FRCC Requirements for Analysis of Protection Misoperations and Corrective Actions Reporting

FRCC-MS-OP-006/r1
Effective: September 5, 2013

<table>
<thead>
<tr>
<th>Approved By:</th>
<th>Date Approved:</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRCC Member Services Operating Committee</td>
<td>October 6, 2011</td>
</tr>
<tr>
<td>FRCC Member Services Operating Committee</td>
<td>September 5, 2013</td>
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</tbody>
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1.0 Purpose/Scope

The purpose of this FRCC document is to insure compliance with the applicable NERC Reliability Standard and further insure that transmission protection systems within the state of Florida operate reliably. This Standard provides for the monitoring, notification and analysis of transmission level, protective relay operations.

2.0 Background

The reliability of the interconnected transmission network is highly dependent on the correct operation of protective relay systems. These systems are designed to quickly isolate specific portions of the transmission network in order to preserve electric system integrity. Protective relays detect abnormal conditions accompanied by excessive current, over/under frequency, or over/under voltage and then operate switching devices to prevent equipment damage and instability. Failure of a protection system to operate might result in power system collapse. On the other hand, operating falsely could result in removing critical elements of the network when needed most, creating a cascading outage. Therefore it is important that protective relay systems operate with a high degree of reliability.

3.0 Responsibilities

Requirements of this document apply to facility owners of generators above 100MW net output and devices and components of the Bulk Electric System (BES) operating at primary voltage of 100 kV and above. This is to include transmission lines, substation busses, and transformers. Protection trip operations are defined as the opening of breakers or interrupting devices by the automatic operation of a protective relay(s). This also includes operations of any Special Protection System (SPS).

3.1 Definitions:

3.1.1 Protection trip Misoperation as defined in the NERC glossary shall mean:

- Any failure of a Protection System element to operate within the specified time when a fault or abnormal condition occurs within a zone of protection.
- Any operation for a fault not within a zone of protection (other than operation as backup protection for a fault in an adjacent zone that is not cleared within a specified time for the protection for that zone).
- Any unintentional Protection System operation when no fault or other abnormal condition has occurred unrelated to on-site maintenance and testing activity.
4.0 **Applicability**

Transmission Owner (TO)

Distribution Provider that owns a transmission Protection System

Generator Owner (GO)

5.0 **Procedural/Process Steps**

5.1 **Procedure for Analysis of Protection Trip Operations**

5.1.1 Each facility owner is responsible for reviewing all protection trip operations within their specific area, including the operation of an SPS. Analysis shall include a determination that a relay action was either correct or incorrect. Incorrect operations, which are defined above in Section 3.1 as misoperations, are to be documented.

5.1.2 Data used for analysis of a relay action and determining the correctness of the operation may be obtained from SCADA, fault locators, fault recorders, disturbance monitors, breaker counters, intelligent relays, sequence of events recorders, and relay targets.

5.1.3 Documentation of correct relay operations is to be maintained in accordance with established internal procedures by each facility owner. Misoperations are to be documented by the region at the FRCC level as provided for in section 4.0 below of this guideline.

5.1.4 The cause of each misoperation is to be investigated by the facility owner. The individual facility owner is responsible for identifying the root cause of a misoperation. The results of the investigation and implementation of a corrective action plan shall be documented by the facility owner.

5.2 **Procedure for Reporting Protection Trip Misoperations**

5.2.1 Each facility owner shall provide a representative contact to the FRCC System Protection and Control Subcommittee (SPCS). That representative and the SPCS will be the contact interface between the FRCC and the owner regarding protective relay actions and misoperations.

5.2.2 Each facility owner shall maintain a log of all generation and transmission relay misoperations and all SPS misoperations as defined under Section 2.0 “Definitions.” The Misoperation report template can be found on the FRCC website “Misoperations Reporting”. The log will contain the information and format as described in Appendix A and will be sent to the FRCC on a
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 quarterly basis per schedule in section 5.2.5 (misoperations@frcc.com). The file name shall be stated as Entity_Quarter_Year (ABC_Qtr2_11). A Corrective Action Plan as defined in NERC glossary shall be included by each facility owner as a part of the quarterly report, and will be reviewed by the SPCS. If a facility owner has no misoperations or Special Protection System Misoperations to report, then the log is to be submitted stating “NONE” for the time period covered. The logs will be compiled by the FRCC and provided to the SPCS for quarterly review. If a misoperation is reported, the entity’s representative is to participate in the next SPCS meeting to give a report of the misoperation.

5.2.3 Reporting of misoperations is the responsibility of the facility owner (line, plant or station) as determined by Transmission Availability Data System (TADS) reporting. Once the investigation has determined the protective system element that misoperated, it is the responsibility of that owner for reporting until the analysis is complete. In special cases where the facility owner does not own any of the protective system, an agreement should be made between the involved owners as to who will report and each owner should have documentation of the agreement.

5.2.4 The review and expert opinions expressed by the members of the SPCS are to be used at the discretion of the facility owner reporting the misoperation. The final reporting responsibility, accountability and implementation of related corrective action plans, remain with the reporting entity.

5.2.5 Following the quarterly review conducted by the FRCC SPCS, a report based on the submitted “NERC Quarterly Misoperations Report” template will be prepared by FRCC Member Services (MS) Staff which contains all potential and actual Protection System misoperations reported by the facility owners. The report shall include the final resolution, as determined by the reporting entity. The FRCC SPCS may provide technical guidance as to whether the Protection System operation was considered to be an actual misoperation or an appropriate operation based on the analysis of the event. FRCC MS Staff will provide the report to the FRCC Regional Entity (RE) quarterly according to the following schedule.
5.3 Periodic Review

5.3.1 This procedure is to be reviewed and approved by the SPCS and the Operating Committee of the FRCC. This procedure is to be changed as required and reviewed at least once every five (5) years, then reaffirmed by the SPCS and Operating Committee.

6.0 References

NERC Reliability Standard PRC-003

NERC Reliability Standard PRC-004

7.0 Attachments

Attachment 1: Misoperation Summary Form (Tab 1)

Attachment 2: FRCC Protection System Misoperation Reporting (Tab 2)

Attachment 3: Misoperations Categories and General Cause Code Definitions (Tab 3)

8.0 Revision History

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Document Number</th>
<th>Document Changes</th>
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<tbody>
<tr>
<td>November 1, 2011</td>
<td>FRCC-MS-OP-006</td>
<td>Conversion of FRCC Handbook document to new format. Replace definition of misoperations with NERC definition; added schedule for reporting; replaced appendices A &amp; B</td>
</tr>
<tr>
<td>FRCC-MS-OP-006 r1</td>
<td>FRCC Requirements for Analysis of Protection Misoperations and Corrective Actions Reporting</td>
<td>Effective Date: 09/05/13</td>
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<tr>
<td>December 2, 2010</td>
<td>FRCC – PROC - RC – PRC-003</td>
<td>Added Regional cause codes to reporting form and definitions as Appendix B. Added editorial clarifications. Added MS to RE reporting process</td>
</tr>
<tr>
<td>April 1, 2010</td>
<td>FRCC – PROC - RC – PRC-003</td>
<td>Revision to include language to more closely follow the NERC Reliability Standards and to identify process of SPCS review of misoperations</td>
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</table>

9.0 FRCC Disclaimer

This supporting document may explain or facilitate implementation of one or more NERC Reliability Standard requirements but does not contain any explicit mandatory requirements subject to compliance enforcement. The requirements and procedures described herein are not intended to be fully inclusive of all activities that may support compliance to a specific NERC Reliability Standard referenced or implied within the procedure.

The FRCC may revise or terminate this document at any time at its discretion without notice. However, every effort will be made by the FRCC to update this document and inform its users of changes as soon as practicable. Nevertheless, it is the user’s responsibility to ensure the most recent version of this document is being used in conjunction with other applicable procedures, including, but not limited to, the applicable NERC Reliability Standards as they may be revised from time to time.

The use of this information in any manner constitutes an agreement to hold harmless and indemnify FRCC and FRCC Member Systems, and FRCC Staff and FRCC Member Employees from all claims of any damages. In no event shall FRCC and FRCC Member Systems, and FRCC Staff and FRCC Member Employees be liable for actual, indirect, special or consequential damages in connection with the use of this information.
Attachment 1

FRCC Protection System Misoperation Reporting
Send Report to: Misoperations@frcc.com
Reports are due to the FRCC according to the schedule in Section 5.2.5

The following is a listing of the detailed entry to be provided in Tab 1 (Misoperation Summary Form) of the spreadsheet found on the FRCC website: Misoperations Reporting

<table>
<thead>
<tr>
<th>Summary Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Submission Year</td>
<td></td>
</tr>
<tr>
<td>Data Submission Quarter</td>
<td></td>
</tr>
<tr>
<td>Functional Entity Type</td>
<td>Functional Entity</td>
</tr>
<tr>
<td>Regional Entity Name</td>
<td></td>
</tr>
<tr>
<td>Functional Entity Name</td>
<td></td>
</tr>
<tr>
<td>Total Number of Protection System Misoperations</td>
<td>0</td>
</tr>
<tr>
<td>Total Number of Protection System Operations by Voltage Class (Please Use Closest Voltage Class to Rated Value)</td>
<td></td>
</tr>
<tr>
<td>&lt;100 kV (Bulk Electric System Elements Only)</td>
<td>0</td>
</tr>
<tr>
<td>100 kV</td>
<td>0</td>
</tr>
<tr>
<td>115 kV</td>
<td>0</td>
</tr>
<tr>
<td>120 kV</td>
<td>0</td>
</tr>
<tr>
<td>138 kV</td>
<td>0</td>
</tr>
<tr>
<td>161 kV</td>
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</tr>
<tr>
<td>230 kV</td>
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<tr>
<td>345 kV</td>
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<tr>
<td>500 kV</td>
<td>0</td>
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<tr>
<td>735 kV</td>
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<tr>
<td>765 kV</td>
<td>0</td>
</tr>
<tr>
<td>HVdc</td>
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</tr>
<tr>
<td>Total Protection System Operations</td>
<td>0</td>
</tr>
</tbody>
</table>
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Attachment 2

FRCC Protection System Misoperation Reporting

Send Report to: Misoperations@frcc.com

Reports are due to the FRCC according to the schedule in Section 5.2.5

The following is a listing of the detailed entry to be provided in Tab 2 (Misoperation Entry Form) of the spreadsheet found on the FRCC website: Misoperations Reporting

Misoperation ID: Please enter a company unique identifier (alphanumeric including underscore) for each unique misoperation. If you are resubmitting a misoperation from a prior quarter, please use the same misoperation id as the misoperation from the prior quarter.

Regional Entity: Select Regional Entity from drop-down list

NERC ID: Enter NERC ID (Format: NCR#####). If your company does not have a NERC ID, please enter the company name.

Misoperation Date: Enter the date of the Misoperation in this MM/DD/YYYY/ format. When copying, use "Paste_Values" to retain format. If no misoperations occurred during the previous quarter, enter NONE.

Misoperation Time: Enter the time of the misoperation in (24 hr.) HH:MM:SS format

Time zone: Select time zone from drop-down list. Detailed Definitions are available under the tab labeled "Definitions".

Facility Name (Location of Misoperation): Identify the name of the facility (i.e., substation or generating station) where the Misoperation occurred.

Equipment Name (protected by Protection System that Misoperated): Identify by name the generator, transmission line, transformer, bus or equipment protected by the Protection System that Misoperated.

Equipment Type: Select type of equipment being protected (e.g., Line, Transformer, etc.) from drop-down list

Facility Voltage: Select system voltage (in kV) of the protected element (if transformer, high side kV) from drop-down list.

Equipment Removed from Service (Permanently or Temporarily) as the result of the Misoperation: Enter names of the equipment becoming unavailable due to the Misoperation (Equipment only refers to circuits, transformers, busses, but not breakers UNLESS the breaker is the only element). Breaker should be used only if a single breaker tripped and did not disconnect any element at one of its terminals (one breaker in a multiple breaker protected line, bus tie breaker, etc.).

Event Description: Provide a brief description of the event and detailed description of Misoperation root causes for those items noted as Corrective Actions- Complete.

Misoperation Category: Select Misoperation Category from drop-down list. Detailed definitions of the categories are available under the tab labeled "Definitions".

Cause(s) of Misoperation: Select root cause(s) of the Misoperation from drop-down list. Detailed definitions of the root causes are available under the tab labeled "Definitions".
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Protection Systems/Components that Misoperated: Only provide information on the components/protection systems that misoperated. If the "Cause of Misoperation" is "Relay failures/malfunctions" or "Incorrect settings/logic/design errors" and the cause is associated with a relay, list relay models (types) and protection schemes.

Relay Technology: If the Cause of Misoperation is "Relay failures/malfunctions" or "Incorrect settings/logic/design errors", identify the relay technology installed. Field Value: Electromechanical, Solid State, or Microprocessor.

Is this a TADS reportable outage? Select Yes or No from drop-down list. The outage is TADS reportable if a TADS Element is placed in a not-in-service state. In-service is a TADS Element that is energized and connected at all its terminals to the system.

The following are TADS Elements for which TADS data are to be collected:
1. AC Circuits ≥ 200 kV (Overhead and Underground)
2. Transformers with ≥ 200 kV low-side voltage
3. AC/DC Back-to-Back Converters with ≥ 200 kV AC voltage, both sides
4. DC Circuits with ≥ +/− 200 kV DC voltage

Enter one or more TADS "Event IDs" if this is a TADS reportable outage?: Create a TADS Event ID using TADS Form 5 (Typically, a TADS Event does not last for more than 5-10 minutes. If a Misoperation lasts for 30 minutes or more, there will likely be more than one TADS Event ID to be entered in this column. The TADS Form 5 "Event IDs" can be entered by the TO (or his delegated reporting entity; i.e. TOP or relay technician) at any time of the day or night. TADS is always running...for those Users who wish to do partial data entry on the same day as the Event)

If the misoperation caused a generator forced outage, select the generator? If the misoperation involved a generator forced outage, please select the generator from the list. If the generator is not listed, please enter the GADS ID of the generator. If there are multiple generators involved, please select the first generator that had a forced outage.

Analysis and Corrective Action Status: Select the status from drop-down list. In general, misoperation analysis is conducted first, then a Corrective Action Plan will be developed and implemented to mitigate the misoperation.

Corrective Action Plan: Identify the corrective actions

Corrective Action Plan Target Completion Date: If analysis or corrective actions are not complete, estimate when either will be complete. Enter date in this MM/DD/YYYY format. When copying, use "Paste Values" to retain format.

Actual Completion Date: If corrective actions are complete, enter actual completion date in this MM/DD/YYYY format. When copying, use "Paste Values" to retain format.

Reported By: Enter the name of the person filling out the report.

Phone: Enter the reporting person's phone number.

E-Mail: Enter the reporting E-MAIL address.

Date Reported: Enter the report date in this MM/DD/YYYY format. When copying, use "Paste Values" to retain format.

Record Retention - 7 Years
Review Cycle – 5 Years

Document Classification
Public
## Misoperations Categories and General Cause Code Definitions

<table>
<thead>
<tr>
<th>Misoperation Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure to Trip</td>
<td>Any failure of a Protection System element to operate when a fault or abnormal condition occurs within a zone of protection (Note: Lack of targeting, such as when a high-speed pilot system is beat out by a high-speed zone, is not a reportable misoperation. If a fault or abnormal condition is cleared in the time normally expected with proper functioning of at least one Protection System, failure of a Protection System element is not a reportable misoperation.)</td>
</tr>
<tr>
<td>Slow Trip</td>
<td>Any failure of a Protection System element that is slower than planned to operate when a fault or abnormal condition occurs within the zone of protection. (Note: Failure of a high-speed system to operate is not a reportable misoperation unless it was determined by the Planning Coordinator or Transmission Planners as essential for transmission system performance.)</td>
</tr>
<tr>
<td>Unnecessary Trip during fault</td>
<td>Any unnecessary Protection System operation for a fault not within the zone of protection. An example of this type of Misoperation is an over-trip due to lack of coordination between Protection Systems (Note: Operation as properly coordinated backup protection for a fault in an adjacent zone that is not cleared within the specified time for the protection for that adjacent zone is not a reportable Misoperation.)</td>
</tr>
<tr>
<td>Unnecessary Trip other than fault</td>
<td>Any unnecessary Protection System operation when no fault or other abnormal condition has occurred (Note that an operation that occurs during on-site maintenance, testing, construction and/or commissioning activities is not a reportable Misoperation.)</td>
</tr>
<tr>
<td>AC system</td>
<td>Note that (1) Failure to automatically reclose after a fault is not a misoperation. (2) Operations which are initiated by control systems (not by Protection Systems), such as those associated with generator controls, or turbine/boiler controls, SVCs, FACTS, HVdc, circuit breaker mechanism, or other facility control systems, are not misoperations.</td>
</tr>
<tr>
<td>AC system</td>
<td>This category includes misoperations due to problems in the ac inputs to the protection system. Examples would include misoperations associated with CT saturation, loss of potential, or rodent damaged wiring in voltage or current circuit.</td>
</tr>
<tr>
<td>As-left personnel error</td>
<td>This category includes misoperations due to the as-left condition of the protection system following maintenance or construction procedures. These include test switches left open, wiring errors not associated with incorrect drawings, carrier grounds left in place, or settings placed in the wrong relay, or incorrect field settings left in the relay that do not match engineering approved settings.</td>
</tr>
<tr>
<td><strong>FRCC Requirements</strong></td>
<td><strong>FRCC Requirements for Analysis of Protection Misoperations and Corrective Actions Reporting</strong></td>
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</tr>
<tr>
<td><strong>Communication Failures</strong></td>
<td>This category includes misoperations due to failures in the communication systems associated with protection schemes inclusive of transmitters and receivers. Examples would include misoperations caused by loss of carrier, spurious transfer trips associated with noise, Telco errors resulting in mal-performance of communications over leased lines, loss of fiber optic communication equipment, or microwave problems associated with weather conditions.</td>
</tr>
<tr>
<td><strong>DC system</strong></td>
<td>This category includes misoperations due to problems in the DC control circuits. These include problems in the battery or charging systems, trip wiring to breakers, or loss of dc power to a relay or communication device.</td>
</tr>
<tr>
<td><strong>Incorrect setting / logic / design errors</strong></td>
<td>This category includes misoperations due to “engineering” errors by the protection system owner. These include setting errors, errors in documentation, and errors in application. Examples would include uncoordinated settings, incorrect schematics, or multiple CT grounds in the design.</td>
</tr>
<tr>
<td><strong>Relay failures / malfunctions</strong></td>
<td>This category includes misoperations due to improper operation of the relays themselves. These may be due to component failures, physical damage to a device, firmware problems, or manufacturer errors. Examples would include misoperations caused by changes in relay characteristic due to capacitor aging, misfiring thyristors, damage due to water from a leaking roof, relay power supply failure, or internal wiring/logic error. Failures of auxiliary tripping relays fall under this category.</td>
</tr>
<tr>
<td><strong>Unknown / unexplainable</strong></td>
<td>This category includes misoperations where no clear cause can be determined. Requires extensive documentation of investigative actions if this cause code is utilized.</td>
</tr>
<tr>
<td><strong>Other / Explainable</strong></td>
<td>This category includes misoperations that were determined to have an identified cause but they do not fit into any of the above categories. For example, temporary changes in network topology that because of their low probability of occurrence are not accounted for in the design of the Protection System.</td>
</tr>
</tbody>
</table>

**TADS Reportable:**

The NERC TADS Data Reporting Instruction Manual should be referenced in determining if an outage qualifies for reporting under the requirements of TADS (Transmission Availability Data System).

In general, outages of the following Elements are reportable under TADS:
- AC Circuits ≥ 200 kV (Overhead and Underground Circuits). Radial circuits are included.
- DC Circuits with ≥ +/-200 kV DC voltage
- Transformers with ≥ 200 kV low-side voltage
- AC/DC Back-to-Back Converters with ≥ 200 kV AC voltage, both sides
Examples of Misoperation Cause Codes

NOTE: These are examples of some types of common problems for each misoperation cause code. These are NOT examples of acceptable descriptions, because they are created, shortened, and generalized for the sake of this document. When reporting misoperations, please provide a detailed description of the original misoperation (description shall be in sufficient detail to permit proper classification), the steps used to investigate the problem, and the corrective action to ensure the misoperation does not occur again.

A) Relay Failure
   - Capacitors failed in the relay. Capacitors were replaced.
   - Relay stuck in picked-up position. Relay contacts were cleaned and the relay re-tested.
   - The carrier ground relay trip contacts closed incorrectly after the fault was cleared. The relay was replaced.

B) Relay Calibration Drift
   - Found the instantaneous overcurrent element picking up very low. Recalibrated relay
   - Single-ended operation caused by JBCG relay contacts out of adjustment. Recalibrated relay.
   - Angle on distance relay was found out-of-calibration. Recalibrated relay.
   - Relay contact bounce caused a carrier misoperation. Relay adjusted and placed back in service.

C) Control Equipment Failure (Aux. Equip/Lockouts, etc.)
   - Loose fuse block
   - Lockout contact failure.

D) Relay Communications System Failure
   (Carrier)
   - A bad card was found in the carrier set and was replaced
   - A bad discriminator card was found in the transfer trip receiver set and was replaced.
   - An open impedance matching transformer was found and replaced.
   - Carrier blocking signal was lost due to a faulty line trap. The line trap was repaired.
   - Failed capacitors in a line trap tuning pack. The capacitors were replaced and the scheme was retested and placed back in service.
   - Failing CCVT caused a carrier misoperation. CCVT was replaced.
   - Found defective carrier auxiliary relay, which was then replaced.
   - Found failed power supply on carrier set, so that the blocking signal was never sent.
   - The carrier set was replaced.
   - High reflective power was found. This was caused by the screw connecting the impedance matching transformer to the inductor being loose. The screw was tightened.
   - There was a bad connection on the coax cable connector in the outdoor tuning box at one end.
   - Resistor failure in carrier receive circuit. The resistor was replaced.
   - Carrier auxiliary relay out of adjustment. Relay was recalibrated.
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<tbody>
<tr>
<td>(Non-Carrier)</td>
</tr>
<tr>
<td>• Radio found bad. Radio replaced.</td>
</tr>
<tr>
<td>• Found significant signal loss on receive fiber.</td>
</tr>
</tbody>
</table>

**E) Design**

- Incorrectly sized resistor in the carrier current path
- Standing trip on the relay due to design error
- Sneak path in circuit.
- CT Circuits grounded at 2 points instead of 1

**F) Settings**

- Directional elements didn’t work properly. Changed settings.
- Incorrect CT ratio setting
- Induced current caused protection to operate. Adjusted settings.
- Miscoordinated reset time between electromechanical relay and microprocessor relay
- Pilot reach reduced to prevent excessive overreach
- Problem with LOP logic caused protection to operate incorrectly. Setting adjusted.
- Problem with line impedance/model data. Problem fixed and settings adjusted
- Newly discovered situation. Settings adjusted to protect for this situation.
- Timer settings increased to coordinate with adjacent protection
- Frequency too close to frequency on adjacent line
- Setting in carrier set wrong. Setting adjusted

**G) Process Execution (Human Error)**

- CT not wired to ratio requested by settings. Wiring adjusted.
- Found carrier turned off on one end.
- Issued relay settings that would have allowed the relay to operate correctly had not yet been applied.
- Potentials were rolled. Wiring adjusted.
- Setting was found incorrect on relay (Issued correctly, applied incorrectly).
- Trip links found open

**H) DC System**

- Corrosion on knife blades. Corrosion cleaned.
- Zener diode failure in DC circuit. Diode replaced.
- Tripping rectified (diode) was shorted. The diode was replaced.

**I) AC System**

- Blown potential fuse. Fuse replaced.
- Problem with polarizing circuits. The wiring was corrected.
- Water in CT junction box caused the differential to operate. Box was resealed and CE replaced.
- Carrier ground relay misoperation caused by opening / closing line switches.
J) Unknown
   - An investigation was not able to identify a cause.

Examples when no submittal is required:
   - Human Error while personnel are in the station working on the equipment that misoperated.
   - Failures to reclose, unless reclosing is of the SPS system
   - Protection system is not part of the BES.

Please refer to NERC Reliability Standard PRC-004 when making a determination on the reportability of a potential misoperation.