PRC-005 Compliance Made Easy with Digital Substations

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AltaLink

- Canada’s first independent transmission provider in 2002
- Responsible for the maintenance and operation of more than 13,000 km of transmission lines and approx. 300 substations (500/240/138 KV AC and one DC link)
- Solely owned by Berkshire Hathaway Energy on Dec 1, 2014
PRC-005 Impact

  - Transmission facility owners and generation owners connecting to bulk electrical system 100KV or above
  - Protection system covers also UFLS/UVLS, RAS, lockout and auxiliary relays

- **Maximum maintenance interval (Unmonitored):**
  - Protective relay: 6 – 12 calendar years to verify AC measurements and digital I/O operation depending on levels of self-monitoring of the relay
  - Trip coils of CBs or interrupting devices: every 6 calendar year to verify correct operation of CB via individual trip coils.
  - Control circuits for protective functions inclusive auxiliary relays: every 12 calendar years to verify continuity of control circuits to trip coils of CBs
  - Electromechanical lockout devices directly in the trip path: every 6 calendar year to verify electrical operations
  - Alarm paths monitoring – every 12 calendar years to verify individual alarm path continuity

- **Maximum maintenance interval (Monitored):** No periodic maintenance required
Current Practice

• **Time-based maintenance**
  - Intervals based on equipment criticality
  - Only proves that relay’s functional aspects are working at the time of testing. Subsequent failure will not be detected until next maintenance

• **Multiple groups are involved (eg. Trip coil involves Apparatus)**

• **Repetitive and time consuming routines to ensure safety and security**

• **Control circuits + Alarm path monitoring**
  - Mostly hardwired paths unmonitored, time consuming to check and test.

• **Trip coil operation**
  - Not all TCs have TCS implemented. The logic itself needs to be tested and maintained. TC operation is mandatory nevertheless.
  - Requires sending crew to site

• **Documentation requirements**

• **Typically lacking up-to-date inventory of auxiliary devices**

• **Overall, higher OPEX due to tighter maintenance intervals & additional assets added to the standard (UFLS)**
Concept of Digital SS

- Modern substation design exploiting digital sensor technology, distributed IEDs, intelligent monitoring and open standards.
- Reduce cost and enhance efficiency, reliability and safety of engineering, maintaining and operating a substation.
- Natively self-monitored communication network
- IEC61850 is the main technology enabler
  - 8-1: Station bus. GOOSE and client/server over MMS
  - IEC61869 – 9 2016 (Digital interface for instrument transformers), standardizes and expands 9-2LE on sampling rate, num/configurability ASDU, time sync etc.
Typical 138kV Bay

Protection system design requirements defined in ISO Rule 502.3
Interconnected Electric System Protection Requirements
Digital Substation Pilot (Blackie)

- 138kV switching station
  - Low system criticality
- Multi-vendor solution
- Station bus – PRP
- Process bus – PRP and P2P
- PTP for time synchronization
- Energized Nov. 2018
Digital Substation Pilot (Blackie)

Vendor ‘A’ IEDs

Vendor ‘B’ IEDs
Benefits – Analog Measurement Monitoring

- Currently require technicians on-site visually compare relay measurements of injected/measured values
- Digital design: continuous monitoring and comparison of analog values and circuits
- Alarms for unacceptable errors
- Less onus on techs to create documentation
- No periodic maintenance
- Reduced OPEX
Benefits – Lockout Relays

- AltaLink currently does not use 86LO as tripping devices
- Digital design: soft lockout (block close) implemented
- Eliminates the need for inventory keeping
- Verified during settings/configuration comparison
- No periodic testing required
Benefits – Trip Coil

- Existing design requires techs on-site to verify TC2 operations
- New digital design has Vendor A & B RIOs actuate individual coils.
- Control handles eliminated, replaced by local IED Pushbutton to achieve same functionality
- Access to both TCs remotely
- Do not require techs on-site for TC verification
Benefits – Control Circuitry Monitoring

- Hardwired circuits are not monitored. You only know it fails when it is needed the most. (TC has TCS but not all...)
- Digital design - majority of ‘control circuitry’ continuously monitored – IEDs to RIOs
- Auxiliary tripping relays eliminated. Trip signals consolidated in RIOs
- Unmonitored control circuits verified during TC verification – RIO to TCs (accessible remotely).
Benefits – Documentation

- The emphasis on detailed documentation of tests and results has increased with PRC-005-6.
- Overhaul of existing enterprise system managing maintenance intervals and test results is required. Some didn’t exist.
- Consolidation of test results from multiple databases.
- Need to create an inventory of auxiliary relays used in trip circuits.
- With digital self-monitored technology efforts and requirements to maintain the evidences are reduced.
- Manual test results are replaced by logs from continuous monitoring.
Conclusions

- PRC-005 has increased the frequency and efforts of Protection System maintenance tasks
- Digital substation technology enables continuous monitoring of previously unmonitored components of the Protection System
- It contributes to the evolution from time-based to condition-based maintenance