

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

In Reply Refer To:
Office of Enforcement
Docket No. PA19-2-000
September 1, 2022

PJM Interconnection, L.L.C.
Christopher C. O'Hara
Senior Vice President, General Counsel, Secretary, and
Chief Compliance Officer
2750 Monroe Blvd.
Audubon, PA 19403

Dear Mr. O'Hara:

1. The Division of Audits and Accounting (DAA) within the Office of Enforcement of the Federal Energy Regulatory Commission (Commission or FERC) has completed an audit of PJM Interconnection, L.L.C. (PJM). The audit covered the period January 1, 2016 through May 31, 2021.
2. The audit evaluated PJM's compliance with: (1) provisions of its Open Access Transmission Tariff, business practices, corporate bylaws, policies, and codes of conduct relating to its market administration obligations; (2) provisions of selected rate schedules and agreements, including PJM's Amended and Restated Operating Agreement; and (3) Order Nos. 825, 831, and other relevant Commission orders. The enclosed audit report contains one finding of noncompliance and three recommendations. The audit report also contains four other matters with 17 recommendations.
3. On August 23, 2022, PJM notified DAA that PJM does not intend to contest the finding of noncompliance and corresponding recommendations. A verbatim copy of PJM's response is included as Section VI to this report. I hereby approve the audit report.
4. PJM should submit its implementation plan to comply with the recommendations within 30 days of the issuance of this delegated letter order. PJM should make quarterly submissions to DAA describing the progress made to comply with the recommendations, including the completion date for each corrective action. As directed by the audit report, these submissions should be made no later than 30 days after the end of each calendar

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quarter, beginning with the first quarter after this audit report is issued, and continuing until all the corrective actions are completed.

5. The Commission delegated the authority to act on this matter to the Director of OE under 18 C.F.R. § 375.311. This delegated order constitutes final agency action. PJM may file a request for rehearing of this order with the Commission within 30 days of the date of this order under 18 C.F.R. § 385.713.

6. This order is without prejudice to the Commission's right to require hereafter any adjustments it may consider proper based on additional information that may come to its attention. In addition, any instance of noncompliance not addressed herein or that may occur in the future may also be subject to investigation and appropriate remedies.

7. I appreciate the courtesies extended to the auditors. If you have any questions, please contact Mr. Gerald Williams, Director and Chief Accountant, Division of Audits and Accounting, at (202) 502-8277.

Sincerely,

Janel
Burdick

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Burdick
Date: 2022.09.01
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Janel Burdick
Director
Office of Enforcement

Enclosure



Federal Energy Regulatory Commission
Office of Enforcement
Division of Audits and Accounting

AUDIT REPORT

Audit of PJM Interconnection, L.L.C.'s
Compliance with:

- Provisions of its Open Access Transmission Tariff, Business Practices, Corporate Bylaws, Policies, and Codes of Conduct Relating to its Market Administration Obligations;
- Provisions of Selected Rate Schedules and Agreements, including PJM's Amended and Restated Operating Agreement; and
- Order Nos. 825, 831, and Other Relevant Commission Orders.

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I. Executive Summary

A. Overview

The Division of Audits and Accounting (DAA) within the Office of Enforcement of the Federal Energy Regulatory Commission (Commission or FERC) has completed an audit of PJM Interconnection, L.L.C. (PJM). The audit evaluated PJM's compliance with: (1) provisions of its Open Access Transmission Tariff (OATT), business practices, corporate bylaws, policies, and codes of conduct relating to its market administration obligations; (2) provisions of selected rate schedules and agreements, including PJM's Amended and Restated Operating Agreement (Operating Agreement); and (3) Order Nos. 825,¹ 831,² and other relevant Commission orders. The audit covered the period of January 1, 2016 through May 31, 2021.

B. PJM Interconnection, L.L.C.

PJM, founded in 1927, is a regional transmission operator (RTO) responsible for the reliable operation of the high-voltage electric transmission system for a control area covering all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia. PJM's transmission grid includes over 84,236 miles of transmission lines, 185,000 MW of generation capacity, summer peak demand of about 149,000 MW, and annual billings of over \$39 billion.

PJM was approved by the Commission as the nation's first fully functioning independent system operator (ISO) in 1997 and became the first fully functioning RTO in 2002. PJM is governed by a ten-member Board of Managers (Board) whose President is responsible for managing PJM's day-to-day operations. The Board oversees PJM's management, selects officers, adopts budgets, approves the regional transmission plan, and performs other functions. Board members are appointed by the Members Committee, a stakeholder committee that provides advice and recommendations to the Board and votes on changes and new programs.

PJM has 1,087 members, which include electric distribution companies, end-use customers, transmission and generation owners, other suppliers, public power companies,

¹ *Settlement Intervals and Shortage Pricing in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Order No. 825, 155 FERC ¶ 61,276 (2016) (Order No. 825).

² *Offer Caps in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Order No. 831, 157 FERC ¶ 61,115 (2016), *order on reh'g*, Order No. 831-A, 161 FERC ¶ 61,156 (2017) (Order No. 831).

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state agencies, and environmental parties. The Board works with these stakeholders in the operation and design of PJM's functions. PJM's principal governing documents include its OATT, which contains rules governing the operation of PJM's energy, capacity, and ancillary services markets, generator interconnection, credit requirements, and other matters, and its Operating Agreement, which defines the roles and responsibilities of the PJM Board, Members Committee, and Office of the Interconnection (PJM management and staff) and contains provisions governing PJM's operations as an RTO.

C. Summary of Compliance Findings

Audit staff identified one area of noncompliance, summarized below. Section IV of this report contains a detailed discussion of this finding.

1. *Offer Capping of Generation Resources* – PJM did not offer cap a self-scheduled generation resource in the Day-ahead energy market for 18 hours on January 21, 2019 despite the fact that its owner had failed the Three Pivotal Supplier (TPS) test. The error was caused by operators applying outdated provisions of PJM's OATT and not applying the updated offer capping provisions in effect since November 1, 2017, along with a lack of written procedures and operator instructions. PJM's application of the outdated provisions may have resulted in additional self-scheduled resources not being appropriately offer capped since November 1, 2017 when the new OATT provisions went into effect.

D. Summary of Other Matters

Audit staff identified four other matters, summarized below. Section V of this report contains a detailed discussion of the other matters.

1. *Order No. 760 Reporting* – PJM should consider improving its data reporting under Order No. 760 by strengthening policies and procedures, devoting additional resources, and enhancing its internal data gathering and reporting processes.
2. *Day-ahead Resource Commitment* – PJM should consider increasing transparency, regarding whether Day-ahead resource commitments

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minimize overall system production costs as required by OATT Attachment K-Appendix, Section 6.4.

3. *Incentives to Follow Dispatch* – PJM should consider strengthening internal procedures to encourage generation resources to follow dispatch instructions.
4. *Software Issues* – PJM should consider improving limitations in certain software applications to ensure accuracy of results.

Recommendations

Findings

DAA's recommendations to remedy this report's one finding of noncompliance are listed below and repeated after the finding in Section IV:

Offer Capping of Generation Resources

1. Develop written procedures, controls, and instructions for operators to ensure that the resources of all generation suppliers, including self-scheduled units, that fail the TPS test are offer capped and committed on the offer schedule recommended by Portfolio Ownership and Bid Evaluation (PROBE).³
2. Provide training to PJM staff on procedures for offer capping resources and periodic refresher training, as needed.
3. Perform a study to confirm whether the resources of all generation suppliers that failed the TPS test were offer capped and committed on the offer schedule recommended by PROBE since PJM implemented its software change in May 2019. Provide the results to audit staff within 90 days of the date of issuance of this audit report.

³ PJM's PROBE application performs the TPS test in the Day-ahead energy market.

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Other Matters

DAA recommends that PJM consider:

Order No. 760 Reporting

4. Documenting all changes made in Order No. 760 data and tables and provide such documentation to Commission staff in a timely fashion as required by Order No. 760 to support and ensure timely submission of data.
5. Strengthening PJM's quality assurance procedures, regularly perform queries of all Order No. 760 tables, and train relevant PJM staff in these revised policies and procedures as needed, so as to ensure that the reported data are consistent and complete, including all necessary definitions and descriptors, with data used in PJM's market and settlement systems.
6. Before and after each data model release, performing additional queries to identify any discrepancies in the data and notify OE/DAS staff of any discrepancies found.
7. Engaging with third party vendors on data documentation to ensure timely and accurate releases of data documentation and model data.
8. Engaging with Commission staff to identify ways to improve reporting of data required by Order No. 760.
9. Reviewing and reforming Order No. 760 compliance according to the PJM compliance commitment document.
10. Devoting additional resources and management support as needed to implement the above recommendations and ensure accurate and timely reporting of Order No. 760 data to Commission staff.

Day-ahead Resource Commitment

11. Ensuring that the definition of overall system production cost is identified in its Manuals and is consistently applied in its implementation of the OATT.
12. Establishing procedures to periodically verify whether software applications used in Day-ahead energy market clearing are committing resources on offer schedules that minimize overall system production costs

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when software application updates affect the calculation of overall system production cost.

13. Examine Day-ahead Energy Market practices to identify opportunities to enhance the accuracy and redetermination of resettlement calculations up to the two-year resettlement period, as stated in the tariff.

Incentives to Follow Dispatch

14. Improving internal procedures for determining whether resources are following dispatch for the purpose of calculating uplift credits in conjunction with the ongoing stakeholder process.
15. Improving internal procedures for implementing Balancing Operating Reserve (BOR) credits to increase incentives for resources to follow dispatch instructions in conjunction with the ongoing stakeholder process.
16. Developing formal written procedures, operator instructions, and training on the release of units not following dispatch to their Market Participants in conjunction with the ongoing stakeholder process.

Software Issues

17. Establishing procedures and controls to perform regular evaluations of the RSC and SPD software applications to ensure that they are functioning as intended.
18. Verifying that PJM's IT SCED software offer caps self-scheduled combustion turbines that fail the TPS test, since such resources have been subject to offer capping since November 1, 2017.
19. Establishing procedures and controls to ensure that, whenever the resources of a generation supplier both fail the TPS test and are offer capped in the Day-ahead and Real-time energy markets, PJM operators identify and properly log those resources as having failed the TPS test regardless of the resource's initial offer type or operating status.
20. Authorizing the software vendor to enhance PJM's RSC application to include Up-to-Congestion transactions in the Day-ahead commitment process.

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E. Compliance and Implementation of Recommendations

Audit staff further recommends that PJM submit the following for audit staff's review:

- A plan for implementing the audit recommendations within 30 days after the audit report is issued in this docket;
- Quarterly reports to DAA describing PJM's progress in completing each corrective action recommended in the audit report. These quarterly nonpublic submissions should be made no later than 30 days after the end of each calendar quarter, beginning with the first quarter after the audit report in this docket is issued, and continuing until completion of all recommended corrective actions; and
- Copies of any written policies and procedures developed in response to the recommendations in this audit report. These documents should be submitted for audit staff's review in the first quarterly filing after PJM completes such written policy or procedure.

II. Background

A. Energy, Capacity, and Ancillary Services Markets

PJM operates competitive wholesale markets that facilitate the purchase and sale of electrical energy, capacity, ancillary services, and other products needed to operate its transmission system.⁴ These markets include:

- *Day-ahead Energy Market:* The Day-ahead energy market balances bids for demand and offers to supply energy the next day (i.e., operating day). Supply offers consist of an economic component, which includes price-megawatt pairs, start-up costs, and no-load costs, and operating parameters, which include notification time, startup time, and minimum run time. All market sellers must submit in Markets Gateway at least one cost-based schedule whose fuel costs are based on an approved fuel cost policy and whose parameters conform to the unit specific parameters for the generator's technology, unless the seller has received an adjustment or exception.⁵ Market sellers of market-based units must also submit a market-based parameter limited schedule and have the option of submitting a market-based, non-parameter limited schedule. Bids and offers for the Day-ahead energy market are submitted by 11:00 AM each day, and results are available by 1:30 PM.⁶ The marginal resource for each appropriate clock hour sets the locational marginal price (LMP), which consists of the system energy price, congestion price, and marginal losses.⁷ All cleared bids and offers in the

⁴ The Day-ahead energy market is defined as the schedule of commitments for the purchase or sale of energy and payment of Transmission Congestion Charges developed as a result of the offers and specifications submitted in accordance with OATT Attachment K-Appendix, Section 1.10. The Real-time energy market is defined as the purchase or sale of energy and payment of Transmission Congestion Charges for quantity deviations from the Day-ahead energy market in the Operating Day.

⁵ Markets Gateway is a tool that allows members to submit demand bids, supply offers, and other information to PJM and obtain data needed to conduct business in the Day-ahead, regulation, and synchronized reserve markets.

⁶ All times are eastern prevailing time.

⁷ LMP is the marginal price of energy at the location where the energy is delivered or received, including energy costs, congestion, and losses (see PJM Manual 11, Section 2.2).

Day-ahead energy market are financially binding, and any deviations are settled in the Real-time energy market.

- *Real-time Energy Market:* The Real-time energy market is a spot market that balances supply and demand in real time based on actual system conditions. Prices are calculated every five minutes, and market sellers are paid the Real-time LMP for any generation that exceeds the Day-ahead scheduled amount. PJM sends resources an electronic dispatch instruction indicating the amount of MWs desired. If a supplier is committed to run by PJM, it may receive operating reserve (uplift) credits to compensate for any difference between its energy, start up, and no-load costs and revenues received from the energy markets.⁸ If a supplier does not follow dispatch, it may incur deviation charges based on the difference between its output and the MWs desired by PJM.
- *Ancillary Services Markets:* PJM operates ancillary services markets needed to balance the transmission system and deliver energy from generation resources to consumers. PJM procures several types of generation reserves from resources not fully loaded that can be quickly available in case of an unexpected loss of generation. The regulation market corrects for short-term changes in electricity use to maintain the stability of the power system and keep the area control error within acceptable bounds.⁹
- *Capacity Market:* PJM's capacity market construct, the Reliability Pricing Model, ensures enough capacity is available to meet peak demand in future delivery years. The main auction, the Base Residual Auction, procures capacity for three years in the future. PJM also utilizes three Incremental Auctions to procure capacity closer to the delivery year. Generation resources clearing the auction are required to offer energy in the Day-ahead energy market during the year committed and to meet PJM's needs during emergency conditions.

B. Market Power Mitigation

PJM uses a TPS test to identify and mitigate local market power, which exists when a generation supplier has the potential to profitably raise the LMP of energy for a

⁸ No-load cost is the hourly fixed cost (or price), expressed in \$/hour, to run the generating unit at zero net output, and it may include hourly no-load cost and other fixed costs.

⁹ Area control error is the difference between scheduled and actual electrical generation, accounting for variations in the system frequency.

sustained period when transmission capacity is constrained, regardless of whether it exercises this power. The TPS test measures the amount of supply available from the two largest suppliers and the supplier tested to meet demand and relieve the constraint.¹⁰ If there is not enough supply from other suppliers to satisfy the constraint, the two largest suppliers and the supplier tested fail the TPS test because they are considered to have local market power. In accordance with OATT Attachment K-Appendix, Section 6.4.1, and the parallel provisions of PJM's Operating Agreement, generation suppliers that fail the TPS test have their resources capped at the price- or cost-based offer schedule that results in the lowest overall system production cost in the Day-ahead energy market and in the lowest dispatch cost in the Real-time energy market.¹¹ While the identification process is applied to all available resources, offer capping is applied on a generation supplier basis, rather than on a resource-by-resource basis.¹²

C. Generator Operating Parameters

In addition to economic offers, market sellers include physical parameters in their offers that reflect the physical operating characteristics of their generation resources. OATT Attachment K-Appendix, Section 6.6(c), requires generation capacity resources to meet eight unit-specific minimum operating parameters posted on PJM's web site. The parameters vary depending on the unit's technology (e.g., AERO CT units, Frame CT units, combined cycle units).¹³ Capacity market sellers that do not believe their resources

¹⁰ PJM's PROBE application performs the TPS test in the Day-ahead energy market, and PJM's Intermediate Term Security Constrained Economic Dispatch application performs the TPS test in the Real-time energy market.

¹¹ All subsequent references to the PJM OATT also refer to the parallel provisions of the Operating Agreement.

¹² OATT Attachment K-Appendix, Section 6.4.1(f)(iii) states that, for the purpose of conducting the TPS test, offer price caps will apply on a generation supplier basis (i.e., not a generating unit by generating unit basis), and only the generation suppliers that fail the TPS test with respect to any hour in the relevant period will have their units that are dispatched with respect to the constraint offer capped. A generation supplier for the purposes of this section includes corporate affiliates.

¹³ These parameters are minimum down time, minimum run time, maximum daily and weekly starts, hot/warm/cold start up times, notification times, turn down ratio, and maximum run time. The current parameters, which were last updated in 2015, are available at: <https://www.pjm.com/-/media/committees->

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can meet their unit-specific minimum operating parameters due to actual physical operating limitations, contractual limitations, or other actual physical constraints,¹⁴ may request a permanent adjustment or exception to one or more minimum operating parameters pursuant to OATT Attachment K-Appendix, Sections 6.6(b) and (h).¹⁵

Requests for adjustments of these parameters and periodic or persistent exceptions (see the explanation in the preceding footnote) are due by February 28th for the upcoming June 1 through May 31 delivery year. Temporary exceptions are deemed automatically accepted upon written notice to PJM and Monitoring Analytics, Inc., PJM's Independent Market Monitor (IMM), at least one business day prior, but can be denied if PJM subsequently determines the request is not supported by actual physical limitations. Market sellers must submit technical data supporting their request to PJM and the IMM, which consult in deciding whether to approve the request.

D. Uplift

Uplift refers to out-of-market payments to generation and demand response resources to compensate for costs not recovered from the Day-ahead and Real-time energy markets. PJM's OATT provides six types of uplift payments,¹⁶ including:

- *Day-ahead Operating Reserve (DAOR) Credits:* Pursuant to OATT Attachment K-Appendix, Section 3.2.3(a) and (b), DAOR credits are paid to pool-scheduled generation resources capable of providing Operating Reserves if their total offered price (including start-up and no-load costs) exceeds revenues from the Day-ahead market.

groups/committees/elc/postings/20150612-june-2015-capacity-performance-parameter-limitations-informational-posting.ashx?la=en.

¹⁴ Section 6.6(c) further requires that the contractual or other actual constraint cannot be simply an economic decision but must be a physical restriction that could not be rectified among any commercial alternatives actually available to the generator.

¹⁵ There are three types of exceptions: (1) Temporary Exceptions, which last 30 days or less during the delivery year; (2) Period Exceptions, which range from 31 days to no more than one year during the delivery year; and (3) Persistent Exceptions, which last for at least one year but are not a permanent adjustment to the unit's parameters.

¹⁶ The three other types of uplift payments are reactive service credits, synchronous condensing credits, and black start services credits.

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- *Balancing Operating Reserve Credits*: Pursuant to OATT Attachment K-Appendix, Section 3.2.3(e), BOR credits are calculated for all synchronized pool-scheduled resources that operate as requested by PJM in the Real-time market. The credits are based on the difference between the resource's revenues (including revenues earned in the Day-ahead energy, balancing, and reserve markets, plus reactive service and DAOR credits) and its real-time costs (including energy offer, start-up, and no-load costs).
- *Lost Opportunity Cost (LOC) Credits*: LOC credits are an incentive for units to follow PJM's dispatch instructions when those instructions deviate from the unit's desired or scheduled output. Pursuant to OATT Attachment K-Appendix, sections 3.2.3(f-1)(i) and (ii), LOC credits are paid to: (1) combustion turbines and diesel engine generators scheduled to operate in the Day-ahead energy market that are not called on to operate in the Real-time market, to the extent that the resources are Flexible Resources;¹⁷ and (2) resources that reduce output in the Real-time market at PJM's direction where the Real-time LMP at the generator bus is higher than the price the unit offered for that level of output.

E. Credit Requirements

Attachment Q of PJM's OATT contains rules intended to ensure that market participants have credit sufficient to support their transactions in PJM's markets and thereby minimize the risk of default. Included are eligibility requirements for participating in PJM's markets; requirements concerning the amount of credit that market participants must maintain based on their exposure in PJM's markets; special credit requirements for virtual transactions, financial transmission rights (FTRs), coordinated transactions, exports, and capacity obligations; requirements for review and verification of risk management policies; minimum financial requirements that must be supported by tangible assets or net worth; and provisions to request an unsecured credit allowance to increase the amount a market participant can transact in PJM's markets.

¹⁷ Flexible Resource is defined as "a generating resource that must have a combined Start-up Time and Notification Time of less than or equal to two hours; and a Minimum Run Time of less than or equal to two hours." PJM OATT, Definitions E – F. Also, "Market Sellers of Flexible Resources that submit a Real-time Offer greater than their resource's Committed Offer in the Day-ahead Energy Market shall not be eligible to receive compensation for lost opportunity costs under any applicable provisions of Schedule 1 of this Agreement." PJM OATT, Attachment K – Appendix, section 3.2.3A(f-1).

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PJM extensively modified its credit risk evaluation requirements in June 2020 in response to a market participant's default on a large portfolio of FTRs in 2018.¹⁸ The modifications require PJM to conduct annual (and periodic) credit reviews to determine the continued eligibility of all market participants to participate in PJM's markets. Credit reviews are required for new market participants and quarterly for all existing market participants. After a two-year transition period, during which equivalent financial statements are accepted, market participants must submit audited financial statements, which PJM will use to determine their minimum capital requirements. Failure to meet these requirements will result in additional collateral or additional restricted collateral requirements, and even higher levels of restricted collateral may be required if PJM's credit department determines that the market participant presents an unreasonable credit risk. In addition, all existing and new market participants must submit officer certificates and risk management policies for review by PJM staff.

F. Generation Interconnection

The generation interconnection process evaluates the potential impacts of connecting generation resources to the PJM system and develops contractual agreements governing the operational and cost responsibilities of PJM and the generators. The interconnection queue also establishes the order in which generation resources are selected to connect to the PJM system. In Order No. 2003, the Commission established uniform processes and procedures for the interconnection of large merchant generators greater than 20 MW in capacity.¹⁹

PJM's interconnection queue has seven stages: (1) Application Received, (2) Feasibility Study, (3) Impact Study, (4) Facilities Study, (5) Final Agreement, (6) Construction of Facilities, and (7) In Service. The interconnection process and Feasibility Study procedures are detailed in OATT Section IV, Subpart A, Section 36, while Subpart A, Sections 205-207 contain procedures for performing System Impact and Facilities Studies. PJM has two interconnection queues each year; applications for the first are due by September 30 and for the second by March 31. For the September 30 queue, PJM's goal is to initiate Interconnection Feasibility Studies by November 1 and

¹⁸ See *PJM Interconnection, LLC*, 171 FERC ¶ 61,173 (2020).

¹⁹ *Standardization of Generator Interconnection Agreements and Procedures*, Order No. 2003, 104 FERC ¶ 61,103 (2003), *order on reh'g*, Order No. 2003-A, 106 FERC ¶ 61,220, *order on reh'g*, Order No. 2003-B, 109 FERC ¶ 61,287 (2004), *order on reh'g*, Order No. 2003-C, 111 FERC ¶ 61,401 (2005), *aff'd sub nom. Nat'l Ass'n of Regulatory Util. Comm'rs v. FERC*, 475 F.3d 1277 (D.C. Cir. 2007), *cert. denied*, 552 U.S. 1230 (2008).

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complete them by January 31. For the March 31 queue, PJM seeks to initiate Feasibility Studies by May 1 and complete them by July 31. If PJM cannot complete Feasibility Studies on time, the OATT requires it to notify the interconnection customer and affected Transmission Owner and provide an estimated completion date and the reasons additional time is needed.

G. Verification of Incremental Energy Offers

Order No. 831, issued in November 2016, requires RTO/ISOs to cap each resource's incremental energy offer at the higher of \$1,000/MWh or the resource's verified cost-based incremental energy offer, and to cap verified cost-based incremental offers at \$2,000/MWh when calculating LMP.²⁰ Grid operators must also verify the costs underlying cost-based incremental energy offers above \$1,000/MWh to ensure they reflect actual or expected costs. PJM submitted compliance filings in May and December 2017 and implemented tariff changes to comply with Order No. 831 in April 2018.

OATT Attachment K-Appendix, Section 6.4.3, details PJM's procedures for verifying the incremental energy component of cost-based offers over \$1,000/MWh. PJM automatically screens any incremental energy offer over \$1,000/MWh against the maximum allowable cost as defined by Section 6.4.3 of Schedule 1 of the OATT, using cost inputs provided by the Market Seller in Member Information Reporting Application (MIRA) and other systems, to determine whether the offer segment exceeds the reasonably expected costs of the generation resource. An incremental energy offer less than or equal to the generator's expected costs is considered a verified offer and is eligible to set LMP provided it does not exceed \$2,000/MWh. However, an incremental energy offer that exceeds the generator's expected costs is deemed unverified and is capped at \$1,000/MWh or the offer price of the most expensive verified offer. Market sellers whose offers are automatically determined to be unverified may submit an exception request with appropriate supporting documentation for further review. One market seller submitted multiple offers over \$1,000/MWh in April 2018, and numerous market sellers submitted offers over \$1,000/MWh and \$2,000/MWh during the cold weather events of February 2021. PJM did not dispatch any offer over \$1,000/MWh during the audit period, and therefore none of the submitted offers over \$1,000/MWh set the LMP. PJM also did not approve any offer over \$2,000/MWh.

²⁰ *Offer Caps in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Order No. 831, 157 FERC ¶ 61,115 (2016), *order on reh'g*, Order No. 831-A, 161 FERC ¶ 61,156 (2017) (Order No. 831).

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H. Electronic Delivery of Information to the Commission

In Order No. 760, the Commission directed RTO/ISOs under its jurisdiction to provide ongoing electronic delivery to the Commission of a range of non-public data relating to the markets they administer.²¹ Order No. 760 specifically required transmission of data relating to physical and virtual offers and bids for energy and ancillary services, energy/ancillary service awards, resource outputs, marginal cost estimates, shift factor data relating to active or binding constraints, financial transmission rights, internal bilateral contracts, uplift charges and credits, and interchange pricing. The Commission expected ongoing electronic delivery of the data to facilitate development and evaluation of its policies and regulations, enhance efforts to detect anti-competitive or manipulative behavior or ineffective market rules, help ensure just and reasonable rates, and lessen the need for ad hoc data requests to obtain information needed to meet its statutory responsibilities, thereby reducing administrative burdens on RTO/ISOs.

Order No. 760 implemented a timetable for the ongoing electronic delivery of the data. Initially, "to allow the Commission to stay abreast of any change in how data described in this final rule is collected," RTO/ISOs are required to notify the Commission in writing of such upcoming change "90 days prior to such a change or as soon as practicable once such a change is known."²² Ultimately, RTO/ISOs are to electronically deliver data to the Commission within seven days after each RTO and ISO creates the datasets in a market run or other procedure."²³ In between these two dates, the transmission of documentation "no later than 30 days prior to the first day of the ongoing delivery for each dataset"²⁴ provides a key milestone, "given that correctly interpreting and understanding the data is a prerequisite to any analytic effort."²⁵

²¹ *Enhancement of Electricity Market Surveillance and Analysis through Ongoing Electronic Delivery of Data from Regional Transmission Organizations and Independent System Operators*, Order No. 760, 139 FERC ¶ 61,053 (2012).

²² Order No. 760, at P 44.

²³ Order No. 760, at P 78.

²⁴ Order No. 760, at P 43.

²⁵ *Id.*

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I. Joint Operating Agreement Between PJM and NYISO

PJM has interconnecting transmission facilities with the New York Independent System Operator, Inc. (NYISO) over which substantial volumes of energy flow between the two operators' regions. To manage these flows, in May 2007, PJM and NYISO executed a Joint Operating Agreement (JOA) establishing uniform protocols and procedures for operating their interconnected transmission facilities. NYISO was designated as filer of the JOA, which is contained in Section 35 of the NYISO OATT, Attachment CC, Joint Operating Agreement Among and Between New York Independent System Operator, Inc. and PJM Interconnection, L.L.C.²⁶ Key provisions include:

- *Shared Benefits:* A coordination committee administers all JOA requirements and ensures that PJM and NYISO operate their interconnection facilities to the benefit of both parties. PJM and NYISO agreed not to charge each other for mutually beneficial services resulting from interconnection, such as transient and steady-state support. The parties also agreed to remain interconnected through the term of the agreement except during force majeure events or planned maintenance where notice is provided in accordance with outage procedures implemented by the coordination committee. The committee also assists PJM and NYISO in following their respective tariffs and operating agreements and develops operating instructions regarding operation of the interconnected facilities.
- *Interconnecting Reliability Operating Limit:* PJM and NYISO share an Interconnecting Reliability Operating Limit (IROL) which, if exceeded, could create instability. The IROL covers all AC and DC ties between PJM and NYISO and has a 3,600 MW limit that is utilized for mutual coordination. This limit was not exceeded during the audit period.
- *Outage Coordination:* PJM and NYISO jointly develop procedures for coordinating transmission and generation outages to maintain system reliability. They also work to resolve any outage conflicts and monitor the impacts of planned or unplanned outages on each other's systems. PJM and NYISO also follow uniform procedures for use of voltage control equipment to maintain a reliable bulk transmission system, and exchange information needed by each other.
- *Market-to-Market Coordination:* PJM and NYISO manage congestion on their interconnected facilities using the market-to-market congestion coordination procedures specified in the Market-to-Market Coordination Schedule attached to

²⁶ The JOA, designated as PJM Rate Schedule No. 45, is available on PJM's web site at: <https://www.pjm.com/~media/documents/agreements/nyiso-joa.ashx>.

the JOA. The procedures allow transmission constraints impacted by generation dispatch changes in the NYISO and PJM markets, or by operation of the phase angle regulators between New York and New Jersey, to be jointly managed in the real-time security-constrained economic dispatch models of both parties. When congestion occurs on a flowgate, the party responsible for the flowgate is expected to initiate re-dispatch to utilize more cost-effective generation in the two markets to manage the congestion. At such times, Coordinated Transaction Scheduling (CTS) rules are implemented which allow transactions to be scheduled based on a bidder's willingness to purchase energy in either the PJM or NYISO Control Area and sell it in the other Control Area. Under the JOA, PJM provides data and information to NYISO to support CTS transactions, and NYISO determines, monitors, and reviews the transactions.

- *Revenue Accounting:* PJM and NYISO have electric metering equipment that measures energy flows across the interconnected facilities at least once each hour for revenue and accounting purposes. Compensation for transmission line losses is determined by the respective standards of PJM and NYISO or as agreed to by the coordination committee.

III. Audit Objectives, Scope, and Methodology

A. Audit Objectives

The audit evaluated PJM's compliance with: (1) provisions of its OATT, business practices, corporate bylaws, policies, and codes of conduct relating to its market administration obligations; (2) provisions of selected rate schedules and agreements, including PJM's Operating Agreement; and (3) Order Nos. 825, 831, and other relevant Commission orders. The audit covered the period from January 1, 2016 through May 31, 2021.

B. Audit Scope and Methodology

Audit staff performed the following actions to facilitate testing and evaluation of PJM's compliance with Commission requirements relevant to audit objectives:

Audit Planning, Processes, and Administration

Audit staff performed these actions to identify the audit risks and to plan the audit field work:

- *Reviewed Public Information* – Conducted an extensive review of public information before commencing the audit. The review provided a basic understanding of PJM's energy market operations, OATT requirements, and key regulatory and business activities. Materials reviewed included PJM annual reports, OATT filings, Commission orders, training and other materials on PJM's website, and other regulatory and media sources.
- *Identified Audit Criteria* – Identified audit criteria including Commission rules, regulations, and other requirements needed to evaluate compliance with audit objectives.
- *Issued Data Requests* – Issued data requests to PJM to collect audit evidence and information. The requested information included corporate organization charts, internal policies, procedures, and controls regarding market operations, corporate compliance and internal audit programs, business practices, training materials, contractual agreements, accounting and reporting activities, regulatory filings, and other pertinent information. The evidence and information were used to test and evaluate compliance with Commission requirements relevant to audit objectives.

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- *Conducted Teleconferences* – Held multiple teleconferences with PJM employees to discuss audit objectives, testing, data request responses, technical and administrative matters, and compliance concerns.
- *Conducted a Site Visit* – Made a site visit to PJM’s headquarters in Audubon, PA to discuss and observe procedures and controls related to audit objectives.
- *Conferred with Subject Matter Experts* – Conferred with Commission staff in other offices to ensure audit findings were consistent with Commission precedent and policy.

Energy Market Operations

The following sections describe actions audit staff performed to evaluate PJM’s compliance with requirements relating to energy market operations:

- *Documented PJM Software Applications* – PJM uses multiple software applications to operate its Day-ahead and Real-time energy markets, including Topper, Resource Scheduling and Commitment (RSC), Scheduling Pricing and Dispatch, Simultaneous Feasibility Test, PROBE, Day-ahead Market Operator Interface, Day-ahead Market Operator Application, Intermediate Term Security Constrained Economic Dispatch (IT SCED), Locational Price Calculator, and Real-time Security Constrained Economic Dispatch (RT SCED). To document the functions, objectives, and data sources of these software applications, and understand how they work together in performing resource commitment, dispatch, and other functions, audit staff:
 - Reviewed the objectives, inputs, outputs, objective functions, constraints modelled, forecast periods, run frequency, and run times of each application, and prepared a spreadsheet detailing key model parameters; and
 - Interviewed PJM staff during the site visit to discuss the operations of each software application and had follow up conference calls to clarify questions encountered in examining and testing the operation of these applications.
- *Test Day-ahead Resource Commitments* – OATT Attachment K-Appendix Section 6.4.1(a), states that if PJM must commit resources out of economic merit order in the Day-ahead energy market due to transmission constraints, the resources must be offer capped and committed on the market-based or cost-based offer schedule that results in the lowest overall system production cost. To test compliance with this requirement, audit staff:

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- Reviewed documentation for a sample of resources committed on market-based offer schedules in the Day-ahead market on January 20-22, 2019, a period of high demand in PJM's region. To determine how PJM's software evaluated offers with inflexible offer parameters, all resources in the sample were committed on market-based offers with 24-hour minimum run times. The documentation included: incremental energy, startup, and no-load costs for the market-based, market-based parameter limited, and cost-based offer schedules PJM evaluated for each resource, standalone production costs (e.g., energy, startup, and no-load costs) for the schedules evaluated, and overall system production costs for the schedules evaluated and committed. Audit staff also reviewed PJM's procedures for verifying its software applications selected the offer schedules that minimized overall system production costs;
- Reviewed data supporting PJM's statement that the objective function and overall system production cost are only available for the final Day-ahead resource commitment of the approved RSC base case, and not for any intermediate solutions examined;
- Discussed alternative methods of verifying that PJM's software selected the resources and offer schedules that minimized overall system production costs, both within the 90-day retention period for the databases used to run the RSC base case, and outside the 90-day retention period;
- Requested that PJM use these alternative methods to test, both within and outside the 90-day retention period, whether it was less expensive to commit selected resources on offer schedules with less restrictive minimum run times than on the offer schedules selected by PJM's software; and
- Discussed situations where, due to transmission constraints, PJM's Day-ahead Market Operator Application may indicate that certain generation units appear economic when not committed, but uneconomic when committed, and how operators respond to such cases.
- *Adjustments and Exceptions to Minimum Operating Parameters* – To evaluate PJM's implementation of the parameter adjustment and exception procedures contained in OATT Attachment K-Appendix, Sections 6.6(b) and 6.6(h), audit staff:
 - Reviewed PJM's procedures for processing exception and adjustment requests, data sources used, and procedures for consulting with the IMM in deciding whether to approve or deny the request;

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- Tested a sample of parameter adjustments that PJM approved during the audit period and: (a) examined whether the requests were submitted by the February 28th deadline for adjustments to become effective in the delivery year beginning June 1; (b) reviewed data PJM considered in evaluating requests; (c) examined how PJM, in consultation with the IMM, determined whether the market seller had demonstrated its request was based on a contractual or other actual constraint as opposed to simply economic considerations; and (d) determined whether PJM met the April 15th deadline for notifying the market seller whether its request was approved or denied;
- Interviewed PJM staff during conference calls to: (i) clarify details of the review process, (ii) understand how PJM treated adjustment requests submitted late, and (iii) discuss the reasons a market seller was not notified on time during the 2018 review;
- Reviewed all exception requests approved, denied, or withdrawn during 2017 and 2018 and queried the appropriate Order No. 760 tables to determine whether market sellers whose requests had been denied or withdrawn had submitted cost-based or market-based parameter limited offer schedules with parameters different from the unit-specific parameters specified for their technology types and, if so, whether PJM had committed such offers; and
- Reviewed an offer submitted with parameters outside the default parameters without an approved exception and reviewed whether PJM had denied the seller's exception request following its submittal and whether PJM had committed the unit.

Market Power Mitigation

Audit staff performed these actions to evaluate PJM's compliance with requirements relating to market power mitigation:

- *Performance of TPS Tests* -- To evaluate PJM's performance of TPS tests and offer capping of resources failing the tests, audit staff:
 - Reviewed PJM's policies and procedures governing performance of the TPS test in the Day-ahead and Real-time energy markets, identified the software and data sources used to perform the tests, and examined how PJM determines the effective MW of incremental supply available to resolve constraints using power distribution factors (DFAX) and other variables;

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- Used Order No. 760 data to select a sample of generation suppliers with potential local market power and reviewed their TPS test and pass/fail scores to determine whether any suppliers with passing TPS test scores (i.e., scores greater than or equal to 1) were indicated as having failed the test and vice versa;
- Reviewed supporting data to understand why a number of suppliers with TPS test scores exactly equal to 1, indicating failure of the TPS test, were indicated as having passed the test; found this issue arose because PJM rounded TPS test scores to one decimal place and reported them as integer values in Order No. 760 tables; repeated the analysis using unrounded TPS test scores provided in data responses;
- Reviewed supporting data to understand why some market sellers with TPS test scores of less than 1, meaning they failed the TPS test, were indicated as having passed the test; reviewed PJM data responses and verified that the suppliers were the two largest suppliers and, in these instances, the third supplier had passed the TPS, indicating there was enough supply from other suppliers to meet the constraint and consequently all three suppliers were deemed to have passed the TPS test; and
- Reviewed supporting data and held discussions with PJM to understand why certain units listed in the spreadsheets that PJM provided to evaluate Day-ahead resource commitments were indicated as having failed the TPS test but were not offer capped; determined these units were located upstream of the constraint (upstream units) and were not offer capped under PJM's procedures.²⁷

Uplift Payments

Audit staff performed these actions to evaluate PJM's compliance with requirements relating to uplift payments:

- *Uplift Payments* – PJM's OATT provides that DAOR credits are paid to pool scheduled resources capable of providing operating reserves, and BOR credits are paid to synchronized pool-scheduled resources that operated as requested by

²⁷ In data responses, PJM stated that OATT Attachment K-Appendix, Section 6.4.1(a), which requires PJM to offer cap resources dispatched out of economic merit order to maintain system reliability, applies only to units located downstream of a constraint where offer caps result in the lowest overall system production cost.

PJM.²⁸ To evaluate compliance with these provisions and test whether DAOR and BOR credits were calculated correctly, audit staff:

- Reviewed PJM's filing in Docket No. ER00-1849-000 establishing OATT Attachment K-Appendix, Section 3.2.3, the Commission's letter order accepting the filing, other Commission orders regarding uplift payments, and the sections of Manual 28, Operating Agreement Accounting, describing the calculation of DAOR, BOR, and LOC credits, and BOR deviation charges;²⁹
- Reviewed PJM's definition of pool-scheduled and self-scheduled units, examined PJM's Markets Gateway Users Guide to understand the values market sellers must designate in their Day-ahead and Real-time offers (e.g., Economic, Must Run, Fixed Gen, ECOMIN, ECOMAX), and issued data requests and interviewed PJM staff to understand how these designations affect eligibility for and calculation of DAOR and BOR credits;
- During the site visit, interviewed employees from PJM Settlements to discuss: (i) procedures for calculating customer billings for energy, uplift, and other services; (ii) data used in the calculations; and (iii) controls to ensure correct calculations, and reviewed a sample of spreadsheets describing the calculations;
- Analyzed Order No. 760 data to determine whether PJM paid DAOR credits to resources offered as Must Run in the Day-ahead energy market or that submitted block-loaded offer schedules (ECOMAX = ECOMIN) and were eligible for DAOR only if PJM committed them for reliability;
- Issued data requests and had conference calls with PJM employees regarding the methods and data sources used to calculate BOR credits, including how PJM Settlements determines the resource's desired MW based on actual MW, Unit Dispatch System basepoint MW, ramp limited desired MW, UDS LMP desired MW, and percent off dispatch, and calculates BOR credits for resources whose actual MW is less than 110 percent of desired MW or greater than 110 percent of desired MW;
- Reviewed the detailed inputs used to calculate BOR credits and examined cases where PJM recalculated BOR credits during the two-year resettlement

²⁸ See PJM OATT, Attachment K-Appendix, Section 3.2.3(a), (b), and (e).

²⁹ *PJM Interconnection, LLC*, 91 FERC ¶ 61,148 (2000).

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window in response to information received from other PJM departments or the IMM, to examine the basis for the recalculations;

- Held several discussions with PJM to understand how PJM operators identify resources not following dispatch, work with them to follow dispatch, and respond to resources not willing or able to follow dispatch, e.g., by requesting the resource to submit an eDART ticket revising its limits, logging the resource as running for company, or releasing the resource to its Market Participant, including how operators log these actions in PJM's Dispatch Management Tool;
- Analyzed data responses listing resources receiving BOR credits for which PJM calculated the deviation MW to determine the percentage of intervals during which their actual MW output was between 110 and 120 percent of desired MW, between 120 and 130 percent, and more than 130 percent of desired MW. Estimated the BOR credits received during intervals when the unit was not following dispatch to compare them with the unit's estimated deviation charges; and
- Reviewed supporting data and documentation regarding the eligibility of solar, wind, and other intermittent resources for BOR credits and examined the calculation of credits for a sample of solar resources.

Credit Requirements

Audit staff performed these actions to evaluate PJM's compliance with requirements relating to credit requirements:

- *Annual Certification and Risk Management Policies* – To evaluate PJM's review of the annual certifications of market participants, audit staff:
 - Reviewed documentation that showed when market participants submitted their annual certification/Officer Certification Forms to identify market participants that did not submit their Officer Certification Forms by the April 30 deadline specified in Attachment Q, or that updated them after April 30;
 - Reviewed how PJM processed late-submitted forms to determine whether the market participants were able to transact in PJM's markets prior to submission and review of the required forms; and

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- Reviewed whether market participants that subsequently changed their status from non-FTR to FTR participant were permitted to transact in the FTR market prior to submission and review of their risk management policies.
- *Verification of Risk Management Policies* – To evaluate PJM’s annual verification of risk management policies required by Attachment Q, audit staff:
 - Reviewed the risk management policies of market participants selected by PJM for an annual audit and tested whether the policies contained the information required by Attachment Q, including but not limited to appropriate training, segregation of duties, and an independent review of activities; and
 - Discussed PJM’s approval of risk management policies that did not appear to contain all required items and reviewed PJM’s rationale for approving them.
- *Review of Collateral and Credit Requirements* – To evaluate PJM’s review of the collateral and credit requirements of market participants, audit staff:
 - Reviewed PJM’s eCredit system to determine whether market participants established and maintained an appropriate level of collateral for each market they transacted in (e.g., FTRs, virtual transactions, export transactions); and
 - Used the eCredit system to compare the credit requirements, market exposures, available credit, credit sources, and unallocated credits for a sample of market participants and requested an explanation regarding market participants whose available credit did not appear adequate to meet their total current exposure. Additionally, audit staff obtained an understanding of PJM’s review process, including the circumstances under which PJM would make collateral calls requiring such market participants to post additional credit.
- *Significant Changes to Attachment Q* – Reviewed the changes PJM made to its Attachment Q in June 2020, including changes to its credit procedures, annual certification procedures, credit verification procedures, and risk management policy reviews to understand the magnitude and impacts of these changes on PJM’s existing credit requirement policies and procedures and whether these changes would enhance PJM’s compliance with FERC regulations prospectively.

Generation Interconnection

Audit staff performed these actions to evaluate PJM’s compliance with requirements relating to generation interconnection:

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- *Interconnection Queue* – To evaluate PJM’s management of the interconnection queue and its performance of Feasibility, System Impact, and Facilities Studies within the timelines specified in the OATT, audit staff:
 - Reviewed OATT requirements regarding generation interconnection, performance of Feasibility, System Impact, and Facilities Studies, and communications with customers regarding the status of their studies;
 - Reviewed PJM’s procedures for managing its interconnection queue, performing studies, and controls to ensure the timely completion of studies;
 - Identified the departments and employees responsible for preparing studies and interviewed managers and staff during the site visit;
 - Reviewed the percentage of studies completed within the timelines prescribed in PJM’s OATT and had conference calls with PJM employees to discuss factors responsible for late studies, including modification or withdrawal of interconnection requests, delays in receiving studies and other information from Transmission Owners, and other factors;
 - Reviewed improvements that PJM implemented to address the causes of late studies, including hiring new staff, reorganization of the Interconnection Projects Department to promote a more consistent workload distribution, earlier performance of Facilities and System Impact Studies, and creation of an internal tool to document analysis results; and
 - Reviewed additional enhancements being explored by PJM and in the Interconnection Process Reform Task Force, including issues and proposals relating to staffing, transparency, queue window scheduling, application process, and other matters.

Joint Operating Agreement with NYISO

Audit staff performed these actions to evaluate PJM’s compliance with requirements relating to its JOA with NYISO:

- Audit staff reviewed PJM’s performance of JOA requirements in the following areas: (1) regional transmission planning; (2) CTS transactions; (3) IROL monitoring; and (4) exchange of data and information.
- *Regional Transmission Planning* – Based on data responses, audit staff determined that PJM and NYISO did not undertake any interregional transmission projects

during the audit period, which audit staff confirmed with DAA's NYISO audit team.

- *CTS Transactions* – Real-time energy market rules allow CTS transactions to be scheduled between the PJM and NYISO control areas based on a bidder's willingness to purchase such energy. Audit staff determined that NYISO is solely responsible for calculating and scheduling CTS transactions, and PJM's only responsibility is to provide data to support NYISO's calculations.
- *IROL Monitoring* – During its examination of the coordination process and through data responses, audit staff found that NYISO has primary responsibility for monitoring the 3,600 MW IROL limit for flows across all transmission ties between PJM and NYISO, and that NYISO maintains an energy management system display showing the actual flow across these facilities, which NYISO communicates to PJM as necessary. Accordingly, audit staff focused its review on PJM's guidelines and procedures for controlling actions to maintain flows below the IROL limit. Also, audit staff requested and reviewed actual flow data to determine whether the IROL limit was exceeded during the audit period.
- *Exchange of Data and Information* – Pursuant to the JOA, PJM and NYISO must regularly exchange substantial amounts of data and information regarding, e.g., their respective energy management systems and models, one-line drawings, equipment ratings, telemetry points, market-to-market flowgate limits and flows, bidding constraint thresholds and shift factors, CTS transactions (including offer types, sources, sinks, and forecasted prices), and CTS interface limits. Audit staff reviewed PJM's procedures for exchanging this data and its controls for ensuring information provided to NYISO received the same confidential treatment as information provided to PJM's members. The controls included procedures for authenticating credentials, firewalls restricting traffic to defined ports and web addresses (URLs), and encryption requirements. Audit staff also inquired whether NYISO had identified any deficiencies in the data and information provided by PJM.

Verification of Incremental Offers (Order No. 831)

Audit staff performed these actions to evaluate PJM's compliance with requirements relating to Order No. 831:

- *Verifying Offers Over \$1,000 per MWh* – To evaluate PJM's compliance with this requirement of Order No. 831, audit staff:

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- Reviewed PJM's procedures for verifying whether offers with incremental energy prices above \$1,000/MWh reflect the market seller's actual or estimated costs – including procedures for reviewing exception templates and supporting data provided by market participants, such as the market seller's approved Fuel Cost Policy, documentation supporting its cost of fuel, fuel transportation costs, and adders, if applicable;
- Reviewed how PJM coordinated its review with the IMM and evaluated cost data entered in the IMM's Member Information Reporting Application database; and
- Examined PJM's review and verification of offers with incremental energy prices over \$1,000/MWh submitted during the audit period. This included reviewing the only offer over \$1,000/MWh prior to the February 2021 cold weather storms; and selecting a sample of the numerous offers over \$1,000/MWh submitted during these weather events. As part of this review, audit staff used Order No. 760 data to identify market sellers that had submitted offers over \$1,000/MWh and then reviewed the market sellers' calculation spreadsheets that PJM provided in data request responses. The review included examining the inputs used in the calculations, testing whether the inputs were consistent in all spreadsheets, requesting an explanation of any exceptions identified, and comparing the energy prices and quantities provided in the exception templates with Order No. 760's required data.

Electronic Delivery of Information to the Commission (Order No. 760)

Audit staff performed these actions to evaluate PJM's compliance with the Commission's Order No. 760 requirements:

- *Compliance Testing and Electronic Delivery of Information* – Evaluation of PJM's electronic delivery of information practices coincided with the compliance testing of PJM's energy markets, market power mitigation practices, payments of uplift to participants, and other scope areas. As part of this review, audit staff used the information contained in the data tables submitted to the Commission under Order No. 760 to evaluate whether information was complete and accurate.

IV. Findings and Recommendations

1. Offer Capping of Generation Resources

PJM did not offer cap a self-scheduled generation resource in the Day-ahead energy market for 18 hours on January 21, 2019, despite the fact that its owner had failed the TPS test. The error was caused by operators applying outdated provisions of PJM's OATT, along with a lack of current written procedures and operator instructions. PJM's application of the outdated provisions may have resulted in additional self-scheduled resources not being appropriately offer capped since November 1, 2017 when the new OATT provisions went into effect.

Pertinent Guidance

- OATT Attachment K-Appendix, section 6.4.1(a) states in relevant part:

If, at any time, it is determined by the Office of the Interconnection in accordance with Sections 1.10.8 or 6.1 of this Schedule that any generation resource may be dispatched out of economic merit order to maintain system reliability as a result of limits on transmission capability, the offer prices for energy from such resource shall be capped as specified below. For such generation resources committed in the Day-ahead Energy Market, if the Office of the Interconnection is able to do so, such offer prices shall be capped for the entire commitment period, and such offer prices will be capped at a cost-based offer in accordance with section 6.4.2 and committed at the market-based offer or cost-based offer which results in the lowest overall system production cost. . . . *Resources that are self-scheduled to run in either the Day-ahead Energy Market or in the Real-time Energy Market are subject to the provisions of this section 6.4.* [Emphasis added.]³⁰

³⁰ The italicized text was proposed by PJM to make self-scheduled resources subject to offer capping and accepted by the Commission, effective November 1, 2017. See *PJM Interconnection, L.L.C.*, 158 FERC ¶ 61,133 (2017). Previously, self-scheduled resources were exempt from offer capping.

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Background

OATT Attachment K-Appendix, Section 6.4.1(a), requires resources taken out of economic merit order due to a transmission constraint to be offer capped and committed on the price- or cost-based offer that minimizes overall system production cost. In evaluating PJM's compliance with this requirement, audit staff found that, on January 21, 2019, PJM committed a self-scheduled resource whose owner had failed the TPS test on its market-based offer for 18 hours despite the fact that PJM's PROBE software had recommended committing the unit on its cheaper cost-based offer.³¹ In data responses, PJM confirmed that PROBE had recommended committing the unit on its cost-based offer, but the Day-ahead operator had disregarded this recommendation. PJM said the operator had acted on an earlier version of its OATT that had exempted self-scheduled units from offer capping, but this requirement had been changed when hourly offers were implemented November 1, 2017.³² Although the resource did not receive uplift or set LMP for intervals, it was not offer capped; failure to offer cap this resource indicates deficiencies in PJM's procedures and controls for mitigating local market power.

After PJM confirmed the error in March 2019, the Day-ahead energy market manager gave a one-time verbal directive informing operators that self-scheduled units were to be offer capped in accordance with OATT Attachment K-Appendix section 6.4.1(a). Furthermore, during this same time, PJM implemented a software change to automatically offer cap units that fail the TPS test. This software change was implemented to further enhance PJM's controls and procedures on offer capping resources that failed the TPS test. By implementing a software change to automatically offer cap resources that fail the TPS test, PJM eliminated the Day-ahead operator's manual process for offer cap resources.

Recommendations

DAA recommends that PJM:

1. Develop written procedures, controls, and instructions for operators to ensure that the resources of all generation suppliers, including self-scheduled units,

³¹ The PROBE software application performs the TPS test and, if the supplier fails the test, determines whether its price- or cost-based offer is cheaper. If PROBE determines that the cost-based offer is cheaper, and the RSC software has committed the resource on a price- or market-based parameter limited schedule offer, PROBE recommends changing the resource's offer to its cost-based offer, and the operator would have to accept the change for its offer to become effective.

³² See *PJM Interconnection, L.L.C.*, 155 FERC ¶ 61,282 (2016).

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that fail the TPS test are offer capped and committed on the offer schedule recommended by PROBE.

2. Provide additional training to PJM staff on procedures for offer capping resources and periodic refresher training as needed.
3. Perform a study to confirm whether the resources of all generation suppliers that failed the TPS test were offer capped and committed on the offer schedule recommended by PROBE since PJM implemented its software change in May 2019. Provide the results to audit staff within 90 days of the date of issuance of this audit report.

V. Other Matters

1. Order No. 760 Reporting

PJM should consider improving its data reporting under Order No. 760 by strengthening policies and procedures, devoting additional resources, and enhancing its internal data gathering and reporting processes.

Background

In Order No. 760,³³ the Commission directed RTO/ISOs under its jurisdiction to provide ongoing electronic delivery of a range of non-public data relating to the markets they administer. Order No. 760 specifically required transmission of data relating to physical and virtual offers and bids for energy and ancillary services, energy/ancillary service awards, resource outputs, marginal cost estimates, shift factor data relating to active or binding constraints, financial transmission rights, internal bilateral contracts, uplift charges and credits, and interchange pricing. The Commission stated that ongoing electronic delivery of the data would facilitate development and evaluation of its policies and regulations, enhance efforts to detect anti-competitive or manipulative behavior or ineffective market rules, help ensure just and reasonable rates, and lessen the need for ad-hoc data requests to obtain information needed to meet its statutory responsibilities, thereby reducing administrative burdens on RTO/ISOs.

Audit staff sought to utilize the significant volume of data that PJM submits to the Commission under Order No. 760 in audit staff's review of PJM's energy markets and evaluation of compliance with selected OATT requirements. However, as described below, audit staff found that, due to gaps, inaccuracies, and formatting errors in certain tables, PJM did not accurately and completely report certain data required by the Commission in Order No. 760.

Inaccurate Energy Offer Data

PJM's "GEN_HOURLY_DA" and "GEN_HOURLY_RT" tables contain detailed information on hourly offers submitted by generators in the Day-ahead and Real-time energy markets, respectively. In seeking to use these tables, audit staff found PJM had inaccurately reported energy offers, no-load and startup costs, and other variables and had not captured updates to supplier offers since November 1, 2017, when hourly offers were implemented. For example, in November 2019, audit staff learned of a discrepancy,

³³ *Enhancement of Electricity Market Surveillance and Analysis through Ongoing Electronic Delivery of Data from Regional Transmission Organizations and Independent System Operators*, Order No. 760, 139 FERC ¶ 61,053 (2012) (Order No. 760).

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which was later confirmed by PJM, between the hourly startup and no-load costs reported in PJM's market and settlements tables for the same resource and intervals. PJM explained that daily startup and no-load cost offers were incorrectly overriding the intraday updates for startup and no-load costs in the market tables. As a result of the errors in the GEN_HOURLY_DA and GEN_HOURLY_RT tables, the Commission had to devote two FTEs over a two-year period to work with PJM and obtain the accurate data needed to effectively monitor PJM's Day-ahead and Real-time energy markets.

Incomplete Data on Resource Parameters

OATT Attachment K-Appendix, Section 6.6, allows generators to request exceptions to the unit specific parameter values specified for their unit types, based on physical characteristics of the unit. Although PJM's Order No. 760 data dictionary indicates the exceptions are provided in the "MKTUNITPARAMETERLIMITEXCEPT" table, audit staff found that this table had been empty since its release in December 2017. Further, in April 2019, PJM told audit staff it had compiled the table from the wrong database, rendering it unusable. As a result, audit staff could not use Order No. 760 data to test whether market sellers submitting offer parameters inconsistent with the unit specific parameters for their generation units had received approved adjustments or exceptions from PJM.

Incomplete TPS Test Data

PJM's "MKTPLANPIVOTALTEST" and "MKTPLANUNITPIVOTALTEST" tables provide TPS test scores for generation suppliers in the Day-ahead and Real-time energy markets, respectively. The TPS test score is the ratio of incremental supply (i.e., total competitive supply less the effective MW available from the two largest suppliers and the supplier tested) to the amount of supply needed to resolve the constraint.³⁴ If the TPS test score is greater than 1.0, there is more than enough incremental supply available to resolve the constraint and the supplier tested and the two largest suppliers are considered nonpivotal and all pass the TPS test. Audit staff found PJM had truncated and reported TPS test scores as whole numbers, instead of providing the entire unrounded TPS test score. As a result, TPS test scores between 1.001 and 1.009 were reported as 1, indicating the generation supplier failed the TPS test, whereas it would actually have passed the TPS test. This prevented audit staff from using these tables to determine whether generation suppliers failing the TPS test were properly offer capped as required by OATT Attachment K-Appendix, Section 6.4. Audit staff also found PJM truncated

³⁴ Effective MW are the capacities of the generation resources adjusted for their impact on the constraint, based on DFAX values, which indicate a generation resource's distribution factor with respect to constraints.

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generator output MWs and reported all DFAX values as zero, which prevented audit staff from verifying PJM's calculation of effective MW.³⁵

Audit staff first identified the issue with the TESTSCORE column in March 2019. To continue with the testing, audit staff requested corrected TESTSCORE data. PJM corrected the TESTSCORE datatype from NUMBER to NUMBER 15,6 (i.e., changing the format from one requiring an integer to one able to include decimals) in PJM's version v5.4 data model release documentation on April 18, 2019, and released the corrected table on June 8, 2019. However, the error persisted in the Commission's database until February 12, 2020, when OE/DAS staff identified it when reviewing the documentation. PJM had not identified the datatype change in either the change log or the release notes back in June 2019. The release notes are provided to the Commission's IT department just before a data model release to ensure the content and format of PJM's data are accurately processed and saved.

Third-Party Software Vendors

Due to gaps and inaccuracies in the Order No. 760 tables, audit staff had to issue numerous and substantial data requests to obtain accurate and complete information for testing certain audit scope areas, which delayed completion of the audit. Audit staff learned that delays in data documentation appear to stem from PJM's reliance on outside vendors for the content, format, and description of the tables to be released. In addition, on multiple occasions, PJM had to modify existing table structures and documentation as part of its normal reporting processes. This suggests that there is a need to strengthen PJM's knowledge of its databases and documentation to lessen reliance on vendors for key information. The same deficiencies hindered the Commission's surveillance function. These deficiencies highlighted the limited staff PJM devoted to Order No. 760 reporting during the audit period and its reliance on vendors to compile and document data reported in its Order No. 760 tables.

Recommendations

DAA recommends that PJM consider:

4. Documenting all changes made in Order No. 760 data and tables and provide such documentation to Commission staff in a timely fashion as required by Order No. 760 to support and ensure timely submission of data.

³⁵ DFAX values can have up to six decimal places, positive or negative, and are almost never zero.

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5. Strengthening PJM's quality assurance procedures, regularly perform queries of all Order No. 760 tables, and train relevant PJM staff in these revised policies and procedures as needed, so as to ensure that the reported data are consistent and complete, including all necessary definitions and descriptors, with data used in PJM's market and settlement systems.
6. Before and after each data model release, performing additional queries to identify any discrepancies in the data and notify OE/DAS staff of any discrepancies found.
7. Engaging with third party vendors on data documentation to ensure timely and accurate releases of data documentation and model data.
8. Engaging with Commission staff to identify ways to improve reporting of data required by Order No. 760.
9. Reviewing and reforming Order No. 760 compliance according to the PJM compliance commitment document, discussed below under Corrective Actions.
10. Devoting additional resources and management support as needed to implement the above recommendations and ensure accurate and timely reporting of Order No. 760 data to Commission staff.

Corrective Actions

As a result of these deficiencies identified during the audit period, PJM has begun efforts to address issues that have arisen regarding its compliance with Order No. 760. These efforts include working with OE's Division of Analytics and Surveillance's (OE/DAS or DAS) staff to update PJM's Order No. 760 filings to include missing data as discussed below. PJM also holds routine meetings with OE/DAS staff to discuss pending issues, data model releases, and backfill requirements. These meetings typically include multiple PJM subject matter experts who respond to the market data specific questions that OE/DAS staff pose while trying to understand and use PJM's Order No. 760 data.

As of December 2019, PJM had revised its MKTPLANPIVOTALTEST; MKTPLANUNITPIVOTALTEST, and MKTUNITPARAMETERLIMITEXCEPT tables to correct inaccurate and incomplete data.

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Effective April 2021, PJM decommissioned the GEN HOURLY DA and GEN HOURLY RT tables after OE staff verified that separate tables recently released by PJM captured accurate data that were missing in the decommissioned tables.

PJM also drafted a compliance commitment document that formally presented its compliance implementation plan and corrective actions to address the deficiencies discussed in this Other Matter. PJM's compliance commitments centered on three objectives: 1) Improve the timeliness of PJM's responses to inquiries from DAS on behalf of the Commission, 2) Improve the quality of the data transmitted from PJM to the Commission, and 3) Demonstrate a significant institutional commitment to Order No. 760 compliance.

Specifically, PJM's commitment includes specific measures to meet Order No. 760's notification, documentation, and submission milestones. PJM will enhance its documentation and work with DAS staff to identify the impact of planned data changes on any screens, reports, or other functionality that DAS or other FERC offices currently rely on. Such enhanced information will entail the specific purpose and use of the information, and examples and calculations where applicable. PJM also commits to conducting a similar exercise for existing data documentation and providing the Commission with Entity Relationship Diagrams ("ERDs") to visually describe Order No. 760 data relationships, prioritized based on the preferences expressed by DAS to support existing DAS screens or other reports or functionality used by other FERC offices.

Further, PJM has committed to creating detailed documentation of its current quality assurance processes. PJM will review new data release designs to ensure that all necessary definitions and descriptors are included with the data release so that definitional, Dimensional/DIM, tables are provided to explain foreign key columns in normalized tables. This review will be documented and include the data de-normalization queries that have been used to ensure the accuracy and completeness of the release design. PJM also commits to enhance its process for remediation of issues that are detected in the data transmission process.

Further, PJM proposes to dedicate additional resources to increase its capacity for supporting its Order No. 760 implementation. Existing and new resources will receive the support of PJM management in ensuring timely compliance with the order.

Furthermore, PJM has committed to expanding the current communication channels with OE/DAS staff to include separate, periodic meetings with senior leaders from PJM's Legal & Compliance, Markets, and Information Technology Services divisions. These meetings will solicit feedback on PJM's Quality Assurance Report metrics, on whether reforms have resulted in the desired, sustained improvement to

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PJM's Order No. 760 implementation, and on any emerging concerns with PJM's Order No. 760 implementation.

Finally, PJM has committed to conducting a holistic programmatic assessment of its existing Order No. 760 implementation. This assessment will include an evaluation of all aspects of the program, including organization, staffing, processes (such as quality assurance, PJM's approach to produce complete, accurate and reliable FERC Order No. 760 data models, etc.), technologies/tools, documentation, and vendor reliance. PJM's Compliance & Operational Excellence division will provide leadership and oversight for the assessment of the existing Order No. 760 implementation and will provide routine status updates to members of PJM's Executive Team. PJM will provide DAA with the results of this assessment, along with a proposed action plan to address its findings, in Q4, 2022. PJM will solicit feedback, as well as endorsement, from DAA on the action plan prior to proceeding with implementation. Once implementation commences, PJM will provide updates on the status of the implementation and solicit feedback from DAS during the above-referenced quarterly meetings.

2. Day-ahead Resource Commitment

PJM should consider increasing transparency regarding whether Day-ahead resource commitments minimize overall system production cost as required by OATT Attachment K-Appendix, Section 6.4.1(a).

Background

To meet demand for energy in the Day-ahead energy market, PJM commits the mix of generation resources that minimizes total production costs, including energy, start-up, and no-load costs. PJM's RSC software develops the initial resource commitment, which is refined by other software applications that analyze additional transmission constraints, provide dispatch MWh and LMP, and mitigate local market power.³⁶ If a resource must be committed out of economic merit order due to a transmission constraint, OATT Attachment K-Appendix, Section 6.4.1(a) requires PJM to cap the resource's offer prices for energy and commit the resource on the price- or cost-based schedule that results in the lowest overall system production cost.³⁷ Section 6.4.1(a) provides that offer price caps apply only to generation suppliers that fail the TPS test used to measure local market power.

Testing to Evaluate Whether PJM was Offer Capping to Schedules that Minimized Overall System Production Cost

During fieldwork, audit staff sought to verify whether PJM capped resources' offers on schedules that minimized overall system production cost during times of transmission constraints. Audit staff analyzed a sample of resources that failed the TPS test and were committed on market-based offers in the Day-ahead energy market during January 20-22, 2019, a period of high demand in the PJM region. To determine how PJM evaluated schedules with long minimum run times, audit staff selected a sample in which all but one resource was committed on a schedule with a 24-hour minimum run time.

³⁶ PJM's Simultaneous Feasibility Test software performs power flow analyses to examine all transmission constraints; Scheduling Pricing and Dispatch software minimizes hourly production costs and develops dispatch MWh and LMP; and PROBE performs the TPS test to determine local market power, compares price- and cost-based offers, and recommends changes to the base case for review and approval by PJM operators.

³⁷ In data responses, PJM stated that overall system production cost is the sum of capacity commitment costs, incremental energy costs above minimum capacity limits, scheduling reserve cost, and violation penalty cost.

Audit staff identified three major issues that hindered verification of PJM's Day-ahead offer capping procedures:

- (a) *Lack of Clear Definition of Terms*: Overall system production cost is not a defined term in Manual 11, Energy & Ancillary Service Market Operations, and is not consistently applied in PJM's OATT.
- (b) *Inability to Re-run "What-If" Scenarios*: In data responses and conference calls with audit staff, PJM explained that it can only provide overall system production cost for the final RSC base case approved by operators, but not for any intermediate combination of resources or offer schedules the software evaluated. This limitation made it difficult for audit staff or PJM to determine whether PJM could have reduced *overall system production cost* by committing any given resource on a different offer schedule, committing it for a different number of hours, or replacing it with a different resource.
- (c) *Lack of Retention of Model Run Case Data Beyond 90 Days*: During the audit, PJM proposed two alternative methods to determine whether RSC's resource commitments minimized overall system production cost. The only viable method involved re-running RSC with sensitivity cases in which selected resources were committed on different offer schedules or replaced with other resources.³⁸ However, this method could only be used within the 90-day retention period for the databases needed to run RSC. Outside of this period, PJM would need to create an entirely new base case, which would be an extremely burdensome process. This could impact the accuracy and redetermination of resettlement calculations beyond the 90-day retention period. Audit staff observed that PJM could more easily perform those resettlement calculations by increasing the retention period. Also, as a result of the limited retention period, audit staff was unable to verify whether PJM was offer capping resources to the schedules that minimized overall system production cost for the sample resources identified during the high demand period of January 2019.

Audit staff encourages PJM to increase transparency regarding whether its Day-ahead resource commitment minimizes overall system production cost. Such increased

³⁸ The other method involved using PROBE to run sensitivity cases involving changes in the offer schedules and resources committed by RSC. However, because PROBE uses a different forecast period and optimization method than RSC, this method did not accurately represent how production costs would change if offer schedules or resources committed were changed.

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transparency will benefit PJM and its customers by increasing assurance and confidence that PJM's systems and processes minimize the cost of energy for consumers.

Recommendations

DAA recommends that PJM consider:

11. Ensuring that the definition of overall system production cost is identified in its Manuals and is consistently applied in its implementation of the OATT.
12. Establishing procedures to periodically verify whether software applications used in Day-ahead energy market clearing are committing resources on offer schedules that minimize overall system production cost when software application updates affect the calculation of overall system production cost.
13. Examine Day-ahead Energy Market practices to identify opportunities to enhance the accuracy and redetermination of resettlement calculations up to the two-year resettlement period, as stated in the tariff.

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3. Incentives to Follow Dispatch

PJM should consider strengthening internal procedures to encourage generation resources to follow dispatch instructions.

Background

For PJM's energy markets to operate efficiently, generation resources need to follow dispatch instructions as closely as possible.³⁹ PJM has submitted numerous regulatory proposals to promote this objective. During the implementation of Day-ahead and Real-time energy markets in 2000, PJM proposed a package of measures, one of the objectives of which was to increase incentives for generators to follow dispatch instructions. These measures included a new Section 3.2.3(e) of OATT Attachment K-Appendix to provide BOR credits to each "synchronized pool-scheduled resource of each Market Seller that operates as requested" by PJM in the Real-time energy market.⁴⁰ BOR credits are a primary means of ensuring resources are not economically disadvantaged for following dispatch instructions in the Real-time energy market. BOR credits are based on the difference between the resource's total revenues (including revenues earned in the Day-ahead energy, balancing, and reserve markets, plus reactive service and DAOR credits) and its real-time costs (including energy offer, startup, and no-load costs).

In 2008, PJM proposed additional measures, developed by its Reserve Markets Working Group, to strengthen incentives for generators to follow dispatch. These measures were partly intended to address the fact that generators "sometimes choose to ignore PJM dispatch instructions" because they could make a higher profit by adhering to their Day-ahead schedule as opposed to the dispatch signal by PJM.⁴¹ To address this matter, PJM proposed modifications to its Operating Reserve mechanism, including a new Section 3.2.3(o) of OATT Attachment K-Appendix to impose BOR deviation charges on resources not following dispatch based on the difference between their actual output and PJM's dispatch instructions. Section 3.2.3(o) considers pool-scheduled and

³⁹ OATT Attachment K-Appendix Section 1.11.3(b) requires that each Market Seller shall ensure that the entity controlling a pool-dispatched resource offered or made available by that Market Seller complies with the energy dispatch signals and instructions transmitted by PJM.

⁴⁰ PJM, Transmittal Letter, Docket No. ER00-1849-000, at 19 (filed Mar. 10, 2000); *see PJM Interconnection, LLC*, 91 FERC ¶ 61,148 (2000) (letter order accepting tariff revisions).

⁴¹ PJM, Transmittal Letter, Docket No. ER08-1569-000, at 7 (filed Sept. 25, 2008).

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dispatchable self-scheduled resources to be not following dispatch if their (a) actual output was not between their Ramp-Limited Desired MW value and the desired dispatch point; (b) Percentage Off Dispatch was greater than 10 percent; or (c) hourly Real-time MW output was not within five percent or 5 MW of hourly integrated Ramp-Limited Desired MW.^{42, 43}

Testing to Evaluate Procedures for Calculating Uplift Credits and Deviation Charges

During fieldwork, audit staff evaluated PJM's procedures for calculating BOR credits and deviation charges. To perform this analysis, audit staff requested a spreadsheet listing all generation units that received BOR credits for which PJM calculated a deviation MW.⁴⁴ Audit staff then estimated the potential BOR credits these units would have earned during intervals when they were not following dispatch and the deviation charges they would have paid for not following dispatch. Since a resource earns BOR credits only when its Balancing Net Revenues in a segment are negative, audit staff only included intervals in which the unit's Balancing Net Revenues was negative.⁴⁵ This approximated the potential BOR credits the unit would have earned during intervals when it did not follow dispatch. As a proxy for deviation charges, audit staff multiplied each unit's hourly deviation (Deviation MW/12) by PJM's daily deviation rate for the RTO region plus the daily rate for the region where the generator

⁴² Pursuant to OATT Attachment K-Appendix, Section 3.2.3(o), Percentage Off Dispatch is calculated as either the minimum of the absolute value differences between the resource's RT Gen MW and (a) the RL Desired MW; (b) the UDS Basepoint MW, or (c) the UDS LMP Desired MW depending on the USERLDESIREDDIND flag.

⁴³ Audit staff notes that the term "following dispatch" is not clearly defined in PJM's OATT and its meaning may be interpreted differently depending on the context.

⁴⁴ Pursuant to OATT Attachment K-Appendix, Section 3.2.3(o), PJM calculates a deviation MW only if the resource did not follow dispatch during a five-minute interval when it operated in the Real-time energy market.

⁴⁵ Balancing Net Revenue is the sum of real-time LMP revenues, operating reserve offsetting synchronous reserve revenue, operating reserve offsetting reactive services revenue, operating reserve offsetting DASR revenue less RT energy offer, startup, and no-load costs. See PJM MSRS Reports Documentation Balancing Operating Reserve Generator Credit (<https://www.pjm.com/-/media/markets-ops/settlements/msrs/5-minute-settlements/operating-reserve/balancing-operating-reserve-generator-credit-detail-descr.ashx>).

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was located (i.e., East or West). To focus on deviations in the Real-time energy market, audit staff excluded resources committed in the Day-ahead energy market.⁴⁶

Table 1 provides the results of the analysis. Audit staff identified 103 generation units in 84 Supplier Groups eligible for BOR credits that did not follow dispatch from January 2020 through February 2021.⁴⁷ These units, which had almost 41,000 MW of capacity,⁴⁸ did not follow dispatch during 2,227 five-minute intervals in which they were an average of 33 percent off dispatch instructions. While most of the 2,227 intervals had only one unit off dispatch, there were some intervals in which two or more units were off dispatch. As shown in Table 1, these units were from 10 to 20 percent off dispatch in 36 percent of these intervals, from 20 to 30 percent off dispatch in 23 percent of the intervals, and more than 30 percent off dispatch in 41 percent of the intervals.

Table 1
Generation Units Eligible for BOR Credits That Did Not Follow Dispatch
Instructions
January 2020 through February 2021

Row	No. of Units	No. of Supplier Groups	Total Capacity of Units (MW)	Intervals Not Following Dispatch in Real-time	Average % Off Dispatch per Interval	Max % Off Dispatch per Interval 1/	Average Amount Off Dispatch per Interval (MW)	Max Amount Off Dispatch per Interval (MW) 1/	% of Intervals Off Dispatch by:		
									10-20%	20-30%	>30 %
1	103	84	40,982	2,227	33%	553%	127	523	36%	23%	41%
Source: PJM data response listing resources receiving BOR credits that had deviation MW calculated from January 2020-February 2021.											
1/ Excludes outliers											

⁴⁶ PJM calculates deviations based on the difference between the unit's: (a) Real-time Settlement MW and Day-Ahead output in MWh; (b) Real-time Settlement Interval MW and UDS LMP Desired MW; and (c) Real-time Settlement Interval MW and Ramp-Limited Desired MW. By eliminating resources operating in the Day-ahead energy market, audit staff limited its analysis to deviations in the Real-time energy market due to (b) and (c).

⁴⁷ PJM groups resources at the same generation node in a Supplier Group. Pursuant to OATT Attachment K-Appendix, Section 3.2.3(h)(i), generation resources with multiple units located at a single bus are able to offset deviations in accordance with the PJM Manuals to determine the net deviation MW at the relevant bus.

⁴⁸ This capacity amount is based on units' submitted ecomax values.

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Audit staff estimated these units were assessed \$11,913 in deviation charges during intervals when they did not follow dispatch (see Table 2 immediately below). However, these charges were only 3 percent of the estimated \$357,400 of potential BOR credits the units earned during these intervals. As shown in Table 2, for every dollar in deviation charges for not following dispatch, the units received \$30 in potential BOR credits. Since the deviation charges were more than offset by the BOR credits, these measures did not appear to sufficiently incentivize the units to follow dispatch, a primary objective of establishing the BOR charges and credits.

Table 2
Potential BOR Credits and Deviation Charges
For Units Not Following Dispatch

Row	No. of Units	Estimated Deviation Charges 1/	Potential BOR Credits During Intervals Not Following Dispatch 2/	Est. Dev Charges as % of Potential BOR Credits	Potential BOR Credits/Est. Dev Charges
1	103	\$11,913	\$357,400	3.3%	30
1/ Deviation MW/12 * (RTO Daily Dev. Rate + Region Daily Dev. Rate).					
2/ Sum of Negative Balancing Net Revenue during intervals when unit did not follow dispatch.					

As shown in Table 3 below, the five largest recipients received an estimated \$177,595 in BOR credits during intervals when they did not follow dispatch. Unit A, the largest recipient, was eligible for an estimated \$46,290 in potential BOR credits during intervals when it averaged 52 percent off dispatch. The potential BOR credits of Unit A were more than 52 times its estimated deviation charges. Unit B did not follow dispatch for 540 intervals during which it earned \$42,145 in potential BOR credits, 12 times more than its estimated deviation charges. Units C and D were eligible for \$38,533 and \$33,242 in potential BOR credits, respectively, when they did not follow dispatch. The data indicates that Units C and D were at least 30 percent off dispatch during more than 90 percent of these intervals; for Unit E this percentage was 69 percent.

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Table 3

Top Five BOR Credit Recipients
That Did Not Follow Dispatch

Row	Unit	MW 1/	Intervals When Not Following Dispatch in Real-time	Average % Off Dispatch	Max % Off Dispatch	% of Intervals Off Dispatch by:			Potential BOR Credits When Not Following Dispatch	Est. Deviation Charges	Potential BOR Credits/Est. Dev Charges
						10-20%	20-30%	>30%			
1	A	640	114	52%	99%	19%	14%	67%	\$46,290	\$879	53
2	B	170	540	30%	60%	13%	46%	42%	\$42,145	\$3,866	11
3	C	400	64	48%	76%	3%	5%	92%	\$38,533	\$504	76
4	D	769	117	50%	70%	3%	2%	96%	\$33,242	\$1,195	28
5	E	635	35	40%	53%	20%	11%	69%	\$17,385	\$204	85
Totals		2,614	870						\$177,595	\$6,648	27
1/ Based on unit's Real-time Economic maximum MW.											

Audit staff's analysis indicated several areas in which PJM could strengthen its procedures to more effectively encourage units to follow dispatch instructions.

Payment of BOR Credits to Resources That Did Not Follow Dispatch

First, although OATT Appendix K-Appendix, Section 3.2.3(e), provides that pool-scheduled units that "operate as requested" by PJM are eligible for BOR credits, audit staff learned that, in practice, PJM provided credits to all pool-scheduled resources that came online at the defined time period requested by operators. Once the units started operating, PJM provided BOR credits for all intervals when LMP did not cover the units' costs, regardless of how poorly the units followed dispatch. Although PJM capped the units' BOR credits on the MWs PJM desired them to produce and the price for the desired MWs, PJM's practice resulted in BOR credits being paid to units during intervals when they were as much as 553 percent off dispatch, based on audit staff's sample.

Weaknesses in Procedures for Logging Variables Used in Uplift Calculations

In addition, audit staff found that certain components of PJM's uplift credit calculations were dependent on manual procedures that PJM did not follow in some instances. First, PJM operators must manually enter certain key inputs into the Dispatch Management Tool and Smartlogs.⁴⁹ Of particular importance were whether a resource

⁴⁹ Dispatch Management Tool is a software tool that enables PJM dispatchers to manage generating unit and transmission constraint information and administer the Real-

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was Economic, Running for PJM, or Running for Company, which determined whether it was pool-scheduled and therefore eligible to receive BOR credits and deviation charges, and whether PJM operators directed a resource to reduce or suspend output, which impacted LOC credit calculations. Inputting these data into the Dispatch Management Tool and Smartlogs is a time-consuming manual process that may interfere with the operators' primary mission of ensuring the reliable operation of the PJM system.

Weaknesses in Procedures for Determining Eligibility for BOR and LOC Credits

PJM Settlements also had to perform an additional manual review of Smartlogs entries to verify whether its calculation of BOR and LOC credits accurately reflected whether the resource followed dispatch. For example, PJM Settlements had to review Smartlogs to verify the Real-time status of the resource (i.e., Economic, Running for PJM, or Running for Company) for the purpose of calculating BOR credits, and to verify whether PJM operators directed the resource to reduce or suspend output for the purpose of calculating LOC credits. If an operator did not manually log an event in Smartlogs, or if the logging was questionable, PJM Settlements had to manually review dispatch call recordings to obtain additional information to determine whether the resource followed dispatch. PJM's reliance on successive manual processes increased the risk of incorrect information being used in the calculation of uplift credits. The potential for errors was illustrated by two instances in which PJM Settlements revised its calculation of BOR credits during the two-year resettlement period based on information provided by another PJM department or the IMM. In both cases, upon closer examination, PJM Settlements determined that, while the resource was logged as economic and dispatchable, it did not respond to dispatch instructions, and therefore PJM corrected the logging used in its BOR credit calculations.

Discretionary Procedures Incentivizing Resources to Follow Dispatch

Further, audit staff found that one of PJM's most potent means for dealing with resources not following dispatch was for the operator to release such resources to their Market Participants, which then had the option of taking the resource offline or continuing to run it for themselves, which made the resource ineligible for BOR credits and deviation charges. However, there is no requirement for operators to release a resource back to its Market Participant for failing to follow dispatch, and audit staff found operators released resources to their Market Participants only on rare occasions after exhausting all other means of encouraging the resource to follow dispatch. Of note, none of the resources in Table 1 was returned to its Market Participant for any of the 2,227 intervals in which resources were off dispatch by as much as 553 percent, as shown

time regulation market. Smartlogs is a logging application that dispatchers use to view system information and log key items of interest in a centralized database.

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in Table 1. Further, PJM lacked formal procedures, operator instructions, or training concerning the release of resources to their Market Participants, and its logging codes lacked adequate detail on the reasons the operators returned the resources to their Market Participants for the effectiveness of this practice to be evaluated. Audit staff believes PJM should address the above limitations so this practice can be a more effective response to resources not following dispatch.

Recommendations

DAA recommends that PJM consider:

14. Improving internal procedures for determining whether resources are following dispatch for the purpose of calculating uplift credits in conjunction with the ongoing stakeholder process.
15. Improving internal procedures for implementing Balancing Operating Reserve (BOR) credits to increase incentives for resources to follow dispatch instructions in conjunction with the ongoing stakeholder process.
16. Developing formal written procedures, operator instructions, and training on the release of units not following dispatch to their Market Participants in conjunction with the ongoing stakeholder process.

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4. PJM Software Issues

PJM should consider improving limitations in certain software applications to ensure accuracy of results.

Background

During fieldwork, audit staff identified deficiencies in software applications used to perform important market functions, including commitment of resources in the Day-ahead energy market, offer capping of resources in the Real-time energy market, logging resources that failed the TPS test but were nonetheless committed on market-based offers, and scheduling of Up-to-Congestion transactions. These deficiencies produced inaccurate results or inadequate records of key functions. The following sections describe these deficiencies in further detail.

Commitment of More Expensive Units Due to Different Model Parameters

PJM's RSC application evaluates bids and offers over a 48-hour commitment period, while PJM's Scheduling Pricing and Dispatch ("SPD") application dispatches units over a 24-hour period. During fieldwork, audit staff examined whether resources with inflexible offer parameters such as long minimum run or minimum down times might appear more economic under RSC's 48-hour forecast period than under the SPD application's 24-hour dispatch period. This could result in inflexible resources being dispatched solely due to the longer forecast period used by RSC. In data responses, PJM acknowledged that the different forecast periods can produce anomalous results. For example, PJM stated that,

Situations can arise in which a [price-based offer] schedule with inflexible parameters selected by RSC is actually more expensive than the resource's [price-based parameter limited] schedule as calculated in [Scheduling Pricing and Dispatch (SPD)], due solely to the difference between RSC's 48-hour commitment window and [SPD's] 24-hour dispatch window.

According to PJM, the Day-ahead operator may sometimes be able to correct such differences, but on other occasions factors such as the resource's minimum run time or weather alerts during the operating day or surrounding days may prevent the operator from making corrections. Since commitment of resources with inflexible parameters can affect energy prices and uplift payments and raise market power concerns in constrained areas, this matter bears closer attention.

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Resources Not Offer Capped in the Real-time Energy Market

During the audit period, PJM identified two software issues that caused certain resources not to be offer capped in the Real-time energy market. The first issue involved an incorrect reading of TPS test results by the Dispatch Management Tool, which caused resources committed in the Real-time energy market due to a transmission constraint and that failed the TPS test not to be offer capped.

The error occurred because the Dispatch Management Tool, which logs resource status changes and other information, checked only unit-level (i.e., resource-level) TPS test results in determining whether a generation supplier's resources should be offer-capped in the Real-time energy market. However, resource-level test results are only created for intervals in which the IT SCED software recommends committing the resource. As a result, generation suppliers that failed the TPS test in intervals during which their resources were not recommended for commitment by IT SCED were not offer capped, as required by OATT Attachment K-Appendix, Section 6.4.1(g).

PJM said this occurs infrequently because IT SCED typically recommends committing resources for multiple intervals and generation suppliers typically fail the TPS test for multiple intervals. To correct this issue, PJM updated the Dispatch Management Tool code to reference generation supplier-level TPS test results, which have values for all intervals of the IT SCED case for which the TPS test was performed.

The second issue resulted from PJM's failure to update its market clearing software when self-scheduled resources became subject to offer capping on November 1, 2017. Due to an oversight, certain self-scheduled combustion turbines offer capped in the Day-ahead energy market were not offer capped for the corresponding hours in the Real-time energy market, as required by OATT Attachment K-Appendix, Section 6.4.1 and Manual 11, Energy & Ancillary Services Market Operations, § 2.3.6.1.⁵⁰

PJM discovered this issue in responding to a market participant's request for information on performance of the TPS test in the Real-time energy market. In preparing its response, PJM discovered that certain of the market participant's self-scheduled combustion turbines that were offer capped in the Day-ahead energy market were not

⁵⁰ OATT Attachment K-Appendix, Section 6.4.1 requires resources committed and offer capped in the Day-ahead energy market to be offer capped for the entire commitment period. Manual 11 § 2.3.6.1 further provides that a self-scheduled and must-run CT must be offer capped in the Real-time energy market during the same intervals it was offer-capped in the Day-ahead energy market. These provisions were effective with the implementation of hourly offers on November 1, 2017.

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offer-capped for the corresponding hours in the Real-time energy market. PJM corrected the defect in September 2019.

Failure to Log Units that were Offer Capped on Market-based Offers

During fieldwork, audit staff found PJM had omitted resources offer capped on market-based offers from a spreadsheet listing all resources offer capped in the Day-ahead energy market. The omission resulted from software deficiencies that prevented PJM from identifying resources offer-capped to market-based offers in the Day-ahead and Real-time energy markets. In the Day-ahead energy market, the operators use the Day-Ahead Market Operator Interface to manually identify resources that fail the TPS test and are offer capped. The operators perform this process after executing the final Day-ahead case but prior to posting results. Since this manual process could delay posting market results, PJM said it was not common practice for the Day-ahead operator to check the offer cap flag if the resource failing the TPS test was committed on a market-based offer schedule. As a result, PJM lacked records of such resources.⁵¹

In the Real-time energy market, audit staff found that, under current logging procedures, PJM did not capture resources offer capped to cost-based offers that failed the TPS test or offline resources offer capped to cost-based offers.⁵²

⁵¹ This matter is different from the finding discussed in Section IV.1. of this report. The finding in Section IV.1. relates to operator error in not offer capping self-scheduled units that failed the Day-ahead TPS test. The matter discussed here concerns software failing to log units that are offer capped to price-based schedules.

⁵² In the Real-time energy market, if a unit on a market-based offer fails the online TPS test, the operator logs it one of two ways. If IT SCED determines the cost-based offer is cheapest, the “TPSTestFailed” flag is set to “2”, the resource’s market-based offer is recorded in the “OldUnitScheduleID” column, and its cost-based offer is recorded in the “NewUnitScheduleID” column. Thus, by filtering for resources with “TPSTestFailed” flag =2, PJM can identify resources initially evaluated on market-based offers that were later offer capped to cost-based offers. If IT SCED determines the market-based offer is cheapest, the Online “TPSTestFailed” flag is set to “3” and the same market-based offer schedule is recorded in both the “OldUnitScheduleID” column and the “NewUnitScheduleID” column. Thus, by filtering for resources with “TPSTestFailed” flag = 3, resources that stayed on market-based offers after being offer capped can be identified. These procedures may not capture resources on cost-based offers that failed the TPS test or offline resources offer capped to cost-based offers.

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Scheduling of Up-to-Congestion Transactions

PJM's RSC application excludes Up-to-Congestion transactions in developing the initial Day-ahead resource commitment, whereas PROBE includes them in determining whether changes in the initial resource commitment are needed to mitigate market power. In data responses, PJM stated that excluding Up-to-Congestion transactions can affect RSC's initial resource commitments because Up-to-Congestion transactions can cause congestion and thus can alter the mix of resources selected to meet demand. As a result, RSC may give different results than it would have if it had considered Up-to-Congestion transactions in the commitment process.

In examining this matter, audit staff learned that the software vendor told PJM it could modify RSC to include Up-to-Congestion transactions in its Day-ahead resource commitment, but PJM had not requested the enhancement because the expected impact was small. Nonetheless, resolving this discrepancy will ensure more consistent market outcomes and therefore should be considered.

Recommendations

DAA recommends that PJM consider:

17. Establishing procedures and controls to perform regular evaluations of the RSC and SPD software applications to ensure that they are producing accurate results. In particular, test and correct as needed software deficiencies leading to the commitment of more expensive units due to different parameters of the commitment and dispatch models themselves (as opposed to different resource parameters).
18. Verifying that PJM's IT SCED software offer caps self-scheduled combustion turbines that fail the TPS test, since such resources have been subject to offer capping since November 1, 2017.
19. Establishing procedures and controls to ensure that, whenever the resources of a generation supplier both fail the TPS test and are offer capped in the Day-ahead and Real-time energy markets, PJM operators identify and properly log those resources as having failed the TPS test regardless of the resource's initial offer type or operating status.
20. Authorizing the software vendor to enhance PJM's RSC application to include Up-to-Congestion transactions in the Day-ahead commitment process.

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Corrective Actions

PJM enhanced the PROBE software so as to identify resources that fail the TPS test in the Day-ahead energy market and are committed on market-based offers. Also, PJM developed a Real-time TPS regression test suite that is run on a monthly basis by the IT Quality Assurance team to make sure that TPS logic still functions with any new SPD releases. However, as of June 2021, PJM had not included the results of either set of enhancements in the Order No. 760 tables provided to the Commission.

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VI. PJM's Response



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August 23, 2022

Gerald Williams
Director and Chief Accountant
Division of Audits and Accounting
Office of Enforcement
Federal Energy Regulatory Commission
888 First Street, NE, Room 5K-13
Washington, D.C. 20426

Re: Formal Responses of PJM Interconnection, L.L.C. to Audit Report, Docket No. PA19-2-000

Dear Mr. Williams,

PJM Interconnection, L.L.C. ("PJM") has received and reviewed a copy of the report summarizing the findings and recommendations of the Division of Audits and Accounting ("DAA") audit of PJM in Docket No. PA19-2-000 (the "Audit Report").

PJM respectfully submits its responses to the findings and recommendations in the Audit Report, in accordance with your correspondence.

Please feel free to contact me if you have any questions or concerns regarding this submission.

Respectfully submitted,

/s/ Thomas DeVita
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I. Compliance Findings and Recommendations

Offer Capping of Generation Resources

- a. *Finding 1 – PJM did not offer cap a self-scheduled generation resource in the Day-ahead energy market for 18 hours on January 21, 2019 despite the fact that its owner had failed the Three Pivotal Supplier (TPS) test. The error was caused by operators applying outdated provisions of PJM's OATT and not applying the updated offer capping provisions in effect since November 1, 2017, along with a lack of written procedures and operator instructions. PJM's application of the outdated provisions may have resulted in additional self-scheduled resources not being appropriately offer capped since November 1, 2017 when the new OATT provisions went into effect.*

PJM Response: PJM agrees with this finding. As referenced in the Audit Report, in May 2019 PJM implemented a software change to enhance PJM's internal controls and procedures on offer capping resources that fail the TPS test.

- b. *Recommendation 1 – Develop written procedures, controls, and instructions for operators to ensure that the resources of all generation suppliers, including self-scheduled units, that fail the TPS test are offer capped and committed on the offer schedule recommended by Portfolio Ownership and Bid Evaluation (PROBE).*

PJM Response: PJM agrees with this recommendation. PJM has already added documentation to the Day-ahead Clearing Process User Guide, and additional controls have been established to load the TPS results into the DA clearing engine.

- c. *Recommendation 2 – Provide training to PJM staff on procedures for offer capping resources and periodic refresher training, as needed.*

PJM Response: PJM agrees with this recommendation, and has already provided additional training regarding the user guide process and the offer capping process. PJM will also provide refresher training to staff along with targeted initial training for new staff.

- d. *Recommendation 3 – Perform a study to confirm whether the resources of all generation suppliers that failed the TPS test were offer capped and committed on the offer schedule recommended by PROBE since PJM implemented its software change in May 2019. Provide the results to audit staff within 90 days of the issuance of the final audit report.*

PJM Response: PJM agrees with this recommendation, and will provide the requested study to audit staff within 90 days of the issuance of the final Audit Report.

II. “Other Matters” Recommendations

Order No. 760 Reporting

- a. *Recommendation 4 – Documenting all changes made in Order No. 760 data and tables and provide such documentation to Commission staff in a timely fashion as required by Order No. 760 to support and ensure timely submission of data.*

PJM Response: PJM agrees with this recommendation, and will implement the reforms referenced in the Audit Report.

- b. *Recommendation 5 – Strengthening PJM’s quality assurance procedures, regularly perform queries of all Order No. 760 tables, and train relevant PJM staff in these revised policies and procedures as needed, so as to ensure that the reported data are consistent and complete, including all necessary definitions and descriptors, with data used in PJM’s market and settlement systems.*

PJM Response: PJM agrees with this recommendation, and will implement the reforms referenced in the Audit Report.

- c. *Recommendation 6 – Before and after each data model release, performing additional queries to identify any discrepancies in the data and notify OE/DAS staff of any discrepancies found.*

PJM Response: PJM agrees with this recommendation, and will implement the reforms referenced in the Audit Report.

- d. *Recommendation 7 – Engaging with third party vendors on data documentation to ensure timely and accurate releases of data documentation and model data.*

PJM Response: PJM agrees with this recommendation, and will implement the reforms referenced in the Audit Report.

- e. *Recommendation 8 – Engaging with Commission staff to identify ways to improve reporting of data required by Order No. 760.*

PJM Response: PJM agrees with this recommendation, and will implement the reforms referenced in the Audit Report.

- f. *Recommendation 9 – Reviewing and reforming Order No. 760 compliance according to the PJM compliance commitment document.*

PJM Response: PJM agrees with this recommendation, and will implement the reforms referenced in the Audit Report.

- g. *Recommendation 10 – Devoting additional resources and management support as needed to implement the above recommendations and ensure accurate and timely reporting of Order No. 760 data to Commission staff.*

PJM Response: PJM agrees with this recommendation, and will implement the reforms referenced in the Audit Report.

Day-Ahead Resource Commitment

- h. *Recommendation 11 – Ensuring that the definition of overall system production cost is identified in its Manuals and is consistently applied in its implementation of the OATT.*

PJM Response: PJM agrees with this recommendation. PJM will add the definition to Manual 11.

- i. *Recommendation 12 – Establishing procedures to periodically verify whether software applications used in Day-ahead energy market clearing are committing resources on offer schedules that minimize overall system production costs when software application updates affect the calculation of overall system production cost.*

PJM Response: PJM agrees with this recommendation. PJM will document its procedures for this process.

- j. *Recommendation 13 – Examine Day-ahead Energy Market practices to identify opportunities to enhance the accuracy and redetermination of resettlement calculations up to the two-year resettlement period, as stated in the tariff.*

PJM Response: PJM agrees with this recommendation, and will conduct the referenced examination.

Incentives to Follow Dispatch

- k. *Recommendation 14 – Improving internal procedures for determining whether resources are following dispatch for the purpose of calculating uplift credits in conjunction with the ongoing stakeholder process.*

PJM Response: PJM agrees with this recommendation.

PJM additionally agrees with footnote 43 in the Audit Report:

“Audit staff notes the term “following dispatch” is not clearly defined in PJM’s OATT and its meaning may be interpreted differently depending on the context.”

To that end, PJM and the IMM have jointly sponsored an issue charge in the stakeholder process to address this ambiguity in the OATT language and clearly

elaborate on the conditions under which a resource is considered to be “operating as requested” by PJM, and therefore eligible for balancing operating reserve credits. This includes defining how closely all resource types must follow PJM’s real-time dispatch signal in order to be considered “operating as requested” by PJM, and how the determination of whether resources are coming online and going offline, consistent with PJM’s operating instructions, is made. This issue charge was approved at the March 9, 2022 Market Implementation Committee meeting. Work commenced the following month and is anticipated to continue through year-end.

PJM believes that reforms to the market rules will streamline some of the internal process improvements that may otherwise be necessary.

- l. Recommendation 15 – Improving internal procedures for implementing Balancing Operating Reserve (BOR) credits to increase incentives for resources to follow dispatch instructions in conjunction with the ongoing stakeholder process.*

PJM Response: PJM agrees with this recommendation.

As referenced above, PJM believes that reforms to the market rules will streamline some of the internal process improvements that may otherwise be necessary.

- m. Recommendation 16 – Developing formal written procedures, operator instructions, and training on the release of units not following dispatch to their Market Participants in conjunction with the ongoing stakeholder process.*

PJM Response: PJM agrees with this recommendation. The Real-time Market Operations Department, the Markets Coordination Department, and the Dispatch Department will develop formal processes, procedures, and training related to the release of units not following dispatch to their Market Participants, in conjunction with the ongoing stakeholder process examining this issue.

As referenced above, PJM believes that reforms to the market rules will streamline some of the internal process improvements that may otherwise be necessary.

Software Issues

- n. Recommendation 17 – Establishing procedures and controls to perform regular evaluations of the RSC and SPD software applications to ensure that they are functioning as intended.*

PJM Response: PJM agrees with this recommendation. PJM staff perform regression testing every time PJM receives a new version of RSC and SPD, prior to implementation into production. PJM will document these procedures and controls.

- o. Recommendation 18 – Verifying that PJM’s IT SCED software offer caps self-scheduled combustion turbines that fail the TPS test, since such resources have been subject to offer capping since November 1, 2017.*

PJM Response: PJM agrees with this recommendation. The Real-time Market Operations Department is in the process of making this verification.

- p. Recommendation 19 – Establishing procedures and controls to ensure that, whenever the resources of a generation supplier both fail the TPS test and are offer capped in the Day-ahead and Real-time energy markets, PJM operators identify and properly log those resources as having failed the TPS test regardless of the resource’s initial offer type or operating status.*

PJM Response: PJM agrees with this recommendation. This documentation is contained in the PROBE results. Exceptions to capping a unit that failed TPS are logged in the database. PJM will document procedures and controls around this process.

- q. Recommendation 20 – Authorizing the software vendor to enhance PJM’s RSC application to include Up-to-Congestion transactions in the Day-ahead commitment process.*

PJM Response: PJM agrees with this recommendation and will implement.

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