

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.
5. Draft 1 of PRC-027-1 was posted for a 45-day formal comment and initial ballot from May 21 – July 5, 2012.

Description of Current Draft

The System Protection Coordination Standard Drafting Team (SPC SDT) created a new results-based standard, PRC-027-1, to coordinate Protection Systems for Interconnected Elements, such that the least number of power system Elements are isolated to clear Faults. This standard incorporates and enhances the coordination aspects of Requirements R3 and R4 from PRC-001-1 (now R2 and R3 of PRC-001-2). The SPC SDT is requesting a posting for stakeholder comments under a 30-day formal comment period.

Anticipated Actions	Anticipated Date
30-day Formal Comment Period with Parallel Successive Ballot	November 2012
Recirculation Ballot	January 2013

Effective Dates:

PRC-027-1 shall become effective on the first day of the first calendar quarter that is six months beyond the date that this standard is approved by applicable regulatory authorities. In those jurisdictions where regulatory approval is not required, the standard shall become effective on the first day of the first calendar quarter that is six months beyond the date 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. For Interconnected Elements 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.

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.

The following terms are defined for use only within PRC-027-1, and should remain with the standard upon approval rather than being moved to the NERC Glossary of Terms:

Interconnected Element: An Element that electrically joins separate Functional Entities, including those Functional Entities that are a part of the same Registered Entity.

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 Elements, such that the least number of power system Elements are isolated to clear Faults.
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 for the purpose of detecting Faults on Interconnected Elements of the BES and that require coordination for isolating those faulted Elements

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 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 identified by the SPCTF assessment of PRC-001-1. 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 (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 results-based standard, concentrating on the reliability aspects (the coordination of new and existing protective systems in the planning horizon) associated with Requirements R3 and R4 of PRC-001-1. 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 Elements, such that the least number of power system Elements are isolated to clear Faults.”

PRC-001-1 contained 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 transferred the responsibility of addressing the operating Requirements R2, R5, and R6 to the drafting team for Project 2007-03 Real-time Operations, charged with revising the TOP group of reliability standards. The Project 2007-03 drafting team retired Requirements R2, R5, and R6 of PRC-001-1 because they address data and data requirements that are included in the proposed Reliability Standard TOP-003-2. The SPC SDT is 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), and focusing on the performance of Protection Systems during Faults. Requirements R3 and R4 of PRC-001-1 (now R2 and R3 of PRC-001-2) will be retired upon appropriate regulatory approval of the proposed standards PRC-001-3 and PRC-027-1. The SPC SDT recommends that Requirement R1 remain in PRC-001-3, until its reliability objective is addressed by either a revision to an existing standard or development of a new standard.

Additionally, the requirements in the proposed Reliability Standard 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 – pending FERC approval) and generator performance during frequency excursions is being addressed by PRC-024-1 in Project 2007-09 Generator Verification.
- Undervoltage Load shedding programs are addressed by PRC-010-0 and PRC-022-1, and will be improved by Project 2008-02, Undervoltage Load Shedding. Generator performance during voltage excursions is addressed by PRC-024-1 in Project 2007-09, Generator Verification.
- Coordination of Generating Unit or Plant Capabilities, Voltage Regulating Controls, and Protection is being addressed by PRC-019-1 in Project 2007-09.

- Transmission relay loadability is addressed in PRC-023-1 and, pending FERC approval, PRC-023-2.
- Generator relay loadability will be addressed by Phase 2 of Relay Loadability: Generation, in Project 2010-13.2.
- Protective relay response during power swings will be addressed in Phase 3 of Project 2010-13.3, Relay Loadability.
- Misoperations identified as coordination issues are investigated and have Corrective Action Plans created in accordance with PRC-003-0 and PRC-004-2a, and will be improved in PRC-004-3 by Project 2010-05.1 Protection Systems: Phase 1 (Misoperations).

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 Element on its System as follows:

1.1.1 Within 48 calendar months after the effective date of this standard, if no Protection System Study for that Interconnected Element exists.

1.1.2 Within six calendar months after determining or being notified of a 10% or greater change in Fault current at an interconnecting bus, as described in Requirement R2, or technically justify why such a study is not required.

1.1.3 According to an agreed upon time frame to meet the schedule when proposing or being notified of a change, as described in Requirement R3, Part 3.1 or Part 3.3, or technically justify why such a study is not required.

1.2. Within 90 calendar days after the completion of each Protection System Study provide to the owner(s) of the Protection System(s) associated with the Interconnected Element(s) a summary of the results of each Protection System Study performed pursuant to this requirement, (including, at a minimum, the protective relay settings reviewed, power system Elements to be isolated, contingencies evaluated, Fault currents used, any issues identified, and any revisions proposed).

Rationale for R1:

Part 1.1 Protection System Studies are necessary to verify coordination of Protection Systems for existing and new Interconnected Element. The drafting team defines the term “Interconnected Element” as “An Element that electrically joins separate Functional Entities, including those Functional Entities that are a part of the same Registered Entity.”

Part 1.1.1 The drafting team believes 48 months is an appropriate period of time for entities to perform the Protection System Studies required where no study exists. The drafting team has no evidence there is widespread miscoordination of Protection Systems associated with Interconnected Elements that warrants a shorter time frame.

Part 1.1.2 The drafting team 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 at an interconnecting bus, where such conditions may warrant a new Protection System Study, or to technically justify why no such study is required, e.g., 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 drafting team believes that entities must perform the studies required when proposing or being notified of changes identified in Requirement R3, or to technically justify why no such study is needed. The drafting team believes the timeframe associated with this requirement is contingent upon the project’s scope and schedule. Specifying a time frame for performing studies associated with Requirement R3 is unnecessary 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 The drafting team believes to properly ensure coordination of Protection Systems associated with Interconnected Element(s), all entities need to share the summary of results of a Protection System Study (PSS) and assess the study results. The drafting team believes that 90 calendar days is a reasonable time for the entity to provide the results of the PSS performed in accordance with Requirement R1 to the owner(s) of the Protection System(s) associated with the Interconnected Element(s).

- M1. Acceptable evidence for Requirement R1, Part 1.1 and its subparts, Parts 1.1.1. and 1.1.2, and 1.1.3 is a dated Protection System Study, or the summary results of each Protection System Study (either in hard copy or electronic file formats) demonstrating that the time frames specified in Parts 1.1.1. and 1.1.2. Acceptable evidence of technical justification for not performing a Protection System Study as specified in Parts 1.1.2 and 1.1.3 could be documented engineering analyses or assessments that demonstrate the change in Fault current or the proposed system change does not impact any aspects of coordination.
- M2. Acceptable evidence for Requirement R1, Part 1.2 demonstrating that the summary results of each Protection System Study (hard copy or electronic file formats) was provided within the specified time frame to the owner(s) of the Protection System(s) associated with the Interconnected Element(s).
- R2. For each Facility associated with an Interconnected Element on its System, the Transmission Owner shall: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning, Long-term Planning*]

2.1. At least once every 24 months:

2.1.1 Perform a short circuit study to determine the present maximum available Fault current values (single line to ground and 3-phase) at the interconnecting bus where a Protection System Study is available per Requirement R1.

2.1.2 Calculate the percent deviation between the Fault current values (single line to ground and 3-phase for the interconnecting bus(s) under consideration) used in the most recent Protection System Study and the Fault current values determined pursuant to Requirement R2, Part 2.1.1, using the following equation:

$$\% \text{ Deviation} = \left| \frac{I_{scs} - I_{pss}}{I_{pss}} \right| \times 100$$

Where: I_{scs} = Fault current value from present short circuit study

Rationale for R2: This requires a periodic review of Fault currents at the interconnecting bus and providing to the results 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 short circuit studies because they maintain the data necessary to perform the studies. The drafting team determined that 10% was an appropriate point to provide this information based on the fact that Protection Systems are typically set with margins above 10%.

Part 2.1 Short circuit databases are customarily updated annually, so the drafting team believes 24 months provides the entities flexibility to schedule and perform the new short circuit studies and calculate the percent deviation. The drafting team believes studies associated with changes that would affect the coordination in less time would be triggered by other requirements in this standard. The drafting team is including this formula to assure a consistent approach is used by each Transmission Owner when calculating the percent deviation in Fault current values.

Part 2.2 The drafting team believes the 30-day time frame is reasonable for providing the Fault current information to the owner(s) of the Protection System(s) associated with the Interconnected Element.

And: I_{pss} = Fault current value used in the most recent Protection System Study

2.2. Within 30 calendar days after identification where the calculation performed, pursuant to Requirement R2, Part 2.1.2, indicates a deviation in Fault current of 10% or greater, provide each owner of the Protection System associated with the Interconnected Element the updated Fault current values (I_{scs}).

M3. Acceptable evidence for Requirement R2, Part 2.1 is dated documentation (hard copy or electronic file formats) that contains the present Fault current values from the short circuit study for each interconnecting bus analyzed and that identifies the percent deviation from the most recent Protection System Study Fault current values determined by the formula.

M4. Acceptable evidence that the updated Fault current values (I_{scs}), along with documentation (hard copy or electronic file formats) for Requirement R2, Part 2.2 was provided within the specified timeframe to each owner of the Protection System associated with the Interconnected Element.

R3. Each Transmission Owner, Generator Owner, and Distribution Provider shall provide to each Transmission Owner, Generator Owner, and Distribution Provider connected to the same Interconnected Element: *[Violation Risk Factor: Medium] [Time Horizon: Operations Planning, Long-term Planning]*

3.1. Details for any change or additions listed below; either at an existing or new Facility associated with the Interconnected Element; or at other facilities when the proposed change modifies the conditions used in the coordination of Protection Systems associated with the Interconnected Element(s).

- New installation, replacement with different types, or modification of: protective relays or protective function settings, communication systems, current transformer ratios and voltage transformer ratios

Rationale for R3: This requires the transfer of appropriate information to the entities associated with each Interconnected Element due to 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 owner(s) of the Protection Systems associated with Interconnected Element(s). The drafting team believes that specifying a single time frame is not 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. Examples of changes to generator units that result in impedance changes could include replacements and re-ratings. This requirement also pertains 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 the requested information in a timely manner in order to perform a Protection System Study, as required in Parts 1.1.1, 1.1.2, and 1.1.3. The drafting team believes 30 calendar days after receipt of the request is a sufficient amount of 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 drafting team believes 30 calendar days is sufficient time to provide the information.

- Changes to a transmission system Element that change any sequence or mutual coupling impedance
 - Changes to generator unit(s) that result in a change in impedance
 - Changes to the generator step-up transformer(s) that result in a change in impedance
- 3.2. Requested information related to the coordination of Protection Systems associated with an Interconnected Element within 30 calendar days of receiving a request or according to an agreed-upon schedule.
- 3.3. Within 30 calendar days, details of changes made to Protection Systems during Misoperation investigations, commissioning, maintenance activities, or emergency replacements made due to failures of Protection System components.
- M5.** Acceptable evidence may include, but is not limited to, a summary of the future project or technical specifications of the proposed changes (e.g., project schedule, protective relaying scheme types and settings) in hard copy or electronic file formats as identified in the bulleted list for Requirement R3, Part 3.1 was provided to each responsible entity connected to the same Interconnected Element.
- M6.** Acceptable evidence for Requirement R3, Part 3.2 is dated documentation (hard copy or electronic file formats) demonstrating the requested information was provided according to the agreed-upon schedule, or within 30 calendar days absent such an agreement.
- M7.** Acceptable evidence for Requirement R3, Part 3.3 is dated documentation (hard copy or electronic file formats) demonstrating the information pertinent to the changes made was provided 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, or according to an agreed upon schedule, review the summary results of a Protection System Study, as described in Requirement R1, Part 1.2, and respond as to whether further action is required.
- 4.2. Prior to implementing any planned change(s) associated with Requirement R3, Part 3.1, confirm the owner(s) of each Facility associated with the affected Interconnected Element accept any resulting Protection System(s) changes.

Rationale for R4: This requirement ensures owner(s) of Protection System(s) associated with Interconnected Elements confirm that the Protection System(s) applied are acceptable per the conditions identified in Parts 4.1 and 4.2.

Part 4.1 The drafting team believes 90 calendar days is a reasonable time for the owner(s) of Protection System(s) associated with Interconnected Elements to review the summary results of a Protection System Study. If any issues are identified that require changes then respond whether further action is required.

Part 4.2 The drafting team believes that proposed modifications (including project schedules) to Facility changes associated with the Interconnected Element, as described in Requirement R3, Part 3.1, must be communicated and accepted prior to the in-service date. Acceptance assures that the coordination of Protection Systems associated with the affected Interconnected Element is achieved.

- M8.** Acceptable evidence for Requirement R4, Part 4.1 is dated documentation (hardcopy or electronic file formats) demonstrating that response was provided according to the agreed-upon schedule, or within 90 calendar days absent such an agreement.
- M9.** Acceptable evidence for Requirement R4, Part 4.2 is dated documentation (hardcopy or electronic file formats) demonstrating that confirmation of acceptance was achieved prior to implementation of any planned Protection System(s) changes.

C. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority

The Regional Entity shall serve as the Compliance enforcement authority unless the applicable entity is owned, operated, or controlled by the Regional Entity. In such cases the ERO or a Regional entity approved by FERC or other applicable governmental authority shall serve as the CEA.

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.

The Transmission Owner, Generator Owner and Distribution Provider that owns a Protection System at an Interconnected Facility shall keep data or evidence to show compliance with Requirements R1, R2, R3, and R4, and Measures M1 through M9, since the last audit, unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

If a Transmission Owner, Generator Owner and Distribution Provider that owns a Protection System at a Facility associated with an Interconnected Element 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.

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 Element per R1, Part 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 at an interconnecting bus per R1, Part 1.1.2, or documented why a study was not required, but was late by 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, Part 1.2, but was late by 10 calendar days or less.</p>	<p>The responsible entity performed a Protection System Study on an Interconnected Element per R1, Part 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 at an interconnecting bus per R1, Part 1.1.2, or documented why a study was not required, but was late by more than 30 calendar days but less than or equal to 40 calendar days.</p> <p>OR</p> <p>The responsible 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.</p>	<p>The responsible entity performed a Protection System Study at an interconnecting bus per R1, Part 1.1.2, or documented why a study was not required, but was late by more than 40 calendar days but less than or equal to 50 calendar days.</p> <p>OR</p> <p>The responsible 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.</p>	<p>The responsible entity performed a Protection System Study at an interconnecting bus per R1, Part 1.1.2, or documented why a study was not required but was late by more than 50 calendar days.</p> <p>OR</p> <p>The responsible entity provided the Protection System Study results in accordance with R1, Part 1.2, but was late by more than 30 calendar days.</p> <p>OR</p>

Standard PRC-027-1 — Protection System Coordination for Performance During Faults

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
						<p>The responsible entity failed to perform a Protection System Study on an Interconnected Element per R1, Parts 1.1.1, 1.1.2, or 1.1.3, or document why a study was not required.</p> <p style="text-align: center;">OR</p> <p>The responsible entity failed to provide Protection System Study results in accordance with R1, Part 1.2.</p>
R2	Long-term Planning	Medium	<p>The Transmission Owner 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>The Transmission Owner 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 40 calendar days.</p>	<p>The Transmission Owner performed a short circuit study as described in R2, Part 2.1, but was late by more than 40 calendar days but less than or equal to 50 calendar days.</p>	<p>The Transmission Owner performed a short circuit study as described in R2, 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</p>

Standard PRC-027-1 — Protection System Coordination for Performance During Faults

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			<p>OR</p> <p>The Transmission Owner provided the owner(s) of the Facility associated with the Interconnected Element the changes in Fault currents, as described in R2, Part 2.2, but was late by less than or equal to 10 calendar days.</p>	<p>OR</p> <p>The Transmission Owner provided the owner(s) of the Facility associated with the Interconnected Element the changes in Fault currents, as described in R2, Part 2.2, but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p>	<p>OR</p> <p>The Transmission Owner provided the owner(s) of the Facility associated with the Interconnected Element the changes in Fault currents, as described in R2, Part 2.2, but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p>	<p>R2, Part 2.1.</p> <p>OR</p> <p>The Transmission Owner provided the owner(s) of the Facility associated with the Interconnected Element the changes in Fault currents, as described in R2, Part 2.2, but was late by more than 30 calendar days.</p> <p>OR</p> <p>The Transmission Owner failed to provide the owner(s) of the Facility associated with the Interconnected Element the changes in Fault currents.</p>
R3	Operations Planning	Medium	<p>The responsible entity provided the requested information per R3, Part 3.2, but was late by 10</p>	<p>The responsible entity provided the requested information per R3, Part 3.2, but was late by more</p>	<p>The responsible entity provided the requested information per R3, Part 3.2, but was late by more</p>	<p>The responsible entity failed to provide information to the owner(s) of the Facility associated with the Interconnected Element for any proposed change identified in R3.1.</p> <p>OR</p> <p>The responsible entity provided the requested information per R3, Part 3.2, but was late by more</p>

Standard PRC-027-1 — Protection System Coordination for Performance During Faults

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

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
						acceptance of the planned changes pursuant to R4, Part 4.2 prior to implementation of those changes.

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 Element 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 System Protection Coordination Standard Drafting Team (SPC 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 drafting team 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. System conditions used in Protection System Studies include maximum generation with the transmission system under normal operating conditions and under single contingency conditions. 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 drafting team believes applicable entities should have a documented Protection System Study for each Interconnected Element to validate the Protection Systems associated with those Interconnected Elements perform in a manner consistent with the purpose of this Standard. Additionally, the drafting team believes that 48 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 drafting team also has no evidence there is widespread miscoordination between owners of Facilities associated with Interconnected Elements 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.

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 Element or document why a study is not required. The drafting team 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, "...or technically justify why such a study is not required." The drafting team believes the six-month time frame associated with this requirement represents 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 a Facility associated with the Interconnected Element, entities must perform a new Protection System Study, or technically justify why such a study is not required. The drafting team 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, "...or technically justify why such a study is not required." The drafting team believes the timeframe associated with this requirement is contingent upon the project's scope and schedule. Specifying a time frame for performing studies associated with Requirement R3 is unnecessary because notification of such a change may occur weeks or years prior to the change due to the wide variety of conditions that may be associated with a particular change. The drafting team 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 directs the entity performing the Protection System Study to provide a summary of the study results to the affected Interconnected Element owner(s). As guidance, the drafting team lists the following inputs and results of a Protection System Study that may be included in the summary provided pursuant to this requirement:

1. A listing of the Protection System(s) owned by the entity performing the study that are adjacent to the bus or Element at the Facility, and were reviewed for coordination of protective relays as part of the study including the contingencies used in the evaluation.

Application Guidelines

2. 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 Facility under study.
3. A listing of any issues associated with the relay settings of the other owner(s) at the 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 drafting team investigated various inputs that would trigger a review of the existing Protection System Studies and determined, through the experience of the drafting team 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 result from the accumulation of incremental changes over time. This requirement mandates 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 2.2.

Polling of drafting team membership and various protection engineering committees indicates that short circuit databases are customarily updated annually. Based on this information, the drafting team 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 2.1. The drafting team believes studies associated with changes that would affect the coordination in less than 24 months would be triggered by conditions addressed by other requirements in this standard.

Requirement R2, Part 2.2 further directs the Transmission Owner to, within 30 calendar days, inform each owner of the Facility associated with the Interconnected Element when short circuit studies indicate that 10% deviations in Fault current have occurred at the interconnecting bus(s). The drafting team believes the 30-day time frame associated with this requirement is reasonable for providing the Fault current information 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 directs the registered functional entity initiating any change to provide the details to the other affected entities of the Interconnected Element so that the owners can evaluate the impact to their Protection Systems due to proposed changes.

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 drafting team recognizes that Facility changes at other locations can impact the Protection System Study of the Facility associated with the Interconnected Element; e.g., the addition of a large autotransformer bank or generator not directly associated with the Interconnected Element. The drafting team 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 drafting team 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 drafting team believes 30 calendar days after receipt of the request is a sufficient amount of 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 changes are made to Protection Systems during Misoperation investigations, commissioning, maintenance activities, or emergency replacements made due to failures of Protection System components. Based upon the limited number of instances that would occur under such circumstances, the drafting team 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

Application Guidelines

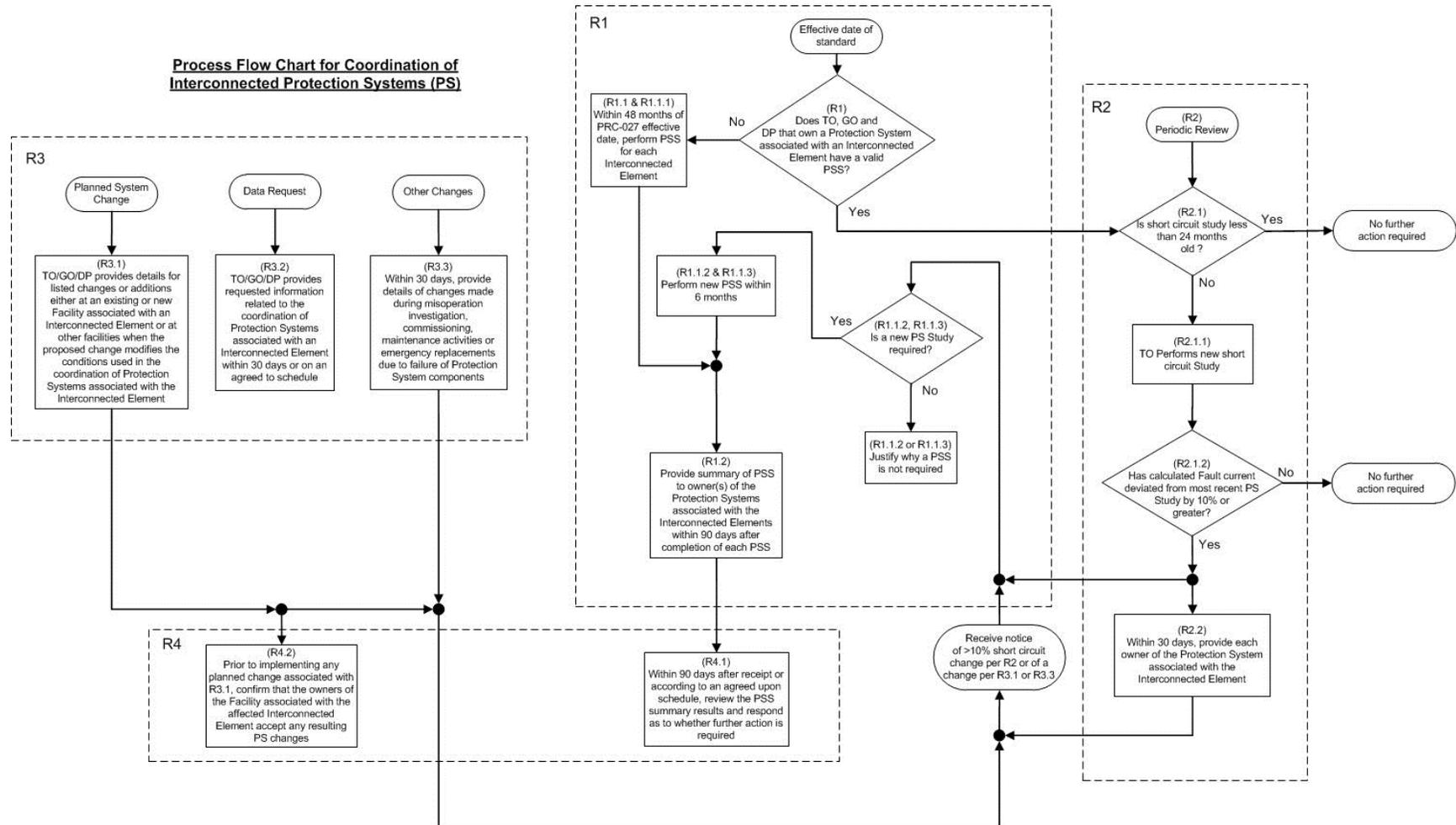
Protection Systems are coordinated consistent with the purpose of this standard. Cooperative participation of Facility owners in communicating Protection System(s) design, and study results will achieve coordination of Protection Systems for reliable operation of the BES during Faults.

Requirement R4, Part 4.1 directs applicable entities, within 90 calendar days after receipt, to review the summary results of a Protection System Study, as described in Requirement R1, Part 1.2; or absent acceptance propose revisions to achieve acceptable results. The drafting team believes 90 calendar days after receipt of the results of a Protection System Study provides a reasonable time for the owners of Facilities to resolve differences and confirm acceptance 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 a Facility associated with the affected Interconnected Element have been considered by all affected entities.

Application Guidelines

Process Flow Chart: Below is a complete representation of the process, including the relationships between requirements:



Example Process

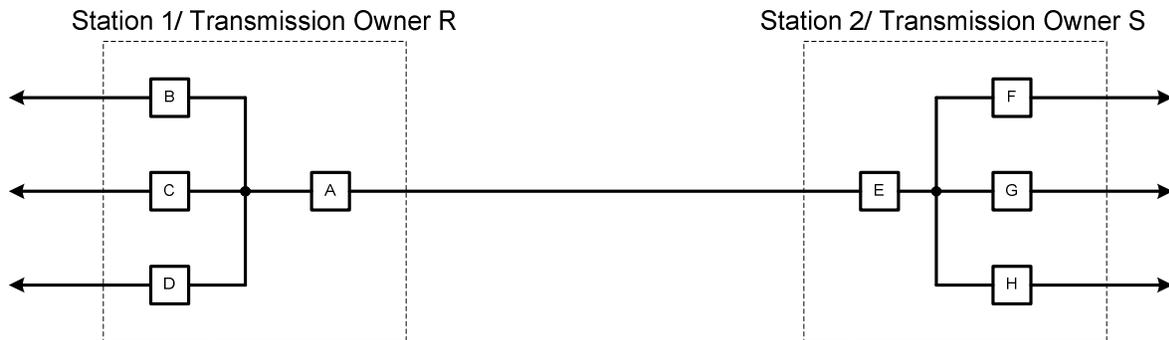
An example of the interaction between entities required to gather the information to perform an accurate study is below.

- 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, within 90 calendar days of receiving the study results from Entity A, confirm agreement 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 purpose of this standard between owners of Facilities associated with the affected Interconnected Element. 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.

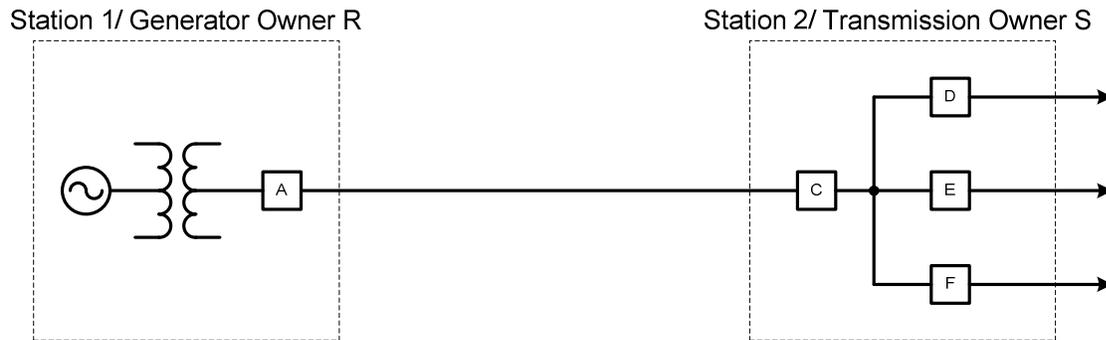
Figure 1



In Figure 1 above, the Interconnected Element between the Transmission Owners 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, Owner S is to review the Protection System settings associated with Breaker A (provided by Owner R) for coordination issues with the Protection System settings associated with Breakers E, F, G, and H. Likewise, Owner R is to review the Protection System settings associated with Breaker E (provided by Owner S) for coordination issues with the Protection System settings associated with Breakers A, B, C, and D.

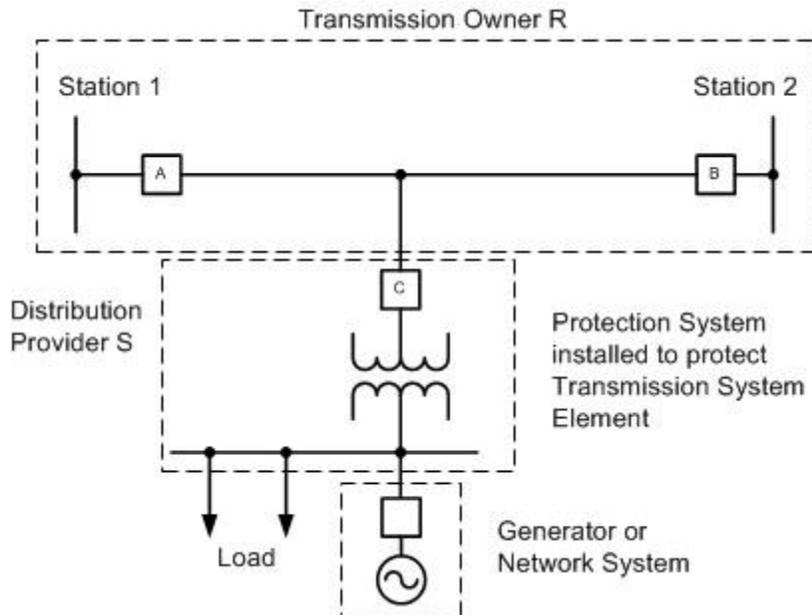
Figure 2



In Figure 2 above, the Interconnected Element between the Transmission Owner and the Generator Owner 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, Transmission Owner S is to review the Protection System settings associated with Breaker A (provided by Owner R) and the generator Protection Systems for coordination issues with the Protection System settings associated with Breakers C, D, E, and F. Likewise, Generation Owner R is to review the Protection System settings associated with Breaker C (provided by Owner S) for coordination issues with the Protection System settings associated with Breaker A or the generator Protection Systems.

Figure 3



In Figure 3 above, the Interconnected Element between the Transmission Owner and the Distribution Provider is the transmission line or tap between the line and Breaker C.

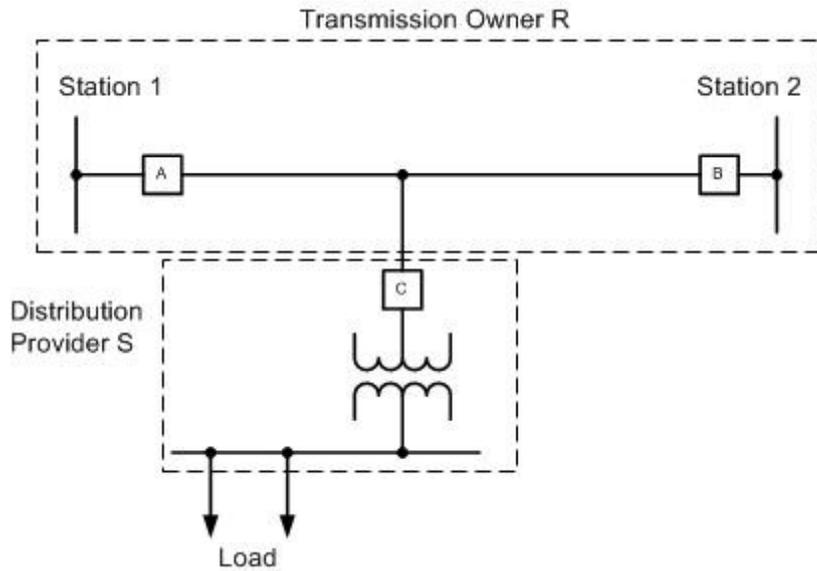
Example: For the purposes of conducting the Protection System Study associated with the Facilities in Figure 3, Transmission Owner R is to review the Protection System settings associated with Line Breaker C (provided by Distribution Provider S) for coordination issues with the Protection System settings associated with Breakers A and B and other Protection Systems at stations 1 and 2.

Notes:

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 detect Faults on the BES Transmission System.

“Protection Systems installed to detect faults on the BES Transmission System” are not inclusive of those relays that may operate for such faults, but are not installed specifically for that purpose (i.e. transformer overcurrent, reverse power, etc.). As an example, reverse power relays are often installed to detect situations where the transmission source becomes de-energized and the distribution bank remains energized from a source on the low-voltage side of the transformer and the settings are calculated based on the charging current of the transformer from the low-voltage side. Although these relays may operate as a result of a Fault on a BES Element, they are not “installed to detect faults on the BES Transmission System.”

Figure 4

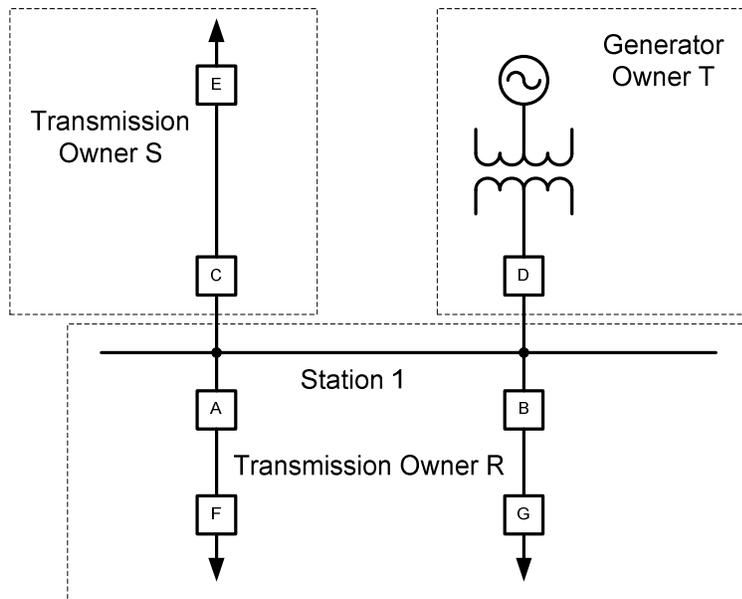


In Figure 4 above, the Interconnected Element between the Transmission Owner and the Distribution Provider is the transmission line or tap between the line and Breaker C.

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 BES transmission system Elements.

Figure 5

Transmission/Generation Facility with Multiple Owners



In Figure 5 above, the Interconnected 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:

Owner R is to review the Protection System settings associated with Breaker C, E, D, and the generator Protection System (provided by Owners S or T) for coordination issues with the Protection System settings associated with Breakers A, B.

Owner S is to review the Protection System settings associated with Breakers A, F, B, G, D, and the generator Protection System (provided by Owners R or T) for coordination issues with the Protection System settings associated with Breaker C. To perform this review, 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.

Owner T is to review the Protection System settings associated with Breakers A, F, B, G, C, and E (provided by Owners R or S) for 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 review, 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.