DIRECT TESTIMONY

OF

HYDE M. MERRILL

ON BEHALF OF

THE SIERRA CLUB

BEFORE THE

STATE CORPORATION COMMISSION OF VIRGINIA

CASE NO. PUE-2009-00043

I. INTRODUCTION

Q: PLEASE STATE YOUR NAME AND DESCRIBE YOUR PROFESSIONAL TRAINING AND BACKGROUND.

A: My name is Hyde M. Merrill. I have a doctorate in electrical engineering from MIT. I have been an independent consulting engineer since 1998. For the preceding 18 years, I worked as a consultant at Power Technologies, Inc., doing power system planning studies and developing tools for power system planning and operation. I worked for American Electric Power Service Corporation for seven years after graduating from college. I have been an adjunct professor at Rensselaer Polytechnic Institute and a visiting assistant professor at MIT. I was

elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) for "contributions to decision analysis considering conflicting objectives and risk in electric power systems." I have published more than 80 technical papers and book chapters, including roughly two dozen on strategic planning in electric power. My curriculum vitae is Exhibit HMM-1.

Q: HAVE YOU PREVIOUSLY PROVIDED TESTIMONY AS AN EXPERT WITNESS OR PROVIDED EXPERT CONSULTING SERVICES?

A: Yes, I have testified before the Michigan Public Service Commission, the Virginia State Corporation Commission, the US Department of Energy, and the Federal Energy Regulatory Commission (FERC). I have advised government agencies, including the World Bank, the Inter-American Development Bank, the US Congress Office of Technology Assessment, the New York State Energy R&D Authority, and the public utilities commissions of New York, Quebec, Panama, Venezuela, Tasmania, and Peru. I have also advised utilities, R&D organizations, and others on power system planning and operation. I have worked in nearly 40 countries.

Q. WHAT DO YOU PROPOSE TO ADDRESS IN YOUR TESTIMONY, DR. MERRILL?

A: Counsel for the Sierra Club asked me to evaluate the need for the proposed PATH project. My evaluation is based principally on reports, data, studies, testimony, and other presentations by PJM (PJM Interconnection) and the sponsors of the proposed project.

Q: DO YOU BELIEVE THERE IS A NEED FOR THE PATH LINE BASED ON YOUR REVIEW?

A: No. The Commission should deny approval and certification of the PATH project. PJM has not convincingly demonstrated the need for this project.

Q: CAN YOU SUMMARIZE YOUR REASONS FOR REACHING THIS CONCLUSION?

A: PJM's planning studies do not justify the PATH line. The vast majority of alleged reliability issues that are presented in support of the PATH line are not based on any modeling or contingency analyses as NERC requires. None of the alleged violations is based on reasonable assumptions regarding the need for power transfer from western to eastern PJM — *i.e.* reasonable Capacity Emergency Transfer Objective ("CETO") values. And even if the alleged violations were based on credible analysis — which they are not — none of them creates a present need to build the proposed PATH line. Rejecting PATH now will allow time to develop far better alternatives for the evolution of the power system within PJM's boundaries.

In contrast, approving this line will lead to increasing reliance by the East Coast on remote coal-fired power plants with continuing or increasing transmission congestion, transmission losses, and a *greater* risk of cascading blackouts.

Q: PLEASE SUMMARIZE THE ISSUES YOU WILL DISCUSS IN YOUR TESTIMONY.

A: First, I will explain why the alleged voltage issues identified by PJM in Exhibit PFM-3 to Mr. McGlynnn's testimony do not establish a need for the PATH line. PJM's claimed vulnerability to widespread voltage collapse was identified for the first time in April 2009, long after the line had been approved based on alleged 500-kV thermal violations. Now, PJM maintains that PATH is required to prevent alleged voltage collapse. However, PJM has admitted that installing 2,000 Mvars of capacitors would eliminate these voltage issues. And Company witnesses have admitted that the PATH project itself entails installation of 1,750 Mvars worth of new capacitors. In other words, PJM has identified a need to install new

capacitors with or without the PATH line in service. So why not install PJM's 2,000 Mvars of capacitors, costing $40 million, instead of the planned-for 1,750 Mvar *and* the $1.8 billion PATH project?

In addition, it is unclear that any capacitors would be needed in the absence of the PATH line. The alleged voltage issues identified in the April 2009 Study are apparently due to undocumented and unjustified changes from the 2008 RTEP[1] planning assumptions, at least some of which appear erroneous. Correcting these changes should resolve most or all of the claimed voltage violations. Finally, using reasonable "CETO" values and accounting for demand side management ("DSM") resources that have cleared the latest RPM auction will further help to resolve or eliminate the alleged voltage issues.

In any case, voltage issues on the scale of the alleged violations presented by PJM can and should be resolved by installing new capacitors, not by building a new 765-kv power line. PJM claims that a conventional remedy, compensation with capacitors, is impractical due to the "sheer number" and cost of about 2,000 Mvar of capacitors that PJM says would solve the alleged voltage problems. PJM also claims that capacitive compensation will make the system harder to operate. These objections are invalid. Again, PJM proposes to install 1,750 Mvar of capacitors as part of the PATH project. Building the PATH line will not avoid installing the capacitors that PJM claims are an "infeasible" alternative.

Second, I will address the alleged thermal violations on lower-voltage facilities that are presented in Exhibit PFM-2 to Mr. McGlynn's testimony. The six 230-kV and 345-kV thermal violations alleged to occur in 2014, and identified for the first time in the April 2009 study, are

[1] The PJM 2008 RTEP (regional transmission expansion plan) is described in a report dated February 27, 2009. The year-long process of developing the plan included creation of data bases and their use in technical studies. I will use "RTEP" to refer to the process, the plan, and the data bases, clarifying to which of these I refer as needed.

minor. They can be resolved at relatively low cost with relatively little environmental impact. By themselves, they do not justify a 765-kV line.

Third, I will address the speculative 500-kV issues that are alleged to occur beginning in 2015 and 2016. The 500-kV thermal violations that PJM has used to justify the PATH line since it was approved in 2007 continue to recede into the future. In the April 2009 study, these alleged violations are not even justified by a "NERC criteria" analyses. They are based wholly on *extrapolated data*, with no contingency or deliverability analyses performed for any years past 2014.

I emphasize that PJM's reported thermal violations beyond the fifth year (2013 in the 2008 RTEP report and 2014 in the April 2009 study) are not based on reliability analyses. A $1.8 billion dollar line should be supported by actual reliability analyses, not extrapolated data.

In addition to the total absence of reliability analyses after 2014, the April 2009 and 2008 RTEP studies cannot demonstrate a need for the PATH project because they ignore key generation and DSM resources in eastern PJM. For example, the RTEP studies failed to include a large power plant with a completed ISA (interconnected service agreement). This is a violation of PJM's published planning standards, which require such plants to be modeled. This plant will push claimed 500-kV thermal violations beginning in 2016 further into the future. In addition, recognizing the demand-management resources called forth in the 2009 RPM auction will push claimed violations even further into the future.

Fundamentally, there is no longer any basis to suggest that PATH is needed in light of alleged imminent reliability violations. Given the significant changes in PJM's analysis between 2007 and 2009, it is unreasonable not to consider far more modest alternatives to building a new 765-kV power line. Yet, despite these significant changes, *PJM has not considered any*

alternatives since 2007[2] and has never considered any of the potential fixes I identify in my testimony. This is not only bad transmission planning, but as Mr. Loehr's testimony points out, it is a risky strategy that will decrease reliability on the overall system by making eastern PJM more dependent on power from distant generators in western PJM.

II. Alleged Voltage Issues

Q: PLEASE EXPLAIN WHAT A VOLTAGE PROBLEM IS.

A: With increased power transfers across a grid, the system's need for so-called "reactive power" may increase. Two things may happen. First, voltages may become lower than technical standards allow. Second, in extreme conditions, analogous to a stalled airplane wing, a luffed sail, or a stalled car engine, the system may become unstable. A local or cascading blackout may result.

Every year PJM identifies and fixes potential future voltage problems. Generally this is done first by providing reactive power by installing capacitors on the distribution system. This maintains a correct power factor and keeps voltage up. When necessary, capacitors can be installed on the EHV system.

Q: IS PJM ALLEGING THAT VOLTAGE ISSUES JUSTIFY THE NEED FOR PATH

A: Yes. PJM discovered alleged widespread voltage problems in the April 2009 study. PJM claims that these alleged issues start occurring in 2014. However, they were not observed in earlier RTEP studies, including the 2008 RTEP study.

Q: IN SUMMARY, WHAT DO YOU THINK CAUSED THESE VIOLATIONS TO APPEAR FOR THE FIRST TIME IN THE APRIL 2009 STUDY?

[2] The sponsors have considered modest variations in line routing. We understand that PJM is thinking of building PATH as a DC instead of an AC line. These are, for the purpose of this proceeding, technical variations, not fundamentally different alternatives.

A: Based on my review, I have concluded that the sudden appearance of these alleged problems is due to changed assumptions, some of which may not reflect changed circumstances in the real world. Specifically, changes in the technical assumptions after the 2008 RTEP study appear to have caused the claimed voltage problems. Some of these changes were undocumented and may have been made in error. Correcting these changes would reduce or eliminate alleged voltage issues. Reducing the unreasonably high CETO objective and accounting for DSM resources would also help to resolve these alleged issues..

Q: IF THESE ALLEGED VOLTAGE ISSUES WERE GENUINE, WOULD PATH BE NEEDED TO RESOLVE THEM? PLEASE SUMMARIZE YOUR OPINION.

A: No. PJM claims the alleged problems cannot be fixed with capacitors, saying that about 2,000 Mvar would be required. PJM claims that the standard capacitor solution to the alleged problems is infeasible because of the amount and cost of the capacitors required. PJM also claims that relying on capacitors will make the power system too hard to operate.

Based on PJM's own data and testimony, these claims are not true. In fact, PJM plans to install almost as many capacitors as part of the PATH line as they say would be needed to resolve the claimed voltage problems without building the line.

Q: WERE THE CLAIMED WIDESPREAD VOLTAGE PROBLEMS FOUND IN THE 2008 RTEP STUDIES?

A: Not according to Mr. McGlynn's testimony or the 2008 RTEP report. PJM confirmed in discovery (PATHVA-00023639) that they were seen for the first time in the April 2009 study. Mr. McGlynn's Exhibit PFM-3 identifies 24 contingencies over a wide area, any one of which could cause voltage violations in 2014, according to PJM.

Q: HAS PJM EVER EXPLAINED WHY THIS ALLEGED PROBLEM SUDDENLY AROSE IN 2009?

A: No. Mr. McGlynn has summarized some of the changes between the 2008 RTEP and April 2009 assumptions. But PJM has given no explanation for what caused the sudden appearance of these "numerous, widespread, and severe" events or of other surprising changes from one study to another. (PATHVA-00023640).

Q: IS THE CETO MODELED BY PJM RELATED TO THE SUPPOSED VOLTAGE PROBLEMS?

A: Yes. The CETO (power transfer objective) is closely linked to the supposed voltage problems. The results presented in Mr. McGlynn's Exhibit PFM-3 depend strongly on how much power is being transferred from the West to the Mid-Atlantic Load Dispatch Area (LDA). In PJM's studies, these transfers are driven by the chosen CETO value. Mr. Loehr has serious doubts about the appropriateness of the CETO targets. I share these concerns – eastern PJM is over-dependent on remote generation.

PFM-3 shows that if transfers are reduced, the supposed voltage problems go away. PJM recently updated its 2014 CETO for the Mid-Atlantic LDA, reducing it to 7,720 MW. (16 Oct. 2009, PATHVA 00027899) This will make the last 8 contingencies listed on PFM-3 irrelevant, reducing the number of alleged voltage collapse contingencies by one-third.

In addition, Mr. Loehr observes that the tests used to diagnose the events in Exhibit PFM-3 are screening tests and should be followed up by stability studies, which apparently were not done. Mr. Loehr is one of the world's most experienced and thoughtful experts on power system reliability. His opinions in this area merit very serious attention.

Q: DID YOU TRY TO FIND OUT WHAT CAUSED THE SUDDEN ADVENT OF THESE CLAIMED WIDESPREAD VOLTAGE PROBLEMS?

A: Yes. I compared the power flow base case used in the April 2009 voltage studies to the one used in 2008 RTEP studies. According to Mr. McGlynn, the alleged voltage problems could be avoided by providing about 2,000 MVAR of reactive (capacitive) power, so I looked for a disappearance of about this magnitude between the 2008 RTEP and April 2009 cases. I found three differences between the cases that added to about 2,000 MVAR. Table 1 summarizes three major changes in reactive power between the 2008 RETP and April 2009 studies. The former study modeled the year 2013, the latter the year 2014. These major changes were in the reactive power supposedly used by customer load in eastern PJM, reactive power provided by large capacitors in Maryland, and reactive power generated by transmission lines in the East.

Table 1. Reactive power changes between 2008 RTEP (2013) and April 2009 (2014) base cases.

	2008 RTEP Study year 2013	**April 2009 Study year 2014**	**Difference**
Reactive load in eastern PJM	-10,954 Mvar	-11,520 Mvar	-566 Mvar
Certain capacitors in Maryland	500 Mvar	0 M	-500 Mvar
Reactive power from circuits in East	9027 Mvar	8098 Mvar	-929 Mvar
		Total	**-1,995 Mvar**

Notes:

- Reactive demand (e.g., load) is treated as negative.
- Reactive supply (e.g., from capacitors and lines) is treated as positive.
- The eastern PJM area considered was PJM's MAAC, plus the PJM 500-kV system, less Rockland

Q: PLEASE EXPLAIN TABLE 1.

A: The first row shows that the reactive load seen by the transmission system increased by 566 MVAR between the 2008 RTEP and April 2009 cases.

Q: IS THIS A SIGNIFICANT INCREASE?

A: Yes, compared to the increase in real load (measured in megawatts, or MW) between the two cases. In PJM, the reactive load averages about 26% of the real load. The real load

increased by 766 MW between the two cases, so the reactive load should have increased by about 198 MVAR. The difference between the change in reactive load (566 MVAR) and what the change should have been (about 198 MVAR) is about 368 MVAR.

Reactive power load should be compensated to maintain appropriate power factors (relation between real and reactive power) at the distribution level, if possible. This compensation is not visible in transmission planning studies, which focus on the higher-voltage system. Most of the 566 MVAR of new uncompensated reactive demand appears to be an error. PJM's load forecasting method, described extensively by PJM witnesses, seems to deal only with real load and does not explain this increase in reactive demand.

Q: WHAT IS YOUR CONCLUSION REGARDING REACTIVE LOAD?

A: The 368 Mvar of reactive demand that appears to be an error contributes to the 2,000 MVAR of uncompensated load identified by Mr. McGlynn.

Q: PLEASE EXPLAIN THE SECOND ROW OF TABLE 1, DR. MERRILL.

A: Two 250-MVAR capacitors were in a 500/230-kV substation in Maryland in the 2008 RTEP but not in the April 2009 study.

Q: PLEASE EXPLAIN THE THIRD ROW OF TABLE 1, DR. MERRILL.

A: Transmission lines may either absorb or produce reactive power, depending on conditions. The files produced by the software do not make comparisons easy. But it appears that three New Jersey circuits that produced a total of about 735 MVAR in the solved 2008 RTEP case were not in the April 2009 case.

Q: WHAT DO YOU CONCLUDE?

A: Mr. McGlynn says that the sudden emergence of alleged widespread voltage problems in 2014 can be cured by about 2,000 MVAR of reactive power. I conclude that if he is right, the

alleged voltage collapse that is projected in 2014 can be attributed in part to growth of reactive demand in the East, most of which appears to be erroneous. It can also be attributed to the removal of two capacitors from the April 2009 case, which appears to be undocumented and unnecessary given that it causes a problem. Finally, it appears that three transmission circuits that were generating a significant amount of reactive power in the 2008 RTEP case have been removed from the April 2009 case. There seem to be similar problems in the Dominion area and possibly in Pennsylvania.

In the aggregate, these questionable changes from the 2008 RTEP and April 2009 studies may explain all or most of Mr. McGlynn's 2,000 MVAR shortfall of reactive power.

Correcting the errors and using more reasonable values of CETO will reduce and may eliminate the voltage problems claimed by Mr. McGlynn. If the problems are not eliminated, the amount of reactive compensation (new capacitors) required will be reduced.

Q: IS THERE ANY EVIDENCE THAT CLAIMED VOLTAGE ISSUES WOULD PERSIST BEYOND 2014?

A: No. Mr. McGlynn characterizes the voltage problems as "beginning in 2014." However, PJM says that, "No P/V [voltage collapse or violation] analysis has been performed for the later years of the planning horizon." (PATHVA-00027825) Mr. McGlynn may assume that the supposed problems will continue to later years, but that is just an assumption.

Q. IF THE ALLEGED VOLTAGE PROBLEMS WERE REAL, COULD THEY BE SOLVED WITH CAPACITORS?

A: Yes, though physical constraints in substations may affect where the capacitors are located. On p. 52 of his testimony, Mr. McGlynn says that about 2,000 Mvar would be needed.

He was more precise under discovery, fixing the amount needed as approximately 2,050 Mvar and identifying five substations where they should be installed. (PATHVA 00022948)

Q: WHY ISN"T PJM INSTALLING CAPACITORS INSTEAD OF BUILDING PATH?

A: Mr. McGlynn says that:

1. The "sheer number of reactive solutions required" makes this infeasible.
2. In addition, four 500 Mvar SVSs would, he says, cost $200 million – "a very expensive proposition."
3. Finally, he says that relying on capacitors to solve the voltage problems would make the system more difficult to operate.

Q: DO YOU AGREE WITH MR. MCGLYNN?

A; No.

Q: WHY NOT?

A: The "sheer number" (2,000 MVAR) isn't unusually high.

PJM routinely uses capacitors to resolve issues of this alleged magnitude. For instance, the 2006 RTEP report says, "Over 2,700 MVA of additional reactive power sources by way of new capacitive reactive devices . . . are required to mitigate identified voltage criteria violations . . . ." (p. 9) Page 12 refers to a later need for about 10,000 MVAR of these devices. No concern is expressed about the impracticality of this "sheer number" of capacitors or about operational difficulties they will cause.

Q: ARE CAPACITORS PART OF THE PATH PROJECT?

Yes. Approximately the same number of capacitors are needed, according to PJM, with or without the PATH line. The supposed voltage problems can be solved with capacitors and without the line, according to PJM. Or they can be solved with about the same number of

capacitors and with the line. So as far as the supposed voltage problems are concerned, the line itself isn't the solution.

Q: HOW DO YOU KNOW? THIS DOESN'T SEEM TO BE IN THE RECORD.

A: I agree. It doesn't seem to be. Mr. Poff describes the engineering and design of the PATH project. However, I cannot find in his testimony filed with the Virginia Commission any mention of capacitors associated with the PATH project.

Q: HOW DO YOU KNOW THAT PATH INCLUDES CAPACITORS?

A: On pages 21 and 22 (of 24) of Mr. Poff's testimony to the Maryland Commission is a paragraph listing the equipment to be installed in the Kemptown substation as part of the PATH project. In a sentence toward the end of this paragraph appear the words, ". . . and two 125 MVAR/F288 MVAR capacitor banks."

In the last sentence of a similar paragraph on page 25 (of 26) of his testimony to the West Virginia Commission, Mr. Poff says, ". . . and a 1,500 MVAR Static VAR System ("SVS"), separated into 1,000 MVAR of static and 500 MVA of dynamic capacitive compensation . . ." at the current midpoint of the line, Welton Spring.

Mr. McGlynn emphasizes strongly that the sheer number, the cost, and the effect on operability of 2,000 Mvar of capacitors makes them "infeasible" for solving the supposed voltage problems. He testifies for many pages of the need for the PATH line to solve his voltage problems.

Then we see in the details of Mr. Poff's testimony, which was part of the information provided to the Maryland Commission and to the West Virginia Commission, that the PATH line will require 1,750 Mvar – just one medium-sized capacitor less than Mr. McGlynn's "infeasible" 2,000 Mvar.

None of this information was provided to the Virginia Commission.

I have found no discussion by witnesses supporting the PATH line about either operational difficulties associated with the 1,750 Mvar of capacitors that PATH will require or how these difficulties will be resolved.

Q: HAS PJM USED CAPACITORS BEFORE?

A: Yes, PJM has a long history of using capacitors to resolve voltage problems. It is a standard solution.

Q: CAN YOU COMMENT ON THE COST OF A CAPCITOR SOLUTION?

A: Yes. Mr. McGlynn said that 2,000 Mvar of SVS's would cost $200 million. An SVS (often called SVC) is an expensive controllable or *dynamic* reactive system. The 2006 RTEP report (27 February 2007, p. 155) estimates that dynamic devices will cost about $100,000 per Mvar, which agrees exactly with Mr. McGlynn's $200 million estimate. Incidentally, $100,000 seems high compared to the cost of recent PJM installations.

However, Mr. McGlynn says elsewhere that the roughly 2,000 Mvar of capacitors required in lieu of the PATH line to resolve his alleged voltage problems are much-cheaper *static* devices. (PATHVA-00022948) The 2006 RTEP report (27 February 2007, p. 155) estimates that static devices (simple capacitors without expensive controls) will cost about $20,000 per Mvar. The total cost for 2,000 Mvar would be $40 million.

This is insignificant compared to the cost of the PATH project.

This is one-fifth the cost that Mr. McGlynn estimates.

Incidentally, using the 2006 RTEP estimates quoted above, the 1,500 Mvar of static and dynamic compensation that the PATH project plans to add at Welton Springs would cost $70

million. The 250 Mvar PATH includes at Kemptown, if they were static, would add $5 million. The $75 million total is almost twice the cost of the stand-alone 2,000 Mvar of capacitors.

III. ALLEGED LOWER VOLTAGE THERMAL ISSUES

Q: WHAT ISSUES DO YOU ADDRESS IN THIS SECTION?

A: In this section I address only the alleged issues relating to the lower-voltage system (345-kV and 230-kV).

Q: DOES PJM CLAIM THAT THESE ISSUES SUPPORT THE ALLEGED NEED FOR THE PATH LINE?

A: Yes.

Q. WHERE ARE THESE ALLEGED THERMAL ISSUES IDENTIFIED?

A: The alleged thermal issues relating to lower voltage line are identified for the first time in the April 2009 Retool Study, and they appear in the first six rows of Exhibit PFM-2 to Mr. McGlynn's testimony. These are the only thermal violations that are alleged to appear in 2014 — the last year in which PJM performed contingency and other formal analyses to evaluate reliability, as will be shown in Section IV below discussing alleged 500-kV thermal issues.

Q: IS PATH NEEDED TO SOLVE THESE ALLEGED RELIABILITY VIOLATIONS?

A: No. These alleged problems are associated with the lower-voltage system. PJM resolves many such problems every year without building 765-kV lines. It is not reasonable to build a 765-kV line to resolve issues that can be addressed with routine fixes that are far less costly, far less intrusive, and in some cases, more effective than the proposed PATH line. PATH is overkill as a solution for four of these six purported issues. According to PJM, PATH is only a temporary fix for the other two.

Q: CAN YOU DESCRIBE THE ALLEGED LOWER VOLTAGE VIOLATIONS IN LINES 4 AND 6 OF EXHIBIT PJM-2 AND EXPLAIN HOW IT WOULD BE POSSIBLE TO RESOLVE THEM?

A: Lines 4 and 6 of PFM-2 describe supposed overloads of 500/230-kV transformers. In confronting this sort of problem, the first solutions to consider are uprating or replacing the transformers. In a worst-case scenario in which a more aggressive solution is required, an additional transformer could be installed at each of the two relevant substations.

Q: CAN YOU DESCRIBE THE ALLEGED LOW-VOLTAGE VIOLATIONS N LINES 1, 2, 3, AND 5 OF EXHIBIT PJM-2 AND EXPLAIN HOW IT WOULD BE POSSIBLE TO RESOLVE THEM?

A: Lines 1 and 3 describe mirror-image effects of supposed outages of one of two parallel 230-kV lines. If either line has an outage, the other supposedly overloads. From my review of documents provided in discovery, I estimate that these lines are about four miles long.

The Dickerson-Pleasant View 230-kV line in suburban Virginia (line 2) supposedly overloads if another line goes out of service in a contingency. In line 5 the supposed contingency overload is on a 345-kV AEP line in Ohio.

Whatever the respective limiting factors on these lines, there are alternative solutions to PATH that should be considered to resolve supposed overloads, including replacing relatively inexpensive items of equipment or fixing the clearance under a single span. More expensive solutions could include reconductoring or building a new line.

PJM has not considered any alternative fixes for these issues, other than the PATH line.

Q. HAS PJM DEMONSTRATED THAT THERE ARE GENUINE LOWER VOLTAGE LINE ISSUES THAT MSUT BE ADDRESSED?

A: No. It is crucial to consider whether these low-voltage issues disappear simply by adopting more reasonable assumptions about the quantity of power transfer that could be required to meet peak load demand in the Mid-Atlantic LDA. The supposed overloads may depend on the transfers and, in particular, on the CETO values that determine the transfers. In response to a request by the Commission staff, PJM recently updated its 2014 CETO for the Mid-Atlantic LDA, reducing the CETO to 7,720 MW. (16 Oct. 2009, PATHVA 00027899). This means that the CETO number that was used as the basis for all of PJM's testing in the April 2009 study was too high, and the results are therefore not credible on that basis alone.

As Mr. Loehr indicates, this revised CETO number is still unreasonably high. Lower CETO numbers may reduce the flows reported with respect to the first 6 lines of Exhibit PFM-2. The recent revision in CETO is significant, and more reasonable CETO assumptions would be even more significant. Some of the reported 2014 violations may no longer occur.

Q: WITH RESPECT TO THESE LOWER VOLTAGE ISSUES, HAS PJM CONSIDERED ALTERNATIVES TO BUILDING THE PATH LINE AND THEIR RESPECTIVE COSTS?

A: No, PJM has not looked for any fixes. (PATHVA 00027890). The only time that PJM considered alternatives to PATH was during the 2007 RTEP process, and at that time, PJM had not identified any of these alleged low-voltage line concerns as a justification for the PATH line.

The appearance of these issues for the first time in the April 2009 Study has not prompted PJM to undertake any further analysis of alternatives. Yet these alleged low-voltage violations constitute all of the thermal issues that arise in 2014. As discussed later in my testimony, all of the other alleged violations that appear in Exhibit PFM-2 to Mr. McGlynn's testimony arise more than five years from now based on extrapolation. In short, PJM has made no effort to consider basic fixes for the few 2014 violations that it is alleging in support of PATH.

Q: CAN YOU ESTIMATE THE COSTS TO FIX THESE ALLEGED LOWER-VOLTAGE SYSTEM PROBLEMS, AS AN ALTERNATIVE TO BUILDING THE PATH LINE?

A: Without knowing why each facility is limited, I can't identify optimal cost-effective solutions, but I can give a rough estimate of what the high-end costs would be using PJM's own reporting of routine upgrade costs as a conservative guide.

The RTEP reports discuss only upgrades whose cost is generally greater than $5 million. Many PJM upgrades are less expensive. Table 2 below is a sample of projects reported in the 2008 RTEP report. The average cost of replacing three 500/230-kV transformers is $7 million. The average cost of the other eight projects is $13 million. If we apply the average transformer replacement costs to the two 500/230-kV transformers in Exhibit PFM-2 we get $14 million. Applying the $13 million average cost of the other eight items in Table 2 to the other four lower-voltage overloads in Exhibit PFM-2 amounts to $52 million. The sum for the six lower voltage overloads in Exhibit PFM-2 is $66 million. This is trivial compared to the cost of the $1.8 billion PATH line.

This $66 million number should be taken as a high upper bound of the cost of fixing the supposed lower-voltage overloads in Exhibit PFM-2. The actual cost would probably be much lower. This is because:

1. The projects in Table 2 are expensive. Many PJM upgrades are too cheap to be included in this table. If they were included, the average would be considerably lower.
2. In particular, some of the projects in Table 2 are likely to be much more complex and expensive than what would be required to fix the alleged violations in Exhibit PFM-2. These include items 27, 34, and 35.

I reiterate that some or all of the supposed 2014 thermal violations may disappear if the recently revised CETO number is used, and especially if a lower value as recommended by Mr. Loehr is used, or if the load reductions covered in Mr. Fagan's testimony are modeled.

Q: WILL PATH BE A PERMANENT FIX FOR ALL OF THE ALLEGED LOWER-VOLATIONS IDENTIFIED IN LINES 1 THROUGH 6 OF MR. MCGLYNN'S TESTIMONY?

A: PJM says that two of them will overload in 2018, even with PATH. PJM claims that the others will not overload until after 2024.

Table 2
Typical more-expensive lower voltage upgrades
(Source: PJM 2008 RTEP report, p. 261)

	Upgrade	Date	Cost (M)	TO Zone(s)	2008 TEAC Review
24	Reconductor the Bradford – Planebrook 230 kV Ckt. 220-31 to provide a normal rating of 677 MVA and emergency rating of 827 MVA	June 2013	7.5	PECO	9/17/2008
25	Add a fourth 230/69 kV transformer at Stanton	November 2011	5.9	PPL	9/17/2008
26	Lackawanna – Oxbow – Rebuild approximately 16.33 miles of transmission line to support bundled conductor	December 2011	19.596	PENELEC	9/17/2008
27	Oxbow – N. Meshoppen – Rebuild approximately 10.6 miles of transmission line to support bundled conductor; North Meshoppen Substation upgrade/replace two CT circuits and replace substation conductor	December 2011	13.597	PENELEC	9/17/2008
28	Juniata – Replace 500/230kV transformer #2	December 2011	10	PPL	9/17/2008
29	South Troy – East Towanda – Reconductor 19.54 miles of the South Troy – East Towanda 115kV transmission line	April 2009	5.373	PENELEC	10/15/2008
31	Keystone – Replace #3 500/230kV Transformer	December 2009	5.5	PENELEC	9/17/2008
32	Keystone – Replace #4 500/230kV Transformer	December 2009	5.5	PENELEC	9/17/2008
33	Frackville – Shenandoah – Rebuild apprx. 5.3 miles of existing 69kV line	August 2008	5.25	PPL	10/15/2008
34	New Tunnel 230-13 kV Substation [2-62 MVA trfs.]		25	PECO	4/23/2008
35	Add Warminster 2nd 230-13 kV Substation [2-62 MVA trfs.]		23	PECO	4/23/2008

IV. ALLEGED 500-KV THERMAL VIOLATIONS

Q: WHAT ISSUES DO YOU DISCUSS IN THIS SECTION?

A: I discuss the alleged 500-kV thermal violations on the first page of Mr. McGlynn's Exhibit PFM-2. I didn't look at the second page because the claimed violations were so far in the future as to be even more speculative that what is shown on the first page. Certainly nothing on page 2 justifies building PATH in 2014. There are no alleged violations that occur before 2019 or later on page 2.

Q: DO YOU BELIEVE THESE ALLEGED 500-KV VIOLATIONS ESTABLISH A NEED FOR PATH?

A. No.

Q: CAN YOU BRIEFLY SUMMARIZE THE REASONS FOR YOUR CONCLUSION?

A: Yes. Since 2006, PJM has identified alleged problems of overloads of the 500-kV system under contingency that are related to PATH. The facilities and contingencies identified have changed from year to year.

No matter what changes in the 500-kv system PJM has predicted, PATH is always asserted to solve all alleged problems. Any line that solves all possible issues far out into the future is either over-designed or poorly analyzed.

Since 2007, when the PATH line was approved by PJM, ostensibly to resolve 500 KV issues, the supposed overloads have receded further into the future. In the 2007 RTEP, the first alleged violations were in 2012, and in the 2008 RTEP the first alleged violations were pushed back to 2013. In the April 2009 study, the onset of the alleged 500-kV problems receded two or three additional years, from 2013 in the 2008 RTEP report to 2015-2016.

In the April 2009 study, the alleged overloads past the fifth year (e.g., years 2015-2024) are not supported by any kind of contingency analysis, as described in the NERC standards, or by the deliverability analyses that PJM performs. The alleged overloads are based purely on extrapolated flows from 2014 and a linear analysis using distribution factors.

Extrapolation rather than detailed modeled is notoriously inaccurate. A $1.8 billion line should not be based on such a flimsy foundation.

Here, all extrapolated results are based on an inaccurate 2014 power flow base case. After 2014, PJM does not alter the base case to reflect new generation projects or DSM resources in the mid-Atlantic LDA

The extrapolation implicitly changes the power transfers and hence the CETO targets which supposedly define the transfers, but without any formal re-determination of the CETO targets. Specifically, the extrapolation is based on 2014 studies. These are based on CETO values that have recently been revised downward. This reduction should reduce the 2014 loadings as well as the extrapolated loadings for later years. The years when alleged contingency loads exceeded 100% may recede into the future. If reasonable, lower CETO objectives were used, as recommended by Mr. Loehr, these reductions and postponements would be greater.

Generation assumptions are equally flawed. For instance, PJM claims that it incorporates in its analyses all generation with a signed ISA. However, it omitted from its studies a proposed 1640-MW generator at Calvert Cliffs, with a first-quarter 2016 in-service date. This generator has not only a signed ISA but also a signed CSA, which is one step further in the interconnection process. This generator would reduce the Mid-Atlantic LDA CETO value. It would also reduce the actual imports into that area. These changes would reduce any alleged overloads beyond 2015. By themselves, these changes would likely postpone the years when the extrapolated loading is alleged to first exceed 100%.

A conservative extension, without growth, of the demand-side management resources that cleared the 2009 RPM auction would have a similar effect on all of the numbers in Exhibit PFM-2.

Not only are PJM's claimed overloads unreliable because they are based on extrapolation, they cannot be audited because PJM did not retain the distribution factors or the

projected generation used to compute the alleged 500-kV overloads identified in the April 2009 study.

Q: PLEASE TRACE THE EVOLUTION OF THE ALLEGED 500-KV OVERLOADS.

A: Figure 1 and Table 3.4, both from the 2007 RTEP, will be helpful in following the discussion below.

Figure 1
Highlighted lines indicate the areas of alleged 500-kV overloads relevant to PATH.

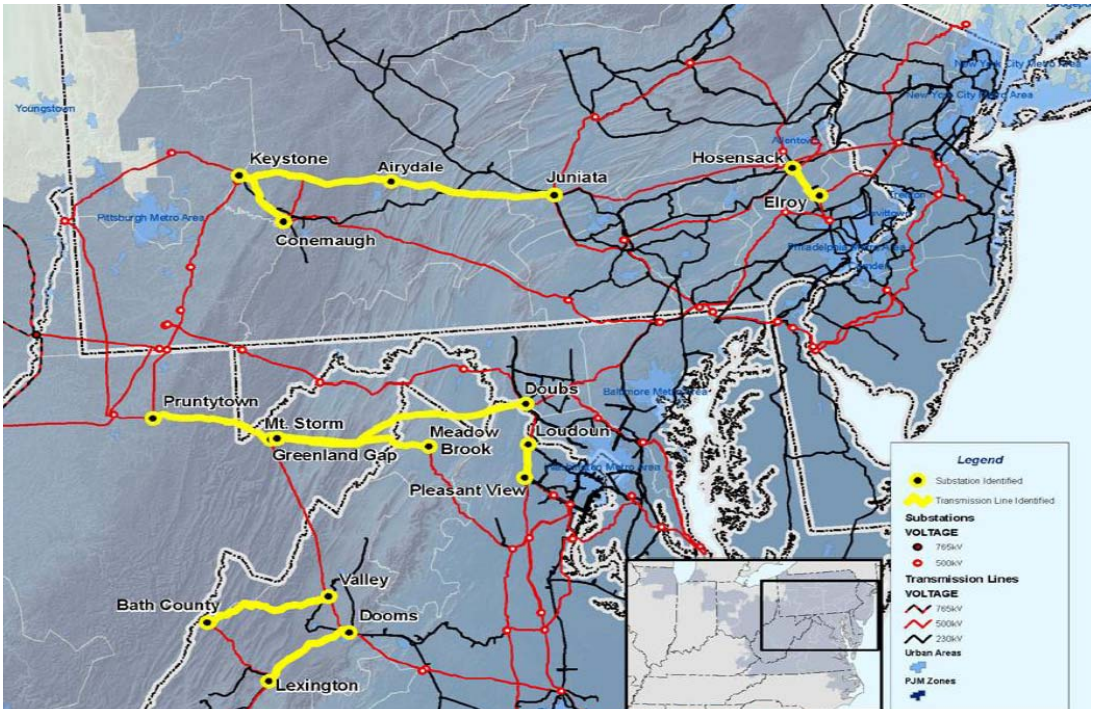

TABLE 3.4: Reliability Criteria Violations Driving Need For Amos – Kemptown Line

Overloaded Facility	Test Resulting in Highest Overload	Year That Facility Loading Exceeds Conductor Rating
Keystone – Airydale 500 kV	Load Deliverability	2012
Keystone – Conemaugh 500 kV	Load Deliverability	2012
Mt. Storm – Doubs 500 kV	Load Deliverability	2012
Airydale – Juniata 500 kV #1	Load Deliverability	2013
Airydale – Juniata 500 kV #2	Load Deliverability	2013
Pruntytown – Mt. Storm 500 kV	Load Deliverability	2015
Harrison – Pruntytown 500 kV	Load Deliverability	2016
Lexington – Dooms 500 kV	Load Deliverability	2017
Loudon – Pleasant View 500 kV	Load Deliverability	2017
Greenland Gap – Meadowbrook 500 kV	Load Deliverability	2020
Mt. Storm – Greenland Gap 500 kV	Load Deliverability	2020
Hosensack – Elroy 500 kV	Load Deliverability	2021
Bath County – Valley 500 kV	Load Deliverability	2022

In 2006, a PJM analysis concluded that with the [TrAIL] line, the only overloads relevant to PATH would be on three 500-kV lines in central Pennsylvania, in 2019 and 2020.

In areas most relevant to PATH, the 2007 TEAC report said that Pennsylvania overloads would now occur in 2012 (the 5th year) and 2013 (an extrapolated year). In addition, overloads were projected on lines near Mt Storm and elsewhere in Virginia, notably Bath County. The claimed 2012 overloads were two Keystone lines (Pennsylvania) and the Mt Storm-Doubs line. Although these were five years out, applications for projects to relieve these alleged overloads were not filed.

In the 2008 RTEP report, the need for PATH was projected to be in 2013, one year later than in the 2007 RTEP report. The alleged violations in the 5th year (2013) continued to be thermal overloads of the Mt Storm-Doubs line and of lines in Pennsylvania in the same area as those identified in the 2007 RTEP report. In the extrapolation region were more Pennsylvania and Virginia lines, including lines in the Bath County system as well as lines near Washington, DC.

In the April 2009 study, there were no claimed thermal overloads in the 500-kV system in 2014, the 5th year. They all occurred in the extrapolation years, beginning in 2015 and 2016. The earliest claimed overloads were of the Mt Storm-Doubs line and of a line in the Bath County system. The Pennsylvania thermal overloads began next.

Q: CAN YOU SUMMARIZE PJM'S PREDICTIONS ABOUT ALLEGED 500-KV LINE OVERLOADS SINCE 2006?

A: The PATH-related overloads were first claimed for the distant future in Pennsylvania, with nothing on the horizon in Virginia. The following year, the claimed overloads in Pennsylvania occurred many years earlier, along with Mt Storm-Doubs. Claimed overloads

began in the 5th year (2012). Other Virginia overloads, including Bath County overloads, were also claimed for the later years. The next year the Virginia lines dominated, with Bath County problems occurring earlier. Overloads again begin in the 5th year (now 2013). In the most recent study the overloads continue to recede, this time to the 7th year (2016). Now the first two claimed overloads are Mt Storm-Doubs and a Bath County line. Overloads on lines elsewhere in Virginia and Pennsylvania are alleged. In summary, there are changes from year to year in the lines claimed to overload.

Q: WHAT DO YOU CONCLUDE FROM THIS HISTORY?

A: PJM projections of alleged 500-kv line overloads are unstable. The first year of claimed overloads moved from 2019 in 2006 to 2012 in 2007 and then receded by a year from 2007 to 2008 and by three years in April 2009. The set of lines involves changes from year to year.

The only constant is that PATH (as it is now called) will solve all alleged problems, whatever they are claimed to be. The line is so big – its thermal limit is 6500 or 7000 MVA - and its impedance is so low, that this conclusion is not a surprise. But PJM fails to demonstrate that the alleged 500kv issues are credible and that there are no more modest, less intrusive, and more cost-effective solutions to solve them.

Q: WHAT IS THE DIFFERENCE BETWEEN THE FIFTH-YEAR ANALYSES AND THE ANALYSES FOR THE SUCCEEDING YEARS?

A: The difference is very significant.

PJM's analysis for the 5th year (e.g., 2014 in the April 2009 studies) uses accepted power-flow tools. While PJM's use of these tools is not necessarily defensible, the results of its analyses for years through 2014 are at least based on contingency analyses.

After the 5th year (2014 in the April 2009 study), there is no further contingency analysis. For 2015 through 2024 (in the April 2009 study), PJM performed no reliability analysis. PJM simply extrapolated the flows it calculated for the year 2014.

As PJM made clear in response to discovery questions: "PJM extrapolated the loading on transmission facilities based on load growth to determine the thermal loadings beyond 2014. Voltage analysis was only performed on the 2014 power flow case." (PATHVA 00027835) "PJM did not develop a 2016 power flow case. PJM extrapolated the loading on transmission facilities based on load growth to determine the thermal loadings beyond 2014." (PATHVA 00027942).

Q: WHAT'S WRONG WITH SUCH EXTRAPOLATION, IN YOUR OPINION?

A: Extrapolation is neither reliable nor accurate.

A $1.8 billion project ought to be supported by real reliability studies, not extrapolated "guesstimates."

Q: WHY IS EXTRAPOLATION UNRELIABLE?

A: I do a lot of work with related problems and have published extensively in this area. As part of one study we took 50 data points and estimated the values of others, whose values we actually knew because this was an experiment. (Mukerji et al, "Creating Data Bases for Power System Planning Using High Order Linear Interpolation," IEEE Transactions on Power Systems, Vol. 3, No. 4, November 1988). Four were outside the range that permitted interpolation. We extrapolated for them using a sophisticated approach. The average extrapolation error was 25.7%.

Q: WHY IS EXTRAPOLATYION UNRELIABLE IN THIS CONTEXT?

A: There are a number of reasons. Some have to do with the fact that we are inferring things outside the range where we have hard information. Others reflect the simple absence of detailed modeling.

For instance, PJM extrapolates flows. As the extrapolated flows change from year to year, the sum of extrapolated flows on any set of lines changes, too. Suppose we are interested in the sum of the flows entering the Mid-Atlantic LDA. In 2014, this sum is approximately the CETO value. It is determined by the CETO value, in fact.

But there is no guarantee that the total flows in later years into this LDA will continue to equal the 2014 CETO – or equal any other predetermined CETO, for that matter. In fact, they probably won't.

Since the supposed load deliverability test overloads are due largely to total imports into this LDA, and since the flows in the extrapolated years are not necessarily related to any computed CETO, there is no fixed relationship between the extrapolated alleged load deliverability overloads and any computed CETO objective. The extrapolated results are therefore without a valid basis.

Q: WOULD THE USE OF REASONABLE CETO VALUES CHANGE THE EXTRAPOLATED PROJECTIONS SET FORTH IN EXHIBIT PJM-2?

A: Yes. As noted above, in October 2009, PJM revised the Mid-Atlantic LDA CETO downward. This appears to be a function of more generators reaching ISA status. Mr. Loehr thinks the CETO objectives are still too high. So do I.

In any event, reducing CETO means reducing the flows into the LDA that are represented in the 2014 studies. This will reduce the year 2014 flows on the 500-kV lines shown on Exhibit PFM-2.

It will also reduce the flows in years 2015-2024.

Q: CAN THE EXTRAPOLATED RESULTS PRESENTED IN EXHIBIT PFM-2, BE INDEPENDENTLY VERIFIED?

A: Nobody, including the Commission staff can replicate or verify them. Doing so would require four sets of numbers.

1. The flows on each monitored line. PJM did not retain the individual runs on which each 2014 number is based.
2. The projected loads for each area. PJM retained these and made them available.
3. The projected generation for each area. PJM did not retain this information.
4. The distribution factors (DFAX). PJM did not retain this information.

In other words, Exhibit PFM-2, which for alleged 500-kV thermal violations is the basis for establishing the need for the PATH project, cannot be replicated or audited independently. The Commission cannot look under the hood. JM did provide descriptions of how the 2014 flows, the projected generation, and the DFAX were calculated. These were not sufficiently unambiguous to permit a skilled planner to replicate their work.

Q: DOES PJM'S EXTRAPOLATION METHOD ACCOUNT FOR ALL NEW GENERATION WITH SIGNED ISAS IN THE MID-ATLANTIC LDA?

A: Based on discovery responses, my understanding is that it does not. In addition, as part of its extrapolation, PJM increases generation "proportionally" to deal with projected future loads.

Q IS THIS A PROBLEM?

A. Yes, as I explain below. PJM ignores its own rules as to when generation should be modeled, and ignores significant amounts of planned generation in its own queue that has not yet

signed an ISA. In addition, generation does not "proportionally" enter the grid – it tends to enter the grid in large chunks.

Q. CAN YOU PROVIDE AN EXAMPLE?

A: Certainly. In relying on the 2014 base case to project overloads in 2015-2024, PJM fails to account for new generation that meets PJM's own criteria for inclusion in analysis. PJM claims to include all new generation with signed ISA, but it does not do so.

For instance, a proposed Calvert Cliff unit appears in PJM's interconnection queue position Q48, with a Q1 2016 in-service date. It has a signed ISA and in fact a CSA as well. Under PJM's rules, this unit should be included in the reliability analysis from 2016 onwards.

The unit does appear in the April 2009 power-flow case, but it is turned off. This is reasonable, as it won't be running in 2014. However, the unit should be turned on starting in 2016.

The extrapolation procedure never recognizes this the new units.

Q: HOW DO YOU KNOW THAT THE EXTRAPOLATION PROCESS DID NOT ACCOUNT FOR NEW GENERATION FROM CALVERT CLIFFS STARTING IN 2016?

A: In two ways. First, the extrapolation procedure as described by PJM does not recognize individual new plants with in-service dates beyond the 5^{th} year (2014, in this case).

Second, the unit is big enough that a significant drop in the Exhibit PFM-2 numbers should show up in 2016 and succeeding years. There is no such drop.

Q: WHAT WOULD BE THE EFFECT OF INCLUDING THIS UNIT N THE RELAIBILITY ANALYSIS?

A: I explored potential effects of incorporating generation from this Calvert Cliffs unit in 2016 with a corresponding drop in generation spread equally among Mt Storm, Amos, and

Kammer – a specific redispatch, if you will, but one that also represents a reasonable proxy for a redispatch spread throughout western PJM.

I calculated my own distribution factors for the line 7 (Exhibit PFM-2) flowgate and applied them based on the three-way split assumption. I derated the Calvert Cliffs unit by 13%, a typical equivalent forced outage rate for large nuclear units

With these assumptions, the flow on the Mt Storm-Doubs line, with the outage of the Meadow Brook-Loudon line, is reduced by 253 MW. This line has an emergency rating of 2598 MW, according to the 2014 base case. In percentage terms, 253 MW is 9.7% of the emergency rating. This means that 9.7% should be subtracted from every number in row 7 of Exhibit PFM-2. This means that the loading (using PJM's extrapolation technique) would not exceed 100% until 2021.

Incidentally, I don't know if PJM uses normal or emergency ratings for their calculation of percentages. If they use normal ratings, then the 9.7% number above becomes 9.9%.

The Commission should not approve a line today based on a projected overload in 2021.

Q: HOW ABOUT THE CLAIMED OVERLOAD OF THIS LINE IN 2015, DR. MERRILL?

A: I will show later that that claimed overload is completely eliminated by recognizing updated demand-side management resources.

Q: HOW ABOUT THE OTHER CLAIMED OVERLOADS IN EXHIBIT PFM-2?

A: I calculated the distribution factors for the rest of the 500-kV flowgates on the first page of PFM-2, and of the345-kV one as well. The post-contingency flows on every one of these will be reduced by the Calvert Cliffs unit and the redispatch I described.

Q: WOULD MODELING THE CALVERT CLIFFS UNIT HAVE ANY OTHER EFFECT ON ALLEGED THERMAL VIOLATIONS ON 500-KV LINES?

A: Yes. It would reduce the calculated CETO for the Mid-Atlantic LDA. This would cause the dispatch modeled in 2014 to change, reducing the base west-to-east flows and further reducing the loading on most or all of these lines in 2014. This should reduce all of the post-2015 500-kV flows show in Exhibit PFM-2, using PJM's extrapolation technique.

Q. DOES THE FACT THAT CALVERT CLIFFS IS A NUCLEAR UNIT AFFECT YOUR CONCLUSIONS?

A. No. I understand that no nuclear plants have been ordered in the U.S. for thirty years and that the new Calvert Cliffs unit is not certain to be in service in 2016. However, the signed ISA and CSA indicate that this is a serious project. Further, my point is that PJM's analysis violated PJM's own protocols. It failed to account for new generation in the LDA of concern that is satisfies PJM's criteria for inclusion and that is reasonably certain to materialize.

Q: HOW WOULD THE MOST RECENT RPM AUCTION AFFECT THE ALLEGED 500-KV THERMAL OVERLOADS?

A: The DSM resources that cleared in the 2009 RPM auction are extremely significant. I will describe the effect that these results would have.

I understand that the cleared demand response (DR) and energy efficiency (EE) from the 2008 auction were incorporated in the load forecast for the April 2009 study, and that these auction results were projected without change into the future by PJM.

I also understand that the 2009 RPM auction cleared 717 MW more in the BGE (Baltimore Gas & Electric) area than did the 2008 auction, and 316 MW in PEPCO and that these additional DSM resources have never been considered.

For modeling convenience, I injected all of this change (1033 MW) at Calvert Cliffs, a reasonably central bus, with compensating reductions divided evenly between Mt Storm, Amos, and Kammer plants.

With these assumptions, the post-contingency flow on the Mt Storm-Doubs line for the line 7 flowgate was reduced by 183 MW. This is 7% of the emergency rating of the line. This 7% should be subtracted from every number on the line 7 flowgate in Exhibit PFM-2. This will eliminate the claimed 0.9% overload in 2015.

Considering both the Calvert Cliffs unit and the EE and DR, the loading on the line will not exceed 100% until 2024.

As with the Calvert Cliffs unit, the loading on all monitored 500-kV and 345-kV lines on the first page of Exhibit PFM-2 will also be reduced, but effective 2014.

This resource should also reduce the CETO objective, similar to the effect of the Calvert Cliffs unit.

Q: HOW ABOUT THE EFFECT OF THE DEMAND RESPONSE AND ENERGY EFFICIENCY IN THE REST OF PJM?

A: I understand that the DR and EE resources that cleared the 2009 RPM auction were greater for every company in eastern PJM than in 2008.

DR and EE elsewhere in eastern PJM will reduce all of the 500-kV and 345-kV flows shown on the first page of Exhibit PFM-2, in addition to the reduction calculated above for DSM in BGE and PEPCO.

Q: CAN YOU SUM UP YOUR CONCLUSIONS REGARDING THE NEED FOR PATH, BASED ON THE CLAIMED 500-KV THERMAL OVERLOADS?

A: Exhibit PFM-2 is the basis for establishing the need for PATH as far as the alleged 500-kV thermal violations are concerned.

The reliability analysis that underlies PFM-2 was not performed beyond 2014. All results beyond 2014 are extrapolated. Extrapolation is neither reliable nor acceptable, particularly for a $1.8 billion project. I pointed out specific errors that extrapolation caused.

PJM failed to include a new unit at Calvert Cliffs, with Q1 2016 in-service date, in spite of its having not only an ISA but also a CSA. Including this unit will reduce all 345-kV and 500-kV numbers on page 1 of PFM-2 from 2016 onward.

Incorporating the cleared energy efficiency and demand response resources from the 2009 RPM auction would further reduce all 345-kV and 500-kV numbers on page 1 of PFM-2, beginning with 2014.

The data used to develop PFM-2 was not retained by PJM. The numbers cannot be validated or audited.

V. TWO POSITIVE RECOMMENDATIONS

Q: DR. MERRILL, HAVE YOU ANY POSITIVE RECOMMENDATIONS?

A: Yes. In addition to the other problems with PJM's planning process identified throughout this testimony, which should be corrected, I have two additional recommendations.

First, PJM's planning needs to consider environmental and economic effects thoroughly and from the beginning, even for projects that they feel are justified by reliability needs.

Q: DON'T THEY ALREADY DO SO?

A: They claim to but they do not. I did a word search on the 2008 RTEP report. Table 3 shows that words related to reliability occur, on the average, more than once per page. Words

related to economics and the environment occur much less frequently. Table 3 reflects PJM's planning efforts.

PJM should consider environmental issues throughout planning, not just at the last stage of line routing. PJM also should consider the true economic effects of its decisions, not just the cost of the line. For example, a 2007 PJM analysis showed that the cost to the rate payer of the Amos – Kemptown line is much greater than the cost of the line itself.

Table 3.
Word occurrences in PJM's 2008 RTEP report (322 pages)

Words	**Occurrences**
reliable, reliability	495
economic, economical	89
environment, environmental	11
greenhouse	0
CO_2	7
carbon	1
subtotal, five environmental terms	19

Q: WHAT IS YOUR SECOND POSITIVE RECOMMENDATION?

A: The regional power system faces two possible paths. One path relies more and more on massive long transmission lines bringing coal-fired power to the eastern seaboard. This is not sustainable and makes the system brittle, susceptible to cascading blackouts. Ten state governors in the region are on record as opposing this path.

The other path is development of cleaner local gas-fired plants and local renewables, including demand-side resources. This is sustainable. PJM claims that its charter is transmission only and precludes considering such a path. Discovery in this case has shown that this is not true. PJM says that it diagnosed the need for the RPM market, led its design, and carried it through the FERC – not at all a transmission effort.

PJM's regional strategy has never been reviewed in detail by any regional body. The FERC and individual state commissions are asked to approve individual projects without a vision of where they will lead. PJM's focus on transmission, with mandatory imposition on member companies, makes it hard for companies to develop non-transmission alternatives.

This Commission should insist on a true strategic assessment of alternative long-range paths as a part of every application.

VI. CONCLUSIONS

Q: CAN YOU PLEASE SUM UP BRIEFLY YOUR TESTIMONY?

A: Yes.

PJM has not demonstrated the need for the PATH line.

PJM bases the claimed need for PATH on 2008 studies, updated in April 2009. The April 2009 study identifies three sets of claimed reliability issues.

1. *Claimed widespread low voltage and voltage collapse*. These were diagnosed for the first time in April 2009. The alleged problems are due, at least in part, to questionable changes in assumptions since the 2008 RTEP studies. The normal fix for such issues – capacitors of various kinds – was dismissed by PJM without careful study, for specious reasons. In fact, Company witnesses have admitted that 2,000 Mvars of voltage support would eliminate the voltage issues driving the "need" for PATH, claiming that such a large number is "infeasible". But the PATH project itself entails installation of 1,750 Mvars worth of voltage support. In addition, an October 2009 update of the CETO transfer target eliminates one-third of the contingencies that cause the claimed issues. Finally, using reasonable "CETO" values and accounting for demand side management

("DSM") resources that have cleared the latest RPM auction will further help to resolve or eliminate the alleged voltage issues.

2. *Claimed overloads on six lower-voltage facilities*. These also were diagnosed for the first time in April 2009. Such problems are routinely resolved on the lower-voltage system, at much lower cost than building a $1.6 billion line. PJM analyzed no alternatives to the PATH line for addressing these issues.

3. *Claimed overloads on 500-kV transmission lines.* Alleged future issues were identified in 2007 (forecast to potentially arise in 2012) and 2008 (beginning one year later, in 2013). In the April 2009 study, they are claimed to show up two or three years later, beginning in 2015 or 2016. However, no contingency or other reliability analyses, or detailed modeling, were done for any year after 2014 – the first year that PATH is allegedly "needed". Instead, the conclusions are based wholly on *extrapolation* from 2014 studies – an inherently unreliable technique. The studies also failed to include a proposed 1,640 MW unit with an executed ISA, in violation of PJM's oft-stated planning standards. Including this unit, and updating DSM resources to reflect the results of the 2009 RPM auction, will significantly reduce the flows on the supposedly-overloaded lines. Using the updated CETO target will further reduce flows on these lines. Finally, the problems diagnosed in the April 2009 study were radically different from those identified in earlier studies. With the exception of superficial "analyses" of capacitors to resolve the alleged voltage issues, *no alternatives* to the PATH line have been evaluated in the context of this new set of alleged problems.

Q: DOES THIS CONCLUDE YOUR TESTIMONY?

A: Yes.