

# Geomagnetic Disturbance Operating Procedure Template

## Generator Operator

### Overview

Operating procedures are the quickest way to put in place actions that can mitigate the adverse effects of geomagnetically induced currents (GIC) on system reliability. They also have the merit of being relatively easy to change as new information and understanding concerning this threat becomes available.

Operating procedures need to be easily understood by, and provide clear direction to, operating personnel. This is especially true since most operators are unlikely to frequently respond to significant GMD events.

Some actions listed below should only be undertaken if supported by an adequate GIC impact study and/or if adequate monitoring systems are available. Otherwise they can make matters worse. Those actions are indicated by the phrase "if supported by studies".

Determining that a geomagnetic disturbance (GMD) is significant enough to warrant the initiation of special operating procedure(s) depends on the geographical location of the power system/equipment in question coincident with the location of the GMD measurement and forecast. Amount of advance notice obviously factor heavily in what specific actions can and should be taken. Note these are recommended actions; specific actions may vary by system configuration, system design and geographic location of the entity.

### Information and Indications

The following are triggers that could be used to initiate operator action:

- External:
  - NOAA Space Weather Prediction Center or other organization issues:
    - Geomagnetic storm Watch (1-3 day lead time)
    - Geomagnetic storm Warning (as early as 15-60 minutes before a storm, and updated as solar storm characteristics change)
    - Geomagnetic storm Alert (current geomagnetic conditions updated as k-index thresholds are crossed )
- Internal:
  - Generator:
    - Reactive power reserves
    - System voltage/MVAR swings/current harmonics
  - Generator Step-Up (GSU) Transformer:
    - GIC measuring devices

- Abnormal temperature rise (hot-spot) and/or sudden significant gassing (where on-line DGA available)
- MVAR losses

## Actions Available to the Operator

The following are possible actions for Generator Operators based on available lead-time:

### Day-of-event (hours in advance, storm imminent):

1. Increase situational awareness
  - a. Monitor for unusual voltage, MVAR swings, and/or current harmonics<sup>1</sup>
  - b. Monitor for Abnormal temperature rise/noise/dissolved gas in transformers
  - c. Monitor geomagnetically induced current (GIC<sup>2</sup>) on banks so-equipped<sup>3</sup>
  - d. Monitor MVAR loss of all EHV GSU transformers as possible
2. Safe system posturing (only if supported by study)
  - a. Redispatch generation (possible implement autorunback<sup>4</sup> if available)

### Real-time actions (based on results of day-of-event monitoring):

1. Safe system posturing
  - a. Manually start fans/pumps on selected transformers to increase thermal margin (check that oil temperature is above 50° C as forced oil flow at lower temperatures may cause static electrification)
2. Unloading reactive load of on-line generation (provides operating margin in case of loss of system reactive capability from SVC/shunt capacitors which may trip due to harmonics)
3. System reconfiguration (only if supported by study)
  - a. Remove transformer(s) from service if imminent damage due to overheating (possibly automatic by relaying)

## Return to normal operation

This should occur two to four hours after the last observed geomagnetic activity.

<sup>1</sup> Harmonic currents can cause rotor heating similar to, but more severe than, negative sequence current heating. Manufacturer should be consulted to determine allowable threshold.

<sup>2</sup> 10 amperes per phase GIC is a good starting point for potential impacts on transformers when GIC capability data and/or triggering levels of GIC are unknown. Newer transformers may have significantly higher GIC capability if specified at the time of construction. For vulnerable transformers, the OEM can perform analytical capability studies to better define a particular design's GIC vs. Time capability for different transformer loadings.

<sup>3</sup> Regarding the effects of GIC on transformers, real-time mitigation (after a storm is already in progress) should not be taken based solely on a single indicator (e.g., increased GIC). At least one additional indicator should be monitored to determine if the transformer is actually being adversely affected (e.g., triggering levels of MVAR loss, current harmonics, temperature rise, etc)

<sup>4</sup> "Autorunback" is a planned automatic rapid load reduction at a relatively higher-than-normal rate (e.g., 15%/min rather than the typical 3-5%/min).

## Related Documents and Links

*2012 Special Reliability Assessment Interim Report: Effects of Geomagnetic Disturbance on the Bulk Power System*, dated February 2012

<http://www.nerc.com/files/2012GMD.pdf>

*Industry Advisory: Preparing for Geomagnetic Disturbances*, dated May 10, 2011

[http://www.nerc.com/fileUploads/File/Events%20Analysis/A-2011-05-10-01\\_GMD\\_FINAL.pdf](http://www.nerc.com/fileUploads/File/Events%20Analysis/A-2011-05-10-01_GMD_FINAL.pdf)