

## 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.
- 5-6. Draft 2 of PRC-027-1 was posted for a 30-day formal comment and successive ballot from November 16 – December 17, 2012.

### Description of Current Draft

The System Protection Coordination Standard Drafting Team (SPC SDT) created a new results-based standard, PRC-027-1, with the stated purpose 'to coordinate Protection Systems for Interconnected Elements, such that Protection System components operate in the least number of power system Elements are isolated to clear desired sequence during Faults.' This standard incorporates and enhances clarifies the coordination aspects of Requirements R3-R2 and R4-R3 from PRC-001-1-2 (now formerly R2-R3 and R3-R4 of PRC-001-21). The SPC SDT is requesting a posting for stakeholder comments under for a 30-day formal comment period with a parallel successive ballot.

Anticipated Actions	Anticipated Date
30-day Formal Comment Period with Parallel Successive Ballot	<u>November 2012</u> <u>June 2013</u>
<u>Conduct</u> Recirculation Ballot	<u>January</u> <u>August</u> 2013
<u>BOT Adoption</u>	<u>August</u> <u>November</u> 2013

**Effective Dates:**

PRC-027-1 shall become effective on the first day of the first calendar quarter that is ~~six~~<sup>12</sup> 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~~<sup>12</sup> 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:** ~~A~~<sup>A BES</sup> Element that electrically joins facilities owned by:  
a) separate ~~Functional~~Registered Entities, including those ~~Functional Entities that are a part of or~~  
b) the same Registered Entity; that represents multiple functional entity responsibilities  
(Distribution Provider, Generator Owner, or Transmission Owner).

**Protection System Coordination 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~~Protection System components operate in the desired sequence during 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:~~

4.2 Facilities: For the purpose of the requirements contained herein, the following Protection Systems owned by each Functional Entity in 4.1 above are those to which these requirements are applicable.

- 4.2.1 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 focused 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-clarified 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~~Protection System components operate in the desired sequence during Faults.”*

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.

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 addressed data and data requirements that are now included in ~~the proposed~~ Reliability Standard TOP-003-2. The NERC Board of Trustees adopted Reliability Standards TOP-003-2 and PRC-001-2 on May 9, 2012.

The SPC SDT revised PRC-001-2. Revisions include the removal of Requirements R2 and R3 (formerly Requirements R3 and R4 of PRC-001-1). These two legacy requirements are being retired because the aspects of coordination they address are incorporated in the proposed Reliability Standard PRC-027-1, Protection System Coordination for Performance During Faults. The SPCSDT believes the training aspects of Requirement R1 would be more appropriately addressed by the PER group of Reliability Standards. Consequently, the drafting team has recommended via the NERC Issues Database that the future drafting team charged with revising PER-005-1 incorporate the reliability objective of Requirement R1 into the revised standard. Until that occurs, Requirement R1 of PRC-001-2 must remain in the standard. In an effort to improve PRC-001-2 until it can be fully retired, the drafting team has provided a measure to accompany Requirement R1. The Applicability section was also updated to clarify which Protection Systems are applicable to Requirement R1. (The ‘Facilities’ portion of the Applicability section is identical to the new stakeholder-approved and NERC Board of Trustees-adopted PRC-005-2.)~~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 eCoordination of Protection Systems aAddressed 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 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 in PRC-025-1 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

### Rationale for R1:

Part 1.1 A Protection System Coordination Study (PSCS) is necessary to verify coordination of Protection Systems for existing and new Interconnected Elements. The drafting team defines the term “Interconnected Element” as “A BES Element that electrically joins facilities owned by: a) separate Registered Entities, or b) the same Registered Entity that represents multiple functional entity responsibilities (Distribution Provider, Generator Owner, or Transmission Owner).”

Part 1.1.1 The drafting team believes 60 calendar months is an appropriate period of time for entities to perform the PSCS 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 12 calendar 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 change at an interconnecting bus, where such conditions may warrant a new PSCS, 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 the requirement for any proposed changes or additions is contingent upon the project’s scope and schedule. Specifying a time frame for performing studies associated with Requirement R3, Part 3.1 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. The drafting team believes that six months is an appropriate period of time for entities to perform the studies required or to technically justify why no such study is needed when details of changes are provided associated with Requirement R3 Part 3.3.

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 PSCS 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 PSCS performed in accordance with Requirement R1, Part 1.1 to the other owner(s) of the Protection System(s) associated with the Interconnected Element(s).

Note: In cases where a single group performs an overall coordination study for a given Interconnected Element; a single document that provides the requirements for a summary of the results of the PSCS would be sufficient for use by both Registered Entities.

### 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, 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 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).~~



- 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 Coordination Study (PSCS) for each of its Interconnected Element on its System Elements as follows:
    - 1.1.1** Within ~~48~~60 calendar months after the effective date of this standard, if no ~~Protection System Study~~PSCS for that Interconnected Element exists.
    - 1.1.2** Within ~~six~~12 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 within six calendar months of being notified of a change as described in Requirement R3, 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~~PSCS, provide to the other owner(s) of the Protection System(s) associated with the Interconnected Element(s), a summary of the results of each ~~Protection System Study~~PSCS performed pursuant to ~~this requirement~~Requirement R1, Part 1.1, (including, at a minimum, the ~~protective relay settings~~Protection Systems reviewed, ~~power system Elements to be isolated, contingencies evaluated, the associated~~ Fault currents used, any issues identified, and any revisions or actions proposed).
- 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~~PSCS, or the summary results of each ~~Protection System Study (either in PSCS~~ (hard copy or electronic file formats) demonstrating ~~that~~ the time frames specified or agreed to in Parts 1.1.1 ~~and~~, 1.1.2 ~~,~~ and 1.1.3 were achieved. Acceptable evidence of a technical justification for not performing a ~~Protection System Study~~PSCS as specified in Parts 1.1.2 and 1.1.3 ~~could be may include, but is not limited to,~~ 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 is dated documentation demonstrating that the summary results of each ~~Protection System Study~~PSCS (hard copy or electronic file formats) ~~was were~~ provided within the specified time frame to the owner(s) of the Protection System(s) associated with the Interconnected Element(s).

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~~~~changes~~ occur that meet the ~~criteria of~~ 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%. Note: short circuit studies are used to determine the Fault current values at the interconnecting bus where a PSCS exists. These studies are typically performed assuming maximum generation and all Facilities in service.~~

~~Part 2.1 Short circuit databases are customarily updated annually, so the~~The drafting team believes 2460 calendar months provides the entities flexibility to ~~either technically justify why Fault current does not affect the Protection System coordination, or~~ schedule and perform the ~~new activities specified in Requirement R2, Parts 2.1 and 2.2.~~

~~The drafting team recognizes the coordination of some types of Protection Systems is unaffected by changes in Fault current and, where technically justified, can be exempted from the short circuit studies and calculate the percent deviation review.~~

~~Part 2.1~~ The drafting team believes ~~studies associated with changes that would affect~~maximum available Fault current values (single line to ground and 3-phase) at the interconnecting bus are necessary quantities needed to review the coordination ~~in less time would be triggered by other requirements in this standard.~~

~~Part 2.2~~ The drafting team is including this ~~formula~~equation to assure a consistent approach is used by each Transmission Owner when calculating the percent ~~deviation~~change in Fault current values.

R2. For each ~~Facility associated with an~~Interconnected Element on its System, the Transmission Owner shall, once every 60 calendar months, technically justify why Fault current does not affect the Protection System coordination, or: [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning, Long-term Planning*]

~~2.1. At least once every 24 months:~~

~~2.2.2.1.~~ 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 Coordination Study (PSCS) is available per Requirement R1.

~~2.3.2.2.~~ Calculate the percent deviationchange 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~~PSCS and the Fault current values determined pursuant to Requirement R2, Part ~~2.1.1,~~ using the following equation:

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

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

And:  $I_{pscs}$  = Fault current value used in the most recent ~~Protection System Study~~PSCS

2.2.1 Within 30 calendar days after identification ~~where the calculation performed,~~ pursuant to Requirement R2, Part 2.1.2, ~~indicates~~of a deviation in Fault currentchange of 10% or greater in either single line to ground or 3-phase Fault current, provide the updated Fault current values ( $I_{scs}$ ) to each owner of the Protection System associated with the Interconnected Element ~~the updated Fault current values ( $I_{scs}$ ).~~



M3. Acceptable evidence of technical justification for not performing a short circuit study as specified in Requirement R2, could be documented engineering analyses or assessments that demonstrate why Fault current does not impact any aspects of coordination.

~~M3.~~M4. Acceptable evidence for Requirement R2, ~~Part Parts 2.1 and 2.2.1~~ 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~~change from the ~~most recent Protection System Study~~ Fault current values used in the most recent PSCS determined by the ~~formula~~equation.

~~M4.~~M5. Acceptable evidence ~~that the updated Fault current values ( $I_{scs}$ ), along with for~~ Requirement R2, Part 2.2.1 is dated documentation (hard copy or electronic file formats) ~~for~~ Requirement R2, Part 2.2 ~~was that the updated Fault current values ( $I_{scs}$ ), were~~ provided within the specified timeframe to each owner of the Protection System associated with the Interconnected Element.

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 PSCSs 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 information about any proposed change or addition (pursuant to Requirement R3, Part 3.1) that requires modification of an entity's short circuit model should be provided to other Protection System owners associated with the Interconnected Element. 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 provided 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 Requirement 1, 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 PSCS, as required in Requirement 1, 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.

~~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.~~

**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 proposed change or additions listed below; either at an existing or new Facility associated with the Interconnected Element; or at other ~~F~~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
- Changes to a transmission system Element that change/alter 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;M6.~~ M6. Acceptable evidence for Requirement R3, Part 3.1 may include, but is not limited, to, documentation (hard copy or electronic file formats) demonstrating that 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;M7.~~ M7. 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;M8.~~ M8. 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.

Rationale for R4: This requirement ensures owner(s) of Protection System(s) associated with Interconnected Elements affirm 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 PSCS and respond. Note: Per Requirement R1, Part 1.2, at a minimum, the summary results of a PSCS must include the Protection Systems reviewed, the associated Fault currents used, any issues identified, and any revisions or actions proposed. The response should indicate acceptance with the review results/conclusions; or rejection of or disagreement with the review results/conclusions and offer of suggestions/modifications to resolve any identified coordination issues. The drafting team recognizes there could be situations where one owner may not agree with the other owner's protection philosophy but they accept the proposed changes since no coordination issues were identified.

Part 4.2 The drafting team believes that proposed changes or modifications (including project schedules) to Facilities associated with the Interconnected Element, as described in Requirement R3, Part 3.1, or modifications suggested in Requirement R4, Part 4.1 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.

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.

**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 PSCS (per Requirement R1, Part 1.2.)~~ and respond ~~as to whether further action is required.~~ the other owner(s):
- Accepting the results, or
  - Rejecting the results and suggesting modifications to resolve any identified coordination issues.
- 4.2.** Prior to implementing any ~~planned~~ proposed change(s) or modifications associated with Requirement R3, Part 3.1, ~~confirm the or Requirement 4, Part 4.1, affirm that the~~ other owner(s) of each Facility associated with the affected Interconnected Element ~~accept any resulting~~ have accepted the Protection System(s) changes including the resolution of any identified coordination issues.

~~M8.M9.~~ 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.M10.~~ 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/proposed~~ Protection System(s) changes or modifications, communications (e.g. email acknowledgements) of those changes were completed, and any identified coordination issues were resolved and accepted.

## 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.~~

As defined in the NERC Rules of Procedure, “Compliance Enforcement Authority” means NERC or the Regional Entity in their respective roles of monitoring and enforcing compliance with the NERC Reliability Standards.

#### 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~~associated with an Interconnected ~~Facility~~Element shall each keep data or evidence to show compliance with Requirements R1, R2, R3, and R4, and Measures M1 through ~~M9~~M10, 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/or~~ 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 <u>Coordination Study</u> on an Interconnected Element <del>per</del><u>as required in Requirement R1, Part 1.1.1, but was late by less than or equal to 30 calendar days.</u></p> <p style="text-align: center;">OR</p> <p>The responsible entity performed a Protection System <u>Coordination Study</u> at an interconnecting bus <del>per</del><u>as required in Requirement R1, Part 1.1.2, or documented technically justified</u> why a study was not required, but was late by less than or equal to 30 calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the Protection</p>	<p>The responsible entity performed a Protection System <u>Coordination Study</u> on an Interconnected Element <del>per</del><u>as required in Requirement R1, Part 1.1.1, but was late by more than 30 calendar days; but less than or equal to 60 calendar days.</u></p> <p style="text-align: center;">OR</p> <p>The responsible entity performed a Protection System <u>Coordination Study</u> at an interconnecting bus <del>per</del><u>as required in Requirement R1, Part 1.1.2, or documented technically justified</u> why a study was not required, but was late by more than 30 calendar days but less than or equal to <del>40</del><u>45</u> calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity</p>	<p>The responsible entity performed a Protection System <u>Coordination Study on an Interconnected Element as required in Requirement R1, Part 1.1.1, but was late by more than 60 calendar days but less than or equal to 90 calendar days.</u></p> <p style="text-align: center;">OR</p> <p><del>The responsible entity performed a Protection System Coordination Study at an interconnecting bus per</del><u>as required in Requirement R1, Part 1.1.2, or documented technically justified</u> why a study was not required, but was late by more than <del>40</del><u>45</u> calendar days but less than or equal to <del>50</del><u>60</u> calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity</p>	<p>The responsible entity performed a Protection System <u>Coordination Study on an Interconnected Element as required in Requirement R1, Part 1.1.1, but was late by more than 90 calendar days.</u></p> <p style="text-align: center;">OR</p> <p><del>The responsible entity performed a Protection System Coordination Study at an interconnecting bus per</del><u>as required in Requirement R1, Part 1.1.2, or documented technically justified</u> why a study was not required but was late by more than <del>50</del><u>60</u> calendar days.</p> <p style="text-align: center;">OR</p> <p>The responsible entity provided the Protection</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>System <u>Coordination</u> Study results in accordance with <u>Requirement</u> R1, Part 1.2, but was late by <u>less than or equal to</u> 10 calendar days <del>or less</del>.</p>	<p>provided the Protection System <u>Coordination</u> Study results in accordance with <u>Requirement</u> R1, Part 1.2, but was late by more than 10 calendar days but less than or equal to 20 calendar days.</p>	<p>provided the Protection System <u>Coordination</u> Study results in accordance with <u>Requirement</u> R1, Part 1.2, but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p>	<p>System <u>Coordination</u> Study results in accordance with <u>Requirement</u> R1, Part 1.2, but was late by more than 30 calendar days.</p> <p>OR</p> <p>The responsible entity failed to perform a Protection System <u>Coordination</u> Study on an Interconnected Element <del>per</del><u>in accordance with Requirement</u> R1, Parts 1.1.1, 1.1.2, or 1.1.3; <del>or document.</del></p> <p>OR</p> <p><u>The responsible entity failed to technically justify</u> why a study was not required <u>in accordance with Requirement R1, Parts 1.1.2 or 1.1.3.</u></p> <p>OR</p> <p>The responsible entity failed to provide Protection System <u>Coordination</u> Study results in accordance with <u>Requirement</u> R1,</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
						Part 1.2.
R2	Long-term Planning	Medium	<p><u>For an Interconnected Element on its System, the Transmission Owner technically justified why Fault current does not affect the Protection System coordination, as required in Requirement R2, but was late by less than or equal to 30 calendar days.</u></p> <p><u>OR</u></p> <p>The Transmission Owner performed a short circuit study, as <del>described</del><u>required</u> in <u>Requirement R2, Part 2.1</u>, but was late by less than or equal to 30 calendar days.</p>	<p><u>For an Interconnected Element on its System, the Transmission Owner technically justified why Fault current does not affect the Protection System coordination, as required in Requirement R2, but was late by more than 30 calendar days but less than or equal to 60 calendar days.</u></p> <p><u>OR</u></p> <p>The Transmission Owner performed a short circuit study as <del>described</del><u>required</u> in <u>Requirement R2, Part 2.1</u>, but was late by more than 30 calendar days but less than or equal to <del>40</del><u>60</u> calendar days.</p>	<p><u>For an Interconnected Element on its System, the Transmission Owner technically justified why Fault current does not affect the Protection System coordination, as required in Requirement R2, but was late by more than 60 calendar days but less than or equal to 90 calendar days.</u></p> <p><u>OR</u></p> <p>The Transmission Owner performed a short circuit study as <del>described</del><u>required</u> in <u>Requirement R2, Part 2.1</u>, but was late by more than <del>40</del><u>60</u> calendar days but less than or equal to <del>50</del><u>90</u> calendar days.</p> <p><u>OR</u></p> <p>The Transmission Owner failed to perform a short circuit study, as <del>described</del><u>required</u> in <u>Requirement R2, Part 2.1</u>.</p> <p><u>OR</u></p> <p>The Transmission Owner failed to calculate the</p>	<p><del>The</del><u>For an Interconnected Element on its System, the Transmission Owner technically justified why Fault current does not affect the Protection System coordination, as required in Requirement R2, but was late by more than 90 calendar days.</u></p> <p><u>OR</u></p> <p><del>The</del><u>The Transmission Owner performed a short circuit study as described</u><u>required</u> in <u>Requirement R2, Part 2.1</u>, but was late by more than <del>50</del><u>90</u> calendar days.</p> <p><u>OR</u></p> <p>The Transmission Owner failed to calculate the</p>

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 <del>described</del><u>required</u> in <u>Requirement R2, Part 2.2.1</u>, 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 <del>described</del><u>required</u> in <u>Requirement R2, Part 2.2.1</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 Transmission Owner provided the owner(s) of the Facility associated with the Interconnected Element, the changes in Fault currents, as <del>described</del><u>required</u> in <u>Requirement R2, Part 2.2.1</u>, but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p>	<p>percent <del>deviation</del><u>change</u> between the Fault currents, according to the <del>formula</del><u>equation</u> designated in <u>Requirement R2, Part 2.4.2</u>.</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 <del>described</del><u>required</u> in <u>Requirement R2, Part 2.2.1</u>, 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 <del>changes in</del><u>updated</u> Fault <del>currents</del><u>current values</u>, as required in <u>Requirement R2, Part 2.2.1</u>.</p>
R3	Operations Planning	Medium				The responsible entity failed to provide <del>information to</del> the

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
			<p>The responsible entity provided the requested information <del>per</del><u>required in Requirement R3, Part 3.2</u>, but was late by <u>less than or equal to 10</u> calendar days <del>or less</del>.</p> <p>OR</p> <p>The responsible entity provided the <u>required</u> information <del>identified</del><u>required</u> in <u>Requirement R3, Part 3.3</u>, but was late by <u>less than or equal to 10</u> calendar days <del>or less</del>.</p>	<p>The responsible entity provided the requested information <del>per</del><u>required in Requirement R3, Part 3.2</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 entity provided the <u>required</u> information <del>identified</del><u>required</u> in <u>Requirement R3, Part 3.3</u>, 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 <del>per</del><u>required in Requirement R3, Part 3.2</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 entity provided the <u>required</u> information <del>identified</del><u>required</u> in <u>Requirement R3, Part 3.3</u>, but was late by more than 20 calendar days but less than or equal to 30 calendar days.</p>	<p>owner(s) of the Facility associated with the Interconnected Element, <u>details</u> for any proposed change <u>or addition</u> identified in <u>Requirement R3, Part 3.1</u>.</p> <p>OR</p> <p>The responsible entity provided the requested information <del>per</del><u>required in Requirement R3, Part 3.2</u>, but was late by more than 30 calendar days.</p> <p>OR</p> <p>The responsible entity provided the <u>required</u> information <del>identified</del><u>required</u> in <u>Requirement R3, Part 3.3</u>, but was late by more than 30 calendar days.</p> <p>OR</p> <p>The responsible entity failed to provide the <del>requested</del> information <u>required in Requirement R3, Part 3.3</u>.</p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R4	Operations Planning	Medium	<p>The responsible entity <del>confirmed</del> <del>acceptance</del> <u>responded in more than 90 calendar days but less than or equal to 100 calendar days following the receipt</u> of the summary results of the Protection System <u>Coordination Study</u> <del>per, as required in Requirement R4, Part 4.1, but was late by 10 calendar days or less.</del></p>	<p>The responsible entity <del>confirmed</del> <del>acceptance</del> <u>responded in more than 100 calendar days but less than or equal to 110 calendar days following the receipt</u> of the summary results of the Protection System <u>Coordination Study</u> <del>per, as required in Requirement R4, Part 4.1, but was late by more than 10 calendar days but less than or equal to 20 calendar days.</del></p>	<p>The responsible entity <del>confirmed</del> <del>acceptance</del> <u>responded in more than 110 calendar days but less than or equal to 120 calendar days following the receipt</u> of the summary results of the Protection System <u>Coordination Study</u> <del>per, as required in Requirement R4, Part 4.1, but was late by more than 20 calendar days but less than or equal to 30 calendar days.</del></p>	<p>The responsible entity <del>confirmed</del> <del>acceptance</del> <u>responded in more than 120 calendar days following the receipt</u> of the summary results of the Protection System <u>Coordination Study</u> <del>per, as required in Requirement R4, Part 4.1, but was late by more than 30 calendar days.</del></p> <p style="text-align: center;">OR</p> <p>The responsible entity failed to <del>confirm</del> <del>acceptance of</del> <u>review</u> the summary results of the Protection System <u>Coordination Study</u> <del>per</del> <u>provided to them in accordance with Requirement R4, Part 4.1.</u></p> <p style="text-align: center;">OR</p> <p>The responsible entity failed to <del>confirm</del> <del>acceptance of the</del> <u>planned</u> <u>respond to the other owners in accordance with Requirement R4, Part</u></p>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
						<p><u>4.1.</u></p> <p style="text-align: center;"><u>OR</u></p> <p><u>The responsible entity failed to affirm that the other owner(s) of each Facility associated with the affected Interconnected Element accepted the Protection System(s) changes pursuant to R4, Part 4.2 including the resolution of any identified coordination issues, prior to implementation of those changes, as required in Requirement R4, Part 4.2.</u></p>

**D. Regional Variances**

None.

**E. Interpretations**

None.

**F. Associated Documents**

None.



### Guidelines and Technical Basis

#### Purpose:

To coordinate Protection Systems for Interconnected Elements, such that Protection System components operate in the desired sequence during Faults.

This standard requires that separate Registered Entities communicate with each other to coordinate Protection System components on existing Interconnected Elements; and communicate with each other prior to the energization of new or modified Protection Systems associated with Interconnected Elements. The goal of the coordination is to verify that the Protection Systems intended for sensing Faults will operate in the desired sequence for internal and external Faults on the Interconnected Element.

#### Requirement R1:

This requirement directs the ~~performance of applicable entities to perform a~~ Protection System ~~Studies~~ Coordination Study (PSCS) for every Interconnected Element to verify coordination of existing Protection Systems where no recent study exists; or when Facility configuration changes are made, or where Fault current ~~deviations~~ changes of 10% or more have occurred. In developing the language to define ~~Protection System Study~~ a PSCS, the System Protection Coordination Standard Drafting Team (~~SPC SDT~~ 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 Coordination Study (PSCS) 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~~ PSCSs 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~~ PSCSs 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~~PSCS 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 ~~4860 calendar~~ 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~~PSCSs must be completed under the following two circumstances:

1. After notification of an identified 10% or greater ~~deviationchange~~ in Fault current; ~~(single line to ground and 3-phase for the interconnecting bus(s) under consideration) used in the most recent PSCS and the Fault current values determined pursuant to Requirement R2, Part 2.1)~~, the notified entities must perform a new ~~Protection System Study~~PSCS 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 ~~deviationchange~~ in Fault current may not necessitate a new ~~Protection System Study~~PSCS 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-12-calendar~~ month time frame associated with this requirement represents a reasonable period to perform the studies that are required after identification by the ~~24-60-calendar~~ 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~~PSCS, or technically justify why such a study is not required. The drafting team recognizes that, based on the scope of the proposed ~~or notified~~ change and/or the Protection Systems installed (e.g., current differential), the change may not necessitate a new ~~Protection System Study~~PSCS 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~~performing a PSCS for any proposed changes or additions is contingent upon the project's scope and schedule. Specifying a time frame for performing studies associated with Requirement R3, Part 3.1 is unnecessary because notification of such a change may occur weeks or years prior to the change due to the wide variety of

## Application Guidelines

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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. The drafting team believes that six calendar months is an appropriate period of time for entities to perform the studies required, or to technically justify why no such study is needed, when details of changes are provided associated with Requirement R3 Part 3.3.

Requirement R1, Part 1.2 directs the entity performing the ~~Protection System Study~~PSCS to provide a summary of the study results to the affected Interconnected Element owner(s). The drafting team believes that 90 calendar days is a reasonable time for the entity to provide the results of the PSCS it performed to the other owner(s) of the Protection System(s) associated with the Interconnected Element(s). (Note: In cases where a single group performs an overall coordination study for a given Interconnected Element; a single document that meets the requirements for a summary of the results of the PSCS would be sufficient for use by both Registered Entities.) As guidance, the drafting team lists the following inputs and results of a ~~Protection System Study~~PSCS 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 which were reviewed for coordination of protective relays as part of the study, including the contingencies used in the evaluation.
2. ~~Data used to determine Fault currents in performing the study, along with a~~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~~PSCSs 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~~PSCS may be necessary. These variations could result from the accumulation of incremental changes over time. This requirement mandates the Transmission Owner either provide a technical justification stating why Fault current does not affect the Protection System coordination of a specific Interconnected Element or perform a periodic review of Fault currents.

Examples of Protection Systems where technical justifications may be used include:

1. Differential elements
2. Distance elements where infeed is not used in determining reach for the protection scheme.
3. Supervised overcurrent elements enabled by:
  - Loss of potential condition
  - Some communication assisted tripping
  - Switch-Onto-Fault (SOTF)
4. Reverse power, definite time &/or time overcurrent elements:
  - Designed to coordinate during maximum generation with the transmission system under normal operating conditions and includes the calculation of the percent deviation between the under single contingency conditions regardless of Fault current.
  - Designed for the protection of equipment other than for the purpose of detecting Faults on BES Elements even though those relays that may operate for such Faults, but are not installed specifically for that purpose (i.e. transformer overcurrent, reverse power, etc.).

The short circuit study provides the Fault current values used in the to calculate the percent change between the most recent Protection System Study PSCS and the present Fault current values indicated by the short circuit study performed pursuant to this requirement Requirement R2, Part 2.1. This calculation is necessary to identify Fault current changes that must be communicated in accordance with Requirement R2, Part 2.2. Short circuit studies are typically performed assuming maximum generation and all Facilities in service.

Polling of The drafting team membership and various protection engineering committees indicates believes that short circuit databases are customarily updated annually. Based on this information, the drafting team believes that requiring a 24-month periodic review of 60 calendar months is an appropriate interval for technically justifying why 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. do not affect the Protection System coordination of a specific Interconnected Element, or for reviewing Fault currents. The drafting team believes studies associated with changes that would affect the coordination in less than 2460 calendar months would be triggered by conditions addressed by other requirements in this standard.

Requirement R2, Part 2.2.1 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% deviationschanges in Fault current have occurred at the interconnecting bus(s). The drafting team believes the 30-calendar 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 Entityfunctional entity responsible for performing the Fault currentshort circuit studies because they maintain the data required to perform the studies. Generator data

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(including data provided by Distribution Providers) is incorporated into the Transmission Owners' short circuit models.

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### Requirement R3:

This directs the registered functional entity initiating any proposed change or addition 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 PSCSs 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 PSCS of the Facility associated with the Interconnected Element; e.g., the addition of a large autotransformer bank or generator not directly ~~associated with~~ connected to 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 PSCS or, absent such agreement, within 30 calendar 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.



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### Requirement R4:

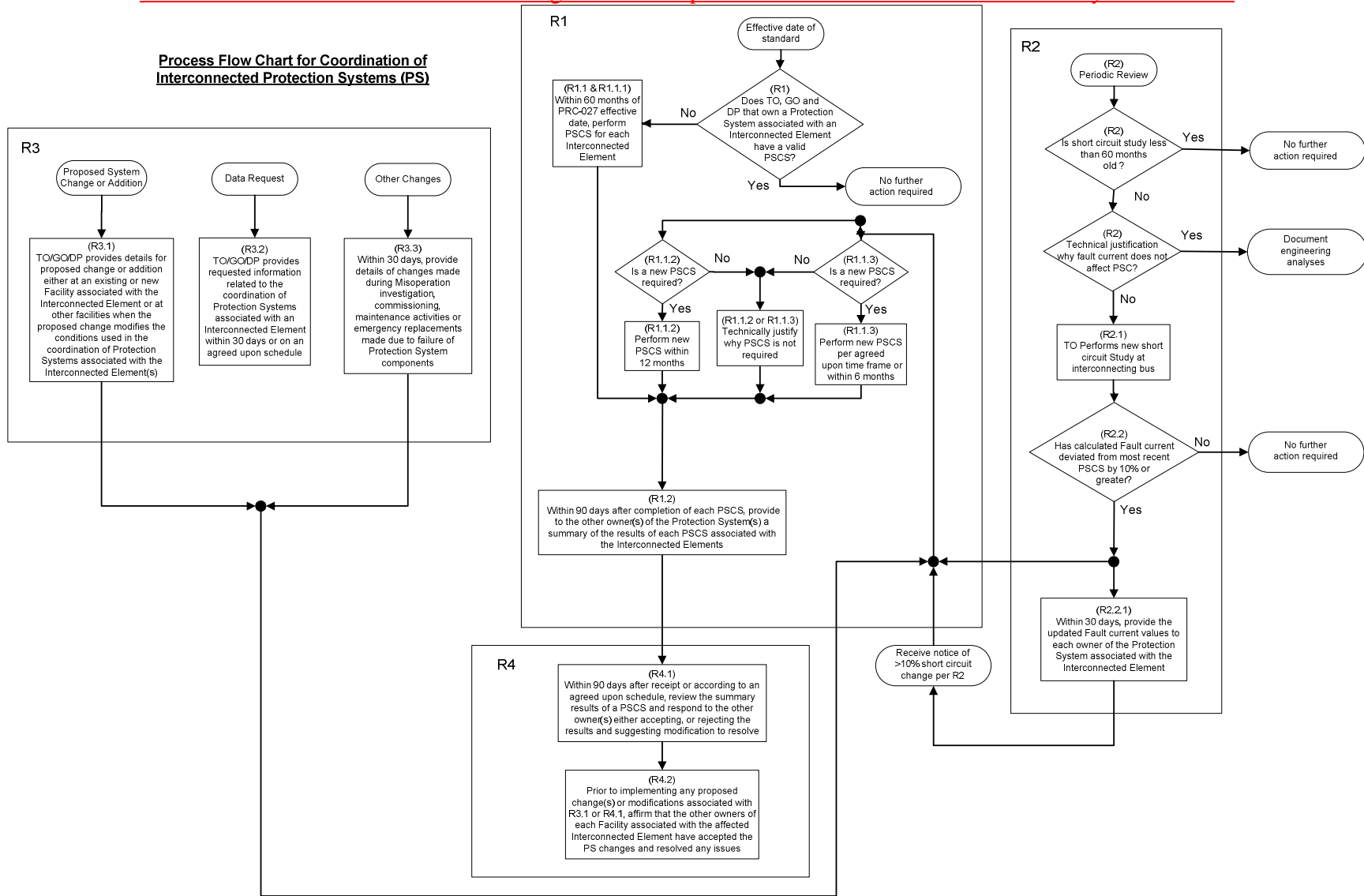
The reliability objective of this requirement is to bring the process of Protection System coordination full circle by gaining the confirmation of interconnected entities that their Protection Systems are coordinated consistent with the purpose of this standard. Cooperative participation of Facility 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~~PSCS, as described in Requirement R1, Part 1.2; ~~or absent acceptance propose revisions and respond as to achieve acceptable results whether they accepting or rejecting the results, and if rejecting, suggesting modifications to resolve any identified coordination issues.~~ The drafting team believes 90 calendar days after receipt of the results of a ~~Protection System Study~~PSCS provides a reasonable time for the owners of Facilities to ~~resolve differences and confirm acceptance that their Protection Systems are coordinated~~review the summary results of a PSCS.

Requirement R4, Part 4.2 directs entities to ~~re~~confirm that ~~planned~~the other owner(s) of each Facility associated with the affected Interconnected Element have accepted the Protection System(s) changes as described in Requirement 3, Part 3.1 are acceptable and Requirement 4, Part 4.1 prior to the in-service date of those changes. Any coordination issues identified during the review must be resolved prior to implementing the proposed changes. The purpose of ~~this requirement~~Requirement 4, Part 4.2 is to assure the effects ~~that planned~~the proposed changes have on Protection Systems at a Facility associated with the ~~affected~~ Interconnected Element have been considered by all affected entities.

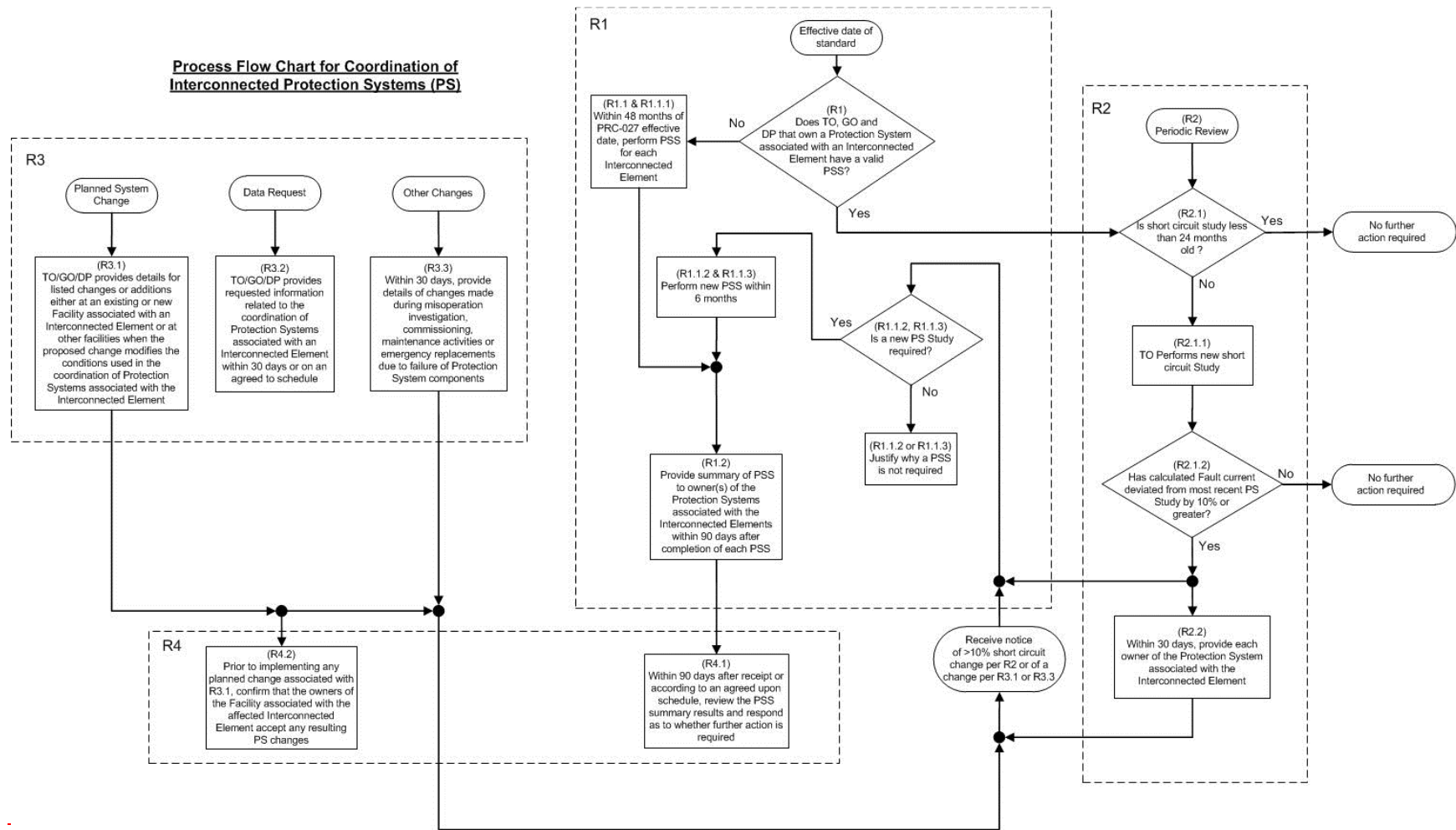
**Process Flow Chart:** Below is a complete representation of the process, including the relationships between requirements:

**Note:** All timeframes referenced in the diagram below represent “calendar month” or “calendar day” timeframes.



# Application Guidelines

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



### Example Process

An example of the interaction between entities required to gather the information to perform an accurate study is ~~below~~provided below. This example is given as general guidance only and is not intended to represent all situations that may occur. More detailed examples are provided along with Figures 1-5 in the section that follows this example.

- The initiating entity (Entity A) will contact the interconnected entity (Entity B) and provide details of the proposed change(s) and may also request up-to-date Protection System information.
- Entities A and B will determine whether a new PSCS is required. In this example both agree that a new study is required. The study may be a joint study, individual studies, or a single study provided by Entity A and reviewed and approved by Entity B. In this example, the latter will occur.
- 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~~PSCS 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~~PSCS.
- Entity B will review the summary information and, within 90 calendar days of receiving the study results from Entity A, ~~confirm agreement that~~respond as to whether any coordination issues were identified, and if any further action is achieved~~required~~.
- 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.~~
  - Ultimately, both entities will collaborate in developing a mutually acceptable solution.

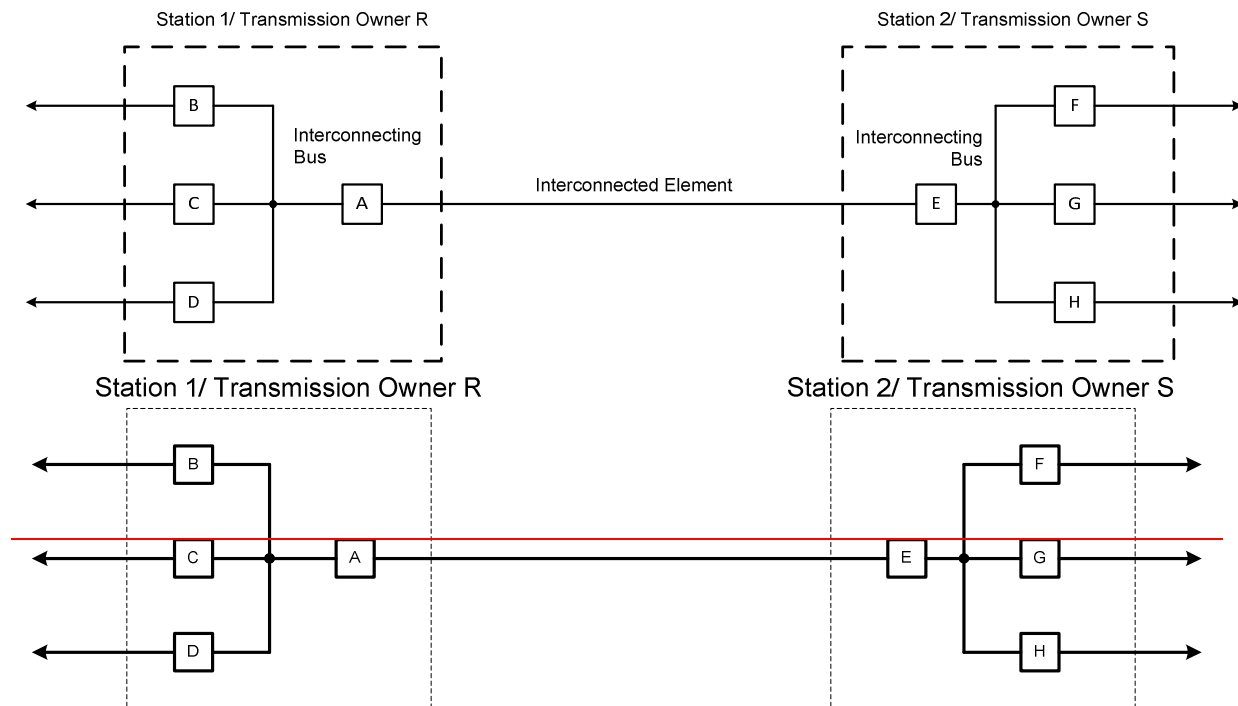
## Diagrams

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, ~~for meeting the requirements of this standard.~~ These examples are not intended to be inclusive of all situations and are based on the assumption that entities employ the appropriate engineering expertise and due diligence in developing settings for their Protection Systems. The examples given also assume a single owner as the initiator of a Protection System Coordination Study (PSCS) for the applicable Interconnected Element. In actuality, any owner or owners may initiate the process. After the reviews of the PSCS or a summary of results, and prior to implementation of the changes, the owners must reach agreement on the final settings to achieve work together to resolve any coordination of the Protection Systems issues identified during those reviews.

### NOTES:

1. Protection System Coordination Studies are typically performed assuming maximum generation and all Facilities in service.
2. Protection Systems of the Transmission Owners, Generator Owners, and Distribution Providers described in the Figures and examples below do not include any systems or components enumerated in the 'Background Section' of this standard under "Other Aspects of Coordination of Protection Systems Addressed by Other Projects".

**Figure 1**



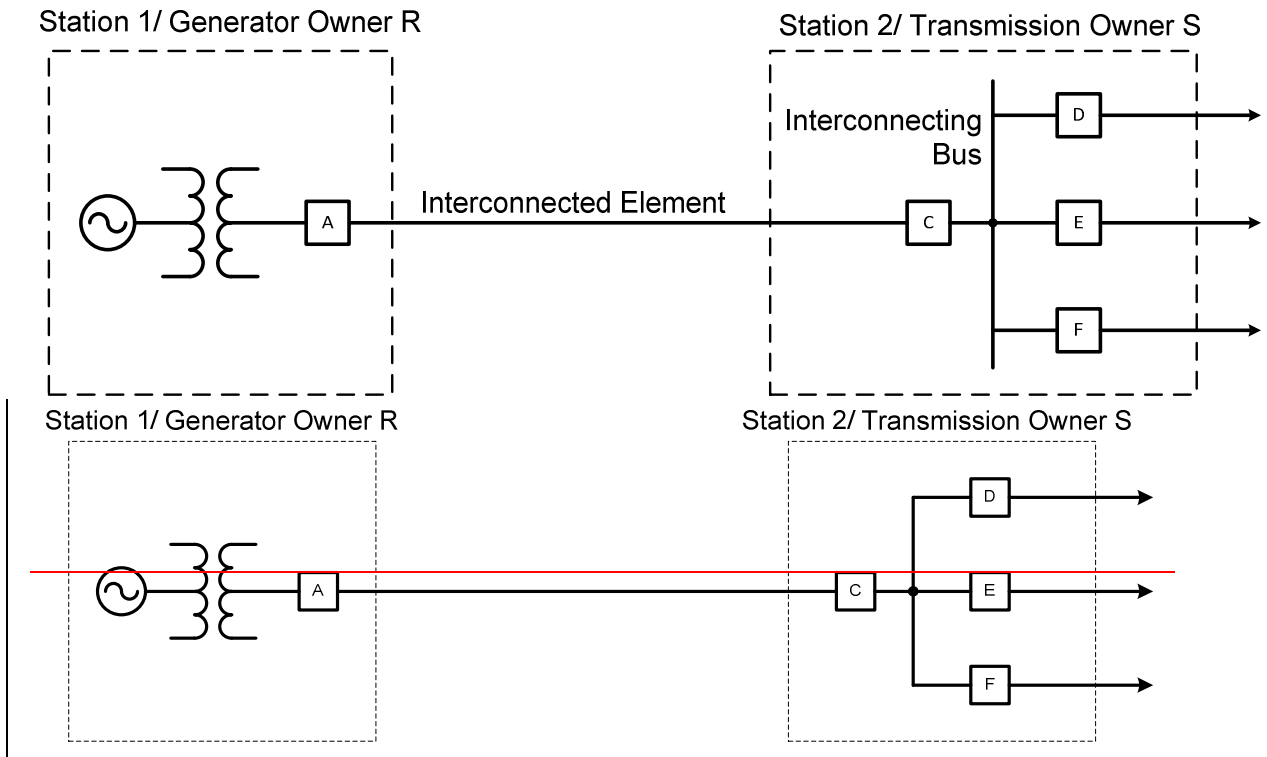
In Figure 1 above, the Interconnected Element between the Transmission Owners is the transmission line between Breakers A and E.

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Example: For the purposes of conducting the ~~Protection System Study~~ PSCS 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, Likewise, Owner S is to develop proposed Protection System settings associated with Breaker E.~~ 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.

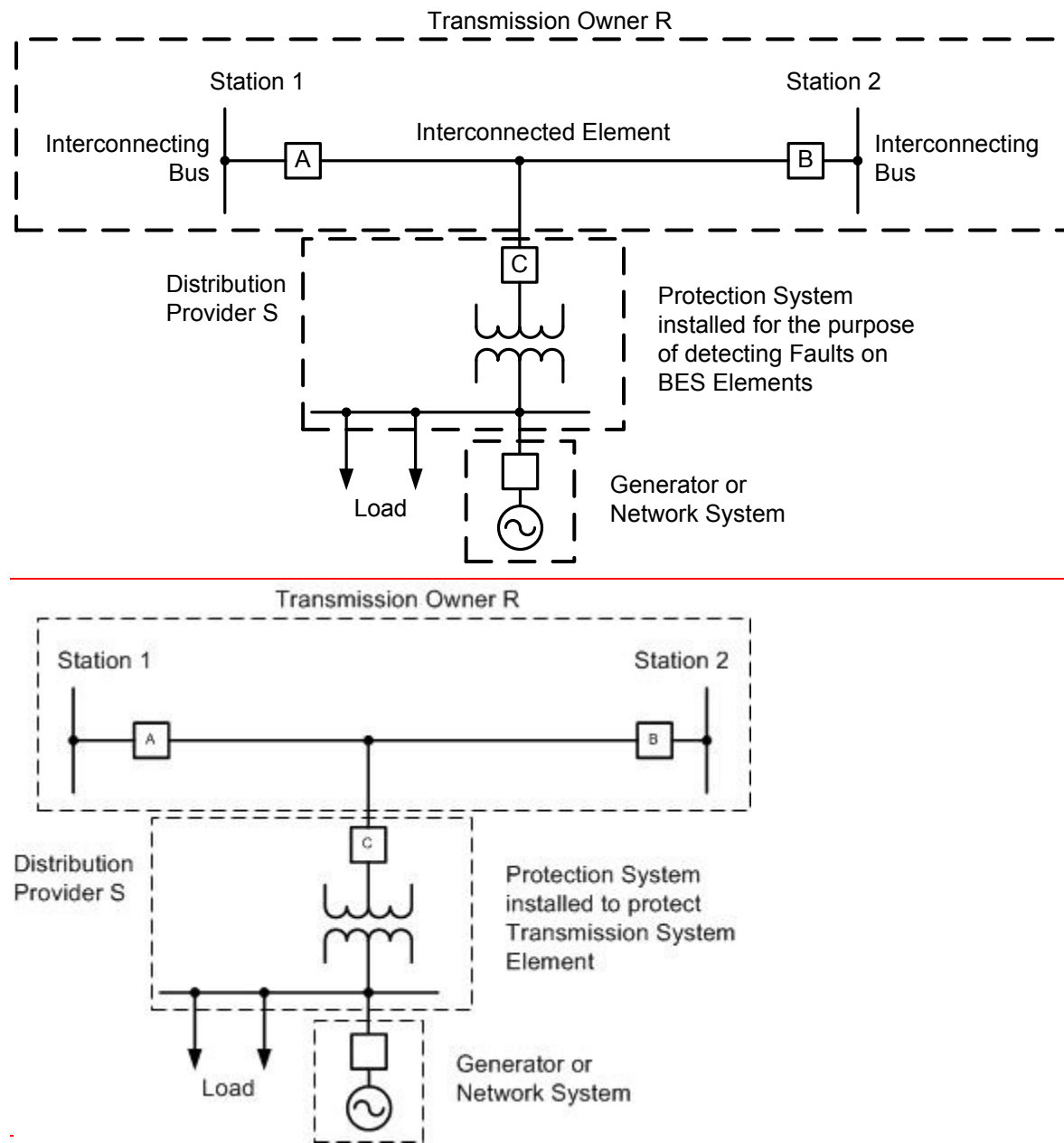
Note: Depending on the actual configuration and/or ownership, ~~breaker~~ Breaker A may, or may not, exist as a GSU unit high-side breaker or a line breaker.

Example: For the purposes of conducting the ~~Protection System Study~~ PSCS associated with the Facilities in Figure 2, Owner R is to develop proposed Protection System settings associated with Breaker A. 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, Likewise, Owner S is to develop proposed Protection System settings associated with Breaker C.

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 **Breaker C and the point of connection to the line between Breakers A and Breaker B**.

Example: For the purposes of conducting the **Protection System Study PSCS** associated with the Facilities in Figure 3, **Distribution Provider S is to develop proposed Protection System settings associated with Breaker C**. 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.

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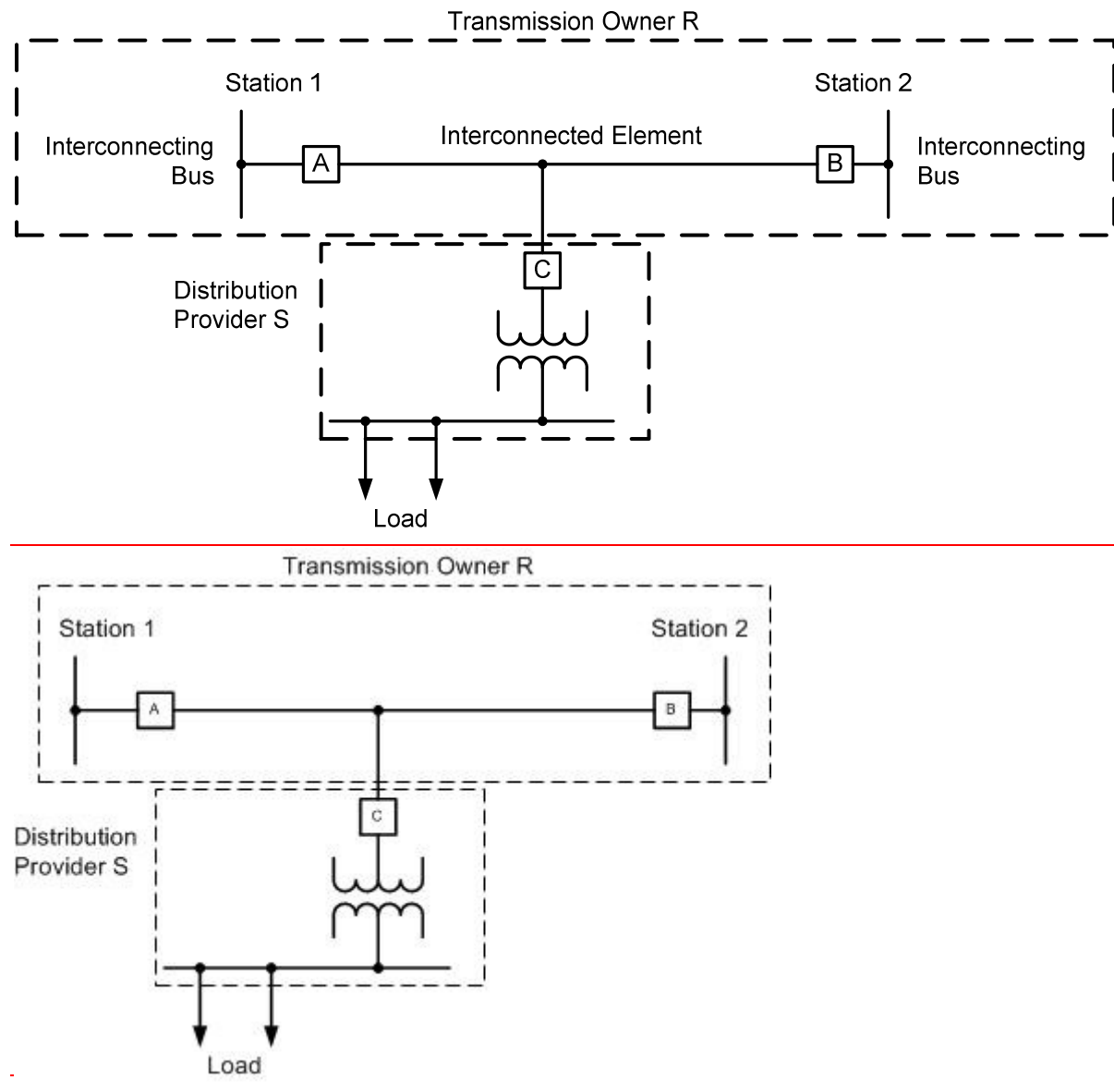
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### Notes:

~~A Protection System Study A PSCS~~ is required per this standard for this example if a Protection System at the Distribution Provider's substation is ~~designed to detect~~installed for the purpose of detecting Faults on ~~the BES Transmission System~~Elements.

“Protection Systems installed ~~to detect faults on~~for the purpose of detecting Faults on BES ~~Transmission System~~”are Elements do not ~~inclusive of those~~include relays that, though they may operate for such ~~faults, but~~Faults, 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 for a power transformer becomes de-energized ~~and (for whatever reason) while~~ the distribution bank remains energized from a source on the low-voltage side ~~of the transformer and~~. In this case, the settings ~~are~~of the reverse power relay are typically calculated based on the charging current of the transformer from the low-voltage side. Although ~~these~~ relays installed and set in this manner may operate as a result of a Fault on a BES Element, they are not ~~“specifically installed to detect faults on~~for the BES Transmission System.”purpose of detecting that Fault.

**Figure 4**



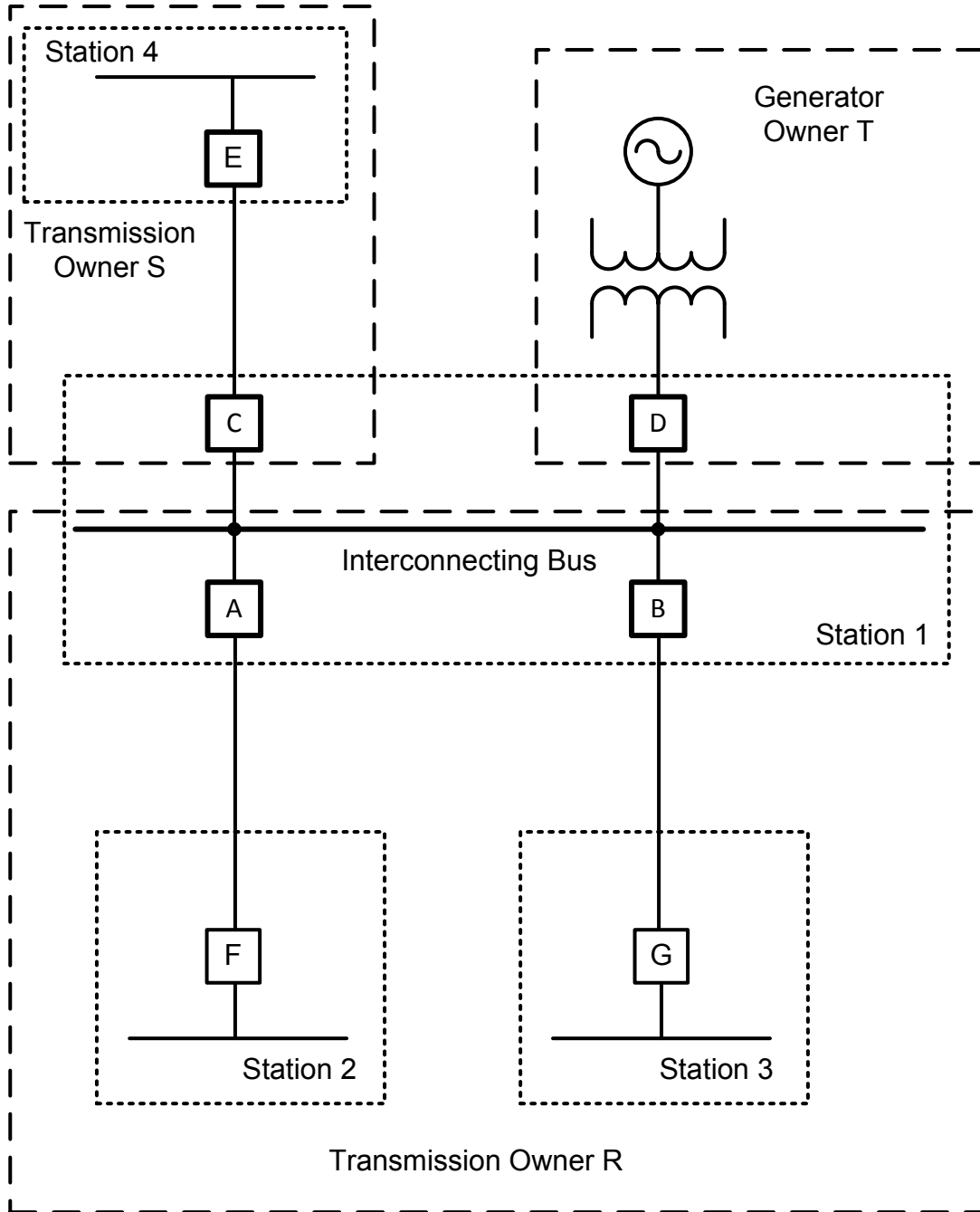
In Figure 4 above, the Interconnected Element between the Transmission Owner and the Distribution Provider is the transmission line or tap between the line and Breaker C.

**Note:** No specific ~~Protection System Study~~ PSCS is required per this standard for this example since the Protection System at the Distribution Provider's substation is not ~~designed to protect~~ installed for the purpose of detecting Faults on BES ~~transmission system~~ Elements.

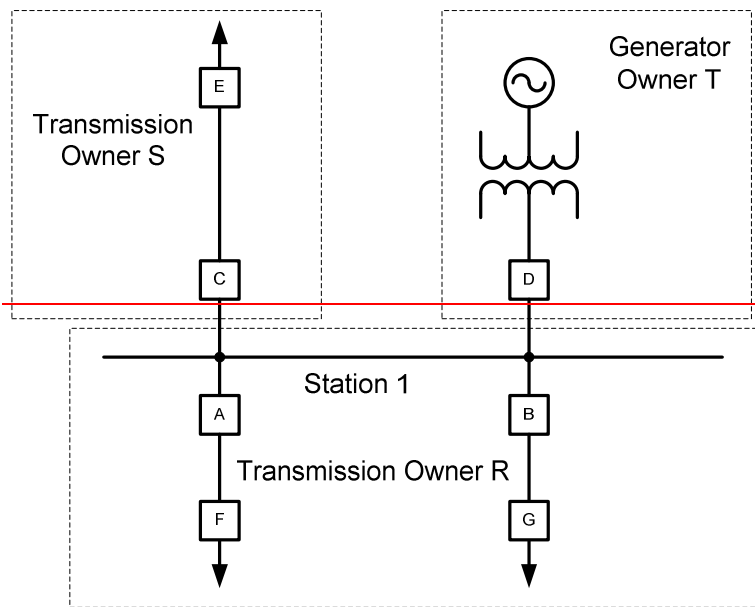
### **Figure 5**

Transmission/Generation Facility with Multiple Owners

Note: In a large majority of cases, Figure 2 would be applicable for most generator interconnections. In Figure 5 below, Transmission Owner S has no direct Protection Systems located at Station 1 that need to be checked for coordination with Generator Owner T.



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In Figure 5 above, the Interconnected Element between the Transmission Owners R and S and ~~the Generation~~Generator 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~~. All direct interconnections are between Owner R and each of the other Owners connected to the common bus at Station 1.

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

Owner S is to develop proposed Protection System settings associated with Breakers C and E.

Owner T is to develop proposed Protection System settings associated with Breaker D, the generator, and its associated equipment.

Owner R is to develop proposed Protection System settings associated with Breakers A, B, F and G.

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

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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.