Working to Perfect the Flow of Energy

PJM Manual 12:

Dispatching Operations

Revision: 12

Effective Date: August 16, 2005

Prepared by

Dispatching

PJM Manual 12:

Dispatching Operations

Table of Contents

Table of Exhibits

Approval

Approval Date: 08/16/05
Effective Date: 08/16/05

Frank J. Koza, Manager

Dispatching Department

Revision History

Revision 12 (08/16/05)

Section 4: (Providing Ancillary Services)

Revised to reflect recent changes to Black Start Service Business Processes

Included new Attachment C: PJM Black Start Test Report Form

Included new Attachment D: PJM Auto Load Reject Test Report Form

Included new Attachment E: PJM Black Start Formulaic Cost Data Form

Included new Attachment F: PJM Black Start Actual Cost Data Form

Revision 11 (01/01/05)

Sections 1, 2, 3, 5

Revised to reflect operations based on the integration of ComEd, AEP, Dayton Power and Light, Duquesne Light, and Dominion

Revision 10 (01/01/04)

Section 4 (Providing Ancillary Service)

Revised to reflect the regulation limit relationships.

Replaced Exhibit 1 with an updated list of PJM Manuals.

Revision 09 (12/01/02)

Revised Section 4: Providing Ancillary Services

Incorporated the procedures that the PJM follows to ensure and monitor Black Start Service.

Revision 08 (04/01/02)

Section 1: Overview

Incorporated PJM West / West duties.

Section 2: Dispatching Tools

Incorporated UDS, EES, eData, SCIS, Emergency Procedure Posting Application, All-call software, and Satellite Phones. Removed Accounting Information section and exhibit.

Section 3: System Control

Included reassigning regulation while on Analog Control, Updated Time Error Correction procedure.

Section 4: Providing Ancillary Services

Incorporation of eDart reporting, implementation of Shared Reserves for DCS events, ARS (PJM West), and Regulation Requirement (PJM West).

Section 5: Transmission Facility Control

Clarification of participant duties (Transmission / Generation).

Attachment A: Instantaneous Reserve Check

Removal of company names.

Attachment B: Voltage Control

Attachment Eliminated.

Revision 07 (05/22/01)

Revised to reflect implementation of PJM Regulation Market.

Removed Attachment A: Definitions & Abbreviations. Attachment A is being developed into a 'new' PJM Manual for ***Definitions and Abbreviations (M-35)***.

Removed Attachment B: Three-Point Curve Utilization.

Renamed Attachment C: PJM Instantaneous Reserve Check and Attachment D: Voltage Control, to Attachment A and Attachment B, respectively.

Revision 06 (06/01/00)

Section 04: Providing Ancillary Services

Revised subsection *Regulation* to reflect changes required to implement the PJM Regulation Market on June 1, 2000.

Attachment E: Process Diagrams

Removed to reflect changes required to implement the PJM Regulation Market on June 1, 2000.

Revision 05 (04/01/00)

Section 05: Transmission Facility Control

Removed reference to Maximum Scheduled Generation within subsections: Corrective Control Strategies, Reactive Limitation Control, and NERC Transmission Loading Relief (TLR) Procedure.

Revision 04 (06/03/99)

Section 02: Dispatching Tools

Moved *Generation Control System* from Mainframe Computer Applications section to PC Applications section. Removed *System Security*, *Megawatt Monitor*, and *Marginal Scheduler* from Mainframe Computer Applications section. Added *Network Analysis and SCADA Programs* and *Resource Scheduling and Commitment* to, and removed *Transmission Security System (TSS)* and *Future TSS* from, the PC Applications section. All these changes made to reflect installation of the new Siemens Energy Management System (EMS).

Changed all references to General Agreement on Parallel Paths (GAPP) to Interchange Distribution Calculator (IDC) to reflect new NERC application.

Modified section on *Dynamic Mapboard* to reflect the fact that it is now driven by the new Siemens computer.

Section 05: Transmission Facility Control

Added information concerning PJM implementation of the NERC Transmission Loading Relief (TLR) Procedure.

Revision 03 (04/01/98)

Section 02: Dispatching Tools

Revised Exhibit 2.1 to reference "Locational Marginal Price" rather than "Market Clearing Price."

Revision 02 (01/01/98)

Section 04: Providing Ancillary Services

Changed “The Regulating Requirement for the PJM RTO is 1.1% of the forecast peak load during On-Peak Periods (from 0500-2359 hours) and 1.1% of the forecast valley during Off-Peak Periods load (from 0000-0459 hours).” from “The Regulating Requirement for the PJM RTO is 1.1% of the forecast peak load during On-Peak Periods (from 0700-2259 hours) and 1.1% of the forecast valley during Off-Peak Periods load (2300-0659 hours).” under “Obligations & Requirements” of “Regulation.”

Changed equation:

LSEs Regulation Obligation = (LSEs Load Allocation Percentage * PJM Regulation Requirement)
- LSEs Share of Joint - Owned Unit Regulation

from:

LSEs Regulation Obligation = (LSEs Load Allocation Percentage * PJM Regulation Requirement)
- LSEs Share of Keystone and Conemaugh Regulation

under "Determining Regulation Assignment" of "Regulation."

Changed "During On-Peak Periods (0500 hours to 2359 hours), the PJM Regulating Requirement is 1.1 % of the PJM RTO's peak load forecast, as determined prior to 0430 hours" from "During On-Peak Periods (0700 hours to 2259 hours), the PJM Regulating Requirement is 1.1 % of the PJM RTO's peak load forecast, as determined prior to 0630 hours" under "Obligations & Requirements" of "Regulation."

Changed "During Off-Peak Periods (0000 hours to 0459 hours), the PJM Regulating Requirement is 1.1 % of the PJM RTO's valley load forecast, as determined prior to 2330." from "During Off-Peak Periods (2300 hours to 0659 hours), the PJM Regulating Requirement is 1.1 % of the PJM RTO's valley load forecast, as determined prior to 2230." under "Obligations & Requirements" of "Regulation."

Changed "Prior to 0430 and 2330 each day, the PJM dispatcher provides the following information to the Local Control Centers for the LSEs, via the PJM ALL-CALL:

- ☞ PJM forecasted peak load and the PJM forecasted valley load for 0430 and 2330, respectively"

from "Prior to 0630 and 2230 each day, PJM dispatcher provides the following information to the Local Control Centers for the LSEs, via the PJM ALL-CALL:

- ☞ PJM forecasted peak load and the PJM forecasted valley load for 0630 and 2230, respectively"

under "Obligations & Requirements" of "Regulation."

Changed "Scheduled MW of Joint-Owned Unit Regulation" from "Scheduled MW of joint-owned Regulation for Keystone and Conemaugh Stations" under "Determining Regulation Assignment" of "Regulation."

Changed "The LSE decides the method of meeting its Regulation Obligation, subsequent to the PJM ALL-CALL notification but no later than 0430 or 2330 for On-Peak and Off-Peak Periods, respectively; the LSE dispatcher reports to PJM the MWs of Regulation by class to meet the LSE's Regulation objective, plus the amount (MW) of any additional Regulation by class which is presently available to regulate." from "The LSE decides the method of meeting its Regulation Obligation, subsequent to the PJM ALL-CALL notification but no later than 0630 or 2230 for On-Peak and Off-Peak Periods, respectively; the LSE dispatcher reports to PJM the MWs of Regulation by

class to meet the LSE's Regulation objective, plus the amount (MW) of any additional Regulation by class which is presently available to regulate." under "Determining Regulation Assignment" of "Regulation."

Attachment E: Process Diagrams

Added "Attachment E: Process Diagrams"

Revision 01 (07/08/97)

Section 2: Dispatching Tools

Added "Note: In Exhibit 2.1, **Congestion Payment Status** and **Participant Paying Congestion** Data Fields are required for transactions utilizing the option of non-firm transmission service willing to pay congestion which were scheduled and approved prior to June 28, 1997" under "Accounting Information."

Section 5: Transmission Facility Control

Deleted "...and for non-firm transactions willing to pay congestion" from Exhibit 5.2 note under "Corrective Control Strategies."

Revision 00 (04/30/97)

Changed references from PJM Interconnection Association to PJM Interconnection, L.L.C.

Changed references from PJM to PJM where appropriate.

Changed references from PJM to PJM RTO where appropriate.

Changed references from PJM IA to PJM.

Changed references from IA to PJM.

Changed references from Mid-Atlantic Market to PJM Interchange Energy Market.

Changed references from Mid-Atlantic Market Operations Agreement to Operating Agreement of PJM Interconnection, L.L.C.

Revision 00 (03/24/97)

This revision is a draft of the PJM Manual for ***Dispatching Operations.***

Introduction

Welcome to the PJM Manual for ***Dispatching Operations***. 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 the PJM RTO and the PJM Energy Market. Exhibit 1 lists the PJM Manuals.

Transmission	M01: Control Center Requirements	M02: Transmission Service Requests	M03: Transmission Operations
	M04: PJM OASIS Operation	M05: Power System Application Data	M06: Financial Transmission Rights
PJM Energy Market	M09: PJM eSchedules	M10: Pre-Scheduling Operations	M11: Scheduling Operations
	M12: Dispatching Operations	M13: Emergency Operations	M15: Cost Development Guidelines
	M36: System Restoration Manual		
Generation and Transmission Interconnection	M14A: Generation and Transmission Interconnection Process Overview	M14B: Generation and Transmission Interconnection Planning	M14C: Generation and Transmission Interconnection Facility Construction
	M14D: Generator Operational Requirements	M14E: Merchant Transmission Specific Requirements	M16: eDART Operations
Reserve	M17: Capacity Obligations	M19: Load Data Systems	M20: PJM Reserve Requirements
	M21: Rules and Procedures for Determination of Generating Capability	M22: Generator Resource Performance Indices	M23: eGADS User Manual
	M24: PJM eCapacity	M25b: eFuel 2.0 – User Manual	
Accounting & Billing	M27: Open Access Transmission Tariff Accounting	M28: Operating Agreement Accounting	M29: Billing
PJM	M33: Administrative Services for PJM Interconnection Agreement	M35: Definitions and Acronyms	

Exhibit 1: List of PJM Manuals

About This Manual

The PJM Manual for ***Dispatching Operations*** is one of a series of manuals within the PJM Energy Market manuals. This manual focuses on the activities that occur in the real-time operation of the PJM Energy Market. The manual describes how PJM dispatches and controls Capacity Resources and how PJM monitors transmission facilities. It also describes how PJM provides Ancillary Services.

PJM Manual for Dispatching Operations consists of five sections. The sections are as follows:

Section 1: Overview

Section 2: Dispatching Tools

Section 3: System Control

Section 4: Providing Ancillary Services

Section 5: Transmission Facility Control

Intended Audience

The intended audiences for PJM Manual for ***Dispatching Operations*** are:

- *PJM Members* -Any participant requesting to purchase or sell energy to or from PJM Energy Market and any participant that schedules bilateral sales or purchases.
- *PJM operations staff* - PJM operations staff monitors the performance of the Capacity Resource
- *PJM dispatchers* - PJM dispatchers are responsible for reliable operation of the PJM RTO and posting information in the OASIS. "PJM dispatchers" refers to both PJM dispatchers located in Valley Forge and Greensburg (PJM West).
- *Transmission Owners/Generation Owners* – The Transmission Owners/Generation Owners system operators/ dispatchers direct operation of the local facilities and communicate with PJM dispatcher to coordinate operation of the Bulk Power Electric Supply system facilities.

References

The References to other documents that provide background or additional detail directly related to the PJM Manual for ***Dispatching Operations*** are:

- NERC Operating Manual
- PJM Manual for Pre-scheduling Operations
- PJM Manual for Scheduling Operations
- PJM Manual for Operating Agreement Accounting
- PJM Manual for Emergency Operations

Using This Manual

Because we believe that explaining concepts is just as important as presenting the procedures, we start each section with the “big picture”. Then, we present details and procedures. This philosophy is reflected in the way we organize the material in this PJM Manual. The following provides an orientation to the manual’s structure.

What You Will Find In This Manual

- A table of contents
- An approval page that lists the required approvals and the revision history
- This introduction
- 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

Section 1: Overview

Welcome to the *Overview* section of the PJM Manual for ***Dispatching Operations***. In this section, you will find the following information:

- A description of the scope and purpose of dispatching (see "Scope & Purpose of Dispatching").
- A list of PJM dispatching responsibilities (see "PJM Responsibilities").
- A list of the PJM Member's dispatching responsibilities (see "PJM Member Responsibilities").

Scope & Purpose of Dispatching

Operation of the PJM RTO involves many activities that are performed by different operating and technical personnel. These activities occur in parallel on a continuous basis, 24 hours a day and can be grouped into three overlapping time frames:

- pre-scheduling operations
- scheduling operations
- dispatching operations

In the PJM Manual for ***Dispatching Operations*** we focus mainly on the activities that take place in the current hour of the Operating Day. Exhibit 1.1 presents the dispatching activities in the form of a timeline. The reference point for the timeline is the "Operating Day", recognizing that every new day becomes an Operating Day. This timeline-type of description is used throughout this PJM Manual.

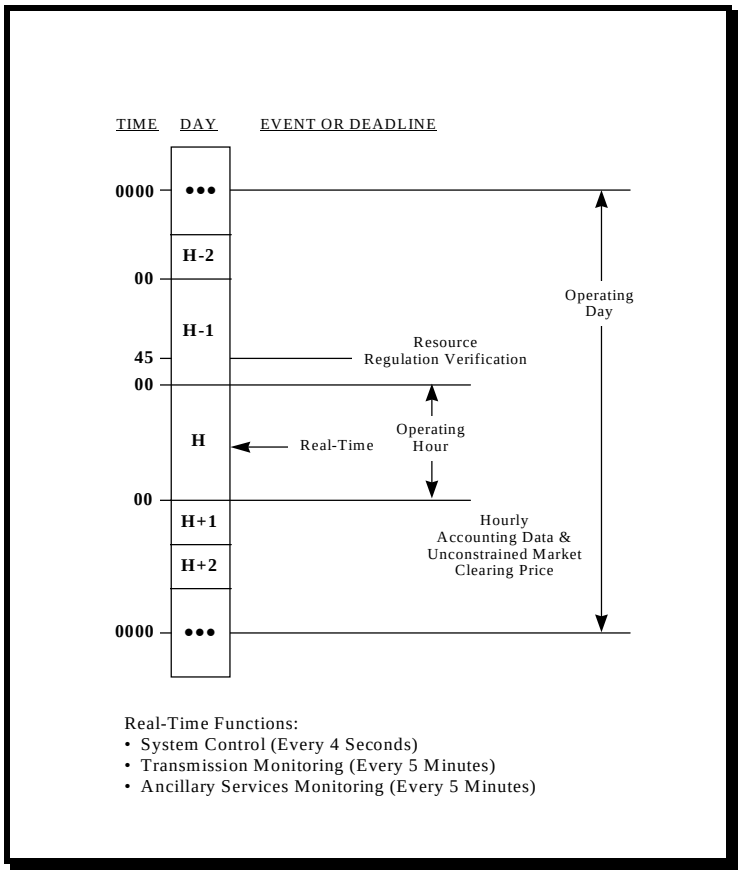

Exhibit 2: Dispatching Timeline

Dispatching includes system control, Ancillary Service monitoring, and transmission system monitoring and control. During the dispatching process, PJM implements and adjusts the Current Operating Plan, which is developed during the scheduling process, to maintain reliability and minimize the cost of supplying the energy, reserves, and other services that are required by the PJM Members and the operation of the PJM RTO. The Current Operating Plan is developed within the guidelines and rules of the Two Pass System.

In this manual we make no special distinction between the terms “price” and “cost”. PJM Members submit their bids accordingly to either actual cost or offer price as designated by PJM for each generation resource. For specific information as to the use of price and cost, refer to the Markets Database section in the PJM Manual for ***Pre-scheduling Operations***.

PJM Responsibilities

PJM monitors and controls the PJM RTO such that the least-cost means of satisfying the projected hourly energy, Operating Reserves, and other Ancillary Services requirements of the Market Buyers, including the reliability requirements of

the PJM Control Area, are met. Specifically, PJM's responsibilities to support dispatching activities include:

- directing PJM Members to adjust the output of any PJM RTO-Scheduled Resource; commit unscheduled PJM RTO resources; cancel selection of PJM Control Area-Scheduled Resources
- operating the PJM RTO transmission system in accordance with NERC and regional reliability council policies, standards, and procedures.
- committing the most cost efficient Regulation and Spinning Reserve service available
- implementing the PJM/MISO Congestion Management procedure for congested transmission facilities external to PJM RTO.
- implementing the NERC Transmission Loading Relief (TLR) procedure as necessary to provide relief to external or internal transmission facilities.
- verifying the accuracy of LMP data during constrained/unconstrained operations.
- implementation of Emergency Procedures in accordance with PJM Manual M-13, Emergency Operations.

PJM Communications

PJM dispatching operations are conducted from two control centers: Greensburg and Valley Forge. The dispatchers in Greensburg and Valley Forge work together as a single team. The Shift Supervisor provides real time leadership over dispatchers in both control centers. Communications between the control centers is facilitated through the use of closed circuit TV through which dispatchers can communicate visually and orally in real time with their counterparts and supervision. System monitoring and control responsibilities are shared between the Greensburg and Valley Forge control centers.

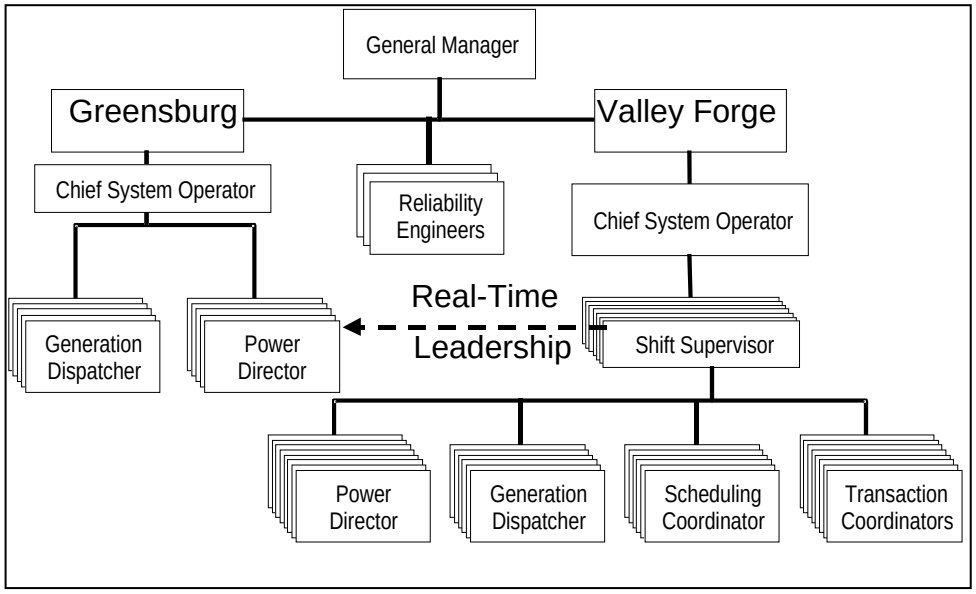

Exhibit 3: Dispatch Operations Overview

PJM Member Responsibilities

Only Market Buyers and Market Sellers are eligible to submit offers and purchase energy or related services in the PJM Energy Market. The PJM Members include the Market Buyers and the Market Sellers.

Market Buyers

There are two general types of Market Buyers:

1. Internal Market Buyer - An Internal Market Buyer is a buyer that is purchasing energy from the PJM Energy Market for consumption by end-users that are located inside the PJM RTO. An Internal Market Buyer may be further classified as a Generating Market Buyer. A Generating Market Buyer is an Internal Market Buyer that owns or has contractual rights to the output of generation resources which are capable of serving the Market Buyer's load in the PJM RTO or selling energy-related services in the PJM Energy Market or elsewhere.
2. External Market Buyer - An External Market Buyer is a Market Buyer that is making purchases of energy from the PJM Energy Market for consumption by end-users that are located outside the PJM RTO.

The Internal Market Buyers' dispatching responsibilities include:

- satisfying its Regulation obligation from its own resources, by contractual arrangement with another PJM Member, or by purchases from the PJM Energy Market

Market Sellers

A Market Seller is a PJM Member that demonstrates to PJM that it meets the standards for the issuance of an order mandating the provision of transmission service under Section 211 of the Federal Power Act, submits an application to PJM, and is approved. By definition, all Market Buyers become Market Sellers upon approval of their applications.

Market Sellers dispatching responsibilities include:

- ensuring each Capacity Resource complies with energy dispatching signals and instructions that are issued by PJM
- complying with Regulation signals and instructions that are issued by PJM

Load Serving Entities

A Load Serving Entity (LSE) is any entity that has been granted authority or has an obligation pursuant to state or local law, regulation, or franchise to sell electric energy to end-users that are located within the PJM RTO. An LSE may be a Market Buyer or a Market Seller.

Section 2: Dispatching Tools

Welcome to the *Dispatching Tools* section of the PJM Manual for ***Dispatching Operations***. In this section you will find the following information:

- A description of PJM Control Center tools used for dispatching and operations (see "*Control Center Tools*").
- A description of the information that is passed on to market accounting (see "*Accounting Information*").

Control Center Tools

The tools that are currently used by PJM operations staff are described according to three categories: EMS computer applications, PC applications, and ancillary tools.

EMS Applications

- Automatic Generation Control (AGC) — This program runs every two seconds, calculating Area Control Error (ACE), Area Regulation (AR), and economic dispatch.
- Security Analysis (SA) – This program runs approximately every 1-2 minutes and calculates the simulated post-contingency flows on a large number of monitored facilities on the PJM system for the loss of selected contingencies.
- State Estimator (SE) – This program runs approximately every minute and provides simulated flows for the PJM system based on current topology and the availability of telemetered data. SE is used to provide the input to the market systems.
- Transfer Limit Calculator (TLC) – This program runs approximately every 5 minutes and establishes transfer limits for selected interfaces on the PJM system. The process that the application uses is to establish the voltage collapse point for these interfaces and applying a suitable margin from the collapse point as the safe operating limit.

PC Applications

- Markets Database —This database is used by the Two-Settlement and Market-Based Regulation Systems. Market Participants update the MDB continuously via XML and Web-based interfaces.
- Resource Scheduling and Commitment (RSC) — This program is used to schedule generation resources for up to a week in advance.
- Transaction Management System (TMS) — Database used by PJM Dispatchers and Transaction Coordinators to manage transaction information.

- Hydro Calculator — This program is used to schedule and optimize hydro generating resources located on the Susquehanna River.
- Dispatch Management Tool (DMT) — The DMT enables PJM Dispatchers to manage generation unit information, transmission constraint information and administer the Regulation Market. The DMT automatically logs unit status changes and provides an electronic source of logging information for Market Settlements.
- Unit Dispatch System (UDS) — This application calculates Security Constrained Economic Dispatch solutions for presentation to the dispatchers. The dispatchers then select the best solution that utilizes least-cost dispatch while simultaneously controlling active transmission constraints.
- Scheduling Coordinator's Worksheet — For Cost Analysis tabulation, Maximum Generation Emergency Report, Minimum Generation Emergency Report, Status Report and Managers Report. This worksheet uses a spreadsheet program via the LAN, and is used to reflect current and projected capacity conditions.
- Interchange Distribution Calculator (IDC) — IDC is a NERC-sponsored program, used in the Eastern Interconnection for the purpose of managing transactions. All interchange transactions are modeled in the IDC and the IDC calculates flow impacts of these transactions on each flowgate. If flow relief on any of these flowgates becomes necessary, the IDC is used to communicate which transactions will be modified or curtailed to provide the relief in accordance with business rules established in the NERC TLR procedure.
- eDART — Dispatcher Applications and Reporting Tool. Internet based system that allows communication of system information between PJM and member company dispatchers, i.e. Generation and Transmission Outage Tickets.
- Enhanced Energy Scheduler (EES) — Internet based system that allows PSE's to submit, revise, and review energy schedules.
- eData — Internet based system that allows PJM Dispatcher and participants to view current and projected system data and emergency procedures information.
- Reliability Coordinator Information System (RCIS) — Internet based system used to exchange operating information among Reliability Coordinators and Control Areas.
- ALL-CALL — Used by PJM operations staff to simultaneously disseminate information to transmission and generation control centers.

Ancillary Tools

- Video Graphic Recorders (VGRs) —VGRs are used to display and record the following:
    - LSE net generation, interchange information, control information, and other critical operating data
    - Analog point data
- Informational TV — This TV is used to obtain weather and Emergency information from selected local network and cable channels.
- Weather Data — Weather reports are printed from the Internet, as posted by the vendor.
- Direct Phone Lines — Direct telephone line communication is available between PJM, the Local Control Centers, LSEs and between PJM and adjacent Control Areas.
- Dynamic Mapboard — The dynamic mapboard displays selected system data; status of lines, transformers, capacitors, and generators; and the results of security analysis of the bulk power transmission system.
- Racal Recording Device — Used to record all phone conversations from dispatching and scheduling positions for documentation.
- Satellite Communications – Push-to-talk all-call and direct point-to-point satellite communications exists with PJM participants and participating external entities as back-up communications.
- Phones/cell phones – Used for back-up communications.

Section 3: System Control

Welcome to the *System Control* section of the PJM Manual for ***Dispatching Operations***. In this section, you will find the following information:

- How PJM adjusts PJM RTO-Scheduled Resources (see "Adjusting PJM Control Area-Scheduled Resources").
- How PJM corrects for time error (see "Time Error").
- How PJM corrects for accumulated inadvertent interchange (see "Inadvertent Interchange").

Adjusting PJM Control Area-Scheduled Resources

The PJM RTO must operate sufficient generating capacity under automatic control to meet its obligation to continuously balance its generation and interchange schedules with its load. It is also required to provide its contribution to frequency Regulation for the Eastern Interconnection.

Under present operating conditions, it is impossible for a Control Area to continuously match its instantaneous changes in load with changes in generation. As a result, frequency deviates from schedule because actual tie line power flow does not continuously match scheduled tie line power flow. This mismatch must be minimized, so as not to impose the PJM RTO's control requirements on the interconnected system. Area Control Error (ACE) is a value that defines how well the PJM Control Area is meeting its obligation.

PJM Area Control Error

Area Control Error is a measure of the mismatch between sources of power and uses of power within the PJM RTO. This mismatch is calculated indirectly as the difference between actual and scheduled net interchange, plus the frequency bias contribution to yield ACE in megawatts. Two additional terms may be included in ACE under certain conditions--the time error bias term and PJM dispatcher adjustment term (manual add). These provide for automatic inadvertent interchange payback and error compensation, respectively.

The sign convention for power flow used at PJM is positive for power flow into PJM. This has been carried over into the ACE calculation, which results in a positive ACE representing overgeneration and a negative ACE representing undergeneration. Exhibit 4 shows the calculation of PJM ACE in block diagram form.

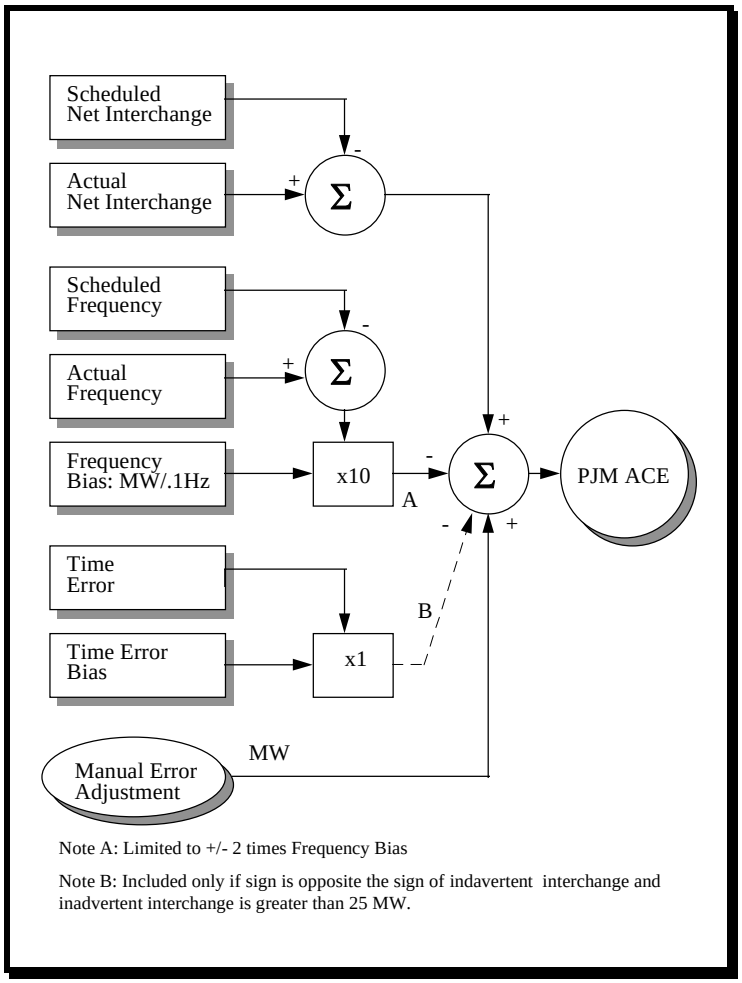

Exhibit 4: Calculation of PJM ACE

ACE Control Modes

There are three modes of control available to PJM dispatcher for the operation of the PJM RTO.

- Flat Frequency Control — Flat frequency control utilizes only power system frequency as the controlling parameter. This mode of control only responds to frequency deviations and does not adjust operations for any interconnection tie line schedule deviations. This mode is applicable only to those instances when the PJM Control Area becomes isolated from the Eastern Interconnection.
- Flat Tie Line Control — Flat tie line control utilizes only interconnection tie line flow as the controlling parameter. This mode of control only responds to net tie flow deviations and does not adjust operation for any frequency deviations. This mode is limited to special circumstances when the PJM Control Area desires to maintain a given net interchange flow and the power system frequency is stable and being controlled by other Control Areas.

- Tie Line Bias Control — Tie line bias control is the most widely used mode of control for multi-Control Area power systems. This mode of control responds to both frequency and net tie line flow deviations. Exhibit 4 shows all of the calculations for tie line bias control. The frequency bias factor for the PJM RTO is set by Interconnection Agreement and accomplishes the following:

1. compensates for automatic governor action so that ACE does not "undo" the changes in generator output due to frequency fluctuations
2. compensates for any lack of PJM governor response by calculating an ACE that produces the PJM RTO's agreed upon share of frequency support to the Eastern Interconnection

NERC Control Performance Standard

The PJM RTO operates sufficient generating capacity under automatic control to satisfy its frequency regulation obligation as a member of the Eastern Interconnection. NERC establishes definitive measures of control performance. These control performance standards are documented in the NERC Operating Manual. The NERC Control Performance Standards (CPS) define a standard of minimum control performance for each Control Area. The standards are summarized as follows:

- Continuous Monitoring — Each Control Area monitors its control performance on a continuous basis against two standards:

  CPS1 — Over a year, the average of the clock-minute averages of a Control Area's ACE divided by minus 10 B (where B is Control Area frequency bias) times the corresponding clock-minute averages of the Interconnection's frequency error must be less than a specific limit. This limit, 'ε', is a constant derived from a targeted frequency bound (limit) that is reviewed and set, as necessary, by the NERC Performance Subcommittee.

  CPS2 — The average ACE for each of the six ten-minute periods during the hour (i.e., for the ten-minute periods ending at 10, 20, 30, 40, 50, and 60 minutes past the hour) must be within specific limits, referred as L10.

- Disturbance Conditions — In addition to CPS1 and CPS2, the Disturbance Control Standard (DCS) is used by each Control Area to monitor control performance during recovery from disturbance conditions. The DCS states that ACE must return either to zero or to its pre-disturbance level within fifteen minutes following the start of the disturbance.

- Requirements — The requirements to achieve compliance are:

1. ACE Values — The ACE used to determine compliance to the CPS must reflect its actual value and exclude short excursions due to transient telemetering problems or other influences such as control algorithm action.

2. CPS Compliance — Each Control Area must achieve CPS1 compliance of 100% and achieve CPS2 compliance of 90%.
3. Performance Standard Surveys — All Control Areas must respond to performance standard surveys that are requested by NERC.
4. Disturbance Control Standard Surveys — Each Control Area must submit a quarterly summary report to NERC documenting the Control Area's compliance to the DCS during the reporting quarter.
5. DCS Compliance — Each Control Area must achieve DCS compliance 100% of the time for reportable disturbances.

Whenever the magnitude of ACE indicates a severe shortage of generation, PJM dispatcher notifies PJM Members to immediately supply energy from their Spinning Reserves. These requests are made via the PJM ALL-CALL communications software.

PJM Control Implementation

PJM uses the PJM ACE signal to establish the required control signals that are sent to each PJM Member whose generating resources come under the direction of PJM. PJM develops two types of control signals as follows:

- Regulation
- dispatch

Regulation Signals

PJM calculates one Regulation signal, as shown by Exhibit 5.

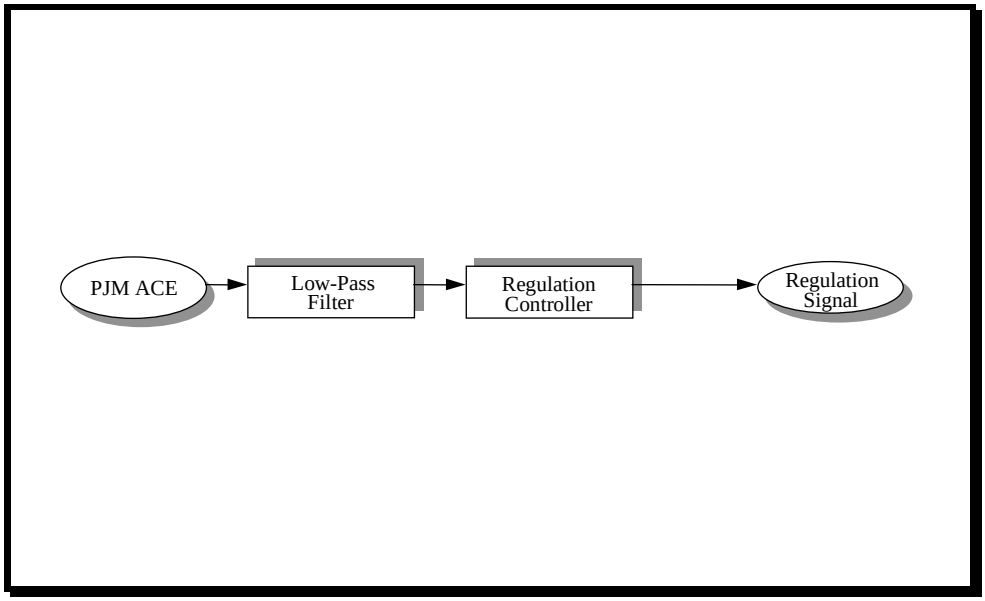

Exhibit 5: PJM Regulation Signals

At present, PJM sends the Regulation signal in the following form to the participating Generation Owners:

- Digital — The Digital Regulation signal is sent to each Generation Owner. The Generation Owners receive this signal and then send the appropriate signal to each regulating generating unit.

Dispatch Signals

The dispatch signals that are calculated by PJM are intended to direct dispatchable generating resources to "follow" the PJM RTO's requirement. The strategy that is used by PJM is to first develop a PJM price signal from the raw PJM ACE calculation. Exhibit 6 shows how the Dispatch Rate and MW signals are calculated for each participating Generation Owner.

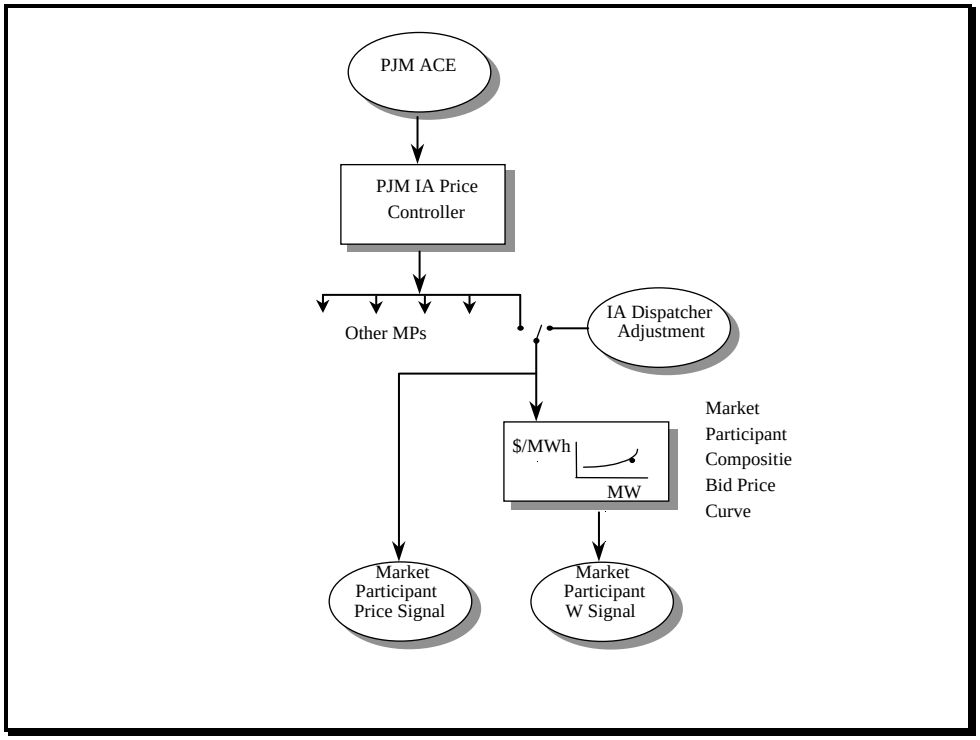

Exhibit 6: Calculation of Dispatch Price and MW Signals

- Step 1 — A common PJM price signal is developed by the UDS tool which acts on load, interchange, transmission constraints and PJM dispatcher input.
- Step 2 — In the event of transmission congestion or other security issues; UDS in conjunction with the PJM dispatcher may recalculate the dispatch price signals for the effected PJM transmission zones. The price signal for a particular PJM Member is then applied to the generation bid prices for that PJM Member.
- Step 3 — The MW versus price relationship is developed by PJM for each participating Generation Owner. The MW versus price relationship is developed

by PJM using the scheduled generator offers submitted Day-Ahead via eMarket. Exhibit 7 shows how the various generation resources are correlated with respect to bid prices in order to develop this total MW versus price relationship.

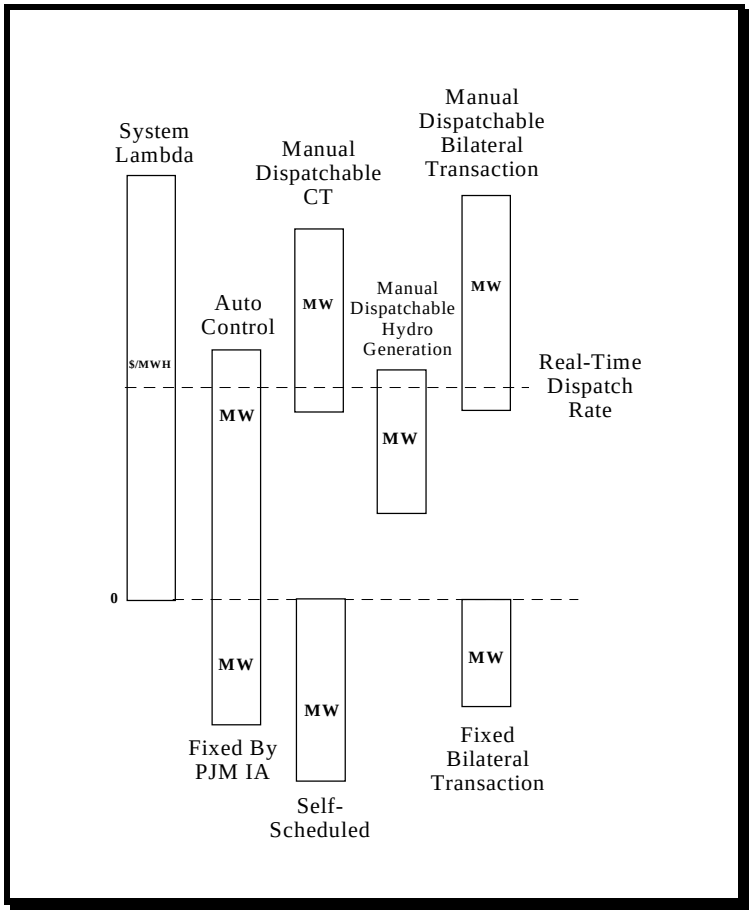

Exhibit 7: Resource Dispatching

It is important to emphasize that the MW versus price relationship applies to manually dispatched, as well as automatically controlled generating units. Since there is a wide mixture of slow and fast responding units and manually dispatched units in the PJM Control Area, the Dispatch Rate signal is adjusted slowly by PJM dispatcher in order to avoid unnecessary generation adjustments.

PJM Member Control Implementation

PJM assigns desired control actions to the Internal PJM Members. PJM Members are responsible for the actual physical control of generating resources. This is generally accomplished through Generation Owners. Exhibit 8 shows the information that is exchanged between PJM and the Generation Owners.

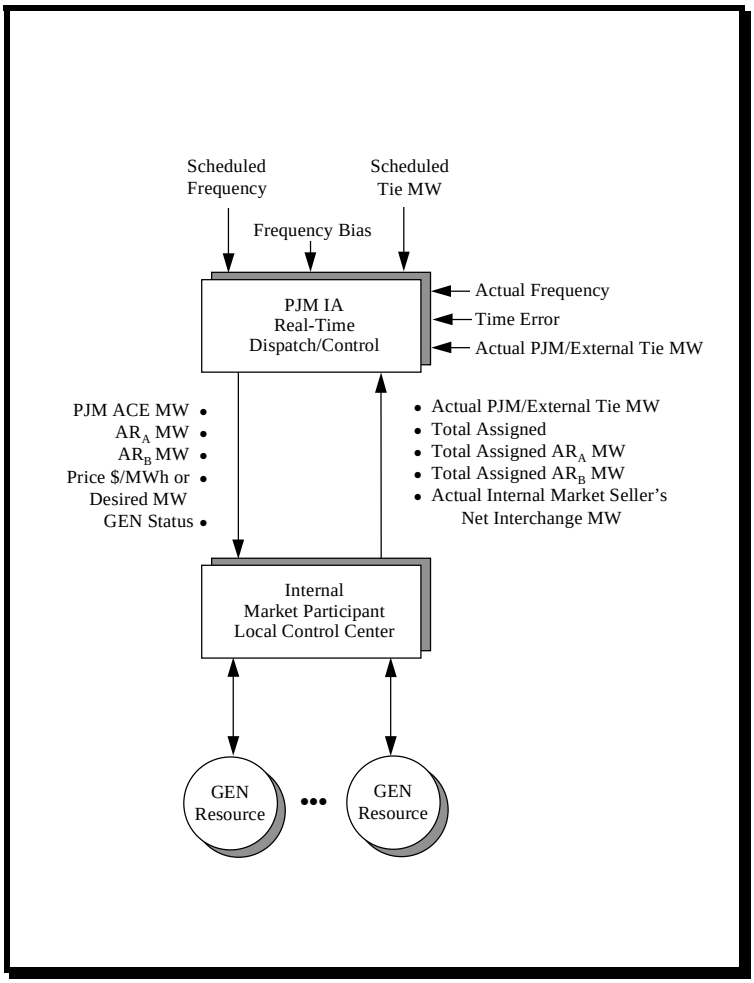

Exhibit 8: PJM Member Interface

The following information is sent by PJM to the Generation Owners:

- PJM ACE MW
- Regulation MW
- price $/MWh or desired MW
- generator status

The following information is sent by the PJM Members to PJM:

- actual PJM/external tie line MW
- actual total generation MW
- total assigned Regulation MW
- actual net interchange MW

The PJM Member's Generation Owner converts the total dispatch signal (price or MW) and the regulation signal to individual unit control signals. PJM Members are expected to respond to the dispatch and regulation signals received from PJM. PJM Members are expected to operate their generating resources as close to desired output levels, as practical, consistent with Good Utility Practice.

Time Error

The system-wide mismatch between load and generation results in frequency deviations from scheduled frequency. The integrated deviation appears as a departure from correct time, i.e., as a time error. Therefore, time error is the accumulation of frequency deviation over a defined period of time.

In accordance with the NERC Operating Manual, each Interconnection designates an Interconnection Monitor to monitor time error and to initiate or terminate corrective action when time error reaches predetermined limits. The PJM RTO is a part of the Eastern Interconnection. The Interconnection Monitor for the Eastern Interconnection is Midwest ISO in Carmel, IN. The Midwest ISO monitors the electric system time against true time, as measured by the National Institute of Standards and Technology (NIST), in Boulder, Colorado. When time error reaches ±10 seconds, The Midwest ISO initiates a time correction. No time error corrections for fast time will be initiated between 0400 and 1100 hours Central Time.

A time correction may be halted, terminated, or extended if the designated Interconnection Time Monitor determines system conditions warrant such action.

After the premature termination of a manual time correction, a slow time correction can be reinstated after the frequency has returned to 60 Hz or above for a period of ten minutes. A fast time correction can be reinitiated after the frequency has returned to 60 Hz or lower for a period of ten minutes. At least 1 hour shall elapse, however, between the termination and re-initiation notices.

Time Error Correction Notification

The Midwest ISO issues the time correction information via a NERC hot-line conference call and a message is posted on the RCIS. A frequency offset of ±0.02 Hz starts and terminates on the hour or half-hour.

PJM Actions:

1. PJM dispatcher notifies the Transmission Owners/Generation Owners, via the PJM ALL-CALL, to announce that time error correction is in effect. To correct for a slow or fast clock, system frequency schedules are offset by ±0.02 Hz and given an assigned letter designator.
2. At the assigned time, PJM dispatcher offsets the frequency schedule setter to 59.98 Hz to correct for fast time error or 60.02 Hz to correct for slow time error.

3. When the time error is reduced to specified levels or if the time error is not corrected in a reasonable period, the Midwest ISO issues the order to return frequency schedule setters to 60.00 Hz. The Midwest ISO initiates a NERC hot-line conference call and posts a message on the RCIS. At this time, PJM dispatcher resets the frequency schedule setter to 60.00 Hz at the assigned time.

4. PJM dispatcher notifies the Transmission Owners/Generation Owners via the PJM ALL-CALL of the cancellation of the time correction, and the time the scheduled system frequency will return to 60.00 Hz.

PJM Member Actions:

None.

Inadvertent Interchange

Inadvertent interchange is defined as the difference between net actual interchange and net scheduled interchange of a control area. It is caused by any of the following factors:

- bias response to frequency deviations occurring on the interconnected system
- metering errors
- inability of system generation to exactly match load and/or net interchange schedule changes

Inadvertent interchange may accumulate in a control area as a megawatt-hour credit or debit. It is accounted for each month. PJM maintains a record of the PJM RTO's accumulated inadvertent interchange for both On- and Off-Peak Periods as defined in the NERC Operating Manual.

- Off-Peak Period is from 2300 to 0659, Monday thru Saturday, and all day Sundays and Holidays
- On-Peak Period is from 0700 to 2259, Monday thru Saturday

Over time, PJM attempts to minimize the amount of accumulated inadvertent interchange. This is accomplished by continually monitoring and correcting for inadvertent interchange. The portion of inadvertent interchange caused by frequency bias is self-compensating if no additional action is taken by PJM dispatcher. This is because on the average, frequency deviations are low as often as they are high. In order for time error to average zero, the inadvertent interchange that flows as the result of frequency bias contribution is balanced automatically by the tie-line bias control.

Correcting for Accumulation of Inadvertent Interchange

It is the responsibility of PJM dispatcher to correct for the accumulation of inadvertent interchange.

PJM Actions:

The reduction of an accumulation (on an On-Peak Period or Off-Peak Period basis as defined above) of inadvertent interchange is accomplished by one of the following two methods:

- Unilateral Payback —Unilateral Payback can only occur when the reduction of the accumulation of inadvertent is in a direction that serves to decrease the time error. An accumulation of undergeneration can only be paid back (requiring the PJM Control Area to overgenerate) when time error is less than zero (i.e., slow). Payback of an accumulation of overgeneration (requiring the PJM RTO to undergenerate) requires a time error greater than zero (i.e., fast).

  The maximum allowed payback per hour is 20% of the PJM RTO's current frequency bias setting. The PJM RTO's frequency bias setting is calculated by PJM and approved by NERC. The maximum payback occurs when the absolute value of time error is one second or more and meets the time error direction criteria described above. When the absolute value of time error is less than one second (and meets the time error direction criteria), payback is scaled down proportionally to the time error (e.g., if time error is 0.5 seconds, payback is 10% of the frequency bias setting).

- Bilateral Payback — Bilateral Payback is scheduled with another Control Area and is accomplished as follows:

- Inadvertent interchange accumulation may be reduced by scheduling a correction with any adjacent control area, provided they have an accumulation in the opposite direction. The amount of schedule established by PJM dispatcher is determined by the following factors:

  - amount of accumulated inadvertent interchange
  - current net interchange schedule in effect
  - current state of the PJM Control Area with respect to load and transmission facilities

  If a schedule cannot be established with the adjacent control area, correction of inadvertent interchange accumulations may be scheduled with a remote Control Area, provided that the intervening Control Area dispatchers are advised of such schedules and are agreeable.

  There may be times when the adjacent control area desires to establish a schedule to reduce inadvertent interchange accumulations with Control Areas other than the PJM RTO.

PJM Members Actions:

None

Section 4: Providing Ancillary Services

Welcome to the *Providing Ancillary Services* section of the PJM Manual for ***Dispatching Operations***. In this section you will find the following information:

- How PJM monitors and restores reserves (see "*Reserves*").
- How PJM determines and assigns Regulation (see "*Regulation*").
- How a generating unit is tested and qualified for Regulation service (see "*Qualifying Regulating Units*").
- How PJM ensures and monitors Black Start Service (see "*Black Start Service*").

Reserves

Reserves are the additional capacity above the expected load. Scheduling excess capacity protects the power system against the uncertain occurrence of future operating events, including the loss of capacity or load forecasting errors.

Monitoring Reserves

PJM is responsible for monitoring the reserves for the PJM Control Area. Periodically, PJM dispatcher takes an Instantaneous Reserve Check (IRC) to determine if adequate reserves exist to meet the PJM Reserve Requirements. An IRC may be taken more frequently if system conditions dictate. When the PJM Generation dispatcher requests an IRC, member dispatchers report the information via eDART. If eDART is unavailable, member dispatchers report the information directly to the PJM Generation dispatcher. Attachment A presents and describes the PJM IRC report.

An IRC provides PJM dispatcher with an indication of the actual reserves that are available at that point in time. By conducting an IRC at strategic points during the day, PJM dispatcher establishes benchmarks between which the actual reserve can be estimated. Since system conditions can change very rapidly, the IRC is only an indication of the actual reported reserves at that point in time. PJM dispatcher uses the results of the IRC to determine if reserve shortages exist and what, if any, Emergency procedures should be declared to supplement the electronic reporting of reserves through the EMS systems.

When the PJM Area Control Error (ACE) indicates undergeneration, the Spinning Reserve total is adjusted downward by the amount of the ACE to reflect the PJM Control Area's generation deficiency. Conversely, when the PJM ACE indicates overgeneration, the Spinning Reserve total is adjusted upward by the amount of the ACE to reflect the PJM Control Area's generation excess. Therefore, when possible PJM dispatcher requests an IRC when the ACE is close to zero MW.

PJM Actions:

1. Using the PJM ALL-CALL, PJM dispatcher requests an IRC.
2. Upon receipt of all Generation Owner reports, PJM dispatcher determines the following values:
   - ☞ PJM Operating Reserve
   - ☞ adjusted Primary Reserve versus Primary Reserve Requirement
   - ☞ adjusted Spinning Reserve versus Spinning Reserve Requirement
   - ☞ unaccounted for capacity
   - ☞ Area Spinning Reserve levels
3. PJM dispatcher compares the values calculated in Step (2) to the corresponding objectives and then determines whether reserve deficiencies exist.
4. Using the PJM eDART, PJM dispatcher reports the results of the IRC to the Generation Owners/Transmission Owners.

PJM Member Actions:

1. The Generation Owner dispatchers promptly report the following values to PJM via eDART. If eDART is unavailable, the values are reported directly to PJM dispatcher via telephone:
   - ☞ Operating Reserve
   - ☞ Spinning Reserve
   - ☞ Quick-start Reserve
   - ☞ Secondary Reserve
   - ☞ scheduled capability that is more that 30 minutes away
   - ☞ capacity reductions that are not known to PJM dispatcher

See the PJM Manual for ***Pre-scheduling Operations*** for more information on the types of reserves.

Loading Reserves

During disturbance conditions (i.e., loss of generation and/or transmission resources), spinning reserve and, to the extent necessary, Quick-Start Reserves are used to recover the ACE so that tie line schedules are maintained. Depending on system conditions, either automatic or manual methods may be used to accomplish this recovery.

- ➢ Automatic Method — Includes setting the Lambda signal (Dispatch Rate) to auto and regulating reserves that are not yet loaded on regulating units.

- Manual Method — Includes raising the Lambda signal manually and committing additional equipment.

PJM Actions:

1. PJM dispatcher determines the approximate amount and location of lost generation, and the amount of spinning reserve that must be loaded to:
   - ☞ correct for the sudden loss of generation located within the PJM Control Area (as indicated by the PJM Control Area's ACE and system frequency deviations)
   - ☞ return interchange transfers or other thermal or reactive limitations to within the appropriate limits
2. PJM dispatcher requests the Generation Owner, via the PJM ALL-CALL, to load a percentage (25%, 50%, 75%, or 100%) of the Spinning Reserve (typically 100%) in the appropriate control zone(s). PJM has several Spinning Reserve markets (MAAC area, ECAR area, MAIN area, and VACAR area). The dispatchers will select the most effective response respecting the requirements of the regional reserve sharing programs in which PJM is a participant.
   - ☞ If specific equipment is excluded from the request, PJM dispatcher calls the appropriate Generation Owner immediately following the PJM ALL-CALL message.
   - ☞ If transmission limits exist or may be caused by loading Spinning and Quick-Start Reserve in certain geographic areas or control zones, PJM dispatcher specifies the areas or control zones that are to be included in the request for Spinning Reserve.
   - ☞ If PJM dispatcher anticipates that loading of Spinning Reserve may continue for longer than ten minutes, PJM dispatcher includes this statement in the PJM ALL-CALL message.
   - ☞ PJM Dispatcher contacts NYISO to implement Shared Reserves (as required, excluding IMO if the PJM reactive transfer limits would be violated).
   - ☞ PJM dispatcher also requests the loading of an appropriate amount of quick-start reserve (as required).
   - ☞ If PJM dispatcher determines that the Spinning Reserve that is being loaded is not sufficient to recover the system from a facility malfunction or failure, PJM dispatcher requests synchronized Secondary Reserve to be loaded (as required).
3. As the Generation Owner dispatchers load the reserves, PJM dispatcher evaluates the effect. PJM dispatcher surveys the generation loaded and

determines that generation that is needed to remain loaded and the replacement generation that can be returned to normal status so that the PJM Control Area load can be economically carried at a new price level.

4. PJM dispatcher cancels the requests, as appropriate.

PJM Members Actions:

1. The generation owners, without regard to price and as quickly as possible, load the requested percentage of Spinning Reserve and Quick-Start Reserve. PJM Members continue to load generation until directed by PJM dispatcher to discontinue.
2. Upon cancellation, the generation owner dispatchers unload the Spinning and Quick-Start Reserve, as directed by PJM dispatcher.

Shared Reserves

Shared Reserve Activation is a procedure between the Northeast Power Coordinating Council (NPCC) and the PJM East Control Zone (MAAC region member companies) to jointly activate a portion of their ten-minute reserve following any of the following situations:

- a sudden loss of generation, transmission, or energy purchase equal to or greater than 80% of its largest contingency
- the largest generation/purchase loss in an area by a participating NPCC area or by PJM
- generation contingencies of less than 1000 MW or an area's largest unit occur under conditions where activation assists in reducing a sustained load/generation mismatch
- periods of significant mismatch of load and generation

The participating systems in NPCC shared reserves are the ISO NE (ISO New England, Inc), the New York Independent System Operator (NYISO), PJM East Control Zone, Maritimes, New Brunswick and Independent Electricity Market Operator (IMO formerly Ontario Hydro). The objective is to provide faster relief of the initial stress on the interconnected transmission system. The NPCC Operating Reserve Policy and the Operating Reserve Policies of all NPCC areas and of the PJM East Control Zone are not changed by any of the provisions of this plan.

The NYISO, being centrally located and equipped with telecommunication facilities to the other participating systems/areas, acts as the plan coordinator.

PJM Actions:

If the loss of generation/purchase is located in the NPCC:

1. The NYISO supervising dispatcher assigns the PJM East Control Zone a share of reserve pick-up. NYISO indicates the amount of participation.
2. PJM dispatcher manually adjusts regulation, loads generation, or Spinning Reserve in selected areas or across the entire PJM East Control Zone based on transfer limitations. This assistance is implemented at a zero time ramp rate immediately following allocation notification. Response by assisting control areas shall respond as quickly as possible, assuming the same obligation as if the contingency occurred within the control area. This should be implemented via manually adjusting regulation if possible.
3. PJM dispatcher notifies the NYISO supervising dispatcher that PJM East Control Zone's reserve pick-up is completed.
4. When the contingency system satisfies its ACE requirements, they notify the NYISO supervising dispatcher, who requests all participants to cancel their shared reserve allocations. The assistance provided by the PJM Control East Zone is ramped out at a ten-minute ramp rate.
5. When the PJM East Control Zone completes its reserve pick-up, PJM dispatcher notifies the Local Control Centers to cancel Spinning Reserve loading.

If the loss of generation/purchase is located in the PJM East Control Zone:

1. PJM dispatcher activates 100% Spinning Reserves and notifies the NYISO supervising dispatcher of generation loss, and includes any special requests. For example, for the loss of a large eastern unit, PJM dispatcher may request IMO not to participate.
2. The NYISO supervising dispatcher activates shared reserves and notifies PJM dispatcher, via conference call, of the ten-minute reserve amount that NPCC members contribute.
3. PJM dispatcher terminates shared reserves (normally ten minutes or less, but no longer than 30 minutes) when the generation loss is replaced.

Payback

Coordination of inadvertent payback will be executed within the same day if possible and within the appropriate on-peak or off-peak hours of the day.

PJM Member Actions:

None.

Restoring Reserves

By continuously monitoring reserves, PJM dispatcher determines reserve deficiencies. During normal operation, PJM dispatcher loads the system based on

economy while monitoring the available reserves. If, however, based on the best judgment of PJM dispatcher after evaluating the results of the IRC, reserve deficiencies exist on the system, the following actions are taken, dependent on the deficiency:

- Spinning Reserve Deficiency — Normally, restoration of Spinning Reserve is accomplished by condensing CTs, or loading Quick-Start or Secondary Reserve to a minimum energy level to provide sufficient Spinning Reserve or to the economic energy level to allow equipment (i.e., steam units) to back down to provide sufficient Spinning Reserve.
- Primary Reserve Deficiency — When PJM dispatcher is assured that the Spinning Reserve objective is covered, PJM dispatcher attempts to eliminate any Primary Reserve deficiency. Restoration is accomplished by any combination of the following actions:

1. loading Secondary Reserve to Primary Reserve status or providing additional Primary Reserve on other equipment
2. bringing additional equipment which is available but not scheduled to operate into the Primary Reserve status

That portion of the Primary Reserve deficiency that is due to an adjustment to the internal PJM Primary Reserve as a result of a net non-capacity interchange scheduled into PJM can be tolerated provided system reliability is not degraded. On these occasions, PJM dispatcher ensures that sufficient shutdown CT and/or hydro capability are readily available to cover the amount of the deficiency.

- Operating Reserve Deficiency — When PJM dispatcher is assured that both the Spinning and Primary Reserve objectives are covered, PJM dispatcher attempts to eliminate any deficiency in Operating Reserve. Sufficient reserve is maintained for coverage of load-forecast uncertainty and probable additional failure or malfunction of generating equipment. The decision of whether to replenish Operating Reserve is based on PJM dispatcher's best judgment. PJM dispatcher may choose to replenish all, some, or none of the Operating Reserve during the operating day.

The Automatic Reserve Sharing System (ARS) – ECAR Region

The Automatic Reserve Sharing System is only intended to be a reliability tool. Its purpose is to increase overall reliability with a faster utilization of reserves, to help prevent the interruption of firm load, and to enhance compliance to the NERC DCS standard.

The ARS system is a group of computer applications which operate on dedicated ECARnet workstations. ARS is primarily designed for the requesting and receiving of power purchases from participating Control Area's contingency reserves. These contingency reserves can be committed to assisting a Control Area's recovery from

specified contingency conditions for a short time. The ARS system automates an accepted formula to prorate contingency assistance among the assisting Control Areas. Participating Control Areas have agreed to utilize the ARS system for all requests of contingency assistance.

Reserves to be Shared

ECAR Document 2 identifies two types of operating reserves: regulation and frequency reserves; and contingency reserves. Reserve sharing only effects the contingency reserves of an ECAR Control Area. The ECAR ARS system calculates daily ARS contingency reserves from the contingency reserve requirement based on the load forecast in the ECAR Projection report.

A Control Area may enter added reserves to the ARS contingency reserves at any time. These are additional reserves over and above the required contingency reserves. Any added reserves included by a Control Area are made available to provide assistance the same as though they were required reserves.

Reserve Sharing Responsibilities

The ECAR ARS system was implemented to provide an easy and consistent method to share contingency reserves among participating ECAR Control Areas. Control Areas participating in the ARS system have agreed to share contingency reserves for the following situations:

- To prevent the interruption of firm load
- To recover from the immediate loss of a unit or designated resource
- To recover from the immediate partial loss of a unit or designated resource
- To recover from the immediate loss of a firm purchase
- To prevent significantly burdening the Interconnection
- As part of ECAR's Inadvertent Monitoring Procedure

A Control area that does not have its required reserves (unless they are being utilized to assist in recovery from a contingency) should enter negative added reserves to reflect the control area's actual contingency reserve status.

Control Areas that are part of the ECAR Reserve Sharing Group for NERC DCS Compliance must enter an ARS contingency request for all reportable DCS events. A reportable DCS event occurs when the Control Area experiences a contingency that creates an instantaneous change in ACE of 1,040 MW or more.

Within 3 working days of an ARS contingency, the Control Area will enter the actual start time of the contingency and whether the contingency is a DCS reportable event. By the 15th of the month following every calendar quarter, ACE data will be entered for all DCS reportable events.

When the ECAR Reserve Sharing Group is not in compliance with NERC's Disturbance Control Standard, each Control Area will be assessed any compliance penalties according to the formulas established by the ECAR Operations Panel. The formulas are described in the Appendix.

Reserve Sharing Utilization

The duration of each request for assistance is between 30 and 59 minutes, as needed, to end the assistance period at either the beginning of the hour or half-past the hour. Interchange transaction tags are not needed before execution of these transactions because their duration is less than 1 hour.

Control Areas participating in the ARS system have agreed to enter requests for contingency assistance within two minutes of a contingency event.

A request for assistance to recover from the immediate loss of all or part of a unit will list the identity of the unit. All other requests for assistance will be listed as "Other Extreme Conditions". When the assistance is identified as "Other Extreme Conditions" for a DCS reportable event, the reason for the assistance request needs to be provided. If the reason is not submitted through the ARS system at the time of the contingency, then the explanation needs to be made to the ECAR office within 3 business days of the contingency.

A Control Area experiencing difficulty in the timely arrangement of power to replace the assistance from an expiring contingency may use the ARS system a second successive time as "Other Extreme Conditions". The amount of the assistance requested will not exceed the expiring contingency.

A Control Area may use the ARS system successively if it is experiencing a sustained operating capacity emergency and has make every effort to balance its generation and interchange schedules to its load by utilizing all available resources without regard to financial cost. The Control Area will notify the Security Coordinator that the CA is in a NERC Energy Emergency Alert. A Control Area should be at NERC's Energy Emergency Alert Level 2 or higher to use the ARS system three or more consecutive times. A Control Area will not use the ARS system to restore reserves. A Control Area may use the ARS system to deplete its reserves to zero.

A Control Area may reduce the reserves available to the ARS system by entering negative reserves in the field for additional reserves. The following are the only acceptable reasons to enter negative added reserves:

- To correct an error in the reserves
- To reduce previously entered positive added reserves
- To correct the reserves when they are based on the ARS default reserves
- To reflect that a Control Area does not have their required reserves.

A Control Area may enter (positive) added reserves at any time. Added reserves are made available to provide assistance the same as though they were required reserves.

Each Control Area may elect to defer the use of their supplemental portion of contingency reserves until after all ECAR spinning reserves have been utilized.

Emergency Reserve Sharing to Prevent Interruption of Firm Load

As soon as the Control Area operator determines that the Control Area does not have sufficient resources to match expected load and may need to implement its emergency load shedding procedures, the Control Area operator will take the following actions:

- Ensure that all emergency operating procedures for the Control Area have been or are being implemented.
- Inform the Security Coordinator that the CA is at a NERC Level 3 Energy Emergency.
- If ARS reserves are not already reduced to zero available reserves, reduce ARS reserves to zero.
- Individually call adjacent Control Areas to arrange a schedule for their contingency reserves that will be made available to your CA under the ECAR emergency reserve sharing procedure.

Continue to call subsequent tiers of control areas as necessary until enough contingency reserves are released to your control area to satisfy your expected capacity shortfall, and prevent implementation of Control Area emergency load shedding procedures.

The Control Area requesting the emergency reserves will maintain sufficient records to fully document the magnitude of this energy emergency, all actions taken to acquire the necessary resources to prevent the interruption of firm load, and all notifications to SC, CAs, local media, etc.

Control Areas providing assistance under the ECAR emergency reserve sharing procedure must enter negative added reserves to ARS to reflect their reduction in ECAR contingency reserves.

Any Control Area implementing the ECAR emergency reserve sharing procedure may be subject to an audit of the Control Area actions regarding the use of the ECAR emergency reserve sharing procedure. The audit will be conducted under the direction of and on behalf of the Operations Panel. The audit may be included as part of another scheduled Control Area audit if requested by the Operations Panel. Scope of the audit will be sufficient to determine if a NERC Level 3 energy emergency did exist or was reasonably expected, and whether the Control Area followed the ECAR emergency reserve sharing procedure.

Transmission System Capability (Group Limits)

Transmission import and export limits in the ARS system are to be consistent with each Control Area's TRM calculations and the physical interconnection capability. When the TRM or interconnection capability along any interconnection path changes, the Control Area is required to change the ARS group (import) limits for that interconnection consistent with the TRM reservations, even if the change is for a short term line outage. The Control Area with the change must notify the other Control Area of the change so the other Control Area can change its group limits, if necessary.

The ARS system may be used when a TLR is in effect. The import capability is provided in TRM and is accessible during a TLR event.

ARS transactions should not aggravate an actual transmission overload condition, nor exceed the physical interconnection capability or network transfer capability.

PJM Action:

Enter requests for contingency assistance within two minutes of a contingency event, listing the identity of the unit.

PJM Member Actions:

None.

MAIN Reserve Sharing

The MAIN reserve sharing program is described in MAIN Guide 5A. This guide defines Operating Reserve and establishes the criteria for (a) the minimum level of Operating Reserve for the MAIN Region and (b) the distribution of such reserves among the member Control Areas of MAIN.

Reserve Requirements

A. The minimum Operating Reserve required in the MAIN Region, on any particular day, shall equal 100% of the gross capability of the Largest Resource planned to be in use in MAIN that day plus the sum of the individual Control Areas' Core Regulating Reserve.

B. The minimum level of Spinning Reserve required for the MAIN region shall equal 50% of the sum of the Control Areas' Operating Reserve.

Distribution of Reserves

The MAIN region maintains a computer system which calculates the distribution of reserve obligations among the MAIN members based on current system conditions.

PJM Action:

Enter requests for assistance due to a contingency event, listing the identity of the unit.

PJM Member Actions:

None.

VACAR Reserve Sharing

PJM, on behalf of Dominion-Virginia Power, participates in the VACAR reserve sharing group, which consists of Dominion-Virginia Power, Duke Power, South Carolina Electric and Gas, Progress Energy-Carolinas, and South Carolina Public Service Authority. The purpose of the agreement is to share reserves to enhance reliability and to decrease the cost of maintaining reserves for each system.

Upon the telephone request of a member, the responding member will provide spinning reserve energy for a period of up to 12 hours to support the needs of the requesting member.

PJM Action:

Responds to requests for assistance due to a contingency event, as requested by another member, by scheduling delivery of VACAR reserve energy to the requesting member for delivery at the border between PJM and the CPL control area.

Request the scheduling of VACAR reserve energy from other VACAR members if needed. Energy will be received at the CPL control area border with PJM..

Dominion-Virginia Power Actions:

Performs billing and provide compensation, as applicable, for reserve energy received by PJM called for on behalf of Dominion or provided by PJM on behalf of Dominion to another VACAR member.

Regulation

The PJM RTO is a single Control Area consisting of multiple Control Zones. Within the PJM Control Area, there are two regulation markets—one consisting of the MAAC member companies (East Regulation Market), and the other consisting of the ECAR, MAIN, and VACAR member companies (West Regulation Market). Regulation for each of the regulation market areas is supplied from generators that are located within their respective metered electrical boundaries. Generation owners providing Regulation are required to comply with standards and requirements of Regulation capability and dispatch, as described in this section.

PJM East Regulation Market Obligations

The Regulating Requirement for the PJM East Regulation Market is 1.1% of the forecast peak load during On-Peak Periods (from 0500-2359 hours) and 1.1% of the forecast valley during Off-Peak Periods load (0000-0459 hours). The generating resources assigned to meet this requirement must be capable of responding to the AR signal within five minutes and must increase or decrease their outputs at the ramping rates that are specified in the data that is submitted to PJM.

PJM West Regulation Market Obligations

The Regulating Requirement for the PJM West Control Zone is 1.0% of the forecast peak load for the entire day. There is no distinction between On-Peak Periods and Off-Peak Periods. The generating resources assigned to meet this requirement must be capable of responding to the AR signal within five minutes and must increase or decrease their outputs at the ramping rates that are specified in the data that is submitted to PJM.

Requirements PJM East & West Regulation Markets

The PJM RTO requires that the Regulation range of a unit is at least twice the amount of Regulation assigned. A unit capable of automatic energy dispatch that is also providing Regulation reduces its energy dispatch range by the regulation assigned to the unit. This redefines the energy dispatch range of that unit. (The unit's assigned regulation subtracted from its regulation maximum forms the upper limit of the new dispatch range, while the unit's regulation minimum plus its assigned regulation forms the lower limit of the new dispatch range.) Exhibit 9 illustrates the limit relationship.

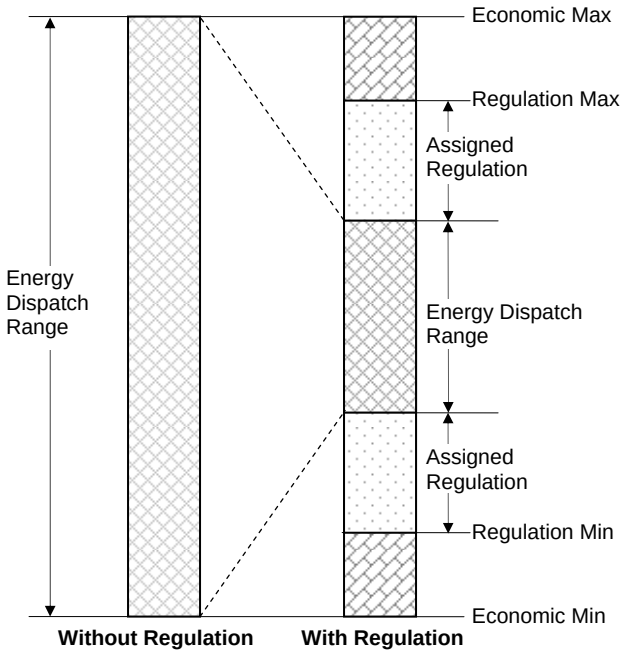

Exhibit 9: Limit Relationship for Regulation

Generation owners wishing to provide Regulation in the PJM control area are required to submit the following data via eMKT no later than 6:00 p.m. day-ahead:

- Assigned Regulation — The MW amount for regulation that is cleared for the unit in the regulation market, which is limited by what the unit can adjust its output to within five minutes while on automatic control.
- Regulation Offer Price — The price in $/MWH at which the owner is willing to provide Regulation from the associated unit.
- Regulating Unit Status — Indication of whether the unit is available, unavailable or self-scheduled for Regulation.
- Regulation Maximum (Max) — The maximum MW value the unit can attain while providing Regulation.
- Regulation Minimum (Min) — The minimum MW value the unit can attain while providing Regulation.

Determining Regulation Assignment

The PJM RTO's Regulating Requirement is a function of the period's load forecast, as determined by the PJM dispatcher. Each LSE is required to provide a share of the PJM Regulating Requirement. An LSE's actual hourly Regulation obligation is determined for the hour, after-the-fact, based on the LSE's total load in the PJM RTO, as follows:

$$LSEs\ \ Regulation\ Obligation = \begin{pmatrix} LSEs\ \ Load\ \ Allocation\ \% \ \times \\ PJM\ \ Regulation\ Requirement \end{pmatrix}$$

An LSE may satisfy its Regulation obligation by any of the following methods:

- Self-Scheduled Resources — An LSE can satisfy its Regulation obligation by self-scheduling Regulation.
- Bilateral Transaction — An LSE can make contractual arrangements with other PJM Members that are able to provide Regulation service.
- PJM Regulation Market Purchases — An LSE can purchase its Regulation obligation from the PJM Regulation Market, i.e., from the excess Regulation capability provided to PJM by Generation owners.

All Regulation offers reported to PJM must provide Regulation that has a quality standard of 75% or greater, as established by verification testing.

PJM Actions:

1. Prior to the beginning of each On and Off-Peak Period, PJM dispatcher determines the PJM Regulating Requirement as follows:
   - ☞ During On-Peak Periods (0500 hours to 2359 hours), the PJM Regulating Requirement is 1.1 % of the PJM Control Area's peak load forecast, as determined prior to 0430 hours.
   - ☞ During Off-Peak Periods (0000 hours to 0459 hours), the PJM Regulating Requirement is 1.1 % of the PJM Control Area's valley load forecast, as determined prior to 2330.
2. At 0330 and 2230, PJM provides the following information to the Transmission Owners/Generation Owners for the LSEs, via the PJM ALL-CALL:
   - ☞ PJM Regulating Requirement for the corresponding On-Peak and Off-Peak Periods.
3. At 2230, PJM provides the PJM West Regulation Requirement for the operating day.

PJM Members Actions:

1. Each LSE determines its estimated Regulation Obligation for the On-Peak and Off-Peak Periods, based on its own forecast load and the information received via the PJM ALL-CALL.
2. Generation owners that have submitted day-ahead regulation offers via eMKT await direction from the PJM dispatcher as to those units to which regulation should be assigned. Generation owners that have self-scheduled Regulation

on any of their units inform the PJM dispatcher when those units are on line and able to provide the self-scheduled Regulation.

3. Once regulation on a unit is self-scheduled by a generation owner, it is no longer eligible to participate as a pool assigned regulating resource for the current operating day.

4. If purchasing Regulation from another entity, the buyer and seller negotiate the transaction and the buyer submits the transaction through the Regulation Bilateral page of eMKT. The rules for these transactions are described in more detail later in this section of the manual.

Dispatching Regulation

PJM obtains the cost efficient Regulation Ancillary Service available, as needed, to meet the PJM RTO's Regulating Requirement. PJM assigns Regulation in economic order based on the total cost of each available unit to provide Regulation, including real time opportunity cost and the unit's Regulation offer price. The AR signals are then automatically sent to the Generation Owners. Generation Owners are responsible for maintaining unit regulating capability. Exhibit 10 shows how the Regulation is assigned to the units.

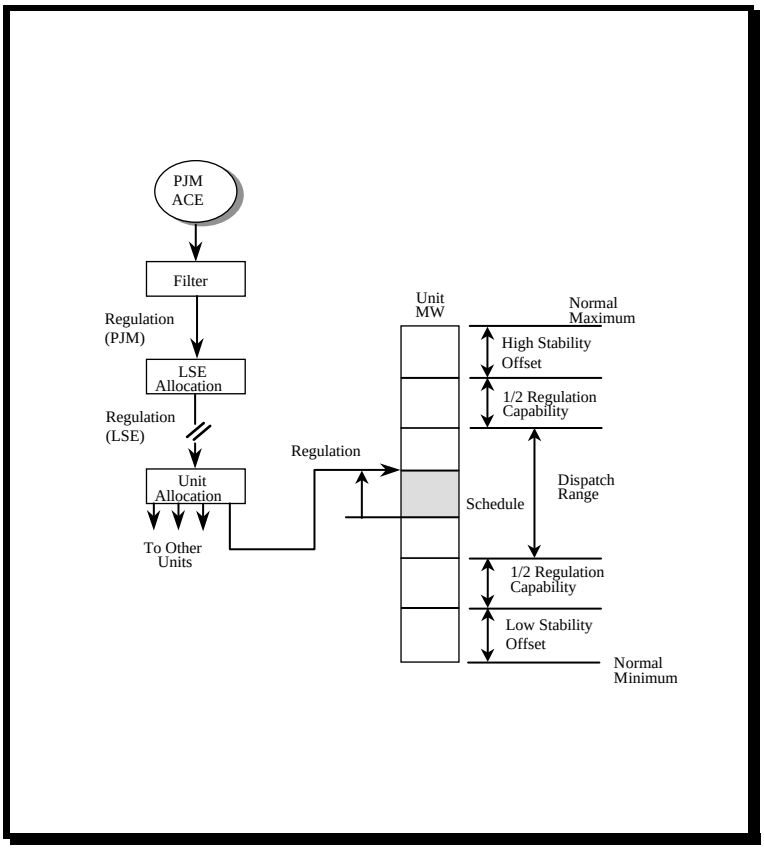

Exhibit 10: Area Regulation Assignment

PJM dispatcher re-assigns regulating capability as necessary to meet the PJM Control Area's Regulating Requirement (within ±15 MW). Market Sellers must comply with Regulation dispatch signals that are transmitted by PJM. Market Sellers must operate their regulating resources as close to desired output levels, as practical, consistent with Good Utility Practices.

Regulation Deficiency

After the initial Regulation assignments are made, and throughout the On/Off-Peak Period, PJM Members report changes to their unit's regulating capabilities. If a unit becomes unable to supply its assigned amount of Regulation, PJM dispatcher may assign additional Regulation to ensure that the total Regulation requirement is met (within ±15 MW). Such assignments are made economically based on each available unit's total cost to provide regulation, including real time opportunity cost and the unit's regulation offer price.

If, after assigning all available Regulation, the PJM Regulating Requirement is still not met (within ±15 MW), PJM dispatcher operates the system without the required amount of Regulation.

In the event there is a loss of EMS communication between PJM and a generation owner, Current Regulation Assignments may have to be reassigned to another Generation Owner until EMS communication is reestablished.

Regulation Excess

If during the period an excess in assigned Regulation occurs and the total PJM RTO Regulation value exceeds the objectives by 15 MW or more, PJM dispatcher de-assigns Regulation economically based on each unit's total cost to provide regulation, including real time opportunity cost and the unit's regulation offer price.

PJM Actions:

1. PJM dispatcher continuously monitors the Regulation and reassigns Regulation as required.
2. PJM's accounting staff determines the billing for the regulating service, according to the procedures in the PJM Manual for ***Operating Agreement Accounting (M-28)***.

PJM Member Actions:

1. When initial assignments and reassignments are made, each affected Generation Owner dispatcher then updates the entity's regulating capability for the AR Control Program.
2. Participants report to PJM dispatcher changes (of at least +/- 1 MW for duration greater than 30 minutes) to assigned Regulation capability.

Participant to Participant Regulation Sales

One PJM Member may sell Regulation Ancillary Service to another PJM Member. The two members must agree on the MW amount of capability being sold, schedule Regulation accordingly, and submit the two-PJM Member Regulation transaction to PJM via eMKT.

PJM Actions:

None.

PJM Member Actions:

1. All two-PJM Member transfers of regulating capability must be submitted as MW amounts via eMKT.
2. The two members agree on the amount and duration of the Regulation transaction prior to the sale.

- The "buying" member submits the MW amount of the two-PJM Member transaction, the selling member, and the start and end time of the transaction via eMKT.
- The "selling" member confirms the transaction via eMKT.

Qualifying Regulating Units

In order to ensure the quality of Regulation supplied to control the PJM RTO, a quality standard is developed. A unit must meet the quality standard to be permitted to regulate.

In general, there are two phases to qualifying a regulating unit:

- certifying the generating unit
- verifying regulating capability

An Area Regulation (AR) test is used for both certifying and verifying regulating capability for a generating unit. It must be emphasized that the Regulation test is not intended to test a unit's governor response to power system frequency changes.

Regulation Test

The AR test is run during a continuous 40-minute period when, in the judgment of PJM test administrator, economic or other conditions do not otherwise change the base generation of the units that are being tested. Changes in base generation for a unit during the test period invalidate the test for that unit.

During the AR test, the AR signal is fixed for the following four ten-minute periods:

- T0-T10
- T10-T20

- T20-T30
- T30-T40

The following steps describe the implementation of the test. It is assumed that the first non-zero AR signal is positive. (Note that the corresponding sequence in which the first non-zero AR signal is negative is equally valid.)

1. T0-T10 — During this time period, the AR signal is equal to zero. This is the initiation of the AR test. This ten-minute period is provided so that the regulating unit settles at its base generation. At T10, the actual generation is sampled and the resulting value defines the base generation for that generating unit.
2. T10-T20 — During this 10 minute period, the AR signal is set to full raise.
3. T20-T30 — During this 10 minute period, the AR signal is set to zero.
4. T30-T40 — During this 10 minute period, the AR signal is set to full lower.
5. T40 — At this time, the AR signal is set to zero to terminate the test.

Exhibit 11 illustrates the Regulation test pattern.

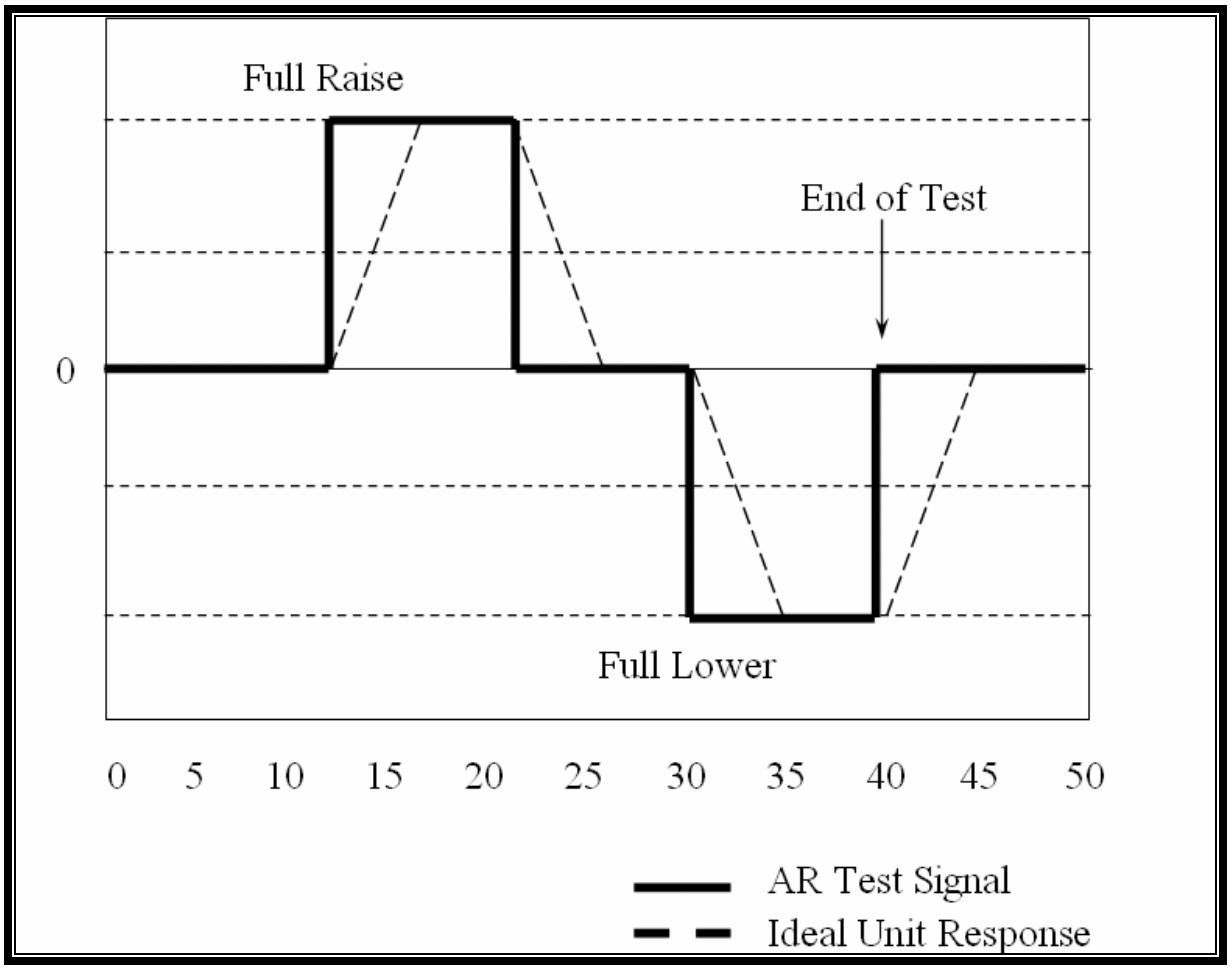

Exhibit 11: Regulation Test Pattern

Once an AR test is announced, a Generation Owner is not permitted to change any unit's Regulation assignment.

Scoring the AR test is based on compliance to two calculations:

- Rate of Response Compliance — The rate of response compliance is a measure of a unit's ability to achieve its Regulation assignment within five minutes.
- Regulation Mismatch Compliance — The Regulation mismatch compliance is a measure of a unit's ability to maintain its actual generation at a constant desired level for five minutes.

These two compliance values are averaged to yield a test score.

The Rate of Response Compliance is an average of three compliance calculations corresponding to the end of each of the three five-minute ramping periods (T15, T25, and T35) during the test.

The Rate of Response Compliance is determined as follows:

- At T15, the actual generation of the generating unit is sampled. This value is called AG15. Note, this is the actual generation and includes both the base generation and the AR response.

The Rate of Response Compliance at time T15 (RORC15) is:

$$RORC15 = 100 - \left[\left(\frac{ABS\ (Base\ Generation + AR\ Signal - AG15)}{Unit's\ Assigned\ AR}\right) \times 100\right]$$

- This calculation is repeated at T25 and T35, yielding RORC25 and RORC35.
- The Rate of Response Compliance is:

$$Rate\ of\ Response\ Compliance = \frac{RORC15 + RORC25 + RORC35}{3}$$

The Regulation Mismatch Compliance is an average of three generation mismatch calculations, corresponding to samples taken during three, five minute periods when the unit response yields an actual generation equal to the base generation, plus the AR signal. These time periods are T15-T20, T25-T30, and T35-T40. During these time periods, the actual generation is sampled.

- During the time period T15-T20, a number of samples, n, of actual generation, AG1, AG2, ..., AGn, are taken. The mismatch for the M20 period is:

$$M20 = \frac{\sum_{i=1}^{n}\left[100 - \left(\left(\frac{ABS\left(Base\ Generation\ +\ AR - AG_i\right)}{Units\ Assigned\ AR}\right) \times 100\right)\right]}{n}$$

$$where\ AG_i = AG1, AG2, ..., AGn$$

- This calculation is repeated for T25-T30 and T35-T40, yielding M30 and M40, respectively.
- The Regulation Mismatch Compliance is:

$$Regulation\ \ Mismatch\ \ Compliance\ = \frac{M20 + M30 + M40}{3}$$

The AR test score is determined by averaging the two compliance values.

$$Test\ \ Score\ = \frac{Rate\ of\ Response\ Compliance\ +\ Regulation\ Mismatch\ Compliance}{2}$$

The range for a valid test score is zero to one hundred percent. Test score results that are equal to 100% indicate the perfect, idealized response. All non-ideal responses yield positive values that decrease as the responses deviate from 100%. Any negative test results default to zero. A valid test requires a continuous 40-minute period of uncorrupted test data. In the event that test data is of questionable

integrity, validation is handled on a case-by-case basis. A unit may be certified only after it achieves three consecutive scores of 75% or above.

Certifying Regulating Unit

Each LSE is required to certify its designated regulating units. The certification process includes notifying PJM before conducting the certification test. The test format must follow PJM Regulation test procedure. Only one test may be performed during each On-Peak or Off-Peak period.

A unit's compliance rating is defined as the sliding average of the five highest test scores (as described in the previous section) of the last seven valid AR tests, weighted by MW of Regulation assigned. The unit's average compliance rating is calculated as follows:

$$Compliance\ \ Rating\ = \frac{\sum(Test\ \ Score)\times(Assigned\ \ Regulating\ \ Capability)}{\sum Assigned\ \ Regulating\ \ Capability}$$

If necessary due to limited available AR test scores, the compliance rating calculation can use a minimum of four test scores. For a unit that has accumulated between four and six valid test scores, the unit's compliance rating is calculated, as follows:

- For a unit with only four valid AR test scores, exclude the lowest test score from the compliance rating calculation.
- For a unit with only five valid AR test scores, exclude the two lowest test scores from the compliance rating calculation.
- For a unit with only six valid AR test scores, exclude the two lowest test scores from the compliance rating calculation.

PJM Actions:

1. PJM maintains a historical database of individual unit Regulation test results and calculates all appropriate compliance information. Individual test results are provided via fax to each participating LSE in a timely manner in order to facilitate a review and validation of results at the participant level.

PJM Member Actions:

1. After the last certification test results are submitted to PJM, PJM notifies LSEs of a unit's certification for Regulation within three working days.

Black Start Service

Black Start capability is necessary to restore the PJM transmission system following a blackout. Black Start Service shall enable PJM and LCCs to designate specific generators whose location and capabilities are required to re-energize the transmission system..

These designated resources, called black start units, are generating units that are able to start without an outside electrical supply or the demonstrated ability of a unit with a high operating factor (subject to PJM approval) to remain operating, at reduced levels, when automatically disconnected from the grid. The planning and maintenance of adequate black start capability for restoration of the PJM control area following a blackout represents a benefit to all transmission customers. All transmission customers must therefore take this service from PJM.

Black Start Service can be provided by units that participate in system restoration. Such units may be eligible for compensation under the Black Start Service. If a partial or system-wide blackout occurs, Black Start Service generating units can assist in the restoration of the PJM control area. Specific generating units identified in specific Transmission Owners' local restoration plan(s), have the capability and training required to start-up without the presence of a synchronized grid to provide the necessary auxiliary station power.

The Transmission Owner restoration plans are implemented if a partial or complete system blackout occurs.

Restoration Assumptions

Transmission customers must purchase black start capability from PJM. Generation resources providing this service must successfully pass the requirements for black start capability.

The LCCs in conjunction with PJM are responsible for identifying the generating units that are critical for PJM control area system restoration. During restoration activities, the LCC manages and deploys the black start capability, as needed, depending on the specific situation.

The LCCs have developed and shall periodically review the Restoration Plan. The LCCs in conjunction with PJM may amend this restoration plan and determine black start requirements to account for changes in the system configuration if either determines that additional black start resources are needed. PJM has the flexibility to seek offers for new resources whenever it amends the current plan.

PJM is responsible for coordinating payments for all black start capability directly to the generating facilities that provide the service. Payments are determined as described in PJM Manual M-27 Open Access Transmission Tariff Accounting.

Jurisdiction

Following the complete loss of system generation (blackout), it will be necessary to establish initial generation that can supply a source of electric power to other system generation and begin system restoration. These initiating generators are referred to as system black start generators. They must be able to self-start without any source of off-site electric power and maintain adequate voltage and frequency while energizing isolated transmission facilities and auxiliary loads of other generators. Generators that can safely reject load down to their auxiliary load or an isolated island of load are another form of black start generator that can aid system restoration.

Definitions

- Black Start Unit – A single generator that can black start.
- Black Start Plant – A plant that includes a unit that can black start. A Black Start Plant with black start units at different voltage levels (electrically separated) will be considered multiple Black Start Plants.

Objectives of Determining Black Start Criticality

1. Provide sufficient amount and redundancy of black start resources to initiate an orderly restoration of critical transmission system components and provide cranking power to generation facilities within PJM.
2. Provide sufficient off-site power to ensure restart for nuclear facilities within PJM within the acceptable time-frame.
3. Provide operational flexibility to address alternate system restoration scenarios as required by facility failures and outages.
4. Critical black start generation is used to restore generator auxiliary load or other critical load to facilitate the system restoration process.

Assumptions

1. Enough black start generation will be deemed critical to facilitate the goal of restoring the majority of the PJM RTO (80% of load) in 16 hours (recognizing other factors are involved in meeting this restoration time).
2. Once a black start unit is started, it can be used to facilitate startup of other units (black start or not) at the same plant.
3. Designated critical black start generation is identified as such in each Transmission Owners restoration plan.
4. Redundancy of critical black start units is desirable due to possibility of unit failure to start or transmission facility failures preventing black start units from serving their intended loads.

Minimum Critical Unit Requirements

Each zone within MAAC will adhere to the MAAC Standards for minimum black start capability. Zones in ECAR shall adhere to the ECAR Standards. Zones in MAIN shall adhere to MAIN standards.

Critical Unit Restrictions for Eligible Compensation under the PJM Black Start Service

1. No more than **three** black start units at any one black start plant will be considered critical and eligible for compensation under the PJM Black Start Service unless approved as an exception.
2. Critical black start units at a plant shall be chosen to minimize the impact of transmission outages or failures on black start capability.

Exceptions

Transmission Owners may request additional black start (more than 3 black start units at a plant) to be considered critical for black start and thus eligible for compensation under the PJM Black Start Service through an exception process.

The exceptions must be for justifiable reliability reasons for system conditions or configurations not incorporated into this document.

Possible exceptions would be due to plant/unit limitations or restrictions, electrical (transmission) characteristics, electrical (auxiliary/balance of plant) characteristics or control characteristics.

These exceptions will be heard on a case by case basis and must be approved by PJM and the PJM SOS-Transmission.

PJM Actions:

1. PJM has collected the list of critical black start units by Transmission Zone.
2. PJM will analyze the critical black start units to ensure an adequate amount of black start generation exists on the system.
3. PJM will analyze any exceptions to the three units per zone rule internally and through the SOS committee.

PJM Member Actions:

1. PJM Transmission Owners will submit any requested changes to the critical black start list due to system configuration changes or changes to System Restoration plans to PJM Performance Compliance Department as they become known. The remainder of existing commitments to black start generators must be fulfilled unless agreed upon by the Generation Owner.

Product Description

Black Start Service - A generating unit is defined as "black start capable" if the following conditions are met:

- The generating unit has the ability of being started and can close an output circuit breaker to a dead bus without energy from other PJM generating units or demonstrated ability to operate at reduced levels upon automatic isolation from the grid in such a way that it meets all requirements stated in the Performance Standards and Testing sections of this document.
- The generating unit owner and PJM have agreed that the unit should be designated as black start capable.
- The generating unit is located where black start capability is determined by the LCC and/or PJM to be useful to system restoration.
- The generating unit must have the ability to close the output breaker to a dead bus within 90 minutes of the request from the local Transmission Owner or PJM.
- A generating unit that is needed for system restoration and participates in black start service tests and System Restoration Drills may be eligible for compensation under black start service.

Generator Owner's Commitment

The generator owner shall be committed to provide black start capability:

- Generators shall commit initially for at least two years to provide black start service from the black start service implementation date, with an annual right to terminate by each party (the generator owner and the transmission owner) with one year's notice. In the event that neither the Black Start Unit owner nor the Transmission Owner exercises its right to terminate by providing a one year notice of termination, the commitment to provide Black Start Service automatically will be extended for an additional year to maintain a rolling two-year commitment.
- All succeeding annual commitments must be at least an additional year to maintain a rolling two-year commitment. Changes in cost may be made annually, but will become effective in the second year of commitment.
- If due to an event of force majeure a generator owner cannot provide Black Start Service, the commitment requirements stated above shall not be binding.
- In the event that a Black Start Unit fails to fulfill its two year rolling commitment to provide Black Start Service, the Black Start Unit owner shall forfeit the received monthly Black Start Service revenues for the period of its non-performance not to exceed revenues for a maximum of one year.

Performance Standards

Each black start unit shall meet the following performance standards:

- The ability to self-start without any source of electric power from another PJM Capacity Resource within the time defined in the system restoration Transmission LCC, as demonstrated through testing or the demonstrated ability to operate at reduced levels when automatically disconnected from the grid.
- The ability to close into a dead (de-energized) bus. This may be demonstrated by (a) physically closing the generator breaker connected to a dead bus while the unit is running or (b) by a test that simulates closing the generator breaker while only the generator side of the breaker is energized.
- If the unit has the ability to operate at reduced levels when automatically disconnected from the grid, this may be demonstrated by {a} physically removing the unit from the grid while the unit is running or {b} by a test that simulates removing the unit from the grid.
- The capability to maintain frequency under varying load. This may be demonstrated by (a) picking up an isolated block of load, or (b) by appropriate dynamic off-line testing of the governor controls.
- The capability to maintain voltage under varying load. This may be demonstrated by (a) picking up an isolated load, (b) by producing both leading and lagging VARs by varying the voltage setting while the unit is synchronized to the system, or (c) by appropriate dynamic off-line testing of the voltage controls.
- Ability for to maintain rated output for a duration as identified by the LCC System Restoration Requirements. Requirements for supply to gas fueled black start units should be considered in the LCC System Restoration Plan. Specific gas supply requirements include, but are not limited to, electric feed to gas gate valves, or local gas compressors needed to maintain gas supply during the restoration process.
- In addition to these unit-specific performance standards, each black start generation owner must maintain procedures for the startup of black start generation at each black start generating station. These standards shall remain in effect for the duration of the commitment.

PJM Obligations

Generators that commit to provide Black Start Service shall not have their black start capable designation terminated within the time of their commitment. PJM shall provide at least a two-year notice to the owner or owners of generating units that are providing Black Start Service prior to terminating that unit's designation as black start capable.

Designated black start generating units shall recognize that PJM shall have the authority to ensure a minimum amount of black start capacity when deciding whether to approve generator outages. Critical black start units will have additional planned outage restrictions as defined in the Section 2 of the PJM Pre-scheduling Manual.

Testing

Every generating unit that is providing black start capability shall be tested to verify that it can be started and operated without being connected to the PJM power system. black start generating unit owners/operators shall annually schedule tests of resources providing black start capability to confirm the ability of such resources to meet the applicable standards for performance and control.

Tests may be scheduled at the discretion of the generation owner, however, tests must be prescheduled with PJM prior to the test. Compensation for energy output delivered to the system shall be provided for the unit's minimum run time at the higher of the unit's cost-capped offer or real-time LMP, plus start-up and no-load costs for up to two start attempts, if necessary. Any unrecovered costs of Black Start Tests should be submitted in writing to the Manager of Market Settlements.

For units with high operating rates with the ability to remain operating at reduced levels when automatically disconnected from the grid, an opportunity cost will be provided to compensate the unit for lost revenue during the black start testing.

Annual tests shall include:

- starting and bringing the resource to synchronous speed without assistance from a system electrical feed.
- testing of all communication circuits.
- simulating switching needed to connect the black start unit to the transmission system following a system blackout.
- testing the features unique to each facility that relate to Black Start Service.

Testing & Training Standards & Records

Each black start generating unit shall be tested to verify it can be started and operated without being connected to the system. The black start generating unit owner/operator shall annually test the start-up and operation of each black start generating unit. Multiple tests may be attempted, following the identification and reporting of corrective actions (See the Non-performance Issues section). Testing records shall include:

- date(s) of test(s)
- duration of test(s) from start of test until unit is on-line
- test conditions (ambient temperature, general weather conditions)

- indication of whether the unit was able to start without being connected to system
- indication of the ability to close a circuit breaker into a dead bus
- indication of the ability to control frequency within the prescribed range and voltage through the control of reactive (both over and under excited
- indication of the ability to remain stable and control voltages while operating isolated from the transmission grid and supplying the source's own auxiliary load.
- description of communications and control systems that are capable of allowing SCADA/EMS data and voice communications, as defined in the PJM Control Center Requirements Manual.
- explanation of failed test and corrective actions taken
- description of operator training
- dates of training
- copies of black start procedures

Documentation of the test results of the start-up and operation of each black start generating unit shall be provided to PJM and the LCC. PJM shall verify that the number, size, and location of black start capable units are sufficient to meet PJM's restoration plan expectations.

Non-performance

If a unit fails a black start test, the unit is given a ten day grace period within which it may re-test without financial penalty.

If the unit does not successfully pass a black start test within the ten day grace period immediately following a failed test, monthly black start revenues will be forfeited from the time of the first unsuccessful test until the unit successfully passes a black start test.

To collect monthly black start revenues, a unit must have a successful black start test on record with PJM within the last 13 months.

PJM Actions:

1. PJM Performance Compliance Department will collect and analyze the Black Start Test data as described above from each black start unit to determine each unit's eligibility for Black Start Service payments.
2. PJM Performance Compliance will notify the LCC if a black start unit in their zone fails to complete a successful black start test in the required timeframe. PJM Performance Compliance will also notify the LCC when units that failed black start tests are again eligible after completing a successful test.
3. PJM Performance Compliance Department will maintain the list of eligible black start units and forward any changes to PJM Market Settlements.

4. PJM Market Monitoring Unit will analyze any requested generator black start cost changes on an annual basis and forward all approved revenue requirements to PJM Market Settlements. The approved revenue requirements will be applied by PJM Market Settlements to Black Start Service payments starting with the month following the submission of the black start cost changes.

PJM Member Actions:

1. Black Start Generation Owners will notify PJM Performance Compliance (Blackstart@pjm.com), as well as the LCC in whose zone the black start unit operates, of expected black start test date.
2. Black Start Generation Owner will notify PJM Operations prior to start of black start test.
3. Black Start Generation Owners will report Black Start Test results using the PJM Black Start Test Report Form displayed in Attachment C of this manual. Generation Owners with Auto Load Reject Units will report their testing results using the PJM Auto Load Reject Test Report Form in Attachment D of this manual. Completed forms and other requested data will be submitted to the PJM Performance Compliance Department using the eDART XLS Upload Process, or by sending an email to Blackstart@pjm.com.
4. Black Start Generation Owners may request changes to their Schedule 6A revenue requirements (formulaic costs) annually by completing the PJM Black Start Formulaic Cost Data Form displayed in Attachment E of this manual. Formulaic cost data requests will be reviewed and approved by the PJM Market Monitoring Unit. Alternatively, Black Start Generation Owners may request changes to their actual costs annually by completing the PJM Black Start Actual Cost Data Form in Attachment F of this manual. Completed cost data forms and other requested data will be submitted with appropriate documentation to the PJM Market Monitoring Unit for analysis using the eDART XLS Upload Process, however actual cost change requests must be filed to with appropriate documentation to the FERC for approval.

Section 5: Transmission Facility Control

Welcome to the *Transmission Facility Control* section of the PJM Manual for ***Dispatching Operations***. In this section you will find the following information:

- Identifies major problems and the means of correction (see "Corrective Control Strategies").
- How PJM controls for reactive limits (see "Reactive Limitation Control").
- How PJM controls voltage (see "Voltage Control").
- How PJM responds to overloaded transmission facilities (see "Thermal Overloaded Transmission").
- Description of regional reliability coordination (see "Reliability Coordination Plan").

Corrective Control Strategies

Below are the major electrical network problems that can occur in the PJM RTO and the primary (or most effective) means of overcoming these problems. Exhibit 12 identifies the major problems as:

- Overloads (pre-post contingency/reactive) and excessive transfers between areas within the PJM RTO
- transmission system low voltage conditions
- transmission system high voltage conditions
- power system low frequency conditions
- power system high frequency conditions

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

Exhibit 12: Corrective Control Strategies

The various available means for control to help alleviate these problems are also listed in Exhibit 12. Some of these controls are automatically applied by local closed-loop control while other controls are acted on by the individual participants upon PJM request. PJM has no direct means of controlling the generation/transmission/distribution system.

Exhibit 13 shows the type of limits that apply to various power system conditions. Nuclear power plants at various locations may have more restrictive voltage limits, imposed by nuclear licensing obligations, than listed in Exhibit 13. In these cases, such limits are to supercede the general guidance provided in Exhibit 13.

Note: Thermal and reactive constraint control includes loading of economic generation (on cost) generation.

Power System Conditions		
Types of Limits	**Pre-Contingency Normal Conditions**	**Post-Contingency Emergency Conditions**
Thermal	Actual Flow < Normal Rating	Contingency Flow < Emergency Rating
Reactive Transfer	Equivalent MW Rating	Equivalent MW Rating
Voltage - 500 kV	500 kV - 550 kV(494kV-540kV in DVP)	500 kV - 550 kV Max 5% kV Drop (494kV – 540 kV Max 10% kV Drop in DVP)
Voltage - 345 kV	328 kV - 362 kV	328 kV - 362 kV
Voltage - 230 kV	219 kV - 242 kV (216.2kV – 241.5kV in DVP)	219 kV - 242 kV (216kV – 241.5 kV in DVP)
Voltage - Customer ANSI Standard	97.5% - 105%	95% - 105.8%
Stability - Steady State	Max 60^{o} Difference for 500 kV System	Max 50^{o} Difference for 500 kV System
Stability - Steady State	Max 40^{o} Difference for Generators	Max 30^{o} Difference for Generators
Stability – Transient		
Stability – Dynamic		
Frequency - 59.3 Hz		Automatic Load Shedding 10% of Peak Load
Frequency - 58.9 Hz		Automatic Load Shedding 10% of Peak Load
Frequency - 58.5 Hz		Automatic Load Shedding 10% of Peak Load

Exhibit 13: Power System Limits

The next subsections describe the procedures that are followed to implement controls in response to specific problems.

Reactive Limitation Control

This section provides operating guidelines for normal and emergency control of transfer interfaces where a reactive limit is reached or exceeded.

PJM Actions:

1. When a reactive limit is approached or exceeded, and non-cost moves are ineffective, out-of-merit assignments are made in the most effective areas to control these limitations. PJM dispatcher also evaluates the impact of the

existing inter-area transfers and modifies the transaction schedules that adversely affect the reactive transfer limit. Prior to out of merit assignments transaction schedules that are not willing to pay congestion are curtailed. If insufficient generation is available to control these limitations, the Emergency procedures contained in the PJM Manual for ***Emergency Operations (M-13)*** are implemented. If the Emergency Procedure steps (from curtailing non-firm contracts through Voluntary Customer Load Curtailment, including implementation of the NERC TLR procedure) are insufficient to control the transfers, a Manual Load Dump Warning is issued to all Generation Owners/Transmission Owners stating the most serious limitation and the estimated amount of load relief required. PJM dispatcher using all available tools, voltage drop curves, actual voltage conditions, proximity to all the different reactive transfer limits, and Transmission Owner impacts, determines the most effective area for load dumping. PJM dispatcher discusses the locations and the amount of load drop required with the affected LSEs.

2. If transfers exceed a reactive transfer limit and voltage conditions are deteriorating and PJM dispatcher determines that the system cannot withstand the occurrence of the contingency, PJM dispatcher orders a Manual Load Dump in the most effective area and in an amount sufficient to return the transfers to within the reactive transfer limit.

If transfers exceed the transfer limit (or a revised transfer limit, if applicable), due to the occurrence of some contingency, but additional actions other than load dumping are available and effective, these actions are first undertaken. If, however, transfers are not returned to within the limits within 30 minutes of the occurrence of the contingency, the PJM Emergency Procedures up to and including load dumping are implemented.

PJM Member Actions:

The Generation Owner/Transmission Owner dispatchers follow actions prescribed in the PJM Manual for ***Emergency Operations (M-13)***.

Voltage Control

The PJM RTO is operated so that normal voltage profiles are maintained at all load levels. Under normal system conditions, the following criteria are used:

- Each LSE is able to supply its reactive load and losses locally at all load levels.
- The 500 kV system is operated so that all 500 kV bus voltages are maintained between 500 kV and 550 kV (494 kV and 540 kV in the Dominion area) on a pre-contingency basis. Maximum voltage capabilities on individual 500 kV buses are given in Attachment B.
- The 345 kV and below portion of the bulk power transmission system is operated so that all bus voltages are maintained within 5% of the nominal voltage on a pre-

contingency basis, unless use of a different bandwidth is required because of equipment design.

No single contingency outage shall exceed either of the following limits at a 500 kV bus:

- a post-contingency voltage drop of five percent (0.20 PU in the Dominion area) on 500 kV facilities
- A post-contingency angular difference which is ten degrees less than the setting of the synchro-check relay. Synchro-check relays are set to 60° for 500 kV terminals and 40° for generators.

PJM regularly examines system conditions for potential voltage problems and advises PJM dispatcher of measures that must be taken to maintain the system within the criteria.

The Generation Owner/Transmission Owner dispatchers establish system voltage control by using controllable reactive sources, including generators, synchronous condensers, and switched capacitors. After the controllable reactive sources are utilized, Load Tap Changing (LTC) transformers may be used to adjust 500 kV and 230 kV voltages.

Voltage Coordination Plan

Six reactive support levels are defined for the purpose of voltage coordination:

- Emergency Heavy — Support that is necessary when there is an actual low voltage situation due to high loads, heavy transfers, or a critical contingency. PJM dispatcher performs the following actions:

1. checks that all shunt capacitors are in service and that all reactors are out of service
2. supplies maximum MVAR generation and if practical, reduces MW generation to increase reactive output
3. adjusts 500/230 kV tap changers to maximize reactive support to the 500 kV systems
4. reduces transfers

- Heavy — Support that is necessary in anticipation of high loads or heavy transfers in order to prevent low voltage situations from occurring which can result in transfer curtailments. PJM dispatcher performs the following actions:

5. issue a Heavy Load Voltage Schedule via PJM All-Call
6. checks that all bulk power shunt capacitors are in service
7. requests Transmission Owner dispatchers to verify that all shunt capacitors are in service

8. implements heavy-load voltage schedule using the PJM ALL-CALL
9. adjusts 500/230 kV tap changers to increase reactive support to the 500 kV system
10. increases generator MVAR output to increase support of 500 kV voltage

- Normal On-Peak — Support that is necessary to supply normal loads during peak conditions. No unusually high loads or transfers are expected. PJM dispatcher performs the following actions:

11. operate within normal on-peak voltage range
12. operate capacitors and 500/230 kV transformers to adjust system voltage

- Normal Off-Peak — Support that is necessary for normal loading during non-peak conditions. No minimum loads or transfers are expected. PJM dispatcher performs the following actions:

13. operate within normal off-peak voltage range
14. operates capacitors and 500/230 kV transformers to adjust system voltages

- Light — Support that is necessary to avoid high voltage due to anticipated minimum load or transfer conditions. PJM dispatcher performs the following actions:

15. may deviate from off-peak voltage range at generation stations to reduce system voltage without exceeding normal station limits
16. requests Transmission Owner dispatchers to switch out underlying shunt capacitors
17. switches out bulk power capacitors
18. operates pumped storage generation in the pumping mode
19. adjusts 500/230 kV transformers so that both the 500 kV and the 230 kV systems reach their maximum voltage limits simultaneously
20. requests Transmission Owner dispatchers to adjust available sub-transmission and distribution transformers so that both the high and low side reach maximum voltage limits simultaneously

- Emergency Light — Support that is necessary when there is an actual high voltage situation due to minimum loads, transfers, and/or critical contingency. PJM dispatcher performs the following actions:

21. directs the Transmission Owner dispatchers to open pre-studied 500 kV lines
22. requests assistance from adjacent Control Areas

Action In a Low Voltage Situation

If voltages are, or are expected to be, below the criteria, the following actions are taken by PJM and the Generation Owners/Transmission Owners.

PJM Actions:

1. PJM dispatcher requests all Generation Owners/Transmission Owners to implement the heavy-load voltage schedule.
2. PJM dispatcher requests that synchronous condensers and switchable capacitors be placed in service unless studies indicate otherwise.
3. PJM dispatcher verifies that all units in operation are supplying maximum MVAR capability.
4. PJM dispatcher adjusts 500/230 kV transformer taps to optimize system voltage.
5. If system voltages are determined to be overly sensitive to slight increases in transfer levels, PJM dispatcher reduces power transfers into the reactive-deficient area to a value that stabilizes voltages. PJM dispatcher re-examines system conditions and reduces the limit, until voltage stability is achieved.

PJM Member Actions:

1. The Generation Owner/Transmission Owner dispatchers respond promptly to specific requests and directions of PJM dispatcher.

500 kV System Voltage Below 500 kV

If the 500 kV system voltage is below 500 kV (or 494 kV in the Dominion area), the following actions are taken:

PJM Actions:

1. PJM dispatcher issues a Manual Load Dump Warning and takes appropriate Emergency procedures (see PJM Manual for ***Emergency Operations (M-13)***), in the effective area.
2. If the 500 kV system voltage has reached a level of, or is decaying toward 470 kV, or any other level as determined by PJM operations planning staff, PJM dispatcher orders sufficient load dumping in the deficient area, so as to stabilize the system voltage at 490 kV or better to protect the system from a loss of a large unit.
3. PJM dispatcher directs Transmission Owners, via the PJM ALL-CALL, to avoid taking any actions that adversely affect the 500 kV system voltage, without first obtaining approval from PJM dispatcher. If the 345 kV system or below has reached a level of 90% of nominal and is continuing to decay, PJM dispatcher orders load dumping in the deficient area, sufficient to return the system voltages to 95% or better.

PJM Member Actions:

1. The Transmission Owner dispatchers promptly dump an amount of load equal to, or in excess of, the amount requested by PJM dispatcher.
2. The Transmission Owner dispatchers report actions taken once implemented.

Action In a High Voltage Situation

The following items apply to voltage control of the overall PJM 500 kV system. It should be noted that high voltage problems of localized nature may be more effectively controlled by selective measures in the particular area.

PJM Actions:

1. PJM dispatcher requests the Transmission Owners to disconnect all switchable capacitors.
2. request system reactors be placed in service where available
3. PJM dispatcher requests the Generation Owners/Transmission Owners to operate units to absorb reactive power.
4. PJM dispatcher requests neighboring Control Areas to assist in reducing voltage.
5. PJM dispatcher requests the Transmission Owners to adjust 500/230 kV transformer taps to optimize system voltage.
6. PJM dispatcher requests the Transmission Owners to reset desired voltage on Static Var Compensators (SVCs).
7. If the above is not sufficient, high voltage problems may possibly be relieved by opening a 500 kV circuit. (Opening a circuit loaded below surge impedance loading, 850 MW, results in a net decrease in line charging). If using the EMS real-time program, PJM dispatcher determines that opening the 500 kV circuit causes no overloads, PJM dispatcher directs the Transmission Owner to open this line at both terminals. PJM dispatcher determines if this action has produced the desired effect; if not, PJM dispatcher directs the Transmission Owner to reclose the line. PJM operations planning staff routinely provide PJM dispatcher with a list of 500 kV circuits that may be opened without degrading system reliability. PJM dispatcher may not open more than one 500 kV circuit for voltage control in an area.

PJM Member Actions:

1. The Generation Owner/Transmission Owner dispatchers respond promptly to specific requests and directions of PJM dispatcher.

Thermal Overloaded Transmission

This section describes the actions to be taken when there is thermal overloading of a transmission facility (line or transformer) at or above the Short Term Emergency (STE) rating. These actions provide protection of high voltage transmission from failure and damage due to overloaded conditions and preservation of system reliability.

The general procedure is to first apply effective corrective actions that can be taken at little or no cost, for example:

- transformer tap adjustments
- phase-angle regulator adjustments
- capacitor/reactor switching
- pre-studied line switching
- curtailment of non-firm transactions not willing to pay for congestion

Transaction Curtailment

PJM may curtail transactions for which the transmission customer has not indicated the desire to buy through congestion. These curtailments are accomplished in an order based on:

- distribution factor impact on the constrained facility
- priority of transmission service
- timestamp of the transmission service request within each priority level

If the transactions which require curtailment are external to PJM, the NERC TLR procedure is invoked.

Generation Redispatch

In the event that further corrective actions are required, the outputs of effective generators are adjusted away (off-cost) from their normal assignments (on-cost).

The generation control cost signal that is sent from PJM to each Generation Owner is established either automatically by computer program or manually by PJM dispatcher (see Exhibit 6 of this PJM manual).

Operating Mode Change Procedure

The following procedures are applied when the PJM RTO conditions require a change in on/off-cost operating modes:

- From On-Cost to Off-Cost — When generation redispatch is necessary, the PJM dispatcher notifies all Generation Owners/Transmission Owners, via the PJM ALL-CALL, that particular Control Zones will be operating off-cost.
- From Off-Cost to On-Cost — When conditions permit the affected Generation Owners/Transmission Owners to return to economic dispatch (on-cost), PJM dispatcher notifies all Local Control Centers, via the PJM ALL-CALL, when the affected LSEs will return to on-cost operations.

A summary of PJM Constraint Control guidelines is included as Attachment B.

PJM Actions:

1. When a transmission facility is loaded above the STE rating, but does not exceed the load dump rating (generally 115% of the STE rating), PJM dispatcher requests adjustments to controllable equipment within a maximum of 15 minutes, to bring the loading to equal or below the STE rating.
2. If the facility is not reduced within 15 minutes, PJM dispatcher orders a load dump to reduce the actual flow on the facility to be equal to or below the STE rating.
3. When a transmission facility is loaded above the load dump rating, PJM dispatcher or Transmission Owner on the receiving end of the overloaded facility, has up to a maximum of five minutes to analyze and relieve the overload. If not reduced to or below the STE rating at the end of five minutes, PJM dispatcher orders a load dump to relieve the facility.
4. PJM dispatcher promptly informs the Transmission Owner dispatcher of any overloads that have occurred and corrective actions being taken.

PJM Member Actions:

1. The Transmission Owner dispatchers promptly inform PJM dispatcher of any overloads that have occurred and corrective actions being taken.
2. The Transmission Owner dispatchers do not open any overloaded transmission, including inter-Control Area and intra-Control Area circuits, under disturbance conditions unless pre-studied or pre-arranged for specific contingencies.
3. If an overloaded transformer or cable cannot be relieved by applying the previous criteria, the LCC dispatcher can open the facility, while taking into account the system conditions and the resulting consequences, versus the consequences of having the facility fail and incur damage.

Attachment A: PJM Instantaneous Reserve Check

PJM Instantaneous Reserve Check

Date: **Time:** **Load: (1)**

LSE Company	(a) Operating Reserve	(b) Spinning East	(b) Spinning Total	(c) Quick-Start Hydro	(c) Quick-Start Other	(d) Secondary Reserve	(e) Reserve Avail. >30	(f) Non-Reported Cap. Reduct
(2) TOTAL		(east only)	(total)	(hydro)	x80%			

*There are occasions when up to a 25 % deficiency (of spinning reserve) can be tolerated, See OM#0004

NON-CAPACITY INTERCHANGE (3) SALES		UNTELEMETERED GEN. (7) & PUMPING LOAD	
NON-CAPACITY INTERCHANGE (4) PURCHASES		(8) NET TIE FLOW	
(5) ACE		NY SHARE H.C. & (9) CEI SHARE SENECA	Not Applicable
REQUIRED SPINNING *(75%=)		CAPACITY REPORTED (10) ON L&C SHEET	
ADJUSTED SPINNING (6) (2bTotal + 3 + 5)		CALC. OPERATING CAPACITY (11) (1 + 2A + 7 - 8 - 9)	
REQUIRED PRIMARY	1700	SCHED. CAPACITY NOT AVAIL. (12) IN 30 MIN. (2e + 2f)	
ADJUSTED PRIMARY (6 + 2cTotal - 4)		UNACCOUNTED FOR CAPACITY (10 - 11 - 12)	
LARGEST CONTINGENCY	@	____MWs Required Spinning X 0.75=____Min. Required Spinning See OM#0004	

REPORTED VIA ALL CALL

OPERATING RESERVE =	TIME of All Call _____
ADJUSTED PRIMARY RESERVE =	REQUIREMENT = 1700
ADJUSTED SPINNING RESERVE =	REQUIREMENT =
UNACCOUNTED FOR CAPACITY =	
RESERVE MOVED FROM SECONDARY TO PRIMARY	ETL _____ CTL _____ WTL_____

Exhibit 14: PJM Instantaneous Reserve Check

Instantaneous Reserve Checks (IRC) - Definitions of Terms

- Date — Date of the request for the IRC
- Time — Time of the request for the IRC

1. Load (Telemetered) — Total PJM Control Area load in MW at the time of the request
    a. Operating Reserve — as reported by LSEs.
    b. Spinning Reserve — as reported by LSEs. Spinning Reserve is reported for both the entire PJM Control Area and for transmission constrained areas within the PJM Control Area, when applicable. PL and GPU should show both an Eastern Spinning Reserve value and a total Spinning Reserve value for their regions.
    c. Quick-Start Reserve — as reported by LSEs. Quick-Start Reserve values are reported for hydro and non-hydro reserves separately.
    d. Secondary Reserve — as reported by LSEs.
    e. Reserve Avail. > 30 — as reported by LSEs. Scheduled capacity not available within 30 minutes.
    f. Non-Reported Cap. Reduct. — as reported by LSEs. Total amount of capacity reductions that have been previously reported to the PJM OI and therefore have not caused an adjustment to be made to the scheduled capacity.
2. Total (Calculated) — Summations of reported reserve values. The Spinning Reserve total (2b) should show the total Eastern Spinning Reserve available, as well as the total Spinning Reserve for all LSEs. The Quick-Start Reserve total (2c) shows the total Hydro Quick-Start Reserve, plus 80% of the non-Hydro Quick-Start Reserve.
3. Non-Capacity Interchange Sales — Amount of interchange sales that are not capacity backed.
4. Non-Capacity Interchange Purchases — Amount of interchange purchases that are not capacity backed.
5. ACE (Telemetered) — Area Control Error at the time of the IRC. Overgeneration is positive (+), undergeneration is negative (-).

Required Spinning — Spinning Reserve Objective.

6. Adjusted Spinning — (calculated): Summation of the Spinning Reserve total (2b), Non-Capacity Interchange Sales (3), and the ACE (5). This accounts for deficiencies or excesses of energy which are present at the time of the IRC.

Required Primary — Primary Reserve Objective.

Adjusted Primary — (calculated): Adjusted Spinning (6), plus the Quick-Start Reserve total (2c), minus Non-Capacity Interchange Purchases (4). This adjusts the Primary Reserve value by applying a factor to the non-hydro Quick-Start total to account for the possible failure of equipment to start and by including the possible reduction in non-capacity interchange.

Largest Contingency — The name of the single contingency having the largest effect on the PJM Control Area at the time of the IRC. The largest contingency may be the loss of generation within the PJM Control Area, loss of a transmission path with a neighboring system, or loss of a non-capacity backed purchase from a neighboring system.

7. Untelemetered Gen. & Pumping Load — Any generation (+) or pumping (-) that is not telemetered. In the future this space may be used for the reporting of Non-Utility Generation (NUGs).

8. Net Tie Flow — (telemetered): Summation of the flows on all ties between the PJM Control Area and the outside world. Flows into the PJM Control Area are positive (+), out of the PJM Control Area are negative (-).

9. NY Share H.C. & CEI Share Seneca — (telemetered): The amount of energy being produced at Homer City which is owned by NYSEG, plus the amount of energy being produced at Seneca which is owned by CEI. This is energy Internal to the PJM Control Area that can not be used to meet the PJM Control Area requirement because it is owned by participants External to the PJM Control Area.

10. Capacity Reported on L&C Sheet — (from Load and Capacity printout): Total PJM Control Area capacity as reported at the beginning of the shift and adjusted for changes which occur during the shift.

11. Calc. Operating Capacity — (calculated): PJM Control Area load (1), plus total Operating Reserve (2a), plus untelemetered generation and pumping load (7), minus net tie flow (8), minus the NY share of Homer City and the CEI share of Seneca (9).

12. Sched. Capacity not Avail. in 30 Min. — (calculated): Summation of total reserve not available within 30 minutes (2e) and the total non-reported capacity reductions (2f).

Unaccounted for Capacity (Calculated) — The capacity reported on the Load and Capacity printout (10), minus the calculated operating capacity (11), minus scheduled capacity not available in 30 minutes (12). This is the amount of capacity that is reported available at the time of the IRC, but cannot be accounted for based on system conditions at the time of the IRC.

Attachment B: Transmission Constraint Control Guidelines

Non-Cost Measures

PJM dispatch utilizes all available non-cost measures prior to generation redispatch. Non-cost measures include but are not limited to:

- PAR adjustments
- Transformer Tap Adjustments
- MVAR adjustments
- Switching Capacitors / Reactors in/out-of-service.
- Switching Transmission facilities in/out-of-service.
- Curtailing Transactions "Not-Willing-to-Pay" congestion.

Once non-cost measures are exhausted, PJM dispatch begins to redispatch generation. Once off-cost operations are activated, the PJM dispatcher will set a desired "threshold" for each individual constraint, which directs the UDS solution to control to the threshold % of the appropriate facility rating. Subsequent UDS cases will continue to control to this percentage, usually 95 – 100% of facility rating, until the threshold is changed or constraint closed by the PJM dispatcher.

Generation Redispatch

PJM, prior to initiating redispatch, reviews available controlling actions and the distribution factor effect on the overloaded facility. PJM also considers whether there are sufficient resources available to control transmission facilities within acceptable limits.

1. Contingency Operations

   PJM will initiate off-cost if reasonable controlling actions are available with an impact effect generally greater than 5%. Once off-cost is initiated, UDS tools will redispatch generation based on dollar per MW effect, considering all on-line flexible units with an impact of 1% or greater. PJM staff has the ability to adjust the controlling percentage on an individual constraint basis. PJM will initiate a Post Contingency Local Load Relief Warning/Action if post-contingency flows exceed designated ratings and insufficient resources are available to control the overloaded facilities.

2. Normal / Actual Overload

   In general PJM initiates off-cost and utilizes controlling actions greater than 5% impact, however, since an actual overload causes real-time loss-of-life on the affected facility, PJM will load generation with an impact effect less than 5%. Once off-cost is initiated, the UDS tool will redispatch generation based

on dollar per MW effect, considering all on-line flexible units with an impact of 1% or greater. PJM staff has the ability to adjust the controlling percentage on an individual constraint basis.

The UDS software continues to monitor projected flows on constrained facilities and sends ramp-limited set points to re-optimize redispatch for constraint control to the designated threshold. The eligibility of units to set Locational Marginal Price is determined by comparing the desired output as calculated by UDS to the actual output as calculated by the State Estimator.

Attachment C: PJM Black Start Test Report Form

PJM BLACK START TEST REPORT FORM

Black Start test scheduling, test results, attachment and related questions can be e-mailed to **blackstart@pjm.com**

SECTION 1 : TEST SCHEDULING

BLACK START GENERATING UNIT NAME _____

TEST SCHEDULED FOR DATE _____

TEST SCHEDULED BY NAME _____

Please notify PJM of scheduled test on above unit a minimum of one (1) day prior to the actual test.

SECTION 2 : TEST PERFORMANCE

TEST PERFORMED ON DATE _____

BLACK START TEST BEGINS AT TIME _____

Please notify PJM Dispatch on the day of the actual test, prior to test start.

TIME OF OUTPUT BREAKER CLOSE TIME _____

The generating unit must have the ability to close the output breaker to a dead bus within 90 minutes.

THE BLACK START TEST DISPLAYED THE ABILITY TO …	ACTUAL EQUIPMENT TEST SUCCESS	SIMULATED EQUIPMENT TEST SUCCESS	ITEM NOT TESTED	TESTING FAILED
… START WITHOUT POWER				
… CLOSE INTO A DE-ENERGIZED BUS				
… OPERATE AT REDUCED LEVELS WHEN DISCONNECTED FROM THE GRID				
… MAINTAIN FREQUENCY UNDER VARYING LOAD				
… MAINTAIN VOLTAGE UNDER VARYING LOAD				
… MAINTAIN BLACKSTART RATED OUTPUT FOR DURATION MATCHING LCC RESTORATION REQ				

Please check the appropriate box above for each testing item.

BLACK START TEST ENDED AT TIME _____

TEST SUPERVISED BY NAME _____

SECTION 3 : TEST FOLLOWUP

AMBIENT WEATHER CONDITIONS AT TIME OF TEST:

_____

_____

BRIEF DESCRIPTION OF COMMUNICATIONS / CONTROL SYSTEMS THAT ARE CAPABLE OF ALLOWING SCADA / EMS DATA AND VOICE COMMUNICATIONS IN EVENT OF ACTUAL RECOVERY:

_____

_____

If not specified above, detailed descriptions may be submitted as attachments to this form.
☐ *Check if no change since last data submission.*

EXPLANATIONS / CORRECTIVE ACTIONS FOR FAILED / NON-PERFORMED TESTS:

_____

_____

_____

_____

TEST RESULTS SUBMITTED TO PJM DATE _____

SECTION 4 : SUBMISSION PROCEDURE

PLEASE SUBMIT RESULTS TO PJM WITHIN 14 DAYS OF THE TEST COMPLETION

FOR AUDITING PURPOSES, SUBMIT THIS EXCEL FILE USING THE BLACKSTART XLS UPLOAD PROCESS*
*Submit .xls files only. If you are concerned that your file did not transfer properly, please contact **blackstart@pjm.com**

PLEASE ALSO SUBMIT THE FOLLOWING DATA IN ELECTRONIC FORM TO **blackstart@pjm.com**
- BlackStart Unit's Testing Procedure
- Description of Communication Systems used in System Restoration
- BlackStart Unit Operator Training description and schedule

Exhibit 15: PJM Black Start Test Report Form

Attachment D: PJM Auto Load Reject Test Report Form

PJM AUTO LOAD REJECT TEST REPORT FORM

Black Start test scheduling, test results, attachment and related questions can be e-mailed to **blackstart@pjm.com**

SECTION 1 : TEST SCHEDULING

ALR GENERATING UNIT NAME _____

TEST SCHEDULED FOR DATE _____

TEST SCHEDULED BY NAME _____

Please notify PJM of scheduled test on above unit a minimum of one (1) day prior to the actual test.

SECTION 2 : TEST PERFORMANCE

TEST PERFORMED ON DATE _____

ALR TEST BEGINS AT TIME _____

Please notify PJM Dispatch on the day of the actual test, prior to test start.

TIME OF OUTPUT BREAKER CLOSE TIME _____

The generating unit must have the ability to close the output breaker to a dead bus within 90 minutes.

THE ALR TEST DISPLAYED THE ABILITY TO …	ACTUAL EQUIPMENT TEST SUCCESS	SIMULATED EQUIPMENT TEST SUCCESS	ITEM NOT TESTED	TESTING FAILED
…SEPARATE FROM SYSTEM AND CONTROL TURBINE SPEED				
… OPERATE AT REDUCED LEVELS WHEN DISCONNECTED FROM THE GRID				
… MAINTAIN FREQUENCY UNDER VARYING LOAD				
… MAINTAIN VOLTAGE UNDER VARYING LOAD				
… RETURN TO RATED OUTPUT WITHIN DURATION MATCHING LCC RESTORATION REQ				
… CLOSE INTO A DE-ENERGIZED BUS				

Please check the appropriate box above for each testing item.

ALR START TEST ENDED AT TIME _____

TEST SUPERVISED BY NAME _____

SECTION 3 : TEST FOLLOWUP

AMBIENT WEATHER CONDITIONS AT TIME OF TEST:

_____

_____

BRIEF DESCRIPTION OF COMMUNICATIONS / CONTROL SYSTEMS THAT ARE CAPABLE OF ALLOWING SCADA / EMS DATA AND VOICE COMMUNICATIONS IN EVENT OF ACTUAL RECOVERY:

_____

_____

If not specified above, detailed descriptions may be submitted as attachments to this form.
☐ *Check if no change since last data submission.*

EXPLANATIONS / CORRECTIVE ACTIONS FOR FAILED / NON-PERFORMED TESTS:

_____

_____

_____

_____

TEST RESULTS SUBMITTED TO PJM DATE _____

SECTION 4 : SUBMISSION PROCEDURE

PLEASE SUBMIT RESULTS TO PJM WITHIN 14 DAYS OF THE TEST COMPLETION

FOR AUDITING PURPOSES, SUBMIT THIS EXCEL FILE USING THE BLACKSTART XLS UPLOAD PROCESS*
*Submit .xls files only. If you are concerned that your file did not transfer properly, please contact **blackstart@pjm.com**

PLEASE ALSO SUBMIT THE FOLLOWING DATA IN ELECTRONIC FORM TO **blackstart@pjm.com**
- ALR Unit's Testing Procedure
- Description of Communication Systems used in System Restoration
- ALR Unit Operator Training description and schedule

Exhibit 16: PJM Auto Load Reject Test Report Form

Attachment E: PJM Black Start Formulaic Cost Data Form

PJM BLACK START FORMULAIC COST DATA FORM

Details of Black Start Revenue Requirements can be found in **Schedule 6A** of the PJM Open Access Transmission Tariff

Note: All data must be submitted on an annual unit by unit basis

COST DATA SUBMITTED ON *DATE:* _____

COST DATA SUBMITTED BY *NAME:* _____

BLACK START GENERATING UNIT NAME _____

INSTALLED CAPACITY _____ MW

FUEL BURN _____ GAL/HR
For Oil Fired Units

FUEL COST (COMMODITY) _____ $/GAL
As defined in Schedule 6A

FUEL HANDLING _____ $/GAL
If Necessary

ANNUAL VOM _____ $
As defined in Cost Development Guidelines (VOM does not include the 10% adder for Cost Capped Operations)

TRAINING _____ $
As defined in Schedule 6A

Additional costs that are exceptions to Schedule 6A may be submitted as attachments to this form.

SUBMISSION PROCEDURE

FOR AUDITING PURPOSES, SUBMIT THIS EXCEL FILE USING THE BLACKSTART XLS UPLOAD PROCESS*
*Submit .xls files only. If you are concerned that your file did not transfer properly, please contact **blackstart@pjm.com**

Exhibit 17: PJM Black Start Formulaic Cost Data Form

Attachment F: PJM Black Start Actual Cost Data Form

PJM BLACK START ACTUAL COST DATA FORM

This form may be used for submission of actual costs for providing black start capability.

Note: All data must be submitted on a unit by unit basis

COST DATA SUBMITTED ON *DATE:* _____

COST DATA SUBMITTED BY *NAME:* _____

BLACK START GENERATING UNIT NAME _____

INSTALLED CAPACITY _____ MW

SECTION 1: CAPITAL COST COMPONENTS

CAPITAL EXPENSE CATEGORIES

Engineering	$
Construction	$
Diesel Generator	$
Electric Switchgear	$
Air Intake Pre-heater System	$
Control/Relay Modifications	$
Miscellaneous Expenses	$
TOTAL	$

CAPITAL STRUCTURE _____

PROJECT COST OF CAPITAL WITH LABOR _____ $

PROJECT LIFE _____ YR(S)

TAX LIFE _____ YR(S)

DEPRECIATION SCHEDULE (TERM & TYPE) _____

SECTION 2: VARIABLE COST COMPONENTS

FUEL BURN _____ GAL/HR
For Oil Fired Units

FUEL COST (COMMODITY) _____ $/GAL
As defined in Schedule 6A

FUEL HANDLING _____ $/GAL
If Necessary

ANNUAL VOM _____ $
As defined in Cost Development Guidelines (VOM does not include the 10% adder for Cost Capped Operations)

TRAINING _____ $
As defined in Schedule 6A

NOTE: All detailed calculations and documentation of actual cost components must accompany this actual cost filing form.

SUBMISSION PROCEDURE

FOR AUDITING PURPOSES, SUBMIT THIS EXCEL FILE USING THE BLACKSTART XLS UPLOAD PROCESS*
*Submit .xls files only. If you are concerned that your file did not transfer properly, please contact **blackstart@pjm.com**

Exhibit 18: PJM Black Start Actual Cost Data Form