PJM Manual 37:

Reliability Coordination

Revision: 23

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Prepared By
Systems Operation Division

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Approval

Approval Date: 04/17/2026~~04/27/2025~~
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Matthew Wharton~~Paul Dajewski~~, Manager, Reliability Engineering

Current Revision

Revision 23 (04/22/2026)

- Cover to Cover Periodic Review
- Updated Manual Owner to Matthew Wharton
- Changed advance applications to advanced network applications
- Replaced all pictures of tables with text tables to be searchable
- Replaced Security Analysis with Contingency Analysis
- Updated Next-Day Security Analysis with Next-Day Reliability Analysis

~~**Administrative Change (Paul Dajewski approved 05/01/2025):**~~

- ~~Revised Go Live date from 04/23/2025 to 05/11/2025~~

~~**Revision 22 (05/11/2025):**~~

- ~~Cover to Cover Periodic Review~~
- ~~Updated Manual Owner to Paul Dajewski, Manager Reliability Engineering~~
- ~~Administrative Updates throughout the Manual~~
  - ~~Corrected links~~
  - ~~Consistency in style~~
  - ~~Added links to references where applicable~~
  - ~~Added clarification language~~
- ~~Aligned TOP Language with PJM Compliance Bulletin 026 - Coordination with External Transmission Operators~~
- ~~Section 2.4.2: Updated 'Enterprise Change Management Standard' to 'Standard Change Control Standard'~~
- ~~Section 3.2:~~
  - ~~Added a reference to PJM Manual 03A Appendix C for details on Transmission Facilities~~
  - ~~Add clarification to default 'Baseline Voltage Limits' to 'PJM Baseline Voltage Limits'~~
- ~~Section 3.7: Removed 'Security Analysis' from comparing results~~

- ~~Attachment A:~~
  - ~~Section D – Removed posting time requirement for next day study results~~
  - ~~Section E – Added reliability assessment to include RTCA, Transient Stability Analysis (TSA)~~

Introduction

Welcome to the **PJM Manual for Reliability Coordination**. In this Introduction, you will find the following information:

- What you can expect from the PJM Manuals in general (see “About PJM Manuals”).
- What you can expect from this PJM Manual (see “About This Manual”).
- How to use this manual (see “Using This Manual”).

About PJM Manuals

The PJM Manuals are the instructions, rules, procedures, and guidelines established by PJM for the operation, planning, and accounting requirements of PJM and the PJM Energy Market. The manuals are grouped under the following categories:

- Transmission
- ~~PJM~~ Energy Market
- Regional Transmission Planning Process~~Generation and transmission interconnection~~
- Reserve
- Accounting &~~and b~~Billing
- ~~PJM~~ Aadministrationve services~~~~
- Miscellaneous

For a complete list of all PJM Manuals, go to the Library section on PJM.com.

About This Manual

The *PJM Manual for Reliability Coordination***PJM Manual for Reliability Coordination** focuses on how PJM and the PJM Members are expected to carry out reliability coordination duties in accordance with the PJM Reliability Plan.

The **PJM Manual for Reliability Coordination***~~PJM Manual for Reliability Coordination~~* consists of five sections. The sections are as listed in the table of contents~~ beginning on page ii~~.

PJM shall annually review and update this manual and provide a copy to neighboring Reliability Coordinators, Transmission Operators, Balancing Authorities, and appropriate Regional Reliability Organizations.

Intended Audience

The intended audiences for the PJM Manual for Reliability Coordination are:

- *PJM Reliability Coordinators and System Operators*— Declare and implement normal operating procedures and emergency procedures.
- *Transmission Owner/Operator* (TO/TOP) *and Generation Owner/Operators* (GO/GOP) — Respond to PJM dispatcher requests for emergency procedures.
- *PJM RTO Balancing Authorities and Transmission Operators* – Coordinate operation of Balancing Authority (BA) and Transmission Operator (TOP) operations with PJM Reliability Coordinator (RC).
- PJM Reliability Coordinators and operations staff — Perform system studies.

References

The references to other documents that provide background or additional detail directly related to the *PJM Manual for Reliability Coordination* are:

- PJM Manual for Balancing Operations (M-12)
- PJM Manual for Transmission Operations (M-03)
- PJM Manual for System Restoration (M-36)
- PJM Manual for Operations Planning (M-38)
- PJM Manual for Emergency Operations (M-13)
- PJM Manual for Generator Operational Requirements (M-14D)
- PJM Manual for Certification and Training Requirements (M-40)
- PJM Operating Agreement
- PJM Open Access Transmission Tariff

Using This Manual

We believe explaining concepts is just as important as presenting procedures. This philosophy is reflected in the way we organize the material in this manual. We start each section with an overview. Then we present details, procedures or references to procedures found in other PJM manuals. The following provides an orientation to the manual's structure.

What You Will Find In This Manual

- A table of contents that lists two levels of subheadings within each of the sections
- An approval page that lists the required approvals and a brief outline of the current revision
- Sections containing the specific guidelines, requirements, or procedures including PJM actions and PJM Member actions
- Attachments that include additional supporting documents, forms, or tables in this PJM Manual

- A section at the end detailing all previous revisions of this PJM Manual

Section 1: Roles and Responsibilities

Welcome to the Roles and Responsibilities section of the **PJM Manual for Reliability Coordination**.

- This section of the manual addresses PJM and the PJM Members' responsive actions to obligations as the PJM Reliability Coordinator.

1.1 Policy Statements

PJM is the Reliability Coordinator for PJM Members within the PJM Reliability Coordinator and Balancing Authority Area. PJM operates in compliance with the PJM Reliability Plan (Attachment A – PJM Reliability Plan).

PJM's authority is addressed in the PJM Operating Agreement (OA), ~~which a~~All PJM members must sign the OA as per Schedule 4 - Standard Form of Agreement to Become a Member of the (PJM) LLC, of the PJM Operating Agreement.

In this document, the PJM members commit to comply with PJM Reliability Coordinator directives unless such actions would violate safety, equipment, or regulatory or statutory requirements (See Attachment B – Excerpt from PJM Operating Agreement regarding authority of PJM). Under these circumstances, the Transmission Operator, Transmission Owner, ~~Balancing Authority,~~ Generator Operator, Transmission Service Provider, Load-Serving Entity, ~~or~~ Purchasing-Selling Entity, or any PJM Member shall immediately inform PJM, the Reliability Coordinator, of the inability to perform the directive so PJM may implement alternate remedial actions.

PJM has clear decision-making authority to act and to direct actions to be taken by Transmission Operators, Transmission Owners, ~~Balancing Authorities,~~ Generator Operators, Load-Serving Entities, ~~and~~ Purchasing-Selling Entities, and any PJM Member within its Reliability Coordinator Area to preserve the integrity and reliability of the Bulk Electric System. These actions shall be taken as described in Attachment C – Constraint Prioritization.

PJM shall act in the interest of reliability for the overall Reliability Coordinator Area and the Interconnection before the interests of any of its members or other entity. PJM is committed to supporting its fellow Reliability Coordinators. PJM has developed coordination agreements in cooperation with its neighboring Reliability Coordinators for the purpose of clarifying roles and responsibilities with these entities and for coordinating response when necessary. [NERC Standard IRO-001]

PJM executes the Reliability Coordinator tasks with a group of highly trained and qualified system operators, all of whom maintain current NERC System Operator Certification as Reliability Coordinator Operators.

PJM Actions

PJM is responsible for the following activities:

- Preparing a PJM Reliability Plan and obtaining approval for the plan from the NERC Operating Committee and appropriate Regional Entity Committees.
- Staffing the Reliability Coordinator activities with trained and certified system operators who maintain the NERC Certification for Reliability Operators.
- Implementing coordination agreements with other Reliability Coordinators.
- Taking actions it determines are consistent with Good Utility Practice and are necessary to maintain the operational integrity of the PJM RTO and the Eastern Interconnection.
- Coordinating emergency procedures and Reliability Coordinator Information System (RCIS) notifications.
- Directing the operations of any PJM Members as necessary to manage, alleviate, or end an emergency, including but not limited to emergency purchases/sales and load shedding.
- Providing information to and receiving information from PJM Members and other Reliability Coordinators, as appropriate to manage, alleviate, or end an Emergency in the PJM RTO or in another Reliability Coordination Area.
- Monitoring voltages, tie flows, line loading, EMS alarms, interchange schedules, ACE Control, Frequency, Interchange Distribution Calculator (IDC), and RCIS.

PJM Member Actions

PJM Members are responsible for performing the following activities:

- Taking any action, as requested or directed by PJM, to manage, alleviate, or end an Emergency or other reliability issue.
- Cooperating with other Transmission and Generation Owners and PJM to carry out requests and instructions received from PJM for the purpose of managing, alleviating, or ending an Emergency or other reliability issue in the PJM Reliability Coordinator area or neighboring Reliability Coordinator area.

Section 2: Facilities

Welcome to the Facilities section of the **PJM Manual for Reliability Coordination**. In this section, you will find the following information:

- A description of the communications facilities used to perform Reliability Coordination activities in PJM
- The data requirements and data exchange process for the population of the real time monitoring tools
- A description of the real time monitoring tools PJM uses to perform Reliability Coordination activities
- Procedures for the maintenance of the real time analysis tools

2.1 Communications Facilities

The communications facilities PJM and its members use to carry out its Reliability Coordinator duties are explained in PJM Manual 01:~~PJM Manual, M-01,~~ Control Center and Data Exchange Requirements, Section 3 [NERC Standard IRO-002].

2.2 Data Requirements

The data exchange requirements and facilities PJM and its members use to carry out its Reliability Coordinator duties are explained in PJM Manual 01: Control Center and Data Exchange Requirements, Section 3. [NERC Standard IRO-002] PJM data specifications for external Reliability Coordinators are detailed in PJM Manual, M-01, Attachment A as well as standing Joint Operating Agreements noted in Section 5 of this manual [NERC Standard IRO-010].

2.3 Real Time Monitoring Tools

The real time monitoring tools PJM uses to carry out its Reliability Coordinator duties are explained in PJM Manual 01: Control Center and Data Exchange Requirements, Section 1 [NERC Standard IRO-002].

2.4 Maintenance of Real Time Monitoring Tools

2.4.1 Capabilities of the on-site support staff

PJM maintains a highly qualified and trained staff to provide support to the real time monitoring tools. The EMS and its associated applications are supported by PJM Operations Engineering Support. This group has full time people on staff during normal business hours, which maintain

the EMS database, the advanced network applications, and troubleshoot EMS problems. Outside of normal business hours, this group is on-call and available for control room staff to address real time problems.

Other real time applications are supported by PJM Operations Planning. This group is responsible for non-EMS applications that also comprise the set of tools for real time monitoring. They work full time during normal business hours and provide on-call support for after-hours requests from the control room.

Backing up the System Operations and Operations Support staff is the Security and IT Operations Center (ITOC). ITOC is staffed on site on a 24 x 7 basis with IT professionals with primary responsibility for the corporate applications, some of which are used indirectly in the real time monitoring role. The ITOC is also the focal point for marshaling~~marshalling~~ support forces in the off-hours to respond to control room concerns.

2.4.2 Change Management Process

Changes to the Real Time Monitoring Tools are implemented in accordance with the guidance contained in the Enterprise Change Control Standard. The Enterprise Change Control Standard is an internal PJM standard established to ensure that changes to PJM business application systems, programs, data, systems software, hardware, and any other aspect of the information-processing environment at PJM, are authorized and applied in a controlled and consistent manner that does not compromise the stability and security of any component in the Information Technology environment [NERC Standard IRO-002].

The PJM Shift Supervisor has final approval authority for all planned outages and maintenance of telecommunication, monitoring, and analysis capabilities [NERC Standard IRO-002]. These outages will be approved or denied by the PJM Shift Supervisor based on system conditions.

Section 3: SOL and IROL Limits

Welcome to the Monitoring System Operating Limits (SOL) and Interconnection Reliability Operating Limit (IROL) Limits section of the **PJM Manual for Reliability Coordination**. In this section, you will find the following information:

- Process for determining SOL and IROL limits
- How PJM monitors SOL and IROL limits

3.1 PJM SOL Methodology

Welcome to the PJM System Operating Limit (SOL) Methodology section of the PJM Manual for Reliability Coordination. In this section, you will find the following information:

- PJM's SOL Methodology for use in determining SOL exceedances for Real-time Assessments (RTA), Real-time monitoring, and the Operations Planning time horizon.
- Sections intentionally laid out to correspond with NERC Standard FAC-011-4 and FAC-014-3 requirements for ease of reading, tracking and measurement against the NERC Standard.
- Process for determining Interconnection Reliability Operating Limit (IROL).

The entirety of Section 3, in full including all subparts, serves as the documented methodology by which PJM and its member TOPs establish SOLs (i.e. PJM's SOL methodology) within the PJM Reliability Coordination area within the Operations Planning time horizon.

3.2 Common Facility Ratings

[FAC-011-4 R2, FAC-014-3 R2, FAC-014-3 R3]

PJM is the registered Reliability Coordinator (RC) for its footprint. PJM is the registered Transmission Operator (TOP) for its footprint except for facilities at or below 138 kV that are owned and operated by American Electric Power (AEP), and the buswork at the U.S. Department of Energy facility at Portsmouth (OH).

For the purpose of ensuring common Facility Ratings are utilized by PJM, its member TOPs, and its member Transmission Owners (TOs) the following owner-provided Facility Ratings shall be used:

Type	Rating	Measure	Description
Thermal	Normal Limit (NL)	MVA	The Normal Limit, or normal continuous thermal rating.
Thermal	Long Term Emergency (LTE)	MVA	Long Term Emergency thermal rating is a 4 hour rating (Reference PJM Manual 03A section 3.3).
Thermal	Short Term Emergency (STE)	MVA	Short Term Emergency thermal rating. See the PJM Manual 03 - Attachment F for further detail.
Thermal	Load Dump (LD)	MVA	Load Dump emergency thermal rating is a 15 minute rating.
Voltage	Normal Low (NL)	kV	Normal Low voltage rating is a normal continuous rating.
Voltage	Emergency Low (EL)	kV	Emergency Low voltage rating is a 4 hour rating.
Voltage	Load Dump (LD)	kV	Load Dump low voltage rating is a 15 minute rating.
Voltage	Normal High (NH)	kV	Normal High voltage rating is a normal continuous rating.
Voltage	Emergency High (EH)	kV	Emergency High voltage rating is a 4 hour rating. See PJM Manual 3 - Section 3 for further detail. Applicable when TO provide rating.
Voltage	Vdrop Limit	%	Post-contingency voltage stability Voltage Drop limitation.

Exhibit 1: PJM Facility Ratings

Type	Rating	Measure	Description
Thermal	**NL**	MVA	The Normal Rating, or normal continuous thermal rating.
Thermal	**LTE or LT**	MVA	Long Term Emergency thermal rating is a 4hr rating. (reference M-03A section 3.3)
Thermal	**STE or ST**	MVA	Short Term Emergency thermal rating. See the PJM M-03: Transmission Operations - Attachment F for further detail.
Thermal	**LD**	MVA	Load Dump emergency thermal rating is a 15m rating.
Voltage	**NL**	KV	Normal Low voltage rating is a normal continuous rating.
Voltage	**EL**	KV	Emergency Low voltage rating is a 4hr rating.
Voltage	**LD**	KV	Load Dump low voltage rating is a 15m rating.
Voltage	**NH**	KV	Normal High voltage rating is a normal continuous rating.
Voltage	**EH**	KV	Emergency High voltage rating is a 4hr rating. See the PJM M-03: Transmission Operations - Section 3 for further detail. Applicable when TO provide rating.

Thermal Ratings

Facility Ratings are required for all lines, transformers, phase-angle regulators (PARs), series devices and flow devices designated as Bulk Electric System (BES) facilities - Monitored Priority (MP) 1 "Reliability and Markets", sub-BES facilities- MP2 "Reliability BES" facilities, and MP6 "Reliability Non-BES" facilities as listed on the PJM Transmission Facilities page. Facility Ratings are documented and administered within the Transmission Equipment Rating Monitor (TERM) sub-tool within the eDART application through the use of ratings tickets. For identified Dynamic Line Rating (DLR) facilities, DLR are similarly maintained within eDART's TERM sub-tool, with real-time DLR taking priority over that of forecasted DLR; and, forecasted DLR taking priority over that of the default ratings tickets. For use in the event DLR are unavailable or not appropriate to the time horizon, the same Rating Set framework (NL, LTE, STE & LD, across all ambient conditions) is required for DLR facilities as that of a non-DLR facility which requires Facility Ratings.

Conditional ratings for specific facility conditions, which when relevant may override the TERM Facility Ratings or DLR, can be found within PJM Manual 03B: Transmission Operating Procedures.

Further information on Transmission Facilities can be found within Appendix C of PJM Manual 03A: Energy Management System (EMS) and Quality Assurance (QA) and eDART's TERM sub-tool can be found within Appendix A of PJM Manual 03A: Energy Management System (EMS) and Quality Assurance (QA), as well as found within the PJM eDART tools page.

Voltage Ratings

Voltage rating sets are required for all bus "equipment" designated as BES facilities and "Reliability and Markets" sub-BES facilities as listed on the PJM Transmission Facilities page. Along with System Voltage Limits, Facility Rating-driven voltage limits are documented and administered within the Transmission Equipment Rating Monitor (TERM) sub-tool within the eDART application.

Where no Facility Rating is either derived, or is determined to be relevant, by the owner for the required equipment above, PJM member equipment owners shall designate default to PJM Baseline Voltage Limits as documented in PJM Manual 03: Transmission Operations. Limits are required at the company zonal/voltage level, and may be overridden by any limits (exceptions) provided by the member at the substation/voltage.

3.3 System Voltage Limits

[FAC-011-4 R3]

The method by which PJM, as a TOP, and TOPs within the PJM Reliability Coordination Area shall determine the System Voltage Limits employed in operations are contained within this subsection.

For the purposes of defining PJM System Voltage Limits, these SOLs are defined below:

Type	Rating	Measure	Description
Voltage	Normal Low (NL)[1]	kV	Normal Low voltage rating is a normal continuous rating.
Voltage	Emergency Low (EL)[1]	kV	Emergency Low voltage rating is a 4 hour rating.
Voltage	Load Dump (LD)[1]	kV	Load Dump low voltage rating is a 15 minute rating.
Voltage	Normal High (NH)[1]	kV	Normal High voltage rating is a normal continuous rating.
Voltage	Emergency High (EH)[1]	kV	Emergency High voltage rating is a 4 hour rating. See PJM Manual 3 - Section 3 for further detail. Applicable when TO provide rating.
Voltage	Vdrop Limit[2]	%	Post-contingency voltage stability Voltage Drop limitation.

Exhibit 2: PJM System Voltage Limits

[1] Rating is utilized as both a Voltage Rating and a System Voltage Limts.

[2] PJM additionally requires a Vdrop Warning (Voltage Drop Warning) for the purposes of proactive identification and mitigation of Vdrop Limits. The Vdrop Warning value is not considered a PJM SOL, but utilized as a control measure to avoid exceedance against the Vdrop Limit SOL value.

Type	Rating	Measure	Description
Voltage	**NL**[1]	KV	Normal Low voltage rating is a normal continuous rating.
Voltage	**EL**[1]	KV	Emergency Low voltage rating is a 4hr rating.
Voltage	**LD**[1]	KV	Load Dump low voltage rating is a 15m rating.
Voltage	**NH**[1]	KV	Normal High voltage rating is a normal continuous rating.
Voltage	**EH**[1]	KV	Emergency High voltage rating is a 4hr rating.
Voltage	**Vdrop Limit**[2]	%	Post-contingency voltage stability Voltage Drop limitation.

[1] Rating is utilized as both a Voltage Rating and a System Voltage Limits.
[2] PJM additionally requires a Vdrop Warning (Voltage Drop Warning) for the purposes of proactive identification and mitigation of Vdrop Limits. The Vdrop Warning value is not considered a PJM SOL, but utilized as a control measure to avoid exceedance against the Vdrop Limit SOL value.

Applicability

System Voltage Limits are required for all bus "equipment" designated as BES facilities and "Reliability and Markets" sub-BES facilities as listed on the PJM Transmission Facilities page.

Where no System Voltage Limit or is either derived, or is determined to be relevant, by the owner for the required equipment above, PJM member equipment owners shall designate default to PJM Baseline Voltage Limits as documented in PJM Manual 03: Transmission Operations. Limits are required at the company zonal/voltage level, and may be overridden by any limits (exceptions) provided by the member at the station/voltage.

Relation to Voltage-Based Facility Ratings

PJM System Voltage Limits are comprised of voltage-based Facility Ratings where they explicitly are defined and provided at the member station level; And, where not provided at the station level, to those voltage-based Facility Ratings provided at the transmission zonal level.

The following hierarchy then exists for the System Voltage Limits applicable to Facility Ratings:

1. Member station specified Facility Ratings;

2. Where no station specific limit is required, member zonal Facility Ratings;
3. Where no station or zonal limit is required, PJM Baseline Voltage Limits are designated by the member for use as their Facility Ratings. PJM Baseline Voltage Limits are documented in PJM Manual 03: Transmission Operations.

Undervoltage Load Shedding Requirement

PJM does not have any Undervoltage Load Shedding (UVLS) systems or programs. Any such UVLS programs or systems developed within the PJM system must have relay settings less than or equal to the System Voltage Limits for the area, thus ensuring the System Voltage Limits are greater than or equal to the in-service BES relay settings. Alternatively, System Voltage Limits may be tuned to ensure the above requirement is met, provided they continue to respect Facility Ratings as well stability performance criteria.

Lowest Allowable System Voltage Limit

PJM's lowest allowable System Voltage Limit can be identified by the LD rating for associated equipment. Common System Voltage Limits for equipment within the PJM footprint, the common System Voltage Limits for use by PJM, its member TOPs and TOs, and adjacent TOPs and RCs within the Eastern Interconnection may be found within PJM's eDART Base Data application under the header of Voltage Limits: Effective Limits.

eDART Base Data link to view PJM Effective (Voltage) Limits.

PJM Voltage Limits are also available publicly on the PJM OASIS - System Information. In order to arrive at such common limits, PJM TOs and TOPs shall coordinate such limits with their neighboring entities to ensure alignment across parties[1].

- PJM shall coordinate with neighboring RCs regarding any unresolved ratings discrepancy between a PJM member TO/TOP and neighboring TO/TOP prior to implementation within the field.

[1] This does not imply that all ratings are universal across a given contiguous voltage level. But, any deviations at the neighboring seams must be known and controllable within the impacted entities.

- Any such discrepancies identified in real-time shall be made known to PJM Dispatch immediately for mitigation between RC entities.

3.4 Stability Limits

[FAC-014-4 R4, FAC-014-3 R4]

The method for determining the stability limits to be used in the Operations Planning time horizon is contained herein. PJM establishes stability limits by utilizing a Transient Stability Assessment tool (TSA) for Day-ahead studies and for Real-time assessments. PJM also documents stability limits in PJM Manual 03B: Transmission Operating Procedures (CEII). The manual procedures are used when the TSA tool is not available.

Stability Limit Establishment: Performance Criteria

Stability Limits shall not exceed the associated facility ratings for any given facility, and as such are not typically derived beyond the associated facility ratings and unit capabilities. (i.e., For such facilities, stability is thus not deemed as a limiting criteria.) In both real-time and post-contingency per applicable contingency analysis, the BES must remain stable, without Cascade or uncontrolled separation.

Criteria Type	Performance	Margin
Steady-state voltage stability	The voltage drop percentage is within applicable voltage drop limit. Reactive Transfer flows are within transfer limits.	n/a
Transient voltage response	The transient voltage response shall recover to a minimum of0.7 p.u after 2.5 seconds	n/a
Angular stability	Generators maintain synchronism following a system disturbance.	n/a
System damping	Units shall demonstrate positive damping in adherence to 3% damping criteria.	n/a

Exhibit 3: PJM Stability Limit Criteria

Criteria Type	Performance	Margin
Steady-state voltage stability	The voltage drop percentage is within applicable voltage drop limit. Reactive Transfer flows are within transfer limits.	n/a
Transient voltage response	The transient voltage response shall recover to a minimum of 0.7 p.u. after 2.5 seconds.	n/a
Angular stability	Generators maintain synchronism following a system disturbance.	n/a
System damping	Units shall demonstrate positive damping in adherence to 3% damping criteria.	n/a

Stability Limit Establishment: Contingencies

PJM Stability Limits shall be established to meet the Stability Performance Criteria above in association with the specific stability contingencies identified within this manual under Section 3.5 SOL Contingency Set. This contingency subset is expected to produce more severe System impacts on its portion of the BES.

Stability Limit Establishment: TOP/RC Coordination

PJM is the registered Reliability Coordinator (RC) for its footprint. PJM is the registered Transmission Operator (TOP) for its footprint except for facilities at or below 138 kV that are owned and operated by American Electric Power (AEP), and the buswork at the U.S. Department of Energy facility at Portsmouth (OH)

With respect to the establishment of Stability Limits within its footprint, PJM establishes these limits, in consultation as needed and where possible with equipment owners, including those TOPs identified above, to ensure the assumptions for such limits are accurate.

Anytime a given stability limit is identified to have impact to another Reliability Coordinator Area within the Eastern Interconnection, PJM works directly with the impacted RC area in the coordination and communication around such limits.

Pre-established areas of known stability concern, including those with impact to other RC areas, are captured within PJM Manual 03B: Transmission Operating Procedures (CEII).

Stability Limit Establishment: Parameters Inputs

PJM establishes stability limits in the Operations Planning horizon and in Real-time. Long term studies establish the stability procedures and limits as documented in PJM Manual 03B: Transmission Operating Procedures (CEII). These studies are generally conservative with input assumptions; typical transfer levels, light loads, area generation at maximum MW and low MVar output, and select transmission outage(s). Near term studies (two-day ahead and day-ahead) to

determine the stability limits reflect the load forecast, transmission outages, generation outages, dispatch pattern, weather forecast, and expected interchange for the operating day.

PJM utilizes Real-time TSA to analyze system stability as documented in PJM Manual - 03: Transmission Operations - Section 3.9. The Real-time TSA utilizes the latest State Estimator solution.

Stability Limit Establishment: Model Details

TSA computes stability limits by using the Real-time EMS network model. TSA interfaces with the EMS and uses the State Estimator solution. The EMS model is designed to support the NERC BES definition on Facilities above 100 kV. PJM considers the Internal World Modeling as "Layer 1" modeling, which explicitly includes BES facilities with all available telemetry to reliably operate the PJM footprint. This telemetry and model data is obtained from the TOs and GOs to ensure that PJM has an accurate model for its internal footprint. The External world/neighboring Reliability Coordinator Area modeling is necessary to allow units to be properly dispatched through Pseudo-Ties, provide proper market-to-market (M2M) coordination[2], and to properly operate the PJM internal system reliably. Refer to PJM Manual - 03A: Energy Management System (EMS) Model Updates and Quality Assurance (QA)-Section 2.2.

Other input data includes the generator dynamic models and the fault clearing times for specific equipment. For equipment without a specific fault clearing time, TSA will use zonal default clearing times.

Stability Limit Establishment: Allowed Uses of RAS and other mitigating actions

Generator stability limit is expressed in terms of generator specific maximum MW or minimum MVar output requirement. Generator output adjustment is a common method used to resolve a stability issue. In cases where a Remedial Action Scheme (RAS) is documented in PJM Manual 03B: Transmission Operating Procedures (CEII), it can be used as mitigation method.

Stability Limit Establishment: UFLS and UVLS Disallowed

PJM does not allow the use of underfrequency load shedding (UFLS) programs and UVLS Programs in the establishment of stability limits.

3.5 SOL Contingency Set for Stability Determination

[FAC-011-4 R5]

The PJM set of Contingency events for use in performing Operational Planning Analysis (OPAs) and Real-time Assessments (RTAs) comprise of single facility failures or malfunction of critical equipment (facilities simulated in contingency analysis are not restricted to the PJM monitored

[2] M2M coordination with with MISO.

facility list) including lines, transformers, Phase Angle Regulators (PARs), generators, capacitors, and reactors whose loss or failure could result in limit exceedances on PJM Monitored Facilities. Refer to PJM Manual - 03: Transmission Operations – Section 1.3 for additional details.

PJM utilizes a subset of EMS Contingency events to determine stability limits. These Contingency events are located near generating plants and include typical zone of clearance facilities. In addition, the contingency events contains specific facility fault clearing times or zonal default fault clearing times. Typically, faults on transmission circuits or transformers located at a plant substation/switch yard are the most severe. PJM applies balanced three phase faults or unbalanced phase to ground faults with delayed clearing. Refer to PJM Manual - 03: Transmission Operations – Section 3.9 for additional details.

Additional stability single or multiple Contingency Events

PJM will model Contingency events as reported by TOs or GOs. These events are single contingency conditions that results in the loss of multiple facilities. PJM will also model any reported delayed clearing as a result of relay outages or degradation.

Contingency events provided by the Planning Coordinator

PJM incorporates credible Contingency events provided by its System Planning (the Planning Coordinator (PC)) to determine stability limits. System Planning communicates these credible or abnormal events to Operations for inclusion in TSA tool.

3.6 SOL Performance and Exceedance Determination

[FAC-011-4 R6]

The following table shows the SOL exceedance criteria.

Condition	Limit Type	Rating Assessed
Actual	Thermal	Normal (NL)
Actual	Voltage	Normal Low (NL) or Normal High (NH)
Actual	Stability	Stability Limit, not to be exceeded
Post-contingency	Thermal	Short Term Emergency (STE)
Post-contingency	Cascade	115% of Load Dump rating
Post-contingency	Voltage	Emergency Low (EL) or Emergency High (EH)
Post-contingency	Stability	Stability Limit, once established, shall be returned below the limit within 15 minutes.

Condition	Limit Type	Rating Assessed
Actual	Thermal	Normal Limit (NL)
Actual	Voltage	Normal Low (NL) or Normal High (NH)
Actual	Stability	Stability Limit, not to be exceeded
Post-Contingency	Thermal	Short Term Emergency (STE)
Post-Contingency	Cascade	115% of Load Dump rating
Post-Contingency	Voltage	Emergency Low (EL) or Emergency High (EH)
Post-Contingency	Stability	Stability Limit, once established, shall be returned below the limit within 15 minutes.

Exhibit 4: SOL Exceedance Criteria

In the no contingency state (i.e., Actuals), for the purposes of SOL performance trending and Exceedance, ratings are leveraged as follows:

- **Thermal Actuals:**
  - Facilities with pre-contingent steady state actual flow below the NL ratings are deemed to be in a trending state, or Trends, with respect to their SOL;
  - Facilities with pre-contingent steady state actual flow at or above the NL rating are deemed to be in Exceedance of their SOL;
    - However, the STE, LTE or LD rating may be leveraged should System adjustments be executed and completed within the time span appropriate to the duration of the respective rating.
- **Voltage Actuals** (System Voltage Limits and Facility Rating-based voltage limits):
  - Facilities with pre-contingent steady state voltage within the NL and NH ratings are deemed to be in a trending state, or Trends, with respect to their SOL;
  - Facilities with pre-contingent stead state voltage at or below the NL or at or above the NH ratings are deemed to be in Exceedance of their SOL;
    - However, the EL, LD or EH rating may be leveraged should System adjustments be executed and completed within the time span appropriate to the duration of the respective rating.
- **Stability Limits with no contingency**
  - Units/stations/areas with pre-contingent limits are not to be exceeded.

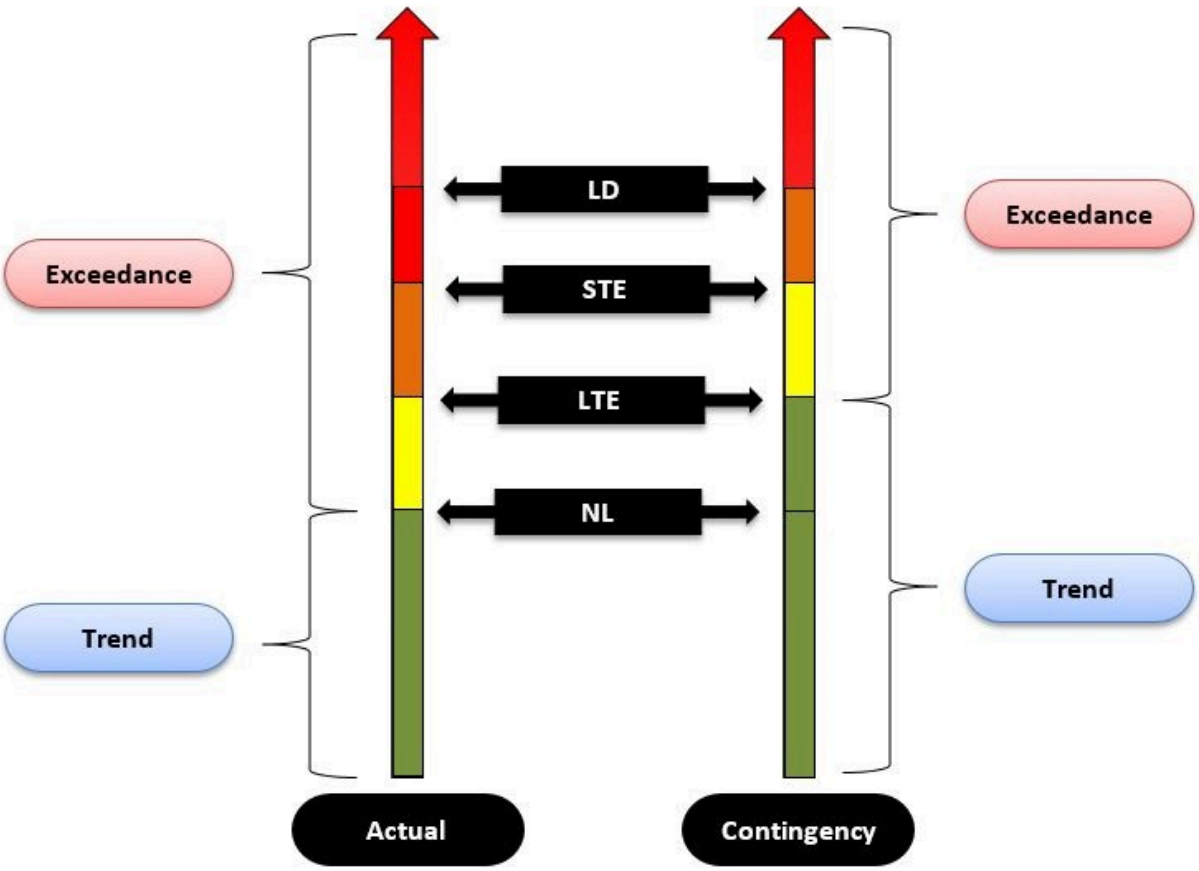
In the post-contingency state (i.e., Contingencies or N-1), for the purposes of SOL performance trending and Exceedance, ratings are leveraged as follows:

- **Thermal Contingencies**:
  - Facilities with post-contingent steady state derived flow below all Emergency ratings (STE, LTE & LD) are deemed to be in a trending state, or Trends, with respect to their SOL;
  - Facilities with post-contingent steady state derived flow above their Emergency ratings (STE, LTE & LD) are deemed to be in Exceedance of their SOL;
    - Facility must not be above the Facility's Load Dump rating.
- **Voltage Contingencies** (System Voltage Limits and Facility Rating-based voltage limits):
  - Facilities with post-contingent steady state derived voltage within the Emergency Low (EL) and Emergency High (EH) voltage limits are deemed to be in a trending state, or Trends, with respect to their SOL;
  - Facilities with post-contingent steady state derived voltage beyond their Emergency ratings (either less than EL or greater than EH) are deemed to be in Exceedance of their SOL;
    - Facility must not be below the Facility's Load Dump voltage limit
  - Transfer flows are within applicable transfer limits.

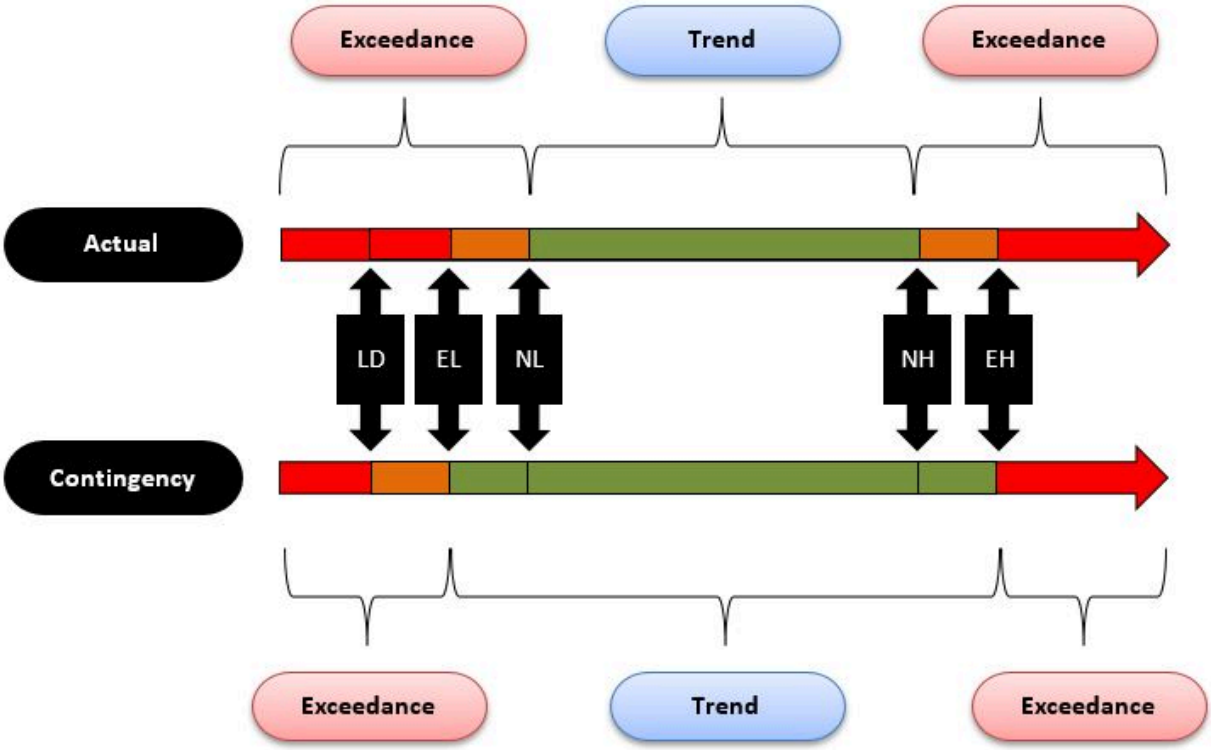
To ensure that instability, Cascading or uncontrolled separation that adversely impact the reliability of the Bulk Electric System do not occur, PJM leverages the following processes and tools:

1. Study and Real-time Transient Stability Assessment within the Operations Planning and Operations time horizons.
2. Cascade Analysis of thermal and voltage exceedances.

- **System Response to Contingency Event**
  For any system limit exceedance, PJM employs non-cost actions, off-cost actions, and emergency procedures prior to load shed.



PJM Thermal Limits as they relate Actual (Steady State, pre-contingency) and Contingency (Post-contingency) trends and exceedances.



PJM Voltage Limits as they relate Actual (Steady State, pre-contingency) and Contingency (Post-contingency) trends and exceedances.

3.7 SOL Exceedance Communication

[FAC-011-4 R7]

PJM is the RC and TOP except as noted in Section 3.2. When there is an SOL trend or exceedance, PJM Dispatch will communicate with the respective TO and compare results prior to initiating controlling actions.

- The EMS Transfer Limit Calculator (TLC) determines the IROL flows and limits. PJM will initiate controlling actions to maintain IROL flows within their respective limits.
- The TSA tool determines the stability limits. PJM will initiate controlling actions by adjusting generator output (MW or MVAR) to maintain stability.
- PJM will resolve SOL exceedances within the time frame policy specified in Manual-03: Transmission Operations - Sections 2 and 3 for the following conditions:
    - Post Contingency SOL exceedances that are identified to have a validated risk of instability, Cascading, and uncontrolled separation;
    - Pre-Contingency SOL exceedances of Facility Ratings;

- Pre-Contingency SOL exceedances of normal minimum System Voltage Limits.

TOs are required to timely communicate pre-Contingency and Post Contingency SOL exceedances to PJM. GOs are required to timely communicate any observed oscillation or instability on their generator(s).

3.8 IROL Identification and Criteria

[FAC-011-4 R8]

PJM performs IROL analysis in the Operating Horizons using the PJM's Operational methodology to determine IROL facilities by simulating transfers across a facility or interface (combination of facilities), comparing thermal and voltage violations associated with a facility.

- A reactive transfer interface is classified as an IROL if wide-area voltage violations occur at transfer levels near the Load Dump thermal limit. The current IROL facilities are defined as nine (9) reactive transfer interfaces. Refer to this Manual - Section 3.10 for additional details.
- The IROL are defined as the reactive transfer convergence limits. The IROL exceedance occurs when the IROL transfer flow is greater than its transfer convergence limit. The IROL Tv is defined as an exceedance for at least 30 minutes.

3.9 SOL Methodology Posting and Sharing Obligations

[FAC-011-4 R9]

PJM documents its SOL methodology in the PJM Manuals. The manuals are available publicly on the pjm.com website.

PJM will provide the SOL methodology manuals to other requesting Reliability Coordinators who has a reliability related need within 30 days. When there is a new revision to the SOL methodology manuals, PJM notifies the adjacent Reliability Coordinators; Planning Coordinator, Transmission Planner, and Transmission Operators within its Reliability area; and Reliability Coordinator that has requested to receive updates via the Stakeholder notification process prior to the effective date of the SOL methodology manuals. PJM manuals are also publicly posted to the PJM website.

3.10 Establishing and Communicating System Operating Limits

[FAC-014-3 R1]

IROL Determination: An IROL is defined in the NERC Glossary of Terms as a System Operating limit that, if violated, could lead to instability, uncontrolled separation, or Cascading outages that adversely impact the reliability of the Bulk Electric System (BES).

PJM performs an IROL analysis in the Planning and Operating Horizons. Planning studies are performed consistent with the ideology contained within PJM Manuals M-14 A through E, evaluating credible "double-contingencies" modeling firm transactions, consistent with planning criteria. Operating studies are performed consistent with the ideology contained within the PJM Manual-03: Transmission Operations, evaluating "single-contingencies".

The Base Case is generally developed using 50/50 (non-diversified) forecasted load levels, net PJM Interchange level determined from the Multi-regional Modeling Working Group (MMWG) Series case that is adjusted for firm point-to-point contracts associated with generation for recent NERC ERAG analysis.

PJM typically screens a large set of possible limiting contingencies as identified in the Operations Assessment Task Force (OATF) results at forecasted 50/50 (non-diversified) peak loads including PJM EMS and maximum credible disturbance contingencies.

PJM's Operational methodology to determine IROL facilities simulates transfers across a facility or interface (combination of facilities), comparing thermal and voltage violations associated with a facility.

The transfers are simulated by increasing the load at the Sink (Control Area(s) or subset of Control Area) with the corresponding generation increase at the Source (typically west of the facility/interface being studied) until a voltage violation/collapse is reached. For simulating transfers into a Sink load pocket, an alternate approach of reducing generation in the Sink may be utilized since increasing Sink load well above its historic peak is not likely to be realized during actual operation.

Thermal Violations that do not result in wide-spread voltage violations / collapse are controlled via load shed procedures documented in PJM Manuals (PJM Manual - 03: Transmission Operations - Section 2 and PJM Manual - 13: Emergency Procedures - Section 5). These procedures require PJM to take emergency actions, including load shed to return flows below Emergency Ratings within 15 minutes and below Load Dump Ratings within 5 minutes. Transmission Owners are required to provide thermal ratings consistent with the time line defined above.

PJM classifies a facility as an IROL facility on the PJM system if wide-area voltage violations occur at transfer levels near the Load Dump thermal limit. Under conditions where only a thermal violation exists, PJM staff will have sufficient time to shed load post-contingency to avoid voltage collapse, and therefore, the facility will not be classified as an IROL facility. Exceptions to this criterion are evaluated on a case-by-case basis. Current IROL facilities are defined as follows:

Transfer Limit/Thermal Rating	Reportable IROL Violation
Eastern Reactive Transfer Interface	Flow exceeds Last Convergent Case Limit for 30 minutes (Tv)
Central Reactive Transfer Interface	Flow exceeds Last Convergent Case Limit for 30 minutes (Tv)
5004/5005 Reactive Transfer Interface	Flow exceeds Last Convergent Case Limit for 30 minutes (Tv)
Western Reactive Transfer Interface	Flow exceeds Last Convergent Case Limit for 30 minutes (Tv)
AP South Reactive Transfer Interface	Flow exceeds Last Convergent Case Limit for 30 minutes (Tv)
Bedington – Black Oak Reactive Transfer Interface	Flow exceeds Last Convergent Case Limit for 30 minutes (Tv)
AEP-DOM Reactive Transfer Limit	Flow exceeds Last Convergent Case Limit for 30 minutes (Tv)
Cleveland (CLVLND) Reactive Transfer Interface	Flow exceeds Last Convergent Case Limit for 30 minutes (Tv)
CE - East Reactive Transfer Interface	Flow exceeds Last Convergent Case Limit for 30 minutes (Tv)

Exhibit 5: IROL

PJM has developed an SOL Methodology for use in the Operating Horizon to ensure reliable BES performance. Including the dynamically calculated limits for the IROL facilities above, the most restrictive applicable limit (thermal / voltage / transient stability / voltage stability) upon all BES facilities and "Reliability and Markets" sub-BES facilities as listed on the PJM Transmission Facilities page are considered SOLs. These SOL shall not exceed the associated ratings for a given facility. For each SOL category, PJM will control on a pre-contingency and post-contingency basis (consistent with NERC Standard FAC-011) as detailed in Operating Guidelines provided in PJM Manual 03 consistent with established SOL methodology:

- Facility Thermal Ratings:
  - Section 2
- Transient, Dynamic, and Voltage Stability Ratings:
  - Section 3.8 and 3.9
- System Voltage Limits:
  - Section 3

Transmission Operating Procedures which may contain facility thermal ratings, transient, dynamic, and voltage stability ratings, or system voltage limits can be found in PJM Manual 03B – Transmission Operating Procedures (CEII).

PJM Actions

- Perform periodic review of facilities and margins as needed after seasonal assessment (OATF Inter regional Winter/Summer) studies are completed
- Discuss identified IROL with the impacted TO/TOP(s)
- Develop Operations Guide for each IROL
- Document Transmission Operator load shedding program
- Develop PI display for each IROL
- Provide IROL training to system operators
- Develop IROL visualization
- Distribute PJM Manual 37 documentation to external systems and provide a response to technical comments within 45 calendar days of receipt to include whether a change will be made to the SOL/IROL Methodology documentation, including reason

PJM Member Actions

- Participate in periodic review of IROL facilities as part of seasonal assessment (OATF Inter-regional Winter/Summer)
- Discuss identified IROL with PJM staff
- Understand IROL Operations Guide
- Document load shedding program
- Provide IROL training to system operators

3.11 Providing SOLs and IROLs

[FAC-014-3 R5]

[R5.1] PJM is the registered RC and PC for its footprint. PJM utilizes common SOLs within its footprint. The IROLs are designated in this Manual and their definitions are listed in PJM Manual - 03: Transmission Operations - Section 3.8.

[R5.2] PJM calculates the IROL limits on a seasonal, Day-ahead, and Real-time basis. The summer and winter seasonal IROL limits are calculated as part of the OATF studies and provided to System Planning with the following information:

- The value of the IROL limits;
- The Facilities critical to the derivation of the IROL (Reactive Interface definitions);
- The associated IROL Tv (as defined in Section 3.10 above);

- The associated critical Contingency(ies) for each IROL;
- A description of the system conditions associated with the IROL;
- And the type of limitation represented by the IROL (as defined in Section 3.10 above).

IROLs and Stability Limits

[R5.3, R5.4] PJM is the registered Reliability Coordinator and the registered Transmission Operator (TOP) for its footprint except for facilities at or below 138 kV that are owned and operated by American Electric Power (AEP), and the buswork at the U.S. Department of Energy facility at Portsmouth (OH). There are no IROLs facilities under the control of AEP or the U.S. Department of Energy facility at Portsmouth.

PJM calculates the Reactive Interface/IROL and stability limits in the Operational Planning Analysis (OPAs) and in Real-time. PJM Manual 38: Operations Planning – Attachment B contains the study details.

For OPAs, PJM calculates the IROL and associated information using the EMS Transfer Limit Calculator (TLC) tool. The Day-ahead study results (IROL and most limiting contingency) are provided in the Day-ahead Reliability Engineering reports and the Second Pass reports. These results are also available in the EMS study cases including the contingency set (associated contingencies) used to determine the IROL.

Other IROL related information are specified in PJM Manual 03: Transmission Operations and Manual 37: Reliability Coordination.

For Real-time Operations, PJM utilizes the TLC tool to calculate the Reactive Transfer interface/ IROL based on the latest EMS State Estimator (SE) solutions. The SE solutions reflect the Real-time system conditions.

The stability limits are documented in PJM Manual 03B: Transmission Operating Procedures (CEII), which is provided to PJM System Planning (the PC), for common operating conditions with the following information:

- The value of the stability limits;
- The Facilities that are critical to the derivation of the stability limit;
- The associated critical Contingency(ies);
- A description of the system conditions associated with the stability limit;

The type of limitation represented by the stability limit (e.g., angular or damping).PJM performs near term stability studies based on expected system conditions. The stability study results are documented in the eDART transmission outage tickets with the following information:

- The value of the stability limit;
- The transmission outage (Facility(ies) that is critical to the derivation of the stability limit;

- The associated critical Contingency;

PJM Manual 03B: Transmission Operating Procedures (CEII) defines the type of limitation represented by the stability limit (e.g., angular or damping) and contains a description of the system conditions associated with the stability limit.

The transmission outage ticket and associated stability limitation notes are included in the Day-ahead Reliability Engineering reports and the Second Pass reports. These reports are posted on a secure Outage Analysis Reporting site on pjm.com for Transmission Operators and Transmission Owners to access and incorporate in their OPAs and Real-time Operations.

In addition to posted reports, stability limits are provided to TOPs and TOs in the TO Connection Stability Viewer tool. Stability Viewer is a logging and record-keeping tool for unit or area stability restrictions. It provides additional information to TOPs and TOs on specific current stability limitations within PJM.

For Real-time Operations, PJM utilizes TSA to assess system stability based on the latest SE solutions.

[R5.5] PJM will provide its SOL information or methodology as documented in the PJM Manuals to TOPs within its footprint upon request. The PJM Manuals are updated periodically and published on pjm.com.

[R5.6] PJM performs an annual assessment of the facilities that are critical to the derivation of the IROLs and their associated critical contingencies. These facilities are provided to each impacted GO or TO within the Reliability Coordinator Area at least once every 12 calendar months.

3.12 Monitoring of SOL and IROL Limits

Monitoring of the SOL and IROL limits is accomplished through the use of the tools described in the PJM Transmission Operations Manual-03, Sections 2 and 3. [NERC Standard IRO-003]

PJM monitors SOL and IROL limits via the PJM EMS. PJM Dispatch prioritizes constraints based on the impact to System Reliability. IROL facilities are facilities that if exceeded have the potential to result in wide-area voltage collapse. All BES facilities and “Reliability and Markets” sub-BES facilities as listed on the PJM Transmission Facilities page pages are considered SOLs, including the subset of SOLs that make up the PJM defined IROLs. Clear guidance and supporting procedures are essential to ensure proper prioritization when attempting to mitigate multiple constraints. This includes guidance when generating units are not following dispatch instructions and the appropriate use of Post-Contingency Local Load Relief Procedures. The following list of actions provides general prioritization guidelines, recommended operator actions, and associated timelines for SOL and IROL limits.

PJM Actions

- PJM Dispatch shall confirm pre-/post-contingency flows and ratings with PJM TO/TOP or external RC.
- PJM Dispatch shall proactively propagate constraints into SCED in order to prepare for unanticipated system events. Constraints above 95% shall be propagated into SCED, but not necessarily bound.
- PJM Dispatch shall evaluate and prioritize constraints, looking for common controlling actions. In general, constraints shall be prioritized in the following manner. Actual violations may hold a higher priority depending on their magnitude and voltage level.
    - Non-Converged contingencies
    - IROL Violations
    - Reactive Transfers
    - Actual Violations
    - Contingency Violations
- PJM dispatch shall utilize SCED to ensure the proper re-dispatch of the system when unanticipated system events force multiple constraints.
- PJM Dispatch shall implement controlling actions in the following order if time permits:
    - Non-cost measures
    - Curtailing “Not-willing-to-pay” transactions that adversely impact constraint.
    - Cost-Effective re-dispatch:
        - Dispatch sufficient generation to control constraints within the allotted timeframe.
        - Initiate Market-to-Market (M2M) Re-dispatch for reciprocally coordinated flowgates.
        - Review regulation assignments and their impact on constrained operations. Localized constraints may require de-committing specific regulating units.
        - Direct generation shift via SCED and phone to ensure generation is following set-points.
        - Review initial dispatch orders to ensure cost-effective constraint control.
        - Monitor generation dispatch and contact units that are not performing.
        - Manually direct generation as required.
    - Emergency Procedures (as detailed in PJM Manual 13), including “safe operating mode” and TLR (**NOTE**: TLR for excessive circulation may be declared prior to initiating off-cost). Curtail transactions that source/sink in priority order if there is insufficient time to declare TLR. Adjust internal curtailments per IDC.
    - If there are insufficient resources available to control constraints within 60 minutes, dispatch shall have formulated and communicated a load shed plan to impacted TO/TOP, issuing a Post-Contingency Local Load Relief Procedure or Manual Load Dump

Warning consistent with PJM Manual 13: Emergency Operations - Section 5: Transmission Security Emergencies.

- Direct manual load shed as required via:
  - Load Shed Directive
  - Manual Load Dump Action

- Report IROL Limit violation exceeding 30 minutes (T_V) or any SOL violations that have become an IROL violation because of changed system conditions to NERC and the applicable Regional Entity within 24 hours.
- Report SOL Limit violations that exceed the following criteria:
  - Thermal Ratings: flow exceeds the time limit associated with the rating (i.e. normal limit = 24 hours, LTE limit = 4 hours, STE limit = 30 minutes - 2 hours, LD – 15 minutes).
  - Transient Stability Ratings and Voltage Stability Ratings: Stability limitation exceedances for 30 minutes or greater based on limits provided in PJM Manual 03: Section 3 and PJM Manual 03B or the most current real-time analysis.
  - System Voltage Limits: a valid non-radial, non-converged system contingency (unsolved) observed in real-time Contingency ~~Security~~ Analysis for 30 minutes or greater.

PJM Member Actions

- PJM Dispatch shall confirm pre-/post-contingency flows and ratings with PJM TO/TOP or external RC.
- TO/TOP Dispatch shall monitor facilities and communicate limit violations to PJM Dispatch.
- Generation Owner Dispatch shall follow SCED desired set point.
- Generation Owner Dispatch shall communicate generator issues that will prohibit units from following SCED desired set points.

A chart that demonstrates the order which PJM Reliability Coordinators prioritize constraints, available actions and associated timelines are included within this manual as Attachment C – Constraint Prioritization.

Section 4: Transmission Loading Relief (TLR)

This is the Transmission Loading Relief section of the **PJM Manual for Reliability Coordination**. In this section, you will find the following information:

- How PJM uses TLR and other procedures to implement loading relief on transmission lines.
- How PJM responds to TLRs issued by neighboring RCs

4.1 Initiating the TLR Process

PJM monitors designated transmission facilities within the PJM RTO as well as tie-lines with adjacent interconnected control areas. When PJM determines overload conditions exist on any designated facility, or would exist for the first contingency loss of another facility, PJM will take all reasonable necessary action(s) to restore transmission facilities within operating security limits.

PJM will generally not use TLR to mitigate a transmission overload (actual or simulated), unless it has exhausted all other means available, short of load shedding (reconfiguration, re-dispatch within the PJM market area, market-to-market (M2M) re-dispatch, etc.).

During periods of excessive circulation, PJM may use TLR and curtail transactions not willing to pay congestion on the PJM system. However, under normal system conditions, PJM will re-dispatch internal generation to the extent possible, and if more relief is needed, PJM will perform the following actions:

- Invoke the Transmission Loading Relief Procedure, in accordance with NERC Standard IRO-006, IRO-006-EAST and NAESB Business Practice WEQ-008
- Curtail external transactions and/or charge external customers for the cost of congestion, as specified in the PJM Open Access Transmission Tariff

If all transactions for which transmission customers have elected not to pay through congestion have been curtailed and further relief is still required on the transmission facility, PJM will begin to curtail all transactions (internal and external) for which transmission customers have elected to pay through congestion, in priority order. [NERC Standard IRO-006-EAST]

PJM Actions

- PJM implements all non-cost measures to control transmission flows.
- PJM curtails transactions with transmission service in PJM that are “not willing to pay through congestion”.
- PJM adjusts output of generators off-cost to alleviate overloads/implements M2M.

- PJM re-dispatches to the fullest extent possible, excluding Maximum Emergency Generation, and initiates the TLR procedure via the IDC. [NERC Standard IRO-006-EAST]
  - PJM will re-evaluate the TLR level at least every clock hour and reissue the TLR via the IDC as needed.
  - PJM will monitor the IDC to confirm all impacted RCs acknowledge the curtailments required in the IDC TLR curtailment report. If curtailments are not acknowledged in a timely manner, PJM will contact the RC to determine if there is a reliability concern and coordinate alternate mitigation options as necessary.
- PJM curtails external transmission customers not willing to pay through congestion and charges other external customers willing to pay for the cost of congestion, as set forth in the PJM Open Access Transmission Tariff.
- PJM curtails transmission customers willing to pay through congestion (and no longer charges those curtailed for congestion) in priority order.

PJM Member Actions

- External transmission customers may elect, in accordance with section 1.10.6A of the Open Access Transmission Tariff, to pay congestion charges during Transmission Loading Relief in the PJM RTO.
- PJM transmission customers may elect to curtail their own transactions at any time if congestion charges have become too great.

4.2 Responding to the TLR Process

PJM monitors the IDC tool continuously and responds to all RC requests for congestion management actions via the TLR process.

PJM Actions

- PJM monitors the IDC tool at all times.
- PJM acknowledges, within 15-minutes, any congestion management actions to be implemented by the external RC initiating the TLR procedure, which may include transaction curtailments, Market Flow curtailment, transmission reconfiguration, Generation – To-Load (GTL) adjustments, etc., provided such actions will not result in a reliability concern. If they would, PJM will contact the issuing RC and develop an alternate plan of action to address both reliability needs.

Section 5: Coordination with Neighboring Reliability Coordinators

Welcome to the Coordination with Neighboring Reliability Coordinators section of the **PJM Manual for Reliability Coordination**. In this section, you will find the following information:

- A summary of coordination agreements between PJM and neighboring Reliability Coordinators
- How PJM communicates with neighboring Reliability Coordinators
- How PJM works with neighboring Reliability Coordinators to mitigate operational problems

5.1 Agreements with Neighboring Reliability Coordinators

PJM has developed coordination agreements with its neighboring Reliability Coordinators, as follows:

- Joint Operating Agreement Between the Midcontinent Independent System Operator, Inc. and PJM Interconnection, L.L.C.
- Joint Reliability Coordination Agreement Among and Between PJM Interconnection, L.L.C., and Tennessee Valley Authority, and Louisville Gas and Electric Company and Kentucky Utilities Company.
- Joint Operating Agreement Among and Between New York Independent System Operator Inc. and PJM Interconnection, L.L.C.
- Adjacent Reliability Coordinator Coordination Agreement between PJM Interconnection, L.L.C. and VACAR South RC

The coordination agreements detail requirements to which both parties are committed to preserve reliability. The agreements address a wide range of topics, including data exchange, ATC calculation, outage coordination, emergency operations, etc. These agreements provide for the ongoing cooperation between the signatories by the establishment of joint operating committees that meet periodically to discuss and resolve operational issues [NERC Standard IRO-014].

5.2 Communications with Neighboring Reliability Coordinators

5.2.1 Communications Facilities

PJM communicates with its neighboring Reliability Coordinators in a number of ways, governed by the urgency of the issue. The communications vehicles include:

- Regular telecommunications over the public switched telephone network
- Satellite telephones
- E-mail

- Reliability Coordinators Information System (RCIS)
- NERC Hotline

5.2.2 Required Notifications

Certain operational situations are of a magnitude that notification to neighboring Reliability Coordinators is necessary. These situations are explained in PJM Manual 13: Emergency Operations. They include:

- Capacity Emergencies
- Extreme Weather—e.g. Tornadoes, Hurricanes, Extreme Temperatures, Geo-Magnetic Disturbances (GMD), Hot Weather, Cold Weather etc.
- Sabotage or Terrorism Incidents (if the event is significant to the PJM system and may impact neighboring systems)
- Transmission Security Emergencies—Heavy Load/Low Voltage situations, IROL limit violations (if the emergency could cause an impact on the neighboring Reliability Coordinator's system)
- Other events—Events which are of such a nature or magnitude that they could impact the operations of the neighboring Reliability Coordinator(s), in the judgment of the operator

In addition, the PJM Reliability Coordinator is responsible to monitor system frequency and ACE control.

The preferred communications method in the above situations is the telephone with a message also being entered on the RCIS.

PJM Actions

- Monitor the transmission system and other media news and weather outlets to identify threats or risks to the reliability of the system.
- If an emergency situation, identified above, is in progress, or imminent, provide notification to the neighboring Reliability Coordinators by phone or conference call. Also, enter a message on the RCIS. If the situation is of a magnitude that coordinated action or assistance may be necessary, organize a conference call on the NERC hotline, or commercial teleconferencing service.
- If the situation is sabotage or terrorism related, notify the appropriate law enforcement authorities.
- Once the situation is concluded, a notification should be provided to the impacted Reliability Coordinators in the same method as the original notification.

PJM Member Actions

- Monitor system conditions and identify potential or actual emergency situations to PJM as soon as possible to permit PJM to organize assistance from the neighboring Reliability Coordinators, if required.

- Follow directives from PJM that may come from neighboring Reliability Coordinators to implement action to mitigate the emergency situation.

5.3 Mitigating Operational Problems

Rapid, coordinated action is sometimes necessary to mitigate or alleviate an operational problem. Such action may require assistance from a neighboring Reliability Coordinator(s). In these situations, clear, concise communications are necessary to develop a coordinated action plan that can be implemented quickly. When working with other Reliability Coordinators, the key is to gain a mutual understanding of the problem at hand and how the other Reliability Coordinator may be of assistance. When a mutually agreed upon course of action cannot be developed, then implement the most conservative course of action.

PJM Actions

- As part of the notification processes described above, or immediately thereafter, contact the neighboring Reliability Coordinator, if there is the potential for assistance. Concisely, yet fully, explain the situation and how the neighboring Reliability Coordinator could be of assistance.
- Be responsive to the needs of the neighboring Reliability Coordinator to require additional information to assess their ability to provide assistance. Provide any necessary information that may be needed to analyze the situation and develop a corrective action.
- PJM Reliability Coordinator shall document, in PJM SmartLog system, the need to enhance the PJM EMS Bulk Electric System external model based on real-time system conditions. The PJM Reliability Coordinator shall communicate the need to enhance the PJM EMS Bulk Electric System external model to PJM Operations Engineering Support.
- Work to achieve a consensus on the course of action to be followed. In the absence of a consensus, adopt the most conservative course of action. Through the course of the discussions and during the implementation of the course of action, document steps taken and points of disagreement in the operator logs.

PJM Member Actions

- Follow directives from PJM that may come from neighboring Reliability Coordinators to implement action to mitigate the emergency situation.

Attachment A: PJM Reliability Plan

PJM RTO Reliability Plan

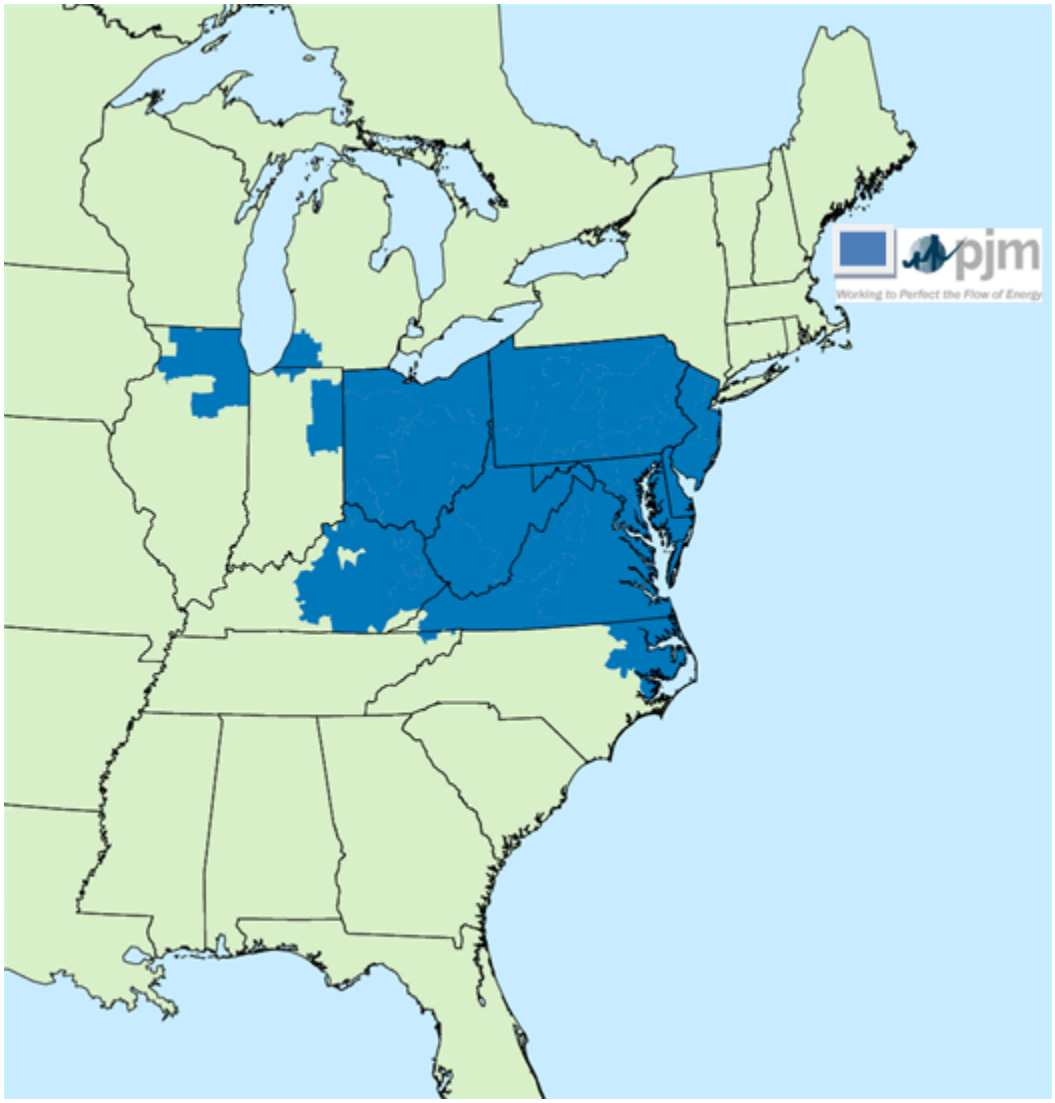


Table of Contents

Introduction

The North American Electric Reliability Corporation (NERC) requires every Region, sub-region, or interregional coordinating group to establish a Reliability Coordinator to provide the reliability assessment and emergency operations coordination for the Balancing Authorities and Transmission Operators within the Regions and across the Regional boundaries.

PJM Interconnection, LLC (PJM) serves as the Reliability Coordinator (RC) for its transmission-owning members. PJM is responsible for regional system reliability, which includes responsibility for both the Bulk Electric System, and lower voltage facilities that have been turned over to PJM for operational control. The PJM functions associated with the reliability of the Bulk Electric System include review and approval of planned facility transmission line outages and generation outages based upon current and projected system conditions, monitoring of real time loading information and calculating post-contingency loadings on the transmission system, administering loading relief procedures, re-dispatch of generation, and ordering curtailment of transactions and/or load. PJM operates a single Balancing Authority (BA) in its footprint and is also responsible for system control performance. PJM reliability procedures and policies are consistent with NERC and Regional Entity Standards. PJM operates within multiple NERC Regional Entities and recognizes each Regional Entity's policies and standards.

A. Responsibilities – Authorization

1. Authority to Act - PJM is responsible for the reliable operation of the Bulk Electric System within its Reliability Coordination Area in accordance with NERC Standards, Regional policies

and standards. PJM's authority to act is derived from a set of agreements all PJM members have executed (See Appendix A). PJM has clear decision-making authority to act and to direct actions taken by its members within its Reliability Coordination Area to preserve the integrity and reliability of the Bulk Electric System.

1.1 PJM has a Wide Area view of its Reliability Coordination Area and neighboring areas that have an impact on PJM's area. PJM has the operating tools, processes and procedures, including the authority, to prevent or mitigate emergency operating situations in both next-day analysis and during real-time conditions per the NERC Standards and Regional policies and standards, as well as the governing documents listed in Appendix A of this document.

1.2 PJM has clear decision-making authority to act and to direct actions taken by its members within its Reliability Coordination Area to preserve the integrity and reliability of the Bulk Electric System. PJM's responsibilities and authorities, as well as its members' responsibilities, are clearly defined in the governing documents.

1.3 PJM has not delegated any of its Reliability Coordinator responsibilities.

2. Independence - PJM will act in the best interest of ensuring reliability for its Reliability Coordination Area and the Eastern Interconnection before that of any other entity. This expectation is clearly identified in the governing documents (see Appendix A).

3. PJM Operating Instructions Compliance - Per the governing documents (see Appendix A), the PJM local control centers shall carry out required emergency actions as directed by PJM, including the shedding of firm load if required, unless such actions would violate safety, equipment, regulatory, or statutory requirements.

B. Responsibilities – Delegation of Tasks

PJM has not delegated any Reliability Coordination tasks.

C. Common Tasks for Next-Day and Current-Day Operations

This section documents how PJM conducts current-day and next-day reliability analysis for its Reliability Coordination Area.

1. Determination of Interconnection Reliability Operating Limits (IROLs) – PJM determines IROLs based on local, regional and inter-regional studies including seasonal assessments and ad hoc studies. The majority of the PJM IROLs are voltage stability interfaces.

During real time operations, PJM calculates the actual flow for the reactive interface IROLs using Transmission Limit Calculator (TLC). TLC uses a state estimator snapshot, calculates a voltage collapse transfer limit, and establishes an operating limit based on a back off from the

calculated collapse point. These limits are calculated approximately every 5 minutes using the current system topology and posted to the PJM website in close to real time.

2. Operation to prevent the likelihood of a SOL or IROL violation in another area of the Interconnection and operation when there is a difference in limits – PJM, through the Joint Operating Agreement with other Reliability Coordinator neighbors, coordinates operations to prevent the likelihood of a SOL or IROL in another area. These agreements include data exchange, Available Transfer Capability coordination, and Outage Coordination and are listed in Appendix B.

Local control centers in the PJM Reliability Coordination Area are required to follow directives provided by PJM and operate to NERC Standards to prevent the likelihood that a disturbance, action, or non-action in its Reliability Coordination Area will result in a SOL or IROL violation in another area of the Interconnection. When there is a difference in derived limits, PJM utilizes the most conservative limit until the difference is resolved.

3. Operation under known and studied conditions and re-position without delay and no longer than 30 minutes – PJM ensures entities within its Reliability Coordination Area always operate under known and studied conditions and they return their systems to a secure operating state following contingency events within approved timelines, regardless of the number of contingency events that occur or the status of their monitoring, operating and analysis tools. PJM also ensures its local control centers re-position the system to be within all IROLs following contingencies within 30 minutes.

On a daily basis, PJM conducts Nnext-Dday Reliability Analysissecurity analyses utilizing planned outages, forecasted loads, generation commitment, and expected net interchange. The analyses include contingency analysis and voltage stability analysis on key interfaces. These analyses model peak conditions for the day and are conducted utilizing first contingency (n-1) analysis. Results and mitigation are documented in the Next-Day Reliability AnalysisSecurity Analysis Report and distributed to PJM staff and neighboring Reliability Coordinators. The Next-Day Reliability AnalysisSecurity Analysis Report is posted to a secure website available to the PJM local control centers and neighbors. Mitigation plans are formed as needed for potential violations determined in the Nnext- dDay Reliability Analysissecurity analysis.

In real time, PJM relies on its telemetry and real-time analysis tools to monitor real time system conditions to identify potential IROL and SOL problems. PJM's operational philosophy is to operate on a pre-contingency basis; that is, to mitigate a simulated overload condition before it occurs.

4. PJM provides transmission service within the PJM Reliability Coordination area. PJM communicates IROLs within its wide-area view and provides updates as needed via reports, morning conference calls, and the ALL-CALL system and real-time via voice and messaging.

5. PJM process for issuing Operating Instructions – PJM uses a number of communications tools for issuing/receiving of Operating Instructions. The primary communications means is the

PJM All-Call System (All-Call) which is a dedicated telephone-based system which sends the Operating Instruction / message to all control centers simultaneously and confirms response. In addition, PJM will follow the verbal message with Emergency Procedures messages on its website through a specific application that runs within its Data Viewer tool and as well direct phone contact as necessary.

D. Next Day Operations

This section documents how PJM conducts next-day reliability analyses for its Reliability Coordination Area.

1. Reliability Analysis and System Studies – PJM conducts next-day reliability analyses for its Area to ensure the Bulk Power System can be operated reliably in normal and post contingency conditions.

On a daily basis, PJM conducts ~~n~~Next-D~~d~~ay Reliability~~security a~~Analyses utilizing known outages, forecasted loads, generation commitment and dispatch, and expected net interchange using the study capability in the PJM EMS. Base case flows on all monitored facilities are compared against the normal rating. Post-contingency flows for all monitored facilities are compared against their emergency rating for all contingencies. Voltage stability analysis is conducted on key critical interfaces to determine a flow limit. Transient stability analysis is performed in accordance with PJM Manual 03 section 3.9. PJM utilizes its analysis tools to monitor expected next day system conditions to identify and resolve potential stability SOL exceedances. The EMS Transfer Limit Calculator (TLC) tool is used to analyze expected next day system conditions to identify and resolve potential IROL exceedances.

Mitigation plans are formed as needed for potential violations determined in the N~~n~~ext- ~~d~~Day Reliability~~security a~~Analysis. Mitigation is of the form of additional generation commitment, system reconfiguration, generation re-dispatch, use of TLR or other local flow mitigation procedures.

2. Information Sharing – Generation Owners and Transmission Owners in the PJM Reliability Coordination Area and neighboring Reliability Coordinator areas provide to PJM all information required for system studies, such as critical facility status, load, generation, Operating Reserve projections, and known interchange transactions.

The entities in the PJM Reliability Coordination Area provide generation and transmission facility statuses to the PJM outage scheduling application (eDART), forecasted loads, operating reserves, and known interchange transactions via OATI webSmartTag. PJM shares this information via an SDX file every fifteen minutes. For entities outside PJM, SDX files are downloaded and loaded into appropriate systems.

Sharing of Study Results - When conditions warrant or upon request, PJM shares the results of its system studies with the entities within its Reliability Coordination Area and/or with other Reliability Coordinators.

A Next-Day Reliability ~~Security~~ Analysis Report is available to PJM and member operations staff and neighboring Reliability Coordinators via secure website. PJM holds daily conference calls with MISO, and others, as necessary, as part of this process.

E. Current Day Operations

This section documents how PJM conducts current-day reliability analyses for its Reliability Coordination Area.

1. PJM uses a suite of real time network analysis tools to continuously monitor all Bulk Power System facilities, including sub-transmission information as needed, within the PJM Reliability Coordination Area and adjacent areas, as necessary, to ensure, at any time, PJM is able to determine any potential SOL and IROL violations within its Reliability Coordination Area.

PJM utilizes a state estimator (SE) and real-time contingency analysis as the primary tool to monitor facilities. The state estimator model includes all BES as well as facilities, generally 69 kV and above, in the PJM Reliability Coordination Area. The model also has extensive representation of neighboring facilities in order to provide an effective wide-area view. This model is updated quarterly and may be updated on demand for emergencies.

Real Time Contingency Analysis (RTCA) is performed on contingencies utilizing the state estimator model approximately every 1-2 minutes. Contingencies include all PJM Reliability Coordination Area equipment which has been turned over to PJM for operational control, and neighboring contingencies that would impact PJM Reliability Coordination Area facilities.

In order to continuously monitor its reactive interfaces, PJM uses a real time calculation tool named Transmission Limit Calculator (TLC). TLC takes a state estimator snapshot and calculates a voltage collapse equivalent flow for the interface, based on current real time telemetry and topology. A back off flow is established to prevent operating to an actual voltage collapse, and PJM operates to maintain flows below this limit.

SCADA alarming is utilized to alert PJM of any actual low or high voltages or facilities loaded beyond their normal or emergency limits.

In addition to the above applications, PJM utilizes a dynamically updated transmission overview display to maintain a wide area view. All transmission facilities 500 kV and above are depicted on the overview with flows (MW and MVAR), indication of facilities out of service, high and low voltage warning and alarming. For more detailed monitoring, bus level one-line diagrams are utilized for station level monitoring and information. The one-line diagrams are populated with the real time telemetered information as well as the state estimated solution.

1.1 PJM notifies neighboring Reliability Coordinators of operational concerns (e.g. declining voltages, excessive reactive flows, or an IROL violation) that it identifies within the neighboring Reliability Coordination Area via direct phone calls, conference calls, NERC hotline calls, and/or RCIS messages. PJM has joint operating agreements with neighboring Reliability Coordinators that are listed in Appendix B. PJM directs actions to provide emergency assistance to all Reliability Coordination neighbors, during declared emergencies, which is required to mitigate the operational concern to the extent that the same entities are taking in kind steps and the assistance would be effective.

2. PJM maintains awareness of the status of all current critical facilities whose failure, degradation or disconnection could result in an SOL or IROL violation within its Reliability Coordination Area via State Estimator, RTCA, SCADA alarming, and transmission displays. PJM is aware of the status of any facilities that may be required to assist Reliability Coordination Area restoration objectives via these same displays and tools.

3. PJM is continuously aware of conditions within its Reliability Coordination Area, and includes real time information in its reliability assessments via automatic updates to the SE, RTCA, TLC, Transient Stability Assessment Tool (TSA), and transmission displays. PJM monitors its Reliability Coordination Area parameters, including the following:

3.1 Current status of Bulk Power System elements (transmission or generation including critical auxiliaries) such as Automatic Voltage Regulators, Remedial Action Schemes (RAS), and system loading are monitored by state estimator, RTCA, SCADA Alarming, and transmission displays. PJM members are required to report to PJM when Automatic Voltage Regulators are not in-service or status changes of RAS.

3.2 Current pre-contingency element conditions (voltage, thermal, or stability) are monitored by state estimator, SCADA Alarming, TLC, and transmission displays.

3.3 Current post- contingency element conditions (voltage, thermal, or stability) are monitored by RTCA, TLC, TSA, and transmission displays.

3.4 System real reserves are monitored versus what is required in EMS. Reactive reserves versus what is required are monitored via monitoring adequacy of calculated post-contingent steady state voltages versus voltage limits, voltage stability interfaces against limits, and reactive reserves versus required for defined zones. Reactive Reserve Checks are made as needed when reactive reserves in real-time indicate lower than expected.

3.5 Capacity and energy adequacy conditions are determined Day Ahead (DA) and monitored real time in accordance with our Market Processes to maintain the required levels of reserves.

3.6 Current ACE, System Frequency and BAAL are displayed in trend charts to the PJM Generation Dispatcher.

3.7 Current local procedures, such as operating procedures, are monitored and coordinated with local control centers and implementation documented in the PJM SmartLogs. TLR procedures in effect are monitored via the Interchange Distribution Calculator and documented in the PJM SmartLogs.

3.8 Generation dispatch is performed for the PJM Balancing Authority Area by the PJM Generation Dispatcher using the Security Constrained Economic Dispatch (SCED) application, which is a single economic constraint controlled dispatch for the entire PJM RTO area.

3.9 Planned transmission or generation outages are reported to PJM via the eDART application. In the PJM EMS, any current Transmission Facility outages which are not associated with an eDART ticket, such as unplanned outages, will automatically create an eDART ticket.

3.10 Contingency Events are monitored by state estimator, RTCA, SCADA Alarming, and transmission displays. Local control centers report Contingency Events on non-monitored facilities to PJM.

4. PJM monitors Bulk Power System parameters that may have significant impacts upon its Reliability Coordination Area and neighboring Reliability Coordination areas with respect to:

4.1 PJM maintains awareness of all Interchange Transactions that wheel-through, source, or sink in its Reliability Coordination Area via OATI webSmartTag and IDC displays. Interchange Transaction information is made available to all Reliability Coordinators via OATI webSmartTag. PJM monitors internal transactions in its market area via the PJM ExSchedule application.

4.2 PJM evaluates and assesses any additional Interchange Transactions that would violate IROL or SOLs by using the IDC as a look-ahead tool. As flows approach their IROL or SOLs, PJM evaluates the incremental loading next-hour transactions would have on the SOLs or IROLs and determines if action needs to be taken to prevent an SOL or IROL violation. PJM has the authority to direct all actions necessary and may utilize all resources to address a potential or actual IROL violation up to and including load shedding. PJM has EMS displays, including the reactive interface limits screen that is designed so the operators can watch and monitor specific IROL limits.

4.3 PJM monitors Operating Reserves versus each Regional requirement to ensure the required amount of Operating Reserves is provided and available as required to meet NERC Control Standards via EMS and meet the Regional obligation. If necessary, PJM will commit additional reserves including obtaining assistance from neighbors.

4.4 PJM identifies the cause of potential or actual SOL or IROL violations via analysis of state estimator results, RTCA results, SCADA Alarming of outages, TLC results, transmission displays of changes, and Interchange Transaction impacts. PJM will initiate control actions including transmission reconfiguration, generation re-dispatch, or emergency procedures to relieve the potential or actual IROL violation without delay, and no longer than 30 minutes. PJM is authorized to direct utilization of all resources, including load shedding, to address a potential

or actual IROL violation. PJM will not solely rely on the TLR procedure to mitigate an IROL violation.

4.5 PJM complies with the start and end times for time error corrections as communicated by the Time Monitor. PJM communicates Geo-Magnetic Disturbance forecast information to local control centers and Generation Operators via the All-Call System and the Emergency Procedures webpage. PJM will assist in development of any required response plan and may move to conservative operating mode to mitigate impacts as needed.

4.6 PJM participates in NERC Hotline discussions, assists in the assessment of reliability of the Regions and the overall interconnected system, and coordinates actions in anticipated or actual emergency situations. PJM will disseminate this information via the All-Call system or individual phone calls.

4.7 PJM monitors system frequency and ACE via trend graph. If the BAAL is outside of the acceptable range, the PJM Regulation will be manually adjusted, if necessary, to utilize the support resources for frequency mitigation. PJM will utilize all resources, including firm load shedding, to relieve the emergent condition.

4.8 PJM coordinates with other Reliability Coordinators and its Generation Operators and local control centers, as needed, on the development and implementation of action plans to mitigate potential or actual SOL, IROL, BAAL or DCS violations. PJM coordinates pending generation and transmission maintenance outages with other Reliability Coordinators and its Generation Operators and local control centers, as needed and within code of conduct requirements, real time via telephone and next-day per the PJM outage scheduling process.

4.9 PJM will assist or request assistance as the Balancing Authority Operator for the RTO from neighboring Reliability Coordinators via the Energy Emergency Alert (EEA) notification process and will conference parties together as appropriate.

4.10 PJM monitors its ACE to identify the sources of problems contributing to frequency, time error, or inadvertent interchange and directs corrective actions per 4.7 above.

4.11 The local control centers within PJM's Reliability Area inform PJM of all changes in status of Remedial Action Schemes (RAS), including any degradation or potential failure to operate, as expected by the local control center. PJM factors these RAS changes into its reliability analyses and updates its contingency definitions as appropriate.

5. PJM issues alerts, as appropriate, to local control centers via the All-Call system, individual phone calls, when it foresees a transmission problem (such as an SOL or IROL violation, loss of reactive reserves, etc.) within its Reliability Area that requires notification. PJM issues alerts, as appropriate, to all Reliability Coordinators via the Reliability Coordinator Information System when it foresees a transmission problem (such as an SOL or IROL violation, loss of reactive reserves, etc.) within its Reliability Area that requires notification.

6. PJM confirms reliability assessment results via analyzing results of state estimator/RTCA, and discussions with local control centers and neighboring Reliability Coordinators. PJM identifies options to mitigate potential or actual SOL or IROL violations via examining existing operating procedures, system knowledge, and power flow analysis to identify and implement only those actions as necessary as to always act in the best interests of the interconnection.

F. Emergency Operations

1. PJM utilizes PJM Manual 13: Emergency Operations, to direct its Members to return the transmission system to within IROL or SOL limits as soon as possible, but no longer than 30 minutes. This procedure includes the actions (e.g. reconfiguration, re-dispatch or load shedding) PJM will direct until relief requested by the TLR process is achieved.

2. PJM utilizes PJM Manual 13: Emergency Operations, when it determines IROL violations are imminent. PJM Emergency Operations documents the processes and procedures PJM follows when directing the re-dispatch of generation, reconfiguring transmission, managing Interchange Transactions, or reducing system demand to mitigate the IROL violation to return the system to a reliable state. PJM coordinates its alert and emergency procedures with other Reliability Coordinators via joint operating agreements listed in Section H.

3. PJM directs actions in the event the loading of transmission facilities progresses to or is projected to progress to an SOL or IROL violation.

3.1 PJM directs reconfiguration and re-dispatch within its market area as needed to prevent or relieve SOL or IROL violations. PJM will not rely on or wait for TLR to relieve IROL violations. PJM will implement TLR if doing so will provide additional relief. PJM will adhere to the TLR congestion report instructions including curtailing transactions and re-dispatching for market flow.

3.2 PJM utilizes market-to-market re-dispatch for its market area for reciprocally coordinated flowgates with MISO and NYISO per the Congestion Management Process (see Appendix B). PJM also coordinates flowgate limits and monitors flows on facilities within TVA, Duke, Progress Energy and other RC areas in order to maintain reliable operation.

3.3 PJM uses market re-dispatch, in conjunction with TLR per the IDC congestion relief report.

3.4 PJM complies with the provisions of the TLR by curtailing Interchange Transactions and re-dispatching for market flow per the IDC congestion relief report.

3.5 PJM will direct reconfiguration, re-dispatch for market areas, and TLR reductions to relieve facilities as necessary. PJM will not rely on TLR as an emergency action.

4. PJM monitors its ACE, and directs action to assist in maintaining system frequency to return within BAAL limits as appropriate.

5. PJM utilizes PJM Manual 13: Emergency Operations, to mitigate an energy emergency within its Reliability Coordination Area. PJM will provide assistance to other Reliability Coordinators per its respective joint operating agreement listed in Appendix B.

6. PJM utilizes PJM Manual 13: Emergency Operations, when it, or a Reserve-Sharing Group, or a Load-Serving Entity within its Reliability Coordination Area is experiencing a potential or actual Energy Emergency. PJM Emergency Operations document the processes and procedures PJM uses to mitigate the emergency condition, including a request for emergency assistance if required.

7. PJM also drills at least annually with its members on Emergency procedures.

G. System Restoration

1. Knowledge of PJM Transmission Owner Restoration Plans – PJM is aware of each transmission owner Restoration Plan and has a written copy of each plan. During system restoration, PJM monitors restoration progress and acts to coordinate any needed assistance. PJM may direct the restoration activities, depending on system conditions.

2. PJM Restoration Plan – The PJM Restoration Procedures are contained in PJM Manual 36: System Restoration. PJM takes action to restore normal operations once an operating emergency has been mitigated in accordance with its Restoration Plan. This Restoration Plan is drilled at least annually.

3. Dissemination of Information – PJM serves as the primary contact for disseminating information regarding restoration to neighboring Reliability Coordinators and members not immediately involved in restoration.

PJM approves, communicates and coordinates the re-synchronizing of major system islands or synchronizing points, so as not to cause a burden on member or adjacent Reliability Coordination Areas.

H. Coordination Agreements and Data Sharing

1. Coordination Agreements: See Appendix B

2. Data Sharing – PJM determines the data requirements to support its reliability coordination tasks and requests such data from members or adjacent Reliability Coordinators. PJM provides for data exchange with local control centers and adjacent Reliability Coordinators via a secure network. PJM members provide data to PJM via ICCP. PJM provides data to entities outside PJM via direct links and Eastern Interconnection Data Sharing Network (EIDSN).

I. Facility

1. PJM performs the Reliability Coordinator function at the PJM Headquarters in Valley Forge, PA along with the PJM Milford control center in Milford Township, PA. The Valley Forge and Milford offices have the necessary voice and data communication links to appropriate entities within PJM to perform their responsibilities. These communication facilities are staffed and available to act in addressing a real-time emergency condition.

2. Adequate Communication Links – PJM maintains satellite phones, cellular phones, and redundant, diversely routed telecommunications circuits. There is also a video link between the Valley Forge and Milford Control Rooms.

3. Multi-directional Capabilities – PJM has multi-directional communications capabilities with its members, and with neighboring Reliability Coordinators, for both voice and data exchange to meet reliability needs of the Interconnection.

4. Real-time Monitoring – PJM has detailed real-time monitoring capability of its Reliability Coordination Area and all first tier companies surrounding the PJM Reliability Coordination Area to ensure potential or actual System Operating Limit of Interconnection Reliability Operating Limit violations are identified.

PJM monitors BES elements (generators, transmission lines, buses, transformers, breakers, etc.) that could result in SOL or IROL violations within its Reliability Coordination Area. PJM monitors both real and reactive power system flows, and operating reserves, and the status of the Bulk Power System elements that are, or could be, critical to SOLs and IROLs and system restoration requirements within its Reliability Coordination Area.

5. Study and Analysis Tools

PJM has adequate analysis tools, including state estimation, pre- and post-contingency analysis capabilities (thermal, stability, and voltage), and wide-area overview displays. PJM has detailed monitoring capability of the PJM Reliability Area and sufficient monitoring capability of the surrounding Reliability Areas to ensure potential reliability violations are identified. PJM continuously monitors key transmission facilities in its area in conjunction with the Members monitoring of local facilities and issues.

PJM ensures SOL and IROL monitoring and derivations continue if the main monitoring system is unavailable. PJM has backup facilities that shall be exercised if the main monitoring system is unavailable.

The systems utilized by PJM include:

- State Estimator and Contingency Analysis
- Status and Analog Alarming
- Overview Displays of PJM Transmission System via Wallboard
- One line diagrams for entire PJM Transmission System
- Dispatch Interactive Map Application (DIMA)

- Transmission Limit Calculator (TLC)
- Voltage Stability Analysis (VSA)
- Transient Stability Analysis (TSA)
- ExSchedules
- Security Constrained Economic Dispatch (SCED)
- Dispatcher Management Tool (DMT)
- Intelligent Event Processor (IEP)

PJM utilizes these tools, which provide information that is easily understood and interpreted by PJM operating personnel. Alarm management is designed to classify alarms in priority for heightened awareness of critical alarms.

PJM controls its Reliability Coordinator analysis tools, including approvals for planned maintenance. PJM has procedures in place to mitigate the effects of analysis tool outages.

J. Staffing

1. Staff Adequately Trained and NERC Certified – The 24 x 7 PJM shift operations team is composed as follows:

- 1 Shift Supervisor*
- 2 Generation Dispatchers*
- 4 Master Dispatchers* - responsible for Transmission Dispatch
- 1 Master Coordinator

In addition, one or more Reliability Engineers* are on shift from 5:00 AM to 12:00 midnight, 7 days per week.

*All people in these positions possess the NERC Reliability Coordinator certification[1].

- Positions that have the primary responsibility, either directly or through communications with others, for the real-time operation of the interconnected Bulk Electric System.
- Positions directly responsible for complying with NERC and Regional Entity Standards.

Each week, one of the shift teams is assigned to training. The training program consists of a set curriculum which includes tests each person must successfully complete. At a minimum, each person must complete 32 hours per year of training and drills using realistic simulations of system emergencies, in addition to other training required to maintain qualified operation personnel.

2. Comprehensive Understanding – PJM operating personnel have an extensive understanding of the transmission system within the PJM Reliability Coordination Area, including the operating

staff, operating practices and procedures, restoration priorities and objectives, outage plans, equipment capabilities, and operational restrictions.

PJM operating personnel place particular attention on SOLs and IROLs and inter-tie facility limits. PJM ensures protocols are in place to allow PJM operating personnel to have the best available information at all times.

PJM's System Operators are trained to perform their duties, both at entry level and in continuous training status. Successful completion of both written and simulator tests are required for each progression step in the control room job family. A Learning Management System is used to track the status of each operator's progress. In addition to the above training, PJM conducts other training sessions PJM System Operators are expected to complete.

3. Standards of Conduct – PJM is independent of the merchant function. PJM does not pass transmission information or data to any wholesale merchant function or retail merchant function that is not made available simultaneously to all such wholesale merchant functions. An officer of PJM has signed the NERC Reliability Coordinators Standards of Conduct. Every PJM employee, not just the operating staff, has completed training on PJM's Standards of Conduct. Refresher training on PJM's Standards of Conduct is conducted annually. Training records are maintained.

Appendix A: PJM Governing Documents

PJM Operating Agreement: https://www.pjm.com/directory/merged-tariffs/oa.pdf

PJM Open Access Transmission Tariff: https://www.pjm.com/directory/merged-tariffs/oatt.pdf

Appendix B: Agreements with External Entities

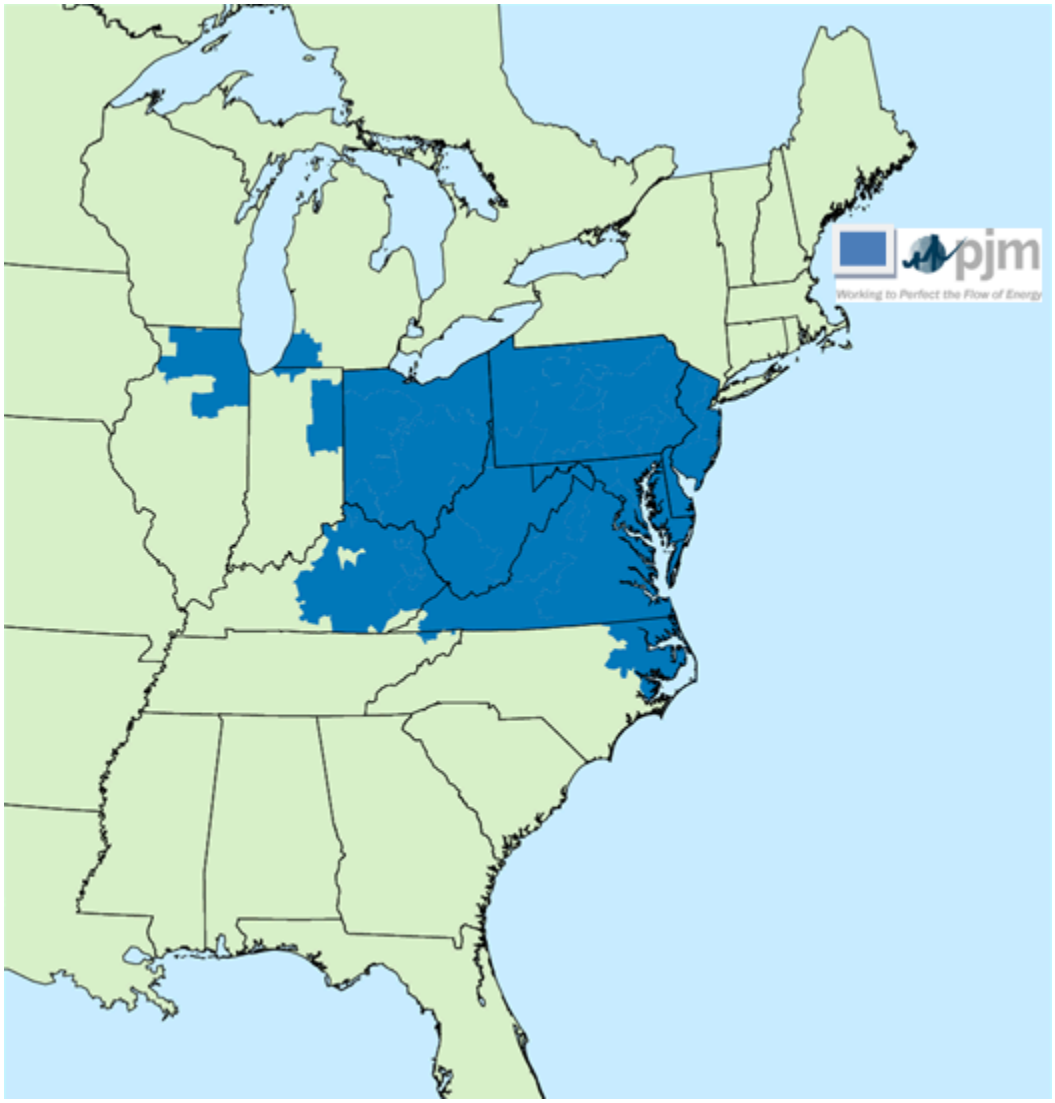
Joint Operating Agreement between the Midcontinent Independent System Operator, Inc. and PJM Interconnection, L.L.C. and the *Congestion Management Process* (MISO/PJM Joint Operating Agreement, Attachment 2)

Joint Reliability Coordination Agreement Among and Between PJM Interconnection, L.L.C., and Tennessee Valley Authority, and Louisville Gas and Electric Company, and Kentucky Utilities Company.

Joint Operating Agreement Among and Between New York Independent System Operator Inc. and PJM Interconnection, L.L.C.

Adjacent Reliability Coordinator Coordination Agreement between PJM Interconnection, L.L.C. and VACAR South RC

Appendix C: PJM Reliability Area Map



Appendix D: PJM TOs and TOPs

PJM Transmission Owner/Operator NERC Registration		
Transmission Owner/Operator	**NERC Registration Number**	**Registration**
American Electric Power	NCR00682	TO - (TOP for 138kV)
AMP Transmission, LLC	NCR11899	TO

PJM Transmission Owner/Operator NERC Registration		
Transmission Owner/Operator	**NERC Registration Number**	**Registration**
Atlantic City Electric Company	NCR00688	TO
Baltimore Gas and Electric Company	NCR00689	TO
Commonwealth Edison Company	NCR08013	TO
Cleveland Public Power	NCR00712	TO
The Dayton Power and Light Company	NCR00748	TO
Delmarva Power and Light Company	NCR00752	TO
Dominion (Virginia Electric and Power Company)	NCR01214	TO
Duke Energy Corporation	NCR00761	TO
Duquesne Light	NCR00762	TO
East Kentucky Power Cooperative	NCR01225	TO
First Energy Utilities	NCR11315	TO
General Electric International - Linden VFT	NCR11747	TO
Hudson Transmission Partners, LLC	NCR11366	TO
Neptune Regional Transmission System, LLC	NCR00130	TO
NextEra Energy Transmission MidAtlantic Indiana, Inc.	NCR12045	TO
Ohio Valley Electric Corporation	NCR00857	TO
PPL Electric Utilities	NCR00884	TO
PECO Energy	NCR08026	TO
Potomac Electric Power Company	NCR00881	TO
Public Service Electric and Gas Company	NCR00896	TO
Rockland Electric Company	NCR00863	TO

PJM Transmission Owner/Operator NERC Registration		
Transmission Owner/Operator	**NERC Registration Number**	**Registration**
Essential Power Rock Springs, LLC	NCR00251	TO
Silver Run Electric, LLC	NCR12020	TO
Southern Maryland Electric Cooperative	NCR00918	TO
Transource West Virginia, LLC	NCR11925	TO
UGI Utilities, Inc.	NCR00935	TO
U.S. Department of Energy	NCR04167	TO
Wabash Valley Power Association, Inc.	NRC00940	TO

Attachment B: Excerpt from PJM Operating Agreement

Excerpt from PJM Operating Agreement, Section 10.4, as it pertains to the authority of PJM [addressing NERC Standard IRO-001]. PJM shall:

- iv) Comply with NERC, and Applicable Regional Entity operation and planning standards, principles and guidelines;
- v) Maintain an appropriately trained workforce, and such equipment and facilities, including computer hardware and software and backup power supplies, as necessary or appropriate to implement or administer this Agreement;
- vi) Direct the operation and coordinate the maintenance of the facilities of the PJM Region used for both load and reactive supply, so as to maintain reliability of service and obtain the benefits of pooling and interchange consistent with this Agreement, and the Reliability Assurance Agreement;
- vii) Direct the operation and coordinate the maintenance of the bulk power supply facilities of the PJM Region with such facilities and systems of others not party to this Agreement in accordance with agreements between the LLC and such other systems to secure reliability and continuity of service and other advantages of pooling on a regional basis.

Attachment C: Constraint Prioritization

Thermal Constraint Priority

Priority	Highest				Lowest	
	Non Converged Contingency ⟷	IROL Facility	Reactive Interfaces	Actual Violations ⟷	Contingency Violations	Limit
Highest	15 Minutes Shed load only if necessary to avoid post - contingency cascading. Communicate Load Dump Plan (PCLLRW) prior to 30 minut es if generation response is insufficient to control within 30 minute timeframe	15 Minutes Shed load only if necessary to avoid post -contingency cascading. Communicate Manual Load Dump Plan prior to 30 minutes if generation response is insufficient to con trol within 30 minute timeframe (Tv) IROL Violations must be controlled within 30 minutes (Tv).	15 Minutes Shed load only if necessary to avoid post - contingency cascading. Communicate Manual Load Dump Plan prior to 30 minutes if generation response is insufficient to control within 30 minute timeframe	5 Minutes Load All available generation. Shed load within 5 minutes to return flows within Emergency Ratings.	30 Minutes Shed load only if necessary to avoid post - contingency cascading. Communicate Load D ump Plan (PCLLRW) prior to 60 minutes if generation response is insufficient to control within 60 minute timeframe	Thermal Load Dump Rating / Reactive Last Convergent Point
	Not Applicable. Refer to Note 1 (below).	Use all effective actions. Communi cate Load Dump Action within 30 minute timeframe.	Use all effective actions and emergency procedures except load shed. Communicate Manual Load Dump Plan prior to 30 minutes if generation response is insufficient to control within 30 minute timeframe	15 Minutes Load All available generation. Shed load within 15 minutes to return flows within Emergency Ratings.	Use all effective actions and emergency procedures except load shed. Communicate Load Dump Plan (PCLLRW) prior to 60 minutes if generation respon se is insufficient to control within 60 minute timeframe	Thermal Emergency Rating / Reactive Recommended Limit
Lowest	Not Applicable. Refer to Note 1 (below).	Trend – continue to monitor. Take non - cost actions to prevent contingency from exceeding eme rgency limit.	Trend – continue to monitor. Take non - cost actions to prevent contingency from exceeding emergency limit.	15 Minutes Use all effective actions and emergency procedures except load dump. Coordinate load dump plan as overload duration approac hed LTE/STE rating definition (i.e. 4 hour, 2 hour, 1 hour or 30 minute rating).	Trend – continue to monitor. Take non -cost actions to prevent contingency from exceeding emergency limit.	Thermal Normal Rating / Reactive Operating Point Limit

Note:

1 – “Non-Converged Contingencies” are considered a ‘sliding’ priority, i.e. it can move up or down the priority list based on modeling accuracy or voltage level.

2- “Actual Violations” are considered a ‘sliding priority’, i.e. it can move up or down the priority list based on the specific situation.

Constraint Control Actions

Priority	Associated Actions
GREEN	Use all non-cost / cost-effective actions: Non-cost measures, including approved switching. Curtailing “Not-willing-to-pay” transactions that adversely impact constraint. Cost-Effective redispatch Dispatch sufficient generation to control constraints within the allotted timeframe. This includes manual redispatch, if necessary. Initiate M2M as appropriate Review regulation assignments and their impact on constrained operations. Localized constraints may require de-committing specific regulating units. Direct generation shift via SCED and phone to ensure generation is following set-points. Review initial dispatch orders to ensure cost-effective constraint control. Monitor generation dispatch and contact units that are not performing. TLR Level 3(note: TLR for excessive circulation may be declared prior to initiating off-cost). Curtail transactions that source/sink in priority order if there is insufficient time to declare TLR. Adjust internal curtailments per IDC.
YELLOW	Use all non-cost / cost-effective (Green) and effective actions and Emergency Procedures: Emergency Procedures: Loading of Quickstart Generation (regardless of cost) 100% Spinning Reserves (appropriate locations) PJM/MISO Safe Operating Mode, if effective TLR 5 (note: TLR for excessive circulation may be declared prior to initiating off-cost). Curtail transactions that source/sink in priority order if there is insufficient time to declare TLR. Adjust internal curtailments per IDC. Loading of Maximum Emergency Generation Post-Contingency Local Load Relief Warning If there are insufficient resources available to control constraints within 60 minutes, dispatch shall have formulated and communicated a load dump plan to impacted TO/TOPs, issuing a Post-Contingency Local Load Relief Procedure. Include post-contingency switching / generation trip options as part of Emergency Procedures Posting message.

Priority	Associated Actions
RED	All of the above plus, shed load if violation still exceeds load dump limit after 5 minutes, Emergency Rating for 15 minutes or to avoid post-contingency cascading situation. Emergency Procedures: Voltage Reduction Manual Load Dump

Note:
In general, procedures shall be implemented in the following order, however, operation conditions or advance lead time may warrant procedures to be implemented in a different order.

Voltage/Reactive Priorities

Voltage Limit	Actual Voltage Limit Exceeded	Post-Contingency Limit Exceeded
Normal High	15 minutes Use all effective non-cost and off-cost actions.	30 minutes Use all effective non-cost actions.
Normal Low	15 minutes, load shed is not used Use all effective non-cost actions, off-cost actions, and emergency procedures except Load Shed Directive	Not Applicable Use all effective non-cost actions
Emergency Low	5 minutes All of the above including Load Shed Directive if voltages are decaying.	15 minutes Use all effective non-cost actions, off-cost actions, and emergency procedures except Load Shed Directive.
Load Dump Low	Immediate All of the above including Load Shed Directive if analysis indicates potential for voltage collapse.	5 minutes All of the above including Load Shed Directive if analysis indicates potential for voltage collapse. Load shed, if necessary, will be implemented

Voltage Limit	Actual Voltage Limit Exceeded	Post-Contingency Limit Exceeded
		in 30 minutes to correct post-contingency simulated voltage violations.
Pre-Contingency Transfer Limit Warning Point (95%)	Not Applicable Use all effective non-cost actions. Prepare for off-cost actions. Prepare for emergency procedures except Load Shed Directive.	Not Applicable Use all effective non-cost actions. Prepare for off-cost actions. Prepare for emergency procedures except Load Shed Directive.
Pre-Contingency Transfer Limit	15 minutes or less depending on the severity All of the above including Load Shed Directive if analysis indicates potential for voltage collapse.	15 minutes or less depending on the severity All of the above including Load Shed Directive if analysis indicates potential for voltage collapse.

Revision History

Administrative Change (Paul Dajewski approved 05/01/2025):

- Revised Go Live date from 04/23/2025 to 05/11/2025

Revision 22 (05/11/2025):

- Cover to Cover Periodic Review
- Updated Manual Owner to Paul Dajewski, Manager Reliability Engineering
- Administrative Updates throughout the Manual
  - Corrected links
  - Consistency in style
  - Added links to references where applicable
  - Added clarification language
- Aligned TOP Language with PJM Compliance Bulletin 026 - Coordination with External Transmission Operators
- Section 2.4.2: Updated 'Enterprise Change Management Standard' to 'Standard Change Control Standard'
- Section 3.2:
  - Added a reference to PJM Manual 03A Appendix C for details on Transmission Facilities
  - Add clarification to default 'Baseline Voltage Limits' to 'PJM Baseline Voltage Limits'
- Section 3.7: Removed 'Security Analysis' from comparing results
- Attachment A:
  - Section D - Removed posting time requirement for next day study results
  - Section E - Added reliability assessment to include RTCA, Transient Stability Analysis (TSA)

Revision 21 (04/01/2024):

- Periodic cover to cover review
- Revised or added the following sections to address FAC-011-4 and FAC-014-3
  - 3.1 PJM SOL Methodology
  - 3.2 Common Facility Ratings

- 3.3 System Voltage Limits
- 3.4 Stability Limits
- 3.5 SOL Contingency Set for Stability Determination
- 3.6 SOL Performance and Exceedance Determination
- 3.7 SOL Exceedance Communication
- 3.8 IROL Identification and Criteria
- 3.9 SOL Methodology Posting and Sharing Obligations
- 3.10 Establishing and Communicating System Operating Limits
- 3.11 Providing SOLs and IROLs
- 3.12 Monitoring of SOL and IROL Limits

- Section 3.10 – Removed references to M-03 - Section 5 and replaced with M-03B
- Section 5.1 and Attachment A: Appendix B - Added LGE and KU to the Joint Reliability Coordination Agreement
- Attachment A: Added TSA and IROL studies for next day operations
- Attachment A: Appendix D – Removed ITCI

Revision 20 (03/22/2023):

- Periodic Review
- Section 4.2 : Removed Native Network Load and replaced with Generation To Load to align with revised terminology from the implementation of OATI Parallel Flow Viewer (PFV)
- Section 5.2.2 : Added Hot & Cold Weather to the Extreme Weather Section

Revision 19 (03/23/2022):

- Periodic review
- Attachment A: Appendix D: Corrected Silver Run Electric to properly show as TO
- Updated manual ownership from Donnie Bielak to Kevin Hatch

Revision 18 (03/29/2021):

- Periodic Review
- Throughout: Replace NERC TLR with “TLR”, NERC IDC with “IDC”, and NERC E-tags with “OATI webSmartTag”, and PJM logs with “PJM SmartLogs”
- Throughout: Corrected grammatical errors
- Section 1.1: Updated links
- Section 1.1: Updated the PJM timing to reference Attachment C
- Section 3.1: Added language for an alternative method for simulating transfers
- Section 3.1: Updated hyperlink for PJM Transmission Facilities page
- Section 5.1: Update hyperlink for VACAR Agreement

- Attachment A: Added Hyperlinks for each section in the Table of Contents
- Attachment A: In Appendix B updated the links and combine the MISO JOA/CMP into one entry
- Attachment A: In Appendix D updated PJM TOs and TOPs to include NextEra Energy Transmission MidAtlantic Indiana as TO, Silver Run Electric as TO, and Wabash Valley Power Association as TO

Revision 17 (04/01/2020)

- Periodic cover-to-cover review.
- Throughout: Replaced Regional Reliability Organization (RRO) term with “Regional Entity”
- Section 1.1: Updated links to PJM governing documents
- Section 5.1: Updated titles and names of external agreements and removed reference to Duke Energy Progress JOA
- Section 5.2.2: Changed Solar Magnetic Disturbance term to Geo-Magnetic Disturbance
- Attachment A: In Appendix A, updated links to PJM governing documents.
- Attachment A: In Appendix B, updated titles and names to external agreements and removed old reference to MISO-PJM-TVA JOA.
- Attachment A: In Appendix D, updated PJM TOs and TOPs to include Transource WV as TO, and updated Linden VFT registration.
- Attachment C: Updated language in Voltage/Reactive Priorities table to be consistent with M-03 section 3.2.

Revision 16 (04/01/2019)

- Periodic cover-to-cover review
- Minor grammatical / formatting changes throughout
- Attachment A “PJM Reliability Plan”: Updated Appendix D: PJM TOs and TOPs to include AMP Transmission, LLC as TO

Revision 15 (4/1/2018):

- Throughout: Minor grammatical / syntax updates, NERC Standard references shorted to master document
- Section 2.4.1, “the Model Management Department in System Operations” changed to “PJM Operations Engineering Support”, “the Operations Support Division” changed to “PJM Operations Planning”
- Section 2.4.2, “(PJM document ID Cera534023)” removed in reference to “The Enterprise Change Management Standard”
- Section 3.2, “issuing a Post-Contingency Local Load Relief Procedure (for facilities 230 kV and below) or Manual Load Dump Warning (for facilities 230 kV and above)” changed to “issuing a Post-Contingency Local Load Relief Procedure or Manual Load Dump Warning

consistent with PJM Manual M-13: Emergency Operations - Section 5: Transmission Security Emergencies"

- Section 4.1, "with MISO" removed to not implicitly exclude NYISO from market-to-market (M2M) re-dispatch
- Section 4.2, "Native Load curtailment changed to "Native Network Load (NNL) curtailment"
- Section 5.2.2, "provide a notification as in 2 above that the situation has been concluded and that no further action is required" changed to "a notification should be provided to the impacted Reliability Coordinators in the same method as the original notification"
- Section 5.3, "PJM Engineering Support" changed to "PJM Operations Engineering Support"
- Attachment A, Updated table of contents format
- Attachment A, Section A, "insuring" changed to "ensuring"
- Attachment A, Section E, "Special Protection Systems (SPS)" changed to "Remedial Action Schemes (RAS)"
- Attachment A, Appendix D, Ohio Valley Electric Corporation added with NERC Registration Number and TO registration and U.S. Department of Energy added with NERC Registration Number and TO/TOP registration

Revision 14 (4/1/2017):

- Section 2.2, updated Data Requirements section noting that PJM's data specifications for external Reliability Coordinators can be found in M-01, Attachment A and existing JOAs.
- Section 2.4.2, added clarification to the Change Management Process indicating authority of the PJM Shift Supervisor for Planned maintenance involving PJM telecommunication, monitoring and analysis tools.
- Updated NERC Standard/Requirement references in Sections 2.3, 4.1, 5.1 and within Attachment A: PJM Reliability Plan.
- Section 3.1, spelled out MMWG and OATF acronyms.
- Section 5.1, corrected MISO's name.
- Attachment A, PJM Reliability Plan:
- Deleted reference to ITC Integration.
- Added Attachment D.
- Section A: changes reference for PJM Directives to PJM Operating Instructions.
- Section C: noted that PJM Day-Ahead Reliability Analysis reports are posted to the secure PJM site.
- Section D: updated timing of SDX download to every 15 minutes.
- Section E:
- Updated to note PJM controls to the BAAL Standard (removed field trial reference
- Updated SPS reference to RAS

- Added clarification to the automated eDART process for unplanned transmission outages
- Section H: updates ISN reference to EIDSN
- Section I: added to PJM System Operators tools list to include DIMA and IEP
- Section J: updated PJM control room staffing requirements
- Cover to Cover Periodic Review

Revision 13 (09/01/2016):

- Section 3.1, Renamed ComEd Reactive Transfer Interface to CE – East Reactive Transfer Interface
- Section 3.1, added clarification noting specific M-03 sections used to support PJM's SOL methodology
- Section 3.2, added controlling actions to the list of actions implemented by PJM for congestion control
- Attachment A: PJM Reliability Plan updated to note ITC as a new PJM TOP effective June 1, 2016
- Cover to Cover Periodic Review

Revision 12 (09/01/2015):

- Section 2.4.2, replaced Change Control Review Board with more detail around PJM's Enterprise Change Management Standard which encompasses the CCRB.
- Section 3.1, Removed effective date footnote with respect to COMED IROL.
- Section 3.1, Updated SOL definition to note that PJM controls to the most conservative limits and that IROLs are an elevated SOL rather than being distinct from SOLs.
- Section 3.1, Removed empty row in IROL table found on page 9.
- Section 3.2, Added clarification to SOL and IROLs monitored by PJM.
- Section 3.2, Added clarification to SOL limit violation reporting.
- Section 5.1, Updated hyperlink for PJM / Duke Energy Progress Joint Operating Agreement (JOA). Updated company name from Progress Energy Carolinas to Duke Energy Progress.
- Administrative Change – Updated references from edata to Data Viewer
- Periodic Review Complete

Revision 11(08/04/2014):

- Updated references for EES to the new ExSchedules application.
- Removed diversified load reference for the OATF studies in Section 3.1. Also updated contingencies modelled in seasonal OATF studies.
- Removed Kammer 765/500Kv transformer and Belmont 765/500Kv transformer IROLs from the IROL table in Section 3.1.

- Updated SOL definition in Section 3.1 to align with the NERC Standard.
- Updated SOL violation to align with the NERC Standard.
- Changed Attachment D reference to Attachment C at the end of Section 3.2 on page 12.

Revision 10 (04/01/2013):

- Updated the PJM Reliability Plan in Attachment A for EKPC integration effective 6/1/2013.
- Removed Attachment C: Change Control Review Board description. This was an old procedure and was out of date. This PJM Change Management procedure is maintained internally in PJM DOCs #596201.
- Added the ComEd Reactive Transfer Interface within table in Section 3.1 SOL and IROL Limit Determination.
- Relabeled Attachment D to Attachment C.

Revision 09 (02/01/2013):

- Revised several department names in Section 2.4.1 based on changes from a company realignment
- Updated the seasonal assessment study names in Section 3.1
- Based upon the FERC Performance Audit Recommendation #23, added a clarifying note to Section 3.1 regarding the time to control thermal IROL exceedances.

Revision 08 (09/01/2012):

- Annual Review
- Adjusted IROL Load Dump plan to indicate Manual Load Dump, not PCLLRW
- Replaced all UDS references with SCED
- Revised the SOL definition to include all 100kV and select sub-100kV equipment.
- Deleted CWIN reference.

Revision 07 (06/01/2011):

- Annual Review
- Removed OVEC from PJM RC footprint.
- Added the CLVLND Reactive Transfer Interface within table in *Section 3.1 SOL and IROL Limit Determination*.
- Updated Attachment A: PJM RTO Reliability Plan.
- Updated the IROL definition in section 3.1 to match the *NERC Glossary of Terms*
- July 11, 2011 – Updated hyperlink for PJM – VACAR South Reliability Agreement

Revision 06 (01/01/2010):

- Updated SOL definition to include all facilities 230kV and above, removing reference to MP-1.

- Added reference to NAESB Business Practice WEQ-008 and other editorial changes in Section 4

Revision 05 (10/01/2009):

- Updated SOL definition and violation criteria.
- Updated links to Joint Operating Agreements.
- Updated Attachment C: Change Control Review Board

Revision 04 (06/26/2009):

- Annual Review
- Reformatted to assist in compliance tracking.

Revision 03 (02/01/2009):

- Added TV indicator to 30 minute response timeframe to IROL facilities, as appropriate, consistent with NERC standards.
- Introduction: added annual review and manual distribution requirement.
- Section 3: Added requirement to respond to external systems comments on SOL/IROL methodology within 45 calendar days.
- Attachment D: Modified Attachment to change 15 minute threshold to 30 minutes. Changed PCLLRW issuance from 30 minute to 60 minutes. Timing changes based on controlling non-IROL constraints to 100% LTE.

Revision 02 (06/01/2008):

- Section 3: Made additional updates to IROL facilities specifically the Kammer 765/500 kV transformer and the Belmont #5 765/500kV transformer Thermal Ratings.

Revision 01 (06/01/2008):

- Updated all sections to include Bulk Electric System (BES)
- Section 3: Updated IROL facilities
- Section 5: Updated Links to Joint Operating Agreements with neighboring Reliability Coordinators.
- Attachment A: Updated PJM RTO Reliability Plan
- Attachment B: Updated Excerpt from PJM Operating Agreement (bullet vi)
- Attachment C: Updated Change Control Review Board to latest version of document

Revision 0 (05/15/2007):

New manual