

Gannon Storm

NERC Observations and After-Action Review

Mark Olson, Manager, Reliability Assessment Space Weather Roundtable February 5, 2025

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- Gannon Storm: the strongest geomagnetic disturbance (GMD) in past two decades occurred in May 2024
- Bulk Power System (BPS) remained stable and served all connected load throughout the 3-day event
- A complete review is in progress using NERC's data collection programs and stakeholder inputs to understand:
 - GIC impacts on the BPS
 - GMD Vulnerability Assessment model accuracy
 - Operating mitigations effectiveness
- After-action review supports continued development for GMD tools and operating procedures
- Results of the review will be available in 2025



Amidst the May 10–12 geomagnetic **#storm**—the largest in over a decade—and resulting **#aurora** spectacle, the electric **#industry** was monitoring ground currents induced by the storm. NERC uses **#geomagnetic** induced current and magnetometer data from reporting entities to better understand system-wide impacts. Considering the magnitude and duration of storm, NERC requests that all entities submit this data by June 30, 2024. Learn more: https://ow.ly/vUv350RNZhL



NERC's social media post for GMD Data



Early Notification Enabled Operators To Posture the Grid

- Reliability Coordinators (RC) received warning from the U.S. Space Weather Prediction Center (SPWC) six hours prior to onset
- Grid operators implemented GMD Operating Procedures as required by mandatory reliability standards
- Actions taken by system operators:
 - Implementing conservative operating protocols
 - Scheduling additional generation
 - Cancellation of some transmission maintenance
 - Increased monitoring of system geomagneticallyinduced currents (GICs) and system performance
- Early notification helped operators implement more extensive mitigations



Severe Geomagnetic Storm LIKELY

KEY MESSAGES: A Severe (G4) Geomagnetic Storm is LIKELY possibly as early as later today and continuing through the weekend; exact timing remains somewhat uncertain. At least seven earth-directed Coronal Mass Ejections (CMEs) are in transit.

WHAT: SWPC's First G4 Watch Since Jan. 2005

IMPACTS: HF communication, GPS, power grids (voltage control), spacecraft, satellite navigation, and other technologies may be affected. Critical infrastructure operators have been notified

CONTEXT: Only three Severe (G4) geomagnetic storms have occurred so far this solar cycle (since 2019); the last was a brief occurrence on March 23. This is SWPC's first G4 Watch since 2005. The last Extreme (G5) event occurred with the Halloween Storms in 2003

CAUSE: The source has been a large, complex sunspot cluster (NOAA Region 3664) that is 16 times the diameter of Earth. Additional activity from this Region is still expected.

Safeguarding Society with Actionable Space Weather Information

Space Weather Prediction Ce



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- System voltages and frequency on the interconnected transmission system were largely unaffected
- United States Northeast, Mid-Atlantic, and Western Canada observed localized impacts to power system equipment
- Reports of GMD-related effects on the BPS:
 - Operator alarms for high GIC and temperatures at power transformers
 - Unexpected transmission line and voltage support equipment disconnects (tripping)
 - Activation of GIC blocking devices
 - High levels of harmonic currents on the system
 - Voltage oscillations at some inverter-based resources



GIC Blocking Device Connected to Large Power Transformer RELIABILITY | RESILIENCE | SECURITY



Analysis of NERC data sources is progressing

U.S. grid equipment owners are required to report in NERC's data systems. Data is finalized after each calendar year.

- GMD Data: over 390 geomagnetically-induced current (GIC) monitors reporting
- Transmission: Outage information on major equipment (transformers, lines)
- Generators: Outage and performance information on generating equipment

NERC's preliminary review agrees with initial reporting of isolated impacts to generators and transmission equipment.



NERC Data Sources include GMD Data System, Transmission Availability Data System (TADS), and Generator Availability Data System (GADS).

GMD Data System is available to the public. Access to GADS, TADS and MIDAS are restricted.

Information is available at: <u>NERC/Performance Analysis</u>



Grid Planners and Operators Shared Gannon Storm Experience

Workshop takeaways:

- Excellent opportunity for GIC model validations
 - Validation studies have been conducted by EPRI, electric industry, and others in the space weather community
 - Lack of magnetometer coverage poses a challenge in some regions
- Isolated instances of GIC interference with voltage support equipment were observed and must be analyzed to prevent future occurrences. Voltage issues are the key risk with GMD events.
- Operators desire more GIC data-sharing during events to improve awareness of system conditions

Key themes are consistent with the findings of the *Space Weather Advisory Group's User Needs* <u>Survey</u>

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NORTH AMERICAN ELECTRIC

Industry Workshop

Geomagnetic Disturbance Mitigation May 2024 GMD Event Review

Hybrid Meeting

October 1, 2024 | 1:00 – 5:30 p.m. Eastern October 2, 2024 | 8:30 a.m. – 12:30 p.m. Eastern

NERC Office 1401 H Street NW Suite 410 Washington, DC 20005

The October 2024 Workshop Materials are available here: <u>October 2024 GMD Workshop</u>



- NERC and our partners in the Electric Reliability Organization reduce risks to the Bulk Power System from severe GMD events through three main efforts:
 - State of the art Reliability Standards | TPL-007-4 and EOP-010-1
 - Partnerships for leading-edge research and tool development
 - Data collection program to improve knowledge and understanding
- We look forward to sharing results of the Gannon Storm after-action review broadly in 2025



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Questions and Answers

