Protective Relay Subcommittee
Misoperations Whitepaper

Status Report to MRO Board of Directors

Mark Gutzmann, Xcel Energy
MRO Board of Directors Meeting
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- Background -

- Misoperations are involved in roughly 70% of BES disturbance events.
- They typically increase the # of facilities removed from service.
- In 2015, NERC announced that the industry should work towards a goal of reducing misoperations by 25%.
- To assist in this effort, the MRO PRS has embarked on a project to identify causes of, and opportunities to reduce, misoperations that occur within MRO.
- Background -

Figure 4.12: NERC Misoperations by Cause Code (2Q 2011–3Q 2014)\textsuperscript{55}

* NERC State of Reliability Report - 2015
- Background -

- The PRS whitepaper will identify specific protection schemes that have a disproportionate share of misoperations within MRO for events from 2010 through 2014.

- The whitepaper will then identify approaches that will effectively help to reduce their occurrence.

- In this initial whitepaper, scheduled for completion this April 2016, four schemes will be discussed.
  - A PRS member will present this whitepaper at the MRO Reliability Conference scheduled for May 25, 2016 at the MRO St. Paul office.

- A second whitepaper will be prepared over the winter of 2016/2017 to address several other schemes and provide effective mitigation approaches for these additional schemes.
Scheme 1: Overcurrent Setting Errors

- Overcurrent protection has been in use since the power system began
  - Simple, easy and fast!
  - Performance affected by system contingencies, growth (or reduction) and directionality
  - Require ‘coordination’ timing with adjacent elements to ensure proper operating order

- Accounted for 68 Misoperations for the time period
  - Ground (residual or neutral) instantaneous overcurrent element highest contributor in this category

- Possible Mitigations
  - Considerations provided for phase and ground instantaneous overcurrent, as well as inverse time ground overcurrent elements
  - Assure setting loadability and adequate margins for growth and contingencies
  - Ensure study of mutual coupling (NERC Lessons Learned) for ground overcurrent elements
  - Specific use on transmission transformers
Scheme 2: Overcurrent Protection in Pilot Schemes

- Overcurrent elements used for fault detection in pilot schemes
- Sensitivity required to ensure protection for high resistivity faults
- Price of this sensitivity is security during communication failures

Possible Mitigations
- Remote/local coordination
- Use of ground distance elements vs. ground overcurrent, where available and practical
- Close attention to polarization methods
Scheme 3: Directional Comparison Blocking (DCB)

- One of the earliest pilot protection systems
- Powerline Carrier (PLC) based communication
- Communication failure tends to cause overtripping (Misoperations)
- Historically used sensitive ground overcurrent elements for fault detection

Possible Mitigations
- Remote/local coordination
- Use of ground distance elements vs. ground overcurrent, where available and practical
- Close attention to polarization methods
- PLC communication design, settings and channel monitoring
Scheme 4: Direct Transfer Trip (DTT)

- Use for breaker failure, transformer, shunt reactor and limited number of piloted systems
- 80% of Misoperations due to transient or noise induced operations (31 total DTT Misoperations)
- Majority of Misoperations on Powerline Carrier systems

MRO System Protection DTT Scheme Mis-Operations

- Communication channel noise transient (58%)
- Moment of device failure communication transient (13%)
- Loss of communication channel transient (10%)
- Output failure (continuous communication key) (6%)
- Transmitter input DC transient (6%)
- Communication transceiver setting errors (3%)
- Guard before trip logic setting (3%)
- Receiver attenuation setting (3%)
Scheme 4: Direct Transfer Trip (DTT)

Possible Mitigations

- Validation timer settings
- Review of channel design considerations
- Redundancy (voting) schemes ($$)
- Noise mitigating scheme improvements
- Numerous industry references for PLC consideration
Summary and Conclusions

- PRS White Paper scheduled for April, 2016

- Targets MRO specific concerns based upon past performance
  - Phase and ground overcurrent elements
  - Overcurrent elements in piloted systems
  - Directional Comparison Blocking (DCB) systems
  - Direct Transfer Trip (DTT) systems

- Follow-up paper with potential topics in Q1, 2017
  - Breaker failure
  - Loss of potential
  - Line differential/phase comparison
  - Current only systems (bus, line and transformer differential)
Protective Relay Subcommittee of the MRO