EOP-010-1 Geomagnetic Disturbance Operations

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• This webinar is being recorded
• This webinar will be posted on the NERC website shortly following today's broadcast
• Questions will be taken via chat at the end of the presentation
• Please complete the short 5 question post-webinar survey
This webinar is part of the NERC outreach effort to educate industry on topics related to BPS reliability.

- NERC offers a webinar series on the 2015 Risk Elements
- GMD events are considered extreme physical events

<table>
<thead>
<tr>
<th>Risk Element</th>
<th>Date</th>
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<tbody>
<tr>
<td>Uncoordinated Protection Systems</td>
<td>April 16, 2015</td>
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<tr>
<td>Monitoring and Situational Awareness</td>
<td>May 21, 2015</td>
</tr>
<tr>
<td>Infrastructure Maintenance</td>
<td>June 18, 2015</td>
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<tr>
<td>Protection System Misoperation</td>
<td>July 16, 2015</td>
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<tr>
<td>Workforce Capability</td>
<td>August 20, 2015</td>
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<td>Long Term Planning and System Analysis</td>
<td>September 17, 2015</td>
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<td><strong>Extreme Physical Events</strong></td>
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</tr>
<tr>
<td>Threats to Cyber Systems</td>
<td>November 19, 2015</td>
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</tbody>
</table>
GMD Concern for the Power System

GICs can cause:
- Increased reactive power consumption
- Transformer heating
- Protection and control misoperation
On May 16, 2013, FERC issued Order 779 which directs NERC to submit Reliability Standards that address the impact of geomagnetic disturbances (GMD) on the reliable operation of the Bulk-Power System.

- **Stage 1 – Operating Procedures**
  - EOP-010, enforceable 4/1/15

- **Stage 2 – Detailed Assessments (Planning Studies)**
  - TPL-007, FERC issued NOPR in May 2015 intending to approve
• R1, R2 – Reliability Coordinators (RCs)
• R3 – Transmission Operators (TOPs) with a Transmission Operator Area that includes a power transformer with a high side wye-grounded winding with terminal voltage greater than 200KV

Does not apply to:
• Balancing Authorities (BAs)
• Generator Operators (GOPs)

Actions are either covered under other requirements or would require detailed studies as described in the whitepaper:  
• For lines less than 200kV, impedance is higher, lines are generally shorter, and lower voltage lines provide minimal contribution to GIC; hence, such lines are ignored. [Example calculation included in the whitepaper]

• If 230 kV lines were ignored, significant GIC could impact system var consumption. [Example calculation included in the whitepaper]

Whitepaper includes rationale explanation, example calculations, and reference list:

http://www.nerc.com/pa/Stand/Project201303GeomagneticDisturbanceMitigation/ApplicableNetwork_clean.pdf
• R1 – Each Reliability Coordinator (RC) required to develop, coordinate, maintain, and implement, as necessary, a GMD Operating Plan

  Possible topics addressed in RC GMD Operating Plan:
  ▪ Acquisition and dissemination of space weather forecast information (R2)
    o NOAA SWPC (US), NRCAN (Canada), Private Service Providers
  ▪ GIC Monitoring and Equipment Monitoring
    o Data acquisition and establishing action triggers from measured data
  ▪ Development and communication of TOP Operating Procedures (R3)
    o Process for coordination within the RC area
  ▪ Coordination with adjacent RCs and TOPs
    o Process for coordination with external entities
• R2 – Each RC is responsible for disseminating forecast and current space weather information

Considerations:

- Is there clarity as to where the information comes from and which parts of the information need to be disseminated and how quickly?
- How is assurance provided that the proper information is received by the TOP operators? (Feedback loop)
- Are the RC operators properly trained to understand the space weather messaging and the need to support the TOP entities?

• EOP-010-1 R2 becomes effective upon retirement of IRO-005-3.1a Requirement R3
  - IRO-005-3.1a retirement is pending FERC approval
• R3 – Each Transmission Operator (TOP) required to develop, maintain, and implement an Operating Procedure or Operating Process to mitigate the effects of GMD events

  Possible topics addressed in TOP Operating Procedures:
  ▪ Acquisition of space weather information from the RC
  ▪ Required analysis for the development of operator actions
  ▪ Operator actions in various timeframes
    ○ Long Lead (1-3 days) – increasing situational awareness, system posturing
    ○ Day of Event – monitoring (GIC monitors, major equipment, reactive resources)
    ○ Real Time – safe system posturing (redispatch, reactive additions); system reconfiguration (remove transformers or transmission lines from service)
    ○ Return to normal operations
• Operating Procedure Template - Transmission Operator
  http://www.nerc.com/comm/PC/Geomagnetic%20Disturbance%20Task%20Force%20GMDTF%202013/Template_TOP.pdf

• Operating Procedure Template – Generation Operator
• Requirements are generally not prescriptive
  ▪ Impacts of GMD vary widely, based on geomagnetic latitude, local geology, system topology, and voltage class

• Compliance needs to ensure that adequate coordination is apparent in RC plans and TOP operating procedures
  ▪ Since GMD events occur over large areas of the system, coordination is of critical importance
  ▪ The science and technology that provides the underpinning to the standard is in its infancy and evolving
  ▪ Analytical tools to assess GMD impacts are just coming into widespread use in the industry
• Effectiveness of operating actions improve based on study
  - GMD response actions can exacerbate the problem due to the ability of GICs to move to adjacent locations if mitigated at one location

• Recognition that the study calculations and results can have wide error bars
  - GIC calculation is not an exact science
  - Harmonics considerations are even less exact

• GMD cannot be effectively mitigated by “hip shooting” actions by the operators
  - Wide scale impacts have to be solved by coordinated actions
  - Transformer overheating is a time dependent phenomenon and the equipment limits have to be established by analysis
Audit Approach to EOP-010-1
• Effective Date for Compliance
  ▪ April 1, 2015 - R1, R3
  ▪ Upon Retirement of IRO-005-3.1a – R3

• Audit Approach Closely Follows the RSAW
  ▪ EOP-010-1 Geomagnetic Disturbance Operations RSAW
R1 Supporting Evidence and Documentation

R1. Each Reliability Coordinator shall develop, maintain, and implement a GMD Operating Plan that coordinates GMD Operating Procedures or Operating Processes within its Reliability Coordinator Area. At a minimum, the GMD Operating Plan shall include:

1.1. A description of activities designed to mitigate the effects of GMD events on the reliable operation of the interconnected transmission system within the Reliability Coordinator Area.

1.2. A process for the Reliability Coordinator to review the GMD Operating Procedures or Operating Processes of Transmission Operators within its Reliability Coordinator Area.

M1. Each Reliability Coordinator shall have a current GMD Operating Plan meeting all the provisions of Requirement R1; evidence such as a review or revision history to indicate that the GMD Operating Plan has been maintained; and evidence to show that the plan was implemented as called for in its GMD Operating Plan, such as dated operator logs, voice recordings, or voice transcripts.

- Key Words
  - develop, maintain, and implement

- Key Content
  - activities designed to mitigate
  - process to review TOP plans
Provide the following evidence, or other evidence to demonstrate compliance.

| Evidence identifying GMD event(s) occurring during the compliance monitoring period to verify implementation of the plan. |
| Provide documented GMD Operating plan. |
| Evidence of implementation, such as operator logs, voice recordings, or other communications, for times when the GMD Operating Plan was executed during a GMD event. |

- Evidence should demonstrate the plan has been
  - developed, maintained, and implemented
- Evidence should demonstrate that the plan contained
  - activities designed to mitigate
  - process to review TOP plans
### Compliance Assessment Approach Specific to EOP-010-1, R1

*This section to be completed by the Compliance Enforcement Authority*

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Confirm the entity’s GMD Operating Plan was developed and maintained in accordance with Requirement R1 as follows:</td>
</tr>
<tr>
<td>Part 1.1</td>
<td>Verify the plan includes a description of activities to mitigate the effects of GMD events on the reliable operation of the interconnected transmission system within the Reliability Coordinator Area.</td>
</tr>
<tr>
<td>Part 1.2</td>
<td>Verify the plan includes a process for the entity to review the GMD Operating Procedures or Operating Processes of Transmission Operators within its Reliability Coordinator Area.</td>
</tr>
<tr>
<td>R1</td>
<td>Verify implementation of plan: (see Note to Auditor below)</td>
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<tr>
<td></td>
<td>- Implementation of plan as called for during GMD events listed.</td>
</tr>
<tr>
<td></td>
<td>- Reviewed the GMD Operating Procedures or Operating Processes as developed in Requirement R3 for Transmission Operators within its Reliability Coordinator Area.</td>
</tr>
</tbody>
</table>

**Note to Auditor:** Requirement R1 includes implementation of the GMD Operating Plan. Auditors can gain reasonable assurance the plan was implemented by determining if actions prescribed by the plan have taken place. For example, if the plan calls for certain activities to occur, then auditors could ask for evidence demonstrating the plan has been implemented.
Examples of Activities to Mitigate the Effects of GMD Events

- Identification of triggers for implementation
- Discontinue maintenance work and restore out of service high voltage transmission lines to service. Avoid taking long lines out of service
- Maintain the system voltage within an acceptable operating range to protect against voltage swings
- Review the availability of the SVC and capacitor banks to respond to voltage deterioration if necessary
- Adjust the loading on HVdc ties
- Reduce the loading on interconnections, critical transmission facilities, and critical transmission interfaces to 90%, or less, of their agreed limits
- Reduce the loading on generators operating at full load to provide reserve power and reactive capacity
• Examples of Activities to Mitigate the Effects of GMD Events (CONT.)
  ▪ In conjunction with personnel at those locations where GMD measurements are to be taken, ensure the monitoring equipment is in service
  ▪ Dispatch generation to manage system voltage, tie line loading and to distribute operating reserve
  ▪ Bring equipment capable of synchronous condenser operation on line to provide reactive power reserve
  ▪ Closely monitor RTCA Voltage contingencies and consider the impact of tripping large shunt and series capacitor banks and static VAR compensators
  ▪ Consider the impact of tripping large shunt capacitor banks and static VAR compensators
  ▪ Identification of conditions for plan deactivation
• Evidence of coordination with TOPs
  - Identify when, how Transmission Operators’ GMD Procedures and Processes are reviewed
  - Provide evidence of such reviews
    o Minutes of Meeting
    o Formal Report
  - Follow-up review with TOPs after a GMD event
Evidence Requested – R2

R2 Supporting Evidence and Documentation

R2. Each Reliability Coordinator shall disseminate forecasted and current space weather information to functional entities identified as recipients in the Reliability Coordinator's GMD Operating Plan.

M2. Each Reliability Coordinator shall have evidence such as dated operator logs, voice recordings, transcripts, or electronic communications to indicate that forecasted and current space weather information was disseminated as stated in its GMD Operating Plan.

Evidence Requested:

Provide the following evidence, or other evidence to demonstrate compliance.

Evidence that forecasted and current space weather information was disseminated to recipients as specified in the GMD Operating Plan, such as operator logs, voice recordings, or other documented communications.
IRO-005-3.1a

R3. Each Reliability Coordinator shall ensure its Transmission Operators and Balancing Authorities are aware of Geo-Magnetic Disturbance (GMD) forecast information and assist as needed in the development of any required response plans.
4. Applicability:

4.1. Functional Entities:

4.1.1 Reliability Coordinator
4.1.2 Transmission Operator with a Transmission Operator Area that includes a power transformer with a high side wye-grounded winding with terminal voltage greater than 200 kV

**R3 Supporting Evidence and Documentation**

R3. Each Transmission Operator shall develop, maintain, and implement a GMD Operating Procedure or Operating Process to mitigate the effects of GMD events on the reliable operation of its respective system. At a minimum, the Operating Procedure or Operating Process shall include:

3.1. Steps or tasks to receive space weather information.

3.2. System Operator actions to be initiated based on predetermined conditions.

3.3. The conditions for terminating the Operating Procedure or Operating Process.

M3. Each Transmission Operator shall have a GMD Operating Procedure or Operating Process meeting all the provisions of Requirement R3; evidence such as a review or revision history to indicate that the GMD Operating Procedure or Operating Process has been maintained; and evidence to show that the Operating Procedure or Operating Process was implemented as called for in its GMD Operating Procedure or Operating Process, such as dated operator logs, voice recordings, or voice transcripts.
Registered Entity Response (Required):

**Question:** Does the Transmission Operator Area include a power transformer with a high side wye-grounded winding with terminal voltage greater than 200 kV?  
? Yes  ? No

If Yes, proceed to the Compliance Narrative below. If No, information supporting the entity’s No response (such as a description of the entity’s process for identifying applicable equipment, an explanation regarding why they are confident there is no such equipment, or other information) that provides the auditor with the necessary reasonable assurance that there is no applicable equipment in the entity’s Area may eliminate further audit testing of this requirement.

[Note: A separate spreadsheet or other document may be used. If so, provide the document reference below.]

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**Evidence Requested:**

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<td>Evidence identifying GMD event(s) occurring during the compliance monitoring period to verify implementation of the plan.</td>
</tr>
<tr>
<td>Provide documented Operating Procedure or Operating Process.</td>
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<tr>
<td>Evidence of implementation, such as operator logs, voice recordings, or other communications, for times when the Operating Procedure or Operating Process was executed during a GMD event.</td>
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### Compliance Assessment Approach Specific to EOP-010-1, R3

*This section to be completed by the Compliance Enforcement Authority*

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<tr>
<th>R3 Confirm the Operating Procedure or Operating Process was developed and maintained to mitigate the effects of GMD events and:</th>
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<tbody>
<tr>
<td>(Part 3.1) Included Steps or tasks to receive space weather information</td>
</tr>
<tr>
<td>(Part 3.2) Included System Operator actions to be initiated based on predetermined conditions.</td>
</tr>
<tr>
<td>(Part 3.3) Included the conditions for terminating the Operating Procedure or Operating Process.</td>
</tr>
<tr>
<td>(R3) Verify implementation of the Operating Procedure or Operating Process (see note below)</td>
</tr>
<tr>
<td>(R3.2) Verify System Operator actions were initiated based on predetermined conditions.</td>
</tr>
<tr>
<td>(R3.3) Verify the Operating Procedure or Operating Process was terminated at specified conditions.</td>
</tr>
</tbody>
</table>

**Note to Auditor:** Requirement R3 includes implementation of the GMD Operating Procedure or Operating Process. Auditors can gain reasonable assurance of implementation by determining if specific actions prescribed by the Operating Procedure or Operating Process have taken place. For example, if the procedure calls for an operator to take an action, then auditors could ask for evidence demonstrating that the action occurred, such as drills. Otherwise, procedure availability, training records, operator knowledge, and/or a dry-run walk-through of the procedure could provide assurance of implementation. Requirement is not applicable if Transmission Operator Area does not include a power transformer with a high side wye-grounded winding with terminal voltage greater than 200 kV.
“high side wye-grounded winding with terminal voltage greater that 200kv” - If none, N/A

- Provide evidence that inventory does not include such equipment

- Include TOP-related steps such as those given in R1 for actions to mitigate
Questions and Answers