

Transmission ITP

PJM Emergency Procedures

PJM State & Member Training Dept.

Objectives



At the conclusion of this presentation, the student will be able to:

- Describe PJM's overall approach to implementing Emergency Procedures
- Identify some potential triggers that may require PJM to initiate Conservative Operations
- Identify the PJM and Member Company actions that will be taken once PJM initiates Conservative Operations
- Identify the PJM and Member Company actions that will be taken once PJM initiates Voltage Control Emergency Procedures

Agenda



- **Emergency Procedures Introduction**

- PJM's philosophy
- NERC Energy Emergency Alerts

- **Conservative Operations**

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

Agenda



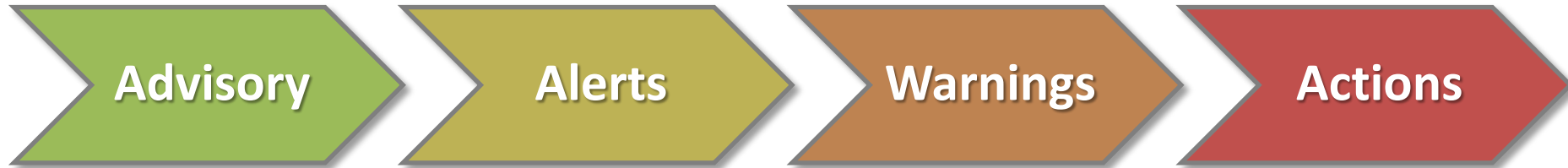
- Voltage Emergencies
 - Low Voltage Alert
 - Heavy Load Voltage Schedule
 - High System voltages
 - Reactive Reserve Checks (RRC's)
- Capacity Emergencies
 - Capacity Shortage Alerts
 - Capacity Shortage Warnings
 - Capacity Shortage Actions
 - Supplementary Status Report (SSR)
 - Capacity Excess Alerts
 - Capacity Excess Warnings
 - Capacity Excess Actions

Emergency Procedures Introduction

- An **emergency** in PJM is defined as:
 - An abnormal system condition requiring manual or automatic action, to:
 - Maintain system frequency
 - Prevent loss of firm load, equipment damage or tripping of system elements
 - Ensure the safety of persons or property
 - Maintain the reliability of the electric system
 - A fuel shortage requiring departure from normal operating procedures
 - Abnormal natural events or man-made threats to reliability
 - Including events external to PJM that may require PJM action

Emergency Procedures Introduction

- 4 levels of emergency procedures:



- Most Advisories, Alerts, Warnings and Actions are communicated via:
 - PJM ALL-CALL
 - Posted to various PJM websites
- Advisories and Alerts are issued in advance of the operating day
- Warnings and Actions are issued during the operating day

Emergency Procedures Introduction

- The PJM dispatcher has the flexibility to:
 - Implement emergency procedures in whatever order is required
 - Exit the emergency procedures in a different order than they are implemented when necessary
- PJM members are expected to implement all emergency procedures immediately
 - Desired relief expected within 30 minutes, unless directed otherwise

Emergency Procedures Introduction

Implementation of Emergency Procedures

- During unconstrained operations:
 - Implemented jointly across all PJM Control Zones, with the exception of Manual Load Dump
 - Manual Load Dump
 - Capacity deficient zone sheds load
 - If all zones are deficient, load shed is implemented proportionally based on level of shortage
- Transmission constraints:
 - May require implementation on a Control Zone basis

NERC Energy Emergency Alerts (EEAs)

- Alerts issued by Reliability Coordinator (RC) to ensure that all RCs understand potential and actual energy emergencies
 - Provides common terminology to use when explaining energy emergencies to each other
- Issued for capacity and energy shortages
 - Issued via the Reliability Coordinators Information System (RCIS)
- Three Levels
 - Levels may be declared in whatever order necessary, no need to proceed sequentially

NERC Energy Emergency Alerts (EEAs)

- **EEA Level 1 – All Available Resources in Use**
 - Issued when a Control Area “foresees or is experiencing conditions where all available resources are committed”
 - Concern about being able to sustain required Operating Reserves
- When does PJM issue?
 - Maximum Generation Emergency Alert

NERC Energy Emergency Alerts (EEAs)

- **EEA Level 2 – Load Management Procedures in Effect**
 - Issued when a Control Area “foresees or has implemented procedures up to but excluding interruption of firm load commitments”
 - Public Appeals, Voltage Reduction, Load Management, Interruption of Non-firm contracts
- When does PJM issue?
 - Emergency Mandatory Load Management Reductions Action, a Voltage Reduction Action, or a Deploy All Resources Action (whichever issued first)

NERC Energy Emergency Alerts (EEAs)

- **EEA Level 3 – Firm Load Interruption Imminent or In Progress**
 - Issued when a Control Area “foresees or has implemented firm load obligation interruption”
 - Prior to declaring:
 - All generation on-line, regardless of cost
 - All purchases made, regardless of cost
 - All non-firm sales recalled
 - All contractually interruptible load curtailed
- When does PJM issue?
 - Manual Load Dump Action

Questions?

Agenda



- Emergency Procedures Introduction
 - PJM's philosophy
 - NERC Energy Emergency Alerts
- **Conservative Operations**
 - 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
 - Bad Weather
 - Thunderstorms
 - Extreme heat or cold

Triggers for Conservative Operations

- Conditions triggering Conservative Operations (*con't*):
 - 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** *(con't)*:

- 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** *(con't)*:

- 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** *(con't)*:

- 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:
 - 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

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 (*con't*):
 - 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 (*con't*):

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

Conservative Operations – Fuel Delivery Emergencies

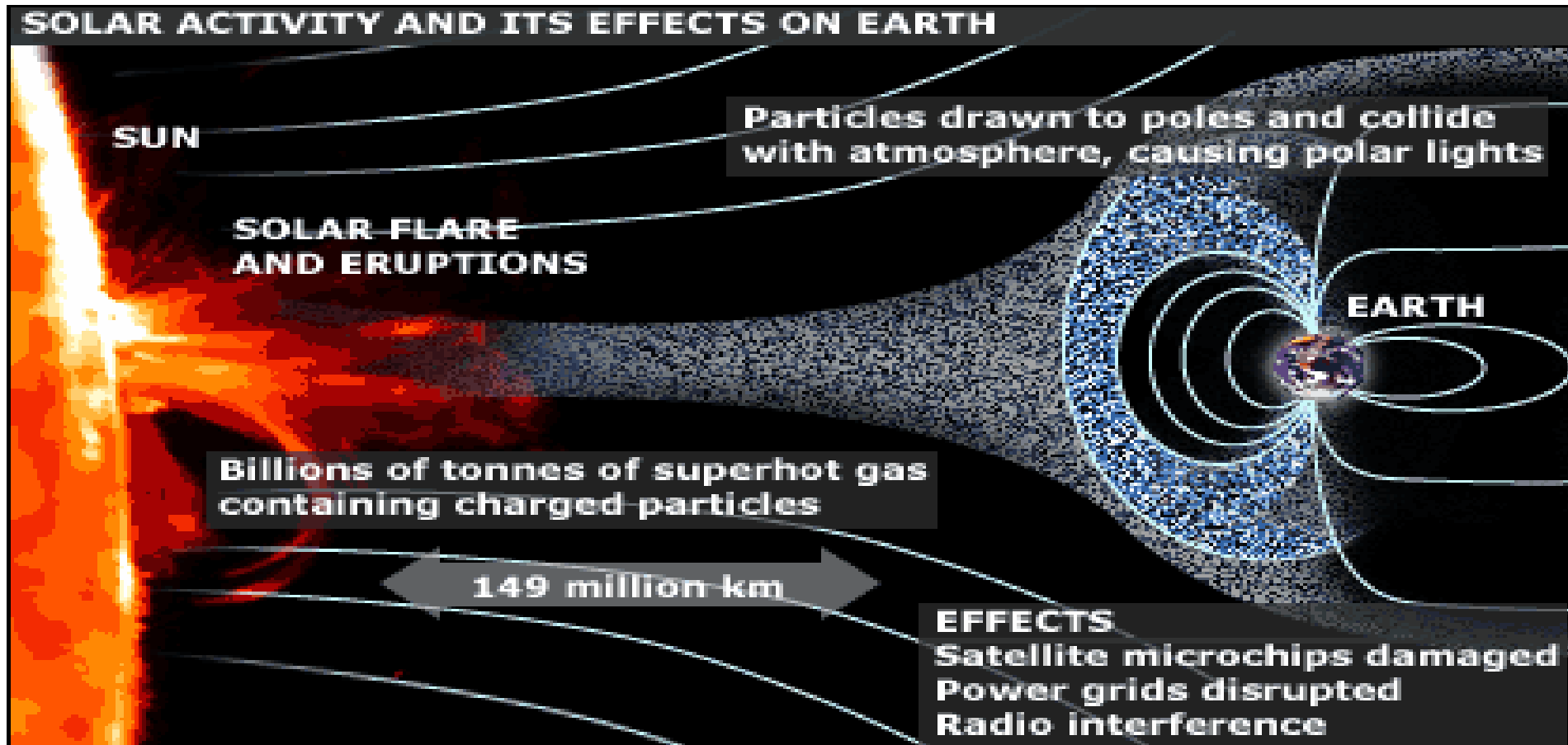
Additional Member Actions

- 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

GeoMagnetic Disturbances (GMDs)

Conservative Operations – Geomagnetic Disturbances

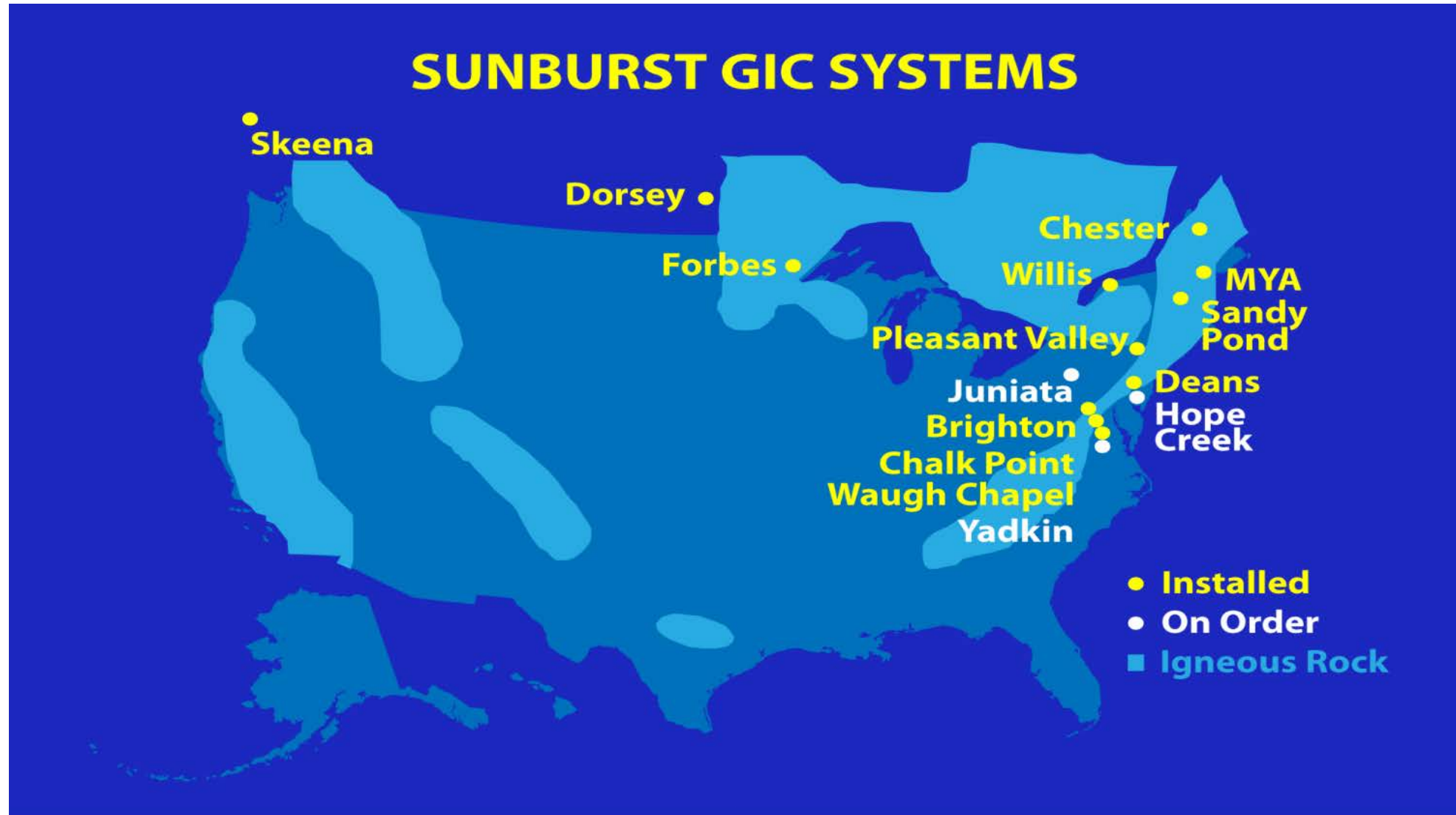
- The concentration of these particles along the earth's magnetic lines can also affect satellites



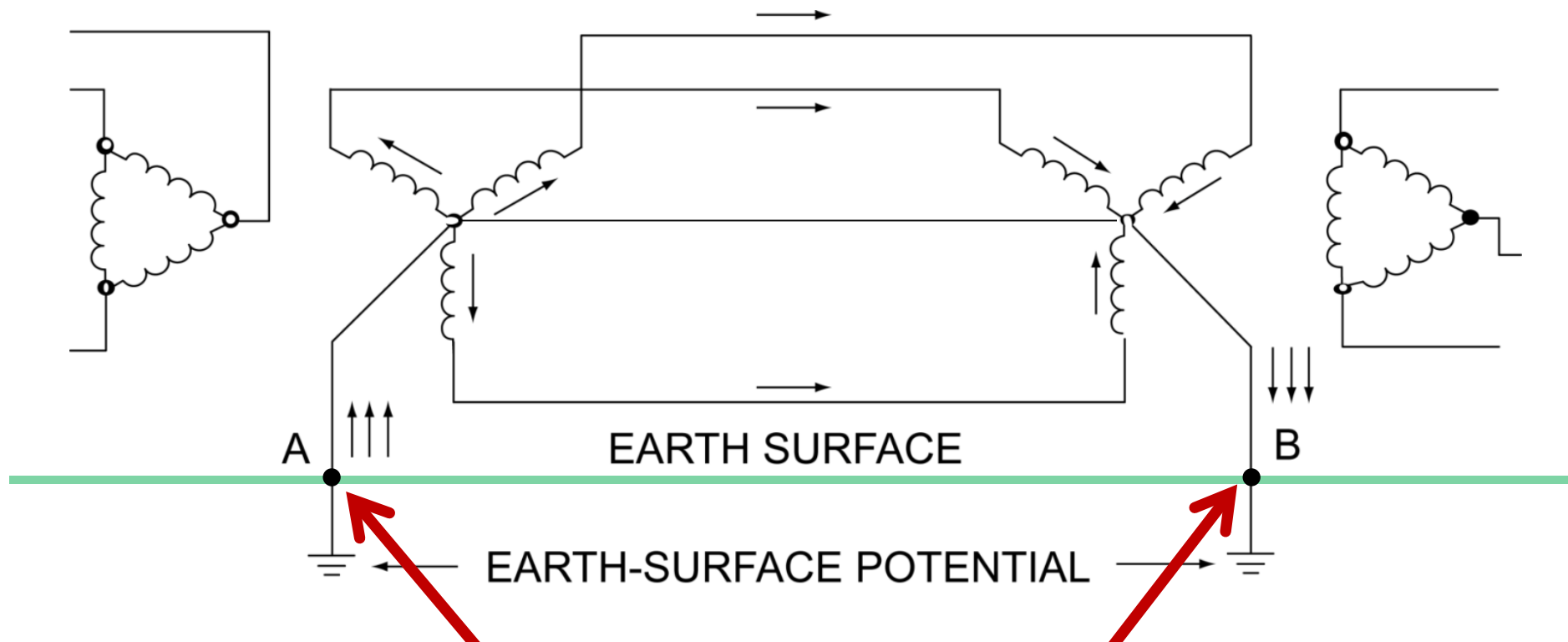
Conservative Operations – Geomagnetic Disturbances

- The GIC currents are DC rather than AC
 - 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



BES Power Transformer Ground Paths

GIC Current Path

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

Conservative Operations – Geomagnetic Disturbances

So why are these currents an issue (*con't*):

- The voltage swings can cause fluctuations in the BES voltages, possibly resulting in control issues
- 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

- Solar disturbances are most commonly reported in the “K” scale severity
 - Intensity rating 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

Conservative Operations – Geomagnetic Disturbances

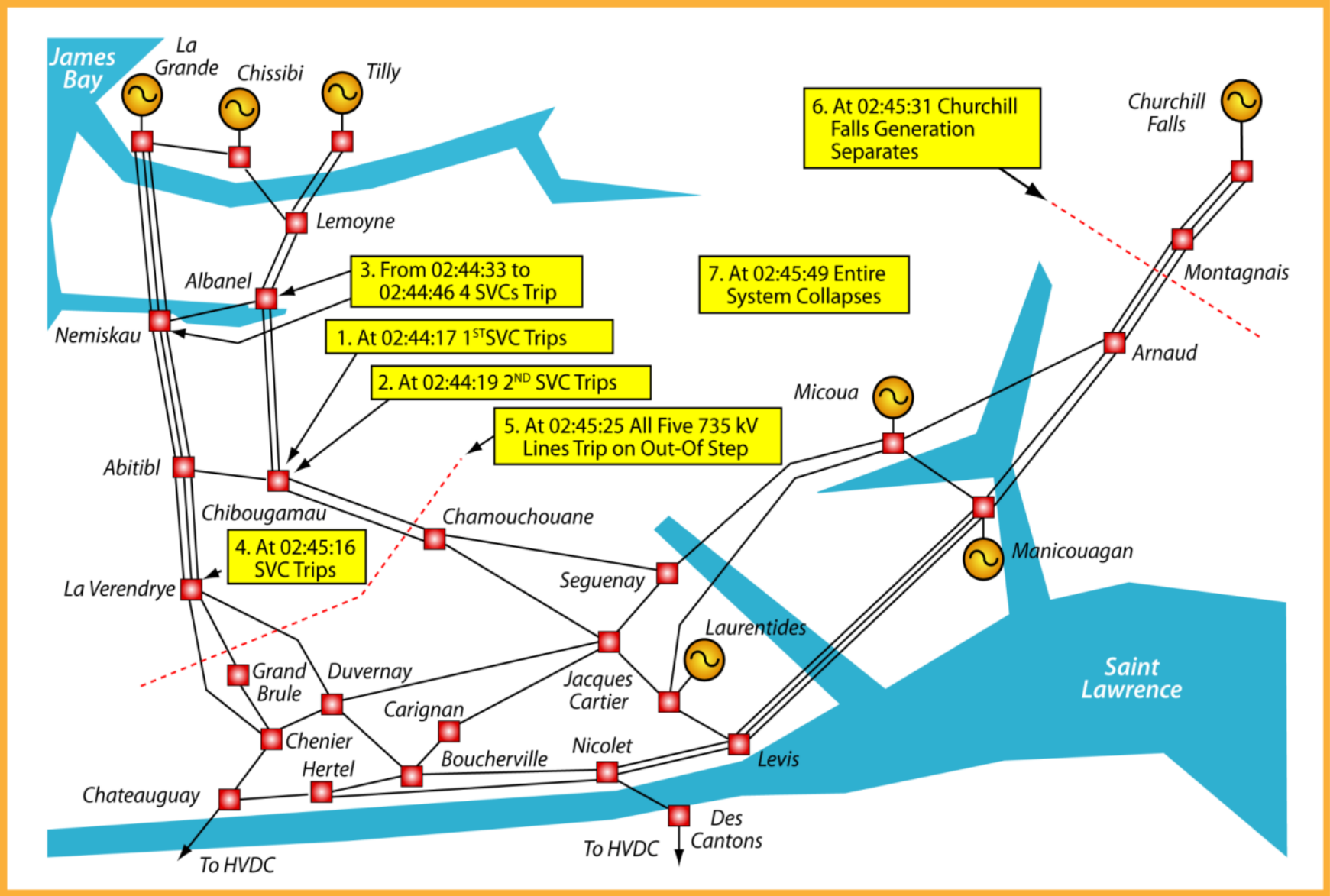
- K Scale Effects on Electric Power Systems
 - K-6: High-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage
 - K-7: Voltage corrections may be required, false alarms triggered on some protection devices
 - K-8: Possible widespread voltage control problems 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

Conservative Operations – Geomagnetic Disturbances

GMD event of
March 13, 1989



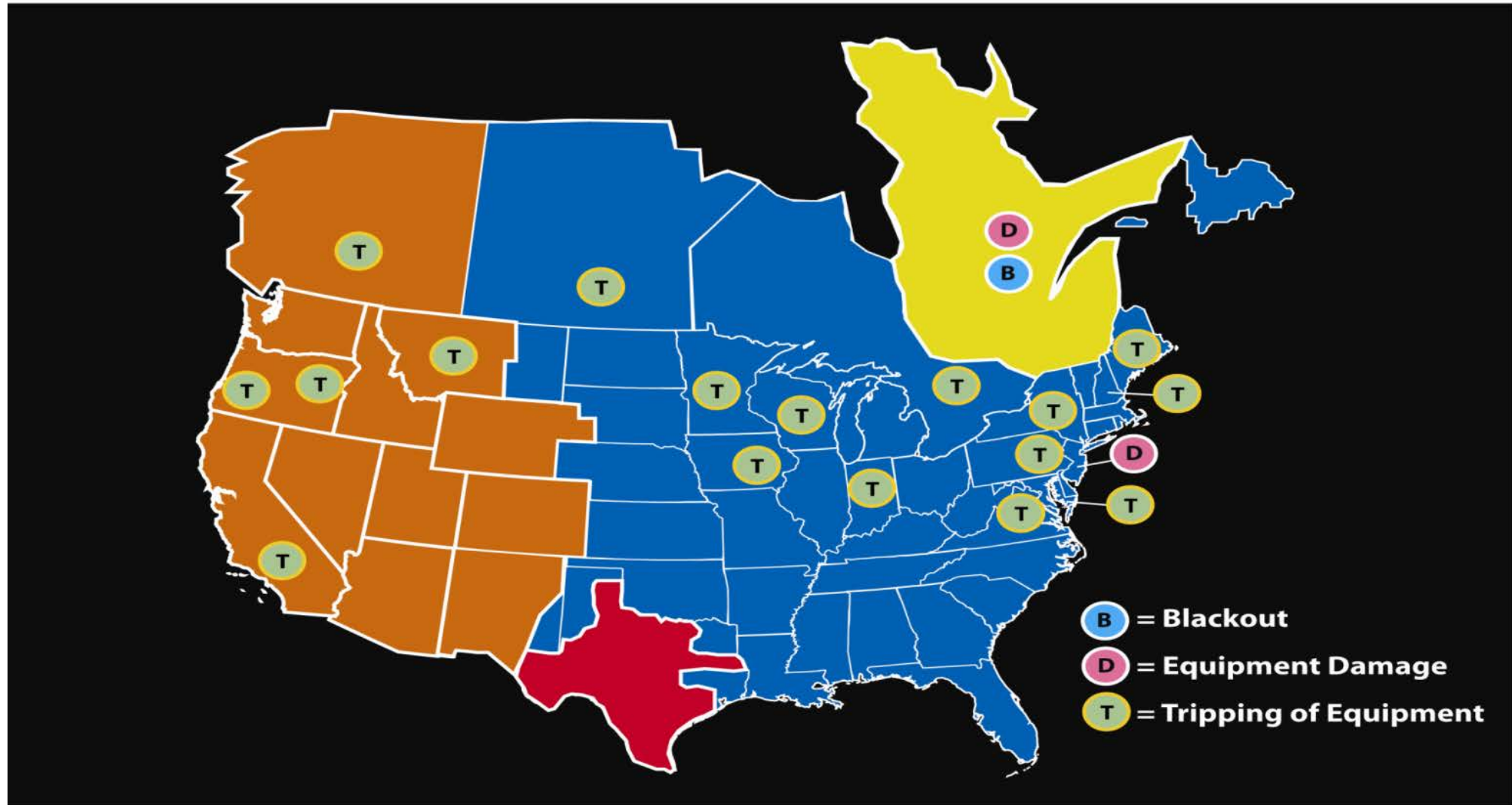
Conservative Operations – Geomagnetic Disturbances

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



Conservative Operations – Geomagnetic Disturbances

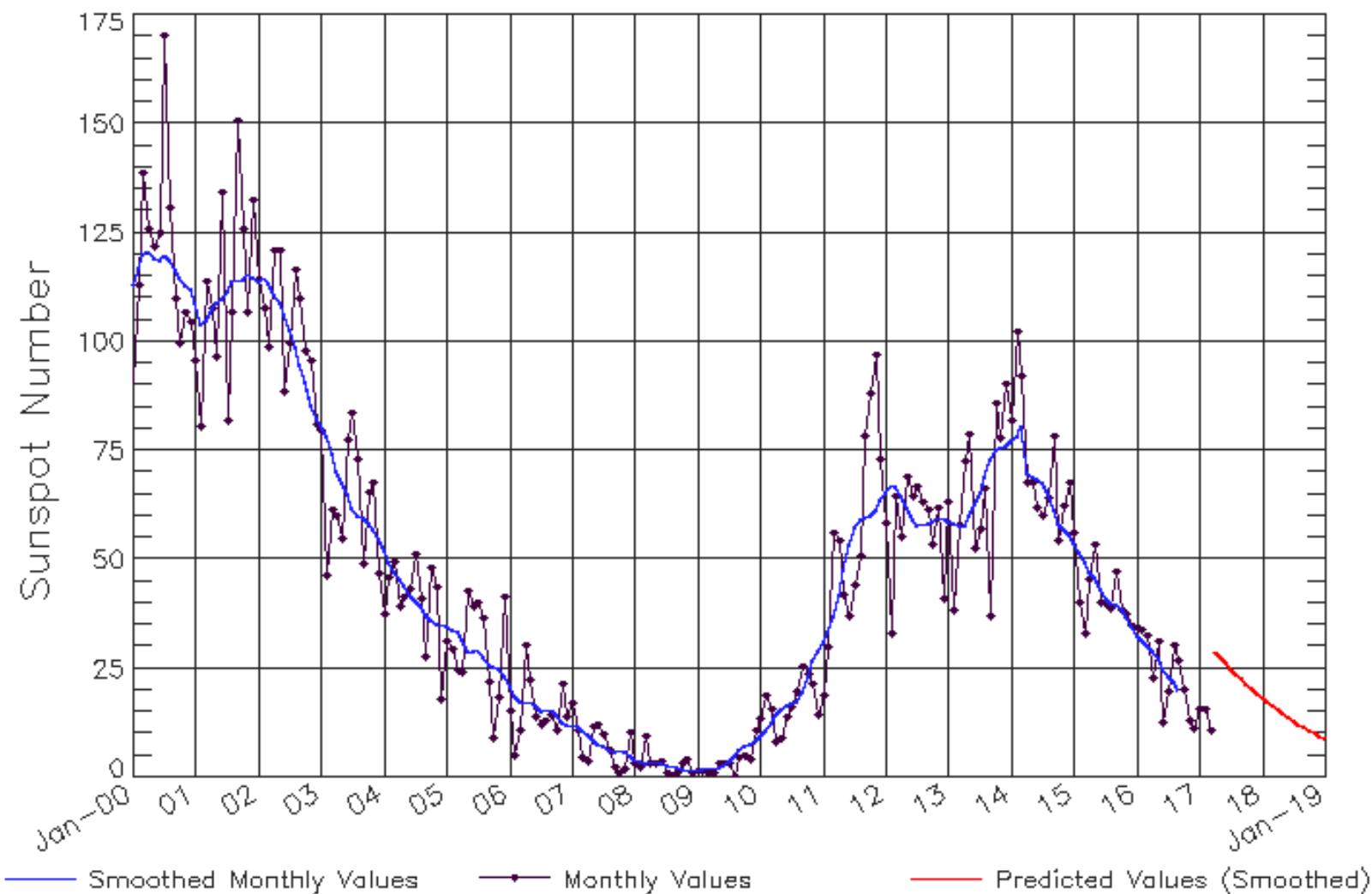
POWER SYSTEM EVENTS DUE TO SMD MARCH 13, 1989



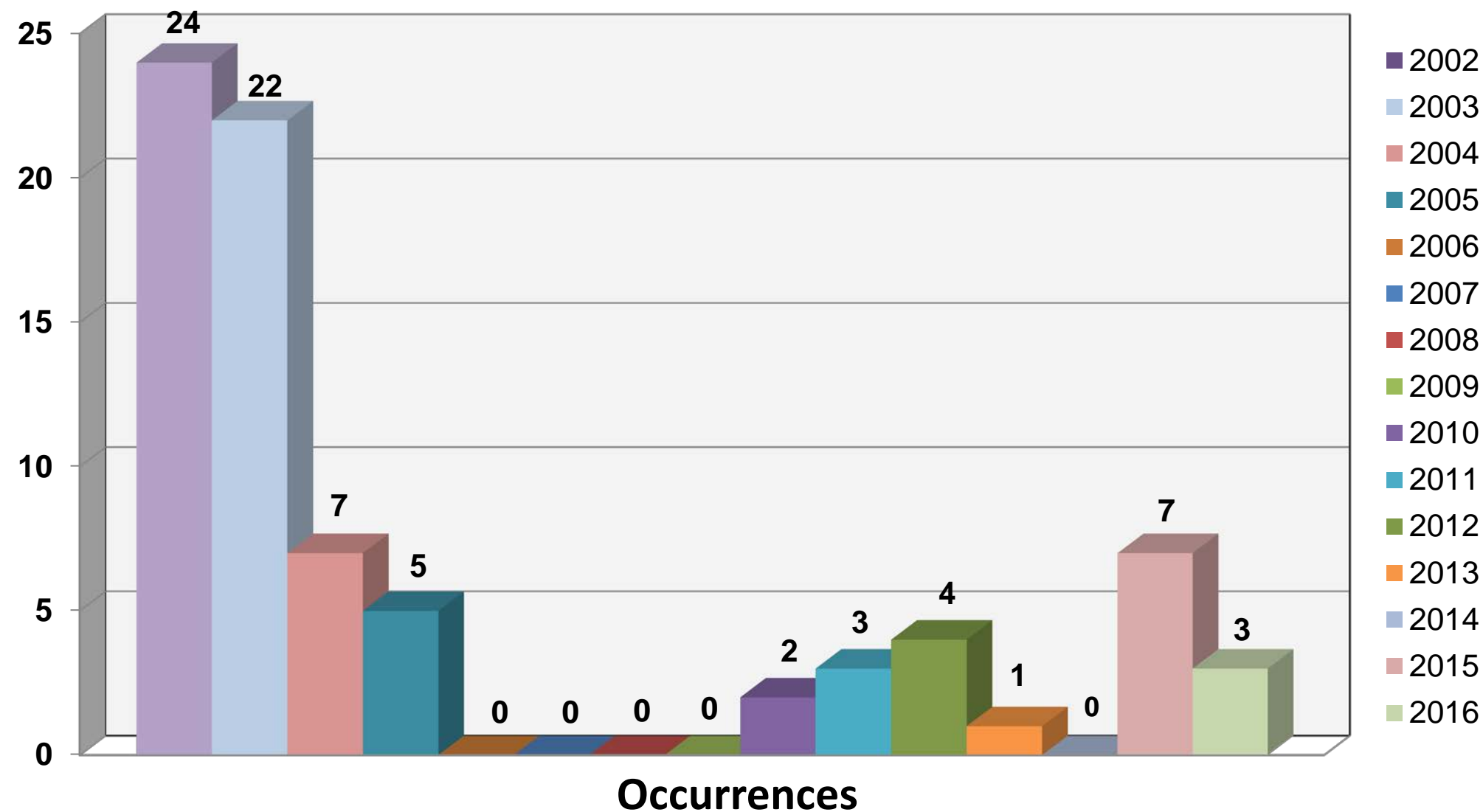
Conservative Operations – Geomagnetic Disturbances

ISES Solar Cycle Sunspot Number Progression

Observed data through Mar 2017



Conservative Operations – Geomagnetic Disturbances



Conservative Operations – Geomagnetic Disturbances

PJM has a Geomagnetic Disturbance operating plan

- Transmission Owners are not required to have GMD operating plans
 - However, TO's that do are required to provide a copy to PJM

Conservative Operations – GMD Warning

- If the National Oceanic and Atmospheric Administration (NOAA) issues a warning or an alert for a potential GMD of severity K7 or greater
 - PJM will provide notification via the ALL-CALL system and Emergency Procedure Posting Application

Conservative Operations – GMD Warning

PJM Actions:

- Will notify Transmission and Generation via the ALL-CALL of GMD Alerts/ Warnings
- 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 will confirm that this measurement is a result of a severe geomagnetic storm by contacting the TO or GO in order to verify

Conservative Operations – GMD Warning

Member Actions:

- Transmission/Generation dispatchers provide confirmation of measurement values as requested by PJM dispatch

Conservative Operations – GMD Action

- When conditions warrant, the PJM dispatcher may take action as soon as necessary for a GMD disturbance
 - Must take action if conditions persist for 10 minutes
- If GIC measurements exceed the associated GIC operating limit (in amperes) at two or more transformers monitored for GIC flow
 - PJM dispatch contacts the TO(s) and GO(s) in order to verify the readings

Conservative Operations – GMD Action

- PJM dispatch will declare a Geomagnetic Disturbance Action and operates the system to geomagnetic disturbance (GMD) transfer limits
- The geomagnetic disturbance transfer limits 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

Conservative Operations – GMD Action

PJM Actions:

- PJM dispatch notifies members (Generation and Transmission) and neighbors via the PJM ALL-CALL, postings on selected PJM web-sties and the NERC RCIS of a Geomagnetic Disturbance Action
- To mitigate the effects of GMD events on the system
 - When the GMD transfer limit is approached or exceeded, generation re-dispatch assignments are made in the most effective areas to control this limit

Conservative Operations – GMD Action

PJM Actions:

- After GIC measurements at all monitored transformers have fallen below the the associated GIC operating limit (in amperes)
 - PJM dispatch continues to operate the system to the geomagnetic disturbance transfer limits for a period of three hours

Conservative Operations – GMD Action

Member Actions:

- Transmission/Generation dispatchers provide confirmation of measurement values as requested by PJM dispatch
- Upon notification of the implementation of this procedure, members that operate facilities with instrumentation installed
 - Record GIC-neutral measurements at remote locations
 - Dispatch personnel to ensure that measurement equipment is working properly
- The member dispatchers report all actions to PJM dispatch

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;
 1. Elevated Threat Alert: Warns of a credible threat against the U.S.
 2. Imminent Threat Alert: Warns of a credible, specific and impending threat against the U.S.
 - 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

Terrorism and Sabotage

NTAS Alert Issued	Other Potential Triggers	PJM Actions-Operations	PJM Actions-Communications
None	<ul style="list-style-type: none">• Suspicious activity reported by adjacent systems	<ul style="list-style-type: none">• Remind all operators of increased vigilance• PJM Operations Management will review and discuss this section of the Emergency Operations manual• Increased vigilance and reporting	<ul style="list-style-type: none">• PJM passes along credible/actionable intelligence• All operations centers should review reporting requirements

Terrorism and Sabotage

NTAS Alert Issued	Other Potential Triggers	PJM Actions-Operations	PJM Actions-Communications
<ul style="list-style-type: none">• Elevated Threat Level	<ul style="list-style-type: none">• Suspicious activity reported by adjacent systems• DHS/FBI issued a Threat Advisory	<ul style="list-style-type: none">• Maintenance outages are analyzed; equipment return times are verified• Maximum Credible contingencies analyzed by PJM Reliability Engineer• Increased vigilance and reporting• Analyze hydro schedules- to increase Black Start capability• Initiate Black Start Assessment- to determine fuel limitations (SSR)	<ul style="list-style-type: none">• Communicate threat through ALL-CALL• Satellite Phone checks (daily/weekly)• Enhance voice communications security• Enhance cyber security scanning• Additional SOS conference calls (no market information)• PJM staffs an Incident Response Team• If an attack occurs, notify members (ALL-CALL)

NTAS Alert Issued	Other Potential Triggers	PJM Actions-Operations	PJM Actions-Communications
<ul style="list-style-type: none"> • Imminent Threat Level 	<ul style="list-style-type: none"> • Cyber event has shut down control center EMS capability, or physical attack at multiple sites • Intelligence of an impending attack on a PJM facility • Cyber event has shut down control center EMS capability, or physical attack at multiple sites • Significant terrorist activity beyond the East Coast 	<ul style="list-style-type: none"> • Adopt more conservative modeling measures (double contingencies, maximum credible disturbances, or lower reactive transfer limits) • Increase Available Operating Reserve • Cancel selected Maintenance Outages –restore outaged equipment (No touch maintenance policy) • Consider staffing selected substations, critical CT sites, and black start units • Increase Synchronized Reserves • Obtain emergency energy bids • Enhance physical security at critical substations 	<ul style="list-style-type: none"> • Communicate threat over ALL CALL • Institute Daily Conference Calls • If cyber attack is occurring consider limiting internet accessibility • PJM maintains 24 hour Operations Management presence • Provide instructions to units to operate within a given set of parameters if communications is lost • Staff Back-Up Control Centers (as necessary) • Reassess the allowed level of communications between generators and transmission operators in order to facilitate necessary communications

Terrorism and Sabotage

Communicating Threats

- Electric Sector-Information Sharing and Analysis Center (NERC operated) receives and reviews information from:
 - U.S. or Canadian Federal Agencies
 - Reliability Coordinator
 - Electric Sector Entities (Region, Control Area, Purchasing-Selling Entity)
 - Other Sector ISACs (Oil and gas, chemical, nuclear, aviation, defense, financial services, etc.)
 - If the information is specific and has credibility, the ES-ISAC will contact the involved entity directly

Terrorism and Sabotage

- ES-ISAC will notify other Electricity Sector Entities as appropriate, including:
 - EEI Security Committee (Edison Electric Institute)
 - APPA (American Public Power Association)
 - EPSA (Electric Power Supply Association)
 - NEI (Nuclear Energy Institute)
 - NRECA (National Rural Electric Cooperative Association)
 - CEA (Consumer Electronics Association)

Terrorism and Sabotage

PJM Actions:

- Communicating Threats
 - 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

Terrorism and Sabotage

PJM Actions:

- Communicating Threats
 - No information shared by Reliability Coordinators will be passed on without approval
 - No information shared is to be delivered to the public media

Terrorism and Sabotage

Member Actions:

Communicating Threats

- If a PJM Member has been contacted by the ES-ISAC, concerning a threat to their facilities, or has received or observed a sabotage event, contact the PJM Shift Supervisor
 - 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 RTO, automatic re-closing capability should be in service for all EHV 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*
- At higher temperatures if increased winds are anticipated
- 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	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

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
 - Whether fuel limited resources are required to be placed into the Maximum Emergency category
- Assume an unavailability factor of 25% to 75% for scheduled interchange

Severe Weather Events

PJM Actions *(con't)*:

- Notify respective generation owners if combustion turbines in excess of 2,000 MW are needed
- 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

Severe Weather Events

PJM Actions *(con't)*:

- Report significant changes in the estimated operating reserve capacity
- Recall/cancel non-critical Generation & Transmission maintenance outages
- Cancel the alert when appropriate

Severe Weather Events

PJM Member Actions:

- 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
- 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

Severe Weather Events

PJM Member Actions *(con't)*:

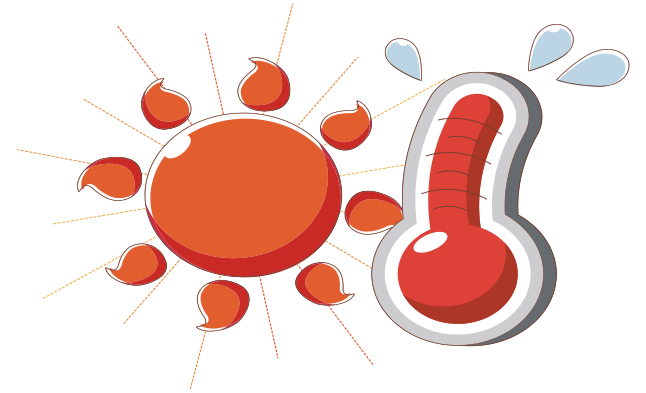
- Attempt to start the most troublesome or unreliable units first
- Review combustion turbine capacities, specifically units using #2 fuel oil that do not have sufficient additive to protect them for low temperatures
- Review fuel supplies/delivery schedules
- Monitor and report projected fuel limitations 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

Severe Weather Events

Hot Weather Alert

- Purpose: Prepare personnel and facilities for extreme hot and/or humid weather conditions
 - 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 a Transmission zone is at or above 90 degrees* Fahrenheit, with high humidity, for multiple days

(*Temperature trigger is 93 degrees for EKPC and Dominion Zones)



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	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

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
- PJM Dispatch recalls/cancels non-critical Generation & Transmission maintenance outages
- 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?

Agenda



- **Voltage Emergencies**

- Low Voltage Alert
- Heavy Load Voltage Schedule
- High System voltages
- Reactive Reserve Checks (RRC's)

- Capacity Emergencies

- Capacity Shortage Alerts
- Capacity Shortage Warnings
- Capacity Shortage Actions

Low Voltage Alert

Low Voltage Alert

Purpose

- Heighten awareness, increase planning, analysis, and preparation efforts when heavy loads and low voltages are anticipated in an upcoming operation period
 - Issued to Generation and Transmission members
 - Can be issued for the entire PJM RTO, specific Control Zone(s) or a subset of Control Zone(s)

Low Voltage Alert

PJM Actions:

- Conduct power flow analysis of future load and transfer increases on the PJM system
 - Evaluate and plan using the analysis, to include:
 - Ensuring necessary off-cost generation is ready to respond to transfer constraints
 - Consider changing the Reactive Transfer back off limit from 50 MW to 300 MW
- Review generation and transmission outages
- Assess impacts of transfers and be prepared to curtail transactions impacting the reactive transfer limits

Low Voltage Alert

PJM Actions:

- Use NERC Interchange Distribution Calculator, assess the impact of parallel flows
 - Prior to dumping load, PJM will invoke the NERC Transmission Loading Relief (TLR) process to provide relief from these parallel flows
- Enhance reactive reporting from members by requesting a Reactive Reserve Check
- Enhance communications among SOS Transmission members via SOS conference calls to discuss the status of critical equipment, voltage trends, and possible corrective actions

Low Voltage Alert

PJM Member Actions:

- Transmission and Generation members notify their management, stations and key personnel
- Defer and maintenance or testing affecting capacity or critical transmission
- Respond to the Reactive Reserve Check by checking status and availability of all critical reactive resources

Heavy Load Voltage Schedule Warning and Action

Heavy Load Voltage Schedule Warning

Purpose

- Issued to members to prepare for maximum support of voltages on the bulk power system
 - Can be issued for the entire PJM RTO, specific Control Zone(s) or a subset of Control Zone(s)

Heavy Load Voltage Schedule Warning

PJM Actions:

- Issue Heavy Load Voltage Schedule Warning to members 4 hours prior to requesting actual implementation of a Heavy Load Voltage Schedule
- Request members to verify that all actions have been taken on the distribution and sub-transmission system to support voltage at the EHV level

Heavy Load Voltage Schedule Warning

PJM Member Actions:

- Ensure, where possible, while still observing established limits
 - Underlying reactors are out of service
 - Underlying capacitors are in service
 - Transformer taps are adjusted to ensure all distribution capacitors are in service
 - Generation Dispatchers ensure that all automatic voltage regulators are in service on generating units

Heavy Load Voltage Schedule Action

Purpose

- Issued at peak load periods to request maximum support of voltage on the bulk power system and to increase reactive reserves at the EHV level
 - Can be issued for the entire PJM RTO, specific Control Zone(s) or a subset of Control Zone(s)

PJM Actions:

- Request all companies implement Heavy Load Voltage Schedule

Heavy Load Voltage Schedule Action

PJM Member Actions:

- Ensure where possible, while still observing established limits
 - Underlying reactors are out of service
 - Underlying capacitors are in service
 - Capacitors on the 500 kV system with PLCs are in service
- Ensure all unit voltage regulators are in service
- Units on the 230 kV system and below should increase MVAR output as necessary to maintain scheduled bus voltages or nominal voltages, whichever is greater
 - Voltage levels should be maintained within predetermined limits at all times
- Units on the EHV level are operated to maintain a reasonable MVAR reserve
 - Reactive moves on these units should be coordinated with PJM
- Inform PJM of any units approaching max MVAR output, unit MVAR restrictions or AVR out of service

High System Voltage Emergencies

High System Voltage

Purpose

- Prepare the system for expected high voltages
 - Coordinate with Transmission owners to take steps to control high voltage prior to entering a light load period
- Take actions in real time when portions of the PJM RTO are experiencing a low load/high voltage condition

High System Voltage

PJM Actions:

- Issue High System Voltage message
- Direct all companies to take actions to control high system voltages
- Generators, synchronous condensers and SVCs within their zone to absorb reactive power
 - Coordinate with Transmission and Generation owners to direct generators to operate outside voltage schedules

High System Voltage

Member Actions:

- Switchable capacitors are out of service, switchable reactors are in service and SVCs are operating in the lead
- Review and request adjustments to generator excitation (within approved bandwidth) so units absorb reactive power as modeled in the reported unit D-curve
- Review and adjust LTC settings as appropriate
 - All LTC (230 kV and above) and voltage schedule adjustments shall be coordinated with PJM dispatch

High System Voltage

Member Actions:

- Generation should operate at the lower bandwidth of their voltage schedule when possible
 - Example: A generator following a voltage schedule of 235 kV +/- 4 kV should be operating to 231 kV if possible
- Voltage schedule adjustments or excitation adjustments outside of the approved bandwidth shall be coordinated with PJM
- Generation communicate with PJM and TOs any restrictions on unit ability to absorb MVARs if it varies from reported capability

Reactive Reserve Checks (RRCs)

Reactive Reserve Checks

Reactive Reserve Check (RRC)

- RRC generally called for during capacity deficient conditions or when a Heavy Load Voltage Schedule Warning is implemented
- The data is displayed as a total at the top of the page and as discrete equipment values below it for:
 - Capacitors
 - Reactors
 - SVC's/ Statcom
 - Units/ Condensers

Reactive Reserve Checks

Reactive Reserve Check (RRC)

- Gives PJM Power Dispatcher a “snapshot” of how many reactive reserves are available on the system at the current time
 - Data will be populated every 5 minutes from PJM’s EMS into eDART to allow TO’s to do self-checks of the data
 - PJM PD will compare company reports to what is currently show in the PJM EMS
 - Expectation is that the RRC will be reported as soon as possible (within 5-10 min.)
 - Checking the data throughout the day is encouraged
 - Significant differences between what the member company reports and what the PJM EMS shows will be followed up on by PJM PD

Reactive Reserve Checks

- Verifying real-time reactive reserves with what are shown in the PJM EMS will help prevent events like the near voltage collapse of 1999
- Routine RRCs will also be performed on a monthly basis (generally on a Sunday)
 - Allows personnel to become familiar with procedure and identify problem data at times when system is not stressed
 - Continues to ensure that the PJM is accurately reflecting the resources available
 - Ensures members have fulfilled their reporting capabilities

**Manual Reference, M-14-D
Generator Operational Requirements
Attachment D**

Reactive Reserve Checks

- PJM assesses the reactive reserve of the associated equipment via three key metrics:
 1. **Capability:** the lagging (and/or leading) capability for a given piece of equipment
 2. **Status:** the real-time connectivity to the PJM System, and is expressed as Online or Offline
 3. **Availability:** this is communicated to PJM through the absence of a PJM eDART ticket (availability) or the presence of an eDART ticket (unavailability) which identifies the equipment as being unavailable

Reactive Reserve Checks

Transmission Owners are required to submit the RRC for all reactive resources in their footprint

- RRCs will track 3 types of reactive reserves:

1. Unit MVAR Reserve = Total lagging MVAR reserve of all synchronized units.

- For each unit, this is the difference between the amount of MVARs currently being supplied to the system and the total maximum MVAR output of the unit at that MW output
- Transmission Owners may have to “poll” Generators in their footprint and ensure there are no unreported problems with MVAR capability
- **Example:** A steam unit is online at 250 MW. It’s D-curve data shows that it is capable of providing 80 MVAR of Reactive capability at that power level. It is currently providing 62 MVAR to the system
- The MVAR Reserve for this unit is 18 MVAR (80 – 62 MVAR)

Reactive Reserve Checks

- RRCs will track 3 types of reactive reserves (*con't*)

2. Condensers/SVCs = Total lagging MVAR capability of all on-line SVC's and Condensers

- For Synchronous Condensers, this is the difference between the amount of MVARs currently being supplied to the system and the total maximum MVAR output of the condenser
- For SVCs this is the difference between how many MVARs the SVC is currently supplying to the system (or removing from it) and the total amount of MVARs the SVC can supply

Reactive Reserve Checks

2. Condensers/SVCs (*con't*)

- **Example 1** – A Condenser is online and providing 45 MVARs to the system. It's D-curve data shows that it is capable of providing 50 MVAR of Reactive capability to the system
 - The MVAR Reserve for this condenser is 5 MVAR. (50 – 45 MVAR)
- **Example 2** – A SVC is online and removing 12 MVARs from the system. The SVC is capable of providing from 30 MVAR of leading reserve to 130 MVAR of lagging reserve to the system
 - The MVAR Reserve for this SVC is 142 MVAR
 - 12 MVAR to go from 12 MVAR leading to neutral, then an additional 130 MVAR of lagging reserve

Reactive Reserve Checks

3. **Capacitor/Reactor** = Total MVAR values of all capacitors that can be energized or reactors that can be removed from service

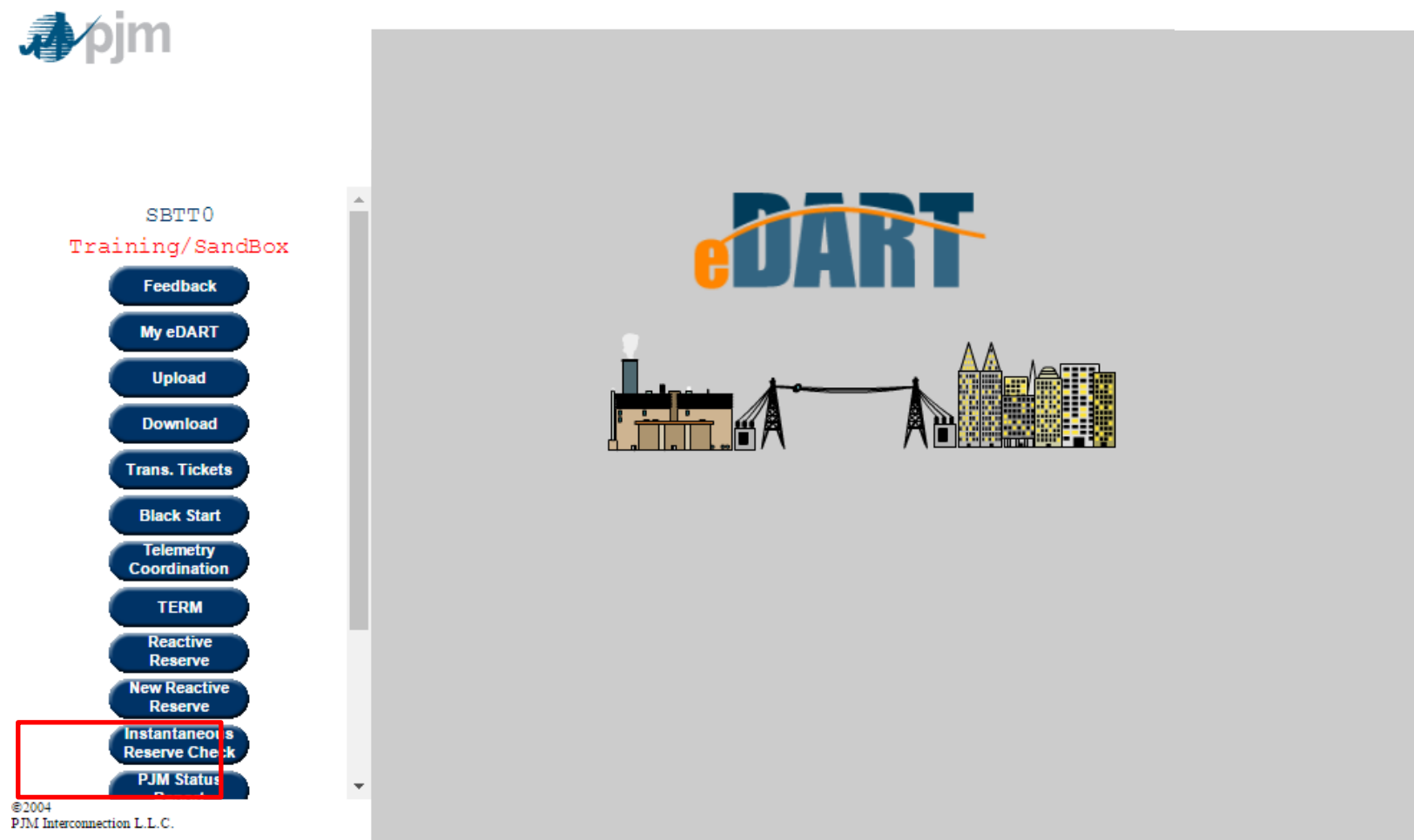
– **Example:** On your system you have the following devices:

Device	Currently in service?
135 MVAR Capacitor	Yes
65 MVAR Reactor	No
35 MVAR Capacitor	No
25 MVAR Reactor	Yes
45 MVAR Capacitor	No

- Your total reserves are 105 MVAR:
 - 25 MVAR Reactor that can be removed from service + 80 Capacitor reserve (35 + 45) that can be placed into service

Reactive Reserve Checks

The Transmission Owner then submits the RRC data via eDART



Reactive Reserve Checks

- PJM will compile the results from all TOs, then make a combined report available through eDART
- When there are discrepancies, PJM can make an individual report available to the TO to resolve

Peak MVAR Reserves Self-Check

Company:

User Name: student44

Request Timestamp: 01/09/2017 13:29

Data Updated: 12/02/2016 14:38

Peak (Current)

Valley

Company	Capacitors	Reactors	SVCs/Statcom	Units/Condensers
AE				
AEP				
APS				
BC				
COMED				
CPP				
DAYTON				
DEOK				
DOM				
DPL				
DUQU				
EKPC				
ENTRGY				
FE				
ITCI				
JC				
ME				
NAEA				
PE				
PEP				
PL				
PN				
PS				
RECO				
SMECO				
SOUTHQ				
UGI				
RTO Total				
Discrepancies Count	0	0	0	122

Capacitors

Reactors

SVCs/Statcom

Units/Condensers

SE Status: Both

Discrepancies Only: ☐

Apply Sort/Filter

Refresh

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Help

Color Legend

Reactive Reserve Checks

PJM Actions:

- PJM will request the RRC via the ALL-CALL
 - They'll also initiate the RRC within the eDART application for the entire PJM CA or on a Control Zone basis, as necessary
- PJM PD will take a snapshot of current PJM EMS reactive data
- Work with individual TOs to resolve any data discrepancies
 - Update PJM EMS if required, so that real-time conditions are modelled

Reactive Reserve Checks

Generation Owner Member Actions:

- Outside of an RRC:
 - Report Capability, Status and/or Availability of their reactive equipment per normal procedures/tools
 - Notify TO/PJM regarding unit reactive performance issues, and update eDART as appropriate
- During an RRC:
 - No action required, unless support directly requested by PJM/TO dispatcher

Reactive Reserve Checks

Transmission Owner Member Actions:

- Outside of an RRC:
 - Report Capability, Status and/or Availability of their dynamic/static reactive equipment per normal procedures/tools
 - Review eDART Reactive Capability Curves for units within the TO's zone, and update LCC EMS or reconcile deviations with PJM/GO as needed
 - Compare LCC EMS information on an equipment level basis to PJM EMS data via the New Reactive Reserve Check: RRC Self-Check form
- During an RRC:
 - TO enters required data in eDART via the eDART RRC Web form or via XML upload

Reactive Reserve Checks

RRC Exercise

PJM has just requested a Reactive Reserve Check. You have polled the Generators in your footprint and confirmed their reactive capability data as follows:

Generator	Max MVAR output	Current MVAR Output	MVAR Reserve
Billings	135	88	47
Southmont	94	94	0
Orwin	65	22	43

You have one SVC in your footprint, and no Synchronous Condensers.
The SVC is currently online with the following data:

MVAR output	Max Leading MVAR	Max Lagging MVAR	MVAR Reserve
-4 (leading)	35	70	74

Reactive Reserve Checks

RRC Exercise *(con't)*:

You also have the following static reactive devices on your system:

Device	Status	MVAR Capability	MVAR Reserve
Morgan Cap Bank 1	In Service	110	0
Danielson Reactor 1	In Service	35	35
Burrows Cap Bank 1	In Service	65	0
Burrows Cap Bank 2	Out of Service	60	60
Addams Cap Bank 1	Out of Service	55	0

Addams Cap Bank 1 is out of service for repairs which are scheduled to last all week.
PJM has a copy of the appropriate eDART request

Reactive Reserve Checks

RRC Exercise (con't):

RRC Company Data

Company: SBT Trans Comp 0

Request ID: 92Request Timestamp: 05/18/2016 13:11

User Name: studenttrans34Posted Timestamp:

CZ Name	Unit MVAR Reserve	Condensers/SVCs	Capacitor / Reactor
AEP	90	74	95
AP			
CE			
DAY			
DLCO			

Submit Form

Refresh

Main Menu

Unit MVAR Reserve - 47 (Billings) + 0 (Southmont) + 43 (Orwin) = 90 MVAR

Condenser/SVC Reserve - 4 MVAR (to go from Leading to Neutral) + 70 = 74 MVAR

Capacitor/Reactor Reserve – 35 (Danielson Reactor out) + 60 (Burrow Cap Bank 2 In) = 95 MVAR
(Addams Cap Bank is unavailable)

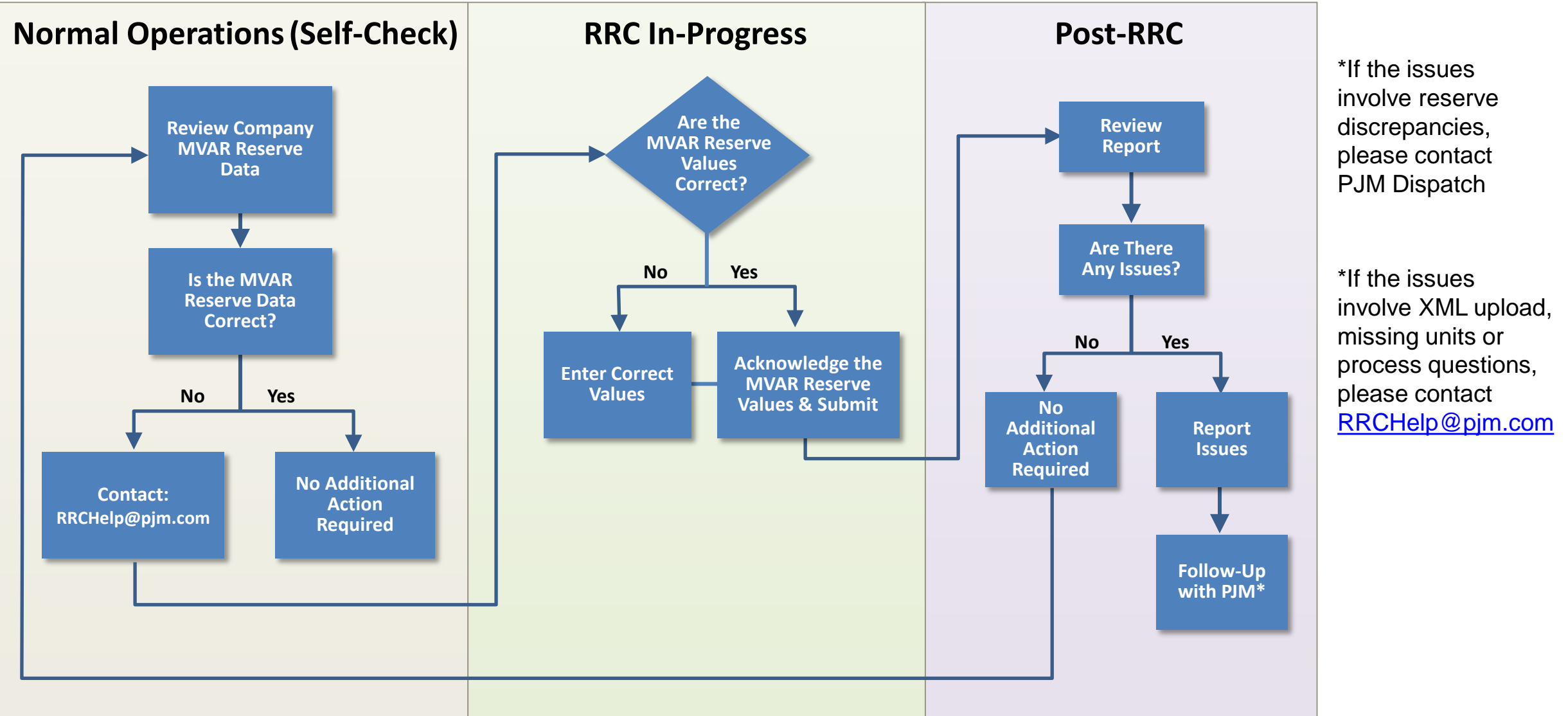
Reactive Reserve Checks – eDART September Enhancements

Reactive Reserve Check Enhancements (Coming in 2017):

**New Reactive
Reserve**

- Self-Check
 - Option to view Peak versus Valley report
 - Separate sections to view reserve values for Capacitors, Reactors, SVCs/Statcoms and Units/Condensers
 - New XML download for self-check report

RRC Flow Chart



What is the Same

Peak MVAR Reserves Self-Check

Company: RRC SELF-CHECK BASE INFO

Request Timestamp: 12/01/2016 12:57

User Name:

Data Updated: 11/08/2016 15:20

☒ Peak (Current)

☐ Valley

Zone	Capacitors	Reactors	SVCs/Statcom	Units/Condensers
	8069.60	403.22	300.00	2891.05
Company Total	8069.60	403.22	300.00	2891.05
Discrepancies Count	0	0	0	19

☒ Capacitors

☐ Reactors

☐ SVCs/Statcom

☐ Units/Condensers

SE Status: Both

Discrepancies Only: ☐

Apply Sort/Filter

Refresh

Main Menu

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Capacitors

1	2								
Company	Station/Equipment Name	KV	eDART Availability	SE Status	SE KV	SE MVAR	Rated MVAR	Lagging Reserve MVAR	
			Y	In-Service	34.99	3.60	3.60	0.00	
			Y	Offline	0.00	0.00	18.00	18.00	
			Y	Offline	0.00	0.00	18.00	18.00	

ZONE/COMPANY AGGREGATE

SORT/FILTER/INFO

EQUIPMENT DISCRETE DATA

What is Changing

Peak MVAR Reserves Self-Check

Company:

Request Timestamp: 12/01/2016 12:57

User Name: SUPER3

Data Updated: 11/08/2016 15:20

Peak (Current)

Valley

Zone	Capacitors	Reactors	SVCs/Statcom	Units/Condensers
<div></div>	8069.60	403.22	300.00	2891.05
Company Total	8069.60	403.22	300.00	2891.05
Discrepancies Count	0	0	0	19

Capacitors

Reactors

SVCs/Statcom

Units/Condensers

SE Status: Both

Discrepancies Only: ☐

Apply Sort/Filter

Refresh

Main Menu

Help

Color Legend

Capacitors

1	2	3							
Company	Station/Equipment Name	Zone	KV	eDART Availability	SE Status	SE KV	SE MVAR	Rated MVAR	Lagging Reserve MVAR

Peak MVAR Reserves Self-Check

Company:

Request Timestamp: 12/01/2016 12:58

User Name: SUPER3

Data Updated: 11/08/2016 15:20

Peak (Current)

Valley

Zone	Capacitors	Reactors	SVCs/Statcom	Units/Condensers
<div></div>	8069.60	403.22	300.00	2891.05
Company Total	8069.60	403.22	300.00	2891.05
Discrepancies Count	0	0	0	19

Capacitors

Reactors

SVCs/Statcom

Units/Condensers

SE Status: Both

Discrepancies Only: ☐

Apply Sort/Filter

Refresh

Main Menu

Help

Color Legend

Reactors

1	2	3							
Company	Station/Equipment Name	Zone	KV	eDART Availability	SE Status	SE KV	SE MVAR	Rated MVAR	Lagging Reserve MVAR

What is Changing

Peak MVAR Reserves Self-Check

Company:

Request Timestamp: 12/01/2016 12:59

User Name: SUPER3

Data Updated: 11/08/2016 15:20

Peak (Current)

Valley

Zone	Capacitors	Reactors	SVCs/Statcom	Units/Condensers
<div></div>	8069.60	403.22	300.00	2891.05
Company Total	8069.60	403.22	300.00	2891.05
Discrepancies Count	0	0	0	19

Capacitors

Reactors

SVCs/Statcom

Units/Condensers

SE Status: Both

SE Mode: Both

Discrepancies Only:

Apply Sort/Filter

Refresh

Main Menu

Help

Color Legend

SVCs/Statcom

1

2

3

Company

Station/Equipment Name

Zone

KV

eDART Availability

SE Status

SE Mode

SE MW

SE MVAR

Max MVAR

Lagging Reserve MVAR

Peak MVAR Reserves Self-Check

Company:

Request Timestamp: 12/01/2016 14:34

User Name: SUPER3

Data Updated: 11/08/2016 15:20

Peak (Current)

Valley

Zone	Capacitors	Reactors	SVCs/Statcom	Units/Condensers
<div></div>	8069.60	403.22	300.00	2891.05
Company Total	8069.60	403.22	300.00	2891.05
Discrepancies Count	0	0	0	19

Capacitors

Reactors

SVCs/Statcom

Units/Condensers

Unit Status: Both

AVR Status: Both

Discrepancies Only:

Apply Sort/Filter

Refresh

Main Menu

Help

Color Legend

Units/Condensers

1

2

3

Company

Station/Equipment Name

Zone

KV

eDART Availability

eDART AVR Auto

Unit Status

AVR Status

SE MW

SE MVAR

Max MVAR

Lagging Reserve MVAR

What is Changing

eDART ticket listed as Unavailable and SE MVAR is not 0

Condition:

- Whenever eDART identifies a facility as unavailable, but the PJM EMS SE MVAR output which would indicate that the facility is in-service

Mismatch between eDART AVR and EMS AVR

Conditions:

- Whenever an eDART AVR ticket exists, but the PJM EMS has the AVR in AUTO (automatic) mode.
- Whenever **no** eDART AVR ticket exists, but the PJM EMS has the AVR in Manual mode

Future or Retired Equipment

Conditions - whenever a facility is marked as:

- Retired in the eDART database
- Future in the eDART database.

Color Legend
eDART Unavailable and SE MVAR is not 0
Mismatch between eDART AVR and EMS AVR
Future or Retired Equipment
Regular
Close Window

Questions?

Agenda



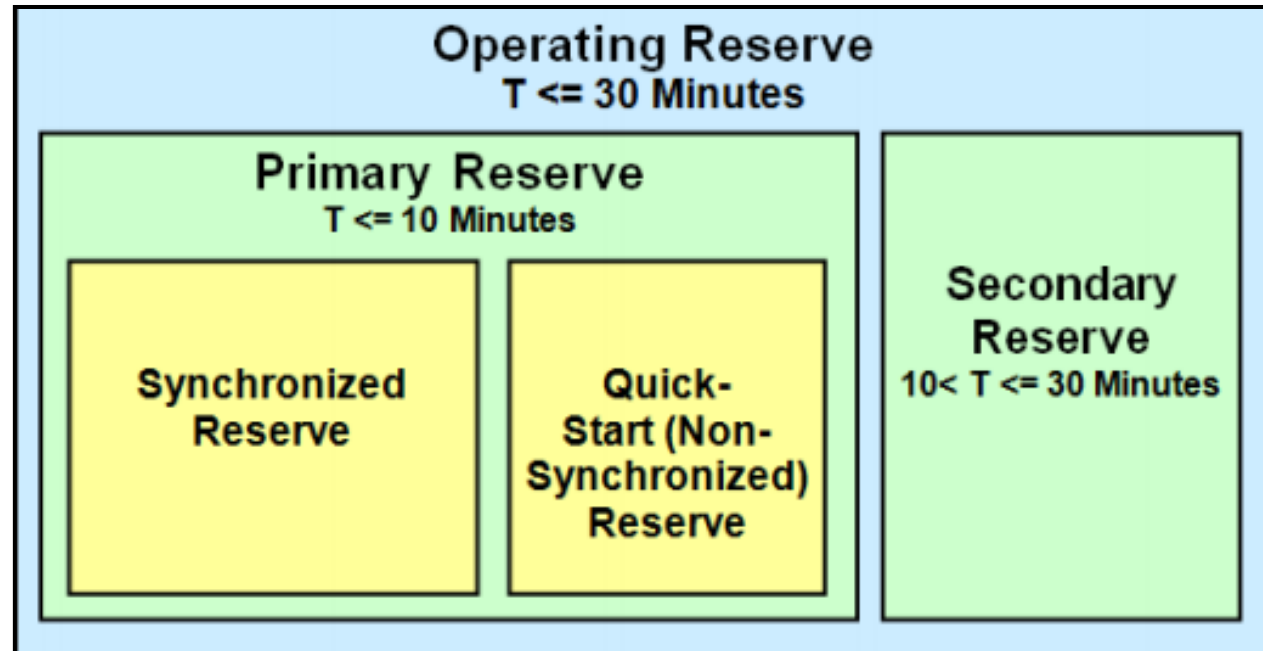
- Voltage Emergencies
 - Low Voltage Alert
 - Heavy Load Voltage Schedule
 - High System voltages
 - Reactive Reserve Checks (RRC's)
- **Capacity Emergencies**
 - Capacity Shortage Alerts
 - Capacity Shortage Warnings
 - Capacity Shortage Actions

Capacity Emergencies

A capacity emergency in PJM is defined as:

- Capacity deficiency condition (capacity shortage)
- Capacity excess condition (light load)

Capacity Emergencies



Area	Ancillary Service Market Area	Day-ahead Scheduling (Operating)	Contingency (Primary)	Synchronized Reserve
RTO	RTO	Annual %	150% Largest Single Contingency	Largest Single Contingency
	Mid-Atlantic & Dominion	N/A	150% of the Largest Single Contingency ¹	Largest Single Contingency ¹
SERC	Dominion	VACAR ARS%	VACAR ARS%	VACAR ARS%

Alerts

Capacity Shortage Alerts

- Alerts are issued in advance (Day-Ahead) of a scheduled load period
 - Allows sufficient time to prepare for anticipated capacity shortages
- The intent of the alert is to keep all affected system personnel aware of the forecast and/or actual status of the PJM RTO
- Four capacity shortage alerts:
 - Unit Startup Notification Alert
 - Maximum Generation Emergency Alert
 - Primary Reserve Alert
 - Voltage Reduction Alert

Capacity Shortages – Alerts



Unit Startup Notification Alert

- Purpose
 - To alert members to place generating units in a state of readiness so that they can be brought online within 48 hours in anticipation of a shortage of operating capacity, stability issues or constrained operations
- Trigger
 - When a reliability assessment determines that long lead time generation is needed for a future period

Capacity Shortages – Unit Startup Notification Alert

PJM Actions:

- Notifications to PJM management and member companies
- Schedule an amount of long lead time generation anticipated to be needed for the operating day(s)
 - In economic order
 - Respecting operating parameters
 - Can be issued for the RTO, specific control zone(s) or individual units
- Alerted units must be in a “State of Readiness” in the lesser of;
 - Submitted notification time + startup time – 48 hours

OR

 - 6 days – 48 hours
 - “State of readiness “ = able to be online within 48 hours
- Evaluate conditions daily to determine when to release units from the state of readiness, or call the units to come online

Capacity Shortages – Unit Startup Notification Alert

**$t \leq -6$ Days Unit
Startup
Notification
Alert Issued**

**$t \leq -5$
Days**

**$t \leq -4$
Days**

**$t \leq -3$
Days**

**$t \leq -2$ Days Unit
is in the “state of
readiness” and
may be called to
come online
 ≤ 48 hours**

**$t \leq -24$
Hours**

**$t = 0$ Earliest
unit is expected
to be online if
called on**

Capacity Shortages – Unit Startup Notification Alert

Member Actions:

- Report Unit capabilities correctly
 - Markets Gateway “time to start” maximum is 6 days
- After reaching a “state of readiness”, if the unit fails to come online with 48 hours after being called by PJM, the unit will be considered on a forced outage until it comes online, or PJM cancels the alert
- Once a unit is scheduled, its offer price is locked for the operating day

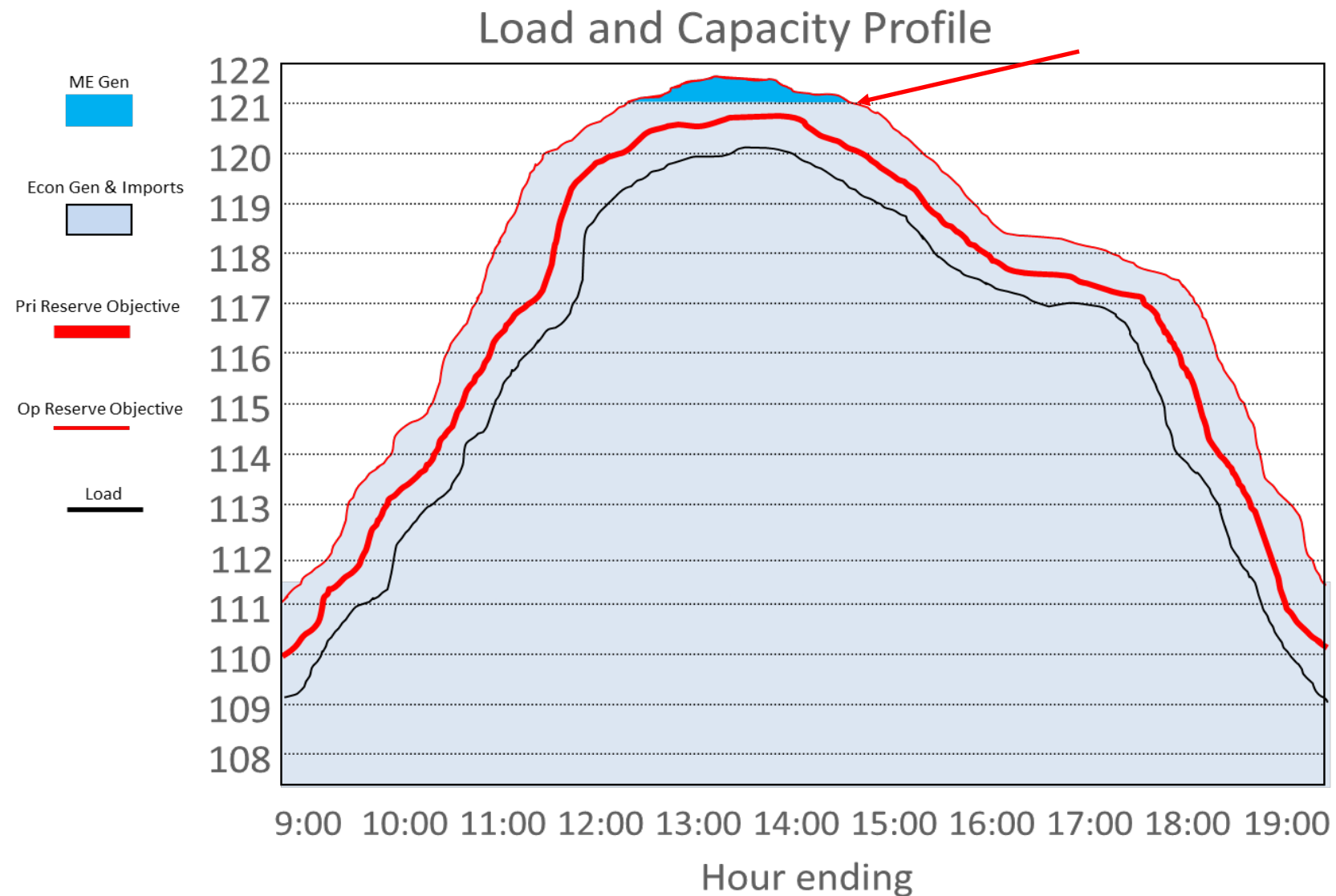
Capacity Shortages – Alerts



Maximum Generation Emergency /Load Management Alert

- **Purpose:** To provide an early alert that system conditions may require the use of the PJM Emergency Procedures
- **Trigger:** When Maximum Generation Emergency is called into the operating capacity, or if Demand Response is projected to be implemented
 - Operating Reserve Requirement is greater than scheduled Operating Reserve
 - Should be issued 1 or more days prior to the operating day in question

Estimated Operating Reserve Less than Operating Reserve Objective



Capacity Shortages – Alerts

Maximum Generation Emergency/Load Management Alert

PJM Actions:

- Notifications to PJM management and member companies
 - States the amount of estimated operating reserve and the requirement
 - Issue NERC Energy Emergency Alert Level 1
- Performs a situation analysis and prepares projections for that day and future periods
 - Capacity
 - Load
 - Interchange
 - Reserve

Capacity Shortages – Alerts

Maximum Generation Emergency/Load Management Alert

PJM Actions:

- Reports any significant changes in the estimated operating reserve capacity
- Sets up Supplementary Status Report if required
 - May elect not to request until operating day for which alert is in effect
- Review the level of dependency on External Transactions to serve PJM load and to determine if the need to implement Capacity Benefit Margin is required

Capacity Shortages – Alerts

Maximum Generation Emergency/Load Management Alert

Member Actions:

- Notifications
 - Management, all stations, key personnel
- Review plans to determine if any maintenance or testing of equipment, scheduled or being performed, on any monitoring, control, transmission, or generating equipment can be deferred or cancelled
 - Suspend any high risk testing of generating or transmission equipment
- Report any and all fuel/environmental limited facilities as they occur

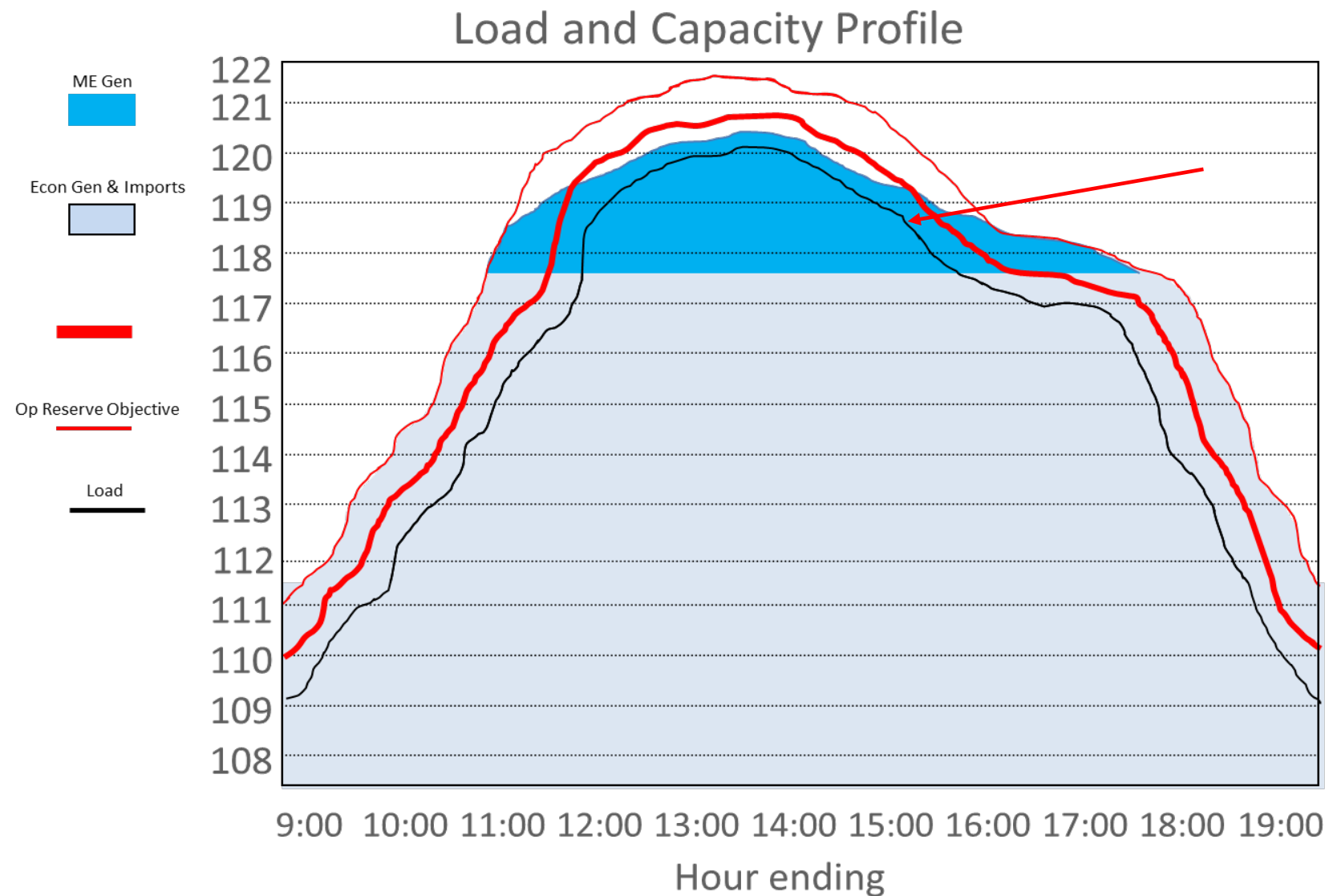
Capacity Shortages – Alerts



Primary Reserve Alert

- Purpose: To alert member of the anticipated shortage of operating reserve capacity for a future critical period
- Trigger: When the estimated operating reserve is less than the forecasted primary reserve requirement

Estimated Operating Reserve Less than Primary Reserve Requirement



Capacity Shortages – Primary Reserve Alert

PJM Actions:

- Notifications to PJM management and member companies
 - States the amount of estimated operating reserve capacity and the requirement
- Reports significant changes in estimated operating reserve capacity

Capacity Shortages – Primary Reserve Alert

Member Actions:

- Notifications
 - Management, all stations, key personnel
- Review plans to determine if any maintenance or testing, scheduled or being performed, on any generating equipment or critical monitoring, control, or bulk power transmission facility can be deferred or cancelled
- Inform PJM of any environmentally restricted units considering the need to obtain a temporary variance from environmental regulators for specific generators to assist in preventing load shed

Capacity Shortages – Alerts



Voltage Reduction Alert

- Purpose: To alert members that a voltage reduction action may be required in a future critical period
- Trigger: When the estimated operating reserve capacity is less than the forecasted synchronized reserve requirement

Capacity Shortages – Voltage Reduction Alert

PJM Actions:

- Notifications to PJM management and member companies
 - Stating the amount of estimated operating reserve capacity and the requirement
 - Advise members that a possibility exists that a voltage reduction will be issued and the estimated hour of implementation

Capacity Shortages – Voltage Reduction Alert

Member Actions:

- Notifications
 - Management, all stations, key personnel
- Take any necessary steps to expedite implementation of voltage reduction, should one become necessary (Transmission Owner Dispatch/LSEs)
- SOS members/PJM Management consider the issuing of Public Appeals
- PJM marketers proceed on heightened awareness regarding potential need for Emergency Energy purchases

Warnings

Capacity Shortages – Warnings

- There are 3 Capacity Emergency Warnings:
 1. Primary Reserve Warning
 2. Voltage Reduction Warning & Reduction of Non-Critical Plant Load
 3. Manual Load Dump Warning

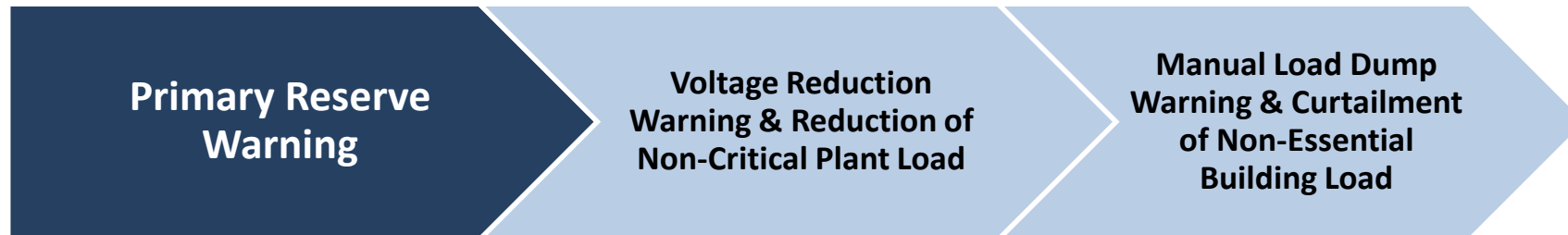
Capacity Shortages – Warnings

- During periods of reserve deficiencies, other measures must be taken to maintain system reliability including:
 - Loading generation that is restricted for reasons other than cost
 - Recalling non-capacity backed off-system sales
 - Purchasing emergency energy from participants / surrounding pools
 - Load relief measures
- Due to system conditions and the time required to obtain results, PJM dispatchers may find it necessary to vary the order of application to achieve the best overall system reliability

Capacity Shortages – Warnings

- Actions taken prior to entering into capacity related Emergency Procedures:
 - Review weather projections, load forecasts, reserve projections and generation performance
 - Ensure LMPs are reflective of system conditions
 - Curtail all non-Firm exports
 - Dispatch may elect to implement an interchange cap to stabilize the amount of interchange during peak hours to protect against volatility

Capacity Shortages – Warnings



Primary Reserve Warning

- Purpose: Warns members that the available primary reserve is less than the required primary reserve and present operations are becoming critical
- Trigger: Issued when the Primary Reserve is less than the Primary Reserve requirement but greater than the Synchronized Reserve requirement

Capacity Shortages – Primary Reserve Warning

PJM Actions:

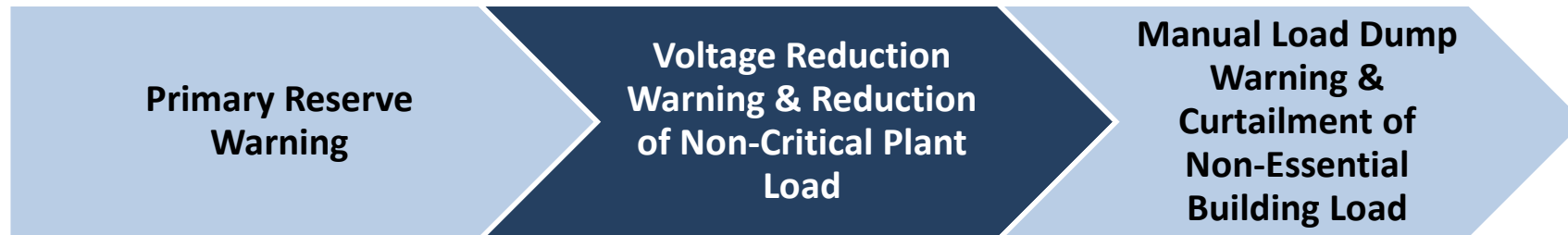
- Issues a warning to members and PJM management stating the amount of adjusted primary reserve capacity and the requirement
- Notifies PJM public information personnel
- Assure that all available equipment is scheduled and requested secondary reserve has been brought to primary reserve status
- Ensures all deferrable maintenance or testing on the communications and control systems has halted (Could occur prior to Primary Reserve Warning)

Capacity Shortages – Primary Reserve Warning

PJM Member Actions:

- Notify management, all stations, and key personnel
- Prepare to load primary reserve, if required
- Ensure all deferrable maintenance or testing affecting capacity or critical transmission is halted
- Generation Dispatchers are to inform PJM of any environmentally restricted units and may consider the need to obtain a temporary variance from environmental regulators for specific generators to assist in preventing load shed
- PJM Marketers remain on a heightened awareness regarding PJM conditions and the potential need for Emergency Energy Purchases

Capacity Shortages – Warnings



Voltage Reduction Warning/Reduction of Non-Critical Plant load

- Purpose: To inform the Member Companies that the available Synchronized Reserve is less than required and present operations may require a voltage reduction
- Trigger: When actual Synchronized Reserve is less than the Synchronized Reserve Requirement
 - All secondary and primary reserve (except restricted Max Emergency capacity) is brought to a Synchronized Reserve status and emergency operating capacity is scheduled from adjacent systems

Capacity Shortages – Voltage Reduction Warning/ Reduction of Non-Critical Plant load

PJM Actions:

- Issues the warning to members and PJM management stating the amount of adjusted synchronized reserve capacity and the requirement
- Notification to the PJM public information personnel
- Notification to the Department of Energy

Capacity Shortages – Voltage Reduction Warning/ Reduction of Non-Critical Plant load

PJM Member Actions:

- Notification to member company management, all stations, and key personnel
- Notification to government agencies
- Order all generating stations to curtail non-essential station light and power
- Prepare for implementation of a Voltage Reduction Action (TO's/LSE's)
- Be aware of the potential to implement load management programs
- PJM marketers remain on a heightened awareness of the potential need for Emergency Energy Purchases

Non-Critical Plant Load

What is Non-Critical Plant Load?

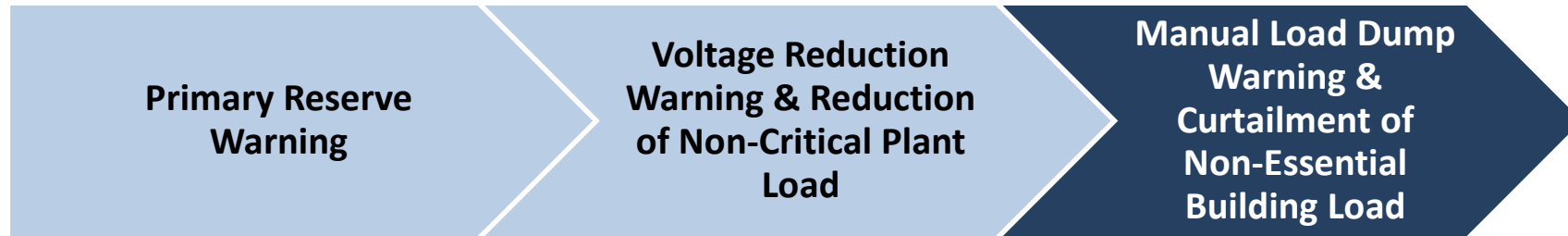
- Non-Critical Plant Load is load that is not required to operate the generator and its essential equipment (lighting, office air conditioning, heating, etc.)
- Non-Critical Plant Load is considered anything that is not needed to produce MWs and MVARs on the system

Non-Critical Plant Load

Examples

<i>Non-Critical Plant Load</i>	<i>Critical Plant Load</i>
Lighting	Feed Water Heaters
Heating	Feed Water Pumps
Air Conditioner	Induction Fans

Capacity Shortages – Warnings



Curtailment of Non-Essential Building Load

- Purpose: Provide additional relief, to be expedited prior to, or at the same time as the Voltage Reduction Action

Capacity Shortages – Curtailment of Non-Essential Building Load

PJM Actions:

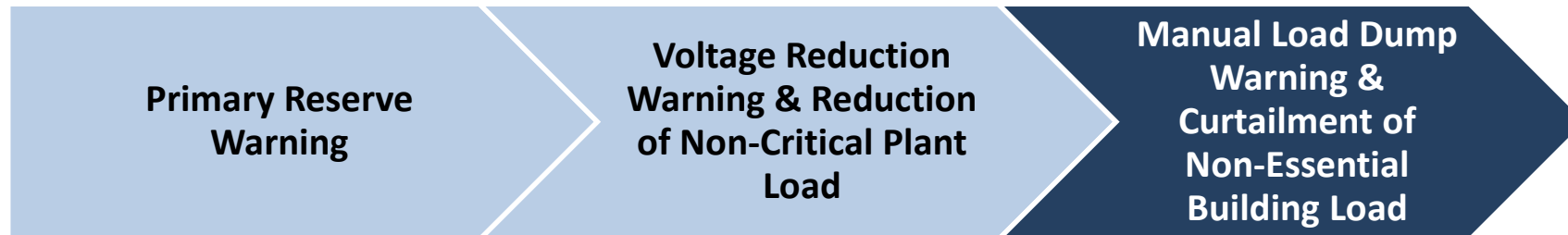
- Notification to PJM Management, PJM public information personnel, and member companies
- Advise members to utilize public appeals to conserve energy
- Issue the request to curtail non-essential building load
- Notify outside systems through the RCIS

Capacity Shortages – Curtailment of Non-Essential Building Load

Member Actions:

- Notification to member company management
- Notification of government agencies (TO's)
- Consider the use of public appeals to conserve energy
- Switch off all non-essential light and power in company-owned commercial, operations, and administration offices (Transmission and Generation)

Capacity Shortages – Warnings



Manual Load Dump Warning

- Purpose: Warn Member Companies of increasingly critical system conditions that may require manually dumping load
- Trigger: When the Primary Reserve is less than the largest operating generating unit, or the loss of a transmission facility jeopardizes reliability after all possible measures have been taken to increase reserves

Capacity Shortages – Manual Load Dump Warning

PJM Actions:

- Issue the warning to members and PJM Management, stating the estimated amount of load relief needed
- Notification to PJM public information personnel
- Notification to include the FERC Division of Reliability
- Establish an awareness with the appropriate Transmission Operators of the need for action with minimum delay
- Examine EHV bus voltages

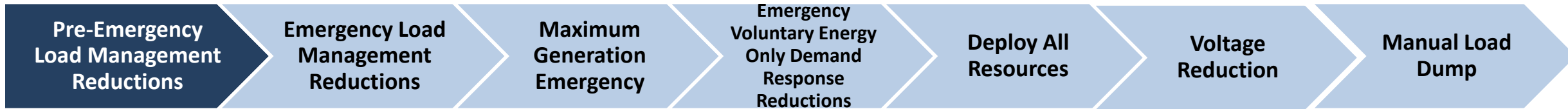
Capacity Shortages – Manual Load Dump Warning

PJM Member Actions:

- Notification to member management
- Notification to government agencies
- Advise all station and key personnel
- Review local procedures and prepare to dump load in the amount requested
- Reinforce internal communications so that load dumping can occur with a minimum delay
- Marketers remain on a heightened awareness of the potential need for Emergency Energy Purchases

Actions

Capacity Shortages – Actions



Pre-Emergency Load Management Reductions

- Purpose: To provide additional load relief by using PJM controllable load management programs (Relief is expected to be required after initiating Maximum Emergency Generation)

Capacity Shortages – Actions

Pre-Emergency Load Management Reductions

- Applies to any site registered in the PJM Demand Response Program as a Demand Resource (a.k.a. DR) type that needs 30, 60 or 120 minute lead time to make its reductions
- These reductions are mandatory when dispatched during the product availability window
- The minimum dispatch duration is 1 hour

Capacity Shortages – Actions

Pre-Emergency Load Management Reductions

PJM Actions:

- Notifications to PJM management, public information personnel, and member companies
- Advises Members to use public appeals for conserving electricity usage
- PJM dispatch notifies other Control Areas through the RCIS system
- Via eLRS System and Emergency Procedures website, PJM will post detailed instructions to the Curtailment Service Providers (CSP) to implement
 - Dispatch 30, 60, and/or 120 minute Pre-Emergency Load Management Reductions (Long Lead Time)
- Via the RCIS, PJM issues a NERC Energy Emergency Alert Level 2

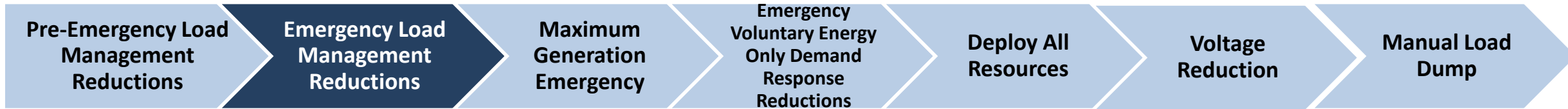
Capacity Shortages – Actions

Pre-Emergency Load Management Reductions

Member Actions:

- Member Curtailment Service Providers implement load reductions as requested by PJM

Capacity Shortages – Actions



Emergency Load Management Reductions

- Purpose: To provide additional load relief by using PJM controllable load management programs (Load relief is expected to be required after initiating Maximum Emergency Generation)

Capacity Shortages – Actions

Emergency Load Management Reductions

- Applies to any site registered in the PJM Demand Response Program as a Demand Resource (DR) type that needs 30, 60 or 120 minute lead time to make its reductions
- These reductions are mandatory when dispatched during the product availability window
- The minimum dispatch duration is 1 hour

Capacity Shortages – Actions

Emergency Load Management Reductions

PJM Actions:

- Notifications to PJM management, public information personnel, and member companies
- Advises Members to use public appeals for conserving electricity usage
- PJM dispatch notifies other Control Areas through the RCIS system
- Via eLRS System and Emergency Procedures website, PJM will post detailed instructions to the Curtailment Service Providers (CSP) to implement dispatch 30, 60 or 120 minute Emergency Load Management Reductions
- Via the RCIS, PJM issues a NERC Energy Emergency Alert Level 2

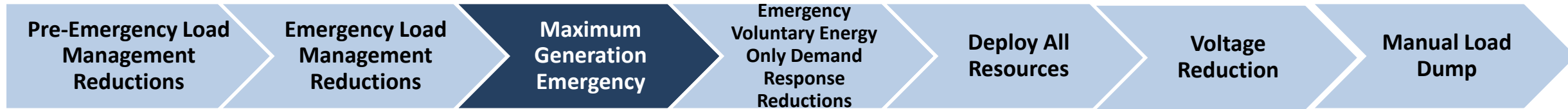
Capacity Shortages – Actions

Emergency Load Management Reductions

Member Actions:

- Member Curtailment Service Providers implement load reductions as requested by PJM
- Member dispatchers notify management of the emergency procedure and that they should consider the use of public appeals to conserve electricity usage
- Member dispatchers notify governmental agencies, as applicable

Capacity Shortages – Actions

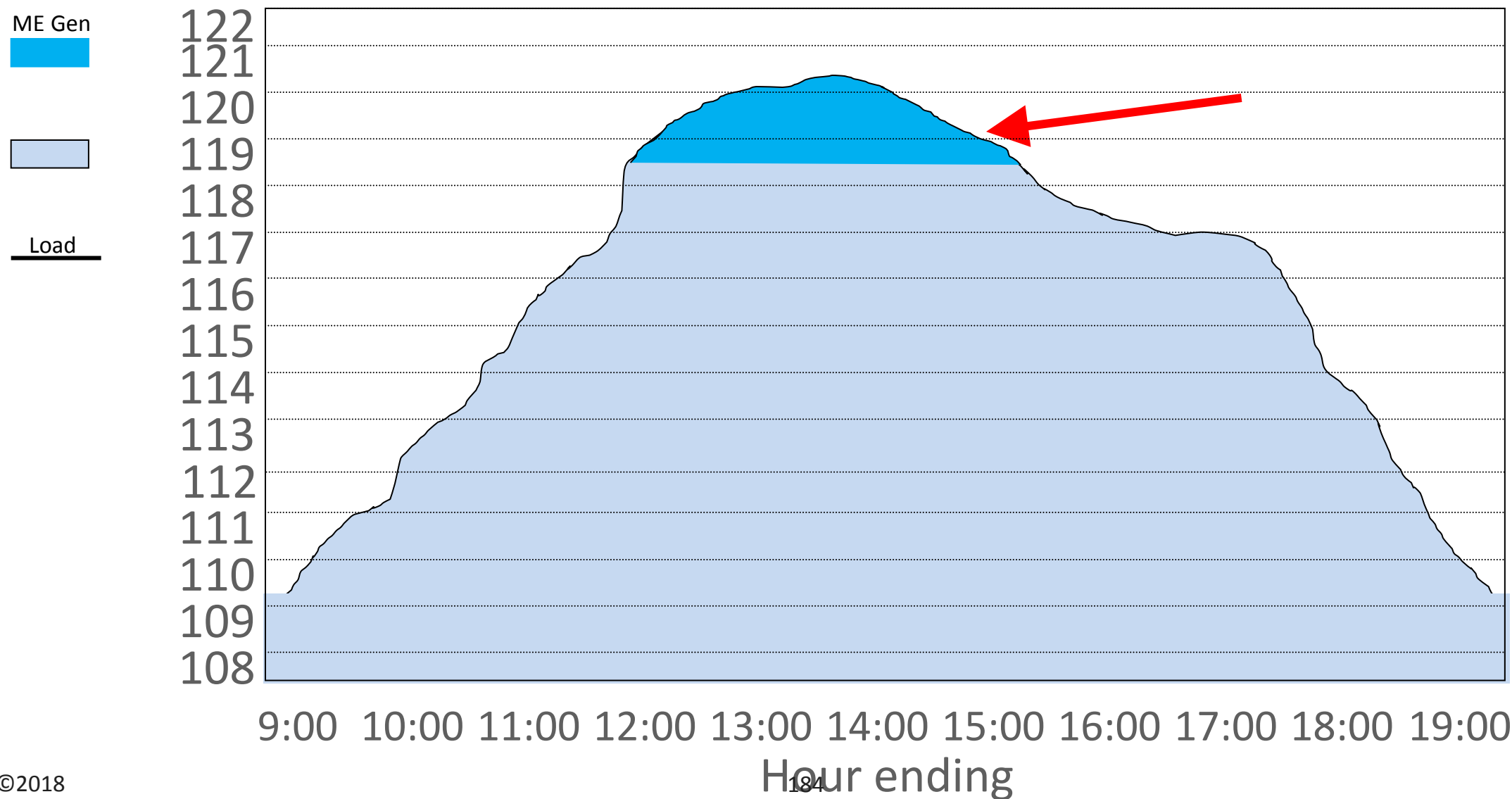


Maximum Generation Emergency

- Purpose: To increase generation above the maximum economic level
- Trigger: Real-time Generation is needed to meet the load demand that is greater than the highest incremental cost level

Load Exceeds Maximum Economic Generation Levels

Load and Capacity Profile



Capacity Shortages – Actions

Maximum Generation Emergency

PJM Actions:

- Issue the Maximum Emergency Generation Action
- Notify PJM management, PJM public information personnel, and member dispatchers
- Implements the Emergency Bid Process, requesting bids by posting messages to selected PJM web-sites, RCIS, and contacting neighboring Control Areas
- Suspend regulation on all resources except for hydroelectric

Capacity Shortages – Actions

Maximum Generation Emergency

PJM Actions:

- Recalls off-system capacity sales from network resources, PJM dispatch will:
 - Determine any limiting transmission constraints internal to PJM that would impact the ability to cut transactions to a specific interface
 - Identify off-system capacity sales associated with the identified interfaces
 - Contact the sink Balancing Authority to determine the impact of transaction curtailment

Capacity Shortages – Actions

Maximum Generation Emergency

PJM Actions:

- Recalls off-system capacity sales from network resources, if the net result of cutting off-system capacity sales would:
 - Put the sink Balancing Authority into load shed then PJM will not curtail the transactions unless it would prevent load shedding within PJM
 - Put PJM in a more severe capacity emergency than it is in currently in
 - Due to reciprocal transaction curtailments from the sink Balancing Authority
 - PJM will not initiate curtailing the transactions

Capacity Shortages – Actions

Maximum Generation Emergency

PJM Actions:

- Declare Maximum Emergency Generation and begins to load Maximum Emergency or start purchases of Emergency Energy bids, based on economics and availability
 - The PJM Member is responsible for delivering (i.e., securing all transmission service) of the energy to one of PJM's borders with a neighboring control area
- Loads Maximum Emergency Generation incrementally as required
- Max Emergency CT's are loaded prior to Max Emergency Steam in order to preserve synchronized reserve

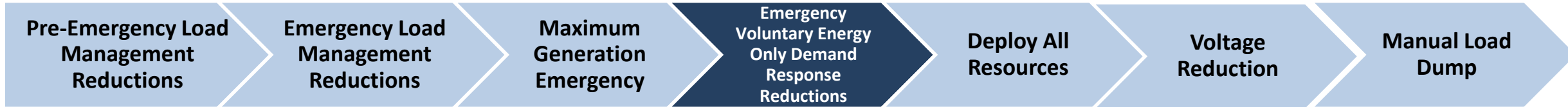
Capacity Shortages – Actions

Maximum Generation Emergency

Member Actions:

- Notify member company management
- Recall off-system capacity sales that are recallable
- Suspend regulation, as requested, and load all units to the Maximum Emergency Generation level, as assigned
- Notify PJM of any Maximum Emergency Generation that was loaded prior to PJM requesting Maximum Emergency Generation be loaded

Capacity Shortages – Actions



Emergency Voluntary Energy Only Demand Response Reductions

- Purpose: Request end-use customers who participate in the Emergency Voluntary Energy Only Demand Response program to reduce load during emergency conditions
- Trigger: Additional load relief is still needed

Capacity Shortages – Actions

Emergency Voluntary Energy Only Demand Response Reductions

- Program criteria:
 - Any site registered in the PJM Demand Response Program as an emergency energy only resource
 - Reductions are strictly **voluntary**

Capacity Shortages – Actions

Emergency Voluntary Energy Only Demand Response Reductions

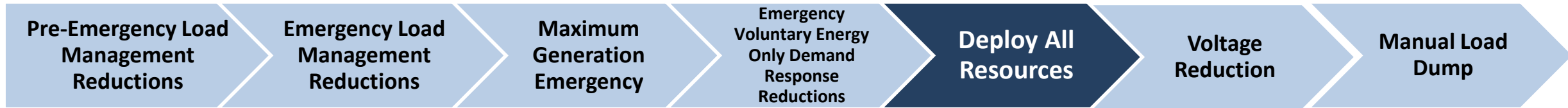
PJM Actions:

- Issues action via the ALL-CALL and posts message on website
- Notifies PJM management, PJM public information personnel, and PJM Markets personnel
- Have Curtailment Service Providers with Demand Resources reduce load

PJM Member Actions:

- Notify management of the emergency procedure

Capacity Shortages – Actions

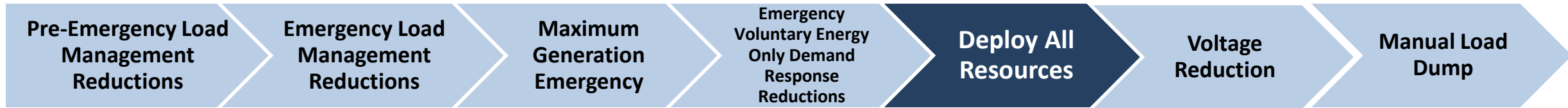


Deploy All Resources

Purpose:

- To instruct members that all generation resources are needed online and at full output, and
- All demand resources are to be reduced immediately upon receipt of dispatch instruction

Capacity Shortages – Actions



Deploy All Resources

Trigger: When unplanned events such as the loss of a transmission or generating facility have resulted in reliable operations being jeopardized

Capacity Shortages – Actions

Deploy All Resources

PJM Actions:

- Suspend all reserve assignments and regulation assignments
- Dispatch Load Management via eLRS
- Recall any external capacity
- Issue a NERC Energy Emergency Alert Level 2 via the RCIS
- Notify PJM Management, PJM public information personnel, and Member Companies

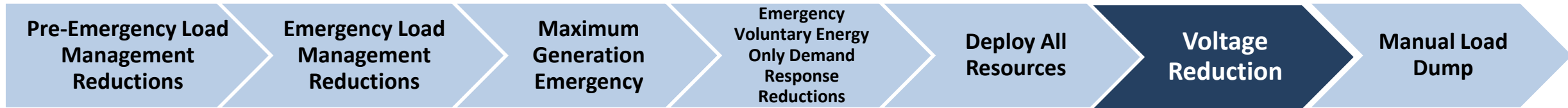
Capacity Shortages – Actions

Deploy All Resources

PJM Member Actions:

- Unless instructed otherwise by PJM Dispatch
 - Raise all available on-line generation to full output (Emergency Maximum)
 - Start up all off-line generation and ramp to full output (Emergency Maximum)
- Member Curtailment Service Providers with Load Management (Pre-Emergency and/or Emergency) reduce load immediately when dispatched
- Notify management of the emergency procedure and consider the use of public appeals for the conservation of energy
- Notification of government agencies

Capacity Shortages – Actions



Voltage Reduction

- Purpose:
 - To reduce voltage on the distribution system in order to reduce demand
 - Provide a sufficient amount of reserve to maintain tie flow schedules and preserve limited energy sources
- Trigger:
 - Load relief still needed to maintain ties

Capacity Shortages – Actions

Voltage Reduction

- Voltage is reduced at distribution levels by 2.5% to 5% of nominal values depending on the area
- Produces a 2-3% decrease in system load increasing transmission voltages
- Generally not noticed by customers
 - Lights dimmer, slower heating

Capacity Shortages – Actions

Voltage Reduction

PJM Actions:

- Notification to PJM Management, PJM public information personnel, and member companies
- Advise members to use public appeals for conservation of energy
- Notification to the Department of Energy
- Investigates loading of shared reserves with neighboring systems prior to a voltage reduction action
- PJM dispatch issues a NERC Energy Emergency Alert Level 2

Capacity Shortages – Actions

Voltage Reduction

PJM Actions:

- Issues the order for a 2.5% to 5% voltage reduction
- Initiates Shortage Pricing if the region where the voltage reduction action has been initiated corresponds with an entire Synchronized Reserve Zone or Sub-Zone

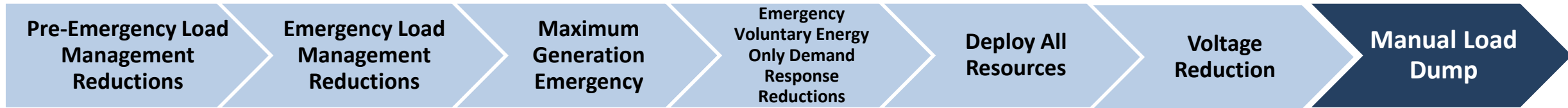
Capacity Shortages – Actions

Voltage Reduction

PJM Member Actions:

- Notification of member company management
- Notification of government agencies
- Consider the use of public appeals to conserve energy
- Take steps to implement a voltage reduction (TO's/LSE's)
- Unless PJM requests a manual adjustment, the Generator must maintain the facility's automatic voltage regulator(s) in service during an Emergency

Capacity Shortages – Actions



Manual Load Dump

- The Manual Load Dump Action is an Operating Instruction from PJM
 - To shed firm load When the PJM RTO cannot provide adequate capacity
 - Meet the PJM RTO's load and tie schedules, or
 - Critically overloaded transmission lines or equipment cannot be relieved in any other way

Capacity Shortages – Actions

Manual Load Dump

PJM Actions:

- Verify that separations have not occurred and that load dumping is desirable on the system being controlled
- Instruct members to suspend all remaining regulation
- Determine which Control Zone(s) are capacity deficient and the relative proportion of deficiency
- Estimate the total amount of load to be dumped and order appropriate members to dump load according to EMS calculations
- Notification to PJM Management, PJM public information personnel, and member companies

Capacity Shortages – Actions

Manual Load Dump

PJM Actions:

- Advise members to consider the use of public appeals to conserve energy
- Notification to other Control Areas through the RCIS
- Notifications to DOE, FEMA, and NERC offices
- Notification to FERC via the FERC Division of Reliability's electronic pager system
- Issue a NERC Energy Emergency Alert Level 3

Capacity Shortages – Actions

Manual Load Dump

PJM Actions:

- Initiates Shortage Pricing if the region where the manual load dump action has been initiated corresponds with an entire Synchronized Reserve Zone or Sub-Zone

Note:

- If a partial restoration of the load dumped is requested by PJM, confirmation of restored load by each member must be made prior to any further load restoration
- If UFLS is insufficient to return frequency to acceptable ranges, PJM will dump sufficient load to restore system frequency

Capacity Shortages – Actions

Manual Load Dump

Member Actions:

- Suspend regulation, as required, prior to load dump
- Notification member company management of the procedure
- Notification of government agencies
- Consider the use of public appeals to conserve energy
- Promptly dump load equal to or in excess of the company's allotment of load dump
- Maintain the requested amount of load relief until the load dump order is cancelled by PJM
- Load dump plan should consider/recognize priority/critical load
- Report amount of load curtailed/restored upon implementation

Capacity Shortages – Actions

Manual Load Dump

- Process described here pertains only to capacity deficient situations
 - For transmission constraints or voltage problems, load dump will be ordered in areas where it is most effective
- If Mid-Atlantic region is deemed deficient, total load shed must be further broken down by Manual Load Dump Allocation Tables
 - Manual M-13, Attachment E
- Manual Load Dump last utilized in PJM on January 19, 1994

Manual 13 – Attachment E

Attachment E: Manual Load Dump Allocation Tables

Winter/Summer Required Manual Load Dump PJM Mid-Atlantic Region																
MW	PS	PE	PPL Zone		BC	GPU	PEPCO ZONE		AE		DPL Zone					Rockland
			PPL	UGI			PEPCO	SMECO	AECO	Vineland	DPL	ODEC	DEMEC	Dover	Easton	
%	17.54%	14.47%	12.02%	0.32%	11.98%	20.22%	9.89%	1.40%	4.25%	0.26%	4.97%	1.18%	0.42%	0.26%	0.11%	0.70%
500	88	72	60	2	60	101	49	7	21	1	25	6	2	1	1	3
1000	175	145	120	3	120	202	99	14	42	3	50	12	4	3	1	7
1500	263	217	180	5	180	303	148	21	64	4	75	18	6	4	2	10
2000	351	289	240	6	240	404	198	28	85	5	99	24	8	5	2	14
3000	526	434	361	10	360	607	297	42	127	8	149	36	13	8	3	21
4000	702	579	481	13	479	809	396	56	170	10	199	47	17	10	4	28
5000	877	724	601	16	599	1011	495	70	212	13	249	59	21	13	5	35

Manual Load Dump Allocation - PJM Mid-Atlantic Region

When issuing a manual Load Dump via All Call, the PJM Dispatcher will include the following information in the message:

- ✓ (1) Area (PJM Mid-Atlantic Region or a zone / company)
- ✓ (2) Total megawatts (refer to appropriate tables for allocation)
- ✓ (3) Allocation table to be used
- ✓ (4) Transmission Zone allocations will be handled separately based on PJM EMS capacity calculations

Allocation percentages are based on 2016 summer but applicable to both 2016 summer and 2016/2017 Winter Load conditions

Exhibit 9: Manual Load Dump Allocation Tables

PJM Manual Load Dump Capability by company is located in [Manual 13: Attachment F](#)

Supplementary Status Report (SSR)

Supplementary Status Report

- The objective of the SSR is to get a real-time “snapshot” of the generating capacity and any fuel and/or resource limitations within the PJM RTO
- Each PJM Member is obligated to provide information for all requested sections that apply to them
- SSR information is used by PJM to perform analysis and prepare a capacity/load/reserve projection whenever the potential exists for an emergency on the PJM bulk power system

Supplementary Status Report

- Supplementary Status Report information is reported using eDART
 - **Generation Owners** supply Instantaneous Capacity and fuel and/or resource Limitations (fuel shortages, emissions restrictions, etc.) and Capacities
- Summary SSR Report with results from all companies is made available on eDART

Manual Reference, M-13
Emergency Operations
Attachment C

Supplementary Status Report

- Unit Capacity Numbers are reported by **Generation Owners**
- This “snapshot” of system capacity helps the PJM Generation Dispatcher get a true picture of the resources still available to him/her
- Only the actual capacity that is available at the specified time of the SSR should be reported. This includes;
 - Capacity from online generation
 - Hydro and CT/Diesel generating units that can be started and synchronized within ten minutes of the time the SSR was requested

Supplementary Status Report

- Generation is summarized in 4 categories:
 - Nuclear
 - Fossil
 - Hydro
 - CT/Diesel
- The remaining capacity is then sub-divided into 2 categories:
 1. On-Cost – the capacity which can be loaded on economics alone (Up to the Economic Max of the Unit)
 2. Max Emergency – any capacity which can be loaded above the Economic Max of the Unit (Emergency Maximum– Economic Maximum)

Supplementary Status Report

- Resource Limited Units
 - A unit is considered to be “resource limited” if it has less than 72 hours of running time at rated capacity because of fuel or other resource limitations
 - A unit that is resource limited should be reported as normal on the SSR, but has additional reporting requirements

Supplementary Status Report

- If PJM is currently in a Hot or Cold Weather Alert, additional restrictions apply. The following units are also considered resource limited, and ***must*** be bid in as “Max Emergency”
 - Steam units with less than **32** hours of fuel
 - Oil, Kerosene or Diesel CTs with less than **16** hours of fuel
 - Gas fired CTs with less than **8** hours of fuel
- If any unit reaches this status, the PJM Master Coordinator should also be informed via phone call

Supplementary Status Report

- Black start unit owners shall not allow their fuel inventory for critical black start CTs to drop below 10 hours at rated capacity
 - If fuel levels drop below 10 hours, notify PJM and place the unit in the “Max Emergency” category
- All resource limitations must be documented in eDART on the SSR

Capacity Excess Conditions

Objectives



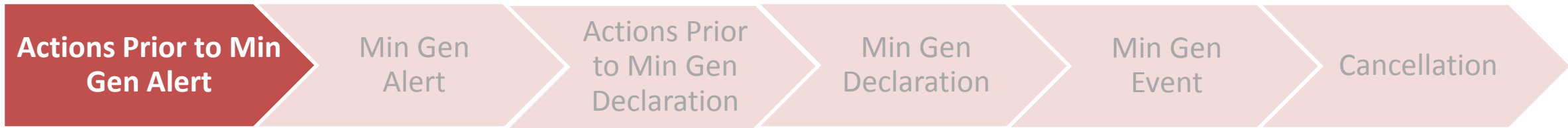
Students will be able to:

- Identify the process and requirements for operating during capacity excess conditions

Capacity Excess Conditions

- Light Load Procedures
 - Failure of a Control Area to provide adequate generation control can result in:
 - Deviations in frequency
 - Inadvertent power flow
 - Stability issues
 - Transmission constraints
- For the RTO to meet its control requirements, it may be necessary to deviate from normal operating procedures during light load periods

Capacity Excess Conditions

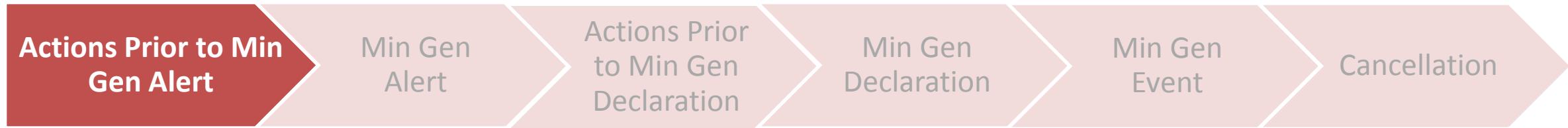


Actions *Prior to* Minimum Generation Alert

PJM Actions:

- Reviews the valley load forecasts over the next several days
 - If the RTO load is projected to be at or below 70,000MWs (Summer/Winter) or 65,000MWs (Spring/Fall), PJM Issues a **Minimum Generation Advisory** message to the Emergency Procedures site 1-2 days ahead of time to provide an informational only notice that a Min Gen Alert/Action is likely

Capacity Excess Conditions

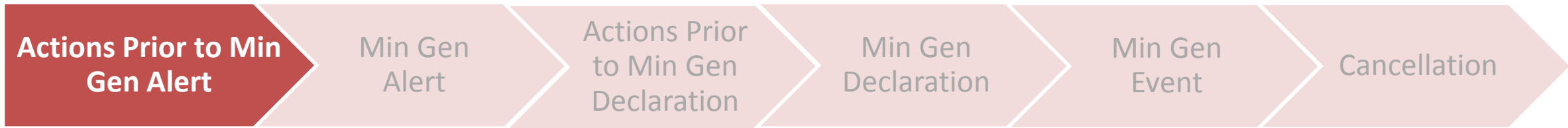


Actions *Prior to* Minimum Generation Alert

PJM Actions:

- Prepares a Minimum Generation Worksheet
 - Determine if Minimum Generation Alert criteria is met
 - Determine if Light Load Procedures are required for the upcoming scheduling period
- Formulate a scheduling strategy for the light load period
- Hydro plant schedules are reviewed to ensure:
 - Pumping at pump storage facilities is maximized
 - Generation at run-of-river facilities is minimized

Capacity Excess Conditions

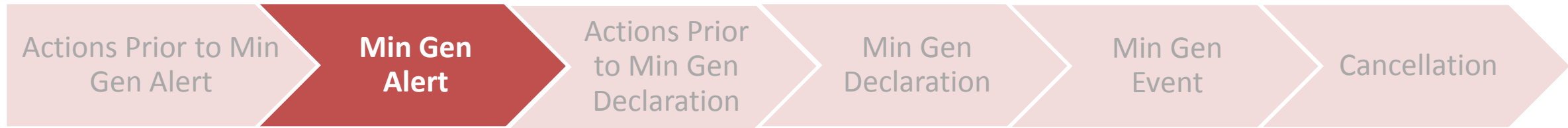


Actions *Prior to* Minimum Generation Alert

Member Actions:

- Generation dispatchers should utilize the advanced notification provided by an Advisory in order to prepare for any action associated with a Minimum Generation Alert

Capacity Excess Conditions



Minimum Generation Alert

- Purpose: To provide an early alert that PJM Emergency Procedures may be required
- Trigger: When the expected generation level is within 2,500 MW of normal minimum energy limits

Capacity Excess Conditions

Minimum Generation Alert

PJM Actions:

- Issues alert for specified light load period when conditions necessitate
 - Issued via ALL-CALL and posts on selected PJM websites and the NERC RCIS
- Provides information to members:
 - Adjusted Minimum generation
 - Valley load estimate
 - Margin values

Capacity Excess Conditions

Minimum Generation Alert

Member Actions:

- Review unit normal maximum and minimum energy limits, as well as emergency minimum limits with station operating personnel
- Generation Dispatchers compile emergency reducible information and report via eDART
- The amount reported to the Reducible on Declaration Column is, by region, the Emergency Reducible Generation (ERG) that will be started down when PJM makes the Minimum Generation Emergency Declaration, before the actual Minimum Generation Event
- The amount reported in the Total Reducible Generation is the total reducible generation available for both the Declaration and Event. Joint-owned generation is reported by the operating company

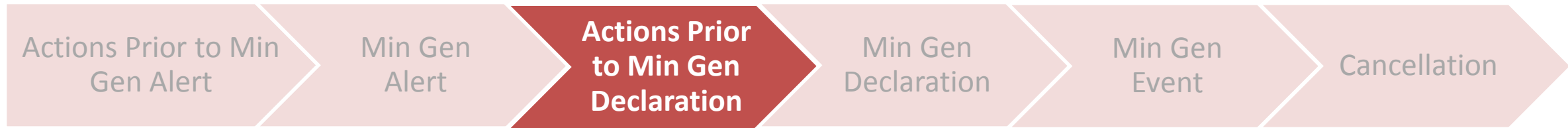
Capacity Excess Conditions

Minimum Generation Alert

Member Actions:

- Schedule additional unit maintenance, as appropriate, during light load periods
- Renew and update resource data in PJM's computer systems
 - Resource availability
 - Energy limits
- Contact PJM dispatch if ramp limits are prohibiting the ability to export energy from the PJM system during the projected period
 - To assist in system control, exports should coincide with load drop-out periods

Capacity Excess Conditions



Actions *Prior* to Minimum Generation Declaration

PJM Actions:

- Re-evaluate valley load estimate and amount of Spot-in transactions
- PJM dispatcher updates the amount of emergency reducible generation available to determine the final strategy
 - The final strategy includes the amount and time frames for the reducible generation to be reduced
- Reduce units to normal minimum generation, review units assigned to regulate, then relieve units that are unable to regulate at or near normal minimum levels

Capacity Excess Conditions

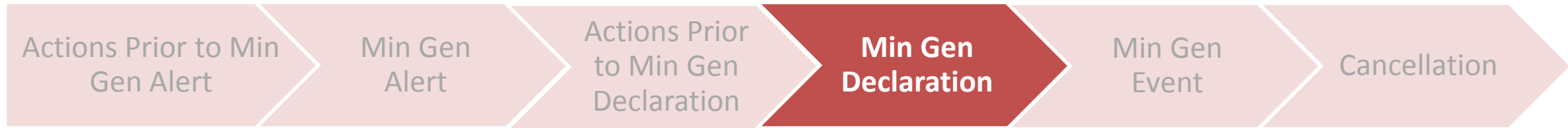


Minimum Generation **Emergency Declaration**

Purpose:

- Notify members of Min Gen survey results and strategy, including:
 - Anticipated amount of reducible generation, and
 - Forecasted time of the reduction

Capacity Excess Conditions



Minimum Generation Emergency Declaration

PJM Actions:

- PJM dispatcher will issue via the ALL-CALL a Minimum Generation Emergency Declaration
- Notify members of the survey results and strategy to include the amount of reducible generation (%) to be reduced and the forecast time
- Posts the Declaration on selected PJM web-sites and the NERC RCIS

Capacity Excess Conditions

Minimum Generation Emergency Declaration

Member Actions:

- Generation Dispatchers ensure their units are following PJM economic base points to Economic Minimum output
- Wind Generation Operators will adjust Wind Turbine Control systems or manually adjust turbine output to achieve the desired SCED base point
- Generation dispatchers reduce generation as reported via eDART on the minimum Generation Form in the Reducible on Declaration column

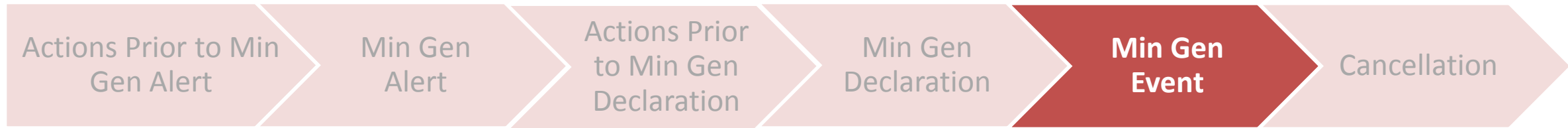
Capacity Excess Conditions

Minimum Generation Emergency Declaration

Member Actions:

- Generation dispatchers determine the specific units that will be reduced and the sequence and timing of reductions based on the direction given by PJM
- Generation dispatchers contact PJM Master Coordinator and report additional Reducible Generation that is reduced beyond what is reported on the Minimum Generation form

Capacity Excess Conditions



Minimum Generation **Event**

Trigger:

- A Minimum Generation Emergency Event is implemented when PJM dispatch can no longer match the decreasing load and utilization of emergency reducible generation as necessary

Capacity Excess Conditions

Minimum Generation Event

PJM Actions:

- PJM dispatcher issues via the ALL-CALL a Minimum Generation Emergency Event and requests Local Generation dispatchers to reduce Emergency Reducible Generation (ERG)
 - In proportion to the total amount of ERG reported minus what was reported as being reducible on declaration
- If the system is transmission constrained, follow the Guidelines for Constrained Operations
- Posts the Declaration on Selected PJM web-sites and the NERC RCIS
- Attempt to sell Emergency Energy to external systems

Capacity Excess Conditions

Minimum Generation Emergency Event

PJM Actions:

- Reduce Network External Designated purchases as required to maintain system control after all internal PJM resources are reduced to Emergency Minimum Levels (100% reducibles implemented)
- Recommend the shutdown of specific units that are not required for area protection during the current load period or the subsequent on-peak period

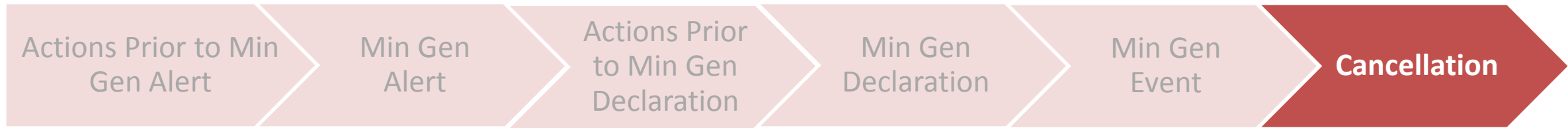
Capacity Excess Conditions

Minimum Generation Emergency Event

Member Action:

- Generation Dispatchers follow the direction of PJM dispatcher
- Implementation of Emergency Reducible Generation Curtailments should be achieved within 15 minutes or within a timeframe that the technology permits
 - PJM should be notified if curtailment is expected to exceed 15 minutes

Capacity Excess Conditions



Cancellation

PJM Actions:

- A PJM dispatcher will cancel a Minimum Generation Emergency when actions taken under these procedures are no longer necessary

Member Actions:

- Generation dispatchers report actual generation that was reduced to the PJM dispatcher

Capacity Excess Conditions

Local Minimum Generation Events

- Implemented when there is an excess generation situation in a localized area or set of areas
 - Which has the potential to result in stability issues or constrained operations

Capacity Excess Conditions

Local Minimum Generation Events

PJM Actions:

- Request local Generation dispatchers to reduce Emergency Reducible Generation
- Curtail dispatchable contracts and Spot Market imports
- Attempt to sell Emergency Energy to external systems
- After 100% Reducible Generation, reduce Network External Designated purchases
- Direct shutdown of effective units not required for area protection

Capacity Excess Conditions

Local Minimum Generation Events

Member Actions:

- Generation dispatchers follow the direction of PJM dispatcher via eDART

*(see eDART ERG Reporting Form in Manual 13 Attachment H)

Contact Information

PJM Client Management & Services

Telephone: (610) 666-8980

Toll Free Telephone: (866) 400-8980

Website: www.pjm.com



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

Resources and References

- PJM Interconnection. (2016). *PJM Manual 3: Transmission Operations (rev 49)*. Retrieved from <http://www.pjm.com/~media/documents/manuals/m03.ashx>
- PJM Interconnection. (2016). *PJM Manual 13: Emergency Operations (rev 60)*. Retrieved from <http://www.pjm.com/~media/documents/manuals/m13.ashx>
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- Miller R. & Malinowski, J. (1994). *“Power System Operation”*. Boston, MA: McGraw-Hill.