Disclaimer

• This training presentation is provided as a reference for preparing for the PJM Certification Exam.
• Note that the following information may not reflect current PJM rules and operating procedures.
• For current training material, please visit: http://pjm.com/training/training-material.aspx
Transmission and Voltage Emergencies

RE Module

Interconnection Training Program

PJM State & Member Training Dept.
• Students will be able to:
  • Describe types of Transmission Emergencies
  • Identify criteria that constitute an emergency
  • Describe actions to alleviate Transmission Emergencies
### Methods of Mitigating Transmission Emergencies

<table>
<thead>
<tr>
<th>Typical Means of Control</th>
<th>Overloads &amp; Excess Transfers</th>
<th>Low Transmission Voltage</th>
<th>High Transmission Voltage</th>
<th>Low Frequency Conditions</th>
<th>High Frequency Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator Active Power Adjustment</td>
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<td>Start Up Generators</td>
<td>Shut Down Generators</td>
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</tr>
<tr>
<td>Phase Angle Regulator Adjustment</td>
<td>Increase/Decrease Phase Angle</td>
<td>Increase MW Flow Across PJM Control Area</td>
<td></td>
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</tr>
<tr>
<td>PJM Interchange Schedule Adjustment</td>
<td>Adjust Import/Export MW</td>
<td></td>
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<tr>
<td>External Interchange Schedule Adjustment</td>
<td>Adjust External Interchange Schedules</td>
<td></td>
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<tr>
<td>Generator Reactive Power Adjustment</td>
<td>Increase Excitation</td>
<td>Decrease Excitation</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Transformer Tap Adjustment</td>
<td>Raise/Lower Tap Position</td>
<td>Raise/Lower Tap Position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shunt Capacitor Switching</td>
<td>Connect to Grid</td>
<td>Disconnect from Grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shunt Reactor Switching</td>
<td>Disconnect from Grid</td>
<td>Connect to Grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synchronous Condenser Adjustment</td>
<td>Increase Excitation</td>
<td>Decrease Excitation</td>
<td></td>
<td></td>
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<tr>
<td>Transmission Line Switching</td>
<td>Selected Line Switching</td>
<td>Outage Pre-studied Lines</td>
<td></td>
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</tr>
<tr>
<td>Circuit Breaker Switching</td>
<td>Change Network Topology</td>
<td>Change Network Topology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumped Storage Pump Operation</td>
<td>Change Pump Status</td>
<td>Shut Down Pumps</td>
<td>Start Up Pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumped Storage Generator Operation</td>
<td>Change Generator Status</td>
<td>Start Up Generators</td>
<td>Shut Down Generators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer Load Voltage Reduction</td>
<td>Apply As Necessary</td>
<td>Apply As Necessary</td>
<td>Apply As Necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer Load Shedding</td>
<td>Apply As Necessary</td>
<td>Apply As Necessary</td>
<td>Apply As Necessary</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Manual Reference:
M-12, Balancing Operations Manual
Section 5
Transmission Facility Control
Methods of Mitigating Transmission Emergencies

- Capacitor/Reactor switching
- Transformer Tap changer adjustment
- Phase Angle Regulator tap adjustment
- Generator/synchronous condenser excitation adjustment
- Switching line/cables out of service
- Loading out of merit (off cost) generation
- All emergency procedures ("Capacity Shortage")
- Purchasing/Selling Emergency Energy
- Transaction Curtailment (Internal procedure and NERC TLR)
Types of Transmission Emergencies

- Thermal
- Reactive
- Stability

Manual Reference

M-03
Transmission Operations
Sections 1,2,3
Types of Transmission Emergencies

• Thermal Overloads
  • Limits
    • Normal
    • Emergency (STE/LTE)
    • Load Dump (115% of STE)
  • Violations may be Actual or Contingency Overloads
Actual **Thermal Overload**

**Types of Transmission Emergencies**

-250 MW

Ratings for each Line
- Normal = 300 MW
- Emergency = 330 MW
- Load Dump = 345 MW

Line Rating
- Normal = 745 MW
- Emergency = 820 MW
- Load Dump = 860 MW

- 1005 MW
  - 141 Mvar

- 755 MW
  - 101% MW

- 0 MW
  - 0 Mvar

755 MW
Actual Thermal Overload

Types of Transmission Emergencies

Ratings for each Line
- Normal = 300 MW
- Emergency = 330 MW
- Load Dump = 345 MW

System Can No Longer Supply Load BLACKOUT!!! Simulation MUST BE ReStarted

Line Rating
- Normal = 745 MW
- Emergency = 820 MW
- Load Dump = 860 MW
Actual Thermal Overload

Choice of which unit to re-dispatch based on lowest cost per MW relief on the constraint
Actual Thermal Overload

Types of Transmission Emergencies

Ratings for each Line
- Normal = 300 MW
- Emergency = 330 MW
- Load Dump = 345 MW

Line Rating
- Normal = 745 MW
- Emergency = 820 MW
- Load Dump = 860 MW
<table>
<thead>
<tr>
<th>Thermal Limit Exceeded</th>
<th>If Actual loading exceeds limit</th>
<th>Time to correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Use all effective actions and emergency procedures except load dump.</td>
<td>15 Minutes</td>
</tr>
<tr>
<td>Emergency</td>
<td>All of the above plus, shed load if violation still exceeds emergency limit after 15 min.</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Load Dump</td>
<td>All of the above plus, shed load if violation still exceeds load dump limit after 5 minutes.</td>
<td>5 minutes</td>
</tr>
</tbody>
</table>

**Legend**

- NON-COST
- OFF-COST
- LOAD SHEDDING
Types of Transmission Emergencies

Thermal Overloads
Limits (Normal, Emergency, Load Dump)
Violations may be Actual or Contingency Overloads

<table>
<thead>
<tr>
<th>Rating</th>
<th>MW</th>
<th>Mvar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Emergency</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>Load Dump</td>
<td>345</td>
<td></td>
</tr>
</tbody>
</table>

Ratings for each Line:

- Normal = 300 MW
- Emergency = 330 MW
- Load Dump = 345 MW

-250 MW
990 MW
31 Mvar
99% Max
740 MW

Ratings for each Line:

- Normal = 745 MW
- Emergency = 820 MW
- Load Dump = 860 MW

Line Rating

755 MW
0 MW
0 Mvar

PJM©2011
Types of Transmission Emergencies

Contingency Thermal Overload

-250 MW
990 MW
740 MW
755 MW
990 MW
126% MW
126% MW
79 MW
377 MW
377 MW
15 MW
0 MW
0 MW
0 Mvar
99% new
458 MW
114 Mvar
114 Mvar

Line Rating
Normal = 745 MW
Emergency = 820 MW
Load Dump = 860 MW

Ratings for each Line
Normal = 300 MW
Emergency = 330 MW
Load Dump = 345 MW

PJM EMS says “what if”

What Corrective Action?
Types of Transmission Emergencies

Contingency Thermal Overload

Taking action on a pre-contingency basis prevents a post-contingency catastrophic failure.
Types of Transmission Emergencies

Contingency Thermal Overload

Taking action on a pre-contingency basis prevents a post-contingency catastrophic failure.
### Types of Transmission Emergencies

<table>
<thead>
<tr>
<th>Thermal Limit Exceeded</th>
<th>If Post-Contingency simulated loading exceeds limit</th>
<th>Time to correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Trend – continue to monitor. Take non-cost actions to prevent contingency from exceeding emergency limit.</td>
<td>N/A</td>
</tr>
<tr>
<td>Emergency</td>
<td>Use all effective actions and emergency procedures except load shed.</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Load Dump</td>
<td>All of the above however, shed load only if necessary to avoid post-contingency cascading.</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>

#### Legend
- **NON-COST**
- **OFF-COST**
- **LOAD SHEDDING**
Transmission Thermal Overloads

• Types
  • Trend
    • Loss of a facility will cause another facility to exceed it’s Normal Rating but still be under it’s Short Term Emergency (STE) rating
  • Contingency
    • Loss of a facility will cause another facility to exceed it’s STE Rating
  • Actual
    • A facility is currently loaded above it’s normal or emergency limit
• The following low/no cost corrective actions should be taken before moving to off-cost generation
  • Transformer Tap Adjustments
  • Phase-Angle Regulator Adjustments
  • Capacitor/Reactor Switching
  • Pre-Studied Line Switching

• When above options exhausted, then --- Off Cost Generation Assignments
  • Based on unit(s) combined generation distribution factors
  • Incremental operating costs
Are there any other method and procedures to alleviate?
Are there any other method and procedures to alleviate?
Transmission Thermal Overloads

- Transaction Curtailment
  - Immediately prior to adjusting generator output, PJM curtails transactions that contribute to overload if:
    - Transmission Customers has indicated they are **not willing to pay transmission congestion** charges
    - Cuts are made based on:
      - Priority of transmission service
      - Timestamp of request
Transmission Thermal Overloads

- **Transaction Curtailment**
  - If overload persists after re-dispatching system;
    - PJM will implement the **NERC** Transmission Loading Relief (TLR) Procedure
    - Cuts are made based on:
      - priority of transmission service
      - Impact of transaction on overload
  - Depending on level of TLR declared:
    - External transactions that impact overload will be:
      - Prevented from starting
      - Curtailed
Transmission Loading Relief procedure

- developed by NERC
- NERC Standard IRO-006-0
- process to control or relieve constrained transmission - may be used instead of/in addition to “local” transmission loading relief procedures

- PJM will **not** issue a TLR for an internal flowgate until after all available generation is loaded (Econ, ME) but prior to any kind of load curtailment

- Other Security Coordinators, however, may issue a TLR which affects contracts in PJM
• 9 Levels of TLR
  • Notification of Reliability Coordinator
  • Hold Interchange Transactions
  • Reallocate Non-firm Transmission Service
  • Curtail Non-firm
  • Re-dispatch generation
  • Reallocate Firm Transmission Service
  • Curtail Firm
  • Implement Emergency Procedures
Types of Reactive Emergencies

- Transfer Limits
  - East, Central, West
  - Bedington-Black Oak
  - AP South
  - AEP-Dominion

- Voltage Drop

- High Voltage

- Low Voltage
• The MW flow limitation across an interface to protect the system from large voltage drops (5%) caused by a contingency

• Reactive Transfer Limit is a MW limit to protect system from a voltage drop problem

• Reactive Transfer Limit is a pre-contingency limit for a post-contingency problem

• Reactive Transfer Limit is limit of net total flow on set of lines
East limit: 5044, 5009, 5026, 5010, 5014 lines

Central limit: 5004, 5005, 5012 lines

Western limit: 5004, 5005, 5006, 5055,
Cleveland interface definition:

- Chamberlin – Harding 345 kV
- Hanna – Juniper 345 kV
- Star – Juniper 345 kV
- Davis Besse – Beaver 345 kV
- Carlisle – Beaver Valley 345 kV
- Erie West – Ashtabula 345 kV
- Ford – Beaver 138 kV
- NASA – Beaver 138 kV
- Camden – Beaver 138 kV
- West Akron – Hickory 138 kV
- West Akron – Brush 138 kV
- Johnson – Beaver 138 kV
- Edgewater – Beaver 138 kV
- Johnson – Loraine 138 kV
- National – Loraine 138 kV
• Limits are calculated ~ every 5 minutes on PJM’s EMS
• The Reactive Transfer Limits are determined by increasing the load in PJM (the sink) with a corresponding generation increase in MISO (the source) until a voltage drop violation is reached.
The Reactive Transfer Limit for an interface is determined as the more restrictive of:

- The minimum pre-contingency transfer interface flow where a post-contingency voltage drop violation (5%) first occurs

- OR

- The minimum pre-contingency transfer interface flow with a converged power flow solution minus the user specified MW backoff (50-300 Mw depending on the interface) value
Reactive Transfer Limits

Post-Contingency Voltage Drop (%)

-10
-8
-6
-4
-2
0

Pre-Contingency Line Flow (MW)

4600
4700
4800
4900
5000
5100

Recommended Transfer Limit

5% voltage drop

Last converged solution
Reactive Transfer Limits

Post-Contingency Voltage Drop (%)

Pre-Contingency Line Flow (MW)

- Last converged solution
- 5% voltage drop
- Recommended Transfer Limit
• Voltage Instability
  • Operating near the “knee” of the voltage drop curve
  • Small increase in flow or load can cause large voltage fluctuation
• Voltage Collapse
  • Separation or blackout of system
• Reactive Transfer Limits are the most critical system reliability limits
  • Largest potential system impact if exceeded
When off-cost for Transfer Limits, Actual Flow (green) should be between Operating Point (yellow) and Transfer Limit (red) to maximize use of transmission.
• Reactive Emergencies: Voltage Drop
  • Violations are of the contingency type, detected by PJM’s EMS Security Analysis
  • Computer monitors if any contingency would cause voltage in any area to drop more than a pre-defined limit (5%)
  • Indicates danger of voltage collapse, system shutdown
  • PJM Dispatcher has 15 minutes to correct violation
  • Primary ways correction occurs that affects MOC dispatcher
    • Unit reactive adjustments
    • Loading out of merit generation
    • Comply with issuance of any emergency procedures
Note: Individual bus voltage drop warnings and limits at voltage levels below 500 kV may vary. Exceptions are listed in PJM Transmission Operations Manual 3 - Exhibit 5.
The following chart details PJM’s Voltage Operating Guidelines for an actual violation.

<table>
<thead>
<tr>
<th>Voltage Limit Exceeded</th>
<th>If Actual voltage limits are violated</th>
<th>Time to correct (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage</td>
<td>Use all effective non-cost and off-cost actions.</td>
<td>Immediate</td>
</tr>
<tr>
<td>Normal Low</td>
<td>Use all effective non-cost actions, off-cost actions, and emergency procedures except load dump.</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Emergency Low</td>
<td>All of the above plus, shed load if voltages are decaying.</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Load Dump Low</td>
<td>All of the above plus, shed load if analysis indicates the potential for a voltage collapse.</td>
<td>Immediate</td>
</tr>
<tr>
<td>Transfer Limit Warning Point (95%)</td>
<td>Use all effective non-cost actions. Prepare for off-cost actions. Prepare for emergency procedures except load shed.</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Transfer Limit</td>
<td>All of the above, plus shed load if analysis indicates the potential for a voltage collapse.</td>
<td>15 minutes or less depending on the severity</td>
</tr>
</tbody>
</table>
The following chart details PJM’s Voltage Operating Guidelines for post-contingency simulated operation.

<table>
<thead>
<tr>
<th>Voltage Limit Exceeded</th>
<th>If post contingency simulated voltage limits are violated</th>
<th>Time to correct (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage</td>
<td>Use all effective non-cost and off-cost actions.</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Normal Low</td>
<td>Use all effective non-cost actions.</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Emergency Low</td>
<td>Use all effective non-cost actions, off-cost actions, and emergency procedures except load shed.</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Load Dump Low</td>
<td>All of the above plus, shed load if analysis indicates the potential for a voltage collapse.</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Voltage Drop Warning</td>
<td>Use all effective non-cost actions.</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Voltage Drop Violation</td>
<td>All effective non-cost and off-cost actions plus, shed load if analysis indicates the potential for a voltage collapse.</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>
The following procedures are utilized when system loads are heavy and bulk power voltage levels are approaching undesirable low levels:

- Low Voltage Alert
- Heavy Load Voltage Schedule Warning
- Heavy Load Voltage Schedule Action
• **Background**
  • Procedure recommended by Root Cause Analysis Report from Summer of ‘99

• **Purpose**
  • To heighten awareness, increase planning, analysis, and preparation efforts

• **Trigger**
  • When PJM is anticipating low voltage problems on the system, a specific Control Zone, or a subset of Control Zones

**Reference Emergency Operations Manual (M-13), Section 3**
• **PJM Actions**
  - Defer maintenance
  - System operators and OPD increase system evaluation
    - PJM will consider raising the Reactive Transfer Limit “back-off” from it’s normal value of 50 MW up to 300 MW
    - Access transfers, limits, transmission overuse, potential need for TLR’s
  - Enhance reporting requirements for reactive resources (Reactive Reserve Check - RRC)
  - Schedule Conference Call as needed

• **Member Actions**
  - Notifications
    - Internal / External
  - Defer maintenance
  - Evaluate, poll reactive resources to verify availability
  - Report any reactive limitations to PJM
Recommendation 3: Investigate the development of a generator MVAR/voltage monitoring process to determine when generators may not be following reported MVAR limits.

Background: Some reactive capability curves that were modeled in the PJM Security Analysis Applications were unachievable, resulting in overly optimistic Transfer Limit Calculations. An investigation of the events surrounding July 6th and July 19th operations indicated that the absence of a policy to validate reactive capability curves was causal to the low voltages that were encountered. The development of a semi-annual review and monitoring process will assist PJM and Local Control Centers (LCCs) in identifying invalid inputs to security analyses and generators that are not adhering to their reported reactive capabilities.

Manual Reference, M-03, Transmission Operations
Attachment J
Generators or LCC becomes aware of Reactive Limitation (or is aware of future limitation)

- AVR out of service
- Reactive Limitation on unit (terminal limit, etc.)
- Capacitor Unavailable

**Notify PJM PD** (Power Dispatcher - Transmission Desk) and affected LCC

PD to document limitation on Outage Ticket

Update PJM EMS Network Applications to reflect limitation

**PD and affected LCC notified when limitation or problem resolved**

Outage Ticket closed out

Updated EMS Network Apps

**Reference Manual 14-D, Attachment D**
Reactive Outage Ticket

- Reporting is accomplished via eDART
- May be called into PJM Power Dispatcher if necessary

Reactive SSR

Member step to be added to one of the emergency procedures

Low Voltage Alert

Purpose is to prompt a polling of Generating Stations to discover any current or foreseeable reactive limitation
• Reactive Reserve Check (RRC)
  • RRC generally called for during capacity deficient conditions or when a Heavy Load Voltage Schedule is implemented
  • Routine RRC’s will be performed on a monthly basis (generally on a Sunday)
  • Allow personnel to become familiar with procedure and identify problem data at times when system in not stressed

Manual Reference, M-14-D, Generator Operational Requirements Attachment D
Reactive Reporting

- **PJM initiates RRC**
  - All Call sent to LCC’s and MOC’s
  - LCC’s responsible for submitting RRC data, All Call should signal to MOC’s the need to verify the reactive capability of their units

- **PJM snapshot of EMS reactive reserve data**
  - Generates Two reports
    - synchronized generator reactive reserve
    - available shunt capacitor VAR reserve
  - PJM can forward reports to the appropriate LCC
    - This allow LCC to see what’s in PJM’s EMS and is meant to aid LCC in resolving any data discrepancies
• **RRC Submission Form**
  
  • Unit Reserve = Total lagging MVAR reserve of all synchronized units.
  
  • Lagging Reserve = Total lagging MVAR capability of all on-line SVC’s and Condensers
  
  • Shunt Reserve = Total MVAR values of all capacitors that can be energized or reactors that can be removed from service.

<table>
<thead>
<tr>
<th>CZ Name</th>
<th>Unit MVAR Reserve</th>
<th>Condensers/SVCs</th>
<th>Capacitor / Reactor</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOM</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PJMCZ</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
### RRC Company Data

- **Company:** Company A  
- **Request ID:** 52  
- **Request Timestamp:** 02/06/2007 09:15  
- **User Name:** SUPER5  
- **Posted Timestamp:**

<table>
<thead>
<tr>
<th>CZ Name</th>
<th>Unit MVAR Reserve</th>
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<td>PJMCZ</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### RRC Report

- **Company:** Company A  
- **User Name:** SUPER5

<table>
<thead>
<tr>
<th>Report ID</th>
<th>Report Timestamp</th>
<th>Posted Timestamp</th>
<th>Unit MVAR Reserve</th>
<th>Condensers/SVCs</th>
<th>Quick Start</th>
<th>Capacitor / Reactor</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>01/31/2007 11:42</td>
<td>01/31/2007 11:46</td>
<td>100</td>
<td>N/A</td>
<td>N/A</td>
<td>100</td>
</tr>
<tr>
<td>32</td>
<td>01/31/2007 11:42</td>
<td>01/31/2007 11:46</td>
<td>100</td>
<td>N/A</td>
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<td>N/A</td>
<td>N/A</td>
<td>100</td>
</tr>
</tbody>
</table>

- **Back**
• PJM Actions:
  - Issues via the All-Call system to request members (LCC and MOC) to prepare for maximum support of voltages on the bulk power system.
  - Given four hours prior to requesting the actual implementation of the Heavy Load Voltage Schedule
  - At the above time, members will be asked to verify that all actions have been taken on the distribution and sub-transmission systems to support the voltage at the EHV level
Heavy Load Voltage Schedule Warning

• Member’s Actions:
  • Ensure all underlying reactors are out of service
  • Ensure all underlying capacitors are in service
  • All transformer taps are adjusted to ensure distribution capacitors are in service
  • Generation Dispatchers ensure all unit voltage regulators are in service
• **Background**
  - All Call Message given at peak load periods to both Generation and Transmission members to request maximum support

• **Purpose**
  - Alert companies of need for maximum voltage support on the bulk power system
  - Initiate actions at time of heavy load period to increase reactive reserves on the 500 kV system

**Reference Emergency Operations Manual (M-13), Section 5**
• **Member Actions**
  
  • **After first ALL-CALL**
    
    • Take all actions on distribution and sub-transmission system to support voltage at EHV level
  
  • **ALL-CALL to Implement the Heavy Load Voltage Schedule**
    
    • All units on 230kv system and below increase MVAR output to maintain levels within pre-determined limits
    
    • All units on the 500kv system should be operated so reasonable MVAR reserve is maintained and coordinated through PJM Power Dispatcher
    
    • Inform PJM Power Dispatcher of any units approaching maximum MVAR output and any abnormal unit MVAR and all unit’s whose voltage regulators are out of service
• PJM controls the following types of Transmission emergencies
  • Thermal overloads and contingencies
  • Voltage violations and voltage drop problems
  • Reactive Transfer Limit
• Data reporting includes:
  • Reactive Reserve Check (RRC)
  • Generator MVAR capability adjustments
  • Voltage Regulator outages
• In addition, all Capacity Shortage emergency procedures can be issued locally for transmission or voltage problems
Questions?
Disclaimer:

PJM has made all efforts possible to accurately document all information in this presentation. The information seen here does not supersede the PJM Operating Agreement or the PJM Tariff both of which can be found by accessing:

For additional detailed information on any of the topics discussed, please refer to the appropriate PJM manual which can be found by accessing: