Review of the Manner in which Locational Marginal Prices ("LMPs") are Established

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On January 27, 2006, the FERC issued an order accepting a Settlement Agreement filed by PJM on November 16, 2005, resolving all issues set for hearing in Docket No. EL03-236-006 and Docket No. EL04-121-000. The issues in these dockets were primarily related to exempting PJM interfaces from offer-capping, utilization of the three-pivotal supplier test to determine whether suppliers have the potential ability to exert market power, and the appropriateness of implementing scarcity pricing in PJM.

Section V, paragraph 14 of the Settlement Agreement states that a review of the manner in which locational marginal prices (LMPs) are set by generating units dispatched to reliably serve load will be conducted by PJM and the PJM Market Monitoring Unit. Consistent with the terms of the settlement, the purpose of this review is to ensure that pricing is consistent with PJM market rules and a robust and competitive market. This report represents the results of that detailed review. The report is organized around the specific questions posed in Section V of the Settlement Agreement, and provides additional, detailed information regarding the circumstances surrounding instances when generating units are brought on-line under PJM direction and/or kept on-line under PJM direction in circumstances where their offer price exceeds the hourly LMP. The discussion highlights the specific reasons why the offer price for such units might be above the LMP on an hourly integrated basis.

Introduction

The PJM real-time LMP calculation is based on determining the set of generator dispatch levels that are required to meet energy requirements within the 5-minute dispatch interval, taking into account the set of energy offers from the generators and any binding transmission constraints that occur within the interval. PJM is responsible for maintaining reliable operations that account for a variety of potential operating situations and contingency events. Since generators cannot instantaneously startup and shutdown, PJM must schedule some generation on-line in advance of actually needing it to serve energy in order to ensure that adequate generation is deployed when needed. Additionally, many generators cannot shutdown and startup again with short turn around, and as a result they specify a minimum down time of several hours to several days. Therefore, in some cases, PJM may keep a generator online for a few hours in anticipation of needing it to cover a forecasted increase in demand in a subsequent operating hour. When generators are deployed because of these timing limitations, they are not necessarily needed to serve energy requirements or to resolve a binding transmission constraint in the current 5 minute dispatch interval. Therefore such generation may not be included in the calculation of LMPs for the 5-minute dispatch interval.

PJM settlements occur on the basis of the hourly integrated LMP[1]. Therefore, if a generator is either not on-line for an entire hour, or if it is not needed to supply energy requirements or to resolve a binding transmission constraint for every interval within the hour, then its hourly integrated LMP may be less than its offer.

Many of the questions that were listed in Section V of the Settlement Agreement use the term "out-of-merit" dispatch. PJM defines out-of-merit dispatch as the dispatch of a generator out of economic merit order in order to resolve a transmission constraint that does not permit dispatch of the next available economic unit in the dispatch order. The questions listed in Section V appear to use the term "out-of-merit" to refer to a situation in which a generator is on-line and operating under PJM's direction, and for which the unit's offer price is higher than the hourly integrated real time LMP at the unit's bus for that hour. Therefore, for the purpose of this review, PJM investigated the situations where this is the case. However, while this definition is consistent with PJM settlements, it is important to note that even though the hourly integrated LMP at a unit's location may be below the unit's offer price on an hourly integrated basis, the 5-minute LMPs for various intervals within the hour could have been at or above the unit's offer price. As discussed in detail in the sections that follow, system conditions can change substantially even within a given clock hour. As further explained in detail in the response to **QUESTION D** below, the MW output from a given unit must be required to serve load, while respecting all transmission constraints, in order to be eligible to set LMP at its location within a five-minute interval. Given the constantly changing nature of the system, it is possible that a unit may therefore be eligible to set price for some 5-minute intervals within a given clock hour but not others, which would result in an hourly integrated LMP that is below its offer.

Further clarification on the classification of such units is required with regard to units operating in real-time as a result of being scheduled in the Day-Ahead Market. The response to **QUESTION K** below summarizes the mechanism by which generating units are scheduled in the Day-Ahead Market. If a unit is determined to be the most economic choice to meet demand while respecting all transmission and unit operating constraints in the day-ahead analysis, it will be scheduled in the Day-Ahead Market and will be paid the day-ahead LMP at its location for the day-ahead scheduled MW quantity. In the real-time market, a generating unit is credited based on its real-time LMP for any incremental MW quantity it produces above the day-ahead scheduled amount and it is charged based on its real time LMP for any decremental MW quantity it produces below the day-ahead scheduled quantity. The situation in which a unit operates in real time at PJM's direction where a real time LMP is below the unit's offer price during the hours for which it was scheduled in the Day-Ahead Market is a normal condition that occurs when a difference between the Day-Ahead Market results and real-time system conditions exists. Under

[1] PJM calculates hourly LMP as the simple average of the twelve, five-minute interval LMPs at a given location in an hour. This average LMP value for the hour at a particular location is referred to as the hourly integrated LMP.

this condition, the unit's owner actually benefits economically from the balancing market settlement, because the energy sold day-ahead is bought back at a lower real-time price and the unit avoids fuel and operating costs. Real time load also benefits in this situation because it pays a lower price for incremental MW consumed in the balancing market. Therefore, real-time hours where the hourly integrated LMP was below a unit's offer price but where the unit also had a day-ahead schedule are not included as hours where hourly LMP is less than the unit offer for the purposes of this review.

Analysis Results

As indicated above, the analysis conducted by PJM and the PJM Market Monitoring Unit in performing this review was organized around the questions posed in Section V, paragraph 14 of the Settlement Agreement. Each question is listed in bold type. Following the question, PJM has listed the answer along the relevant supporting analysis results.

QUESTION A, What are the reasons units are brought on-line out-of-merit, e.g., economics, location, availability, run times, start limitations, ramping constraints? What percentage share of total out-of-merit dispatch does each respective "reason" represent?
AND
QUESTION B, What are the reasons why out-of-merit units are kept on-line past their minimum run times, e.g., economics, location, availability, run times, start limitations, ramping constraints? What percentage share does each respective "reason" represent? [2]

The actions taken by PJM dispatchers in real-time are recorded in dispatcher logs. The significant volume of manually logged data renders it impractical to examine each and every unit operation over a long period of time for the purpose of conducting this review. Therefore, to accomplish the required review, PJM sampled data from specific periods during the year that were chosen to be a representative cross-section of system conditions. The data collected for this review was drawn from four separate weeks in 2005. The four, one week sampling periods were: January 19 to January 25, April 20 to April 26, July 20 to July 26, and October 5 to October 11. Each sample week begins on a Wednesday and ends on a Tuesday, such that both weekday and weekend conditions are captured.

Because the operational characteristics of steam units are considerably different than the operational characteristics of combustion turbines (CTs), the response to these questions have been broken in two categories: steam unit operation and CT unit operation.

[2] This section responds to both question A and B, due to the related nature of the questions and the resulting analysis.

Combined cycle units can be modeled as either steam units or CTs in the PJM systems. For the purposes of this review, when a combined cycle unit was modeled in the PJM systems as a steam unit, it was counted as a steam unit in the breakdowns that appear below. Similarly, if a combined cycle unit was modeled as a CT, it was counted as a CT in the breakdowns below.

The data for both steam and CT units is first broken down at a high level into the total unit hours during the sample periods where units were running at the discretion of the market participant vs. unit hours where the units were running at the direction of PJM. Following the general breakdowns, the reasons why units were brought on-line when LMP < unit offer price and the reasons why units were kept on-line past their minimum run times when LMP < unit offer price are analyzed separately for both steam units and CT units. There are several reasons for steam units that are common to both bringing units on-line when LMP < unit offer price and keeping units on-line past their minimum run times when LMP < unit offer price, and these common reasons are analyzed separately as well.

General analysis of steam unit hours in the four sample periods

Table 1 shows the total steam unit run hours for the sample periods and the breakdown of the unit hours associated with steam units running as self-scheduled by the market participant and running under PJM direction.

	(1) Total Run hours	(2) Running for Market Participant		(3) Running for PJM		(4) hours when LMP < unit offer price	
	Hrs	Hrs	% of total run hours	Hrs	% of total run hours	Hrs	% of total run hours
Week of Jan19-25	38081	13609	36%	24472	64%	668	1.8%
Week of Apr 20-26	28982	11190	39%	17792	61%	210	0.7%
Week of July 20-26	51119	12415	24%	38704	76%	1908	3.7%
Week of Oct 5-11	36033	9936	28%	26097	72%	349	1.0%
4-Week TOTAL	154215	47150	31%	107065	69%	3135	2.0%

Table 1: Steam unit run hours for the four sample periods

A description of the data categories in Table 1 is provided below.

(1) Total Run Hours: Total run hours are the hours where steam units are generating megawatts (MW) in real-time. There were a total of 154,215 unit hours in the 4 sample weeks.

(2) Running for Market Participant – Steam Units: The Running for Market Participant column indicates the hours during which on-line steam units are operating at the discretion of the unit owner and not for PJM, including those hours where units were self-scheduled and self-dispatched. Self-scheduled and self-dispatched units are not eligible to set LMP on a 5-minute basis. During the study period, 47,150 unit hours or approximately 31 percent of the total real-time steam unit hours were in this category.

(3) Running for PJM – Steam Units: The Running for PJM column indicates hours during which on-line steam units were operating in response to PJM direction. 107,065 unit hours or approximately 69 percent of the total, real-time steam unit hours were in this category. This category can include hours, depending on circumstances, where units may have been eligible to set LMP on a five minute basis.

(4) Hours when LMP < unit offer price – Steam Units: This column indicates those hours where on-line steam units were operating when LMP < unit offer price. 3,135 unit hours or approximately 2 percent of the total, real-time steam unit hours were in this category. As discussed below, these hours are the focus of the analysis performed to outline the reasons steam units are brought on-line by PJM in real time when LMP < unit offer price and kept on line by PJM when LMP < unit offer price in response to questions A and B respectively.

Steam Unit Hours when LMP < unit offer price: Analysis of reasons for bringing units on-line when LMP < unit offer price and/or keeping units on-line past their minimum run times when LMP < unit offer price

Table 2 provides a summary of reasons for steam unit operation when LMP < unit offer price. Nine reasons are identified. There are three reasons for bringing units on-line, four additional reasons that can be applied to both bringing units on-line and keeping units on-line past their minimum run times, and still two additional reasons that apply only to keeping units on-line past their minimum run times. The conditions described by each of these nine reasons are associated with hours where units were operated in anticipation of being necessary to serve load or control transmission constraints. However, because the units' output was not required for some or all of the 5-minute intervals within the indicated hours, these unit hours represented those where LMP < unit offer price. The reasons are numbered 1 through 9 in Table 2 as well as in the detailed descriptions that follow to allow for easy reference.

	Total hours when LMP < offer price	Reasons for bringing units on-line						Reasons common to bringing units on-line and keeping units on-line								Reasons for keeping units on-line			
		Reliability				Unit restrictions		Reliability								Reliability		Unit restrictions	
		(1) Started early for Morning Pickup		(2) For Trans. Cons-traints		(3) Min Run		(4) Reliability Run (RA)		(5) Dispatch Reliability (DR)		(6) OPD/ Reliability Engineer		(7) Reactive Gen		(8) Kept longer than DA for System Reliability		(9) Min Down	
	Hrs	Hrs	%	Hrs	%	Hrs	%	Hrs	%	Hrs	%	Hrs	%	Hrs	%	Hrs	%	Hrs	%
Week of Jan19-25	668	23	3%	12	2%	49	7%	305	46%	261	39%	0	0%	0	0%	15	2%	3	0%
Week of Apr 20-26	210	17	8%	0	0%	9	4%	122	58%	30	14%	28	13%	0	0%	4	2%	0	0%
Week of July 20-26	1908	200	10%	0	0%	158	8%	827	43%	439	23%	78	4%	96	5%	93	5%	17	1%
Week of Oct 5-11	349	2	1%	19	5%	44	13%	46	13%	167	48%	19	5%	36	10%	16	5%	0	0%
4-Week TOTAL	3135	242	8%	31	1%	260	8%	1300	41%	897	29%	125	4%	132	4%	128	4%	20	1%

Table 2: Steam Unit Operation when hourly LMP < unit offer price: Reasons for bringing units on-line and keeping units on-line

Reasons for bringing units on-line while hourly LMP < unit offer price: Steam Units

There are three reasons that apply to bringing a steam unit on-line when LMP < unit offer price. These reasons are (1) bringing steam units on-line early (i.e. – prior to the start of their day-ahead schedule) to assist with the morning load pickup; (2) transmission constraint control; and (3) minimum run time. During the sample periods, these three reasons accounted for a total of approximately 17% of the total, real time, steam unit hours when LMP < unit offer price. Each of these reasons is described in more detail below.

(1) Operation of steam units earlier than their day-ahead scheduled time to assist with the morning pickup - PJM Dispatch may schedule units to come on-line earlier than their Day-Ahead schedule during the morning load pickup periods. The main reason for asking units to come on-line earlier is concern that other steam units, already scheduled to be on-line, will not able to keep up with the fast load increases during the morning pickup period. 242 unit hours or approximately 8 percent of the steam generation hours when LMP < unit offer price were due to units being called on earlier than their Day-Ahead schedule.

Rationale for operation when LMP < unit offer price: When the Steam Units are being pre-positioned for morning load pickup, their MW output may not be necessary to serve load economically or control transmission constraints at all times during the morning pickup. Such units are started so that it will be available to serve load at a subsequent time. At times, such action is needed to ensure sufficient generation response capability is available given the physical limitations and long start cycles of such plants. When such units are started early, it is generally because the dispatcher has detected an unexpected change in load or in generator performance. Since these decisions are made in advance, the conditions can change subsequently. For example, the other units, those already on-line, may subsequently perform better than expected, making the output from the units that were started early unnecessary to serve load or control transmission constraints. For these reasons, some steam units may be online when LMP < unit offer price. PJM Dispatch makes the decision to start steam units earlier based on the forecast system conditions in the evening before the operating day. Changes in real-time system conditions such as lighter system load during the pickup period, higher interchange import and changes in self-scheduled generation by participants may cause the additional steam units scheduled by the dispatchers to be online when LMP < unit offer price.

(2) Transmission Constraints – Steam units typically have long start-up times and long minimum run times. Operators will sometimes need to call on these units well in advance when future system conditions are expected that warrant the need for these units to control transmission constraints. During the study period, 31 unit hours or approximately 1 percent of the steam unit hours when LMP < unit offer price were due to units scheduled for expected transmission constraints.
Rationale for operation when LMP < unit offer price: Due to the long minimum down time and long start-up time requirements for most steam units, it is very unlikely that PJM Dispatch can start a steam unit with short notice should it become necessary to control a transmission constraint. In order to ensure reliable operations, PJM Dispatch may schedule steam units when the power flow and security analysis tools available to them indicate that the unit will be required to control transmission constraints during the upcoming operating period. If forecasted system conditions that warranted the scheduling of a particular steam unit for transmission constraint control do not materialize as expected and the output of the unit is not required, then the unit will be online when LMP < unit offer price.

(3) Unit Minimum Run Time – Once a Steam Unit comes on-line, the physical parameters of the unit, including its minimum run time, must be respected. Therefore, even if system conditions have changed such that the unit is no longer necessary to economically serve load or control the transmission constraint for which it was started, the unit must be kept on-line until the minimum run time is exhausted. 259 unit hours, or approximately 8 percent, of the steam generation hours when LMP < unit offer price were due to units that could not be immediately shut down once they were no longer required due to the minimum run time constraint.

Rationale for operation when LMP < unit offer price: There are many reasons why a unit will become unnecessary prior to the expiration of its minimum run time. It is possible, for example, that the unit was the most economic choice for controlling a transmission constraint even though it was known when it was chosen that it would not be required for its entire minimum run time. Alternatively, real-time system conditions can change significantly after a steam unit is started, rendering the unit's output unnecessary to maintain power balance or to control transmission constraints at the time. Regardless of the reason, the unit will be operating when LMP < unit offer price during the times when its output is unnecessary for economic dispatch or transmission constraint control.

Reasons common to bringing units on-line when LMP < unit offer price and keeping units on-line past their minimum run times when LMP < unit offer price: Steam Units

The four reasons that can be applied to both bringing a steam unit on-line when LMP < unit offer price and keeping it on-line past its minimum run time when LMP < unit offer price are: (4) the unit is scheduled in the Reliability Assessment; (5) the unit is scheduled for dispatch reliability; (6) the unit is scheduled by the Reliability Engineer; and (7) the unit is scheduled for reactive support. During the sample periods, these four reasons accounted for a total of approximately 78% of the total, real time, steam unit hours when LMP < unit offer price. Each of these reasons is described in more detail below.

(4) Reliability Assessment – The Reliability Assessment application utilizes the PJM load forecast to determine the amount of generation that will be required to meet demand and reserves beyond what was scheduled in the Day-Ahead Market. In order to ensure that adequate generating capability will be operating in real time to meet the PJM load forecast as well as the PJM operating reserve objective, the Reliability Assessment may schedule additional units that were not scheduled in the Day-Ahead Market. During the study period, 1,300 unit hours or approximately 41 percent of the steam generation hours when LMP < unit offer price were due to units scheduled for the Reliability Assessment.
Rationale for operation when LMP < unit offer price: The Reliability Assessment application is an automated security-constrained unit commitment application that is executed at 1800 hours on the day prior to the operating day based on forecasted system conditions. It is important to note that the objective of the Reliability Assessment application is to minimize startup costs and costs to operate units at minimum energy levels to schedule sufficient on-line capability to meet the system reserve requirements in additional to meeting the PJM load forecast. A steam unit scheduled on-line using this objective has the potential of being operated when LMP < unit offer price in real-time because it is scheduled specifically to ensure that adequate reserves exist on the PJM system to account for differences between the Day-Ahead Market conditions and real-time operating conditions, load forecast error, unit trips or start failures, less-than-expected interchange, and other potential system

events. Additionally, changes in real-time system conditions from what is expected at 1800 hours on the day prior such as lighter system load, higher-than-forecasted external imports and more self-scheduled generation by participants may cause the steam units scheduled by the Reliability Assessment to not be required in real-time to economically serve load or control transmission constraints and therefore to be operated when LMP < unit offer price.

(5) Dispatch Reliability – PJM Dispatch may schedule additional units for reliability purposes during the operating day based on continuous analysis of expected system conditions via power flow and security analysis tools. Should dispatch personnel identify the need to schedule additional units for reliability purposes, these units will be called on-line according to an analysis of the most cost-effective means to address the identified reliability concern. During the study period, 897 unit hours or approximately 29 percent of the steam generation hours when LMP < unit offer price were due to units scheduled for Dispatch Reliability.
Rationale for operation when LMP < unit offer price: PJM Dispatch is making next-day commitment decisions based on the output of security analysis tools using forecasted system conditions, as well as operating experience. System conditions on a particular operating day, however, can change significantly. Changes such as lighter than expected system load, higher interchange imports or more self-scheduled generation by participants can all contribute significantly to real-time system conditions that differ from forecasts. The PJM market has historically been designed to provide a maximum amount of participant flexibility in making scheduling changes in both transactions and generation operations. This flexibility can create substantial intra-day fluctuations. In addition, flows on certain transmission constraints can be extremely volatile. It is possible that PJM dispatchers will call on steam units with the expectation that they will be necessary to control a transmission constraint, only to have the constraint become less binding intermittently throughout the operating day. In such cases, the units called to control that constraint may set price for some intervals during several hours of a particular day because they are required to control the constraint at some times, but be operated when LMP < unit offer price from an hourly integrated standpoint for the majority of the their run time.

(6) Reliability Engineer Assessment – The PJM Reliability Engineers make a daily assessment of the approved transmission facility outages. As a result of this analysis, units that were not scheduled in the Day-Ahead Market or identified by the Reliability Assessment and that are critical to the reliable operation of the system during the approved transmission facility outages may be scheduled by the Reliability Engineer. For the study period, there were 125 unit hours or approximately 4 percent of the steam generation hours when LMP < unit offer price were due to units scheduled for the Reliability Engineer Assessment.
Rationale for operation when LMP < unit offer price: The PJM Reliability Engineers are making next-day commitment decisions based on power flow and security analysis using forecasted system conditions. If the system conditions during

the transmission facility outage change, such as lighter system load, change in interchange import and more self-schedule generation by participants, or if the transmission outage for which the units were scheduled is cancelled, such that the committed units are not required to control transmission constraint caused by the outage, these unit operations occur when LMP < unit offer price.

(7) Reactive Support – PJM Dispatch may need to schedule a unit to maintain area voltages at reliable levels. Generally, the main reasons for needing reactive support in an area are conditions resulting from transmission facility outages or generation outages. During the study period, there were 132 unit hours or approximately 4 percent of the steam generation hours operated when LMP < unit offer price were due to units scheduled for Reactive Support.
Rationale for operation when LMP < unit offer price: Since the LMP algorithm can only recognize thermal constraints, PJM will create thermal surrogate constraints to represent reactive voltage problems. The PJM reactive interface constraints are examples of post-contingency voltage constraints that are translated into thermal limits for the purposes of control and submission to the Locational Pricing Algorithm. If a local voltage constraint appears suddenly or unexpectedly, it may not be possible to immediately create a thermal representation of the constraint. Similarly, if the constraint is not expected to persist for a significant period of time, it may be impractical to create a thermal representation since by the time it is created and inserted into the PJM monitoring systems, the voltage constraint will have been relieved. Therefore, when units are operated to maintain reliable system voltages and a thermal representation is not created for the voltage constraint, the units operating for the constraint may occur when LMP < unit offer price.

Reasons units are kept on-line past their minimum run times when LMP < unit offer price: Steam Units

There are two reasons that steam units are kept on-line when LMP < unit offer price after their minimum run time has been exhausted. These reasons are (8) system reliability and (9) unit minimum down time restriction. During the sample periods, these two reasons accounted for a total of approximately 5% of the total, real time, steam unit hours when LMP < unit offer price. Each of these reasons is described in more detail below.

(8) System reliability – PJM Dispatch may operate units beyond their Day-Ahead schedule to ensure system reliability. When a number of steam units are released by the Day-Ahead Market at the end of the same hour, such a schedule may create system control issues in real-time. Even though the Day-Ahead arket respects ramp limitations, the existence of financial bids/offers and flexible demand bids in this market may mask control issues that will materialize in real-time. When many steam units have the same ending hour on their day-ahead schedule, PJM Dispatch may decide to release them in small groups and keep some of the units longer so that not

too many units are released at the same time in order to avoid system control problems. During the study period, there were 127 unit hours or approximately 4 percent of the steam generation hours when LMP < unit offer price that were due to units being kept on-line beyond their Day-Ahead schedule for system reliability. **Rationale for operation when LMP < unit offer price**: Since these unit operations are for reliability purposes, their power output may not be required in real-time to economically serve load or control transmission constraints and therefore the may be operated when LMP < unit offer price. Typically, as system conditions change and units are released in an orderly fashion, the units that remain on-line will set price for individual intervals within their remaining run hours, but may be operated when LMP < unit offer price on the basis of the hourly integrated LMP.

(9) Unit Minimum Down Time – due to economic considerations or reliability concerns, PJM Dispatch may need to keep a unit on-line beyond its Day-Ahead schedule. For example, a unit may be held on past its day-ahead schedule because the PJM system load does not begin to decrease as early as forecasted, or because a transmission constraint persists for a longer period of time than was originally expected. When a unit is held on-line longer than it was scheduled in the Day-Ahead Market, it may no longer be possible to meet the unit's minimum down time requirement before the unit is required to be on-line according to its Day-Ahead schedule for the following day. PJM Dispatch may therefore be required to keep the unit on-line until the Day-Ahead schedule begins in the next operating period despite the fact that the unit's output is not needed for those hours. If the unit's output is not needed for those hours until its next day-ahead schedule starts, it will be operated when LMP < unit offer price for those hours. During the study period, 20 hours, or approximately 1 percent of the total, steam unit generation hours when LMP < unit offer price were due to the operation of units such that their Minimum Down Time requirement was not violated. **Rationale for operation when LMP < unit offer price**: During the hours the unit is kept on so that the minimum down time requirement is not violated, the output of the unit may not be required in real-time to serve load economically or control transmission constraints and therefore be operated when LMP < unit offer price.

General Analysis of CT Unit Hours in the four sample periods

Table 3 shows the total CT run hours for the four sample periods and the breakdown of the unit hours associated with CT units running for the participant, running for PJM, and operating when LMP < unit offer price.

	Total Run hours	Running for Market Participant		Running for PJM		Hours w/ LMP < Unit Offer Price	
	Hours	Hours	% total CT run hours	Hours	% total CT run hours	Hours	% total CT run hours
Week of Jan19-25	1660	179	11%	1481	89%	981	59%
Week of Apr 20-26	831	229	28%	602	72%	510	61%
Week of July 20-26	5209	464	9%	4745	91%	2923	56%
Week of Oct 5-11	3681	428	12%	3253	88%	2754	75%
4-Week TOTAL	11381	1300	11%	10081	89%	7168	63%

Table 3: CT unit run hours for the four sample periods

A description of the data categories in Table 3 is provided below.
(1) Total Run Hours – CT Units: This column shows the total unit hours where CT units were producing megawatts (MW) during the sample periods. There were a total of 11,381 unit hours where CT units were operating in real-time in the 4 sample weeks.

(2) Running for Market Participant – CT Units: This category includes unit hours during which CT units are operating at the discretion of the company and not for PJM, including self-scheduled unit hours. Self-scheduled units are not eligible to set LMP on a 5-minute basis. During the study period, 1,300 unit hours or approximately 11 percent of the total CT run hours in the sample periods were in this category.

(3) Running for PJM Dispatch – CT Units: This category includes unit hours associated with CT units operating in response to PJM direction. During the study period, 10,081 unit hours or approximately 89 percent of the total CT run hours were in this category. Unit hours associated with this category can include hours, depending on circumstances, where units may have been eligible to set LMP.

(4) Hours when LMP < unit offer price – CT Units: This category includes hours associated with CT units that are operating when LMP < unit offer price. During the study period, 7,168 unit hours, or approximately 63 percent of the total CT run hours were in this category. As discussed below, these hours are the focus of the analysis performed regarding the reasons CT units are brought on-line by PJM in real time when LMP < unit offer price and kept on line by PJM when LMP < unit offer price in response to questions A and B, respectively.

CT Unit Hours when LMP < unit offer price: Analysis of rationales for bringing units on-line and/or keeping units on-line

There were a total of 7,168 CT unit hours when LMP < unit offer price during the four-week sampling period that forms the basis of this analysis. This value will be used in

comparing the categories of such CT unit operation. These hours are divided in two categories: reasons for bringing CT units on-line; and reasons for keeping CT units on-line past their minimum run times.

Reasons for bringing units on-line when LMP < unit offer price: CT Units

Table 4 provides a summary of reasons for bringing a CT on-line when LMP < unit offer price. The hours reported in Table 4 and described below include only the operating hours when LMP < unit offer price in the sample period where the CT minimum run time has not been exhausted. During the study period, there were a total of 3,407 hours when LMP < unit offer price related to bringing CT units on-line. Four reasons are identified for CT unit operation for bringing units on-line when LMP < unit offer price, and these reasons are described in detail below.

	Total hours for bringing on CTs w/ LMP < Offer	Reasons for bringing CT units on-line							
		(1) Started for Morning Pickup		(2) For Trans. Constraints		(3) Reactive Gen		(4) Dispatch Reliability	
	Hrs	Hrs	%	Hrs	%	Hrs	%	Hrs	%
Week of 1/19-25/2005	542	279	51%	121	22%	0	0%	142	27%
Week of 4/20-26/2005	463	232	50%	143	31%	0	0%	88	19%
Week of 7/20-26/2005	1492	149	10%	571	38%	25	2%	747	50%
Week of 10/5-11/2005	910	171	19%	557	61%	0	0%	182	20%
4-Week TOTAL	3407	831	24%	1392	41%	25	1%	1159	34%

Table 4: CT Unit Operation when LMP < unit offer price: Reasons for bringing units on-line

(1) Units Started for Morning Load Pickup – PJM Dispatch may require scheduling CTs during the morning load pickup (4:00 a.m. to 8:00 a.m.). CTs, particularly those that can be started in a relatively short timeframe, may be required to maintain power balance while other on-line units are not able to keep up with the fast load increases during pickup periods. During the study period, 831 unit hours, or approximately 24 percent of the CT hours of operation when LMP < unit offer price were due to CT units scheduled for the morning pickup.
Rationale for operation when LMP < unit offer price: PJM Dispatch makes the decision to start CT units for the morning pickup based on the forecasted system conditions and the expected steam unit response. Real-time system conditions may change after the CT units are started, such as lighter system load during the pickup period (i.e. – slower than expected load pickup), higher than expected interchange import, and better than expected steam unit ramp performance. As a result, CT generation may not be required to serve load economically or to control transmission constraints once it has been started, and therefore the CT operations may occur when

LMP < unit offer price. It is possible, and more than likely, that CT units started during the morning pickup may set price for multiple 5-minute intervals during some hours, but once the steam generation catches up with the load pickup, the generation may operate when LMP < unit offer price for the remainder of those hours. In these cases, the hourly integrated LMP for the hour will be below the unit's offer price. In some cases, a CT unit's minimum run time may also contribute to the operating hours that are reported in the load pickup category.

(2) Transmission Constraints – PJM Dispatch operates CT units for transmission constraint control throughout each operating day. CT units are required in many instances for constraint control because they are the most cost-effective units available, or steam units not responding quickly enough to control the constraint. Once CT units are on-line, PJM Dispatch continually assesses the cost-effectiveness of their operation and determines when they can be released. During the study period, 1,392 unit hours, or approximately 41 percent of the CT generation hours for bringing units on-line when LMP < unit offer price were due to units scheduled for the Transmission Constraints.
Rationale for operation when LMP < unit offer price: PJM Dispatch makes the decision to start CT units for transmission control based on the expected system conditions and the expected response of the other units already on-line and able to follow PJM dispatch instructions. Real-time system conditions may change after the CT units are started, such as system load, interchange transactions, self-scheduled unit operations and better steam unit steam response to PJM dispatch signal. These changing system conditions can cause the CT units that have been brought on-line due to transmission constraints to no longer be required to control those constraints, and therefore the CT operations will occur with LMP < unit offer price. Additionally, PJM Dispatch may only plan to use the CT generation for a portion of the unit minimum run time. The CT operation will occur with LMP < unit offer price for the portion of the minimum run time not required by PJM. It is important to note that CT units often operate at the margin, and as a result, as system conditions and the flows on transmission constraints constantly change, will not be required to control the constraint for which they were started during every 5-minute interval. Therefore, it is very likely that CTs started for transmission constraints will set price for some 5-minute intervals and not others during any given hour, and as a result the hourly integrated LMP will be less than unit offer price for those hours.

(3) Voltage Support - PJM Dispatch may need to schedule a unit to maintain area voltages. Generally, the main reasons for needing reactive support in an area are transmission facility outages or generation outages. During the study period, 25 unit hours, or approximately 1 percent of the CT generation hours for bringing units on-line when LMP < unit offer price were due to units scheduled for voltage support.
Rationale for operation when LMP < unit offer price: Since the LMP algorithm can only recognize thermal constraints, PJM will create thermal surrogate constraints to represent reactive voltage problems. The PJM reactive interface constraints are

examples of post-contingency voltage constraints that are translated into thermal limits for the purposes of control and submission to the Locational Pricing Algorithm. If a local voltage constraint appears suddenly or unexpectedly, it may not be possible to immediately create a thermal representation of the constraint. Similarly, if the constraint is not expected to persist for a significant period of time, it may be impractical to create a thermal representation since by the time it is created an inserted into the PJM monitoring systems, the voltage constraint will have been relieved. Therefore, when units are operated to maintain reliable system voltages and a thermal representation is not created for the local voltage constraint, the units operating for the constraint may be have an LMP < unit offer price.

(4) Dispatch Reliability – PJM Dispatch may require scheduling CTs to maintain system control. Throughout the operating day, changing system conditions such as RTO interchange and hydro-electric pump and generation schedule changes require CTs to be scheduled to maintain system control. During the study period, 1,159 unit hours, or approximately 34 percent of the CT generation hours for bringing units on-line when LMP < unit offer price were due to units scheduled for system control. **Rationale for operation when LMP < unit offer price**: PJM Dispatch makes the decision to start CT units for system control based on the forecasted system conditions and the expected ramping capability of other units already on-line and able to follow PJM dispatch instructions. Real-time system conditions, such as PJM load and interchange, may change after the CT units are started. In addition, self-scheduled unit operations by market participants and better than expected steam unit response to PJM dispatch signal can also lead to situations where the CT generation is not required to economically serve load or to control transmission constraints which results in LMP < unit offer price. PJM Dispatch may also only plan to use the CT generation for a portion of the unit minimum run time. The CT operation will be in the situation where LMP < unit offer price for the portion of the minimum run time not required by PJM.

Reasons for keeping units on-line past their minimum run times while when LMP < unit offer price: CT Units

There were a total of 3,761 hours with LMP < unit offer price during the 4-week sample period for CT units kept on-line past their minimum run times. Table 5 shows the breakdown of these unit hours into the associated reasons for keeping CT units on-line with LMP < unit offer price once their minimum run times have expired. Three reasons are identified. They are keeping units for on-line for reliability, maximum starts per day restriction and minimum down time restriction. There are several reasons listed under the general category “Reliability” that PJM dispatchers may keep a CT unit on-line past its minimum run time even though economics suggest the unit be released. These reasons include: upcoming load pickup (morning and evening), transmission constraints, and area voltage control.

Total hours keeping CTs on-line w/ LMP < Offer	Reasons for keeping CT units on-line											
	Reliability								Unit Restrictions			
	(5) Economic (load peaks)		(6) Transmission constraints		(7) Area Voltage Control		(8) Others		(9) Max Starts per day		(10) Min Down	
Hrs	Hrs	%	Hrs	%	Hrs	%	Hrs	%	Hrs	%	Hrs	%
439	142	32%	163	37%	0	0%	51	12%	70	16%	13	3%
47	7	15%	40	85%	0	0%	0	0%	0	0%	0	0%
1431	0	0%	921	64%	65	5%	42	2%	222	16%	181	13%
1844	81	4%	1545	84%	0	0%	109	6%	78	4%	31	2%
3761	230	6%	2669	71%	65	2%	202	5%	370	10%	225	6%

Table 5: CT Unit Operation with LMP < unit offer price: Reasons for keeping units on-line

(5) Keeping CT units for morning/evening peaks – PJM Dispatch may decide to keep CT units after their minimum run time has been exhausted because CT units are expected to be needed during the upcoming peak period, or the load pickup leading up to that peak period. In these cases, the dispatcher may decide it is not practical to cycle the unit off and then back on prior to the expected peak period and may therefore keep the unit on-line. During the study period, 230 unit hours, or approximately 6 percent, were associated with units being kept on-line past their minimum run times were due to load pick-up periods.

Rationale for operation when LMP < unit offer price: Since the PJM dispatchers are keeping these units on-line with the expectation that the upcoming peak conditions will necessitate their operations, their power output may not be required in the interim to serve load economically or control transmission constraints. As a result, the condition where LMP < unit offer price could occur during the timeframe when these units are kept on-line prior to actually being required either economically or for transmission constraints.

(6) Keeping CT units for transmission constraints - PJM Dispatch may also keep CT units on-line after their minimum run time has been exhausted for transmission constraints. For example, CT units may be called on to control a transmission constraint and after it has been controlled, it is expected that the constraint may return. In such a case, if the CT units are released, the dispatchers may not be able to get them back on-line quickly enough to mitigate the constraint within the timeframe required by reliability standards. During the study period, 2,669 unit hours or approximately 71 percent of CT operating hours past their minimum run times with LMP < unit offer price were due to transmission constraints.

Rationale for operation when LMP < unit offer price: Since the PJM dispatchers are keeping these units on-line with the expectation that future system conditions will necessitate their operations, their power output may not be required in the interim to

serve load economically or control transmission constraints. As a result, the LMP is < unit offer price during the timeframe when these units are kept on-line prior to actually being required either economically or for transmission constraints.

(7) Keeping CT units for area voltage control - PJM Dispatch may also keep CT units on-line after their minimum run time has been exhausted for area voltage control. For example, a CT may be initially scheduled for economics and after its minimum run time has expired, PJM Dispatch determines that the CT is still required for area voltage support even though economics suggest the CT should be released. During the study period, 65 unit hours, or approximately 2 percent of the hours where CTs were kept on-line past their minimum run times with LMP < unit offer price were due to units kept on-line for area voltage control.
Rationale for operation when LMP < unit offer price: Since the LMP algorithm can only recognize thermal constraints, PJM will create thermal surrogate constraints to represent reactive voltage problems. The PJM reactive interface constraints are examples of post-contingency voltage constraints that are translated into thermal limits for the purposes of control and submission to the Locational Pricing Algorithm. If a local voltage constraint suddenly or unexpectedly, it may not be possible to immediately create a thermal representation of the constraint. Similarly, if the constraint is not expected to persist for a significant period of time, it may be impractical to create a thermal representation since by the time it is created an inserted into the PJM monitoring systems, the voltage constraint will have been relieved. Therefore, when units are operated to maintain reliable system voltages and a thermal representation is not created for the voltage constraint, the units operating for the constraint may have LMP < unit offer price.

(8) Keeping CT units for other – There were 202 unit hours or approximately 5 percent of the hours where CTs were kept on-line past their minimum run time and where LMP < unit offer price for other miscellaneous reasons related to maintaining system reliability.

(9) Maximum Starts per Day – PJM Dispatch must evaluate the ability to restart a unit should it once again become required. If a unit could be released but is expected to be needed again, and there are no more starts available for that unit for the operating day, PJM Dispatch cannot release the unit. During the study period, there were 370 unit hours, or approximately 10 percent of the CT unit hours for CTs kept on-line past their minimum run times where LMP < unit offer price and where logging specifically indicates that units were kept on-line due to the maximum starts per day restriction. It should be noted that this category is likely under represented in the statistical results because the limitation on starts may in fact be the cause for retaining a unit logged under one of the reliability categories such as transmission control.
Rationale for operation when LMP < unit offer price: PJM keeps start-restricted CT units on-line because of anticipated conditions where the CT units may be needed later on that day. During the hours the units are kept on, the output of the unit may

not be required in real-time to serve load economically or control transmission constraints and therefore the units' operation will occur with LMP < unit offer price.

(10) Minimum Down Time – Similar to the maximum starts per day restriction, a CT unit limited by a minimum down time may require PJM Dispatch to keep the unit on-line after the minimum run time has been exhausted even though economics suggest the unit should be released. If the unit is released and is expected to be needed again prior to the expiration of the minimum time the unit is required to be off-line, PJM Dispatch cannot release the unit. During the study period, there were 225 unit hours, or approximately 6 percent of the CT unit hours for CTs kept on-line past their minimum run times where LMP < unit offer price and where logging specifically indicates that the units kept on-line due to the minimum down time restriction. It should be noted that this category is likely under represented in the statistical results because the minimum down time may in fact account for many of the hours for which a unit is logged under one of the reliability categories such as transmission control.

Rationale for operation when LMP < unit offer price: PJM keeps the minimum down time restricted CT units on-line because of anticipated conditions where the CT units may be needed later on that day. During the hours the units are kept on, the output of the unit may not be required in real-time to serve load economically or control transmission constraints and therefore operation will occur with LMP < unit offer price.

QUESTION C, What are the protocols for taking out-of-merit units off-line, e.g. economics, location, availability, run times, start limitations, ramping, constraints?

The process for releasing units takes into account many factors. The system operator makes an assessment of the current and future system conditions prior to releasing units. The operator must consider the current and expected load, the current and expected generation, the current and expected interchange, the current and expected transmission outages, the current and expected generation outages, and the current and expected transmission constraints. The operator also needs to evaluate the generation unit parameters such as unit economics, minimum run time, minimum down time, time to start, fuel limitations, emission restrictions, remote start capability and number of starts per day or week. Only after making these assessments, can a decision be made to release a unit.

PJM dispatchers are charged with the responsibility of maintaining the reliable operation of the PJM system. In order to be certain that system reliability is not compromised, the release of generating units must be done in a deliberate and orderly manner, maintaining system control and considering the potential for system conditions to change unexpectedly. Changing system conditions, along with the ability for PJM market participants to take their own actions in response to market

price signals, requires a conservative approach to unit releases in order to ensure reliability is maintained. In most cases, units that are released cannot be immediately restarted so the decision to release equipment must be well planned.

Under extreme operating conditions the system operator must also account for variability and restrictions and complexity involving emergency procedures, and load management implementation/restoration.

After each operating day, PJM operation performance department conducts a review of generation deployment and produces a feedback report for system operators in order to provide continuous process improvement.

QUESTION D, Are out-of merit units eligible to set price during the 5-minute intervals when they are brought on-line? Do they in fact set price?

The 5-minute LMP calculation is conducted by an automated PJM application called the Locational Pricing Algorithm ("LPA"). Since the LMP calculation is based on actual generation output rather than a theoretical optimal dispatch, it is necessary to screen generators and transactions to determine if they are eligible to participate in the LMP calculation.

A component of the LPA called the LPA Preprocessor performs this screening function by analyzing the following to determine if a generator is following economic dispatch instructions.

- Generator state estimated MWh output
- Generator offer price curves
- Economic dispatch rates
- Desired MW level for each generator specified by UDS

In order for a generating unit to be eligible to set price on the PJM system, its output must be required to serve load while respecting any binding transmission constraints and it must be following PJM dispatch instructions. The LPA Preprocessor program therefore acts as a real-time performance monitoring function for generators that have designated themselves as responsive to PJM dispatch instructions (i.e. – "Dispatchable"). Dispatchable generators whose actual MW output is determined to be less than or equal to 110 percent of the desired MW level are considered to be following the economic dispatch instructions and are therefore eligible to be passed through to the LMP calculation. The desired MW output for steam units must be above their minimum output level in order for them to be eligible to set price. CT units, however, must simply have a desired MW output that is greater than zero to be eligible. The LPA preprocessor also identifies and validates any generators that are specifically requested by dispatch through the Unit Dispatch System (UDS) to operate

in order to control a transmission constraint. These generators are designated as eligible to set LMP if they are on-line and following the dispatch instruction. The LPA Preprocessor also screens transactions that are designated as dispatchable to determine if their offer data is consistent with current dispatch rates and if they are therefore eligible to set LMP. Generators that are not eligible to participate in the LMP calculation are those that are declared must run or that are not following economic dispatch requests based on the criteria outline above.

Generators and transactions that are eligible to participate in the LMP calculation are those that are needed to serve load in the five minute interval and that are following the economic dispatch requests as described above. These eligible generators or transactions are modeled in the LMP calculation as flexible generators with offer prices that correspond to the value from their offer curve at actual MW output (or MW schedule for transactions). The LPA Preprocessor calculates this Real-time offer value using the following criteria:

- If the generator's MW value determined by the state estimator is less than or equal to the desired MW value, then the Real-time offer value is calculated by comparing the state estimated MW output to the offer curve.
- If the generator's state estimated MW value is greater than the desired MW value, then the Real-time offer value is calculated by comparing the desired MW value to the offer curve.

The eligible generators and transactions are introduced to the LPA as flexible generators (or loads) and are modeled at actual MW output with a small bandwidth to allow for solution tolerance. Generators that are not eligible to participate in LMP calculations are modeled as inflexible generators with their MW output fixed at the actual MW value from the state estimator solution.

Sample Week	% of Total CT Hours with LMP < Offer Price
Jan 19-25	34
Apr 20-26	40
July 20-26	33
Oct 5-11	53

Table 6: CT Hours with LMP < Offer Price for ALL 5-minute intervals within the hour.

As can be seen from table 6 above, the percent of CT hours for which LMP was below the unit's offer price for all 5-minute intervals in a given hour is less than the percent of

CT hours for which LMP was below the unit's offer price on an hourly integrated basis that was reported in Table 3. This is because CTs that are brought on-line and operate at the direction of PJM are eligible to set price for individual, 5-minute intervals within a given hour. However, if a given unit sets price for only a portion of the hour, the hourly integrated LMP may be less than the unit's offer. Therefore, as expected, the number of unit hours for which the LMP was less than the unit's offer price for any 5-minute interval within the hour is less than the number of unit hours for which the hourly integrated LMP was below the unit's offer price. The statistics displayed in Table 6 illustrate that CT units brought on-line at PJM's direction are eligible to and do set price on a 5-minute basis even if LMP < offer price on an hourly integrated basis.

QUESTION E, What is the difference between out-of-merit dispatch and differing demand/load levels, e.g. peak, non-peak, seasonal?

For the purpose of **QUESTIONS E, F and G** below, out-of-merit generation has been defined as it was earlier in the review, as units for which the hourly integrated real-time LMP was below the unit's offer. Units that had a day ahead schedule in a given hour where not included in the category of LMP < unit offer price for reasons explained previously. Economic generation has been defined as units that had a bid that was less than or equal to the hourly integrated real-time LMP. Self-scheduled generation has been defined as MWs that were produced at the direction of the generation owner or MWs that were produced above the real time LMP that the generation owner incurred the cost to produce. In this section, generation operated when LMP < offer price is further separated such that MW produced by such units as a result of the fact that they were assigned by PJM to provide Regulation are identified separately.

The analysis PJM performed in response to **QUESTIONS E, F and G** was for the entire calendar year 2005. During off-peak hours (1-7 and 24) in 2005, on average, economic generation represented 45% of the total MWs, generation operated when LMP < offer price represented 6%, Regulation MW with LMP < offer price represented 2%, and self-scheduled generation 47%. During peak hours (8-23) in 2005, on average, economic generation represented 53% of the total MWs, generation operated when LMP < offer price represented 3%, Regulation MW with LMP < offer price represented less than 1% and self-scheduled generation 44%. This average hourly breakdown of these categories of generation for 2005, in relation to the average hourly load, is illustrated in Figure 1.

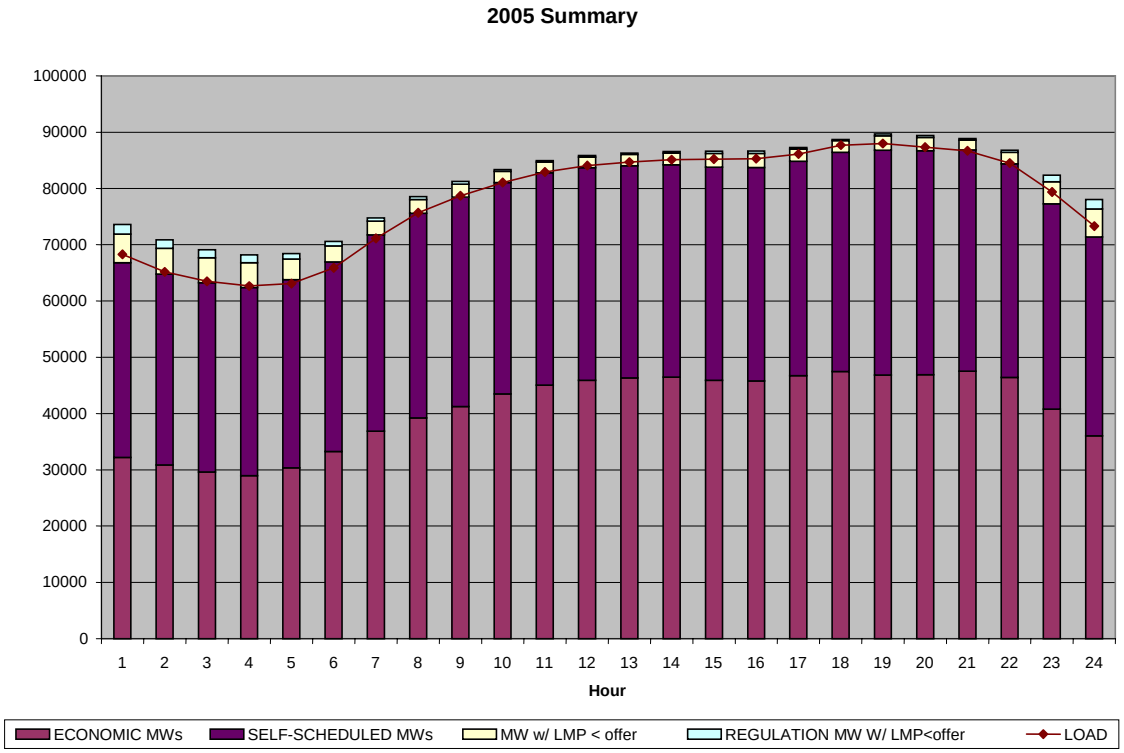

Figure 1 - 2005 Summary: Generation Breakdown

For calendar year 2005, the seasons were broken out as follows: winter (January, February, December), spring (March, April, May), summer (June, July, August), and fall (September, October, November).

For the winter months, which can be seen in Figure 2, economic generation represents 49% of the total generated MWs, generation operated with LMP < offer price represents 3%, Regulation MWs operated with LMP < offer price represents 1% and self-scheduled generation 47%. During the spring, illustrated in Figure 3, economic generation represents 47% of the total MWs, generation operated when LMP < offer price represents 3%, Regulation MWs operated with LMP < offer price accounts for less than 1% and self-scheduled generation represents 50%. Economic and generation operated when LMP < offer price increase slightly to 53% and 4%, respectively, during the summer, while self-scheduled generation decreases to 42% and Regulation MWs operated with LMP < offer price remains steady at 1%. Figure 4 illustrates this breakdown. Similarly, in the fall, shown in Figure 5, economic generation represents 51%, generation operated when LMP < offer price represents 4%, Regulation MWs operated with LMP < offer price 1% and self-scheduled generation 44%. Refer to Tables 7 through 10 for a further seasonal breakdown of the generation MWs.

	WINTER		
	OFF-PEAK	ON-PEAK	TOTAL
ECONOMIC	46%	51%	49%
MW w/ LMP < OFFER	4%	3%	3%
REG MW W/ LMP < OFFER	1%	0%	1%
SELF-SCHEDULED	49%	46%	47%

Table 7 - Winter 2005 - Generation Breakdown by demand level

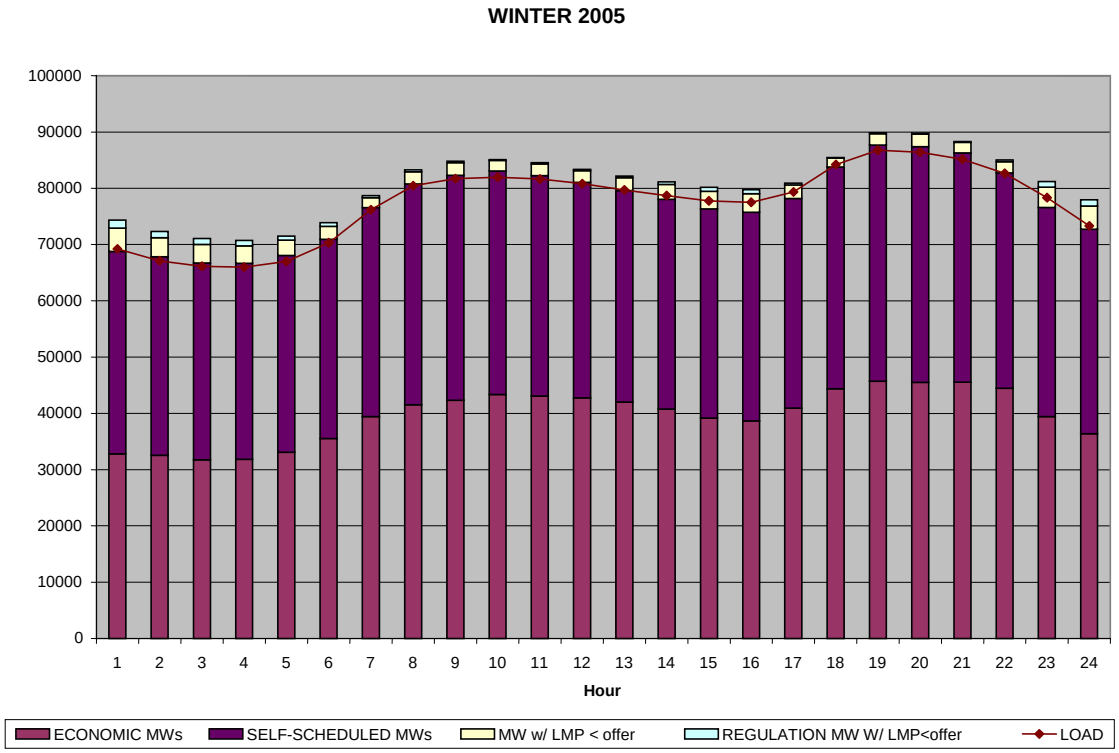

Figure 2 - Winter 2005: Generation Breakdown

	SPRING		
	OFF-PEAK	ON-PEAK	TOTAL
ECONOMIC	42%	49%	47%
MW W/ LMP < OFFER	5%	2%	3%
REG MW W/ LMP < OFFER	1%	0%	0%
SELF-SCHEDULED	52%	49%	50%

Table 8 - Spring 2005 - Generation Breakdown by demand level

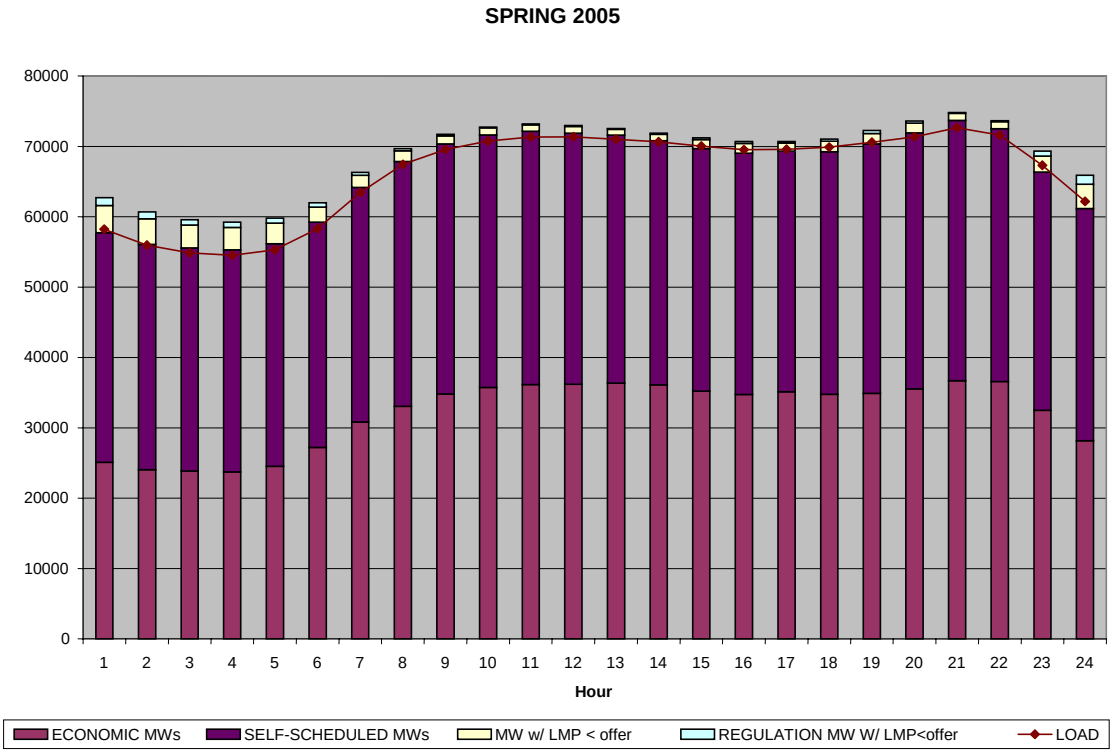

Figure 3 - Spring 2005: Generation Breakdown

	SUMMER		
	OFF-PEAK	ON-PEAK	TOTAL
ECONOMIC	47%	56%	53%
MW w/ LMP < OFFER	7%	3%	4%
REG MW W/ LMP < OFFER	2%	0%	1%
SELF-SCHEDULED	44%	41%	42%

Table 9 - Summer 2005 - Generation Breakdown by demand level

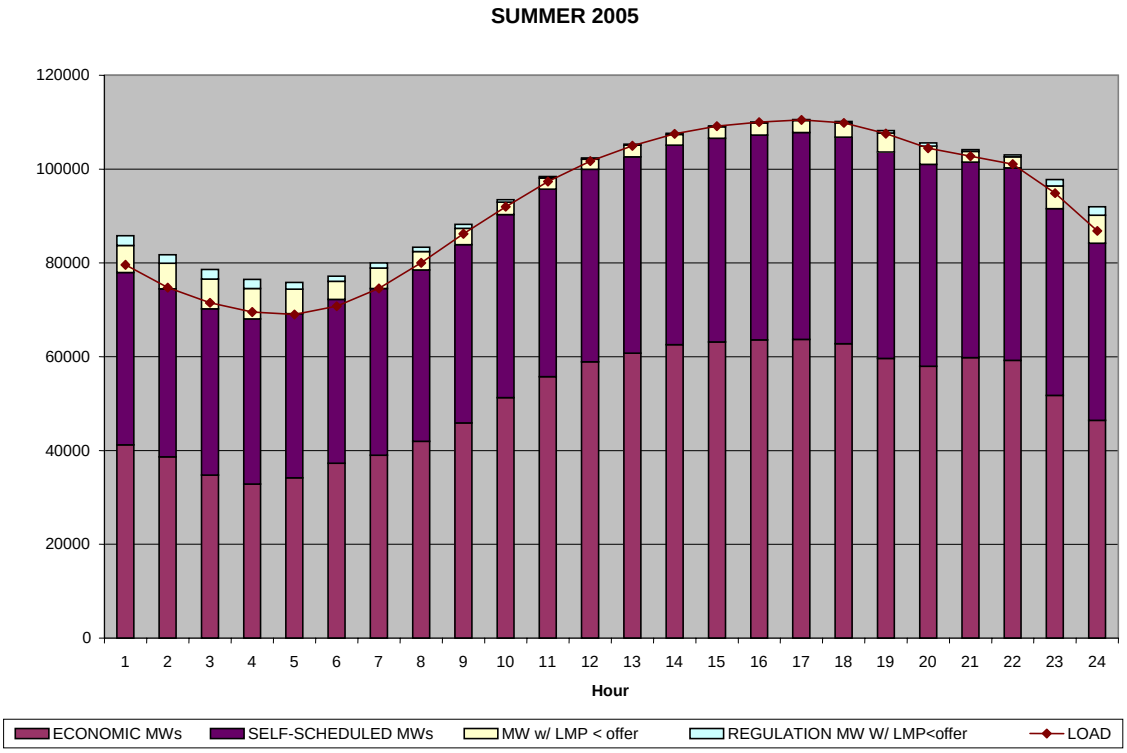

Figure 4 - Summer 2005: Generation Breakdown

	FALL		
	OFF-PEAK	ON-PEAK	TOTAL
ECONOMIC	44%	53%	51%
MW W/ LMP < OFFER	7%	3%	4%
REG MW W/ LMP < OFFER	2%	1%	1%
SELF-SCHEDULED	47%	43%	44%

Table 10 - Fall 2005 - Generation Breakdown by demand level

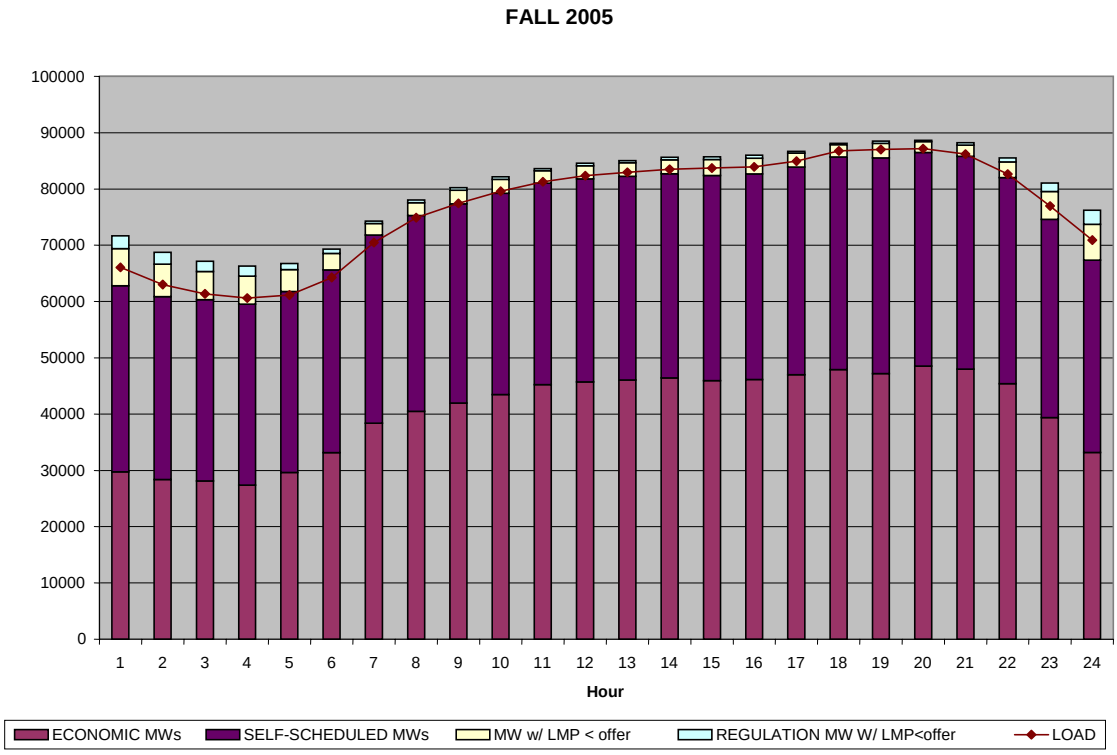

Figure 5 - Fall 2005: Generation Breakdown

QUESTION E, continued, What is the correlation between out-of-merit dispatch and differing demand/load conditions by location?

For purposes of this section, the PJM footprint was split into two locations: PJM Classic and the Newly Integrated Areas.

For calendar year 2005, unit MWs operated with LMP < offer price are similar across the 2 locations within the PJM footprint at 5% in PJM Classic and 6% in the newly integrated areas, during the off-peak hours (1-7, 24). This is also true during on-peak hours (8-23) where such operating situations occur 3% of MWs in PJM Classic and 2% of MWs in the newly integrated areas. Refer to Table 11 below, for a more detailed breakdown of MWs for each area, and to Figures 6 and 7 for a graphical display.

	PJM Classic		Newly Integrated Areas	
	OFF-PEAK	ON-PEAK	OFF-PEAK	ON-PEAK
ECONOMIC	32%	40%	53%	61%
MW W/ LMP < OFFER	5%	3%	6%	2%
REG MW W/ LMP < OFFER	2%	1%	2%	0%
SELF-SCHEDULED	61%	56%	39%	37%

Table 11 - Locational breakdown of generation

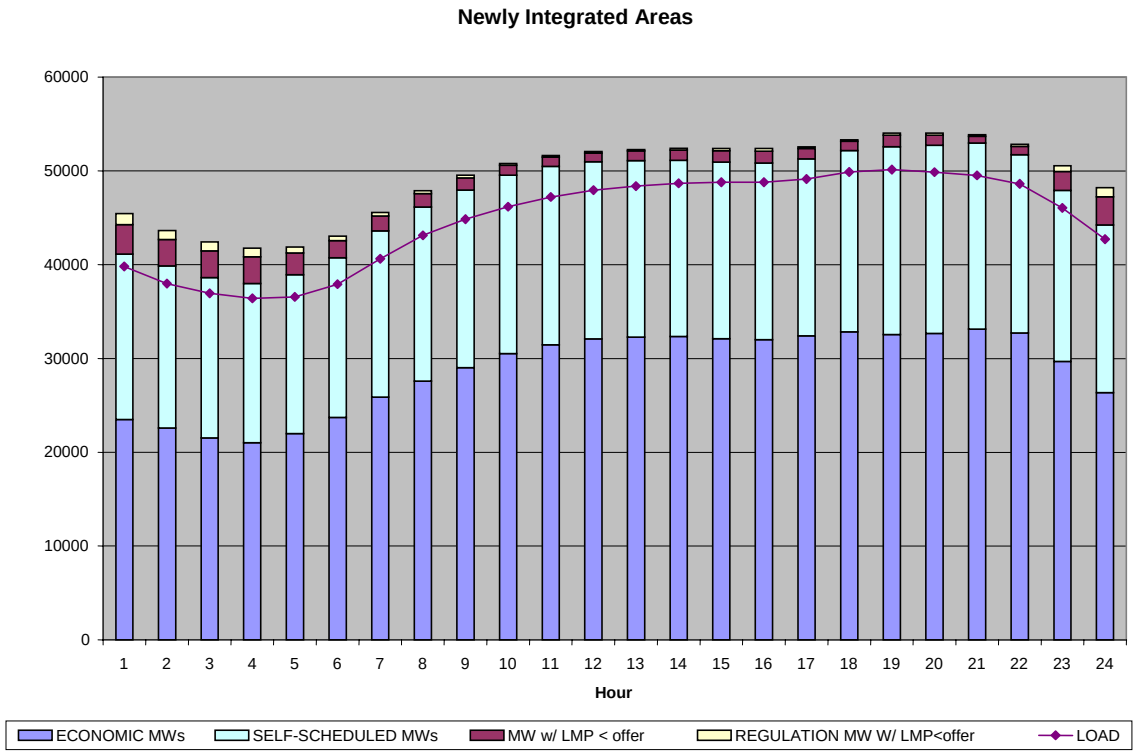

Figure 6 – Newly Integrated Areas: Generation Breakdown

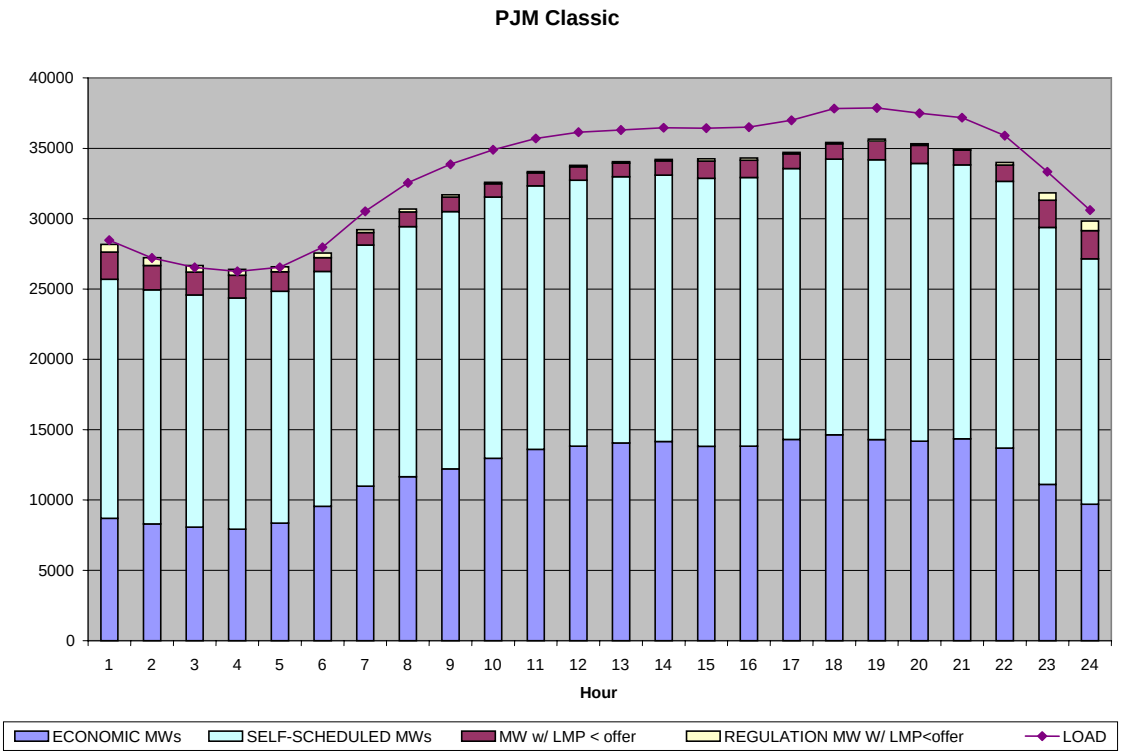

Figure 7 - PJM Classic: Generation Breakdown

QUESTION F, What is the percentage of out-of-merit dispatch overall as compared to the total amount of energy dispatched?

Referring to Figure 1, unit MWs operated with LMP < offer price represented 5% of the total average hourly amount of energy dispatched in 2005, 1% of which was related to Regulation. The remaining energy consisted of 50% of economic generation and 45% of self-scheduled generation.

QUESTION G, As the PJM region expanded, did out-of-merit dispatch increase, decrease, or remain the same?

With the integrations of AEP and Dayton Power and Light in October of 2004, Duquesne on January 1, 2005 and Dominion Virginia Power on May 1, 2005, total generation MW operation when LMP < offer price did not change significantly, decreasing from 5.0% to 4.7%. Economic generation increased slightly from 50.8% before the integrations, to 51.2%. There was a negligible change in self-scheduled generation, from 44.2% prior to the integrations to 44.1% following the integrations.

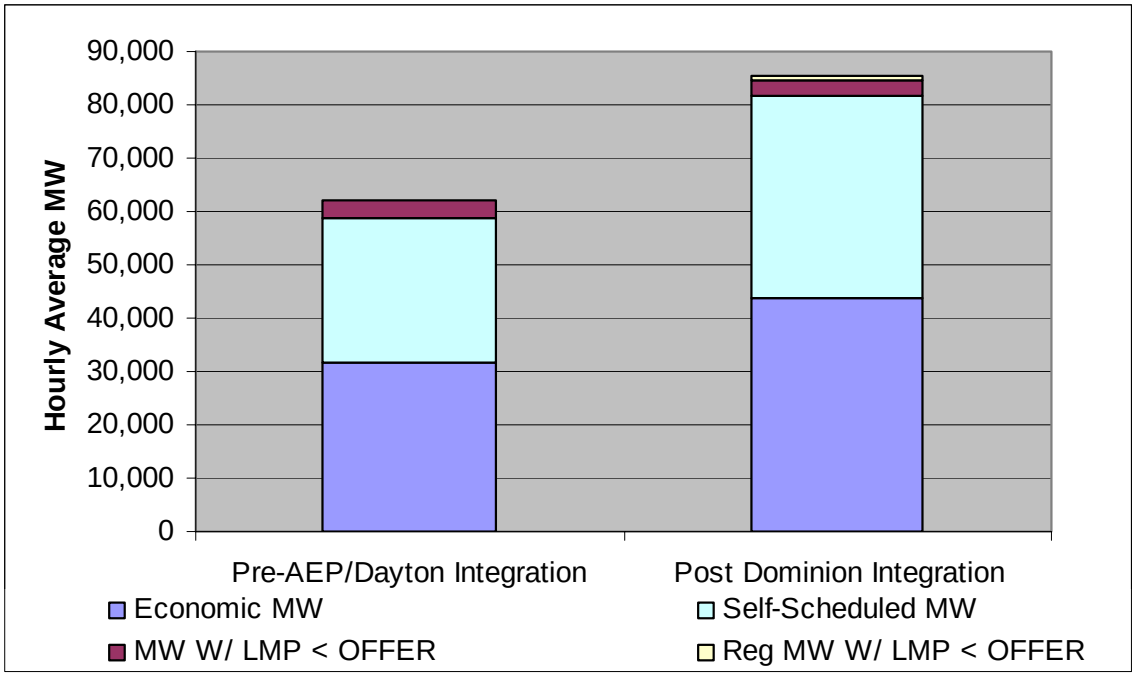

Figure 8 - Generation Before and After PJM Integrations

QUESTION H, What constraints on combustion turbine dispatch, i.e. self-scheduling, maximum emergency designations, etc., cause or contribute to out-of-merit dispatch?

Restricted flexibility due to constraining unit parameters is one contributor to operation of generation with LMP < unit offer price. Such operation can be minimized by having a flexible fleet of units. The system operators must adhere to the unit parameters while maintaining system reliability. The first and foremost goal of the system operator is to reliably operate the system. The system operator must make decisions to schedule units and release units to match load and interchange while adhering to the unit parameters. The unit operating parameters that impact the efficiency of dispatch are:

Time to start - Units with short start times are more effective because they can be started closer to the time actually needed. Units with longer start times have a greater chance of being operated with LMP < offer price by the time they actually come on line because system conditions change over time and can change the economic nature of system operator choices.

Number of starts per day – Number of starts per day limitations may affect a decision to keep a unit on-line for a future period when economics suggest it to be released, because once the operator releases a unit with no remaining starts available for that day, the unit cannot be started again until the next operating day.

Number of starts per week – Number of starts per week limitations may result in a decision not to start a unit because it may be more beneficial during a future period. It may also result in a decision to start the unit and keep it operating after its minimum run time has expired even if it begins operating at LMP < offer price, knowing that it will not be available to start again during a future period.

Minimum run time – Minimum run time limitations may result in operation of a unit longer than it would have otherwise run purely for economics. In such a case, the unit may be economic for a portion of its run time, but operate with LMP < offer price for the time period when it is not needed for economics but must be operated in order to satisfy the minimum run time parameter.

Minimum down time – Minimum down time limitations may result in a decision not to release the unit after its minimum run time has been exhausted because of the inability to cycle the unit and bring it back on line when it again is economic to operate. During the time period when the unit would otherwise be released but is held on line in the expectation of future economic hours, the unit may be operated with LMP < offer price.

Fuel limitations – Units with fuel limitations may result in a decision not to start them because of an anticipated need to operate the units at a future period. Another unit will be started in its place which may not be the best economical choice, and may have at least some hours of operation when LMP < offer price due to more restrictive parameters.

Remote start capability - Units with remote start capability can improve unit availability, however, they can be more limiting in cases where failure to start requires dispatching a crew to the station to determine start problems.

Emissions restrictions – Units with emission restrictions may result in a decision not to start them. Another unit will be started in its place which may not be the most economical choice, and may have at least some hours of operation when LMP < offer price due to more restrictive operating parameters.

Start dependability – start failure rates, which may be significant for certain units during certain times of the year, may cause operators to call more units than are actually required to serve load respecting transmission constraints because they must account for start failures if response time is critical. The additional units are required to maintain reliability given the possibility that one or more of the units

called will fail to start. In such situations, the extra units may experience operation when LMP < offer price.

QUESTION I, Are constraints used to dispatch units on a cost-capped basis entered into PJM's constraint logger/state estimator in a timely manner?

Yes, PJM has an automated process for logging transmission constraints; this logging takes place as soon as the operator determines the need for constrained operation.

QUESTION J, Are units run past their minimum run times when no constraint posting is made?

Yes. The following conditions can result in a unit being operated beyond its minimum run time when no associated constraint posting is made:

- If a constraint is expected to return later in day because of load shape or other system conditions impacting the constraint;
- If changes in generation levels from other resources are expected to occur;
- If changes in interchanges schedules are expected to occur.

Additional, detailed descriptions of these conditions appear above in response to **QUESTIONS C and H**.

QUESTION K, How are out-of-merit units scheduled in the Day-Ahead security constrained dispatch? What is the procedure for validating results? How are errors corrected? Are out-of-merit units scheduled day-ahead treated differently than out-of-merit units dispatched during real-time operation?

The Day-Ahead Market is based on a highly automated, least cost, security-constrained, unit commitment and dispatch application. The Day-Ahead Market is a financial market that respects physical generation operating constraints and all transmission constraints. This market includes generation offers, demand bids, demand response bids and virtual offers / bids. The Day-Ahead Market security constrained dispatch is based on minimizing the total production cost of running the PJM system. The unit commitment program will calculate the production cost for each individual unit and schedule units according to least total production cost that satisfies both unit and system constraints. Total production cost of a unit includes start-up, no-load, and incremental offer. Reserve requirements based on the fixed, bid-in demand are included in the Day-Ahead Market, thus in order to yield the least-production cost system solution, generation may be committed during periods when the unit's LMP solves below its offer. In the Day-Ahead Market, units that are committed because of unit operating limitations or reserves rather than to serve energy in an hour will have LMP < offer price. Since the Day-Ahead Market clearing

is based on an automated optimization engine with a complete set of hourly data specified in advance, such unit operation is minimized.

The validity and accuracy of Day-Ahead Market and Reliability Assessment results are verified by the market/dispatch operators and by the external auditors through procedures which are designed to satisfy the requirements of the SAS-70 auditing process. These procedures are documented in the audit reports that are distributed to PJM Members.

Units committed in the Day-Ahead Market and Reliability Assessment processes are treated the same as units scheduled and dispatched at PJM's direction during real-time operation in the sense that these generation resources are guaranteed to at least fully recover revenue sufficient to meet their accepted offer. PJM unit operation in real-time is based on real-time economic dispatch, the real-time dispatch program does not consider the units day-ahead scheduled MW quantity.

Information Posting Review

Section V of the Settlement Agreement indicates that PJM should review the posting of information related to these subjects. The PJM competitive market operation depends upon market participants having access to comprehensive Day-Ahead Market model results and to real-time system conditions. The PJM Day-Ahead Market information posting, eMarket, contains a comprehensive set of market model input data and market results that are sufficient for market participants to actively compete in the market. The primary PJM real-time system and market information posting systems are eMarket and eData which provide a large volume of real-time information on system conditions such as ACE, load, interchange, transmission constraints, power flows, etc. From the perspective of generation operation, PJM could provide more automated information to unit owners regarding why their units are scheduled through the eMarket real-time information screens. From a competitive market information perspective, PJM has developed a market information posting enhancement straw proposal that is currently being discussed in the stakeholder process. The recommendations in this proposal are beyond the scope of this report and as such will not be discussed further here. The PJM proposal is posted on the PJM website under the Market Implementation Committee materials.

As a consequence of this information posting review associated with generation dispatch and as a result of discussions with stakeholders, PJM has modified certain data posting procedures and content as summarized below.

PJM has created Management Reports on system operations and market operations that are presented at each Members Committee meeting. These reports include information

on monthly total Operating Reserve payments. The reports also contain a variety of additional information.

PJM has expanded the posting of load forecast information to retain the original daily load forecast that is performed at 1800 on the day prior to the operating day and is utilized in the Reliability Assessment.

PJM has added unit-specific real-time electronic notification to generation owners regarding when a unit is offer-capped in real-time. This will be enhanced in the near future to include specific transmission constraint information related to the offer capping event.

PJM plans to post operating reserve charges by day and total generation MW committed in the Reliability assessment by day.

PJM expects to consider additional information posting enhancements in discussions with stakeholders during the 180-day stakeholder process that is specified in the Settlement Agreement.

Summary and Conclusions

The PJM systems are operating as designed and according to the market rules with respect to units appropriately setting price when operating at PJM's direction and required to meet energy demand while respecting binding transmission constraints. There are many conditions which can cause units to be operated when LMP < offer price. The PJM dispatchers are charged with maintaining the reliability of the PJM system, and dispatching generation in the most economical manner possible while ensuring system reliability is not compromised. The dynamic nature of the bulk power system and the ability of market participants to react quickly to market signals necessarily complicates the dispatchers' ability to minimize unit operation with LMP < offer price by adding to the uncertainty involved in their decisions. The PJM dispatchers utilize technologically advanced power flow and security analysis tools to optimize the scheduling decisions they make. However, the constantly changing and sometimes volatile nature of the bulk power system at times causes generation to be operated with LMP < offer price. Additionally, reliable power system operating practices require PJM to maintain reserves to cover unanticipated system events which also contributes to a small amount of such operation.

As explained above, only 3% of the generation MW output were related to operation with LMP < unit offer price during on-peak hours in 2005 and 6% was related to operation with LMP < unit offer price during off-peak hours in 2005. These results are consistent with expected operating reserve margins of between 3% and 7.5% that are established in the PJM region. However, PJM recognizes the need to minimize such operation by

ensuring optimal scheduling practices, and will maintain efforts toward continuous process improvements in this regard.

In fact, in the past six months PJM has implemented several process improvements and operating tools to assist the dispatchers in managing operational uncertainty. The enhanced procedures and tools have provided more timely feedback to the operators regarding the specific results of generation scheduling decisions, and have resulted in significant reduction in operating reserve payments since December, 2005. These enhancements have been discussed at length in the PJM stakeholder process and will not be detailed further in this report.

The statistical results for unit operation when hourly LMP < unit offer are reported in this document for the 2005 operating year. The dispatch enhancements that were implemented in December 2005 and in first quarter 2006 will have reduced the frequency of occurrence of this type of unit operation.

PJM has recognized the need to continue to take advantage of evolving advanced technology to assist the operators in making real-time commitment decisions. To this end, PJM has developed an enhanced, forward looking UDS tool, and is in the process of implementing this tool in the production environment. Further, PJM has embarked upon the AC2 project, which will result in the implementation of the next generation of technological innovation in the operation of the PJM system. Continued utilization of the most advanced analysis tools available to the industry will ensure that the best dispatch decisions are made given the most up-to-date real-time system information.

PJM has no specific rule changes to recommend as a result of this analysis. However, PJM suggests the following topics to be discussed in the 180-day stakeholder process that commences with the release of this report.

1. A significant portion of unit operation with LMP < unit offer price is due to dispatcher concerns regarding unit flexibility. Given the aging generation fleet, the amount of generation that has restricted capability to follow flexible dispatch instructions and the less-than-optimal unit response that has been experienced, greater incentive may be needed for units to follow dispatch instructions. If the PJM dispatchers had more certainty with regard to which generators were able to follow dispatch instructions and with a more detailed expectation of their rate of response, system control would be enhanced and unit operation with LMP < offer price could be further minimized because less generation would need to be operated to account for potential scenarios where units do not follow dispatch instructions. The PJM stakeholder should discuss potential opportunities to improve generation flexibility in this area.

2. PJM posts a significant amount of information with regard to the system conditions that result in the scheduling and dispatch decisions of the operators. The availability

of this data on a real-time basis is part of what causes the conditions facing PJM dispatchers to change so rapidly, since it enables market participants to react quickly to market signals. However, the data and the participant actions it enables are crucial to the efficient operation of the market, and should continue to be enhanced. Additional after-the-fact data postings may provide greater transparency into PJM dispatch decisions on the part of the market participants. For example, public posting of generator and load bid/offer data in a timeframe that more closely follows real-time operations would provide participants with the ability to more accurately reconstruct and analyze the set of resources available to PJM dispatchers. PJM and its stakeholders should continue to work through the stakeholder process to ensure that the information required to allow market participants to react to market conditions in an informed manner, as well as provide the appropriate level of transparency into dispatcher decisions, is readily available.

3. The PJM market has been designed based on providing market participants with flexibility to schedule financial transactions in the day ahead market and to make short term changes to their transactions and unit status in the real time market. While this type of flexibility is critical to the operation of the competitive market, at certain times during the operating day and under certain transmission constrained conditions, this flexibility creates a certain amount of operational uncertainty which contributes to increased operating reserves and increased unit operation with LMP < offer price. PJM stakeholders should discuss the balance between maximizing market flexibility and providing the dispatcher with near-term operational certainty.

PJM expects to consider these topics and topics that are already being discussed related to operating reserves in the Reserve Markets Working group in discussions with stakeholders during the 180-day stakeholder process that is specified in the Settlement Agreement.