PRC-005-2
Protection System Maintenance

FRCC Spring Compliance Workshop
April 14-16, 2015
Objectives

• Introduction
• A brief history of PRC-005
  – PRC-005-1b vs. PRC-005-2
  – Transition from PRC-005-1b to PRC-005-2
• PRC-005-2/3/4
  – Discuss Applicability of PRC-005-2
  – Evidence and retention periods
  – Summary of Requirements
  – Future standards development
• Implementation Plan
• Audit Approach
• Lesson Learned
• PRC-005-2 – Protection System Maintenance
  – Replaces four *legacy* standards
    • PRC-005-1.1b – Transmission and Generation Protection System Maintenance and Testing
    • PRC-008-0 – Implementation and Documentation of Underfrequency Load Shedding Equipment Maintenance Program
    • PRC-011-0 – Undervoltage Load Shedding System Maintenance and Testing
    • PRC-017-0 – Special Protection System Maintenance and Testing
PRC-005-1.1b vs. PRC-005-2

• PRC-005-1.1b
  – Required entities to define and follow a program
    • Intervals
    • Summary of Procedures
    • Basis for both
    • Protection Systems Program Implementation (Interval / Last Date Tested)
• PRC-005-2
  – (R1, R2) Entities define program – time based, performance based, or a combination
    • Including monitoring attributes (if appropriate) to extend intervals
    • Entity has some flexibility
      – Example – may explicitly define every individual component
      – Example – may choose to implement program on a station basis – and maintain everything in station on a schedule (excluding batteries)
PRC-005-1.1b vs. PRC-005-2

• PRC-005-2
  – (R3, R4) Standard establishes maximum intervals and minimum activities
    • No “basis document” needed if intervals are followed
    • If performance based program
      – Basis rationale needed with specific performance and analytical requirements to extend interval
  – (R5) Unresolved Maintenance Issues
    • If entity discovers problems that can’t be fixed within maintenance interval
    • Must have (and show progress on) a plan to resolve [Mitigation Plan]
      – May be brief – e.g. replace failed component with similar equipment
      – May be lengthy – e.g. replace/upgrade with new equipment – involving design, acquisition, and construction
Transition to PRC-005-2

• Entities currently have a PRC-005-1.1b program
  – May not include all elements of PRC-005-2 (Aux relays/sudden pressure relays)
• Entities are allowed to implement PRC-005-2 systematically (Implementation Plan)
  – So the program is sustainable in the future
• As entities implement PRC-005-2
  – They will perform initial maintenance activities during implementation
    • But may have only initial evidence until second scheduled maintenance interval occurs
    • Implementation Plan (4 pages) requires entities to identify “what is being transitioned – and when”
• Some entities may have begun to implement elements of PRC-005-2
  – But others waiting for effective date of the Order – 4/01/15 – to begin implementation per Implementation Plan
• Evidence will show compliance to PRC-005-1b and other legacy PRC standards
  – And will gradually show compliance to PRC-005-2
PRC-005-2 Applicability

- Applicable (Entities same as PRC-005-1.1b)
  - Transmission Owner
  - Generator Owner
  - Distribution Provider
PRC-005-2 Applicability

- Protection Systems installed for purpose of detecting faults on BES
  - Protection Systems on non-BES facilities – “If not for this Protection System, what detects and clears the fault from this terminal?”
- UFLS to meet ERO requirements
- UVLS for BES reliability
- SPS for BES reliability
- Generator Facilities
  - Trip the generator directly or via lockout/auxiliary relays
  - GSU transformer protection
  - Aggregate Generator protection – per BES definition
  - Station Service / Excitation transformers on generator bus which trip the generator directly or via lockout/auxiliary relays
PRC-005-2 Measures

• Documented program per R1
  – Time based / Performance based / Combination
  – If using monitoring to extend intervals – prove the monitoring
    • Example: Manufacturers’ specifications, engineering drawings

• For performance based per R2
  – Documentation of maintenance results and analysis
  – Must meet all criteria in Attachment A

• Program execution per R3 and / or R4
  – Similar to PRC-005-1b
    • Summaries
    • Dated Maintenance records / inspection records / work orders

• Unresolved Maintenance Issues per R5
  – Work orders, replacement Component Order, project schedules with completed milestones, invoices, RMAs or purchase orders, etc.
PRC-005-2 Evidence Retention

- Sufficient to demonstrate compliance since last audit
  - Requirement R1
    - Current program description
    - Any superseded program descriptions since last audit
  - Requirement R2 – R3 – R4 – R5
    - For intervals less than audit interval
      - Records of all maintenance since audit
    - For longer intervals
      - Most recent two performances of each activity
        » Since intervals can be up to 12 calendar years, may be 24 years of records
        » For components newly applicable per PRC-005-2 – may not have records per above until after two intervals
• Establish program
• Describe time-based, performance-based, or combination
  – Simplest – “Maintain all components according to the unmonitored intervals within the Tables in the standard.”
  – Station batteries **MUST** be in time-based program
• If using monitoring to extend intervals (continuous)
  – Must prove that the monitoring is there, and meets the minimum standards expressed in the Tables
For performance-based maintenance

- Specific Criteria detailed in Attachment A
- To establish a performance-based maintenance program for specific component types (Segment)
  - List with description of components within segment
    - Minimum population – 60 components – must be similar enough to expect consistent performance across population
  - Maintain the components in the segment according to the Tables until results are available for at least 30 members of population
    - Document the activities and results
      - Including Countable Events (e.g. problems discovered during maintenance)
  - Analyze activities and results to determine overall performance and develop intervals
  - Maintain according to intervals – maximum allowable countable events – 4% of the greater of last 30 tested within segment, or all components maintained in last year
• For performance-based maintenance
  – Specific Criteria detailed in Attachment A
  – To continue (maintain) a performance-based maintenance program for specific component types (Segment)
    • Update list of segment population at least annually
      – Segment population must remain at 30 or more
    • Maintain at least 3 individual components of segment or 5% of segment population per year (whichever is greater)
      – Establishes an effective maximum interval of 20 years
  • Analyze prior year performance
  • Determine new intervals (if necessary) to limit Countable Events to 4% of all components in segment, for greater of 30 components in segment or all components maintained in last year
  • If countable events exceed 4%, must implement an action plan to reduce to less than 4% within 3 years
PRC-005-2 R3 and R4

- R3 is for time-based; R4 is for performance-based
- “Implement program”
  - All relevant minimum activities
    - Within all relevant maximum intervals
- Per Tables Or PBM intervals
- If entity, in their “program” per R1, says they’re doing more, and/or more often than the Tables – or their PBM
  - The Table / PBM intervals and activities govern for compliance
- Entity may elect to do more than the standard requires
• Unresolved Maintenance Issues
• PRC-005-2 requires entities to complete their program within specified intervals
  – Reflects leaving components in “proper working order”
• Some problems may not be correctable within maintenance interval
  – May require equipment replacement or substantial repair
  – PRC-001 requires that system operators be aware of degraded Protection Systems and operate accordingly
• Entities must have, and show progress, on plans to correct.
  – No specific timeliness requirements because of wide variation in related corrective activities
• Entities should describe how they are implementing this process in their R1 program
PRC-005 Future Developments

• PRC-005-3
  – Adds Automatic Reclosing
    • Applicability limited to Automatic Reclosing that could directly affect BES stability
    • Subject to enforcement – April 1, 2016

• PRC-005-4
  – Adding sudden pressure relays
  – Awaiting FERC approval
Conclusion

• PRC-005-2 becomes mandatory and enforceable April 1, 2015 (R1, R2, R5)
  – As established by lengthy NERC implementation plan

• Establishes specific minimum activities and maximum intervals
  – Subject to condition monitoring and performance-based maintenance
Conclusion

- While more specific and detailed than PRC-005-1.1b …
  - Needs judgment on part of entities
  - Needs dialog between entities and auditors to understand entity’s approach to standard
- Requires considerably more documentation to demonstrate compliance
- Requires documentation to be maintained for longer period of time
Implementation Plan

• While entities are transitioning to the requirements of PRC-005-2, each entity must be prepared to identify:
  – All of its applicable Protection System components.
  – Whether each component has last been maintained according to PRC-005-2 or under PRC-005-1b, PRC-008-0, PRC-011-0, or PRC-017-0 (*Legacy* standards).

• Implementation Plan uses a phased approach to accommodate spreading the maintenance and testing out over a reasonable period of time.

• *Legacy* standards will be retired following full implementation of PRC-005-2. (April 1, 2027)
Entities must maintain documentation to demonstrate compliance with PRC-005-1b, PRC-008-0, PRC-011-0, and PRC-017-0 until that entity meets the requirements of PRC-005-2.

- Each entity will maintain each of their Protection System components according to their maintenance program already in place for the legacy standards or according to the program for PRC-005-2, **but not both**.

- Once an entity has designated PRC-005-2 as its maintenance program for specific Protection System components, they **cannot revert** to the legacy program for those components.

- New components added after April 1, 2015 **must** be in the PRC-005-2 program.
## Implementation Plan (cont’d)

<table>
<thead>
<tr>
<th>Max. Maintenance Interval</th>
<th>% Compliant</th>
<th>By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>100%</td>
<td>Oct. 1, 2015 (1D/1Q 18 mo. following regulatory approval)</td>
</tr>
<tr>
<td>1-2 calendar years</td>
<td>100%</td>
<td>Apr. 1, 2017 (1D/1Q 36 mo. following regulatory approval)</td>
</tr>
<tr>
<td>3 calendar years</td>
<td>30%</td>
<td>Apr. 1, 2016 (1D/1Q 24 mo. following regulatory approval)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note 1</td>
</tr>
<tr>
<td>3 calendar years</td>
<td>60%</td>
<td>Apr. 1, 2017 (1D/1Q 36 mo. following regulatory approval)</td>
</tr>
<tr>
<td>3 calendar years</td>
<td>100%</td>
<td>Apr. 1, 2018 (1D/1Q 48 mo. following regulatory approval)</td>
</tr>
<tr>
<td>6 calendar years</td>
<td>30%</td>
<td>Apr. 1, 2017 (1D/1Q 36 mo. following regulatory approval)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note 2</td>
</tr>
<tr>
<td>6 calendar years</td>
<td>60%</td>
<td>Apr. 1, 2019 (1D/1Q 60 mo. following regulatory approval)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note 1</td>
</tr>
<tr>
<td>12 calendar years</td>
<td>100%</td>
<td>Apr. 1, 2021 (1D/1Q 84 mo. following regulatory approval)</td>
</tr>
<tr>
<td>12 calendar years</td>
<td>30%</td>
<td>Apr. 1, 2019 (1D/1Q 60 mo. following regulatory approval)</td>
</tr>
<tr>
<td>12 calendar years</td>
<td>60%</td>
<td>Apr. 1, 2023 (1D/1Q 108 mo. following regulatory approval)</td>
</tr>
<tr>
<td>12 calendar years</td>
<td>100%</td>
<td>Apr. 1, 2027 (1D/1Q 156 mo. following regulatory approval)</td>
</tr>
</tbody>
</table>

1 Or, for generating plants with scheduled outage intervals exceeding two years, at the conclusion of the first succeeding maintenance outage.
2 Or, for generating plants with scheduled outage intervals exceeding three years, at the conclusion of the first succeeding maintenance outage.
1. Incomplete inventory – integrating four programs into one and adding newly identified components (Reclosers, sudden pressure, aux relays, etc.)

2. Misclassification of inventory (incorrect assignment of Table)

3. Use of contractors and obtaining suitable documents to meet Table’s Maintenance Activities. How are you performing “verification”?

4. Long term retention of documents.

5. Coordinating intervals for relays and Control Circuitry associated with Protective Functions which may have different time intervals.

6. Transferring sufficient number of components to meet the implementation table percentages.
Audit Approach - Sampling Process

FRCC PRC-005-2 Sampling Process similar to PRC-005-1
Note: the PRC-023 tab has been removed from the PRC-005 spreadsheet and will be sent separately if PRC-023 is part of the compliance monitoring process.

1) Send out a new document “DOC –XX PRC-005-2 BES Substations & BES Generation Plants Inventory” that requests a complete list of BES Substations & BES Generation Plants in the 90-day notification letter for entities with more than eight (8) locations.

a) If the entity owns less than nine (9), send document DOC-15 in the ninety (90) -day notification letter to obtain the entire protection system device inventory in all substations (go to step 3).
FRCC PRC-005-2 Sampling Process similar to PRC-005-1

2) PRC-005-2 BES Substations & BES Generation Plants Inventory is to be returned five (5) business days after the receipt of the 90 day notification letter.

3) R2/R4 Determine if Entity is using Performance Based Maintenance, use sampling methodology to request verification of testing along with evidence how PBM intervals were established.
Audit Approach - Sampling Process

FRCC PRC-005-2 Sampling Process similar to PRC-005-1

4) Audit team to perform a sample on the Inventory.
   a) Audit team to develop this initial sample and submit to registered entity within five (5) business days.

5) Registered Entity to submit the completed DOC-15 for all components identified in the sampled locations with initial data submittal due thirty (30) days following the receipt of the 90 day letter.
R3/R4  Audit team to develop six (6) separate samples, one for each type of Protection system device:

a) Relays (Tables 1-1 & 2)
   i. PRC-005-1 Request evidence that of the most recent test report and the dates for the last two tests.
   ii. PRC-005-2 Request evidence that of the most recent maintenance record for each activity in the entity program (per table 1-1) for each selected component included in the sample.
   iii. PRC-005-2 For any component that has monitored alarm attributes used to justify extended maximum maintenance intervals or reduced maintenance activities, provide evidence the alarm path conveys alarm signals to a location where corrective action can be initiated per Table 2.
R3/R4 Audit team to develop six (6) separate samples, one for each type of Protection system device:

b) Communications Systems (Tables 1-2 and 2)

i. PRC-005-1 Request evidence that of the most recent test report and the dates for the last two tests.

ii. PRC-005-2 Request evidence that of the most recent maintenance record for each activity in the entity program (per table 1-2) for each selected component included in the sample.

iii. PRC-005-2 For any component that has monitored alarm attributes used to justify extended maximum maintenance intervals or reduced maintenance activities, provide evidence the alarm path conveys alarm signals to a location where corrective action can be initiated per Table 2.
Audit team to develop six (6) separate samples, one for each type of Protection system device:

c) Voltage and Current Sensing Devices (Tables 1-3 and 2)
   i. PRC-005-1 Request evidence that of the most recent test report and the dates for the last two tests.
   ii. PRC-005-2 Request evidence that of the most recent maintenance record for each activity in the entity program (per table 1-2) for each selected component included in the sample.
   iii. PRC-005-2 For any component that has monitored alarm attributes used to justify extended maximum maintenance intervals or reduced maintenance activities, provide evidence the alarm path conveys alarm signals to a location where corrective action can be initiated per Table 2.
Audit Approach-Sample Types

**R3/R4** Audit team to develop six (6) separate samples, one for each type of Protection system device:

d) Control Circuitry associated with Protective Functions (Tables 1-5)

i) PRC-005-1 Request evidence that of the most recent test report and the dates for the last two tests.

ii) PRC-005-2 Request evidence that of the most recent maintenance record for each activity in the entity program (per table 1-5) for each selected component included in the sample.

iii) PRC-005-2 For any component that has monitored alarm attributes used to justify extended maximum maintenance intervals or reduced maintenance activities, provide evidence the alarm path conveys alarm signals to a location where corrective action can be initiated per Table 2.
R3/R4 Audit team to develop six (6) separate samples, one for each type of Protection system device:

e) Batteries (tables 1-4a, 1-4b, 1-4c)

   i) Request most recent test record for each type of maintenance activity in the entity program (per tables’ 1-4a, 1-4b, and 1-4c) for all batteries at all sampled locations.
R3/R4 Audit team to develop six (6) separate samples, one for each type of Protection system device:

f) UVLS and UFLS Systems (table 1-3)

i) Request the list of UFLS relays last submitted to the FRCC PRC-006 procedure at the sending of the 90 day letter along with a list of UVLS relays

ii) Perform a random sample, if required, to the provided list and

(1) Verify that current and/or voltage signal values are provided to the protective relays.

(2) Verify Protection System dc supply voltage.

(3) Verify the path from the relay to the lockout and/or tripping auxiliary relay (including essential supervisory logic).

(4) Verify electrical operation of electromechanical lockout and/or tripping auxiliary devices.
Audit team will prepare and send to the entity a data request identifying the sampled components (items a thru f) requesting appropriate records and documents be provided to demonstrate the minimum testing requirements had been completed.

Audit team will review the documents provided for the data request and either determine a “no finding”, submit another data request, request an interview for clarification or determine a possible non-compliance.
Questions?
Reference Documents

- Implementation Plan

- FAQ Document (PRC-005-2/3)

- Southern Company PRC-005-2 Workshop Presentation