Implementing GMD Standard TPL-007-1: Transmission Planner/Owner Viewpoint

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Who (PC or TP) Does What? When?

PC & TP

Done!

R1: Determine responsibilities (7/1/2017)

PC

(TP Provides Data)

R2: Assemble model(s) and equipment data (7/1/2018)

R5: Provide GIC Data (1/1/2019)

PC or TP

R4: GMD Vulnerability Assessment
R3: Planning Criteria (1/1/2022)

R6: Transformer Thermal Impact Assessment (GO/TO) (1/1/2021)

PC or TP

TP with PC

R7: Corrective Action Plan(s) (1/1/2022)

GO & TO

http://www.nerc.com/pa/Stand/Pages/Project-2013-03-Geomagnetic-Disturbance-Mitigation.aspx
Process Not Linear, Schedule Is

- Geomagnetic Field
  - B(t)
- Geoelectric Field
  - E(t)
- Earth Conductivity Model
- dc System Model
- GIC
  - vars
- Transformer Model (Magnetic)
- Power Flow Analysis
- Potential Mitigation Measures
- Bus Voltages
- Line Loading & var Reserves
  - Critical Temperatures
  - Temp(t)
- Transformer Model (Thermal)
- Assessment Criteria
- Operating Procedures and Mitigation Measures (if needed)
- Fail
- Pass

Jan. 1, 2017
- R1
  - Identify Responsibilities

July 1, 2017
- R2
- System Models

July 1, 2018
- R5
  - GIC Flow Information

Jan. 1, 2019
- R6
  - Thermal Assessment

Jan. 1, 2021
- R3, R4, and R7
  - Perf. Criteria
  - GMD Assessment
  - Corrective Action Plan
R2 – GMD Model Assembly (PC)

• Internal/External Info from TOs, GOs, etc. (MOD-032)
  • MISO Needs Data by 12/1/2017 to Complete Model by 7/1/2018

• GMD Models Require Data Not Used in Other Studies
  • Earth Model, Substation Latitude and Longitude
  • Grounding Resistance (Substation Has One Ground Grid)
  • Transformer Core Design (Available?), Vector Group
  • DC Resistance Information (Lines, Transformers, Shunts, etc.)
  • GIC Blocking Devices, etc.

• Whatever Significantly Affects GIC Included
  • Transformers with High Side Y-Grounded Winding > 200 kV
  • System > 200 kV and Short Ties Between 200 kV Busses
  • Shunt Reactors on Delta Tertiaries Not Included

• Collecting Data & Assembling Model Requires Effort!
R5 – Provide GIC Data (PC or TP)

- GIC Flow Data from Completed GMD Simulations Provided to BES Transformer Owners
- R1 Determined if PC or TP Responsible
- ATC Agreed to Give PC Responsibility
  - Concentrate Efforts on One Study
  - Eliminate Conflicting Results (In and Out of ATC)
  - Time: Must Be Completed by 1/1/2019
- ATC May Repeat MISO Analysis
  - Better Understand Phenomena on Our System
  - To Effectively Contribute to CAP (R7)
- What if ATC Took Responsibility?
R6 – Xformer Thermal Assessment (GO/TO)

• Transformer Owners Done by 1/1/2021
• If Benchmark Event GIC ≥ 75 A/phase
• Base on GIC Flow Provided (R5)
• Document Analysis Assumptions
• Document Suggested Actions and Analysis to Mitigate GIC Impact (If Any)
• Provide Responsible Entities Results (R1)
Susceptibility Varies by Design

- **Strongly Susceptible**
  - Single Phase (Shell & Core Form)
  - 3-Phase Shell Form
  - 3-Phase 5 Legged Core Form
- **Weakly Susceptible**
  - 3-Phase 3 Legged Core Form
Transformer GIC Thermal Analysis

• GIC Analysis Requirements
  • Ambient Temperature
  • Preload Condition
  • DC Current: Amplitude and Duration
  • Temperature Limits: Oil, Windings, Steel Structure

• ATC to have Manufacturers Perform Analysis
  • Transformer Design Information Proprietary
  • Have Tools, Models and Expertise
  • Archives of Old Designs
  • Design Records of Defunct Manufacturers
  • Schedule and Budget for this Analysis!
• Must Develop Acceptable Steady State Voltage Performance Criteria During Benchmark Event
  • By 1/1/2022 (In Reality Much Sooner)
  • Probably Not the Same Throughout MISO
  • In Addition to Table 1 Requirements
• TPL-007 Table 1 Steady State Requirements
  • No Collapse, Cascading and Uncontrolled Islanding
  • Generation Loss is Acceptable
  • System Adjustments, Transmission Configuration Changes and Generation Dispatch Allowed if Executable in Applicable Facility Rating Time Limits
• Firm Transmission Interruption and Load Loss Allowed but Must be Minimized
R4 – Vulnerability Assessment (TP or PC)

- ATC Agreed to Give PC the Responsibility (R1)
- Required Every 60 Months (First 1/1/2022)
- Benchmark Event Using R2 Models
- On and Off Peak Load Models for at Least One Year in Near Term Planning Horizon
- Table 1 Performance Requirements
- Provide Results to (1) Reliability Coordinator, and Adjacent PCs and TPs within 90 Days of Completion and (2) Any Functional Entity that Submits a Written Request and has a Reliability Related Need
R7 – CAP (PC and TP) by 1/1/2022

• Required if Performance Requirements Not Met
• List Deficiencies and Actions Required to Fix
  • Transmission or Generation Facility Installation, Modification or Removal
  • Protection/RAS Installation, Modification or Removal
  • Operating Procedures (Must Specify How Long Needed)
  • Demand Side Management, New Technologies, etc.
• Provide to RC, Adjacent PCs and TPs, Functional Entities Referenced in CAP and Any Entity Submitting a Written Request within Required Time Limits
But Wait! There's More: TPL-007-2

The final ballot for TPL-007-2 – Transmission System Planned Performance for Geomagnetic Disturbance Events concluded at 8 p.m. Eastern, Monday, October 30, 2017.

Voting statistics are listed below, and the Ballot Results page provides the detailed results.

<table>
<thead>
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<th>Quorum / Approval</th>
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<td>88.74% / 73.35%</td>
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**Next Steps**
The standard will be submitted to the Board of Trustees for adoption and then filed with the appropriate regulatory authorities.

- **R8** – Supplemental Vulnerability Assessment
- **R9** – Supplemental GIC Flow to Transformers
- **R10** – Supplemental Thermal Assessment
- **R11/12** – Measure GIC & Geomagnetic Data
- **CAP Timelines** – 2 yr Procedure, 4 yr Hardware
- **Future**: GMD Harmonic Analysis (EPRI)
Questions?