Fundamentals of Transmission Operations

Conservative Operations

PJM State & Member Training Dept.

Agenda

- General Actions
- Fuel Delivery Emergencies
- Environmental Alert Emergencies
- Geomagnetic Disturbances (GMDs)
- Terrorism and Sabotage Events
- Severe Weather events

Triggers for 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 BES remains reliable in the face of the additional threats

Triggers for Conservative Operations

- Some conditions which may trigger PJM to implement Conservative Operations include;
  - Fuel Delivery Issues
    - Ice/snow impacting fuel deliveries
    - Possible curtailments of Natural Gas supplies
  - Forest or Brush Fires
    - Smoke from the fires can cause lines above them to short to ground
  - Environmental Alerts
    - Emissions limits may affect the output of older units

Triggers for Conservative Operations

- Conditions triggering Conservative Operations (cont.):
  - Bad Weather
    - Thunderstorms
    - Extreme heat or cold
  - Geomagnetic Disturbances (GMDs)
  - Terrorist or Sabotage threats against the BES
    - Including recent copper theft events
  - Actual attacks against physical or cyber assets critical to the operation of the BES
    - Substation equipment
    - Company EMS components
  - PJM entering an “unknown operating state”, as defined by NERC.

Triggers for Conservative Operations

- We will discuss general actions PJM can take when implementing Conservative Operations, as well as specific actions to address specific triggers
  - PJM has a variety of additional actions available, depending on which trigger has initiated the need for Conservative Operations

General Actions

PJM Actions during Conservative Operations - General

- General Actions:
  - PJM will analyze power flows into, across and through the PJM control area to determine if it is in jeopardy
    - PJM's most critical limits are the Interconnection Reliability Operating Limits (IROLs), which are determined by flows across the system
      - Transfer Limits can be reduced
      - Contracts may be suspended or cut
      - TLRs may be issued

PJM Actions during Conservative Operations - General

- General Actions (cont.):
  - PJM may initiate additional off-cost operations to limit or reduce flows across critical interfaces
  - PJM may purchase (or load) additional reserves, making more resources available to respond to any unexpected events

PJM Actions during Conservative Operations - General

- General Actions (cont.):
  - PJM may look at the possibility of losing multiple pieces of equipment simultaneously
    - Normal operation – PJM studies single contingencies
    - May look at selected double contingencies (shared right-of-way)
    - May look at “Maximum Credible Disturbances”
    - If the analysis shows vulnerability, PJM may take additional actions to allow the system to survive these events
      - Load additional reserves
      - System reconfiguration
      - Additional off-cost operation

PJM Actions during Conservative Operations - General

- General Actions (cont.):
  - PJM may implement an additional layer of security on communications with and between members
    - May require additional verification with members when issuing instructions or responding to reports
    - May increase the frequency of Satellite Phone checks
  - PJM may ask for additional updates on system status
    - More frequent IRCs, SSRs, and/or RRCs
    - More frequent SOS Conference calls
  - PJM may ask members to staff their back-up control centers, critical BES Substations, or black start facilities

Member Company Actions during Conservative Operations - General

- As with all emergency conditions, PJM expects that Member companies will comply with and follow the specific requests and direction of PJM during these events
  - Provide additional reporting data
  - Man substations or generating plants
  - Follow PJM operational directives (Transmission) or Dispatch signals (Generation)

Fuel Delivery Emergencies

Conservative Operations - 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, the Gas companies must give priority of service to customers using Natural Gas for heating over those using Natural Gas for Power Generation
  - This has led to some generating plants being unavailable to generate during heavy load periods

Conservative Operations - Fuel Delivery Emergencies

- In conjunction with NYISO and ISO-NE, PJM 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, including;
    - 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

Conservative Operations - Fuel Delivery Emergencies

- RTO Natural Gas Coordination Procedure (cont.):
  - 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 resources are used to best protect the Interconnection, not an individual RTO

Conservative Operations - Fuel Delivery Emergencies

Additional PJM Actions

- Work with NYISO and ISO-NE to determine the need to implement these procedures
- Provide information to the Interstate Pipelines concerning the need for gas-powered generation to operate and request information concerning pipeline status, emergency procedures, and/or contract curtailments
- Take the information provided to develop a joint strategy to maximize use of the available resources among the RTOs

Conservative Operations - Fuel Delivery Emergencies

Additional PJM Actions (cont.):

- Limit the granting of Generator Outages during these periods, to maximize availibility
- Adopt Conservative Operations

Conservative Operations - Fuel Delivery Emergencies

Additional Member Actions

- Provide facility information on gas-fired generation
  - Gas Supplier
  - Data on physical connections to the Interstate gas supply system
- Inform PJM of any delivery limitations to their gas supply
- Comply with any and all operational instructions issued by PJM

Environmental Alert Emergencies

Conservative Operations - Environmental Alert Emergencies

- When PJM is anticipating Capacity Shortages on the system, we can work with Member companies to lift operating restrictions on generators who may be limited in Operating hours (or output) due to Environmental restrictions –
  - Emissions limits (pollutants, opacity)
  - Cooling Water discharge temperature limits
  - Noise limitations

Conservative Operations - Environmental Alert Emergencies

Additional PJM Actions

- PJM will work proactively with the regulating agency (EPA, or State or Federal agencies) to support member requests to have restrictions waived temporarily
  - Some agencies “weigh” requests from RTOs more heavily than those of the Generation Owners

Conservative Operations - Environmental Alert Emergencies

Additional Member Actions

- Working in conjunction with PJM, submit the appropriate requests to temporarily suspend the Environmental restrictions on generating units

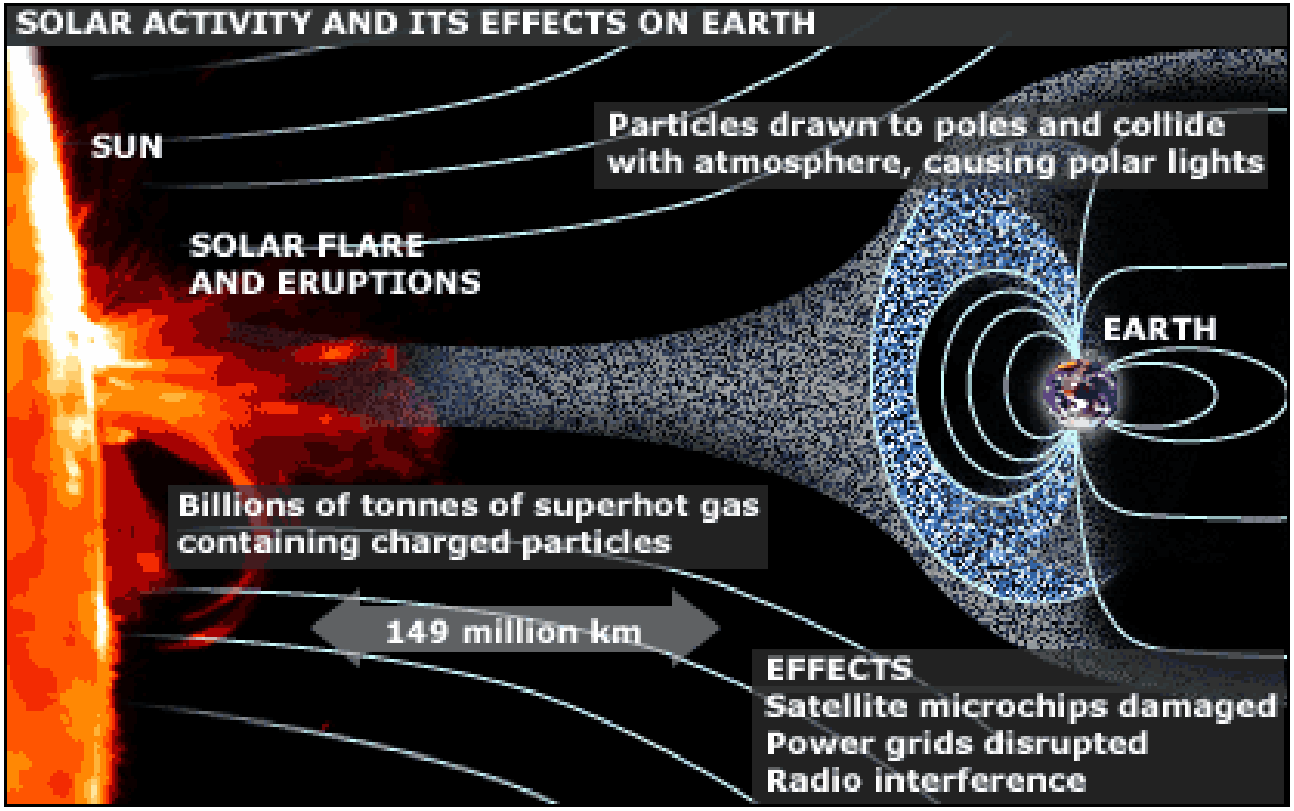
Geomagnetic Disturbances (GMDs)

Conservative Operations - Geomagnetic Disturbances

- As part of its normal functioning, the sun puts off a constant stream of ionized particles – know as the solar wind – which streams out in all directions
- A portion of these ionized particles reach the earth, and interact with its magnetic field
  - Depending on the alignment of the charge on the particles, they are either deflected, or channeled to the north and south magnetic poles
    - Some of the particles interact in the atmosphere, causing the Northern (and Southern) Lights

Conservative Operations - Geomagnetic Disturbances

- The concentration of these particles along the earth's magnetic lines can also affect satellites



(Image courtesy of NASA)

Conservative Operations - Geomagnetic Disturbances

- The charge particles induce currents in the atmosphere, which in turn interact with the earth's magnetic fields to induce voltage potentials in the earth's crust
- The voltage potentials, in turn, result in the formation of Geo-magnetically Induced Currents (GICs) that travel through the earth's crust as they try to equalize the voltage potentials

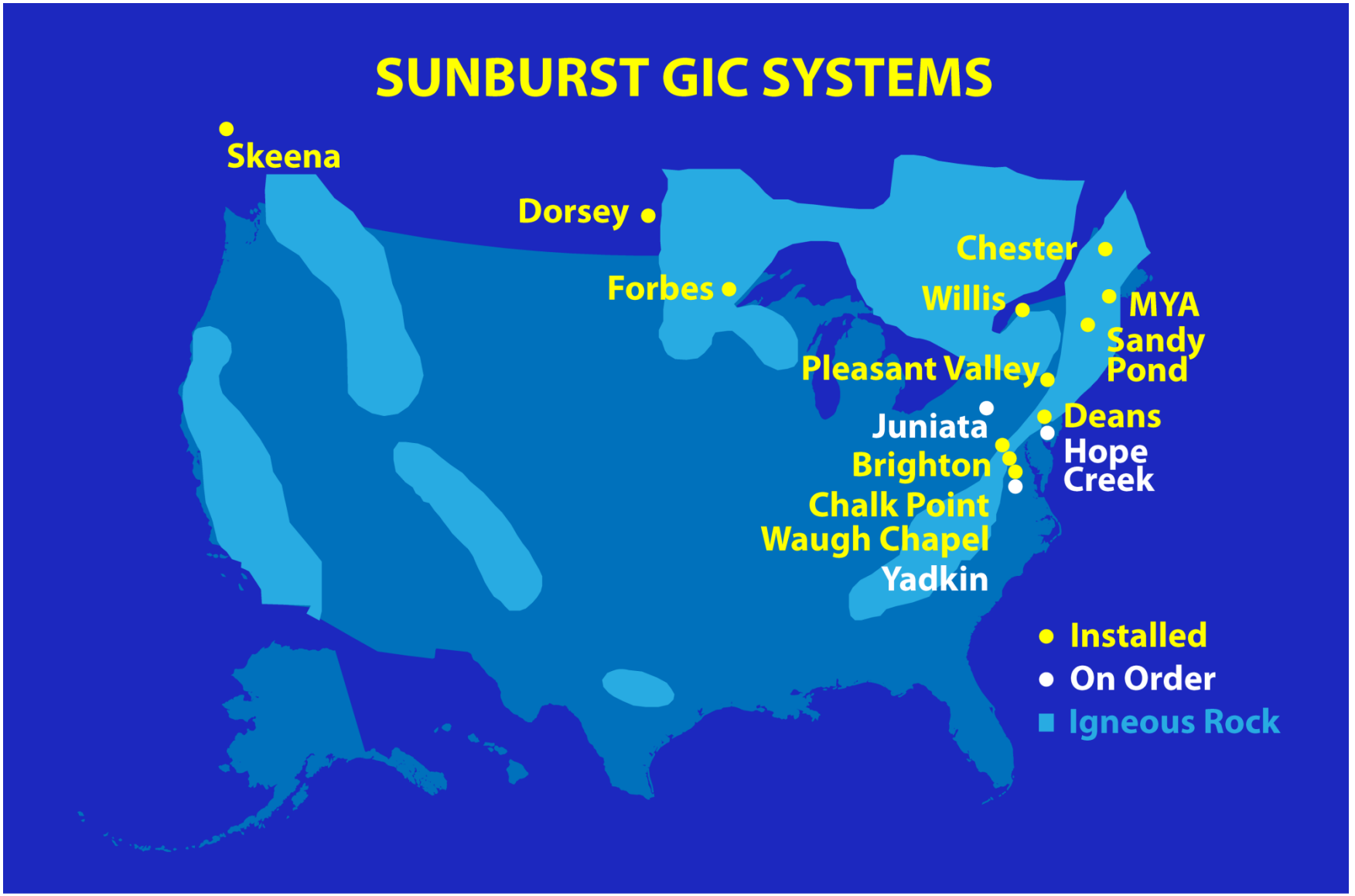
Conservative Operations - Geomagnetic Disturbances

- Certain types of increased solar activity can increase the density of the solar wind, and therefore the magnitude of the GICs
  - Solar flares
  - Sunspots
  - Coronal Mass Ejections (CMEs)
- The time from the solar event until the affects are seen on the earth vary from 1-6 days

Conservative Operations - Geomagnetic Disturbances

- The GIC currents are DC, rather than AC currents, and their magnitude increases with the intensity of the disturbance
- Certain areas of the earth's crust contain significant amounts of igneous rock, which resists the flow of these currents
- Electricity – like water – prefers to follow the path of least resistance

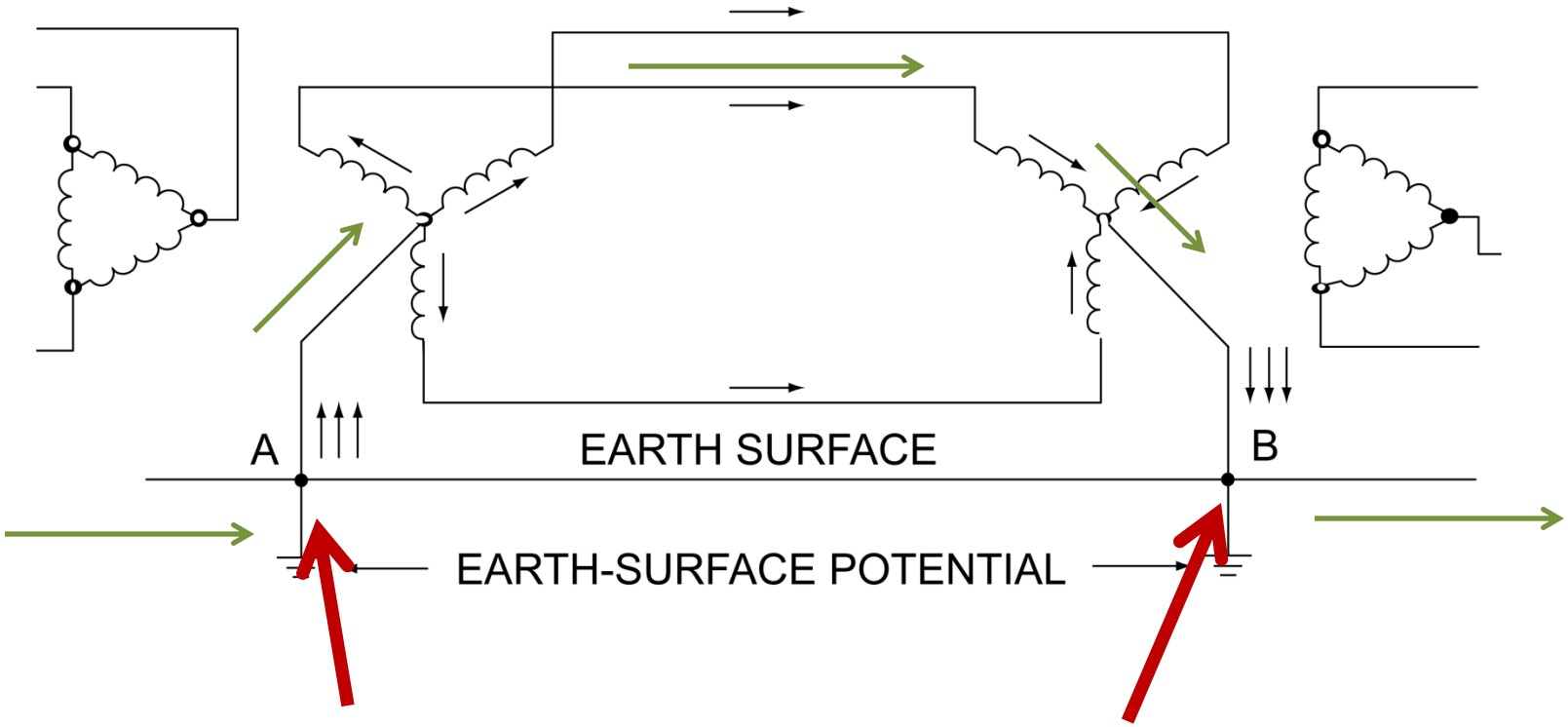
Conservative Operations - Geomagnetic Disturbances



Conservative Operations - Geomagnetic Disturbances

- By constructing the Bulk Electric System, we have inadvertently given these currents a much less resistant path to flow along
  - 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

Conservative Operations - Geomagnetic Disturbances



BES Power Transformer Ground paths

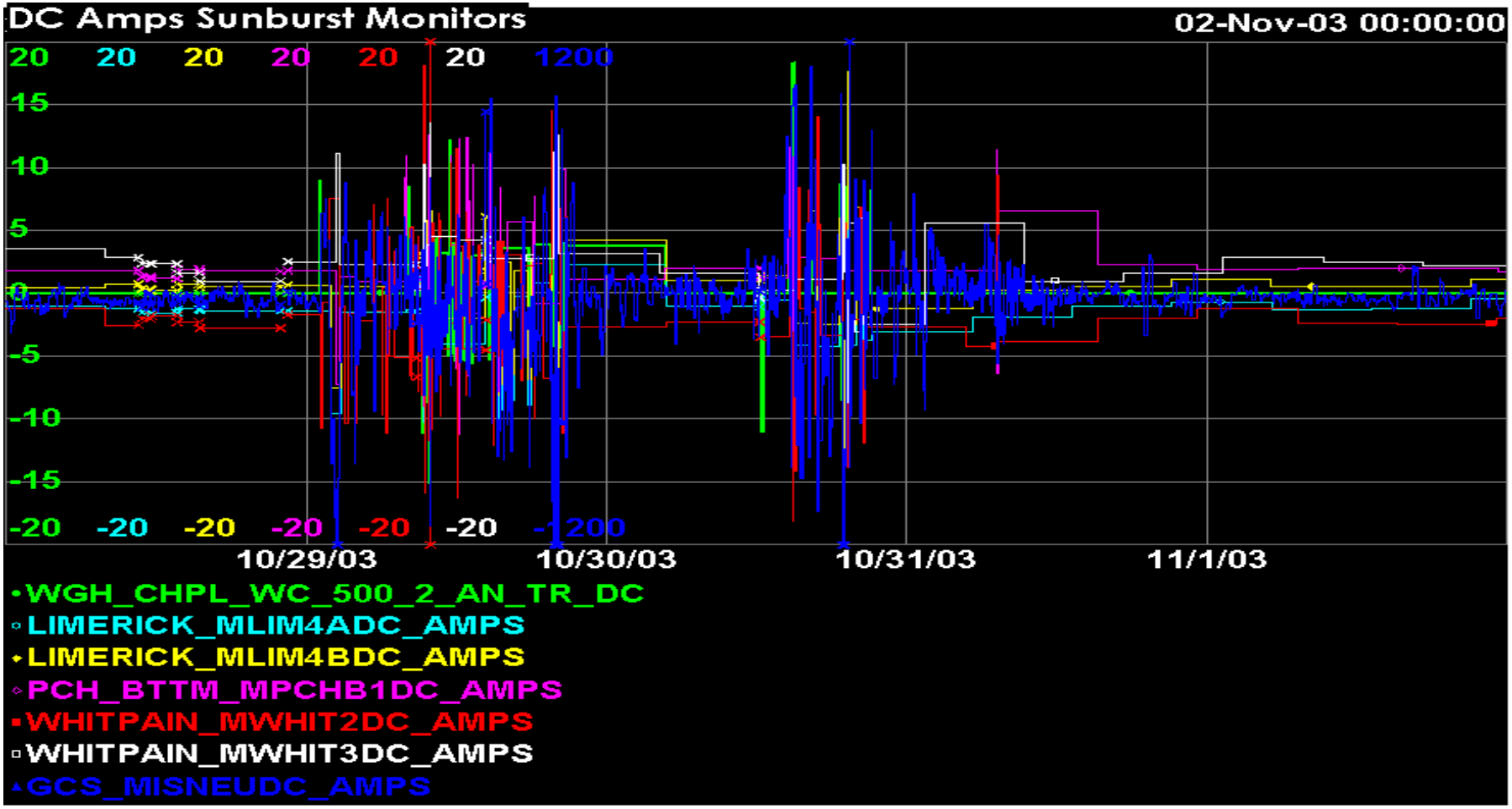
GIC current path

Conservative Operations - Geomagnetic Disturbances

- PJM has installed special monitoring to detect these currents at locations known to be prone to GIC activity
  - Meadowbrook (Winchester VA)
  - Missouri Ave (Atlantic City NJ)
  - Limerick, Susquehanna, and Hope Creek Nuclear stations
  - Whitpain
  - Waugh Chapel

Geo-Magnetic Disturbances

Sunburst Monitors in PJM



Conservative Operations - Geomagnetic Disturbances

- A recent problem?? No Way!!!
  - August 28 – September 2, 1859 – Solar Superstorm – The "Carrington Event"
    - First event recorded by humans from a truly global perspective
    - Largest recorded Geomagnetic storm
    - Burned up telegraph lines throughout the U.S. and Europe
    - Telegraph Operators Shocked, Telegraph paper caught on fire, some telegraph systems seemed to send and receive messages despite being disconnected

Conservative Operations - Geomagnetic Disturbances

Transcript from actual telegraph operators during the 1859 event…

- **Boston operator (to Portland operator):** "Please cut off your battery entirely from the line for fifteen minutes."
- **Portland operator:** "Will do so. It is now disconnected."
- **Boston:** "Mine is also disconnected, and we are working with the auroral current. How do you receive my writing?"
- **Portland:** "Better than with our batteries on. Current comes and goes gradually."
- **Boston:** "My current is very strong at times, and we can work better without batteries, as the Aurora seems to neutralize and augment our batteries alternately, making current too strong at times for our Relay magnets. Suppose we work without batteries while we are affected by this trouble."
- **Portland:** "Very well. Shall I go ahead with business?"
- **Boston:** "Yes. Go ahead."

They continued operating using only the geo-magnetic currents!!

Conservative Operations - Geomagnetic Disturbances

- So why are these currents an issue
  - The presence of these DC currents in BES transformers augments the presence of harmonic currents caused by their operation
    - This leads to overheating of the windings, potentially damaging the transformer
    - These currents can also become “trapped” in the magnetic fields, causing a dramatic increase in the amount of MVAR demand (and losses) in the transformers
    - These increases and decreases in MVAR demand can cause voltage swings in generating units, if the transformer being affected is a unit step-up transformer – potentially damaging the generator excitation systems
    - The voltage swings can cause fluctuations in the BES voltages, possibly resulting in control issues

Conservative Operations - Geomagnetic Disturbances

- So why are these currents an issue (cont.):
  - The presence of current flow in neutral, or ground circuits may cause equipment to trip
    - Capacitor banks, SVCs, and other equipment may be protected by unbalanced neutral relays

Conservative Operations - Geomagnetic Disturbances

- Forecasters at NOAA's Space Weather Prediction Center - Boulder, Colorado

(Courtesy of NOAA website)

Conservative Operations - Geomagnetic Disturbances

- Solar disturbances are most commonly reported in the “K” scale severity
  - Rates the intensity based on magnetometer data measuring Earth’s magnetic field
  - Scale is K-0 to K-9
  - Uses an average intensity over a 3-hour period
  - If an intensity of K-5 or higher is predicted or observed, an alert is issued by NOAA

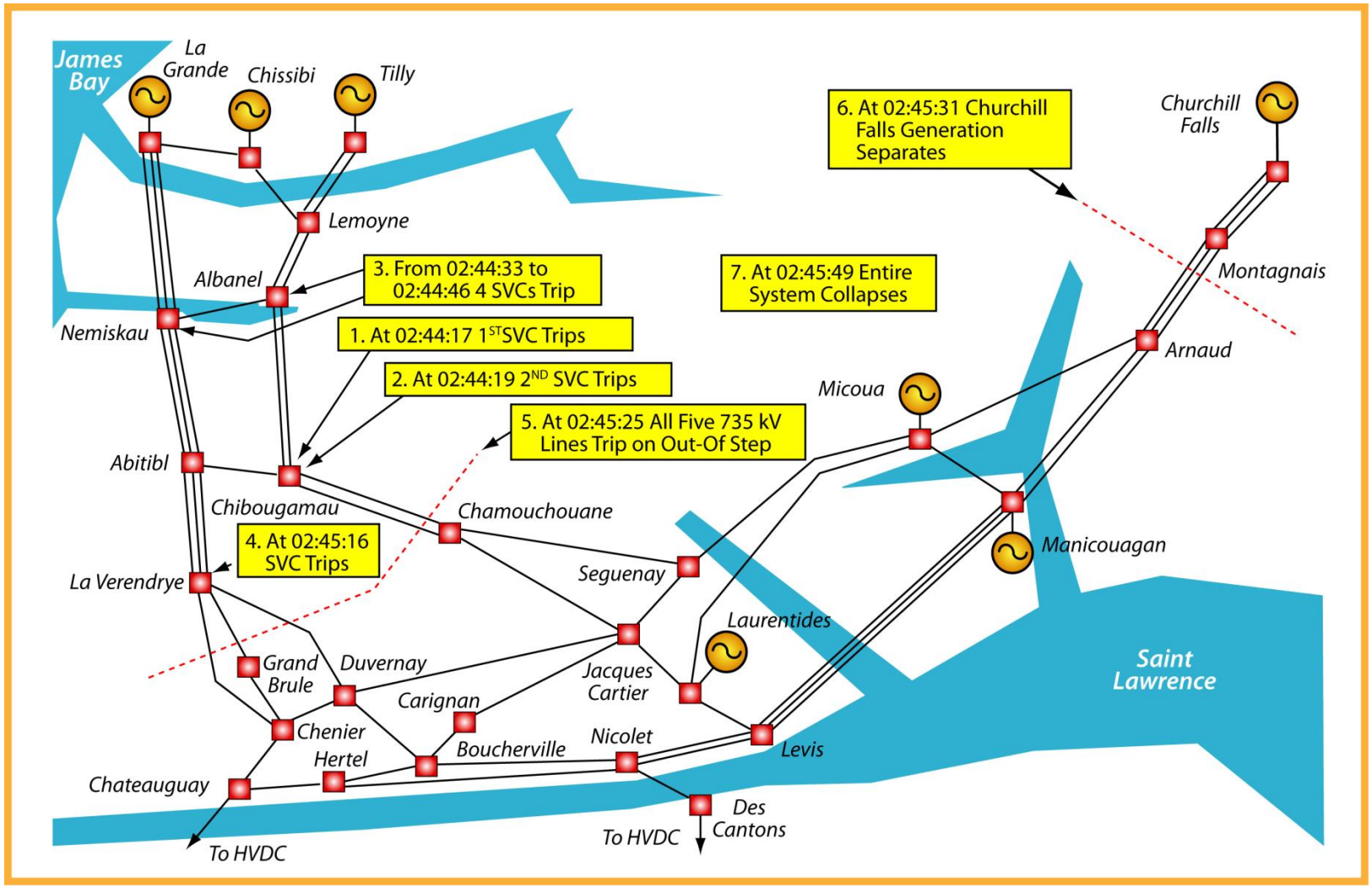
Conservative Operations - Geomagnetic Disturbances

- K Scale Effects on Electric Power Systems
  - K-6: High-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage
  - K-7: Voltage corrections may be required, false alarms triggered on some protection devices
  - K-8: Possible widespread voltage control problems and some protective systems could mistakenly trip out key assets from the grid
  - K-9: Widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage

Conservative Operations - Geomagnetic Disturbances

- Hydro Quebec GMD Event – March 13, 1989
  - Seven SVC's tripped
  - Five 735kV lines from La Grande Complex tripped
  - Freq and Voltage dropped
  - U/F Load shed schemes operated
    - Not enough to make up loss of 9500 MW of generation
  - Rest of system collapsed
  - Total time from start of event ~ 90 sec
  - Damage to several SVCs, GSUs and other misc pieces of equipment

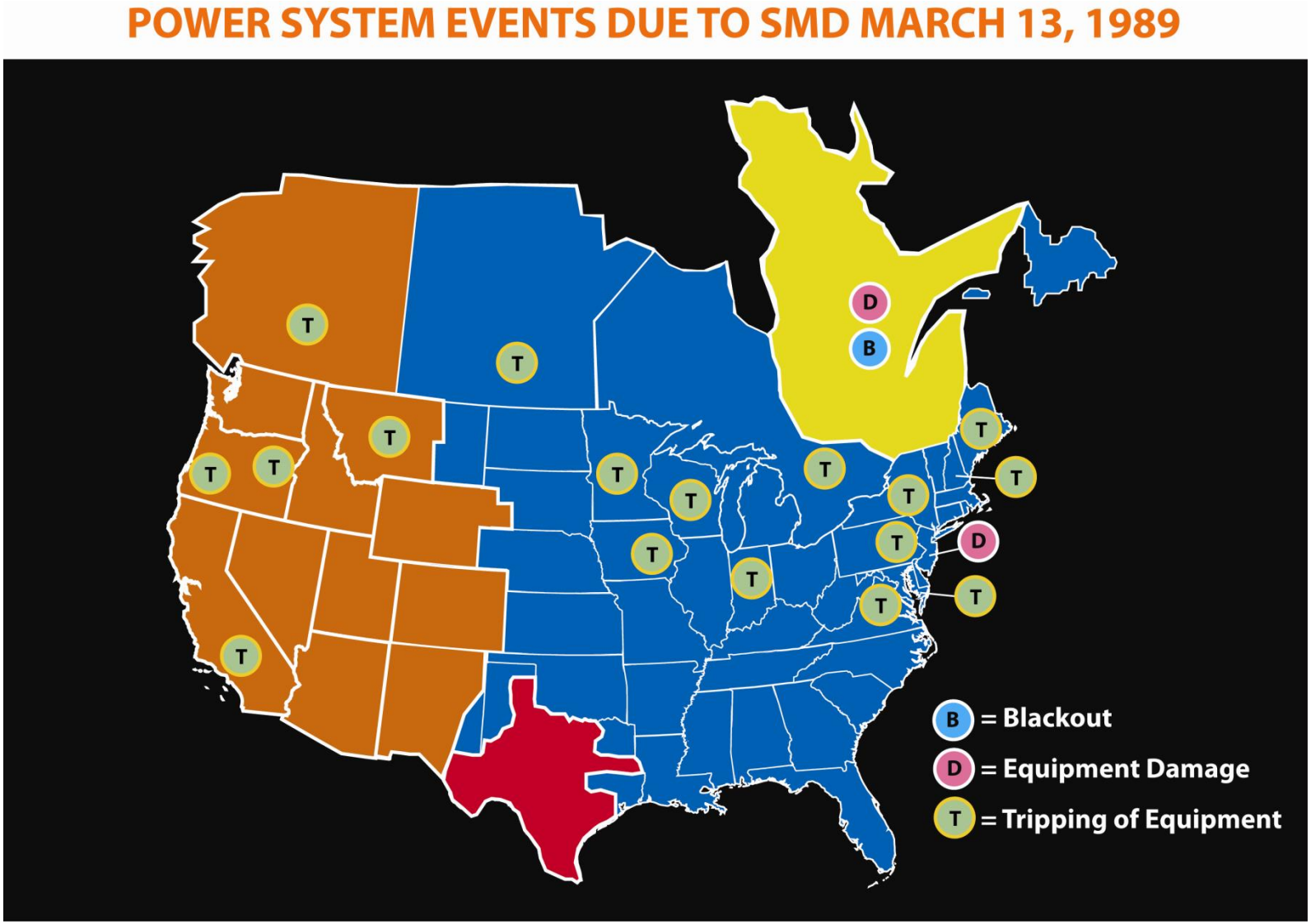
GMD Event of March 13, 1989



Conservative Operations - Geomagnetic Disturbances

- PJM Effects from the same storm:
  - Salem Nuclear Unit Step-up Transformer
  - Low voltage winding damage
  - Insulator damage
  - Manufacturer had 2 yr delivery time
  - Spare found on system and replaced in 6 weeks

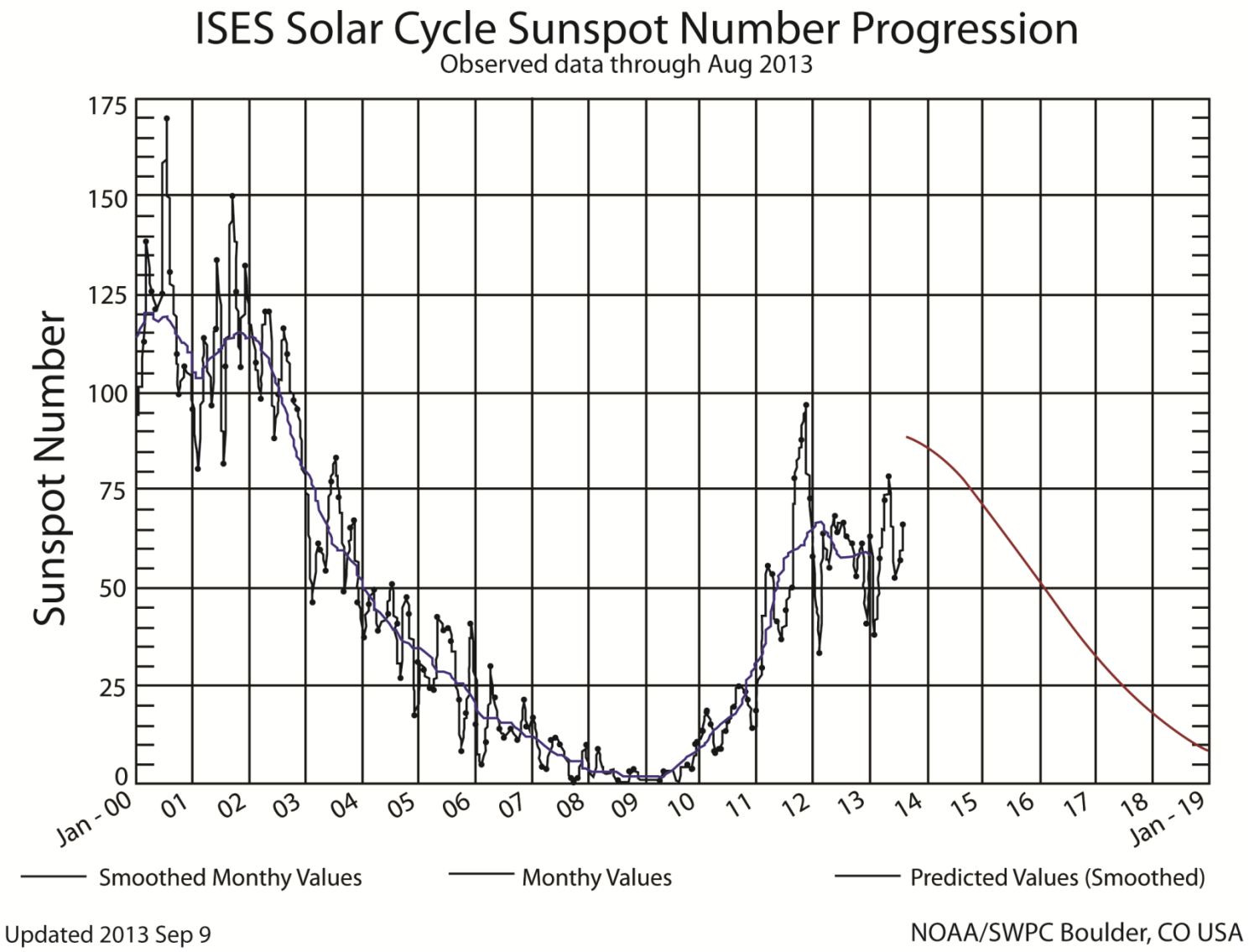
GMD Event of March 13, 1989



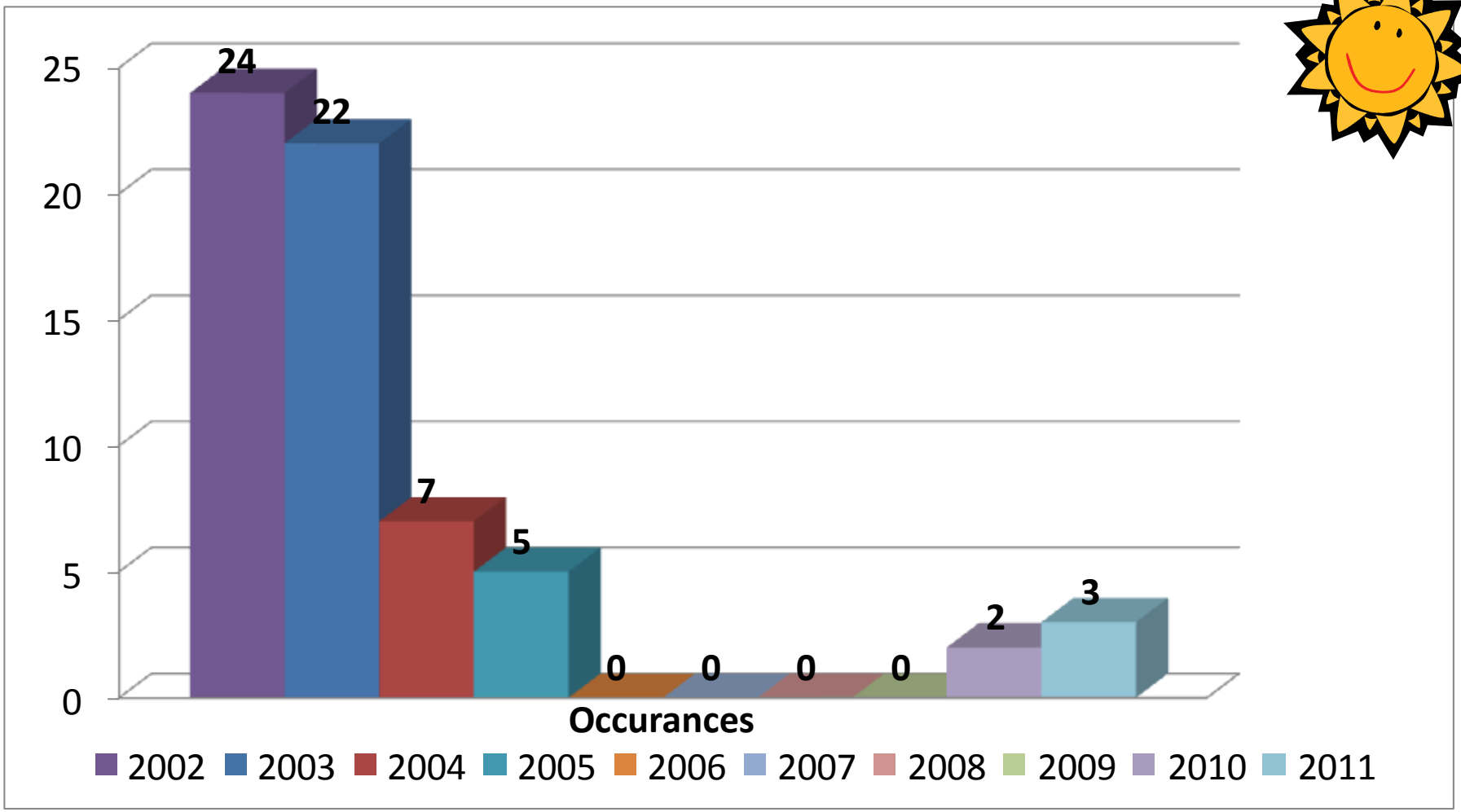
Conservative Operations - Geomagnetic Disturbances

- There is a direct correlation between the number of sunspots observed, and the number of GMD events experienced in a year
  - Sunspot activity follows an 11-year cycle of increasing and decreasing activity

Sun Spot Cycle



Geo-Magnetic Disturbances



Conservative Operations - Geomagnetic Disturbances

Additional PJM Actions

- PJM has a Geomagnetic Disturbance Procedure
- The procedure is implemented when:
  - A DC measurement of 10 amps or greater is detected at either Missouri Ave or Meadowbrook

  AND

  - The measurement is confirmed by at least one other source;
    - Excess Transformer current at Meadowbrook, Beddington, Doubs, or Black Oak
    - High MVAR requirements on the transformers at Hope Creek or Salem Nuclear stations
    - High DC measurements at Limerick or Peach Bottom

Conservative Operations - Geomagnetic Disturbances

- When the GMD is confirmed, PJM will:
  - Operate the system to Geomagnetic Disturbance Transfer Limits (~95% of normal limits)
    - This analysis is based on studies showing the potential for
      - Partial or complete loss of the Hydro Quebec Phase 2 DC line to Sandy Pond (NYISO)
      - Reduction or complete loss of Artificial Island (Salem/Hope Creek)
      - Probable tripping of certain EHV capacitors (Juniata)

Conservative Operations - Geomagnetic Disturbances

- When the GMD is confirmed, PJM will (cont.):
  - Reduce Salem 1 & 2 units to 80% power, and Hope Creek to 85% power if any of the following are noted;
    - Erratic MVAR output from any of the units
    - Excess MVAR consumption by the unit step-up transformers
      - >80 MVAR for Salem
      - >60 MVAR for Hope Creek
    - Transformer neutral DC currents > 5 amperes

Conservative Operations - Geomagnetic Disturbances

PJM will cancel the procedure when;

- DC measurements at Missouri Avenue have fallen below 10 amperes, and are confirmed by at least one of the other sources

AND

- The readings remain below 10 amperes for at least 3 hours

Terrorism and Sabotage Emergencies

Conservative Operations - Terrorism and Sabotage

- 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

Conservative Operations - Terrorism and Sabotage

- Key PJM actions are based upon Threat Levels issued by the Department of Homeland Security (DHS)
  - DHS now uses the National Terrorism Advisory System (NTAS)
  - NTAS has 2 types of alerts;
    - Elevated Threat Alert – warns of a credible threat again the US
    - Imminent Threat Alert – warns of a credible, specific and impending threat against the US
    - These alerts are issued with a “sunset provision”, which means the alert will expire after a certain time
    - DHS can extend the alert if there is a valid reason to do so based on new or updated information
  - Link to the DHS website for further information;
    - http://www.dhs.gov/ntas-public-guide

Conservative Operations - Terrorism and Sabotage

Additional PJM Actions – No NTAS Alert Issued

NTAS Alert Issued	Other potential triggers	PJM Actions - Operations	PJM Actions - Communications
None	• Suspicious activity on neighboring systems	• Remind all operators to use increased vigilance • PJM will review and update Emergency Operations Manuals	• PJM will pass any information received to Member Companies

Conservative Operations - Terrorism and Sabotage

Additional PJM Actions – Elevated Threat Alert Issued

NTAS Alert Issued	Other potential triggers	PJM Actions - Operations	PJM Actions - Communications
Elevated Threat	• Suspicious activity on neighboring systems • NIPC or FBI issues a Threat Advisory	• Maintenance outages are analyzed, equipment return times are verified • PJM Reliability Engineers analyze for "Max Credible" contingencies • Analyze Hydro schedules, increase Black Start capability • Initiate a Black Start Assessment • Determine and fuel limitations (SSR)	• More frequent Satellite Phone checks (Daily/Weekly) • Enhanced voice communication security • Enhanced Cyber Security Scanning • Additional SOS Conference Calls (No Market Information) • PJM Staffs an Incident Response Team • Notify members immediately if any attack occurs

Conservative Operations - Terrorism and Sabotage

Additional PJM Actions – Imminent Threat Alert Issued

NTAS Alert Issued	Other potential triggers	PJM Actions - Operations	PJM Actions - Communications
Imminent Threat	• A cyber attack is affecting one or more control centers • A Physical attack has occurred in the PJM footprint • Intelligence of an impending attack on a PJM facility • Significant terrorist activity beyond the east coast	• Adopt more conservative modeling measures (Double contingencies, Max Credible disturbances, lower Reactive Transfer limits) • Cancel Maintenance – restore outage equipment ("No touch" maintenance policy) • Staff Selected substations, critical CT sites, and black start units • Obtain Emergency Energy bids • Initiate a fuel Assessment (SSR) • Enhanced physical security at substations	• Institute daily conference calls • If a cyber attack is occurring, limit internet access • Maintain 24 hour PJM Management presence • Provide instructions to units to operate within a set of parameters in communications is lost • Direct members to staff back-up control centers • Reassess the allowed level of communication between Transmission and Generation companies to facilitate effective response actions

Conservative Operations - Terrorism and Sabotage

- Communicating Threats – PJM Actions
  - Timely and clear communications between PJM and its Members, in both directions is KEY in the successful managing of any suspected or actual crisis
  - PJM will monitor the Reliability Coordinator Information System (RCIS) for the presence of sabotage or terror events, and will alert other RC's of events on the PJM system via the RCIS
    - If information is urgent or time-sensitive, a Reliability Coordinator Conference call will be convened

Conservative Operations - Terrorism and Sabotage

- Communicating Threats – PJM Actions (cont.):
  - Electric Sector-Information Sharing and Analysis Center (ESISAC) receives and reviews information from:
    - US or Canadian Federal Agencies
    - Reliability Coordinator
    - ES Entities (Region, Control Area, Purchasing-Selling Entity)
    - Other Sector ISACs
  - If the information is specific and has credibility, the ES-ISAC will contact the involved entity directly

Conservative Operations - Terrorism and Sabotage

- Communicating Threats – PJM Actions (cont.):
  - ES-ISAC will notify other Electricity Sector Entities as appropriate, including:
    - EEI Security Committee (Edison Electric Institute)
    - APPA (American Public Power Association)
    - EEI
    - EPSA (Electric Power Supply Association)
    - NEI (Nuclear Energy Institute)
    - NRECA (National Rural Electric Cooperative Association)
    - CEA (Consumer Electronics Association)
  - No information shared by Reliability Coordinators will be passed on without approval
  - No information shared is to be delivered to the public media

Conservative Operations - Terrorism and Sabotage

- Communicating Threats – Member Actions
  - If a PJM Member has been contacted by the ES-ISAC, concerning a threat to their facilities, contact the PJM Shift Supervisor at 610-666-8806
  - In the event a PJM member company operator has received or observed a sabotage event, contact the PJM Shift Supervisor at 610-666-8806
    - PJM will then communicate the information to other Reliability Coordinators, via the RCIS
    - PJM will rapidly assess and pass the information to its members via the All-Call for urgent/time sensitive material, or via the SOS or email for general/non-actionable material

Severe Weather Emergencies

Severe Weather Events

- Severe Storms
  - When storms are in the vicinity of the PJM Control Area, automatic re-closing capability should be in service for all 500 kV and up and also 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

Severe Weather Events

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 cancelled
- Inform affected members of any storms moving into the area
- May implement ***Conservative Operations***

PJM Member Actions:

- Notify PJM Dispatcher of any storms in their systems
- Restore auto-reclosing, or take other actions as instructed by PJM

Severe Weather Events

- ***Cold Weather Alert:***
  - Purpose:
    - Prepare personnel and facilities for expected extreme cold weather conditions
  - Trigger
    - When the forecasted weather conditions approach minimum or actual temperatures for a Control Zone fall near or below 10 degrees Fahrenheit

      AND/OR
    - Anticipated increased winds

      AND/OR
    - Expected spot market gas curtailments during load pick-up periods

Severe Weather Events

- ***Cold Weather Alert:***
  - PJM utilizes the following weather locations and approximate unavailability rates to declare Cold Weather Alerts on a PJM Control Area or Control Zone basis

Control Zone	Region	Weather site	Unavailabilty
PJM	Mid-Atlantic	Philadelphia	4000 - 5000 MW
AP	Western	Pittsburgh	1000 – 2000 MW
AEP	Western	Columbus	2000 – 3000 MW
Dayton	Western	Dayton	1000 – 2000 MW
ComEd	Western	Chicago	2000 – 3000 MW
Dominion	Southern	Richmond	2000 – 3000 MW

Severe Weather Events

PJM Actions:

- Notify PJM management, PJM public information personnel, and members
- Issue Cold Weather Alert, including;
  - Control Zone(s)
  - Forecasted low temperature
  - Forecasted duration of the condition
  - Amount of estimated operating reserve and requirement
  - Reminder that certain fuel limited resources are required to be placed into the Maximum Emergency category
- Assume an unavailability factor of 25% to 75% for scheduled interchange
- Notify respective generation owners if combustion turbines in excess of 2,000 MW are needed

Severe Weather Events

PJM Actions (cont.):

- If the predicted minimum temperature is -5 degrees F or less, or if there is a significant increase in unit unavailability, increase the level of unavailability of CT Generation, and commit additional reserves to cover
- Confer with generation owners;
  - Instruct them to call in or schedule personnel within sufficient time to ensure that all generators are started and available for loading for the morning pick-up
  - Poll large combined-cycle units regarding projected availability during the reserve adequacy run
- Report significant changes in the estimated operating reserve capacity
- Cancel the alert when appropriate

Severe Weather Events

PJM Member Actions:

- Call in or schedules personnel in sufficient time to ensure that all CT and diesel generators that are expected to operate will be started and be available for loading when needed for the morning pick-up
  - Includes operations, maintenance, and technical personnel
  - Units may be run at engine idle or loaded as necessary
- CTs may be started to provide additional Synchronized Reserves
  - Fuel reserves and deliveries will be monitored closely
- Attempt to start the most troublesome or unreliable units first
- Review combustion turbine capacities, specifically units using #2 fuel oil that do not have sufficient additive to protect them for low temperatures

Severe Weather Events

PJM Member Actions (cont.):

- Review fuel supplies/delivery schedules
- Monitor and report projected fuel limitations to PJM
- Contact PJM if it is anticipated that spot market gas is unavailable, resulting in unit unavailability
- Contact PJM if there are gas-fired CTs placed in Maximum Emergency Generation due to daily gas limitations of less than 8 hours
- Review plans to determine if any maintenance or testing, scheduled or being performed, on any monitoring, control, transmission, or generating equipment can be deferred or cancelled

Severe Weather Events

- ***Hot Weather Alert***
  - Purpose
    - Prepare personnel and facilities for extreme hot and/or humid weather conditions which may cause capacity requirements and unit unavailability to be higher than forecast for an extended period of time
  - Trigger
    - When the forecasted maximum or actual temperature for any zone is at or above 90 degrees Fahrenheit, with high humidity, for multiple days

Severe Weather Events

- ***Hot Weather Alert***
  - PJM utilizes the following weather locations and approximate unavailability rates to declare Hot Weather Alerts on a PJM Control Area or Control Zone basis

Control Zone	Region	Weather site	Unavailability
PJM	Mid-Atlantic	Philadelphia	2000 - 2500 MW
AP	Western	Pittsburgh	500 – 1000 MW
AEP	Western	Columbus	1000 – 1500 MW
Dayton	Western	Dayton	500 – 1000 MW
ComEd	Western	Chicago	1000 – 1500 MW
Dominion	Southern	Richmond	1000 – 1500 MW

Severe Weather Events

PJM Actions:

- Notify PJM management and member dispatchers
- Issue Hot Weather Alert, including;
  - Control Zone(s)
  - Forecasted high temperature
  - Forecasted duration of the condition
  - Amount of estimated operating reserve and requirement
  - Reminder that certain fuel limited resources are required to be placed into the Maximum Emergency category
- Report significant changes in operating reserve capacity
- Cancel the alert when appropriate

Severe Weather Events

PJM Member Actions:

- Notify management
- Advise all generating stations and key personnel
- Determine if any maintenance or testing can be deferred or cancelled
- Report to PJM all fuel/environmental limited facilities as they occur and update as needed
- Contact PJM to inform them of any gas-fired generation placed in Maximum Emergency Generation due to daily gas limitations of less than 8 hours

Questions?

Resources and References

- PJM Manual 3 – Transmission Operations, Revision 43 (2013) Linked from; http://www.pjm.com/~/media/documents/manuals/m03.ashx

- PJM Manual 13: Emergency Operations, Revision 53 (2013 Linked from; http://www.pjm.com/~/media/documents/manuals/m13.ashx

- Robert Miller & James Malinowski (1994). “Power System Operation”. Boston, MA. McGraw-Hill.