
	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b>	RC0430
		<b>Version No.</b>	3.1
		<b>Effective Date</b>	11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction: None</b>	

## Table of Contents

Purpose.....	2
1. Responsibilities.....	2
2. Scope/Applicability.....	2
3. Procedure Detail.....	2
3.1. Background.....	2
3.2. SWPC Initiated Phone Calls.....	2
3.3. Long Lead Time.....	3
3.4. Day of Event.....	4
3.5. Real-Time Conditions.....	5
3.6. Cancellation.....	6
3.7. TOP GMD Operating Procedure Review.....	6
4. GMD Monitor Transition.....	7
5. Supporting Information.....	7
Operationally Affected Parties.....	7
References.....	7
Definitions.....	8
Version History.....	8
6. Periodic Review Procedure.....	9
Review Criteria & Incorporation of Changes.....	9
Frequency.....	9
Appendix – <b>See Appendix 1: NOAA Space Weather Scales Chart on following page.</b> .....	9
Appendix 1: NOAA Space Weather Scales Chart.....	10

	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b> RC0430
		<b>Version No.</b> 3.1
		<b>Effective Date</b> 11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction: None</b>

## Purpose

Identify actions needed to mitigate the effects of a forecasted or real-time Geomagnetic Disturbance (GMD) event. In addition, to provide the process for Transmission Operator (TOP) submittal of GMD Procedures and Processes for Reliability Coordinator (RC) review.<sup>1</sup>

## 1. Responsibilities

- Reliability Coordinator Operator
- Operations Compliance Support

## 2. Scope/Applicability

RC GMD Operating Plan to coordinate GMD Operating Procedures and processes within the RC West Area. The plan will focus on coordination with TOPs with a TOP area, which 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, geomagnetic-induced currents (GIC) may cause transformer hot spot heating or damage, loss of reactive power sources, increased reactive power demand, and protection system malfunctions, 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 potentially impacting GMD events to its area and, if necessary, coordinate mitigation actions.

### 3.2. SWPC Initiated Phone Calls

RC West has subscribed to receive SWPC email notifications, which will be delivered to the CAISO Reliability Coordination inbox. SPWC may also make a phone notification by calling the NERC Hotline. During such calls, the Eastern Interconnection GMD Monitor will take a roll call of all RCs present. The current Western Interconnection GMD Monitor, as specified in Section 4, has the

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

	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b> RC0430
		<b>Version No.</b> 3.1
		<b>Effective Date</b> 11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction: None</b>

responsibility of ensuring that all Western Interconnection RCs are notified of the SWPC call and information provided.

Western Interconnection GMD Monitor Actions
<ul style="list-style-type: none"> <li>• <b>Participate</b> in all SWPC initiated NERC Hotline calls. <i>Note if any Western Interconnection RC is not present on the call as the Eastern Interconnection GMD monitor takes roll.</i></li> <li>• <b>Notify</b> the Western Interconnection GMD Monitor if they are not present on the NERC Hotline call. The Western Interconnection GMD Monitor has the responsibility of notifying all other Western Interconnection RCs that did not participate.</li> <li>• <b>Proceed</b> with actions outlined in Sections 3.3 - 3.5, below as applicable, depending on the notification type.</li> </ul>


### 3.3. Long Lead Time

The SWPC may issue a GMD Watch several days before an expected event. Upon 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 Area.<sup>2</sup> No action is required for rating of G2 or lower, (Refer to Appendix 1 for definitions of Geomagnetic Storm Categories).

Western Interconnection GMD Monitor Actions
<ul style="list-style-type: none"> <li>• <b>Monitor</b> SWPC for notification of GMD Watches with a rating of <math>\geq</math> G3.</li> <li>• <b>Send</b> a notification of the GMD Watch to all RC West area BAs and TOPs via the Grid Messaging System (GMS). Ensure that the following information is included: <ul style="list-style-type: none"> <li>○ NOAA Geomagnetic Storm Scale (G3 – G5),</li> <li>○ Date(s) of predicted geomagnetic storm, and</li> <li>○ Latitude(s) impacted by geomagnetic storm.</li> </ul> </li> </ul>

Reliability Coordinator Actions
<ul style="list-style-type: none"> <li>• <b>Confirm</b> the Western Interconnection GMD Monitor sent notification of GMD Watch with above information to all RC West area BAs and TOPs via GMS.</li> <li>• <b>If the Western Interconnection GMD Monitor is unable to send the notification,</b> <ul style="list-style-type: none"> <li>○ <b>Send</b> GMD Watch notification as described within Western Interconnection GMD Monitor Actions.</li> </ul> </li> <li>• <b>Request</b> potentially affected entities to review their GMD Operating Procedures.</li> </ul>

<sup>2</sup> EOP-010-1 R1.1

	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b>	RC0430
		<b>Version No.</b>	3.1
		<b>Effective Date</b>	11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction: None</b>	

<b>Reliability Coordinator Actions</b>
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- **Assess** readiness of Black Start generators and cranking paths.
- Severe GMDs may require additional measures if supported by Operations Engineering (OE) study:
  - **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.

### 3.4. Day of Event


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

<b>Western Interconnection GMD Monitor Actions</b>
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- **Monitor** SWPC and verify GMD Watch still in effect.
- **Issue** reminder notification of GMD Watch with a rating of  $\geq G3$  to all Western Interconnection RCs and RC West area BAs and TOPs via GMS. This should be done early, so that BAs and TOPs have time to review and implement their GMD Operating Procedures. Verify that the GMD Watch notification correctly includes the following information:
  - NOAA Geomagnetic Storm scale (G3 – G5),
  - Date(s) of predicted geomagnetic storm, and
  - Geomagnetic latitude impacted.

<b>Reliability Coordinator Actions</b>
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- **Confirm** the Western Interconnection GMD Monitor sent notification of GMD Watch with above information to all RC West area BAs and TOPs via GMS.
- If the Western Interconnection GMD Monitor is unable to send the notification,
  - **Send** GMD Watch notification as described within Western Interconnection GMD Monitor Actions.
- **Request** potentially affected entities to review their GMD Operating Procedures.
- **Assess** readiness of Black Start 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.

	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b> RC0430
		<b>Version No.</b> 3.1
		<b>Effective Date</b> 11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction:</b> <b>None</b>

Reliability Coordinator Actions
<ul style="list-style-type: none"> <li>○ <b>Coordinate</b> with entities to enter conservative operations with possibly reduced transfer limits. Longer Extra-High Voltage lines, in particular, are more susceptible to GIC.</li> <li>○ <b>Coordinate</b> with entities to ensure series capacitors are in service</li> </ul>


### 3.5. 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 Area.<sup>3</sup>

Western Interconnection GMD Monitor Actions
<ul style="list-style-type: none"> <li>● <b>Monitor</b> SWPC for notification of GMD Warning or Alert with a rating of <math>\geq G3</math> or a K- index <math>\geq Kp 7</math>.</li> <li>● <b>Send</b> a GMD notification to all RC West area BAs and TOPs via GMS. Verify that the GMD Warning or Alert notification correctly includes the following information: <ul style="list-style-type: none"> <li>○ NOAA Geomagnetic Storm scale (G3 – G5),</li> <li>○ Geomagnetic Disturbance K index scale (Kp 7 – Kp 9),</li> <li>○ Date/Time of predicted geomagnetic storm, and</li> <li>○ Geomagnetic latitude impacted.</li> </ul> </li> </ul>

Reliability Coordinator Actions
<ul style="list-style-type: none"> <li>● <b>Confirm</b> the Western Interconnection GMD Monitor sent notification of GMD Warning or Alert with above information to all RC West area BAs and TOPs via GMS.</li> <li>● If the Western Interconnection GMD Monitor is unable to send the notification, <ul style="list-style-type: none"> <li>○ <b>Send</b> GMD Warning or Alert notification as described within Western Interconnection GMD Monitor Actions.</li> </ul> </li> <li>● <b>Request</b> entities to report unusual operating conditions that may be caused by the GMD.</li> <li>● <b>Coordinate</b> with entities, as applicable, to implement their GMD Operating Procedures.</li> <li>● <b>Monitor</b> Reactive Reserves.</li> <li>● <b>Monitor</b> voltages and reactive flows for unusual readings and swings.</li> <li>● <b>Prepare</b> for unplanned capacitor bank, SVC and HVDC tripping.</li> </ul>

<sup>3</sup> EOP-010-1 R2

	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b>	RC0430
		<b>Version No.</b>	3.1
		<b>Effective Date</b>	11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction: None</b>	

Reliability Coordinator Actions
<ul style="list-style-type: none"> <li>• <b>Prepare</b> for possible false SCADA and ICCP indications from disrupted telecommunications systems.</li> <li>• <b>Coordinate</b> removal from service of transformers that are in imminent danger of overheating.</li> </ul>

### 3.6. Cancellation

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

Western Interconnection GMD Monitor Actions
<ul style="list-style-type: none"> <li>• <b>Monitor</b> SWPC for GMD Cancellation notification.</li> <li>• <b>Send</b> a GMD Cancellation notification to all Western Interconnection <b>BAs and TOPs</b> via GMS.</li> </ul>

Reliability Coordinator Actions
<ul style="list-style-type: none"> <li>• <b>Confirm</b> the Western Interconnection GMD Monitor sent notification of GMD Cancellation to all RC West area BAs and TOPs via GMS.</li> <li>• If the Western Interconnection GMD Monitor is unable to send the notification, <ul style="list-style-type: none"> <li>○ <b>Send</b> GMD Cancellation notification as described within Western Interconnection GMD Monitor Actions.</li> </ul> </li> </ul>


### 3.7. TOP GMD Operating Procedure Review

RC West shall review the GMD Operating Procedures or Operating Processes of Transmission Operators within its RC Area.<sup>4</sup> The CAISO Operations Compliance team shall work in conjunction with the RC to facilitate reviews of the GMD Operating Plan(s) submitted by TOPs.

The EOP-010 plans can be submitted to RC West each time the plan(s) are updated. RC West does not have an annual or periodic update requirement for EOP-010 plans.

The Plan Review Submissions library on the RC West secure website shall be used by the TOPs to upload GMD Operating Procedures or Processes for RC review. The TOPs shall upload the document(s) with a completed RC0430A EOP-010 Plan Review Checklist.

<sup>4</sup> EOP-010-1 R1. 1.2

	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b>	RC0430
		<b>Version No.</b>	3.1
		<b>Effective Date</b>	11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction: None</b>	

Within 30 calendar days of receipt, RC West 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 RC West's review, specifying any timeframe for resubmittal of its GMD procedure if revisions are identified.

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

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

## 4. GMD Monitor Transition

The current Western GMD Monitor will contact the next scheduled GMD monitor no later than October 1 to begin coordinating the transition that will occur on February 1 of the following year. This Coordination should include local procedure(s) currently in use, data requirements and communications. In the event that the designated Western Interconnection GMD Monitor is unable to fulfill its responsibilities, the previous GMD monitor should maintain the capability to perform the GMD monitor duties.

The Reliability Coordinators in the Western Interconnection will rotate the GMD monitor responsibilities on an annual basis as follows:

- BCRC - February 1, 2021 through January 31, 2022
- SPP West RC - February 1, 2022 through January 31, 2023
- AESO - February 1, 2023 through January 31, 2024


## 5. Supporting Information

### Operationally Affected Parties

Shared with the Public.

### References

NERC Requirements	EOP-010-1 R1, R2
Operating Procedures	
Other References	

	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b>	RC0430
		<b>Version No.</b>	3.1
		<b>Effective Date</b>	11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction: None</b>	

## 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.
NERC	North American Electric Reliability Corporation
NOAA	National Oceanic and Atmospheric Administration

## Version History

Version	Change	Date
1.0	Approved by Steering Committee.	9/26/18
2.0	Included new responsibilities as the Western Interconnection GMD Monitor.	12/03/19
2.1	Distinguished Western Interconnection GMD Monitor responsibilities from normal RC Responsibilities and various formatting/grammar corrections.	4/21/20
2.2	Section 2 & 3.2: Updates made due to BCRC assuming GMD Monitor obligations from RC West as of 2/1. Sections 3.3 & 3.5, 2nd bullet: Removed "Western Interconnection RCs" since this is no longer applicable. Section 4: Removed RC West from list of rotating RCs. Changes were coordinated with BCRC. Replaced blackstart with Black Start throughout and minor grammar edit to Section 5.	2/01/21
3.0	Periodic Review: Section 3.2: Corrected minor error in language regarding current Western Interconnection GMD Monitor.	11/01/21



	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b>	RC0430
		<b>Version No.</b>	3.1
		<b>Effective Date</b>	11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction: None</b>	

Version	Change	Date
	Section 4: Updated rotation of GMD Monitor with SPP taking over in February 1, 2022 and AESO following in 2023.	
3.1	Section 3.3-3.7: Included actions for RC Operator to confirm notifications sent by the GMD Western Connection Monitor are sent to RC West Area BAs and TOPs. Added note regarding Appendix 1 under Appendix section.	11/22/21

## 6. Periodic Review Procedure

### Review Criteria & Incorporation of Changes


There are no specific review criteria identified for this document.

### Frequency

Review at least once every three years.

**Appendix –** See **Appendix 1: NOAA Space Weather Scales Chart** on following page.

RC0430A EOP-010 Plan Review Checklist

	<b>Reliability Coordinator Procedure</b>	<b>Procedure No.</b> RC0430
		<b>Version No.</b> 3.1
		<b>Effective Date</b> 11/22/2021
<b>GMD Operating Plan</b>		<b>Distribution Restriction:</b> <b>None</b>

## 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		
<b>Geomagnetic Storms</b>				
<b>G 5</b>	Extreme	<p><b>Power systems:</b> 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><b>Spacecraft operations:</b> may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites.</p> <p><b>Other systems:</b> 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)
<b>G 4</b>	Severe	<p><b>Power systems:</b> possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid.</p> <p><b>Spacecraft operations:</b> may experience surface charging and tracking problems, corrections may be needed for orientation problems.</p> <p><b>Other systems:</b> 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)
<b>G 3</b>	Strong	<p><b>Power systems:</b> voltage corrections may be required, false alarms triggered on some protection devices.</p> <p><b>Spacecraft operations:</b> 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><b>Other systems:</b> 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)
<b>G 2</b>	Moderate	<p><b>Power systems:</b> high-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage.</p> <p><b>Spacecraft operations:</b> corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions.</p> <p><b>Other systems:</b> 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)
<b>G 1</b>	Minor	<p><b>Power systems:</b> weak power grid fluctuations can occur.</p> <p><b>Spacecraft operations:</b> minor impact on satellite operations possible.</p> <p><b>Other systems:</b> 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](http://www.swpc.noaa.gov/Aurora))

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