TIP 359: Improved System Modeling for GMD and EMP Assessments

Context

The potential for geomagnetic disturbances (GMDs) and electromagnetic pulse (EMP) to cause significant impacts on the power grid is now a well-recognized issue. Recently, NERC has been directed by FERC to develop reliability standards to address GMD assessments*, with the GMD operational/reliability standards already in effect (NERC standard EOP-010-1). GMDs induce very low frequency (much less than 1 Hz) electric fields at the earth's surface and consequently drive quasi-dc geomagnetically induced current (GIC) in the grid. GICs can cause half-cycle saturation of transformers, giving rise to harmonics and increased reactive power absorption in transformers. This transformer reactive power loss could severely impact the system voltage stability, while harmonics currents can cause misoperation of protection devices. Unintended isolation of needed components such as capacitor banks and transformers during GMDs further increase the vulnerability of the network to voltage collapse, as seen in the March 1989 collapse of Hydro-Quebec.

Description

This work builds upon the recent successful GMD modeling and validation works by the University of Illinois and other industrial partners. These efforts include an EPRI project on GIC flow modeling and the collaboration with AEP to assess their system.

The project will provide BPA engineers with a methodology for a validated GMD flow model and benchmark GMD scenarios, as required to be available per the upcoming FERC standards.

The first goal of this project is to establish an integrated system-data model to validate the GIC flow model. This can be used by BPA to construct a benchmark GMD storm scenario as required by standards, and to improve the accuracy of the GIC flow modeling. The second goal is to develop and validate the modeling of transformer response to the GIC flow using BPA system power flow data, as an extension to the GIC flow validation to improve the quantitative understanding of the negative GMD impacts in planning studies. The third goal of this project is to build on the GMD modeling to develop models and tools for EMP assessment of power systems, in the necessary power system dynamics time frame.

Why It Matters

Better GMD/EMP model results by validating the source of uncertainty using real data provide a higher probability of mitigating the potential impacts at both system level (higher reactive power losses) or asset level (transformer/capacitor misoperation). And better GMD/EMP assessment models would provide operators with the tools needed to mitigate system voltage collapse and transformer heating, which would help prevent wide-area power outages.

The research activities on GMD assessment and benchmark electric field construction directly fulfills the requirements per the recently released NERC reliability/ operational standard EOP-010-1.

Goals and Objectives

The overall objective of this work is to contribute to geomagnetic disturbance (GMD) and electromagnetic pulse (EMP) assessments for the BPA system, with various-level models of improved accuracy. This ultimate benefit includes enhanced decision-making regarding planning, operations and mitigation strategies in the presence of GMDs. This will be achieved by validating several GMD-related system parameters and modeling approaches for the BPA system, thanks to available data measurement during GMD storms.

Deliverables

All the validation results and methods developed in each of the tasks described earlier will be provided to BPA. Discussion on the accuracy of the GIC flow model will be offered to guide future placement of GIC monitoring devices. Documentation on the usage of those methods will also be provided.

The validation studies performed using these methods and the results of those will be delivered through reports, including the discrepancies found and the following analysis. Deliverables will include the development of the benchmark Electric field model for the BPA footprint, as required by the NERC standards. At each stage gate, all required and applicable reports, documents and tools will be submitted to BPA for evaluation of sufficient progress.

A final report will be provided, describing the execution and achievements of the entire project in detail, as well as charting out the future directions.

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Project Start Date: October 1, 2015

Project End Date: September 30, 2017

Reports & References

* "Reliability Standards for Geomagnetic Disturbances," FERC Final Rule, Docket No. RM12-22-000; Order No. 779, May 16 2013

Links

Participating Organizations

University of Illinois at Urbana-Champaign (UIUC)
Computational Physics, Inc. (CPI), Boulder, CO

Funding

Total Project Cost:	$503,000
BPA Share:	$251,000
BPA FY2016 Budget:	$132,000

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