TEXAS RE
Ensuring electric reliability for Texans

PRC-027-1

Coordination of Protection Systems for Performance During Faults

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O&P Compliance Engineer

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Agenda

- **Background**
- **PRC-027-1**
  - Purpose
  - Applicability
  - Implementation Plan
- **PRC-027-1 R1 and R3**
  - Requirement and Audit Exercise
- **PRC-027-1 R2**
  - Requirement and Audit Exercise

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- In 2009, NERC identified mis-coordination between generation and transmission as one of the contributing factors for misoperations that occurred between 2005 and 2008.

- “In 2013, NERC issued a Misoperations Report prepared by the Protection System Misoperations Task Force. The Misoperations Report identified “ways to potentially reduce the amount of future misoperations” and concluded that ‘[m]isoperations due to setting errors can potentially be reduced.’ The identified techniques to reduce incorrect settings, included: peer reviews, increased training, more extensive fault studies, standard templates for setting standard schemes using complex relays, and periodic review of existing settings when there is a change in system topography.”

2019 NERC State of Reliability Report

- Overall Misoperations rate for 2018 – 8%

- Three largest causes of Misoperation
  - Incorrect settings/logic/design errors
  - Relay failure/malfunctions
  - Communication failures

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PRC-027-1 Purpose

To maintain the coordination of Protection Systems installed to detect and isolate Faults on Bulk Electric System (BES) Elements, such that those Protection Systems operate in the intended sequence during Faults.

PRC-027-1 Applicability

Generator Owners

Transmission Owners

Distribution Providers that own:

- Protection Systems installed to detect and isolate Faults on BES Elements.

PRC-027-1 – R2 Attachment A

- **Applicable to BES Elements with following Protection System functions:**
  - 21 – Distance if:
    - infeed is used in determining reach (phase and ground distance), or
    - zero-sequence mutual coupling is used in determining reach (ground distance).
  - 50 – Instantaneous overcurrent
  - 51 – AC inverse time overcurrent
  - 67 – AC directional overcurrent if used in a non-communication-aided protection scheme

PRC-027-1 Implementation Plan

- **Effective April 01, 2021**
- **Required on effective date:**
  - R1 – documented process
  - R2 – a Fault current baseline (if using Option 2)
  - R3 – utilize the process

- **PRC-001-1.1(ii) retired at midnight of the day immediately prior to effective date**

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PRC-027-1

Establish process for developing new or revised settings – R1

Utilize process for new or revised settings – R3

Periodically review existing settings – R2

Largest causes of Misoperations

- Incorrect modeling
- Incorrect relay settings
- Calculation errors

PRC-027-1 – R1 and R3

- **R1** - Establish a process for developing new and revised Protection System settings for BES Elements, such that the Protection Systems operate in the intended sequence during Faults.

- **R3** - Utilize the process established in R1 to develop new and revised Protection System settings for BES Elements.

PRC-027-1 – Part 1.1

- **R1** - Establish a process for developing new and revised Protection System settings for BES Elements, such that the Protection Systems operate in the intended sequence during Faults.

  The process shall include:

  - **Part 1.1** A review and update of short-circuit model data for the BES Elements under study.

Risks of “incorrect settings”

- Example 1:

  A breaker was slow to trip due to incorrect settings. The actual line impedance was larger than the model impedance which was used to set the relays.

- Example 2:

  A 138 kV line over tripped during a fault due to incorrect settings. Mutual coupling impedance with a parallel 345 kV circuit in the model is incorrect.

Example

Entity 1

Entity 2

Part 1.1 – Bad Example

Entity 1 process states

To be in compliant with Part 1.1, the process will include a review and update of short-circuit model data for the BES elements.

Part 1.1 – Good Example

Entity 2 process states

The process will include

- Checklist of the protection data to be reviewed
- Clear identification of the source data
- Documents actions to be taken when inaccurate data is identified
- Roles and responsibilities

PRC-027-1 – Part 1.2

- **R1** -The process shall include:
  - **Part 1.2** A review of the developed Protection System settings.

Risks of “not reviewing settings”

- Example:

  A line terminal Misoperated during a fault due to incorrect settings.
  An incorrect template was used to calculate the relay settings.

Part 1.2 – Bad Example

Entity 1 process states

To be in compliant with Part 1.2, the process will include a review of the developed Protection System settings.

Part 1.2 – Good Example

Entity 2 process states

The process will include

- Templates to ensure consistency in development of settings
- Defined criteria to review settings
- Process for peer reviews
- Process to review setting changes from root cause investigations of Misoperations

PRC-027-1 – Part 1.3

- **Part 1.3** For Protection System settings applied on BES Elements that electrically join Facilities owned by separate functional entities (Transmission Owners, Generator Owners, and Distribution Providers), provisions to:
  - **1.3.1** Provide the proposed Protection System settings to the owner(s) of the electrically joined Facilities.
  - **1.3.3** Verify that identified coordination issue(s) associated with the proposed Protection System settings for the associated BES Elements are addressed prior to implementation.
  - **1.3.4** Communicate with the other owner(s) of the electrically joined Facilities regarding revised Protection System settings resulting from unforeseen circumstances that arise during implementation or commissioning, Misoperation investigations, maintenance activities, or emergency replacements required as a result of Protection System component failure.

Risks of “not addressing coordination before implementation”

- Example:

  A line trip due to incompatible relays used on pilot protection scheme.

Part 1.3 – Bad Example

Entity 1 process states

To be in compliant with Part 1.3, the process will include:

CUT and PASTE of requirement language

Part 1.3 – Good Example

Entity 2 process includes

- Contact information of responsible person/owner for applicable entities.
- Controls that are in-place to ensure response is obtained before implementing.
- Checklist to address issues before implementing settings.
- Process to account for one-off's – like emergency replacements, changes during commissioning etc

PRC-027-1 – Part 1.3

- **Part 1.3** For Protection System settings applied on BES Elements that electrically join Facilities owned by separate functional entities (Transmission Owners, Generator Owners, and Distribution Providers), provisions to:
  - **1.3.2** Respond to any owner(s) that provided its proposed Protection System settings pursuant to Requirement R1, Part 1.3.1 by identifying any coordination issue(s) or affirming that no coordination issue(s) were identified.

Part 1.3 – Bad Example

Entity 1 process states

To be in compliant with Part 1.3, the process will include:

CUT and PASTE of requirement language

Part 1.3 – Good Example

Entity 2 process includes

- A system that stores and tracks requests and responses
- Automatic notifications if requests were unassigned or past due

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PRC-027-1 – R2

- **Option 1:** Perform a Protection System Coordination Study in a time interval not to exceed six-calendar years; or

- **Option 2:** Compare present Fault current values to an established Fault current baseline and perform a Protection System Coordination Study when the comparison identifies a 15 percent or greater deviation in Fault current values (either three phase or phase to ground) at a bus to which the BES Element is connected, all in a time interval not to exceed six-calendar years; or,

- **Option 3:** Use a combination of the above.

Requirement R2– Bad Example

Entity 1

- No criteria for the options selected.
- Choosing Option 1 for their System to avoid compliance obligations until six years after the effective date.
- Choosing SLG fault current because their consultant said so.

Requirement R2– Good Example

Entity 2

- A documented criteria on where Option 1 and Option 2 are utilized.
- Identifying what faults currents are used for verification – SLG, 3ϕ.
- Criteria on where the fault current baseline is established – generator, GSU, or at POI etc.

Questions?