Emergency Procedures: Conservative Operations

Weather/Environmental & Sabotage/Terrorism

Student Guide

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State & Member Training

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Objectives

- Identify triggers that may require PJM to initiate Conservative Operations
- Identify PJM and Member actions that will be taken once PJM initiates Conservative Operations

Triggers for Implementing Conservative Operations

Conservative Operations

Conservative Operations

- Certain events, conditions, or circumstances may put the Bulk Electric System (BES) at an increased level of risk, compared to normal operating conditions
- In these situations, PJM — as the Reliability Coordinator — must implement additional actions to ensure the system remains reliable in the face of additional threats

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Triggers for Conservative Operations

- Potential fuel delivery issues
- Forest or brush fires
- Weather-related events
- Environmental alerts
- Geo-magnetic Disturbances
- Physical or cyber-attacks, including credible threats
- Entering an unknown operating state

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General PJM Actions in Response to Conservative Operations

General Actions During Conservative Operations - PJM

- Analyze power flows into, across and through the control area to determine if it is jeopardy
  - Most critical limits are the IROLs, which are determined by flow across the system
    - Transfer limits can be reduced
    - Contracts may be suspended or cut
    - TLRs may be issued

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General Actions During Conservative Operations - PJM

- May initiate additional off-cost operations to limit or reduce flows across critical interfaces
- May purchase (or load) additional reserves

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General Actions During Conservative Operations - PJM

- Look at the possibility of losing multiple pieces of equipment simultaneously
  - Normal Operation - study single contingencies
  - May look at selected double contingencies
  - May look at Max Credible Disturbances
  - If analysis shows vulnerability, may take additional actions to survive these events
    - Load additional reserves
    - System reconfiguration
    - Additional off-cost operation

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General Actions During Conservative Operations - PJM

- Implement an additional layer of security on communications with and between members
  - Additional verification with members when issuing Instructions or responding to reports
  - Increase frequency of Satellite Phone checks
- Ask for additional updates on system status
  - More frequent IRCs and/or RRCs
  - More frequent SOS conference calls
- Ask members to staff back-up control centers, critical BES stations or black start facilites

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General Member Actions in Response to Conservative Operations

General Actions During Conservative Operations - Members

- PJM expects that Member companies will comply with and follow the specific requests and direction of PJM during these events
  - Provide additional reporting data
  - Generation dispatchers report any and all resource limited facilities as they occur via Markets Gateway, and update PJM Dispatch as appropriate
  - Staff substations or generating plants
  - Follow PJM operational directives (Transmission) or dispatch signals (Generation)

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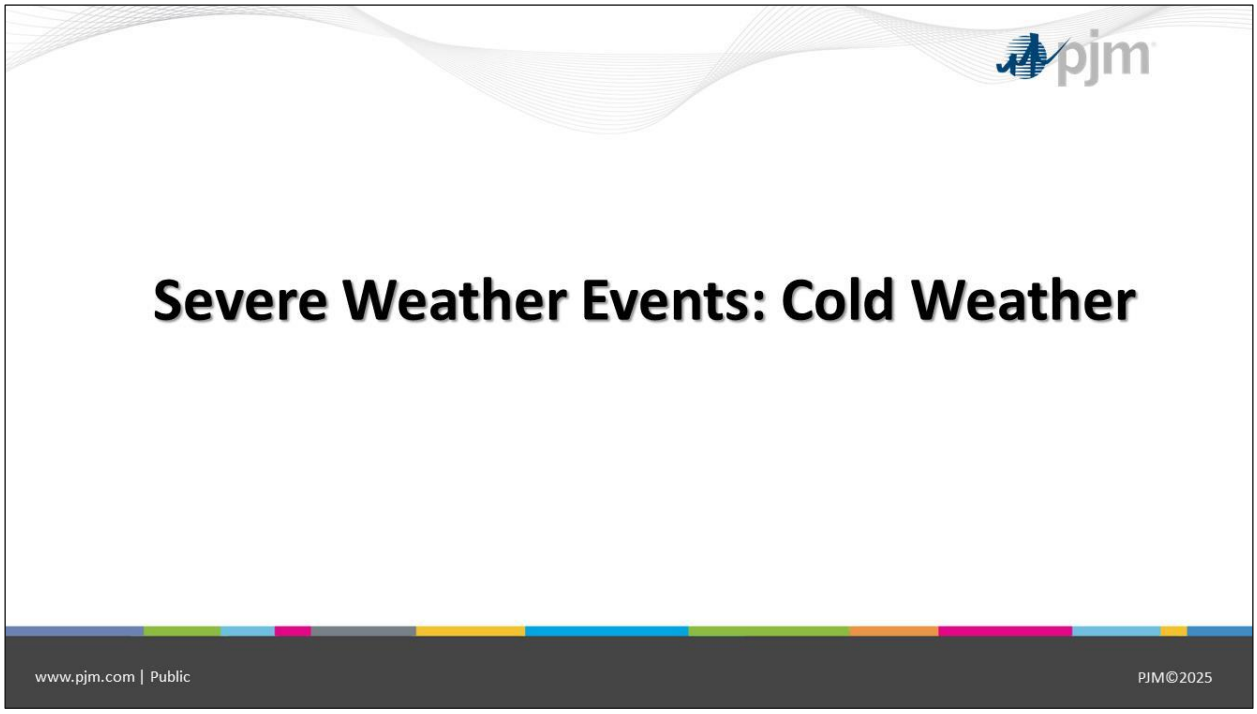
Cold Weather Advisory



Cold Weather Advisory

Cold Weather Advisory: provides early notice that a Cold Weather Alert may be required; intended to give PJM members ample time to gather information required by several NERC Standards

- PJM will attempt to issue the advisory as far in advance as possible, typically within 3-5 days but given fluctuating and changing weather forecasts advisories could be issued up to 24 hours in advance
- Members are to take any necessary precautions to prepare generating facilities for cold weather operations

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Cold Weather Advisory

- **PJM Actions**
  - Notifications to Members
    - PJM Dispatch notifies members via All-Call of forecasted temperatures and effective dates
    - PJM issues Cold Weather Advisory via Emergency Procedures Posting

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Cold Weather Advisory

- **PJM Member Actions**
  - Freeze Protection
    - Prepare by erecting temporary windbreaks or shelters, positioning heaters, verifying heat trace systems, or draining equipment prone to freezing
  - Operational Review
    - Review weather forecasts, determine any forecasted operational changes, and *notify PJM of any changes*
    - Members are to **update Markets Gateway and eDART** by entering **unit specific operation limitations** associated with cold weather preparedness

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Cold Weather Advisory

Operating limitations include:
Generator capability and availability
Fuel supply and inventory concerns
Fuel switching capabilities
Environmental constraints
Generating unit minimums (design temperature, historical operating temperature or current cold weather performance temperature as determined by an engineering analysis)

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Cold Weather Alert

Cold Weather Alert

Cold Weather Alert: prepares personnel and facilities for expected extreme cold weather conditions

- Issued when forecasted weather conditions approach *minimum or actual temperatures of 10 degrees Fahrenheit or below**
  - Can be initiated at higher temperatures if PJM anticipates *increased winds,* **or**
  - If PJM projects a portion of gas-fired capacity is unable to obtain spot market gas during load pick-up periods

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Cold Weather Alert

Control Zone	Region	Weather	Unavailability
Mid-Atlantic	Mid-Atlantic	Philadelphia	4000 - 5000 MW
FE-South/Duq	Western	Pittsburgh	500 - 1000 MW
AEP	Western	Columbus	1000 - 1500 MW
Dayton	Western	Dayton	500 - 1000 MW
ComEd	Western	Chicago	2000 - 3000 MW
Dominion	Southern	Richmond	1000 - 2000 MW
FE-West	Western	Cleveland	500 - 1000 MW
DEOK	Western	Cincinnati	200 - 300 MW
EKPC	Western	Winchester	200 - 300 MW

- PJM may increase the level of expected unavailability of generation if:
  - The predicted minimum temperature is -5 degrees Fahrenheit or less, **OR**
  - Recent unit performance has shown a significant increase in unit unavailability

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Cold Weather Alert - PJM Actions

Notification

- Notify PJM management, public, and members about expected cold weather
- Issue Cold Weather Alert
- Report significant changes in the estimated operating reserve capacity

Interchange Management

- Assume an unavailability factor of 25%-75% for scheduled interchange

Resource Coordination

- Notify GOs if more than 2000 MW from CTs are needed
- Confer with GOs to ensure they have personnel available to prepare generators to start when needed
- Poll large combined cycle units regarding projected availability during the reserve adequacy run

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Cold Weather Alert - PJM Actions

- Cold Weather Alert includes:
  - Control Zone
  - Forecasted low temperature
  - Forecasted duration of conditions
  - Amount of estimated operating reserve and reserve requirement
  - Reminder to GOs to update their unit parameters in Markets Gateway
  - Whether resource limited units are required to be placed into Maximum Emergency category

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Cold Weather Alert - Member Actions

Maintenance Review

- Evaluate if any maintenance on critical equipment can be postponed or canceled

Personnel Management

- Schedule sufficient personnel in advance, including operations, maintenance, and technical staff as needed

Generator Operations

- Units may need to idle or load as required
- Start CTs early, if needed, to provide additional synchronized reserves

Fuel Management

- Monitor fuel reserves and delivery schedules closely
- Prioritize starting the most unreliable units first
- Check CTs for adequate additives to handle low temperatures
- Report any projected fuel limitations to PJM
- Notify PJM if there are any issues with availability of spot market gas or other factors leading to unit unavailability

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Hot Weather Alert

Severe Weather Events: Hot Weather

Hot Weather Alert

Hot Weather Alert: prepares personnel and facilities for extreme hot and/or humid weather conditions which may cause capacity requirements/unit unavailability to be substantially higher than forecasted, and which are expected to persist for an extended period

- Issued when projected temperatures are to exceed *90 degrees Fahrenheit**, with high humidity, for multiple days
  - *Temperature threshold for Dominion and EKPC Control Zones is *93 degrees Fahrenheit*
  - Can be issued at lower temperatures if there are significant amounts of generation and transmission outages that reduce available generating capacity

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Hot Weather Alert

Control Zone	Region	Weather	Unavailability
Mid-Atlantic	Mid-Atlantic	Philadelphia	2000 - 2500 MW
FE-South/Duq	Western	Pittsburgh	300 - 500 MW
AEP	Western	Columbus	500 - 1000 MW
Dayton	Western	Dayton	300 - 500 MW
ComEd	Western	Chicago	1000 - 1500 MW
Dominion	Southern	Richmond	500 - 1000 MW
FE-West	Western	Cleveland	300 - 500 MW
DEOK	Western	Cincinnati	100 - 200 MW
EKPC	Western	Winchester	100 - 200 MW

- PJM uses weather locations and approximate unavailability rates
  - Unavailability numbers are conservative estimates
  - Values can be adjusted based on the duration of weather, actual unit performance, projected environmental impacts (i.e., river water temperatures, hydro elevation)

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Hot Weather Alert - PJM Actions

Notification

- Notify management and members about expected hot weather
- Issue Hot Weather Alert, detailing the estimated operating reserve capacity and requirements
- Remind GOs to update their unit parameters in Markets Gateway

Maintenance Management

- Non-critical maintenance outages are recalled or canceled

Resource Assessment

- Determine whether certain resource-limited units need to be classified under the Maximum Emergency category due to weather conditions

Forecast Review

- Load and interchange forecasts are reviewed alongside increases in MW unavailability

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Hot Weather Alert - Member Actions

Notification & Updates

- Notify management and other impacted personnel
- GDs update unit parameters such as Start-up, Notification times, Min and Max Run times, and Eco Min/Max settings in Markets Gateway

Resource Management

- Report any resource-limited facilities to PJM through Markets Gateway as they occur

Operational Adjustments

- Review and possibly defer or cancel any ongoing or scheduled maintenance or testing on critical equipment

Reporting & Scheduling

- Resource Limited Resources update the Max Run Time field in Markets Gateway if less than 24 hours of runtime is remaining
- Adjust the "early return time" for any planned generator outages as per the guidelines in PJM Manual for Pre-Scheduling Operations (M-10), Section 2.2

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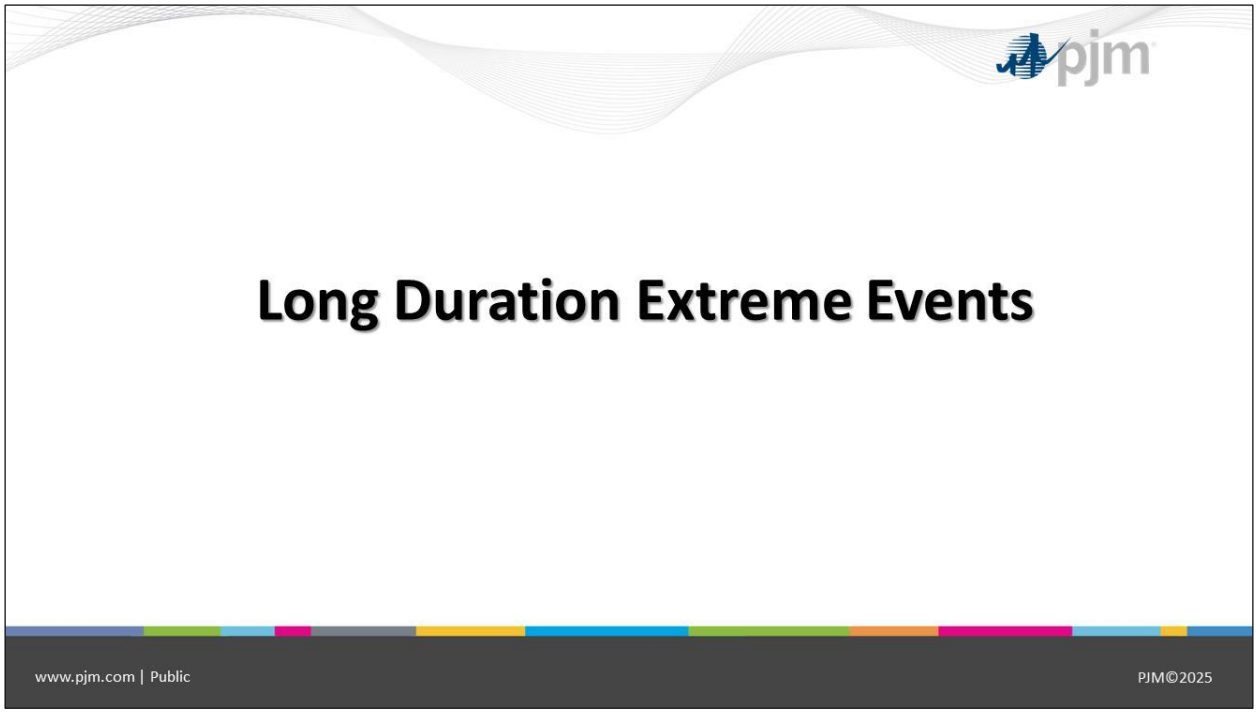
Long Duration Weather Events



Long Duration Extreme Events

- Examples of long duration extreme events include:
  - Extended Cold Weather
  - Long Duration Blizzard and/or Icing Conditions
  - Wide-Area Flooding
  - Impacts of Extreme Weather (i.e. Hurricane Damage) expected to last more than 72 hours
  - Physical or Cyber Events

Long Duration Extreme Events: extreme events, expected to last more than 72 hours, during which wide-scale fuel disruptions may occur

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Long Duration Extreme Events

PJM Member Actions

- Generation dispatchers report to PJM Dispatch any and all resource limited facilities via Markets Gateway

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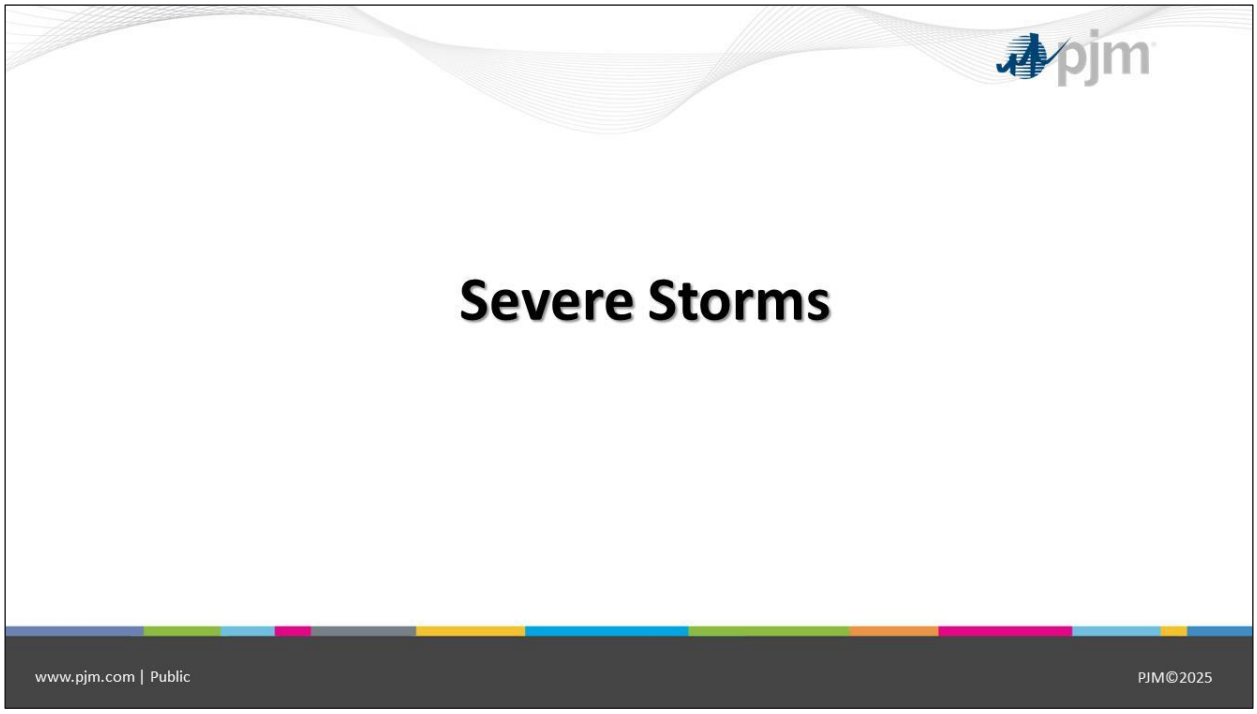
Severe Storms



Severe Storms

- When storms are in the vicinity of the PJM RTO, automatic re-closing capability should be in service for all EHV and critical 230 kV and above circuits
- If automatic reclosing is unsuccessful in restoring equipment to service, consideration should be given to additional manual tests
  - Tornadoes, hurricanes, etc. may cause permanent damage to equipment
  - Additional testing should weigh the potential risk to the public from testing downed wires or damaged facilities

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Severe Storms

PJM Actions

- Request automatic reclosing capability be put into service on critical facilities
- May request maintenance and testing on critical transmission, generating, control, or monitoring equipment be deferred or canceled
- Inform affected Members of any storms moving into their area

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Severe Storms

Member Actions

- Transmission dispatchers notify PJM of any storms in their systems
- Restore auto-reclosing, or take other actions as instructed by PJM
- Notify PJM any time automatic reclosing is removed from service

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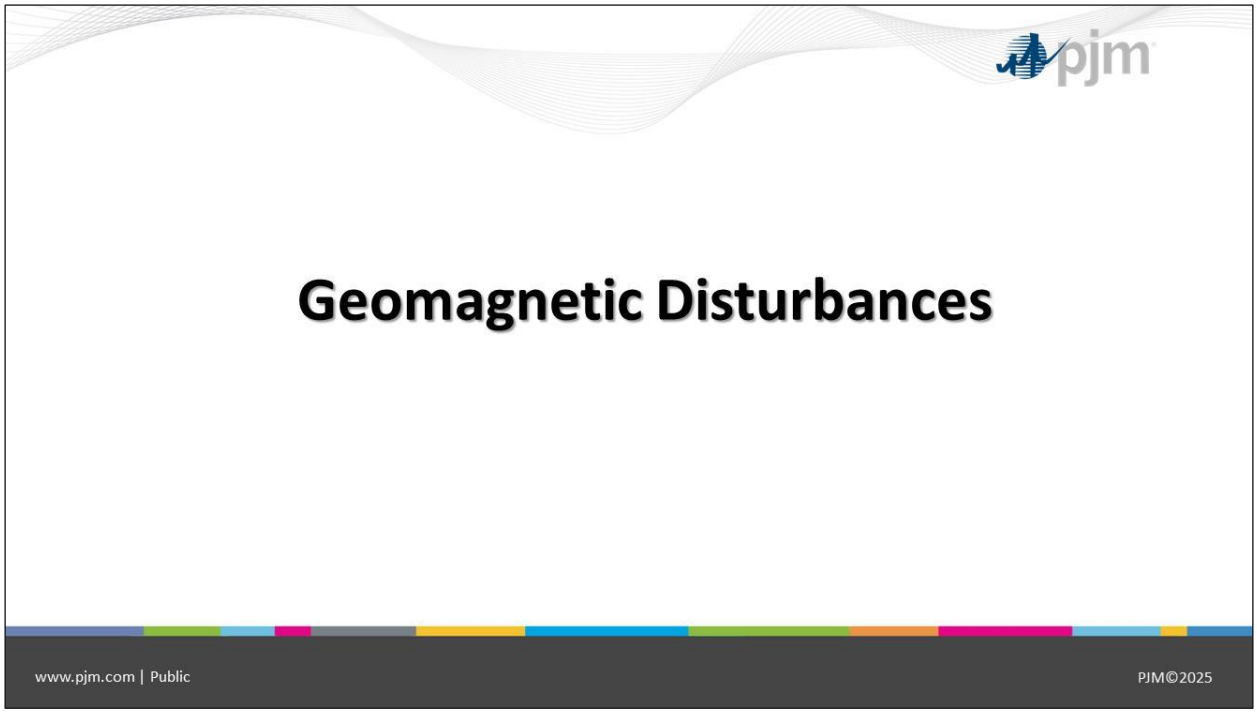
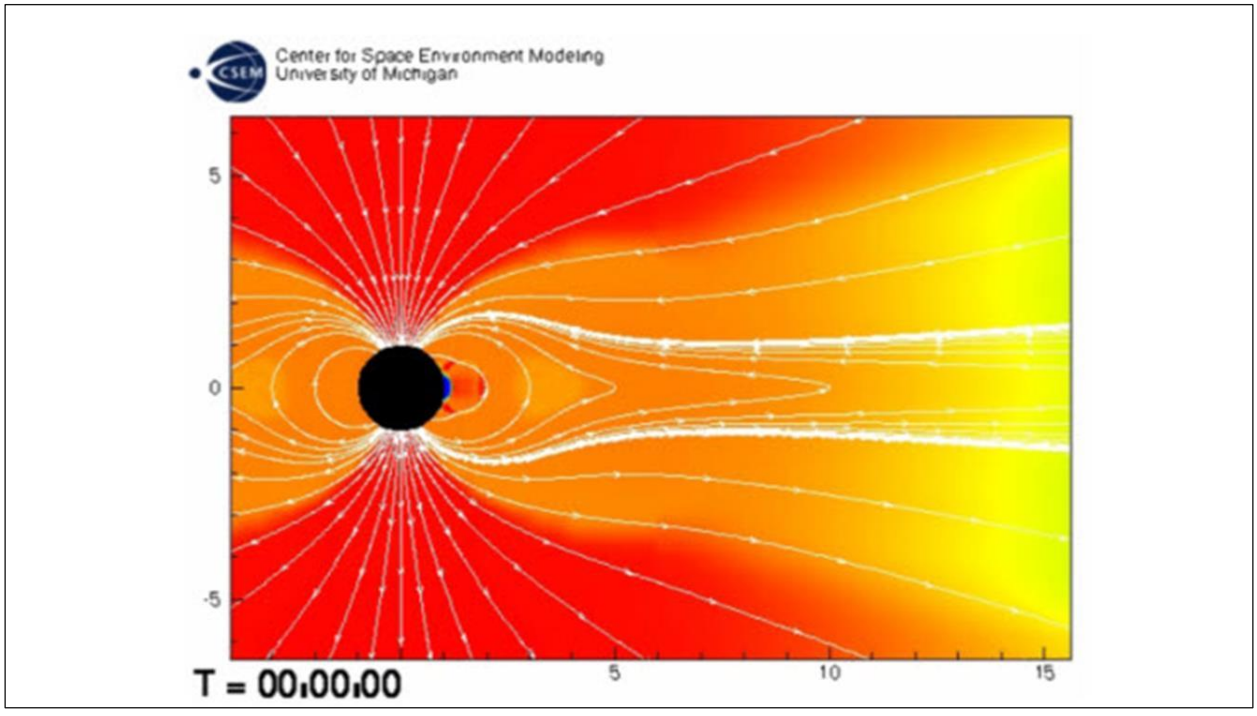
Geomagnetic Disturbances





CABLES DAMAGED BY SUNSPOT AURORA

Ships to Be Sent Out to Mend Lines Put Out of Service by Magnetic Display.

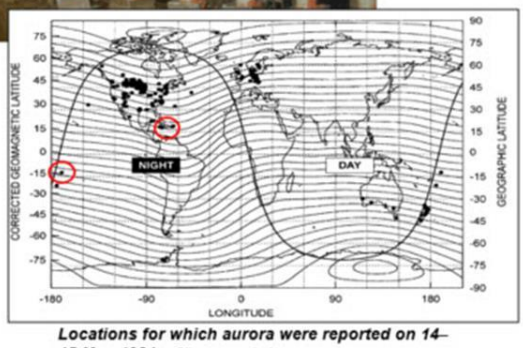
SUNSPOT CREDITED WITH RAIL TIE-UP

New York Central Signal System Put Out of Service by Play of Northern Lights.

The New York Times
Published: May 16, 1921

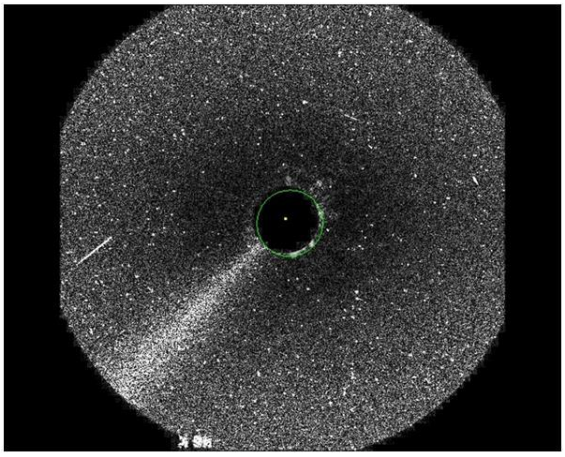
The sunspot which caused the brilliant aurora borealis on Saturday night and the worst electrical disturbance in memory on the telegraph systems was credited with an unprecedented thing at 7:04 o'clock yesterday morning, when the entire signal and switching system of the New York Central Railroad below 125th Street was put out of operation, followed by a fire in the control tower at Fifty-seventh Street and Park Avenue.

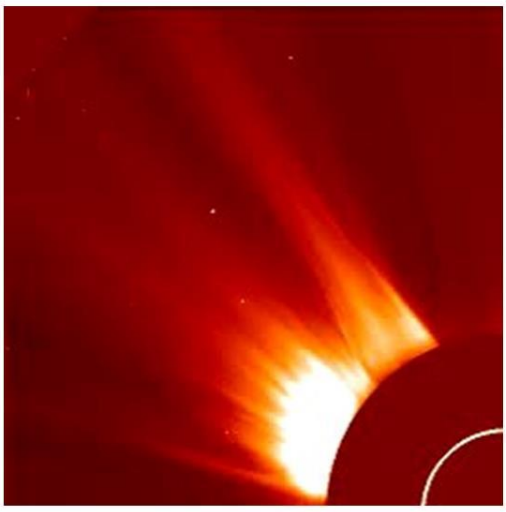
This is the first time that a sunspot has been blamed for such a piece of mischief. From other accounts it appeared



Locations for which aurora were reported on 14–15 May 1921 – *Silverman, et al.*

NOAA Forecasting: Coronographs





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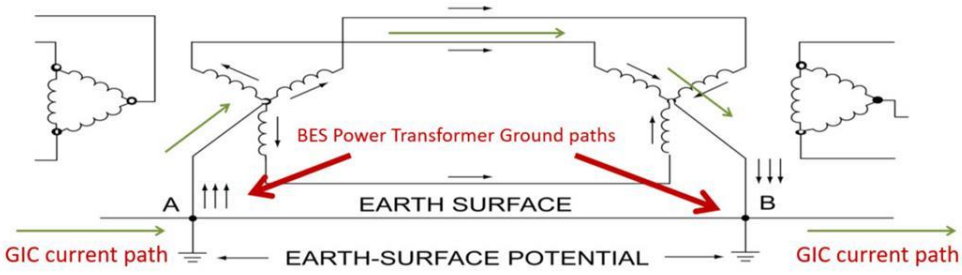
Geomagnetic Disturbances

- The vast majority of BES Power Transformers are connected in a grounded Wye-Delta configuration
- The GICs in high ground resistance areas travel up the ground path into the BES Power Transformers, travel along the transmission lines, and return to the ground via a BES transformer ground path in the area of lower induced voltage potential



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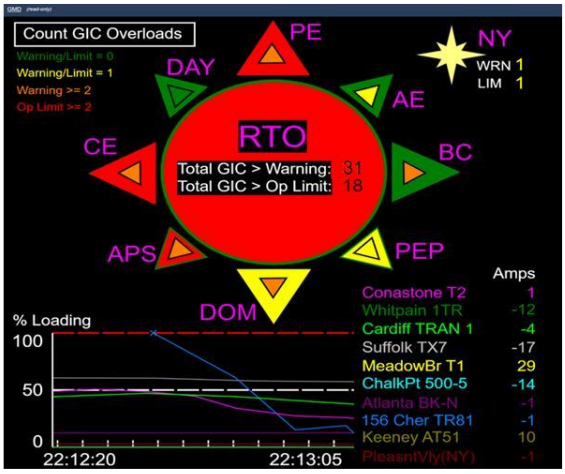
Geomagnetic Disturbances

- Special monitoring equipment to detect geomagnetically induced currents is located throughout the PJM RTO known to be prone to GIC activity



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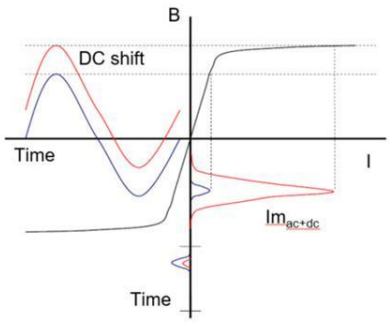
Impacts of GMDs

Impacts of GMDs

- Transformer 1/2 Cycle Saturation
- Geomagnetically Induced Current (GIC):
  - Quasi-DC: <0.1 HZ
- Saturated Transformers
  - Hot spots form inside
  - Consume more MVARs
  - Harmonic source

Hot-spots | MVARs | Harmonics



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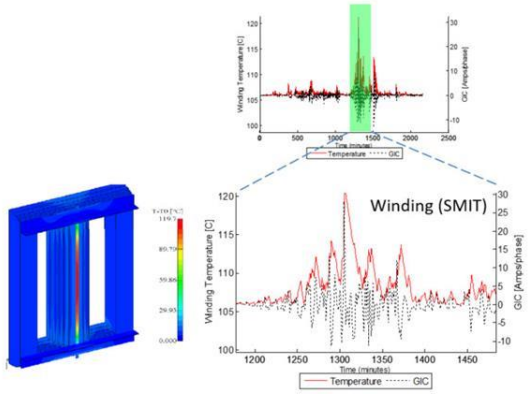
Transformer Hot Spots

- Heating is not instantaneous
  - Rate-of-rise and final temperature are quite different for different active and structural parts
- Thermal Analysis
  - Ambient temperature
  - Loading condition
  - GIC
- Vibration and Noise from DC saturated transformers
  - 20 dB jump
  - Vibration is function of GIC and not a big concern

Hot-spots | MVARs | Harmonics



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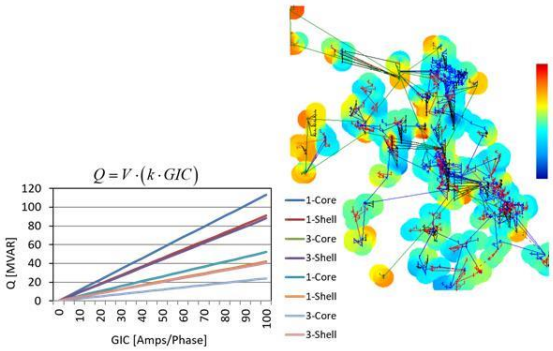
Voltage Stability

- Transformers consume extra reactive power:
  - Voltage stability
  - Potential issues with state estimator

Hot-spots | MVARs | Harmonics



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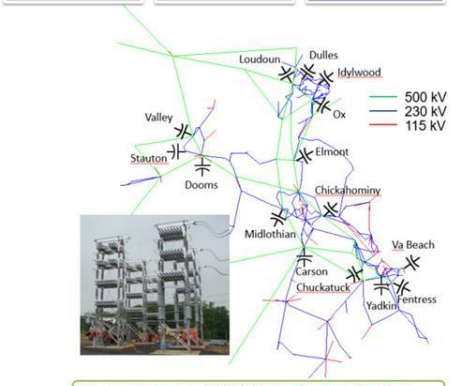
Impact of Harmonics

- Impact of Harmonics:
  - Protection system and fuses
  - Generator negative sequence heating
  - Control devices

Hot-spots | MVARs | Harmonics



Harmonics caused 1989 Hydro-Quebec blackout

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GMD Procedures

Applicable NERC Standards

NERC Standard EOP-010: to mitigate the effects of geomagnetic disturbance (GMD) events by implementing Operating Plans, Processes and Procedures

- Each RC shall develop, maintain and implement a GMD Operating Plan and procedure
- Each RC shall disseminate forecasted and current space weather

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Applicable NERC Standards

NERC Standard TPL-007: to establish requirements for Transmission system planned performance during geomagnetic disturbance (GMD) events

- Identity individual and joint responsibilities of the planning entities for model maintenance and studies for GMD Vulnerability Assessments
- Maintain System and GIC models needed for those studies

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Geomagnetic Disturbances

- Transmission Owners have the option (not a requirement) of developing operating plans specific to GMD activity, and must share them with PJM and coordinate with PJM prior to implementing them.

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NOAA: Kp-index (or G-scale)

NOAA Forecast

- Watch: long term forecast (1 day ahead)
- Warning: short lead time (hours ahead)
- Alert: real-time activity

K-index was not designed for power systems

Category		Effect	Physical measure	Average Frequency (1 cycle = 11 years)
Scale	Descriptor	Duration of event will influence severity of effects		
Geomagnetic Storms			Kp values* determined every 3 hours	Number of storm events when Kp level was met; (number of storm days)
G 5	Extreme	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. Spacecraft operations: may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. 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.) **	Kp=9	4 per cycle (4 days per cycle)
G 4	Severe	Power systems: possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. Spacecraft operations: may experience surface charging and tracking problems, corrections may be needed for orientation problems. 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.) **	Kp=8	100 per cycle (60 days per cycle)
G 3	Strong	Power systems: voltage corrections may be required, false alarms triggered on some protection devices. 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. 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.) **	Kp=7	200 per cycle (130 days per cycle)
G 2	Moderate	Power systems: high-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. Spacecraft operations: corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. 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.) **	Kp=6	600 per cycle (360 days per cycle)
G 1	Minor	Power systems: weak power grid fluctuations can occur. Spacecraft operations: minor impact on satellite operations possible. Other systems: migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine) **	Kp=5	1700 per cycle (900 days per cycle)

Minor impact

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Geomagnetic Disturbance Warning

If the **National Oceanic and Atmospheric Administration (NOAA)** issues a warning or alert for a potential geo-magnetic storm of severity ***K7 or greater***

PJM Actions

- PJM Dispatch notifies members (Generation and Transmission) via the PJM ALL-CALL of GMD warnings/alerts issued by the NOAA
- If GIC measurements exceed the associated GIC operating limit (in amperes) *at one and only one* of the transformers monitored for GIC flow, PJM Dispatch contacts the TO or GO in order to verify that the readings are accurate

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Geomagnetic Disturbance Warning

PJM Member Actions

- Transmission/Generation dispatchers provide confirmation of measurement values as requested by PJM Dispatch.
- Generation dispatchers provide as much advance notification as possible regarding details of more restrictive plant procedures that may result in plant reductions to protect equipment

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Geomagnetic Disturbance Action

- PJM dispatcher may take action as soon as necessary for a GMD disturbance but **must take action if conditions persist for 10 minutes**.
  - If GIC measurements exceed the associated limit at *two or more transformers* monitored for GIC flow, PJM Dispatch contacts the TO(s) and GO(s) in order to verify the readings are accurate and determine if excess MVAR exist at area transformers
  - PJM also checks NOAA GMD (http://www.swpc.noaa.gov/) to confirm if any storm warnings or alerts have been issued

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Geomagnetic Disturbance Action

- Upon identification of a GMD, PJM Dispatch declares a **Geomagnetic Disturbance Action** and operates the system to GMD transfer limits, which are determined from studies modeling various scenarios, including:
  - Partial or complete loss of Hydro Quebec Phase 2 DC line to Sandy Pond
  - Reduction or complete loss of generation at Artificial Island
  - Tripping of certain EHV capacitors

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Geomagnetic Disturbance Action

PJM Actions

- Notify Members and neighbors via the PJM ALL-CALL, postings on selected PJM websites, and the RCIS
- Begin to operate the system to the GMD transfer limits, beginning generation re-dispatch as needed when limits are approached or exceeded
- Evaluate the impact of the existing inter-area transfers and modify the schedules that adversely affect the GMD transfer limit
  - May require other capacity-related emergency procedures if sufficient generation is not available
  - Pre-contingency load shed will not be used to control transfers to the GMD transfer limit
- Continue to operate to the GMD transfer limits for a period of 3 hours, after GIC measurements at all monitored transformers have fallen below the associated GIC operating limit

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Geomagnetic Disturbance Action

PJM Member Actions

- Transmission/Generation dispatchers provide confirmation of measurement values as requested by PJM Dispatch
- Generation dispatchers provide as much advance notification as possible regarding details of more restrictive plant procedures that may result in plant reductions to protect equipment
- Members that operate GIC recording instruments will dispatch personnel to ensure that measurement equipment working properly
- Members employing a MVAR summing algorithm method initiate data collection
- Transmission/Generation dispatchers report all actions to PJM Dispatch

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Fuel Delivery Emergencies

Fuel Delivery Emergencies

- Not only PJM, but RTOs and ISOs throughout North America have been affected by natural gas curtailments during cold weather periods
  - When natural gas supply or deliverability issues occur during cold weather, **gas companies must give priority to heating over power generation**
- This has led to some generating plants being unavailable to generate during heavy load periods

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Fuel Delivery Emergencies

- PJM, in conjunction with NYISO and ISO-NE, has developed and maintains an RTO Natural Gas Coordination Procedure
  - The 3 RTOs will communicate jointly with Natural Gas Suppliers and the operators of Interstate Gas pipelines to manage potential inadequacy situations
  - Each RTO has developed a database of natural gas infrastructure in its footprint

Location of units fueled by natural gas	Interstate pipeline supplier or LDC
Connection point on gas pipeline system	Contract arrangements for gas supply and transmission
Complete set of maps of the gas lines serving its system	Contact list for suppliers

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Fuel Delivery Emergencies

- RTO Natural Gas Coordination Procedure
  - The RTOs will work jointly to share all information and work with suppliers to determine the best overall use for limited gas resources
  - This larger picture view helps protect the Eastern Interconnection as a whole, ensuring resource are used to best protect the Interconnection, not an individual RTO

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Fuel Delivery Emergencies

PJM Actions

- Monitor weather conditions, identify forecast conditions that trigger a Cold Weather Alert
- Analyze and forecast the need for natural gas-fired resources, and determine the need to invoke the Inter RTO Natural Gas Coordination procedure
- Request a conference call with ISO New England and New York ISO to share its assessment of the need for its natural gas-fired resources
- RTO/ISO will share a high level summary of the expected electrical demand and capacity conditions; expected need for natural gas-fired generation; and contact information for the interstate pipelines within each RTO

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Fuel Delivery Emergencies

- The RTOs will **jointly** communicate with the interstate pipelines to include:
  - Summary of the expected electrical demand and capacity conditions in the RTOs during the forecasted weather event
  - Expected need for the natural gas-fired generation
  - Contact information for the interstate pipelines within each RTO
- Each RTO will follow-up individually with each of its pipeline suppliers, requesting:
  - The operational status of the pipeline
  - The presence or anticipation of any Operational Flow Orders (OFOs), or other emergency procedures
  - An assessment of the pipeline's ability to serve contracts for generation through the expected duration of the event

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Fuel Delivery Emergencies

- After collecting pipeline data, the RTOs will share the information, reconvene, and determine actions to be taken including:
  - Modifications of the generation dispatch day-ahead to account for expected unavailability of gas-fired generation
  - Limitations of the granting of outages to maximize availability of generation resources
  - Adoption of conservative operations actions intended to mitigate risks associated with gas system contingencies or gas-fired generation unavailability

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Fuel Delivery Emergencies

Member Actions

- Provide information on their facilities prior to winter
- Provide any information relative to delivery limitations to their gas supply
- Notify PJM if voluntary pre-contingency fuel switching will be implemented
- Comply with all operational instructions issued by PJM

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Wildfires

Wildfire Procedures

Wildfire Procedures

Wildfire Procedures: procedures PJM developed to guide operations during periods of active or anticipated wildfires

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PJM Actions

Analysis

- Consult with staff meteorologists to evaluate extent of risk, discuss with impacted TOs and GOs
- Run real time and future studies, examining impact of potential impacts to transmission facilities
- Coordinate with TOs to evaluate status of facility outages
- Evaluate if Conservative Operations are warranted

Communication

- Communicate with Members and neighboring RCs, as needed

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Member Actions

Analysis & Communication

- Monitor red flag wild fire warnings and high risk wild fire conditions, notifying PJM as needed
- Notify PJM in advance, or as soon as possible, regarding any circuits that will be de-energized to prevent wild fire risk
- Evaluate existing and future outages, communicating with PJM on recalled or rescheduled outages
- Evaluate and communicate to PJM the need to turn off reclosing for MP1 facilities and other facilities, as determined by the TO
- Review facility ratings and communicate to PJM if there is the need to de-rate facilities

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Sabotage/Terrorism Emergencies

What is sabotage?

Sabotage: a deliberate or planned disturbance or event that could potentially threaten the reliability of the Bulk Electric System (BES) or lead to cascading outages

What are some examples of potential sabotage events?

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General Conditions

- Responses to any triggers include a multi-faceted plan to safeguard personnel and maintain interconnection reliability, including:
  - Power system operations
  - Communications
  - Cyber security
  - Physical security
- Emphasis is on operations and communications based upon the specific threat and intelligence
  - Actual response can be tailored to the event, as needed

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Triggers for Emergency Procedures

- Key PJM actions are based on Threat Levels issued by the Department of Homeland Security (DHS)
  - **Elevated Threat Alert**: warns of a credible threat against the US
  - **Imminent Threat Alert**: warns of a credible, specific, and impending threat against the US
- PJM may act ahead of DHS alerts if PJM becomes aware of a possible threat before DHS issues an alert/advisory

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Elevated Threat - PJM Actions

Communication	• Relevant information shared with Members via the ALL-CALL • Emphasis on need for thorough reporting • Enhance Voice Communication Security • SOS conference calls scheduled, as needed
Analysis	• Maintenance outages, including confirmation of emergency return times • Maximum credible contingencies • Hydro schedules • Black start assessment to determine fuel limitations
Preparedness	• Maintain vigilance • Increased Satellite Phone Checks (daily to start, weekly thereafter) • Staff an Incident Response Team

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Elevated Threat - Member Actions

Communication	• Review reporting requirements/process • Participate in PJM-hosted conference calls
Preparedness	• Consider limited, or full, activation of emergency preparedness action plans

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Imminent Threat - PJM Actions

Communication	• Submit DOE-417 report to DOE, NERC, and RF and/or SERC • Relevant information shared with GOs/TOs via the ALL-CALL, as allowable • Institute daily conference calls with GOs/TOs, as necessary to assess posture • Refrain from posting emergency actions on the Emergency Procedures website
Operations	• Operate to more conservative modeling measures • May initiate manual dispatch (when EMS not available) • Increase available Synchronized and 30 Minute Reserves • Cancel maintenance outages/restore outaged equipment in impacted area • Obtain emergency energy bids as a precaution • Initiate Black Start Assessment to determine fuel limitations

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Imminent Threat - PJM Actions

Staffing	• PJM Dispatcher alerts relevant internal emergency response teams • PJM maintains 24 hour Operations management presence; increases operator staffing • Consider staffing select substations/CT sites/Black Start units • Recommends enhanced physical security at critical substations

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Imminent Threat - Member Actions

Communication	• Notify management
Operations	• Consider activating the emergency preparedness plan • Respond to requests and directions of PJM Dispatch • Follow PJM's Manual Dispatch, if applicable (loss of EMS)
Staffing	• Staff BUCC • Consider enhancing staffing and security at critical substations • If requested by PJM, staff critical CTs and black start units

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Communicating Threats

- **Electricity Information Sharing and Analysis Center (E-ISAC)** receives and reviews information from:
  - US or Canadian Federal Agencies
  - Reliability Coordinators
  - Electric Sector Entities (Region, Control Area, Purchasing-Selling Entity)
  - Other Sector ISACs (Chemical, defense, financial services, etc.)
- If the information is *specific* and *credible*, the E-ISAC will contact the involved entity directly

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Communicating Threats

PJM Actions	Member Actions
– Monitor and report relevant information to the Reliability Coordinator Information System (RCIS) • For time-sensitive issues, a Reliability Coordinator Conference Call will be convened – No information shared by RCs will be passed on without approval – No information shared is to be delivered to the public media	– Contact the PJM Shift Supervisor if: • Contacted by E-ISAC regarding a threat to a facility • The Member has observed or received a report about a sabotage event – PJM will then communicate the information: • To other RCs via the RCIS • To Members via the ALL-CALL (for urgent matters) or through the SOS/email (for non-actionable matters)

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Other Scenarios

- Additional scenarios requiring preparedness and response plans:
  - Loss of internet
  - Loss of all telecommunications
  - Bad data exchange
  - Unauthorized remote operation of a BES asset

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Other Scenarios

Communication	• Submit DOE-417 report, as necessary • Ensure availability of and use alternative means of communication, including testing/verification • Ensure effective information sharing
Operations	• Validate data for accuracy, switching to alternative data sources if necessary • Consider postponing or canceling maintenance outages in impacted areas • Conduct additional system analyses/assessments • Respond to requests and directions of PJM Dispatch
Staffing	• Notify appropriate emergency response teams • Consider staffing critical facilities to assist with communication

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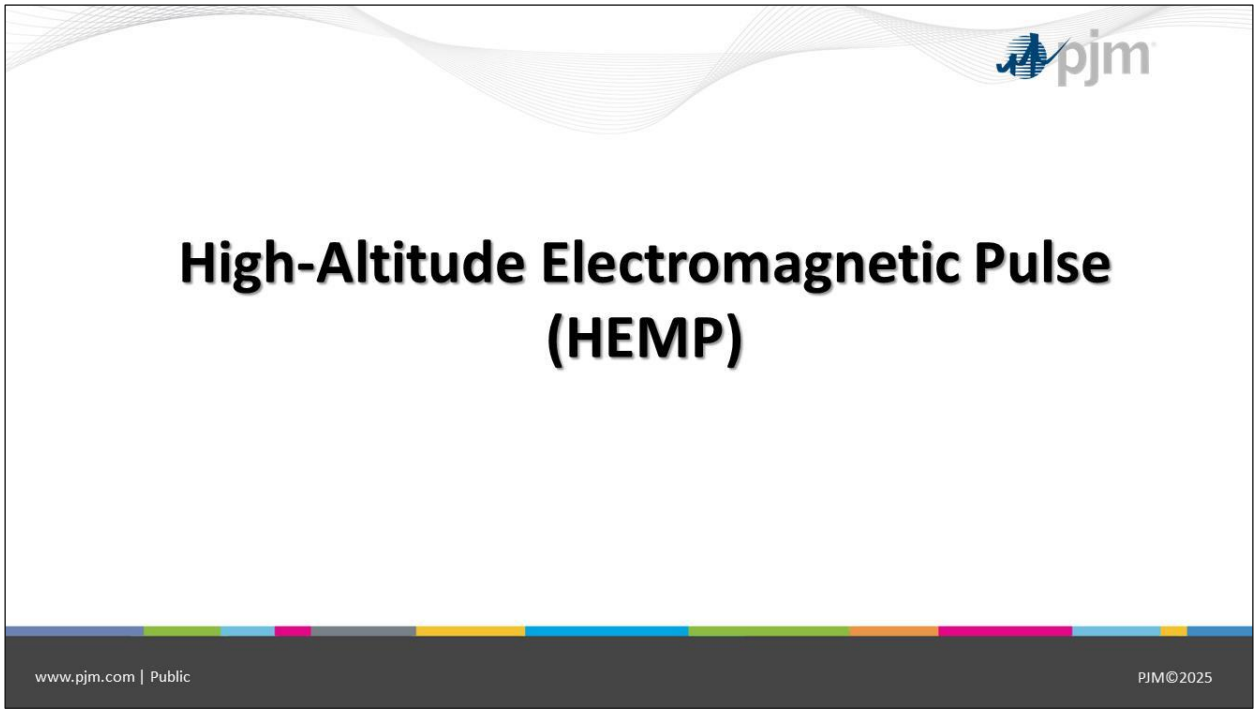
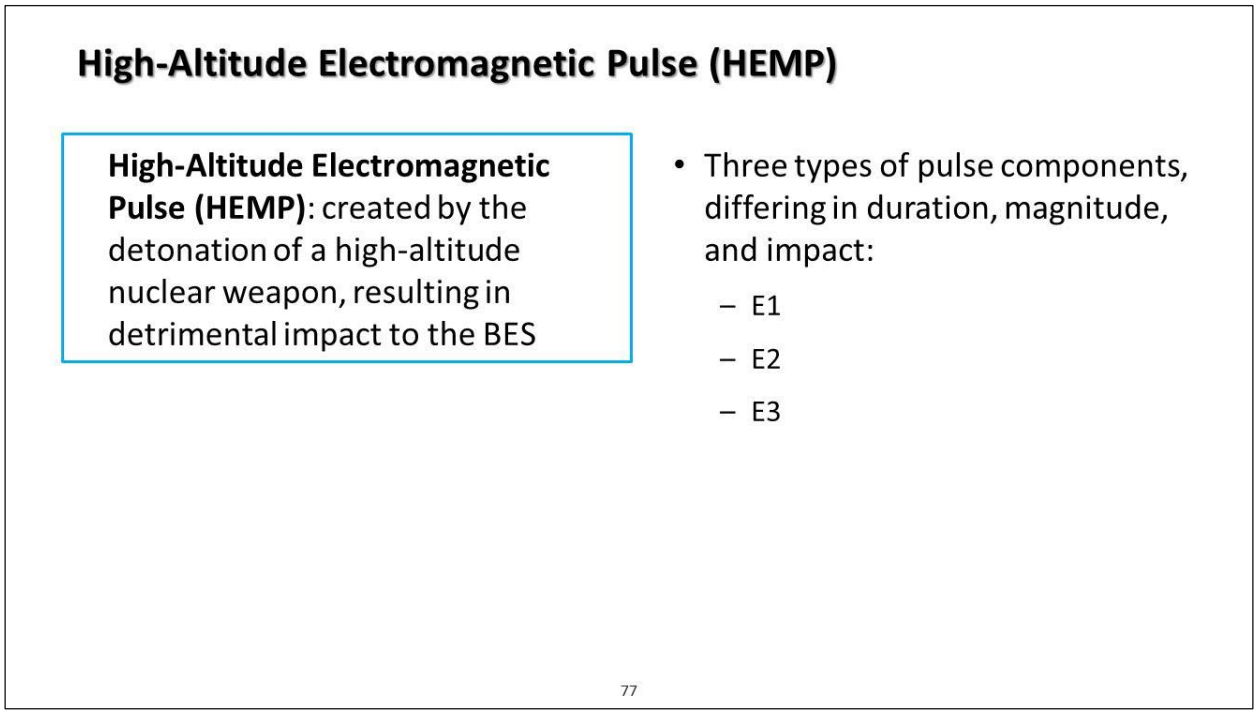
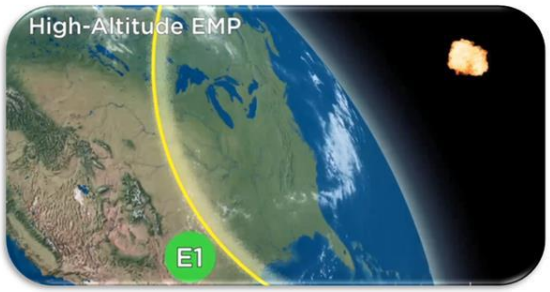
High-Altitude Electromagnetic Pulse (HEMP)





HEMP – E1

- **E1 pulse**
  - High magnitude, short duration narrow pulse
  - High amplitude (50kV/m)
  - Has significant electric field similar to fields observed in an EHV substation during switching or fault events
    - During a HEMP, levels observed over a much wider area
  - Can result in damage to protective relays, monitoring equipment and communication devices



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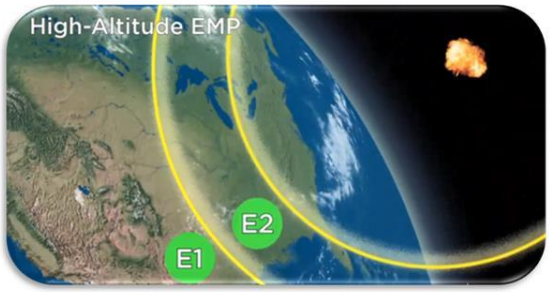
HEMP – E2

- **E2 pulse**
  - An intermediate pulse with characteristics similar to lightning
  - Amplitude is 0.1 kV/m
    - Far less than a lightning strike or an E1 pulse
  - Potential impacts to electric infrastructure expected to be minimal



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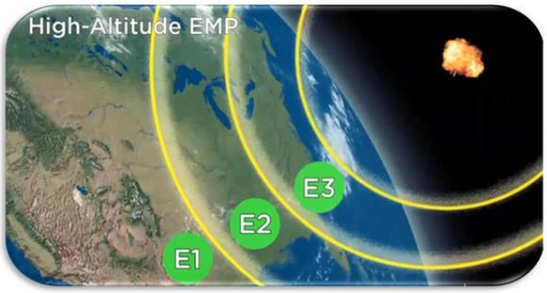
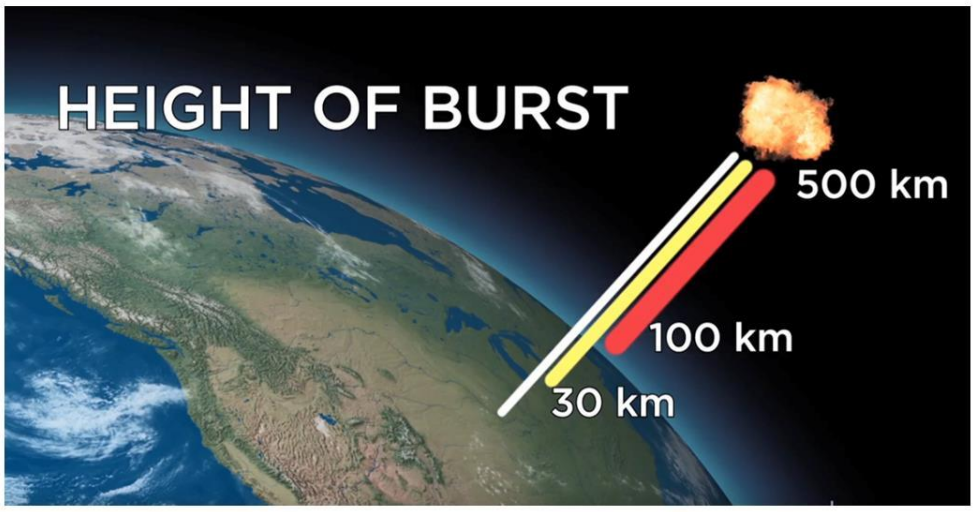
HEMP – E3

- **E3 pulse**
  - Late impact similar in nature to a severe GMD
  - Cause high-magnitude GMD-like effects across a wide-spread area
    - Duration 4-5 minutes
    - Cause hot spots on power transformers
    - Causes greater reactive consumption
    - Increase risk of equipment failure and possible voltage collapse



80

Altitude Above Target = Effectiveness



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HEMP Preparedness

While this is considered a *High-Impact Low-Frequency (HILF) event*, PJM believes that the multifaceted, wide-area, extreme impacts of an HEMP event on the BES system warrant having an action plan for PJM operations.

- PJM's response plan assumes that no sufficient warning would be provided and includes the following elements:
  1. Re-Establish Communication with Members
  2. Assess System Damage
  3. Prepare for Black Start if necessary

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HEMP Preparedness

Importance of Communication. The biggest challenge expected after a HEMP is the potential complete loss of communications without prior warning. PJM Members are strongly encouraged to store back-up satellite phones in shielded bags when not in use.

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PJM Actions

- PJM Dispatchers will gather operational information from Generation/Transmission Owners, including:
  - Communication capabilities
  - Monitoring/control capabilities
  - Damage to BES transmission facilities and generators, including protective relaying systems, black start units, and cranking paths
  - Load lost

System Status	PJM's Corresponding Action
Minimal HEMP Impacts	Operate under Conservative Operations
Interconnection Stable	Begin restoring isolated parts of system
Blackout	Coordinate black start efforts with TOs/GOs

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Member Actions

Communication	• Importance of establishing communications, including use of back-up communication systems
Data Sharing	• Gather relevant system status information and be prepared to report that to PJM when communication is re-established
Staffing	• Staff critical facilities

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Reporting Emergencies

Background

- The US Department of Energy (DOE) has established mandatory reporting requirements for electric emergency incidents & disturbances
- NERC Standard EOP-004 covers critical reporting of electrical emergency incidents, disturbances or destruction that disrupts the operation of grid critical infrastructure
- DOE Form DOE-417 addresses additional reporting requirements such as cyber attacks and loss of customers
- Responsible Entities must report by submitting ***either*** the Attachment 2 form included in EOP-004 or a DOE-417 form

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NERC Standard EOP-004 Requirements

- Event reporting Operating Plans shall be in place that include protocols for reporting to NERC and other organizations, such as:
  - Regional Entities
  - Company personnel
  - Responsible Entities
  - Reliability Coordinators
  - Law enforcement
  - Government authorities

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NERC Standard EOP-004 Requirements

- Events must be reported per an entity's Operating Plan within 24 hours of recognition of meeting an event type threshold for reporting or by the end of the next business day, if the event occurs on a weekend
  - Weekend is designated as starting Friday at 4:00 pm, and ending as of Monday at 8:00 am
- Evidence of reporting an event must include a copy of a completed NERC EOP-004 Attachment 2 form or a DOE OE-417 form and evidence of submittal such as operator logs, voice recordings, electronic mail messages, and fax confirmations demonstrating the report was submitted

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Disturbance Reporting DOE-417

Report Type / Action	Filing Instructions
Emergency Alert Report Within One Hour of the Incident	Schedule 1 and lines N-S and the Cyber Attributes of line T (If criteria 2 is met) of Schedule 2 must be filed
Normal Alert Report Within Six Hours of the Incident	Schedule 1 and lines N-S of Schedule 2 must be filed if none of the Emergency Alert criteria applies
Attempted Cyber Compromise Within 1 Calendar Day	Schedule 1 and lines N-S and the Cyber Attributes of line T of Schedule 2 must be filed if none of the Emergency or Normal Alert criteria applies
System Report By the later of 24 hours OR by the end of the next business day	Schedule 1 and lines N - S of Schedule 2 must be filed if one or more of the following criteria are met and none of the Emergency Alert, Normal Report, or Attempted Cyber Compromise criteria apply
Update Report Select "Update" as the Alert Status on line A of the form.	Schedule 1 and lines N-S of Schedule 2 and the Cyber Attributes on line T (if criteria 2 or 14 are met) should be resubmitted if information or changes have occurred after an initial report was filed
Final Report Within 72 hours of the incident. Select "Final" as the Alert Status on line A of the form	Schedule 1 and all of Schedule 2 must be submitted to provide complete disruption information

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DOE-417 Required Submissions

Who must submit? Balancing Authorities, Reliability Coordinators, some generating entities, and electric utilities

- Electric utilities must provide information to the BA when necessary and file a Form DOE-417 where a BA is not involved
- Computer centers and physical security departments of electric utilities may file directly based on selected areas of the Form DOE-417, as identified in the instructions
- BAs and RCs can file a joint report, or BAs and electric utilities can file a combined report
- Notification must be done at the time of the filing

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Reporting Methods

- Online (Preferred Method): https://doe417.pnnl.gov/
  - Instructions on how to use the online system can be accessed at: https://doe417.pnnl.gov/instructions
- E-mail: doehqeoc@hq.doe.gov
- Fax: (202) 586-8485
- Telephone: (202) 586-8100

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U.S. Department of Energy Form DOE-417	ELECTRIC EMERGENCY INCIDENT AND DISTURBANCE REPORT	OMB No. 1901-0288 Approval Expires: 08/31/2027 Burden Per Response: 1.8 hours

NOTICE: This report is **mandatory** under Public Law 93-275. Failure to comply may result in criminal fines, civil penalties and other sanctions as provided by law. For the sanctions and the provisions concerning the confidentiality of information submitted on this form, see General Information section of the instructions. **Title 18 USC 1001 makes it a criminal offense for any person knowingly and willingly to make to any Agency or Department of the United States any false, fictitious, or fraudulent statements as to any matter within its jurisdiction.**

RESPONSE DUE:

Within 1 hour of the incident, submit Schedule 1 and lines N - S in Schedule 2 as an Emergency Alert report if criteria 1-9 are met. If criterion 2 is met, also submit the Cyber Attributes on line T in Schedule 2.
Within 6 hours of the incident, submit Schedule 1 and lines N - S in Schedule 2 as a Normal Report if only criteria 10-13 are met.
By the end of the next calendar day after a determination, submit Schedule 1 and lines N – S and the Cyber Attributes on line T in Schedule 2 as an Attempted Cyber Compromise if criterion 14 is met.
By the later of 24 hours after the recognition of the incident OR by the end of the next business day submit Schedule 1 and lines N - S in Schedule 2 as a System Report if criteria 15-26 are met. *Note: 4:00pm local time will be considered the end of the business day.*

Submit updates as needed and/or a final report (all of Schedules 1 and 2) within 72 hours of the incident.

For NERC reporting entities registered in the United States, NERC has approved that the form DOE-417 meets the submittal requirements for NERC. There may be other applicable regional, state and local reporting requirements.

METHODS OF FILING RESPONSE
(Retain a completed copy of this form for your files.)

Online: Submit form via online submission at: https://www.oe.netl.doe.gov/OE417/
FAX: FAX Form DOE-417 to the following facsimile number: (202) 586-8485
Alternate: If you are unable to submit online or by fax, forms may be e-mailed to doehqeoc@hq.doe.gov, or call and report the information to the following telephone number: (202) 586-8100

SCHEDULE 1 -- ALERT CRITERIA
(Page 1 of 4)

Criteria for Filing (Check all that apply) – See Instruction: For More Information

EMERGENCY ALERT File within 1-Hour If any box 1-9 on the right is checked, this form must be filed within 1 hour of the incident: check Emergency Alert (for the Alert Status) on **Line A** below.	1. ☐ Physical attack that causes major interruptions or impacts to critical infrastructure facilities or to operations 2. ☐ Reportable Cyber Security Incident *(as defined in the NERC Glossary of Terms)* 3. ☐ Cyber event that is not a *Reportable Cyber Security Incident* that causes interruptions of electrical system operations. 4. ☐ Complete operational failure or shut-down of the transmission and/or distribution electrical system 5. ☐ Electrical System Separation (Islanding) where part or parts of a power grid remain(s) operational in an otherwise blacked out area or within the partial failure of an integrated electrical system 6. ☐ Uncontrolled loss of 300 Megawatts or more of firm system loads for 15 minutes or more from a single incident 7. ☐ Firm load shedding of 100 Megawatts or more implemented under emergency operational policy 8. ☐ System-wide voltage reductions of 3 percent or more 9. ☐ Public appeal to reduce the use of electricity for purposes of maintaining the continuity of the Bulk Electric System
NORMAL REPORT File within 6-Hours If any box 10-13 on the right is checked AND none of the boxes 1-9 are checked, this form must be filed within 6 hours of the incident: check Normal Report (for the Alert Status) on **Line A** below.	10. ☐ Physical attack that could potentially impact electric power system adequacy or reliability; or vandalism which targets components of any security systems 11. ☐ Cyber event that could potentially impact electric power system adequacy or reliability 12. ☐ Loss of electric service to more than 50,000 customers for 1 hour or more 13. ☐ Fuel supply emergencies that could impact electric power system adequacy or reliability
ATTEMPTED CYBER COMPROMISE File within 1-Day If box 14 on the right is checked AND none of the boxes 1-13 are checked, this form must be filed by the end of the next calendar day after the determination of the attempted cyber compromise: check Attempted Cyber Compromise (for the Alert Status) on **Line A** below.	14. ☐ Cyber Security Incident that was an attempt to compromise a High or Medium Impact Bulk Electric System Cyber System or their associated Electronic Access Control or Monitoring Systems

Schedule 1

Disturbance Info: Select the type of disturbance that has taken place - check all that apply (continues on next page)

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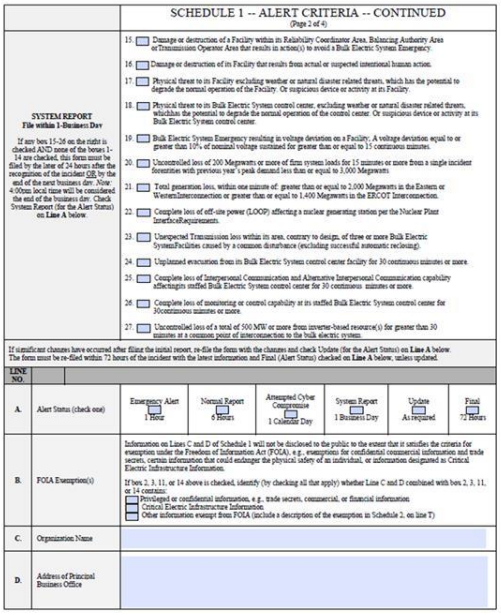

SCHEDULE 1 -- ALERT CRITERIA -- CONTINUED
(Page 2 of 4)

SYSTEM REPORT
File within 1-Business Day

If any box 15-26 on the right is checked AND none of the boxes 1-14 are checked, this form must be filed by the later of 24 hours after the recognition of the incident OR by the end of the next business day. Note: 4:00pm local time will be considered the end of the business day. Check System Report (for the Alert Status) on **Line A** below.

15. ☐ Damage or destruction of a Facility within its Reliability Coordinator Area, Balancing Authority Area or Transmission Operator Area that results in action(s) to avoid a Bulk Electric System Emergency.
16. ☐ Damage or destruction of its Facility that results from actual or suspected intentional human action.
17. ☐ Physical threat to its Facility excluding weather or natural disaster related threats, which has the potential to degrade the normal operation of the Facility. Or suspicious device or activity at its Facility.
18. ☐ Physical threat to its Bulk Electric System control center, excluding weather or natural disaster related threats, whichhas the potential to degrade the normal operation of the control center. Or suspicious device or activity at its Bulk Electric System control center.
19. ☐ Bulk Electric System Emergency resulting in voltage deviation on a Facility; A voltage deviation equal to or greater than 10% of nominal voltage sustained for greater than or equal to 15 continuous minutes.
20. ☐ Uncontrolled loss of 200 Megawatts or more of firm system loads for 15 minutes or more from a single incident forentities with previous year's peak demand less than or equal to 3,000 Megawatts.
21. ☐ Total generation loss, within one minute of greater than or equal to 2,000 Megawatts in the Eastern or WesternInterconnection or greater than or equal to 1,400 Megawatts in the ERCOT Interconnection.
22. ☐ Complete loss of off-site power (LOOP) affecting a nuclear generating station per the Nuclear Plant InterfaceRequirements.
23. ☐ Unexpected Transmission loss within its area, contrary to design, of three or more Bulk Electric SystemFacilities caused by a common disturbance (excluding successful autosmatic reclosing).
24. ☐ Unplanned evacuation from its Bulk Electric System control center facility for 30 continuous minutes or more.
25. ☐ Complete loss of Interpersonal Communication and Alternative Interpersonal Communication capability affectingits staffed Bulk Electric System control center for 30 continuous minutes or more.
26. ☐ Complete loss of monitoring or control capability at its staffed Bulk Electric System control center for 30continuous minutes or more.
27. ☐ Uncontrolled loss of a total of 500 MW or more from inverter-based resource(s) for greater than 30 minutes at a common point of interconnection to the bulk electric system.

If significant changes have occurred after filing the initial report, re-file the form with the changes and check Update (for the Alert Status) on **Line A** below. The form must be re-filed within 72 hours of the incident with the latest information and Final (Alert Status) checked on **Line A** below, unless updated.

LINE NO.							
A.	Alert Status (check one)	Emergency Alert ☐ 1 Hour	Normal Report ☐ 6 Hours	Attempted Cyber Compromise ☐ 1 Calendar Day	System Report ☐ 1 Business Day	Update ☐ As required	Final ☐ 72 Hours
B.	FOIA Exemption(s)	Information on Lines C and D of Schedule 1 will not be disclosed to the public to the extent that it satisfies the criteria for exemption under the Freedom of Information Act (FOIA), e.g., exemptions for confidential commercial information and trade secrets, certain information that could endanger the physical safety of an individual, or information designated as Critical Electric Infrastructure Information. If box 2, 3, 11, or 14 above is checked, identify (by checking all that apply) whether Line C and D combined with box 2, 3, 11, or 14 contains: ☐ Privileged or confidential information, e.g., trade secrets, commercial, or financial information. ☐ Critical Electric Infrastructure Information. ☐ Other information exempt from FOIA (include a description of the exemption in Schedule 2, on line T)					
C.	Organization Name						
D.	Address of Principal Business Office						

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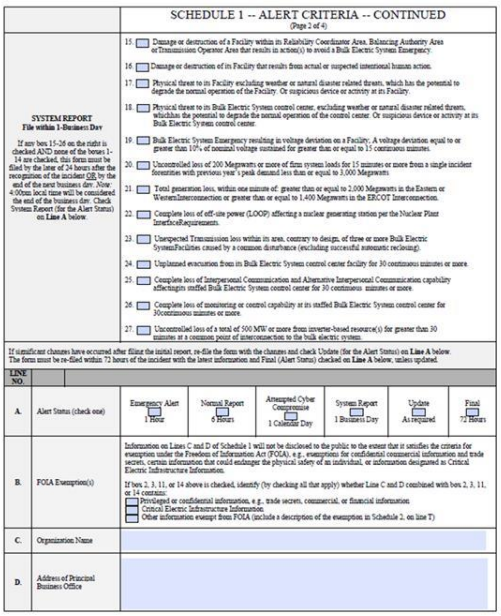
Schedule 1

Disturbance Info: Select the type of disturbance that has taken place - check all that apply



SCHEDULE 1 -- ALERT CRITERIA -- CONTINUED
(Page 2 of 4)

SYSTEM REPORT
File within 1-Business Day

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D.	Address of Principal Business Office						

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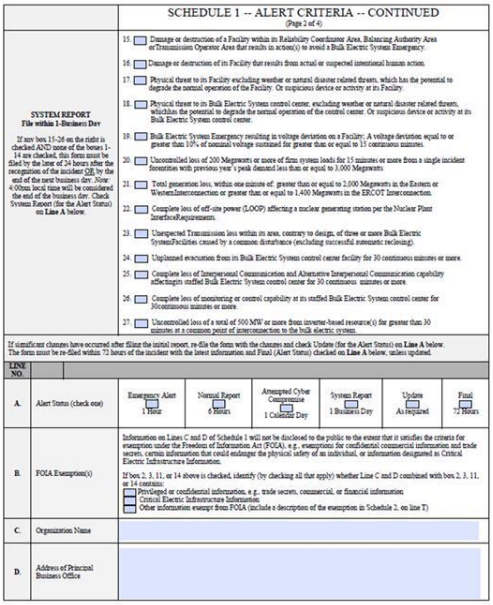
Schedule 1

Disturbance Info: Select the type of disturbance that has taken place - check all that apply

Alert Status: Select the type of report



SCHEDULE 1 -- ALERT CRITERIA -- CONTINUED
(Page 2 of 4)

SYSTEM REPORT
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C.	Organization Name						
D.	Address of Principal Business Office						

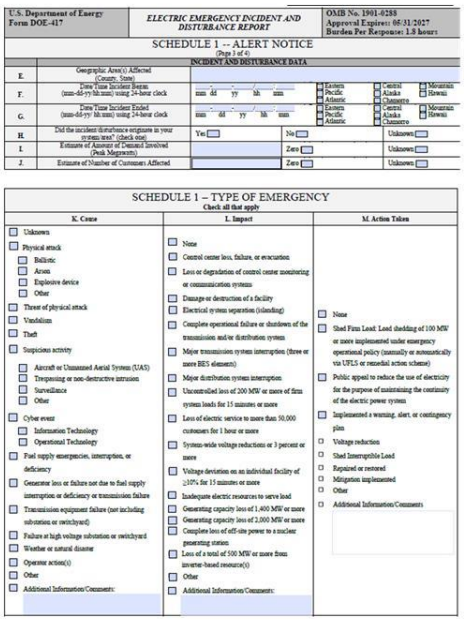
Schedule 1

Disturbance Info: Select the type of disturbance that has taken place - check all that apply

Alert Status: Select the type of report

Organization Info: Select the type of report, and enter name and address of organization

96



U.S. Department of Energy
Form DOE-417

ELECTRIC EMERGENCY INCIDENT AND DISTURBANCE REPORT

OMB No. 1901-0288
Approval Expires: 08/31/2027
Burden Per Response: 1.9 hours

SCHEDULE 1 -- ALERT NOTICE
(Page 3 of 4)

	INCIDENT AND DISTURBANCE DATA			
E.	Geographic Area(s) Affected (County, State)			
F.	Date/Time Incident Began (mm-dd-yy/hh:mm) using 24-hour clock	mm dd yy hh mm	☐ Eastern ☐ Pacific ☐ Atlantic ☐ Central ☐ Alaska ☐ Chamorro ☐ Mountain ☐ Hawaii	
G.	Date/Time Incident Ended (mm-dd-yy/ hh:mm) using 24-hour clock	mm dd yy hh mm	☐ Eastern ☐ Pacific ☐ Atlantic ☐ Central ☐ Alaska ☐ Chamorro ☐ Mountain ☐ Hawaii	
H.	Did the incident/disturbance originate in your system/area? (check one)	Yes ☐	No ☐	Unknown ☐
I.	Estimate of Amount of Demand Involved (Peak Megawatts)		Zero ☐	Unknown ☐
J.	Estimate of Number of Customers Affected		Zero ☐	Unknown ☐

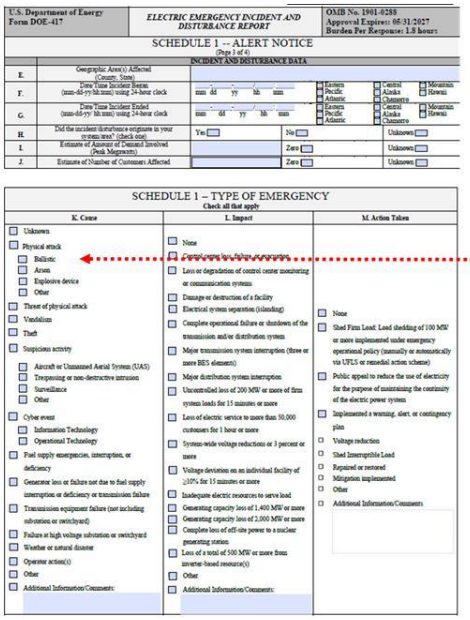
SCHEDULE 1 – TYPE OF EMERGENCY
Check all that apply

K. Cause	L. Impact	M. Action Taken
☐ Unknown ☐ Physical attack ☐ Ballistic ☐ Arson ☐ Explosive device ☐ Other ☐ Threat of physical attack ☐ Vandalism ☐ Theft ☐ Suspicious activity ☐ Aircraft or Unmanned Aerial System (UAS) ☐ Trespassing or non-destructive intrusion ☐ Surveillance ☐ Other ☐ Cyber event ☐ Information Technology ☐ Operational Technology ☐ Fuel supply emergencies, interruption, or deficiency ☐ Generator loss or failure not due to fuel supply interruption or deficiency or transmission failure ☐ Transmission equipment failure (use including substation or switchyard) ☐ Failure at high voltage substation or switchyard ☐ Weather or natural disaster ☐ Operator action(s) ☐ Other ☐ Additional Information/Comments:	☐ None ☐ Control center loss, failure, or evacuation ☐ Loss or degradation of control center monitoring or communication systems ☐ Damage or destruction of a facility ☐ Electrical system separation (islanding) ☐ Complete operational failure or shutdown of the transmission and/or distribution system ☐ Major transmission system interruption (three or more BES elements) ☐ Major distribution system interruption ☐ Uncontrolled loss of 200 MW or more of firm system loads for 15 minutes or more ☐ Loss of electric service to more than 50,000 customers for 1 hour or more ☐ System-wide voltage reductions or 3 percent or more ☐ Voltage deviation on an individual facility of ≥10% for 15 minutes or more ☐ Inadequate electric resources to serve load ☐ Generating capacity loss of 1,400 MW or more ☐ Generating capacity loss of 2,000 MW or more ☐ Complete loss of off-site power to a nuclear generating station ☐ Loss of a total of 500 MW or more from inverter-based resource(s) ☐ Other ☐ Additional Information/Comments:	☐ None ☐ Shed Firm Load: Load shedding of 100 MW or more implemented under emergency operational policy (manually or automatically via UFLS or remedial action scheme) ☐ Public appeal to reduce the use of electricity for the purpose of maintaining the continuity of the electric power system ☐ Implemented a warning, alert, or contingency plan ☐ Voltage reduction ☐ Shed Interruptible Load ☐ Repaired or restored ☐ Mitigation implemented ☐ Other ☐ Additional Information/Comments

Schedule 1

Incident & Disturbance Data: Select & enter all appropriate information regarding disturbance

97



U.S. Department of Energy
Form DOE-417

ELECTRIC EMERGENCY INCIDENT AND DISTURBANCE REPORT

OMB No. 1901-0288
Approval Expires: 05/31/2027
Burden Per Response: 1.5 hours

SCHEDULE 1 -- ALERT NOTICE
(Page 1 of 4)

INCIDENT AND DISTURBANCE DATA

E.	Geographic Area(s) Affected (County, State)	
F.	Date/Time Incident Began (mm-dd-yy/hh:mm) using 24-hour clock	mm dd yy hh mm — Eastern, Pacific, Atlantic, Central, Alaska, Chamorro, Mountain, Hawaii
G.	Date/Time Incident Ended (mm-dd-yy/ hh:mm) using 24-hour clock	mm dd yy hh mm — Eastern, Pacific, Atlantic, Central, Alaska, Chamorro, Mountain, Hawaii
H.	Did the incident/disturbance originate in your system/area? (check one)	Yes / No / Unknown
I.	Estimate of Amount of Demand Involved (Peak Megawatts)	Zero / Unknown
J.	Estimate of Number of Customers Affected	Zero / Unknown

SCHEDULE 1 – TYPE OF EMERGENCY
Check all that apply

K. Cause

- Unknown
- Physical attack
  - Ballistic
  - Arson
  - Explosive device
  - Other
- Threat of physical attack
- Vandalism
- Theft
- Suspicious activity
  - Aircraft or Unmanned Aerial System (UAS)
  - Trespassing or non-destructive intrusion
  - Surveillance
  - Other
- Cyber event
  - Information Technology
  - Operational Technology
- Fuel supply emergencies, interruption, or deficiency
- Generator loss or failure not due to fuel supply interruption or deficiency or transmission failure
- Transmission equipment failure (not including substation or switchyard)
- Failure at high voltage substation or switchyard
- Weather or natural disaster
- Operator action(s)
- Other
- Additional Information/Comments:

L. Impact

- None
- Control room loss, failure, or evacuation
- Loss or degradation of control center monitoring or communication systems
- Damage or destruction of a facility
- Electrical system separation (islanding)
- Complete operational failure or shutdown of the transmission and/or distribution system
- Major transmission system interruption (three or more BES elements)
- Major distribution system interruption
- Uncontrolled loss of 200 MW or more of firm system loads for 15 minutes or more
- Loss of electric service to more than 50,000 customers for 1 hour or more
- System-wide voltage reductions or 3 percent or more
- Voltage deviation on an individual facility of ≥10% for 15 minutes or more
- Inadequate electric resources to serve load
- Generating capacity loss of 1,400 MW or more
- Generating capacity loss of 2,000 MW or more
- Complete loss of off-site power to a nuclear generating station
- Loss of a total of 500 MW or more from inverter-based resource(s)
- Other
- Additional Information/Comments:

M. Action Taken

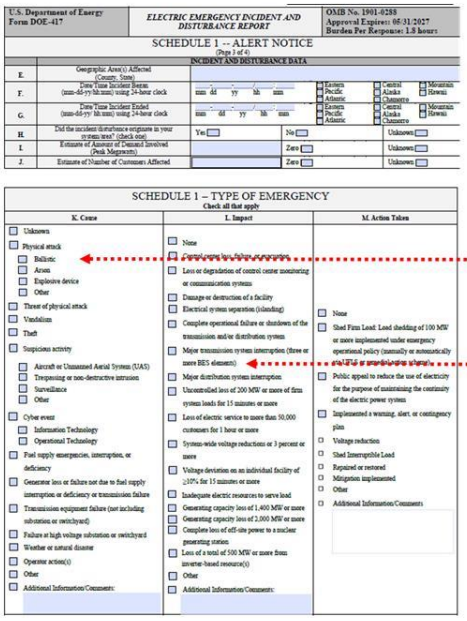
- None
- Shed Firm Load: Load shedding of 100 MW or more implemented under emergency operational policy (manually or automatically via UFLS or remedial action scheme)
- Public appeal to reduce the use of electricity for the purpose of maintaining the continuity of the electric power system
- Implemented a warning, alert, or contingency plan
- Voltage reduction
- Shed Interruptible Load
- Repaired or restored
- Mitigation implemented
- Other
- Additional Information/Comments

Schedule 1

Incident & Disturbance Data: Select & enter all appropriate information regarding disturbance

Cause of Incident: Select all options that apply if cause is known

98



U.S. Department of Energy
Form DOE-417

ELECTRIC EMERGENCY INCIDENT AND DISTURBANCE REPORT

OMB No. 1901-0288
Approval Expires: 05/31/2027
Burden Per Response: 1.5 hours

SCHEDULE 1 -- ALERT NOTICE
(Page 1 of 4)

INCIDENT AND DISTURBANCE DATA

E.	Geographic Area(s) Affected (County, State)	
F.	Date/Time Incident Began (mm-dd-yy/hh:mm) using 24-hour clock	mm dd yy hh mm — Eastern, Pacific, Atlantic, Central, Alaska, Chamorro, Mountain, Hawaii
G.	Date/Time Incident Ended (mm-dd-yy/ hh:mm) using 24-hour clock	mm dd yy hh mm — Eastern, Pacific, Atlantic, Central, Alaska, Chamorro, Mountain, Hawaii
H.	Did the incident/disturbance originate in your system/area? (check one)	Yes / No / Unknown
I.	Estimate of Amount of Demand Involved (Peak Megawatts)	Zero / Unknown
J.	Estimate of Number of Customers Affected	Zero / Unknown

SCHEDULE 1 – TYPE OF EMERGENCY
Check all that apply

K. Cause

- Unknown
- Physical attack
  - Ballistic
  - Arson
  - Explosive device
  - Other
- Threat of physical attack
- Vandalism
- Theft
- Suspicious activity
  - Aircraft or Unmanned Aerial System (UAS)
  - Trespassing or non-destructive intrusion
  - Surveillance
  - Other
- Cyber event
  - Information Technology
  - Operational Technology
- Fuel supply emergencies, interruption, or deficiency
- Generator loss or failure not due to fuel supply interruption or deficiency or transmission failure
- Transmission equipment failure (not including substation or switchyard)
- Failure at high voltage substation or switchyard
- Weather or natural disaster
- Operator action(s)
- Other
- Additional Information/Comments:

L. Impact

- None
- Control room loss, failure, or evacuation
- Loss or degradation of control center monitoring or communication systems
- Damage or destruction of a facility
- Electrical system separation (islanding)
- Complete operational failure or shutdown of the transmission and/or distribution system
- Major transmission system interruption (three or more BES elements)
- Major distribution system interruption
- Uncontrolled loss of 200 MW or more of firm system loads for 15 minutes or more
- Loss of electric service to more than 50,000 customers for 1 hour or more
- System-wide voltage reductions or 3 percent or more
- Voltage deviation on an individual facility of ≥10% for 15 minutes or more
- Inadequate electric resources to serve load
- Generating capacity loss of 1,400 MW or more
- Generating capacity loss of 2,000 MW or more
- Complete loss of off-site power to a nuclear generating station
- Loss of a total of 500 MW or more from inverter-based resource(s)
- Other
- Additional Information/Comments:

M. Action Taken

- None
- Shed Firm Load: Load shedding of 100 MW or more implemented under emergency operational policy (manually or automatically via UFLS or remedial action scheme)
- Public appeal to reduce the use of electricity for the purpose of maintaining the continuity of the electric power system
- Implemented a warning, alert, or contingency plan
- Voltage reduction
- Shed Interruptible Load
- Repaired or restored
- Mitigation implemented
- Other
- Additional Information/Comments

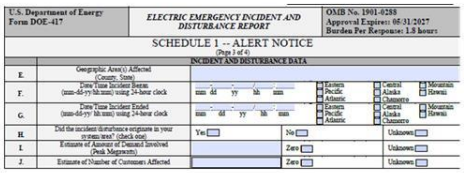
Schedule 1

Incident & Disturbance Data: Select & enter all appropriate information regarding disturbance

Cause of Incident: Select all options that apply if cause is known

Impact: Select all options that apply

99



U.S. Department of Energy Form DOE-417 | ELECTRIC EMERGENCY INCIDENT AND DISTURBANCE REPORT | OMB No. 1901-0288 Approval Expires: 05/31/2027 Burden Per Response: 1.5 hours

SCHEDULE 1 -- ALERT NOTICE

(Page 1 of 4)

INCIDENT AND DISTURBANCE DATA

E.	Geographic Area(s) Affected (County, State)	
F.	Date/Time Incident Began (mm-dd-yy/hh:mm) using 24-hour clock	mm dd yy hh mm
G.	Date/Time Incident Ended (mm-dd-yy/ hh:mm) using 24-hour clock	mm dd yy hh mm
H.	Did the incident/disturbance originate in your system/area? (check one)	Yes / No / Unknown
I.	Estimate of Amount of Demand Involved (Peak Megawatts)	Zero / Unknown
J.	Estimate of Number of Customers Affected	Zero / Unknown

Eastern, Pacific, Atlantic, Central, Alaska, Canada, Mountain, Hawaii

SCHEDULE 1 – TYPE OF EMERGENCY

Check all that apply

K. Cause	L. Impact	M. Action Taken
Unknown	None	None
Physical attack: Ballistic; Arson; Explosive device; Other	Complete loss of control center monitoring or communication systems	Shed Firm Load: Load shedding of 100 MW or more implemented under emergency operational policy (manually or automatically
Threat of physical attack	Less or degradation of control center monitoring or communication system	Public appeal to reduce the use of electricity for the purpose of maintaining the continuity of the electric power system
Vandalism	Damage or destruction of a facility	Implemented a warning, alert, or contingency plan
Theft	Electrical system separation (islanding)	Voltage reduction
Suspicious activity: Aircraft or Unmanned Aerial System (UAS); Trespassing or non-destructive intrusion; Surveillance; Other	Complete operational failure or shutdown of the transmission and/or distribution system	Shed Interruptible Load
Cyber event: Information Technology; Operational Technology	Major transmission system interruption (three or more BES elements)	Repaired or restored
Fuel supply emergencies, interruption, or deficiency	Major distribution system interruption	Mitigation implemented
Generator loss or failure not due to fuel supply interruption or deficiency or transmission failure	Uncontrolled loss of 200 MW or more of firm system loads for 15 minutes or more	Other
Transmission equipment failure (not including substation or switchyard)	Loss of electric service to more than 50,000 customers for 1 hour or more	Additional Information/Comments
Failure at high voltage substation or switchyard	System-wide voltage reductions or 3 percent or more	
Weather or natural disaster	Voltage deviation on an individual facility of ≥10% for 15 minutes or more	
Operator action(s)	Inadequate electric resources to serve load	
Other	Generating capacity loss of 1,400 MW or more	
Additional Information/Comments:	Generating capacity loss of 2,000 MW or more	
	Complete loss of off-site power to a nuclear generating station	
	Loss of a total of 500 MW or more from inverter-based resource(s)	
	Other	
	Additional Information/Comments:	

Schedule 1

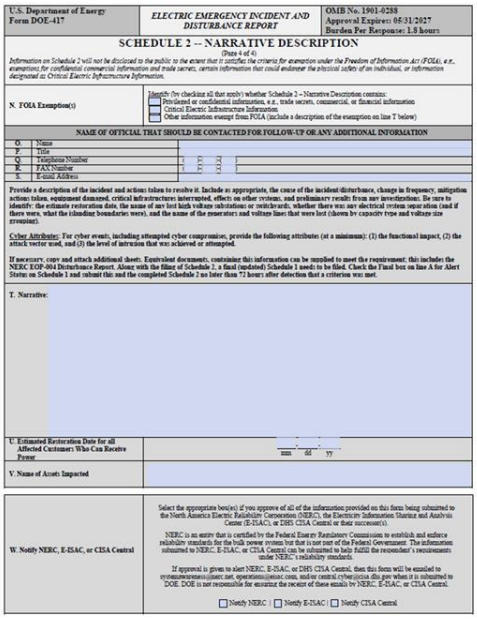
Incident & Disturbance Data: Select & enter all appropriate information regarding disturbance

Cause of Incident: Select all options that apply if cause is known

Impact: Select all options that apply

Actions Taken: Select all options that apply based on actions taken since disturbance occurred

100



U.S. Department of Energy Form DOE-417 | ELECTRIC EMERGENCY INCIDENT AND DISTURBANCE REPORT | OMB No. 1901-0288 Approval Expires: 05/31/2027 Burden Per Response: 1.5 hours

SCHEDULE 2 -- NARRATIVE DESCRIPTION

(Page 4 of 4)

Information on Schedule 2 will not be disclosed to the public to the extent that it satisfies the criteria for exemption under the Freedom of Information Act (FOIA), a.e., exemptions for confidential commercial information and trade secrets, certain information that could endanger the physical safety of an individual, or information designated as Critical Electric Infrastructure Information.

N. FOIA Exemption(s)

Identify (by checking all that apply) whether Schedule 2 – Narrative Description contains:
- Privileged or confidential information, e.g., trade secrets, commercial, or financial information
- Critical Electric Infrastructure Information
- Other information exempt from FOIA (include a description of the exemption on line T below)

NAME OF OFFICIAL THAT SHOULD BE CONTACTED FOR FOLLOW-UP OR ANY ADDITIONAL INFORMATION

O.	Name
P.	Title
Q.	Telephone Number ( ) -
R.	FAX Number ( ) -
S.	E-mail Address

Provide a description of the incident and actions taken to resolve it. Include as appropriate, the cause of the incident disturbance, change in frequency, mitigation actions taken, equipment damaged, critical infrastructures interrupted, effects on other systems, and preliminary results from any investigations. Be sure to identify: the estimate restoration date, the name of any lost high voltage substations or switchyards, whether there was any electrical system separation (and if there were, what the islanding boundaries were), and the name of the generators and voltage lines that were lost (shown by capacity type and voltage size groupings).

Cyber Attributes: For cyber events, including attempted cyber compromise, provide the following attributes (at a minimum): (1) the functional impact, (2) the attack vector used, and (3) the level of intrusion that was achieved or attempted.

If necessary, copy and attach additional sheets. Equivalent documents, containing this information can be supplied to meet the requirement; this includes the NERC EOP-004 Disturbance Report. Along with the filing of Schedule 2, a final (updated) Schedule 1 needs to be filed. Check the Final box on line A for Alert Status on Schedule 1 and submit this and the completed Schedule 2 no later than 72 hours after detection that a criterion was met.

T. Narrative:

U. Estimated Restoration Date for all Affected Customers Who Can Receive Power	mm dd yy
V. Name of Asset: Impacted	

W. Notify NERC, E-ISAC, or CISA Central

Select the appropriate box(es) if you approve of all of the information provided on this form being submitted to the North America Electric Reliability Corporation (NERC), the Electricity Information Sharing and Analysis Center (E-ISAC), or DHS CISA Central or their successor(s).

NERC is an entity that is certified by the Federal Energy Regulatory Commission to establish and enforce reliability standards for the bulk power system but that is not part of the Federal Government. The information submitted to NERC, E-ISAC, or CISA Central can be submitted to help fulfill the respondent's requirements under NERC's reliability standards.

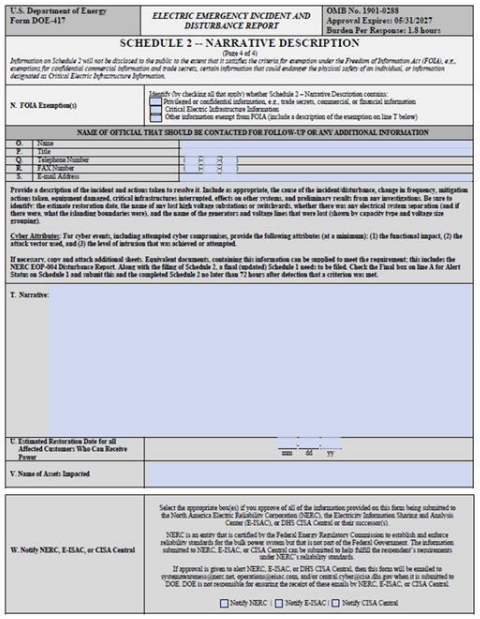
If approval is given to alert NERC, E-ISAC, or DHS CISA Central, then this form will be emailed to systemawareness@nerc.net, operations@eisac.com, and/or central.cyber@cisa.dhs.gov when it is submitted to DOE. DOE is not responsible for ensuring the receipt of these emails by NERC, E-ISAC, or CISA Central.

☐ Notify NERC ☐ Notify E-ISAC ☐ Notify CISA Central

Schedule 2

Lines O-S: Contact info for official that needs to be contacted for follow-up

101



U.S. Department of Energy
Form DOE-417

ELECTRIC EMERGENCY INCIDENT AND DISTURBANCE REPORT

OMB No. 1901-0288
Approval Expires: 05/31/2027
Burden Per Response: 1.8 hours

SCHEDULE 2 -- NARRATIVE DESCRIPTION

(Page 4 of 4)

Information on Schedule 2 will not be disclosed to the public to the extent that it satisfies the criteria for exemption under the Freedom of Information Act (FOIA), e.g., exemptions for confidential commercial information and trade secrets, certain information that could endanger the physical safety of an individual, or information designated as Critical Electric Infrastructure Information.

N. FOIA Exemption(s)

Identify (by checking all that apply) whether Schedule 2 – Narrative Description contains:
- ☐ Privileged or confidential information, e.g., trade secrets, commercial, or financial information
- ☐ Critical Electric Infrastructure Information
- ☐ Other information exempt from FOIA (include a description of the exemption on line T below)

NAME OF OFFICIAL THAT SHOULD BE CONTACTED FOR FOLLOW-UP OR ANY ADDITIONAL INFORMATION

O.	Name	
P.	Title	
Q.	Telephone Number	( ) -
R.	FAX Number	( ) -
S.	E-mail Address	

Provide a description of the incident and actions taken to resolve it. Include as appropriate, the cause of the incident/disturbance, change in frequency, mitigation actions taken, equipment damaged, critical infrastructures interrupted, effects on other systems, and preliminary results from any investigations. Be sure to identify: the estimate restoration date, the name of any lost high voltage substations or switchyards, whether there was any electrical system separation (and if there were, what the islanding boundaries were), and the name of the generators and voltage lines that were lost (shown by capacity type and voltage size groupings).

Cyber Attributes: For cyber events, including attempted cyber compromise, provide the following attributes (at a minimum): (1) the functional impact, (2) the attack vector used, and (3) the level of intrusion that was achieved or attempted.

If necessary, copy and attach additional sheets. Equivalent documents, containing this information can be supplied to meet the requirement; this includes the NERC EOP-004 Disturbance Report. Along with the filing of Schedule 2, a final (updated) Schedule 1 needs to be filed. Check the Final box on line A for Alert Status on Schedule 1 and submit this and the completed Schedule 2 no later than 72 hours after detection that a criterion was met.

T. Narrative:

U. Estimated Restoration Date for all Affected Customers Who Can Receive Power — mm dd yy

V. Name of Assets Impacted

W. Notify NERC, E-ISAC, or CISA Central

Select the appropriate box(es) if you approve of all of the information provided on this form being submitted to the North America Electric Reliability Corporation (NERC), the Electricity Information Sharing and Analysis Center (E-ISAC), or DHS CISA Central or their successor(s).

NERC is an entity that is certified by the Federal Energy Regulatory Commission to establish and enforce reliability standards for the bulk power system but that is not part of the Federal Government. The information submitted to NERC, E-ISAC, or CISA Central can be submitted to help fulfill the respondent's requirements under NERC's reliability standards.

If approval is given to alert NERC, E-ISAC, or DHS CISA Central, then this form will be emailed to systemawareness@nerc.net, operations@eisac.com, and/or central.cyber@cisa.dhs.gov when it is submitted to DOE. DOE is not responsible for ensuring the receipt of these emails by NERC, E-ISAC, or CISA Central.

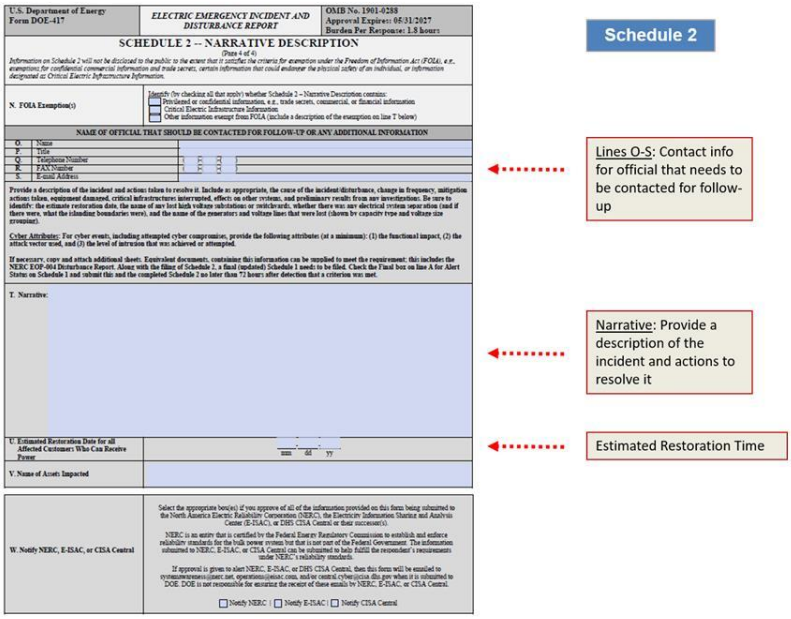
☐ Notify NERC | ☐ Notify E-ISAC | ☐ Notify CISA Central

Schedule 2

Lines O-S: Contact info for official that needs to be contacted for follow-up

Narrative: Provide a description of the incident and actions to resolve it

102



U.S. Department of Energy
Form DOE-417

ELECTRIC EMERGENCY INCIDENT AND DISTURBANCE REPORT

OMB No. 1901-0288
Approval Expires: 05/31/2027
Burden Per Response: 1.8 hours

SCHEDULE 2 -- NARRATIVE DESCRIPTION

(Page 4 of 4)

Information on Schedule 2 will not be disclosed to the public to the extent that it satisfies the criteria for exemption under the Freedom of Information Act (FOIA), e.g., exemptions for confidential commercial information and trade secrets, certain information that could endanger the physical safety of an individual, or information designated as Critical Electric Infrastructure Information.

N. FOIA Exemption(s)

Identify (by checking all that apply) whether Schedule 2 – Narrative Description contains:
- ☐ Privileged or confidential information, e.g., trade secrets, commercial, or financial information
- ☐ Critical Electric Infrastructure Information
- ☐ Other information exempt from FOIA (include a description of the exemption on line T below)

NAME OF OFFICIAL THAT SHOULD BE CONTACTED FOR FOLLOW-UP OR ANY ADDITIONAL INFORMATION

O.	Name	
P.	Title	
Q.	Telephone Number	( ) -
R.	FAX Number	( ) -
S.	E-mail Address	

Provide a description of the incident and actions taken to resolve it. Include as appropriate, the cause of the incident/disturbance, change in frequency, mitigation actions taken, equipment damaged, critical infrastructures interrupted, effects on other systems, and preliminary results from any investigations. Be sure to identify: the estimate restoration date, the name of any lost high voltage substations or switchyards, whether there was any electrical system separation (and if there were, what the islanding boundaries were), and the name of the generators and voltage lines that were lost (shown by capacity type and voltage size groupings).

Cyber Attributes: For cyber events, including attempted cyber compromise, provide the following attributes (at a minimum): (1) the functional impact, (2) the attack vector used, and (3) the level of intrusion that was achieved or attempted.

If necessary, copy and attach additional sheets. Equivalent documents, containing this information can be supplied to meet the requirement; this includes the NERC EOP-004 Disturbance Report. Along with the filing of Schedule 2, a final (updated) Schedule 1 needs to be filed. Check the Final box on line A for Alert Status on Schedule 1 and submit this and the completed Schedule 2 no later than 72 hours after detection that a criterion was met.

T. Narrative:

U. Estimated Restoration Date for all Affected Customers Who Can Receive Power — mm dd yy

V. Name of Assets Impacted

W. Notify NERC, E-ISAC, or CISA Central

Select the appropriate box(es) if you approve of all of the information provided on this form being submitted to the North America Electric Reliability Corporation (NERC), the Electricity Information Sharing and Analysis Center (E-ISAC), or DHS CISA Central or their successor(s).

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☐ Notify NERC | ☐ Notify E-ISAC | ☐ Notify CISA Central

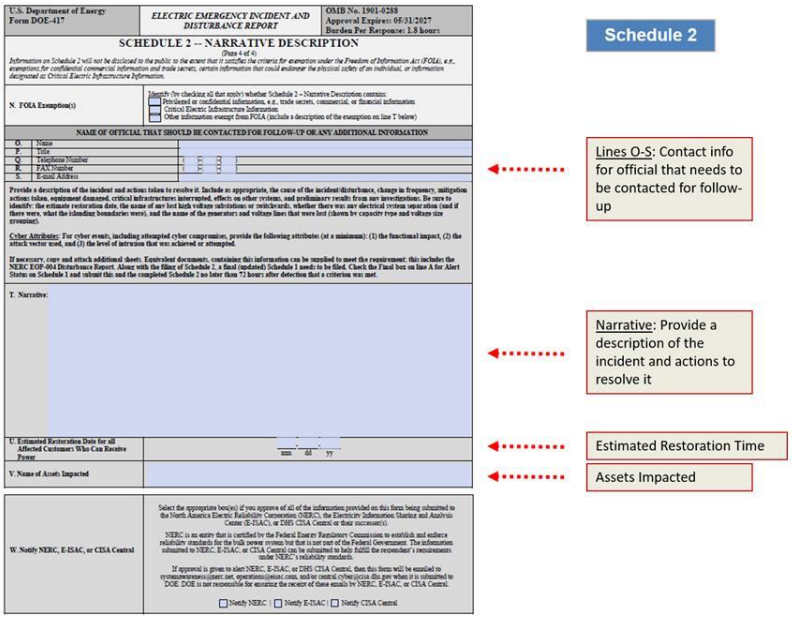
Schedule 2

Lines O-S: Contact info for official that needs to be contacted for follow-up

Narrative: Provide a description of the incident and actions to resolve it

Estimated Restoration Time

103



U.S. Department of Energy
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ELECTRIC EMERGENCY INCIDENT AND DISTURBANCE REPORT

OMB No. 1901-0288
Approval Expires: 05/31/2027
Burden Per Response: 1.8 hours

SCHEDULE 2 -- NARRATIVE DESCRIPTION

(Page 4 of 4)

Information on Schedule 2 will not be disclosed to the public to the extent that it satisfies the criteria for exemption under the Freedom of Information Act (FOIA), e.g., exemptions for confidential commercial information and trade secrets, certain information that could endanger the physical safety of an individual, or information designated as Critical Electric Infrastructure Information.

N. FOIA Exemption(s)

Identify (by checking all that apply) whether Schedule 2 – Narrative Description contains:
- Privileged or confidential information, e.g., trade secrets, commercial, or financial information
- Critical Electric Infrastructure Information
- Other information exempt from FOIA (include a description of the exemption on line T below)

NAME OF OFFICIAL THAT SHOULD BE CONTACTED FOR FOLLOW-UP OR ANY ADDITIONAL INFORMATION

O.	Name	
P.	Title	
Q.	Telephone Number	( ) -
R.	FAX Number	( ) -
S.	E-mail Address	

Provide a description of the incident and actions taken to resolve it. Include as appropriate, the cause of the incident/disturbance, change in frequency, mitigation actions taken, equipment damaged, critical infrastructures interrupted, effects on other systems, and preliminary results from any investigation. Be sure to identify: the estimate restoration date, the name of any lost high voltage substations or switchyards, whether there was any electrical system separation (and if there were, what the islanding boundaries were), and the name of the generators and voltage lines that were lost (shown by capacity type and voltage size groupings).

Cyber Attributes: For cyber events, including attempted cyber compromise, provide the following attributes (at a minimum): (1) the functional impact, (2) the attack vector used, and (3) the level of intrusion that was achieved or attempted.

If necessary, copy and attach additional sheets. Equivalent documents, containing this information can be supplied to meet the requirement: this includes the NERC EOP-004 Disturbance Report. Along with the filing of Schedule 2, a final (updated) Schedule 1 needs to be filed. Check the Final box on line A for Alert Status on Schedule 1 and submit this and the completed Schedule 2 no later than 72 hours after detection that a criterion was met.

T. Narrative:

U. Estimated Restoration Date for all Affected Customers Who Can Receive Power	mm dd yy
V. Name of Assets Impacted	

W. Notify NERC, E-ISAC, or CISA Central

Select the appropriate box(es) if you approve of all of the information provided on this form being submitted to the North America Electric Reliability Corporation (NERC), the Electricity Information Sharing and Analysis Center (E-ISAC), or DHS CISA Central or their successor(s).

NERC is an entity that is certified by the Federal Energy Regulatory Commission to establish and enforce reliability standards for the bulk power system but that is not part of the Federal Government. The information submitted to NERC, E-ISAC, or CISA Central can be submitted to help fulfill the respondent's requirements under NERC's reliability standards.

If approval is given to alert NERC, E-ISAC, or DHS CISA Central, then this form will be emailed to systemawareness@nerc.net, operations@eisac.com, and/or central.cyber@cisa.dhs.gov when it is submitted to DOE. DOE is not responsible for ensuring the receipt of these emails by NERC, E-ISAC, or CISA Central.

☐ Notify NERC ☐ Notify E-ISAC ☐ Notify CISA Central

Schedule 2

Lines O-S: Contact info for official that needs to be contacted for follow-up

Narrative: Provide a description of the incident and actions to resolve it

Estimated Restoration Time

Assets Impacted

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Reporting Responsibilities

- Specific to the PJM Operating Plan, if an event requires a report to be submitted, PJM will submit an event report
  - Member Companies are required to provide the event information to PJM via either the Attachment 2 in NERC EOP-004 or the DOE-417 form
  - Copies of the reports required for EOP-004 are to be provided to PJM ***six hours prior to the 24-hour submittal deadline*** to allow time for PJM to meet reporting requirements
- Attachment 2 and/or DOE-417 report must be submitted by the Entity Responsible to PJM at the following address: dispsup@pjm.com

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Reporting Responsibilities

- PJM will then review and submit the report to the following organizations:
  - NERC: systemawareness@nerc.net & Operations@EISAC.com
  - DOE: doehqeoc@hq.doe.gov
  - RF: disturbance@rfirst.org
  - SERC: reporting_line_sit@list-serc1.org & SAEA@SERC1.org
- When PJM submits a report, PJM will copy the affected Members with the report

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Reporting Responsibilities

- EOP-004-4 reporting requirements may result in several entities reporting the same event
  - If the event requires both the TO and TOP to submit a report, then PJM and the Member Company will both submit event reports
- DOE-417 reports may be required to be submitted earlier (1 or 6 hours)
- PJM Manual 13, Attachment J assists with identifying timelines for submission of reports
- PJM will review and submit the final report to NERC, DOE, RF and/or SERC

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Reporting Responsibilities

- Member Companies may also have direct compliance responsibility to submit a DOE-417 form, or to file an EOP-004 report, where the Member is required to report an event to applicable law enforcement and government agencies, per R1 of NERC Standard EOP-004 and their specific Operating Plan

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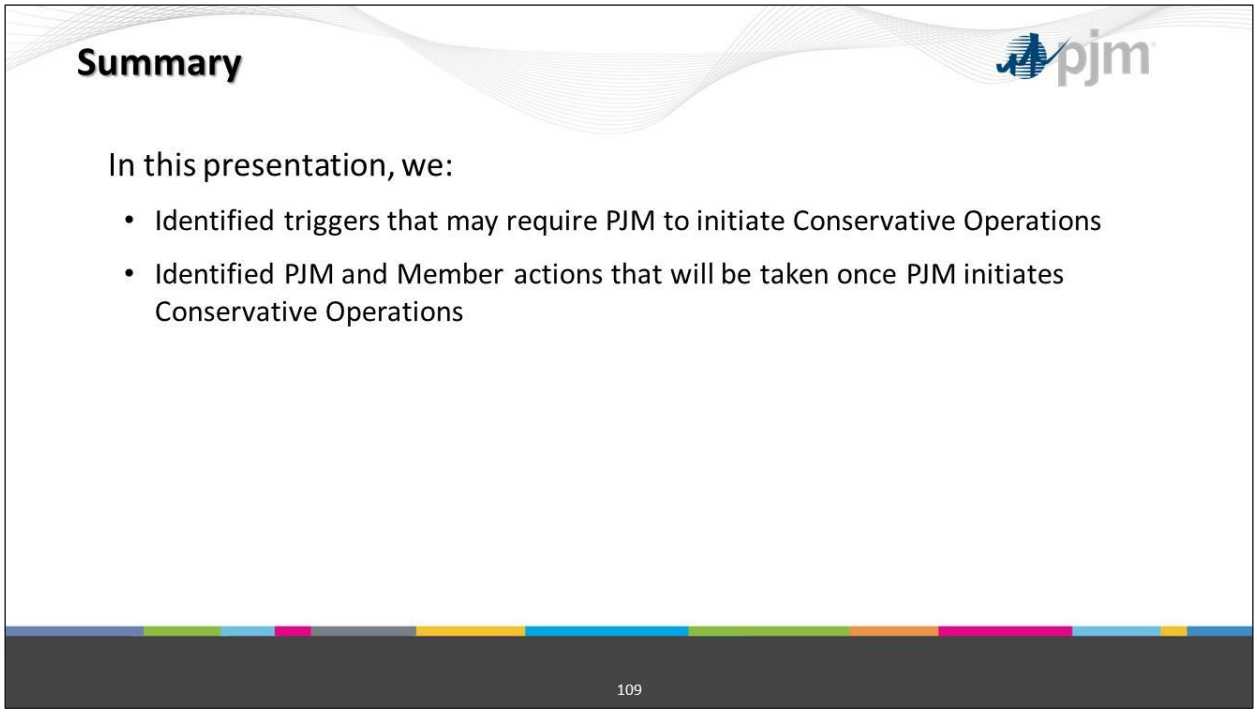
Summary



Questions?

PJM Client Management & Services	
Telephone:	(610) 666-8980
Toll Free Telephone:	(866) 400-8980
Website:	www.PJM.com
Email:	trainingsupport@pjm.com

Member Community

The Member Community is PJM's self-service portal for members to search for answers to their questions or to track and/or open cases with Client Management & Services