UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

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PJM Interconnection, L.L.C.	)	Docket No. ER09-1063-004
	)	

AFFIDAVIT OF JAMES F. WILSON
IN SUPPORT OF COMMENTS AND PROTEST OF
THE PENNSYLVANIA PUBLIC UTILITY COMMISSION

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I. Introduction

1. My name is James F. Wilson. I am an economist, principal of Wilson Energy Economics, and affiliate of LECG, LLC. My business address is 4800 Hampden Lane Suite 200, Bethesda, MD 20814.

2. I have 25 years of consulting experience to the electric power and natural gas industries. Many of my past assignments have focused on the economic and policy issues arising from the introduction of competition into these industries, including restructuring policies, market design, and market power. Other engagements have included contract litigation and damages; pipeline rate cases; forecasting and market assessment; evaluating allegations of market manipulation; probabilistic modeling of utility planning problems; and a wide range of other issues arising in these industries. I also spent five years in Russia in the early 1990s advising on the reform, restructuring, and development of the Russian electricity and natural gas industries for the World Bank and other clients.

3. I have submitted affidavits and presented testimony in proceedings of the Federal Energy Regulatory Commission ("Commission"), state regulatory agencies, and U.S. district court. I hold a B.A. in Mathematics from Oberlin College and an M.S. in Engineering-Economic Systems from Stanford University. My curriculum vitae, summarizing my experience and listing past testimony, is Exhibit PaPUC-2, attached hereto.

4. I have been involved in electricity restructuring and wholesale market design for over twenty years in PJM, New England, Ontario, California, Russia, and other regions. I have also been involved in issues of reliability planning, resource adequacy, and peak load forecasting. With regard to the PJM system, I have been involved in a broad range of market design and planning issues over the past several years. I followed the Shortage Pricing Working Group stakeholder process that led to the PJM Filing and participated in some of its meetings.

5. This affidavit was prepared at the request of the Pennsylvania Public Utility Commission. On June 18, 2010, PJM Interconnection, L.L.C. ("PJM") filed a package of tariff

revisions to establish new market rules for times of shortage or near-shortage in operating reserves ("PJM Filing", "PJM Proposal") supported by the affidavit of Paul M. Sotkiewicz, Ph.D. ("Sotkiewicz Affidavit"). I have been asked to review and evaluate the PJM Filing and recommend whether the proposals should be accepted or some modifications are warranted. Specifically, I was asked to evaluate the PJM Proposal's consistency with economic efficiency, the interests of market buyers and Pennsylvania electricity consumers, and compliance with the principles set forth in relevant Commission orders. I was also asked to review and consider the alternative compliance proposal and supporting statement filed on July 18, 2010 by Monitoring Analytics, the Independent Market Monitor for PJM ("IMM", "IMM Proposal", "IMM Statement").

II. Summary of Recommendations

6. Revisions to PJM's rules for pricing during operating reserve shortages have the potential to increase the reliability and efficiency of PJM's markets, encouraging additional resources and load reductions during times of system stress. The PJM Proposal includes changes to rules for pricing during operating reserve shortages and other related changes to the PJM market rules.

7. The fundamental structure of the PJM Proposal is generally consistent with the requirements of Order 719[1] and the shortage pricing mechanisms approved by the Commission and implemented by other RTOs. However, several elements of the PJM Proposal should be modified to ensure that it leads to efficient pricing and does not burden electricity consumers with additional costs without commensurate benefits. In addition, changes are needed to PJM's resource adequacy market rules to reflect the reliability and generator revenue impacts of the new shortage pricing rules. These changes are summarized in the following paragraphs and in Table 1, below.

A. Operating Reserve Demand Curve and Penalty Factors

8. The PJM Proposal calls for application of the "operating reserve demand curve" approach to shortage pricing, with dispatch reflecting joint optimization of energy and operating

[1] Wholesale Competition in Regions with Organized Electric Markets, Order No. 719, 73 Fed. Reg. 64,100 (Oct. 28, 2008), FERC Stats. & Regs. ¶ 31,281 (2008).

reserves. Maximum prices for both Synchronized Reserves and Primary Reserves are set to $850/MWh after a transition period, leading to a maximum possible price of $1,700/MWh for operating reserves and $2,700/MWh for energy.

9. Energy and operating reserve prices should reflect and be consistent with system conditions. $1,700/MWh and $2,700/MWh are not excessive operating reserve and energy prices, respectively, when operating reserves are extremely short and the risk of having to curtail firm load is significantly elevated. However, the PJM Proposal allows prices to rise to these levels when there is little or even no operating reserve shortage, due to the single-step form of the operating reserve demand curve PJM has proposed. In addition, PJM's proposed approach of simply summing the Penalty Factors when two reserve products are short, or when nested zones are both short, increases prices to very high levels that under some circumstances are not justified by system conditions and the corresponding value of operating reserves. PJM's proposed operating reserve demand curve and the proposed additive approach to multiple reserve zones should be changed to better align operating reserve and energy prices with actual system conditions and the value of energy and operating reserves under those conditions. Specifically, the proposal should be modified to use an operating reserve demand curve with at least three steps. This would set prices that better correspond to the value of reserves, reduce incentives to exercise market power, and provide a better fit with other elements of PJM's proposal; it would also be more consistent with Order 719 and the practices of other RTOs. These benefits and recommendations are described in greater detail in a later section of this affidavit.

B. Resource Pricing and Price Formation

10. PJM proposes to allow emergency demand response and emergency purchases to set price. However, these resources are not subject to mitigation and the proposal raises market power concerns. These proposed changes are not fundamental or essential to the implementation of shortage pricing, and PJM should defer them until some experience with shortage pricing has been gained. This will provide time to address the market power concerns and also the lack of telemetry and metering for emergency demand resources.

11. PJM also proposes that when emergency actions such as voltage reduction or manual load dump are taken, prices will be administratively held at the maximum levels. PJM should provide more specific details (tariff language) for how it plans to treat such emergency

actions under the full range of system conditions under which they could be taken, how pricing would work for the duration of the emergency actions, and how pricing based on supply and demand would be restored. PJM's proposal should minimize the extent and duration of this administrative override of the pricing mechanism.

C. Market Buyer Protections

12. While shortage pricing rules are deliberately designed to allow very high prices when necessary, legitimate shortage pricing events should not occur or be extremely rare on the PJM system over the next several years. This is because PJM already has procured a substantial amount of excess capacity for all times through May 31, 2014 through its Reliability Pricing Model ("RPM") capacity construct, and peak load growth is expected to be slow after 2014.[2] However, if the mechanism is not well designed, or if extreme events occur, shortage pricing may not be so inconsequential.

13. Shortage pricing rules necessarily increase the incentives to exercise market power due to the potential for higher energy and operating reserve prices they afford. While the PJM Proposal includes some market power protections, additional protections are needed. The IMM Statement raises several additional concerns that should be addressed, and some potentially risky, non-essential elements of the PJM Proposal should be delayed until operational experience has been gained with the mechanism.

14. Experience in other RTOs suggests that routine or transient system conditions can trigger shortage pricing events when there is little or no actual shortage or threat to reliability. PJM did not address this potential problem in its proposal. PJM should have discussed how such shortage pricing "false positives" could potentially occur under its proposal and how its proposal minimizes vulnerability to them. PJM should be directed to provide this discussion and correct its proposal to provide additional protections against any such vulnerabilities.

15. Despite excess capacity on the PJM system, and even with market power mitigation rules in place, shortage pricing could potentially cause many hours of very high prices and substantial transfers of wealth from consumers to producers due to any of the following types of causes: common mode failure affecting multiple capacity resources, such as the loss of

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[2] PJM Load Forecast Report, January 2010, Table B-1 (showing the PJM RTO summer peak load growing at 1.4%, 1.2%, and 1.1% in 2015, 2016 and 2017, respectively.

a major electric or natural gas transmission facility or a legislative or judicial action that would shut down multiple generating plants; a flaw in the new market rules allowing repeated "false positives" for shortage pricing, possibly exacerbated by supplier strategies to exploit the flaw; or repeated exercise of market power or gaming due to a failure to anticipate and mitigate all such strategies in designing the rules. An enormous transfer of wealth from consumers to producers in a very short period of time through the operation of the shortage pricing mechanism under such circumstances could make a bad situation much worse for consumers while creating an undeserved windfall for suppliers. PJM should implement an added layer of protection against potential instances of unjustified, "runaway" shortage pricing in the form of an "emergency circuit breaker" provision that would only be initiated by Commission order, and I suggest a way such protection could be structured.

D. Interaction of Shortage Pricing with Resource Adequacy and RPM

16. The proposed rules for pricing during operating reserve shortages contribute to resource adequacy and reliability, operating in the day-of and day-ahead time frame. PJM also has rules and markets for resource adequacy operating in the planning time frame of months to years ahead, specifically, its RPM capacity construct. RPM and its price and quantity parameters must be coordinated and consistent with PJM's shortage pricing rules. Both the additional revenues that result from the new rules and the additional supply and demand reductions they attract need to be reflected in setting RPM parameters to avoid procuring excess capacity at excess cost.

17. The PJM Proposal fails to adapt its existing RPM resource adequacy rules to the new shortage pricing approach and should be modified to correct this omission. In particular, revenues from shortage pricing should be reflected in RPM without an unnecessary multi-year lag, as would result from the PJM Proposal. The shortcomings of RPM's historical-average energy and ancillary services offset methodology are exacerbated by shortage pricing, and this mechanism should eventually be replaced with a forward-looking approach. In the meanwhile, a shortage pricing true-up should be implemented, and I suggest how such a mechanism should be structured. The additional supply and additional demand reductions resulting from the new rules also should be reflected in the amount of capacity to be acquired through RPM.

18. These recommendations are summarized in Table 1. In the remainder of this affidavit I further explain the need for these changes and describe the recommendations in more detail. The IMM Proposal includes several differences from the PJM Proposal. I share the IMM's concerns regarding the increased potential for market power resulting from shortage pricing, and I support some but not other of the IMM's specific proposed changes to the PJM Proposal, as noted in several places in this affidavit.

Table 1: Summary of Recommended Changes to the PJM Proposal

<u>Operating Demand Curve and Penalty Factors:</u>

- Implement Operating Reserve Demand Curve with three steps:
- 10% of Reserve Req't @ $250/MWh, 20% @ $400/MWh, 70% @ $850/MWh
- Second penalty factor for nested zones = $400/MWh

<u>Resource Pricing and Price Formation:</u>

- Defer allowing emergency demand response and purchases to set price
- Monitor Day-ahead DECs above $1,000/MWh for evidence of market power
- PJM to provide further details of treatment of voltage reductions or load dump

<u>Market Buyer Protections:</u>

- PJM to address vulnerabilities to false positives
- PJM to address IMM's concerns about market power
- Implement emergency "circuit breaker" provision

<u>Connecting Shortage Pricing to Resource Adequacy and RPM:</u>

- Implement forward-looking Energy and Ancillary Services Offset (longer term)
- Implement transitional shortage revenue true-up based on reference resource
- Reflect non-RPM capacity attracted by shortage pricing in capacity requirements

19. The remainder of this affidavit is organized as follows. The next section presents some key principles that should guide the design of the shortage pricing mechanism and the related changes to PJM's market rules. The final section discusses the PJM Proposal and describes the specific modifications that I recommend. Both of these sections address elements of the PJM Proposal in the same four categories as reflected in this summary section: The

operating reserve demand curve and penalty factors; resource pricing and price formation; market buyer protections; and the interaction between shortage pricing and PJM's RPM resource adequacy construct.

III. Market Rules for Pricing during Operating Reserve Shortages: Key Principles

A. The Operating Reserve Demand Curve Approach

20. Historically, system operators dealt with circumstances of low operating reserves through an escalating sequence of administrative, emergency actions; prices and markets played little or no role. As noted in Order 719, allowing prices to rise during periods when operating reserves are relatively low encourages new sources of supply and price-responsive demand reductions, contributing to reliability and efficiency. Over the coming years, we can expect peak loads to become increasingly manageable and price-responsive through both demand response programs (under which demand reductions are promised in advance) and also as a result of loads becoming increasingly responsive to real-time price signals as a result of smart grid developments. Allowing prices to rise when operating reserves are relatively low both encourages the development of such resources and also makes use of them to balance supply and demand at times of system stress without having to resort to manual load dumps, voltage reductions, or other "emergency" measures.

21. The operating reserve demand curve approach provides a framework for pricing during times of low operating reserves. In Order 719 the Commission described the approach as follows:

> Under the third approach, RTOs and ISOs would establish a demand curve for operating reserves, which establishes a predetermined schedule of prices according to the level of operating reserves. As operating reserves become shorter, the price increases. (P 221)

22. The operating reserve demand curve approach is also consistent with Order 719's call for "prices that accurately reflect the value of energy" (P 192): the value of incremental operating reserve is high when reserves are significantly below the desired levels, and the value of incremental reserve is low when the amounts considered needed to provide a very high level of reliability have been obtained.

23. Note that under the operating reserve demand curve approach, the *maximum* level to which energy and operating reserve prices can rise should be a relatively unimportant

characteristic of the pricing rules because this price level should be achieved only under extreme conditions when the risk of having to resort to manual load dump is quite high. This should be expected to occur rarely (if at all), and if the market is working efficiently (meaning, prices rise to the maximum level only when they really need to, rather than due to poorly structured demand curves, market power, gaming, "false positives" or other illegitimate reasons), all stakeholders should recognize the appropriateness of high price levels under such extraordinary circumstances. The operating reserve demand curve should provide for operating reserve prices that rise as the degree of shortage increases, consistent with the incremental value of reserves under various system circumstances. Prices should not rise to high levels when operating reserves are close to target levels; under such conditions, the risk to the system, and the value of incremental operating reserve, is low.

B. Resource Pricing and Price Formation

24. PJM's markets and dispatch will be most efficient if all supply and demand resources are dispatched based on prices reflecting the willingness to generate or to reduce consumption. The concept of "emergency" resources that are invoked administratively on an out-of-market basis should be phased out. Allowing emergency resources to appear in the dispatch stack at prices that reflect their willingness to generate or to reduce consumption will result in more elastic supply and demand at high price levels and improve the efficiency of system operation and pricing when operating reserves are relatively low. As the amount of demand response on the PJM system grows, it becomes inefficient for all of it to be invoked administratively and simultaneously, as shown in recent PJM analyses under the subject "Demand Response Saturation."[3]

25. Resource classifications and dispatch rules reflecting the historical, administrative approaches to coping with system stress, triggered based on whether reserves have or have not fallen below a specific level or whether PJM has or has not declared an "emergency", are inconsistent with the operating reserve demand curve concept and efficient price-driven dispatch, and should be minimized. However, this goal must be balanced against the risk of unintended

[3] Tom Falin, Manager, Resource Adequacy Planning, PJM, *Demand Response Saturation Analysis*, presentation to Markets and Reliability Committee, May 18, 2010, slides 8 and 9 (showing that when all demand response is

results or market power as a more market-driven approach to system operation during times of system stress is implemented. For some types of resources, revised definitions, better measurement or market power mitigation may be needed before they can be treated in this manner.

C. The Need for Additional Market Buyer Protections

26. The PJM Proposal introduces rules intended to raise prices during operating reserve shortages and increase the maximum energy price from $1,000/MWh to $2,700/MWh. It creates new markets for operating reserve products and replaces out-of-market purchases with purchases that set market-clearing prices earned by all providers of a service. While the various changes have legitimate purposes, the theoretical basis for them assumes market power either does not exist or is effectively mitigated. Complex packages of rule changes also risk creating unanticipated gaming strategies through which market participants are able to benefit by exploiting weaknesses in the rules. This suggests that in implementing substantial changes to market rules as PJM has proposed, it can be wise to err on the side of caution and pursue a staged approach, delaying non-essential, potentially risky changes until some experience has been gained. This also suggests there is value to anticipating the possibility of extremely costly malfunctions of the mechanism and putting in place provisions for limiting unwarranted impacts on consumers.

D. Connecting Pricing during Operating Reserve Shortages to Resource Adequacy

27. Market rules for pricing during operation reserve shortages operate in the day-ahead, hour-ahead and real-time time frames to acquire sufficient resources to maintain reliable system operation. These rules influence decisions such as generating unit start-up, shut-down and operating levels, and actions by loads to reduce consumption. "Resource adequacy" refers to rules, procedures and markets that operate months and years in advance toward the same objective – sufficient resources to ensure reliability. Resource adequacy rules and markets (RPM) are intended to influence the longer-term decisions to build or retire generating plants or to implement new demand response.

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invoked during the same six-hour period, the daily peak is reduced by less than the amount of the demand response and the full value of the demand response is not realized).

28. While an effective resource adequacy approach results in adequate capacity to meet planning reliability standards ("one day in ten years"), this does not obviate the need for and value of shortage pricing, as there is always some chance of a combination of events leading to low reserves. Rules for pricing during operating reserve shortages and rules pertaining to resource adequacy are both needed, and there are important connections between the two.

a. The Megawatts: Improved rules allowing higher prices during operating reserve shortages attract additional non-RPM resources and load reductions and reduce the amount of capacity that must be arranged in advance through RPM to provide the target level of reliability.

b. The Dollars: Rules allowing higher prices during operating reserve shortages reduce RPM capacity needs and also flatten and spread the peak loads through additional price-responsive demand. As a result, peaking generating plants will see more hours of profitable operation to provide energy and operating reserves and higher net revenues. This will reduce the amount of revenue peaking plants will require through RPM.

29. These connections to resource adequacy may be relatively modest at first but will grow as the market adapts to the new shortage pricing regime. The package of changes to the rules at this time should recognize and anticipate the growing connections between pricing during operating reserve shortages and resource adequacy. The resource adequacy construct should recognize the increasing revenue opportunities presented by the revised shortage pricing rules, and this link should not include substantial lags. The resource adequacy construct should also recognize the reduced RPM capacity needs resulting from the revised shortage pricing rules.

30. The market design changes adopted in this proceeding should not include features that will impede or discourage the associated market adaptations or that will have to be fundamentally changed as the market evolves. Note that if resource adequacy is not adapted to the reduced capacity needs resulting from revised shortage pricing rules, the result will be excess capacity at excess cost. Current resource adequacy rules are already highly conservative (based on the "one day in ten years" standard and various conservative assumptions) and if, in addition, they fail to recognize the potential impact of shortage pricing on peak period supply and demand reductions, there could continue to be substantial excess capacity for many years. If that occurs,

shortage pricing will be nearly superfluous, and price-responsive demand and other market developments may be delayed.[4]

IV. Shortage Pricing Proposal: Discussion and Recommendations

31. This section discusses various elements of the PJM Proposal in greater detail and provides further explanation of the recommended changes to it.

A. Operating Reserve Demand Curve and Penalty Factors

1. Background: Operating Reserves and Reserve Requirements

32. Operating reserves – capacity standing ready to produce energy quickly if required -- are arranged to be able to deal with possible contingencies and unexpected events such as sudden generation outages or unexpectedly high load. Operating reserves are valuable because they allow operating the system with a very high level of reliability and reduce the risk of loss of load.

33. PJM classifies operating reserves into "Primary" reserves that can respond within 10 minutes and "Secondary" reserves that can respond within 30 minutes. The shortage pricing proposal pertains only to Primary (10 minute) reserves. Primary reserves are further classified into "Synchronized" and "Non-Synchronized" reserves, defined in the PJM Manuals as follows:[5]

> Synchronized Reserve is reserve capability that can be converted fully into energy or load that can be removed from the system within 10 minutes of the request from the PJM dispatcher and must be provided by equipment electrically synchronized to the system.
>
> Non-Synchronized Reserve is reserve capability that can be fully converted into energy or load that can be removed from the system within 10 minutes of the request from the PJM dispatcher and is provided by equipment not electrically synchronized to the system.

34. While both Synchronized and Non-Synchronized reserves must be able to respond in 10 minutes, Synchronized reserves are required to be electrically synchronized and, therefore, are considered more reliable and valuable than Non-Synchronized reserves.[6] While PJM has

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[4] This concept is further developed in Wilson, James F., *Reconsidering Resource Adequacy*, Part 2 (Public Utilities Fortnightly, May 2010), p. 45. http://www.fortnightly.com/exclusive.cfm?o_id=355.

[5] *PJM Manual 10: Pre-Scheduling Operations*, Revision 25 effective January 1, 2010, Section 3: Reserve Requirements, p. 16, available at http://www.pjm.com/~/media/documents/manuals/m10.ashx.

[6] PJM Manual 10, p. 17.

operated markets to acquire Synchronized reserves, it not operated a market for Primary reserves or obtained firm commitments to provide it, and it has not paid for provision of Primary reserves. As described by the IMM, PJM has not carefully measured or tracked Primary Reserves.[7]

35. PJM establishes a Reserve Requirement for Synchronized reserve "at the discretion of PJM after careful review to ensure appropriate system reliability and maintain compliance with applicable NERC [North American Electric Reliability Corporation] and Regional Reliability Organization requirements."[8] PJM also establishes a separate, larger Reserve Requirement for Primary reserve (sum of Synchronized and Non-Synchronized reserve). The applicable Regional Reliability Organization is Reliability*First* Corporation ("RFC") for all of the RTO except the Dominion sub-zone.

36. The applicable NERC and RFC reserve standards are defined in NERC's Standard BAL-002-0[9] and RFC's Standard BAL-002-RFC-02.[10] NERC's Standard BAL-002-0 requires (section R3.1) that Primary reserves (also called "Contingency" reserves) cover the most severe single contingency. PJM establishes a higher Primary Reserve Requirement in its manuals: 150 percent of the largest unit for the RFC area, and 1,700 MW for the Mid-Atlantic zone.[11]

37. RFC's Standard BAL-002-RFC-02, section R1, calls for a Balancing Authority to "have a documented methodology" to determine its reserve requirements, or to meet various default requirements specified in the standard, including a Synchronized reserve requirement (referred to as "Spinning" reserve) of at least 50% of the most severe single contingency. PJM establishes a higher Synchronized Reserve Requirement in its manuals: equal to the Largest Unit for the RFC area and for the Mid-Atlantic zone.[12]

38. The Sotkiewicz Affidavit states (p. 9) that PJM establishes the reserve requirements based on system conditions and they are usually around 1,300 MW for

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[7] IMM Statement, p. 41.

[8] PJM Manual 10, p. 18.

[9] NERC's BAL-002-0, Disturbance Control Performance, is available at http://www.nerc.com/files/BAL-002-0.pdf and is included as Exhibit PaPUC-3.

[10] RFC's BAL-002-RFC-02, Operating Reserves, is available at http://www.rfirst.org/Documents/Standards/Approved/BAL-002-RFC-02.pdf and is included as Exhibit PaPUC-4.

[11] PJM Manual 13, p. 11.

[12] PJM Manual 13, p. 11.

Synchronized Reserve and about 2,000 MW for Primary Reserve for the RTO Region (RFC portion). For the Mid-Atlantic zone, the Synchronized Reserve Requirement is usually around 1,150 MW and the Primary Reserve Requirement around 1,700 MW, according to the Sotkiewicz Affidavit.

2. The Value of Energy and Operating Reserves Under Shortage Conditions

39. Order 719 reflected a concern that energy prices in RTO markets did not rise high enough and reflect the value of energy when operating reserves are short, providing inadequate price signals and harming reliability.

> The Commission continues to find that existing rules that do not allow for prices to rise sufficiently during an operating reserve shortage to allow supply to meet demand are unjust, unreasonable, and may be unduly discriminatory. In particular, they may not produce prices that accurately reflect the **value of energy** and, by failing to do so, may harm reliability, inhibit demand response, deter entry of demand response and generation resources, and thwart innovation. (Order 719, P 192, emphasis added)

40. The value of energy is quantified by focusing on the impact on firm consumers when their consumption must be curtailed, often called the Value of Lost Load, or "VOLL". The PJM Filing and Sotkiewicz Affidavit cite the $3,500/MWh value for VOLL that was developed by the Midwest Independent Transmission System Operator (MISO) as a parameter of its Commission-approved shortage pricing rules.[13] While arguments are made for lower or higher values for VOLL for use in shortage pricing, the $3,500/MWh value falls within a broad range of reasonableness and a re-examination of VOLL is not needed for the purposes of evaluating the proposed shortage pricing rules. (A much higher, $25,000/MWh estimate of VOLL for certain types of customers, cited in the Sotkiewicz Affidavit, is not an appropriate value to use for consideration of shortage pricing rules.[14])

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[13] PJM Filing, p. 25, and Sotkiewicz Affidavit, p. 17, citing Midwest Independent System Operator, Inc., 122 FERC ¶ 61,172 (2008) at P 215.

[14] The VOLL for use in shortage pricing should reflect the average value of lost load for the customers most likely to be curtailed and lose service when reserves fall to low levels, under the likely circumstances of the curtailment. A manual load dump due to low reserves would likely take the form of a rotating blackout, with customers likely to lose service for only a short period. The Sotkiewicz Affidavit (at footnote 45 and 53) cites a report by Lawrence Berkeley Laboratories for the $25,000/MWh value. This is an estimated VOLL for large and medium commercial and industrial customers. As the LBL report notes (p. 28), "larger customers are likely to have both backup generation and power conditioning." This will be especially true of customers who place a high value on service. Thus, while some customers' VOLL may be high, they most likely are not exposed to the quality of service provided by PJM or a possible rotating blackout and their VOLL is not relevant here.

41. Operating reserves are valuable because they reduce the risk of loss of load. If operating reserves were allowed to fall close to zero the system would be at risk of a potentially catastrophic transmission system failure and wide-spread outage. At such levels of operating reserve, the incremental value of each megawatt of reserves would be well in excess of VOLL due to the high risk of a major outage affecting many customers. Instead of allowing reserves to fall to such levels, system operators take controlled actions such as voltage reduction or manual load dump to preserve the reserves needed to operate the transmission system reliably; in principle, such actions would be taken when the value of incremental reserves is approaching VOLL, because each megawatt of curtailed firm load would create approximately one megawatt of operating reserve. This minimum amount of operating reserve is, of course, much lower than the Primary or Synchronized Reserve Requirement, which are set to provide a high level of reliability to firm customers and avoid needing to curtail them to maintain reserves.

42. At any level of operating reserves, the incremental value of one additional megawatt of operating reserve depends on how the incremental megawatt would further reduce the risk of having to curtail firm load in the hour to preserve minimum operating reserve. The expected frequency of load loss in an hour, given a quantity of operating reserve, can be called the Conditional Loss of Load Expectation, or CLOLE. The value of incremental operating reserve is roughly the CLOLE times the VOLL. To see this, suppose the RTO has 1699 MW of operating reserve and is evaluating the last megawatt to meet the Reliability Requirement of 1700 MW. Suppose the risk of having to curtail firm load to preserve minimum operating reserve, when reserves are at this level, is considered to be one tenth of one percent (0.1% or probability = 0.001). If the extra megawatt of reserve is not acquired, with probability 0.001 the RTO will later have to curtail an additional megawatt to preserve minimum operating reserve in the hour. Therefore the expected cost to the system, if the additional megawatt of reserve is not acquired now, is 0.001 x 1 MW x $3,500/MWh = $3.50/MWh. This suggests that to purchase reserves optimally and efficiently under these assumptions, the RTO should acquire this last megawatt if it is available at a price less than $3.50/MWh.

43. The concept that the incremental value of reserves is based on the reduction in the expected load loss and the value of lost load, and that the operating reserve demand curve should

reflect this value, is widely accepted.[15] The concept is reflected explicitly in the MISO tariff provisions for shortage pricing, although in a very conservative form.[16] The Commission has recognized that the operating demand curve values should reflect the value of reserves at various deficiency levels in approving shortage pricing rules for other RTOs:

> As explained by Mr. Jones, the demand curves allow the market prices to reflect the reliability value of capacity and regulation capability to the market at various deficiency levels on both a market wide and zonal basis. When the market for energy or one of the ancillary services products is deficient, the pricing rules reflect the reliability value of this deficiency in the market price for both the deficient product and the other products.[17]

44. As operating reserves decline, the CLOLE rises. When reserves are extremely low and voltage reductions or manual load dump very likely, each incremental megawatt of reserve obviates the need for close to an expected megawatt of load loss, and the value of incremental operating reserve approaches the VOLL. Thus, it is appropriate that shortage pricing rules allow the prices of energy and operating reserve to rise to close to VOLL levels under such extreme circumstances when a voltage reduction or manual load dump becomes very likely. PJM's proposal accomplishes this, allowing for maximum energy and reserve prices of $2,700/MWh and $1,700/MWh, respectively.

45. The Reserve Requirements have been chosen to provide a very high level of reliability, so uUnder normal conditions when PJM is able to acquire its full Reserve Requirement for both reserve products (Synchronized and Primary), the CLOLE is extremely low. In most hours of the year, operating reserve is abundantly available and its cost is very low

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[15] See, for instance, Potomac Economics, Ltd., *Report on Shortage Pricing*, filed May 15, 2009 in FERC Docket No. RM07-19, p. 7 ("If purchased optimally, reserves should be purchased only until the cost of procuring additional reserves equals the incremental reduction in the expected cost of losing load."); Hogan, William W., *Scarcity Pricing and Locational Operating Reserve Demand Curves*, presented June 2, 2010 at FERC Technical Conference on Unit Commitment Software, Docket No. AD10-12, p. 10-23 ("the loss of load probabilities times the locational VOLL yields the operating reserve demand…"); Market Surveillance Committee of the California ISO (Frank A. Wolak, James Bushnell, and Benjamin F. Hobbs), *Opinion on Reserve Scarcity Pricing Design*, December 2, 2009, p. 4 (reserve scarcity demand curve values should be set based on the change in loss-of-load probability and value of lost load); Centolella, Paul A., *Scarcity Pricing: Enabling Price Responsive Demand*, June 18, 2009, p. 12 (operating reserve demand curve slope reflects declines in LOLE and value of expected unserved energy).

[16] Midwest ISO FERC Electric Tariff, Schedule 28, Section III (referring to the estimated conditional probability of a loss of load and setting VOLL to $3,500/MWh) and Midwest ISO, Energy and Operating Reserve Markets Business Practices Manual BPM-002-r7, effective March 11, 2010, p. 5-11 and Exhibit 5-1 (also referring to the conditional probability of a loss of load).

[17] Midwest Independent System Operator, Inc., 122 FERC ¶ 61,172 (2008) at P 215.

(the average cost of Synchronized Reserve in the Mid-Atlantic subzone was under $10/MWh in 2009[18]). Given the low cost of incremental operating reserve in most hours, if PJM believed increasing the Synchronized or Primary Reserve Requirements would appreciably reduce the CLOLE, it would have exercised its discretion to do so. The CLOLE will rise continuously as reserves decline, so if the CLOLE is very low when reserves equal the requirements, it is also very low when reserves are only a few MW above or below the requirement. Taking 0.001 as the value of CLOLE when reserves equal the requirements, as in the example above (PJM has not quantified this, and I believe the CLOLE is likely considerably lower than this probability when reserves are close to the requirement), the value of the last increment of operating reserve PJM normally acquires is roughly VOLL times the CLOLE, or $3,500/MWh x 0.001 = $3.50/MWh. That is, if the Reserve Requirement is 1,700 MW and PJM has acquired so far 1,699 MW, the value of the last MW to meet the requirement would also be very roughly $3.50/MWh.

3. PJM's Proposed Operating Reserve Demand Curve

46. The PJM Filing states (p. 3) that its proposal utilizes an operating reserve demand curve, consistent with Order 719, but also acknowledges (p. 24), "The PJM Proposal is a simple form of demand curve that assigns a high price beginning with the first megawatt of reserve shortage." However, the Commission described the operating reserve demand curve approach to shortage pricing in Order 719 as "establish[ing] a predetermined schedule of prices according to the level of operating reserves. As operating reserves become shorter, the price increases." (P 221). Under the PJM Proposal, for each reserve product, the entire Reserve Requirement is acquired at a price up to the Penalty Factor. If PJM's proposal is a demand curve, it's a "vertical" demand curve with a single step. PJM's proposed demand curve is unlike the operating demand curves of other RTOs which include multiple steps.[19] The vertical operating reserve demand curve leads to inefficient prices and has other drawbacks, described below, and

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[18] Monitoring Analytics, *2009 State of the Market Report for PJM*, p. 392.

[19] See, for instance, California ISO Tariff section 27.1.2.3.2 (describing the Scarcity Reserve Demand Curve for Non-Spinning Reserve with three steps, 0 MW to 70 MW, 70 MW to 210 MW, and greater than 210 MW of shortage); or NYISO Tariff Rate Schedule 4 – Payment for Supplying Operating Reserves, section 15.4.7(g) (describing the Operating Reserve Demand Curve for total 30-minute reserves with three steps, 0 MW to 200 MW, 200 MW to 400 MW, and greater than 400 MW of shortage).

the PJM Proposal should be modified to include at least three steps in the operating reserve demand curve.

47. Under the PJM Proposal, PJM would pay up to the Primary Reserve Penalty Factor (ultimately, $850/MWh) to make sure it acquires the last increment of Primary reserve, more than 100 times its value, estimated above as roughly $3.50/MWh.

48. To pay up to $850/MWh for an increment of reserve that provides only $3.50/MWh in value to consumers is economically irrational and inefficient. PJM does not assert that its operating reserve demand curve leads to prices consistent with or in any way related to the incremental value of these reserves right up to the Reserve Requirement. Instead, the Sotkiewicz Affidavit suggests that the Reserve Requirements are "mandated" so PJM is required to purchase the entire amount (p. 18). The PJM Filing states (at p. 21) "Capacity available in PJM to be assigned as reserves, regardless of its cost, will be assigned as reserves" and suggests that PJM would purchase reserves on an out-of-market basis if available even at prices above the $850/MWh Penalty Factor. However, as described above, PJM has discretion in setting its Reserve Requirements and sets them above the levels required by NERC and RFC. To the extent NERC, RFC, or PJM reliability standards or practices are being correctly interpreted by PJM as precluding use of an operating reserve demand curve, the Commission should direct that those rules or standards be modified.

49. While purchasing operating reserves right up to the full Reliability Requirement at any price is a questionable practice, under the current Tariff, the impact on consumers is small. Circumstances leading to high prices for operating reserves occur infrequently and the excess cost of each instance is not large (when 100 MW worth $3.50/MWh are purchased at $850/MWh, the excess cost is ($850/MWh - $3.50/MWh) x 100 MW = $84,650/hour).

50. However, under the PJM Proposal, the cost to consumers of such inefficient purchases would be compounded by using the excessive price as a market-clearing price to be paid to all providers of operating reserve in the hour. In addition, the incremental operating reserve purchase can raise the cost of energy through the joint optimization of energy and operating reserves, potentially increasing the cost to consumers to many millions of dollars. This potentially turns a minor inefficiency into a major inefficiency and a major burden on wholesale market buyers and end use consumers.

51. The PJM Proposal should be modified to include at least three steps in the operating reserve demand curves, to bring prices more in line with value (a specific proposal is described later in this section). There are multiple advantages to a stepped operating reserve demand curve compared to PJM's proposed vertical demand curve.

a. The prices paid for operating reserve when quantities are close to the target amounts would be much closer to the value of the reserves (while remaining safely in excess of the value).

b. Hours with shortage pricing would more closely correspond to the hours when there is an actual operating reserve shortage. Under the PJM Proposal, PJM will pay high prices for reserves, up to $850/MWh, in hours when the Reserve Requirement is satisfied and there is no operating reserve shortage.

c. The need for shortage pricing, when it occurs, will more often be reflected in cleared reserve quantities at least slightly below the target levels. Under the PJM Proposal, when shortage pricing results in prices up to $850/MWh, stakeholders will simply have to believe that had PJM not paid such high prices, there might have been a reserve shortage; to identify whether in fact a reserve shortage would have occurred would require examining the entire set of energy and operating reserve offers and reconstructing the joint optimization of energy and reserves and associated opportunity cost calculations.

d. The risk of exercise of market power or gaming to raise operating reserve prices would be lower with a stepped demand curve. It is well known that with a vertical demand curve (and inelastic demand more generally) there is higher vulnerability to gaming or exercise of market power to raise price.

e. Attempts to raise prices through gaming or exercise of market power may also be deterred by the fact that with a stepped curve, prices can only be raised to high levels if there is some reduction (however small) of reserves below the target amounts. Under the PJM Proposal, sellers could raise reserve prices to $850/MWh without any reduction in reserves below the target amounts.

f. In addition, as described in the following subsections, a stepped demand curve would go a long way to mitigate the inefficient impacts of PJM's proposal to apply additive penalties factors when operating reserves shortages occur for two reserve products or for nested zones.

52. A stepped demand curve would also better conform to the requirements and guidance of Order 719. In particular:

a. Order 719 stated at P 251, "As to when these pricing rules would go into effect, it is when the RTO or ISO has an operating reserve shortage." The PJM Proposal sets shortage prices when the full requirement is acquired and there is no shortage.
b. Order 719 stated at P 221, "As operating reserves become shorter, the price increases." PJM's vertical demand curve for each reserve product does not accomplish this.
c. Order 719 at P 192 called for "prices that accurately reflect the value of energy", and a stepped operating reserve demand curve more accurately matches prices paid to value.

53. The Sotkiewicz Affidavit (at p. 22) suggests that if the Penalty Factors are set too low, these prices could "inappropriately be a part of the calculation of energy prices potentially leading to higher energy prices than would be necessary." However, this should not be the case, as the operating reserve demand curve limits the willingness to pay for operating reserve and the maximum opportunity cost within the joint optimization of energy and operating reserves; a lower limit should not have the impact of raising energy prices. This statement may reflect a shortcoming in the envisioned logic for joint optimization, which is not described in detail in the PJM Filing, Sotkiewicz Affidavit, or proposed tariff language. If so, the logic should be further developed to not inappropriately raise energy prices when operating reserve cost exceeds the willingness to pay as reflected in the operating reserve demand curve.

4. Additive Penalty Factors for Multiple Reserve Products

54. The PJM Proposal calls for establishing separate operating reserve demand curves for two operating reserve products, Synchronized Reserve and Primary Reserve (sum of Synchronized and Non-Synchronized Reserve). Under the PJM Proposal, the price for each product can rise to the Penalty Factor for the product ($850/MWh is proposed for each product) when otherwise the Reserve Requirement cannot be satisfied. When PJM is otherwise unable to acquire the Reserve Requirement for Primary Reserve and for Synchronized Reserve

simultaneously, it is proposed that the price for Synchronized Reserve, which can contribute to both requirements, would be $1,700/MWh ($850 + $850) and energy prices could be as high as $1,000/MWh more than this, or $2,700/MWh.

55. As with the proposed vertical demand curve shape, this proposed approach fails to result in prices that reasonably correspond to the value of reserves under various circumstances, for two reasons. First, a Primary reserve shortage is a less serious circumstance, while a Synchronized reserve shortage is a much more serious condition, as the Sotkiewicz Affidavit recognizes (p. 12).

56. Second, the simple additive approach does not result in prices consistent with the seriousness of the operating reserve circumstances across the range of possible combinations of Primary and Synchronized reserve shortages, especially in light of the proposed vertical demand curves.

57. Table 2 shows that the two-product additive approach with vertical demand curves leads to prices that are substantially inconsistent with the value of reserves under various circumstances. While some of these combinations may be extremely unlikely, the PJM Proposal allows them, which could create gaming opportunities and false positives. The examples are based on a Synchronized Reserve Requirement of 1,150 MW and a Primary Reserve Requirement of 1,700 MW (typical values for the Mid-Atlantic zone).

58. In Table 2, cases A, B, D and E all represent very similar conditions with reserves close to or equal to the requirements (so very low incremental value of reserves), but these cases result in very different prices. Cases B and C represent very different levels of system stress, but the resulting operating reserve prices would be the same. Similarly, cases E and F represent very different levels of system stress but the same operating reserve prices.

Table 2: Penalty Factors Under Various Reserve Shortage Circumstances (based on PJM Proposal and typical Mid-Atlantic reserve requirements)

Case	Primary Reserves	Synchronized Reserves	Seriousness of System Conditions	Primary/Sync Resv. Prices
A	>=1,700 MW (full Req't)	>=1,150 MW (full Req't)	Normal; no reserve shortage	$0 / $0
B	1,690 MW (slightly short)	1,150 MW (full Req't)	Minor; small Primary reserve shortage	$850 / $850
C	1,150 MW (no Non-Sync)	1,150 MW (full Req't)	More serious; all Sync but no Non-Sync reserves	$850 / $850
D	1,690 MW (slightly short)	1,140 MW (slightly short)	Small Primary, Sync shortages; not a very serious condition? But false positive?	$850 / $1700
E	1,700 MW (full Req't)	1,140 MW (slightly short)	Small Sync shortage; not a very serious condition? But false positive?	$0 / $850
F	1,700 MW (full Req't)	200 MW (severely short)	Very serious condition But false positive?	$0 / $850

59. While very high reserve and energy prices are justified when the system is at greater risk, the proposed approach with vertical demand curves and additive Penalty Factors does not accomplish this. It results in a very poor correspondence between price and risk or value, potentially setting very high prices when there is virtually no reserve shortage (as in cases B, D or E) or the same reserve price across a wide range of system conditions (comparing case B to C, or case E to F).

60. While some of these examples may be unrealistic and unlikely to occur, I doubt anyone can predict with any confidence how market participants will respond to these new market rules and how likely various outcomes may be once they are implemented. The market rules should be designed to provide a strong correspondence between prices and value under a broad range of circumstances, even if some of the circumstances are considered impossible or unlikely to occur, or it may create opportunities for gaming or risk of false positives.

61. Note also that having two reserve products with additive penalty factors does not result in or approximate an operating reserve demand curve with two steps. As the examples above demonstrate, either Sync or Primary Reserve can become quite low while the Penalty Factor remains $850/MWh, but if both are just slightly short the $1,700/MWh price can apply.

62. The Sotkiewicz Affidavit (at p. 25) suggests that as system stress increases, first Primary reserves will be short, and if the situation further worsens, Synchronized reserves may also become short. However, the PJM Proposal, applying separate operating reserve demand curves for Synchronized and Primary reserves, allows for a Synchronized reserve shortage when there is no Primary reserve shortage. This should occur rarely if at all (because available Non-Synchronized reserves can essentially be converted to Synchronized reserves by calling them to produce energy, allowing other units to be backed down to provide Synchronized reserves), and may indicate a false positive when it does occur.

63. If Sync can only be short when Primary reserves are very low, a single operating demand curve for both products, with steps recognizing when Sync reserves begin to go short, would result in a better match between reserve price and value and prevent such false positives. PJM should consider using a single operating reserve demand curve for the two products.

5. Additive Penalty Factors for Nested Reserve Regions

64. PJM also proposes to sum the penalty factors when reserves are short in a Reserve Zone and in the RTO Region. Again, this is not justified based on reserve value and results in inefficient pricing.

65. When reserves are short in a Reserve Zone they will have elevated value. When, in addition, reserves are also short in the surrounding RTO Region, the value of reserves in the Reserve Zone is somewhat higher, because such reserves not only lower the outage risk (CLOLE) in the Reserve Zone, but also have the potential to reduce the outage risk for the RTO Region. However, the increase in the value of operating reserves located in the Reserve Zone, due to the fact that the RTO Region also has a reserve shortage, would generally be small and far less than the doubling of the value that would result from the proposed approach. This is because the circumstances that could lead to an actual outage in the Reserve Zone and in the RTO Region are likely highly correlated. Incremental operating reserve located in the Reserve Zone only increases in value due to a reserve shortage in the RTO Region to the extent there could be an actual outage in the RTO Region while, at the same time, there was no outage in the Reserve Zone. If, instead, load loss in the RTO Region would likely occur simultaneous with load loss in the Reserve Zone, the presence of a simultaneous reserve shortage in the RTO

Region adds little to the incremental value of operating reserve in the Reserve Zone.[20] This suggests that when there is a reserve shortage in a nested Reserve Zone and simultaneously in the RTO Region (or a surrounding Reserve Zone), rather than doubling the Penalty Factor and reserve value, a much smaller increment should be used, reflecting the degree of correlation in the two areas' conditional outage risks.

6. Phase-In of Penalty Factors

66. PJM proposes to phase in the full penalty factors: beginning with $250/MWh in 2011, the penalty factors would increase to $400/MWh in 2012 and $550/MWh in 2013 before achieving the proposed final value of $850/MWh in 2014. The purpose of the transition is to "allow market participants a period of time to gain experience with the new mechanism and to become more comfortable with hedging against higher prices that are associated with reserve shortage conditions." Sotkiewicz Affidavit, p. 28. PJM's proposal results in phasing in the penalty factors over three years, from 2011 to 2014, consistent with the phase-in example noted in Order 719 (P 254). Phasing in the maximum penalty factors is prudent, as the implementation of shortage pricing entails substantial changes to PJM's rules and markets. The phase-in is especially important under PJM's proposal involving vertical demand curves and additive penalty factors for multiple reserve products or zones. If steps are added to the operating reserve demand curve, the phase-in proposal would be interpreted as setting annual maximums for the prices on each step of the curve.

7. Operating Reserve Demand Curve and Penalty Factors: Recommendations

67. Based on the discussion in this section, I recommend the PJM Proposal be modified to include multiple steps in the operating reserve demand curves and to lower the second Penalty Factor when nested zones are short:

68. **Stepped Operating Reserve Demand Curve**. The operating reserve demand curves should be modified to have at least three steps. To keep the structure simple while achieving the most important distinctions, I suggest three steps equal to 10%, 20% and the remaining 70% of the reliability requirement, priced at $250/MWh, $400/MWh and $850/MWh.

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[20] For a rigorous discussion of locational operating reserve pricing that supports and generalizes this example, see Hogan, William W., *Scarcity Pricing and Locational Operating Reserve Demand Curves*, presented June 2, 2010 at the FERC Technical Conference on Unit Commitment Software, Docket No. AD10-12, p. 19-27.

Of course, these steps and prices should be set so that the prices remain well above the incremental value of operating reserve at each level of reserve. If PJM presents analysis suggesting that the value of reserves at these levels might exceed these prices (I consider this unlikely to be the case), the steps or prices should be adjusted.

69. **Synchronized/Primary Reserve Prices and Penalty Factors**. If steps are added to each operating reserve product's demand curve as recommended above, the inefficiency of using additive operating reserve prices and penalty factors for the two reserve products would be mitigated and I would recommend no changes to the two penalty factors. However, consideration should also be given to implementing a single operating demand curve for Primary and Synchronized reserves.

70. **Nested Zone Penalty Factor**. The PJM Proposal should also be modified to apply a much smaller second Penalty Factor when reserves are short in a Reserve Zone and in a surrounding zone, consistent with the relatively small increment in the value of nested zone operating reserve that likely results from this circumstance. I suggest $400/MWh. This value should reflect the estimated likelihood that curtailment could occur in the surrounding zone when curtailment was not occurring in the nested zone, as described above.

71. **Penalty Factor Phase-In**. With a stepped demand curve, PJM's proposed transitional penalty factors ($250/MWh for 2011, $400/MWh for 2012, and $500/MWh for 2013) would be applied as maximum values for all steps for each year. Thus, my proposal compares to the PJM Proposal in the following way:

a. In 2011, there is no difference between my proposal and PJM's Proposal. All steps of the operating reserve demand curves would be priced at $250/MWh, and the second penalty factor for nested zones would also be $250/MWh.
b. In 2012, the only difference would be the relatively small price difference ($250/MWh compared to $400/MWh) applicable to the last 10% up to the Reserve Requirement. The nested zone value would be the same ($400/MWh).
c. In 2013 and later years, there would be a price difference for the two smaller steps (10% and 20%) and for the nested zone penalty factor.

B. Resource Pricing and Price-Setting

72. The PJM Proposal includes various changes related to its shortage pricing proposal intended to improve resource pricing and price formation. Some of these changes are discussed in this section.

1. Relaxation of the Price Cap on Day-Ahead Bids

73. PJM proposes to raise the price cap on demand and virtual bids in the Day-ahead market to the maximum price level that may be attained in the Real-time market ($2,700/MWh). This is necessary to allow Day-ahead prices to equilibrate with Real-time market prices when shortage pricing is anticipated and Real-time market prices in excess of $1,000/MWh are expected. The Sotkiewicz Affidavit describes how a $1,000/MWh price cap in the Day-ahead market, when market participants anticipate much higher prices in the Real-time market, would lead to gaming strategies and a need to pro-rate offers to clear supply and demand. Sotkiewicz Affidavit, p. 31. I agree that the $1,000/MWh price cap in the Day-ahead market should be lifted if much higher prices are possible in the Real-time market to prevent such gaming and inefficiency.

74. However, while necessary, this change does raise additional market power concerns. Suppliers clearing large portfolios of capacity mainly in the Day-ahead market may have an incentive to offer virtual bids ("DECs") at prices even above the prices they expect in the Real-time market reflecting shortage, in order to raise the Day-ahead price even above expected Real-time prices. While the DEC bids may make a loss, this could be more than compensated by a higher price earned by the capacity sold in the Day-ahead market if the price there is raised. I do not see how this can be mitigated, so the IMM should monitor it carefully.

2. Emergency Demand Response and Emergency Purchases Setting Price

75. PJM proposes that prices in the Real-time market can be set by emergency demand response, emergency purchases from outside the RTO Region, or generation from emergency segments of generators already on-line and operating. PJM states that this allows Real-time prices to reflect system conditions and the actual marginal cost of energy at any time.

76. The IMM recommends retaining the current rules which do not allow emergency demand response or emergency purchases to set price. IMM states that allowing such resources to set price raises new market power concerns because such offers are not subject to mitigation and may be submitted by entities in a position to benefit by higher Real-time market prices.

IMM also states that allowing emergency demand response to set price would reduce the dispatch fidelity because these resources are not required to have the telemetry, metering and specific bus location required of dispatchable resources.

77. Allowing these resources to appear in the dispatch stack at prices that reflect their willingness to generate or to reduce consumption will result in more elastic supply and demand at high price levels and improve the efficiency of system operation and pricing when operating reserves are relatively low. The goal should be to see price-driven dispatch of as many resources as possible.

78. However, these reforms raise market power concerns, and are not fundamental or essential to the implementation of shortage pricing. PJM should defer these changes until some experience with shortage pricing has been gained and it is able to address the market power concerns and also the lack of telemetry and metering for emergency demand resources.

3. Price Formation under Voltage Reduction or Manual Load Dump

79. PJM also proposes how emergency actions such as a voltage reduction or manual load dump will be treated under the shortage pricing rules. Because such actions may reduce system load by a substantial amount, they could potentially relieve operating reserve shortages and, thereby, lower prices, which according to PJM would send the wrong price signal.

80. Such actions are generally taken only when the system is already in both a Primary and Synchronized reserve shortage,[21] and PJM proposes to maintain prices reflective of the combined penalty factors ($1,700/MWh) when such actions are taken. However, PJM provides no details of how this would be done, how the system would be balanced when prices may exceed the level that matches supply and demand, and how it would return to normal pricing based on the joint optimization of energy and operating reserves.

81. These emergency actions have the same effect as a huge customer dropping off the system, which naturally would tend to reduce prices. While prices should not decline sharply when these administrative actions are taken, it is also true that the proposed approach leaves the system in a state under which prices are no longer reflecting the actual state of supply and

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[21] PJM Manual 13: Emergency Operations, Section 2: Capacity Emergencies, p. 17 (a voltage reduction alert is implemented when the estimated operating reserve capacity is less than the forecasted synchronized reserve requirement).

demand. PJM should provide more detail in its Tariff regarding how it plans to treat such emergency actions under the full range of system conditions under which such actions could be taken, how pricing would work for the duration of the emergency actions, and how pricing based on supply and demand would be restored. PJM's proposal should minimize the extent and duration of this administrative override of the shortage pricing mechanism.

C. Market Buyer Protections

82. Shortage pricing allows energy and operating reserve prices to rise to much higher levels than was possible in the past; this greatly increase the incentives for market participants to take actions to try to raise prices. In addition, shortage pricing reduces out-of-market purchases and sets market-clearing prices based on the shortage pricing. This greatly increases the potential impact of high prices on consumer costs. For these reasons, shortage pricing should be implemented with careful attention to ways the rules could lead to incorrect or inefficient results, and ways market participants might be able to exploit the rules.

83. The PJM Proposal reflects inadequate attention to the potential impacts of the proposed shortage pricing rules and related changes on consumers in several respects, discussed in this section. The Sotkiewicz Affidavit expresses the view that "reserve shortages should be highly infrequent occurrences in the presence of a resource adequacy construct such as RPM" (p. 6) and "since scarcity/shortage events occur so infrequently, there should be no real concern about a significant or measurable transfer of wealth from suppliers to load" (p. 26). Even allowing that the latter statement probably intended to acknowledge concerns regarding transfers of wealth from load to suppliers (transfers the other direction do not occur), the statement suggests that the designers of the PJM Proposal fail to appreciate the potentially game-changing nature of the proposed package of changes and the risk that it could lead to unintended and very costly results. While market participants, including bother suppliers and consumers, have behaved in certain ways in the past during times of system stress, the PJM Proposal creates new incentives and opportunities that could lead to entirely new strategies and substantially different results.

1. Shortage Pricing False Positives

84. A shortage pricing false positive is an instance when prices rise to levels consistent with the presence of a shortage or near-shortage condition, but the system actually has

no shortage or a much less severe shortage. False positives would occur due to flaws in the shortage pricing and related market rules, perhaps exacerbated by market participant strategies to exploit the flaws. The PJM Filing does not even discuss the risk of false positives or claim that the PJM Proposal will not be vulnerable to false positives, which have been a concern and a problem under other RTO's shortage pricing rules[22] and could have much larger impacts on the PJM system. The IMM expresses the view (IMM Statement, p. 42) that the PJM Proposal is vulnerable to this problem.

85. PJM should provide additional discussion of how false positives could potentially occur and how its proposal minimizes vulnerability to false positives, and correct the rules or propose additional protections against any vulnerabilities that may remain.

2. Market Power and Market Power Mitigation

86. The PJM Proposal calls for eliminating the current rules that relax market power mitigation during scarcity events, so that mitigation applies during hours of shortage pricing. However, the IMM Statement notes several market power concerns that result from the PJM Proposal:

a. Increased incentive to exercise market power, and reduced protection against it, resulting from increasing the maximum energy price from $1,000/MWh to $2,700/MWh (p. 19);
b. Potential exercise of market power in the Day-ahead market resulting from lifting the $1,000/MWh cap on Day-ahead market offers (p. 22);
c. Impact of separate offers for energy and within-hour synchronized reserves (p. 47);
d. Lack of a must-offer requirement for synchronized reserves (p. 49);
e. Allowing emergency demand response to set price (p. 59);
f. Allowing emergency purchases to set price (p. 61).

87. While I discuss some of these concerns elsewhere in this affidavit, I have not evaluated all of these concerns. It is very difficult to forecast the strategies market participants may be able to devise in response to multiple changes to PJM's market rules. PJM should

[22] See, for instance, Potomac Economics, 2005 State of the Markets Report, New York ISO, pages 84-86 (finding a substantial number of 15-minute intervals with shortage pricing but no actual shortage).

address these concerns and adjust its proposal to provide stronger protections against exercise of market power. In light of these concerns, some of the non-essential elements of the PJM Proposal should be delayed until operational experience has been gained with the mechanism.

3. Shortage Pricing Emergency "Circuit Breaker" Provision

88. Operating reserve shortages should be very rare over the next several years due to the PJM system's present excess capacity. However, despite excess capacity, there could potentially be many hours of shortage pricing and substantial transfers of wealth from consumers to suppliers due to any of the following types of causes:

a. A common mode failure affecting multiple capacity resources, such as the loss of a major electric or natural gas transmission facility or a group of generating units. This could result from an act of God (e.g., extreme weather), or by legislative, regulatory or judicial action (e.g., shutting down coal or nuclear plants based on an interpretation of environmental, safety or public health laws), or a terrorist act, to give a few examples.

b. A flaw in the new market rules allowing repeated false positives for shortage pricing, possibly exacerbated by supplier strategies to exploit the flaw.

c. Substantial, repeated exercise of market power or gaming to cause shortage pricing and high prices, which could be possible if these strategies are not fully anticipated and mitigated in designing the shortage pricing rules.

89. Should the PJM system encounter an extreme situation resulting in insufficient capacity and operating reserves day after day, PJM should of course continue to acquire resources, including very high-priced resources, as needed to operate the system reliably and maintain service to as many customers as possible. However, should circumstances occur that result in the shortage pricing mechanism setting very high reserve and energy prices on multiple hours day after day, it could rapidly cause an enormous transfer of wealth from consumers to producers, making a bad situation for consumers even worse while causing a windfall for suppliers. This concern led to discussion in the stakeholder process of "force majeure" type provisions that would trigger a suspension of some aspects of the shortage pricing mechanism under certain extreme circumstances. The topic was discussed in the Shortage Pricing Working Group and a force majeure proposal was voted on at the Markets and Reliability Committee, gaining substantial support.

90. The PJM Proposal should be modified to include what could be called an emergency "circuit breaker" provision that could be activated only by Commission order. The provision might work as follows:

a. **Circuit Breaker Provision**. PJM would add to its Tariff rules that, if activated by Commission order, would prescribe that all purchases of energy or ancillary services above a price threshold (such as $1,000/MWh) would temporarily be compensated on an out-of-market basis (cost plus an adder) rather than establishing market-clearing prices above the threshold.

b. **Trigger for PJM Filing**. The rules would also specify that, should the cumulative hours of shortage pricing exceed a threshold (say, 30 hours over a 10-day period), or should PJM prospectively expect that hours of shortage pricing may exceed a threshold (for instance, due to an event resulting in a loss of facilities), PJM must file with the Commission within a very short period a description of the recent and/or anticipated circumstances and a rough estimate of the potential impact on prices and consumers. PJM would also file any additional information it felt might be useful to the Commission for determining whether it would be appropriate to activate the circuit breaker provisions.

c. **Activation and Termination of Circuit Breaker Provisions**. The circuit breaker provisions would only go into effect upon an order of the Commission, and the Commission would also determine the circumstances under which normal pricing would be resumed.

91. Other approaches could be followed for protecting consumers from extended periods of very high prices under the shortage pricing rules and the unwarranted transfers of wealth they could cause. However, because such a circumstance would likely arise quite suddenly and the Commission typically only addresses problems with market rules prospectively, there is value in anticipating such instances and having tariff rules and a process in place for addressing such instances in a timely manner.

92. It is also worth noting that for some scenarios that could lead to an extended period of shortage pricing, the duration of the situation might depend to a great extent upon the actions of an entity that happens to benefit from the shortage pricing and transfer of wealth it causes. Many scenarios of major generation or transmission outages leading to shortage pricing would involve facilities owned and maintained by PJM entities that also own or are affiliated with considerable portfolios of generation that would earn the shortage prices. Such entities' incentives to bring the affected generation or transmission facilities back into service as soon as possible will be compromised by the very high prices resulting from the shortage pricing rules. A circuit breaker provision would mitigate this unfortunate incentive to some extent.

D. Interaction of Shortage Pricing with Resource Adequacy and RPM

93. Order 719 recognized the connection between shortage pricing and capacity markets and required RTOs to address this in their shortage pricing compliance filings.

> Shortage pricing in an emergency and capacity markets for long-term resource adequacy assurance serve largely distinct purposes, but we agree that they should not work at cross purposes. Adding any new element to a market design can have effects on the other elements. We require that each RTO and ISO address in its compliance filing how its selected method of shortage pricing interacts with its existing market design. Order 719, P 204.

94. Operating reserve pricing and the RPM capacity construct both are directed at having adequate resources for reliability, operating in different timeframes. The reformed rules for pricing during operating reserve shortages will attract additional supply- and demand-side resources during times of system stress, increasing reliability. These rules will also increase the prices and revenues available to all resources that contribute to reliability during such times. It is very important that PJM's RPM resource adequacy construct, operating in the months- to years-ahead time frame, take these impacts (both megawatts and dollars) into account, lest RPM acquire excess capacity at an excessive cost.

95. The Sotkiewicz Affidavit suggests that shortage pricing is needed, despite the presence of RPM, because capacity is acquired through RPM only "to meet *expected* peak system and energy market conditions" (p. 6, emphasis in original) and resource adequacy requirements are "based on expected peak weather conditions and forecast economic conditions" (p. 6-7). The Sotkiewicz Affidavit suggests that some combination of extreme realizations of peak weather, economic conditions, or supply resource performance would lead to reserve shortage conditions (p. 7). These statements about how the RPM capacity requirements are established are incorrect. The modeling used to determine the Reliability Requirements to be acquired through RPM is probabilistic and represents very extreme outcomes for peak load multiple standard deviations about expected loads.[23] The modeling also probabilistically represents very extreme combinations of generator outages. The assistance available from neighboring systems is also represented probabilistically, and these and other assumptions also reflect various very

[23] *2009 PJM Reserve Requirement Study*, p. 15, available at http://www.pjm.com/documents/~/media/documents/reports/ 2009-pjm-reserve-requirement-study.ashx.

conservative choices. This probabilistic and very conservative modeling approach then determines the amount of capacity required to provide a very high level of reliability -- "one day in ten years." In addition, all of these assumptions are revisited annually, and if conditions change and estimated requirements increase as a delivery year approaches, RPM rules call for acquiring additional capacity through incremental auctions. The Sotkiewicz Affidavit states, "Had the RPM construct procured enough capacity to account for the extreme realization, the cost of maintaining such a *level o*f capacity would drive up the price of capacity in the RPM and the amount of capacity procured increasing overall wholesale market expenditures to guard against low probability, extreme realizations of weather, economic activity, and supply resource performance." In fact, the RPM construct already does procure enough capacity to account for low probability, extreme realizations, and it already does drive up wholesale market expenditures. This is why shortage pricing should be a different way, rather than an additional way, for capacity suppliers to be compensated for contributing to reliability in times of peak demand or low supply.

96. With respect to shortage revenues, PJM proposes to allow the extra revenues to flow through the existing mechanism whereby net energy and ancillary services ("E&AS") earnings are reflected in the RPM construct through the existing E&AS "offsets". The IMM proposes an approach to offsetting certain shortage revenues against RPM payments in the year the shortage revenues occur. With respect to the impact of shortage pricing on capacity requirements, neither PJM nor IMM made any proposal.

1. PJM's Proposal: The Existing RPM E&AS Offsets

97. RPM is designed to provide additional "capacity" payments that are considered necessary because it is believed net revenues from PJM's E&AS markets are inadequate to attract and retain sufficient generating capacity to provide desired levels of reliability. Consistent with this concept, a sloped capacity "demand" curve is constructed based around a price equal to the estimated amount a "reference unit" (combustion turbine) would have to earn from RPM capacity payments to break even over the life of the unit. This price ("Net CONE") is established by subtracting from the reference unit's estimated levelized cost of construction ("CONE") an estimate of the reference unit's anticipated average net earnings from E&AS markets over the life of the project (the "E&AS Offset"). For example, if CONE is $200/MW-day and the E&AS Offset is $40, this concept suggests that Net CONE is $160/MW-day, and

RPM is designed to provide the additional $160/MW-day the combustion turbine is considered to need to make construction worthwhile. If the E&AS Offset rises to $70 (for instance, due to higher electricity prices, or new shortage pricing rules) the amount the reference unit would need to earn from RPM declines to $130/MW-day. Net CONE, and the RPM capacity demand curve, would be lowered, and RPM clearing prices would also decline.

98. In concept, the RPM E&AS offsets are supposed to reflect expectations of future E&AS market revenues. However, because a forward-looking approach to estimating future net E&AS earnings has never been developed, instead the RPM E&AS Offsets have been calculated based on a three-year historical average. In addition to the E&AS Offset for the Net CONE calculation, historical three-year average *unit-specific* E&AS offsets are determined and subtracted from estimated unit-specific avoidable costs to set the RPM offer caps for existing units.

99. A pulse of extra E&AS revenues, as could result from shortage revenues, will increase the E&AS Offsets, lowering the RPM capacity demand and supply curves and, as a result, lowering RPM clearing prices and revenues. However, because the E&AS Offsets are calculated based on three-year historical averages, a pulse of extra E&AS revenues in, say, 2011 will be reflected in the E&AS offsets calculated for the RPM auctions held in 2012, 2013, and 2014 to determine capacity prices and revenues for the 2015/2016, 2016/2017, and 2017/2018 delivery years, respectively. Thus, under the current approach, a pulse in E&AS revenues in one year only affects RPM parameters and prices for the delivery years four, five and six years later, when market conditions may be very different.

100. In addition, the impact on future RPM revenues through the E&AS offsets of a pulse of extra E&AS revenues at any time may be greater or less than the magnitude of the pulse, depending primarily on the clearing point on the RPM demand curve (the IMM Statement, Appendix B presents some scenarios in this regard).

101. A three-year historical average is a very poor proxy or estimate for E&AS revenues three additional years into the future. For example, if the years 2008 to 2010 had been characterized by excess capacity and low E&AS earnings, the E&AS offsets used in the RPM auctions held in 2011 for the 2014/2015 delivery year would be low, and the Net CONE and offer cap values would be high, resulting in higher RPM prices for that delivery year. But if market participants and potential entrants actually expect E&AS revenues in 2014 to be much

higher than they were during 2008-2010 (due, for instance, to shortage pricing rules, or reduced capacity excess), the higher RPM parameters and prices would not be necessary or appropriate to attract and retain sufficient capacity for that delivery year. Similarly, if E&AS revenues were higher during the historical period than the market expects going forward, the RPM construct may offer prices that are too low. This approach results in RPM parameters that may be substantially out of sync with market expectations.

102. That the historical three-year average is a poor approach to determining the E&AS Offsets has been recognized by stakeholders, PJM's consultant,[24] and the Commission.[25] In 2008 through the PJM Capacity Market Evolution Committee, stakeholders attempted to work out the details of a replacement approach. PJM proposed a forward-looking E&AS offset based on forward fuel or electricity prices,[26] while the IMM proposed an ex post true-up of scarcity revenues.[27] However, no alternative approach has received sufficient stakeholder support.

103. Shortage pricing will make the flaws of the existing E&AS offset approach more costly and disruptive to the RPM mechanism. Shortage revenues are likely to be very uneven from year to year, making total E&AS revenues much more volatile; in years with hot summers (such as 2006 or 2010), and in years when capacity is relatively tight (for whatever reasons), there could be many hours of shortage pricing and substantial shortage revenue, while in years with excess capacity or a mild summer, there may be no shortage pricing events at all. As the IMM describes (IMM Statement, p. 36-37), because pulses of shortage revenues would only affect RPM prices for delivery years several years following the shortage events, RPM price signals would be well out of sync with anticipated capacity and capacity revenue needs. Therefore, shortage pricing, by making E&AS earnings larger and more volatile, exacerbates the disconnect between a historical average E&AS offset and anticipated market conditions and

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[24] The Brattle Group, *Review of PJM's Reliability Pricing Model (RPM)*, June 30, 2008, p. 53-54 (stating that E&AS Offsets based on historical averages can result in uneconomic and inaccurate price signals, and recommending alternatives, such as a forward looking offset with an ex post true-up).

[25] PJM Interconnection, L.L.C., 124 FERC ¶ 61,272, Order on Motion for Technical Conference, P 45 ("Given the critical importance of Net CONE to RPM, PJM and its stakeholders need to thoroughly review and refine the methodology for determining energy and ancillary services revenue offsets…").

[26] PJM, *Methodology for Computing Forward Looking E&AS Offsets in RPM with a Stylized Example*, presented at Capacity Market Evolution Committee meeting, September 29, 2008.

[27] Monitoring Analytics, *Summary of Position of Independent Market Monitor for PJM on RPM Market Design Issues*, Capacity Market Evolution Committee meeting, October 6, 2008.

E&AS earnings. While a better approach to determining the E&AS Offsets has always been needed, with shortage pricing the need becomes more urgent. E&AS earnings should increase over the coming years due to increasing price-responsive demand and other market reforms, further contributing to the need for reform of the historical E&AS Offset approach.

104. In addition, for delivery years through 2013/2014, RPM parameters were set without anticipation of shortage pricing, resulting in higher RPM prices than would have been set had the E&AS offset anticipated future shortage pricing. If resources earning these RPM prices also earn shortage revenues in these delivery years, arguably they will have been paid twice for the same reliability service, which would be undeserved and unfair to the consumers paying the bills.

105. For these reasons, PJM's proposal to simply allow shortage revenues to flow through the existing RPM E&AS Offset calculations should be revised. Basing RPM parameters for a delivery year on market prices and revenues four to six years in the past is no longer acceptable. The PJM Proposal also allows duplicative payments for shortage events and for RPM for delivery years through 2013/2014.

2. The IMM Proposal for a Shortage Revenue "True Up"

106. The IMM proposes a Shortage Pricing Revenue True Up Mechanism (IMM Statement, p. 33) to offset shortage revenues against capacity payments in the same year. Under the IMM proposal, capacity resources (that is, resources that have cleared in RPM and will receive RPM capacity payments) would not retain shortage revenues unless and to the extent those revenues exceed the resource's RPM payment in a delivery year. The example is given of a capacity resource that receives $100/MW-day from RPM and on three days of shortage pricing during the delivery year stood to receive $120/MW-day in shortage revenue, but would receive only the $20/MW-day amount in excess of the RPM payment. Had the shortage revenues been less than $100/MW-day, the resource would receive no shortage revenues. For this calculation, IMM proposes that shortage revenues are identified based on the impact of the penalty factors when they are added to energy prices under the shortage pricing rules. Because shortage pricing occurs directly only in the real-time market, only revenues earned in the real-time market would be subject to the proposed True Up mechanism. Also, the True Up applies only to the amount of capacity cleared in RPM, not any additional capacity that might be available from the same resource.

107. However, the IMM's proposed true-up would not reflect shortage revenues in RPM in a timely and effective manner. The main problem with the IMM proposal is that it will likely result in very little of the shortage revenues being trued up. Under most circumstances, capacity sellers will not expect annual shortage revenues to exceed the RPM payment (certainly not early in the delivery year when there has been little or no shortage pricing as yet) and, therefore, would expect that under this True Up mechanism, any shortage revenues they might earn would not be retained. As a result, on days when a chance of shortage pricing is anticipated, capacity sellers would strongly prefer to clear in the Day-ahead market where they will retain all revenues, rather than the Real-time market where any shortage revenues would be lost through the True Up mechanism. Capacity sellers would also expect that the Day-ahead market price will reflect the expectation of shortage revenues in the Real-time market due to arbitrage using INCs and DECs. Loads would also prefer the Day-ahead market under these circumstances, as prices will be less volatile there and possibly lower to the extent arbitrage is incomplete. As a result, it can be expected that on days when shortage pricing is considered a possibility, nearly all the output of capacity sellers will clear in the Day-ahead rather than the Real-time market and there will be very little capacity seller shortage revenue captured by the True Up mechanism. Day-ahead weather and load forecasts are fairly accurate, so some of the days and hours when high demand may lead to shortage pricing should be reasonably predictable. Capacity sellers clearing in the Day-ahead market will in fact earn shortage revenues (prices in the Day-ahead market should reflect expected Real-time shortage prices, due to arbitrage), but these earnings will not be captured by the True Up mechanism that operates only on Real-time revenues.

108. A second problem with the IMM proposal is that it identifies shortage revenues based on operating reserve prices equal to the penalty factor. With PJM's proposed vertical demand curve and Penalty Factors equal to \$850/MWh, operating reserve prices can rise to close to \$850/MWh and this would not be considered shortage revenue under the IMM's proposed True-Up because the penalty factor does not yet apply. With the recommended stepped operating reserve demand curve, revenues would be classified as shortage revenues once operating reserve prices equaled the price on the first step of the curve.

109. Finally, a lesser problem with the IMM True Up proposal is that, to the extent there are sales subject to the true up, it can weaken the capacity seller's incentive to perform. If

a capacity seller's output clears in the Real-time market and, in addition, the seller anticipates its annual shortage revenue to be less than the RPM payment, the seller will anticipate that the shortage portion of the prices earned will not be retained. Thus, the incentive to perform is weakened and even eliminated for any portion of the capacity for which the cost (including any opportunity cost) exceeds the non-shortage portion of the price. However, the RPM penalty provisions provide additional incentives to perform.

3. Recommendation for Reflecting Shortage Revenues in RPM

110. Neither the PJM Proposal, with its substantially lagged reflection of shortage revenues in RPM, nor the IMM True Up proposal, which could result in very little true up of shortage revenues for capacity sellers, adequately connects shortage pricing to the RPM construct. In addition, neither proposal addresses the broader problem that RPM's E&AS Offset, based on a historical average, does not accurately forecast future E&AS earnings with or without shortage revenues. Nor would either proposal address the problem that RPM prices have been set through May 31, 2014 without consideration of the shortage pricing rules that will be in effect beginning in 2011.

111. The existing RPM E&AS Offset approach based on a historical average should be replaced with a properly forward-looking E&AS Offset, with or without a provision for true-up based on actual delivery year revenues, as has been discussed in the past. The revised E&AS Offset and True Up approach should address all E&AS revenues, including shortage revenues without distinction.

112. As a transitional measure for the delivery years for which RPM auctions have already been run (and perhaps an additional year or two until a replacement E&AS Offset approach is implemented), an effective true up mechanism could be put in place that might work as follows:[28]

a. Capacity sellers would retain the greater of RPM revenues or shortage revenues for each delivery year. For the purpose of determining whether shortage revenues exceeded RPM revenues, shortage revenues would be estimated based on the

[28] This shortage revenue offset is similar to that proposed by DTE Energy Trading in the Shortage Pricing Working Group process, available at http://www.pjm.com/~/media/committees-groups/committees/mc/20100603/20100603-item-04-dte-energy-trading-alternative-proposal.ashx.

operation of a “reference unit” (combustion turbine), not actual unit performance. If, based on this measure, shortage revenues were greater than the RPM payment, the capacity seller would retain all actual earned shortage revenues but receive no RPM payment for the year. If instead, according to this measure, shortage revenues were less than the RPM payment, the capacity seller would receive an RPM payment equal to the difference between the RPM payment and the reference unit’s estimated shortage revenue.

b. In calculating the reference unit shortage revenues, it would be assumed that the reference unit sells its output into the Real-time market. Because the shortage revenues expected to be available in the Real-time market should also be reflected in the Day-ahead market prices through arbitrage, this will be a reasonable estimate of shortage revenues even though most capacity clears in the Day-ahead market. Alternatively, it could be assumed that the reference unit split its output between the Day-ahead and Real-time markets based on the actual proportions in each hour, and the shortage revenue earned in the Day-ahead market would be the difference between the actual Day-ahead price and the Real-time price net of the shortage portion of the price when there is shortage.

113. This approach corrects the main problem with the IMM’s proposed True Up, as it captures shortage revenues, whether earned directly in the Real-time market or in expectation in the Day-ahead market. In addition, it has the advantage of leaving all incentives to perform in place. Because shortage revenues are estimated based on the performance of a reference unit, not actual performance, at the margin a capacity seller retains all earned revenues. The amount by which the RPM payment may be reduced due to shortage pricing is independent of actual unit performance.

114. PJM criticizes revenue offset mechanisms on two grounds. First, PJM states that a revenue offset “violates the Commission’s criteria regarding incentives for new demand response and generation investment as such a policy introduces uncertainty regarding revenue streams from the RPM commitment three years forward.” PJM Filing, p. 44. However, the revenue offset mechanism actually *reduces* investor’s uncertainty about future revenues. Shortage revenues are highly volatile, and a revenue offset mechanism makes the *sum of* RPM payment plus shortage payment much more stable and predictable than a mechanism with an

RPM payment that is invariant to shortage revenues. Potential investors naturally are concerned with total revenues, and potential uncertainty in total revenues, more than individual revenue components.

115. Second, PJM suggests that a revenue offset mechanism violates Commission policy regarding "comparable treatment and compensation during reserve shortage conditions" because RPM and non-RPM resources would be treated differently. PJM Filing, p. 44. This too is incorrect. RPM resources are being paid to provide a reliability service. They have been promised a payment in advance in return for their contribution to reliability. Non-RPM resources have made no such advance commitment, so it is entirely appropriate that these two types of resources are treated differently under the shortage rules. In any case, under the recommended offset approach described above, RPM resources do in fact receive and retain actual shortage revenues earned, just like non-RPM resources, while the RPM payment is reduced based on estimated reference resource shortage revenue earnings. Therefore, PJM's two objections to an offset mechanism are incorrect. The recommended revenue offset approach is consistent with the Commission's policies and Order 719's call for shortage pricing proposals to consider interactions with capacity constructs.

4. Linking the Shortage Pricing Mechanism to Capacity Requirements

116. Shortage pricing will attract additional non-RPM supply resources and additional demand reductions during periods of system stress. These additional resources reduce the amount of capacity that must be arranged in advance through RPM to meet reliability standards.

117. PJM's existing methodologies[29] for determining the amount of capacity to be procured through RPM (the Reliability Requirements for the RTO Region and for Locational Deliverability Areas) will not anticipate the additional supplies and demand reductions resulting from a shortage pricing mechanism. The methodology determines the amount of capacity required to satisfy reliability standards (assuming a very conservative amount of assistance from neighboring systems), and it is assumed that this amount of capacity must be procured through

[29] PJM's approach to determining its installed reserve margin and Reliability Requirements is documented in *2009 PJM Reserve Requirement Study*, available at http://www.pjm.com/documents/~/media/documents/reports/2009-pjm-reserve-requirement-study.ashx.

RPM. Shortage pricing is designed to attract non-RPM supply- or demand-side resources, and such resources are assumed to be zero in the determination of capacity requirements.

118. If the resources attracted by the shortage pricing mechanism are not reflected, the Reliability Requirements will be larger than necessary, RPM will acquire excess capacity, and capacity prices and costs will be excessive as a result. In addition, the excess capacity depresses E&AS prices and revenues, lowering the value of demand response and price-responsive demand and potentially discouraging and delaying the further implementation of smart meters and devices.

119. The PJM Proposal should be modified to explicitly call for reflecting the impacts of shortage pricing on future capacity requirements. Specifically, estimates of the additional non-RPM supply and demand response that will become available during peak periods should be reflected in the modeling to estimate capacity needs to meet the applicable reliability standards. Because RPM rules include "incremental auctions" closer to each delivery year through which additional capacity can be procured if needed, it is not necessary to apply highly conservative assumptions in estimating Reliability Requirements three years in advance. Therefore, forward-looking estimates of the impacts of shortage pricing should be used rather than delaying until actual historical data becomes available.

120. This completes my affidavit.