BEFORE THE PUBLIC UTILITIES COMMISSION OF NEW HAMPSHIRE

CASE NUMBER: DE 11-250

IN THE MATTER OF THE PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE INVESTIGATION OF MERRIMACK STATION SCRUBBER COSTS AND COST RECOVERY

Direct Testimony of

FRANK T. DIPALMA

AND

C. LARRY DALTON

On Behalf of

The Staff of the New Hampshire Public Utilities Commission

DECEMBER 23, 2013

Table of Contents

I. INTRODUCTION AND BACKGROUND................................1

II. SUMMARY OF FINDINGS...11

III. SECTION DETAILS...16

1. Project Initiation..16
2. Contracting Strategies..18
3. Market Cost Review...19
4. Technology...21
5. Project Estimates...23
6. Project Cost Controls...30
7. Performance...37

List of Exhibits

EXHIBIT JCI 01 – Resume of Frank T. DiPalma

EXHIBIT JCI 02 – Resume of C. Larry Dalton, PE.

EXHIBIT JCI 03 – Resume of William M. Williams JR.

EXHIBIT JCI 04 – Comparison of Cost Estimates for Clean Air Project, URS versus Sargent & Lundy

EXHIBIT JCI 05 – Clean Air Project Scope Changes

1. INTRODUCTION AND BACKGROUND

Identification of Witness

Q. Mr. DiPalma, please state your name and business address.

A. My name is Frank DiPalma. I work for Jacobs Consultancy Inc. ("Jacobs Consultancy"). My business address is 5995 Rogerdale Road, Houston, Texas 77072.

Q. Mr. Dalton, please state your name and business address.

A. My name is Larry Dalton. I work for Jacobs Engineering Group Inc. ("Jacobs"). My business address is 1041 East Butler Road, Greenville, South Carolina 29607.

Q. Mr. DiPalma, what position do you hold at Jacobs Consultancy?

A. I am currently a Director in the Utilities Practice.

Q. Mr. Dalton, what position do you hold at Jacobs Engineering?

A. I am currently a Senior Power Engineer.

Q. Mr. DiPalma, what is your background and qualifications for your testimony in this proceeding?

A. I am a management consultant in the energy industry with over 30 years of experience assessing and working for electric and gas utilities. In addition to

Jacobs Consultancy, my consulting experience includes employment with Stone & Webster Consultants as Associate Director. My direct utility operating experience has been gained from being employed as an officer, manager or engineer for Public Service Electric & Gas Company and Mountaineer Gas Company. My expertise includes general and operations management, distribution engineering, business development, customer service, process engineering, project management, strategic planning, and regulatory compliance.

As a management consultant in the energy industry, I have had numerous assignments where a utility's approach to project management on large construction projects was assessed.

Recent electric and gas industry project management-related assignments include:

- Spectra Energy - Performed a Critical Assessment Study of Project Execution for the New Jersey-New York Pipeline Expansion Project (2011).
- Public Service Electric and Gas Company - In connection with the State of New Jersey, Board of Public Utilities Mandated Management Audit (2010 - 2011).
- Fitchburg Gas and Light Company d/b/a Unitil - In connection with the Massachusetts Department of Public Utilities Mandated Management Audit (2010 - 2011).
- Puget Sound Energy - In connection with the Washington Utilities and Transportation Commission Review of Mandated Gas Safety Activities (2008-2009).

- Connecticut Department of Public Utility Control - Performed a technical evaluation of 11 proposals to build 500 MW of new peaking generation units in Connecticut (2008).
- Spectra Energy - Management and technical review of the Gas Pipeline Project Management and Delivery Process (2007-2008).
- Yankee Gas Services - In connection with the Connecticut Department of Public Utility Control Mandated Management Audit (2007-2008).

In addition, my expertise includes periodically providing expert utility-related testimony. Recently, I have testified during hearings related to the following:

- Exelon Corporation and Constellation Energy Group, Inc. Merger for the Maryland Public Service Commission (2011).
- First Energy Corp. and Allegheny Energy, Inc. Merger for the Maryland Public Service Commission (2010).
- The replacement of approximately 70,000 Rockford Eclipse meter shut-off valves, currently in South Jersey Gas Company's distribution system (2010).
- The potential impacts on Baltimore Gas and Electric in connection with Electricité de France's purchase of half of Constellation Energy Group's Nuclear Holdings for the Maryland Public Service Commission (2009).
- The proposed merger of Exelon and PSEG for the New Jersey Board of Public Utilities regarding reliability and safety of the electric delivery business (2005).

I have also assisted others in the preparation of testimony. While both at Mountaineer Gas and PSEG, I helped prepare testimony in the following areas: specific capital initiatives or projects to be included in rate base, operations, and maintenance programs to be recovered as expense, rate case preparation, and documentation, and appliance service costs.

I am a graduate of New Jersey Institute of Technology with a degree in Mechanical Engineering, and Fairleigh Dickinson University with a Master's in Business Administration.

A copy of my résumé, which includes a list of electric and gas utility clients and commission requested assessments, is attached to this testimony as EXHIBIT JCI 01.

Q. Mr. Dalton, what is your background and qualifications for your testimony in this proceeding?

A. I am a Mechanical Engineer who has spent most of my career designing power plants. I have had extensive experience in utility, industrial, waste-to-energy, and institutional plants. Assignments vary in levels of involvement and run from conceptual studies through detailed design, commissioning, and start-up. Some projects are for only one phase, but a vast majority of the projects with which I have been involved have included the full scope, from concept to start-up, and in many cases, beyond. I am presently engaged in engineering studies for several pulp and paper mill power plants, some of which I have been performing engineering work in for nearly 40 years. My experience includes engineering the plants from fuel receipt through discharge of solid, liquid, and gaseous streams, with particular emphasis on air pollution control systems. Every power plant has some type, or types, of environmental aspects, the control of which may encompass many technologies. I have studied and designed essentially every type of pollution control, including mechanical separation, electrostatic precipitation, wet and dry scrubbing, and fabric filtration.

Recent power plant assignments include:

- NewPage Corporation – Biron, WI/Duluth, MN/Escanaba, MI/Luke, MD/Rumford, ME/Wisconsin Rapids, WI/Wickliffe, KY - Prepared studies and estimates to determine the alternatives available for decreasing emissions to allow compliance with upcoming federal regulations. Studies covered 15 boilers that burn a wide variety of fuels, including coal, biomass, oil, gas, tire derived fuel, industrial sludge, and off-gasses from pulping operations (2011-2012).
- Covanta – Worked on design of a waste-to-energy plant in Dublin, Ireland. This plant, located on the River Liffey in downtown Dublin, will burn municipal garbage from the greater Dublin area to divert it from landfills and produce power as a by-product (2009-2010).
- Rayonier – Jesup, GA:
    - Prepared a study and estimate, followed by implementation of modifications to combustion and pollution control systems on two chemical recovery boilers. Project increased combustion

efficiency and increased the capability of the electrostatic precipitator in order to decrease emissions (2011).

  - Prepared a study and estimate for a new biomass boiler and turbine generator to replace existing aged equipment. The new installation, including pollution control equipment will decrease emissions and comply with upcoming federal regulations for industrial boilers (2011).

- Domtar:
  - Espanola, ON – Prepared a study and estimate to install a wet scrubber for pollution control to replace an inadequately sized electrostatic precipitator (2011).
  - Plymouth, NC – Assisted in preparation of an estimate, followed by design and installation of gas burning capability on a biomass fired boiler. (2011- 2012).
- Marafiq – Yanbu, Saudi Arabia:
  - Served as Owner's Engineer in the design of two new 250 MW oil fired units in the industrial city on the Black Sea. Activities included review of turnkey contract documents, including process and instrument diagrams, calculations, and operations descriptions, to ensure compliance with the specification (2010-2011).
  - Served as Owner's Engineer in preparation of an estimate and turnkey specification for the supply of three 250 MW oil fired units in the industrial city on the Black Sea. Activities included

preparation of plant layout, process and instrument diagrams, equipment list, and specification. Also included were evaluation of proposals, attendance at contractor proposal reviews, and selection of successful contractor (2010).

- Progress Energy – Raleigh, NC:
  - Alliance Manager and lead Power Engineer for over 200 ongoing plant projects for all of its fleet. Typical projects include ash systems modifications, installation of new electrostatic precipitators, acting as Owner's Engineer on installation of flue gas desulfurization systems, and coal systems upgrades (1994-2011).
  - Assisted in site selection and development of eight new combustion turbine plants in North Carolina, South Carolina, and Georgia. Combined capacity of the plants total over 6,000 MW (1997-2004).
- Connecticut Peaking Generation Units, Connecticut Department of Public Utility Control – Performed Technical Evaluation of 11 proposals to build 500 MW of new peaking generation units (2008).
- University of Pennsylvania – Served as the technical lead in a project to assist the University in a dispute with its supplier concerning cost of utilities. The process involved the development of a hypothetical power plant to produce the University's steam and chilled water. (2006-2007).
- University of Massachusetts – Amherst, MA:

- Prepared a study and estimate for the installation of a biomass steam generator at the Amherst campus. Various types of combustion systems were considered; including grate fired and fluidized bed boilers and gasification technology (2009-2010).
- Prepared a design-build specification for the installation of a biomass steam generator at the Amherst campus. The specification was structured so that the bidders could propose alternative technologies for the steam generator.

A copy of my résumé, which includes a list of clients, is attached to this testimony as EXHIBIT JCI 02.

Q. Please describe the activities of Jacobs Engineering and Jacobs Consultancy.

A. Jacobs Engineering Group Inc. is one of the world's largest and most diverse providers of professional technical services with more than 70,000 employees worldwide. Jacobs offers a full-spectrum support to industrial, commercial, and government clients across multiple markets and geographies. Services include scientific and specialty consulting as well as all aspects of engineering and construction and operations and maintenance. Our global network includes more than 200 offices in over 25 countries.

Q. What is the purpose of your joint testimony in this proceeding?

A. The New Hampshire Public Utilities Commission (Commission) on January 26, 2010, contracted Jacobs Consultancy to monitor the progress of the Public Service of New Hampshire (PSNH) Clean Air Project at its Merrimack Station coal-fired electric generating plant. PSNH was installing a wet scrubber at Merrimack Station to comply with state environmental requirements.[1]

Q. What was Jacobs' Scope of Work with respect to monitoring the Clean Air Project progress?

A. Jacobs' Scope of Work was threefold:

1) Due diligence on completed portions of the project.

   The Due Diligence Report, completed in June 2011, addressed portions of the New Hampshire Clean Air Project already completed. The report covered items such as technology selected, accuracy of estimate, cost and schedule with major deviations noted and detailed, and PSNH project controls.

2) Monitoring of the ongoing portion of the project.

   Quarterly reports coupled with site visits focused on monitoring the progress of the New Hampshire Clean Air Project. The Quarterly Reports track the progress of the Scrubber Project, noting deviations from budget and schedule, and highlighting major project accomplishments. In total, three Quarterly Reports were completed.

3) Summarization of project completion.

   The New Hampshire Clean Air Project Final Report, completed in August of 2012, summarizes project completion. This report includes knowledge gained from the previous Due Diligence and Quarterly Reports, as well an overall

[1] See RSA 125-O: 11, et seq.

assessment of the project's safety, program management, performance, costs, and ongoing power plant operation.

Q. Can you summarize the approach that Jacobs utilized in carrying out this independent review?

A. Jacobs employed a workflow process to accomplish the investigation in an efficient and concurrent approach that would uncover key issues concerning the Clean Air Project. Our team conducted its review using a process that consisted of four principal stages:

1) The project initiation stage - involved initial conference calls/meetings with the Commission and PSNH to provide us with a thorough understanding of expectations, as well as an orientation to PSNH's Clean Air Project.
2) The investigation, data gathering, and fact-finding stage - entailed a detailed review of PSNH's project management process to assess if essentials such as the appropriate project controls, systems, and processes were in place, and if PSNH properly executed its plans relative to the scrubber installation.
3) Our analysis stage - made use of both quantitative and qualitative assessment techniques. Data reviewed included documents requested and received, information gathered during interviews, and quarterly site visits.
4) The reporting stage - consisted of a report on the completed portion of the project as of June 2011, Quarterly Site Visit Reports, and a Final Report.

Q. Who assisted you in this review?

A. This independent investigation was performed under our direct supervision with the assistance of another Jacobs' employee, William Williams. A copy of his résumé is included in EXHIBIT JCI 03.

Q. How is the remainder of your testimony organized?

A. The next portion of our testimony, titled **SUMMARY OF FINDINGS**, presents an overview of our findings and conclusions with regard to the New Hampshire Clean Air Project at Merrimack Station.

The main body of our testimony, titled **SECTION DETAILS,** supports our findings and conclusions, and is organized into seven topic areas as follows:

1) **Project Initiation**
2) **Contracting Strategies**
3) **Market Cost Review**
4) **Technology**
5) **Project Estimates**
6) **Project Cost Controls**
7) **Performance**

2. SUMMARY OF FINDINGS

Q. What is your overall opinion with regard to the New Hampshire Clean Air Project at Merrimack Station?

A. The New Hampshire Clean Air Project at Merrimack Station was a well-defined and documented effort. The PSNH team conducted a thorough analysis of the technical requirements prior to initiating the project and followed its parent company's, Northeast Utilities, well-defined procedures to ensure compliance with both regulatory and business requirements. The selection process for establishing URS Corporation (URS) as Program Manager was a thorough and fruitful procedure followed by an equally thorough process for selecting equipment suppliers and contractors.

Given the size and complexity of the New Hampshire Clean Air Project at Merrimack Station, the construction approach functioned as planned. The various contractors worked well together, eventually achieving a better than average safety record. Throughout the project, PSNH exercised good oversight by properly controlling cost and schedule, as evidenced by the project being completed under budget and ahead of schedule.

The installation of the secondary wastewater treatment system was a necessary addition in order to reduce the liquids effluent to zero, resulting in nothing being discharged into the river; and reduce the solid effluent to a minimum amount that can be disposed of in licensed landfills.

Most importantly, based on early testing in 2012, there are indications that the Wet Flue Gas Desulphurization System could performed at or above the guaranteed mercury removal performance levels, and exceed the State mandated requirements.

Q. What key assessments and conclusions support your overall opinion regarding the New Hampshire Clean Air Project?

A. Our key assessments and conclusions supporting our overall opinion are as follows:

Large Project Review Process - Northeast Utilities and PSNH procurement, risk review, approval, and contracting strategy processes are well developed for projects of this size. Northeast Utilities' Large Project Review Process calls for numerous internal assessments, risk mitigation factors considerations, and approvals. PSNH determined the most appropriate contracting strategy, conducted a flue gas desulphurization installation cost comparison, and worked to understand market conditions and their impact on large construction projects.

Cost Estimates - Large projects typically go through a series of project estimate stages as they move from conceptual design through detailed engineering design and pre-construction design to construction, estimates reflect a better-defined scope of work enabling cost to be refined. PSNH's process for developing the project estimate chain follows this sequence with the initial conceptual estimate, the detailed Clean Air Project estimate, and the current estimate. The initial estimates of $250M were developed based on existing flue gas desulphurization designs and installations, and did not contain any specific mercury or sulfur dioxide guarantees, PSNH costs, or site-specific needs. The later Clean Air Project estimate of $457M was developed with the support of URS and contained a detailed estimate and actual proposal price, including mercury and sulfur dioxide guarantees, all PSNH costs, including AFUDC, as well as specific-site needs. Jacobs was able to reconcile the 2005 and 2006 conceptual estimates and the 2008 detailed Clean Air Project estimates. Since the 2008 estimate, there have been several budget reductions and additions, and as a result, it is now estimated the project will become completed for $421M,[2] approximately eight percent below budget.

Project Schedule - While the statute required a completion date of the mandated Clean Air Project in mid-2013, the detailed project schedule, published in June 2008, projected an in-service date of mid-2012. When Jacobs reviewed the schedule and verified actual construction, it was evident the completion date shown in the schedule was reasonable and attainable.

Project Management Approach - Along with providing its own internal oversight, PSNH made use of two engineering firms to help manage the project. URS was employed as Program Manager and R.W. Beck as Independent Engineer. As the Program Manager, URS performed the engineering, procurement, and construction management role; and as Independent Engineer, R.W. Beck provided an independent third-party oversight of the engineering, procurement, and construction functions. PSNH's oversight role consisted of project manager, contract management, project schedule control, and project cost control. These established safeguards for project overview and control helped to ensure that the Clean Air Project was controlled and managed effectively.

Construction Approach - The coordination of the entire site construction interfaced well. Each of the contractors for the various project islands was

[2] We are aware that a detailed audit of the costs was performed by the Commission Staff. Our project review was separate from that audit and, therefore, any dollar amounts discussed in our testimony are independent of the results of that audit.

responsible for all aspects within their scope and URS handled the Balance of Plant[3] construction coordination issues.

Safety - Safety performance was initially below what would be expected from a high quality project team. However, after the implementation of a Safety Recovery Plan, the project experienced a reduction in its recordable incident rate achieving acceptable levels of safety.

Program Manager - PSNH had a relatively small staff available to manage the project. Consequently, PSNH decided to engage URS as the Program Manager for the project. URS did a competent job in its project management role and in providing essential plant engineering services.

Project Performance - PSNH was proactive in getting the project underway as soon as possible, and through good ongoing management by PSNH and URS, the project was completed a year ahead of schedule. A key factor in this aspect of project performance was PSNH's anticipation that there might be sizeable delays, either due to weather or due to interveners,[4] resulting in establishing a more than adequate initial schedule. PSNH reduced the budget by $35M, for a final estimate of $421M, due to higher productivity and lower commodity costs, which held change orders for the project to six percent of the final project estimate. URS set up an excellent commissioning team and processes early, involving all appropriate parties, resulting in a smooth commissioning process. Units were tied-in and operational 22 months earlier than mandated and 10 months ahead of PSNH's schedule.

---

[3] Balance of Plant is the sum of all equipment for safe operation as well as the technical coordination of all concerned parts of a power plant.

[4] Interveners refer to any potential actions by outside groups that may interrupt the construction schedule.

Project Scope Changes - During the course of the Clean Air Project, nine project scope changes totaling $42.7M were encountered. These changes included a limestone truck unloading system and scales, corrosion protection of the flue gas desulphurization vessel, acoustic study changes, and improved wastewater treatment systems. The improved wastewater treatment system consisted of an enhanced wastewater treatment system and a secondary wastewater treatment system.

3. SECTION DETAILS

1. Project Initiation

Q. Please describe the internal process that Northeast Utilities and its subsidiary PSNH used during project review and approval.

A. Northeast Utilities has the policy that all procurements over $5M are subjected to their Large Procurement Process and reviewed by their Risk Management Council.[5] The Large Procurement Process[6] objectives are to conduct risk analysis, ensure prudence/due diligence, provide lowest total cost, and manage "What If" scenarios. This allows for a structured and consistent approach to contracting for projects and standardizes the signoff and approval process and reporting requirements. In addition, it also establishes the participation of the core team, risk management, and the executive risk management panel. If, as in this case, the

[5] DR JCI-023 NU Purchasing Policy Manual

[6] DR JCI-023 ERMC Large Project Process

procurement exceeds $25M, an Executive Risk Management Council review is also required. The Executive Risk Management Council,[7] along with the Risk and Capital Committee, has the responsibility for ensuring Northeast Utilities is prudently managing its principal enterprise-wide risks.

In addition, the Risk and Capital Committee will:

- Provide oversight for the development and implementation of Enterprise Risk Management and corporate Risk Management Policy.
- Provide oversight for the risk assessments prepared in accordance with the Risk Management Policy.
- Review and assess the risks associated with strategic projects and/or proposals and policy and investment decisions that expose Northeast Utilities to material financial, strategic, operational, or reputation risk.
- Review key risk topics that could materially affect the Company.
- Review the Northeast Utilities business and functional area risk and financial assessments of capital projects undertaken in accordance with the Risk and Capital Committee Project Approval Policy and Procedures and make recommendations to the Company's CEO for approval, if required.

Q. Were any external studies conducted on PSNH's behalf?

[7] DR JCI-023 Risk and Capital Committee Charter

A. Yes, PSNH contracted with R.W. Beck to conduct a Contracting Strategy Study and Power Advocate to study the market conditions associated with capital construction projects in general and retrofit scrubber projects in particular.

2. Contracting Strategies

Q. Please describe the R.W. Beck Contracting Study in greater detail.

A. PSNH has a relatively small staff and is aware that a project as large as the Clean Air Project at Merrimack Station would need a sizeable number of personnel and decided that outside project management help would be needed. PSNH retained R.W. Beck to provide contract strategy consulting engineering services associated with implementation of the project. In order to develop the contract strategy, R.W. Beck took into account:

- Realities of the current market for scrubber projects.
- Influence of the current market conditions on contracting options.

The R.W. Beck Draft Study[8] reviewed four different contracting options.

The four options considered were:

1) Turnkey EPC Contract – Fixed Price Proposal[9]
2) Turnkey EPC Contract – Fixed Price After "Open Book"[10]
3) Alliance EPC Contract – Contractor and PSNH Share the Risk[11]

---

[8] DR JCI-034 R.W. Beck Contracting Strategies Report Mercury Scrubber Project

[9] Fixed Price – means that the stated price is fixed for some portion of the work or piece(s) of equipment or materials throughout the term of the agreement, subject to adjustment based on change orders.

[10] Open Book is a method of procurement that allows each party to have access to the project cost information allowing all non-final pricing to be developed, as costs are known.

4) EPCM Contract - Contractor reimbursed for all costs plus fee[12]

R.W. Beck recommended the EPCM contract as the best approach for the Merrimack Project and PSNH chose to contract with URS to be its EPCM contractor providing full program management services.

3. Market Cost Review

Q. Please describe the Power Advocate, Inc. Study in greater detail.

A. PSNH hired Power Advocate, Inc. in 2008 to conduct a thorough review of the market conditions associated with capital construction projects and retrofit scrubber projects. This study was updated in March 2009[13]. The study, specifically sought to assist in a review of URS' cost estimate to determine its reasonability by accurately comparing the cost of this project with other wet scrubber projects through a normalization of the dollars per kilowatt cost. It also considered the project's risk mitigation strategy in conjunction with the overall cost control technique in order to develop a comprehensive project cost management assessment. The updated study took into account the considerable opportunities for PSNH to capitalize on current favorable market conditions with un-awarded project subcontracts. For example, the foundations contract was

---

[11] An Alliance Contract is a relationship between two or more parties to pursue a set of agreed upon goals, or to meet a critical business need, while remaining independent organizations.

[12] Engineering, Procurement, Construction Management is a contract where the contractor is responsible for the design, procurement, construction, and management phases of a project. Typically, the contractor is reimbursed for all costs (direct and indirect) it incurs to perform the work, plus a fee (profit).

[13] DR JCI-031 Power Advocate, Merrimack Station Clean Air Project Cost Estimate Analysis March, 2009

executed in February 2009, at $6 Million less than the URS 2008 estimate. The report evaluated the unique site-specific factors, including engineering, Balance of Plant, flue gas desulphurization, material handling considerations, and how these factors affect the overall project cost.

Q. Please describe PSNH's approach to project management.

A. Consistent with what is often done in the industry, PSNH decided to outsource the management of this large capital-intensive project. For the Merrimack Project, PSNH made use of two leading engineering firms to manage the project, with strong internal oversight. URS was selected as Program Manager, and R.W. Beck as Independent Oversight Engineer.

URS established a typical project organization for this type project. They assigned a project manager whose functions centered on managing the engineering disciplines as the project scope was developed. As the design progressed and the construction activities on the project began in earnest, the project manager's role was focused more in the field. URS assigned a construction manager, who reports to the project manager, to handle the day-to-day construction activities. Reporting to the construction manager were various superintendents who provided the intimate coordination and monitoring required for a well-run project.

R.W. Beck was selected as an independent third-party oversight of the engineering, procurement, and construction of the Clean Air Project. They were tasked with conducting monthly site visits to review the final design for general compliance with contract guarantees, the progress of design for compliance with the milestone schedule, the progress of the procurement specifications and procurement contracts and reports for general suitability regarding start-up and performance. They also consulted with project participants in advance of scheduled major inspection tests, start of important work phases, and reviewed the activities of the project to ensure that appropriate due diligence was performed, appropriate alternatives were considered, and actions taken were prudent[14]. They also prepared a monthly Independent Engineer's Report.

4. <u>Technology</u>

Q. What did the Clean Power Act require PSNH to do?

A. In 2002, the State of New Hampshire passed the New Hampshire Clean Power Act to address four pollutant emissions, sulfur dioxide (SO2), nitrogen oxide (NOx), mercury (Hg), and carbon dioxide (CO2). In 2005, Senate Bill - 128 was introduced requiring mercury emissions be reduced at the Merrimack Station plant to 24 pounds per year through a technology identified as Activated Carbon Injection. In 2006, The New Hampshire Clean Power Act was amended to require reduced mercury emissions by 80 percent using wet flue gas desulphurization technology no later than July 1, 2013.

Q. Please describe in greater detail the viability of various mercury emission approaches.

---

[14] DR JCI-035 Over-site Role of R.W. Beck

A. RSA 125-O:13, III required PSNH to conduct tests and implement as practicable mercury reduction control technologies or methods to achieve reductions, and then to report the results. Basically, there are two technologies available with potential to significantly reduce mercury emissions, activated carbon injection followed by a baghouse,[15] and wet flue gas scrubbing. PSNH performed pilot testing for the activated carbon injection approach for their units firing the specific coals that are used. The level of removal of mercury shown in these pilot tests were, as other tests in the industry have shown, below the level mandated by the New Hampshire Legislature.

When addressing sulfur emissions, there are alternatives compatible with the carbon injection process. This process involves a spray drier-type scrubber or a circulating fluidized bed-type scrubber. These alternatives are referred to as "dry" type scrubbing in that they introduce lime slurry into the flue gas stream to react with the sulfur compounds, which along with the mercury compounds, is then captured in the baghouse. While both of these dry-type scrubbing technologies would improve the sulfur removal, neither could achieve the specified mercury removal level.

Q. Was the technology required by RSA 125-O:13, III correct for the application?

A. PSNH did a thorough evaluation and was able to confirm the technology mandated by the Legislature was viable for the specified levels of mercury and sulfur

[15] Baghouse is a generic name for Air Pollution Control Equipment (APC) that is designed around the use of engineered fabric filter tubes, envelopes or cartridges in the dust capturing, separation or filtering process.

removal. In Jacobs' opinion, the technology required was correct for the application.

PSNH also initiated the practical enhancements needed to ensure success for the system. These enhancements included:

- Additional height to the absorber body to ensure adequate residence time for proper chemical reaction between scrubber fluid and mercury.
- Diameter of the absorber body was also expanded for enhanced residence time.
- Additional level of sprays in absorber body to ensure thorough contact with the flue gas, again to ensure proper chemical reactions.

Q. Was PSNH able to get a performance guarantee regarding the amount of mercury removal?

A. Yes, PSNH selected the only vendor who was willing to provide a performance guarantee. The guarantee was that a minimum of 85 percent of mercury would be removed.

5. <u>Project Estimates</u>

Q. How are major utility projects, like the Clean Air Project, estimated?

A. Typically, utilities go through a series of project estimate stages that depend on the level of information accessible and cost estimate parameters available. As projects move from conceptual design through detailed engineering design and pre-construction design to construction, estimates become better defined and refined. Cost estimates will change in response to design concept modifications, variations in scope, more detailed material cost estimates, and as build sequence modifications. Any of these changes can affect the total cost; and in some cases appreciably.

Q. Did PSNH have project estimates developed for the Clean Air Project?

A. Yes, in total there were three project estimates. In 2005, Sargent & Lundy prepared an initial conceptual project estimate of $250M for the installation of a flue gas desulfurization scrubber.[16] In 2006, Sargent & Lundy issued additional information associated with the conceptual cost estimate of $250M; and in 2008, after awarding the program management services to URS, URS developed a detailed project estimate of $457M.[17]

Q. Is it unusual that a program manager would develop the detailed estimate for a project that it would manage, especially since there were project bonuses applied to budget and schedule goals?

A. This is not unusual, but is rather the norm for this type of project. Before an accurate, detailed estimate can be prepared, there are significant amounts of preliminary engineering and equipment selection required to accurately define the project. The program manager is the one best capable to perform these functions. However, to ensure there are no questions of impropriety or conflicts of interest,

---

[16] Flue-Gas Desulphurization refers to the technology used to remove sulfur dioxide (SO_2) from the exhaust flue gases of fossil fuel power plants.
[17] DR JCI-025 Janus Report.

there must be a close oversight of the project. If the Owner has adequate, experienced staff, they can do it themselves. If, as was the case in this project, the Owner does not have the staff, an outside and competent firm must be engaged to provide this function. For the Clean Air Project at the Merrimack Station, PSNH hired R.W. Beck, an experienced and competent firm, to provide this service.

Q. Describe the conceptual project estimate developed by Sargent & Lundy.

A. The cost estimates provided by Sargent & Lundy relied on past installations of flue gas desulphurization and certain specific Merrimack Station conditions. During the conceptual pricing of a scrubber system, Sargent & Lundy and PSNH found flue gas desulfurization suppliers were open to discussions, but unwilling to provide mercury reduction guarantees and equipment pricing with associated guarantees. Based on limited available information, Sargent & Lundy issued an initial conceptual estimate of $250M for the installation of a flue gas desulphurization system at Merrimack Station.

Q. Was the original cost estimate by Sargent & Lundy a firm estimate?

A. No, Sargent & Lundy was contracted to develop an early conceptual estimate to satisfy legislative and stakeholders' discussions. Since the estimate relied on past scrubber installations for flue gas desulphurization, limited Merrimack Station conditions and no mercury reduction guarantees, it only could serve as an early conceptual estimate.

Q. Why were the costs associated with mercury reduction guarantees excluded from the Sargent & Lundy conceptual estimate?

A. At the time of the estimate, the state-of-the-art regarding mercury removal was evolving. Consequently, the estimate contained one very significant caveat, "No specific mercury guarantee was included in Sargent & Lundy's pricing since it was not available at this time from suppliers."[18]

Q. Was the estimate by URS a firm estimate?

A. Yes, this estimate was based on a detailed study, which incorporated site-specific needs, included mercury reduction and equipment guarantees, and contained project specific AFUDC.[19] It also built upon Sargent & Lundy's conceptual project cost estimate assumptions and determined that a number of enhancements were needed.

Q. Did Jacobs request, from PSNH, a detailed reconciliation between the Sargent & Lundy conceptual and URS firm estimates?

A. Yes, Jacobs requested and did receive a detailed draft reconciliation table from PSNH. A condensed version of PSNH's table was reproduced and is identified as EXHIBIT JCI 04 – Comparison of Cost Estimates for Clean Air Project, URS versus Sargent & Lundy.[20]

---

[18] DR JCI-037 Mercury Reduction.

[19] AFUDC stands for Allowance for Funds Used During Construction. AFDUC is an accounting mechanism that accounts for the net cost of construction of borrowed funds used for construction purposes and a reasonable rate on funds when so used.

[20] DR JCI-026 Comparison of Cost Estimates.

Q. Was Jacobs' review able to reconcile the difference between the Sargent & Lundy conceptual and URS firm estimates?

A. EXHIBIT JCI 04 – Comparison of Cost Estimates for Clean Air Project, URS versus Sargent & Lundy attempts to compare line item by line item the various major item descriptions. However, the comparison is complicated by the fact that a number of Sargent & Lundy line items are not broken down similar to the URS cost estimate, inhibiting a direct comparison. For example, items 1 through 7, in the URS estimate, are displayed as item 1 in the 2005 Sargent Lundy estimate. Despite our inability to make this direct comparison, we were able to reconcile the various estimates after reviewing the Item Description, the side-by-side comparison, and assessing the Discussion of the Differences.

Q. **What major factors account for the difference between the 2005 and 2006 Sargent & Lundy[21] cost estimates and the 2008 URS cost estimate?**

A. The major factors that account for the difference between the Sargent & Lundy cost estimate and the URS cost estimate can be grouped into three categories: 1.) progression from the initial conceptual estimate to detailed design estimate, 2.) site-specific factors, and 3.) economic and commodity volatility.

Q. Please elaborate for each category why there is a difference between the cost estimates.

[21] DR JCI-009 Sargent & Lundy Wet FGD Retrofit Conceptual Cost Estimate_

A. 1.) Progression from the initial conceptual estimate to detailed design estimate – as previously explained, project estimates go through stages that depend on the level of information accessible and cost estimate parameters available. In this instance, firm price contracts with vendor guarantees replaced initial estimated pricing and with the majority of project design completed, preliminary engineering estimates were replaced. Detailed design necessitated certain enhancements including:

- Separate ducts for MK-1 and MK-2 generating units involved almost 2,000 tons of steel, as compared to a single duct requiring 365 tons of steel. This enhancement provided for increased operating flexibility by allowing either generating unit to safely operate independent of each of the other.
- Nearly doubled the size of the gypsum storage building to 26,600 square feet from 14,000 square feet; conforming to the Town of Bow requirement that all handling of the gypsum had to be indoors.
- A larger absorber tank was needed in order to assure sufficient mercury removal, adding a substantial amount of exotic metal to the tank's construction.
- Additional scrubber spray level was added to the scrubber in order to help assure sufficient mercury removal.

2.) Site-specific factors – Sargent & Lundy completed their analysis based on like-project experience, consequently their conceptual cost estimates needed to be reassessed by URS to embody site-specific factors. Site-specific factors include:

- Scrubber must guarantee approximately 84 percent mercury reduction as primary design criteria.
- Two power generation units with pressurized cyclone design furnaces of differing sizes must be connected to the one scrubber system.
- The Merrimack Station site is congested, requiring relocation of various equipment, and created a more difficult and expensive work environment.
- Harsh and moist winters common in the Northeast needed to be factored in. Examples of site-specific, weather-related enhancements include:
    - Railroad car unloader became a rotary dump as compared to a bottom dump to ensure unloading capabilities during moisture-related freeze ups.
    - Basis for silo discharge was rotary plow dischargers as compared to a basic hopper arrangement due to winter conditions.
    - Totally enclosed conveyor galleries as compared to a hooded conveyor system for proper moisture management.
    - Included a limestone emergency silo fill-bucket elevator and receiving hopper to ensure unloading capabilities during moisture-related freeze ups.

3.) Economic and commodity volatility – in the time period between the Sargent & Lundy cost estimate and the URS cost estimate, significant commodity price escalation was being experienced both nationally and in the world economy.

Jacobs Engineering Estimating Group estimated that during this time period, prices for certain materials and commodities escalated between 45 and 60 percent[22].

Q. Was Jacobs able to justify the cost differences between the various project estimates?

A. Looking at the major cost categories and the reason for their change, including items such as Owners' cost, contingency, AFUDC, cost escalation, and items[23] that were excluded from the original preliminary estimates, we conclude that the differences between the various estimates are justifiable.

6. <u>Project Cost Controls</u>

Q. Please describe PSNH's cost control process.

A. Project costs are reported and controlled at various levels against the project Code of Accounts.[24] A Clean Air Project resource analyst maintained the Project Cost Summary and the project manager reviewed the actual costs, comparing them to the projected costs and revised future cost projections as necessary.

---

[22] Based on various alloy commodity price indices fluctuations, which occurred between 2005 and 2008.

[23] DR JCI-010 NU Scrubber Cost

[24] A code of accounts is an essential tool in the management of any project as it allows the ability to easily distinguish multiple components of a project without need to remember lengthy names or terminologies.

Contract management was accomplished using change notices and change orders, and processed, as outlined in Section 10.6 of the URS Project Execution Plan and Attachment K of the PXP, PEP-314 Change Control.[25]

Change Orders must be approved by PSNH and URS management and were processed in accordance with Article 6 of the Contract.

Q. What was the dollar amount of change orders and was this unusual for a project of this size?

A. There were 777 change orders totaling $27.6M, which is 6 percent of the original budget. The change order amount is within the acceptable industry range of 5 to 7 percent[26].

Q. Please describe any project scope changes.

A. During the course of the Clean Air Project, nine project scope changes were added resulting in a net increase of $42.7M to the cost of the project[27]. Referring to EXHIBIT JCI 05 - Clean Air Project Scope Changes, eight of the project scope changes were increased while one was a decreased. Scope change increases included a limestone truck unloader and scales, corrosion protection of the flue gas desulphurization vessel, acoustic study changes, enhanced mercury and arsenic system, an enhanced wastewater treatment system, a soda ash softening process and the relocation of the service water pump house. The majority of the scope changes, both in number and cost, for the Clean Air Project

[25] DR JCI-001 Project Execution Plan Part II.
[26] Benchmark is based on industry experience.
[27] DR JCI-046 Scope changes to final budget plan 06/18/08

were a result of either, permitting, cost saving or technical issues found after the initial engineering was completed.

Q. Can you describe each of these project scope increases in greater detail?

A. **Items 1 and 2 Limestone Truck Unloading and Scales** - PSNH determined that, due to physical site limitations, it was more effective to retrofit the existing unloading system than to build a new one for limestone unloading. To ensure it would have flexibility in the delivery of limestone and obtain cost competiveness, PSNH decided to build a limestone truck unloading system. Truck scales were installed at the same time to reduce third-party charges for weighing trucks.

Item 3 Corrosion Protection of the Flue Gas Desulphurization Vessel - At the time of the scrubber design, the industry accepted type 2205 Stainless Steel as a suitable and cost effective material to use on the absorber vessel. Near the end of construction, PSNH learned from the power industries experience that type 2205 Stainless Steel was experiencing unexpected corrosion in similar installations and contracted with Sargent & Lundy to evaluate and recommend actions to minimize corrosion in the absorber vessel. Sargent & Lundy[28] recommended installation of a Potential Adjustment Protection System[29] to protect against corrosion of degraded weld heat affected zones and design inherent crevices. The Sargent & Lundy study also identified other construction deficiencies and recommended correcting them to the extent achievable to minimize the corrosion possibilities. PSNH did not perform studies to predict lifespan with the corrosion, but was able

[28] DR JCI-039 WFGD Reaction Tank Evaluation
[29] Potential Adjustment Protection systems upgrade the corrosion resistance of passive metals making their corrosion resistance comparable to higher-grade alloys.

to learn from the experience of others. Similar installations were experiencing significant corrosion in less than one year. Therefore, such predictive studies would have been of minimal value. The more telling aspect was the rapid deterioration observed in some very similar absorber vessel units with the same metallurgy as the Merrimack Station unit. In addition, the project was the stage where action had to be taken as soon as possible to prevent the corrosion observed at similar installations from manifesting itself at Merrimack Station. Consequently, PSNH heeded the advice of the Sargent & Lundy Study.

The cost of the actions taken to minimize the potential corrosion was relatively small for the assurance that the installation would be reliable and able to operate well into the future. The New Hampshire Clean Air Project, when conceived, contracted, and constructed, was envisioned to operate for many decades into the future, so in Jacobs' opinion, the decision to install the Corrosion Protection System was a prudent one.

Item 4 Acoustic Changes - Throughout the Clean Air Project, PSNH worked with the Town of Bow to obtain the necessary permits and waivers needed for construction activities. Acoustic changes were made to accommodate activities during the construction and as a result from testing of equipment. In addition, several scope changes were made to accommodate changes required by the Town of Bow. These changes included the Gypsum Building Expansion, Booster Fan Enclosure, and Service Water Pump House Relocation.

Item 5 Enhanced Wastewater Treatment System - In order to meet the New Hampshire Department of Environmental Services imposed emission limits on water discharge, PSNH installed an enhanced wastewater treatment system for $3.5M. This system provides for polishing treatment of mercury and arsenic downstream of the primary wastewater treatment system.

Item 6 Secondary Wastewater Treatment System - This system is designed to receive the effluent from the enhanced wastewater treatment system and to reduce it further. Phase 1 of the secondary wastewater treatment system reduces the volume of water to 0-5 gpm through concentration and crystallization and the effluent can be recycled into the process. In Phase 2, which involves an additional crystallizer step and dewatering, the liquid effluent is reduced to zero, resulting in no liquids being discharged into the river. The output of the secondary wastewater system also reduces the solid effluent to an amount that can be disposed of in a licensed landfill.

Item 7 Soda Ash Softening Process - Due to the hardness of the water, the Soda Softening Process was required to minimize metal plating during the evaporation process, enabling a proper functioning secondary wastewater treatment system.

Item 8 Service Water Pump House Relocation - Relocation to the north bank of the station's treatment pond allowed for the use of recycled water in the scrubber, avoided potential permitting delays, minimized impact on the project's electrical substation construction and improved operational access.

Q. Can you describe the project scope decrease in greater detail?

A. **Item 1 New Rail Unloading Facility for Limestone** - The New Rail Unloading Facility for Limestone was included in the URS estimate, but eventually it was recognized that it would be more efficient and just as effective to modify the existing Railcar Unloading System.

Q. Were there any overall project cost reductions to offset the costs associated with the project scope changes?

A. Although the $47.2M in net scope change additions increased the total project cost, the project was able to remain within budget due to savings in other areas achieved during the course of the project. Savings resulted from lower than anticipated subcontractor bids, lower commodity costs due to the changing economic cycle, and higher productivity.

Q. Why did PSNH feel that the single largest change in scope item, the secondary wastewater treatment system, was needed?

A. Based on the Environmental Protection Agency's position, that discharge from the secondary wastewater treatment system could only be accommodated by adding it to the plant's National Pollutant Discharge Elimination System (aka NPDES) permit, and the NPDES Permit Process has been in revision for 14 years, PSNH felt that approval[30] would be an extremely long process, possibly taking many years. A delay of this magnitude could also delay the start-up of the scrubber and keep the Merrimack Station from operating.

[30] DR JCI-042 Risks in Obtaining the Remaining Operation Permit – Wet Flue Gas Desulfurization (WFGD) Discharge.

Consequently, to avoid further potential litigation and possibly years of delay in placing the unit into operation, PSNH elected to install the secondary wastewater treatment system. As previously mentioned, the output of this secondary system reduces the liquids effluent to zero, resulting in nothing being discharged into the river and reduces the solid effluent to a minimum that can be disposed of in existing licensed landfills.

The original construction plans had the treated water from the wastewater treatment system discharging into the river. PSNH had to reconfigure the system due to permit and litigation issues during the early part of the system construction. This redesign eliminated the need for the discharge portion to the river. All discharge from the original engineering designs now enters the secondary system. The wastewater treatment system, that now includes the primary and secondary wastewater treatment, works together to have true zero liquid discharge in conjunction with the wet scrubber.[31]

Q. What are the benefits associated with the installed wastewater system?

A. While the installation of the secondary wastewater system represents a significant cost of $36.4M[32], it is in line with costs for similar installations that have been and are being installed on other power plant flue gas desulphurization systems. By choosing to add the secondary treatment system, PSNH sought to avoid potential litigation delays that probably would have accompanied a public involvement in the revision of the plant NPDES permit, potentially rendering the

[31] Jacobs WWT Inquiry 821.

[32] Includes the secondary waste water treatment $32.6M plus the soda ash softening process $3.8M.

Merrimack Station output unusable. The new enhanced wastewater treatment system and secondary wastewater systems are providing immediate benefits of eliminating the discharge of metals, especially mercury and arsenic, into the Merrimack river.

This is a path being taken by a number of utilities in the U.S. to avoid potentially costly delays. These systems provide the ultimate cleanup of the scrubber effluent and in zero heavy metals being discharged into the country's waterways. Based on PSNH's corporate environmental and legal opinions, and faced with the real possibility of not being able to place the Scrubber Project into service at completion, PSNH chose to add the secondary treatment system. Based on the operational intentions for the Merrimack Station that existed when the decision was made to add this last system to ensure on-time start-up, PSNH felt that is was a prudent decision. The secondary wastewater system was the only method available to avoid an effluent discharge and therefore, without it, likely to further delay the long sought after NPDES permit. Consequently, PSHN decided to proceed with the installation of this system. Considering the cost of the secondary wastewater system, which is in line with similar installations, and the fact that this system would allow the Merrimack Station to meet the Legislative mandate for mercury removal, it is Jacobs' opinion that the decision to install the secondary wastewater system was a prudent one.

7. <u>Performance</u>

Q. In your opinion, how well did PSNH Clean Air Project teams perform?

A. Given the size and complexity of the New Hampshire Clean Air Project at the Merrimack Station, the construction approach functioned as planned. The various contractors worked well together and produced a project that was on schedule and within budget. The project safety performance initially was above (worse than) the national average and, after the development of a Safety Recovery Plan, the project experienced a reduction in its recordable incident rate. URS performed the project management role adequately developing a Commissioning Plan that led to unit tie-in with minimal problems.

Q. Is the system performing as guaranteed and within compliance?

A. The system, based on early testing in 2012, indicates that the Wet Flue Gas Desulphurization System could perform at or above the guaranteed mercury removal performance levels and exceed the State mandated requirements. The preliminary test results from an independent lab indicated a 96-98 percent removal of both sulfur and mercury. However, it will only be after more thorough testing, evaluation, and plant operations that the technology will be proven consistently effective.

Q. Was the system installed economically?

A. During our October 2010 Due Diligence Review, it was stated that the project estimate was revised from $457M to $430M. The reduction was due to higher productivity than estimated in subcontractor bids, lower than anticipated commodity costs, and favorable weather conditions during the major construction period in 2008 through 2010. Several contract additions were made to cover secondary water treatment, cathodic protection, and enhanced treatment for the primary water treatment without changing the final estimate of $430M.[33] In October 2011, PSNH further reduced reserves by $8M and revised the project estimate to $422M. As of January 31, 2013, the final estimate for the project was $421M. This final estimate included all additional systems, work, and studies identified after the project started.

Q. Does this conclude your testimony?

A. Yes.

[33] DR 040 CAP Cost Summary January-April 2011.