirement R3, part 3.1 that may be associated with a particular change. This is because the SDT sees the entity initiating any change as having the incentive to move the process along in a timely fashion in order to both keep the associated project on schedule and confirm the changes are acceptable “prior to the in-service date” as stipulated by Requirement R4, part 4.2.

Requirement R3, part 3.2 allows for entities to agree upon a schedule, appropriate to the circumstances, for providing the details needed to conduct a Protection System Study or, absent such agreement, within 30 days of a request for this information. This requirement provides a means for entities to receive requested information in a timely manner. In consideration of circumstances where the information may not be readily available or may be incomplete due the retirement of personnel, the purging of records, change of ownership, etc., it also provides the flexibility of mutually agreeing to a schedule for exchanging information. The SDT believes 30 calendar days after receipt of the request is a sufficient time to provide the requested information where no other agreement exists.

Additionally, this requirement includes a provision for providing details associated with changes to the previously agreed upon coordination when: (1) Protection System errors are found during misoperation investigations, commissioning, or maintenance activities; (2) emergency replacements are made due to failures of Protection System components. Based upon the limited number of instances that would occur under such circumstances, the SDT believes 30 calendar days after determining that changes are required is an appropriate time frame for providing the associated details to affected entities.

### **Requirement R4:**

The reliability objective of this requirement is to bring the process of Protection System coordination full-circle by gaining the confirmation of interconnected entities that their Protection Systems are coordinated consistent with the purpose of this standard. Cooperative participation of Interconnected Facility owners in communicating Protection System(s) design and study results will achieve coordination of Protection Systems for reliable operation of the BES during Faults.

Requirement R4, part 4.1 directs applicable entities to confirm agreement within 90 days of receiving a summary of results from an entity performing the Protection System Study that the results indicate, and/or follow-up revisions achieve coordination of the entities’

## Application Guidelines

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associated Protection Systems. The SDT believes 90 calendar days after receipt of the results of a Protection System Study provides a reasonable time for the owners of Interconnected Facilities to resolve differences and reach agreement that their Protection Systems are coordinated.

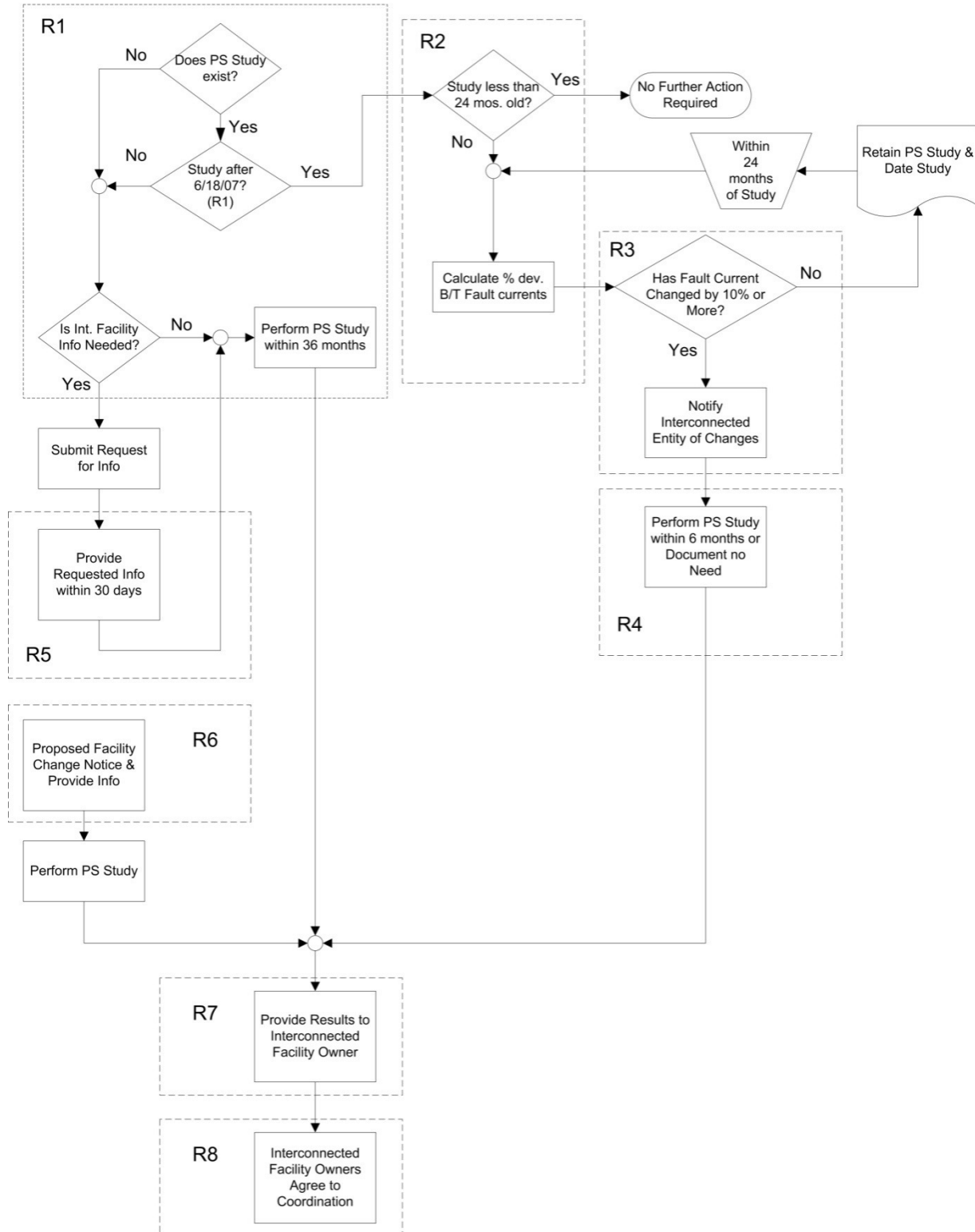
Requirement R4, part 4.2 directs entities to confirm that planned changes described in Requirement 3.1 are acceptable prior to the in-service date of those changes. The purpose of this requirement is to assure the effects that planned changes have on Protection Systems at Interconnected Facilities have been considered by all affected entities.

Requirement R4, parts 4.3.1 and 4.3.2 direct confirmation within 30 calendar days that changes are acceptable when corrections are made due to Protection System errors found during misoperation investigations, commissioning, or maintenance activities, or when emergency replacements are made due to failures of Protection System components. Based upon the limited number of instances that would occur under such circumstances, the SDT believes 30 calendar days provides adequate time for achieving such agreement.

**Process Flow Chart**

Below is a complete representation of the process including the relationships between requirements:

**Process Flow Chart for Coordination of Interconnected Facility Protection Systems (PS)**



## **Application Guidelines**

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### **Example Process**

An example of the interaction between entities required to gather the information to perform an accurate study is below.

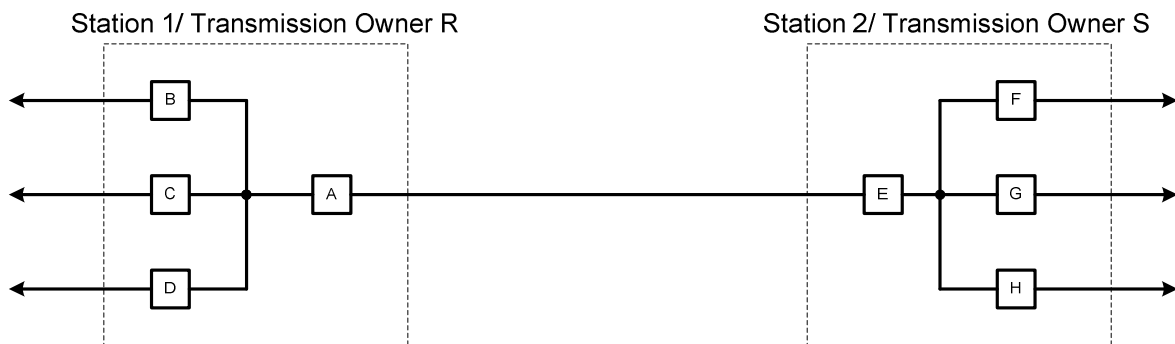
- The initiating entity (Entity A) will contact the interconnected entity (Entity B) and request up-to-date Protection System information.
- Upon receipt of the above request for information, Entity B will provide the information within 30 calendar days or an agreed upon time frame.
- Entity A will perform a Protection System Study using the information received.
- Entity A will provide a summary of the results of the study to Entity B within 90 calendar days of completing the Protection System Study.
- Entity B will review the summary information and confirm agreement within 90 calendar days of receiving the study results from Entity A that coordination is achieved.
  - In cases where the study reveals that changes to Protection Systems are needed, Entity B would propose to Entity A revisions that achieve acceptable results.
- Documentation of the final agreement is required prior to implementation of planned changes.

## Application Guidelines

### Diagrams

Introduction: The diagrams below are intended to provide guidance related to the responsibilities associated with the Purpose of this Standard between Owners of interconnected Facilities. After the reviews and prior to implementation of the changes, the owners must reach agreement on the final settings to achieve coordination of the Protection Systems.

Figure #1



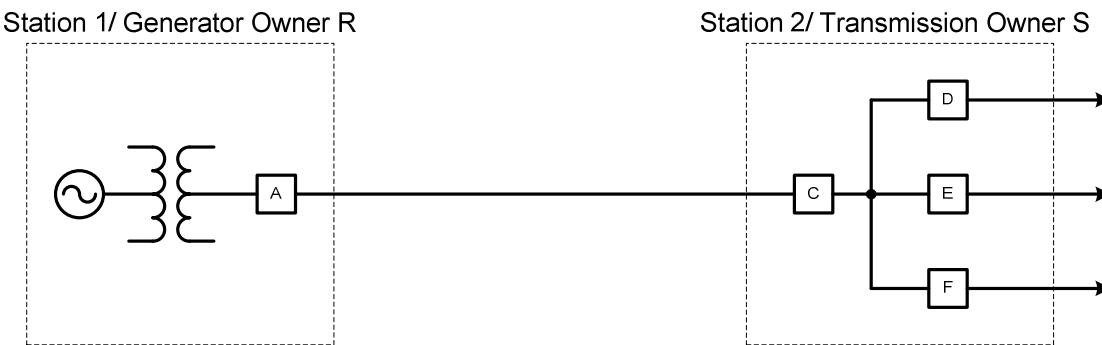
In Figure 1 above, the interconnecting Element between the Transmission interconnected Facilities (Station 1 – Transmission Owner R and Station 2 – Transmission Owner S) is the transmission line between Breakers A and E.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 1, the responsibility for Owner S is to verify that the Protection System settings associated with Breaker A (provided by Owner R) do not result in coordination issues with the Protection System settings associated with Breakers E, F, G, and H. Likewise, the responsibility for Owner R is to verify that the Protection System settings associated with Breaker E provided by Owner S do not result in coordination issues with the Protection System settings associated with Breakers A, B, C, and D.

## Application Guidelines

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Figure #2



In Figure 2 above, the interconnecting Element between the Transmission to Generation Interconnected Facilities (Station 1 – Generation Owner R and Station 2 – Transmission Owner S) is the transmission line or bus between Breakers A and C.

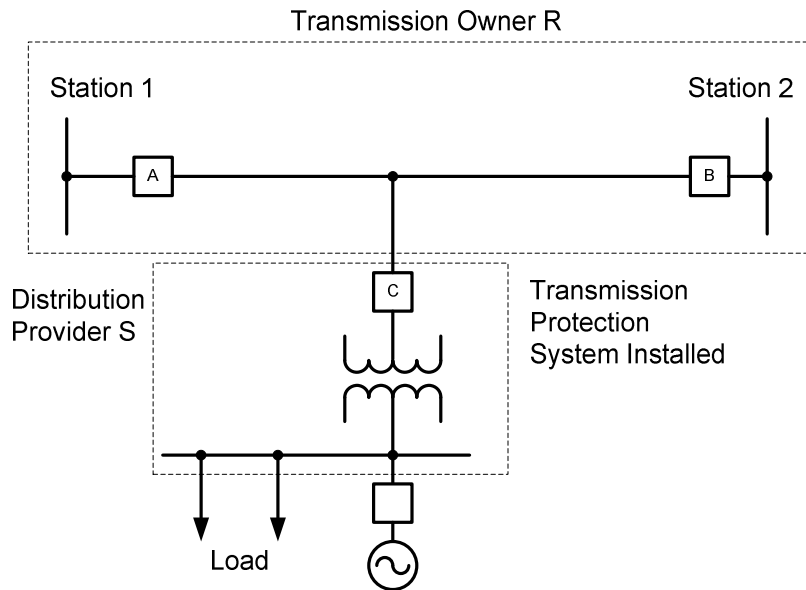
Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 2, the responsibility for Transmission Owner S is to verify that the Protection System settings associated with Breaker A (provided by Owner R) and the generator Protection Systems do not result in coordination issues with the Protection System settings associated with Breakers C, D, E, and F. Likewise, the responsibility for Generation Owner R is to verify that the Protection System settings associated with Breaker C (provided by Owner S) do not result in coordination issues with the Protection System settings associated with Breaker A or the generator Protection Systems.



## Application Guidelines

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Figure #3



In Figure 3 above, the interconnecting Element between the Transmission Owner to Distribution Provider (with a generator) interconnected Facilities (Transmission Owner R line between Breakers A and B – Distribution Provider S) is the transmission line or tap between the line and Breaker C.

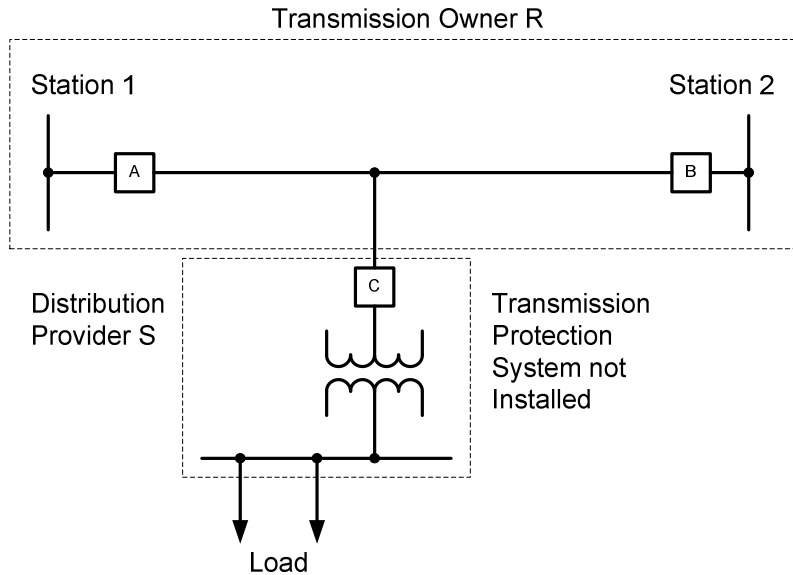
Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 3, the responsibility for Transmission Owner R is to verify that the Protection System settings associated with Line Breaker C (provided by Distribution Provider S) and the generator Protection Systems do not result in coordination issues with the Protection System settings associated with Breakers A and B and other Protection Systems at stations 1 and 2. Likewise, the responsibility for Distribution Provider S is to verify that the Protection System settings associated with Breakers A and B provided by Owner R do not result in coordination issues with the Protection System settings associated with Breaker C and the generator Protection Systems. In order to perform this verification, it will be necessary that the Generator Owner provide Distribution Provider S with its generator Protection System settings.

**Note:** A Protection System Study is required per this Standard for this example if a Protection System at the Distribution Provider's substation is designed to protect transmission Elements.

## Application Guidelines

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Figure #4



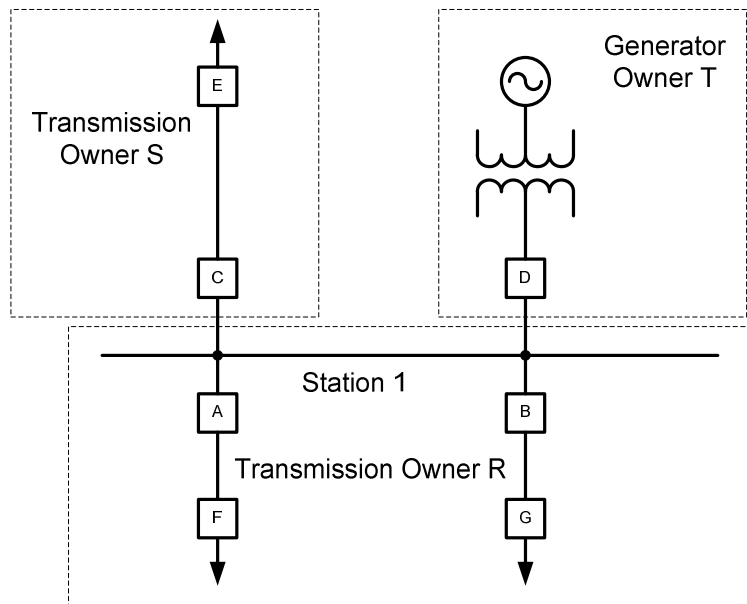
In Figure 4 above, the interconnecting Element between the Transmission Owner to Distribution Provider interconnected Facilities (Transmission Owner R line between Breakers A and B – Distribution Provider S) is the transmission line or tap between the line and Breaker C.

**Note:** No specific Protection System Study is required per this Standard for this example since the Protection System at the Distribution Provider’s substation is not designed to protect transmission Elements.

## Application Guidelines

Figure 5

Transmission/Generation Facility with Multiple Owners



In Figure 5 above, the interconnecting Element between the Transmission Owners R and S and the Generation Owner T is the common Transmission bus. In this example, Transmission Owner S and Generator Owner T are not directly interconnected to each other at Transmission Station 1 and all direct interconnections are between Owner R and each of the other Owners connected to the bus.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 5:

The responsibility for Owner R is to verify that the Protection System settings associated with Breaker C, E, D, and the generator Protection System (provided by Owners S or T) do not result in coordination issues with the Protection System settings associated with Breakers A, B.

The responsibility for Owner S is to verify that the Protection System settings associated with Breakers A, F, B, G, D, and the generator Protection System (provided by Owners R or T) do not result in coordination issues with the Protection System settings associated with Breaker C. To perform this verification, it will be necessary that Transmission Owner R provide Owner S with its settings for Breakers A, F, B, and G as well as the settings for Breaker D and generator Protection System settings provided to Owner R by Generator Owner T.

The responsibility for Owner T is to verify that the Protection System settings associated with Breakers A, F, B, G, C, and E (provided by Owners R or S) do not result in coordination issues with the Protection System settings associated with Breaker D or the Protection Systems associated with generator Protection Systems. In order to perform this verification, it will be necessary that Transmission Owner R provide Generator Owner T with its settings for Breakers A, F, G, and B as well as the settings for Breaker C and E provided to Owner R by Transmission Owner S.



## Standard Development Timeline

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*This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.*

### Development Steps Completed

1. Draft 1 of SAR posted for comment June 11, 2007 – July 10, 2007.
2. SAR approved on August 13, 2007.
3. First posting of revised standard PRC-001-2 on September 11, 2009
4. Transitioned from a revision of PRC-001-1 to development of PRC-027-1 based on industry comments, Quality Review feedback, and consideration of FERC directives relative to the existing requirements of PRC-001-1.

### Description of Current Draft

The SPC SDT created a new results-based standard PRC-027-1 to coordinate Protection Systems utilized to protect interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those that are actually required to isolate Faults and maintain reliability, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards. This standard incorporates and enhances the coordination aspects of Requirements R3 and R4 from PRC-001-1. The SPC SDT is requesting a posting for stakeholder comments under a 30-day formal comment period.

Anticipated Actions	Anticipated Date
Post first draft of standard for 30-day Formal Comment Period.	May 2012
45-day Formal Comment Period with Parallel Initial Ballot	August 2012
30-day Formal Comment Period with Parallel Successive Ballot	November 2012

**Effective Dates:**

PRC-027-1 shall become effective on the first day of the first calendar quarter that is twelve months beyond the date that this standard is approved by applicable regulatory authorities. In those jurisdictions where regulatory approval is not required, this standard shall become effective on the first day of the first calendar quarter that is twelve months beyond the date that this standard is approved by the NERC Board of Trustees, or as otherwise made effective pursuant to the laws applicable to such ERO governmental authorities.

**Version History**

Version	Date	Action	Change Tracking
1	TBD	Project 2007-06 – PRC-027-1	New

**Definitions of Terms Used in Standard**

*This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved. When the standard becomes effective, these defined terms will be removed from the individual standard and added to the Glossary.*

**Terms:**

**Interconnected Facility:** Facilities [am1] that are electrically joined by one or more Element(s) and are owned by different functional entities.

**Protection System Study:** A study that demonstrates existing or proposed Protection Systems operate in the desired sequence for clearing Faults.

*When this standard has received ballot approval, the text boxes will be moved to the Application Guidelines Section of the Standard.*

## A. Introduction

1. **Title:** Protection System Coordination for Performance During Faults
2. **Number:** PRC-027-1
3. **Purpose:** To coordinate Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those required to isolate Faults, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards.
4. **Applicability:**
  - 4.1. **Functional Entities:**
    - 4.1.1 Transmission Owner
    - 4.1.2 Generator Owner
    - 4.1.3 Distribution Provider
  - 4.2 **Facilities:**

Protection Systems installed at Interconnected Facilities.
5. **Background:**

On December 7, 2006, the NERC Planning Committee approved the assessment of Reliability Standard PRC-001 – System Protection Coordination prepared by the NERC System Protection and Control Task Force (SPCTF). The SPCTF noted problems with the applicability to entities and vagueness of requirements in the existing PRC-001-1 Reliability Standard. The SPCTF concluded that the deficiencies of Reliability Standard PRC-001-1 were magnified by having requirements that addressed protection coordination of protection functions and capabilities in the operating and planning timeframes. Consequently, the SPCTF recommended that the requirements for the operating horizon and planning horizon be clearly delineated, and possibly divided into two standards.

The NERC Standards Committee approved a Standard Authorization Request that included the modifications noted by the SPCTF for posting on June 5, 2007. The SAR was posted for comment from June 11, 2007 – July 10, 2007 and was subsequently approved.

The Project 2007-06 – System Protection Coordination Standard Drafting Team (SPC SDT) posted an initial draft of Reliability Standard PRC-001-2 on September 11, 2009 for comments. In that draft, the SPC SDT attempted to address all issues ~~addressed the planning and non-operational issues~~ identified by the SPCTF assessment ~~for of~~ PRC-001-1. PRC-001-1 contains a non-specific training requirement (Requirement R1), three operating time frame requirements (Requirements R2, R5 and R6), and two planning requirements (Requirements R3 and R4). The SPC SDT responded to the comments from the initial posting of PRC-001-2 and incorporated pertinent suggestions into the second draft of the standard in the first quarter of 2010. This second draft was developed in the results-based format and went through a NERC Quality Review (QR) in December 2010. Based on the results from the QR, and after informal consultations with industry stakeholders, as well as NERC and FERC staffs, the drafting team decided to follow the SPCTF recommendation and focus their knowledge and expertise on developing a new standard concentrating on the

reliability aspects associated with the planning horizon Requirements R3 and R4 of PRC-001-1 – the coordination of new and existing protective systems. These aspects of coordination are incorporated and enhanced in the proposed Reliability Standard PRC-027-1 – Protection System Coordination for Performance During Faults with the stated purpose: To coordinate Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those required to isolate Faults, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards.

Accordingly, Requirements R3 and R4 of PRC-001-1 will be retired leaving Requirements R1, R2, R5, and R6 remaining with PRC-001-2. The SPC SDT recommends that the training aspects of PRC-001-1, Requirement R1 be addressed by Reliability Standard PER-005-1 with revision to its Applicability section to include the Generator Operator. The SPC SDT also recommends the operating Requirements R2, R5, and R6 be addressed by the SDT (for Project 2007-03 Real-time Operations) revising the TOP group of Reliability Standards, as well as the operating time frame issues identified in FERC Order 693. These operating time frame requirements involved detecting Protection System failures, informing operators, and taking quick corrective actions; consequently, the SPC SDT transferred the Order 693 directives associated with Reliability Standard PRC-001-1, Requirements R2, R5, and R6 to Project 2007-03 Real-time Operations for inclusion in the revisions of the appropriate operating standards associated within that project. Additionally, the SPC SDT determined that the training aspects of PRC-001-1, Requirement R1 are more appropriately addressed by Reliability Standard PER-005-1 with revision to its Applicability section to include the Generator Operator. The two remaining requirements, Requirements R3 and R4 of PRC-001-1 address the coordination of new and existing protective systems. These aspects of coordination are incorporated and enhanced in the proposed Reliability Standard PRC-027-1 – Protection System Coordination for Performance During Faults.

The SPC SDT responded to the comments from the initial posting of PRC-001-2 and incorporated pertinent suggestions into the second draft of the standard in the first quarter of 2010. This second draft went through a NERC Quality Review in December 2010, which resulted in substantial changes to the standard. After informal consultations with industry stakeholders, as well as NERC and FERC staffs, the drafting team decided to focus their knowledge and expertise on developing a standard with the stated purpose: To coordinate Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those required to isolate Faults, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards. The SPC SDT is presenting this first draft of PRC-027-1 for stakeholder review and comment.

Additionally, the requirements in PRC-027-1 take into account Recommendation 21 C of the Final Report on the August 14, 2003 Blackout in the United States and Canada written by the U.S.-Canada Power System Task Force which identified the need to address “the appropriate use of time delays in relays”, by requiring that individual interconnected entities cooperate in designing and setting their Protection Systems to achieve coordination.



**Other Aspects of coordination of Protection Systems addressed by other Projects:**

Fault clearing is the only aspect of protection coordination that is addressed by Reliability Standard PRC-027-1. Other items such as over/under frequency, over/under voltage, coordination of generating unit or plant voltage regulating controls, and relay loadability are addressed by the following existing standards or current projects.

- Underfrequency load shedding programs are addressed by PRC-006-1 (Project 2007-01 Underfrequency Load Shedding) and generator performance during frequency excursions is addressed by PRC-024-1 (Project 2007-09 Generator Verification).
- Undervoltage Load shedding programs are addressed by PRC-010-0 and will be improved by Project 2008-02 Undervoltage Load Shedding. Generator performance during voltage excursions is addressed by PRC-024-1x (Project 2007-09 Generator Verification).
- Coordination of Generating Unit or Plant Voltage Regulating Controls with Generating Unit or Plant Capabilities and Protection is addressed in PRC-019-1 (Project 2007-09).
- Transmission relay loadability is addressed in PRC-023-2.
- Generator relay loadability will be addressed in Phase 2 of Project 2010-13 Relay Loadability Order.
- Protective relay response during power swings will be addressed in Phase 3 of Project 2010-13 Relay Loadability Order.
- Misoperations identified as coordination issues are investigated and have Corrective Action Plans created in accordance with PRC-003-0 and PRC-004-2 (Project 2010-05.1).

The SPC SDT believes that including these other aspects of protection coordination within PRC-027-1 would cause duplication or conflict with requirements and compliance measurements of other standards.

## B. Requirements and Measures

**R1.** Each Transmission Owner, Generator Owner, and Distribution Provider shall:  
*[Violation Risk Factor: Medium] [Time Horizon: Operations Planning, Long-term Planning]*

**1.1.** Perform a Protection System Study for each Interconnected Facility to verify that Protection Systems do not remove power system Elements from service except for those required to isolate Faults as follows:

**1.1.1** Within 36 calendar months after the effective date of this standard, if no Protection System Study for that Interconnected Facility exists that was performed on or subsequent to June 18, 2007.

**1.1.2** Within 6 calendar months after determining, or being notified of, a 10% or greater change in Fault current for that Interconnected Facility, as described in Requirement R2, unless the entity can demonstrate such a study is not required.

**1.1.3** When proposing or being notified of a change at the Interconnected Facility as described in Requirement R3, Part 3.1 or Part 3.3 unless the entity can demonstrate such a study is not required.

**1.2.** Provide to each affected Interconnected Facility owner, a summary of the results of each Protection System Study performed pursuant to this requirement, including at a minimum, the Protection System(s) reviewed, any issues identified, and any revisions proposed within 90 calendar days after the completion of each Protection System Study.

### Rationale for R1:

Part 1.1-This requires a Protection System study has been performed for every Interconnected Facility to verify coordination of existing Protection Systems. The SDT uses the term “Interconnected Facilities” to identify those Facilities that are electrically joined by a single Element and are owned by different entities. (Note: This also applies to a single owner with multiple functional registrations.)

Part 1.1.1 Protection System studies performed after June 18, 2007 (the effective date of PRC-001-1) and in accordance with PRC-001-1, are sufficient to meet Requirement R1, Part 1.1.1. The SDT believes that 36 months is an appropriate period of time for entities to perform the studies required where no study exists. The SDT has no evidence there is widespread miscoordination between Interconnected Facilities that warrants a shorter time-frame.

Part 1.1.2 The SDT believes that 6 months is an appropriate period of time for entities to perform the studies required when determining, or being notified of, a 10% or greater fault current deviation, where such conditions may warrant a new Protection System Study, or to justify why no such study is needed, i.e., when a line is protected by dual current differential systems with no backup elements set that are dependent upon fault current.

Part 1.1.3 The SDT believes that entities must perform the studies required when proposing or being notified of changes identified in Requirement R3 or to justify why no such study is needed. The SDT believes that no time frame is required for studies associated with Requirement R3 because notification of such a change may occur weeks or years prior to the change. The initiating entity has the incentive to provide the identified information as soon as possible to ensure timely implementations.

Part 1.2 This requirement provides for the communication of the results of a Protection System Study to allow the interconnected owner to review the results. The SDT believes to properly ensure coordination of Protection Systems of Interconnected Facilities; all entities need to assess the study results. The SDT believes that 90 calendar days is a reasonable time for the entity to provide the results of the Protection System Study performed in accordance with Requirement R1 to the Interconnected Facility owner.

- M1.** Acceptable evidence for Requirement R1, Part 1.1 is dated documentation indicating a Protection System Study was performed such as a dated summary of the results of the Protection System Study.
- M2.** Acceptable evidence for Requirement R1, Part 1.2. is dated documentation which may include emails, electronic files, or hard copy records demonstrating transmittal and receipt of the summary of results of each Protection System Study within the specified time frame.
- R2.** For each Interconnected Facility, each Transmission Owner shall: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning, Long-term Planning*]
- 2.1.** Not less than once every twenty-four months, perform a short-circuit study to determine the present Fault current values.
  - 2.2.** Calculate the percent deviation between the Fault current values (Single Line to Ground and 3-Phase for the Bus(s) or Element(s) under consideration) used in the most recent Protection System Study and the Fault current values determined pursuant to Requirement R2, Part 2.1 using the following equation:
 
$$\% \text{ Deviation} = \left( \frac{V_{scs} - V_{pss}}{V_{pss}} \right) \times 100$$

Where:  $V_{scs}$  = Fault current value from present short-circuit study

And:  $V_{pss}$  = Fault current value from most recent Protection System Study
  - 2.3.** Within 30 calendar days after identification of any deviation in Fault current values found to be 10% or greater, notify each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility.
- M3.** Acceptable evidence for R2, Part 2.1 is dated documentation or an electronic file containing the output(s) of the percent deviation calculation(s) including the Facilities analyzed.
- M4.** Acceptable evidence for R2, Part 2.2 is dated documentation or an electronic file that verifies the formula used in the analysis pursuant to Part 2.1.
- M5.** Acceptable evidence for R2, Part 2.3 is documentation demonstrating the transmittal and receipt of the notification to each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility.

**Rationale for R2:** This requires a periodic review of Fault currents and notification to the applicable entities when deviations occur that meet the Requirement R2 criteria. It is important that Interconnected Facility owners are kept aware of changes that could affect proper performance of their Protection Systems. The Transmission Owner is identified as the entity responsible for performing the Fault current studies because they maintain the data necessary to perform the studies. The SDT determined that 10% was an appropriate point at which to require notification based on the fact that Protection System elements that can be affected by Fault current are typically set with margins well above 10%.

Part 2.1 Short-circuit databases are customarily updated annually, so the SDT believes 24 months provides the entities flexibility to schedule and perform the new short-circuit studies and calculate the percent deviation. The SDT believes studies associated with changes that would affect the coordination in less time would be triggered by other requirements in this standard.

Part 2.2 The SDT is requiring this formula to assure a consistent approach is used by each Transmission Owner when calculating the percent deviation in Fault current vales.

Part 2.3 The SDT believes the 30-day time frame is reasonable for sending notification(s) to the interconnected entity(s).

**R3.** Each Transmission Owner, Generator Owner, and Distribution Provider shall provide to each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility, the details (e.g., project schedule, protective relaying scheme types and settings) as follows: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*]

**3.1.** For any change or additions listed below; either, at an existing or new Interconnected Facility, or at other Facilities when the proposed change modifies the conditions used in the coordination of Protection Systems of the Interconnected Facilities.

- New installation, replacement with different types, or modification of: protective relays or protective function settings, communication systems, current transformer ratios and voltage transformer ratios.
- Changes to line lengths and/or conductor size or spacing.
- Additions, removals, and/or replacements of transmission system Element(s).
- Changes to generator unit(s) including replacements, re-ratings, and impedances.
- Replacement of the generator step-up transformer(s).

**3.2.** According to an agreed upon schedule with a Transmission Owner, Generator Owner, or Distribution Provider; or absent such an agreement, within 30 calendar days of receiving a request for information.

**3.3.** Within 30 calendar days after:

- 3.3.1** Corrections are made when Protection System errors are found during misoperation investigations, commissioning, or maintenance activities.
- 3.3.2** Emergency replacements are made due to failures of Protection System components.

**M6.** Acceptable evidence for R3, Part 3.1 is documentation which may include emails, electronic files, or hard copy records demonstrating transmittal and receipt of project information.

**Rationale for R3:** This requires the transfer of appropriate information to the entities connected at each interconnection due circumstances identified in Parts 3.1 3.2, and 3.3

**Part 3.1** The reliability objective of this requirement is to enable the process of conducting Protection System Studies by ensuring that the information is provided to the Interconnected Facility owner(s) in a timely manner. The SDT believes that no single time frame is appropriate for the wide variety of conditions that will need to be evaluated. The list in the requirement is inclusive as it comprises either the protective equipment itself or the power system Elements that affect the coordination of Protection Systems. This requirement would also pertain to changes identified as a result of studies performed in Part 1.1.

**Part 3.2** The purpose of this requirement is to provide a means for an entity to receive requested information from an interconnected owner in a timely manner in order to perform a Protection System Study as required in Parts 1.1.1, 1.1.2, 1.1.3 The SDT believes 30 calendar days after receipt of the request is a sufficient time to provide this information. The requirement also provides some flexibility for the parties involved to determine an otherwise agreed to schedule, if appropriate.

**Part 3.3** The SDT believes 30 calendar days after the conditions noted in Parts 3.3.1 and 3.3.2 is sufficient time to provide the information.

Evidence may include, but is not limited to, a summary of the future project or technical specifications of the proposed changes.

**M7.** Acceptable evidence for R3, Part 3.2 is dated documentation demonstrating the requested information was delivered according to the agreed upon schedule or within 30 calendar days absent such an agreement.

**M8.** Acceptable evidence for R3, Part 3.3 is dated documentation demonstrating the information was delivered within 30 calendar days.

**R4.** Each Transmission Owner, Generator Owner, and Distribution Provider shall: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*]

**4.1.** Within 90 calendar days after receipt, confirm agreement with the summary results of a Protection System Study, as described in Requirement R1, Part 1.2, or absent such agreement propose revisions to achieve acceptable results.

**4.2.** Prior to the in-service date of any planned change at the Interconnected Facility, confirm the Protection System(s) changes as described in Requirement R3, Part 3.1, are acceptable.

**4.3.** Within 30 calendar days after receipt:

**4.3.1** Confirm the Protection System(s) changes are

acceptable pursuant to notification received per Requirement R3, Part 3.3.1.

**4.3.2** Confirm the Protection System(s) changes are acceptable pursuant to notification received per Requirement R3, Part 3.3.2.

**M9.** Acceptable evidence for R4, Parts 4.1, 4.2, and 4.3 is dated documentation (electronic or hard copy) demonstrating confirmation was achieved in accordance with the respective timeframe.

**Rationale for R4:** This requirement ensures owners of Interconnected Facilities confirm that the each Protection System(s) applied on each of its Interconnected Facilities is acceptable per the conditions identified in Parts 4.1, 4.2, and 4.3.

**Part 4.1** The SDT believes ninety (90) calendar days is a reasonable time for the owners of existing Interconnected Facilities to resolve differences and reach agreement.

**Part 4.2** The SDT believes that proposed modifications (including implementation schedules) to Interconnected Facilities as described in Requirement R3, Part 3.1 must be communicated and agreed to prior to the in-service date. Agreement assures that the coordination of Protection Systems for Interconnected Facilities is achieved.

**Part 4.3** The SDT believes thirty (30) calendar days is a reasonable time for the owners of existing Interconnected Facilities to resolve differences and reach agreement for the conditions noted in Parts 4.3.1 and 4.3.2

## C. Compliance

### 1. Compliance Monitoring Process

#### 1.1. Compliance Enforcement Authority

Regional Entity

#### 1.2. Evidence Retention

The following evidence retention periods identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full time period since the last audit.

**1.2.1** Each Responsible Entity shall retain data or evidence for three calendar years unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

**1.2.2** If a Registered Entity is found non-compliant, it shall keep information related to the non-compliance until mitigation is complete and approved or for the time specified above, whichever is longer.

**1.2.3** The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent audit records.

#### 1.3. Compliance Monitoring and Assessment Processes:

Compliance Audit

Self-Certification

Spot Checking

Compliance Investigation

Self-Reporting

Complaint

#### 1.4. Additional Compliance Information

None

Table of Compliance Elements

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R1	Operations Planning, Long-term Planning	Medium	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.1 but was late by less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.2 or documented why a study was not required but was late by less than or equal to 10 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible</p>	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.1 but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.2 or documented why a study was not required but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible</p>	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.2 or documented why a study was not required but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible</p>	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per R1, Part 1.1.2 or documented why a study was not required but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			entity provided the Protection System Study results in accordance with R1, Part 1.2 but was late by 10 calendar days or less.	entity provided the Protection System Study results in accordance with R1, Part 1.2 but was late by more than 10 calendar days but less than or equal to 20 calendar days.	entity provided the Protection System Study results in accordance with R1, Part 1.2 but was late by more than 20 calendar days but less than or equal to 30 calendar days.	entity provided the Protection System Study results in accordance with R1, Part 1.2 but was late by more than 30 calendar days.  OR The responsible entity failed to perform a Protection System Study on an Interconnected Facility per R1, Parts 1.1.1, 1.1.2, or 1.1.3, or document why a study was not required.  OR The responsible entity failed to provide Protection System Study results in accordance with R1, Part 1.2.
<b>R2</b>	<b>Long-term Planning</b>	<b>Medium</b>	The Transmission Owner performed a short-circuit study as described in R2,	The Transmission Owner performed a short-circuit study as described in R2,	The Transmission Owner performed a short-circuit study as described in R2,	The Transmission Owner performed a short-circuit study as described in R2,



R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			<p>Part 2.1 but was late by less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner notified the Interconnected Facility owner of the changes in Fault currents but was late by less than or equal to 10 calendar days.</p>	<p>Part 2.1 but was late by more than 30 calendar days but less than or equal to 40 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner notified the Interconnected Facility owner of the changes in Fault currents but was late by more than 10 calendar days but less than or equal to</p>	<p>Part 2.1 but was late by more than 40 calendar days but less than or equal to 50 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner notified the Interconnected Facility owner of the changes in Fault currents but was late by more than 20 calendar days but less than or equal to</p>	<p>Part 2.1 but was late by more than 50 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner failed to perform a short-circuit study as described in R2, Part 2.1.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner failed to calculate the percent deviation between the Fault currents according to the formula designated in R2, Part 2.2.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner notified the Interconnected Facility owner of the changes in Fault currents but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
				20 calendar days.	30 calendar days.	The Transmission Owner failed to notify the Interconnected Facility owner of the changes in Fault currents.
<b>R3</b>	<b>Operations Planning</b>	<b>Medium</b>	<p>The responsible entity provided the requested information per R3, Part 3.2 but was late by 10 calendar days or less.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the</p>	<p>The responsible entity provided the requested information per R3, Part 3.2 but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the</p>	<p>The responsible entity provided the requested information per R3, Part 3.2 but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the</p>	<p>The responsible entity failed to provide information to the owners of the interconnected Facilities for any proposed change identified in R3.1.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the requested information per R3, Part 3.2 but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			required information identified in R3, Part 3.3 but was late by 10 calendar days or less.	required information identified in R3, Part 3.3 but was late by more than 10 calendar days but less than or equal to 20 calendar days.	required information identified in R3, Part 3.3 but was late by more than 20 calendar days but less than or equal to 30 calendar days	required information identified in R3, Part 3.3 but was late by more than 30 calendar days.  OR The responsible entity failed to provide the requested information.
<b>R4</b>	<b>Operations Planning</b>	<b>Medium</b>	The responsible entity confirmed agreement with the summary results of the Protection System Study per R4, Part 4.1 but was late by 10 calendar days or less.	The responsible entity confirmed agreement with the summary results of the Protection System Study per R4, Part 4.1 but was late by more than 10 calendar days but less than or equal to 20 calendar days.	The responsible entity confirmed agreement with the summary results of the Protection System Study per R4, Part 4.1 but was late by more than 20 calendar days but less than or equal to 30 calendar days.	The responsible entity confirmed agreement with the summary results of the Protection System Study per R4, Part 4.1 but was late by more than 30 calendar days.  OR The responsible entity failed to confirm agreement with the summary results of the Protection System Study per R4, Part 4.1.

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			<p>OR</p> <p>The responsible responded to the confirmation request per R4, Part 4.3, but was late by 10 calendar days or less.</p>	<p>OR</p> <p>The responsible responded to the confirmation request per R4, Part 4.3, but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p>	<p>OR</p> <p>The responsible responded to the confirmation request per R4, Part 4.3, but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p>	<p>OR</p> <p>The responsible entity failed to confirm acceptance of the planned changes pursuant to R4, Part 4.2 prior to implementation of those changes.</p> <p>OR</p> <p>The responsible responded to the confirmation request per R4, Part 4.3, but was late by more than 30 calendar days.</p> <p>OR</p> <p>The responsible entity failed to respond to the confirmation request per R4, Part 4.3.</p>

**D. Regional Variances**

None.

**E. Interpretations**

None.

**F. Associated Documents**

None.

### Guidelines and Technical Basis

#### Requirement R1:

This requirement directs the performance of Protection System Studies for every interconnected Facility to verify coordination of existing Protection Systems where no recent study exists or when Facility configuration or Fault current deviations of 10% or more have occurred. In developing the language to define Protection System Study, the SDT considered various reference books discussing protective relaying theory and application along with the following description of “coordination of protection” from the pending revision of IEEE C37.113 Guide for Protective Relay Applications to Transmission Lines:

*“The process of choosing current or voltage settings, or time delay characteristics of protective relays such that their operation occurs in a specified sequence so that interruption to customers is minimized and least number of power system elements are isolated following a system Fault.”*

Using the reference material cited above as guidance, the SDT defined the term Protection System Study for use within the PRC-027-1 Reliability Standard as:

“A study that demonstrates existing or proposed Protection Systems operate in the desired sequence for clearing Faults.”

Protection System Studies comprise a variety of assessments and underlying database activities that cumulatively serve to provide verification that Protection Systems will function as designed. Typical database activities performed during these studies include assembling impedance data for Fault studies and modeling Protection Systems. Ultimately, the particular studies performed depend on the protective relays installed, their application, and the Protection System philosophies of each Transmission Owner, Generator Owner, and Distribution Provider. These studies may include graphical coordination of protection characteristics on time-current or impedance graphs; relay scheme simulation studies using sequence of operations during pre-defined Faults; and sensitivity studies to confirm effective reaches, sufficient operating parameters (energy or operating torque), and adequate directional polarizing quantities.

The SDT believes applicable entities should have a documented Protection System Study for each interconnected Facility to validate the Protection Systems perform in a manner consistent with the purpose of this Standard. Additionally, the SDT believes that 36 months is an appropriate amount of time for entities to perform the initial studies expected under this requirement. This period considers the time some entities may require to create project scopes, acquire proposals, and secure contracts to hire external resources that may be needed to perform the studies. The SDT also has no evidence there is widespread miscoordination between interconnected Facilities that might warrant a shorter time-frame for the studies to be performed. Protection Systems are continually challenged by Faults on the BES but records collected for Reliability Standard PRC-004 do not indicate that lack of coordination was the predominate root cause of reported Misoperations.

It should be noted that Protection System studies performed after June 18, 2007 (the effective date of PRC-001-1) are sufficient to meet Requirement R1.

## Application Guidelines

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Parts 1.1.2 and 1.1.3 further direct that Protection System Studies must be completed under the following two circumstances:

1. After notification of an identified 10% or greater deviation in Fault current, the notified entities must perform a new Protection System study of the Interconnected Facility or document why a study is not required. The SDT recognizes that, based on the Protection Systems installed (e.g., current differential), a 10% or greater deviation in Fault current may not necessitate a new Protection System Study be performed; therefore this part of the requirement includes the statement, “unless the entity can demonstrate that such a study is not required”. The SDT believes the 6-month time frame associated with this requirement represents is a reasonable period to perform the studies that are required after identification by the 24-month Fault current review.
2. After proposing or being notified of a change at an Interconnected Facility, entities must perform a new Protection System study or document why a study is not required. The SDT recognizes that, based on the scope of the proposed change and/or the Protection Systems installed (e.g., current differential), the change may not necessitate a new Protection System Study be performed; therefore this part of the requirement includes the statement, “unless the entity can demonstrate that such a study is not required”. The SDT believes that specifying a single time frame for evaluation of the wide variety of conditions that may be associated with a particular change is not appropriate. This is because the SDT sees the entity initiating any change as having the incentive to move this along in a timely fashion in order to both keep the associated project on schedule and confirm the changes are acceptable “prior to the in-service date” as stipulated by Requirement R4, Part 4.2.

Requirement R1, Part 1.2 requires that the entity performing the Protection System Study to provide a summary of the study results to the affected owners of Protection Systems applied at interconnected Facilities. As guidance, the SDT lists the following inputs and results of a Protection System Study that may be included in the summary provided pursuant to this requirement:

1. Data used to determine Fault currents in performing the study along with a listing of the single-line-to-ground and 3-phase Fault currents for the Bus or Element at the Interconnected Facility under study.
2. A listing of the Protection System(s) owned by the entity performing the study that are adjacent to the Bus or Element at the Interconnected Facility and were reviewed for coordination of protective relays as part of the study.
3. A listing of any issues associated with the relay settings of the other owner(s) at the Interconnected Facility that were identified by the study.
4. Any proposed revisions to a Protection System or its protective relay settings that were identified by the study.

### Requirement R2:

The SDT investigated various inputs that would trigger a review of the existing Protection System Studies, and determined through the experience of the SDT members, along with informal surveys of several regional protection and control committees, that variations in Fault currents of 10% or more are an appropriate indicator that an updated Protection System Study may be necessary. These variations could have resulted from the accumulation of incremental changes over time. This requires a periodic review of Fault currents and includes the calculation of the percent deviation between the Fault current values used in the most recent Protection System Study and the present Fault current values indicated by the short-circuit study performed pursuant to this requirement. This calculation is necessary to identify Fault current changes that must be communicated in accordance with Requirement R2, Part 2.3.

Polling of SDT membership and various protection engineering committees indicates that short-circuit databases are customarily updated annually. Based on this information, the SDT believes that requiring a 24-month periodic review of Fault currents provides entities additional flexibility to schedule and perform these studies and calculate the percent deviation as described in Requirement R2, Part 2.2. The SDT believes studies associated with changes that would affect the coordination in less than 24-months would be triggered by other requirements in this standard.

Requirement R2, Part 2.3 further directs the Transmission Owner to, within 30 calendar days, inform interconnected Facility owners when short-circuit studies indicate that 10% deviations in Fault current have occurred at the Interconnected Facility. The SDT believes the 30-day time frame associated with this requirement is reasonable for sending notification to the interconnected entity(s) and is consistent with other NERC Reliability Standards.

In Requirement R2, the Transmission Owner is identified as the functional entity responsible for performing the Fault current studies because they maintain the data required to perform the studies. Generator data (including data provided by Distribution Providers) is incorporated into the Transmission Owners' short circuit models.

### Requirement R3:

This requires the Interconnected Facility owners to evaluate the impact to their Protection Systems due to proposed changes by requiring the registered functional entity initiating the changes to provide the details to the other affected entities of the Interconnected Facility. Documentation provided to these other owners may include, but is not limited to: power system configurations; protection schemes; schematics; instrument transformer ratios; type of relay(s); communication equipment applied for protection; and Protection System settings. The recipient will incorporate the applicable information into its Protection System Studies to evaluate whether changes are required.

The list of applicable changes provided in Requirement R3, Part 3.1 is inclusive, as it comprises either the protective equipment itself or the power system Elements that



affect the coordination of Protection Systems. The SDT recognizes that other Facility changes not directly associated with the interconnection can impact the Protection System Study of the interconnected Facilities; e.g., the addition of a large autotransformer bank or generator not directly associated with the interconnected Facilities. The SDT believes that it is not appropriate to specify a single time frame for providing the details of the wide variety of conditions listed in Requirement R3, Part 3.1 that may be associated with a particular change. This is because the SDT sees the entity initiating any change as having the incentive to move the process along in a timely fashion in order to both keep the associated project on schedule and confirm the changes are acceptable “prior to the in-service date” as stipulated by Requirement R4, Part 4.2.

Requirement R3, Part 3.2 allows for entities to agree upon a schedule, appropriate to the circumstances, for providing the details needed to conduct a Protection System Study or, absent such agreement, within 30 days of a request for this information. This requirement provides a means for entities to receive requested information in a timely manner. In consideration of circumstances where the information may not be readily available or may be incomplete due the retirement of personnel, the purging of records, change of ownership, etc., it also provides the flexibility of mutually agreeing to a schedule for exchanging information. The SDT believes 30 calendar days after receipt of the request is a sufficient time to provide the requested information where no other agreement exists.

Additionally, this requirement includes a provision for providing details associated with changes to the previously agreed upon coordination when: (1) Protection System errors are found during misoperation investigations, commissioning, or maintenance activities; (2) emergency replacements are made due to failures of Protection System components. Based upon the limited number of instances that would occur under such circumstances, the SDT believes 30 calendar days after determining that changes are required is an appropriate time frame for providing the associated details to affected entities.

### **Requirement R4:**

The reliability objective of this requirement is to bring the process of Protection System coordination full-circle by gaining the confirmation of interconnected entities that their Protection Systems are coordinated consistent with the purpose of this standard. Cooperative participation of Interconnected Facility owners in communicating Protection System(s) design and study results will achieve coordination of Protection Systems for reliable operation of the BES during Faults.

Requirement R4, Part 4.1 directs applicable entities to confirm agreement within 90 days of receiving a summary of results from an entity performing the Protection System Study that the results indicate, and/or follow-up revisions achieve coordination of the entities’ associated Protection Systems. The SDT believes 90 calendar days after receipt of the results of a Protection System Study provides a reasonable time for the owners of Interconnected Facilities to resolve differences and reach agreement that their Protection Systems are coordinated.

## Application Guidelines

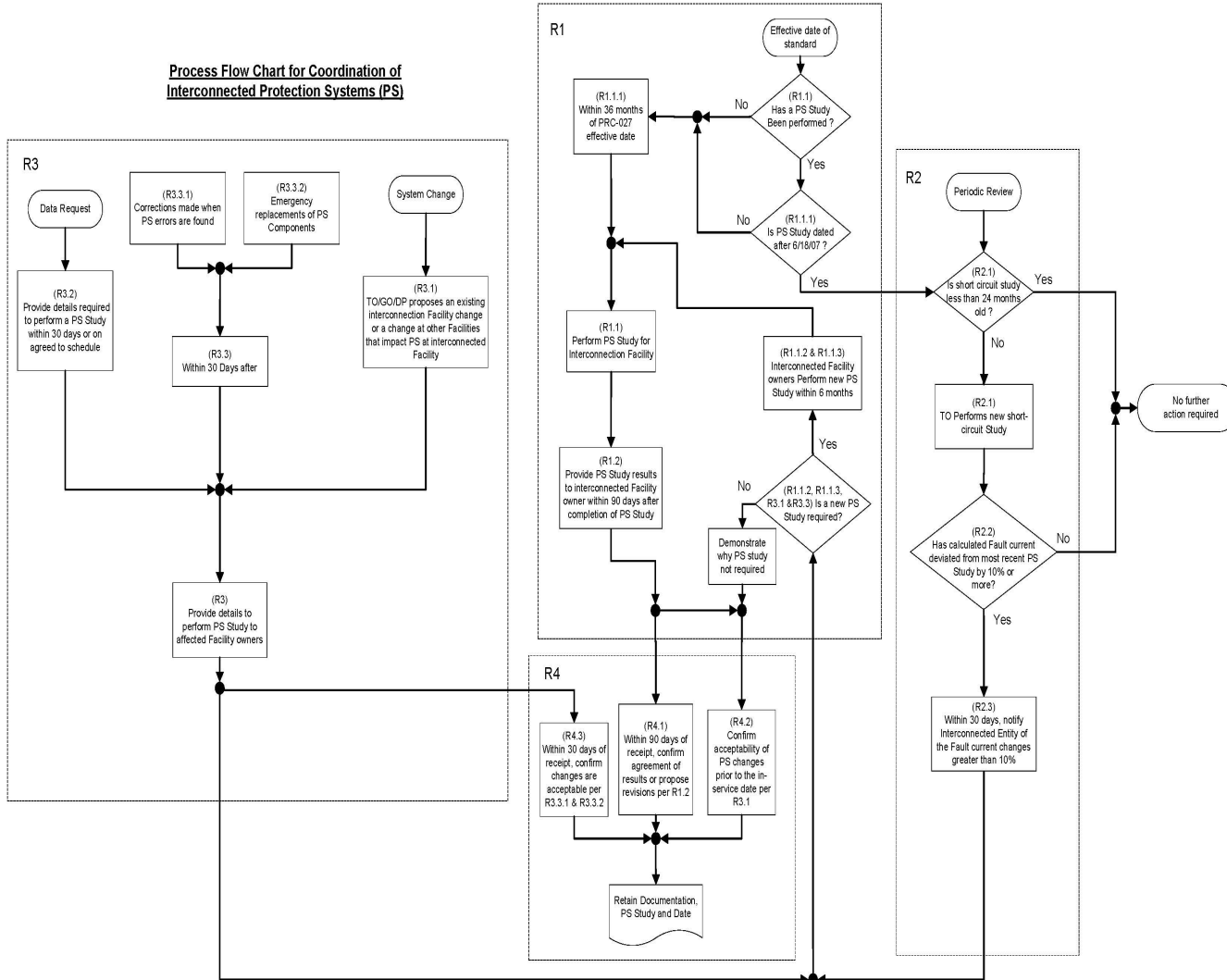
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Requirement R4, Part 4.2 directs entities to confirm that planned changes described in Requirement 3.1 are acceptable prior to the in-service date of those changes. The purpose of this requirement is to assure the effects that planned changes have on Protection Systems at Interconnected Facilities have been considered by all affected entities.

Requirement R4, Parts 4.3.1 and 4.3.2 direct confirmation within 30 calendar days that changes are acceptable when corrections are made due to Protection System errors found during misoperation investigations, commissioning, or maintenance activities, or when emergency replacements are made due to failures of Protection System components. Based upon the limited number of instances that would occur under such circumstances, the SDT believes 30 calendar days provides adequate time for achieving such agreement.

## Process Flow Chart

Below is a complete representation of the process including the relationships between requirements:



## **Application Guidelines**

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### **Example Process**

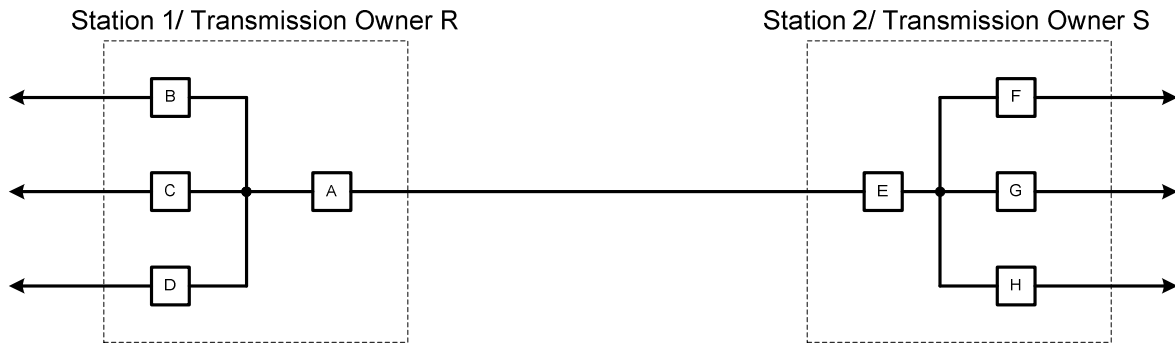
An example of the interaction between entities required to gather the information to perform an accurate study is below.

- The initiating entity (Entity A) will contact the interconnected entity (Entity B) and request up-to-date Protection System information.
- Upon receipt of the above request for information, Entity B will provide the information within 30 calendar days or an agreed upon time frame.
- Entity A will perform a Protection System Study using the information received.
- Entity A will provide a summary of the results of the study to Entity B within 90 calendar days of completing the Protection System Study.
- Entity B will review the summary information and confirm agreement within 90 calendar days of receiving the study results from Entity A that coordination is achieved.
  - In cases where the study reveals that changes to Protection Systems are needed, Entity B would propose to Entity A revisions that achieve acceptable results.
- Documentation of the final agreement is required prior to implementation of planned changes.

### Diagrams

Introduction: The diagrams below are intended to provide guidance related to the responsibilities associated with the Purpose of this Standard between Owners of interconnected Facilities. After the reviews and prior to implementation of the changes, the owners must reach agreement on the final settings to achieve coordination of the Protection Systems.

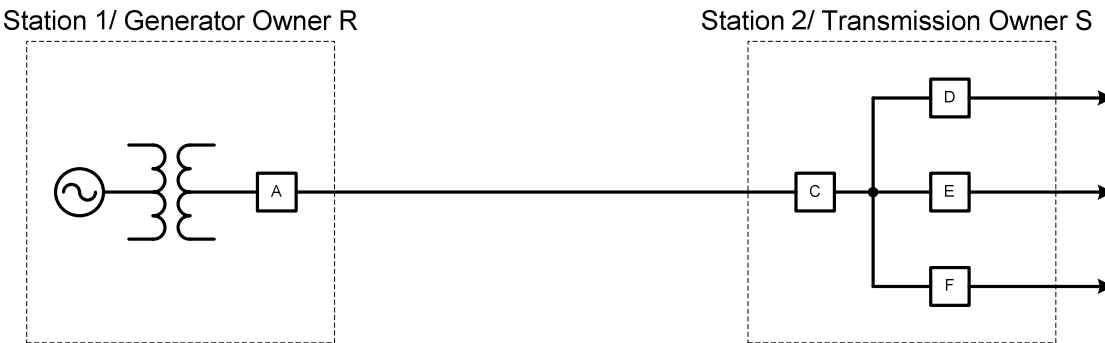
**Figure 1**



In Figure 1 above, the interconnecting Element between the Transmission interconnected Facilities (Station 1 – Transmission Owner R and Station 2 – Transmission Owner S) is the transmission line between Breakers A and E.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 1, the responsibility for Owner S is to verify that the Protection System settings associated with Breaker A (provided by Owner R) do not result in coordination issues with the Protection System settings associated with Breakers E, F, G, and H. Likewise, the responsibility for Owner R is to verify that the Protection System settings associated with Breaker E provided by Owner S do not result in coordination issues with the Protection System settings associated with Breakers A, B, C, and D.

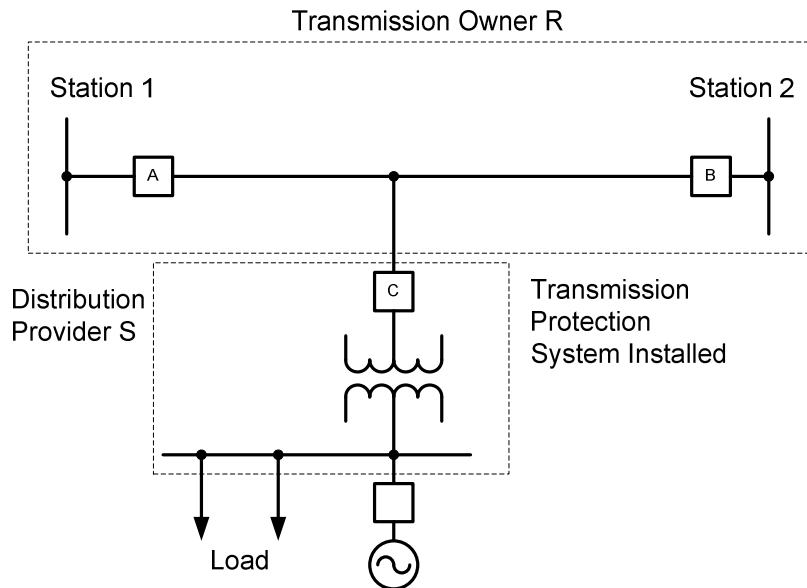
**Figure 2**



In Figure 2 above, the interconnecting Element between the Transmission to Generation Interconnected Facilities (Station 1 – Generation Owner R and Station 2 – Transmission Owner S) is the transmission line or bus between Breakers A and C.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 2, the responsibility for Transmission Owner S is to verify that the Protection System settings associated with Breaker A (provided by Owner R) and the generator Protection Systems do not result in coordination issues with the Protection System settings associated with Breakers C, D, E, and F. Likewise, the responsibility for Generation Owner R is to verify that the Protection System settings associated with Breaker C (provided by Owner S) do not result in coordination issues with the Protection System settings associated with Breaker A or the generator Protection Systems.

**Figure 3**[p2]



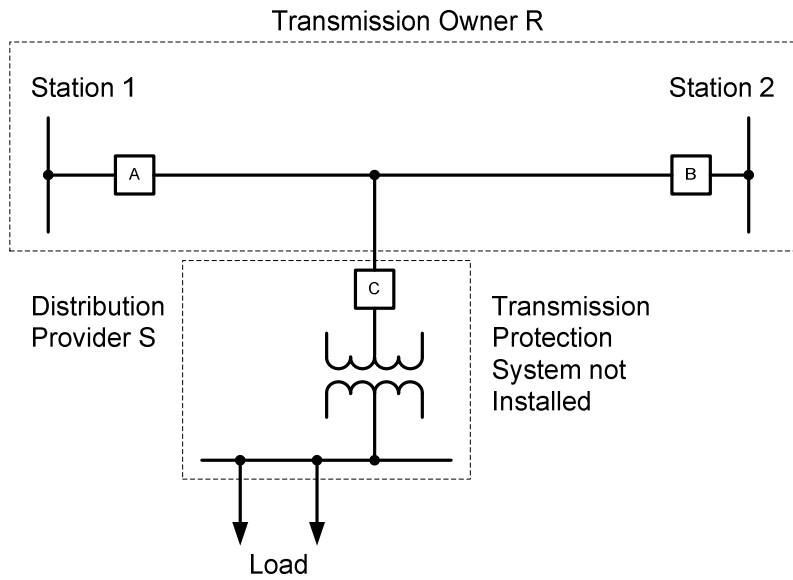
In Figure 3 above, the interconnecting Element between the Transmission Owner to Distribution Provider (with a generator) interconnected Facilities (Transmission Owner R line between Breakers A and B – Distribution Provider S) is the transmission line or tap between the line and Breaker C.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 3, the responsibility for Transmission Owner R is to verify that the Protection System settings associated with Line Breaker C (provided by Distribution Provider S) and the generator Protection Systems do not result in coordination issues with the Protection System settings associated with Breakers A and B and other Protection Systems at stations 1 and 2. Likewise, the responsibility for Distribution Provider S is to verify that the Protection System settings associated with Breakers A and B provided by Owner R do not result in coordination issues with the Protection System settings associated with Breaker C and the generator Protection Systems. In order to perform this verification, it will be necessary that the Generator Owner provide Distribution Provider S with its generator Protection System settings.

**Note:** A Protection System Study is required per this Standard for this example if a Protection System at the Distribution Provider's substation is designed to protect transmission Elements.

## Application Guidelines

**Figure 4**[p3]



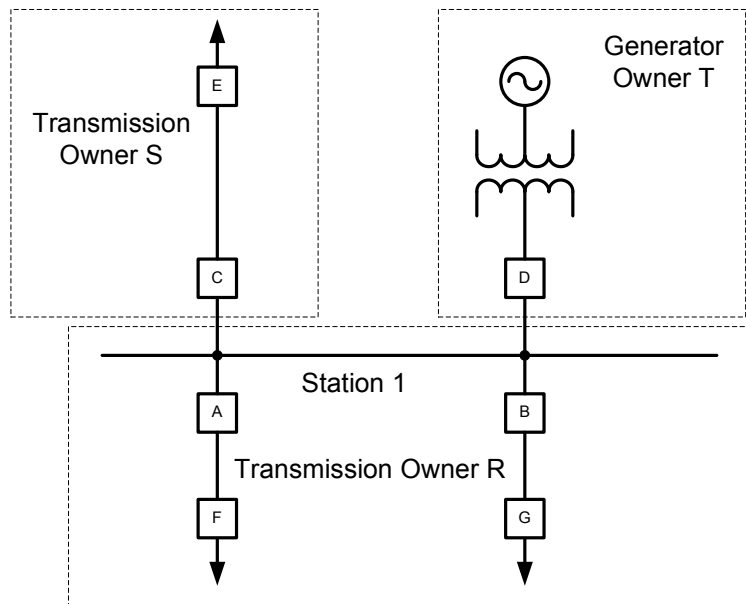
In Figure 4 above, the interconnecting Element between the Transmission Owner to Distribution Provider interconnected Facilities (Transmission Owner R line between Breakers A and B – Distribution Provider S) is the transmission line or tap between the line and Breaker C.

**Note:** No specific Protection System Study is required per this Standard for this example since the Protection System at the Distribution Provider's substation is not designed to protect transmission Elements.



**Figure 5**

Transmission/Generation Facility with Multiple Owners



In Figure 5 above, the interconnecting Element between the Transmission Owners R and S and the Generation Owner T is the common Transmission bus. In this example, Transmission Owner S and Generator Owner T are not directly interconnected to each other at Transmission Station 1 and all direct interconnections are between Owner R and each of the other Owners connected to the bus.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 5:

The responsibility for Owner R is to verify that the Protection System settings associated with Breaker C, E, D, and the generator Protection System (provided by Owners S or T) do not result in coordination issues with the Protection System settings associated with Breakers A, B.

The responsibility for Owner S is to verify that the Protection System settings associated with Breakers A, F, B, G, D, and the generator Protection System (provided by Owners R or T) do not result in coordination issues with the Protection System settings associated with Breaker C. To perform this verification, it will be necessary that Transmission Owner R provide Owner S with its settings for Breakers A, F, B, and G as well as the settings for Breaker D and generator Protection System settings provided to Owner R by Generator Owner T.

The responsibility for Owner T is to verify that the Protection System settings associated with Breakers A, F, B, G, C, and E (provided by Owners R or S) do not result in coordination issues with the Protection System settings associated with Breaker D or the Protection Systems associated with generator Protection Systems. In order to perform this verification, it will be necessary that Transmission Owner R provide Generator Owner T with its settings for Breakers A, F, G, and B as well as the settings for Breaker C and E provided to Owner R by Transmission Owner S.

## Standard Development Timeline

*This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.*

### Development Steps Completed

1. Draft 1 of SAR posted for comment June 11, 2007 – July 10, 2007.
2. SAR approved on August 13, 2007.
3. First posting of revised standard PRC-001-2 on September 11, 2009
4. Transitioned from a revision of PRC-001-1 to development of PRC-027-1 based on industry comments, Quality Review feedback, and consideration of FERC directives relative to the existing requirements of PRC-001-1.

### Description of Current Draft

The SPC SDT created a new ~~Results~~results-based standard PRC-027-1 to coordinate Protection Systems utilized to protect interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those that are actually required to isolate Faults and maintain reliability, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards. This standard incorporates and enhances the coordination aspects of Requirements R3 and R4 from PRC-001-1. The SPC SDT is requesting a posting for stakeholder comments under a 30-day formal comment period.

Anticipated Actions	Anticipated Date
Post first draft of standard for 30-day Formal Comment Period.	May 2012
45-day Formal Comment Period with Parallel Initial Ballot	August 2012
30-day Formal Comment Period with Parallel Successive Ballot	November 2012

**Effective Dates:**

PRC-027-1 shall become effective on the first day of the first calendar quarter that is twelve months beyond the date that this standard is approved by applicable regulatory authorities. In those jurisdictions where regulatory approval is not required, this standard shall become effective on the first day of the first calendar quarter that is twelve months beyond the date that this standard is approved by the NERC Board of Trustees, or as otherwise made effective pursuant to the laws applicable to such ERO governmental authorities.

**Version History**

Version	Date	Action	Change Tracking
1	TBD	Project 2007-06 – PRC-027-1	New

**Definitions of Terms Used in Standard**

*This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved. When the standard becomes effective, these defined terms will be removed from the individual standard and added to the Glossary.*

**Terms:**

**Interconnected Facility:** Facilities <sup>[am1]</sup> that are electrically joined by one or more ~~Elements~~ Element(s) and are owned by different functional entities.

**Protection System Study:** A study that demonstrates existing or proposed Protection Systems operate in the desired sequence for clearing Faults.

*When this standard has received ballot approval, the text boxes will be moved to the Application Guidelines Section of the Standard.*

## A. Introduction

1. **Title:** Protection System Coordination for Performance During Faults
2. **Number:** PRC-027-1
3. **Purpose:** To coordinate Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those required to isolate Faults, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards.
4. **Applicability:**
  - 4.1. **Functional Entities:**
    - 4.1.1 Transmission Owner
    - 4.1.2 Generator Owner
    - 4.1.3 Distribution Provider
  - 4.2 **Facilities:**

Protection Systems installed at Interconnected Facilities.

### 5. Background:

On December 7, 2006, the NERC Planning Committee approved the assessment of Reliability Standard PRC-001 – System Protection Coordination prepared by the NERC System Protection and Control Task Force (SPCTF). The SPCTF noted problems with the applicability to entities and vagueness of requirements in the existing PRC-001-1 Reliability Standard. The SPCTF concluded that the deficiencies of Reliability Standard PRC-001-1 were magnified by having requirements that addressed protection coordination of protection functions and capabilities in the operating and planning timeframes.

The NERC Standards Committee approved a Standard Authorization Request that included the modifications noted by the SPCTF for posting on June 5, 2007. The SAR was posted for comment from June 11, 2007 – July 10, 2007 and was subsequently approved.

The Project 2007-06 – System Protection Coordination Standard Drafting Team (SPC SDT) posted an initial draft of Reliability Standard PRC-001-2 on September 11, 2009 for comments. In that draft, the SPC SDT addressed the planning and non-operational issues identified by the SPCTF assessment for PRC-001-1 as well as the operating time frame issues identified in FERC Order 693. These operating time frame requirements involved detecting Protection System failures, informing operators, and taking quick corrective actions; consequently, the SPC SDT transferred the Order 693 directives associated with Reliability Standard PRC-001-1, Requirements R2, R5, and R6 to Project 2007-03 Real-time Operations for inclusion in the revisions of the appropriate operating standards associated within that project. Additionally, the SPC SDT determined that the training aspects of PRC-001-1, Requirement R1 are more appropriately addressed by Reliability Standard PER-005-1 with revision to its Applicability section to include the Generator Operator. The two remaining requirements, Requirements R3 and R4 of PRC-001-1 address the coordination of new and existing protective systems. These aspects of coordination are

incorporated and enhanced in the proposed Reliability Standard PRC-027-1 – Protection System Coordination for Performance During Faults.

The SPC SDT responded to the comments from the initial posting of PRC-001-2 and incorporated pertinent suggestions into the second draft of the standard in the first quarter of 2010. This second draft went through a NERC Quality Review in December 2010, which resulted in substantial changes to the standard. After informal consultations with industry stakeholders, as well as NERC and FERC staffs, the drafting team decided to focus their knowledge and expertise on developing a standard with the stated purpose: To coordinate Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those ~~that are actually~~ required to isolate Faults ~~and maintain reliability~~, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards. The SPC SDT is presenting this first draft of PRC-027-1 for stakeholder review and comment.

Additionally, the requirements in PRC-027-1 take into account Recommendation 21 C of the Final Report on the August 14, 2003 Blackout in the United States and Canada written by the U.S.-Canada Power System Task Force which identified the need to address “the appropriate use of time delays in relays”, by requiring that individual interconnected entities cooperate in designing and setting their Protection Systems to achieve coordination.

**Other Aspects of coordination of Protection Systems addressed by other Projects:**

Fault clearing is the only aspect of protection coordination that is addressed by Reliability Standard PRC-027-1. Other items such as over/under frequency, over/under voltage, coordination of generating unit or plant voltage regulating controls, and relay loadability are addressed by the following existing standards or current projects.

- Underfrequency load shedding programs are addressed by PRC-006-1 (Project 2007-01 Underfrequency Load Shedding) and generator performance during frequency excursions is addressed by PRC-024-1 (Project 2007-09 Generator Verification).
- Undervoltage Load shedding programs are addressed by PRC-010-0 and will be improved by Project 2008-02 Undervoltage Load Shedding. Generator performance during voltage excursions is addressed by PRC-024-1x (Project 2007-09 Generator Verification).
- Coordination of Generating Unit or Plant Voltage Regulating Controls with Generating Unit or Plant Capabilities and Protection is addressed in PRC-019-1 (Project 2007-09).
- Transmission relay loadability is addressed in PRC-023-2.
- Generator relay loadability will be addressed in Phase 2 of Project 2010-13 Relay Loadability Order.
- Protective relay response during power swings will be addressed in Phase 3 of Project 2010-13 Relay Loadability Order.

- Misoperations identified as coordination issues are investigated and have Corrective Action Plans created in accordance with PRC-003-0 and PRC-004-2 (Project 2010-05.1).

The SPC SDT believes that including these other aspects of protection coordination within PRC-027-1 would cause duplication or conflict with requirements and compliance measurements of other standards.

**B. Requirements and Measures**

**R1.** Each Transmission Owner, Generator Owner, and Distribution Provider shall: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning, Long-term Planning]*

**1.1.** Perform a Protection System Study for each Interconnected Facility to verify that Protection Systems do not remove power system Elements from service except for those required to isolate Faults as follows:

**1.1.1** Within 36 calendar months after the effective date of this standard, if no Protection System Study for that Interconnected Facility exists that was performed on or subsequent to June 18, 2007.

~~1.1.2~~

~~1.1.1.1.2~~ Within 6 calendar months after determining, or being notified of, a 10% or greater change in Fault current for that Interconnected Facility, as described in Requirement R2, unless the entity can demonstrate such a study is not required.

~~1.1.2.1.3~~ When proposing or being notified of a change at the Interconnected Facility as described in Requirement R3, ~~part~~Part 3.1 or ~~part~~Part 3.3 unless the entity can demonstrate such a study is not required.

**1.2.** Provide to each affected Interconnected Facility owner, a summary of the results of each Protection System Study performed pursuant to this requirement, including at a

**Rationale for R1 ~~R1~~:**

~~Part 1.1~~-This ~~requirement ensures~~requires a Protection System study has been performed for every Interconnected Facility to verify coordination of existing Protection Systems. The SDT uses the term “Interconnected Facilities” to identify those Facilities that are electrically joined by a single Element and are owned by different entities. (Note: This also applies to a single owner with multiple functional registrations.)

~~R1~~Part 1.1.1 Protection System studies performed after June 18, 2007 (the effective date of PRC-001-1) and in accordance with PRC-001-1, are sufficient to meet Requirement R1, ~~Part~~ 1.1.1. The SDT believes that 36 months is an appropriate period of time for entities to perform the studies required where no study exists. The SDT has no evidence there is widespread miscoordination between Interconnected Facilities that warrants a shorter time-frame.

~~R1~~Part 1.1.2 The SDT believes that 6 months is an appropriate period of time for entities to perform the studies required when determining, or being notified of, a 10% or greater fault current deviation, ~~-where~~ such conditions may warrant a new Protection System Study, or to justify why no such study is needed, i.e., when a line is protected by dual current differential systems with no backup elements set that are dependent upon fault current.

~~R1~~Part 1.1.3 The SDT believes that entities must perform the studies required when proposing or being notified of changes identified in Requirement R3 or to justify why no such study is needed. The SDT believes that no time frame is required for studies associated with Requirement R3 because notification of such a change may occur weeks or years prior to the change. The initiating entity has the incentive to provide the identified information as soon as possible to ensure timely implementations.

~~R1~~Part 1.2 This requirement provides for the communication of the results of a Protection System Study to allow the interconnected owner to review the results. The SDT believes to properly ensure coordination of Protection Systems of Interconnected Facilities; all entities need to assess the study results. The SDT believes that 90 calendar days is a reasonable time for the entity to provide the results of the Protection System Study performed in accordance with Requirement R1 to the ~~interconnected~~Interconnected

minimum, the Protection System(s) reviewed, any issues identified, and any revisions proposed within 90 calendar days after the completion of each Protection System Study.

**M1.** Acceptable evidence for Requirement R1, ~~part~~Part 1.1 is dated documentation indicating a Protection System Study was performed such as a dated summary of the results of the Protection System Study.

**M2.** Acceptable evidence for Requirement R1, ~~part~~Part 1.2. is dated documentation which may include emails, electronic files, or hard copy records demonstrating transmittal and receipt of the summary of results of each Protection System Study within the specified time frame.

**R2.** For each Interconnected Facility, each Transmission Owner shall: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning, Long-term Planning*]

**2.1.** Not less than once every twenty-four months, perform a short-circuit study ~~and analyze the percent deviation between the Fault current values used in the most recent Protection System Study (Single Line to Ground and 3-Phase for Bus or Element under consideration) and~~to determine the present Fault current values ~~indicated by the short-circuit study.~~

**2.2.** Calculate the percent deviation between the Fault current values ~~analyzed(Single Line to Ground and 3-Phase for the Bus(s) or Element(s) under consideration) used in the most recent Protection System Study and the Fault current values determined~~ pursuant to Requirement R2, ~~part~~Part 2.1 using the following equation:

$$\% \text{ Deviation} = \left( \frac{V_{scs} - V_{pss}}{V_{pss}} \right) \times 100$$

Where:  $V_{scs}$  = Fault current value from present short-circuit study

And:  $V_{pss}$  = Fault current value from most recent Protection System Study

**2.3.** Within 30 calendar days after identification of any deviation in Fault current values found to be 10% or greater, notify each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility.

**M3.** Acceptable evidence for ~~Requirement~~R2, ~~part~~Part 2.1 is dated documentation or an electronic file containing the

**Rationale for R2:** This requires a periodic review of Fault currents and notification to the applicable entities when deviations occur that meet the Requirement R2 criteria. It is important that Interconnected Facility owners are kept aware of changes that could affect proper performance of their Protection Systems. The Transmission Owner is identified as the entity responsible for performing the Fault current studies because they maintain the data necessary to perform the studies. The SDT determined that 10% was an appropriate point at which to require notification based on the fact that Protection System elements that can be affected by Fault current are typically set with margins well above 10%.

Ratio period and no entities meet tl is imp Facilit change perform System is iden for per studies data ne studies 10% w which on the elemer Fault c margin Part 2. custom SDT b the ent and pe studies deviati associ affect t would require Part 2. formul approa Transn calcula Fault c Part 2. day tin sendin interco

2.1 This requirement identifies which facilities must be analyzed and when. Short-circuit databases are customarily updated annually, so the SDT believes 24 months provides the entities flexibility to schedule and perform the new short-circuit studies and calculation of percent deviation. The SDT believes studies associated with changes that would affect the coordination in less time would be triggered by other requirements in this standard.

2.2. This Part provides the formula to be used in the calculation for the facility under consideration.

2.3 The SDT believes the 30-day time frame is reasonable for sending notification(s) to the interconnected entity(s).



output(s) of the percent deviation calculation(s) including the Facilities analyzed.

M4. Acceptable evidence for ~~Requirement R2, part~~Part 2.2 is dated documentation or an electronic file that verifies the formula used in the analysis pursuant to ~~Requirement~~Part 2.1.

M5. Acceptable evidence for ~~Requirement R2, part~~Part 2.3 is documentation demonstrating the transmittal and receipt of the notification to each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility.

R3. Each Transmission Owner, Generator Owner, and Distribution Provider shall provide to each Transmission Owner, Generator Owner, and Distribution Provider connected to each Interconnected Facility, the details (e.g., project schedule, protective relaying scheme types and settings, etc.) as follows: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*]

3.1. For any change or additions listed below; either, at an existing or new Interconnected Facility, or at other Facilities when the proposed change modifies the conditions used in the coordination of Protection Systems of the Interconnected Facilities.

- New installation, replacement with different types, or modification of: protective relays or protective function settings, communication systems, current transformer ratios and voltage transformer ratios.
- Changes to line lengths and/or conductor size or spacing.
- Additions, removals, and/or replacements of transmission system Element(s).
- Changes to generator unit(s) including replacements, re-ratings, and impedances.
- Replacement of the generator step-up transformer(s).

3.2. According to an agreed upon schedule with a Transmission Owner, Generator Owner, or Distribution Provider; or absent such an agreement, within 30 calendar days of receiving a request for information.

Rationale for R3: This requires the transfer of appropriate information to the entities connected at each interconnection due circumstances identified in Parts 3.1 3.2, and 3.3

Part 3.1 The reliability objective of this requirement is to enable the process of conducting Protection System Studies by ensuring that the information is provided to

~~Rationale for R3: This requires the transfer of appropriate information to the entities connected at each interconnection due circumstances identified in R3.1 R3.2, and R3.3~~

~~3.1 The reliability objective of this requirement is to enable the process of conducting Protection System Studies by ensuring that the information is provided to the Interconnected Facility owner(s) in a timely manner. The SDT believes that no single time frame is appropriate for the wide variety of conditions that will need to be evaluated. The list in the requirement is inclusive as it comprises either the protective equipment itself or the power system Elements that affect the coordination of Protection Systems. This requirement would also pertain to changes identified as a result of studies performed in R1.1.~~

~~R3.2 The purpose of this requirement is to provide a means for an entity to receive requested information from an interconnected owner in a timely manner in order to perform a Protection System Study as required by R1.1.1, R1.1.2, R1.1.3 The SDT believes 30 calendar days after receipt of the request is a sufficient time to provide this information. The requirement also provides some flexibility for the parties involved to determine an otherwise agreed to schedule, if appropriate.~~

~~R3.3 The SDT believes 30 calendar days after the conditions noted in Part 3.3.1 and Part 3.3.2 is a sufficient time to provide the information.~~

3.3. Within 30 calendar days after:

3.3.1 Corrections are made when Protection System errors are found during misoperation investigations, commissioning, or maintenance activities.

3.3.2 Emergency replacements are made due to failures of Protection System components.

M6. Acceptable evidence for Requirement R3, partPart 3.1 is documentation which may include emails, electronic files, or hard copy records demonstrating transmittal and receipt of project information. Evidence may include, but is not limited to, a summary of the future project or technical specifications of the proposed changes.

M7. Acceptable evidence for Requirement R3, partPart 3.2 is dated documentation demonstrating the requested information was delivered according to the agreed upon schedule or within 30 calendar days absent such an agreement.

M8. Acceptable evidence for Requirement R3, partPart 3.3 is dated documentation demonstrating the information was delivered within 30 calendar days.

R4. Each Transmission Owner, Generator Owner, and Distribution Provider shall: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning]*

4.1. Within 90 calendar days after receipt, confirm agreement with the summary results of the summary of a Protection System Study, as described in Requirement R1, partPart 1.2, or absent such agreement propose revisions to achieve acceptable results.

4.2. Prior to the in-service date of any planned change at the Interconnected Facility, confirm the Protection System(s) changes as described in Requirement R3, partPart 3.1, are acceptable.

4.3. Within 30 calendar days after receipt:

4.3.1 Confirm the Protection System(s) changes are acceptable pursuant to notification received per Requirement R3, Part 3.3.1.

~~4.3.1.3.2~~ 4.3.1.3.2 Confirm the Protection System(s) changes are acceptable pursuant to notification received per Requirement R3, partPart 3.3.1.2.

~~4.3.2~~ 4.3.2 Confirm the Protection System(s) changes are acceptable pursuant to notification received per Requirement R3, part 3.3.2.

Rationale for R4: This requirement ensures owners of Interconnected Facilities confirm that the each Protection System(s) applied on each of its Interconnected Facilities is acceptable per the conditions identified in parts R4Parts 4.1, R44.2, and R44.3.

R4Part 4.1 The SDT believes ninety (90) calendar days is a reasonable time for the owners of existing Interconnected Facilities to resolve differences and reach agreement.

~~R4Part 4.2. The purpose of this requirement is to assure. The SDT believes that entities achieve agreement(s) prior to implementing proposed modifications (including implementation schedules) to Interconnected Facilities as described in Requirement R3, Part 3.1 must be communicated and agreed to prior to the in-service date. Agreement assures that proposals are properly communicated and implementations are appropriately scheduled. The SDT believes the agreements reached through these efforts provide assurance that~~ the coordination of Protection Systems for Interconnected Facilities is achieved.

| **M9.** Acceptable evidence for ~~Requirement R4~~, Parts 4.1, 4.2, and 4.3 is dated documentation (electronic or hard copy) demonstrating confirmation was achieved in accordance with the respective timeframe.

|

## C. Compliance

### 1. Compliance Monitoring Process

#### 1.1. Compliance Enforcement Authority

Regional Entity

#### 1.2. Evidence Retention

The following evidence retention periods identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full time period since the last audit.

**1.2.1** Each Responsible Entity shall retain data or evidence for three calendar years unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

**1.2.2** If a Registered Entity is found non-compliant, it shall keep information related to the non-compliance until mitigation is complete and approved or for the time specified above, whichever is longer.

**1.2.3** The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent audit records.

#### 1.3. Compliance Monitoring and Assessment Processes:

Compliance Audit

Self-Certification

Spot Checking

Compliance Investigation

Self-Reporting

Complaint

#### 1.4. Additional Compliance Information

None

Table of Compliance Elements

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R 1	Operations Planning, Long-term Planning	Medium	<p>The responsible entity performed a Protection System Study on an Interconnected Facility per <u>R-R1, Part 1.1.1</u> but was late by less than or equal to 30 calendar days.</p> <p>OR</p> <p>The responsible entity performed a Protection System Study on an <u>interconnectedInterconnected</u> Facility per <u>R-R1, Part 1.1.2</u> or documented why a study was not required but was late by less than or equal to 10 calendar days.</p> <p>OR</p> <p>The responsible entity provided the Protection System Study results in accordance with <u>R-R1, Part 1.2</u> but was late by</p>	<p>The responsible entity performed a Protection System Study on an <u>interconnectedInterconnected</u> Facility per <u>R-R1, Part 1.1.1</u> but was late by more than 30 calendar days.</p> <p>OR</p> <p>The responsible entity performed a Protection System Study on an <u>interconnectedInterconnected</u> Facility per <u>R-R1, Part 1.1.2</u> or documented why a study was not required but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p> <p>OR</p> <p>The responsible entity provided the Protection System Study results in accordance with <u>R1,</u></p>	<p>The responsible entity performed a Protection System Study on an <u>interconnectedInterconnected</u> Facility per <u>R-R1, Part 1.1.2</u> or documented why a study was not required but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p> <p>OR</p> <p>The responsible entity provided the Protection System Study results in</p>	<p>The responsible entity performed a Protection System Study on an <u>interconnectedInterconnected</u> Facility per <u>R-R1, Part 1.1.2</u> or documented why a study was not required but was late by more than 30 calendar days.</p> <p>OR</p> <p><u>The responsible entity provided the Protection</u></p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			10 calendar days or less.	<u>Part 1.2</u> but was late by more than 10 calendar days but less than or equal to 20 calendar days.	accordance with R1, <u>Part 1.2</u> but was late by more than 20 calendar days but less than or equal to 30 calendar days.	<p><u>System Study results in accordance with R1, Part 1.2 but was late by more than 30 calendar days.</u></p> <p>OR</p> <p>The responsible entity failed to perform a Protection System Study on an <u>interconnected</u> <u>Interconnected</u> Facility per <u>R-R1, Parts 1.1.1, R1.1.2, or R1.1.3</u>, or document why a study was not required.</p> <p><del>OR</del></p> <p><del>The responsible entity provided the Protection System Study results in accordance with R1.2 but was late by more than 30 calendar days.</del></p> <p>OR</p> <p>The responsible entity failed to provide Protection System Study results in accordance with R1, <u>Part 1.2</u>.</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R 2	Long-term Planning	Medium	<p>The Transmission Owner <del>calculated the percent deviation between the Fault currents on an interconnected Bus or Element</del> performed a short-circuit study as described in R2, Part 2.1 but was late by less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission</p>	<p>The Transmission Owner <del>calculated the percent deviation between the Fault currents on an interconnected Bus or Element</del> performed a short-circuit study as described in R2, Part 2.1 but was late by more than 30 calendar days but less than or equal to <del>60</del>40 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission</p>	<p>The Transmission Owner <del>calculated the percent deviation between the Fault currents on an interconnected Bus or Element</del> performed a short-circuit study as described in R2, Part 2.1 but was late by more than <del>60</del>40 calendar days but less than or equal to <del>90</del>50 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission</p>	<p>The Transmission Owner <del>calculated the percent deviation between the Fault currents on an interconnected Bus or Element</del> performed a short-circuit study as described in R2, Part 2.1 but was late by more than <del>90</del>50 calendar days.</p> <p style="text-align: center;"><u>OR</u></p> <p><u>The Transmission Owner failed to perform a short-circuit study as described in R2, Part 2.1.</u></p> <p style="text-align: center;">OR</p> <p>The Transmission Owner failed to calculate the percent deviation between the Fault currents <del>on an interconnected Bus or Element</del> according to the formula designated in <u>R2, Part 2.2.</u></p> <p style="text-align: center;">OR</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			Owner notified the <del>interconnected</del> <u>Interconnected</u> Facility owner of the changes in Fault currents but was late by less than or equal to 10 calendar days.	Owner notified the <del>interconnected</del> <u>Interconnected</u> Facility owner of the changes in Fault currents but was late by more than 10 calendar days but less than or equal to 20 calendar days.	Owner notified the <del>interconnected</del> <u>Interconnected</u> Facility owner of the changes in Fault currents but was late by more than 20 calendar days but less than or equal to 30 calendar days.	<p>The Transmission Owner notified the <del>interconnected</del><u>Interconnected</u> Facility owner of the changes in Fault currents but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The Transmission Owner failed to notify the <del>interconnected</del><u>Interconnected</u> Facility owner of the changes in Fault currents.</p> <p style="text-align: center;">OR</p> <p><del>The Transmission Owner failed to calculate the percent deviation between the Fault currents on an interconnected Bus or Element according to the formula Designated in R2.2.</del></p>
<b>R 3</b>	<b>Operations Planning</b>	<b>Medium</b>				The responsible entity failed to provide information to the owners of the



R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			<p>The responsible entity provided the requested information per <del>R.R3, Part 3.2</del> but was late by 10 calendar days or less.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the required information identified in R3, <del>Part 3.3</del> but was late by 10 calendar days or less.</p>	<p>The responsible entity provided the requested information per <del>R.R3, Part 3.2</del> but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the required information identified in R3, <del>Part 3.3</del> but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p>	<p>The responsible entity provided the requested information per <del>R.R3, Part 3.2</del> but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the required information identified in R3, <del>Part 3.3</del> but was late by more than 20 calendar days but less than or equal to 30 calendar days</p>	<p>interconnected Facilities for any proposed change identified in R3.1.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the requested information per <del>R.R3, Part 3.2</del> but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the required information identified in R3, <del>Part 3.3</del> but was late by more than 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity failed to provide the requested information.</p>
<b>R 4</b>	<b>Operations</b>	<b>Medium</b>	The responsible entity <del>agreed to confirmed agreement with</del> the	The responsible entity <del>agreed to confirmed agreement with</del> the	The responsible entity <del>agreed to confirmed agreement with</del> the	The responsible entity <del>agreed to confirmed agreement with</del> the

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
	<b>Planning</b>		<p><u>summary</u> results of the Protection System Study <del>on-an interconnected Facility</del> per <u>R-R4, Part 4.1</u> but was late by 10 calendar days or less.</p> <p>OR</p> <p>The responsible responded to the confirmation request per <u>R-R4, Part 4.3</u>, but was late by 10 calendar days</p>	<p><u>summary</u> results of the Protection System Study <del>on-an interconnected Facility</del> per <u>R-R4, Part 4.1</u> but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p> <p>OR</p> <p>The responsible responded to the confirmation request per <u>R-R4, Part 4.3</u>, but was late by more than 10</p>	<p><u>summary</u> results of the Protection System Study <del>on-an interconnected Facility</del> per <u>R-R4, Part 4.1</u> but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p> <p>OR</p> <p>The responsible responded to the confirmation request per <u>R-R4, Part 4.3</u>, but was late by more than 20</p>	<p><u>summary</u> results of the Protection System Study <del>on-an interconnected Facility</del> per <u>R-R4, Part 4.1</u> but was late by more than 30 calendar days.</p> <p>OR</p> <p>The responsible entity failed to <del>agree to</del> <u>confirm agreement with</u> the <u>summary</u> results of the Protection System Study <del>on-an interconnected Facility</del> per <u>R-R4, Part 4.1</u>.</p> <p>OR</p> <p>The responsible entity failed to <del>agree to</del> <u>confirm acceptance of</u> the <u>planned</u> changes <del>proposed in R</del> <u>pursuant to R4, Part 4.2</u> prior to implementation of those changes.</p> <p>OR</p> <p>The responsible responded to the confirmation request per <u>R-R4, Part 4.3</u>, but was late by more than 30</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			or less.	calendar days but less than or equal to 20 calendar days.	calendar days but less than or equal to 30 calendar days.	calendar days. <del>OR</del>  OR The responsible entity failed to <del>The responsible responded</del> <u>respond</u> to the confirmation request per <del>R-R4, Part</del> <u>4.3</u> .

**D. Regional Variances**

None.

**E. Interpretations**

None.

**F. Associated Documents**

None.

### Guidelines and Technical Basis

#### Requirement R1:

This requirement directs the performance of Protection System Studies for every interconnected Facility to verify coordination of existing Protection Systems where no recent study exists or when Facility configuration or Fault current deviations of 10% or more have occurred. In developing the language to define Protection System Study, the SDT considered various reference books discussing protective relaying theory and application along with the following description of “coordination of protection” from the pending revision of IEEE C37.113 Guide for Protective Relay Applications to Transmission Lines:

*“The process of choosing current or voltage settings, or time delay characteristics of protective relays such that their operation occurs in a specified sequence so that interruption to customers is minimized and least number of power system elements are isolated following a system Fault.”*

Using the reference material cited above as guidance, the SDT defined the term Protection System Study for use within the PRC-027-1 Reliability Standard as:

“A study that demonstrates existing or proposed Protection Systems operate in the desired sequence for clearing Faults.”

Protection System Studies comprise a variety of assessments and underlying database activities that cumulatively serve to provide verification that Protection Systems will function as designed. Typical database activities performed during these studies include assembling impedance data for Fault studies and modeling Protection Systems. Ultimately, the particular studies performed depend on the protective relays installed, their application, and the Protection System philosophies of each Transmission Owner, Generator Owner, and Distribution Provider. These studies may include graphical coordination of protection characteristics on time-current or impedance graphs; relay scheme simulation studies using sequence of operations during pre-defined Faults; and sensitivity studies to confirm effective reaches, sufficient operating parameters (energy or operating torque), and adequate directional polarizing quantities.

The SDT believes applicable entities should have a documented Protection System Study for each interconnected Facility to validate the Protection Systems perform in a manner consistent with the purpose of this Standard. Additionally, the SDT believes that 36 months is an appropriate amount of time for entities to perform the initial studies expected under this requirement. This period considers the time some entities may require to create project scopes, acquire proposals, and secure contracts to hire external resources that may be needed to perform the studies. The SDT also has no evidence there is widespread miscoordination between interconnected Facilities that might warrant a shorter time-frame for the studies to be performed. Protection Systems are continually challenged by Faults on the BES but records collected for Reliability Standard PRC-004 do not indicate that lack of coordination was the predominate root cause of reported Misoperations.

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It should be noted that Protection System studies performed after June 18, 2007 (the effective date of PRC-001-1) are sufficient to meet Requirement R1.

~~Sub requirements~~Parts 1.1.2 and 1.1.3 further direct that Protection System ~~studies~~Studies must be completed under the following two circumstances:

1. After notification of an identified 10% or greater deviation in Fault current, the notified entities must perform a new Protection System study of the Interconnected Facility or document why a study is not required. The SDT recognizes that, based on the Protection Systems installed (e.g., current differential), a 10% or greater deviation in Fault current may not necessitate a new Protection System Study be performed; therefore this part of the requirement includes the statement, “unless the entity can demonstrate that such a study is not required”. The SDT believes the 6-month time frame associated with this requirement represents is a reasonable period to perform the studies that are required after identification by the 24-month Fault current review.
2. After proposing or being notified of a change at an Interconnected Facility, entities must perform a new Protection System study or document why a study is not required. The SDT recognizes that, based on the scope of the proposed change and/or the Protection Systems installed (e.g., current differential), the change may not necessitate a new Protection System Study be performed; therefore this part of the requirement includes the statement, “unless the entity can demonstrate that such a study is not required”. The SDT believes that specifying a single time frame for evaluation of the wide variety of conditions that may be associated with a particular change is not appropriate. This is because the SDT sees the entity initiating any change as having the incentive to move this along in a timely fashion in order to both keep the associated project on schedule and confirm the changes are acceptable “prior to the in-service date” as stipulated by Requirement R4, ~~part~~Part 4.2.

Requirement R1, ~~part~~Part 1.2 requires that the entity performing the Protection System Study to provide a summary of the study results to the affected owners of Protection Systems applied at interconnected Facilities. As guidance, the SDT lists the following inputs and results of a Protection System Study that may be included in the summary provided pursuant to this requirement:

1. Data used to determine Fault currents in performing the study along with a listing of the single-line-to-ground and 3-phase Fault currents for the Bus or Element at the Interconnected Facility under study.
2. A listing of the Protection System(s) owned by the entity performing the study that are adjacent to the Bus or Element at the Interconnected Facility and were reviewed for coordination of protective relays as part of the study.
3. A listing of any issues associated with the relay settings of the other owner(s) at the Interconnected Facility that were identified by the study.

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4. Any proposed revisions to a Protection System or its protective relay settings that were identified by the study.

### Requirement R2:

The SDT investigated various inputs that would trigger a review of the existing Protection System Studies, and determined through the experience of the SDT members, along with informal surveys of several regional protection and control committees, that variations in Fault currents of 10% or more are an appropriate indicator that an updated Protection System Study may be necessary. These variations could have resulted from the accumulation of incremental changes over time. This requires a periodic review of Fault currents and includes the calculation of the percent deviation between the Fault current values used in the most recent Protection System Study and the present Fault current values indicated by the short-circuit study performed pursuant to this requirement. This calculation is necessary to identify Fault current changes that must be communicated in accordance with Requirement R2, ~~part~~Part 2.3.

Polling of SDT membership and various protection engineering committees indicates that short-circuit databases are customarily updated annually. Based on this information, the SDT believes that requiring a 24-month periodic review of Fault currents provides entities additional flexibility to schedule and perform these studies and calculate the percent deviation as described in Requirement R2, ~~part~~Part 2.2. The SDT believes studies associated with changes that would affect the coordination in less than 24-months would be triggered by other requirements in this standard.

Requirement R2, ~~part~~Part 2.3 further directs the Transmission Owner to, within 30 calendar days, inform interconnected Facility owners when short-circuit studies indicate that 10% deviations in Fault current have occurred at the Interconnected Facility. The SDT believes the 30-day time frame associated with this requirement is reasonable for sending notification to the interconnected entity(s) and is consistent with other NERC Reliability Standards.

In Requirement R2, the Transmission Owner is identified as the functional entity responsible for performing the Fault current studies because they maintain the data required to perform the studies. Generator data (including data provided by Distribution Providers) is incorporated into the Transmission Owners' short circuit models.

### Requirement R3:

This requires the Interconnected Facility owners to evaluate the impact to their Protection Systems due to proposed changes by requiring the registered functional entity initiating the changes to provide the details to the other affected entities of the Interconnected Facility. Documentation provided to these other owners may include, but is not limited to: power system configurations; protection schemes; schematics; instrument transformer ratios; type of relay(s); communication equipment applied for protection; and Protection System settings. The recipient will incorporate the applicable

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information into its Protection System Studies to evaluate whether changes are required.

The list of applicable changes provided in Requirement R3, ~~part~~Part 3.1 is inclusive, as it comprises either the protective equipment itself or the power system Elements that affect the coordination of Protection Systems. The SDT recognizes that other Facility changes not directly associated with the interconnection can impact the Protection System Study of the interconnected Facilities; e.g., the addition of a large autotransformer bank or generator not directly associated with the interconnected Facilities. The SDT believes that it is not appropriate to specify a single time frame for providing the details of the wide variety of conditions listed in Requirement R3, ~~part~~Part 3.1 that may be associated with a particular change. This is because the SDT sees the entity initiating any change as having the incentive to move the process along in a timely fashion in order to both keep the associated project on schedule and confirm the changes are acceptable “prior to the in-service date” as stipulated by Requirement R4, ~~part~~Part 4.2.

Requirement R3, ~~part~~Part 3.2 allows for entities to agree upon a schedule, appropriate to the circumstances, for providing the details needed to conduct a Protection System Study or, absent such agreement, within 30 days of a request for this information. This requirement provides a means for entities to receive requested information in a timely manner. In consideration of circumstances where the information may not be readily available or may be incomplete due the retirement of personnel, the purging of records, change of ownership, etc., it also provides the flexibility of mutually agreeing to a schedule for exchanging information. The SDT believes 30 calendar days after receipt of the request is a sufficient time to provide the requested information where no other agreement exists.

Additionally, this requirement includes a provision for providing details associated with changes to the previously agreed upon coordination when: (1) Protection System errors are found during misoperation investigations, commissioning, or maintenance activities; (2) emergency replacements are made due to failures of Protection System components. Based upon the limited number of instances that would occur under such circumstances, the SDT believes 30 calendar days after determining that changes are required is an appropriate time frame for providing the associated details to affected entities.

### Requirement R4:

The reliability objective of this requirement is to bring the process of Protection System coordination full-circle by gaining the confirmation of interconnected entities that their Protection Systems are coordinated consistent with the purpose of this standard. Cooperative participation of Interconnected Facility owners in communicating Protection System(s) design and study results will achieve coordination of Protection Systems for reliable operation of the BES during Faults.

Requirement R4, ~~part~~Part 4.1 directs applicable entities to confirm agreement within 90 days of receiving a summary of results from an entity performing the Protection System Study that the results indicate, and/or follow-up revisions achieve coordination of the entities’



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associated Protection Systems. The SDT believes 90 calendar days after receipt of the results of a Protection System Study provides a reasonable time for the owners of Interconnected Facilities to resolve differences and reach agreement that their Protection Systems are coordinated.

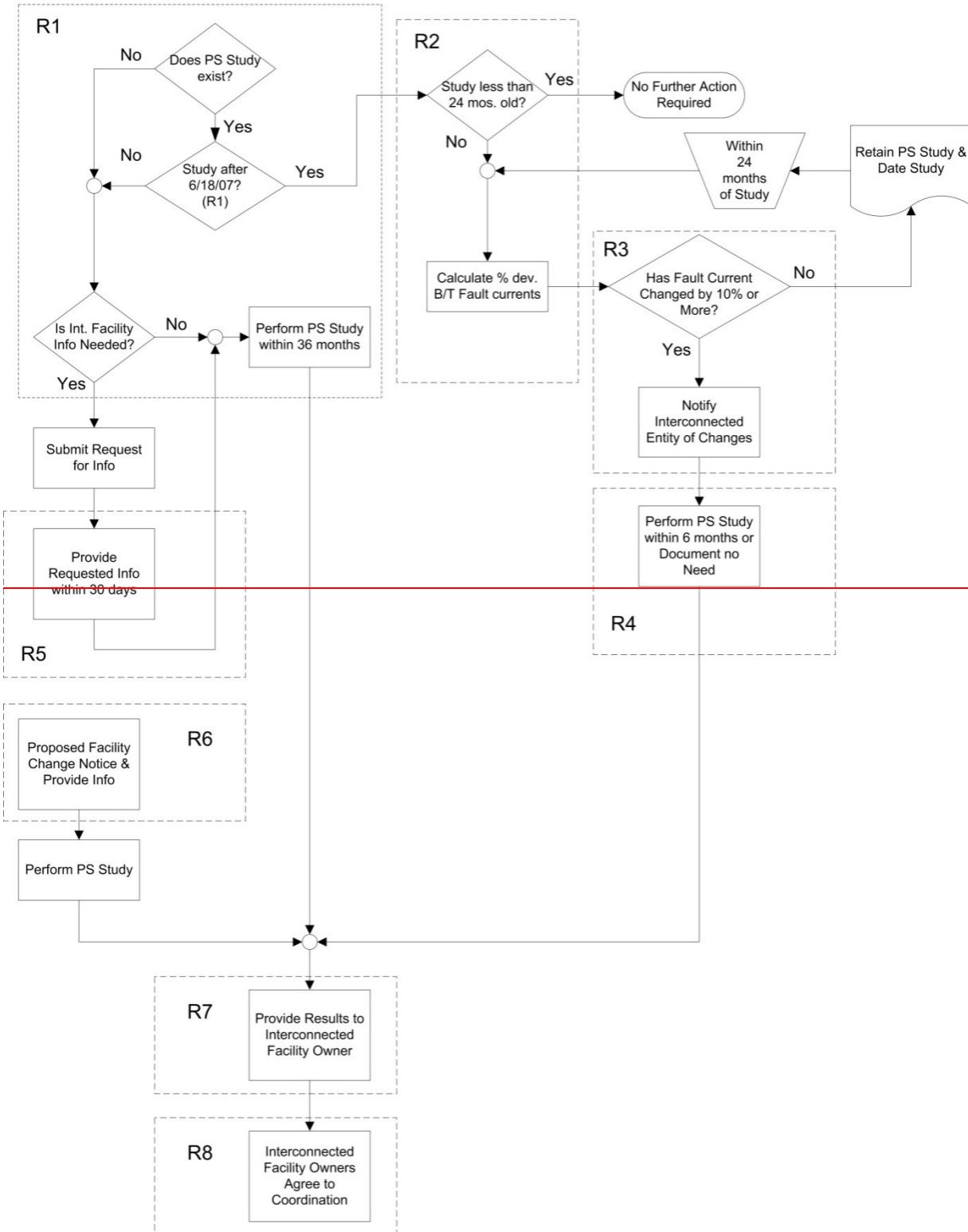
Requirement R4, ~~part~~Part 4.2 directs entities to confirm that planned changes described in Requirement 3.1 are acceptable prior to the in-service date of those changes. The purpose of this requirement is to assure the effects that planned changes have on Protection Systems at Interconnected Facilities have been considered by all affected entities.

Requirement R4, ~~parts~~Parts 4.3.1 and 4.3.2 direct confirmation within 30 calendar days that changes are acceptable when corrections are made due to Protection System errors found during misoperation investigations, commissioning, or maintenance activities, or when emergency replacements are made due to failures of Protection System components. Based upon the limited number of instances that would occur under such circumstances, the SDT believes 30 calendar days provides adequate time for achieving such agreement.

**Process Flow Chart**

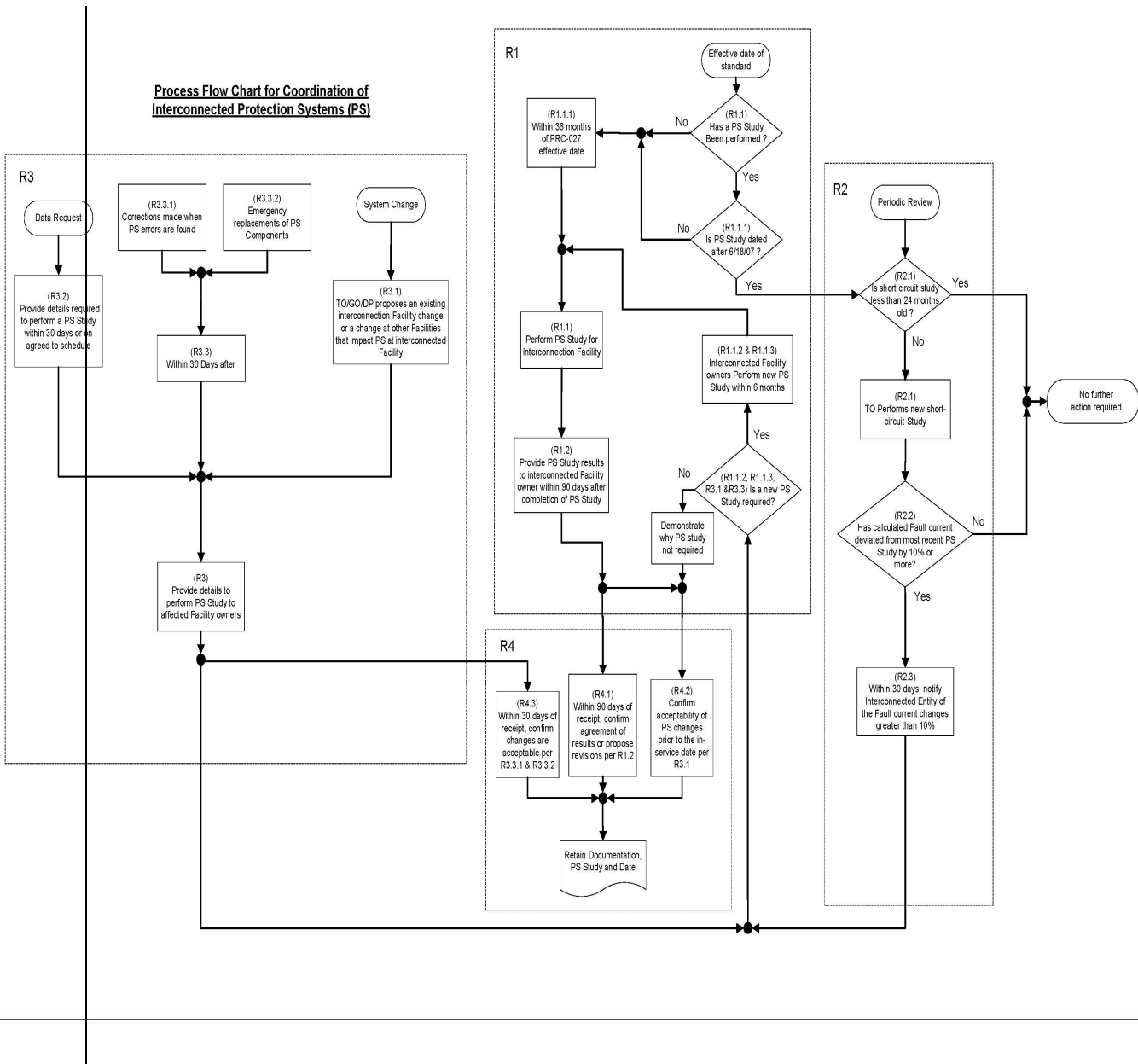
Below is a complete representation of the process including the relationships between requirements:

**Process Flow Chart for Coordination of Interconnected Facility Protection Systems (PS)**



# Application Guidelines

**Process Flow Chart for Coordination of Interconnected Protection Systems (PS)**



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### Example Process

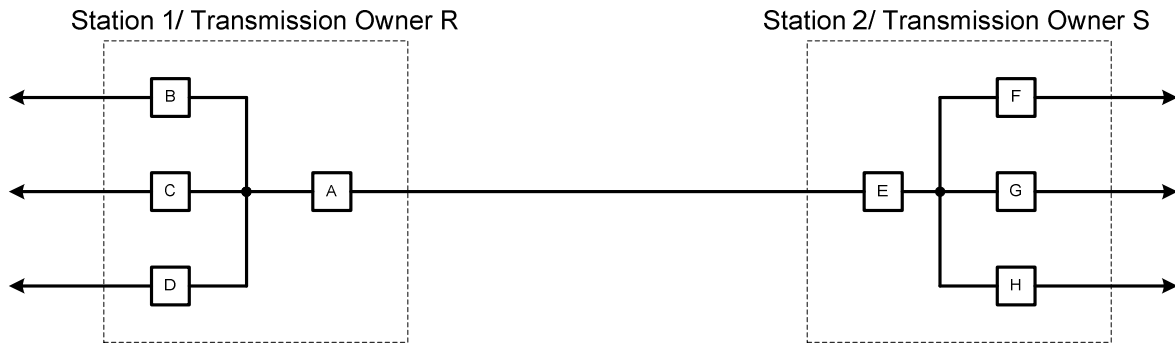
An example of the interaction between entities required to gather the information to perform an accurate study is below.

- The initiating entity (Entity A) will contact the interconnected entity (Entity B) and request up-to-date Protection System information.
- Upon receipt of the above request for information, Entity B will provide the information within 30 calendar days or an agreed upon time frame.
- Entity A will perform a Protection System Study using the information received.
- Entity A will provide a summary of the results of the study to Entity B within 90 calendar days of completing the Protection System Study.
- Entity B will review the summary information and confirm agreement within 90 calendar days of receiving the study results from Entity A that coordination is achieved.
  - In cases where the study reveals that changes to Protection Systems are needed, Entity B would propose to Entity A revisions that achieve acceptable results.
- Documentation of the final agreement is required prior to implementation of planned changes.

## Diagrams

Introduction: The diagrams below are intended to provide guidance related to the responsibilities associated with the Purpose of this Standard between Owners of interconnected Facilities. After the reviews and prior to implementation of the changes, the owners must reach agreement on the final settings to achieve coordination of the Protection Systems.

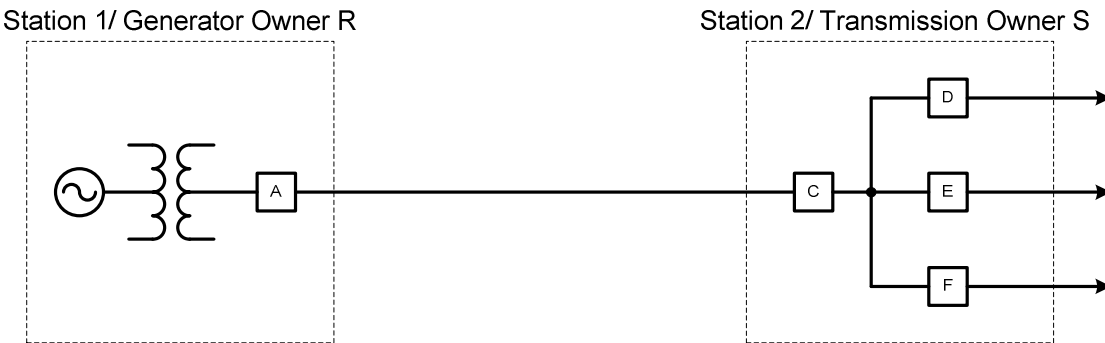
**Figure #1**



In Figure 1 above, the interconnecting Element between the Transmission interconnected Facilities (Station 1 – Transmission Owner R and Station 2 – Transmission Owner S) is the transmission line between Breakers A and E.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 1, the responsibility for Owner S is to verify that the Protection System settings associated with Breaker A (provided by Owner R) do not result in coordination issues with the Protection System settings associated with Breakers E, F, G, and H. Likewise, the responsibility for Owner R is to verify that the Protection System settings associated with Breaker E provided by Owner S do not result in coordination issues with the Protection System settings associated with Breakers A, B, C, and D.

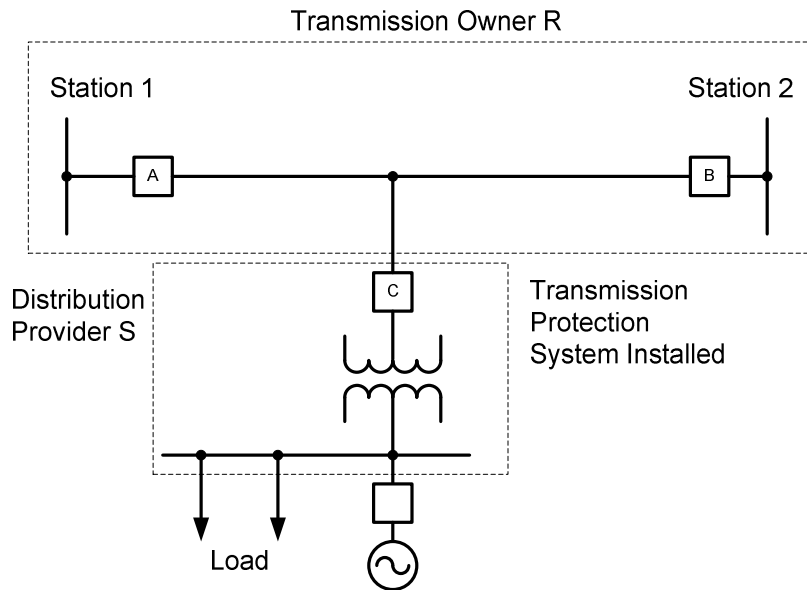
**Figure #2**



In Figure 2 above, the interconnecting Element between the Transmission to Generation Interconnected Facilities (Station 1 – Generation Owner R and Station 2 – Transmission Owner S) is the transmission line or bus between Breakers A and C.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 2, the responsibility for Transmission Owner S is to verify that the Protection System settings associated with Breaker A (provided by Owner R) and the generator Protection Systems do not result in coordination issues with the Protection System settings associated with Breakers C, D, E, and F. Likewise, the responsibility for Generation Owner R is to verify that the Protection System settings associated with Breaker C (provided by Owner S) do not result in coordination issues with the Protection System settings associated with Breaker A or the generator Protection Systems.

**Figure #3**<sup>[p2]</sup>



In Figure 3 above, the interconnecting Element between the Transmission Owner to Distribution Provider (with a generator) interconnected Facilities (Transmission Owner R line between Breakers A and B – Distribution Provider S) is the transmission line or tap between the line and Breaker C.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 3, the responsibility for Transmission Owner R is to verify that the Protection System settings associated with Line Breaker C (provided by Distribution Provider S) and the generator Protection Systems do not result in coordination issues with the Protection System settings associated with Breakers A and B and other Protection Systems at stations 1 and 2. Likewise, the responsibility for Distribution Provider S is to verify that the Protection System settings associated with Breakers A and B provided by Owner R do not result in coordination issues with the Protection System settings associated with Breaker C and the generator Protection Systems. In order to perform this verification, it will be necessary that the Generator Owner provide Distribution Provider S with its generator Protection System settings.

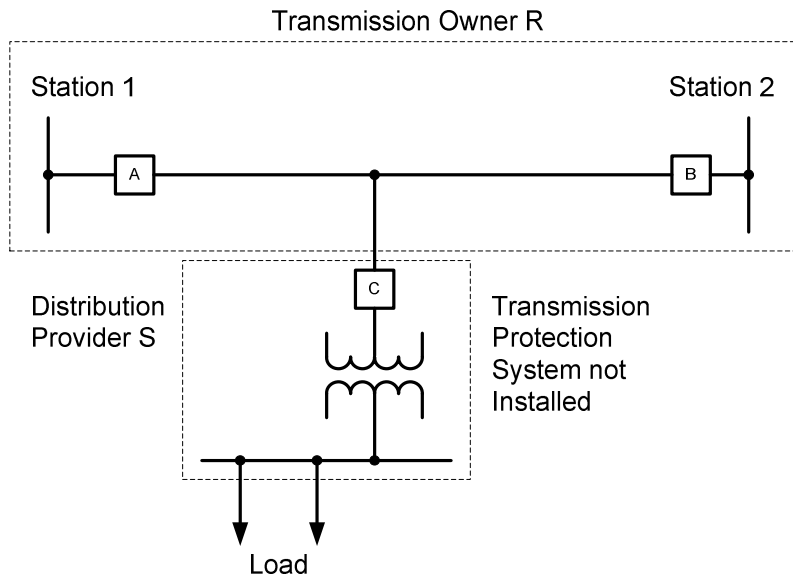
**Note:** A Protection System Study is required per this Standard for this example if a Protection System at the Distribution Provider's substation is designed to protect transmission Elements.





## Application Guidelines

**Figure #4**<sup>[p3]</sup>

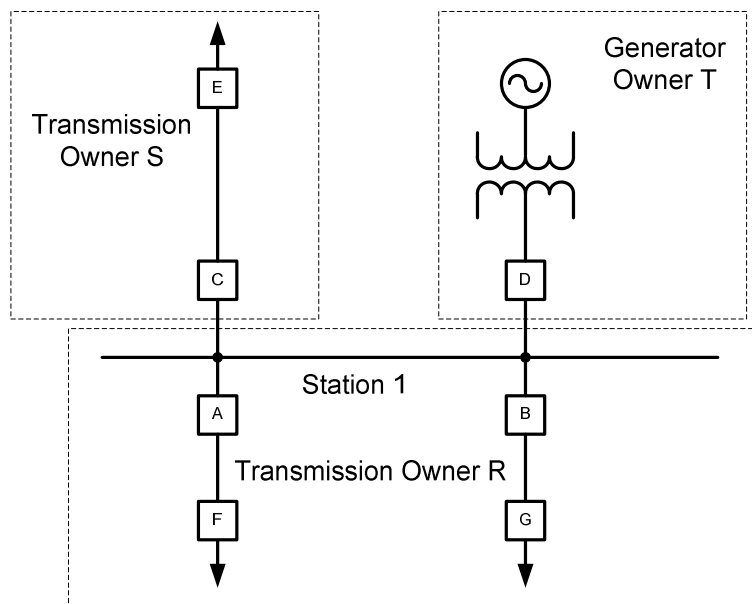


In Figure 4 above, the interconnecting Element between the Transmission Owner to Distribution Provider interconnected Facilities (Transmission Owner R line between Breakers A and B – Distribution Provider S) is the transmission line or tap between the line and Breaker C.

**Note:** No specific Protection System Study is required per this Standard for this example since the Protection System at the Distribution Provider's substation is not designed to protect transmission Elements.

**Figure 5**

Transmission/Generation Facility with Multiple Owners



In Figure 5 above, the interconnecting Element between the Transmission Owners R and S and the Generation Owner T is the common Transmission bus. In this example, Transmission Owner S and Generator Owner T are not directly interconnected to each other at Transmission Station 1 and all direct interconnections are between Owner R and each of the other Owners connected to the bus.

Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 5:

The responsibility for Owner R is to verify that the Protection System settings associated with Breaker C, E, D, and the generator Protection System (provided by Owners S or T) do not result in coordination issues with the Protection System settings associated with Breakers A, B.

The responsibility for Owner S is to verify that the Protection System settings associated with Breakers A, F, B, G, D, and the generator Protection System (provided by Owners R or T) do not result in coordination issues with the Protection System settings associated with Breaker C. To perform this verification, it will be necessary that Transmission Owner R provide Owner S with its settings for Breakers A, F, B, and G as well as the settings for Breaker D and generator Protection System settings provided to Owner R by Generator Owner T.

The responsibility for Owner T is to verify that the Protection System settings associated with Breakers A, F, B, G, C, and E (provided by Owners R or S) do not result in coordination issues with the Protection System settings associated with Breaker D or the Protection Systems associated with generator Protection Systems. In order to perform this verification, it will be necessary that Transmission Owner R provide Generator Owner T with its settings for Breakers A, F, G, and B as well as the settings for Breaker C and E provided to Owner R by Transmission Owner S.



## **Project 2007-06 System Protection Coordination Request for Industry Feedback**

### **Request for Industry Feedback:**

The System Protection Coordination Standard Drafting Team is requesting that the Regional Reliability Organizations solicit feedback from their respective “Protection and Control” working groups relative to the solutions proposed in this document as a means to address the potential reliability gaps identified by the Standard Drafting Team.

The Standard Drafting Team’s schedule for posting the proposed, new Reliability Standard PRC-027-1 is to finalize the necessary documents during the week of March 19, 2012. Therefore, the Standard Drafting Team requests the RRO protection groups provide preliminary feedback by March 19, 2012.

### **Introduction and Background**

On December 7, 2006, the NERC Planning Committee approved the assessment of Reliability Standard PRC-001 (System Protection Coordination) prepared by the NERC System Protection and Control Task Force (SPCTF). The SPCTF noted problems with the applicability to entities and vagueness of requirements in the existing PRC-001-1 Reliability Standard. The SPCTF concluded that the deficiencies of PRC-001-1 were magnified by having requirements that addressed protection coordination issues in the operating, operations planning, and planning horizons.

The NERC Standards Committee approved a Standard Authorization Request (SAR) on June 5, 2007 that included the modifications noted by the SPCTF assessment. The SAR was posted for comment from June 11, 2007 – July 10, 2007 and was subsequently approved. Following this approval, the Standards Committee established Project 2007-06 and opened nominations for Standard Drafting Team Members during the period of August 15-29, 2007.

The Standard Drafting Team selected for Project 2007-06 – System Protection Coordination posted an initial draft of Reliability Standard PRC-001-2 to industry on September 11, 2009. In that draft, the System Protection Coordination Standard Drafting Team (SPCSDT) addressed the planning and non-operational issues of PRC-001-1 identified by the SPCTF assessment as well as the operating time frame issues identified in FERC Order 693. These operating time frame requirements involve detecting Protection System failures, informing operators, and taking quick, corrective operator actions. Considering the operations-based nature of the requirements at issue, the SPCSDT transferred the Order 693 directives associated with Reliability Standard

## Protection System Coordination

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PRC-001-1, Requirements R2, R5, and R6 to Project 2007-03 Real-time Operations for inclusion in the revisions of the appropriate operating standards associated within that project.

Additionally, the SPCSDT determined that the training aspects of PRC-001-1, Requirement R1 would be more appropriately addressed by Reliability Standard PER-005-1 with revision to its Applicability section to include the Generator Operator. The two remaining requirements of PRC-001-1, Requirements R3 and R4, address the coordination of new and existing protective systems, and remain the focus of the Project 2007-06 System Protection Coordination Standard Drafting Team.

During review of the existing PRC-001-1 Requirements R3 and R4 and various other NERC, FERC, and industry feedback, the SPCSDT identified potential reliability gaps which it will address in a proposed, new Reliability Standard PRC-027-1 – Protection System Coordination for Performance During Faults. This concept paper is designed to solicit stakeholder input regarding several key aspects of the proposed Standard.

### For Reference:

#### **PRC-001-1**

**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.

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

### New Definitions Applicable to the Proposed Standard:

**Interconnected Facility:** Facilities that are electrically joined by a single Element and are owned by different entities. (Note: This also applies to a single owner with multiple functional registrations.)

**Protection System Study:** A study of the Coordination of Protective Relays to insure that the existing or selected Primary and Backup Protective Relay settings of all other owners at an Interconnected Facility have sufficient Coordination Time Delay with the adjacent Protection Systems owned by the owner conducting the study.

February 28, 2012

### *What is the reliability objective of this standard?*

The SPC SDT proposes that the reliability objective of its project is to Design and implement Protection Systems for Interconnected Facilities, such that those Protection Systems do not remove power system Elements from service except for those required to isolate Faults, while meeting the system performance specified within requirements established in other approved NERC Reliability Standards.

1. Do you support this reliability objective? If not, please identify why not.

### *Assignment of Functional Entities in the Applicability Section:*

Applicability of the existing Reliability Standard PRC-001-1 is assigned to Balancing Authorities, Transmission Operators, and Generator Operators. The System Protection Coordination Standard Drafting Team recognizes that the technical work necessary to ensure proper coordination of Protection Systems is performed by the owners of the Protection Systems and not typically carried out by the functional entities currently listed in the applicability section of PRC-001-1.

The SDT proposes that owners (Transmission Owners, Generator Owners, and Distribution Providers) of Protection Systems are the proper entities to verify that coordination of Protection Systems exists including when the different Owners are different registered Entities within the same company (i.e. the entity as a Transmission Owner and a Generator Owner).

2. Do you agree with the SDT? If not, please identify why not.

### *Lack of Coverage for Existing Facilities:*

Requirement R3 of the existing Reliability Standard PRC-001-1, only applies to coordination of new Protection Systems or changes to existing Protection Systems. The SPC SDT proposes that to meet the reliability objective, that each owner of a Protection System applied on a Facility where different Functional Entities interconnect, should have a valid protection system study (e.g., relay coordination study) completed within 36 months of the approval of the proposed Reliability Standard PRC-027-1.

Note: Existing protection system studies completed after the effective date of PRC-001-1 (June 18, 2007) are considered to be satisfactory for meeting this requirement.

3. Do you agree that it is necessary for owners to verify that this coordination exists on existing interconnected Facilities? If not, please identify why not.

## Protection System Coordination

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### *Requirement for a Periodic Review and Proposed Trigger:*

The existing Reliability Standard PRC-001-1 requires no periodic review of the system conditions used to determine coordination of Protection Systems on interconnected Facilities. The SPC SDT proposes using variations in Fault currents as a trigger for initiating a re-verification of the coordination of Protection Systems for interconnected Facilities. Variations in fault currents result from the accumulation of incremental changes over time. The SPC SDT proposes that rather than require a “fixed” interval for review of Protection System coordination, tying the need to re-verify to the % change in Fault current is an efficient method of determining when to re-verify the existence of Protection System coordination. Through informal industry sampling conducted to identify a methodology for triggering such a review, the Standard Drafting Team determined that a change of +/- 10% in fault current (3 phase, or phase to ground) provided an appropriate level to require a review.

4. Do you agree that using changes in Fault current is an efficient method of determining when to re-verify coordination of Protection Systems for Interconnected Facilities? If yes, then do you agree with the +/- 10% trigger? If you disagree with either the use of Fault current as a trigger, or the +/- 10% threshold, please identify what you think would be a better method of determining when to re-verify the existence of coordination.

## Implementation Plan

### Project 2007-06 System Protection Coordination

#### PRC-027-1

#### Approvals Requested

- PRC-027-1 Protection System Coordination for Performance During Faults
- PRC-001-2 System Protection Coordination (Retiring legacy Requirements R3 and R4)

#### Applicable Entities

Standard	Applicable Entities					
	TO	GO	DP	TOP	GOP	BA
PRC-027-1: Protection System Coordination for Performance During Faults	X	X	X			
PRC-001-2: System Protection Coordination				X	X	X

#### Defined Terms in the NERC Glossary

The standards drafting team proposes the following new definition:	
<b>Interconnected Facilities</b>	BES Facilities that are electrically joined by one or more Element(s) and are owned by different functional, operating, or corporate entities.
<b>Protection System Study</b>	A study that demonstrates existing or proposed Protection Systems operate in the desired sequence for clearing Faults.

#### Background

On December 7, 2006, the NERC Planning committee approved the assessment of Standard PRC-001-1 (System Protection Coordination) prepared by the NERC System Protection and Control Task Force (SPCTF). The SPCTF asserted:

*“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.”*

And further:

*“The SPCTF... recommends that the requirements for the operating horizon and planning horizon be clearly delineated and warrants consideration of dividing this standard into two standards.”*



The Standard Committee approved the Standard Authorization Request with modifications by the SPCTF for posting on June 5, 2007. The SAR was posted for comment from June 11, 2007 – July 10, 2007 and was subsequently approved.

With the development of the proposed Reliability Standard PRC-027-1, the Standard Drafting Team (SDT) for Project 2007-06 – System Protection Coordination, has followed the observations and recommendation of the NERC SPCTF assessment of PRC-001-1. The SDT accomplishes this by:

1. Incorporating and building upon the elements of the two planning horizon Requirements R3 and R4 of PRC-001-1 in a new standard (as recommended by the SPCTF assessment), focusing on the performance of Protection Systems during Faults. (Requirements R3 and R4 of PRC-001-1 will be retired upon appropriate regulatory approval of the proposed PRC-001-2 and PRC-027-1.)
2. Assigning responsibility to the appropriate functional entities – the Protection System equipment owners, specifically: Transmission Owners, Generator Owners, and Distribution Providers.
3. Transferring the responsibility of addressing the three operating horizon Requirements R2, R5, and R6 of PRC-001-1 to Project 2007-03 Real-time Operations for inclusion in the revisions of the appropriate operating standard(s) within that project.

Note: The proposed disposition of Requirements R2, R5, and R6 of PRC-001-1 is posted on the Project 2007-03 page. The Project 2007-03 SDT is recommending retirement of Requirements R2, R5, and R6 of PRC-001-1 because they address data and data requirements, which is covered in TOP-003-2. The Project 2007-03 SDT included a redlined version of PRC-001-1 and a clean version of PRC-001-2 with the conforming changes, along with a mapping document and implementation plan describing the translation of the legacy requirements into TOP-003-2.

4. Leaving the training-related legacy Requirement R1 of PRC-001-1 in PRC-001-2 (thereby not creating a reliability gap) until it is incorporated into a new standard or a revision to an existing standard.

### **General Considerations**

Two drafting teams (Project 2007-06 System Protection Coordination and Project 2007-03 Real-time Operations) have coordinated on addressing the legacy requirements of PRC-001-1. Prior to this posting, the Project 2007-03 Real-time Operations posted a clean version of PRC-001-2 showing Requirements R2, R5, and R6 removed. This posting of PRC-027-1 includes a version of PRC-001-2 showing the removal of the legacy Requirements R3 and R4; only the legacy Requirement R1 remains in the clean version of PRC-001-2.

### **Effective Date of New or Revised Standards**

PRC-027-1	PRC-027-1 shall become effective on the first day of the first calendar quarter that is three months beyond the date that this standard is approved by
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applicable regulatory authorities where such explicit approval is required. Where no regulatory approval is required the standard shall become effective on the first day of the first calendar quarter that is three months beyond the date this standard is approved by the NERC Board of Trustees, or as otherwise prescribed by the laws or regulations of the applicable ERO governmental authorities. For Facility interconnections between Canadian Facilities (that recognize the NERC Board of Trustees or other ERO governmental authority approval) and U.S. Facilities (that recognize FERC approval), the effective date shall be the FERC approved effective date.

PRC-001-2                      Same effective date as PRC-027-1.

### **Implementation Plan for Definitions**

Effective date of PRC-027-1.

### **Implementation Plan for PRC-027-1 Requirements R1 through R4**

Entities shall be 100% compliant with Requirements R1 through R4 on the effective date of PRC-027-1.

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**Subject:** NERC System Protection Coordination Standard Drafting Team is requesting feedback on the attached Concept Paper  
**Date:** Thursday, March 01, 2012 11:27:13 AM  
**Attachments:** [Concepts Paper\\_PRC027\\_022812.docx](#)

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George, Art, Kris, Bill, Ding, Daren, Heidt, Jerry,

As the Chair or member of your Region's respective System Protection Committee, the NERC System Protection Coordination Standard Drafting Team is requesting feedback on the attached Concept Paper related to a new proposed **PRC-027-1: Protection System Coordination for Performance During Faults**. Note: I have copied the respective Regional Staff liaison to the respective group.

As noted in the attachment, the SDT has a scheduled meeting on March 20-21 and we would like any preliminary feedback prior to that meeting. Realizing that your respective groups may not have formal meetings scheduled prior to that time, we obviously will accept feedback after that date; however please try to have your groups formal feedback to me prior to April 2, 2012.

Please let me thank you in advance for your assistance. Your groups feedback will be instrumental as the SDT moves forward toward our first formal posting in April.

Philip B. Winston  
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