Title of Tutorial*

Implementing Fault Location Isolation and Service Restoration (FLISR) on Distribution Circuits with High DER Penetration – Strategies for Success

Length of Tutorial*

Four (4) hours

Abstract*

For several decades, electric distribution utilities have been able to achieve significant reliability improvements by quickly isolating faulted feeder sections and restoring power to healthy sections using FLISR on their distribution feeders. The growing penetration of DERs presents new challenges, such as load masking and incorrect fault location due to DER fault current contributions, that may impact the performance of these legacy systems. DER presence also provides opportunities for improved FLISR performance such as freeing capacity to permit load transfers on heavily loaded feeders and supporting islanded microgrids on isolated feeders that lack backup sources. The proposed tutorial will provide basic information on how FLISR works, equipment requirements, reliability improvement benefits obtained, and strategies for addressing the new challenges posed by DER presences and opportunities to leverage DERs for optimal performance.

Target Audience*

The proposed tutorial targets distribution control center operators and field operation staff who are responsible for managing the electric distribution system, engineers who are responsible for distribution circuit design and DER connections, distribution automation and communication specialists, and other stakeholders that are focused on achieving high service reliability for the benefit of the utility's customers.

Prerequisites

Attendees should have basic understanding of electric distribution system design and operating practices, protection systems for the distribution system (protective relays, reclosers, etc.), and distributed energy resources (generation, storage, and controllable loads) that may be connected to the distribution system. Some knowledge about distribution SCADA systems and advanced distribution management systems (ADMS) is also beneficial.

Learning Objectives*

At the conclusion of this tutorial students will be familiar with:

- FLISR operation and benefits
- Equipment requirements, including medium voltage switches, communication network requirements, and computer hardware and software needed to implement FLISR
- FLISR design characteristics such as the types of switches to use and optimal quantity of switches to install
- FLISR switch placement for optimal performance
- Potential adverse impacts of DERs, and opportunities to leverage DERs to optimize FLISR performance
- Business case for FLISR deployment.

Course Outline*

Historical Perspective (30 minutes)

- Auto-restoration over the years (historical perspective)
- Completely manual approach
- Use of automatic reclosers
- Auto throwover (ATO) schemes
- Non-communicating automatic sectionalizing
- Rules-based SCADA solution
- Decentralized FLISR (S&C Intelliteam)Advanced model-driven FLISR with DER Awareness (next generation).

How FLISR works (60 minutes)

- Key terms and definition
- Step through FLISR operating sequence for typical fault,
- Triggering events and events that should <u>not</u> trigger FLISR (load shedding, manual operation)
- FLISR Operating Modes (manual, advisory mode, fully-automatic mode)
- Features of ADMS Model-Driven FLISR, generation of switching plans for additional benefits, plus return to normal strategy)
- FLISR return to normal configuration (including cold load pickup considerations)
- Special operating conditions (FLISR operation during live line work and during widespread outages (storm emergencies))

Equipment requirements (60 minutes)

- Choosing the right type of switch (line reclosers, automatic sectionalizers, remote-controlled load break switches, manual gang-operated switches with add-on motor operator, pad mount versus overhead switches, use of ring main units (RMU), single pole switching versus gang operated devices)
- Required sensors (load measuring devices, line post sensors, faulted circuit interrupters (FCIs), bi-directional fault detectors, detectors embedded in switchgear, protective relays)

- Communication facilities (available options such as cellular, licensed/unlicensed wireless, fiber optic, power line carrier; communication protocols, security concerns (Physical and cyber)).
- Power supply characteristics (choice of power sources, use of batteries/chargers)
- Enclosures (ingress protection (IP) ratings, use of enclosure heaters or cooling)
- including coordination difficulties for series reclosers, required sensors (bidirectional FCIs, measurement devices), required communication facilities)

Potential Opportunities and Adverse impacts of DERs (40 minutes)

- Adverse impacts
    - Masked load
    - DER fault current contributions
    - Problems with transferring DERs to backup feeder (reverse power flow issues, high voltage)
- Opportunities
    - Leveraging DER capabilities to release capacity on heavily loaded circuits
    - Establish islanded microgrids for isolated feeder sections with no backup

Quantities of FLISR Switches and Switch placement strategy (30 minutes)

- Optimal quantities of FLISR switches (diminishing returns, coordination issues)
- Potential impact of small change in switch locations
- Approach to determine optimal switch placement
    - Strategy for optimal switch placement to achieve maximum reliability improvement
    - Demonstrate switch placement analysis using IEEE standard models.

Calculating the benefits of FLISR (20 minutes)

- Predicted SAIDI/SAIFI changes
- Predicted MAIFI (momentary) changes, momentary versus permanent outage tradeoff
- Converting reliability improvement benefits to monetary and strategic (soft) benefits

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Number of Presenters*

Two (2)

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Instructor Bio(s)

Robert Uluski has over 40 years of experience in electric utility Transmission and Distribution (T&D) automation systems. His experience includes planning and implementing energy storage, microgrid control systems, advanced distribution management systems (DMS), feeder automation systems, substation automation, protective relay systems, and distributed resource energy management systems (DERMS). Bob has helped numerous North American and International electric utilities to plan, design, and implement computer and communication systems for automating distribution feeders and T&D substations, along with DMS and enterprise level systems that make optimal use of these automation facilities. Bob is also a recognized expert in developing the business case for implementing these systems. Bob has considerable experience in conducting tutorials on Distribution Automation technologies and advanced applications for DMS, having presented many training courses on the subject at DistribuTECH, NRECA TechAdvantage, IEEE, EUCI, and others. Bob has also presented a course on DA fundamentals and Conservation Voltage Reduction (CVR) principles for the Ohio Public Utility Commission members. In 2010, the IEEE Power and Energy Society awarded Bob the Douglas M. Staszesky Distribution Automation award in recognition of significant contribution to the deployment of Distribution Automation in the electric utility industry. Bob is a Registered professional engineer in states of Massachusetts and Pennsylvania.

Dr. Stuart Borlase has over 25 years of experience in the modernization and business transformation of utility, energy and industrial markets. His experience includes smart grid, grid real-time monitoring and control, substation automation, distribution automation, protective relaying systems, digital substations, IT/OT integration, and asset management. His roles have included progressively more influential positions with Schneider Electric, Siemens, Wipro Technologies, and General Electric.