

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

NERC SPCS Assessment of Standards:

- PRC-003-1 – Regional Procedure for Analysis of Misoperations of Transmission and Generation Protection Systems
- PRC-004-1 – Analysis and Mitigation of Transmission and Generation Protection Misoperations
- PRC-016-1 – Special Protection System Misoperations

A Technical Review of Standards

Prepared by the

System Protection and Controls Subcommittee

of the

NERC Planning Committee

May 22, 2009

116-390 Village Blvd., Princeton, NJ 08540
609.452.8060 | 609.452.9550 fax
www.nerc.com

Table of Contents

Executive Summary	3
Assessment of PRC-003-1.....	4
Assessment of PRC-004 and PRC-016-0.....	8

Introduction

When the original scope for the System Protection and Control Task Force (SPCTF, now the System Protection and Control Subcommittee – SPCS) was developed, one of the assigned items was to review all of the existing PRC-series of Reliability Standards, to advise the Planning Committee, and to develop Standards Authorization Requests, as appropriate, to address any perceived deficiencies.

This report presents the SPCS’ assessment of three of the PRC standards pertaining to relay misoperations:

- PRC-003-1 – Regional Procedure for Analysis of Misoperations of Transmission and Generation Protection Systems
- PRC-004-1 – Analysis and Mitigation of Transmission and Generation Protection Misoperations
- PRC-016-1 – Special Protection System Misoperations

This report serves as a precursor for a Standards Authorization Request (SAR) for modifications to PRC-003 that will be submitted by the SPCS.

Executive Summary

Standard PRC-003 is intended to ensure that all System Protection Misoperations are analyzed and mitigated according to guidelines established by the regions. The FERC, in Order 693, dated March 16, 2007, declared this standard as a “fill in the blank” type of standard that does not merit approval unless it is modified to make it more specific and consistent for all Regions. The SPCS concurs with the FERC order and provides recommendations on how the standard can be rewritten.

Because the procedures for analyzing and mitigating Misoperations were to be established by the regions, there is significant dissimilarity between the Misoperation data reported by each region, resulting in a virtually unusable misoperation metric for North America. SPCS recommends a change to the definition of Misoperation (Reportable Protection Misoperation) to provide uniformity to the misoperation data reported to the regions and NERC.

Protection System elements used for Special Protection Systems (SPS) or Remedial Action Schemes (RAS) are no different from those used for non Special Protection Systems. The revision to Standard PRC-003 should therefore apply to all Protection Systems, including SPS and RAS.

The SPCS also recommends that Standard PRC-016-0 – Special Protection System Misoperations, be requirements, merging its SPS/RAS Misoperation reporting, Corrective Action Plans, and tracking requirements into PRC-004 – Analysis and Mitigation of Transmission and Generation Protection System Misoperations.

Whenever an SPS/RAS misoperates and requires a Corrective Action Plan, that plan should become subject to review under PRC-012 to ensure that the changes proposed to the SPS are still properly designed, meet performance requirements, and is coordinated with other Protection Systems. Therefore, PRC-012 should be revised to require that review and PRC-004 should be modified to refer to that review process.

A Standards Authorization Request (SAR) will be submitted by the SPCS calling for a standards project to:

- Revise the definition of Misoperation (Reportable Protection Misoperation)
- Modify PRC-003, PRC-004, and PRC-012
- Retire PRC-016.

Assessment of PRC-003-1

PRC-003-1 – Regional Procedure for Analysis of Misoperations of Transmission and Generation Protection Systems requires the regions to establish procedures for analysis of Misoperations. This has resulted in significant and substantive differences in regional procedures and this was noted in FERC’s recommendation for “greater uniformity.”

SPCS proposes updating the PRC-003-1 standard to be applicable to all regions based on following tenets:

1. **Applicability** – The existing standard says that the Protection Systems shall be reviewed but does not specify which systems apply to this standard.

It is necessary for the new standard to define the protections systems to which the standard applies:

- Transmission Protection Systems which trip:
 - a. Transmission system elements 200-kV and above
 - b. Operationally significant system elements 100-kV to 200-kV
 - c. Transformers with 100-kV or higher on the low side
 - d. GSU transformers with high side voltages of 100-kV or higher
- Generation Protection Systems which trip:
 - a. Transmission system elements 200-kV and above
 - b. Operationally significant system elements 100-kV to 200-kV
 - c. Transformers with 100-kV or higher on the low side
 - d. GSU transformers with high side voltages of 100-kV or higher
 - e. Generators connected through GSU transformers with high side voltages of 100-kV or higher
- Protection Systems that trip aggregate generation of 75 MW or more (such as wind farms, geothermal, or solar) connected to the transmission system at 100-kV or higher.

2. **Definitions** – The NERC Glossary of Terms currently defines Misoperation as:

Misoperation (current definition)

- 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

The existing definition does not address what are reportable and non-reportable misoperations. Reportable misoperations should be redefined in terms of both dependability and security, as a function of the impact of the Protection Systems on the electric system performance. SPCS recommends the following definition:

Reportable Protection Misoperation (proposed definition)

Dependability (failure to operate):

- Failure of the composite Protection System to initiate the isolation of a faulted power system Element as designed or within its designed operating time.
- Failure of the composite Protection System to operate as intended for a non-fault condition, such as out-of-step, overload, etc., within its designed operating time.
- Failure of an SPS/RAS, UVLS system, or UFLS system to operate for an intended condition or within its designed operating time.

Security (false or undesirable operations):

- Improper operation of a Protection System in absence of a fault on the power system Element it is designed to protect.
- Improper operation of a Protection System during a fault on any other power system Element it is not designed to protect.
- Improper operation of an SPS/RAS, UVLS system, or UFLS system in absence of its designed trigger conditions.
- Over-response of an SPS/RAS, UVLS system, or UFLS system

Notes to the proposed definition:

- A. *The composite Protection System in the context of this standard is the total complement of protection for a system Element (line, bus, transformer, generator, etc). Primary and secondary protection of a given Element is considered as the composite Protection System, not two separate Protection Systems.*

- B. Delayed clearing, where a high-speed system is employed and is essential for transmission system performance, is considered a reportable misoperation of the high-speed system.*
 - C. Lack of targeting of the high-speed system, such as when it is beat out by a high-speed zone, is not considered a reportable misoperation.*
 - D. Multiple misoperations of a Protection System before it can be reasonably investigated and remedied should be considered as a single misoperation.*
 - E. Failure to automatically reclose after a fault is not a reportable misoperation.*
 - F. Human errors made in protection settings either as calculated or as installed, or wiring errors, which result in a misoperation are reportable.*
 - G. Protection System operations related to on-site maintenance, testing, construction and or commissioning activities for that Protection System, when no fault or other abnormal condition has occurred, are not considered reportable Protection System misoperations.*
 - H. Operations which are initiated by control systems (not by the Protection Systems), such as those associated with generator controls or turbine/boiler controls, SVCs, FACTS, HVDC, circuit breaker mechanism, or insulation media, or other facility control systems, are not reportable Protection System misoperations.*
 - I. Protection System operations which occur with the protected element already out of service, that do not trip any in-service elements, are not reportable Protection System misoperations.*
3. **Reporting of Misoperations** – Because the current PRC-003 calls for regional procedures and reporting requirements, there is a wide variation in those requirements from region to region, making comparison of misoperations metrics at the NERC level virtually impossible. Since any assessment of the success or failure of the NERC protection-related standards to maintain or improve reliability depends on those metrics, it is important to provide for uniformity.

The variations in definitions can be corrected by the adoption of the Reportable Protection Misoperation definition above.

Uniform reporting can be addressed by following proposed reporting requirements:

- Transmission Owner or Generation Owners that own Protection Systems shall submit a quarterly report of the total number of events analyzed, the number of Protection System misoperations, and the number of events still under analysis, in a prescribed

- format (to be part of the revised PRC-003 standard) no later than two calendar months after each quarter.
- The regions shall, in turn, submit a quarterly report to NERC – consolidated data for the Region in a prescribed format (also part of the revised PRC-003 standard).
 - The regions shall provide any additional information on misoperations to NERC as requested.
4. **Analyses of All Protection System Operations** – All transmission and generation Protection System operations should be analyzed to determine if the operation was correct. Merely reporting the number of misoperations is meaningless unless put in the context of the total number of operations.
5. **Peer Review of Misoperations** – Peer review of misoperations and tracking of mitigation plans is an important part of improving Protection System performance. Logically, that function should be done by the Regional Entities. However, since standards requirements cannot be placed on the Regional Entities, the following suggestions are made but the mechanics are left open.
- The regions, through their appropriate committees or subcommittee, shall review the misoperation reports. This review should determine whether further analysis, data, or other documentation is required, and it will confirm that appropriate mitigation is defined and scheduled.
 - The regions should maintain records of the quarterly reports and confirm the implementation of any proposed mitigation plan.
 - The regions should track the mitigation of reported misoperations to avoid further occurrences.
-

Assessment of PRC-004 and PRC-016-0

NERC standards PRC-004-1 – Analysis and Mitigation of Transmission and Generation Protection Misoperations, and PRC-016 – Special Protection System Misoperations both require that Protection System misoperations are analyzed and reported, and that corrective actions are taken where necessary. However, PRC-016 exclusively applies to special protection systems (SPS), also known as remedial action schemes (RAS). Since analysis and reporting of protection system misoperations is the same regardless of whether or not a SPS/RAS is involved; there is no need for a separate standard. Standard PRC-004-1 should be revised to include SPS/RAS, and PRC-016 should be retired.

SPS Corrective Action Plan Review

PRC-012-0 – Special Protection System Review Procedure is intended to provide a review procedure to ensure that all SPS/RAS are properly designed, meet performance requirements, and are coordinated with other Protection Systems.

Whenever an SPS/RAS misoperates and requires a Corrective Action Plan, that plan should become subject to review under PRC-012 to ensure that the changes proposed to the SPS are still properly designed, meet performance requirements, and are coordinated with other Protection Systems. Therefore, PRC-012 should be revised to require that review and PRC-004 should refer to that review process.

Proposed PRC-004-1 Revisions

SPCS recommends the following revisions to PRC-004-1 requirements to encompass those of PRC-016:

R1. The Transmission Owner and any Distribution Provider that owns a transmission Protection System or SPS shall each analyze its transmission Protection System or SPS Misoperations and shall develop and implement a Corrective Action Plan to avoid future Misoperations of a similar nature in accordance with Standard PRC-003 (revised).

R2. The Generator Owner shall analyze its generator Protection System or SPS Misoperations, and shall develop and implement a Corrective Action Plan to avoid future Misoperations of a similar nature in accordance with Standard PRC-003 (revised).

R3. The Transmission Owner, Generator Owner, and Distribution Provider that owns a transmission Protection System or an SPS shall provide documentation of the misoperation

analyses and the Corrective Action Plans to its Regional Reliability Organization and NERC upon request (within 90 calendar days).

R4. All Corrective Action Plans for SPS shall be subject to SPS Review Procedures in accordance with Standard PRC-012.

Appendix A – System Protection and Control Subcommittee

John L. Ciuffo

Chairman

Manager, P&C Strategies and Standards
Hydro One, Inc.

Jonathan Sykes

Vice-Chairman

Senior Principal Engineer, System Protection
Salt River Project

Michael J. McDonald

Investor-Owned Utility

Senior Principal Engineer, System Protection
Ameren Services Company

William J. Miller

Investor-Owned Utility

Consulting Engineer
Exelon Corporation

George Pitts

U.S. Federal

Transmission Planning
Tennessee Valley Authority

Sungsoo Kim

Canada Provincial

Senior Protection Engineer
Ontario Power Generation Inc.

Joe T. Uchiyama

U.S. Federal

Senior Electrical Engineer
U.S. Bureau of Reclamation

Charles W. Rogers

Transmission Dependent Utility

Principal Engineer
Consumers Energy Co.

Joseph M. Burdis

ISO/RTO

Senior Consultant / Engineer, Transmission
and Interconnection Planning
PJM Interconnection, L.L.C.

Jim Ingleson

ISO/RTO

Senior Electric System Planning Engineer
New York Independent System Operator

Bryan J. Gwyn

RE – NPCC

Manager, Protection Standards and Support
National Grid USA

Philip Tatro

RE – NPCC Alternate

Consulting Engineer
National Grid USA

Henry (Hank) Miller

RE – RFC

Principal Electrical Engineer
American Electric Power

Deven Bhan

RE – MRO

Electrical Engineer, System Protection
Western Area Power Administration

John Mulhausen

RE – FRCC

Manager, Design and Standards
Florida Power & Light Co.

Philip B. Winston

RE – SERC

Manager, Protection and Control
Georgia Power Company

Dean Sikes

RE – SPP

Manager - Transmission Protection, Apparatus, & Metering
Cleco Power

Samuel Francis

RE – TRE

Senior Director of Engineering
Oncor Electric Delivery

Baj Agrawal

RE – WECC

Principal Engineer
Arizona Public Service Company

Josh Wooten

U.S. Federal Alternate

System Protection and Analysis
Tennessee Valley Authority

W. O. (Bill) Kennedy

Canada Member-at-Large

Principal
b7kennedy & Associates Inc.

Robert W. Cummings

NERC Staff Coordinator

Director of Event Analysis & Information Exchange
NERC

Tom Wiedman

Subject Matter Expert – NERC Consultant

President
Wiedman Power System Consulting, Ltd.

Jonathan D Gardell

Subject Matter Expert – NERC Consultant

Executive Advisor
Quanta Technology

Eric A Udren

Subject Matter Expert
Executive Advisor
Quanta Technology

Murty Yalla

Subject Matter Expert
President
Beckwith Electric Company Inc.

David Angell

Correspondent
T&D Planning Engineering Leader
Idaho Power Company

Hasnain Ashrafi

Correspondent
Engineer
Sargent & Lundy

Dac-Phuoc Bui

Correspondent
Engineer
Hydro-Quebec TransÉnergie

Jeanne Harshbarger

Correspondent
System Protection Engineer
Puget Sound Energy, Inc.

Fred Ipock

Correspondent
Senior Engineer - Substations & Protection
City Utilities of Springfield, Missouri

Evan T. Sage

Correspondent
Senior Engineer
Potomac Electric Power Company

Joe Spencer

Correspondent
Manager of Planning and Engineering
SERC Reliability Corporation

Bob Stuart

Correspondent
Senior Director - Transmission
BrightSource Energy, Inc.

James D. Roberts

Correspondent
Transmission Planning
Tennessee Valley Authority