MIDWEST RELIABILITY ORGANIZATION

NPCC, Inc.

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Protection System Commissioning Program Review Project

March 2, 2022

FERC
FEDERAL ENERGY REGULATORY COMMISSION

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Outline

- Background
- PSC Review Project Process
- PSC Programs Findings
- PSC Procedures Findings
- Questions

(PSC – Protection System Commissioning)

Background: Misoperations

- Efforts to reduce Misoperations (Misops) resulting from improper PSC
  - 2015-2021 NERC Issued Lessons Learned
  - 2017 IEEE WG I-25 guide Commissioning Testing of Protection Systems
  - 2019 Analysis of Protection System Misops

Background: MIDAS Review

- Process: Sample ‘Event Description’ and ‘Corrective Action’ MIDAS fields to determine PSC impact on Misops.
- Finding: 18 – 36% of Misops could be attributed to issues that PSC should have detected.

PSC Review Project Process

- Eight registered entities and one PSC contractor.
- Selected based on geographical locations and performance data such as events and Misop rates.
- Surveys and Interviews on participants' PSC programs and Procedures.
- Used the IEEE WG I-25 guide as a benchmark.
- Team discussed and agreed upon the best practices, opportunities for improvement, and related recommendations.

PSC Programs

- All participants but one had a formal commissioning program; however, none of the participants' programs were as comprehensive as the IEEE WG I-25 guide recommends.
- No participant maintained a centralized document that contained all five key elements of an effective PSC program.

Recommendation

- All entities should document a formal PSC program. Having a formal, documented program in a central location (e.g., a single document) allows easy reference to all the elements of the program.

5 Key Elements of Effective PSC Programs

- Stated goals and objectives
- Well-defined plans to perform commissioning
- Clearly identified lines of responsibility
- Authority given to responsible parties
- Feedback methods for improvements

Stated Goals and Objectives

- Three participants failed to document their PSC program goals and objectives in a program document.
- These participants embedded the goals and objectives in the procedures and activities outlined in their equipment commissioning processes.

Recommendation:

- All Entities should have a formal company PSC program that includes the goals and objectives of the program. Having a company-wide document that clearly describes the commissioning goals and objectives provides employees clear direction for their tasks.

Well-defined Plans to Perform Commissioning

- Plans ranged from standard form-type checklists to tests and forms for specific types and models of equipment. Observations included:
  - a detailed internally developed testing guideline listing the different tests to perform based on the equipment being commissioned
  - No instructions on what the commissioning team should look for when performing a commissioning test on equipment
  - no guidance with equipment specific checklist
  - one participant reported that it did not develop any checklist

Well-defined Plans to Perform Commissioning (cont'd)

Recommendation

- All Entities should review their PSC programs for adequate detail. Entities should consider including how to perform the commissioning tests that are required for each specific project. All Entities should follow the guidance provided in the Annex A of the IEEE WG I-25 guide.

Best Practice

- One participant included with every project a detailed commission testing plan specific to that project in terms of depth, scope, type of equipment involved, level of complexity, and each plan detailed how to perform required tests and checks.

Clearly Identified Lines of Responsibility

- For the seven participants with formal programs, director/manager was the most common level of management required for approval.
- Some participants required personnel to complete formal training to qualify to perform commissioning and some participants only required on the job training. Two participants required a licensed PE to lead the PSC process.

Clearly Identified Lines of Responsibility

Recommendation

- Have well-documented training requirements of classroom and on-the-job training coupled with some type of proficiency assessment to ensure well-qualified commission testing personnel.

Best Practice

- Some participants designated senior management from different departments of the company to collectively share responsibility for approval of the PSC program. Senior management involvement is likely to draw attention to and support commission testing programs.

Authority Given to Responsible Parties

Best Practice

- One participant reported that during contractor selection, it used a multi-layer selection process. Initially, the participant vetted the contractors for required qualifications. Then the participant's protection and control personnel vetted the contractor employees who would perform the actual commission testing.

Best Practice

- Some participants reported that their oversight personnel have frequent meetings with the contractor to review work performance, as this allows for prompt resolution of issues.

Feedback Methods to Improve the Plan

Best Practice

- Some participants used a standardized form to document lessons learned made available through a network application.
- The review of the lessons learned was required in a documented scope development process for new projects.
- Shared lessons learned information with external industry groups

8 Core Elements of PSC Procedure

- Planning and sequencing
- Print and technical review
- Preparing installed equipment for modification
- Equipment and device acceptance testing
- Equipment isolation
- Functional testing
- Operational (or in-service load) checks
- Documentation

Planning and Sequencing

- Participants reported similar organization process for coordinating PSC testing when other facility owners are involved

Best Practice

- As part of the commissioning process on tie lines, some participants employed back-to-back relay testing (i.e., in a testing in a laboratory environment) and end-to-end testing onsite.
- Back-to-back testing was also performed when installing unfamiliar relay models, configurations, and or firmware editions.

Print and Technical Review

Recommendation

- Entities should ensure that a design review is performed prior to the start of construction activities.
- When using third-party contractors, all Entities should ensure that the contract requires this design review. This is even more important in instances where the project involves multiple owners and separate design groups.
- The independent design review allows the correction of any identified errors with the concurrence of the design group(s) while keeping the objectivity of the commissioning group.

Preparing Installed Equipment for Modification

Best Practice

- One participant reported that the engineering package identified all equipment that needed to be isolated or shorted to ensure adequate in-service protection throughout all stages of the project.
- The participant explained that it also required the commissioning group to perform a peer-check of the isolations and shorted equipment on drawings and review any discrepancies or questions prior to the outage.

Equipment and Device Acceptance Testing

Recommendation

- All Entities should compare their acceptance testing practices to those listed in Section 3 (Commissioning Testing of Protection Schemes) of the IEEE WG I-25 guide and incorporate practices that provide opportunities for process improvement.
- Thorough acceptance testing can help ensure that the correct equipment has been provided; that the equipment is in good working order; and that it is functioning as designed.

Equipment Isolation

Recommendation

- All Entities should maintain a documented isolation log. The contents of the isolation log should be standardized and include, at a minimum, the repositioning of test switches, temporary jumpers, and shorting blocks; who made the changes; time and date of the change; and when the equipment was returned to normal.

Best Practice

- Some participants maintained an isolation log and tagged the circuits at the point of isolation for equipment isolation.

Functional Testing

Recommendation

- All Entities should implement end-to-end testing for all bulk electric system communication-based protection schemes as recommended by the IEEE WG I-25 guide. Communication failures are one of the top three causes for Misoperations.

Recommendation

- All Entities should perform current testing on all phases to ground, phase-to-phase, and 3-phase faults. This will ensure that CT ratios, CT and polarity, and polarization of ground elements is correct for all fault scenarios.

Operational (or in-service load) checks

Recommendation

- CT circuit errors represent a significant portion of misops primarily due to incorrect CT ratios, incorrect CT polarity, and CT's left in the shorted position. Entities should perform:
  - A final walk-down process to ensure that CT and VT circuits are correct prior to being placed in service.
  - In-service loading is above the minimum equipment requirements so that sufficient current magnitude is available for accurate measurement.

Operational Checks (cont'd)

- Operational tests and measurements include current and voltage magnitude, phase angle and polarity with respect to the primary quantities.
- Operational measurements from different relays, meters, fault recorders, SCADA transducers, and other devices that use the same voltage and current signals should be compared with each other to ensure similar measured quantities at each device.

Documentation

Recommendation

- All Entities should update their PSC procedure documentation as necessary to accurately reflect what is being done in the field. Entities should pay particular attention when copying documentation from other procedures.