

## **Exhibit WCI-1 Resume of Frank DiPalma**

**Name:** **FRANK T. DiPALMA**

**Title:** **Partner/Principal**

**Education:** Fairleigh Dickinson University, MBA Management/Finance  
New Jersey Institute of Technology, BS Mechanical Engineering  
University of Michigan, Executive Development Program

**Professional Affiliations:** American Gas Association  
Society of Gas Operators  
Southern Gas Association  
University of West Virginia, Institute of Technology (Adjunct Professor)

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**Career Synopsis:**

An operations oriented engagement/project manager who leads teams of consultants to resolve complex business problems in power generation and transmission and distribution entities; skilled at directing, planning and implementing approach and objectives for client's project; experienced in engineering and operations management, process improvement, project management, construction, business development, marketing, continuous improvement, strategic alliances, labor relations, strategic planning, change management, organization assessments and regulatory compliance. Consulting expertise supports both management and technical projects, with assignments grouped in the following categories: Operations Reviews, Merger Due Diligence, Safety and Reliability Reviews, Emergency Response, Integrity Management, Benchmarking, Regulatory Assessments and Various Studies.

**Selected Consulting Assignments:**

***Management Audit of Central Hudson Gas and Electric (2016- present) New York New York State Public Service Commission***

Serving as Williams project manager, we are conducting a focused review of the electric and gas operations as well as the project management and work management functions. The scope of the audit has a heavy emphasis on Reforming the Energy Vision (REV) and its implications from a customer, regulatory and utility perspective.

***Rate case assessment of Southwest Gas Corporation for the Arizona Corporation Commission (2016-present)***

Southwest Gas Corporation filed a rate application with the Commission in May 2016 requesting a revenue increase of approximately \$31.9 million which would represent a 4.25% increase over current revenues. My role is to facilitate the examination and analysis of Southwest's filed Arizona Depreciation Rate Study.

***Management Audit of United Illuminating (2015-2016) Public Utility Regulatory Authority***

Served as Jacobs' responsible officer and project manager we are conducting a comprehensive diagnostic review the major functions of UI. The scope of the audit includes: organization and

management, financial systems and controls, marketing, engineering and operations, information technology, customer-service operations, and relationships with parent company.

***Gas Infrastructure Filing - Public Service Electric and Gas Company (2015)***

PSE&G wanted to initiate a gas infrastructure filing to replace approximately 4,000 miles of cast iron and bare steel, while recovering all associated costs in a timely manner. To address requirements for a comprehensive filing, Jacobs analyze and developed: a Safety case, a Business case and a Program execution plan. The analysis resulted in Jacobs preparing direct testimony that was filed with the NJ Board of Public Utilities on February 27, 2015.

***Operational Due Diligence Consulting in Connection with the Exelon - Pepco Holdings Incorporated Merger (2015) Maryland Public Service Commission and Delaware Public Service Commission***

Analyzed and testified as to the potential impacts on Pepco Holdings' two operating utilities in Maryland and Delaware. Jacobs' role was to assist the Maryland and Delaware Public Service Commission's (MDPSC) and (DEPSC) Staff in determining if the transaction was in the public interest by assessing how it could affect the reliability, adequacy and safety of electric service in Maryland and gas and electric service in Delaware. Specific support activities included: analysis of pre-filed materials, participate in discovery, provide expert analysis, provide expert testimony, develop cross examination, assist in brief preparation, and support settlement discussions.

***Public Service New Hampshire Clean Air Project at Merrimack Station (2010 – 2014) The New Hampshire Public Utilities Commission***

PSNH was installing a wet scrubber at Merrimack Power Generating Station, originally the project was estimated to cost \$250M, at the time Jacobs was assigned to the project the cost estimate had increased to \$457M. Acting as both responsible officer and project manager, our scope of work included: due diligence on completed portions of the project, monitoring of the ongoing portion of the project, quarterly reports to track the progress and summarization of project completion. The project due diligence was summarized in testimony and presented at a New Hampshire Commission cost of service hearing.

***Electric Reliability Reporting Metrics of the New York State Electric Utilities (2014-2015) New York State Public Service Commission***

The objective of the audit was to verify that the data provided by the six major New York State electric utilities to the NYSPSC is sound and accurate, and reflects the appropriate levels of reliability. Serving as project manager, we reviewed the completeness and accuracy of data collected by various systems, identified opportunities for improvements and recommend best practices metrics.

***Technical Reliability Study of Curaçao Refinery Utilities (2014) Refineria Isla Curaçao B.V.***

Prior to deciding on possible investment strategies, it was important to determine the reliability of the supply of the steam, water, air, electricity utilities from Curaçao Refinery Utilities (CRU) to Refineria Isla. Accordingly, Jacobs was contracted to: review equipment maintenance

schedules and operating data, configuration and integration; perform a physical site visit to examine the condition of the equipment and review operating logs; perform life-expectancy estimation on the main equipment; benchmark the performance and reliability of the equipment; evaluate CRU using a SWOT analysis; Identify significant gaps and mitigation requirements, and prepare recommendations.

***Root Cause Analysis of Weld Failure (2014) Enbridge Pipeline Inc.***

A tie-in weld failure was detected while conducting a commissioning hydrostatic test on a new 36-inch pipeline. In view of the nature and complexity of the weld failure, Enbridge wanted to have an independent third-party opinion identify the events or causes that resulted in the defective girth weld. Acting as project manager and facilitator, Jacobs SME's conducted a root cause analysis (RCA) conducted interviews; utilized knowledge gained through our operations risk management assessments; participated in a facilitated RCA session; and conducted the facilitation effort.

***Conduct Comprehensive Review of UGI's Penn Natural Gas, Inc Gas Program and Activities (2014)***

Conducted a comprehensive review of UGI PNG's Natural Gas Distribution programs and activities based on their operating policies, processes, standards, procedures, systems, records, culture, staffing levels, and training programs. Serving as responsible officer, specific areas of focus were organizational silos, decision-making, knowledge sharing in the areas of leak management, corrosion management, transmission integrity management, and emergency response.

***Conduct Technical Due Diligence Power Generation Assets (2013) Elliott Management Corp.***

Elliott was interested in acquiring fossil and renewable power generation assets located in Latin America. Serving as responsible officer and project manager, Jacobs performed a technical, organizational, environmental, and power market assessment. In addition, we provided assumptions for Elliott's cash flow spreadsheet and develop a Dispatch/Market Analysis Model.

***Conduct Operational Risk Management Assessments (2013 to 2014) Enbridge Pipeline Inc.***

Enbridge wanted to determine ongoing conformance with project management systems and to identify current good practices and improvement opportunities to achieve industry leadership in pipeline construction. Serving as project manager, Jacobs conducted several Operational Risk Management Assessments for both pipelines and major facility construction that focused on organizational design, delegations of authority, and knowledge sharing within the 2000-person field organization structure.

***Investigation into the Performance of Connecticut's Electric and Gas Distribution Companies in Restoring Service Following Storm Sandy (2013) Connecticut Public Utilities Regulatory Authority***

Serving as responsible officer, Jacobs provided technical expertise to PURA's staff in areas pertaining to electric distribution company and gas company preparation for and action in response to significant outages that occurred as a result to Hurricane Sandy.

***Assessment of Safety Policies and Emergency Response Procedures (2013) NiSource***

In response to a gas related incident, NiSource sought an independent review of its safety policies and emergency response procedures. Included in the projects scope of work was a review of the pertinent policies, processes and procedures; identification of opportunities for improvement; and development of roadmap for how these opportunities should be prioritized for implementation. Serving as project manager, our analysis involved assessing policies, practices and procedures in the categories of emergency response, facility damage prevention, and leak management and leak investigation. In each category, unclear decision-making, communication barriers, poor organization structure were contributing factors contributing factors.

***Transmission and Growth Strategy Assignments (2012 to 2015) Central Alberta Rural Electric***

Serving as responsible officer, Jacobs performed the following assignments:

- Operational Capabilities Report to support right to serve all new customers within its territory.
- Transmission Report to support having costs allocated directly for existing transmission lines.
- Load Settlement Report to determine the feasibility of taking over the existing lines.
- Independent Operating Agreement with Fortis.
- Fortis-AB Rate Case Phase 2 Assistance for CAREA as merged with North Parkland.

***Responding to the Requirements of Public Act No. 12-148, An Act Enhancing Emergency Preparedness and Response (2012) Connecticut Public Utilities Regulatory Authority***

In the aftermath of Tropical Storm Irene and the October 2011 Snow Storm, Connecticut recognized the need to enhance emergency preparedness and response and establish electric and gas company performance standards for emergency preparation and service restoration. Acting as project manager, Jacobs facilitated an interactive process with five utilities, Rate Council and Commission Staff.

***Technical Analysis of the New Jersey Natural Gas Company's Safety Acceleration Facility Enhancement Program (2012) New Jersey Division of Rate Counsel***

Working as project manager, Jacobs performed an assessment of NJNG proposal to undertake a five year \$204 million capital investment program for the replacement of existing cast iron and unprotected steel distribution mains and services; and achieve cost recovery through annual rate adjustment filings.

***Assessment of Pacific Gas & Electric Co. Pipeline Safety Enhancement Plan (2011-2012) CPUC***

The PSEP is a multiphase, multiyear, multibillion dollar program that is in addition to PG&E's existing transmission pipeline maintenance and integrity management programs. Jacobs was

asked by the CPUC to review the PSEP, supporting work papers and testimony filed by PG&E, as well as interveners.

***Management Audit of Public Service Electric and Gas Company (2010-2011) NJBPU***

Jacobs Consultancy participated in an independent management audit of PSE&G mandated by The State of New Jersey's Board of Public Utilities (BPU). Serving as Jacobs' project manager, the technical and management practices of PSE&G were assessed in the areas of electric transmission and distribution, gas transmission and distribution, gas procurement and supply and contractor performance.

***Energy Reliability Consulting Exelon - Constellation Energy Merger (2011) Maryland PSC***

Analyzed the potential impacts on BGE in connection with the Exelon and Constellation Energy Merger; my role was to assist the Maryland Public Service Commission's (MDPSC's) Staff in determining if the transaction was in the public interest by assessing how it could affect the reliability, adequacy and safety of electric and gas service in the State of Maryland.

***Assessment Study of Project Execution of Major Gas Pipeline Project (2011) Spectra Energy***

Performed a Critical Assessment study of project execution for the New Jersey-New York Pipeline Expansion Project. As project manager coordinated a review the risk mitigation areas already recognized, and identified additional issues that may arise, which could impede permitting and construction of the Project. In total, 13-risk mitigation areas and strategies already recognized were expanded, six additional risk mitigation issues were identified, and four additional project management tools were suggested.

***Report of the Independent Review Panel, San Bruno Explosion (2010-2011) CPUC***

Jacobs was retained by the Independent Review Panel to gather and review facts and suggest recommendations for the improvement and safe management of PG&E's natural gas transmission lines. Serving as project manager our investigation identified multiple weaknesses in PG&E's management and oversight, as well as in the CPUC's resources and organizational focus.

***Management Audit of Fitchburg Gas and Light Company d/b/a Unitil (2010-2011) Massachusetts Department of Public Utilities***

Jacobs Consultancy was asked to conduct an independent management audit of FG&E. Serving as engagement director and project manager, the management practices of both FG&E and Unitil were assessed in the areas of strategic planning, staffing and workforce management, management and control, customer and public relations and emergency preparedness and response planning.

***Develop an Economic Model and Provide Testimony for Rockford Eclipse Valve Replacement (2009-2010) South Jersey Gas Company***

Developed an economic model for estimating the cost of replacing approximately 70,000 Rockford Eclipse (RE) valves, currently in South Jersey's distribution system. Advanced how

actual costs would be accumulated and tracked against the RE valve replacement estimate developed to assure that all RE placement costs are tracked, and that only RE replacement costs are tracked. Served as an expert witness presenting testimony for the RE valve replacement in South Jersey Gas Company's 2010 base rate case. Testimony resulted in establishing an activity-based tracker for annual cost recovery throughout the multiyear replacement program.

***Operations and Energy Reliability Consulting in Connection with the merger of First Energy Corp. and Allegheny Energy, Inc. (2010) Maryland Public Service Commission***

Analyzed from a reliability and operations perspective the problem areas, deficiencies, and merits of the proposed acquisition of AYE by FE. My role was to serve as the Maryland Public Service Commission's expert electric witness testifying as to the potential impact on AYE's Potomac Edison reliability and safety in a post-merger environment.

***Service Response and Communications of CL&P and UI following the Outages from the Severe Weather (2010) Connecticut Department of Public Utility Control***

The scope of this assignment entailed: analysis of pre-filed testimony, preparation of discovery requests, auditing CL&P's and UI's procedures, examination of the evidence, cross-examination at public hearings and providing the DPUC with a report containing. Serving as project manager, Jacobs conducted its investigation in seven focus areas: Emergency Planning, Preparedness, Restoration Performance, Mutual Assistance, Post-storm Activities, Best Practices and Other.

***Energy Reliability Consulting in Connection with the Electricité de France Purchase of Constellation Energy Group's Nuclear Holdings (2009) MD PSC***

Analyzed the potential impacts on BGE in connection with Electricité de France's proposed purchase of half of Constellation Energy Group's Nuclear Holdings. Serving as the MDPSC's expert electric and gas witness, I testified to: overall electric reliability performance, effectiveness of the vegetation management program and other maintenance and inspection programs, adequacy of funding for capital asset replacement and operations & maintenance needs, need for contemplated cast-iron replacement program, need to re-examine service replacement policy and assessment of customer satisfaction surveys.

***Workforce Study Analysis of Illinois Electric Utilities (2008) Illinois Commerce Commission***

The Illinois Commerce Commission retained Jacobs Consultancy to conduct a workforce study analysis of the five major Illinois electric utilities. The intent of the analysis was to determine the adequacy of in-house staffing in each job critical to maintaining quality reliability and restoring service. The study also included: assessment of asset management practices, use of technology, operational practices, system maintenance and condition, call center, safety and training.

***Technical Evaluation of New Connecticut Peaking Generation Units (2008) Connecticut DPUC***

Coordinated a technical evaluation and review of 11 proposals to build 500 MW of new peaking generation units in the state of Connecticut. Our work included: land site costs, insurance, capital costs, operating costs, starting capacities, type of fuel, proximity and availability of electric and gas connections, inclusion of NOx controls, heat rate, permit schedule, and other critical path items.

***Energy Reliability Consulting Services in Connection with the Exelon-PSEG Proposed Merger (2005-2006) New Jersey Board of Public Utilities***

Jacobs Consultancy completed 14-month engagement analyzing the problem areas, deficiencies, and merits of the proposed acquisition of PSEG by Exelon, with specific emphasis on how the proposed merger may affect New Jersey ratepayers.

***Organization Assessment and Work Force Analysis (2006-2007)  
City of Atlanta, Department of Water Management***

Served as Jacobs' project manager, conducting an Organization Assessment and Work Force Analysis of City of Atlanta DWM, Safety and Security Division. The Division is responsible for securing approximately 57 water management related facilities and 1400 DWM employees. The analysis covered: strategic direction, DWM expectations, ongoing operations, workforce management practices, determination of areas of strength, as well as areas of potential improvement. Benchmarking was utilized to help expand horizons and to identify gaps. In addition, a workforce analysis was conducted to quantify the effort associated with position responsibilities, communications, and knowledge.

**Industry Assignments:**

***Operations-***Responsible for the installation, operations and maintenance of the gas distribution system, managed workforces between 500 and 1000 employees.

***Engineering-*** Managed the planning, budgeting, design, measurement and engineering support services.

***Quality Management/Process Improvement-***Designed, implemented and promoted quality and organizational activities including organization design, culture change, knowledge transfer, workforce staffing, communications and process improvement.

***Technical Support and Regional Performance-***Developed a technology and performance focus to improve performance, reduce costs and improve customer service

**Designated Expert Witness:**

- Exelon-Pepco Holdings merger (Delaware Public Service Commission), 2015
- Exelon - Pepco Holdings merger (Maryland Public Service Commission), 2015
- New Hampshire Clean Air Project at Merrimack Station cost of service (New Hampshire Public Utilities Commission), 2014



- Exelon and Constellation Energy merger (Maryland Public Service Commission), 2011
- First Energy Corp. and Allegheny Energy, Inc. merger (Maryland Public Service Commission), 2010
- Rockford Eclipse valve replacement cost of service (South Jersey Gas Company), 2010
- Electricité de France purchase of Constellation Energy Group's Nuclear Holdings (Maryland Public Service Commission), 2009
- Exelon and PSEG merger (New Jersey Public Utilities Commission), 2006
- Ductile iron pipe failure - Larkhall, Scotland (Transco), 2002

**Employment History:**

Williams Consulting Inc. (2015 – present) *Partner/Principal*

Jacobs Consultancy Inc. (2002 – 2015) *Director*

Stone & Webster Consultants (2000 – 2002) *Associate Director*

Mountaineer Gas Company (1996 – 2000) *Vice President of Operations and Engineering*

Public Service Electric & Gas Company (1968 – 1996) *various senior management positions*

## **Exhibit WCI-2 Resume of William Williams**

**Name:** **WILLIAM M. WILLIAMS JR.**

**Title:** **Partner/Principal**

**Education:** Saint Leo College, BA, Business Administration  
Saint Leo University, Graduate level Business courses

**Certifications:** FEMA- NIMS, ICS

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**Career Synopsis:**

Mr. Williams is an experienced executive with a strong background in operations, team building, process improvements and performance monitoring. He is heavily experienced in project management, materials management, budgeting, corporate strategic planning, information systems planning, maintenance management, root cause analysis, property records, organization and staffing assessments in the utility industries. Career focus on leadership positions in operations, logistics, materials management, changes management, and total quality.

**Selected Consulting Assignments:**

- Participated as a lead in conducting a focused review of Central Hudson Gas and Electric, gas and electric operations as well as the project management and work management functions. The scope of the audit has a heavy emphasis on Reforming the Energy Vision (REV) and its implications from a customer, regulatory and utility perspective.
- Participated as a lead in a distribution plant evaluation for Central Maine Power on behalf of the Maine Public Utilities Commission. This effort included a review of reliability performance, system design and planning, vegetation management and a physical condition assessment of the distribution system.
- Participated in a study led by Jacobs Consultancy to determine the workforce adequacy of the five Illinois investor owned utilities for the Illinois Commerce Commission. This effort included a review of work practices, labor resources both internal and external, work backlog, workforce management and construction and maintenance practices.
- Project Coordinator in the NJBPU service reliability focused management audits of the four New Jersey-based electric utilities. To determine the effectiveness of their response and communications during a major outage.
- Participated in a focused management audit of Fitchburg Gas and Electric Company, a unit of Unitil. The audit covers Strategic Planning, Staffing & Workforce Management, Management & Control, Customer & Public Relations, and Emergency Preparedness & Response Planning.

- Participating in a focus audit of the six electric companies in New York with an emphasize on assessing of each individual utility's systems, policies, procedures and programs that are used to compile its data that are used in the performance metrics that are currently reported to the Commission and Staff.
- Participated in a storm response audit of Connecticut Light and Power Company and United Illuminating preparation and response to a major winter storm in March 2010.
- Participated in a management audit of Public Service Electric and Gas Company. Focus areas include electric system operations and maintenance, reliability, expansion planning, load management, fuels management, and SmartGrid.
- Participated as a lead consultant in a study for the City of Ocala to evaluate the city electric department's operational efficiency and effectiveness, to evaluate the city's full requirements contract with FMPA, and to assess quantitative and qualitative aspects for the city to remain in the electric utility business or consider selling.
- Participated in a due diligence review as to the potential impacts on Pepco Holdings' two operating utilities in Maryland and Delaware. Jacobs' role was to assist the Maryland and Delaware Public Service Commission's (MDPSC) and (DEPSC) Staff in determining if the transaction was in the public interest by assessing how it could affect the reliability, adequacy and safety of electric service in Maryland and gas and electric service in Delaware. The assignment covered thorough review of the operations and reliability functional areas of the current and merged utility and included preparation of direct filed testimony and surrebuttal testimony.
- Participated in a due diligence review of the proposed acquisition of Allegheny Energy (AYE) by First Energy Corp. (FE). The assignment covered thorough review of the operations and reliability functional areas of the current and merged utility and included preparation of direct filed testimony and surrebuttal testimony.
- Participated in a due diligence review of the proposed Exelon/Constellation merger. The assignment covered thorough review of the operations and reliability functional areas of the current and merged utility and included preparation of direct filed testimony and surrebuttal testimony.
- Participated in a due diligence review of the proposed Exelon-PSE&G merger on behalf of the New Jersey Board of Public Utilities. This assignment covered a thorough review of the customer service functional area, including the call center, customer service centers, the customer information system, street lighting, customer billing and complaint resolution.
- Participated in a review of Questar Gas Company's gas gathering and processing contracts on behalf of the Utah Division of Public Utilities. This study included arms-length determination of relationships, costs, pricing and performance over the past five years with a particular focus on cost of service rate spike experienced in 2007.

- Participated as a lead consultant for an engagement to provide an independent review and comments on a series of reports prepared by PacifiCorp in response to a winter storm outage that affected up to 190,000 customers over an 8-day period. The assignment included a comprehensive analysis of the report with focus on conclusions and recommendations and the level of completeness and conformance with the terms of reference. We prepared professional opinions regarding the conclusions and recommendations contained in the report, and offered additional conclusions and recommendations with supporting rationale, analysis, and/or industry comparisons as appropriate. We were subsequently retained to review PacifiCorp's implementation progress for the 18 recommendations in our original report.
- Participated in the analysis and development of testimony in support of a major East Coast combination utility regulatory filing related to a proposed accelerated gas mains replacement program. The work effort comprised three distinct areas safety case, the cost-benefit analysis and project execution that was presented in testimony.
- Participated in reviewing the capital investment program for New Jersey Natural Gas Company. Assessment included engineering issues, planning project management concerns, and developing measures for success.
- Participating in a review of Enbridge pipelines 79, 6B and Flanagan South construction operational risk management practices and procedures. The work effort included a comprehensive review of documents, site visits and interviews with staff.
- Participated in a review of the San Bruno pipeline explosion for PG&E on behalf of the California Public Utilities Commission, with a focus on adequacy of PG&E's Gas Emergency Plan and execution during the event in accordance with the plan.
- Participating in a management audit of United Illuminating as lead on audit sections covering Customer Service, Materials Management, Facilities, Safety and Fleet Management.
- Participated in providing technical expertise to Connecticut Public Utilities Regulatory Authority's (PURA's) staff in areas pertaining to electric distribution company and gas company preparation for and action in response to significant outages that occurred as a result to Hurricane Sandy.
- Participated in an emergency response standards review for the Connecticut Public Utility Regulatory Authority. The review focuses on preparation and plans, restoration activities, including mutual assistance and communications to assist stakeholders. A comparison of standards emplaced by other regulatory jurisdictions is under review.
- Participated in a review of Soctia Gas Network business plans submitted for Ofgen's RIIO-GD1. The review included the areas of outputs, efficient expenditure, uncertainty and risk and financial costs.

- Participating in several assignments for EQUUS (formerly Central Alberta Rural Electric Association), including: review of operational process and resource capacity and providing specialized analysis of transmission cost allocation; feasibility of becoming a load serving agency in the Province; development of a new independent operating agreement with Fortis; developed a allocated cost of service model; developing an investment model and provided assistance during the Fortis Phase 2 rate filing.
- Participated in a review of Central Alberta Rural Electric Association operational capacity and providing specialized analysis of transmission cost allocation and feasibility of becoming a load serving agency in the Province, development of a new independent operating agreement with Fortis and assistance during the Fortis Phase 2 rate filing.
- Participated in an assessment to determine the technical reliability of the Curacao Refinery Utilities B.V. installations to deliver the contractual utilities (steam, air, water and electricity) to Refineria Isla Curacao B.V. and the life expectancy of the Curacao Refinery Utilities B.V. installations.
- Participated in an asset acquisition due diligence review for an asset management company interested in acquiring power generation assets in Central America. The work effort included a comprehensive review of documents, site visits to four power plants, interviews with local seller staff, developing and employing a model to simulate market conditions for projections of future asset viability and economic benefits.
- Participating in a review of Public Service New Hampshire Flue Gas Desulphurization installation that includes a due diligence report on the completed portion and on-going monitoring of the project.
- Project Manager of a gap analysis and benchmarking project involving electric plant operations at ALCOA's Rockdale, Texas. The results help to determine areas for improvement in operations and improve the plant competitiveness.
- Participated in a cost causation Cost of Service Study that developed a cost of service model for EQUUS.
- Participated in the development of energy assurance planning documents, procedures and table-top exercises for the states of North Dakota and Idaho. This assignment includes development of critical asset information, identification and assessment of vulnerabilities and development of mitigation methods for energy supply system disruptions.
- Project Manager on the Bahamas Telecommunications Corporation organization and staffing study. Developed staffing requirements and organization structure, which reduced staff by 40 % and saving \$62 million a year.
- Project Manager in a study of internal practice management systems for Stone & Webster Engineering Corporation

**Industry Assignments:**

- ***Operations Management***

- Responsible for daily power generation operation during manager absence and acted as intermediary between Division staff of 250 personnel and upper management.
- Supervised a staff of 29 maintenance and outage planning, administrative and warehousing personnel, including four supervisory personnel for an electric production division.
- Supervised a staff of 61 plant materials managers, administrative, production control and purchasing personnel in 7 states for a major glass manufacturer.
- Facilitated and developed the strategic planning process for a municipal utility department.
- Implemented best practice change management methodologies.
- Directed the review and rewriting of department wide policies and procedures.
- Developed performance indicators and management tracking system for glass and utility industry.
- Directed training department for craft and operations personnel.
- Directed power production committee that determined root cause of equipment failures and plant shut downs.

- ***Reliability, Management Audits and Operational Assessments***

- Participated as a lead in an audit and analysis of distribution line extension costs and their derivation for Central Maine Power on behalf of the Maine Public Utilities Commission.
- Provided litigation support for PacifiCorp for a federal district court case and a Wyoming Public Utilities Commission filing relative to claimed losses due to outages suffered over a period of five years.
- Project Manager on multiple projects for JEA that resulted in approximately \$2.25 million yearly saving, which included the following:
  - Multi-phased cost analysis and work process improvement project involving Customer Service areas.
  - Facilitating the implementation of process improvement for JEA and Duval County Tax Collector in areas of operations, facilities design, call center staffing and design, and training.
  - Multi-phased work process improvement project involving staffing assessment of the Jacksonville Water and Sewer Department pre-merger.

- Cost benefits analysis project of the merger between the electric and water and sewer departments.
- Multi-phased work process improvements and staffing assessment and reassignment project involving the support staff.
- Project Manager in charge of a multi-phased Cost Analysis and Work Process Improvements project involving JEA, the Jacksonville Public Utilities Department and Duval County Tax Collector's Office.
- Responsible for performing benchmarking study of various utilities including Transmission Pipeline Australia and Entergy Gulf States.
- Consultant responsible for developing Table of Organization and Equipment as part of a fleet assessment for National Grid.
- Participated in a major service quality assessment for Entergy Gulf States in the area of distribution. This included field inventory and inspection of over 8,000 distribution poles and ancillary pole mounted equipment, computer modeling to suggest potential reliability improvements and their costs and a review of capital, operations and maintenance budgets, methods and procedures.
- Participated in a comprehensive review of distribution operations and maintenance for Nevada Power.
- ***Maintenance and Materials Management***
  - Project Manager on a base line cost analysis project of a large southeastern utility materials management process. Recommended process improvements that resulted in a \$1.5 million yearly saving and a onetime saving of \$2.3 million.
  - Managed all warehousing and inventory operations, responsible for overseeing the physical facility redesign and rearrangement planning, and executing the organizational modification at an operating municipal power plant.
  - Managed a team of consultants and professional consulting engineers in establishing a comprehensive outage planning and work force management/productivity measurement and improvement program at an operating municipal power plant.
  - Consultant responsible for conducting materials management portions of focused management and operations audits for Chattanooga Gas Company, U.S. Virgin Islands PSC, and Nevada Power Company.
  - Provided logistical support for the preparation of 80 uniform plant maintenance procedures and associated, detailed standard time estimates.
  - Managed staff of plant maintenance planner for outage efforts of an operating municipal power plant reducing outage time from seven weeks to 3 and average saving \$1.3 million a year.



- Provided leadership and project management during the design of the maintenance and materials management system needed for computerization support of the plant's work force management program.
- Responsible for integration of the material management and productions control department into a single business unit with a yearly saving of \$300,000.
- Lead the formation of "RAPID" parts delivery program for 216 participating utilities. Responsible for electronic data gathering, cataloging, and information integrity, which allowed utilities to lower inventories by 15%.
- **Organization/Feasibility Studies**
  - Consultant involved in developing staffing requirements for new gas companies at the Abu Dhabi Natural Gas Distribution Company in the Emirate of Abu Dhabi and Chilquinta Gas Distribution Company in Santiago, Chile.
- **Budgeting**
  - Developed a 10-year forecast of O&M and capital budgets and administered annual budget of over \$74 million using business analysis of budget versus productivity.
  - Set and monitored performance indicators based on financial data.

**Employment History:**

<b><u>Williams Consulting, Inc.</u></b>	2015 - Present
<i>Partner &amp; Principal</i>	
<b><u>Jacobs Consultancy Inc.</u></b>	2010 – 2015
<i>Group Manager</i>	
<b><u>Williams Consulting, Inc.</u></b>	2000 – 2010
<i>Principal &amp; Consultant</i>	
<b><u>Stone &amp; Webster Management Consultants, Inc.</u></b>	
<i>Senior Consultant</i>	1999 – 2000
<i>Consultant</i>	1995 –1999
<b><u>City of Lakeland, Electric and Water Department</u></b>	1984 – 1994
<i>Assistant Plant Manager</i>	
<b><u>Thatcher Glass Manufacturing Company</u></b>	1976 – 1984
<i>Corporate Materials Manager</i>	
<b><u>Plant City Steel Corporation</u></b>	1971 – 1976
<i>Production Control Manager</i>	

## **Exhibit WCI-3 Energy and Capacity Transactions -2015**

This exhibit describes for Public Service Company of New Hampshire's (PSNH) d/b/a Eversource Energy (Eversource or EE), its generation unit's relationship with the 2015 energy market, the growing influence of the market in supplying PSNH's default Energy Service, the sources of PSNH energy and capacity, the costs associated with Energy Service, energy supply and capacity, and Eversource's management of the energy procurement function.

### **PSNH Generation Units' Relationship with the 2015 Energy Market**

Prior to 2010 many of PSNH's generating units had been considered base-load generation with energy output generally lower priced than the market. However, that relationship began to change and today most of PSNH units have become peaking generation with output generally more expensive than the market. Consequently, previously base-load coal units, like Merrimack-1, Merrimack-2, Schiller-4, and Schiller-6 are being placed on economic reserve for many more hours than in previous years.

The price of energy purchased from the Independent System Operator-New England (ISO-NE) market remained relatively low during 2015, except for sharp price spikes during the winter months, predominantly in February. These spikes were primarily a result of sharply higher natural gas prices which came about because of the significant natural gas transmission pipeline constraints that exist throughout New England. Since natural gas is a significant fuel for power generation, higher natural gas prices result when gas supply is also used to heat residential and commercial buildings. This favorably impacted PSNH's generating fleet as it was able to supply more of its customer energy needs because of the fuel diversity of PSNH's supply portfolio. In addition, Burgess BioPower provided a greater percentage of load requirements due to improved generation performance in 2015<sup>22</sup>.

PSNH retains load serving responsibility for customers who have not selected a competitive supplier. In 2015 PSNH provided from its own generating facilities 52% of its default Energy Service (ES) peak supply and 57% of its ES off-peak supply<sup>23</sup>. PSNH continued to increasingly rely on the market for a growing portion of its energy requirements. For 2015, 48% of PSNH's on peak energy and 43% of its off-peak energy requirements for all classes of customers were met from the market. To provide a basis of comparison, the market supplied 41% of PSNH's on peak energy and 39% of off-peak energy for 2014<sup>24</sup>.

During 2015 PSNH's monthly ES peak load ranged from a low of 564 MW/Hr in October to a high of 906 MW/Hr in January<sup>25</sup>. On peak monthly energy needs ranged from 146 GWh in November to GWh in 244 in January, and off-peak monthly energy needs ranged from 137 GWh in October to 241 GWh in January, as highlighted in Figure 1 – Source of 2015 System Monthly Needs. During 2015, PSNH met part of its total system supply by purchases from other suppliers including bilateral contracts. In 2015 external supply needs ranged from a low of 4% of monthly on peak energy requirements in February to a high of 65% in both June and August. While off-

<sup>22</sup> Document request number Staff 2 – 21.

<sup>23</sup> Frederick B. White direct testimony supporting the reconciliation of revenues and expenses, attachment FBW-2.

<sup>24</sup> Document request number Staff 2 – 21.

<sup>25</sup> Document request number Staff 2 – 18.

peak supplies from the market in 2015 ranged from a low of 2% in February to a high of 69% in August.

**Figure 1 – Source of 2015 System Monthly Needs<sup>26</sup>**

Period	System Peak (MH/Hr)	System Monthly Needs (GWh)		Market Supply (%)	
		On peak	Off-peak	On peak	Off-peak
January	906	244	245	13	10
February	894	231	212	4	2
March	782	204	194	34	31
April	597	164	140	60	50
May	709	147	158	59	51
June	664	171	138	65	56
July	825	211	160	62	58
August	743	191	178	65	69
September	802	167	147	63	64
October	564	151	137	61	55
November	644	146	153	63	56
December	705	188	167	56	51
<b>Total for 2015</b>	<b>906</b>	<b>2215</b>	<b>2028</b>	<b>48%</b>	<b>43%</b>

Note: May not add due to rounding.

## **PSNH's Sources of Energy and Capacity in 2015**

### **Energy Sources**

To meet customer energy requirements in 2015, PSNH had available an energy resource capacity of about 1225 MW for summer months and 1272 MW for winter months<sup>27</sup>. PSNH generation portfolio is comprised of the following resource units: hydroelectric (49 MW from nine stations, Amoskeag Hydro, Manchester; Ayers Island, Bristol; Canaan Hydro, West Stewartstown; Eastman Falls, Franklin; Garvins Falls, Bow; Gorham Hydro, Gorham; Hooksett Hydro, Hooksett; Jackman Hydro, Hillsborough; Smith Hydro, Berlin) coal and biomass (574 MW from the Merrimack and Schiller stations, gas/oil 419 MW from Newington and Wyman Unit 4, combustion turbines (82 MW from five units) biomass (67.5 MW from Burgess BioPower), wind (2 MW from Lempster), and non-utility generation (21 MW from Public Utilities Regulatory Policy Act (PURPA) mandated purchases and 10 MW from one Independent Power Provider (IPP) buyout replacement contract, which terminated in June 2015).

### **Capacity Requirements**

ISO-NE administers rules governing the Forward Capacity Market and conducts Forward Capacity Auctions to obtain the lowest resource cost necessary to meet the Installed Capacity Requirements, as well as establish a market value of capacity<sup>28</sup>. Accordingly, PSNH must meet

<sup>26</sup>Frederick B. White direct testimony supporting the reconciliation of revenues and expenses, attachment FBW-2

<sup>27</sup> In New England, generating units have winter and summer capability ratings. The summer ratings are generally lower to reflect higher ambient and cooling water temperatures.

<sup>28</sup> Capacity refers to a proven rating of a generator under specific conditions.

its 2015 share of the ISO-NE monthly capacity requirements, which ranged from 1,107 MW in September to 1,384 MW in January. The difference between PSNH resources and the ISO-NE monthly capacity requirement, including reserve requirements, must be met through supplemental capacity purchases. The PSNH market supplemental capacity requirement purchases varied from 35 MW in March to 162 MW in January<sup>29</sup>.

### **PSNH's Reliance on Supplemental Supplies**

Load obligation requirements due to customer migrated load was greater than planned during the months of January, February and December. PSNH believes significant reverse customer migration, which was not forecasted in their planning assumptions, was responsible for the difference. For example, at the beginning of January 452 MW of migrated customer loads were forecasted as compared to 379 MW of customer loads that actually did migrate. Beyond the winter months more stable off-season energy prices resulted in a reasonably predictable customer migration<sup>30</sup>.

To meet its load responsibility, PSNH makes supplemental on-peak and off-peak<sup>31</sup> energy purchases. In 2015, during both on-peak and off-peak periods, purchases varied by period and expected unit operation. PSNH made purchases based on scheduled unit maintenance and without assuming specific contingencies. In addition, the unit capacity value used by PSNH includes a reduction in unit capacity factor, reflecting estimated potential forced outages and estimated reserve shutdowns. The supplemental energy needs and capacity requirements increase if any portion of PSNH's generation portfolio is unavailable when needed to serve load, or if loads are higher than planned due to variations in the weather or customer migration. Likewise, these requirements are reduced when loads are less than planned due to variation in the weather or customer migration.

Figure 2 shows how PSNH's on-peak and off-peak energy requirements were supplied both historically and in 2015 by its own resources and the bilateral and ISO-NE spot markets<sup>32</sup>. In 2015 PSNH owned fossil generation provided a smaller percentage of load requirements and purchased a greater percentage due to lower energy market prices. In trending the data between 2010 and 2015, it clearly shows that PSNH owned generation is providing reduced amounts of on peak and off-peak energy and more cost-effective bilateral and ISO-NE spot market purchases are filling in the gap. Actual weather, customer migration patterns and major unit outages can also alter the year-to-year percentages.

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<sup>29</sup> Frederick B. White direct testimony supporting the reconciliation of revenues and expenses, attachment FBW-5.

<sup>30</sup> Document request number Staff 2 – 08.

<sup>31</sup> Defined by ISO-NE as weekends, holidays, and weekday hours 1-7 and hour 24.

<sup>32</sup> Document request number Staff 2 – 21.

	PSNH Owned Generation (Percent)		Bilateral and Spot Energy (Percent)	
	On Peak	Off-peak	On peak	Off-peak
2010	74	82	27	18
2011	63	69	37	31
2012	57	63	43	37
2013	66	70	34	30
2014	59	61	41	39
2015	52	57	48	43

**Figure 2-Supply of PSNH Energy Requirements from PSNH and Market Sources**

The amount of total generation PSNH has provided to its customers has steadily declined over the last five years. Figure 3-Energy Provided by PSNH Owned Generation is a bar chart which describes the three categories of PSNH generation, hydro, steam/fossil and combustion turbine and how the energy they have provided has varied over the last six years. In 2010 PSNH generation facilities combined provided almost 4 million MWh and in 2015 those same facilities provided only slightly over 1.7 million MWh<sup>33</sup>. The generation source with the most significant reduction has consistently been electricity generated by steam from the fossil units.

**Figure 3-Energy Provided by PSNH Owned Generation**

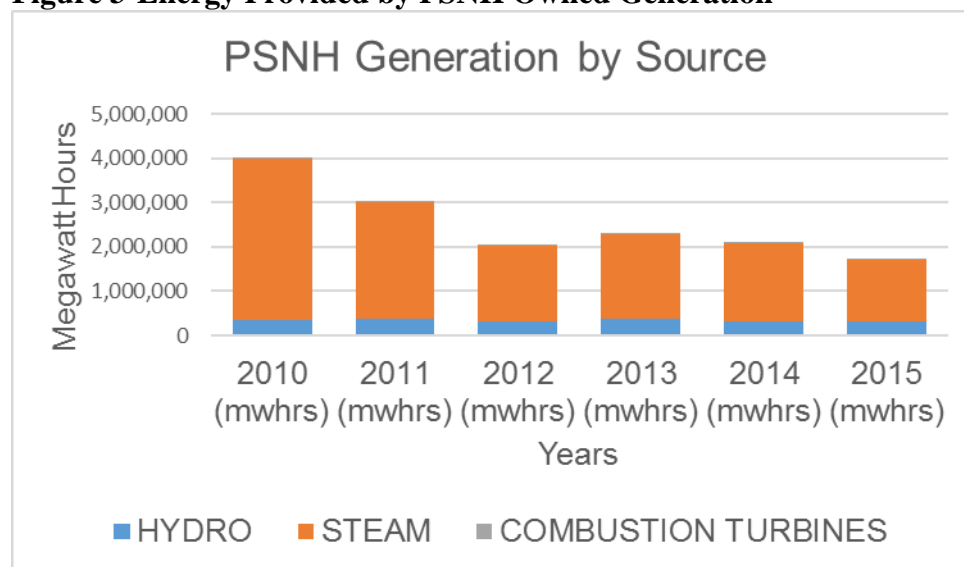


Figure 4- Historical PSNH Supplemental Purchases and Source, depicts PSNH's historical and 2015 market purchases and their source by percent<sup>34</sup>. ISO-NE spot market purchases are trending

<sup>33</sup> Document request number staff 2-14.

<sup>34</sup> Document request number staff 2-13.

higher and have reached their highest point for both yet for both on peak and off-peak supplemental purchases in 2015.

**Figure 4- Historical PSNH Supplemental Purchases and Source**

	Supplemental Purchases (GWh)	Monthly Bilateral (%)	Short-term Bilateral (%)	ISO-NE Spot Market Purchases (%)
<b>On peak</b>				
2010	1,011	90	3	7
2011	1,114	43	23	34
2012	1,141	40	18	42
2013	760	47	24	28
2014	888	18	25	57
2015	1,059	21	8	71
<b>Off peak</b>				
2010	564	41	7	52
2011	820	8	15	77
2012	876	12	16	72
2013	611	16	22	62
2014	773	0	20	80
2015	872	0	3	97

Note: May not add due to rounding

### **2015 Energy Costs**

PSNH meets its energy requirements through its own generation, PURPA mandated purchases, power purchase agreements and through supplemental purchases of energy from the market. PSNH made purchases based on monthly analyses that involved modeling hourly forecasts by month, including a hydro schedule, hourly load forecast, IPP forecast, and its own resources. In the sections that follows, we first discuss the forecasted and actual ES costs, then the cost associated with energy purchases less energy sales, and finally, the costs associated with capacity supply and offsetting revenues.

### **Energy Service (ES) Costs**

The ES rate was forecasted to be 10.56 cents between January 1, 2015 and June 30, 2015 and 8.98 cents between July 1, 2015 and December 31, 2015. ES costs include the fuel costs associated with PSNH's generation as well as costs and revenues from energy and capacity purchases and sales. In addition, costs related to the New Hampshire Renewable Portfolio Standard, Regional Greenhouse Gas Initiative, IPP power valued at market prices and revenue requirements of generation are also included. Furthermore, recovery of the scrubber costs at Merrimack station were partially recovered in 2015 through a Commission approved a temporary rate of .98 cents per KWh are also included. As of December 31, 2015, the ES had a net adjusted

under-recovery balance of \$129.8 million. The reason for this net adjusted under-recovery was primarily due to the deferred scrubber costs of \$123.8 million.

With the scrubber adjusted under-recovery cost removed, the ES would have been \$6 million under-recovered. This under-recovery resulted from \$21.3 million revenues lower than forecasted primarily driven by migration, \$3.4 million of higher O&M expense than forecasted offset by approximately \$18.7 million of combined return on rate base, energy expenses and other expenses lower than forecast.

### **Energy Purchases**

In 2015 approximately 1,059 GWh of peak energy were purchased at an average cost of \$40.73 per MWh. 305 GWh were purchased bilaterally at an average cost of \$37.48 per MWh. To address supplemental requirements and planned unit outage needs, 244 GWh of the 305 GWh were procured from fixed price monthly contracts. To address unplanned outages and higher load periods, 85 GWh of the 305 GWh were procured from fixed price short term daily or weekly arrangements<sup>35</sup>. The ISO-NE hourly spot market made up the bulk of the 1059 GWh of peak energy needs and amounting to 754 GWh at an average cost of \$42.04 per MWh.

Also, in 2015 approximately 872 GWh of off-peak energy were purchased at an average cost of \$29.67 per MWh. To address supplemental requirements and unplanned unit outage needs, 29 GWh of the 872 GWh were purchased from fixed price shorter-term arrangements. While the ISO-NE hourly spot market made up the bulk of the 872 GWh of off-peak energy needs and amounting to 843 GWh at an average cost of \$29.54 per MWh.

PSNH's net monthly on-peak energy requirements were 0 to 54 GWh of bilateral purchases, and less than one to 53 GWh of spot market purchases. PSNH's monthly off-peak net energy requirements were 0 to 40 GWh of bilateral purchases, and 1 to 92 GWh of spot market purchases. PSNH determines its incremental energy needs from the market based on actual expected weather and actual unit operational conditions rather than the forecasted average weather in the energy forecast<sup>36</sup>.

In 2015, PSNH purchased 304 GWh of on-peak bilateral energy for \$11.4 million and 28 GWh of off peak bilateral energy for \$.96 million. PSNH also spot-purchased 754 GWh of on-peak energy for \$31.7 million, and 843 GWh of off-peak energy for \$24.9 million. Total energy purchases totaled \$69.0 million.

PSNH conducts biweekly phone calls that include discussion with the generating station management, fuels, operations, and bidding/scheduling personnel. Plant personnel share capacity/energy planning informed of impending developments at the plants<sup>37</sup>.

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<sup>35</sup> Frederick B. White direct testimony supporting PSNH bilateral and ISO-NE spot purchases and sales-2015, attachment FBW-3.

<sup>36</sup> Ibid.

<sup>37</sup> Frank DiPalma and Bill Williams observed a biweekly call while interviewing and conducting a site visit at the Schiller station on October 6, 2016.



**Energy Sales**

Purchases are made in advance of anticipated energy needs. If actual loads are lower than expected, surplus energy may result in the system requiring its sale into the market. PSNH made spot sales into the ISO-NE spot market both from its own units and resale of unneeded purchased energy. In 2015 PSNH sold 51 GWh of on-peak energy for \$6.9 million and 98 GWh of off-peak energy for \$10.0 million. The amount of purchased/self-generated energy PSNH resold into the market totaled \$16.9 million. Total PSNH energy purchases cost \$69.0 million, resulting in a net cost of energy purchases of \$52.1 million, which is significantly higher than the 2014 net cost of \$19.6 million and 2013 net cost of \$23.1 million. During the last three year, net sales volumes have decreased resulting in net purchase volume increases<sup>38</sup>.

**Capacity Supply and Revenues**

Capacity market resources are paid for providing capacity in the ISO-NE marketplace. Total capacity payments are paid each month to PSNH based on its relative share of the prior commitment period's peak demand. Amounts paid for providing capacity are determined based on the Forward Capacity Market (FCM) rules. Capacity prices originate from two separate Forward Capacity Auctions (FCA) conducted by ISO-NE. The purpose of the FCA is to secure the lowest cost resources necessary to meet the ISO-NE Installed Capacity Requirements and to establish a value of capacity. In 2015 PSNH was paid for capacity rate of \$3.21 per kW-month for the January through May period and \$3.43 per kW-month for the June through December period<sup>39</sup>.

During 2015, a total of 411,304 MW-months of capacity qualified for credits in the ISO-NE capacity market. PSNH was allocated a capacity obligation of 3.45%. Consequently, PSNH's supply resources had a capacity supply obligation of 14,192 MW-months of capacity comprised of its own generation, non-utility IPP's (including Burgess BioPower and Lempster Wind), and Hydro-Québec interconnection capacity credits<sup>40</sup>. The difference between PSNH resources and the ISO-NE monthly capacity requirement, including reserve requirements, must be met through supplemental capacity purchases. The market supplemental capacity requirement purchases varied from 35 MW in March to 162 MW in January<sup>41</sup>. In 2015 PSNH owned units provided

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<sup>38</sup> This explanation was provided at the NH PUC's Technical Session held on November 18.

<sup>39</sup> Document request number staff 2-22.

<sup>40</sup> Frederick B. White direct testimony supporting PSNH Capacity Positions -2015, attachment FBW-5.

<sup>41</sup> Frederick B. White direct testimony supporting the reconciliation of revenues and expenses, attachment FBW-4.

13,173 MW-months capacity to ISO-New England, producing \$41.3 million revenue credited to the Energy Service rate.

### PSNH's Management of Energy Procurement

To conduct business in the ISO-NE energy and capacity markets, PSNH uses the resources of its parent company, Eversource Energy (Eversource or EE). Figure 5 below, depicts the total Eversource staffing and the number of Full Time Employees (FTEs) charged to PSNH to participate in the New England market<sup>42</sup>.

**Figure 5-FTE Time Sheet Allocation of Eversource's Electric Supply Department**

	2011		2012		2013		2014		2015	
	EE	PSNH	EE	PSNH	EE	PSNH	EE	PSNH	EE	PSNH
<b>Bidding &amp; Scheduling</b>	2.00	1.97	2.00	2.00	2.00	1.78	2.00	1.50	2.00	1.38
<b>Resource Planning/Analysis</b>	4.00	2.34	4.00	2.27	3.00	1.60	3.00	1.49	3.00	1.53
<b>Energy &amp; Capacity Purchasing</b>	2.00	.70	2.00	.78	2.00	.65	1.63	.46	1.00	.11
<b>Standard Offer &amp; Default Service Procurement</b>	3.00	.00	3.00	.00	2.00	.02	2.14	.01	3.00	.01
<b>Contract Administration</b>	3.00	.00	3.00	.00	2.00	.00	1.55	.00	1.00	.01
<b>Renewable Power Contracts</b>	1.00	.00	1.00	.02	3.00	.24	3.23	.00	2.77	.04
<b>Administrative Support</b>	1.00	.28	1.00	.23	1.00	.02	1.0	.25	1.00	.24 <sup>43</sup>
<b>Management</b>	1.00	.09	1.00	.12	1.00	.09	1.0	.11	1.00	.22
<b>Total</b>	<b>17.00</b>	<b>5.38</b>	<b>17.00</b>	<b>5.12</b>	<b>16.00</b>	<b>4.39</b>	<b>15.55</b>	<b>3.82</b>	<b>14.77</b>	<b>3.53</b>

Note: May not add due to rounding.

PSNH's energy procurement is managed and coordinated by Eversource. The principal responsibilities of Eversource's Electric Supply Department in serving the needs of PSNH continue to be bidding and scheduling and resource planning and analysis; and to a lesser extent energy and capacity purchasing. From an organizational viewpoint, the New Hampshire management FTE represents a portion of the Eversource manager based in Connecticut.

Between 2011 and 2015, Eversource gradually reduce the FTEs in its Electric Supply Department by 2.3 FTEs. This reduction resulted in an allocation reduction to PSNH of

<sup>42</sup> Document request number Staff 2 – 19.

<sup>43</sup> This explanation was provided at the NH PUC's Technical Session held on November 18.

approximately 1.8 FTEs. Eversource has stated that the reduction was possible due to several reasons: in 2011 and 2012 the FTE allocation to PSNH was relatively high as result of the work on several one-off dockets i.e. the Scrubber Docket, a Divestiture Docket and the AEE Docket; and today, the company is able to accomplish more work with less due to increased efficiencies. Time required to support the PSNH energy procurement and companion activities is directly charged by most of the Eversource Electric Supply Department staff.

## **Exhibit WCI-4 2015 Outage Review**

This exhibit covers an overview of the outages that occurred at Eversource's generation fleet including both forced and planned outages<sup>44</sup>.

### **Merrimack Outages For 2015**

Merrimack Station has transition its station maintenance and operations from prior base load operations to a more cyclical market environment as well as prepare for high reliability during the high demand periods.

Attention to safety and environmental compliance is one indicator of good operational performance. PSNH stated that Merrimack Station had one lost time accidents and no air permit or water permit violations in 2015.

#### **2015 Merrimack Station Unit 1 Outages**

##### **Outage Number: MK1-A**

During Unit 1 operation, the 1A forced draft fan vibration had slowly, but steadily increased over the course of a week. With low weekend energy demand and prices anticipated, the station took this short outage to make a balance adjustment to correct vibration issues with this fan. Unit 1 was economically offered and not selected in ISO's Day-Ahead market for January 3, 2015 and was released by ISO to shut down that morning. The Unit was declared unavailable to clean and inspect the fan wheel and to add a small balance weight. A subsequent balance check was performed with acceptable results. The unit was released to ISO at 14:45 on Saturday, January 3, 2015. The unit was phased at ISO's request at 09:04 on January 4, 2015.

##### **Outage Number: MK1-B**

Winter weather conditions with wet and freezing coal were responsible for multiple fuel flow interruptions on both units during this time. Operations personnel experienced repeated loss of coal flow to the boiler's coal feeders due to pluggage caused by frozen coal in the silo outlet downcomers, resulting in loss of individual cyclone burner flames. The unit was operating at a significantly reduced 39MW load due to lost fires in 1A and 1C. While fires in 1A and 1C were being reestablished, 1B downcomer plugged and the fire was lost. While attempting to reestablish 1B feeder, and with the other two fires operating at very low output and air flow, a sudden change in furnace pressure occurred and the unit tripped. The Unit was immediately restarted.

##### **Outage Number: MK1-C**

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<sup>44</sup> Document request number Staff 1 – 003.

With both units on line, Unit 2 tripped because of an issue with one of the Unit's boiler draft indications as detailed in MK2-A. The trip and subsequent events caused a loss of all Unit 2 power, including the cooling water pumps that supply the station's air compressors. Without the air compressors operating, instrument air pressure that controls many of the critical valves and dampers on Unit 1 quickly decayed. With the loss of instrument air pressure, operators were unable to control critical valve functions, e.g., feedwater flow to maintain boiler drum level. The decision was made to take the unit off-line. Once operators restarted TA-3000A compressor and reestablished control air pressure, the unit was immediately restarted.

**Outage Number: MK1-D**

Critical path for this planned outage was the inspection and repair of the HP/IP/LP turbine and generator. HP/IP turbine blade rows 13R, 15R, 16R, 1C and both the governor end and generator end rows of L-1 blades were replaced in Siemens Charlotte facility. The generator was inspected, cleaned, the core tightened and electrically tested. The boiler projects involved cyclone maintenance, upper and lower furnace maintenance, economizer casing repairs, partial front wall casing replacement and miscellaneous visual as well as NDE boiler inspection activities. The uppermost layer of catalyst was replaced in the SCR. In all, turbine, boiler, mechanical, I&C and electrical accounted for 1,947 activities.

**Outage Number(s): MK1-E, MK1-F, MK1-G, MK1-H, MK1-I, MK1-J**

The Unit 1 planned maintenance outage involved the complete disassembly and inspection of the high pressure, intermediate pressure and low pressure (HP/IP/LP) turbine components as well as the generator. Multiple turbine blade rows were replaced during the outage and repairs were completed on other turbine blade rows. At the completion of this extensive outage work, some post-outage turbine testing and balancing was anticipated and proved to be required to reduce vibration to acceptable levels. Multiple "balance moves" were completed during this time, where small balance weights are screwed into specific threaded balance holes in the rotor assembly. For each balance move, the unit must be taken off-line and the rotor fully stopped to install or remove the applicable weight, then the unit restarted and taken through various load conditions to collect vibration data. One of these balance moves and subsequent data collection runs was completed on Saturday morning, June 6, 2015, with data indicating another small weight adjustment was needed. During this run a small steam leak at the right-side throttle valve leak-off check valve bonnet under the turbine belly was also noted. Because energy demand and prices were very low, the decision was made to suspend balancing work for the remainder of the weekend, allowing the leaking check valve and surrounding area to cool for repair on Monday, June 8, 2015. This schedule avoided unnecessary weekend overtime expense and the self-

scheduled operation of the unit during low market prices. Work was completed on Monday; and the unit was released to ISO at 21:39 in reserve status.

**Outage Number: MK1-K**

During post outage turbine testing and balancing efforts, a steam leak developed at the right (east) side throttle valve body flange. With testing completed, the unit off-line in reserve status and energy demand and prices low, a maintenance outage was scheduled with ISO to make the necessary repairs.

**Outage Number: MK1-L**

While investigating a turbine oil leak, a station mechanic working with tools in a tight location made contact causing the turbine's vacuum trip mechanism to operate, tripping the Unit. The Unit was immediately restarted. Steps have been taken to reinforce for the workforce on these type of situations; and a barrier has been installed to physically preclude subsequent occurrences.

**Outage Number: MK1-M**

During the planned Unit 2 maintenance outage, an upgrade of the Emerson Ovation Distributed Control System (DCS) was completed. The Ovation DCS provides process and equipment control for the Merrimack Station FGD system which is common to both Units. During the hardware and software changes, a short period was required when the entire control system and therefore the FGD system was out of service. Since the scrubber is required to operate either of the Merrimack boilers, Unit 1 was declared unavailable until the work was completed.

**Outage Number: MK1-N**

The Unit 1 boiler feed pump (BFP) discharge valve is equipped with a motor operated actuator with a handwheel for manual operation. During the previous unit shutdown, the valve failed in the open position and could not be operated either electrically or manually. It was determined that the bronze jam nut that links the motor operator to the valve had become seized to the valve shaft, requiring both a new shaft and new jam nut. The unit was removed from service to isolate the line and valve and allow valve disassembly and installation of the replacement parts. This valve had been inspected and repaired during the spring 2015 maintenance outage and repairs included the replacement of the threaded valve stem. Because the motor operated valve actuator appeared to be in satisfactory condition, no repairs or replacement was performed on this component. See MK1-O for additional discussion.

**Outage Number: MK1-O**

The Unit 1 dearator block valve is equipped with a motor operated actuator with a handwheel for manual operation. The valve failed in the open position. It could not be operated electrically or manually. An outage was taken to disassemble and repair the valve. Like the boiler feedpump discharge valve described in MK1-N above, this valve had been inspected and repaired during the spring 2015 maintenance outage and repairs to both included the replacement of the threaded valve stems. Because the motor operated valve actuators of both valves appeared to be in satisfactory condition, no repairs or replacements were performed on those components. It is believed that the internal threads of the bronze drive nuts, part of the actuator assemblies of each valve, had elongated or were worn sufficiently from working with the original stem threads that they did not mesh perfectly and after repeated operation became jammed. It should be noted that these maintenance activities, replacing valve stems without repairing or replacing actuator components were typical of prior repairs and without prior issues. Likewise, the valve repair vendor indicated that replacement of valve stem without replacing the drive nut is typically not an issue and that in both cases, the new stems and existing drive nuts had been assembled by hand without obvious interference or problem. In the future, the station plans to replace both components as a pair; that is, if the stem is replaced the actuator drive nut will also be replaced to ensure a new matching thread and to prevent reoccurrence.

**2015 Merrimack Station Unit 2 Outages****Outage Number: MK2-A**

The Unit 2 Control Operator noticed a potentially faulty indication with two of the boiler flue gas pressure differential indications. An Equipment Operator in the plant was requested to blow down draft connections to clear any possible pluggage. The operator proceeded to sequentially clear the connections, including those on the FGD flues. The three FGD draft indications are utilized by the boiler's Burner Management System (BMS) and control logic requires that two of the three signals be active at all times. The operator blowing down the FGD draft connections had completed the first connection and was moving on to the second connection. The system recognized the second indication out of service before the first had been fully reestablished. The lag in establishing proper signal from the first pressure indicator connection line was greater than anticipated or typical. The BMS safety system, not recognizing two of the three indications as active, initiated a trip of the unit's booster fans, resulting in a sudden high boiler furnace pressure excursion and boiler trip. Due to a subsequent loss of instrument air pressure, Unit 1 was taken off line shortly after the Unit 2 trip as described in MK1-B. Unit 1 restart activities were initiated first, followed immediately by the Unit 2 restart. Procedures have been modified to ensure two signals are verified at all times.

**Outage Number: MK2-B**

Unit 2 was removed from service due to excessive water usage and to repair a significant flue gas leak at the south vertical buckstay. A complete boiler inspection identified tube leaks in 2C, 2G and 2F cyclones. All cyclone leak areas were weld repaired to original wall thickness. New studs were welded on the cyclone tubes and refractory was reinstalled once all the tube leaks were repaired. A final boiler pressure test was performed, and there were no other waterside leaks found. Critical path for the outage was repair of the south vertical buckstay at elevation 345' and resultant flue gas leak. This vertical I-beam acts to restrain the boiler side walls against the internal flue gas pressure and to maintain the boiler's box shape in the upper superheater area. This vertical buckstay is attached to a matching member on the north wall by horizontal tie-bars that stretch across the boiler's width, at the top through the penthouse and at the bottom below the superheater floor. The tie bars at the upper south sidewall's junction with boiler roof tubes in the penthouse had failed, allowing the sidewall to bow out of position and the penthouse flue gas seal to fail. Repairs involved significant scaffolding erection, insulation/lagging/casing and refractory seal removal and rigging installation efforts before the wall could be pulled back into position to a serviceable condition and the tie-bar reestablished. After refractory, casing, insulation and lagging replacement was completed, the Unit was released to ISO in reserve status. This was a temporary repair completed as expediently as possible due to the potential for high energy demand and prices at the time. More permanent repairs to the area were completed during MK2-C.

**Outage Number: MK2-C**

With the unit off-line in reserve status, it was declared unavailable to make a more permanent repair to the south (right sidewall) vertical buckstay. Repair efforts were similar in nature to those described in Unit 2 Outage Number "B" above, but significantly larger in scope as a larger area of the upper sidewalls were maneuvered to obtain a tighter seal at the sidewall/furnace roof juncture. Sections of the buckstay's connection components were replaced as well as multiple tie-bar attachments along the entire sidewall. Repairs were completed with the on-site assistance of a structural engineering consultant from boiler OEM Babcock & Wilcox. During this outage, multiple other boiler and balance of plant activities were completed, including an inspection of the FGD absorber vessel.

**Outage Number: MK2-D**

At 16:10 on September 7, 2015, ISO New England requested the startup of Merrimack Unit 2. Startup schedule parameters maintained by ISO required the unit to be on-line at 08:10 on September 8, 2015. The startup was longer in duration than normal, due to additional time required to meet the permissive for minimum turbine inlet steam temperature before rolling the turbine. A main steam drain valve, used to flow steam through the secondary superheater and



main steam piping to achieve this temperature permissive had failed in a partially open position, restricting flow and the rate of temperature increase. The proper temperature was achieved and the unit phased at 09:26. The unit was considered unavailable for the period between scheduled phase time and the actual phase time. The main steam drain valve was replaced during the fall 2015 outage to eliminate further issues.

**Outage Number: MK2-E**

Critical path for this outage was the replacement of the Unit 2 boiler's primary superheater, horizontal reheat superheater and partial replacement of the economizer elements. Both the primary superheater and horizontal reheat superheater section are arranged with two tube banks, each with one hundred seven serpentine assemblies across the width of the unit. The vertical stringer tubes which run vertically through and support all three boiler sections were also replaced. Other boiler maintenance activities included cyclone pin studding and refractory replacement, slag tank maintenance, upper furnace repairs to vertical secondary superheater and reheat superheater pendants.

The outage work scope included over 2,300 work activities, involving the boiler as well as mechanical balance of plant, electrical and instrumentation maintenance. Two layers of catalyst modules of the Selective Catalytic Reduction system were also replaced with fresh material to ensure NOx emissions compliance and both the boiler and FGD system's Distributed Control Systems were updated.

**2015 Merrimack Station CT-1 Outages****Outage Number: MKCT1-A**

The unit was declared out of service to replace a failed battery charger. The charger ensures that the unit's back-up power supply batteries are charged and able to provide emergency power to its control system in the event of a main power supply failure or interruption. Power isolation required to replace the charger also isolated starting power for the CT.

**Outage Number: MKCT1-B**

The safety valve on the start-pack high-pressure receiver tank began to prematurely lift preventing the tank from holding a full "charge" of pressurized air. This receiver stores the energy used to start the combustion turbine in the form of compressed air. When called to start, compressed air is used to drive a pneumatic starter motor that rotates the turbine to firing speed. The starting pack system needed to be depressurized and the CT declared out of service to facilitate replacement of the relief valve.

**Outage Number: MKCT1-C**

As described in CT-1 Outage “B”, compressed air is used to drive a pneumatic starter motor that rotates the turbine to firing speed. An aftercooler had been recently installed in this system to allow better filtration of the air and reduce contamination of downstream valve actuator components. Low ambient temperatures however, caused the aftercooler to freeze the condensate that it is designed to extract. This caused a blockage in the compressed air pathway used to supply air to the start-pack receiver tank and loss of the “starter air pressure okay” start permissive. Station operating procedures have been modified such that the aftercooler will be turned off during future low ambient temperature periods to prevent reoccurrence.

**Outage Number: MKCT1-D**

Scheduled inspection and maintenance activities of the combustion turbine, generator, control system and fuel system.

**Outage Number: MKCT1-E**

The State of New Hampshire’s Above-Ground Storage Tank regulations require internal inspection of the four tanks that supply fuel to both combustion turbines every ten years. While transferring fuel from 1-D tank to prepare the tank for cleaning and inspection, the fuel supply system to both combustion turbines became air bound and unable to provide fuel for operation. The unit was declared out of service until fuel supply could be reestablished. An inspection revealed that the internal fuel pump suction line, which operates on a float arrangement depending on tank level 1-D, was caught on its guide wire. This caused the fuel pump suction to be elevated several feet above its normal position exposing it to air at a much higher tank level than expected. This condition was corrected during inspection.

**Outage Number: MKCT1-F**

New revenue watt-hour meters were installed by the Eversource Transmission group to replace obsolete equipment and to improve metering accuracy. This required access to the potential transformer (PT) and current transformer (CT) circuits of the 13.8KV bus and necessitated isolating CT-1 electrically to complete the work.

**2015 Merrimack Station CT-2 Outages****Outage Number: MKCT2-A**

During periods of cold weather and higher oil viscosity, the CT-2 generator lube oil system requires additional time to build and establish steady oil pressure than during warmer times of the year. The recently installed digital control system utilizes a timer, not used in the prior

controls that will trip the unit if sufficient oil pressure is not recognized within the allowed time. An adjustment to this timer was needed, to accommodate the additional time need to established oil pressure conditions in severe cold weather and the work required the unit's entire control system to be out of service for a short time.

**Outage Number: MKCT2-B**

Additional programming changes were being made to CT-2's control system by the OEM to address the low temperature starting changes discussed in CT-2 Outage "A" above. The changes required the initiation of several start sequences that exercised ancillary systems, such as oil pumps and valves, but did not actually fire the engine. The low ambient outdoor temperature, compounded by the frequency of the start sequences, proved to be too much for the generator oil sump heater to keep up with and resulted in a low oil sump temperature. The unit was declared out of service until the sump heater could restore the sump temperature and associated start permissive.

**Outage Number: MKCT2-C**

Scheduled inspection and maintenance activities of the combustion turbine, generator, control system and fuel system.

**Outage Number: MKCT2-D**

The State of New Hampshire's Above-Ground Storage Tank regulations require internal inspection of the four tanks that supply fuel to both combustion turbines every ten years. While transferring fuel from 1-D tank to prepare the tank for cleaning and inspection, the fuel supply system to both combustion turbines became air bound and unable to provide fuel for operation. The unit was declared out of service until fuel supply could be reestablished. Later inspection revealed that the internal fuel pump suction line, which operates on a float arrangement depending on tank level 1-D, was caught on its guide wire. This caused the fuel pump suction to be elevated several feet above its normal position exposing it to air at a much higher tank level than expected. Situation was corrected during inspection.

**Outage Number: MKCT2-E**

New revenue watt-hour meters were installed by the Eversource Transmission group to replace obsolete equipment and to improve metering accuracy. This required access to the potential transformer (PT) and current transformer (CT) circuits of the 13.8KV bus and necessitated isolating CT-2 electrically to complete the work.

**Outage Number: MKCT2-F**

The unit failed to start when requested by ISO due to low fuel pressure. Investigation found the main fuel pump discharge valve closed from a prior maintenance activity. The valve was reopened and the unit successfully test run.

**Evaluation for Merrimack**

WCI has reviewed the outages above and found them to be reasonable and not unexpected for these units and their vintage, or necessary for proper operation of the unit. WCI concluded that PSNH conducted proper management oversight during these outages.

**Newington-1**

No major capital projects occurred in 2015.

Attention to safety and environmental compliance is one indicator of good operational performance. Newington achieved a safety record of no lost time accidents (LTAs) for the last 15 years. Newington has had only one LTA in the last 25 years. Newington reported no air or water permit violations for 2015.

**2015 Newington Station Unit 1 Outages****Outage Number: NT-A**

During the startup activities as the unit transferred from #2 oil to #6 oil there was an increase in opacity. The opacity reading remained high, so fires were removed to investigate the issue. No specific problems were found. The unit was restarted with no issues, resulting in a one-hour and 15-minute late start.

**Outage Number: NT-B**

The unit was on line after scheduled 0400 phase from hot start conditions. The unit was ramping to 100 MW and in the process of swapping from the Startup Boiler Feed Pump to the Main Boiler Feed Pump the unit tripped on a high drum level. There is a range of parameters (flow, pressure, timing, etc.) of these pumps which allow for transfer. This day the operator was at the edge of the desired range which resulted in a failed swap to the main pump. ESCC was informed of the trip and the unit commenced a startup procedure.

**Outage Number: NT-C**

The unit was off line on reserve in a hot standby condition when water was discovered leaking under the boiler at the #1 boiler corner. The unit was taken out of service. One leak was found on the front waterwall 2<sup>nd</sup> tube from the left wall at elevation 159'. The leak was pad welded and during the hydro another small leak was discovered at elevation 105' left waterwall 8<sup>th</sup> tube from the rear in the economizer outlet. The second leak was pad welded and following a successful hydro, the unit was released to ISO-NE for dispatch where it remained on reserve in a cold standby condition.

**Outage Number: NT-D**

The unit was taken out of service for a scheduled overhaul. The critical path for the outage was the upgrade/replacement of the Newington ABB Distributed Control System (DCS) for the Main Turbine and the Main Boiler Feed Pump Turbine. The work included the replacement of all operator/engineer workstations, network equipment, power supplies, and other new hardware and software, to bring the system up-to-date.

**Outage Number: NT-E**

The unit was taken out of service for a scheduled maintenance inspection. The initial scope was a generator crawl-through inspection completed by Siemens. As the inspection progressed, the scope was expanded to include a major generator inspection with a Siemens FSP 370 inspection (with the rotor out). A bump test was also performed.

**Outage Number: NT-F**

The unit had phased on line at 1009 for post outage Burner Management System testing and balancing with a self-schedule. The BMS system began experiencing flame detection and scanner issues resulting in a boiler trip. A logic change was made in the BMS system. Additionally, the exciter was removed from service at 1343 for a balance weight change by Siemens then returned to service at 1558 and the unit was restarted. The unit was phased and the BMS testing was completed.

**Evaluation**

WCI has reviewed the outages above and found them to be reasonable and not unexpected for these units and their vintage, or necessary for proper operation of the unit. WCI concluded that PSNH conducted proper management oversight during these outages.

WCI performed a station walk down on 10/06/16 and found the station to be reasonably tidy and clean.

**Schiller Unit Outages For 2015**

Attention to safety and environmental compliance is one indicator of good operational performance. Schiller continues to focus on improving its safety record. To that end, Schiller achieved no lost time accidents in 2015. In addition, Schiller states that no water or air permit violations occurred in 2015.

**2015 Schiller Station Unit 4 Outages****Outage Number: SR4-A**

Unit 4 was in the process of starting up and was at 6 MW. When the third oil gun was lit, a boiler vibration that was noticeable in the control room occurred. At that moment, the boiler tripped on “high furnace draft” which was the apparent cause of the vibration. The boiler systems were lined up and restarted with no further incident. The assessment was that some ash clinkers on the screen tubes dislodged causing the vibration. The high furnace draft likely occurred during the high vibration. While the Operator was focused on assessing the high vibration incident, it is likely the furnace draft increased in that brief period.

**Outage Number: SR4-B**

Unit 4 was self-scheduled with ISO for annual stack testing. The unit had been phased and was online for approximately 3 minutes when it tripped offline due to a low vacuum condition in the condenser. It was determined that condenser vacuum level was close to low but still allowed phasing of the unit. No physical leaks were found and the unit was immediately restarted.

**Outage Number: SR4-C**

T&D planned work in the high yard required Schiller units 4 and 6, as well as CT-1 to be unavailable on Friday and Saturday from 0700 to 1600 and Sunday from 0700 to 1400. This work was discussed with Generation to minimize the unavailability of the units and thus the potential impact to customers.

**Outage Number: SR4-D**

T&D planned work in the high yard required Schiller units 4 and 6, as well as CT-1 to be unavailable on Friday and Saturday from 0700 to 1600 and Sunday from 0700 to 1400. This work was discussed with Generation to minimize the unavailability of the units and thus the potential impact to customers.

**Outage Number: SR4-E**

T&D planned work in the high yard required Schiller units 4 and 6, as well as CT-1 to be unavailable on Friday and Saturday from 0700 to 1600 and Sunday from 0700 to 1400. This

work was discussed with Generation to minimize the unavailability of the units and thus the potential impact to customers.

**Outage Number: SR4-F**

The unit was online for 31 minutes when a high drum level trip occurred. The cause of the high drum level condition was determined to be that the main feed water valve was leaking by sufficiently to result in a high drum level. The valve will be disassembled and inspected/repairs during the next annual overhaul. In the interim, all Control Operators have been notified of this condition and can take necessary steps to avoid a similar trip event due to this valve leak by.

**Outage Number: SR4-G**

The unit was scheduled offline for oil piping changes. These changes are part of the Regulatory requirement to decommission the existing underground storage oil tank, typically referred to as the Schiller Day Tank. The outage was necessary to modify the piping to the new oil storage tank.

**Outage Number: SR4-H**

During shutdown of the unit, the packing failed in the small discharge valve on 4B BFP. Since this was a 1" size valve, the decision was made to replace it versus repacking it. There was no problem identified resulting in the packing failure.

**Outage Number: SR4-I**

The unit was online at the time the leak was discovered. Upon inspection, a lower waterwall header hand hole cap was found cracked about one quarter of the circumference. Cracking in these locations are monitored regularly for propagation into the main header area.

**Outage Number: SR4-J**

The unit was phased and while attempting to increase the load, the megawatt meter showed a rapid increase to approximately 10 mw then down to 0 mw at which time the unit tripped off line 3 minutes after phasing. The governor ram assembly appeared to stick causing this event. This has occurred, though infrequently over the years. As a resolution, Siemens inspects and lubricates them as needed.

**Outage Number: SR4-K**

The unit tripped offline due to a high drum level shortly after start-up. This was determined to be due to the main feedwater control valve leaking by. In this instance, while the Control Operator knew to compensate for the valve leakage as recognized in SR4-F, the leakage was still sufficient to cause a high drum level and the unit trip.



**Outage Number: SR4-L**

The unit was returned to reserve shut down mode after being released from service at 0113 on Saturday October 31<sup>st</sup>. Operations noted water leaking from the boiler and suspected an economizer tube leak. Upon inspection, one leak was found outside the seal bar on the northeast corner first tube bottom row and repaired by pad welding in the economizer section.

**Outage Number: SR4-M**

Operations noted water leaking from the boiler. Upon inspection, one leak was found and repaired by installing a dutchman<sup>45</sup> section. It was in the #1 tube in the northeast corner.

**2015 Schiller Station Unit 5 Outages****Outage Number: SR5-B**

During normal operations, the C-5 conveyor motor drive belt failed. This belt failure prevents the flow of wood chips to the fuel storage silos, limiting the remaining run time for the boiler. A Stock Handler was called in immediately to get a new replacement belt out of stock.

While the belt replacement was ongoing, the unit load was reduced to conserve as much fuel as possible. In parallel, multiple attempts were made to fire the gas burner to stabilize the boiler. These attempts to light the gas burner were unsuccessful due to high air flow issues. The unit eventually had to be taken offline due to dropping steam pressure and temperature.

Each attempt to light the gas burner was determined to be unsuccessful due to the inability to reduce air flow low enough so as to “not blow out the flame”. As the air flow was reduced, the furnace pressure went lower approaching the trip point. The atmospheric dampers and secondary air dampers were opened in an attempt to minimize the ID fan “draw” from the furnace. Also, two sections of the bag house were closed. All these efforts were still unsuccessful. Further investigation isolated the problem to the ID fan with the focus on the internal linkage assembly. An inspection found the internal south vane linkage broken. A new linkage assembly was fabricated on site. The linkage was installed and the vanes were stroked to test operation of the new linkage.

**Outage Number: SR5-C**

The C5 conveyor belt was found to have a tear. This conveyor belt supplies the wood fuel from the wood yard to the U5 boiler. Upon inspection, it was found that the conveyor belt had torn approximately 80% across the width of the belt at the location of one of the initial

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<sup>45</sup> Dutchman: A short lead nipple used to join two pipes which are otherwise not long enough to be joined.

installation splices (2 splices total) from 2015. Portland Rubber belting company was contacted and requested to assist with the repair work. The repair consisted of a mechanical splice to the belt at this time. Upon completion, the C-5 conveyor was run to check it's tracking and verify no abnormal contact points. The C-5 motor drive belt was inspected, alignment checked, and tension adjusted as part of the repair process. No problems noted. After further discussion with the belt manufacturer ("Goodyear"), Goodyear agreed to redo both splices during the planned spring outage, utilizing a 28" overlap vulcanizing process as compared to the original 14" overlap. The 28" overlap will offer a stronger connection.

**Outage Number: SR5-D**

The unit was operating at full load when an in-bed boiler tube leak developed which caused the unit to trip due to low drum level. An internal inspection was performed. One (1) tube was found to be leaking due to external erosion. Six (6) additional tubes were noted as needing to be pad welded as part of that inspection. Bed material and water were also found in the air plenum.

A fish mouth leak was repaired with a dutchman in bank 7 tube #12 in the outside loop on the bottom side of the bend. Six small padwelds were used to repair four (4) tubes on the west side of the boiler and two (2) tubes on east side. There were two (2) damaged tuyeres replaced and the air plenum was vacuumed out.

**Outage Number: SR5-E**

Annual maintenance work completed in the spring coincident with New England mud season.

**Outage Number: SR5-F**

The Control Room Operator (CRO) reported that the Governor Speed changer was not responding to load adjustments from the control room or the switchboard. The load on the unit did respond to local adjustments made manually at the speed changer, which is located on the front of the turbine governor. It was determined that the unit would have to be offline in order to remove the speed changer and perform an inspection of the unit. The decision was made to take the unit off line to correct the speed changer issue and avoid any potential risks associated with no remote load adjustment capability.

Siemens was immediately contacted to have a field engineer on site to oversee removal, inspection and repair of the governor speed changer. Upon disassembly of the speed changer, it was found that the drive motor shaft and coupling assembly had sustained damage. While a new shaft was in inventory on site, the coupling

needed to be obtained. The most expeditious schedule was the use of the Generation Maintenance Machine Shop. The damaged coupling was taken to our Generation Maintenance Machine Shop and a new shaft was fabricated. The new one was machined and arrived the following day. The speed changer unit was reassembled and installed with oversight from the Siemens representative.

**Outage Number: SR5-G**

The unit was online when a tube leak occurred. It was suspected to be in the economizer section. Unit was taken offline for inspection and subsequent repairs. The inspection found one tube leak in the northeast corner in the first tube at elevation 40'. The casing was opened to access the tube. The loop was removed and replaced with a dutchman. The contractor, Thielsch checked thicknesses in the economizer which resulted in two more Dutchman. In-bed tubes were also inspected resulting in completing six additional pad welds and two more dutchman.

**Outage Number: SR5-H**

The unit was online when an in-bed tube leak occurred. The inspection found two tube failures in bank #11, in tube 1 at the top and south side of the 2nd loop, this caused the failure to bank #10, tube #14 on both upper and lower loops. The damaged portions were removed and dutchmen were installed to complete repairs.

**Outage Number: SR5-I**

The unit was taken offline for planned maintenance in conjunction with the Transmission Hi-yard work outage. The critical path work for this overhaul was the inspection and cleaning associated with all six cyclones. An in-bed tube inspection was conducted. Tuyere inspections were completed with replacement as needed. The ash removal drag chain was replaced as part of winter reliability review. An inspection of the eight modules in the baghouse was completed. Each module or compartment has 360 bags.

**2015 Schiller Station Unit 6 Outages****Outage Number: SR6-A**

At 15:20 on Wednesday 3/4/15 Unit 6 was taken offline due to a waterwall tube leak. The leak on the east wall at approximately El 56' was repaired by pad welding. A nearby sootblower spraying directly on the tube causing OD erosion is the suspected cause. The soot blower itself is not the direct issue, but a slight bow in the wall causing that tube to be more in line with the initial spray. A slight adjustment was made to the sootblower. This tube area will be monitored.

**Outage Number: SR6-B**

Planned Transmission Outage to #1 Buss in High Yard T&D planned work in the high yard required Schiller units 4 and 6, as well as CT-1 to be unavailable on Friday and Saturday from

0700 to 1600 and Sunday from 0700 to 1400. This work was discussed with Generation to minimize the unavailability of the units and thus the potential impact to customers.

**Outage Number: SR6-C**

Planned Transmission Outage to #1 Buss in High Yard T&D planned work in the high yard required Schiller units 4 and 6, as well as CT-1 to be unavailable on Friday and Saturday from 0700 to 1600 and Sunday from 0700 to 1400. This work was discussed with Generation to minimize the unavailability of the units and thus the potential impact to customers.

**Outage Number: SR6-D**

Planned Transmission Outage to #1 Buss in High Yard T&D planned work in the high yard required Schiller units 4 and 6, as well as CT-1 to be unavailable on Friday and Saturday from 0700 to 1600 and Sunday from 0700 to 1400. This work was discussed with Generation to minimize the unavailability of the units and thus the potential impact to customers.

**Outage Number: SR6-E**

The unit was phased online at 0945. The unit was online for 30 minutes when a low drum level trip occurred. An assessment concluded that as the load was increased, the feedwater flow was unable to keep up with the steam demand.

**Outage Number: SR6-F**

The unit was scheduled offline for oil piping changes. These changes are part of the Regulatory requirement to decommission the existing underground storage oil tank, aka Schiller Day Tank. The outage was necessary to modify the piping to the new oil storage tank.

**Outage Number: SR6-G**

Planned turbine maintenance.

**Outage Number: SR6-H**

The unit phased at 1242. Boiler tripped off at 1335 due to low oil pressure. Day tank oil temperature was at 170 degrees which is at the upper end of the temperature range resulting in a change in the viscosity which limited the oil pump's ability to build the necessary pressure. This condition delayed the boiler re-firing for 45 minutes while more oil was added to the day tank in an effort to increase the viscosity of the oil in the tank. The boiler was available to re-fire within minutes in order to build steam and reroll the turbine. ISO was contacted and made aware of the units availability, ISO declined bringing the unit up as of that time. Unit returned to reserve status. Operation personnel were notified to closely monitor the new day tank temperatures given the changes recently made in the fuel oil system. The recent transition to a

new indoor day tank was a factor and adjustments to set point should preclude future such oil viscosity issues.

**Outage Number: SR6-I**

During The unit planned maintenance outage in September, one of the Superheater headers was replaced which can introduce large amounts of weld slag and associated debris in the steam path. To alleviate potential damage to the turbines, strainer baskets were installed at that time in the throttle valves. Due to their finer mesh and the build-up of debris, these need to be removed within a couple months of operation. Working with Bidding & Scheduling, this day was selected due to forecasts suggesting that Unit #6 would not be taken in the Day Ahead schedule.

**2015 Schiller CT Station Outages****Outage Number: SRCT-A**

Planned Transmission Outage to #1 Buss in High Yard T&D planned work in the high yard required Schiller units 4 and 6, as well as CT-1 to be unavailable on Friday and Saturday from 0700 to 1600 and Sunday from 0700 to 1400. This work was discussed with Generation to minimize the unavailability of the units and thus the potential impact to customers.

**Outage Number: SRCT-B**

Planned Transmission Outage to #1 Buss in High Yard T&D planned work in the high yard required Schiller units 4 and 6, as well as CT-1 to be unavailable on Friday and Saturday from 0700 to 1600 and Sunday from 0700 to 1400. This work was discussed with Generation to minimize the unavailability of the units and thus the potential impact to customers.

**Outage Number: SRCT-C**

Planned Transmission Outage to #1 Buss in High Yard T&D planned work in the high yard required Schiller units 4 and 6, as well as CT-1 to be unavailable on Friday and Saturday from 0700 to 1600 and Sunday from 0700 to 1400. This work was discussed with Generation to minimize the unavailability of the units and thus the potential impact to customers.

**Outage Number: SRCT-D**

Wood Brothers Group performed this routine annual inspection and service. Fuel filters were changed. The boroscope inspection of the rotor was completed with no issues noted.

**Evaluation**

WCI has reviewed the outages above and found them to be reasonable and not unexpected for these units and their vintage, or necessary for proper operation of the

unit. WCI concluded that PSNH conducted proper management oversight during these outages.

WCI performed a station walk down on 10/06/16 and found the station to be reasonably tidy and clean.

#### **W. F. Wyman Station – Unit #4**

The W. F. Wyman Station is a generating station that sells power into the New England market. PSNH owns an approximate 3 percent interest in the Wyman Unit #4. NextEra Energy Resources (NextEra) is the majority owner of the unit and, as such, is responsible for day-to-day operations. As a minority owner, PSNH is aware of how the plant conducts business, but has little influence over day-to-day operations of the plant. This distinction is made because the fact that PSNH is a minority owner results in a different evaluation of prudence than would be applied to wholly owned units providing energy to PSNH customers. Wyman Unit #4 is a high cost oil unit operating under tight environmental restrictions and at an annual capacity factor of less than 5%.

#### **2015 Wyman Station Outages**

##### **Outage Number: Wyman-A**

PWF 4 Late Start on Breaker Failure to Close. Discovered the procedural low limit for unit voltage did not meet the synch relay requirements. The procedure was revised to increase the low voltage limit.

##### **Outage Number: Wyman-B**

Wyman Unit 4 Condenser Tube Plug Failure - Boiler Contamination. Discovered an old tube plug failed. Repaired failed plug, subsequently replaced all old tube plugs.

##### **Outage Number: Wyman-C**

PWF 4 Maintenance Outage for Circulating Water Piping Leak

A circulating water piping plug failed resulting in a leak to the surrounding yard area. Plug was replaced using standard technique.

##### **Outage Number: Wyman-D**

PWF 4 MOF - ID Fan Servo Replacement

A control oil leak prompted preparations and execution of the control servo replacement.

**Outage Number:** Wyman-E

PWF 4 MOF Superheat Tube Leak

Tube leak discovered during a hydrotest. Due to physical location, tube was removed from service by removing and capping the stub ends.

**Outage Number:** Wyman-F

PWF 4 Maintenance Outage 4A ID Fan

Additional adjustments required on replacement control servo.

**Outage Number:** Wyman-G

PWF 4 MOF for Condenser Tube Plug Replacement

Due to the forced outage in February, all old plugs were removed and replaced with new

company mandated standard plugs.

**Outage Number:** Wyman-H

PWF 4 POF Annual Outage for Boiler Inspection

**Evaluation**

WCI reviewed the above outages and found them either to be reasonable and not unexpected for this unit and its vintage, or necessary for proper operation of the unit. WCI concluded that PSNH conducted proper management oversight with its limited ownership.

## **Exhibit WCI-5 Capital Project Review**



<b>2015 <sup>46</sup> Capital Expenses</b>	<b>Project Descriptions for Merrimack Station</b>
<b>\$9,157,100</b>	<b>MK2 Horizontal Reheater Replacement C15MK175</b> <p>The Unit 2 boiler's horizontal reheat superheater section is comprised of two horizontal tube banks, each with one hundred seven (107) serpentine assemblies arranged across the width of the boiler. These are the two center horizontal tube banks in the boiler's backpass. Recent tube failures indicated a significant reliability risk and close element spacing and attachments made thorough inspection and repair impossible. The horizontal reheater elements were replaced to ensure reliability, including hanger tubes and jumper tubes to the vertical reheater section.</p>
<b>\$6,985,900</b>	<b>MK2 Primary Superheater Replacement C15MK170</b> <p>The Unit 2 primary superheater section is likewise comprised of two horizontal tube banks, each with one hundred seven serpentine assemblies arranged across the width of the unit. The primary superheater was last replaced in 1982. The current elements having experienced over thirty years of demanding service. The arrangement of these tube sections makes access and repair of leaks very difficult and time consuming; this particular repair resulting in approximately 2.8 days of unavailability at a cost to customers of \$1,786,605. Given the current condition and the same inability to fully inspect and make preemptive repairs in this section, more failures were thought likely to occur. The primary superheater elements were replaced to ensure reliability, including hanger tubes.</p>

<sup>46</sup> Document request number Staff 1-02.

<b>\$2,707,500</b>	<b>2014/2015</b> <b>MK1 Turbine HP/LP Blade Replacements</b> <b>C14MK400 13R/15R - \$692.8</b> <b>C14MK410 L-1 - \$1255.7</b> <b>C15MK350 16R - \$355.4</b> <b>C15MK360 1C - \$403.6</b> <p>Previous inspections and Non-Destructive Examination (NDE) by OEM Siemens/Westinghouse resulted in recommendations by Siemens to replace Unit 1 HP/IP turbine blade rows 13R, 15R, and both the exciter end and generator end rows of L-1 blades to ensure unit performance, reliability and eliminate risk of potential blade failures. Those rows were planned for the 2015 maintenance outage. During the outage, additional inspection and NDE determined the need to also replace rows 16R and 1C blades. Partial payments were made for the 13R, 15R and L-1 blades in 2014, for installation in 2015.</p>
<b>2015 Capital Expenses</b>	<b>Project Descriptions for Schiller Station</b>
<b>\$2,494,200</b>	<b>Purchase and Install Dry Sorbent System C14SR010</b> <p>This project was associated with the new EPA MATS Regulation. The project was to design and install a dry sorbent injection system common to both #4 &amp; 6 to control acid gas emissions. This project started in 2014 and was commissioned in 2015.</p>
<b>\$657,500</b>	<b>Replace Fuel Oil Day Tank C14SR016</b> <p>This project involved the decommissioning and retirement of the existing fuel oil day tank, considered to be an underground tank per NH DES regulations. As such, NH regulations required it to be eliminated by December 2015. This project started in 2014 and was completed in 2015.</p>
<b>\$561,600</b>	<b>Replace Row 2R Control Stage Turbine C15SR009</b> <p>This project involved the replacement of the Row 2R Control Stage turbine blades on unit #6. During the 2009 inspection, Siemens Engineering recommended that these blades be replaced during the next scheduled HP Turbine inspection outage. Specifically, these blades were showing signs of solid particle erosion of the rivet heads and the leading edges of the blades. Failure of the rivet heads allows the blade shrouds to lift from the cylindrical forces during the operation of the turbine. Should this occur and the shrouds break free, they will pass through several other stages of blades, causing damage to them as they pass through.</p>