2005 BASELINE RTEP REPORT

For the 2006 - 2010 Period

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Table of Contents

INTRODUCTION **1**
EXECUTIVE SUMMARY **2**
KEY FINDINGS 3
OBJECTIVE AND SCOPE **5**
ANALYSIS METHODOLOGY **6**
RESULTS **8**

INTRODUCTION

The PJM Regional Transmission Expansion Planning (RTEP) Process requires that cost responsibility for facility enhancements be established. There are three types of facility enhancements for which cost assignment must be made:

- Attachment Facilities required solely to interconnect a new generation or merchant transmission project,
- Network Facilities that are required to enhance the network solely or in part because of a proposed project, and
- Network Facilities required to support load growth.

In order to establish a starting point for development of Regional Transmission Expansion Plans and determine cost responsibility for expansion facilities, a 'baseline' analysis of system adequacy and security is necessary. The purpose of this analysis is threefold:

- to identify areas where the system, as planned, is not in compliance with the applicable reliability standards (for purposes of this report, "applicable reliability standards" will refer to NERC, MAAC, ECAR, SERC, MAIN, PJM and the individual transmission owner reliability standards). The baseline system will be analyzed using the same criteria and analysis methods that will be used for assessing the impact of proposed new interconnection projects. This will ensure that the need for system enhancement of the baseline system and enhancements due to interconnection projects are determined in a consistent and equitable manner.
- to bring those areas into compliance, develop and recommend facility expansion plans, including cost estimates and estimated in-service dates.
- to establish what will be included as baseline costs in the allocation of the costs of expansion for those generation and merchant transmission projects proposing to connect to the PJM system.

The system as planned is tested for its compliance with applicable reliability standards and PJM design standards to accommodate the forecast demand, committed resources, and commitments for firm transmission services for a specified time frame. Areas not in compliance with the standards are identified and enhancement plans are developed to achieve compliance.

The 'baseline' analysis and the resulting expansion plans serve as the base system for the conduct of Feasibility Studies and Impact Studies.

This report presents the results of the 'baseline' analysis from 2006 through 2010 for the PJM "footprint" as it existed in March 2006.

EXECUTIVE SUMMARY

PJM has responsibility for the development of a Regional Transmission Expansion Plan (RTEP) for the PJM system that will meet the needs of the region in a reliable, economic and environmentally acceptable manner. PJM also is responsible for recommending the assignment of any transmission expansion costs to the appropriate parties. In order to carry out these responsibilities, it is necessary to establish a starting point or 'baseline' from which the need and responsibility for enhancements can be determined.

In order to establish that baseline, PJM has defined the five (5) year period from 2006 through 2010 as the 2005 "baseline" planning period. The existing system plus any planned modifications to the transmission system scheduled to be in service prior to the 2010 summer peak period was chosen as the base system. All new generation and merchant transmission projects in Queues A through L that executed a Facility Study Agreement were also included in this baseline system along with any associated transmission enhancements as identified in the Impact Studies. Any Transmission Owner identified transmission enhancements independent of those associated with new generation or merchant transmission projects were also included. Only firm transmission service currently committed for the period was represented.

PJM has conducted a comprehensive load flow analysis of the ability of the PJM system to meet all applicable reliability planning criteria which are listed below:

- NERC Planning Standards ftp://www.nerc.com/pub/sys/all_updl/pc/pss/ps9709.pdf
- MAAC Reliability Principles and Standards (http://www.maac-rc.org/reference/princstandards.html) will be applied for all facilities included in the MAAC Compliance Facility list (http://www.maac-rc.org/reports/eia_ferc_nerc/downloads/comp-facil.pdf).
- ECAR Reliability Criteria (Document No. 1) (http://www.ecar.org/documents/document%201_6-98.pdf) will be applied to all ECAR networked transmission systems rated 100 kV or higher.
- MAIN Reliability Criteria **(http://www.maininc.org/bg/bgidx.htm)** will be applied to all MAIN networked transmission systems rated 100 kV or higher.
- SERC Reliability Criteria (http://www.serc1.org/Pages/ComplianceContentPage.aspx?ID=25) will be applied to all SERC networked transmission systems rated 100 kV and higher.
- PJM Reliability Planning Criteria as contained in Manual M14B Attachment G (http://www.pjm.com/contributions/pjm-manuals/pdf/m14bv04.pdf)
- Transmission Owner Reliability Planning Criteria as filed in their respective FERC 715 filing.

All conditions where the system was not in compliance with the applicable reliability standards were documented and system reinforcements required to bring the system into compliance were identified along with estimated cost and lead-time to implement them.

Those areas that were found to be non-compliant with applicable reliability standards establish the need for reinforcement in those areas independent of any future interconnection projects not included in the baseline analysis. This fact and the identified reinforcements to bring the system

into compliance will be used in evaluating the impact of the projects in Queues O that qualify and elect to proceed with the impact studies. The extent to which reinforcements identified in the baseline analysis are advanced, deferred, modified or eliminated will be used in determining cost responsibility for the final plans in the RTEP.

It should be recognized that the reinforcements proposed in this baseline analysis might be modified or eliminated as a result of generation or merchant transmission projects being added to or removed from the system. The development of the RTEP for PJM is an ongoing process, which will include the conduct of impact studies and development of plans to accommodate the new interconnection projects in Queues O. Upon completion of the impact studies some projects may elect not to proceed. When it is determined which projects will commit to proceed, a new baseline RTEP will be developed to meet the needs of the region, including the accommodation of all new projects committed to connect, during the next 5 year period. That RTEP will be recommended to the PJM Board of Directors for approval of proposed enhancements and will serve as the baseline for the next Queue of proposed projects.

The PJM Transmission Owners may identify the need to build additional system reinforcements that are not identified as required through the RTEP analysis.

KEY FINDINGS

The following areas of the system as planned through 2010 were found to be non-compliant with applicable reliability standards without additional reinforcement. These areas are described below along with any identified reinforcements to achieve compliance. The detailed descriptions of the conditions that result in non-compliance are reported in the Results section of this report. The cost estimates below are based on the cost estimates provided at the March 1, 2006 TEAC meeting.

1) The Endless Caverns 230/115 kV transformer is contingency overloaded at 101% for the loss of the Greenland – Meadow Brook 500kV circuit. The recommended upgrade is to replace the L breaker and switches at Endless Caverns 115kV substation at an estimate cost of $0.6 million.
2) The Carolina – Woodland 115 kV circuit is contingency overloaded at 107% for the loss of Earleys – Roanoke Valley 230 kV circuit. The recommended solution is to install SPS at Earleys 115kV substation at an estimate cost of $1.0 million.
3) The Eatons Ferry – Kerr 115kV circuit is contingency overloaded at 101% for the loss of the Kerr – Carolina 115 kV circuit. The recommended solution is to reconductor the Club House – South Hill and Chase City – South Hill 115 kV circuits at estimated cost of $30 million.
4) The Falls – Idylwood 230 kV and Arlington – Glen Carlyn 230 kV circuits are contingency overloaded at 130% for the loss of Glebe – Ox and Glebe – Jeff St. 230 kV circuits. The recommended solution is to reconductor the Idylwood – Arlington 230 kV circuit at estimated cost of $2.0 million.
5) The Gallows – Ox 230 kV circuit is contingency overloaded at 101% for the loss of the Glebe – Ox and Glebe – Jeff St. 230 kV circuits. The recommended solution is to reconductor the Gallows – Ox 230 kV circuit at estimated cost of $3.0 million.
6) The Rock Spring – Keeney 500 kV circuit is contingency overloaded at 102% for the loss of the Peach Bottom – Limerick 500 kV circuit under the Eastern Mid Atlantic region load deliverability test. The recommended solution is to replace a line trap and disconnect switch at Keeney, and a potential transformer and wave trap at Rock Springs 500 kV substations at an cost of $0.4 million.

7) The Keystone – Conemaugh 500 kV circuit is contingency overloaded at 106% for the loss of the Keystone – Airydale 500 kV circuit under the Eastern Mid Atlantic region load deliverability test. The recommended solution is to replace a wave trap and relay at Conemaugh, and a wave trap at Keystone 500 kV substations at an estimated cost of $0.5 million.
8) The Frankford – Indian River 138 kV is contingency overloaded at 101% for the loss of the Indian River – Omar – Bethany 138 kV circuit under the DPL load deliverability test. The recommended solution is to replace a 1200A wave trap at Indian River substation at an estimated cost of $0.2 million.
9) The loss of the Keeney – Rock Springs 500 kV circuit resulted in a widespread voltage problems under the Eastern Mid Atlantic region load deliverability test. The recommended solution is to install 400 MVAR capacitor in the vicinity of the Branchburg 500 kV substation at an estimated cost of $9.0 million.
10) The loss of several generators in JCP&L and PSE&G resulted in a widespread voltage problems under the Eastern Mid Atlantic region load deliverability test. The recommended solution is to install 600 MVAR reactive devices in the vicinity of the Whippany 230 kV substation at an estimated cost of $35 million. PJM will continue to refine the exact locations including any potential mix of static and dynamic reactive devices with Transmission Owners.
11) The Whitpain 500/230 kV transformers #1 and #3 are pre-contingency overloaded at 101% under the Eastern Mid Atlantic region load deliverability test. The recommended solutions are listed below:
    - Install a new 500/230 kV substation in PECO, and tap the high side on the Elroy – Whitpain 500 kV and the low side on the North Wales – Perkiomen 230 kV circuit at an estimated cost of $25.5 million.
    - Add a new 230 kV circuit between Whitpain and Heaton substations at an estimated cost of $21.7 million.
    - Reconductor the Whitpain – Plymouth Meeting 230 kV circuit at an estimate cost of $1.5 million.
    - Convert the Heaton 230kV bus to a ring bus at an estimated cost of $4.1 million.
    - Reconductor the Heaton - Warminster 230 kV circuit at an estimated cost of $2.5 million.
    - Reconductor the Warminster – Buckingham 230 kV circuit at an estimated cost of $1.8 million.
    - Add a new 500 kV breaker at Whitpain substation between transformer #3 and the 230 kV circuit #5029 at an estimated cost of $2.2 million.

OBJECTIVE AND SCOPE

The objectives of this study were as follows:

- To identify areas where the system as planned for the period 2006 through 2010 would not be in compliance with applicable reliability standards.
- To develop and recommend preliminary facility expansion plans, including cost estimates and estimated in service dates, to bring those areas into compliance.
- To establish what will be included as baseline expansion costs for the allocation of the costs of expansion for those projects included in Queues O.

The scope of this study included analysis for the period 2006 through 2010 to determine compliance with the all applicable reliability planning criteria.

Other than as required for the PJM Reliability Planning Criteria or an individual transmission owner criteria, the system was not analyzed under non-peak load flow conditions on the basis that the system can and will be dispatched to remain within first contingency operating limits. Transmission constraints on market dispatch are economic constraints. Economic constraints are not considered violations of reliability criteria as long as the system can be adjusted to remain within reliability limits on a pre-contingency basis.

The necessity of all system reinforcements previously identified in the previous RTEP Baseline Reports and the Queue A through N Impact Studies were evaluated. Any previously identified reinforcements that are no longer required were documented and removed from the list of RTEP Reinforcements.

ANALYSIS METHODOLOGY

Load flow simulation was based on a representation of the 2010 forecast peak load, existing capacity resources, and all proposed interconnection projects in Queues A through N that executed a Facility Study Agreement. All firm transmission services committed for the 2010 period were represented in the base case (see below). In addition, any transmission reinforcements planned to be placed in service by 2010 summer were represented.

RTEP 2010 – INTERCHANGE		
FROM	**TO**	**MW**
PJM	AMRN	-39
PJM	CIN	241
PJM	EKPC	0
PJM	FE	1040
PJM	IP	-1506
PJM	LGEE	134
PJM	OVEC	-1390
PJM	ALTW	314
PJM	ALTE	216
PJM	CPLE	359
PJM	CPLW	250
PJM	DUK	150
PJM	MEC	1420
PJM	MECS	1079
PJM	NIPS	400
PJM	NYIS	1342
PJM	WEC	985
Total		**4995**

A load flow base case was developed for 2010 representing projected diversified summer peak loads across the PJM Control Area. All in-service PJM capacity resources were dispatched at approximately 93% of the installed capacity value. All remaining Queue A through N generators were initially modeled at 0 MW.

Study of all voltage limits was completed using this base system. For analysis pertaining to thermal limits including Generator Deliverability and Load Deliverability a multitude of dispatch patterns were analyzed. A complete description of the Generator and Load Deliverability procedures is contained in Attachment E of PJM Manual M14B.

The 2010 base case was also used to analyze network transfer capability. To maintain reliability in a competitive capacity market, resources must contribute to the deliverability of electricity in the Control Area in two ways: 1) energy must be deliverable from the aggregate of resources available to the Control Area to load in portions of the Control Area experiencing a localized capacity emergency, or deficiency, 2) capacity resources within a given electrical area must, in aggregate, be able to be exported to other areas of the Control Area within some bounds that separate the reliability requirements of the Control Area from the reasonable economic function of the market place. PJM has developed two methods for evaluating the adequacy of network transfer capability for each of these deliverability requirements. These methods are described in

more detail in Attachment E of PJM Manual M14B.

The CETO/CETL method will be used to determine if the Capacity Emergency Transfer Limit (CETL) to each of the various electrical areas of PJM is sufficient to deliver each respective area's Capacity Emergency Transfer Objective (CETO).

The PJM Generation Deliverability procedure was used to determine if Network Transfer Capability was adequate to deliver all capacity resources out of defined areas to the network.

Finally, a short circuit analysis will be performed to determine if any of the 230 kV, 345 kV, or 500 kV breakers are overdutied. Calculated single phase to ground and three phase fault currents will be compared to breaker interrupting capability provided by the transmission owners for each breaker. All breakers having ratings less than the calculated fault currents will be identified.

RESULTS

The results of the baseline analysis for the 2006 – 2010 period are presented below. The cost estimates below are based on the cost estimates provided at the March 1, 2006 TEAC meeting.

PJM Generator and Load Deliverability Results

The PJM generator and load deliverability analysis were completed as defined in the procedures of Manual M14B. In general these tests involve n-0 (pre-contingency) and n-1 (single contingency) analysis to determine the sufficiency of transfer capability between generation resources and load within the PJM system. The Load Deliverability test assures that there is adequate import capability to serve load pockets experiencing a capacity emergency condition while the Generator Deliverability test assures that PJM capacity resources will not be bottled at peak load conditions.

The following areas of the PJM system were found to not be in compliance for the Generator Deliverability and Load Deliverability tests for the 2006 – 2010 study period.

1. The Endless Caverns 230/115 kV transformer is contingency overloaded for the loss of the Greenland – Meadow Brook 500kV circuit. The recommended upgrade is to replace the L breaker and switches at Endless Caverns 115kV substation at an estimate cost of $0.6 million.
2. The Carolina – Woodland 115 kV circuit is contingency overloaded for the loss of Earleys – Roanoke Valley 230 kV circuit. The recommended solution is to install SPS at Earleys 115kV substation at an estimate cost of $1.0 million.
3. The Eatons Ferry – Kerr 115kV circuit is contingency overloaded for the loss of the Kerr – Carolina 115 kV circuit. The recommended solution is to reconductor the Club House – South Hill and Chase City – South Hill 115 kV circuits at estimated cost of $30 million.
4. The Falls – Idylwood 230 kV and Arlington – Glen Carlyn 230 kV circuits are contingency overloaded for the loss of Glebe – Ox and Glebe – Jeff St. 230 kV circuits. The recommended solution is to reconductor the Idylwood – Arlington 230 kV circuit at estimated cost of $2.0 million.
5. The Gallows – Ox 230 kV circuit is contingency overloaded for the loss of the Glebe – Ox and Glebe – Jeff St. 230 kV circuits. The recommended solution is to reconductor the Gallows – Ox 230 kV circuit at estimated cost of $3.0 million.
6. The Rock Spring – Keeney 500 kV circuit is contingency overloaded for the loss of the Peach Bottom – Limerick 500 kV circuit under the Eastern Mid Atlantic region load deliverability test. The recommended solution is to replace a line trap and disconnect switch at Keeney, and a potential transformer and wave trap at Rock Springs 500 kV substations at an cost of $0.4 million.
7. The Keystone – Conemaugh 500 kV circuit is contingency overloaded for the loss of the Keystone – Airydale 500 kV circuit under the Eastern Mid Atlantic region load deliverability test. The recommended solution is to replace a wave trap and relay at Conemaugh, and a wave trap at Keystone 500 kV substations at an estimated cost of $0.5 million.
8. The Frankford – Indian River 138 kV is contingency overloaded for the loss of the Indian River – Omar – Bethany 138 kV circuit under the DPL load deliverability test. The recommended solution is to replace a 1200A wave trap at Indian River substation at an estimated cost of $0.2 million.

9. The loss of the Keeney – Rock Springs 500 kV circuit resulted in a widespread voltage problems under the Eastern Mid Atlantic region load deliverability test. The recommended solution is to install 400 MVAR capacitor in the vicinity of the Branchburg 500 kV substation at an estimated cost of $9.0 million.
10. The loss of several generators in JCP&L and PSE&G resulted in a widespread voltage problems under the Eastern Mid Atlantic region load deliverability test. The recommended solution is to install 600 MVAR reactive devices in the vicinity of the Whippany 230 kV substation at an estimated cost of $35 million. PJM will continue to refine the exact locations including any potential mix of static and dynamic reactive devices with Transmission Owners.
11. The Whitpain 500/230 kV transformers #1 and #3 are pre-contingency overloaded under the Eastern Mid Atlantic region load deliverability test. The recommended solutions are listed below:
    - Install a new 500/230 kV substation in PECO, and tap the high side on the Elroy – Whitpain 500 kV and the low side on the North Wales – Perkiomen 230 kV circuit at an estimated cost of $25.5 million.
    - Add a new 230 kV circuit between Whitpain and Heaton substations at an estimated cost of $21.7 million.
    - Reconductor the Whitpain – Plymouth Meeting 230 kV circuit at an estimate cost of $1.5 million.
    - Convert the Heaton 230kV bus to a ring bus at an estimated cost of $4.1 million.
    - Reconductor the Heaton - Warminster 230 kV circuit at an estimated cost of $2.5 million
    - Reconductor the Warminster – Buckingham 230 kV circuit at an estimated cost of $1.8 million.
    - Add a new 500 kV breaker at Whitpain substation between transformer #3 and the 230 kV circuit #5029 at an estimated cost of $2.2 million.

NERC Category A & B Contingency Results - the PJM system was studied with all facilities in service and also for the loss of a single generator, transmission circuit, or transformer.

The 2010 system was tested for compliance with PJM, Transmission Owner, and Regional Reliability council application of all NERC category A & B contingencies. All facilities monitored by PJM Operations were also tested against the PJM Reliability Criteria for n-0 and n-1 conditions. Where the physical design of connections or breaker arrangements resulted in the outage of more than the faulted facility when the fault was cleared, such additional facilities were also outaged in the load flow. For example, if a transformer is tapped off a line without a breaker, both the line and transformer were outaged as a single contingency event.

Facilities with pre-contingency flows equal to or higher than 100% of the normal rating and facilities with post contingency flows equal to or higher than 100% of the 4-hour emergency rating were identified. In addition, voltages were monitored based on the existing voltage limits used in PJM Operations.

All areas of the PJM system were found to be in compliance for the 2006 – 2010 study period.

NERC Category C Contingencies

For the nine NERC Category C contingencies, no problems have been identified in all studies completed to date. There is remaining category C analysis for 2010 ongoing and results of those studies will be documented in an Addendum to this report.