
Compliance
FUNDAMENTALS
November 14, 9:00 a.m. to 12:00 p.m. Mountain

WECC

PRC-005-6

Protection Systems, Automatic Reclosing and Sudden Pressure Relaying Maintenance Basics

November 14, 2024

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Compliance Auditors

Agenda

- PRC-005 History and Future
- Applicable Protection Systems
- Elements of Automatic Reclosing and Sudden Pressure Relaying
- PRC-005-6
  - R1, Protection System Maintenance Program (PSMP)
  - R2, Performance-based Maintenance Intervals
  - R3, Time-based Maintenance Intervals and Activities
  - R4, Performance-based Maintenance Activities
  - R5, Unresolved Maintenance Issues
- Resources and References
- Q&A

PRC-005 History

Purpose Statements:

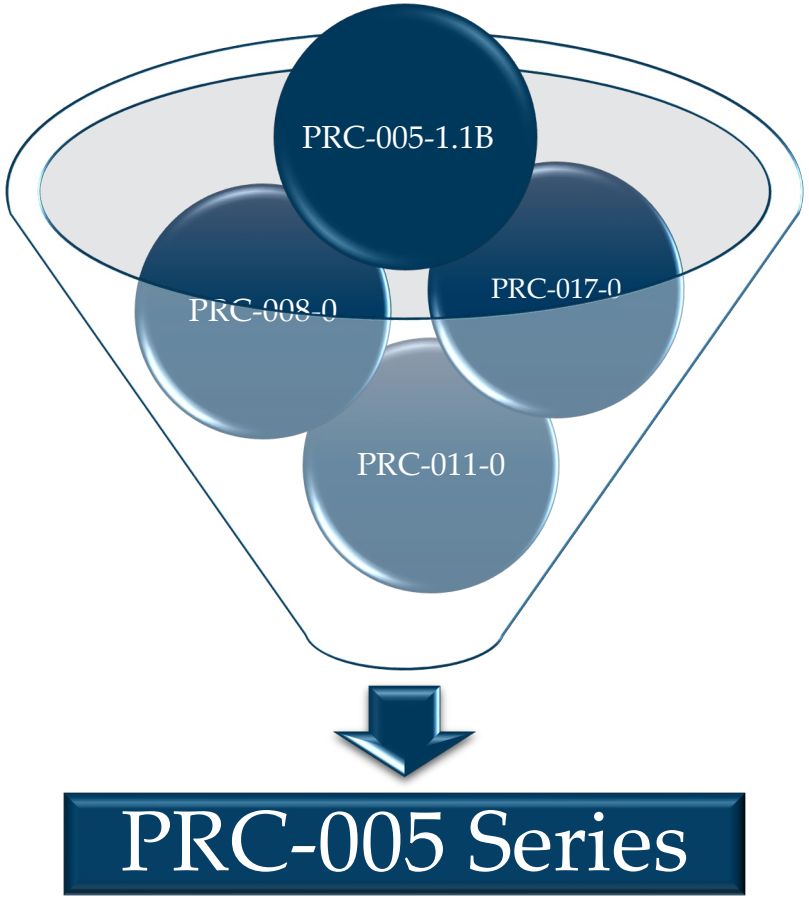
- PRC-005-0: To ensure all **transmission protection system misoperations are analyzed** for cause and corrective action, and **maintenance and testing programs are developed and implemented**.
- PRC-005-1: To ensure all transmission **and generation** Protection Systems affecting the reliability of the BES are maintained and tested.
- PRC-005-2: To **document and implement programs** for the maintenance of all Protection Systems affecting the reliability of the BES so these Protection Systems are **kept in working order**.
- PRC-005-3: To document and implement programs for the maintenance of all Protection Systems **and Automatic Reclosing** affecting the reliability of the BES so they are kept in working order.
- PRC-005-4 through PRC-005-6: To document and implement programs for the maintenance of all Protection Systems, Automatic Reclosing, **and Sudden Pressure Relaying** affecting the reliability of the BES so they are kept in working order.

PRC-005: History (continued)

Version	Description
PRC-005-1	Entity develop PSMP with activities and intervals for five component types. Action of protection considered.
PRC-005-2	NERC defines activities and intervals. Includes UVLS, UFLS, and SPS. Purpose of protection considered.
PRC-005-2i, 2ii	Aggregate total BES Dispersed Power resources >75MVA. SPS became RAS.
PRC-005-3, 3i, 3ii	Added Automatic Reclosing.
PRC-005-4	Added Sudden Pressure Relaying.
PRC-005-5	Removal of required maintenance of dispersed generation.
PRC-005-6	Added Supervisory associated with Automatic Reclosing. Combined versions of -3, -4, -5, and -6.

PRC-005: History (continued)

- Did you know?
  - Adopted by NERC: February 8, 2005
  - PRC-005 was the most violated standard in 2008 (documentation related)
  - PRC-005-2 combined and replaced PRC-005-1.1B, PRC-008, PRC-011 and PRC-017



PRC-005-6: Future

- NERC Project 2019-04 Modifications to PRC-005-6
  - Standards Authorization Request (SAR) to clarify Applicability of PRC-005-6 for Automatic Voltage Regulators (AVR)
  - Transition from PRC-005-6 to PRC-005-7
  - Clarify Protection Systems within DC excitation systems
  - Add verbiage on "non-battery-based energy storage and electro-chemical-based energy storage"
  - Add prescribed maintenance activities
  - Add "UFLS Only DP" applicability
  - Supplementary Reference and FAQ
  - Lower Priority—On hold

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The overarching purpose of PRC_005 is to

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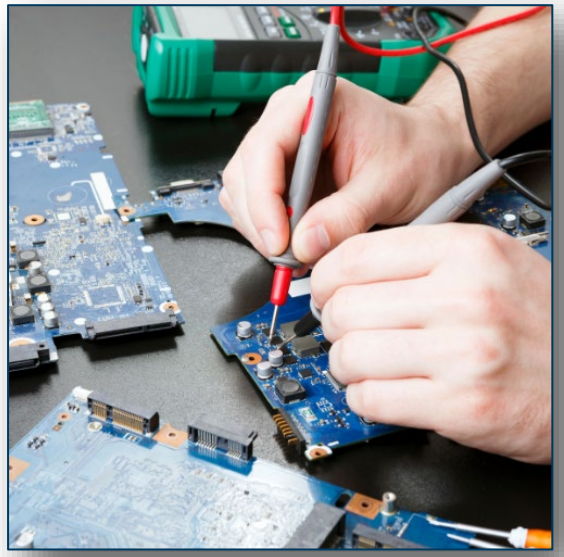
PRC-005-6

Standard	Title	Purpose	Applicability
PRC-005-6	*Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance*	To document and implement programs for the maintenance of all Protection Systems, Automatic Reclosing, and Sudden Pressure Relaying affecting the reliability of the BES so they are kept in working order.	• Transmission Owner • Generator Owner • Distribution Provider



Component vs. Component Type

- Component
  - Any individual discrete piece of equipment included in a Protection System, Automatic Reclosing, or Sudden Pressure Relaying
- Component Type
  - Any one of the *five* specific elements of a Protection System
  - Any one of the *four* specific elements of Automatic Reclosing
  - Any one of the *two* specific elements of Sudden Pressure Relaying

Protection Systems

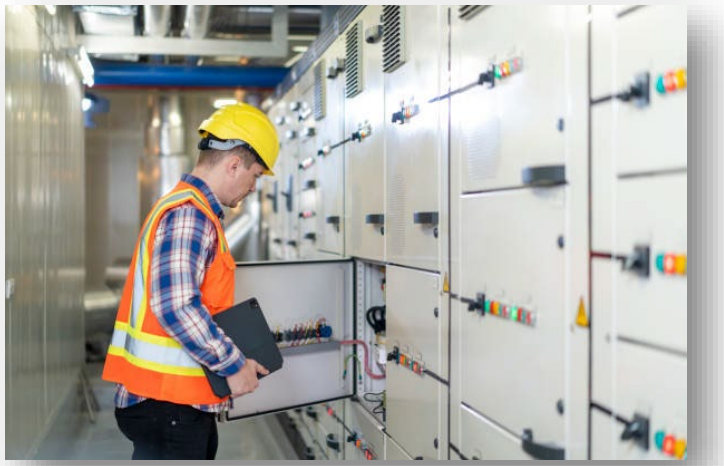
- Installed for the purpose of detecting a Fault(s) on BES Elements (lines, buses, transformers, etc.)
- Underfrequency load shedding systems installed per NERC requirements
- Undervoltage load shedding systems installed to prevent system voltage collapse or voltage instability for BES reliability
- Installed as part of a Remedial Action Scheme (RAS) for BES reliability

Protection Systems (continued)

- Generator Facilities that are part of the BES
- Trip the generator either directly or via lockout or auxiliary tripping relays
- Generator step-up transformers for generators that are part of the BES
- Station service or excitation transformers connected to the generator bus of generators that are part of the BES that act to trip the generator either directly or via lockout or tripping auxiliary relays
- Aggregating dispersed BES generation from the point where those resources aggregate to greater than 75 MVA to a common point of connection at 100 kV or above

Automatic Reclosing

- Reclosing relay
- Supervisory relays that perform voltage and/or sync check functions that enable or disable operation of the reclosing relay
- Voltage sensing devices associated with supervisory relays
- Control circuitry with the reclosing relay



Sudden Pressure Relaying

- A system that trips an interrupting device to isolate the equipment it is monitoring and includes the following Components:
  - Fault pressure relay—a mechanical relay or device that detects rapid changes in gas pressure, oil pressure, or oil flow that are indicative of Faults within liquid-filled, wire-wound equipment.
  - Control circuitry associated with a fault pressure relay.

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Protection Systems include all except:

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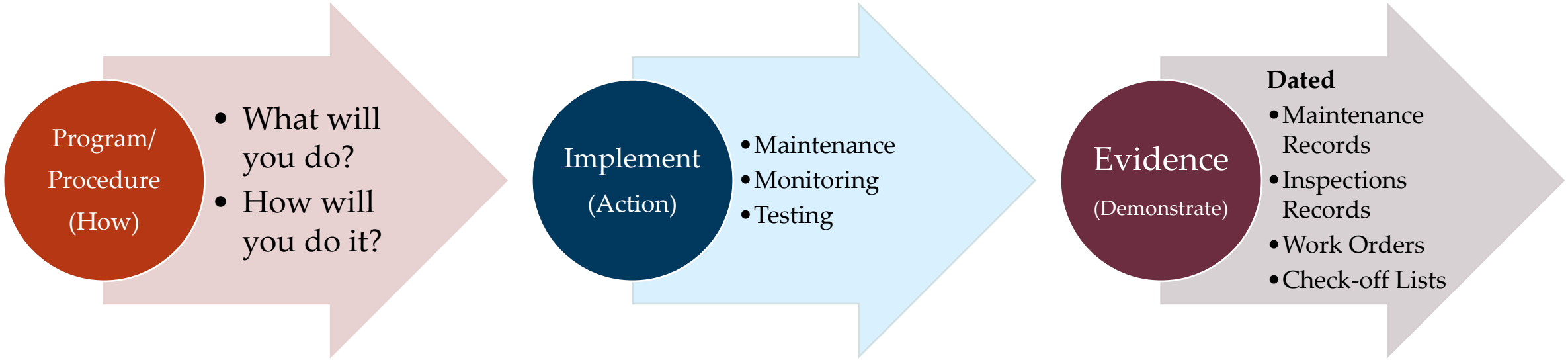
Compliance Program



PRC-005-6 R1

- Establish a Protection System Maintenance Program (PSMP) for your Protection Systems, Automatic Reclosing, and Sudden Pressure Relaying.
- Include the applicable monitored Component attributes applied consistent with the maintenance intervals specified in *Tables 1-1* through *1-5*, *Table 2*, *Table 3*, *Table 4-1* through *4-3*, and *Table 5*.
- Retention:
  - Keep current dated PSMP, as well as any superseded versions since the previous compliance audit, including the documentation that specifies the type of maintenance program.

PRC-005-6 R1 (continued)

Protection System Maintenance Program

- Include the applicable monitored components using Section 4.2, Facilities. (BES elements, UFLS/UVLS, RAS, etc.)
- Identify maintenance method (time-based, performance-based, or combination).
- Create a procedure/program based on maintenance method and applicable components.
  - Define roles and responsibilities.
  - How will you test? Who will perform the testing? How often?
  - What will be used to track inventory, scheduling, and work order/maintenance completion?
  - Where will testing and dated maintenance records be preserved/archived?
  - Is the procedure periodically reviewed and updated?
  - Who will ensure implementation?
  - Retention period of evidence.

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An exceptional compliance program consists of the following except:

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PRC-005-6 R2

- Performance-based Maintenance Intervals
  - *Attachment A: Criteria for a Performance-based Protection System Maintenance Program*
    - To **establish** the technical justification for the **initial use** of a performance-based PSMP
    - To **maintain** the technical justification for the **ongoing use** of a performance-based PSMP

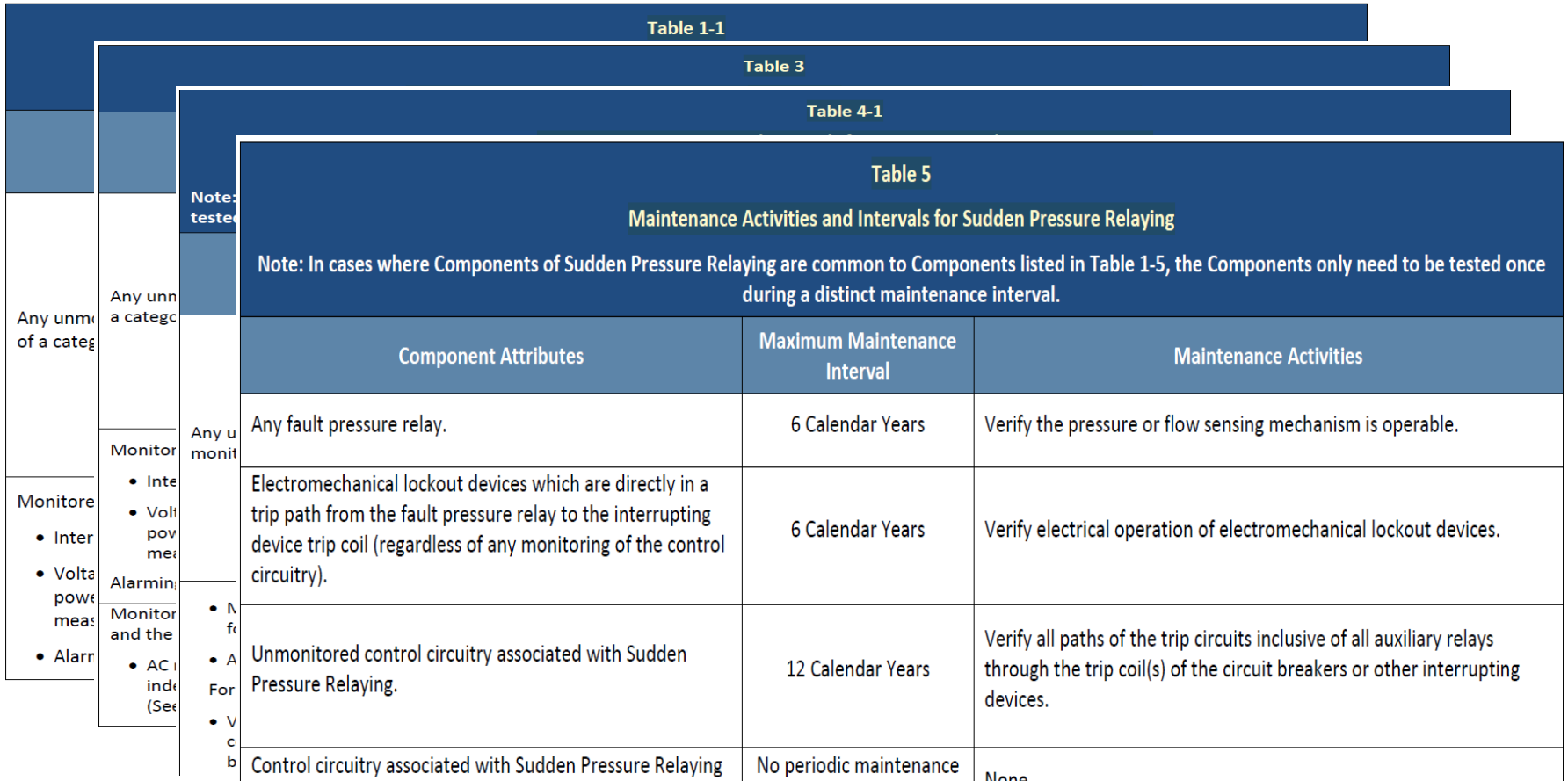
Countable Event

A failure of a component requiring repair or replacement, any condition discovered during the maintenance which requires corrective action *or* a Protection System Misoperation attributed to hardware failure or calibration failure.

- Not included
  - Misoperations due to
    - Product design
    - Software errors
    - Relay settings different from specified settings
    - Configuration or application errors

PRC-005-6 R2/R3

Maintenance Activities and Intervals established in *Tables 1-1* through *1-5, Table 3, Tables 4-1* through *4-3,* and *Table 5.*



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Requirement 2 uses time-based maintenance in accordance with the minimum maintenance activities and maximum maintenance intervals described within PRC-005-6.

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PRC-005-6 R3

Time-based maintenance program(s)

- Maintenance should be implemented in accordance with the minimum maintenance activities and maximum maintenance intervals described within *Tables 1-1* through *1-5*, *Table 2*, *Table 3*, *Table 4-1* through *4-3*, and *Table 5*.
- Artifacts may include, but are not limited to, dated maintenance records, dated maintenance summaries, dated check-off lists, dated inspection records, or dated work orders.
- Retention:
  - Keep documentation of the most recent and prior performance of that maintenance activity.

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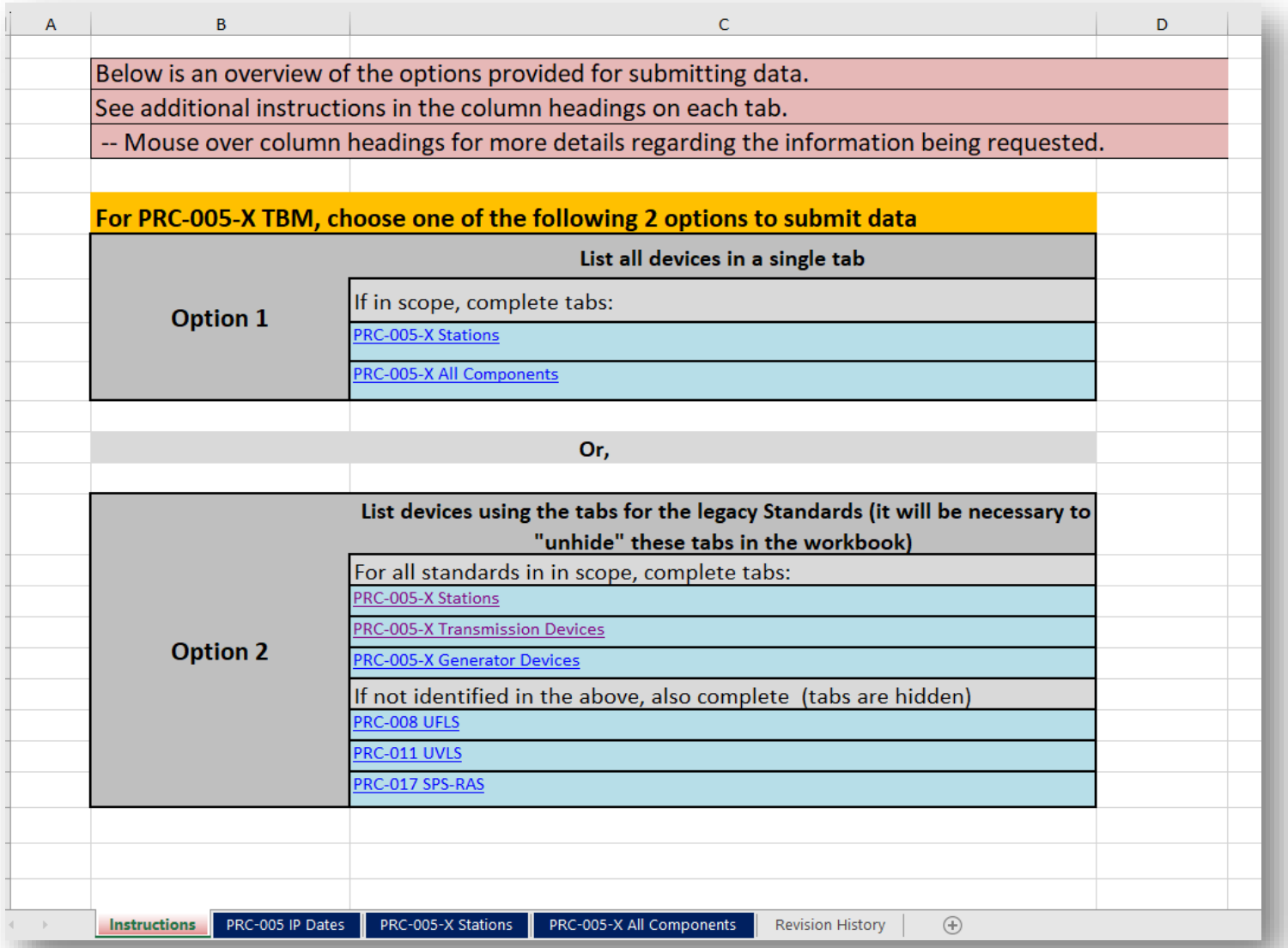
Protection Systems Maintenance Summary

Instructions

- Options for entering data
  - Stations
  - Components
    - Transmission devices
    - Generator Devices
    - UFLS
    - UVLS
    - SPS-RAS



Below is an overview of the options provided for submitting data.
See additional instructions in the column headings on each tab.
-- Mouse over column headings for more details regarding the information being requested.

For PRC-005-X TBM, choose one of the following 2 options to submit data

Option 1	**List all devices in a single tab**
	If in scope, complete tabs:
	PRC-005-X Stations
	PRC-005-X All Components

Or,

Option 2	**List devices using the tabs for the legacy Standards (it will be necessary to "unhide" these tabs in the workbook)**
	For all standards in in scope, complete tabs:
	PRC-005-X Stations
	PRC-005-X Transmission Devices
	PRC-005-X Generator Devices
	If not identified in the above, also complete (tabs are hidden)
	PRC-008 UFLS
	PRC-011 UVLS
	PRC-017 SPS-RAS

Instructions | PRC-005 IP Dates | PRC-005-X Stations | PRC-005-X All Components | Revision History

<Public>

Protection Systems Maintenance Summary

- Implementation Plan Milestone
  - Enforcement date
  - Component
  - Maintenance interval
  - Percentage required to be tested

USA

1/1/2025	Auto Reclosing	12 calendar years	60%
1/1/2025	Sudden Pressure	12 calendar years	60%
4/1/2027	Protection System	12 calendar years	100%
1/1/2029	Auto Reclosing	12 calendar years	100%
1/1/2029	Sudden Pressure	12 calendar years	100%

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10/1/2025	Auto Reclosing	6 calendar years	100%
10/1/2025	Sudden Pressure	6 calendar years	100%
10/1/2025	Protection System	12 calendar years	60%
10/1/2027	Auto Reclosing	12 calendar years	60%
10/1/2027	Sudden Pressure	12 calendar years	60%
10/1/2029	Protection System	12 calendar years	100%
10/1/2031	Auto Reclosing	12 calendar years	100%
10/1/2031	Sudden Pressure	12 calendar years	100%

Enforcement Date	Component	Implementation Plan Milestone	% Required
10/1/2017	Protection System	R1 (PSMP)	100%
4/1/2018	Protection System	<1 calendar year	100%
10/1/2018	Protection System	3 calendar years	30%
10/1/2019	Auto Reclosing	R1 (PSMP)	100%
10/1/2019	Sudden Pressure	R1 (PSMP)	100%
10/1/2019	Protection System	1-2 calendar years	100%
10/1/2019	Protection System	3 calendar years	60%
10/1/2019	Protection System	6 calendar years	30%
10/1/2020	Protection System	3 calendar years	100%
10/1/2021	Auto Reclosing	6 calendar years	30%
10/1/2021	Sudden Pressure	6 calendar years	30%
10/1/2021	Protection System	12 calendar years	30%
10/1/2021	Protection System	6 calendar years	60%
10/1/2023	Auto Reclosing	6 calendar years	60%
10/1/2023	Auto Reclosing	12 calendar years	30%
10/1/2023	Sudden Pressure	6 calendar years	60%
10/1/2023	Sudden Pressure	12 calendar years	30%
10/1/2023	Protection System	6 calendar years	100%
10/1/2025	Auto Reclosing	6 calendar years	100%
10/1/2025	Sudden Pressure	6 calendar years	100%
10/1/2025	Protection System	12 calendar years	60%
10/1/2027	Auto Reclosing	12 calendar years	60%
10/1/2027	Sudden Pressure	12 calendar years	60%
10/1/2029	Protection System	12 calendar years	100%
10/1/2031	Auto Reclosing	12 calendar years	100%
10/1/2031	Sudden Pressure	12 calendar years	100%

Instructions | PRC-005 IP Dates | PRC-005-X Stations | PRC-005-X All Components | Revision History

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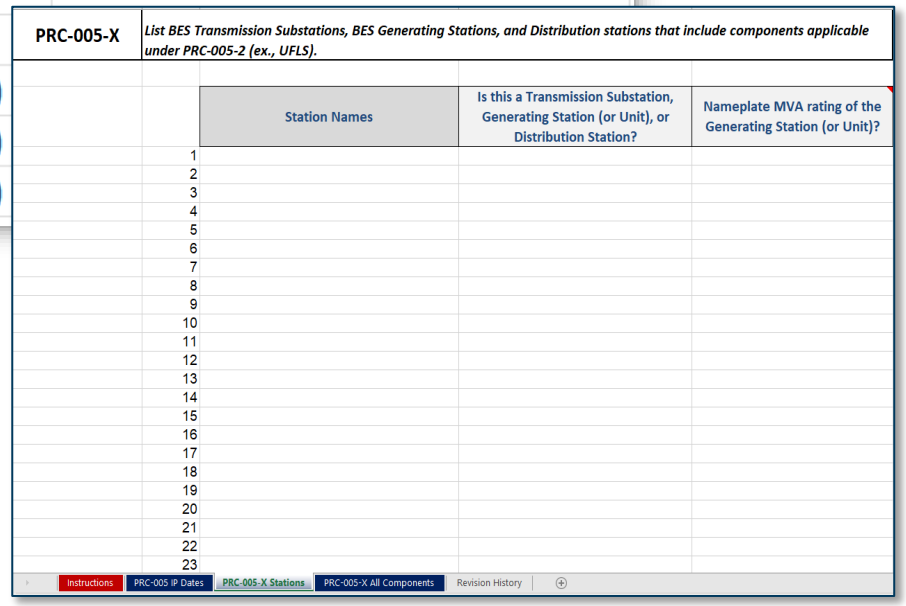
Protection Systems Maintenance Summary

List BES Transmission Substations, BES Generating Stations, and Distribution stations that include components applicable under PRC-005-2 (ex., UFLS).

	Station Names	Is this a Transmission Substation, Generating Station (or Unit), or Distribution Station?	Nameplate MVA rating of the Generating Station (or Unit)?
1	Old McDonald Farm (OMF)	Substation	
2	Sesame Street Sub (SSS)	Substation	
4	Humpty Dumty Mill (HDM)	Distribution Station (UFLS Only, Non-BES)	
5	Yankee Doodle Mill (YDM)	Distribution Station (UFLS Only, Non-BES)	
6	Bubble Gum Plywood (BGP)	Distribution Station (UFLS Only, Non-BES)	



- List of stations that contain applicable components.
- Identify unit or substation (transmission, distribution or generation unit)
- Include MVA Rating

Protection Systems Maintenance Summary

- Station name
- Component name (unique identifier)
- Component description (ex., SEL)
- Component Table (applicable to component type —protective relay, SPRs, batteries, etc.)
- Component Application (UFLS/UVLS/Both/Blank)

Station Name	Component Name	Component Description	Component Type or Table (ex. "Relay" or "Table 1-1")	Component Application (UFLS, UVLS, SPS)
Old McDonald Farm (OMF)	7212	SEL-387	Table 1-1	
Old McDonald Farm (OMF)	7213	SEL-387	Table 1-1	
Sesame Street Sub (SSS)	7049	SEL-421	Table 1-1	
Sesame Street Sub (SSS)	7050	SEL-421	Table 1-1	
Humpty Dumty Mill (HDM)	5094	SEL-351S	Table 3	Underfrequency
Humpty Dumty Mill (HDM)	7753	SEL-351S	Table 3	Underfrequency
Yankee Doodle Mill (YDM)	7633	SEL-751A	Table 3	Underfrequency
Yankee Doodle Mill (YDM)	7634	SEL-751A	Table 3	Underfrequency
Bubble Gum Plywood (BGP)	F35	GE Multilin F35 relay	Table 3	Underfrequency
Bubble Gum Plywood (BGP)	T60	GE Multilin T60 relay	Table 3	Underfrequency

Last Test Date (MM/DD/YYYY)	Prior Test Date (MM/DD/YYYY)	Program Version used for Last Test	Program Version used for Prior Test	Maximum Unmonitored Maintenance Interval	Selected Maintenance Interval	General Notes
2/25/2023	New Install	PRC-005-6	New Install	6 Years	6 Years	New Installation on 2/25/2023
2/25/2023	2/25/2017	PRC-005-6	PRC-005-6	6 Years	6 Years	
4/9/2018	12/9/2014	PRC-005-6	PRC-005-6	6 Years	6 Years	
4/9/2018	Replacement	PRC-005-6	Replacement	6 Years	6 Years	Replaced on 4/9/2018
8/20/2022	1/26/2016	PRC-005-6	PRC-005-6	12 Years	6 Years	
8/20/2022	1/26/2016	PRC-005-6	PRC-005-6	12 Years	6 Years	
3/14/2023	2/2/2017	PRC-005-6	PRC-005-6	12 Years	6 Years	
3/14/2023	2/2/2017	PRC-005-6	PRC-005-6	12 Years	6 Years	
6/30/2021	3/4/2016	PRC-005-6	PRC-005-2	12 Years	6 Years	
6/30/2021	3/4/2016	PRC-005-6	PRC-005-2	12 Years	6 Years	

- Last/Prior test date
- Program version for last/prior test date (PRC-005-6/PRC-005-2/PRC-005-1)
- Maximum maintenance interval (interval determined in the standard)
- Selected Maintenance Interval (maintenance interval entity selects for components ≤ to standard interval)
- General Notes (replaced, new install, etc.)

Implementation Recommendations

Protection Systems Maintenance Summary Spreadsheet

- Completeness, no empty fields.
- Prior and last test date are filled.
  - Time between each test date falls within applicable interval established in Maintenance Activity tables. You can use the commissioning date as a test date.
- Fields are filled out correctly.
  - Component name—unique identifier will help in reviewing testing records and matching them to the component listed.
  - General notes can be used for energization dates, component ownership, replacements, it can be left empty as well.
  - Selected maintenance interval is what you set, must be equal to or less than the maximum maintenance interval.

R3 Implementation

- Consistency—following maintenance procedure in line with your PSMP.
- Ensure contractors follow the standard.
- Applicable components being tested in accordance with the minimum maintenance activities prescribed within the tables.
  - Correct tables being used for the correct components.
  - Meeting intervals (looking at dated records and time between each maintenance period).
- Entity following the implementation percentages milestones.
- Maintenance records are consistent and accurate—lead us to the answer!
  - Circle or highlight test results (for example, input and output values).
- No fluff! Adding information or documents that aren't required isn't always better—information overload.

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The component unique identifier field in Protection Systems Maintenance Summary Spreadsheet is labeled as:

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R4 Implementation

- Implement and Follow Performance-based Maintenance (PBM) PSMP
- **Establish or maintain under PBM during audit period**
  - Ensure Protection System, Automatic Reclosing, and Sudden Pressure Relaying Components in Segments are maintained in accordance with PBM time intervals in effect
  - Ensure alarm paths associated with Protection System, Automatic Reclosing, and Sudden Pressure Relaying Components in Segments are maintained in accordance with Table 2, where monitoring is used to determine maintenance activities performed on Component
  - Ensure supporting documentation that mandatory PBM maintenance activities reported as completed are performed on Components within Segments
  - Plan for transitioning Protection System Maintenance from previous versions of PRC-005 to PRC-005-6 in accordance with PRC-005-6 Implementation Plan
    - Ensure percentages maintained during transition to PRC-005-6 are in accordance with PRC-005-6 Implementation Plan

PRC-005-6 R4

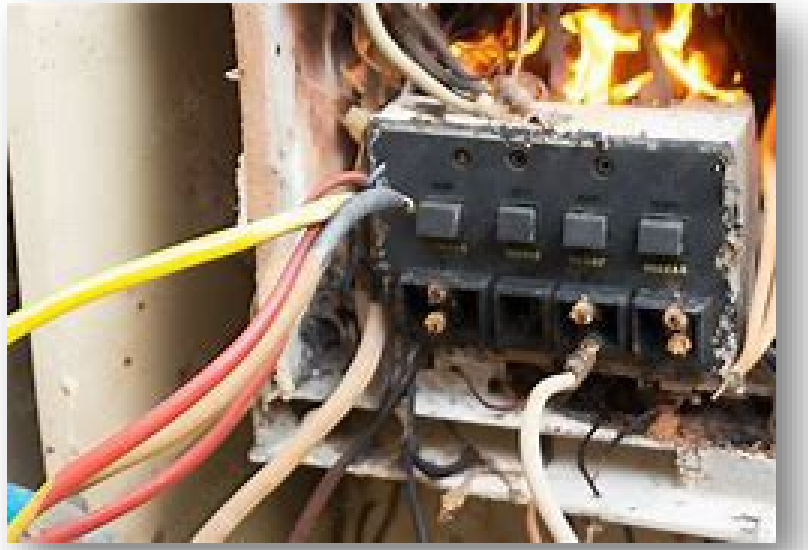
Retention of Protection System, Automatic Reclosing, or Sudden Pressure Relaying Component records

- When maintenance activity **interval is longer** than audit cycle, retain documentation of **most recent performance** of maintenance activity
- When maintenance activity **interval is shorter** than audit cycle, retain documentation **of all performances** of maintenance activity **since previous audit date**

PRC-005-6 R5

Unresolved Maintenance Issue

A deficiency identified during a maintenance activity that causes the Component not to meet the intended performance, cannot be corrected during the maintenance interval, and requires follow-up corrective action.



R5 Implementation

- Demonstrate efforts to correct identified Unresolved Maintenance Issues.
- Artifacts may include work orders, replacement component orders, invoices, project schedules with completed milestones, return material authorizations, or purchase orders.
- Retention
  - Keep documentation of Unresolved Maintenance Issues identified by the entity since the last audit, including all that were resolved.

R5 Implementation Recommendations

Effort to correct!

- Priority of maintenance and procedure to resolve unresolved maintenance in PSMP.
  - What will you do if you cannot correct it in a timely manner?
- Time frame to correct identified unresolved maintenance.
  - Give yourself a time frame to correct and follow through.
- Tracking of your unresolved maintenance via spreadsheet, workflow, etc.

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Unresolved maintenance issue evidence can include the following except:

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PRC-005 Resources & References

- ERO Enterprise Endorsed Implementation Guidance
- PRC-005-6 Technical Rationale (April 2020)
- Supplementary Reference and FAQ - PRC-005-6 Protection System Maintenance, (Standard Drafting Team – 2015)
- Supplementary Reference and FAQ - PRC-005-7 Protection System Maintenance, (Standard Drafting Team – 2023)
- Considerations for Maintenance and Testing of Auto-reclosing Schemes, NERC System Analysis and Modeling Subcommittee, and NERC System Protection and Control Subcommittee (November 2012)
- Sudden Pressure Relays and Other Devices that Respond to Non-Electrical Quantities – SPCS Input for Standard Development in Response to FERC Order No. 758, NERC System Protection and Control Subcommittee (December 2013)
- Controls Guidance and Failure Points PRC-005-6 (WECC)
- TexasRE, PRC-005-6 Implementation Plan (US)
- Complying With The New Versions Of PRC-005, NERC SPP Workshop (March 15, 2016)

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