

Definitions of Terms Used in Standard

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

Protection System Maintenance Program (PSMP) — An ongoing program by which Protection System components are kept in working order and proper operation of malfunctioning components is restored. A maintenance program for a specific component includes one or more of the following activities:

- ~~Verification~~ — ~~A means of determining~~ Verify — Determine that the component is functioning correctly.
- ~~Monitoring~~ — ~~Observation of~~ Monitor — Observe the routine in-service operation of the component.
- ~~Testing~~ — ~~Application of~~ Test — Apply signals to a component to observe functional performance or output behavior, or to diagnose problems.
- ~~Inspection~~ — ~~To detect~~ Inspect — Detect visible signs of component failure, reduced performance and degradation.
- ~~Calibration~~ — ~~Adjustment of~~ Calibrate — Adjust the operating threshold or measurement accuracy of a measuring element to meet the intended performance requirement.
- ~~Upkeep~~ — ~~Routine activities necessary to assure that the component remains in good working order and implementation of any manufacturer's hardware and software service advisories which are relevant to the application of the device.~~
- ~~Restoration~~ — ~~The actions to restore proper operation of~~ Restore — Return malfunctioning components to proper operation.

Protection System (modification)

- ~~— Protective relays, communication~~ which respond to electrical quantities,
- ~~communications~~ systems necessary for correct operation of protective functions,
- ~~voltage and current sensing devices providing~~ inputs to protective relays ~~and associated circuitry from the voltage and current sensing devices,~~
- ~~station dc supply associated with protective functions (including station batteries, battery chargers, and non-battery-based dc supply), and~~
- control circuitry associated with protective functions ~~from the station dc supply~~ through the trip coil(s) of the circuit breakers or other interrupting devices.

The following terms are defined for use only within PRC-005-2, and should remain with the standard upon approval rather than being moved to the Glossary of Terms.

Maintenance Correctable Issue – Failure of a component to operate within design parameters such that it cannot be restored to functional order by repair or calibration during performance of the initial on-site activity. Therefore this issue requires follow-up corrective action.

Segment – Protection Systems or components of a consistent design standard, or a particular model or type from a single manufacturer that typically share other common elements. Consistent performance is expected across the entire population of a segment. A segment must contain at least sixty (60) individual components.

Component Type - Any one of the five specific elements of the Protection System definition.

Component – A component is any individual discrete piece of equipment included in a Protection System, such as a protective relay or current sensing device. For components such as control circuits, the designation of what constitutes a control circuit component is very dependent upon how an entity performs and tracks the testing of the control circuitry. Some entities test their control circuits on a breaker basis whereas others test their circuitry on a “local zone of protection” basis. Thus, entities are allowed the latitude to designate their own definitions of “control circuit components.” Another example of where the entity has some discretion on determining what constitutes a single component is the voltage and current sensing devices, where the entity may choose either to designate a full three-phase set of such devices or a single device as a single component.

Countable Event – Any failure of a component which requires repair or replacement, any condition discovered during the verification activities in Tables 1-1 through 1-5 which requires corrective action, or a Misoperation attributed to hardware failure or calibration failure. Misoperations due to product design errors, software errors, relay settings different from specified settings, Protection System component configuration errors, or Protection System application errors are *not* included in Countable Events.

A. Introduction

1. **Title:** Protection System Maintenance
2. **Number:** PRC-005-2
3. **Purpose:** To ensure all transmission and generation Protection Systems affecting the reliability of the Bulk Electric System (BES) are maintained.
4. **Applicability:**
 - 4.1. **Functional Entities:**
 - 4.1.1 Transmission Owners
 - 4.1.2 Generator Owners
 - 4.1.3 Distribution Providers
 - 4.2. **Facilities:**
 - 4.2.1 Protection Systems applied on, or designed to provide protection for, the BES.
 - 4.2.2 Protection ~~System components~~Systems used for underfrequency load-shedding systems installed per ERO underfrequency load-shedding requirements.
 - 4.2.3 Protection ~~System components~~Systems used for undervoltage load-shedding systems installed to prevent system voltage collapse or voltage instability for BES reliability.
 - 4.2.4 Protection ~~System components~~Systems installed as a Special Protection System (SPS) for BES reliability.
 - 4.2.5 Protection Systems for generator Facilities that are part of the BES, including:
 - 4.2.5.1 Protection ~~System components~~Systems that act to trip the generator either directly or via generator lockout or auxiliary tripping relays.
 - 4.2.5.2 Protection Systems for generator step-up transformers for generators that are part of the BES.
 - 4.2.5.3 Protection Systems for transformers connecting aggregated generation, where the aggregated generation is part of the BES (e.g., transformers connecting facilities such as wind-farms to the BES).
 - 4.2.5.4 Protection Systems for generator-connected station service transformers for generators that are part of the BES.
 - 4.2.5.5 Protection Systems for system-connected station service transformers for generators that are part of the BES.
5. **(Proposed) Effective Date:** See Implementation Plan

B. Requirements

- R1. Each Transmission Owner, Generator Owner, and Distribution Provider shall establish a Protection System Maintenance Program (PSMP) for its Protection Systems ~~that use measurements of voltage, current, frequency and/or phase angle to determine~~

~~anomalies and to trip a portion of the BES¹ and that are~~ applied on, or ~~are~~ designed to provide protection for, the BES. The PSMP ~~must~~shall: [*Violation Risk Factor: ~~High~~Medium*] [*Time Horizon: Long Term Planning*]

1.1. ~~Identify~~Address all Protection System ~~components;~~component types.

1.2. ~~Identify whether each~~which Protection System component ~~is~~types are addressed through time-based (~~per Table 1a~~), condition-based (~~per Table 1b or 1c~~), performance-based (per PRC-005 Attachment A), or a combination of these maintenance methods ~~and identify the associated maintenance interval;~~

1.3. ~~For each Protection System component, include all maintenance activities specified in Tables 1a, 1b, or 1c associated with the maintenance method used per Requirement 1, part 1.1; and~~

1.4.1.2. ~~Include all~~ (per PRC-005-Attachment A). All batteries associated with the station dc supply component of a Protection System shall be included in a time-based program as described in Table 1-4.

1.3. Identify the associated maintenance intervals for time-based programs

1.4. Include all monitoring attributes and related maintenance activities applied to each Protection System component type, to include those specified in Tables 1-1 through 1-5.

1.5. Identify calibration tolerances or other equivalent parameters for each Protection System component type that establish acceptable parameters for the conclusion of maintenance activities.

R2. Each Transmission Owner, Generator Owner, and Distribution Provider that uses ~~condition-based~~ maintenance intervals ~~in its PSMP for partially or fully~~for monitored Protection Systems described in Tables 1-1 through 1-5, shall ~~ensure the~~verify those components ~~to which the condition-based criteria are applied;~~ possess the monitoring attributes identified in Tables ~~1b or 1c~~1-1 through 1-5 in its PSMP. [*Violation Risk Factor: Medium*] [*Time Horizon: Long Term Planning*]

R3. Each Transmission Owner, Generator Owner, and Distribution Provider that uses performance-based maintenance intervals in its PSMP shall follow the procedure established in PRC-005 Attachment A to establish and maintain its performance-based intervals. [*Violation Risk Factor: Medium*] [*Time Horizon: ~~Long Term~~Operations Planning*]

R4. Each Transmission Owner, Generator Owner, and Distribution Provider shall implement and follow its PSMP, including identification of the resolution of all maintenance correctable issues² as follows: [*Violation Risk Factor: ~~Medium~~High*] [*Time Horizon: ~~Long Term~~Operations Planning*]

4.1. ~~For time based or condition based maintenance programs, perform~~Perform the maintenance activities ~~detailed in Table 1 (for the appropriate monitoring~~

¹ ~~Devices that sense non-electrical conditions, such as thermal or transformer sudden pressure relays are not included within the scope of this standard.~~

² ~~A maintenance correctable issue is a failure of a device to operate within design parameters that cannot be restored to functional order by repair or calibration while performing the initial on-site maintenance activity, and that requires follow up corrective action~~

~~level(s))~~ for all Protection System components according to the PSMP established ~~perin~~ in accordance with Requirement ~~R1~~ within R1:

4.1.1. For time-based maintenance programs, perform maintenance activities no less frequently than the maximum allowable intervals ~~not to exceed those~~ established in Tables ~~1a, 1b, and 1e~~ 1-1 through 1-5.

4.1.2. For performance-based maintenance programs, perform the maintenance activities ~~detailed in Table 1 (for no less frequently than the appropriate monitoring level(s))~~ for all Protection System components ~~in accordance within the maximum allowable~~ intervals established ~~perin~~ Requirement R3.

4.2. ~~Ensure either~~ Either verify that the components are within the acceptable parameters ~~established in accordance with Requirement R1, Part 1.5~~ at the conclusion of the maintenance activities, or initiate resolution of any ~~necessary activities to correct unresolved-identified~~ maintenance correctable issues³.

C. Measures

M1. Each Transmission Owner, Generator Owner and Distribution Provider ~~will~~ shall have a current or updated documented Protection System Maintenance Program that addresses ~~protective relays, communication systems necessary for correct operation of protective functions, voltage and current sensing inputs to protective relays and associated circuitry from the voltage and current sensing devices, station de supply, and control circuitry associated with protective functions from the station de supply through the trip coil(s)~~ all component types of the circuit breakers or other interrupting devices its Protection Systems, as required by Requirement R1. For each ~~protection system~~ Protection System component type, the documentation shall include the type of maintenance program applied; (time-based, performance-based, or a combination of these maintenance methods), maintenance activities, and maintenance intervals as specified in Requirement R1, Parts 1.1 through 1.4 5.

M2. Each Transmission Owner ~~and~~, Generator Owner, and Distribution Provider that uses a ~~condition-based~~ maintenance ~~program should~~ intervals for monitored Protection Systems shall have evidence such as engineering drawings or manufacturer's information showing that the components possess the monitoring attributes identified in Tables ~~1b or 1e~~ 1-1 through 1-5, as required by Requirement R2.

M3. Each Transmission Owner, Generator Owner, ~~or~~ and Distribution Provider that uses a performance-based maintenance program ~~should~~ shall have evidence such as equipment lists, dated maintenance records, and dated analysis records and results that its current performance-based maintenance program is in accordance with Requirement R3.

M4. Each Transmission Owner, Generator Owner, ~~or~~ and Distribution Provider shall have evidence such as dated maintenance records ~~or, dated~~ maintenance summaries ~~(including dates that the components were maintained)~~ that, dated check-off lists, dated inspection records or

³ ~~A maintenance correctable issue is a failure of a device to operate within design parameters that cannot be restored to functional order by repair or calibration while performing the initial on-site maintenance activity and that requires follow-up corrective action.~~

dated work orders as evidence that it has implemented the Protection System Maintenance Program and initiated resolution of identified maintenance correctable issues in accordance with Requirement R4.

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Monitoring Responsibility

Regional Entity

~~1.2. Compliance Monitoring Period and Reset Time Frame~~

~~Not Applicable~~

1.3.1.2. Compliance Monitoring and Enforcement Processes:

Compliance Audits

Self-Certifications

Spot Checking

Compliance Violation Investigations

Self-Reporting

Complaints

1.4.1.3. Data Retention

The Transmission Owner, Generator Owner, and Distribution Provider shall each ~~retain~~keep data or evidence to demonstrate compliance as identified below unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

For R1, the Transmission Owner, Generator Owner, and Distribution Provider shall each keep its current dated Protection System Maintenance Program including the documentation that specifies the type of maintenance program applied for each Protection System component type.

For R2, the Transmission Owner, Generator Owner, and Distribution Provider shall each keep the evidence that proves the Protection System components possess the identified monitoring attributes as long as they are used to justify the intervals and activities associated with a performance-based maintenance program as identified within Tables 1-1 through 1-5.

For R3 and R4, the Transmission Owner, Generator Owner, and Distribution Provider shall each keep documentation of the two most recent performances of each distinct maintenance activity for the Protection System components, or to the previous ~~on-~~sitescheduled audit date, whichever is longer.

The Compliance Enforcement Authority shall keep the last periodic audit report and all requested and submitted subsequent compliance records.

1.5.1.4. Additional Compliance Information

None.

2. Violation Severity Levels

| Requirement Number | Lower VSL | Moderate VSL | High VSL | Severe VSL |
|--------------------|--|---|---|---|
| R1 | <p>The entity's PSMP included all of the 'types' of components included in the definition of 'Protection System', but, for no more than 5% of the components, failed<u>Failed</u> to either</p> <ul style="list-style-type: none"> identify the component, <p>specify whether <u>the one</u> component <u>type</u> is being addressed by time-based, condition-based, or performance-based maintenance, or,</p> <p>Include all maintenance activities specified in Table 1a, Table 1b, or Table 1c, as applicable.</p> | <p>The entity's PSMP included all of the 'types' of components included in the definition of 'Protection System', but, for greater than 5%, but no more than 10% of the components, failed<u>Failed</u> to either</p> <ul style="list-style-type: none"> identify the component, <p>specify whether <u>the two</u> component <u>types are</u> being addressed by time-based, condition-based, or performance-based maintenance, or</p> <p>Include all maintenance activities specified in Table 1a, Table 1b, or Table 1c, as applicable.</p> | <p>The entity's PSMP included all of the 'types' of components included in the definition of 'Protection System', but, for greater than 10%, but no more than 15%, of the components, failed to either</p> <ul style="list-style-type: none"> identify the component, specify whether the component is being addressed by time-based, condition-based, or performance-based maintenance, or <p>Include<u>Failed to include station batteries in a time-based program</u></p> <p><u>OR</u></p> <p><u>Failed to include</u> all maintenance activities <u>relevant for the identified monitoring attributes</u> specified in <u>Table 1a, Table 1b, or Table 1c, as applicable</u><u>Tables 1-1 through 1-5.</u></p> <p><u>OR</u></p> <p><u>Failed to establish calibration tolerance or equivalent parameters to determine if components are within acceptable parameters.</u></p> | <p>The entity's PSMP failed to address one or more of the types of components included in the definition of 'Protection System'</p> <p>or</p> <p>Entity has not established a PSMP.</p> <p>or</p> <p><u>OR</u></p> <p>The entity's<u>entity's</u> PSMP included all of the 'types' of components<u>failed to address three or more component types</u> included in the definition of 'Protection System', but, for more than 15% of the components, failed to either</p> <ul style="list-style-type: none"> identify the component, <p><u>OR</u></p> <ul style="list-style-type: none"> Failed to <u>specify whether the three or more</u> component <u>types are</u> being addressed by time-based, condition-based, or performance-based maintenance, or <p>Include all maintenance activities specified in Table 1a, Table 1b, or Table 1c, as applicable.</p> |

Standard PRC-005-2 — Protection System Maintenance

| Requirement Number | Lower VSL | Moderate VSL | High VSL | Severe VSL |
|--------------------|--|---|--|--|
| R2 | <p>Entity has Protection System components in a condition-based PSMP, but documentation to support Partially-Monitored Protection System classification or Fully-Monitored Protection System classification<u>the monitoring attributes used to determine relevant intervals</u> is incomplete on no more than 5% of the Protection System components maintained according to Tables 4b and 4c.1-1 <u>through 1-5.</u></p> | <p>Entity has Protection System elements in a condition-based PSMP, but documentation to support Partially-Monitored Protection System classification or Fully-Monitored Protection System classification<u>monitoring attributes used to determine relevant intervals</u> is incomplete on more than 5%, but 10% or less, of the Protection System components maintained according to Tables 4b and 4c.1-1 <u>through 1-5.</u></p> | <p>Entity has Protection System elements in a condition-based PSMP, but documentation to support Partially-Monitored Protection System classification or Fully-Monitored Protection System classification<u>monitoring attributes used to determine relevant intervals</u> is incomplete on more than 10%, but 15% or less, of the Protection System components maintained according to Tables 4b and 4c.1-1 <u>through 1-5.</u></p> | <p>Entity has Protection System elements in a condition-based PSMP, but documentation to support Partially-Monitored Protection System classification or Fully-Monitored Protection System classification<u>monitoring attributes used to determine relevant intervals</u> is incomplete on more than 15% of the Protection System components maintained according to Tables 4b and 4c.1-1 <u>through 1-5.</u></p> |
| R3 | <p>Entity has Protection System elements in a performance-based PSMP but has:</p> <p>1) Failed to reduce countable events to less than 4% within three years- OR</p> <p><u>OR</u></p> <p>2) Failed to annually document program activities, results, maintenance dates, or countable events for 5% or less of components in any individual segment OR</p> <p><u>OR</u></p> <p>3) Maintained a segment with 54-59 components or containing different manufacturers.</p> | NA | <p>Entity has Protection System elements in a performance-based PSMP but has failed to reduce countable events to less than 4% within four years.</p> | <p>Entity has Protection System components in a performance-based PSMP but has:</p> <p>1) Failed to reduce countable events to less than 4% within five years- OR</p> <p><u>OR</u></p> <p>2) Failed to annually document program activities, results, maintenance dates, or countable events for over 5% of components in any individual segment- OR</p> <p><u>OR</u></p> <p>3) Maintained a segment with less than 54 components- OR</p> |

Standard PRC-005-2 — Protection System Maintenance

| Requirement Number | Lower VSL | Moderate VSL | High VSL | Severe VSL |
|--------------------|---|---|--|--|
| | | | | <p><u>OR</u></p> <p>4) Failed to annually:</p> <ul style="list-style-type: none"> • <u>Annually</u> update the list of components, • Perform maintenance on the greater of 5% of the segment population or 3 components, or • Annually analyze the program activities and results for each segment. |
| R4 | <p>Entity has failed to complete scheduled program on 5% or less of total Protection System components.</p> <p><u>OR</u></p> <p><u>Entity has failed to initiate resolution on 5% or less of identified maintenance-correctable issues.</u></p> | <p>Entity has failed to complete scheduled program on greater than 5%, but no more than 10% of total Protection System components-</p> <p><u>OR</u></p> <p><u>Entity has failed to initiate resolution on greater than 5%, but no more than 10% of identified maintenance-correctable issues.</u></p> | <p>Entity has failed to complete scheduled program on greater than 10%, but no more than 15% of total Protection System components-</p> <p><u>OR</u></p> <p><u>Entity has failed to initiate resolution on greater than 10%, but no more than 15% of identified.</u></p> | <p>Entity has failed to complete scheduled program on greater than 15% of total Protection System components-</p> <p style="text-align: center;">or</p> <p><u>OR</u></p> <p>Entity has failed to initiate resolution or <u>on greater than 15% of identified</u> maintenance-correctable issues.</p> |

E. Regional ~~Differences~~Variances

None

F. Supplemental Reference Documents

The following documents present a detailed discussion about determination of maintenance intervals and other useful information regarding establishment of a maintenance program.

1. PRC-005-2 Protection System Maintenance Supplementary Reference — July 2009.
2. NERC Protection System Maintenance Standard PRC-005-2 FREQUENTLY ASKED QUESTIONS — Practical Compliance and Implementation DRAFT 1.0 — June 2009

Version History

| Version | Date | Action | Change Tracking |
|----------------|-------------|---|------------------------|
| 2 | TBD | Complete revision, absorbing maintenance requirements from PRC-005-1, PRC-008-0, PRC-011-0, PRC-017 | Complete revision |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|--|---|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar Years <u>calendar years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p>For microprocessor relays, check:</p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • For microprocessor relays, verify <u>Verify</u> acceptable measurement of power system input values. |
| <p>Voltage and Current Sensing Inputs to Protective Relays and associated circuitry</p> | <p>12 Calendar Years</p> | <p>Verify proper functioning of the current and voltage signals necessary for Protection System operation from the voltage and current sensing devices to the protective relays.</p> |

Standard PRC-005-2 – Protection System Maintenance

| | | |
|---|---|--|
| <p>Control and trip circuits with electromechanical trip or auxiliary contacts (except for Monitored microprocessor relays, UFLS protective relay with the following::</p> <ul style="list-style-type: none"> • <u>Internal self diagnosis and alarming.</u> • <u>Voltage and/or current waveform sampling three or UVLS)more times per power cycle, and conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self monitoring and alarming (see Table 2).</u> • <u>Alarming for power supply failure (see Table 2).</u> | <p><u>6 Calendar Years</u> <u>12 calendar years</u></p> | <p>Perform a complete functional trip test that includes all sections. <u>Verify:</u></p> <ul style="list-style-type: none"> • <u>Settings are as specified.</u> • <u>Operation of the Protection System control relay inputs and trip circuits, including all electromechanical trip and auxiliary contacts outputs that are essential to proper functioning of the Protection System.</u> • <u>Acceptable measurement of power system input values.</u> |
| <p>Control and trip circuits with unmonitored solid-state trip or auxiliary contacts (except for UFLS or UVLS) Monitored microprocessor protective relay with preceding row attributes and the following:</p> <ul style="list-style-type: none"> • <u>Ac measurements are continuously verified by comparison to an independent ac measurement source, with alarming for excessive error. (See Table 2)</u> • <u>Some or all binary or status inputs and control outputs are monitored by a process that continuously demonstrates ability to perform as designed, with alarming for failure. (See Table 2)</u> • <u>Alarming for change of settings. (See Table 2)</u> | <p><u>12 Calendar Years</u> <u>calendar years</u></p> | <p>Perform a complete functional trip test that includes all sections of <u>Verify only the Protection System control unmonitored relay inputs and trip circuits, including all solid-state trip and auxiliary contacts (e.g. paths with no moving parts), devices, and connections outputs that are essential to proper functioning of the Protection System.</u></p> |
| <p>Control and trip circuits with electromechanical trip or auxiliary (UFLS/UVLS Systems Only)</p> | <p><u>6 Calendar Years</u></p> | <p>Perform a complete functional trip test that includes all sections of the Protection System control and trip circuits, including all electromechanical trip and auxiliary contacts essential to proper functioning of the Protection System, except that verification does not require actual tripping of circuit breakers or interrupting devices.</p> |
| <p>Control and trip circuits with unmonitored solid-state trip or auxiliary contacts (UFLS/UVLS Systems Only)</p> | <p><u>12 Calendar Years</u></p> | <p>Perform a complete functional trip test that includes all sections of the Protection System control and trip circuit, including all solid-state trip and auxiliary contacts (e.g. paths with no moving parts), devices, and connections essential to proper functioning of the Protection System, except that verification does not require actual tripping of circuit breakers or interrupting devices.</p> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|--|---|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar <u>Years</u> calendar <u>years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p>For microprocessor relays, check:</p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • For microprocessor relays, verify <u>Verify</u> acceptable measurement of power system input values. |
| <p>Station dc Supply (used only for UVLS or UFLS)</p> | <p>(when the associated UVLS or UFLS system is maintained)</p> | <p>Verify proper voltage of the dc supply.</p> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|--|--|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar <u>Years</u> calendar <u>years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p><u>For microprocessor relays, check:</u></p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • <u>For microprocessor relays, verify</u> <u>Verify</u> acceptable measurement of power system input values. |

| | | |
|--|---------------------------|---|
| <p>Station dc supply</p> <p>Draft 3: November 17, 2010</p> | <p>18 Calendar Months</p> | <p><u>Verify:</u></p> <ul style="list-style-type: none"> • <u>State of charge of the individual battery cell/units</u> • <u>Float voltage of battery charger</u> • <u>Battery continuity</u> • <u>Battery terminal connection resistance</u> • <u>Battery cell to cell connection resistance</u> <p><u>Inspect:</u></p> <ul style="list-style-type: none"> • <u>Cell condition of all individual battery cells where cells are visible or measure battery cell/unit internal ohmic values where the cells are not visible</u> • <u>Physical condition of battery rack</u> • <u>The condition of non-battery based dc supply</u> |
|--|---------------------------|---|

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|--|--|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar Years <u>calendar years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p><u>For microprocessor relays, check:</u></p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • <u>For microprocessor relays, verify</u> <u>Verify</u> acceptable measurement of power system input values. |
| <p><u>Station dc supply (that has as a component any type of battery)</u></p> | <p><u>3 Calendar Months</u></p> | <p><u>Check:</u></p> <ul style="list-style-type: none"> • <u>Electrolyte level (excluding valve-regulated lead-acid batteries)</u> • <u>Station dc supply voltage</u> • <u>For unintentional grounds</u> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|---|---|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 <u>Calendar Years</u> calendar years</p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> <u>• Test and calibrate</u> <p>For microprocessor relays, check:</p> <ul style="list-style-type: none"> <u>• Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. <u>• For microprocessor relays, verify</u> <u>Verify</u> acceptable measurement of power system input values. |
| <p>Station dc supply (that has as a component Valve Regulated Lead-Acid batteries)</p> | <p>3 Calendar Years</p> <p>— or —</p> <p>3 Calendar Months</p> | <p>Verify that the station battery can perform as designed by conducting a performance or service capacity test of the entire battery bank. (3 calendar years)</p> <p>— or —</p> <p>Verify that the station battery can perform as designed by evaluating the measured cell/unit internal ohmic values to station battery baseline. (3 months)</p> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|---|---|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar Years calendar <u>years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p>For microprocessor relays, check:</p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • For microprocessor relays, verify <u>Verify</u> acceptable measurement of power system input values. |
| <p>Station dc supply (that has as a component Vented Lead-Acid Batteries)</p> | <p>6 Calendar <u>Years</u> — or — 18 Calendar <u>Months</u></p> | <p>Verify that the station battery can perform as designed by conducting a performance, service, or modified performance capacity test of the entire battery bank. (6 calendar years)</p> <p>— or —</p> <p>Verify that the station battery can perform as designed by evaluating the measured cell/unit internal ohmic values to station battery baseline. (18 Months)</p> |
| <p>Station dc supply (that has as a component Nickel-Cadmium batteries)</p> | <p>6 Calendar Years</p> | <p>Verify that the substation battery can perform as designed by conducting a performance service, or modified performance capacity test of the entire battery bank.</p> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|--|---|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar Years <u>calendar years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p>For microprocessor relays, check:</p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • For microprocessor relays, verify <u>Verify</u> acceptable measurement of power system input values. |
| <p>Station dc supply (battery is not used)</p> | <p>6 Calendar Years</p> | <p>Verify that the dc supply can perform as designed when the ac power from the grid is not present.</p> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|--|---|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar <u>Years</u> calendar <u>years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p>For microprocessor relays, check:</p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • For microprocessor relays, verify <u>Verify</u> acceptable measurement of power system input values. |
| <p>Station dc Supply (battery is not used)</p> | <p>18 Calendar Months</p> | <p>Verify proper voltage of the station dc supply.</p> <p>Verify that no unintentional dc supply grounds are present.</p> <p>Perform a visual inspection, of all components of the station dc supply to verify that the physical condition of the station dc supply is as desired and any visual inspection if required by the manufacturer on the condition of the dc supply that is the source of dc power when ac power is unavailable.</p> <p>Verify where applicable the proper voltage level of each component of the station dc supply.</p> <p>Verify the correct operation of ac powered dc power supplies.</p> <p>Verify the continuity of all circuit connections that can be affected by wear or corrosion. Inspect all circuit connections that can be affected by wear and corrosion</p> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|--|---|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar Calendar Years years</p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p>For microprocessor relays, check:</p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • For microprocessor relays, verify <u>Verify</u> acceptable measurement of power system input values. |
| <p>Associated communications systems</p> | <p>3 Calendar Calendar Months Months</p> | <p>Verify that the Protection System communications system is functional.</p> |
| <p>Associated communications systems</p> | <p>6 Calendar Calendar Years Years</p> | <p>Verify that the performance of the channel and the quality of the channel meets performance criteria, such as via measurement of signal level, reflected power, or data error rate.</p> <p>Verify proper functioning of communications equipment inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify the signals to/from the associated protective relay(s).</p> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|--|---|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar Years <u>calendar years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p>For microprocessor relays, check:</p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • For microprocessor relays, verify <u>Verify</u> acceptable measurement of power system input values. |
| <p>UVLS and UFLS relays that comprise a protection scheme distributed over the power system</p> | <p>6 Calendar Years</p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify proper functioning of the relay trip outputs.</p> <p>For microprocessor relays verify the proper functioning of the A/D converters.</p> <p>Verify that settings are as specified.</p> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|--|--|---|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar <u>Years</u> calendar <u>years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p>For microprocessor relays, check:</p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • For microprocessor relays, verify <u>Verify</u> acceptable measurement of power system input values. |
| <p>Relay sensing for Centralized UFLS or UVLS systems UVLS and UFLS relays that comprise a protection scheme distributed over the power system</p> | <p>See Maintenance Activities</p> | <p>Perform all of the Maintenance activities listed above as established for components of the UFLS or UVLS systems at the intervals established for those individual components. The output action may be breaker tripping, or other control action that must be verified, but may be verified in overlapping segments. A grouped output control action need be verified only once within the specified time interval, but all of the UFLS or UVLS components whose operation leads to that control action must each be verified.</p> |

Table 1a — Time-Based Maintenance — Level 1 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Unmonitored Protection System Components

General Description: Protection System components which do not have self-monitoring alarms, or if self-monitoring alarms are available, the alarms are not transmitted to a location where action can be taken for alarmed failures.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4.

Table 1-1

Component Type - Protective Relay

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component <u>Attributes</u> | Maximum Maintenance Interval | Maintenance Activities |
|---|--|--|
| <p>Protective Relays <u>Any unmonitored protective relay not having all the monitoring attributes of a category below.</u></p> | <p>6 Calendar Years <u>calendar years</u></p> | <p>Test and calibrate the relays (other than microprocessor relays) with simulated electrical inputs. (Note 1)</p> <p>Verify that settings are as specified -</p> <p><u>For non-microprocessor relays:</u></p> <ul style="list-style-type: none"> • <u>Test and calibrate</u> <p><u>For microprocessor relays, check:</u></p> <ul style="list-style-type: none"> • <u>Verify operation of</u> the relay inputs and outputs that are essential to proper functioning of the Protection System. • <u>For microprocessor relays, verify</u> <u>Verify</u> acceptable measurement of power system input values. |
| <p>SPS</p> | <p>See Maintenance Activities</p> | <p>Perform all of the Maintenance activities listed above as established for components of the SPS at the intervals established for those individual components. The output action may be breaker tripping, or other control action that must be verified, but may be verified in overlapping segments. A grouped output control action need be verified only once within the specified time interval, but all of the SPS components whose operation leads to that control action must each be verified.</p> |

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|-------------------------------------|---|--|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> ● Internal self diagnosis and alarm capability ● Alarm must assert for power supply failures ● Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar or month s</p> | <p>Verify <u>that</u> the status of relays is normal with no alarms indicated.</p> <p>Verify acceptable measurement of power <u>communications</u> system input values.</p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional</u>.</p> |

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|-------------------------------------|---|--|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> Internal self diagnosis and alarm capability Alarm must assert for power supply failures Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar months</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of <u>power communications system input values.</u></p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |

| | | | |
|--|--|--------------------------|--|
| Voltage and Current Sensing Inputs to Protective Relays and associated | <p>No Level 2 monitoring attributes are defined — use Level 1 Maintenance Activities</p> | <p>12 Calendar Years</p> | <p>Verify the proper functioning of current and voltage circuit signals necessary for Protection System operation from the voltage and current sensing devices to the protective relays.</p> |
|--|--|--------------------------|--|

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|---|---|---|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> Internal self diagnosis and alarm capability Alarm must assert for power supply failures Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years <u>3</u> calendar months</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of power <u>communications</u> system input values.</p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |
| Control Circuitry (Trip Coils and Auxiliary Relays) | <p>Monitoring and alarming of continuity of trip circuits(s)</p> | <p>6 Calendar Years</p> | <p>Verify that each breaker trip coil, each auxiliary relay, and each lockout relay is electrically operated within this time interval.</p> |

Standard PRC-005-2 – Protection System Maintenance

| | | | | |
|--|---|--|--|--|
| <p>Control Circuitry (Trip Circuits) (except for UFLS/UVLS)</p> | <p>6 calendar or years</p> | <p>Monitoring of Protection System component inputs, outputs, and connections with reporting of monitoring alarms to a location where action can be taken</p> <p>Connection paths using electronic signals or data messages are monitored by periodic signal changes or messages that verify ability to convey Protection System operating values</p> <p>Verify that the channel meets performance criteria such as signal level, reflected power, or data error rate.</p> <p>Verify essential signals to and from other Protection System components.</p> | <p>12 Calendar Years</p> | <p>Verify that the alarms will be received at the location where action can be taken.</p> |
| <p>Control and trip circuitry</p> | <p>Monitoring of the continuity of breaker trip circuits along with the presence of tripping voltage supply all the way from relay terminals (or from inside the relay) through to the trip coil(s), including any auxiliary contacts essential to proper Protection System operation. If a trip circuit comprises multiple paths, each of the paths must be monitored, including monitoring of the operating coil circuit(s) and the tripping circuits of auxiliary tripping relays and lockout relays. Alarming for loss of continuity or dc supply for trip circuits is reported to a location where action can be taken. <u>Any communications system with continuous monitoring or periodic automated testing for the presence of the channel function, and alarming for loss of function. (See Table 2)</u></p> | <p>12 Calendar Years calendar or years</p> | <p>Verify that the alarms will be received at the location where action can be taken <u>channel meets performance criteria such as signal level, reflected power, or data error rate.</u></p> <p><u>Verify essential signals to and from other Protection System components.</u></p> | |

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|-------------------------------------|---|---|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> • Internal self diagnosis and alarm capability • Alarm must assert for power supply failures • Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar or months</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of <u>power communications system input values.</u></p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |

Draft 3: November 17, 2010

Monitor and alarm for:

- Station dc supply voltage
- Unintentional dc grounds

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|-------------------------------------|---|---|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> Internal self diagnosis and alarm capability Alarm must assert for power supply failures Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years <u>3</u> calendar months</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of power <u>communications</u> system input values.</p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |
| Station dc supply | <p>No Level 2 monitoring attributes are defined—use Level 1 Maintenance Activities</p> | <p>18 Calendar Months</p> | <p>Inspect:</p> <ul style="list-style-type: none"> Cell condition of individual battery cells where cells are visible, or measure battery cell/unit internal ohmic values where cells are not visible Physical condition of battery rack The condition of non-battery based dc supply |

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|---|---|--|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> Internal self diagnosis and alarm capability Alarm must assert for power supply failures Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar or month s</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of power <u>communications</u> system input values.</p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |
| Station dc supply (that has as a component Valve Regulated Lead | <p>No Level 2 monitoring defined — use Level 1 Maintenance Activities</p> | <p>3 Calendar Years — or — 3 Calendar Months</p> | <p>Verify that the station battery can perform as designed by conducting a performance or service capacity test of the entire battery bank. (3 calendar years)</p> <p>— or —</p> <p>Verify that the station battery can perform as designed by evaluating the measured cell/unit internal ohmic values to station battery baseline. (3 months)</p> |

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|--|---|---|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> Internal self diagnosis and alarm capability Alarm must assert for power supply failures Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar months</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of power <u>communications</u> system input values.</p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |
| Station dc supply (that has as a component Vented Lead-Acid batterie | <p>No Level 2 monitoring attributes are defined — use Level 1 Maintenance Activities</p> | <p>6 Calendar Years — or — 18 Calendar Months</p> | <p>Verify that the substation battery can perform as designed by conducting a performance service, or modified performance capacity test of the entire battery bank. (6 calendar years)</p> <p>— or —</p> <p>Verify that the station battery can perform as designed by evaluating the measured cell/unit internal ohmic values to station battery baseline. (18 Months)</p> |

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|--|---|--|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> • Internal self diagnosis and alarm capability • Alarm must assert for power supply failures • Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar or month s</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of <u>power communications system input values.</u></p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |
| Station dc supply (that has as a component Nickel-Cadmium batteries) | <p>No Level 2 monitoring attributes are defined — use Level 1 Maintenance Activities</p> | <p>6 Calendar Years</p> | <p>Verify that the substation battery can perform as designed by conducting a performance service, or modified performance capacity test of the entire battery bank.</p> |

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|---|---|--|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> Internal self diagnosis and alarm capability Alarm must assert for power supply failures Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar months</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of power <u>communications</u> system input values.</p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |
| Station dc Supply (battery is not used) | <p>No Level 2 monitoring attributes are defined — use Level 1 Maintenance Activities</p> | <p>6 Calendar Years</p> | <p>Verify that the dc supply can perform <u>as designed when ac power from the grid is not present.</u></p> |

Standard PRC-005-2 – Protection System Maintenance

| | | | | | |
|---|---|--------------------------|--|---|---------------------|
| <p>Associated communications system</p> | <p>Monitoring and alarming of protection communications system by mechanisms that check for presence of the communications channel.</p> | <p>12 Calendar Years</p> | <p>Verify that <u>Any communications system with continuous monitoring or periodic automated testing for the performance of the channel and the quality of the channel meets performance using</u> criteria, such as via <u>measurement of</u> signal level, reflected power, or data error rate.</p> <p>Verify proper functioning of communications equipment inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify the signals to/from the associated protective relay(s).</p> <p>Verify proper functioning of alarm notification, and alarming for excessive performance degradation. (See Table 2)</p> | <p><u>No periodic maintenance specified</u></p> | <p><u>None.</u></p> |
|---|---|--------------------------|--|---|---------------------|

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|-------------------------------------|---|--|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> Internal self diagnosis and alarm capability Alarm must assert for power supply failures Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar or month s</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of power <u>communications</u> system input values.</p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |

UVLS and UFLS relays that comprise a protection

Includes internal self diagnosis and alarm capability, which must assert for power supply failures. Includes input voltage or current waveform sampling three

November 17, 2010

Verify the status of relays as in service with no alarms.

Verify acceptable measurement of power system input values the proper function of the A/D converters (if included in relay)

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|--|---|---|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> Internal self diagnosis and alarm capability Alarm must assert for power supply failures Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar or month s</p> | <p>Verify <u>that the status of relays is normal with no alarms indicated.</u></p> <p>Verify acceptable measurement of power <u>communications</u> system input values.</p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional.</u></p> |
| Relay sensing for centralized UFLS or UVLS systems | <p>See the attributes of Level 2 Monitoring for the individual components of the SPS</p> | <p>See Maintenance Intervals for the individual components of the UFLS/UVLS</p> | <p>Perform all of the Maintenance activities listed above as established for components of the UFLS or UVLS systems at the intervals established for those individual components. The output action may be breaker tripping, or other control action that must be verified, but may be verified in overlapping segments. A grouped output control action need be verified only once within the specified time interval, but all of the UFLS or UVLS components whose operation leads to that control action must each be verified.</p> |

Table 1b — Condition-Based Maintenance - Level 2 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Partially Monitored Protection System Components

General Description: Protection System components whose conditions or alarms are automatically provided daily (or more frequently) to a location where action can be taken for alarmed failures. Detected maintenance-correctable issues for Level 2 Monitored Protection Systems must be reported within 1 day or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 2 monitoring includes all monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4. **Table 1-2**

Component Type - Communications Systems

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 2 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|-------------------------------------|---|---|--|
| Protective Relays | <p>Includes</p> <ul style="list-style-type: none"> • Internal self diagnosis and alarm capability • Alarm must assert for power supply failures • Input voltage or current waveform sampling three or more times per power cycle <p>Conversion of samples to numeric values for measurement calculations by microprocessor electronics that are also performing self diagnosis and alarming. <u>Any unmonitored communications system necessary for correct operation of protective functions, and not having all the monitoring attributes of a category below.</u></p> | <p>12 Calendar Years 3 calendar months</p> | <p>Verify <u>that</u> the status of relays is normal with no alarms indicated.</p> <p>Verify acceptable measurement of power <u>communications</u> system input values.</p> <p>For microprocessor relays, check the relay inputs and outputs that are essential to proper functioning of the Protection System.</p> <p>Verify that settings are as specified.</p> <p>Verify that the relay alarms will be received at the location where action can be taken.</p> <p>Verify correct operation of output actions that are used for tripping <u>is functional</u>.</p> |
| SPS | <p>See the attributes of Level 2 Monitoring for the individual components of the SPS</p> | <p>See Maintenance Intervals for the individual components of the SPS</p> | <p>Perform all of the Maintenance activities listed above as established for components of the SPS, at the intervals established for those individual components. The output action may be breaker tripping, or other control action that must be verified, but may be verified in overlapping segments. A grouped output control action need be verified only once within the specified time interval, but all of the SPS components whose operation leads to that control action must each be verified.</p> |

Table 1c — Condition-based Maintenance — Level 3 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Fully Monitored Protection System Components

General Description: Protection System components in which every function required for correct operation of that component is continuously monitored and verified, and detected maintenance-correctable issues reported. Level 3 Monitored Protection Systems also includes verification of the means by which alarms and monitored values are transmitted to a location where action can be taken. Detected maintenance-correctable issues for Level 3 Monitored Protection Systems must be reported within 1 hour or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 3 Monitoring includes all attributes of Level 2 Monitoring, with additional monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4, Table 1-3

Component Type - Voltage and Current Sensing Devices Providing Inputs to Protective Relays

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 3 Monitoring Component Attributes for Component | | Maximum Maintenance Interval | Maintenance Activities |
|--|--|-------------------|--|--|
| Protective Relays | Relay A/D converters are continuously monitored and alarmed | Continuous | | Continuous verification of the status of the relays Alarm on change of settings |
| Protective Relays with trip contacts | All Level attributes, except relay possesses mechanical output contacts | 12 Calendar Years | | Verify proper functioning of the relay trip contacts. |
| Voltage and Current Sensing Inputs to Protective Relays and associated circuitry | Verification of the analog values (magnitude and phase angle) measured by the microprocessor relay or comparable device, by comparing against other measurements using other <u>Any</u> voltage and current sensing devices <u>not having monitoring attributes of the category below.</u> | | Continuous <u>12 calendar years</u> | Continuous verification and comparison <u>Verify that acceptable measurements</u> of the current and voltage signals <u>from are received by the voltage and current sensing devices of the Protection System protective relays.</u> |

Table 1c — Condition-based Maintenance — Level 3 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Fully Monitored Protection System Components

General Description: Protection System components in which every function required for correct operation of that component is continuously monitored and verified, and detected maintenance-correctable issues reported. Level 3 Monitored Protection Systems also includes verification of the means by which alarms and monitored values are transmitted to a location where action can be taken. Detected maintenance-correctable issues for Level 3 Monitored Protection Systems must be reported within 1 hour or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 3 Monitoring includes all attributes of Level 2 Monitoring, with additional monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4-Table 1-3

Component Type - Voltage and Current Sensing Devices Providing Inputs to Protective Relays

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 3 Monitoring Component Attributes for Component | | Maximum Maintenance Interval | Maintenance Activities |
|---|--|---|-------------------------------------|---|
| Protection System control and trip circuitry | Monitoring and alarming of the alarm path itself | Continuous | | Continuous verification of the status of the monitored control circuits |
| Station dc supply | No Level 3 monitoring attributes are defined— use Level 1 Maintenance Activities and intervals | 18 Calendar Months | | Inspect: <ul style="list-style-type: none"> • Cell condition of all individual battery cells where cells are visible— or measure battery cell/unit internal ohmic values where the cells are not visible • Physical condition of battery rack • The condition of non-battery-based dc supply |
| Station dc supply (that has as a component Valve Regulated Lead-Acid batteries) | No Level 3 monitoring attributes are defined— use Level 1 Maintenance Activities and intervals | 3 Calendar Years —or— 3 Calendar Months | | Verify that the station battery can perform as designed by conducting a performance or service capacity test of the entire battery bank. (3 calendar years) —or— Verify that the station battery can perform as designed by evaluating the measured cell/unit internal ohmic values to station battery baseline. (3 months) |

Table 1c — Condition-based Maintenance — Level 3 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Fully Monitored Protection System Components

General Description: Protection System components in which every function required for correct operation of that component is continuously monitored and verified, and detected maintenance-correctable issues reported. Level 3 Monitored Protection Systems also includes verification of the means by which alarms and monitored values are transmitted to a location where action can be taken. Detected maintenance-correctable issues for Level 3 Monitored Protection Systems must be reported within 1 hour or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 3 Monitoring includes all attributes of Level 2 Monitoring, with additional monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4-Table 1-3

Component Type - Voltage and Current Sensing Devices Providing Inputs to Protective Relays

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 3 Monitoring Component Attributes for Component | | Maximum Maintenance Interval | Maintenance Activities |
|--|--|--|-------------------------------------|--|
| Station dc supply (that has as a component Vented Lead-Acid Batteries) | No Level 3 monitoring attributes are defined— use Level 1 Maintenance Activities and intervals | 6-Calendar Years — or — 18-Calendar Months | | Verify that the station battery can perform as designed by conducting a performance service, or modified performance capacity test of the entire battery bank. (6 calendar years) — or — Verify that the station battery can perform as designed by evaluating the measured cell/unit internal ohmic values to station battery baseline. (18 Months) |
| Station dc supply (that has as a component Nickel-Cadmium batteries) | No Level 3 monitoring attributes are defined— use Level 1 Maintenance Activities and intervals | 6-Calendar Years | | Verify that the substation battery can perform as designed by conducting a performance service, or modified performance capacity test of the entire battery bank. |

Table 1c — Condition-based Maintenance — Level 3 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Fully Monitored Protection System Components

General Description: Protection System components in which every function required for correct operation of that component is continuously monitored and verified, and detected maintenance-correctable issues reported. Level 3 Monitored Protection Systems also includes verification of the means by which alarms and monitored values are transmitted to a location where action can be taken. Detected maintenance-correctable issues for Level 3 Monitored Protection Systems must be reported within 1 hour or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 3 Monitoring includes all attributes of Level 2 Monitoring, with additional monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4-Table 1-3

Component Type - Voltage and Current Sensing Devices Providing Inputs to Protective Relays

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 3 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|--|--|------------------------------|---|
| Station dc Supply (any battery technology) | Monitoring and alarming for station dc supply voltage, unintentional dc grounds, electrolyte level of all cells of a station battery, individual battery cell/unit state of charge, battery continuity of station battery and cell-to-cell and battery terminal resistance | Continuous | Continuous monitoring of station dc supply voltage, unintentional dc grounds, electrolyte level of all cells of a station battery, individual battery cell/unit state of charge, battery continuity of station battery and cell-to-cell and battery terminal resistance are provided with alarming to remote location upon any failure of the monitoring device or when sensors for the devices are out of calibration. |

Table 1c — Condition-based Maintenance — Level 3 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Fully Monitored Protection System Components

General Description: Protection System components in which every function required for correct operation of that component is continuously monitored and verified, and detected maintenance-correctable issues reported. Level 3 Monitored Protection Systems also includes verification of the means by which alarms and monitored values are transmitted to a location where action can be taken. Detected maintenance-correctable issues for Level 3 Monitored Protection Systems must be reported within 1 hour or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 3 Monitoring includes all attributes of Level 2 Monitoring, with additional monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4-Table 1-3

Component Type - Voltage and Current Sensing Devices Providing Inputs to Protective Relays

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 3 Monitoring Component Attributes for Component | Maximum Maintenance Interval | Maintenance Activities |
|--|---|------------------------------|--|
| Station dc Supply which do not use a station battery | No Level 3 monitoring attributes are defined— use Level 1 Maintenance Activities and intervals | 6-Calendar Years | Verify that the dc supply can perform as designed when the ac power from the grid is not present. |
| Associated communications systems | Evaluating the performance of the channel and its interface to protective relays to determine the quality of the channel and alarming if the channel does not meet performance criteria | Continuous | Continuous verification that the performance and quality of the channel meets performance criteria is provided. Continuous verification of the communications equipment alarm system is provided. |

Table 1c — Condition-based Maintenance — Level 3 Monitoring

Maximum Allowable Testing Intervals and Maintenance Activities for Fully Monitored Protection System Components

General Description: Protection System components in which every function required for correct operation of that component is continuously monitored and verified, and detected maintenance-correctable issues reported. Level 3 Monitored Protection Systems also includes verification of the means by which alarms and monitored values are transmitted to a location where action can be taken. Detected maintenance-correctable issues for Level 3 Monitored Protection Systems must be reported within 1 hour or less of the maintenance-correctable issue occurring, to a location where action can be taken to initiate resolution of the maintenance-correctable issue. Level 3 Monitoring includes all attributes of Level 2 Monitoring, with additional monitoring attributes as listed below for the individual type of component.

General Maintenance Requirements: Perform maintenance activities listed and initiate necessary corrective actions in accordance with Requirement R4-Table 1-3

Component Type - Voltage and Current Sensing Devices Providing Inputs to Protective Relays

Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.

| Type of Protection System Component | Level 3 Monitoring Component Attributes for Component | | Maximum Maintenance Interval | Maintenance Activities |
|---|--|------------|------------------------------|---|
| UVLS and UFLS relays that comprise a protection scheme distributed over the power system. | The relay A/D converters are continuously monitored and alarmed. | Continuous | | Continuous verification of the status of the relays Alarm on change of settings Verification does not require actual tripping of circuit breakers or interrupting devices |

Standard PRC-005-2 – Protection System Maintenance

| | | | | | |
|--|--|-----------------------------------|--|---|---------------------|
| <p>Relay sensing for centralized UFLS or UVLS systems.</p> | <p>See the attributes of Level 3 Monitoring for the individual components of the UFLS/UVLS</p> | <p>See Maintenance Activities</p> | <p>Perform all of the Maintenance activities listed above as established for components of the UFLS or UVLS systems at the intervals established for those individual components. The output action may be breaker tripping, or other control action that must be verified, but may be verified in overlapping segments. A grouped output control action need be verified only once within the specified time interval, but all of the UFLS or UVLS components whose operation leads to that control action must each be verified. <u>Voltage and Current Sensing devices connected to microprocessor relays with AC measurements are continuously verified by comparison of sensing input value as measured by the microprocessor relay to an independent ac measurement source, with alarming for unacceptable error or failure.</u></p> | <p><u>No periodic maintenance specified</u></p> | <p><u>None.</u></p> |
| <p>SPS</p> | <p>See the attributes of Level 3 Monitoring for the individual components of the SPS</p> | <p>See Maintenance Activities</p> | | <p>Perform all of the Maintenance activities listed above as established for components of the SPS at the intervals established for those individual components. The output action may be breaker tripping, or other control action that must be verified, but may be verified in overlapping segments. A grouped output control action need be verified only once within the specified time interval, but all of the SPS components whose operation leads to that control action must each be verified.</p> | |

Notes for Table 1a, Table 1b, and Table 1c

For some Protection System components, adjustment is required to bring measurement accuracy within parameters established by the asset owner based on the specific application of the component. A calibration failure is the result if testing finds the specified parameters to be out of tolerance.

| Table 1-4 Component Type - Station dc Supply <u>Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted.</u> | | |
|--|---|--|
| <u>Component Attributes</u> | <u>Maximum Maintenance Interval</u> | <u>Activities</u> |
| <u>Any dc supply for a UFLS or UVLS system.</u> | <u>When control circuits are verified</u> | <u>Verify dc supply voltage</u> |
| <u>Any unmonitored station dc supply not having the monitoring attributes of a category below. (excluding UFLS and UVLS)</u> | <u>3 Calendar Months</u> | <u>Verify:</u> <ul style="list-style-type: none"> • <u>Station dc supply voltage</u> <u>Inspect:</u> <ul style="list-style-type: none"> • <u>Electrolyte level (excluding valve-regulated lead acid batteries)</u> • <u>For unintentional grounds</u> |
| | <u>18 Calendar Months</u> | <u>Verify:</u> <ul style="list-style-type: none"> • <u>State of charge of the individual battery cells/units</u> • <u>Float voltage of battery charger</u> • <u>Battery continuity</u> • <u>Battery terminal connection resistance</u> • <u>Battery internal cell-to-cell or unit-to-unit connection resistance (where available to measure)</u> <u>Inspect:</u> <ul style="list-style-type: none"> • <u>Cell condition of all individual battery cells where cells are visible – or measure battery cell/unit internal ohmic values where the cells are not visible</u> • <u>Physical condition of battery rack</u> • <u>Condition of non-battery-based dc supply</u> |
| <u>Any unmonitored Station dc supply in which a battery is not used and not having the monitoring attributes of a category below. (excluding UFLS and UVLS)</u> | <u>6 Calendar Years</u> | <u>Verify that the dc supply can perform as designed when ac power from the grid is not present.</u> |
| <u>Unmonitored Station dc supply with Valve Regulated Lead-Acid (VRLA) batteries that does not have the monitoring attributes of a category below. (excluding UFLS and UVLS)</u> | <u>3 Calendar Months</u> | <u>Verify that the station battery can perform as designed by evaluating the measured cell/unit internal ohmic values to station battery baseline.</u> |

Standard PRC-005-2 – Protection System Maintenance

| Table 1-4 Component Type - Station dc Supply | | |
|---|-------------------------------------|--|
| Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted. | | |
| <u>Component Attributes</u> | <u>Maximum Maintenance Interval</u> | <u>Activities</u> |
| | ----- or ----- | |
| | <u>3 Calendar Years</u> | <u>Verify that the station battery can perform as designed by conducting a performance or service capacity test of the entire battery bank.</u> |
| <u>Unmonitored Station dc supply with Vented Lead-Acid Batteries (VLA) that does not have the monitoring attributes of a category below. (excluding UFLS and UVLS)</u> | <u>18 Calendar Months</u> | <u>Verify that the station battery can perform as designed by evaluating the measured cell/unit internal ohmic values to station battery baseline.</u> |
| | ----- or ----- | |
| | <u>6 Calendar Years</u> | <u>Verify that the station battery can perform as designed by conducting a performance, service, or modified performance capacity test of the entire battery bank.</u> |
| <u>Unmonitored Station dc supply with Nickel-Cadmium (Ni-Cad) batteries that does not have the monitoring attributes of a category below. (excluding UFLS and UVLS)</u> | <u>6 Calendar Years</u> | <u>Verify that the station battery can perform as designed by conducting a performance service, or modified performance capacity test of the entire battery bank.</u> |
| <u>Monitored Station dc supply (excluding UFLS and UVLS) with:</u> <u>Monitor and alarm for variations from defined levels (See Table 2):</u> <ul style="list-style-type: none"> • <u>Station dc supply voltage (voltage of battery charger)</u> • <u>State of charge of the individual battery cell/units</u> • <u>Battery continuity of station battery</u> • <u>Cell-to-cell (if available) and battery terminal resistance</u> | <u>18 calendar months</u> | <u>Inspect:</u> <ul style="list-style-type: none"> • <u>Cell condition of all individual battery cells where cells are visible – or measure battery cell/unit internal ohmic values where the cells are not visible</u> • <u>Physical condition of battery rack</u> • <u>Condition of non-battery-based dc supply</u> |

Standard PRC-005-2 – Protection System Maintenance

| Table 1-4 Component Type - Station dc Supply | | |
|---|-------------------------------------|--|
| Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted. | | |
| <u>Component Attributes</u> | <u>Maximum Maintenance Interval</u> | <u>Activities</u> |
| <ul style="list-style-type: none"> • <u>Electrolyte level of all cells in a station battery</u> • <u>Unintentional dc grounds</u> • <u>Cell/unit internal ohmic values of station battery</u> | <u>6 calendar years</u> | <u>Verify that the monitoring devices are calibrated (where necessary)</u> |
| <u>Continuously monitored Station dc supply (excludes UFLS and UVLS) with preceding row attributes and the following:</u> <ul style="list-style-type: none"> • <u>The monitoring devices themselves are monitored.</u> | <u>18 calendar months</u> | <u>Inspect:</u> <ul style="list-style-type: none"> • <u>Cell condition of all individual battery cells where cells are visible – or measure battery cell/unit internal ohmic values where the cells are not visible</u> • <u>Physical condition of battery rack</u> • <u>Condition of non-battery-based dc supply</u> |

Standard PRC-005-2 – Protection System Maintenance

| Table 1-5 | | |
|---|--|--|
| Component Type - Control Circuitry | | |
| Note: Table requirements apply to all components of Protection Systems, UVLS and UFLS Systems, and SPSs except as noted. | | |
| <u>Component Attributes</u> | <u>Maximum Maintenance Interval</u> | <u>Activities</u> |
| <u>Trip coils or actuators of circuit breakers, interrupting devices, or mitigating devices (excluding UFLS or UVLS systems).</u> | <u>6 calendar years</u> | <u>Verify that each trip coil is able to operate the circuit breaker, interrupting device, or mitigating device.</u> |
| <u>Trip coils of circuit breakers and interrupting devices in UFLS or UVLS systems.</u> | <u>No periodic maintenance specified</u> | <u>None.</u> |
| <u>Electromechanical trip or auxiliary devices</u> | <u>6 calendar years</u> | <u>Verify electrical operation of electromechanical trip and auxiliary devices</u> |
| <u>Unmonitored Control circuitry associated with protective functions</u> | <u>12 calendar years</u> | <u>Verify all paths of the control and trip circuits.</u> |
| <u>Control circuitry whose continuity and energization or ability to operate are monitored and alarmed (See Table 2).</u> | <u>No periodic maintenance specified</u> | <u>None.</u> |

| <u>Table 2 – Alarming Paths</u> | | |
|--|---|--|
| <u>In Tables 1-1 through 1-5, alarm attributes used to justify extended maximum maintenance intervals and/or reduced maintenance activities are subject to the following maintenance requirements</u> | | |
| <u>Component Attributes</u> | <u>Maximum Maintenance Interval</u> | <u>Activities</u> |
| <p><u>Any alarm path through which alarms in Tables 1-1 through 1-5 are conveyed from the alarm origin to the location of corrective action, and not having all the attributes of the category below.</u></p> <p><u>Alarms are automatically reported within 24 hours of DETECTION to a location where corrective action can be taken.</u></p> | <p><u>When alarm producing device or system is verified</u></p> | <p><u>Verify that the alarm signals are conveyed to a location where corrective action can be taken.</u></p> |
| <p><u>Alarm Path with monitoring:</u></p> <p><u>The location where corrective action is taken receives an alarm within 24 hours for failure of any portion of the alarming path from the alarm origin to the location where corrective action can be taken.</u></p> | <p><u>No periodic maintenance specified</u></p> | <p><u>None.</u></p> |

PRC-005 — Attachment A

Criteria for a Performance-Based Protection System Maintenance Program

Purpose: To establish a technical basis for initial and continued use of a performance-based Protection System Maintenance Program (PSMP).

~~**Segment:** In this procedure, the term, “segment” is a grouping of Protection Systems or components from a single manufacturer, with common factors such that consistent performance is expected across the entire population of the segment, and shall only be defined for a population of 60 or more individual components.⁴~~

To establish the technical justification for the initial use of a performance-based PSMP:

1. Develop a list with a description of components included in each designated segment of the Protection System component population.
2. Maintain the components in each segment according to the time-based maximum allowable intervals established in ~~Table 1~~Tables 1-1 through 1-5 until results of maintenance activities for the segment are available for a minimum of 30 individual components of the segment.
3. Document the maintenance program activities and results for each segment, including maintenance dates and countable events⁵ for each included component.
4. Analyze the maintenance program activities and results for each segment to determine the overall performance of the segment and develop maintenance intervals.
5. Determine the maximum allowable maintenance interval for each segment such that the segment experiences countable events on no more than 4% of the components within the segment, for the greater of either the last 30 components maintained or all components maintained in the previous year.

To maintain the technical justification for the ongoing use of a performance-based PSMP:

1. At least annually, update the list of Protection System components and segments and/or description if any changes occur within the segment.
2. Perform maintenance on the greater of 5% of the components (addressed in the performance based PSMP) in each segment or 3 individual components within the segment in each year.
3. For the prior year, analyze the maintenance program activities and results for each segment to determine the overall performance of the segment.
4. If the components in a Protection System segment maintained through a performance-based PSMP experience 4% or more countable events, develop, document, and

~~⁴ Entities with smaller populations of component devices may aggregate their populations to define a segment and shall share all attributes of a single performance-based program for that segment.~~

⁵ Countable events include any failure of a component requiring repair or replacement, any condition discovered during the verification activities in Table 1a through Table 1c which requires corrective action, or a Misoperation attributed to hardware failure or calibration failure.

implement an action plan to reduce the countable events to less than 4% of the segment population within 3 years.

5. Using the prior year's data, determine the maximum allowable maintenance interval for each segment such that the segment experiences countable events on no more than 4% of the components within the segment, for the greater of either the last 30 components maintained or all components maintained in the previous year.