TPL-007 Revisions
NERC Standards Project 2013-03 GMD Mitigation

Frank Koza, PJM Interconnection
GMD Task Force Meeting
February 21, 2017
...the Commission approves Reliability Standard TPL-007-1 as just, reasonable, not unduly discriminatory or preferential and in the public interest. While we recognize that scientific and operational research regarding GMD is ongoing, we believe that the potential threat to the bulk electric system warrants Commission action at this time, including efforts to conduct critical GMD research and update Reliability Standard TPL-007-1 as appropriate.

U.S. Federal Energy Regulatory Commission (FERC)
September 2016
• Order No. 830 directs NERC to revise TPL-007 to address Commission concerns
  ▪ Modify the benchmark GMD event definition used for GMD assessments
  ▪ Require entities to collect GMD data
  ▪ Establish deadlines for Corrective Action Plans (CAPs) and mitigating actions to address identified GMD impacts

• Revisions must be filed by May 2018
Initiation of Standards Project

- Standards drafting team (SDT) appointed in December 2016
  - Initial meeting January 2017
- Standards Authorization Request (SAR) posted for comment December 2016 – January 2017
## Standard Drafting Team

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A brief review of TPL-007-1...

- TPL-007-1 addresses risks of voltage collapse and equipment damage in the Bulk Electric System (BES) caused by GMD events.

- Entities involved:
  - Planning Coordinators and Transmission Planners
  - Transmission Owners
  - Generator Owners
Components of TPL-007-1
- Benchmark GMD event
- GMD Vulnerability Assessment
- Corrective Action Plan (CAP)

Implementation phased in over five year period beginning July 2017
• Assessments are based on a severe 1-in-100 year GMD event. Two components for analysis:
  - Amplitude of 8 V/km scaled to the entity’s planning area
  - Wave shape for assessing transformer hot-spot heating

Source: NERC Benchmark GMD Event Description, May 2016
Calculated Peak Geoelectric Field

\[ E_{\text{peak}} = 8 \times \alpha \times \beta \text{ (in V/km)} \]

where,

- \( E_{\text{peak}} \) = Benchmark geoelectric field amplitude at System location
- \( \alpha \) = Factor adjustment for geomagnetic latitude
- \( \beta \) = Factor adjustment for regional Earth conductivity model

8 V/km is the peak geoelectric field amplitude at reference location (60° N geomagnetic latitude, resistive ground model)
• Statistical occurrence of extreme geoelectric field amplitudes is characterized considering spatial scales:
  ▪ Same data source as NERC interim report
  ▪ Spatially local geoelectric field enhancements do not characterize wide area effects
    ▪ Localized peak 20 V/km
    ▪ Wide area averages of 8 V/km.

• White paper includes SDT’s analysis of:
  ▪ Localized geomagnetic activity on a representative system
  ▪ Reference storm wave shape comparison

• Order No. 830 directed development of changes to the benchmark
• The objective of the GMD vulnerability assessment is to prevent instability, uncontrolled separation, or cascading failure of the System during a GMD event

• System performance is evaluated based on
  - System steady-state voltage criteria established by the planning entity
  - Cascading and uncontrolled islanding shall not occur
• TOs and GOs conduct thermal impact assessment of BES power transformers
• Provide results within 24 months
• Techniques:
  ▪ Manufacturer performance curves
  ▪ Thermal response simulation
  ▪ Thermal impact screening

• Assessment is not required for transformers < 75 A per phase peak GIC for the Benchmark
The Commission approves the reference peak geoelectric field amplitude figure proposed by NERC. In addition, the Commission... directs NERC to develop revisions to the benchmark GMD event definition so that the reference peak geoelectric field amplitude component is not based solely on spatially-averaged data.

-Order No. 830 P 44
...the Commission directs NERC to revise Requirement R6 to require registered entities to apply spatially averaged and non-spatially averaged peak geoelectric field values, or some equally efficient and effective alternative, when conducting thermal impact assessments.

-Order No. 830 P 65
Enhancements to the Benchmark

• What do we know about “local enhancements”/peak events?
  ▪ Initial review of data from several significant events—Quebec/1989; Greenland/Halloween, 2003; Svalbard, Norway/Halloween, 2003; Alaska/March 2015
    ▪ Waveform similarities—local intense peak (2-3 min in duration)
    ▪ Longitudinal extent: ~500km; Latitudinal extent; ~100km
    ▪ Peak Amplitude increase: ~ a factor of 2

• How might be account for “local enhancements” in the existing benchmark?
  ▪ Superimpose onto the existing wave shape
  ▪ A second waveshape with known enhancement
  ▪ Change existing spatially-averaged amplitude and then apply local enhancement
  ▪ “Moving box” analysis
  ▪ “Category D” type event—analyze, but CAP not required
• TPL-007 requires CAP when the GMD Vulnerability Assessment indicate system performance requirements are not met

• Options include
  ▪ Hardening the system
  ▪ Installing monitors
  ▪ Operating procedures

• Order No. 830 directs revisions to establish CAP deadlines (P 101)
  ▪ One year for development of CAP
  ▪ Two years for implementing operating procedure mitigation
  ▪ Four years for implementing hardware mitigation
The Commission ... adopts the NOPR proposal in relevant part and directs NERC to develop revisions to Reliability Standard TPL-007-1 to require responsible entities to collect GIC monitoring and magnetometer data as necessary to enable model validation and situational awareness, including from any devices that must be added to meet this need. The NERC standard drafting team should address the criteria for collecting GIC monitoring and magnetometer data... and provide registered entities with sufficient guidance in terms of defining the data that must be collected....

-Order No. 830 P 88
• SDT is reviewing SAR comments and beginning work on revisions
• Intend to seek input and keep GMD Task Force informed of progress
• Refer to NERC website: Project 2013-03 GMD Mitigation
Questions and Answers
Back-up Slides
GMD Vulnerability Assessment

- Documented evaluation of potential susceptibility to voltage collapse, Cascading, or localized damage of equipment due to geomagnetic disturbances
- Requirements are contained in TPL-007-1
- Responsible Entities (PCs/TPs) perform the assessment of the Near-Term Transmission Planning Horizon every 60 months
  - Examine On-Peak Load and Off-Peak Load
TPL-007-1 Implementation Plan

January 1, 2017*

July 2017
- R1
- Identify Responsibilities

July 2018
- R2
- System Models

January 2019
- R5
- GIC Flow Information

January 2021
- R6
- Thermal Assessment

January 2022
- R3, R4, and R7
- GMD Assessment
- Corrective Action Plan

*January 1, 2017 is the first day of the calendar quarter after Order No. 830 becomes effective. For more info see the Implementation Plan posted on the project page.