



*Working to Perfect the Flow of Energy*

PJM Manual 01

# Control Center and Data Exchange Requirements

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Prepared by

System Operations Division

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## PJM Manual 01

# Control Center Requirements

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**Current Revision**

***Revision 18 (01/24/2011):***

- Added reference to Manual 40 in section 2.6
- Revision to 2.7 – changed 2 hours to 1 hour (EOP-008)
- **Revisions** to 4.2.4 for 3 part communications

## Introduction

Welcome to the *PJM Manual for Control Center Requirements*. 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 the PJM Interconnection, L.L.C. for the operation, planning, and accounting requirements of the PJM RTO and the PJM Energy Market. The manuals are grouped under the following categories:

- Transmission
- PJM Energy Market
- Generation and transmission interconnection
- Reserve
- Accounting and Billing
- PJM administrative services

For a complete list of all PJM Manuals, go to [www.pjm.com](http://www.pjm.com) and select *–Manuals–* under the *–Documents–* pull-down menu.

### About This Manual

The *PJM Manual for Control Center Requirements* is one of a series of manuals within the Transmission Owners manuals. This manual focuses on the requirements for control centers of signatories to the Operating Agreement of PJM Interconnection, L.L.C. The manual describes the telecommunication linkages to the PJM Interconnection, L.L.C. and the recommended characteristics of these control center computer systems and the buildings housing these systems. It also summarizes the computer services and systems at the PJM Interconnection, the standards for billing quality MWh meters, and meter accuracy standards.

PJM staff will review and update this manual on an annual basis and review the updates with PJM control center operators.

The *PJM Manual for Control Center Requirements* consists of five sections and two attachments. These sections are listed in the table of contents beginning on page ii.

### Intended Audience

The intended audiences for the PJM Manual for Control Center Requirements are:

- Applicants to the Operating Agreement of PJM Interconnection, L.L.C.
- All PJM Members Company Control Rooms

- PJM staff

## References

There are some other reference documents that provide both background and detail. The *PJM Manual for Control Center Requirements* does not replace any of the information in these reference documents. These documents are the primary source for specific requirements and implementation details.

## Using This Manual

Because we believe that explaining concepts is just as important as presenting the procedures, we start each section with an overview. Then, we present details and procedures. This philosophy is reflected in the way we organize the material in this manual. The following paragraphs provide an orientation to the manual's structure.

## What You Will Find In This Manual

- A table of contents that lists two levels of subheadings within each of the sections
- An approval page that lists the required approvals and a brief outline of the current revision
- Sections containing the specific guidelines, requirements, or procedures including PJM actions and PJM Member actions
- Attachments that include additional supporting documents, forms, or tables in this PJM Manual
- A section at the end detailing all previous revisions of this PJM Manual
- PJM Operations Manager will review this manual on a minimum of an annual basis for updates and changes and review with the PJM Systems Operation Subcommittee.

## Section 1: PJM Systems

Welcome to the *PJM Systems* section of the *PJM Manual for Control Center Requirements*. In this section you will find the following information:

- Descriptions of the PJM control center systems (see *PJM Systems*”).

### ***PJM Systems***

PJM operates several functional systems that directly interface with PJM Members. Systems that are wholly internal to PJM and have no direct PJM Member interface are not listed.

The following systems are used to operate the PJM RTO and support the Energy Market:

- Energy Management System (EMS)
- Generation Management System (GMS)
- PJM SCADA System
- Data Historian System
- Enhanced Energy Scheduler (EES)
- Two Settlement System (eMKT)
- Dispatch Management Tool (DMT)
- Unit Dispatch System (UDS)
- Regulation Market
- Synchronized Reserve Market
- Operations Planning Tools
- Available Transfer Capability (ATC) Program
- Open Access Same-Time Information System (OASIS)
- Dispatcher Analysis and Reporting Tool (eDART)
- Other eSuite Tools (eMTR, eSchedules, eFTR)
- PJM Voice Communications
- Reliability Coordinator Information System (RCIS)

The following systems are used for planning purposes:

- Generator Availability Data System (eGADS)
- Capacity Reporting Program (eRPM)
- Central Planning Database
- Transmission Planning Tools

## 1.1 Energy Management System (EMS)

The PJM EMS performs the real-time monitoring and security analysis functions for the entire PJM region. Generation control signals to units in PJM are handled by the Energy Management System (EMS) and Generation Management System (GMS) described in the next section.

The EMS consists of seven major subsystems:

- *Real-Time EMS* — the Real-time EMS is responsible for monitoring, analysis, and real-time coordination of the PJM region. It includes a full complement of monitoring, generation control, state estimation and security analysis software. PJM Members supply telemeter data to the PJM real-time EMS and may receive data and control signals from the PJM real-time EMS.
- *HIS* — The Historical Information System (HIS) stores periodic and event-driven snapshots of telemeter and calculated EMS data. There is no direct interaction between PJM Members and the HIS system.
- *DTS* — The Dispatcher Training Simulator (DTS) system is used to train PJM dispatchers. Member company operators participate in Fall Restoration Drills using PJM's DTS.
- *Development System* — The Development System allows the PJM staff to develop software, database, and displays for the Real-Time EMS, HIS, BUCC, GMS and DTS systems, without interfering with the operation of those systems. There is no direct interaction between PJM Members and the Development System.
- *Test System* — The Test System provides an independent test environment to validate changes developed on the Development System, prior to installing them on the Real-Time EMS. PJM Members may exchange telemetry with the Test System to verify telemeter points, to test data communications, to test communications failover capabilities and to test application programs.
- *Process Control Test (PCT) System* — The PCT system is a parallel test system with access to live data used to test and verify software and database changes prior to promoting those changes to the on-line production EMS. There is no direct interaction between PJM Members and the PCT system.
- *Back-Up Control Center (BUCC) EMS* — The BUCC system provides an off-site back-up EMS capability which is completely separate from the redundantly configured production EMS. In the event that the PJM main control room or computer facility is unavailable, the BUCC system can assume all EMS on-line functions. PJM Members may exchange telemetry with the BUCC system when it is activated in place of the real-time production EMS.

## 1.2 Generation Management System (GMS)

The GMS provides generation control functions for generators in the PJM Western Region. PJM Members in the Western Region supply telemeter data to the GMS and may receive data and control signals from the GMS. Western Region Members also supply transmission system data to the PJM EMS in the Eastern Region office to support the state estimator and security analysis functions.

### 1.3 SCADA-Supervisory Control and Data Acquisition

The PJM SCADA system allows PJM to communicate directly with individual generators or smaller Control Centers. The system uses computer, database and digital communications technology to implement the use of common standards in an open environment, independent of any particular vendor or proprietary protocols system.

The PJM SCADA system is designed to allow transfer of both generation and revenue data via one system. A data concentrator (e.g. Remote Terminal Unit, Generator Control System, etc.) is located at the Member's site, and, after collecting data from the industrial metering equipment, communicates with PJM's SCADA system using either DNP 3.0, Level 2 (Distributed Network Protocol) or ICCP (Inter-Control Center Protocol).

The system allows real-time bi-directional transfer of analog and digital data into the system database for storage and real-time transfer to the EMS system.

Information can also be sent from the EMS system through the SCADA system via ICCP and/or DNP 3.0 to the customer, allowing for Automatic Generation Control (AGC), set point, device control, and other functions.

**NOTE:** Although DNP 3.0, Level 2 is a minimum functional requirement, the additional installation of object 23.5 is strongly recommended for all users. Without this object installed, collection of revenue data becomes difficult.

### 1.4 Data Historian System

The Data Historian System serves as a data archive for operational data in near-real-time. It provides visualization tools for presenting data to operators and provides a permanent archive of data for post-event study and analysis. Telemeter data is archived from EMS and other operational data is imported from other sources, including Market Systems

### 1.5 Enhanced Energy Scheduler (EES)

The Enhanced Energy Scheduler (EES) records customer requests for interchange transactions, the bulk power scheduled between PJM and neighboring regions. PJM personnel use EES to process and schedule these transactions. The EES validates PJM ramp, use of transmission reservation rights, and other PJM scheduling business rules as described in the PJM Manual for Scheduling Operations.

### 1.6 Two Settlement System (eMKT)

The Two-Settlement system consists of two markets, a day-ahead market and a real-time balancing market. The Day-ahead Market is a forward market in which hourly clearing prices are calculated for each hour of the next operating day based on generation offers, demand bids Increment offers, Decrement bids and bilateral transaction schedules submitted into the Day-ahead Market. The balancing market is the real-time energy market in which the clearing prices are calculated every five minutes based on the actual system operations security-constrained economic dispatch. Separate accounting settlements are performed for each market, the day-ahead market settlement is based on scheduled hourly quantities and on day-ahead hourly prices, the balancing settlement is based on actual hourly (integrated) quantity deviations from day-ahead scheduled quantities and on real-time prices integrated

over the hour. The day-ahead price calculations and the balancing (real-time) price calculations are based on the concept of Locational Marginal Pricing.

The Day-ahead Market enables participants to purchase and sell energy at binding day-ahead prices. It also allows transmission customers to schedule bilateral transactions at binding day-ahead congestion charges based on the differences in LMPs between the transaction source and sink. Load Serving Entities (LSEs) may submit hourly demand schedules, including any price sensitive demand, for the amount of demand that they wish to lock-in at day-ahead prices. Any generator that is a PJM designated capacity resource must submit a bid schedule into the day-ahead market even if it is self-scheduled or unavailable due to outage. Other generators have the option to bid into the day-ahead market. Transmission customers may submit fixed, dispatchable or 'up to' congestion bid bilateral transaction schedules into the day-ahead market and may specify whether they are willing to pay congestion charges or wish to be curtailed if congestion occurs in the Real-time Market. All spot purchases and sales in the day-ahead market are settled at the day-ahead prices. After the daily quote period closes, PJM will calculate the day-ahead schedule based on the bids, offers and schedules submitted, using the scheduling programs described in section 2 of this manual, based on least-cost, security constrained unit commitment and dispatch for each hour of the next operating day. The day-ahead scheduling process will incorporate PJM reliability requirements and reserve obligations into the analysis. The resulting Day-ahead hourly schedules and Day-ahead LMPs represent binding financial commitments to the Market Participants. Financial Transmission Rights (FTRs) are accounted for at the Day-ahead LMP values (see the *PJM Manual for **Financial Transmission Rights (M-06)***).

The Real-time Energy Market is based on actual real-time operations. Generators that are designated PJM capacity resources that are available but not selected in the day-ahead scheduling may alter their bids for use in the Real-time Energy Market during the Generation Rebidding Period from 4:00 PM to 6:00 PM (otherwise the original bids remain in effect for the balancing market). Real-time LMPs are calculated based on actual system operating conditions as described by the PJM state estimator. LSEs will pay Real-time LMPs for any demand that exceeds their day-ahead scheduled quantities (and will receive revenue for demand deviations below their scheduled quantities). Generators are paid Real-time LMPs for any generation that exceeds their day-ahead scheduled quantities (and will pay for generation deviations below their scheduled quantities). Transmission customers pay congestion charges based on Real-time LMPs for bilateral transaction quantity deviations from day-ahead schedules. All spot purchases and sales in the balancing market are settled at the Real-time LMPs.

## 1.7 Dispatch Management Tool (DMT)

The Dispatch Management Tool (DMT) is a software tool that is designed to enable the PJM dispatchers to manage generating unit and transmission constraint information and administer the Real-Time Regulation Market. Since many of the current dispatcher logging activities is position independent, the DMT allows each dispatcher position to view the same generation and transmission constraint information simultaneously. This real-time sharing of logging information provides the PJM dispatchers with an efficient communication vehicle to help them perform their job functions more effectively.

The DMT is used by the PJM dispatchers to:

- View and record real-time unit generation information

- View and record unit generation scheduling information
- Review the chronological log of generation events
- Analyze system resources
- Record and calculate regulation assignment information
- Record and calculate Synchronized Reserve assignment information
- View and record real-time transmission constraint information

### **1.8 Open Access Same-time Information System (OASIS)**

The PJM OASIS system maintains transmission and ancillary services information for PJM Members. OASIS operates on a collection of PJM and PJM Member computers linked by private and public networks. For additional information, see the [PJM Manual for PJM OASIS Operation \(M-04\)](#).

### **1.9 Other eSuite Tools (eMTR, eSchedules, eFTR)**

The other eSuite tools are all Web-based tools that PJM members use to facilitate the exchange of information with PJM and support various PJM market activities

### **1.10 Planning Systems**

PJM operates several planning systems which are used to run studies for reliability and capacity planning and for transmission planning. Reliability and capacity planning includes the Generating Availability Data System (GADS) database and eRPM are computer programs and databases used for entering, storing, and reporting generating unit data concerning outages, unit performance, and fuel performance. In addition, PJM Members provide information to the PJM Central Planning Database, a database containing planning information relating to generation production costs, load flow analyses, short circuit and system dynamics studies, and LSE load data. Additional details about these planning functions may be found in the [PJM Manual for Load Data Systems \(M-19\)](#), and the [PJM Manual for PJM Reserve Requirements \(M-20\)](#).

PJM also performs transmission planning studies. For example, PJM Members staffs provide transmission planning capacity and load data to the PJM Transmission Planning Tool which generates performance adequacy and reliability assessments (see the [PJM Manual for Transmission Service Request \(M-02\)](#)).

## Section 2: Member Control Center Requirements

Welcome to the *Control Center Requirements* section of the PJM Manual for *Control Center Requirements*. In this section you will find the following information:

- A description of the different categories of control centers (see *-PJM Control Center Categories*”).
- An overview of PJM Member responsibilities (see *-PJM Member Data Exchange*”).
- Computer system requirements for Control Centers (see *-Computer System Requirements*”).
- Communications requirements (see *-Communications Requirements*”).
- Requirements for control center physical facilities (see *-Facilities Requirements*”).
- Control center staffing recommendations (see *-Control Center Staffing*”).

### 2.1 PJM Control Center Categories

PJM Members may be involved with transmission operations, generation operations, load service operations, and/or PJM Energy Market participation. Depending upon the functions they perform and the services they require from PJM, the control center for each PJM Member will fall into one or more of the designations defined below. The specific functions, systems, and communications capabilities of that control center depend upon the responsibilities of the PJM Member:

- *Local Control Center* — An entity that participates in the Operating Agreement of PJM Interconnection, L.L.C. (Agreement) and operates and controls Designated Transmission Facilities establishes a Local Control Center (LCC) to facilitate its responsibilities regarding the security of the PJM RTO.
- *Market Operations Center* — An entity that participates in the Agreement and operates and controls generation within the PJM RTO establishes a Market Operations Center (MOC) to facilitate its responsibilities regarding the security of the PJM RTO.
- *Load Service Center* — any entity that participates in the Agreement and operates and controls load (but without generation or Designated Transmission Facilities) establishes a Load Service Center (LSC) to facilitate its responsibilities for its load in the PJM RTO. Entities responsible for load that also operate transmission and/or generation may not need an LSC, as they can discharge these responsibilities from an LCC or MOC.
- *Marketing Center* — a participant in the Agreement as a Power Marketer, Wholesale System User, Other Supplier, or Transmission Customer establishes a Marketing Center to facilitate communications with PJM concerning its participation in the PJM Energy Market.

Many PJM Members are involved in more than one of the four areas of responsibility discussed above. Each member is obligated to be in compliance with the Code of Conduct requirements established in FERC Order 2004. Entities participating in the PJM Energy

Market may establish a separate MOC. All of these four categories of control centers are referred to collectively in this manual as “control centers”.

## 2.2 PJM Member Data Exchange

PJM Members support a variety of PJM functions appropriate to their business requirements and level of participation requirement in PJM. For each of the PJM services described in this section, data is exchanged between PJM and one or more of the categories of PJM Member control centers. The following PJM services are further defined in Attachment A, Information Services Matrix. In this attachment, the references to “Member Type” translate to control center category as follows:

- Regional Transmission Owner — Local Control Center (LCC)
- Generating Entity — Market Operations Center (MOC)
- Load Serving Entity — Load Service Center (LSC)
- Marketer — Marketing Center
- *Generation Scheduling Services* — MOCs input generation, pre-scheduling, scheduling, Synchronized Reserve bids, and regulation bids, and outage data to PJM, and PJM output hourly and daily generation scheduling information to LCCs, MOCs, and LSCs (see the ***PJM Manual for Pre-Scheduling Operations (M-10)*** and the ***PJM Manual for Scheduling Operations (M-11)***).
- *EMS Services* — LCCs, MOCs and LSCs input real-time transmission and generation information plus generator regulation and availability data and PJM outputs real-time transmission status, generation status, generation dispatch and regulation signals, and operations & emergency information (see the ***PJM Manual for Dispatching Operations (M-12)***).
- *Transmission Maintenance Planning Services* — LCCs input transmission maintenance schedules which are confirmed by PJM to all PJM Members (see the ***PJM Manual for Transmission Operations (M-03)***).
- *Transmission Services* — OASIS is used at LSCs and Marketing Centers to input transmission reservations and by PJM to output Available Transmission Capacity, energy transactions, transmission congestion information, approved transmission reservation requests, and other market information to all categories of control centers (see the ***PJM Manual for Transmission Service Request (M-02)*** and the ***PJM Manual for PJM OASIS Operation (M-04)***).
- *Energy Transaction Services* — bilateral energy transactions are input from all categories of control centers and are confirmed by PJM (see the ***PJM Manual for Scheduling Operations (M-11)*** and the ***PJM Manual for Dispatching Operations (M-12)***).
- *Long-term Planning Services* — LCCs, MOCs, and LSCs input capacity, load, system characteristics information, generator events, production costs, outage reports and long-term planning information and PJM outputs the results of studies and assessments to all categories of control centers (see the ***PJM Manual for Load Data Systems (M-19)***).

- *PJM Administration Services* — PJM outputs general administrative information and FERC filings to all PJM Members via the PJM Web site.

## 2.3 Computer System Requirements

Each PJM Member's control center serves as the primary operating link to the PJM control center and includes computer system hardware and software that supports their responsibilities under the Agreement.

### 2.3.1 Transmission Monitoring Capability

Transmission Owners shall provide transmission monitoring at their Local Control Centers including monitoring of circuit loading, voltages, limit violations and contingency analysis. Basic software should include State Estimation and Security Analysis functions to monitor actual and contingency conditions.

In the event that PJM's monitoring systems are unavailable, PJM may notify Transmission Owners that they are the sole monitor for their portions of the bulk power transmission system. In that scenario, PJM will communicate the situation via the All-Call. PJM is expecting that the Transmission Owner(s) will use their monitoring systems to (1) assess the reliability of their portions of the bulk power transmission system via contingency analysis and SCADA; (2) communicate any contingency or limit violations on any bulk electric system facility to PJM as soon as possible. If the Transmission Owner determines that corrective actions are necessary to preserve system reliability, then PJM shall approve the corrective action, unless immediate action is necessary. If immediate action is necessary, the TO shall implement the action and report to PJM any actions taken.

The continuous calculation and monitoring of post-contingency voltages for nuclear power plants (for the loss of the nuclear unit) is an important requirement to ensure that adequate voltage is always available for the operation of the nuclear safety systems. Given this requirement, the nuclear power plant(s) shall be notified in cases where the transmission monitoring capability (at PJM and the Transmission Owner) becomes unavailable and the ability to calculate the post-contingency voltages is lost. [There may be situations where the calculations are only being performed at PJM. In this case, loss of the PJM capability shall trigger the notification to the nuclear power plant(s).] The notification will go via the All-Call from PJM to the Transmission Owner(s) who will then communicate with the applicable nuclear power plant(s).

#### System Availability

The computer hardware and software at each control center shall achieve a long-term 99.95% availability level for those reliability functions directly affecting the successful operation of PJM. Any application that supplies operational data to PJM, accepts generation control signals from PJM, or otherwise links to the real-time operational aspects of the PJM control system is considered vital to reliability. Other applications may be considered to be vital to a PJM Member's operations and therefore, shall also achieve 99.95% availability. Redundant hardware configurations with either automatic or rapid manual failover schemes are generally necessary to achieve 99.95% availability.

### **2.3.2 Data Backup & Archiving**

All PJM Members shall prepare and implement a backup and archiving plan which minimizes the loss of vital data upon the occurrence of any hardware failure or a catastrophic system loss.

### **2.3.3 Computer System Security**

Control centers with electronic data links to the PJM computer systems require rigorous computer system security provisions to prevent unauthorized access and unintentional operation. Due to the sensitive nature of both operational and financial data, control center computer systems shall include appropriate techniques such as password log-on for internal users, hardware and software security controls for external users, and on-line virus detection capabilities. Telecommunication circuits connected to any control center computer system shall utilize firewall technology to prevent unauthorized access from external sources.

### **2.3.4 System Maintenance**

Due to the operational requirements and economic benefits of a PJM Member's control center computer system, a computer system (hardware, software, and network) maintenance service arrangement with 24-hour, 7 day/week call-out provisions or on-site staff, is required to ensure appropriate levels of system availability to implement database changes, and to modify user interface displays.

### **2.3.5 Expansion Capability**

PJM Member computer system hardware, software, and network shall be expandable to accommodate growth in their system and operations and to accommodate future changes to the organization and responsibilities of the PJM RTO and the PJM Energy Market. PJM services and marketing activities are all expected to increase and the control center computer systems shall be expandable to accommodate this expected growth. System design shall provide for orderly addition of computer hardware, software, and network through adherence to accepted system standards and Good Utility Practice.

### **2.3.6 Data Integrity**

PJM maps quality codes sent by member companies into four quality codes:

1. Good (valid data);
2. Manually Substituted by company;
3. Telemetry Failure; and
4. Suspect (usually indicating value is bad).

Details on quality code translations are given in the following documents:

- PJM ICCP Network Interface Control Document, Version 1.1, March 27, 2000.
- PJM ICCP Communications Workbook, Version 1.1, March 27, 2000.
- Running list of updates to the PJM ICCP NICD and Workbook, Version 1.1 January 30, 2001.

Member companies should only send valid quality codes. In particular, companies with front-end data servers should insure that the front-end server does not initiate data transfers

with PJM until the front-end server has begun receiving valid and current data from the company EMS or other data source. Sending even a single scan with zero values or other bad data for analog or switch statuses can cause massive alarm generation and improper operation of State Estimator and other vital functions.

PJM provides new members and existing members the testing requirements for system commissioning and on-going support. When commissioning a new system, members should request the latest copy of the *PJM ICCP Testing Requirements* document from PJM. The required tests include:

For new members:

1. Server to server communication verification over PJMNET
2. Exchange of NERC ICCP Association Information Exchange Form
3. Exchange of client and server data points needed before ICCP Association testing
4. Ability to initiate an ICCP Association with PJM
5. Ability to support an ICCP Dual direction Client-Server Association
6. Ability to provide real-time SCADA data during testing along with the ability to change values and quality codes
7. Ability to participate in testing with the designated PJM TEST system
8. Participation in Failover testing to verify required network, server, and communication redundancy

For existing members:

1. All of the above (1 to 8). New members testing requirements
2. The ability to test with the designated PJM TEST system while supporting the real time PJM EMS system
3. The ability to test changes with the PJM designated TEST system before putting the changes in production with the real time PJM EMS system
4. The ability to support Failover testing to verify required network, server, and communications redundancy for existing member changes while still supporting the real time PJM EMS system
5. PJM Member companies are required to successfully complete the PJMNET ICCP Communications Failover Test before going into production with the PJM real time EMS system. The purpose of this test is to verify redundancy from company ICCP servers to PJM ICCP servers. In the process of doing this ICCP server to server Failover testing all network hardware components such as: routers, firewalls, and PJMNET communication lines will have their redundancy validated.
6. In order to accomplish site to site failover between PJM EMS and the PJM BUCC or PJM GMS and PJM EMS (depending on member company situation), member company ICCP systems must be able to support up to four IP addresses in their ICCP association start up sequential server hunt list.

## 2.4 Communications Requirements

Telecommunications (voice and data) circuits, which must be reliable and secure, shall be tested regularly and/or monitored on-line, with special attention given to emergency channels.

## 2.5 Facilities Requirements

This section discusses the control center facility considerations for a PJM Member, including the physical space housing operations staff and, if appropriate, a computer room, communications room, and power supply area. While these considerations apply to all PJM Member categories, the specific implementation of control center facilities considerations shall be appropriate for the nature of the computer systems and communications equipment installed.

### 2.5.1 Environmental Characteristics

In order to ensure the PJM Member's computer system availability and data reliability discussed in the previous section, its control center facilities shall provide an environment that is suitable for its equipment and personnel during the hottest and coldest outdoor temperatures that can be anticipated.

- The range of control center temperature and humidity shall be controlled appropriately for the installed computer systems and communications equipment. The most restrictive temperature and humidity characteristics of any item of equipment in each room of the control center, the total heat load of that equipment, and the projected growth shall establish the design criteria for the heating, ventilating, and air conditioning systems provided.
- Control room operators, technical staff, and maintenance personnel should be able to function comfortably.
- Where feasible, heating, and air conditioning equipment shall be backed up with redundant or auxiliary systems to allow operations to continue indefinitely following the failure of any single temperature controlling device or motor control center.
- If the control center is located in the proximity of a polluting atmosphere such as a coal-fired power plant, a positive pressure shall be maintained in the computer room using filtered air to minimize the accumulation of airborne contaminants on the computer system circuit boards and components.

### 2.5.2 Power Supply & Conditioning

Because of the importance of non-stop operation of the PJM RTO and the sensitivity of computer equipment to minor power disturbances, a stable and secure supply of AC power for the equipment in the control room, computer room, and communications room shall be provided and installed in compliance with current National Electric Code provisions.

- An uninterruptible power supply (UPS) (i.e., battery charger, battery, and inverter) and a backup generator is necessary to supply power to operator display equipment, computer systems and communications equipment. A completely redundant power supply with dual UPS may also be utilized.

- K-rated transformers and oversized neutral conductors shall be employed as necessary to mitigate the effects of harmonic distortion created by non-linear loads.
- The UPS battery shall have sufficient capacity to operate the computer system, and communications equipment until stable emergency generation can be achieved. Periodic maintenance and testing of the battery cells and inter-cell connections shall be performed.
- The backup generator shall be tested periodically under load to ensure its availability under loss of power conditions. Fuel supply for the backup generator should be sufficient for a five-day period. If applicable, redundant backup generators should be considered.
- An emergency lighting system should be provided with adequate battery capacity for several hours.
- The heating, cooling, and ventilation equipment shall also be powered by the backup generator (but not by the UPS).
- A high quality, common earth ground shall be provided, in accordance with IEEE standards, for the computer system and communications equipment to provide a low impedance path for rapid clearing of electrical faults and to reduce electromagnetic interference.
- If UPS power is not provided, TVSS protection for power and communications circuits shall be provided to mitigate the effects of lightning strikes and AC power excursions.
- Where warranted, external power to the control center shall be supplied from two sources, such as two distribution feeders that follow diverse routing from separate electric substations.

### **2.5.3 Area Access Security**

Access to PJM Member control rooms should be restricted. For example, access could be controlled by means of a single entry point monitored by office personnel during business hours and, at other times, either by control room personnel via closed-circuit TV monitors and remotely controlled locks or by a cipher/key/badge-reader lock. Emergency exits/entrances should be sealed and alarmed in conformance with local fire regulations.

### **2.5.4 Information Flow to Control Room Personnel**

A protocol shall be established concerning information transfer from PJM Member staff to the appropriate staff members and their supervisor responsible for coordinating and directing work in the PJM Member's control center. Topics covered shall include the following:

- Inquiries to the shift team and their on-shift supervision.
- Access control to the control room.
- Approvals for Computer outages.
- The PJM shift supervisor and Support Center shall be notified of any computer system outages.

- In case of implementation of PJM Emergency Procedures, all non-essential personnel shall leave the control center and non-essential computer system hardware and software maintenance should be terminated.

### **2.5.5 Smoke & Fire Protection**

Smoke and fire detection equipment shall be installed to detect smoke and fire, warn personnel to hand-extinguish the fire or evacuate the facility, and, where warranted, automatically extinguish the fire. Smoke and fire protection equipment shall conform to the current version of NEC, local, state, and national codes.

### **2.5.6 Backup Recovery Procedures**

In accordance with BAL-005-0, “Automatic Generation Control,” PJM, as the Balancing Authority, provides adequate and reliable backup power supplies and performs weekly tests (system conditions permitting) at the primary control and other backup locations to ensure continuous operation of AGC and vital data recording equipment during loss of the normal power supply.

The AGC program is monitored by a function called the “Multi-Computer System (MCS) function.” This function monitors all vital EMS programs, including AGC, and initiates a failover to the backup server if a problem is detected with the application. Data links to each member company are also monitored such that any interruption in data feed is indicated via alarm messages and an indicator on the main menu and by individual quality codes on all data affected by the link outage. In addition, the generation dispatcher has graphic presentations of ACE and other AGC data in front of them at all times so any interruption in the program or its calculations are readily apparent as a flat-line on the graphs.

PJM Members shall comply with PJM backup procedures. For PJM Members that interface with the PJM EMS, all the necessary backup voice and data circuits must be provided between the Local Control Center and PJM. Generation owners should design their generation control systems with the capability to accept alternate control inputs from backup PJM systems including manual operation as directed by PJM operations personnel.

PJM Members shall provide PJM backup operations training for its operators and participate in the training exercises conducted by PJM. PJM Members shall review the design of their backup support plans with the PJM Customer Relations Department to ensure compliance with this requirement.

All PJM Members shall develop a backup recovery plan to cover various contingencies, including maintaining an off-site storage location for updated copies of all software and data files necessary to restore control center functions. The backup recovery plan is subject to review by PJM.

PJM systems provide multiple levels of redundancy in order to mitigate various levels of Control Center functionality degradation. This redundancy and the associated Business Continuity Plans developed by PJM ensure that PJM can meet its responsibilities under the PJM Operating Agreements as well as NERC standards. The following descriptive material provides a high level view of key areas included in the Business Continuity Plan and in detailed PJM operating procedures.

Portions of the PJM Control Center capability are housed in diverse physical locations. The PJM campus in Valley Forge, PA houses one control center and a second control center is located at the backup control center. Each control center has access to the primary EMS

and maintains redundant communications capability for data and voice. In addition, a backup EMS system is located at the PJM Learning Center.

Generation Control: PJM is capable of calculating Area Control Error (ACE) via the Primary EMS (PRD), Backup EMS (BUCC) and GMS. Each system is physically located at different sites to increase redundancy. The PJM Operator has the ability within each tool to select alternative tie sources to correct for poor data quality.

***PJM Actions:***

- PJM Dispatcher verifies accuracy of ACE calculation.
- PJM Dispatcher controls to appropriate ACE by manually correcting any inaccurate data inputs.
- PJM Dispatcher notifies support personnel of data quality issue.
- PJM Dispatcher fails over to alternative system in the event of a widespread data quality issue.
- PJM returns to normal operations when data/ACE calculation issues are resolved.

Transmission Analysis: PJM is capable of performing transmission analysis via a Primary EMS (PRD) and Backup EMS (BUCC). System Operators have the ability to fail over from the primary to the backup EMS in real time. Testing is scheduled on a weekly basis. Transmission Operators are responsible to monitor/control their transmission system in the event that both the primary and backup EMS is unavailable.

***PJM Actions:***

- PJM Dispatcher verifies the accuracy of the Network Applications (NA) results.
- PJM Dispatcher attempts to resolve inaccurate NA results by troubleshooting data inputs and manually over riding incorrect device statuses, tuning parameters, etc.
- PJM Dispatcher notifies support personnel of issue.
- If appropriate, PJM Dispatcher switches to Backup EMS.
- PJM Dispatcher notifies companies via the All-Call of NA status.
- PJM Dispatch notifies Transmission Owners and external systems via RCIS if unable to monitor system via Backup EMS.
- PJM returns to normal operations when appropriate.

Data Integrity: PJM is capable of failing ICCP links from primary to secondary communication servers. System Operators have the ability to fail over from the primary to the standby server in real time. Testing is scheduled on a weekly basis.

***PJM Actions:***

- PJM Dispatcher verifies the accuracy/status of the data links.
- PJM Dispatcher notifies support personnel of data quality issue.
- PJM Dispatcher, if appropriate, will fail over from the primary to the standby server in real time on primary EMS.

- PJM Dispatcher, if appropriate, will fail-over to Backup EMS if communication problems exist on both primary and stand by communication servers on primary EMS.

Voice communication: Voice communications are available from the Valley Forge control room and backup sites. Within each site there are multiple levels of redundancy, including dedicated ring-downs, manual dial, business voice systems, cellular, satellite, all-call and facsimile communications. Testing is conducted on a periodic basis.

***PJM Actions:***

- PJM Dispatcher will utilize the appropriate phone system, based on availability, following this hierarchy: British Telecom (BT), tradenet, backup phone, cell, satellite.

These plans and procedures for maintaining PJM Control Center functionality are integrated into the PJM Business Continuity Plan. Periodic training on the plan elements and specific actions required by System Operators is included in PJM's normal operating training curriculum. The Business Continuity Plan is tested on a semi-annual basis via drills and procedural exercises. System Operators are responsible for conducting the periodic tests, participating in the Business Continuity Exercise and participating in debriefing activities designed to identify and implement improvements to the overall process. Detailed operating procedures are documented in the Business Continuity Plan.

## **2.6 Control Center Staffing**

PJM Member control centers must be staffed with competent personnel trained (reference PJM Manual 40) for all normal and emergency situations that might be anticipated. Control room operator staffing levels should be prudently determined based upon the impact of the PJM Member's operations. Possibilities for control room staffing include combinations of the following:

- One or more operators in the control room 24 hours a day, 7 days a week
- One or more operators in the control room during business hours or hours of operation
- Responsible personnel not in the control room but able to be contacted by the PJM dispatcher within one minute

While staffing guidelines cannot cover all situations, the following general guidelines may be useful:

- Transmission Owners, Generation Owners, and other Load Serving Entities that participate in the operation and security of the PJM RTO and/or that must respond to generation adjustment or load shedding during normal or emergency conditions must staff their control center 24 hours a day, 7 days a week, with 100% availability of staff.
- Owners of generation which operates infrequently may require continuous control center staffing only during the hours of their units' operation. They must be able to answer telephone questions and directions within one minute of a call initiation by PJM.

- Market Participants must be able to respond to telephone questions about their scheduled transactions within one minute of a call initiation by PJM.

### **2.6.1 Staffing Upon Loss of an EMS or a 765 kV, 500 kV, or 345 kV RTU**

If a PJM Member's EMS becomes unavailable, some PJM Members move their dispatchers to a backup control center while others send staff to man their vital operational facilities. PJM Members should continue to stay in contact with and provide as much information as possible to PJM. If an EHV substation RTU becomes unavailable, the respective Transmission Owner may be required to send staff to that substation to telephone information to the LCC and to PJM.

## **2.7 PJM Member Back Up Capability Required to Support PJM in its TOP Role**

If a PJM member primary EMS capability becomes unavailable, PJM will need back up capability to be available (within 1 hour) from that member so that PJM can continue to perform its obligations as the TOP during such interruptions. Specifically, PJM requires the following from the PJM members during the loss of the transmission owner EMS:

- NERC Standard TOP-004, R1 requires the TOP to operate within the limits of its IROLs and SOLs. If the data for monitoring the IROLs and SOLs passes through the PJM member EMS and that capability becomes lost, then the PJM member is required to have a back up capability to ensure that the necessary data continues to be provided to PJM.
- NERC Standard TOP-004, R6 requires the TOP to have formal policies and procedures to ensure transmission reliability. If the PJM member is unable to execute operating procedures that may be implemented by PJM, such as switching or load shedding, due to the unavailability of its EMS or other operational tools, then the PJM member is required to have a back up capability to be able to execute these actions.
- NERC Standard TOP-006, R1, R2, R5-7, requires data to be provided to PJM to ensure reliability. If such data is interrupted by unavailability of the PJM member EMS, then the PJM member is required to have a back up capability to ensure that the necessary data continues to be provided to PJM.
- NERC Standard TOP-008, R1-4 requires PJM to take immediate action to mitigate potential and actual IROL or SOL violations. Many of those actions require the PJM member to execute actions requested by PJM. If the unavailability of the PJM member EMS or other tools prevents the execution of those actions, then the PJM member is required to have back up capability to ensure that it can execute PJM-requested actions.

## Section 3: Data Exchange Requirements

Welcome to the *Communications & Data Exchange Requirements* section of the PJM Manual for *Control Center Requirements*. In this section you will find the following information:

- Data exchanges with new PJM Members (see *Introduction*).
- Data exchanged between PJM and PJM Member's EMS systems (see *Energy Management System (EMS) Data Exchange*).
- Information available to Market Participants (see *OASIS Information Exchange*).
- Data exchanged over telephone and facsimile machines (see *Dispatch Voice and Facsimile Communications*).
- Usage of backup communications systems (see *Alternative Voice Communications*).
- Requirement to support the PJM emergency backup dispatch center (see *EMS Backup Communications*).

### 3.1 Introduction

Communications between PJM Members and PJM depend upon a combination of electronic data, dispatch and business voice links, facsimile, Internet communications (e.g., to OASIS), and floppy disk and paper reports sent by courier or US mail.

- PJM Members (and PJM) may require additional time after signing the Operating Agreement to establish electronic data links.
- PJM Members with real-time data to be exchanged with PJM and with a significant participation in the supply of information to the PJM RTO require electronic communications via the EMS and eSuite data exchanges.
- New PJM Members with a small amount of data to be exchanged and that do not require real-time links to PJM should use facsimile and voice communications for their PJM communications.
- New PJM Members already communicating with PJM through another PJM Member's electronic communications systems should arrange to continue using those communications systems where this is feasible; separate electronic communications links can be planned and installed subsequently if necessary.

## 3.2 Energy Management System (EMS) Data Exchange

Energy Management System (EMS) information is exchanged between PJM EMS computers and the EMS systems of PJM Members primarily to support real-time functions such as PJM RTO network monitoring, generation control, and security analysis as well as non-real time functions, such as generation scheduling, accounting information, messages, and reports. The information exchange occurs periodically, by exception, and upon demand.

### 3.2.1 EMS Communications System

PJM and PJM Members exchange EMS information between their respective EMS computer systems via PJMnet, which is a dual redundant frame relay network using the Inter-control Center Communications Protocol (ICCP).

### 3.2.2 PJM EMS Communication Protocols

The EMS utilizes a communication protocol based on the Inter-control Center Communications Protocol (ICCP) standard. PJM supports block 1 (scanned data), block 2 (exception data) and block 4 (messages) of this protocol. PJM requires that members support blocks 1 and 2.

ICCP is a comprehensive, international standard for real-time data exchange within the electric power utility industry. It is intended to support inter-utility real-time data exchange which is vital to the operation of interconnected systems.

A detailed description of the format and content of the ICCP Conformance Blocks as adapted to PJM needs may be found in the following documents:

- PJM ICCP Network Interface Control Document (NICD) Version 1.1, dated March 27, 2000.
- PJM ICCP Communications Workbook Version 1.1, dated March 27, 2000.
- Running list of updates to the PJM ICCP NICD and Workbook, Version 1.1, January 30, 2001.

The appropriate documents will be supplied to applicant PJM Members to describe data types and message structures and to supply detailed information on network protocol and line discipline.

### 3.2.3 EMS Data Exchange

EMS data is exchanged between each PJM Member's EMS and the PJM EMS computer system periodically on one of several fixed cycles, as well as on demand, by exception, and interactively.

- The EMS data sent cyclically from PJM Members to PJM includes the following types of information sent with associated data quality codes:
  - data needed for the PJM control programs
  - data needed for monitoring generation
  - data needed for monitoring transmission
  - data needed for monitoring interchange

- The EMS data sent cyclically from the existing PJM EMS to each PJM Member's EMS includes the following types of information:
  - System control data
  - Generation and transmission information required for monitoring and security analysis programs
  - Area Regulation data
- Cyclic data exchanged at the fast scan rate (i.e., two seconds) is used to develop the PJM Area Control Error (ACE) and associated individual PJM Member Area Regulation megawatt values. Cyclic data exchanged at a slower scan rate (i.e., every ten seconds) is used to develop dispatch control values, security monitoring, and data tracking.
- Cyclic data may also be sent hourly from PJM Members which define the accumulated energy values.
- PJM Members are responsible for the accuracy of the data they send to PJM. A maximum of 2% overall inaccuracy in the repeatability of data from transducers or potential transformers/current transformers (PTs/CTs) is allowed for instantaneous monitored values (see Section 5, Meter Accuracy Standards). Hourly MWh readings data must be provided to PJM daily to ensure accurate billing. Regular calibration of PJM Member metering is necessary to keep the data as accurate as possible (see Section 4, Billing Metering Standards).
- Data exchanged either by exception, on demand, or interactively between PJM Member's and the PJM EMS systems include the following:
  - Breaker, disconnect, and line status changes, with associated data quality code information (integrity scans for exception data shall be at 30 minute intervals)
  - Emergency messages in text format

Each PJM Member is responsible for determining data quality indicators for all data transmitted to PJM. Both failed individual values and any value calculated using a failed point must be flagged. At times, state estimated values may suffice for an interim period. However, when a point fails for an extended period, a manual update of the point's value is necessary to keep the data as accurate as possible.

PJM member systems will report to PJM the outage of any equipment which handles telemeter 345 kV or higher and tie data sent to PJM. This equipment includes remote terminal units (RTU), data links, etc., which telemeter 345 kV and higher voltage facilities and tie line values, megawatt flows, megavar flows, and voltage. Scheduled outages should be reported one day in advance, and again prior to switching the equipment out of service. The loss of any of this equipment should be reported immediately after such an occurrence. The PJM control room should be notified when the outaged equipment is returned to service.

When data communication outages occur, the following data must be kept manually updated:

- Megawatt line flows for 345 kV or higher lines and all tie lines. If megawatt values cannot be given, provide the best data available, i.e. MVA, state estimated data, etc.
- Bus voltages for all 345 kV or higher stations.

Affected data must be updated:

- After the loss of a major generator or transmission line;
- When the data value has a detected change of more than 100 MW on a 500 kV or higher line, or more than 50 MW on a 345 kV and below;
- At least every 30 minutes, and more frequently as determined by PJM.
- Whenever changes occur, 500/345/230 kV tap changes and 345 kV or higher breaker positions should be manually updated. MVAR values for the 345 kV or higher lines will be updated only when requested by PJM.

### **3.2.4 PJMnet Communications System**

PJMnet is a dual-redundant frame relay network that PJM utilizes as the primary wide-area network for communicating Control Center data to and from PJM. PJMnet will support:

- Inter-Control Center Communications Protocol (ICCP) data links to Control Centers.
- SCADA links to plants via remote terminal units (RTUs) using Distributed Network Protocol (DNP).

PJMnet connects member Local Control Centers (LCCs), Market Operations Centers (MOCs) and generating plants to PJM's primary and emergency backup Control Centers in the Eastern Region as well as to the backup PJM Control Center. Private voice and data permanent virtual circuits (PVCs) are provided to link to PJM's primary and emergency backup Control Centers. The number of physical interfaces and their capacity will be determined by the impact of your facilities on overall PJM Operations. LCCs, MOCs and generating plants are expected to install metering and use their own EMS/GMS/SCADA or equivalent system to collect data. PJM will provide redundant ICCP network connections and dual routers at the member company location.

Exhibit 5 in Manual 14D

(<http://www.pjm.com/documents/~/media/documents/manuals/m14d.ashx>) shows the types of equipment necessary for exchanging generation data with PJM.

PJM will supply a PJMnet connection to LCCs and generation sites per customer eligibility as indicated in manual 14D. This will include installation of the frame relay connections (local loop, PVC's, etc.) and routers as well as ongoing Network Operations Support and maintenance of the PJMnet components. If dual circuits are provided, PJM will route them as diverse from each other as practicable within the existing infrastructure. Installation will be completed within 90 calendar days of the completion of the site survey contingent upon timely completion of the member supplied items. The member company will be responsible for the following:

- AC power within five (5) feet of equipment site.
- Power outlet(s) will be quad box outlet on a separate breaker for each router.
- Adequate cooling.
- Mounting location for PJMnet router and modem equipment.
- An environment clean and free from excessive dust or debris, dry (5 to 95% humidity, non-condensing), of moderate temperature (32 to 104 degrees F), well-ventilated and well-illuminated.
- Adequate station ground.
- Dial up modem lines for out of band router access by NOC.
- Return of the "Welcome Letter" either agreeing to PJM assigned IP address scheme or providing specific member requirements in this area.

### 3.3 OASIS Information Exchange

PJM is responsible for providing the Open Access Same-time Information System (OASIS) for PJM RTO Transmission Providers and Customers (see the **PJM Manual for PJM OASIS Operation (M-04)**). The information on the OASIS network includes Available Transfer Capability and other important transmission and ancillary services data. Market Participants are responsible for establishing Market Operations Centers which implement the necessary communications with OASIS.

#### 3.3.1 Transmission Customer Communications

Transmission Customers use the public Internet to access PJM OASIS. OASIS Customers must register with PJM before they access the PJM OASIS system and login each time a connection is established. The primary interface to request transmission or ancillary service and to provide information to PJM OASIS is on-line data entry forms available on the OASIS display pages. These forms are used to request the purchase of services and to offer products for sale, as well as to post other transmission-related information. Instructions on how to interface with OASIS are available on the OASIS display pages or from the PJM OASIS Account Administrator. If a Transmission Customer enhanced OASIS connections, a direct connection is available, at additional cost.

### 3.3.2 Transmission Provider Communications

Transmission Providers are directly connected to the PJM OASIS system via PJMNET and it is possible for them to use SQL\*NET protocol and ORACLE Forms user interface software to display and post information to the OASIS. ORACLE Forms are used to post and modify data, approve purchase requests, offer products for sale, and post “Want” ads. PJM is responsible for administering and posting information associated with the provision of transmission service as required by FERC.

### 3.4 EMS Backup Communications

To implement backup communications, the PJM EMS control information is sent to the Generation Management System (GMS) so that the GMS can back up the PJM EMS for AGC purposes if there is a PJM EMS outage. Generation owning members need to be prepared to accept AGC signals from the back up sources to ensure control continuity in the event of an AGC outage on either EMS or GMS.

### 3.5 Real-Time Analysis Monitoring Requirements for System Security

PJM analyzes the system security of the PJM system using information telemetered from PJM Members. Phase and line-end location of metering is as mutually agreed between the two connected systems, must be consistent with established system metering, and must be coordinated with PJM. The following analog and status information is required for this analysis:

- Required Analog Data:
  - Voltages for buses at 34 kV and above (or 69 kV and above, if lower voltage equipment is not monitored), MW and MVAR values for generating units greater than 1 MW including steam, nuclear, hydro and combustion turbine units and non-utility generator units (usually individual unit generation but total station generation may be telemetered in special circumstances) if connected directly to the transmission system.
  - MW and MVAR values (both ends) for designated transmission lines at 69 kV and above (if single-phase metering is employed, the B-phase is preferred)
  - Transformer phase angle regulator (PAR) tap positions for modeled and controlled transformers (high side metering or low side with a loss calculation)
  - MVAR values for synchronous condensers
  - MVAR injection on 34 kV buses (or 69 kV if lower voltage equipment is not monitored)
  - Selected station frequencies
  - Frequency of Acquisition — <10 seconds
- Required Status Data:
  - Circuit breaker status for each modeled facility at 69 kV and above
  - Breaker and disconnect statuses as modeled

- Transformer fixed tap settings (change in no-load tap setting)
- *Frequency of Acquisition* — Upon change of status.

PJM Members have the capability to validate data and send accurate manually adjusted data until inaccurate metering is corrected if state estimated data will not suffice. In case of a computer failure or outage, all data should be sent once the computer reinitializes. See the *PJM Manual for [Transmission Operations](#) (M-03)* for more information.

### 3.6 Dispatching Requirements

The following requirements are intended to assure reliable dispatch and operation of the PJM system:

- All tie line MW and MWH data are telemetered to PJM and the neighboring Control Area and emanate from a common agreed upon terminal using common primary metering equipment. Daily billing MWH data can be submitted via eMTR.
- Tie-line MWH metering is not submitted on an hourly basis per NERC Standard BAL-005-0, however, this data is submitted on a daily basis via eMTR. PJM Dispatch utilizes an EMS alarming process to compare State Estimator data to tie-line telemetry in order to detect data accuracy issues on a more frequent basis than hourly intervals.
- Combustion turbines supply accurate real-time status information and report failure-to-start situations.
- 500 kV and significant 345 kV and 230 kV locations require disturbance recording equipment for post-disturbance analysis. These devices should have the capability to retain historical data for future analysis.
- PJM Members participate in the payback of the accumulation of inadvertent interchange as directed by PJM.
- The amount of generator regulating capacity reported to PJM is accurate and committed to the system.
- The amount of generator reserve capacity reported to PJM is accurate and committed to the system.

PJM Members, generating stations, and fault recorders are time synchronized to assure accurate recording times for system events.

## Section 4: Voice Communications

### 4.1 Dispatch Voice & Facsimile Communications

The dispatch voice system provides high-priority voice communications between PJM and various PJM Members, as described below. The dispatch voice system hardware consists of the All Call system, Ring Down circuits, and manual dial circuits. Equipment at PJM includes a British Telecom (BT) / BT digital switch and a Nortel Meridian PBX. Access and interfacing to the communications service providers is configured so that either switch can operate in stand-alone mode, but economy and performance are optimized when they are operating together.

Communications via facsimile machines is another redundant means of exchanging information between PJM operations, accounting, and planning personnel and all categories of PJM Members.

**PJM and PJM Members shall use English as the language for all communications between them and shall issue directives in a clear, concise, and definitive manner. These communications shall ensure the recipient of the PJM Directive repeats the information back correctly and the initiator shall acknowledge the response as correct or repeat the original statement to resolve any misunderstandings (i.e., 3-Part Communications) per NERC COM Standards.**

#### 4.1.1 All Call System

The All Call system is used by PJM operators to contact Local Control Centers (LCCs), Market Operations Centers (MOCs), and Load Serving Centers (LSCs), either individually or simultaneously for information exchange under both normal and emergency situations. The All Call is based on the Dialogic Communications Corp. Communicator, an emergency notification system that provides PJM system operators the ability to broadcast voice, text or fax messages. The All Call operates over PSTN (Public Switched Telephone Network). The system is capable of sending messages to 72 numbers simultaneously. If the more than 72 locations must be contacted the system will dial the additional numbers as lines become available. Continuous retry logic ensures 100% of the facilities are contacted by cycling through primary, secondary, and tertiary numbers until positive confirmation of message receipt. Both real-time displays and reports of response status are available to PJM System Operators.

Each control facility is required to have a dedicated PSTN line for the primary All Call number. Secondary and tertiary do not have to be dedicated to the All Call System; they may be PBX or cellular, not pager. Acknowledgement of message receipt by each participant is required. Logs of responses and response times are provided to PJM's Performance Compliance department for analysis.

#### 4.1.2 Ring Down Circuits

Private Lines with automatic ringing (PLAR) or dual central office (DCO) lines are used to provide Ring Down or simulated Ring Down capability to LCCs, some Market Operations

Centers (MOCs), and Load Service Centers (LSCs). These circuits provide virtually instantaneous point to point access between PJM and PJM Members.

### **4.1.3 Manual Dial**

In addition to private line capability, the PJM BT switch also interfaces with both the PJM Meridian PBX and Central Office (CO) Lines to provide manual dial capability to all categories of PJM Members via the Public Switch Telephone Network (PSTN). Manual dial serves as backup to the Ring Down system in case that system fails.

### **4.1.4 Facsimile Communications**

Facsimile communications is widely used in the PJM Control Center to communicate with all PJM Members. Facsimile machines support energy marketing, energy scheduling, unit scheduling, accounting, dispatch operations, and system restoration. These facsimile machines are connected to either the PJM Nortel Meridian PBX or CO Lines.

## **4.2 Alternative Voice Communications**

The dispatch voice system (All Call, Ring Down, and manual dial PBX) is designed to provide voice communications during normal circumstances. Should the PJM primary All Call System, Ring Down, Manual Dial, and Facsimile Communication fail, the following systems provide alternative communication capabilities in the event the normal system is not effective for some reason:

### **4.2.1 Business Voice System**

Each dispatch position is provided with a standalone phone set, configured with speed dial using CO Lines, which serve as a backup for the PJM BT switch to provide communication between the PJM control center and all PJM Members in the event of BT switch failure.

### **4.2.2 Cellular Telephones**

Cellular telephones are used by PJM dispatchers as an alternate method of voice communication. Cellular phones can be used to coordinate activities while physically moving personnel to the PJM emergency dispatch center.

### **4.2.3 Satellite Telephones**

Satellite telephones are used by PJM dispatchers as an alternate method of voice communication. These telephones are used to protect against loss of common carrier services. Member companies desiring to avail themselves of satellite point to point capability must apply via PJM Customer Relations (610-666-8980).

Transmission Owners shall have satellite phone capabilities at both their primary and back-up facilities. Satellite phones are required for all Generation Operator (GO) control centers which control one or more units totaling 500 MW or greater.

Functional Requirements for Satellite Phones:

- Compatible with PJM satellite network
- Ability to receive dedicated all-call
- Ability to bypass the ground phone (PSTN) network

Additional Notes:

- If the emergency plan for a generator control center is to co-locate with a transmission control center which has a satellite phone, this will meet the requirement, however, companies need to examine the availability of these systems for both transmission and generator communications during an emergency.
- Companies need to also provide similar (radio, satellite, etc.) redundant communications from their control centers to their plants.
- PJM may also require specific vital generation units to maintain a satellite phone.

#### **4.2.4 Three Part Communications**

All operators should use their name and company name when answering a phone call. This will ensure that the caller has the correct party prior to communication beginning.

PJM system operators and member transmission and generation operators should always practice three-part communications to avoid errors and miscommunications.

Three-part communications consists of the sender delivering the message to the receiver. The receiver repeating back the information to the sender while questioning for clarification. The original sender will confirm if the receiver has the message correct.

Three-part communications is required when the operators are exchanging important operational information. A partial list of these situations is presented below. If there is a question about whether the situation warrants the use of three-part communication, it should be used.

Examples of generation operations utilizing three-part communications:

- Unit starts
- Unit trips or releases
- Requests from PJM for additional generation
- Outages (eDART ticket numbers and unit designations)
- Synchronized Reserve or Regulation assignments
- Manual dispatch of generation
- Emergency operations related information

Examples of transmission operations utilizing three-part communications:

- Transmission switching
- Capacitor switching
- Outages (eDART ticket number and line numbers, not every circuit breaker)
- PCLLRW issuance and cancellation
- TLR curtailments in transactions
- Market to Market redispatch
- Emergency operations related information

In addition, it would be expected that anytime information is exchanged that is not thoroughly understood (whether it be due to speech impediment, accent, or because information was not clearly articulated, etc.), a repeat back should be requested and followed up on, constituting three-part communications. The use of the term —“directive” should be used if additional clarification is needed - either by the issuer or the receiver of the critical communication.

PJM All call messages do NOT require repeating as the receiver can repeat the message by selecting “9” on the telephone keypad. It is the responsibility of any party receiving information via an all call to follow up with the initiator of the information if there is not clear understanding of the message. PJM receives confirmation of member confirmation through electronic means and will follow-up with individual companies if appropriate.

PJM also performs communication audits of operator conversations to ensure that three-part communication is being consistently utilized.

In addition, it is possible for PJM to issue directives in each of its operational roles (as the RC, TOP, or BA). PJM Directives are defined as instructions from PJM to its members to take actions to control Inter Regional Operating Limits (IROL) or initiate load dump measures for capacity or transmission emergencies as described in PJM Manual 13, Section 2 and Section 5. These Directives could be issued through a PJM All Call or through direct voice communications to the applicable member companies. The following are examples of communications which could be considered Directives by PJM (PJM Directives require 3 part communication):

- PJM as Reliability Coordinator:
  - Direct actions to implement load dump plans to control IROLs
- PJM as Transmission Operator:
  - Directing Generation to manually lower or increase unit output outside of automated dispatch signals to control IROLs
  - Directing selected generation to trip off-line to control IROLs
  - Direct actions to implement load dump plans for the purposes of transmission control
- PJM as Balancing Authority:
  - Directing Generation to deploy synchronous reserves to restore DCS after a unit trip to control an IROL
  - Direct actions to implement load dump plans to rectify capacity deficiencies.
- All operators must be cognizant of the time constraints associated with system operations such as limits over emergency ratings, load dumps, IROLs, DCS events, etc. It will often be necessary to quickly confirm status, ratings, output, options, etc. prior to initiating the directive or operational instruction. Once this is complete, the PJM operator will initiate the instruction by:
  - Restating the desired action
  - Receiving and or requesting the repeat back by the receiver
  - Acknowledging the correct repeat back

- From this point on, the receiving operator should be focused on implementing the directed actions.

**NOTE:** PJM members are obligated to follow all operational instructions or Directives as described in the PJM Operating Agreement, NERC Standards and PJM Manuals. If a PJM member is unable to comply with PJM instructions, the member should notify PJM of the restriction (based on safety, loss of life, or damage to equipment) so PJM is able to implement other actions to alleviate the operation problems.

## Section 5: Metering Requirements

Welcome to the *Metering Requirements* section of the PJM Manual for *Control Center Requirements*. In this section you will find the following information:

- A general description of the purpose of having billing metering standards (see “*Purpose & Criteria*”).
- The overall requirements for the billing metering (see “*General Guidelines*”).
- The basic metering requirements in terms of accuracy, backup, location, alternative installation methodology, tie circuits, non-contiguous load, and maintenance (see “*Primary Metering Requirements*”).

### 5.1 Purpose & Criteria

All electricity recording metering equipment is operated and maintained to assure, to the maximum extent possible, that the equipment provides an accurate record of the quantities supplied to and received by all parties. Each PJM Member is responsible for properly maintaining its metering and telemeter equipment in accordance with applicable ANSI standards.

This section provides the minimum standard requirements for the billing metering for new meter installations to be used in transactions with PJM. The standards apply to new meter installations, replacement meter installations, or upgrades to existing installations.

The standards in this section are a minimum requirement and do not supersede more restrictive agreements. In cases in which standards differ, the most restrictive criteria take precedence. More specific standards may be required by local, state, or federal regulations, host utilities, service providers, or as are mutually agreed upon.

### 5.2 General Guidelines

All PJM Members involved with any interface with PJM abide by the following general guidelines for Billing Meter Standards:

- Reliable and compliant operational metering equipment is in place for any metered service that is billed.
- Meter information is automatically electronically communicated to PJM by the producer, host utility, or transmitter in order to ensure timely accounting and billing. This enables PJM to identify and resolve erroneous information and to account and bill for services. Communication between PJM Members other than PJM may utilize any method, such as voice notification or paper document that is mutually agreeable.
- Billing metering systems are capable of collecting and storing bi-directional information for intervals as determined by the parties involved. The expense and practicality of reporting information for small data intervals may not be cost effective or prudent. The average of instantaneous values can be used, providing a mutually agreed upon accuracy is obtained and applicable standards are achieved. Meter intervals can be of lesser duration for some services, but common intervals are fifteen minutes, thirty minutes, and sixty minutes. Collected meter information may be

transmitted to the appropriate parties with a different frequency than it is collected, as communications systems permit.

- The megawatt-hour (MWh) is the standard unit of service measurement. Service may be measured in kilowatt-hours (kWh) if required by specific services, local or state regulations, host utilities, service providers, or as are mutually agreed upon by the parties involved. kWh information may be used by the parties involved but must be converted to MWh information before transmission to PJM.
- All metered generator data values are to be supplied to the required parties in **net** form. **Net** shall be defined as **gross** output minus unit station light and power components. When metering limitations require **gross** values to be used, the **gross** to **net** calculation method must be approved by the PJM Operating Committee for use by PJM Members in the calculation of **net** data values.
- All meter records and associated documentation are retained for a period of seven years for independent auditing purposes.
- Any dispute involving any aspect of the billing metering standards or their application are resolved as described in the PJM Manual for **Administrative Services for the PJM Interconnection Agreement (M-33)**.

### 5.3 Primary Metering Requirements

The primary metering requirements are:

- For billing purpose, watt-hour meters are recognized as the official source of meter information.
- Metering devices must be capable of collecting and storing information for intervals required by the service provided, and as mutually agreed upon by the parties involved.
- Any generation unit participating in the PJM Energy Market is required to have independent metering devices that are capable of recording generation net MWh output. When metering limitations require variance from this standard, the metering system must be mutually agreed upon by the parties involved.
- All manual or additional meter reading or comparisons required to ensure consistent valid meter information (**tie-up**), are performed prior to the billing cycle, as mutually agreed by the parties involved. Current billing cycles are monthly.

Each meter must follow the specific metering requirements associated with:

- Accuracy
- Backup Metering Requirements
- Location of Meter Points
- Alternative Approach
- PJM Member-to-PJM Member Tie Circuits
- Geographically Non-Contiguous Load

- Pool-to-Pool Tie Circuits
- Maintenance

### 5.3.1 Accuracy

The minimum metering accuracy for each measuring device is defined by prevailing ANSI and NERC standards. The standards in this attachment are a minimum requirement, and do not supersede more restrictive agreements. In cases in which standards differ, the most restrictive criteria take precedence.

The manufactured accuracy class of all energy interchange billing devices should be accurate within  $\pm 0.3\%$  of full scale.

An individual metering system at a metering point location includes all components from the meter location through to the system operator destination. The accuracy of the total energy interchange billing metering system, at each generator or transformer location, is to be within 1.0%. More restrictive standards may be required by local or state regulations, host utilities, service providers, or as are mutually agreed upon by the parties involved.

Each individual metering system at each metering point location used for billing is tested by the owner of the equipment at intervals of two years and its accuracy of registration maintained in accordance with good practice. At the request of any party, an individual meter system will be tested, but, if an error of less than 1.0% is observed, the requesting party will pay for the test. PJM is to be notified of the error for auditing purposes.

### 5.3.2 Backup Metering Requirements

The backup metering system is of sufficient accuracy to serve as a replacement for the primary metering system. The average of instantaneous values may be used as a backup source, provided mutually agreed upon accuracy is obtained and applicable standards are achieved.

The backup metering system is capable of collecting interchange data and logically comparing data with the primary meter system so that material differences may be detected in a reasonable time.

If any test of an individual metering system discloses an error of greater than 1.0%, the accounts of the parties shall be adjusted for no more than two months for which the inaccuracy is estimated to have occurred. Longer correction periods, if confirmed by recorded information or defined as a result of the dispute resolution process, may be mutually agreed upon by the parties involved. All errors of the above magnitude shall be reported to PJM and documented for auditing purposes.

### 5.3.3 Location of Meter Points

Interchange billing metering is provided on the system as follows:

- *Transformers: Through-Transmission* — EHV interchange metering points are provided from the secondary side of all through-transmission transformers connected to the 500 kV EHV system. For example, interchange metering is provided on the 230 kV side of a 500/230 kV through-transmission transformer.
- *Generators and Transformers Radially Tapped* — Generators and transformers that are not through transmission (including unit station service transformers) and that are

tapped directly on the 500 kV EHV system are provided with interchange metering on the primary side (500 kV) of the step-up, station service or radial transformer. For instance, a generator connected to the EHV system has an interchange metering point on the 500 kV side of the unit step-up transformer. All other generators and transformers not connected to the 500 kV system provide information as received from the high side or the low side of the unit transformer.

#### **5.3.4 Alternative Approach**

In lieu of providing interchange billing metering, a PJM Member may elect to install a watt-hour metering system on the opposite side of the transformer than directed above (the 500 kV side of the through-transmission transformer or the 230 kV side of the radial transformers) provided that a compensation system is included to capture and adequately adjust interchange values to account for transformer losses. Any design for alternative metering approaches shall be documented and made known to PJM and all parties involved. Any alternative approach must be approved by PJM.

For through-transmission transformers, interchange values may be determined from the 500 kV side if compensation is installed which subtracts transformer losses when power is imported to the PJM Member or adds transformer losses for exported power.

#### **5.3.5 PJM Member-to-PJM Member Tie Circuits**

PJM Member-to-PJM Member tie circuits not associated with the EHV system and under the direction of PJM have interchange metering provided at one terminal end with or without the agreed upon compensation circuitry per agreement between the two PJM Members. This terminal is regarded as the official source for interchange values.

#### **5.3.6 Geographically Non-Contiguous Load**

Any PJM Member serving a load which is geographically non-contiguous to its defined service area documents and makes known to PJM, and all other parties involved, any metering and system conventions implemented in order to meter the load. Metering devices may be met by contractual arrangement with any party involved. Any alternative approach must be approved by PJM prior to implementation. This enables PJM to monitor and control the transmission system, to identify and resolve erroneous information, to account and bill for services, and to take appropriate action for reliability concerns.

#### **5.3.7 Balancing Authority Tie Circuits**

The requirements for documentation for any Balancing Authority tie circuit interchange delivery and metering point is set forth in the agreements between PJM and applicable parties. The requirements for the metering of these points conforms to the standards contained in this document, except in the case of existing equipment. If existing equipment is used in metering of these points, and the equipment does not comply with these standards, both parties then mutually agree to accept the metering. For billing purposes, watt-hour meters are recognized as the official source of meter information.

#### **5.3.8 Maintenance**

The accuracy of all recording meters, as required to transact energy services, is verified by tests conducted by the equipment owner once every two years. If such test identifies, or other indications show, a recording meter is out of service or inaccurate, the owner must take action to restore the meter to correct operation within a reasonable time. In the interim,

backup metering may be used as mutually agreed by the parties involved. All equipment must be restored to correct operation within the period of 30 days from the date of discovery, or a date mutually agreed upon by all parties. If equipment installation or replacement is required to resolve the inaccuracy, all equipment must be correctly operating at a date mutually agreed upon by all parties. PJM is notified of the inaccuracy, interim procedures, and resolution for auditing purposes.

Periodic accuracy compliance testing may be requested by PJM Member agreement groups, as required. Authentication of current meter testing and validation of newly installed or repaired meter systems may also be required.

The results of all accuracy testing are reported to PJM. As a minimum, PJM maintains a metering database documenting the test results for all PJM Member metering tests that show errors of greater than 1% for auditing purposes.

## 5.4 Meter Accuracy Standards

Welcome to the *Meter Accuracy Standards* section of the PJM Manual for *Control Center Requirements*. In this section you will find the following information:

- A general description of the purpose and applicability of metering standards (see *Purpose*).
- The overall requirements for telecommunications metering (see *General Guidelines*).
- The overall requirements for metering accuracy (see *Primary Metering Accuracy*).
- Requirements for data needed for system control data (see *System Control Monitoring Requirements*).
- Requirements for data used in system security monitoring (see *Real-Time Analysis Monitoring Requirements for System Security*).
- A description of the requirements intended to assure reliable dispatch (see *Dispatching Requirements*).

## 5.5 Purpose

This section provides the minimum standard requirements for telecommunications metering, such as MW, MVAR, and kW values, to be used when communicating information to PJM. The standards apply to new meter installations, replacement meter installations, or upgrades to existing installations. The requirements for billing meters are covered in Section 4.

These standards are a minimum requirement and do not supersede more restrictive agreements. In cases in which standards differ, the most restrictive criteria take precedence. More specific standards may be required by local, state, or federal regulations, host utilities, service providers, or as are mutually agreed upon.

## 5.6 General Guidelines

All PJM Members involved with any interface with PJM abide by the following general guidelines for telecommunications metering:

- All electric measurement equipment is operated and maintained so as to assure, to the maximum extent possible, that it provides an accurate record of the quantities supplied to and received by all parties.
- Each PJM Member is responsible for properly maintaining its metering and telemeter equipment in accordance with applicable ANSI standards.
- Metered information is automatically electronically communicated to PJM by the producer, host utility, or transmitter in order to ensure system security and reliability.
- It is important to recognize the importance of accurate data as well as the need to meet deadlines associated with updating this data, since the failure to provide accurate and timely data affects reliable system operations.

## 5.7 Primary Metering Accuracy

For all new metering installations, the following primary transducer accuracy guidelines are followed:

Primary Transducer	Accuracy Guideline
Frequency Transducers	0.001 Hz
Potential Transformers	0.30%
Current Transformers	0.30%
MW/MVAR/Voltage Transducers	0.25%
Remote Terminal Units (A/D)	0.25%

*Exhibit 2: Primary Transducer Accuracy Guideline*

This accuracy guideline results in an overall metering accuracy better than 2% and satisfies the NERC BAL standards. Billing accurate telemeter data values should be supplied whenever possible.

## 5.8 System Control Monitoring Requirements

Data required for system control monitoring provides PJM dispatcher with the necessary information to meet the continuous requirement of matching the generation with the load demand and to assure that system security is maintained. There are four classes of system control data:

- System control data
- Area regulation data
- Dispatch data
- Reserve data

The frequency and accuracy of data transmission, unless otherwise noted, applies to the primary source of telemeter data, the backup source when the primary is unavailable and backup source for tie line and frequency data.

### 5.8.1 System Control Data

System control data is required to match the load demand with the available generation. This is accomplished by measuring the actual tie-flow values and the actual frequency and using them in a calculation with the scheduled total tie-line value and the scheduled frequency. PJM Members that control generation participate in time error control by raising or lowering frequency schedules by 0.02 Hz at the direction of PJM (see the *PJM Manual for Dispatching Operations (M-12)*).

System control data is also required to facilitate system restoration (see the *PJM Manual for System Restoration (M-36)*). Specifically, a system frequency measurement is required to be transmitted to PJM from each Transmission Zone.

- Frequency of Acquisition —  $\leq 4$  seconds
- Metering Accuracy — 2%

### 5.8.2 Area Regulation

Area regulation data is required to ensure that the instantaneous mismatches of load and generation are corrected by sending a generation control signal to those plants/stations/PJM Members scheduled to provide this ancillary service. PJM calculates the desired area regulation signal and the signal is transmitted to the designated provider of this service.

- Frequency of Acquisition —  $\leq 4$  seconds
- Metering Accuracy — 2%

PJM Members must have the ability to receive a regulation signal and must have the ability to adjust generation manually to maintain scheduled interchange if automatic generation control becomes inoperative.

### 5.8.3 Dispatch Data

The plant/station/PJM Member provides to PJM the individual generation availability by providing the necessary information to dispatch the generation. For PJM dispatchable generation, the appropriate operating data points are provided to PJM either through an EMS data link or through the eMarket interface whenever the data changes. For self-scheduled generation, the self-scheduled value is transmitted twenty minutes prior to any changes. PJM uses its Unit Dispatch System (UDS) to determine the appropriate generation output which is then sent to each plant/station/PJM Member in the form of an individual unit MW base point, to be used as the dispatch signal, and an individual unit dispatch lambda, used for informational purposes only. PJM Members with generation notify PJM of any actual or potential changes in unit status or capacity.

- Frequency of Acquisition —  $\leq 10$  seconds
- Metering Accuracy — 2%

### 5.8.4 Reserve Data

The availability of generation reserve is transmitted to PJM from the individual plant/station/PJM Member. This data is used to determine the reliability of the PJM RTO.

- Frequency of Acquisition —  $\leq 10$  seconds
- Metering Accuracy — 2%

### Attachment A: Information Access Matrix

The following Information Access Matrix lists each of the major PJM services that affect PJM Members. It differentiates these services by PJM member type and by information access method. This Information Access Matrix should be considered as a rough approximation only. The PJM Customer Relations and Training Department is available to provide more specific information concerning PJM services and access methods.

A: Generation Scheduling Services						
	Information Services	PJM Member Regional Transmission Owner	PJM Member Generating Entity	PJM Member Load Serving Entity	PJM Member Marketer	Neighboring Control Areas
	<b>Inputs to PJM</b>					
A.1	Hydro Constraint Information (pool scheduled resources) [submitted daily by hydro plants]		2			
A.2	Generator Outage Information [submitted daily]		1			4
A.3	Daily Generator Bids (cost, availability, etc.) [submitted by noon for next day]		3			
	<b>Outputs from PJM</b>					
A.4	Daily Hydro Schedules (hourly generation and capacity) [read only]		2			
A.5	Daily Hydro Schedule Updates		2			
A.6	Daily Managers Report on Joint Owned Units [reported to joint plant owners]		5			
A.7	Daily Load Forecasts (peak loads, congestion)	O		O	O	O
A.8	Reliability Information (Forecasted Load, Minimum Generation Problems, Outages, Available Capacity)	O				X
A.9	Daily Generator Bid Confirmations (cost, availability, etc.)		2			
A.10	Selected Generators (next day schedule)[distributed to selected generator owners]		2			
<p>Key:</p> <ul style="list-style-type: none"> <li>X - Required Service</li> <li>O - Optional Service</li> <li>1 - Mandatory For All Generation Within the PJM RTO</li> <li>2 - Mandatory For Unit Specific Generation Bidding</li> <li>3 - Mandatory For All Capacity Resources</li> <li>4 - System Reliability Information Only</li> <li>5 - Mandatory For Joint-Owned Unit Owners</li> <li>6 - Mandatory If Not Attainable From Existing Telemetry</li> <li>7 - Mandatory For Generators Offering Regulation</li> </ul>						

*Exhibit 3: Generation Scheduling Services*



B: EMS Services						
	Information Services	PJM Member Regional Transmission Owner	PJM Member Generating Entity	PJM Member Load Serving Entity	PJM Member Marketer	Neighboring Control Areas
	<b>Inputs to PJM</b>					
B.1	CT Generator Availability Updates		1			
B.2	Confirmed Regulation MWs		7			
B.3	Telemetry Status & Analog Values [real-time]	X	X	6		4
	<b>Outputs from PJM</b>					
B.4	CT On/Off Times for PJM Units Only		1			
B.5	Requests for Regulation MWs		7			
B.6	Real-time Transmission Status (Line Outages, etc.) [PJM dispatcher communication to other CCs]	X				4
B.7	Real-time Generation Status (Generation Inquiries, etc.) [PJM dispatcher communication to other CCs]		X			4
B.8	Real-time Informational, Operational, and Emergency Messages [broadcast to all LCCs]	X				
B.9	Generation Dispatch [relayed ≤ 10s, or manually]		X			
B.10	Generation Regulation Control [relayed ≤ 10s]		7			
B.11	Real-time Telemetry (status & analog values) [relayed to other CCs]	X	X	6		4
Key: X - Required Service O - Optional Service 1 - Mandatory For All Generation Within the PJM RTO 2 - Mandatory For Unit Specific Generation Bidding 3 - Mandatory For All Capacity Resources 4 - System Reliability Information Only 5 - Mandatory For Joint-Owned Unit Owners 6 - Mandatory If Not Attainable From Existing Telemetry 7 - Mandatory For Generators Offering Regulation						

Exhibit 4: EMS Services

C: Historical EMS Data Services						
	Information Services	PJM Member Regional Transmission Owner	PJM Member Generating Entity	PJM Member Load Serving Entity	PJM Member Marketer	Neighboring Control Areas
	<b>Inputs to PJM</b>					
C.1	Historical EMS Information Requests [submitted periodically to PJM for processing]	X				4
	<b>Outputs from PJM</b>					
C.2	Historical EMS Information [distributed to requesting parties]	X				4
<p>Key:            X - Required Service            O - Optional Service            1 - Mandatory For All Generation Within the PJM RTO            2 - Mandatory For Unit Specific Generation Bidding            3 - Mandatory For All Capacity Resources            4 - System Reliability Information Only            5 - Mandatory For Joint-Owned Unit Owners            6 - Mandatory If Not Attainable From Existing Telemetry            7 - Mandatory For Generators Offering Regulation</p>						

*Exhibit 5: Historical EMS Data Services*

<b>D: Transmission Maintenance Planning Services</b>						
	<b>Information Services</b>	<b>PJM Member Regional Transmission Owner</b>	<b>PJM Member Generating Entity</b>	<b>PJM Member Load Serving Entity</b>	<b>PJM Member Marketer</b>	<b>Neighboring Control Areas</b>
<b>Inputs to PJM</b>						
D.1	3-4 Day Ahead Transmission Maintenance Schedules [planned outages, submitted by transmission providers per Manual 03]	X				
D.2	3-4 Day Ahead Neighboring Control Area Transmission Maintenance Schedules (planned outages) [submitted by neighboring control areas]					X
<b>Outputs from PJM</b>						
D.3	3-4 Day Ahead Transmission Maintenance Schedules (planned outages) [confirmation of D.1]	X				X
D.4	3-4 Day Ahead Neighboring Control Area Transmission Maintenance Schedules (planned outages) [confirmation of D.2]					X
D.5	Transmission Maintenance Schedule (planned outages) [monthly report sent to all transmission providers]	X				X
Key: X - Required Service O - Optional Service 1 - Mandatory For All Generation Within the PJM RTO 2 - Mandatory For Unit Specific Generation Bidding 3 - Mandatory For All Capacity Resources 4 - System Reliability Information Only 5 - Mandatory For Joint-Owned Unit Owners 6 - Mandatory If Not Attainable From Existing Telemetry 7 - Mandatory For Generators Offering Regulation						

*Exhibit 6: Transmission Maintenance Planning Services*

E: Transmission Services						
	Information Services	PJM Member Regional Transmission Owner	PJM Member Generating Entity	PJM Member Load Serving Entity	PJM Member Marketer	Neighboring Control Areas
<b>Inputs to PJM</b>						
E.1	Transmission Reservations [reserved through OASIS]		O	X	X	
E.2	Network Transmission Services			X		
<b>Outputs from PJM</b>						
E.3	Available Transmission Capacity [posted on OASIS]			X	X	
E.4	Actual Energy Transactions [posted on OASIS 7 days later]	X	X	X	X	
E.5	Informational Messages [posted on OASIS]	X	X	X	X	
E.6	Ancillary Services [posted on OASIS]	X	X	X	X	
E.7	Approved Transmission Reservation Requests			X	X	
E.8	Summary of Month End Transactions	X				
<p>Key:</p> <ul style="list-style-type: none"> <li>X - Required Service</li> <li>O - Optional Service</li> <li>1 - Mandatory For All Generation Within the PJM RTO</li> <li>2 - Mandatory For Unit Specific Generation Bidding</li> <li>3 - Mandatory For All Capacity Resources</li> <li>4 - System Reliability Information Only</li> <li>5 - Mandatory For Joint-Owned Unit Owners</li> <li>6 - Mandatory If Not Attainable From Existing Telemetry</li> <li>7 - Mandatory For Generators Offering Regulation</li> </ul>						

*Exhibit 7: Transmission Services*

<b>F: Energy Transaction Services</b>						
	<b>Information Services</b>	<b>PJM Member Regional Transmission Owner</b>	<b>PJM Member Generating Entity</b>	<b>PJM Member Load Serving Entity</b>	<b>PJM Member Marketer</b>	<b>Neighboring Control Areas</b>
	<b>Inputs to PJM</b>					
F.1	External Energy Transactions			X	X	
F.2	Non-PJM Energy Transactions (Wheels, etc.) [submitted by neighboring control areas]					X
F.3	Updates / Additions to Energy Transaction Schedule			X	X	X
F.4	Internal Energy Transactions			X		
	<b>Outputs from PJM</b>					
F.5	External Energy Transactions [collectively confirmed by PJM & communicated to neighboring control areas]			X	X	X
<p>Key:            X - Required Service            O - Optional Service            1 - Mandatory For All Generation Within the PJM RTO            2 - Mandatory For Unit Specific Generation Bidding            3 - Mandatory For All Capacity Resources            4 - System Reliability Information Only            5 - Mandatory For Joint-Owned Unit Owners            6 - Mandatory If Not Attainable From Existing Telemetry            7 - Mandatory For Generators Offering Regulation</p>						

*Exhibit 8: Energy Transaction Services*



G: Long-term Planning Services						
	Information Services	PJM Member Regional Transmission Owner	PJM Member Generating Entity	PJM Member Load Serving Entity	PJM Member Marketer	Neighboring Control Areas
	<b>Inputs to PJM</b>					
G.1	Capacity Information (spreadsheets)	X				
G.2	Load Information (spreadsheets)	X				
G.3	Load Flow Information	X				
G.4	Short Circuit Information	X				
G.5	Dynamics Information	X	1			
G.6	LAS Load Information	X				
G.7	Generator Events Information (GADS dataset) [submitted by plant operations]	X	1			
G.8	PROMOD information File (Generation Production Cost Information) [submitted by generation planning into central planning database]	X	1			
G.9	Generation Planning Maintenance Outage Reports [compiled from transmission planning tools]	X	1			
G.10	Long-term Capacity Planning Information [submitted by transmission planning]	X				
G.11	Performance Adequacy Assessments (financial Studies)	X	X	X	X	
G.12	Generator Planning Study [distributed to committee members]	X	O	O	O	
G.13	Supplemental Agreement (Forecast Obligation) [distributed to committee members]	X	O	O	O	
G.14	LAS Report [submitted to Reliability Committee]	X	O			
G.15	GORP Reports [distributed to generation planning]	X	O			
Key: X - Required Service O - Optional Service 1 - Mandatory For All Generation Within the PJM RTO 2 - Mandatory For Unit Specific Generation Bidding 3 - Mandatory For All Capacity Resources 4 - System Reliability Information Only 5 - Mandatory For Joint-Owned Unit Owners 6 - Mandatory If Not Attainable From Existing Telemetry 7 - Mandatory For Generators Offering Regulation						

Exhibit 9: Long-term Planning Services



<b>H: PJM Administration Services</b>						
	<b>Information Services</b>	<b>PJM Member Regional Transmission Owner</b>	<b>PJM Member Generating Entity</b>	<b>PJM Member Load Serving Entity</b>	<b>PJM Member-Marketer</b>	<b>Neighboring Control Areas</b>
	<b>Outputs from PJM</b>					
H.1	PJM Information [on PJM Web site]	X	X	X	X	X
H.2	MAAC Information [on PJM Web site]	X	X	X	X	X
H.3	FERC Filings [on PJM Web site]	X	X	X	X	X
H.4	Training Information [on PJM Web site]	X	X	X	X	X
H.5	Emergency Information [on PJM Web site]	X	X	X	X	X
H.6	General Administration Information [distributed via fax to all participants]	X	X	X	X	X
H.7	Regulatory Reporting (FERC 714, 715; EIA 411)	X	X	X	X	
Key: X - Required Service O - Optional Service 1 - Mandatory For All Generation Within the PJM RTO 2 - Mandatory For Unit Specific Generation Bidding 3 - Mandatory For All Capacity Resources 4 - System Reliability Information Only 5 - Mandatory For Joint-Owned Unit Owners 6 - Mandatory If Not Attainable From Existing Telemetry 7 - Mandatory For Generators Offering Regulation						

*Exhibit 10: PJM Administration Services*

## Attachment B: Schedule of Data Submittals

In order for PJM to provide satisfactory evidence to demonstrate compliance, PJM members are required to provide the following information to PJM on a frequency noted below. PJM will publish annual calendar and reporting methods:

- Self-certification of tie line meter accuracy. Submittal to be provided via secure website. Ref: BAL-005, R17; TOP-006, R6 (Annual)
- Self-certification of UFLS data (similar to current process for annual request of information). Submittal to be provided via secure website. Ref: EOP-003, R2 (Annual)
- Self-certification of how each TO plans to implement load reduction in sufficient time and amount if directed by PJM. Submittal to be provided via secure website. Ref: EOP-008, R3 (Annual)
- Assurance that their personnel have been trained annually in the implementation of the training plan and that they have participated in restoration exercises with auditable records that could be obtained upon request by PJM. Assurance could be made by TOs via submittals provided via secure website. Ref: EOP-005, Attachment 1, No. 7 (Annual)
- Submit TO restoration plan via a secure website. Ref: EOP-005, R2 (Annual)
- Certification that telecommunication facilities/equipment that will be utilized during a system restoration (all the way down to that equipment that will be used when communicating with crews and black start units) have been periodically tested and verified that they are in a ready state (i.e. with discrepancies/issues resolved). In addition, TOs must maintain auditable records of such testing. Ref: EOP-005, R5 (Annual)
- TO backup plan and functionality to ensure the continuous submittal of reliability data to ensure monitoring and mitigation of IROL and SOL violations. PJM to verify suitability of the plan. Ref: TOP-008, R1 (One time and as changes are made)
- TO plan to maintain backup capability for monitoring and control of critical substation devices and submittal of a critical facilities list to PJM. Submittal to be provided via secure website. Ref: EOP-008, R1.3 (Annual)
- Coordinate a TO backup test with PJM and provide evidence of its performance. Submittal to be provided via secure website. Ref: EOP-008, R1.5 (Annual)
- Certification to PJM that the TO restoration plan has been reviewed in its entirety and updated appropriately. Such review effort should be noted in plan revision history section. Annual submittal to be provided via secure website. Ref: EOP-008, R1.7 (Annual)

## Attachment C: Notification of Member Company System Outages

1. Members and PJM should provide an email coordination notice 24 business hours in advance of significant system changes *that could affect ICCP data link communications or the data exchange with PJM*.
  - a. Data Set Switches (this does not include database updates, editing data exchange lists, etc. unless they include an outage)
  - b. Significant Software Enhancements
  - c. Communication line outages
  - d. Backup center testing
  - e. Failovers to alternate sites
  - f. ICCP server failovers.
  - g. Network and Firewall maintenance
  - h. RTU outages or changes to RTU data sent to PJM for RTUs connected to Bulk Electric System (BES) facilities.
2. The PJM EMS Networking group will coordinate any technical details, additional support, etc. with the member company.
3. Members providing notification should send it to the following email address ([outage@pjm.com](mailto:outage@pjm.com)). In an emergency, call the PJM Support Center at 610-666-8886 or the Dispatch Supervisor at 610-666-8806.
4. The notification should include:
  - The action being taken by the member company (see 1 above)
  - Planned length *and expected time* of the outage
  - Potential impact to PJM
  - *Member contact information*
5. Member Company System Operator should coordinate final outage with the PJM Dispatch Supervisor (610-666-8806) 15 minutes prior to the event. (PJM will communicate any additional system conditions which would cause the outage to affect system reliability).
6. PJM will notify member companies of PJM initiated outages via an email list at least 24 business hours in advance through a self subscribing alias Exchange list.

**Note:** In order for a Member Company to receive an email alert of a PJM generated outage, the company must have a permanent email address for this purpose. PJM will send outages to that email address, not the address of an individual person, since people can be re-assigned and change responsibilities. Additionally, the member

company must subscribe to the outage list at [pjm-linkoutage@lists.pjm.com](mailto:pjm-linkoutage@lists.pjm.com).

7. PJM will follow-up significant outages with an All Call message 15 minutes prior to the outage.

### **Emergency System Outages and Unscheduled System Outages**

1. Member Company System Operator should immediately notify PJM when an event as occurred to include EMS and State Estimator outages.
2. The member company should attempt to provide input into the expected length of the outage.
3. Member Company should notify PJM when system has returned to normal.
4. The PJM Manual 13, Emergency Operations Section, should be followed for all Emergency System Outages.

### **Outage Tracking**

1. All outages (planned and unplanned) causing link reliability to drop below 99.8% in a 24 hour period will be reported and tracked with a cause code by PJM.
2. In the event that PJM detects a member outage of one hour or greater, PJM will immediately email the appropriate SIS representative in order to alert that representative and facilitate determination of outage details.
3. The following information items will be tracked for outages:
  - a. Company Identifier (3 letter)
  - b. Outage length (in minutes)
  - c. Cause code (see table below):

Code	Description
PTV	PJM Telecom Vendor
MTV	Member Telecom Vendor
PPO	PJM Planned Outage
MPO	Member Company Planned Outage
PUO	PJM Unplanned Outage
MUO	Member Company Unplanned Outage
OTH	Other

**Revision History****Revision 17 (01/01/2010)**

- Corrected section 2.7 from PJM EMS to transmission owner EMS and clarified timing requirement – within 2 hours
- Updated Section 3.2.3 changing 500 kV to 345 kV
- Updated language in section 4.2.4 to include a PJM definition of Directives
- Updated section 5.3.3 – generators (less than 500 kV) can be metered from high side or low side of GSU.
- Updated tables in Attachment A
- Added Attachment C – notification for system outages affecting telecommunications to include EMS and State Estimator outages.

*Correction made January 4, 2010 to fix subsection numbering in section 4.2 and the table of contents.*

**Revision 16 (10/05/2009)**

- Removed Attachment B – Nuclear Protocols – will be contained in M39 to be published 10/1/09
- Added Attachment B – Annual Data Submissions for Transmission Owners
- Added Section 2.7 – Backup Capability Requirements for Transmission Owners
- Updated language in Section 4.2.3 for 3 part communications and use of the term —~~de~~fectives”

**Revision 15 (06/01/2009)**

- PJM has conducted the 2009 annual review and update based on this effective date

**Revision 14 (05/09/2008)**

- 3 part communications guidance
- Annual review and update of complete manual for 2008.

**Revision 13 (05/15/07)****Section 2: Control Center Requirements**

Moved Training and Certification requirements to new Manual M40 Certification and Training Requirements.

**Section 3: Communications & Data Exchange Requirements**

- Provided language related to data communication outages and reporting.
- Provided additional clarity regarding satellite phone requirements.

**Attachment C: PJM System Operator Training Requirements**

Moved to new Manual M40 Certification and Training Requirements

**Attachment D: Continuing Education Hour (CEH) Tracking Process**

Moved to new Manual M40 Certification and Training Requirements.

Introduction trimmed to eliminate redundant information.

List of PJM Manuals exhibit removed, with directions given to PJM Web site where all the manuals can be found.

Section 4: Meter Accuracy Standards permanently moved to the end of the manual.

**Revision 12 (09/13/06)**

Section 2: Control Center Requirements

- Provided additional clarity regarding —Backup Recovery Procedures.”

Attachment C: PJM System Operator Training Requirements

- Added more details to compliance monitoring, levels and process for noncompliance.

Attachment D: Continuing Education Hour (CEH) Tracking Process

- Made revisions to reporting forms.

**Revision 11 (06/19/06)**

Attachment C: PJM System Operator Training Requirements

- Added Training Requirements for Demand Resources providing Ancillary Services.
- Deleted obsolete paragraph on page 79 regarding certification of incumbent system operators.

Section 1 (PJM Systems), Page 8: Removed word —analog”.

**Revision 10 (02/07/06)**

Added Attachment D: Continuing Education Hour (CEH) Tracking

Added provision to maintain PJM System Operator Certification through CEH's to Attachment C.

Miscellaneous minor revisions to correct current naming of Member Training offerings, and references to NERC policies.

Revisions were made on the following pages: 20-22, 27, 39, 54, 57, 62, 69, 80-83, 86-89, 91 and 102-118.

**Revision 09 (9/01/05)**

Added Attachment C: PJM System Operator Training Requirements.

Added Nuclear Power Plant voltage notification.

**Revision 08 (1/01/05)**

Miscellaneous member comments and reflect the retirement of the Back Up Analog Control System.

**Revision 07 (5/15/04)**

Miscellaneous member comments, not incorporated in Revision 6

Updated PJM List of Manuals

**Revision 06 (3/31/04)**

Added descriptions of the Generation Management System (GMS), the Process Control Test (PCT) System, the Back-Up Control Center (BUCC) System, the PJM SCADA System, the OSI PI Data Historian System and clarified member obligations for ICCP communications including data integrity requirements and transmission monitoring requirements.

**Revision 05 (12/31/03)**

Added Attachment B: Nuclear Plant Communications Protocol, December 17, 2003

**Revision 04 (05/01/03)**

Revised Section 3: Communications & Data Exchange Requirements. Updated to include satellite phone requirements for generation operator control centers.

**Revision 03 (04/04/03)**

Complete revision of manual to reflect PJM Standards and Systems.

**Revision 02 (12/31/00)**

Removed Attachment A: Definitions and Abbreviations. Attachment A is being developed into a new PJM Manual for [Definitions and Acronyms \(M35\)](#).

**Revision 01 (04/01/98)**

Attachment B: Information Access Matrix

*Exhibit B.7: Grid Accounting Services revised to change "Market Clearing Price" to "Locational Marginal Price."*

**Revision 00 (07/30/97)**

This revision is the preliminary draft of the PJM Manual for *Control Center Requirements*.