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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Industry Webinar – Draft Standard

Project 2010-13.2 Phase 2 of Relay Loadability: Generation
PRC-025-1 Generator Relay Loadability

December 13, 2012

RELIABILITY | ACCOUNTABILITY




Agenda

- Welcome, Introductions and Administrative
- NERC Antitrust Guidelines
- Opening Remarks
- Project Background
- FERC Directives
- PRC-025-1 – Generator Relay Loadability (GENRLO)

Introductions

- Industry Stakeholders and Team Members
  - Charlie Rogers, Standard Drafting Team (SDT) Chair, Consumers Energy
- NERC Staff
  - Scott Barfield-McGinnis, NERC Standards Developer
  - Phil Tatro, NERC Technical Advisor

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GENRLO SDT Members

Member	Registered Entity
Charles W. Rogers, Chair	Consumers Energy
Jeff Billo	ERCOT
S. Bryan Burch, P.E.	Southern Company
Steven Hataway	Florida Power and Light Company
Jonathan Hayes	Southwest Power Pool, Inc.
Mike Jensen	Pacific Gas and Electric Company
Xiaodong Sun	Ontario Power Generation, Inc.
Sudhir Thakur	Exelon Generation
Joe T. Uchiyama	U.S. Bureau of Reclamation
Benson Vuong	Salt River Project
David Youngblood	Luminant Energy
Scott Barfield-McGinnis (Project Advisor)	North American Electric Reliability Corporation
Phil Tatro (Technical Advisor)	North American Electric Reliability Corporation

Administrative

- Two hour webinar
- Presentation the first hour
- Informal Question and Answer session during the second half
  - Submitted via the chat feature
  - Presenters will attempt to address each question
  - Some questions may require SDT consideration
  - Session is intended to provide better understanding
  - Reduce the number of minor comments the team will need to respond to from a comment period

Antitrust Guidelines

- NERC Antitrust Guidelines
  - It is NERC's policy and practice to obey the antitrust laws and to avoid all conduct that unreasonably restrains competition. This policy requires the avoidance of any conduct that violates, or that might appear to violate, the antitrust laws. Among other things, the antitrust laws forbid any agreement between or among competitors regarding prices, availability of service, product design, terms of sale, division of markets, allocation of customers or any other activity that unreasonably restrains competition. It is the responsibility of every NERC participant and employee who may in any way affect NERC's compliance with the antitrust laws to carry out this commitment.

Disclaimer

- Disclaimer
  - Participants are reminded that this meeting is public. Notice of the meeting was posted on the NERC website and widely distributed. The notice included the number for dial-in participation. Participants should keep in mind that the audience may include members of the press and representatives of various governmental authorities, in addition to the expected participation by industry stakeholders.
  - Proposed standard text in this presentation may not reflect the finalized draft of the posted standard after this webinar

Opening Remarks

- Today's important takeaways
  - Results-Based Standard (RBS)
    - Risk-based focus
    - Applies to the Generator Owner
    - Addresses short durations (i.e., during "field forcing")
    - Applies to generator load-responsive protective relays
      - Generator units
      - Generator step-up (GSU) transformers
      - Auxiliary transformers that support plant operation
  - Guidelines and Technical Basis is key to understanding
  - Coordination with other standards development
  - Filing deadline of September 2013

Terminology

- The following terms used in the presentation mean:
  - GO – Generator Owner
  - GSU – Generator Step-up
  - MVA – megavoltampere
  - Mvar – megavoltampere-reactive
  - MW – megawatts
  - PC – Planning Coordinator
  - TP – Transmission Planner

Project Background

- FERC Order No. 733
  - PRC-023-1 Transmission Relay Loadability (Phase 1)
    - Directed modifications implemented in PRC-023-2
  - PRC-025-1 Generator Relay Loadability (Phase 2)
    - Develop a new Reliability Standard addressing generator relay loadability, with its own individual timeline, and not a revision to an existing Standard
  - Protective Relay Loadability due to Stable Power Swings (Phase 3)
    - Develop a Reliability Standard that requires use of protective relay systems that can differentiate between faults and stable power swings and, when necessary, phases out protective relays that cannot meet this requirement

Directives

- FERC Order No. 733
  - March 18, 2010
  - Docket No. RM08-13-000
- 1 primary directive (paraphrased)
  - P106 – Address generator loadability in a new standard
- 3 supporting directives (paraphrased)
  - P104 – Address GSU and unit auxiliary transformers
  - P105 – ERO to submit a schedule
  - P108 – Consider using a percentage of the rating

Background

- Need for a standard
  - During disturbances
    - Generators tripped unnecessarily
    - Condition did not pose a risk to the generator
    - Tripping expanded the scope and/or extended the duration
  - August 14, 2003 findings
    - 290 generators tripped
  - During depressed and fluctuating voltage
    - Generators provide reactive power within their dynamic capability
    - Providing reactive power aids system recovery
    - Loss of reactive power may exacerbate a voltage disturbance
    - Loss of real power may exacerbate a frequency disturbance

PRC-025-1

- Structure
  - Single Requirement/Measure
  - Attachment 1: Relay Settings
    - Table 1. Relay Loadability Evaluation Criteria
  - Guidelines and Technical Basis
    - Generator Performance
    - Generator Phase Distance Relays
    - Generator Phase Time Overcurrent Relay – Voltage Restrained
    - Generator Phase Time Overcurrent Relay – Voltage Controlled
    - Generator Step-up Transformer Phase Time Overcurrent Relay
    - Generator Step-up Transformer Phase Distance Relay
    - Auxiliary Transformer Phase Time Overcurrent Relay

PRC-025-1 Purpose

- Purpose
  - To set load-responsive generator protective relays at a level to prevent unnecessary tripping of generators during system disturbance for conditions that do not pose a risk of damaging the generator.
- Disturbance History
  - Unnecessary tripping expanded scope/duration of outages
  - Conditions during recoverable phase of a disturbance
    - Depressed voltage
    - Need for reactive power
    - Continue the supply of real power

PRC-025-1 Applicability

- Entities (3.1): Generator Owner that applies load-responsive protective relays on Facilities listed in 3.2, Facilities
- Facilities (3.2): The following Elements of the Bulk Electric System generation Facilities, including those identified as Blackstart Resources in the Transmission Operator's system restoration plan:
  - Generating unit(s)
  - Generator step-up (i.e., GSU) transformer(s)
  - Auxiliary transformer(s) that supply overall auxiliary power necessary to keep generating unit(s) online[1]

Load Responsive Relays Inclusion

- Phase distance (21)
- Phase time overcurrent (51)
- Phase time overcurrent – Voltage controlled (51 V-C)
- Phase time overcurrent – Voltage restrained (51 V-R)
- Phase directional time overcurrent (67)

Load Responsive Relays Exclusions

- Relay elements armed only when generator is off-line
- Phase fault detector relay elements used to supervise other applicable load-responsive relay elements
- Relay elements that are only enabled when other protection elements fail
- Relay elements used only for Special Protection Systems
- Relay elements designed only for overload protection

PRC-025-1 R1/M1

- **R1.** Each Generator Owner shall ~~install~~ apply settings that are in accordance with PRC-025-1 – Attachment 1: Relay Settings, on each load-responsive protective relay while maintaining reliable fault protection.
- **M1.** For each load-responsive protective relay, each Generator Owner shall have and provide as evidence, dated documentation of: (1) setting~~s~~ calculations, and (2) that settings were applied ~~installed~~ in accordance with PRC-025-1 – Attachment 1: Relay Settings.

Guidelines and Technical Basis

- "Maintaining Reliable Fault Protection"
  - GO considers both the requirements within this standard and its desired fault protection goals, and perform modifications to its protective relays or protection philosophies as necessary to achieve both

Field Forcing

- When a synchronous generator experiences a depressed voltage, it will respond by increasing its Reactive Power output to support the generator terminal voltage
- Results in exceeding the steady-state reactive capability of the generator - may result in operation of load-responsive protective functions
  - Short duration (typically several seconds) – Depends on the application of excitation system controls
- Durations longer than fault clearing and shorter than overload conditions

Attachment 1

- Synchronous Units
  - Real Power – Maximum gross in MW as reported to the PC or TP
  - Reactive Power – Mvar based on the unit's nameplate MVA at rated power factor
- Asynchronous Units
  - Site *aggregate* MVA output at rated power factor

Attachment 1 Continued

- GSU Transformer
  - Synchronous Units - Pickup Setting Criteria calculations are based on Real and Reactive Power
  - Asynchronous Units - Site's *aggregate* MVA output at rated power factor
- Unit Auxiliary Transformers
  - Based on nameplate maximum MVA rating or actual load

Calculation Variables

- MW/Mvar “capability”
  - Real Power - Maximum reported
  - Reactive Power – Derived from MW rating or by simulation
- Options - Ease of calculation
  - 0.95 p.u. generator bus voltage – easiest, approximates the stressed system conditions
  - 0.85 p.u. system voltage – more involved and precise
  - Simulation – most involved and precise

Calculation Variables Continued

- Unit auxiliary transformer
  - Based on nameplate
  - Based on connected load
    - Can be either calculated or observed
  - Simulation of auxiliary load performance
    - Detailed characteristics of all connected loads

Table 1 – Options 1

Table 1. Relay Loadability Evaluation Criteria				
Application	**Relay Type**	**Option**	**Bus Voltage**	**Pickup Setting Criteria**
Synchronous generators	Phase Distance Relay (21) – Directional toward the Transmission System	1.1	Generator bus voltage corresponding to **0.95** per unit of the high-side nominal voltage times the turns ratio of the generator step-up transformer	The impedance element shall be set less than the impedance derived from 115% of: (1) Real Power output – 100% of maximum gross MW capability reported to the Planning Coordinator or Transmission Planner, and (2) Reactive Power output – a value that equates to 150% of rated MW
		1.2	**Calculated** generator bus voltage corresponding to **0.85** per unit nominal voltage on the high-side terminals of the generator step-up transformer (including the transformer turns ratio **and** impedance)	The impedance element shall be set less than the impedance derived from 115% of: (1) Real Power output - 100% of maximum gross reported to the Planning Coordinator or Transmission Planner, and (2) Reactive Power output – a value that equates to 150% of rated MW
		1.3	**Simulated** generator bus voltage corresponding to **0.85** per unit nominal voltage on the high-side terminals of the generator step-up transformer (including the transformer turns ratio **and** impedance)	The impedance element shall be set less than the impedance derived from 115% of: (1) Real Power output – 100% of maximum gross MW capability reported to the Planning Coordinator or Transmission Planner, and (2) Reactive Power output – a value that equates to the Maximum Mvar output determined by simulation

Implementation

- Draft 1 proposal
  - 48 months
- Draft 2 proposal – Phased approach
  - 48 months for calculations
  - 48 months for applying settings (existing)
  - 72 months for applying settings (replacements)

Standards Coordination

- Project 2007-06 System Protection Coordination
  - PRC-001-1
  - PRC-027-1
- Project 2007-09 – Generator Verification
  - MOD-025-2
  - PRC-024-1
- Existing Standards
  - PRC-023-2

Question and Answer Session

- Please submit your questions via the chat window
  - Please reference slide number, standard section, etc.
  - Presenters will respond to as many as possible
  - Some questions may have to be deferred to the team
  - This session is intended to help general understanding
- Comments for the official record
  - Comments must be submitted during open comment periods
  - Webinar and chat comments are not a part of the project record

Commenting

- Effective feedback:
  - Specific to question, brevity is best
  - Provide suggestions or alternative approaches
  - Indicating agreement with others is preferred over copying the comments (e.g., “ABC agrees with XYZ’s comments...” or “ABC agrees with XYZ’s comments except for…”) Provide proposed change and rationale
- Less effective feedback:
  - Repeating same comment multiple times
  - No reference to where suggested change should occur
  - Non-specific concerns (e.g., “This standard is not needed.”)

Conclusion

- NERC Project Advisor, Scott Barfield-McGinnis
  - Email at scott.barfield@nerc.net
  - Telephone: 404-446-9689
  - For requests to be added to the team distribution plus list
- Timeline
  - 45-Day Formal Comment Period – January 2013
  - Initial Ballot last ten days of comment period
- FERC deadline – September 2013
  - Compressed timeline is required to achieve the necessary steps within the standards development process