Exhibit A

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

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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

24 Jacobs Consultancy, my consulting experience includes employment with Stone
25 & Webster Consultants as Associate Director. My direct utility operating
26 experience has been gained from being employed as an officer, manager or
27 engineer for Public Service Electric & Gas Company and Mountaineer Gas
28 Company. My expertise includes general and operations management,
29 distribution engineering, business development, customer service, process
30 engineering, project management, strategic planning, and regulatory compliance.
31 As a management consultant in the energy industry, I have had numerous
32 assignments where a utility's approach to project management on large
33 construction projects was assessed.
34 Recent electric and gas industry project management-related assignments include:
35 • Spectra Energy - Performed a Cr itical Assessment Study of Project
36 Execution for the New Jersey -New York Pipeline Expansion Project
37 (2011).
38 • Public Service Electric and Gas Company - In connection with the State
39 of New Jersey, Board of Public Utilities Mandated Management Audit
40 (2010 - 2011).
41 • Fitchburg Gas and Light Company d/b/a Unitil - In connection with the
42 Massachusetts Department of Public Utilities Mandated Management
43 Audit (2010 - 2011).
44 • Puget Sound Energy - In connection with the Washington Utilities and
45 Transportation Commission Review of Mandated Gas Safety Activities
46 (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 includ es 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).

69 I have also assisted others in the preparation of testimony. While both at
70 Mountaineer Gas and PSEG, I helped prepare testimony in the following areas:
71 specific capital initiatives or projects to be included in rate base, operations, and
72 maintenance programs to be recovered as expense, rate case preparation, and
73 documentation, and appliance service costs.
74 I am a graduate of New Jersey Institute of Technology with a degree in
75 Mechanical Engineering, and Fairleigh Dickinson University with a Master's in
76 Business Administration.
77 A copy of my résumé, which includes a list of electric and gas utility clients and
78 commission requested assessments, is attached to this testimony as EXHIBIT JCI
79 01.
80
81 **Q. Mr. Dalton, what is your background and qualifications for your testimony**
82 **in this proceeding?**
83 A. I am a Mechanical Engineer who has spent most of my career designing power
84 plants. I have had extensive experience in utility, industrial, waste-to-energy, and
85 institutional plants. Assignments vary in levels of involvement and run from
86 conceptual studies through detailed design, commissioning, and start-up. Some
87 projects are for only one phase, but a vast majority of the projects with which I
88 have been involved have included the full scope, from concept to start-up, and in
89 many cases, beyond. I am presently engaged in engineering studies for several
90 pulp and paper mill power plants, some of which I have been performing
91 engineering work in for nearly 40 years. My experience includes engineering the

92 plants from fuel receipt through discharge of solid, liquid, and gaseous streams ,
93 with particular emphasis on air pollution control systems. Every power plant has
94 some type, or types, of environmental aspects, the control of which may
95 encompass many technologies. I have studied and designed essentially every type
96 of pollution control , including mechanical separation, electrostatic precipitation,
97 wet and dry scrubbing, and fabric filtration.
98 Recent power plant assignments include:
99 • NewPage Corporation – Biron, WI/Duluth, MN/Escanaba, MI/Luke,
100 MD/Rumford, ME/Wisconsin Rapids, WI/Wicklif fe, KY - Prepared
101 studies and estimates to determine the alternatives available for
102 decreasing emissions to allow compliance with upcoming federal
103 regulations. Studies covered 15 boilers that burn a wide variety of fuels,
104 including coal, biomass, oil, gas , tire derived fuel, industrial sludge, and
105 off-gasses from pulping operations (2011-2012).
106 • Covanta – Worked on design of a waste -to-energy plant in Dublin,
107 Ireland. This plant, located on the River Liffey in downtown Dublin, will
108 burn municipal garbage f rom the greater Dublin area to divert it from
109 landfills and produce power as a by-product (2009-2010).
110 • Rayonier – Jesup, GA:
111 o Prepared a study and estimate, followed by implementation of
112 modifications to combustion and pollution control systems on two
113 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:

159 o Prepared a study and estimate for the installation of a biomass
160 steam generator at the Amherst campus. Various type s of
161 combustion systems were considered; including grate fired and
162 fluidized bed boilers and gasification technology (2009-2010).
163 o Prepared a design -build specification for the installation of a
164 biomass steam generator at the Amherst campus. The
165 specification was structured so that the bidders c ould propose
166 alternative technologies for the steam generator.
167 A copy of my résumé, which includes a list of clients, is attached to this testimony
168 as EXHIBIT JCI 02.
169
170 **Q. Please describe the activities of Jacobs Engineering and Jacobs Consultancy.**
171 A. Jacobs Engineering Group Inc. is one of the world 's largest and most diverse
172 providers of professional technical services with more than 70,000 employees
173 worldwide. Jacobs offers a full-spectrum support to industrial, commercial, and
174 government clients across mul tiple markets and geographies . Services include
175 scientific and specialty consulting as well as all aspects of engineering and
176 construction and operations and maintenance. Our global network includes more
177 than 200 offices in over 25 countries.
178
179 **Q. What is the purpose of your joint testimony in this proceeding?**
180 A. The New Hampshire Public Utilities Commission (Commission) on January 26,
181 2010, contracted Jacobs Consultancy to monitor the progress of the Public Service

182 of New Hampshire (PSNH) Clean Air Project at its Merrimack Station coal-fired
183 electric generating plant . PSNH was installing a wet scrubber at Merrimack
184 Station to comply with state environmental requirements.[1]
185
186 **Q. What was Jacobs' Scope of Work with respect to monitoring the Clean Air**
187 **Project progress?**
188 A. Jacobs' Scope of Work was threefold:
189 1) Due diligence on completed portions of the project.
190 The Due Diligence Report, completed in June 2011, addressed portions of the
191 New Hampshire Clean Air Project already completed. The report covered
192 items such as technology selected, accuracy of estimate, cost and schedule
193 with major deviations noted and detailed, and PSNH project controls.
194 2) Monitoring of the ongoing portion of the project.
195 Quarterly reports coupled with site visits focused on monitoring the progress
196 of the New Hampshire Clean Air Project. The Quarterly Reports track the
197 progress of the Scrubber Project, noting deviations from budget and schedule ,
198 and highlighting major project accomplishments. In total, three Quarterly
199 Reports were completed.
200 3) Summarization of project completion.
201 The New Hampshire Clean Air Project Final Report, completed in August of
202 2012, summarizes project completion. This report includes knowledge gained
203 from the previous Due Diligence and Quarterly Reports, as well an overall

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

204 assessment of the project's safety, program management, performance, costs ,
205 and ongoing power plant operation.
206
207 **Q. Can you summarize the approach that Jacobs utilized in carrying out this**
208 **independent review?**
209 A. Jacobs employed a workflow process to accomplish the investigation in an
210 efficient and concurrent approach that would un cover key issues concerning the
211 Clean Air Project. Our team conducted its review using a process that consisted
212 of four principal stages:
213 1) The project initiation stage - involved initial conference calls/meetings with
214 the Commission and PSNH to provide us with a thorough understanding of
215 expectations, as well as an orientation to PSNH's Clean Air Project.
216 2) The investigation, data gathering , and fact-finding stage - entailed a detailed
217 review of PSNH's project management process to assess if essentials such as
218 the appropriate project controls, systems, and processes were in place, and if
219 PSNH properly executed its plans relative to the scrubber installation.
220 3) Our analysis stage - made use of both quantitative and qualitative assessment
221 techniques. Data revi ewed included documents requested and received ,
222 information gathered during interviews, and quarterly site visits.
223 4) The reporting stage - consisted of a report on the completed portion of the
224 project as of June 2011, Quarterly Site Visit Reports, and a Final Report.
225
226 **Q. Who assisted you in this review?**

227 A. This independent investigation was performed under our direct supervision with
228 the assistance of another Jacobs' employee , William Williams . A copy of his
229 résumé is included in EXHIBIT JCI 03.
230
231 **Q. How is the remainder of your testimony organized?**
232 A. The next portion of our testimony, titled **SUMMARY OF FINDINGS**, presents
233 an overview of our findings and conclusions with regard to the New Hampshire
234 Clean Air Project at Merrimack Station.
235 The main body of our testimony, titled **SECTION DETAILS ,** supports our
236 findings and conclusions, and is organized into seven topic areas as follows:
237 **1) Project Initiation**
238 **2) Contracting Strategies**
239 **3) Market Cost Review**
240 **4) Technology**
241 **5) Project Estimates**
242 **6) Project Cost Controls**
243 **7) Performance**
244
245 **2. <u>SUMMARY OF FINDINGS</u>**
246
247 **Q. What is your overall opinion with regard to the New Hampshire Clean Air**
248 **Project at Merrimack Station?**

249 A. The New Hampshire Clean Air Project at Merrimack Station was a well -defined
250 and documented effort. The PSNH team conducted a thorough analysis of the
251 technical requirements prior to initiating the project and followed its parent
252 company's, Northeast Utili ties, well -defined procedures to ensure compliance
253 with both regulatory and business requirements. The selection process for
254 establishing URS Corporation (URS) as Program Manager was a thorough and
255 fruitful procedure followed by an equally thorough proces s for selecting
256 equipment suppliers and contractors.
257 Given the size and complexity of the New Hampshire Clean Air Project at
258 Merrimack Station, the construction approach functioned as planned. The various
259 contractors worked well together, eventually ach ieving a better than average
260 safety record. Throughout the project, PSNH exercised good oversight by
261 properly controlling cost and schedule, as evidenced by the project being
262 completed under budget and ahead of schedule.
263 The installation of the secondary w astewater treatment system was a necessary
264 addition in order to reduce the liquids effluent to zero, resulting in nothing being
265 discharged into the river; and reduce the solid effluent to a minimum amount that
266 can be disposed of in licensed landfills.
267 Most importantly, based on early testing in 2012, there are indications that the
268 Wet Flue Gas Desulphurization System could performed at or above the
269 guaranteed mercury removal performance levels, and exceed the S tate mandated
270 requirements.
271

272 **Q. What key assessments and conclusions support your overall opinion**
273 **regarding the New Hampshire Clean Air Project?**
274 A. Our key assessments and conclusions supporting our overall opinion are as
275 follows:
276 **Large Project Review Process** - Northeast Utilities and PSNH procurement, risk
277 review, approval, and contracting strategy processes are well developed for
278 projects of this size. Northeast Utilities' Large Project Review Process calls for
279 numerous internal assessments, risk mitigation factors considerations , and
280 approvals. PSNH determined the most appropriate contracting strategy,
281 conducted a flue gas desulphurization installation cost comparison, and worked to
282 understand market conditions and their impact on large construction projects.
283 **Cost Estimates** - Large projects typically go through a series of project estimate
284 stages as they move from conceptual design through detailed engineering design
285 and pre -construction design to construction, estimates reflect a better-defined
286 scope of work enabling cost to be refined. PSNH's process for developing the
287 project estimate chain follows this sequence with the initial conceptual estimate,
288 the detailed Clean Air Project estimate, and the current estimate. The initial
289 estimates of $250M were developed based on existin g flue gas desulphurization
290 designs and installations, and did not contain any specific mercury or sulfur
291 dioxide guarantees, PSNH costs, or site -specific needs. The later Clean Air
292 Project estimate of $457M was developed with the support of URS and contained
293 a detailed estimate and actual proposal price, including mercury and sulfur
294 dioxide guarantees, all PSNH costs , including AFUDC, as well as specific -site

295 needs. Jacobs was able to reconcile the 2005 and 2006 conceptual estimates and
296 the 2008 detailed Clean Air Project estimates. Since the 2008 estimate, there
297 have been several budget reductions and additions, and as a result, it is now
298 estimated the project will become completed for $421M,[2] approximately eight
299 percent below budget.
300 **Project Schedule** - While the statute required a completion date of the mandated
301 Clean Air Project in mid-2013, the detailed project schedule, published in June
302 2008, projected an in-service date of mid-2012. When Jacobs reviewed the
303 schedule and verified actual construction, it was evident the completion date
304 shown in the schedule was reasonable and attainable.
305 **Project Management Approach** - Along with providing its own internal
306 oversight, PSNH made use of two engineering firms to help manage the project.
307 URS was employed as Program Manager and R.W. Beck as Independent
308 Engineer. As the Program Manager, URS performed the engineering,
309 procurement, and construction management role; and as Independent Engineer,
310 R.W. Beck provided an independent third-party over sight of the engineering,
311 procurement, and construction functions. PSNH's oversight role consisted of
312 project manager, contract management, project schedule control, and project cost
313 control. These established safeguards for project overview and control helped to
314 ensure that the Clean Air Project was controlled and managed effectively.
315 **Construction Approach** - The coordination of the entire site construction
316 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.

317 responsible for all as pects within their scope and URS handled the Balance of
318 Plant[3] construction coordination issues.
319 **Safety -** Safety performance was initially below what would be expected from a
320 high quality project team. However, after the implementation of a Safety
321 Recovery Plan, the project experienced a reduction in its recordable incident rate
322 achieving acceptable levels of safety.
323 **Program Manager -** PSNH had a relatively small staff available to manage the
324 project. Consequently, PSNH decided to engage URS as the Program Manager
325 for the project. URS did a competent job in its project management role and in
326 providing essential plant engineering services.
327 **Project Performance -** PSNH was proactive in getting the project underway as
328 soon as possible, and through good ongoing management by PSNH and URS, the
329 project was completed a year ahead of schedule. A key factor in this aspect of
330 project performance was PSNH's anticipation that there might be sizeable delays,
331 either due to weather or due to interveners,[4] resulting in establishing a more than
332 adequate initial schedule. PSNH reduced the budget by $35M, for a final estimate
333 of $42 1M, due to higher productivity and lower commodity costs, which held
334 change orders for the project to six perc ent of the final project estimate. URS set
335 up an excellent commissioning team and process es early, involving all
336 appropriate parties, resulting in a smooth commissioning process. Units were tied-
337 in and operational 22 months earlier than mandated and 10 mon ths ahead of
338 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.

339 **Project Scope Changes -** During the course of the Clean Air Project, nine project
340 scope changes totaling $42.7M were encountered. These changes included a
341 limestone truck unloading system and scales, corrosion protection of the flue gas
342 desulphurization vessel, acoustic study changes, and improved wastewater
343 treatment systems. The improved wastewater treatment system consisted of
344 an enhanced w astewater treatment system and a secondary wastewater
345 treatment system.
346
347 **3. SECTION DETAILS**
348
349 **1. Project Initiation**
350
351 **Q. Please describe the internal process that Northeast Utilities and its subsidiary**
352 **PSNH used during project review and approval.**
353 A. Northeast Utilities has the policy that all procurements over $5M are subjected to
354 their Large Procurement Process and reviewed by their Risk Management
355 Council.[5] The Large Procurement Process[6] objectives are to conduct risk analysis,
356 ensure prudence/due diligence, provide lowest total cost , and manage "What If"
357 scenarios. This allows for a structured and consistent approach to contracting for
358 projects and standardizes the signoff and approval process and reporting
359 requirements. In addition, it also establishes the participation of the core t eam,
360 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

361 procurement exceeds $25M, an Executive Risk Management Council review is
362 also required. The Executive Risk Management Council,[7] along with the Risk and
363 Capital Committe e, has the responsibility for ensuring Northeast Utilities is
364 prudently managing its principal enterprise-wide risks.
365 In addition, the Risk and Capital Committee will:
366 • Provide oversight for the development and implementation of Enterprise
367 Risk Management and corporate Risk Management Policy.
368 • Provide oversight for the risk assessments prepared in accordance with
369 the Risk Management Policy.
370 • Review and assess the risks associated with strategic projects and/or
371 proposals and policy and investment decisions tha t expose Northeast
372 Utilities to material financial, strategic, operational, or reputation risk.
373 • Review key risk topics that could materially affect the Company.
374 • Review the Northeast Utilities business and functional area risk and
375 financial assessments of capital projects undertaken in accordance with
376 the Risk and Capital Committee Project Approval Policy and Procedures
377 and make recommendations to the Company's CEO for approval, if
378 required.
379
380 **Q. Were any external studies conducted on PSNH's behalf?**

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

381 A. Yes, PSNH contracted with R.W. Beck to conduct a Contracting Strategy Study
382 and Power Advocate to study the market conditions associated with capital
383 construction projects in general and retrofit scrubber projects in particular.
384
385 **2. <u>Contracting Strategies</u>**
386
387 **Q. Please describe the R.W. Beck Contracting Study in greater detail.**
388 A. PSNH has a relatively small staff and is aware that a project as large as the Clean
389 Air Project at Merrimack Station would need a sizeable number of personnel and
390 decided that outside project management help would be needed. PSNH retained
391 R.W. Beck to provide contract strategy consulting engineering services associated
392 with implementation of the project. In order to develop the contract strategy, R.W.
393 Beck took into account:
394 • Realities of the current market for scrubber projects.
395 • Influence of the current market conditions on contracting options.
396 The R.W. Beck Draft Study[8] reviewed four different contracting options.
397 The four options considered were:
398 1) Turnkey EPC Contract – Fixed Price Proposal[9]
399 2) Turnkey EPC Contract – Fixed Price After "Open Book"[10]
400 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.

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

402 R.W. B eck recommended the EPCM contract as the best approach for the

403 Merrimack Project and PSNH chose to contract with URS to be its EPCM

404 contractor providing full program management services.

405

406 **3. <u>Market Cost Review</u>**

407

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

409 A. PSNH hired Power Advocate, Inc. in 2008 to conduct a thorough review

410 of the market conditions associated with capital construction projects and retrofit

411 scrubber projects. This study was updated in March 2009[13]. The study,

412 specifically sought to assist in a review of URS' cost estimate to determine its

413 reasonability by accurately comparing the cost of this project with other wet

414 scrubber projects through a normalization of the dollars per kilowatt cost. It also

415 considered the project's risk mitigation strategy in conjunction with the overall

416 cost control technique in order to develop a comprehensive project cost

417 management assessment. The updated study took into account the considerable

418 opportunities for PSNH to capitalize on current favorable market conditions with

419 un-awarded project subcontracts. For example, the foundations contract was

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[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

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

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

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

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

439 R.W. Beck was selected as an independent third -party oversight of the
440 engineering, procurement, and construction of the Clean Air Project. They were
441 tasked with conducting monthly site visits to review the final design for general
442 compliance with contract guarantees, the progress of design for compliance with

443 the milestone s chedule, the progress of the procurement specifications and
444 procurement contracts and reports for general suitability regarding start -up and
445 performance. They also consulted with project participants in advance of
446 scheduled major inspection tests, start of important work phases, and reviewed the
447 activities of the project to ensure that appropriate due diligence was performed,
448 appropriate alternatives were considered, and actions taken were prudent[14]. They
449 also prepared a monthly Independent Engineer's Report.
450
451 **4. <u>Technology</u>**
452
453 **Q. What did the Clean Power Act require PSNH to do?**
454 A. In 2002, the State of New Hampshire passed the New Hampshire Clean Power
455 Act to address four pollutant emissions, sulfur dioxide (SO2), nitrogen oxide
456 (NOx), mercury (Hg), and carb on dioxide (CO2). In 2005, Senate Bill - 128 was
457 introduced requiring mercury emissions be reduced at the Merrimack Station
458 plant to 24 pounds per year through a technology identified as Activated Carbon
459 Injection. In 2006, The New Hampshire Clean Power Act was amended to require
460 reduced mercury emissions by 80 percent using wet flue gas desulphurization
461 technology no later than July 1, 2013.
462
463 **Q. Please describe in greater detail the viability of various mercury emission**
464 **approaches.**

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

465 A. RSA 125-O:13, III required PSNH to conduct tests and implement as practicable
466 mercury reduction control technologies or methods to achieve reductions, and
467 then to report the results. Basically, there are two technologies available with
468 potential to significantly reduce mercury emissions, activated carbon injection
469 followed by a baghouse,[15] and wet flue gas scrubbing. PSNH performed pilot
470 testing for the activated carbon injection approach for their units firing the
471 specific coals that are used. The level of removal of mercury shown in these pilot
472 tests were, as other tests in the industry have shown, below the level mandated by
473 the New Hampshire Legislature.
474 When addressing sulfur emissions, there are alternatives compatible with the
475 carbon injection process. This process involves a spray drier-type scrubber or a
476 circulating fluidized bed-type scrubber. These alternatives are referred to as "dry"
477 type scrubbing in that they introduce lime slurry into the flue gas stream to react
478 with the sulfur compounds, which along with the mercury compounds, is then
479 captured in the baghouse. While both of these dry-type scrubbing technologies
480 would improve the sulfur removal, neither could achieve the specified mercury
481 removal level.
482
483 **Q. Was the technology required by RSA 125-O:13, III correct for the**
484 **application?**
485 A. PSNH did a thorough evaluation and was able to confirm the technology mandated
486 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 reside nce 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

510 pre-construction design to construction, estimates become better defined and
511 refined. Cost estimates will change in response to design concept modifications,
512 variations in scope, more detailed material cost estimates, and as build sequence
513 modifications. Any of these changes can affect the total cost; and in some cases
514 appreciably.
515
516 **Q. Did PSNH have project estimates developed for the Clean Air Project?**
517 A. Yes, in total there were three project estimates. In 2005, Sargent & Lundy
518 prepared an initial conceptual project estimate of $250 M for the installation of a
519 flue gas desulfurization scrubber.[16] In 2006, Sargent & Lundy issued additional
520 information associated with the conceptual cost estimate of $250 M; and in 2008,
521 after awarding the program management services to URS, URS developed a
522 detailed project estimate of $457M.[17]
523
524 **Q. Is it unusual that a program manager would develop the detailed estimate for**
525 **a project that it would manage, especially since there were project bonuses**
526 **applied to budget and schedule goals?**
527 A. This is not unusual, but is rather the norm for this type of project. Before an
528 accurate, detailed estimate can be prepared, there are significant amounts of
529 preliminary engineering and equipment selection required to accurately define the
530 project. The program manager is the one best capable to perform these functions.
531 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.

532 there must be a close oversight of the project. If the Owner has adequate,
533 experienced staff, they can do it themselves. If, as was the case in this project, the
534 Owner does not have the staff, an outside and competent firm must be engaged to
535 provide this function. For the Clean Air Project at the Merrimack Station, PSNH
536 hired R.W. Beck, an experienced and competent firm, to provide this service.
537
538 **Q. Describe the conceptual project estimate developed by Sargent & Lundy.**
539 A. The cost estimate s provided by Sargent & Lundy relied on past installations of
540 flue gas desulphurization and certain specific Merrimack Station conditions.
541 During the conceptual pricing of a scrubber system, Sargent & Lundy and PSNH
542 found flue gas desulfurization suppliers were open to discussions, but unwilling to
543 provide mercury reduction guarantees and eq uipment pricing with associated
544 guarantees. Based on limited available information, Sargent & Lundy i ssued an
545 initial conceptual estimate of $250M for the installation of a flue gas
546 desulphurization system at Merrimack Station.
547
548 **Q. Was the original cost estimate by Sargent & Lundy a firm estimate?**
549 A. No, Sargent & Lundy was contracted to develop an early conceptual estimate to
550 satisfy legislative and stakeholders' discussions. Since the estimate relied on past
551 scrubber installations for flue gas desulphuriz ation, limited Merrimack Station
552 conditions and no mercury reduction guarantees, it only could serve as an early
553 conceptual estimate.
554

555 **Q. Why were the costs associated with mercury reduction guarantees excluded**
556 **from the Sargent & Lundy conceptual estimate?**
557 A. At the time of the estimate, the state -of-the-art regarding mercury removal was
558 evolving. Consequently, the estimate contained one very significant caveat, "No
559 specific mercury guarantee was included in Sargent & Lundy's pricing since it
560 was not available at this time from suppliers."[18]
561
562 **Q. Was the estimate by URS a firm estimate?**
563 A. Yes, this estimate was based on a detailed study , which incorporated site-specific
564 needs, included mercury reduction and equipment guarantees, and contained
565 project specific AFUDC. [19] It also built upon Sargent & Lundy's conceptual
566 project cost estimate assumptions and determined that a number of enhancements
567 were needed.
568
569 **Q. Did Jacobs request, from PSNH , a detailed reconciliation between the**
570 **Sargent & Lundy conceptual and URS firm estimates?**
571 A. Yes, Jacobs requested and did receive a detailed draft reconciliation table from
572 PSNH. A condensed version of PSNH's table was reproduced and is identified as
573 EXHIBIT JCI 04 – Comparison of Cost Estimates for Clean Air Project, URS
574 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.

575

576 **Q. Was Jacobs' review able to reconcile the difference between the Sargent &**

577 **Lundy conceptual and URS firm estimates?**

578 A. EXHIBIT JCI 04 – Comparison of Cost Estimates for Clean Air Project, URS

579 versus Sargent & Lundy attempts to compare line item by line item the various

580 major item descriptions. However, the comparison is complicated by the fact that

581 a number of Sargent & Lundy line items are not broken down similar to the URS

582 cost estimate, inhibiting a direct comparison. For example, items 1 through 7, in

583 the URS estimate, are displayed as item 1 in the 2005 Sargent Lundy estimate.

584 Despite our inability to make this direct comparison, we were able to reconcile the

585 various estimates after reviewing the Item Description, the side-by-side

586 comparison, and assessing the Discussion of the Differences.

587

588 Q. **What major factors account for the difference between the 2005 and 2006**

589 **Sargent & Lundy[21] cost estimates and the 2008 URS cost estimate?**

590 A. The major factors that account for the difference between the Sargent & Lundy

591 cost estimate and the URS cost estimate can be grouped into three categories: 1.)

592 progression from the initial conceptual estimate to detailed design estimate, 2.)

593 site-specific factors, and 3.) economic and commodity volatility.

594

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

596 **estimates.**

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

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

603 • Separate ducts for MK-1 and MK-2 generating units involved almost
604 2,000 tons of steel, as compared to a single duct requiring 365 tons of
605 steel. This enhancement provided for increased operating flexibility by
606 allowing either generating unit to safely operate independent of each of
607 the other.

608 • Nearly doubled the size of the gypsum storage building to 26,600 square
609 feet from 14,000 square feet; conforming to the Town of Bow
610 requirement that all handling of the gypsum had to be indoors.

611 • A larger absorber tank was needed in order to assure sufficient mercury
612 removal, adding a substantial amount of exotic metal to the tank's
613 construction.

614 • Additional scrubber spray level was added to the scrubber in order to
615 help assure sufficient mercury removal.

616 2.) Site-specific factors – Sargent & Lundy completed their analysis based on like-
617 project experience, consequently their conceptual cost estimates needed to be
618 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 var ious equipment, and created a more difficult and expensive work environment.
- Harsh and moist winters common in the Northeast need ed 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 gal leries 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.

641 Jacobs Engineering Estimating Group estimated that during this time period,
642 prices for certain materials and commodities escalated between 45 and 60
643 percent[22].
644
645 **Q. Was Jacobs able to justify the cost differences between the various project**
646 **estimates?**
647 A. Looking at the major cost categories and the reason for their change, including
648 items such as Owners' cost, contingency, AFUDC, cost escalation, and items[23]
649 that were excluded from the original preliminary estimates, we conclude that the
650 differences between the various estimates are justifiable.
651
652 **6. <u>Project Cost Controls</u>**
653
654 **Q. Please describe PSNH's cost control process.**
655 A. Project costs are reported and controlled at various levels against the project
656 Code of Accounts.[24] A Clean Air Project resource analyst maintained the Project
657 Cost Summary and the project manager reviewed the actual costs, comparing
658 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.

659 Contract management was accomplished using change notices and change orders,
660 and processed, as outlined in Section 10.6 of the URS Project Execution Plan and
661 Attachment K of the PXP, PEP-314 Change Control.[25]
662 Change Orders must be approved by PSNH and URS management and were
663 processed in accordance with Article 6 of the Contract.
664
665 **Q. What was the dollar amount of change orders and was this unusual for a**
666 **project of this size?**
667 A. There were 777 change orders totaling $27.6M, which is 6 percent of the original
668 budget. The change order amount is within the acceptable industry range of 5 to 7
669 percent[26].
670
671 **Q. Please describe any project scope changes.**
672 A. During the course of the Clean Air Project, nine project scope changes were
673 added resulting in a net increase of $42.7M to the cost of the project [27]. Referring
674 to EXHIBIT JCI 05 - Clean Air Project Scope Changes, eight of the project scope
675 changes were increased while one was a decreased. Scope change increases
676 included a limestone truck unloader and scales, corrosion protection of the flue
677 gas desulphurization vessel, acoustic study changes, enhanced mercury and
678 arsenic system, an enhanced wastewater treatment system, a soda ash
679 softening process and the relocation of the service water pump house. The
680 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

681 were a result of either, permitting , cost saving or technical issues found after the
682 initial engineering was completed.
683
684 **Q. Can you describe each of these project scope increases in greater detail?**
685 A. **Items 1 and 2 Limestone Truck Unloading and Scales** - PSNH determined that,
686 due to physical site limitations, it was more effective to retrofit the existing
687 unloading system than to build a new one for limestone unloading. To ensure it
688 would have flexibility in the delivery of limestone and obtain co st competiveness,
689 PSNH decided to build a limestone truck unloading system. Truck scales were
690 installed at the same time to reduce third-party charges for weighing trucks.
691 **Item 3 Corrosion Protection of the Flue Gas Desulphurization Vessel** - At the
692 time of the scrubber design, the industry accepted type 2205 Stainless Steel as a
693 suitable and cost effective material to use on the absorber vessel. Near the end of
694 construction, PSNH learned from the power industries experience that type 2205
695 Stainless Steel was experiencing unexpected corrosion in similar installations and
696 contracted with Sargent & Lundy to evaluate and recommend actions to minimize
697 corrosion in the absorber vessel. Sargent & Lundy[28] recommended installation of
698 a Potential Adju stment Protection System [29] to protect against corrosion of
699 degraded weld heat affected zones and design inherent crevices. The Sargent &
700 Lundy study also identified other construction deficiencies and recommended
701 correcting them to the extent achievable to minimize the corrosion possibilities.
702 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.

703 to learn from the experience of others. Similar installations were experiencing
704 significant corrosion in less than one year. Therefore, such predictive studies
705 would have been of minimal value. The more telling aspect was the rapid
706 deterioration observed in some very similar absorber vessel units with the same
707 metallurgy as the Merrimack Station unit. In addition, the project was the stage
708 where action had to be taken as soon as possible to prevent the corrosion observed
709 at similar installations from manifesting itself at Merrimack Station.
710 Consequently, PSNH heeded the advice of the Sargent & Lundy Study.
711 The cost of the actions taken to minimize the potential corrosion was relatively
712 small for the assurance that the installation would be reliable and able to operate
713 well into the future. The New Hampshire Clean Air Project, when conceived,
714 contracted, and constructed, was envisioned to operate for many decades into the
715 future, so in Jacobs' opinion, the decision to install the Corrosion Protection
716 System was a prudent one.
717 **Item 4 Acoustic Changes** - Throughout the Clean Air Project, PSNH worked
718 with the Town of Bow to obtain the necessary permits and waivers needed for
719 construction activities. Acoustic changes were made to accommodate activities
720 during the construction and as a result from testing of equipment. In addition,
721 several scope changes were made to accommodate changes required by the Town
722 of Bow. These changes included the Gypsum Building Expansion, Booster Fan
723 Enclosure, and Service Water Pump House Relocation.
724 **Item 5 Enhanced Wastewater Treatment System** - In order to meet the
725 New Hampshire Department of Environmental Services imposed emission

726 limits on water discharge , PSNH installed an enhanced wastewater treatment
727 system for $3.5M. This system provides for polishing treatment of mercury
728 and arsenic downstream of the pri mary wastewater treatment system.
729 **Item 6 Secondary Wastewater Treatment System** - This system is designed
730 to receive the effluent from the enhanced wastewater treatment system and to
731 reduce it further. Phase 1 of the secondary wastewater treatment system reduces
732 the volume of water to 0 -5 gpm through concentration and crystallization and the
733 effluent can be recycled into the process. In Phase 2, which involves an
734 additional crystallizer step and dewa tering, the liquid effluent is reduced to zero,
735 resulting in no liquids being discharged into the river. The output of th e
736 secondary wastewater system also reduces the solid effluent to an amount that can
737 be disposed of in a licensed landfill.
738 **Item 7 Sod a Ash Softening Process** - Due to the hardness of the water, the
739 Soda Softening Process was r equired to minimize metal plating during the
740 evaporation process, enabling a proper functioning secondary wastewater
741 treatment system.
742 **Item 8 Service Water Pump Hou se Relocation** - Relocation to the north
743 bank of the station's treatment pond allowed for the use of recycled water in
744 the scrubber, avoided potential permitting delays, minimized impact on the
745 project's electrical substation construction and improved operational access.
746
747 **Q. Can you describe the project scope decrease in greater detail?**

748 A. **Item 1 New Rail Unloading Facility for Limestone** - The New Rail Unloading
749 Facility for Limestone was included in the URS estimate, but eventually it was
750 recognized that it would be more efficient and just as effective to modify the
751 existing Railcar Unloading System.
752
753 **Q. Were there any overall project cost reductions to offset the costs associated**
754 **with the project scope changes?**
755 A. Although the $47.2M in net scope change additions increased the total project
756 cost, the project was able to remain within budget due to savings in other areas
757 achieved during the course of the project. Savings resulted from lower than
758 anticipated subcontractor bids, lower commodity costs due to the changing
759 economic cycle, and higher productivity.
760
761 **Q. Why did PSNH feel that the single largest change in scope item, the**
762 **secondary wastewater treatment system, was needed?**
763 A. Based on the Environmental Protection Agency's position, that discharge from
764 the secondary wastewater treatment system could only be accommodated by
765 adding it to the plant's National Pollutant Discharge Elimination System (aka
766 NPDES) permit, and the NPDES Permit Process has been in revision for 14 years,
767 PSNH felt that approval[30] would be an extremely long process, possibly taking
768 many years. A delay of this magnitude could also delay the start-up of the
769 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.

770 Consequently, to avoid further potential litigation and possibly years of delay in
771 placing the unit into operation, PSNH elected to install the secondary wastewater
772 treatment system. As previously mentioned , the output of this secondary system
773 reduces the liquids effluent to zero, resulting in nothing being discharged into the
774 river and reduces the solid effluent to a minimum that can be disposed of in
775 existing licensed landfills.
776 The original construction plans had the treated water from the wastewater
777 treatment system discharging into the river. PSNH had to reconfigure the system
778 due to permit and litigation issues during the early part of the system construction.
779 This redesign eliminated the need for the discharge portion to the river. All
780 discharge from the original engineering designs now enters the secondary system.
781 The wastewater treatment system , that now includes the primary and secondary
782 wastewater treatment , works together to have true zero liquid discharge in
783 conjunction with the wet scrubber.[31]
784
785 **Q. What are the benefits associated with the installed wastewater system?**
786 A. While the installation of the secondary wastewater system represents a significant
787 cost of $36.4M[32], it is in line with costs for similar installations that have been
788 and are being installed on other power plant flue gas desulphurization systems.
789 By choosing to add the secondary treatment system, PSNH sought to avoid
790 potential litigation delays that pr obably would have accompanied a public
791 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.

792 Merrimack Station output unusable. The new enhanced wastewater treatment
793 system and secondary wastewater systems are providing immediate benefits of
794 eliminating the discharge of metals, especially mercury and arsenic, into the
795 Merrimack river.
796 This is a path being taken by a number of utilities in the U.S. to avoid potentially
797 costly delays. These systems provide the ultimate cleanup of the scrubber
798 effluent and in zero heavy metals being discharged into the country's waterways.
799 Based on PSNH's corporate environmental and legal opinions, and faced with the
800 real possibility of not b eing able to place the Scrubber Project into service at
801 completion, PSNH chose to add the secondary treatment system. Based on the
802 operational intentions for the Merrimack Station that existed when the decision
803 was made to add this last system to ensure o n-time start-up, PSNH felt that is was
804 a prudent decision. The secondary wastewater system was the only method
805 available to avoid an effluent discharge and therefore , without it, likely to further
806 delay the long sought after NPDES permit. Consequently , PSHN decided to
807 proceed with the installation of this system. Considering the cost of the secondary
808 wastewater system, which is in line with similar installation s, and the fact that this
809 system would allow the Merrimack Station to meet the L egislative man date for
810 mercury removal, it is Jacobs' opinion that the decision to install the secondary
811 wastewater system was a prudent one.
812
813 **7. <u>Performance</u>**
814

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

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

824

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

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

833

834 **Q. Was the system installed economically?**

835 A. During our October 2010 Due Diligence Review, it was stated that the project
836 estimate wa s revised from $457M to $430M. The reduction was due to higher
837 productivity than estimated in subcontractor bids , lower than anticipated
838 commodity costs, and favorable weather conditions during the major construction

839 period in 2008 through 2010. Several contract additions were made to cover

840 secondary water treatment, cathodic protection, and enhanced treatment for the

841 primary water treatment without changing the final estimate of $430M.[33] In

842 October 2011, PSNH further reduced reserves by $8M and revised the project

843 estimate to $422M. As of January 31, 2013, the final estimate for the project was

844 $421M. This final estimate included all additional systems, work, and studies

845 identified after the project started.

846

847 **Q. Does this conclude your testimony?**

848 A. Yes.

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