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|  California ISO | Reliability Coordinator Procedure | Procedure No. | RC0430 |
| | | Version No. | 1.0 |
| | | Effective Date | 7/01/2019 |
| GMD Operating Plan | | Distribution Restriction: None | |

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Purpose

Identify actions needed to mitigate the effects of a forecasted or Real-time geomagnetic disturbance (GMD) event. Also to provide the process for Transmission Operator (TOP) submittal of GMD Procedures and Processes for Reliability Coordinator (RC) review¹

1. Responsibilities

- Reliability Coordinator Operator
- Operations Compliance Support

2. Scope/Applicability

- RC GMD Operating Plan to coordinate GMD Operating Procedures and processes within the CAISO RC Area. The plan will focus on coordination with TOPs with a TOP area that includes a power transformer with a high side wye-grounded winding with terminal voltage greater than 200 kV.


3. Procedure Detail

3.1. Background

GMD events have the potential to adversely impact the reliable operation of interconnected transmission systems. During a GMD event, geomagnetically-induced currents (GIC) may cause transformer hot-spot heating or damage, loss of reactive power sources, increased reactive power demand, and protection system malfunction, the combination of which may result in voltage collapse and potential blackouts.

NOAA's Space Weather Prediction Center (SWPC) will issue notifications of upcoming and current GMD events. SWPC will typically issue a GMD Watch *1 to 3 days before*, and Warnings and Alerts *up to an hour before* and during the event. The RC Operator will monitor these SWPC notifications and will communicate potential impacting GMD events to its area and, if necessary, coordinate mitigation actions.

¹ EOP-010-1 Functional Entity applicability - Required by TOPs with an area that includes a power transformer with a high side wye-grounded winding with terminal greater than 200 kV.

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3.2. Long Lead Time

The SWPC may issue a GMD Watch up to several days before an expected event. Upon (Refer to Appendix 1 for definitions of Geomagnetic Storm Categories) notification by the SWPC of a GMD Watch with a rating \geq G3, the RC Operator will send a GMD notification to BAs and TOPs in the RC area². No action is required for rating of G2 or less.


| Reliability Coordinator Actions |
|---|
| <ul style="list-style-type: none"> • Monitor SWPC for notification of GMD Watches with a rating of \geq G3. • Send a GMD Watch notification to BA and TOP entities in the RC area via the Grid Messaging System (GMS). Ensure that the following information is included: <ul style="list-style-type: none"> ○ NOAA Geomagnetic Storm scale (G3 – G5), ○ Date(s) of predicted geomagnetic storm, and ○ Geomagnetic latitude impacted. • Request potentially affected entities to review their GMD Operating Procedures. • Assess readiness of blackstart generators and cranking paths. • Severe GMDs may require additional measures if supported by Operations Engineering (OE) study: <ul style="list-style-type: none"> ○ Request entities to return equipment on outage to service (especially series capacitors which can limit GIC flow). ○ Request reschedule or delay of planned outages that could affect the reliability of the grid. |

3.3. Day of Event

The RC Operator should have increased situational awareness and be ready to coordinate mitigation plans.

| Reliability Coordinator Actions |
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| <ul style="list-style-type: none"> • Monitor SWPC and verify GMD Watch still in effect. • Issue reminder notification of GMD Watch with a rating of \geq G3. This should be done early, so that BAs and TOPs have time to review and implement their GMD Operational Procedures. Verify that the GMD Watch notification correctly includes the following information: <ul style="list-style-type: none"> ○ NOAA Geomagnetic Storm scale (G3 – G5), ○ Date(s) of predicted geomagnetic storm, and ○ Geomagnetic latitude impacted. |

² EOP-010-1 R1.1

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Reliability Coordinator Actions

- **Request** potentially affected entities to review their GMD Operating Procedures.
- **Assess** readiness of blackstart generators and cranking paths.
- Severe GMDs may require additional measures if supported by OE study:
 - **Coordinate** with entities to be ready to start off-line generation and synchronous condensers to provide reserve power and reactive capacity if necessary.
 - **Coordinate** with entities to enter conservative operations with possible reduced transfer limits. Longer Extra-High Voltage lines, in particular, are more susceptible to GIC.
 - **Coordinate** with entities to ensure series capacitors are in service


3.4. Real-Time Conditions

SWPC will issue GMD *Warnings* up to an hour before a GMD event, and *Alerts* immediately before and during the event itself. Alerts will also be issued if the K index level is increased. Upon notification by the SWPC of a GMD Warning or Alert with a rating of $\geq G3$ and a K- index $\geq Kp 7$, the RC Operator will send a GMD notification to BAs and TOPs in the RC area³.

Reliability Coordinator Actions

- **Monitor** SWPC for notification of GMD Warning or Alert with a rating of $\geq G3$ and a K- index $\geq Kp 7$.
- **Send** a GMD notification to BA and TOP entities in the RC area via GMS. Verify that the GMD Warning or Alert notification correctly includes the following information:
 - NOAA Geomagnetic Storm scale (G3 – G5),
 - Geomagnetic Disturbance K index scale (Kp 7 – Kp 9),
 - Date/Time of predicted geomagnetic storm, and
 - Geomagnetic latitude impacted.
- **Request** entities to report unusual operating conditions that may be caused by the GMD.
- **Coordinate** with entities, as applicable, to implement their GMD Operating Procedures.
- **Monitor** Reactive Reserves.
- **Monitor** voltages and reactive flows for unusual readings and swings.
- **Prepare** for unplanned capacitor bank, SVC and HVDC tripping.
- **Prepare** for possible false SCADA and ICCC indications from disrupted telecommunications systems.
- **Coordinate** removal from service of transformers that are in imminent danger of overheating.

³ EOP-010-1 R2

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3.5. Cancellation

When an active Warning, Watch, or Alert is no longer in effect, the SWPC will send out a cancellation notification. The RC Operator will send a GMD Cancellation notification to BAs and TOPs in the RC area.

| Reliability Coordinator Actions |
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| <ul style="list-style-type: none"> • Monitor SWPC for GMD Cancellation notification. • Send a GMD Cancellation notification to BA and TOP entities in the RC area via GMS. |

3.6. TOP GMD Operating Procedure Review

The CAISO RC shall review the GMD Operating Procedures or Operating Processes of Transmission Operators within its RC Area⁴. The CAISO Operations Compliance Support shall work in conjunction with the RC to facilitate reviews of the GMD Operating Plan(s) submitted by TOPs.

The CAISO RC shall provide a secure website for BAs and TOPs to upload GMD Operating Procedures or Processes for RC review. The TOPs shall upload the document(s) with a completed EOP-010 Operating Procedure Checklist.


Within 30 calendar days of receipt, the CAISO RC shall:

- Review each submitted GMD procedure on the basis of compatibility and inter-dependency with other TOPs' procedures,
- **Review** TOP-submitted documents and work to ensure no conflicts with other TOP Operating Procedures or Processes,
- Review each submitted GMD procedure for coordination to avoid risk to Wide Area reliability, and
- Notify each submitting TOP of the results of its review, specifying any time frame for resubmittal of its GMD procedure if revisions are identified.

Each TOP shall address any reliability risks identified by the CAISO RC and resubmit its GMD procedure to CAISO RC within the specified time period.

Upon CAISO RC's completion of the review process, the RC will post a review letter to the secure site and notify the submitting TOP entity.

⁴ EOP-010-1 R1. 1.2

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4. Supporting Information

Operationally Affected Parties

Shared with Public.

References

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|----------------------------|------------------|
| NERC Requirements | EOP-010-1 R1, R2 |
| BA/TOP Operating Procedure | |
| Other References | |


Definitions

The following terms capitalized in this Operating Procedure are in accordance with the NERC Glossary, and/or otherwise when used are as defined below:

| Term | Description |
|-----------------------------------|--|
| Geomagnetic Disturbance (GMD) | Solar induced disturbances in the earth's magnetic field. GMDs may result in large low frequency currents flowing in the earth's surface which may enter the power system and damage transformers. |
| Reliability Coordinator (RC) Area | The collection of generation, transmission, and loads within the boundaries of the Reliability Coordinator. Its boundary coincides with one or more Balancing Authority Areas. |

Version History

| Version | Change | Date |
|---------|---------------------------------|---------|
| 1.0 | Approved by Steering Committee. | 9/26/18 |
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5. Periodic Review Procedure

Appendix

Appendix 1: NOAA Space Weather Scales Chart

| Category | | Effect | Physical measure | Average Frequency (1 cycle = 11 years) |
|---------------------------|------------|---|------------------|--|
| Scale | Descriptor | Duration of event will influence severity of effects | | |
| Geomagnetic Storms | | | | |
| G 5 | Extreme | <p>Power systems: widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage.</p> <p>Spacecraft operations: may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites.</p> <p>Other systems: pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).**</p> | Kp=9 | 4 per cycle (4 days per cycle) |
| G 4 | Severe | <p>Power systems: possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid.</p> <p>Spacecraft operations: may experience surface charging and tracking problems, corrections may be needed for orientation problems.</p> <p>Other systems: induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).**</p> | Kp=8 | 100 per cycle (60 days per cycle) |
| G 3 | Strong | <p>Power systems: voltage corrections may be required, false alarms triggered on some protection devices.</p> <p>Spacecraft operations: surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems.</p> <p>Other systems: intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).**</p> | Kp=7 | 200 per cycle (130 days per cycle) |
| G 2 | Moderate | <p>Power systems: high-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage.</p> <p>Spacecraft operations: corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions.</p> <p>Other systems: HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).**</p> | Kp=6 | 600 per cycle (360 days per cycle) |
| G 1 | Minor | <p>Power systems: weak power grid fluctuations can occur.</p> <p>Spacecraft operations: minor impact on satellite operations possible.</p> <p>Other systems: migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).**</p> | Kp=5 | 1700 per cycle (900 days per cycle) |

* Based on this measure, but other physical measures are also considered.

** For specific locations around the globe, use geomagnetic latitude to determine likely sightings (see www.swpc.noaa.gov/Aurora)